Multifunctional Chiral Silanol Ligands for Enantioselective Catalysis

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I. General Information

Abbreviations. The following abbreviations are used throughout: trimethylsilyl (TMS), phenyltrimethylsilane (PhTMS), Sodium tetrakis[3,5-bis(trifluoromethyl)phenyl] borate ($NaBAr^F$), silver hexafluoroantimonate(V) ($AgSbF_6$), ethyl acetate (EtOAc), isopropanol (IPA), tetrahydrofuran (THF), toluene (PhMe), dichloromethane (DCM), enantiomeric ratio (er), enantiomeric excess (ee), chlorobenzene (PhCl), triethylamine (Et_3N), tetramethylethylenediamine (TMEDA), molecular sieves (MS), thionyl chloride ($SOCl_2$), Palladium on carbon (Pd/C)

Synthesis, Purification, and Analysis. Dry DCM, THF, Et_2O and PhMe were dispensed from a solvent purification system that passes solvent through two columns of dry neutral alumina prior to use. All other reagents, unless otherwise noted, were purchased from commercial sources.

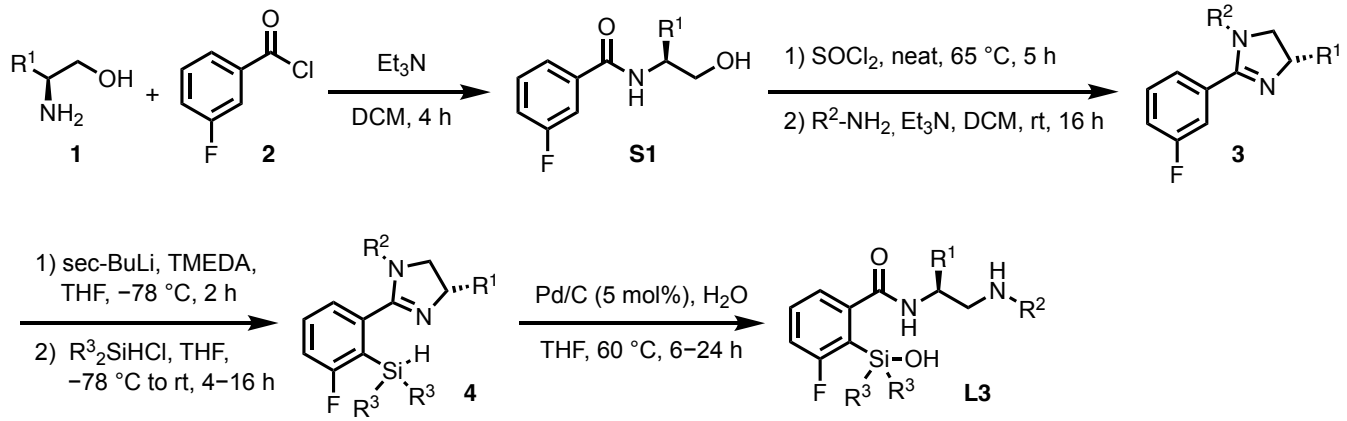
Chlorosilanes were purchased from Gelest; CuCl, aniline, 3-fluorobenzoyl chloride, 3Å spherical molecular sieves, *sec*-BuLi (1.4 M in cyclohexane), chloroform were purchased from Sigma-Aldrich; $NaBAr^F$ was purchased from AA Blocks LLC; Pd/C (10 wt%, dry support) used for general ligand synthesis was purchased from Sigma-Aldrich (unless otherwise indicated in section IV); L-tert-leucinol was purchased from Ambeed; L-valinol was purchased from Chem-Impex International, Inc.; Diazoester **5** known compounds were synthesized based on previously published literature. ^{1}H NMR data was consistent with literature results.

All reactions were performed in flame-dried and argon-purged glassware (including 8 mL KIMAX Borosilicate glass vials fitted with rubber septa). Spherical 3Å molecular sieves were activated by flame-drying, then cooled under vacuum (<1 torr). Reactions were analyzed by thin layer chromatography (TLC) on EMD glass plates that were pre-coated with silica gel 60 F254. The reactions were purified by column chromatography using Acros silica gel 60 Å (0.035-0.070 mm).

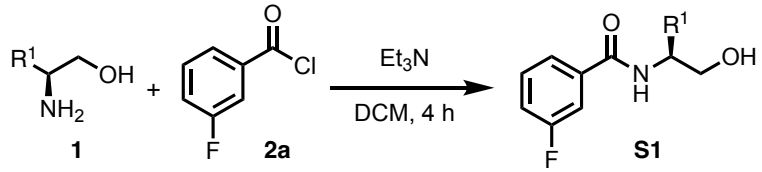
All nuclear magnetic resonance (NMR) spectra were recorded at ambient temperature at 800, 600, 400, and/or 300 MHz. Spectra obtained on 800 MHz Bruker Avance III equipped with Bruker CPTCI Cryoprobe (800 MHz for ^{1}H; 200 MHz for ^{13}C), 600 MHz Bruker Avance III equipped with Bruker CPTCI Cryoprobe (600 MHz for ^{1}H; 151 MHz for ^{13}C), Bruker Avance IIIHD Nanobay Spectrometer (400 MHz for ^{1}H; 101 MHz for ^{13}C; 376 MHz for ^{19}F; 79 MHz for ^{29}Si), 300 MHz Bruker Avance-NEO Spectrometer (300 MHz for ^{1}H; 76 MHz for ^{13}C; 283 MHz for ^{19}F), and/or Varian VNMRS (600 MHz for ^{1}H; 151 MHz for ^{13}C). The ^{1}H spectral data are reported as follows: chemicals shifts were reported in parts per million downfield from tetramethylsilane internal standard on the δ scale, multiplicity (s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet; dd, doublet of doublets, ddd, doublet of doublet of doublet, dddd, doublet of doublet of doublet of doublets and br, broadened), coupling constant (Hz), and integration. Apparent signals are indicated with app. and are used when signals with multiple couplings appear to form a certain peak type. Carbon NMR chemical shifts are reported in ppm from tetramethylsilane (TMS at 0.0 ppm) with the solvent reference employed as the internal standard (deuterochloroform ($CDCl_3$) at 77.16 ppm or deuterobenzene (C_6D_6) at 128.06 ppm). 19F NMR chemical shifts were reported relative to external reference of trifluorotoluene in CDCl3 at −62.86 ppm. Infrared data were collected using a Thermo Fisher Scientific Nicolet™ iS10 FT-IR spectrometer with a Smart iTX™ accessory (diamond ATR). Data was normalized to base peak in all cases. Crystal structures were measured on a Bruker APEX-II CCD. High-resolution mass spectra (HRMS) were acquired on a Thermo Fisher Scientific Electron LTQ-Orbitrap XL Hybrid mass spectrometer on positive ESI mode. Low-resolution mass spectra (LRMS) ASAP-ACPI-MS data were acquired on a Advion Interchim Scientific expression® Compact Mass Spectrometer (CMS) with Atmospheric Solids Analysis Probe (ASAP®). TLC-MS data were acquired on a Advion Plate Express™ combined with Advion CMS. Melting points were taken on an EZ-melting apparatus and were uncorrected. High performance liquid chromatography (HPLC) data were obtained on Shimadzu LC-20AB system with CHIRALPAK® AD-H column (4.6 x 250 mm, 5 µm), CHIRALPAK® OD-H column (4.6 x 250 mm, 5 µm) or CHIRALPAK® AS column (4.6 x 250 mm, 5 µm) and Shimadzu SPD-M20A photodiode array detector. Each HPLC sample was eluted at a constant flow rate with isocratic hexanes/isopropanol system and 40 or 30 °C column oven temperature.

II. General Procedure

IIA. Procedure for Standard Silanol Ligand Syntheses

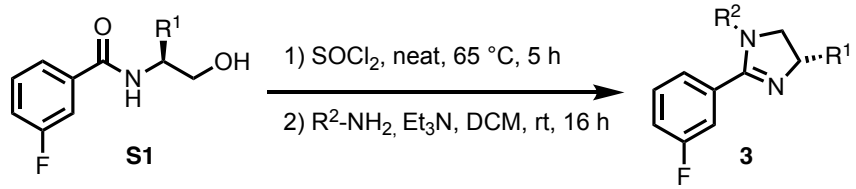


Procedure A: Synthesis of β-hydroxy amides



Amino alcohol (1.05 equiv) was added directly into a flame-dried round-bottom flask, dissolved in DCM (0.3 M) and purged with argon. Dry triethylamine was added (1.50 equiv) followed by the dropwise addition of 3-fluorobenzoyl chloride (1.00 equiv). The reaction was exothermic and the evolution of HCl gas could be observed. After 4 h of stirring the reaction was quenched with saturated aq. 1M NaOH (30 mL). The aqueous phase was extracted with DCM (3 × 20 mL). The combined organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The product was dried under high vacuum for over 6 h to fully remove triethylamine. The product was carried on without further purification.

Procedure B: Synthesis of imidazolines



The experimental procedure was adapted from a previous literature report.[1] Amide (1.0 equiv) was added by difference (directly from reagent bottle or flask to reaction vial) into a flame-dried microwave vial, followed by the addition of thionyl chloride (4.0 equiv). (Caution: HCl and SO_2 gas evolves as the reaction proceeds) The vial was capped with a septum and a balloon to collect the evolved gas. The solution was stirred for 4−5 h at 65 °C. The resulting yellow crude oil was transferred to a separate flame-dried 24/40 single neck round bottom flask.[2] Excess thionyl chloride was removed by rotary evaporation with the water-bath temperature set to 40 °C.[3] The resulting crude dichloride was dissolved in 30 mL of dry DCM (30 mL). To this solution, dry triethylamine (3.0 equiv) was added, followed by the addition of R^2–NH_2 (1.2 equiv). The

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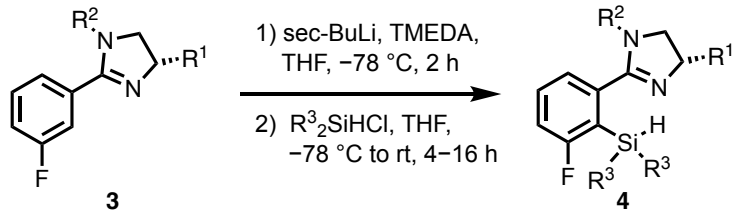
[1] (a) Menges, F.; Neuburger, M.; Pfaltz, A. *Org. Lett.* **2002**, *4*, 4713–4716. (b) Boland, N. A.; Casey, M.; Hynes, S. J.; Matthews, J. W.; Smyth, M. P. *J. Org. Chem.* **2002**, *67*, 3919–3922.

[2] A 24/40 neck round-bottom flask is used to increase the efficiency of $SOCl_2$ removal via rotary evaporation.

[3] Residual $SOCl_2$ must be removed to avoid reacting with Et_3N in the next step, which causes the reaction mixture to turn a dark brown color; leading to lower yields.

resulting orange reaction mixture was stirred at room temperature for 16 h. Afterwards, the solution was stirred with 20 mL of aq. 2.5 M NaOH for 10 min to remove excess aniline. The aqueous phase was then extracted with DCM (2 × 20 mL). The combined organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The resulting reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:3 *v*/*v*/*v*).

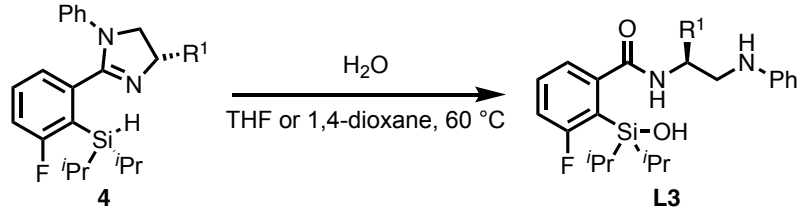
Procedure C: Synthesis of imidazoline silanes (4)



Imidazoline (1.0 equiv) was added directly into a flame-dried round-bottom flask, dissolved in THF (0.15 M), and the mixture was purged under argon for 5 min. The reaction was cooled to –78 °C and tetramethylethylenediamine (TMEDA) (2.0 equiv, unless otherwise indicated) was added followed by the dropwise addition of *sec*-butyl lithium (1.4 M in cyclohexane, 2.0 equiv, unless otherwise indicated). The reaction was stirred at –78 °C for 2 h and then chlorosilane (2.1 equiv, unless otherwise indicated) was added. The reaction was stirred for an additional 6−16 h while gradually reaching room temperature. The solution was quenched with saturated aq. $NaHCO_3$ (10 mL) and the aqueous phase was extracted with diethyl ether (3 × 5 mL). The combined organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:3 *v*/*v*/*v*) to yield the corresponding silane (**4**).

Procedure D: Synthesis of aminoamide-silanols (L3)

Method A: Metal-free hydrolysis

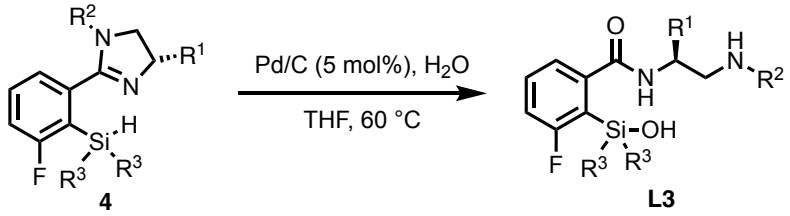


See further discussion in Section III in the supporting information

To a flask, silane (1.0 equiv) was dissolved in THF or 1,4-dioxane[4] (0.15 M, unless otherwise indicated). Then, deionized water (10 equiv) was added. The reaction was capped and stirred at 60 °C (unless otherwise indicated). The reaction was monitored using TLC and/or ^{19}F NMR spectroscopy for the consumption of starting material silane. TLC conditions: hexanes/EtOAc/Et_3N, 7:1:0.15 v/v/v. Once the silane was fully consumed, the reaction was diluted with Et_2O, dried over $MgSO_4$, filtered, and concentrated in vacuo. The reaction mixture was purified using flash chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:1.5 v/v/v) to yield silanol.

[4] We obtained consistent results with both THF and 1,4-dioxane. However, for longer reaction times, 1,4-dioxane is preferred to prevent solvent evaporation.

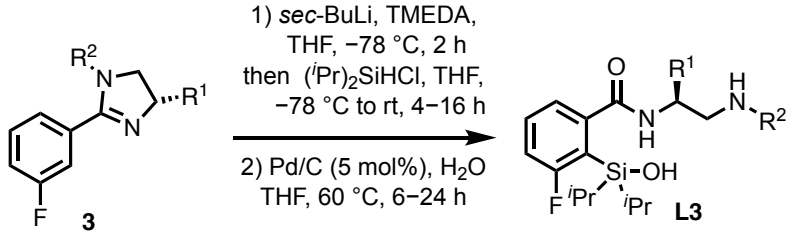
Method B: Pd-catalyzed hydrolysis



To a flask, silane and imidazoline mixture (1.0 equiv) was dissolved in THF (0.15 M, unless otherwise indicated). Pd/C (10 wt% Pd on C, 0.05 equiv) was added followed by the addition of deionized water (10 equiv). (Caution: H_2 gas evolves as the reaction proceeds) The reaction was capped with a septum equipped with a needle and was stirred at 60 °C (unless otherwise indicated). The reaction was monitored using TLC and/or ^{19}F NMR spectroscopy for the consumption of starting material silane. TLC conditions: hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*. Once silane was fully consumed, the reaction was diluted with Et_2O, and filtered through a pad of Celite to remove Pd/C. The filtrate was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The reaction mixture was purified using flash chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:1.5 *v*/*v*/*v*) to yield silanol.

Procedure E: Synthesis of silanol when there is an inseparable mixture for the silane

In this case of specific silanes (R^1 = iPr, R^2 = 4-CF_3Ph, 4-OMePh, and cyclohexyl), the silane compound and unreacted imidazoline are closely overlapping so that they cannot be separated using silica gel flash column chromatography, and the silanes are carried forward to the hydrolysis step where the silanol products are separated.

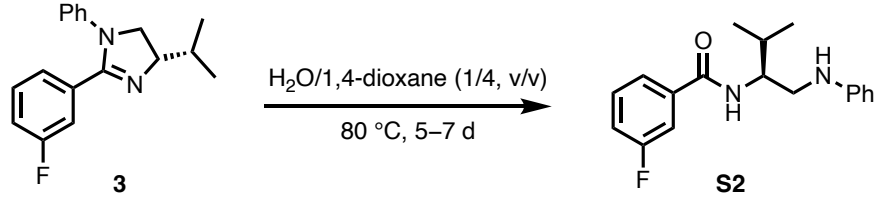


Step 1: imidazoline (**3**, 1.0 equiv) was dissolved in THF (0.15 M) and the mixture was purged under argon for 5 min. The reaction was cooled to –78 °C and tetramethylethylenediamine (TMEDA) (1.2 equiv, unless otherwise indicated) was added followed by the dropwise addition of *sec*-butyl lithium (1.4 M in cyclohexane, 1.2 equiv, unless otherwise indicated). The reaction was stirred at –78 °C for 2 h (unless otherwise indicated) and then chlorosilane (1.3 equiv, unless otherwise indicated) was added. The reaction was allowed to slowly warm to room temperature and then stirred for an additional 16−24 h at which time it was quenched with saturated aq. $NaHCO_3$ (10 mL). The aqueous phase was extracted with diethyl ether (3 × 5 mL) and dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The reaction mixture was filtered through a silica plug (DCM/MeOH, 10:1 *v*/*v*) to yield a mixture of unreacted imidazoline and the corresponding silane, which is carried on directly to the next step without further purification. Confirmation of the silane product was achieved through distinctive peaks in ^1H NMR and ^{19}F NMR spectroscopy.

Step 2: To a flask, the silane and imidazoline mixture (1.0 equiv, calculated based off the silane) was dissolved in THF (0.15 M, unless otherwise indicated). Pd/C (10 wt% Pd on C, 0.05 equiv) was added followed by the drop-wise addition of deionized water (10 equiv). (Caution: H_2 gas evolves as the reaction proceeds) The reaction was capped with a septum equipped with a needle, and was stirred at 60 °C. The reaction was monitored using TLC and/or ^{19}F NMR spectroscopy for the consumption of silane starting material. TLC conditions: hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*. Once the silane was fully consumed, the

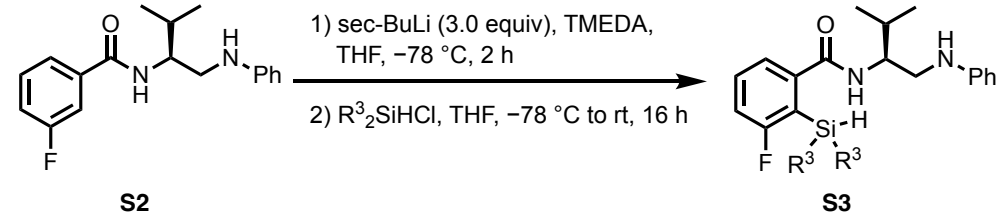
reaction was diluted with Et_2O and filtered through a pad of Celite to remove Pd/C. The filtrate was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The reaction mixture was purified using flash chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:1.5 *v*/*v*/*v*) to yield the silanol.

Procedure F: Synthesis of aminoamide from imidazoline



To a flask, the imidazoline starting material was dissolved in 1,4-dioxane/H_2O (0.4 M, 4:1 *v*/*v*) and the reaction mixture was warmed up to 80 ˚C. Typically, the reaction required approximately 5−7 days for complete consumption of the starting material when performed in the absence of Pd/C and without a silane/silanol. The progress of the reaction was monitored by TLC to track the consumption of the imidazoline starting material. TLC conditions: hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*. Once the imidazoline was fully consumed, the reaction mixture was diluted with Et_2O and extracted with brine. The combine organic layer was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:40:3 *v*/*v*/*v*) to yield the corresponding aminoamide.

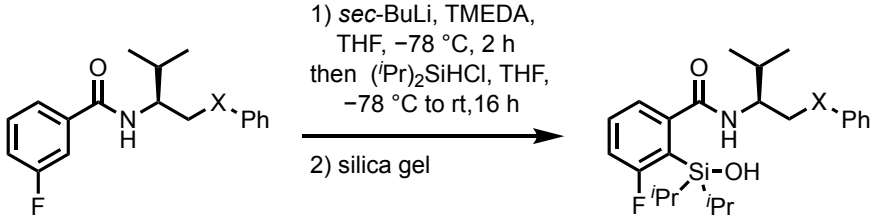
Procedure G: Synthesis of aminoamide silane from aminoamide



Aminoamide (1.0 equiv) was dissolved in THF (0.15 M) and the mixture was purged under argon for 5 min. The reaction was cooled to –78 °C and tetramethylethylenediamine (TMEDA) (3.0 equiv, unless otherwise indicated) was added followed by the dropwise addition of *sec*-butyl lithium (1.4 M in cyclohexane, 3.0 equiv, unless otherwise indicated). The reaction was stirred at –78 °C for 2 h and then chlorosilane (3.1 equiv, unless otherwise indicated) was added. The reaction was stirred for an additional 6−16 h while gradually reaching room temperature. The solution was quenched with saturated aq. $NaHCO_3$ (10 mL) and the aqueous phase was extracted with diethyl ether (3 × 5 mL). The combined organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:3 *v*/*v*/*v*) to yield the corresponding silane.

Procedure H: Synthesis of aminoamide silanol through unstable silane (for the silanes that reacted with silica gel)

In this case of specific silanes (X = N-CH_3, O), the silane compounds reacted with silica gel (SiO_2) and converted into the corresponding silanols.

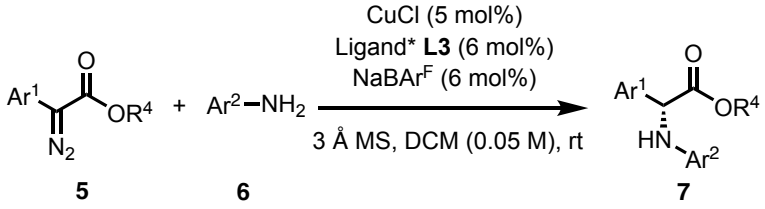


X = N-CH_3, **S4**
X = O, **S5**

X = N-CH_3, **L6**
X = O, **L7**

Aminoamide (1.0 equiv) was dissolved in THF (0.15 M) and the mixture was purged under argon for 5 min. The reaction was cooled to –78 °C and tetramethylethylenediamine (TMEDA) (3.0 equiv, unless otherwise indicated) was added followed by the dropwise addition of *sec*-butyl lithium (1.4 M in cyclohexane, 3.0 equiv, unless otherwise indicated). The reaction was stirred at –78 °C for 2 h and then diisopropylchlorosilane (3.1 equiv, unless otherwise indicated) was added. The reaction was allowed to slowly warm to room temperature and then stirred for an additional 16−24 h at which time it was quenched with 10 mL of saturated aq. $NaHCO_3$ (unless otherwise indicated). The aqueous phase was extracted with diethyl ether (2 × 5 mL). The combined organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The silane product is unstable and found to react with silica gel and form the corresponding silanol. The crude mixture was wet loaded in $CHCl_3$ onto a silica gel flash column for purification. Note - H_2 gas evolution was observed on the silica gel surface. The silanol product was purified via the flash chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:1.5 *v*/*v*/*v*).

Procedure I: Procedure for the enantioselective N−H insertions



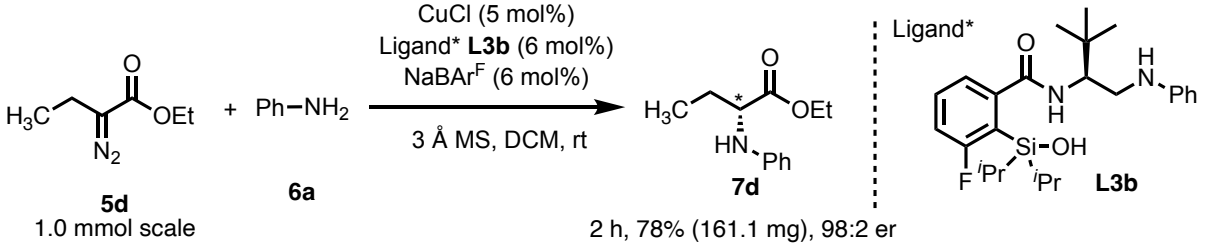
A 7 mL vial containing 50 mg of 3Å molecular sieves (MS) and a stir bar was flame-dried under high vacuum (<1 torr). After the vial cooled to room temperature, it was purged with argon. CuCl (1.0 mg, 0.010 mmol, 0.050 equiv), $NaBAr^F$ (10.6 mg, 0.012 mmol, 0.060 equiv) and the corresponding ligand (0.06 equiv, 0.012 mmol) were added by difference measurement (directly from reagent bottle or flask to the reaction vial). The vial was re-purged with argon three times and capped with a septum and an Ar-balloon. Anhydrous DCM (2.0 mL) was then added, the resulting mixture was stirred (~270 rpm to avoid molecular sieves being pulverized) for 2 h at room temperature. In a separate 7 mL vial, 50 mg of 3Å molecular sieves was added and flame-dried under high vacuum (<1 torr). After the vial cooled to room temperature, it was purged with argon and capped with a septum and an Ar-balloon. The corresponding diazoester (1.0 equiv, 0.2 mmol), amine (1.0 equiv, 0.2 mmol) and anhydrous DCM (2.0 mL) were added into the vial. This solution was drawn into a 3-mL syringe with long needle and added dropwise into the stirring solution over 2 min. The appearance of N_2 gas bubbles during the reaction is sometimes observed, and this can be taken as an indication of good reactivity. The reaction mixture was stirred at room temperature and the reaction progress was monitored using TLC. TLC conditions: hexanes/EtOAc, 9.5:0.5 *v*/*v*. After the diazoester was fully consumed or the reaction time reached 16 h, the mixture was filtered through a silica plug (~0.5 cm of silica gel in a Pasteur pipette), washed with ~1 mL DCM, and evaporated *in vacuo*. The products were purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) to furnish pure chiral amino acid derivatives.

Procedure J: Procedure for HPLC Analysis

The silica-filtered reaction mixture was spotted onto a TLC plate (4 × 4 cm). The plate was placed in a TLC chamber to develop, and the product band was etched off the plate with a razor blade. The loose silica was washed with hexanes/isopropanol (IPA) (0.6 mL, 70:30 *v*/*v*) and filtered through glass fiber to furnish HPLC samples.

Note: *The enantiomeric ratios were not affected by using different HPLC sample preparation methods. The three different HPLC sampling methods are listed: a) etched-off from TLC plate described above; b) filtered unpurified reaction mixtures diluted with hexanes/IPA (70:30 v/v); c) purified product after flash column chromatography diluted with hexanes/IPA (70:30 v/v).*

Procedure K: Procedure for 1 mmol-scale enantioselective N−H insertions of diazoester and aniline



(0.2 mmol scale: 45 min, 88%, 98:2 er)

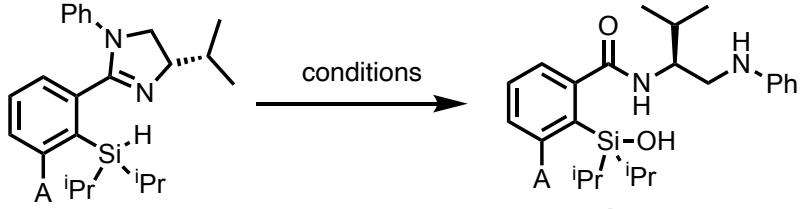
A 50 mL round bottom flask containing 250 mg of 3Å spherical molecular sieves (MS) and a stir bar was flame-dried under high vacuum (<1 torr). After the vial cooled to room temperature, it was purged with argon. CuCl (5.0 mg, 0.050 mmol, 0.05 equiv), $NaBAr^F$ (53 mg, 0.060 mmol, 0.06 equiv) and silanol-containing ligand **L3b** (26 mg, 0.060 mmol, 0.06 equiv) were added. The vial was re-purged with argon three times and capped with a septum and an Ar-balloon. Anhydrous DCM (10 mL) was then added, the resulting mixture was stirred (~360 rpm to avoid molecular sieves being pulverized) for 2 h at room temperature. In a separate 20 mL vial, 250 mg of 3Å molecular sieves was added and flame-dried under high vacuum (<1 torr). After the vial cooled to room temperature, it was purged with argon and capped with a septum and an Ar-balloon. The corresponding diazoester (**5d,**142 mg, 1.00 mmol, 1.00 equiv), aniline (**6a**, 93 mg, 1.00 mmol, 1.00 equiv) and anhydrous DCM (10 mL) were added into the vial. This solution was drawn into a 12-mL syringe with long needle and added dropwise into the stirring solution over 5 min. The reaction mixture was stirred at room temperature and the reaction progress was monitored using TLC. After diazoester was fully consumed, the mixture was filtered through a silica plug (~1 cm of silica gel in a Pasteur pipette), washed with ~3 mL DCM, and evaporated *in vacuo*. The products were purified using flash chromatography to furnish pure chiral amine (**7d**, 88%, 161 mg).

III. Discussion of Ligand Synthesis

We have discovered that the most efficient approach to synthesizing the desired aminoamide silanol **L3** proceeds through the imidazoline silane **4**. The imidazoline silane readily undergoes the ring-opening reaction converting the silane into silanol during Pd/C hydrolysis in one step. Compared to the direct synthesis of the aminoamide scaffold, which usually entails a three- to four-step synthesis process,[5] this approach is notably more efficient and modular.

For specific substrates (Table S1), it is notable that the aminoamide silanol **L3** can form (i.e. the Si-H to Si-OH conversion proceeds) without the use of any Pd catalyst. Although we acknowledge the potential presence of trace amounts of residual Pd or other metals in the chlorosilane reagent, the fact that we can successfully synthesize the ligand without the need for adding Pd remains an appealing method. These observations suggest that the hydrolysis of both the silane and imidazoline are facilitated based on the structural features, and is unlikely to be driven solely by Pd residues. The active silane might be the gateway to aminoamide silanol.

Table S1. Examples of aminoamide silanol formation without Pd



4 **L3**

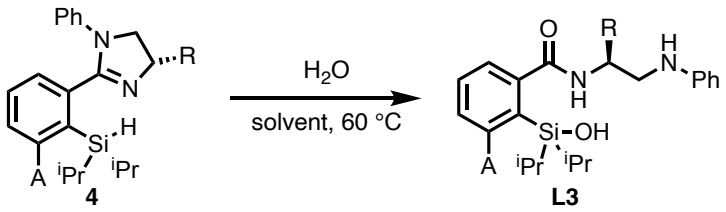
Entry	A	**4**	Conditions	Time	Conversion of **4** (%)[b]
1[a]	F	**4a**	H_2O, THF, 60 °C	16 h	>95%
2	F	**4a**	H_2O, THF, rt[c]	16 h	<5%
3[a]	H	**4e**	H_2O, THF, 60 °C	16 h	>95%
4	H	**4e**	rt[c]	3 d	20%

[a]Reactions performed under standard reaction conditions General procedure-Procedure D (Method A): silane **4** (0.1 mmol), H_2O (1 mmol), solvent (0.15 M). [b]Conversion determined using ^{19}F NMR or ^{1}H NMR spectroscopy. [c]rt = 18−24 °C

Imidazoline silanes **4** with different steric groups were investigated for the potential of the hydrolysis reaction to proceed without a Pd catalyst (Table S2). When R = *i*-Pr, the aminoamide silanol product was generated after stirring overnight at 60 °C; for a 1-gram scale reaction, a longer reaction time was required for completion (entries 1−2, Table S2). When a tert-butyl group was used as the steric group, no aminoamide silanol formed (entries 4−5, Table S2). Despite the intentional addition of HCl, the reactivity of silanol remained low (entry 6, Table S2), suggesting that trace acid does not significantly promote silanol formation.

[5] Dong, Z.-Y.; Zhao, J.-H.; Wang, P.; Yu, J.-Q. *Org. Lett.* **2022**, *24* (42), 7732–7736.

Table S2. Scope of the no-Pd hydrolysis from imidazoline silane **4** to aminoamide silanol **L3**

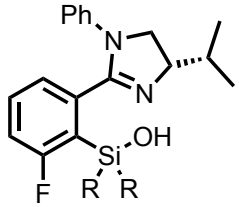


Entry[a]	A	R	**4**	Solvent[b]	Additive	Time	Conversion of **4** (%)[c]
1	F	*i*Pr	**4a**	THF	-	16 h	>95% (63%)
2[d]	F	*i*Pr	**4a**	THF	-	53 h	>95% (54%)
3	F	*i*Pr	**4a**	1,4-dioxane	-	16 h	>95%
4	F	*t*Bu	**4b**	1,4-dioxane	-	7 d	NR[e]
5	F	*t*Bu	**4b**	THF	-	3 d	NR[e]
6	F	*t*Bu	**4b**	1,4-dioxane	HCl (1 mol%)	3 d	30%
7	F	Ph	**4d**	1,4-dioxane	-	40 h	45%
8	H	*i*Pr	**4e**	THF	-	16 h	>95% (83%)
9	H	*t*Bu	**4f**	1,4-dioxane	-	7 d	23%

[a]Reactions performed under standard reaction conditions using General Procedure D (Method A): silane **4** (0.1 mmol), H_2O (1 mmol), solvent (0.15 M). [b]Consistent results with both THF and 1,4-dioxane were obtained; however, for longer reaction times, 1,4-dioxane solvent is preferred to prevent solvent evaporation. [c]Conversion determined using ^{19}F NMR or ^{1}H NMR spectroscopy; isolated yield in parentheses. [d]Reaction performed with 954 mg (2.4 mmol) of silane. [e]No reaction observed.

IV. Exploration of Synthetic Approaches for Imidazoline Silanols L2

We made multiple attempts to synthesize the imidazoline silanes or silanols through different methods for comparison, but unfortunately, we were not able to obtain the desired products as shown in Figure S1, due to conversion to the ring-opened aminoamide product. We present these unsuccessful attempts and observations in this section.



L2a, R = *i*Pr
L2b, R = CH_3

Figure S1. Imidazoline silanols that could not be successfully isolated or synthesized.

We were not able to observe or isolate the initial designed imidazoline silanol ligand **L2a** (Figure S2). Instead, aminoamide silanol **L3** was the sole silanol product formed under the Pd/C hydrolysis conditions. Although our preference was to use Pd/C hydrolysis for making silanols from silanes to obtain pure silanols that do not contain HCl,[6] we still attempted to synthesize **L2a** by quenching *in-situ* generated imidazoline silylchloride with $NaHCO_3$ (Figure S2-A). However, **L2a** could not be obtained through this method either.

[6] Tran, N. T.; Wilson, S. O.; Franz, A. K. *Org. Lett.* **2012**, *14* (1), 186–189.

Initially, no reaction was observed when the Pd/C hydrolysis was performed at room temperature. The reaction temperature was then increased to 60 °C, which led to successful hydrolysis (Figure S2-B, see the discussion in Section III). The lack of reactivity at room temperature may have been due to the inactivity of the Pd/C catalyst.[7]

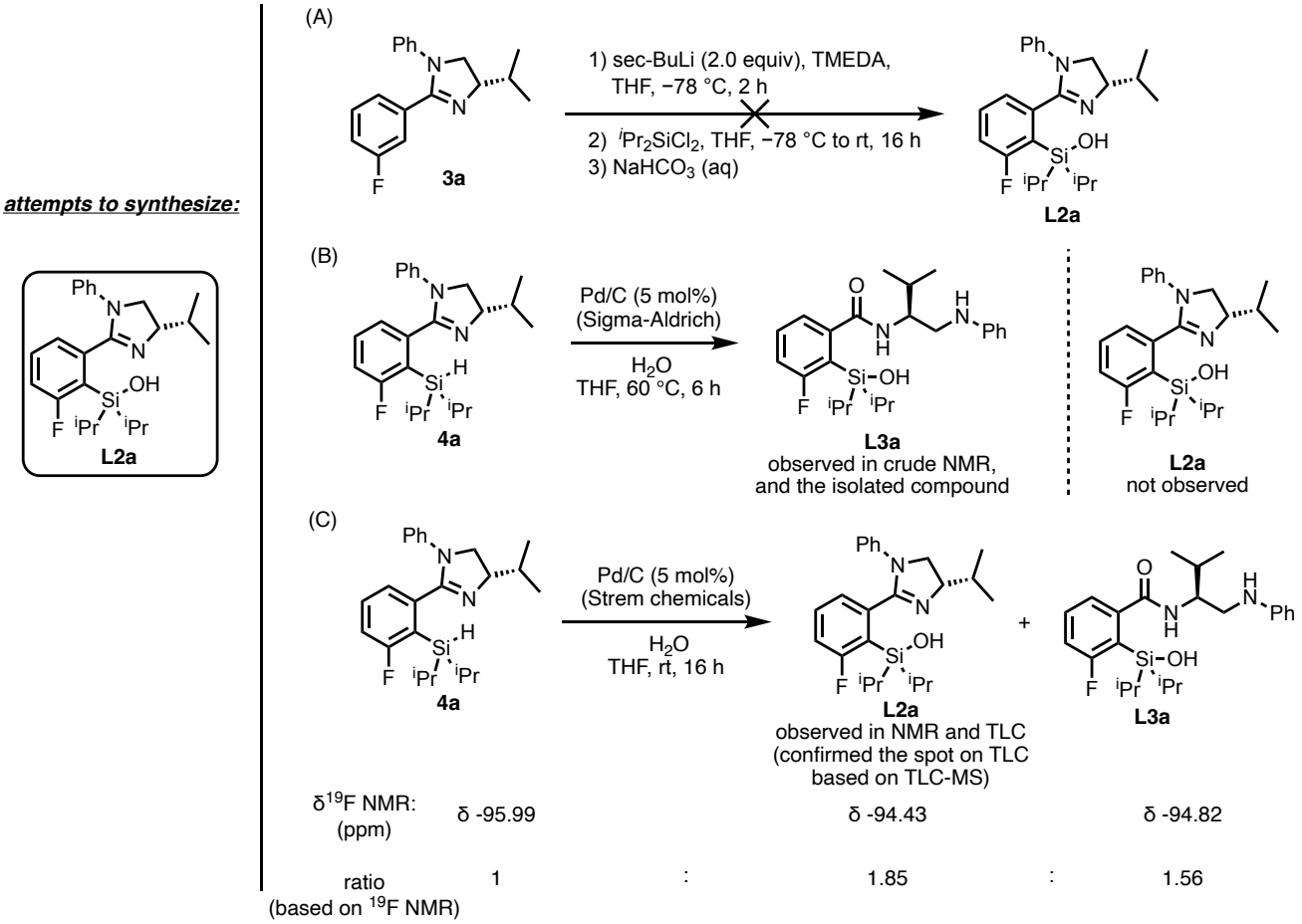


Figure S2. Efforts towards the synthesis of imidazoline silanol **L2a**.

Figure S2-C shows the results of a Pd/C hydrolysis at room temperature, which was performed using higher reactive Pd/C purchased from Strem Chemicals. Imidazoline silanol **L2** formation was initially observed after 2 h of reaction time, and the reaction was continuously monitored for an additional 4 h. The presence of imidazoline silanol on the TLC plate was confirmed based on TLC-MS (Figure S3). Although some silane remained, protodesilylation occurred, and the reaction was allowed to proceed overnight. After 16 h, ^{19}F NMR analysis was performed, which showed the formation of both imidazoline silanol and aminoamide silanol, with their respective ratios depicted in Figure S2-C. To prevent further conversion of imidazoline silanol to aminoamide silanol, standard procedures were followed to work up the reaction. This involved the addition of $MgSO_4$, filtration through celite to remove the Pd/C catalyst, and rotavapping. However, during the rotavapping at 34 °C in a water bath for ~7 min, the crude mixture changed from yellow to black. Subsequent TLC and ^{19}F NMR analyses confirmed the conversion of both imidazoline silane and imidazoline

[7] Crawford, C. J.; Qiao, Y.; Liu, Y.; Huang, D.; Yan, W.; Seeberger, P. H.; Oscarson, S.; Chen, S. *Org. Process Res. Dev.* **2021**, *25* (7), 1573–1578.

silanol to aminoamide silanol. The TLC analysis and ^{19}F NMR spectra obtained before and after workup are shown in Figure S3.

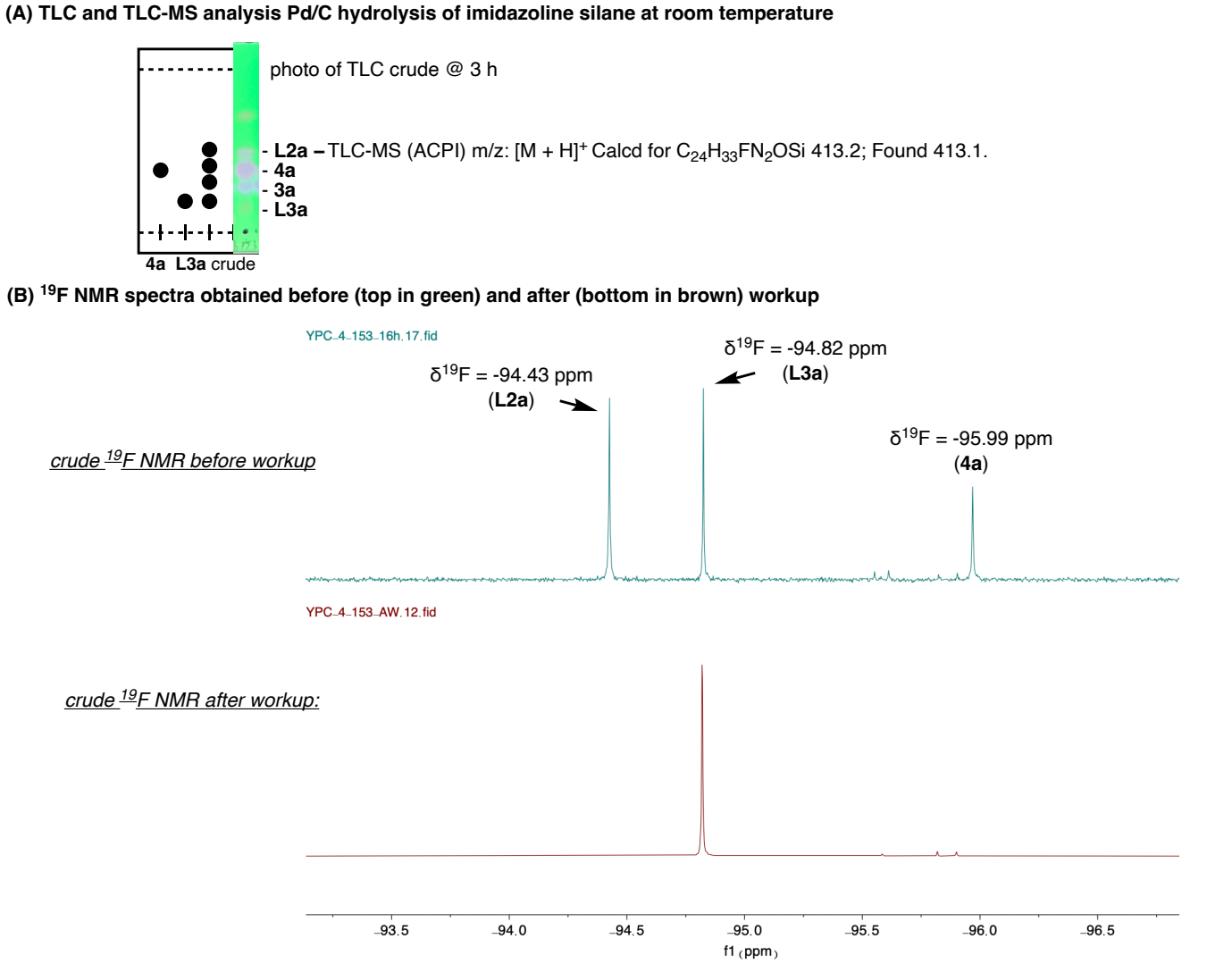


Figure S3. TLC analysis and ^{19}F NMR spectra of the hydrolysis reaction in Figure S1-C.

An imidazoline silanol with a dimethyl substituent on the silicon was observed and isolated from the Pd/C hydrolysis at room temperature (Figure S4). In crude NMR, the reaction showed 60% desilylation of the silane and 40% imidazoline silanol formation. However, during purification on a silica gel column, the aminoamide silanol was formed. Despite isolating a small quantity of imidazoline silanol **L2b** and collecting ^{1}H and ^{19}F NMR data (Figure S5, top), its instability was observed as it converted to aminoamide silanol **L3g** in $CDCl_3$ within a day (Figure S5, bottom). The spectral data obtained after a day align with the spectra of the aminoamide silanol synthesized using an alternative route (see the characterization data of **L3g**). This observation suggests that the unstable imidazoline silanol tends to undergo conversion into the aminoamide silanol under the given conditions.

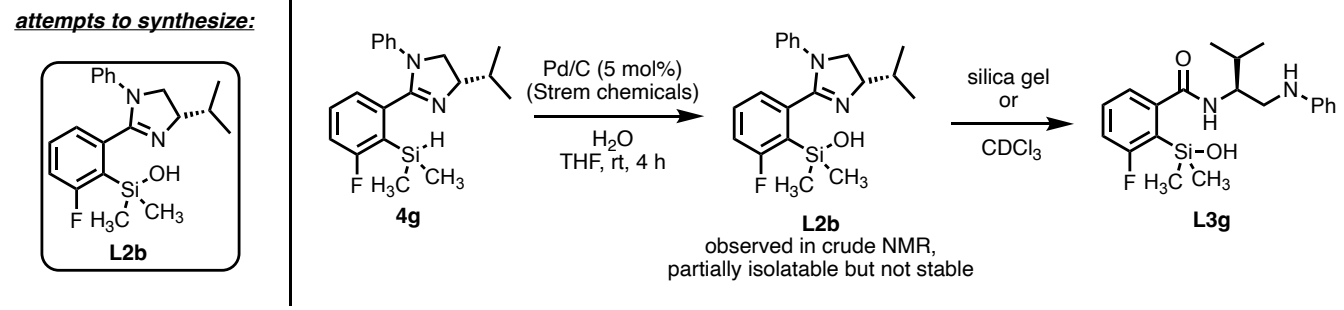
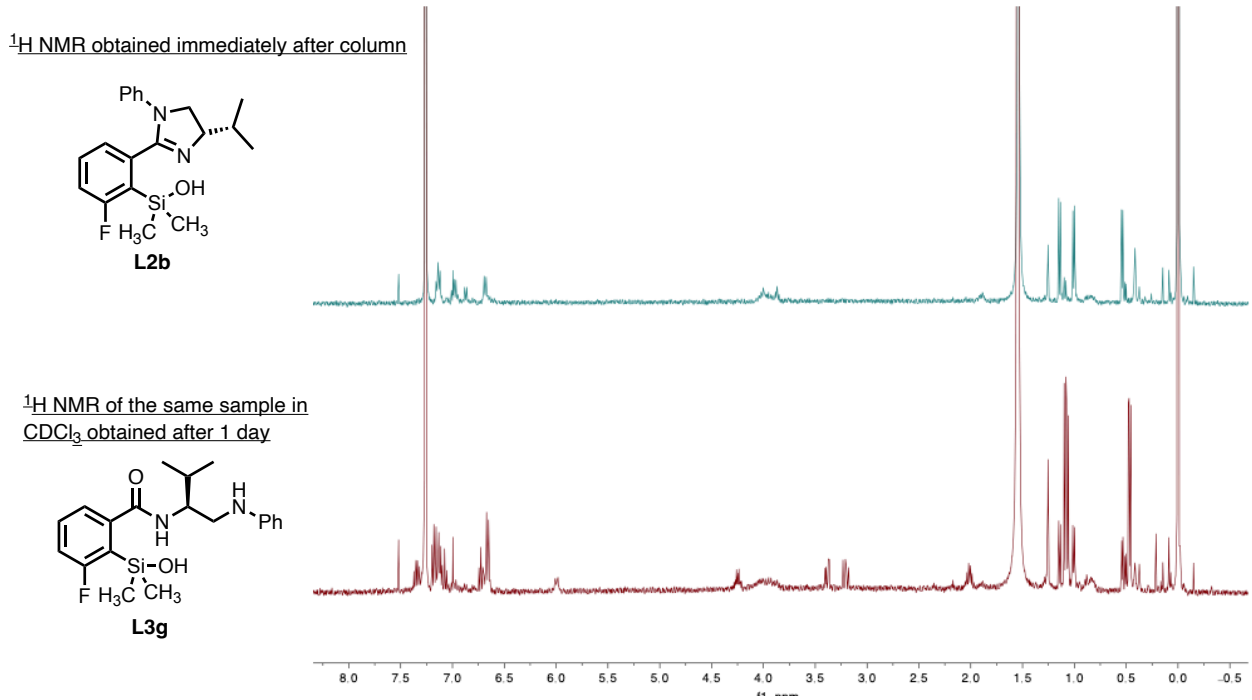


Figure S4. Efforts towards the synthesis of imidazoline silanol **L2b**.

(A) ^{1}H NMR spectra in $CDCl_3$ obtained immediately after column purification (top) and in $CDCl_3$ after 1day (bottom)



(B) ^{19}F NMR spectra in $CDCl_3$ obtained immediately after column purification (top) and in $CDCl_3$ after 1day (bottom)

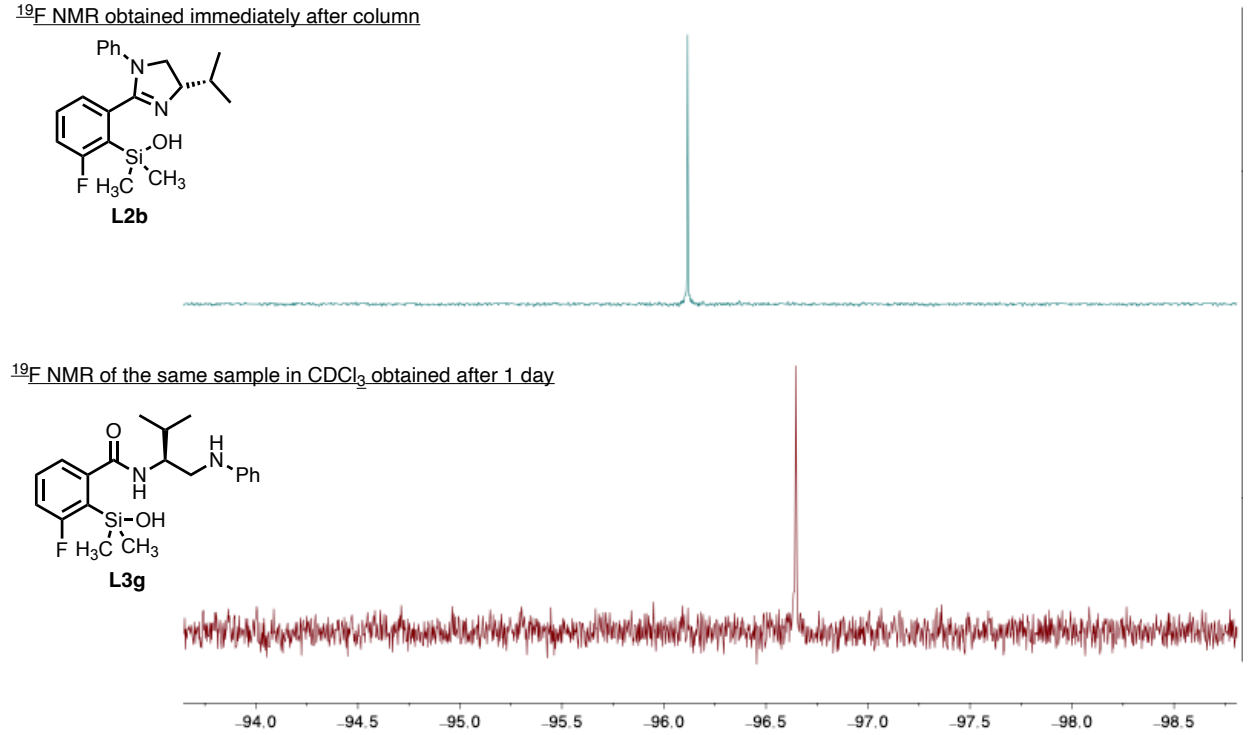
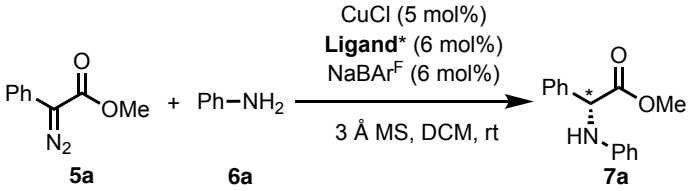


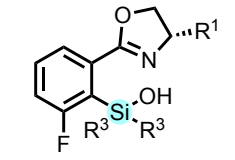
Figure S5. Comparison of (A)^{1}H NMR spectra and (B) ^{19}F NMR spectra obtained immediately after column purification and after 1 day.

V. Optimization, Ligand Validation, and Analysis

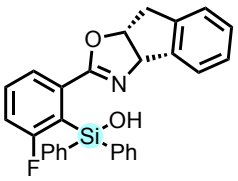
Table S3. Ligand optimization for enantioselective N−H insertion of α-phenyl-α-diazoesters with aniline.



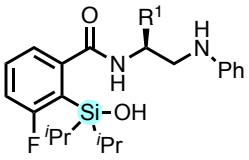
Ligand*



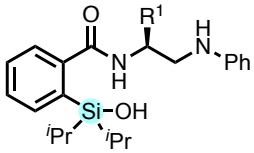
L1a: R^1 = ^{i}Pr, R^3 = Ph
L1b: R^1 = ^{t}Bu, R^3 = ^{i}Pr



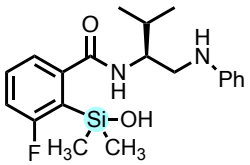
L1c



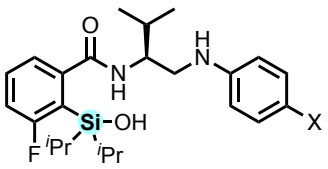
L3a: R^1 = ^{i}Pr
L3b: R^1 = ^{t}Bu
L3c: R^1 = CH_3
L3d: R^1 = Ph



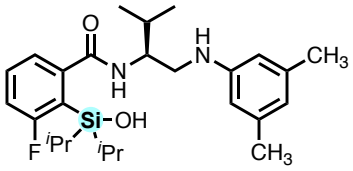
L3e: R^1 = ^{i}Pr
L3f: R^1 = ^{t}Bu



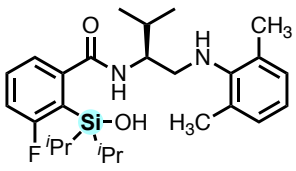
L3g



L3h, X = CF_3
L3i, X = OMe



L3j

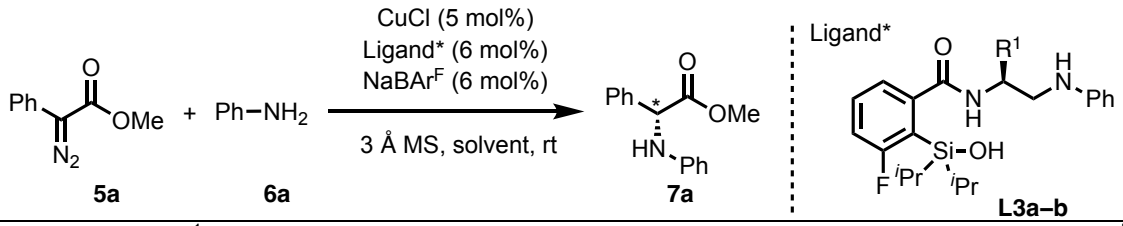


L3k

Entry[a]	Ligand	Time	Yield (%)[b]	er[c]
1	**L1a**	16 h	74	60:40 (-)
2	**L1b**	16 h	63	61:39 (-)
3	**L1c**	22 h	42	55:45 (-)
4	**L3a**	1 h	84	89:11
5	**L3b**	**1 h**	**80**	**91:9**
6	**L3c**	2 h	71	77:23
7	**L3d**	1 h	69	79:21
8	**L3e**	1 h	70	80:20
9	**L3f**	1 h	70	86:14
10	**L3g**	1 h	59	56:44
11	**L3h**	45 min	92	55:45
12	**L3i**	1.5 h	79	81:19
13	**L3j**	1 h	65	85:15
14	**L3k**	16 h	31	50:50
15	**No L**	1 h	73	50:50

[a]Reactions performed under standard reaction conditions (General procedure-Procedure I): Diazoester **5a** (0.2 mmol), aniline **6a** (0.2 mmol), CuCl (5 mol%), $NaBAr^F$ (6 mol%), ligand (6 mol%), and activated spherical 3 Å mol sieves (50 mg) at room temperature. [b]NMR yield using phenyltrimethylsilane (Ph−TMS) as internal standard; isolated yield in parentheses. [c]Determined using CSP-HPLC with a Chiralpak OD-H column. [d]**L1a−c** produced the opposite enantiomer.

Table S4. Optimization of the Enantioselective N−H Insertions.

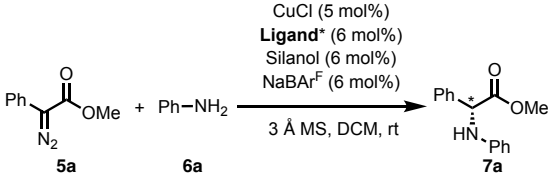


5a **6a** **7a** **L3a–b**

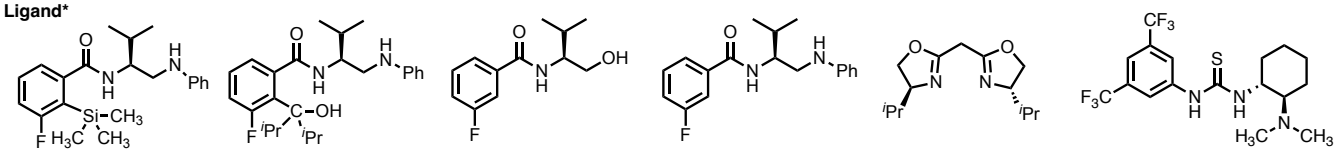
Entry[a]	Catalyst	R^1	Counter-anion	Solvent	Conc. (M)	Temp.	Time (h)	Yield (%)[b]	er[c]
1	CuCl	^{i}Pr	$NaBAr^F$	DCM	0.1	rt	1	84	87:13
2	-	^{i}Pr	$NaBAr^F$	DCM	0.1	rt	16	<5	nd[h]
3	CuCl	^{i}Pr	--	DCM	0.1	rt	1	72	51:49
4	CuCl	^{i}Pr	$AgSbF_6$	DCM	0.1	rt	1	85	56:44
5[d]	CuCl	^{i}Pr	$NaBAr^F$	DCM	0.1	rt	1	77 (76)	80:20
6[e]	CuCl	^{i}Pr	$NaBAr^F$	DCM	0.1	rt	0.5	80	87:13
7	[Cu(OTf)•½C_6H_6]	^{i}Pr	$NaBAr^F$	DCM	0.1	rt	1	77	84:16
8	CuBr	^{i}Pr	$NaBAr^F$	DCM	0.1	rt	1	71	83:17
9	$Cu(OTf)_2$	^{i}Pr	$NaBAr^F$	DCM	0.1	rt	16	89	55:45
10	$Cu(OAc)_2$	^{i}Pr	$NaBAr^F$	DCM	0.1	rt	1	84	64:36
11	$CuCl_2$	^{i}Pr	$NaBAr^F$	DCM	0.1	rt	1	80	83:17
12	$CuBr_2$	^{i}Pr	$NaBAr^F$	DCM	0.1	rt	1	72	84:16
13	CuCl	^{i}Pr	$NaBAr^F$	PhMe	0.1	rt	1	66	78:22
14	CuCl	^{i}Pr	$NaBAr^F$	benzene	0.1	rt	16	44	78:22
15	CuCl	^{i}Pr	$NaBAr^F$	PhCl	0.1	rt	1	74	79:21
16	CuCl	^{i}Pr	$NaBAr^F$	THF	0.1	rt	16	37	50:50
17	CuCl	^{i}Pr	$NaBAr^F$	$CHCl_3$	0.1	rt	1	66	66:34
18	CuCl	^{i}Pr	$NaBAr^F$	DCE	0.1	rt	1	49	85:15
19	CuCl	^{i}Pr	$NaBAr^F$	DCM	0.1	0 °C	6	37	78:22
20	CuCl	^{i}Pr	$NaBAr^F$	DCM	0.1	−78 °C	24	<5	64:36
21	CuCl	^{i}Pr	$NaBAr^F$	DCM	0.1	0 °C to rt	3	69	81:19
22	CuCl	^{i}Pr	$NaBAr^F$	DCM	0.1	−78 °C to rt	3	69	80:20
23	CuCl	^{i}Pr	$NaBAr^F$	DCM	0.05	rt	1	83	89:11
24	CuCl	^{i}Pr	$NaBAr^F$	DCM	0.013	rt	1	60	92:8
25[f]	CuCl	^{i}Pr	$NaBAr^F$	DCM	0.05	rt	1	79	88:12
26	CuCl	^{t}Bu	$NaBAr^F$	DCM	0.1	rt	1	80	87:13
27	CuCl	^{t}Bu	$NaBAr^F$	DCM	0.05	rt	1	80	91:9
28	CuCl	^{t}Bu	$NaBAr^F$	DCM	0.025	rt	1	75	91:9
29[g]	CuCl	^{t}Bu	$NaBAr^F$	DCM	0.05	rt	1	82	91:9

[a]Reactions performed under standard reaction conditions (General procedure-Procedure I): Diazoester **5a** (0.2 mmol), aniline **6a** (0.2 mmol), CuCl (5 mol%), $NaBAr^F$ (6 mol%), ligand (6 mol%), and activated spherical 3 Å mol sieves (50 mg) at room temperature. [b]NMR yield using Ph−TMS as internal standard; isolated yield in parentheses. [c]Determined using CSP-HPLC with a Chiralpak OD-H column. [d]Reaction was performed without 3 Å mol sieves. [e]Starting material **5a** and **6a** were added using syringe pump over a period of 30 min at room temperature. [f]CuCl and $NaBAr^F$ were precomplexed for 1 h, followed by the addition of ligand. The pre-complexation was stirred for an additional hour, and then the starting materials were added. [g]Reaction was performed with 100 mg of 3 Å mol sieves. [h]Not determined.

Table S5. Ligand Validation of Enantioselective N−H Insertion of α-Phenyl-α-diazoester **5a** with Aniline **6a**.



Ligand*

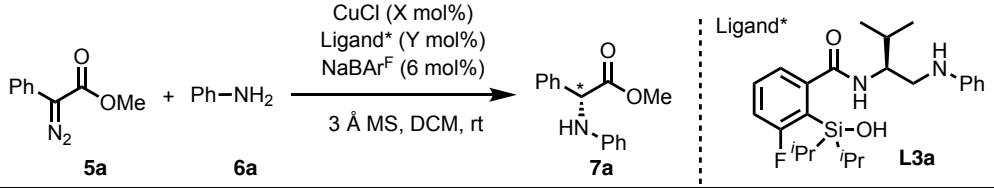


L4 L5 S1a S2 (*S*,*S*)-*i*Pr-BOX chiral thiourea

Entry[a]	Ligand	Silanol	Time (h)	Yield (%)[b]	er[c]
1	**L4**	-	1	82	50:50
2	**L5**	-	1	59	50:50
2	**S1a**	-	1	63	52:48
3	**S2**	-	1	65	51:49
4	**(*S*,*S*)-*i*Pr-BOX**[d]	-	2	38	52:48
5	**S2**	**L3a**	16	35	59:41
6	**S2**	$^{i}Pr_2PhSiOH$	0.5	80	50:50
7	**S2**	Ph_3SiOH	0.5	78	50:50
8	**chiral thiourea**	-	1	72	50:50

[a]Standard reaction conditions: **5a** and **6a** (0.2 mmol), CuCl (5 mol%), $NaBAr^F$ (6 mol%), ligand (6 mol%), silanol (6 mol%, if applicable), and spherical 3Å mol sieves (50 mg) in DCM (0.05 M) at room temperature. [b]Yield determined using ^1H NMR spectroscopy with Ph-TMS as internal standard. [c]Determined using CSP-HPLC analysis with a Chiralpak OD-H column. [d](*S*,*S*)-*i*Pr-BOX, 2,2'-methylenebis[(*4S*)-4-isopropyl-2-oxazoline].

Table S6. Results of M/L ratio experiments.

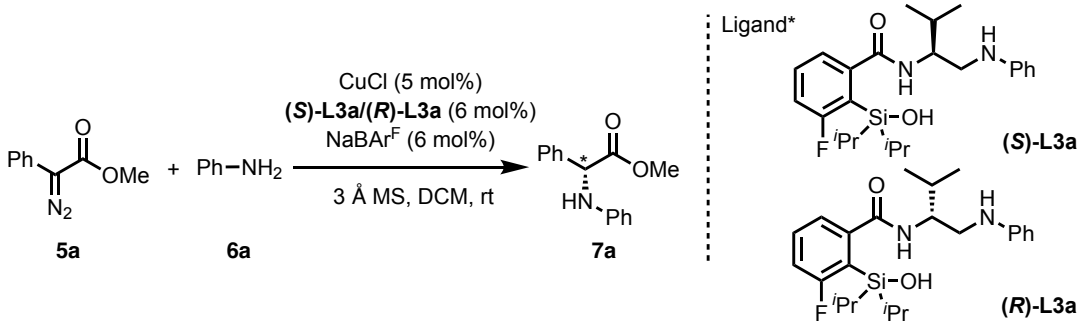


Entry[a]	**M/L**	X (mol%)	Y (mol%)	Time (h)	Yield (%)[b]	er[c]
1	**1/1.2**	5	6	1	83	89:11
2	**2/1**	5	2.5	1	70	88:12
3	**1/2**	5	10	1	90	84:16

[a]Reactions performed under standard reaction conditions (General procedure-Procedure I): Diazoester **5a** (0.2 mmol), aniline **6a** (0.2 mmol), CuCl (X mol%), $NaBAr^F$ (6 mol%), ligand **L3a** (Y mol%), and activated spherical 3 Å mol sieves (50 mg) at room temperature. [b]NMR yield using Ph-TMS as internal standard [c]Determined using CSP-HPLC with a Chiralpak OD-H column.

VI. Evaluation of Non-linear Behavior and M/L Ratio Experiments

a. Experiment procedure for evaluating nonlinear behavior



Six 7 mL scintillation vials each equipped with 50 mg 3 Å molecular sieves and a stir bar flame-dried under high vacuum (<1 torr). After the vial cooled to room temperature, the flasks were purged with argon. CuCl (0.05 equiv, 0.010 mmol, 1.0 mg), $NaBAr^F$ (0.06 equiv, 0.012 mmol, 10.6 mg) and the (*S*)-**L3a** (X mol%) and (*R*)-**L3a** (Y mol%) were added by difference (directly from reagent bottle or flask to reaction vial). The vials were re-purged with argon for three times and capped with septa and Ar-balloons. Anhydrous DCM (2.0 mL) was then added, the resulting mixture was stirred (~270 rpm to avoid molecular sieves being grounded) for 2 h at room temperature. In a separate 7 mL vial, 50 mg of 3Å molecular sieves was added and flame-dried under high vacuum (<1 torr). After the vial cooled to room temperature, it was purged with argon and capped with a septum and an Ar-balloon. The corresponding diazoester (1.0 equiv, 0.2 mmol), amine (1.0 equiv, 0.2 mmol) and anhydrous DCM (2 mL) were added into the vial. This solution was drawn into a 3-mL syringe with long needle and added dropwise into the stirring solution over 2 min. The reaction mixture was stirred at room temperature and the reaction progress was monitored using TLC. After diazoester fully consumed, the mixture was filtered through a silica plug (~0.5 cm of silica gel in a Pasteur pipette), washed with ~1mL DCM, and evaporated *in vacuo*. The enantiomeric ratio results were obtained using HPLC analysis with a chiral OD-H column.

Table S7. Evaluation of non-linear behavior in enantioselective N−H insertion

X (mol%)	Y (mol%)	ee of ligand (%)	ee of product (%)
6.0	0.0	100	78
5.5	0.5	83.3	64
5.0	1.0	66.7	56
4.5	1.5	50.0	44
4.0	2.0	33.3	27
3.5	2.5	16.7	12
3.0	3.0	0	0

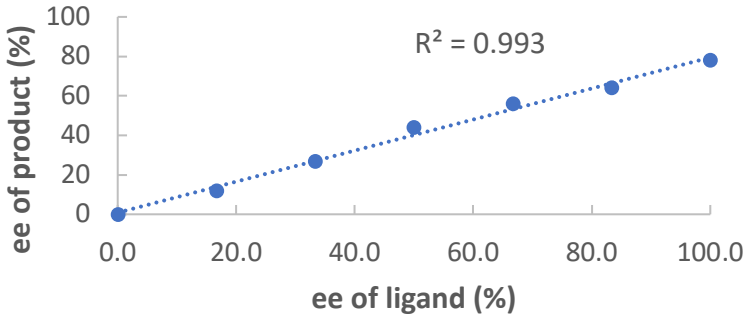
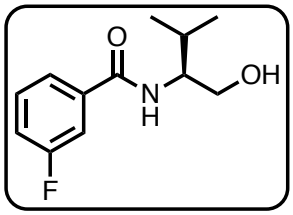


Figure S6. No nonlinear behavior observed in enantioselective N−H insertion of α-phenyl-α-diazoesters with aniline.

VII. Characterization Data

Ligand syntheses:

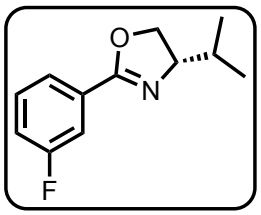
(*S*)-3-fluoro-*N*-(1-hydroxy-3-methylbutan-2-yl)benzamide (S1a)



Synthesized according to the General Procedure A using L-valinol (1.50 g, 13.0 mmol), 3-fluorobenzoyl chloride (1.50 mL, 12.3 mmol) and Et_3N (2.60 mL, 18.5 mmol). The product was purified using extraction and dried under high vacuum to give the β-hydroxy amide (**S1a**) as a white powder (2.77 g, >99%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.45 (m, 2H), 7.39 (td, *J* = 8.0, 5.5 Hz, 1H), 7.19 (td, *J* = 8.0, 2.7 Hz, 1H), 6.42 (s, 1H), 3.99 – 3.89 (m, 1H), 3.80 (d, *J* = 4.3 Hz, 2H), 2.67 (s, 1H), 2.10 – 1.93 (m, *J* = 6.9 Hz, 1H), 1.03 (d, *J* = 6.8 Hz, 3H), 1.01 (d, *J* = 6.8 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 167.1 (d, $^4J_{C,F}$ = 2.2 Hz), 162.9 (d, $^1J_{C,F}$ = 248.0 Hz), 137.0 (d, $^3J_{C,F}$ = 6.6 Hz), 130.4 (d, $^3J_{C,F}$ = 8.1 Hz), 122.5 (d, $^4J_{C,F}$ = 2.9 Hz), 118.7 (d, $^2J_{C,F}$ = 21.3 Hz), 114.5 (d, $^2J_{C,F}$ = 22.7 Hz), 63.8, 57.6, 29.4, 19.7, 19.2; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$): δ −111.71; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{12}H_{17}FNO_2$ 226.1243; Found 226.1244.

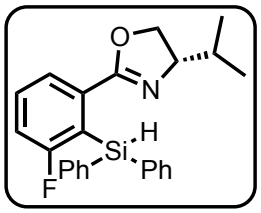
(*S*)-2-(3-fluorophenyl)-4-isopropyl-4,5-dihydrooxazole (S6a)



β-hydroxy amide (**S1a**) (1.85 g, 8.22 mmol, 1.00 equiv), *p*-toluenesulfonyl chloride (2.06 g, 10.9 mmol, 1.32 equiv) and 4-dimethylaminopyridine (0.005g, 0.04 mmol, 0.005 equiv) were dissolved in DCM (27 mL) and the flask was purged under argon for 5 min. Triethylamine (3.43 mL, 24.7 mmol, 3.00 equiv) was added dropwise and the reaction was allowed to stir for 14 h. The reaction was diluted with diethyl ether (10 mL) and quenched with saturated aq. $NaHCO_3$ (10 mL). The aqueous phase was extracted with diethyl ether (3 × 20 mL). The combined organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo.* The reaction mixture was purified by column chromatography (8:1 hexanes/EtOAc to 5:1 hexanes/EtOAc) to yield the titled product as a clear oil (1.41 g, 83 %).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.74 (ddd, *J* = 7.7, 1.3, 1.3 Hz, 1H), 7.65 (ddd, *J* = 9.6, 2.7, 1.3 Hz, 1H), 7.37 (ddd, *J* = 8.0, 7.9, 5.7 Hz, 1H), 7.16 (dddd, *J* = 8.3, 8.3, 2.7, 1.1 Hz, 1H), 4.42 (ddd, *J* = 6.5, 6.5, 2.5 Hz, 1H), 4.20 – 4.03 (m, 2H), 1.96 – 1.75 (m, 1H), 1.03 (d, *J* = 6.7 Hz, 3H), 0.93 (d, *J* = 6.7 Hz, 3H); ^{13}C{^{1}H} NMR (76 MHz, $CDCl_3$) δ 162.6 (d, *J* = 246.0 Hz), 162.4 (d, *J* = 3.0 Hz), 130.2 (d, *J* = 8.2 Hz), 130.0 (d, *J* = 8.2 Hz), 124.1 (d, *J* = 3.0 Hz), 118.2 (d, *J* = 21.3 Hz), 115.4 (d, *J* = 23.4 Hz), 72.8, 70.5, 32.9, 19.0, 18.2; ^{19}F{^{1}H} NMR (283 MHz, $CDCl_3$) δ –112.84. IR (neat) 2958, 2873, 1653, 1614, 1587, 1450, 1190, 1070, 968, 847, 793 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{12}H_{15}FNO$ 208.1137; Found 208.1126.

(*S*)-2-(2-(diphenylsilyl)-3-fluorophenyl)-4-isopropyl-4,5-dihydrooxazole (S7)

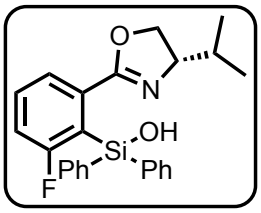


Synthesized according to the General Procedure C for silane formation using oxazoline (**S6a**) (600 mg, 2.90 mmol, 1.00 equiv), *sec*-BuLi (1.4 M in cyclohexane, 2.69 mL, 3.77 mmol, 1.20 equiv), TMEDA (0.52 mL, 3.77 mmol, 1.20 equiv) and diphenylchlorosilane (0.73 mL, 3.8 mmol, 1.3 equiv). The reaction mixture was preliminary purified via flash column chromatography (hexanes/EtOAc, 8:1 *v*/*v*) to yield the silane as a clear oil (0.802 g, 71%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 – 7.63 (m, 3H), 7.63 – 7.57 (m, 2H), 7.45 (ddd, *J* = 8.0, 7.7, 5.7 Hz, 1H), 7.41 – 7.30 (m, 6H), 7.11 (ddd, *J* = 8.5, 8.5, 1.2 Hz, 1H), 5.58 (d, *J* = 7.2 Hz, 1H), 3.95 (dd, *J* = 9.8, 8.5 Hz, 1H), 3.78 (t, *J* = 8.5 Hz, 1H), 3.63 (td, *J* = 9.8, 6.8 Hz, 1H), 1.65 – 1.55 (m, 1H), 0.90 (d, *J* = 6.7 Hz, 3H), 0.80 (d, *J* = 6.7 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 168.0 (d, *J* = 244.3 Hz), 163.7 (d, *J* = 2.9 Hz), 137.0 (d, *J* = 9.5 Hz), 135.6, 135.4, 133.7 (d, *J* = 2.2 Hz), 133.4 (d, *J* = 2.2 Hz), 132.3 (d, *J* = 9.2 Hz), 129.58, 129.47, 127.91, 127.90, 125.5 (d, *J* = 2.9 Hz), 120.9 (d, *J* = 27.5 Hz), 117.8 (d, *J* = 26.4 Hz), 73.0, 70.5, 32.8, 19.2, 18.7; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –94.15; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ –27.51 (d, *J* = 11.7 Hz). IR (neat) 3068, 2958, 2143, 1655, 1595, 1429, 1226, 1109, 804, 731, 696 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{24}H_{25}FNOSi$ 390.1689; Found 390.1673.

Note: *The silane was found to be stable at benchtop to air and atmospheric moisture for >24 months with minimal decomposition.*

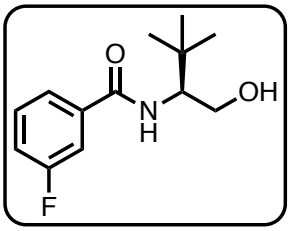
(*S*)-(2-fluoro-6-(4-isopropyl-4,5-dihydrooxazol-2-yl)phenyl)diphenylsilanol (L1a)



Synthesized according to the General Procedure D for silanol formation using oxazoline silane (**S7**) (0.50 g, 1.28 mmol, 1.00 equiv), Pd/C (10 wt%, 70 mg, 0.07 mmol) and H_2O (0.23 mL, 13 mmol) in diethyl ether (15 mL) at room temperature for 3 h and monitored using TLC for the consumption of starting material. The reaction mixture was purified by flash chromatography (5:1 hexanes/EtOAc) to yield silanol as a white solid (0.48 g, 92%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53 (s, 1H), 7.79 (dd, *J* = 7.8, 1.1 Hz, 1H), 7.63 (ddt, *J* = 13.3, 6.5, 1.7 Hz, 4H), 7.44 (ddd, *J* = 8.0, 8.0, 5.8 Hz, 1H), 7.40 – 7.30 (m, 6H), 7.07 (ddd, *J* = 9.3, 8.2, 1.2 Hz, 1H), 4.25 (dd, *J* = 9.7, 8.3 Hz, 1H), 3.96 (dd, *J* = 8.5, 8.5 Hz, 1H), 3.86 (ddd, *J* = 9.9, 8.8, 6.9 Hz, 1H), 1.70 – 1.54 (m, *J* = 6.8 Hz, 1H), 0.94 (d, *J* = 6.7 Hz, 3H), 0.83 (d, *J* = 6.7 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 167.22 (d, *J* = 242.5 Hz), 165.32 (d, *J* = 3.3 Hz), 137.11 (d, *J* = 2.9 Hz), 136.76 (d, *J* = 2.6 Hz), 134.82, 134.79 (d, *J* = 2.2 Hz), 134.72, 134.54 (d, *J* = 2.2 Hz), 131.86 (d, *J* = 9.5 Hz), 129.66 (d, *J* = 11.7 Hz), 127.66, 126.87 (d, *J* = 2.6 Hz), 124.42 (d, *J* = 28.6 Hz), 118.95 (d, *J* = 27.9 Hz), 72.48, 70.57, 32.76, 18.91, 18.72; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –89.29; ^{29}Si{^{1}H}NMR (79 MHz, $CDCl_3$) δ –17.33 (d, *J* = 11.0 Hz); IR (neat) 3447, 3068, 2960, 1641, 1593, 1427, 1250, 1113, 974, 887, 804, 698 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{24}H_{25}FNO_2Si$ 406.1638; Found 406.1625.

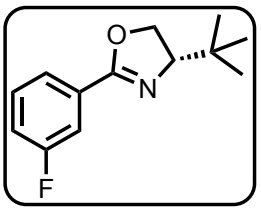
(*S*)-3-fluoro-*N*-(1-hydroxy-3,3-dimethylbutan-2-yl)benzamide (S1b)



Synthesized according to the General Procedure A using L-tert-Leucinol (1.51 g, 13.0 mmol), 3-fluorobenzoyl chloride (1.50 mL, 12.3 mmol) and Et_3N (2.60 mL, 18.5 mmol). The product was purified using extraction and dried under high vacuum to give the β-hydroxy amide as a white powder (2.95 g, >99%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 – 7.48 (m, 2H), 7.43 (ddd, *J* = 8.0, 7.8, 5.6 Hz, 1H), 7.22 (dddd, *J* = 8.3, 8.3, 2.6, 1.0 Hz, 1H), 6.27 (d, *J* = 7.9 Hz, 1H), 4.05 (ddd, *J* = 7.9, 7.2, 3.5 Hz, 1H), 3.95 (dd, *J* = 11.2, 3.5 Hz, 1H), 3.71 (dd, *J* = 11.2, 7.2 Hz, 1H), 2.23 (s, 1H), 1.04 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 167.5 (d, $^4J_{C,F}$ = 2.6 Hz), 162.9 (d, $^1J_{C,F}$ = 248.0 Hz), 137.1 (d, $^3J_{C,F}$ = 7.0 Hz), 130.5 (d, $^3J_{C,F}$ = 8.1 Hz), 122.5 (d, $^4J_{C,F}$ = 2.9 Hz), 118.7 (d, $^2J_{C,F}$ = 21.3 Hz), 114.6 (d, $^2J_{C,F}$ = 23.1 Hz), 63.2, 60.0, 34.1, 27.2; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –111.74; IR (neat): 3296, 3076, 2962, 2871, 1637, 1585, 1541, 1221, 802, 679 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{13}H_{19}FNO_2$ 240.1400; Found 240.1403; mp: 100 −102 °C.

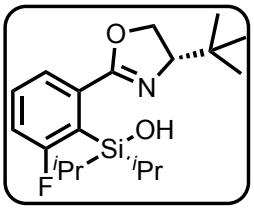
(*S*)-4-(*tert*-butyl)-2-(3-fluorophenyl)-4,5-dihydrooxazole (S6b)



β-hydroxy amide (**S1b**) (650 mg, 2.72 mmol, 1.0 equiv), *p*-toluenesulfonyl chloride (673 mg, 3.53 mmol, 1.3 equiv) and 4-dimethylaminopyridine (2.6 mg, 0.013 mmol, 0.005 equiv) were dissolved in DCM (20 mL) and the flask was purged under argon for 5 min. Triethylamine (1.13 mL, 8.16 mmol, 3.00 equiv) was added dropwise and the reaction was allowed to stir for 16 h. The reaction was diluted with diethyl ether (10 mL) and quenched with saturated aq. $NaHCO_3$ (10 mL). The aqueous phase was extracted with diethyl ether (3 × 20 mL), and the combined organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo.* The reaction mixture was purified by column chromatography (10:1 hexanes/EtOAc to 8:1 hexanes/EtOAc) to yield the titled product as a clear oil (230 mg, 38 %).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.74 (ddd, *J* = 7.8, 1.3, 1.3 Hz, 1H), 7.65 (ddd, *J* = 9.6, 2.7, 1.5 Hz, 1H), 7.37 (ddd, *J* = 8.1, 8.0, 5.7 Hz, 1H), 7.16 (dddd, *J* = 8.4, 8.4, 2.7, 1.1 Hz, 1H), 4.36 (dd, *J* = 10.1, 8.2 Hz, 1H), 4.24 (dd, *J* = 8.2, 8.2 Hz, 1H), 4.05 (dd, *J* = 10.1, 8.2 Hz, 1H), 0.95 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 162.6 (d, *J* = 245.8 Hz), 162.4 (d, *J* = 3.3 Hz), 130.3 (d, *J* = 8.1 Hz), 130.0 (d, *J* = 8.1 Hz), 124.1 (d, *J* = 3.3 Hz), 118.2 (d, *J* = 21.3 Hz), 115.4 (d, *J* = 23.5 Hz), 76.4, 69.1, 34.2, 26.0; ^{19}F{^{1}H} NMR (283 MHz, $CDCl_3$) δ –112.90; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{13}H_{16}FNO$ 222.1294; Found 222.1284.

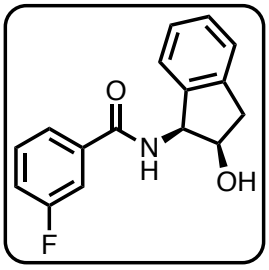
(*S*)-(2-(4-(*tert*-butyl)-4,5-dihydrooxazol-2-yl)-6-fluorophenyl)diisopropylsilanol (L1b)



Synthesized according to the General Procedure E for silane formation using oxazoline (**S6b**) (215 mg, 0.970 mmol), *sec*-BuLi (1.4 M in cyclohexane, 0.84 mL, 1.20 mmol), TMEDA (180 µL, 1.20 mmol) and diisopropylchlorosilane (220 µL, 1.30 mmol). The reaction mixture was filtered through a silica plug (hexanes/EtOAc, 6:1 *v*/*v*) to yield the mixture of unreacted oxazoline (**S6b**) and the corresponding oxazoline silane (**S8**). The resulting mixture was carried on to the next step. Confirmation of the product was obtained through diagnostic peaks in ^{1}H NMR and ^{19}F NMR with δ –95.70 ppm.
For silanol formation, mixture of unreacted oxazoline and oxazoline-silane (**S6b**:**S8**, 1:20, 263 mg, 0.785 mmol, calculated based off silane), Pd/C (10 wt%, 42 mg, 0.039 mmol) and H_2O (140 µL, 7.8 mmol) were used in THF (0.15 M) at room temperature for 16 h. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 10:1 *v*/*v*/*v*) to give the silanol as a crystalline white solid (223 mg, 65%) over two steps.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.58 (s, 1H), 7.85 (dd, *J* = 7.9, 1.1 Hz, 1H), 7.40 (ddd, *J* = 8.0, 7.9, 6.1 Hz, 1H), 7.13 (ddd, *J* = 8.0, 7.9, 1.1 Hz, 1H), 4.36 (dd, *J* = 10.1, 8.5 Hz, 1H), 4.22 (dd, *J* = 8.5, 8.5 Hz, 1H), 4.14 (dd, *J* = 10.1, 8.5 Hz, 1H), 1.38 – 1.18 (m, 2H), 1.09 (dd, *J* = 7.0, 7.0 Hz, 6H), 1.04 – 0.98 (m, 3H), 0.97 (s, 9H), 0.91 (dd, *J* = 7.4, 1.2 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 166.98 (d, *J* = 237.0 Hz), 165.47 (d, *J* = 3.3 Hz), 134.63 (d, *J* = 12.8 Hz), 130.76 (d, *J* = 9.9 Hz), 127.50 (d, *J* = 2.2 Hz), 125.85 (d, *J* = 34.5 Hz), 118.29 (d, *J* = 29.3 Hz), 76.00, 68.28, 34.06, 26.01, 18.03, 18.00, 17.95, 17.92, 17.64, 15.29 (d, *J* = 4.0 Hz), 14.46 (d, *J* = 5.9 Hz); ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –93.20; ^{29}Si{^{1}H}NMR (79 MHz, $CDCl_3$) δ 7.09 (d, *J* = 7.3 Hz); HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{19}H_{31}FNO_2Si$ 352.2108; Found 352.2099.

3-fluoro-*N*-((1*S*,2*R*)-2-hydroxy-2,3-dihydro-1*H*-inden-1-yl)benzamide (S9)

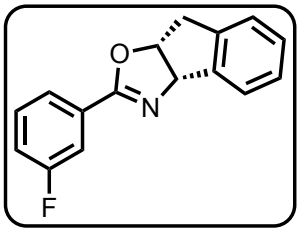


(1*S*,2*R*)-(-)-*cis*-1-Amino-2-indanol (1.29 g, 8.64 mmol, 1.05 equiv) was added to a round-bottom flask, dissolved in DCM (27 mL) and purged with argon for 5 min. Triethylamine was added (1.81 mL, 12.96 mmol, 1.50 equiv) followed by the dropwise addition of 3-fluorobenzoyl chloride (1.00 mL, 8.23 mmol, 1.00 equiv). The reaction was exothermic and the evolution of HCl gas could be observed. After one hour of stirring the reaction was quenched with 1M NaOH (10 mL). The aqueous phase was extracted with DCM (3 × 5 mL). The combined organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The reaction mixture was carried on without further purification.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 – 7.54 (m, 2H), 7.42 (ddd, *J* = 8.1, 7.9, 5.5 Hz, 1H), 7.35 (d, *J* = 6.8 Hz, 1H), 7.31 – 7.27 (m, 2H), 7.26 – 7.16 (m, 2H), 6.85 (d, *J* = 6.8 Hz, 1H), 5.60 (dd, *J* = 7.9, 5.2 Hz, 1H), 4.75 (br, 1H), 3.26 (dd, *J* = 16.6, 5.2 Hz, 1H), 3.01 (dd, *J* = 16.6, 2.2 Hz, 1H), 2.14 (br, 1H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 166.8 (d, *J* = 2.6 Hz), 162.9 (d, *J* = 248.0 Hz), 140.6, 140.0, 136.6 (d, *J* = 7.0 Hz), 130.4 (d, *J* = 7.7 Hz), 128.6, 127.5, 125.6, 124.8, 122.7 (d, *J* = 3.3 Hz), 118.9 (d, *J* = 21.3 Hz), 114.7 (d, *J* = 23.1 Hz),

73.8, 58.1, 40.1; $^{19}F\{^{1}H\}$ NMR (376 MHz, $CDCl_3$) δ –111.66; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{15}FNO_2$ 272.1087; Found 272.1086.

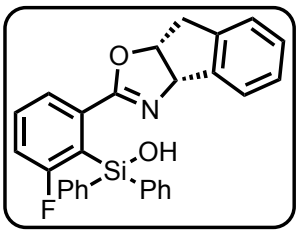
(3a*S*,8a*R*)-2-(3-fluorophenyl)-3a,8a-dihydro-8*H*-indeno[1,2-*d*]oxazole (S6c)



Titanium(IV) tetraisopropoxide (4.55 g, 16 mmol, 4.00 equiv) was added to a round-bottom flask containing amide (**S9**) (1.09 g, 4.00 mmol, 1.00 equiv). The mixture was stirred at 150 °C for 14 h with a Dean-Stark trap to remove isopropanol. After cooling to room temperature, 3-(dimethylamino)-1,2-propanediol (1.89 mL, 16 mmol, 4.00 equiv) was added and then the reaction was allowed to stir for 0.5 h. EtOAc (20 mL) and deionized water (20 mL) were added and a white solid formed which became soluble after 2 h of stirring. The aqueous layer was extracted with ethyl acetate (3 × 10 mL). The combined organic phase was dried over $MgSO_4$, filter and concentrated *in vacuo.* The reaction mixture was purified via column chromatography (3:1 hexanes/EtOAc) to yield the indanol as a white solid (0.93 g, 92%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, *J* = 7.8 Hz, 1H), 7.62 (ddd, *J* = 9.6, 2.7, 1.6 Hz, 1H), 7.55 (dd, *J* = 6.9, 3.0 Hz, 1H), 7.37 – 7.22 (m, 4H), 7.17 – 7.07 (m, 1H), 5.73 (d, *J* = 8.2 Hz, 1H), 5.48 (ddd, *J* = 8.2, 6.8, 1.8 Hz, 1H), 3.50 (dd, *J* = 17.9, 6.8 Hz, 1H), 3.35 (dd, *J* = 17.9, 1.8 Hz, 1H); $^{13}C\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) δ 163.1 (d, *J* = 2.9 Hz), 162.5 (d, *J* = 246.1 Hz), 141.9, 139.8, 130.1 (d, *J* = 8.1 Hz), 130.0 (d, *J* = 8.1 Hz), 128.7, 127.6, 125.7, 125.4, 124.2 (d, *J* = 2.9 Hz), 118.3 (d, *J* = 21.3 Hz), 115.5 (d, *J* = 23.5 Hz), 83.5, 77.2, 39.9; $^{19}F\{^{1}H\}$ NMR (376 MHz, $CDCl_3$) δ –112.78; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}FNO$ 254.0981; Found 254.0977.

(2-((3a*S*,8a*R*)-3a,8a-dihydro-8*H*-indeno[1,2-*d*]oxazol-2-yl)-6-fluorophenyl)diphenylsilanol (L1c)



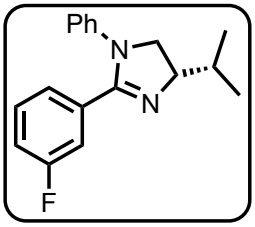
Indanol (**S6c**) (1.00 g, 3.95 mmol, 1.00 equiv) was dissolved in THF (13 mL) and purged under argon for 5 min. The reaction was cooled to –78 °C and TMEDA (0.71 mL, 4.7 mmol, 1.2 equiv) was added followed by the dropwise addition of *sec*-butyl lithium (1.4 M, 3.64 mL, 4.74 mmol, 1.20 equiv). The reaction was allowed to stir at –78 °C for 2 h and then diphenylchlorosilane (1.12 mL, 5.14 mmol, 1.30 equiv) was added. The reaction was allowed to warm to room temperature and then stirred for an additional 30 min at which time it was quenched with saturated aq. $NaHCO_3$ (10 mL). The aqueous phase was extracted with diethyl ether (3 × 5 mL), and the combined organic phase was washed with brine (2 × 5 mL) and dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The reaction mixture was filter through a silica plug (hexanes/EtOAc, 3:1 *v*/*v*) to yield the mixture of unreacted indanol and the corresponding silane. The resulting mixture was carried on to the next step. Confirmation of the product was obtained through diagnostic peaks in ^{1}H NMR and ^{19}F NMR with δ -94.09 ppm.

For silanol formation, mixture of unreacted indanol and silane (4:1, 800 mg, 1.8 mmol, 1.0 equiv, calculated based off silane) was dissolved in diethyl ether (30 mL). Pd/C (0.20 g, 0.090 mmol, 0.050 equiv, 5 wt %) was added followed by the drop-wise addition of deionized water (0.331 mL, 18.4 mmol, 10.0 equiv). The reaction was capped with a septum was stirred at room temperature for 3 h and monitored by TLC for the

consumption of starting material (Caution: H_2 gas evolves as the reaction proceeds). The Pd/C was removed by filtration and the filtrate was dried over $MgSO_4$. The reaction mixture was purified by flash chromatography (5:1 hexanes/EtOAc) to yield silanol as a white solid (0.678 g, 82%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 (s, 1H), 7.75 (dd, *J* = 7.8, 1.1 Hz, 1H), 7.69 – 7.60 (m, 2H), 7.49 – 7.29 (m, 7H), 7.28 (d, *J* = 7.4 Hz, 1H), 7.27 – 7.15 (m, 5H), 7.04 (ddd, *J* = 8.6, 8.2, 1.1 Hz, 1H), 5.57 (d, *J* = 8.2 Hz, 1H), 5.27 (ddd, *J* = 8.3, 7.0, 1.8 Hz, 1H), 3.41 (dd, *J* = 18.0, 7.0 Hz, 1H), 3.17 (dd, *J* = 18.0, 1.8 Hz, 1H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 167.2 (d, *J* = 242.8 Hz), 165.7 (d, *J* = 3.3 Hz), 140.6, 139.4, 137.0 (d, *J* = 2.9 Hz), 136.6 (d, *J* = 2.6 Hz), 134.9 (d, *J* = 9.9 Hz), 134.62, 134.60, 134.58, 134.56, 131.8 (d, *J* = 9.5 Hz), 129.7, 129.5, 128.9, 127.9, 127.7, 127.6, 126.7 (d, *J* = 2.9 Hz), 125.6 (d, *J* = 11.0 Hz), 124.4 (d, *J* = 28.6 Hz), 118.9 (d, *J* = 27.5 Hz), 83.3, 76.2, 39.7; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –89.56; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ -17.55 (d, *J* = 10.6 Hz); IR (neat) 3321, 3068, 2918, 1633, 1593, 1427, 1113, 1022, 999, 883, 698 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{28}H_{23}FNO_2Si$ 452.1482; Found 452.1500.

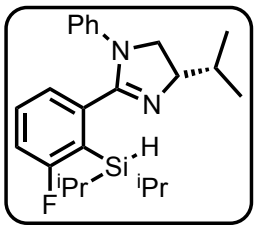
(*S*)-2-(3-fluorophenyl)-4-isopropyl-1-phenyl-4,5-dihydro-1*H*-imidazole (3a)



Synthesized according to the General Procedure B for imidazoline formation using β-hydroxy amide (**S1a**) (1.50 g, 6.66 mmol), thionyl chloride (1.90 mL, 26.6 mmol), Et_3N (2.80 mL, 20.0 mmol) and aniline (0.73 mL, 7.8 mmol). The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*) to give the imidazoline as a yellow oil (1.73 g, 92%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.27 − 7.14 (m, 5H), 7.07−6.96 (m, 2H), 6.78 − 6.75 (m, 2H), 4.14 − 4.02 (m, 2H), 3.73 − 3.61 (m, 1H), 1.98 − 1.85 (m, 1H), 1.05 (d, *J* = 6.7 Hz, 3H), 0.96 (d, *J* = 6.7 Hz, 3H). ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$): δ 162.5 (d, $^1J_{C,F}$ = 246.5 Hz), 160.4 (d, $^4J_{C,F}$ = 2.6 Hz), 143.0, 133.8 (d, $^3J_{C,F}$ = 8.1 Hz), 129.9 (d, $^3J_{C,F}$ = 8.1 Hz), 128.9, 124.6 (d, $^4J_{C,F}$ = 2.9 Hz), 123.6, 122.6, 116.9 (d, $^2J_{C,F}$ = 21.3 Hz), 115.9 (d, $^2J_{C,F}$ = 23.1 Hz), 70.4, 56.6, 33.2, 19.00, 18.0; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$): δ −112.71; IR (neat) 2958, 2871, 1594, 1576, 1495, 1444, 1306, 1207, 847, 754, 694 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{18}H_{20}FN_2$ 283.1610; Found 283.1595.

(*S*)-2-(2-(diisopropylsilyl)-3-fluorophenyl)-4-isopropyl-1-phenyl-4,5-dihydro-1*H*-imidazole (4a)



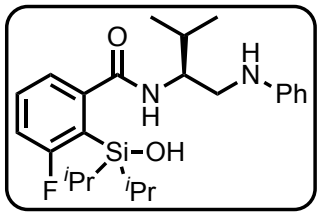
Synthesized according to the General Procedure C for silane formation using imidazoline (**3a**) (980 mg, 3.54 mmol), *sec*-BuLi (1.4 M in cyclohexane, 3.0 mL, 4.3 mmol), TMEDA (0.63 mL, 4.3 mmol) and diisopropylchlorosilane (0.79 mL, 4.6 mmol). The reaction mixture was purified via flash column chromatography (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*) to yield the silane as a pale yellow oil (1.24 g, 88%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.37 (ddd, *J* = 8.2, 7.5, 6.0 Hz, 1H), 7.24 (d, *J* = 6.6 Hz, 1H), 7.10 – 6.97 (m, 3H), 6.88 – 6.78 (m, 1H), 6.68 – 6.58 (m, 2H), 4.03 – 3.88 (m, 2H), 3.82 – 3.68 (m, 2H), 1.99 – 1.84 (m, 1H), 1.28 – 1.14 (m, 2H), 1.13 (d, *J* = 6.7 Hz, 3H), 1.05 – 0.93 (m, 9H), 0.80 (d, *J* = 7.4 Hz, 3H), 0.69 (d, *J* = 7.4

Hz, 3H); $^{13}C\{^1H\}$ NMR (76 MHz, $CDCl_3$) δ 167.1 (d, $^1J_{C,F}$ = 240.3 Hz), 160.6 (d, $^4J_{C,F}$ = 2.5 Hz), 141.9 (d, $^3J_{C,F}$ = 12.0 Hz), 141.0, 131.7 (d, $^3J_{C,F}$ = 9.3 Hz), 128.7, 125.6 (d, $^4J_{C,F}$ = 2.7 Hz), 122.0, 121.8 (d, $^2J_{C,F}$ = 34.6 Hz), 119.4, 115.5 (d, $^3J_{C,F}$ = 26.7 Hz), 70.8, 54.5, 33.6, 19.8, 19.0, 19.0, 18.9, 11.6 (d, $^4J_{C,F}$ = 2.2 Hz), 11.3 (d, $^4J_{C,F}$ = 2.2 Hz); $^{19}F\{^1H\}$ NMR (376 MHz, $CDCl_3$): δ −95.99; $^{29}Si\{^1H\}$ NMR (79 MHz, $CDCl_3$) δ 2.05 (d, $^3J_{Si,F}$ = 3.3 Hz); IR (neat) 2941, 2862, 2127, 1595, 1498, 1379, 1223, 1003, 879, 796 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{24}H_{34}FN_2Si$ 394.2475; Found 397.2459.

Note: *The silane (**4a**) was found to be unstable and completely converted into aminoamide silanol (**L3a**) under air and atmospheric moisture in 3 months. However, stored at -20 °C, it remained stable for >3 months with minimal decomposition.*

(*S*)-3-fluoro-2-(hydroxydiisopropylsilyl)-*N*-(3-methyl-1-(phenylamino)butan-2-yl)benzamide (L3a)



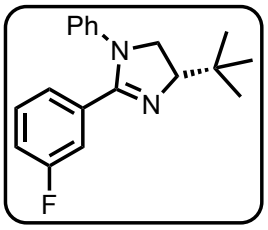
Method A:
Synthesized according to the General Procedure D (Method A) for silanol formation using silane (**L3a**) from previous step (954 mg, 2.41 mmol) and H_2O (434 µL, 24.1 mmol) in THF (16 mL, 0.15 M) at 60 °C for 53 h. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:1.5 *v*/*v*/*v*) to give the silanol (**L3a**) as a crystalline white solid (544 mg, 54%).

Method B:
Synthesized according to the General Procedure D (Method B) for silanol formation using imidazoline (**4a**) and silane (**L3a**) mixture from previous step (1.02 g, 2.58 mmol), Pd/C (10 wt%, 137 mg, 0.129 mmol) and H_2O (0.46 mL, 25.8 mmol) in THF (0.15 M) at 60 °C for 6 h. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:1.5 *v*/*v*/*v*) to give the silanol (**L3a**) as a crystalline white solid (622 mg, 56%).

^1H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.30 (m, 1H), 7.21 – 7.14 (m, 2H), 7.11 (d, *J* = 7.4 Hz, 1H), 7.10 – 7.03 (m, 1H), 6.77 – 6.60 (m, 3H), 5.92 (d, *J* = 9.6 Hz, 1H), 4.25 (dddd, *J* = 9.6, 9.6, 6.0, 3.8 Hz, 1H), 3.97 (br, 2H), 3.39 (dd, *J* = 12.3, 3.8 Hz, 1H), 3.17 (dd, *J* = 12.3, 9.6 Hz, 1H), 2.07 – 1.92 (m, 1H), 1.35 – 1.25 (m, 2H), 1.14 – 1.02 (m, 12H), 0.99 (dd, *J* = 7.4, 1.0 Hz, 3H), 0.97 – 0.90 (m, 3H); $^{13}C\{^1H\}$ (101 MHz, $CDCl_3$) δ 172.9 (d, $^4J_{C,F}$ = 2.6 Hz), 166.8 (d, $^1J_{C,F}$ = 240.3 Hz), 148.4, 145.3 (d, $^3J_{C,F}$ = 11.4 Hz), 131.5 (d, $^3J_{C,F}$ = 9.2 Hz), 129.4, 122.9 (d, $^2J_{C,F}$ = 34.8 Hz), 122.8 (d, $^4J_{C,F}$ = 2.6 Hz), 117.8, 116.8 (d, $^2J_{C,F}$ = 27.9 Hz), 113.0, 55.4, 46.4, 31.1, 19.8, 18.5, 17.84 (d, $^5J_{C,F}$ = 2.6 Hz), 17.81 (d, $^5J_{C,F}$ = 2.2 Hz), 17.42, 17.38, 14.2 (d, $^4J_{C,F}$ = 2.0 Hz), 13.8 (d, $^4J_{C,F}$ = 2.9 Hz); $^{19}F\{^1H\}$ NMR (376 MHz, $CDCl_3$): δ −94.81; $^{29}Si\{^1H\}$ NMR (79 MHz, $CDCl_3$) δ 9.06 (d, $^3J_{Si,F}$ = 4.8 Hz). IR (neat) 3356, 3265, 2943, 2866, 1635, 1603, 1508, 1221, 1107, 849, 748 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M - H_2O + H]^+$ Calcd for $C_{24}H_{34}FN_2OSi$ 413.2424; Found 413.2413; mp: 94−96 °C; R_f = 0.20 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*); HPLC analysis: Chiralpak AD-H column, n-hexane/2-propanol = 97/3, 1.0 mL/min, λ = 254 nm, 40 °C, t_R (*S*, major) = 6.1 min; t_R (*S*, minor) = 8.4 min, >99:1 er.

Note: *The silanol was found to be stable to air and atmospheric moisture for >30 months with minimal decomposition and no loss of catalytic activity.*

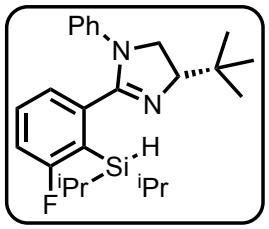
(*S*)-4-(*tert*-butyl)-2-(3-fluorophenyl)-1-phenyl-4,5-dihydro-1*H*-imidazole (3b)



Synthesized according to the General Procedure B for imidazoline formation using β-hydroxy amide (**S1b**) (900 mg, 3.76 mmol), thionyl chloride (1.10 mL, 13.4 mmol), Et_3N (1.58 mL, 10.1 mmol), and aniline (0.41 mL, 4.0 mmol). The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:3.0 *v*/*v*/*v*) to give the imidazoline as a yellow oil (699 mg, 63%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.21 (m, 3H), 7.20 – 7.12 (m, 2H), 7.08 – 6.95 (m, 2H), 6.80 – 6.72 (m, 2H), 4.13 (dd, *J* = 11.0, 9.5 Hz, 1H), 3.99 (dd, *J* = 11.0, 7.6 Hz, 1H), 3.67 (dd, *J* = 9.5, 7.5 Hz, 1H), 0.98 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 162.5 (d, *J* = 246.1 Hz), 160.5 (d, *J* = 2.6 Hz), 143.1, 133.8 (d, *J* = 7.7 Hz), 129.9 (d, *J* = 8.1 Hz), 128.9, 124.6 (d, *J* = 2.9 Hz), 123.7, 122.8, 116.9 (d, *J* = 21.3 Hz), 115.9 (d, *J* = 22.7 Hz), 74.0, 55.5, 34.4, 26.0; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –112.73; HRMS (ESI/Orbitrap) m/z: [M + H]$^+$ Calcd for $C_{19}H_{22}FN_2$ 297.1767; Found 297.1760; mp: 84−86 °C.

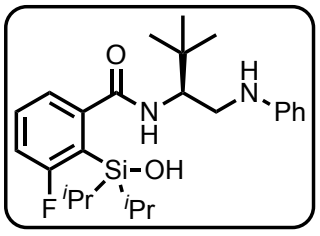
(*S*)-4-(*tert*-butyl)-2-(2-(diisopropylsilyl)-3-fluorophenyl)-1-phenyl-4,5-dihydro-1*H*-imidazole (4b)



Synthesized according to the General Procedure C for silane formation using imidazoline (**3b**) (600 mg, 2.03 mmol), *sec*-BuLi (1.4 M in cyclohexane, 1.74 mL, 2.43 mmol), TMEDA (0.45 mL, 2.6 mmol) and diisopropylchlorosilane (0.36 mL, 2.43 mmol). The reaction mixture was purified via flash column chromatography (140:20:3.0 *v*/*v*/*v*) to yield the silane as a pale yellow oil (0.731 g, 88%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.33 (m, 1H), 7.31 – 7.26 (m, 1H), 7.10 – 6.98 (m, 3H), 6.84 (dd, *J* = 7.4, 7.4 Hz, 1H), 6.67 – 6.60 (m, 2H), 4.03 – 3.81 (m, 3H), 3.78 (ddd, *J* = 3.4, 3.4, 3.3 Hz, 1H), 1.26 – 1.16 (m, 1H), 1.18 – 1.07 (m, 1H), 1.04 (s, 9H), 1.04 – 0.94 (m, 6H), 0.78 (d, *J* = 7.4 Hz, 3H), 0.72 (d, *J* = 7.5 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 167.2 (d, *J* = 240.3 Hz), 160.8, 141.2, 131.7 (d, *J* = 9.2 Hz), 128.7, 125.7 (d, *J* = 2.9 Hz), 122.0, 122.0 (d, *J* = 34.8 Hz), 119.6, 115.5 (d, *J* = 26.8 Hz), 74.2, 52.7, 34.0, 26.6, 19.29, 19.21, 19.18, 19.17, 11.5 (d, *J* = 2.2 Hz), 11.4 (d, *J* = 2.2 Hz); ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –95.81; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ 1.81 (d, $^3J_{Si,F}$ = 3.4 Hz); IR (neat) 2946, 2861, 2131, 1595, 1498, 1379, 1221, 1005, 879, 798 cm^{-1}; HRMS (ESI/Orbitrap) m/z: [M + H]$^+$ Calcd for $C_{25}H_{36}FN_2Si$ Si 411.2632; Found 411.2638.

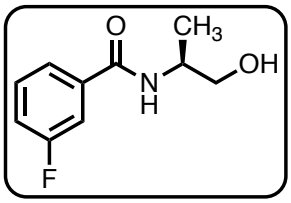
(*S*)-*N*-(3,3-dimethyl-1-(phenylamino)butan-2-yl)-3-fluoro-2-(hydroxydiisopropylsilyl)benzamide (L3b)



Synthesized according to the General Procedure D for silanol formation using silane (**4b**) from previous step (650 mg, 1.70 mmol), Pd/C (10 wt%, 90 mg, 0.085 mmol) and H_2O (0.30 mL, 17 mmol) in THF (0.1 M) at 60 °C for 16 h. The reaction mixture was purified using flash column chromatography (SiO_2, gradient from hexanes/EtOAc/Et_3N, 140:20:3.0 *v*/*v*/*v* to 140:40:3.0 *v*/*v*/*v*) to give the silanol as a crystalline white solid (522 mg, 60%). R_f = 0.23 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 (ddd, *J* = 8.2, 7.9, 5.8 Hz, 1H), 7.21 – 7.10 (m, 3H), 7.07 (dd, *J* = 8.5, 8.5 Hz, 1H), 6.74 – 6.65 (m, 3H), 5.89 (d, *J* = 10.8 Hz, 1H), 4.27 (ddd, *J* = 10.8, 10.8, 3.1 Hz, 1H), 3.98 (br, 1H), 3.47 (dd, *J* = 10.8, 3.1 Hz, 1H), 3.02 (dd, *J* = 10.8, 10.8 Hz, 1H), 1.40 – 1.22 (m, 2H), 1.16 – 1.05 (m, 15H), 1.02 (dd, *J* = 7.5, 1.4 Hz, 3H), 0.91 (d, *J* = 7.5 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 173.0 (d, $^4J_{C,F}$ = 2.6 Hz), 166.8 (d, $^1J_{C,F}$ = 240.6 Hz), 148.5, 145.5 (d, $^3J_{C,F}$ = 11.7 Hz), 131.6 (d, $^3J_{C,F}$ = 9.2 Hz), 129.3, 122.9 (d, $^2J_{C,F}$ = 34.8 Hz), 122.6 (d, $^4J_{C,F}$ = 2.6 Hz), 117.6, 116.8 (d, $^2J_{C,F}$ = 27.5 Hz), 113.0, 58.2, 44.6, 34.6, 26.9, 17.85 (d, $^5J_{C,F}$ = 1.6 Hz), 17.82 (d, $^5J_{C,F}$ = 2.1 Hz), 17.42, 17.37, 14.3 (d, $^4J_{C,F}$ = 2.2 Hz), 13.6 (d, $^4J_{C,F}$ = 2.9 Hz); ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$): δ −94.80; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ 9.36 (d, $^3J_{Si,F}$ = 4.9 Hz); IR (neat) 3373, 2945, 2866, 1645, 1603, 1506, 1221, 1107, 748 cm^{-1}; HRMS (ESI/Orbitrap) m/z: [M – H_2O + H]$^+$ Calcd for $C_{25}H_{36}FN_2OSi$ 427.2581; Found 427.2588; mp: 92−96 °C.

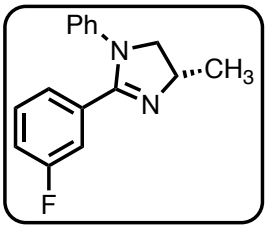
(*S*)-3-fluoro-*N*-(1-hydroxypropan-2-yl)benzamide (S1c)



Synthesized according to the General Procedure A using L-alaninol (649 mg, 8.64 mmol), 3-fluorobenzoyl chloride (1.00 mL, 8.22 mmol) and Et_3N (1.72 mL, 12.3 mmol). The product was purified using extraction and dried under high vacuum to give the β-hydroxy amide as a white powder (>99%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (d, *J* = 7.7 Hz, 1H), 7.44 (ddd, *J* = 8.3, 2.6, 2.6 Hz, 1H), 7.29 (ddd, *J* = 8.3, 7.7, 5.5 Hz, 1H), 7.12 (ddd, *J* = 8.3, 8.3, 2.6 Hz, 1H), 7.03 (d, *J* = 7.8 Hz, 1H), 4.27 – 4.13 (m, 1H), 4.08 (s, 1H), 3.70 (dd, *J* = 11.2, 4.0 Hz, 1H), 3.60 (dd, *J* = 11.2, 5.6 Hz, 1H), 1.24 (d, *J* = 6.8 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 166.9 (d, *J* = 2.2 Hz), 162.6 (d, *J* = 247.6 Hz), 136.6 (d, *J* = 7.0 Hz), 130.2 (d, *J* = 7.7 Hz), 122.6 (d, *J* = 2.9 Hz), 118.5 (d, *J* = 21.3 Hz), 114.4 (d, *J* = 22.7 Hz), 66.0, 48.2, 17.0; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –111.74; HRMS (ESI/Orbitrap) m/z: [M + H]$^+$ Calcd for $C_{10}H_{13}FNO_2$ 198.0929; Found 198.0923.

(*S*)-2-(3-fluorophenyl)-4-methyl-1-phenyl-4,5-dihydro-1*H*-imidazole (3c)

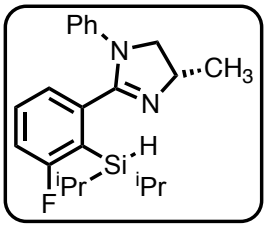


Synthesized according to the General Procedure B for imidazoline formation using β-hydroxy amide (**S1c**) (604 mg, 2.22 mmol), thionyl chloride (0.65 mL, 8.9 mmol), Et_3N (930 µL, 6.67 mmol) and aniline (240 µL, 2.67 mmol). The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*) to give the imidazoline as a clear oil (542 mg, 96%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 – 7.20 (m, 3H), 7.17 (dddd, *J* = 7.4, 7.4, 2.9, 1.9 Hz, 2H), 7.07 – 7.01 (m, 1H), 6.99 (dd, *J* = 7.4, 1.2 Hz, 1H), 6.77 (ddd, *J* = 8.7, 2.9, 1.9 Hz, 2H), 4.32 (ddq, *J* = 9.9, 8.0, 6.6 Hz, 1H), 4.13 (dd, *J* = 9.9, 9.1 Hz, 1H), 3.62 (dd, *J* = 9.1, 8.0 Hz, 1H), 1.41 (d, *J* = 6.6 Hz, 3H); ^{13}C{^{1}H} NMR (101

MHz, $CDCl_3$) δ 162.4 (d, *J* = 246.5 Hz), 160.2 (d, *J* = 2.6 Hz), 143.0, 133.6 (d, *J* = 8.1 Hz), 129.8 (d, *J* = 8.1 Hz), 128.9, 124.6 (d, *J* = 3.3 Hz), 123.6, 122.5, 117.0 (d, *J* = 20.9 Hz), 115.9 (d, *J* = 23.1 Hz), 61.1, 60.0, 22.3; $^{19}F\{^1H\}$ NMR (376 MHz, $CDCl_3$) δ –112.68; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{16}FN_2$ 255.1297; Found 255.1287. R_f = 0.29 (hexanes/EtOAc/Et_3N, 7:2:0.15 *v*/*v*/*v*).

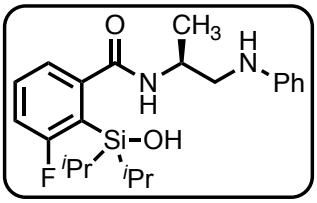
(*S*)-2-(2-(diisopropylsilyl)-3-fluorophenyl)-4-methyl-1-phenyl-4,5-dihydro-1*H*-imidazole (4c)



Synthesized according to the General Procedure C for silane formation using imidazoline (**3c**) (254 mg, 1.00 mmol), *sec*-BuLi (1.4 M in cyclohexane, 1.50 mL, 2.10 mmol), TMEDA (315 µL, 2.10 mmol) and diisopropylchlorosilane (320 µL, 2.20 mmol). The reaction mixture was purified via flash column chromatography (140:20:3.0 *v*/*v*/*v*) to yield the silane as a pale yellow oil (332 mg, 98%).

^1H NMR (400 MHz, $CDCl_3$) δ 7.39 (ddd, *J* = 8.3, 7.5, 6.0 Hz, 1H), 7.26 (dt, *J* = 7.6, 1.1 Hz, 1H), 7.14 – 6.97 (m, 3H), 6.85 (tt, *J* = 6.9, 1.1 Hz, 1H), 6.68 – 6.60 (m, 2H), 4.31 (ddq, *J* = 9.7, 8.5, 6.6 Hz, 1H), 4.11 (dd, *J* = 9.7, 8.7 Hz, 1H), 3.78 (dd, *J* = 6.6, 3.5 Hz, 1H), 3.65 (dd, *J* = 8.7, 8.7 Hz, 1H), 1.45 (d, *J* = 6.6 Hz, 3H), 1.32 – 1.10 (m, 2H), 1.04 (d, *J* = 7.6 Hz, 3H), 0.99 (d, *J* = 7.6 Hz, 3H), 0.84 (dd, *J* = 7.6, 1.0 Hz, 3H), 0.69 (dd, *J* = 7.6, 1.0 Hz, 3H); $^{13}C\{^1H\}$ NMR (101 MHz, $CDCl_3$) δ 166.99 (d, *J* = 240.3 Hz), 160.32 (d, *J* = 2.2 Hz), 141.76 (d, *J* = 12.1 Hz), 140.88, 131.56 (d, *J* = 8.8 Hz), 128.69, 125.41 (d, *J* = 2.9 Hz), 121.94, 121.70 (d, *J* = 34.5 Hz), 119.27, 115.44 (d, *J* = 26.8 Hz), 59.58, 58.07, 21.96, 19.22, 19.15, 19.08 (d, *J* = 1.5 Hz), 18.87 (d, *J* = 1.5 Hz), 11.53 (d, *J* = 1.8 Hz), 11.19 (d, *J* = 2.6 Hz); $^{29}Si\{^1H\}$ NMR (79 MHz, $CDCl_3$) δ 2.09 (d, *J* = 3.3 Hz); $^{19}F\{^1H\}$ NMR (376 MHz, $CDCl_3$) δ –96.03; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{22}H_{30}FN_2Si$ 369.2162; Found 369.2149. R_f = 0.34 (hexanes/EtOAc/Et_3N, 7:2:0.15 *v*/*v*/*v*).

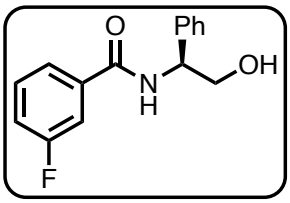
(*S*)-3-fluoro-2-(hydroxydiisopropylsilyl)-*N*-(1-(phenylamino)propan-2-yl)benzamide (L3c)



Synthesized according to the General Procedure D for silanol formation using silane (**4c**) from previous step (262 mg, 0.711 mmol), Pd/C (10 wt%, 38 mg, 0.036 mmol) and H_2O (130 µL, 7.11 mmol) in THF (5 mL, 0.15 M) at 60 °C for 6 h. The reaction mixture was purified using flash column chromatography (SiO_2, gradient from hexanes/EtOAc/Et_3N, 140:20:3 *v*/*v*/*v* to 140:40:3 *v*/*v*/*v*) to give the silanol as a white solid (183 mg, 64%).

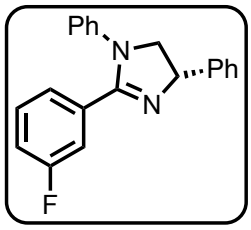
^1H NMR (400 MHz, $CDCl_3$) δ 7.32 (ddd, *J* = 8.2, 8.1, 5.8 Hz, 1H), 7.16 (ddd, *J* = 8.1, 2.3, 1.2 Hz, 2H), 7.13 – 6.99 (m, 2H), 6.75 – 6.61 (m, 3H), 6.05 (d, *J* = 8.5 Hz, 1H), 4.41 (dqdd, *J* = 8.5, 7.9, 6.6, 4.6 Hz, 1H), 3.31 (dd, *J* = 12.8, 4.6 Hz, 1H), 3.19 (dd, *J* = 12.8, 7.9 Hz, 1H), 1.38 – 1.18 (m, 5H), 1.09 (dd, *J* = 7.3, 2.1 Hz, 6H), 0.96 (ddd, *J* = 7.3, 7.0, 1.1 Hz, 6H); $^{13}C\{^1H\}$ NMR (101 MHz, $CDCl_3$) δ 172.20 (d, *J* = 2.2 Hz), 166.73 (d, *J* = 240.6 Hz), 148.20, 145.03 (d, *J* = 11.7 Hz), 131.37 (d, *J* = 9.2 Hz), 129.42, 122.97 (d, *J* = 2.6 Hz), 122.75 (d, *J* = 34.5 Hz), 117.88, 116.78 (d, *J* = 27.9 Hz), 113.11, 49.49, 46.38, 18.97, 17.81 (d, *J* = 2.2 Hz), 17.74 (d, *J* = 2.2 Hz), 17.38, 17.36, 14.12 (d, *J* = 2.2 Hz), 13.99 (d, *J* = 2.9 Hz); $^{19}F\{^1H\}$ NMR (376 MHz, $CDCl_3$) δ –94.86; $^{29}Si\{^1H\}$ NMR (79 MHz, $CDCl_3$) δ 9.02 (d, *J* = 4.8 Hz); HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{22}H_{32}FN_2O_2Si$ 403.2217; Found 403.2227. R_f = 0.22 (hexanes/EtOAc/Et_3N, 7:2:0.15 *v*/*v*/*v*).

(*S*)-3-fluoro-*N*-(2-hydroxy-1-phenylethyl)benzamide (S1d)



Synthesized according to the General Procedure A using (*S*)-(+)-2-phenylglycinol (1.77 g, 13.0 mmol), 3-fluorobenzoyl chloride (1.50 mL, 12.3 mmol) and Et_3N (2.60 mL, 18.5 mmol). The product was dried under high vacuum to fully remove triethylamine and was carried on without further purification.

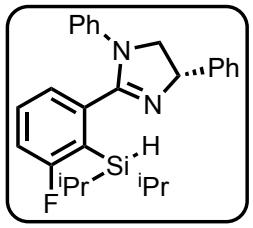
(*S*)-2-(3-fluorophenyl)-1,4-diphenyl-4,5-dihydro-1*H*-imidazole (3d)



Synthesized according to the General Procedure B for imidazoline formation using β-hydroxy amide (**S1d**) (650 mg, 2.51 mmol), thionyl chloride (0.73 mL, 10 mmol), Et_3N (1.05 mL, 7.53 mmol) and aniline (0.28 mL, 3.0 mmol). The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:3.0 *v*/*v*/*v*) to give the imidazoline as a yellow oil (500 mg, 63%).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.41 – 7.23 (m, 8H), 7.22 – 7.15 (m, 2H), 7.08 (ddd, *J* = 8.3, 2.6, 1.3 Hz, 1H), 7.05 – 6.98 (m, 1H), 6.88 – 6.74 (m, 2H), 5.35 (dd, *J* = 10.8, 8.3 Hz, 1H), 4.47 (dd, *J* = 10.8, 9.5 Hz, 1H), 3.93 (dd, *J* = 9.5, 8.3 Hz, 1H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 162.5 (d, *J* = 246.5 Hz), 161.5 (d, *J* = 2.6 Hz), 143.8, 142.8, 133.3 (d, *J* = 8.1 Hz), 129.9 (d, *J* = 8.4 Hz), 129.1, 128.8, 127.5, 126.9, 124.8 (d, *J* = 2.9 Hz), 124.1, 123.0, 117.2 (d, *J* = 21.3 Hz), 116.2 (d, *J* = 23.1 Hz), 67.9, 62.0; ^{19}F{^{1}H} NMR (283 MHz, $CDCl_3$) δ –112.51; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{21}H_{18}FN_2$ 317.1454; Found 317.1448. R_f = 0.24 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

(*S*)-2-(2-(diisopropylsilyl)-3-fluorophenyl)-1,4-diphenyl-4,5-dihydro-1*H*-imidazole (4d)

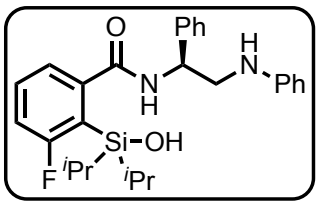


Synthesized according to the General Procedure C for silane formation using imidazoline (**3d**) (222 mg, 0.706 mmol), *sec*-BuLi (1.4 M in cyclohexane, 1.1 mL, 1.5 mmol), TMEDA (220 µL, 1.48 mmol) and diisopropylchlorosilane (270 µL, 1.55 mmol). The reaction mixture was purified via flash column chromatography (hexanes/EtOAc/Et_3N, 140:20:3.0 *v*/*v*/*v*) to yield the silane as a pale orange oil (248 g, 82%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 – 7.49 (m, 2H), 7.47 – 7.36 (m, 4H), 7.33 – 7.27 (m, 1H), 7.13 – 7.03 (m, 3H), 6.88 (t, *J* = 7.4 Hz, 1H), 6.68 (d, *J* = 8.0 Hz, 2H), 5.36 (dd, *J* = 9.8, 9.8 Hz, 1H), 4.39 (dd, *J* = 9.8, 9.8 Hz, 1H), 4.04 (ddd, *J* = 9.8, 9.8, 1.8 Hz, 1H), 3.89 – 3.80 (m, 1H), 1.29 – 1.11 (m, 2H), 1.06 – 0.92 (m, 6H), 0.81 (d, *J* = 7.4 Hz, 3H), 0.68 (d, *J* = 7.4 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 167.0 (d, *J* = 240.3 Hz),

161.7 (d, *J* = 2.2 Hz), 143.4, 141.4 (d, *J* = 12.1 Hz), 140.6, 131.7 (d, *J* = 9.2 Hz), 128.7 (d, *J* = 22.0 Hz), 127.3, 127.2, 125.7 (d, *J* = 2.9 Hz), 122.4, 121.8 (d, *J* = 34.8 Hz), 119.6, 115.7 (d, *J* = 26.4 Hz), 67.6, 58.9, 19.1, 18.9, 11.5, 11.2; $^{19}F\{^{1}H\}$ NMR (376 MHz, $CDCl_3$) δ –95.77; $^{29}Si\{^{1}H\}$ NMR (79 MHz, $CDCl_3$) δ 2.06 (d, *J* = 3.3 Hz); HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{27}H_{32}FN_2Si$ 431.2319; Found 431.2314. R_f = 0.27 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

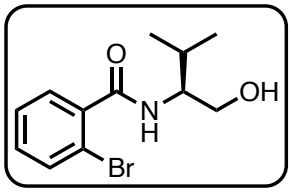
(*S*)-3-fluoro-2-(hydroxydiisopropylsilyl)-*N*-(1-phenyl-2-(phenylamino)ethyl)benzamide (L3d)



Synthesized according to the General Procedure D for silanol formation using silane (**4d**) from previous step (215 mg, 0.500 mmol), Pd/C (10 wt%, 27 mg, 0.025 mmol) and H_2O (90 µL, 5.0 mmol) in THF (3 mL, 0.15 M) at 60 °C for 16 h. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:3.0 *v*/*v*/*v* to 140:40:3.0 *v*/*v*/*v*) to give the silanol as a crystalline white solid (157 mg, 68%).

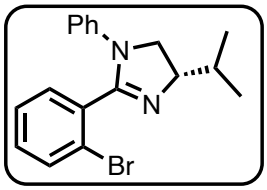
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.29 (m, 6H), 7.22 – 7.13 (m, 3H), 7.12 – 7.03 (m, 1H), 6.74 (dddd, *J* = 7.3, 7.3, 1.1, 1.1 Hz, 1H), 6.68 (dd, *J* = 8.7, 1.2 Hz, 2H), 6.53 (d, *J* = 8.3 Hz, 1H), 5.47 (ddd, *J* = 7.7, 7.7, 5.4 Hz, 1H), 4.00 (br, 1H), 3.70 – 3.55 (m, 2H), 1.37 – 1.22 (m, 2H), 1.09 (dd, *J* = 11.3, 7.4 Hz, 6H), 0.96 (ddd, *J* = 7.4, 3.0, 1.2 Hz, 6H); $^{13}C\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) δ 172.0 (d, $^{4}J_{C,F}$ = 2.6 Hz), 166.8 (d, $^{1}J_{C,F}$ = 240.6 Hz), 147.9, 144.7 (d, $^{3}J_{C,F}$ = 11.7 Hz), 139.2, 131.5 (d, $^{3}J_{C,F}$ = 9.2 Hz), 129.5, 129.3, 128.3, 126.6, 123.1 (d, $^{2}J_{C,F}$ = 34.5 Hz), 123.1 (d, $^{4}J_{C,F}$ = 2.9 Hz), 118.4, 117.0 (d, $^{2}J_{C,F}$ = 28.2 Hz), 113.5, 53.8, 49.1, 17.9 (d, $^{5}J_{C,F}$ = 2.2 Hz), 17.8 (d, $^{5}J_{C,F}$ = 2.2 Hz), 17.43, 17.39, 14.2 (d, $^{4}J_{C,F}$ = 2.6 Hz), 14.0 (d, $^{4}J_{C,F}$ = 2.9 Hz); $^{19}F\{^{1}H\}$ NMR (376 MHz, $CDCl_3$) δ –94.72; $^{29}Si\{^{1}H\}$ NMR (79 MHz, $CDCl_3$) δ 8.95 (d, *J* = 4.8 Hz); IR (neat) 3294, 2945, 2835, 1641, 1585, 1495, 1448, 750, 694 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M – H_2O + H]^+$ Calcd for $C_{27}H_{32}FN_2OSi$ 447.2268; Found 447.2264; mp: 85−87 °C. R_f = 0.17 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

(*S*)-2-bromo-*N*-(1-hydroxy-3-methylbutan-2-yl)benzamide (S1e)



Synthesized according to the General Procedure A using L-valinol **1a** (994 mg, 9.64 mmol), 3-fluorobenzoyl chloride **2b** (1.20 mL, 9.18 mmol) and Et_3N (2.00 mL, 13.8 mmol). The product was dried under high vacuum to fully remove triethylamine and was carried on without further purification.

(*S*)-2-(2-bromophenyl)-4-isopropyl-1-phenyl-4,5-dihydro-1*H*-imidazole (3e)

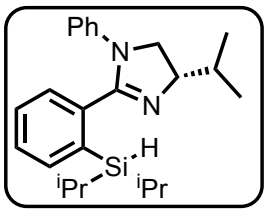


Synthesized according to the General Procedure B for imidazoline formation using β-hydroxy amide (**S1e** (900 mg, 2.50 mmol), thionyl chloride (0.73 mL, 10 mmol), Et_3N (1.05 mL, 7.53 mmol) and aniline (0.28 mL,

3.0 mmol). The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:3.0 *v*/*v*/*v*) to give the imidazoline as a yellow oil (638 mg, 75%).

^1H NMR (400 MHz, $CDCl_3$) δ 7.48 (dd, *J* = 7.6, 1.8 Hz, 2H), 7.32 (ddd, *J* = 7.7, 7.6, 1.3 Hz, 1H), 7.22 (ddd, *J* = 7.7, 7.7, 1.9 Hz, 1H), 7.13 – 7.04 (m, 2H), 6.89 (tt, *J* = 6.9, 1.2 Hz, 1H), 6.66 (dd, *J* = 8.6, 1.2 Hz, 2H), 4.15 – 3.97 (m, 2H), 3.77 (dd, *J* = 8.6, 8.6 Hz, 1H), 1.99 (dh, *J* = 13.5, 6.8 Hz, 1H), 1.10 (d, *J* = 6.8 Hz, 3H), 1.04 (d, *J* = 6.8 Hz, 3H); $^{13}C\{^1H\}$ NMR (101 MHz, $CDCl_3$) δ 159.7, 141.0, 134.3, 133.1, 131.0, 130.8, 128.7, 127.6, 122.5, 122.2, 119.4, 70.2, 53.7, 33.0, 19.1, 18.4; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{18}H_{20}BrN_2$ 343.0810; Found 343.0803.

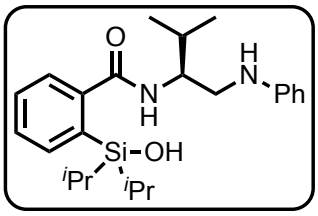
(*S*)-2-(2-(diisopropylsilyl)phenyl)-4-isopropyl-1-phenyl-4,5-dihydro-1*H*-imidazole (4e)



Synthesized according to the General Procedure C for silane formation using imidazoline (**3e**) (684 mg, 2.00 mmol), *sec*-BuLi (1.4 M in cyclohexane, 2.10 mL, 3.00 mmol), TMEDA (450 µL, 3.00 mmol) and diisopropylchlorosilane (470 µL, 3.20 mmol). The reaction mixture was purified via flash column chromatography (hexanes/EtOAc/Et_3N, 140:20:3 *v*/*v*/*v*) to remove the protonated imidazoline. However, the silane was found to be unstable and started turning into silanol in the silica column, and hence, pure characterization data was not collected. A mixture (3:1, 171 mg) of imidazoline silane (**3e**) and aminoamide silanol (**L3e**) was isolated.

***Note**: The silane was found to be unstable and started turning into silanol under air and atmospheric moisture after the flash silica column. Confirmation of the product was achieved through $^{29}Si\{^1H\}$ NMR (79 MHz, $CDCl_3$) with δ 2.60 ppm and ASAP-MS (ACPI) m/z: [M + H]+ Calcd for $C_{24}H_{35}N_2Si$ 379.3; Found 379.4.*

(*S*)-2-(hydroxydiisopropylsilyl)-*N*-(3-methyl-1-(phenylamino)butan-2-yl)benzamide (L3e)

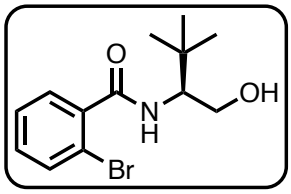


Method A:
Synthesized according to the General Procedure D (Method A) for silanol formation using a mixture of imidazoline silane (**S3e**) and aminoamide silanol (**L3e**) from previous step (3:1, 84 mg, 0.22 mmol) and H_2O (40 µL, 2.2 mmol) in THF (1.5 mL, 0.15 M) at 60 °C for 16 h. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:3 *v*/*v*/*v* to 140:40:3 *v*/*v*/*v*) to give the silanol as a crystalline white solid (75 mg, 83%).

Method B:
Synthesized according to the General Procedure D (Method B) for silanol formation using a mixture of imidazoline silane (**S3e**) and aminoamide silanol (**L3e**) from previous step (3:1, 80 mg, 0.21 mmol), Pd/C (10 wt%, 11 mg, 0.011 mmol) and H_2O (38 µL, 2.1 mmol) in THF (1.5 mL, 0.15 M) at 60 °C for 6 h. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:3 *v*/*v*/*v* to 140:40:3 *v*/*v*/*v*) to give the silanol as a crystalline white solid (43 mg, 50%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (d, *J* = 7.2 Hz, 1H), 7.44 (td, *J* = 6.9, 2.2 Hz, 1H), 7.39 – 7.33 (m, 2H), 7.17 (tt, *J* = 7.3, 2.2 Hz, 2H), 6.71 (tt, *J* = 7.4, 1.2 Hz, 1H), 6.65 (dd, *J* = 8.7, 1.2 Hz, 2H), 6.04 (d, *J* = 9.5 Hz, 1H), 4.31 – 4.18 (m, 1H), 3.98 (br, 1H), 3.38 (dd, *J* = 12.4, 4.1 Hz, 1H), 3.22 (dd, *J* = 12.4, 8.9 Hz, 1H), 2.08 – 1.94 (m, 1H), 1.37 – 1.23 (m, 2H), 1.07 (t, *J* = 7.5 Hz, 12H), 0.97 (dd, *J* = 7.5, 6.3 Hz, 6H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 172.9, 148.4, 142.1, 137.2, 135.6, 129.8, 129.4, 129.0, 126.5, 117.8, 113.0, 55.3, 46.5, 30.8, 19.8, 18.5, 17.9, 17.9, 17.6, 17.6, 13.6, 13.5; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ 6.42; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{24}H_{37}N_2O_2Si$ 413.2624; Found 413.2615. R_f = 0.21 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

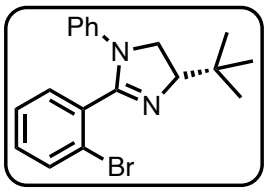
(*S*)-2-bromo-*N*-(1-hydroxy-3,3-dimethylbutan-2-yl)benzamide (S1f)



Synthesized according to the General Procedure A using L-tert-Leucinol **1b** (0.56 g, 4.8 mmol), 2-bromobenzoyl chloride **2b** (0.60 mL, 4.6 mmol) and Et_3N (0.96 mL, 6.9 mmol). The product was purified using extraction and dried under high vacuum to give the β-hydroxy amide as a white powder (1.38 g, >99%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 – 7.54 (m, 2H), 7.37 (ddd, *J* = 7.5, 7.5, 1.2 Hz, 1H), 7.32 – 7.24 (m, 1H), 4.07 (ddd, *J* = 9.4, 7.4, 3.5 Hz, 1H), 3.96 (dd, *J* = 11.4, 3.5 Hz, 1H), 3.69 (dd, *J* = 11.4, 7.4 Hz, 1H), 1.05 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 168.8, 138.1, 133.5, 131.5, 129.9, 127.8, 119.2, 63.3, 60.5, 33.9, 27.2; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{13}H_{19}BrNO_2$ 300.0599; Found 300.0605.

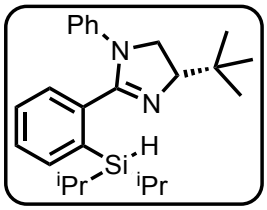
(*S*)-2-(2-bromophenyl)-4-(*tert*-butyl)-1-phenyl-4,5-dihydro-1*H*-imidazole (3f)



Synthesized according to the General Procedure B for imidazoline formation using β-hydroxy amide (**S1f**) (500 mg, 1.67 mmol), thionyl chloride (0.49 mL, 6.7 mmol), Et_3N (0.70 mL, 5.0 mmol) and aniline (0.18 mL, 2.0 mmol). The reaction mixture was purified using flash column chromatography (SiO_2, gradient from 100% DCM to 20:1 DCM/MeOH) to give the imidazoline as a yellow oil (466 mg, 79%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (ddd, *J* = 8.0, 1.5, 1.5 Hz, 2H), 7.33 (ddd, *J* = 7.5, 7.5, 1.3 Hz, 1H), 7.22 (ddd, *J* = 7.6, 7.5, 1.8 Hz, 1H), 7.14 – 7.04 (m, 2H), 6.94 – 6.86 (m, 1H), 6.71 – 6.63 (m, 2H), 4.08 – 3.96 (m, 2H), 3.88 – 3.76 (m, 1H), 1.05 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 159.8, 141.1, 134.3, 133.2, 131.2, 130.9, 128.8, 127.6, 122.6, 122.3, 119.7, 74.0, 52.6, 34.4, 26.3. HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{19}H_{22}BrN_2$ 357.0966; Found 357.0961.

(*S*)-4-(*tert*-butyl)-2-(2-(diisopropylsilyl)phenyl)-1-phenyl-4,5-dihydro-1*H*-imidazole (4f)

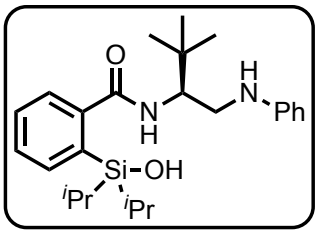


Synthesized according to the General Procedure C for silane formation using imidazoline (**3f**) (380 mg, 1.07 mmol), *sec*-BuLi (1.4 M in cyclohexane, 1.52 mL, 2.13 mmol), TMEDA (320 µL, 2.13 mmol) and

diisopropylchlorosilane (330 µL, 2.25 mmol). The reaction mixture was purified via flash column chromatography (hexanes/EtOAc/Et_3N, 140:20:3 *v*/*v*/*v*) to yield the silane as a pale yellow oil (252 mg, 60%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 (dd, *J* = 5.7, 3.1 Hz, 1H), 7.42 – 7.37 (m, 1H), 7.37 – 7.30 (m, 2H), 7.09 – 7.00 (m, 2H), 6.82 (t, *J* = 7.4 Hz, 1H), 6.62 (d, *J* = 8.2 Hz, 2H), 3.96 (dd, *J* = 10.2, 10.2 Hz, 1H), 3.91 – 3.81 (m, 3H), 1.24 – 1.16 (m, 1H), 1.16 – 1.08 (m, 1H), 1.07 – 1.01 (m, 15H), 0.83 (t, *J* = 7.1 Hz, 6H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 161.7, 141.8, 139.4, 135.9, 135.4, 129.3, 129.1, 128.5, 128.2, 121.8, 119.9, 77.5, 77.2, 76.8, 74.1, 53.1, 34.0, 26.5, 19.3, 19.2, 19.0, 11.6, 11.3; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ 2.54; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{25}H_{36}N_2Si$ 393.2726; Found 393.2719; R_f = 0.76 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

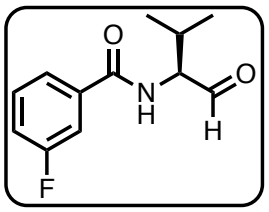
(*S*)-*N*-(3,3-dimethyl-1-(phenylamino)butan-2-yl)-2-(hydroxydiisopropylsilyl)benzamide (L3f)



Synthesized according to the General Procedure D for silanol formation using silane (**4f**) from the previous step (200 mg, 0.51 mmol), Pd/C (10 wt%, 27 mg, 0.025 mmol) and H_2O (92 µL, 5.1 mmol) in THF (0.15 M) at 60 °C for 16 h. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:3 *v*/*v*/*v* to 140:40:3 *v*/*v*/*v*) to give the silanol as a crystalline white solid (132 mg, 61%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (d, *J* = 7.3 Hz, 1H), 7.48 – 7.41 (m, 1H), 7.41 – 7.33 (m, 2H), 7.22 – 7.10 (m, 2H), 6.74 – 6.58 (m, 3H), 5.98 (d, *J* = 10.1 Hz, 1H), 4.27 (ddd, *J* = 10.6, 10.6, 3.1 Hz, 1H), 4.00 (br, 2H), 3.48 (dd, *J* = 10.6, 3.1 Hz, 1H), 3.11 – 3.02 (m, 1H), 1.34 – 1.26 (m, 2H), 1.11 – 1.04 (m, 15H), 0.99 (d, *J* = 7.5 Hz, 3H), 0.95 (d, *J* = 7.5 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 173.19, 148.54, 142.28, 137.19, 135.57, 129.73, 129.35, 129.02, 126.34, 117.64, 112.96, 77.48, 77.16, 76.84, 58.18, 45.10, 34.49, 26.97, 17.90, 17.89, 17.58, 17.56, 13.76, 13.45; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ 6.47; IR (neat) 3334, 2947, 2864, 1639, 1603, 1508, 1462, 1014, 881, 744 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M - H_2O + H]^+$ Calcd for $C_{25}H_{37}N_2OSi$ 409.2675; Found 409.2674; mp: 82−84 °C; R_f = 0.25 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

(*S*)-3-fluoro-*N*-(3-methyl-1-oxobutan-2-yl)benzamide (S10)



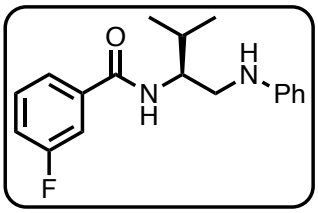
Synthesized based off reported procedure.[8] To a solution of β-hydroxy amide (**S1a**) (540 mg, 2.40 mmol, 1.0 equiv) in DCM at 0 °C, Dess-Martin periodinane (0.70 mL, 9.6 mmol, 4.0 equiv) was added portion-wise. After stirring 10 min, the reaction was allowed to warm to room temperature and stirred for 16 h. The reaction mixture was poured into aqueous solution of saturated $Na_2S_2O_3$/$NaHCO_3$ (10 mL, 1:1 *v*/*v*). The aqueous phase was extracted with DCM (2 × 20 mL), and the combined organic phase was dried over $MgSO_4$, filtered,

[8] Kinens, A.; Sejejs, M.; Kamlet, A. S.; Piotrowski, D. W.; Vedejs, E.; Suna, E. *J. Org. Chem.* **2017**, *82* (2), 869–886.

and concentrated *in vacuo*. The resulting reaction mixture was purified using flash column chromatography (SiO_2, DCM/MeOH, 20:1 *v*/*v*) to give the aldehyde as a clear oil (617 mg, 89%). R_f = 0.47 (DCM/MeOH, 20:1 *v*/*v*). The product was immediately used in the next step to prevent racemization.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.75 (s, 1H), 6.60 (ddd, *J* = 7.7, 1.3, 1.3 Hz, 1H), 6.54 (ddd, *J* = 9.4, 2.1, 2.1 Hz, 1H), 6.41 (ddd, *J* = 8.0, 7.9, 5.6 Hz, 1H), 6.22 (dddd, *J* = 8.3, 8.3, 2.6, 1.0 Hz, 1H), 6.05 (d, *J* = 7.7 Hz, 1H), 3.78 (dd, *J* = 7.7, 4.7 Hz, 1H), 1.53 – 1.37 (m, 1H), 0.08 (dd, *J* = 11.0, 6.9 Hz, 6H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 199.9, 166.5 (d, *J* = 2.6 Hz), 162.7 (d, *J* = 247.6 Hz), 136.2 (d, *J* = 7.0 Hz), 130.3 (d, *J* = 7.7 Hz), 122.6 (d, *J* = 2.9 Hz), 118.8 (d, *J* = 21.3 Hz), 114.6 (d, *J* = 22.7 Hz), 63.8, 29.3, 19.1, 18.0; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –111.56; IR (neat): 3296, 3074, 2966, 1726, 1645, 1585, 1553, 1481, 1221, 752, 679 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{12}H_{15}FNO_2$ 224.1087; Found 224.1082.

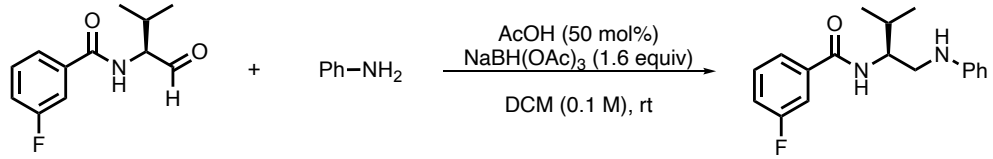
(*S*)-3-fluoro-*N*-(3-methyl-1-(phenylamino)butan-2-yl)benzamide (S2)



Aminoamide **S2** can be synthesized by two methods:
Method 1 is preferred, while method 2 was used for confirming spectroscopic data

Method 1) Synthesized according to the General Procedure F for aminoamide formation through ring-opening of imidazoline using imidazoline (**3a**, 1.22 g, 4.32 mmol) in 1,4-dioxane/H_2O (8 mL/2mL). The reaction was completed in 5−7 days. The resulting reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:40:3 *v*/*v*/*v*) to give the aminoamide as a white solid (1.12 g, 86%).

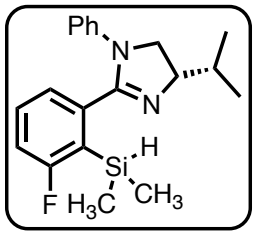
Method 2) Synthesized using reductive-amination method



To a solution of aldehyde (**S10**) (223 mg, 1.00 mmol, 1.0 equiv) and acetic acid (28 µL, 0.49 mmol, 0.5 equiv) in DCM (10 mL, 0.1 M) at 0 °C, aniline (0.13 mL, 1.50 mmol, 1.5 equiv) was added. The solution was added with sodium triacetoxyborohydride (318 mg, 1.50 mmol, 1.6 equiv) and stirred for overnight at room temperature. To quench the reaction, aq. 1M NaOH (5 mL) was added while stirring. The aqueous phase was extracted with DCM (2 × 10 mL), and the combined organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The resulting reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:40:3 *v*/*v*/*v*) to give the aminoamide as a white solid (111 mg, 37%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.32 (m, 3H), 7.23 – 7.11 (m, 3H), 6.70 (tt, *J* = 7.3, 1.1 Hz, 1H), 6.62 (dd, *J* = 8.6, 1.1 Hz, 2H), 6.05 (d, *J* = 8.6 Hz, 1H), 4.25 (tdd, *J* = 8.4, 6.1, 4.1 Hz, 1H), 4.01 (s, 1H), 3.39 (dd, *J* = 12.5, 4.2 Hz, 1H), 3.25 (dd, *J* = 12.5, 8.4 Hz, 1H), 2.10 – 1.94 (m, *J* = 6.8 Hz, 1H), 1.06 (d, *J* = 7.1 Hz, 3H), 1.04 (d, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 167.13 (d, *J* = 2.6 Hz), 162.79 (d, *J* = 247.6 Hz), 148.42, 136.94 (d, *J* = 6.6 Hz), 130.33 (d, *J* = 8.1 Hz), 129.42, 122.46 (d, *J* = 2.9 Hz), 118.58 (d, *J* = 21.3 Hz), 117.68, 114.45 (d, *J* = 22.7 Hz), 55.27, 46.53, 30.55, 19.66, 18.57; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ −111.68. IR (neat) 3296, 2962, 1635, 1601, 1585, 1539, 1502, 1483, 1269, 748, 690 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{18}H_{22}FN_2O$ 301.1716; Found 301.1710; mp: 99 −103 °C. R_f = 0.43 (hexanes/EtOAc/Et_3N, 7:2:0.15 *v*/*v*/*v*).

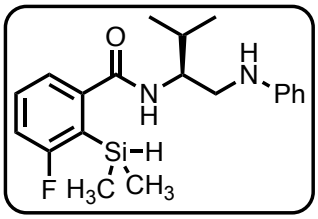
(*S*)-2-(2-(dimethylsilyl)-3-fluorophenyl)-4-isopropyl-1-phenyl-4,5-dihydro-1*H*-imidazole (4g)



Synthesized according to the General Procedure C for silane formation using imidazoline (**3a**) (282 mg, 1.0 mmol), *sec*-BuLi (1.4 M in cyclohexane, 1.5 mL, 2.1 mmol), TMEDA (0.31 mL, 2.1 mmol) and diisopropylchlorosilane (0.24 mL, 2.2 mmol). The reaction mixture was purified via flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*) to yield the silane as a pale yellow oil (0.260 g, 76%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 (ddd, *J* = 8.2, 7.9, 6.0 Hz, 1H), 7.25 (d, *J* = 7.5 Hz, 1H), 7.12 – 7.03 (m, 2H), 7.00 (t, *J* = 8.5 Hz, 1H), 6.86 (tt, *J* = 7.1, 1.1 Hz, 1H), 6.61 – 6.53 (m, 2H), 4.29 – 4.18 (m, *J* = 3.7 Hz, 1H), 4.04 – 3.92 (m, 2H), 3.80 – 3.68 (m, 1H), 2.01 – 1.88 (m, 1H), 1.11 (d, *J* = 6.7 Hz, 3H), 1.01 (d, *J* = 6.8 Hz, 3H), 0.11 (dd, J = 3.8, 1.5 Hz, 3H), 0.02 (dd, J = 3.8, 1.5 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.72 (d, J = 241.0 Hz), 160.64 (d, J = 2.2 Hz), 140.78, 140.39 (d, J = 11.0 Hz), 131.67 (d, J = 9.2 Hz), 128.64, 125.20 (d, J = 2.9 Hz), 123.58 (d, J = 31.2 Hz), 122.11, 119.53, 115.79 (d, J = 26.0 Hz), 70.33, 54.00, 33.14, 19.37, 18.71, –3.65 (d, J = 2.9 Hz), –3.90 (d, J = 3.3 Hz); ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –98.84; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ –20.99 (d, J = 9.2 Hz); HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{20}H_{26}FN_2Si$ 341.1849; Found 341.1835.

(*S*)-2-(dimethylsilyl)-3-fluoro-*N*-(3-methyl-1-(phenylamino)butan-2-yl)benzamide (S3b)

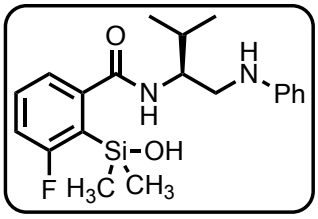


Synthesized according to the General Procedure G for silane formation using aminoamide (**S2**) (85 mg, 0.28 mmol), *sec*-BuLi (1.4 M in cyclohexane, 0.61 mL, 0.85 mmol), TMEDA (0.13 mL, 0.85 mmol) and dimethylchlorosilane (100 µL, 0.88 mmol). The reaction mixture was purified via flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 7:2:0.15 *v*/*v*/*v*) to yield the silane as a clear oil (31 mg, 31%).

Note: *Aminoamide silanol (**L3g**) formed during purification in silica gel chromatography. Isolated the silanol as a clear oil (52 mg, 49%).*

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 (dd, *J* = 7.6, 5.3 Hz, 1H), 7.41 (dd, *J* = 7.3, 1.8 Hz, 1H), 7.33 (dd, *J* = 8.8, 1.5 Hz, 1H), 7.20 – 7.11 (m, 2H), 6.70 (tt, *J* = 7.3, 1.1 Hz, 1H), 6.66 – 6.58 (m, 2H), 6.09 (d, *J* = 9.1 Hz, 1H), 4.47 (pd, *J* = 3.8, 2.2 Hz, 1H), 4.24 (tdd, *J* = 8.5, 6.1, 4.1 Hz, 1H), 4.00 (s, 1H), 3.38 (dd, *J* = 12.5, 4.1 Hz, 1H), 3.25 (dd, *J* = 12.5, 8.4 Hz, 1H), 2.10 – 1.93 (m, *J* = 6.8 Hz, 1H), 1.05 (dd, *J* = 7.6, 6.9 Hz, 6H), 0.38 (dd, *J* = 3.8, 0.9 Hz, 6H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 167.31 (d, *J* = 242.8 Hz), 167.16 (d, *J* = 2.6 Hz), 148.43, 138.27 (d, *J* = 7.3 Hz), 136.29 (d, *J* = 11.0 Hz), 129.42, 128.05 (d, *J* = 30.8 Hz), 122.12 (d, *J* = 2.9 Hz), 117.67, 113.46 (d, *J* = 27.5 Hz), 112.86, 55.22, 46.54, 30.57, 19.67, 18.57, –3.96, –3.98; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –100.00; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ –18.84 (d, *J* = 7.3 Hz); IR (neat) 3296, 2960, 2139, 1633, 1602, 1541, 1508, 1392, 879, 748 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{20}H_{28}FN_2Si$ 359.1948; Found 359.1955. R_f = 0.48 (hexanes/EtOAc/Et_3N, 7:2:0.15 *v*/*v*/*v*).

(**S**)-3-fluoro-2-(hydroxydimethylsilyl)-N-(3-methyl-1-(phenylamino)butan-2-yl)benzamide (L3g)



Method A:

*Since the aminoamide silane is not stable in silica gel column the silanol was able to be isolated from the synthesis of the corresponding aminoamide silane (***S3b***).*

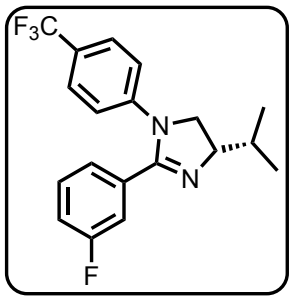
Synthesized according to the General Procedure G for silane formation using aminoamide (**S2**) (85 mg, 0.28 mmol), *sec*-BuLi (1.4 M in cyclohexane, 0.61 mL, 0.85 mmol), TMEDA (0.13 mL, 0.85 mmol) and dimethylchlorosilane (100 µL, 0.88 mmol). The reaction mixture was purified via flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 7:2:0.15 *v*/*v*/*v*) to yield the silane as a clear oil (31 mg, 31%). Aminoamide silanol (**L3g**) formed during purification in silica gel chromatography. Isolated the silanol as a clear oil (52 mg, 49%).

Method B:

Synthesized according to the General Procedure D for silanol formation using imidazoline silane (**4g**) (89 mg, 0.26 mmol), Pd/C (10 wt%, 18 mg, 0.013 mmol) and H_2O (47 µL, 2.6 mmol) in THF (2 mL, 0.15 M) at room temperature for 2 h. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:40:1.5 *v*/*v*/*v*) to give the silanol as a white solid (54 mg, 55%).

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.41 – 7.28 (m, 1H), 7.24 – 7.02 (m, 4H), 6.72 (tt, *J* = 7.3, 1.2 Hz, 1H), 6.66 (dd, *J* = 8.7, 1.1 Hz, 2H), 6.00 (d, *J* = 9.8 Hz, 1H), 4.25 (dddd, *J* = 9.8, 9.3, 6.9, 3.9 Hz, 1H), 4.03 (s, 1H), 3.38 (dd, *J* = 12.3, 4.0 Hz, 1H), 3.20 (dd, *J* = 12.3, 9.3 Hz, 1H), 2.01 (dq, *J* = 13.6, 6.9 Hz, 1H), 1.08 (t, *J* = 6.9 Hz, 6H), 0.47 (d, *J* = 2.5 Hz, 3H), 0.46 (d, *J* = 2.9 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 172.31 (d, *J* = 2.3 Hz), 167.13 (d, *J* = 242.1 Hz), 148.32, 143.98 (d, *J* = 10.5 Hz), 131.52 (d, *J* = 9.4 Hz), 129.48, 125.71 (d, *J* = 31.4 Hz), 122.49 (d, *J* = 2.8 Hz), 118.03, 117.53 (d, *J* = 27.5 Hz), 113.14, 55.42, 46.68, 30.96, 29.85, 19.81, 18.53, 1.82 (d, *J* = 3.3 Hz), 1.48 (d, *J* = 4.4 Hz); ^{19}F{^{1}H} NMR (283 MHz, $CDCl_3$) δ –96.64; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ 5.25 (d, *J* = 8.4 Hz); IR (neat) 3364, 3280, 3055, 2960, 1633, 1602, 1508, 1256, 1223, 829, 748, 692 cm^{-1}; HRMS (ESI/Orbitrap) m/z: [M – H_2O + H]$^+$ Calcd for $C_{20}H_{28}FN_2O_2Si$ 357.1798; Found 357.1791; R_f = 0.22 (hexanes/EtOAc/Et_3N, 7:2:0.15 *v*/*v*/*v*).

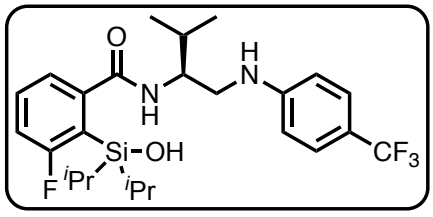
(*S*)-2-(3-fluorophenyl)-4-isopropyl-1-(4-(trifluoromethyl)phenyl)-4,5-dihydro-1*H*-imidazole (3h)



Synthesized according to the General Procedure B for imidazoline formation using β-hydroxy amide (**S1a**) (1.000 g, 4.439 mmol), thionyl chloride (1.30 mL, 17.8 mmol), Et_3N (1.86 mL, 13.3 mmol) and 4-(trifluoromethyl)aniline (0.67 mL, 5.3 mmol). The reaction mixture was purified using flash column chromatography (SiO_2, gradient from 100% DCM to 20:1 DCM/MeOH) to give the imidazoline (**3h**) as a yellow oil (0.82 g, 53%).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.44 – 7.35 (m, 2H), 7.37 – 7.20 (m, 3H), 7.17 – 7.04 (m, 1H), 6.81 – 6.70 (m, 2H), 4.20 – 4.02 (m, 2H), 3.73 (ddd, *J* = 5.7, 5.6, 1.8 Hz, 1H), 2.03 – 1.82 (m, 1H), 1.05 (d, *J* = 6.8 Hz, 3H), 0.96 (d, *J* = 6.7 Hz, 3H); ^{13}C{^{1}H} NMR (76 MHz, $CDCl_3$) δ 162.7 (d, *J* = 247.1 Hz), 159.3 (d, *J* = 2.7 Hz), 145.5 (d, *J* = 1.1 Hz), 133.4 (d, *J* = 7.9 Hz), 130.3 (d, *J* = 8.2 Hz), 126.1 (q, *J* = 3.8 Hz), 124.5 (d, *J* = 3.3 Hz), 124.4 (q, *J* = 33.0 Hz), 124.3 (q, *J* = 271.1 Hz), 120.9, 117.5 (d, *J* = 21.3 Hz), 115.9 (d, *J* = 22.9 Hz), 70.5, 55.9, 33.1, 18.9, 18.1; ^{19}F{^{1}H} NMR (283 MHz, $CDCl_3$) δ –61.96, –111.96; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{19}H_{19}F_4N_2$ 351.1484; Found 351.1472.

(*S*)-3-fluoro-2-(hydroxydiisopropylsilyl)-*N*-(3-methyl-1-((4-(trifluoromethyl)phenyl)amino)butan-2-yl)benzamide (L3h)

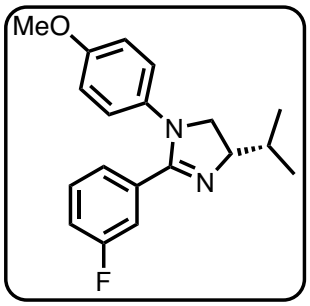


Synthesized according to the General Procedure E for silane formation using imidazoline (**3h**) (1.09 g, 3.12 mmol), *sec*-BuLi (1.4 M in cyclohexane, 2.67 mL, 3.74 mmol), TMEDA (0.56 mL, 3.74 mmol) and diisopropylchlorosilane (0.69 mL, 4.0 mmol). The reaction mixture was filter through a silica plug (DCM/MeOH, 10:1 *v*/*v*) to yield the mixture of unreacted imidazoline and silane (**3h**:**4h**, 1:3). The resulting mixture was carried on to the next step, and the imidazoline is removed after the purification in the next step. Confirmation of the silane product was achieved through distinctive peaks in ^{1}H NMR and ^{19}F NMR with δ −95.42 ppm.

For silanol formation using mixture of imidazoline (**3h**) and silane (**4h**) from previous step (1:3, 1.19 g, 2.56 mmol, calculated based off silane), Pd/C (10 wt%, 136 mg, 0.128 mmol) and H_2O (0.46 mL, 25.6 mmol) in THF (0.15 M) at 60 °C for 6 h. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:1.5 *v*/*v*/*v*) to give the silanol as a crystalline white solid (561 mg, 44%) over two steps. R_f = 0.23 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.32 (m, 3H), 7.14 – 7.03 (m, 2H), 6.68 (d, *J* = 8.6 Hz, 2H), 5.87 (d, *J* = 9.9 Hz, 1H), 4.86 (br, 1H), 4.29 (dddd, *J* = 9.9, 9.9, 5.9, 3.5 Hz, 1H), 3.53 (br, 1H), 3.40 (dd, *J* = 12.2, 3.5 Hz, 1H), 3.13 (dd, *J* = 12.2, 9.9 Hz, 1H), 2.05 – 1.92 (m, 1H), 1.37 – 1.23 (m, 2H), 1.17 – 0.98 (m, 15H), 0.92 (d, *J* = 7.5 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 173.1 (d, *J* = 2.3 Hz), 166.7 (d, *J* = 240.8 Hz), 150.9, 145.2 (d, *J* = 11.6 Hz), 131.6 (d, *J* = 9.1 Hz), 126.7 (q, *J* = 3.7 Hz), 125.2 (q, *J* = 270.4 Hz), 122.6 (d, *J* = 34.8 Hz), 122.6 (d, *J* = 2.6 Hz), 118.9 (q, *J* = 32.4 Hz), 116.9 (d, *J* = 27.6 Hz), 112.0, 55.1, 46.1, 31.3, 19.9, 18.4, 17.8 (d, *J* = 2.1 Hz), 17.4 (d, *J* = 1.5 Hz), 17.2 (d, *J* = 2.2 Hz), 14.2 (d, *J* = 1.8 Hz), 13.6 (d, *J* = 2.6 Hz), 13.2 (d, *J* = 1.1 Hz); ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –60.95 (3F), –94.71 (1F); ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ 9.86 (d, *J* = 4.9 Hz); IR (neat) 3344, 2945, 2866, 1616, 1596, 1533, 1325, 1105, 1065, 827 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M – H_2O + H]^+$ Calcd for $C_{25}H_{33}F_4N_2OSi$ 481.2298; Found 481.2291; mp: 86−90 °C.

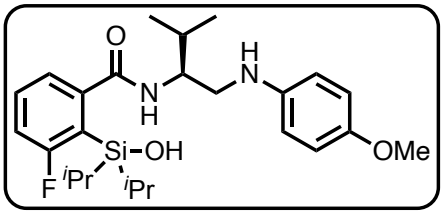
(*S*)-2-(3-fluorophenyl)-4-isopropyl-1-(4-methoxyphenyl)-4,5-dihydro-1*H*-imidazole (3i)



Synthesized according to the General Procedure B for imidazoline formation using β-hydroxy amide (**S1a**) (0.50 g, 2.22 mmol), thionyl chloride (0.65 mL, 8.9 mmol), Et_3N (0.93 mL, 6.7 mmol) and *p*-anisidine (0.33 mL, 2.7 mmol). The reaction mixture was purified using flash column chromatography (SiO_2, gradient from 100% DCM to 10:1 DCM/MeOH) to give the imidazoline as a yellow oil (0.39 g, 53%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 – 7.15 (m, 3H), 7.05 – 6.96 (m, 1H), 6.81 – 6.68 (m, 4H), 4.11 – 3.98 (m, 2H), 3.74 (s, 3H), 3.55 (ddd, *J* = 5.3, 5.2, 2.0 Hz, 1H), 1.98 – 1.84 (m, 1H), 1.05 (d, *J* = 6.7 Hz, 3H), 0.96 (d, *J* = 6.7 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 162.4 (d, *J* = 243.9 Hz), 156.5, 136.7, 133.7 (d, *J* = 7.7 Hz), 129.8 (d, *J* = 8.4 Hz), 125.2, 124.7 (d, *J* = 2.9 Hz), 116.8 (d, *J* = 20.9 Hz), 116.0 (d, *J* = 23.1 Hz), 114.3, 70.4, 57.5, 55.5, 33.3, 19.0, 18.1; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –112.91; HRMS (ESI/Orbitrap) m/z: [M + H]$^+$ Calcd for $C_{19}H_{22}FN_2O$ 313.1716; Found 313.1708.

(*S*)-3-fluoro-2-(hydroxydiisopropylsilyl)-*N*-(1-((4-methoxyphenyl)amino)-3-methylbutan-2-yl)benzamide (L3i)

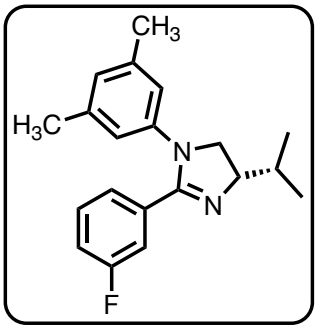


Synthesized according to the General Procedure E for silane formation using imidazoline (**3f**) (0.320 g, 1.00 mmol), *sec*-BuLi (1.4 M in cyclohexane, 0.88 mL, 1.2 mmol), TMEDA (0.18 mL, 1.2 mmol) and diisopropylchlorosilane (0.23 mL, 1.3 mmol). The reaction mixture was filter through a silica plug (DCM/MeOH, 10:1 *v*/*v*) to yield the mixture of unreacted imidazoline (**3i**) and the corresponding silane (**4i**), (**3i**:**4i**, 1:1). The resulting mixture was carried on to the next step. Confirmation of the silane product was achieved through distinctive peaks in ^{1}H NMR and ^{19}F NMR with δ -96.18 ppm.
For silanol formation, mixture of imidazoline (**3i**) and silane (**4i**) (1:1, 236 mg, 0.553 mmol, calculated based off silane), Pd/C (10 wt%, 29 mg, 0.028 mmol) and H_2O (0.10 mL, 5.5 mmol) were used in THF (0.15 M) at 60 °C for 16 h. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:2.5 *v*/*v*/*v*) to give the silanol as a crystalline white solid (210 mg, 38%) over two steps. R_f = 0.26 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 (ddd, *J* = 8.2, 8.2, 5.8 Hz, 1H), 7.13 (d, *J* = 7.7 Hz, 1H), 7.06 (ddd, *J* = 8.5, 8.4, 1.0 Hz, 1H), 6.82 – 6.73 (m, 2H), 6.70 – 6.61 (m, 2H), 5.95 (d, *J* = 9.5 Hz, 1H), 4.24 (dddd, *J* = 9.5, 9.5, 6.1, 3.8 Hz, 1H), 3.88 (br, 2H), 3.74 (s, 3H), 3.33 (dd, *J* = 12.2, 3.8 Hz, 1H), 3.12 (dd, *J* = 12.2, 9.5 Hz, 1H), 2.06 – 1.92 (m, 1H), 1.36 – 1.21 (m, 2H), 1.12 – 1.02 (m, 12H), 0.99 (dd, *J* = 7.5, 1.3 Hz, 3H), 0.93 (dd, *J* = 7.5, 1.2 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 172.7 (d, *J* = 2.2 Hz), 166.8 (d, *J* = 240.6 Hz), 152.5, 145.4 (d, *J* = 11.4 Hz), 142.6, 131.4 (d, *J* = 9.2 Hz), 122.9 (d, *J* = 34.5 Hz), 122.8 (d, *J* = 2.6 Hz), 116.8 (d, *J* = 27.9 Hz), 114.8 (d, *J* = 53.9 Hz), 55.9, 55.4, 47.5, 31.1, 19.8, 18.5, 17.9 (d, *J* = 2.2 Hz), 17.8 (d, *J* = 2.2 Hz), 17.4, 14.2 (d, *J* = 2.2 Hz), 13.9 (d, *J* = 2.6 Hz); ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –94.85; ^{29}Si{^{1}H} NMR

(79 MHz, $CDCl_3$) δ 8.79 (d, *J* = 4.8 Hz); IR (near) 3323, 2943, 2866, 1633, 1595, 1510, 1464, 1221, 1030, 883 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M - H_2O + H]^+$ Calcd for $C_{25}H_{36}FN_2O_2Si$ 443.2530; Found 443.2523.

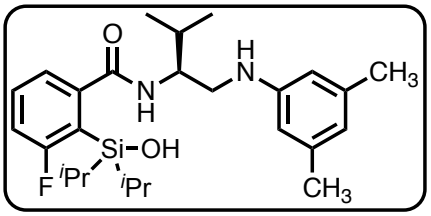
(*S*)-1-(3,5-dimethylphenyl)-2-(3-fluorophenyl)-4-isopropyl-4,5-dihydro-1*H*-imidazole (3j)



Synthesized according to the General Procedure B for imidazoline formation using β-hydroxy amide (**S1a**) (0.541 g, 2.40 mmol), thionyl chloride (0.70 mL, 9.6 mmol), Et_3N (1.00 mL, 7.20 mmol) and 3,5-dimethylaminde (0.36 mL, 2.88 mmol). The crude product was purified using flash column chromatography (SiO_2, gradient from 100% DCM to 20:1 DCM/MeOH) to give the imidazoline as a yellow oil (0.288 g, 37%).

^1H NMR (400 MHz, $CDCl_3$) δ 7.29 – 7.18 (m, 3H), 7.09 – 6.99 (m, 1H), 6.65 (s, 1H), 6.39 (s, 2H), 4.13 – 4.00 (m, 2H), 3.70 – 3.59 (m, 1H), 2.16 (s, 6H), 1.98 – 1.86 (m, 1H), 1.04 (d, *J* = 6.8 Hz, 3H), 0.96 (d, *J* = 6.8 Hz, 3H); $^{13}C\{^1H\}$ NMR (101 MHz, $CDCl_3$) δ 162.4 (d, *J* = 246.1 Hz), 160.7 (d, *J* = 2.9 Hz), 142.7, 138.6, 129.8 (d, *J* = 8.4 Hz), 125.7, 124.7 (d, *J* = 2.9 Hz), 120.6, 117.0 (d, *J* = 21.3 Hz), 116.0 (d, *J* = 23.1 Hz), 69.9, 56.7, 33.2, 21.4, 19.0, 18.0; $^{19}F\{^1H\}$ NMR (376 MHz, $CDCl_3$) δ -112.87; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{20}H_{24}FN_2$ 311.1923; Found 311.1912.

(*S*)-*N*-(1-((3,5-dimethylphenyl)amino)-3-methylbutan-2-yl)-3-fluoro-2-(hydroxydiisopropylsilyl)benzamide (L3j)

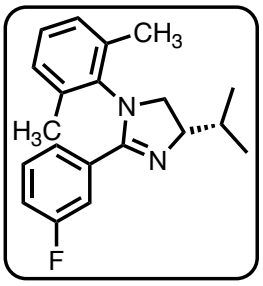


Synthesized according to the General Procedure C for silane formation using imidazoline (**3j**) (261 mg, 0.796 mmol), *sec*-BuLi (1.4 M in cyclohexane, 1.3 mL, 1.8 mmol), TMEDA (0.27 mL, 1.8 mmol) and diisopropylchlorosilane (0.34 mL, 2.0 mmol). The crude silane product was purified via flash column chromatography (DCM/MeOH, 20:1 v/v) but reacted with silica gel, partially converting into the titled silanol on the surface of the silica column. The isolated product was a mixture of silane **4j** and the titled silanol. Confirmation of the silane formation was achieved through distinctive peaks in ^1H NMR and ^{19}F NMR with δ -96.24 ppm.

The mixture was then subjected to silane hydrolysis following General Procedure D using silane (**4j**) (320 mg, 0.724 mmol, calculated based off silane), Pd/C (10 wt%, 39 mg, 0.036 mmol) and H_2O (0.13 mL, 7.2 mmol) in THF (0.07 M) at room temperature for 16 h. The crude product was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:1.5 *v*/*v*/*v*) to give the silanol as a crystalline white solid (250 mg, 69%). R_f = 0.18 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.35 (ddd, *J* = 8.3, 7.5, 5.9 Hz, 1H), 7.13 (d, *J* = 7.4 Hz, 1H), 7.06 (ddd, *J* = 9.1, 8.3, 1.0 Hz, 1H), 6.38 (s, 1H), 6.33 (s, 2H), 5.92 (d, *J* = 9.6 Hz, 1H), 4.24 (dddd, *J* = 9.6, 9.6, 6.1, 3.7 Hz, 1H), 3.90 (br, 2H), 3.37 (dd, *J* = 12.2, 3.7 Hz, 1H), 3.13 (dd, *J* = 12.2, 9.6 Hz, 1H), 2.23 (s, 6H), 2.04 – 1.92 (m, 1H), 1.40 – 1.21 (m, 2H), 1.15 – 1.03 (m, 12H), 1.00 (dd, *J* = 7.4, 1.5 Hz, 3H), 0.94 (dd, *J* = 7.4, 1.1 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 172.8 (d, $^4J_{C,F}$ = 2.6 Hz), 166.8 (d, $^1J_{C,F}$ = 240.3 Hz), 148.5, 145.3 (d, $^3J_{C,F}$ = 11.7 Hz), 139.0, 131.5 (d, $^3J_{C,F}$ = 9.2 Hz), 122.9 (d, $^2J_{C,F}$ = 35.2 Hz), 122.8 (d, $^4J_{C,F}$ = 2.6 Hz), 119.8, 116.8 (d, $^2J_{C,F}$ = 27.9 Hz), 111.1, 55.4, 46.4, 31.2, 21.6, 19.8, 18.5, 17.9 (d, $^5J_{C,F}$ = 2.2 Hz), 17.8 (d, $^5J_{C,F}$ = 2.2 Hz), 17.43, 17.39, 14.3 (d, $^4J_{C,F}$ = 1.8 Hz), 13.8 (d, $^4J_{C,F}$ = 2.6 Hz); ^{19}F{^{1}H} NMR (283 MHz, $CDCl_3$) δ -94.89; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ 9.03 (d, *J* = 5.1 Hz); IR (neat) 3375, 2958, 2864, 1653, 1603, 1508, 881, 856, 791, 667 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M - H_2O + H]^+$ Calcd for $C_{26}H_{38}FN_2OSi$ 441.2737; Found 441.2733; mp: 139 −143 °C.

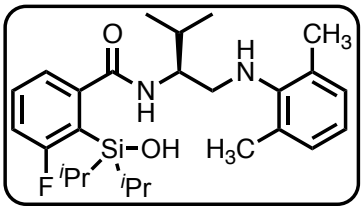
(*S*)-1-(2,6-dimethylphenyl)-2-(3-fluorophenyl)-4-isopropyl-4,5-dihydro-1*H*-imidazole (3k)



Synthesized according to the General Procedure B for imidazoline formation using β-hydroxy amide (**S1a**) (0.541 g, 2.40 mmol), thionyl chloride (0.70 mL, 9.6 mmol), Et_3N (1.00 mL, 7.20 mmol) and 2,6-dimethylaminde (0.36 mL, 2.88 mmol). The crude product was purified using flash column chromatography (SiO_2, gradient from 100% DCM to 20:1 DCM/MeOH) to give the imidazoline as a yellow oil (0.459 g, 58%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.19 – 7.08 (m, 3H), 7.08 – 6.92 (m, 4H), 4.18 (ddd, *J* = 11.2, 9.4, 6.3 Hz, 1H), 3.78 (dd, *J* = 11.2, 9.4 Hz, 1H), 3.52 (dd, *J* = 9.4, 9.4 Hz, 1H), 2.25 (s, 3H), 2.17 (s, 3H), 2.07 – 1.98 (m, 1H), 1.11 (d, *J* = 6.7 Hz, 3H), 1.01 (d, *J* = 6.8 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 162.5 (d, *J* = 2.9 Hz), 162.2 (d, *J* = 245.8 Hz), 139.2, 136.8, 136.4, 129.7 (d, *J* = 8.4 Hz), 129.1 (d, *J* = 2.2 Hz), 127.8, 123.8 (d, *J* = 2.9 Hz), 117.2 (d, *J* = 20.9 Hz), 115.3 (d, *J* = 23.5 Hz), 70.4, 54.6, 33.5, 19.4, 18.4, 18.3, 18.2; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ -112.80; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{20}H_{24}FN_2$ 311.1923; Found 311.1911.

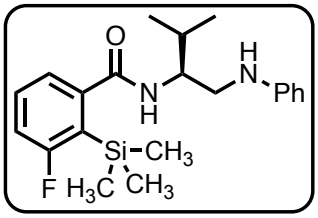
(*S*)-*N*-(1-((2,6-dimethylphenyl)amino)-3-methylbutan-2-yl)-3-fluoro-2-(hydroxydiisopropylsilyl)benzamide (L3k)



Synthesized according to the General Procedure H for silane formation using imidazoline (**3k**) (250 mg, 0.762 mmol), *sec*-BuLi (1.4 M in cyclohexane, 0.71 mL, 0.99 mmol), TMEDA (0.15 mL, 0.99 mmol) and diisopropylchlorosilane (0.18 mL, 1.1 mmol). The crude silane product reacted with silica gel and turned into the titled silanol product on the surface and during silica column chromatography. The crude product was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:1.5 *v*/*v*/*v*) to give the silanol as a crystalline white solid (201 mg, 58%) over two steps. R_f = 0.23 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.08 – 6.93 (m, 5H), 6.88 (ddd, *J* = 9.1, 8.2, 1.1 Hz, 1H), 6.81 (d, *J* = 7.8 Hz, 1H), 4.04 (ddd, *J* = 10.6, 10.5, 7.9 Hz, 1H), 3.71 (dd, *J* = 10.6, 9.9 Hz, 1H), 3.55 (dd, *J* = 9.9, 9.9 Hz, 1H), 2.26 (s, 3H), 2.22 (s, 3H), 1.98 – 1.82 (m, 1H), 1.39 – 1.20 (m, 2H), 1.19 – 1.08 (m, 9H), 1.04 – 0.94 (m, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 167.0 (d, $^{1}J_{C,F}$ = 236.6 Hz), 165.2 (d, $^{4}J_{C,F}$ = 2.6 Hz), 139.6, 138.0 (d, $^{3}J_{C,F}$ = 12.5 Hz), 136.3, 136.1, 129.8 (d, $^{3}J_{C,F}$ = 9.5 Hz), 129.1 (d, $^{4}J_{C,F}$ = 2.2 Hz), 127.5, 125.8 (d, $^{4}J_{C,F}$ = 2.2 Hz), 125.2 (d, $^{2}J_{C,F}$ = 34.8 Hz), 116.3 (d, $^{2}J_{C,F}$ = 28.2 Hz), 70.8, 55.7, 34.3, 19.7, 19.3, 18.8, 18.7, 18.4 (d, $^{5}J_{C,F}$ = 1.8 Hz), 18.3 (d, $^{5}J_{C,F}$ = 2.6 Hz), 17.9, 17.8 (d, $^{6}J_{C,F}$ = 1.1 Hz), 15.1 (d, $^{4}J_{C,F}$ = 2.9 Hz), 14.8 (d, $^{4}J_{C,F}$ = 4.0 Hz); ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ -93.79; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ 8.53 (d, *J* = 8.1 Hz); IR 3279, 2956, 2864, 1645, 1578, 1464, 1419, 1219, 883, 849, 796 cm^{-1}; HRMS (ESI/Orbitrap) m/z: [M + H]$^{+}$ Calcd for $C_{26}H_{40}FN_2O_2Si$ 459.2843; Found 459.2838.

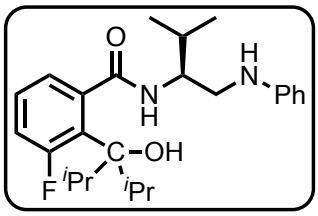
(S)-3-fluoro-N-(3-methyl-1-(phenylamino)butan-2-yl)-2-(trimethylsilyl)benzamide (L4)



Synthesized according to the General Procedure G for silane formation using aminoamide (**S2**) (150 mg, 0.50 mmol), *sec*-BuLi (1.4 M in cyclohexane, 1.14 mL, 1.60 mmol, 3.2 equiv), TMEDA (240 µL, 1.60 mmol, 3.2 equiv) and trimethylchlorosilane (210 µL, 1.65 mmol). The reaction mixture was purified via flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*) to yield the silane as a clear oil (67 mg, 36%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 (ddd, *J* = 8.2, 7.5, 5.6 Hz, 1H), 7.25 – 7.15 (m, 2H), 7.15 – 7.01 (m, 2H), 6.74 (tt, *J* = 7.3, 1.1 Hz, 1H), 6.65 (dd, *J* = 8.6, 1.1 Hz, 2H), 5.90 (d, *J* = 9.1 Hz, 1H), 4.27 – 4.18 (m, 1H), 3.45 (d, *J* = 7.2 Hz, 1H), 3.39 (dd, *J* = 12.4, 4.3 Hz, 1H), 3.27 (dd, *J* = 12.4, 8.3 Hz, 1H), 2.13 – 2.04 (m, 1H), 1.10 (d, *J* = 3.0 Hz, 3H), 1.09 (d, *J* = 3.0 Hz, 3H), 0.40 (d, *J* = 2.1 Hz, 9H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.05 (d, *J* = 2.6 Hz), 168.01 (d, *J* = 243.2 Hz), 148.33, 145.14 (d, *J* = 10.3 Hz), 131.07 (d, *J* = 9.5 Hz), 129.47, 125.38 (d, *J* = 30.4 Hz), 122.61 (d, *J* = 2.6 Hz), 117.75, 117.17 (d, *J* = 28.2 Hz), 112.88, 55.06, 46.40, 30.57, 29.85, 19.63, 18.59, 1.00, 0.96; ^{19}F NMR (376 MHz, $CDCl_3$) δ -94.72; ^{29}Si NMR (79 MHz, $CDCl_3$) δ -3.78 (d, *J* = 6.2 Hz); HRMS (ESI/Orbitrap) m/z: [M + H]$^{+}$ Calcd for $C_{21}H_{30}FNOSi$ 373.2111; Found 373.2097; R_f = 0.20 (hexanes/EtOAc/Et_3N, 7:2:0.15 *v*/*v*/*v*).

(*S*)-3-fluoro-2-(3-hydroxy-2,4-dimethylpentan-3-yl)-*N*-(3-methyl-1-(phenylamino)butan-2-yl)benzamide (L5)

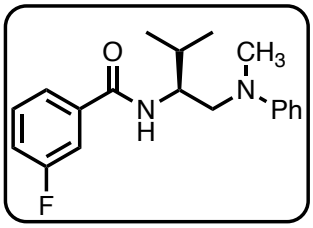


Aminoamide (**S2**, 170 mg, 0.57 mmol, 1.0 equiv) was directly into a flame-dried round bottom flask, dissolved in THF (2 mL), and purged under argon for 5 min. The reaction was cooled to –78 °C and TMEDA (270 µL, 3.2 equiv) was added followed by the dropwise addition of *sec*-butyl lithium (1.4 M in cyclohexane, 3.2 equiv, 1.3 mL). The mixture was stirred at –78 °C for 2 h to form lithiated aminoamide. In a separate flask, $CeCl_3$ (461 mg, 1.88 mmol, 3.3 equiv) was added and flame-dried under high vacuum (<1 torr). After the vial cooled to room temperature, it was purged with argon and capped with a septa with an Ar-balloon. 2,4-dimethylpentan-3-one (265 mg, 1.88 mmol, 3.3 equiv) and anhydrous THF (2 mL) were added into the flask. The mixture was stirred at room temperature for 1 h to activate the ketone. At which point, the lithiated

aminoamide solution was drawn into a 5-mL syringe with long needle and added dropwise into the stirring solution at –78 °C. The reaction was allowed to stir at room temperature and stirred for 40 h. The solution was quenched with saturated aq. NH_4Cl (7 mL) and the aqueous phase was extracted with EtOAc (3 × 5 mL) and dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:40:3 *v*/*v*/*v*) to yield the corresponding silane (9 mg, 4%).

^1H NMR (800 MHz, $CDCl_3$) δ 7.67 (t, *J* = 6.9 Hz, 1H), 7.40 (dd, *J* = 8.1, 1.9 Hz, 1H), 7.37 (dd, *J* = 12.8, 1.9 Hz, 1H), 7.15 (dd, *J* = 8.6, 7.3 Hz, 2H), 6.69 (tt, *J* = 7.3, 1.1 Hz, 1H), 6.63 (dd, *J* = 8.7, 1.1 Hz, 2H), 6.03 (d, *J* = 8.9 Hz, 1H), 4.26 (dddd, *J* = 8.8, 8.8, 6.1, 4.0 Hz, 1H), 4.02 (s, 1H), 3.39 (dd, *J* = 12.4, 4.1 Hz, 1H), 3.25 (dd, *J* = 12.4, 8.8 Hz, 1H), 2.55 – 2.51 (m, 2H), 2.06 – 1.98 (m, *J* = 6.8 Hz, 1H), 1.06 (dd, *J* = 12.0, 6.8 Hz, 6H), 0.87 (dd, *J* = 6.7, 2.0 Hz, 6H), 0.80 (dd, *J* = 6.9, 2.1 Hz, 6H); $^{13}C\{^1H\}$ NMR (151 MHz, $CDCl_3$) δ 167.02 (d, *J* = 2.0 Hz), 159.65 (d, *J* = 244.0 Hz), 148.46, 135.23 (d, *J* = 7.7 Hz), 133.68 (d, *J* = 13.2 Hz), 131.38 (d, *J* = 5.5 Hz), 129.47, 121.50 (d, *J* = 2.8 Hz), 117.76, 115.28 (d, *J* = 28.1 Hz), 112.92, 82.16 (d, *J* = 5.5 Hz), 55.15, 46.87, 33.91 (d, *J* = 2.8 Hz), 33.88 (d, *J* = 2.8 Hz), 30.67, 29.85, 19.77, 18.55, 17.98, 17.97, 16.72; $^{19}F\{^1H\}$ NMR (376 MHz, $CDCl_3$) δ –106.60; HRMS (ESI/Orbitrap) m/z: [M + H]+ Calcd for $C_{25}H_{36}FN_2O_2$ 415.2761; Found 415.2761. R_f = 0.35 (hexanes/EtOAc/Et_3N, 7:2:0.15 v/v/v).

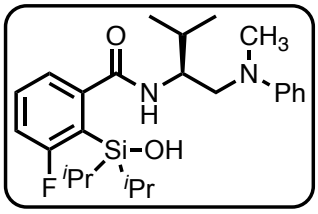
(*S*)-3-fluoro-*N*-(3-methyl-1-(methyl(phenyl)amino)butan-2-yl)benzamide (S4)



To a solution of aldehyde (**S10**) (220 mg, 0.987 mmol, 1.0 equiv) and acetic acid (28 µL, 0.49 mmol, 0.5 equiv) in DCM at 0 °C, N-methyl aniline (0.13 mL, 1.2 mmol, 1.2 equiv) was added. The solution was added with sodium triacetoxyborohydride (335 mg, 1.58 mmol, 1.60 equiv) and stirred for overnight at room temperature. To quench the reaction, aq. 1M NaOH (5 mL) was added while stirring. The aqueous phase was extracted with DCM (2 × 10 mL), and the combined organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The resulting reaction mixture was purified using flash column chromatography (SiO_2, DCM/MeOH, 30:1 *v*/*v*) to give the product **S4** as a white solid (65.7 mg, 21%). R_f = 0.32 (DCM/MeOH, 30:1 *v*/*v*).

^1H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.19 (m, 3H), 7.17 – 7.05 (m, 2H), 6.80 (d, *J* = 8.3 Hz, 2H), 6.72 (dd, *J* = 7.3, 7.3 Hz, 1H), 5.82 (d, *J* = 9.4 Hz, 1H), 4.41 (dddd, *J* = 9.4, 9.3, 5.7, 5.5 Hz, 1H), 3.76 (dd, *J* = 14.9, 9.3 Hz, 1H), 3.37 (dd, *J* = 14.9, 5.7 Hz, 1H), 2.97 (s, 3H), 2.07 – 1.91 (m, 1H), 1.09 – 1.00 (m, 6H); $^{13}C\{^1H\}$ NMR (101 MHz, $CDCl_3$) δ 166.5 (d, *J* = 2.6 Hz), 162.7 (d, *J* = 247.6 Hz), 150.2, 137.2 (d, *J* = 7.0 Hz), 130.1 (d, *J* = 7.7 Hz), 129.7, 122.3 (d, *J* = 3.3 Hz), 118.2 (d, *J* = 21.3 Hz), 116.8, 114.2 (d, *J* = 23.1 Hz), 112.6, 53.5 (d, *J* = 22.7 Hz), 38.4, 30.3, 19.8, 17.9; $^{19}F\{^1H\}$ NMR (376 MHz, $CDCl_3$) δ –111.99; IR (neat): 3280, 3064, 2960, 2872, 1633, 1597, 1585, 1504, 1215, 744, 690 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{19}H_{24}FN_2O$ 315.1872; Found 315.1873.

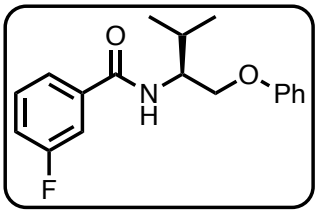
(*S*)-3-fluoro-2-(hydroxydiisopropylsilyl)-*N*-(3-methyl-1-(methyl(phenyl)amino)butan-2-yl)benzamide (L6)

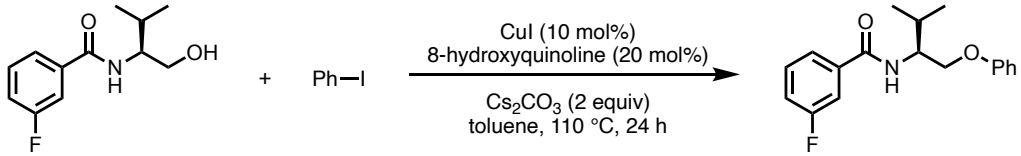


Synthesized according to the General Procedure H for silane formation using methylated-aminoamide (**S4**) (120 mg, 0.382 mmol), *sec*-BuLi (1.4 M in cyclohexane, 0.65 mL, 0.92 mmol, 2.4 equiv), TMEDA (0.14 mL, 0.92 mmol, 2.4 equiv) and diisopropylchlorosilane (0.16 mL, 0.96 mmol, 2.5 equiv). The crude silane product reacted with silica gel and turned into the titled silanol product on the surface of silica column chromatography. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:1.5 *v*/*v*/*v*) to give the silanol as a crystalline white solid (84 mg, 49%) over two steps. R_f = 0.31 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.20 (m, 2H), 7.14 (ddd, *J* = 8.0, 7.7, 6.0 Hz, 1H), 6.98 (ddd, *J* = 8.7, 8.4, 1.0 Hz, 1H), 6.84 – 6.76 (m, 2H), 6.75 (dddd, *J* = 7.2, 7.2, 1.0, 1.0 Hz, 1H), 6.39 (dd, *J* = 7.5, 1.0 Hz, 1H), 5.76 (d, *J* = 9.7 Hz, 1H), 4.41 (dddd, *J* = 9.7, 9.7, 5.5, 5.2 Hz, 1H), 3.89 (br, 1H), 3.72 (dd, *J* = 14.8, 9.7 Hz, 1H), 3.31 (dd, *J* = 14.9, 5.5 Hz, 1H), 2.97 (s, 3H), 2.05 – 1.88 (m, 1H), 1.33 – 1.16 (m, 2H), 1.15 – 0.97 (m, 12H), 1.00 – 0.83 (m, 6H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 172.1 (d, *J* = 2.6 Hz), 166.8 (d, *J* = 239.9 Hz), 150.2, 144.9 (d, *J* = 11.7 Hz), 131.2 (d, *J* = 9.2 Hz), 129.8, 123.3 (d, *J* = 34.5 Hz), 123.0 (d, *J* = 2.6 Hz), 117.0, 116.8 (d, *J* = 27.9 Hz), 112.7, 53.7, 53.1, 38.3, 30.3, 19.7, 17.9 (d, *J* = 1.8 Hz), 17.9, 17.8 (d, *J* = 1.8 Hz), 17.5, 17.4, 14.5 (d, *J* = 2.9 Hz), 13.9 (d, *J* = 2.9 Hz); ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –94.76; ^{29}Si NMR (79 MHz, $CDCl_3$) δ 8.17 (d, *J* = 5.5 Hz); IR (neat): 3427, 2943, 2864, 1632, 1597, 1506, 1446, 1221, 858, 746 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{25}H_{38}FN_2O_2Si$ 445.2686; Found 445.2678.

(*S*)-3-fluoro-*N*-(3-methyl-1-phenoxybutan-2-yl)benzamide (S5)



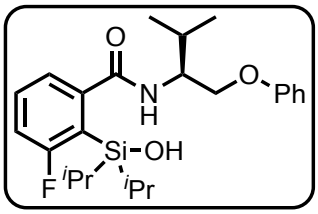


A 7 mL microwave vial containing Cs_2CO_3 (2.0 equiv, 1.96 mmol, 639 mg) and a stir bar was flame-dried under high vacuum (<1 torr). After the vial cooled to room temperature, it was purged with argon. β-hydroxyamide (**S1a**) (1.5 equiv, 2.22 mmol, 500 mg), CuI (0.1 equiv, 0.15 mmol, 29 mg) and 8-hydroxyquinoline (0.2 equiv, 0.30 mmol, 44 mg) were added by difference (directly from reagent bottle or flask to reaction vial). The vial was re-purged with argon and sealed with a PTFE silicone septa, and anhydrous toluene (2 mL) was then added and was stirred for 24 h at 110 °C. To quench the reaction, H_2O (3 mL) was added while stirring. The aqueous phase was extracted with DCM (2 × 10 mL), and the combined organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 6:1 *v*/*v*) to give the product as a clear liquid (74.1 mg, 17%). R_f = 0.27 (hexanes/EtOAc, 6:1 *v*/*v*).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 – 7.45 (m, 2H), 7.39 (ddd, *J* = 8.1, 7.9, 5.7 Hz, 1H), 7.33 – 7.26 (m, 2H), 7.19 (dddd, *J* = 8.3, 8.3, 2.6, 1.0 Hz, 1H), 6.97 (tt, *J* = 7.3, 1.1 Hz, 1H), 6.94 – 6.88 (m, 2H), 6.43 (d, *J* = 9.0 Hz, 1H), 4.24 (dddd, *J* = 9.3, 8.0, 3.4, 3.4 Hz, 1H), 4.18 (dd, *J* = 9.5, 3.4 Hz, 1H), 4.09 (dd, *J* = 9.5, 3.4 Hz,

1H), 2.18 (dqq, *J* = 8.0, 6.8, 6.8 Hz, 1H), 1.06 (dd, *J* = 6.8, 4.7 Hz, 6H); $^{13}C\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) δ 166.1 (d, *J* = 2.6 Hz), 162.9 (d, *J* = 248.0 Hz), 158.8, 137.1 (d, *J* = 7.0 Hz), 130.4 (d, *J* = 8.1 Hz), 129.7, 122.5 (d, *J* = 2.9 Hz), 121.4, 118.6 (d, *J* = 21.3 Hz), 114.6, 114.5 (d, *J* = 17.6 Hz), 67.8, 54.7, 29.7, 19.8, 19.5; $^{19}F\{^{1}H\}$ NMR (283 MHz, $CDCl_3$) δ –111.74;; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{18}H_{21}FNO_2$ 302.1556; Found 302.1554.

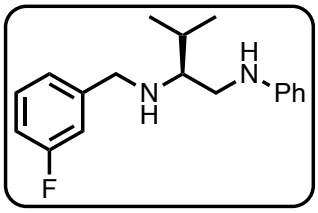
(*S*)-3-fluoro-2-(hydroxydiisopropylsilyl)-*N*-(3-methyl-1-phenoxybutan-2-yl)benzamide (L7)

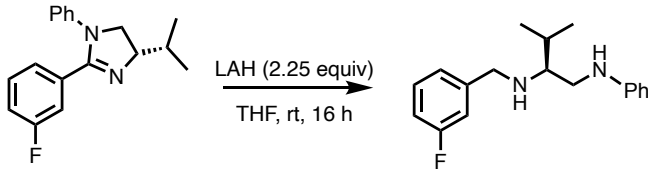


Synthesized according to the General Procedure H using **S5** (70 mg, 0.23 mmol), *sec*-BuLi (1.4 M in cyclohexane, 0.35 mL, 0.49 mmol, 2.1 equiv), TMEDA (57 µL, 0.49 mmol, 2.1 equiv) and diisopropylchlorosilane (75 µL, 0.51 mmol, 2.2 equiv). The crude silane product reacted with silica gel and turned into the titled silanol product on the surface of silica column chromatography. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 6:1 *v*/*v*) to give the silanol as a clear liquid (15 mg, 15%) over two-steps. R_f = 0.41 (hexanes/EtOAc, 6:1 *v*/*v*).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 (ddd, *J* = 8.3, 7.5, 5.8 Hz, 1H), 7.32 – 7.26 (m, 2H), 7.22 (dd, *J* = 7.5, 1.2 Hz, 1H), 7.08 (ddd, *J* = 9.1, 8.3, 1.1 Hz, 1H), 6.97 (tt, *J* = 7.4, 1.1 Hz, 1H), 6.95 – 6.90 (m, 2H), 6.36 (d, *J* = 9.4 Hz, 1H), 4.22 (dddd, *J* = 9.4, 8.0, 3.5, 3.5 Hz, 1H), 4.18 – 4.10 (m, 2H), 3.84 (s, 1H), 2.16 (dqq, *J* = 8.2, 6.8, 6.8 Hz, 1H), 1.36 – 1.17 (m, 2H), 1.12 – 1.01 (m, 12H), 0.97 (dd, *J* = 7.5, 1.3 Hz, 3H), 0.91 (dd, *J* = 7.5, 1.3 Hz, 3H); $^{13}C\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) δ 171.94 (d, *J* = 2.2 Hz), 166.92 (d, *J* = 240.3 Hz), 158.72, 145.08 (d, *J* = 11.4 Hz), 131.38 (d, *J* = 9.2 Hz), 129.72, 123.39 (d, *J* = 34.1 Hz), 123.14 (d, *J* = 2.9 Hz), 121.43, 117.05 (d, *J* = 27.9 Hz), 114.71, 67.76, 55.15, 29.56, 19.75, 19.48, 17.83 (d, *J* = 2.6 Hz), 17.75 (d, *J* = 2.2 Hz), 17.42, 17.35, 14.19 (d, *J* = 2.6 Hz), 14.13 (d, *J* = 2.9 Hz); $^{29}Si\{^{1}H\}$ NMR (79 MHz, $CDCl_3$) δ 8.46 (d, *J* = 5.1 Hz); $^{19}F\{^{1}H\}$ NMR (376 MHz, $CDCl_3$) δ –94.60; IR (neat) 3296, 2943, 2866, 1635, 1597, 1497, 1240, 1221, 856, 752 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M – H_2O + H]^+$ Calcd for $C_{24}H_{33}FNO_2Si$ 414.2264; Found 414.2253.

(*S*)-*N*^{2}-(3-fluorobenzyl)-3-methyl-*N*^{1}-phenylbutane-1,2-diamine (S11)





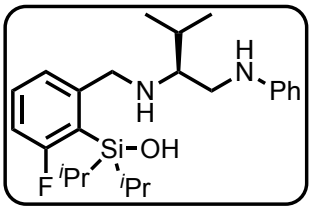
86% yield

Imidazoline (**3a**) (516 mg, 1.83 mmol, 1.0 equiv) was added directly into a flame-dried round bottom flask, dissolved in THF (2 mL) and purged with argon. Lithium aluminum hydride solution (4.0 M in Et_2O, 1.00 mL, 4.11 mmol, 2.25 equiv) was added dropwise at room temperature. After 16 h of stirring, the reaction was cooled to 0 °C, then was quenched with 20% KOH aqueous solution (0.70 mL) and further added H_2O (1 mL). The aqueous phase was extracted with Et_2O (3 × 3 mL), and the combined organic phase was dried

over $MgSO_4$, filtered, and concentrated *in vacuo*. The resulting reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:1.5 *v*/*v*/*v*) to yield the diamine as a pale yellow oil (471 mg, 86%). R_f = 0.28 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.34 – 7.22 (m, 1H), 7.22 – 7.12 (m, 2H), 7.11 – 7.01 (m, 2H), 6.99 – 6.87 (m, 1H), 6.69 (dddd, *J* = 7.2, 7.2, 1.1, 1.1 Hz, 1H), 6.64 – 6.53 (m, 2H), 4.13 (s, 1H), 3.81 (d, *J* = 13.5 Hz, 1H), 3.74 (d, *J* = 13.5 Hz, 1H), 3.20 (dd, *J* = 12.0, 4.1 Hz, 1H), 2.94 (dd, *J* = 12.0, 7.5 Hz, 1H), 2.61 (ddd, *J* = 7.5, 5.7, 4.1 Hz, 1H), 2.07 – 1.85 (m, 1H), 1.00 (d, *J* = 6.9 Hz, 3H), 0.95 (d, *J* = 6.9 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 163.1 (d, *J* = 245.8 Hz), 148.9, 143.7 (d, *J* = 7.0 Hz), 130.0 (d, *J* = 8.4 Hz), 129.3, 123.7 (d, *J* = 2.9 Hz), 117.4, 115.0 (d, *J* = 21.3 Hz), 113.9 (d, *J* = 21.3 Hz), 113.1, 61.8, 50.9 (d, *J* = 1.8 Hz), 43.7, 29.4, 19.5, 18.4; ^{19}F{^{1}H} NMR (283 MHz, $CDCl_3$) δ –113.36; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{18}H_{24}FN_2$ 287.1923; Found 287.1917.

(*S*)-(2-fluoro-6-(((3-methyl-1-(phenylamino)butan-2-yl)amino)methyl)phenyl)diisopropylsilanol (L8)



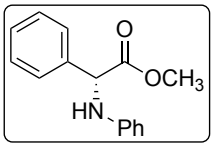
Synthesized according to the General Procedure H for silane formation using diamine (**S11**) (204 mg, 0.713 mmol), *sec*-BuLi (1.4 M in cyclohexane, 1.02 mL, 1.43 mmol, 2.0 equiv), TMEDA (0.21 mL, 1.4 mmol, 2.0 equiv) and diisopropylchlorosilane (0.27 mL, 1.6 mmol, 2.2 equiv). The reaction mixture was quenched with brine (5 mL), and the aqueous phase was extracted with diethyl ether (4 × 5 mL, or until no organic compound was found in aqueous layer). The combined organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo*.

The crude silane product reacted with silica gel and turned into the titled silanol product on the surface of silica column chromatography. The reaction mixture was purified using flash column chromatography (SiO_2, hexanes/EtOAc/Et_3N, 140:20:1.5 *v*/*v*/*v*) to give the silanol as a clear oil (85 mg, 30%) over two steps. R_f = 0.55 (hexanes/EtOAc/Et_3N, 7:1:0.15 *v*/*v*/*v*).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 – 7.23 (m, 1H), 7.25 – 7.15 (m, 2H), 7.12 (d, *J* = 8.3 Hz, 1H), 7.07 (dd, *J* = 9.9, 2.5 Hz, 1H), 6.92 (ddd, *J* = 8.0, 7.5, 2.6 Hz, 1H), 6.77 – 6.67 (m, 2H), 4.26 (dd, *J* = 1.7, 1.7 Hz, 1H), 4.23 (d, *J* = 15.9 Hz, 1H), 4.04 (d, *J* = 15.9 Hz, 1H), 3.38 – 3.24 (m, 2H), 3.13 (dd, *J* = 8.8, 5.8 Hz, 1H), 1.93 – 1.80 (m, 1H), 1.49 – 1.35 (m, 2H), 1.21 – 1.09 (m, 3H), 1.07 – 0.98 (m, 12H), 0.88 – 0.76 (m, 3H); ^{13}C{^{1}H} NMR (76 MHz, $CDCl_3$) δ 163.08 (d, *J* = 245.5 Hz), 148.67, 144.31 (d, *J* = 6.3 Hz), 129.73 (d, *J* = 8.2 Hz), 129.24, 123.34 (d, *J* = 2.7 Hz), 114.64 (d, *J* = 21.5 Hz), 114.57, 113.61 (d, *J* = 21.3 Hz), 62.03, 50.29 (d, *J* = 1.9 Hz), 47.28, 28.97, 20.05, 18.35, 17.70, 17.47, 17.41 (d, *J* = 1.6 Hz), 17.26, 15.50, 14.63, 14.34, 13.37; ^{19}F{^{1}H} NMR (283 MHz, $CDCl_3$) δ –113.57; ^{29}Si{^{1}H} NMR (79 MHz, $CDCl_3$) δ 10.61; IR (neat) 3280, 2994, 2949, 2837, 1448, 1409, 1113, 1013, 580 cm^{-1}; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{24}H_{38}FN_2OSi$ 417.2737; Found 417.2722.

Enantioselective N−H insertion products:

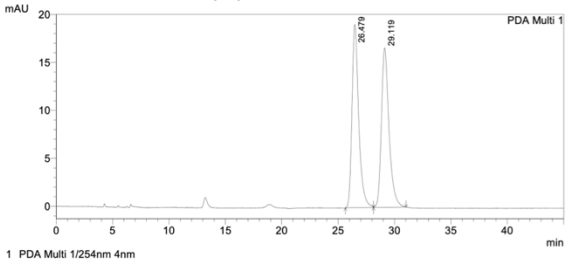
methyl (*R*)-2-phenyl-2-(phenylamino)acetate (7a)



According to the General Procedure I, diazoester **5a** (35.2 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 1 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (38.6 mg, 80%). ^{1}H NMR spectral data matches that of previous report.[9]

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 0.7 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 26.3 min; t_R (*S*, minor) = 36.8 min, 91:9 er.

*HPLC trace for: (A) racemic standard of **7a***



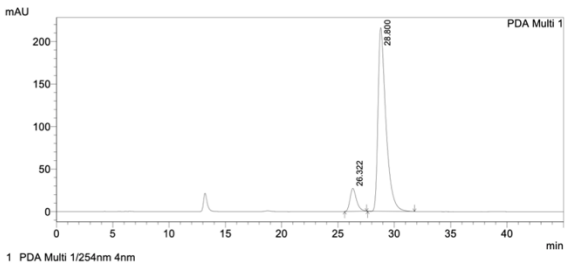
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-2-190-RAC.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	26.479	788858	19076	50.360	53.460
2	29.119	777588	16606	49.640	46.540
Total		1566446	35682	100.000	100.000

*(B) enantiomerically enriched **(R)-7a***



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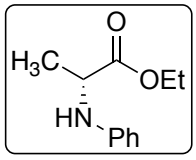
PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-40-L.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	26.322	1069979	27039	9.217	11.132
2	28.800	10538294	215852	90.783	88.868
Total		11608273	242892	100.000	100.000

ethyl phenyl-*D*-alaninate (7b)



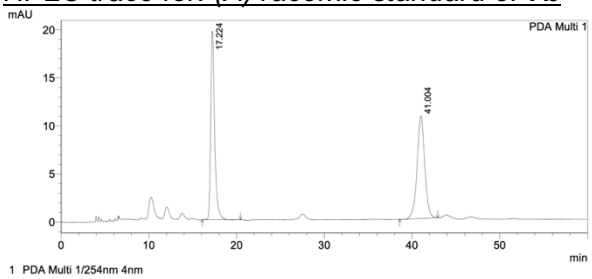
According to the General Procedure I, diazoester **5b** (25.6 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 45 min. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 98:2 *v*/*v*) and isolated as a clear oil (25.1 mg, 65%). ^{1}H NMR spectral data matches that of previous report.[10]

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 0.7 mL/min, λ = 254 nm, 40 °C, t_R (*S*, minor) = 16.3 min; t_R (*R*, major) = 40.8 min, 96:4 er.

[9] Shen, G.; Liu, H.; Chen, J.; He, Z.; Zhou, Y.; Wang, L.; Luo, Y.; Su, Z.; Fan, B. *Org. Biomol. Chem.* **2021**, *19* (16), 3601–3610.

[10] Zhu, Y.; Liu, X.; Dong, S.; Zhou, Y.; Li, W.; Lin, L.; Feng, X. *Angew. Chem. Int. Ed.* **2014**, *53* (6), 1636–1640.

*HPLC trace for: (A) racemic standard of **7b***



1 PDA Multi 1/254nm 4nm

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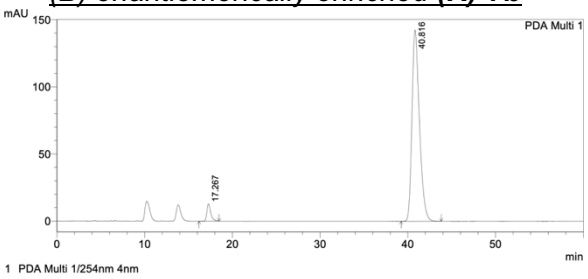
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.224	606839	19608	48.493	64.763
2	41.004	644563	10669	51.507	35.237
Total		1251402	30277	100.000	100.000

*(B) enantiomerically enriched **(R)-7b***



1 PDA Multi 1/254nm 4nm

< Peak Table >

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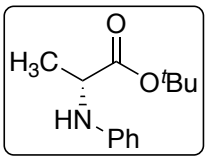
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.267	394113	12869	4.463	8.285
2	40.816	8437517	142459	95.537	91.715
Total		8831630	155329	100.000	100.000

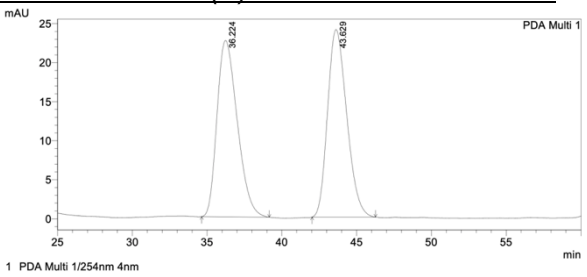
***tert*-butyl phenyl-*D*-alaninate (7c)**



According to the General Procedure I, diazoester **5c** (31.2 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 45 min. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 98:2 *v*/*v*) and isolated as a clear oil (36.7 mg, 83%). ^{1}H NMR spectral data matches that of previous report.[10]

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 0.2 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 36.1 min; t_R (*S*, minor) = 43.4 min, 94:6 er.

*HPLC trace for: (A) racemic standard of **7c***



1 PDA Multi 1/254nm 4nm

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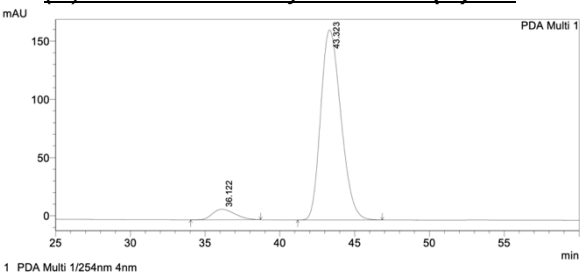
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	36.224	2131888	22595	49.857	48.478
2	43.629	2144159	24014	50.143	51.522
Total		4276047	46609	100.000	100.000

*(B) enantiomerically enriched **(R)-7c***



1 PDA Multi 1/254nm 4nm

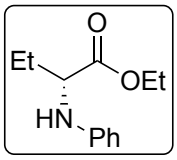
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-102-Me-OtBu-DA-L-OD-99-1-0.2ml.lcd

PDA Ch1 254nm 4nm

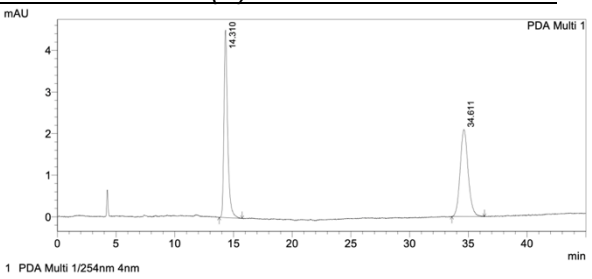
Peak#	Ret. Time	Area	Height	Area %	Height %
1	36.122	942076	9065	5.776	5.266
2	43.323	15366834	163078	94.224	94.734
Total		16308910	172143	100.000	100.000

ethyl (*R*)-2-(phenylamino)butanoate (7d)



According to the General Procedure I, diazoester **5d** (28.4 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 40 min. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 98:2 *v*/*v*) and isolated as a clear oil (36.7 mg, 88%). ^{1}H NMR spectral data matches that of previous report.[11]
HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 0.7 mL/min, λ = 254 nm, 40 °C, t_R (*S*, minor) = 13.4 min; t_R (*R*, major) = 33.4 min, 98:2 er.

*HPLC trace for: (A) racemic standard of **7d***



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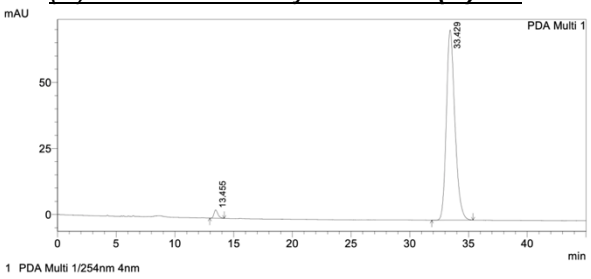
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.310	98041	4508	49.836	68.315
2	34.611	98687	2091	50.164	31.685
Total		196728	6599	100.000	100.000

*(B) enantiomerically enriched **(R)-7d***



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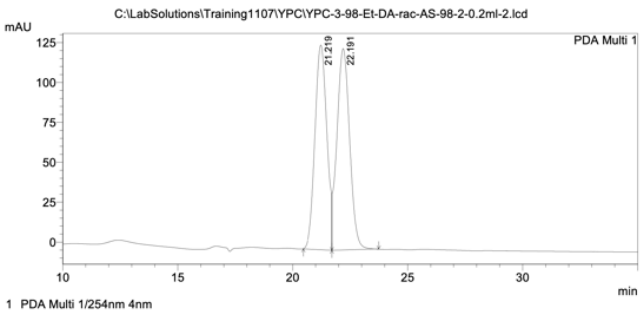
PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-98-Et-DA-L-OD-99-1-0.7ml.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.455	72410	3156	1.948	4.202
2	33.429	3644669	71943	98.052	95.798
Total		3717079	75098	100.000	100.000

Note: The HPLC data below using Chiralpak AS-H column was utilized to determine the absolute configuration of compound **7b−f**. The major and minor peaks are discernible and used for comparison with previous HPLC data.[12]
HPLC analysis: Chiralpak AS-H column, n-hexane/2-propanol = 98/2, 0.2 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 21.5 min; t_R (*S*, minor) = 22.5 min.



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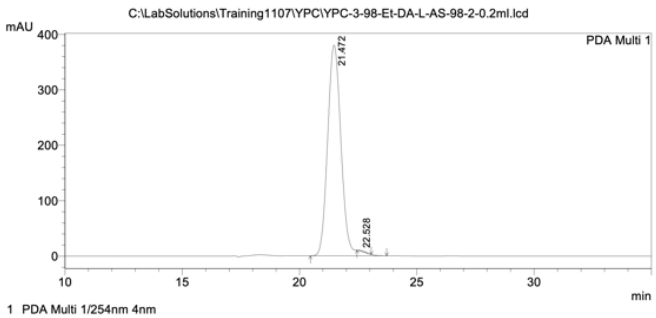
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	21.219	4632904	128331	48.800	50.400
2	22.191	4860834	126295	51.200	49.600
Total		9493738	254626	100.000	100.000



< Peak Table >

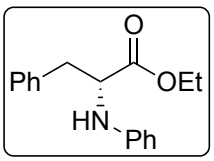
PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-98-Et-DA-L-AS-98-2-0.2ml.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	21.472	15160243	379920	99.767	99.750
2	22.528	35452	953	0.233	0.250
Total		15195695	380872	100.000	100.000

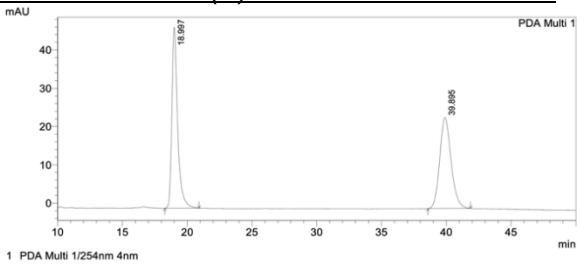
[11] Tian, H.; Xu, W.; Liu, Y.; Wang, Q. *Org. Lett.* **2020**, *22* (13), 5005–5008.
[12] Liu, B.; Zhu, S.-F.; Zhang, W.; Chen, C.; Zhou, Q.-L. *J. Am. Chem. Soc.* **2007**, *129* (18), 5834–5835.

ethyl phenyl-*D*-phenylalaninate (7e)



According to the General Procedure I, diazoester **5e** (40.8 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 16 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a clear oil (44.5 mg, 83%). ^{1}H NMR spectral data matches that of previous report.[13]
HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 95/5, 0.5 mL/min, λ = 254 nm, 40 °C, t_R (*S*, minor) = 19.4 min; t_R (*R*, major) = 40.0 min, 98:2 er.

HPLC trace for: (A) racemic standard of ***7e***



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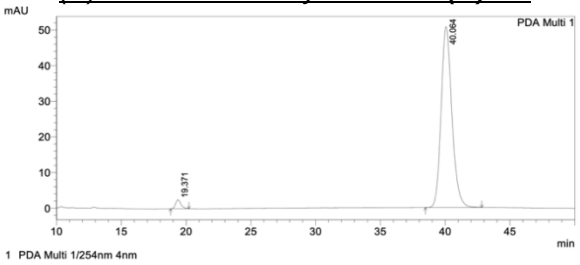
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.997	1458124	47260	50.126	66.538
2	39.895	1450782	23767	49.874	33.462
Total		2908906	71027	100.000	100.000

(B) enantiomerically enriched ***(R)-7e***

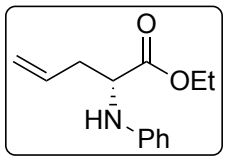


< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-113-Bn-DA-L-OD-95-5-0.5ML-60MIN-OD.lcd
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.371	72729	2539	2.417	4.767
2	40.064	2935941	50737	97.583	95.233
Total		3008670	53277	100.000	100.000

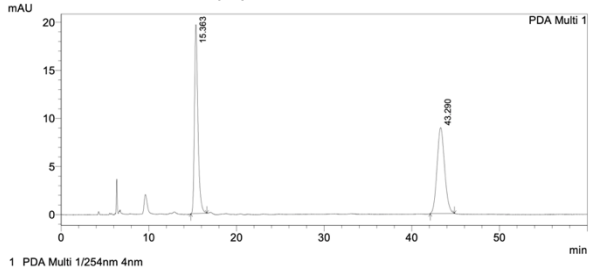
ethyl (*R*)-2-(phenylamino)pent-4-enoate (7f)



According to the General Procedure I, diazoester **5f** (30.8 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 16 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 98:2 *v*/*v*) and isolated as a clear oil (19.7 mg, 45%). ^{1}H NMR spectral data matches that of previous report.[14]
HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 0.7 mL/min, λ = 254 nm, 40 °C, t_R (*S*, minor) = 14.8 min; t_R (*R*, major) = 42.6 min, 94:6 er.

[13] Bachmann, S.; Fielenbach, D.; Jørgensen, K. A. *Org. Biomol. Chem.* **2004**, *2* (20), 3044–3049.
[14] Ramakrishna, K.; Jayarani, A.; Koothradan, F. F.; Sivasankar, C. *Appl Organomet Chem* **2020**, *34* (9). https://doi.org/10.1002/aoc.5748.

*HPLC trace for: (A) racemic standard of **7f***



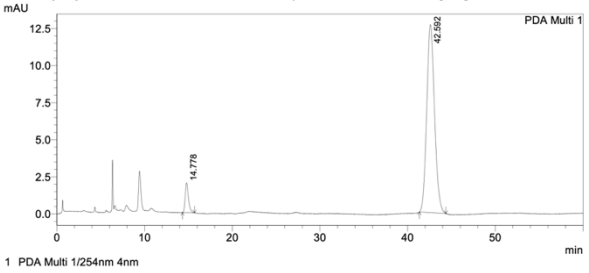
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-114-ALLYL-DA-rac-OD-99-1-0.7ML-.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	15.363	538548	19646	50.289	68.757
2	43.290	532354	8927	49.711	31.243
Total		1070903	28573	100.000	100.000

*(B) enantiomerically enriched **(R)-7f***



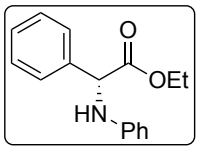
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-114-2-ALLYL-DA-L-OD-99-1-0.7ML-TLC-2.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.778	51949	2014	6.208	13.715
2	42.592	784802	12670	93.792	86.285
Total		836750	14684	100.000	100.000

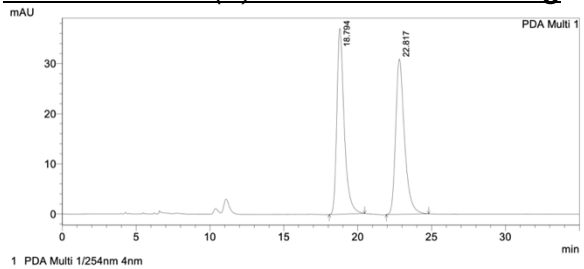
ethyl (*R*)-2-phenyl-2-(phenylamino)acetate (7g)



According to the General Procedure I, diazoester **5g** (38.0 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 1 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (43.9 mg, 86%). ^{1}H NMR spectral data matches that of previous report.[9]

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 0.7 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 18.2 min; t_R (*S*, minor) = 22.0 min, 92:8 er.

*HPLC trace for: (A) racemic standard of **7g***



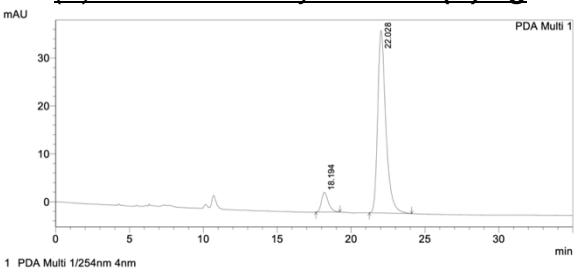
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-57-OEt-rac-OD-99-1-0.7ml-032922.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.794	1282963	37042	49.831	54.475
2	22.817	1291660	30956	50.169	45.525
Total		2574623	67998	100.000	100.000

*(B) enantiomerically enriched **(R)-7g***



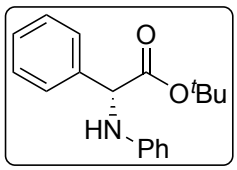
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\Optimization\YPC-3-57-OEt--2h-L-OD-99-1-0.7ml-2.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.194	133169	4108	8.344	9.728
2	22.028	1462768	38122	91.656	90.272
Total		1595937	42230	100.000	100.000

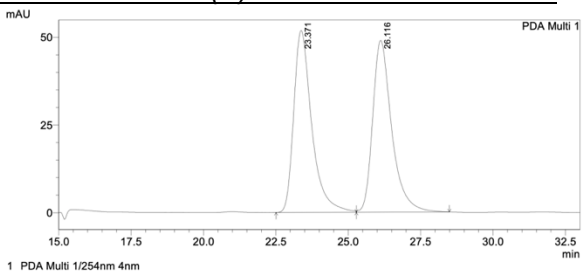
***tert*-butyl (*R*)-2-phenyl-2-(phenylamino)acetate (7h)**



According to the General Procedure I, diazoester **5h** (43.6 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 1 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (50.0 mg, 89%). ^{1}H NMR spectral data matches that of previous report.[9]

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99.5/0.5, 0.2 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 25.4 min; t_R (*S*, minor) = 25.8 min, 91:9 er.

*HPLC trace for: (A) racemic standard of **7h***



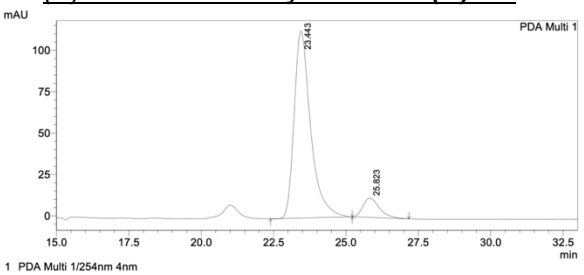
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\Optimization\YPC-3-16-OtBu-rac-OD-95-5-0.2-2.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	23.371	2241643	51826	50.093	51.435
2	26.116	2233363	48935	49.907	48.565
Total		4475006	100760	100.000	100.000

*(B) enantiomerically enriched **(R)-7h***



< Peak Table >

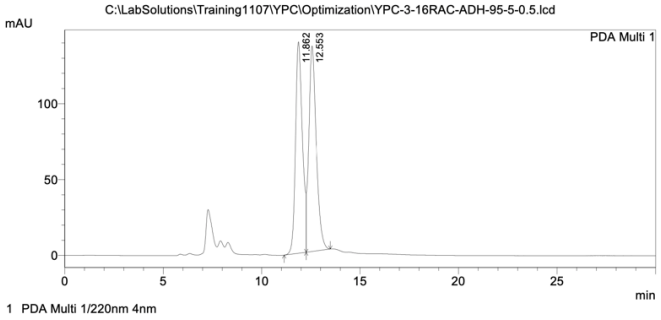
PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-53-OtBu-L-OD-95-5-0.2.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	23.443	4479188	112853	90.697	90.587
2	25.823	459460	11727	9.303	9.413
Total		4938648	124581	100.000	100.000

Note: The HPLC data obtained below using Chiralpak AD-H column was utilized to determine the absolute configuration of compound **7a** and **7g−x**. The major and minor peaks are discernible and used for comparison with previous HPLC data.[15]

HPLC analysis: Chiralpak AD-H column, n-hexane/2-propanol = 95/5, 0.5 mL/min, λ = 220 nm, 40 °C, t_R (*R*, major) = 11.7 min; t_R (*S*, minor) = 12.3 min.

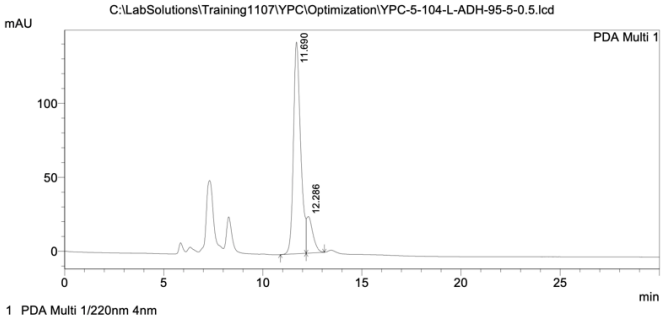


< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\Optimization\YPC-3-16RAC-ADH-95-5-0.5.lcd

PDA Ch1 220nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.862	3399579	139314	48.512	50.699
2	12.553	3608123	135471	51.488	49.301
Total		7007702	274784	100.000	100.000



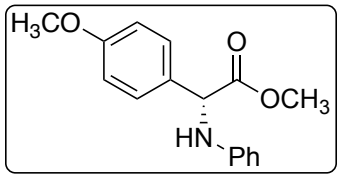
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\Optimization\YPC-5-104-L-ADH-95-5-0.5.lcd

PDA Ch1 220nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.690	3600855	142969	86.605	85.254
2	12.286	556916	24728	13.395	14.746
Total		4157771	167697	100.000	100.000

methyl (*R*)-2-(4-methoxyphenyl)-2-(phenylamino)acetate (7i)

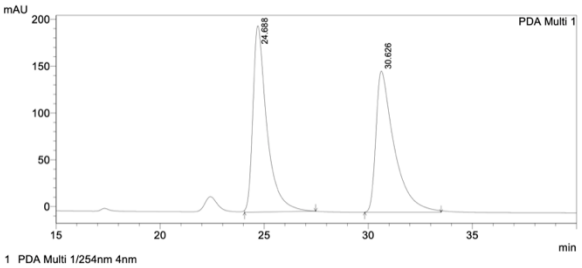


According to the General Procedure I, diazoester **5i** (41.2 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 1 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 96:4 *v*/*v*) and isolated as a white solid (28.7 mg, 53%). ^{1}H NMR spectral data matches that of previous report.[9]

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 1.0 mL/min, λ = 254 nm, 40 °C, t_R (*S*, minor) = 24.6 min; t_R (*R*, major) = 30.2 min, 90:10 er.

[15] Pan, J.-B.; Zhang, X.-G.; Shi, Y.-F.; Han, A.-C.; Chen, Y.-J.; Ouyang, J.; Li, M.-L.; Zhou, Q.-L. *Angew. Chem. Int. Ed.* **2023**, *62* (15), e202300691.

*HPLC trace for: (A) racemic standard of **7i***



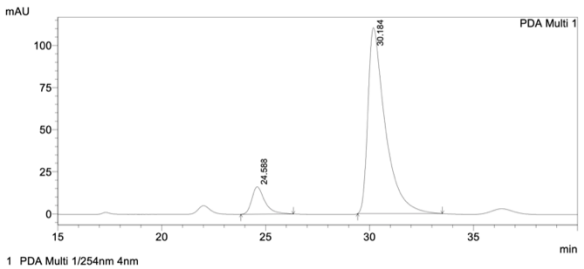
< Peak Table >

PeakTable C:\LabSolutions\Training1107\KBH\KBH-I-171-OMe-racemic-pubtry1.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	24.688	9312408	198889	50.124	56.865
2	30.626	9266287	150867	49.876	43.135
Total		18578695	349756	100.000	100.000

*(B) enantiomerically enriched **(R)-7i***



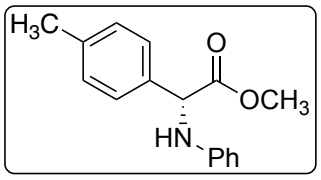
< Peak Table >

PeakTable C:\LabSolutions\Training1107\KBH\KBH-I-171-OMe-L-pubtry1.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	24.588	705686	16204	9.896	12.803
2	30.184	6425221	110368	90.104	87.197
Total		7130907	126572	100.000	100.000

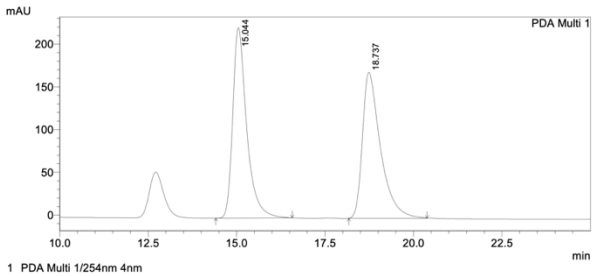
methyl (*R*)-2-(phenylamino)-2-(*p*-tolyl)acetate (7j)



According to the General Procedure I, diazoester **5j** (38.1 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 1 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 90:10 *v*/*v*) and isolated as a white solid (43 mg, 84%). ^{1}H NMR spectral data matches that of previous report.[16]

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 1.0 mL/min, λ = 254 nm, 40 °C, t_R (*S*, minor) = 15.2 min; t_R (*R*, major) = 18.9 min, 89:11 er.

*HPLC trace for: (A) racemic standard of **7j***



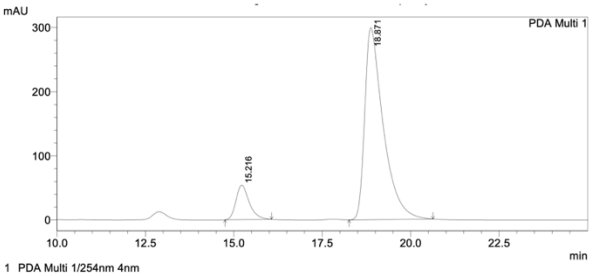
< Peak Table >

PeakTable C:\LabSolutions\Training1107\KBH\KBH-I-171-Me-racemic-pubtry1.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	15.044	6099927	222729	50.161	56.602
2	18.737	6060710	170773	49.839	43.398
Total		12160637	393502	100.000	100.000

*(B) enantiomerically enriched **(R)-7j***



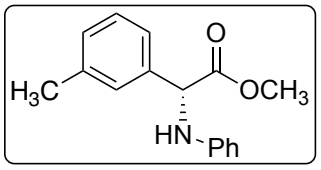
< Peak Table >

PeakTable C:\LabSolutions\Training1107\KBH\KBH-I-171-Me-L-pubtry1.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	15.216	1401259	53811	11.406	15.244
2	18.871	10884094	299180	88.594	84.756
Total		12285353	352991	100.000	100.000

methyl (*R*)-2-(phenylamino)-2-(*m*-tolyl)acetate (7k)

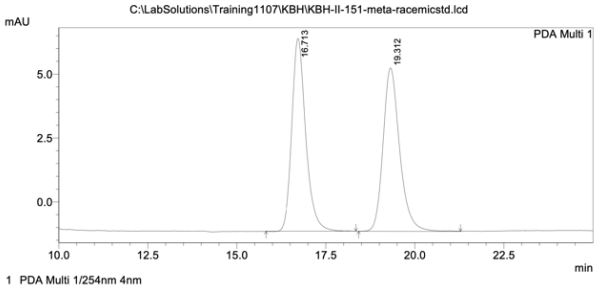


According to the General Procedure I, diazoester **5f** (38.1 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 1 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 90:10 *v*/*v*) and isolated as a white solid (39 mg, 76%).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.33 – 7.22 (m, 2H), 7.27 – 7.18 (m, 1H), 7.19 – 7.06 (m, 3H), 6.70 (tt, *J* = 7.3, 1.1 Hz, 1H), 6.56 (dd, *J* = 8.7, 1.1 Hz, 2H), 5.03 (d, *J* = 5.8 Hz, 1H), 4.90 (d, *J* = 5.8 Hz, 1H), 3.72 (s, 3H), 2.34 (s, 3H); ^{13}C NMR (76 MHz, $CDCl_3$) δ 172.6, 146.2, 138.8, 137.7, 129.4, 129.3, 128.9, 128.0, 124.5, 118.2, 113.5, 60.9, 52.9, 21.6; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{18}NO_2$ 256.1337; Found 256.1333.

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 1.0 mL/min, λ = 254 nm, 40 °C, t_R (*S*, minor) = 16.0 min; t_R (*R*, major) = 18.2 min, 92:8 er.

HPLC trace for: (A) racemic standard of ***7k*** *(B) enantiomerically enriched* ***(R)-7k***

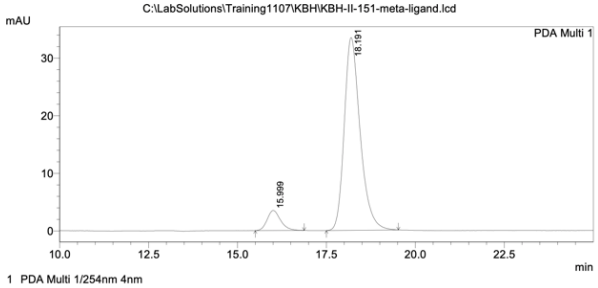


< Peak Table >

PeakTable C:\LabSolutions\Training1107\KBH\KBH-II-151-meta-racemicstd.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	16.713	205812	7540	49.898	54.126
2	19.312	206657	6391	50.102	45.874
Total		412469	13931	100.000	100.000



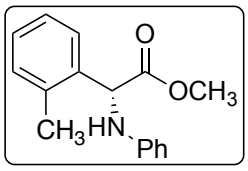
< Peak Table >

PeakTable C:\LabSolutions\Training1107\KBH\KBH-II-151-meta-ligand.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	15.999	91189	3483	8.057	9.427
2	18.191	1040652	33469	91.943	90.573
Total		1131841	36952	100.000	100.000

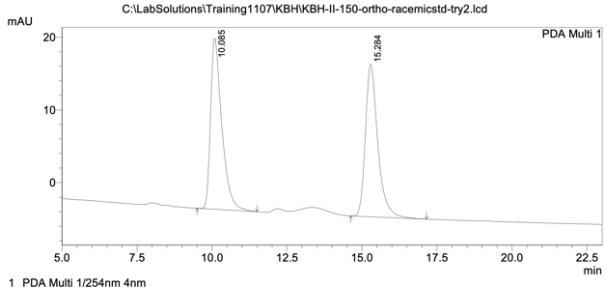
methyl (*R*)-2-(phenylamino)-2-(*o*-tolyl)acetate (7l)



According to the General Procedure I, diazoester **5l** (38.1 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 1 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 90:10 *v*/*v*) and isolated as a white solid (34 mg, 67%).
HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 1.0 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 10.3 min; t_R (*S*, minor) = 15.5 min, 71:29 er.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 (d, *J* = 6.8 Hz, 1H), 7.24 – 7.14 (m, 3H), 7.12 (tt, *J* = 7.3, 2.1 Hz, 2H), 6.70 (tt, *J* = 7.3, 1.2 Hz, 1H), 6.57 – 6.48 (m, 2H), 5.28 (d, *J* = 6.1 Hz, 1H), 4.80 (d, *J* = 6.1 Hz, 1H), 3.72 (s, 3H), 2.53 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.9, 146.3, 136.7, 136.0, 131.1, 129.4, 128.3, 126.8, 126.6, 118.3, 113.3, 57.5, 52.8, 19.6; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{18}NO_2$ 256.1337; Found 256.1333.

*HPLC trace for: (A) racemic standard of **7l***



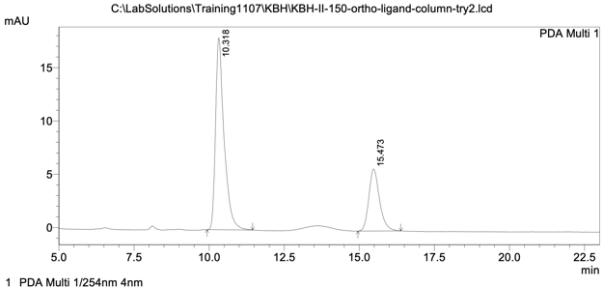
< Peak Table >

PeakTable C:\LabSolutions\Training1107\KBH\KBH-II-150-ortho-racemicstd-try2.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.085	610792	23525	50.286	52.891
2	15.284	603833	20953	49.714	47.109
Total		1214624	44479	100.000	100.000

*(B) enantiomerically enriched **(R)-7l***



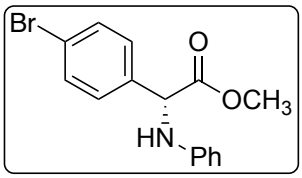
< Peak Table >

PeakTable C:\LabSolutions\Training1107\KBH\KBH-II-150-ortho-ligand-column-try2.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.318	356654	17990	71.224	75.567
2	15.473	144098	5817	28.776	24.433
Total		500752	23807	100.000	100.000

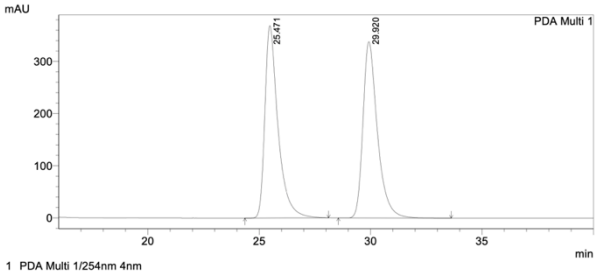
methyl (*R*)-2-(4-bromophenyl)-2-(phenylamino)acetate (7m)



According to the General Procedure I, diazoester **5m** (50.8 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 2 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (46.0 mg, 72%). ^{1}H NMR spectral data matches that of previous report.[9]

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 97/3, 0.5 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 25.9 min; t_R (*S*, minor) = 30.4 min, 86:14 er.

*HPLC trace for: (A) racemic standard of **7m***



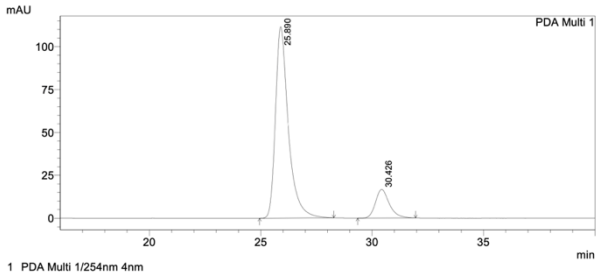
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-76-4-Br-DA-rac-OD-97-3-0.5ml.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	25.471	15155418	368890	49.885	52.173
2	29.920	15225217	338158	50.115	47.827
Total		30380635	707049	100.000	100.000

*(B) enantiomerically enriched **(R)-7m***



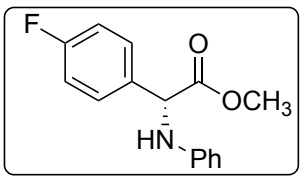
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-76-4-Br-DA-L-OD-97-3-0.5ml.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	25.890	4506985	111555	86.255	86.989
2	30.426	718177	16685	13.745	13.011
Total		5225163	128240	100.000	100.000

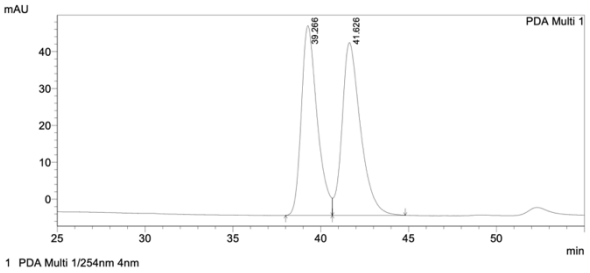
methyl (*R*)-2-(4-fluorophenyl)-2-(phenylamino)acetate (7n)



According to the General Procedure I, diazoester **5n** (38.8 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 1 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (47.7 mg, 92%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.43 (m, 2H), 7.13 (dd, *J* = 8.6, 7.3 Hz, 2H), 7.05 (t, *J* = 8.6 Hz, 2H), 6.72 (tt, *J* = 7.3, 1.1 Hz, 1H), 6.55 (dd, *J* = 8.7, 1.1 Hz, 2H), 5.07 (d, *J* = 5.7 Hz, 1H), 4.97 (d, *J* = 5.7 Hz, 1H), 3.75 (s, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 172.1, 162.7 (d, *J* = 246.9 Hz), 145.7, 133.4 (d, *J* = 3.3 Hz), 129.3, 128.9 (d, *J* = 8.1 Hz), 118.3, 115.8 (d, *J* = 21.6 Hz), 113.4, 60.0, 52.9; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ –113.84; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{15}H_{15}FNO_2$ 260.1087; Found 260.1083.
HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99.5/0.5, 0.8 mL/min, λ = 254 nm, 40 °C, t_R (*S*, minor) = 39.7 min; t_R (*R*, major) = 42.0 min, 82:18 er.

*HPLC trace for: (A) racemic standard of **7n***



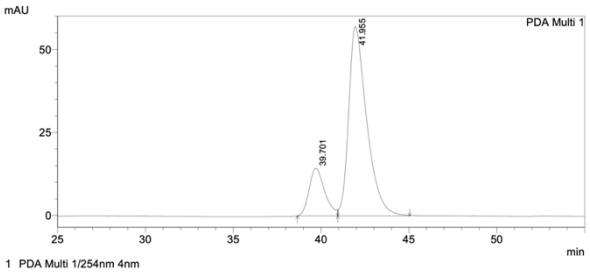
< Peak Table >

PeakTable C:\LabSolutions\Training1107\KBH\KBH-I-171-F-racemic-pubtry1.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	39.266	3218658	51347	48.583	52.337
2	41.626	3406352	46761	51.417	47.663
Total		6625010	98108	100.000	100.000

*(B) enantiomerically enriched **(R)-7n***



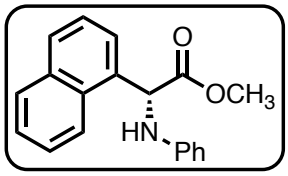
< Peak Table >

PeakTable C:\LabSolutions\Training1107\KBH\KBH-I-171-F-L-pubtry1.lcd

PDA Ch1 254nm 4nm

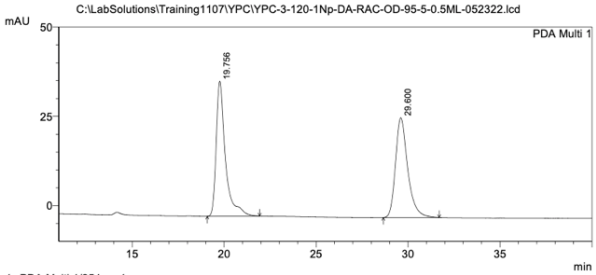
Peak#	Ret. Time	Area	Height	Area %	Height %
1	39.701	877792	14337	17.717	20.105
2	41.955	4076842	56976	82.283	79.895
Total		4954633	71313	100.000	100.000

methyl (*R*)-2-(naphthalen-1-yl)-2-(phenylamino)acetate (7o)



According to the General Procedure I, diazoester **5o** (45.2 mg, 0.200 mmol) and aniline (18.6 mg, 0.200 mmol) were used and the reaction was stirred for 2 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (50.4 mg, 87%). ^{1}H NMR spectral data matches that of previous report.[9]
HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 95/5, 0.5 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 19.0 min; t_R (*S*, minor) = 27.8 min, 82:18 er.

*HPLC trace for: (A) racemic standard of **7o***



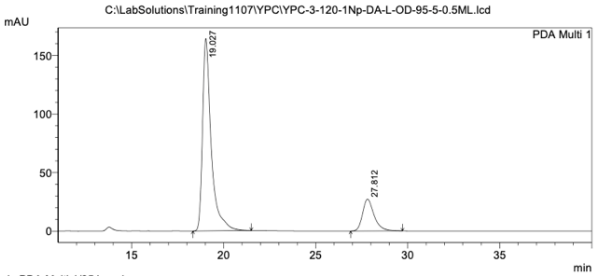
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-120-1Np-DA-RAC-OD-95-5-0.5ML-052322.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.756	1318768	37825	50.507	57.493
2	29.600	1292294	27965	49.493	42.507
Total		2611062	65790	100.000	100.000

*(B) enantiomerically enriched **(R)-7o***



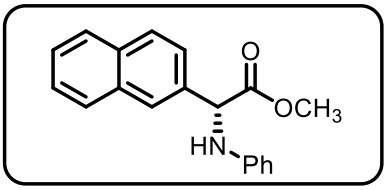
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-120-1Np-DA-L-OD-95-5-0.5ML.lcd

PDA Ch1 254nm 4nm

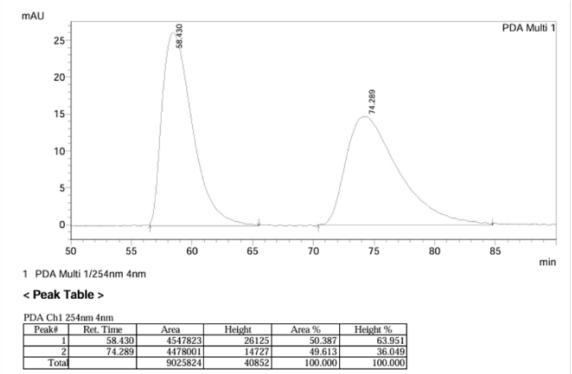
Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.027	5398404	164151	81.961	85.791
2	27.812	1188163	27186	18.039	14.209
Total		6586567	191337	100.000	100.000

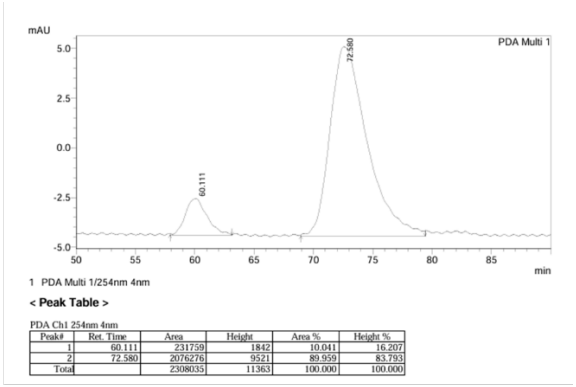
methyl (R)-2-(naphthalen-2-yl)-2-(phenylamino)acetate (7p)



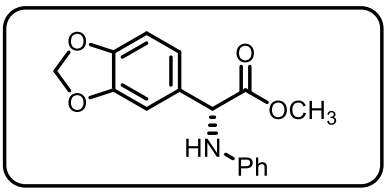
According to the General Procedure I, diazoester **5p** (41.8 mg, 0.185 mmol) and aniline (23.7 mg, 0.254 mmol) were used and the reaction was stirred for 1 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (46.0 mg, 85%). ^{1}H NMR spectral data matches that of previous report.[16]
HPLC analysis: Chiralpak AD-H column, n-hexane/2-propanol = 95.5/0.5, 0.5 mL/min, λ = 254 nm, 40 °C, t_R (minor) = 72.6 min; t_R (major) = 60.1 min, 90:10 er.

*HPLC trace for: (A) racemic standard of **7p*** *(B) enantiomerically enriched **(R)-7p***





methyl (R)-2-(benzo[d][1,3]dioxol-5-yl)-2-(phenylamino)acetate (7q)



According to the General Procedure I, diazoester **5q** (43.4 mg, 0.200 mmol) and aniline (25.4 mg, 0.272 mmol) were used and the reaction was stirred for 1 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (45.6 mg, 81%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.19 – 7.08 (m, 2H), 7.02 – 6.94 (m, 2H), 6.82 – 6.76 (m, 1H), 6.72 (tt, J = 7.3, 1.1 Hz, 1H), 6.61 – 6.53 (m, 2H), 5.98 – 5.92 (m, 2H), 4.99 (d, J = 5.6 Hz, 1H), 4.94 (d, J = 5.6 Hz, 1H), 3.74 (s, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 172.42, 148.26, 147.77, 145.94, 131.58, 129.35, 120.94, 118.25, 113.52, 108.62, 107.61, 101.35, 60.47, 52.95. HRMS (ESI/Orbitrap) m/z: [M + H]+ Calcd for $C_{16}H_{16}NO_4$ 286.1079; Found 286.1077.

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 97/3, 1 mL/min, λ = 254 nm, 40 °C, t_R (minor) = 39.3 min; t_R (*major*) = 33.4 min, 92:8 er.

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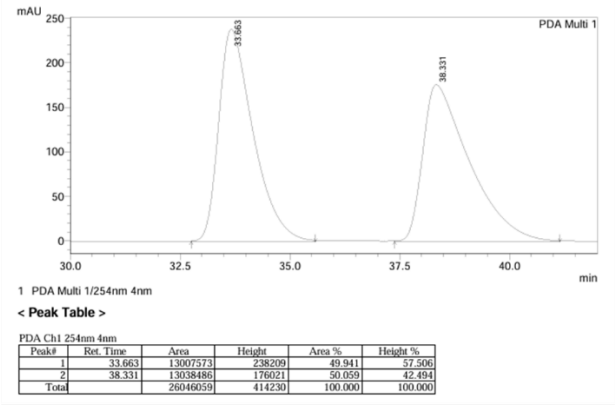
[16]Wu, W.; Zhao, H.; Chen, J.; Zhang, F.; Fan, B. *Chemistry – A European Journal* **2022**, *28* (68), e202202460. https://doi.org/10.1002/chem.202202460.

*HPLC trace for: (A) racemic standard of **7q***

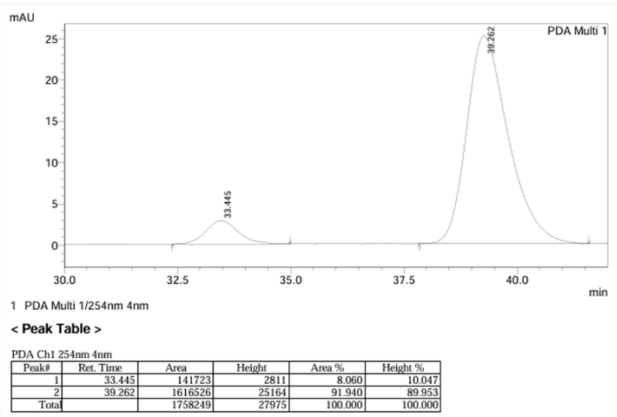


< Peak Table >

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	33.663	13007573	238209	49.941	57.506
2	38.331	13038486	176021	50.059	42.494
Total		26046059	414230	100.000	100.000

*(B) enantiomerically enriched **(R)-7q***

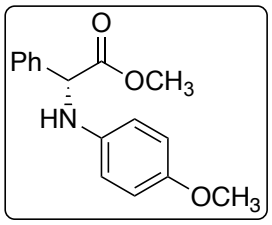


< Peak Table >

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	33.445	141723	2811	8.060	10.047
2	39.262	1616526	25164	91.940	89.953
Total		1758249	27975	100.000	100.000

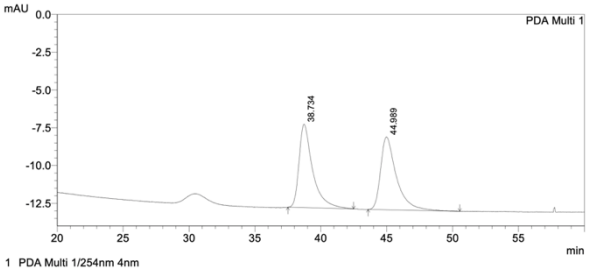
methyl (*R*)-2-((4-methoxyphenyl)amino)-2-phenylacetate (7r)



According to the General Procedure I, α-phenyl-α-diazoesters **5a** (35.2 mg, 0.200 mmol) and *p*-anisidine **6r** (24.6 mg, 0.200 mmol) were used and the reaction was stirred for 16 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (30.2 mg, 56%). ^{1}H NMR spectral data matches that of previous report.[9]

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99.5/0.5, 1.0 mL/min, λ = 254 nm, 40 °C, t_R (*S*, minor) = 39.4 min; t_R (*R*, major) = 45.8 min, 76:24 er.

*HPLC trace for: (A) racemic standard of **7r***



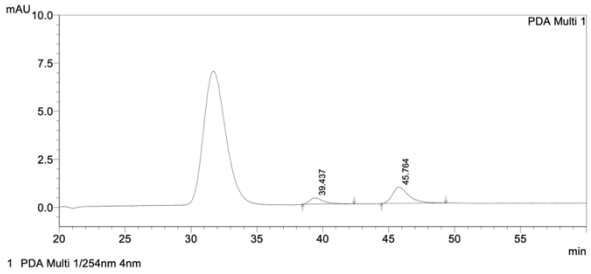
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-101-4-OMe-NH2-rac-OD-99.5-0.5-1.0ml--.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	38.734	396475	5514	49.715	53.354
2	44.989	401024	4820	50.285	46.646
Total		797499	10334	100.000	100.000

*(B) enantiomerically enriched **(R)-7r***



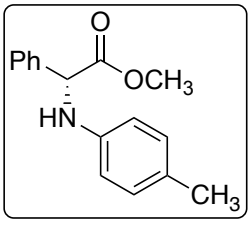
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-101-4-OMe-NH2-L-OD-99.5-0.5-1.0ml-b.lcd

PDA Ch1 254nm 4nm

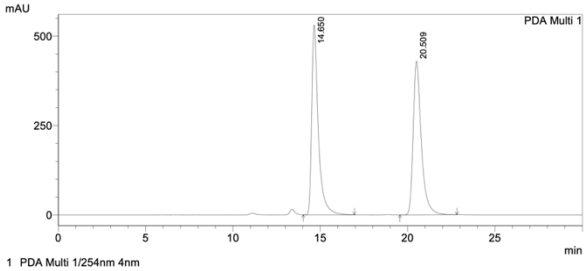
Peak#	Ret. Time	Area	Height	Area %	Height %
1	39.437	23183	324	24.156	27.787
2	45.764	72790	841	75.844	72.213
Total		95973	1164	100.000	100.000

methyl (*R*)-2-phenyl-2-(*p*-tolylamino)acetate (7s)



According to the General Procedure I, α-phenyl-α-diazoesters **5a** (35.2 mg, 0.200 mmol) and *p*-toluidine **6s** (21.4 mg, 0.200 mmol) were used and the reaction was stirred for 16 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (38.3 mg, 75%). ^{1}H NMR spectral data matches that of previous report.[17]
HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 97/3, 0.5 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 14.7 min; t_R (*S*, minor) = 20.2 min, 87:13 er.

*HPLC trace for: (A) racemic standard of **7s***



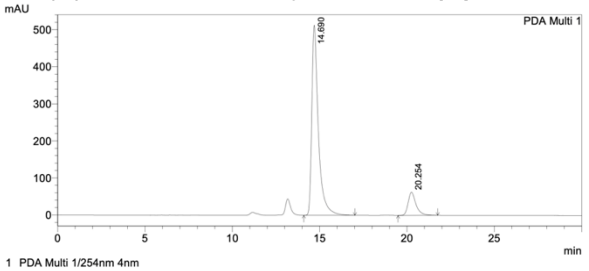
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-91-4-Me-NH2-rac-OD-97-3-0.5ml.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.650	13875020	530958	49.952	55.224
2	20.509	13901843	430505	50.048	44.776
Total		27776863	961463	100.000	100.000

*(B) enantiomerically enriched **(R)-7s***



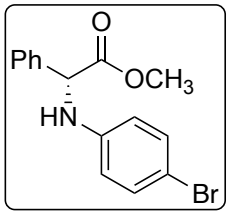
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-91-4-Me-NH2-L-OD-97-3-0.5ml.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.690	13402270	512636	87.198	89.111
2	20.254	1967649	62642	12.802	10.889
Total		15369919	575277	100.000	100.000

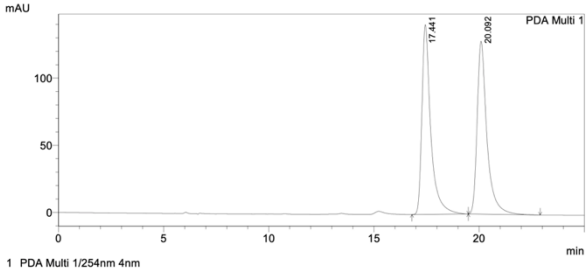
methyl (*R*)-2-((4-bromophenyl)amino)-2-phenylacetate (7t)



According to the General Procedure I, α-phenyl-α-diazoesters **5a** (35.2 mg, 0.200 mmol) and 4-bromoaniline (34.4 mg, 0.200 mmol) were used and the reaction was stirred for 45 min. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (43.8 mg, 69%). ^{1}H NMR spectral data matches that of previous report.[9]
HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 97/3, 0.5 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 17.0 min; t_R (*S*, minor) = 19.7 min, 92:8 er.

[17] Huang, W.-S.; Xu, Z.; Yang, K.-F.; Chen, L.; Zheng, Z.-J.; Xu, L.-W. *RSC Adv.* **2015**, *5* (58), 46455–46463.

*HPLC trace for: (A) racemic standard of **7t***



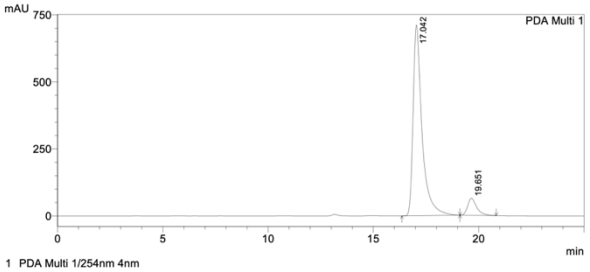
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-87-4-Br-NH2-rac-OD-97-3-0.5ml.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.441	4144528	141243	49.978	52.313
2	20.092	4148122	128756	50.022	47.687
Total		8292650	269999	100.000	100.000

*(B) enantiomerically enriched **(R)-7t***



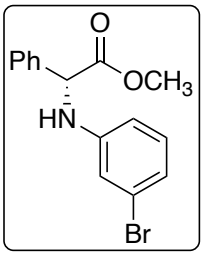
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-87-4-Br-NH2-L-OD-97-3-0.5ml.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.042	20949940	710931	91.659	91.792
2	19.651	1906447	63572	8.341	8.208
Total		22856387	774503	100.000	100.000

methyl (*R*)-2-((3-bromophenyl)amino)-2-phenylacetate (7u)

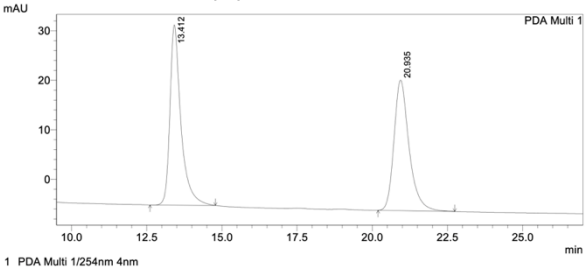


According to the General Procedure I, α-phenyl-α-diazoesters **5a** (35.2 mg, 0.200 mmol) and 3-bromoaniline (34.4 mg, 0.200 mmol) were used and the reaction was stirred for 2 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 98:2 *v*/*v*) and isolated as a white solid (43.3 mg, 68%). R_f = 0.37 (hexanes/EtOAc, 97:3 *v*/*v*).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 – 7.42 (m, 2H), 7.40 – 7.27 (m, 3H), 6.95 (dd, *J* = 8.0, 8.0 Hz, 1H), 6.80 (ddd, *J* = 7.9, 1.8, 1.0 Hz, 1H), 6.70 (dd, *J* = 2.1, 2.1 Hz, 1H), 6.44 (ddd, *J* = 8.3, 2.4, 1.0 Hz, 1H), 5.09 – 5.00 (m, 2H), 3.73 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.0, 147.3, 137.1, 130.6, 129.1, 128.6, 127.3, 123.3, 121.1, 116.3, 112.1, 60.5, 53.1; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{15}H_{15}BrNO_2$ 320.0286; Found 320.0287.

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 1.0 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 12.9 min; t_R (*S*, minor) = 20.0 min, 90:10 er.

*HPLC trace for: (A) racemic standard of **7u***



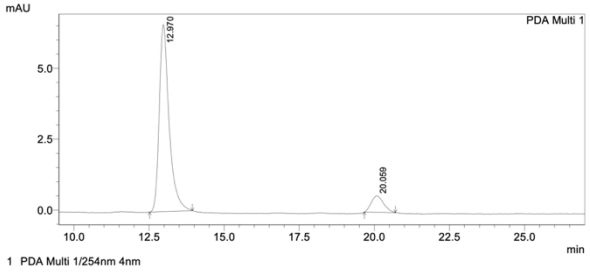
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-4-67-3-Br-NH2-L-OD-99-1-1.0ml.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.412	928921	36417	50.226	58.008
2	20.935	920566	26362	49.774	41.992
Total		1849487	62780	100.000	100.000

*(B) enantiomerically enriched **(R)-7u***



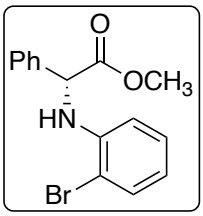
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-4-67-3-Br-NH2-L-OD-99-1-1.0ml-122222.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	12.970	150237	6595	90.100	91.919
2	20.059	16507	580	9.900	8.081
Total		166745	7175	100.000	100.000

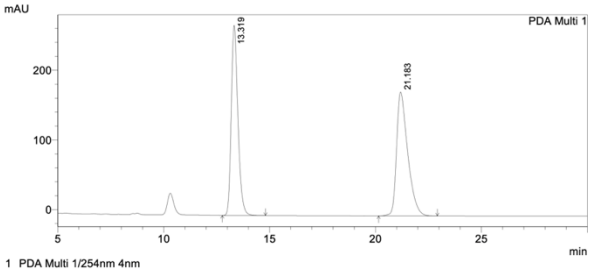
methyl (*R*)-2-((2-bromophenyl)amino)-2-phenylacetate (7v)



According to the General Procedure I, α-phenyl-α-diazoesters **5a** (35.2 mg, 0.200 mmol) and 2-bromoaniline (34.4 mg, 0.200 mmol) were used and the reaction was stirred for 2 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 98:2 *v*/*v*) and isolated as a white solid (54.4 mg, 85%). R_f = 0.52 (hexanes/EtOAc, 98:2 *v*/*v*). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.47 (m, 2H), 7.43 (dd, *J* = 7.9, 1.6 Hz, 1H), 7.39 – 7.29 (m, 3H), 7.06 – 6.97 (m, 1H), 6.56 (ddd, *J* = 7.7, 7.7, 1.5 Hz, 1H), 6.35 (dd, *J* = 8.2, 1.6 Hz, 1H), 5.73 (d, *J* = 5.5 Hz, 1H), 5.10 (d, *J* = 5.8 Hz, 1H), 3.75 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.8, 143.0, 137.1, 132.7, 129.1, 128.6, 128.5, 127.3, 118.7, 112.3, 110.3, 60.8, 53.1. HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{15}H_{15}BrNO_2$ 320.0286; Found 320.0290.

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 1.0 mL/min, λ = 254 nm, 40 °C, t_R (*S*, minor) = 14.2 min; t_R (*R*, major) = 21.4 min, 90:10 er.

*HPLC trace for: (A) racemic standard of **7v***



1 PDA Multi 1/254nm 4nm

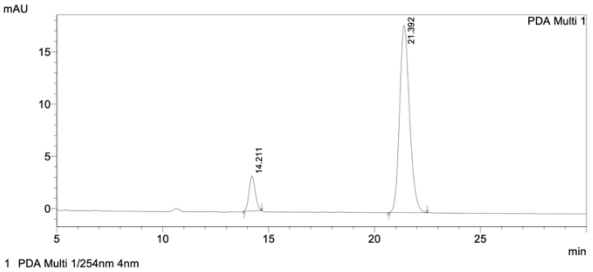
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-4-66-2-Br-NH2-RAC-OD-99-1-1.0ml.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.319	5955366	272677	47.912	60.540
2	21.183	6474306	177732	52.088	39.460
Total		12429672	450409	100.000	100.000

*(B) enantiomerically enriched **(R)-7v***



1 PDA Multi 1/254nm 4nm

< Peak Table >

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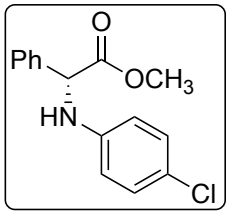
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.211	68245	3348	10.478	15.754
2	21.392	583051	17904	89.522	84.246
Total		651296	21252	100.000	100.000

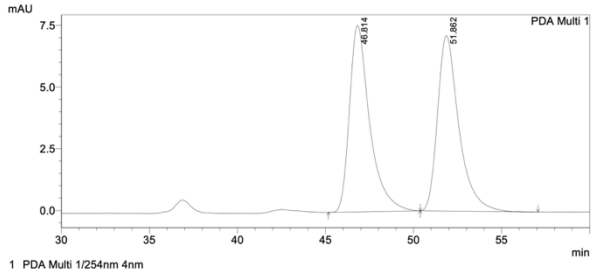
methyl (*R*)-2-((4-chlorophenyl)amino)-2-phenylacetate (7w)



According to the General Procedure I, α-phenyl-α-diazoesters **5a** (35.2 mg, 0.200 mmol) and 4-chloroaniline (25.5 mg, 0.200 mmol) were used and the reaction was stirred for 45 min. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (47.5 mg, 86%). ^{1}H NMR spectral data matches that of previous report.[9]

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 98/2, 0.2 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 48.4 min; t_R (*S*, minor) = 51.5 min, 93:7 er.

HPLC trace for: (A) racemic standard of ***7w***



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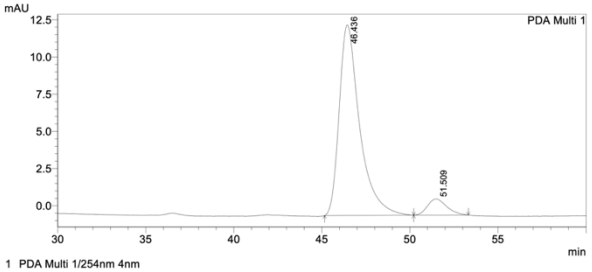
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	46.814	604322	7556	50.208	51.501
2	51.862	599320	7116	49.792	48.499
Total		1203642	14672	100.000	100.000

(B) enantiomerically enriched ***(R)-7w***



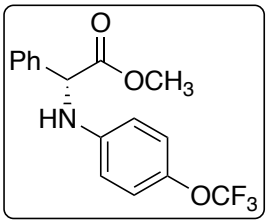
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-109-4-Cl-NH2-L-OD-98-2-0.2ml.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	46.436	1031832	12806	92.660	92.191
2	51.509	81734	1085	7.340	7.809
Total		1113567	13891	100.000	100.000

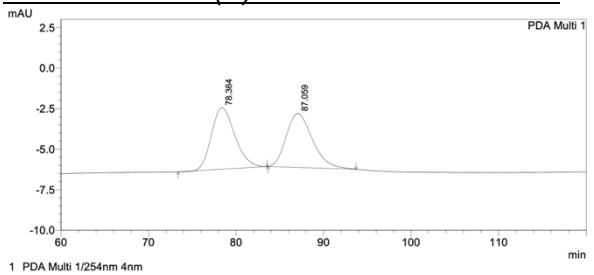
methyl (*R*)-2-phenyl-2-((4-(trifluoromethoxy)phenyl)amino)acetate (7x)



According to the General Procedure I, α-phenyl-α-diazoesters **5a** (35.2 mg, 0.200 mmol) and 4-trifluoromethoxy aniline (35.4 mg, 0.200 mmol) were used and the reaction was stirred for 1 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (60.4 mg, 93%). R_f = 0.16 (hexanes/EtOAc, 95:5 *v*/*v*).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 – 7.43 (m, 2H), 7.41 – 7.26 (m, 3H), 7.01 – 6.92 (m, 2H), 6.54 – 6.45 (m, 2H), 5.06 (d, *J* = 5.7 Hz, 1H), 5.02 (d, *J* = 5.7 Hz, 1H), 3.73 (s, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 172.2, 144.8, 141.1 (q, *J* = 1.8 Hz), 137.3, 129.1, 128.6, 127.3, 122.5, 120.8 (q, *J* = 255.5 Hz), 113.8, 60.9, 53.1; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ -58.45; HRMS (ESI/Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{15}F_3NO_3$ 326.1004; Found 326.1012.
HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 98/2, 0.2 mL/min, λ = 254 nm, 40 °C, t_R (*S*, minor) = 78.9 min; t_R (*R*, major) = 87.5 min, 90:10 er.

HPLC trace for: (A) racemic standard of ***7x***



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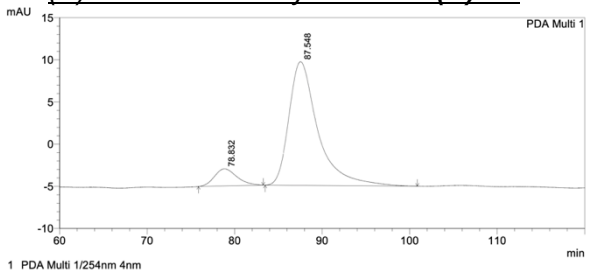
PeakTable C:\LabSolutions\Training1107\YPC\YPC-4-71-4-OCF3-NH2-rac-AD-94-6-0.1ml-120min.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	78.364	706909	3801	50.389	53.313
2	87.059	695984	3328	49.611	46.687
Total		1402893	7129	100.000	100.000

(B) enantiomerically enriched ***(R)-7x***



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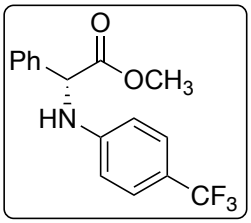
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	78.832	360258	2034	9.597	12.183
2	87.548	3393449	14664	90.403	87.817
Total		3753707	16698	100.000	100.000

methyl (*R*)-2-phenyl-2-((4-(trifluoromethyl)phenyl)amino)acetate (7y)

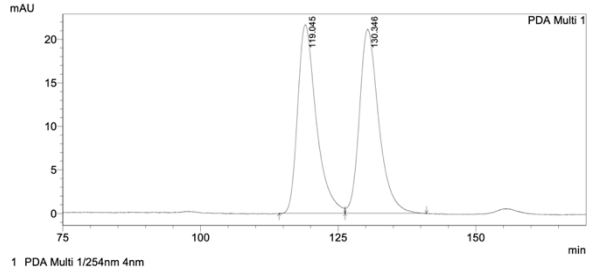


According to the General Procedure I, α-phenyl-α-diazoesters **5a** (35.2 mg, 0.200 mmol) and 4-(trifluoromethyl)aniline (32.2 mg, 0.200 mmol) were used and the reaction was stirred for 45 min. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (57.2 mg, 93%). ^{1}H NMR spectral data matches that of previous report.[18]

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 0.1 mL/min, λ = 254 nm, 30 °C, t_R (*R*, major) = 118.2 min; t_R (*S*, minor) = 129.6 min, 81:19 er.

[18] Zhao, P.; Huang, D.; Wang, F.; Han, T.; Yang, M.; Wang, K.; Hu, Y. *Applied Organom Chemis* **2022**, *36*, e6479.

HPLC trace for: (A) racemic standard of ***7y***



1 PDA Multi 1/254nm 4nm

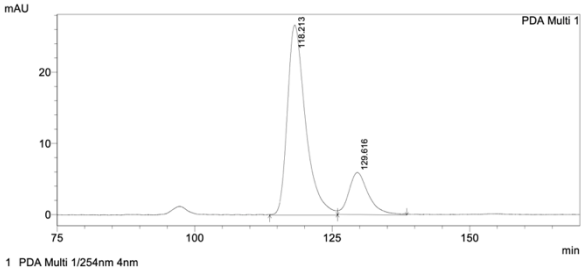
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-90-4-CF3-NH2-RAC-OD-99-1-0.1ml-30C-B-170min--.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	119.045	5097109	21672	49.722	50.597
2	130.346	5154024	21160	50.278	49.403
Total		10251133	42832	100.000	100.000

(B) enantiomerically enriched ***(R)-7y***



1 PDA Multi 1/254nm 4nm

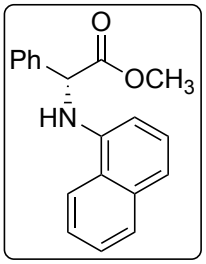
< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-90-4-CF3-NH2-L-OD-99-1-0.1ml-30C-170min--.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	118.213	6174987	26717	80.682	81.860
2	129.616	1478504	5921	19.318	18.140
Total		7653491	32638	100.000	100.000

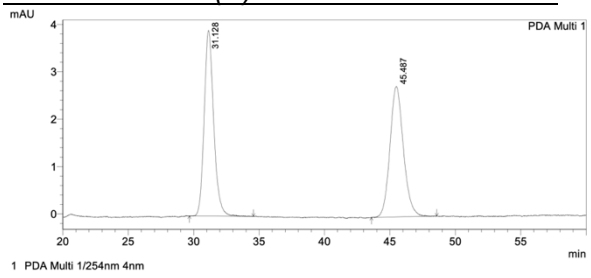
methyl (*R*)-2-(naphthalen-1-ylamino)-2-phenylacetate (7z)



According to the General Procedure I, α-phenyl-α-diazoesters **5a** (35.2 mg, 0.200 mmol) and 1-naphthyl aniline (28.6 mg, 0.200 mmol) were used and the reaction was stirred for 16 h. The product was purified using flash column chromatography (SiO_2, hexanes/EtOAc, 95:5 *v*/*v*) and isolated as a white solid (27.9 mg, 48%). ^{1}H NMR spectral data matches that of previous report.[9]

HPLC analysis: Chiralpak OD-H column, n-hexane/2-propanol = 99/1, 1.0 mL/min, λ = 254 nm, 40 °C, t_R (*R*, major) = 31.3 min; t_R (*S*, minor) = 45.9 min, 80:20 er.

HPLC trace for: (A) racemic standard of ***7z***



1 PDA Multi 1/254nm 4nm

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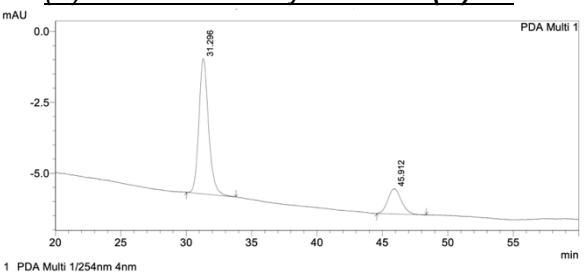
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	31.128	197655	3915	50.135	58.735
2	45.487	196589	2751	49.865	41.265
Total		394244	6666	100.000	100.000

(B) enantiomerically enriched ***(R)-7z***



1 PDA Multi 1/254nm 4nm

< Peak Table >

PeakTable C:\LabSolutions\Training1107\YPC\YPC-3-67-Np-L-OD-99-1-1.0ml.lcd

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	31.296	246231	4776	79.557	84.219
2	45.912	63272	895	20.443	15.781
Total		309504	5671	100.000	100.000

VIII. Computational Details

Computational Methods

DFT calculations were performed at the M06/6-311+G(d,p)-SDD(Cu)/SMD(DCM)//B3LYP-D3/6-31G(d)-SDD(Cu) level of theory using the *Gaussian 16* program.[19] Geometries of all stationary points were optimized using the dispersion-corrected[20] B3LYP-D3 functional[21] with the SDD basis set for copper[22] and the 6-31G(d) basis set for other atoms. Vibrational frequency calculations at the same level of theory of the geometry optimization to confirm if each structure is a local minimum. Single point energy calculations were carried out using the M06 functional[23] with the SDD basis set for copper and the 6-311+G(d,p) basis set for other atoms. Quasi-harmonic approximations with the Grimme's approach [24] were performed using Goodvibes package,[25] with a vibrational frequency cut-off of 100 cm^{-1} in entropy calculations. Solvation energy corrections were calculated using the SMD solvation model[26] in single point energy calculations with dichloromethane as solvent. All Gibbs free energies were calculated at the standard conditions (*i.e.*, 298.15K, 1 mol/L). Due to the large flexibility of the ligand, conformational sampling was performed for the copper-carbene complex and **L3a** using the Conformer-Rotamer Ensemble Sampling Tool (CREST) program.[27] This utilizes the iMTD-GC [28] workflow that combines the semiempirical tight-binding based quantum mechanical method GFN2-xTB [29] to perform metadynamics sampling (MTD) of conformers. The conformations of the ligand from the crystal structures of $[(L3a)_2/Na\cdot(H_2O)_2]^+[BAr^F]^-$ and L3a were used as a starting geometry for the conformational search. Initial conformational sampling with CREST resulted in 1184 and 2253 conformers for the Cu-carbene and L3a using a 1.0 Å RMSD threshold, energy threshold of 0.25 kcal/mol, and an energy window of 12.0 kcal/mol. The CREGEN toolkit from the same program was then used to filter out these conformers with 15% lower bound for rotational constant threshold, 1.0 Å for RMSD, 0.75 kcal/mol for energy threshold between conformers, and an energy window of 12.0 kcal/mol (with the --notopo keyword), yielding 225 conformers for the Cu-carbene and 288 for the ligand, which were then optimized at the DFT level. This resulted in 10 conformers of the Cu-carbene complex and only one conformer for L3a within an energy window of 3.0 kcal/mol. The lowest energy conformers of the Cu-carbene complex are reported in Figure S7.

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[19] M. J. Frisch, G. W. Trucks, H. B. Schlegel, G. E. Scuseria, M. A. Robb, J. R. Cheeseman, G. Scalmani, V. Barone, G. A. Petersson, H. Nakatsuji, X. Li, M. Caricato, A. V. Marenich, J. Bloino, B. G. Janesko, R. Gomperts, B. Mennucci, H. P. Hratchian, J. V. Ortiz, A. F. Izmaylov, J. L. Sonnenberg, Williams, F. Ding, F. Lipparini, F. Egidi, J. Goings, B. Peng, A. Petrone, T. Henderson, D. Ranasinghe, V. G. Zakrzewski, J. Gao, N. Rega, G. Zheng, W. Liang, M. Hada, M. Ehara, K. Toyota, R. Fukuda, J. Hasegawa, M. Ishida, T. Nakajima, Y. Honda, O. Kitao, H. Nakai, T. Vreven, K. Throssell, J. A. Montgomery Jr., J. E. Peralta, F. Ogliaro, M. J. Bearpark, J. J. Heyd, E. N. Brothers, K. N. Kudin, V. N. Staroverov, T. A. Keith, R. Kobayashi, J. Normand, K. Raghavachari, A. P. Rendell, J. C. Burant, S. S. Iyengar, J. Tomasi, M. Cossi, J. M. Millam, M. Klene, C. Adamo, R. Cammi, J. W. Ochterski, R. L. Martin, K. Morokuma, O. Farkas, J. B. Foresman, D. J. Fox, Gaussian 16 Rev. C.01, Wallingford, CT, **2016**.

[20] S. Grimme, J. Antony, S. Ehrlich, H. Krieg, *J. Chem. Phys.* **2010**, *132*.

[21] (a) A. D. Becke, *J. Chem. Phys.* **1993**, *98*, 5648–5652. b) C. Lee, W. Yang, R. G. Parr, *Phys. Rev. B* **1988**, *37*, 785–789.

[22] (a) M. Dolg, U. Wedig, H. Stoll, H. Preuss, *J. Chem. Phys* **1987**, *86*, 866–872. (b) J. M. Martin, A. Sundermann, *J. Chem. Phys.* **2001**, *114*, 3408-3420.

[23] Y. Zhao, D. G. Truhlar, *Theor. Chem. Acc.* **2008**, *120*, 215–241.

[24] S. Grimme, *Chem. – Eur. J.* **2012**, *18*, 9955-9964.

[25] G. Luchini, J. V. Alegre-Requena, I. Funes-Ardoiz, R. S. Paton, *F1000Res.* **2020**, *9*, 291. *Version 3.0.2*

[26] A. V. Marenich, C. J. Cramer, D. G. Truhlar, *J. Phys. Chem. B* **2009**, *113*, 6378-6396.

[27] P. Pracht, F. Bohle, S. Grimme, *Phys. Chem. Chem. Phys.* **2020**, *22*, 7169-7192.

[28] S. Grimme, *J. Chem. Theory Comput.* **2019**, *15*, 2847-2862.

[29] C. Bannwarth, S. Ehlert, S. Grimme, *J. Chem. Theory Comput.* **2019**, *15*, 1652-1671.

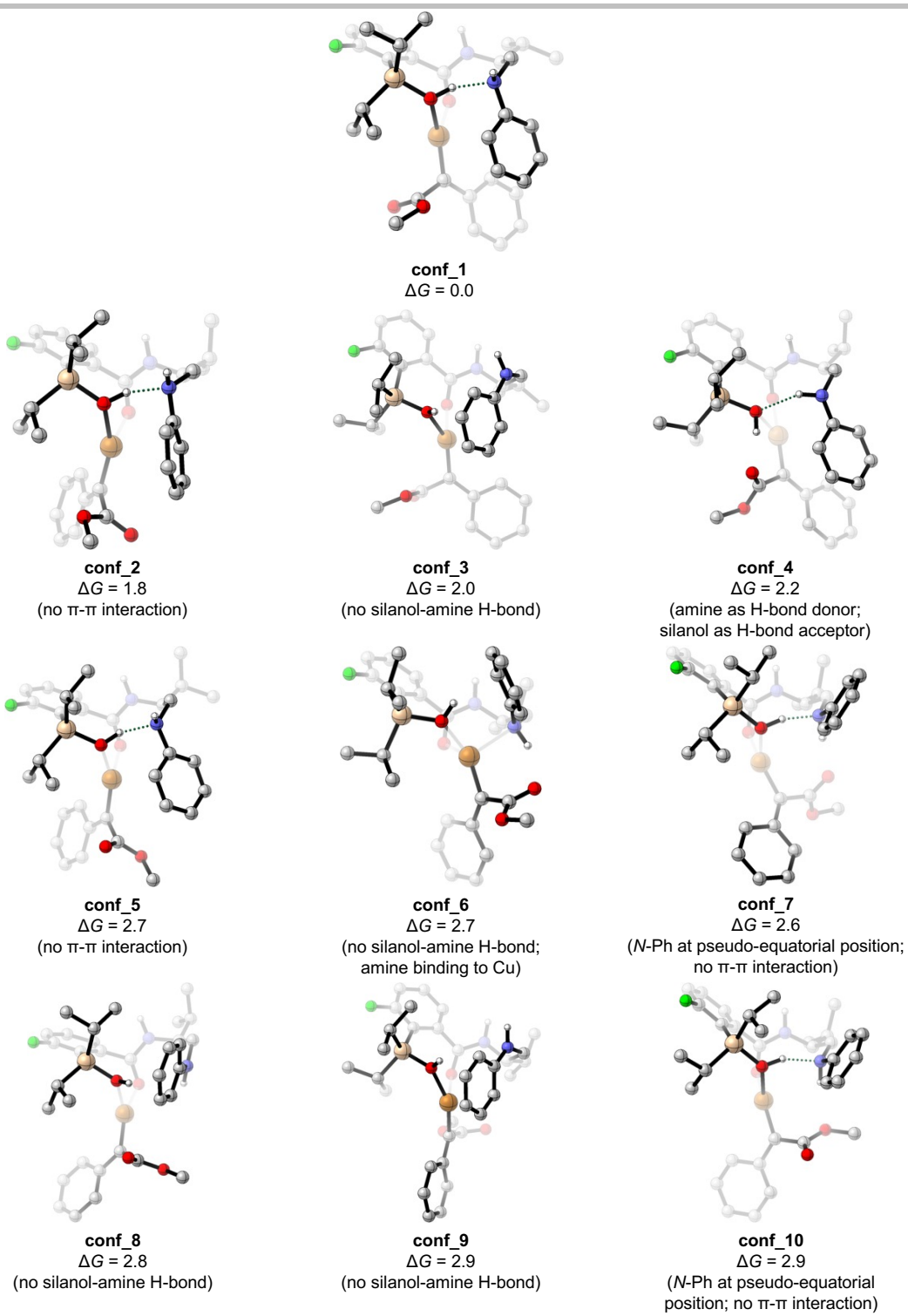

Figure S7. Most stable conformers of the Cu-carbene complex within 3.0 kcal/mol. Gibbs free energies are reported in kcal/mol with respect to **conf_1**.

Additional Computational Results

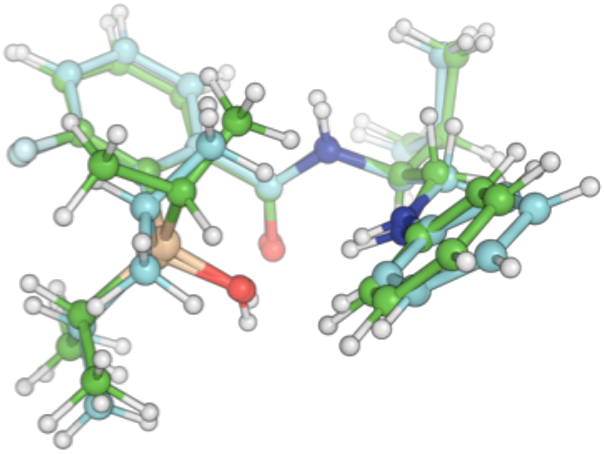

Figure S8. Overlay for the crystal structure of **L3a** (cyan) with the most stable DFT-optimized conformation (green). The root-mean-square-difference (RMSD) resulting from overlaying the 9 heavy atoms in the ring is 0.16 Å.

Cartesian Coordinates

conf_1

```
B3LYP-D3 SCF energy in gas phase (au):      -2280.50242276
B3LYP-D3 enthalpy in gas phase (au):        -2279.74649376
B3LYP-D3 free energy in gas phase (au):     -2279.860752
M06 SCF energy in solution (au):            -2279.76473381
M06 enthalpy in solution (au):              -2279.00880481
M06 free energy in solution (au):           -2279.134439
Cartesian coordinates
ATOM      X           Y             Z
Si    -2.420973    -1.170284     0.682239
O     -0.878353    -0.473014     0.880983
H     -0.750381     0.373298     1.406009
C     -2.088397    -2.997593     0.348400
H     -3.048302    -3.511432     0.495950
C     -1.623210    -3.277247    -1.094644
H     -2.355609    -2.940160    -1.835162
H     -1.465569    -4.352161    -1.245636
H     -0.666976    -2.787674    -1.323673
C     -1.075350    -3.549329     1.373064
H     -0.096432    -3.067882     1.257751
H     -0.937744    -4.628636     1.229876
H     -1.401950    -3.396966     2.409291
C     -3.383653    -0.807793     2.272542
H     -2.702152    -1.105109     3.085827
C     -3.680710     0.697568     2.425175
H     -2.769663     1.307931     2.378411
H     -4.168042     0.905863     3.385497
H     -4.355554     1.045426     1.632869
C     -4.675652    -1.637558     2.408091
H     -5.384747    -1.411120     1.605224
H     -5.171650    -1.420566     3.362114
```

H	-4.475020	-2.714001	2.376677
C	-3.200135	-0.302749	-0.813881
C	-4.377602	-0.824725	-1.349141
F	-4.892370	-1.936856	-0.760398
C	-5.056349	-0.293314	-2.437494
H	-5.965617	-0.769139	-2.788270
C	-4.529723	0.845286	-3.046129
H	-5.035237	1.284057	-3.900666
C	-3.352458	1.417609	-2.559348
H	-2.934408	2.297054	-3.040924
C	-2.698539	0.846596	-1.461960
C	-1.412134	1.481684	-1.011029
N	-1.538795	2.477483	-0.114985
H	-2.480184	2.748639	0.143562
O	-0.301806	1.100156	-1.437171
C	-0.420172	3.259362	0.420655
H	0.470801	2.831865	-0.045314
C	-0.524613	4.749544	0.007851
H	-1.350455	5.204362	0.577236
C	0.771579	5.508060	0.342458
H	1.005143	5.509790	1.411721
H	0.689246	6.553457	0.029077
H	1.623356	5.069436	-0.193395
C	-0.833552	4.884805	-1.491919
H	-0.847979	5.939484	-1.783946
H	-1.804532	4.454269	-1.755074
H	-0.067725	4.378219	-2.092618
C	-0.352199	3.052683	1.947064
H	0.324610	3.783900	2.402026
H	-1.344528	3.236336	2.373036
N	0.027228	1.675797	2.306716
H	-0.313471	1.456981	3.240877
C	1.413366	1.291615	2.205594
C	1.741200	-0.032718	2.542627
H	0.955605	-0.713038	2.858538
C	3.056016	-0.482341	2.445963
H	3.283549	-1.513878	2.694372
C	4.064391	0.376999	2.001625
H	5.087634	0.025176	1.915764
C	3.739421	1.686458	1.654359
H	4.512014	2.364512	1.304267
C	2.422553	2.149255	1.753005
H	2.208022	3.178185	1.489628
Cu	0.622606	-0.580673	-0.483639
C	2.259718	-1.363671	-0.862073
C	3.460304	-0.689901	-1.220055
C	4.723346	-1.347202	-1.246609
C	5.874633	-0.645284	-1.562744
C	5.791878	0.719762	-1.880382
C	4.560920	1.388516	-1.873111
C	3.407127	0.696120	-1.538390
C	2.280153	-2.838046	-0.755361
O	2.574625	-3.291951	0.474033
C	2.472596	-4.728216	0.643001
O	1.985095	-3.532333	-1.708846
H	4.780404	-2.402970	-1.000641
H	6.836837	-1.147473	-1.574871
H	6.696364	1.263409	-2.139192

```
H     4.513970     2.442729    -2.127625
H     2.440526     1.190848    -1.526689
H     3.176220    -5.238701    -0.018508
H     1.456152    -5.058718     0.418966
H     2.718810    -4.911635     1.688065
```

conf_2

```
B3LYP-D3 SCF energy in gas phase (au):      -2280.50289542
B3LYP-D3 enthalpy in gas phase (au):        -2279.74665042
B3LYP-D3 free energy in gas phase (au):     -2279.861748
M06 SCF energy in solution (au):            -2279.76140964
M06 enthalpy in solution (au):              -2279.00516464
M06 free energy in solution (au):           -2279.132030
Cartesian coordinates
ATOM      X           Y             Z
Si    -1.252786    -0.783584     1.966498
O     -0.495592     0.456234     1.073097
H     -1.027817     1.262086     0.789421
C      0.142910    -1.684405     2.871905
H     -0.328189    -2.162678     3.742724
C      0.783042    -2.794471     2.011848
H      1.219786    -2.384124     1.091863
H      0.060275    -3.565428     1.728426
H      1.594219    -3.283655     2.565317
C      1.227582    -0.708048     3.376830
H      0.820397     0.096145     3.998327
H      1.763742    -0.242901     2.541840
H      1.967805    -1.249760     3.978754
C     -2.565607     0.050159     3.049631
H     -2.968906    -0.741323     3.698311
C     -1.966233     1.153242     3.944959
H     -1.234032     0.754951     4.654434
H     -2.751934     1.649754     4.527947
H     -1.458789     1.922900     3.348249
C     -3.734038     0.601914     2.205516
H     -4.499455     1.052412     2.848991
H     -4.217705    -0.183036     1.612972
H     -3.393705     1.383278     1.512185
C     -2.121935    -1.907265     0.709986
C     -2.674173    -3.098684     1.178618
F     -2.512315    -3.379814     2.499492
C     -3.373000    -4.008903     0.397387
H     -3.765912    -4.914596     0.846449
C     -3.545953    -3.712165    -0.954621
H     -4.089758    -4.401359    -1.593239
C     -3.025749    -2.528920    -1.484133
H     -3.160398    -2.297309    -2.537039
C     -2.321119    -1.642985    -0.660983
C     -1.757290    -0.395575    -1.285035
N     -2.601583     0.656312    -1.334289
H     -3.538847     0.518208    -0.978675
O     -0.587897    -0.342032    -1.707781
C     -2.267339     1.932807    -1.964637
H     -1.256443     1.792588    -2.345897
C     -3.185295     2.225609    -3.180305
H     -2.866492     3.203538    -3.567806
C     -2.958293     1.180147    -4.282192
H     -3.543570     1.426401    -5.173869
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H    -3.269379     0.183750    -3.945493
H    -1.903356     1.122639    -4.572692
C    -4.677127     2.320194    -2.820275
H    -5.261476     2.567825    -3.712002
H    -4.888362     3.091178    -2.071594
H    -5.063455     1.362692    -2.446671
C    -2.268067     3.082609    -0.938739
H    -1.988614     4.008849    -1.457594
H    -3.283584     3.216533    -0.554466
N    -1.401988     2.870859     0.243610
H    -1.852783     3.276120     1.059621
C    -0.036008     3.302027     0.212283
C     0.793647     3.050609    -0.892138
H     0.399922     2.598472    -1.793653
C     2.148557     3.394484    -0.842014
H     2.782575     3.183253    -1.695951
C     2.693473     3.967250     0.306657
H     3.746640     4.227227     0.335439
C     1.869807     4.205688     1.409851
H     2.276610     4.659477     2.309066
C     0.515654     3.876535     1.364916
H    -0.117486     4.069006     2.228751
Cu     1.038489     0.190793    -0.163481
C     2.764586    -0.371930    -0.574678
C     3.128019    -1.548773    -1.284143
C     4.487297    -1.951344    -1.446652
C     4.797519    -3.128460    -2.105354
C     3.766291    -3.928860    -2.622324
C     2.422685    -3.551706    -2.489064
C     2.101758    -2.375029    -1.831169
C     3.852127     0.507584    -0.088740
O     4.061806     0.396020     1.228526
C     5.034051     1.305687     1.795449
O     4.424716     1.281031    -0.834648
H     5.280770    -1.321022    -1.058219
H     5.832419    -3.432616    -2.225661
H     4.015366    -4.852295    -3.138017
H     1.638972    -4.178044    -2.903395
H     1.068939    -2.053983    -1.733015
H     5.139335     0.999994     2.835420
H     4.659668     2.329511     1.727623
H     5.986714     1.226489     1.266717
```

conf_3

```
B3LYP-D3 SCF energy in gas phase (au):      -2280.49796143
B3LYP-D3 enthalpy in gas phase (au):        -2279.74224443
B3LYP-D3 free energy in gas phase (au):     -2279.857713
M06 SCF energy in solution (au):            -2279.76019025
M06 enthalpy in solution (au):              -2279.00447325
M06 free energy in solution (au):           -2279.131129
Cartesian coordinates
ATOM      X           Y             Z
Si    -2.310029    -1.154712     0.289050
O     -0.823031    -0.500694     0.849722
H     -0.692470    -0.410423     1.811645
C     -1.890670    -2.632408    -0.818640
H     -1.025285    -3.094639    -0.318486
C     -3.036505    -3.666065    -0.864071
```

H	-2.749144	-4.523991	-1.484743
H	-3.943879	-3.235613	-1.302007
H	-3.297063	-4.049157	0.128369
C	-1.470589	-2.240356	-2.250127
H	-0.641231	-1.527332	-2.277076
H	-2.307693	-1.780953	-2.788992
H	-1.158663	-3.127367	-2.814836
C	-3.279428	-1.634728	1.841670
H	-4.174544	-2.157716	1.483473
C	-2.467675	-2.618381	2.711148
H	-1.551635	-2.159301	3.102189
H	-2.171667	-3.516123	2.156427
H	-3.059196	-2.944538	3.575349
C	-3.742389	-0.413506	2.658810
H	-2.890173	0.175983	3.018789
H	-4.312230	-0.730957	3.540675
H	-4.383759	0.251510	2.070106
C	-3.185857	0.234518	-0.677653
C	-4.545557	0.062307	-0.934530
F	-5.122000	-1.102669	-0.536960
C	-5.363499	0.991557	-1.567548
H	-6.411864	0.761917	-1.723926
C	-4.793268	2.190673	-1.985550
H	-5.400491	2.933015	-2.493717
C	-3.434655	2.425408	-1.764875
H	-2.981435	3.342462	-2.130981
C	-2.640836	1.460470	-1.129509
C	-1.174090	1.724351	-1.008678
N	-0.804244	2.914358	-0.503911
H	-1.540156	3.536965	-0.195404
O	-0.337690	0.880897	-1.401452
C	0.587756	3.309316	-0.271678
H	1.151834	2.372513	-0.251505
C	1.162877	4.186398	-1.411368
H	0.646469	5.158318	-1.381290
C	2.668543	4.427678	-1.201751
H	3.208607	3.471763	-1.153671
H	2.890377	4.993133	-0.291490
H	3.081247	4.992625	-2.043431
C	0.921869	3.550666	-2.789163
H	1.352151	4.179707	-3.575173
H	-0.144030	3.432157	-3.005831
H	1.385235	2.559522	-2.850354
C	0.681362	3.984002	1.120394
H	1.732880	4.184472	1.345212
H	0.187085	4.962231	1.084827
N	0.089734	3.238507	2.212223
H	-0.870009	3.455837	2.436488
C	0.532936	2.000335	2.642595
C	1.785573	1.471900	2.271415
H	2.455730	2.049769	1.645400
C	2.191692	0.216579	2.731323
H	3.159233	-0.166316	2.420922
C	1.377106	-0.543605	3.571419
H	1.699193	-1.517629	3.923999
C	0.144505	-0.010445	3.970997
H	-0.495296	-0.565297	4.651425
C	-0.277534	1.236440	3.511167

H	-1.232188	1.639913	3.840584
Cu	0.847023	-0.378424	-0.361109
C	2.361454	-1.394237	-0.678652
C	3.743458	-1.060922	-0.563517
C	4.778869	-2.024490	-0.721435
C	6.108739	-1.661245	-0.571229
C	6.439275	-0.330949	-0.276779
C	5.440527	0.643773	-0.132657
C	4.111163	0.281621	-0.272691
C	2.028238	-2.742291	-1.201336
O	1.626772	-3.604616	-0.255306
C	1.212528	-4.906826	-0.738295
O	2.064745	-2.972901	-2.394476
H	4.522223	-3.050901	-0.963595
H	6.893529	-2.401860	-0.687696
H	7.482811	-0.050311	-0.165121
H	5.711508	1.672587	0.083171
H	3.318130	1.015635	-0.176594
H	2.026760	-5.385791	-1.286903
H	0.345066	-4.802722	-1.394457
H	0.958478	-5.475592	0.155008

conf_4

B3LYP-D3 SCF energy in gas phase (au): -2280.50483763
B3LYP-D3 enthalpy in gas phase (au): -2279.74868563
B3LYP-D3 free energy in gas phase (au): -2279.861656
M06 SCF energy in solution (au): -2279.76265392
M06 enthalpy in solution (au): -2279.00650192
M06 free energy in solution (au): -2279.129319
Cartesian coordinates

ATOM	X	Y	Z
Si	-2.264679	-1.472719	0.549979
O	-0.775720	-0.672262	0.777603
H	-0.069127	-1.314359	1.018935
C	-1.881675	-3.104810	-0.334408
H	-1.034718	-3.503901	0.244869
C	-3.012865	-4.149622	-0.287416
H	-2.661697	-5.107447	-0.691814
H	-3.874406	-3.836066	-0.883461
H	-3.366577	-4.330848	0.733664
C	-1.402310	-2.877264	-1.781465
H	-0.545331	-2.193996	-1.840696
H	-2.199795	-2.449647	-2.400570
H	-1.099858	-3.824140	-2.247876
C	-3.017133	-1.683726	2.271078
H	-3.990931	-2.175135	2.147465
C	-2.117530	-2.584813	3.141318
H	-1.120420	-2.144151	3.274469
H	-1.985125	-3.582658	2.707305
H	-2.548441	-2.714621	4.141673
C	-3.244967	-0.317132	2.946620
H	-3.690866	-0.442092	3.940986
H	-3.915413	0.323970	2.361478
H	-2.296320	0.219468	3.084138
C	-3.354984	-0.307213	-0.490571
C	-4.680184	-0.708307	-0.678120
F	-5.060979	-1.897614	-0.143952
C	-5.649374	0.019024	-1.357767

H	-6.650437	-0.386949	-1.454126
C	-5.293597	1.257297	-1.885642
H	-6.026361	1.850986	-2.422885
C	-3.992708	1.732704	-1.713439
H	-3.707974	2.698785	-2.120684
C	-3.041345	0.956605	-1.038523
C	-1.669247	1.540795	-0.908992
N	-1.567302	2.583492	-0.082672
H	-2.415169	2.855889	0.400533
O	-0.699474	1.102903	-1.577377
C	-0.343243	3.330561	0.233210
H	0.451080	2.868472	-0.359186
C	-0.467403	4.814448	-0.182173
H	0.493306	5.273987	0.091789
C	-0.642320	4.941774	-1.701790
H	-1.594576	4.504628	-2.025773
H	0.161446	4.430771	-2.244330
H	-0.641404	5.993861	-2.004491
C	-1.580239	5.562507	0.569575
H	-2.572872	5.163533	0.321947
H	-1.585182	6.618428	0.281514
H	-1.454237	5.519958	1.656776
C	-0.023734	3.108933	1.729191
H	0.708683	3.849636	2.064048
H	-0.926400	3.280699	2.327280
N	0.467133	1.783543	2.034849
H	-0.203920	1.025374	1.954004
C	1.790755	1.410446	1.887971
C	2.172959	0.098065	2.269913
H	1.413292	-0.590162	2.623837
C	3.511755	-0.278172	2.290174
H	3.770684	-1.279419	2.623233
C	4.507732	0.608873	1.879293
H	5.551907	0.316060	1.892925
C	4.133685	1.885264	1.441265
H	4.894506	2.583161	1.103051
C	2.799279	2.288830	1.439007
H	2.551087	3.290455	1.104871
Cu	0.759365	0.015783	-1.014056
C	2.265902	-1.040812	-0.721930
C	3.624507	-0.706217	-0.944027
C	3.936910	0.553527	-1.535123
C	5.245229	0.900902	-1.833736
C	6.282743	0.010013	-1.532508
C	6.014829	-1.221029	-0.913305
C	4.710583	-1.573663	-0.613729
C	1.911324	-2.390328	-0.202755
O	2.320110	-3.374104	-1.007652
C	1.843985	-4.707379	-0.692617
O	1.236993	-2.580893	0.806543
H	3.117357	1.225771	-1.768712
H	5.464658	1.854986	-2.302227
H	7.307804	0.276577	-1.774378
H	6.830698	-1.895180	-0.672327
H	4.506674	-2.528366	-0.143220
H	2.161386	-4.992994	0.312475
H	2.293460	-5.353227	-1.445203
H	0.754236	-4.736090	-0.757466

conf_5

B3LYP-D3 SCF energy in gas phase (au): -2280.50528438
B3LYP-D3 enthalpy in gas phase (au): -2279.74919338
B3LYP-D3 free energy in gas phase (au): -2279.862950
M06 SCF energy in solution (au): -2279.76123640
M06 enthalpy in solution (au): -2279.00514540
M06 free energy in solution (au): -2279.129913
Cartesian coordinates

ATOM	X	Y	Z
Si	-1.644078	-1.681712	0.167559
O	-0.314937	-0.620964	0.221635
H	-0.353141	0.199705	0.821479
C	-0.896493	-3.358098	-0.268286
H	-1.698627	-4.101638	-0.167382
C	-0.395951	-3.396630	-1.725382
H	-1.208397	-3.246845	-2.443974
H	0.078751	-4.360153	-1.951083
H	0.351683	-2.613106	-1.920199
C	0.230383	-3.709924	0.723806
H	1.046471	-2.978674	0.669445
H	0.650778	-4.698603	0.499440
H	-0.123982	-3.730359	1.761322
C	-2.481867	-1.562759	1.859105
H	-1.645789	-1.533134	2.574188
C	-3.268044	-0.244431	2.006116
H	-4.128662	-0.219456	1.326231
H	-2.643202	0.632556	1.797233
H	-3.644852	-0.130609	3.029275
C	-3.366039	-2.777492	2.200901
H	-3.772389	-2.679010	3.215068
H	-2.803050	-3.717143	2.160275
H	-4.211023	-2.867830	1.510693
C	-2.775794	-1.056717	-1.227234
C	-3.880001	-1.828104	-1.587319
F	-4.063333	-3.004494	-0.930492
C	-4.802144	-1.482369	-2.566820
H	-5.631698	-2.147201	-2.781661
C	-4.620277	-0.277674	-3.244679
H	-5.323977	0.020421	-4.015532
C	-3.532779	0.542169	-2.934033
H	-3.382632	1.475811	-3.468561
C	-2.625627	0.150112	-1.944751
C	-1.441280	1.029828	-1.665946
N	-1.643772	2.014819	-0.780315
H	-2.581239	2.094597	-0.405096
O	-0.333840	0.823688	-2.217282
C	-0.625228	2.940739	-0.261361
H	0.331140	2.593388	-0.662682
C	-0.857655	4.382951	-0.769213
H	-0.038529	4.979271	-0.342665
C	-0.747263	4.442184	-2.298836
H	-1.556806	3.875463	-2.773597
H	0.202450	4.023588	-2.651255
H	-0.816576	5.476722	-2.650043
C	-2.186834	4.981508	-0.283704
H	-2.286475	6.014191	-0.632366
H	-2.264904	4.996318	0.809098

H	-3.045259	4.426022	-0.683127
C	-0.582360	2.828390	1.274311
H	-0.061776	3.700975	1.693446
H	-1.602951	2.844605	1.668324
N	0.059923	1.572733	1.675355
H	1.040873	1.592009	1.379512
C	-0.033491	1.122188	3.033875
C	0.679081	-0.042464	3.364950
H	1.293254	-0.523438	2.607315
C	0.578995	-0.587746	4.641677
H	1.136642	-1.488107	4.883874
C	-0.240167	0.011778	5.604000
H	-0.323350	-0.417277	6.597690
C	-0.943452	1.169167	5.275598
H	-1.574899	1.651292	6.016375
C	-0.840380	1.731679	3.999010
H	-1.385090	2.642771	3.777252
Cu	1.115025	-0.098396	-1.145767
C	2.943192	0.001060	-0.863164
C	3.930739	-1.015357	-0.754092
C	5.266444	-0.758110	-0.323976
C	6.180799	-1.792349	-0.213591
C	5.792820	-3.104028	-0.528050
C	4.487508	-3.387423	-0.955805
C	3.568563	-2.357862	-1.067580
C	3.284962	1.397400	-0.493044
O	4.142980	1.974070	-1.335716
C	4.364218	3.395504	-1.151021
O	2.759001	1.975790	0.452841
H	5.568284	0.257573	-0.092523
H	7.195819	-1.591571	0.114111
H	6.515000	-3.910853	-0.439586
H	4.202056	-4.406384	-1.196653
H	2.552508	-2.554188	-1.393500
H	3.414869	3.932368	-1.221916
H	5.035835	3.686084	-1.957113
H	4.818091	3.581467	-0.175159

conf_6

B3LYP-D3 SCF energy in gas phase (au): -2280.50138844
B3LYP-D3 enthalpy in gas phase (au): -2279.74505644
B3LYP-D3 free energy in gas phase (au): -2279.858657
M06 SCF energy in solution (au): -2279.76155607
M06 enthalpy in solution (au): -2279.00522407
M06 free energy in solution (au): -2279.129594
Cartesian coordinates

ATOM	X	Y	Z
Si	-1.335697	-1.461490	1.611080
O	-0.621440	0.024391	1.179866
H	-1.168323	0.868672	1.106238
C	0.060571	-2.497852	2.355663
H	-0.429913	-3.205357	3.040083
C	0.827956	-3.317912	1.298358
H	1.292776	-2.665049	0.549049
H	0.179037	-4.026846	0.775858
H	1.634731	-3.889712	1.773406
C	1.042658	-1.628555	3.172444
H	0.542143	-1.022883	3.935412

H	1.608846	-0.947902	2.526636
H	1.771189	-2.268092	3.685584
C	-2.787202	-1.085384	2.767669
H	-3.189724	-2.066786	3.059906
C	-2.343089	-0.344548	4.044271
H	-1.862613	0.613676	3.804321
H	-1.632110	-0.930816	4.634983
H	-3.204954	-0.126921	4.687239
C	-3.912017	-0.313399	2.048648
H	-4.765752	-0.154070	2.718344
H	-4.278301	-0.849701	1.165302
H	-3.568349	0.677648	1.723447
C	-2.015274	-2.212574	0.005535
C	-2.482405	-3.525713	0.047694
F	-2.387293	-4.180805	1.235576
C	-3.034045	-4.205601	-1.029804
H	-3.368435	-5.229924	-0.906153
C	-3.140458	-3.528826	-2.244713
H	-3.569633	-4.030460	-3.106520
C	-2.702202	-2.206688	-2.350493
H	-2.788092	-1.677926	-3.295567
C	-2.145428	-1.562214	-1.239958
C	-1.668225	-0.144897	-1.409659
N	-2.604149	0.804049	-1.216260
H	-3.542820	0.491510	-1.001642
O	-0.482898	0.121196	-1.691384
C	-2.359113	2.242792	-1.353952
H	-1.305703	2.318075	-1.629998
C	-3.206774	2.835638	-2.508591
H	-3.044911	2.159699	-3.359052
C	-4.712228	2.862940	-2.201298
H	-5.102064	1.876536	-1.919485
H	-5.272765	3.186758	-3.083920
H	-4.947425	3.563883	-1.391772
C	-2.699719	4.226237	-2.921993
H	-3.231420	4.572620	-3.814151
H	-1.629449	4.207992	-3.159003
H	-2.865224	4.974655	-2.138031
C	-2.580018	2.940929	0.002070
H	-2.611424	4.028205	-0.137949
H	-3.553245	2.647155	0.406511
N	-1.568824	2.555843	1.001348
H	-1.934210	2.712066	1.938891
C	-0.245299	3.121385	0.906902
C	0.696710	2.716073	1.867781
H	0.406141	2.009137	2.639510
C	2.003108	3.198194	1.822407
H	2.714542	2.864853	2.571459
C	2.393933	4.076443	0.807732
H	3.409967	4.455450	0.768467
C	1.464506	4.469100	-0.153568
H	1.754396	5.154681	-0.944464
C	0.147836	4.001063	-0.108316
H	-0.555248	4.343051	-0.858178
Cu	0.977705	0.177408	-0.019558
C	2.773521	-0.160560	-0.346412
C	3.260936	-1.215368	-1.171476
C	4.633038	-1.602714	-1.188764

C	5.060758	-2.645267	-1.993368
C	4.139650	-3.313328	-2.814942
C	2.787533	-2.943838	-2.831239
C	2.347216	-1.914348	-2.014826
C	3.764503	0.578682	0.470494
O	4.465295	1.482734	-0.223565
C	5.435854	2.243740	0.532959
O	3.884703	0.354462	1.661325
H	5.343857	-1.084094	-0.553617
H	6.104257	-2.943872	-1.993832
H	4.481325	-4.127004	-3.448776
H	2.089176	-3.465705	-3.477838
H	1.305120	-1.607235	-2.020741
H	5.796616	3.011118	-0.150575
H	6.254961	1.593122	0.850202
H	4.969735	2.689788	1.413201

conf_7

B3LYP-D3 SCF energy in gas phase (au): -2280.51090377
B3LYP-D3 enthalpy in gas phase (au): -2279.75424777
B3LYP-D3 free energy in gas phase (au): -2279.867971
M06 SCF energy in solution (au): -2279.76173032
M06 enthalpy in solution (au): -2279.00507432
M06 free energy in solution (au): -2279.128886
Cartesian coordinates

ATOM	X	Y	Z
Si	-1.909185	-1.468874	-0.914693
O	-0.748633	-1.129775	0.306435
H	-1.052313	-1.208082	1.229711
C	-0.931239	-1.774817	-2.498568
H	-0.528204	-0.780663	-2.740313
C	0.255884	-2.744885	-2.347956
H	-0.081938	-3.772477	-2.173724
H	0.918867	-2.463239	-1.521993
H	0.855206	-2.753577	-3.267522
C	-1.866860	-2.209083	-3.645817
H	-1.313431	-2.268499	-4.590976
H	-2.700769	-1.513457	-3.793052
H	-2.293317	-3.201730	-3.455681
C	-2.923875	-2.909986	-0.216728
H	-3.508350	-3.316274	-1.052300
C	-1.999135	-4.024239	0.320441
H	-1.315265	-4.408017	-0.443066
H	-2.596954	-4.869639	0.682706
H	-1.390574	-3.671508	1.162505
C	-3.911714	-2.465591	0.881906
H	-4.646263	-1.744968	0.512457
H	-3.389131	-2.013603	1.735375
H	-4.463068	-3.330958	1.269965
C	-2.974642	0.097171	-1.144516
C	-4.275526	-0.036717	-1.627390
F	-4.704041	-1.277631	-1.972481
C	-5.176969	1.010665	-1.788750
H	-6.169703	0.804682	-2.174026
C	-4.761966	2.295585	-1.451255
H	-5.439099	3.134965	-1.574238
C	-3.465530	2.501410	-0.974910
H	-3.127007	3.510532	-0.756911

C	-2.582206	1.422437	-0.835705
C	-1.168536	1.706124	-0.436918
N	-0.987102	2.500341	0.640163
H	-1.812122	2.824299	1.127315
O	-0.211965	1.226522	-1.078754
C	0.318409	2.991512	1.091788
H	1.024706	2.706183	0.306972
C	0.324104	4.535529	1.210919
H	1.336368	4.802632	1.545270
C	0.092012	5.184642	-0.160969
H	-0.910682	4.956179	-0.541971
H	0.819277	4.830456	-0.900445
H	0.180522	6.273654	-0.092809
C	-0.671190	5.075060	2.251817
H	-0.580722	6.163145	2.328739
H	-0.502271	4.661607	3.251773
H	-1.711794	4.868029	1.967035
C	0.749891	2.281200	2.384678
H	1.666793	2.758490	2.748761
H	-0.005559	2.407524	3.164972
N	1.022089	0.834402	2.194496
H	2.024983	0.659309	2.284775
C	0.296950	-0.113811	2.973785
C	-1.093419	-0.009658	3.147415
H	-1.628031	0.840841	2.737531
C	-1.792168	-1.010067	3.831530
H	-2.864686	-0.908327	3.969765
C	-1.125333	-2.133711	4.323796
H	-1.673230	-2.911368	4.845918
C	0.256504	-2.240753	4.141094
H	0.789625	-3.105375	4.525752
C	0.966259	-1.241022	3.477508
H	2.041067	-1.322431	3.341098
Cu	1.046900	-0.165817	0.109912
C	2.834366	-0.378684	-0.370332
C	3.479711	0.046106	-1.567281
C	4.891906	-0.026621	-1.751450
C	5.469470	0.385696	-2.940935
C	4.659369	0.881687	-3.973835
C	3.268350	0.966367	-3.820338
C	2.682121	0.553894	-2.634410
C	3.656751	-0.873724	0.753254
O	4.190168	-2.079455	0.535561
C	4.857370	-2.697773	1.663305
O	3.767851	-0.251645	1.806914
H	5.515676	-0.421210	-0.956342
H	6.544726	0.325250	-3.076538
H	5.117327	1.202026	-4.905601
H	2.654639	1.350584	-4.629089
H	1.608189	0.615930	-2.493426
H	5.684685	-2.071557	2.004143
H	5.218872	-3.654922	1.290602
H	4.148829	-2.844845	2.482590

conf_8

B3LYP-D3 SCF energy in gas phase (au): -2280.49889806
B3LYP-D3 enthalpy in gas phase (au): -2279.74344506
B3LYP-D3 free energy in gas phase (au): -2279.858735

M06 SCF energy in solution (au): -2279.75883624
M06 enthalpy in solution (au): -2279.00338324
M06 free energy in solution (au): -2279.129808
Cartesian coordinates

ATOM	X	Y	Z
Si	-0.492403	-1.098812	1.791245
O	-0.084003	0.218456	0.796598
H	-0.015631	1.107344	1.202172
C	1.091675	-1.663153	2.644809
H	0.810628	-2.379859	3.427010
C	2.060090	-2.362329	1.672409
H	1.629994	-3.278398	1.253766
H	2.992174	-2.634412	2.183671
H	2.332200	-1.700775	0.840200
C	1.767808	-0.442306	3.308076
H	2.109398	0.282598	2.558778
H	2.649378	-0.758026	3.879356
H	1.099152	0.079982	4.004086
C	-1.868384	-0.538572	2.959002
H	-1.508169	0.404028	3.401666
C	-3.164852	-0.224012	2.187392
H	-3.581027	-1.132018	1.731490
H	-2.993290	0.513729	1.396295
H	-3.927675	0.183620	2.862130
C	-2.120280	-1.546587	4.097547
H	-2.920389	-1.189623	4.757623
H	-1.227306	-1.700603	4.713275
H	-2.426764	-2.525314	3.708972
C	-1.145132	-2.320372	0.495017
C	-1.230368	-3.663403	0.865620
F	-0.808174	-3.993680	2.113948
C	-1.724054	-4.684397	0.064537
H	-1.743905	-5.701145	0.441411
C	-2.189155	-4.349765	-1.205149
H	-2.584346	-5.120477	-1.859462
C	-2.158349	-3.019971	-1.628746
H	-2.528080	-2.758823	-2.616266
C	-1.637916	-2.017365	-0.795833
C	-1.657781	-0.632939	-1.397781
N	-2.867263	-0.070557	-1.477889
H	-3.629269	-0.571903	-1.039471
O	-0.645933	-0.086185	-1.905834
C	-3.192413	1.174738	-2.190326
H	-2.407070	1.299757	-2.943761
C	-4.543482	1.029446	-2.931148
H	-4.671716	1.970438	-3.482617
C	-4.492259	-0.115053	-3.954045
H	-4.408323	-1.090235	-3.458709
H	-3.639428	-0.008012	-4.634289
H	-5.405426	-0.131266	-4.557326
C	-5.746495	0.875652	-1.985240
H	-6.673083	0.819786	-2.565051
H	-5.843074	1.716715	-1.291153
H	-5.693615	-0.048421	-1.392924
C	-3.152064	2.381656	-1.233473
H	-3.639079	3.236086	-1.727799
H	-3.744060	2.147413	-0.344083
N	-1.795329	2.697392	-0.841848

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H    -1.075402     2.453385    -1.507540
C    -1.359623     3.028486     0.424609
C     0.033803     3.120492     0.660558
H     0.714089     2.992295    -0.179210
C     0.539220     3.347193     1.941660
H     1.615649     3.370984     2.080864
C    -0.329373     3.511899     3.025518
H     0.059097     3.685357     4.023546
C    -1.706182     3.475064     2.791173
H    -2.398438     3.628072     3.614713
C    -2.224623     3.245737     1.515377
H    -3.299922     3.237051     1.376430
Cu    1.076083     0.179105    -0.963637
C     2.890799     0.557091    -0.961702
C     3.980698    -0.326356    -1.201446
C     5.333538     0.036896    -0.938696
C     6.362254    -0.857561    -1.183549
C     6.071893    -2.128831    -1.701842
C     4.750767    -2.513017    -1.973323
C     3.717538    -1.625143    -1.723623
C     3.197800     1.893121    -0.397655
O     3.204737     2.876624    -1.300961
C     3.427334     4.214800    -0.784996
O     3.348488     2.034891     0.804780
H     5.553328     1.013992    -0.520399
H     7.390306    -0.578729    -0.975479
H     6.882971    -2.825245    -1.895469
H     4.542484    -3.499191    -2.375681
H     2.686277    -1.898004    -1.929555
H     2.581332     4.520664    -0.164558
H     3.508452     4.848977    -1.666291
H     4.345651     4.245668    -0.194734
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conf_9

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B3LYP-D3 SCF energy in gas phase (au):      -2280.50286333
B3LYP-D3 enthalpy in gas phase (au):        -2279.74700733
B3LYP-D3 free energy in gas phase (au):     -2279.861268
M06 SCF energy in solution (au):            -2279.76007040
M06 enthalpy in solution (au):              -2279.00421440
M06 free energy in solution (au):           -2279.128136
Cartesian coordinates
ATOM      X           Y             Z
Si    -1.679694    -1.992920    -0.249092
O     -0.545041    -1.216923     0.788161
H     -0.689790    -1.308479     1.749148
C     -0.681384    -2.797030    -1.636105
H      0.207750    -3.207166    -1.130269
C     -1.451227    -3.969580    -2.281550
H     -0.833155    -4.450093    -3.049659
H     -2.371134    -3.625787    -2.767060
H     -1.730344    -4.738398    -1.552239
C     -0.205388    -1.798351    -2.709826
H      0.397594    -0.986854    -2.293667
H     -1.058720    -1.339697    -3.223680
H      0.397380    -2.317529    -3.465859
C     -2.539791    -3.221481     0.909846
H     -3.214105    -3.820680     0.287395
C     -1.511670    -4.170943     1.560129
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H	-0.807289	-3.629261	2.204967
H	-0.921305	-4.715328	0.814008
H	-2.017636	-4.914994	2.187502
C	-3.392941	-2.510748	1.979485
H	-2.780236	-1.872105	2.631981
H	-3.890233	-3.241722	2.628666
H	-4.168261	-1.879648	1.531615
C	-2.913388	-0.698749	-0.904843
C	-4.107522	-1.194438	-1.430835
F	-4.267262	-2.544317	-1.483819
C	-5.154026	-0.417508	-1.913320
H	-6.041539	-0.901297	-2.306353
C	-5.011647	0.966453	-1.877381
H	-5.803826	1.604413	-2.256613
C	-3.839332	1.527864	-1.368281
H	-3.712931	2.606757	-1.379191
C	-2.801255	0.712495	-0.895215
C	-1.530467	1.380264	-0.456568
N	-1.675883	2.425411	0.391602
H	-2.606570	2.624125	0.732788
O	-0.425938	1.007537	-0.882140
C	-0.558652	3.189674	0.938286
H	0.339219	2.681232	0.580698
C	-0.527821	4.645495	0.404101
H	0.257333	5.162040	0.975283
C	-0.126642	4.664574	-1.076910
H	-0.864274	4.121354	-1.681733
H	0.849730	4.195117	-1.223715
H	-0.081358	5.692481	-1.452644
C	-1.851404	5.397932	0.617298
H	-2.659345	4.948250	0.026011
H	-1.751314	6.436092	0.285319
H	-2.169499	5.425143	1.665897
C	-0.585346	3.149356	2.488110
H	0.368218	3.550369	2.856324
H	-1.365979	3.817167	2.862899
N	-0.846513	1.845690	3.066714
H	-1.732420	1.719568	3.531862
C	0.037443	0.802794	3.149993
C	1.344220	0.864634	2.605786
H	1.708480	1.773914	2.140360
C	2.224137	-0.221358	2.762948
H	3.233588	-0.124728	2.375869
C	1.828042	-1.395020	3.407018
H	2.517190	-2.224623	3.522676
C	0.526103	-1.468894	3.917769
H	0.193610	-2.366534	4.431785
C	-0.358612	-0.399291	3.789380
H	-1.353312	-0.466488	4.224652
Cu	1.153166	-0.280637	0.330989
C	2.667894	0.088437	-0.693379
C	3.946325	-0.532876	-0.737754
C	5.025035	-0.015102	-1.510505
C	6.249268	-0.664230	-1.532541
C	6.425942	-1.842285	-0.791678
C	5.380067	-2.377668	-0.025078
C	4.155500	-1.730631	0.003137
C	2.450970	1.344256	-1.440618

O	2.138330	1.141098	-2.720179
C	1.604689	2.275217	-3.444706
O	2.504084	2.424526	-0.872376
H	4.881284	0.894860	-2.084717
H	7.069429	-0.265977	-2.121408
H	7.386871	-2.348745	-0.814121
H	5.532690	-3.292935	0.538110
H	3.325301	-2.121668	0.584641
H	0.623326	2.523581	-3.036177
H	1.522095	1.942118	-4.478317
H	2.275329	3.133190	-3.363137

conf_10

B3LYP-D3 SCF energy in gas phase (au): -2280.50147204
B3LYP-D3 enthalpy in gas phase (au): -2279.74516904
B3LYP-D3 free energy in gas phase (au): -2279.859140
M06 SCF energy in solution (au): -2279.76072672
M06 enthalpy in solution (au): -2279.00442372
M06 free energy in solution (au): -2279.129390
Cartesian coordinates

ATOM	X	Y	Z
Si	-1.720252	-0.964253	1.500021
O	-0.439698	-0.088630	0.791927
H	-0.595180	0.821890	0.407695
C	-0.830692	-2.149413	2.671673
H	-0.093179	-1.495861	3.164289
C	-1.721463	-2.771799	3.763979
H	-2.274482	-2.012629	4.328625
H	-1.107394	-3.333583	4.478428
H	-2.452661	-3.464324	3.337470
C	-0.056981	-3.240869	1.905071
H	-0.738420	-3.903645	1.358515
H	0.526479	-3.860111	2.597740
H	0.648449	-2.820054	1.174997
C	-2.888194	0.285142	2.297944
H	-3.707682	-0.306051	2.731452
C	-2.193077	1.072029	3.427788
H	-1.797988	0.410768	4.207471
H	-2.899210	1.761663	3.906452
H	-1.360902	1.673150	3.043816
C	-3.494311	1.242003	1.250353
H	-4.220926	1.917283	1.718042
H	-4.012625	0.700743	0.449058
H	-2.722244	1.877643	0.797505
C	-2.618535	-1.863374	0.079688
C	-3.704529	-2.680259	0.395255
F	-4.048529	-2.789087	1.705060
C	-4.470113	-3.377937	-0.530550
H	-5.293439	-3.995196	-0.187829
C	-4.149841	-3.248093	-1.880693
H	-4.729007	-3.780509	-2.628578
C	-3.091219	-2.423989	-2.268748
H	-2.843568	-2.312360	-3.320628
C	-2.338362	-1.751323	-1.299988
C	-1.221516	-0.865129	-1.767830
N	-1.599876	0.353442	-2.177823
H	-2.592228	0.553016	-2.144335
O	-0.025178	-1.239808	-1.762970

C	-0.709138	1.418277	-2.654982
H	0.302272	1.002586	-2.598957
C	-0.998219	1.772839	-4.133657
H	-0.260675	2.542900	-4.400117
C	-0.765134	0.554526	-5.037536
H	-1.496088	-0.235583	-4.828278
H	0.235850	0.132070	-4.894281
H	-0.870257	0.832270	-6.091048
C	-2.400692	2.363882	-4.347712
H	-3.186812	1.636699	-4.105181
H	-2.537654	2.636671	-5.398726
H	-2.571814	3.266545	-3.750870
C	-0.809960	2.624960	-1.705417
H	-0.387315	3.517600	-2.190339
H	-1.863166	2.839241	-1.501425
N	-0.139934	2.328135	-0.435857
H	0.832346	2.078817	-0.618432
C	-0.195846	3.276470	0.636507
C	0.688781	3.091580	1.712322
H	1.411458	2.279955	1.690019
C	0.634057	3.937033	2.817794
H	1.328123	3.782631	3.638784
C	-0.308485	4.968283	2.874830
H	-0.353969	5.622796	3.739505
C	-1.185879	5.148948	1.807252
H	-1.918999	5.949943	1.834228
C	-1.132360	4.314218	0.686280
H	-1.818986	4.487380	-0.134930
Cu	1.225658	-0.683110	-0.275304
C	3.050036	-0.422560	-0.083260
C	4.093940	-1.388137	-0.063976
C	5.464380	-1.049210	0.145852
C	6.440338	-2.031122	0.129905
C	6.083276	-3.369025	-0.099454
C	4.745144	-3.732594	-0.308924
C	3.762698	-2.757032	-0.287139
C	3.403143	0.998657	0.159789
O	3.078973	1.808997	-0.874453
C	3.436048	3.207559	-0.703037
O	3.841478	1.393379	1.223219
H	5.734969	-0.018454	0.345655
H	7.480392	-1.769060	0.296075
H	6.854852	-4.133802	-0.112958
H	4.483846	-4.771161	-0.484648
H	2.720557	-3.016173	-0.451296
H	2.846683	3.650031	0.103236
H	3.207773	3.677394	-1.659005
H	4.499315	3.298582	-0.471492

L3a

B3LYP-D3 SCF energy in gas phase (au): -1585.07718060
B3LYP-D3 enthalpy in gas phase (au): -1584.48622260
B3LYP-D3 free energy in gas phase (au): -1584.587675
M06 SCF energy in solution (au): -1584.50261324
M06 enthalpy in solution (au): -1583.91165524
M06 free energy in solution (au): -1584.019666
Cartesian coordinates

ATOM	X	Y	Z

Si	1.555270	-1.162803	0.382754
O	0.301988	-0.827134	1.452795
H	0.456686	-0.059246	2.036603
C	2.885780	-2.162044	1.282061
H	3.642153	-2.440246	0.536443
C	3.572167	-1.322742	2.376466
H	4.059020	-0.431998	1.962678
H	4.338230	-1.910817	2.899264
H	2.850325	-0.985939	3.132015
C	2.275147	-3.448750	1.871591
H	1.489461	-3.213634	2.599622
H	3.040413	-4.042433	2.389304
H	1.829975	-4.086730	1.098061
C	0.734775	-2.093648	-1.048558
H	0.043141	-2.794828	-0.558926
C	-0.113553	-1.150895	-1.924673
H	-0.840112	-0.587063	-1.331023
H	-0.678199	-1.720672	-2.673324
H	0.523162	-0.434489	-2.460415
C	1.721415	-2.905681	-1.908051
H	2.283632	-3.634332	-1.312394
H	2.451542	-2.256817	-2.404443
H	1.184392	-3.459460	-2.689395
C	2.276376	0.483363	-0.269069
C	3.427385	0.452238	-1.056872
F	4.037108	-0.748763	-1.257743
C	3.999239	1.557842	-1.674985
H	4.900509	1.431876	-2.265424
C	3.380790	2.796045	-1.513867
H	3.802635	3.678839	-1.985256
C	2.218504	2.894258	-0.747439
H	1.732484	3.856608	-0.612474
C	1.685160	1.758254	-0.126920
C	0.461156	1.939480	0.734362
N	-0.677592	2.185596	0.040707
H	-0.621056	2.151761	-0.968720
O	0.506903	1.855216	1.966203
C	-2.003834	2.311732	0.651677
H	-1.845640	2.144296	1.720958
C	-2.581942	3.735002	0.466299
H	-3.547597	3.736700	0.991709
C	-1.673615	4.777442	1.132820
H	-0.702607	4.827947	0.626083
H	-1.485851	4.532018	2.183855
H	-2.127635	5.773624	1.087113
C	-2.840431	4.093919	-1.005283
H	-3.264945	5.100839	-1.083846
H	-3.539521	3.401370	-1.486352
H	-1.906706	4.092533	-1.582894
C	-2.921640	1.199978	0.122376
H	-3.956866	1.433411	0.409027
H	-2.900035	1.199131	-0.983596
N	-2.541381	-0.085077	0.668253
H	-1.570787	-0.182326	0.955210
C	-3.104303	-1.266813	0.198852
C	-2.535841	-2.498482	0.593920
H	-1.670539	-2.486939	1.250344
C	-3.074892	-3.700046	0.150260

H	-2.616126	-4.634194	0.465996
C	-4.195720	-3.719102	-0.689137
H	-4.614260	-4.660930	-1.031814
C	-4.766667	-2.506627	-1.072418
H	-5.639575	-2.498247	-1.721078
C	-4.233167	-1.289268	-0.641233
H	-4.699509	-0.362528	-0.959579

IX. X-ray Crystallography Data and Crystallization Procedures

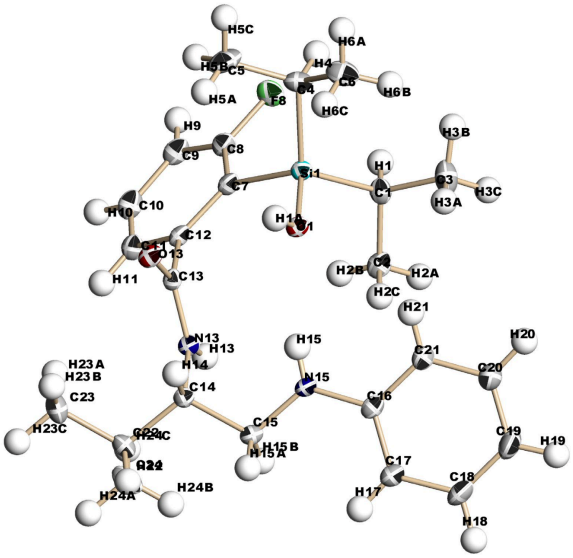


Figure S9. ORTEP of **L3a** (CCDC 2289933).

X-ray Crystallography Data for L3a (CCDC 2289933):

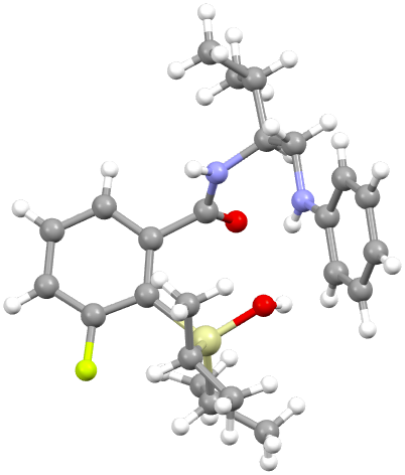
Crystals were grown from slow diffusion in DCM. A colorless block with approximate orthogonal dimensions 0.134 x 0.331 x 0.380mm^3 was placed and optically centered on the Bruker[31] Venture Dual source Kappa diffractometer with Photon2 CMOS detector at –173°C(100K). Indexing of the unit cell used a random set of reflections collected from three series of 0.5° wide ω-scans, 5 seconds per frame, and 30 frames per series that were well distributed in reciprocal space. Data were collected [MoKα] with 0.3° wide scans, variable time per frame dependent upon detector 2θ angle and varying φ and omega angles such that nearly all unique reflections were collected at least once. The crystal to detector distance was 65.00mm, thus providing a complete sphere of data to $2\theta_{max}$=61.10°.

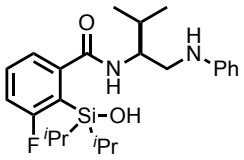
Structural determination and Refinement:
All crystallographic calculations were performed on a Surface Pro7 with Intel i7-1065G7 at 1.30GHz with four cores, eight processors and 16GB of extended memory. Data collected were corrected for Lorentz and polarization effects with Saint[30] and absorption using Blessing's method and merged as incorporated with the program Sadabs.[31] The SHELXTL[32] program package was implemented to determine the probable space group and set up the initial files. System symmetry, systematic absences and intensity statistics indicated the standard non-centrosymmetric hexagonal space group P6$_1$22 (no. 178). The structure was determined by direct methods with nearly all non-hydrogen atoms being located directly for the molecule

[30] Bruker (2019) APEX3 (Version 2019.0) and (2016) SAINT (Version 8.37a). Bruker AXS Inc., Madison, Wisconsin, USA.
[31] (a) An Empirical Correction for Absorption Anisotropy, Blessing, R. H. (1995). Acta Cryst., A51, 33-38. (b) Sheldrick, G.M., SADABS (2016) Version 2016/2, 'Siemens Area Detector Absorption Correction' Universität Göttingen: Göttingen, Germany.
[32] Sheldrick, G.M., (2002). SHELXTL. Version 6.1. Bruker AXS Inc., Madison, Wisconsin, USA.

using the program XT.[33] The structure was refined with XL.[34] The 113873 data collected were merged, based upon identical indices, to 63537 data, and then merged for least squares refinement to 7401 unique data [R(int)=0.0386]. All non-hydrogen atoms were refined anisotropically. All hydrogen atoms were initially idealized and then allowed to refine freely during the final refinement stage. The final structure was refined to convergence with R(F)=4.04%, wR(F^2)=9.33%, GOF=1.152 for all 7401 unique reflections [R(F)=3.78, wR(F^2)=9.20% for those 7034 data with Fo > 4σ(Fo)]. The final difference-Fourier map was featureless indicating that the structure is both correct and complete. An empirical correction for extinction was also attempted but found to be negative and therefore not applied.

Table S8. Crystal data and structure refinement for **L3a** (CCDC 2289933).





Identification code	JF3111F3_60MI	(YPC-2-49)
Empirical formula	C24 H35 F N2 O2 Si	
Formula weight	430.63	
Temperature	100(2) K	
Wavelength	0.71073 Å	
Crystal system	Hexagonal	
Space group	$P6_122$	
Unit cell dimensions	a = 11.3851(8) Å	α= 90°.
	b = 11.3851(8) Å	β= 90°.
	c = 64.721(7) Å	γ = 120°.
Volume	7265.2(13) $Å^3$	
Z	12	
Density (calculated)	1.181 Mg/m^3	
Absorption coefficient	0.126 mm^{-1}	
F(000)	2784	

[33] Sheldrick, G. M., (2014) SHELXT, Universität Göttingen: Göttingen, Germany. Structure determination program. Private communication.
[34] Sheldrick, G. M., (2017). SHELXL2017/1. Universität Göttingen: Göttingen, Germany.

Crystal size	0.380 x 0.331 x 0.134 mm^3
Crystal color and habit	Colorless Block
Diffractometer	Bruker Photon2 CMOS
Theta range for data collection	1.888 to 30.550°.
Index ranges	-16<=h<=16, -16<=k<=16, -92<=l<=90
Reflections collected	63449
Independent reflections	7401 [R(int) = 0.0386]
Observed reflections (I > 2sigma(I))	7034
Completeness to theta = 25.242°	100.0 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.9185 and 0.8361
Solution method	SHELXT (Sheldrick, 2014)
Refinement method	SHELXL-2018/3 (Sheldrick, 2018) Full-matrix least-squares on F^2
Data / restraints / parameters	7401 / 0 / 411
Goodness-of-fit on F^2	1.152
Final R indices [I>2sigma(I)]	R1 = 0.0378, wR2 = 0.0920
R indices (all data)	R1 = 0.0404, wR2 = 0.0933
Absolute structure parameter	0.01(2)
Largest diff. peak and hole	0.277 and -0.189 e.$Å^{-3}$

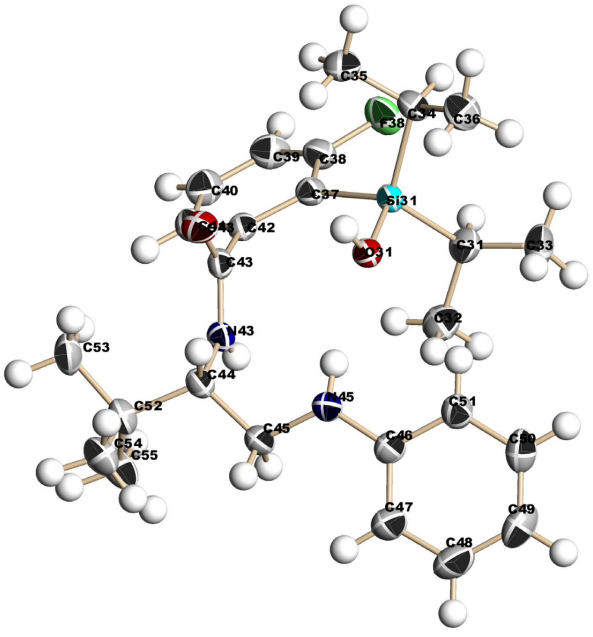


Figure S10. ORTEP of **L3b** (CCDC 2289935).

X-ray Crystallography Data for L3b (CCDC 2289935):

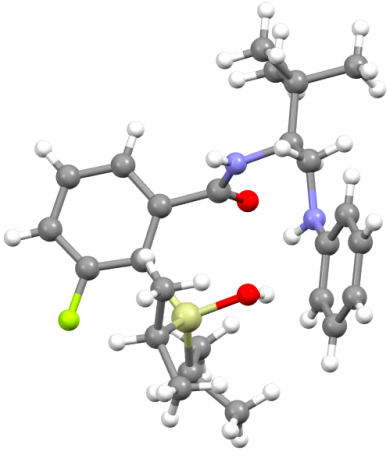
Crystals were grown from slow diffusion in DCM. A colorless block with approximate orthogonal dimensions 0.196 x 0.249 x 0.269 mm^3 was placed and optically centered on the Bruker[31] Venture Dual source Kappa diffractometer with Photon2 CMOS detector at –93°C(190K). Indexing of the unit cell used a random set of reflections collected from three series of 0.5° wide ω-scans, 5 seconds per frame, and 30 frames per series that were well distributed in reciprocal space. Data were collected [MoKα] with 0.3° wide scans, variable time per frame dependent upon detector 2θ angle and varying φ and omega angles such that nearly all unique reflections were collected at least once. The crystal to detector distance was 65.00mm, thus providing a complete sphere of data to $2\theta_{max}$=54.99°.

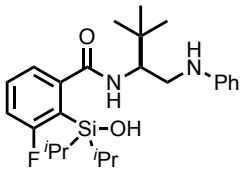
Structural determination and Refinement:

All crystallographic calculations were performed on a Surface Pro7 with Intel i7-1065G7 at 1.30GHz with four cores, eight processors and 16GB of extended memory. Data collected were corrected for Lorentz and polarization effects with Saint[31] and absorption using Blessing's method and merged as incorporated with the program Sadabs.[32] The SHELXTL[33] program package was implemented to determine the probable space group and set up the initial files. System symmetry, systematic absences and intensity statistics indicated the non-centrosymmetric monoclinic space group $P2_1$ (no. 4). The structure was determined by direct methods with the non-hydrogen atoms being located directly for the molecule using the program XT.[34] The structure was refined with XL.[35] The 59107 data collected were merged, based upon identical indices to 23292 data, then for least squares refinement to 11858 unique data [R(int)=0.0155]. One t-butyl ligand was found to be disordered, modeled and found to be present in two orientations, 0.50:0.50. All non-hydrogen atoms were refined anisotropically. Hydrogen atoms were initially idealized, then their thermal parameters allowed to refine throughout the final refinement stage. The final structure was refined to convergence with R(F)=3.97%, wR(F2)=8.60%, GOF=1.038 for all 11858 unique reflections [R(F)=3.44%, wR(F2)=8.29% for those 10811 data with Fo > 4σ(Fo)]. The final difference-Fourier map was featureless indicating that the structure is both correct and complete. An empirical correction for extinction was also attempted and found to be negative and therefore not applied. The absolute structure parameters were determined to be: Flack(x),[32] 0.009(16); Hooft(y),[35] -0.001(17) and the Parsons(z),[35] -0.001(14) indicating that the structure's absolute configuration has been determined reliably; these values would be close to 1.0 if the structure were inverted.

[35] (a) Hooft, R.W.W, Straver, L.H. & Spek, A.L. **2008**, *J. Appl, Cryst. 41*, 96-103. (b) Thompson,A.L. & Watkin, D.J. **2009**, *Tetrahedron*

Table S9. Crystal data and structure refinement for **L3b** (CCDC 2289935).





Identification code	JF3154FMI	(YPC-3-117)
Empirical formula	C25 H37 F N2 O2 Si	
Formula weight	444.65	
Temperature	90(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	$P2_1$	
Unit cell dimensions	a = 10.4984(6) Å	α= 90°.
	b = 23.5281(13) Å	β= 109.2216(12)°.
	c = 11.1188(6) Å	γ = 90°.
Volume	2593.3(2) $Å^3$	
Z	4	
Density (calculated)	1.139 Mg/m^3	
Absorption coefficient	0.120 mm^{-1}	
F(000)	960	
Crystal size	0.269 x 0.249 x 0.196 mm^3	
Crystal color and habit	Colorless Block	
Diffractometer	Bruker Photon2 CMOS	
Theta range for data collection	2.229 to 27.463°.	
Index ranges	-13<=h<=13, -30<=k<=30, -14<=l<=14	
Reflections collected	23292	
Independent reflections	11858 [R(int) = 0.0155]	
Observed reflections (I > 2sigma(I))	10811	
Completeness to theta = 25.242°	99.9 %	
Absorption correction	Semi-empirical from equivalents	

Max. and min. transmission	0.9745 and 0.9363
Solution method	SHELXT (Sheldrick, 2014)
Refinement method	SHELXL-2018/3 (Sheldrick, 2018) Full-matrix least-squares on F^2
Data / restraints / parameters	11858 / 39 / 679
Goodness-of-fit on F^2	1.038
Final R indices [I>2sigma(I)]	R1 = 0.0344, wR2 = 0.0829
R indices (all data)	R1 = 0.0397, wR2 = 0.0860
Absolute structure parameter	0.009(16)
Largest diff. peak and hole	0.149 and -0.209 e.Å^{-3}

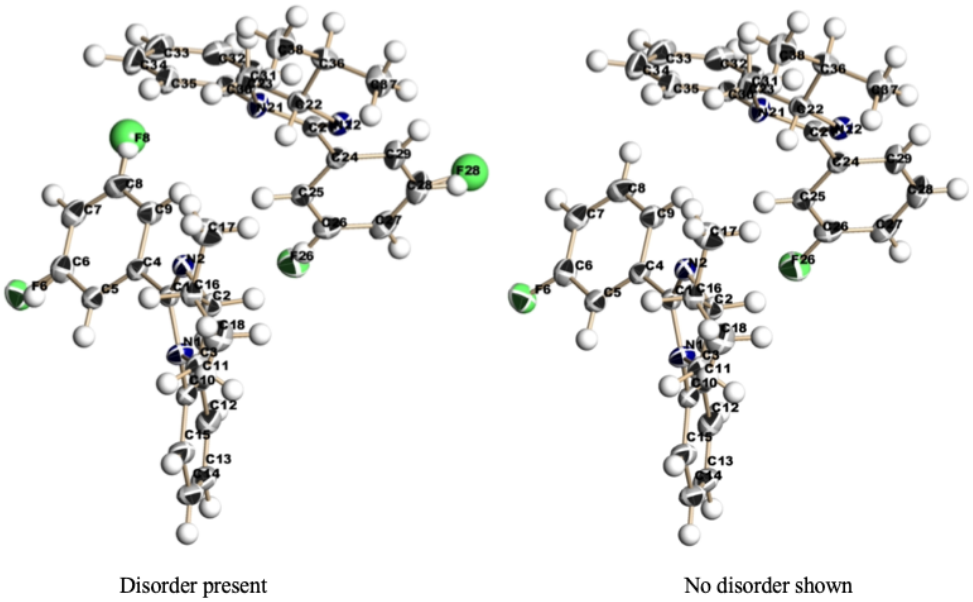


Figure S11. ORTEP of **3a** (CCDC 2289936).

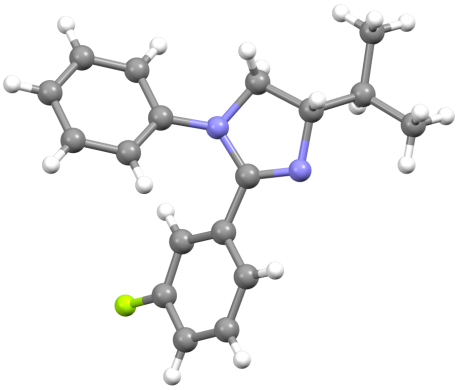
X-ray Crystallography Data for 3a (CCDC 2289936):

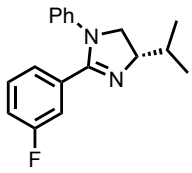
Crystals were grown from slow diffusion in DCM. A colorless block with approximate orthogonal dimensions 0.462 x 0.557 x 0.872 mm^3 was placed and optically centered on the Bruker[31] Venture Dual source Kappa diffractometer with Photon2 CMOS detector at –83°C(190K). Indexing of the unit cell used a random set of reflections collected from three series of 0.5° wide ω-scans, 5 seconds per frame, and 30 frames per series that were well distributed in reciprocal space. Seven ω-scan data frame series were collected [MoK_α] with 0.3° wide scans, 15 seconds per frame and 606 frames collected per series at varying φ angles and plus/minus 32 degrees for the detector. The crystal to detector distance was 5.15 cm, thus providing a complete sphere of data to $2\theta_{max}$=55.11°.

Structural determination and Refinement:
All crystallographic calculations were performed on a Surface Pro7 with Intel i7-1065G7 at 1.30GHz with four cores, eight processors and 16GB of extended memory. Data collected were corrected for Lorentz and polarization effects with Saint[31] and absorption using Blessing's method and merged as incorporated with the program Sadabs.[32] The SHELXTL[33] program package was implemented to determine the probable

space group and set up the initial files. System symmetry, systematic absences and intensity statistics indicated the non-centrosymmetric orthorhombic space group $P2_12_12_1$ (no. 19). The structure was determined by direct methods with the molecule being located using the program XT.[34] The structure was refined with XL.[35] The 50305 data collected were merged based upon identical indices to 25518, then merged for least squares refinement to 7028 unique data [R(int)=0.0215]. All full occupancy non-hydrogen atoms were refined anisotropically. Two disorders were found in the fluorinated rings of the two molecules and these were optimized to 0.95:0.05 and 0.82:0.18, respectively. Hydrogen atoms were idealized and those fully occupied had their thermal parameters refined during the final refinement stages. The final structure was refined to convergence with R(F)=3.58%, wR(F^2)=7.98%, GOF=1.016 for all 7028 unique reflections [R(F)=3.19%, wR(F^2)=7.72% for those 6516 data with Fo > 4σ(Fo)]. The final difference-Fourier map was featureless indicating that the structure is both correct and complete. An empirical correction for extinction was also attempted and found to be negative and therefore not applied. The structure's absolute structure parameters were determined to be: Flack(x),[36] 0.04(19); Hooft(y),[37] 0.07(17) and the Parsons(z),[36] 0.04(18) indicating that the structure's absolute configuration has been determined reliably; these values would be close to 1.0 if the structure were inverted.

Table S10. Crystal data and structure refinement for **3a** (CCDC 2289936).





Identification code	JF3173FMI (YPC-4-4)	
Empirical formula	C18 H19 F N2	
Formula weight	282.35	
Temperature	190(2) K	
Wavelength	0.71073 Å	
Crystal system	Orthorhombic	
Space group	$P2_12_12_1$	
Unit cell dimensions	a = 11.6012(2) Å	α= 90°.
	b = 14.6138(3) Å	β= 90°.
	c = 17.9894(3) Å	γ = 90°.
Volume	3049.88(10) Å^3	
Z	8	
Density (calculated)	1.230 Mg/m^3	
Absorption coefficient	0.081 mm^{-1}	
F(000)	1200	

Crystal size	0.872 x 0.557 x 0.462 mm^3
Crystal color and habit	Colourless Block
Diffractometer	Bruker APEX-II CCD
Theta range for data collection	1.795 to 27.556°.
Index ranges	-15<=h<=15, -19<=k<=18, -23<=l<=23
Reflections collected	25518
Independent reflections	7028 [R(int) = 0.0215]
Observed reflections (I > 2sigma(I))	6516
Completeness to theta = 25.242°	99.9 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.9632 and 0.8900
Solution method	SHELXT (Sheldrick, 2015) Acta Cryst., A71, 3-8
Refinement method	SHELXL-2018/3 (Sheldrick, 2018) Full-matrix least-squares on F^2
Data / restraints / parameters	7028 / 9 / 433
Goodness-of-fit on F^2	1.016
Final R indices [I>2sigma(I)]	R1 = 0.0319, wR2 = 0.0772
R indices (all data)	R1 = 0.0358, wR2 = 0.0798
Absolute structure parameters	Flack = 0.04(19). Parsons = 0.03(18), Hooft = 0.07(17)
Largest diff. peak and hole	0.186 and -0.168 e.$Å^{-3}$

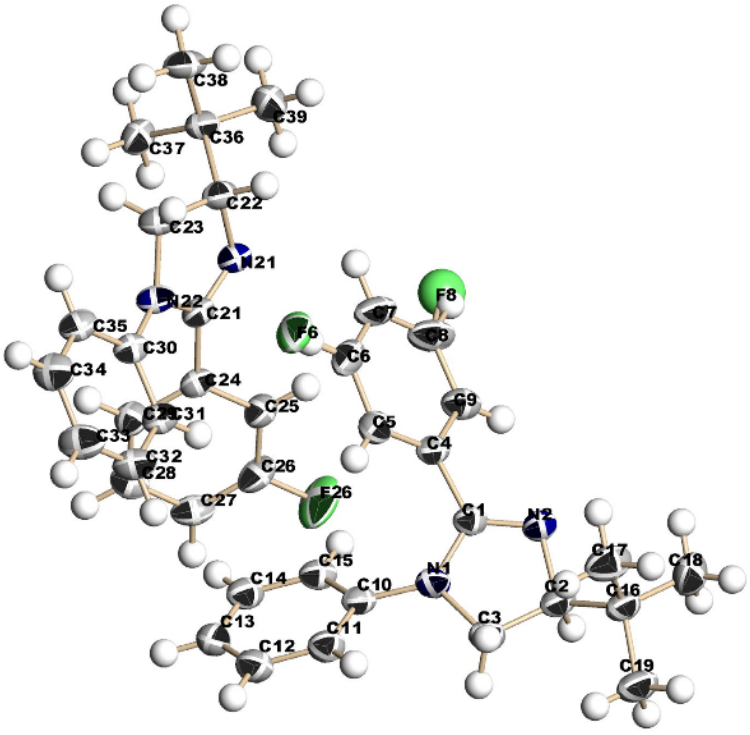


Figure S12. ORTEP of **3b** (CCDC 2289937); F6:F8, 0.84:0.16 Disorder.

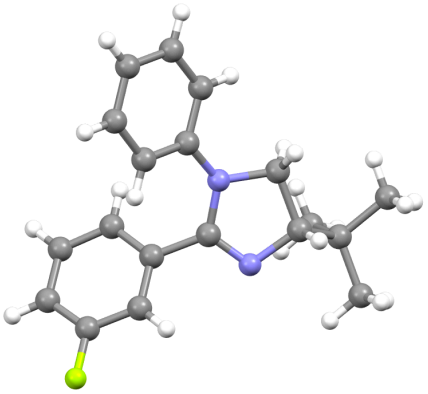
X-ray Crystallography Data for 3b (CCDC 2289937):

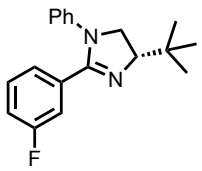
Crystals were grown from slow diffusion in DCM. A colorless block with approximate orthogonal dimensions 0.203 x 0.249 x 0.479 mm^3 was placed and optically centered on the Bruker[31] Venture Dual source Kappa diffractometer with Photon2 CMOS detector at –83°C(190K). Indexing of the unit cell used a random set of reflections collected from three series of 0.5° wide ω-scans, 5 seconds per frame, and 30 frames per series that were well distributed in reciprocal space. Data were collected [CuKα] with 0.3° wide scans, variable time per frame dependent upon detector 2θ angle and varying φ and omega angles such that nearly all unique reflections were collected at least once. The crystal to detector distance was 65.00mm, thus providing a complete sphere of data to $2\theta_{max}$=142.2°.

Structural determination and Refinement:

All crystallographic calculations were performed on a Surface Pro7 with Intel i7-1065G7 at 1.30GHz with four cores, eight processors and 16GB of extended memory. Data collected were corrected for Lorentz and polarization effects with Saint[31] and absorption using Blessing's method and merged as incorporated with the program Sadabs.[32] The SHELXTL[33] program package was implemented to determine the probable space group and set up the initial files. System symmetry, and lack of systematic absences indicated the triclinic space groups P-1 (no. 2) or the non-centrosymmetric triclinic space group P1 (no. 1). Intensity statistics were inconclusive with |E2-1|= 0.782 but leaning towards P1. The structure was determined by direct methods with the non-hydrogen atoms of the two unique molecules being located directly using the program XT.[34] The structure was refined with XL.[35] as two nicely ordered molecules with one possessing a slight disorder in the orientation of the Fluorinated ring in a 0.84:0.16 ratio. The 18398 data collected were merged, for least squares refinement to 5849 unique data [R(int)=0.0149]. All full occupancy non-hydrogen atoms were refined2anisotropically. The final structure was refined to convergence with R(F)=3.22%, wR(F)=8.94%, GOF=1.014 for all 5849 unique reflections [R(F)=3.21%, wR(F2)=8.93% for those 5834 data with Fo > 4σ(Fo)]. The final difference-Fourier map was featureless indicating that the structure is both correct and complete. An empirical correction for extinction was also attempted and found to be negative and therefore not applied. The absolute structure parameters were determined to be: Flack(x),[32] 0.07(14); Hooft(y),[36] 0.05(10) and Parsons(z),[35] -0.02(3) indicating that the structure's absolute configuration has been determined reliably; these values would be close to 1.0 if the structure were inverted.

Table S11. Crystal data and structure refinement for **3b** (CCDC 2289937).





Identification code	JF3216KF (YPC-3-147)
Empirical formula	C19 H21 F N2
Formula weight	296.38
Temperature	190(2) K

Wavelength	1.54178 Å	
Crystal system	Triclinic	
Space group	P1	
Unit cell dimensions	a = 9.9901(3) Å	α= 60.8907(8)°.
	b = 10.2226(3) Å	β= 67.0468(9)°.
	c = 10.5066(3) Å	γ = 63.2718(8)°.
Volume	816.90(4) $Å^3$	
Z	2	
Density (calculated)	1.205 Mg/m^3	
Absorption coefficient	0.628 mm^{-1}	
F(000)	316	
Crystal size	0.479 x 0.249 x 0.203 mm^3	
Crystal color and habit	Colorless Shard	
Diffractometer	Bruker Photon2 CMOS	
Theta range for data collection	5.080 to 71.100°.	
Index ranges	-12<=h<=12, -12<=k<=12, -12<=l<=12	
Reflections collected	18398	
Independent reflections	5849 [R(int) = 0.0149]	
Observed reflections (I > 2sigma(I))	5834	
Completeness to theta = 67.679°	99.6 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.8945 and 0.8531	
Solution method	SHELXT (Sheldrick, 2015) Acta Cryst., A71, 3-8	
Refinement method	SHELXL-2018/3 (Sheldrick, 2018) Full-matrix least-squares on F^2	
Data / restraints / parameters	5849 / 7 / 451	
Goodness-of-fit on F^2	1.014	
Final R indices [I>2sigma(I)]	R1 = 0.0321, wR2 = 0.0893	
R indices (all data)	R1 = 0.0322, wR2 = 0.0894	
Absolute structure parameter	0.07(14)	
Largest diff. peak and hole	0.197 and -0.226 $e.Å^{-3}$	

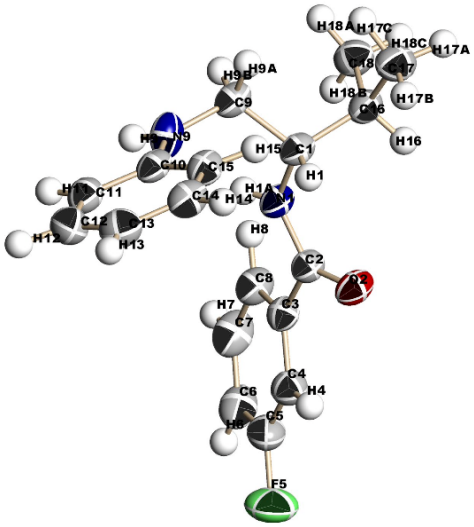


Figure S13. ORTEP of **S2** (CCDC 2289938).

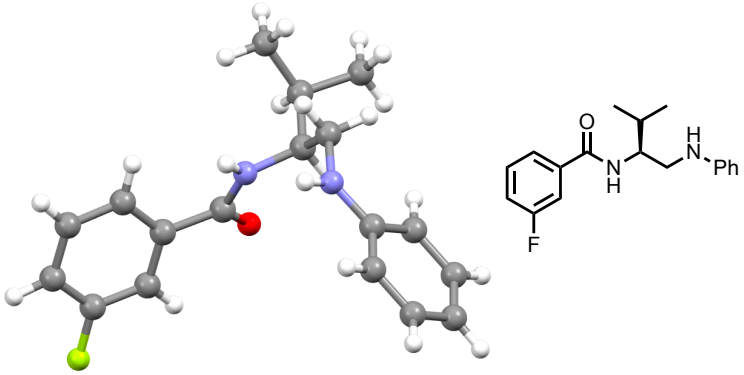
X-ray Crystallography Data for S2 (CCDC 2289938):

Crystals were grown from slow diffusion in DCM. A colorless block with approximate orthogonal dimensions 0.038 x 0.076 x 0.364 mm^3 was placed and optically centered on the Bruker[31] Venture Dual source Kappa diffractometer with Photon2 CMOS detector at –142°C(131K). Indexing of the unit cell used a random set of reflections collected from three series of 0.5° wide ω-scans, 10 seconds per frame, and 30 frames per series that were well distributed in reciprocal space using CuKa radiation. Data were collected [CuKα] with 0.5° wide scans, variable time per frame dependent upon detector 2θ angle and varying φ and omega angles such that nearly all unique reflections were collected at least once. The crystal to detector distance was 6.50cm, thus providing a complete sphere of data to 2θmax= 159.30°.

Structural determination and Refinement:

All crystallographic calculations were performed on a Surface Pro7 with Intel i7-1065G7 at 1.30GHz with four cores, eight processors and 16GB of extended memory. Data collected were corrected for Lorentz and polarization effects with Saint[31] and absorption using Blessing's method and merged as incorporated with the program Sadabs.[32] The SHELXTL[33] program package was implemented to determine the probable space group and set up the initial files. System symmetry, systematic absences and intensity statistics indicated the non- centrosymmetric orthorhombic space group P212121 (no. 19). The structure was determined by direct methods with the non-hydrogen atoms for the molecule being located using the program XT.[34] The structure was refined with XL.[35] The 12076 data collected were merged based upon identical indices to 7941, then merged for least squares refinement to 3222 unique data [R(int)=0.0582]. All non-hydrogen atoms were refined anisotropically. Hydrogen atoms were idealized initially and then allowed to refine freely throughout the final refinement stages. The final structure was refined to convergence with R(F)=4.55%, wR(F2)=12.00%, GOF=1.050 for all 3222 unique reflections [R(F)=4.43%, wR(F2)=11.79% for those 3093 data with Fo > 4σ(Fo)]. The final difference-Fourier map was featureless indicating that the structure is both correct and complete. An empirical correction for extinction was also attempted and found to be negative and therefore not applied. The absolute structure parameters were determined to be: Flack(x),[32] -0.03(13); Hooft(y),[31] -0.02(11) and the Parsons(z),[36] -0.04(10) indicating that the structure's absolute configuration has been determined reliably; these values would be close to 1.0 if the structure were inverted.

Table S12. Crystal data and structure refinement for **S2** (CCDC 2289938).



Identification code	JF3275KFMI (YPC-4-138-SM)	
Empirical formula	C18 H21 F N2 O	
Formula weight	300.37	
Temperature	190(2) K	
Wavelength	1.54178 Å	
Crystal system	Orthorhombic	
Space group	$P2_12_12_1$	
Unit cell dimensions	a = 5.2703(3) Å	α= 90°.
	b = 13.9801(9) Å	β= 90°.
	c = 21.4626(14) Å	γ = 90°.
Volume	1581.35(17) Å^3	
Z	4	
Density (calculated)	1.262 Mg/m^3	
Absorption coefficient	0.703 mm^{-1}	
F(000)	640	
Crystal size	0.519 x 0.177 x 0.050 mm^3	
Crystal color and habit	Colorless Rod	
Diffractometer	Bruker Photon2 CMOS	
Theta range for data collection	3.773 to 74.626°.	
Index ranges	-6<=h<=5, -17<=k<=16, -26<=l<=24	
Reflections collected	7941	
Independent reflections	3222 [R(int) = 0.0582]	
Observed reflections (I > 2sigma(I))	3093	
Completeness to theta = 67.679°	99.9 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.8176 and 0.5381	
Solution method	SHELXT (Sheldrick, 2015) Acta Cryst., A71, 3-8	

Refinement method	SHELXL-2018/3 (Sheldrick, 2018) Full-matrix least-squares on F^2
Data / restraints / parameters	3222 / 0 / 283
Goodness-of-fit on F^2	1.050
Final R indices [I>2sigma(I)]	R1 = 0.0443, wR2 = 0.1179
R indices (all data)	R1 = 0.0455, wR2 = 0.1200
Absolute structure parameter	-0.03(13)
Largest diff. peak and hole	0.227 and -0.168 e.Å^{-3}

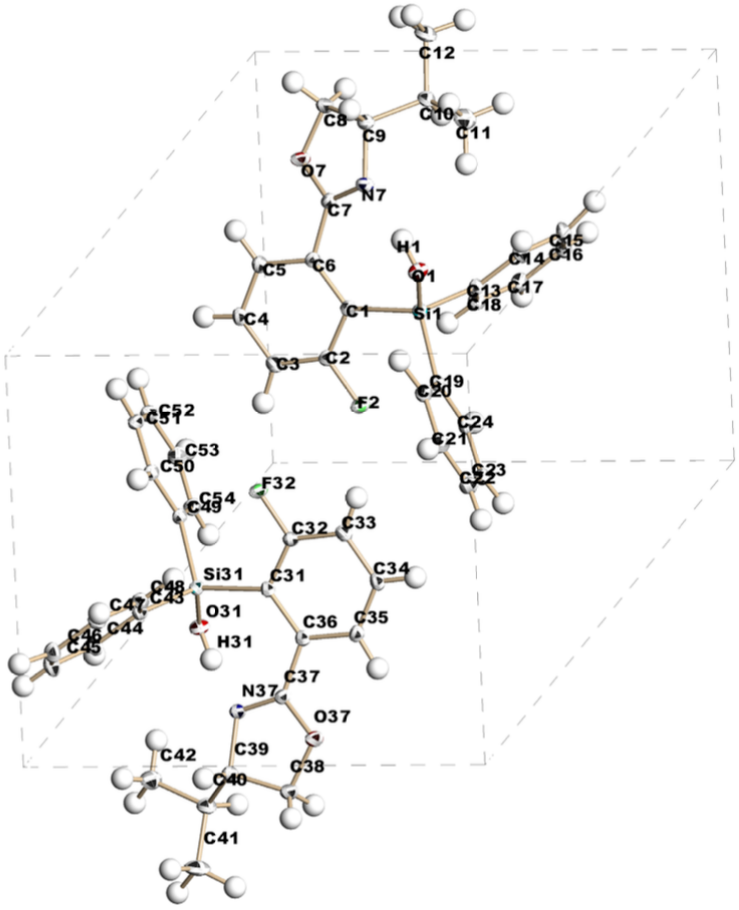


Figure S14. ORTEP of **L1a** (CCDC 2289939).

X-ray Crystallography Data for L1a (CCDC 2289939):

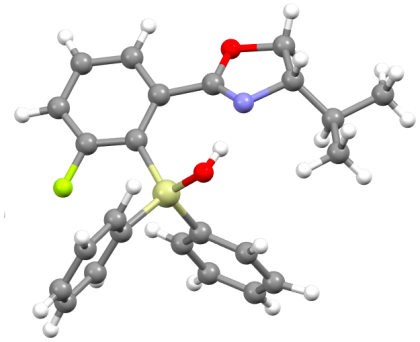
Crystals were grown from slow diffusion in DCM. A colorless block with approximate orthogonal dimensions 0.298 x 0.340 x 0.454 mm^3 was placed and optically centered on the Bruker[31] Venture Dual Source Kappa Photon2 diffractometer at –173°C(100K). Indexing of the unit cell used a random set of reflections collected from three series of 0.5° wide ω-scans, 10 seconds per frame, and 30 frames per series that were well distributed in reciprocal space. Data were collected [MoKα] with 0.3° wide scans, variable time per frame dependent upon detector 2θ angle and varying φ and omega angles such that nearly all unique reflections

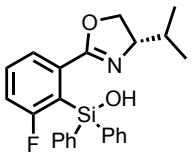
were collected at least once. The crystal to detector distance was 65.00mm, thus providing a complete sphere of data to 2θmax= 61.05°.

Structural determination and Refinement:

All crystallographic calculations were performed on a Surface Pro7 with Intel i7-1065G7 at 1.30GHz with four cores, eight processors and 16GB of extended memory. Data collected were corrected for Lorentz and polarization effects with Saint[31] and absorption using Blessing's method and merged as incorporated with the program Sadabs.[32] The SHELXTL[33] program package was implemented to determine the probable space group and set up the initial files. System symmetry, and lack of systematic absences indicated the triclinic space groups P-1 (no.2) or the non-centrosymmetric triclinic space group P1 (no. 1). Intensity statistics were inconclusive with |E2-1|= 0.884 but leaning towards P-1. The structure was determined by direct methods with the non-hydrogen atoms being located directly using the program XT[34] in both P-1 (Z=Z'=1) and P1 (Z'=2). The structures were refined with XL[35] and it became apparent that in P-1 the molecule possessed multiple forms of disorder, see Figure 1 below, while in P1 there were two unique, nicely ordered molecules. The final refinement was performed in P1 for the two unique molecules with all atoms refining freely, including all of the hydrogen atoms. The only issue in P1 was the location of the hydrogen atom labeled H(1) attached to O(1). The atom was freely located using HFIX 147 as was H(31) attached to O(31) but this atom freely refined to about 0.7A from O(1) so it was therefore refined with two distant restraints (DFIX), see Figure 2. The 55771 data collected were merged, for least squares refinement to 12230 unique data [R(int)=0.0151]. All non-hydrogen atoms were refined anisotropically. The final structure was refined to convergence with R(F)=2.84%, wR(F2)=8.10%, GOF=1.020 for all 12230 unique reflections [R(F)=2.80, wR(F2)=8.06% for those 12023 data with Fo > 4σ(Fo)]. The final difference-Fourier map was featureless indicating that the structure is both correct and complete. An empirical correction for extinction was also attempted and found to be negative and therefore not applied. The absolute structure parameters were determined to be: Flack(x),[32] -0.0.030(15); Hooft(y),[36] - 0.035(12) and Parsons(z),[35] - 0.017(11) indicating that the structure's absolute configuration has been determined reliably; these values would be close to 1.0 if the structure were inverted.

Table S13. Crystal data and structure refinement for **L1a** (CCDC 2289939).





Identification code	JF3112P1FMI (YPC-2-55)
Empirical formula	C24 H24 F N O2 Si
Formula weight	405.53
Temperature	100(2) K
Wavelength	0.71073 Å
Crystal system	Triclinic
Space group	P1

Unit cell dimensions	a = 10.6067(19) Å	α= 61.010(4)°.
	b = 10.8407(19) Å	β= 70.064(4)°.
	c = 10.999(2) Å	γ = 89.897(5)°.
Volume	1019.2(3) $Å^3$	
Z	2	
Density (calculated)	1.321 Mg/m^3	
Absorption coefficient	0.145 mm^{-1}	
F(000)	428	
Crystal size	0.454 x 0.340 x 0.298 mm^3	
Crystal color and habit	Colorless Block	
Diffractometer	Bruker Photon2 CMOS	
Theta range for data collection	2.084 to 30.525°.	
Index ranges	-15<=h<=15, -15<=k<=15, -15<=l<=15	
Reflections collected	55770	
Independent reflections	12230 [R(int) = 0.0151]	
Observed reflections (I > 2sigma(I))	12023	
Completeness to theta = 25.242°	99.9 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.9624 and 0.9436	
Solution method	SHELXT (Sheldrick, 2014)	
Refinement method	SHELXL-2018/3 (Sheldrick, 2018) Full-matrix least-squares on F^2	
Data / restraints / parameters	12230 / 5 / 715	
Goodness-of-fit on F^2	1.020	
Final R indices [I>2sigma(I)]	R1 = 0.0280, wR2 = 0.0806	
R indices (all data)	R1 = 0.0284, wR2 = 0.0810	
Absolute structure parameter	-0.030(15)	
Largest diff. peak and hole	0.417 and -0.255 $e.Å^{-3}$	

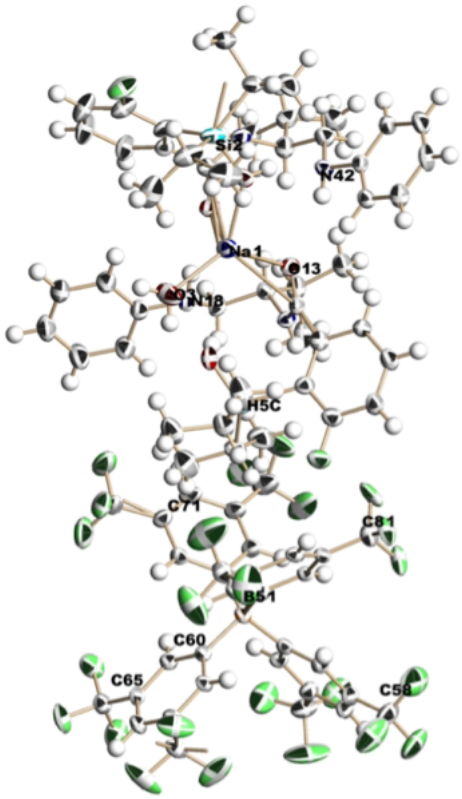
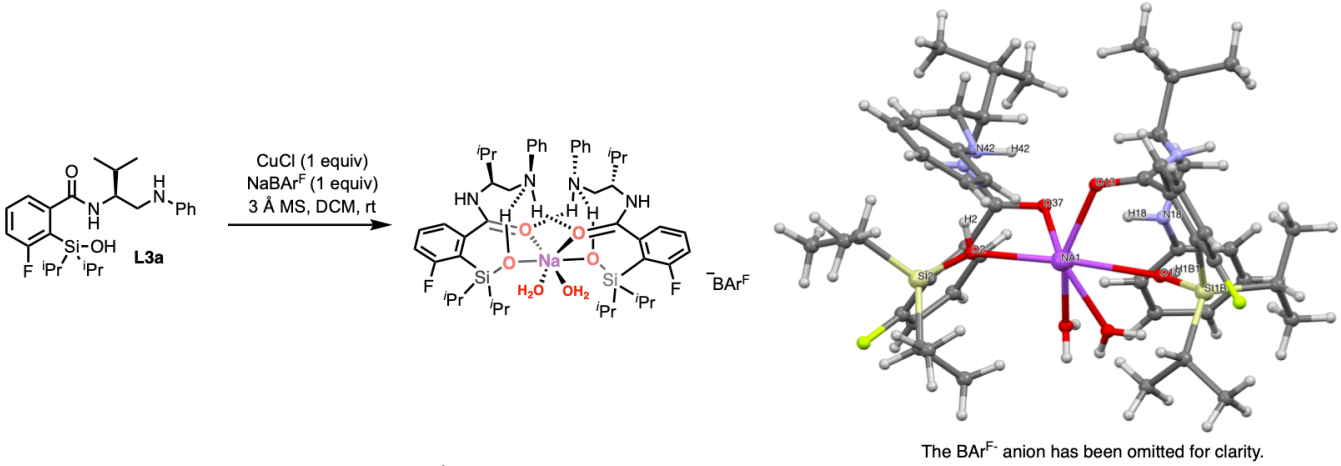


Figure S15. ORTEP of $[C_{48}H_{72}N_4O_5F_2Si_2Na][C_{32}H_{12}BF_{24}]$ (CCDC 2311643).

X-ray Crystallography Data for $[C_{48}H_{72}N_4O_5F_2Si_2Na][C_{32}H_{12}BF_{24}]$ (CCDC 2311643):

Procedure: Crystallization of complex $[(L3a)_2/Na\cdot(H_2O)_2]^+[BAr^F]^-$



A 7 mL vial containing 50 mg of 3Å molecular sieves and a stir bar was flame-dried under high vacuum (<1 torr). After the vial cooled to room temperature, it was purged with argon. CuCl (0.010 mmol, 0.050 equiv), NaBAr^F (0.010 mmol, 0.050 equiv), and **L3a** (0.010 mmol, 0.050 equiv) were added by difference measurement (directly from reagent bottle or flask to reaction vial). The vial was re-purged with argon for three times and capped with a septum and an Ar-balloon. Anhydrous DCM (0.60 mL) was then added, the resulting mixture was stirred (~270 rpm to avoid molecular sieves being grounded) at room temperature. At

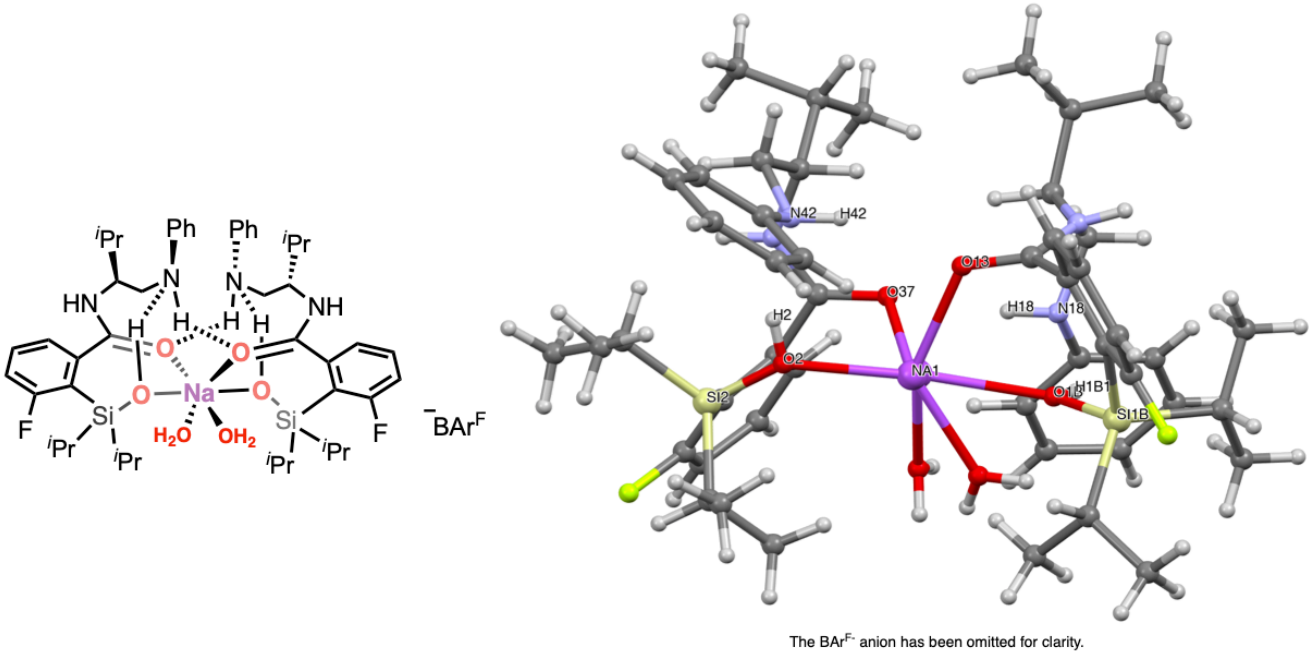
120 min, the solution (0.55 mL) of the mixture was filtered through Celite and transferred directly into an oven-dried, argon-purged NMR tube capped with a rubber septum. Single crystals were grown during the slow solvent evaporation over two months.

Note: The crystallization process was conducted using the same preparation method as the N-H insertion (Procedure I), with the modification that the complex formed in-situ filtered through Celite for crystallization purposes. Notably, the filtrate from this alternative setup was confirmed to catalyze the N-H insertion (Scheme 2.1), achieving 52% yield and 80:20 er over 16 h. The slower reaction rate and enantioselectivity compared to the standard reaction (1 h, 84%, 89:11 er) were attributed to the non-inert filtration under atmospheric conditions and moisture introduction from Celite.

A colorless plate with approximate orthogonal dimensions 0.190 x 0.459 x 0.288mm^3 was placed and optically centered on the Bruker[31] Duo APEXII CCD system at –183°C(90K). Indexing of the unit cell used a random set of reflections collected from three series of 0.5° wide ω-scans, 10 seconds per frame, and 30 frames per series that were well distributed in reciprocal space. Five ω-scan data frame series were collected [MoK_α] with 0.3° wide scans, 30 seconds per frame and 606 frames collected per series at varying φ angles. The crystal to detector distance was 5.15cm, thus providing a complete sphere of data to $2\theta_{max}$=55.18°.

Structural determination and Refinement:
All crystallographic calculations were performed on a Surface Pro7 with Intel i7-1065G7 at 1.30GHz with four cores, eight processors and 16GB of extended memory. Data collected were corrected for Lorentz and polarization effects with Saint[31] and absorption using Blessing's method and merged as incorporated with the program Sadabs.[32] The SHELXTL[33] program package was implemented to determine the probable space group and set up the initial files. System symmetry, lack of systematic absences and intensity statistics indicated the non-centrosymmetric triclinic space group P1 (no. 1). The structure was determined by direct methods with the location of a majority of the non-hydrogen atoms for the two molecules with the program XT.[34] The structure was refined with XL.[35] The 33064 data collected were merged for least squares refinement to 19110 unique data [R(int)=0.0161]. All full occupancy non-hydrogen atoms were refined anisotropically. Multiple disorders were observed and optimized for the two molecules. Hydrogen atoms attached to Nitrogen atoms labeled N13, N18, N37 and N42 had distance (DFIX) restraints applied while the thermal parameters were allowed to refine freely. One of the moieties attached to the central Na1 atoms was found to be disordered and along with two water molecules bound to the central Na1 atom that was optimized to 0.82:0.18. The $B(C_8H_3F_6)_4$ molecule was found to possess multiple disorders that were also optimized. A variety of restraints were required for structural refinement and those commands included distance restraints (SADI, DFIX), similar thermal motion restraints for atoms that were overlapping or nearly so (SIMU, ISOR, EADP) and fragments deemed to be identical were optimized (SAME). Hydrogen atoms were otherwise idealized throughout the final refinement. The final structure was refined to convergence with R(F)=7.02%, wR(F2)=16.49%, GOF=1.033 for all 19110 unique reflections [R(F)=5.96%, wR(F2)=15.49% for those 16393 data with Fo > 4σ(Fo)]. The final difference-Fourier map was featureless indicating that the structure is both correct and complete.

Table S14. Crystal data and structure refinement for $[C_{48}H_{72}N_4O_5F_2Si_2Na][C_{32}H_{12}BF_{24}]$ (CCDC 2311643).



Identification code	JF3155FF (YPC-3-170)
Empirical formula	C80 H84 B F26 N4 Na O5 Si2
Formula weight	1765.49
Temperature	90(2) K
Wavelength	0.71073 Å
Crystal system	Triclinic
Space group	P1
Unit cell dimensions	a = 12.8653(14) Å α= 76.0784(15)°.
	b = 12.9386(14) Å β= 80.3071(16)°.
	c = 14.2525(16) Å γ = 65.8644(15)°.
Volume	2094.9(4) Å^3
Z	1
Density (calculated)	1.399 Mg/m^3
Absorption coefficient	0.157 mm^{-1}
F(000)	910
Crystal size	0.520 x 0.459 x 0.190 mm^3
Crystal color and habit	Colorless Plate
Diffractometer	Bruker Photon2 CMOS
Theta range for data collection	1.740 to 27.509°.
Index ranges	-16<=h<=16, -16<=k<=16, -18<=l<=18

Reflections collected	33064
Independent reflections	19110 [R(int) = 0.0161]
Observed reflections (I > 2sigma(I))	16393
Completeness to theta = 25.242°	100.0 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.9541 and 0.8636
Solution method	SHELXT (Sheldrick, 2015) Acta Cryst., A71, 3-8
Refinement method	SHELXL-2019/2 (Sheldrick, 2019) Full-matrix least-squares on F^2
Data / restraints / parameters	19110 / 455 / 1442
Goodness-of-fit on F^2	1.033
Final R indices [I>2sigma(I)]	R1 = 0.0596, wR2 = 0.1549
R indices (all data)	R1 = 0.0702, wR2 = 0.1649
Absolute structure parameter	0.01(7)
Largest diff. peak and hole	0.912 and -0.549 e.$Å^{-3}$

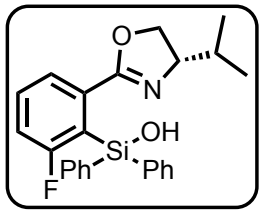
Copies of spectra –

A. Ligands (**L1**–**L8**)

B. Ligand precursors (**3**–**4** & **S1**–**S11**)

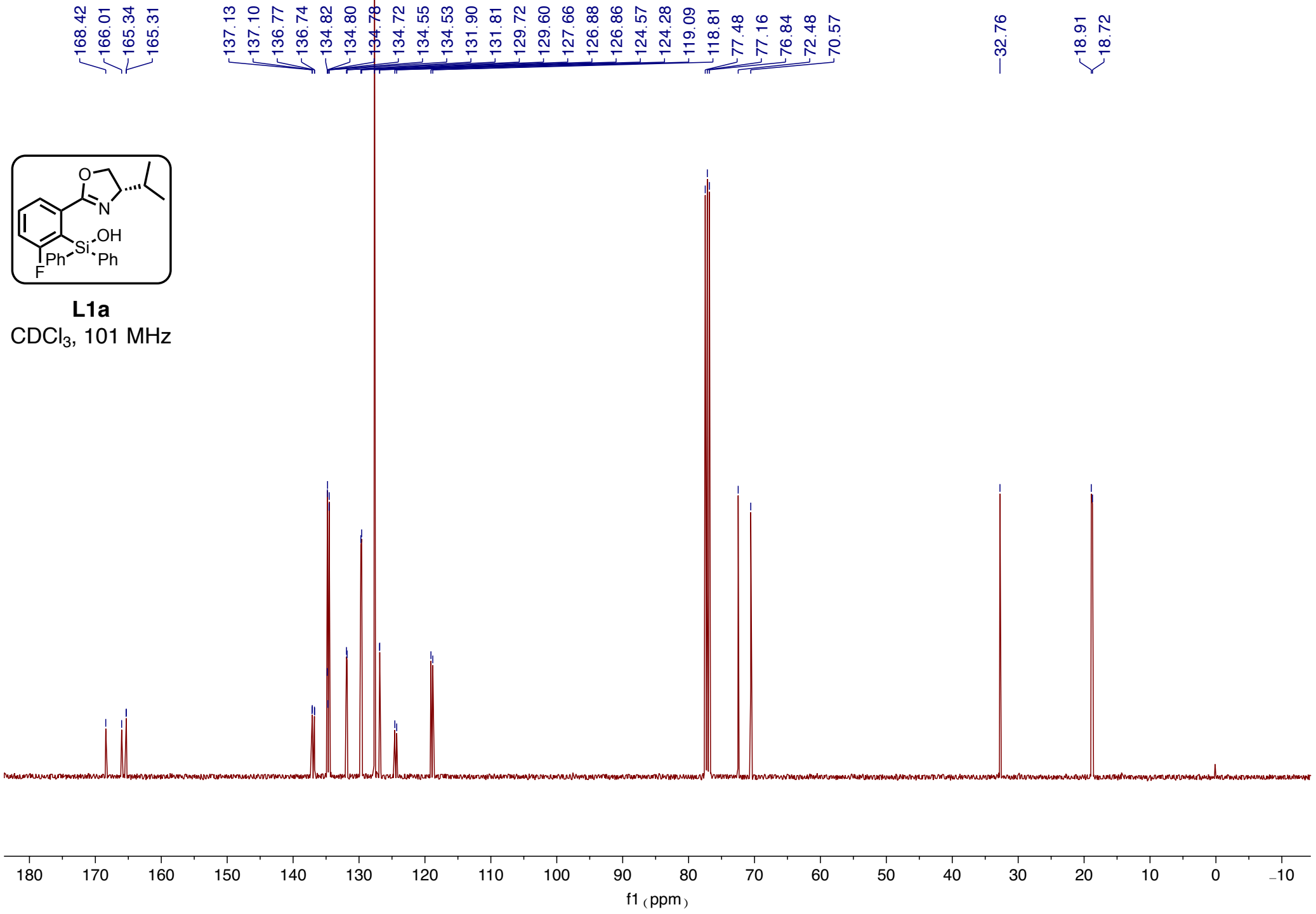
C. N–H insertion substrates (**7a**–**7z**)

Copies of spectra - Ligands (**L1**–**L8**)



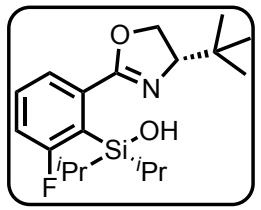
L1a

$CDCl_3$, 400 MHz



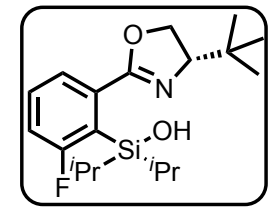
L1a

$CDCl_3$, 101 MHz



L1b

$CDCl_3$, 400 MHz



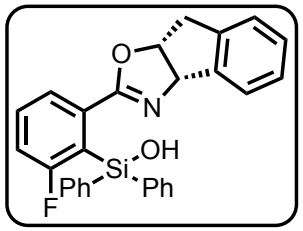
L1b

$CDCl_3$, 101 MHz

168.16
165.80
165.49
165.46
134.69
134.56
130.81
130.71
127.51
127.49
126.03
125.68
118.44
118.14
77.48
77.16
76.84
76.00
68.28
34.06
26.01
18.03
18.00
17.95
17.92
17.64
15.31
15.27
14.49
14.43

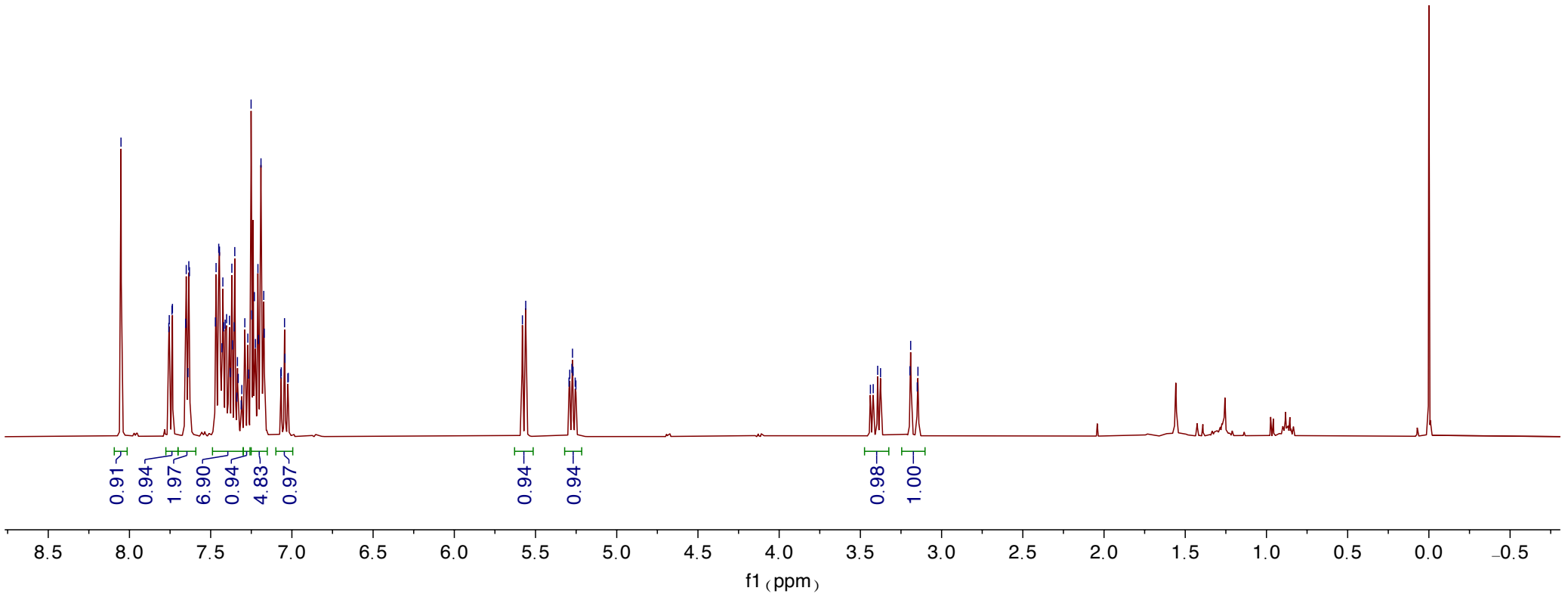
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

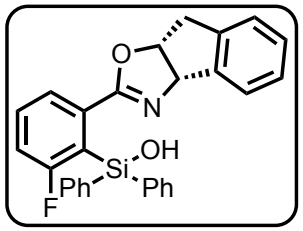
f1 (ppm)



L1c

$CDCl_3$, 400 MHz





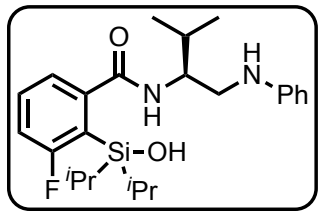
L1c

$CDCl_3$, 101 MHz

168.39
165.97
165.67
165.64
140.59
139.44
137.00
136.97
136.59
136.56
134.99
134.89
134.62
134.60
134.58
134.56
131.84
131.75
129.67
129.49
128.90
127.89
127.72
127.56
126.76
126.73
125.62
125.51
124.53
124.25
119.07
118.80
83.33
77.48
77.16
76.84
76.21
39.70

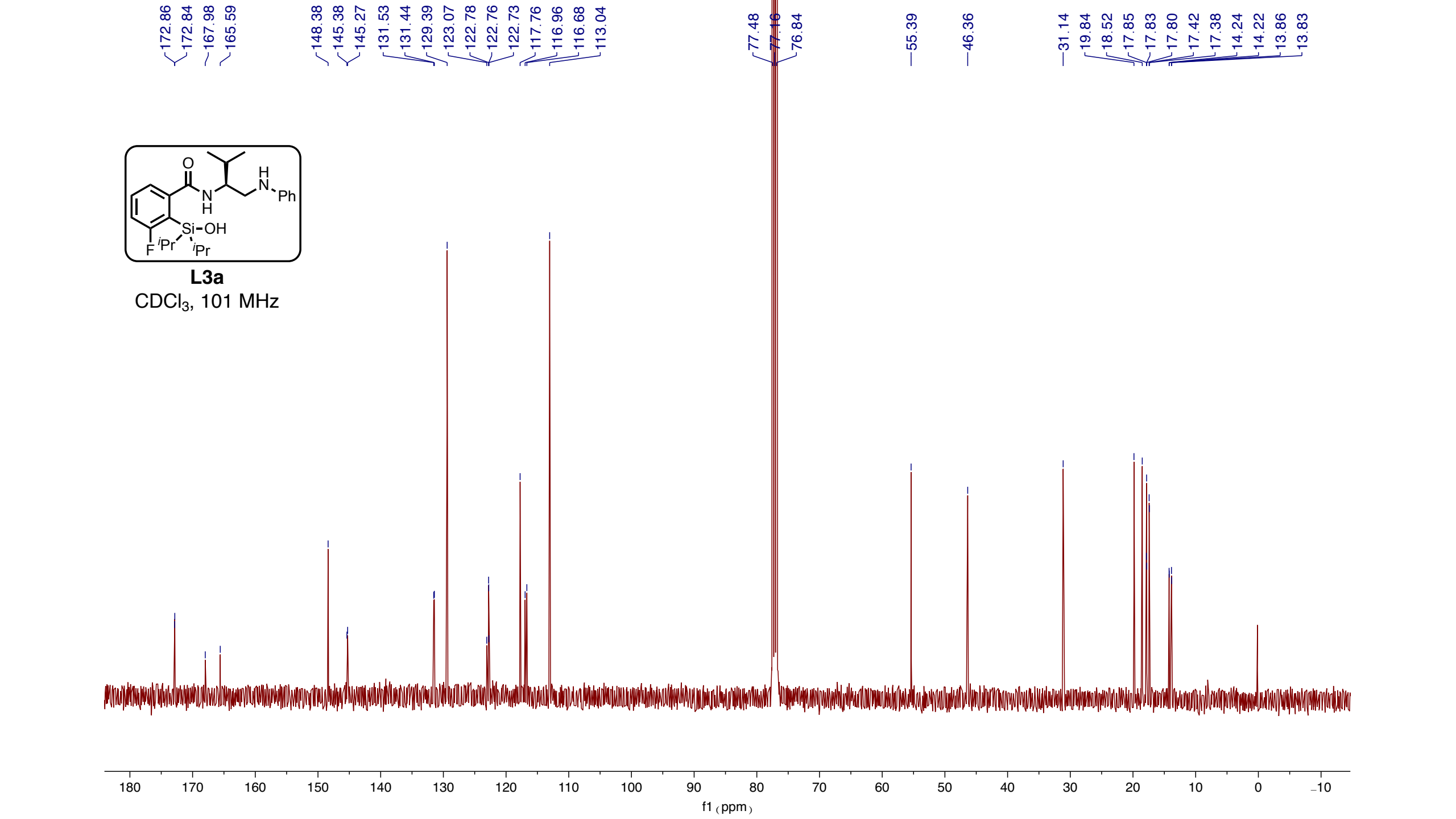
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

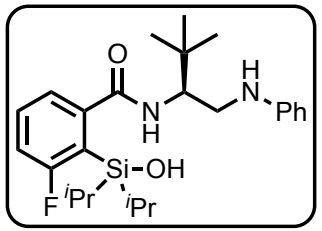
f1 (ppm)



L3a

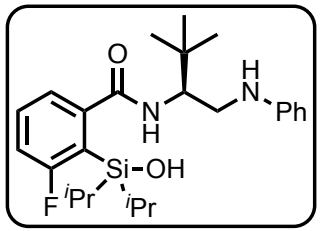
$CDCl_3$, 400 MHz


172.86
172.84
167.98
165.59
148.38
145.38
145.27
131.53
131.44
129.39
123.07
122.78
122.76
122.73
117.76
116.96
116.68
113.04
77.48
77.16
76.84
55.39
46.36
31.14
19.84
18.52
17.85
17.83
17.80
17.42
17.38
14.24
14.22
13.86
13.83
O
H
N
Ph
N
H
Si-OH
F
iPr
iPr
L3a
CDCl3, 101 MHz
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



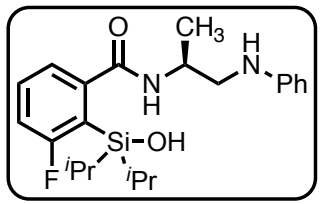
L3b

$CDCl_3$, 400 MHz



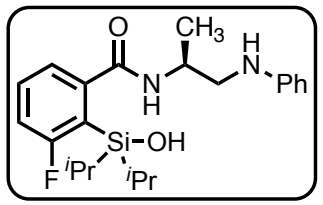
L3b

$CDCl_3$, 101 MHz



L3c

$CDCl_3$, 400 MHz



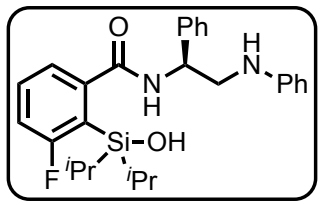
L3c

$CDCl_3$, 101 MHz

172.21
172.19
167.93
165.54
148.20
145.09
144.97
131.42
131.33
129.42
122.98
122.96
122.92
122.58
117.88
116.91
116.64
113.11
77.48
77.16
76.84
49.49
46.38
18.97
17.82
17.79
17.75
17.73
17.38
17.36
14.13
14.11
14.01
13.98

180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

f1 (ppm)



L3d

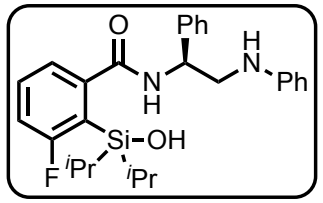
$CDCl_3$, 400 MHz

7.42 7.42 7.40 7.38 7.38 7.37 7.36 7.36 7.34 7.34 7.32 7.20 7.18 7.18 7.17 7.16 7.15 7.09 7.09 7.07 7.05 6.76 6.74 6.74 6.74 6.72 6.69 6.69 6.67 6.67 5.47 5.29 CH2Cl2 3.63 3.62 3.61 3.60 1.31 1.30 1.29 1.28 1.26 1.11 1.09 1.08 1.06 0.98 0.97 0.97 0.97 0.96 0.95 0.95 0.95

5.85 3.03 1.07 1.09 1.96 1.01 1.00 0.94 2.17 2.20 5.86 6.13

8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 −0.5

f1 (ppm)



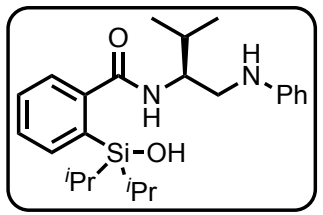
L3d

$CDCl_3$, 101 MHz

171.98
171.95
168.03
165.64
147.88
144.80
144.69
139.19
131.50
131.41
129.50
129.27
128.34
126.65
123.29
123.07
123.04
122.95
118.35
117.18
116.90
113.45
77.48
77.16
76.84
53.81
49.09
17.86
17.84
17.81
17.79
17.43
17.39
14.26
14.23
13.97
13.95

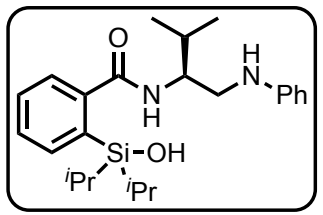
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

f1 (ppm)



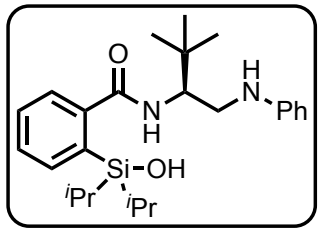
L3e

$CDCl_3$, 400 MHz



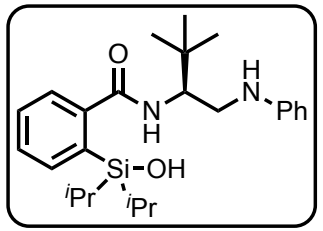
L3e

$CDCl_3$, 400 MHz



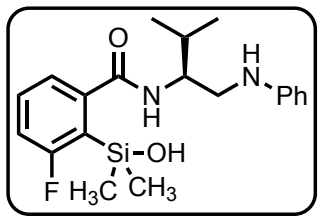
L3f

$CDCl_3$, 400 MHz



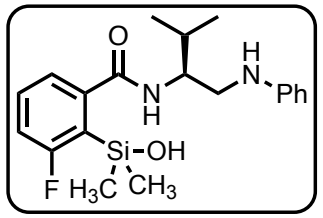
L3f

$CDCl_3$, 101 MHz



L3g

$CDCl_3$, 400 MHz



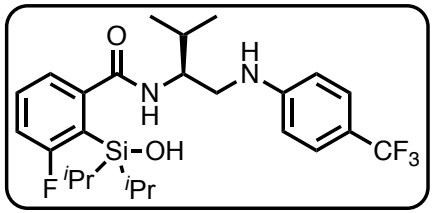
L3g

$CDCl_3$, 101 MHz

172.31
172.30
167.93
166.33
148.32
144.01
143.94
131.55
131.49
129.48
125.82
125.61
122.50
122.49
118.03
117.62
117.44
113.14
77.37
77.16
76.95
55.42
46.68
30.96
29.85
19.81
18.53
1.83
1.81
1.50
1.47

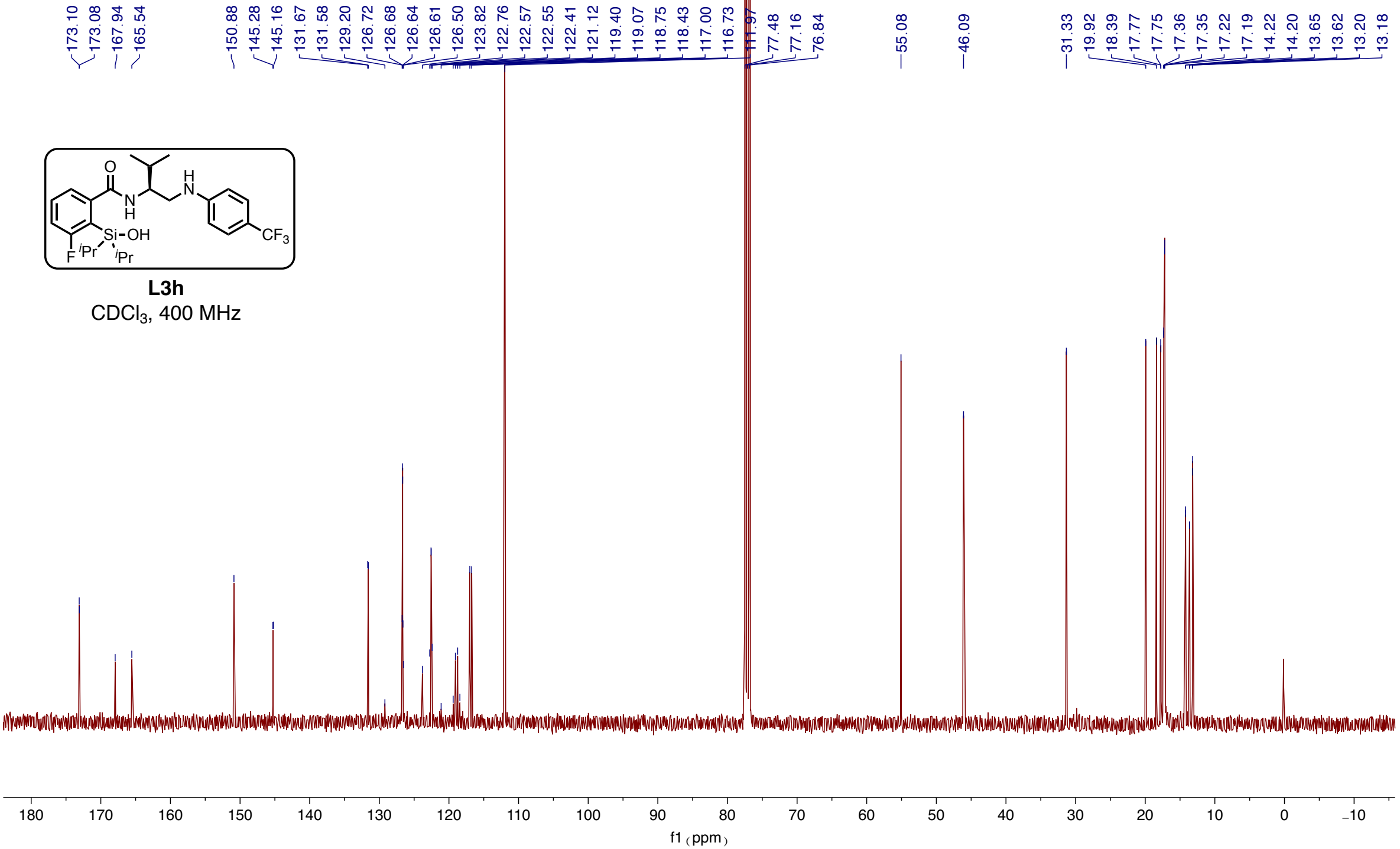
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

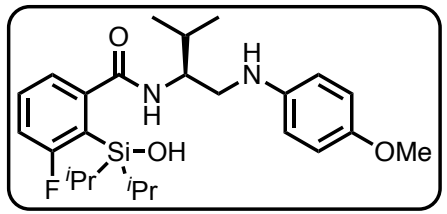
f1 (ppm)



L3h

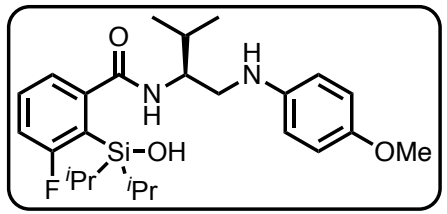
$CDCl_3$, 400 MHz


173.10
173.08
167.94
165.54
150.88
145.28
145.16
131.67
131.58
129.20
126.72
126.68
126.64
126.61
126.50
123.82
122.76
122.57
122.55
122.41
121.12
119.40
119.07
118.75
118.43
117.00
116.73
111.97
77.48
77.16
76.84
55.08
46.09
31.33
19.92
18.39
17.77
17.75
17.36
17.35
17.22
17.19
14.22
14.20
13.65
13.62
13.20
13.18
O
H
N
N
H
Si-OH
F
iPr
iPr
CF3
L3h
CDCl3, 400 MHz
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



L3i

$CDCl_3$, 400 MHz



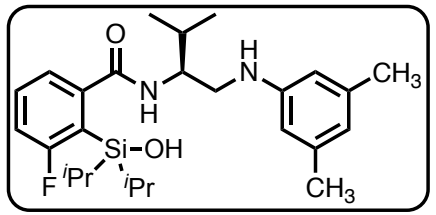
L3i

$CDCl_3$, 101 MHz

172.74
172.72
167.96
165.57
152.50
145.46
145.35
142.55
131.49
131.40
123.08
122.85
122.82
122.73
116.90
116.62
115.03
114.49
77.48
77.16
76.84
55.94
55.37
47.45
31.09
19.81
18.53
17.87
17.85
17.82
17.79
17.40
14.25
14.23
13.88
13.85

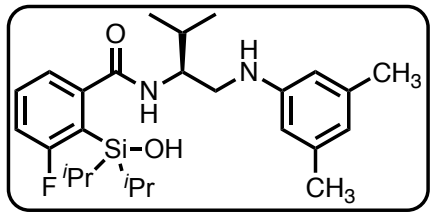
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

f1 (ppm)



L3j

$CDCl_3$, 400 MHz



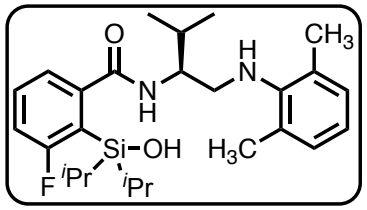
L3j

$CDCl_3$, 101 MHz

172.82
172.80
167.97
165.58
148.48
145.40
145.28
139.02
131.50
131.41
123.10
122.78
122.75
119.78
116.93
116.65
111.06
77.48
77.16
76.84
55.38
46.40
31.20
21.59
19.82
18.53
17.88
17.85
17.83
17.80
17.43
17.39
14.28
14.26

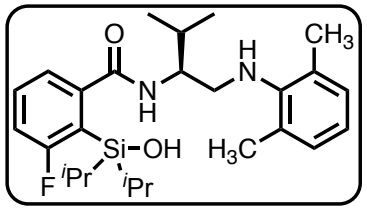
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

f1 (ppm)



L3k

$CDCl_3$, 400 MHz



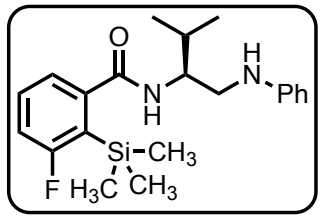
L3k

$CDCl_3$, 101 MHz

168.20 165.85 165.17 165.15 139.56 138.09 137.97 136.34 136.09 129.90 129.80 129.06 129.04 127.52 125.77 125.74 125.36 125.01 116.41 116.13 77.48 77.16 76.84 70.82 55.70 34.28 19.68 19.26 18.84 18.66 18.42 18.40 18.34 18.32 17.90 17.79 17.79 15.15 15.12 14.81 14.77

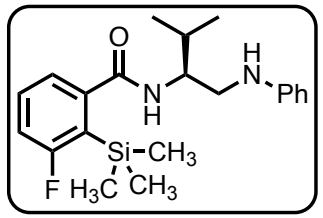
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

f1 (ppm)



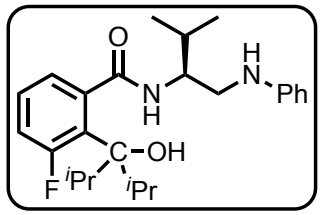
L4

$CDCl_3$, 400 MHz



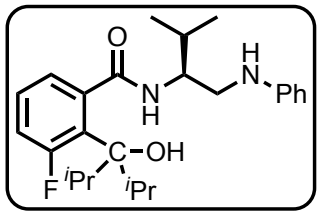
L4

$CDCl_3$, 101 MHz



L5

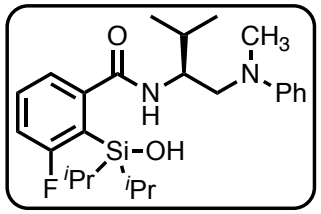
$CDCl_3$, 800 MHz



L5

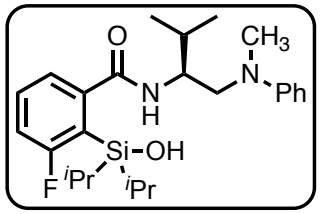
$CDCl_3$, 151 MHz

Note: *The signal for carbon ^{1}J to fluorine exhibits broadening (also noted in ^{1}H and ^{19}F NMR). To visualize the signals, more than 30,000 scans were required, leading to the appearance of trace impurities.*



L6

$CDCl_3$, 400 MHz



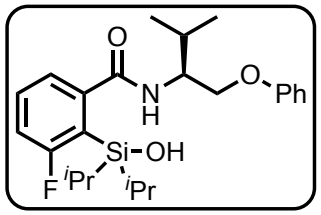
L6

$CDCl_3$, 101 MHz

172.10
172.07
167.99
165.61
150.22
144.94
144.82
131.23
131.14
129.78
123.44
123.10
123.05
123.03
116.95
116.93
116.65
112.70
77.48
77.16
76.84
53.71
53.14
38.34
30.33
19.72
17.90
17.89
17.85
17.82
17.50
17.40
14.48
14.45
13.93
13.90

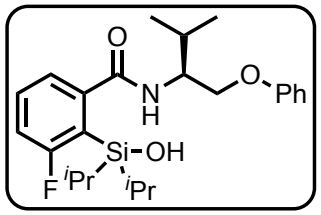
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

f1 (ppm)



L7

$CDCl_3$, 400 MHz



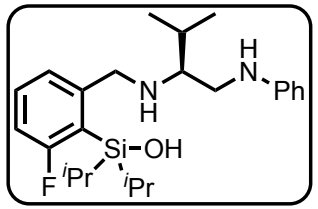
L7

$CDCl_3$, 101 MHz

171.95
171.93
168.11
165.72
158.72
145.14
145.02
131.42
131.33
129.72
123.56
123.22
123.15
123.12
121.43
117.19
116.91
114.71
77.48
77.16
76.84
67.76
55.15
29.56
19.75
19.48
17.84
17.81
17.76
17.74
17.42
17.35
14.20
14.18
14.15
14.12

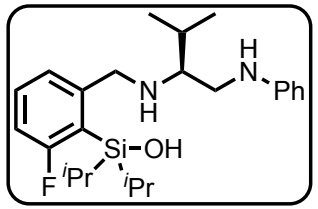
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

f1 (ppm)



L8

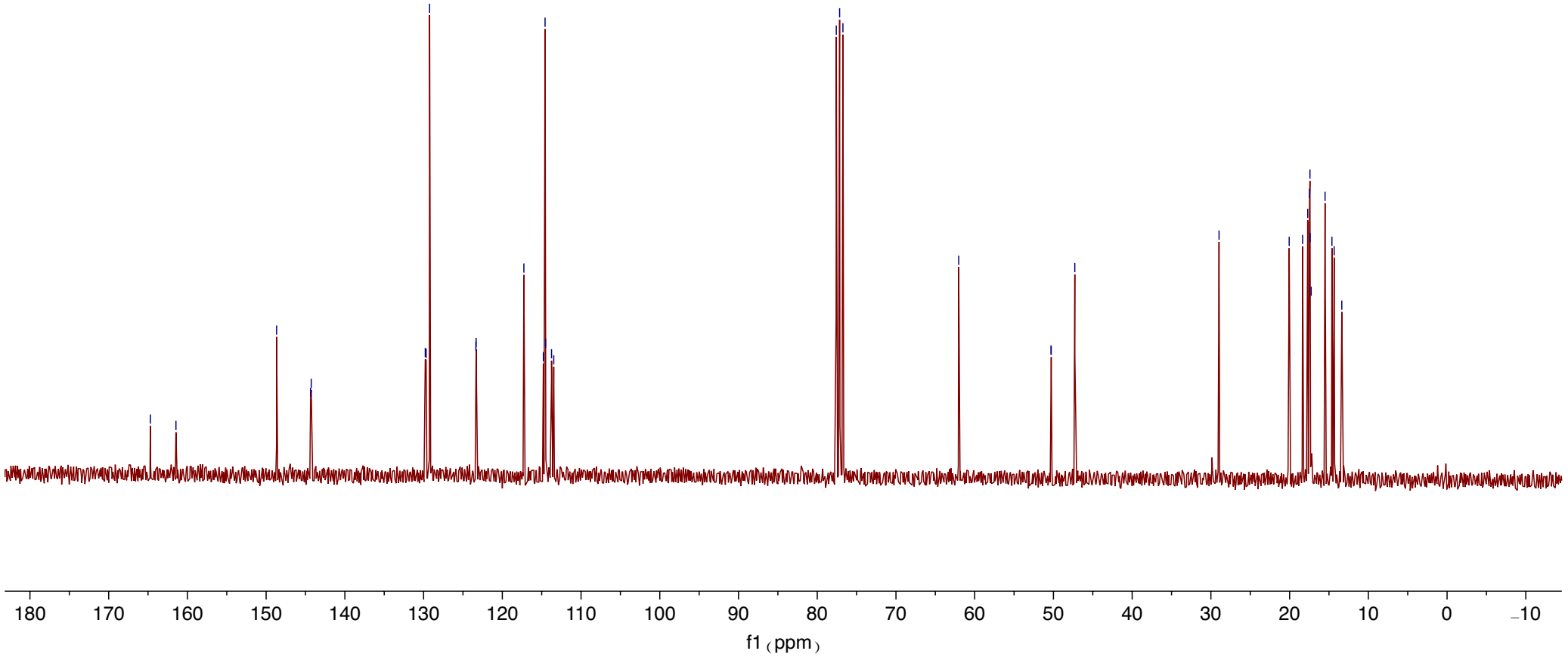
$CDCl_3$, 400 MHz



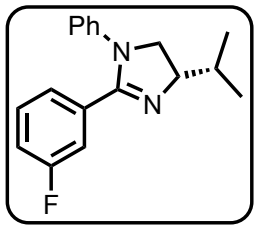
L8

$CDCl_3$, 76 MHz

164.71
161.46
148.67
144.36
144.27
129.79
129.68
129.24
123.36
123.33
117.26
114.79
114.57
114.50
113.75
113.47
77.58
77.16
76.74
62.03
50.30
50.28
47.28
28.97
20.05
18.35
17.70
17.47
17.42
17.40
17.26
15.50
14.63
14.34
13.37

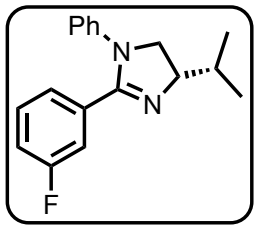


Copies of spectra – Ligand precursors (**3**–**4** & **S1**–**S11**)



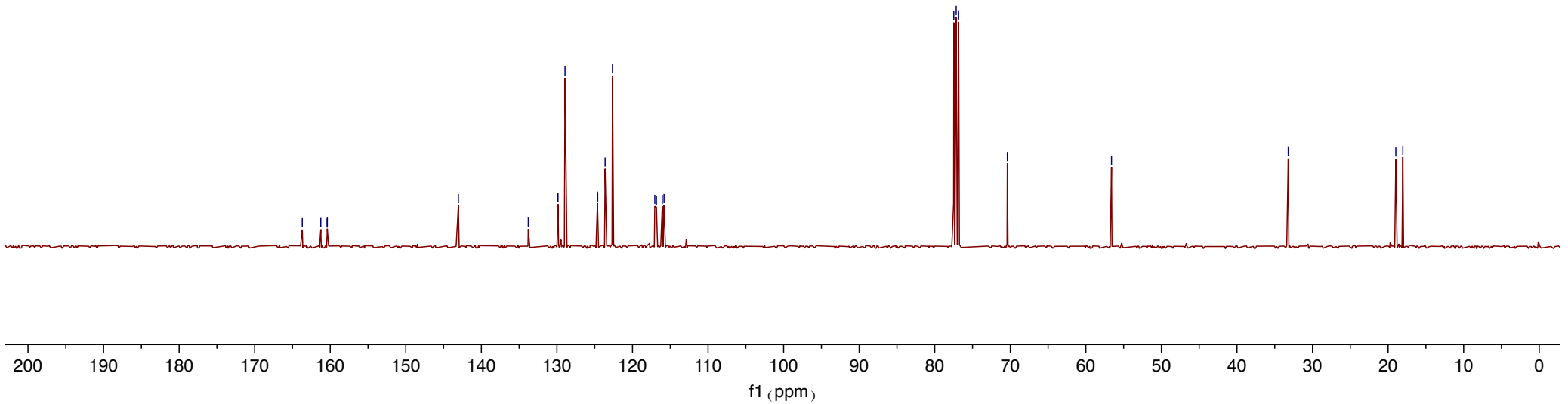
3a

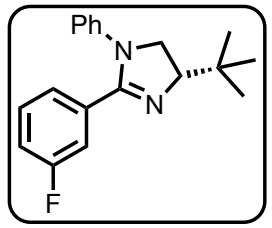
$CDCl_3$, 400 MHz



3a

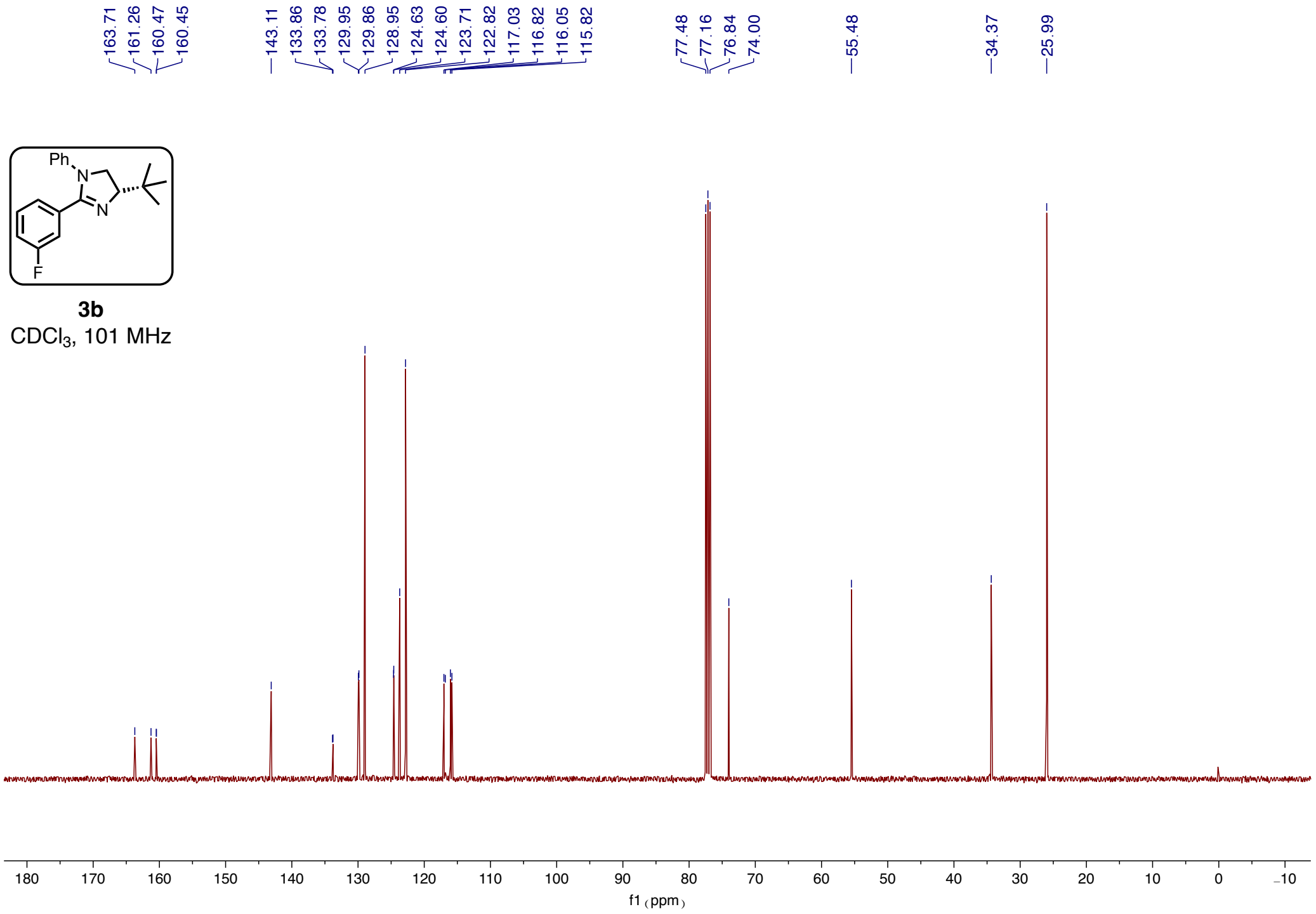
$CDCl_3$, 101 MHz

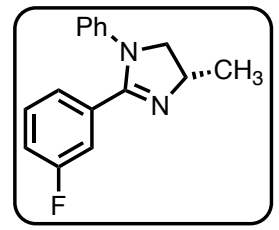




3b

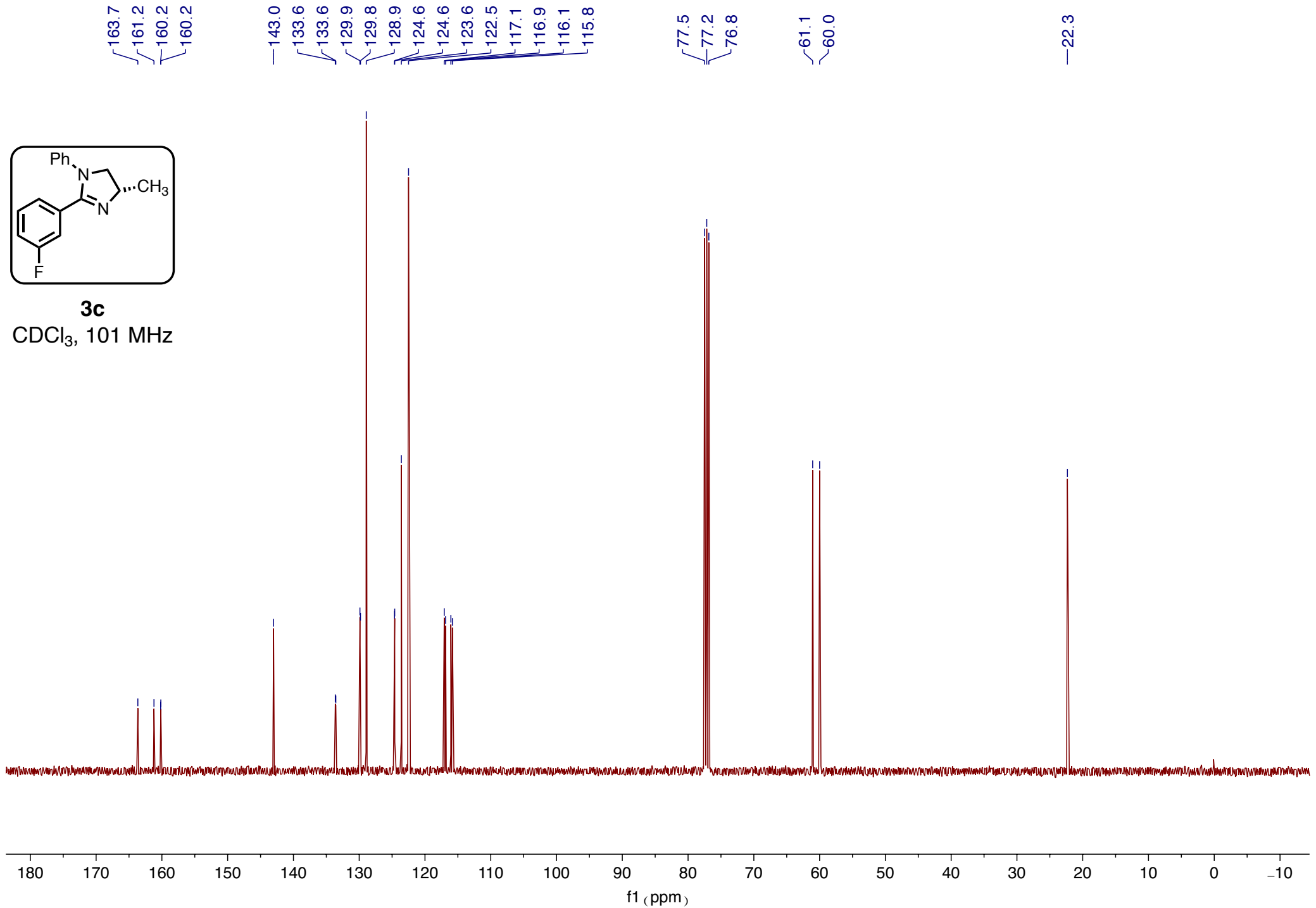
$CDCl_3$, 400 MHz

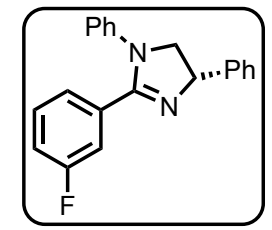

163.71
161.26
160.47
160.45
143.11
133.86
133.78
129.95
129.86
128.95
124.63
124.60
123.71
122.82
117.03
116.82
116.05
115.82
77.48
77.16
76.84
74.00
55.48
34.37
25.99
Ph
N
N
F
3b
CDCl3, 101 MHz
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



3c

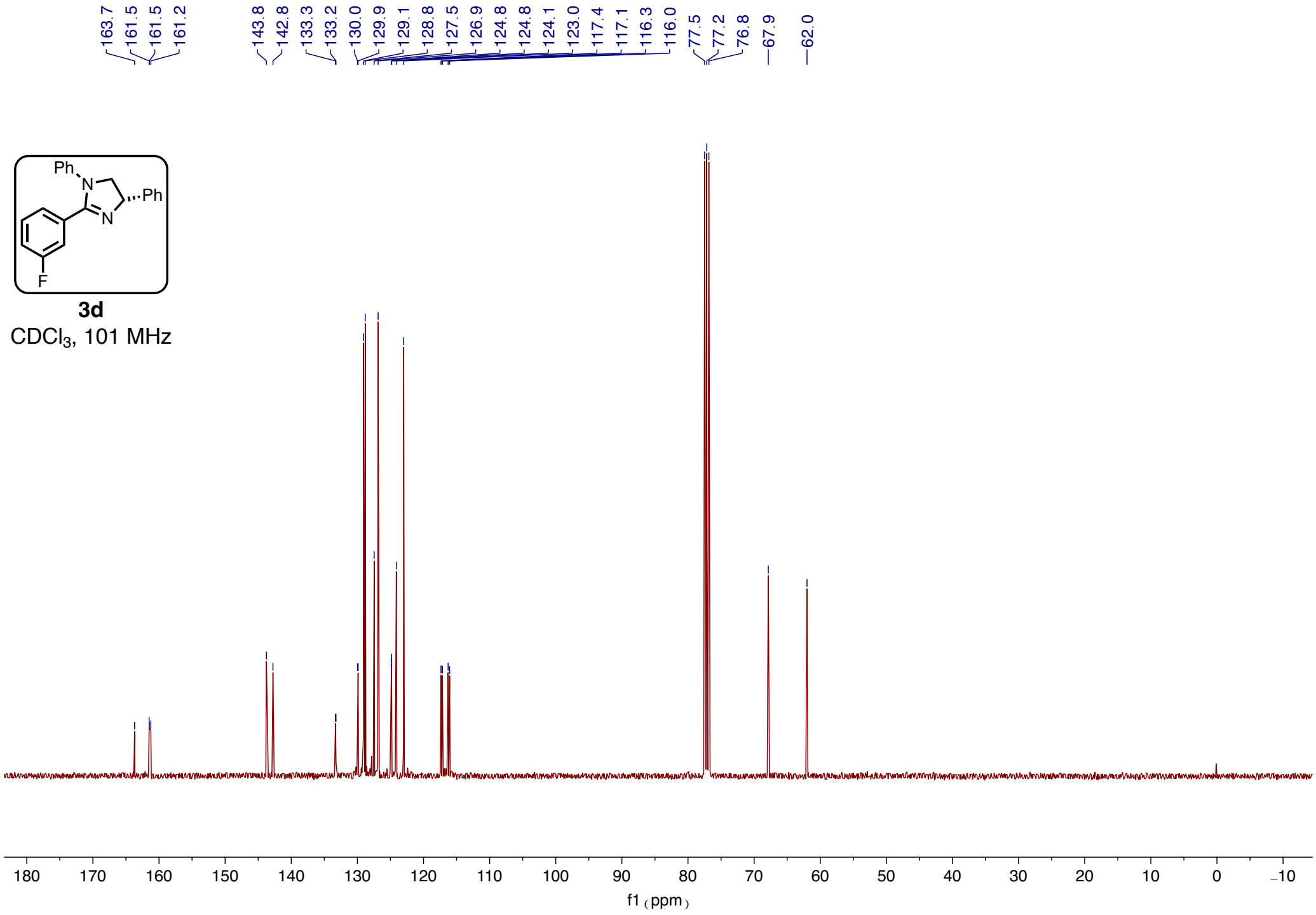
$CDCl_3$, 400 MHz

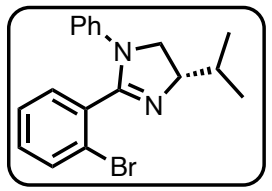

163.7
161.2
160.2
160.2
143.0
133.6
133.6
129.9
129.8
128.9
124.6
124.6
123.6
122.5
117.1
116.9
116.1
115.8
77.5
77.2
76.8
61.1
60.0
22.3
Ph
N
N
CH3
F
3c
CDCl3, 101 MHz
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



3d

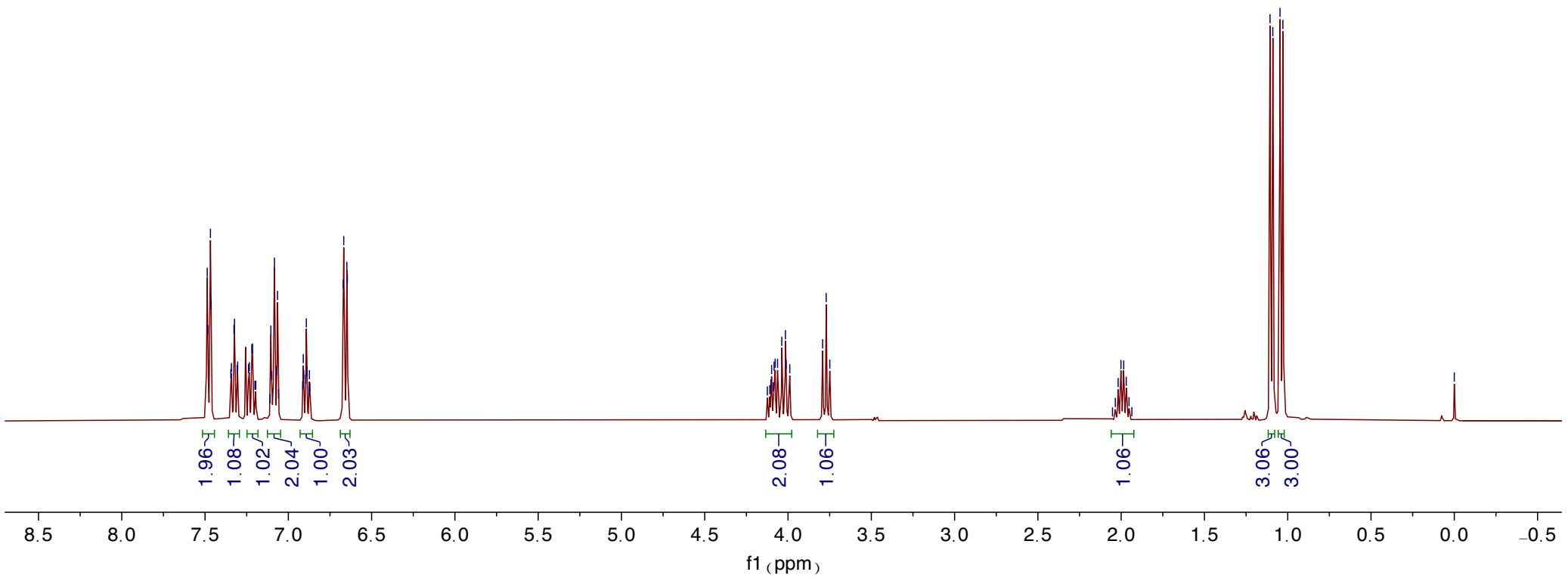
$CDCl_3$, 400 MHz

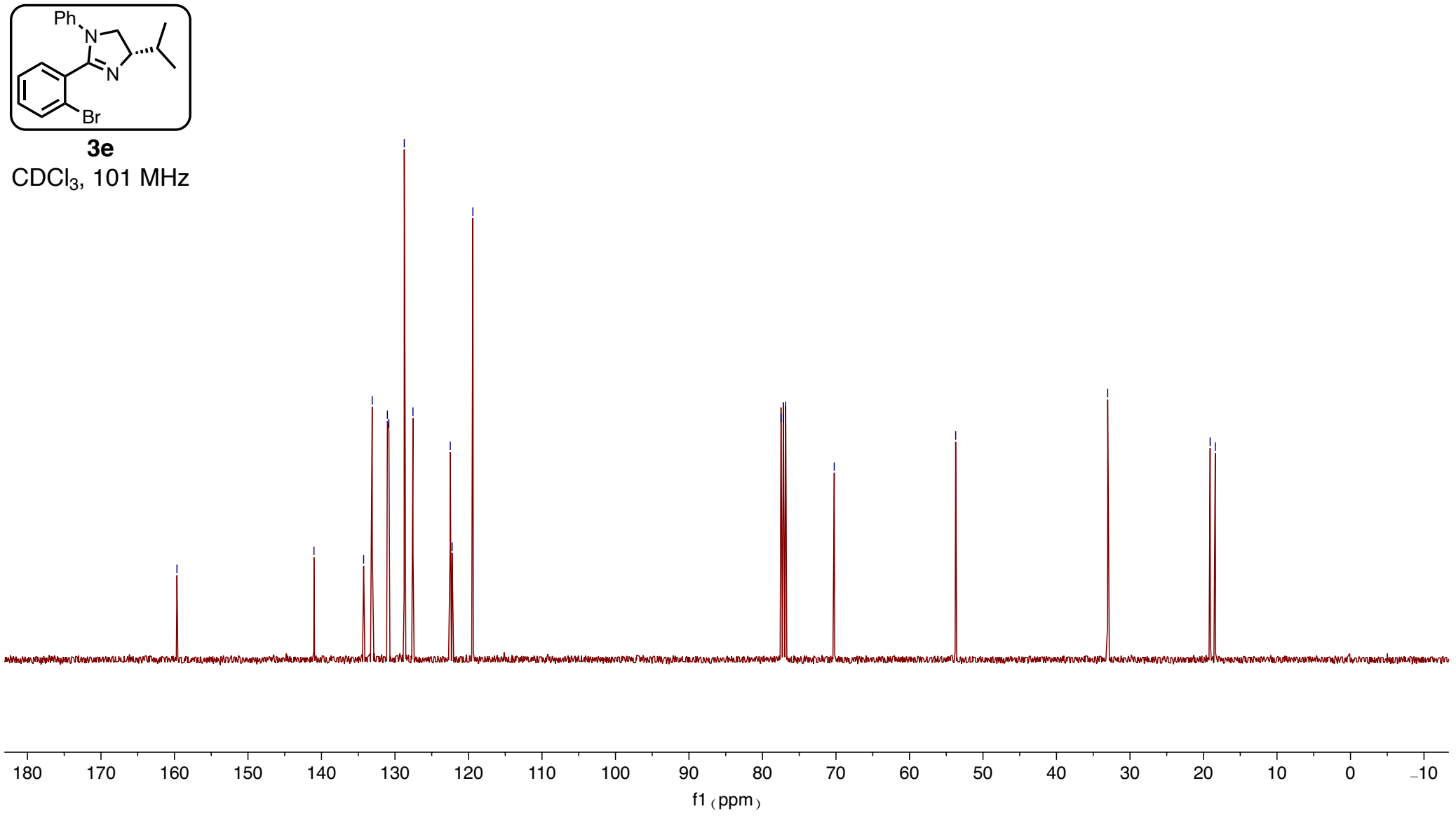

163.7
161.5
161.5
161.2
143.8
142.8
133.3
133.2
130.0
129.9
129.1
128.8
127.5
126.9
124.8
124.8
124.1
123.0
117.4
117.1
116.3
116.0
77.5
77.2
76.8
67.9
62.0
Ph
N
Ph
N
F
3d
CDCl3, 101 MHz
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)

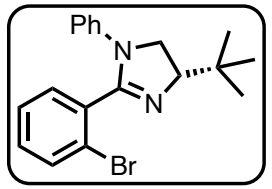


3e

$CDCl_3$, 400 MHz

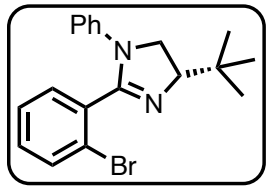



159.7
141.0
134.3
133.1
131.0
130.8
128.7
127.6
122.5
122.2
119.4
77.5
77.2
76.8
70.2
53.7
33.0
19.1
18.4
Ph
N
N
Br
3e
CDCl3, 101 MHz
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



3f

$CDCl_3$, 400 MHz



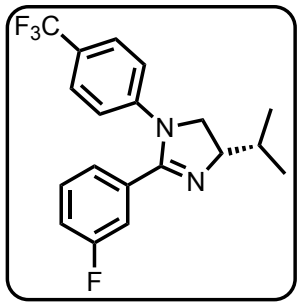
3f

$CDCl_3$, 101 MHz

159.8
141.1
134.3
133.2
131.2
130.9
128.8
127.6
122.6
122.3
119.7
77.5
77.2
76.8
74.0
52.6
34.4
26.3

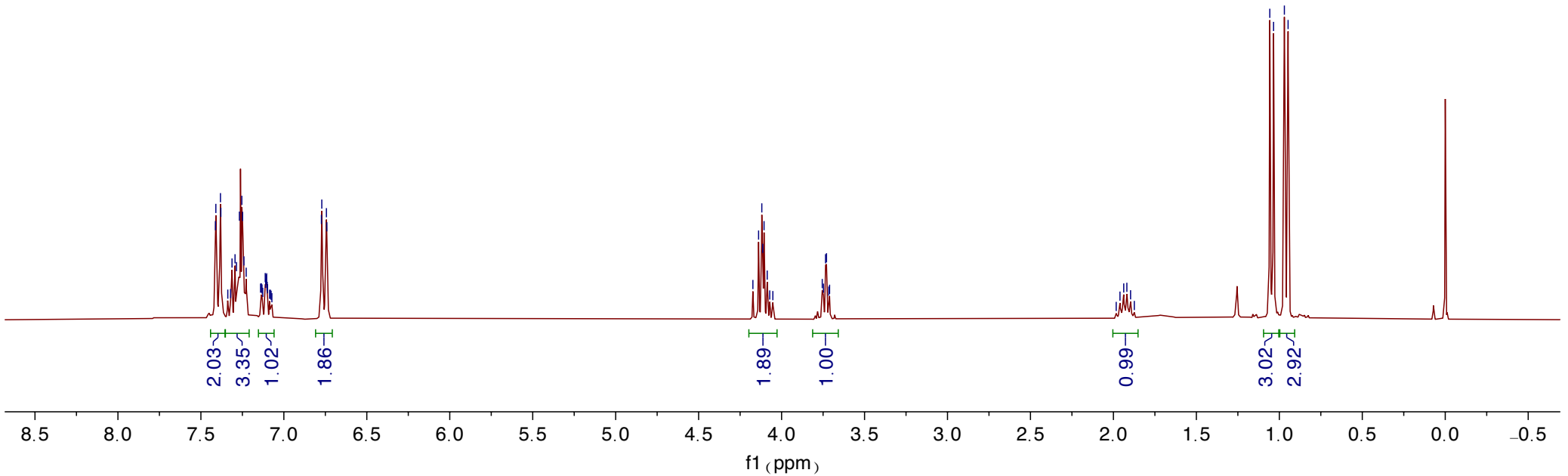
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

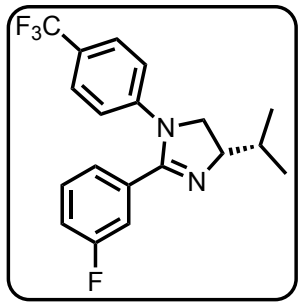
f1 (ppm)



3h

$CDCl_3$, 400 MHz





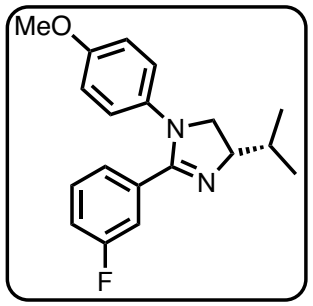
3h

$CDCl_3$, 101 MHz

164.3
161.0
159.3
159.2
145.5
145.5
133.5
133.4
130.4
130.3
126.2
126.1
126.1
126.0
124.7
124.5
124.5
124.2
122.5
120.9
117.6
117.3
116.0
115.7
77.6
77.2
76.7
70.5
55.9
33.1
18.9
18.1

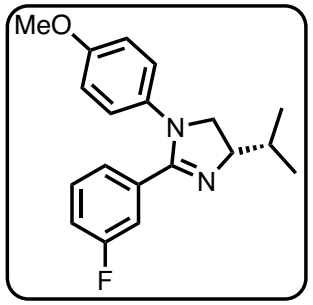
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

f1 (ppm)



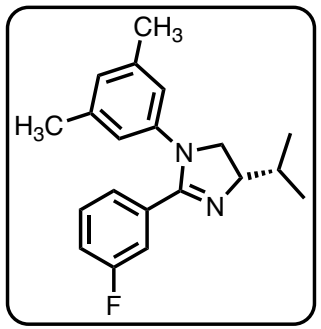
3i

$CDCl_3$, 400 MHz



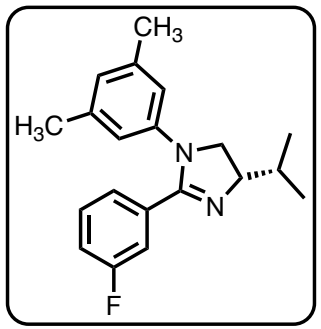
3i

$CDCl_3$, 101 MHz



3j

$CDCl_3$, 400 MHz



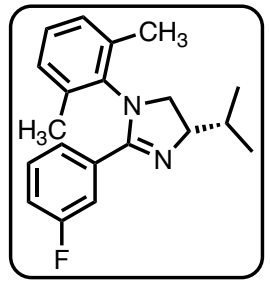
3j

$CDCl_3$, 101 MHz

163.7
161.2
160.7
160.7
142.7
138.6
129.9
129.8
125.7
124.7
124.7
120.6
117.1
116.9
116.1
115.9
77.5
77.2
76.8
69.9
56.7
33.2
21.4
19.0
18.0

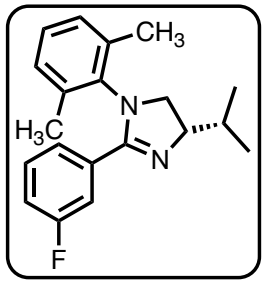
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

f1 (ppm)



3k

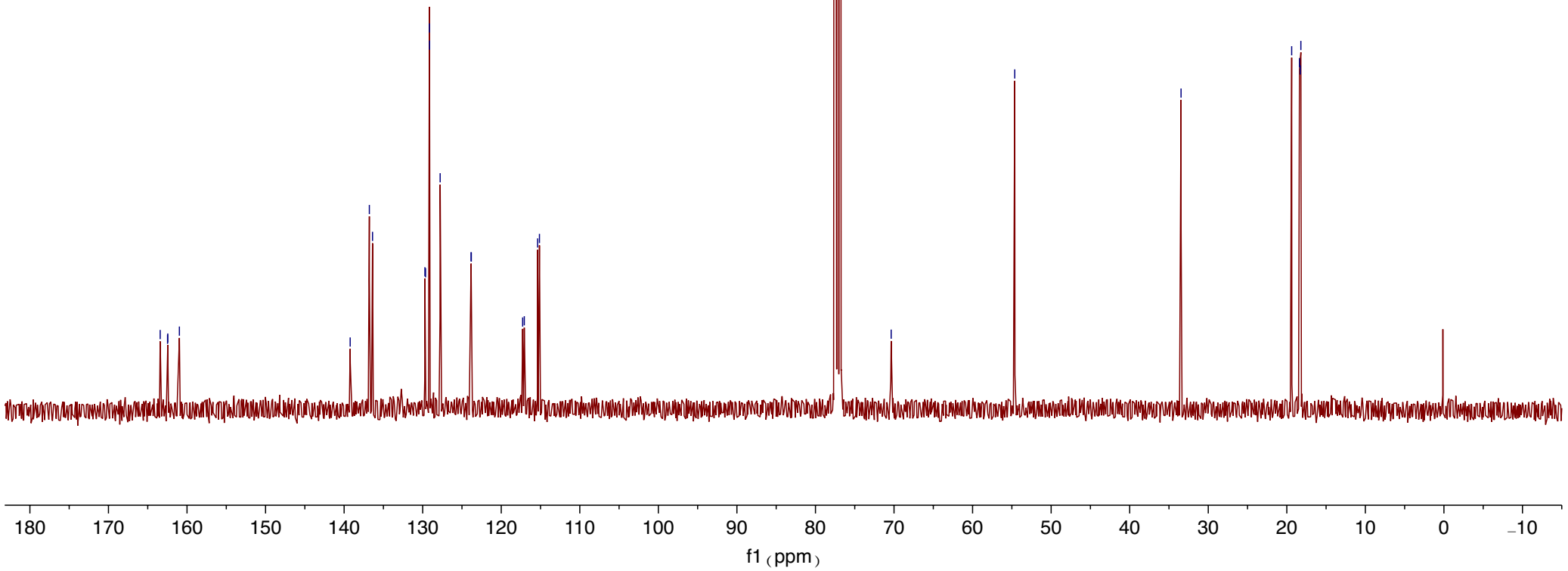
$CDCl_3$, 400 MHz

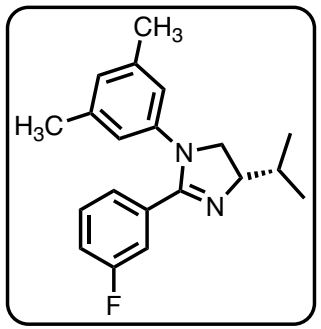


3k

$CDCl_3$, 101 MHz

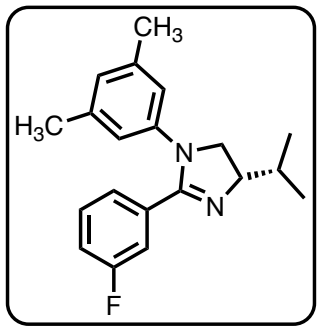
163.4
162.5
162.4
161.0
139.2
136.8
136.4
129.7
129.6
129.1
129.1
127.8
123.8
123.8
117.3
117.1
115.4
115.1
77.5
77.2
76.8
70.4
54.6
33.5
19.4
18.4
18.3
18.2





3j

$CDCl_3$, 400 MHz



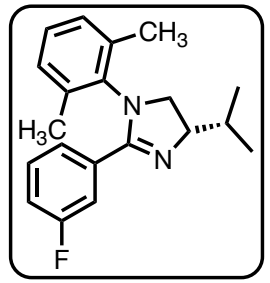
3j

$CDCl_3$, 101 MHz

163.7
161.2
160.7
160.7
142.7
138.6
129.9
129.8
125.7
124.7
124.7
120.6
117.1
116.9
116.1
115.9
77.5
77.2
76.8
69.9
56.7
33.2
21.4
19.0
18.0

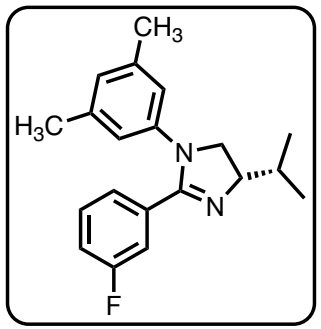
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

f1 (ppm)



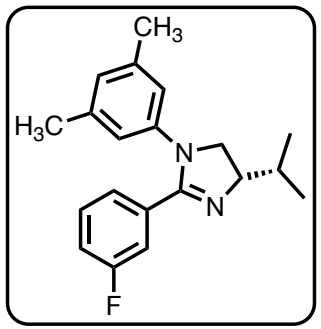
3k

$CDCl_3$, 400 MHz



3j

$CDCl_3$, 400 MHz



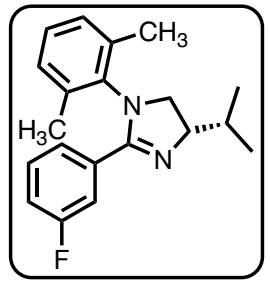
3j

$CDCl_3$, 101 MHz

163.7
161.2
160.7
160.7
142.7
138.6
129.9
129.8
125.7
124.7
124.7
120.6
117.1
116.9
116.1
115.9
77.5
77.2
76.8
69.9
56.7
33.2
21.4
19.0
18.0

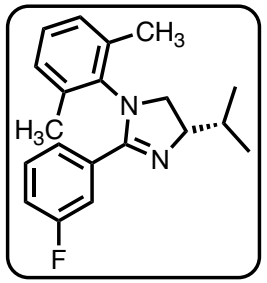
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

f1 (ppm)



3k

$CDCl_3$, 400 MHz



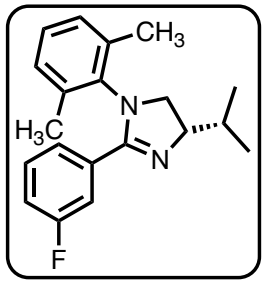
3k

$CDCl_3$, 101 MHz

163.4 162.5 162.4 161.0 139.2 136.8 136.4 129.7 129.6 129.1 129.1 127.8 123.8 123.8 117.3 117.1 115.4 115.1 77.5 77.2 76.8 70.4 54.6 33.5 19.4 18.4 18.3 18.2

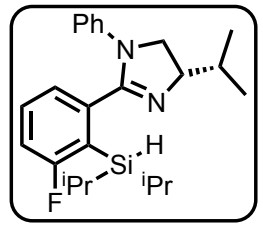
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

f1 (ppm)



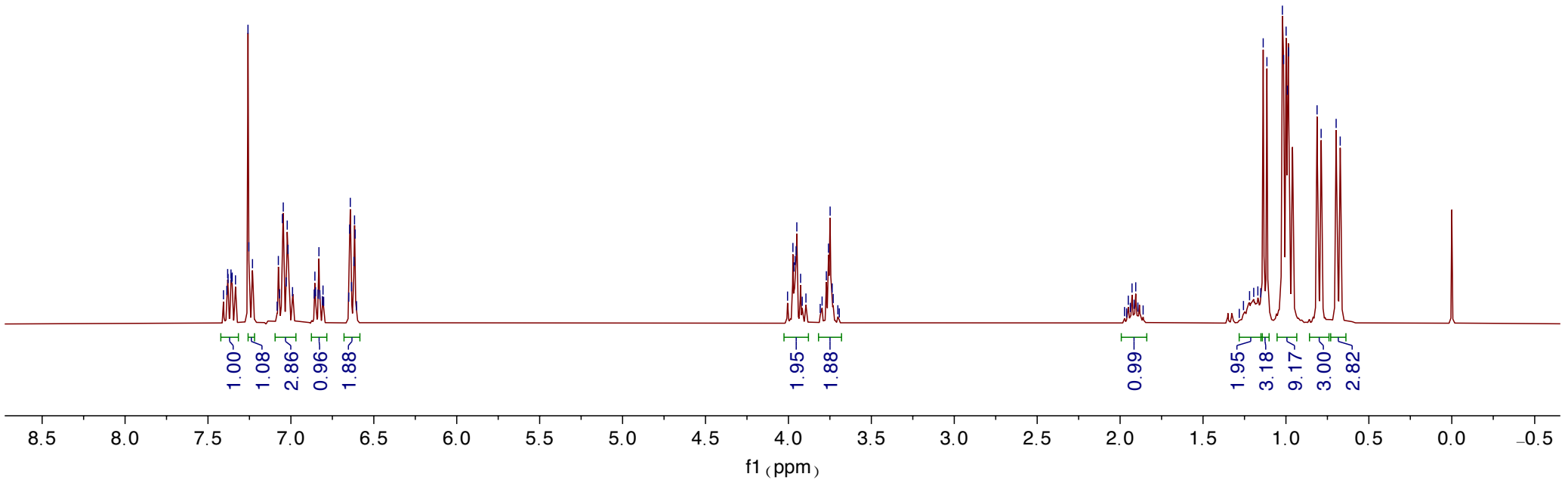
3k

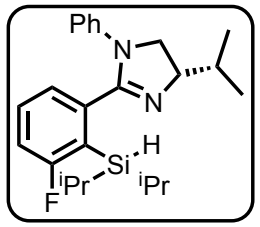
$CDCl_3$, 101 MHz



4a

$CDCl_3$, 400 MHz

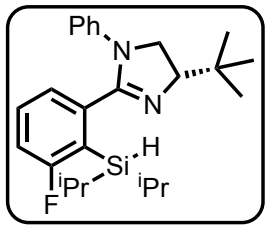




4a

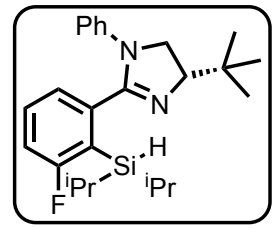
$CDCl_3$, 101 MHz

168.7
165.5
160.7
160.6
142.0
141.8
141.0
131.7
131.6
128.7
125.6
125.6
122.1
122.0
121.6
119.4
115.7
115.3
77.6
77.2
76.7
70.8
54.5
33.6
19.8
19.2
19.0
19.0
18.9
11.6
11.5
11.3
11.3



4b

$CDCl_3$, 400 MHz



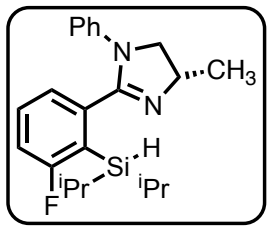
4b

$CDCl_3$, 101 MHz

168.35
165.96
160.81
141.20
131.78
131.69
128.74
125.75
125.73
122.13
121.99
121.79
119.60
115.64
115.37
77.48
77.16
76.84
74.19
52.69
33.97
26.62
19.29
19.21
19.18
19.17
11.52
11.50
11.41
11.39

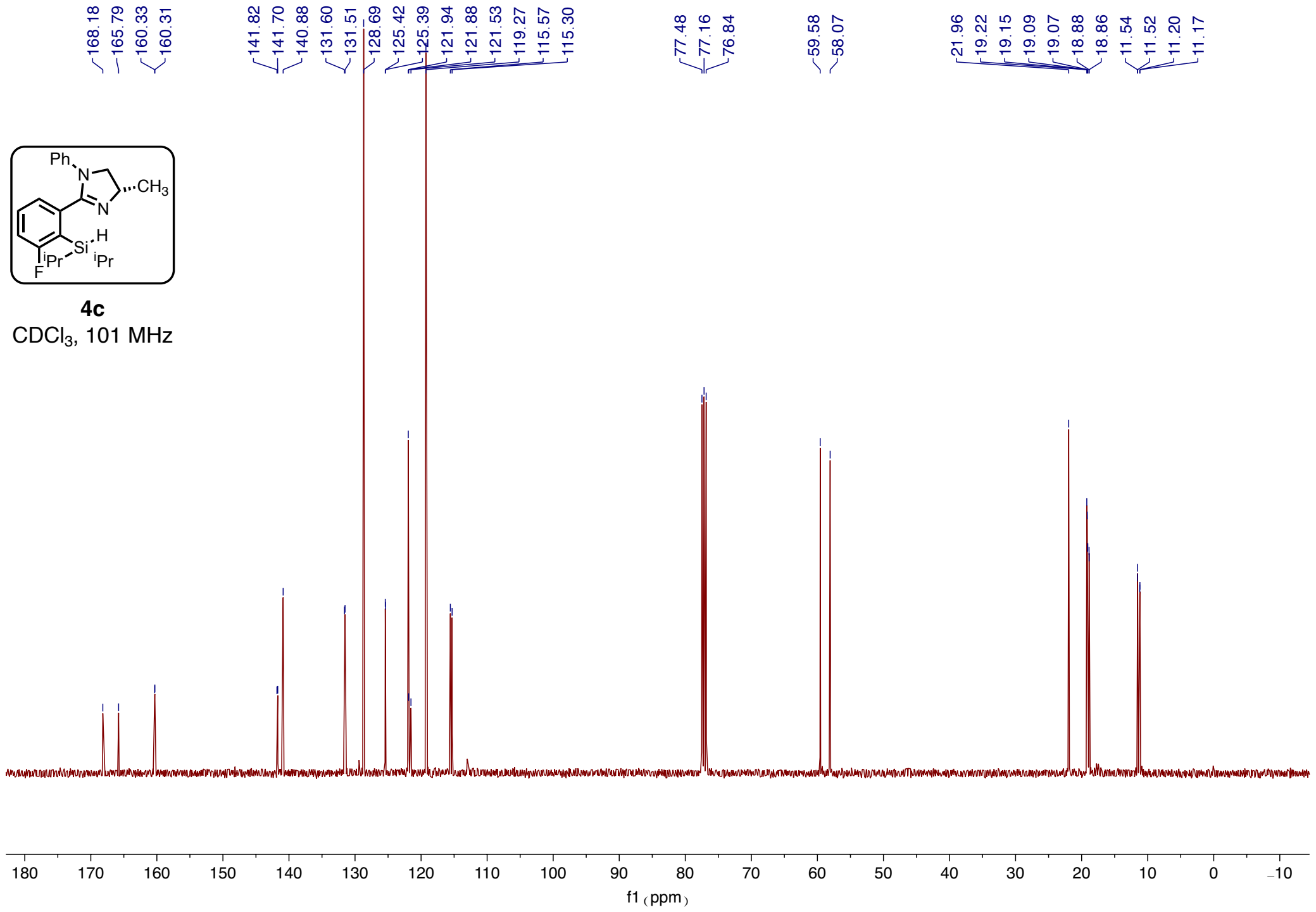
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

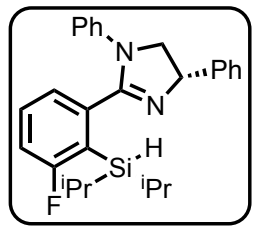
f1 (ppm)



4c

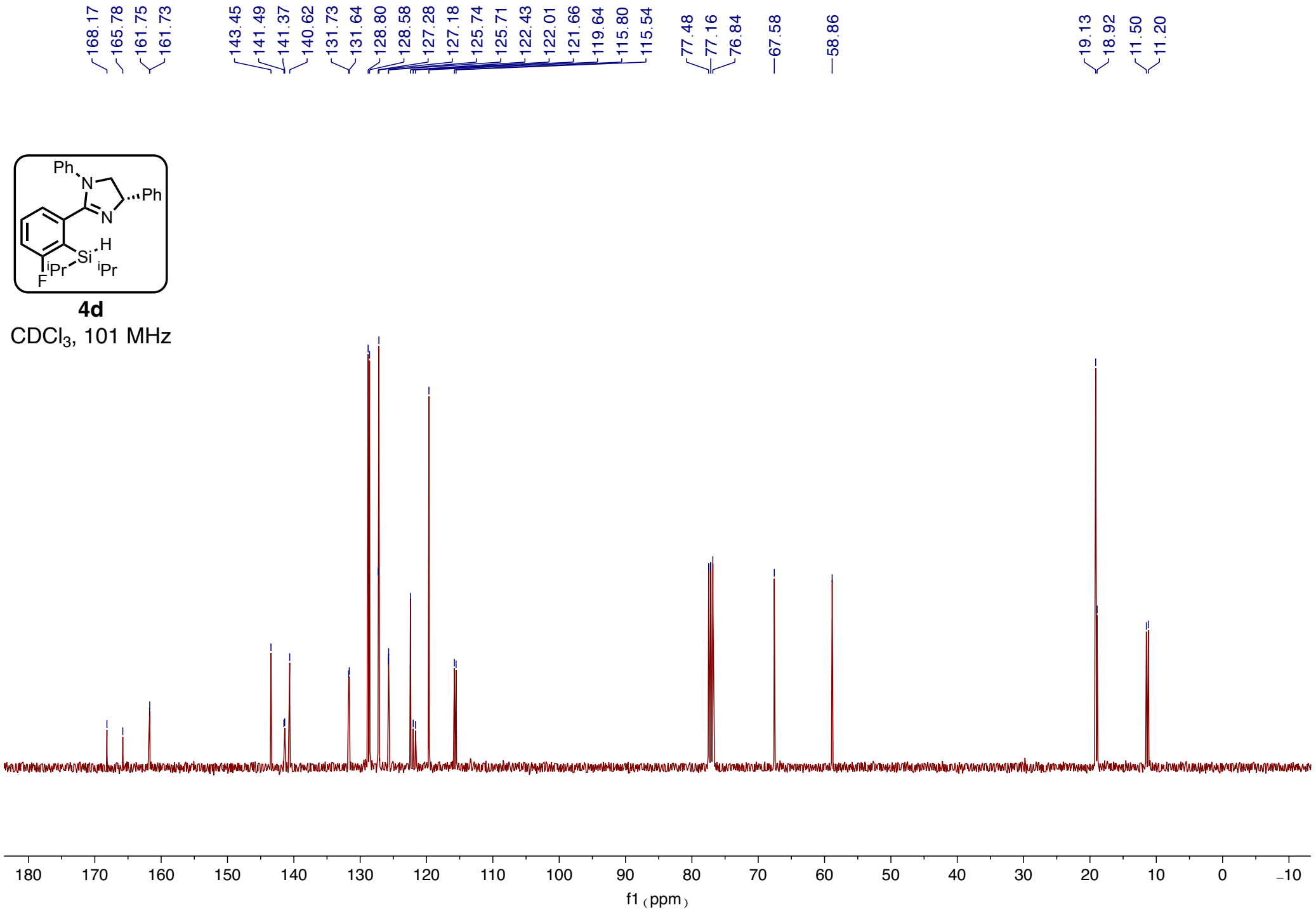
$CDCl_3$, 400 MHz

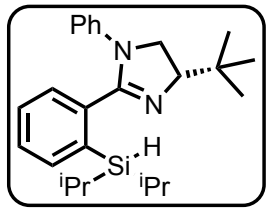

168.18
165.79
160.33
160.31
141.82
141.70
140.88
131.60
131.51
128.69
125.42
125.39
121.94
121.88
121.53
119.27
115.57
115.30
77.48
77.16
76.84
59.58
58.07
21.96
19.22
19.15
19.09
19.07
18.88
18.86
11.54
11.52
11.20
11.17
Ph
N
CH3
N
H
Si
iPr
iPr
F
4c
CDCl3, 101 MHz
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



4d

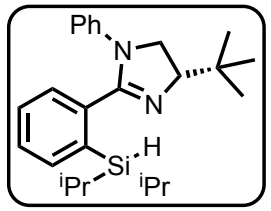
$CDCl_3$, 400 MHz


168.17
165.78
161.75
161.73
143.45
141.49
141.37
140.62
131.73
131.64
128.80
128.58
127.28
127.18
125.74
125.71
122.43
122.01
121.66
119.64
115.80
115.54
77.48
77.16
76.84
67.58
58.86
19.13
18.92
11.50
11.20
Ph
N
Ph
N
Si
H
iPr
iPr
F
4d
CDCl3, 101 MHz
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



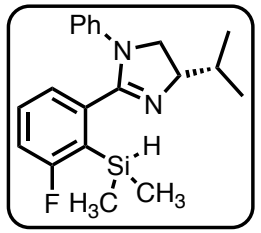
4f

$CDCl_3$, 400 MHz



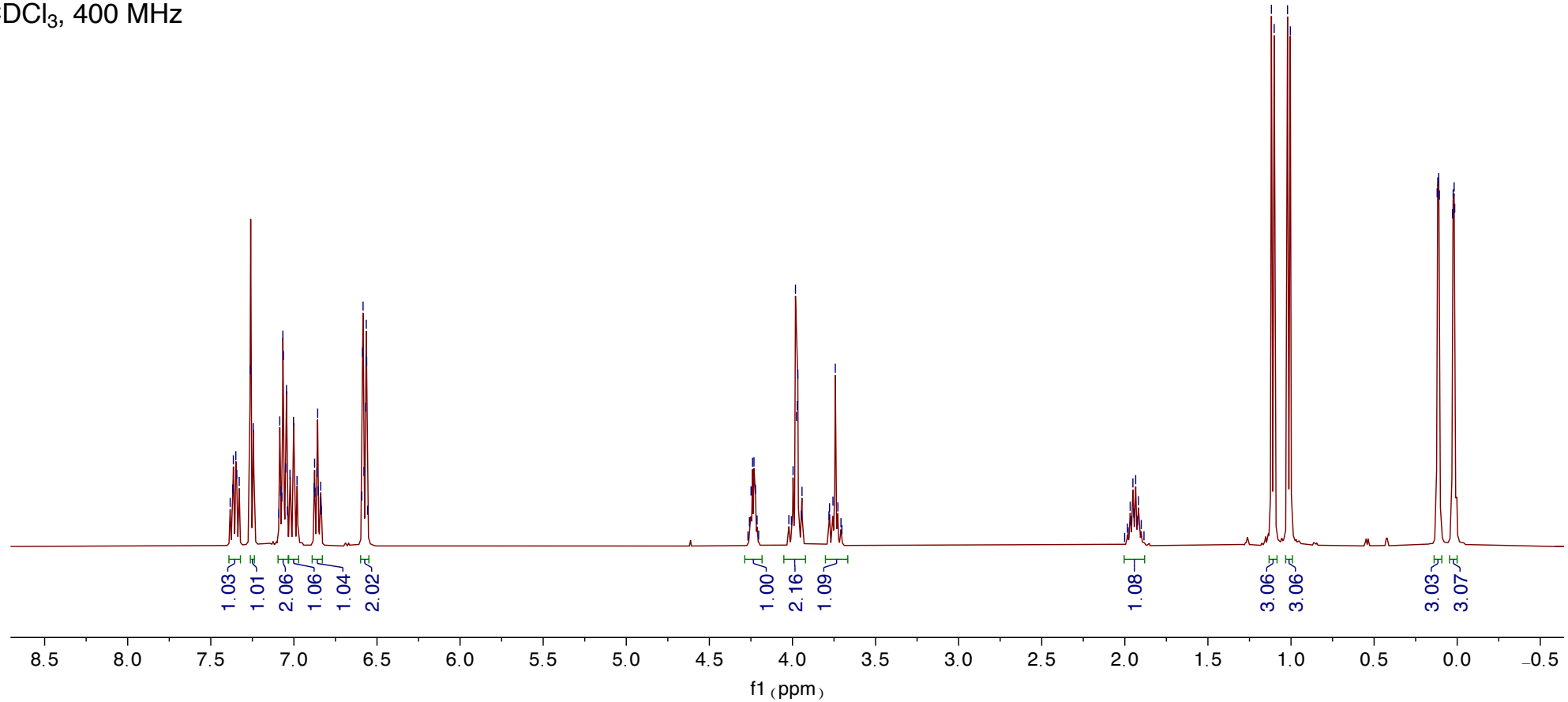
4f

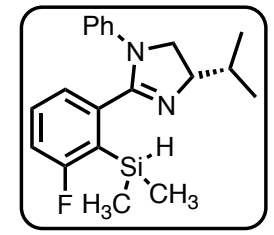
$CDCl_3$, 101 MHz



4g

$CDCl_3$, 400 MHz





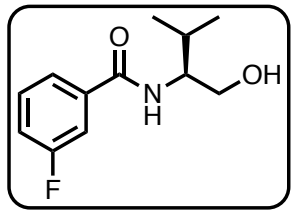
4g

$CDCl_3$, 101 MHz

168.92
166.52
160.65
160.63
140.78
140.45
140.34
131.71
131.62
128.64
125.21
125.18
123.74
123.43
122.11
119.53
115.92
115.66
77.48
77.16
76.84
70.33
54.00
33.14
19.37
18.71
3.63
3.66
3.89
3.92

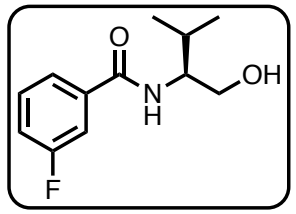
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

f1 (ppm)



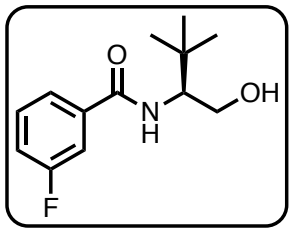
S1a

$CDCl_3$, 400 MHz



S1a

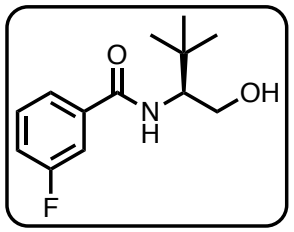
$CDCl_3$, 101 MHz



S1b

$CDCl_3$, 400 MHz

f1 (ppm)



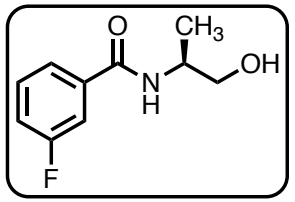
S1b

$CDCl_3$, 101 MHz

167.5
167.5
164.2
161.7
137.1
137.0
130.5
130.4
122.5
122.5
118.8
118.6
114.7
114.5
77.5
77.2
76.8
63.2
60.0
34.1
27.2

180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

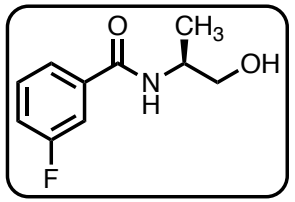
f1 (ppm)



S1c

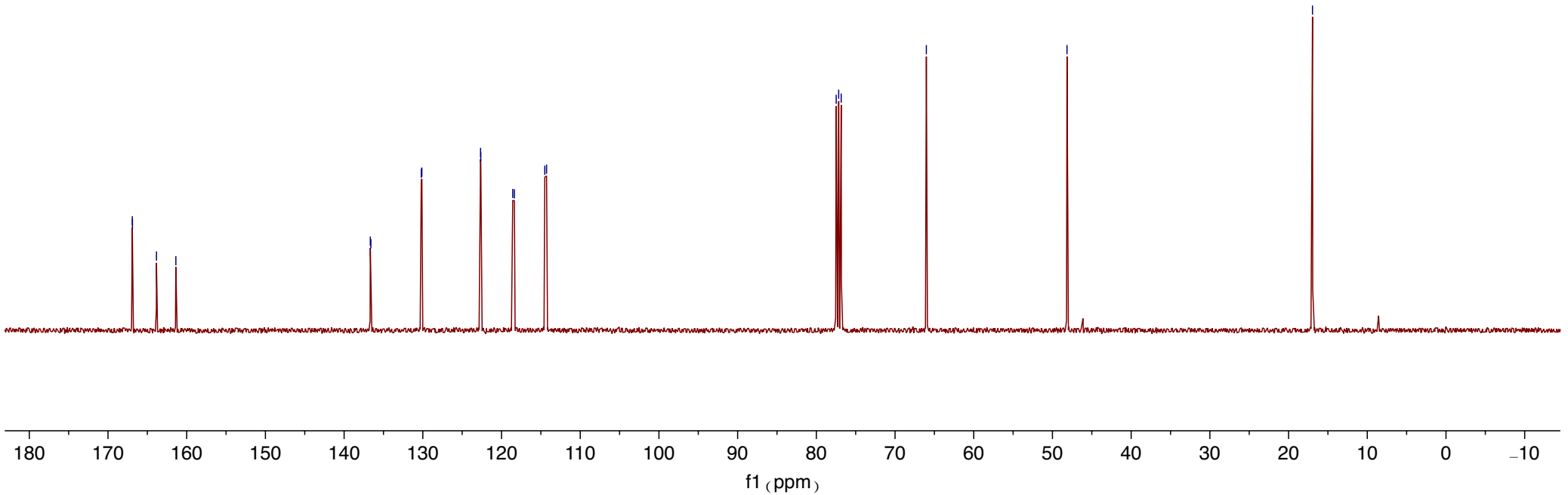
$CDCl_3$, 400 MHz

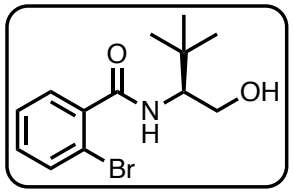
166.9
166.9
163.8
161.4
136.7
136.6
130.2
130.1
122.7
122.6
118.6
118.4
114.5
114.3
77.5
77.2
76.8
66.0
48.2
17.0



S1c

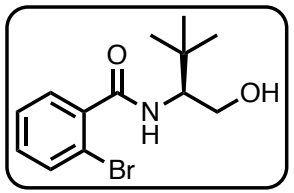
$CDCl_3$, 101 MHz





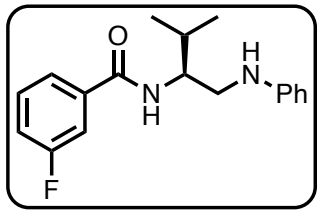
S1f

$CDCl_3$, 400 MHz



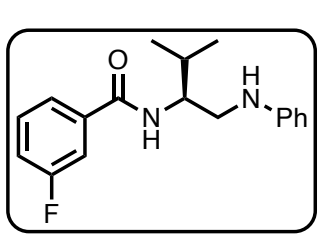
S1f

$CDCl_3$, 101 MHz



S2

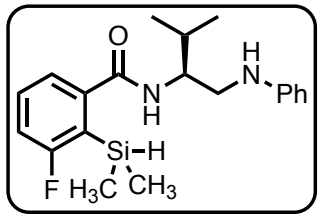
$CDCl_3$, 400 MHz



S2

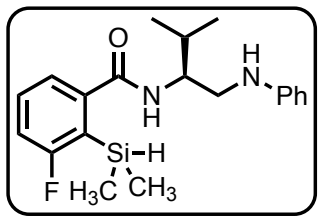
$CDCl_3$, 101 MHz

167.1
167.1
164.0
161.6
148.4
137.0
136.9
130.4
130.3
129.4
122.5
122.4
118.7
118.5
117.7
114.6
114.3
112.9
77.5
77.2
76.8
55.3
46.5
30.6
19.7
18.6



S3b

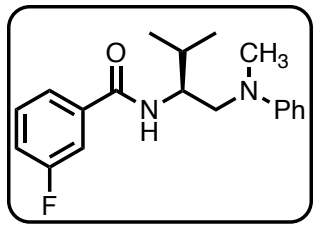
$CDCl_3$, 400 MHz



S3b

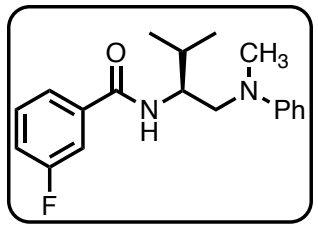
$CDCl_3$, 101 MHz

168.52
167.17
167.14
166.10
148.43
138.30
138.23
136.35
136.24
129.42
128.20
127.90
122.14
122.11
117.67
113.59
113.32
112.86
77.48
77.16
76.84
55.22
46.54
30.57
19.67
18.57
3.96
3.98



S4

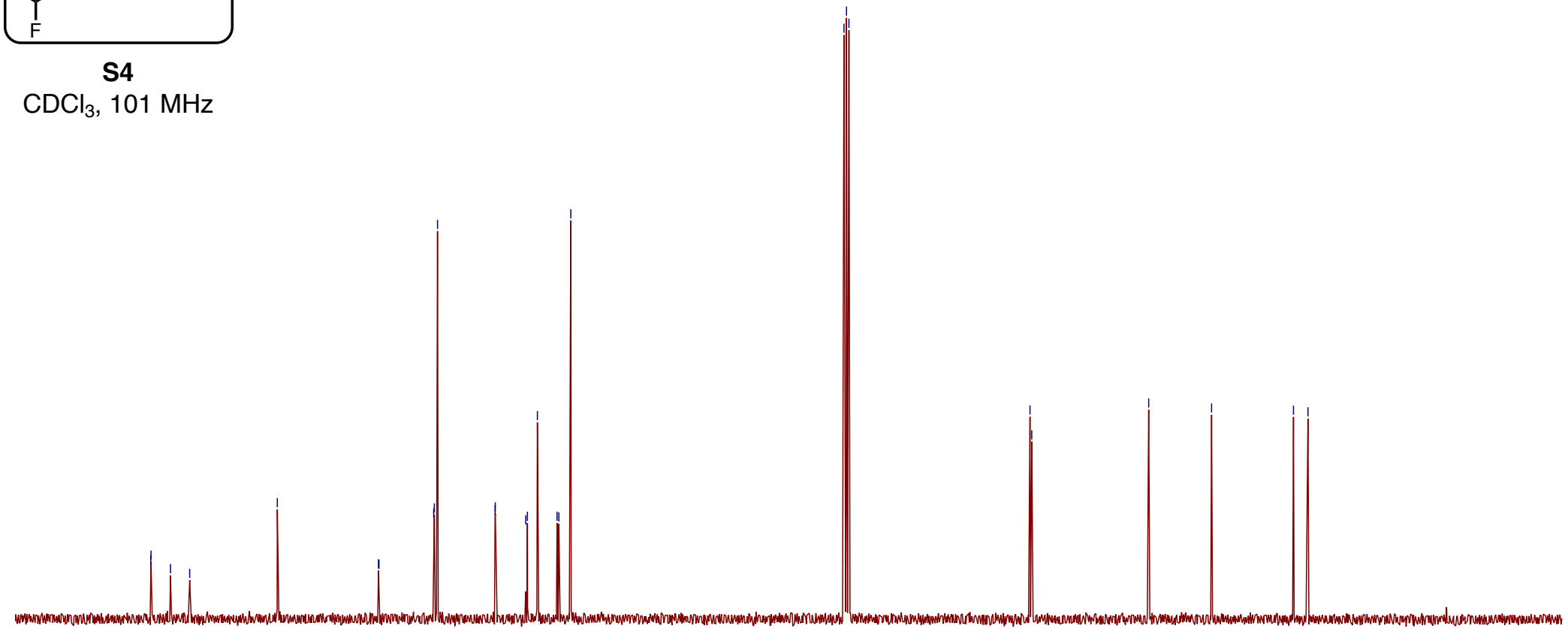
$CDCl_3$, 400 MHz

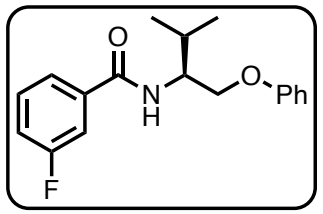


S4

$CDCl_3$, 101 MHz

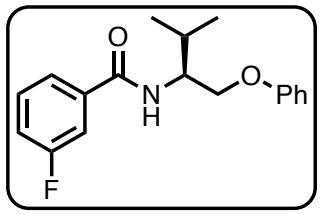
166.47
166.45
163.94
161.48
150.23
137.25
137.18
130.15
130.08
129.66
122.27
122.24
118.33
118.12
116.84
114.32
114.09
112.55
77.48
77.16
76.84
53.60
53.37
38.36
30.28
19.77
17.91





S5

$CDCl_3$, 400 MHz



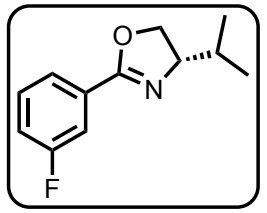
S5

$CDCl_3$, 101 MHz

166.14
166.12
164.14
161.67
158.77
137.18
137.11
130.43
130.35
129.71
122.48
122.45
121.36
118.71
118.50
114.65
114.60
114.43
77.48
77.16
76.84
67.82
54.73
29.66
19.75
19.46

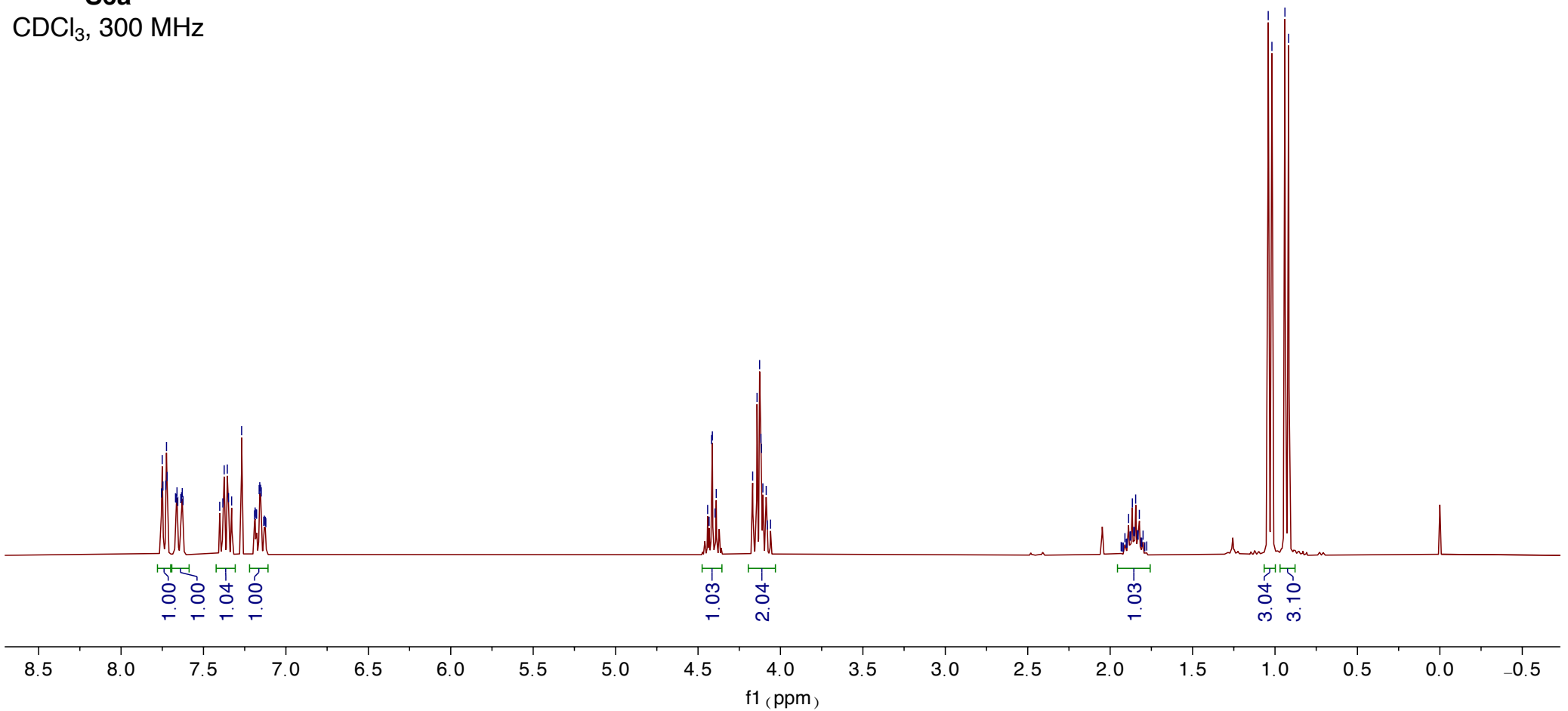
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

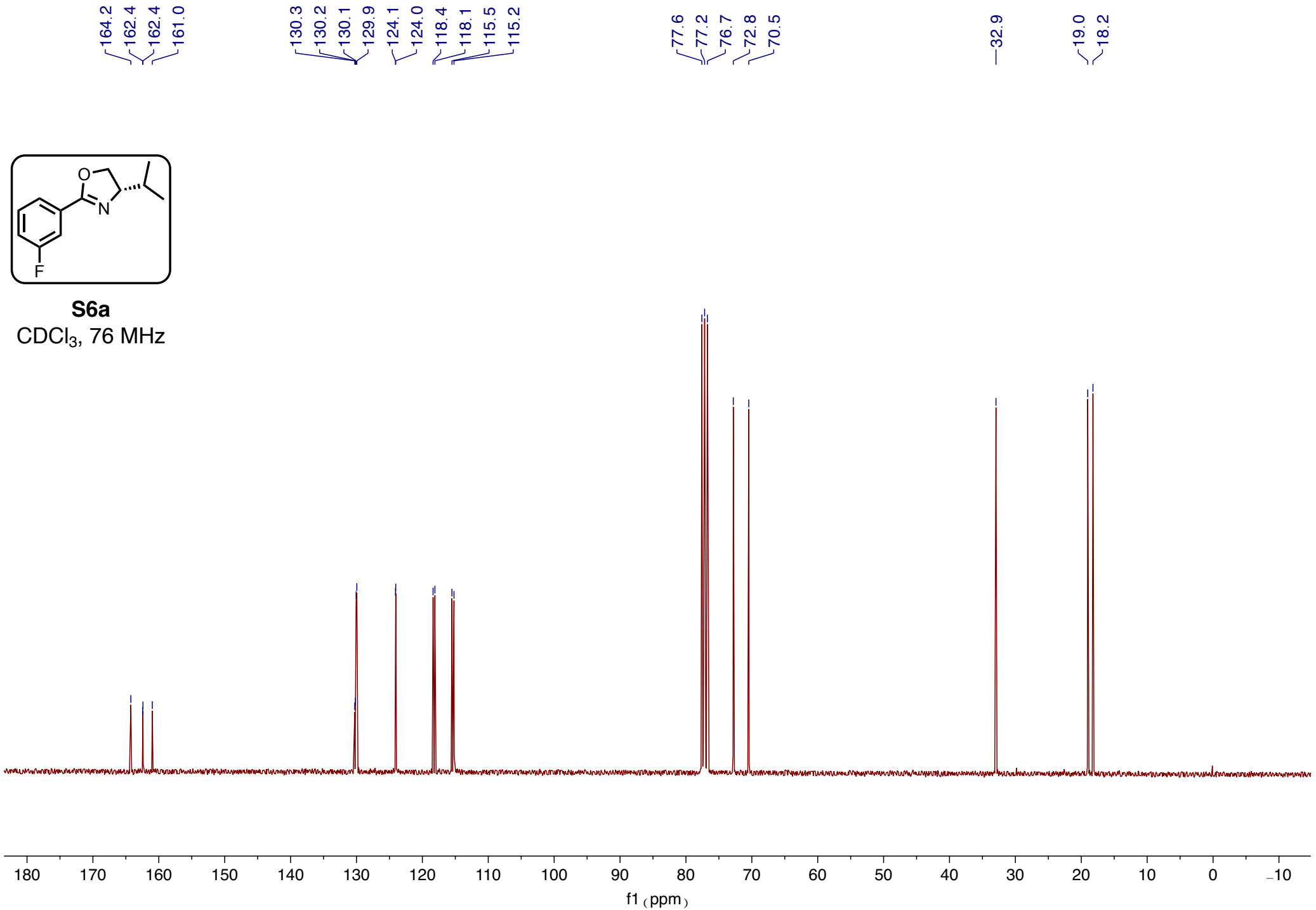
f1 (ppm)



S6a

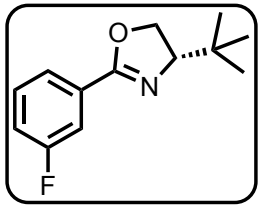
$CDCl_3$, 300 MHz





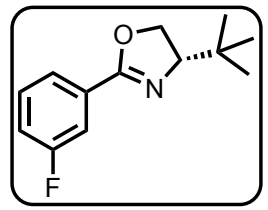
S6a

$CDCl_3$, 76 MHz



S6b

$CDCl_3$, 400 MHz



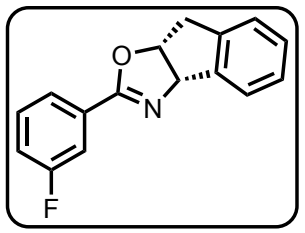
S6b

$CDCl_3$, 101 MHz

163.87
162.37
162.34
161.42
130.32
130.24
130.04
129.96
124.11
124.08
118.33
118.12
115.52
115.28
77.48
77.16
76.84
76.42
69.08
34.18
26.00

180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10

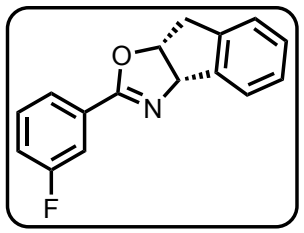
f1 (ppm)



S6c

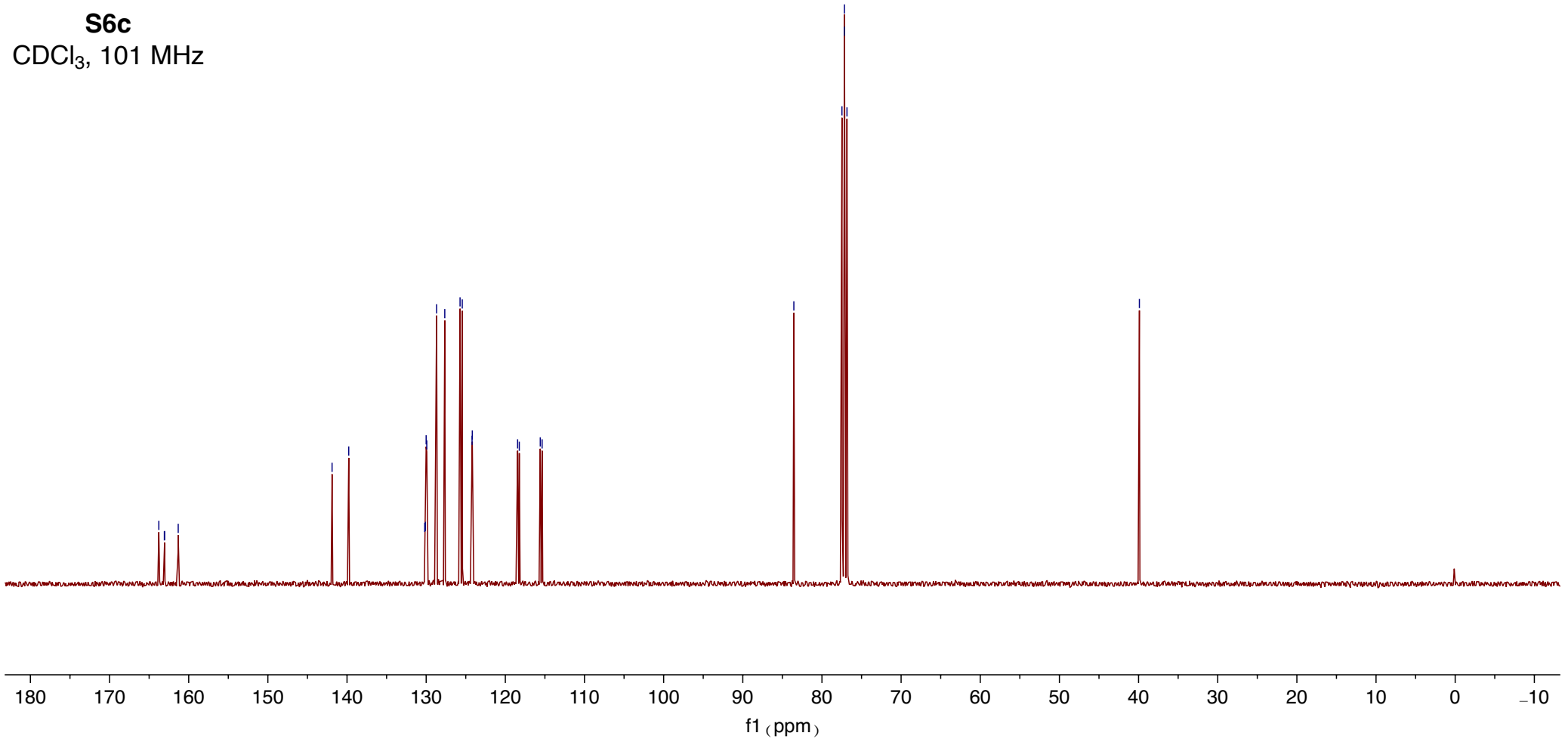
$CDCl_3$, 400 MHz

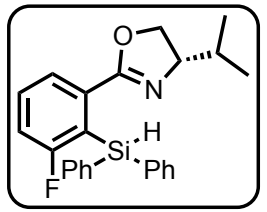
f1 (ppm)



S6c

$CDCl_3$, 101 MHz

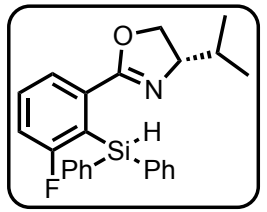




S7

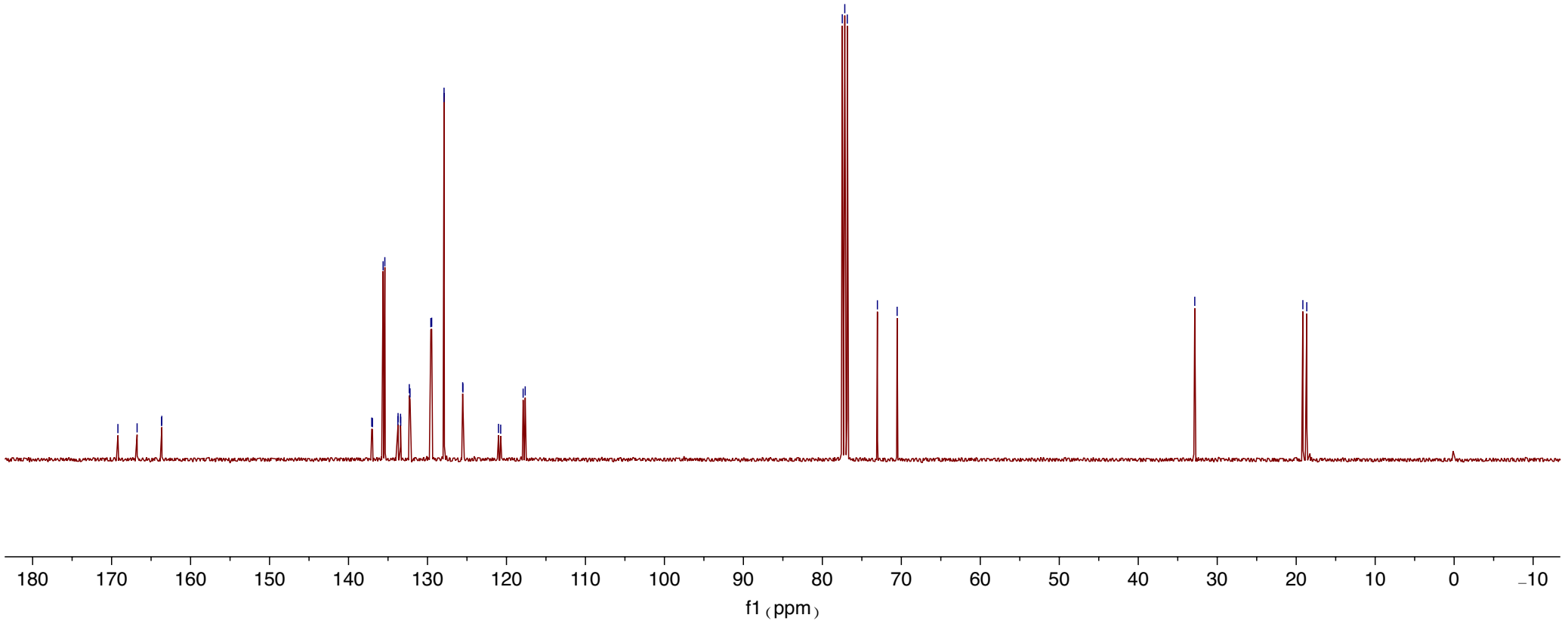
$CDCl_3$, 400 MHz

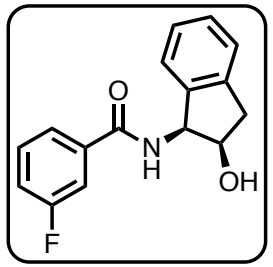
169.20
166.77
163.67
163.64
137.06
136.97
135.62
135.40
133.75
133.73
133.41
133.39
132.30
132.21
129.58
129.47
127.91
127.90
125.55
125.52
121.01
120.73
117.89
117.63
77.48
77.16
76.84
73.03
70.53
32.84
19.16
18.66



S7

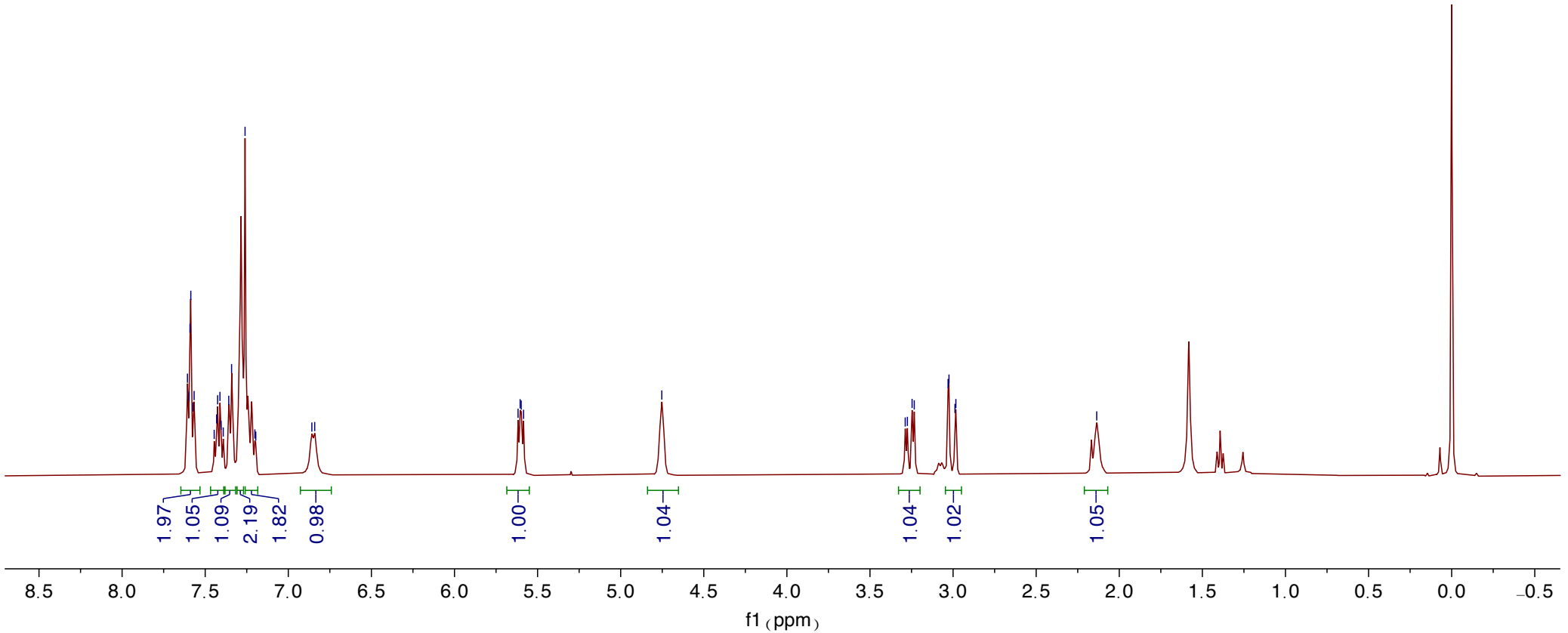
$CDCl_3$, 101 MHz

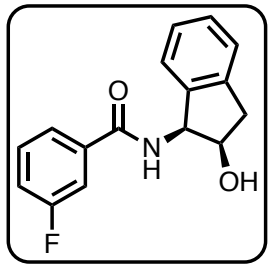




S9

$CDCl_3$, 400 MHz





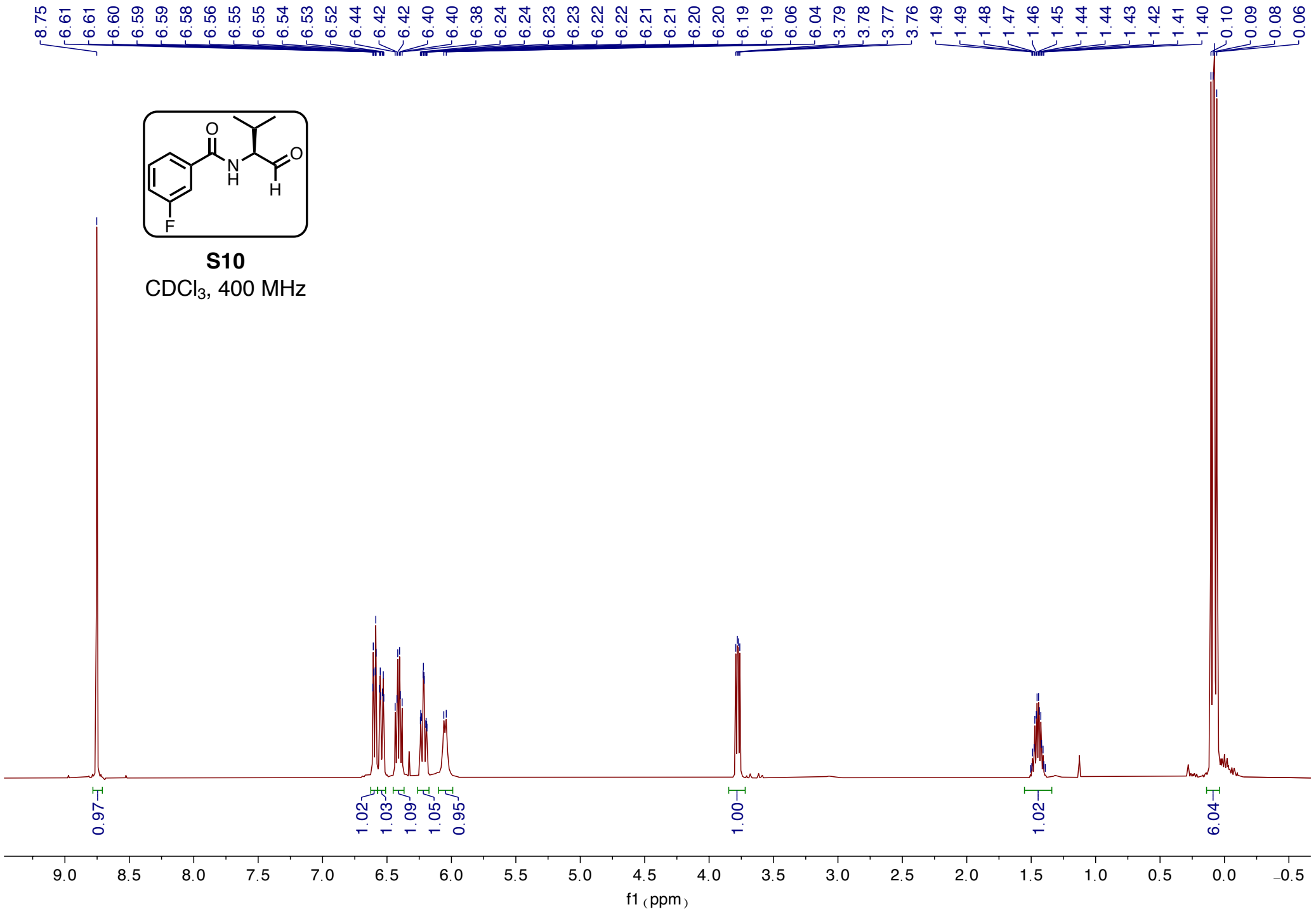
S9

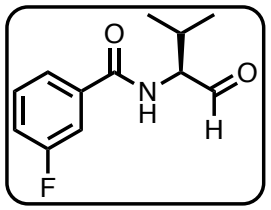
$CDCl_3$, 101 MHz

166.83
166.81
164.15
161.68
140.64
140.01
136.60
136.53
130.45
130.38
128.57
127.50
125.57
124.83
122.70
122.67
118.97
118.76
114.84
114.61
77.48
77.16
76.84
73.83
58.11
40.11

180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

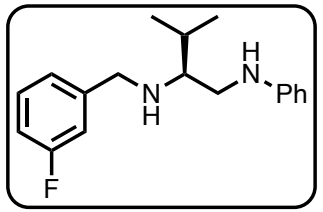
f1 (ppm)


8.75 6.61 6.61 6.60 6.59 6.59 6.58 6.56 6.55 6.55 6.54 6.53 6.52 6.44 6.42 6.42 6.40 6.40 6.38 6.24 6.24 6.23 6.23 6.22 6.22 6.21 6.21 6.20 6.20 6.19 6.19 6.06 6.04 3.79 3.78 3.77 3.76 1.49 1.49 1.48 1.47 1.46 1.45 1.44 1.44 1.43 1.42 1.41 1.40 0.10 0.09 0.08 0.06
O
N
H
O
H
F
S10
CDCl3, 400 MHz
0.97
1.02
1.03
1.09
1.05
0.95
1.00
1.02
6.04
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)



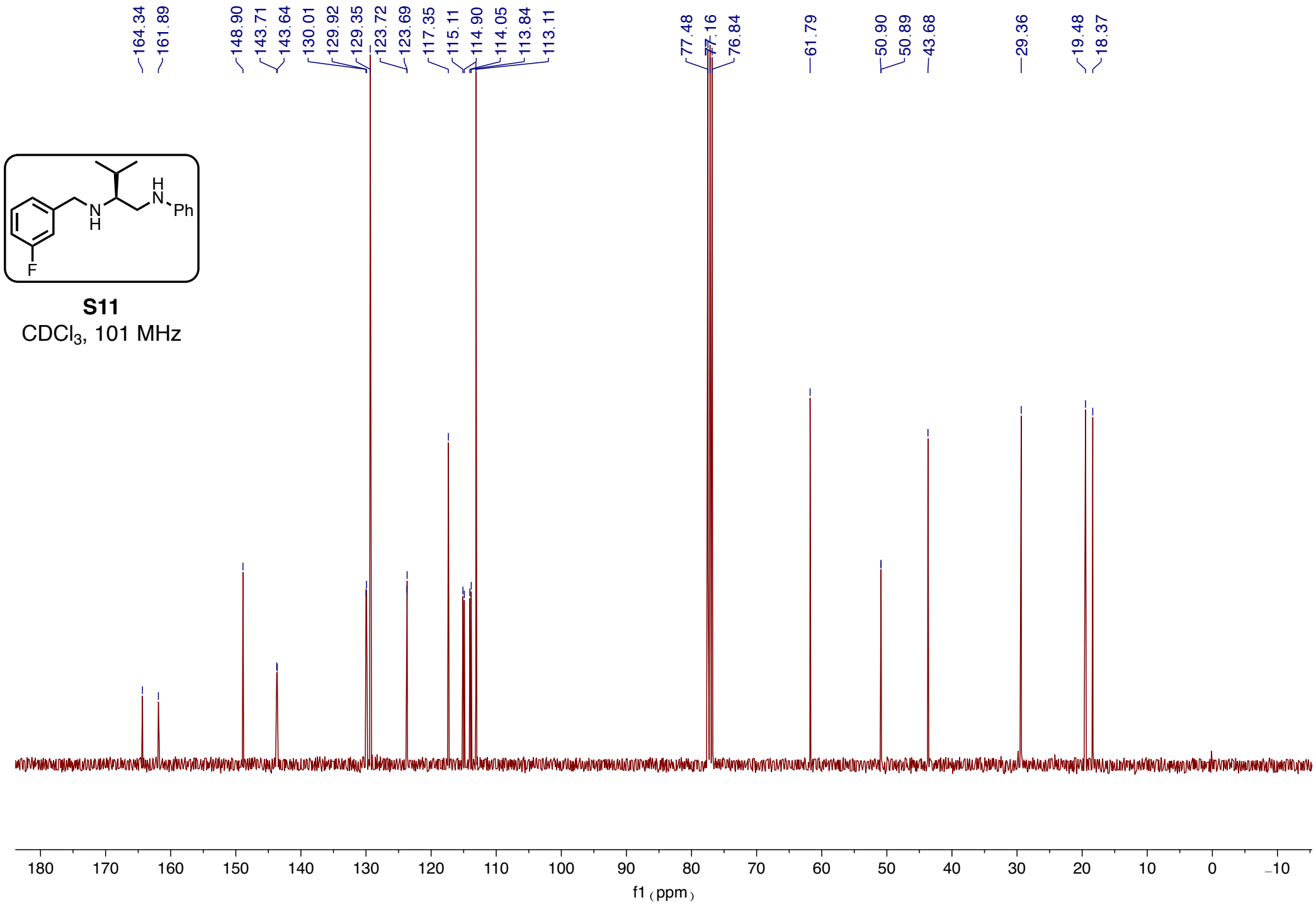
S10

$CDCl_3$, 101 MHz



S11

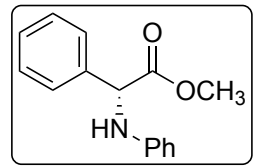
$CDCl_3$, 300 MHz



S11

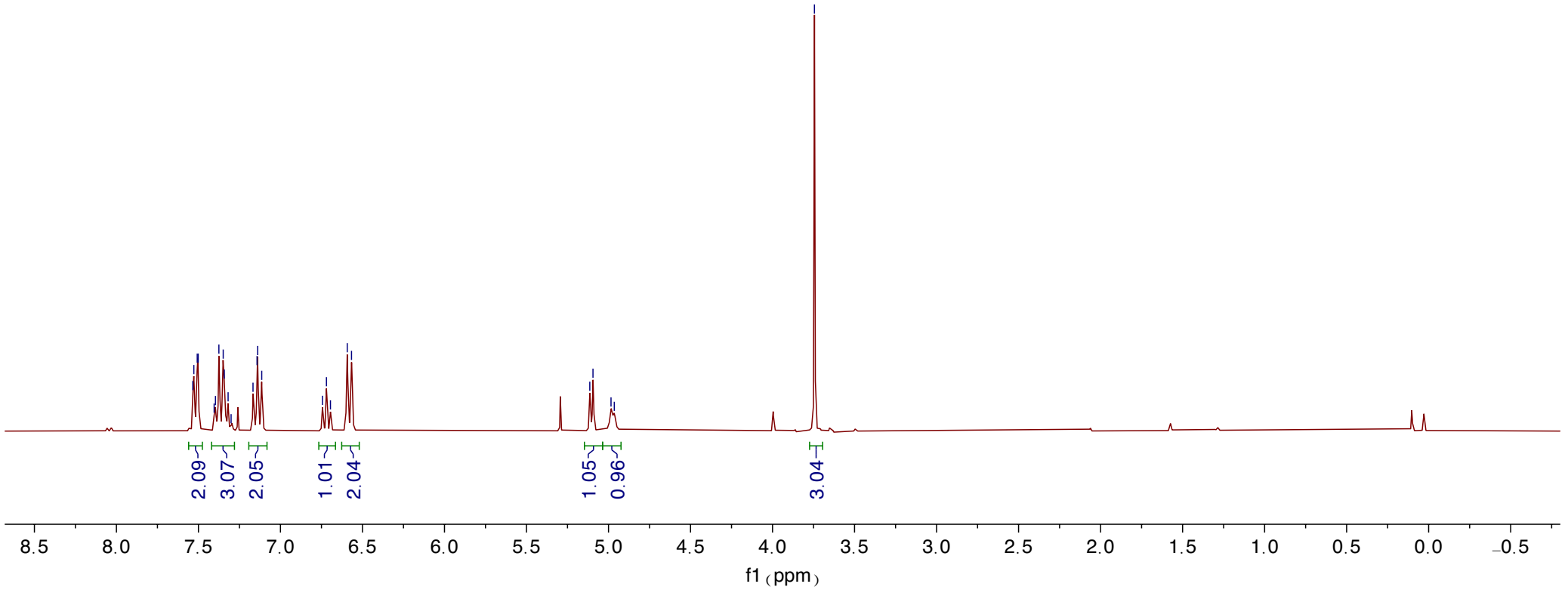
$CDCl_3$, 101 MHz

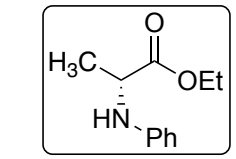
Copies of spectra – N–H insertion substrates (**7a**–**7z**)



7a

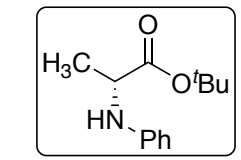
$CDCl_3$, 400 MHz





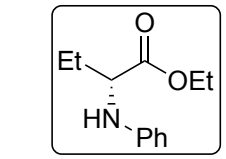
7b

$CDCl_3$, 400 MHz



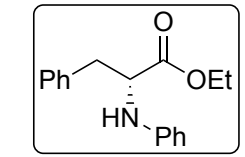
7c

$CDCl_3$, 400 MHz



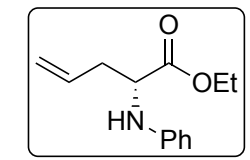
7d

$CDCl_3$, 400 MHz



7e

$CDCl_3$, 400 MHz



7f

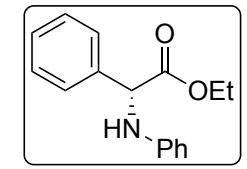
$CDCl_3$, 400 MHz

7.26 7.17 6.76 6.74 6.71 6.63 6.60 5.86 5.84 5.83 5.81 5.80 5.78 5.77 5.76 5.75 5.72 5.20 5.19 5.17 5.17 5.14 5.14 5.13 4.23 4.20 4.18 4.16 4.14 4.13 4.10 2.67 2.65 2.62 2.60 2.58 2.56 2.54 1.28 1.25 1.23

1.94 0.99 1.95 1.12 1.04 0.90 3.98 2.00 3.28

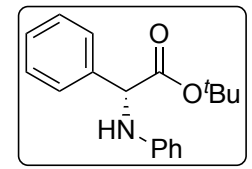
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

f1 (ppm)



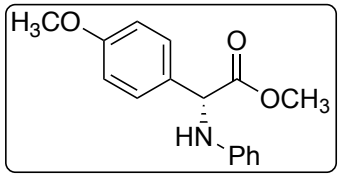
7g

$CDCl_3$, 400 MHz



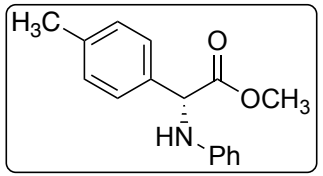
7h

$CDCl_3$, 400 MHz



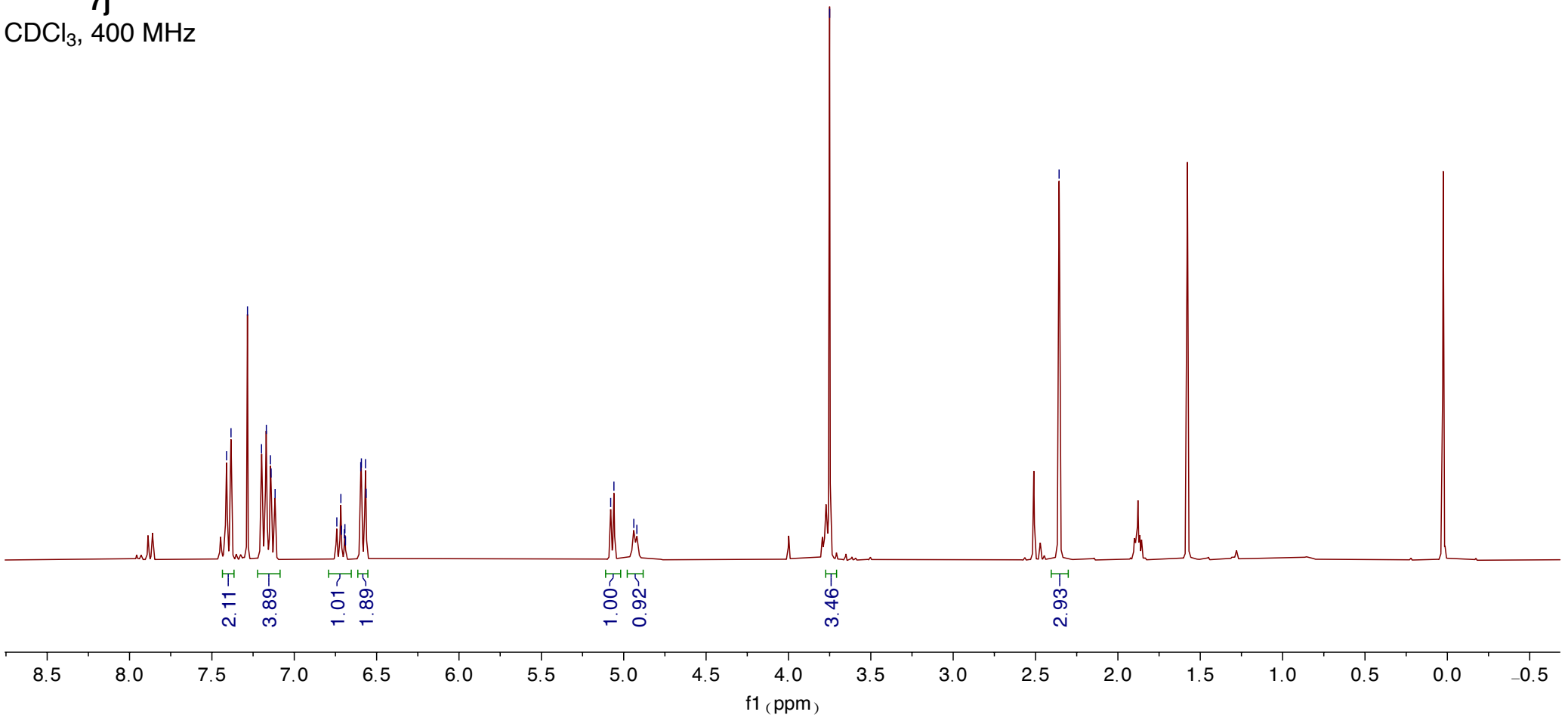
7i

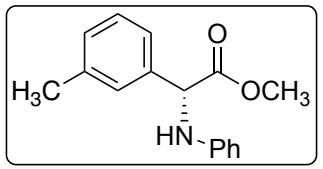
$CDCl_3$, 400 MHz



7j

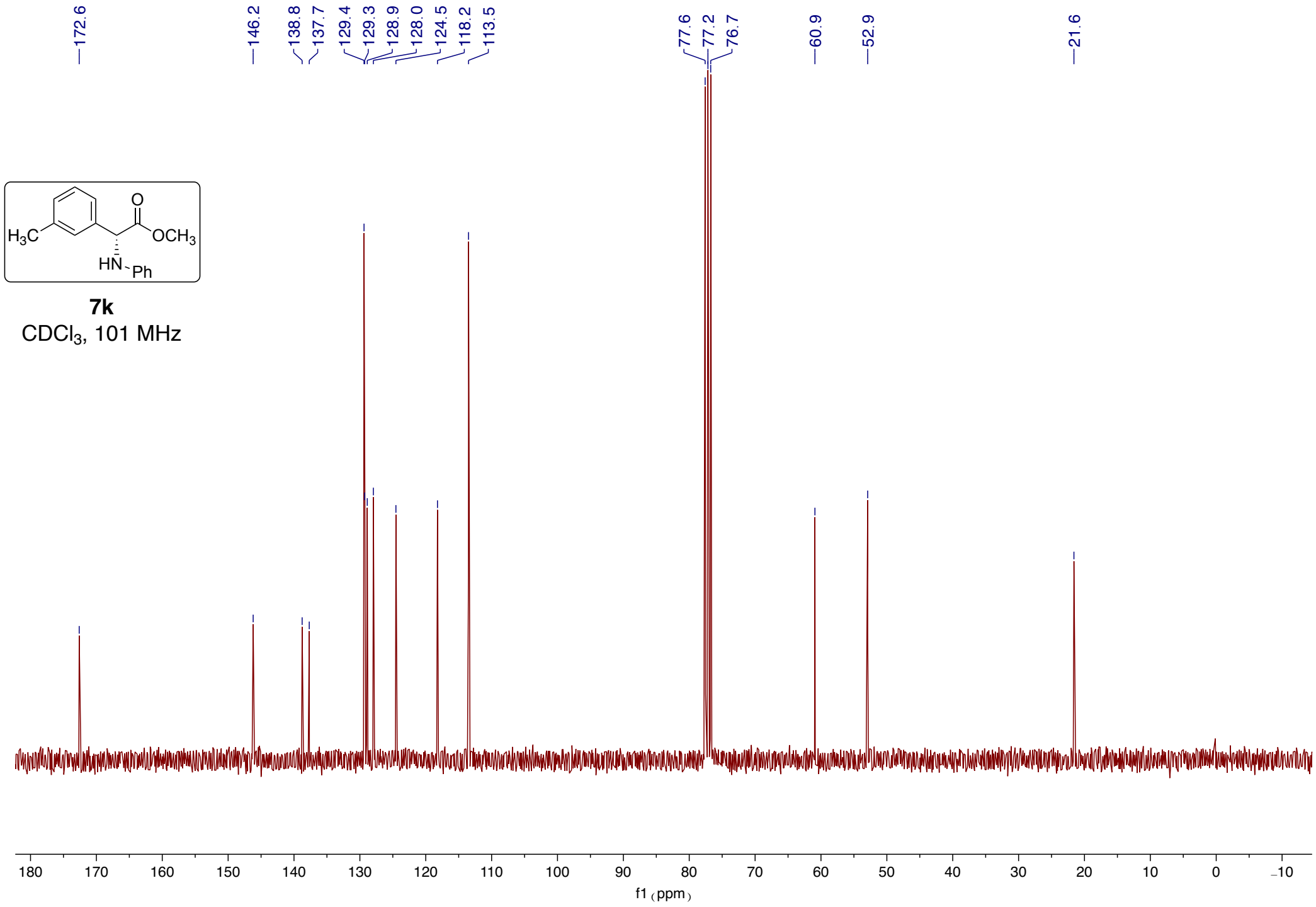
$CDCl_3$, 400 MHz

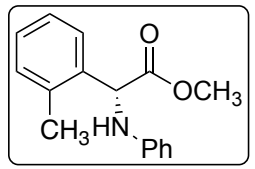




7k

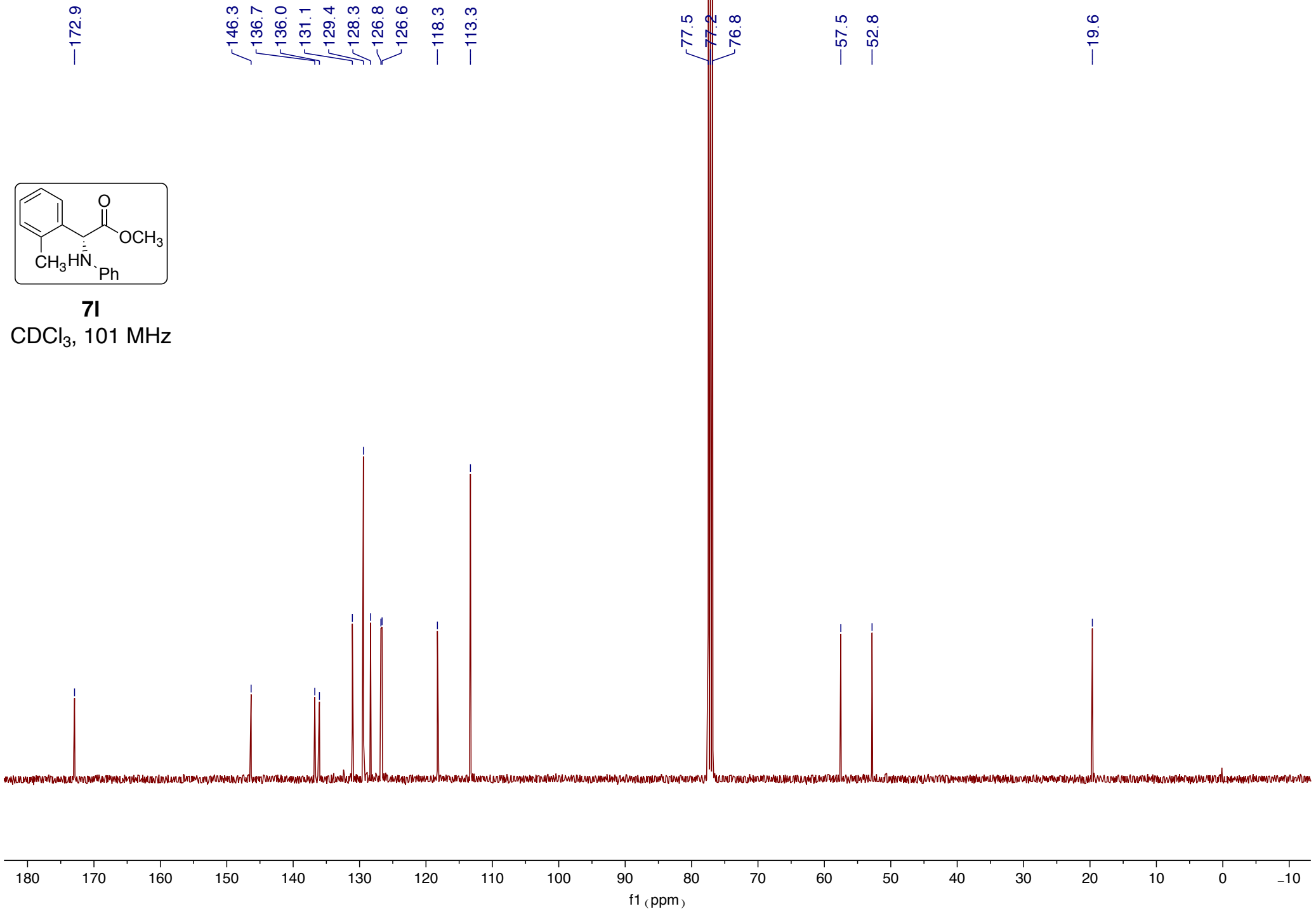
$CDCl_3$, 400 MHz


172.6
146.2
138.8
137.7
129.4
129.3
128.9
128.0
124.5
118.2
113.5
77.6
77.2
76.7
60.9
52.9
21.6
O
H3C
OCH3
HN
Ph
7k
CDCl3, 101 MHz
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



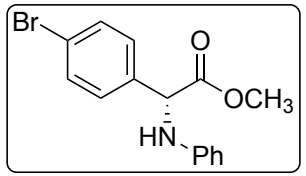
7l

$CDCl_3$, 400 MHz



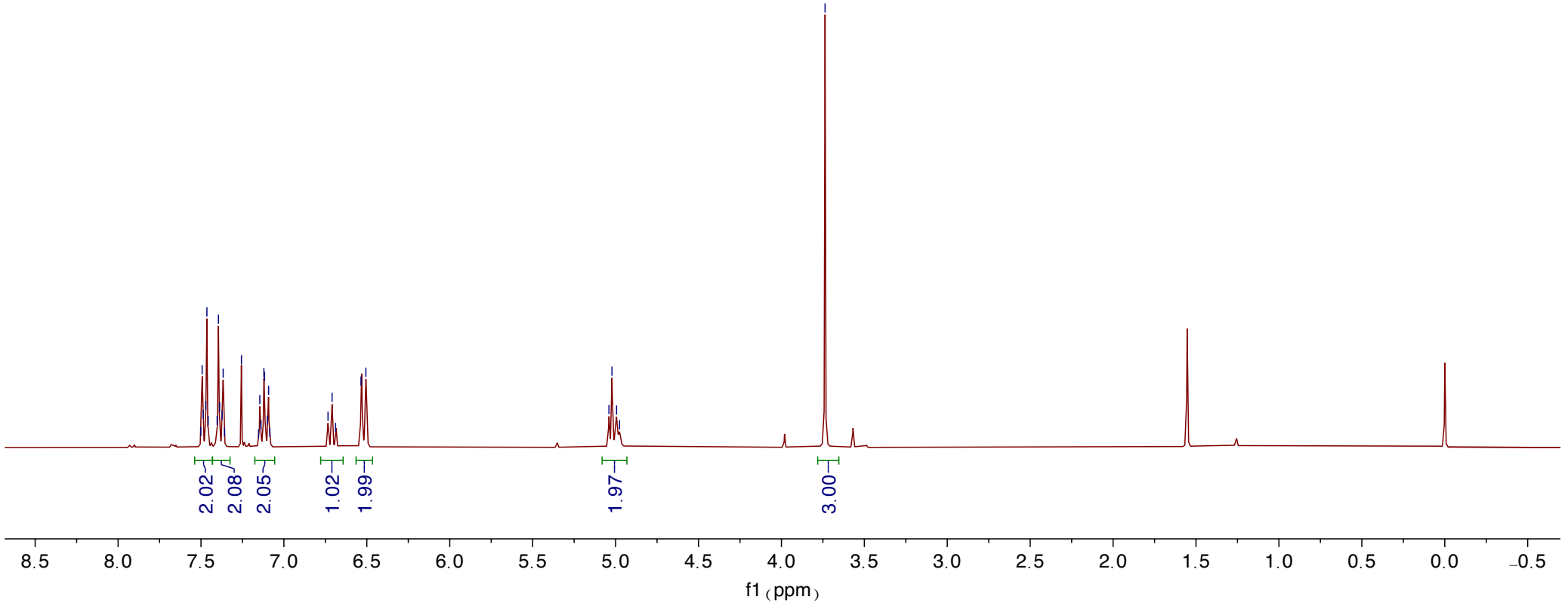
7l

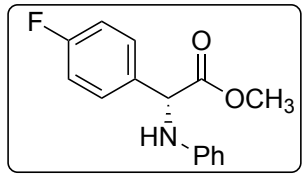
$CDCl_3$, 101 MHz



7m

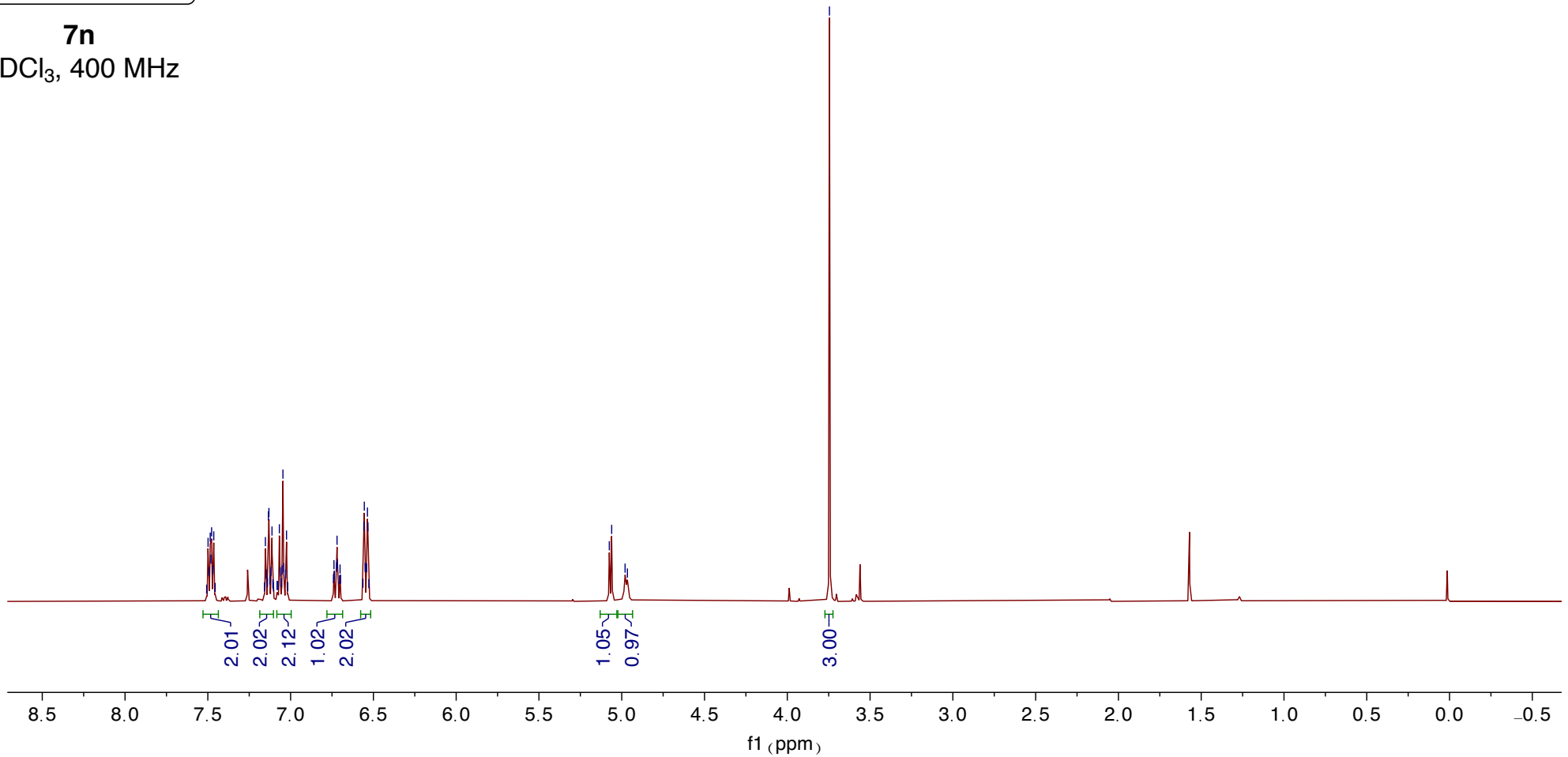
$CDCl_3$, 400 MHz

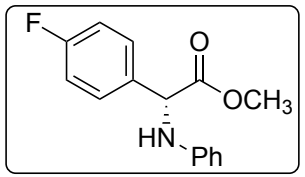




7n

$CDCl_3$, 400 MHz





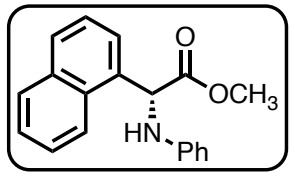
7n

$CDCl_3$, 101 MHz

172.2
164.0
161.5
145.8
133.5
133.5
129.4
129.1
129.0
118.4
116.1
115.8
113.6
77.5
77.2
76.8
60.1
53.0

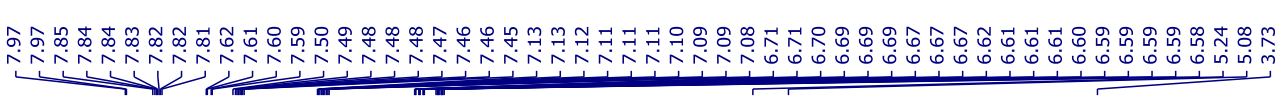
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10

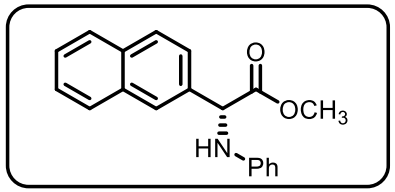
f1 (ppm)



7o

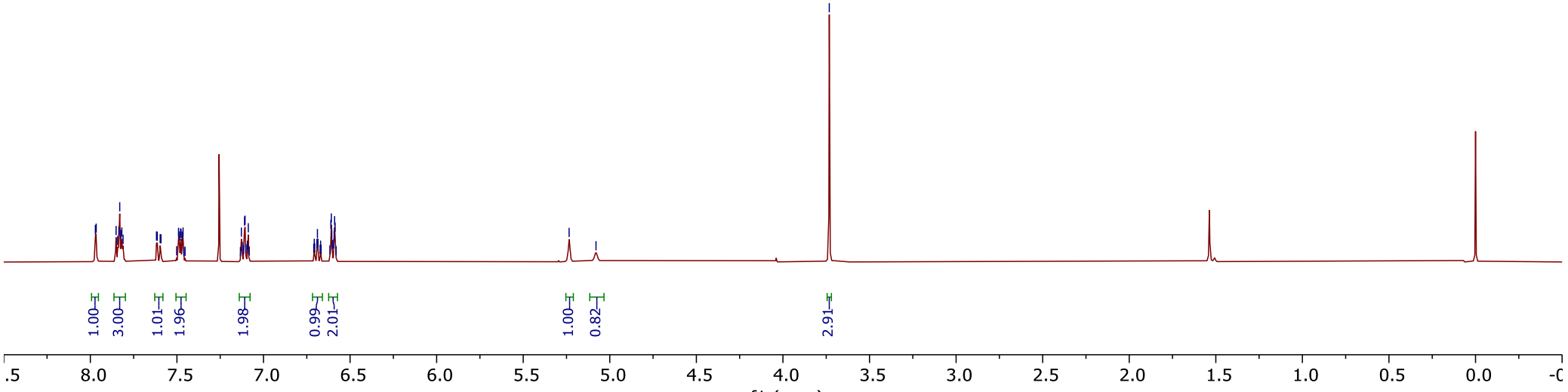
$CDCl_3$, 400 MHz

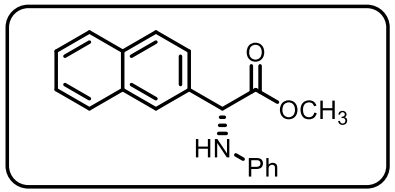




7p

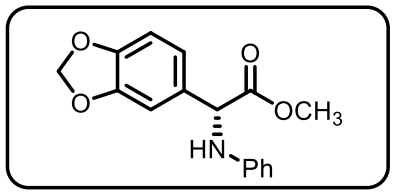
$CDCl_3$, 400 MHZ





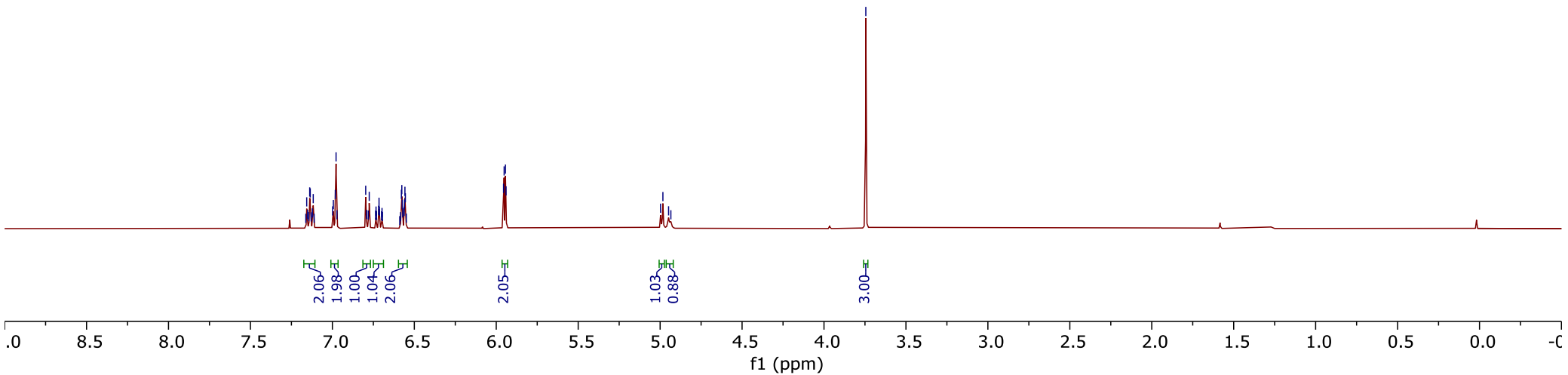
7p

$CDCl_3$, 101 MHZ

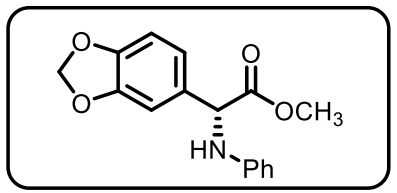


7q

$CDCl_3$, 400 MHZ

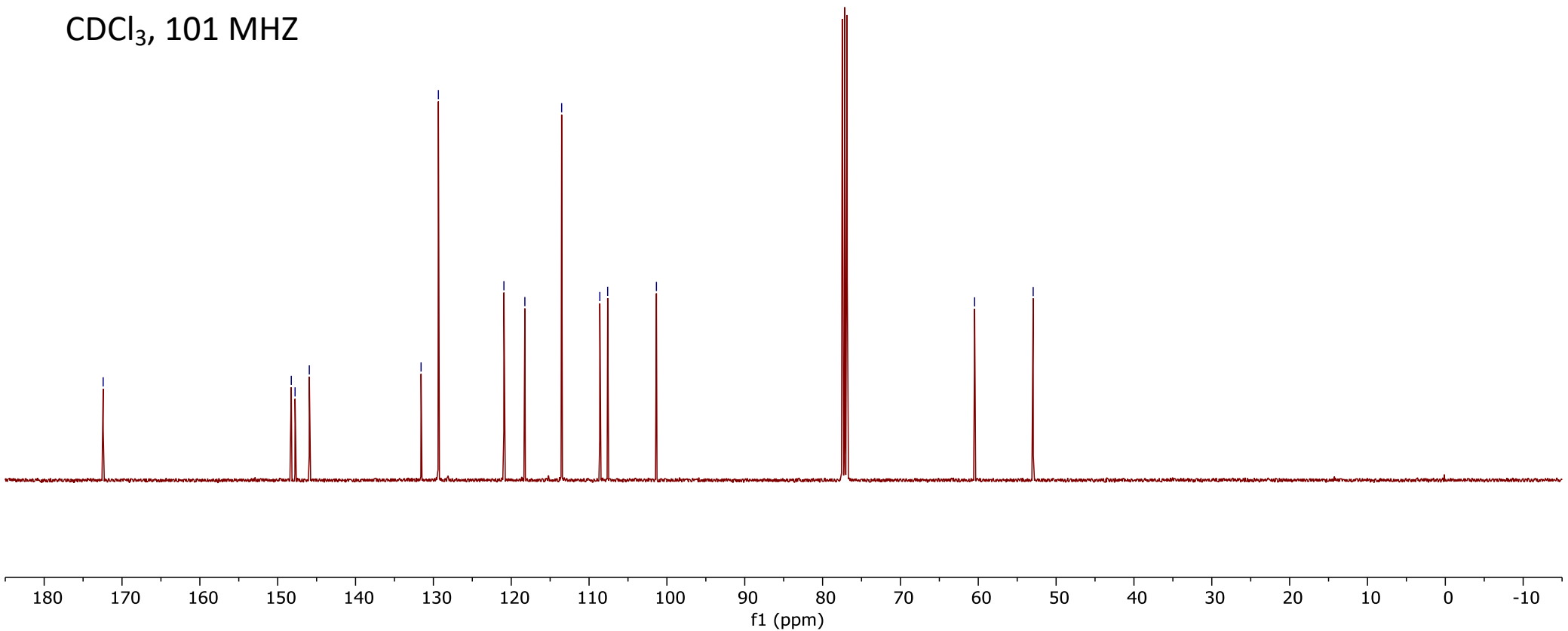


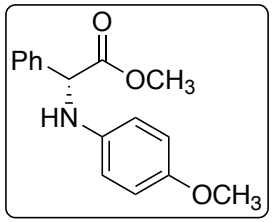
172.42
148.26
147.77
145.94
131.58
129.35
120.94
118.25
113.52
108.62
107.61
101.35
60.47
52.95



7q

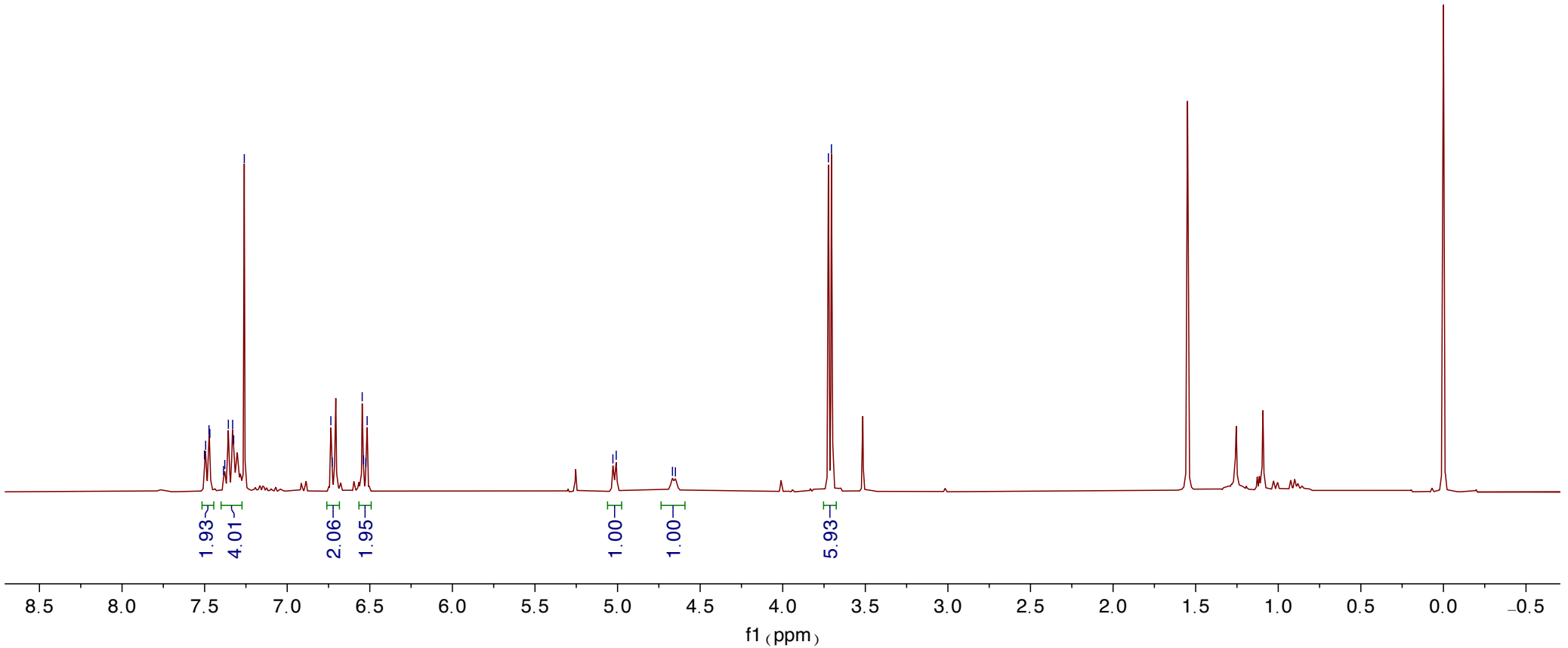
$CDCl_3$, 101 MHZ

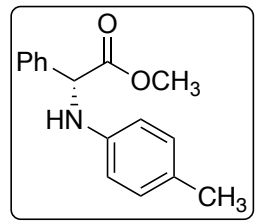




7r

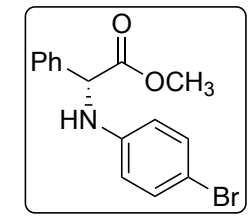
$CDCl_3$, 400 MHz





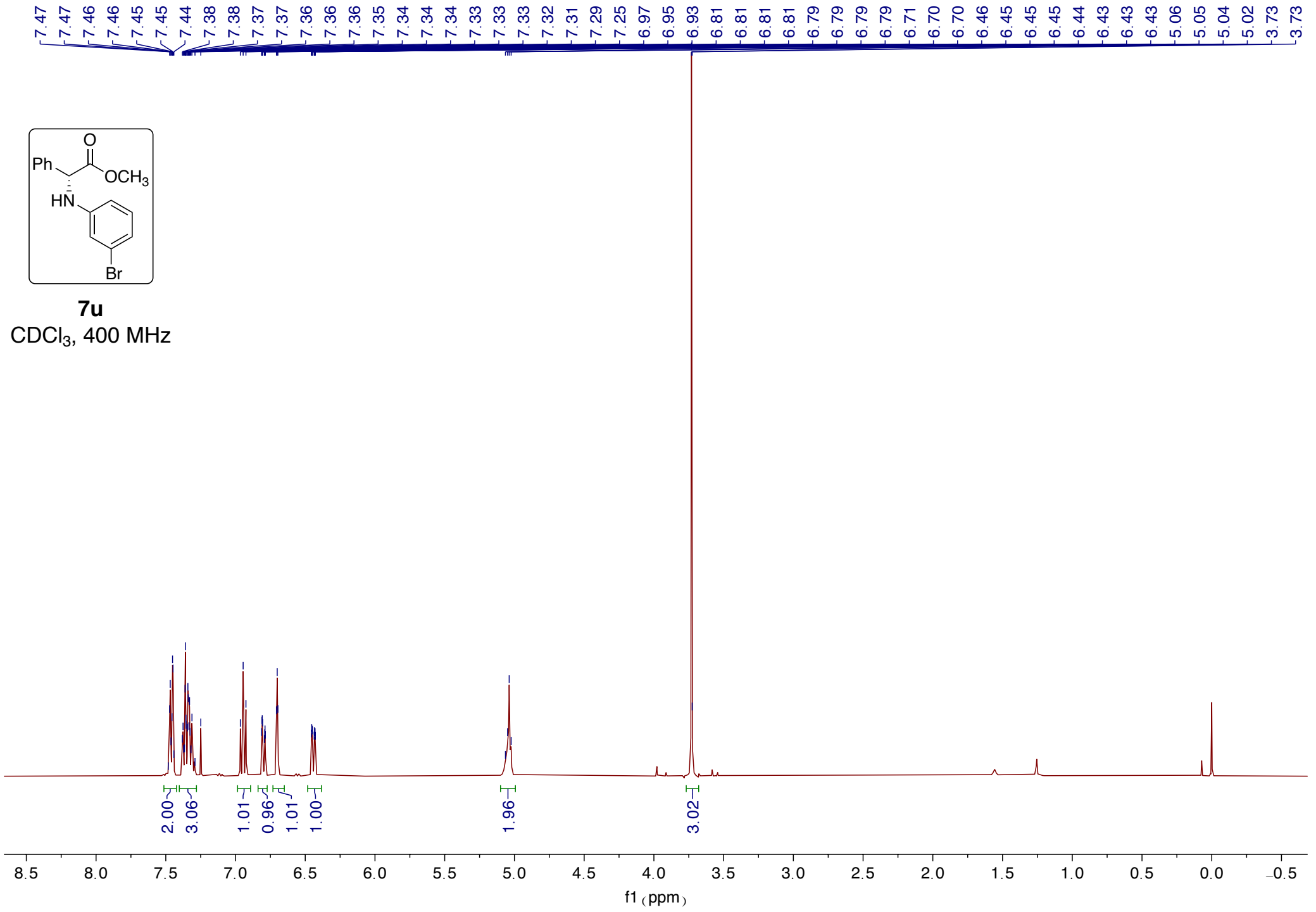
7s

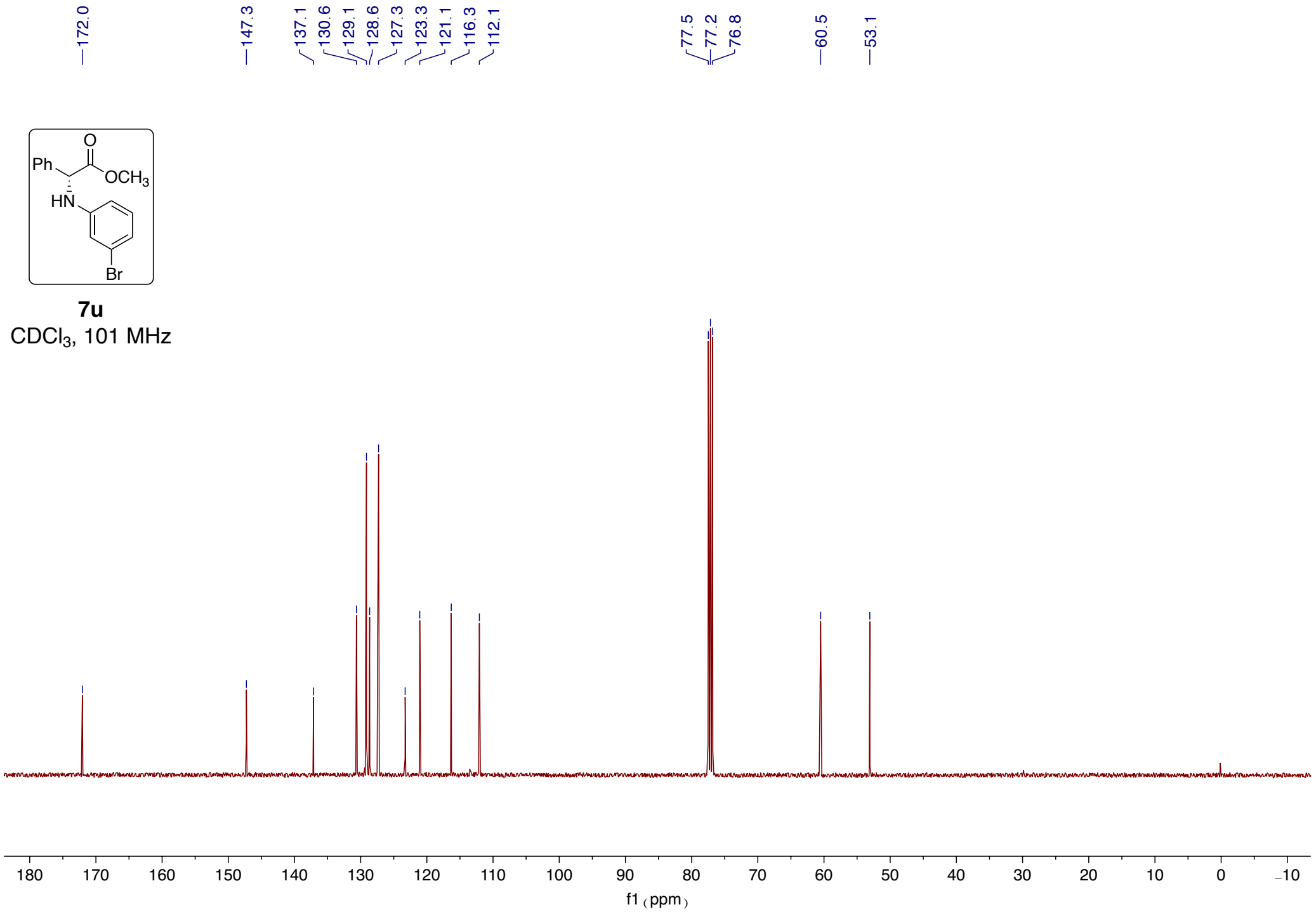
$CDCl_3$, 400 MHz

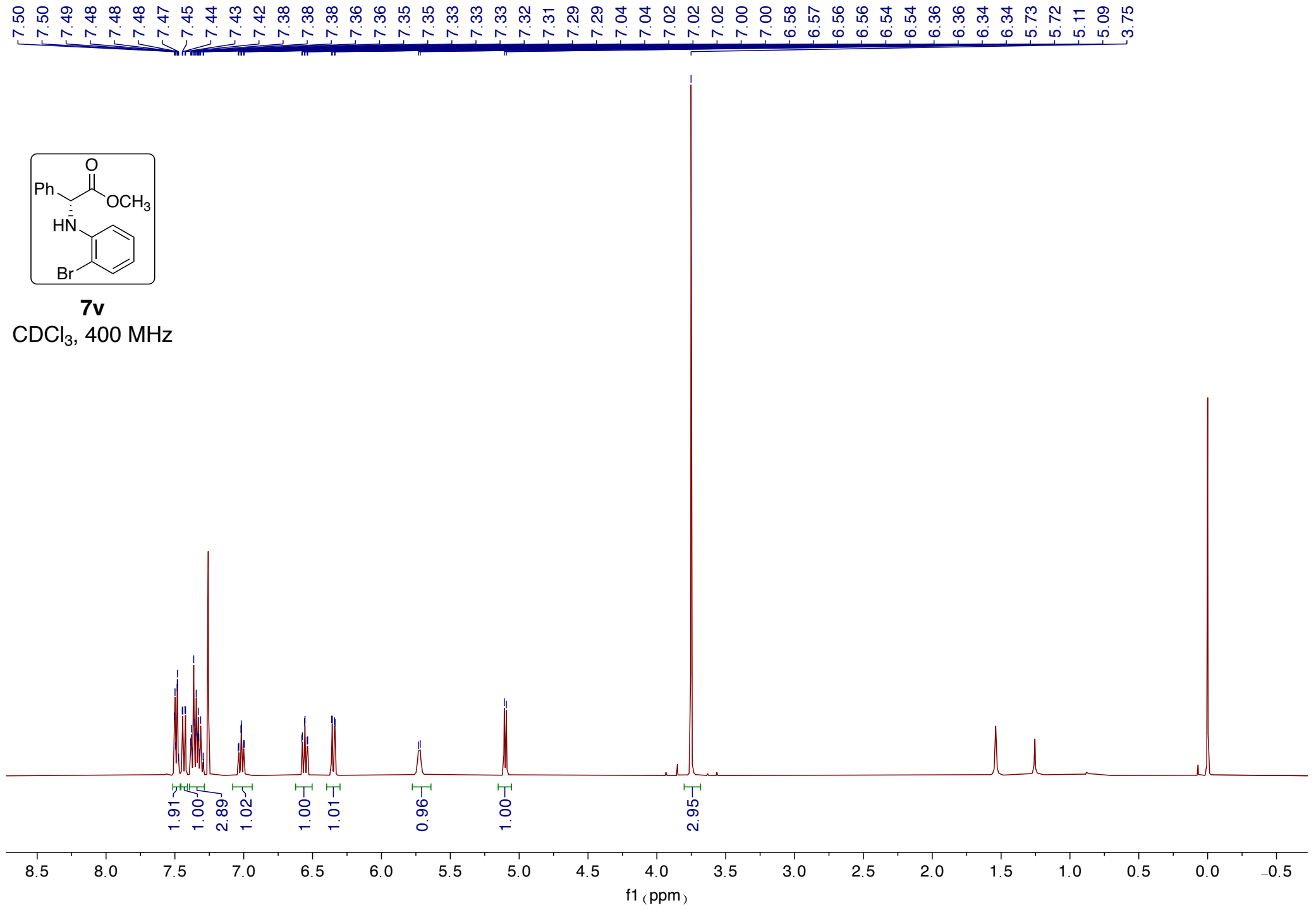


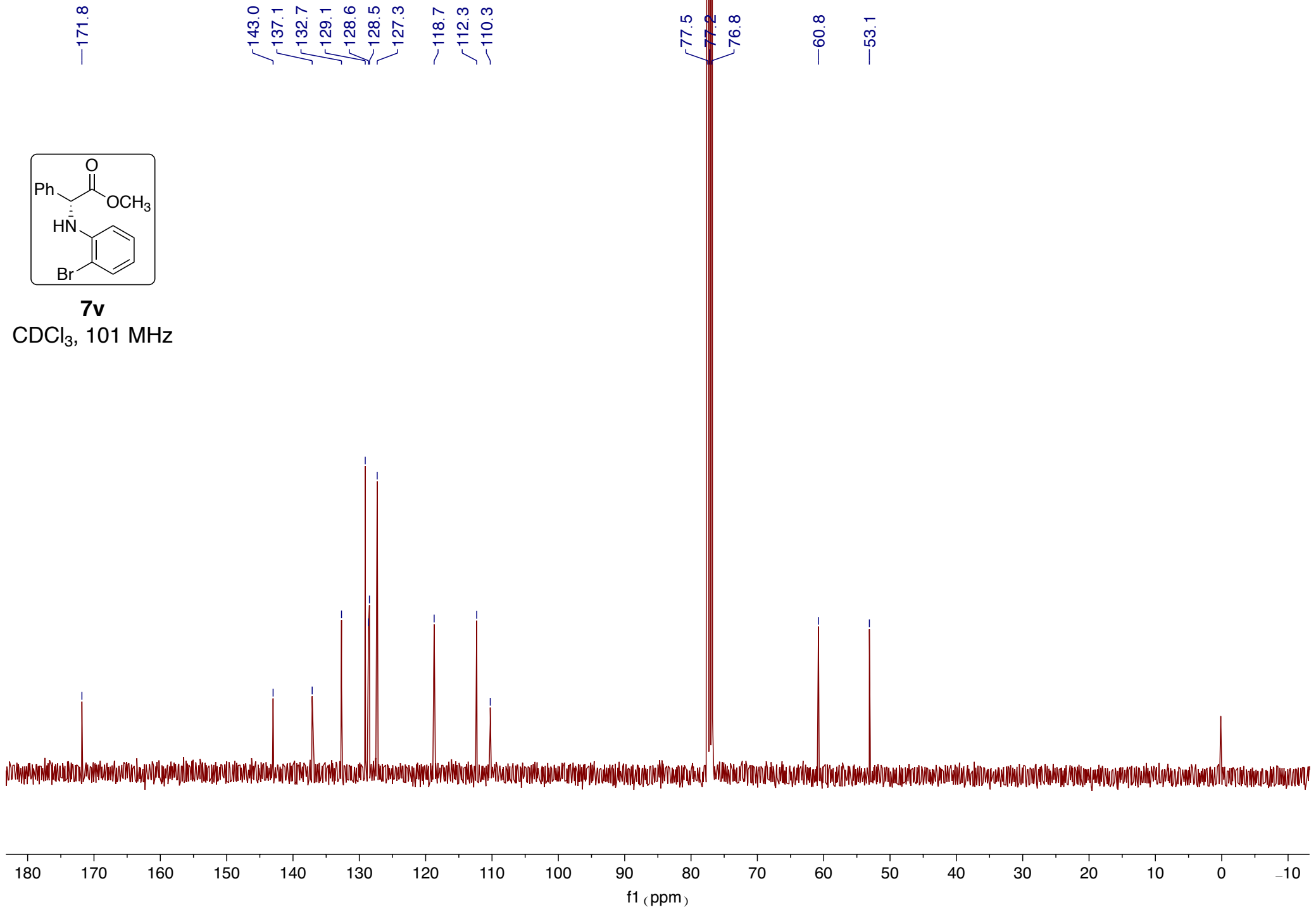
7t

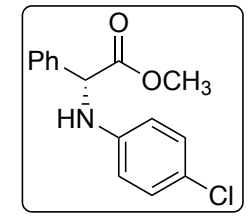
$CDCl_3$, 400 MHz


7.47 7.47 7.46 7.46 7.45 7.45 7.44 7.38 7.38 7.37 7.37 7.36 7.36 7.36 7.35 7.34 7.34 7.34 7.33 7.33 7.33 7.32 7.31 7.29 7.25 6.97 6.95 6.93 6.81 6.81 6.81 6.81 6.79 6.79 6.79 6.79 6.71 6.70 6.70 6.46 6.45 6.45 6.45 6.44 6.43 6.43 6.43 5.06 5.05 5.04 5.02 3.73 3.73
O
Ph
OCH3
HN
Br
7u
CDCl3, 400 MHz
2.00
3.06
1.01
0.96
1.01
1.00
1.96
3.02
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 −0.5
f1 (ppm)


172.0
147.3
137.1
130.6
129.1
128.6
127.3
123.3
121.1
116.3
112.1
77.5
77.2
76.8
60.5
53.1
O
Ph
OCH3
HN
Br
7u
CDCl3, 101 MHz
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)

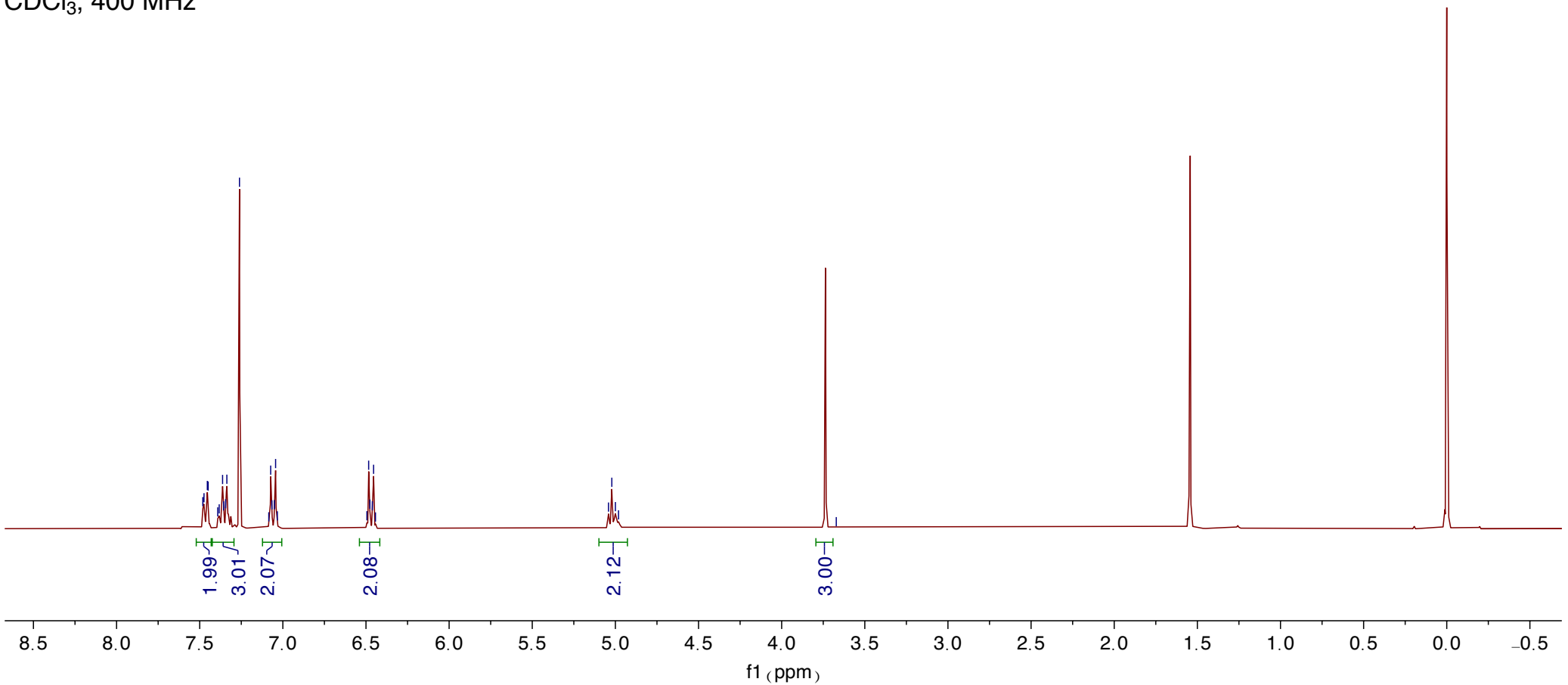

7.50 7.50 7.49 7.48 7.48 7.48 7.47 7.45 7.44 7.43 7.42 7.38 7.38 7.36 7.36 7.35 7.35 7.33 7.33 7.33 7.32 7.31 7.29 7.29 7.04 7.04 7.02 7.02 7.00 7.00 6.58 6.57 6.56 6.56 6.54 6.54 6.36 6.36 6.34 6.34 5.73 5.72 5.11 5.09 3.75
O
Ph
OCH3
HN
Br
7v
CDCl3, 400 MHz
1.91 1.00 2.89 1.02 1.00 1.01 0.96 1.00 2.95
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

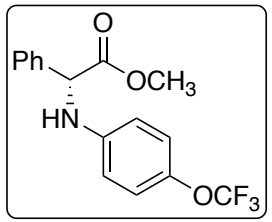

171.8
143.0
137.1
132.7
129.1
128.6
128.5
127.3
118.7
112.3
110.3
77.5
77.2
76.8
60.8
53.1
O
Ph
OCH3
HN
Br
7v
CDCl3, 101 MHz
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



7w

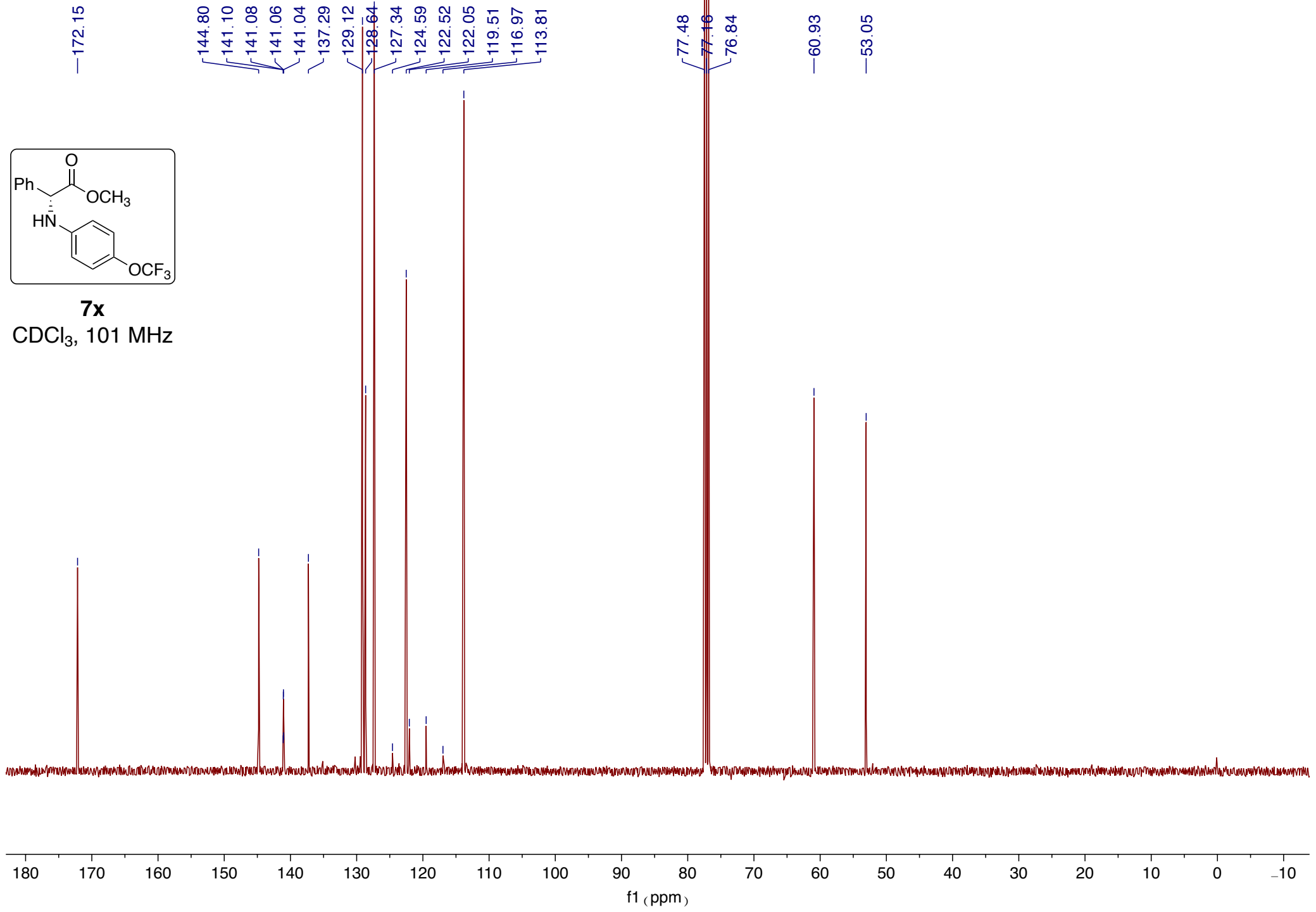
$CDCl_3$, 400 MHz

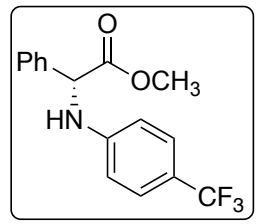




7x

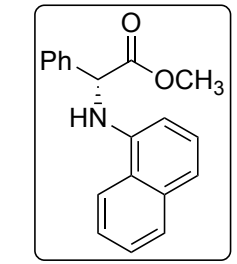
$CDCl_3$, 400 MHz


172.15
144.80
141.10
141.08
141.06
141.04
137.29
129.12
128.64
127.34
124.59
122.52
122.05
119.51
116.97
113.81
77.48
77.16
76.84
60.93
53.05
O
Ph
OCH3
HN
OCF3
7x
CDCl3, 101 MHz
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



7y

$CDCl_3$, 400 MHz



7z

$CDCl_3$, 400 MHz