Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.
This journal is © The Royal Society of Chemistry 2022

Supporting Information

Synthesis of 3-Substituted 2-Oxindoles from Secondary α-Bromo-Propionanilides via Palladium-Catalyzed Intramolecular Cyclization

Table of Contents

I. General experimental information S2
II. Optimization of the reaction conditions S3
III. General procedure for the synthesis of starting materials S9
IV General procedure for the synthesis of 3-substituted 2-oxindoles S9
V. Derivatization experiments S10
VI. Enantioselectivities as determined by chiral HPLC S11
VII. Characterization of compounds S13
VIII. NMR spectra S37
IX. Determination of kinetic isotope effects S199
X. References S213

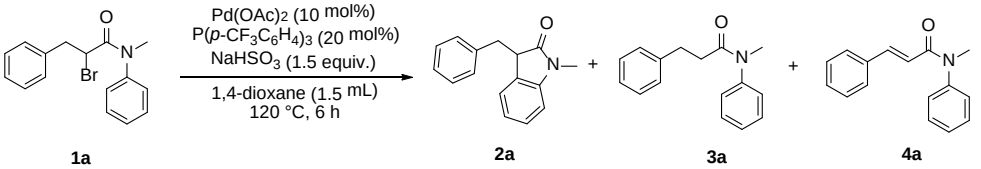
I. General experimental information

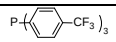
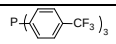
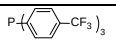
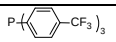
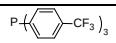
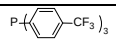
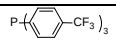
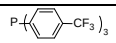
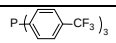
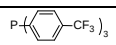
Solvents and chemicals: All air-sensitive procedures were conducted in an argon-filled glovebox or by Schlenk techniques under argon. Anhydrous THF were distilled freshly before use over sodium and benzophenone. Dichloromethane (DCM) were distilled from CaH_2. Other solvents used in this work were obtained from commercial sources and were used without further purification, such as hexane (Fisher, ACS grade), ethyl acetate (EtOAc) (Fisher, ACS grade) and so on. Most of the reagents used in this work were purchased from Sigma-Aldrich and Alfa Aesar Chemical companies and were used without further purification unless otherwise specified.

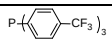
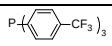
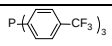
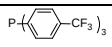
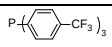
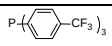
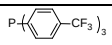
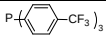
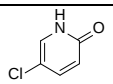
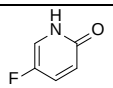
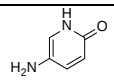
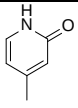
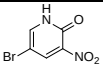
Spectroscopies (NMR, HRMS, HPLC): Nuclear magnetic resonance (^{1}H, ^{13}C, and ^{19}FNMR) spectra were recorded with a Bruker-BioSpin AVANCE III HD NMR spectrometer (400 MHz, 101 MHz and 376 MHz respectively). Chemical shifts are reported parts per million (ppm) referenced to $CDCl_3$ (δ 7.26 ppm), tetramethylsilane (TMS, δ 0.00 ppm) for ^{1}H NMR; $CDCl_3$ (δ 77.16 ppm) for ^{13}C NMR. Spectra data were reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublet, td = triplet of doublet and m = multiplet), coupling (*J*) constant and integration. To distinguish, some ^{13}C NMR chemical shifts retain two decimal places. High-resolution mass spectra (HRMS) were obtained on an Impact II UHR-TOF mass spectrometry equipped with an ESI or APCI source from Bruker at FuJian Institute of Research on the Structure of Matter. Protonated molecular ions $(M + H)^+$ or sodium adducts $(M + Na)^+$ were used for empirical formula confirm. Enantiomeric excess was determined by HPLC analysis on Chiralpak AD-H column (Daicel Chemical Industries, LTD) on Shimadzu LC-20AD.

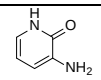
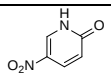
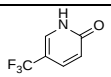
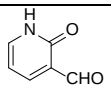
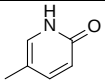
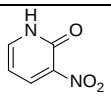
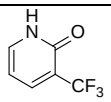
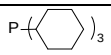
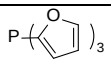
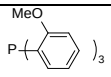
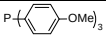
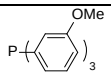
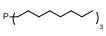
II. Optimization of the reaction conditions

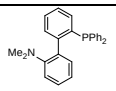
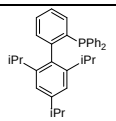
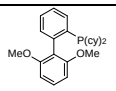
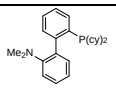
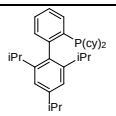
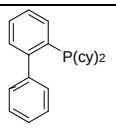
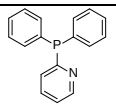
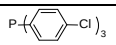
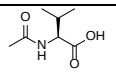
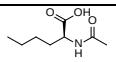
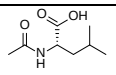
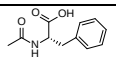
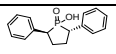
Table S1. Optimization of the reaction conditions[a]

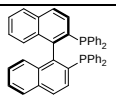
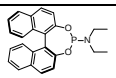
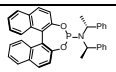
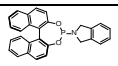
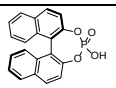
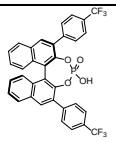
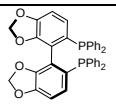
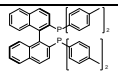
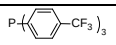
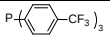
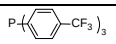
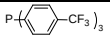
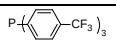


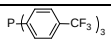
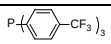
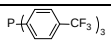
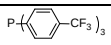
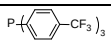
Entry	Catalyst (mol%)	L	Base (equiv.)	Solvent (1.5 mL)	Time/ h	Temp./°C	Yield[b] **2a** (%)	Yield[b] **3a** (%)	Yield[b] **4a** (%)
1	$Pd(OAc)_2$ 10%		Cs_2CO_3 (1.5)	1,4-dioxane	6	120	29	10	22
2	$Pd(OAc)_2$ 10%		Li_2CO_3 (1.5)	1,4-dioxane	6	120	14	0	9
3	$Pd(OAc)_2$ 10%		NaH_2PO_4 (1.5)	1,4-dioxane	6	120	12	0	5
4	$Pd(OAc)_2$ 10%		Na_2HPO_4 (1.5)	1,4-dioxane	6	120	18	trace	7
5	$Pd(OAc)_2$ 10%		CsOAc (1.5)	1,4-dioxane	6	120	22	8	27
6	$Pd(OAc)_2$ 10%		CH_3OLi (1.5)	1,4-dioxane	6	120	10	8	38
7	$Pd(OAc)_2$ 10%		^{t}BuOLi (1.5)	1,4-dioxane	6	120	0	trace	87
8	$Pd(OAc)_2$ 10%		^{t}BuONa (1.5)	1,4-dioxane	6	120	trace	16	42
9	$Pd(OAc)_2$ 10%		CF_3COOK (1.5)	1,4-dioxane	6	120	40	trace	13
10	$Pd(OAc)_2$ 10%		CsF (1.5)	1,4-dioxane	6	120	42	8	24

11	$Pd(OAc)_2$ 10%		K_2HPO_4 (1.5)	1,4-dioxane	6	120	63	4	8
12	$Pd(OAc)_2$ 10%		K_3PO_4 (1.5)	1,4-dioxane	6	120	65	7	16
13	$Pd(OAc)_2$ 10%		$NaHCO_3$ (1.5)	1,4-dioxane	6	120	75	6	8
14	$Pd(OAc)_2$ 10%		HCOOK (1.5)	1,4-dioxane	6	120	67	20	10
15	$Pd(OAc)_2$ 10%		K_2CO_3 (1.5)	1,4-dioxane	6	120	58	4	11
16	$Pd(OAc)_2$ 10%		Et_3N (1.5)	1,4-dioxane	6	120	70	10	12
17	$Pd(OAc)_2$ 10%		$KHSO_3$ (1.5)	1,4-dioxane	6	120	84	6	7
18	**$Pd(OAc)_2$ 10%**		**$NaHSO_3$ (1.5)**	**1,4-dioxane**	**6**	**120**	**95**	**0**	**0**
19	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	10	13	14
20	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	10	5	9
21	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	18	25	14
22	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	16	13	17
23	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	18	11	11
24	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	10	3	21

25	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	18	15	15
26	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	10	6	8
27	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	24	21	23
28	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	trace	2	trace
29	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	16	6	10
30	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	20	17	15
31	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	18	11	20
32	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	trace	trace	13
33	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	34	58	8
34	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	18	6	11
35	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	24	5	9
36	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	28	25	11
37	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	6	trace	17

38	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	12	12	9
39	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	30	29	16
40	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	34	7	7
41	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	36	17	20
42	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	36	32	16
43	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	46	29	16
44	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	38	12	24
45	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	79	10	9
46	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	18	13	15
47	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	24	14	16
48	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	40	16	19
49	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	8	6	8
50	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	11	0	0

51	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	14	trace	5
52	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	45	7	30
53	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	18	4	15
54	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	14	4	19
55	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	22	3	5
56	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	19	10	trace
57	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	42	0	0
58	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	44	2	4
59	$Pd(TFA)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	80	4	6
60	$Pd(dba)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	20	0	0
61	$Pd(PPh_3)_4$ (10%)		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	25	0	0
62	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	toluene	6	120	68	0	5
63	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	HFIP	6	120	34	18	14

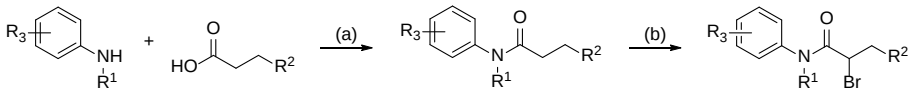
64	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	CH_3CN	6	120	22	48	29
65	$Pd(OAc)_2$ 7.5%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	83	0	0
66	$Pd(OAc)_2$ 5.0%		$NaHSO_3$ (1.5)	1,4-dioxane	6	120	69	0	0
67	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	4	120	82	0	0
68	$Pd(OAc)_2$ 10%		$NaHSO_3$ (1.5)	1,4-dioxane	6	100	75	0	0

[a] Unless otherwise noted, reactions were carried out by using **1a** (0.1 mmol), Pd-catalyst (0.01mmol, 10 mol %), ligand (0.02 mmol, 20 mol %) and base (0.15 mmol, 1.5 equiv.) in 1,4-dioxane (1.5 mL) at 120 °C under argon atmosphere for 6 hours. [b] Yields were determined by ^{1}H-NMR spectroscopic analysis of crude mixtures using 1,3,5-trimethoxybenzene (16.8 mg, 0.1 mmol) as internal standard.

III. General procedure for the synthesis of starting materials

Starting materials **1a-1h'** were prepared according to the **procedure A**. The starting material **1l'** was prepared according to a reported procedure.[1]

procedure A:

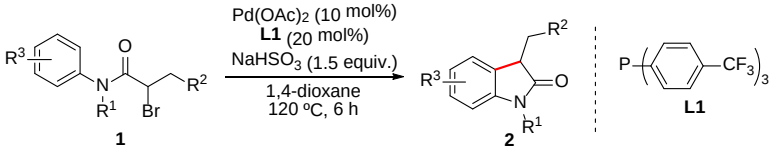


(a) In a dry and Ar-filled round bottom flask, acid (4.6 mmol, 1.0 equiv.) and DMAP (0.23 mmol, 0.05 equiv.) was dissolved in dry DCM (0.2 M), then aniline (4.6 mmol, 1.0 equiv.) and DIC (4.8 mmol, 1.1 equiv.) were added at room temperature. After completion (monitored by TLC), filtered, condense filtrate under reduced pressure, the crude product was purified by silica gel column chromatography (PE/EtOAc = 15:1) to afford amide.

(b) To a solution of amide (3.77 mmol, 1.0 equiv.) in THF (0.2 M), LiHMDS (1 M in THF, 4.9 mmol, 1.3 equiv.) was added dropwise at -78 ℃. After 30 minutes, NBS (4.9 mmol, 1.3 equiv.) was added carefully. Then the reaction mixture was stirred at -78 ℃. After completion (monitored by TLC), the reaction mixture was extracted with ethyl acetate (50 mL × 3). The combined ethyl acetate extract was dried over anhydrous Na_2SO_4 and filtrated. After the solvent was concentrated under reduced pressure, the crude product was purified by silica gel column chromatography (PE/EtOAc = 15:1) to afford the starting material.

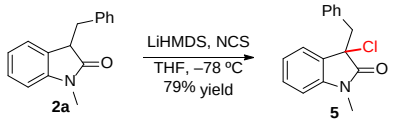
IV. General procedure for the synthesis of 3-substituted 2-oxindoles

procedure B:

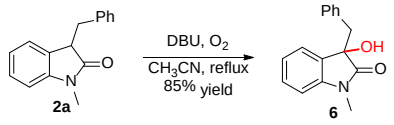


In a dry and Ar-filled glovebox, the oven-dried Schlenk tube (10 mL) containing a stirring bar was charged with substrates (0.2 mmol, 1.0 equiv.), $Pd(OAc)_2$ (10 mol%), tris[4-(trifluoromethyl)phenyl]phosphine (20 mol%), $NaHSO_3$ (0.3 mmol, 1.5 equiv.) and 1,4-dioxane (3.0 mL). The mixture was stirred at 120 ℃ for 6 h. Upon completion of the reaction, the crude reaction mixture was filtered and the solvent was removed under reduced pressure. The crude ^1H NMR spectrum was taken using 1,3,5-trimethoxybenzene as internal standard. The resulting residue was purified by flash silica gel chromatography or preparative thin layer chromatography using petroleum ether/ethyl acetate (20:1-10:1) as the eluent to give the desired products.

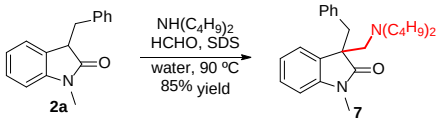
V. Derivatization experiments



Chlorination: To a solution of oxindole **2a** (142 mg, 0.6 mmol) in THF (0.2 M), LiHMDS (1 M in THF, 0.78 ml, 1.3 equiv.) was added dropwise at -78 ℃. After 30 minutes, NCS (104 mg, 1.3 equiv.) was added carefully. Then the reaction mixture was stirred at -78 ℃. After completion (monitored by TLC), the reaction mixture was extracted with ethyl acetate (50 mL × 3). The combined ethyl acetate extract was dried over anhydrous Na_2SO_4 and filtrated. After the solvent was concentrated under reduced pressure, the residue was purified by column chromatography on silica gel (PE/EtOAc = 15:1) to afford the target product **5** (128 mg, 79% yield).



Hydroxylation: A mixture of oxindole **2a** (71 mg, 0.3 mmol) and DBU (45.7 mg, 1.0 equiv.) in CH_3CN (3 mL) was heated to reflux for 1 h under O_2 balloon atmosphere. After completion, the reaction mixture was washed with H_2O (20 mL) and exacted with ethyl acetate (20 mL × 3). The combined ethyl acetate extract was dried over anhydrous Na_2SO_4 and filtrated. After the solvent was concentrated under reduced pressure, the residue was purified by column chromatography on silica gel (PE/EA = 10:1) to afford the target product **6** (64 mg, 85% yield).

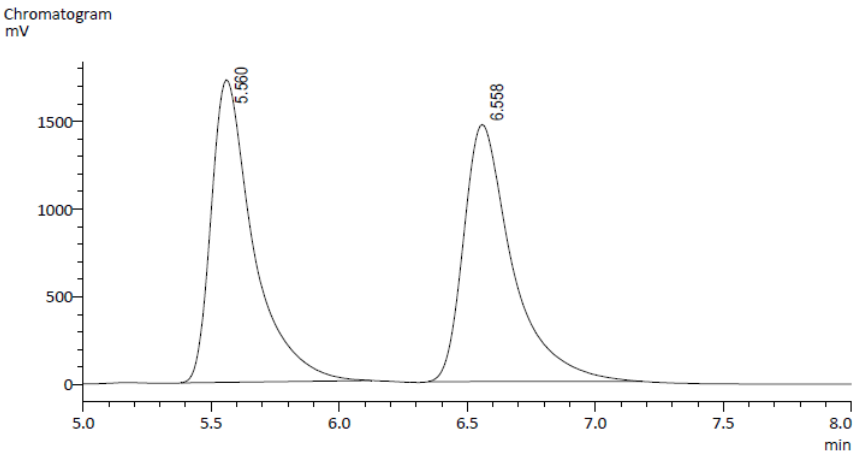


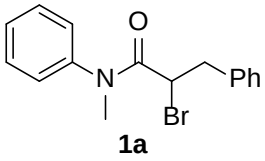
Aminomethylation: An ordinary vial charged with a magnetic stirring bar, oxindole **2a** (71 mg, 0.3 mmol), SDS (8.8 mg, 10 mol %), dibutylamine (116 mg, 3.0 equiv.) and water (6.0 mL). To the mixture was added HCHO (27 mg, 3.0 equiv.) and then the mixture was stirred at 90 ℃. After completion of the reaction as monitored by TLC, the aqueous layer was extracted with EtOAc (40 mL×3), and the combined organic layers were dried over anhydrous Na_2SO_4. The mixture was concentrated in vacuo and the residue was purified by column chromatography on silica gel (PE/EA = 10:1) to give the corresponding product **7** (96 mg, 85% yield).

VI. Enantioselectivities as determined by chiral HPLC

Enantiomeric excesses were determined by HPLC analysis (Chiralpak column AD-H, λ = 254 nm, *n*-hexane/*i*-PrOH = 90:10, flow rate: 1.0 mL/min, 30 °C.)

Racemic **1a**:



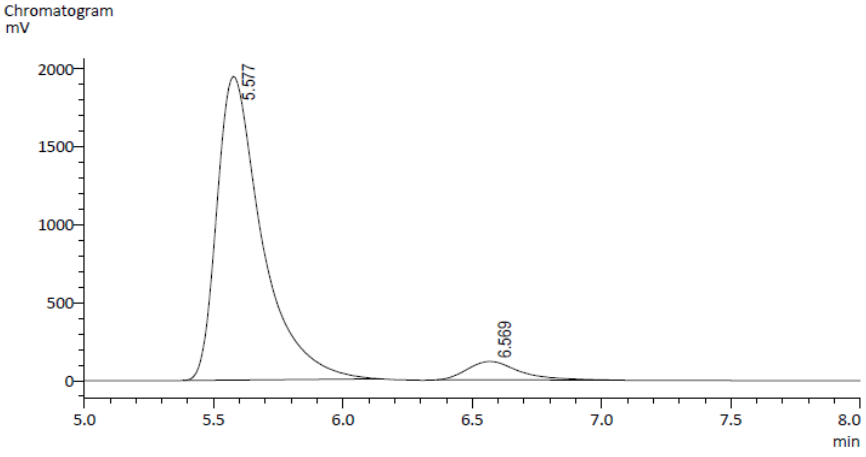


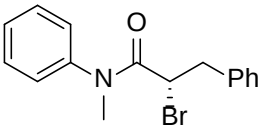
1a

<Peak Table>
Detector A 254nm

Peak#	Retention Time (min)	Area (mAU*min)	Height (mAU)	Area Ratio (%)
1	5.560	19692763	1724598	50.358
2	6.558	19413017	1466408	49.642
Total		39105780	3191006	100.000

Chiral **1a**:



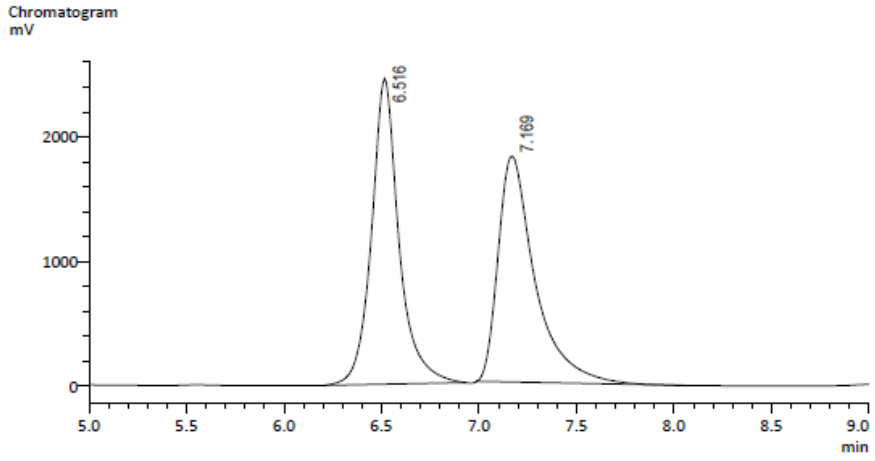


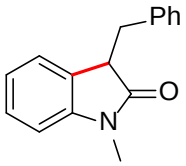
(*S*)-**1a** (*ee* = 87%)

<Peak Table>
Detector A 254nm

Peak#	Retention Time (min)	Area (mAU*min)	Height (mAU)	Area Ratio (%)
1	5.577	23598007	1943727	93.541
2	6.569	1629451	117531	6.459
Total		25227457	2061258	100.000

Cyclization of the chiral substrate (*S*)-**1a** (*ee* = 87%) under the standard conditions to afford a racemic **2a**:



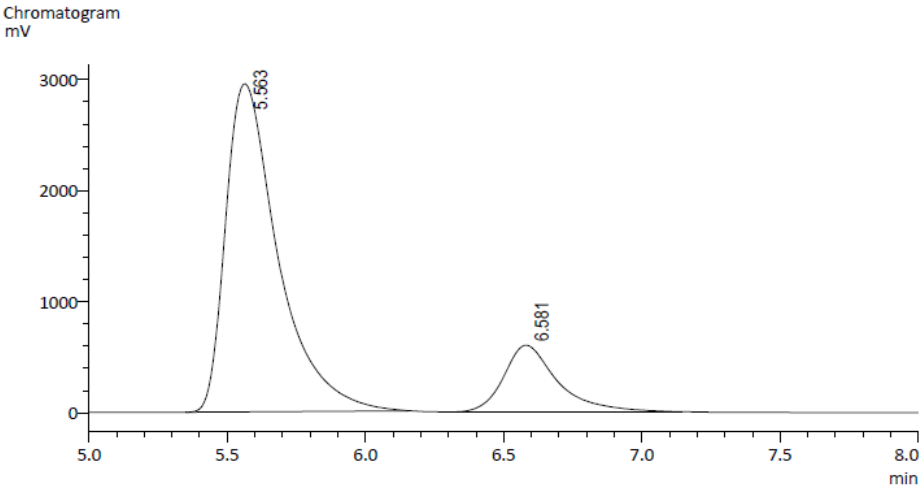


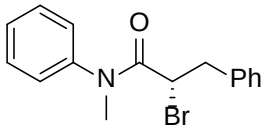
2a (*ee* = 0)

<Peak Table>
Detector A 254nm

Peak#	Retention Time (min)	Area (mAU*min)	Height (mAU)	Area Ratio (%)
1	6.516	24166267	2457674	50.363
2	7.169	23817477	1815769	49.637
Total		47983743	4273442	100.000

Recovery of the chiral substrate (*S*)-**1a** (before reaction, *ee* = 87%) under the standard conditions without palladium:





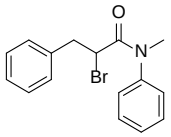
(*S*)-**1a** (*ee* = 66%)

<Peak Table>
Detector A 254nm

Peak#	Retention Time (min)	Area (mAU*min)	Height (mAU)	Area Ratio (%)
1	5.563	39002400	2953616	82.868
2	6.581	8063173	599047	17.132
Total		47065574	3552663	100.000

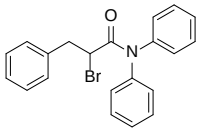
VII. Characterization of compounds

*2-bromo-N-methyl-N,3-diphenylpropanamide (**1a**):*



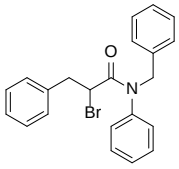
Following the **procedure A**, the substrate was prepared using 3-phenylpropanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eulent. **1a**: yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.35–7.23 (m, 6H), 7.10–7.06 (m, 2H), 6.72 (s, 2H), 4.25 (dd, *J* = 10.3, 5.1 Hz, 1H), 3.55 (dd, *J* = 12.9, 10.5 Hz, 1H), 3.16 (s, 3H), 3.07 (dd, *J* = 13.1, 5.1 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.4, 142.5, 137.2, 129.8, 129.4, 128.5, 128.3, 127.2, 127.0, 43.4, 41.6, 37.8. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{16}BrNONa^+$ $[M+Na]^+$: 340.0307, found: 340.0306.

*2-bromo-N,N,3-triphenylpropanamide (**1b**):*



Following the **procedure A**, the substrate was prepared using diphenylamine as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eulent. **1b**: brown solid, **mp** = 61-64 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.32–7.22 (m, 8H), 7.18–7.11 (m, 3H), 7.07 (d, *J* = 7.9 Hz, 2H), 6.79 (s, 2H), 4.42 (dd, *J* = 10.8, 4.9 Hz, 1H), 3.65 (dd, *J* = 13.0, 10.7 Hz, 1H), 3.14 (dd, *J* = 13.0, 4.9 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.5, 142.1, 141.5, 137.2, 129.8, 129.7, 128.9, 128.6, 128.4, 128.4, 127.4, 126.5, 126.0, 44.1, 41.5. **HRMS** (ESI, m/z) Calcd for $C_{21}H_{18}BrNONa^+$ $[M+Na]^+$: 402.0464, found: 402.0460.

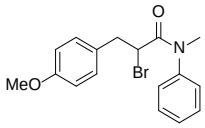
*N-benzyl-2-bromo-N,3-diphenylpropanamide (**1c**):*



Following the **procedure A**, the substrate was prepared using *N*-benzylaniline as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eulent. **1c**: white solid, **mp** = 73-74 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.21–6.97 (m, 13H), 7.92–6.86 (m, 2H), 4.88 (d, *J* = 14.3 Hz, 1H), 4.47 (d, *J* = 14.3 Hz, 1H), 4.12 (dd, *J* = 10.7, 4.8 Hz, 1H), 3.52 (dd, *J* = 12.9, 10.8 Hz, 1H), 3.00 (dd, *J* = 13.0, 4.8 Hz, 1H). **^{13}C NMR** (101

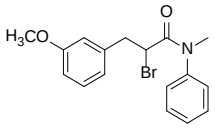
MHz, $CDCl_3$) δ 168.3, 140.8, 137.2, 136.5, 129.7, 129.5, 128.7, 128.6, 128.5, 128.3, 128.2, 127.4, 127.3, 53.4, 43.4, 41.7. **HRMS** (ESI, m/z) Calcd for $C_{22}H_{20}BrNONa^+$ $[M+Na]^+$: 416.0620, found: 416.0622.

*2-bromo-3-(4-methoxyphenyl)-N-methyl-N-phenylpropanamide (**1d**):*



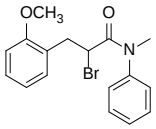
Following the **procedure A**, the substrate was prepared using 3-(4-methoxyphenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1d**: yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.32–7.28 (m, 3H), 7.01 (d, *J* = 8.2 Hz, 2H) 6.83–6.74 (m, 4H), 4.22 (dd, *J* = 10.4, 5.1 Hz, 1H), 3.80 (s, 3H), 3.49 (dd, *J* = 13.1, 10.6 Hz, 1H), 3.17 (s, 3H), 3.01 (dd, *J* = 13.2, 5.0 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.5, 158.8, 142.6, 130.5, 129.8, 129.3, 128.4, 127.1, 113.9, 55.3, 43.6, 40.8, 37.8. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{18}BrNO_2Na^+$ $[M+Na]^+$: 370.0413, found: 370.0414.

*2-bromo-3-(3-methoxyphenyl)-N-methyl-N-phenylpropanamide (**1e**):*



Following the **procedure A**, the substrate was prepared using 3-(3-methoxyphenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1e**: yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.34–7.28 (m, 3H), 7.21–7.17 (m, 1H), 6.91–6.50 (m, 5H), 4.25 (dd, *J* = 10.2, 5.2 Hz, 1H), 3.76 (s, 3H), 3.52 (dd, *J* = 13.1, 10.3 Hz, 1H), 3.17 (s, 3H), 3.06 (dd, *J* = 13.1, 5.2 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.6, 159.9, 142.7, 138.9, 129.9, 129.6, 128.5, 127.2, 121.8, 114.7, 113.2, 55.3, 43.5, 41.9, 37.9. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{18}BrNO_2Na^+$ $[M+Na]^+$: 370.0413, found: 370.0415.

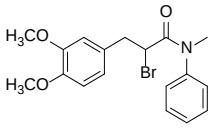
*2-bromo-3-(2-methoxyphenyl)-N-methyl-N-phenylpropanamide (**1f**):*



Following the **procedure A**, the substrate was prepared using 3-(2-methoxyphenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1f**: white solid, **mp** = 95-97 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.35–7.30 (m, 3H), 7.28–7.23 (m, 1H), 7.18 (d, *J* = 7.4 Hz, 1H), 6.99–6.61 (m, 4H), 4.49 (dd, *J* = 9.1, 5.9 Hz, 1H), 3.55 (s, 3H), 3.36 (dd, *J* = 12.9, 9.2 Hz, 1H), 3.24 (dd, *J* = 13.0, 5.9 Hz, 1H), 3.16 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 169.2, 157.7, 143.1, 131.9, 129.7, 128.7, 128.2, 127.2, 125.3,

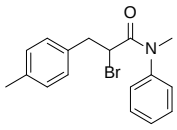
120.6, 109.9, 54.8, 42.5, 37.8, 37.1. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{18}BrNO_2Na^+$ $[M+Na]^+$: 370.0413, found: 370.0413.

*2-bromo-3-(3,4-dimethoxyphenyl)-N-methyl-N-phenylpropanamide (**1g**):*



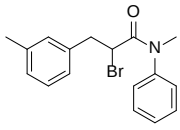
Following the **procedure A**, the substrate was prepared using 3-(3,4-dimethoxyphenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1g**: white solid, **mp** = 96-98 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.44–7.20 (m, 3H), 6.94–6.43 (m, 5H), 4.26 (dd, *J* = 10.7, 4.8 Hz, 1H), 3.87 (s, 3H), 3.80 (s, 3H), 3.49 (dd, *J* = 13.1, 10.8 Hz, 1H), 3.16 (s, 3H), 3.01 (dd, *J* = 13.1, 4.8 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 167.9, 148.4, 147.7, 142.2, 129.3, 129.3, 127.9, 126.6, 121.2, 112.0, 110.8, 55.5, 55.4, 43.0, 40.9, 37.3. **HRMS** (ESI, m/z) Calcd for $C_{18}H_{20}BrNO_3Na^+$ $[M+Na]^+$: 400.0519, found: 370.0516.

*2-bromo-N-methyl-N-phenyl-3-(p-tolyl)propenamide (**1h**):*



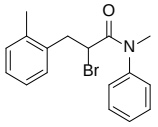
Following the **procedure A**, the substrate was prepared using 3-(*p*-tolyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1h**: white solid, **mp** = 61-63 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.26–7.21 (m, 3H), 7.02 (d, *J* = 7.9 Hz, 2H), 6.90 (d, *J* = 7.9 Hz, 2H), 6.70 (s, 2H), 4.16 (dd, *J* = 10.1, 5.3 Hz, 1H), 3.43 (dd, *J* = 13.2, 10.1 Hz, 1H), 3.11 (s, 3H), 2.98 (dd, *J* = 13.3, 5.3 Hz, 1H), 2.27 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.4, 142.5, 136.7, 134.1, 129.7, 129.2, 129.1, 128.3, 127.0, 43.6, 41.2, 37.7, 21.1. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{18}BrNONa^+$ $[M+Na]^+$: 354.0464, found: 354.0464.

*2-bromo-N-methyl-N-phenyl-3-(m-tolyl)propenamide (**1i**):*



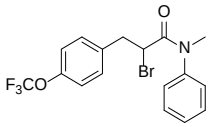
Following the **procedure A**, the substrate was prepared using 3-(*m*-tolyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1i**: yellow solid, **mp** = 53-55 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.33–7.27 (m, 3H), 7.17–7.13 (m, 1H), 7.07 (d, *J* = 7.6 Hz, 1H), 6.87–6.69 (m, 4H), 4.24 (dd, *J* = 10.4, 5.0 Hz, 1H), 3.48 (dd, *J* = 13.0, 10.5 Hz, 1H), 3.14 (s, 3H), 3.02 (dd, *J* = 13.1, 5.0 Hz, 1H), 2.29 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.4, 142.5, 138.0, 137.0, 130.1, 129.7, 128.4, 128.3, 127.8, 127.0, 126.4, 43.4, 41.6, 37.7, 21.3. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{18}BrNONa^+$ $[M+Na]^+$: 354.0464, found: 354.0465.

*2-bromo-N-methyl-N-phenyl-3-(o-tolyl)propenamide (**1j**):*



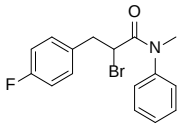
Following the **procedure A**, the substrate was prepared using 3-(*o*-tolyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1j**: white solid, **mp** = 80-83 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.26 (m, 3H), 7.21–7.10 (m, 4H), 6.67 (s, 2H), 4.28 (dd, *J* = 10.1, 5.2 Hz, 1H), 3.51 (dd, *J* = 13.3, 10.3 Hz, 1H), 3.18–3.13 (m, 4H), 2.02 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.7, 142.8, 136.9, 135.4, 130.6, 130.5, 129.9, 128.5, 127.5, 127.1, 126.2, 42.3, 39.2, 37.9, 19.1. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{18}BrNONa^+$ $[M+Na]^+$: 354.0464, found: 354.0464.

*2-bromo-N-methyl-N-phenyl-3-(4-(trifluoromethoxy)phenyl)propenamide (**1k**):*



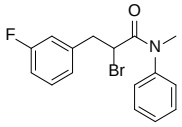
Following the **procedure A**, the substrate was prepared using 3-(4-(trifluoromethoxy)phenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1k**: yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.34–7.32 (m, 3H), 7.16–7.11 (m, 4H), 6.76 (s, 2H), 4.21 (dd, *J* = 10.3, 5.1 Hz, 1H), 3.56 (dd, *J* = 13.2, 10.4 Hz, 1H), 3.18 (s, 3H), 3.09 (dd, *J* = 13.2, 5.1 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.3, 148.5 (d, *J* = 2.0 Hz), 142.6, 136.2, 130.9, 130.0, 128.6, 127.0, 121.2, 120.6 (q, *J* = 258.6 Hz), 43.0, 41.0, 37.9. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -57.94. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{15}BrF_3NO_2Na^+$ $[M+Na]^+$: 424.0130, found: 424.0133.

*2-bromo-3-(4-fluorophenyl)-N-methyl-N-phenylpropanamide (**1l**):*



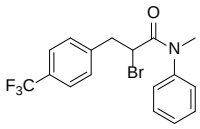
Following the **procedure A**, the substrate was prepared using 3-(4-fluorophenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1l**: yellow solid, **mp** = 56-58 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.40–7.29 (m, 3H), 7.08–7.05 (m, 2H), 6.99–6.95 (m, 2H), 6.79 (s, 2H), 4.21 (dd, *J* = 10.3, 5.2 Hz, 1H), 3.52 (dd, *J* = 13.3, 10.4 Hz, 1H), 3.18 (s, 3H), 3.05 (dd, *J* = 13.3, 5.2 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.3, 162.0 (d, *J* = 246.4 Hz), 142.6, 133.1 (d, *J* = 4.0 Hz), 131.1 (d, *J* = 8.1 Hz), 129.9, 128.5, 127.0, 115.4 (d, *J* = 22.2 Hz), 43.2 (d, *J* = 2.0 Hz), 40.7, 37.9. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -115.08. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{15}BrFNONa^+$ $[M+Na]^+$: 358.0213, found: 358.0219.

*2-bromo-3-(3-fluorophenyl)-N-methyl-N-phenylpropanamide (**1m**):*



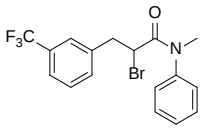
Following the **procedure A**, the substrate was prepared using 3-(3-fluorophenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1m**: yellow solid, **mp** = 41-43 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.28–7.25 (m, 3H), 7.17 (dd, *J* = 14.2, 7.9 Hz, 1H), 6.89 (td, *J* = 8.5, 2.6 Hz, 1H), 6.85–6.47 (m, 4H), 4.15 (dd, *J* = 10.1, 5.3 Hz, 1H), 3.46 (dd, *J* = 13.2, 10.2 Hz, 1H), 3.10 (s, 3H), 2.99 (dd, *J* = 13.3, 5.3 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.2, 162.8 (d, *J* = 247.5 Hz), 142.6, 139.7 (d, *J* = 8.1 Hz), 130.1 (d, *J* = 8.1 Hz), 129.9, 128.6, 127.0, 125.2 (d, *J* = 3.0 Hz), 116.3 (d, *J* = 22.2 Hz), 114.2 (d, *J* = 21.2 Hz), 42.9, 41.3, 37.9. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -112.94. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{15}BrFNONa^+$ $[M+Na]^+$: 358.0213, found: 358.0214.

*2-bromo-N-methyl-N-phenyl-3-(4-(trifluoromethyl)phenyl)propenamide (**1n**):*



Following the **procedure A**, the substrate was prepared using 3-(4-(trifluoromethyl)phenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1n**: yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.53 (d, *J* = 8.0 Hz, 2H), 7.38–7.30 (m, 3H), 7.20 (d, *J* = 7.9 Hz, 2H), 6.80 (s, 2H), 4.24 (dd, *J* = 9.9, 5.5 Hz, 1H), 3.59 (dd, *J* = 13.3, 10.0 Hz, 1H), 3.20–3.10 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 167.9, 142.3, 141.3, 129.9, 129.7, 129.4 (q, *J* = 32.3 Hz), 128.5, 126.8, 125.3 (q, *J* = 4.0 Hz), 124.1 (q, *J* = 272.7 Hz), 42.7, 41.1, 37.7. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -62.44. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{15}BrF_3NONa^+$ $[M+Na]^+$: 408.0181, found: 408.0184.

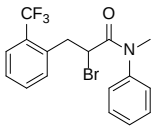
*2-bromo-N-methyl-N-phenyl-3-(3-(trifluoromethyl)phenyl)propenamide (**1o**):*



Following the **procedure A**, the substrate was prepared using 3-(3-(trifluoromethyl)phenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1o**: yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.56 (d, *J* = 7.7 Hz, 1H), 7.45–7.41 (m, 1H), 7.36–7.32 (m, 5H), 6.76 (s, 2H), 4.27 (dd, *J* = 10.5, 5.0 Hz, 1H), 3.62 (dd, *J* = 13.2, 10.5 Hz, 1H), 3.16–3.12 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.0, 142.5, 138.3, 133.2, 131.1 (q, *J* = 32.3 Hz), 130.0, 129.2, 128.7, 126.9, 126.0 (q, *J* = 3.0 Hz), 124.1 (q, *J* = 4.0

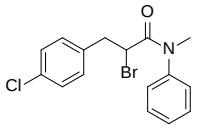
Hz), 124.0 (q, *J* = 273.7 Hz), 42.6, 41.4, 37.8. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -62.59. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{15}BrF_3NONa^+$ $[M+Na]^+$: 408.0181, found: 408.0183.

*2-bromo-N-methyl-N-phenyl-3-(2-(trifluoromethyl)phenyl)propenamide (**1p**):*



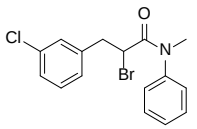
Following the **procedure A**, the substrate was prepared using 3-(2-(trifluoromethyl)phenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1p**: colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.62 (d, *J* = 7.8 Hz, 1H), 7.56–7.38 (m, 6H), 6.77 (s, 2H), 4.33 (dd, *J* = 8.5, 6.4 Hz, 1H), 3.65 (dd, *J* = 14.0, 8.7 Hz, 1H), 3.39 (dd, *J* = 14.0, 6.1 Hz, 1H), 3.24 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.4, 142.3, 135.3, 133.0, 131.8, 129.8, 128.9 (q, *J* = 30.3 Hz), 128.4, 127.5, 126.7, 126.2 (q, *J* = 6.1 Hz), 124.1 (q, *J* = 274.7 Hz), 42.8 (d, *J* = 2.0 Hz), 38.1, 37.8. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -59.78. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{15}BrF_3NONa^+$ $[M+Na]^+$: 408.0181, found: 408.0181.

*2-bromo-3-(4-chlorophenyl)-N-methyl-N-phenylpropanamide (**1q**):*



Following the **procedure A**, the substrate was prepared using 3-(4-chlorophenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1q**: yellow solid, **mp** = 53-55 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.36–7.33 (m, 3H), 7.26 (d, *J* = 8.3 Hz, 2H), 7.03 (d, *J* = 8.3 Hz, 2H), 6.82 (s, 2H), 4.20 (dd, *J* = 10.2, 5.3 Hz, 1H), 3.52 (dd, *J* = 13.3, 10.2 Hz, 1H), 3.19 (s, 3H), 3.06 (dd, *J* = 13.3, 5.3 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.3, 142.7, 135.9, 133.2, 130.9, 130.0, 128.8, 128.6, 127.2, 43.1, 41.0, 38.0. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{15}BrClNONa^+$ $[M+Na]^+$: 373.9918, found: 373.9919.

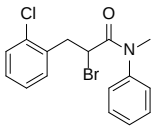
*2-bromo-3-(3-chlorophenyl)-N-methyl-N-phenylpropanamide (**1r**):*



Following the **procedure A**, the substrate was prepared using 3-(3-chlorophenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1r**: yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.37–7.34 (m, 3H), 7.29–7.17 (m, 2H), 7.04–6.99 (m, 2H), 6.80 (s, 2H), 4.24 (dd, *J* = 10.3, 5.2 Hz, 1H), 3.51 (dd, *J* = 13.2, 10.4 Hz, 1H), 3.17 (s, 3H), 3.05 (dd, *J* = 13.2, 5.2 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ

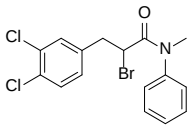
168.0, 142.4, 139.1, 134.2, 129.8, 129.8, 129.3, 128.5, 127.6, 127.3, 126.9, 42.7, 41.1, 37.7. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{15}BrClNONa^+$ $[M+Na]^+$: 373.9918, found: 373.9918.

*2-bromo-3-(2-chlorophenyl)-N-methyl-N-phenylpropanamide (**1s**):*



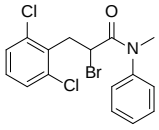
Following the **procedure A**, the substrate was prepared using 3-(2-chlorophenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1s**: white solid, **mp** = 71-73 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.37–7.27 (m, 5H), 7.24–7.18 (m, 2H), 6.82 (s, 2H), 4.48 (dd, *J* = 8.8, 6.3 Hz, 1H), 3.52 (dd, *J* = 13.4, 8.9 Hz, 1H), 3.32 (dd, *J* = 13.4, 6.2 Hz, 1H), 3.19 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.6, 142.5, 134.8, 134.5, 132.6, 130.0, 129.4, 128.9, 128.5, 127.0, 41.6 39.4, 37.9. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{15}BrClNONa^+$ $[M+Na]^+$: 373.9918, found: 373.9917.

*2-bromo-3-(3,4-dichlorophenyl)-N-methyl-N-phenylpropanamide (**1t**):*



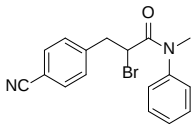
Following the **procedure A**, the substrate was prepared using 3-(3,4-dichlorophenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1t**: white solid, **mp** = 101-103 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.39–7.35 (m, 4H), 7.16 (d, *J* = 2.1 Hz, 1H), 6.98–6.88 (m, 3H), 4.21 (dd, *J* = 10.1, 5.4 Hz, 1H), 3.49 (dd, *J* = 13.4, 10.1 Hz, 1H), 3.20 (s, 3H), 3.05 (dd, *J* = 13.4, 5.4 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.0, 142.5, 137.6, 132.6, 131.4, 131.3, 130.6, 130.1, 129.0, 128.7, 127.1, 42.5, 40.6, 38.0. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}BrCl_2NONa^+$ $[M+Na]^+$: 407.9528, found: 407.9522.

*2-bromo-3-(2,6-dichlorophenyl)-N-methyl-N-phenylpropanamide (**1u**):*



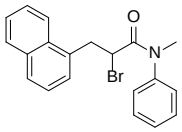
Following the **procedure A**, the substrate was prepared using 3-(2,6-dichlorophenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1u**: white solid, **mp** = 96-98 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.40–7.34 (m, 3H), 7.14 (d, *J* = 8.0 Hz, 2H), 7.14–7.06 (m, 3H), 4.69 (dd, *J* = 8.7, 5.7 Hz, 1H), 3.77 (dd, *J* = 14.5, 8.8 Hz, 1H), 3.54 (dd, *J* = 14.5, 5.7 Hz, 1H), 3.28 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.3, 142.4, 136.0, 133.2, 129.7, 128.7, 128.4, 128.3, 126.8, 41.8, 37.9, 35.7. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}BrCl_2NONa^+$ $[M+Na]^+$: 407.9528, found: 407.9528.

*2-bromo-3-(4-cyanophenyl)-N-methyl-N-phenylpropanamide (**1v**):*



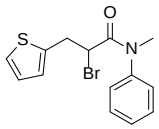
Following the **procedure A**, the substrate was prepared using 3-(4-cyanophenyl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1v**: white solid, **mp** = 74-76 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.59 (d, *J* = 8.2 Hz, 2H), 7.39–7.37 (m, 3H), 7.23 (d, *J* = 8.0 Hz, 2H), 6.89 (s, 2H), 4.25 (dd, *J* = 9.7, 5.7 Hz, 1H), 3.60 (dd, *J* = 13.3, 9.8 Hz, 1H), 3.20–3.15 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 167.8, 142.7, 142.3, 132.3, 130.2, 130.0, 128.7, 126.9, 118.6, 111.1, 42.3, 41.3, 37.9. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{15}BrN_2ONa^+$ $[M+Na]^+$: 365.0260, found: 365.0263.

*2-bromo-N-methyl-3-(naphthalen-1-yl)-N-phenylpropanamide (**1w**):*



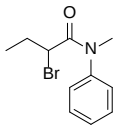
Following the **procedure A**, the substrate was prepared using 3-(naphthalen-1-yl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1w**: white solid, **mp** = 78-79 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.2 Hz, 1H), 7.78–7.76 (m, 1H), 7.55 (d, *J* = 8.5 Hz, 1H), 7.44–7.40 (m, 1H), 7.36 (d, *J* = 4.9 Hz, 2H), 7.30–7.26 (m, 1H), 7.06–7.02 (m, 1H), 6.88 (s, 2H), 6.26 (s, 2H), 4.55–4.44 (m, 1H), 3.88 (dd, *J* = 13.4, 10.6 Hz, 1H), 3.64 (dd, *J* = 13.5, 4.8 Hz, 1H), 3.03 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.3, 141.9, 133.5, 132.6, 131.5, 129.2, 128.6, 128.1, 127.9, 127.8, 126.2, 126.2, 125.5, 125.3, 122.6, 42.3, 38.8, 37.4. **HRMS** (ESI, m/z) Calcd for $C_{20}H_{18}BrNONa^+$ $[M+Na]^+$: 390.0464, found: 390.0465.

*2-bromo-N-methyl-N-phenyl-3-(thiophen-2-yl)propenamide (**1x**):*



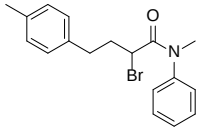
Following the **procedure A**, the substrate was prepared using 3-(thiophen-2-yl)propanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1x**: yellow solid, **mp** = 44-46 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.42–7.33 (m, 3H), 7.22 (d, *J* = 5.1 Hz, 1H), 7.09–6.70 (m, 4H), 4.24 (dd, *J* = 10.4, 4.8 Hz, 1H), 3.84 (dd, *J* = 14.2, 10.5 Hz, 1H), 3.35 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.4, 142.7, 139.2, 130.0, 128.5, 127.2, 127.1, 127.1, 124.9, 42.6, 38.0, 35.6. **HRMS** (ESI, m/z) Calcd for $C_{14}H_{14}BrSNONa^+$ $[M+Na]^+$: 345.9872, found: 345.9871.

*2-bromo-N-methyl-N-phenylbutanamide (**1y**):*



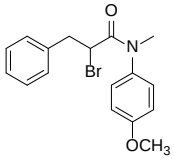
Following the **procedure A**, the substrate was prepared using butyric acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1y**: colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.45–7.24 (m, 3H), 7.21 (d, *J* = 7.4 Hz, 2H), 3.95 (t, *J* = 7.4 Hz, 1H), 3.23 (s, 3H), 2.12–1.98 (m, 1H), 1.92–1.78 (m, 1H), 0.80 (t, *J* = 7.3 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 169.1, 142.9, 130.0, 128.5, 127.2, 45.8, 38.0, 28.7, 12.1. **HRMS** (ESI, m/z) Calcd for $C_{11}H_{14}BrNONa^+$ $[M+Na]^+$: 278.0151, found: 278.0153.

*2-bromo-N-methyl-N-phenyl-4-(p-tolyl)butanamide (**1z**):*



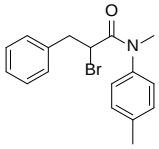
Following the **procedure A**, the substrate was prepared using 4-(p-tolyl)butanoic acid as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1z**: yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.29–7.19 (m, 3H), 7.05–7.01 (m, 2H), 6.93 (d, *J* = 7.9 Hz, 2H), 6.87 (d, *J* = 7.9 Hz, 2H), 3.97 (t, *J* = 7.2 Hz, 1H), 3.19 (s, 3H), 2.57–2.41 (m, 2H), 2.32–2.12 (m, 5H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 169.0, 142.7, 137.0, 135.6, 129.9, 129.2, 128.3, 128.2, 127.1, 43.7, 38.0, 36.7, 32.7, 21.1. **HRMS** (ESI, m/z) Calcd for $C_{18}H_{20}BrNONa^+$ $[M+Na]^+$: 368.0620, found: 368.0618.

*2-bromo-N-(4-methoxyphenyl)-N-methyl-3-phenylpropanamide (**1a'**):*



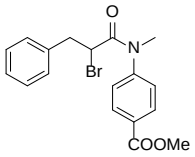
Following the **procedure A**, the substrate was prepared using 4-methoxy-*N*-methylaniline as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1a'**: brown solid, **mp** = 87-89 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.25 (m, 3H), 7.15–7.05 (m, 2H), 6.82–6.40 (m, 4H), 4.27 (dd, *J* = 10.3, 5.2 Hz, 1H), 3.80 (s, 3H), 3.54 (dd, *J* = 13.1, 10.4 Hz, 1H), 3.13 (s, 3H), 3.08 (dd, *J* = 13.1, 5.2 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.8, 159.2, 137.3, 135.3, 129.5, 128.6, 128.1, 127.2, 114.9, 55.5, 43.4, 41.7, 38.0. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{18}BrNO_2Na^+$ $[M+Na]^+$: 370.0413, found: 370.0414.

*2-bromo-N-methyl-3-phenyl-N-(p-tolyl)propenamide (**1b'**):*



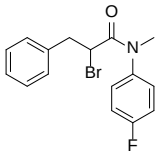
Following the **procedure A**, the substrate was prepared using *N*,4-dimethylaniline as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1b'**: yellow solid, **mp** = 46-48 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.29–7.24 (m, 3H), 7.17–7.01 (m, 4H), 6.59 (s, 2H), 4.28 (dd, *J* = 10.3, 5.1 Hz, 1H), 3.54 (dd, *J* = 13.0, 10.4 Hz, 1H), 3.12 (s, 3H), 3.06 (dd, *J* = 13.1, 5.1 Hz, 1H), 2.33 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.3, 139.8, 138.2, 137.1, 130.2, 129.3, 128.4, 127.0, 126.6, 43.3, 41.5, 37.6, 20.9. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{18}BrNONa^+$ $[M+Na]^+$: 354.0464, found: 354.0468.

*methyl 4-(2-bromo-N-methyl-3-phenylpropanamido)benzoate (**1c'**):*



Following the **procedure A**, the substrate was prepared using methyl 4-(methylamino)benzoate as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1c'**: yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.99 (d, *J* = 8.6 Hz, 2H), 7.44–7.24 (m, 3H), 7.17–7.00 (m, 2H), 6.79 (s, 2H), 4.21 (dd, *J* = 10.5, 4.8 Hz, 1H), 3.95 (s, 3H), 3.57 (dd, *J* = 12.9, 10.8 Hz, 1H), 3.19 (s, 3H), 3.10 (dd, *J* = 13.1, 4.8 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.1, 165.9, 146.5, 137.0, 131.1, 130.0, 129.4, 128.6, 127.3, 127.0, 52.4, 43.1, 41.6, 37.6. **HRMS** (ESI, m/z) Calcd for $C_{18}H_{18}BrNO_3Na^+$ $[M+Na]^+$: 398.0362, found: 398.0360.

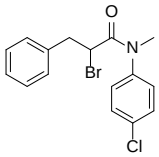
*2-bromo-N-(4-fluorophenyl)-N-methyl-3-phenylpropanamide (**1d'**):*



Following the **procedure A**, the substrate was prepared using 4-fluoro-*N*-methylaniline as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1d'**: white solid, **mp** = 96-97 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.34–7.25 (m, 3H), 7.12–7.06 (m, 2H), 7.02–6.94 (m, 2H), 6.68 (s, 2H), 4.20 (dd, *J* = 10.5, 4.9 Hz, 1H), 3.55 (dd, *J* = 13.0, 10.6 Hz, 1H), 3.14 (s, 3H), 3.08 (dd, *J* = 13.1, 4.9 Hz, 1H). **^{13}C NMR** (101 MHz, CDCl3) δ 168.4, 161.9 (d, *J* = 250.5 Hz), 138.5 (d, *J* = 3.0 Hz), 137.2, 129.4, 128.9 (d, *J* = 8.1 Hz), 128.6,

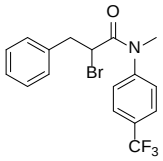
127.3, 116.7 (d, *J* = 23.2 Hz), 43.0, 41.6, 37.9. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -112.28. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{15}BrFNONa^+$ $[M+Na]^+$: 358.0213, found: 358.0215.

*2-bromo-N-(4-chlorophenyl)-N-methyl-3-phenylpropanamide (**1e'**):*



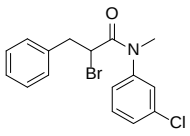
Following the **procedure A**, the substrate was prepared using 4-chloro-*N*-methylaniline as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1e'**: white solid, **mp** = 71-73 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.30–7.14 (m, 5H), 7.03 (dd, *J* = 6.4, 2.7 Hz, 2H), 6.55 (s, 2H), 4.12 (dd, *J* = 10.6, 4.9 Hz, 1H), 3.48 (dd, *J* = 13.0, 10.7 Hz, 1H), 3.06 (s, 3H), 3.01 (dd, *J* = 13.0, 4.9 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.3, 141.1, 137.2, 134.2, 130.0, 129.5, 128.6, 128.5, 127.3, 43.0, 41.7, 37.8. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{15}BrClNONa^+$ $[M+Na]^+$: 373.9918, found: 373.9919.

*2-bromo-N-methyl-3-phenyl-N-(4-(trifluoromethyl)phenyl)propenamide (**1f'**):*



Following the **procedure A**, the substrate was prepared using *N*-methyl-4-(trifluoromethyl)aniline as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1f'**: yellow solid, **mp** = 50-52 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.57 (d, *J* = 8.3 Hz, 2H), 7.32–7.28 (m, 3H), 7.12–7.08 (m, 2H), 6.81 (s, 2H), 4.16 (dd, *J* = 10.7, 4.8 Hz, 1H), 3.57 (dd, *J* = 12.9, 10.8 Hz, 1H), 3.17 (s, 3H), 3.10 (dd, *J* = 13.0, 4.8 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 171.9, 147.0, 140.9, 128.9 (q, *J* = 40.4 Hz), 128.4 (d, *J* = 2.0 Hz), 128.3 (q, *J* = 18.2 Hz), 127.6, 126.7, 126.1, 123.7 (q, *J* = 272.7 Hz), 37.2, 35.9, 31.6. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -62.61. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{15}BrF_3NONa^+$ $[M+Na]^+$: 408.0181, found: 408.0184.

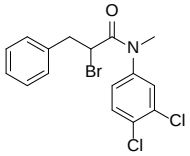
*2-bromo-N-(3-chlorophenyl)-N-methyl-3-phenylpropanamide (**1g'**):*



Following the **procedure A**, the substrate was prepared using 3-chloro-*N*-methylaniline as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1g'**: white solid, **mp** = 80-81 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.33–7.23 (m, 5H), 7.08 (dd, *J* = 6.6, 2.9 Hz, 2H), 6.67 (s, 2H), 4.19 (dd, *J* = 10.7,

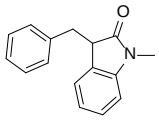
4.8 Hz, 1H), 3.53 (dd, *J* = 13.0, 10.7 Hz, 1H), 3.12 (s, 3H), 3.07 (dd, *J* = 13.0, 4.9 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.0, 143.5, 136.9, 134.9, 130.7, 129.2, 128.6, 127.3, 127.2, 125.1, 42.8, 41.6, 37.5. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{15}BrClNONa^+$ $[M+Na]^+$: 373.9918, found: 373.9919.

*2-bromo-N-(3,4-dichlorophenyl)-N-methyl-3-phenylpropanamide (**1h'**):*



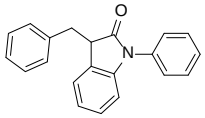
Following the **procedure A**, the substrate was prepared using 3,4-dichloro-*N*-methylaniline as starting material, then purified by flash chromatography with hexanes/ethyl acetate (15:1) as the eluent. **1h'**: yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.30 (d, *J* = 8.4 Hz, 1H), 7.26–7.20 (m, 3H), 7.05–6.98 (m, 2H), 6.54 (s, 2H), 4.10 (dd, *J* = 10.9, 4.6 Hz, 1H), 3.46 (dd, *J* = 13.0, 10.9 Hz, 1H), 3.01–2.96 (m, 4H). **^{13}C NMR** (101 MHz, CDCl3) δ 168.1, 141.8, 137.0, 133.6, 132.9, 131.5, 129.4, 129.3, 128.8, 127.5, 126.5, 42.7, 41.7, 37.7. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}BrCl_2NONa^+$ $[M+Na]^+$: 407.9528, found: 407.9527.

*3-benzyl-1-methylindolin-2-one (**2a**):*



Following the **procedure B**, isolated by column chromatography on silica gel. **2a**: 42.7 mg, yield 90%, yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.28–7.13 (m, 6H), 6.94–6.86 (m, 1H), 6.76–6.71 (m, 2H), 3.70 (dd, *J* = 9.4, 4.4 Hz, 1H), 3.49 (dd, *J* = 13.7, 4.5 Hz, 1H), 3.14 (s, 3H), 2.87 (dd, *J* = 13.6, 9.4 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.1, 144.3, 138.0, 129.5, 128.5, 128.4, 128.0, 126.7, 124.6, 122.1, 108.0, 47.1, 36.9, 26.2. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{15}NONa^+$ $[M+Na]^+$: 260.1046, found: 260.1047.

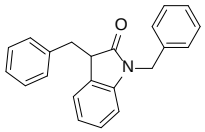
*3-benzyl-1-phenylindolin-2-one (**2b**):*



Following the **procedure B**, isolated by column chromatography on silica gel. **2b**: 28.7 mg, yield 48%, yellow solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.44–7.36 (m, 2H), 7.34–7.26 (m, 1H), 7.18–7.10 (m, 5H), 7.10–7.02 (m, 3H), 6.94–6.85 (m, 2H), 6.57 (d, *J* = 7.9 Hz, 1H), 3.84 (dd, *J* = 8.1, 4.4 Hz, 1H), 3.44 (dd, *J* = 13.5, 4.4 Hz, 1H), 3.09 (dd, *J* = 13.5, 8.2 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.6, 144.5, 137.4, 134.6, 129.7, 128.3, 128.2, 128.2, 128.0,

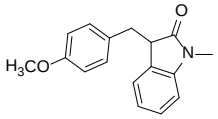
126.8, 126.8, 124.8, 122.6, 109.3, 47.3, 37.2. **HRMS** (ESI, m/z) Calcd for $C_{21}H_{17}NONa^+$ $[M+Na]^+$: 322.1202, found: 322.1202.

*1,3-dibenzylindolin-2-one (**2c**):*



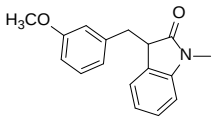
Following the **procedure B**, isolated by column chromatography on silica gel. **2c**: 52.6 mg, yield 84%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.16–7.09 (m, 6H), 7.08–7.03 (m, 2H), 7.02–6.97 (m, 1H), 6.90–6.81 (m, 4H), 6.47 (d, *J* = 7.8 Hz, 1H), 4.95 (d, *J* = 15.8 Hz, 1H), 4.56 (d, *J* = 15.8 Hz, 1H), 3.77 (dd, *J* = 8.0, 4.3 Hz, 1H), 3.43 (dd, *J* = 13.6, 4.3 Hz, 1H), 3.06 (dd, *J* = 13.6, 8.1 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.0, 143.5, 137.5, 135.7, 129.8, 128.8, 128.4, 128.3, 128.0, 127.5, 127.0, 126.8, 124.6, 122.2, 109.2, 47.2, 43.6, 36.6. **HRMS** (ESI, m/z) Calcd for $C_{22}H_{19}NONa^+$ $[M+Na]^+$: 336.1359, found: 336.1357.

*3-(4-methoxybenzyl)-1-methylindolin-2-one (**2d**):*



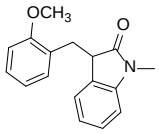
Following the **procedure B**, isolated by column chromatography on silica gel. **2d**: 45.4 mg, yield 85%, yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.26–7.18 (m, 1H), 7.05 (d, *J* = 8.5 Hz, 2H), 6.96–6.88 (m, 1H), 6.81–6.71 (m, 4H), 3.77 (s, 3H), 3.66 (dd, *J* = 9.1, 4.5 Hz, 1H), 3.42 (dd, *J* = 13.8, 4.5 Hz, 1H), 3.14 (s, 3H), 2.85 (dd, *J* = 13.7, 9.1 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.2, 158.4, 144.3, 130.5, 130.0, 128.6, 128.0, 124.6, 122.1, 113.7, 108.0, 55.3, 47.4, 36.0, 26.2. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{17}NO_2Na^+$ $[M+Na]^+$: 290.1151, found: 290.1152.

*3-(3-methoxybenzyl)-1-methylindolin-2-one (**2e**):*



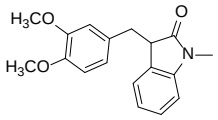
Following the **procedure B**, isolated by column chromatography on silica gel. **2e**: 45.9 mg, yield 86%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.20–7.06 (m, 2H), 6.89–6.80 (m, 1H), 6.72–6.63 (m, 5H), 3.66 (s, 3H), 3.63 (dd, *J* = 9.7, 4.5 Hz, 1H), 3.40 (dd, *J* = 13.6, 4.4 Hz, 1H), 3.08 (s, 3H), 2.75 (dd, *J* = 13.6, 9.5 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.2, 159.6, 144.3, 139.7, 129.4, 128.5, 128.1, 124.7, 122.2, 121.9, 114.7, 112.5, 108.0, 55.3, 47.1, 37.0, 26.3. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{17}NO_2Na^+$ $[M+Na]^+$: 290.1151, found: 290.1153.

*3-(2-methoxybenzyl)-1-methylindolin-2-one (**2f**):*



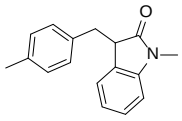
Following the **procedure B**, isolated by column chromatography on silica gel. **2f**: 42.7 mg, yield 80%, yellow solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.28–7.16 (m, 2H), 7.07 (d, *J* = 6.5 Hz, 1H), 6.91–6.80 (m, 3H), 6.77 (d, *J* = 7.8 Hz, 1H), 6.54 (d, *J* = 7.4 Hz, 1H), 3.87 (dd, *J* = 10.1, 5.1 Hz, 1H), 3.80 (s, 3H), 3.59 (dd, *J* = 13.4, 5.1 Hz, 1H), 3.20 (s, 3H), 2.68 (dd, *J* = 13.4, 10.2 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.7, 157.8, 144.2, 131.4, 129.1, 128.1, 127.7, 126.8, 124.8, 121.8, 120.2, 110.3, 107.7, 55.2, 44.9, 32.3, 26.2. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{17}NO_2Na^+$ $[M+Na]^+$: 290.1151, found: 290.1151.

*3-(3,4-dimethoxybenzyl)-1-methylindolin-2-one (**2g**):*



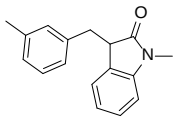
Following the **procedure B**, isolated by column chromatography on silica gel. **2g**: 42.2 mg, yield 71%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.28–7.19 (m, 1H), 6.97–6.92 (m, 1H), 6.86 (d, *J* = 7.8 Hz, 1H), 6.79–6.58 (m, 4H), 3.84 (s, 3H), 3.74 (s, 3H), 3.69 (dd, *J* = 9.0, 4.6 Hz, 1H), 3.41 (dd, *J* = 13.7, 4.3 Hz, 1H), 3.13 (s, 3H), 2.89 (dd, *J* = 13.7, 8.8 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.2, 148.6, 147.7, 144.4, 130.3, 128.5, 128.0, 124.6, 122.1, 121.6, 112.4, 110.9, 108.0, 55.9, 55.8, 47.4, 36.4, 26.2. **HRMS** (ESI, m/z) Calcd for $C_{18}H_{19}NO_3Na^+$ $[M+Na]^+$: 320.1257, found: 320.1259.

*1-ethyl-3-(4-methylbenzyl)indolin-2-one (**2h**):*



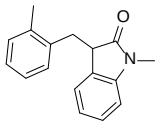
Following the **procedure B**, isolated by column chromatography on silica gel. **2h**: 41.7 mg, yield 83%, yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.27–7.18 (m, 1H), 7.06–7.02 (m, 4H), 6.94–6.86 (m, 1H), 6.75 (d, *J* = 8.1 Hz, 2H), 3.68 (dd, *J* = 9.3, 4.4 Hz, 1H), 3.45 (dd, *J* = 13.7, 4.5 Hz, 1H), 3.15 (s, 3H), 2.82 (dd, *J* = 13.7, 9.5 Hz, 1H), 2.30 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.2, 144.3, 136.2, 134.9, 129.3, 129.1, 128.6, 128.0, 124.6, 122.1, 108.0, 47.2, 36.5, 26.2, 21.2. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{17}NONa^+$ $[M+Na]^+$: 274.1202, found: 274.1202.

*1-methyl-3-(3-methylbenzyl)indolin-2-one (**2i**):*



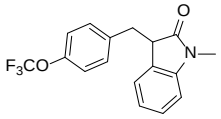
Following the **procedure B**, isolated by column chromatography on silica gel. **2i**: 41.2 mg, yield 82%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.25–7.08 (m, 2H), 7.04–6.92 (m, 3H), 6.93–6.85 (m, 1H), 6.78–6.68 (m, 2H), 3.67 (dd, *J* = 9.6, 4.5 Hz, 1H), 3.46 (dd, *J* = 13.6, 4.5 Hz, 1H), 3.14 (s, 3H), 2.78 (dd, *J* = 13.6, 9.7 Hz, 1H), 2.29 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.2, 144.2, 138.0, 137.9, 130.2, 128.5, 128.2, 127.9, 127.4, 126.4, 124.6, 122.0, 107.9, 47.0, 36.8, 26.1, 21.4. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{17}NONa^+$ $[M+Na]^+$: 274.1202, found: 274.1205.

*1-methyl-3-(2-methylbenzyl)indolin-2-one (**2j**):*



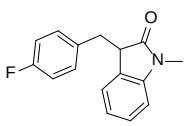
Following the **procedure B**, isolated by column chromatography on silica gel. **2j**: 32.6 mg, yield 65%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.28–7.16 (m, 5H), 6.89–6.78 (m, 2H), 6.54 (d, *J* = 7.4 Hz, 1H), 3.67 (dd, *J* = 11.0, 4.5 Hz, 1H), 3.53 (dd, *J* = 13.9, 4.6 Hz, 1H), 3.23 (s, 3H), 2.73 (dd, *J* = 13.9, 11.1 Hz, 1H), 2.28 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.4, 144.2, 136.9, 136.8, 130.6, 130.1, 128.7, 128.0, 126.9, 126.0, 124.8, 122.1, 108.0, 45.8, 34.5, 26.3, 19.7. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{17}NONa^+$ $[M+Na]^+$: 274.1202, found: 274.1203.

*1-methyl-3-(4-(trifluoromethoxy)benzyl)indolin-2-one (**2k**):*



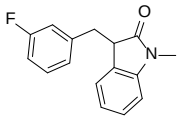
Following the **procedure B**, isolated by column chromatography on silica gel. **2k**: 52.6 mg, yield 82%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.29–7.20 (m, 1H), 7.15 (d, *J* = 8.5 Hz, 2H), 7.07 (d, *J* = 8.3 Hz, 2H), 7.00–6.92 (m, 1H), 6.84 (d, *J* = 7.3 Hz, 1H), 6.75 (d, *J* = 7.8 Hz, 1H), 3.70 (dd, *J* = 8.5, 4.6 Hz, 1H), 3.44 (dd, *J* = 13.7, 4.5 Hz, 1H), 3.13 (s, 3H), 2.99 (dd, *J* = 13.7, 8.6 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.8, 148.1, 144.4, 136.6, 130.9, 128.3, 128.1, 124.4, 122.3, 120.8, 120.6 (d, *J* = 257.6 Hz), 108.2, 47.0, 36.1, 26.2. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -57.91. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{14}F_3NO_2Na^+$ $[M+Na]^+$: 344.0869, found: 344.0868.

*3-(4-fluorobenzyl)-1-methylindolin-2-one (**2l**):*



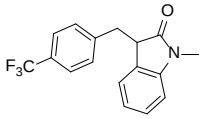
Following the **procedure B**, isolated by column chromatography on silica gel. **2l**: 36.7 mg, yield 72%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.27–7.20 (m, 1H), 7.08 (dd, *J* = 8.1, 5.6 Hz, 2H), 6.97–6.89 (m, 3H), 6.83 (d, *J* = 7.3 Hz, 1H), 6.74 (d, *J* = 7.8 Hz, 1H), 3.68 (dd, *J* = 8.5, 4.5 Hz, 1H), 3.41 (dd, *J* = 13.8, 4.5 Hz, 1H), 3.13 (s, 3H), 2.95 (dd, *J* = 13.7, 8.6 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.0, 163.0, 160.6, 144.4, 133.5 (d, *J* = 3.0 Hz), 131.0 (d, *J* = 8.1 Hz), 128.2, 124.5, 122.2, 115.1(d, *J* = 21.2 Hz), 108.1, 47.2, 36.0, 26.2. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -116.37. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}FNONa^+$ $[M+Na]^+$: 278.0952, found: 278.0953.

*3-(3-fluorobenzyl)-1-methylindolin-2-one (**2m**):*



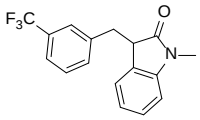
Following the **procedure B**, isolated by column chromatography on silica gel. **2m**: 38.2 mg, yield 75%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.29–7.16 (m, 2H), 7.00–6.82 (m, 4H), 6.77 (dd, *J* = 14.2, 7.6 Hz, 2H), 3.70 (dd, *J* = 8.9, 4.6 Hz, 1H), 3.46 (dd, *J* = 13.7, 4.6 Hz, 1H), 3.15 (s, 3H), 2.91 (dd, *J* = 13.7, 9.0 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.8, 162.7 (d, *J* = 247.5 Hz), 144.3, 140.5 (d, *J* = 7.1 Hz), 129.8 (d, *J* = 8.1 Hz), 128.2, 128.1, 125.2 (d, *J* = 2.0 Hz), 124.5, 122.3, 116.3 (d, *J* = 21.2 Hz), 113.7 (d, *J* = 20.2 Hz), 108.1, 46.9, 36.5 (d, *J* = 1.0 Hz), 26.2. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -113.39. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}FNONa^+$ $[M+Na]^+$: 278.0952, found: 278.0953.

*1-methyl-3-(4-(trifluoromethyl)benzyl)indolin-2-one (**2n**):*



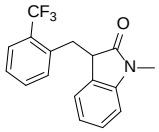
Following the **procedure B**, isolated by column chromatography on silica gel. **2n**: 51.2 mg, yield 84%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.49 (d, *J* = 8.0 Hz, 2H), 7.28–7.21 (m, 3H), 7.00–6.92 (m, 1H), 6.84 (d, *J* = 7.4 Hz, 1H), 6.76 (d, *J* = 7.8 Hz, 1H), 3.74 (dd, *J* = 8.5, 4.6 Hz, 1H), 3.49 (dd, *J* = 13.7, 4.6 Hz, 1H), 3.14 (s, 3H), 3.05 (dd, *J* = 13.7, 8.6 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.7, 144.3, 142.0, 129.9, 129.1 (q, *J* = 33.3 Hz), 128.4, 127.9, 125.3 (q, *J* = 3.0 Hz), 124.4, 124.3 (q, *J* = 272.7 Hz), 122.4, 108.3, 46.8, 36.5, 26.2. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -62.39. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{14}F_3NONa^+$ $[M+Na]^+$: 328.0920, found: 328.0920.

*1-methyl-3-(3-(trifluoromethyl)benzyl)indolin-2-one (**2o**):*



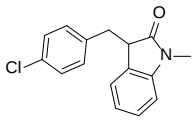
Following the **procedure B**, isolated by column chromatography on silica gel. **2o**: 48.2 mg, yield 79%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.48–7.41 (m, 1H), 7.39–7.29 (m, 3H), 7.27–7.18 (m, 1H), 6.99–6.91 (m, 1H), 6.83 (d, *J* = 7.3 Hz, 1H), 6.73 (d, *J* = 7.8 Hz, 1H), 3.72 (dd, *J* = 8.2, 4.7 Hz, 1H), 3.47 (dd, *J* = 13.7, 4.7 Hz, 1H), 3.11 (s, 3H), 3.06 (dd, *J* = 13.7, 8.4 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.7, 144.3, 138.7, 132.9, 130.5 (q, *J* = 32.3 Hz), 128.7, 128.3, 127.7, 126.2 (q, *J* = 3.0 Hz), 124.3, 124.1 (q, *J* = 272.7 Hz), 123.6 (q, *J* = 4.0 Hz), 122.3, 108.2, 46.8, 36.6, 26.1. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -62.64. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{14}F_3NONa^+$ $[M+Na]^+$: 328.0920, found: 328.0919.

*1-methyl-3-(2-(trifluoromethyl)benzyl)indolin-2-one (**2p**):*



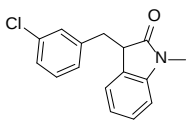
Following the **procedure B**, isolated by column chromatography on silica gel. **2p**: 36.6 mg, yield 60%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 7.9 Hz, 1H), 7.56–7.49 (m, 1H), 7.46 (d, *J* = 7.6 Hz, 1H), 7.43–7.35 (m, 1H), 7.28–7.20 (m, 1H), 7.00–6.74 (m, 2H), 6.58 (d, *J* = 7.4 Hz, 1H), 3.77 (dd, *J* = 9.4, 6.2 Hz, 1H), 3.59 (dd, *J* = 14.6, 6.1 Hz, 1H), 3.23 (s, 3H), 3.05 (dd, *J* = 14.6, 9.5 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.0, 144.1, 137.3 (d, *J* = 2.0 Hz), 132.0, 131.8, 129.3 (q, *J* = 29.3 Hz), 128.2, 128.1, 127.0, 126.4 (q, *J* = 6.1 Hz), 124.57 (q, *J* = 274.7 Hz), 124.59, 122.2, 108.1, 46.0, 33.7 (d, *J* = 1.0 Hz), 26.3. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -58.92. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{14}F_3NONa^+$ $[M+Na]^+$: 328.0920, found: 328.0920.

*3-(4-chlorobenzyl)-1-methylindolin-2-one (**2q**):*



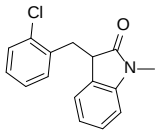
Following the **procedure B**, isolated by column chromatography on silica gel. **2q**: 47.2 mg, yield 87%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.27–7.16 (m, 3H), 7.06 (d, *J* = 8.3 Hz, 2H), 6.99–6.91 (m, 1H), 6.84 (d, *J* = 7.3 Hz, 1H), 6.75 (d, *J* = 7.8 Hz, 1H), 3.69 (dd, *J* = 8.4, 4.4 Hz, 1H), 3.41 (dd, *J* = 13.7, 4.6 Hz, 1H), 3.14 (s, 3H), 2.95 (dd, *J* = 13.7, 8.6 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.8, 144.3, 136.3, 132.5, 130.8, 128.4, 128.2, 128.0, 124.4, 122.2, 108.1, 46.9, 36.0, 26.2. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}ClNONa^+$ $[M+Na]^+$: 294.0656, found: 294.0659.

*3-(3-chlorobenzyl)-1-methylindolin-2-one (**2r**):*



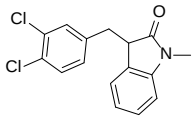
Following the **procedure B**, isolated by column chromatography on silica gel. **2r**: 49.9 mg, yield 92%, yellow solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.28–7.13 (m, 4H), 7.08–7.01 (m, 1H), 6.98–6.91 (m, 1H), 6.82–6.73 (m, 2H), 3.69 (dd, *J* = 8.8, 4.8 Hz, 1H), 3.44 (dd, *J* = 13.8, 4.6 Hz, 1H), 3.15 (s, 3H), 2.89 (dd, *J* = 13.7, 9.0 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.8, 144.3, 140.1, 134.1, 129.6, 129.6, 128.3, 128.0, 127.7, 127.0, 124.5, 122.3, 108.2, 46.8, 36.5, 26.3. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}ClNONa^+$ $[M+Na]^+$: 294.0656, found: 294.0657.

*3-(2-chlorobenzyl)-1-methylindolin-2-one (**2s**):*



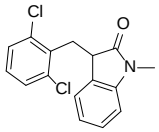
Following the **procedure B**, isolated by column chromatography on silica gel. **2s**: 46.6 mg, yield 86%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.41–7.36 (m, 1H), 7.26–7.17 (m, 4H), 6.92–6.84 (m, 1H), 6.80 (d, *J* = 7.8 Hz, 1H), 6.62 (d, *J* = 7.4 Hz, 1H), 3.85 (dd, *J* = 9.8, 5.5 Hz, 1H), 3.60 (dd, *J* = 13.8, 5.5 Hz, 1H), 3.22 (s, 3H), 2.91 (dd, *J* = 13.8, 9.9 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.0, 144.2, 136.2, 134.5, 131.9, 129.8, 128.4, 128.3, 128.1, 126.7, 124.7, 122.1, 108.0, 44.9, 34.9, 26.3. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}ClNONa^+$ $[M+Na]^+$: 294.0656, found: 294.0656.

*3-(3,4-dichlorobenzyl)-1-methylindolin-2-one (**2t**):*



Following the **procedure B**, isolated by column chromatography on silica gel. **2t**: 50.0 mg, yield 82%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.24 (m, 2H), 7.22 (d, *J* = 2.0 Hz, 1H), 7.01–6.94 (m, 2H), 6.88 (d, *J* = 7.4 Hz, 1H), 6.76 (d, *J* = 7.8 Hz, 1H), 3.69 (dd, *J* = 8.3, 4.7 Hz, 1H), 3.37 (dd, *J* = 13.8, 4.7 Hz, 1H), 3.14 (s, 3H), 2.96 (dd, *J* = 13.8, 8.4 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.6, 144.3, 138.1, 132.3, 131.4, 130.8, 130.3, 129.0, 128.4, 127.7, 124.3, 122.4, 108.3, 46.7, 35.8, 26.3. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{13}Cl_2NONa^+$ $[M+Na]^+$: 328.0266, found: 328.0266.

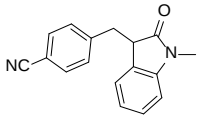
*3-(2,6-dichlorobenzyl)-1-methylindolin-2-one (**2u**):*



Following the **procedure B**, isolated by column chromatography on silica gel. **2u**: 32.3 mg, yield 53%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.34 (d, *J* = 8.0 Hz, 2H), 7.28–7.15 (m, 2H), 6.92–6.80 (m, 1H), 6.83 (d, *J* = 7.8 Hz, 1H), 6.56 (d, *J* = 7.4 Hz, 1H), 3.96 (dd, *J* = 10.2, 6.9 Hz, 1H), 3.59 (dd, *J* = 13.6, 6.9 Hz, 1H), 3.28 (dd, *J* = 13.6,

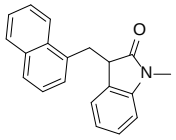
10.3 Hz, 1H), 3.24 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.6, 144.2, 136.4, 134.6, 128.7, 128.5, 128.1, 128.0, 124.3, 122.3, 108.1, 43.2, 32.6, 26.3. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{13}Cl_2NONa^+$ $[M+Na]^+$: 328.0266, found: 328.0266.

*4-((1-methyl-2-oxoindolin-3-yl)methyl)benzonitrile (**2v**):*



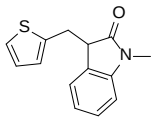
Following the **procedure B**, isolated by column chromatography on silica gel. **2v**: 41.9 mg, yield 80%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.52 (d, *J* = 8.2 Hz, 2H), 7.31–7.20 (m, 3H), 7.03–6.95 (m, 1H), 6.89 (d, *J* = 7.3 Hz, 1H), 6.76 (d, *J* = 7.8 Hz, 1H), 3.76 (dd, *J* = 7.9, 4.9 Hz, 1H), 3.46 (dd, *J* = 13.7, 4.8 Hz, 1H), 3.18–3.04 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.4, 144.3, 143.4, 132.1, 130.3, 128.5, 127.5, 124.2, 122.4, 118.9, 110.7, 108.3, 46.6, 36.7, 26.2. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{14}N_2ONa^+$ $[M+Na]^+$: 285.0998, found: 285.1000.

*1-methyl-3-(naphthalen-1-ylmethyl)indolin-2-one (**2w**):*



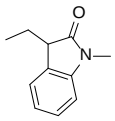
Following the **procedure B**, isolated by column chromatography on silica gel. **2w**: 39.0 mg, yield 68%, yellow solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.26 (d, *J* = 8.3 Hz, 1H), 7.91 (d, *J* = 7.9 Hz, 1H), 7.82 (d, *J* = 8.2 Hz, 1H), 7.62–7.48 (m, 2H), 7.47–7.39 (m, 1H), 7.29 (d, *J* = 6.9 Hz, 1H), 7.27–7.18 (m, 1H), 6.85–6.77 (m, 2H), 6.41 (d, *J* = 7.3 Hz, 1H), 4.14 (dd, *J* = 14.0, 3.8 Hz, 1H), 3.85 (dd, *J* = 11.1, 3.7 Hz, 1H), 3.26 (s, 3H), 2.97 (dd, *J* = 13.9, 11.2 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.5, 144.2, 134.7, 134.2, 131.8, 129.1, 129.0, 128.0, 128.0, 127.9, 126.5, 125.9, 125.3, 125.2, 123.8, 122.1, 108.0, 46.0, 35.1, 26.4. **HRMS** (ESI, m/z) Calcd for $C_{20}H_{17}NONa^+$ $[M+Na]^+$: 310.1202, found: 310.1204.

*1-methyl-3-(thiophen-2-ylmethyl)indolin-2-one (**2x**):*



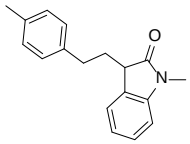
Following the **procedure B**, isolated by column chromatography on silica gel. **2x**: 35.0 mg, yield 72%, yellow solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.22–7.14 (m, 1H), 7.01 (d, *J* = 5.1 Hz, 1H), 6.93–6.84 (m, 2H), 6.80–6.76 (m, 1H), 6.71–6.65 (m, 2H), 3.64 (dd, *J* = 8.3, 4.4 Hz, 1H), 3.53 (dd, *J* = 14.7, 4.3 Hz, 1H), 3.20 (dd, *J* = 14.8, 8.3 Hz, 1H), 3.07 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.6, 144.5, 140.0, 128.3, 128.1, 126.7, 126.4, 124.5, 124.3, 122.4, 108.1, 47.3, 31.0, 26.3. **HRMS** (ESI, m/z) Calcd for $C_{14}H_{13}NOSNa^+$ $[M+Na]^+$: 266.0610, found: 266.0611.

*3-ethyl-1-methylindolin-2-one (**2y**):*



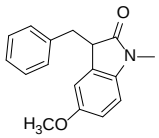
Following the **procedure B**, isolated by column chromatography on silica gel. **2y**: 28.0 mg, yield 80%, colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.19 (m, 2H), 7.08–7.04 (m, 1H), 6.82 (d, *J* = 7.7 Hz, 1H), 3.41 (t, *J* = 5.8 Hz, 1H), 3.20 (s, 3H), 2.09–1.93 (m, 2H), 0.89 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 178.0, 144.6, 129.1, 127.9, 123.9, 122.4, 108.0, 46.8, 26.2, 23.8, 10.2. **HRMS** (ESI, m/z) Calcd for $C_{11}H_{13}NONa^+$ $[M+Na]^+$: 198.0889, found: 198.0888.

*1-methyl-3-(4-methylphenethyl)indolin-2-one (**2z**):*



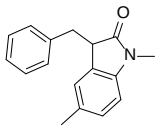
Following the **procedure B**, isolated by column chromatography on silica gel. **2z**: 45.5 mg, yield 86%, colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.32–7.22 (m, 2H), 7.10–7.00 (m, 5H), 6.82 (d, *J* = 7.7 Hz, 1H), 3.46 (t, *J* = 6.0 Hz, 1H), 3.18 (s, 3H), 2.74–2.55 (m, 2H), 2.29 (s, 3H), 2.23 (dd, *J* = 14.4, 7.9 Hz, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.8, 144.5, 138.3, 135.6, 129.2, 129.1, 128.5, 128.0, 123.9, 122.4, 108.1, 45.0, 32.6, 31.6, 26.2, 21.1. **HRMS** (ESI, m/z) Calcd for $C_{18}H_{19}NONa^+$ $[M+Na]^+$: 288.1359, found: 288.1362.

*3-benzyl-5-methoxy-1-methylindolin-2-one (**2a'**):*



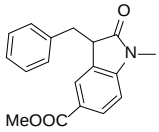
Following the **procedure B**, isolated by column chromatography on silica gel. **2a'**: 43.3 mg, yield 82%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.23–7.12 (m, 3H), 7.14–7.08 (m, 2H), 6.67 (dd, *J* = 8.4, 2.5 Hz, 1H), 6.57 (d, *J* = 8.4 Hz, 1H), 6.23 (d, *J* = 2.2 Hz, 1H), 3.60 (dd, *J* = 9.7, 4.5 Hz, 1H), 3.57 (s, 3H), 3.43 (dd, *J* = 13.6, 4.5 Hz, 1H), 3.06 (s, 3H), 2.76 (dd, *J* = 13.6, 9.7 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.8, 155.6, 138.1, 137.9, 129.8, 129.6, 128.4, 126.8, 112.5, 112.1, 108.2, 55.8, 47.6, 37.0, 26.3. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{17}NO_2Na^+$ $[M+Na]^+$: 290.1151, found: 290.1153.

*3-benzyl-1,5-dimethylindolin-2-one (**2b'**):*



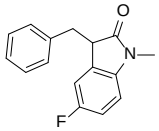
Following the **procedure B**, isolated by column chromatography on silica gel. **2b'**: 45.2 mg, yield 90%, yellow solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.29–7.18 (m, 3H), 7.16 (d, *J* = 6.8 Hz, 2H), 7.01 (d, *J* = 7.8 Hz, 1H), 6.66–6.54 (m, 2H), 3.67 (dd, *J* = 9.2, 4.5 Hz, 1H), 3.47 (dd, *J* = 13.7, 4.5 Hz, 1H), 3.12 (s, 3H), 2.87 (dd, *J* = 13.7, 9.3 Hz, 1H), 2.22 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.1, 141.9, 138.2, 131.6, 129.5, 128.6, 128.3, 128.2, 126.7, 125.5, 107.7, 47.2, 36.9, 26.2, 21.2. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{17}NONa^+$ $[M+Na]^+$: 274.1202, found: 274.1204.

*methyl 3-benzyl-1-methyl-2-oxoindoline-5-carboxylate (**2c'**):*



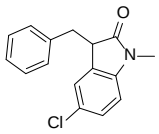
Following the **procedure B**, isolated by column chromatography on silica gel. **2c'**: 49.0 mg, yield 83%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.98 (d, *J* = 8.2 Hz, 1H), 7.58 (s, 1H), 7.26–7.19 (m, 3H), 7.14–7.06 (m, 2H), 6.76 (d, *J* = 8.2 Hz, 1H), 3.88 (s, 3H), 3.76 (dd, *J* = 8.0, 4.8 Hz, 1H), 3.46 (dd, *J* = 13.6, 4.8 Hz, 1H), 3.15 (s, 3H), 3.06 (dd, *J* = 13.6, 8.1 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.3, 167.0, 148.5, 137.1, 130.8, 129.5, 128.4, 128.2, 126.9, 125.8, 124.1, 107.5, 52.1, 46.9, 36.6, 26.4. **HRMS** (ESI, m/z) Calcd for $C_{18}H_{17}NO_3Na^+$ $[M+Na]^+$: 318.1101, found: 318.1102.

*3-benzyl-5-fluoro-1-methylindolin-2-one (**2d'**):*



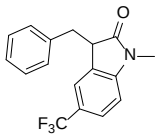
Following the **procedure B**, isolated by column chromatography on silica gel. **2d'**: 46.4 mg, yield 91%, yellow solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.30–7.19 (m, 3H), 7.15 (d, *J* = 6.7 Hz, 2H), 6.92 (td, *J* = 9.0, 2.6 Hz, 1H), 6.65 (dd, *J* = 8.5, 4.2 Hz, 1H), 6.47 (dd, *J* = 8.2, 2.4 Hz, 1H), 3.70 (dd, *J* = 9.2, 4.6 Hz, 1H), 3.49 (dd, *J* = 13.7, 4.5 Hz, 1H), 3.14 (s, 3H), 2.87 (dd, *J* = 13.7, 9.4 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.8, 158.9 (d, *J* = 240.4 Hz), 140.3, 137.6, 130.0 (d, *J* = 8.1 Hz), 129.4, 128.6, 127.0, 114.2 (d, *J* = 23.2 Hz), 112.8 (d, *J* = 25.3 Hz), 108.3 (d, *J* = 8.1 Hz), 47.5, 36.8, 26.4. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -121.02. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}FNONa^+$ $[M+Na]^+$: 278.0952, found: 278.0953.

*3-benzyl-5-chloro-1-methylindolin-2-one (**2e'**):*



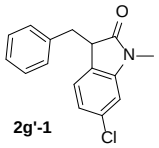
Following the **procedure B**, isolated by column chromatography on silica gel. **2e'**: 47.2 mg, yield 87%, white solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.30–7.12 (m, 6H), 6.74–6.63 (m, 2H), 3.62 (dd, *J* = 9.1, 4.6 Hz, 1H), 3.39 (dd, *J* = 13.7, 4.6 Hz, 1H), 3.05 (s, 3H), 2.82 (dd, *J* = 13.7, 9.1 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 176.6, 142.9, 137.4, 130.1, 129.4, 128.5, 128.0, 127.5, 127.0, 125.1, 108.9, 47.2, 36.8, 26.3. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}ClNONa^+$ $[M+Na]^+$: 294.0656, found: 294.0656.

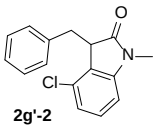
*3-benzyl-1-methyl-5-(trifluoromethyl)indolin-2-one (**2f'**):*



Following the **procedure B**, isolated by column chromatography on silica gel. **2f**': 53.4 mg, yield 88%, yellow solid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.42 (d, *J* = 8.1 Hz, 1H), 7.28–7.11 (m, 3H), 7.09–7.00 (m, 2H), 6.87 (s, 1H), 6.72 (d, *J* = 8.2 Hz, 1H), 3.65 (dd, *J* = 8.9, 4.7 Hz, 1H), 3.42 (dd, *J* = 13.6, 4.7 Hz, 1H), 3.09 (s, 3H), 2.83 (dd, *J* = 13.6, 9.0 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.0, 147.3, 137.2, 129.5, 128.9, 128.6, 127.1, 125.9 (q, *J* = 4.0 Hz), 124.4 (q, *J* = 272.7 Hz), 124.4 (q, *J* = 33.3 Hz), 121.8 (q, *J* = 4.0 Hz), 107.7, 47.0, 36.8, 26.4. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -61.63. **HRMS** (ESI, m/z) Calcd for $C_{17}H_{14}F_3NONa^+$ $[M+Na]^+$: 328.0920, found: 328.0922.

*3-benzyl-6-chloro-1-methylindolin-2-one (**2g'-1**), 3-benzyl-4-chloro-1-methylindolin-2-one (**2g'-2**):*





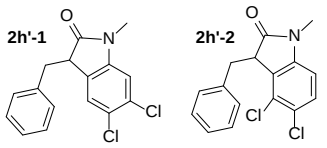
Following the **procedure B**, isolated as a pair of inseparable regioisomers by column chromatography on silica gel. **2g'-1:2g'-2 = 44:56** (46.1 mg, yield 85%), yellow solid.

2g'-1 (minor isomer): **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.20–6.85 (m, 5H), 6.80 (dd, *J* = 7.9, 1.7 Hz, 1H), 6.66 (s, 1H), 6.53 (d, *J* = 7.9 Hz, 1H), 3.60 (dd, *J* = 9.4, 4.8 Hz, 1H), 3.40 (dd, *J* = 13.7, 4.6 Hz, 1H), 3.05 (s, 3H), 2.77 (dd, *J* = 13.6, 9.4Hz, 1H).

2g'-2 (major isomer): **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.20–6.85 (m, 7H), 6.38 (d, *J* = 7.7 Hz, 1H), 3.74 (apparent t, *J* = 4.6 Hz, 1H), 3.54 (dd, *J* = 13.4, 5.2 Hz, 1H), 3.37 (dd, *J* = 13.3, 4.0 Hz, 1H), 2.89 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 177.0, 176.3, 145.9, 145.5, 137.6, 136.3, 133.9, 130.8, 129.4, 129.4, 129.2, 128.5, 127.8, 126.9, 126.7, 126.6, 125.5, 125.4, 122.9, 121.9, 108.8, 106.3, 47.6, 46.8, 36.8, 33.7, 26.3, 26.2. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}ClNONa^+$ $[M+Na]^+$: 294.0656, found: 294.0659.

*3-benzyl-5,6-dichloro-1-methylindolin-2-one (**2h'-1**), 3-benzyl-4,5-dichloro-1-methylindolin-2-one (**2h'-2**):*



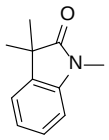
Following the **procedure B**, isolated as a pair of inseparable regioisomers by column chromatography on silica gel. **2h'-1:2h'-2 = 37:63** (47.0 mg, yield 77%), yellow oil.

2h'-1 (minor isomer): **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.35–6.88 (m, 5H), 6.81 (s, 1H), 6.75 (s, 1H), 3.67 (dd, *J* = 9.3, 4.6 Hz, 1H), 3.50–3.40 (m, 1H), 3.11 (s, 3H), 2.87 (dd, *J* = 13.7, 9.2 Hz, 1H).

2h'-2 (major isomer): **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.35–6.88 (m, 6H), 6.40 (d, *J* = 8.3 Hz, 1H), 3.83 (apparent t, *J* = 4.6 Hz, 1H), 3.62 (dd, *J* = 13.6, 5.2 Hz, 1H), 3.50–3.40 (m, 1H), 2.95 (s, 3H).

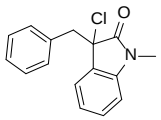
^{13}C NMR (101 MHz, $CDCl_3$) δ 176.4, 176.0, 144.2, 143.9, 137.1, 135.9, 132.0, 129.8, 129.4, 129.3, 129.2, 128.6, 128.3, 128.0, 127.4, 127.1, 126.8, 126.4, 126.0, 125.5, 109.9, 107.0, 48.3, 46.8, 36.7, 33.6, 26.4, 26.2. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{13}Cl_2NONa^+$ $[M+Na]^+$: 328.0266, found: 328.0268.

*1,3,3-trimethylindolin-2-one (**2l'**)*[2]*:*



Following the **procedure B**, isolated by column chromatography on silica gel. **2l'**: 33.5 mg, yield 96%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30–7.24 (m, 1H), 7.21 (d, *J* = 7.4 Hz, 1H), 7.07 (t, *J* = 7.5 Hz, 1H), 6.85 (d, *J* = 7.7 Hz, 1H), 3.22 (s, 3H), 1.37 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 181.5, 142.8, 136.0, 127.8, 122.6, 122.4, 108.2, 44.3, 26.3, 24.5.

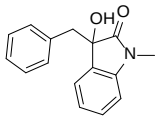
*3-benzyl-3-chloro-1-methylindolin-2-one (**5**):*



Yield 79%, colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.23 (d, *J* = 7.4 Hz, 1H), 7.20–7.13 (m, 1H), 7.07–6.96 (m, 4H), 6.86 (d, *J* = 6.3 Hz, 2H), 6.53 (d, *J* = 7.8 Hz, 1H), 3.51–3.40 (m, 2H), 2.93 (s, 3H). **^{13}C NMR** (101 MHz,

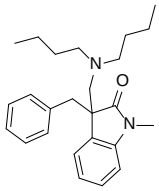
$CDCl_3$) δ 173.6, 142.7, 133.6, 130.5, 130.2, 128.7, 128.0, 127.3, 124.9, 123.1, 108.5, 65.2, 45.3, 26.4. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}ClNONa^+$ $[M+Na]^+$: 294.0656, found: 294.0656.

*3-benzyl-3-hydroxy-1-methylindolin-2-one (**6**):*



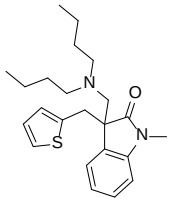
Yield 85%, colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.27–7.21 (m, 1H), 7.19 (d, *J* = 7.2 Hz, 1H), 7.14–7.02 (m, 4H), 6.96–6.90 (m, 2H), 6.62 (d, *J* = 7.8 Hz, 1H), 3.33 (d, *J* = 12.8 Hz, 1H), 3.17 (d, *J* = 12.8 Hz, 1H), 2.97 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 178.2, 143.2, 134.2, 130.4, 129.7, 129.5, 127.8, 126.9, 124.6, 123.0, 108.3, 77.7, 45.0, 26.0. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{14}F_3NONa^+$ $[M+Na]^+$: 276.0995, found: 276.0996.

*3-benzyl-3-((dibutylamino)methyl)-1-methylindolin-2-one (**7**):*



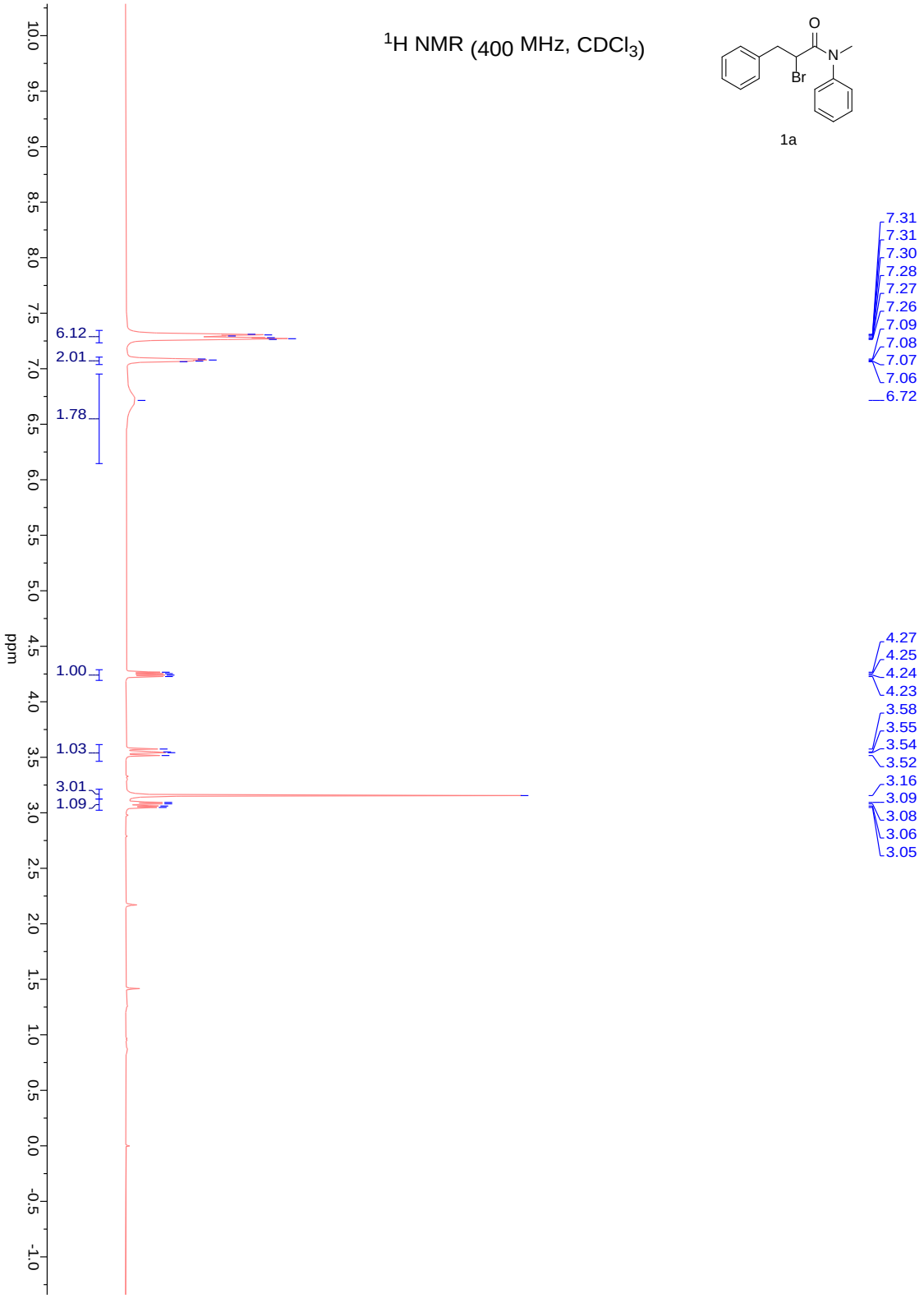
Yield 85%, colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.23 (d, *J* = 7.3 Hz, 1H), 7.16–7.09 (m, 1H), 7.02–6.95 (m, 4H), 6.84 (dd, *J* = 6.5, 3.0 Hz, 2H), 6.54 (d, *J* = 7.7 Hz, 1H), 3.16–2.92 (m, 4H), 2.94 (s, 3H), 2.33–2.15 (m, 4H), 1.24–0.89 (m, 8H), 0.76 (t, *J* = 7.2 Hz, 6H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 179.0, 144.5, 136.1, 131.1, 130.0, 127.6, 127.5, 126.3, 124.4, 121.5, 107.5, 62.6, 56.7, 55.2, 41.3, 29.1, 25.8, 20.3, 14.2. **HRMS** (ESI, m/z) Calcd for $C_{25}H_{35}N_2O^+[M+H]^+$: 379.2744, found: 379.2746.

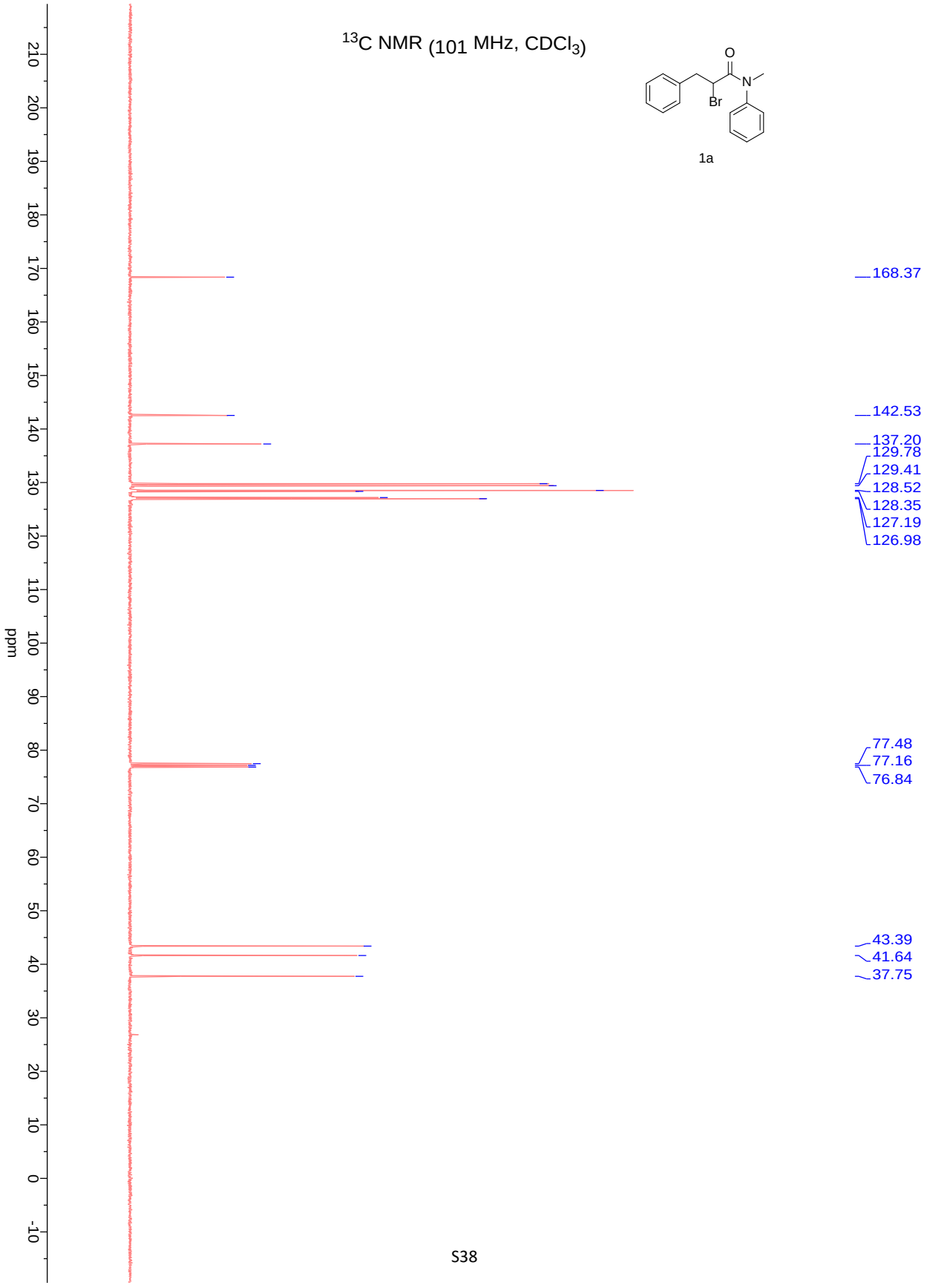
3-((dibutylamino)methyl)-1-methyl-3-(thiophen-2-ylmethyl)indolin-2-one[3]*:*



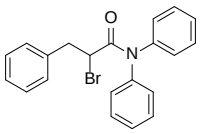
Yield 75%, yellow oil; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.30–7.25 (m, 1H), 7.22 (t, *J* = 7.6 Hz, 1H), 7.04 (t, *J* = 7.4 Hz, 1H), 6.89 (d, *J* = 4.5 Hz, 1H), 6.75–6.62 (m, 2H), 6.55 (d, *J* = 2.5 Hz, 1H), 3.28 (dd, *J* = 39.5, 14.2 Hz, 2H), 3.10–2.92 (m, 5H), 2.34–2.14 (m, 4H), 1.21–0.91 (m, 8H), 0.77 (t, *J* = 7.2 Hz, 6H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 178.8, 144.9, 138.0, 131.1, 128.0, 126.7, 126.2, 124.2, 124.0, 121.8, 107.7, 62.6, 56.4, 55.2, 35.3, 29.1, 26.1, 20.4, 14.3.

VIII. NMR spectra



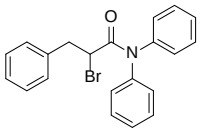

^{13}C NMR (101 MHz, CDCl$_3$)
O
N
Br
1a
ppm
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
168.37
142.53
137.20
129.78
129.41
128.52
128.35
127.19
126.98
77.48
77.16
76.84
43.39
41.64
37.75

^{1}H NMR (400 MHz, $CDCl_3$)



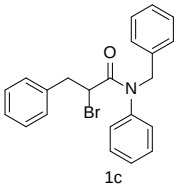
1b

^{13}C NMR (101 MHz, $CDCl_3$)



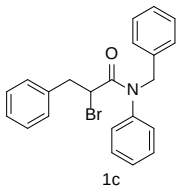
1b

^{1}H NMR (400 MHz, $CDCl_3$)



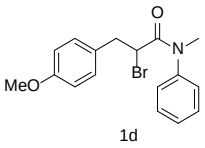
1c

^{13}C NMR (101 MHz, $CDCl_3$)



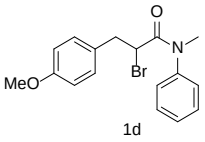
1c

^{1}H NMR (400 MHz, $CDCl_3$)

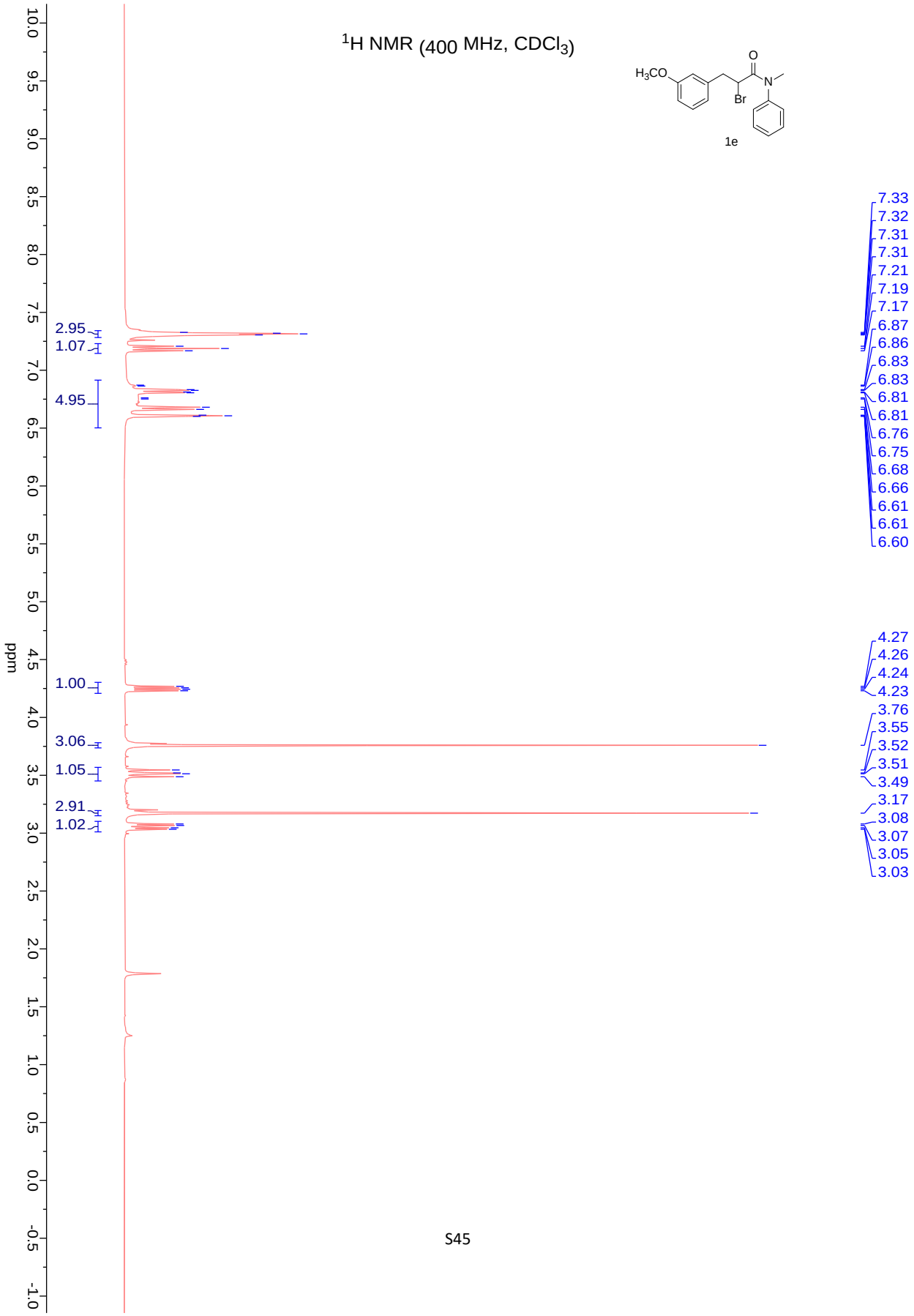


1d

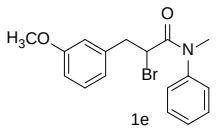
^{13}C NMR (101 MHz, $CDCl_3$)



1d

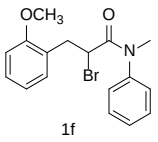

^{1}H NMR (400 MHz, $CDCl_3$)
H_3CO
O
N
Br
1e
ppm
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
2.95
1.07
4.95
1.00
3.06
1.05
2.91
1.02
7.33
7.32
7.31
7.31
7.21
7.19
7.17
6.87
6.86
6.83
6.83
6.81
6.81
6.76
6.75
6.68
6.66
6.61
6.61
6.60
4.27
4.26
4.24
4.23
3.76
3.55
3.52
3.51
3.49
3.17
3.08
3.07
3.05
3.03

^{13}C NMR (101 MHz, $CDCl_3$)

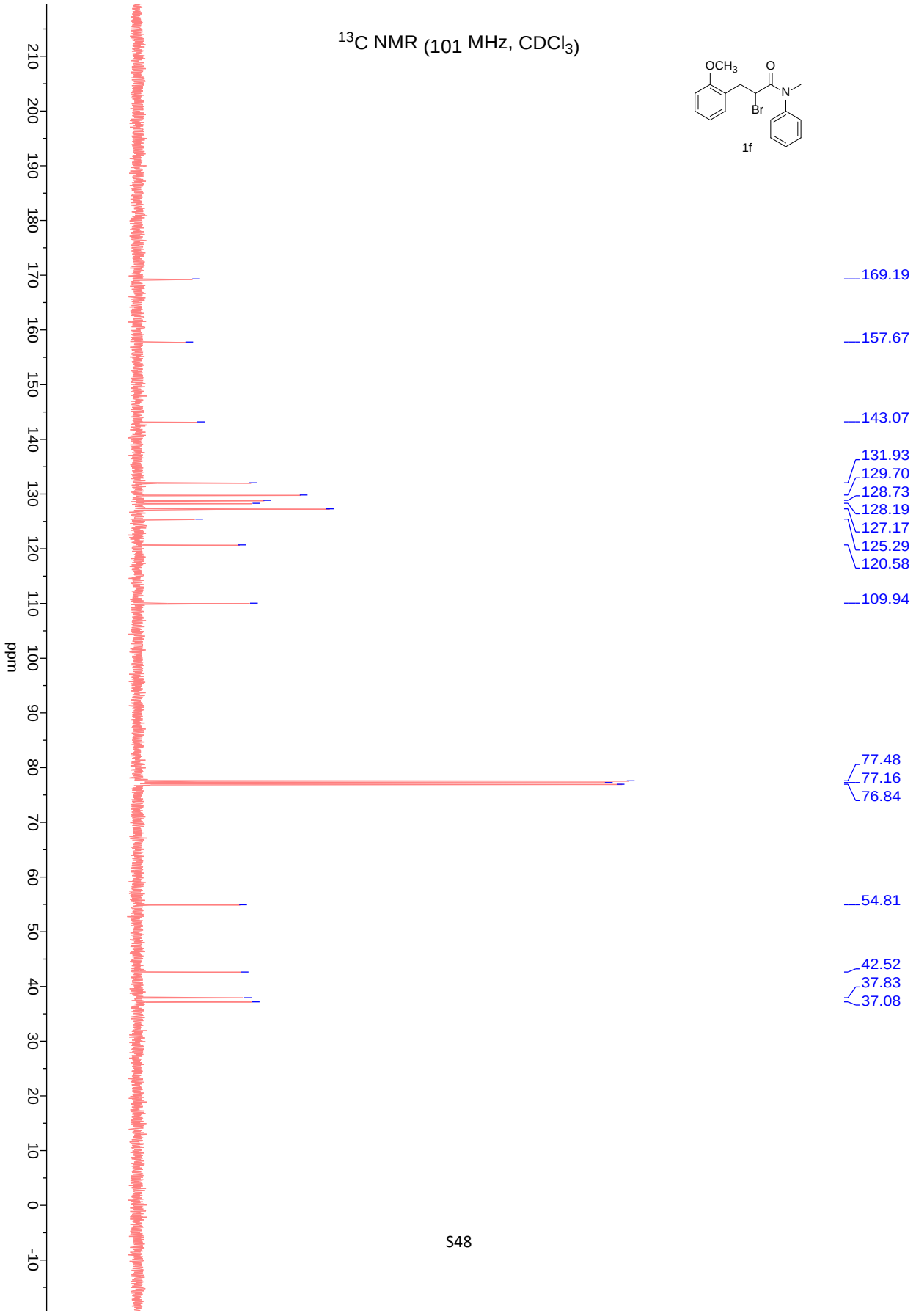


1e

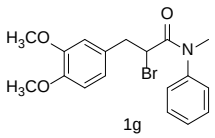
^{1}H NMR (400 MHz, $CDCl_3$)



1f

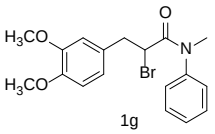

13C NMR (101 MHz, CDCl3)
OCH3
O
N
Br
1f
169.19
157.67
143.07
131.93
129.70
128.73
128.19
127.17
125.29
120.58
109.94
77.48
77.16
76.84
54.81
42.52
37.83
37.08
ppm
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

^{1}H NMR (400 MHz, $CDCl_3$)

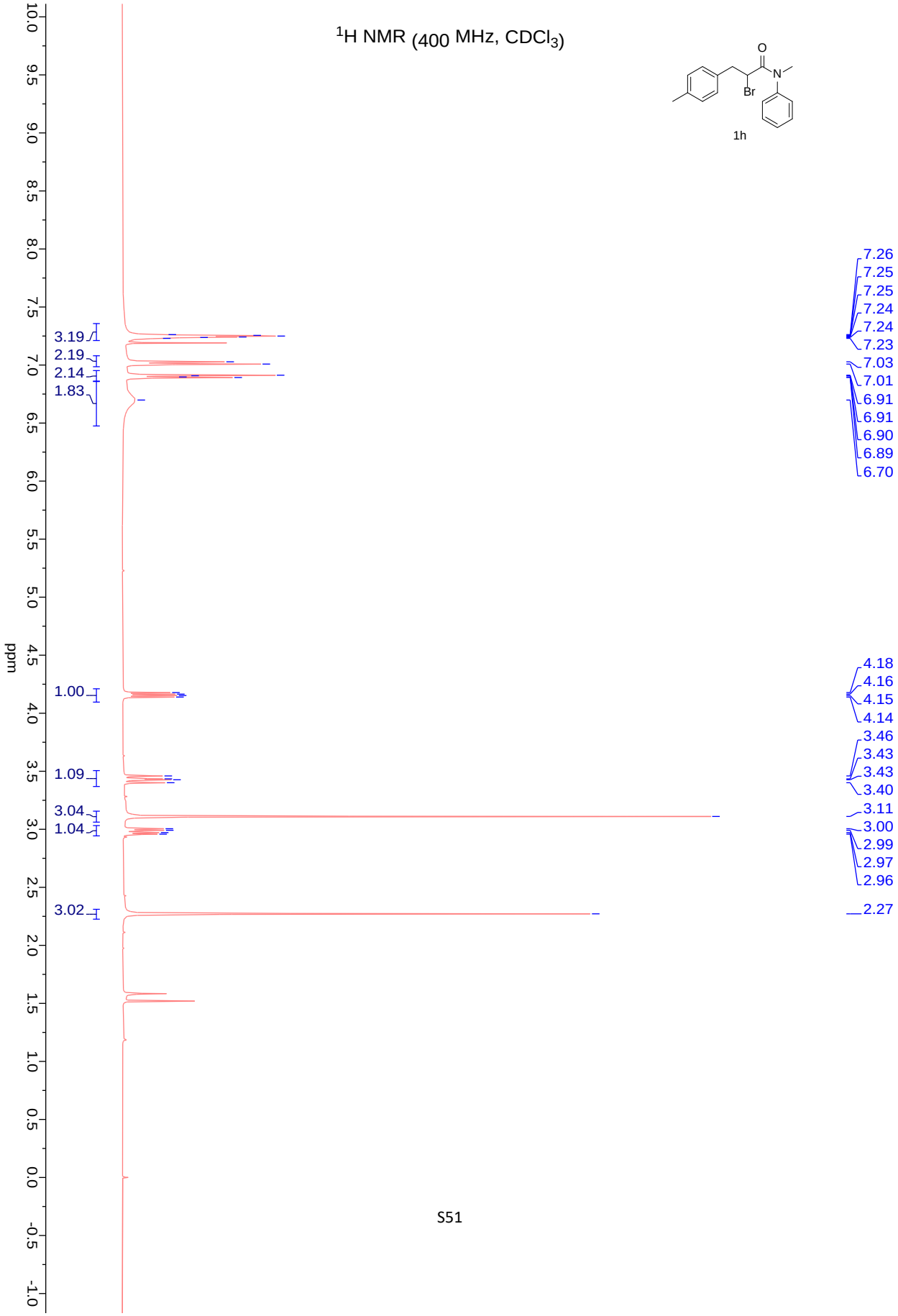


1g

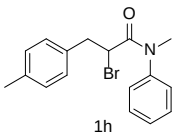
^{13}C NMR (101 MHz, $CDCl_3$)



1g

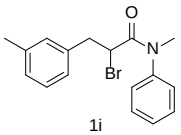

^{1}H NMR (400 MHz, $CDCl_3$)
O
N
Br
1h
ppm
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
3.19
2.19
2.14
1.83
1.00
1.09
3.04
1.04
3.02
7.26
7.25
7.25
7.24
7.24
7.23
7.03
7.01
6.91
6.91
6.90
6.89
6.70
4.18
4.16
4.15
4.14
3.46
3.43
3.43
3.40
3.11
3.00
2.99
2.97
2.96
2.27

^{13}C NMR (101 MHz, $CDCl_3$)

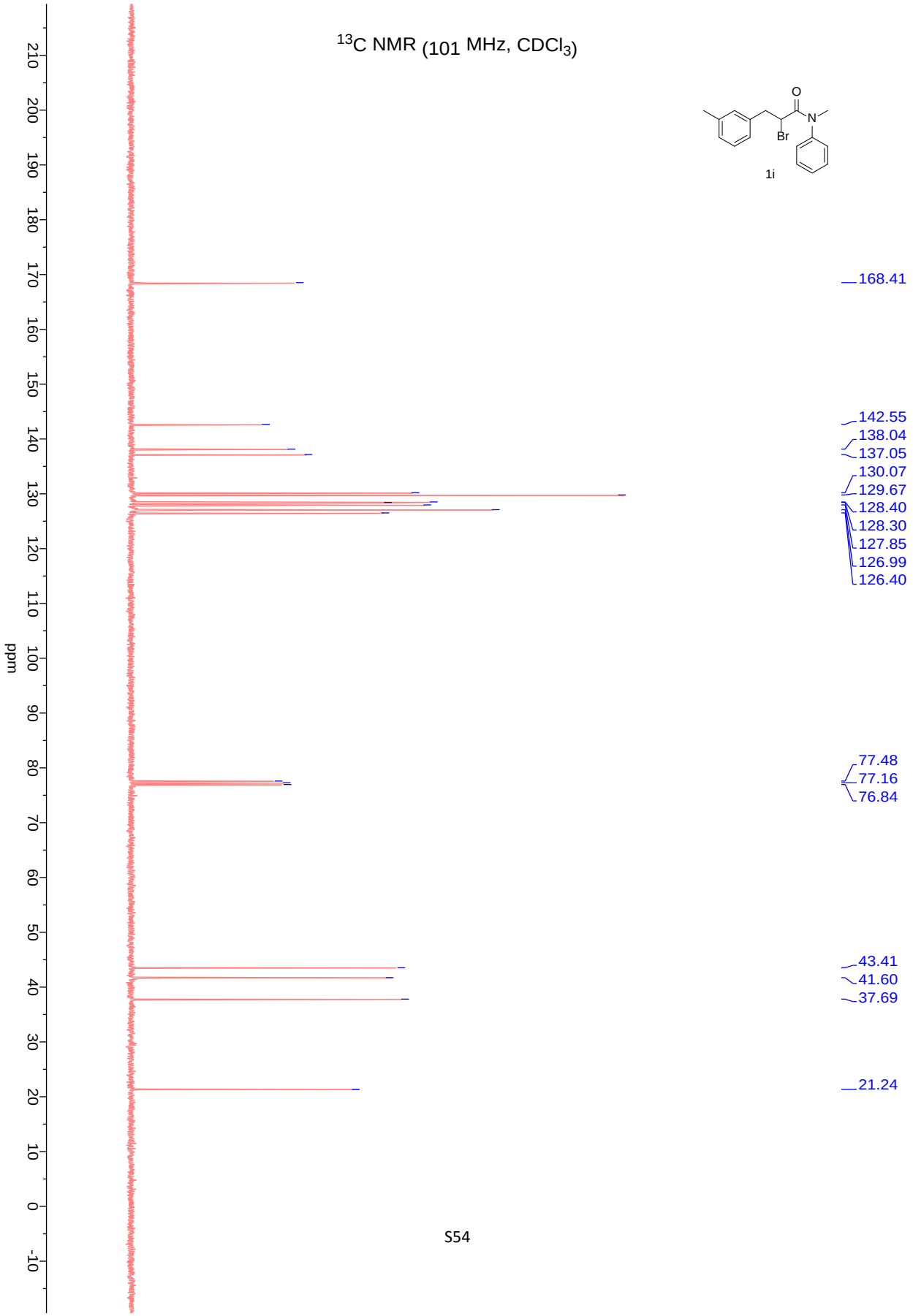


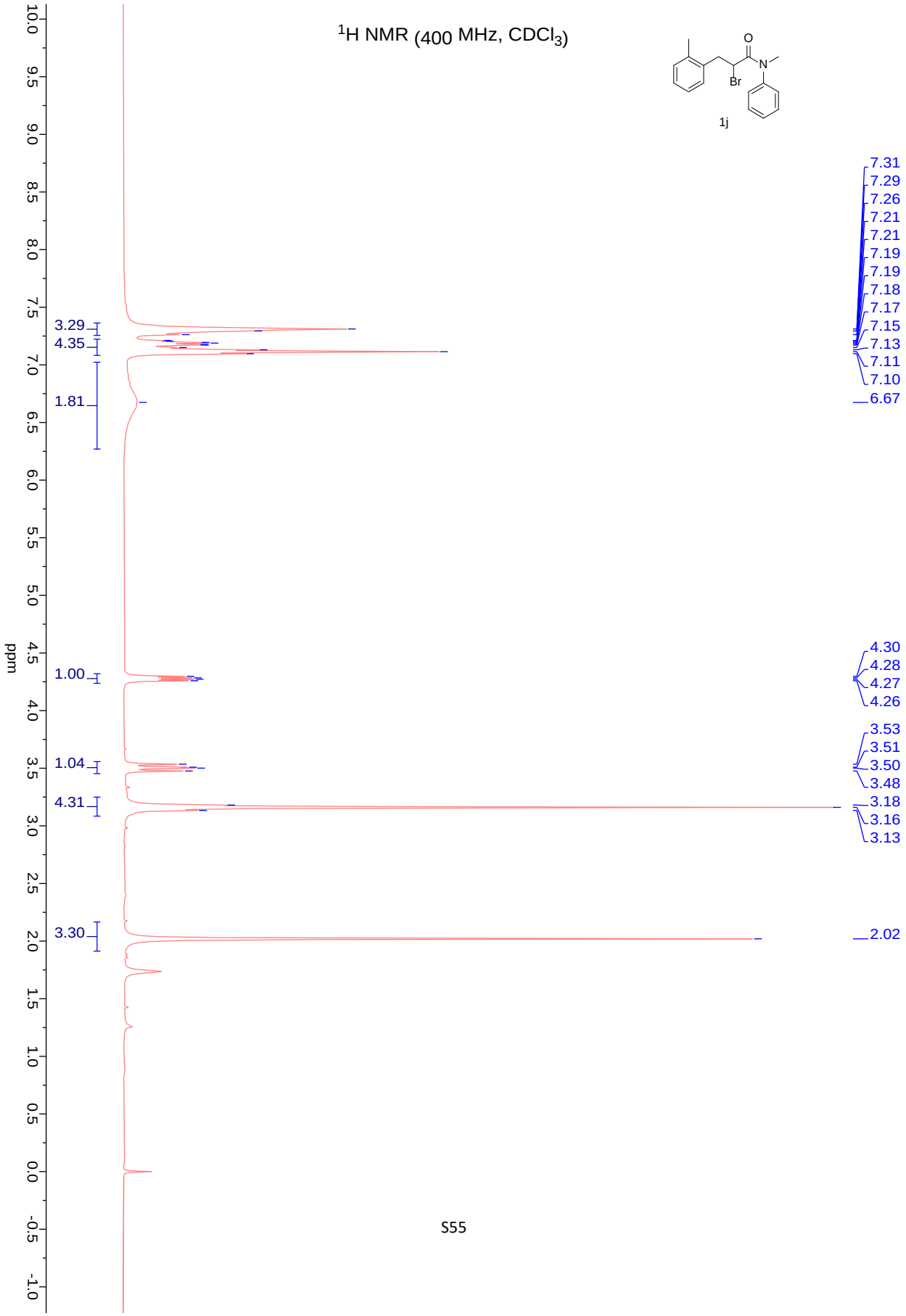
1h

^{1}H NMR (400 MHz, $CDCl_3$)

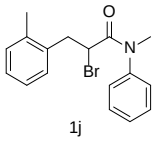


1i

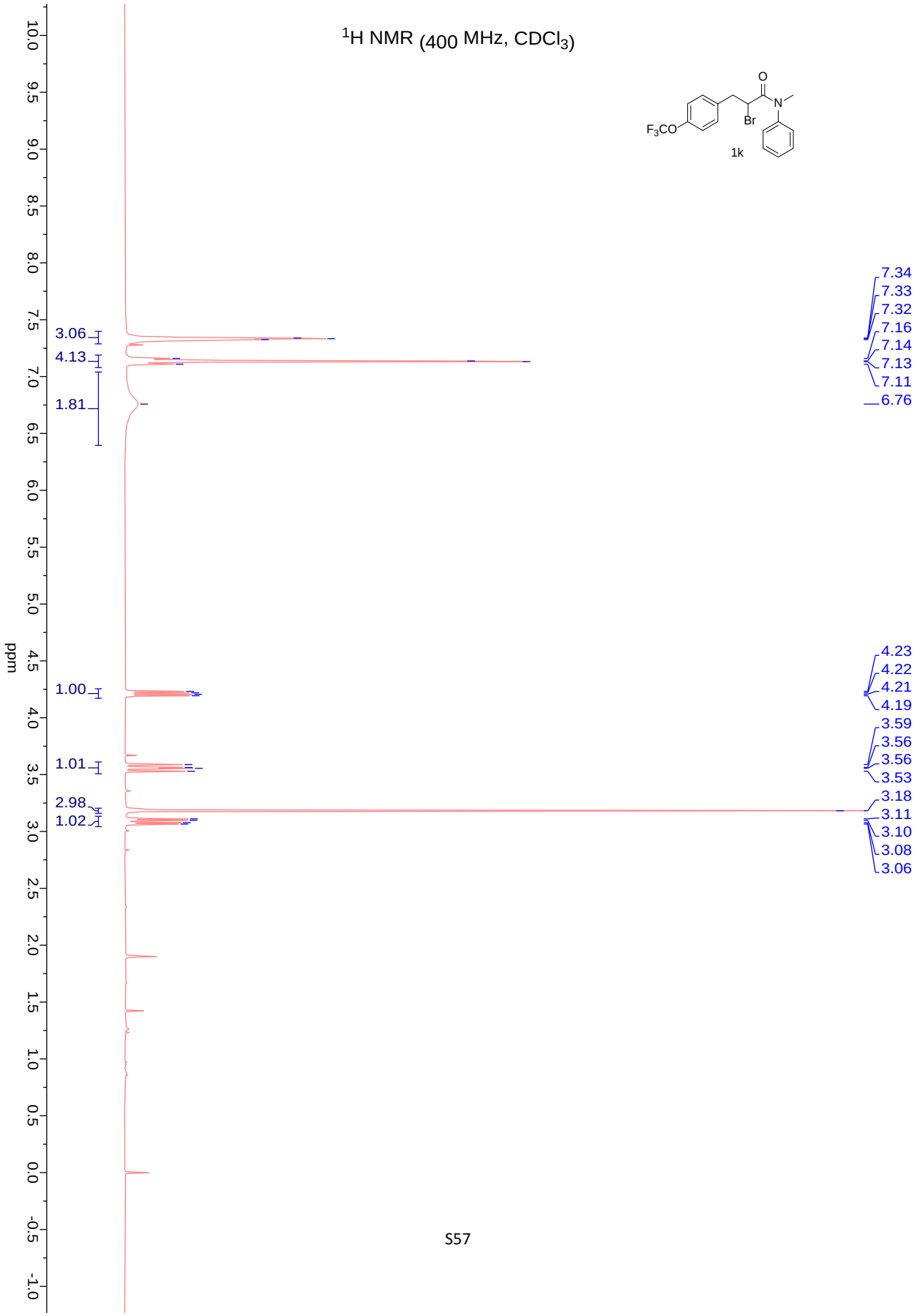

^{13}C NMR (101 MHz, $CDCl_3$)
O
N
Br
1i
168.41
142.55
138.04
137.05
130.07
129.67
128.40
128.30
127.85
126.99
126.40
77.48
77.16
76.84
43.41
41.60
37.69
21.24
ppm
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10


^{1}H NMR (400 MHz, $CDCl_3$)
O
N
Br
1j
ppm
10.0
9.5
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
-1.0
3.29
4.35
1.81
1.00
1.04
4.31
3.30
7.31
7.29
7.26
7.21
7.21
7.19
7.19
7.18
7.17
7.15
7.13
7.11
7.10
6.67
4.30
4.28
4.27
4.26
3.53
3.51
3.50
3.48
3.18
3.16
3.13
2.02

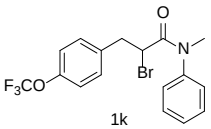
^{13}C NMR (101 MHz, $CDCl_3$)



1j

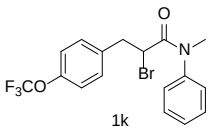

^{1}H NMR (400 MHz, $CDCl_3$)
O
N
Br
F_3CO
1k
7.34
7.33
7.32
7.16
7.14
7.13
7.11
6.76
4.23
4.22
4.21
4.19
3.59
3.56
3.56
3.53
3.18
3.11
3.10
3.08
3.06
3.06
4.13
1.81
1.00
1.01
2.98
1.02
ppm
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0

^{13}C NMR (101 MHz, $CDCl_3$)



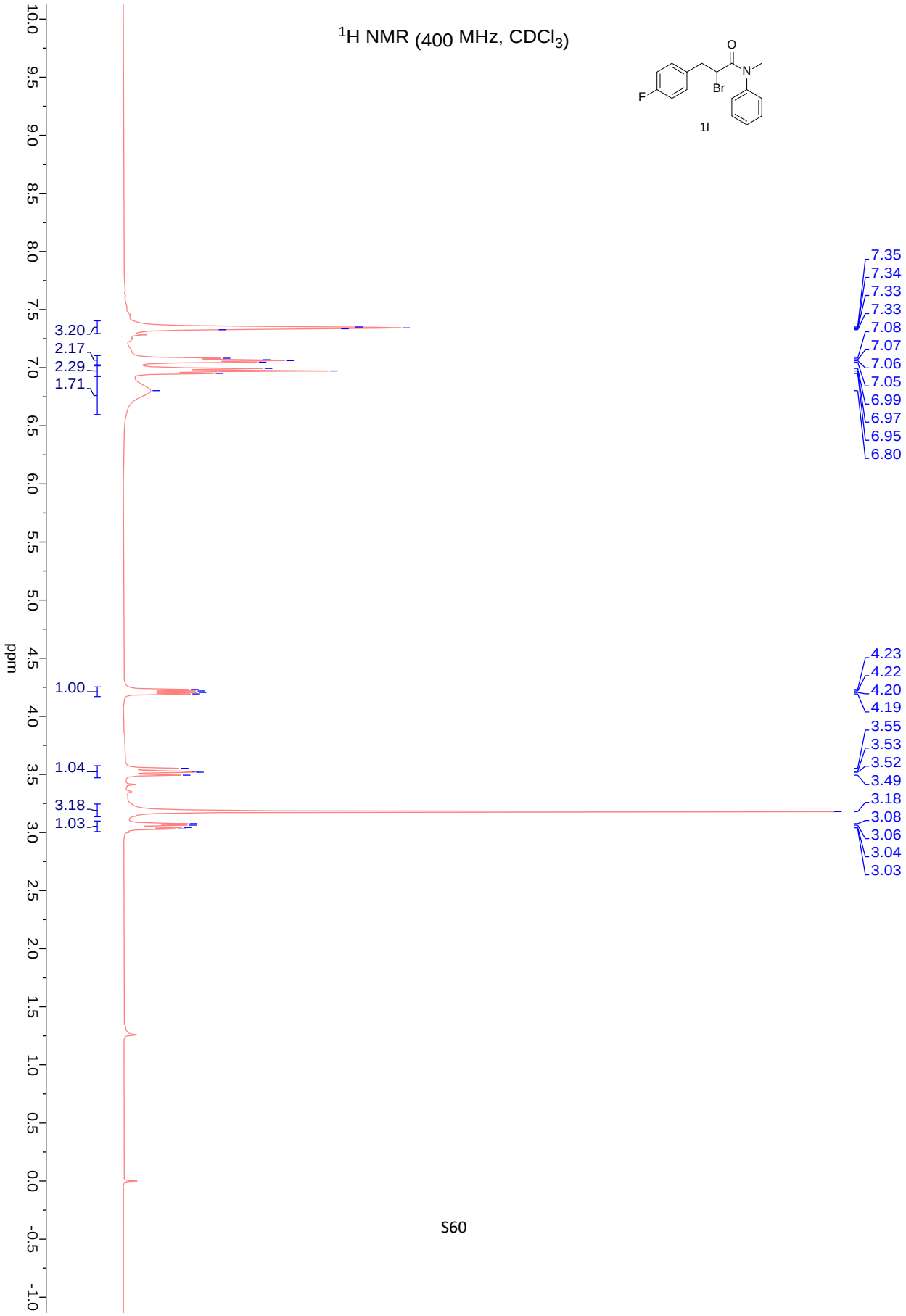
1k

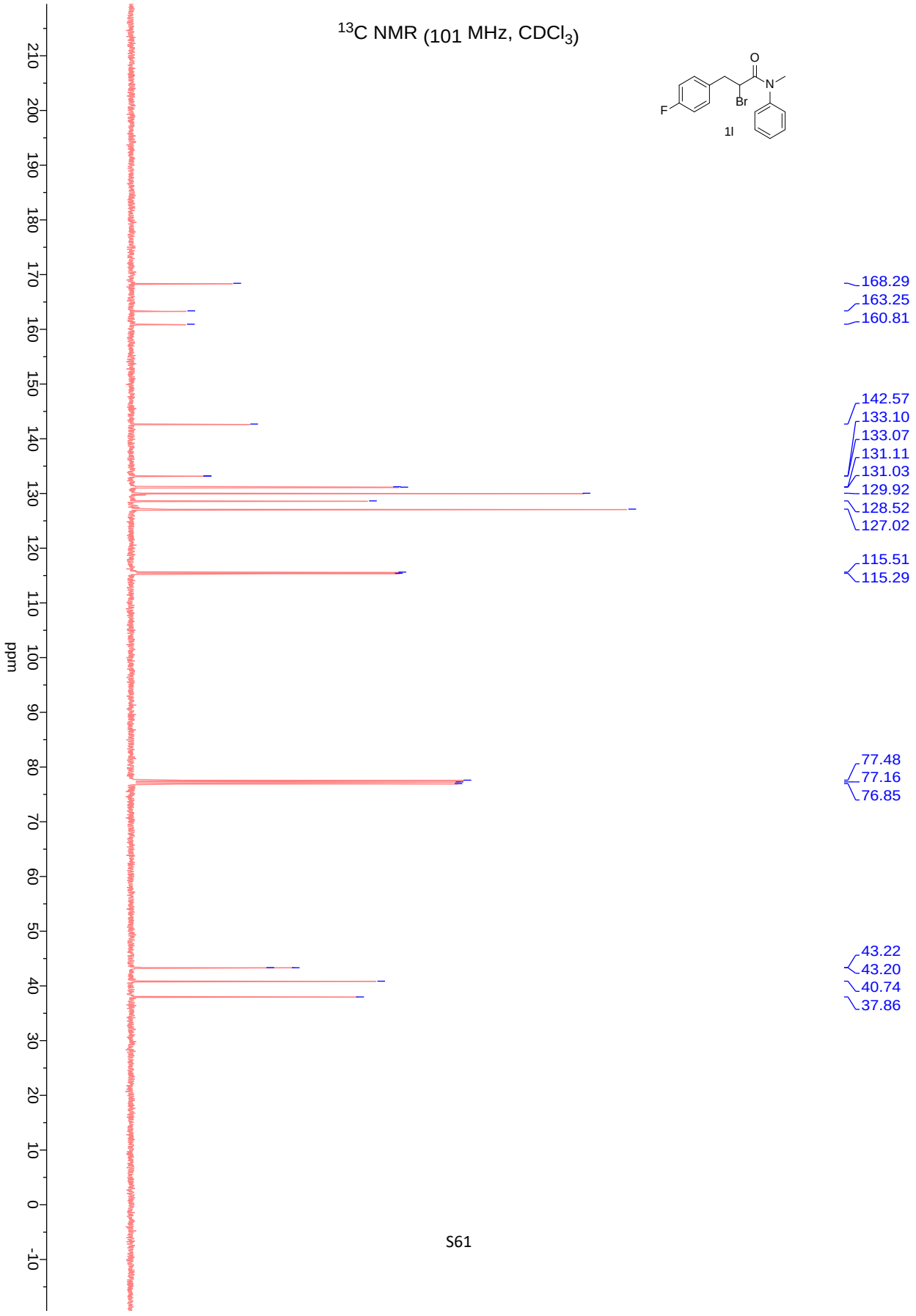
^{19}F NMR (376 MHz, $CDCl_3$)



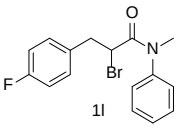
1k

-57.94

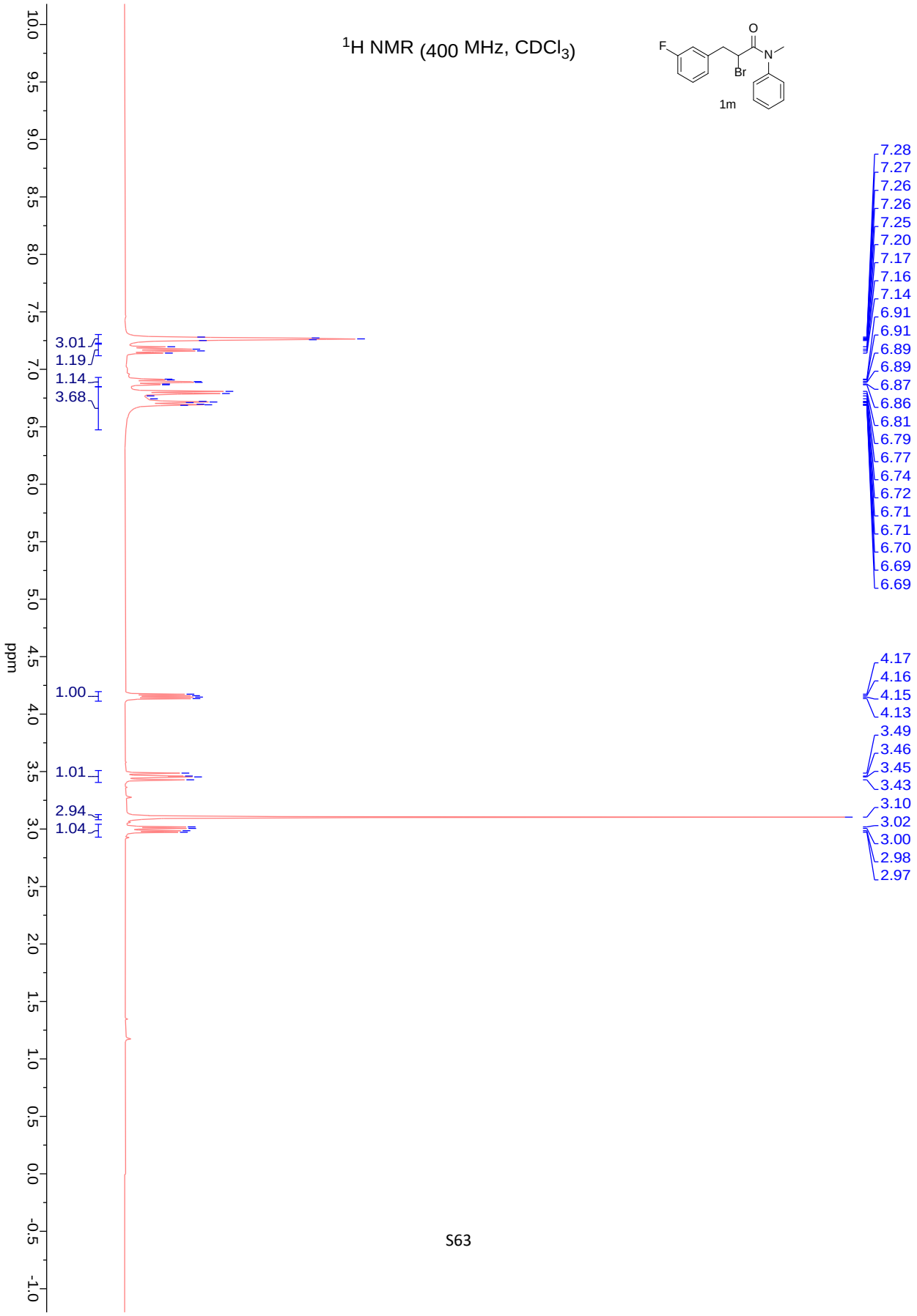

^{1}H NMR (400 MHz, $CDCl_3$)
O
N
Br
F
1l
7.35
7.34
7.33
7.33
7.08
7.07
7.06
7.05
6.99
6.97
6.95
6.80
4.23
4.22
4.20
4.19
3.55
3.53
3.52
3.49
3.18
3.08
3.06
3.04
3.03
3.20
2.17
2.29
1.71
1.00
1.04
3.18
1.03
ppm
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0

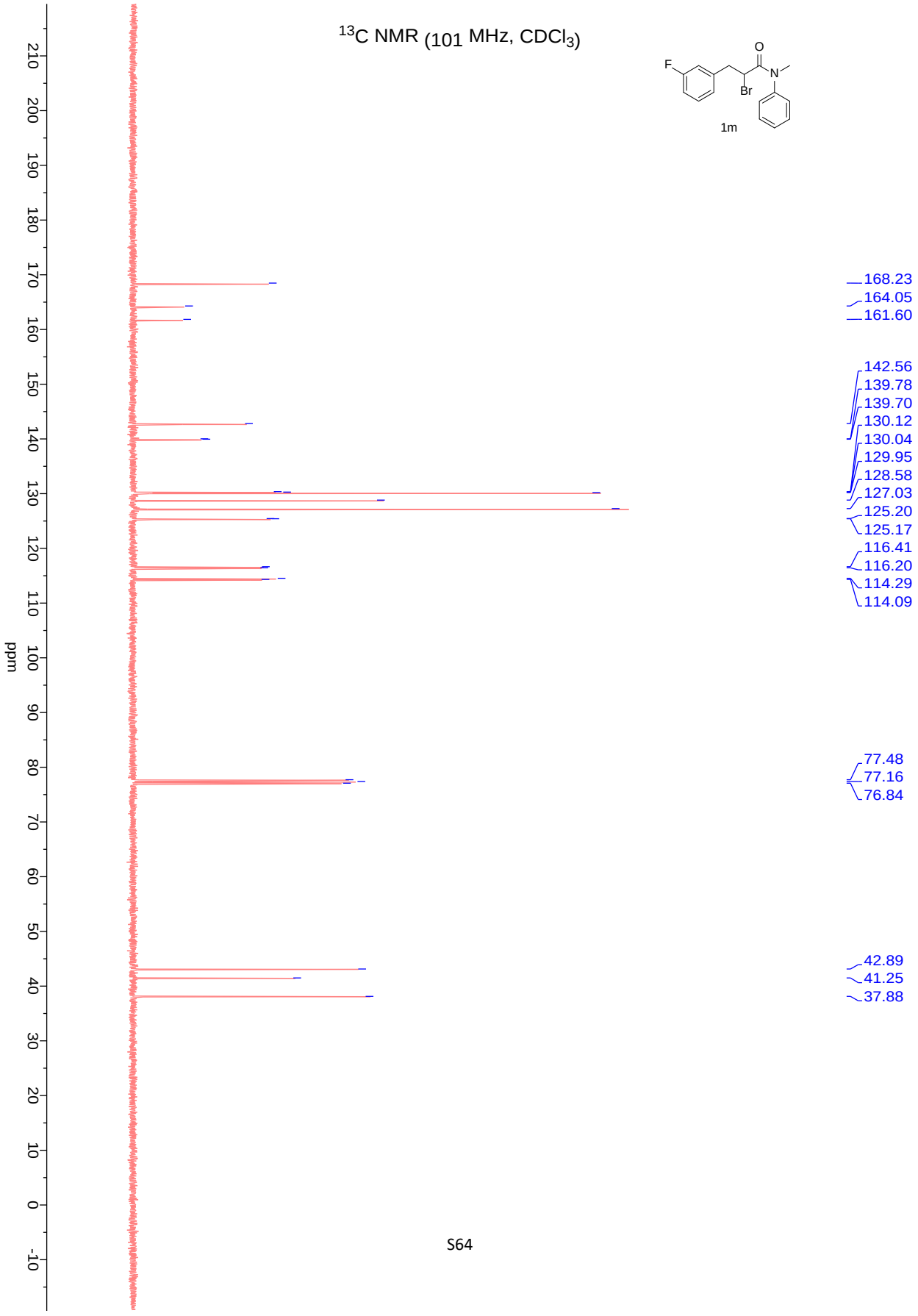

^{13}C NMR (101 MHz, $CDCl_3$)
O
N
Br
F
1l
168.29
163.25
160.81
142.57
133.10
133.07
131.11
131.03
129.92
128.52
127.02
115.51
115.29
77.48
77.16
76.85
43.22
43.20
40.74
37.86
ppm
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

^{19}F NMR (376 MHz, $CDCl_3$)

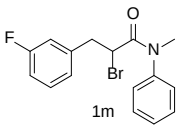


1l


^{1}H NMR (400 MHz, $CDCl_3$)
F
O
N
Br
1m
7.28
7.27
7.26
7.26
7.25
7.20
7.17
7.16
7.14
6.91
6.91
6.89
6.89
6.87
6.86
6.81
6.79
6.77
6.74
6.72
6.71
6.71
6.70
6.69
6.69
4.17
4.16
4.15
4.13
3.49
3.46
3.45
3.43
3.10
3.02
3.00
2.98
2.97
3.01
1.19
1.14
3.68
1.00
1.01
2.94
1.04
ppm
10.0
9.5
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
-1.0


^{13}C NMR (101 MHz, $CDCl_3$)
F
O
N
Br
1m
168.23
164.05
161.60
142.56
139.78
139.70
130.12
130.04
129.95
128.58
127.03
125.20
125.17
116.41
116.20
114.29
114.09
77.48
77.16
76.84
42.89
41.25
37.88
ppm
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

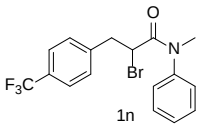
^{19}F NMR (376 MHz, $CDCl_3$)



1m

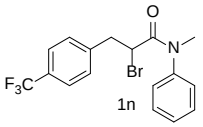
-112.93

^{1}H NMR (400 MHz, $CDCl_3$)



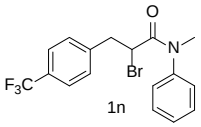
1n

^{13}C NMR (101 MHz, $CDCl_3$)



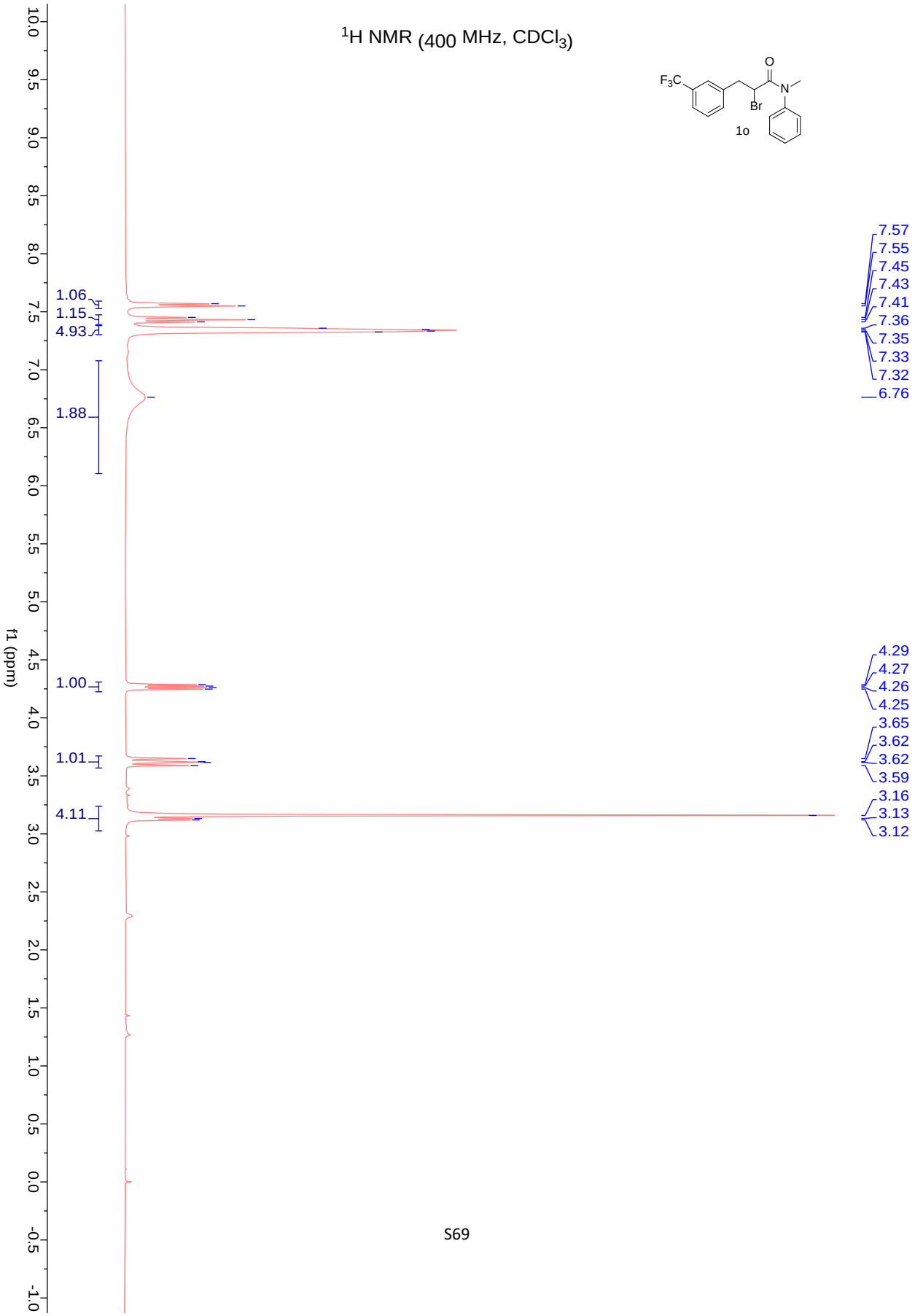
1n

^{19}F NMR (376 MHz, $CDCl_3$)

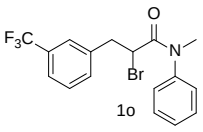


1n

-62.43

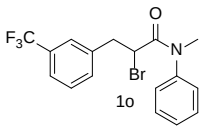

^{1}H NMR (400 MHz, $CDCl_3$)
F_3C
O
N
Br
1o
7.57
7.55
7.45
7.43
7.41
7.36
7.35
7.33
7.32
6.76
4.29
4.27
4.26
4.25
3.65
3.62
3.62
3.59
3.16
3.13
3.12
1.06
1.15
4.93
1.88
1.00
1.01
4.11
f1 (ppm)

^{13}C NMR (101 MHz, $CDCl_3$)



1o

^{19}F NMR (376 MHz, $CDCl_3$)

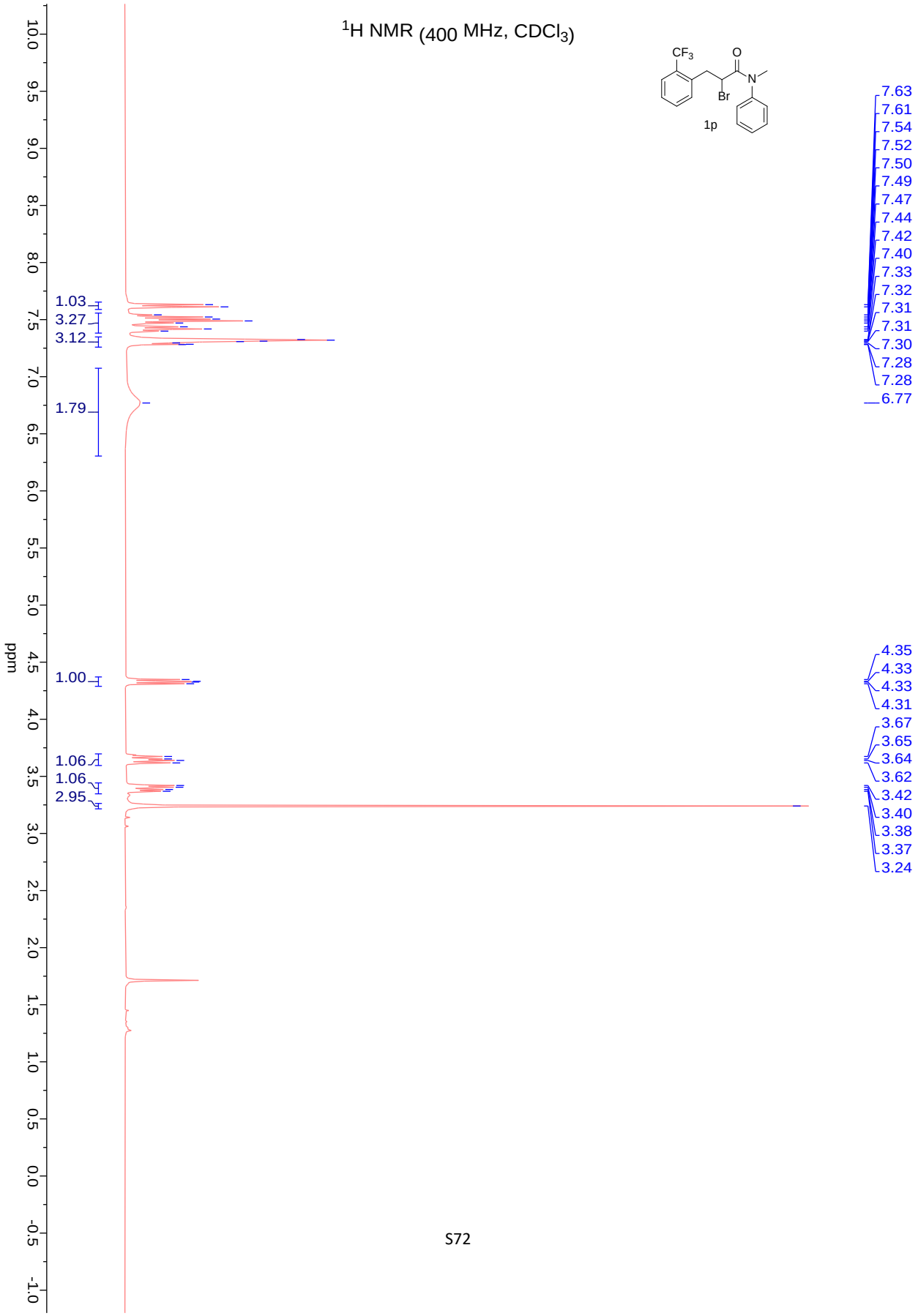


1o

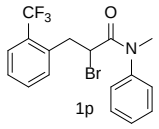
-62.59

f1 (ppm)

10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210

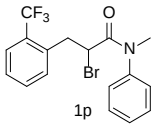

^{1}H NMR (400 MHz, $CDCl_3$)
CF_3
O
N
Br
1p
7.63
7.61
7.54
7.52
7.50
7.49
7.47
7.44
7.42
7.40
7.33
7.32
7.31
7.31
7.30
7.28
7.28
6.77
4.35
4.33
4.33
4.31
3.67
3.65
3.64
3.62
3.42
3.40
3.38
3.37
3.24
1.03
3.27
3.12
1.79
1.00
1.06
1.06
2.95
ppm

^{13}C NMR (101 MHz, $CDCl_3$)



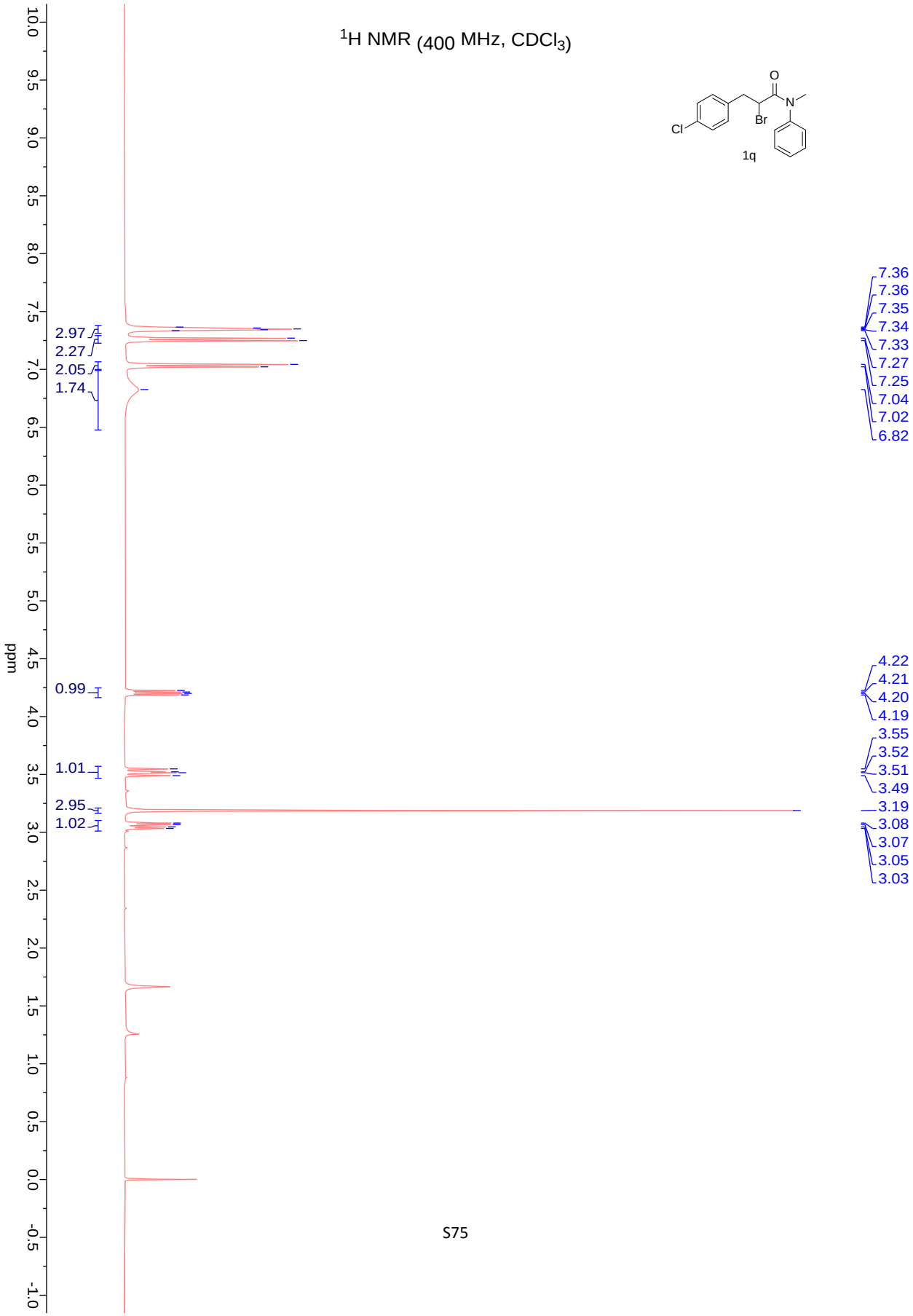
1p

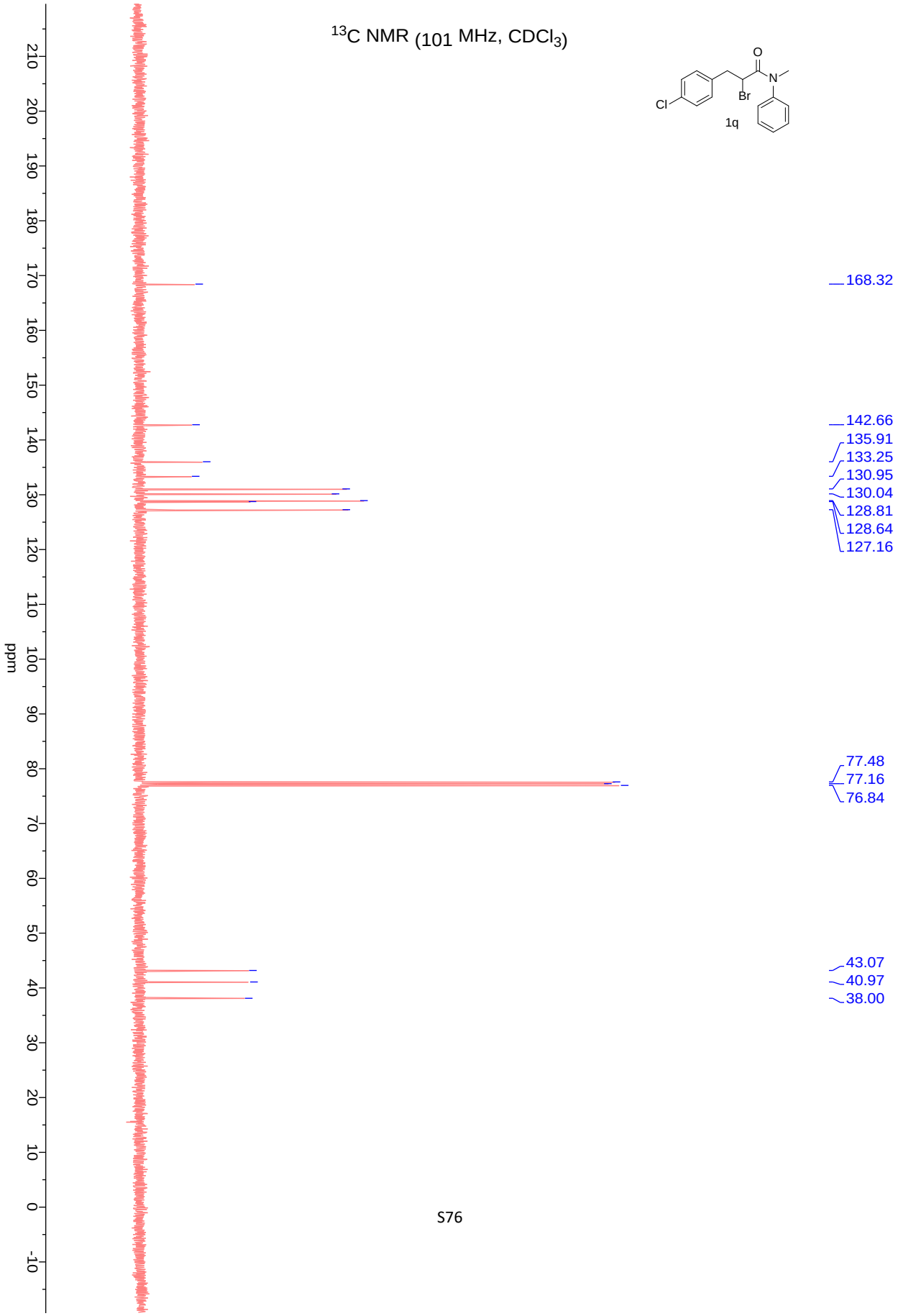
^{19}F NMR (376 MHz, $CDCl_3$)

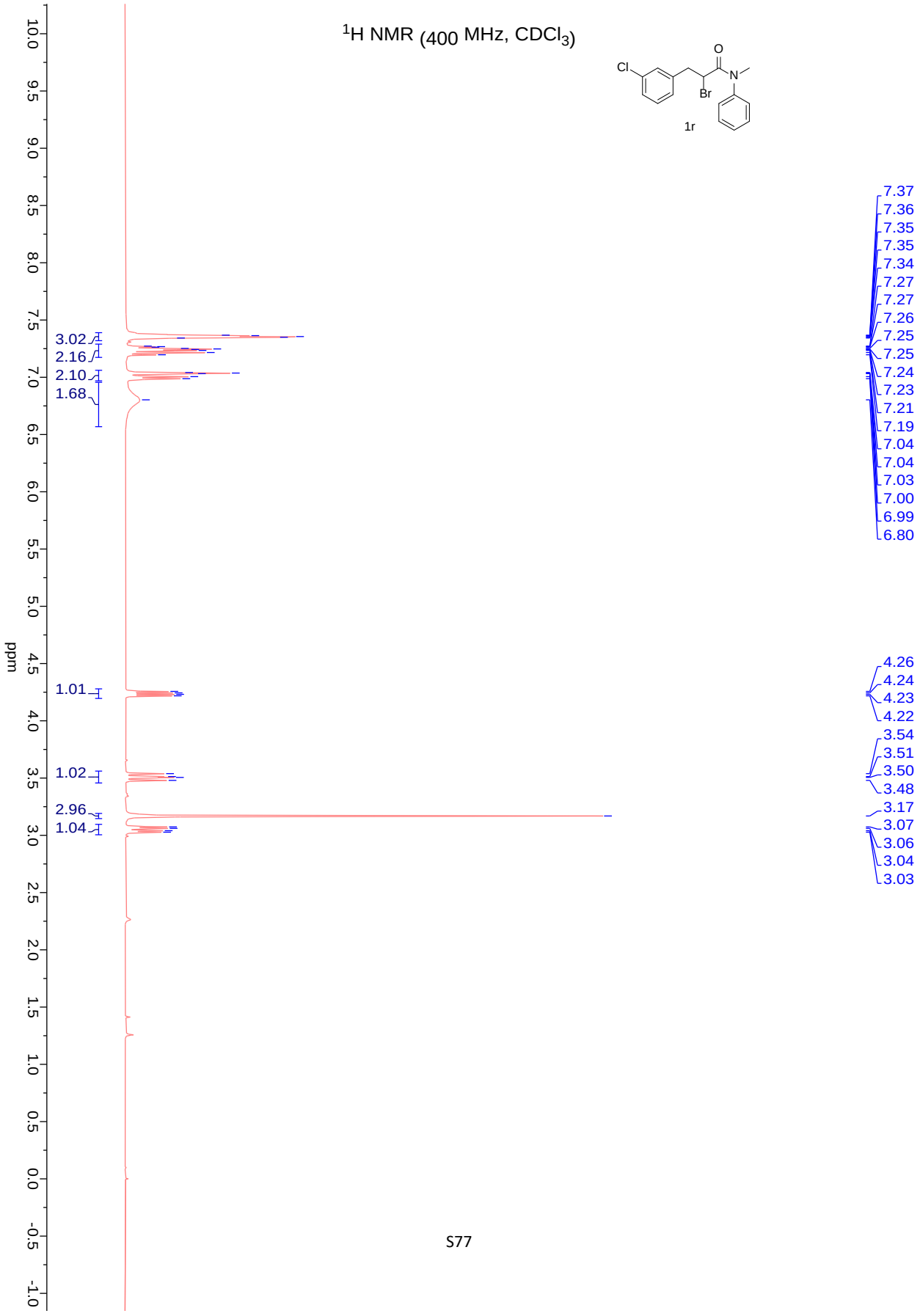


1p

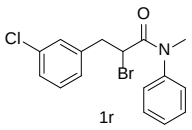
-59.78


^{1}H NMR (400 MHz, $CDCl_3$)
O
N
Br
Cl
1q
7.36
7.36
7.35
7.34
7.33
7.27
7.25
7.04
7.02
6.82
4.22
4.21
4.20
4.19
3.55
3.52
3.51
3.49
3.19
3.08
3.07
3.05
3.03
2.97
2.27
2.05
1.74
0.99
1.01
2.95
1.02
ppm
10.0
9.5
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
-1.0

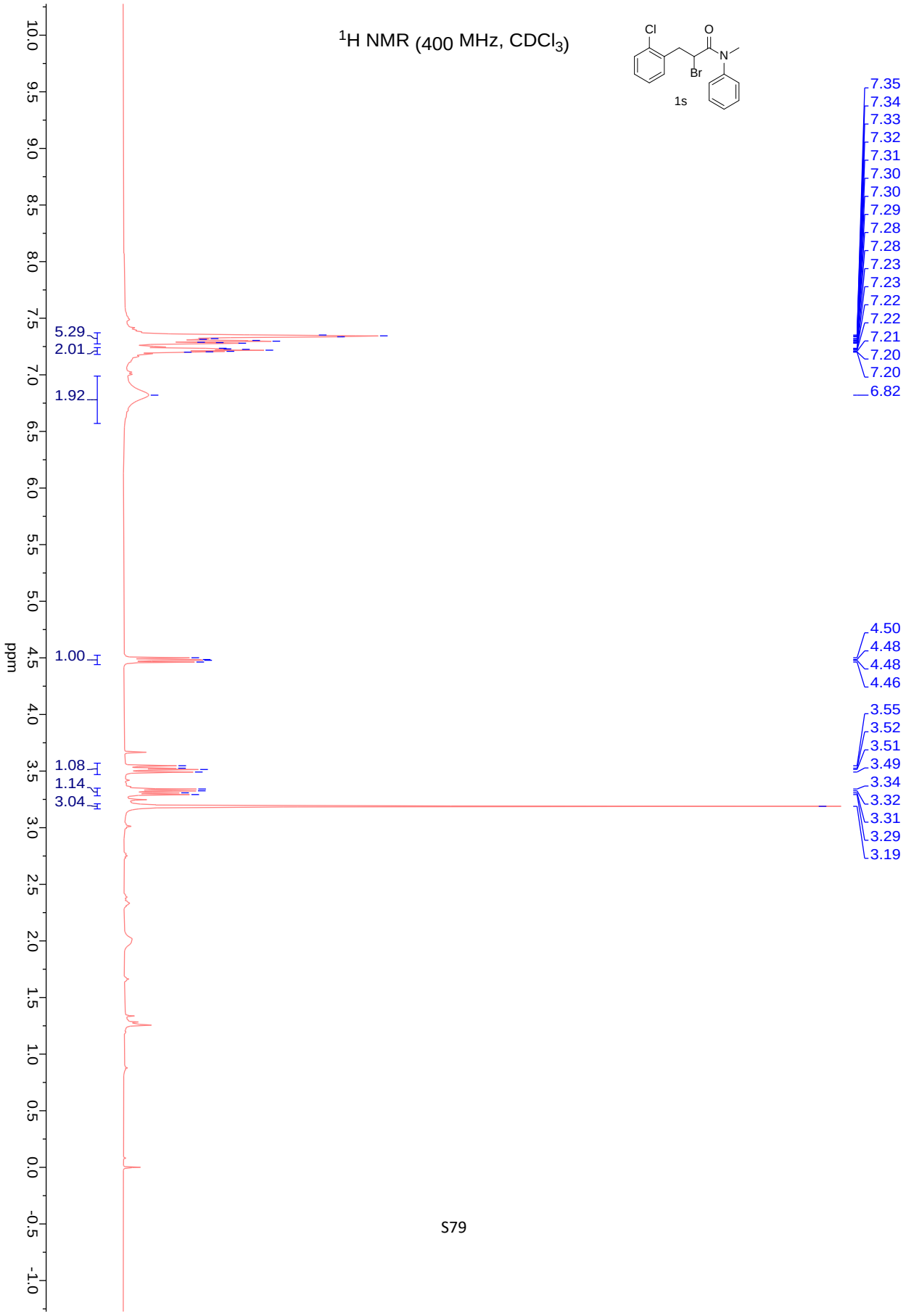

^{13}C NMR (101 MHz, $CDCl_3$)
O
N
Br
Cl
1q
168.32
142.66
135.91
133.25
130.95
130.04
128.81
128.64
127.16
77.48
77.16
76.84
43.07
40.97
38.00
ppm
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

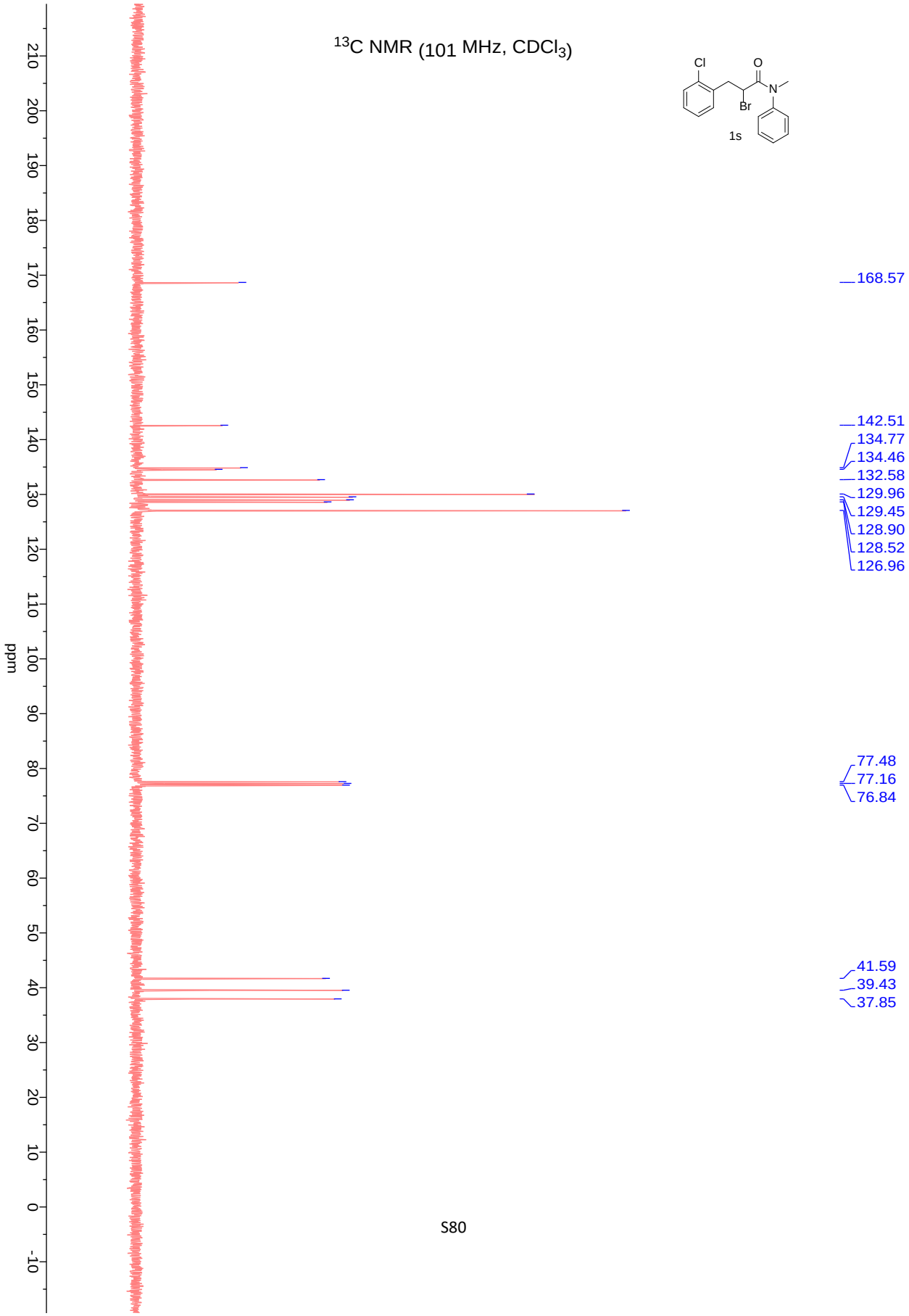

^{1}H NMR (400 MHz, $CDCl_3$)
Cl
O
N
Br
1r
7.37
7.36
7.35
7.35
7.34
7.27
7.27
7.26
7.25
7.25
7.24
7.23
7.21
7.19
7.04
7.04
7.03
7.00
6.99
6.80
4.26
4.24
4.23
4.22
3.54
3.51
3.50
3.48
3.17
3.07
3.06
3.04
3.03
3.02
2.16
2.10
1.68
1.01
1.02
2.96
1.04
ppm
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0

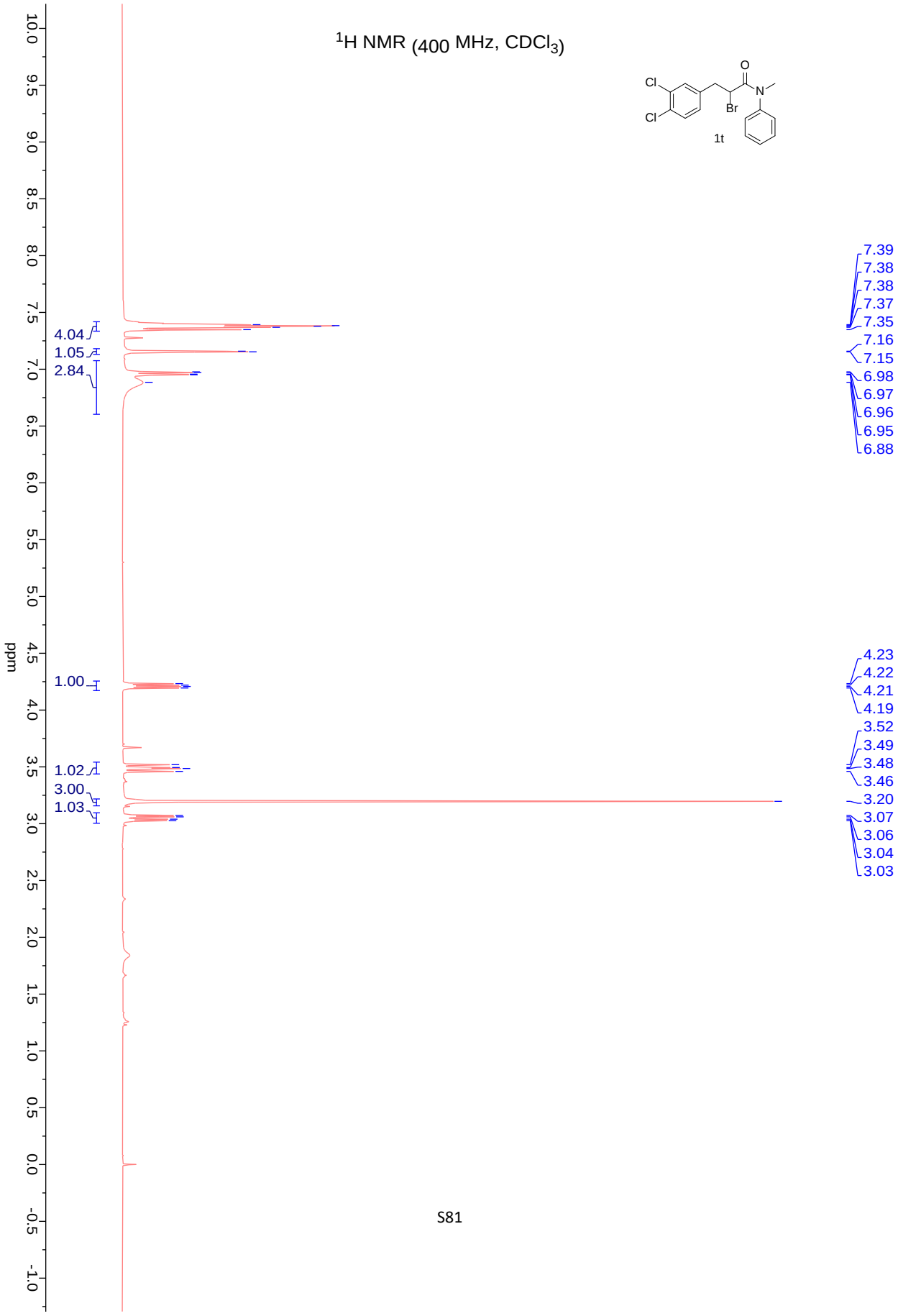
^{13}C NMR (101 MHz, $CDCl_3$)



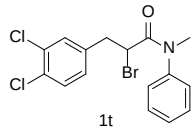
1r


^{1}H NMR (400 MHz, $CDCl_3$)
Cl
O
N
Br
1s
7.35
7.34
7.33
7.32
7.31
7.30
7.30
7.29
7.28
7.28
7.23
7.23
7.22
7.22
7.21
7.20
7.20
6.82
4.50
4.48
4.48
4.46
3.55
3.52
3.51
3.49
3.34
3.32
3.31
3.29
3.19
5.29
2.01
1.92
1.00
1.08
1.14
3.04
ppm

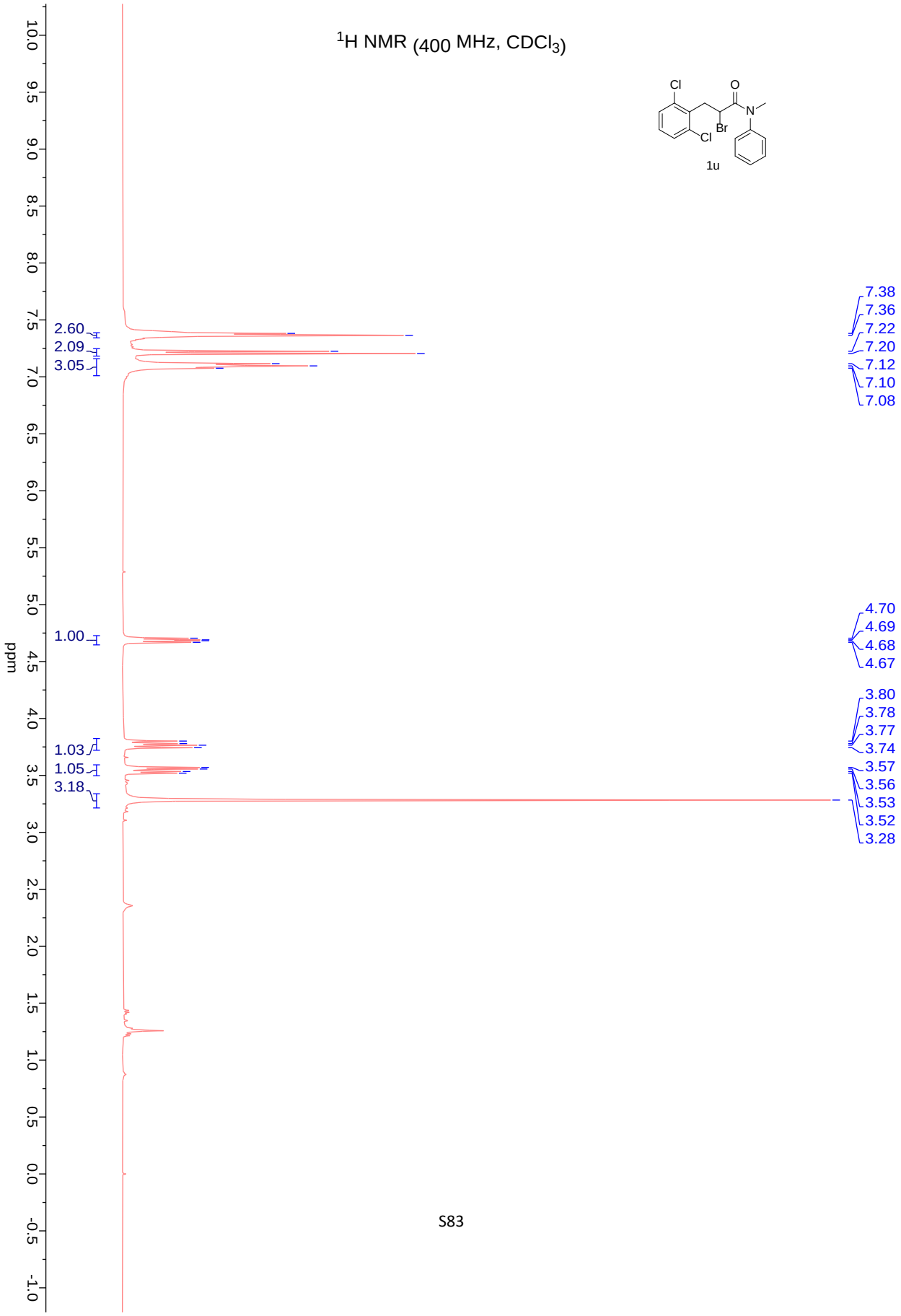

^{13}C NMR (101 MHz, $CDCl_3$)
Cl
O
N
Br
1s
168.57
142.51
134.77
134.46
132.58
129.96
129.45
128.90
128.52
126.96
77.48
77.16
76.84
41.59
39.43
37.85
ppm
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10


^{1}H NMR (400 MHz, $CDCl_3$)
Cl
Cl
O
N
Br
1t
7.39
7.38
7.38
7.37
7.35
7.16
7.15
6.98
6.97
6.96
6.95
6.88
4.23
4.22
4.21
4.19
3.52
3.49
3.48
3.46
3.20
3.07
3.06
3.04
3.03
4.04
1.05
2.84
1.00
1.02
3.00
1.03
ppm
10.0
9.5
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
-1.0

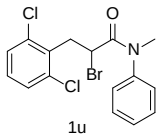
^{13}C NMR (101 MHz, $CDCl_3$)



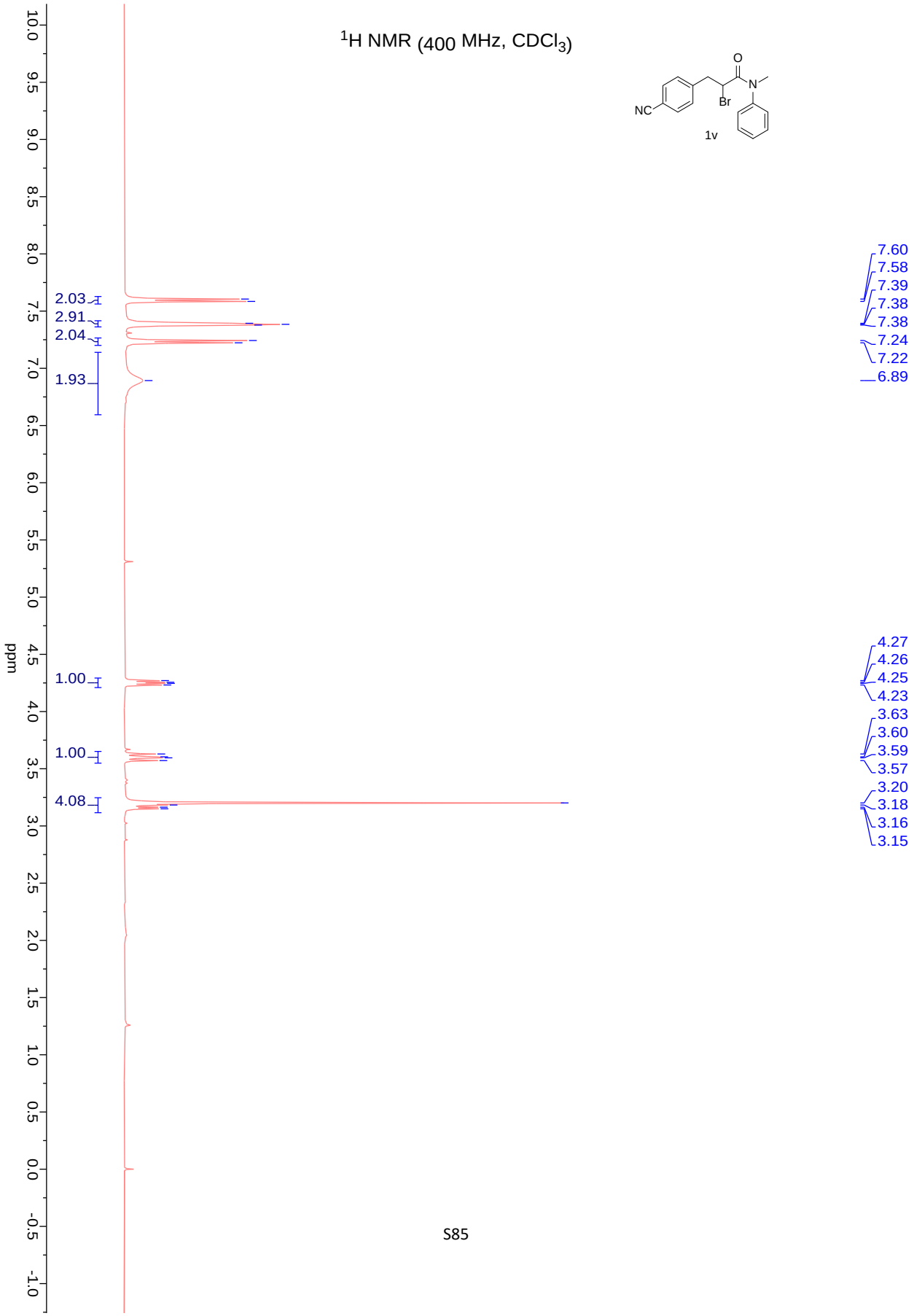
1t


^{1}H NMR (400 MHz, $CDCl_3$)
Cl
O
N
Br
Cl
1u
7.38
7.36
7.22
7.20
7.12
7.10
7.08
4.70
4.69
4.68
4.67
3.80
3.78
3.77
3.74
3.57
3.56
3.53
3.52
3.28
2.60
2.09
3.05
1.00
1.03
1.05
3.18
ppm
10.0
9.5
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
-1.0

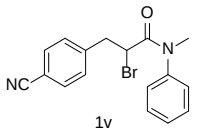
^{13}C NMR (101 MHz, $CDCl_3$)



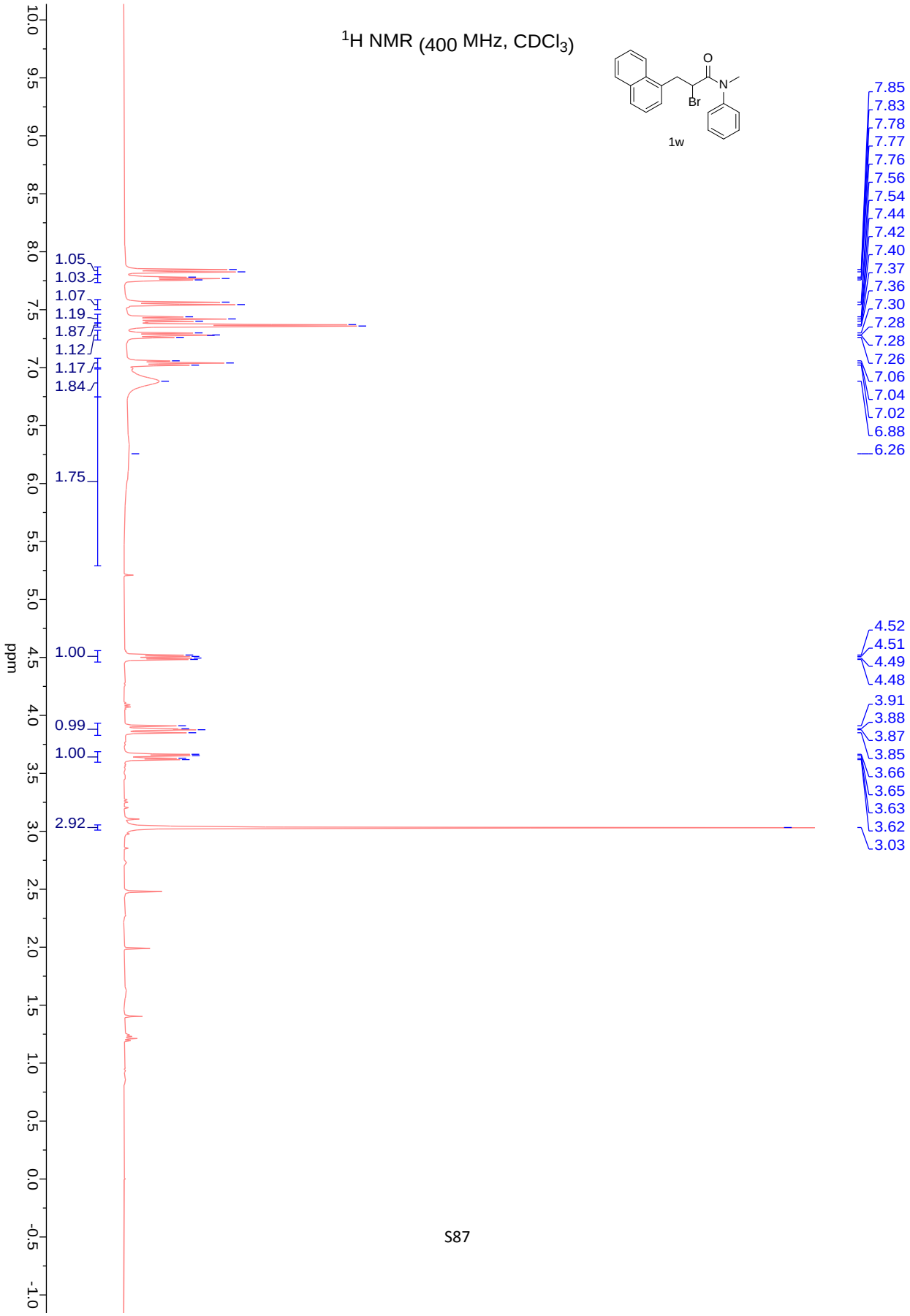
1u


^{1}H NMR (400 MHz, $CDCl_3$)
NC
Br
O
N
1v
ppm
10.0
9.5
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
-1.0
2.03
2.91
2.04
1.93
1.00
1.00
4.08
7.60
7.58
7.39
7.38
7.38
7.24
7.22
6.89
4.27
4.26
4.25
4.23
3.63
3.60
3.59
3.57
3.20
3.18
3.16
3.15

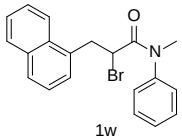
^{13}C NMR (101 MHz, $CDCl_3$)



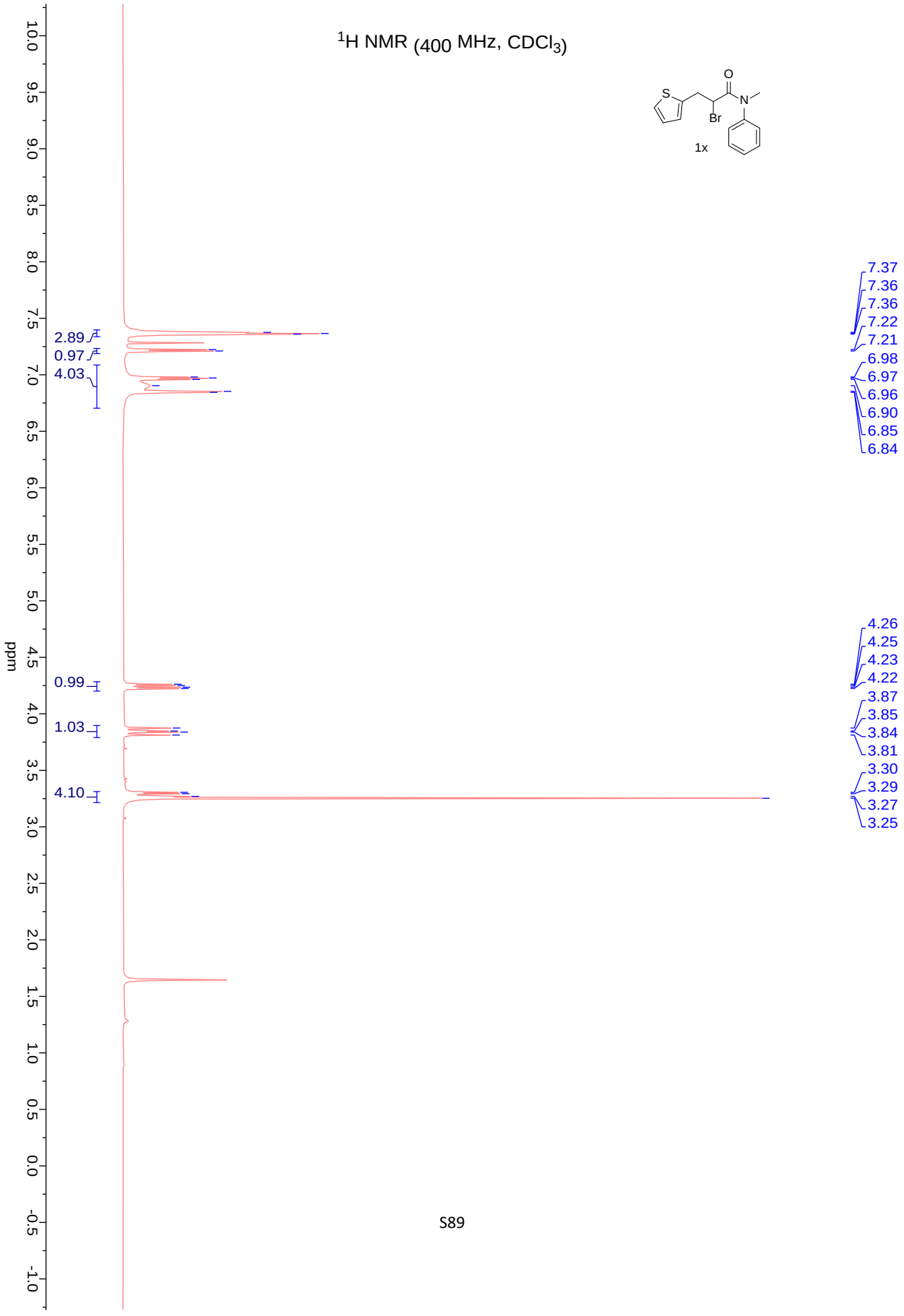
1v

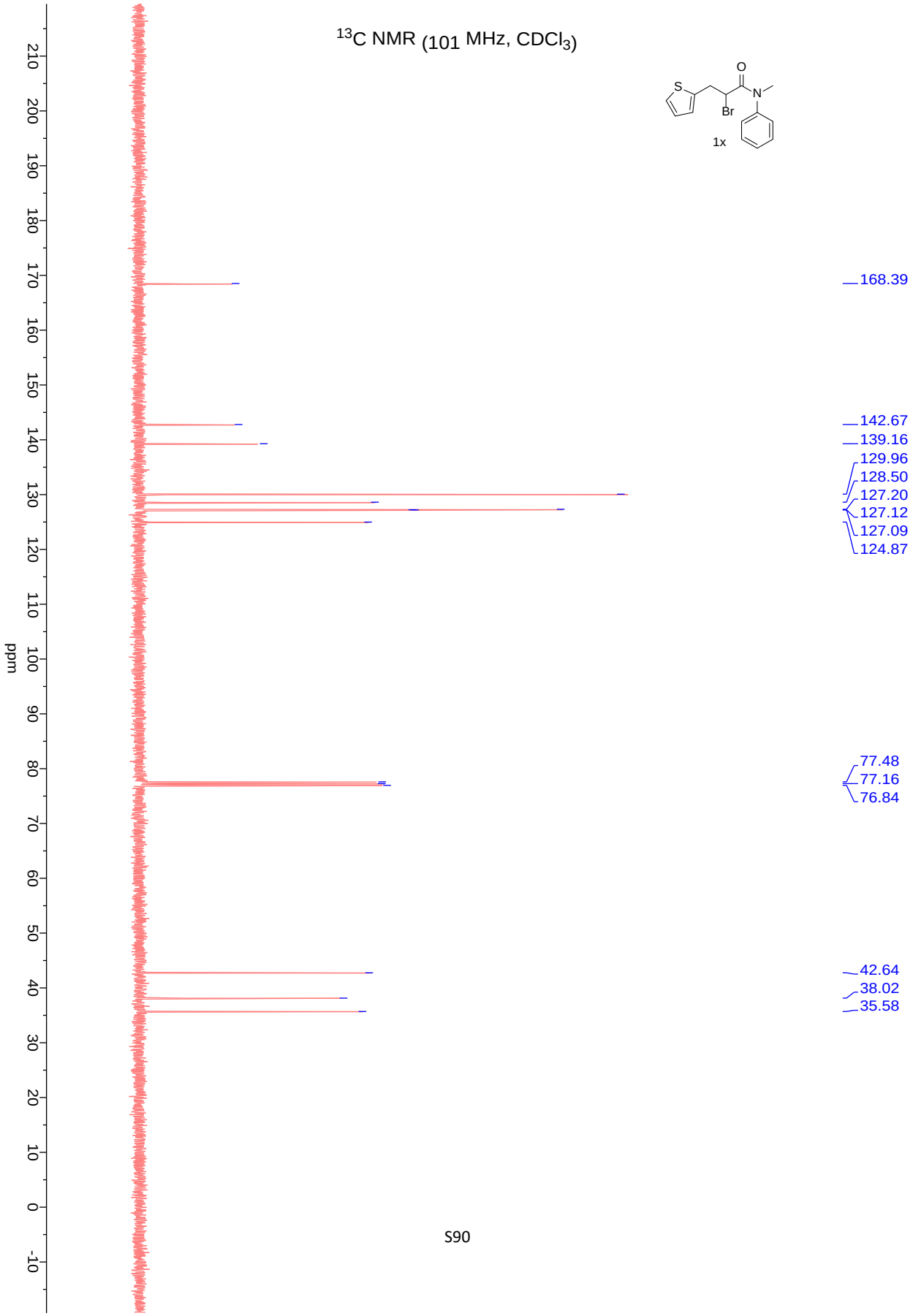

^{1}H NMR (400 MHz, $CDCl_3$)
1w
Br
O
N
ppm
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1.05
1.03
1.07
1.19
1.87
1.12
1.17
1.84
1.75
1.00
0.99
1.00
2.92
7.85
7.83
7.78
7.77
7.76
7.56
7.54
7.44
7.42
7.40
7.37
7.36
7.30
7.28
7.28
7.26
7.06
7.04
7.02
6.88
6.26
4.52
4.51
4.49
4.48
3.91
3.88
3.87
3.85
3.66
3.65
3.63
3.62
3.03

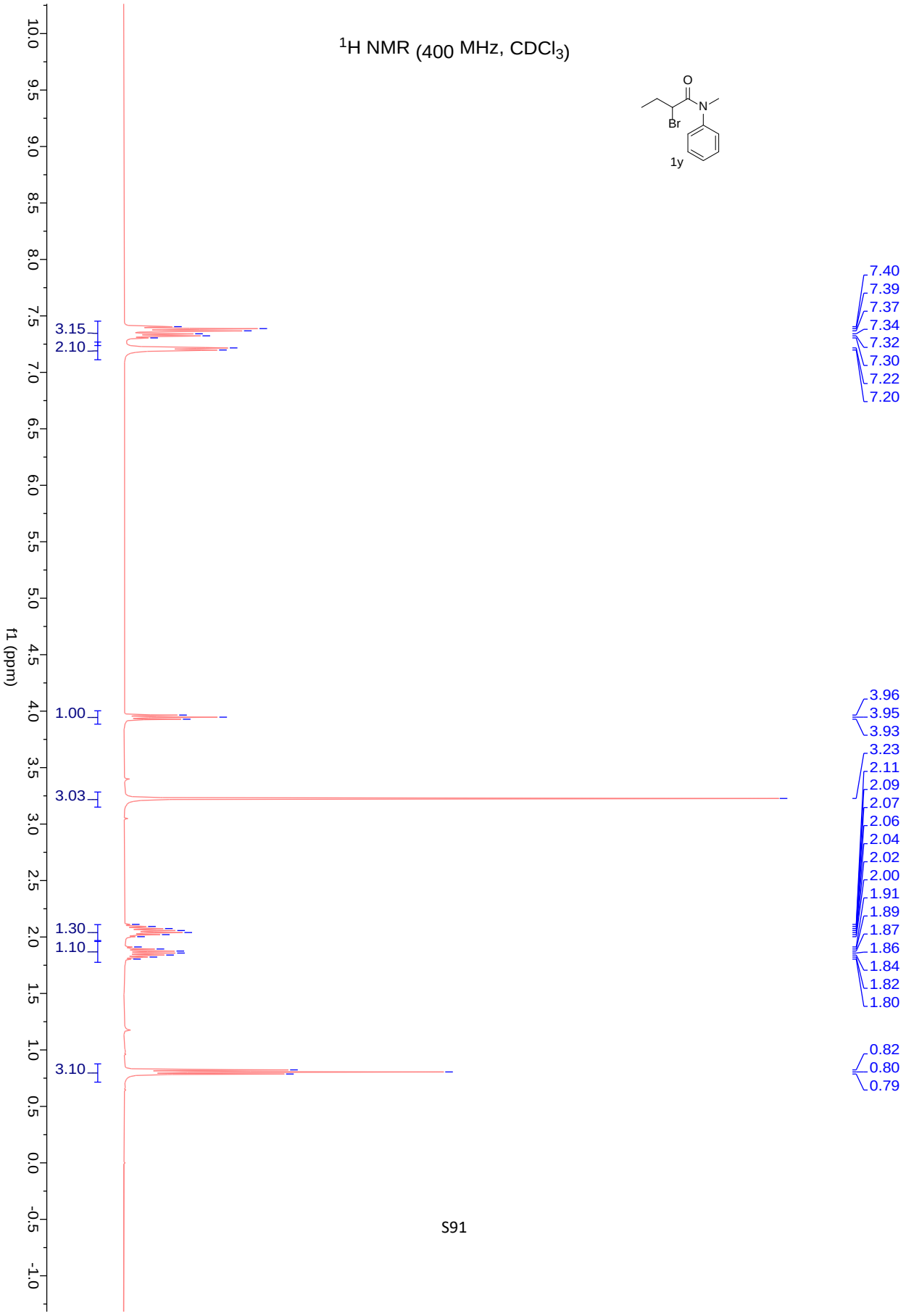
^{13}C NMR (101 MHz, $CDCl_3$)

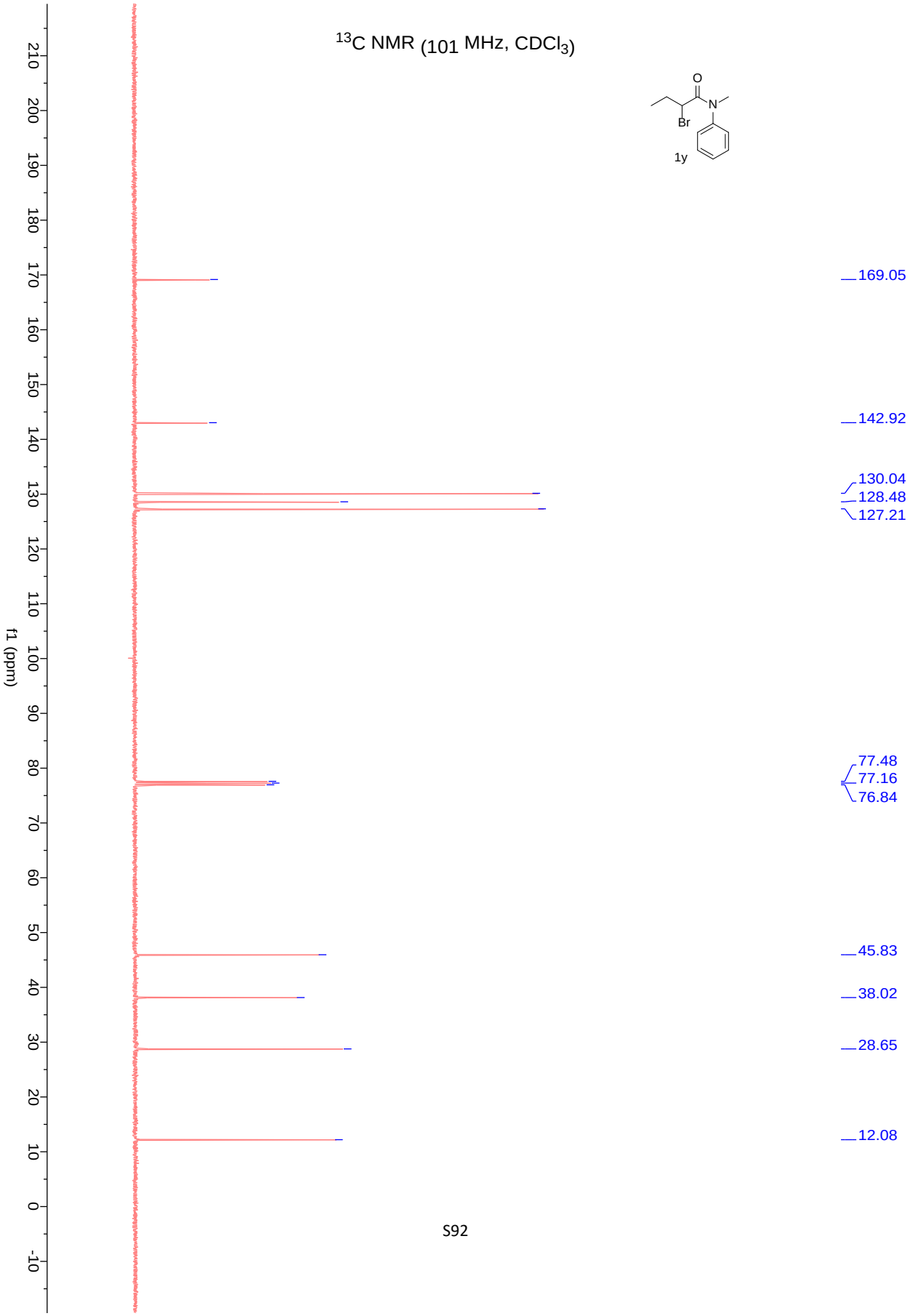


1w

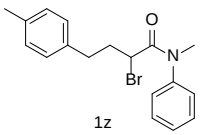

^{1}H NMR (400 MHz, $CDCl_3$)
S
O
N
Br
1x
7.37
7.36
7.36
7.22
7.21
6.98
6.97
6.96
6.90
6.85
6.84
4.26
4.25
4.23
4.22
3.87
3.85
3.84
3.81
3.30
3.29
3.27
3.25
2.89
0.97
4.03
0.99
1.03
4.10
ppm


^{13}C NMR (101 MHz, $CDCl_3$)
1x
168.39
142.67
139.16
129.96
128.50
127.20
127.12
127.09
124.87
77.48
77.16
76.84
42.64
38.02
35.58
ppm


^{1}H NMR (400 MHz, $CDCl_3$)
O
N
Br
1y
f1 (ppm)
10.0
9.5
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
-1.0
3.15
2.10
1.00
3.03
1.30
1.10
3.10
7.40
7.39
7.37
7.34
7.32
7.30
7.22
7.20
3.96
3.95
3.93
3.23
2.11
2.09
2.07
2.06
2.04
2.02
2.00
1.91
1.89
1.87
1.86
1.84
1.82
1.80
0.82
0.80
0.79

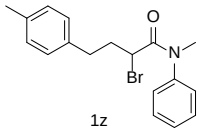

^{13}C NMR (101 MHz, $CDCl_3$)
O
N
Br
1y
169.05
142.92
130.04
128.48
127.21
77.48
77.16
76.84
45.83
38.02
28.65
12.08
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

^{1}H NMR (400 MHz, $CDCl_3$)

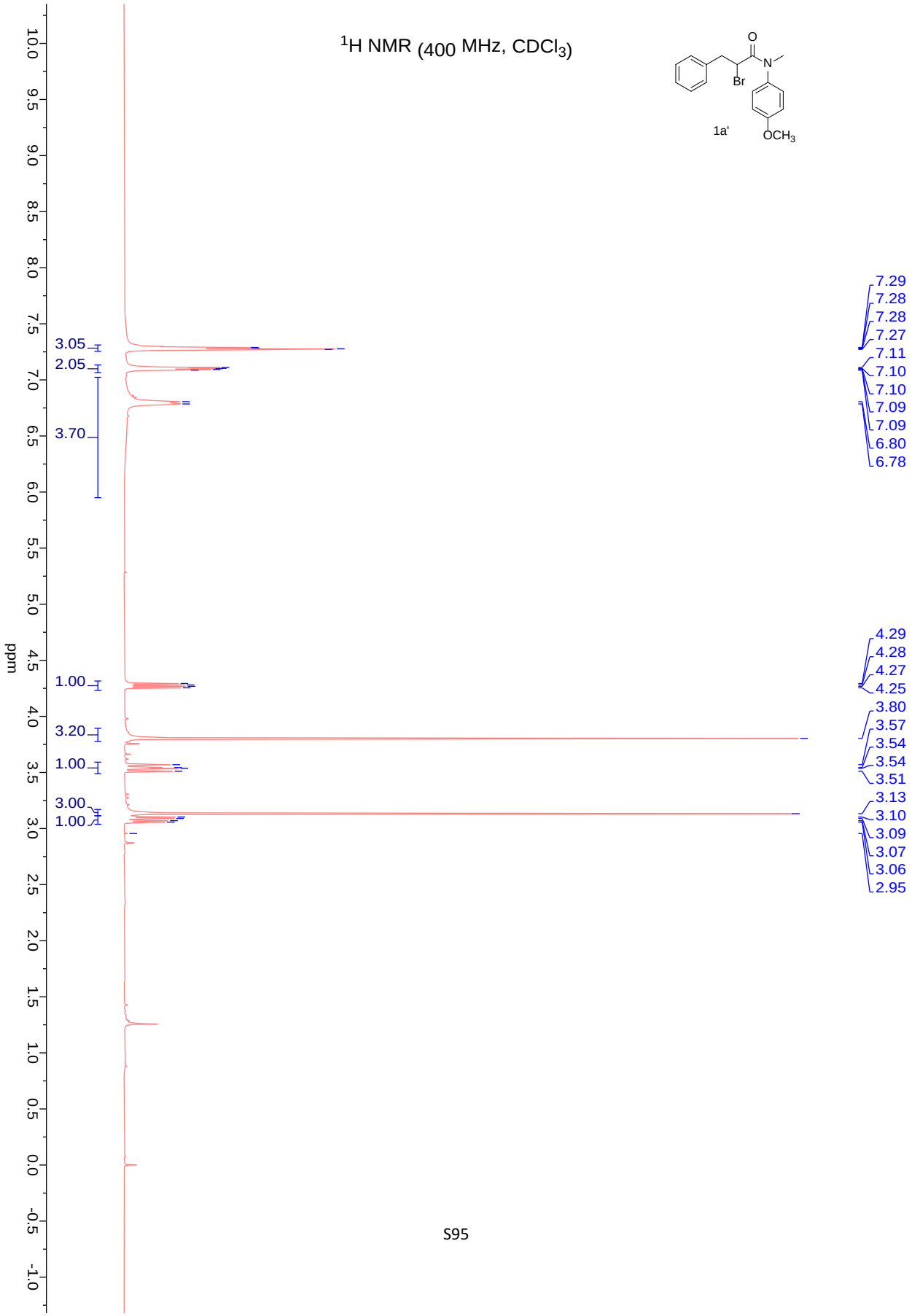


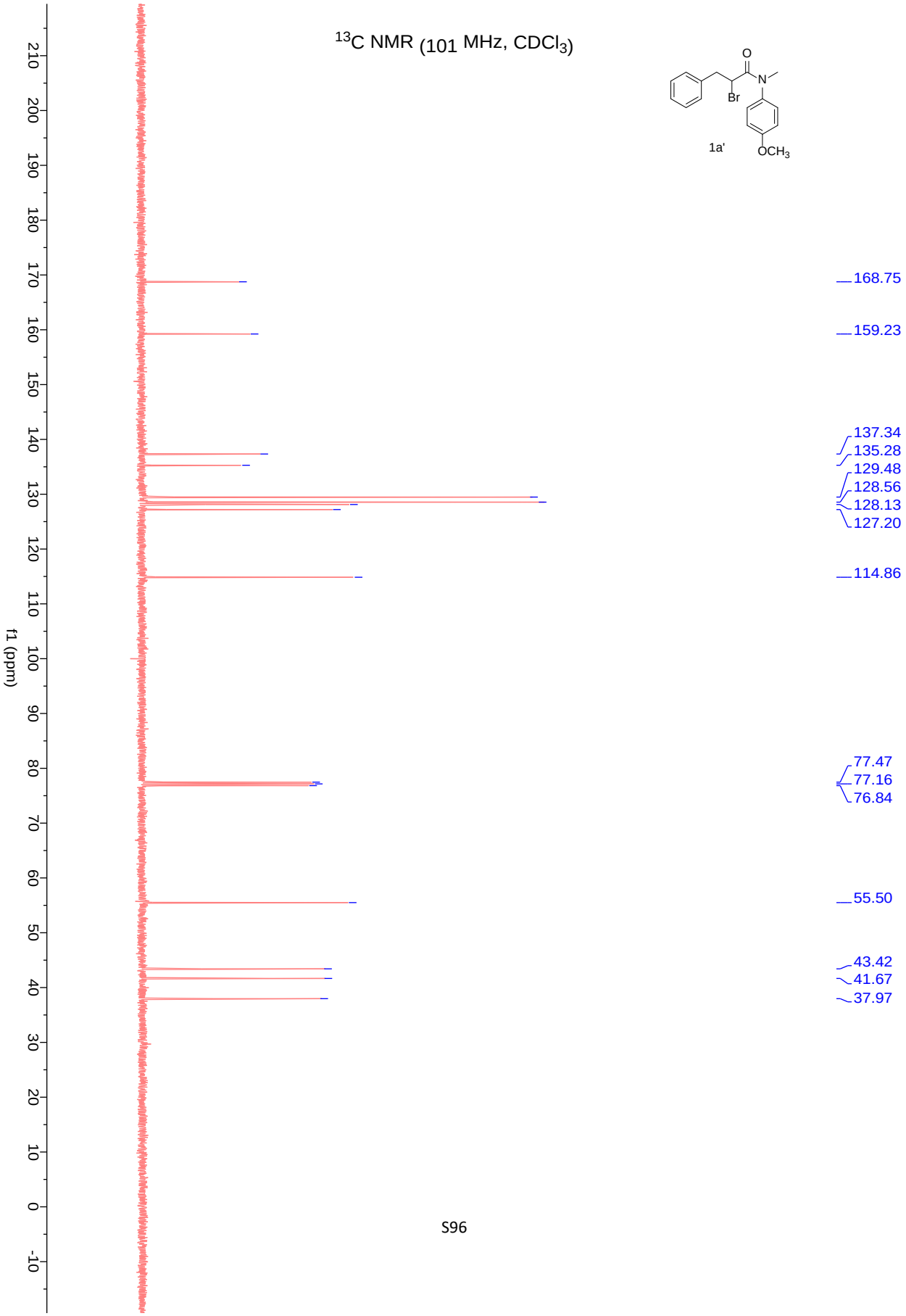
1z

^{13}C NMR (101 MHz, $CDCl_3$)

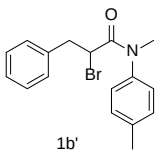


1z

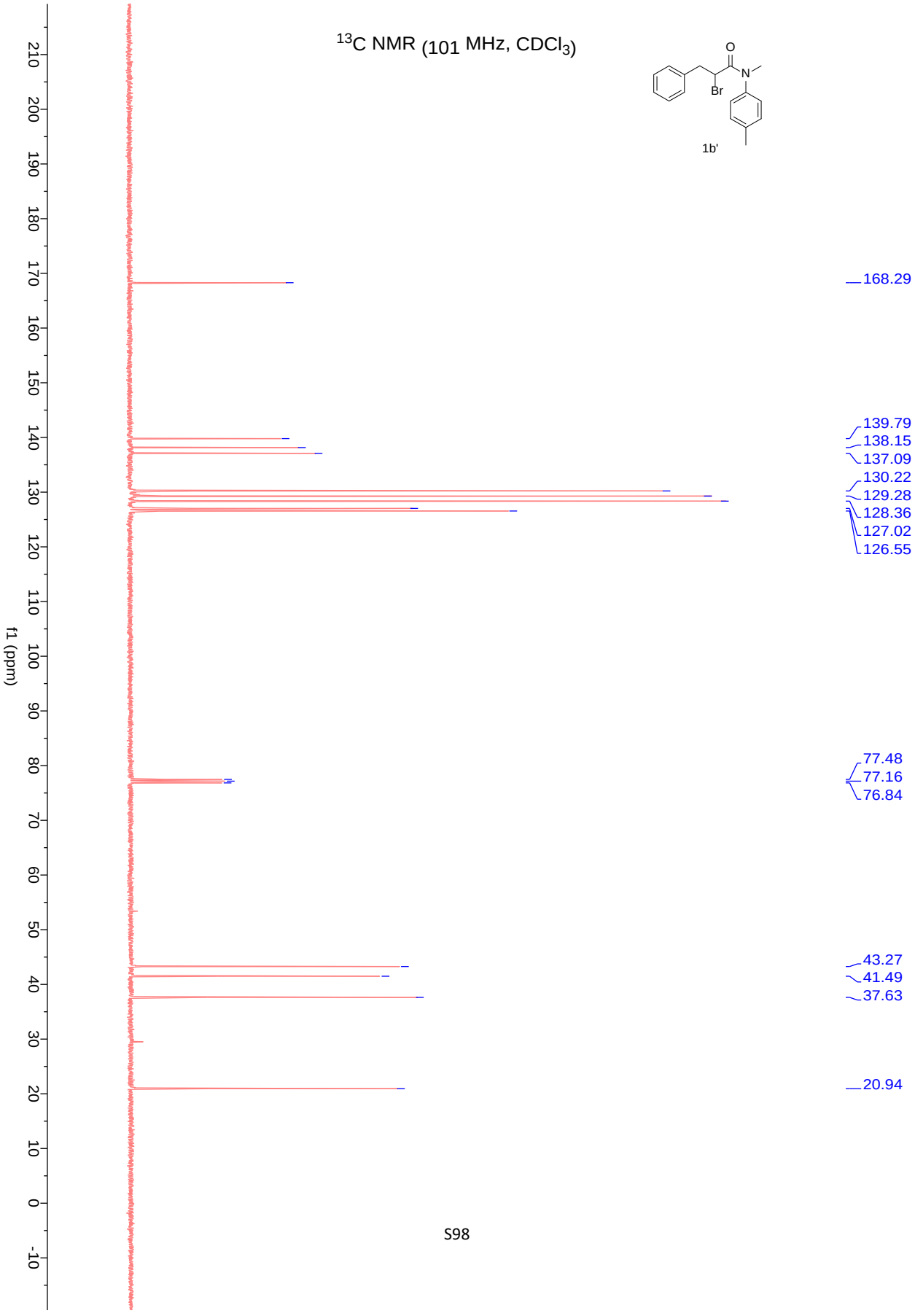

^{1}H NMR (400 MHz, $CDCl_3$)
O
N
Br
1a'
OCH_3
ppm
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
3.05
2.05
3.70
1.00
3.20
1.00
3.00
1.00
7.29
7.28
7.28
7.27
7.11
7.10
7.10
7.09
7.09
6.80
6.78
4.29
4.28
4.27
4.25
3.80
3.57
3.54
3.54
3.51
3.13
3.10
3.09
3.07
3.06
2.95


^{13}C NMR (101 MHz, $CDCl_3$)
O
N
Br
1a'
OCH_3
168.75
159.23
137.34
135.28
129.48
128.56
128.13
127.20
114.86
77.47
77.16
76.84
55.50
43.42
41.67
37.97
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

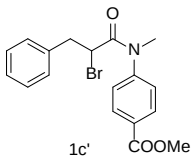
^{1}H NMR (400 MHz, $CDCl_3$)



1b'

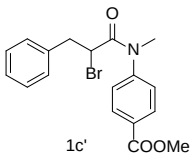

^{13}C NMR (101 MHz, $CDCl_3$)
O
N
Br
1b'
168.29
139.79
138.15
137.09
130.22
129.28
128.36
127.02
126.55
77.48
77.16
76.84
43.27
41.49
37.63
20.94
f1 (ppm)

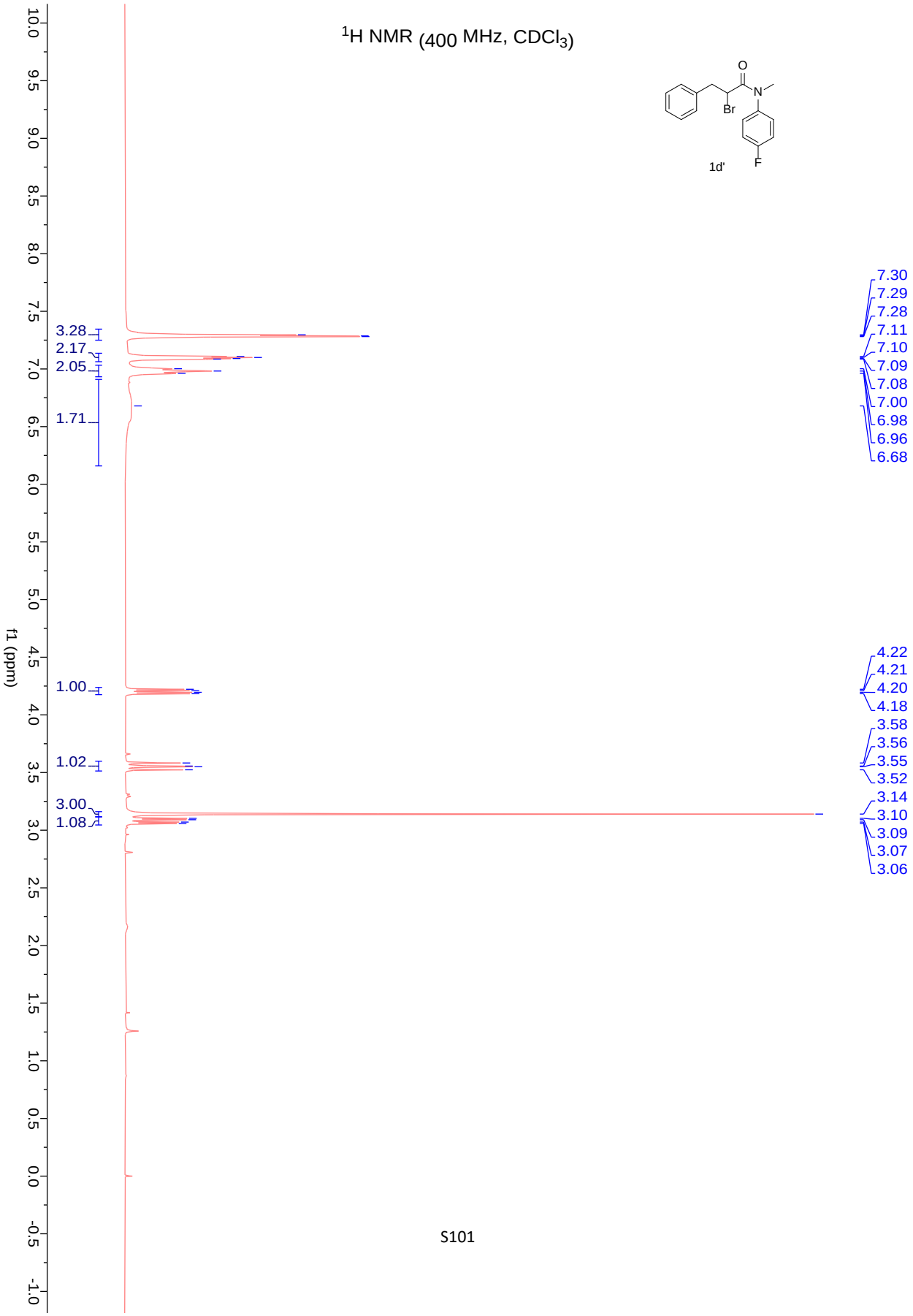
^{1}H NMR (400 MHz, $CDCl_3$)

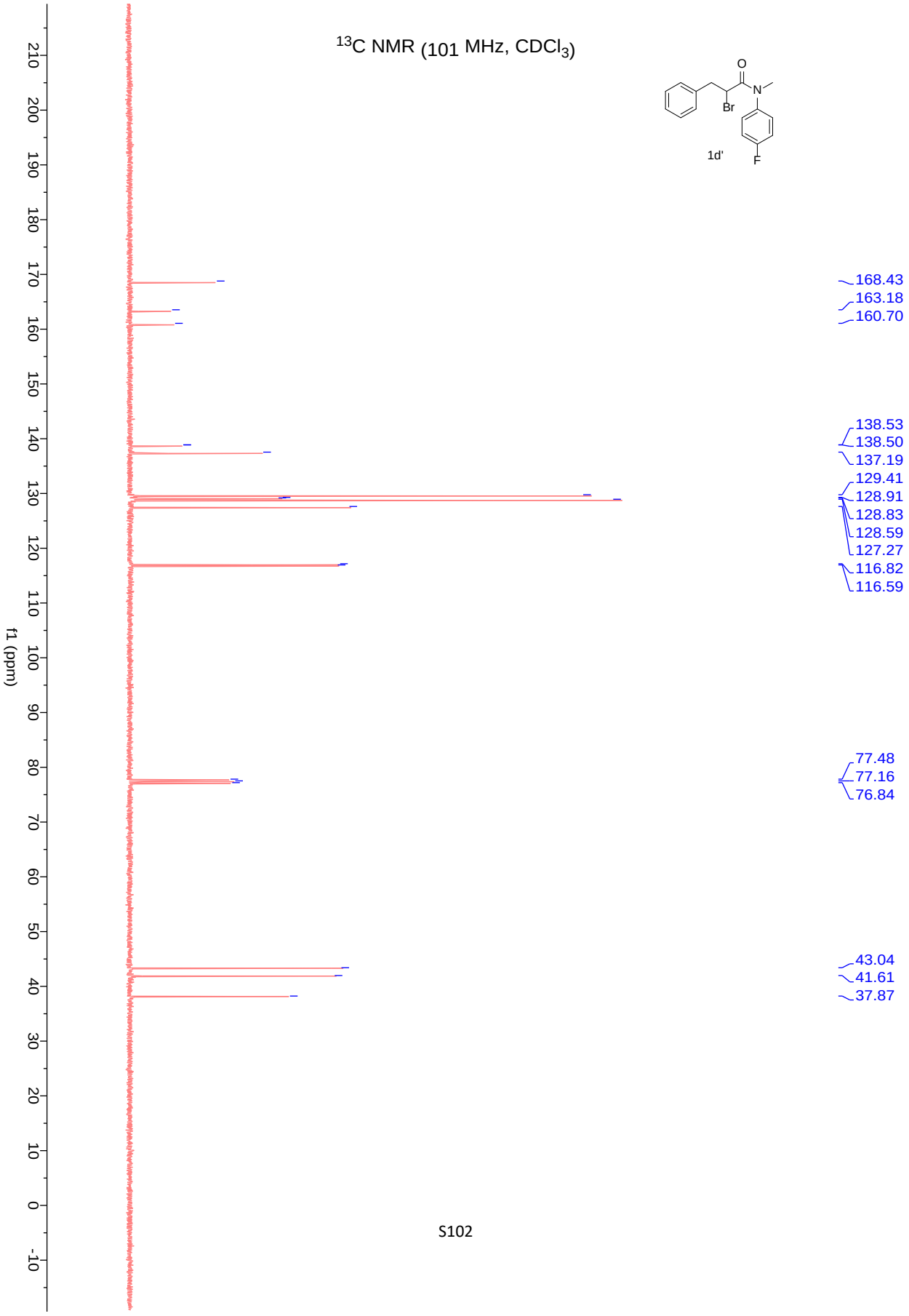


1c'

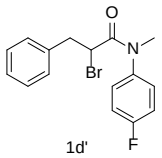
^{13}C NMR (101 MHz, $CDCl_3$)




^{1}H NMR (400 MHz, $CDCl_3$)
O
N
Br
F
1d'
f1 (ppm)
10.0
9.5
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
-1.0
3.28
2.17
2.05
1.71
1.00
1.02
3.00
1.08
7.30
7.29
7.28
7.11
7.10
7.09
7.08
7.00
6.98
6.96
6.68
4.22
4.21
4.20
4.18
3.58
3.56
3.55
3.52
3.14
3.10
3.09
3.07
3.06


^{13}C NMR (101 MHz, $CDCl_3$)
O
N
Br
F
1d'
168.43
163.18
160.70
138.53
138.50
137.19
129.41
128.91
128.83
128.59
127.27
116.82
116.59
77.48
77.16
76.84
43.04
41.61
37.87
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

^{19}F NMR (376 MHz, $CDCl_3$)

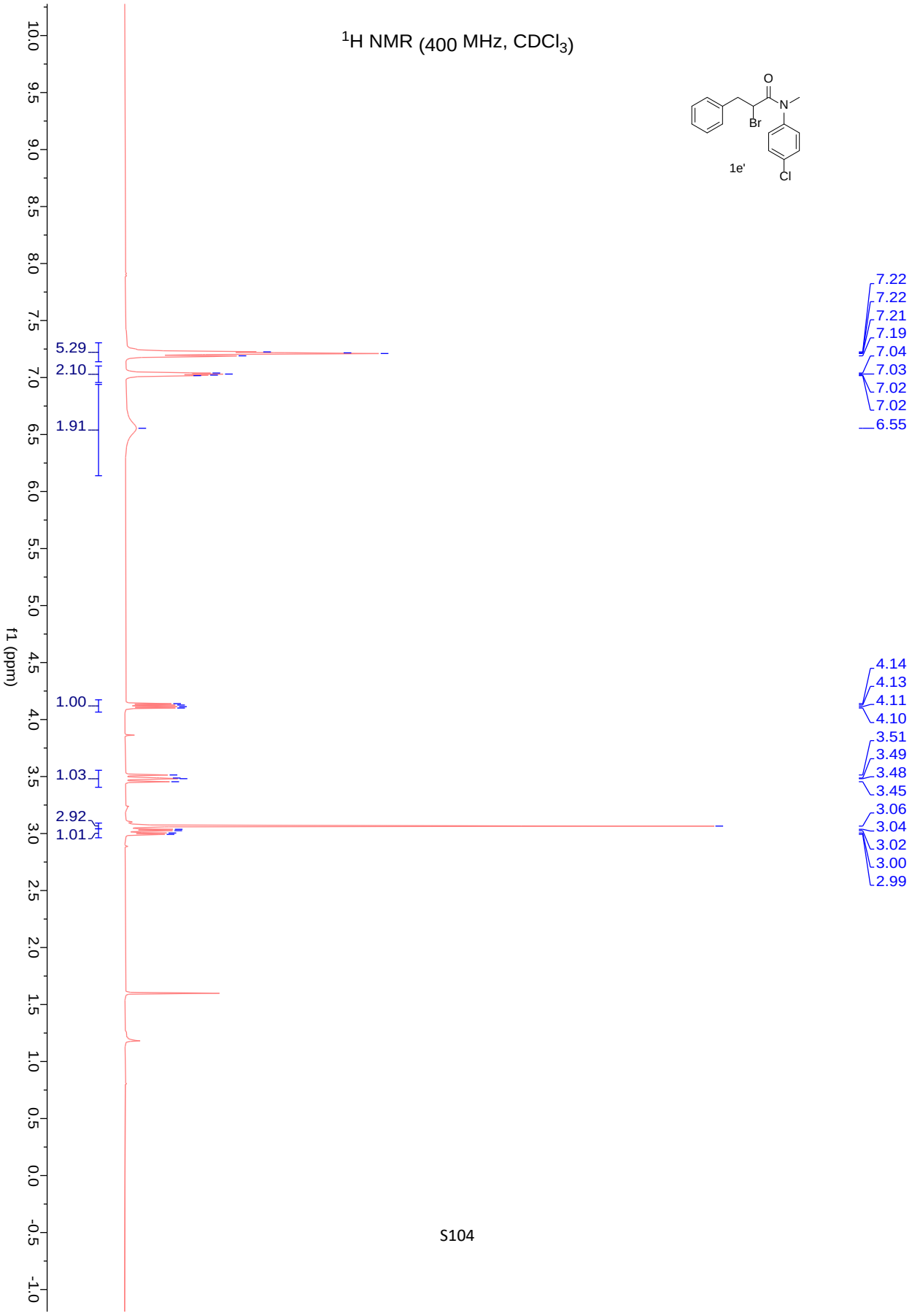


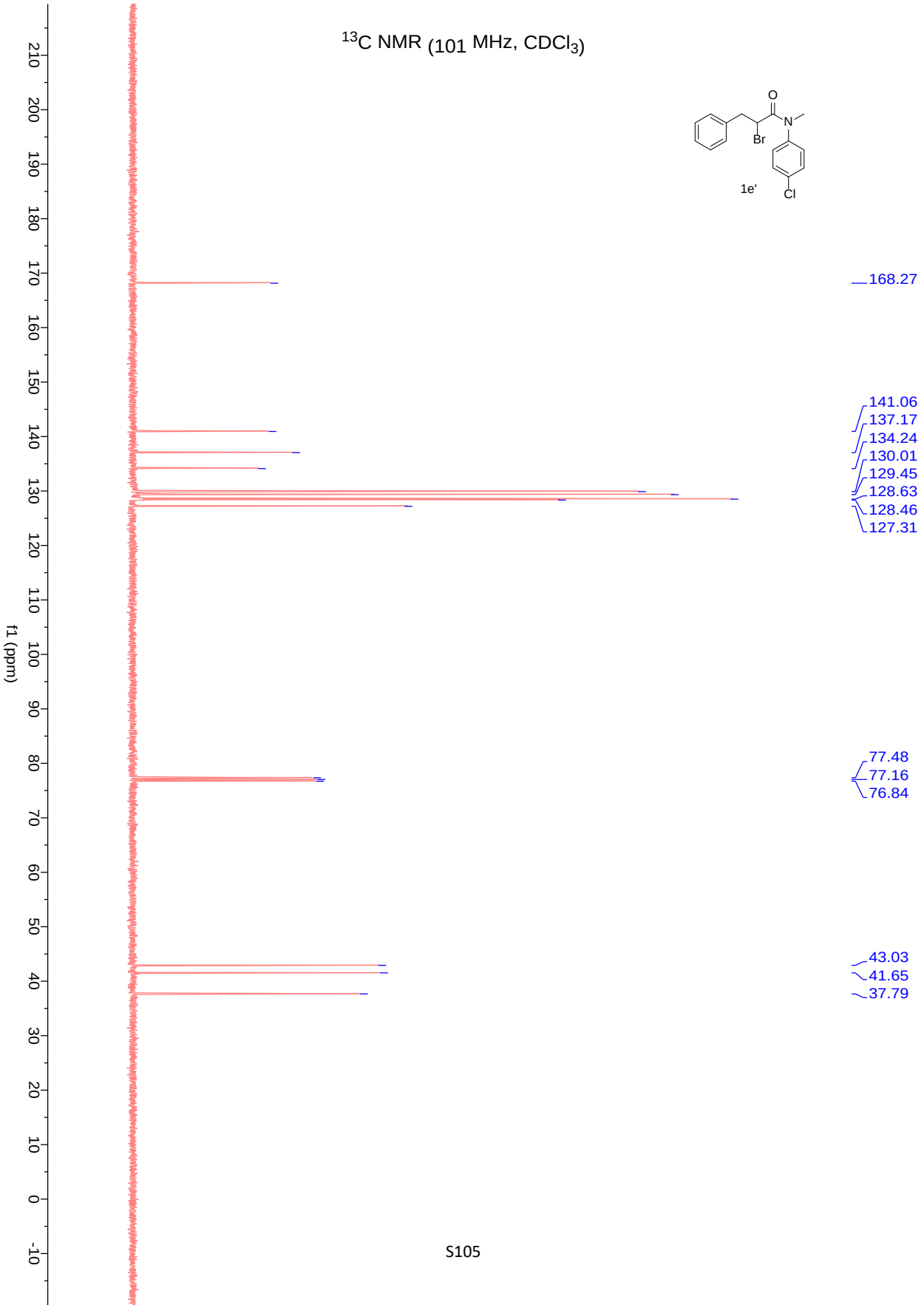
1d'

-112.28

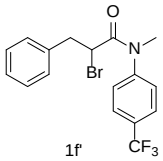
f1 (ppm)

10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210

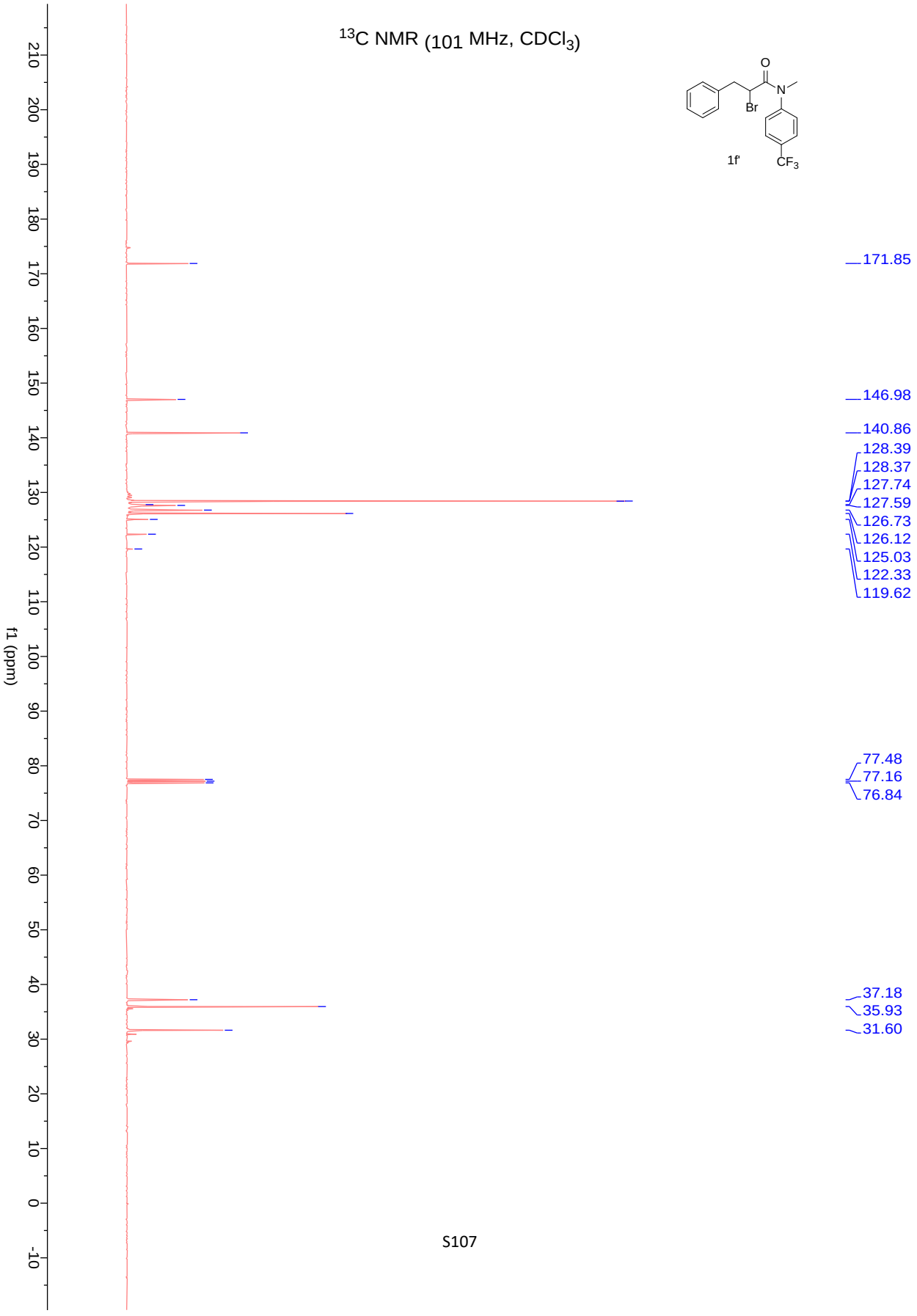

^{1}H NMR (400 MHz, $CDCl_3$)
O
N
Br
Cl
1e'
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
5.29
2.10
1.91
1.00
1.03
2.92
1.01
7.22
7.22
7.21
7.19
7.04
7.03
7.02
7.02
6.55
4.14
4.13
4.11
4.10
3.51
3.49
3.48
3.45
3.06
3.04
3.02
3.00
2.99


^{13}C NMR (101 MHz, CDCl$_3$)
O
N
Br
Cl
1e'
168.27
141.06
137.17
134.24
130.01
129.45
128.63
128.46
127.31
77.48
77.16
76.84
43.03
41.65
37.79
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

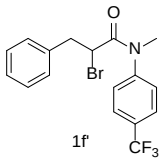
^{1}H NMR (400 MHz, $CDCl_3$)



1f'


^{13}C NMR (101 MHz, $CDCl_3$)
O
N
Br
1f'
CF_3
171.85
146.98
140.86
128.39
128.37
127.74
127.59
126.73
126.12
125.03
122.33
119.62
77.48
77.16
76.84
37.18
35.93
31.60
f1 (ppm)

^{19}F NMR (376 MHz, $CDCl_3$)

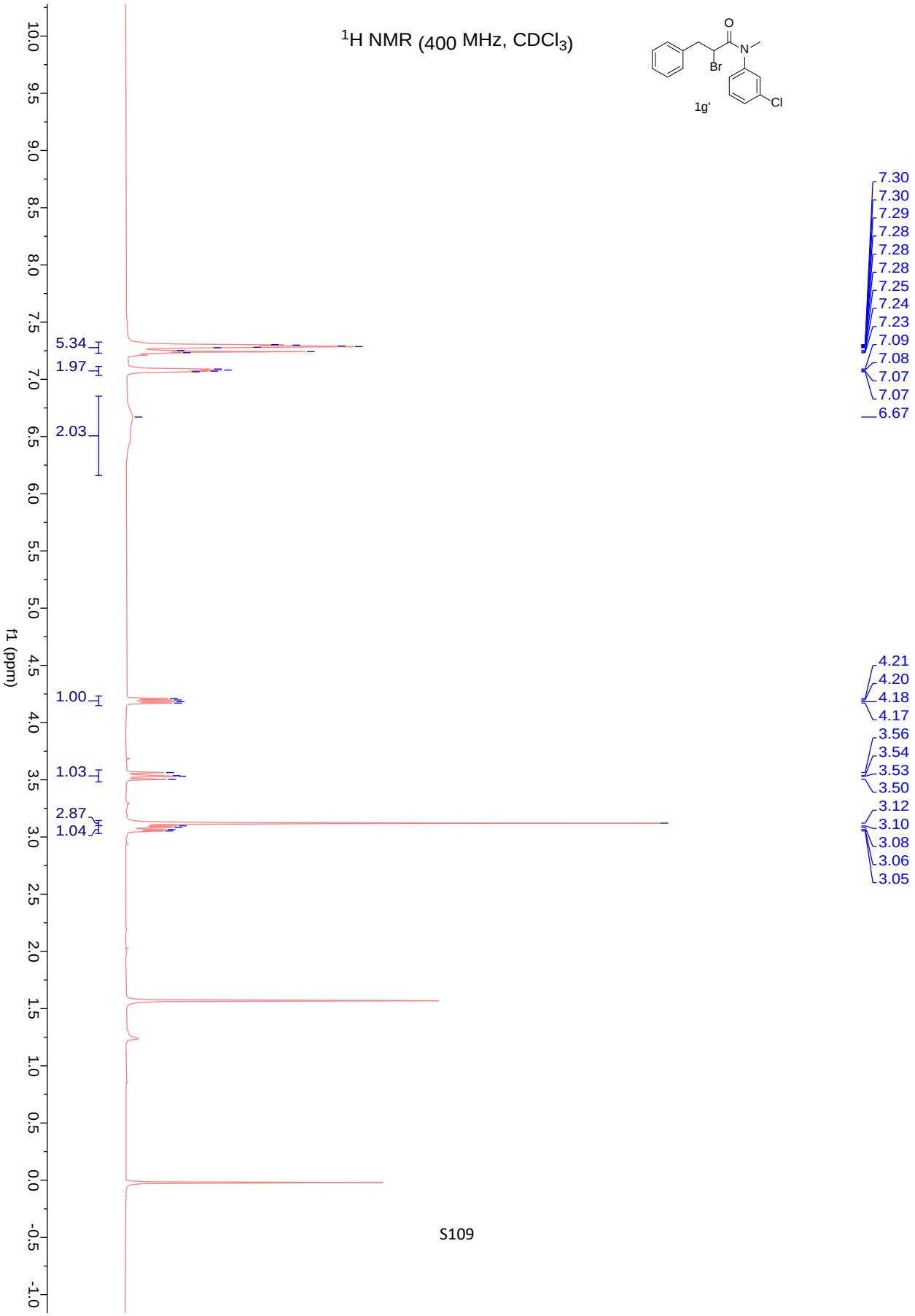


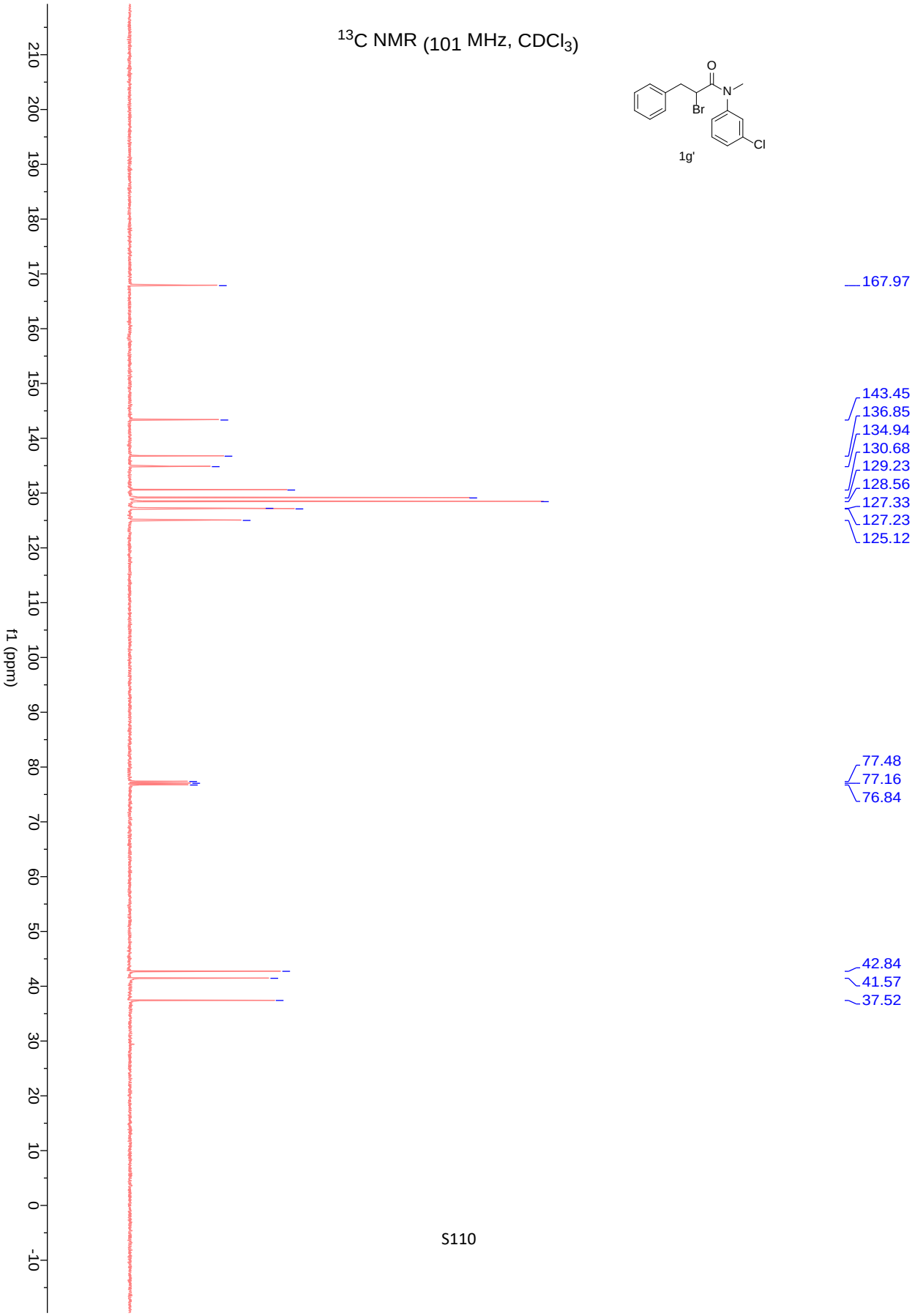
1f'

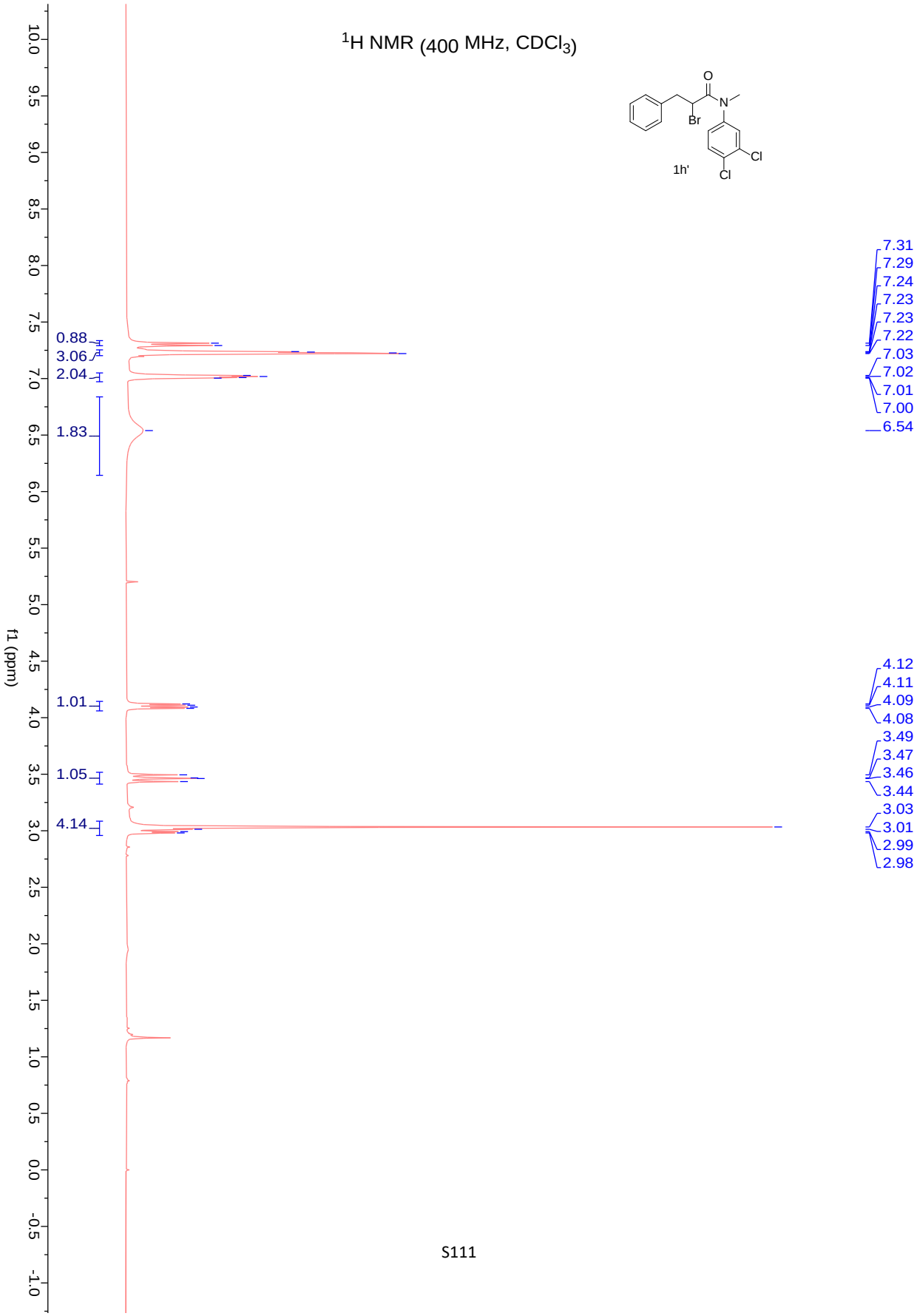
-62.61

f1 (ppm)

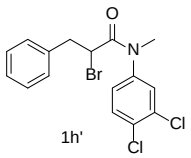
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210


^{1}H NMR (400 MHz, $CDCl_3$)
O
N
Br
Cl
1g'
f1 (ppm)
10.0
9.5
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
-1.0
5.34
1.97
2.03
1.00
1.03
2.87
1.04
7.30
7.30
7.29
7.28
7.28
7.28
7.25
7.24
7.23
7.09
7.08
7.07
7.07
6.67
4.21
4.20
4.18
4.17
3.56
3.54
3.53
3.50
3.12
3.10
3.08
3.06
3.05

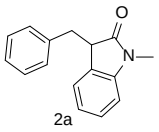

^{13}C NMR (101 MHz, $CDCl_3$)
O
N
Br
Cl
1g'
167.97
143.45
136.85
134.94
130.68
129.23
128.56
127.33
127.23
125.12
77.48
77.16
76.84
42.84
41.57
37.52
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

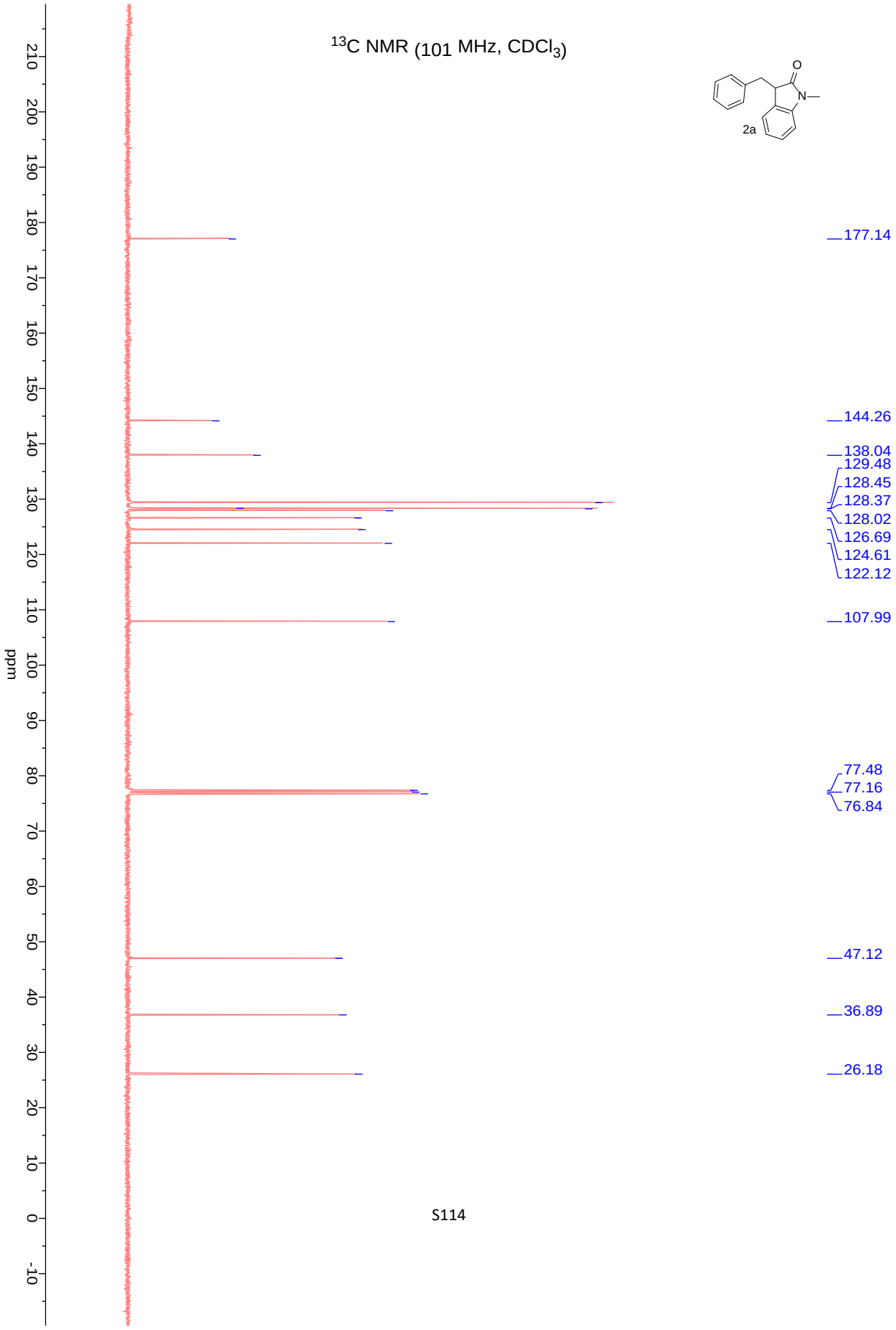

^{1}H NMR (400 MHz, $CDCl_3$)
O
N
Br
Cl
Cl
1h'
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
0.88
3.06
2.04
1.83
1.01
1.05
4.14
7.31
7.29
7.24
7.23
7.23
7.22
7.03
7.02
7.01
7.00
6.54
4.12
4.11
4.09
4.08
3.49
3.47
3.46
3.44
3.03
3.01
2.99
2.98

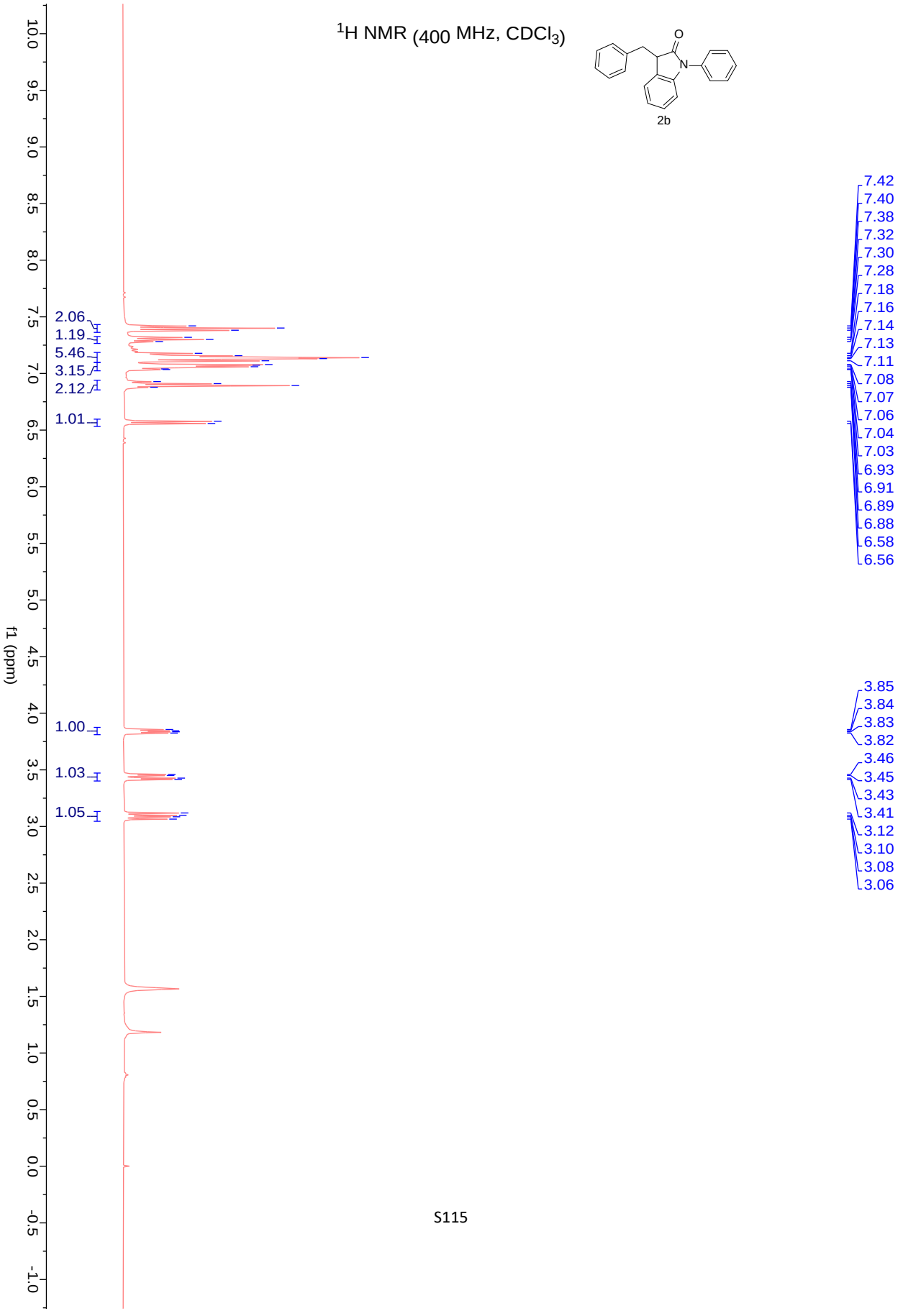
^{13}C NMR (101 MHz, $CDCl_3$)

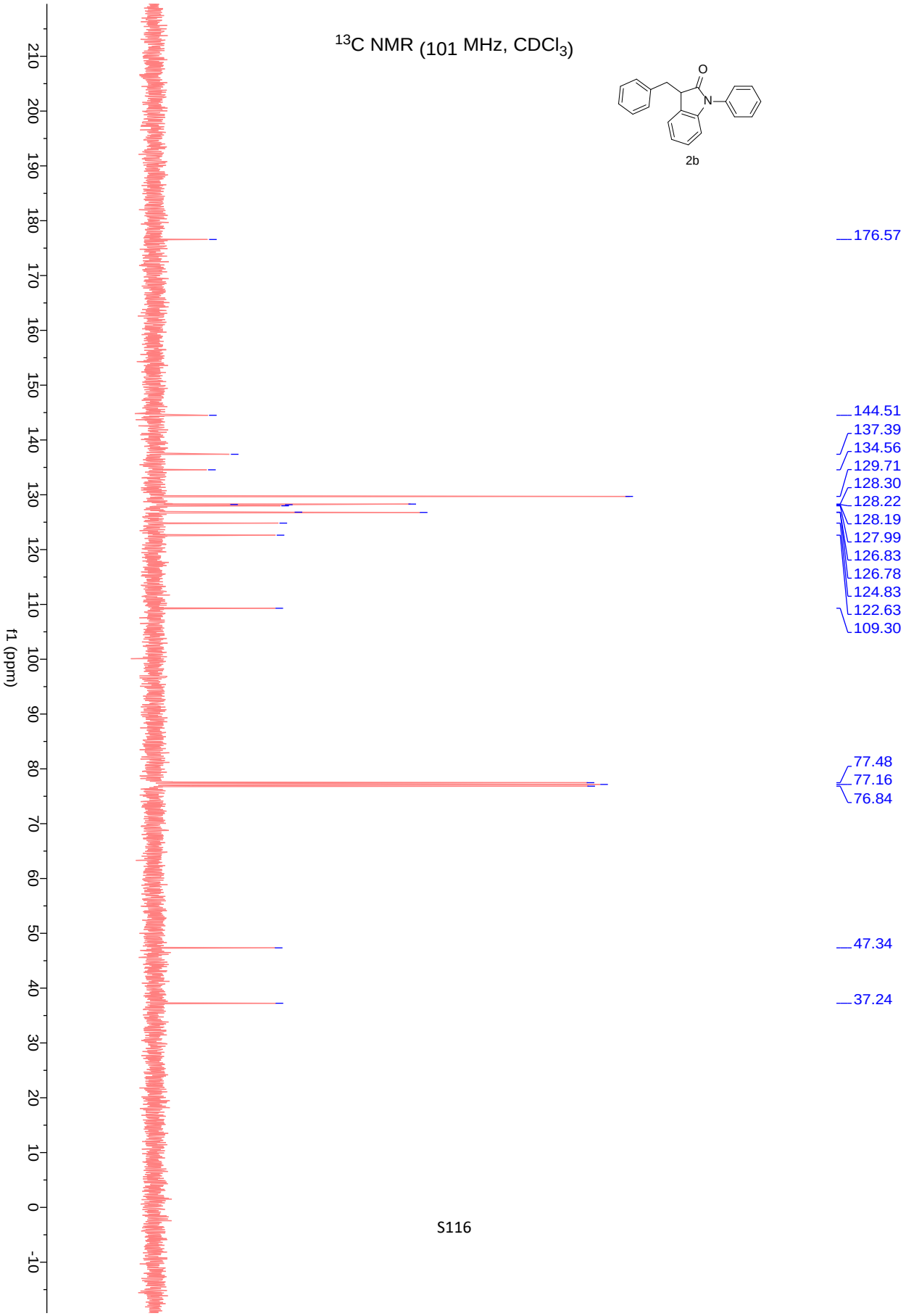


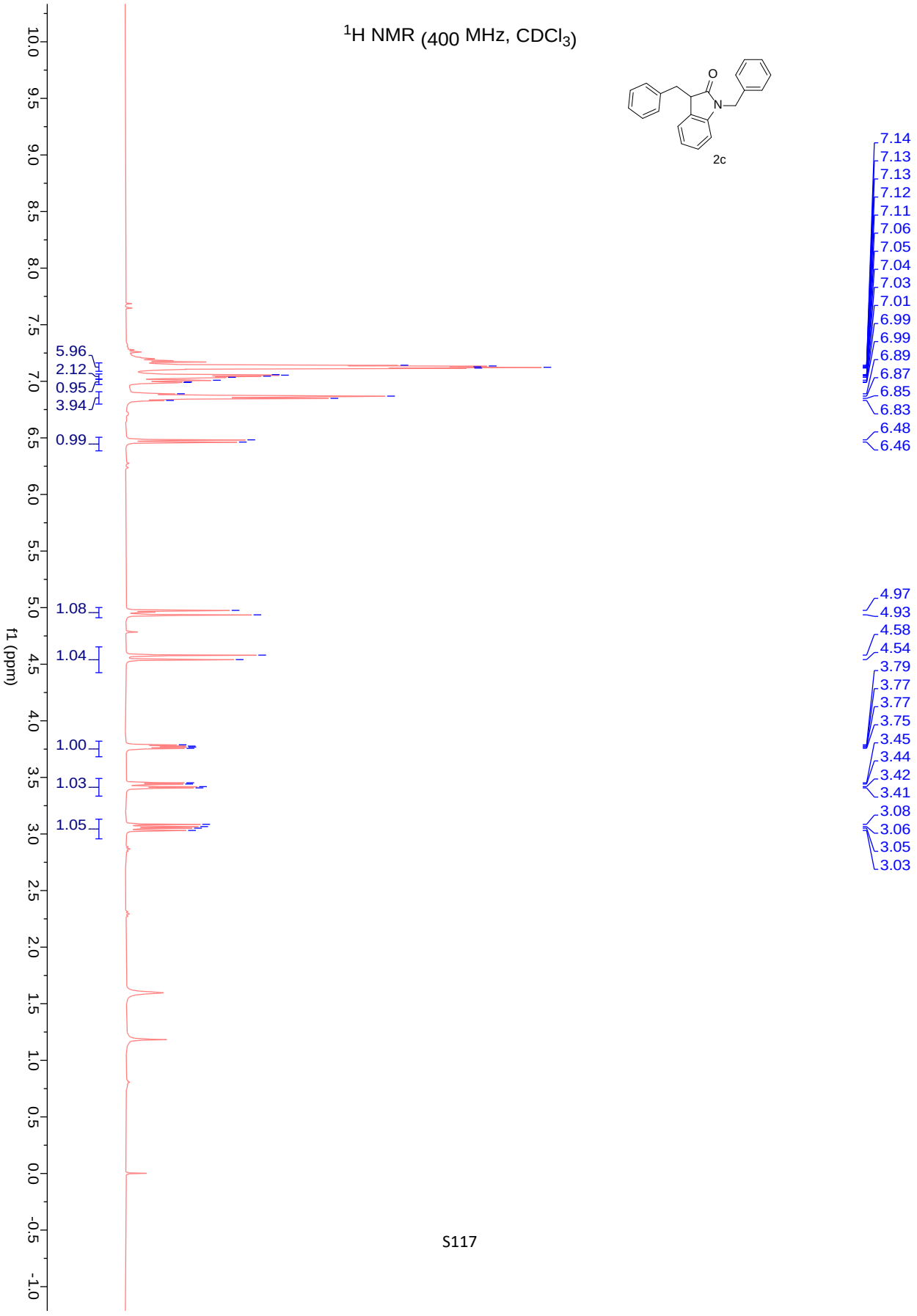
^{1}H NMR (400 MHz, $CDCl_3$)

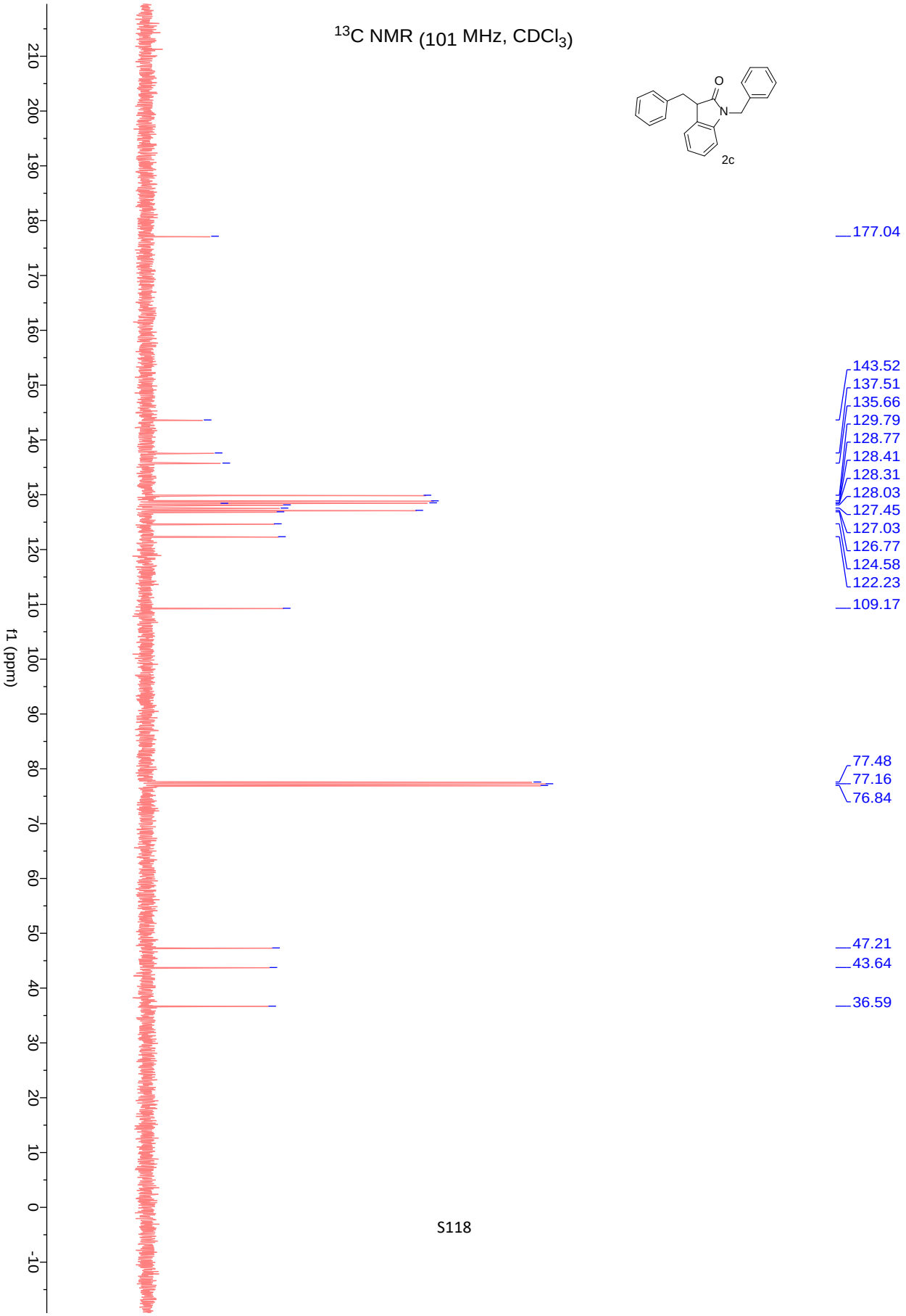



^{13}C NMR (101 MHz, $CDCl_3$)
O
N
2a
177.14
144.26
138.04
129.48
128.45
128.37
128.02
126.69
124.61
122.12
107.99
77.48
77.16
76.84
47.12
36.89
26.18
ppm
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

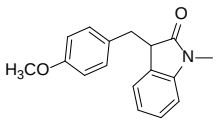

^{1}H NMR (400 MHz, $CDCl_3$)
O
N
2b
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
2.06
1.19
5.46
3.15
2.12
1.01
1.00
1.03
1.05
7.42
7.40
7.38
7.32
7.30
7.28
7.18
7.16
7.14
7.13
7.11
7.08
7.07
7.06
7.04
7.03
6.93
6.91
6.89
6.88
6.58
6.56
3.85
3.84
3.83
3.82
3.46
3.45
3.43
3.41
3.12
3.10
3.08
3.06


^{13}C NMR (101 MHz, $CDCl_3$)
O
N
2b
176.57
144.51
137.39
134.56
129.71
128.30
128.22
128.19
127.99
126.83
126.78
124.83
122.63
109.30
77.48
77.16
76.84
47.34
37.24
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10


^{1}H NMR (400 MHz, $CDCl_3$)
O
N
2c
f1 (ppm)
10.0
9.5
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
-1.0
5.96
2.12
0.95
3.94
0.99
1.08
1.04
1.00
1.03
1.05
7.14
7.13
7.13
7.12
7.11
7.06
7.05
7.04
7.03
7.01
6.99
6.99
6.89
6.87
6.85
6.83
6.48
6.46
4.97
4.93
4.58
4.54
3.79
3.77
3.77
3.75
3.45
3.44
3.42
3.41
3.08
3.06
3.05
3.03

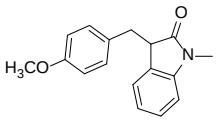

^{13}C NMR (101 MHz, $CDCl_3$)
O
N
2c
177.04
143.52
137.51
135.66
129.79
128.77
128.41
128.31
128.03
127.45
127.03
126.77
124.58
122.23
109.17
77.48
77.16
76.84
47.21
43.64
36.59
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

^{1}H NMR (400 MHz, $CDCl_3$)

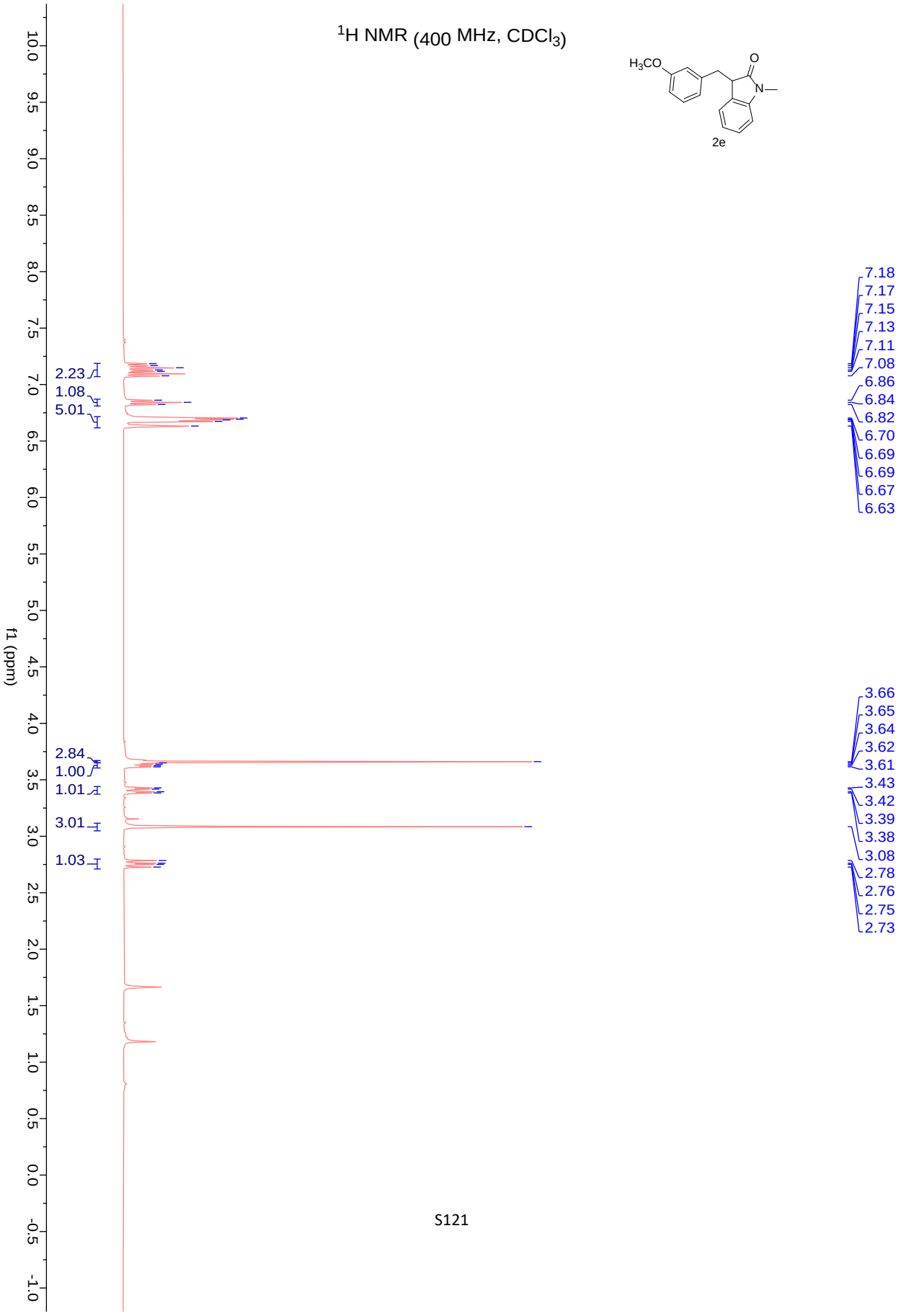


2d

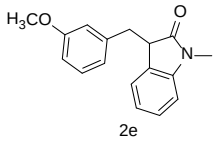
^{13}C NMR (101 MHz, $CDCl_3$)



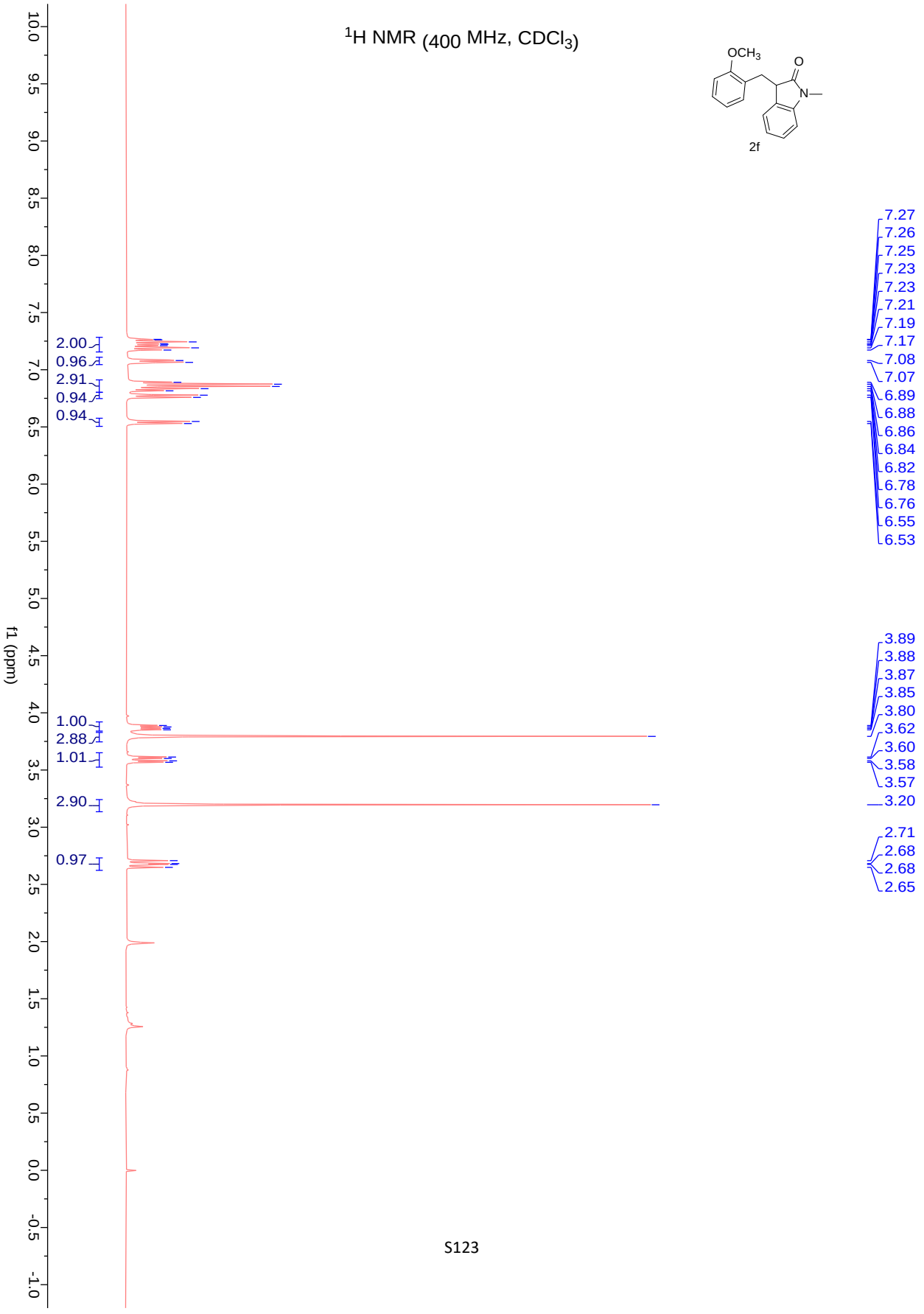
2d

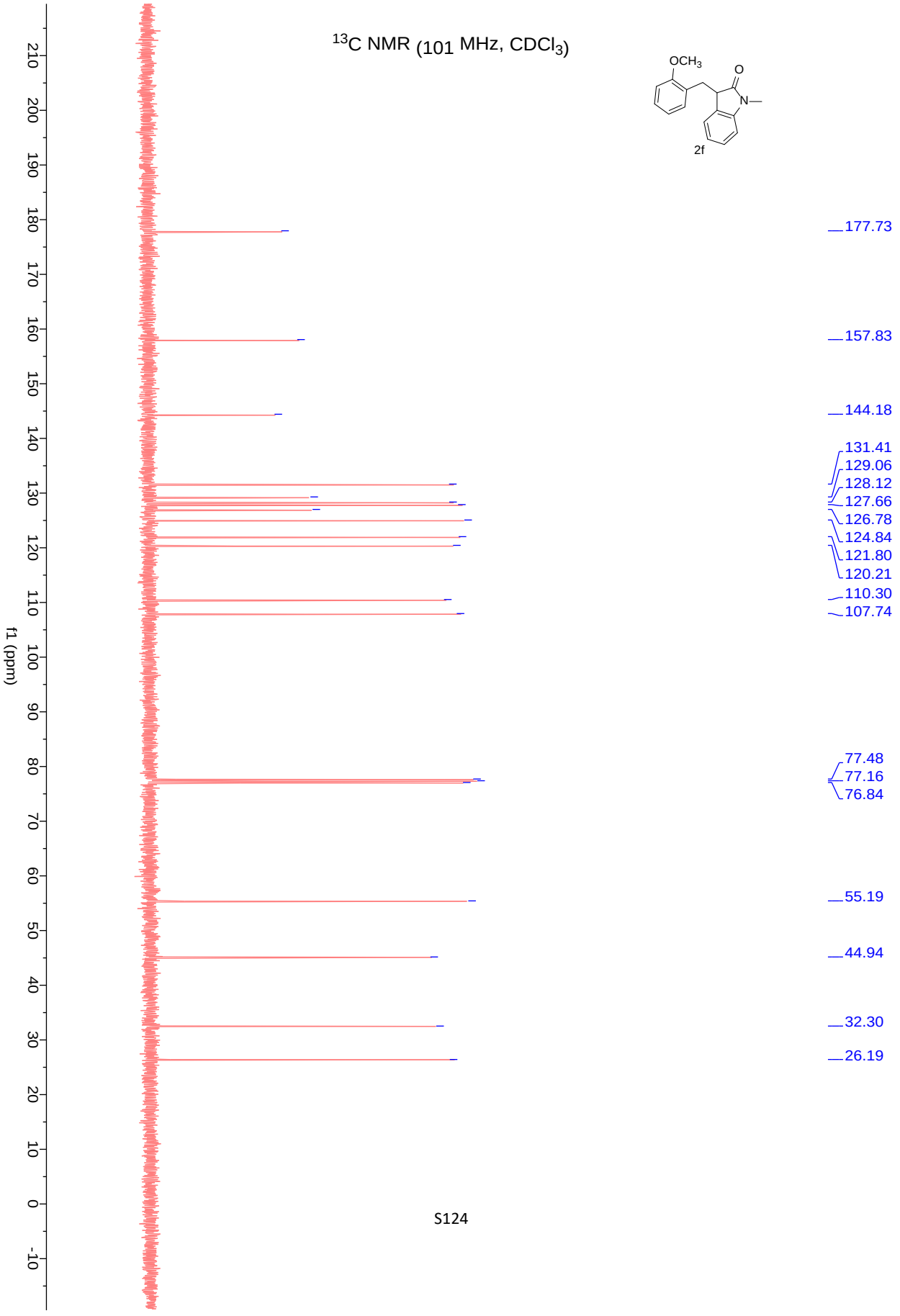

^{1}H NMR (400 MHz, CDCl$_3$)
H$_3$CO
O
N
2e
7.18
7.17
7.15
7.13
7.11
7.08
6.86
6.84
6.82
6.70
6.69
6.69
6.67
6.63
3.66
3.65
3.64
3.62
3.61
3.43
3.42
3.39
3.38
3.08
2.78
2.76
2.75
2.73
2.23
1.08
5.01
2.84
1.00
1.01
3.01
1.03
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0

^{13}C NMR (101 MHz, $CDCl_3$)

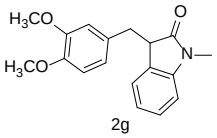


2e


^{1}H NMR (400 MHz, $CDCl_3$)
OCH_3
O
N
2f
f1 (ppm)
10.0
9.5
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
-1.0
2.00
0.96
2.91
0.94
0.94
1.00
2.88
1.01
2.90
0.97
7.27
7.26
7.25
7.23
7.23
7.21
7.19
7.17
7.08
7.07
6.89
6.88
6.86
6.84
6.82
6.78
6.76
6.55
6.53
3.89
3.88
3.87
3.85
3.80
3.62
3.60
3.58
3.57
3.20
2.71
2.68
2.68
2.65

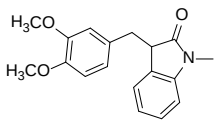

^{13}C NMR (101 MHz, $CDCl_3$)
OCH_3
O
N
2f
177.73
157.83
144.18
131.41
129.06
128.12
127.66
126.78
124.84
121.80
120.21
110.30
107.74
77.48
77.16
76.84
55.19
44.94
32.30
26.19
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

^{1}H NMR (400 MHz, $CDCl_3$)

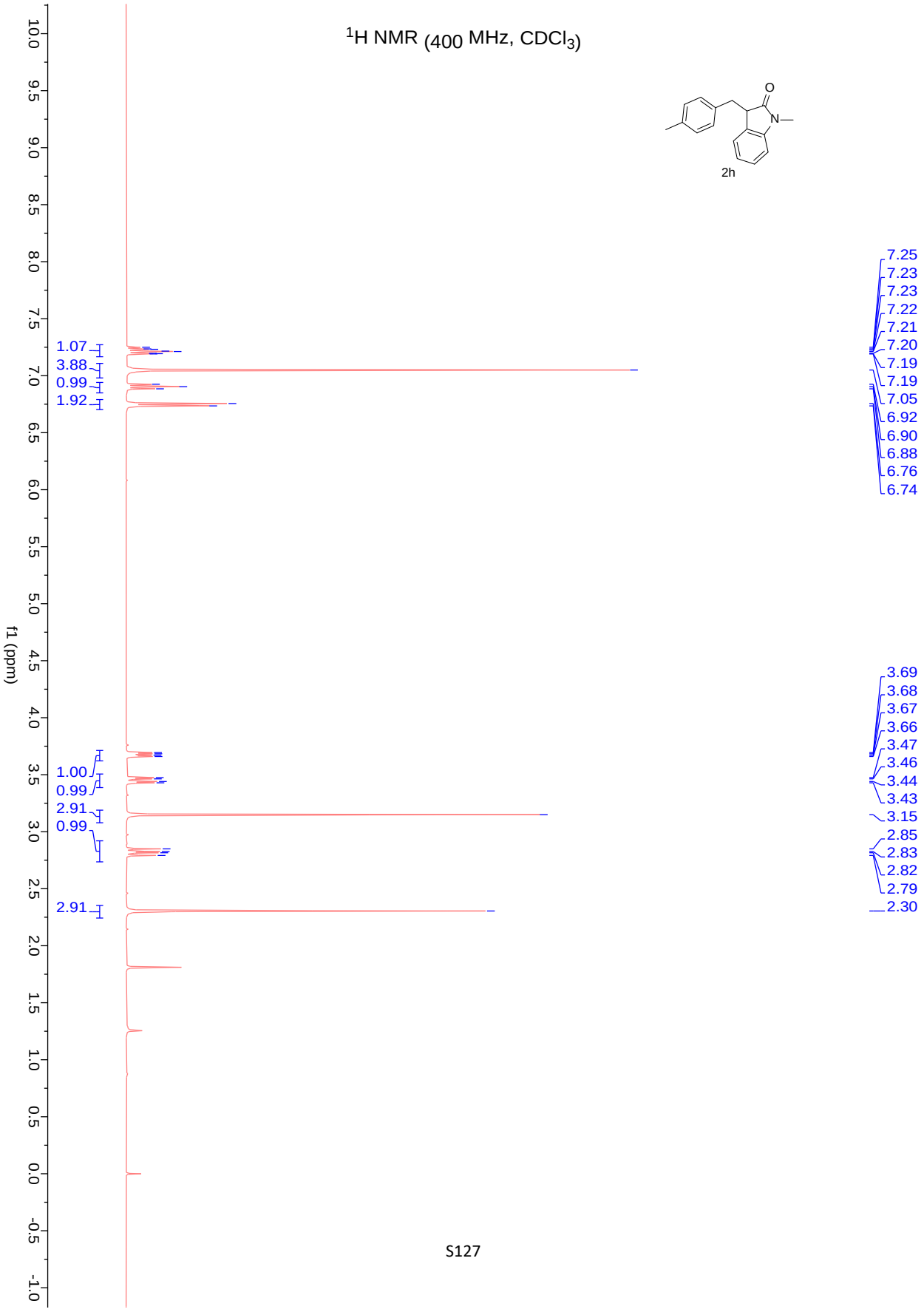


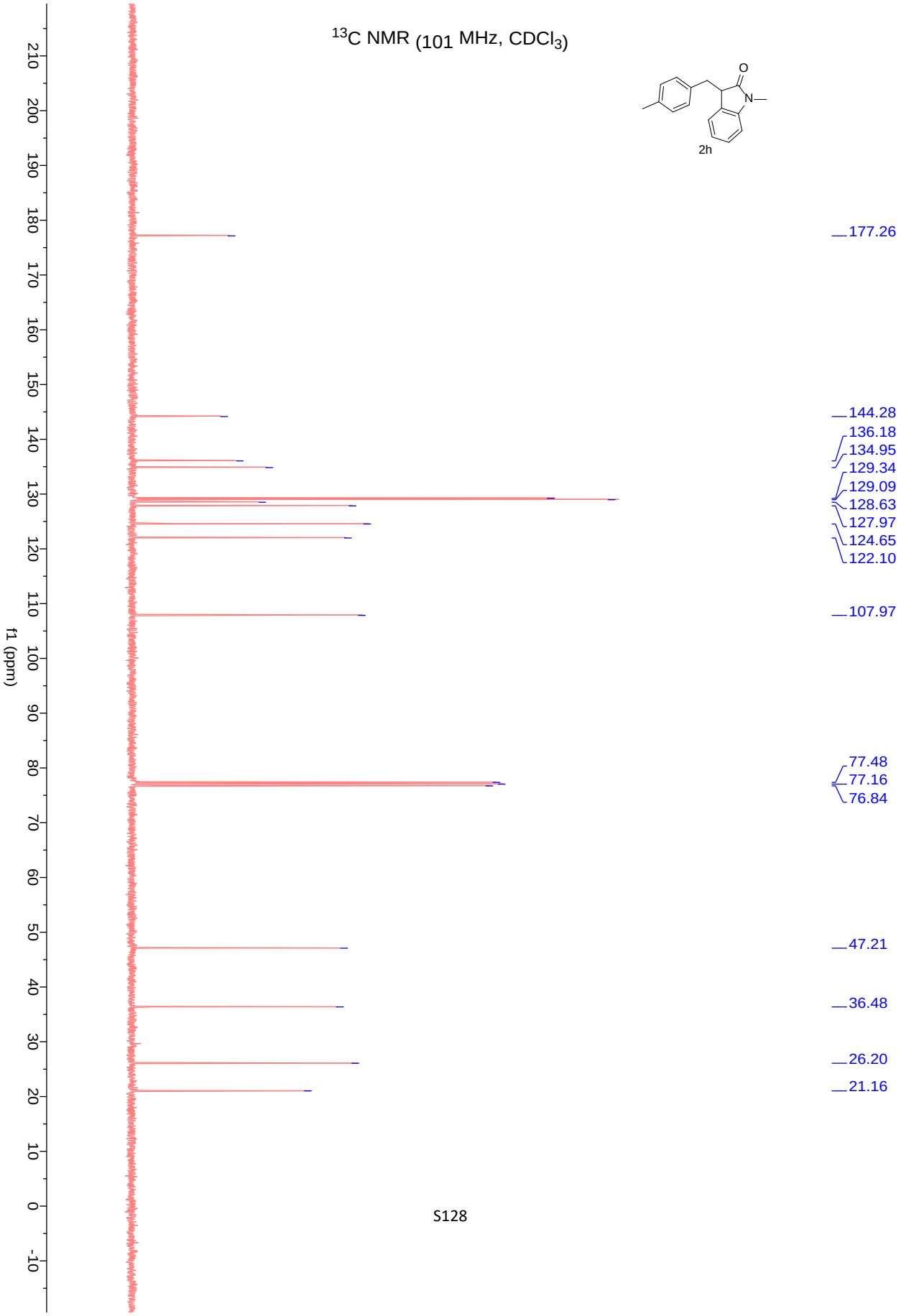
2g

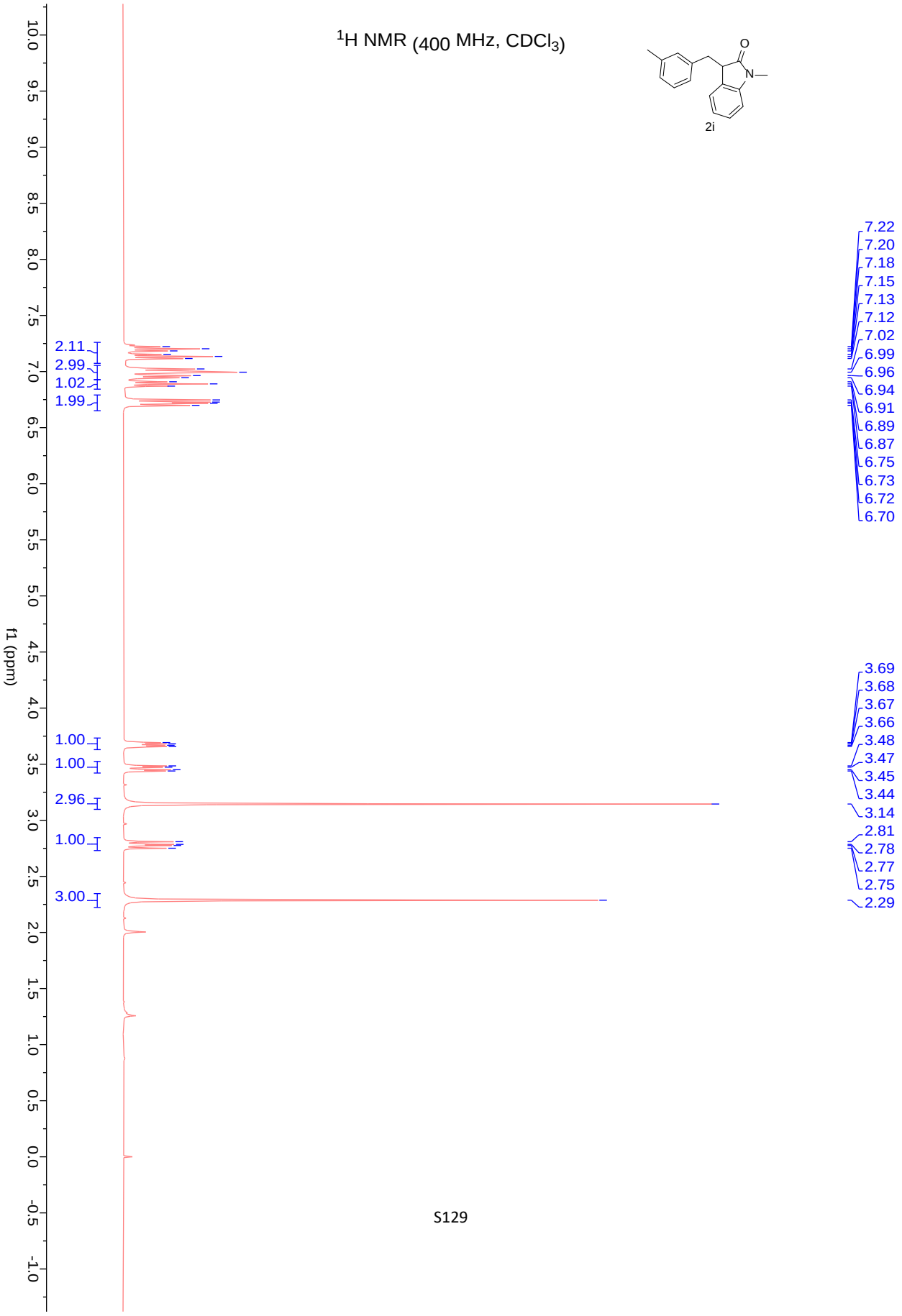
^{13}C NMR (101 MHz, $CDCl_3$)



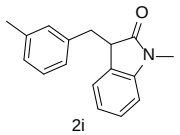
2g


^{1}H NMR (400 MHz, CDCl$_3$)
O
N
2h
f1 (ppm)
10.0
9.5
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
-1.0
1.07
3.88
0.99
1.92
1.00
0.99
2.91
0.99
2.91
7.25
7.23
7.23
7.22
7.21
7.20
7.19
7.19
7.05
6.92
6.90
6.88
6.76
6.74
3.69
3.68
3.67
3.66
3.47
3.46
3.44
3.43
3.15
2.85
2.83
2.82
2.79
2.30

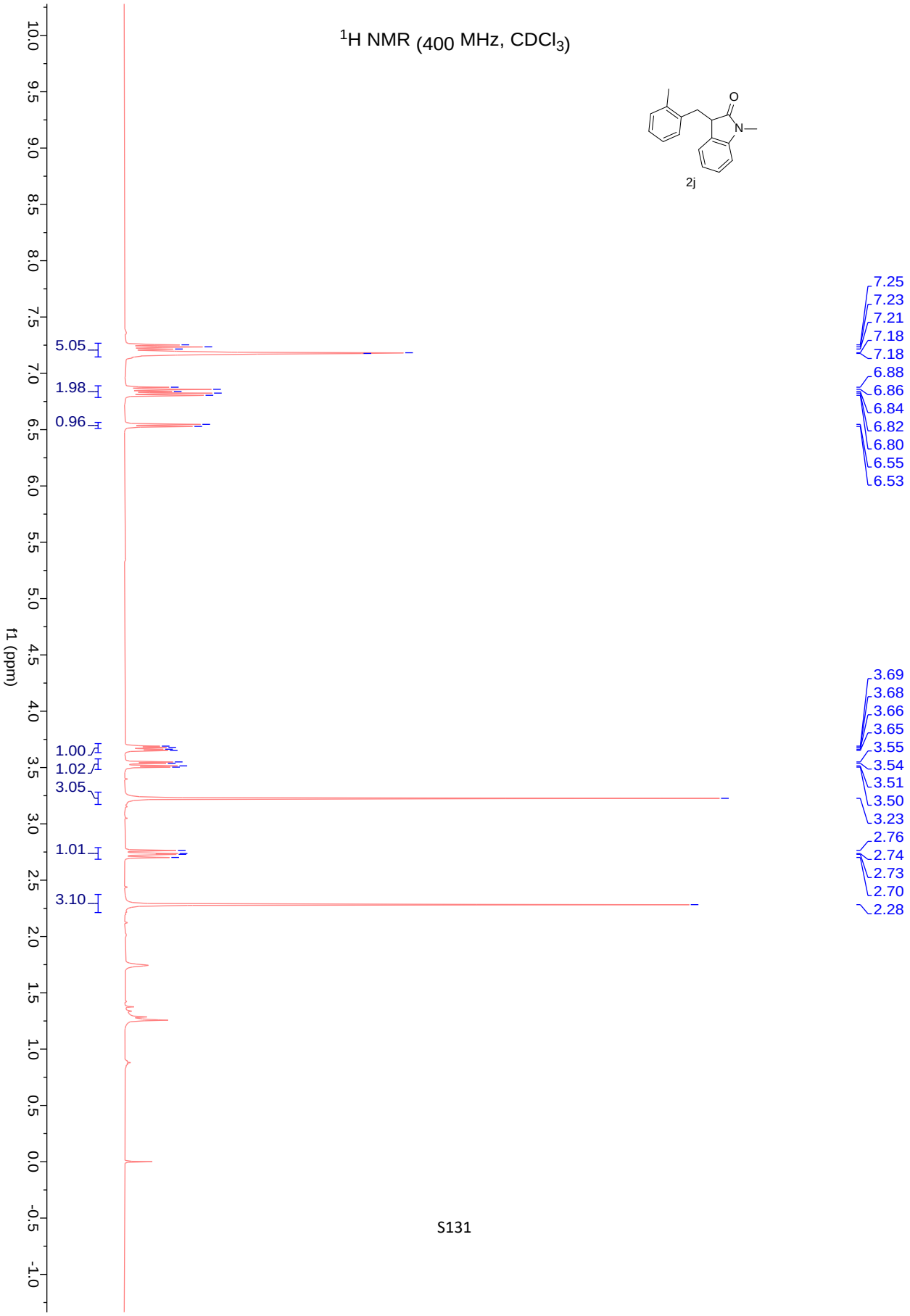

^{13}C NMR (101 MHz, $CDCl_3$)
O
N
2h
177.26
144.28
136.18
134.95
129.34
129.09
128.63
127.97
124.65
122.10
107.97
77.48
77.16
76.84
47.21
36.48
26.20
21.16
f1 (ppm)

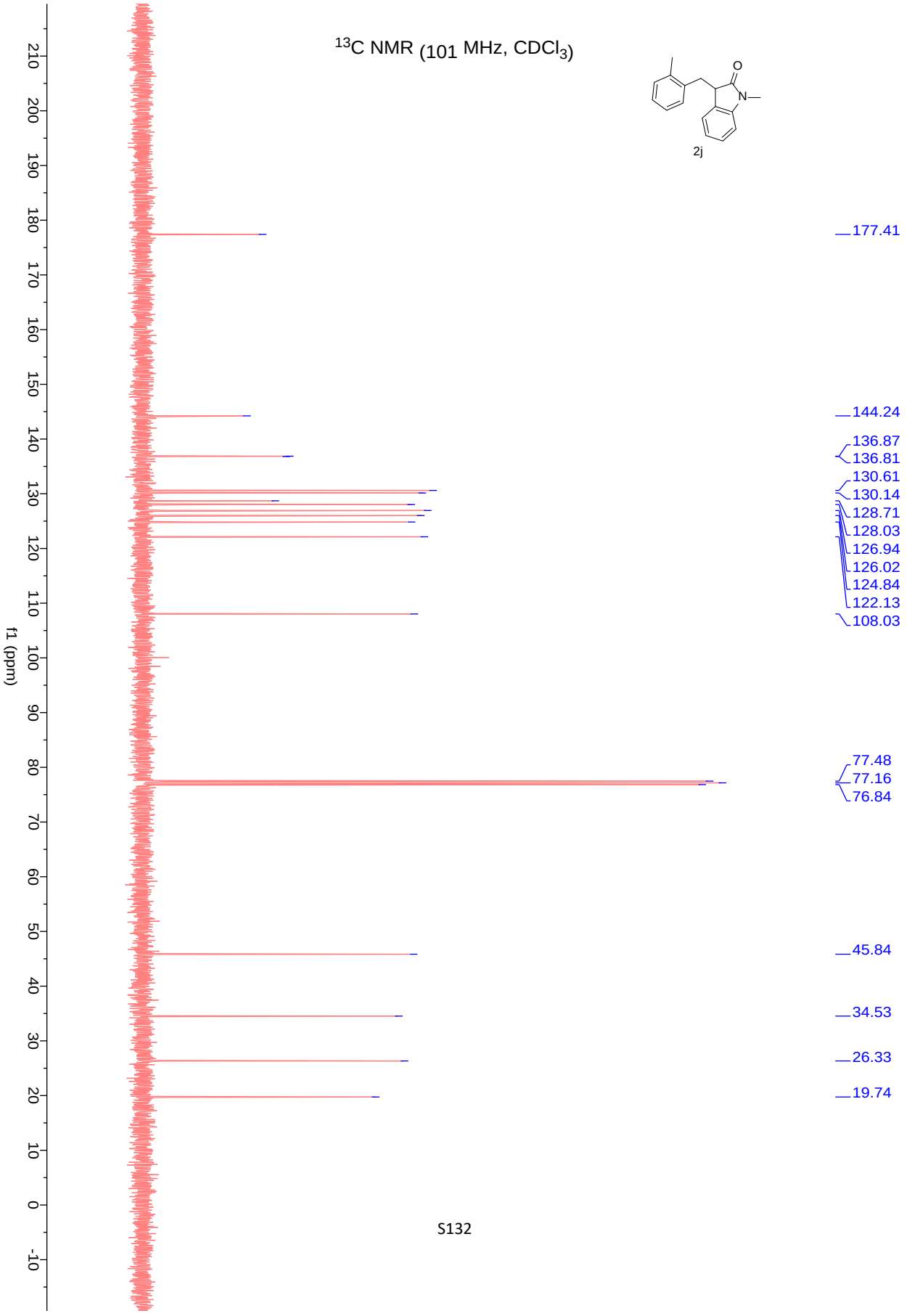

^{1}H NMR (400 MHz, CDCl$_3$)
O
N
2i
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
2.11
2.99
1.02
1.99
1.00
1.00
2.96
1.00
3.00
7.22
7.20
7.18
7.15
7.13
7.12
7.02
6.99
6.96
6.94
6.91
6.89
6.87
6.75
6.73
6.72
6.70
3.69
3.68
3.67
3.66
3.48
3.47
3.45
3.44
3.14
2.81
2.78
2.77
2.75
2.29

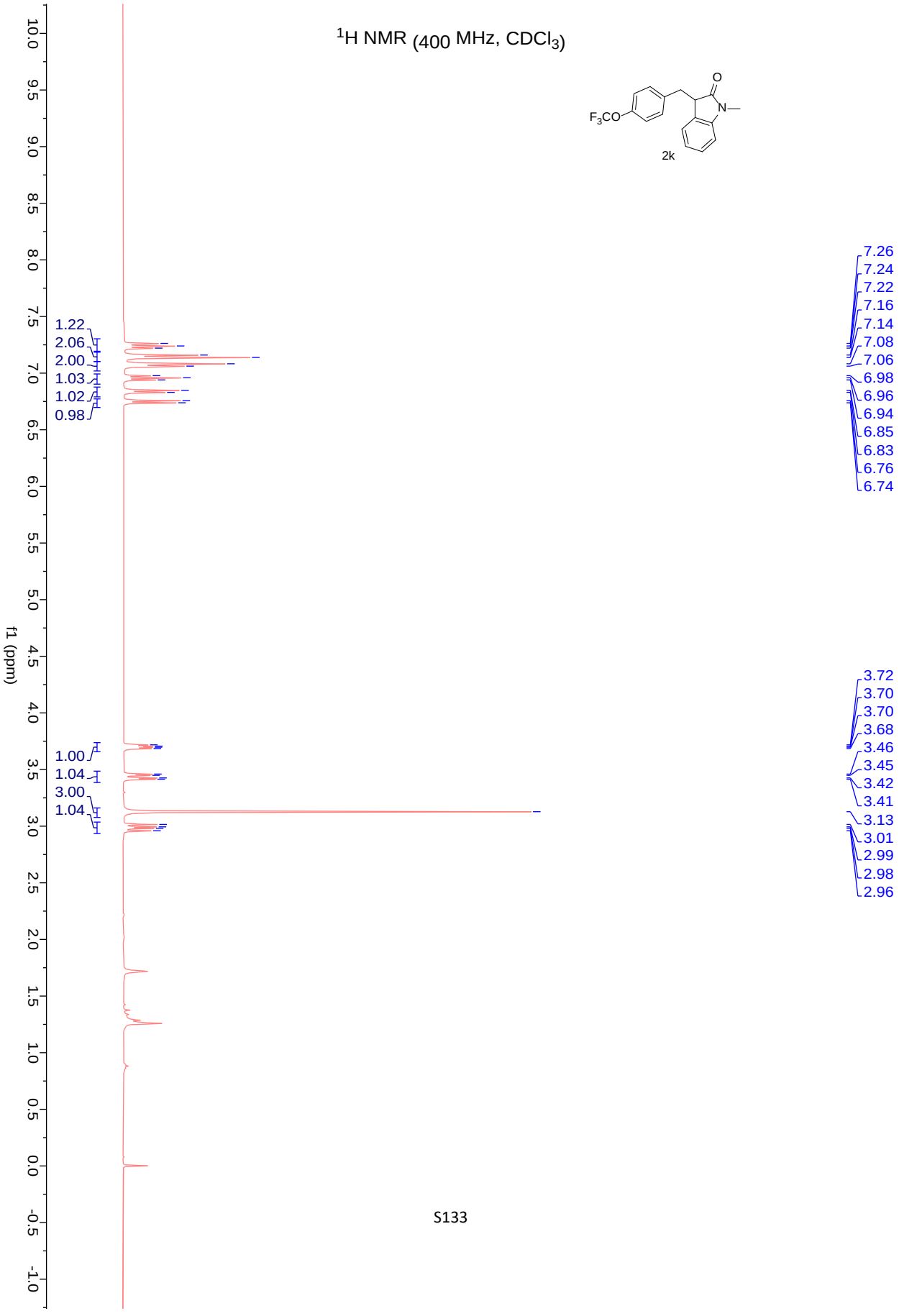
^{13}C NMR (101 MHz, $CDCl_3$)

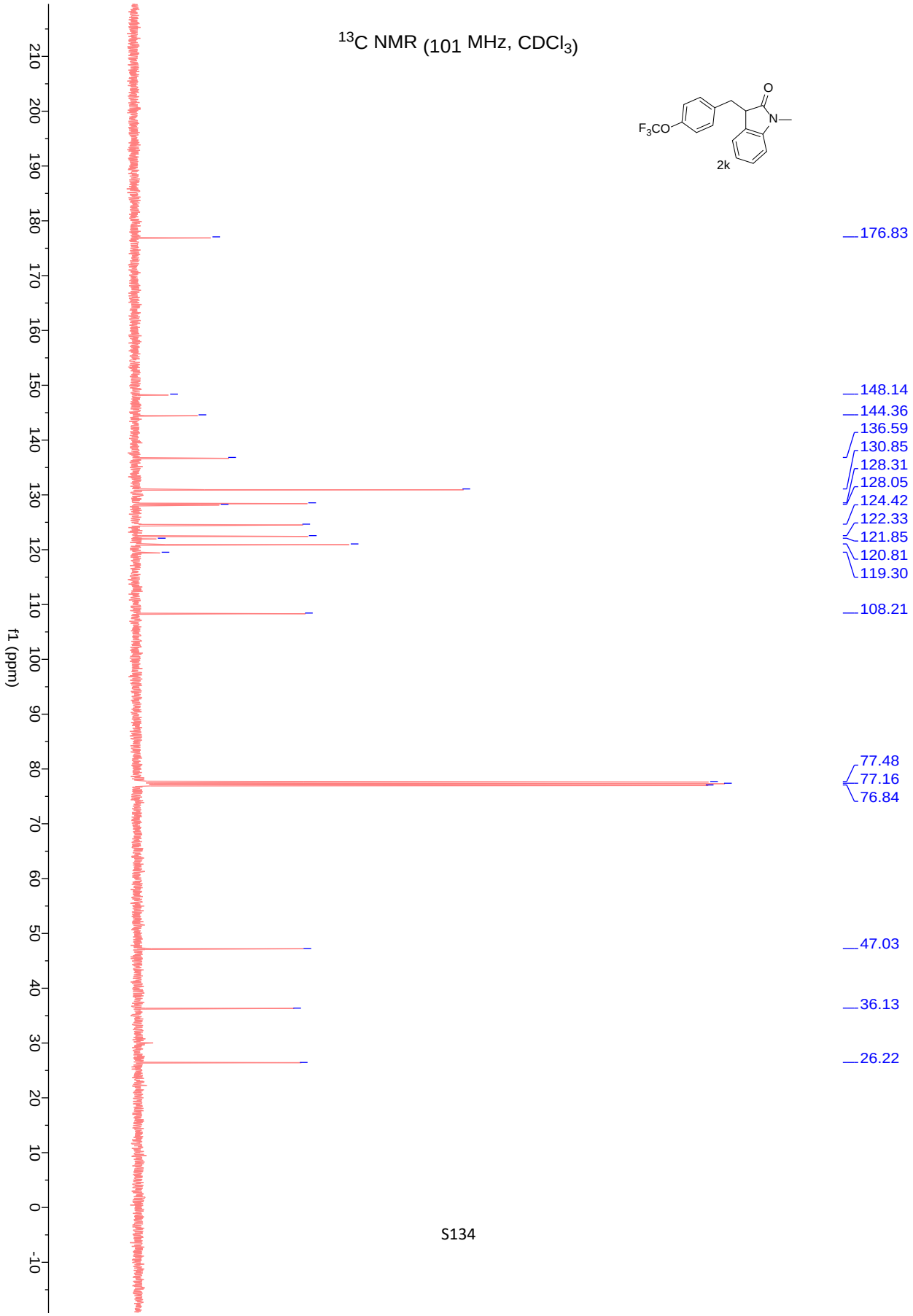


2i

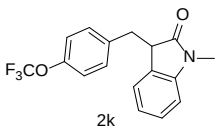

^{1}H NMR (400 MHz, $CDCl_3$)
O
N
2j
7.25
7.23
7.21
7.18
7.18
6.88
6.86
6.84
6.82
6.80
6.55
6.53
3.69
3.68
3.66
3.65
3.55
3.54
3.51
3.50
3.23
2.76
2.74
2.73
2.70
2.28
5.05
1.98
0.96
1.00
1.02
3.05
1.01
3.10
f1 (ppm)


^{13}C NMR (101 MHz, $CDCl_3$)
O
N
2j
177.41
144.24
136.87
136.81
130.61
130.14
128.71
128.03
126.94
126.02
124.84
122.13
108.03
77.48
77.16
76.84
45.84
34.53
26.33
19.74
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10


^{1}H NMR (400 MHz, $CDCl_3$)
F_3CO
O
N
2k
f1 (ppm)
10.0
9.5
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
-1.0
1.22
2.06
2.00
1.03
1.02
0.98
1.00
1.04
3.00
1.04
7.26
7.24
7.22
7.16
7.14
7.08
7.06
6.98
6.96
6.94
6.85
6.83
6.76
6.74
3.72
3.70
3.70
3.68
3.46
3.45
3.42
3.41
3.13
3.01
2.99
2.98
2.96

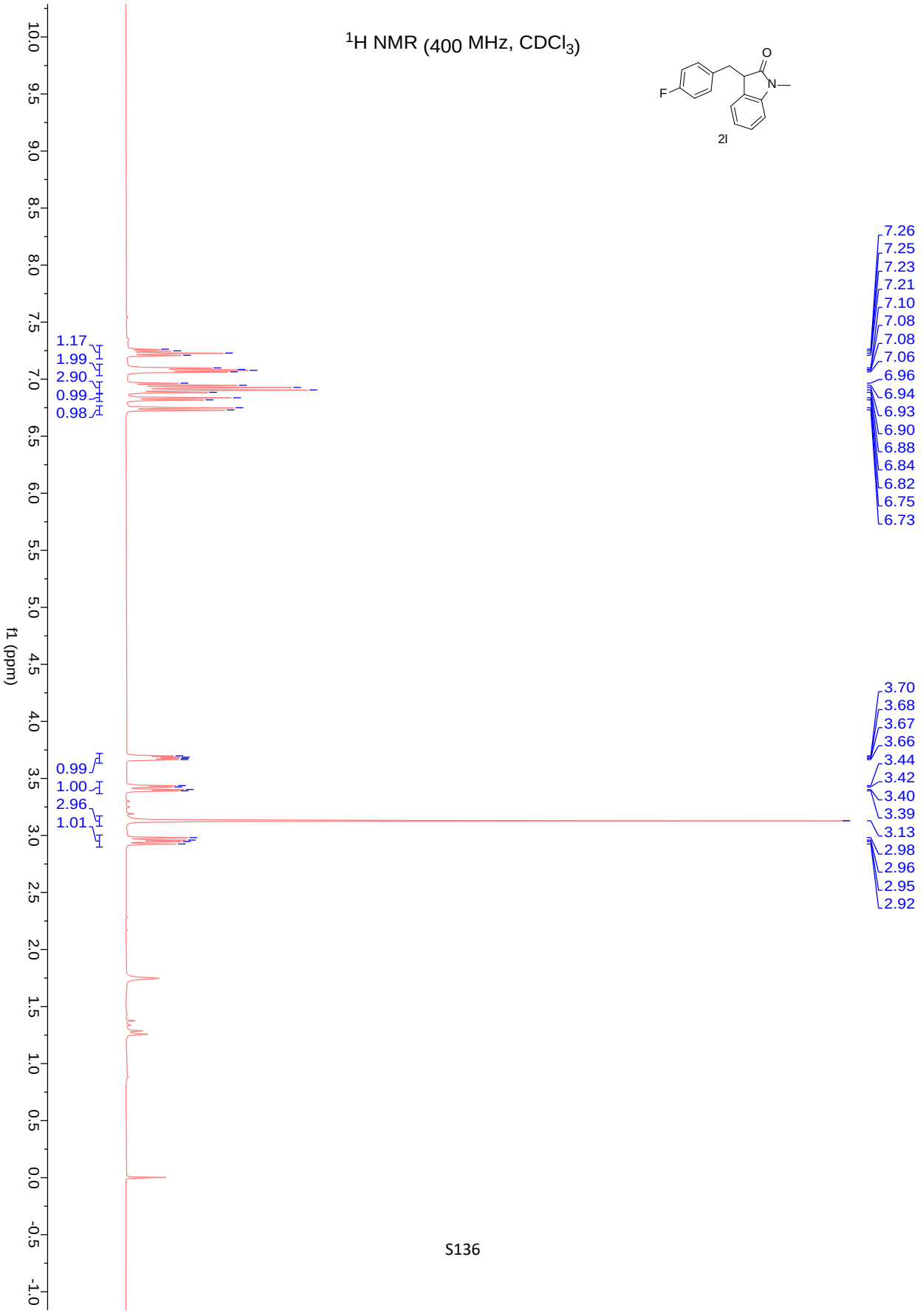

^{13}C NMR (101 MHz, $CDCl_3$)
F_3CO
O
N
2k
176.83
148.14
144.36
136.59
130.85
128.31
128.05
124.42
122.33
121.85
120.81
119.30
108.21
77.48
77.16
76.84
47.03
36.13
26.22
f1 (ppm)

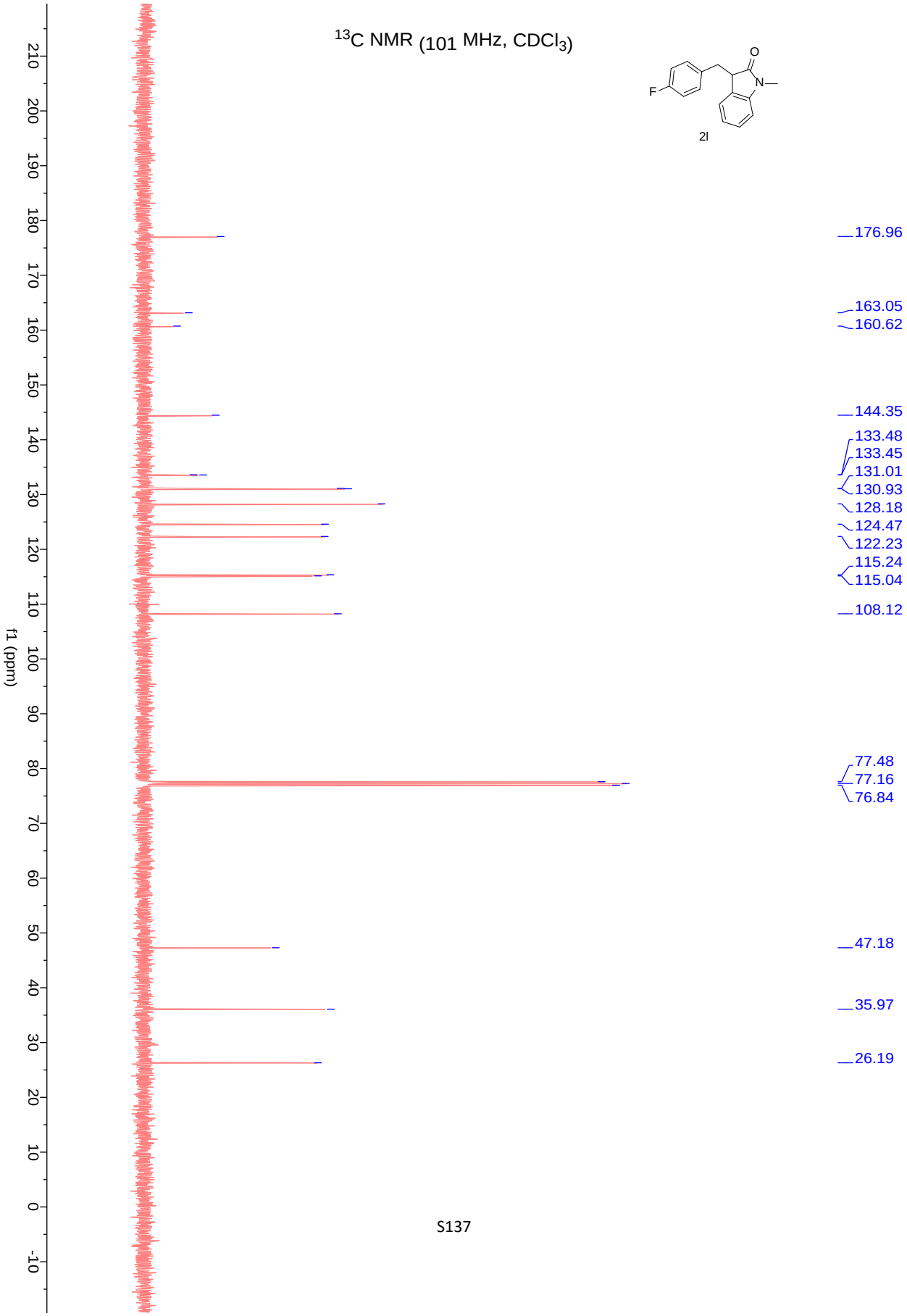
^{19}F NMR (376 MHz, $CDCl_3$)



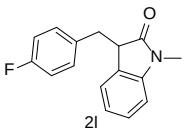
2k

-57.91

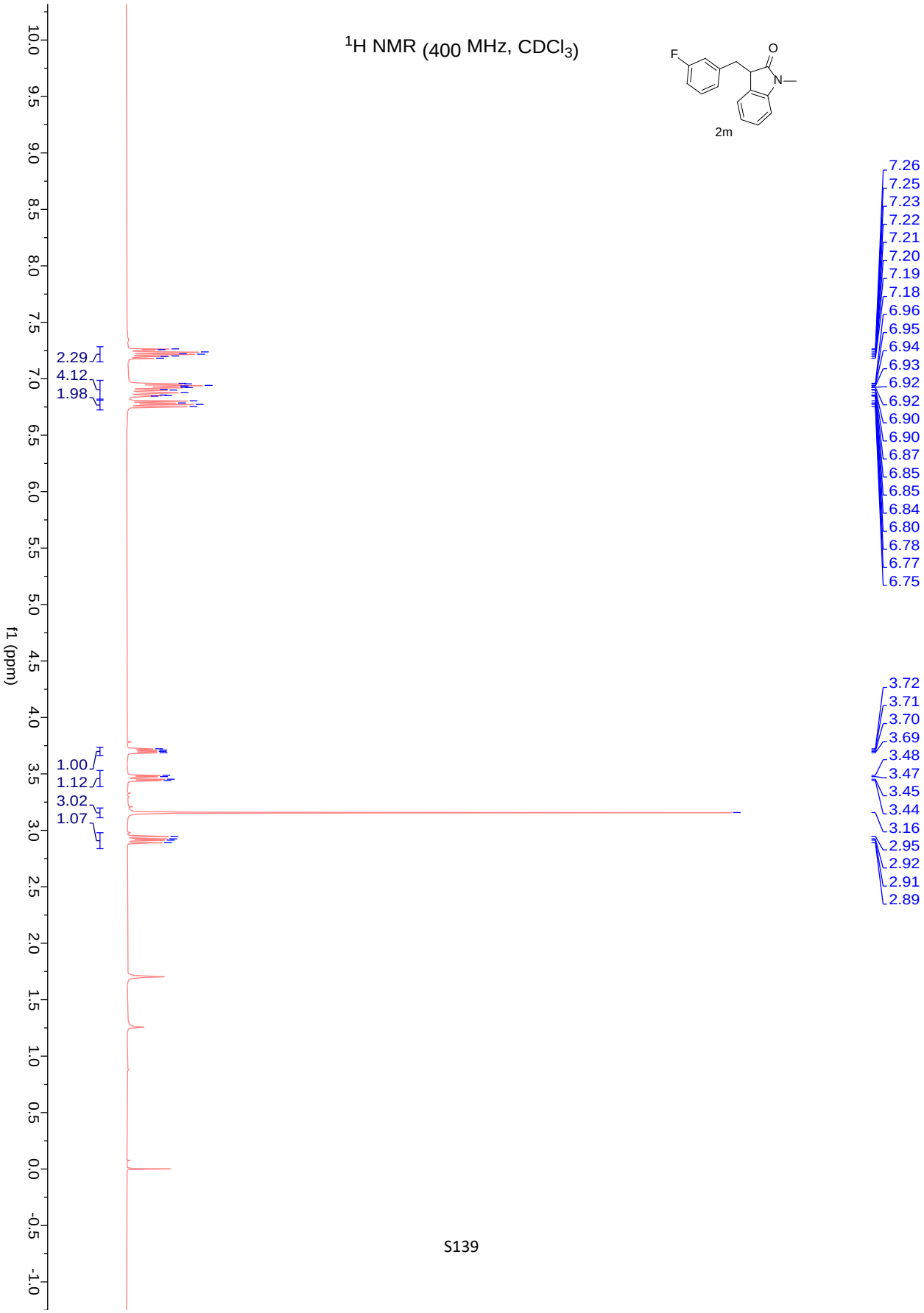

^{1}H NMR (400 MHz, $CDCl_3$)
O
N
F
2l
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1.17
1.99
2.90
0.99
0.98
0.99
1.00
2.96
1.01
7.26
7.25
7.23
7.21
7.10
7.08
7.08
7.06
6.96
6.94
6.93
6.90
6.88
6.84
6.82
6.75
6.73
3.70
3.68
3.67
3.66
3.44
3.42
3.40
3.39
3.13
2.98
2.96
2.95
2.92


^{13}C NMR (101 MHz, $CDCl_3$)
F
O
N
2l
176.96
163.05
160.62
144.35
133.48
133.45
131.01
130.93
128.18
124.47
122.23
115.24
115.04
108.12
77.48
77.16
76.84
47.18
35.97
26.19
f1 (ppm)

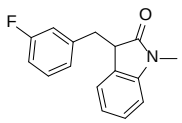
^{19}F NMR (376 MHz, $CDCl_3$)



2l

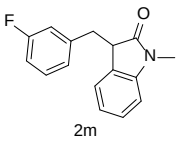

^{1}H NMR (400 MHz, $CDCl_3$)
F
O
N
2m
7.26
7.25
7.23
7.22
7.21
7.20
7.19
7.18
6.96
6.95
6.94
6.93
6.92
6.92
6.90
6.90
6.87
6.85
6.85
6.84
6.80
6.78
6.77
6.75
3.72
3.71
3.70
3.69
3.48
3.47
3.45
3.44
3.16
2.95
2.92
2.91
2.89
2.29
4.12
1.98
1.00
1.12
3.02
1.07
f1 (ppm)

^{13}C NMR (101 MHz, $CDCl_3$)



2m

^{19}F NMR (376 MHz, $CDCl_3$)



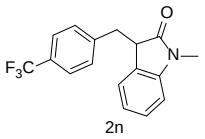
2m

-113.39

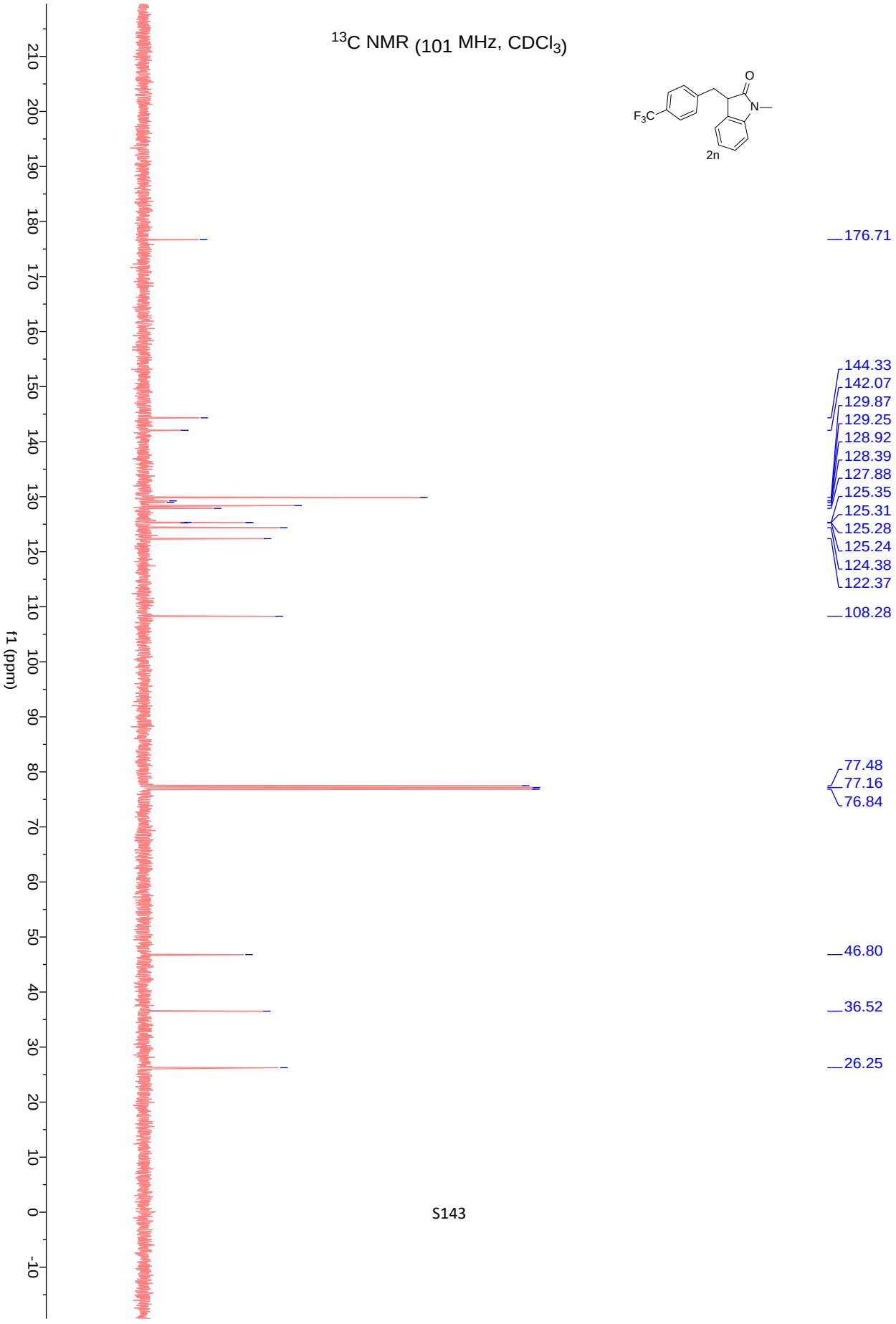
f1 (ppm)

10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210

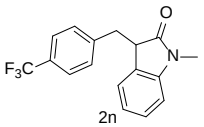
^{1}H NMR (400 MHz, $CDCl_3$)



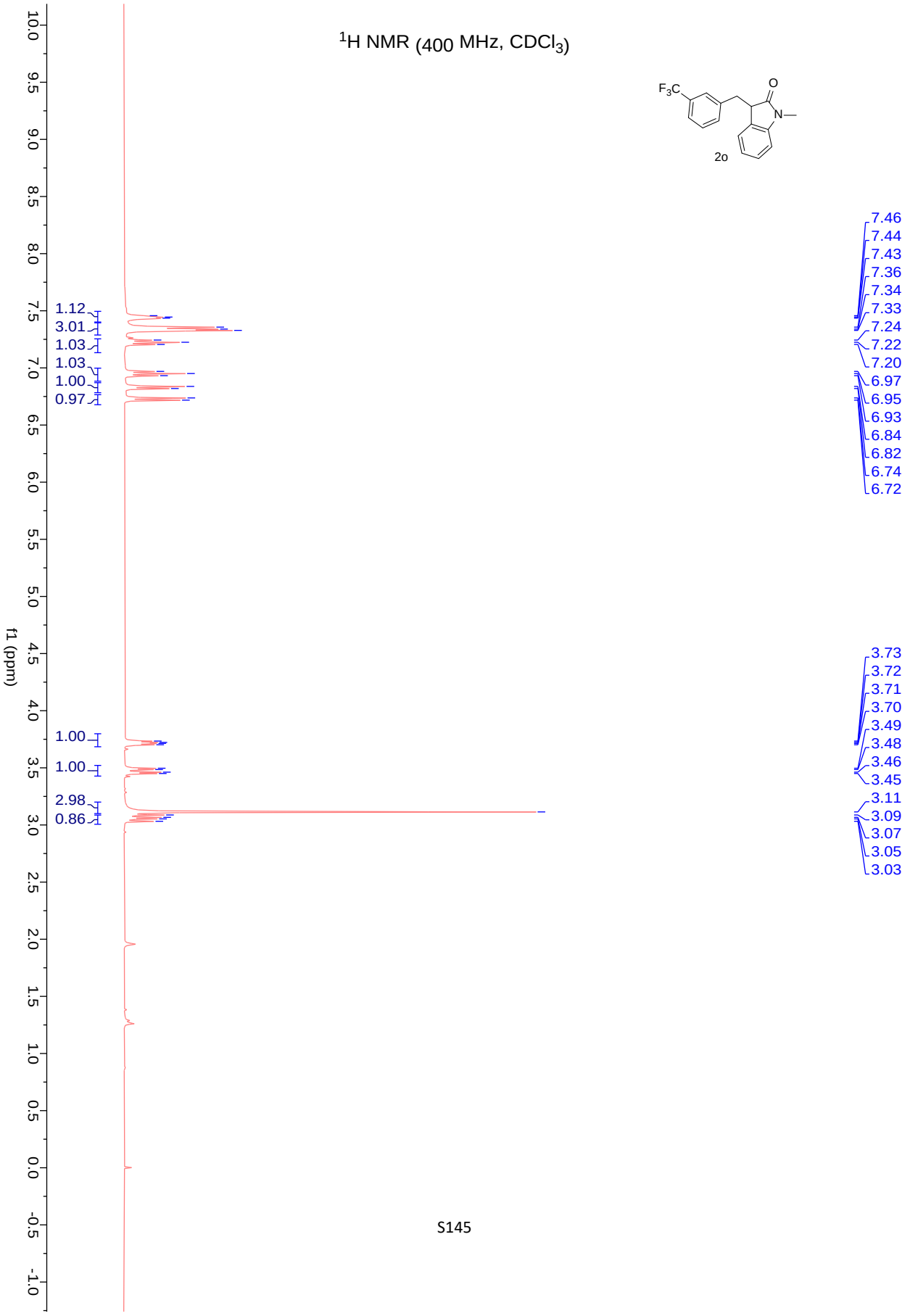
2n

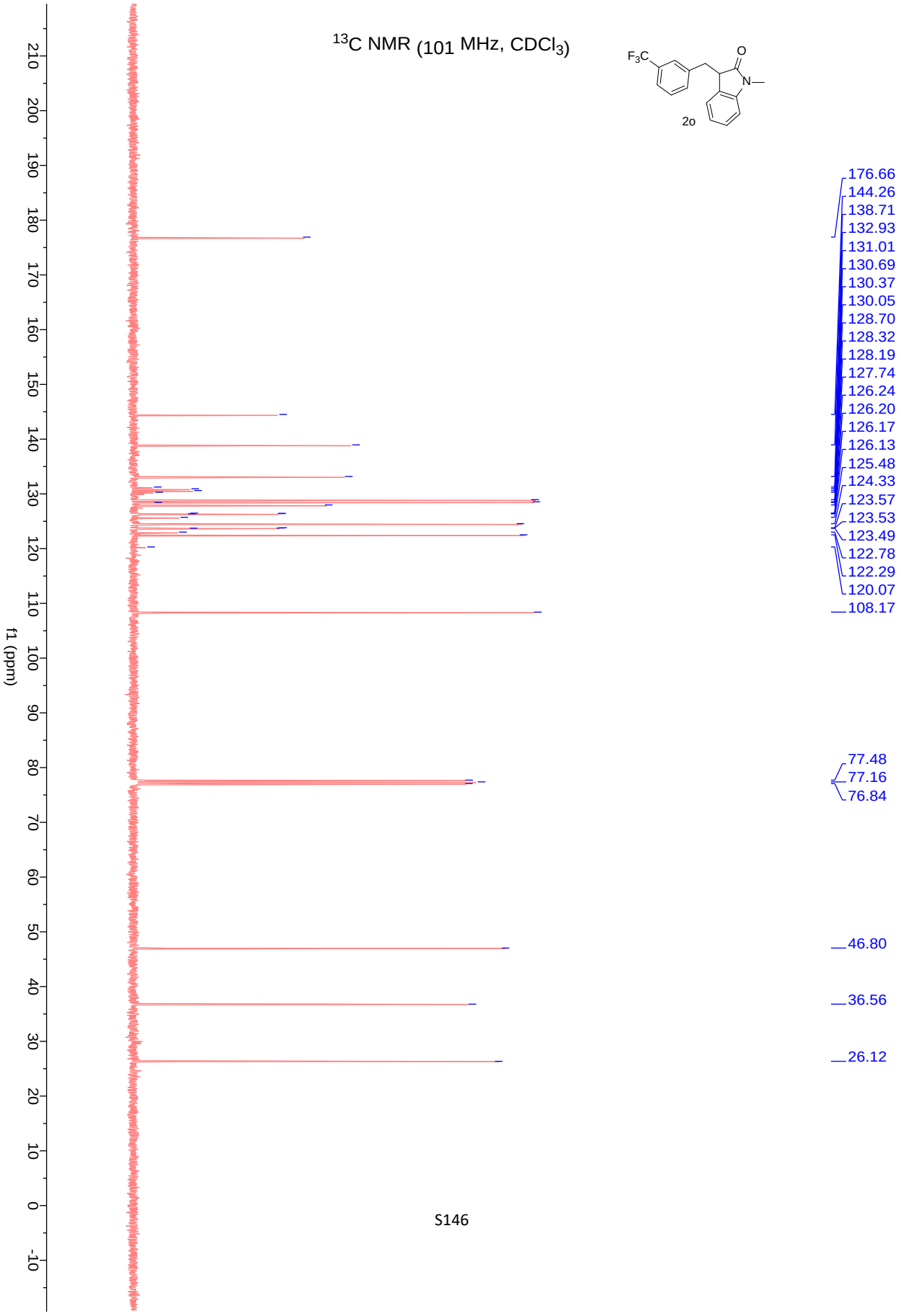

^{13}C NMR (101 MHz, $CDCl_3$)
O
N
F_3C
2n
176.71
144.33
142.07
129.87
129.25
128.92
128.39
127.88
125.35
125.31
125.28
125.24
124.38
122.37
108.28
77.48
77.16
76.84
46.80
36.52
26.25
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

^{19}F NMR (376 MHz, $CDCl_3$)

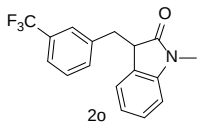


-62.39

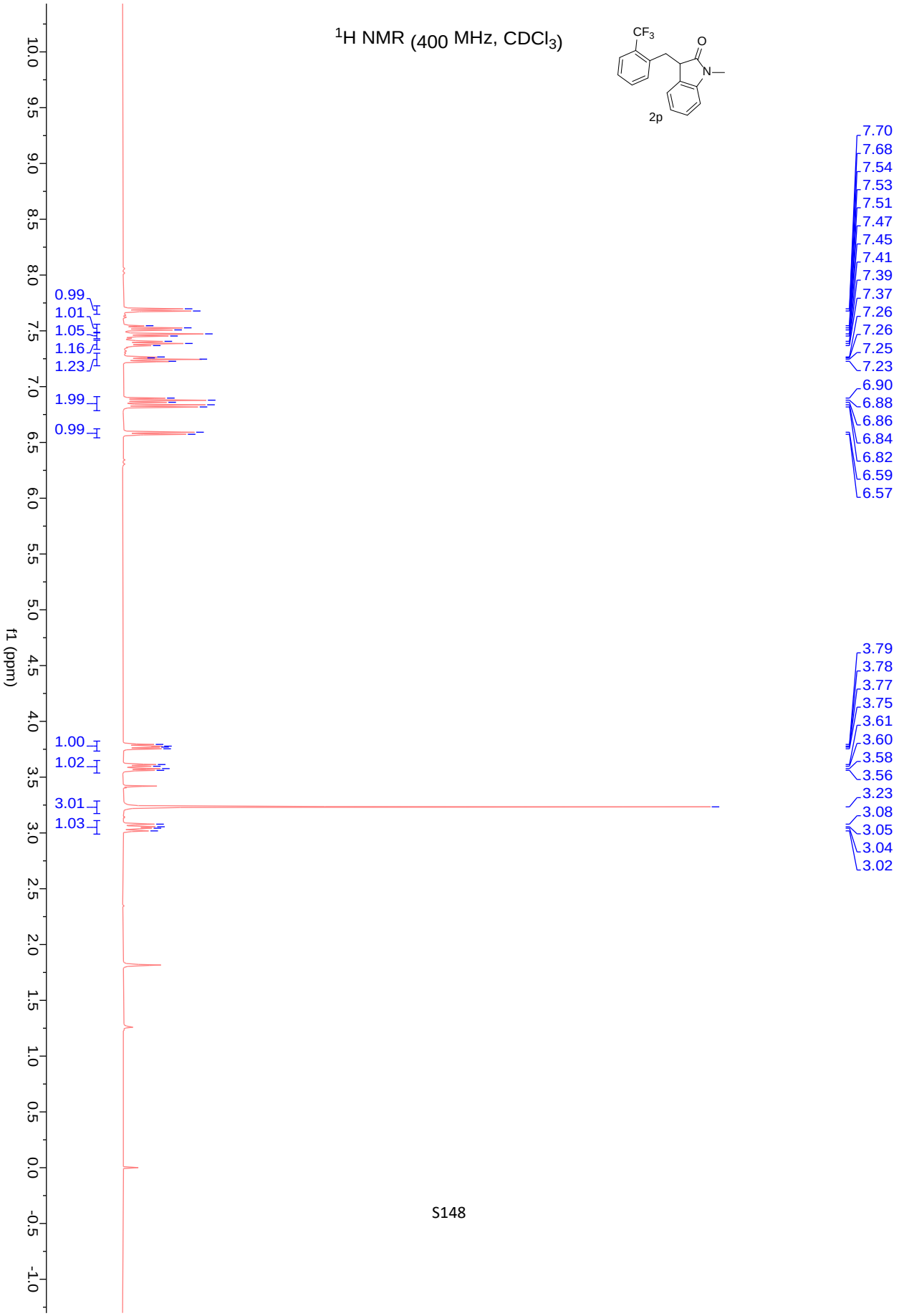

^{1}H NMR (400 MHz, $CDCl_3$)
F_3C
O
N
2o
7.46
7.44
7.43
7.36
7.34
7.33
7.24
7.22
7.20
6.97
6.95
6.93
6.84
6.82
6.74
6.72
3.73
3.72
3.71
3.70
3.49
3.48
3.46
3.45
3.11
3.09
3.07
3.05
3.03
1.12
3.01
1.03
1.03
1.00
0.97
1.00
1.00
2.98
0.86
f1 (ppm)

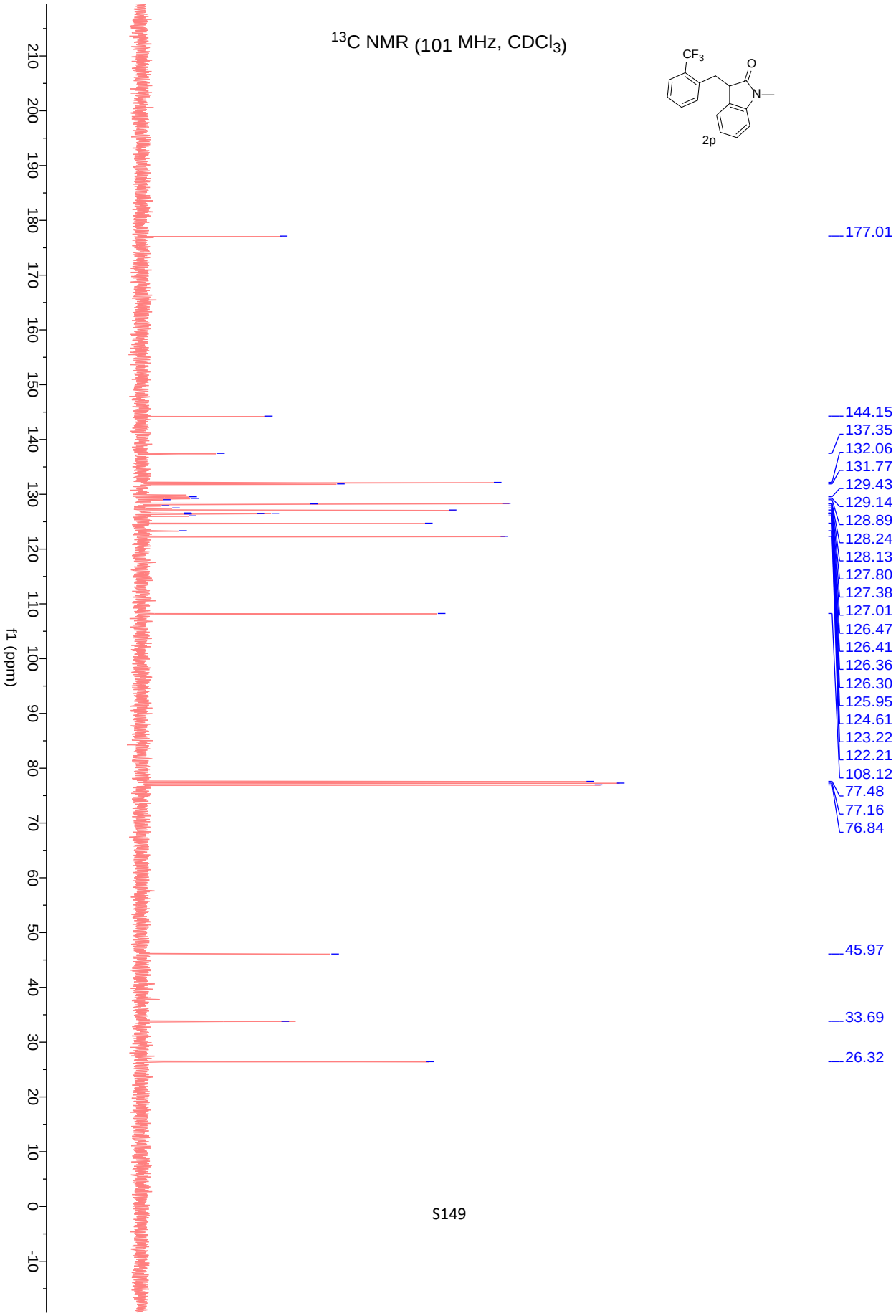

^{13}C NMR (101 MHz, $CDCl_3$)
F_3C
O
N
2o
176.66
144.26
138.71
132.93
131.01
130.69
130.37
130.05
128.70
128.32
128.19
127.74
126.24
126.20
126.17
126.13
125.48
124.33
123.57
123.53
123.49
122.78
122.29
120.07
108.17
77.48
77.16
76.84
46.80
36.56
26.12
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

^{19}F NMR (376 MHz, $CDCl_3$)

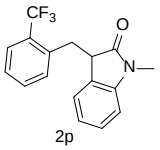


-62.64


^{1}H NMR (400 MHz, CDCl$_3$)
CF$_3$
O
N
2p
f1 (ppm)
10.0
9.5
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
-1.0
0.99
1.01
1.05
1.16
1.23
1.99
0.99
1.00
1.02
3.01
1.03
7.70
7.68
7.54
7.53
7.51
7.47
7.45
7.41
7.39
7.37
7.26
7.26
7.25
7.23
6.90
6.88
6.86
6.84
6.82
6.59
6.57
3.79
3.78
3.77
3.75
3.61
3.60
3.58
3.56
3.23
3.08
3.05
3.04
3.02


^{13}C NMR (101 MHz, $CDCl_3$)
CF_3
O
N
2p
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
177.01
144.15
137.35
132.06
131.77
129.43
129.14
128.89
128.24
128.13
127.80
127.38
127.01
126.47
126.41
126.36
126.30
125.95
124.61
123.22
122.21
108.12
77.48
77.16
76.84
45.97
33.69
26.32

^{19}F NMR (376 MHz, $CDCl_3$)



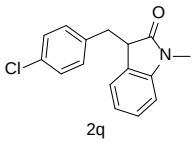
2p

-58.92

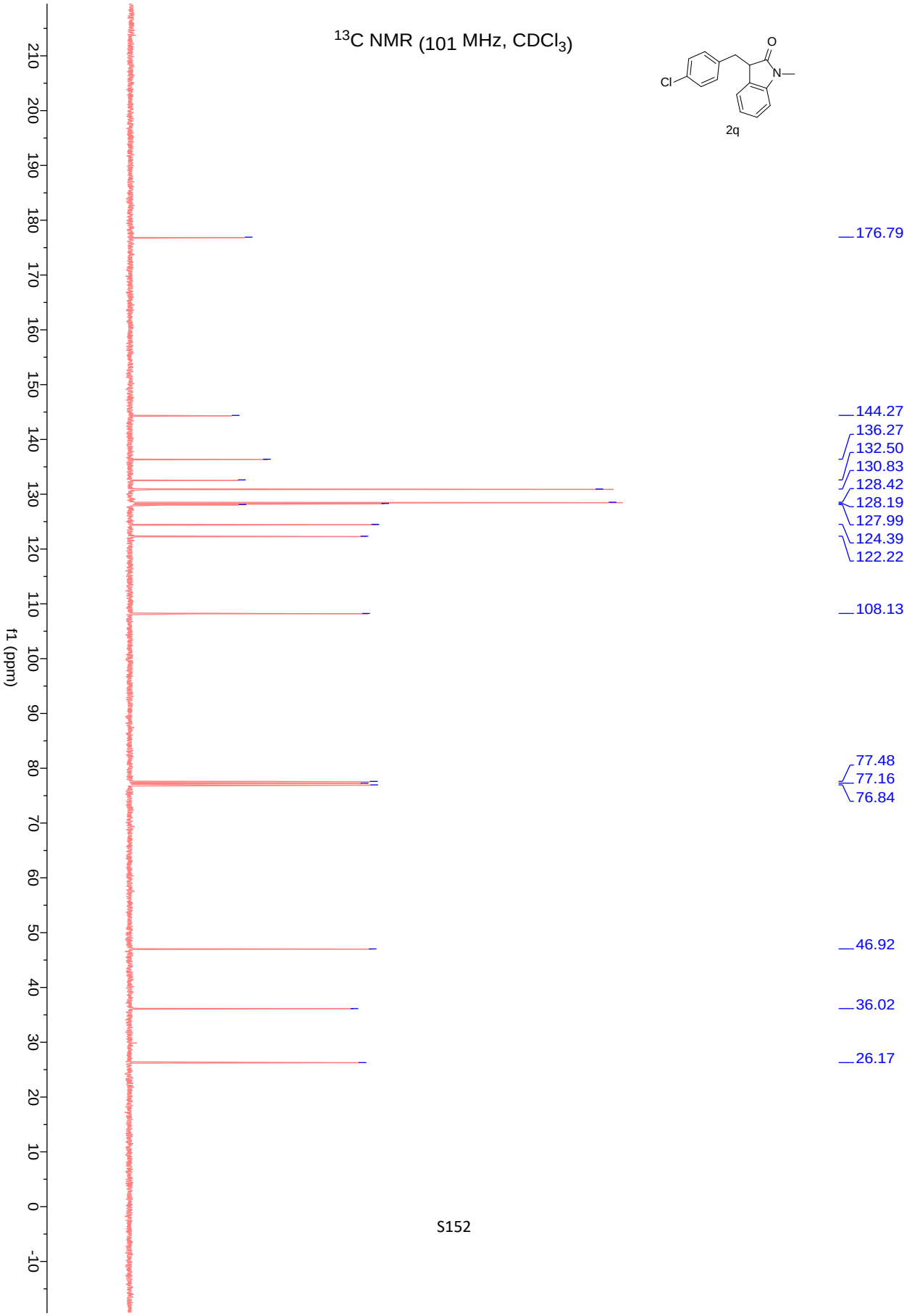
f1 (ppm)

10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210

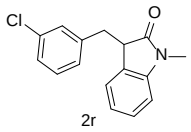
^{1}H NMR (400 MHz, $CDCl_3$)

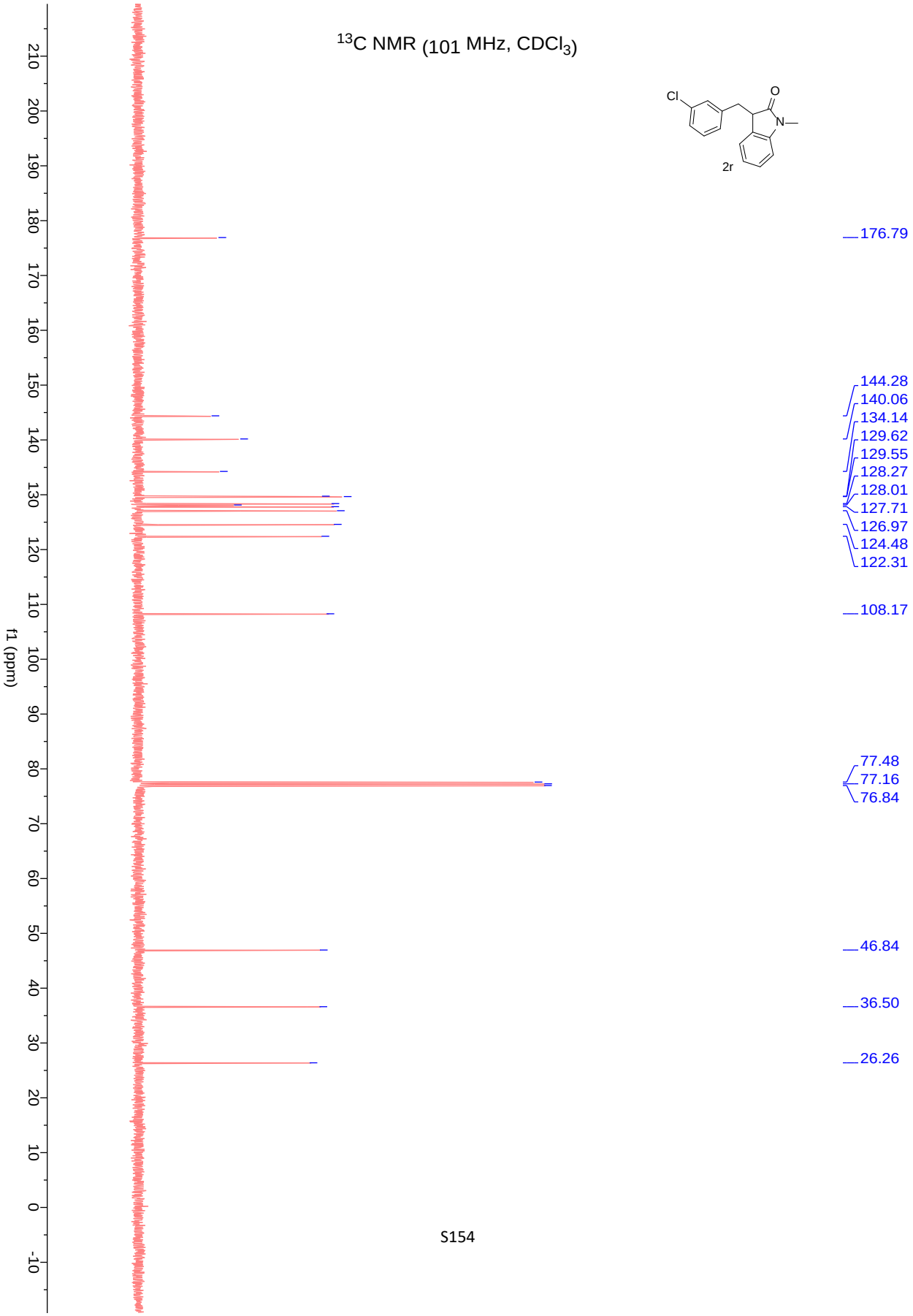


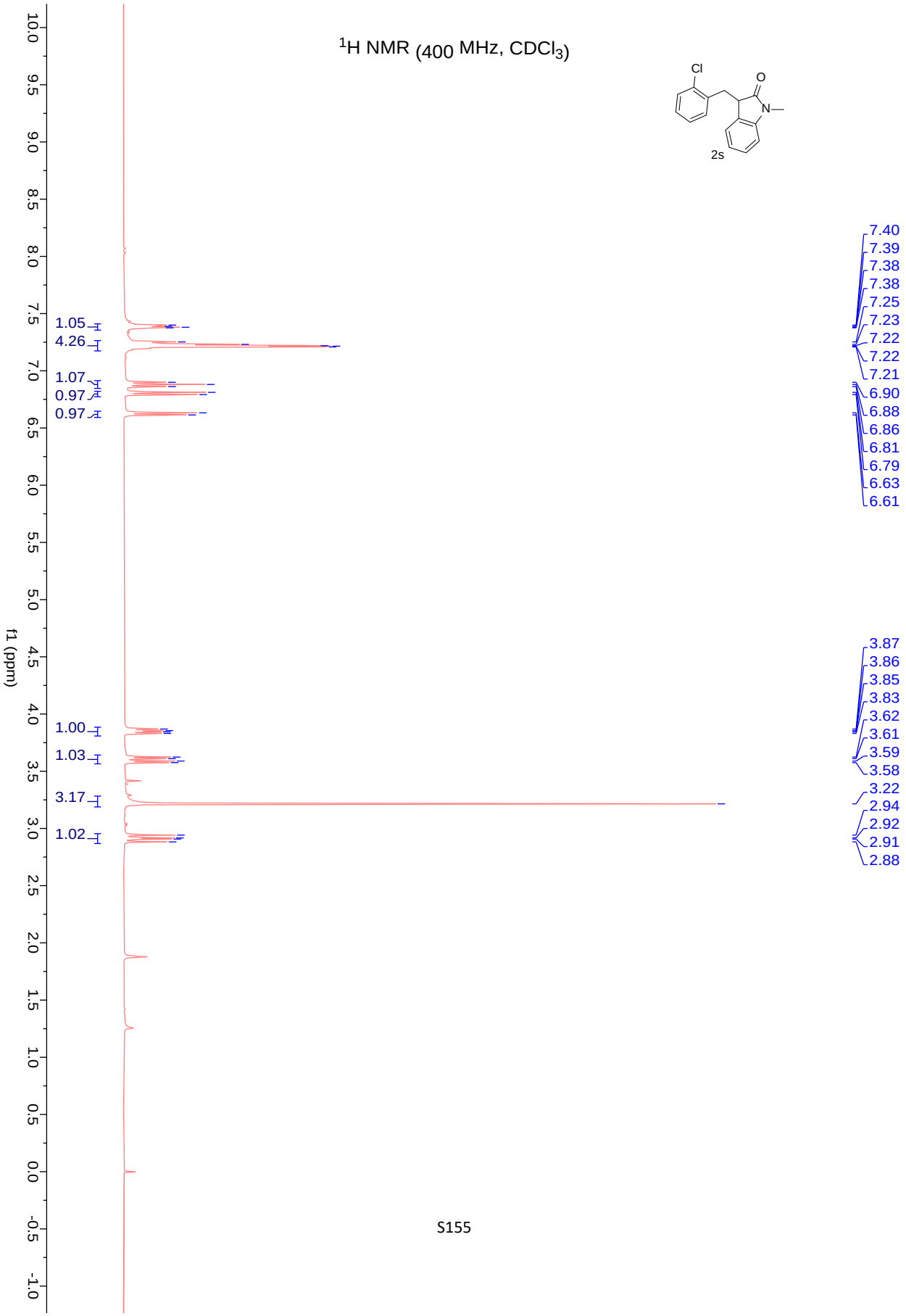
2q

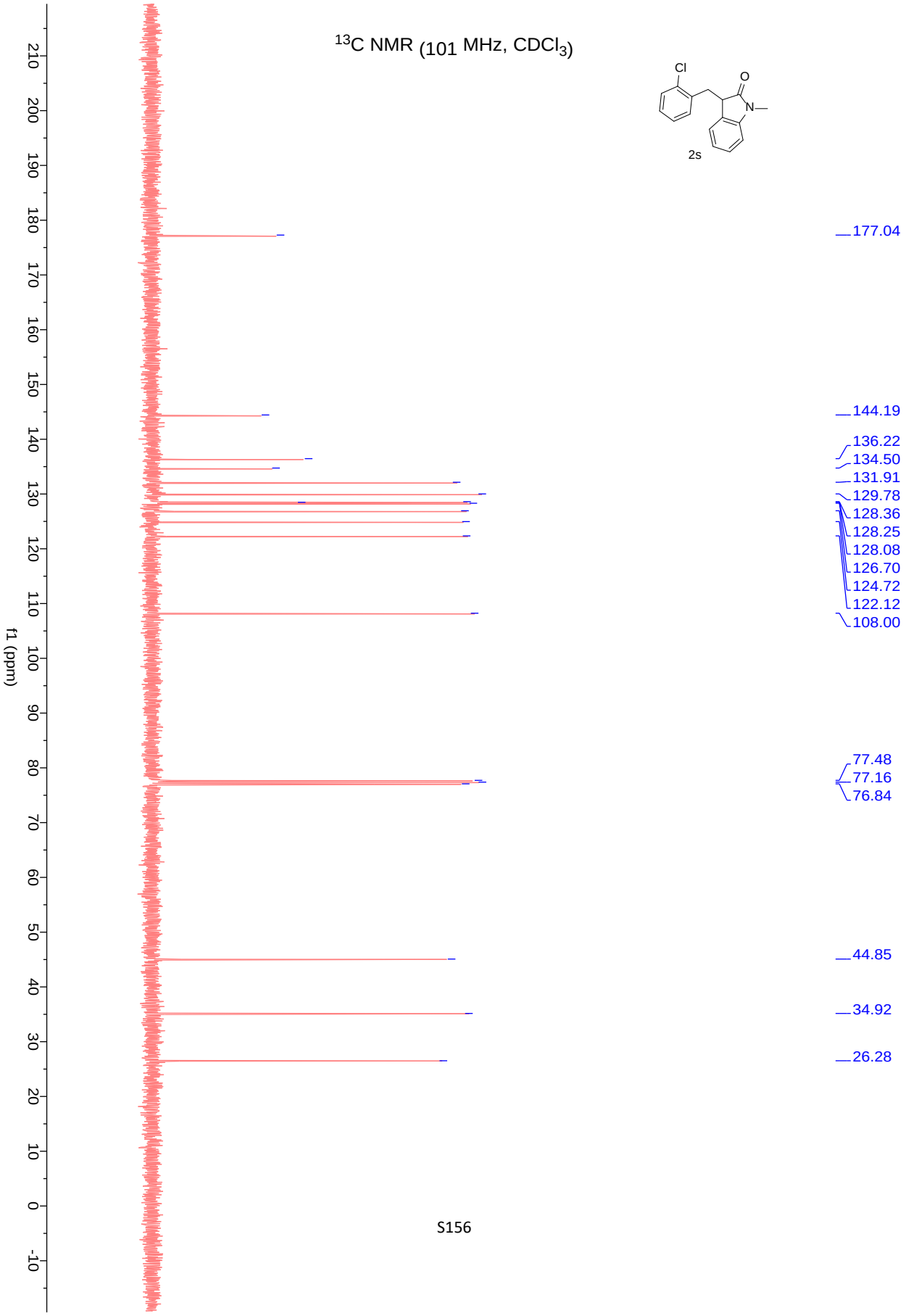

^{13}C NMR (101 MHz, $CDCl_3$)
Cl
O
N
2q
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
176.79
144.27
136.27
132.50
130.83
128.42
128.19
127.99
124.39
122.22
108.13
77.48
77.16
76.84
46.92
36.02
26.17

^{1}H NMR (400 MHz, $CDCl_3$)

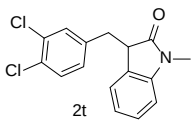


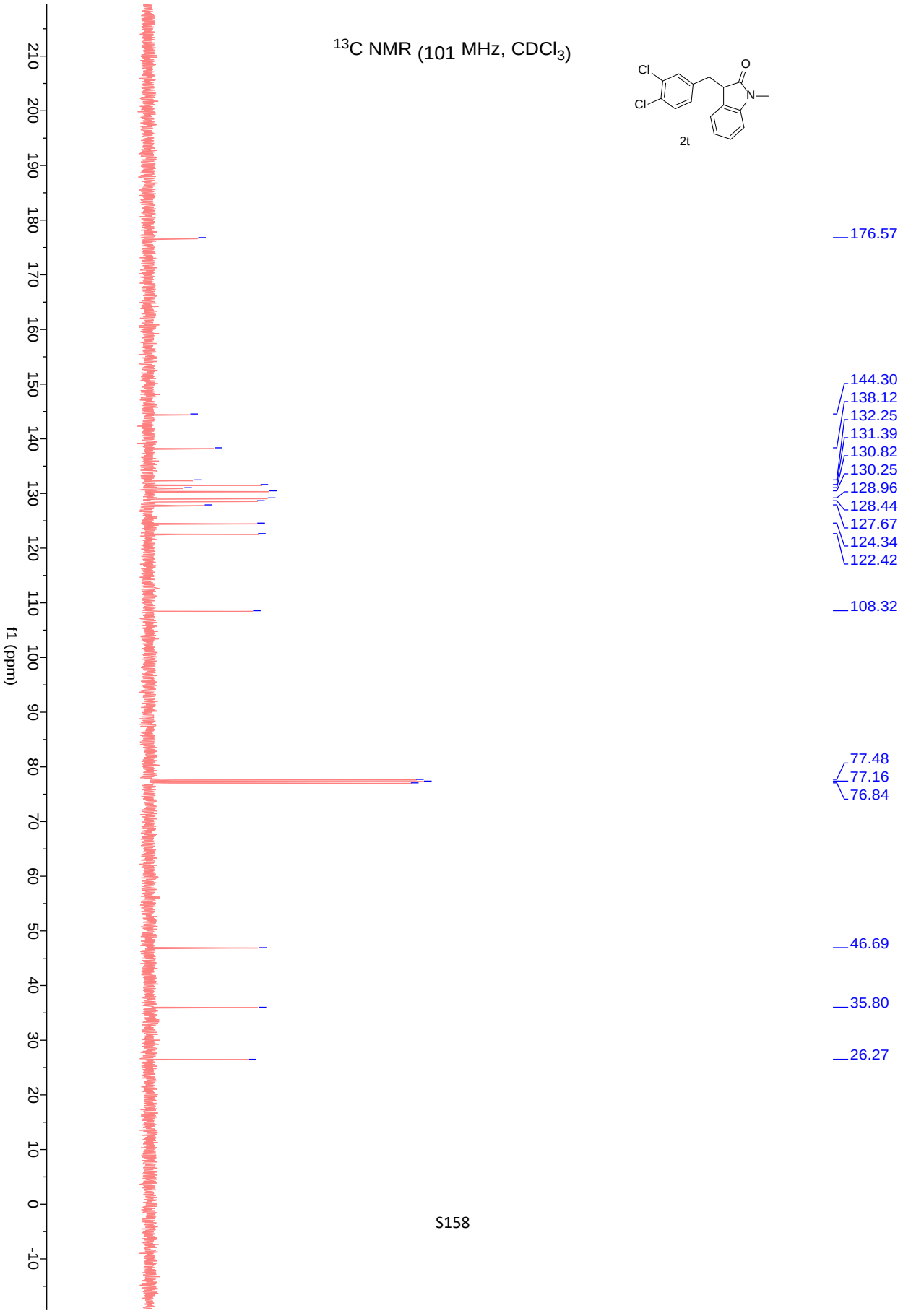

^{13}C NMR (101 MHz, $CDCl_3$)
Cl
O
N
2r
176.79
144.28
140.06
134.14
129.62
129.55
128.27
128.01
127.71
126.97
124.48
122.31
108.17
77.48
77.16
76.84
46.84
36.50
26.26
f1 (ppm)


^{1}H NMR (400 MHz, $CDCl_3$)
Cl
O
N
2s
f1 (ppm)
10.0
9.5
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
-1.0
1.05
4.26
1.07
0.97
0.97
1.00
1.03
3.17
1.02
7.40
7.39
7.38
7.38
7.25
7.23
7.22
7.22
7.21
6.90
6.88
6.86
6.81
6.79
6.63
6.61
3.87
3.86
3.85
3.83
3.62
3.61
3.59
3.58
3.22
2.94
2.92
2.91
2.88

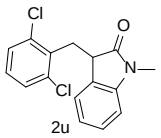

^{13}C NMR (101 MHz, $CDCl_3$)
Cl
O
N
2s
177.04
144.19
136.22
134.50
131.91
129.78
128.36
128.25
128.08
126.70
124.72
122.12
108.00
77.48
77.16
76.84
44.85
34.92
26.28
f1 (ppm)

^{1}H NMR (400 MHz, $CDCl_3$)

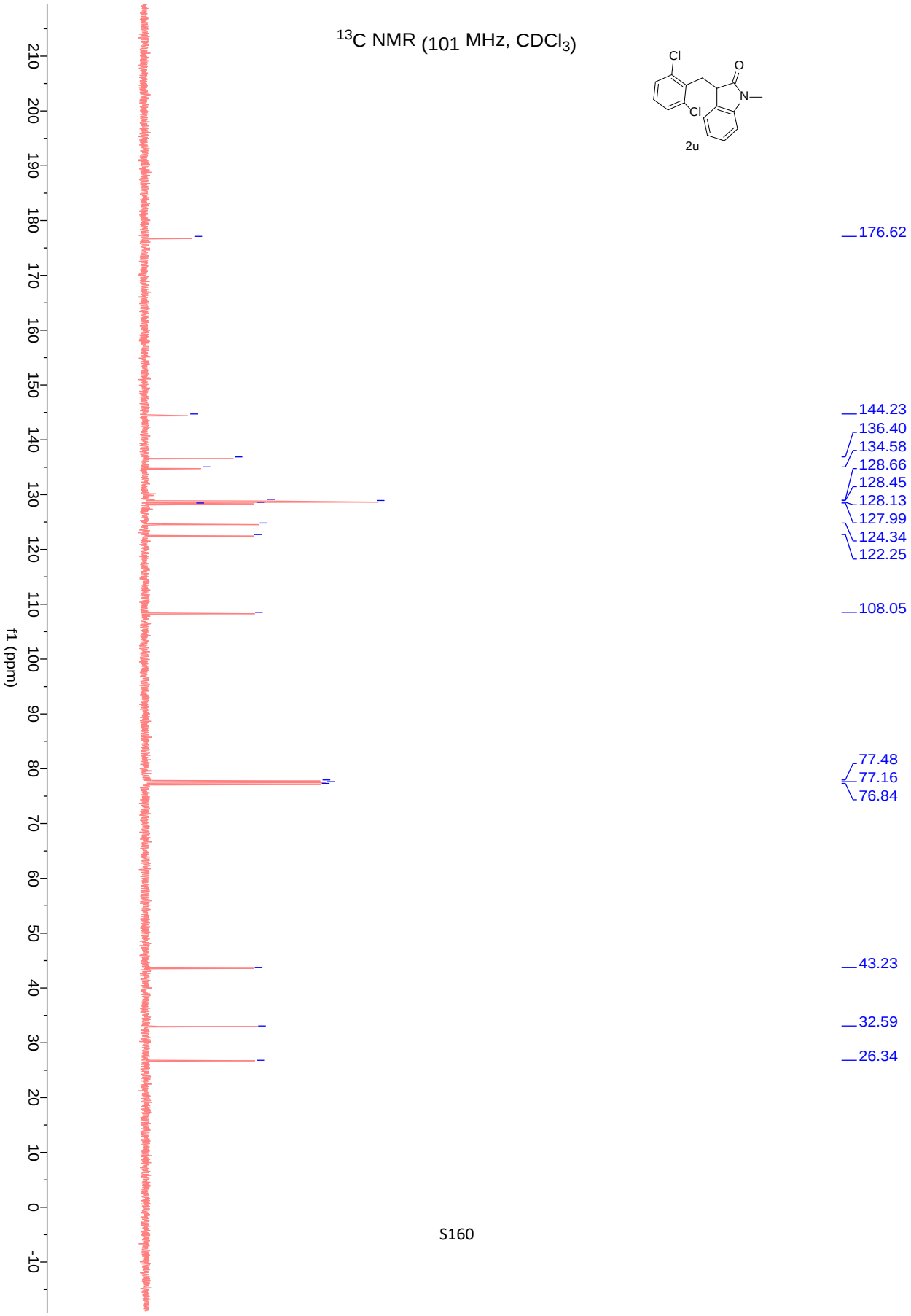



^{13}C NMR (101 MHz, $CDCl_3$)
Cl
Cl
O
N
2t
176.57
144.30
138.12
132.25
131.39
130.82
130.25
128.96
128.44
127.67
124.34
122.42
108.32
77.48
77.16
76.84
46.69
35.80
26.27
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

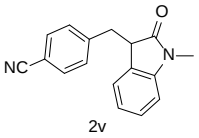
^{1}H NMR (400 MHz, $CDCl_3$)



2u

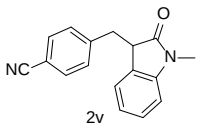

^{13}C NMR (101 MHz, CDCl$_3$)
Cl
O
N
Cl
2u
176.62
144.23
136.40
134.58
128.66
128.45
128.13
127.99
124.34
122.25
108.05
77.48
77.16
76.84
43.23
32.59
26.34
f1 (ppm)

^{1}H NMR (400 MHz, $CDCl_3$)

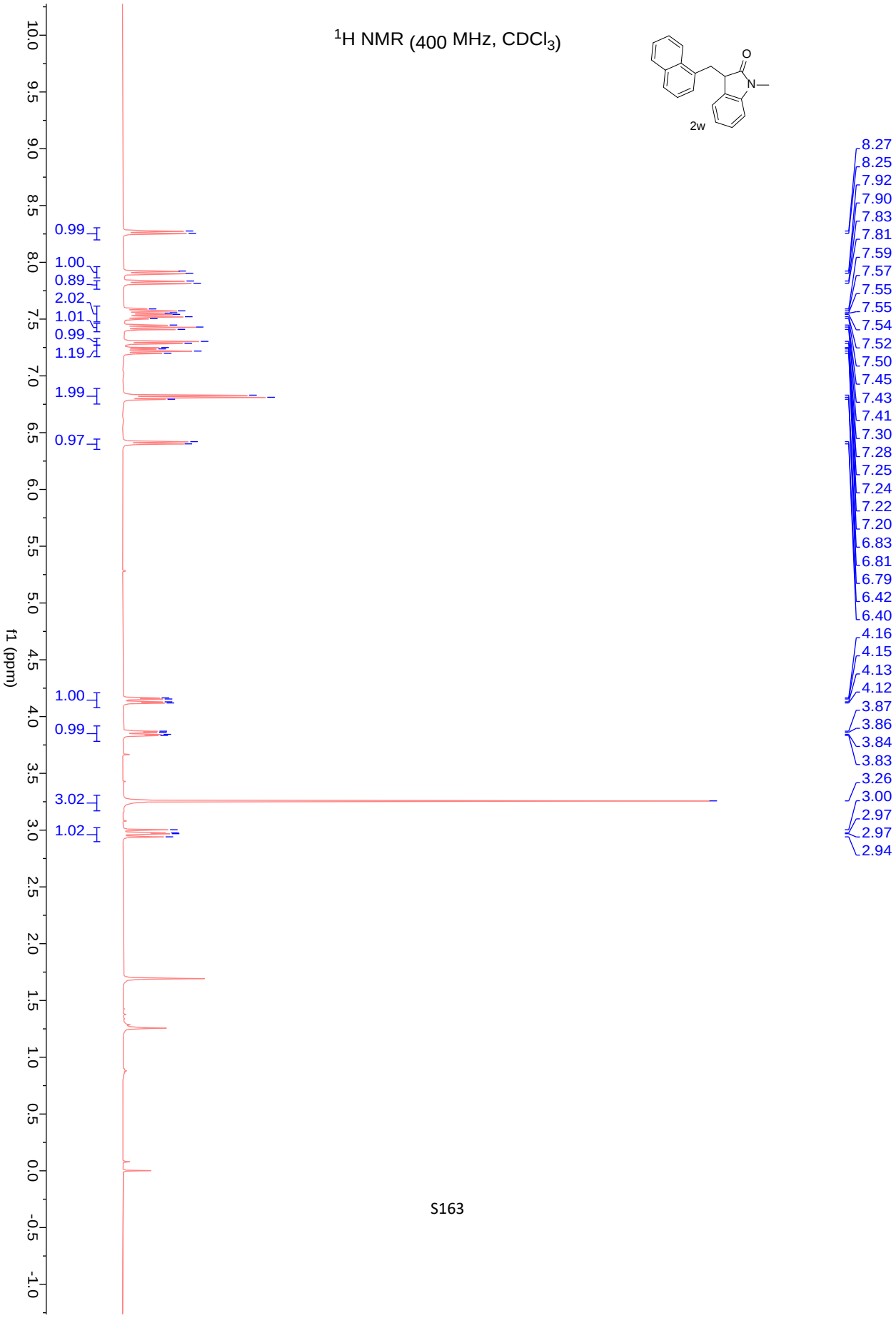


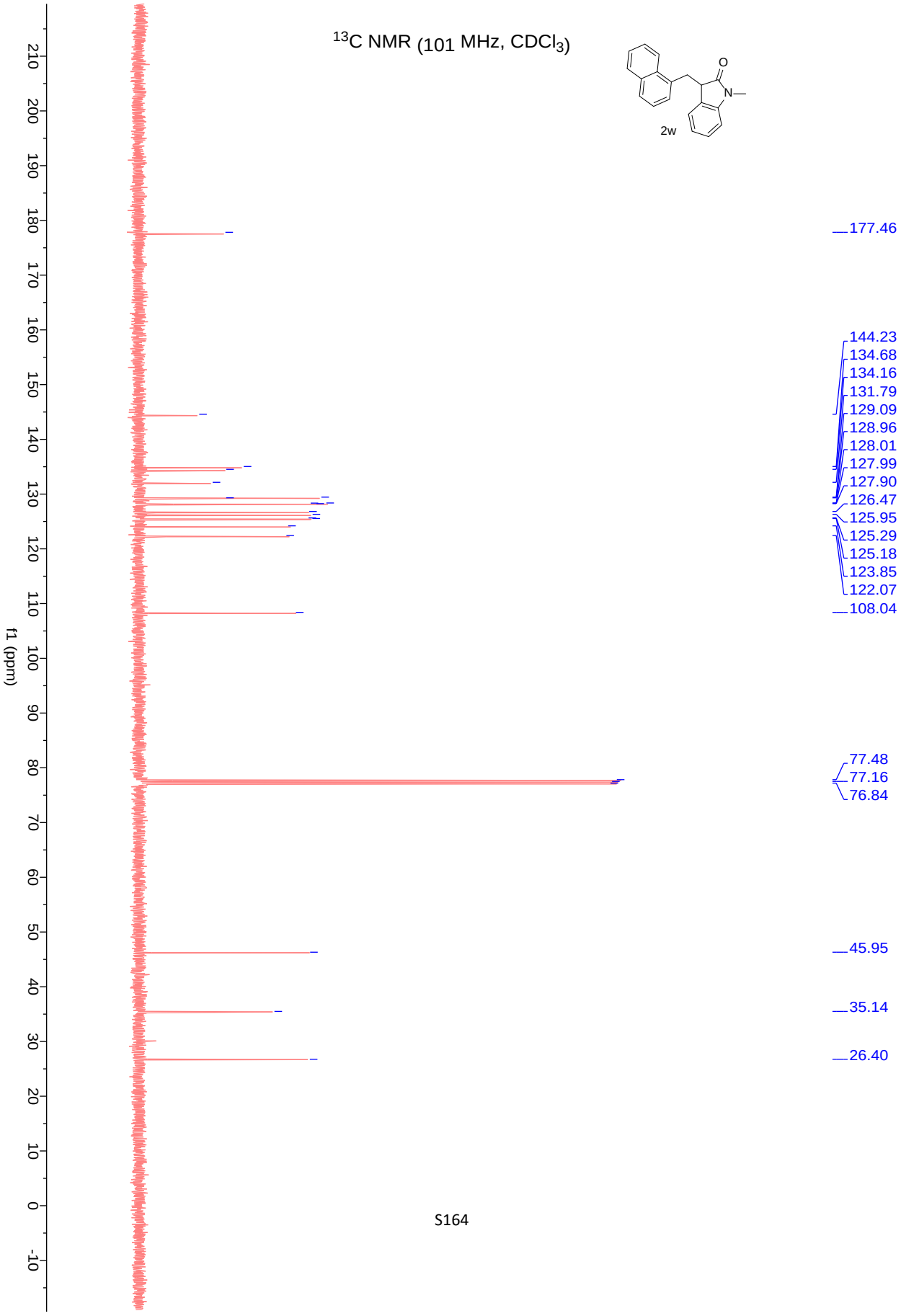
2v

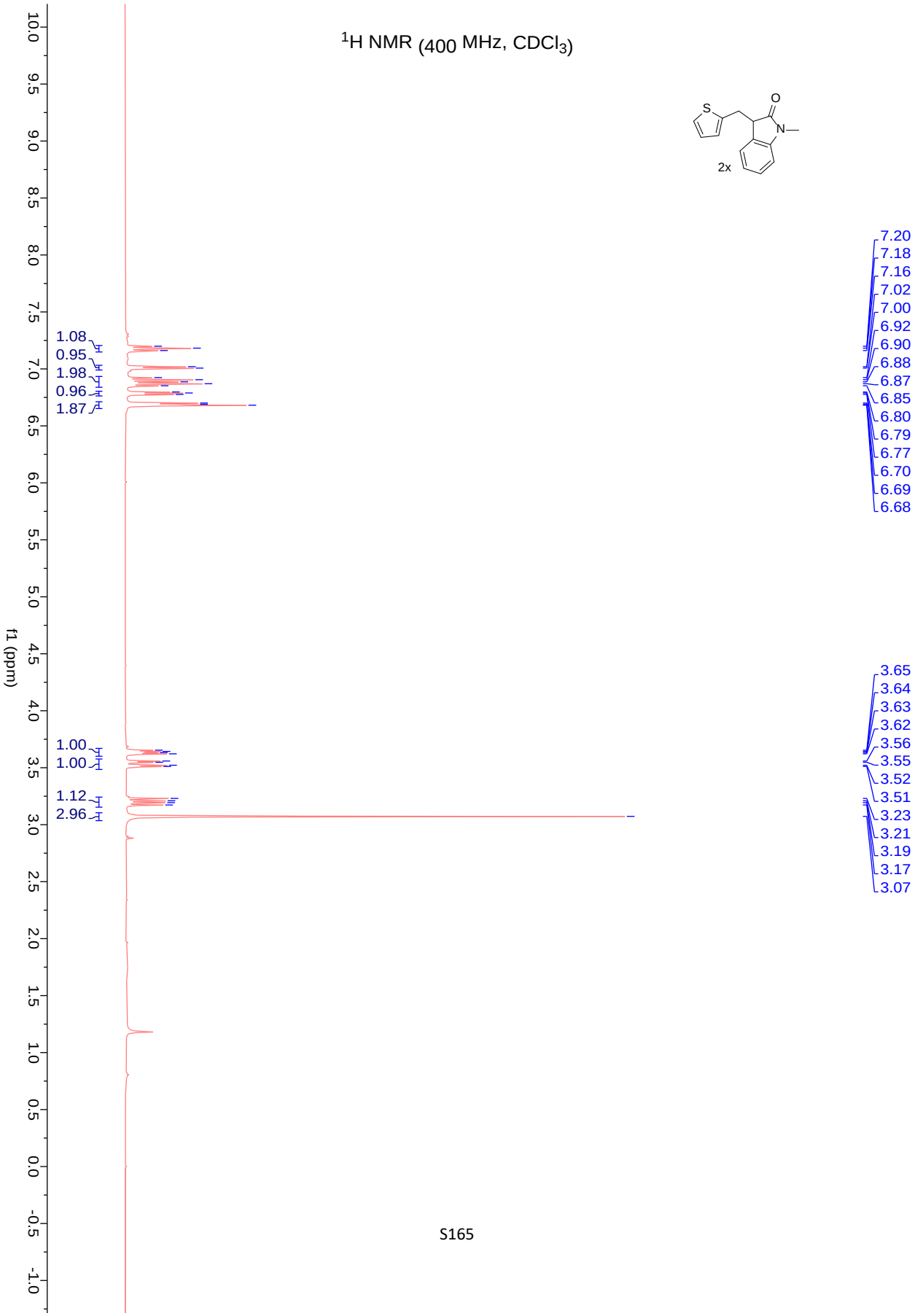
^{13}C NMR (101 MHz, $CDCl_3$)

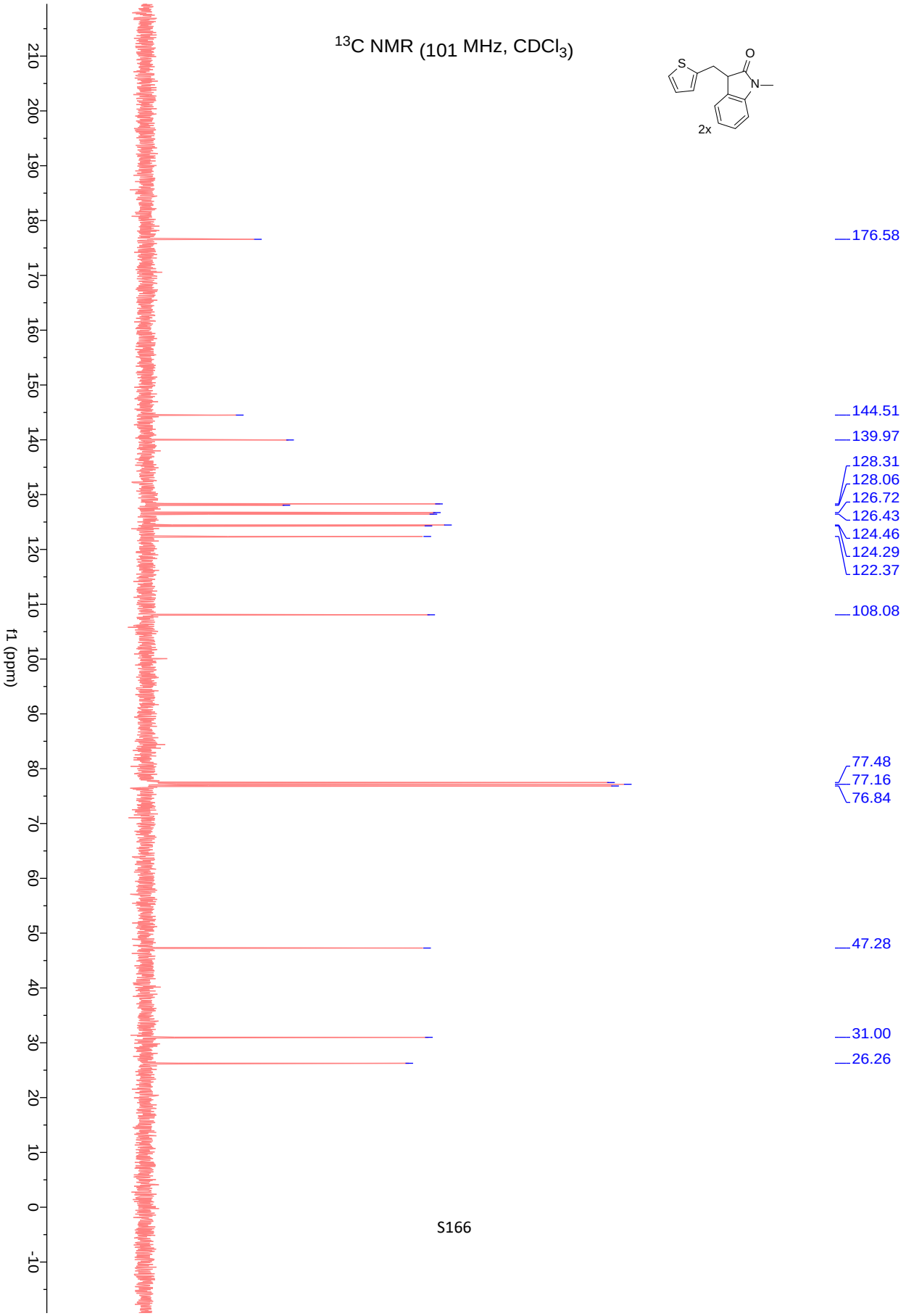


2v

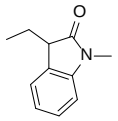

^{1}H NMR (400 MHz, $CDCl_3$)
2w
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
0.99
1.00
0.89
2.02
1.01
0.99
1.19
1.99
0.97
1.00
0.99
3.02
1.02
8.27
8.25
7.92
7.90
7.83
7.81
7.59
7.57
7.55
7.55
7.54
7.52
7.50
7.45
7.43
7.41
7.30
7.28
7.25
7.24
7.22
7.20
6.83
6.81
6.79
6.42
6.40
4.16
4.15
4.13
4.12
3.87
3.86
3.84
3.83
3.26
3.00
2.97
2.97
2.94


^{13}C NMR (101 MHz, $CDCl_3$)
O
N
2w
177.46
144.23
134.68
134.16
131.79
129.09
128.96
128.01
127.99
127.90
126.47
125.95
125.29
125.18
123.85
122.07
108.04
77.48
77.16
76.84
45.95
35.14
26.40
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

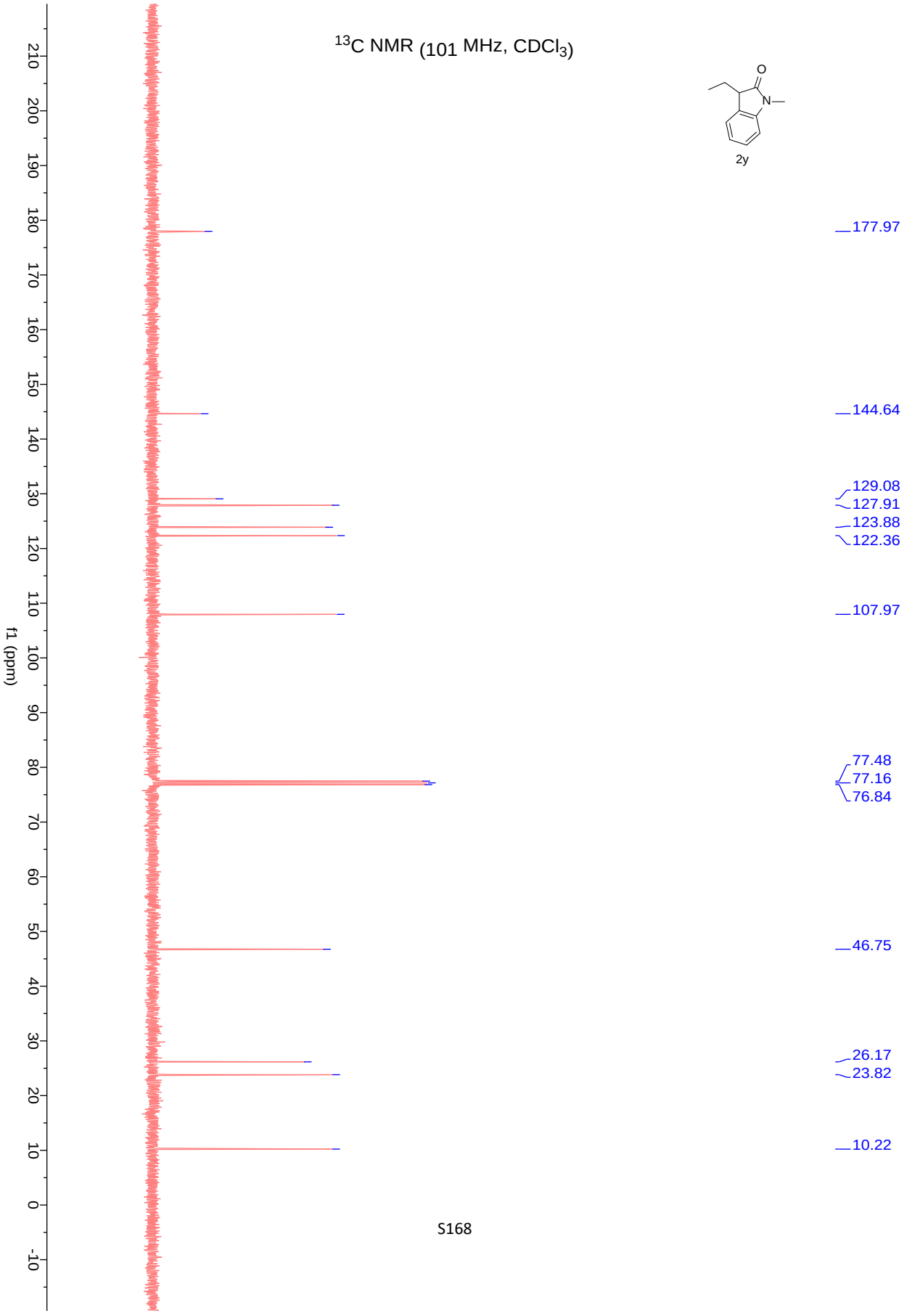

^{1}H NMR (400 MHz, $CDCl_3$)
S
O
N
2x
7.20
7.18
7.16
7.02
7.00
6.92
6.90
6.88
6.87
6.85
6.80
6.79
6.77
6.70
6.69
6.68
3.65
3.64
3.63
3.62
3.56
3.55
3.52
3.51
3.23
3.21
3.19
3.17
3.07
1.08
0.95
1.98
0.96
1.87
1.00
1.00
1.12
2.96
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0

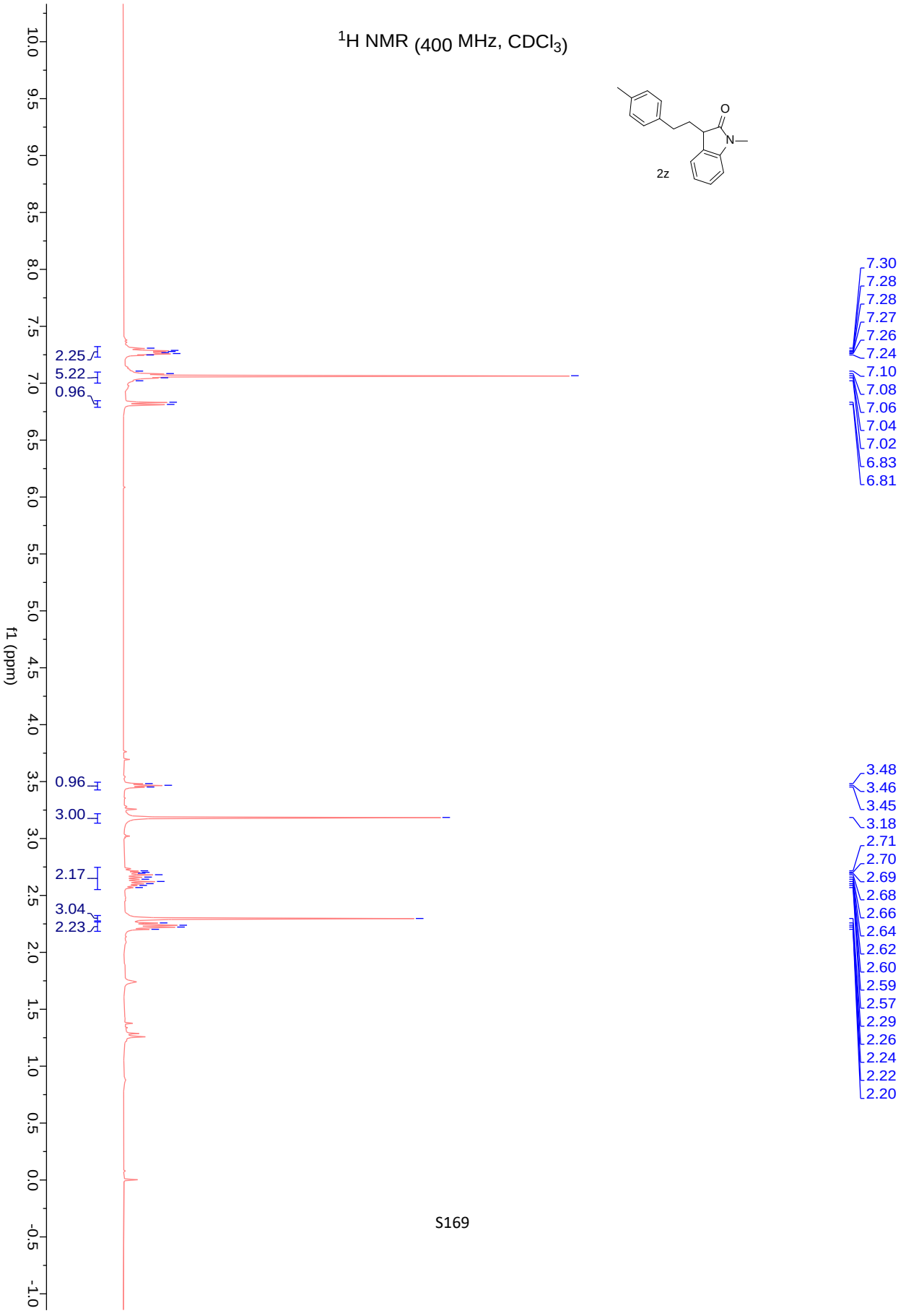

^{13}C NMR (101 MHz, $CDCl_3$)
S
O
N
2x
176.58
144.51
139.97
128.31
128.06
126.72
126.43
124.46
124.29
122.37
108.08
77.48
77.16
76.84
47.28
31.00
26.26
f1 (ppm)

^{1}H NMR (400 MHz, $CDCl_3$)

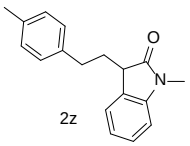


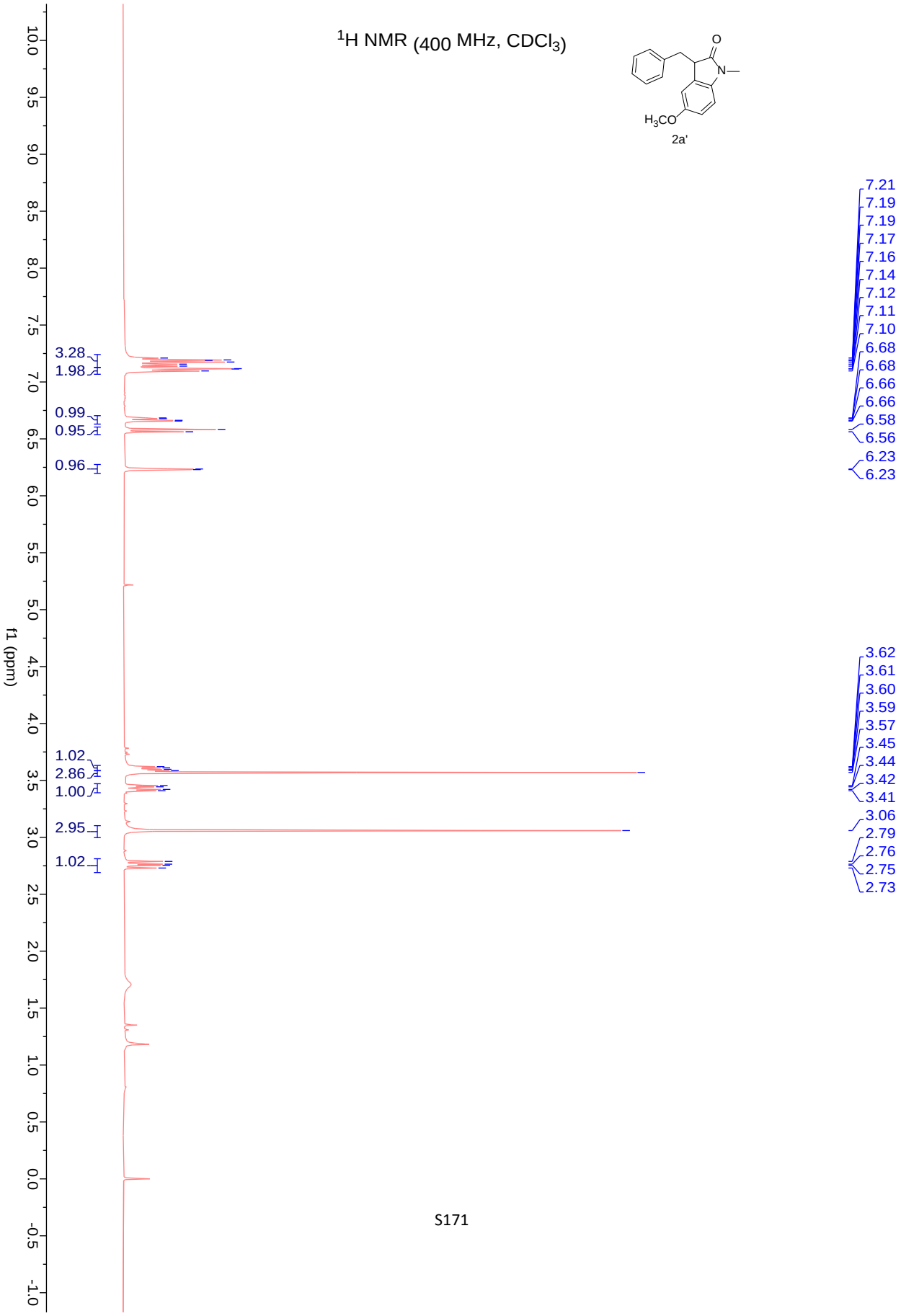
2y


^{13}C NMR (101 MHz, $CDCl_3$)
O
N
2y
177.97
144.64
129.08
127.91
123.88
122.36
107.97
77.48
77.16
76.84
46.75
26.17
23.82
10.22
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

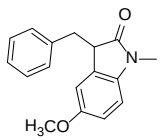

^{1}H NMR (400 MHz, $CDCl_3$)
2z
O
N
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
2.25
5.22
0.96
0.96
3.00
2.17
3.04
2.23
7.30
7.28
7.28
7.27
7.26
7.24
7.10
7.08
7.06
7.04
7.02
6.83
6.81
3.48
3.46
3.45
3.18
2.71
2.70
2.69
2.68
2.66
2.64
2.62
2.60
2.59
2.57
2.29
2.26
2.24
2.22
2.20

^{13}C NMR (101 MHz, $CDCl_3$)

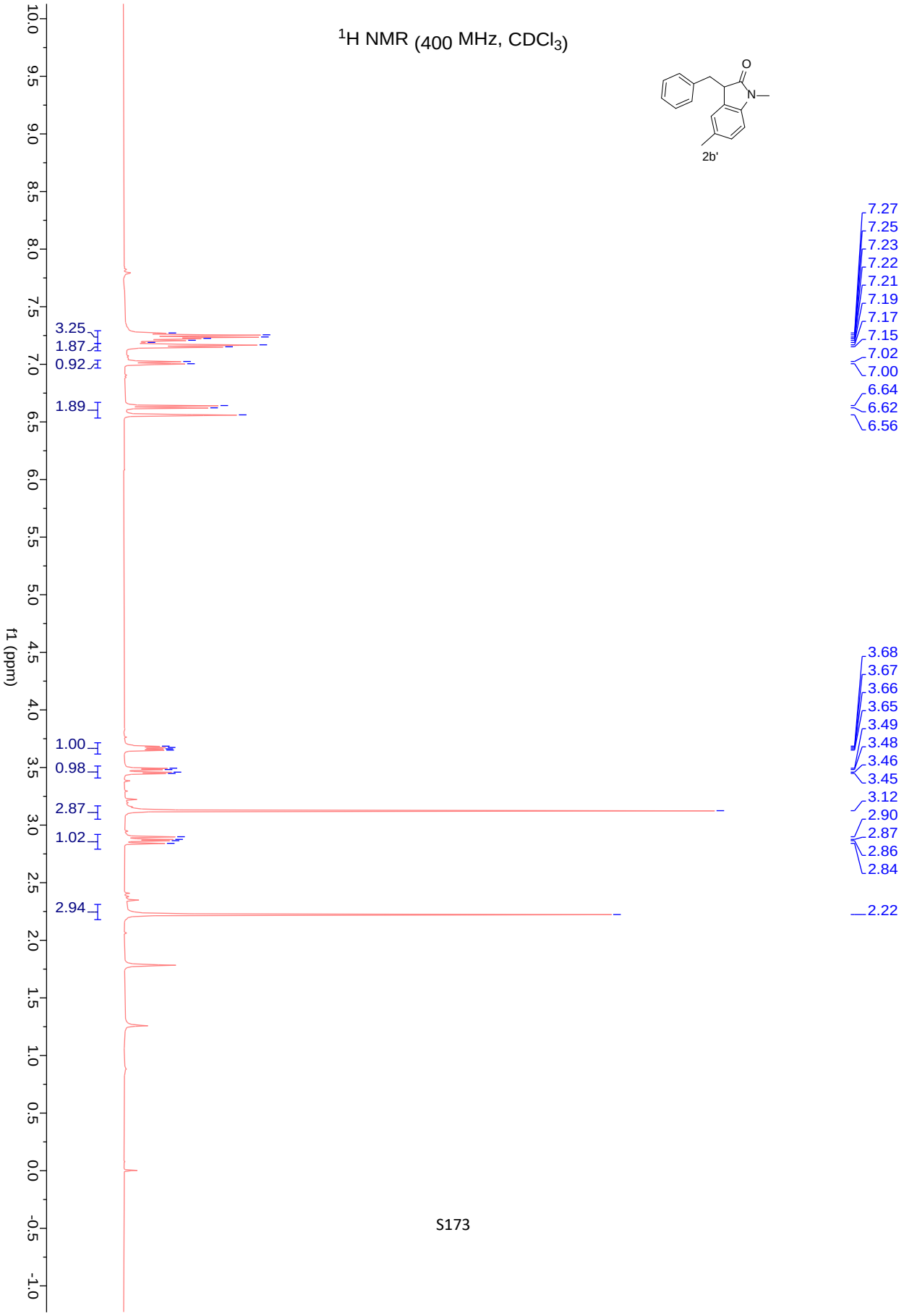


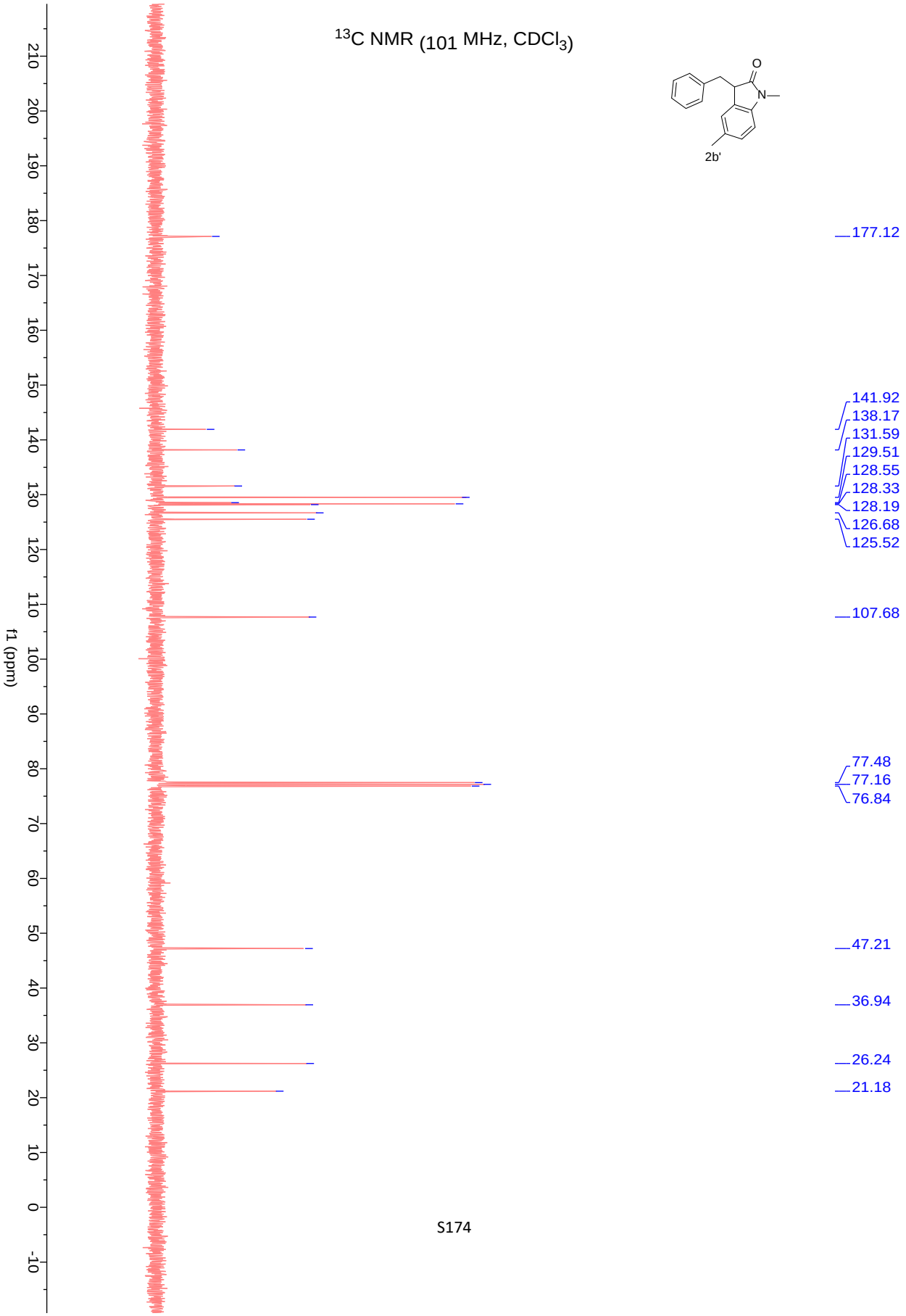

^{1}H NMR (400 MHz, CDCl$_3$)
O
N
H$_3$CO
2a'
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
3.28
1.98
0.99
0.95
0.96
1.02
2.86
1.00
2.95
1.02
7.21
7.19
7.19
7.17
7.16
7.14
7.12
7.11
7.10
6.68
6.68
6.66
6.66
6.58
6.56
6.23
6.23
3.62
3.61
3.60
3.59
3.57
3.45
3.44
3.42
3.41
3.06
2.79
2.76
2.75
2.73

^{13}C NMR (101 MHz, $CDCl_3$)

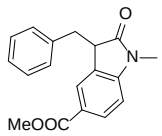


2a'

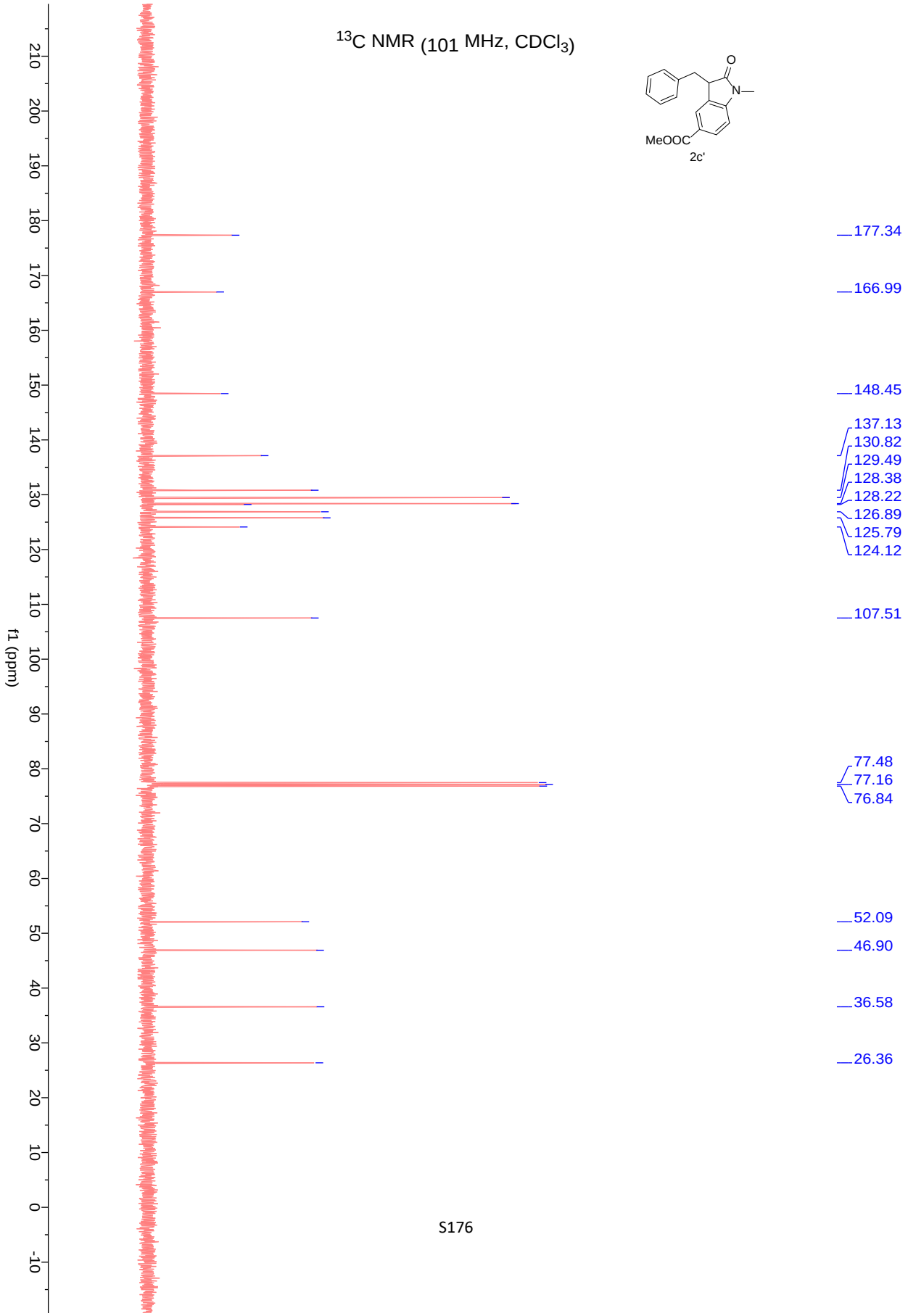

^{1}H NMR (400 MHz, CDCl$_3$)
O
N
2b'
7.27
7.25
7.23
7.22
7.21
7.19
7.17
7.15
7.02
7.00
6.64
6.62
6.56
3.68
3.67
3.66
3.65
3.49
3.48
3.46
3.45
3.12
2.90
2.87
2.86
2.84
2.22
3.25
1.87
0.92
1.89
1.00
0.98
2.87
1.02
2.94
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0


^{13}C NMR (101 MHz, CDCl$_3$)
O
N
2b'
177.12
141.92
138.17
131.59
129.51
128.55
128.33
128.19
126.68
125.52
107.68
77.48
77.16
76.84
47.21
36.94
26.24
21.18
f1 (ppm)

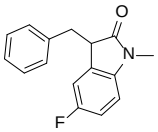
^{1}H NMR (400 MHz, $CDCl_3$)



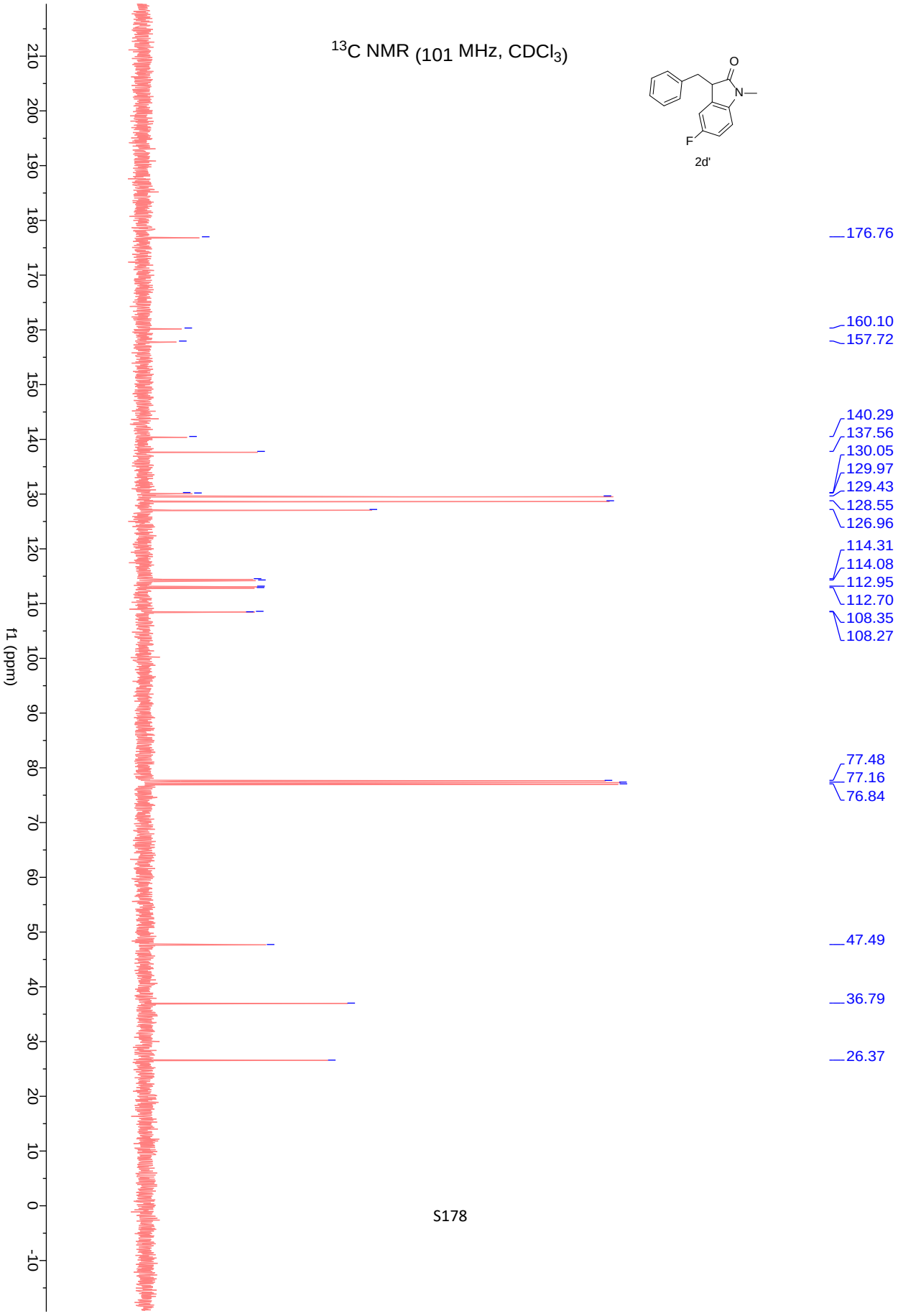
2c'


^{13}C NMR (101 MHz, $CDCl_3$)
O
N
MeOOC
2c'
177.34
166.99
148.45
137.13
130.82
129.49
128.38
128.22
126.89
125.79
124.12
107.51
77.48
77.16
76.84
52.09
46.90
36.58
26.36
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

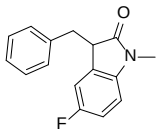
^{1}H NMR (400 MHz, $CDCl_3$)



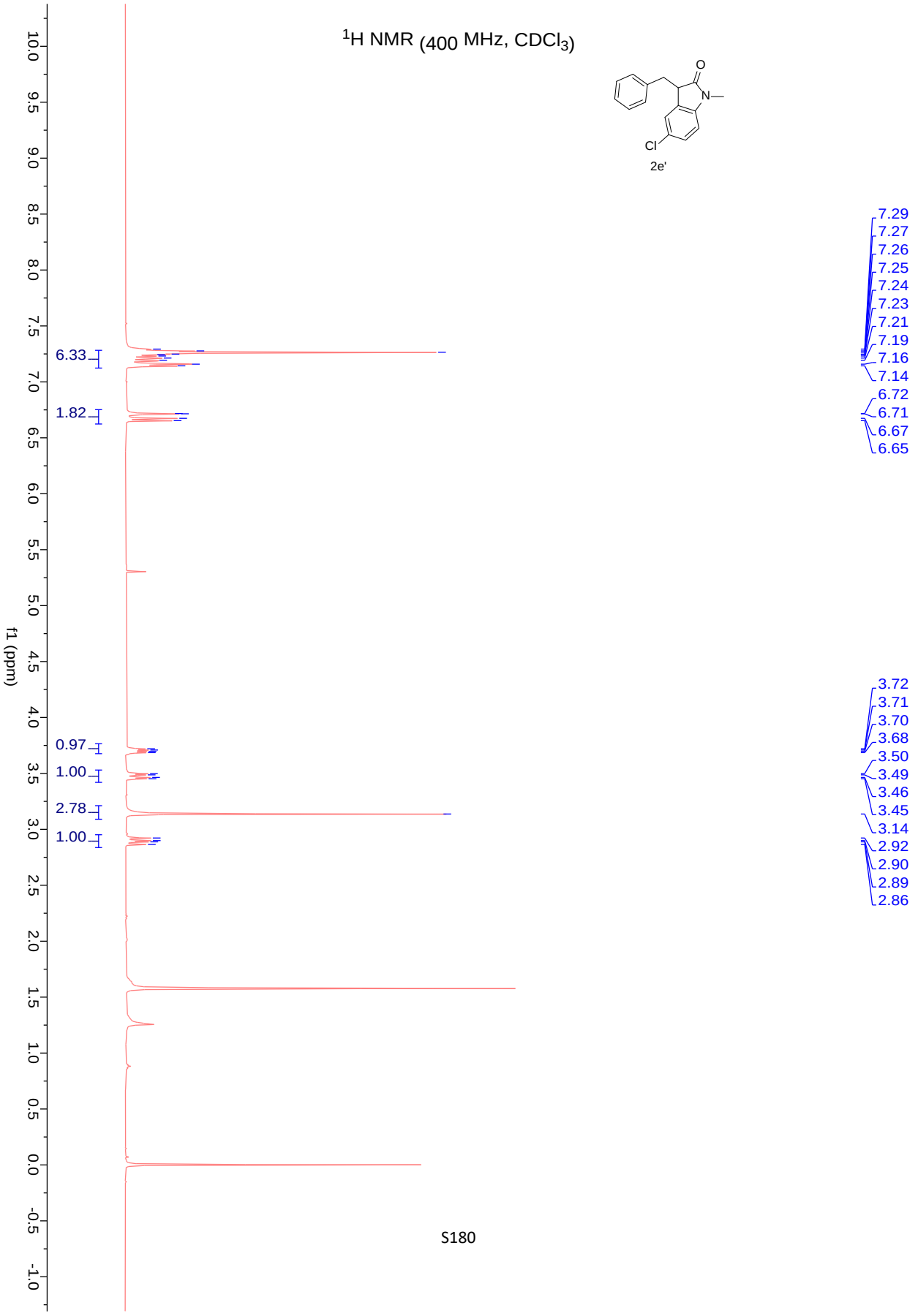
2d'


^{13}C NMR (101 MHz, $CDCl_3$)
O
N
F
2d'
176.76
160.10
157.72
140.29
137.56
130.05
129.97
129.43
128.55
126.96
114.31
114.08
112.95
112.70
108.35
108.27
77.48
77.16
76.84
47.49
36.79
26.37
f1 (ppm)

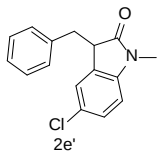
^{19}F NMR (376 MHz, $CDCl_3$)



2d'

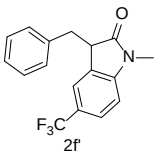

^{1}H NMR (400 MHz, $CDCl_3$)
O
N
Cl
2e'
7.29
7.27
7.26
7.25
7.24
7.23
7.21
7.19
7.16
7.14
6.72
6.71
6.67
6.65
3.72
3.71
3.70
3.68
3.50
3.49
3.46
3.45
3.14
2.92
2.90
2.89
2.86
6.33
1.82
0.97
1.00
2.78
1.00
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0

^{13}C NMR (101 MHz, $CDCl_3$)

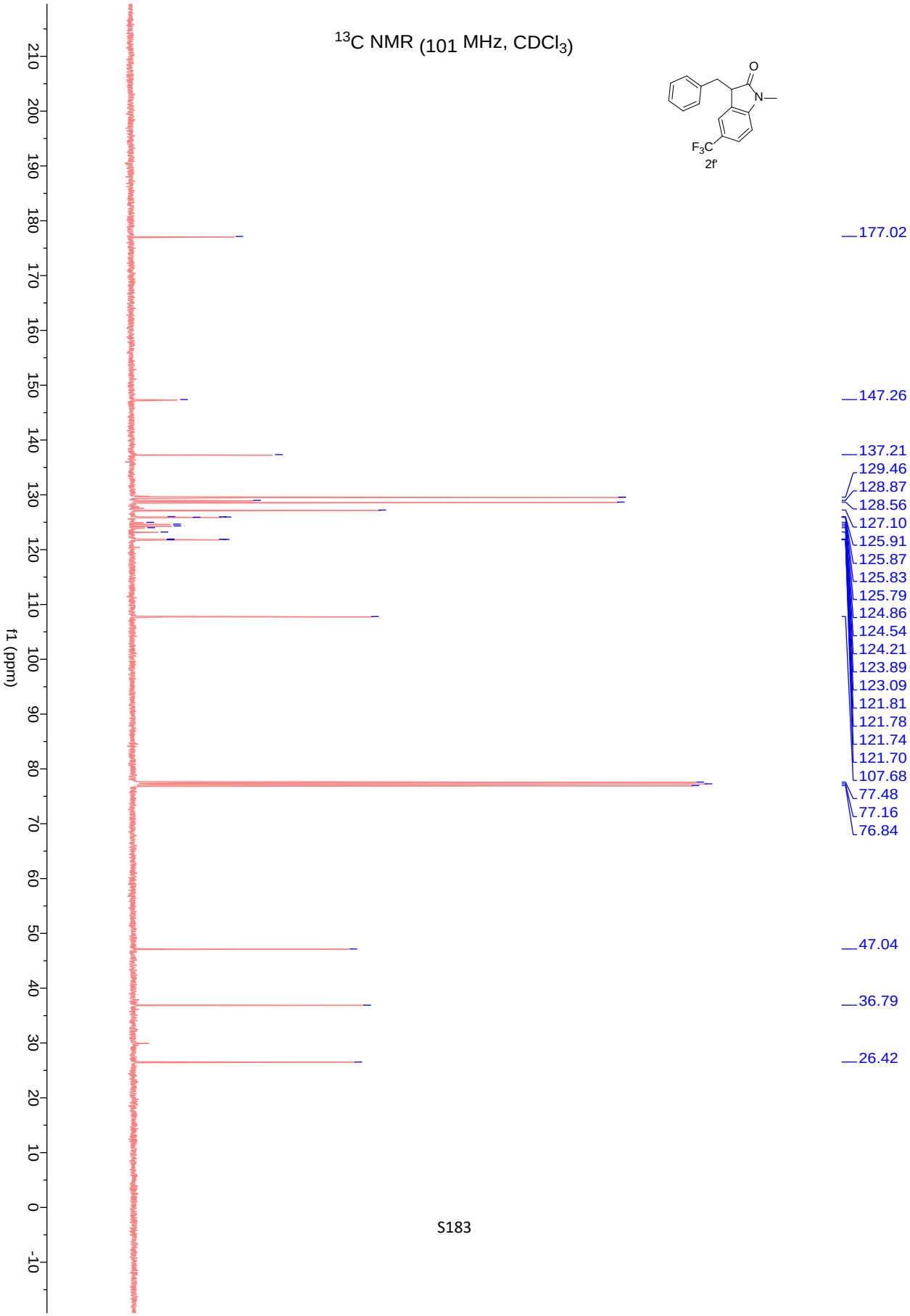


2e'

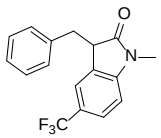
^{1}H NMR (400 MHz, $CDCl_3$)



2f'


^{13}C NMR (101 MHz, $CDCl_3$)
O
N
F_3C
2f'
177.02
147.26
137.21
129.46
128.87
128.56
127.10
125.91
125.87
125.83
125.79
124.86
124.54
124.21
123.89
123.09
121.81
121.78
121.74
121.70
107.68
77.48
77.16
76.84
47.04
36.79
26.42
f1 (ppm)

^{19}F NMR (376 MHz, $CDCl_3$)

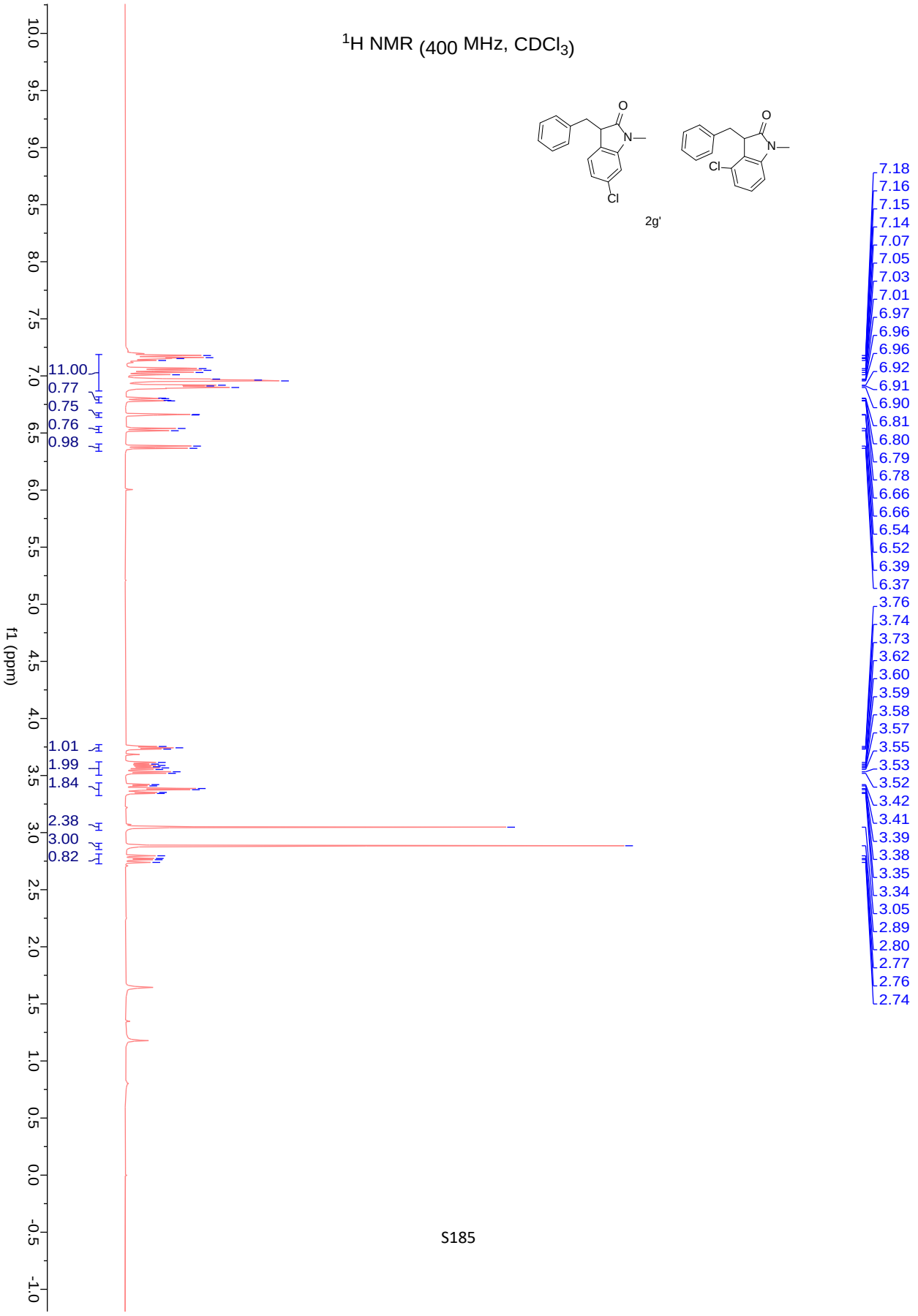


2f'

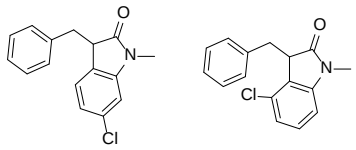
-61.63

f1 (ppm)

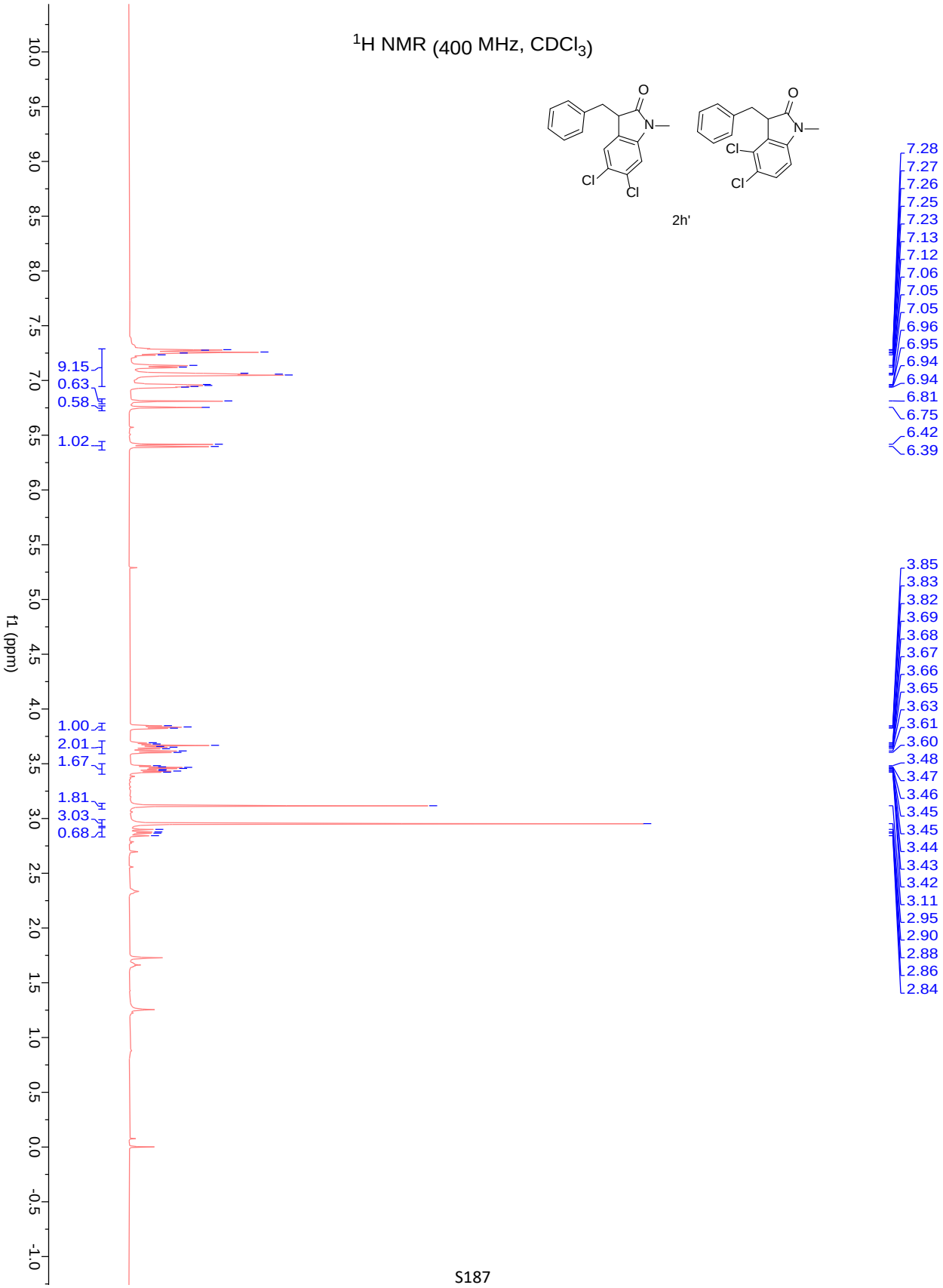
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210

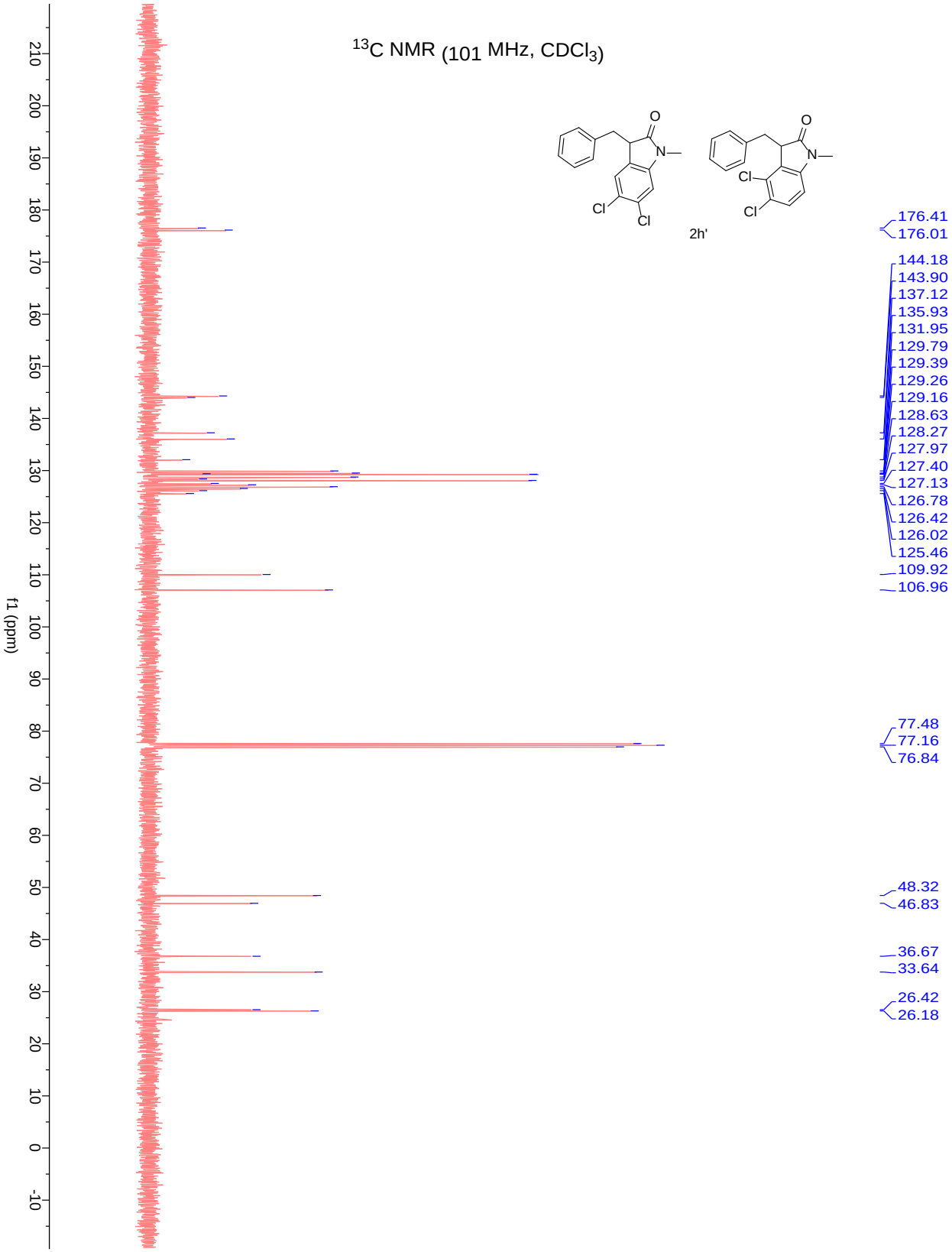

^{1}H NMR (400 MHz, $CDCl_3$)
2g'
f1 (ppm)
11.00
0.77
0.75
0.76
0.98
1.01
1.99
1.84
2.38
3.00
0.82
7.18
7.16
7.15
7.14
7.07
7.05
7.03
7.01
6.97
6.96
6.96
6.92
6.91
6.90
6.81
6.80
6.79
6.78
6.66
6.66
6.54
6.52
6.39
6.37
3.76
3.74
3.73
3.62
3.60
3.59
3.58
3.57
3.55
3.53
3.52
3.42
3.41
3.39
3.38
3.35
3.34
3.05
2.89
2.80
2.77
2.76
2.74

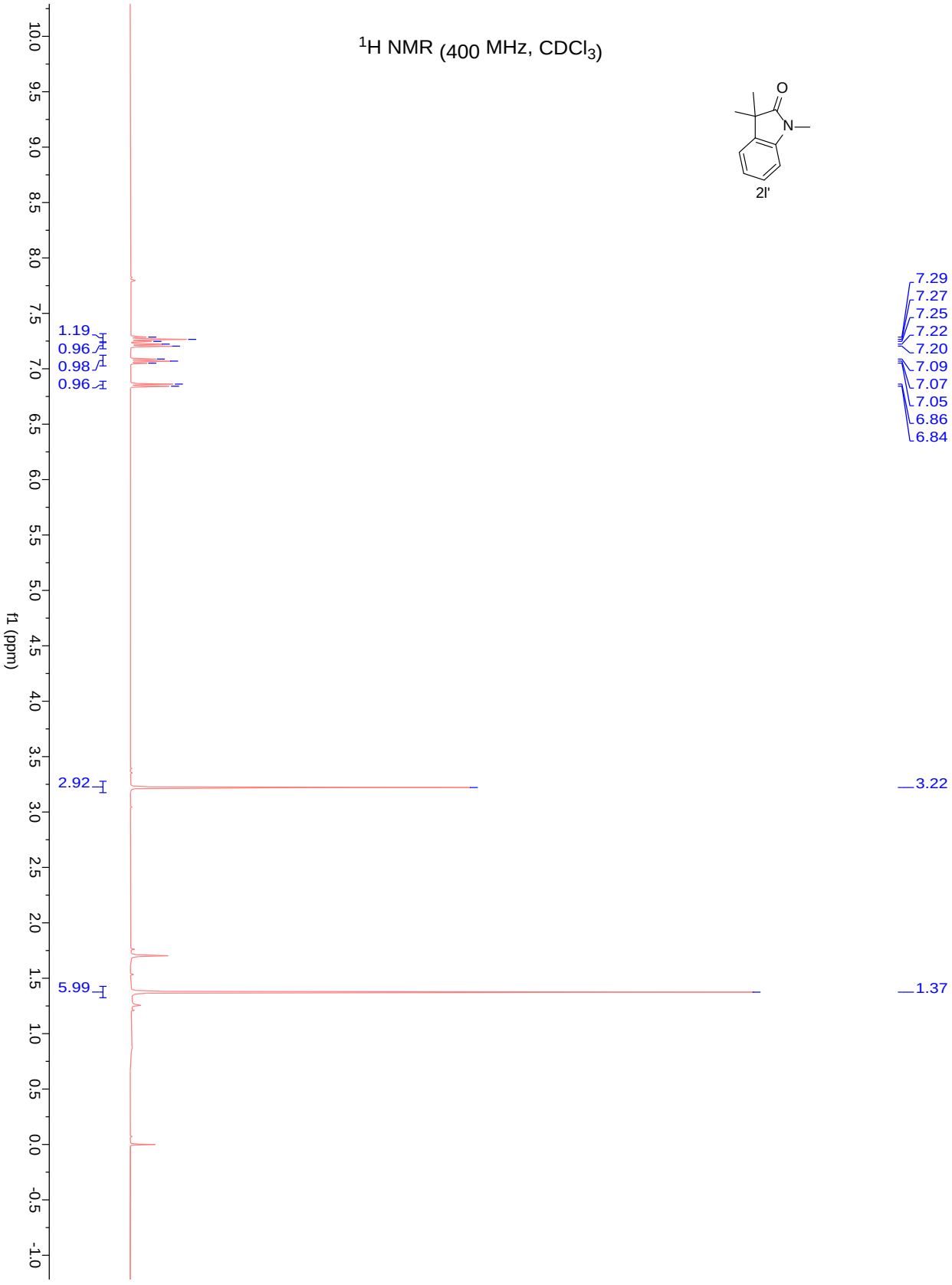
^{13}C NMR (101 MHz, $CDCl_3$)



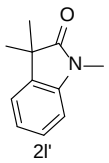
2g'


^{1}H NMR (400 MHz, $CDCl_3$)
2h'
f1 (ppm)
10.0
9.5
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
-1.0
9.15
0.63
0.58
1.02
1.00
2.01
1.67
1.81
3.03
0.68
7.28
7.27
7.26
7.25
7.23
7.13
7.12
7.06
7.05
7.05
6.96
6.95
6.94
6.94
6.81
6.75
6.42
6.39
3.85
3.83
3.82
3.69
3.68
3.67
3.66
3.65
3.63
3.61
3.60
3.48
3.47
3.46
3.45
3.45
3.44
3.43
3.42
3.11
2.95
2.90
2.88
2.86
2.84

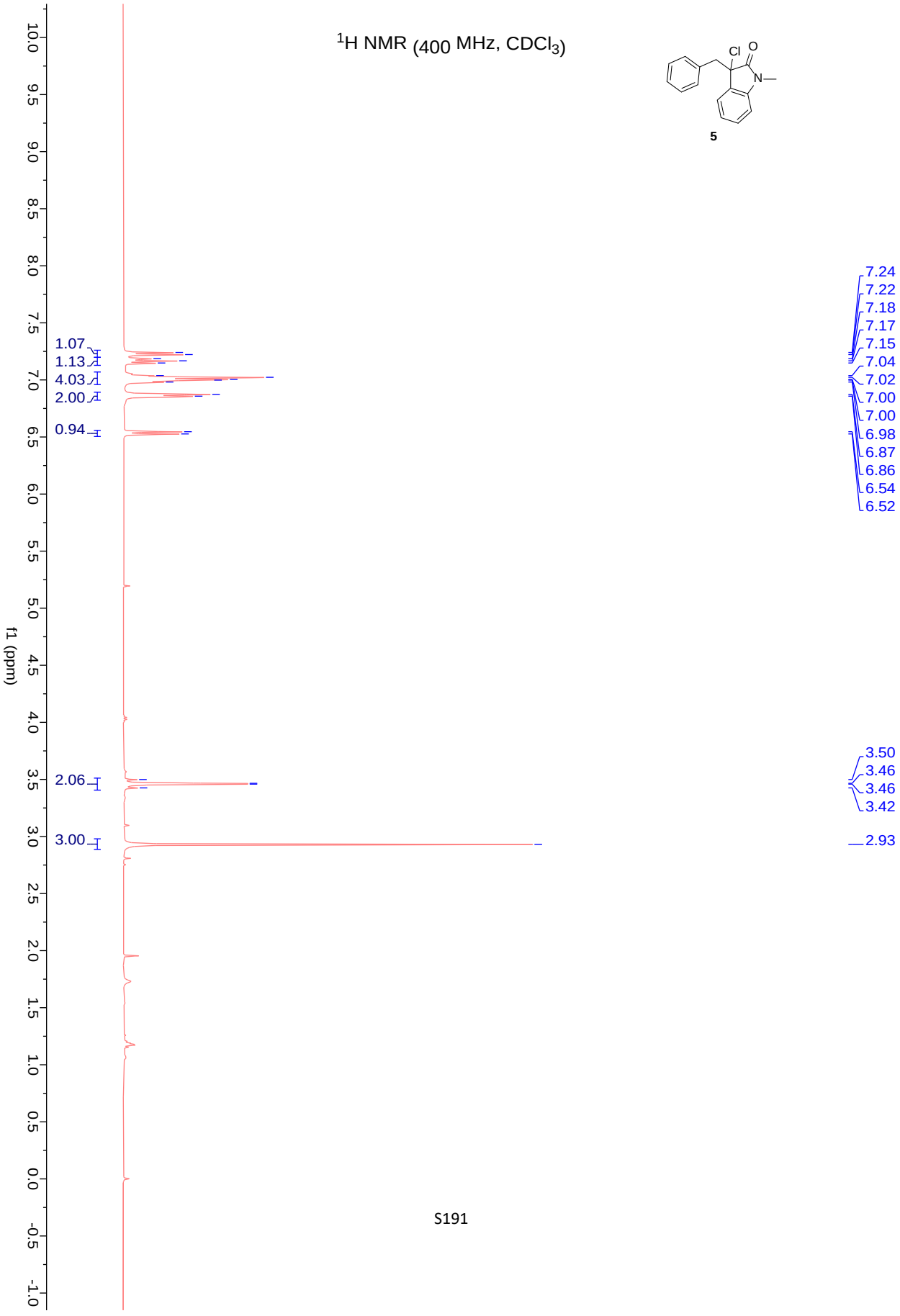

^{13}C NMR (101 MHz, $CDCl_3$)
2h'
176.41
176.01
144.18
143.90
137.12
135.93
131.95
129.79
129.39
129.26
129.16
128.63
128.27
127.97
127.40
127.13
126.78
126.42
126.02
125.46
109.92
106.96
77.48
77.16
76.84
48.32
46.83
36.67
33.64
26.42
26.18
f1 (ppm)

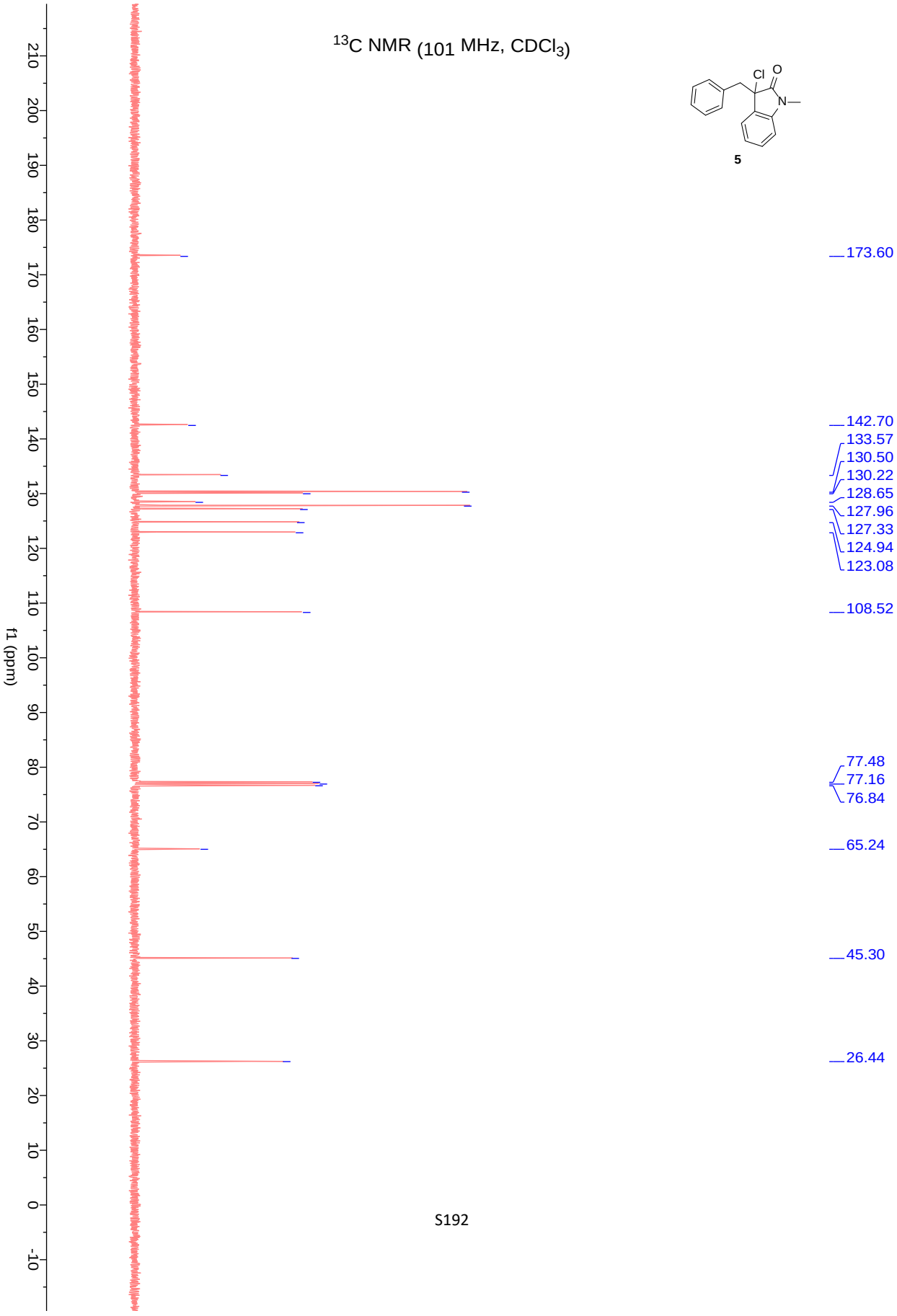

^{1}H NMR (400 MHz, $CDCl_3$)
O
N
2l'
7.29
7.27
7.25
7.22
7.20
7.09
7.07
7.05
6.86
6.84
1.19
0.96
0.98
0.96
2.92
5.99
3.22
1.37
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0

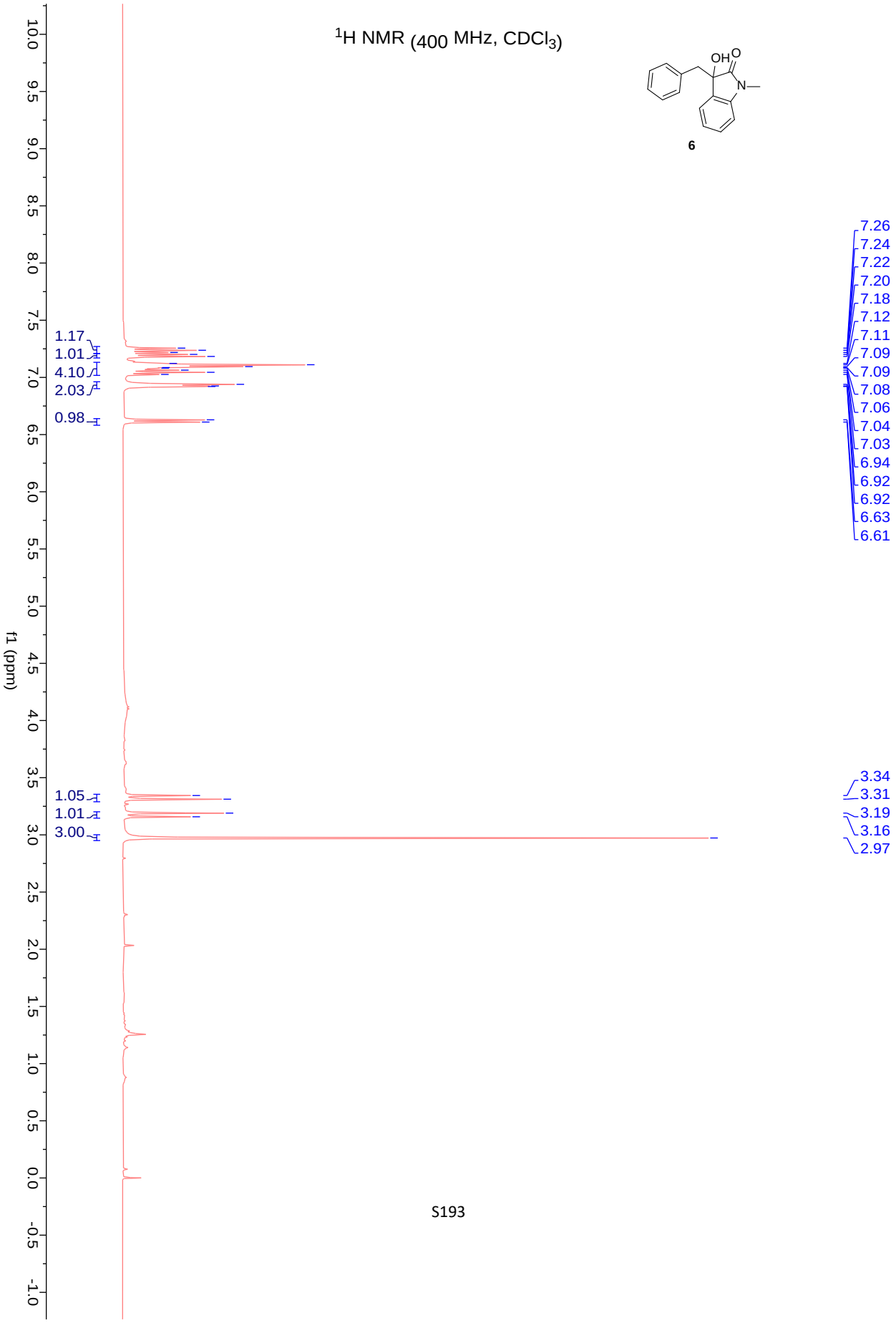
^{13}C NMR (101 MHz, $CDCl_3$)



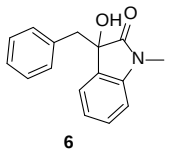
2l'


^{1}H NMR (400 MHz, $CDCl_3$)
Cl
O
N
5
f1 (ppm)
10.0
9.5
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
-1.0
1.07
1.13
4.03
2.00
0.94
2.06
3.00
7.24
7.22
7.18
7.17
7.15
7.04
7.02
7.00
7.00
6.98
6.87
6.86
6.54
6.52
3.50
3.46
3.46
3.42
2.93

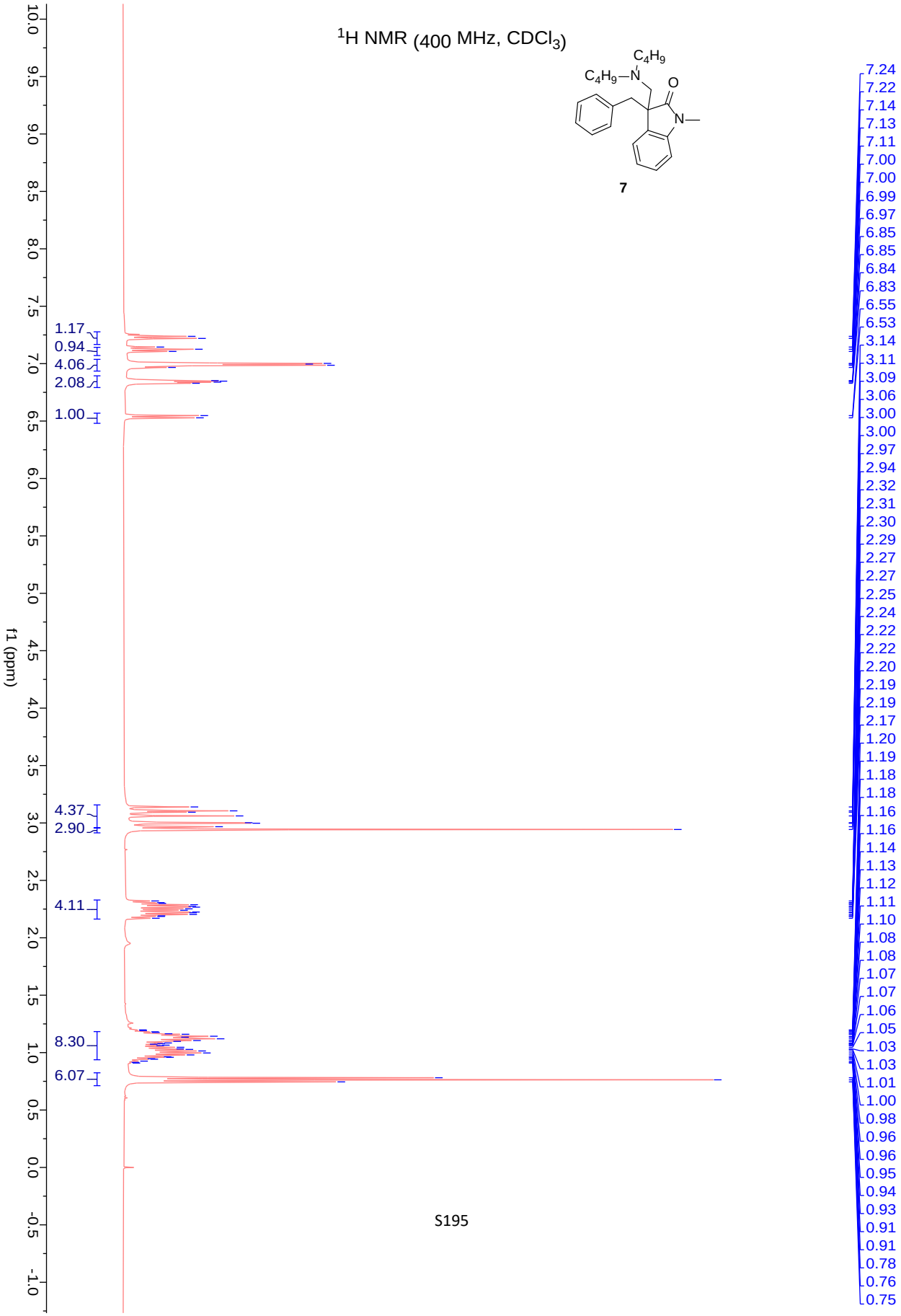

^{13}C NMR (101 MHz, $CDCl_3$)
Cl
O
N
5
173.60
142.70
133.57
130.50
130.22
128.65
127.96
127.33
124.94
123.08
108.52
77.48
77.16
76.84
65.24
45.30
26.44
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10


^{1}H NMR (400 MHz, $CDCl_3$)
OH
O
N
6
7.26
7.24
7.22
7.20
7.18
7.12
7.11
7.09
7.09
7.08
7.06
7.04
7.03
6.94
6.92
6.92
6.63
6.61
3.34
3.31
3.19
3.16
2.97
1.17
1.01
4.10
2.03
0.98
1.05
1.01
3.00
f1 (ppm)

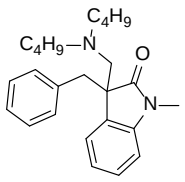
^{13}C NMR (101 MHz, $CDCl_3$)



6

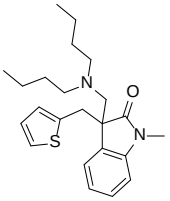

^{1}H NMR (400 MHz, $CDCl_3$)
C_4H_9
C_4H_9—N
O
N—
7
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1.17
0.94
4.06
2.08
1.00
4.37
2.90
4.11
8.30
6.07
7.24
7.22
7.14
7.13
7.11
7.00
7.00
6.99
6.97
6.85
6.85
6.84
6.83
6.55
6.53
3.14
3.11
3.09
3.06
3.00
3.00
2.97
2.94
2.32
2.31
2.30
2.29
2.27
2.27
2.25
2.24
2.22
2.22
2.20
2.19
2.19
2.17
1.20
1.19
1.18
1.18
1.16
1.16
1.14
1.13
1.12
1.11
1.10
1.08
1.08
1.07
1.07
1.06
1.05
1.03
1.03
1.01
1.00
0.98
0.96
0.96
0.95
0.94
0.93
0.91
0.91
0.78
0.76
0.75

^{13}C NMR (101 MHz, $CDCl_3$)

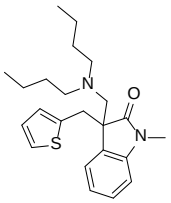


7

^{1}H NMR (400 MHz, $CDCl_3$)



^{13}C NMR (101 MHz, $CDCl_3$)



IX. Determination of kinetic isotope effects

Intramolecular Case:

***N*-benzyl-2-bromoaniline:** In a dried 100 mL round bottom flask, 2-bromoaniline (1.0 g, 5.8 mmol) and the corresponding aldehyde (0.9 mL, 8.7 mmol) were dissolved in 10 mL MeOH. Acetic acid (490 μL, 8.7 mmol) was added and the reaction was stirred at rt for 30 min. Then, the reaction was cooled down to 0 °C and sodium cyanoborohydride (0.48 g, 7.6 mmol) was added in two portions over 30 min. The reaction was allowed to stir from 0 °C to rt overnight (or until complete by TLC). The reaction was quenched with a saturated aq. solution of sodium bicarbonate (20 mL) and then extracted with Et_2O (3 x 20 mL). The combined organic layers were dried with Na_2SO_4, filtered and the solvent was removed under reduced pressure. The crude was flashed in 5% DCM/petroleum ether to give the title compound 1.2 g (78%) of colorless oil.[4]

***N*-benzyl-2-bromo-*N*-methylaniline：** In a dried 250 mL round bottom flask, *N*-benzyl-2-bromoaniline (1.0 g, 3.83 mmol) and 37% w.t. paraformaldehyde (10.4 g, 115 mmol) were dissolved in 150 mL CH_3CN. Acetic acid (10.0 mL, 172.4 mmol) was added and the reaction was stirred at rt for 30 min. Then, the reaction was cooled down to 0 °C and sodium cyanoborohydride (313.0 mg, 5.0 mmol) was added in two portions over 30 min. The reaction was allowed to stir from 0 °C to rt overnight (or until complete by TLC). The reaction was quenched with a saturated aq. solution of sodium bicarbonate (30 mL) and then extracted with Et_2O (3 x 30 mL). The combined organic layers were dried with Na_2SO_4, filtered and the solvent was removed under reduced pressure. The crude was flashed in 5% DCM/petroleum ether to give the title compound 0.9 g (85%) of colorless oil.[4]

***N*-benzyl-2-*d*-*N*-methylaniline:** An oven-dried 50 mL round bottomed flask filled with Ar. The flask was charged with *N*-benzyl-2-bromo-*N*-methylaniline (0.85 g, 3.1 mmol), anhydrous THF (10 mL) was added, and the colorless solution was cooled to -78 °C. A solution of freshly titrated *n*-BuLi in hexanes (1.6 M, 2.1 mL, 3.4 mmol) was added dropwise, forming a dark red solution. After 1 h at -78 °C, CD_3OD (226 μL, 5.6 mmol) was added, forming an orange suspension. After warming to room temperature, the mixture was washed with H_2O (10 mL). The aqueous fraction was extracted with ethyl acetate (10 mL), and the combined organics were washed with brine, dried (Na_2SO_4), filtered through cotton, and concentrated to an oil. Purification by silica gel chromatography afforded the title compound as a yellow oil 0.51 g (82%). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.33–7.22 (m, 2H), 7.23–7.15 (m, 5H), 6.76–6.62 (m, 2H), 4.48 (s, 2H), 2.96 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 149.9, 149.8, 139.1, 129.3, 129.2, 128.7, 127.0, 126.8, 116.6, 112.4, 56.7, 38.6.

2-bromo-*N*-methyl-3-phenyl-*N*-(phenyl-2-*d*)propanamide ([D_1]-1a): A flask containing *N*-benzyl-*N*-methylaniline-2-*d* (0.45 g, 2.3 mmol) and 10% Pd/C (23 mg, 5 mmol) was evacuated and backfilled with H_2 via a filled balloon. Ethyl acetate (5 mL) was added, and the reaction was allowed to stir at room temperature under 1 atm of H_2. The reaction progress was monitored by GC. Once all of the starting carbamate had been consumed, the reaction mixture was filtered through a plug of Celite. Concentration of the filtrate afforded the crude *N*-methyl-

(phenyl-2-*d*)aniline. Then in a dry and Ar-filled round bottom flask, crude aniline and pyridine (353 μL, 4.1 mmol) were dissolved in dry DCM (0.1 M), then 2-bromo-3-phenylpropanoyl chloride (566 mg, 2.3 mmol) was added dropwise at room temperature. After completion (monitored by TLC), filtered, condense filtrate under reduced pressure, the crude product was purified by silica gel column chromatography (PE/EtOAc = 15:1) to afford a yellow solid 527 mg (72%). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.38–7.23 (m, 6H), 7.15–7.05 (m, 2H), 6.74 (s, 1H), 4.26 (dd, *J* = 10.3, 5.2 Hz, 1H), 3.57 (dd, *J* = 13.0, 10.5 Hz, 1H), 3.19 (s, 3H), 3.10 (dd, *J* = 13.1, 5.1 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.5, 142.6, 137.3, 129.9, 129.8, 129.5, 128.6, 128.4, 127.3, 127.1, 43.51, 41.7, 37.9. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{15}BrDNONa^+$ $[M+Na]^+$: 341.0370, found:341.0372.

Determination of Intramolecular Isotope Effect: In a dry and Ar-filled glovebox, the oven-dried Schlenk tube (10 mL) containing a stirring bar was charged with 2-bromo-*N*-methyl-3-phenyl-*N*-(phenyl-2-*d*)propanamide **[D_1]-1a** (0.2 mmol, 1.0 equiv.), $Pd(OAc)_2$ (10 mol%), tris[4-(trifluoromethyl)phenyl]phosphine (20 mol%), $NaHSO_3$ (0.3 mmol , 1.5 equiv.) and 1,4-dioxane (3.0 mL). The mixture was stirred at 120 ℃ for 6 h. Upon completion of the reaction, the crude reaction mixture was filtered and the solvent were removed under reduced pressure. Inspection of the aromatic region of the ^{1}H NMR spectrum indicated that the 7-position of the product oxindole was 60% protonated, indicating an intramolecular isotope effect of k_H/k_D = 0.7 (compare Figures S1 and S2).

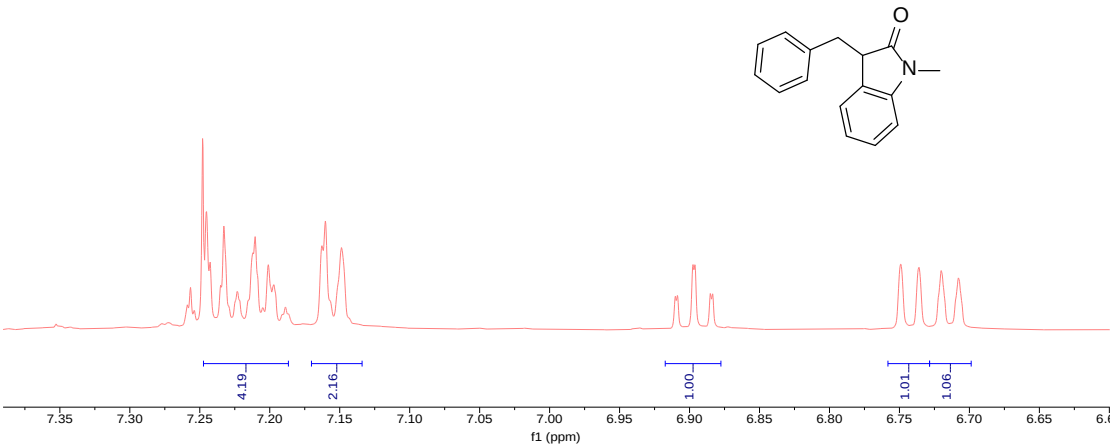


Figure S1. Aromatic region of 3-benzyl-1-methylindolin-2-one **2a**

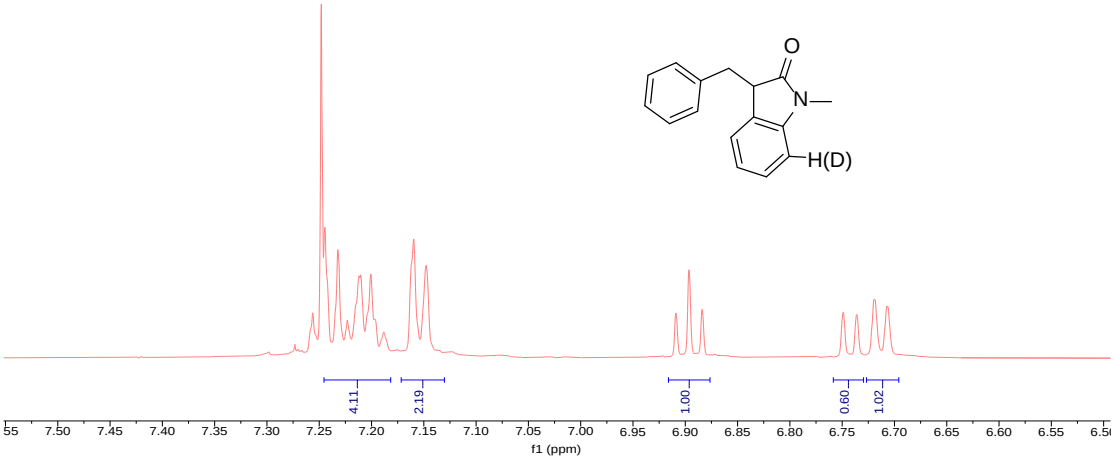


Figure S2. Aromatic region of isolated products from cyclization of **[D_1]-1a**

Intermolecular Case:

***d*$_5$-Acetanilide**: A 100 mL Erlenmeyer flask containing a solution of d_7-aniline (1.0 g, 10 mmol) in glacial acetic acid (2 mL) was treated with acetic anhydride (1.4 mL, 15 mmol). After standing at room temperature for 20 min, the solution was treated with cold H_2O (15 mL) in one portion, causing crystallization of a colorless solid. The flask was stored in the refrigerator for 30 min, and the solid was filtered via suction, washed thoroughly with cold water, and dried *in vacuo* to afford the title compound 1.0 g (71%).[5]

***d*$_5$-*N*-Methylacetanilide**: A round bottomed flask was charged with d_5-acetanilide (0.9 g, 6.4 mmol) and NaH (60% dispersion in mineral oil, 0.2 g, 8.4 mmol). The flask was evacuated and backfilled with nitrogen, and anhydrous THF (15 mL) was added. The resulting suspension was allowed to stir at room temperature for 15 min. Dimethyl sulfate (0.7 mL, 7.7 mmol) was added dropwise. After 3 h at room temperature, the reaction mixture was treated with ethyl acetate (5 mL) and H_2O (10 mL). The aqueous layer was extracted with ethyl acetate (5 mL), and the combined organics were washed with brine, dried (Na_2SO_4), filtered through cotton, and concentrated. The crude material obtained was purified by recrystallization from EtOH/hexanes to give the title compound as a colorless solid 0.8 g (81%).[5]

2-bromo-*N*-methyl-3-phenyl-*N*-(phenyl-*d*$_5$)propanamide ([D$_5$]-1a): A mixture of d_5-*N*-methylacetanilide (0.75 g, 4.9 mmol), NaOH (353 mg, 8.8 mmol), and H_2O (4.0 mL) was heated at 100 °C for 6 h. The mixture was allowed to cool, and was extracted with ethyl acetate (10 mL × 2). The combined organic layers were washed with brine, dried (Na_2SO_4), filtered through cotton, and concentrated. Purification by silica gel chromatography afforded the *N*-methyl-(phenyl-d_5)aniline as a yellow oil. Then in a dry and Ar-filled round bottom flask, aniline and pyridine (0.7 mL, 8.8 mmol) were dissolved in dry DCM (0.1 M), then 2-bromo-3-phenylpropanoyl chloride (1.2 g, 4.9 mmol) was added dropwise at room temperature. After completion (monitored by TLC), filtered, condense filtrate under reduced pressure, the crude product was purified by silica gel column chromatography (PE/EtOAc = 15:1) to afford the product as a yellow solid (1.1 g, 70%). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.30–7.27 (m, 3H), 7.08 (dd, *J* = 6.4, 3.0 Hz, 2H), 4.24 (dd, *J* = 10.3, 5.2 Hz, 1H), 3.55 (dd, *J* = 13.1, 10.3 Hz, 1H), 3.17 (s, 3H), 3.08 (dd, *J* = 13.1, 5.2 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.5, 142.5, 137.3, 129.5, 128.6, 127.3, 43.5, 41.8, 37.9. **HRMS** (ESI, m/z) Calcd for $C_{16}H_{11}BrD_5NONa^+$ $[M+Na]^+$: 345.0621, found: 345.0622.

Determination of Intermolecular Isotope Effect:

In a dry and Ar-filled glovebox, the oven-dried Schlenk tube (10 mL) containing a stirring bar was charged with 2-bromo-*N*-methyl-*N*,3-diphenylpropanamide **1a** (0.1 mmol, 0.5 equiv.), 2-bromo-*N*-methyl-3-phenyl-*N*-(phenyl-d_5)propanamide **[D$_5$]-1a** (0.1 mmol, 0.5 equiv.), $Pd(OAc)_2$ (10 mol%), tris[4-(trifluoromethyl)phenyl] phosphine (20 mol%), $NaHSO_3$ (0.3 mmol , 1.5 equiv.) and 1,4-dioxane (3.0 mL). The mixture was stirred at 120 ℃ for 20 min. The crude material was analyzed by ^{1}H NMR spectroscopy (600 MHz, Figure S3). It can be seen that the cyclization proceeded to ~18% conversion. However, in the characteristic region of benzene ring, the signal peaks of the product overlap with interfering peaks. As a result, the experimental results were observed after purification by

column chromatography on silica gel (17% isolated yield). Comparing this data (Figure S4) with the spectrum of standard product (**2a**, Figure S1), about 44% oxindole formed comes from the deuterated substrate, indicating a value of k_H/k_D = 1.27.

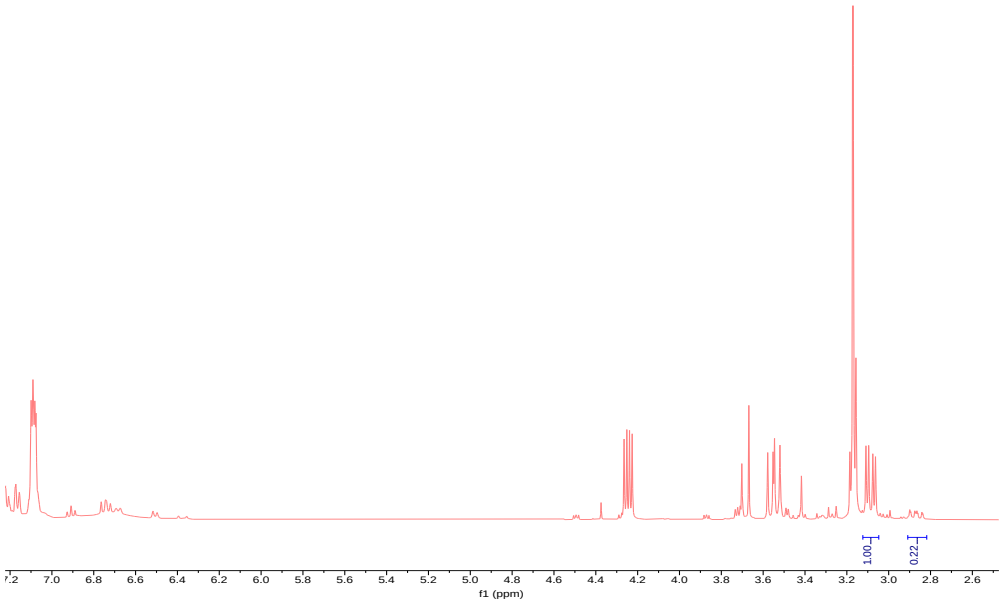


Figure S3. ^{1}H-NMR spectrum of crude mixture from intermolecular competitive experiment (20 min)

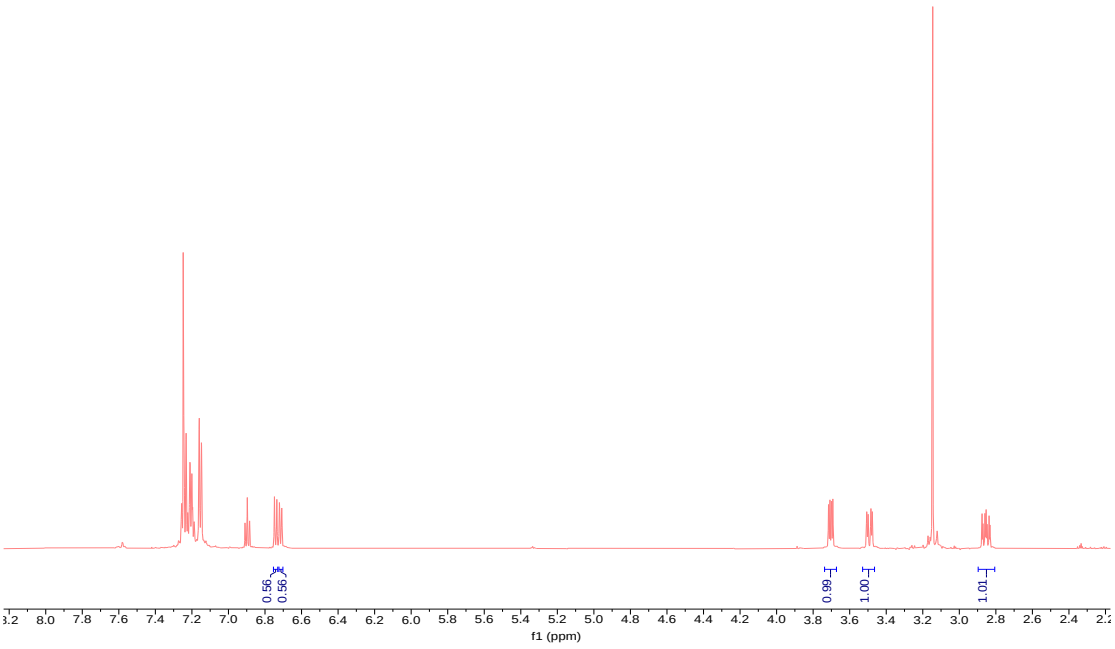


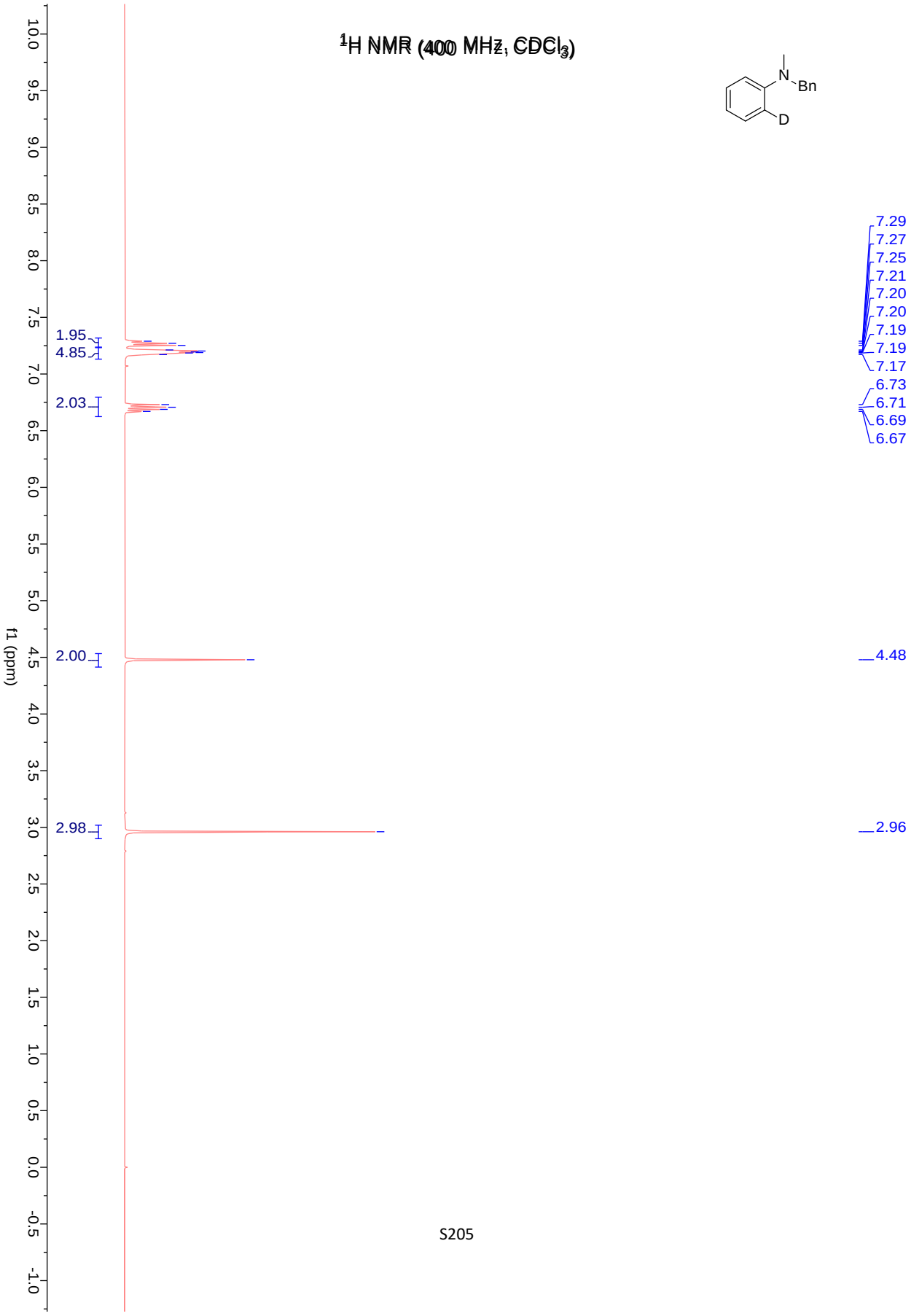
Figure S4. ^{1}H-NMR spectrum of the isolated product from intermolecular competitive experiment (20 min)

KIE experiments with completely parallel settings:

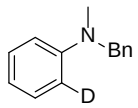
(1) In a dry and Ar-filled glovebox, the oven-dried Schlenk tube (10 mL) containing a stirring bar was charged with 2-bromo-*N*-methyl-*N*,3-diphenylpropanamide **1a** (0.2 mmol, 1.0 equiv.), $Pd(OAc)_2$ (10 mol%), tris[4-(trifluoromethyl)phenyl]phosphine (20 mol%), $NaHSO_3$ (0.3 mmol , 1.5 equiv.) and 1,4-dioxane (3.0 mL). The mixture was stirred at 120 ℃ for 15 min. After purification by column chromatography on silica gel, **2a** was obtained in 13% yield.

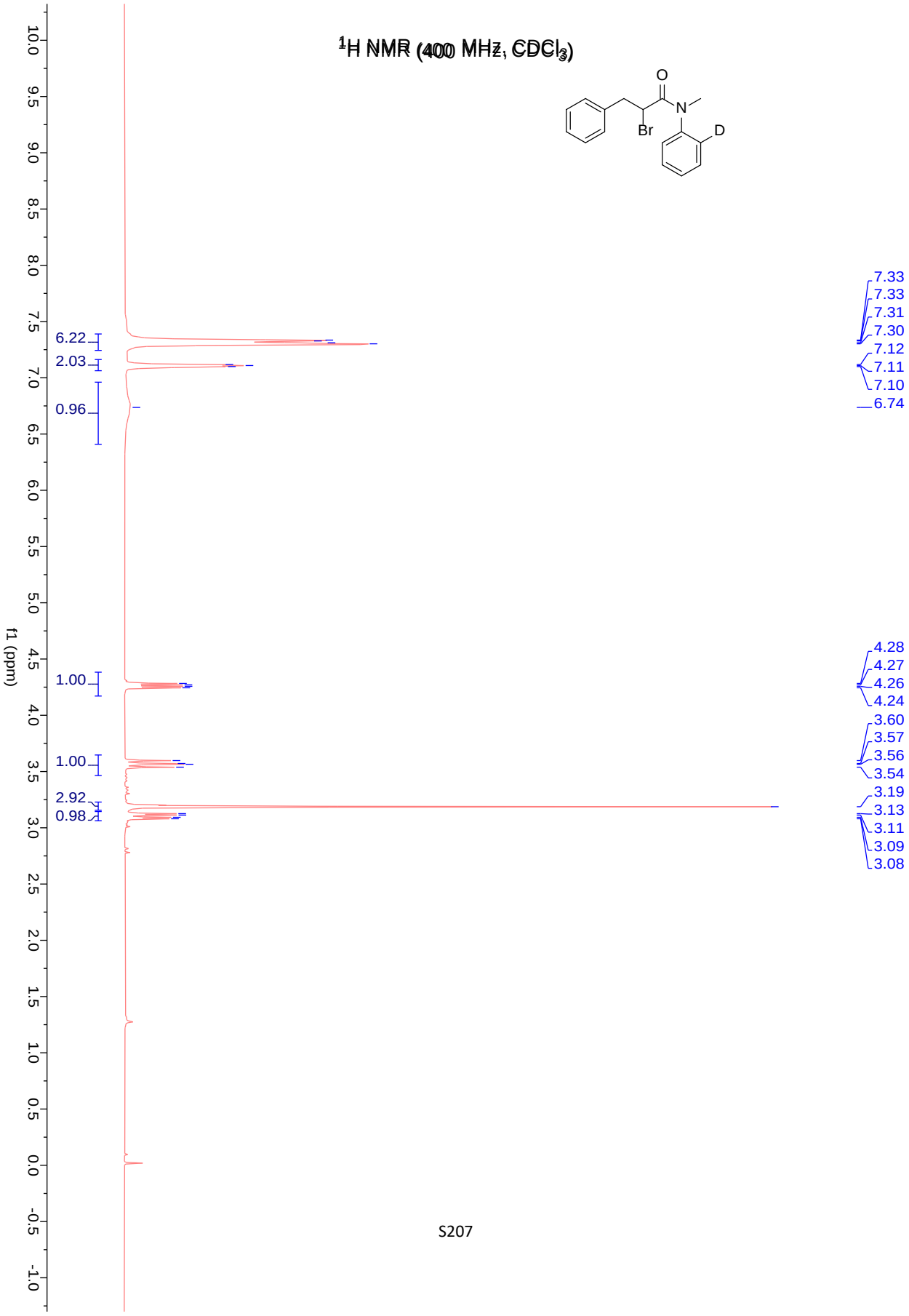
(2) In a dry and Ar-filled glovebox, the oven-dried Schlenk tube (10 mL) containing a stirring bar was charged with 2-bromo-*N*-methyl-3-phenyl-*N*-(phenyl-d_5)propanamide **[D_5]-1a** (0.2 mmol, 1.0 equiv.), $Pd(OAc)_2$ (10 mol%), tris[4-(trifluoromethyl)phenyl]phosphine (20 mol%), $NaHSO_3$ (0.3 mmol , 1.5 equiv.) and 1,4-dioxane (3.0 mL). The mixture was stirred at 120 ℃ for 15 min. After purification by column chromatography on silica gel, **[D_4]-2a** was obtained in 10% yield.

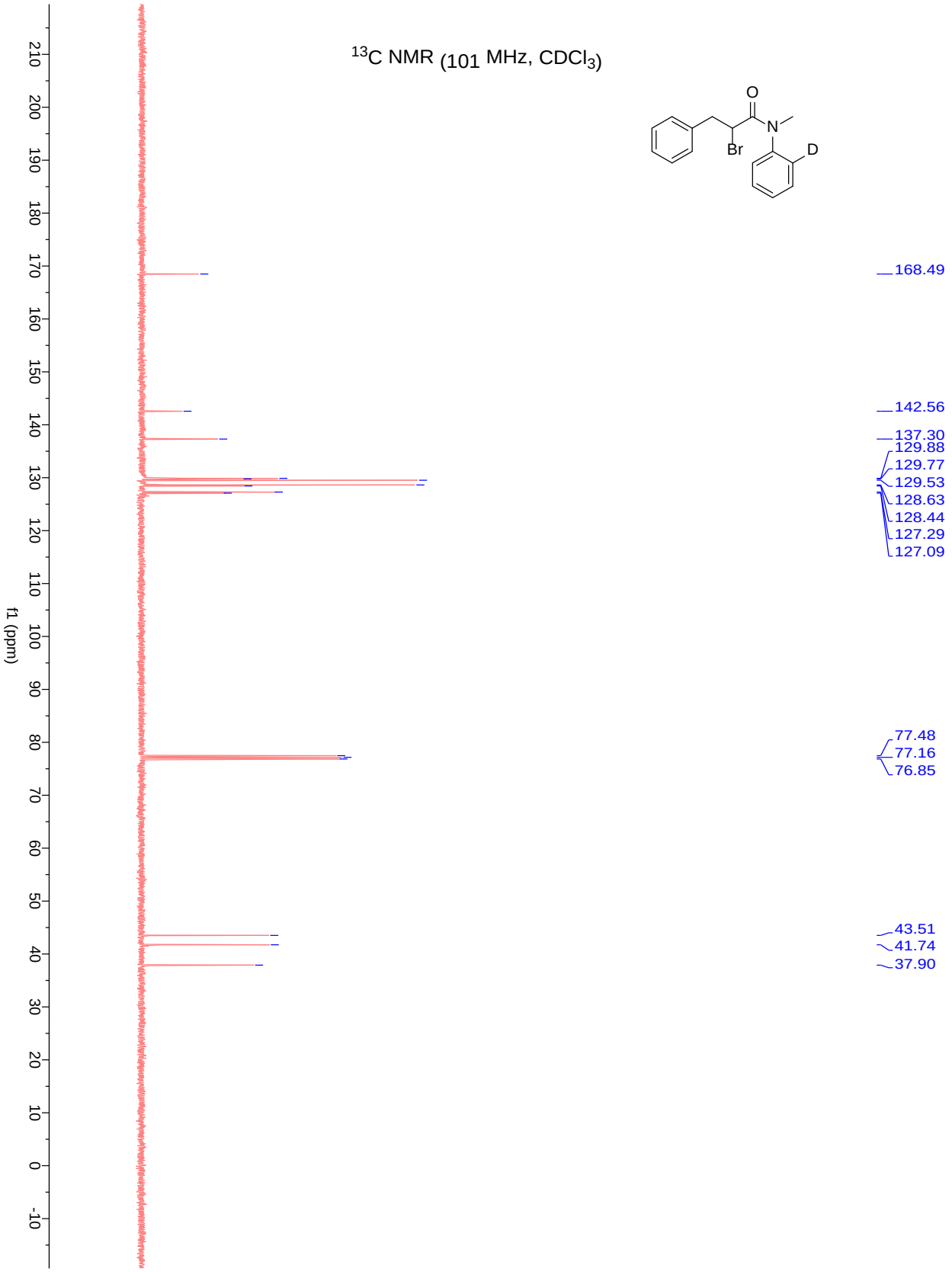
3-benzyl-1-methylindolin-2-one-4,5,6,7-d_4 **[D_4]-2a**: **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.27–7.13 (m, 5H), 3.72 (dd, *J* = 9.5, 4.5 Hz, 1H), 3.50 (dd, *J* = 13.7, 4.6 Hz, 1H), 2.87 (dd, *J* = 13.7, 9.5 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.3, 138.1, 129.5, 128.4, 126.8, 47.2, 37.0, 26.3.

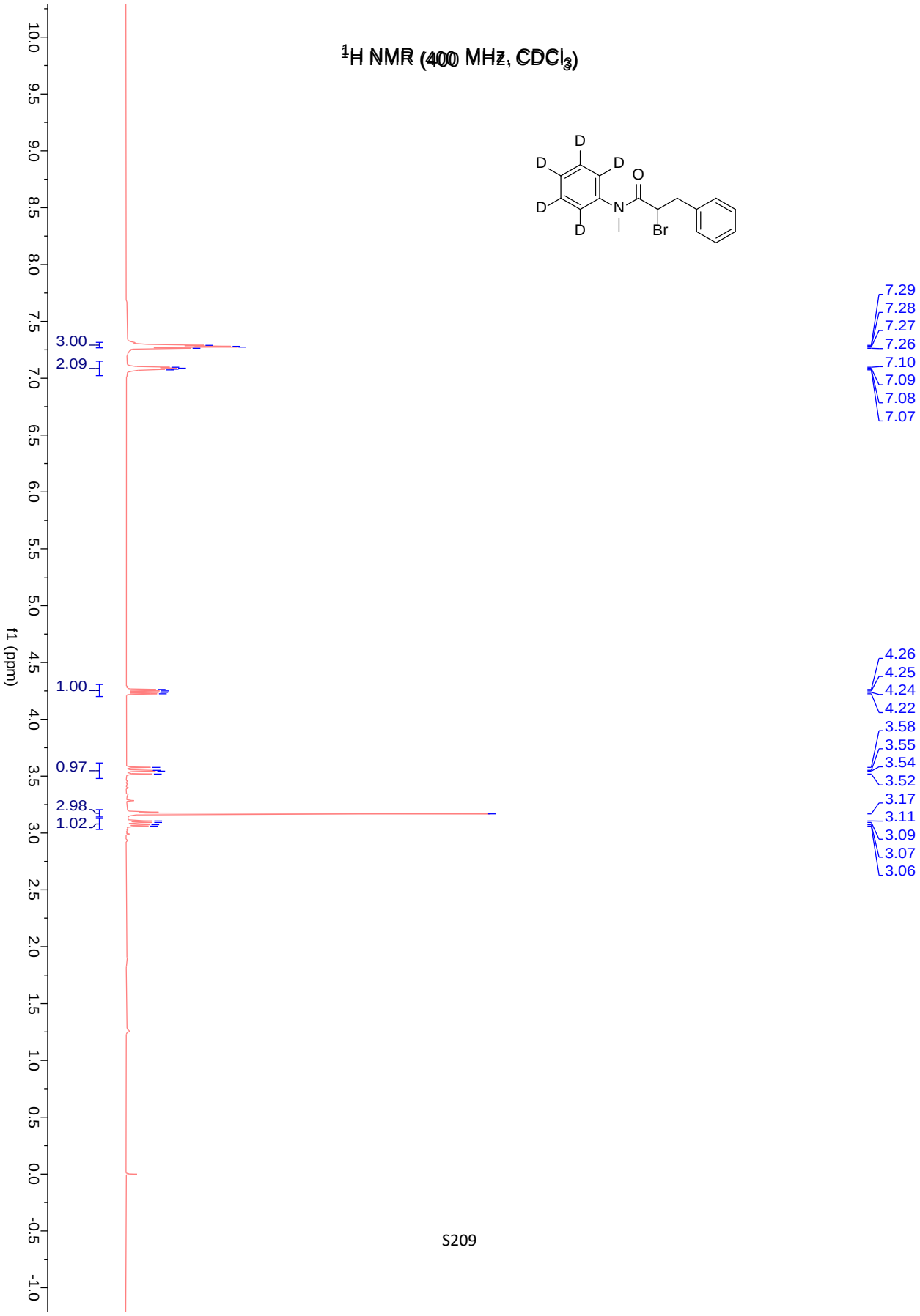

^{1}H NMR (400 MHz, CDCl$_3$)
N
Bn
D
7.29
7.27
7.25
7.21
7.20
7.20
7.19
7.19
7.17
6.73
6.71
6.69
6.67
4.48
2.96
1.95
4.85
2.03
2.00
2.98
f1 (ppm)

^{13}C NMR (101 MHz, $CDCl_3$)

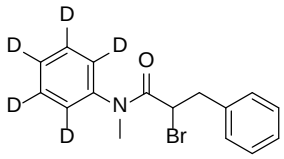


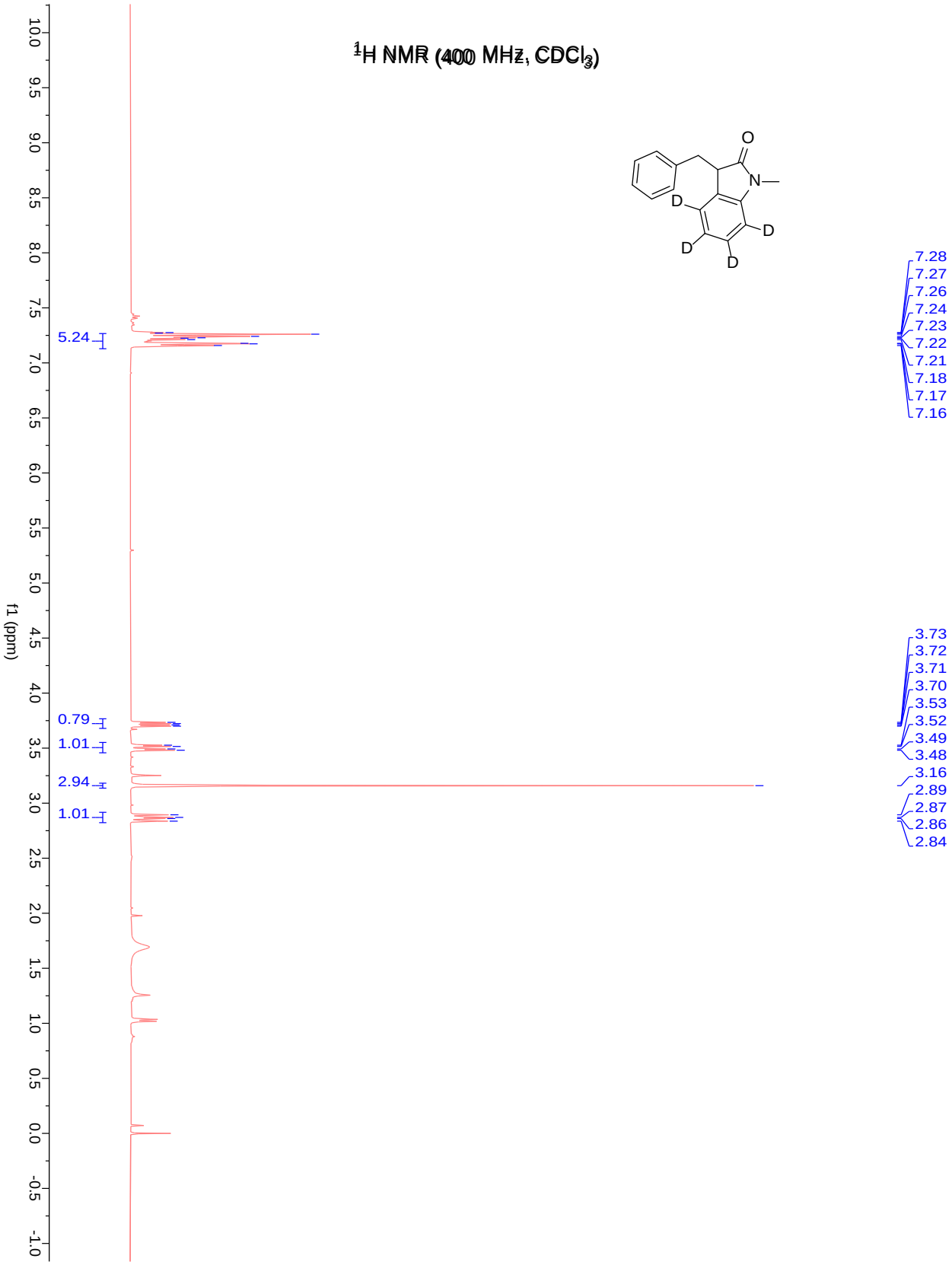

^{1}H NMR (400 MHz, CDCl$_3$)
O
N
Br
D
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
6.22
2.03
0.96
1.00
1.00
2.92
0.98
7.33
7.33
7.31
7.30
7.12
7.11
7.10
6.74
4.28
4.27
4.26
4.24
3.60
3.57
3.56
3.54
3.19
3.13
3.11
3.09
3.08


^{13}C NMR (101 MHz, $CDCl_3$)
O
N
Br
D
168.49
142.56
137.30
129.88
129.77
129.53
128.63
128.44
127.29
127.09
77.48
77.16
76.85
43.51
41.74
37.90
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

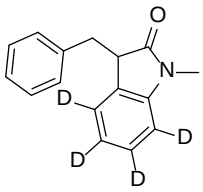

^{1}H NMR (400 MHz, $CDCl_3$)
D
D
D
D
D
O
N
Br
7.29
7.28
7.27
7.26
7.10
7.09
7.08
7.07
4.26
4.25
4.24
4.22
3.58
3.55
3.54
3.52
3.17
3.11
3.09
3.07
3.06
3.00
2.09
1.00
0.97
2.98
1.02
f1 (ppm)

^{13}C NMR (101 MHz, $CDCl_3$)




^{1}H NMR (400 MHz, $CDCl_3$)
O
N
D
D
D
D
7.28
7.27
7.26
7.24
7.23
7.22
7.21
7.18
7.17
7.16
3.73
3.72
3.71
3.70
3.53
3.52
3.49
3.48
3.16
2.89
2.87
2.86
2.84
5.24
0.79
1.01
2.94
1.01
f1 (ppm)

^{13}C NMR (101 MHz, $CDCl_3$)



X. References

1. C. P. Chuang, Y. Y. Chen, T. H. Chuang and C. H. Yang, Copper-Salt-Promoted Carbocyclization Reactions of α-Bromo-*N*-arylacylamides. *Synthesis*, 2016, **49** (6), 1273.

2. L Ackermann, R Vicente, and N Hofmann, Air-Stable Secondary Phosphine Oxide as Preligand for Palladium-Catalyzed Intramolecular α-Arylations with Chloroarenes, *Org. Lett.*, 2009, **11** (19), 4274.

3. X. L. Liu, X. M. Zhang and W. C. Yuan, A Simple and Eco-friendly Method for the Aminomethylation of 3-Substituted Oxindoles via Three-Component Mannich Reaction in Aqueous Media, *Tetrahedron Lett.*, 2011, **52**, 903.

4. Y. T. Daniela Sustac Roman and Andre B. Charette, Potassium tert-Butoxide Promoted Intramolecular Arylation via a Radical Pathway, *Org. Lett.*, 2011, **13** (12), 3242.

5. S. L. Buchwald and E. J. Hennessy, Synthesis of Substituted Oxindoles from α-Chloroacetanilides via Palladium-Catalyzed C-H Functionalization, *J. Am. Chem. Soc.*, 2003, **125**, 12084.