Electronic Supplementary Material (ESI) for ChemComm.
This journal is © The Royal Society of Chemistry 2023

Supporting Information

Synthesis of 2-Substituted Bicyclo[1.1.0]butanes *via* a Zincocyclopropanation using Bromoform as the Carbenoid Precursor

Léa Thai-Savard and André B. Charette*

Centre in Green Chemistry and Catalysis, Department of Chemistry, Université de Montréal, 1375, av. Thérèse Lavoie-Roux, Montréal, Québec H2V 0B3, Canada

Table of Contents

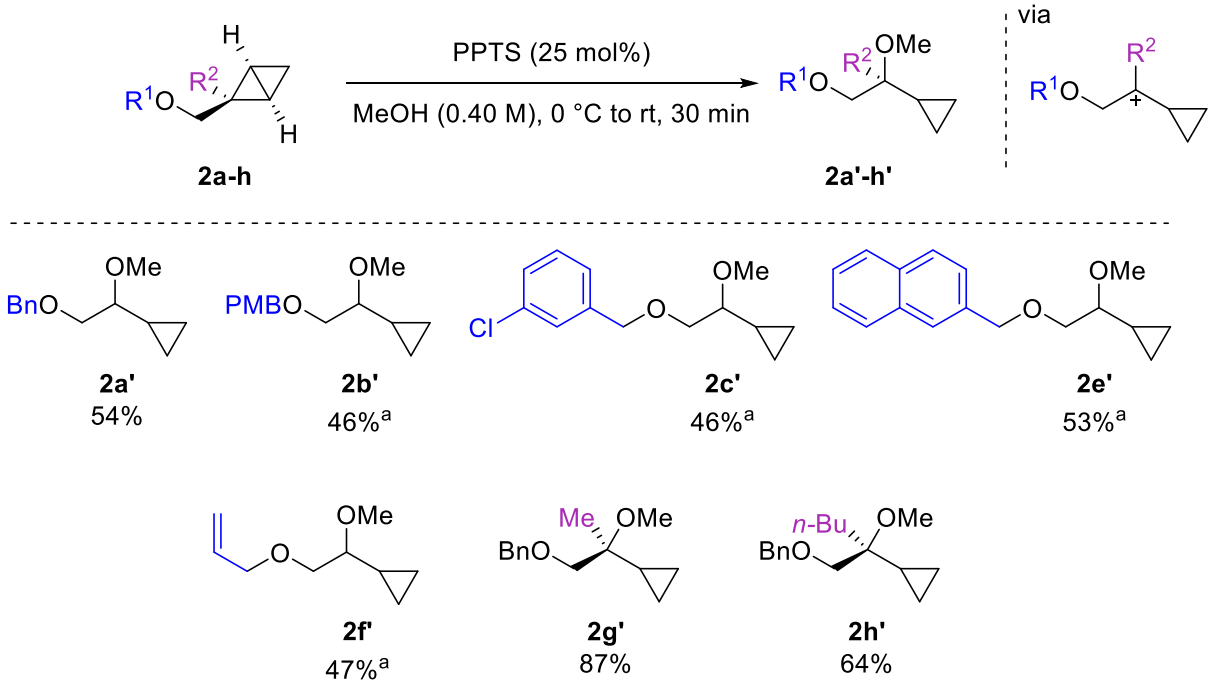
1. General information

General: All non-aqueous reactions were run under argon atmosphere with rigid exclusion of moisture from reagents and glassware using standard techniques for manipulating air-sensitive compounds.[1] All glassware was stored in the oven and flame-dried under argon prior to use. Flash column chromatography was performed using 230-400 mesh silica (Silicycle) of the indicated solvent system according to standard technique[2] or on Santai Technologies flash chromatography cartridges on a Sepabean instrument. Analytical thin-layer chromatography (TLC) was performed on precoated, glass-backed silica gel (Merck 60 F254). Visualisation of the developed chromatogram was performed by UV light (254 nm) and/or using *para*-anisaldehyde (PA) stain. Nuclear magnetic resonance spectra were recorded on a Bruker Avance 400 or 500 MHz spectrometer. Chemical shifts for ^{1}H NMR spectra are recorded in parts per million with the solvent resonance as the reference $CDCl_3$ (δ = 7.26 ppm). Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, qn = quintet, m = multiplet and br = broad), coupling constant in Hz and integration. Chemical shifts for ^{13}C NMR spectra are recorded in parts per million using the central peak of $CDCl_3$ (δ = 77.16 ppm) as the reference. All ^{13}C NMR spectra were recorded on a Bruker Avance 126 MHz and obtained with complete proton decoupling. All NMR yields were determined using ^{1}H NMR with triphenylmethane as an internal standard. When ambiguous, proton, carbon and stereochemistry assignments were established using COSY, NOESY and/or DEPT experiments. Infrared spectra were taken on a Bruker Vertex Series FTIR (neat) and are reported in reciprocal centimeters (cm^{-1}). High resolution mass spectra were performed by the Centre régional de spectroscopie de masse de l'Université de Montréal.

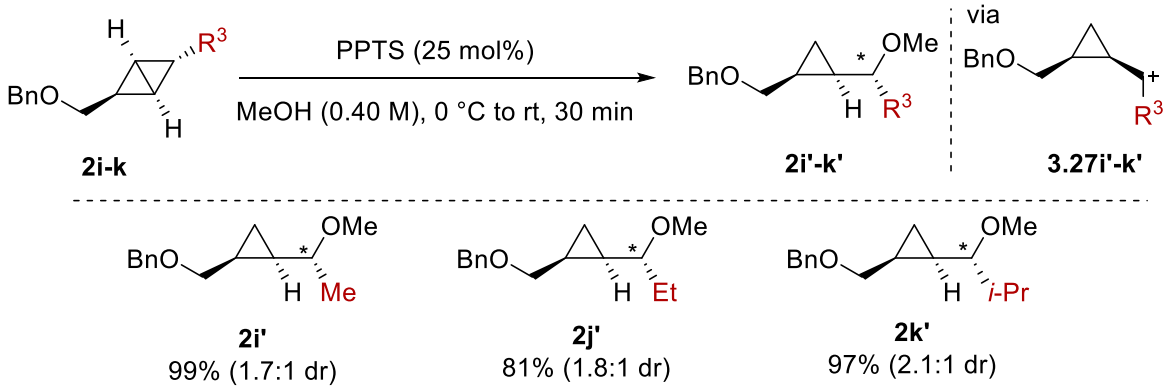
Solvents and reagents: Anhydrous, oxygen-free solvents were obtained by distillation. Tetrahydrofuran (THF) was freshly distilled over sodium and benzophenone. Dichloromethane (CH_2Cl_2) and methanol (MeOH) were freshly distilled over CaH_2. Diethyl ether (Et_2O) was obtained by filtration through drying columns on a filtration system.[3] Unless otherwise stated, commercially available reagents were used as supplied or purified by standard techniques when necessary. Triethylamine (Et_3N) was freshly distilled over potassium hydroxide. Reagents were purified based on standard techniques, unless otherwise stated.[4] Zinc iodide was purchased from Alfa Aesar, heated to 150 °C in an oil bath under high vacuum overnight and stored in the glovebox prior to use. Bromoform was purchased from Sigma Aldrich, washed with concentrated sulfuric acid until colorless, then water and $NaHCO_3$, distilled very slowly in an oil bath and kept at –20 °C in the dark for several months. Distilling bromoform with overheating (i.e. heat gun) leads to a release of bromine and affects zincocyclopropanation yield and purity. *N*-Iodosuccinimide (NIS) was freshly recrystallized from dioxane/CCl_4. *n*-Butyllithium was freshly titrated using recrystallized diphenylacetic acid. Non-commercial starting materials were synthesized according to literature procedures.

Compound Handling/Storage: During all handling, exposure of iodocyclopropanes and iodocyclobutanes to light should be minimised. Iodocyclopropanes may be stored for prolonged periods below 10 °C in the dark without noticeable decomposition.

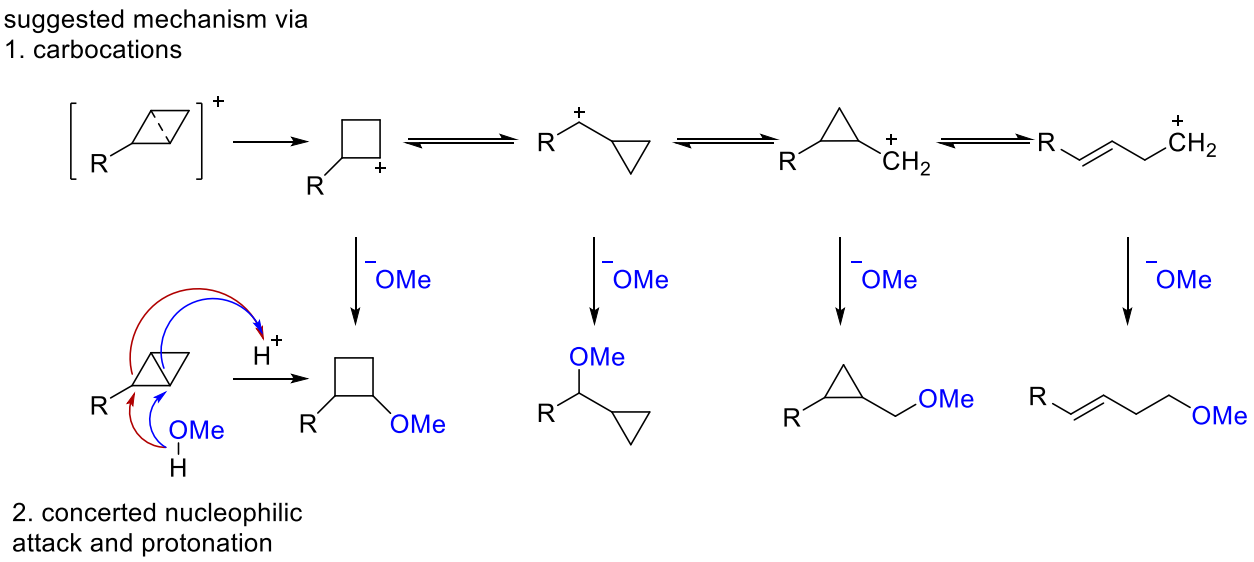
2. Methanol addition to 2- and 2,2-substituted BCB catalyzed by pyridinium *p*-toluenesulfonate (PPTS)



Scheme S1. Methanol addition to 2- and 2,2-substituted BCB catalyzed PPTS



Scheme S2. Methanol addition to 2,4-substituted BCBs catalyzed by PPTS



Scheme S3. Suggested mechanism via nonclassical carbocations or concerted nucleophilic attack and protonation

2. Optimization studies

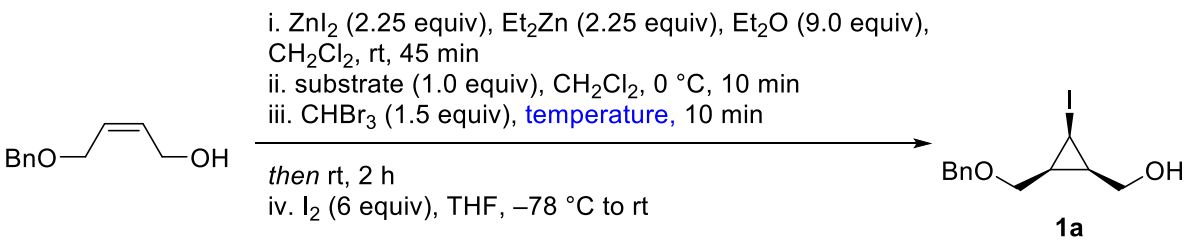
2.1 Optimization of carbenoid formation temperature

Optimization procedure

In a flame-dried 20 mL microwave vial, under argon, neat diethylzinc (147 µL, 1.43 mmol, 2.25 equiv) was added to dried zinc iodide (457 mg, 1.43 mmol, 2.25 equiv) and anhydrous diethyl ether (601 µL, 5.72 mmol, 9 equiv) in freshly distilled dichloromethane (3.5 mL) and upon observation of full dissolution of the reaction mixture (about 45-60 minutes). (*Z*)-4-(benzyloxy)but-2-en-1-ol[4] (113 mg, 0.636 mmol, 1.0 equiv) was weighed in a separate flame-dried 5 mL microwave vial, then purged under argon during 5 minutes, then dissolved in freshly distilled CH_2Cl_2 (0.5 mL). The first vial was cooled down to 0 °C and the solution of the second vial was added via a cannula to the first vial. After 10 minutes at 0 °C, the reaction mixture was cooled down to *x* temperature using the corresponding iced cold water or dry ice/acetone bath. Bromoform (83.4 uL, 0.954 mmol, 1.5 equiv) was added to give a pale yellowish suspension. After 10 minutes at *x* temperature, the bath was removed, the reaction mixture was stirred for 2 hours at room temperature. The reaction flask was cooled down to –78 °C in a dry ice/acetone bath. In a separate flame-dried 10 mL microwave vial, iodine (970 mg, 3.80 mmol, 5.0 equiv) was weighed and purged under argon, then dissolved in freshly distilled tetrahydrofuran (2 mL) and this solution was added via a cannula to the

first flask. After 5 minutes, the bath was removed, and the reaction mixture was allowed to warm up to room temperature and quenched with aqueous HCl 2 M. Triphenylmethane was carefully weighed (≈20-25 mg) and added as the internal standard. The cyclopropane was extracted from the aqueous layer by washing with diethyl ether (3×10 mL) and the combined organic layers were washed successively with saturated solution of sodium sulfite and brine, dried over anhydrous magnesium sulfate and filtered. The volatiles were removed under reduced pressure to afford cyclopropane **1a**.

Table 1. Optimization of carbenoid formation temperature



Entry	Temperature	NMR yield **1a** (%)[a]	Starting material recovery (%)[a]
1	0 °C	43	35
2	–6 °C	37	56
3	–40 °C	59	41
4	–78 °C	86	-

[a]Determined using triphenylmethane as the internal standard. Entries done on 0.636 mmol of allylic alcohols.

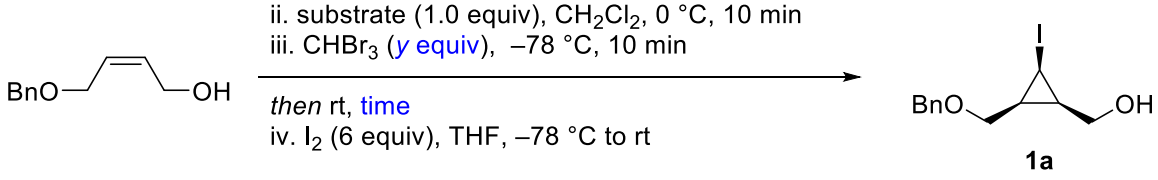
2.2 Optimization of stoichiometry and reaction time

Optimization procedure

In a flame-dried 20 mL microwave vial, under argon, neat diethylzinc (*x* equiv) was added to dried zinc iodide (*x* equiv) and anhydrous diethyl ether (4*x* equiv) in freshly distilled dichloromethane (3.5 mL) and upon observation of full dissolution of the reaction mixture (about 45-60 minutes). (*Z*)-4-(benzyloxy)but-2-en-1-ol[4] (113 mg, 0.636 mmol, 1.0 equiv) was weighed in a separate flame-dried 5 mL microwave vial, then purged under argon during 5 minutes, then dissolved in freshly distilled dichloromethane (0.5 mL). The first vial was cooled down to 0 °C and the solution of the second vial was added via a cannula to the first vial. After 10 minutes at 0 °C, the reaction mixture was cooled down to –78 °C in a dry ice/acetone bath.

Bromoform (*y* equiv) was added to give a pale yellowish suspension. After 10 minutes at –78 °C temperature, the bath was removed, the reaction mixture was stirred 0.5-2 hours at room temperature. The reaction flask was cooled down to –78 °C again. In a separate flame-dried 10 mL microwave vial, iodine (970 mg, 3.80 mmol, 5.0 equiv) was weighed and purged under argon, then dissolved in freshly distilled tetrahydrofuran (2 mL) and this solution was added via a cannula to the first flask. After 5 minutes, the bath was removed, and the reaction mixture was allowed to warm up to room temperature and quenched with aqueous HCl 2 M. Triphenylmethane was carefully weighed (≈20-25 mg) and added as the internal standard. The cyclopropane was extracted from the aqueous layer by washing with diethyl ether (3×10 mL) and the combined organic layers were washed successively with saturated solution of sodium sulfite and brine, dried over anhydrous magnesium sulfate and filtered. The volatiles were removed under reduced pressure to afford cyclopropane **1a**.

Table 2. Optimization of EtZnI and carbenoid equivalents and reaction time

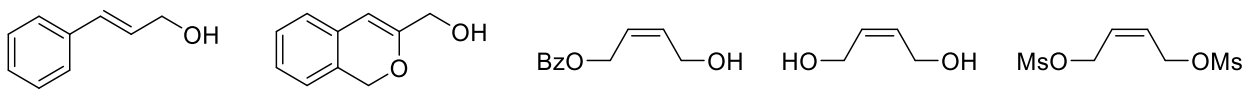


1a

Entry	Equiv of EtZnI-2Et$_2$O	Equiv of $CHBr_3$	Reaction time (h)	NMR yield **1a** (%)[a]	Starting material recovery (%)[a]
1	4.5	1.5	2	83	11
2	5.5	2	2	74	0
3	5.0	2	2	79	0
4	4.5	1.5	1	91	0
5	4.5	1.5	0.5	40	48

[a]Determined using triphenylmethane as the internal standard. Entries done on 0.636 mmol of allylic alcohols

2.3 Unsuccessful substrates for zincocyclopropanation



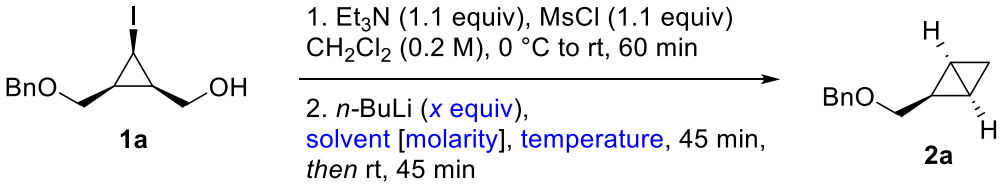
no reaction | no reaction | no reaction | traces | degradation

2.4 Optimization of cyclization

Optimization procedure

In a flame-dried 5 mL microwave vial, triethylamine (40 µL, 0.25 mmol, 1.1 equiv) was added to iodocyclopropylmethanol **1a** (0.25 mmol, 1.0 equiv) in dichloromethane (1.0 mL, 0.25 M) at 0 °C. Then, methanesulfonyl chloride (20 µL, 0.25 mmol, 1.1 equiv) was added. The reaction mixture was allowed to warm up to room temperature, stirred during 60 minutes, then quenched with a saturated solution of sodium bicarbonate. The cyclopropane was extracted from the aqueous layer by washing with dichloromethane (3×5 mL) and the combined organic layers were washed with brine, dried over anhydrous magnesium sulfate and filtered into a 25 mL round bottom flask. The volatiles were removed under reduced pressure. A septum and a magnetic stir bar were added and the flask was purged with argon during 5 minutes. The chosen solvent (*x* mL) was added and the reaction flask was cooled down to the desired temperature using a dry ice/acetone bath. *n*-Butyllithium (2.5 M in THF, *y* equiv) was added over 15 minutes using a syringe pump (2 mL/h). The reaction flask was stirred at the chosen temperature for 45 minutes, then the dry ice/acetone bath was removed, and the flask was allowed to warm up to room temperature and stirred for another 45 minutes. The reaction mixture was quenched with a saturated solution of sodium bicarbonate, the bicyclo[1.1.0]butane was extracted from the aqueous layer by washing with diethyl ether (3×10 mL) and the combined organic layers were washed with brine, dried over anhydrous magnesium sulfate and filtered. Triphenylmethane was added as the internal standard. The volatiles were carefully removed under reduced pressure to afford bicyclo[1.1.0]butane **2a**.

Table 3. Optimization studies for the cyclization of 1a



Entry	Equivalents of *n*-BuLi	Concentration [M]	Solvent	Temperature (°C)	NMR yield **2a** (%)[a]
1	2.2	0.05	THF	–78	91 (38)[b]
2	1.1	0.05	THF	–78	67
3	3.3	0.05	THF	–78	54
4	2.2	0.01	THF	–78	84

5	2.2	0.20	THF	–78	74
6	2.2	0.05	Et_2O	–78	58
7	2.2	0.05	THF	–40	74
8[c]	2.2	0.05	THF	–78	42

[a]NMR yield determined using triphenylmethane as the internal standard. Entries done on 0.25 mmol. [b]Isolated yield shown in parentheses. [c]*tert*-BuLi instead of *n*-BuLi.

3. Experimental procedures

3.1 General procedure A: Synthesis of allylic alcohols

In a flame-dried round bottom flask, under argon, at 0 °C, sodium hydride (60% dispersion in mineral oil, 1.2 equiv) was added in portions over 20 minutes to 2-butene-1,4-diol (3.0 equiv) in THF (0.70 M) to give a yellow suspension. NaH must be added very slowly in order to avoid di-deprotonation, which leads to di-Bn product. The ice bath was removed and the reaction was allowed to warm to room temperature and stirred 60 minutes. Then, the reaction mixture was cooled down to 0 °C again, then freshly distilled benzyl bromide derivative (1.0 equiv) was added dropwise over 10 minutes. The ice bath was removed and the reaction was allowed to warm to room temperature and stirred overnight, then poured on a saturated aqueous solution of ammonium chloride. The allylic alcohol was extracted from the aqueous layer by washing three times with diethyl ether. The combined organic layers were washed with brine, dried over magnesium sulfate, filtered and the volatiles were removed under reduced pressure to obtain a yellow liquid. The residue was purified by flash chromatography (15-40% EtOAc in hexanes) to afford benzyl protected allylic alcohols.

3.2 General procedure B: Zincocyclopropanation with 1.5 equiv of carbenoid

In a flame-dried 20 mL microwave vial, under argon, neat diethylzinc (160 µL, 1.55 mmol, 2.05 equiv) was added to dried zinc iodide (500 mg, 1.55 mmol, 2.05 equiv) and anhydrous diethyl ether (660 µL, 6.30 mmol, 8.25 equiv) in freshly distilled dichloromethane (3.5 mL) at room temperature. Upon observation of full dissolution of the reaction mixture (about 1 hour), the flask was cooled down to 0 °C with a water/ice bath. Allylic alcohol (0.763 mmol, 1.0 equiv) was weighed in a separate flame-dried 5 mL microwave vial, then purged under argon during 5 minutes, then dissolved in freshly distilled dichloromethane (0.5 mL). This solution was added via a cannula to the first vial. After 10 minutes at 0 °C,

the reaction flask was cooled down to –78 °C in a dry ice/acetone bath and distilled bromoform (100 µL, 1.14 mmol, 1.50 equiv) was added to give a pale yellowish suspension. After 30 minutes at –78 °C, the bath was removed, the reaction mixture was stirred 3 hours at room temperature. The reaction flask was cooled down to –78 °C again. In a separate flame-dried 10 mL microwave vial, iodine (970 mg, 3.80 mmol, 5.0 equiv) was weighed and purged under argon, then dissolved in freshly distilled tetrahydrofuran (2.0 mL) and this solution was added via a cannula to the first flask. After 5 minutes, the bath was removed and the reaction mixture was allowed to warm up to room temperature and quenched with aqueous HCl 2.0 M. The cyclopropane was extracted from the aqueous layer by washing with diethyl ether (3×10 mL) and the combined organic layers were washed successively with saturated solution of sodium sulfite and brine, dried over anhydrous magnesium sulfate and filtered. The volatiles were removed under reduced pressure. The residue was purified by flash chromatography (30% ethyl acetate/hexanes or 20% diethyl ether/dichloromethane when incompletion of the reaction) to afford the desired cyclopropanes **1a–f**, **h–j**.

3.3 General procedure C: Zincocyclopropanation with 2.0 equiv of carbenoid

In a flame-dried 20 mL microwave vial, neat diethylzinc (203 µL, 1.98 mmol, 2.6 equiv) was added to dried zinc iodide (633 mg, 1.98 mmol, 2.6 equiv) and anhydrous diethyl ether (833 µL, 7.93 mmol, 10.4 equiv) in dichloromethane (3.5 mL) under argon at room temperature. Upon observation of full dissolution of the reaction mixture (about 1 hour), the flask was cooled down to 0 °C with a water/ice bath. In a separate flame-dried 5 mL microwave vial, allylic alcohol (0.763 mmol, 1.0 equiv) was dissolved in dichloromethane (0.5 mL). This solution was added via a cannula to the first flask. After 10 minutes at 0 °C, the reaction flask was cooled down to –78 °C in a dry ice/acetone bath and freshly distilled bromoform (133 µL, 1.53 mmol, 2.0 equiv) was added to give a yellowish solution. After 30 minutes at that temperature, the bath was removed, the reaction mixture was allowed to warm up to room temperature and stirred 3 hours. The reaction flask was cooled down to –78 °C again. In a separate flame-dried 10 mL microwave vial, iodine (970 mg, 3.81 mmol, 5.0 equiv) was dissolved in tetrahydrofuran (2.0 mL) and this solution was added via a cannula to the first flask. After 5 minutes, the reaction mixture was allowed to warm up to room temperature and quenched with aqueous HCl 2.0 M. The cyclopropane was extracted from the aqueous layer by washing with diethyl ether (3×10 mL) and the combined organic layers were washed successively with saturated solution of sodium sulfate and brine, dried over anhydrous magnesium sulfate and filtered. The volatiles were removed under reduced pressure. The residue was purified by flash chromatography (0–30% ethyl acetate/hexanes or 0-20% diethyl ether/dichloromethane when incompletion of the reaction) to afford the desired cyclopropane **1g**,**k**.

3.4 General procedure D: Cyclization of cyclopropylmethanols

In a flame-dried 20 mL microwave vial, triethylamine (1.1 equiv) was added to iodocyclopropylmethanol **1a-k** (1.0 equiv) in dichloromethane (2.0 mL, 0.30 M) at 0 °C in an ice bath. Then, methanesulfonyl chloride (1.1 equiv) was added. The reaction mixture was allowed to warm up to room temperature, stirred during 60 minutes, then quenched with a saturated solution of sodium bicarbonate. The cyclopropane was extracted from the aqueous layer by washing with dichloromethane (3×5 mL) and the combined organic layers were washed with brine, dried over anhydrous magnesium sulfate and filtered into a 50 mL round bottom flask. The volatiles were removed under reduced pressure. A septum and a magnetic stir bar were added and the flask was purged with argon during 5 minutes. Freshly distilled tetrahydrofuran (0.05 M) was added and the reaction flask was cooled down to –78 °C in a dry ice/acetone bath. Freshly titrated *n*-butyllithium (2.5 M in THF, 2.2 equiv) was added over 15 minutes using a syringe pump (2 mL/h). The reaction flask was stirred at –78 °C during 45 minutes, then the dry ice/acetone bath was removed and the flask was allowed to warm up to room temperature and stirred another 45 minutes. The reaction mixture was quenched with a saturated solution of sodium bicarbonate, the bicyclo[1.1.0]butane was extracted from the aqueous layer by washing with diethyl ether (3×10 mL) and the combined organic layers were washed with brine, dried over anhydrous magnesium sulfate and filtered. The volatiles were carefully removed under reduced pressure to obtain bicyclo[1.1.0]butanes **2a-k**. The residue was used as is for next step or purified by flash chromatography (2% diethyl ether/pentane).

3.5 Scale-up procedure for cyclization of cyclopropylmethanol 2a

In a flame-dried 100 mL round-bottom flask, triethylamine (1.59 mL, 11.4 mmol, 1.1 equiv) was added to iodocyclopropylmethanol **1a** (3.29 g, 10.3 mmol, 1.0 equiv) in dichloromethane (35 mL, 0.30 M) at 0 °C in an ice bath. Then, methanesulfonyl chloride (0.88 mL, 11.4 mmol, 1.1 equiv) was added dropwise. The reaction mixture was allowed to warm up to room temperature, stirred during 60 minutes, then quenched with a saturated solution of sodium bicarbonate. The cyclopropane was extracted from the aqueous layer by washing with dichloromethane (3×20 mL) and the combined organic layers were washed with brine, dried over anhydrous magnesium sulfate and filtered into a 500 mL round bottom flask. The volatiles were removed under reduced pressure. A septum and a magnetic stir bar were added and the flask was purged with argon during 5 minutes. Freshly distilled tetrahydrofuran (200 mL, 0.05 M) was added and the reaction flask was cooled down to –78 °C in a dry ice/acetone bath. Freshly titrated *n*-butyllithium (10.3 mL, 2.2 M in THF, 22.8 mmol, 2.2 equiv) was added over 120 minutes using a syringe pump (5 mL/h, syringe pump addition). The reaction flask was stirred at –78 °C during 45 minutes, then the ice/acetone bath was removed and the flask was allowed to warm up to room temperature and stirred another 45 minutes. The reaction

mixture was quenched with a saturated solution of sodium bicarbonate, the bicyclo[1.1.0]butane was extracted from the aqueous layer by washing with diethyl ether (3×50 mL) and the combined organic layers were washed with brine, dried over anhydrous magnesium sulfate and filtered. The volatiles were carefully removed under reduced pressure to obtain bicyclo[1.1.0]butane **2a** (1.55–1.64 g, 8.90–9.12 mmol, 89–91%). The residue was used as is for next step.

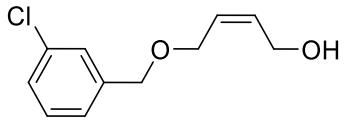
3.6 General procedure E: Ring opening of bicyclo[1.1.0]butanes

In a flame-dried 5 mL microwave vial, pyridinium *p*-toluenesulfonate (0.25 equiv) was added to bicyclo[1.1.0]butanes **2a–k** (1.0 equiv) in methanol (0.40 M) at 0 °C in an ice bath. The reaction mixture was allowed to warm up to room temperature and stirred during 30 minutes. The reaction mixture was quenched with an aqueous saturated solution of sodium bicarbonate, the desired compound was extracted from the aqueous layer by washing with dichloromethane (3×5 mL) and the combined organic layers were washed with brine, dried over anhydrous magnesium sulfate and filtered. The volatiles were removed under reduced pressure and the residue was purified by flash chromatography (0-20% diethyl ether/hexanes) to afford the ring-opened compounds **2a'–k'**.

4. Characterization data

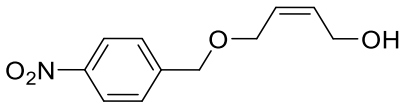
4.1 Characterization data for allylic alcohols S1–S2

(*Z*)-4-((3-Chlorobenzyl)oxy)but-2-en-1-ol (S1)



Allylic alcohol **S1** was synthesized using general procedure A using 40 mmol of 3-chlorobenzyl bromide as the starting material and obtained as a yellow liquid (2.07 g, 72%). **Rf**: 0.19 (30% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.37 (s, 1 H, *o*-Ar), 7.31-7.30 (m, 2 H, Ar), 7.25-7.23 (m, 1 H, Ar), 5.89-5.85 (m, 1 H, =CH), 5.79-5.75 (m, 1 H, =CH), 4.52 (s, 2 H, OC**H$_2$**Ar), 4.23 (t, *J* = 5.7 Hz, 2 H, CH-C**H$_2$**OCH$_2$Ar), 4.13 (dd, *J* = 4.2, 0.55 Hz, 2 H, CH-C**H$_2$**OH), 1.72-1.68 (m, 1 H, O**H**). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 140.0 (**C**q-Cl), 134.4 (**C**q, Ar), 132.5 (=**C**H), 129.8 (=**C**H), 128.2 (**C**H, Ar), 127.9 (**C**H, Ar), 127.8 (**C**H, Ar), 125.7 (**C**H, Ar), 71.6 (O**C**H$_2$Ar), 65.9 (**C**H$_2$OCH$_2$Ar), 58.8 (**C**H$_2$OH). **FTIR** (cm^{-1}) (neat): 3385 br (OH), 2861, 1600, 1576, 1475, 1431, 1206, 1077, 1029, 869, 782, 683, 412. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{11}H_{13}ClO_2$ $[M+Na]^+$: 235.0496; found 235.0502, 236.0531 (3:1 ratio).

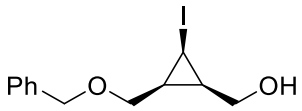
(*Z*)-4-((4-Nitrobenzyl)oxy)but-2-en-1-ol (S2)



Allylic alcohol **S2** was synthesized using general procedure A using 40 mmol of 4-nitrobenzyl bromide as the starting material and obtained as a yellow liquid (818 mg, 27%). **Rf**: 0.16 (30% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 8.23 (m, *J* = 8.7 Hz, 2 H, Ar), 7.53 (m, *J* = 8.7 Hz, 2 H, Ar), 5.91-5.87 (m, 1 H, =CH), 5.81-5.76 (m, 1 H, =CH), 4.65 (s, 2 H, OC**H$_2$**Ar), 4.25 (t, *J* = 5.9 Hz, 2 H, CHC**H$_2$**OCH_2Ar), 4.20 (d, *J* = 6.3 Hz, 2 H, CHC**H**$_2$OH), 1.61 (t, *J* = 5.7 Hz, 1 H, O**H**). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 147.5 (**C**q-NO_2), 145.6 (**C**q, Ar), 132.6 (=**C**H), 127.9 (=**C**H), 127.8 (2×**C**H, Ar), 123.7 (2×**C**H, Ar), 71.1 (O**C**H_2Ar), 66.4 (**C**H_2OCH_2Ar), 58.8 (**C**H_2OH). **FTIR** (cm^{-1}) 3394 br (OH), 2859, 1605, 1517, 1344, 1086, 1015, 847, 738. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{11}H_{13}NO_4$ $[M+H]^+$: 246.0737; found 246.0731.

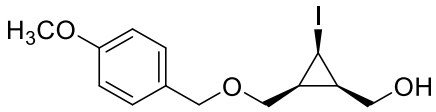
4.2 Characterization data for iodocyclopropanes 1a–f

(±)-((1*R*,2*S*,3*S*)-2-((benzyloxy)methyl)-3-iodocyclopropyl)methanol (1a)



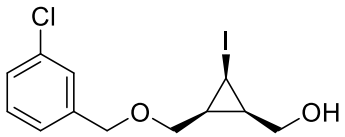
Iodocyclopropane **1a** was synthesized using general procedure B using (*Z*)-4-(benzyloxy)but-2-en-1-ol[5] as the starting material and obtained as a colorless oil (174.5 mg, 86% yield). **Rf**: 0.25 (30% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.41-7.36 (m, 4 H, Ph), 7.36-7.32 (m, 1 H, *p*-Ph), 4.60 (s, 2 H, PhC**H$_2$**O), 3.90-3.82 (m, 2 H, C**H$_2$**OH), 3.62 (dd, *J* = 12.1, 8.7 Hz, 1 H, 1×C**H$_2$**OBn), 3.55 (dd, *J* = 10.4, 9.1 Hz, 1 H, 1×C**H**$_2$OBn), 2.91 (t, *J* = 7.8 Hz, 1 H, C**H**I), 2.41 (br s, 1 H, O**H**), 1.31-1.28 (m, 2 H, 2×C**H**$_{cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 137.4 (**C**q, Ar), 128.6 (2×**C**H, Ar), 128.0 (**C**H, Ar), 128.0 (2×**C**H, Ar), 73.5 (O**C**H_2Ph), 72.2 (**C**H_2OBn), 64.5 (**C**H_2OH), 20.4 (**C**$H_{cyclopropyl}$), 17.5 (**C**$H_{cyclopropyl}$), –4.2 (**C**HI). **FTIR** (cm^{-1}) (neat): 3410 br (OH), 3029, 2862, 1495, 1453, 1370, 1231, 1206, 1069, 1025, 909, 816, 736, 363, 606, 464. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{12}H_{15}IO_2$ $[M+Na]^+$: 341.0009, found 341.0012.

(±)-((1*R*,2*S*,3*S*)-2-Iodo-3-(((4-methoxybenzyl)oxy)methyl)cyclopropyl)methanol (1b)



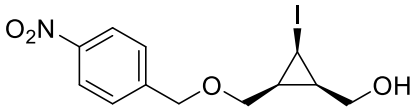
Iodocyclopropane **1b** was synthesized using general procedure B using (*Z*)-4-((4-methoxybenzyl)oxy)but-2-en-1-ol[6] as the starting material and obtained as a yellowish oil (186.3 mg, 70% yield). The characterization data were identical in all respect to those reported in the literature.[6] **Rf**: 0.22 (20% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.29 (dt, *J* = 8.7, 6.6 Hz, 2 H, Ar), 6.89 (dt, *J* = 8.7, 6.6 Hz, 2 H, Ar), 4.53 (d, AB syst, *J* = 14.0 Hz, 1 H, 1×OC**H**$_2$Ar), 4.50 (d, AB syst, *J* = 14.0 Hz, 1H, 1×OC**H**$_2$Ar), 3.88-3.81 (m, 5 H, OC**H**$_3$, C**H**$_2$OH, C**H**$_2$OPMB), 3.60 (ddd, *J* = 11.5, 8.4, 2.7 Hz, 1 H, 1×C**H**$_2$OPMB), 3.52 (dd, *J* = 10.3, 9.2 Hz, 1 H, 1×C**H**$_2$OH), 2.90 (t, *J* = 7.7 Hz, 1 H, C**H**I), 2.65 (dd, *J* = 9.5, 3.4 Hz, 1 H, O**H**), 1.33-1.23 (m, 2 H, 2×C**H**$_{cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 159.5 (**C**qOMe, Ar), 129.7 (2×**C**H, Ar), 129.5 (**C**q, Ar), 114.0 (2×**C**H, Ar), 73.1 (O**C**H$_2$Ar), 71.8 (**C**H$_2$OPMB), 64.5 (**C**H$_2$OH), 55.3 (O**C**H$_3$), 20.3 (**C**H$_{cyclopropyl}$), 17.5 (**C**H$_{cyclopropyl}$), –4.1 (**C**HI). **FTIR** (cm^{-1}) (neat): 3443 br (OH), 2932, 2865, 1612, 1513, 1247, 1175, 1081, 1033, 818. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{13}H_{17}IO_3$ $[M+Na]^+$: 371.0115, found 371.0130.

(±)-((1*R*,2*S*,3*S*)-2-(((3-Chlorobenzyl)oxy)methyl)-3-iodocyclopropyl)methanol (1c)



Iodocyclopropane **1c** was synthesized using general procedure B using (*Z*)-4-((3-chlorobenzyl)oxy)but-2-en-1-ol **S1** as the starting material and obtained as a yellowish oil (203.2 mg, 75% yield). **Rf**: 0.35 (40% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.38 (s, 1 H, *o*-Ar), 7.35-7.29 (m, 2 H, Ar), 7.27-7.25 (m, 1 H, Ar), 4.57 (s, 2 H, OC**H**$_2$Ar), 3.88-3.79 (m, 2 H, C**H**$_2$O), 3.65 (dd, *J* = 12.2, 8.2 Hz, 1 H, 1×C**H**$_2$OH), 3.57 (dd, *J* = 10.3, 8.6 Hz, 1 H, 1×C**H**$_2$O), 2.92 (t, *J* = 7.8 Hz, 1 H, C**H**I), 2.23 (br s, 1 H, O**H**), 1.35-1.26 (m, 2 H, 2×C**H**$_{cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 139.5 (**C**qCl, Ar), 134.5 (**C**q, Ar), 129.9 (**C**H, Ar), 128.1 (**C**H, Ar), 127.9 (**C**H, Ar), 125.8 (**C**H, Ar), 72.6 (O**C**H$_2$Ar), 72.3 (**C**H$_2$OCH$_2$Ar), 64.4 (**C**H$_2$OH), 20.4 (**C**H$_{cyclopropyl}$), 17.6 (**C**H$_{cyclopropyl}$), –4.1 (**C**HI). **FTIR** (cm^{-1}) (neat): 3402 br (OH), 2918, 2866, 1600, 1576, 1475, 1431, 1372, 1232, 1206, 1099, 1076, 1024, 888, 780, 705, 682, 598, 432. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{12}H_{14}ClIO_2$ $[M+NH_4]^+$: 370.0065, found 370.0065.

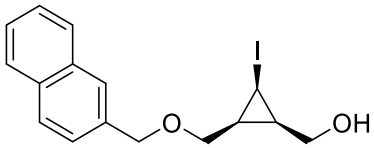
(±)-((1*R*,2*S*,3*S*)-2-Iodo-3-(((4-nitrobenzyl)oxy)methyl)cyclopropyl)methanol (1d)



Iodocyclopropane **1d** was synthesized using general procedure B using (*Z*)-4-((4-nitrobenzyl)oxy)but-2-en-1-ol **S2** as the starting material and obtained as a yellowish oil (183.3 mg, 58% yield). **Rf**: 0.19 (40% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 8.25 (dt, *J* = 8.8, 6.6 Hz, 2 H, Ar), 7.56 (dt, *J* = 8.8, 6.6 Hz, 2 H, Ar), 4.70 (s, 2 H, OC**H$_2$**Ar), 3.85 (ddd, *J* = 10.6, 8.3, 2.9 Hz, 2 H, OC**H$_2$**), 3.69-3.63 (m, 2 H, C**H$_2$**OH), 2.94 (t, *J* = 7.7 Hz, 1 H, C**H**I), 1.61 (s, 1 H, O**H**), 1.33 (tt, *J* = 7.6, 5.0 Hz, 2 H, 2×C**H**$_{cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 147.6 (**C**q-NO_2, Ar), 145.0 (**C**q, Ar), 128.0 (2×**C**H, Ar), 123.8 (2×**C**H, Ar), 72.8 (O**C**H_2Ar), 72.1 (**C**H_2O**C**H_2Ar), 64.4 (**C**H_2OH), 20.4 (**C**H$_{cyclopropyl}$), 17.7 (**C**H$_{cyclopropyl}$), –4.0 (**C**HI). **FTIR** (cm^{-1}) (neat): 3415 br (OH), 2865, 1605, 1518, 1345, 1233, 1091, 1016, 849, 739. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{12}H_{14}NIO_4$ $[M+Na]^+$: 385.9860, found 385.9850.

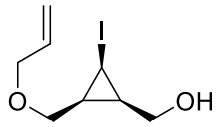
Note: **1d** could not be separated from 2 mol% of 2-(((4-nitrobenzyl)oxy)methyl)cyclopropyl)methanol

(±)-((1*R*,2*S*,3*S*)-2-Iodo-3-((naphthalen-2-ylmethoxy)methyl)cyclopropyl)methanol (1e)



Iodocyclopropane **1e** was synthesized using general procedure B using (*Z*)-4-(naphthalen-2-ylmethoxy)but-2-en-1-ol[7] as the starting material and obtained as yellow crystals (69.4 mg, 25% yield). **mp**.: 54.1-56.6 °C. **Rf**: 0.47 (10% diethyl ether/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.89-7.86 (m, 3 H, Ar), 7.83 (s, 1 H, Ar), 7.54-7.49 (m, 3 H, Ar), 4.76 (s, 2 H, OC**H$_2$**Ar), 3.92-3.89 (m, 1 H, 1×C**H$_2$**OH), 3.86-3.82 (m, 2 H, 1×C**H$_2$**OH), 3.67-3.58 (m, 2 H, OC**H$_2$**CH), 2.91 (t, *J* = 7.8 Hz, 1 H, C**H**I), 2.62 (br s, 1 H, O**H**), 1.32-1.30 (m, 2 H, 2×C**H**$_{cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 134.9 (**C**q, Ar), 133.3 (**C**q, Ar), 133.1 (**C**q, Ar), 128.5 (**C**H, Ar), 127.9 (**C**H, Ar), 127.8 (**C**H, Ar), 126.9 (**C**H, Ar), 126.3 (**C**H, Ar), 126.1 (**C**H, Ar), 125.8 (**C**H, Ar), 73.6 (O**C**H_2-Ar), 72.2 (**C**H_2O**C**H_2Ar), 64.5 (**C**H_2OH), 20.4 (**C**H$_{cyclopropyl}$), 17.6 (**C**H$_{cyclopropyl}$), –4.1 (**C**HI). **FTIR** (cm^{-1}) (neat): 3431 br (OH), 2053, 2864, 1372, 1232, 1123, 1085, 1027, 856, 817, 752, 475. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{16}H_{17}IO_2$ $[M+K]^+$: 406.9905, found 406.9909.

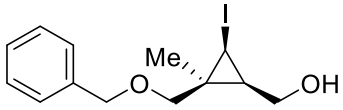
(±)-((1*R*,2*S*,3*S*)-2-((Allyloxy)methyl)-3-iodocyclopropyl)methanol (1f)



Iodocyclopropane **1f** was synthesized using general procedure B using (*Z*)-4-(allyloxy)but-2-en-1-ol[8] as the starting material and obtained as a colorless liquid (135.1 mg, 66% yield). **Rf**: 0.20 (30% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 5.94 (ddt, *J* = 17.2, 10.4, 5.8, Hz, 1 H, C**H**=CH_2), 5.33 (dq, *J* = 17.2, 1.4 Hz, 1 H, 1×CH=C**H**$_2$), 5.25 (dq, *J* = 10.4, 1.4 Hz, 1 H, 1×CH=C**H**$_2$), 4.09 (ddd, *J* = 12.5, 5.7, 1.3 Hz, 1 H, 1×C**H**$_2$CH=CH_2), 4.04 (ddd, *J* = 12.5, 5.7, 1.3 Hz, 1 H, 1×C**H**$_2$CH=CH_2), 3.85 (td, *J* = 10.5, 6.1 Hz, 2 H, C**H**$_2$OH), 3.61 (dd, *J* = 12.2, 8.8 Hz, 1 H, 1×CHC**H**$_2$O), 3.51 (dd, *J* = 10.4, 9.2 Hz, 1 H, 1×CHC**H**$_2$O), 2.91 (t, *J* = 7.8 Hz, 1 H, C**H**I), 2.68 (br s, 1H, O**H**), 1.34-1.23 (m, 2 H, 2×C**H**$_{cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 133.9 (**C**H=CH_2), 118.0 (CH=**C**H_2), 72.15 (O**C**H_2-CH=CH_2), 72.08 (**C**H_2OH), 64.5 (**C**H_2O-allyl), 20.3 (**C**H$_{cyclopropyl}$), 17.4 (**C**H$_{cyclopropyl}$), –4.2 (**C**HI). **FTIR** (cm^{-1}) (neat): 3406 br (OH), 2861, 1416, 1231, 1072, 1019, 924, 594, 558. **HRMS** (ESI, Pos) *m/z*: calcd for $C_8H_{13}IO_2$ $[M+Na]^+$: 290.9852, found 290.9850.

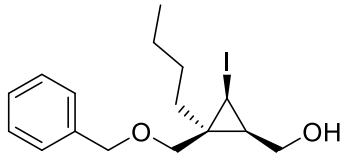
4.3 Characterization data for 2-substituted iodocyclopropanes 1g–h

(±)-((1*R*,2*S*,3*S*)-2-((Benzyloxy)methyl)-3-iodo-2-methylcyclopropyl)methanol (1g)



Iodocyclopropane **1g** was synthesized using general procedure B using (*Z*)-4-(benzyloxy)-3-methylbut-2-en-1-ol[9] as the starting material and obtained as a colorless oil (210.5 mg, 83% yield). **Rf**: 0.41 (30% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.40-7.32 (m, 5 H, Ph), 4.63 (d, *J* = 11.8 Hz, 1 H, 1×OC**H**$_2$Ph), 4.57 (d, *J* = 11.8 Hz, 1 H, 1×OC**H**$_2$Ph), 3.83 (dd, *J* = 12.1, 6.4 Hz, 1 H, 1×C**H**$_2$OH), 3.68 (d, *J* = 10.0 Hz, 1 H, 1×C**H**$_2$OBn), 3.63 (d, *J* = 10.0 Hz, 1 H, 1×C**H**$_2$OBn), 3.54 (dd, *J* = 12.1, 9.3 Hz, 1 H, 1×C**H**$_2$OH), 2.78 (br s, 1 H, O**H**), 2.64 (d, *J* = 7.9 Hz, 1 H, C**H**I), 1.30 (s, 3 H, C**H**$_3$), 1.08 (ddd, *J* = 9.3, 7.9, 6.4 Hz, 1 H, C**H**$_{cyclopropyl}$CH_2OH). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 137.4 (**C**q, Ar), 128.6 (2×**C**H, Ar), 128.0 (**C**H, Ar), 127.9 (2×**C**H, Ar), 76.7 (O**C**H_2Ph), 73.6 (**C**H_2OBn), 65.3 (**C**H_2OH), 28.1 (**C**H$_{cyclopropyl}$), 23.6 (**C**H_3), 22.6 (**C**q), 2.1 (**C**HI). **FTIR** (cm^{-1}) (neat): 3419 br (OH), 3029, 2955, 925, 2901, 2861, 1454, 1414, 1361, 1226, 1087, 1071, 1027, 737, 698, 608. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{13}H_{17}IO_2$ $[M+K]^+$: 370.9905, found 370.9910.

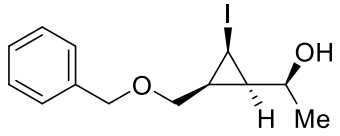
(±)-((1*R*,2*S*,3*S*)-2-((Benzyloxy)methyl)-2-butyl-3-iodocyclopropyl)methanol (1h)



Iodocyclopropane **1h** was synthesized using general procedure C using (*Z*)-3-((benzyloxy)methyl)hept-2-en-1-ol[9] as the starting material and obtained as a yellow oil (236.9 mg, 83% yield). **Rf**: 0.28 (20% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.40-7.34 (m, 5 H, Ph), 4.62 (d, AB syst, *J* = 11.7 Hz, 1 H, 1×OC**H**$_2$Ph), 4.55 (d, AB syst, *J* = 11.7 Hz, 1 H, 1×OC**H**$_2$Ph), 3.83 (ddd, *J* = 12.1, 10.3, 6.4 Hz, 1 H, 1×C**H**$_2$OH), 3.78 (dd, *J* = 10.1, 0.6 Hz, 1 H, 1×C**H**$_2$OBn), 3.56 (dd, *J* = 10.1, 0.6 Hz, 1 H, 1×C**H**$_2$OBn), 3.54 (dt, *J* = 9.2, 2.7 Hz, 1 H, 1×C**H**$_2$OH), 2.84 (dq, *J* = 10.1, 2.3 1 H, O**H**), 2.66 (d, *J* = 8.0 Hz, 1 H, C**H**I), 1.85 (td, *J* = 14.9, 6.9 Hz, 1 H, 1×C**H**$_2$C$_3$H$_7$), 1.37-1.24 (m, 4 H, CH$_2$C**H**$_2$C**H**$_2$CH$_3$), 1.14 (td, *J* = 14.4, 6.9 Hz, 1 H, 1×C**H**$_2$C$_3$H$_7$), 1.06 (ddd, *J* = 9.2, 8.0, 6.4 Hz, 1 H, C**H**$_{cyclopropyl}$CH$_2$OH), 0.90 (t, *J* = 7.3 Hz, 3 H, C**H**$_3$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 137.4 (Cq, Ar), 128.6 (2×CH, Ar), 128.02 (CH, Ar), 128.97 (2×CH, Ar), 74.3 (O**C**H$_2$Ph), 73.5 (**C**H$_2$OH), 65.2 (**C**H$_2$OBn), 37.0 (**C**H$_2$CH$_2$CH$_2$CH$_3$), 28.1 (**C**H$_2$CH$_3$), 27.7 (**C**H$_{cyclopropyl}$), 26.4 (Cq), 22.8 (**C**H$_2$CH$_3$), 14.1 (**C**H$_3$), 1.6 (**C**HI). **FTIR** (cm^{-1}) (neat): 3432 br (OH), 2954, 2927, 2857, 1454, 1364, 1223, 1069, 1027, 735, 697, 609. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{16}H_{23}IO_2$ $[M+Na]^+$: 397.0635, found 397.0649.

4.4 Characterization data for 1-substituted cyclopropyl methanols 1i–k

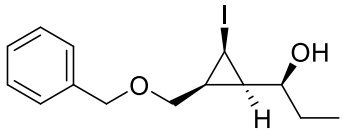
(±)-((1*R*,2*S*,3*R*)-2-((Benzyloxy)methyl)-3-iodocyclopropyl)ethanol (1i)



Iodocyclopropane **1i** as synthesized using general procedure C using (*Z*)-5-(benzyloxy)pent-3-en-2-ol[6] as the starting material and obtained as a colorless oil (185.8 mg, 73% yield). The characterization data were identical in all respect to those reported in the literature.[6] **Rf**: 0.30 (30% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.42-7.38 (m, 4 H, Ph), 7.34-7.32 (m, 1 H, *p*-Ph), 4.60 (d, *J* = 11.8 Hz, 1 H, 1×OC**H**$_2$Ph), 4.55 (d, *J* = 11.8 Hz, 1 H, 1×OC**H**$_2$Ph), 3.69 (dqd, *J* = 9.9, 6.2, 2.6 Hz 1 H, C**H**OH), 3.58 (tt, *J* = 7.5, 6.8 Hz, 2 H, C**H**$_2$OBn), 2.91 (t, *J* = 7.5 Hz, 1 H, C**H**I), 2.05 (d, *J* = 2.6 Hz, 1 H, O**H**), 1.39 (d, *J* =

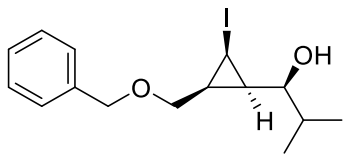
6.2 Hz, 3 H, C**H**$_3$), 1.29 (dq, *J* = 10.2, 7.5 Hz, 1 H, C**H**$_{cyclopropyl}$CH$_2$OBn), 1.02 (td, *J* = 9.9, 7.5 Hz, 1 H, C**H**$_{cyclopropyl}$CHOH). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 137.9 (**C**q, Ar), 128.5 (2×**C**H, Ar), 127.9 (2×**C**H, Ar), 127.8 (**C**H, Ar), 73.4 (O**C**H$_2$Ph), 71.1 (**C**H$_2$OBn), 69.3 (**C**HOH), 26.5 (**C**H$_3$), 22.2 (**C**H$_{cyclopropyl}$), 19.1 (**C**H$_{cyclopropyl}$), –1.7 (**C**HI). **FTIR** (cm^{-1}) (neat): 3427 br (OH), 2970, 2860, 1454, 1371, 1233, 1090, 1028, 940, 738, 698, 608. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{13}H_{17}IO_2N$ $[M+Na]^+$: 355.0165, found 355.0179.

(±)-((1*R*,2*S*,3*R*)-2-((Benzyloxy)methyl)-3-iodocyclopropyl)propan-1-ol (1j)



Iodocyclopropane **1j** was synthesized using general procedure C using (*Z*)-6-(benzyloxy)hex-4-en-3-ol[6] as the starting material and obtained as a colorless oil (179.0 mg, 69% yield). The characterization data were identical in all respect to those reported in the literature.[6] **Rf**: 0.24 (20% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.39-7.38 (m, 4 H, Ar), 7.34-7.32 (m, 1 H, Ar), 4.61 (d, AB syst, *J* = 11.7 Hz, 1 H, 1×OC**H**$_2$Ph), 4.54 (d, AB syst, *J* = 11.7 Hz, 1 H, 1×OC**H**$_2$Ph), 3.63 (dd, *J* = 10.0, 6.5 Hz, 1 H, 1×C**H**$_2$OBn), 3.53 (dd, *J* = 10.0, 7.7 Hz, 1 H, 1×C**H**$_2$OBn), 3.42 (ddd, *J* = 10.0, 7.6, 4.3 Hz, 1 H, C**H**OH), 2.92 (t, *J* = 7.6 Hz, 1 H, C**H**I), 2.03 (br s, 1 H, O**H**), 1.75-1.62 (m, 2 H, C**H$_2$**CH$_3$), 1.29 (dtd, *J* = 10.0, 7.7, 6.5 Hz, 1 H, **C**H$_{cyclopropyl}$CH$_2$OBn), 1.04 (tdq, *J* = 7.6, 5.7, 2.4 Hz, 1 H, **C**H$_{cyclopropyl}$CHOH), 1.02 (t, *J* = 7.3 Hz, 3 H, CH$_2$C**H$_3$**). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 138.0 (**C**q, Ar), 128.5 (2×**C**H, Ar), 127.9 (2×**C**H, Ar), 127.8 (**C**H, Ar), 74.0 (**C**HOH), 73.4 (O**C**H$_2$Ph), 71.2 (**C**H$_2$OBn), 29.3 (**C**H$_2$CH$_3$), 25.2 (**C**H$_{cyclopropyl}$), 19.3 (**C**H$_{cyclopropyl}$), 10.1 (**C**H$_3$), –1.6 (**C**HI). **FTIR** (cm^{-1}) (neat): 3445 br (OH), 2962, 2924, 1496, 1454, 1371, 1233, 1088, 968, 804, 737, 698, 606, 459. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{14}H_{19}IO_2$ $[M+Na]^+$: 369.0322, found 369.0325.

(±)-((1*R*,2*S*,3*R*)-2-((Benzyloxy)methyl)-3-iodocyclopropyl)-2-methylpropan-1-ol (1k)

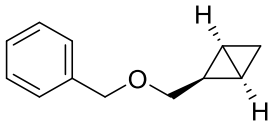


Iodocyclopropane **1k** was synthesized using general procedure C using (*Z*)-6-(benzyloxy)-2-methylhex-4-en-3-ol[6] as the starting material and obtained as a colorless oil (187.5 mg, 68% yield). The characterization

data were identical in all respect to those reported in the literature.[6] **Rf**: 0.34 (30% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.40-7.37 (m, 4 H, Ph), 7.34-7.31 (m, 1 H, *p*-Ph), 4.61 (d, AB syst, *J* = 11.7 Hz, 1 H, 1×OC**H**$_2$Ph), 4.55 (d, AB syst, *J* = 11.7 Hz, 1 H, 1×OC**H**$_2$Ph), 3.69 (dd, *J* = 10.0, 5.7 Hz, 1 H, 1×C**H**$_2$OBn), 3.49 (dd, *J* = 10.0, 8.3 Hz, 1 H, 1×C**H**$_2$OBn), 3.27 (dd, *J* = 10.0, 4.7 Hz, 1 H, C**H**OH), 2.94 (t, *J* = 7.6 Hz, 1 H, C**H**I), 1.99 (br s, 1 H, O**H**), 1.84 (ttd, *J* = 6.9, 6.8, 4.7 Hz, 1 H, C**H**$(CH_3)_3$), 1.31 (dtd, *J* = 10.1, 8.3, 5.7 Hz, 1 H, C**H**$_{cyclopropyl}$$CH_2$OBn), 1.10 (td, *J* = 10.1, 7.7 Hz, 1 H, C**H**$_{cyclopropyl}$CHOH), 1.03 (d, *J* = 6.8 Hz, 3 H, C**H$_3$**), 1.01 (d, *J* = 6.8 Hz, 3 H, C**H$_3$**). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 138.0 (**C**q, Ar), 128.4 (2×**C**H, Ar), 127.9 (2×**C**H, Ar), 127.8 (**C**H, Ar), 76.7 (**C**HOH), 73.5 (**C**H_2OPh), 71.3 (**C**H_2OBn), 33.3 (**C**H$(CH_3)_3$), 23.6 (**C**$H_{cyclopropyl}$), 20.0 (**C**$H_{cyclopropyl}$), 19.4 (**C**H_3), 17.2 (**C**H_3), –1.1 (**C**HI). **FTIR** (cm^{-1}) (neat): 3495, 2959, 2871, 1496, 1367, 1235, 1156, 1091, 1027, 988, 806, 737, 698, 611. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{15}H_{21}IO_2$ $[M+Na]^+$: 383.0478, found 383.0480.

4.5 Characterization data for 2-monosubstituted bicyclo[1.1.0]butanes 2a–f and corresponding ring-opened adducts 2a'–f'

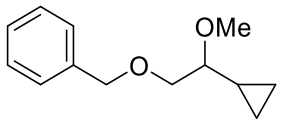
(±)-(1*R*,3*S*)-2-((Benzyloxy)methyl)bicyclo[1.1.0]butane (2a)



Bicyclo[1.1.0]butane **2a** was synthesized using general procedure D using iodocyclopropane **1a** (1.40 g, 4.4 mmol) as the starting material and obtained as a colorless liquid (700.8 mg, 91% yield). The crude was purified by a rapid flash column chromatography (2% diethyl ether/pentane) on silica gel to afford a colorless liquid (290.1 mg, 38% yield). **Rf**: 0.49 (10% diethyl ether/pentane). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.37-7.36 (m, 4 H, Ph), 7.31-7.30 (m, 1 H, *p*-Ph), 4.57 (s, 2 H, OC**H$_2$**Ph), 3.29 (d, *J* = 6.9 Hz, 2 H, C_{BCB}HC**H$_2$**OBn), 2.64 (tt, *J* = 6.9, 3.4 Hz, 1 H, C_{BCB}**H**CH_2O), 1.83 (td, *J* = 3.1, 1.7 Hz, 1 H, 1×C_{BCB}**H**$_2$), 1.57 (td, *J* = 3.6, 1.5 Hz, 2 H, 2×C_{BCB}**H**), 1.41 (d, *J* = 1.7 Hz, 1 H, 1×C_{BCB}**H**$_2$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 138.6 (**C**q, Ph), 128.3 (2×**C**H, Ph), 127.7 (2×**C**H, Ph), 127.5 (**C**H, Ph), 72.6 (O**C**H_2Ph), 63.7 (**C**H_2OBn), 45.8 (C_{BCB}HCH_2OBn), 30.2 (**C**$_{BCB}H_2$), 1.2 (2×**C**$_{BCB}$H). **FTIR** (cm^{-1}) (neat): 3029, 2985, 2904, 2855, 1496, 1454, 1345, 1143, 1075, 1028, 989, 721, 697, 608. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{12}H_{14}O$ $[M+H]^+$: 175.1117, found 175.1117.

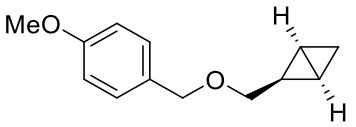
Note: Product is very acid sensitive, volatile and has a short half-life at room temperature. It can be kept at –20 °C under argon for 2-3 days. It decomposes over silica.

((2-Cyclopropyl-2-methoxyethoxy)methyl)benzene (2a')



Cyclopropane **2a'** was synthesized using general procedure E using crude BCB **2a** (139.4 mg, 0.8 mmol) as the starting material. The crude was purified by flash column chromatography on silica gel to afford a colorless liquid (99.3 mg, 54% yield). **Rf**: 0.11 (5% diethyl ether/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.38-7.35 (m, 4 H, Ph), 7.32-7.30 (m, 1 H, *p*-Ph), 4.63 (d, AB syst, *J* = 12.2 Hz, 1 H, 1×OC**H**$_2$Ph), 4.60 (d, AB syst, *J* = 12.2 Hz, 1 H, 1×OC**H**$_2$Ph), 3.65 (dd, *J* = 10.3, 3.3 Hz, 1 H, 1×C**H**$_2$OBn), 3.59 (dd, *J* = 10.3, 6.3 Hz, 1 H, 1×C**H**$_2$OBn), 3.50 (s, 3 H, OC**H**$_3$), 2.74 (ddd, *J* = 8.6, 6.5, 3.3 Hz, 1 H, C**H**OMe), 0.87 (dtt, *J* = 8.6, 5.0, 2.5 Hz, 1 H, C**H**$_{cyclopropyl}$), 0.70-0.63 (m, 1 H, C**H**$_{cyclopropyl}$), 0.51-0.40 (m, 2 H, 2×C**H**$_{cyclopropyl}$), 0.17-0.10 (m, 1 H, C**H**$_{cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 138.5 (**C**q, Ph), 128.4 (2×**C**H, Ph), 127.6 (2×**C**H, Ph), 127.5 (**C**H, Ph), 84.5 (**C**HOMe), 73.4 (O**C**H$_2$Ph), 73.1 (**C**H$_2$OBn), 57.4 (O**C**H$_3$), 11.8 (**C**H$_{cyclopropyl}$), 4.4 (**C**H$_{2cyclopropyl}$), 0.6 (**C**H$_{2cyclopropyl}$). **FTIR** (cm^{-1}) (neat): 3065, 3029, 3005, 2978, 2926, 2893, 2856, 2824, 1454, 1364, 1199, 1097, 1027, 822, 736, 698 **HRMS** (ESI, Pos) *m/z*: calcd for $C_{13}H_{18}O_2$ $[M+Na]^+$: 229.1199, found 229.1203.

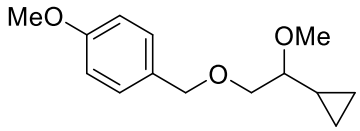
(±)-(1*R*,3*S*)-2-(((4-Methoxybenzyl)oxy)methyl)bicyclo[1.1.0]butane (2b)



Bicyclo[1.1.0]butane **2b** was synthesized using general procedure D, using iodocyclopropane **1b** (97.5 mg, 0.3 mmol) as the starting material and obtained as a colorless liquid (89% yield). The crude was purified by flash column chromatography (2% diethyl ether/pentane) on silica gel to afford a colorless liquid (13.7 mg, 24% yield). **Rf**: 0.44 (5% diethyl ether/pentane). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.29 (dt, *J* = 8.4, 6.6 Hz, 2 H, Ar), 6.89 (dt, *J* = 8.6, 6.6 Hz, 2 H, Ar), 4.49 (s, 2 H, OC**H**$_2$Ar), 3.83 (s, 3 H, OC**H**$_3$), 3.26 (d, *J* = 6.9 Hz, 2 H, C_{BCB}HC**H**$_2$OPMB), 2.63 (tt, *J* = 6.9, 3.4 Hz, 1 H, C_{BCB}**H**CH$_2$O), 1.82 (td, *J* = 3.1, 1.7 Hz, 1 H, 1×C_{BCB}**H**$_2$), 1.56 (td, *J* = 3.2, 1.5 Hz, 2 H, 2×C_{BCB}**H**), 1.40 (q, *J* = 1.4 Hz, 1 H, 1×C_{BCB}**H**$_2$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 159.1 (**C**q-OMe, Ar), 130.7 (**C**q, Ar), 129.3 (2×**C**H, Ar), 113.7 (2×**C**H, Ar), 72.2 (O**C**H$_2$Ar), 63.4 (**C**H$_2$OPMB), 45.8 (O**C**H$_3$), 55.3 (**C**$_{BCB}$HCH$_2$O), 30.2 (**C**$_{BCB}$H$_2$), 1.2 (2×**C**$_{BCB}$H). **FTIR**

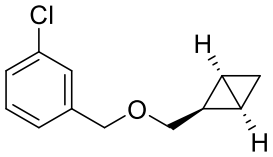
(cm^{-1}) (neat): 2986, 2934, 2906, 2836, 1612, 1512, 1301, 1245, 1173, 1143, 1079, 1035, 819, 721. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{13}H_{16}O_2$ $[M+H]^+$: 205.1223, found 205.1225.

1-((2-Cyclopropyl-2-methoxyethoxy)methyl)-4-methoxybenzene (2b')



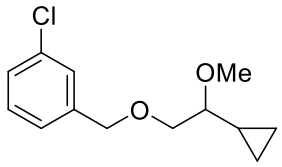
Cyclopropane **2b'** was synthesized using general procedure E using crude BCB **2b** (51.1 mg, 0.2 mmol) as the starting material. The crude was purified by flash column chromatography on silica gel to afford a colorless liquid (27.2 mg, 46% yield). **Rf**: 0.23 (10% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.30 (dt, *J* = 8.8, 6.6 Hz, 2 H, Ar), 6.90 (dt, *J* = 8.4, 6.6 Hz, 2 H, Ar), 4.56 (d, AB syst, *J* = 11.9 Hz, 1 H, 1×OC**H**$_2$Ph), 4.52 (d, AB syst, *J* = 11.9 Hz, 1 H, 1×OC**H**$_2$Ph), 3.83 (s, 3 H, OC**H$_3$**), 3.61 (dd, *J* = 10.3, 3.3 Hz, 1 H, 1×C**H**$_2$OBn), 3.55 (dd, *J* = 10.3, 6.6 Hz, 1 H, 1×C**H**$_2$OBn), 3.49 (s, 3 H, OC**H$_3$**), 2.72 (ddd, *J* = 8.7, 6.6, 3.3 Hz, 1 H, C**H**OMe), 0.90-0.81 (m, 1 H, C**H**$_{cyclopropyl}$), 0.68-0.62 (m, 1 H, C**H**$_{cyclopropyl}$), 0.49-0.39 (m, 2 H, 2×C**H**$_{cyclopropyl}$), 0.16-0.09 (m, 1 H, C**H**$_{cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 159.1 (**C**q, Ar), 130.5 (**C**q, Ar), 129.2 (2×**C**H, Ar), 113.7 (2×**C**H, Ar), 84.5 (**C**HOMe), 73.0 (O**C**H$_2$Ph), 72.8 (**C**H$_2$OBn), 57.3 (O**C**H$_3$), 55.3 (O**C**H$_3$), 11.8 (**C**H$_{cyclopropyl}$), 4.4 (**C**H$_{2cyclopropyl}$), 0.6 (**C**H$_{2cyclopropyl}$). **FTIR** (cm^{-1}) (neat): 3003, 2931, 2896, 2858, 2836, 1613, 1513, 1464, 1363, 1301, 1247, 1173, 1095, 1035, 821. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{14}H_{20}O_3$ $[M+Na]^+$: 259.1305, found 259.1301.

(±)-(1*R*,3*S*)-2-(((3-Chlorobenzyl)oxy)methyl)bicyclo[1.1.0]butane (2c)



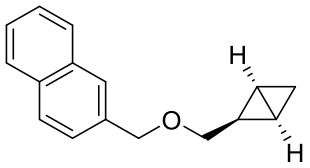
Bicyclo[1.1.0]butane **2c** was synthesized using general procedure D using iodocyclopropane **1c** (211.6 mg, 0.6 mmol) as the starting material, obtained as a colorless liquid (95% yield) and used as is for next step. Yield was determined by ^{1}H-NMR analysis of the crude mixture. Due to instability, only ^{1}H NMR could be obtained. **^{1}H NMR** (400 MHz, $CDCl_3$) δ ppm 7.37 (s, 1 H, Ar), 7.27-7.24 (m, 3 H, Ar), 4.53 (s, 2 H, OC**H$_2$**Ar), 3.29 (d, *J* = 7.0 Hz, 2 H, C_{BCB}HC**H$_2$**OCH$_2$Ar), 2.64 (tt, *J* = 6.9, 3.4 Hz, 1 H, C_{BCB}**H**CH$_2$O), 1.84 (td, *J* = 3.2, 1.8 Hz, 1 H, 1×C_{BCB}**H**$_2$), 1.58 (td, *J* = 3.3, 1.3 Hz, 2 H, 2×C_{BCB}**H**), 1.41-1.40 (m, 1 H, 1×C_{BCB}**H**$_2$).

1-Chloro-3-((2-cyclopropyl-2-methoxyethoxy)methyl)benzene (2c')



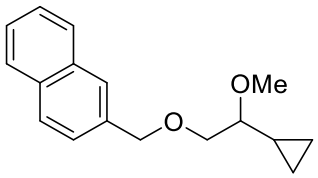
Cyclopropane **2c'** was synthesized using general procedure E using BCB **2c** (0.6 mmol) as the starting material. The crude was purified by flash column chromatography on silica gel to afford colorless liquid (74.3 mg, 46% yield). **Rf**: 0.21 (5% diethyl ether /hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.39 (s, 1 H, Ar), 7.32-7.23 (m, 3 H, Ar), 4.58 (s, 2 H, OC**H**$_2$Ph), 3.65 (dd, *J* = 10.3, 3.2 Hz, 1 H, 1×C**H**$_2$OBn), 3.59 (dd, *J* = 10.3, 6.4 Hz, 1 H, 1×C**H**$_2$OBn), 3.50 (s, 3 H, OC**H**$_3$), 2.74 (dd, *J* = 8.7, 6.4, 3.2Hz, 1 H, C**H**OMe), 0.92-0.83 (m, 1 H, C**H**$_{cyclopropyl}$), 0.71-0.65 (m, 1 H, C**H**$_{cyclopropyl}$), 0.53-0.47 (m, 1 H, C**H**$_{cyclopropyl}$), 0.47-0.41 (m, 1 H, C**H**$_{cyclopropyl}$), 0.18-0.10 (m, 1 H, C**H**$_{cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 140.6 (**C**q, Ar), 134.3 (Cq, Ar), 129.6 (**C**H, Ar), 127.6 (**C**H, Ar), 127.6 (**C**H, Ar), 125.5 (**C**H, Ar), 84.5 (**C**HOMe), 73.3 (O**C**H$_2$Ph), 72.6 (**C**H$_2$OBn), 57.4 (O**C**H$_3$), 11.7 (**C**H$_{cyclopropyl}$), 4.5 (**C**H$_{2cyclopropyl}$), 0.6 (**C**H$_{2cyclopropyl}$). **FTIR** (cm^{-1}) (neat): 3004, 2927, 2894, 2859, 2824, 1600, 1576, 1431, 1359, 1198, 1097, 1022, 948, 868, 779, 682. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{13}H_{17}ClO_2$ $[M+Na]^+$: 263.0809, found 263.0810.

(±)-2-((((1*R*,3*S*)-Bicyclo[1.1.0]butan-2-yl)methoxy)methyl)naphthalene (2e)



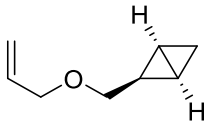
Bicyclo[1.1.0]butane **2e** was synthesized using general procedure D using iodocyclopropane **1e** (220.9 mg, 0.6 mmol) as the starting material, obtained as a colorless liquid (53% yield) and used as is for next step. Yield was determined by ^{1}H-NMR analysis of the crude mixture using triphenylmethane as the internal standard. Due to instability, only ^{1}H NMR could be obtained. **Rf**: 0.51 (10% diethyl ether/hexanes).**^{1}H NMR** (400 MHz, $CDCl_3$) δ ppm 7.86-7.83 (m, 2 H, Ar), 7.81 (s, 1 H, Ar), 7.51-7.48 (m, 2 H, Ar), 7.25-7.23 (m, 1 H, Ar), 7.15-7.13 (m, 1 H, Ar), 4.73 (s, 2 H, OC**H**$_2$Ar), 3.33 (d, *J* = 7.1 Hz, 2 H, C_{BCB}HC**H**$_2$O), 2.64 (tt, *J* = 7.1, 3.3 Hz, 1 H, C_{BCB}**H**CH$_2$O), 1.84-1.82 (m, 1 H, 1×C_{BCB}**H**$_2$), 1.59-1.56 (m, 2 H, 2×C_{BCB}**H**), 1.41 (d, *J* = 1.4, 1 H, 1×C_{BCB}**H**$_2$).

2-((2-Cyclopropyl-2-methoxyethoxy)methyl)naphthalene (2e')



Cyclopropane **2e'** was synthesized using general procedure E using BCB **2e** (80.7 mg, 0.4 mmol) as the starting material. The crude was purified by flash column chromatography on silica gel to afford colorless liquid (81.5 mg, 53% yield). **Rf**: 0.30 (10% diethyl ether /hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.89-7.84 (m, 3 H, Ar), 7.83 (s, 1 H, Ar), 7.57-7.46 (m, 3 H, Ar), 4.80 (d, AB syst, *J* = 12.5 Hz, 1 H, 1×OC**H**$_2$Ph), 4.77 (d, AB syst, *J* = 12.5 Hz, 1 H, 1×OC**H**$_2$Ph), 3.69 (dd, *J* = 10.3, 3.3 Hz, 1 H, 1×C**H**$_2$OBn), 3.64 (dd, *J* = 10.3, 6.5 Hz, 1 H, 1×C**H**$_2$OBn), 3.52 (s, 3 H, OC**H$_3$**), 2.77 (ddd, *J* = 8.7, 6.5, 3.3 Hz, 1 H, C**H**OMe), 0.94-0.85 (m, 1 H, C**H**$_{cyclopropyl}$), 0.71-0.64 (m, 1 H, C**H**$_{cyclopropyl}$), 0.51-0.40 (m, 2 H, 2×C**H**$_{cyclopropyl}$), 0.17-0.10 (m, 1 H, C**H**$_{cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 136.0 (**C**q, Ar), 133.3 (**C**q, Ar), 133.0 (**C**q, Ar), 128.1 (**C**H, Ar), 127.9 (**C**H, Ar), 127.7 (**C**H, Ar), 126.3 (**C**H, Ar), 126.0 (**C**H, Ar), 125.8 (**C**H, Ar), 125.7 (**C**H, Ar), 84.6 (**C**HOMe), 73.5 (O**C**H$_2$Ph), 73.1 (**C**H$_2$OBn), 57.3 (O**C**H$_3$), 11.8 (**C**H$_{cyclopropyl}$), 4.4 (**C**H$_{2cyclopropyl}$), 0.7 (**C**H$_{2cyclopropyl}$). **FTIR** (cm^{-1}) (neat): 3057, 3005, 2926, 2894, 2857, 2825, 1463, 1368, 1342, 1170, 1123, 1095, 1020, 949, 855, 817, 750, 475. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{17}H_{20}O_2$ $[M+NH_4]^+$: 274.1802, found 274.1810.

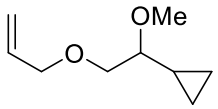
(±)-(1*R*,3*S*)-2-((Allyloxy)methyl)bicyclo[1.1.0]butane (2f)



Bicyclo[1.1.0]butane **2f** was synthesized using modified general procedure D, using iodoyclopropane **1f** (171.6 mg, 0.6 mmol) as the starting material and diethyl ether as the solvent. The desired compound was obtained as an orange liquid (85% yield) and used as is for next step. Yield was determined by ^{1}H-NMR analysis of the crude mixture. Due to instability, only ^{1}H NMR could be obtained. **Rf**: 0.57 (30% ethyl acetate/hexanes). **^{1}H NMR** (400 MHz, $CDCl_3$) δ ppm 5.99-5.89 (m, 1 H, *J* = 17.3, 10.6, 5.8 Hz, CH_2=C**H**), 5.28 (ddt, *J* = 17.3, 2.6, 1.7 Hz, 1 H, 1×=C**H**$_{2(trans)}$), 5.19 (ddt, *J* = 10.6, 2.6, 1.4 Hz, 1 H, 1×=C**H**$_{2(cis)}$), 4.02 (dt, *J* = 5.8, 2.3 Hz, 2 H, OC**H$_2$**CH=CH_2), 3.25 (d, *J* = 7.0 Hz, 2 H, C_{BCB}HC**H$_2$**O-allyl), 2.62 (tt, *J* = 6.9, 3.2

Hz, 1 H, C_{BCB}**H**CH_2O), 1.84-1.83 (m, 1 H, 1×C_{BCB}**H**$_2$), 1.59-1.56 (m, 2 H, 2×C_{BCB}**H**), 1.41 (d, *J* = 1.4, 1 H, 1×C_{BCB}**H**$_2$).

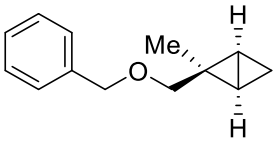
(2-(Allyloxy)-1-methoxyethyl)cyclopropane (2f').



Cyclopropane **2f'** was synthesized using general procedure E and using BCB **2f** (67.6 mg, 0.5 mmol) as the starting material. The crude was purified by flash column chromatography on silica gel to afford a colorless liquid (58.7 mg, 47% yield). **Rf**: 0.34 (10% diethyl ether/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 6.00-5.90 (m, 1 H, C**H**=CH_2), 5.31 (dq, *J* = 17.2, 1.6 Hz, 1 H, 1×CH=C**H**$_{2(trans)}$), 5.21 (dq, *J* = 10.4, 1.4 Hz, 1 H, 1×CH=C**H**$_{2(cis)}$), 4.08-4.05 (m, 2 H, OC**H**$_2$CH=CH_2), 3.61 (dd, *J* = 10.3, 3.2 Hz, 1 H, 1×OC**H**$_2$CHOMe), 3.56 (dd, *J* = 10.3, 6.7 Hz, 1 H, 1×OC**H**$_2$CHOMe), 3.50 (s, 3 H, OC**H**$_3$), 2.72 (ddd, *J* = 8.8, 6.7, 3.2 Hz, 1 H, C**H**OMe), 0.89-0.81 (m, 1 H, C**H**$_{cyclopropyl}$), 0.71-0.63 (m, 1 H, C**H**$_{cyclopropyl}$), 0.53-0.47 (m, 1 H, C**H**$_{cyclopropyl}$), 0.47-0.41 (m, 1 H, C**H**$_{cyclopropyl}$), 0.19-0.12 (m, 1 H, C**H**$_{cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 134.9 (**C**H=CH_2), 117.0 (CH=**C**H_2), 84.5 (O**C**H_2), 73.1 (O**C**H_2CH=CH_2), 72.4 (**C**HOMe), 57.3 (O**C**H_3), 11.7 (**C**$H_{cyclopropyl}$), 4.4 (**C**$H_{2cyclopropyl}$), 0.5 (**C**$H_{2cyclopropyl}$). **FTIR** (cm^{-1}) (neat): 3006, 2979, 2892, 2856, 1464, 1094, 1021, 995, 922, 179.10474 822, 5. **HRMS** (ESI, Pos) *m/z*: calcd for $C_9H_{16}O_2$ $[M+Na]^+$: 179.1043, found 179.1047.

4.6 Characterization data for 2,2-disubstituted bicyclo[1.1.0]butanes 2g–h and ring-opened adducts 2g'–h'

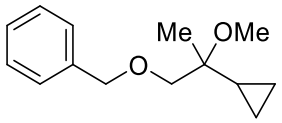
(±)-(1*R*,2*S*,3*S*)-2-((Benzyloxy)methyl)-2-methylbicyclo[1.1.0]butane (2g)



Bicyclo[1.1.0]butane **2g** was synthesized using general procedure D using iodocyclopropane **1g** (149.5 mg, 0.4 mmol) as the starting material, obtained as a colorless liquid (86% yield) and used as is for next step. Yield was determined by ^{1}H-NMR analysis of the crude mixture. Due to instability, only ^{1}H NMR could be obtained. **Rf**: 0.66 (10% diethyl ether/hexanes). **^{1}H NMR** (400 MHz, $CDCl_3$) δ ppm 5.36-5.23 (m, 5 H, Ar),

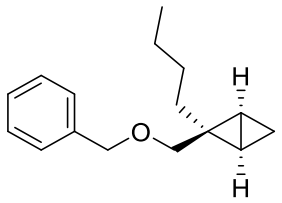
4.57 (s, 2 H, OC**H₂**Ph), 3.27 (s, 2 H, C_{BCB}C**H₂**OBn), 1.79-1.77 (m, 1 H, 1×C_{BCB}**H₂**), 1.36-1.34 (m, 1 H, C_{BCB}**H**), 1.30-1.27 (m, 2 H, 1×C_{BCB}**H₂** and C_{BCB}**H**), 1.25 (s, 3 H, C**H₃**).

((2-Cyclopropyl-2-methoxypropoxy)methyl)benzene (2g').



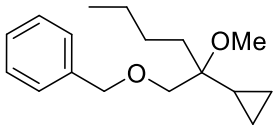
Cyclopropane **2g'** was synthesized using general procedure E using BCB **2g** (72.9 mg, 0.4 mmol) as the starting material. The crude was purified by flash column chromatography on silica gel to afford colorless liquid (74.8 mg, 87% yield). **Rf**: 0.41 (10% diethyl ether/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.41-7.34 (m, 4 H, Ph), 7.32-7.29 (m, 1 H, Ph), 4.62 (s, 2 H, OC**H₂**Ph), 3.46 (d, *J* = 9.8 Hz, 1 H, 1×C**H₂**OBn), 3.39 (d, *J* = 9.8 Hz, 1 H, 1×C**H₂**OBn), 3.35 (s, 3 H, OC**H₃**), 1.06-0.98 (m, 1 H, C**H**$_{cyclopropyl}$), 0.96 (s, 3 H, C**H₃**), 0.55-0.46 (m, 2 H, 2×C**H**$_{cyclopropyl}$), 0.44-0.37 (m, 1 H, C**H**$_{cyclopropyl}$), 0.24-0.17 (m, 1 H, C**H**$_{cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 138.6 (**C**q, Ph), 128.3 (2×**C**H, Ph), 127.5 (2×**C**H, Ph), 127.4 (**C**H, Ph), 76.3 (**C**qOMe), 76.0 (**C**H_2OPh), 73.4 (**C**H_2OBn), 50.2 (O**C**H_3), 16.0 (**C**H_3), 15.8 (**C**H$_{cyclopropyl}$), 1.0 (**C**$H_{2cyclopropyl}$). 0.7 (**C**$H_{2cyclopropyl}$). **FTIR** (cm^{-1}) (neat): 2976, 2937, 2895, 2856, 1202, 1497, 1454, 1365, 1095, 1021, 735, 697. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{14}H_{20}O_2$ $[M+Na]^+$: 243.1355, found 243.1354.

(±)-(1*R*,2*S*,3*S*)-2-((Benzyloxy)methyl)-2-butylbicyclo[1.1.0]butane (2h)



Bicyclo[1.1.0]butane **2h** was synthesized using general procedure D using iodocyclopropane **1h** (224.6 mg, 0.6 mmol) as the starting material, obtained as a colorless liquid (91% yield) and used as is for next step. Due to instability, only ^{1}H NMR could be obtained. **Rf**: 0.67 (10% diethyl ether/hexanes). **^{1}H NMR** (400 MHz, $CDCl_3$) δ ppm 5.37-5.29 (m, 5 H, Ar), 4.56 (s, 2 H, OC**H₂**Ph), 3.27 (s, 2 H, C**H₂**OBn), 1.79-1.78 (m, 1 H, 1×C_{BCB}**H₂**), 1.56-1.53 (m, 2 H, C**H₂**$_{Bu}$), 1.36-1.34 (m, 4 H, 1×C_{BCB}**H₂**, C_{BCB}**H**, C**H₂**$_{Bu}$), 1.28-1.34 (m, 3 H, C**H₂**$_{Bu}$ and C_{BCB}**H**), 0.90 (t, *J* = 7.0 Hz, 3 H, C**H₃**).

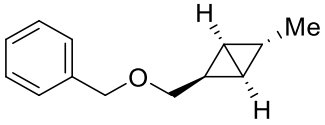
(((2-Cyclopropyl-2-methoxyhexyl)oxy)methyl)benzene (2h')



Cyclopropane **2h'** was synthesized using general procedure E using crude BCB **2h** (0.6 mmol) as the starting material. The crude was purified by flash column chromatography on silica gel to afford a colorless liquid (92.5 mg, 64% yield). **Rf**: 0.41 (10% diethyl ether/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.40-7.34 (m, 4 H, Ph), 7.33-7.29 (m, 1 H, Ph), 4.57 (d, AB syst, *J* = 12.4 Hz, 1 H, 1×OC**H**$_2$Ph), 4.54 (d, AB syst, *J* = 12.4 Hz, 1 H, 1×OC**H**$_2$Ph), 3.39 (d, *J* = 9.7 Hz, 1 H, 1×C**H**$_2$OBn), 3.34 (d, *J* = 9.7 Hz, 1 H, 1×C**H**$_2$OBn), 3.31 (s, 3 H, OC**H**$_3$), 1.61-1.44 (m, 2 H, C**H**$_{2Bu}$), 1.40-1.25 (m, 4 H, C**H**$_{2Bu}$, 2×C**H**$_{2cyclopropyl}$), 0.96-0.89 (m, 4 H, C**H**$_{2Bu,}$ 2×C**H**$_{2cyclopropyl}$), 0.49-0.37 (m, 4 H, C**H**$_{cyclopropyl}$, C**H**$_3$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 138.6 (**C**q, Ph), 128.3 (2×**C**H, Ph), 127.5 (2×**C**H, Ph), 127.4 (**C**H, Ph), 76.6 (**C**qOMe), 73.8 (O**C**H_2Ph), 73.4 (**C**H_2OBn), 50.0 (O**C**H_3), 31.8 (**C**H_{2Bu}), 25.2 (**C**H_{2Bu}), 23.4 (**C**H_{2Bu}), 16.2 (**C**$H_{2cyclopropyl}$), 14.2 (**C**$H_{cyclopropyl}$), 0.7 (**C**$H_{2cyclopropyl}$). **FTIR** (cm^{-1}) (neat): 3008, 2954, 2934, 2860, 1455, 1362, 1206, 1097, 1026, 1097, 1026, 734, 697. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{17}H_{26}O_2$ $[M+Na]^+$: 285.1825, found 285.1831.

4.7 Characterization data for 2,4-disubstituted bicyclo[1.1.0]butanes 2i–k and ring-opened adducts 2i'–k'

(±)-(1*R*,2*S*,3*S*,4*S*)-2-((Benzyloxy)methyl)-4-methylbicyclo[1.1.0]butane (2i)



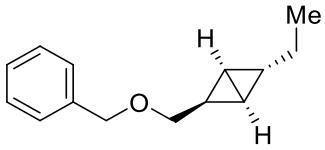
Bicyclo[1.1.0]butane **2i** was synthesized using general procedure D using iodocyclopropane **1i** (199.3 mg, 0.6 mmol) as the starting material, obtained as a colorless liquid used as is for next step. 45% Yield was determined by ^{1}H-NMR analysis of the crude mixture using triphenylmethane as the internal standard. Due to instability, only ^{1}H NMR could be obtained. **Rf**: 0.49 (10% diethyl ether/hexanes). **^{1}H NMR** (400 MHz, $CDCl_3$) δ ppm 7.30-7.23 (m, 5 H, Ph), 4.56 (s, 2 H, OC**H**$_2$Ph), 3.29 (d, *J* = 6.9 Hz, 2 H, C_{BCB}HC**H**$_2$OBn),

2.64 (tt, *J* = 7.1, 3.6 Hz, 1 H, C_{BCB}**H**CH_2OBn), 1.84-1.81 (m, 1 H, C_{BCB}**H**CH_3), 1.37-1.36 (m, 2 H, 2×C_{BCB}**H**), 1.07 (d, *J* = 5.6 Hz, 3 H, C**H₃**).

(±)-((((1*S*,2*R*)-2-(1-Methoxyethyl)cyclopropyl)methoxy)methyl)benzene (2i')

Cyclopropane **2i'** was synthesized using general procedure E using BCB **2i** (0.3 mmol) as the starting material. Diastereoisomeric ratio (1.7:1) was determined by ^{1}H-NMR analysis of the crude mixture. The crude was purified by flash column chromatography on silica gel to afford colorless oil (62.0 mg, 99% yield). *Major diastereoisomer*. **Rf**: 0.25 (10% diethyl ether/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.40-7.34 (m, 4 H, Ph), 7.34-7.29 (m, 1 H, Ph), 4.58 (d, AB syst, *J* = 11.9 Hz, 1 H, 1×OC**H**$_2$Ph), 4.50 (d, AB syst, *J* = 11.9 Hz, 1 H, 1×OC**H**$_2$Ph), 3.65 (dd, *J* = 10.2, 6.5 Hz, 1 H, 1×C**H**$_2$OBn), 3.51-3.44 (m, 1 H, C**H**OMe), 3.41 (dd, *J* = 10.2, 8.4 Hz, 1 H, 1×C**H**$_2$OBn), 3.38 (s, 3 H, OC**H₃**), 1.37 (d, *J* = 6.2 Hz, 3 H, C**H₃**), 1.35-1.25 (m, 1 H, 1×C**H**$_{2cyclopropyl}$), 1.07 (qd, *J* = 8.6, 5.8 Hz, 1 H, C**H**$_{cyclopropyl}$), 0.84 (td, *J* = 8.6, 4.8 Hz, 1 H, C**H**$_{cyclopropyl}$), 0.35 (dd, *J* = 5.6, 4.8 Hz, 1 H, 1×C**H**$_{2cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 138.3 (**C**q, Ph), 128.4 (2×**C**H, Ph), 127.8 (2×**C**H, Ph), 127.6 (**C**H, Ph), 77.4 (**C**HOMe), 72.8 (O**C**H_2Ph), 70.4 (**C**H_2OBn), 56.1 (O**C**H_3), 21.5 (**C**$H_{cyclopropy}$), 20.8 (**C**H_3), 13.9 (**C**$H_{cyclopropyl}$), 9.5 (**C**$H_{2cyclopropy}$). **FTIR** (cm^{-1}) (neat): 2971, 2929, 2859, 2817, 1454, 1372, 1202, 1175, 1091, 1028, 1002, 736, 698. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{14}H_{20}O_2$ $[M+H]^+$: 221.1536, found 221.1526. *Minor diastereoisomer*. **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.40-7.34 (m, 4 H, Ph), 7.34-7.29 (m, 1 H, Ph), 4.58 (s, 2 H, OC**H₂**Ph), 3.77 (dd, *J* = 10.3, 6.2 Hz, 1 H, 1×C**H**$_2$OBn), 3.40 (m, 1 H, 1×C**H**$_2$OBn), 3.31 (s, 3 H, C**H₃**), 2.95 (dt, *J* = 9.0, 6.0, Hz, 1 H, C**H**OMe), 1.28 (d, *J* = 6.0 Hz, 3 H, C**H₃**), 1.35-1.25 (m, 1 H, 1×C**H**$_{2cyclopropyl}$), 1.03 (qd, *J* = 8.7, 5.4 Hz, 1 H, C**H**$_{cyclopropyl}$), 0.85 (td, *J* = 8.7, 4.9 Hz, 1 H, C**H**$_{cyclopropyl}$), 0.14 (dd, *J* = 5.4, 4.9 Hz, 1 H, 1×C**H**$_{2cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) 138.6 (**C**q, Ph), 128.4 (2×**C**H, Ph), 127.7 (2×**C**H, Ph), 127.5 (**C**H, Ph), 76.6 (**C**HOMe), 72.7 (O**C**H_2Ph), 70.3 (**C**H_2OBn), 55.6 (O**C**H_3), 22.1 (**C**$H_{cyclopropyl}$), 19.8 (**C**H_3), 16.3 (**C**$H_{cyclopropyl}$), 7.7 (**C**$H_{2cyclopropyl}$).

(±)-(1*R*,2*S*,3*S*,4*S*)-2-((Benzyloxy)methyl)-4-ethylbicyclo[1.1.0]butane (2j)

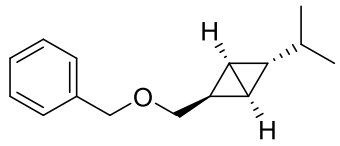


Bicyclo[1.1.0]butane **2j** was synthesized using general procedure D using iodocyclopropane **1j** (198.4 mg, 0.6 mmol) as the starting material, obtained as a colorless liquid and used as is for next step. 48% Yield was determined by ^{1}H-NMR analysis of the crude mixture using triphenylmethane as the internal standard. Due to instability, only ^{1}H NMR could be obtained. **Rf**: 0.51 (10% diethyl ether in hexanes). **^{1}H NMR** (400 MHz, $CDCl_3$) δ ppm 7.30-7.25 (m, 5 H, Ph), 4.56 (s, 2 H, OC**H$_2$**Ph), 3.29 (d, *J* = 7.1 Hz, 2 H, C_{BCB}HC**H$_2$**OBn), 2.54 (tt, *J* = 7.2, 3.4 Hz, 1 H, C_{BCB}**H**CH_2O), 1.84-1.81 (m, 1 H, C_{BCB}**H**Et), 1.40-1.36 (m, 2 H, 2×C_{BCB}**H**), 1.08-1.01 (m, 2 H, C**H$_2$**CH_3), 0.97 (t, *J* = 7.4 Hz, 3 H, C**H$_3$**).

(±)-((((1*S*,2*R*)-2-(1-Methoxypropyl)cyclopropyl)methoxy)methyl)benzene (2j')

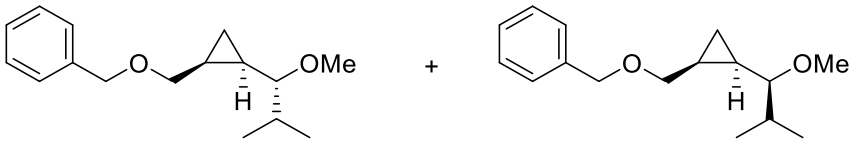
Cyclopropane **2j'** was synthesized using general procedure E using BCB **2j** (0.6 mmol) as the starting material. Diastereoisomeric ratio (1.8:1) was determined by ^{1}H-NMR analysis of the crude mixture using triphenylmethane as internal standard. The crude was purified by flash column chromatography on silica gel to afford colorless oil (55.1 mg, 81% yield). *Major diastereoisomer*. **Rf**: 0.26 (10% diethyl ether /hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.43-7.34 (m, 4 H, Ph), 7.34-7.29 (m, 1 H, Ph), 4.58 (d, AB syst, *J* = 11.8 Hz, 1 H, 1×OC**H$_2$**Ph), 4.51 (d, *J* = 11.8 Hz, 1 H, 1×OC**H$_2$**Ph), 3.50 (dd, *J* = 10.1, 7.0 Hz, 1 H, 1×C**H$_2$**OBn), 3.45 (dd, *J* = 10.1, 7.6 Hz, 1 H, 1×C**H$_2$**OBn), 3.39 (s, 3 H, C**H$_3$**), 2.83-2.76 (m, 1 H, C**H**OMe), 1.68-1.58 (m, 2 H, C**H$_2$**CH_3), 1.35-1.25 (m, 1 H, 1×C**H**$_{2cyclopropyl}$), 1.25-1.17 (m, 1 H, C**H**$_{cyclopropyl}$), 1.00-0.94 (m, 4 H, C**H**$_{cyclopropyl,}$ C**H$_3$**), 0.50-0.42 (m, 1 H, 1×C**H**$_{2cyclopropy}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 138.4 (**C**q, Ph), 128.4 (2×**C**H, Ph), 127.8 (2×**C**H, Ph), 127.6 (**C**H, Ph), 81.9 (**C**HOMe), 72.9 (O**C**H_2Ph), 70.4 (**C**H_2OBn), 56.3 (O**C**H_3), 27.8 (**C**H_2CH_3), 19.3 (**C**H_3), 13.9 (**C**H$_{cyclopropyl}$), 9.5 (**C**H$_{cyclopropyl}$), 9.4 (**C**H$_{2cyclopropyl}$). **FTIR** (cm^{-1}) (neat): 2964, 2928, 2874, 2857, 2857, 2818, 1454, 1375, 1198, 1166, 1077, 1028, 926, 735, 697, 609. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{15}H_{22}O_2$ $[M+Na]^+$: 257.1512, found 257.1510.

(±)-(1*R*,2*S*,3*S*,4*S*)-2-((Benzyloxy)methyl)-4-isopropylbicyclo[1.1.0]butane (2k)



Bicyclo[1.1.0]butane was synthesized using general procedure D using iodocyclopropane **1k** (216.1 mg, 0.6 mmol) as the starting material, obtained as a crude mixture and used as is for next step. 29% Yield was determined by ^{1}H-NMR analysis of the crude mixture using triphenylmethane as the internal standard. Due to instability, only ^{1}H NMR could be obtained. **^{1}H NMR** (400 MHz, $CDCl_3$) δ ppm 7.31-7.24 (m, 5 H, Ph), 4.57 (s, 2 H, 1×OC**H**$_2$Ph), 3.30 (d, *J* = 7.1 Hz, 2 H, C**H**$_2$OBn), 2.53 (tt, *J* = 7.1, 3.7 Hz, 1 H, **C**$_{BCB}$HCH$_2$O), 1.86-1.83 (m, 1 H, C$_{BCB}$**H**CH(CH$_3$)$_2$), 1.41-1.39 (m, 2 H, 2×C$_{BCB}$**H**), 0.98 (d, *J* = 6.7 Hz, 6 H, 2×C**H**$_3$), 0.85 (td, *J* = 8.4, 4.7 Hz, 1 H, C**H**(CH$_3$)$_2$).

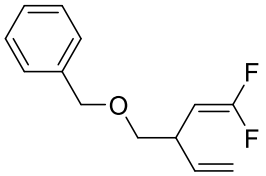
(±)-((((1*S*,2*R*)-2-(1-Methoxy-2-methylpropyl)cyclopropyl)methoxy)methyl)benzene (2k').



Cyclopropane **2k'** was synthesized using general procedure E using BCB **2k** (0.2 mmol) as the starting material. Diastereoisomeric ratio (2.1:1) was determined by ^{1}H-NMR analysis of the crude mixture using triphenylmethane as internal standard. The crude was purified by flash column chromatography on silica gel to afford colorless oil (41.4 mg, 97% yield). **Rf**: 0.24 (10% diethyl ether /hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.42-7.34 (m, 4 H, Ph), 7.34-7.29 (m, 1 H, Ph), 4.58 (d, AB syst, *J* = 11.9 Hz, 1 H, 1×OC**H**$_2$Ph), 4.52 (d, AB syst, *J* = 11.9 Hz, 1 H, 1×OC**H**$_2$Ph), 3.54 (dd, *J* = 10.0, 7.0 Hz, 1 H, 1×C**H**$_2$OBn), 3.42 (dd, *J* = 10.0, 7.5 Hz, 1 H, 1×C**H**$_2$OBn), 3.38 (s, 3 H, OC**H**$_3$), 2.70 (dd, *J* = 8.6, 4.2 Hz, 1 H, C**H**OMe), 1.96-1.87 (m, 1 H, C**H**(CH$_3$)$_2$), 1.24-1.14 (m, 1 H, 1×C**H**$_{2cyclopropyl}$), 1.00-0.94 (m, 8 H, 2×C**H**$_{cyclopropyl}$, 2×C**H**$_3$), 0.48 (ddd, *J* = 9.9, 5.4, 1.1 Hz, 1 H, 1×C**H**$_{2cyclopropyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 138.4 (**C**q, Ph), 128.4 (2×**C**H, Ph), 127.8 (2×**C**H, Ph), 127.6 (**C**H, Ph), 85.0 (**C**HOMe), 72.9 (O**C**H$_2$Ph), 70.6 (**C**H$_2$OBn), 57.1 (O**C**H$_3$), 32.4 (**C**H(CH$_3$)$_3$), 19.1 (**C**H$_3$), 17.6 (**C**H$_3$), 17.0 (**C**H$_{cyclopropyl}$), 14.2 (**C**H$_{cyclopropyl}$), 9.0 (**C**H$_{2cyclopropyl}$). **FTIR** (cm^{-1}) (neat): 2959, 2872, 2818, 1454, 1365, 1197, 1167, 1089, 1028, 967, 735, 697, 609. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{16}H_{24}O_2$ [M+Na]$^+$: 271.1668, found 271.1673.

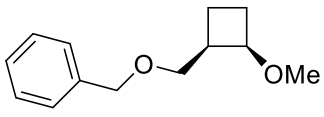
5. Experimental procedures and characterization data of post-functionalized adducts 3–9

(((4,4-Difluoro-2-vinylbut-3-en-1-yl)oxy)methyl)benzene (3)



In a flame-dried 5 mL microwave vial, anhydrous sodium iodide (18.0 mg, 0.120 mmol, 20% mol) was added to bicyclo(1.1.0)butane **2a** (105 mg, 0.600 mmol, 1.0 equiv) in THF (1.5 mL, 0.4 M) to give a yellow solution. Trifluoromethyltrimethylsilane (220 uL, 1.50 mmol, 2.5 equiv) was added dropwise and the reaction mixture stirred at room temperature during 60 minutes. The reaction mixture was filtered over cotton, the volatiles were removed under reduced pressure and the residue was purified by flash chromatography (5% diethyl ether /hexanes) to afford pentadiene **3** as a colorless liquid (45.7 mg, 37% yield). **Rf**: 0.59 (10% diethyl ether/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.40-7.31 (m, 5 H, Ph), 5.85 (ddd, *J* = 17.1, 10.4, 6.3 Hz, 1 H, C**H**=CH_2), 5.17 (dt, *J* = 17.1, 1.4 Hz, 1 H, 1×=C**H**$_2$), 5.14 (dt, *J* = 10.4, 1.3 Hz, 1 H, 1×=C**H**$_2$), 4.57 (s, 2 H, OC**H**$_2$Ph), 4.26 (ddd, *J* = 25.4, 9.6, 2.7 Hz, 1 H, C**H**=CF_2), 3.48 (dd, *J* = 6.2, 0.7 Hz, 2 H, C**H**$_2$OBn), 3.34-3.23 (m, 1 H, C**H**CH_2OBn). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 156.6 (dd, *J* = 288.4, 286.7 Hz, =**C**F_2), 138.2 (C**H**=CH_2), 137.1 (**C**q, Ph), 128.4 (2×**C**H, Ph), 127.7 (**C**H, Ph), 127.6 (2×**C**H, Ph), 115.9 (**C**H_2=CH), 78.2 (dd, *J* = 22.5, 19.7 Hz, **C**H=CF_2), 73.0 (O**C**H_2Ph), 72.9 (t, *J* = 2.2 Hz, **C**H_2CHCH=CF_2), 38.1 (d, *J* = 4.6 Hz, **C**HCH=CF_2). **^{19}F NMR** (471 MHz, $CDCl_3$) δ ppm –87.26 (d, *J* = 43.8 Hz), –89.25 (dd, *J* = 43.8, 25.4 Hz). **FTIR** (cm^{-1}) (neat): 2858, 1743, 1642, 1496, 1454, 1361, 1271, 1186, 1099, 1028, 992, 961, 916, 816, 735, 697, 605, 466. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{13}H_{14}F_2O$ $[M+Ag]^+$: 331.0058, found 331.0049.

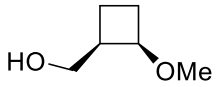
(±)-((((1*R*,2*R*)-2-Methoxycyclobutyl)methoxy)methyl)benzene (4)



At room temperature in a 5 mL microwave vial, mercury (II) acetate (95.6 mg, 0.300 mmol, 1.0 equiv) was added to bicyclo[1.1.0]butane **2a** (52.3 mg, 0.300 mmol, 1.0 equiv) in MeOH (0.5 mL, 0.6 M) to give a yellow suspension. After 30 minutes, TLC showed complete conversion of starting material. Aqueous NaOH 3 M (1.50 mL, 4.50 mmol, 15.0 equiv) was added dropwise to give a grey suspension. The mixture

was stirred during 10 minutes. A solution of sodium borohydride (11.9 mg, 0.315 mmol, 1.05 equiv) in NaOH 3 M (1.5 mL, 4.5 mmol, 15.0 equiv) was added dropwise using a syringe. The mixture was stirred during 30 minutes, then filtered over cotton and rinsed with diethyl ether to remove Hg(s). The cyclobutane was extracted from the aqueous layer by washing with diethyl ether (3×10 mL) and the combined organic layers were washed with brine, dried over magnesium sulfate, filtered and the volatiles were removed under reduced pressure. The residue was purified by flash chromatography (0-10% EtOAc in hexanes) to afford cyclobutane **4** (32.2 mg, 52 %) as a colorless liquid. **Rf**: 0.31 (10% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.40-7.34 (m, 4 H, Ph), 7.31 (dd, *J* = 5.8, 2.9 Hz, 1 H, Ph), 4.59 (d, AB syst, *J* = 12.0 Hz, 1 H, OC**H**$_2$Ph), 4.54 (d, AB syst, *J* = 12.0 Hz, 1 H, OC**H**$_2$Ph), 3.98 (dd, *J* = 7.4, 7.2 Hz, 1 H, C**H**OMe), 3.81 (dd, *J* = 9.4, 7.2 Hz, 1 H, C**H**$_2$OBn), 3.61 (dd, *J* = 9.4, 3.3 Hz, 1 H, C**H**$_2$OBn), 3.28 (s, 3 H, OCH_3), 2.83 (ddd, *J* = 11.0, 7.2, 3.3 Hz, 1 H, C**H**$_{cyclobutyl}$), 2.27-2.20 (m, 1 H, C**H**$_{2cyclobutyl}$), 2.08-1.98 (m, 1 H, C**H**$_{2cyclobutyl}$), 1.81-1.72 (m, 1 H, C**H**$_{2cyclobutyl}$), 1.65-1.57 (m, 1 H, C**H**$_{2cyclobutyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 138.7 (**C**q, Ph), 128.4 (2×**C**H, Ph), 127.7 (2×**C**H, Ph), 127.5 (**C**H, Ph), 75.2 (**C**H$_{cyclobutyl}$OMe), 73.2 (O**C**H$_2$Ph), 69.5 (**C**H$_2$OBn), 56.4 (O**C**H$_3$), 40.3 (**C**H$_{cyclobutyl}$CH$_2$OBn), 27.9 (**C**H$_{2cyclobutyl}$), 17.0 (**C**H$_{2cyclobutyl}$). **FTIR** (cm^{-1}) (neat): 2933, 2862, 1496, 1453, 1362, 1228, 1199, 1125, 1092, 1026, 844, 734, 697, 608, 557, 456. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{13}H_{18}O_2$ $[M+Na]^+$: 229.1199, found 229.1191.

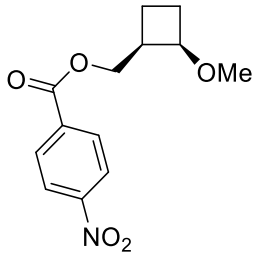
(±)-((1*R*,2*R*)-2-Methoxycyclobutyl)methanol (S3)



At room temperature, in a flame-dried 25 mL round bottom flask, under nitrogen, palladium hydroxide (27.2 mg, 0.194 mmol, 20 wt. % Pd on carbon, wet) was added to cyclobutane **4** (200 mg, 0.970 mmol, 1.0 equiv) in freshly distilled MeOH (19 mL, 0.05 M). A hydrogen balloon was added and H_2 was degassed in the solution for 2 minutes, then the exit was removed and the balloon was left during the reaction. The mixture was stirred at room temperature during 15 hours, then filtered over a 1:1 ratio of celite/silica and rinsed with diethyl ether. The volatiles were carefully removed under reduced pressure (careful volatile product). The residue was purified by flash chromatography (30% diethyl ether/petroleum ether) to afford cyclobutyl methanol **S3** (106 mg, 72 %) as a colorless liquid. **Rf**: 0.17 (30% ethyl acetate/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 4.07 (ddd, J_1 = J_2 = J_3 = 7.3 Hz, 1 H, C**H**OMe), 3.97 (dd, *J* = 11.3, 8.9 Hz, 1 H, C**H**$_2$OH), 3.73 (dd, *J* = 11.3, 5.0 Hz, 1 H, C**H**$_2$OH), 3.27 (s, 3 H, OCH_3), 2.75 (td, *J* = 7.8, 3.4 Hz, 1 H, C**H**CH$_2$O), 2.52 (br s, 1 H, O**H**), 2.31-2.20 (m, 1 H, 1×C**H**$_{2cyclobutyl}$COMe), 2.13-2.00 (m, 1 H, 1×C**H**$_{2cyclobutyl}$COMe), 1.73 (dq, *J* = 11.6, 8.8 Hz, 1 H, 1×C**H**$_{2cyclobutyl}$), 1.53 (ddt, *J* = 11.6, 10.8, 3.3 Hz, 1 H,

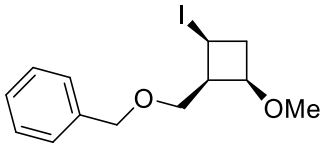
1×C**H**$_{2cyclobutyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 76.1 (**C**HOCH$_3$), 63.4 (**C**H$_2$OH), 55.7 (O**C**H$_3$), 41.4 (**C**H$_{cyclobutyl}$), 27.6 (**C**H$_{2cyclobutyl}$CHOCH$_3$), 15.3 (**C**H$_{2cyclobutyl}$). **FTIR** (cm^{-1}) (neat): 3407, 2937, 2874, 2826, 1454, 1358, 1194, 1120, 1015, 883, 834, 759, 561. **HRMS** (ESI, Pos) *m/z*: calcd for $C_6H_{12}O_2$ [M+Na]$^+$: 139.0729, found 139.0727.

(±)-((1*R*,2*R*)-2-Methoxycyclobutyl)methyl 4-nitrobenzoate (5)



Under nitrogen, in a flame-dried 5 mL microwave vial, freshly distilled triethylamine (83.7 uL, 0.600 mmol, 1.5 equiv), then DMAP (catalytic amount) were added to cyclobutyl methanol **S3** (46.5 mg, 0.400 mmol, 1.0 equiv) in CH_2Cl_2 (0.5 mL, 0.80 M). The reaction mixture was cooled down to 0 °C in an ice bath, 4-nitrobenzoyl chloride (111 mg, 0.600 mmol, 1.5 equiv) in CH_2Cl_2 (0.2 mL) was added with a syringe and the reaction was stirred at room temperature during 30 minutes. The reaction mixture was quenched with saturated aqueous solution of $NaHCO_3$ and the cyclobutane was extracted from the aqueous layer by washing with diethyl ether (3×5 mL). The combined organic layers were washed with brine, dried over magnesium sulfate, filtered and the volatiles were removed under reduced pressure. The residue was purified by flash chromatography (10% diethyl ether in hexanes) to afford cyclobutane **5** (65.8 mg, 62%) as a yellow solid. **mp**: 37-39 °C. **Rf**: 0.13 (10% diethyl ether in hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 8.31 (dt, J = 8.9, 6.8 Hz, 2 H, Ar), 8.23 (dt, J = 8.9, 6.8 Hz, 2 H, Ar), 4.68 (dd, AB syst. J = 11.3, 7.2 Hz, 1 H, C**H**$_2$O), 4.55 (dd, AB syst, J = 11.3, 7.8 Hz, 1 H, C**H**$_2$O), 4.05 (ddd, $J_1 = J_2 = J_3$ = 7.3 Hz, 1 H, C**H**OMe), 3.29 (s, 3 H, OC**H**$_3$), 2.99 (dt, J = 7.3, 3.9 Hz, 1 H, C**H**CH$_2$O), 2.36-2.27 (m, 1 H, C**H**$_{2cyclobutyl}$CO), 2.21-2.11 (m, 1 H, C**H**$_{2cyclobutyl}$CO), 1.86 (tdt, J = 11.7, 9.0, 8.5, Hz, 1 H, C**H**$_{2cyclobutyl}$), 1.71 (ttd, J = 11.3, 3.5, 0.1 Hz, 1 H, C**H**$_{2cyclobutyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 164.9 (Ar**C**OO), 150.5 (**C**q-NO$_2$, Ar), 135.9 (**C**q, Ar), 130.7 (2×**C**H, Ar), 123.5 (2×**C**H, Ar), 74.8 (**C**HOMe), 65.2 (**C**H$_2$OCO), 56.4 (O**C**H$_3$), 39.1 (**C**HCH$_2$O), 27.9 (**C**H$_{2cyclobutyl}$CO), 16.6 (**C**H$_{2cyclobutyl}$). **FTIR** (cm^{-1}) (neat): 2933, 1722, 1607, 1527, 1457, 1348, 1270, 1199, 1118, 1102, 1040, 1014, 957, 873, 852, 784. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{13}H_{15}NO_5$ [M+H]$^+$: 266.1023, found 266.1021.

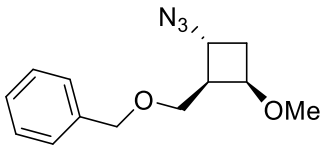
(±)-((((1*R*,2*R*,4*R*)-2-iodo-4-methoxycyclobutyl)methoxy)methyl)benzene (6)



In a flame-dried 5 mL microwave vial, a fresh solution of recrystallized *N*-iodosuccinimide (0.9 mL, 1 M in distilled THF, 1.1 equiv) was added to crude 2-((benzyloxy)methyl)bicyclo[1.1.0]butane **2a** (139 mg, 0.8 mmol, 1.0 equiv) in methanol (4 mL, 0.20 M) at room temperature and the reaction mixture was stirred during 30 minutes. The reaction mixture was quenched with a saturated solution of sodium bicarbonate and the cyclobutane was extracted from the aqueous layer by washing with diethyl ether (3×5 mL). The combined organic layers were washed successively with saturated solution of sodium sulfate and brine, dried over anhydrous magnesium sulfate and filtered. The volatiles were removed under reduced pressure and the residue was purified by flash chromatography (0-5% diethyl ether/hexanes) to afford iodocyclobutane **6** as a single diastereoisomer and a colorless liquid (205.1 mg, 77% yield). **Rf:** 0.63 (10% diethyl ether/hexanes). **^{1}H NMR** (500 MHz, $CDCl_3$) δ ppm 7.44-7.40 (m, 2 H, *o*-Ph), 7.37 (dd, *J* = 7.2, 1.8 Hz, 2 H, *m*-Ph), 7.31 (tt, *J* = 7.2, 1.1 Hz, 1 H, *p*-Ph), 4.65 (d, AB syst, *J* = 11.6 Hz, 1 H, OC**H**$_2$Ph), 4.58 (d, AB syst, *J* = 11.6 Hz, 1 H, OC**H**$_2$Ph), 4.25 (dt, *J* = 9.6, 7.8 Hz, 1 H, C**H**I), 4.00 (dd, *J* = 13.9, 6.8 Hz, 1 H, C**H**OMe), 3.92 (dd, *J* = 9.7, 7.1 Hz, 1 H, C**H**$_2$OBn), 3.67 (dd, *J* = 9.7, 6.3 Hz, 1 H, C**H**$_2$OBn), 3.31 (s, 3 H, OC**H**$_3$), 3.06-2.93 (m, 2 H, C**H**$_{cyclobutyl}$CH$_2$OBn, 1×C**H**$_{2cyclobutyl}$), 2.60-2.53 (m, 1 H, 1×C**H**$_{2cyclobutyl}$). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 138.4 (**C**q, Ph), 128.4 (2×**C**H, Ph), 127.9 (2×**C**H, Ph), 127.6 (**C**H, Ph), 74.2 (**C**H$_{cyclobutyl}$OMe), 73.5 (O**C**H$_2$Ph), 72.2 (**C**H$_2$OBn), 57.1 (O**C**H$_3$), 46.0 (**C**H$_{cyclobutyl}$), 42.8 (**C**H$_{2cyclobutyl}$), 11.7 (**C**HI). **FTIR** (cm^{-1}) (neat): 2983, 2933, 2879, 2860, 2829, 1496, 1453, 1363, 1217, 1114, 1029, 834, 737, 698. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{13}H_{17}IO_2$ $[M+Na]^+$: 355.0165, found 355.0167.

Note: NIS must be free of HI and freshly recrystallized from dioxane/CCl_4.

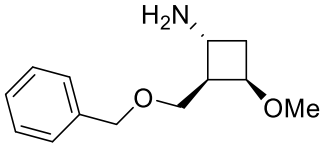
(±)-((((1*R*,2*S*,4*R*)-2-Azido-4-methoxycyclobutyl)methoxy)methyl)benzene (7)



In a flame-dried 10 mL round bottom flask, sodium azide (173 mg, 2.5 mmol, 2.5 equiv) was added to iodocyclobutane **6** (332 mg, 1.0 mmol, 1.0 equiv) in DMF (5 mL, 0.2 M) under argon. The reaction mixture

was heated to 80 °C in an oil bath and stirred during 18 hours. The mixture was allowed to cool down to room temperature, then water (5 mL) was added. The cyclobutane was extracted from the aqueous layer by washing with diethyl ether (3×5 mL) and the combined organic layers were washed with brine, dried over magnesium sulfate, filtered and the volatiles were removed under reduced pressure to afford cyclobutylazide **7** as a yellow liquid (240.2 mg, 97%), which was used without purification for next step. **Rf**: 0.30 (10% ethyl acetate/hexanes). **^{1}H NMR** (500 Hz, $CDCl_3$) δ ppm 7.38-7.37 (m, 4 H, Ph), 7.33-7.31 (m, 1 H, *p*-Ph), 4.57 (d, *J* = 18.0 Hz, 1 H, 1×OC**H$_2$**Ph), 4.55 (dd, *J* = 18.0 Hz, 1 H, 1×OC**H$_2$**Ph), 4.04 (td, *J* = 7.6, 2.7, 1 H, $C_{cyclobutyl}$**H**N_3), 3.87 (dd, *J* = 14.8, 7.2 Hz, 1 H, $C_{cyclobutyl}$**H**OMe), 3.74 (dd, *J* = 9.6, 7.6 Hz, 1 H, 1×C**H$_2$**OBn), 3.59 (dd, *J* = 9.7, 7.2 Hz, 1 H, 1×C**H$_2$**OBn), 3.28 (s, 3 H, OC**H$_3$**), 2.80 (quintt, *J* = 7.2, 0.9 Hz, 1 H, $C_{cyclobutyl}$**H**CH_2OBn), 2.33 (dddd, *J* = 12.8, 8.2, 2.8, 0.6 Hz, 1 H, 1×$C_{cyclobutyl}$**H$_2$**), 2.16 (dtd, *J* = 13.5, 6.8, 1.7 Hz, 1 H, 1×$C_{cyclobutyl}$**H$_2$**). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 138.3 (**C**q, Ph), 128.4 (2×**C**H, Ph), 127.7 (2×**C**H, Ph), 127.6 (**C**H, *p*-Ph), 73.2 (O**C**H_2Ph), 72.7 (**C**$_{cyclobutyl}$$HN_3$), 66.9 (**C**$H_2$OBn), 56.8 (O**C**$H_3$), 56.3 (**C**$_{cyclobutyl}$HOMe), 47.5 (**C**$_{cyclobutyl}$$HCH_2$OBn), 33.3 (**C**$_{cyclobutyl}$$H_2$). **FTIR** ($cm^{-1}$) (neat): 2930, 2097 (N=N=N), 1496, 1454, 1365, 1341, 1261, 1216, 1097, 1028, 737, 698, 605, 469. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{13}H_{17}N_3O_2$ $[M+Ag]^+$: 354.0366, found 354.0358.

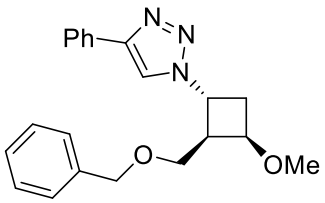
(±)-(1*S*,2*R*,3*R*)-2-((Benzyloxy)methyl)-3-methoxycyclobutan-1-amine (8)



In a 10 mL round bottom flask, triphenylphosphine (315 mg, 1.20 mmol, 2.0 equiv), then hydrochloric acid 5 M (2.52 mL, 12.6 mmol, 20.0 equiv) were successively added to cyclobutylazide **7** (148 mg, 0.600 mmol, 1.0 equiv) in THF (2.00 mL) at room temperature. After 2 hours, saturated Na_2CO_3 (aq) was added and the cyclobutane was extracted from the aqueous layer by washing with ethyl acetate (3×5 mL). Combined organic layers were washed with brine, dried over magnesium sulfate, filtered and the volatiles were removed under reduced pressure. The residue was purified by flash chromatography (5% MeOH/CH_2Cl_2) to afford aminocyclobutane **8** (85.5 mg, 64%) as a brown oil. **Rf**: 0.30 (10% MeOH/CH_2Cl_2). **^{1}H NMR** (500 Hz, $CDCl_3$) δ ppm 7.38-7.35 (m, 4 H, Ph), 7.32-7.30 (m, 1 H, *p*-Ph), 4.56 (d, *J* = 17.2 Hz, 1 H, 1×C**H$_2$**Ph), 4.53 (d, *J* = 17.2 Hz, 1 H, 1×C**H$_2$**Ph), 4.02 (td, *J* = 6.4, 2.4 Hz, 1 H, $C_{cyclobutyl}$**H**N) 3.74 (td, *J* = 8.3, 0.9 Hz, 1 H, C**H$_2$**OBn), 3.60 (dd, *J* = 9.6, 7.0 Hz, 1 H, $C_{cyclobutyl}$**H**OMe), 3.28 (s, 3 H, OC**H$_3$**), 2.47 (ddt, *J* = 6.9, 6.8, 6.7 Hz, 1 H, $C_{cyclobutyl}$**H**CH_2OBn), 2.32-2.27 (m, 1 H, 1×$C_{cyclobutyl}$**H$_2$**), 2.05 (br s, 2 H, N**H$_2$**) 1.88 (dt, *J* = 13.1, 6.9 Hz, 1 H, 1×$C_{cyclobutyl}$**H$_2$**). **^{13}C NMR** (126 MHz, CD_3OD) δ ppm 138.2 (**C**q, Ph), 128.0 (2×**C**H, Ph), 127.3

(2×**C**H, Ph), 127.4 (**C**H, *p*-Ph), 72.6 (O**C**H_2Bn), 72.5 (**C**H-N), 66.8 (**C**H_2OBn), 55.7 (O**C**H_3), 47.6 (**C**$H_{cyclobutyl}$-CH_2OBn), 33.1 (**C**$_{cyclobutyl}H_2$). **FTIR** (cm^{-1}) (neat): 2926, 2856, 1454, 1365, 1100, 1074, 740, 699, 459. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{13}H_{19}NO_2$ $[M+H]^+$: 222.1489, found 222.1492.

(±)-1-((1*S*,2*R*,3*R*)-2-((Benzyloxy)methyl)-3-methoxycyclobutyl)-4-phenyl-1H-1,2,3-triazole (9)

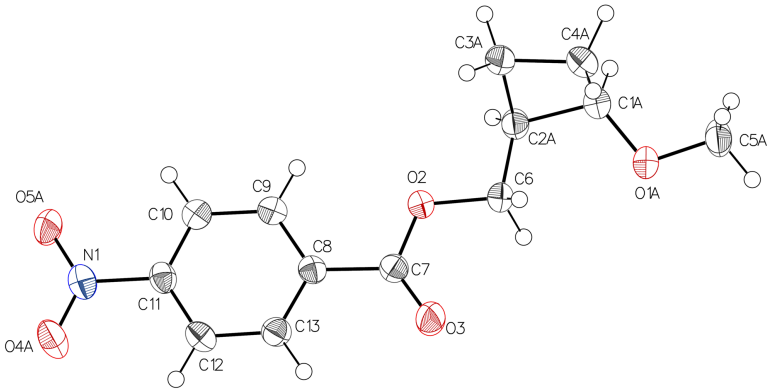


In a 5 mL flame-dried microwave vial, copper (I) iodide (5.01 mg, 0.025 mmol, 25 mol%) was added to cyclobutylazide **7** (24.7 mg, 0.100 mmol, 1.0 equiv) in THF (1.00 mL, 0.10 M) to give a white suspension. Triethylamine (0.03 mL, 0.200 mmol, 2.0 equiv) and phenylacetylene (0.02 mL, 0.150 mmol, 1.5 equiv) were successively added and the reaction mixture turned yellow. The reaction mixture was stirred at room temperature during 18 hours. The mixture was filtered over celite, rinsed with CH_2Cl_2 and the volatiles were removed under reduced pressure. The residue was purified by flash chromatography (20% EtOAc in hexanes) to afford cyclobutane **9** (31.9 mg, 91%) as white needles. **mp**. 62.7-63.1 °C. **Rf**: 0.25 (30% ethyl acetate/hexanes). **^{1}H NMR** (500 Hz, $CDCl_3$) δ ppm 7.85 (s, 1 H, $C_{triazole}$**H**), 7.77 (dt, *J* = 7.1, 5.5 Hz, 2 H, Ph), 7.43 (tt *J* = 7.3, 1.6 Hz, 3 H, Ph) 7.36-7.32 (m, 6 H, Ph), 4.96 (ddd, $J_1 = J_2 = J_3$ = 7.8 Hz, 1 H, $C_{cyclobutyl}$**H**OMe), 4.55 (s, 2H, OC**H$_2$**Ph), 4.24 (td, *J* = 6.5, 2.3 Hz, 1 H, $C_{cyclobutyl}$**H**N), 3.87 (dd, *J* = 9.9, 6.8 Hz, 1 H, 1×C**H**$_2$OBn), 3.82 (dd, *J* = 9.9, 6.8 Hz, 1 H, 1×C**H**$_2$OBn), 3.37 (s, 3H, OC**H$_3$**), 3.27 (quintt, *J* = 7.4, 1.0 Hz, 1 H, $C_{cyclobutyl}$**H**-CH_2OBn), 2.94 (quintt, *J* = 6.5, 1.3 Hz, 1 H, 1×$C_{cyclobutyl}$**H$_2$**), 2.70 (dddd, *J* = 13.1, 8.7, 2.2, 0.5 Hz, 1 H, 1×$C_{cyclobutyl}$**H$_2$**). **^{13}C NMR** (126 MHz, $CDCl_3$) δ ppm 147.6 (**C**$q_{triazole}$-Ph), 138.1 (**C**q, Ar), 130.7 (**C**q, Ar), 128.8 (2×**C**H, Ph), 128.5 (2×**C**H, Ph), 128.0 (**C**H, Ph), 127.8 (2×**C**H, Ph), 125.7 (2×**C**H, Ph), 119.6 (**C**$_{triazole}$H), 73.3 (O**C**H_2Ph), 73.0 (**C**HN), 67.3 (**C**H_2OBn), 56.9 (**C**$_{cyclobutyl}$HOMe), 55.9 (O**C**H_3), 48.1 (**C**$_{cyclobutyl}$HCH_2OBn), 33.4 (**C**$_{cyclobutyl}H_2$). **FTIR** (cm^{-1}) (neat): 3031, 2927, 1455, 1347, 1212, 1112, 1075, 1028, 974, 820, 695, 515, 461. **HRMS** (ESI, Pos) *m/z*: calcd for $C_{21}H_{23}N_3O_2$ $[M+H]^+$: 350.1863, found 350.1848.

6. X-ray crystallographic data for cyclobutanes 5 and 9

The data for cyclobutane **5** cha240(2), crystallized from diethyl ether/hexanes, were collected from a shock-cooled single crystal at 100 K on a Bruker Smart APEX three-circle diffractometer with a Microfocus

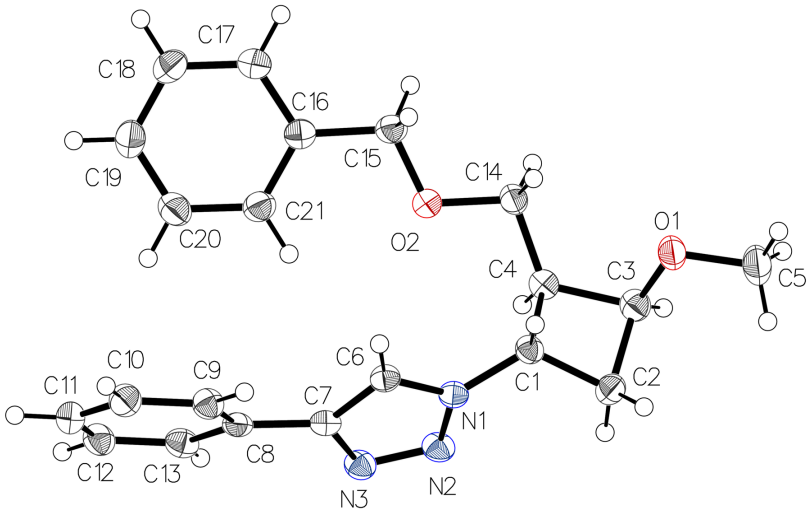
Source using Quazar MX Mirror Optics as monochromator and a Bruker APEX2 CCD detector. The diffractometer was equipped with an Oxford Cryostream 700 low temperature device and used Cu Kα radiation (λ = 1.54178 Å). All data were integrated with *SAINT* and a multi-scan absorption correction using *SADABS* was applied.[10] The structure was solved by dual methods using XT and refined by full-matrix least-squares methods against F^2 by *XL*.[11,12] Structure solution and refinement cycles were performed within the graphical user interface of *OLEX2*.[13] All non-hydrogen atoms were refined with anisotropic displacement parameters. The hydrogen atoms were refined isotropically on calculated positions using a riding model with their U_{iso} values constrained to 1.5 times the U_{eq} of their pivot atoms for terminal sp^3 carbon atoms and 1.2 times for all other carbon atoms. Disordered moieties were refined using bond lengths restraints while for the displacement parameter the refinement used a combination of restraints and constraints. This report and the CIF file were generated using FinalCif.



CCDC deposition number	2116653
Empirical formula	$C_{13}H_{15}NO_5$
Formula weight	265.26
Temperature [K]	100
Crystal system	monoclinic
Space group (number)	$P2_1/n$ (14)
a [Å]	6.27910(10)
b [Å]	26.4160(6)
c [Å]	8.3767(2)
α [°]	90
β [°]	109.284(1)
γ [°]	90
Volume [Å^3]	1311.48(5)
Z	4
ϱ_{calc} [gcm^{-3}]	1.343
μ [mm^{-1}]	0.876
F(000)	560
Crystal size [mm^3]	0.31×0.15×0.09
Crystal color	clear light colorless
Crystal shape	Plate

Radiation	Cu K_α (λ=1.54178 Å)
2θ range [°]	6.69 to 144.20 (0.81 Å)
Index ranges	-7 ≤ h ≤ 7
	-32 ≤ k ≤ 32
	-10 ≤ l ≤ 10
Reflections collected	18080
Independent reflections	2574
	R_{int} = 0.0326
	R_{sigma} = 0.0175
Completeness to θ = 67.679°	99.9 %
Data / Restraints / Parameters	2574/182/230
Goodness-of-fit on F^2	1.084
Final R indexes	R_1 = 0.0494
[I≥2σ(I)]	wR_2 = 0.1235
Final R indexes	R_1 = 0.0516
[all data]	wR_2 = 0.1250
Largest peak/hole [eÅ^{-3}]	0.36/-0.28

The data for cyclobutane **9** cha256(2), crystallized from diethyl ether/hexanes, were collected from a shock-cooled single crystal at 150 K on a Bruker Venture Metaljet κ-geometry diffractometer with a Metal Jet using Helios MX Mirror Optics as monochromator and a Bruker CMOS Photon III detector. The diffractometer was equipped with an Oxford Cryostream 700 low temperature device and used Ga Kα radiation (λ = 1.34139 Å). All data were integrated with *SAINT* (2020) and a multi-scan absorption correction using *SADABS* 2016/2 was applied.[10] The structure was solved by dual methods with XT and refined by full-matrix least-squares methods against F^2 using XL.[11,12] Structure solution and refinement cycles were performed within the graphical user interface of *OLEX2*.[13] All non-hydrogen atoms were refined with anisotropic displacement parameters. The hydrogen atoms were refined isotropically on calculated positions using a riding model with their U_{iso} values constrained to 1.5 times the U_{eq} of their pivot atoms for terminal sp^3 carbon atoms and 1.2 times for all other carbon atoms. Crystallographic data for the structures reported in this paper have been deposited with the Cambridge Crystallographic Data Centre.[13] This report and the CIF file were generated using FinalCif.



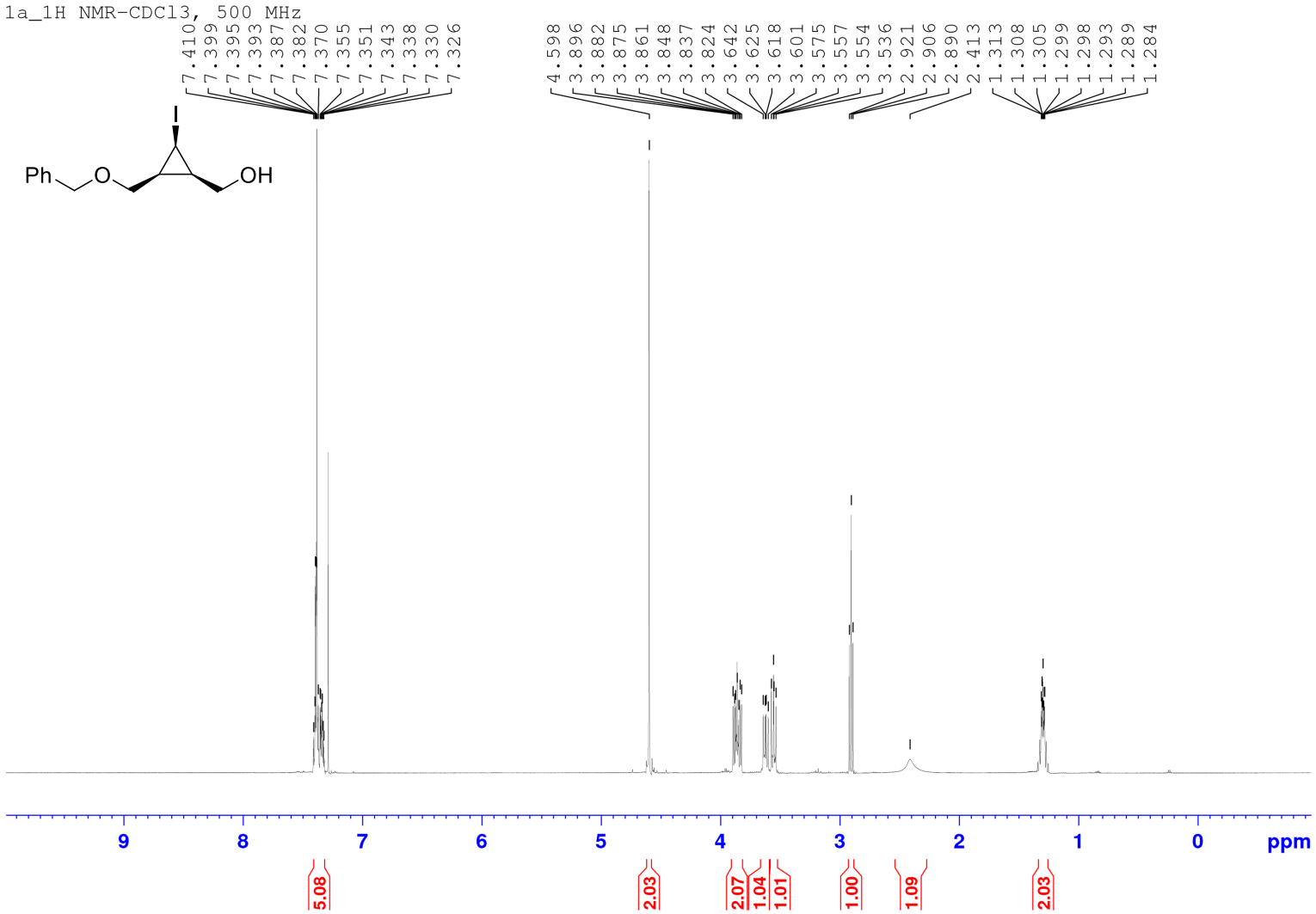
CCDC deposition number	2175205
Empirical formula	$C_{21}H_{23}N_3O_2$
Formula weight	349.42
Temperature [K]	150
Crystal system	monoclinic
Space group (number)	$P2_1/n$ (14)
a [Å]	15.3404(6)
b [Å]	5.5177(2)
c [Å]	21.3195(8)
α [°]	90
β [°]	97.548(2)
γ [°]	90
Volume [Å^3]	1788.93(12)
Z	4
ρ_{calc} [gcm^{-3}]	1.297
μ [mm^{-1}]	0.431
F(000)	744
Crystal size [mm^3]	0.02×0.02×0.4
Crystal color	clear light colorless
Crystal shape	needle
Radiation	Ga K_α (λ=1.34139 Å)
2Θ range [°]	6.61 to 111.83 (0.81 Å)
Index ranges	-18 ≤ h ≤ 18
	-6 ≤ k ≤ 6
	-26 ≤ l ≤ 25
Reflections collected	16661
Independent reflections	3493
	R_{int} = 0.0331
	R_{sigma} = 0.0309
Completeness to θ = 53.594°	100.0 %
Data / Restraints / Parameters	3493 / 0 / 236
Goodness-of-fit on F^2	1.054

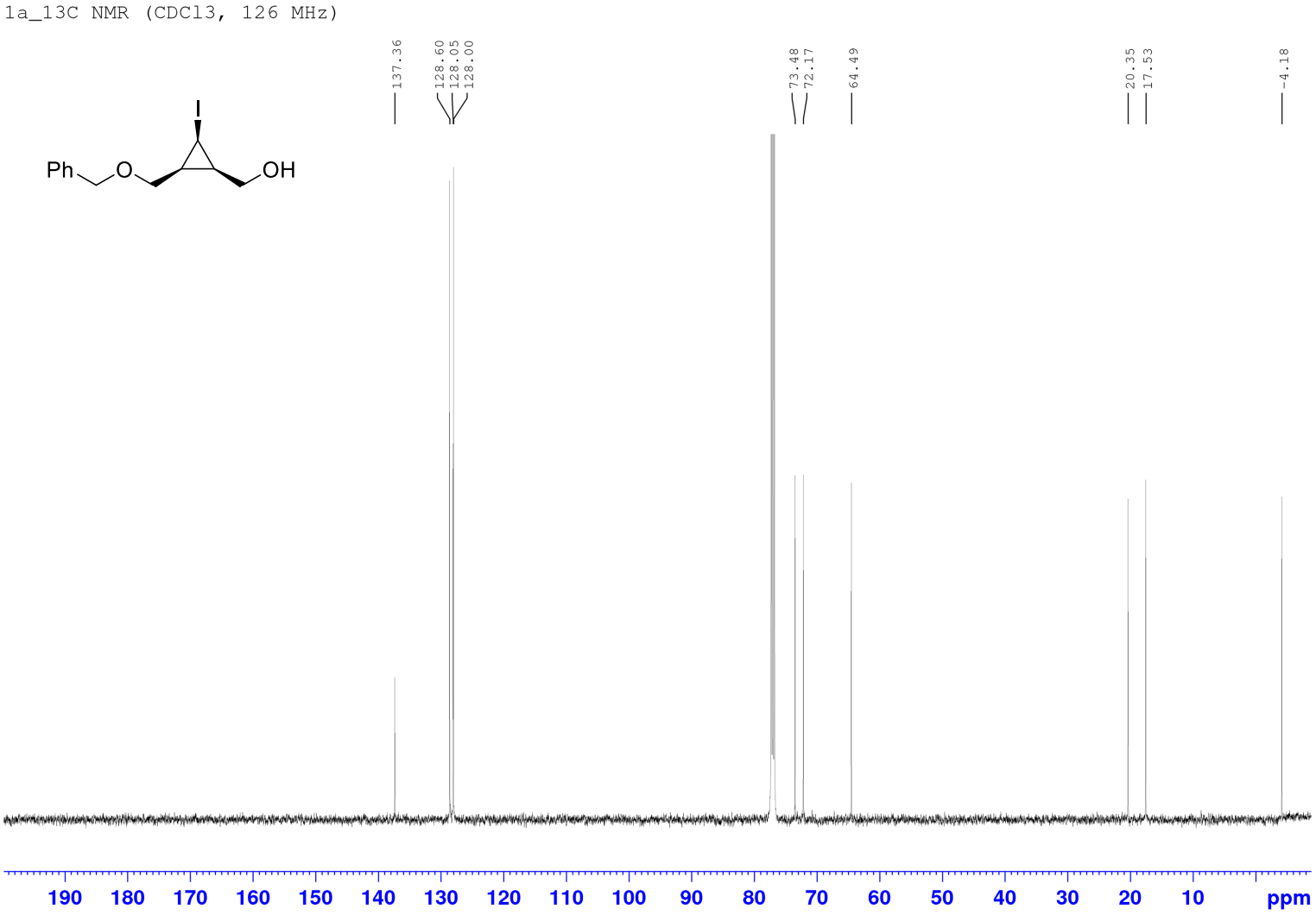
Final *R* indexes	$R_1 = 0.0379$
[$I \geq 2\sigma(I)$]	$wR_2 = 0.0936$
Final *R* indexes	$R_1 = 0.0551$
[all data]	$wR_2 = 0.1021$
Largest peak/hole [eÅ^{-3}]	0.19/−0.20

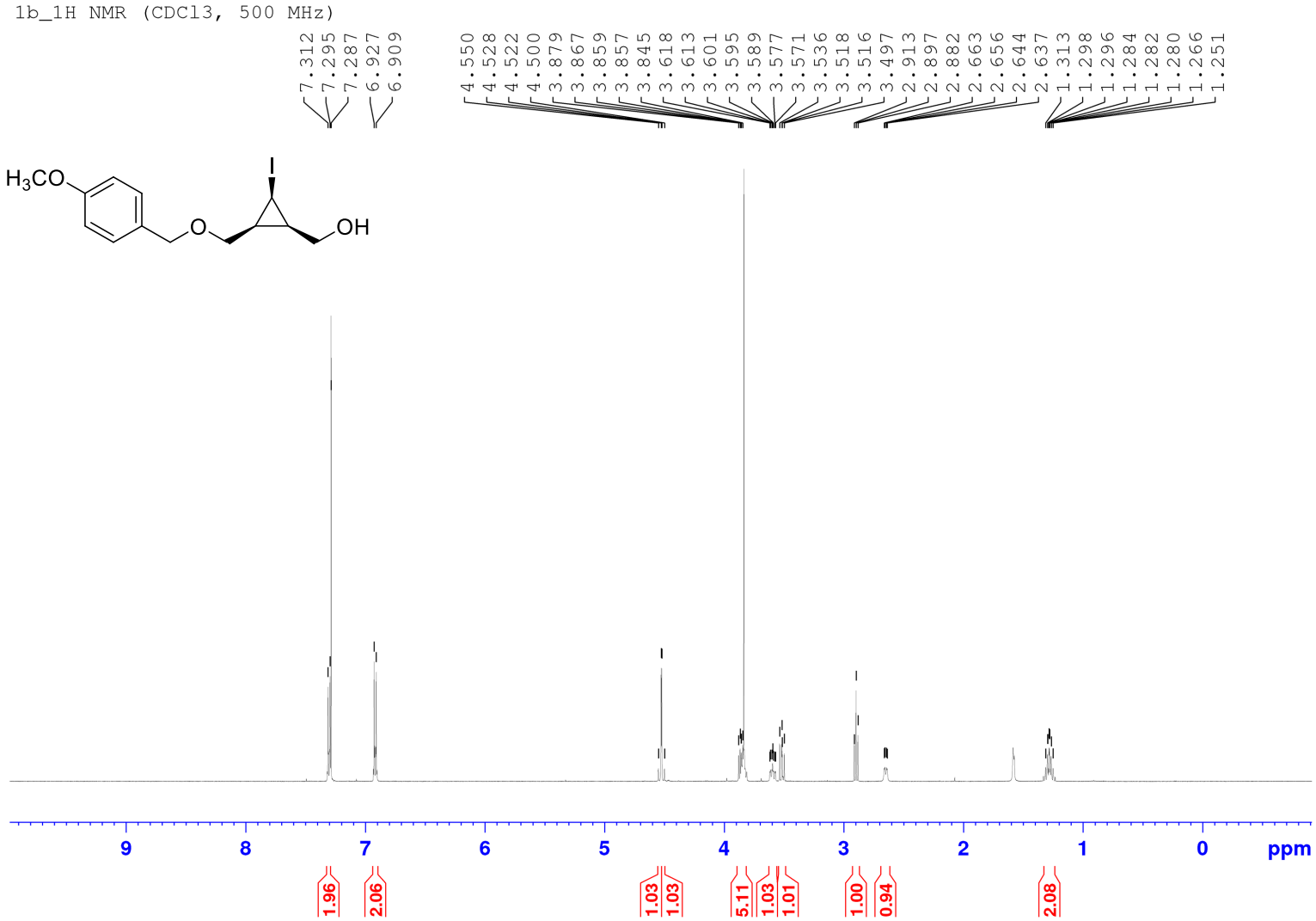
7. References

[1] D. F. Shiver and M. A. Drezdon, The manipulation of air-sensitive compounds; 2nd Edition ed.; Wiley: New York, 1986.
[2] W. C. Still, M. Kahn and A. Mitra., Rapid Chromatographic Technique for Preparative Separations with Moderate Resolution., *J. Org. Chem*., 1978, **43**, 2923–2925.
[3] A. B. Pangborn, M. A. Giardello, R. H. Grubbs, R. K. Rosen and F. J. Timmers, *Organometallics* 1996, **15**, 1518–1520.
[4] D. D. Perrin and W. L. F. Armarego, Purification of Laboratory Chemicals, 3rd ed.; Butterworth-Heinemann Publications, 1988.
[5] K. Hirano, A. T. Biju, I. Piel, and F. Glorius. N-Heterocyclic Carbene-Catalyzed Hydroacylation of Unactivated Double Bonds., *J. Am. Chem. Soc*., 2009, **131**, 14190–14191.
[6] J.-F. Fournier, S. Mathieu and A. B. Charette, Diastereoselective Zinco-Cyclopropanation of Chiral Allylic Alcohols with Gem-Dizinc Carbenoids, *J. Am. Chem. Soc*. 2005, **127**, 13140–13141.
[7] V. Subramanian, M. Moumé-Pymbock, T. Hu, and D. Crich, Protecting Group-Free Glycoligation by the Desulfurative Rearrangement of Allylic Disulfides as a Means of Assembly of Oligosaccharide Mimetics, *J. Org. Chem*. 2011, **76**, 3691–3709.
[8] X.-Z. Shu, C. M. Schienebeck, X. Li, X. Zhou, W. Song, L. Chen, I. A. Guzei and W. Tang, Rhodium-Catalyzed Stereoselective Intramolecular [5 + 2] Cycloaddition of 3-Acyloxy 1,4-Enyne and Alkene. *Org. Lett*. 2015, **17**, 5128–5131.
[9] D. F. Fischer, Z. Q. Xin, and R. Peters, Asymmetric Formation of Allylic Amines with N-Substituted Quaternary Stereocenters by PdII-Catalyzed Aza-Claisen Rearrangements. *Angew. Chem. Int. Ed*. 2007, **46**, 7704–7707.
[10] L. Krause, R. Herbst-Irmer, G. M. Sheldrick and D. Stalke, Comparison of silver and molybdenum microfocus X-ray sources for single-crystal structure determination, *J. Appl. Cryst*. 2015, **48**, 3–10.
[11] G. M. Sheldrick, Integrated space-group and crystal-structure determination, *Acta Cryst*. 2015, A71, 3–8.
[12] G. M. Sheldrick, Crystal structure refinement with SHELXL, *Acta Cryst*. 2015, C71, 3–8.
[13] O. V. Dolomanov, L. J. Bourhis, R. J. Gildea, J. A. K. Howard and H. Puschmann, OLEX2: a complete structure solution, refinement and analysis program, *J. Appl. Cryst*. 2009, **42**, 339-341.

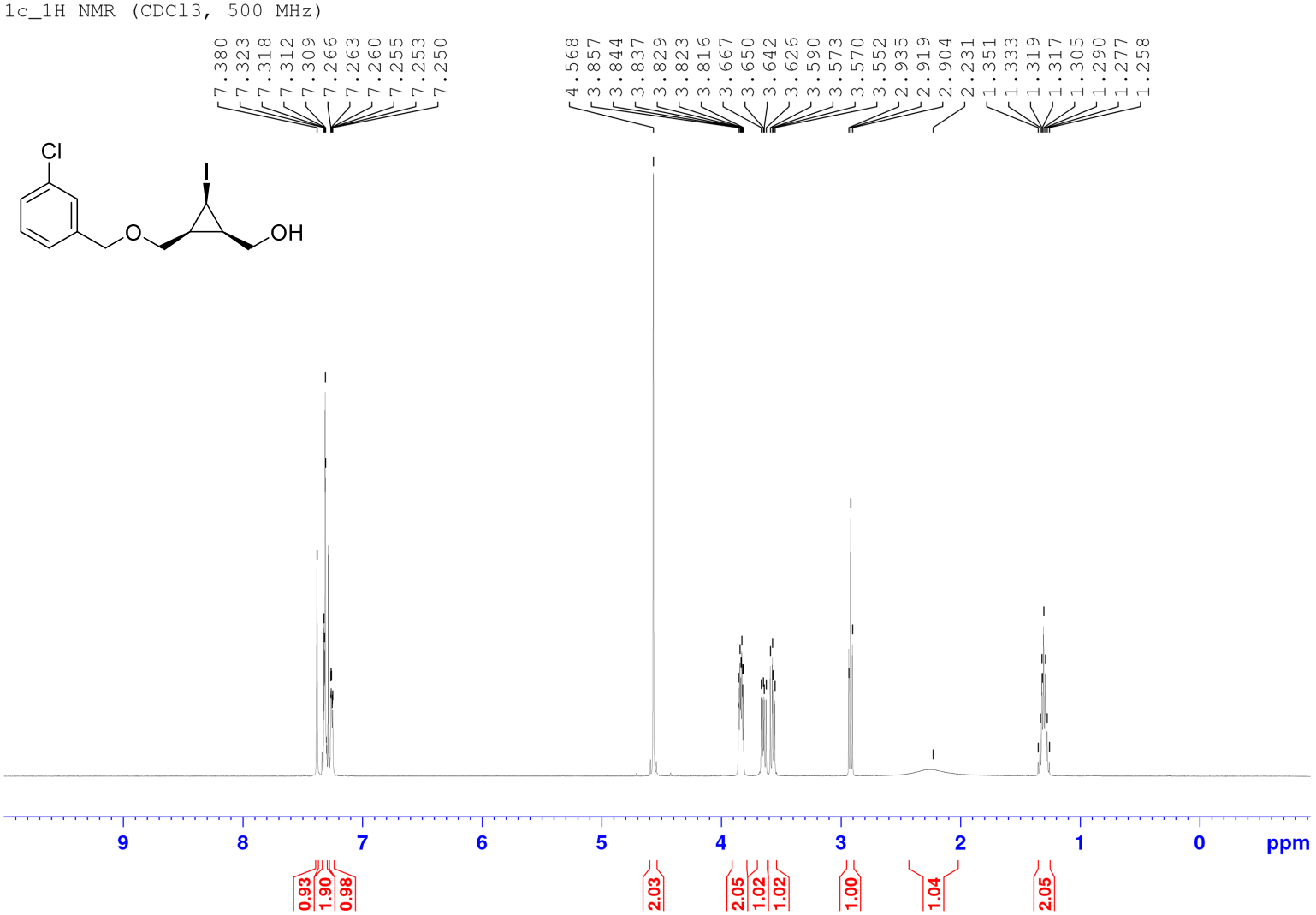
8. ^{1}H, and ^{13}C and NMR Spectra

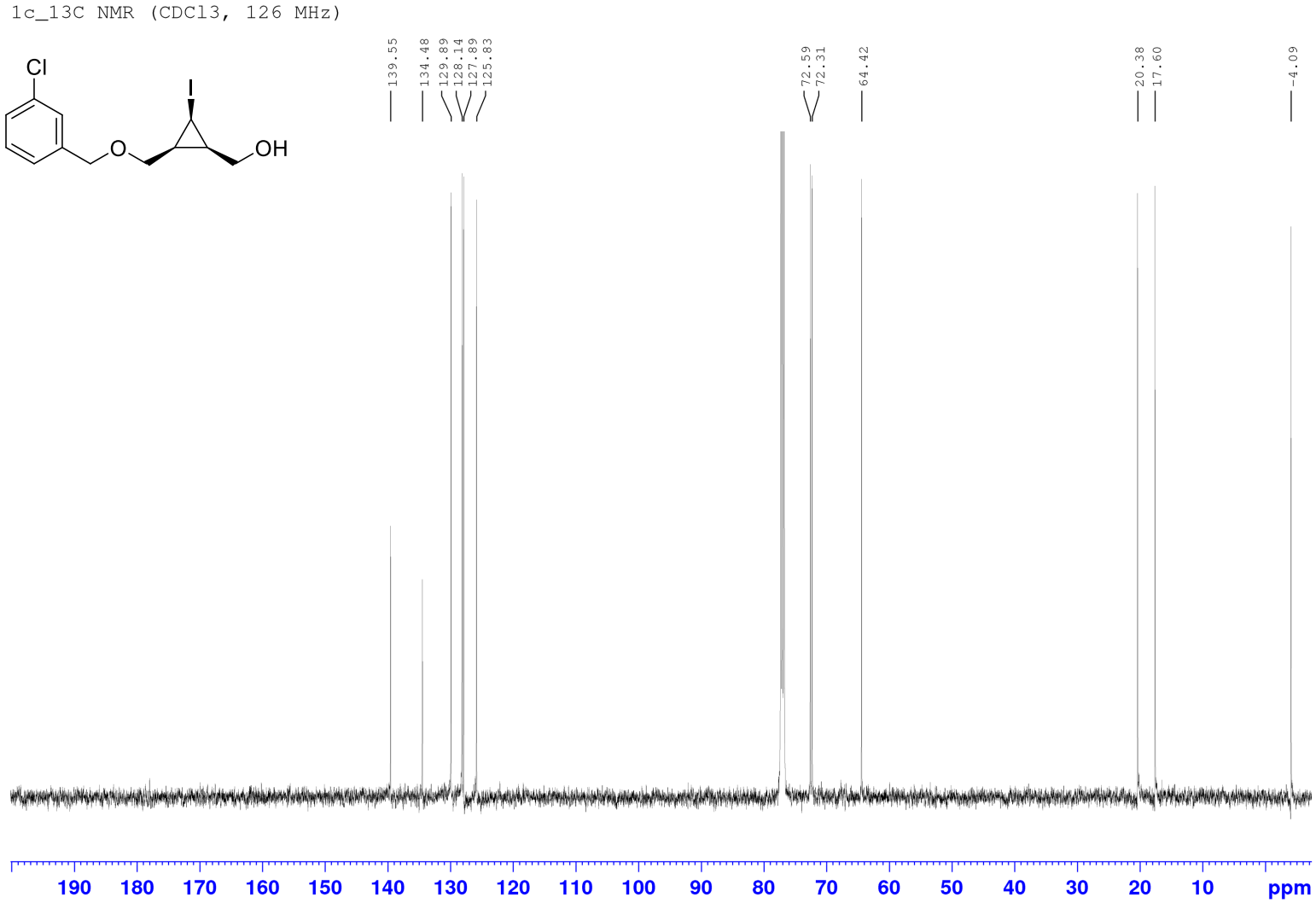

1a_1H NMR-CDCl3, 500 MHz
7.410
7.399
7.395
7.393
7.387
7.382
7.370
7.355
7.351
7.343
7.338
7.330
7.326
4.598
3.896
3.882
3.875
3.861
3.848
3.837
3.824
3.642
3.625
3.618
3.601
3.575
3.557
3.554
3.536
2.921
2.906
2.890
2.413
1.313
1.308
1.305
1.299
1.298
1.293
1.289
1.284
Ph
O
OH
9
8
7
6
5
4
3
2
1
0
ppm
5.08
2.03
2.07
1.04
1.01
1.00
1.09
2.03

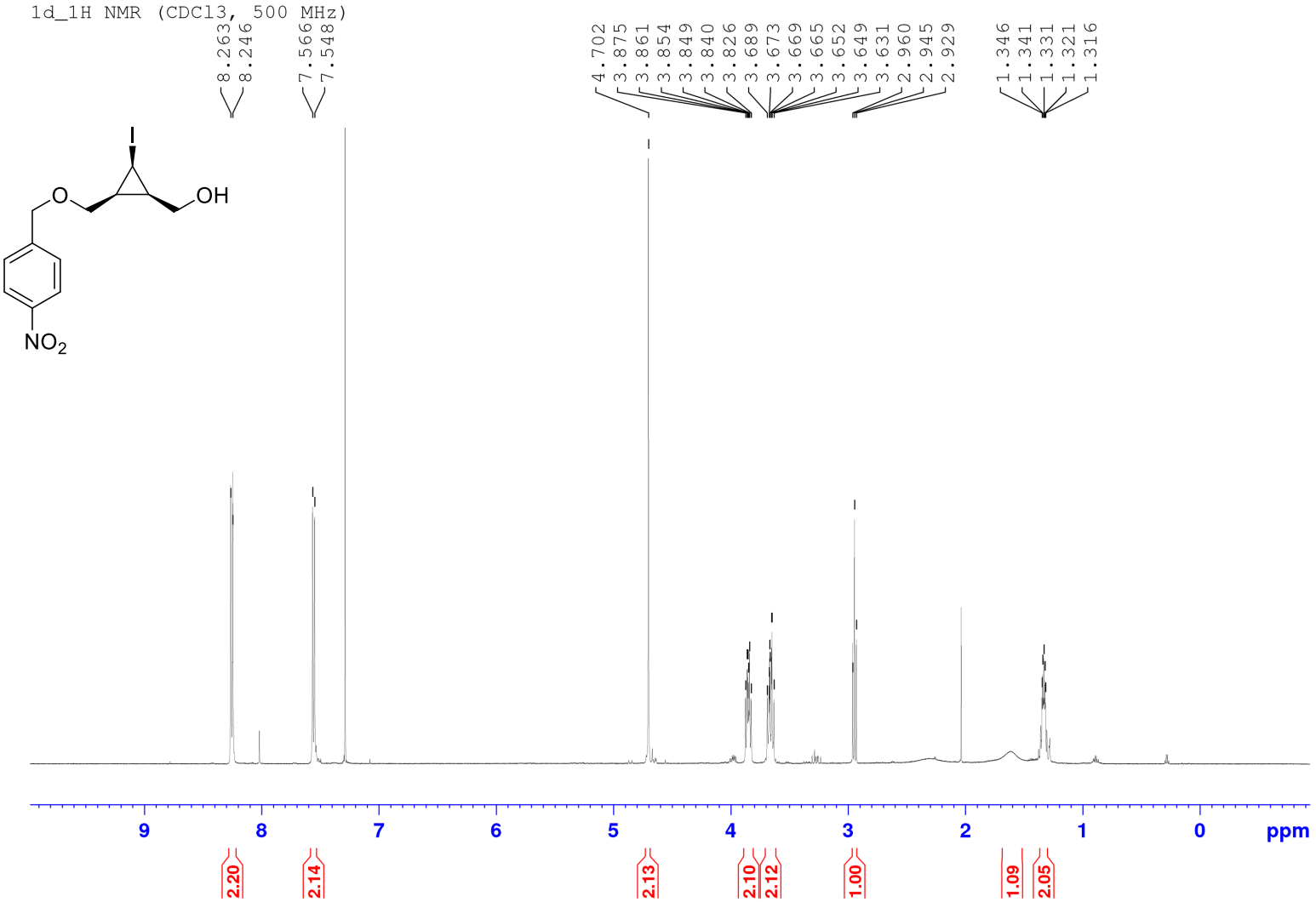

1a_13C NMR (CDCl3, 126 MHz)
137.36
128.60
128.05
128.00
73.48
72.17
64.49
20.35
17.53
-4.18
Ph
O
OH
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

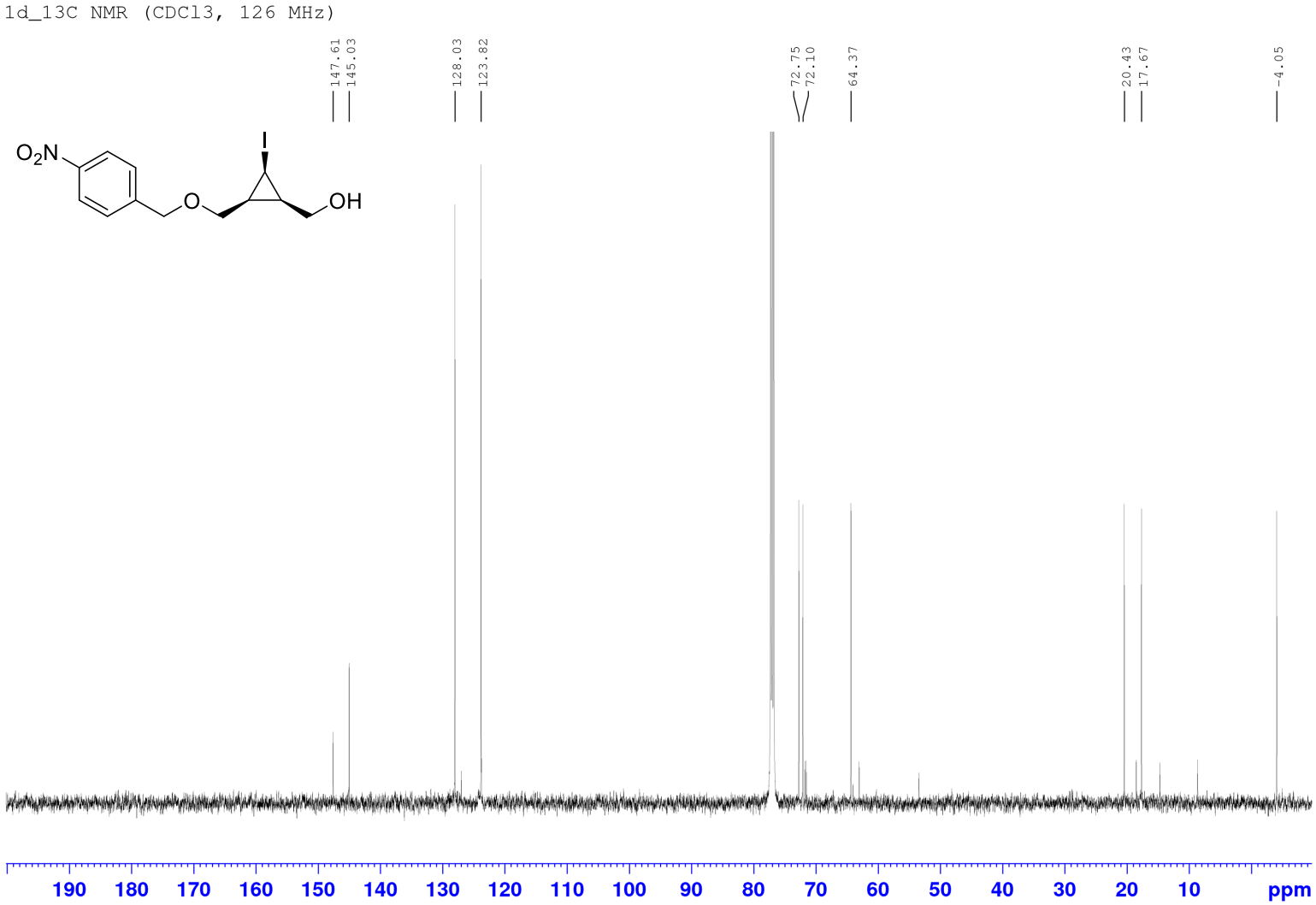

1b_1H NMR (CDCl3, 500 MHz)
7.312
7.295
7.287
6.927
6.909
4.550
4.528
4.522
4.500
3.879
3.867
3.859
3.857
3.845
3.618
3.613
3.601
3.595
3.589
3.577
3.571
3.536
3.518
3.516
3.497
2.913
2.897
2.882
2.663
2.656
2.644
2.637
1.313
1.298
1.296
1.284
1.282
1.280
1.266
1.251
H3CO
O
OH
9
8
7
6
5
4
3
2
1
0
ppm
1.96
2.06
1.03
1.03
5.11
1.03
1.01
1.00
0.94
2.08

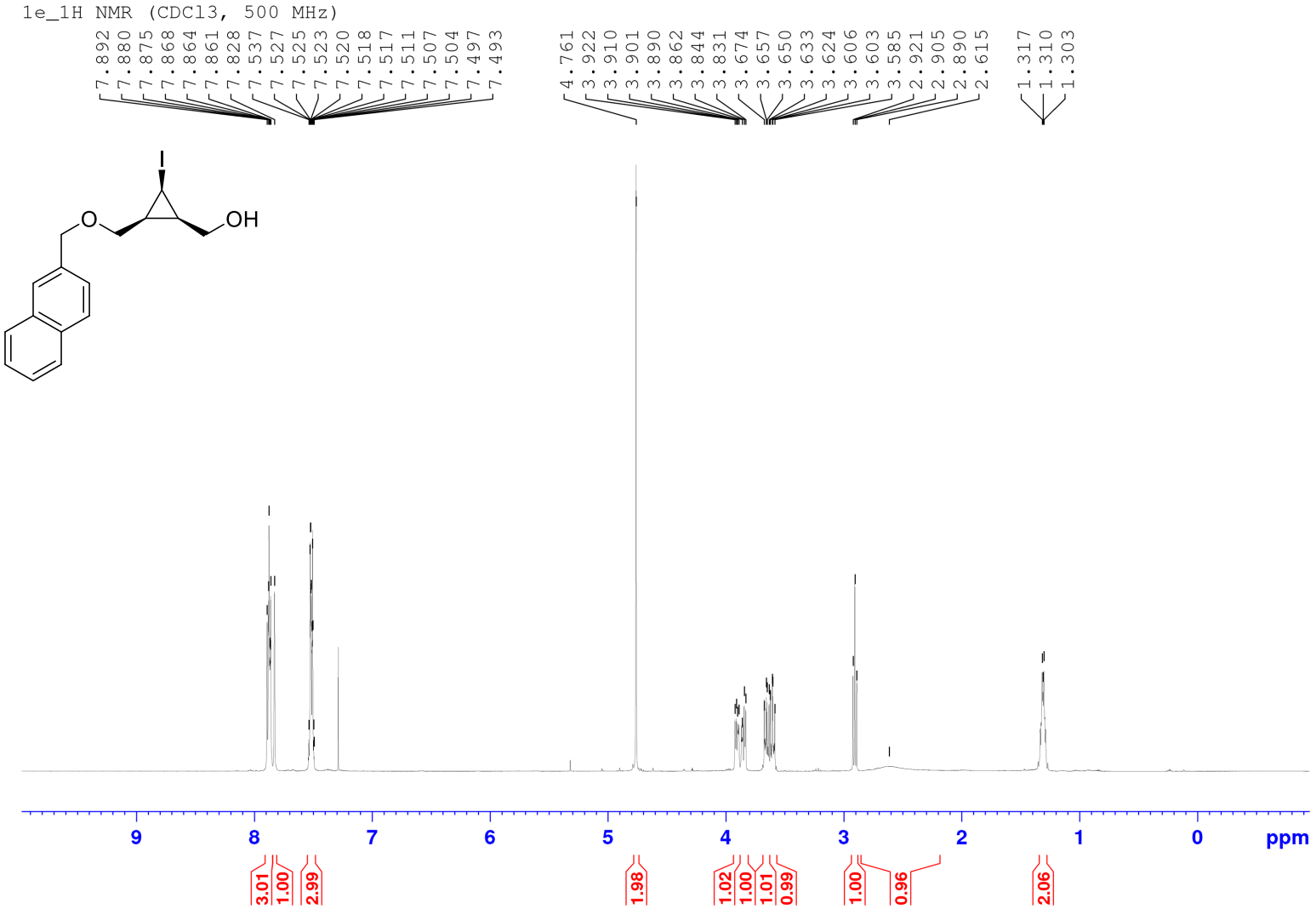

1b_13C NMR (CDCl3, 126 MHz)
159.48
129.67
129.46
113.97
73.10
71.84
64.47
55.30
20.31
17.50
-4.08
H3CO
O
OH
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

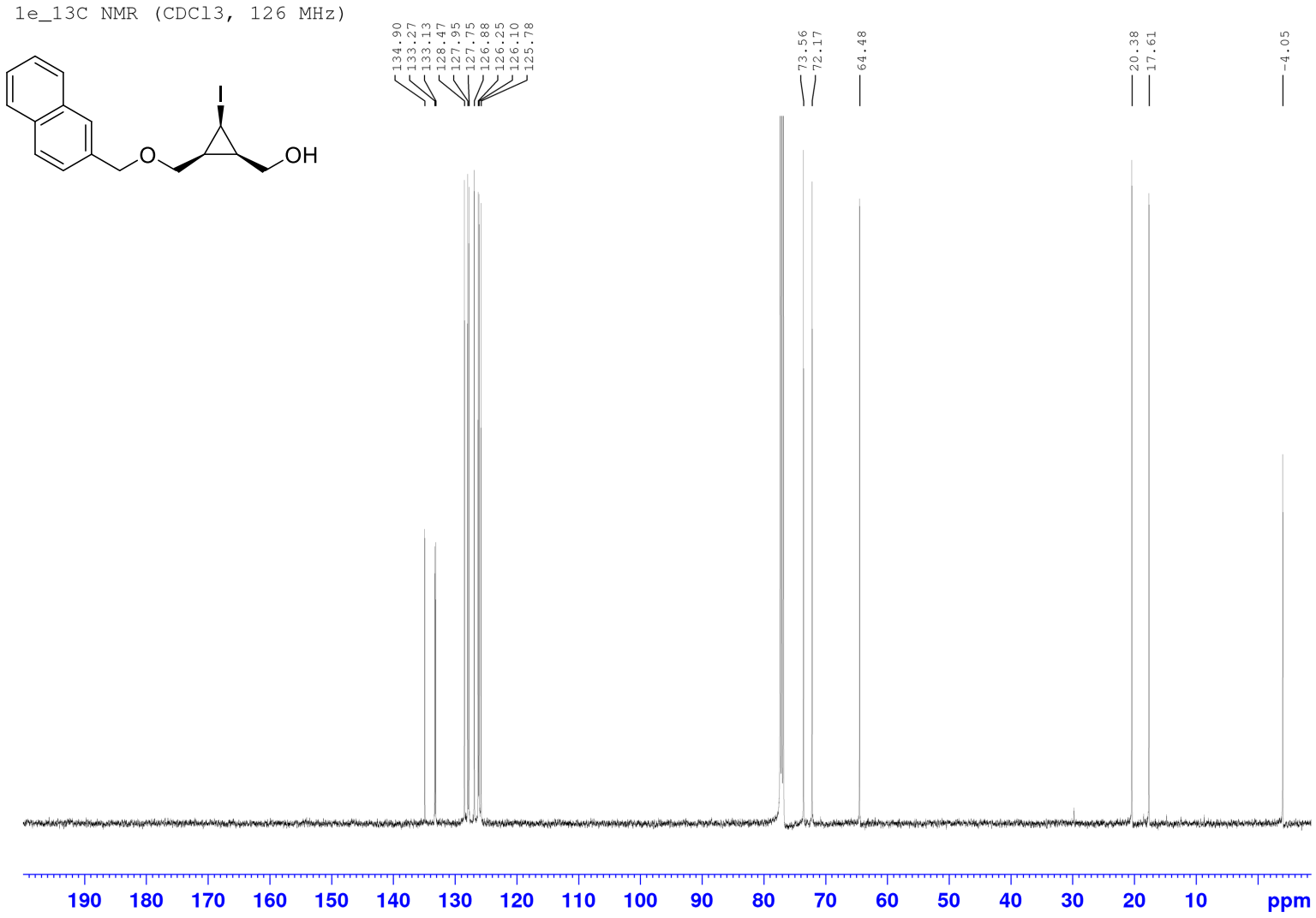

1c_1H NMR (CDCl3, 500 MHz)
7.380
7.323
7.318
7.312
7.309
7.266
7.263
7.260
7.255
7.253
7.250
4.568
3.857
3.844
3.837
3.829
3.823
3.816
3.667
3.650
3.642
3.626
3.590
3.573
3.570
3.552
2.935
2.919
2.904
2.231
1.351
1.333
1.319
1.317
1.305
1.290
1.277
1.258
Cl
O
OH
9
8
7
6
5
4
3
2
1
0
ppm
0.93
1.90
0.98
2.03
2.05
1.02
1.02
1.00
1.04
2.05

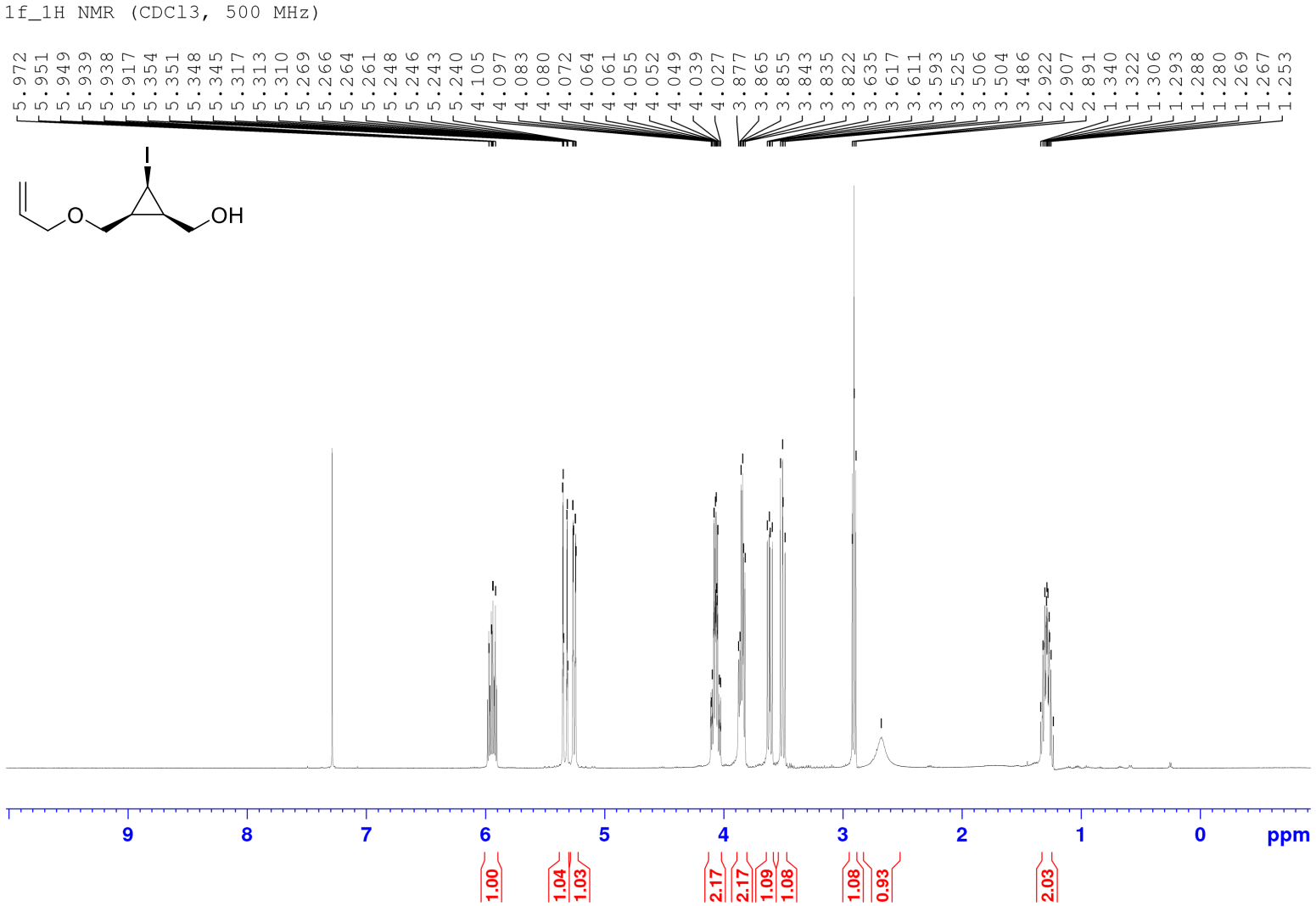

1c_13C NMR (CDCl3, 126 MHz)
Cl
I
O
OH
139.55
134.48
129.89
128.14
127.89
125.83
72.59
72.31
64.42
20.38
17.60
-4.09
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


1d_1H NMR (CDCl3, 500 MHz)
8.263
8.246
7.566
7.548
4.702
3.875
3.861
3.854
3.849
3.840
3.826
3.689
3.673
3.669
3.665
3.652
3.649
3.631
2.960
2.945
2.929
1.346
1.341
1.331
1.321
1.316
O
OH
NO2
9
8
7
6
5
4
3
2
1
0
ppm
2.20
2.14
2.13
2.10
2.12
1.00
1.09
2.05

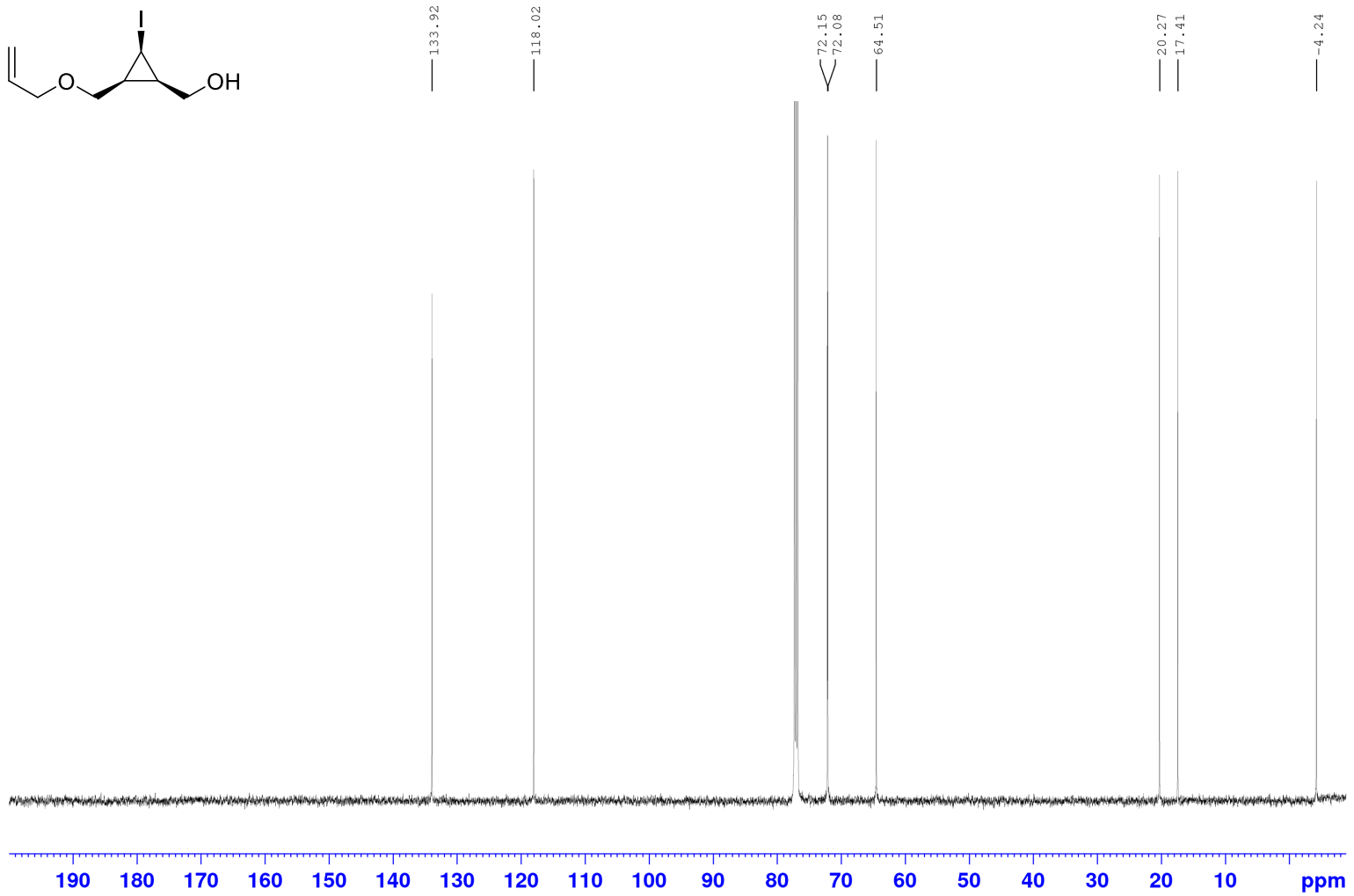

1d_13C NMR (CDCl3, 126 MHz)
147.61
145.03
128.03
123.82
72.75
72.10
64.37
20.43
17.67
-4.05
O2N
I
O
OH
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

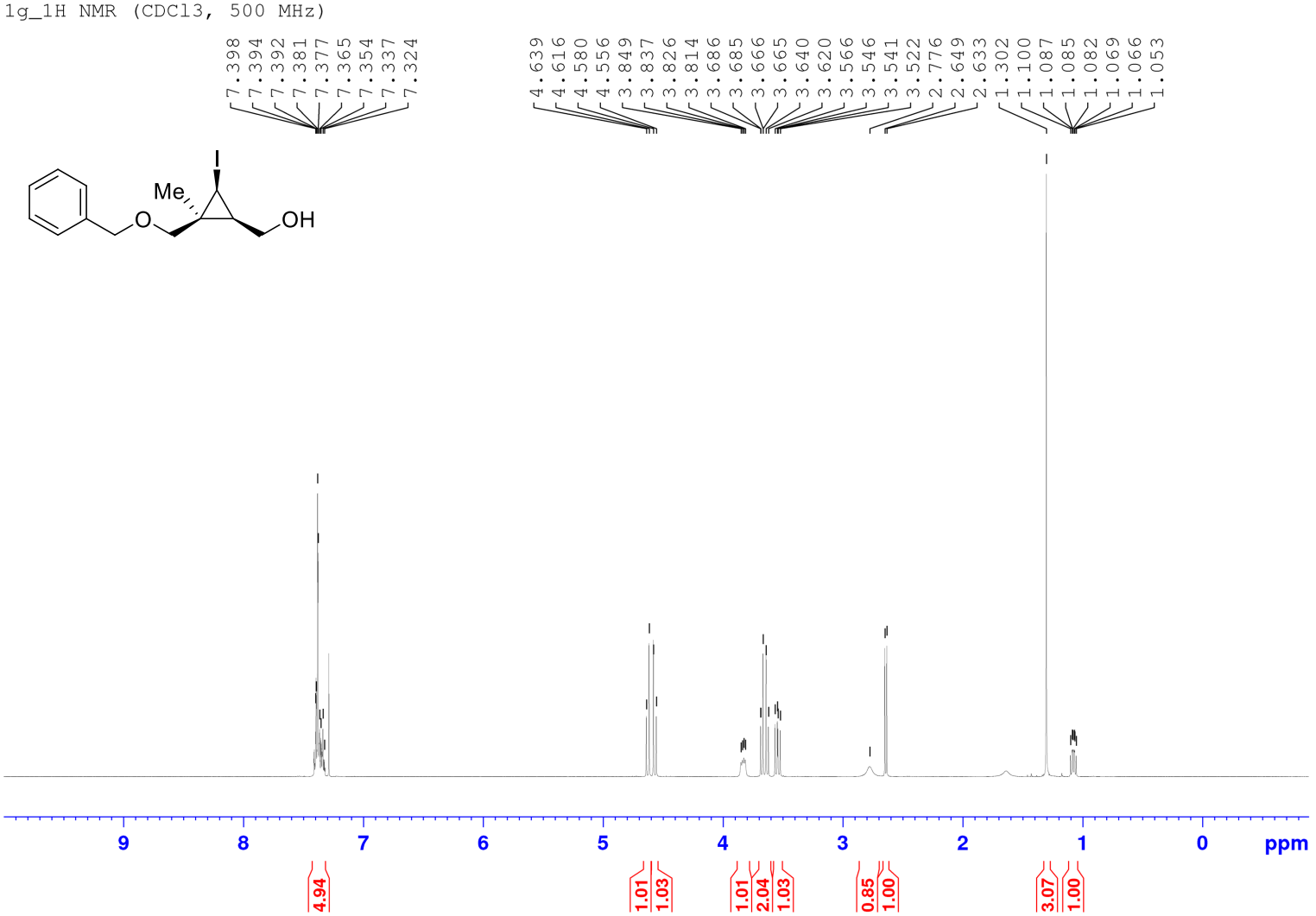

1e_1H NMR (CDCl3, 500 MHz)
7.892
7.880
7.875
7.868
7.864
7.861
7.828
7.537
7.527
7.525
7.523
7.520
7.518
7.517
7.511
7.507
7.504
7.497
7.493
4.761
3.922
3.910
3.901
3.890
3.862
3.844
3.831
3.674
3.657
3.650
3.633
3.624
3.606
3.603
3.585
2.921
2.905
2.890
2.615
1.317
1.310
1.303
I
O
OH
9
8
7
6
5
4
3
2
1
0
ppm
3.01
1.00
2.99
1.98
1.02
1.00
1.01
0.99
1.00
0.96
2.06

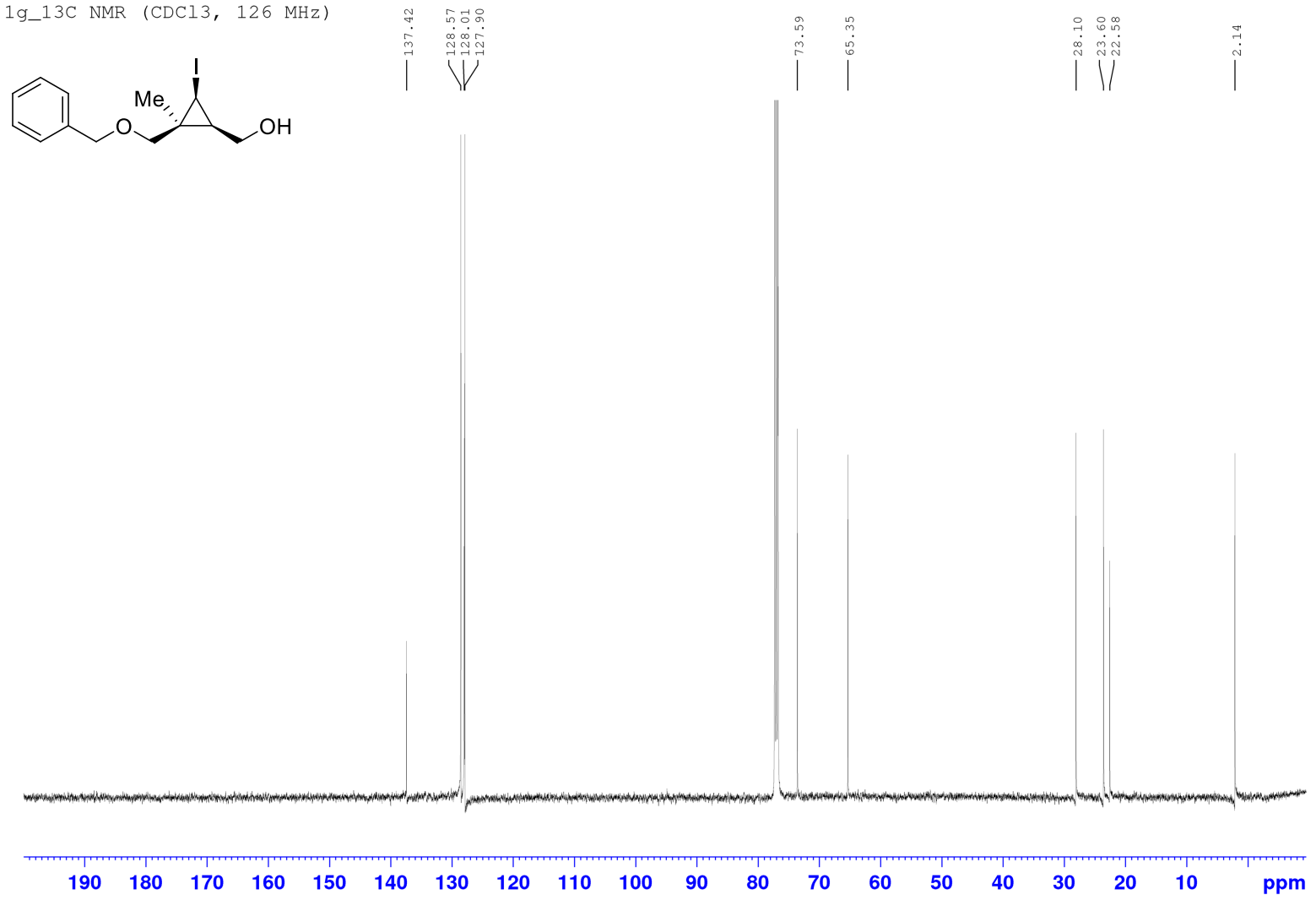

1e_13C NMR (CDCl3, 126 MHz)
134.90
133.27
133.13
128.47
127.95
127.75
126.88
126.25
126.10
125.78
73.56
72.17
64.48
20.38
17.61
-4.05
O
OH
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

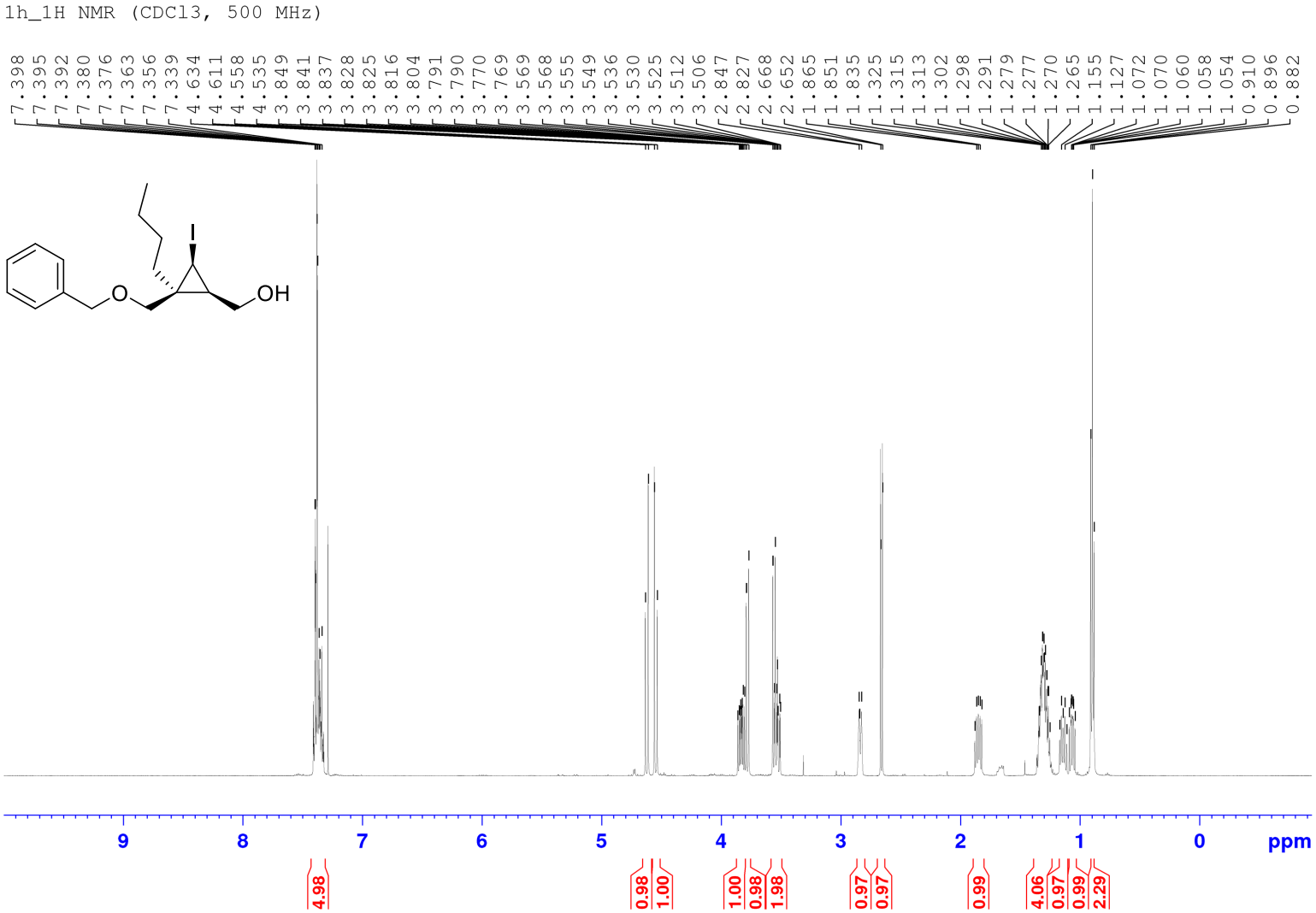

1f_1H NMR (CDCl3, 500 MHz)
5.972
5.951
5.949
5.939
5.938
5.917
5.354
5.351
5.348
5.345
5.317
5.313
5.310
5.269
5.266
5.264
5.261
5.248
5.246
5.243
5.240
4.105
4.097
4.083
4.080
4.072
4.064
4.061
4.055
4.052
4.049
4.039
4.027
3.877
3.865
3.855
3.843
3.835
3.822
3.635
3.617
3.611
3.593
3.525
3.506
3.504
3.486
2.922
2.907
2.891
1.340
1.322
1.306
1.293
1.288
1.280
1.269
1.267
1.253
O
OH
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.04
1.03
2.17
2.17
1.09
1.08
1.08
0.93
2.03

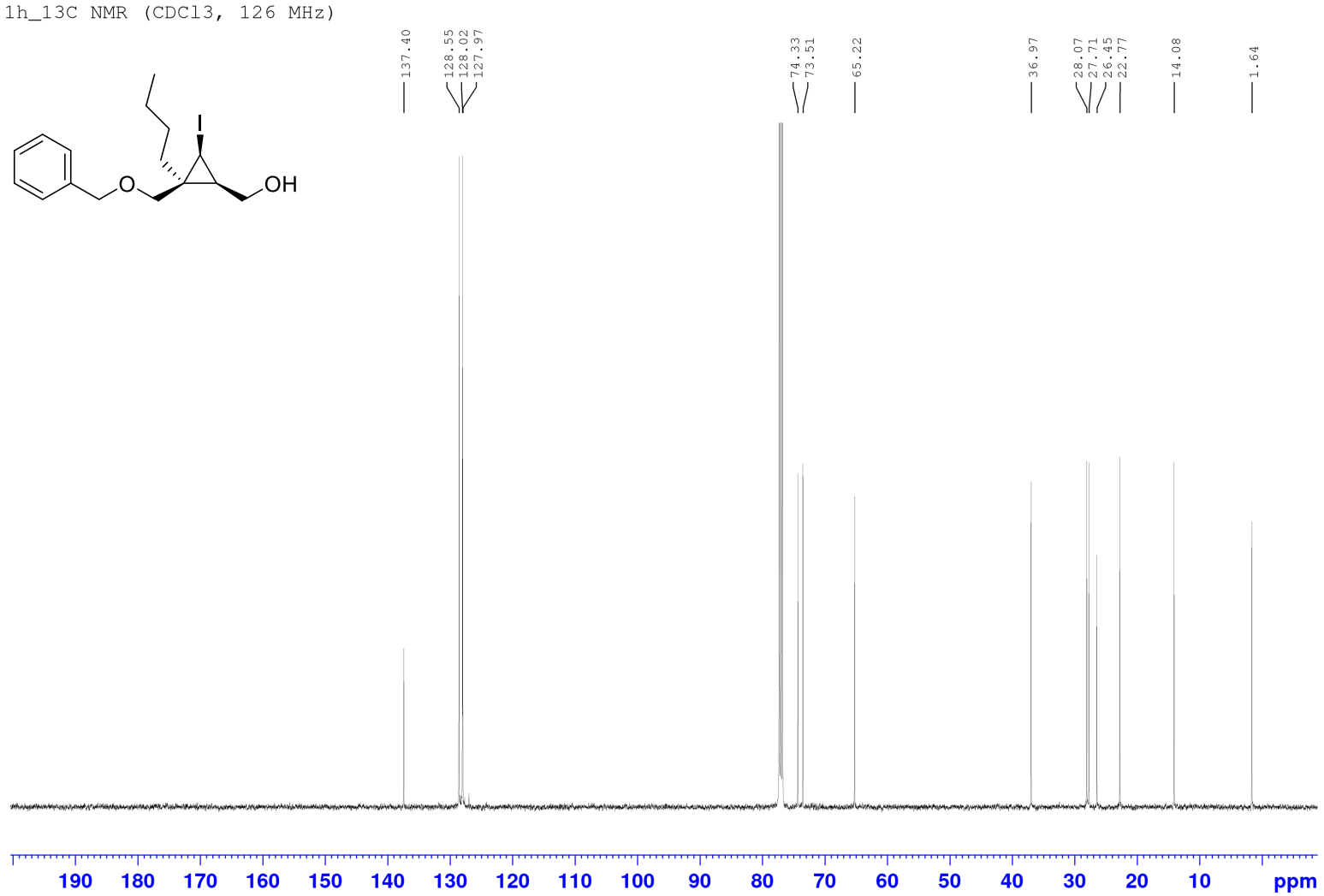
1f_13C NMR (CDCl3, 126 MHz)

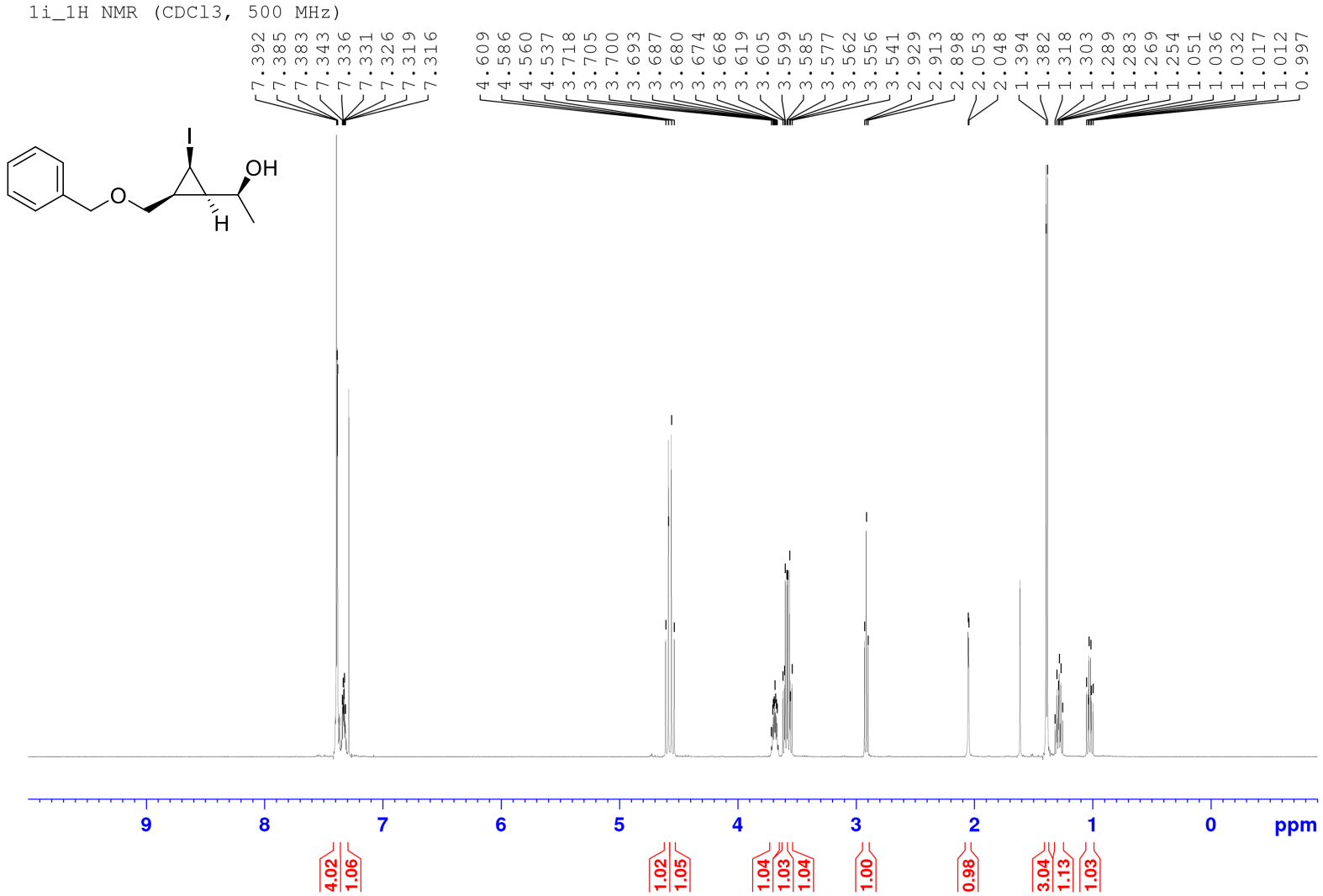


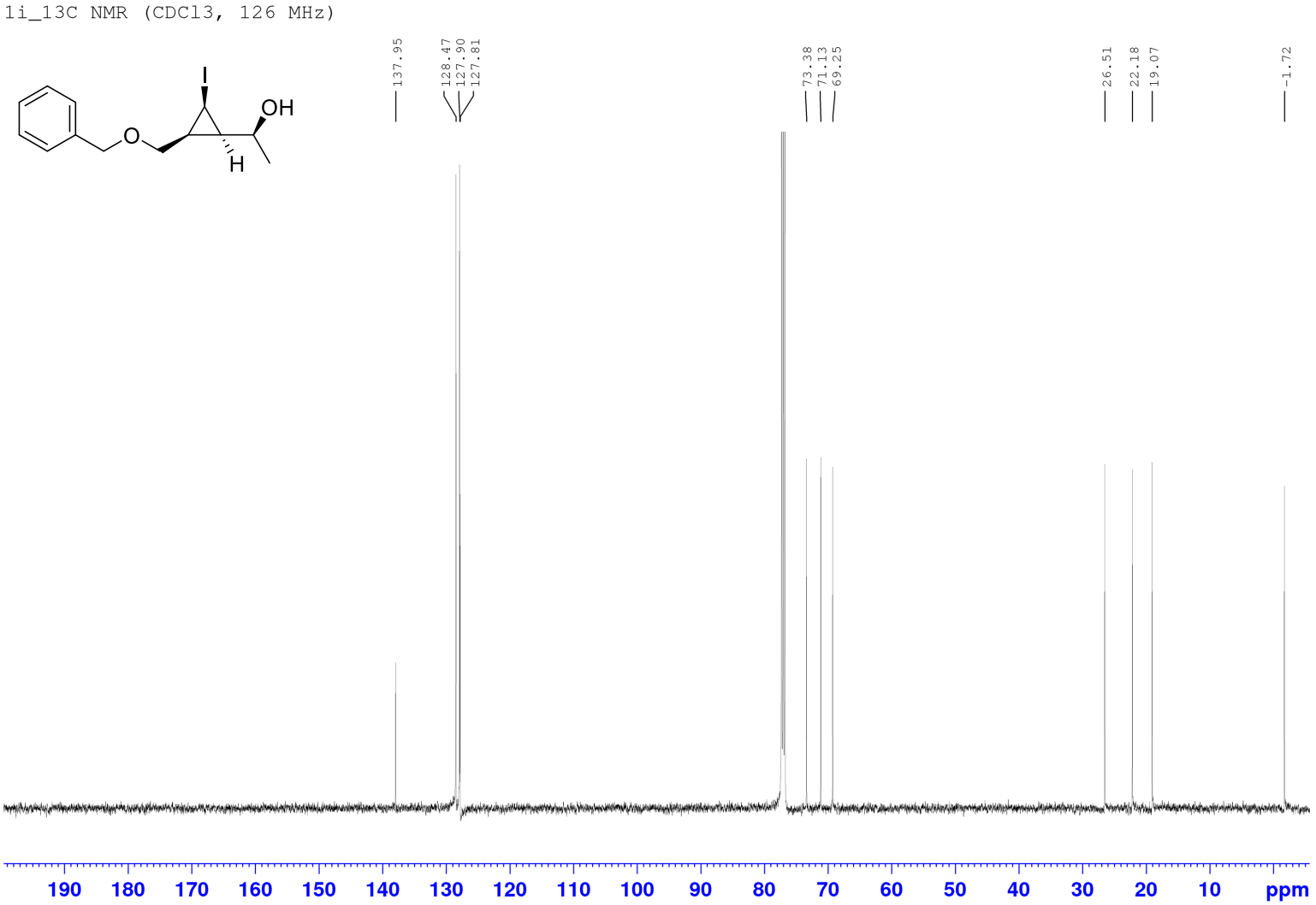

1g_1H NMR (CDCl3, 500 MHz)
7.398
7.394
7.392
7.381
7.377
7.365
7.354
7.337
7.324
4.639
4.616
4.580
4.556
3.849
3.837
3.826
3.814
3.686
3.685
3.666
3.665
3.640
3.620
3.566
3.546
3.541
3.522
2.776
2.649
2.633
1.302
1.100
1.087
1.085
1.082
1.069
1.066
1.053
Me
O
OH
9
8
7
6
5
4
3
2
1
0
ppm
4.94
1.01
1.03
1.01
2.04
1.03
0.85
1.00
3.07
1.00

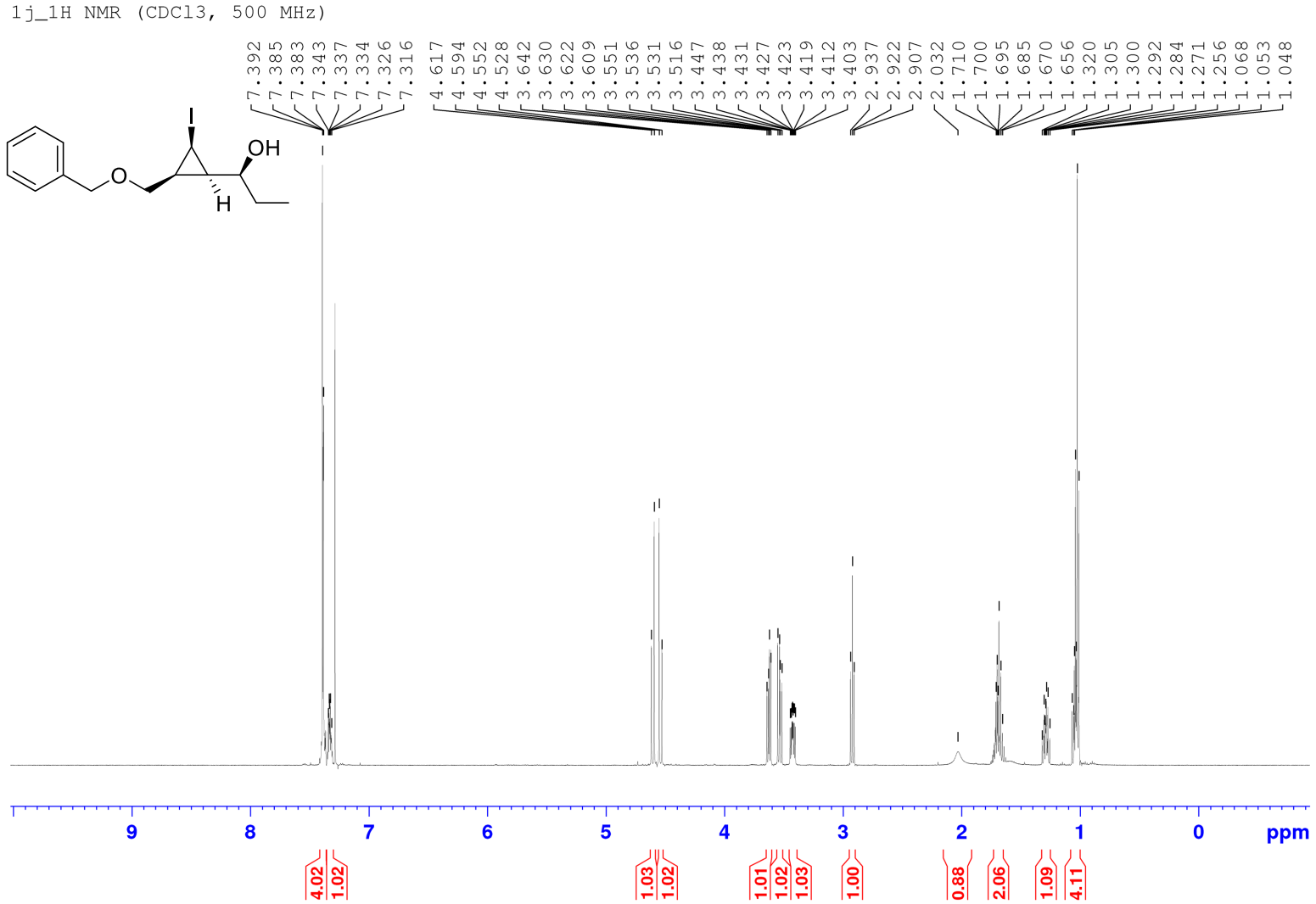

1g_13C NMR (CDCl3, 126 MHz)
137.42
128.57
128.01
127.90
73.59
65.35
28.10
23.60
22.58
2.14
Me
O
OH
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

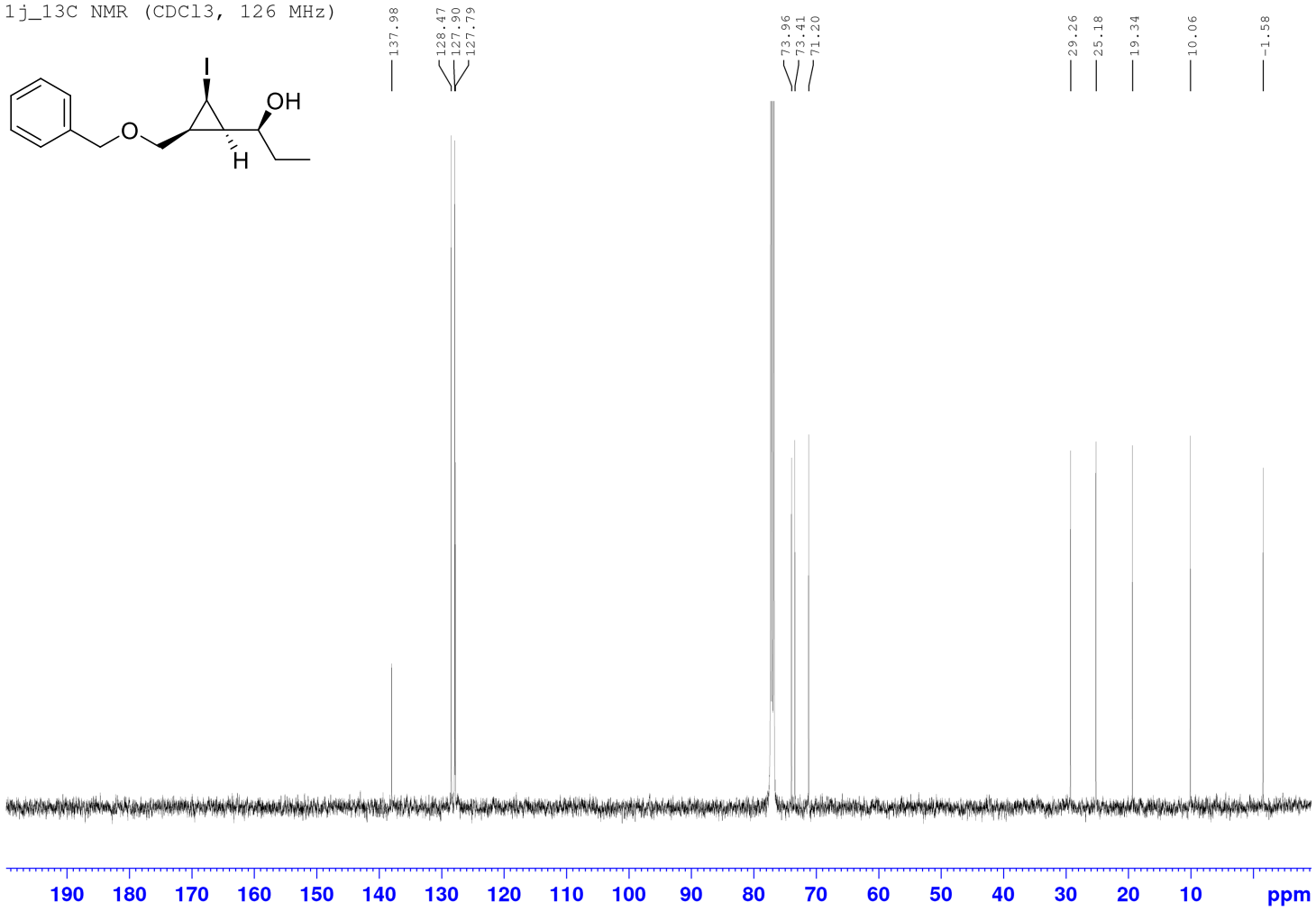

1h_1H NMR (CDCl3, 500 MHz)
7.398
7.395
7.392
7.380
7.376
7.363
7.356
7.339
4.634
4.611
4.558
4.535
3.849
3.841
3.837
3.828
3.825
3.816
3.804
3.791
3.790
3.770
3.769
3.569
3.568
3.555
3.549
3.536
3.530
3.525
3.512
3.506
2.847
2.827
2.668
2.652
1.865
1.851
1.835
1.325
1.315
1.313
1.302
1.298
1.291
1.279
1.277
1.270
1.265
1.155
1.127
1.072
1.070
1.060
1.058
1.054
0.910
0.896
0.882
O
OH
9
8
7
6
5
4
3
2
1
0
ppm
4.98
0.98
1.00
1.00
0.98
1.98
0.97
0.97
0.99
4.06
0.97
0.99
2.29

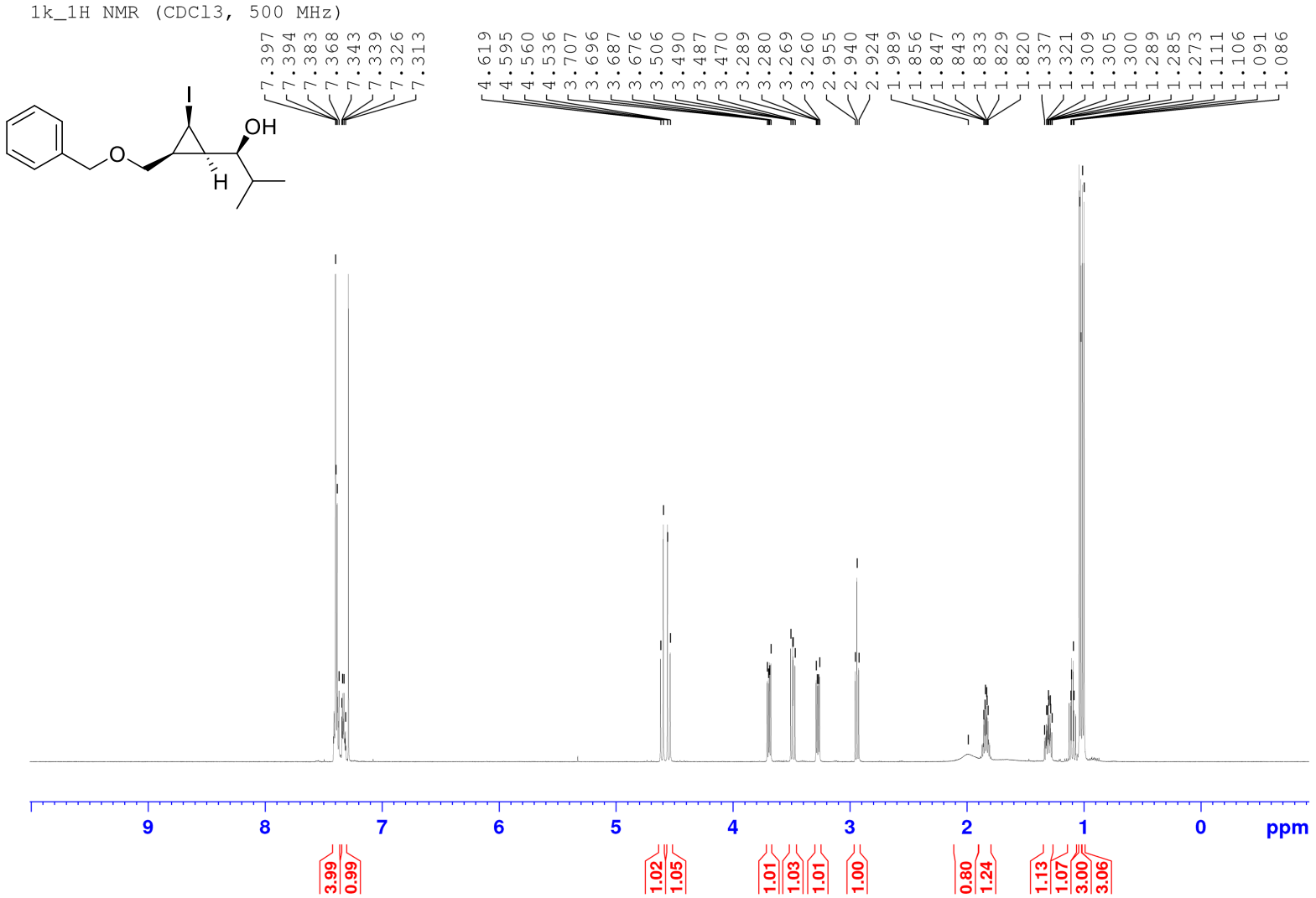

1h_13C NMR (CDCl3, 126 MHz)
137.40
128.55
128.02
127.97
74.33
73.51
65.22
36.97
28.07
27.71
26.45
22.77
14.08
1.64
I
O
OH
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

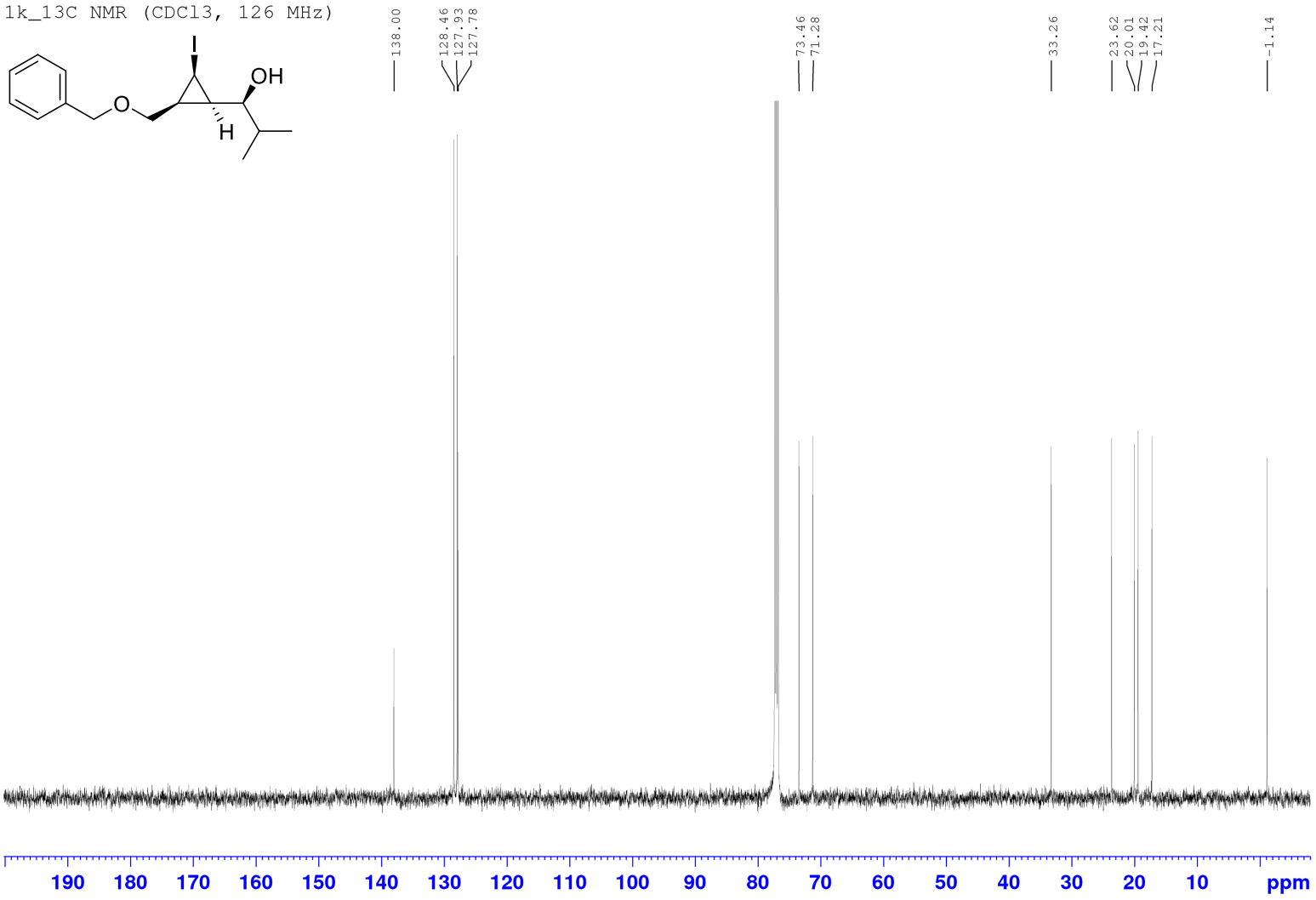

1i_1H NMR (CDCl3, 500 MHz)
7.392
7.385
7.383
7.343
7.336
7.331
7.326
7.319
7.316
4.609
4.586
4.560
4.537
3.718
3.705
3.700
3.693
3.687
3.680
3.674
3.668
3.619
3.605
3.599
3.585
3.577
3.562
3.556
3.541
2.929
2.913
2.898
2.053
2.048
1.394
1.382
1.318
1.303
1.289
1.283
1.269
1.254
1.051
1.036
1.032
1.017
1.012
0.997
OH
O
H
9
8
7
6
5
4
3
2
1
0
ppm
4.02
1.06
1.02
1.05
1.04
1.03
1.04
1.00
0.98
3.04
1.13
1.03

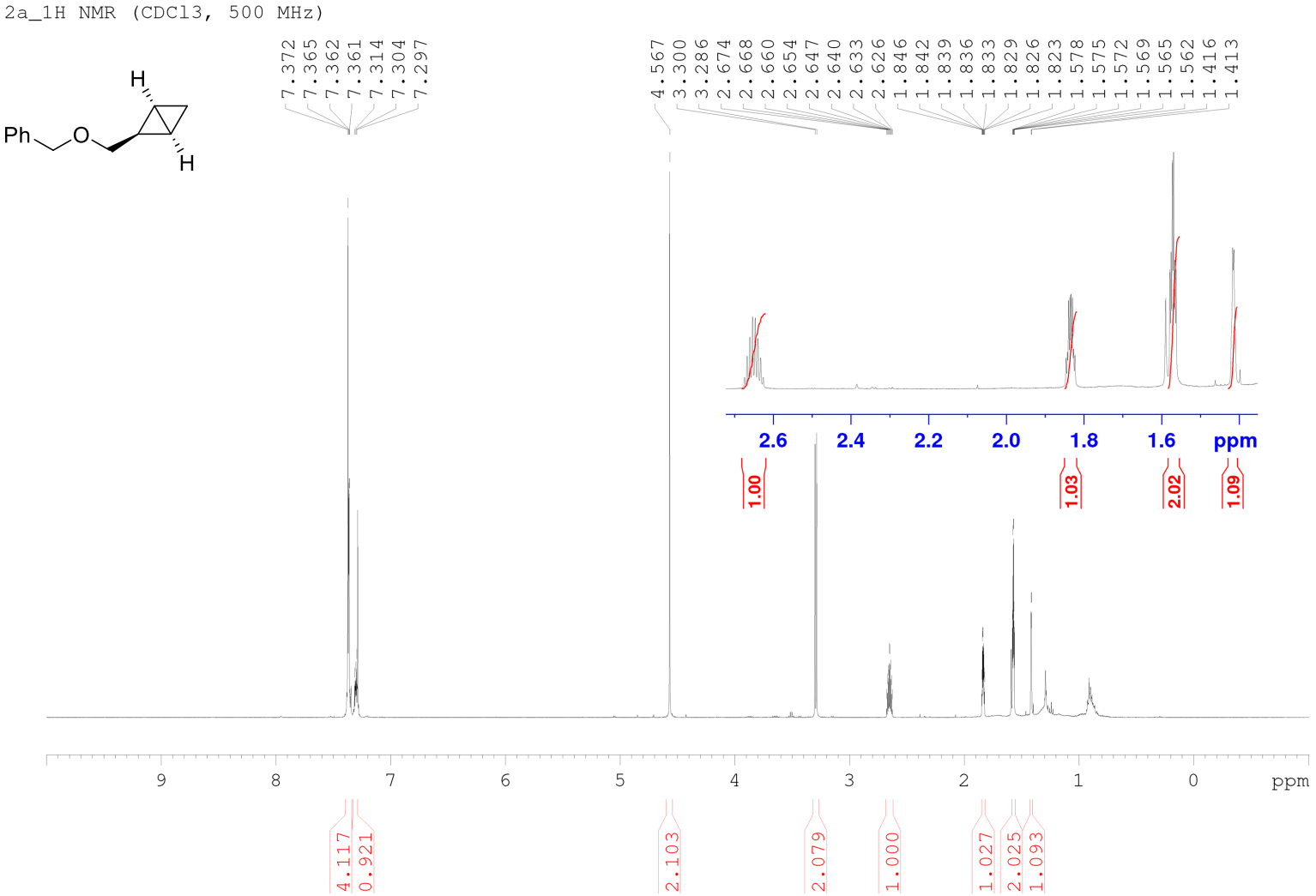

1i_13C NMR (CDCl3, 126 MHz)
137.95
128.47
127.90
127.81
73.38
71.13
69.25
26.51
22.18
19.07
-1.72
I
OH
O
H
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


1j_1H NMR (CDCl3, 500 MHz)
7.392
7.385
7.383
7.343
7.337
7.334
7.326
7.316
4.617
4.594
4.552
4.528
3.642
3.630
3.622
3.609
3.551
3.536
3.531
3.516
3.447
3.438
3.431
3.427
3.423
3.419
3.412
3.403
2.937
2.922
2.907
2.032
1.710
1.700
1.695
1.685
1.670
1.656
1.320
1.305
1.300
1.292
1.284
1.271
1.256
1.068
1.053
1.048
OH
O
H
9
8
7
6
5
4
3
2
1
0
ppm
4.02
1.02
1.03
1.02
1.01
1.02
1.03
1.00
0.88
2.06
1.09
4.11

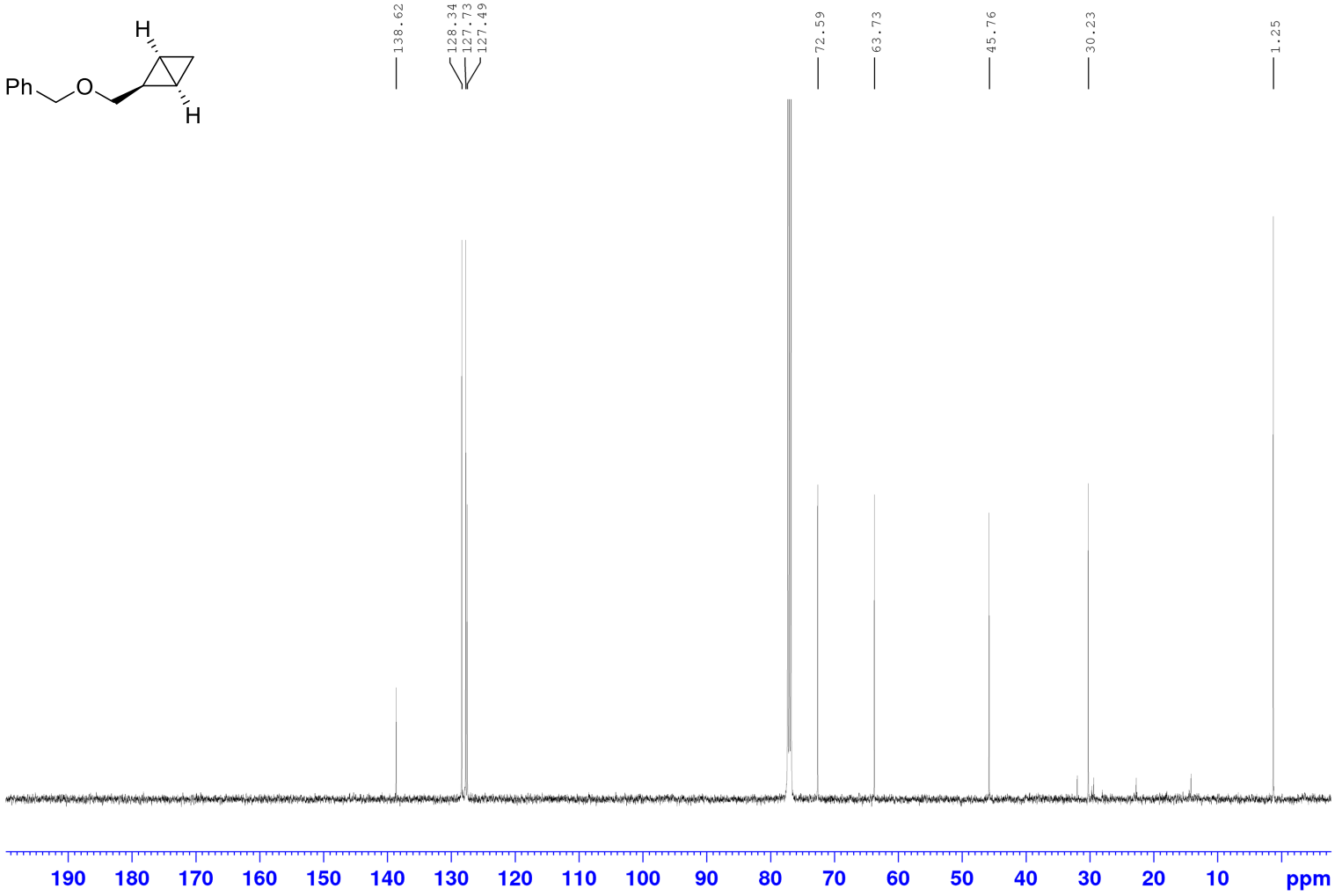

1j_13C NMR (CDCl3, 126 MHz)
137.98
128.47
127.90
127.79
73.96
73.41
71.20
29.26
25.18
19.34
10.06
-1.58
I
OH
O
H
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

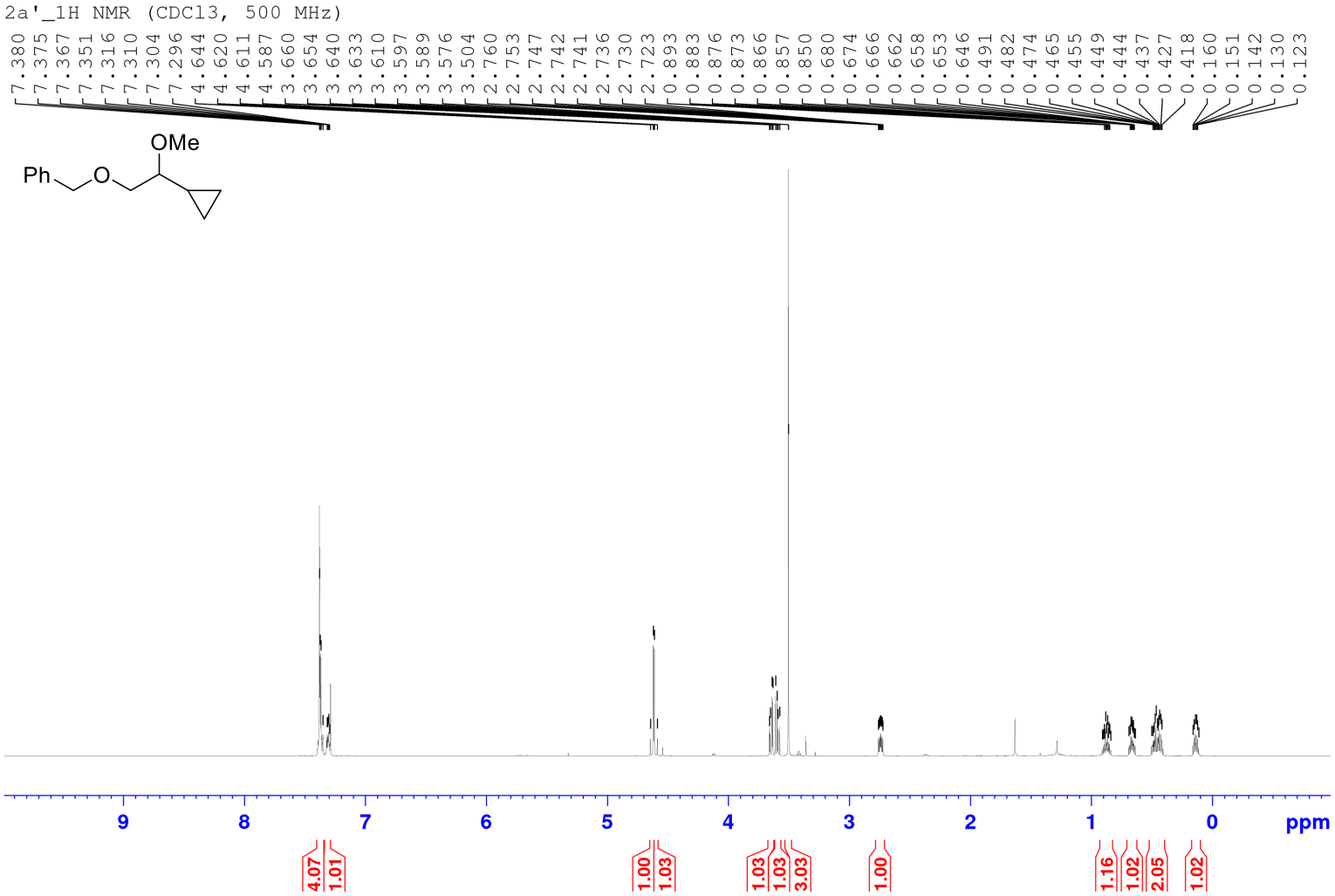

1k_1H NMR (CDCl3, 500 MHz)
7.397
7.394
7.383
7.368
7.343
7.339
7.326
7.313
4.619
4.595
4.560
4.536
3.707
3.696
3.687
3.676
3.506
3.490
3.487
3.470
3.289
3.280
3.269
3.260
2.955
2.940
2.924
1.989
1.856
1.847
1.843
1.833
1.829
1.820
1.337
1.321
1.309
1.305
1.300
1.289
1.285
1.273
1.111
1.106
1.091
1.086
I
OH
O
H
9
8
7
6
5
4
3
2
1
0
ppm
3.99
0.99
1.02
1.05
1.01
1.03
1.01
1.00
0.80
1.24
1.13
1.07
3.00
3.06

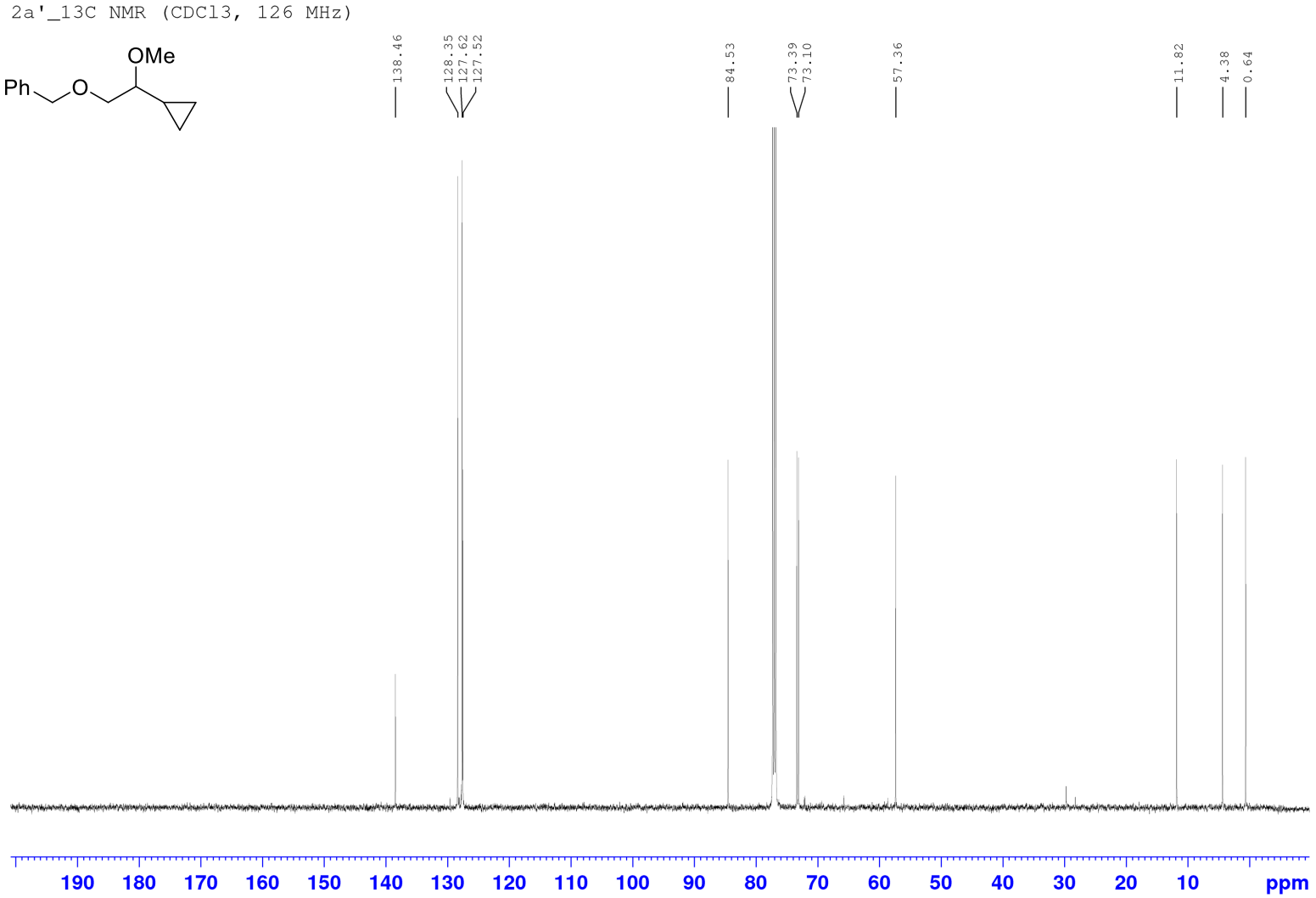

1k_13C NMR (CDCl3, 126 MHz)
138.00
128.46
127.93
127.78
73.46
71.28
33.26
23.62
20.01
19.42
17.21
-1.14
OH
O
H
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

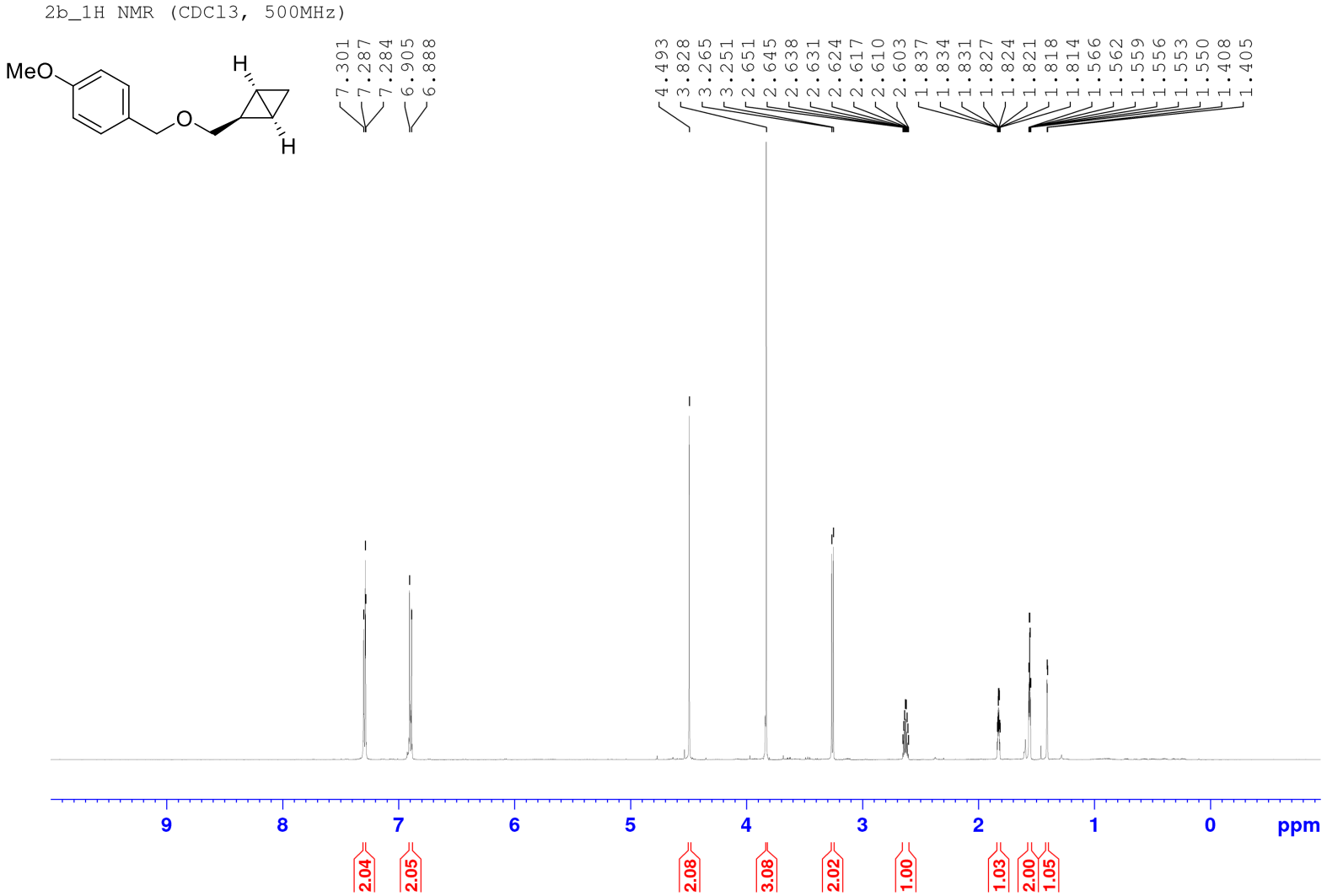

2a_1H NMR (CDCl3, 500 MHz)
Ph
O
H
H
7.372
7.365
7.362
7.361
7.314
7.304
7.297
4.567
3.300
3.286
2.674
2.668
2.660
2.654
2.647
2.640
2.633
2.626
1.846
1.842
1.839
1.836
1.833
1.829
1.826
1.823
1.578
1.575
1.572
1.569
1.565
1.562
1.416
1.413
2.6
2.4
2.2
2.0
1.8
1.6
ppm
1.00
1.03
2.02
1.09
9
8
7
6
5
4
3
2
1
0
ppm
4.117
0.921
2.103
2.079
1.000
1.027
2.025
1.093

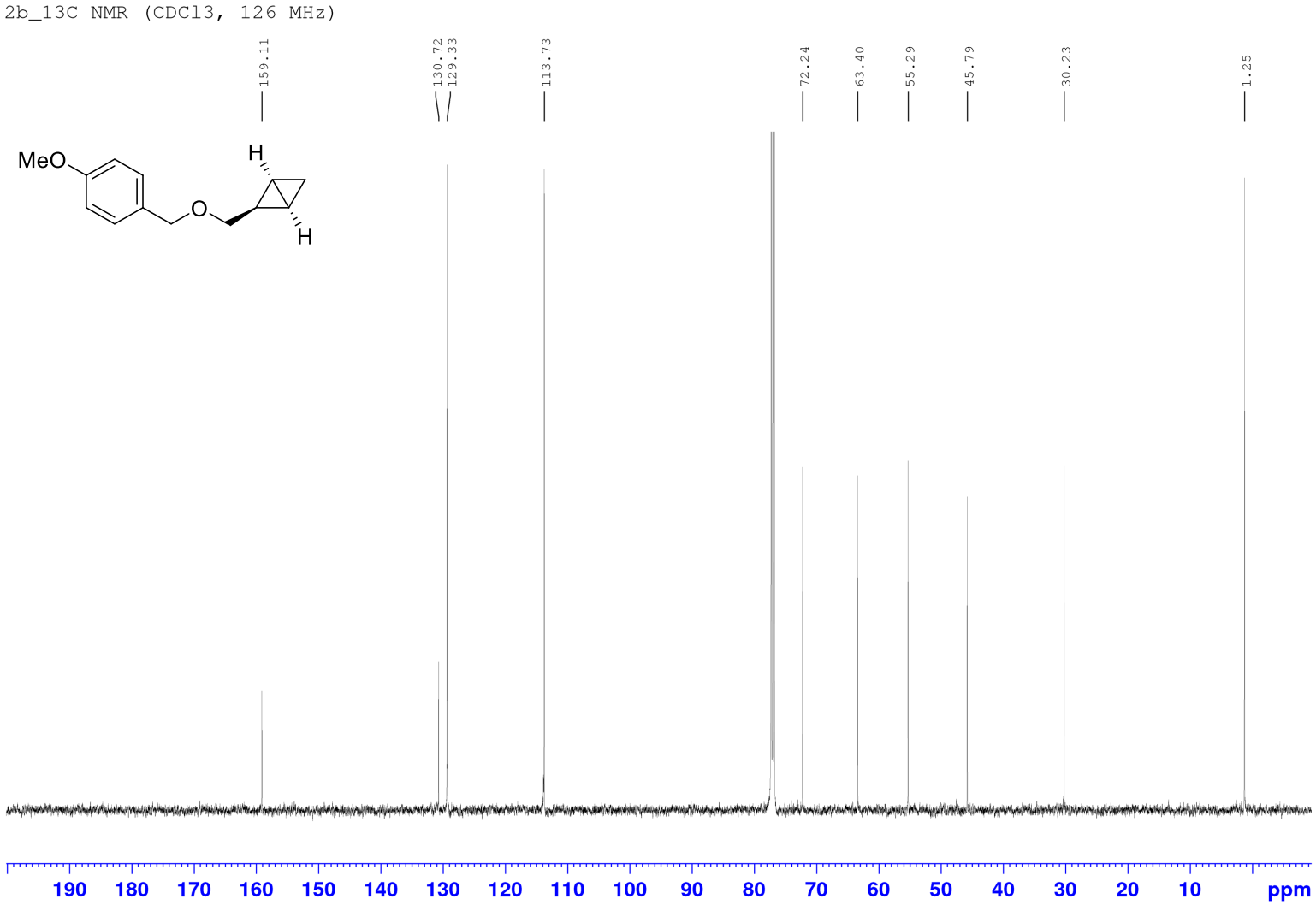
2a_13C NMR (CDCl3, 126 MHz)

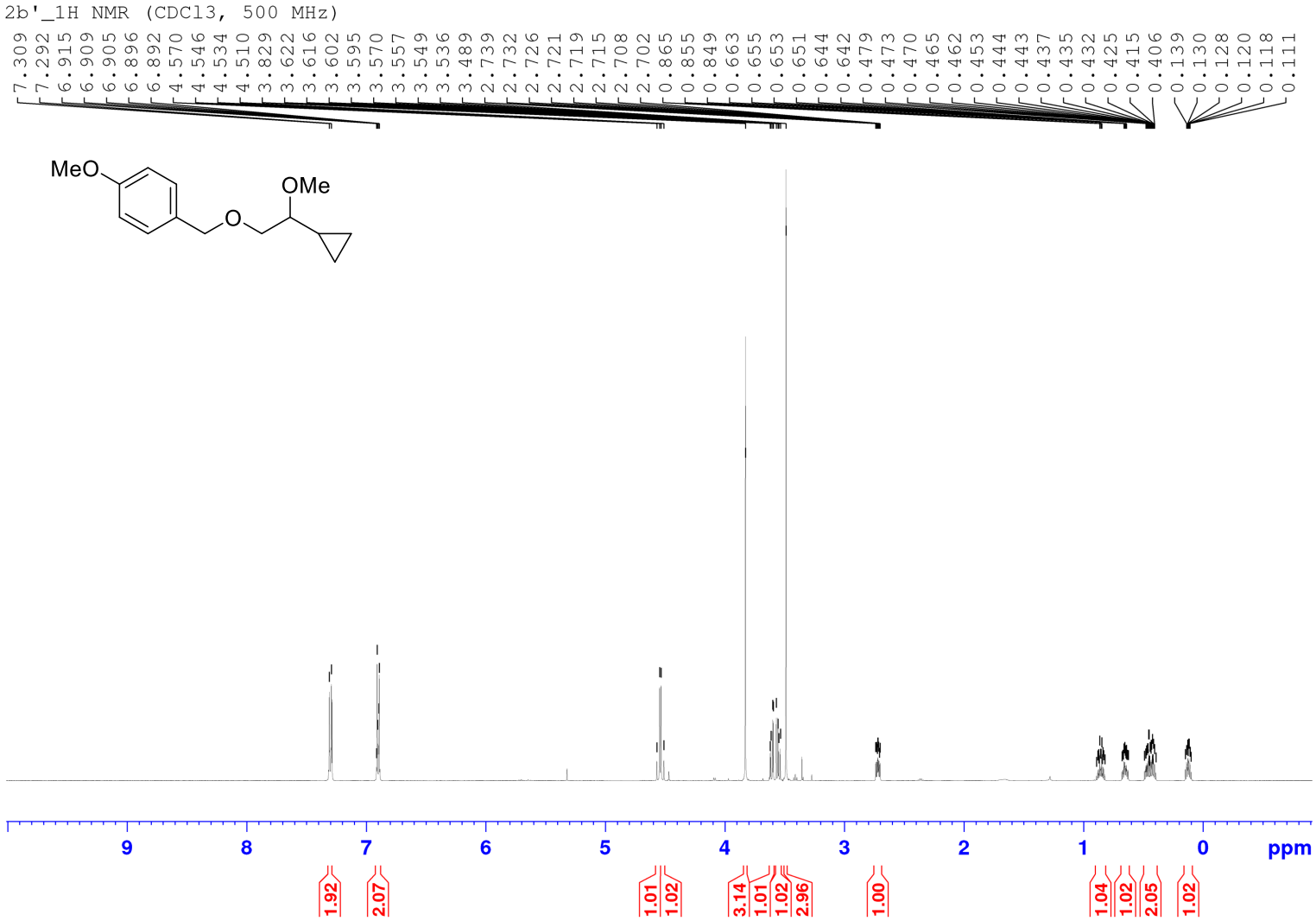


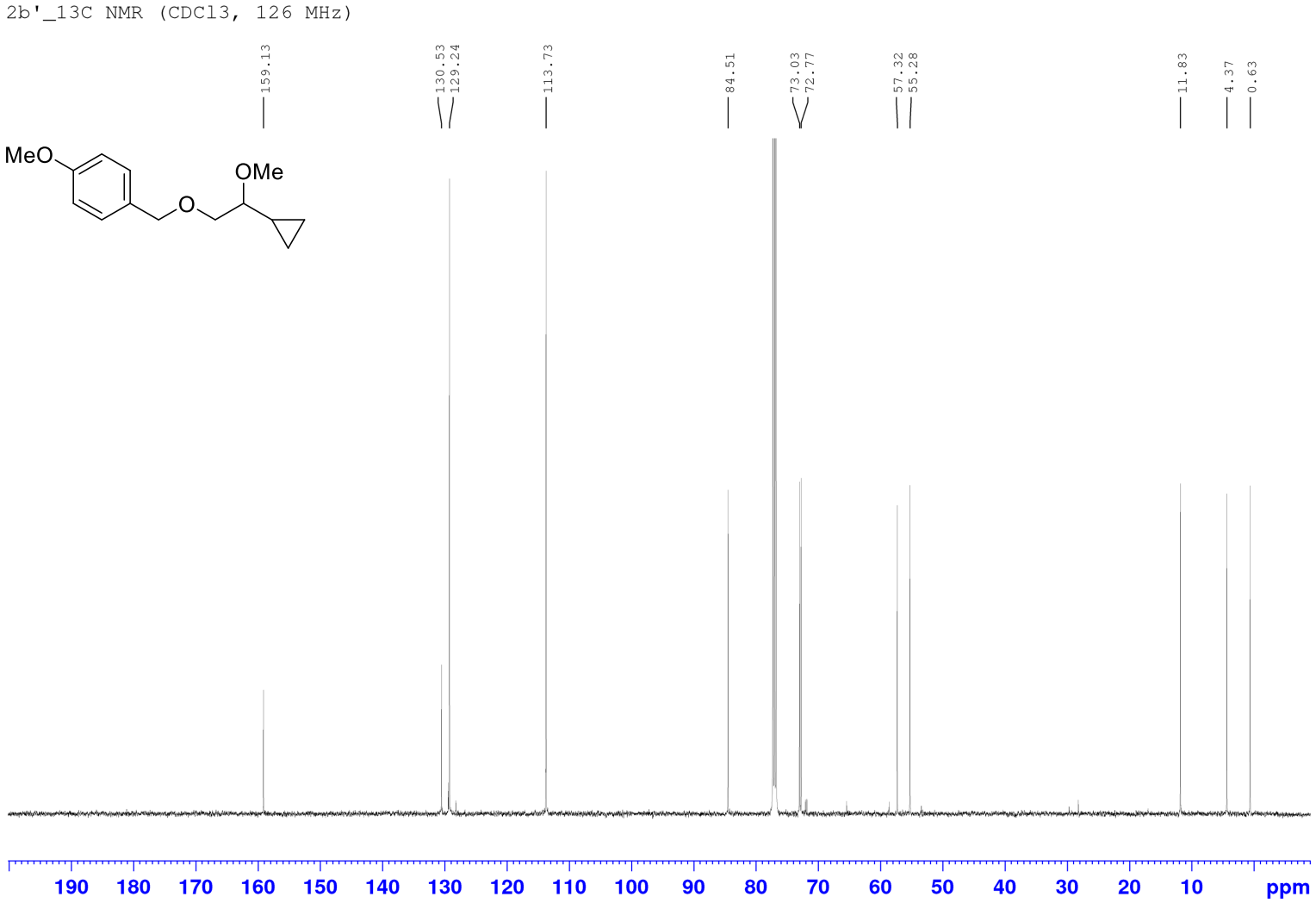

2a'_1H NMR (CDCl3, 500 MHz)
7.380
7.375
7.367
7.351
7.316
7.310
7.304
7.296
4.644
4.620
4.611
4.587
3.660
3.654
3.640
3.633
3.610
3.597
3.589
3.576
3.504
2.760
2.753
2.747
2.742
2.741
2.736
2.730
2.723
0.893
0.883
0.876
0.873
0.866
0.857
0.850
0.680
0.674
0.666
0.662
0.658
0.653
0.646
0.491
0.482
0.474
0.465
0.455
0.449
0.444
0.437
0.427
0.418
0.160
0.151
0.142
0.130
0.123
OMe
Ph
O
9
8
7
6
5
4
3
2
1
0
ppm
4.07
1.01
1.00
1.03
1.03
1.03
3.03
1.00
1.16
1.02
2.05
1.02

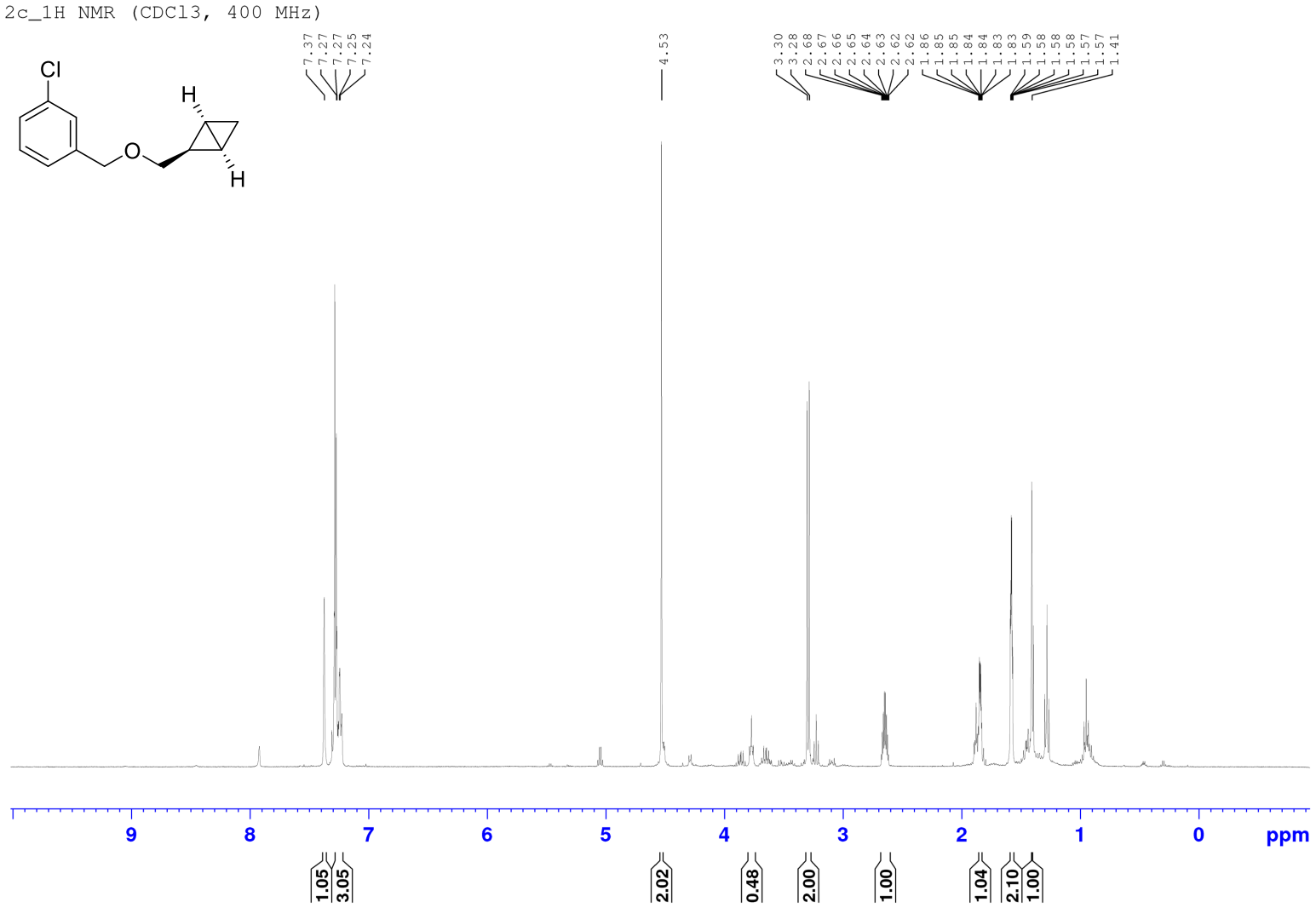

2a'_13C NMR (CDCl3, 126 MHz)
OMe
Ph
O
138.46
128.35
127.62
127.52
84.53
73.39
73.10
57.36
11.82
4.38
0.64
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

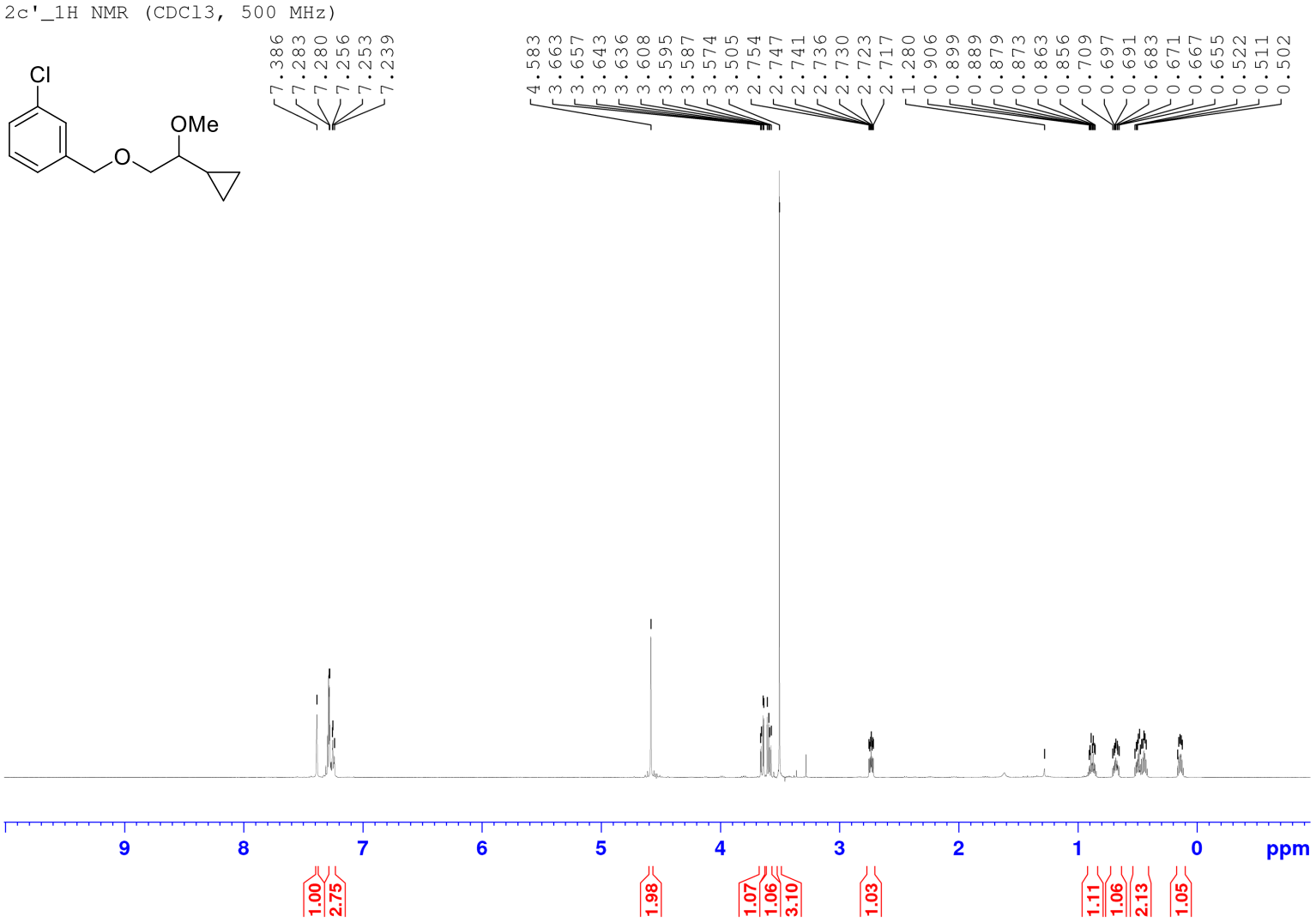

2b_1H NMR (CDCl3, 500MHz)
MeO
O
H
H
7.301
7.287
7.284
6.905
6.888
4.493
3.828
3.265
3.251
2.651
2.645
2.638
2.631
2.624
2.617
2.610
2.603
1.837
1.834
1.831
1.827
1.824
1.821
1.818
1.814
1.566
1.562
1.559
1.556
1.553
1.550
1.408
1.405
9
8
7
6
5
4
3
2
1
0
ppm
2.04
2.05
2.08
3.08
2.02
1.00
1.03
2.00
1.05

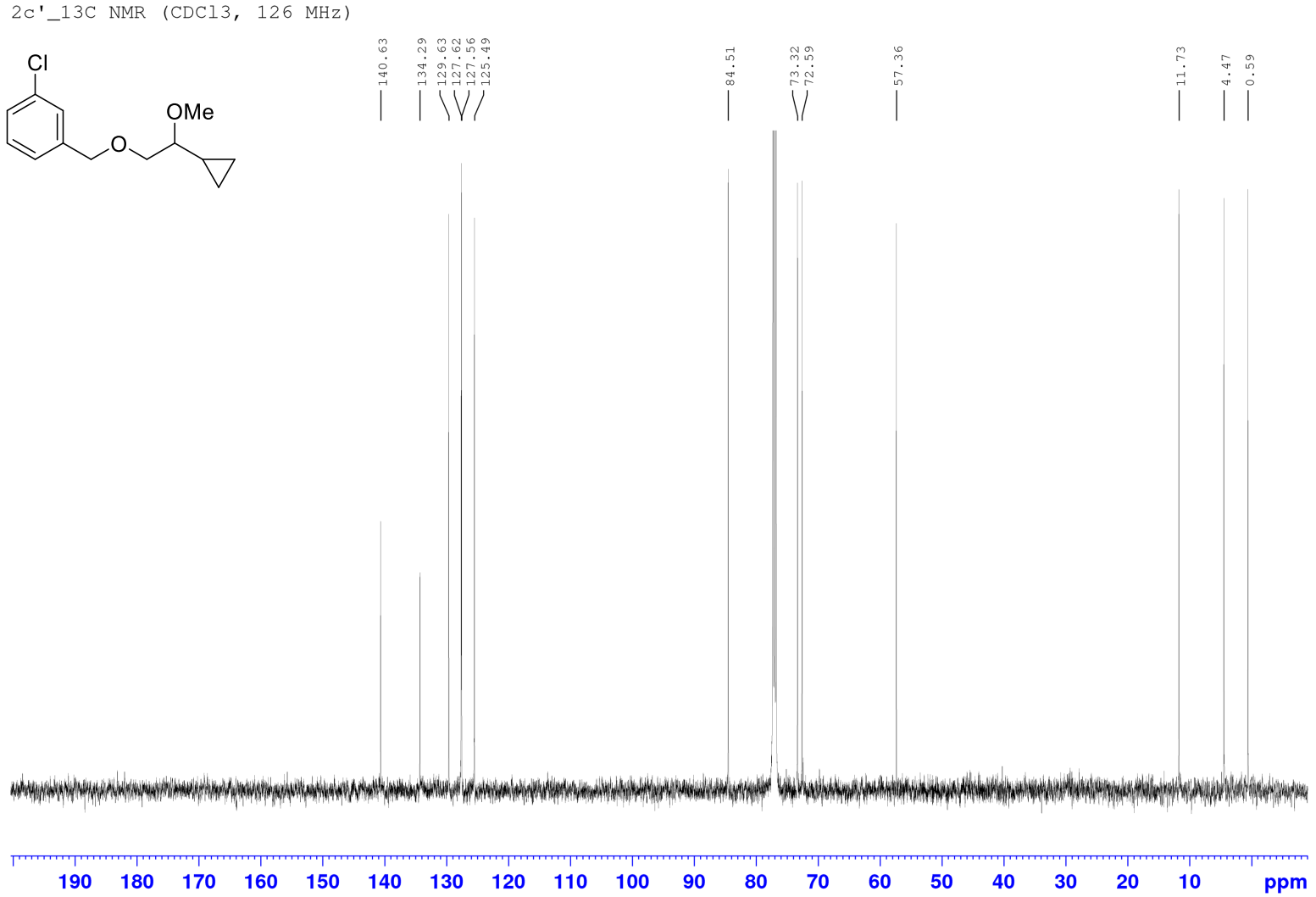

2b_13C NMR (CDCl3, 126 MHz)
159.11
130.72
129.33
113.73
72.24
63.40
55.29
45.79
30.23
1.25
MeO
O
H
H
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

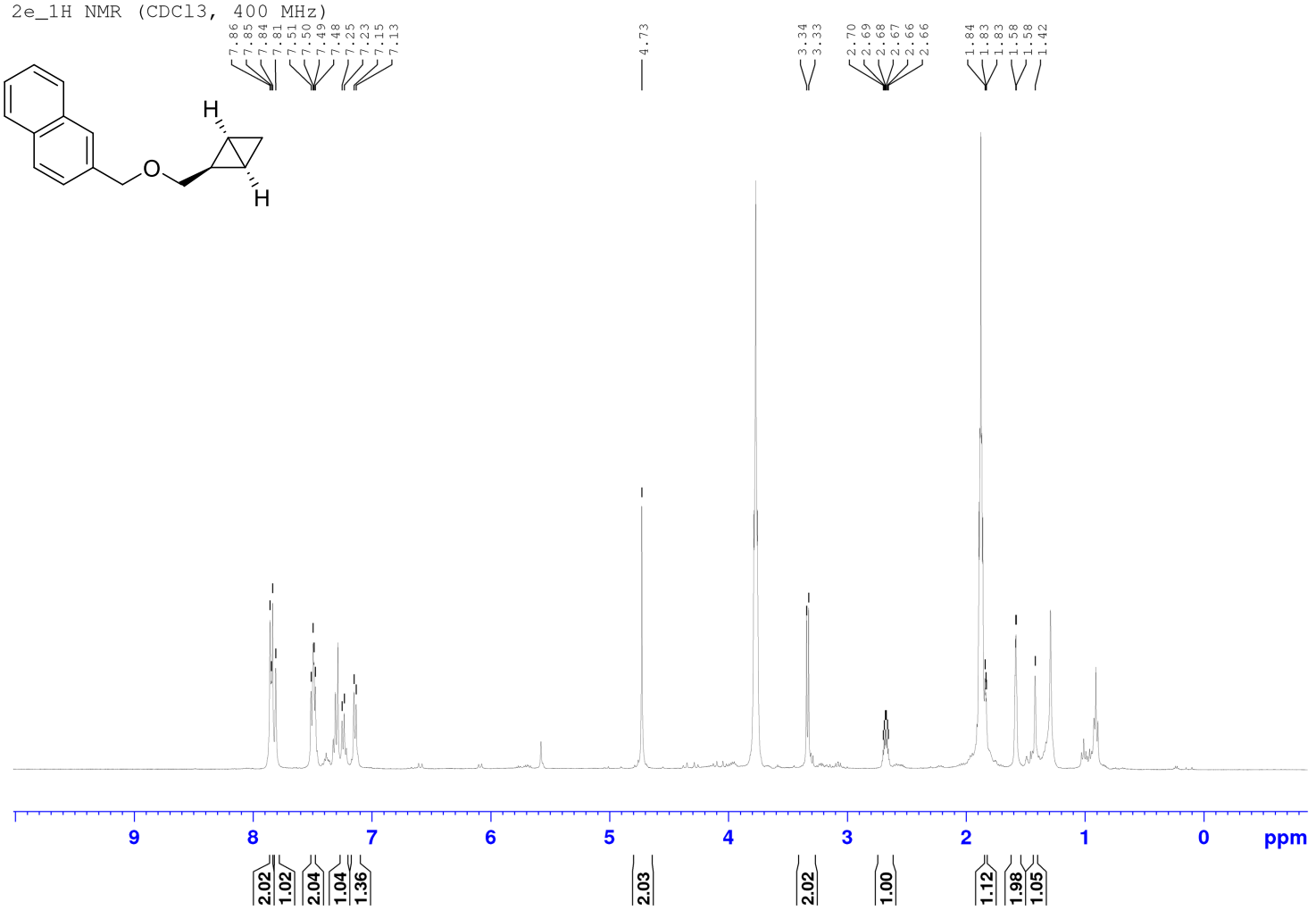

2b'_1H NMR (CDCl3, 500 MHz)
7.309
7.292
6.915
6.909
6.905
6.896
6.892
4.570
4.546
4.534
4.510
3.829
3.622
3.616
3.602
3.595
3.570
3.557
3.549
3.536
3.489
2.739
2.732
2.726
2.721
2.719
2.715
2.708
2.702
0.865
0.855
0.849
0.663
0.655
0.653
0.651
0.644
0.642
0.479
0.473
0.470
0.465
0.462
0.453
0.444
0.443
0.437
0.435
0.432
0.425
0.415
0.406
0.139
0.130
0.128
0.120
0.118
0.111
MeO
OMe
O
9
8
7
6
5
4
3
2
1
0
ppm
1.92
2.07
1.01
1.02
3.14
1.01
1.02
2.96
1.00
1.04
1.02
2.05
1.02

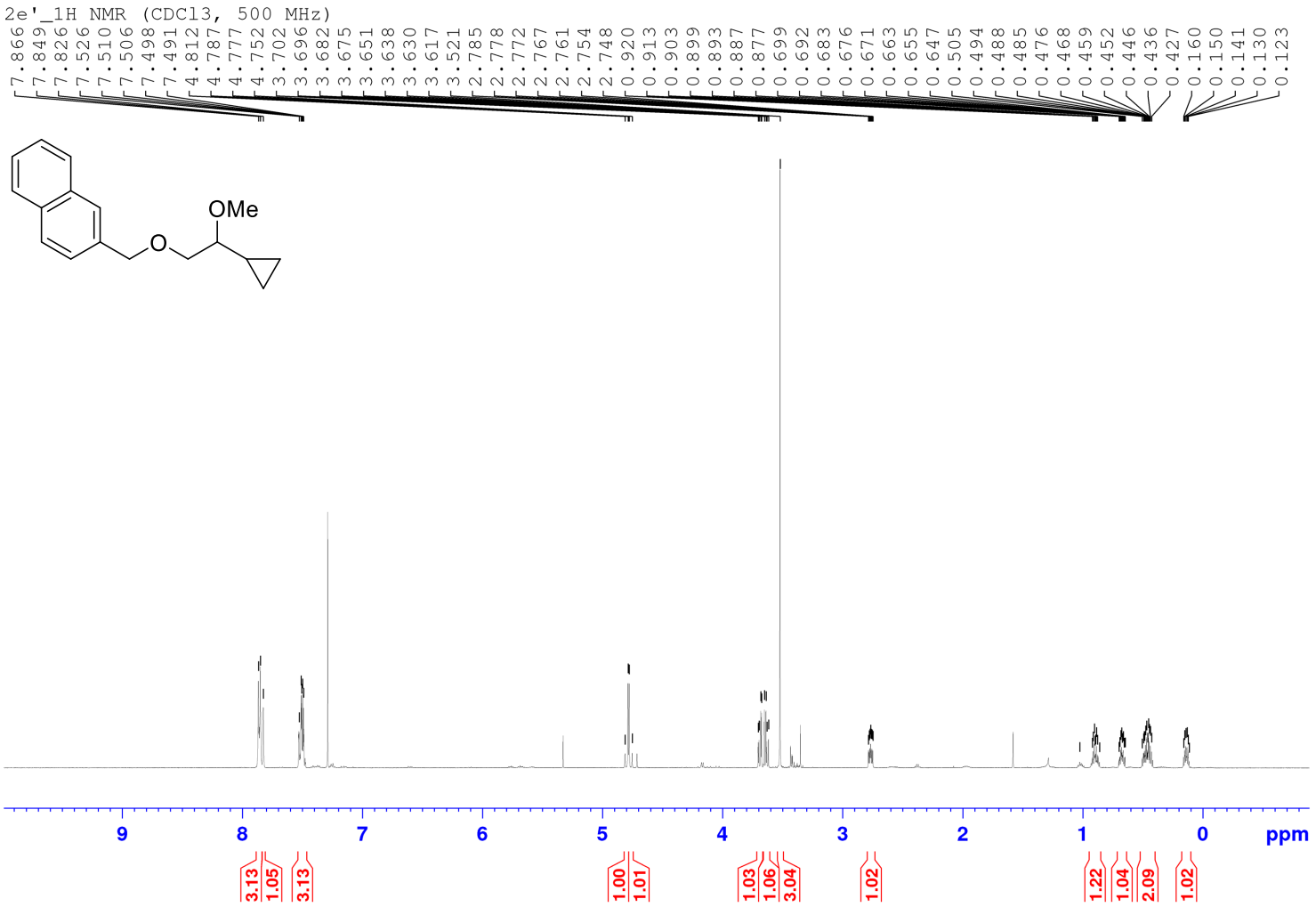

2b'_13C NMR (CDCl3, 126 MHz)
159.13
130.53
129.24
113.73
84.51
73.03
72.77
57.32
55.28
11.83
4.37
0.63
MeO
OMe
O
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

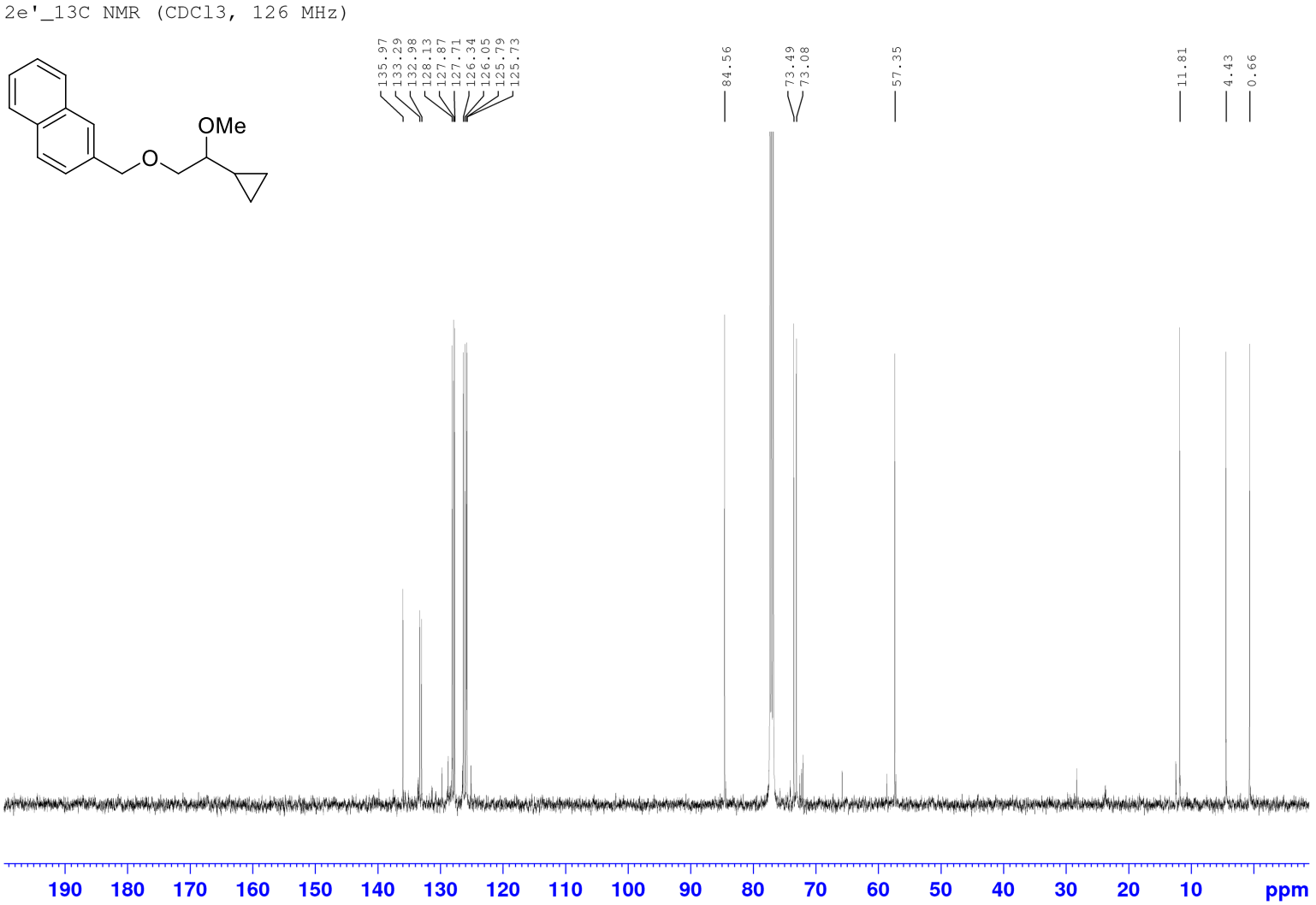

2c_1H NMR (CDCl3, 400 MHz)
Cl
H
O
H
7.37
7.27
7.27
7.25
7.24
4.53
3.30
3.28
2.68
2.67
2.66
2.65
2.64
2.63
2.62
2.62
1.86
1.85
1.85
1.84
1.84
1.83
1.83
1.59
1.58
1.58
1.57
1.57
1.41
9
8
7
6
5
4
3
2
1
0
ppm
1.05
3.05
2.02
0.48
2.00
1.00
1.04
2.10
1.00

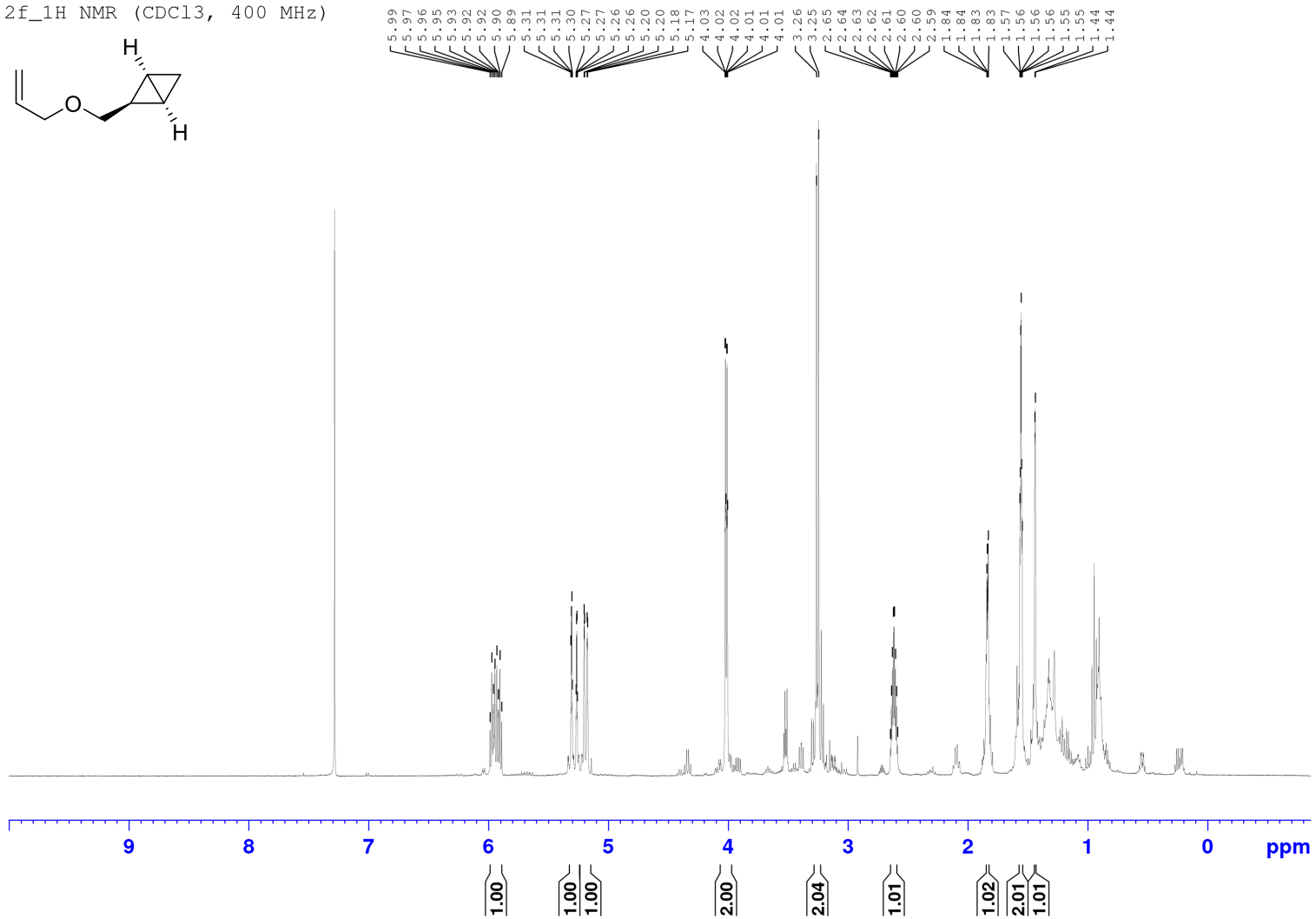

2c'_1H NMR (CDCl3, 500 MHz)
Cl
OMe
O
7.386
7.283
7.280
7.256
7.253
7.239
4.583
3.663
3.657
3.643
3.636
3.608
3.595
3.587
3.574
3.505
2.754
2.747
2.741
2.736
2.730
2.723
2.717
1.280
0.906
0.899
0.889
0.879
0.873
0.863
0.856
0.709
0.697
0.691
0.683
0.671
0.667
0.655
0.522
0.511
0.502
9
8
7
6
5
4
3
2
1
0
ppm
1.00
2.75
1.98
1.07
1.06
3.10
1.03
1.11
1.06
2.13
1.05

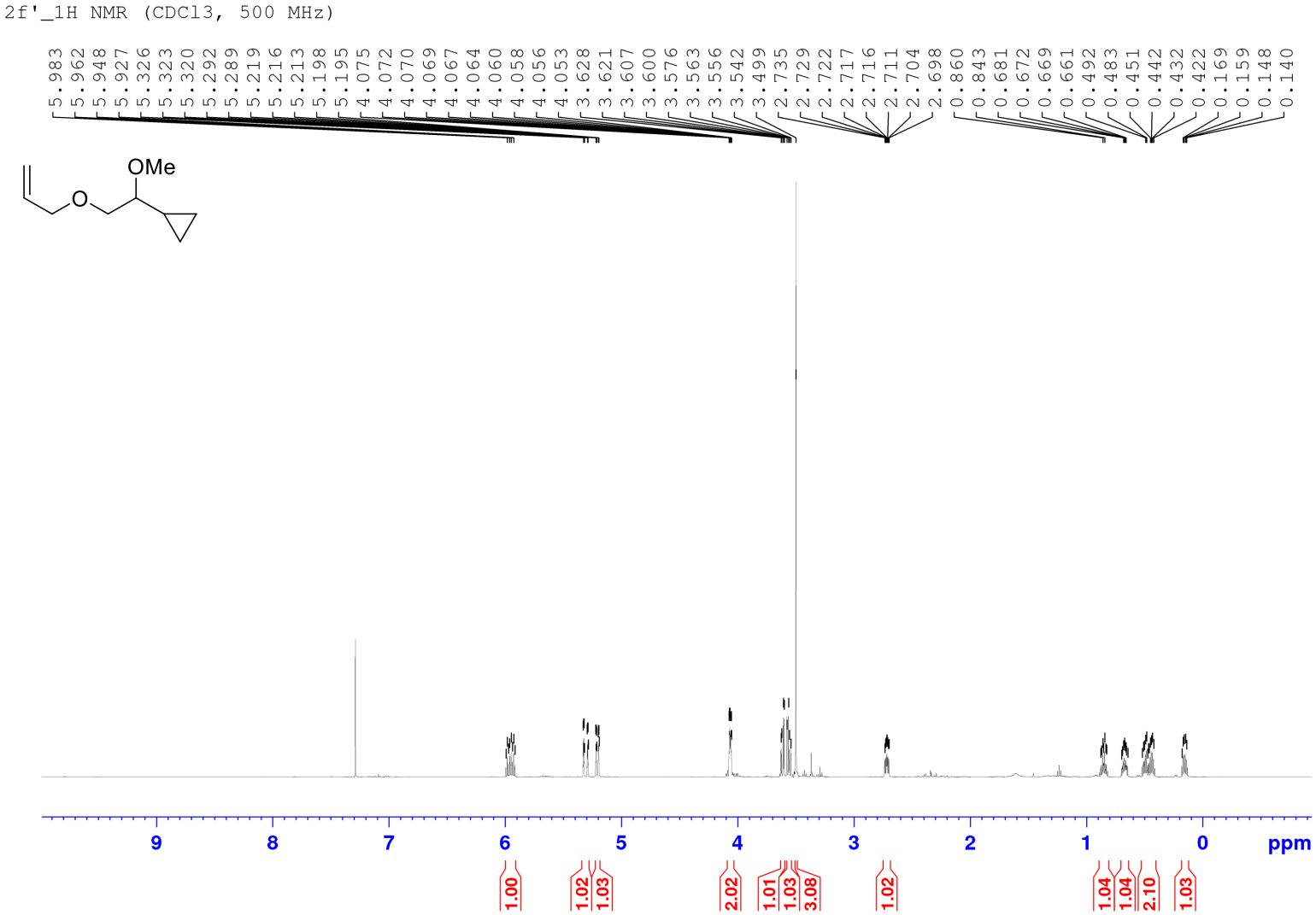

2c'_13C NMR (CDCl3, 126 MHz)
Cl
OMe
O
140.63
134.29
129.63
127.62
127.56
125.49
84.51
73.32
72.59
57.36
11.73
4.47
0.59
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

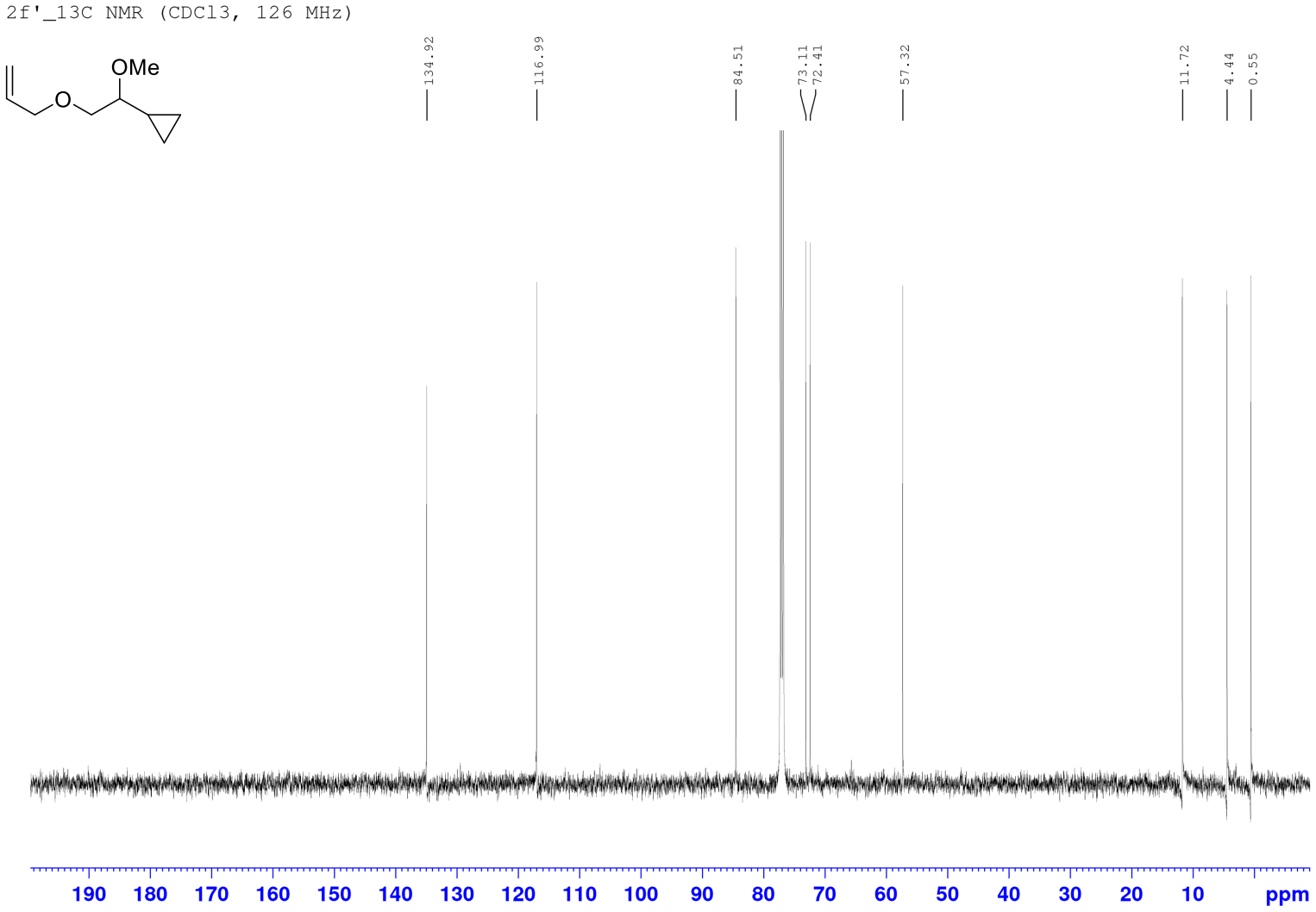

2e_1H NMR (CDCl3, 400 MHz)
7.86
7.85
7.84
7.81
7.51
7.50
7.49
7.48
7.25
7.23
7.15
7.13
4.73
3.34
3.33
2.70
2.69
2.68
2.67
2.66
2.66
1.84
1.83
1.83
1.58
1.58
1.42
H
O
H
9
8
7
6
5
4
3
2
1
0
ppm
2.02
1.02
2.04
1.04
1.36
2.03
2.02
1.00
1.12
1.98
1.05

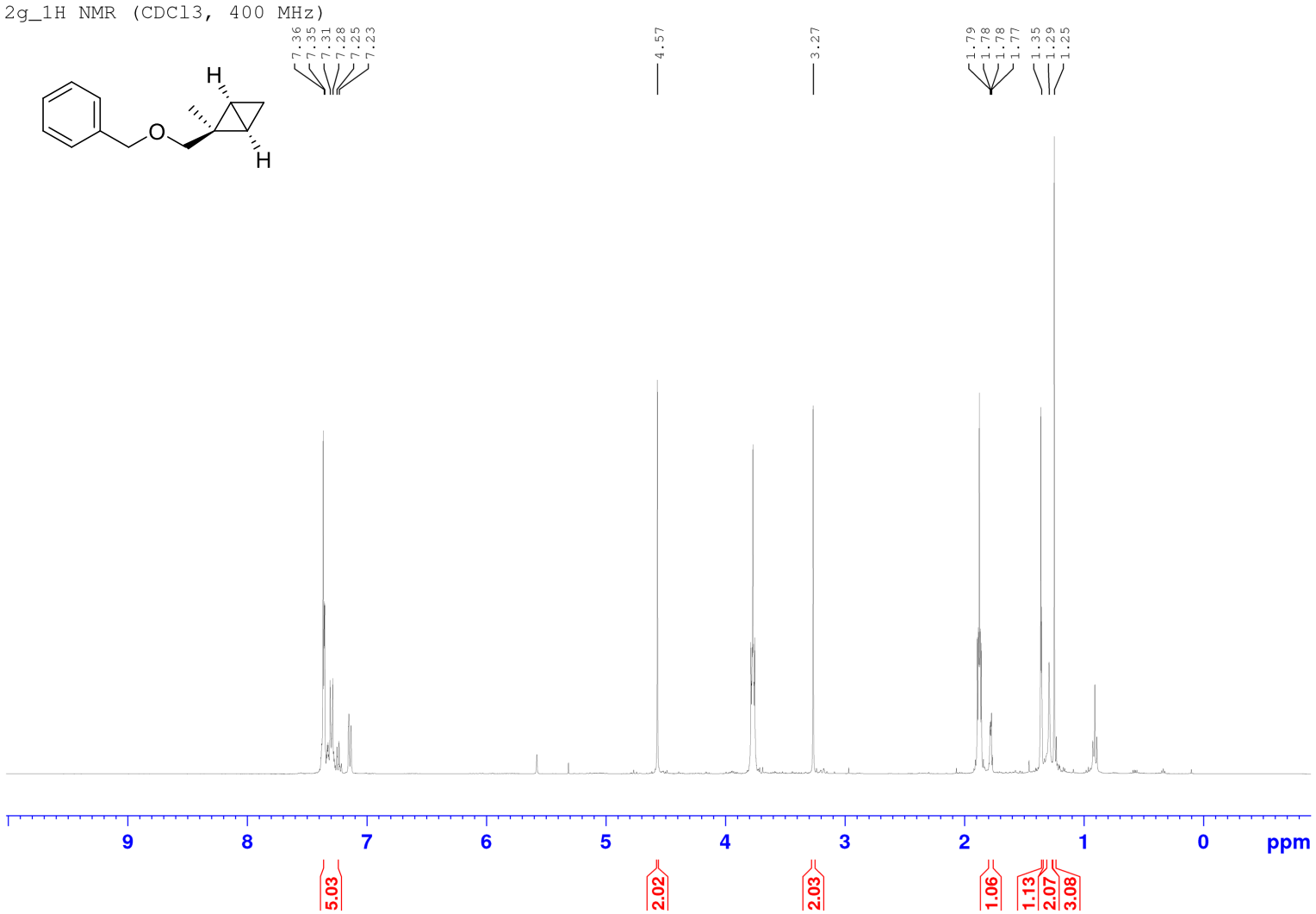

2e'_1H NMR (CDCl3, 500 MHz)
7.866
7.849
7.826
7.526
7.510
7.506
7.498
7.491
4.812
4.787
4.777
4.752
3.702
3.696
3.682
3.675
3.651
3.638
3.630
3.617
3.521
2.785
2.778
2.772
2.767
2.761
2.754
2.748
0.920
0.913
0.903
0.899
0.893
0.887
0.877
0.699
0.692
0.683
0.676
0.671
0.663
0.655
0.647
0.505
0.494
0.488
0.485
0.476
0.468
0.459
0.452
0.446
0.436
0.427
0.160
0.150
0.141
0.130
0.123
OMe
O
9
8
7
6
5
4
3
2
1
0
ppm
3.13
1.05
3.13
1.00
1.01
1.03
1.06
3.04
1.02
1.22
1.04
2.09
1.02

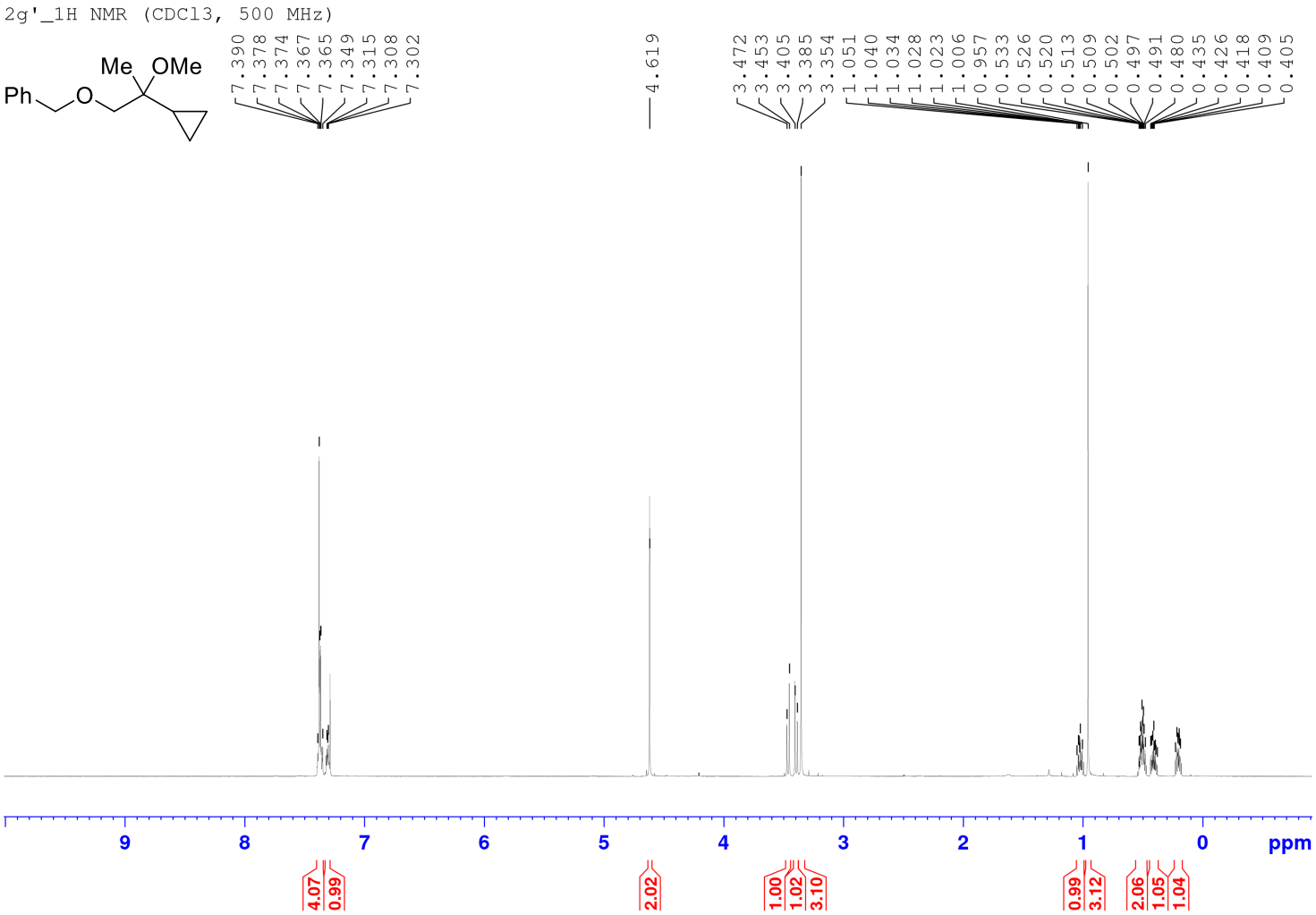

2e'_13C NMR (CDCl3, 126 MHz)
OMe
O
135.97
133.29
132.98
128.13
127.87
127.71
126.34
126.05
125.79
125.73
84.56
73.49
73.08
57.35
11.81
4.43
0.66
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

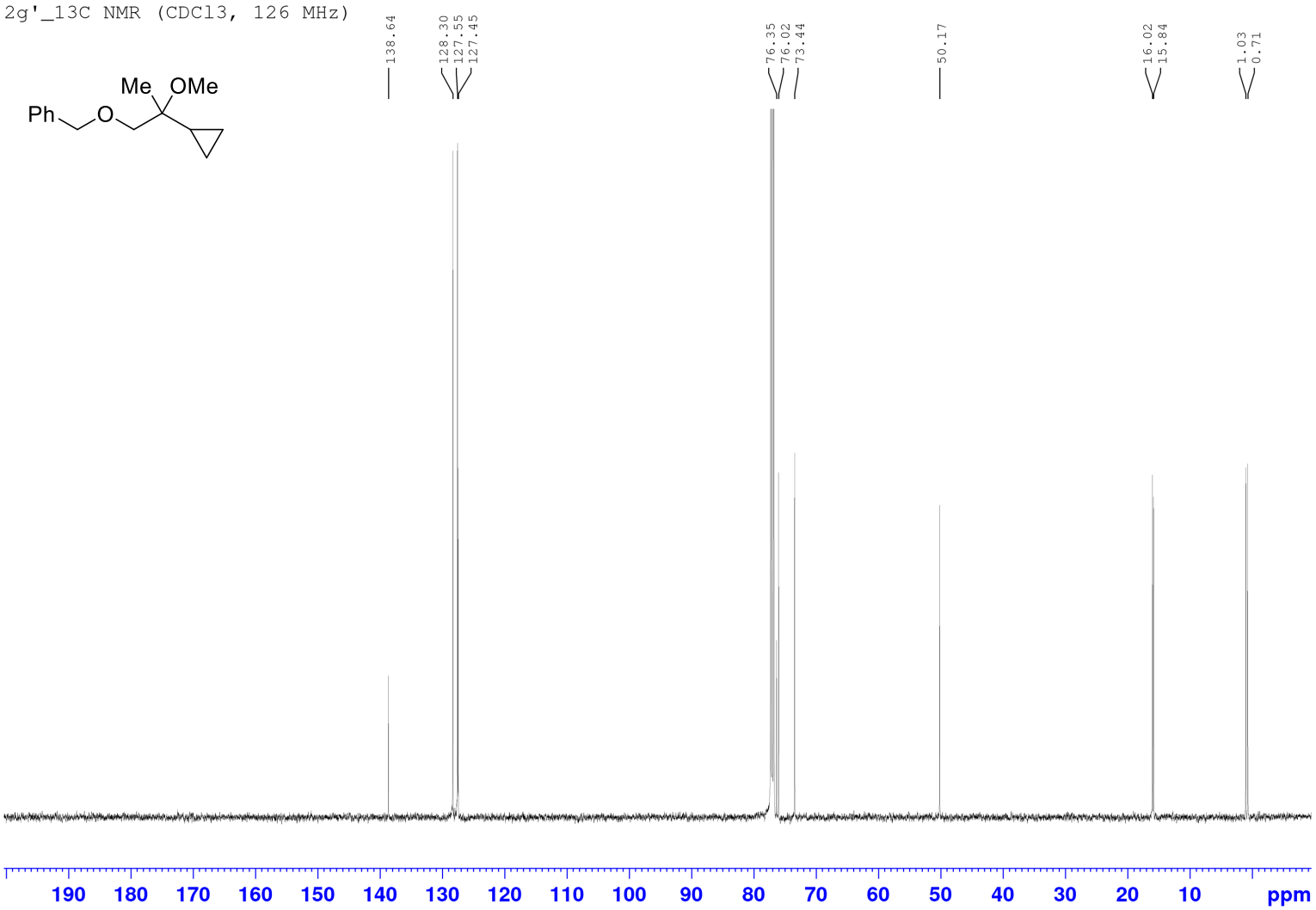

2f_1H NMR (CDCl3, 400 MHz)
5.99 5.97 5.96 5.95 5.93 5.92 5.92 5.90 5.89 5.31 5.31 5.31 5.30 5.27 5.27 5.26 5.26 5.20 5.20 5.18 5.17 4.03 4.02 4.02 4.01 4.01 4.01 3.26 3.25 2.65 2.64 2.63 2.62 2.61 2.60 2.60 2.59 1.84 1.84 1.83 1.83 1.57 1.56 1.56 1.56 1.55 1.55 1.44 1.44
H
O
H
9 8 7 6 5 4 3 2 1 0 ppm
1.00 1.00 1.00 2.00 2.04 1.01 1.02 2.01 1.01

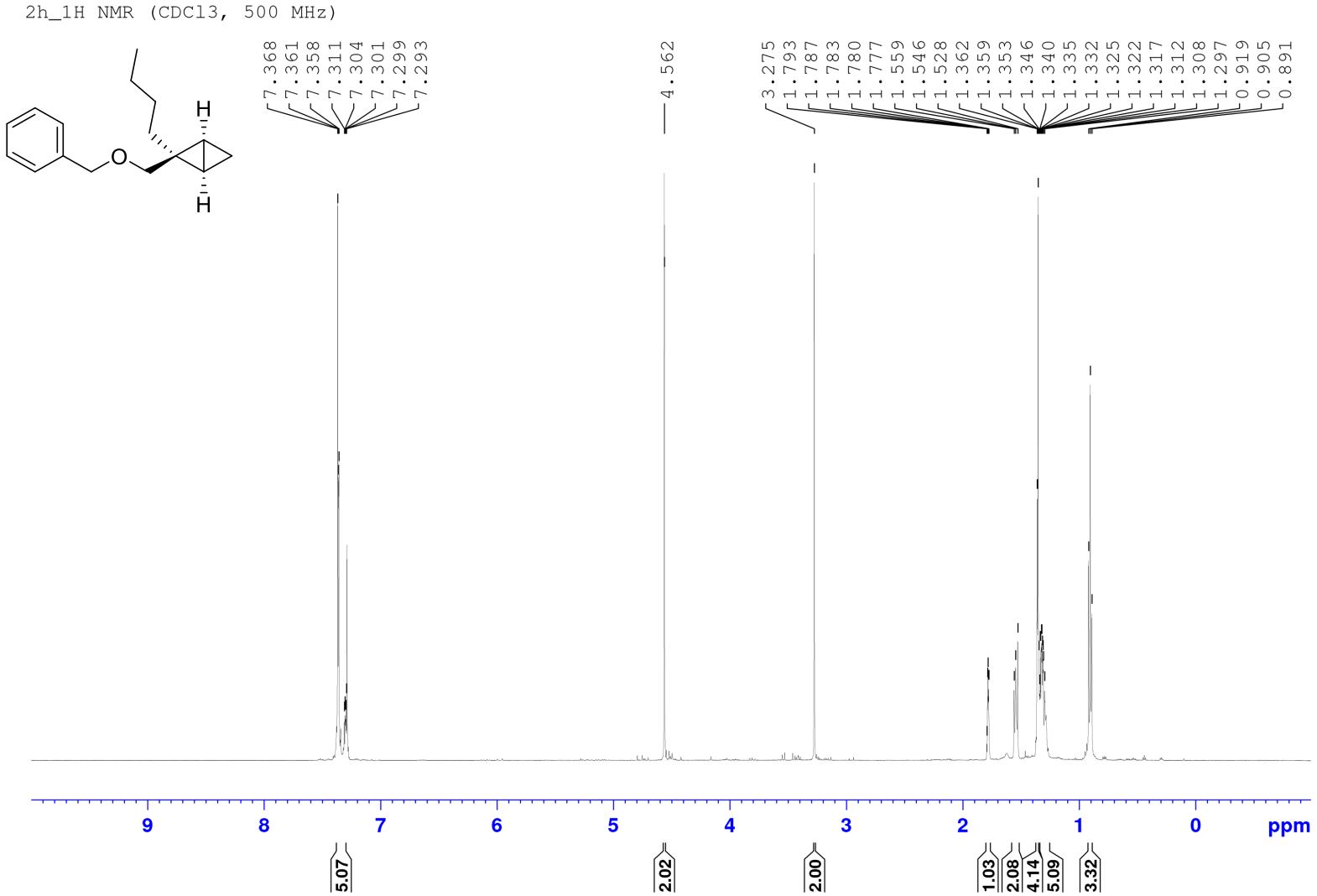

2f'_1H NMR (CDCl3, 500 MHz)
5.983
5.962
5.948
5.927
5.326
5.323
5.320
5.292
5.289
5.219
5.216
5.213
5.198
5.195
4.075
4.072
4.070
4.069
4.067
4.064
4.060
4.058
4.056
4.053
3.628
3.621
3.607
3.600
3.576
3.563
3.556
3.542
3.499
2.735
2.729
2.722
2.717
2.716
2.711
2.704
2.698
0.860
0.843
0.681
0.672
0.669
0.661
0.492
0.483
0.451
0.442
0.432
0.422
0.169
0.159
0.148
0.140
OMe
O
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.02
1.03
2.02
1.01
1.03
3.08
1.02
1.04
1.04
2.10
1.03

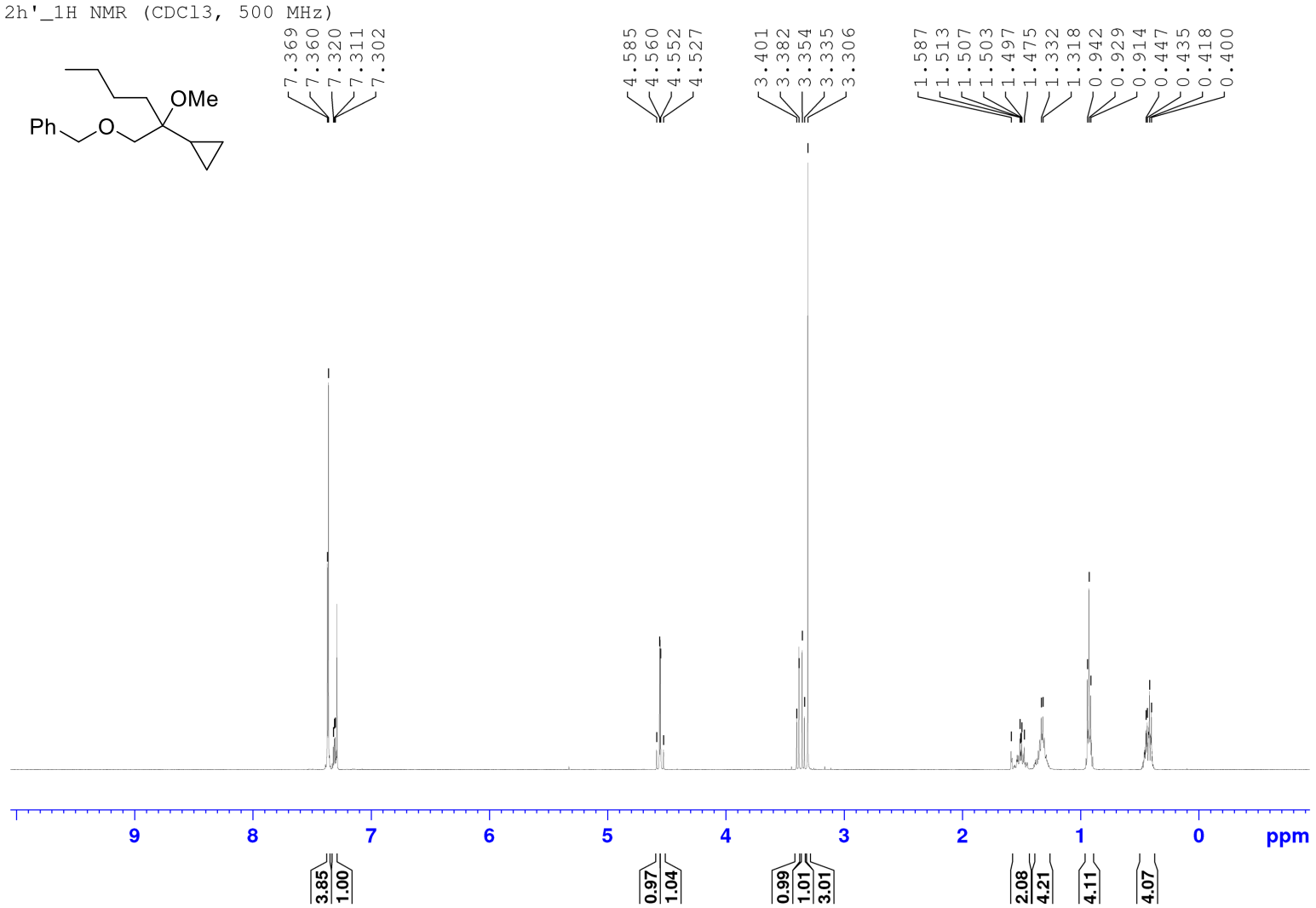

2f'_13C NMR (CDCl3, 126 MHz)
OMe
O
134.92
116.99
84.51
73.11
72.41
57.32
11.72
4.44
0.55
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

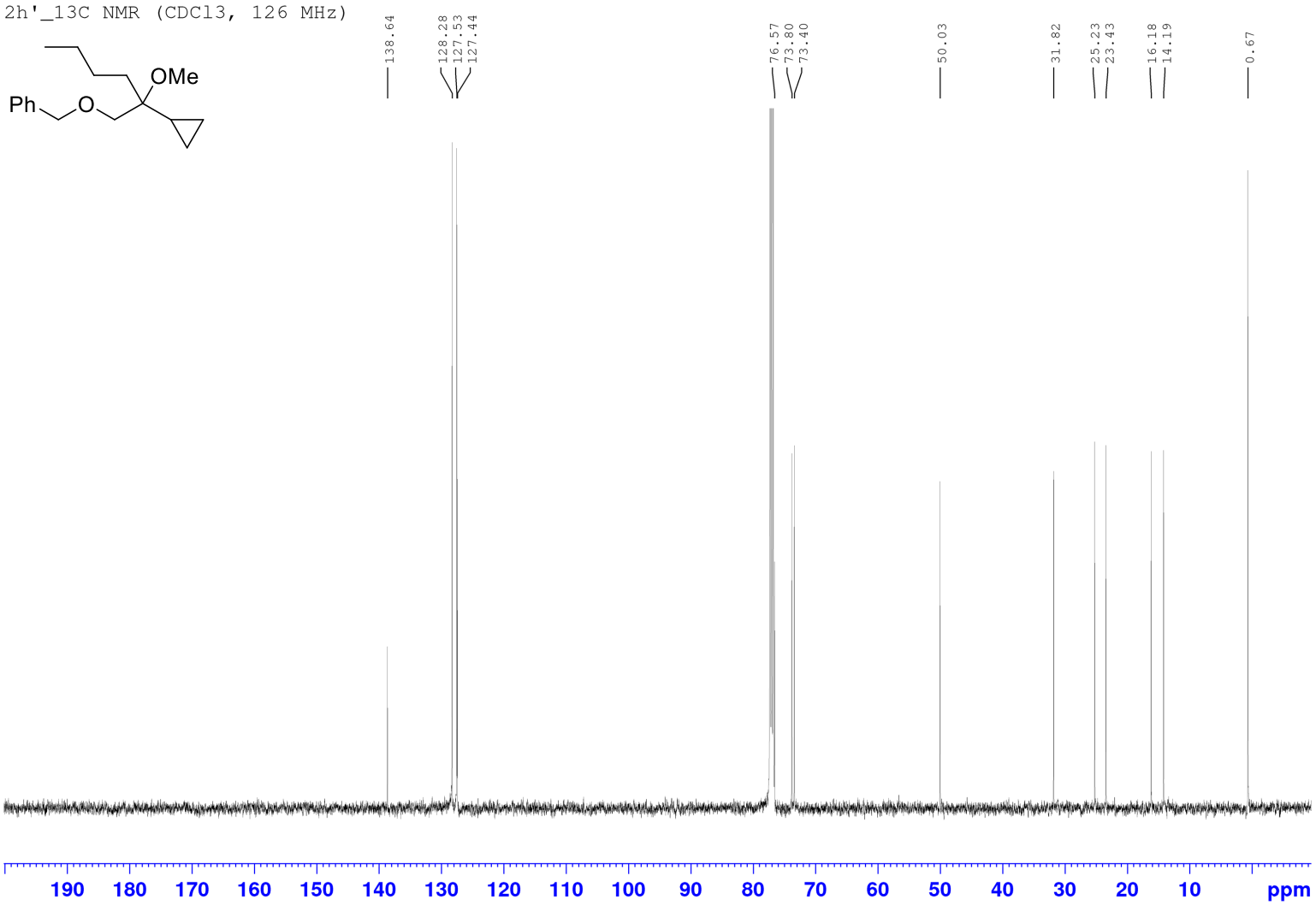

2g_1H NMR (CDCl3, 400 MHz)
7.36
7.35
7.31
7.28
7.25
7.23
4.57
3.27
1.79
1.78
1.78
1.77
1.35
1.29
1.25
H
O
H
9
8
7
6
5
4
3
2
1
0
ppm
5.03
2.02
2.03
1.06
1.13
2.07
3.08

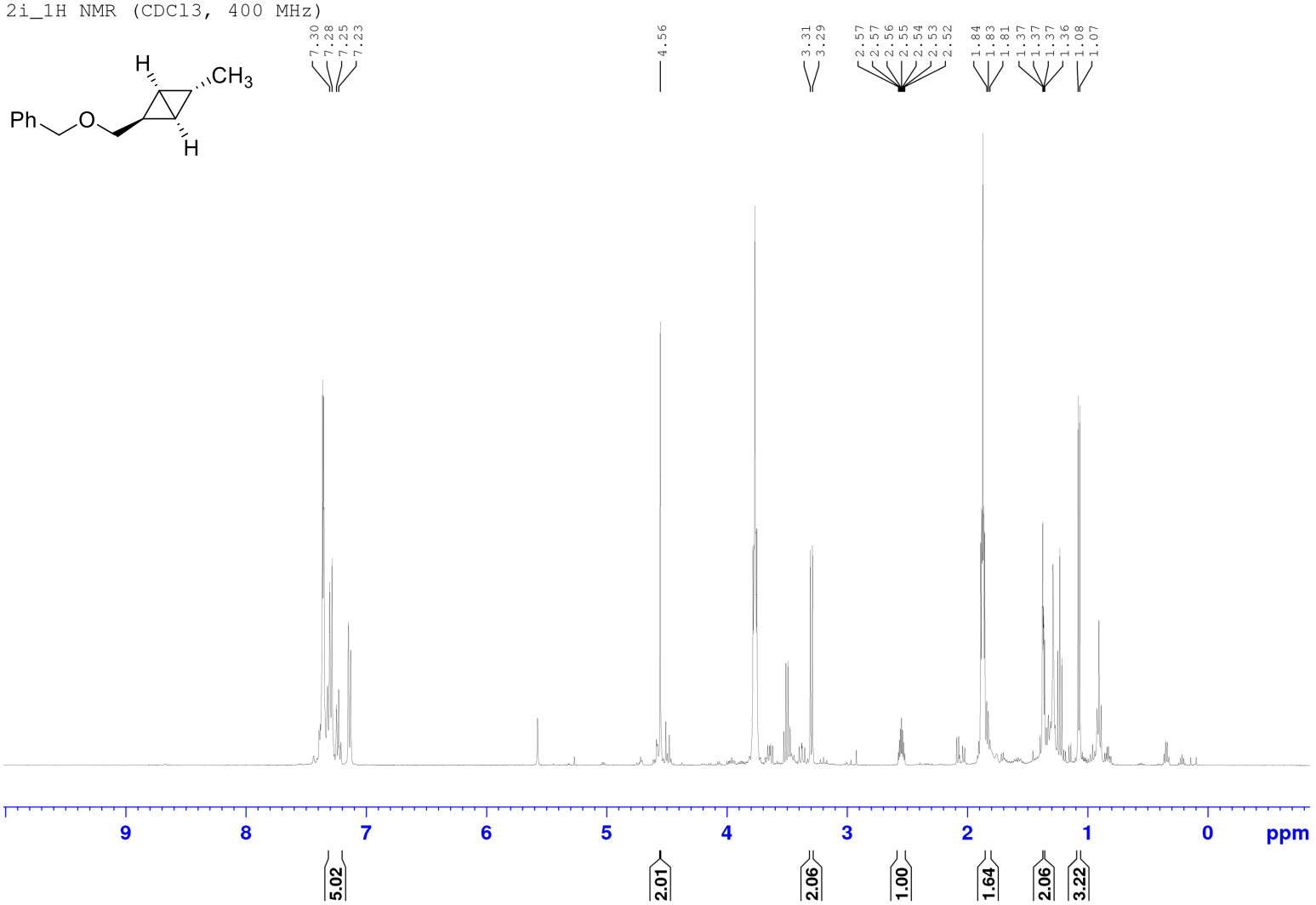

2g'_1H NMR (CDCl3, 500 MHz)
Ph
O
Me
OMe
7.390
7.378
7.374
7.367
7.365
7.349
7.315
7.308
7.302
4.619
3.472
3.453
3.405
3.385
3.354
1.051
1.040
1.034
1.028
1.023
1.006
0.957
0.533
0.526
0.520
0.513
0.509
0.502
0.497
0.491
0.480
0.435
0.426
0.418
0.409
0.405
9
8
7
6
5
4
3
2
1
0
ppm
4.07
0.99
2.02
1.00
1.02
3.10
0.99
3.12
2.06
1.05
1.04

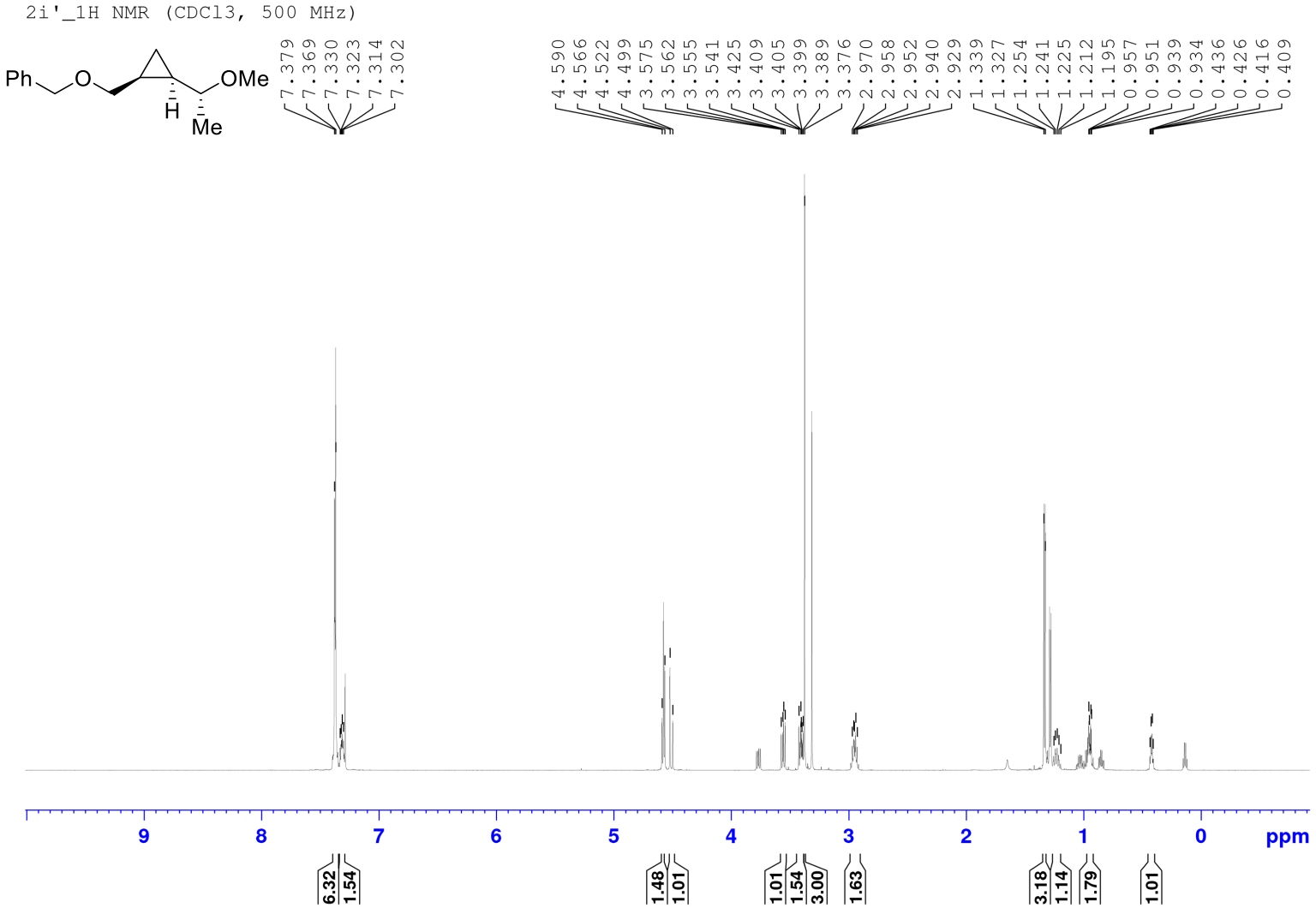

2g'_13C NMR (CDCl3, 126 MHz)
Me
OMe
Ph
O
138.64
128.30
127.55
127.45
76.35
76.02
73.44
50.17
16.02
15.84
1.03
0.71
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

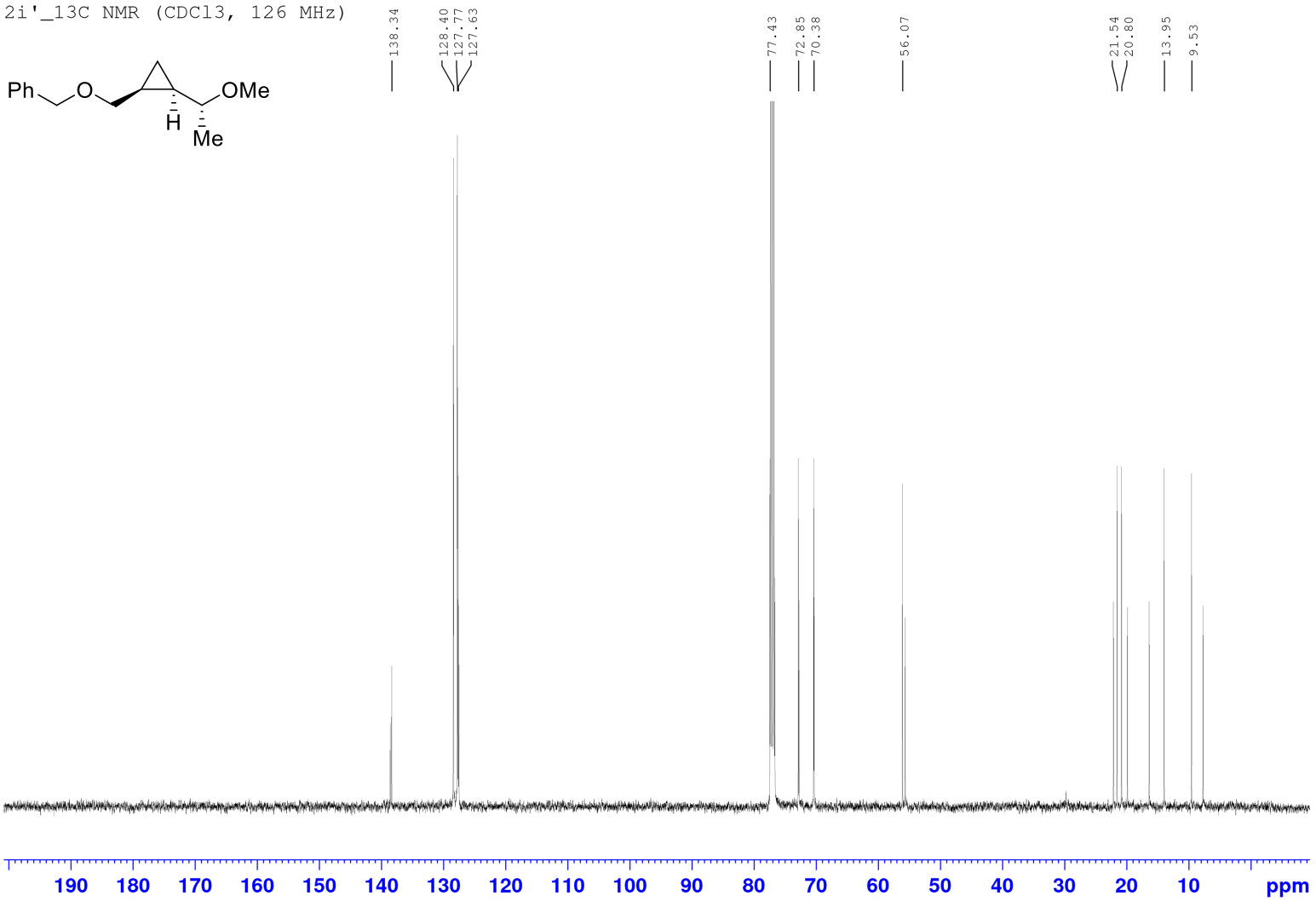

2h_1H NMR (CDCl3, 500 MHz)
7.368
7.361
7.358
7.311
7.304
7.301
7.299
7.293
4.562
3.275
1.793
1.787
1.783
1.780
1.777
1.559
1.546
1.528
1.362
1.359
1.353
1.346
1.340
1.335
1.332
1.325
1.322
1.317
1.312
1.308
1.297
0.919
0.905
0.891
O
H
H
9
8
7
6
5
4
3
2
1
0
ppm
5.07
2.02
2.00
1.03
2.08
4.14
5.09
3.32

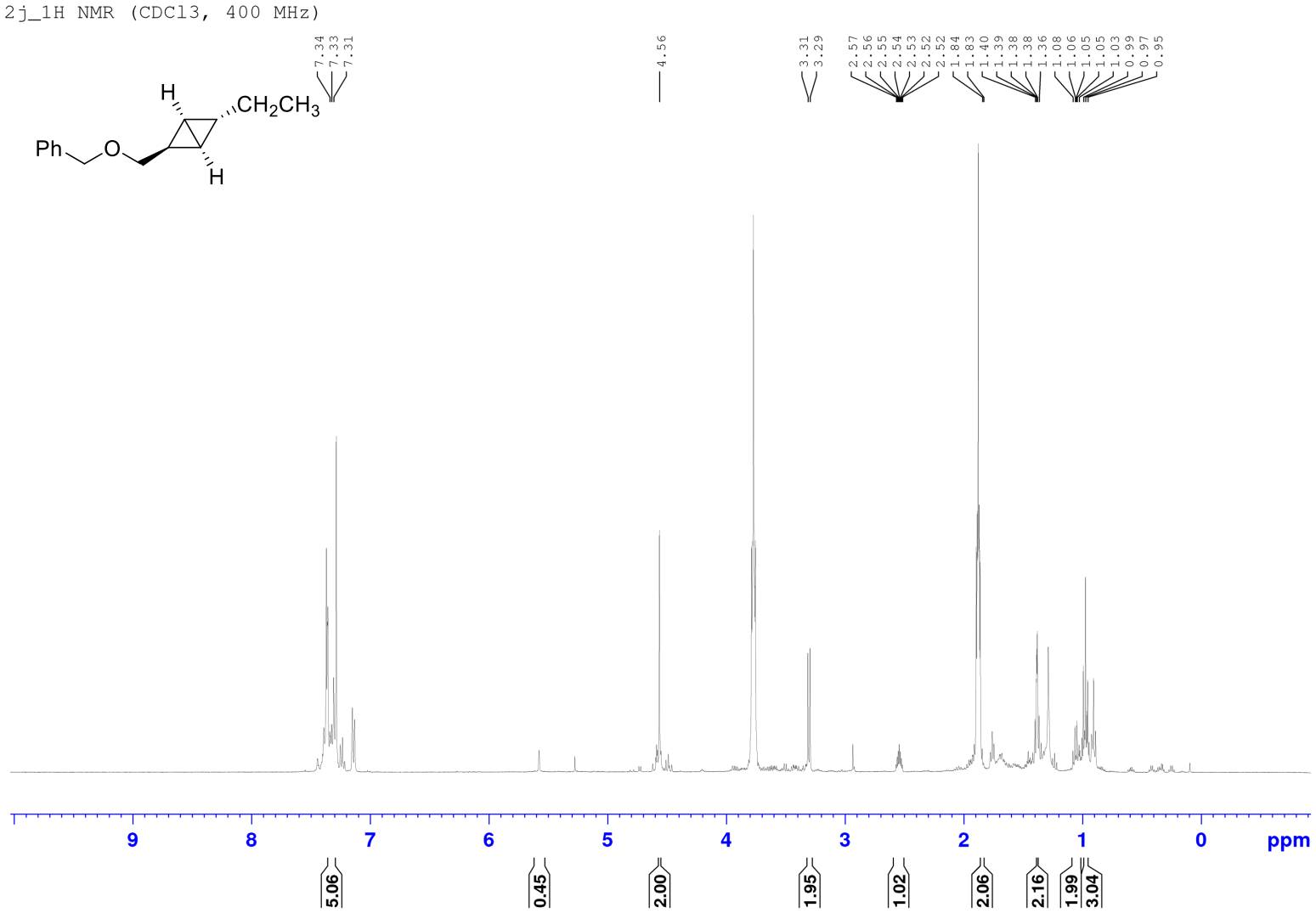

2h'_1H NMR (CDCl3, 500 MHz)
OMe
Ph
O
7.369
7.360
7.320
7.311
7.302
4.585
4.560
4.552
4.527
3.401
3.382
3.354
3.335
3.306
1.587
1.513
1.507
1.503
1.497
1.475
1.332
1.318
0.942
0.929
0.914
0.447
0.435
0.418
0.400
9
8
7
6
5
4
3
2
1
0
ppm
3.85
1.00
0.97
1.04
0.99
1.01
3.01
2.08
4.21
4.11
4.07

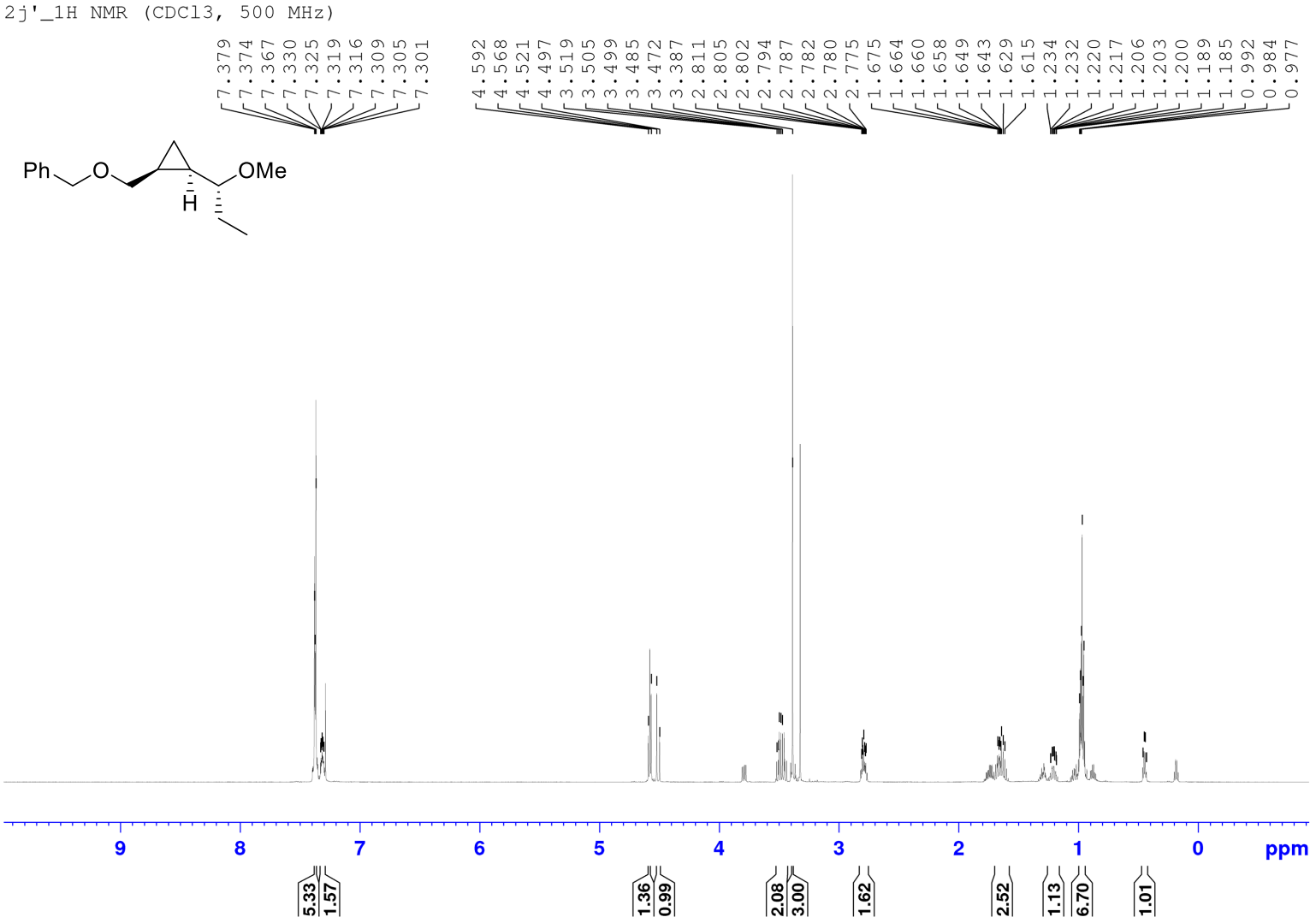

2h'_13C NMR (CDCl3, 126 MHz)
OMe
Ph
O
138.64
128.28
127.53
127.44
76.57
73.80
73.40
50.03
31.82
25.23
23.43
16.18
14.19
0.67
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

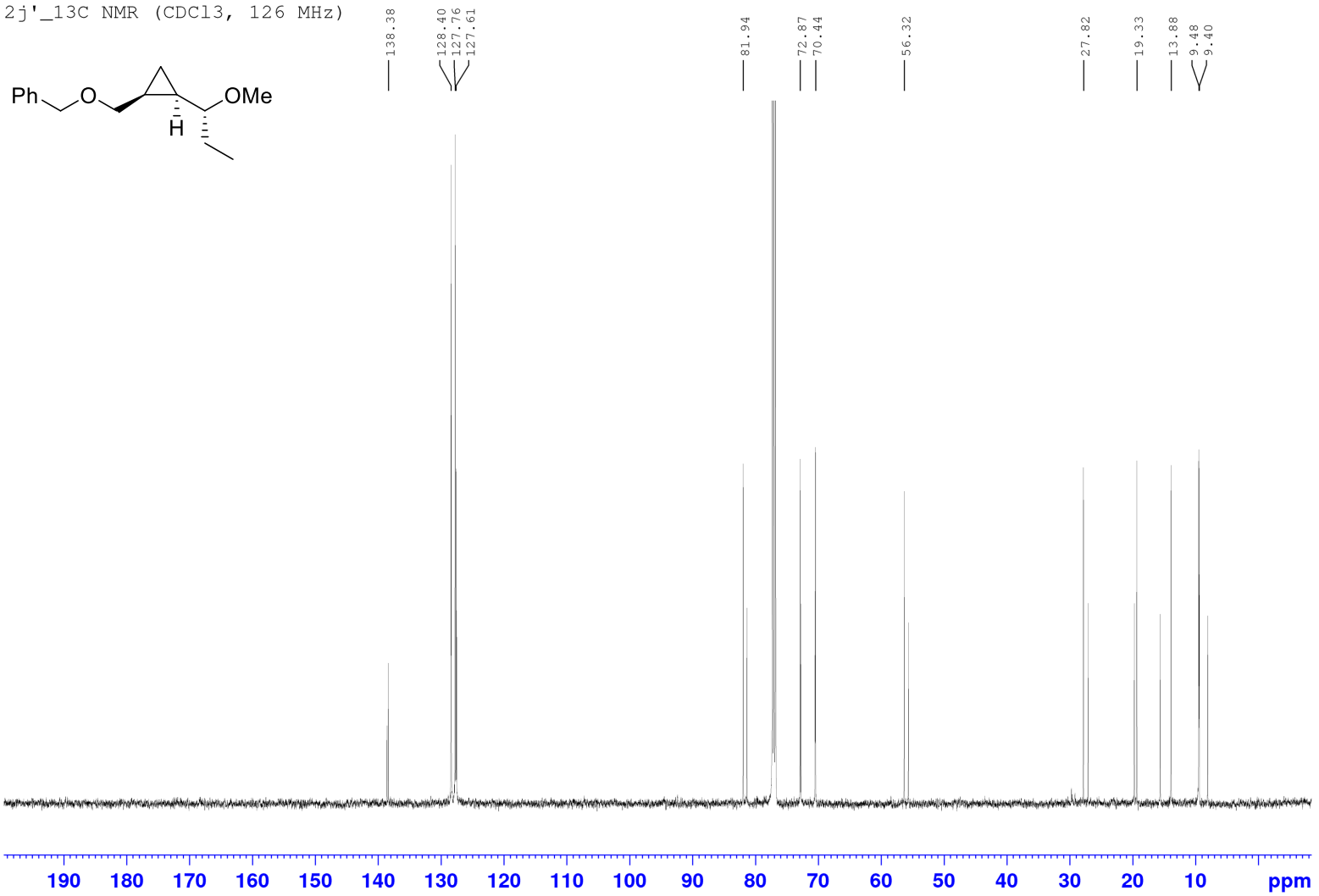

2i_1H NMR (CDCl3, 400 MHz)
7.30
7.28
7.25
7.23
4.56
3.31
3.29
2.57
2.57
2.56
2.55
2.54
2.53
2.52
1.84
1.83
1.81
1.37
1.37
1.37
1.36
1.08
1.07
H
CH3
Ph
O
H
9
8
7
6
5
4
3
2
1
0
ppm
5.02
2.01
2.06
1.00
1.64
2.06
3.22

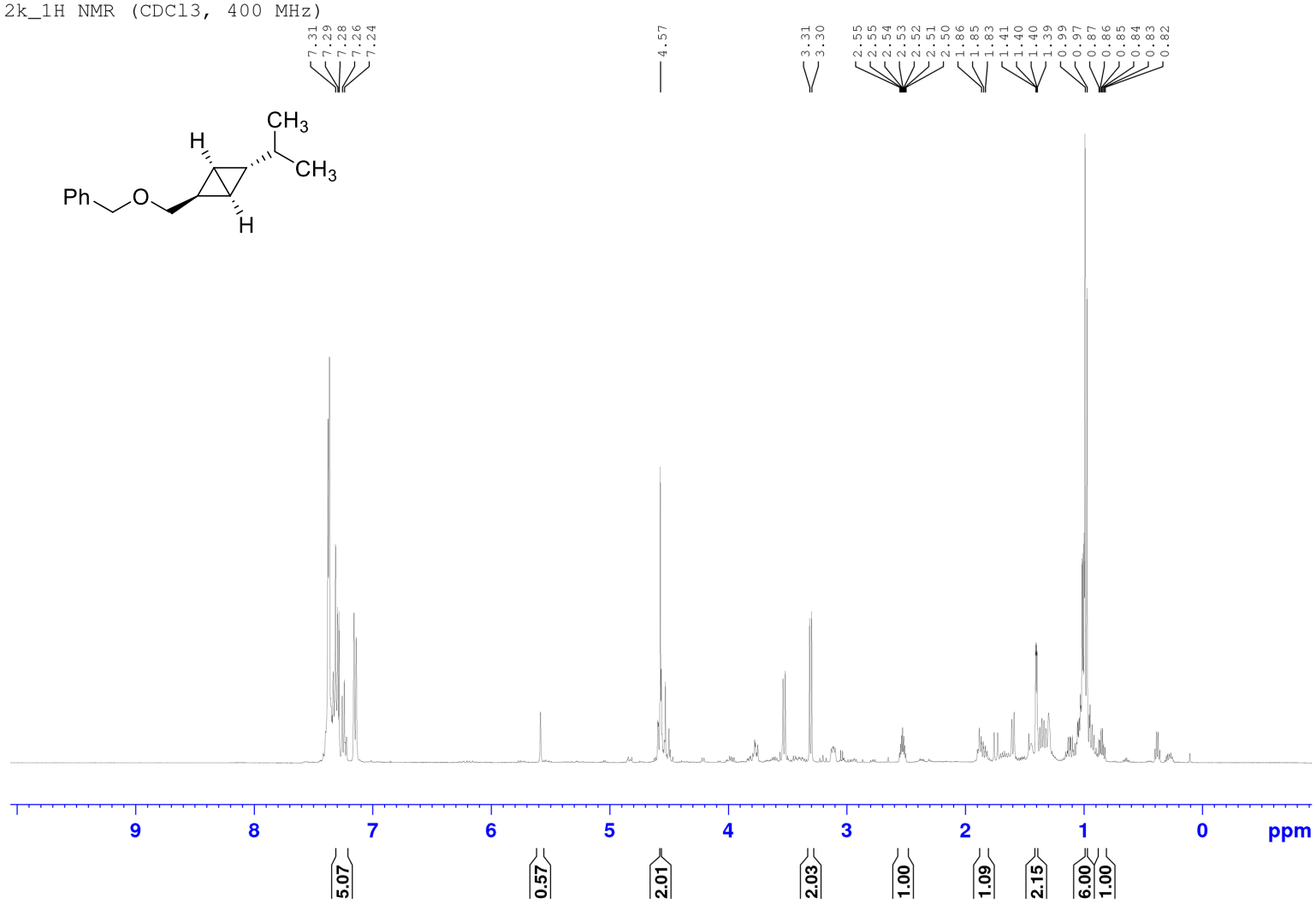

2i'_1H NMR (CDCl3, 500 MHz)
Ph
O
OMe
H
Me
7.379
7.369
7.330
7.323
7.314
7.302
4.590
4.566
4.522
4.499
3.575
3.562
3.555
3.541
3.425
3.409
3.405
3.399
3.389
3.376
2.970
2.958
2.952
2.940
2.929
1.339
1.327
1.254
1.241
1.225
1.212
1.195
0.957
0.951
0.939
0.934
0.436
0.426
0.416
0.409
9
8
7
6
5
4
3
2
1
0
ppm
6.32
1.54
1.48
1.01
1.01
1.54
3.00
1.63
3.18
1.14
1.79
1.01

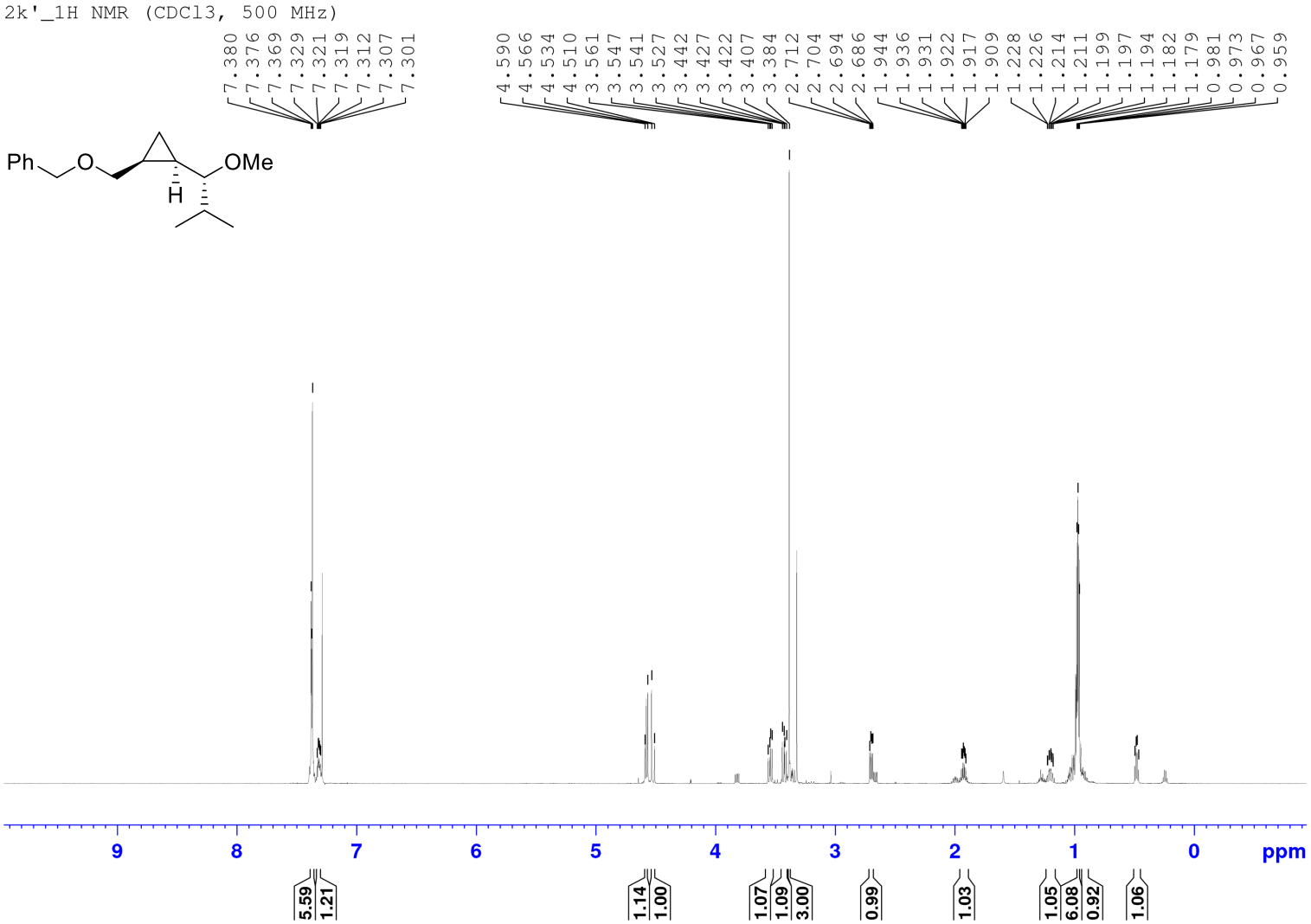

2i'_13C NMR (CDCl3, 126 MHz)
Ph
O
OMe
H
Me
138.34
128.40
127.77
127.63
77.43
72.85
70.38
56.07
21.54
20.80
13.95
9.53
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

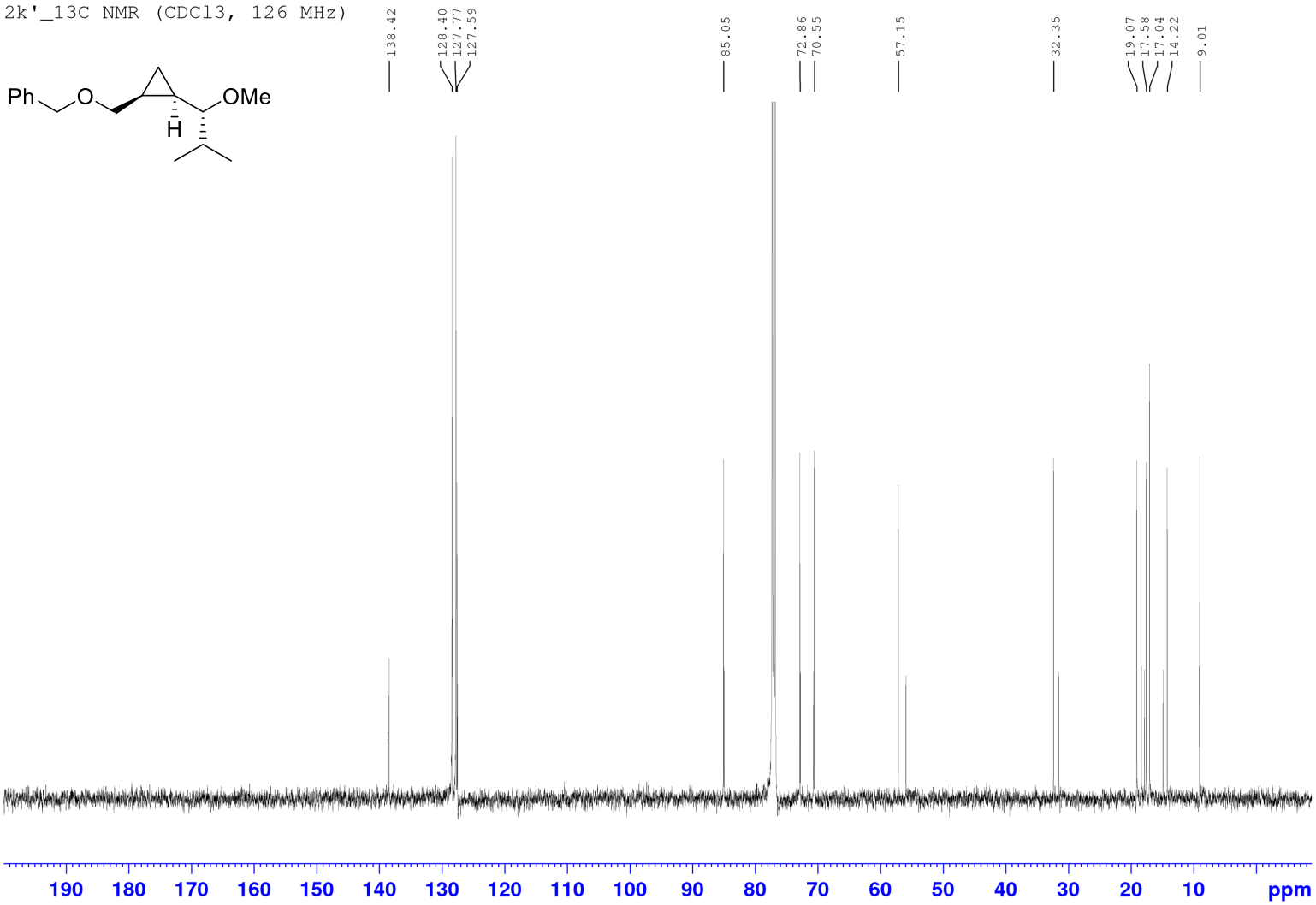

2j_1H NMR (CDCl3, 400 MHz)
7.34
7.33
7.31
4.56
3.31
3.29
2.57
2.56
2.55
2.54
2.53
2.52
2.52
1.84
1.83
1.40
1.39
1.38
1.38
1.36
1.08
1.06
1.05
1.05
1.03
0.99
0.97
0.95
H
CH2CH3
Ph
O
H
9
8
7
6
5
4
3
2
1
0
ppm
5.06
0.45
2.00
1.95
1.02
2.06
2.16
1.99
3.04

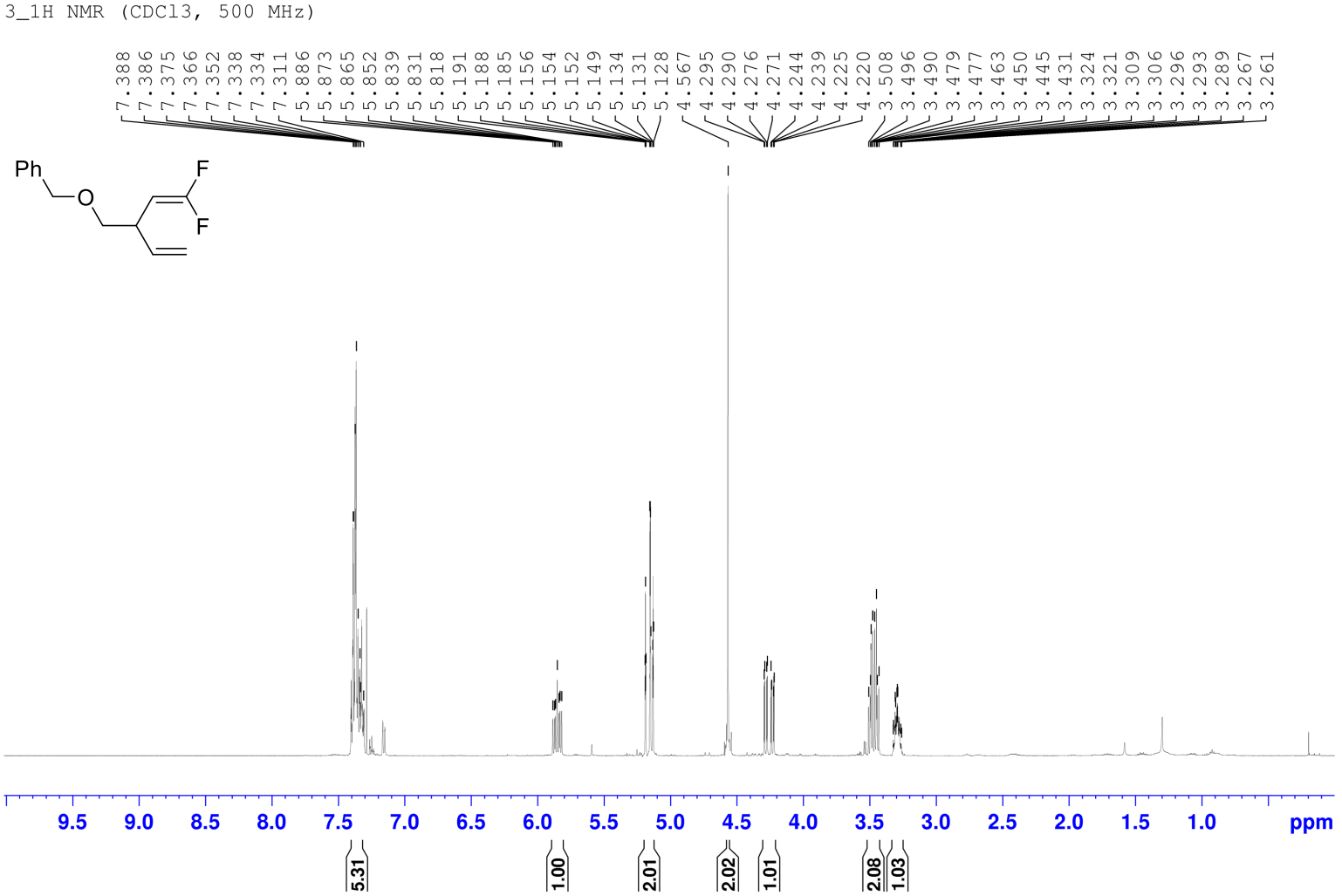

2j'_1H NMR (CDCl3, 500 MHz)
7.379
7.374
7.367
7.330
7.325
7.319
7.316
7.309
7.305
7.301
4.592
4.568
4.521
4.497
3.519
3.505
3.499
3.485
3.472
3.387
2.811
2.805
2.802
2.794
2.787
2.782
2.780
2.775
1.675
1.664
1.660
1.658
1.649
1.643
1.629
1.615
1.234
1.232
1.220
1.217
1.206
1.203
1.200
1.189
1.185
0.992
0.984
0.977
Ph
O
OMe
H
9
8
7
6
5
4
3
2
1
0
ppm
5.33
1.57
1.36
0.99
2.08
3.00
1.62
2.52
1.13
6.70
1.01


2j'_13C NMR (CDCl3, 126 MHz)
Ph
O
OMe
H
138.38
128.40
127.76
127.61
81.94
72.87
70.44
56.32
27.82
19.33
13.88
9.48
9.40
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

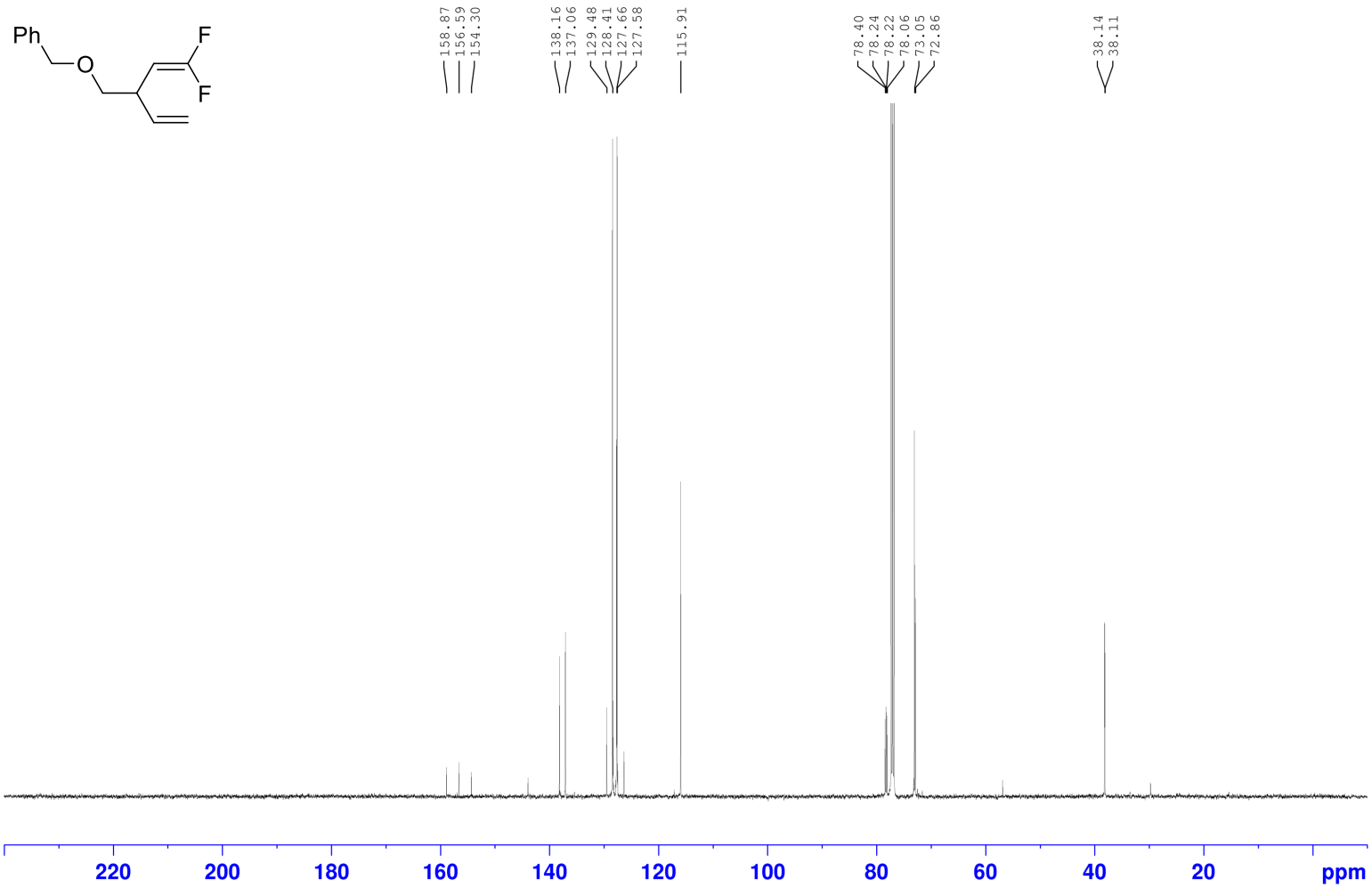

2k_1H NMR (CDCl3, 400 MHz)
7.31
7.29
7.28
7.26
7.24
4.57
3.31
3.30
2.55
2.55
2.54
2.53
2.52
2.51
2.50
1.86
1.85
1.83
1.41
1.40
1.39
0.99
0.97
0.87
0.86
0.85
0.84
0.83
0.82
CH3
CH3
H
Ph
O
H
9
8
7
6
5
4
3
2
1
0
ppm
5.07
0.57
2.01
2.03
1.00
1.09
2.15
6.00
1.00

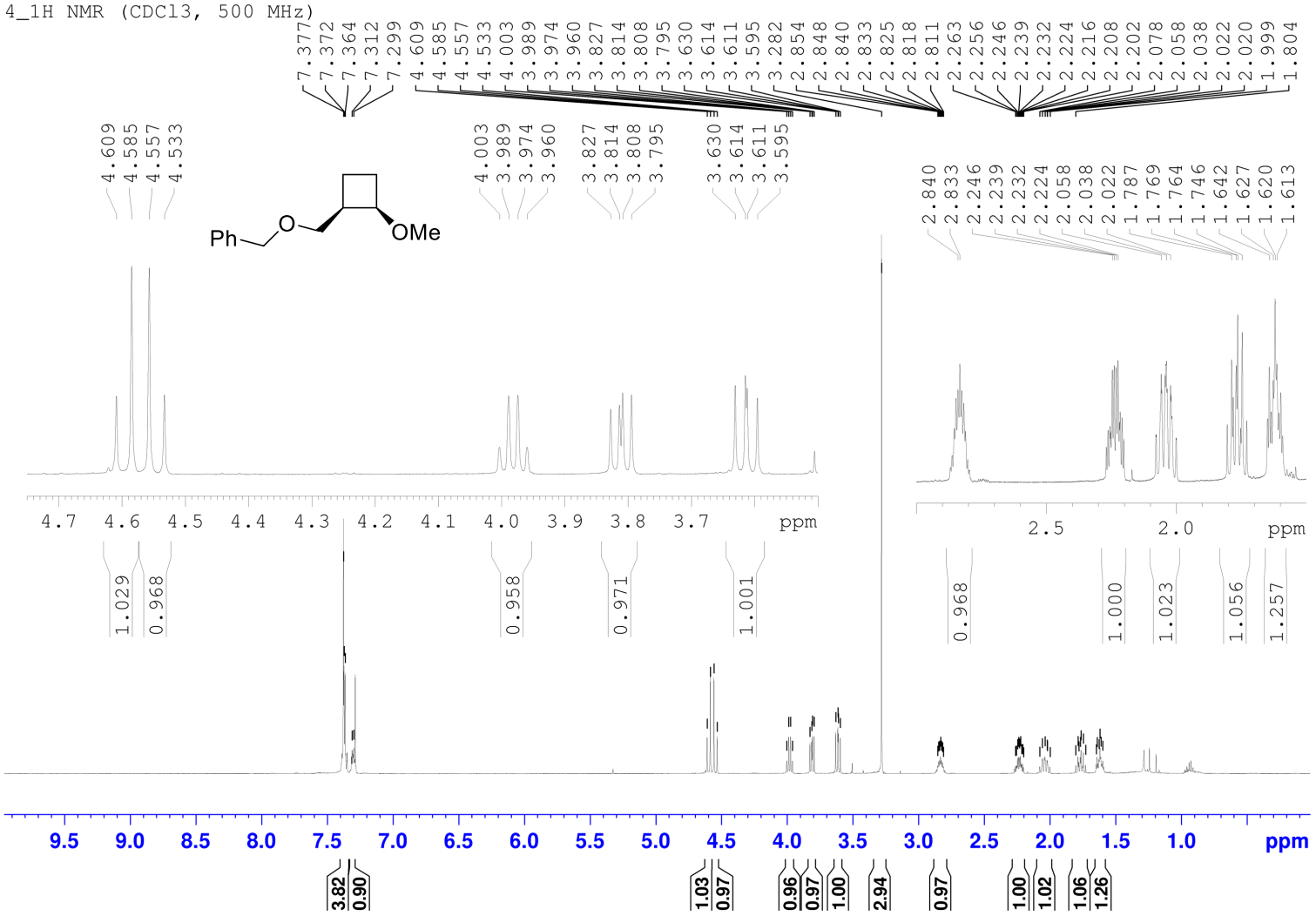

2k'_1H NMR (CDCl3, 500 MHz)
7.380
7.376
7.369
7.329
7.321
7.319
7.312
7.307
7.301
4.590
4.566
4.534
4.510
3.561
3.547
3.541
3.527
3.442
3.427
3.422
3.407
3.384
2.712
2.704
2.694
2.686
1.944
1.936
1.931
1.922
1.917
1.909
1.228
1.226
1.214
1.211
1.199
1.197
1.194
1.182
1.179
0.981
0.973
0.967
0.959
Ph
O
OMe
H
9
8
7
6
5
4
3
2
1
0
ppm
5.59
1.21
1.14
1.00
1.07
1.09
3.00
0.99
1.03
1.05
6.08
0.92
1.06

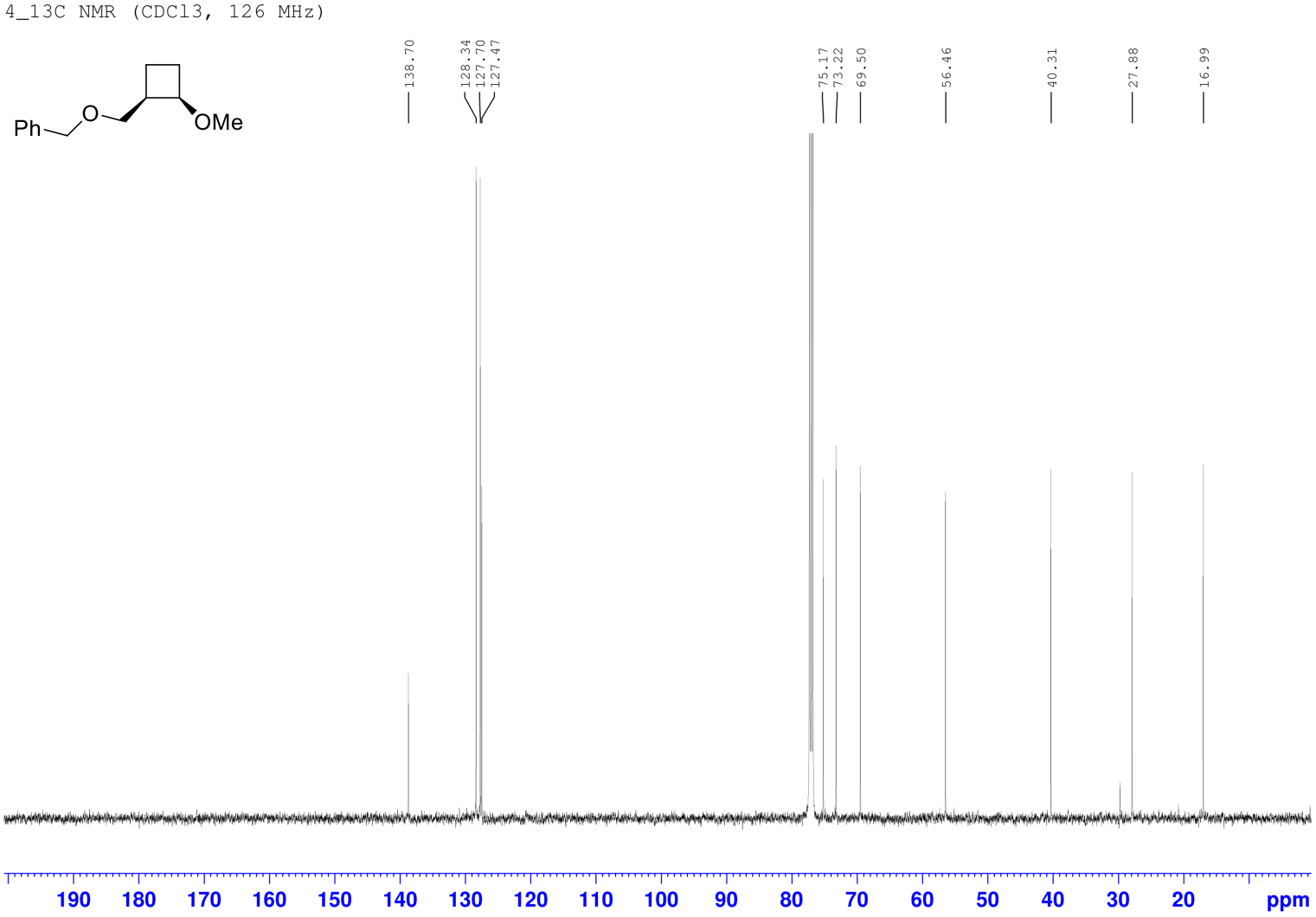

2k'_13C NMR (CDCl3, 126 MHz)
Ph
O
OMe
H
138.42
128.40
127.77
127.59
85.05
72.86
70.55
57.15
32.35
19.07
17.58
17.04
14.22
9.01
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

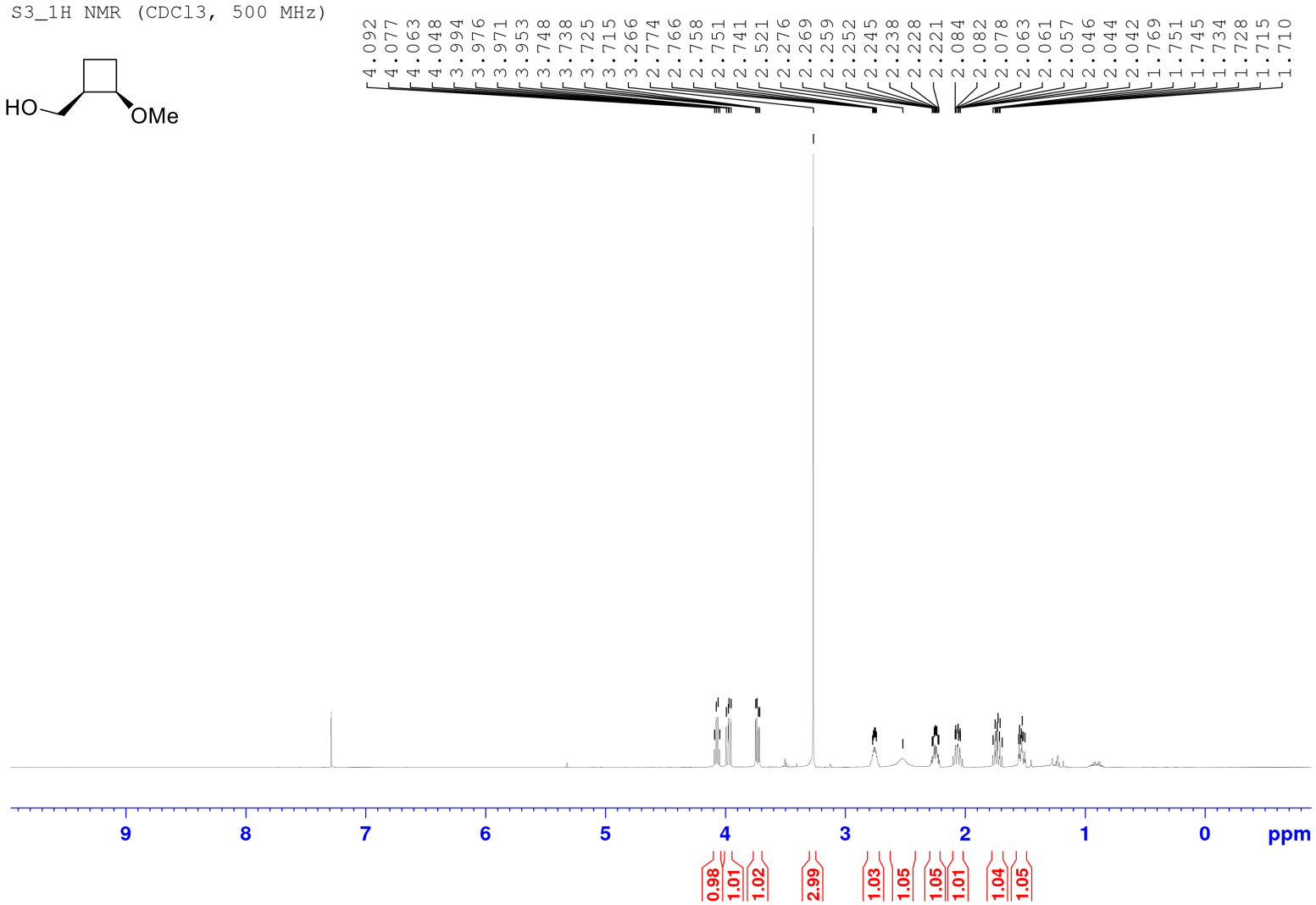

3_1H NMR (CDCl3, 500 MHz)
7.388
7.386
7.375
7.366
7.352
7.338
7.334
7.311
5.886
5.873
5.865
5.852
5.839
5.831
5.818
5.191
5.188
5.185
5.156
5.154
5.152
5.149
5.134
5.131
5.128
4.567
4.295
4.290
4.276
4.271
4.244
4.239
4.225
4.220
3.508
3.496
3.490
3.479
3.477
3.463
3.450
3.445
3.431
3.324
3.321
3.309
3.306
3.296
3.293
3.289
3.267
3.261
Ph
O
F
F
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
ppm
5.31
1.00
2.01
2.02
1.01
2.08
1.03

3_13C NMR (CDCl3, 126 MHz)

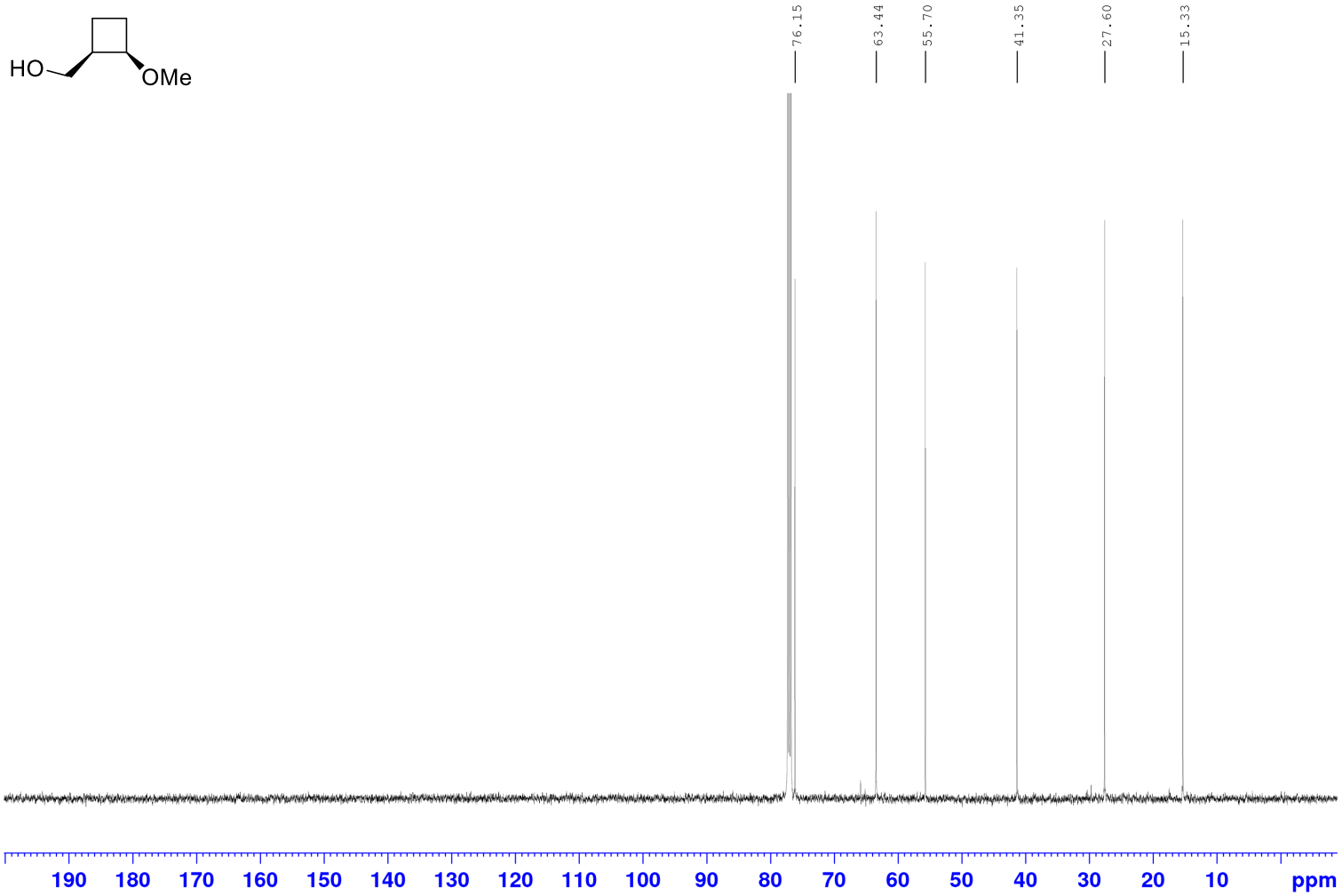



4_1H NMR (CDCl3, 500 MHz)
Ph
O
OMe
ppm

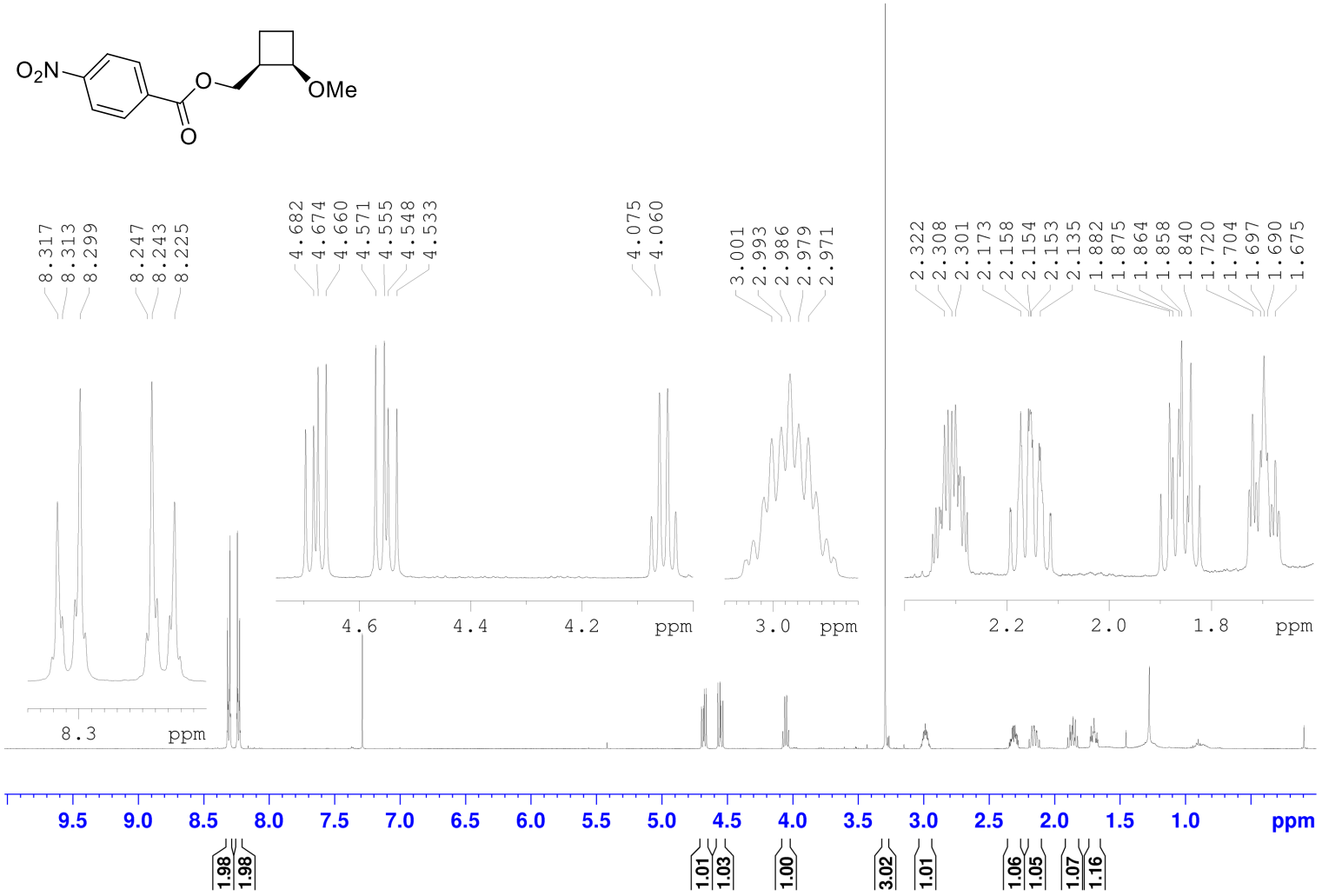

4_13C NMR (CDCl3, 126 MHz)
Ph
O
OMe
138.70
128.34
127.70
127.47
75.17
73.22
69.50
56.46
40.31
27.88
16.99
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

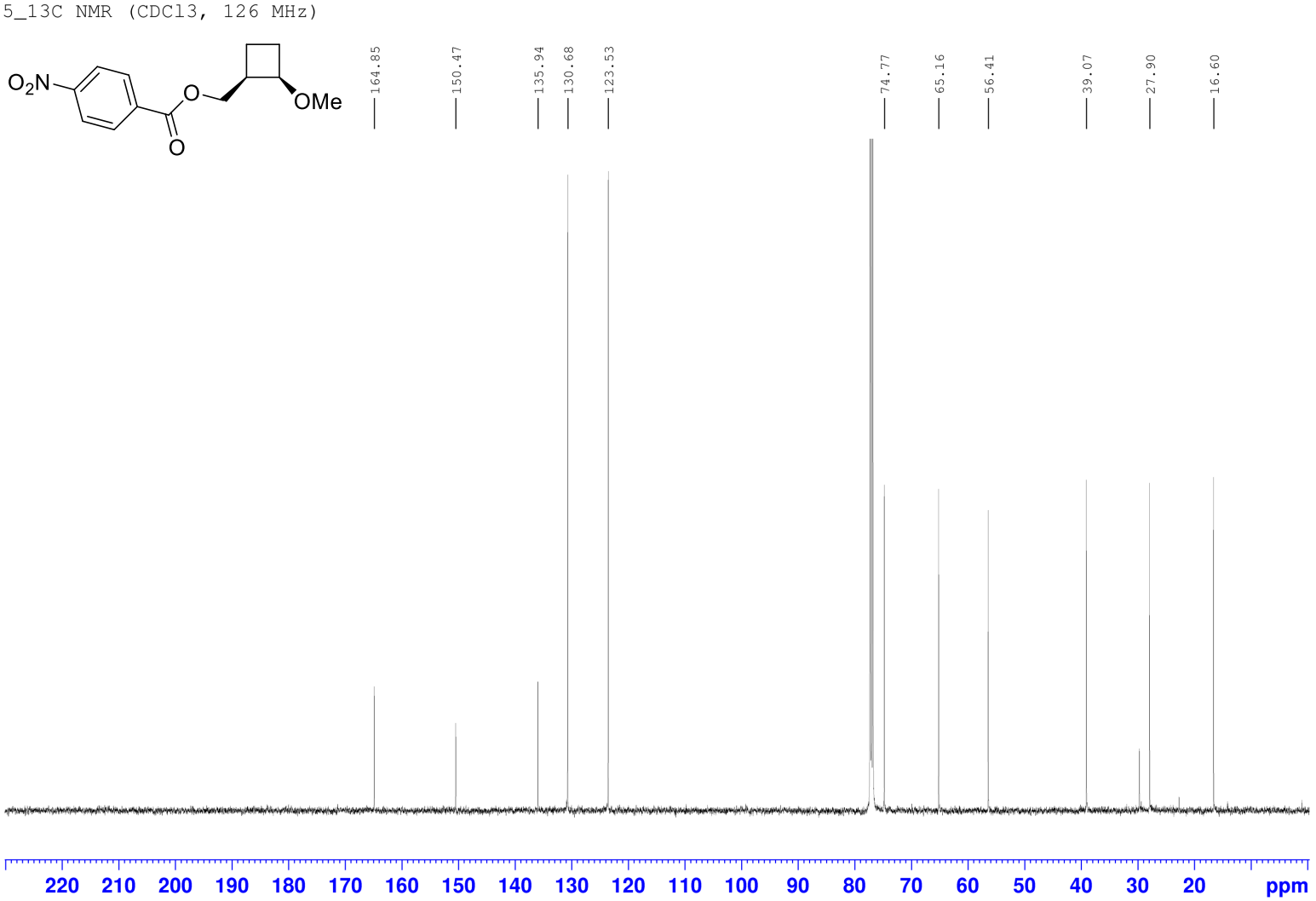

S3_1H NMR (CDCl3, 500 MHz)
HO
OMe
4.092
4.077
4.063
4.048
3.994
3.976
3.971
3.953
3.748
3.738
3.725
3.715
3.266
2.774
2.766
2.758
2.751
2.741
2.521
2.276
2.269
2.259
2.252
2.245
2.238
2.228
2.221
2.084
2.082
2.078
2.063
2.061
2.057
2.046
2.044
2.042
1.769
1.751
1.745
1.734
1.728
1.715
1.710
9
8
7
6
5
4
3
2
1
0
ppm
0.98
1.01
1.02
2.99
1.03
1.05
1.05
1.01
1.04
1.05

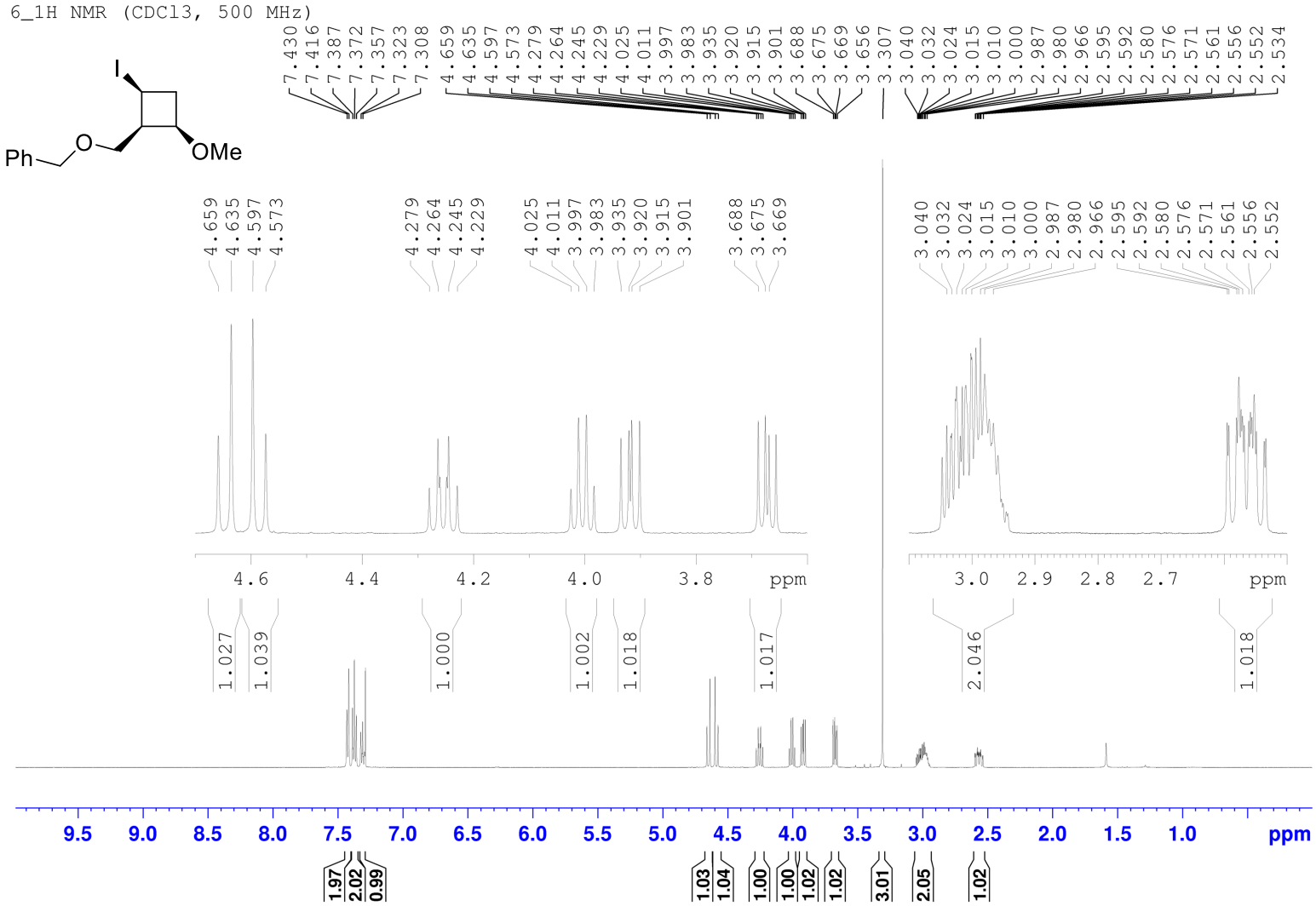
S3_13C NMR (CDCl3, 126 MHz)

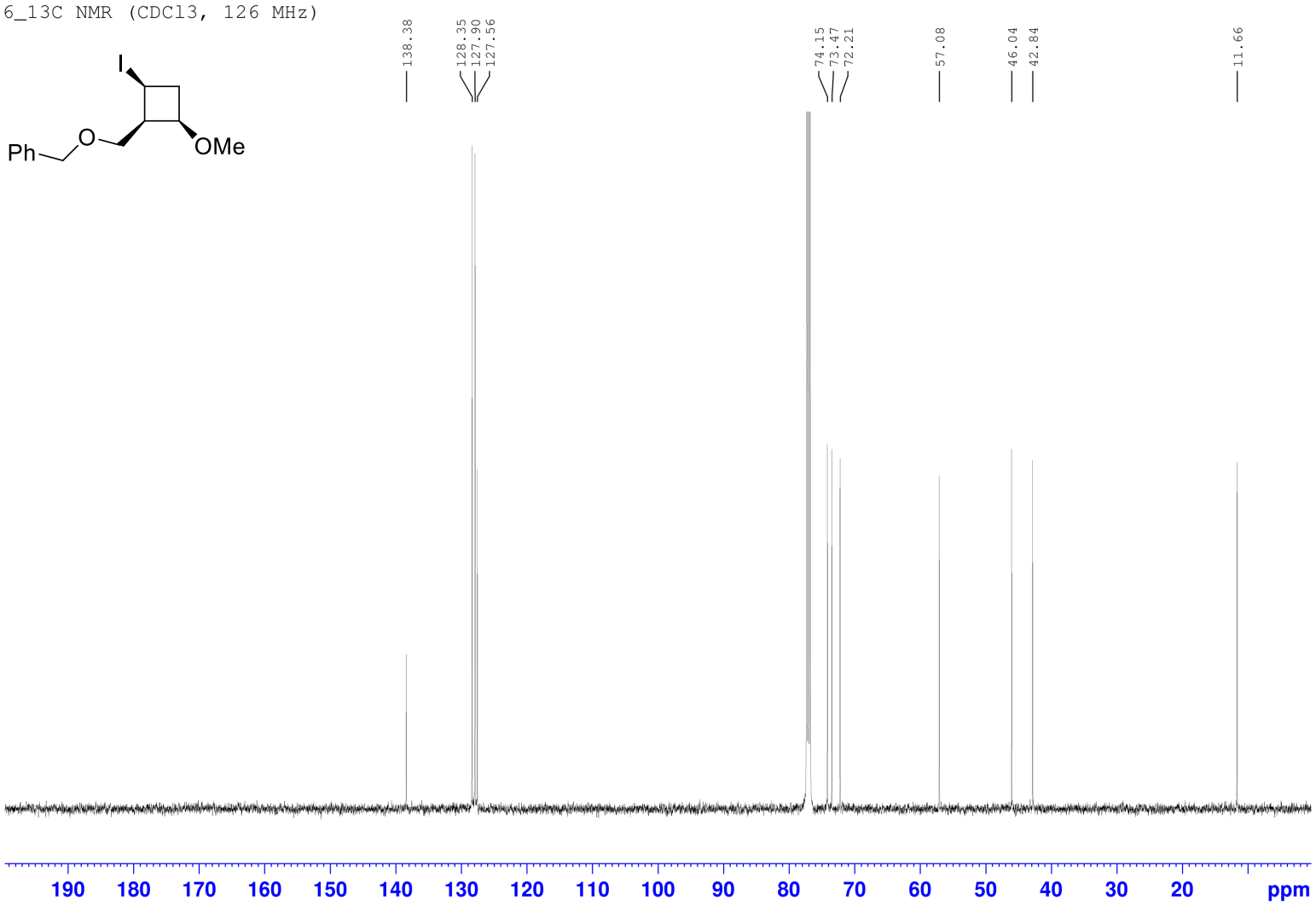


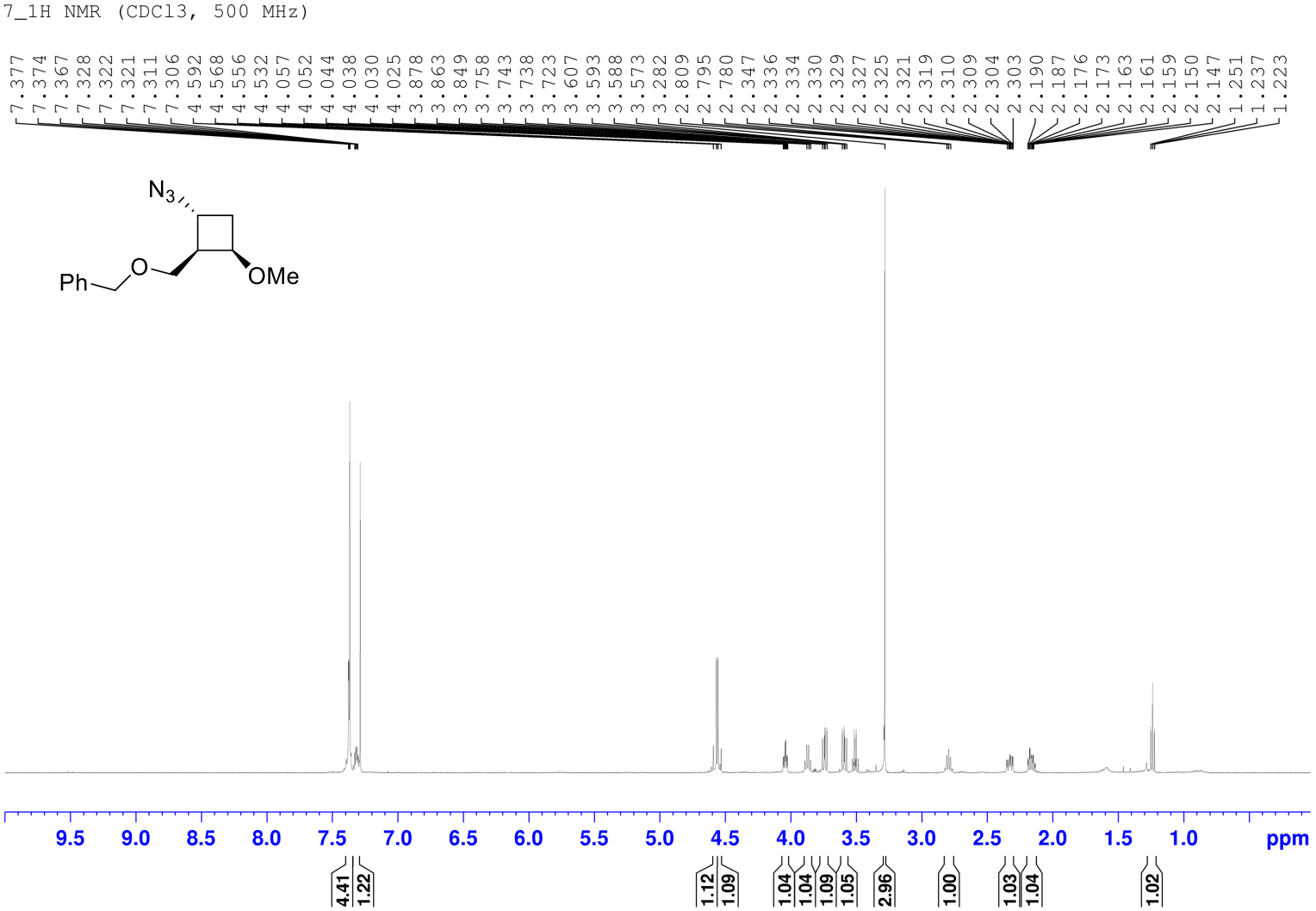
5_1H NMR (CDCl3, 500 MHz)

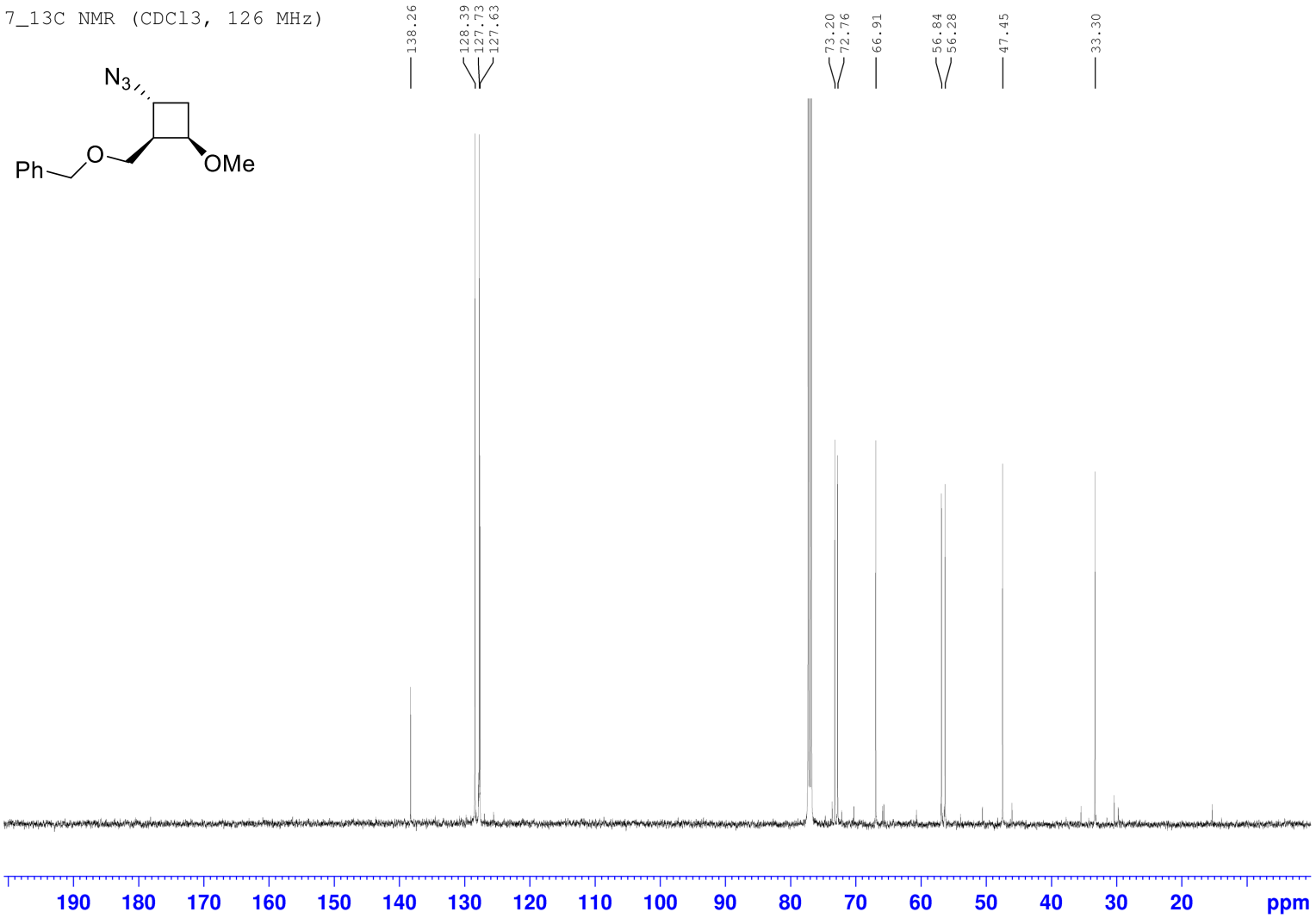


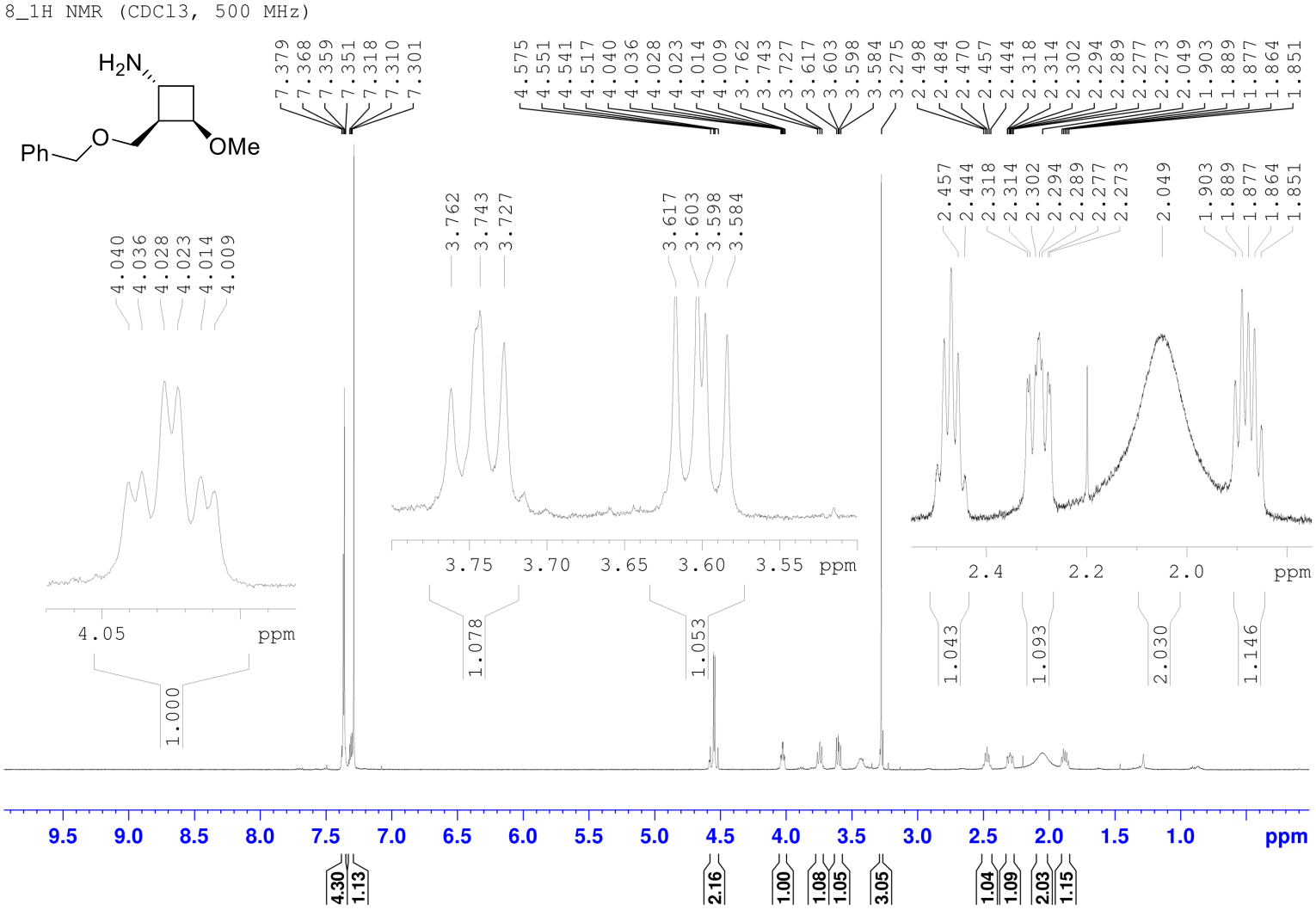

5_13C NMR (CDCl3, 126 MHz)
O2N
O
O
OMe
164.85
150.47
135.94
130.68
123.53
74.77
65.16
56.41
39.07
27.90
16.60
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm


6_1H NMR (CDCl3, 500 MHz)
I
O
Ph
OMe
7.430 7.416 7.387 7.372 7.357 7.323 7.308
4.659 4.635 4.597 4.573 4.279 4.264 4.245 4.229 4.025 4.011 3.997 3.983 3.935 3.920 3.915 3.901 3.688 3.675 3.669 3.656
3.307
3.040 3.032 3.024 3.015 3.010 3.000 2.987 2.980 2.966 2.595 2.592 2.580 2.576 2.571 2.561 2.556 2.552 2.534
4.6 4.4 4.2 4.0 3.8 ppm
3.0 2.9 2.8 2.7 ppm
1.027 1.039 1.000 1.002 1.018 1.017 2.046 1.018
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 ppm
1.97 2.02 0.99 1.03 1.04 1.00 1.00 1.02 1.02 3.01 2.05 1.02

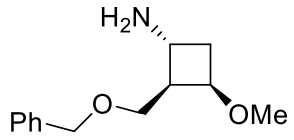

6_13C NMR (CDCl3, 126 MHz)
I
O
Ph
OMe
138.38
128.35
127.90
127.56
74.15
73.47
72.21
57.08
46.04
42.84
11.66
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

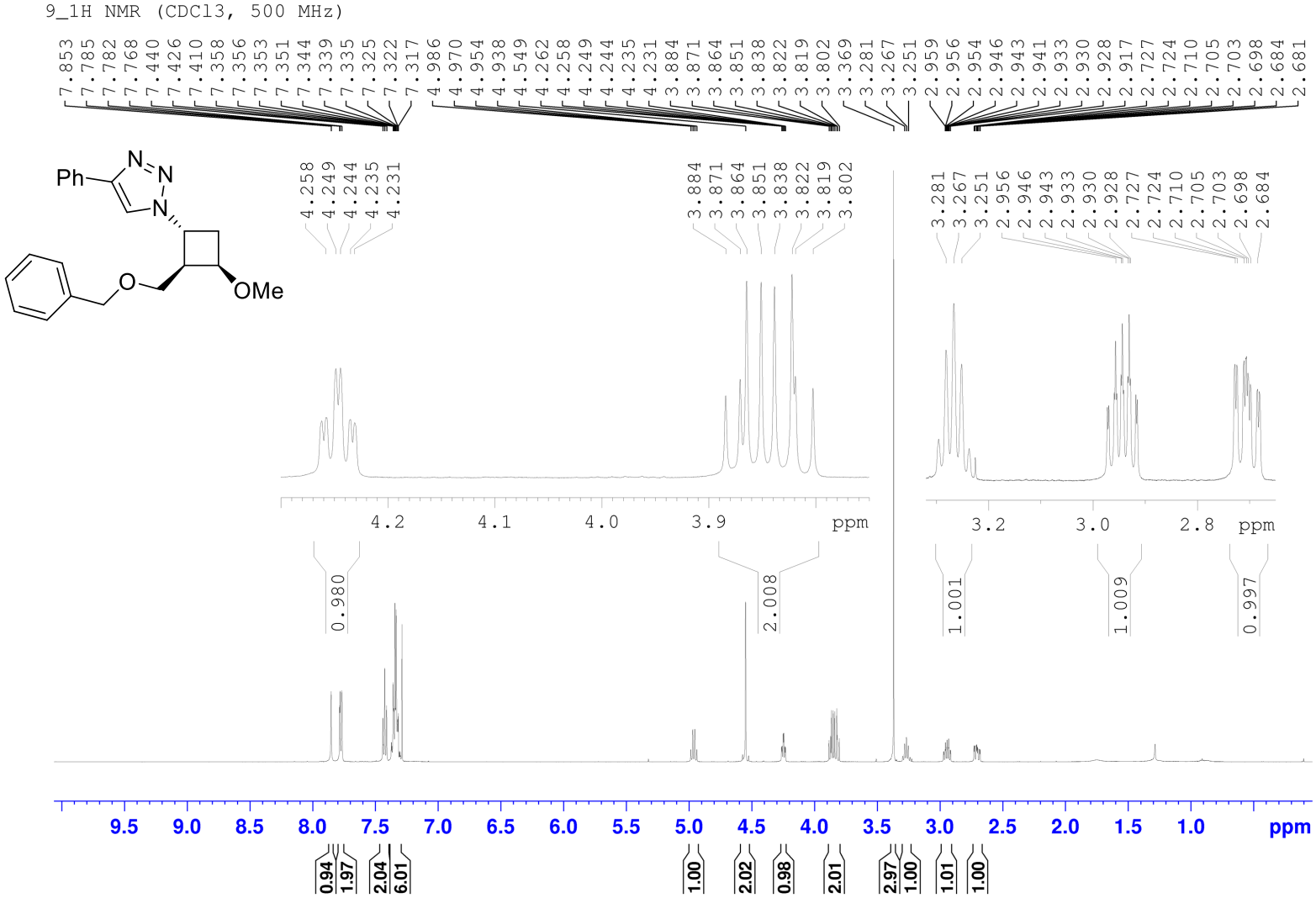

7_1H NMR (CDCl3, 500 MHz)
7.377
7.374
7.367
7.328
7.322
7.321
7.311
7.306
4.592
4.568
4.556
4.532
4.057
4.052
4.044
4.038
4.030
4.025
3.878
3.863
3.849
3.758
3.743
3.738
3.723
3.607
3.593
3.588
3.573
3.282
2.809
2.795
2.780
2.347
2.336
2.334
2.330
2.329
2.327
2.325
2.321
2.319
2.310
2.309
2.304
2.303
2.190
2.187
2.176
2.173
2.163
2.161
2.159
2.150
2.147
1.251
1.237
1.223
N3
O
Ph
OMe
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
ppm
4.41
1.22
1.12
1.09
1.04
1.04
1.09
1.05
2.96
1.00
1.03
1.04
1.02

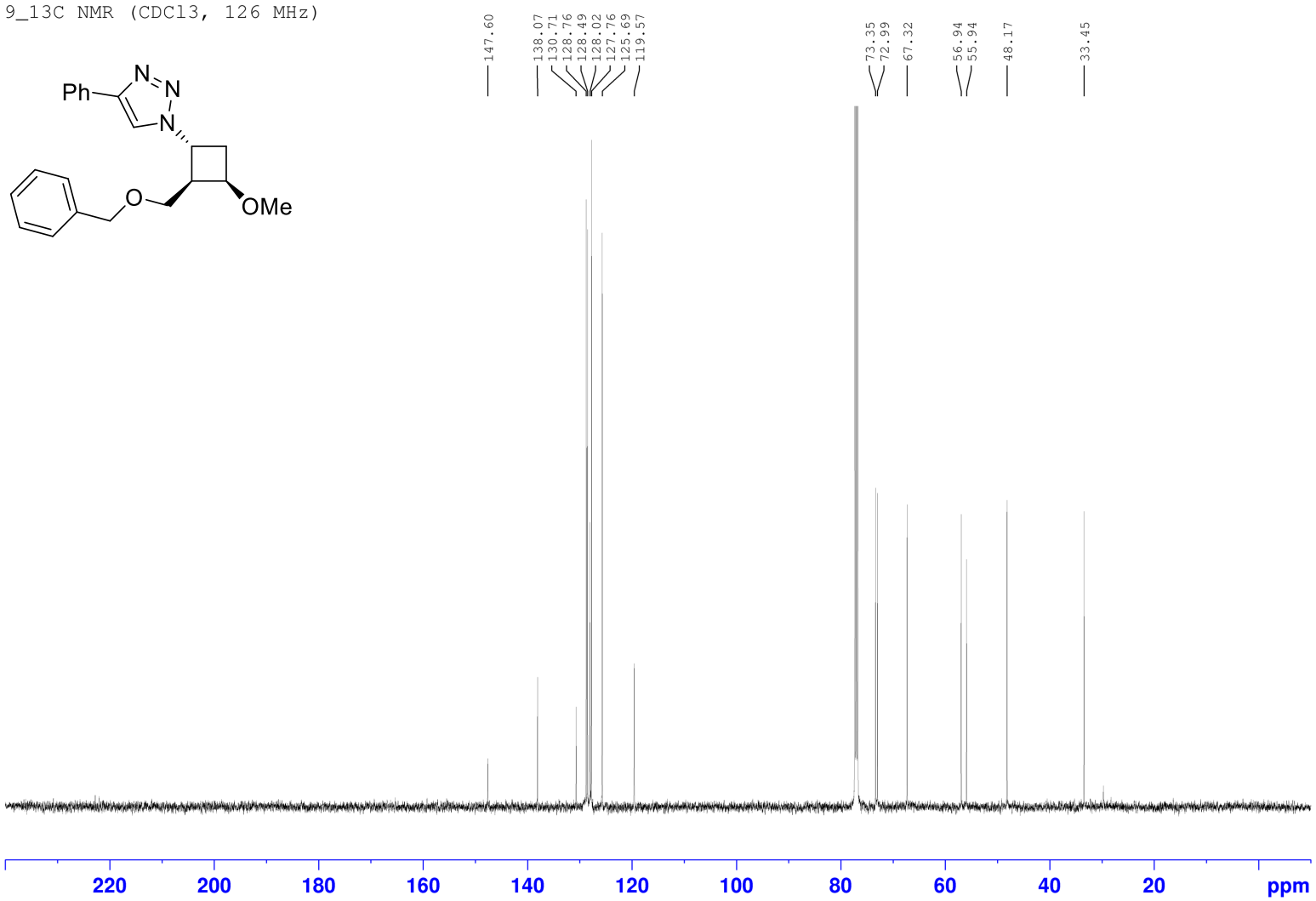

7_13C NMR (CDCl3, 126 MHz)
N3
O
Ph
OMe
138.26
128.39
127.73
127.63
73.20
72.76
66.91
56.84
56.28
47.45
33.30
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm


8_1H NMR (CDCl3, 500 MHz)
H2N
Ph
O
OMe
7.379 7.368 7.359 7.351 7.318 7.310 7.301
4.575 4.551 4.541 4.517 4.040 4.036 4.028 4.023 4.014 4.009 3.762 3.743 3.727 3.617 3.603 3.598 3.584 3.275 2.498 2.484 2.470 2.457 2.444 2.318 2.314 2.302 2.294 2.289 2.277 2.273 2.049 1.903 1.889 1.877 1.864 1.851
4.040 4.036 4.028 4.023 4.014 4.009
3.762 3.743 3.727
3.617 3.603 3.598 3.584
2.457 2.444 2.318 2.314 2.302 2.294 2.289 2.277 2.273 2.049 1.903 1.889 1.877 1.864 1.851
4.05 ppm
3.75 3.70 3.65 3.60 3.55 ppm
2.4 2.2 2.0 ppm
1.000
1.078
1.053
1.043
1.093
2.030
1.146
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 ppm
4.30 1.13 2.16 1.00 1.08 1.05 3.05 1.04 1.09 2.03 1.15

8_13C NMR (CDCl3, 126 MHz)




9_1H NMR (CDCl3, 500 MHz)
7.853 7.785 7.782 7.768 7.440 7.426 7.410 7.358 7.356 7.353 7.351 7.344 7.339 7.335 7.325 7.322 7.317
4.986 4.970 4.954 4.938 4.549 4.262 4.258 4.249 4.244 4.235 4.231
3.884 3.871 3.864 3.851 3.838 3.822 3.819 3.802 3.369 3.281 3.267 3.251
2.959 2.956 2.954 2.946 2.943 2.941 2.933 2.930 2.928 2.917 2.727 2.724 2.710 2.705 2.703 2.698 2.684 2.681
Ph
N
N
N
O
OMe
4.2 4.1 4.0 3.9 ppm
3.2 3.0 2.8 ppm
0.980
2.008
1.001
1.009
0.997
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 ppm
0.94 1.97 2.04 6.01 1.00 2.02 0.98 2.01 2.97 1.00 1.01 1.00


9_13C NMR (CDCl3, 126 MHz)
Ph
N
N
O
OMe
147.60
138.07
130.71
128.76
128.49
128.02
127.76
125.69
119.57
73.35
72.99
67.32
56.94
55.94
48.17
33.45
220
200
180
160
140
120
100
80
60
40
20
ppm