Supporting Information

Pd(II)-catalyzed B(9)-alkynylation of *o*-carboranes and *m*-carboranes

Hao-Tian Zhang,[a] Yan Gao,[b] Yan-Na Ma,[a]* and Xuenian Chen[a,b]*

[a] *College of Chemistry, and Institute of Green Catalysis, Zhengzhou University, Zhengzhou, Henan, 450001 (China)*

[b] *School of Chemistry and Chemical Engineering, Henan Key Laboratory of Boron Chemistry and Advanced Energy Materials, Henan Normal University, Xinxiang, Henan 453007 (China)*

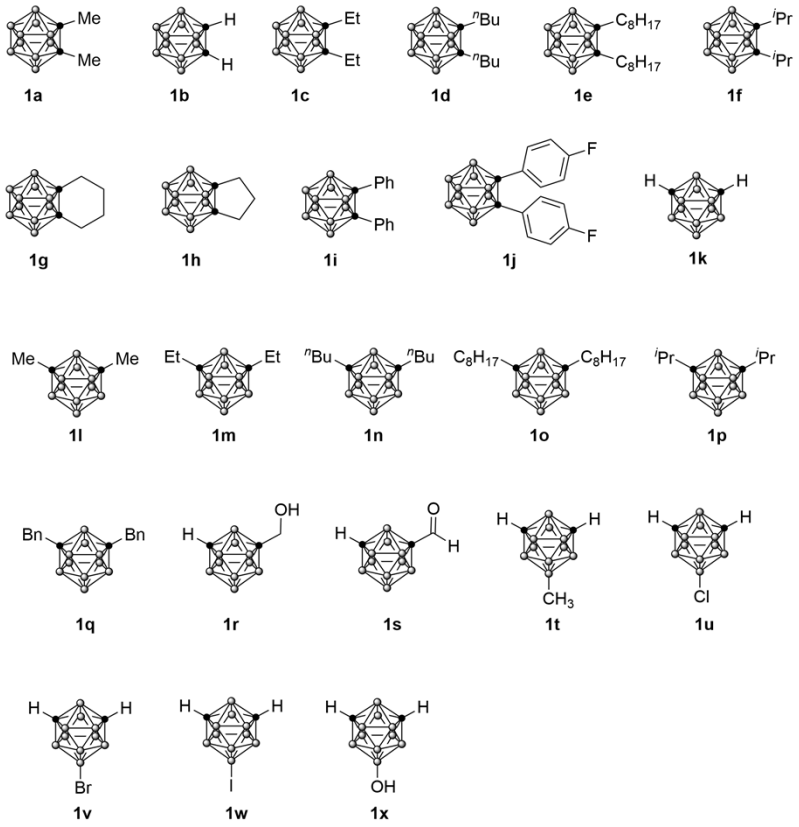
E-mail: mayanna@zzu.edu.cn; xuenian_chen@zzu.edu.cn.

Table of Contents

1. General Information

^{1}H, ^{13}C, ^{11}B, and ^{19}F NMR spectra were recorded on Bruker Advance III600 spectrometer at 600, 151, 193, and 565 MHz, respectively. All chemical shifts were reported in δ units with references to the residual solvent resonances of the deuterated solvents for proton and carbon chemical shifts, and to external $BF_3 \cdot OEt_2$ (0.00 ppm) for boron chemical shifts. High-Resolution Mass Spectra (HRMS (ESI-TOF)) were recorded on a Bruker Mass spectrometer using ESI-TOF (electrospray ionization-time of flight). GC-MS analyses were performed on SHIMADZU GCMS-QP 2020. Triisopropylsiliconacetylenyl bromide can be purchased in the market. Starting *o*-carborane **1b**, 1,2-Ph_2-*o*-carborane **1i**, *m*-carborane **1k** were purchased from Zhengzhou Yuanli technology. Carboranes **1a**,[1] **1c-1h**,[1] **1j**,[2] **1l-1q**,[1] **1r,**[3] **1s**,[4] **1t**,[5] **1u-1w**,[6] **1x**[7] were prepared according to literature procedures. All other chemicals were purchased from Aldrich, Acros Organics, J&K Chemicals, Energy Chemical, Aladdin, Macklin, or TCI and used without further purification. Thin-layer chromatography (TLC) was performed using 60 mesh silica gel plates visualized with short-wavelength UV light (254 nm).

2. Structure of starting carboranes



3. Experimental Section

3.1 General procedure for the B(9)-alkynylation of *o*/*m*-carboranes

Carborane **1** (0.20 mmol), (bromoethynyl)triisopropylsilane **2a** (2.0 equiv, 0.40 mmol), $Pd(OAc)_2$ (10 mol%, 0.02 mmol), $AgPF_6$ (3.0 equiv, 0.60 mmol) were mixed in TFA (1 ml). The resulting mixture was stirred in a closed flask at room temperature for 24 h under air atmosphere. After removal of organic solvents under reduced pressure, the residue was subjected to flash column chromatography on silica gel (200-300 mesh) to give the product.

3.2 Synthesis of terminal alkyne 4

Compound **3l** (354 mg, 1 mmol) and TBAF (2 mL, 2 mmol, 1M in THF) were mixed in THF (5 mL). The resulting mixture was stirred at 0 °C for 1 h. After hydrolysis with water (20 mL) and extraction with ethyl acetate (20 mL x 3), the organic layers were combined and concentrated to dryness in vacuo. The residue was subjected to flash column chromatography to give the product **4**.

3.3 Synthesis of 5

N,*N*-dimethyl aniline (51 mg, 0.42 mmol) was added to the reaction mixture of **4** (39.2mg, 0.2 mmol) and $B_{10}H_{14}$ (26 mg, 0.21 mmol) in toluene. Then the reaction mixture was stirred at 115 °C for 24 hours. After cooling to room temperature, water (10 mL) was added to the mixture and extracted with ethyl acetate (10 mL x 3). The organic layers were combined and concentrated to dryness in vacuo. The residue was subjected to flash column chromatography to give the product **5**.

3.4 Synthesis of 6

To a mixture of PPh_3 (52.4 mg, 0.2 mmol) and terminal alkyne **4** (39.2 mg, 0.2 mmol) in DCM (2.0 mL) was added NBS (71.2 mg, 0.4 mmol). The reaction mixture was stirring at room temperature for 6 hours. After removal of the solvent with a rotary evaporator, the residue was purified by column chromatography to give the product **6**.The reaction requires the recovery of raw materials and repeat again.

3.5 Synthesis of 7

Compound **4** (39.2 mg, 0.2 mmol), PhI (81.6 mg, 0.4 mmol), $Pd(PPh_3)Cl_2$ (7.0 mg, 0.01 mmol), CuI (3.8 mg, 0.02 mmol) and NEt_3 (1 mL) were mixed in toluene (4 mL). The resulting mixture was heated at 80 °C for 12 h. After hydrolysis with water (10 mL) and extraction with ethyl acetate (10 mL x 3), the organic layers were combined and concentrated to dryness in vacuo. The residue was purified by column chromatography to give the product **7**.

3.6 Synthesis of 8

Compound **4** (58.8 mg, 0.3 mmol), CrO_3 (178.2 mg, 1.8 mmol, 6 eq), H_2SO_4 (16 μL, 0.3 mmol, 1 eq), were mixed in HOAc (1.5 mL), The resulting mixture was stirring at room temperature for 1 h, quenching the mixture with saturated $NaHCO_3$, and extracting with EA (10 mL x 3). The residue was purified by column chromatography to give the product **8**.

3.6 Synthesis of 9 and 10

Under N_2 atmosphere, *n*-BuLi (1.38 ml, 1.6 M / hexane, 2.2 mmol) was added to the solution of **4** in THF (20 mL) at -78 °C. After that, the reaction mixture was warmed up to room temperature and stirred for 1 hour. Then the mixture was cooled to -78 °C, benzaldehyde (224 μL, 2.2 mmol) or acetone (163μL, 2 mmol) in THF (10 mL) was added. The reaction was slowly warmed up to room temperature and was stirred for 1 hour. Saturated aqueous solution of NH_4Cl was added, and extract the aqueous layer with Et_2O. Dry the organic phase over Na_2SO_4. Filter the mixture and concentrate in vacuo. Purify the crude product by flash column chromatography on silica gel to obtain the final product.

3.7 Synthesis of product 11

To a solution of alkyne (39.2 mg, 0.2 mmol) in acetone (50 mL) was added N-bromosuccinimide (3.36 mg, 0.02 mmol) and $AgNO_3$ (39.16 mg, 0.22 mmol). The reaction mixture was stirred at room

temperature under exclusion of light for 2 h. Upon completion the reaction mixture was concentrated under reduced pressure and filtered through a celite plug to afford crude **11** which was submitted to the next step without further purification.

4. Mechanistic study

(a) 1,2-Me_2-*o*-carborane **1a** (0.1 mmol) was stirred in CF_3COOH (1 mL) at room temperature for 30 minutes; (b) 1,2-Me_2-*o*-carborane **1a** (0.1 mmol) and $Pd(OAc)_2$ (0.01 mmol, 10 mol%) were stirred in CF_3COOH (1 mL) at room temperature for 30 minutes; (c) 1,2-Me_2-*o*-carborane **1a** (0.1 mmol), $Pd(OAc)_2$ (0.01 mmol, 10 mol%) and $AgPF_6$ (0.3 mmol) were stirred in CF_3COOH (1 mL) at room temperature for 30 minutes; (d) 1,2-Me_2-*o*-carborane **1a** (0.1 mmol) and $AgPF_6$ (0.3 mmol) were stirred in CF_3COOH (1 mL) at room temperature for 30 minutes.

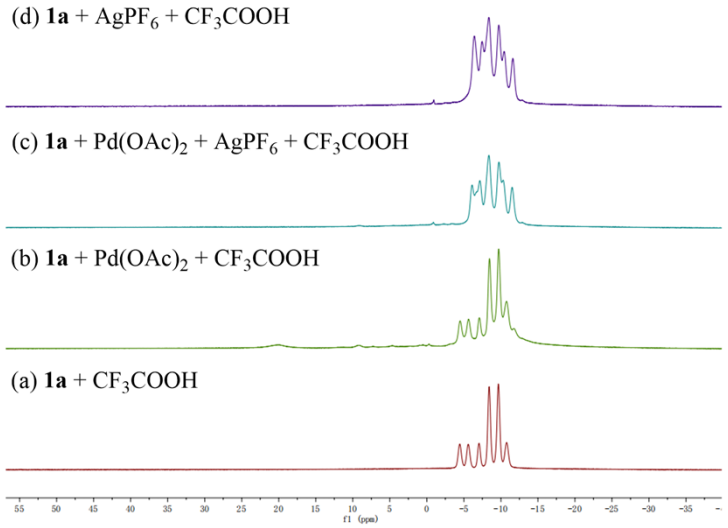


Figure S1 ^{11}B NMR.

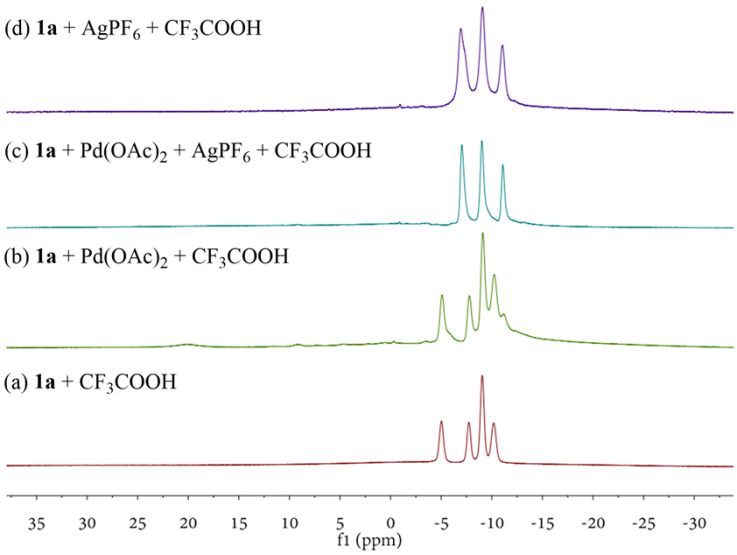
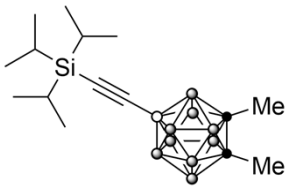


Figure S2 ^{11}B{^{1}H} NMR

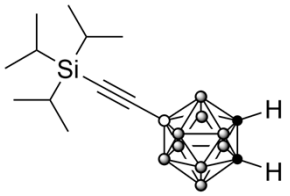
5. Characterization data



3a. Yield 60% . Yellow liquid. **Eluent**: PE:EA = 20:1

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.02 (d, *J* = 3.5 Hz, 7H), 1.16 – 0.94 (m, 21H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 29.73, 18.57, 11.33. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -4.55 (2B), -7.50 (6B), 11.93 (2B).

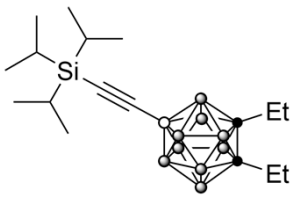
HRMS(ESI-TOF): m/z calcd for $C_{15}{}^{10}B_2{}^{11}B_8H_{36}Si$ [M+Na]+: 375.3490. Found: 375.3463.



3b. Yield 59% . Yellow liquid. **Eluent**: PE:EA = 20:1

^{1}H NMR (400 MHz, $CDCl_3$) δ 3.58 – 3.36 (m, 2H), 1.16 – 0.95 (m, 21H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 52.75, 49.30, 29.73, 18.63, 11.26. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -1.75 (1B), -2.46 (1B), -8.45 (2B), -13.39 (2B), -14.56 (2B), -15.66 (2B).

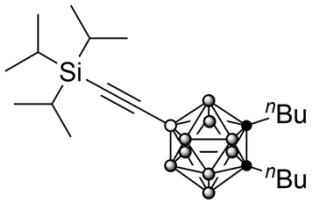
HRMS(ESI-TOF): m/z calcd for $C_{13}{}^{10}B_2{}^{11}B_8H_{29}Si$ [M+Na]+: 347.3176. Found: 347.3177.



3c. Yield 61% . Yellow liquid. **Eluent**: PE:EA = 20:1

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.22 (dq, *J* = 7.6, 1.3 Hz, 5H), 1.24 – 1.12 (m, 7H), 1.11 – 0.96 (m, 21H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 75.48, 28.55, 27.88, 18.64, 14.08, 14.00, 11.30. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -4.33 (2B) -9.64 (2B) -10.79 (4B) -11.94 (2B).

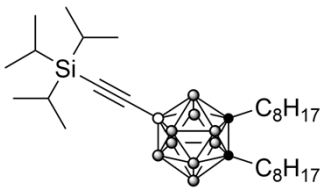
HRMS(ESI-TOF): m/z calcd for $C_{17}{}^{10}B_2{}^{11}B_8H_{40}Si$ [M+Na]+: 403.3804. Found: 403.3804.



3d. Yield 62% . Yellow liquid. **Eluent**: PE:EA = 20:1

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.16 – 2.07 (m, 5H), 1.56 – 1.45 (m, 6H), 1.31 (dtd, *J* = 14.6, 7.5, 2.8 Hz, 5H), 1.08 – 0.98 (m, 21H), 0.92 (td, *J* = 7.3, 4.7 Hz, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 74.69, 34.83, 34.15, 31.82, 31.70, 22.43, 18.64, 13.64, 11.30. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -4.36 (2B), -9.67 (2B), -10.87 (4B), -11.79 (2B).

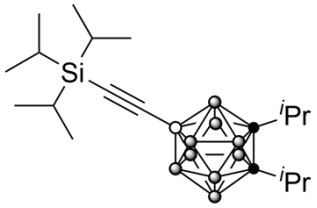
HRMS(ESI-TOF): m/z calcd for $C_{21}{}^{10}B_1{}^{11}B_9H_{48}Si$ [M+Na]+: 460.4402. Found: 460.4395.



3e. Yield 63%. Yellow liquid. **Eluent**: PE:EA = 20:1

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.15 – 2.03 (m, 5H), 1.59 – 1.47 (m, 5H), 1.27 (s, 20H), 1.04 (d, *J* = 5.1 Hz, 20H), 0.88 (t, *J* = 6.1 Hz, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 74.73, 35.09, 34.42, 31.75, 29.75, 29.65, 29.26, 29.09, 22.61, 18.64, 14.06, 11.30. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -4.58 (2B), -11.56 (8B).

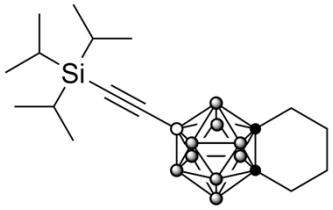
HRMS(ESI-TOF): m/z calcd for $C_{29}{}^{10}B_1{}^{11}B_9H_{64}Si$ [M+Na]+: 572.5660. Found:572.5663.



3f. Yield 47%. Yellow liquid. **Eluent**: PE:EA = 20:1

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.29 (dqd, *J* = 13.8, 6.9, 5.9, 4.0 Hz, 3H), 1.21 (dd, *J* = 8.8, 6.9 Hz, 12H), 1.14 – 0.92 (m, 21H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 86.97, 83.27, 30.71, 30.24, 24.45, 24.32, 18.66, 11.30. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -3.85 (2B), -8.68 (2B), -11.65 (2B) -12.78 (4B).

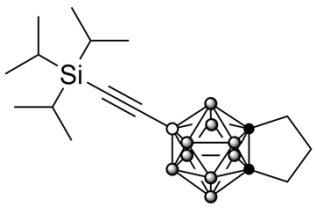
HRMS(ESI-TOF): m/z calcd for $C_{19}{}^{10}B_1{}^{11}B_9H_{44}Si$ [M+Na]+: 432.4088 Found: 432.4089.



3g. Yield 48%. Yellow liquid. **Eluent**: PE:EA = 20:1

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.42-2.43 (m, 4H), 1.56-1.58 (m, 4H), 1.08 – 0.96 (m, 21H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 71.48, 68.10, 32.75, 32.19, 19.74, 19.55, 18.64, 18.46, 11.28. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -5.12 (2B), -8.39 (2B), -9.33 (2B), -10.45 (2B), -12.48 (2B).

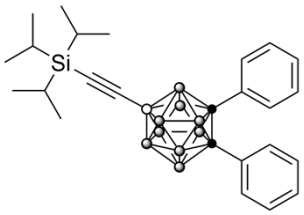
HRMS(ESI-TOF): m/z calcd for $C_{17}{}^{10}B_2{}^{11}B_8H_{38}Si$ [M+Na]+: 401.3648. Found: 401.3649.



3h. Yield 45%. Yellow liquid. **Eluent**: PE:EA = 20:1

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.47 – 2.31 (m, 6H), 1.02 – 0.90 (m, 21H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 82.48, 34.51, 34.01, 32.21, 18.64, 11.28. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -5.97 (2B), -7.24 (2B), -9.91 (2B), -11.41 (2B), -12.56 (2B).

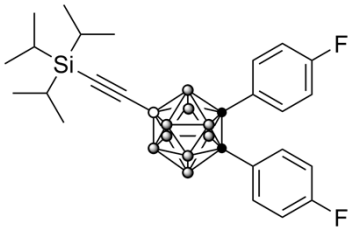
HRMS(ESI-TOF): m/z calcd for $C_{16}{}^{10}B_2{}^{11}B_8H_{36}Si$ [M+Na]+: 387.3491. Found: 387.3506.



3i. Yield 34%. Yellow liquid. **Eluent**: PE

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 (dq, *J* = 7.2, 1.5 Hz, 3H), 7.26 – 7.20 (m, 2H), 7.16 – 7.10 (m, 3H), 1.19 – 0.96 (m, 21H).**^{13}C NMR (101 MHz, $CDCl_3$)** δ 130.72, 130.61, 130.24, 128.29, 83.64, 18.66, 11.28. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -2.09 (2B), -9.54 (6B) -12.04 (2B).

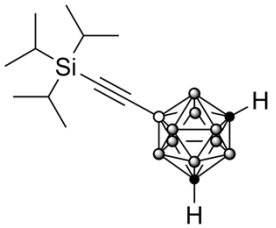
HRMS(ESI-TOF): m/z calcd for $C_{25}{}^{10}B_1{}^{11}B_9H_{40}Si$ [M+Na]+: 500.3780. Found: 500.3774.



3j. Yield 28%. Yellow liquid. **Eluent**: PE:EA = 20:1

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.05 (m, 6H), 6.99 – 6.85 (m, 2H), 0.98 (d, *J* = 4.7 Hz, 21H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ163.29, 160.83, 132.41, 132.32, 132.24, 130.07, 130.06, 129.99, 129.98, 126.51, 126.48, 126.39, 126.36, 118.20, 118.09, 117.96, 117.84, 117.79, 117.58, 82.16, 18.64, 11.25.**^{19}F NMR (376 MHz, $CDCl_3$)** δ -111.43. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -1.60 (2B), -9.35 (6B), -12.08 (2B).

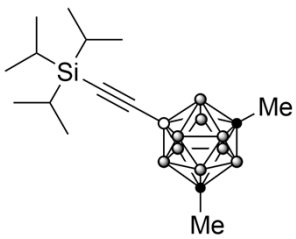
HRMS(ESI-TOF): m/z calcd for $C_{25}{}^{10}B_1{}^{11}B_9H_{38}SiF_2$ [M+Na]+: 536.3591. Found: 536.3582.



3k. Yield 48%. Yellow liquid. **Eluent**: PE

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.88 (s, 2H), 1.13 – 0.99 (m, 21H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 29.71, 18.63, 11.27. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -6.08 (2B), -9.52 (2B), -12.80 (2B), -14.12 (2B), -17.81 (1B), -19.69 (1B)

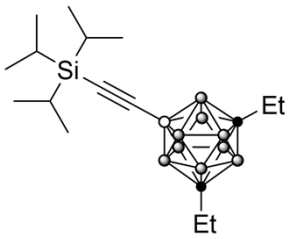
HRMS(ESI-TOF): m/z calcd for $C_{13}{}^{10}B_2{}^{11}B_8H_{32}Si$ [M+Na]+: 347.3176. Found: 347.3150.



3l. Yield 64%. Yellow liquid. **Eluent**: PE

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.52 (s, 6H), 0.98 – 0.79 (m, 21H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 24.33, 18.65, 11.28. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -6.80 (2B), -9.47 (4B), -10.88 (2B), -12.94 (1B), -15.88 (1B).

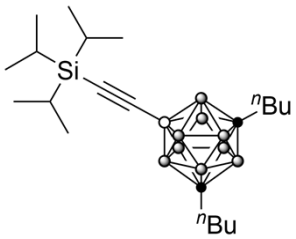
HRMS(ESI-TOF): m/z calcd for $C_{15}{}^{10}B_2{}^{11}B_8H_{36}Si$ [M+Na]+: 375.3490. Found: 375.3485.



3m. Yield 59%. Yellow liquid. **Eluent:** PE

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.98 (q, *J* = 7.6 Hz, 4H), 1.17 – 1.00 (m, 21H), 0.97 (t, *J* = 7.6 Hz, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 30.31, 18.66, 14.25, 11.30. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -6.94 (2B), -10.18 (2B), -10.81 (2B), -12.19 (2B), -14.63 (1B), -16.08 (1B).

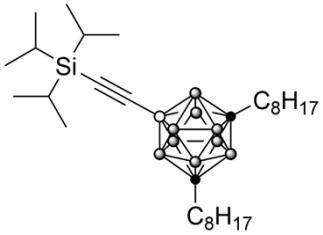
HRMS(ESI-TOF): m/z calcd for $C_{17}{}^{10}B_2{}^{11}B_8H_{40}Si$ [M+Na]+: 403.3804. Found: 403.3790.



3n. Yield 61%. Yellow liquid. **Eluent**: PE

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.92 – 1.86 (m, 4H), 1.32 (ddd, *J* = 12.1, 6.0, 3.1 Hz, 4H), 1.25 – 1.19 (m, 4H), 1.13 – 0.99 (m, 20H), 0.87 (t, *J* = 7.2 Hz, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 36.73, 32.03, 22.33, 18.66, 13.70, 11.30. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -6.82 (2B), -10.38 (4B), -12.10 (2B), -14.54 (1B), -16.02 (1B).

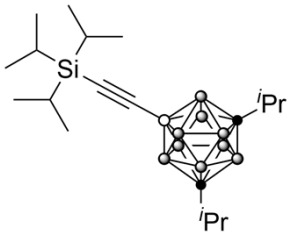
HRMS(ESI-TOF): m/z calcd for $C_{21}{}^{10}B_1{}^{11}B_9H_{48}Si$ [M+Na]+: 460.4402. Found: 460.4394.



3o. Yield 62%. Yellow liquid. **Eluent**: PE

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.92 – 1.85 (m, 4H), 1.37 – 1.16 (m, 24H), 1.13 – 1.03 (m, 21H), 0.88 (t, *J* = 6.9 Hz, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 36.98, 31.78, 29.95, 29.17, 29.14, 22.62, 18.66, 14.08, 11.30. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -6.81 (2B), -10.32 (4B), -10.47 (4B), -14.15 (2B).

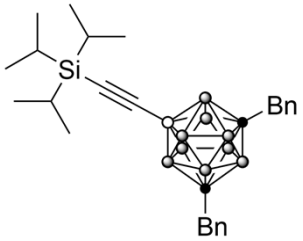
HRMS(ESI-TOF): m/z calcd for $C_{29}{}^{10}B_1{}^{11}B_9H_{64}Si$ [M+Na]+: 572.5660. Found: 572.5675.



3p. Yield 48% . Yellow liquid. **Eluent**: PE

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.19 – 2.14 (m, 2H), 1.11 – 1.04 (m, 21H), 1.03 (s, 6H), 1.02 (s, 6H).**^{13}C NMR (101 MHz, $CDCl_3$)** δ 80.23, 33.81, 23.89, 18.67, 11.31. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -6.61 (2B), -10.54 (2B), -11.49 (2B), -12.87 (2B), -15.26 (1B), -16.69 (1B).

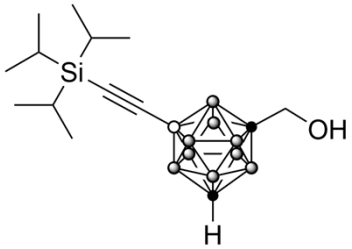
HRMS(ESI-TOF): m/z calcd for $C_{19}{}^{10}B_1{}^{11}B_9H_{44}Si$ [M+Na]+: 432.4088. Found: 432.4081.



3q. Yield 38%. Yellow liquid. **Eluent**: PE

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 (d, *J* = 1.9 Hz, 2H), 7.27 (d, *J* = 2.0 Hz, 3H), 7.05 – 7.02 (m, 3H), 3.12 (s, 4H), 2.44 – 2.04 (m, 9H), 1.06 (d, *J* = 4.7 Hz, 21H).**^{13}C NMR (101 MHz, $CDCl_3$)** δ 136.82, 129.83, 128.39, 127.51, 42.97, 29.73, 18.66, 11.28. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -6.33 (2B), -9.85 (4B), -11.94 (2B), -14.76 (1B), -16.36 (1B).

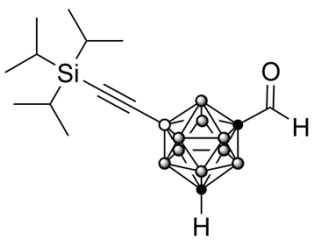
HRMS(ESI-TOF): m/z calcd for $C_{27}{}^{10}B_1{}^{11}B_9H_{44}Si$ [M+Na]+: 528.4094. Found: 528.4082.



3r. Yield 37%. Yellow liquid. **Eluent**: PE

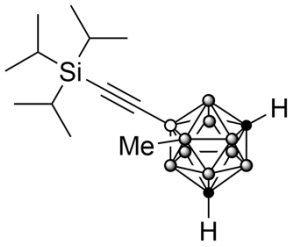
^{1}H NMR (400 MHz, $CDCl_3$) δ 4.28 (s, 1H), 2.91 (s, 1H), 2.09 (s, 2H), 1.06 (s, 21H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 64.21, 20.46, 18.62, 11.26. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -4.05 (2B), -20.30 – -10.09 (8B).

HRMS(ESI-TOF): m/z calcd for $C_{14}{}^{10}B_2{}^{11}B_8H_{34}SiO$ [M+Na]+: 377.3282. Found: 377.3242.

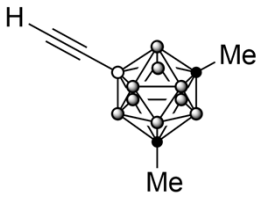


3s. Yield 33%. Yellow liquid. **Eluent**: PE

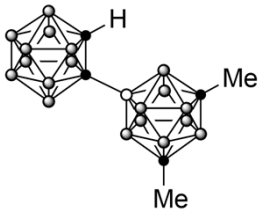
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.05 (s, 1H), 3.04 (s, 1H), 1.07 (d, *J* = 3.9 Hz, 21H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 185.04, 54.02, 18.62, 11.22. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -5.77 (2B), -9.22 (2B), -12.13 (2B), -13.42 (2B), -17.16 (1B), -18.95 (1B).
HRMS(ESI-TOF): m/z calcd for $C_{14}{}^{10}B_2{}^{11}B_8H_{32}SiO$ [M+H]+: 375.3126. Found: 375.3216.



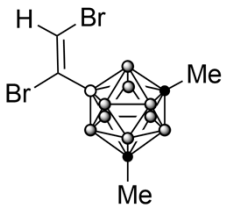
3t. Yield 27%. Yellow liquid. **Eluent**: PE
^{1}H NMR (400 MHz, $CDCl_3$) δ 2.81 (s, 2H), 1.15 – 0.98 (m, 21H), 0.42 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 52.23, 18.65, 11.24. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -0.01 (2B), -5.49 (2B), -9.12 (1B), -13.63 (3B), -20.00 (1B), -21.46 (1B).
HRMS(ESI-TOF): m/z calcd for $C_{14}{}^{10}B_2{}^{11}B_8H_{34}Si$ [M+Na]+: 349.3332. Found: 349.3307.`



4. Yield 60%. White solid. Melting point: 46 – 48 °C. **Eluent**: PE
^{1}H NMR (400 MHz, $CDCl_3$) δ 3.40 (s, 1H), 1.72 (s, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 70.82, 61.24, 24.28. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -6.82 (2B), -9.64 (3B), -10.64 (3B), -12.75 (1B), -14.04 (1B).
HRMS(ESI-TOF): m/z calcd for $C_6{}^{10}B_2{}^{11}B_8H_{16}$ [M+H]+: 197.2331. Found: 197.2321.



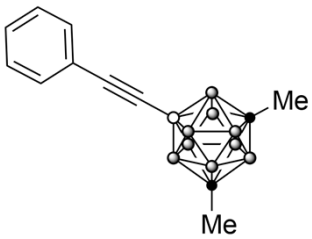
5. Yield 77% . White solid. Melting point: 230 – 232 °C. **Eluent**: PE:DCM = 5:1
^{1}H NMR (400 MHz, $CDCl_3$) δ 3.40 (s, 1H), 1.72 (s, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 70.82, 61.24, 24.28.**^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -1.77 (1B), -2.78 (1B), -7.13 (1B), -8.16 (1B), -12.76 – -9.73 (5B), -14.09 (1B).
HRMS(ESI-TOF): m/z calcd for $C_6{}^{10}B_4{}^{11}B_{16}H_{26}$ [M+H]+:315.4117 . Found: 315.4096.



6. Yield 60%. Yellow solid. Melting point: 53 – 55°C. **Eluent**: PE

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.08 (d, *J* = 9.1 Hz, 1H), 1.73 (s, 6H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 111.06, 70.18, 24.48. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -2.85 (1B), -6.74 (2B), -9.48 (3B), -10.71 (2B), -12.89 (2B).

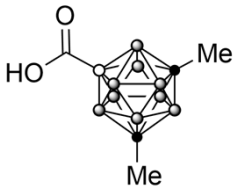
HRMS(ESI-TOF): m/z calcd for $C_6{}^{1110}B_2{}^{11}B_8H_{16}Br_2$ [M+H]+: 356.0597. Found:356.0519 .



7. Yield 90%. Yellow liquid. **Eluent**: PE

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.33 (m, 2H), 7.25 – 7.14 (m, 3H), 1.65 (s, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 130.88, 127.00, 126.82, 122.96, 68.95, 23.34. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -6.86 (2B), -9.46 (3B), -10.72 (3B), -12.79 (1B), -14.24 (1B).

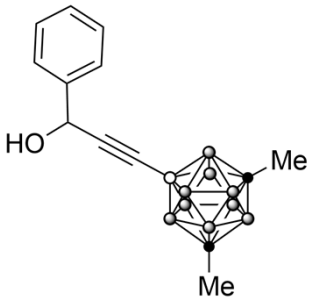
HRMS(ESI-TOF): m/z calcd for $C_{12}{}^{10}B_2{}^{11}B_8H_{20}$ [M+H]+: 273.2647 Found: 273.2628.



8. Yield 65%. White solid. Melting point: 169 – 170 °C. **Eluent**: EA

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.74 (s, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 70.98, 24.25. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -7.36 (3B), -10.09 (5B), -12.33 (2B).

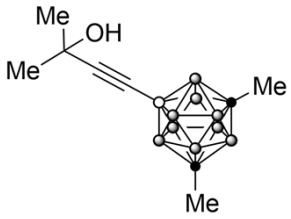
HRMS(ESI-TOF): m/z calcd for $C_5{}^{10}B_2{}^{11}B_8H_{16}O_2$ [M+H]+: 241.2230. Found: 241.2219.



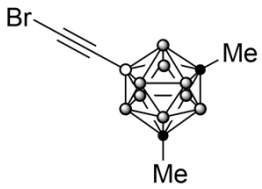
9. Yield 76% . White liquid. **Eluent**: PE:EA = 3:1

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (dd, *J* = 7.2, 1.8 Hz, 2H), 7.38 (dd, *J* = 8.2, 6.4 Hz, 2H), 7.34 – 7.29 (m, 1H), 5.46 (d, *J* = 6.3 Hz, 1H), 2.13 (d, *J* = 6.5 Hz, 1H), 1.71 (s, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 128.49, 128.17, 126.89, 65.12, 24.35. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -6.93 (2B), -9.62 (4B), -10.71 (2B), -12.71 (1B), -14.10 (1B).

HRMS(ESI-TOF): m/z calcd for $C_{13}{}^{10}B_2{}^{11}B_8H_{22}O$ [M+Na]+: 325.2573. Found: 325.2570.



10. Yield 80%. White solid. Melting point: 133 – 135 °C. **Eluent**: PE:EA = 3:1
^{1}H NMR (400 MHz, $CDCl_3$) δ 1.69 (s, 6H), 1.49 (s, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 69.92, 65.45, 31.51, 24.33. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -6.92, -10.17 (d, *J* = 162.4 Hz), -13.63 (d, *J* = 191.2 Hz). **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -5.92 (2B), -9.54 (4B), -10.81 (2B), -12.88 (1B), -14.37 (1B).
HRMS(ESI-TOF): m/z calcd for $C_9{}^{10}B_2{}^{11}B_8H_{23}O$ [M+H]+: 256.2829. Found: 256.2835

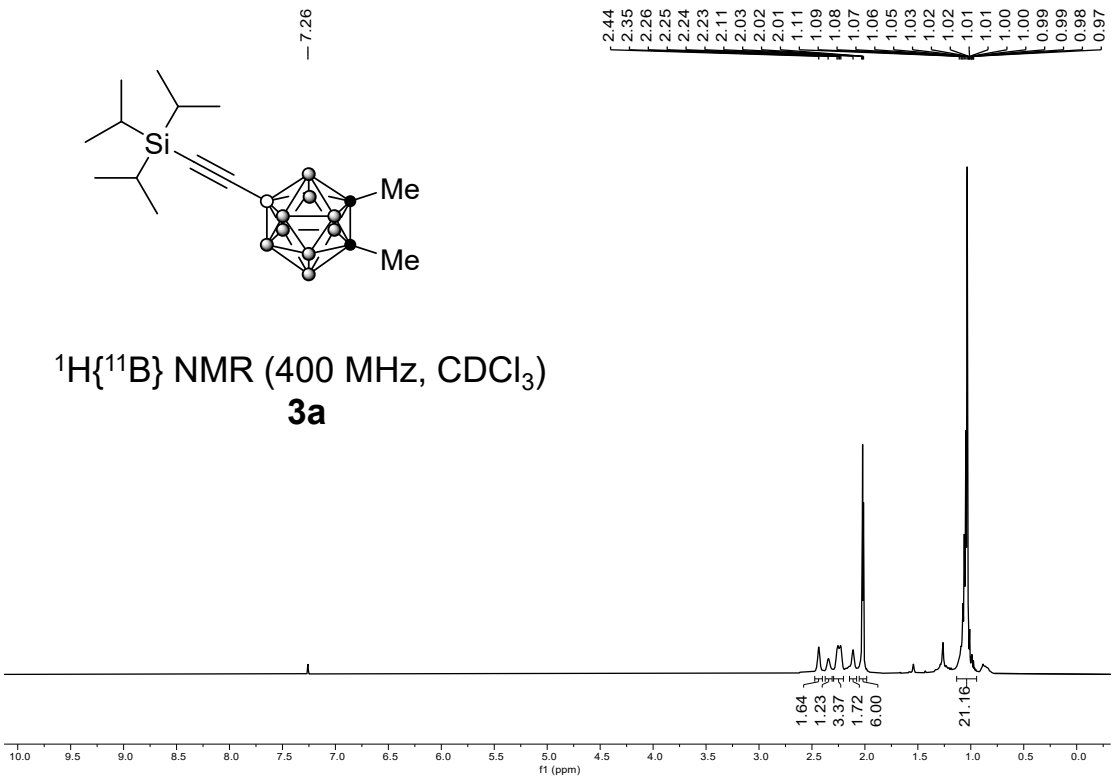


11. Yield 83%. Yellow solid. Melting point: 113 – 114 °C. **Eluent**: PE:DCM = 1:1
^{1}H NMR (400 MHz, $CDCl_3$) δ 1.70 (s, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 70.13, 24.33. **^{11}B{^{1}H} NMR (128 MHz, $CDCl_3$)** δ -6.94 (2B), -9.69 (4B), -10.73 (2B), -12.83 (1B), -14.16 (1B).
HRMS(ESI-TOF): m/z calcd for $C_6{}^{10}B_1{}^{11}B_9H_{15}Br$ [M+Na]+:298.1240 . Found: 298.1269.

6. References

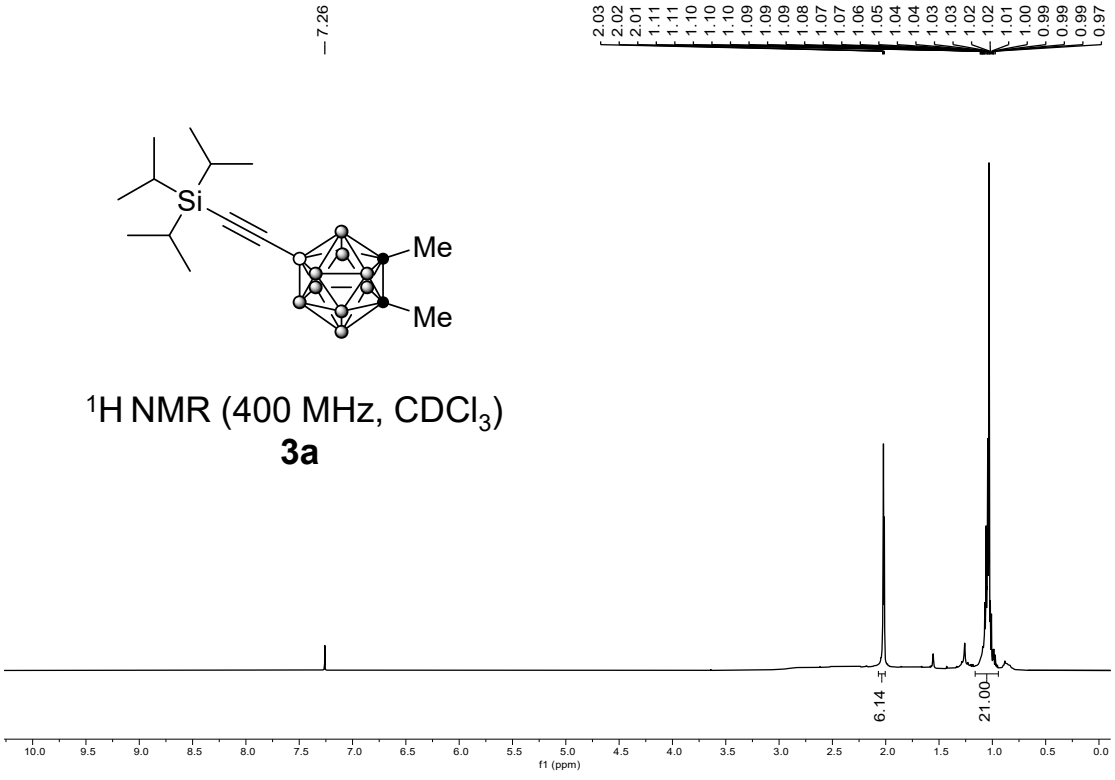
1. T. L. Heying, J. W. Ager Jr, S. L. Clark, R. P. Alexander, S. Papetti, J. A. Reid and S. I. Trotz, *Inorg. Chem.,* 1963, **2**, 1097.
2. S.-Y. Kim, Y.-J. Cho, H.-J. Son, C. H. Kim and S. O. Kang, *J. Organomet. Chem*., 2018, **865**, 152.
3. L. Deng, H. S. Chan, Z. Xie, *J. Am. Chem. Soc*., 2006, **128**, 7728.
4. P. Dozzo, R. A. Kasar and S. B. Kahl. *Inorg. Chem.*, 2005, **44**, 8053.
5. Z. Zheng, W. Jiang, A. A. Zinn, C. B. Knobler, M. F. Hawthorne, M. F. *Inorg. Chem.,* 1995, **34**, 2095
6. W. Lu,Y. Wu, Y.-N. Ma, F. Chen, X. Chen, *Inorg. Chem.,* 2023, **62**, 885.
7. Y.-N. Ma, H. Ren, Y. Wu, N. Li, F. Chen and X. Chen, *J. Am. Chem. Soc.*, 2023, **145**, 7331.

7. NMR spectra



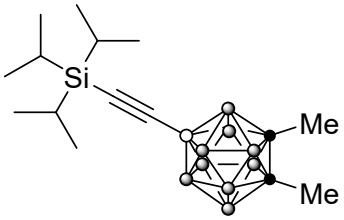
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

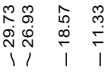
3a



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

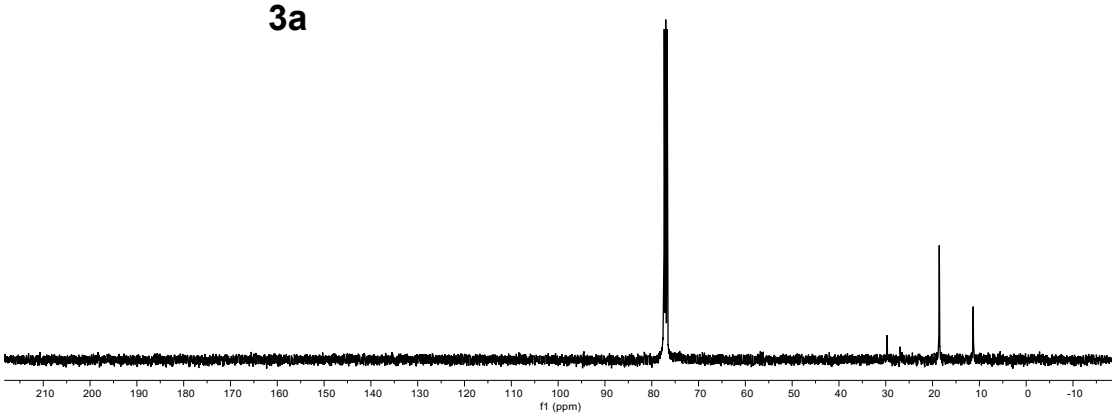
3a

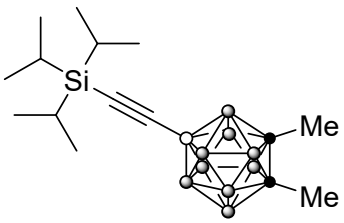


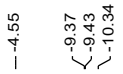


^{13}C NMR (101 MHz, $CDCl_3$)

3a

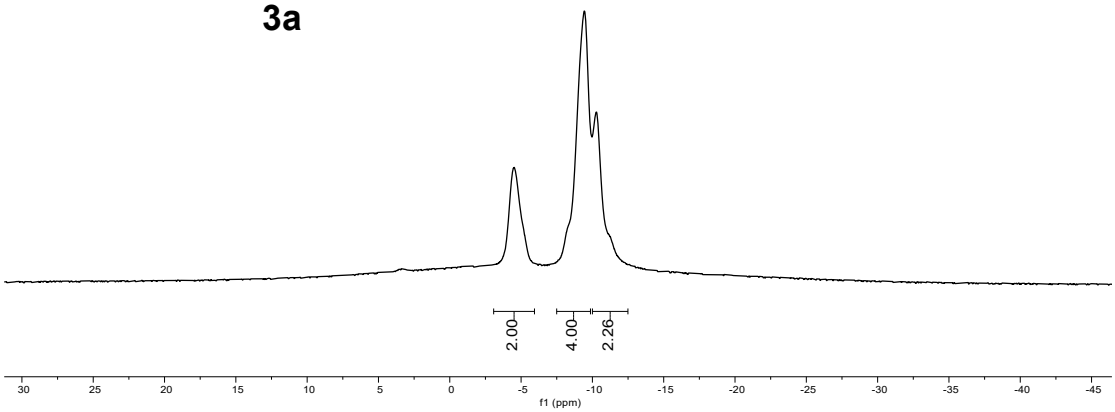


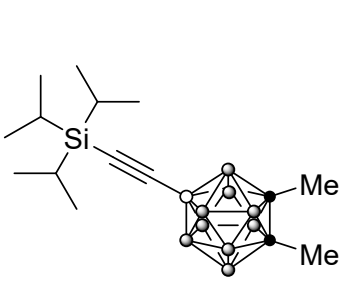


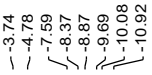


$^{11}B\{^1H\}$ NMR (128 MHz, $CDCl_3$)

3a

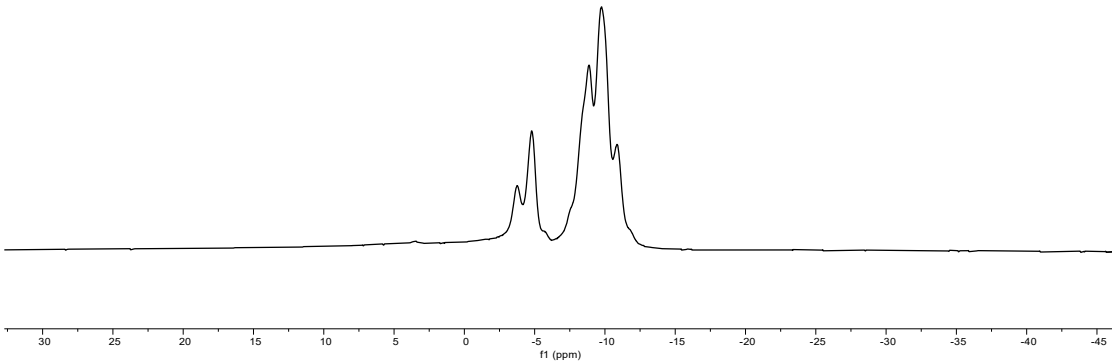


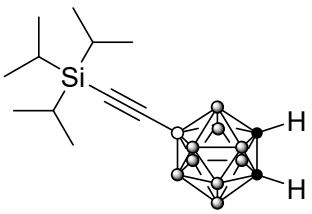


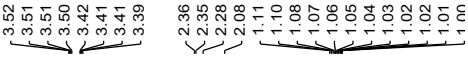


^{11}B NMR (128 MHz, $CDCl_3$)

3a

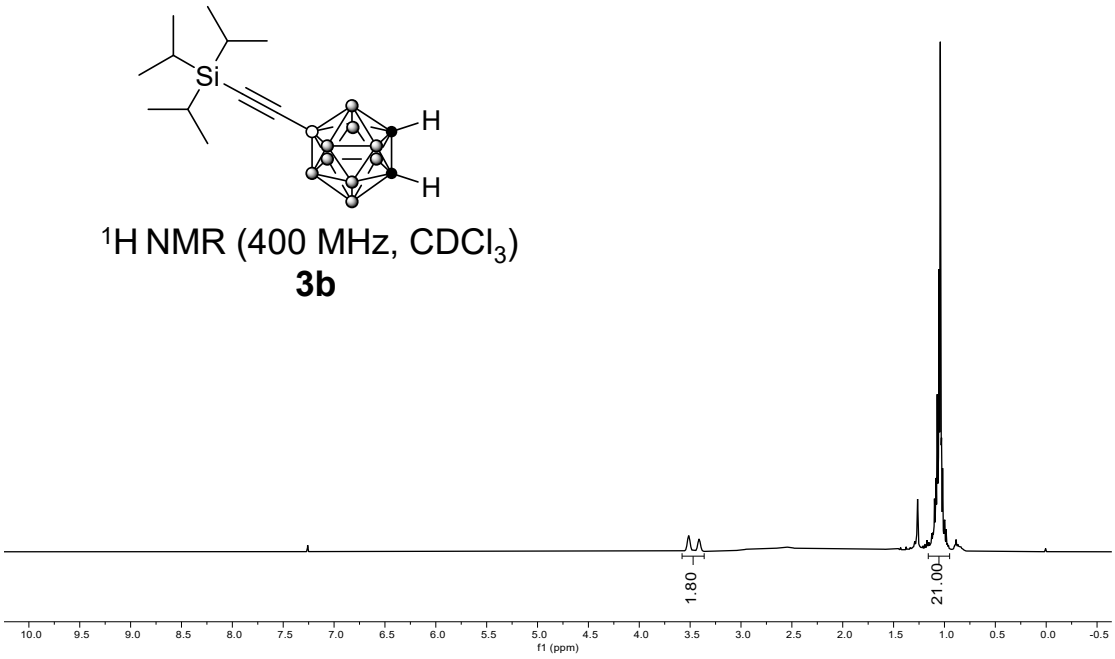






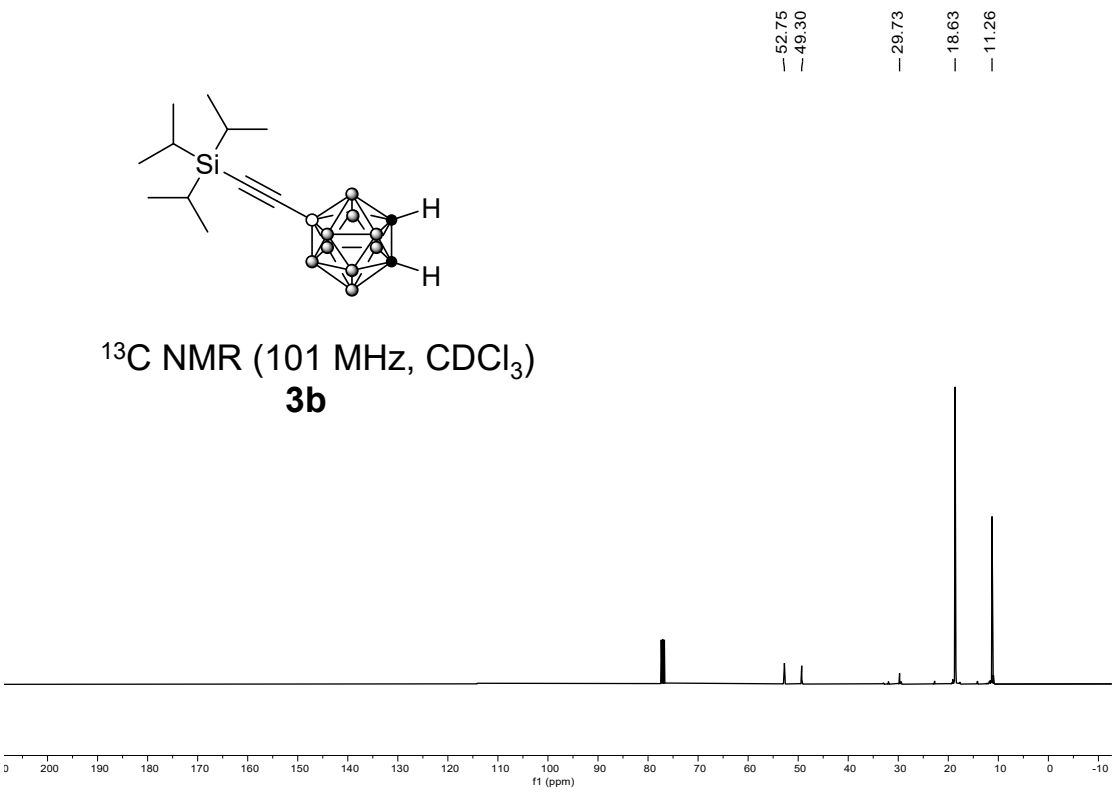
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3b



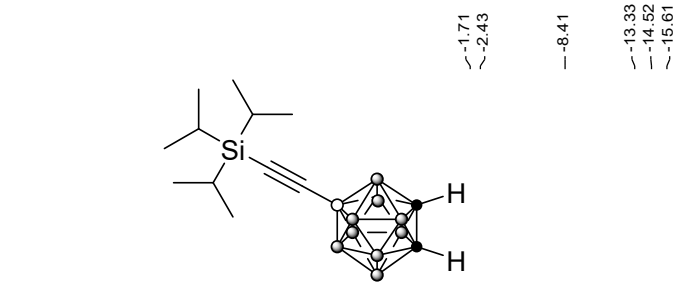
^{1}H NMR (400 MHz, $CDCl_3$)

3b



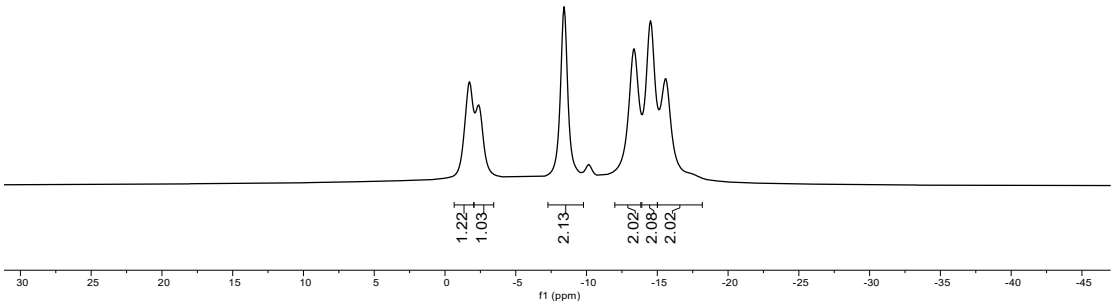
^{13}C NMR (101 MHz, $CDCl_3$)

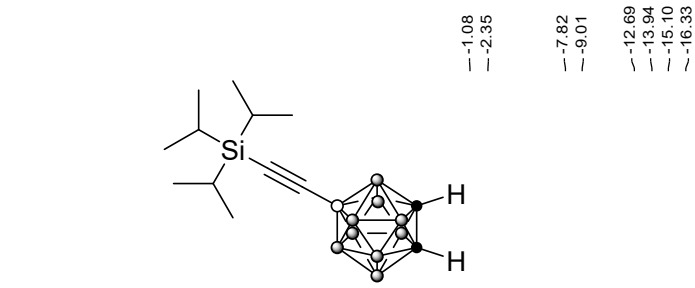
3b



$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

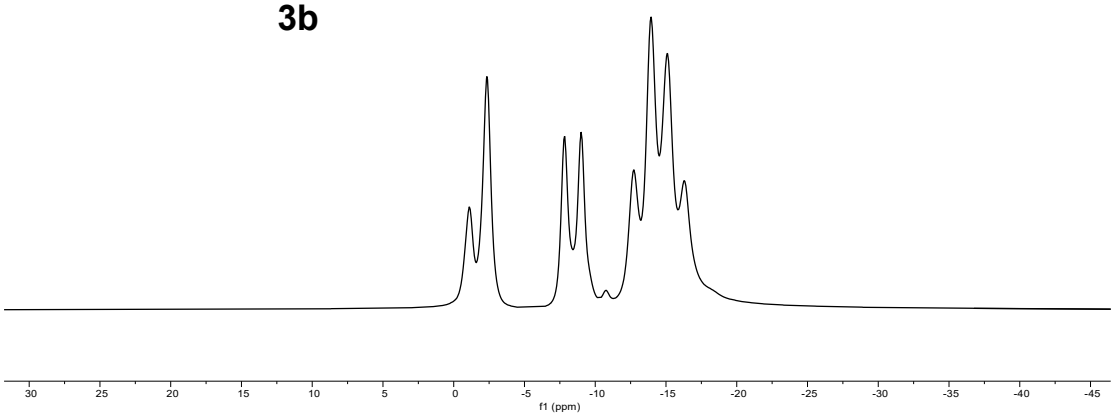
3b

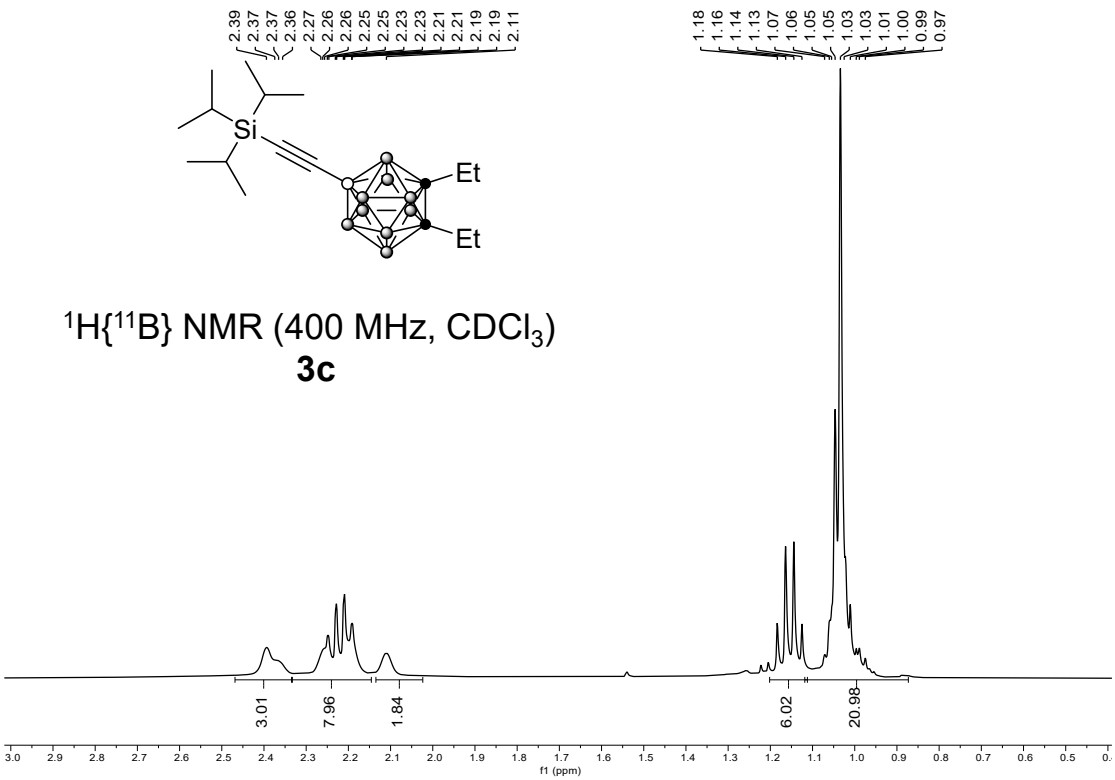




^{11}B NMR (128 MHz, $CDCl_3$)

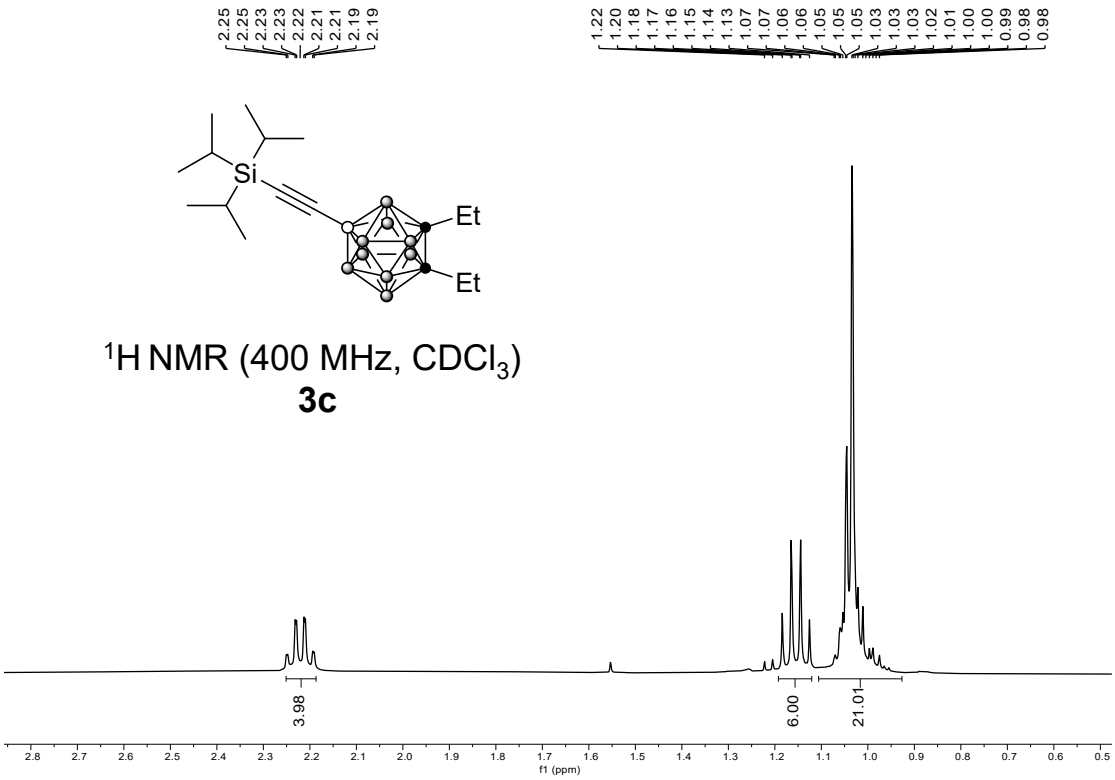
3b





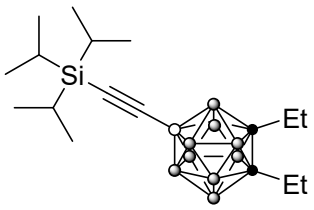
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3c



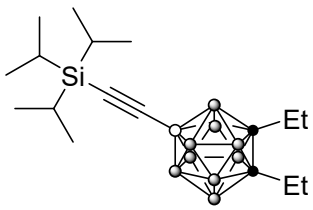
^{1}H NMR (400 MHz, $CDCl_3$)

3c



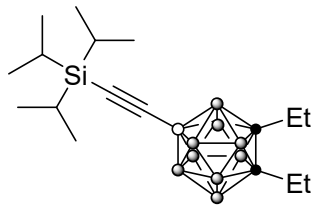
^{13}C NMR (101 MHz, $CDCl_3$)

3c



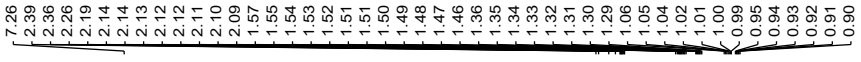
$^{11}B\{^1H\}$ NMR (128 MHz, $CDCl_3$)

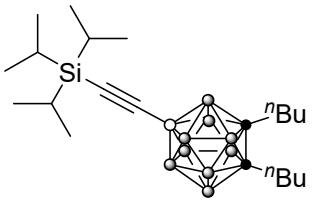
3c



^{11}B NMR (128 MHz, $CDCl_3$)

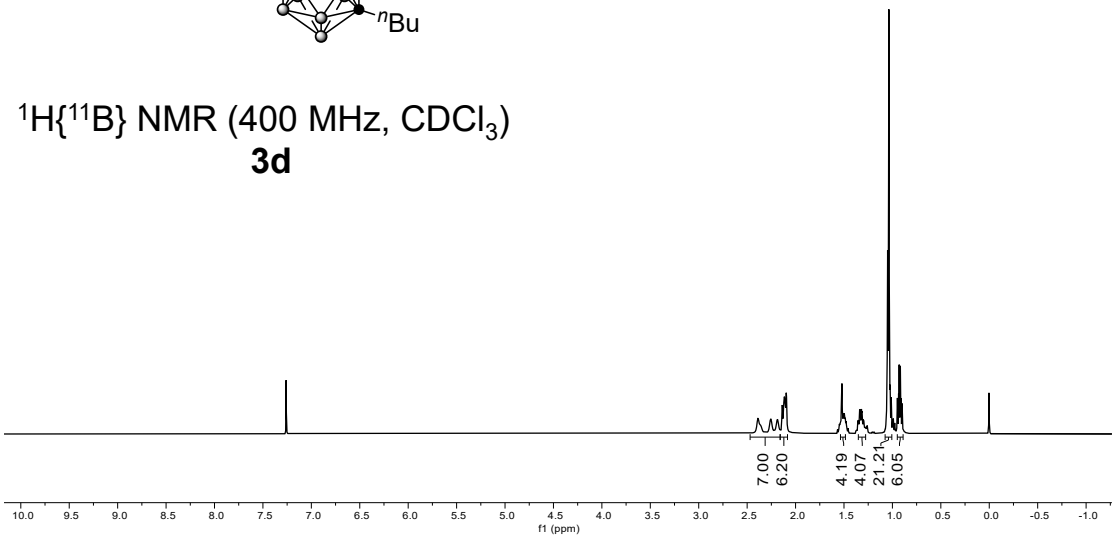
3c

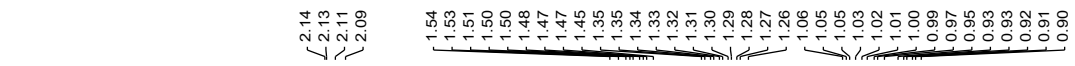


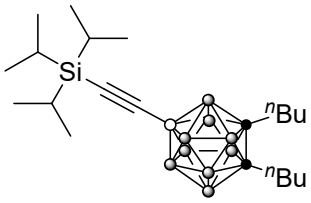


$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3d

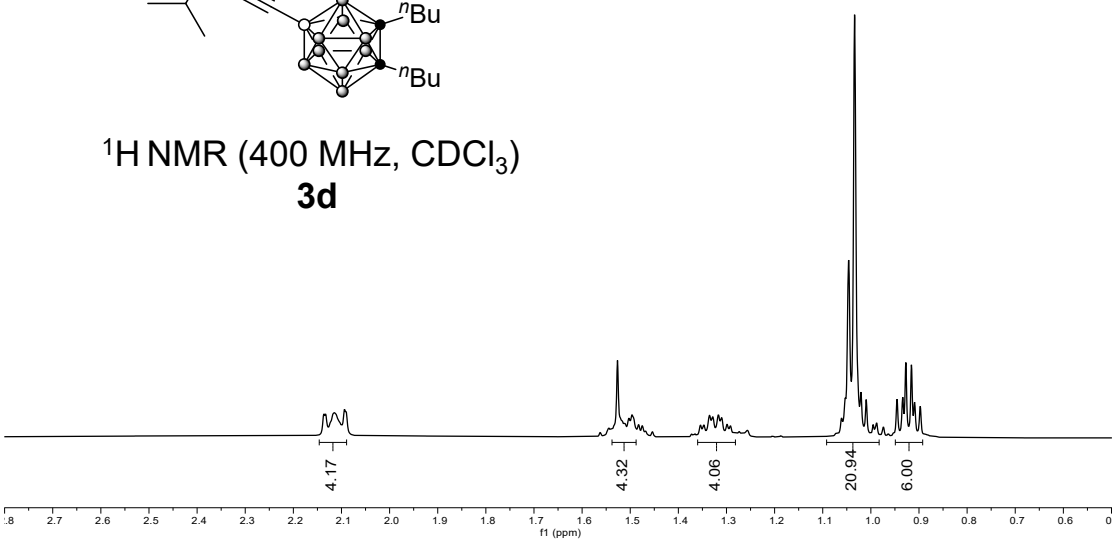


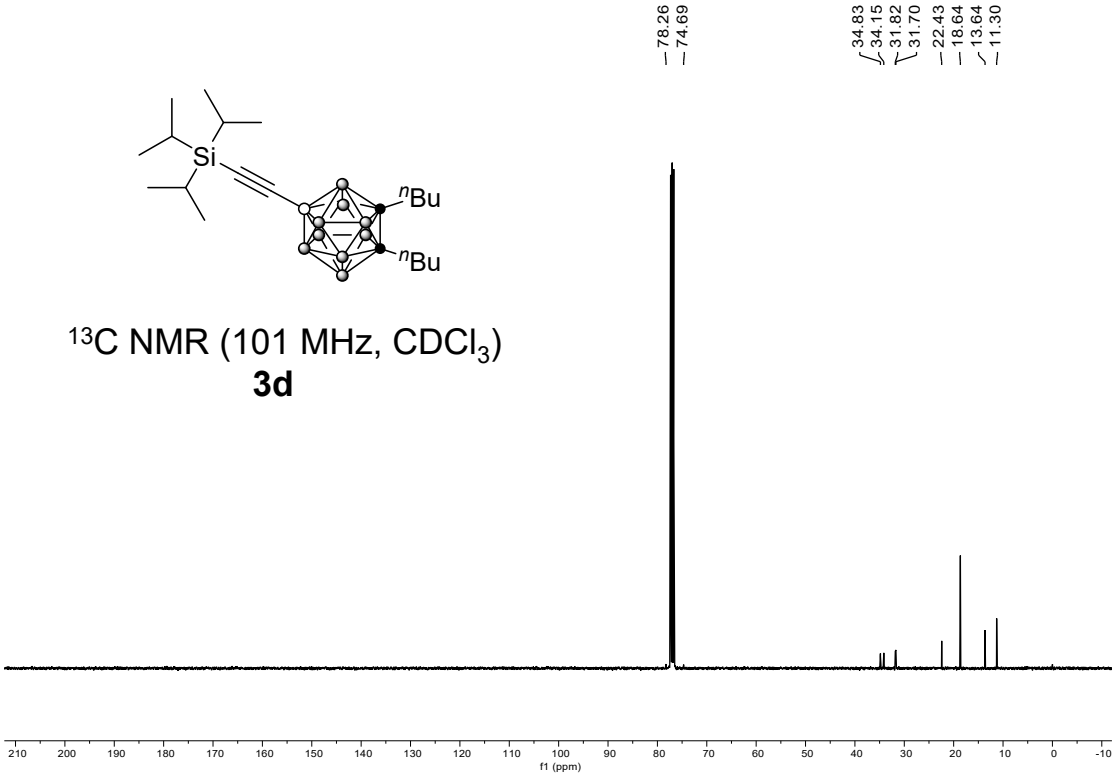




^{1}H NMR (400 MHz, $CDCl_3$)

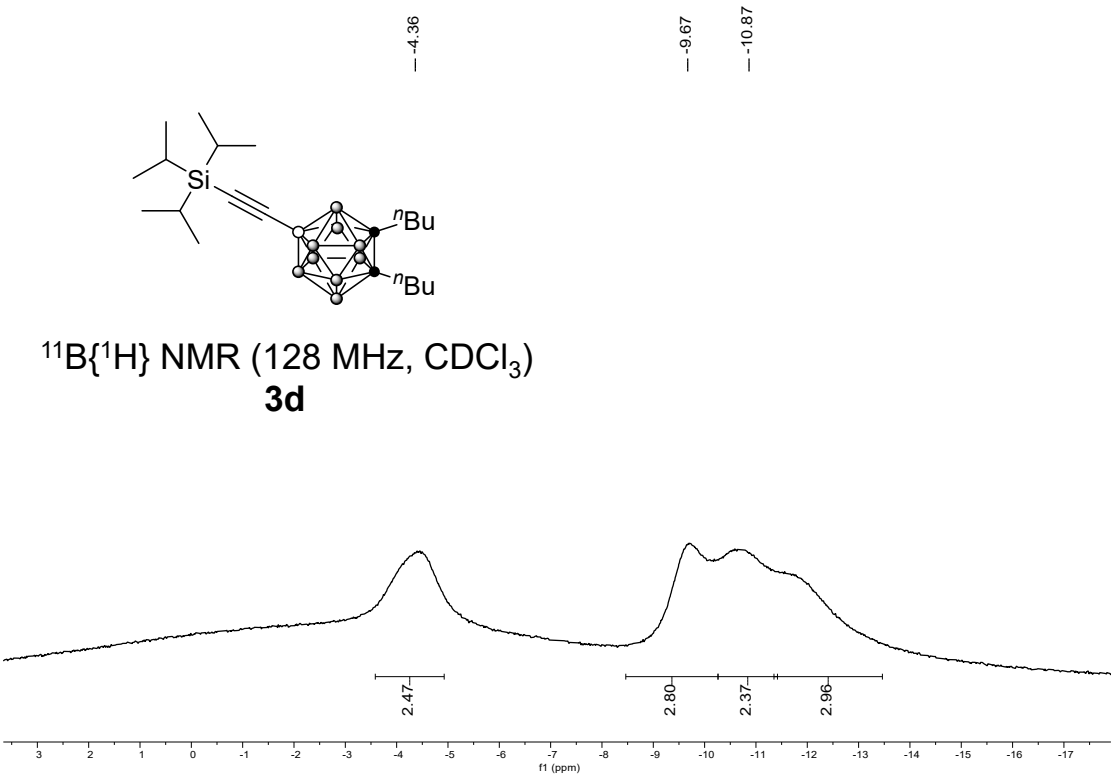
3d





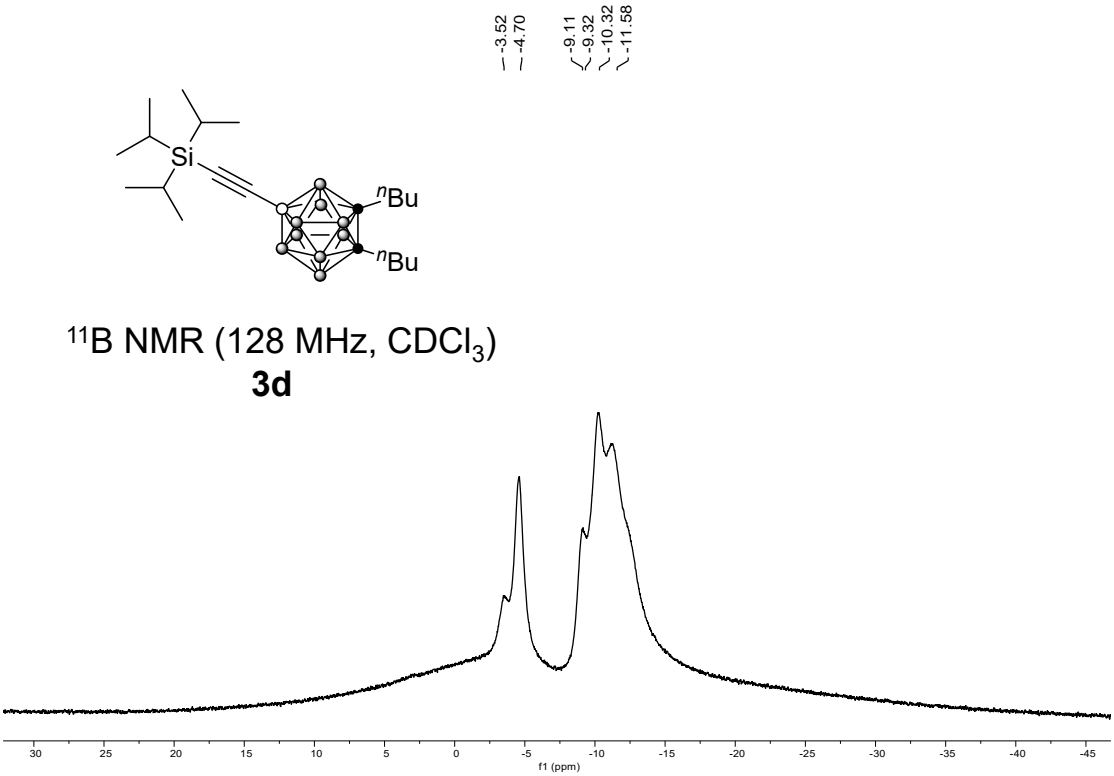
^{13}C NMR (101 MHz, $CDCl_3$)

3d



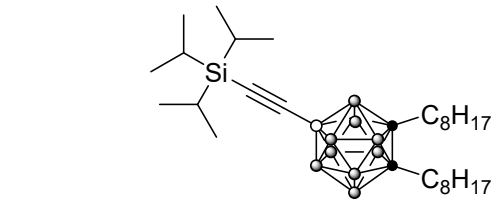
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

3d



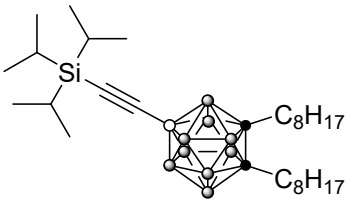
^{11}B NMR (128 MHz, $CDCl_3$)

3d



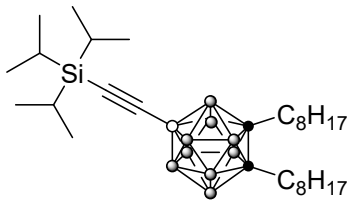
$^1H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3e



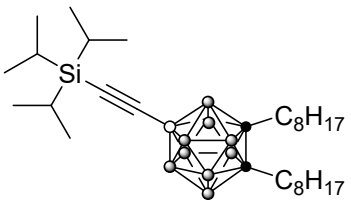
^1H NMR (400 MHz, $CDCl_3$)

3e



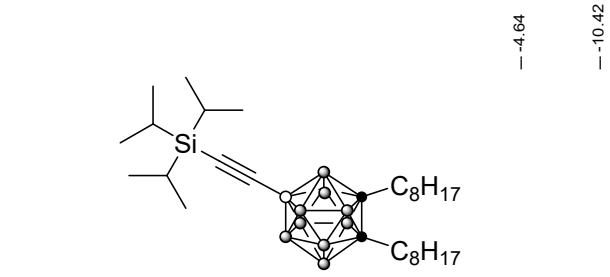
^{13}C NMR (101 MHz, $CDCl_3$)

3e



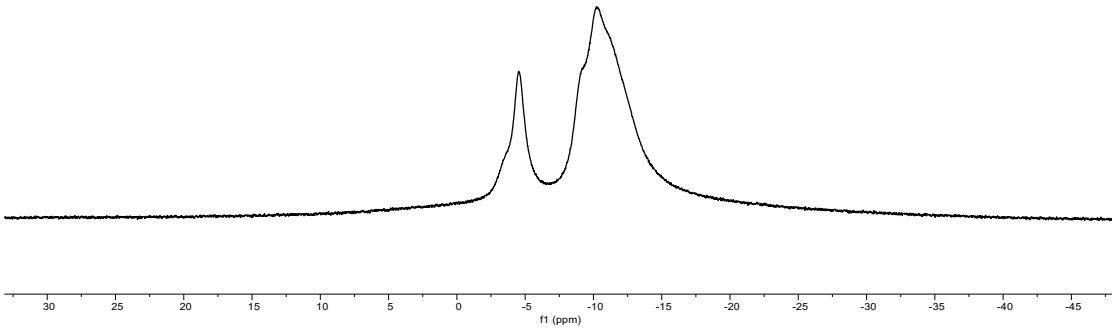
$^{11}B\{^1H\}$ NMR (128 MHz, $CDCl_3$)

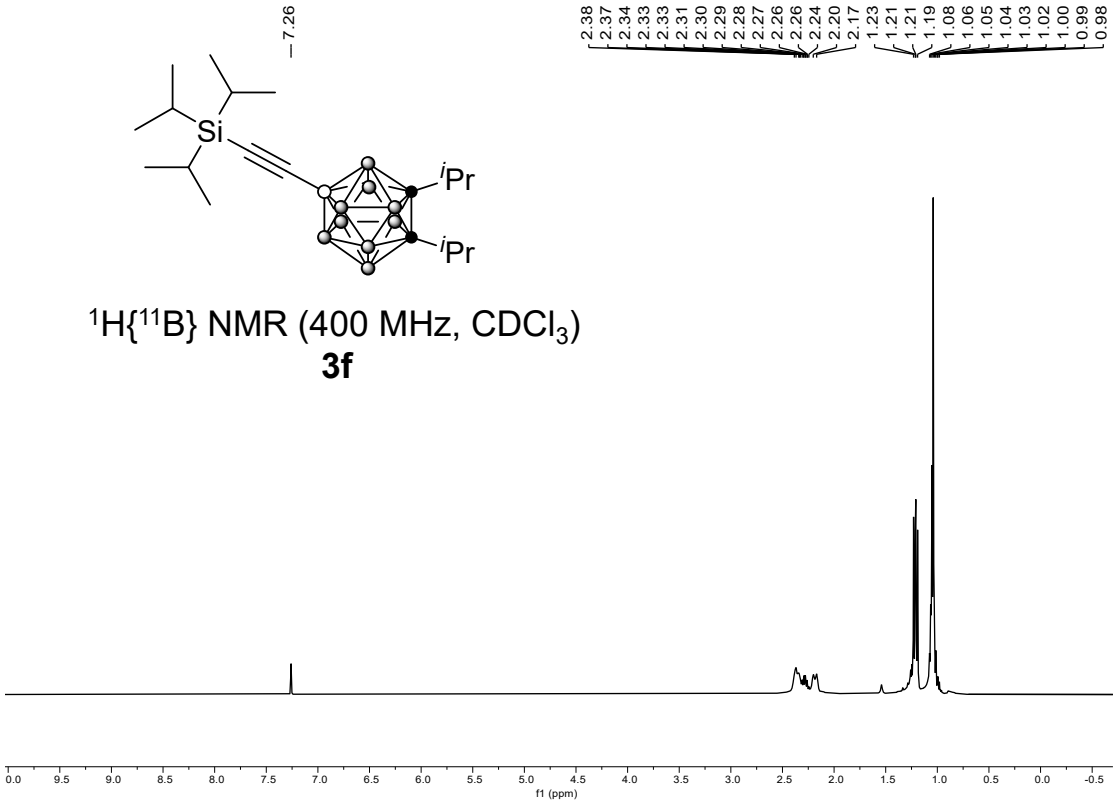
3e



^{11}B NMR (128 MHz, $CDCl_3$)

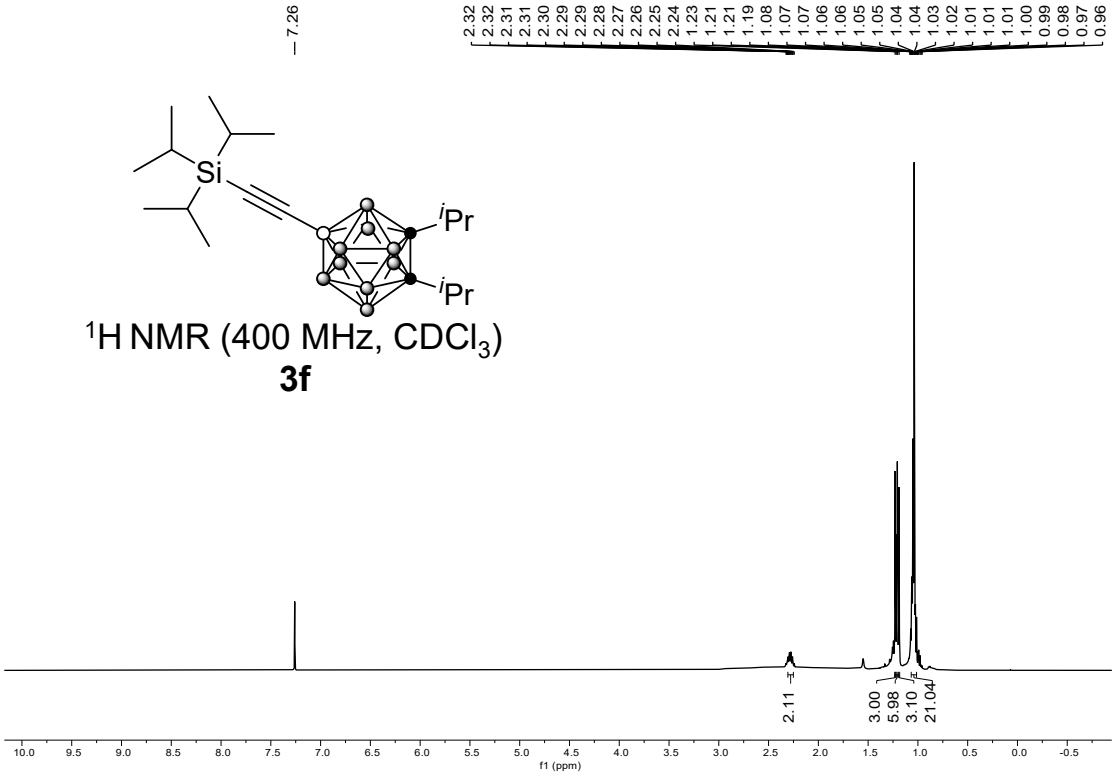
3e





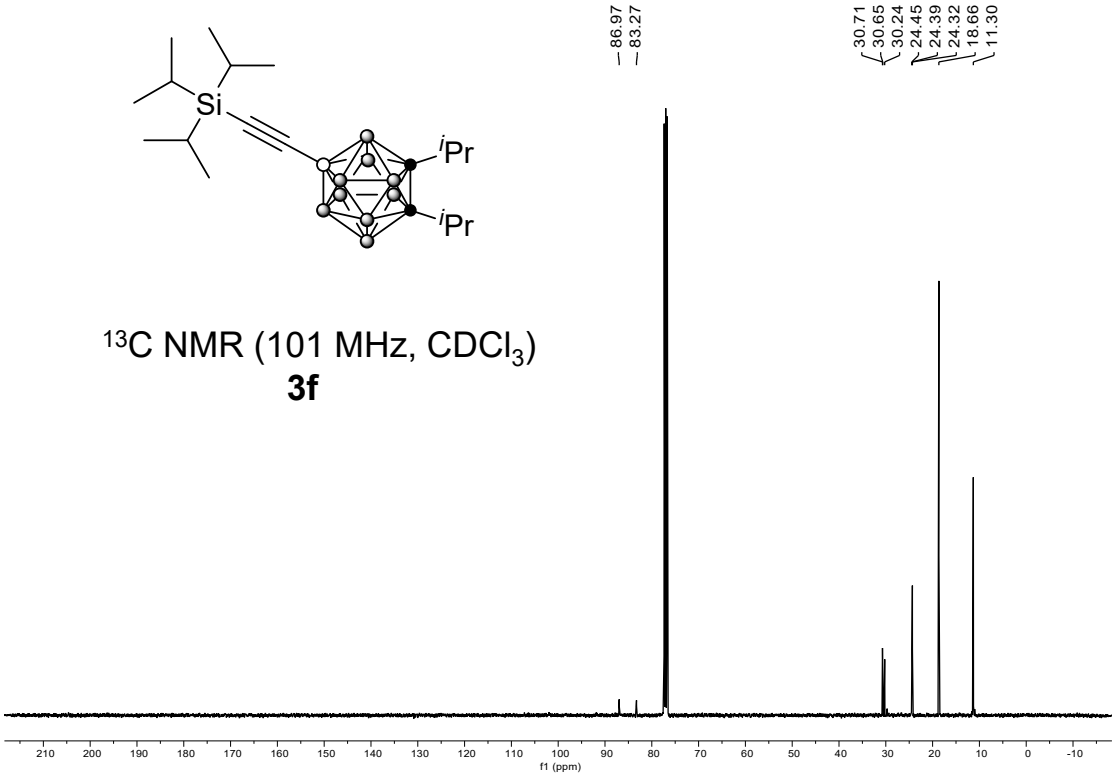
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3f



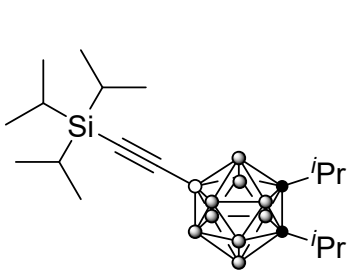
^{1}H NMR (400 MHz, $CDCl_3$)

3f



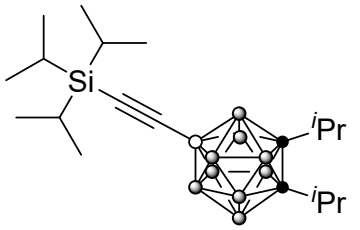
^{13}C NMR (101 MHz, $CDCl_3$)

3f



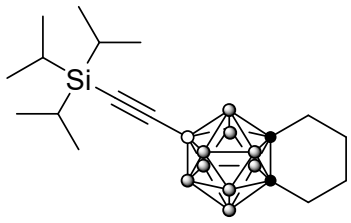
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

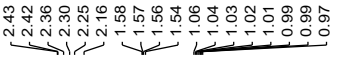
3f



^{11}B NMR (128 MHz, $CDCl_3$)

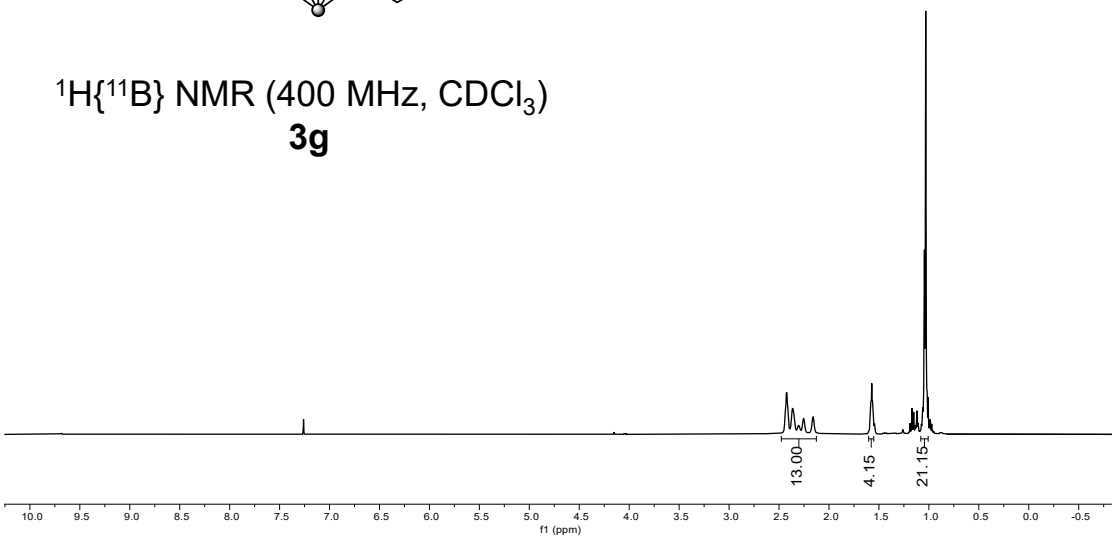
3f

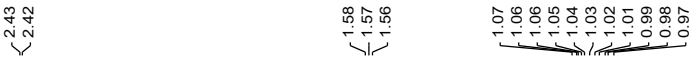


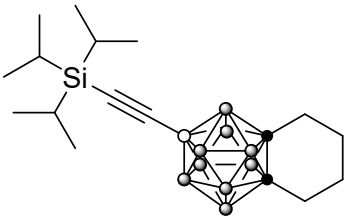


$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3g

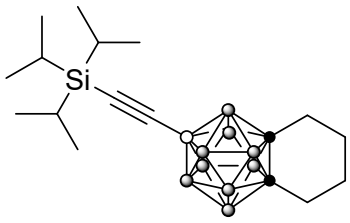






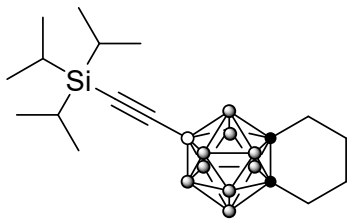
^{1}H NMR (400 MHz, $CDCl_3$)

3g



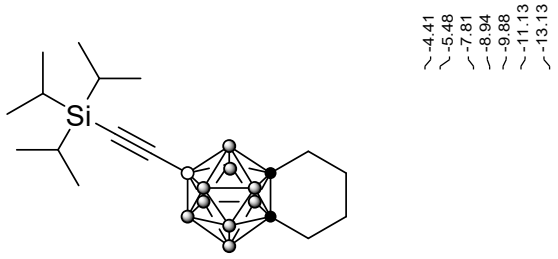
^{13}C NMR (101 MHz, $CDCl_3$)

3g



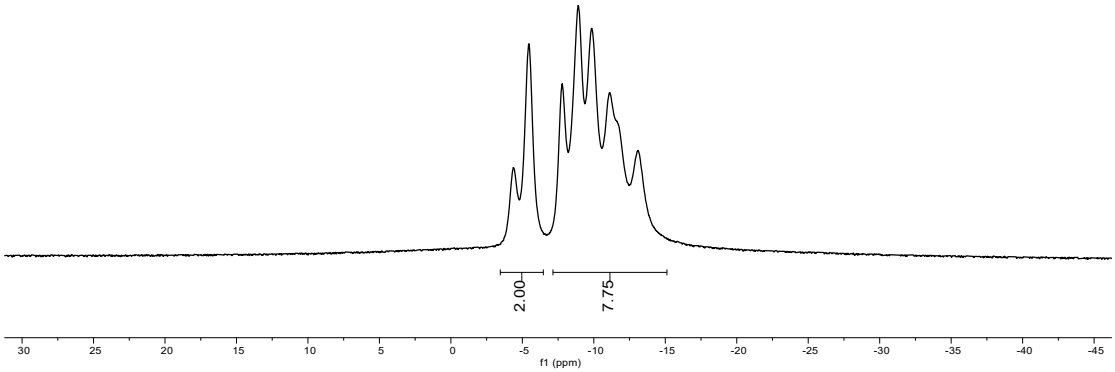
$^{11}B\{^1H\}$ NMR (128 MHz, $CDCl_3$)

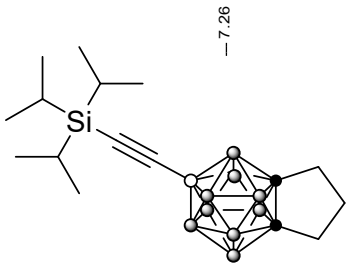
3g

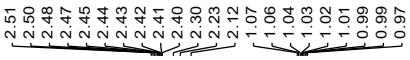


^{11}B NMR (128 MHz, $CDCl_3$)

3g

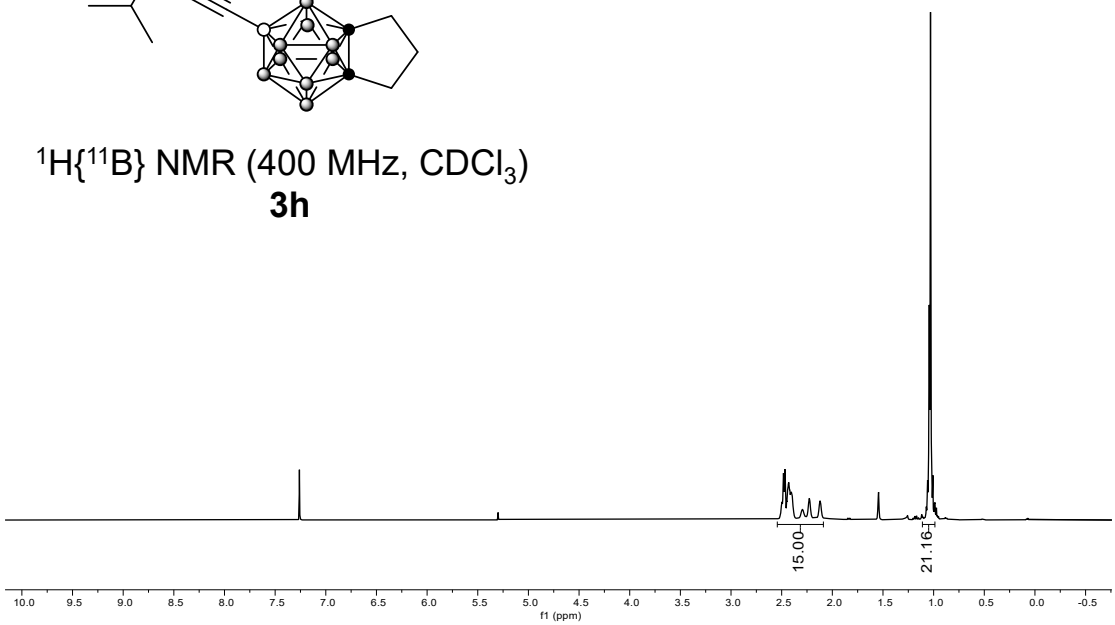


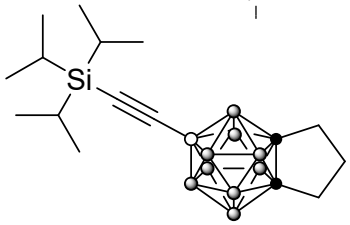




$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

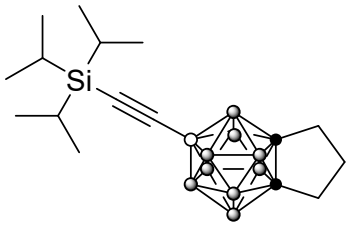
3h





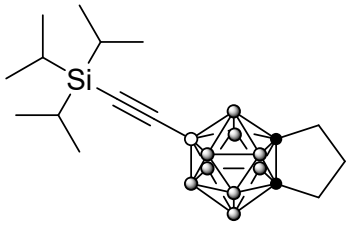
^{1}H NMR (400 MHz, $CDCl_3$)

3h



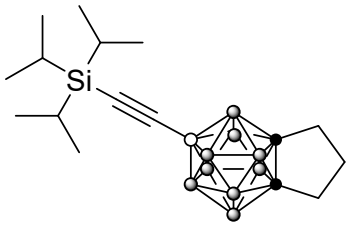
^{13}C NMR (101 MHz, $CDCl_3$)

3h



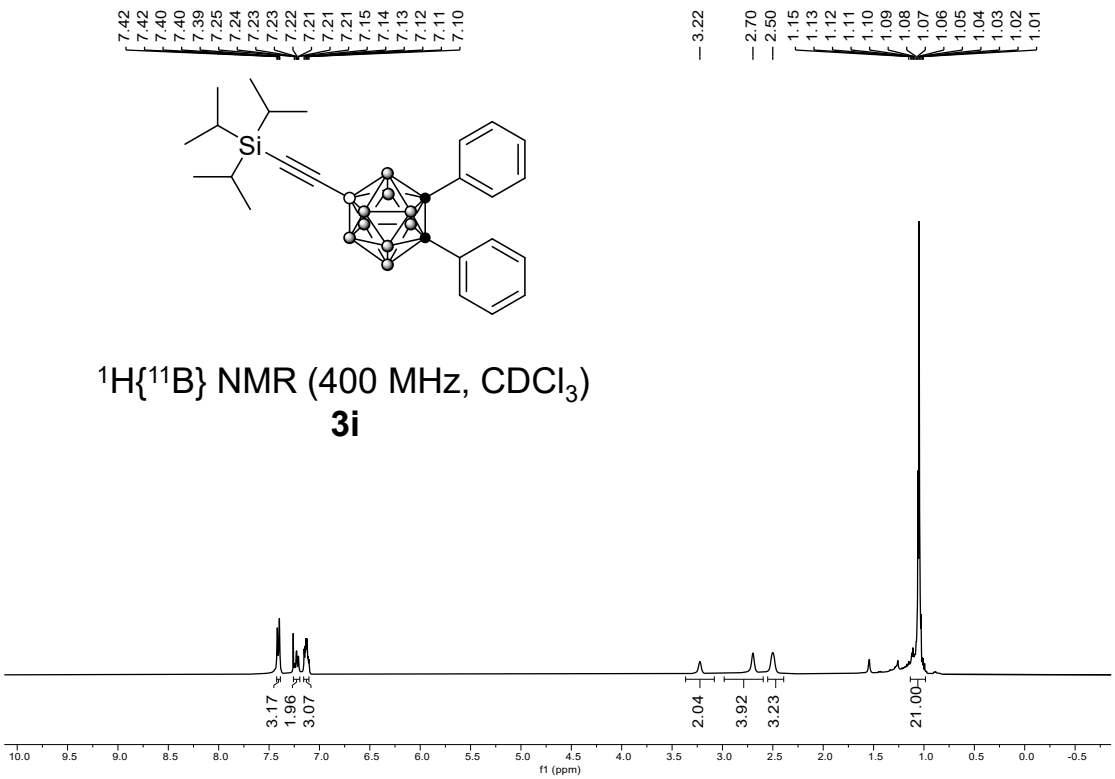
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

3h



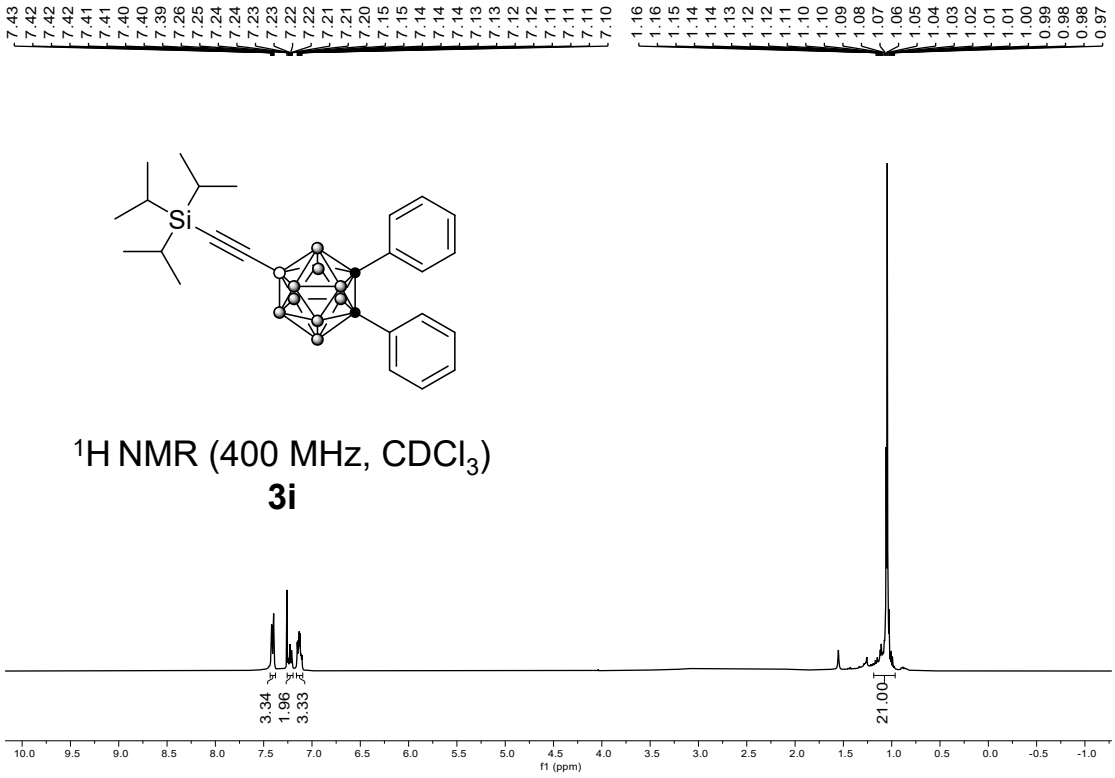
^{11}B NMR (128 MHz, $CDCl_3$)

3h



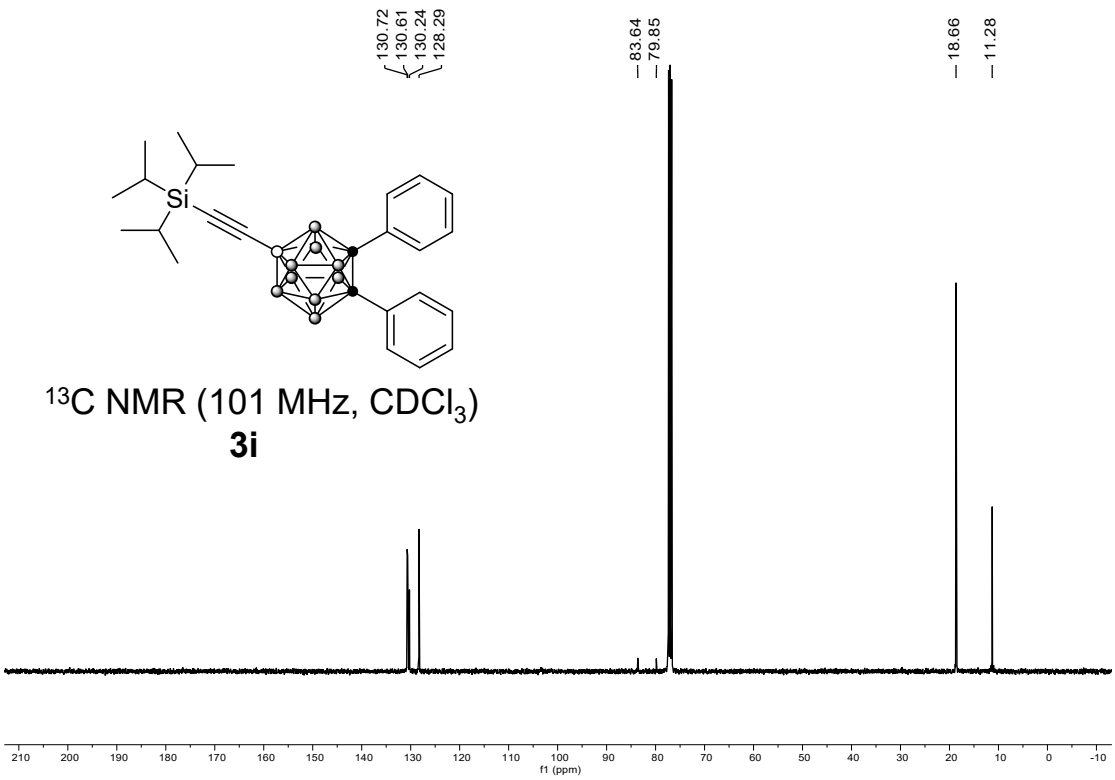
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3i



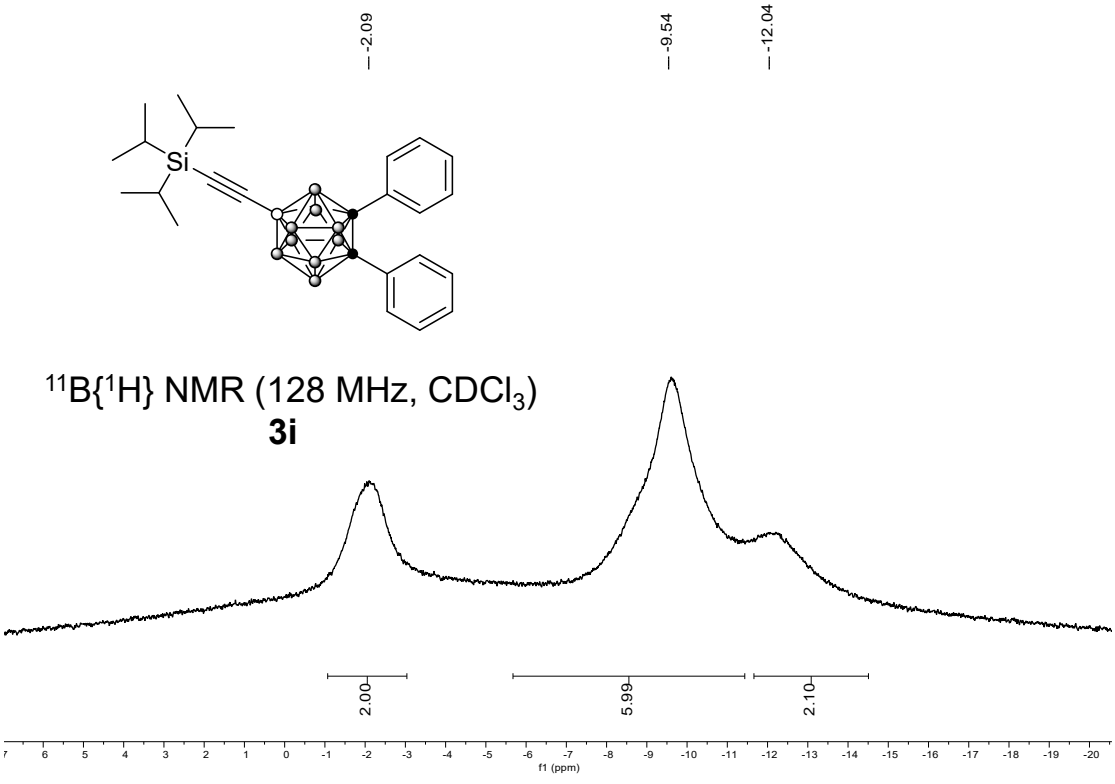
^{1}H NMR (400 MHz, $CDCl_3$)

3i



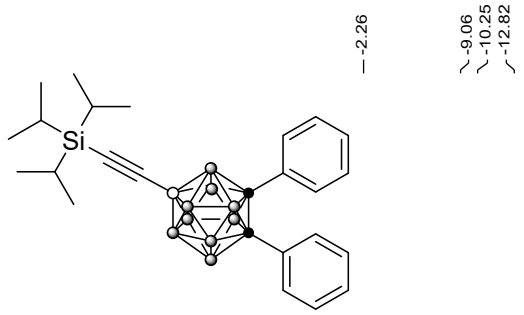
^{13}C NMR (101 MHz, $CDCl_3$)

3i



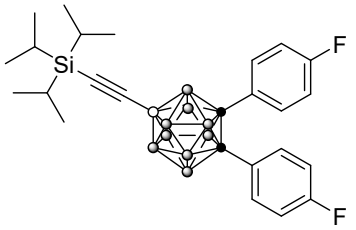
$^{11}B\{^1H\}$ NMR (128 MHz, $CDCl_3$)

3i



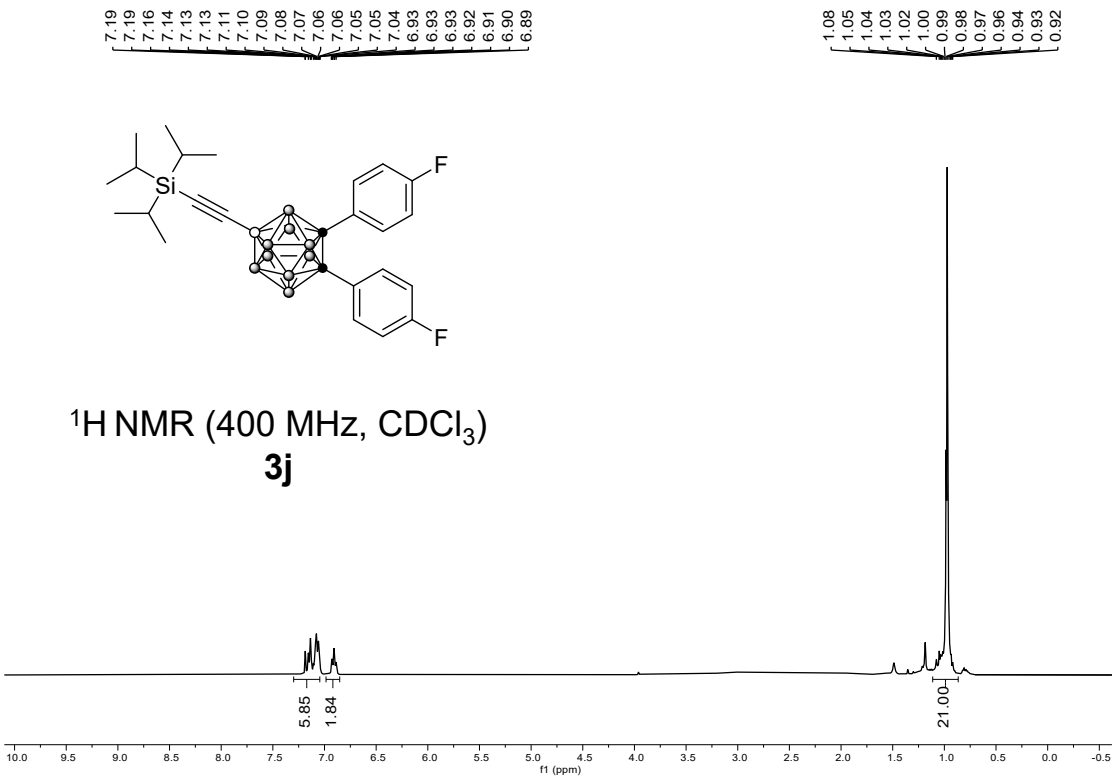
^{11}B NMR (128 MHz, $CDCl_3$)

3i



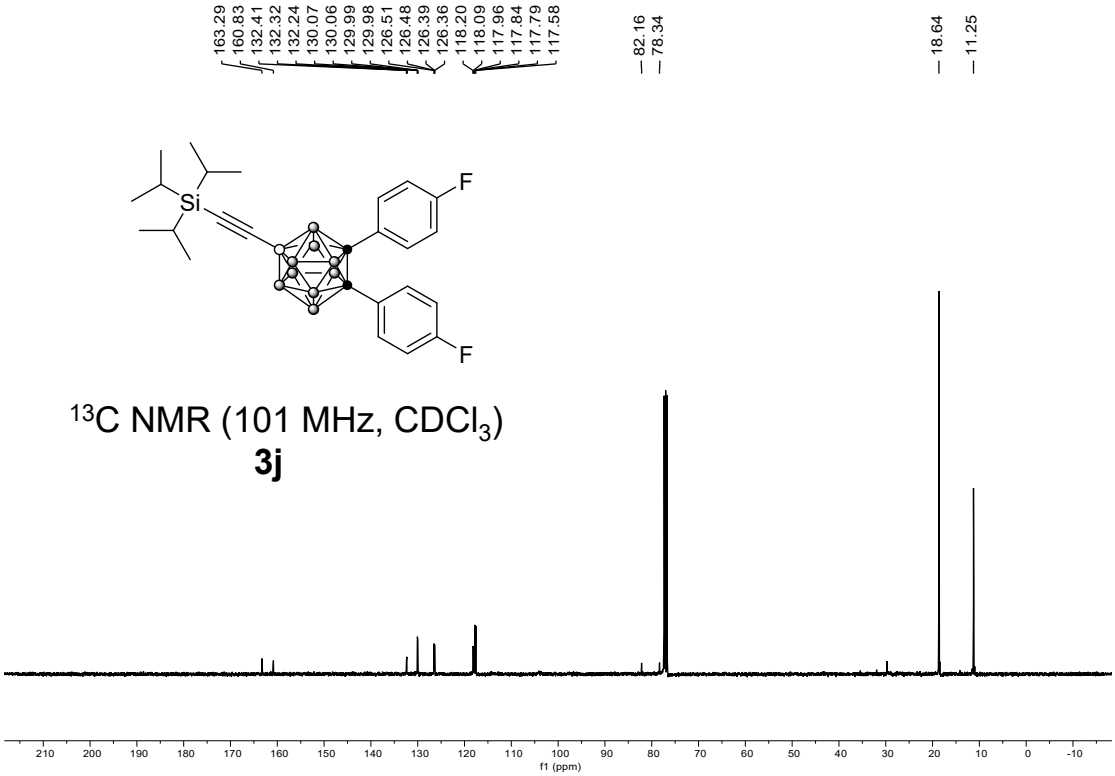
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3j



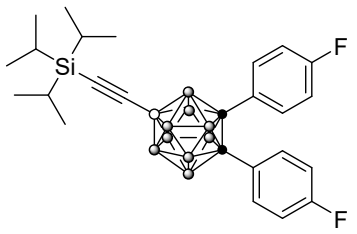
^{1}H NMR (400 MHz, $CDCl_3$)

3j



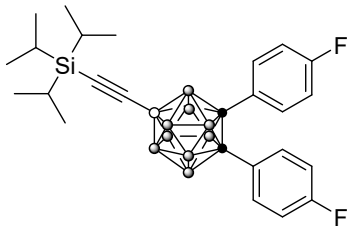
^{13}C NMR (101 MHz, $CDCl_3$)

3j



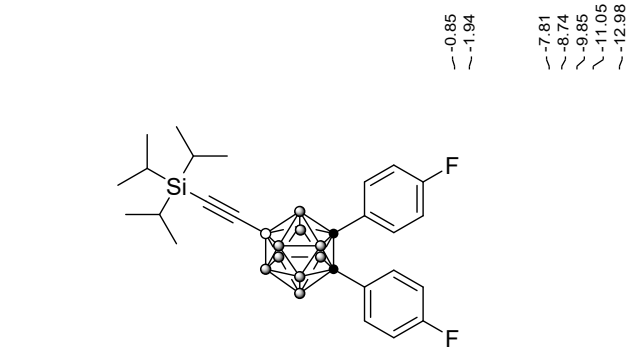
^{19}F NMR (376 MHz, $CDCl_3$)

3j



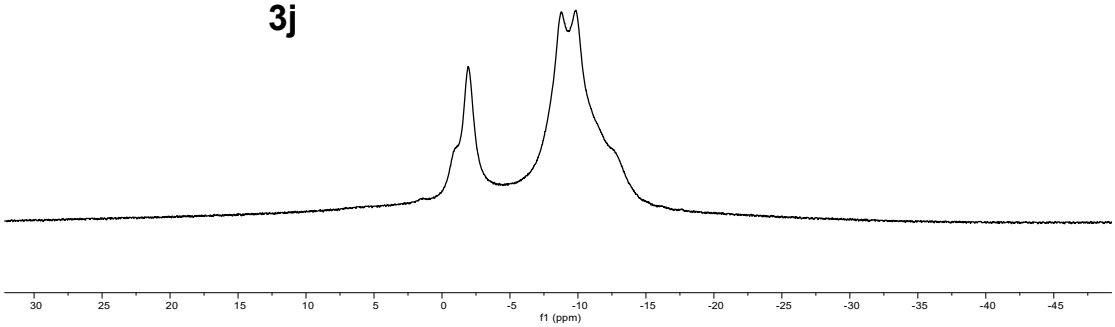
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

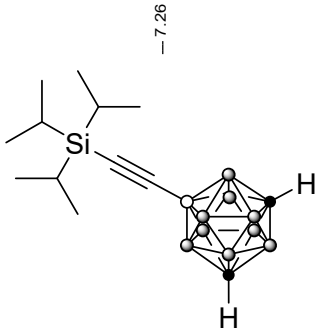
3j

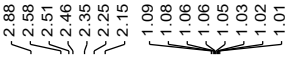


^{11}B NMR (128 MHz, $CDCl_3$)

3j

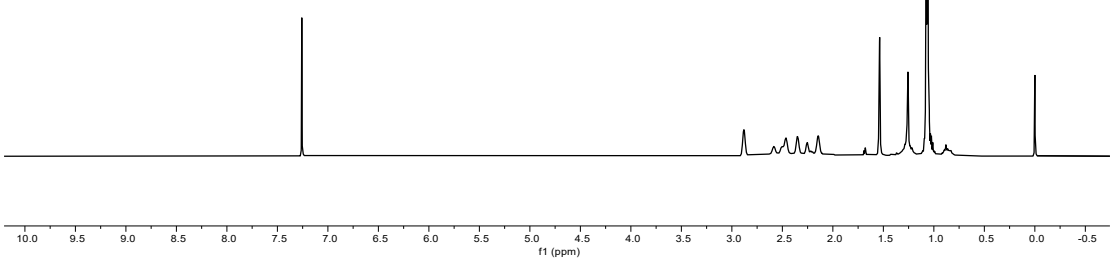


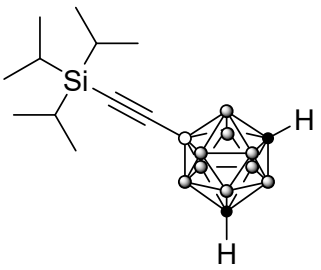




$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

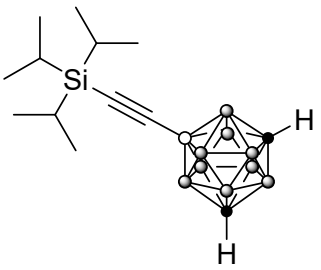
3k





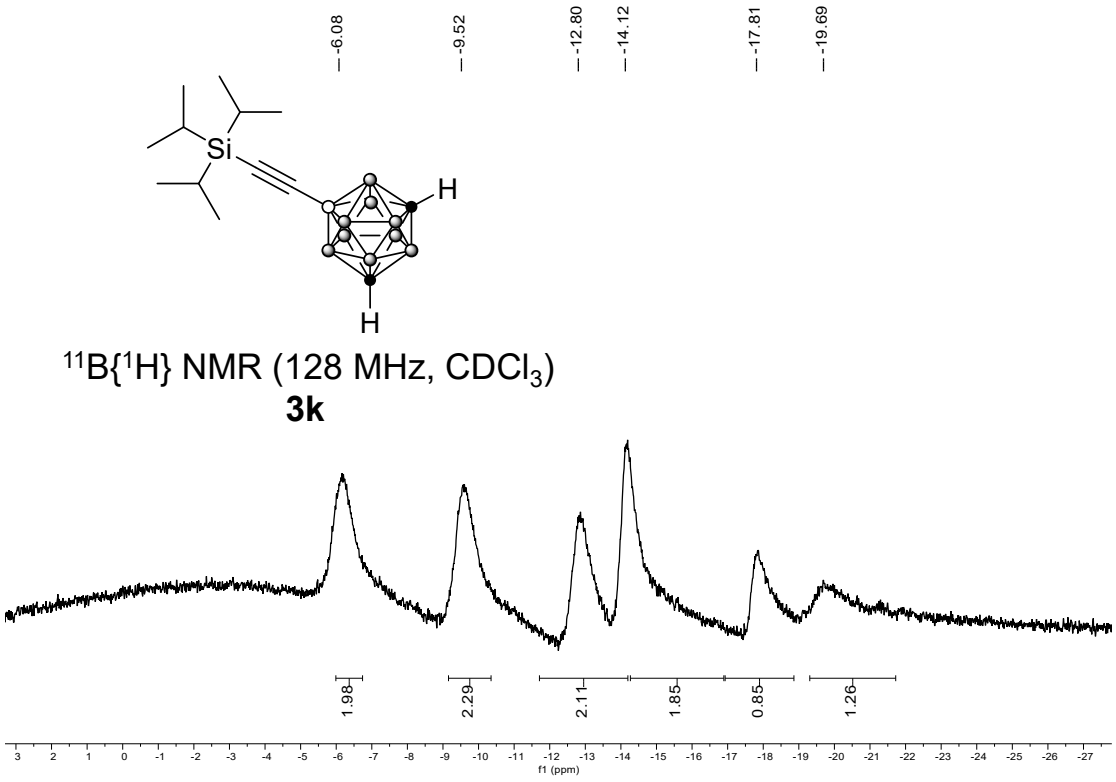
^{1}H NMR (400 MHz, $CDCl_3$)

3k



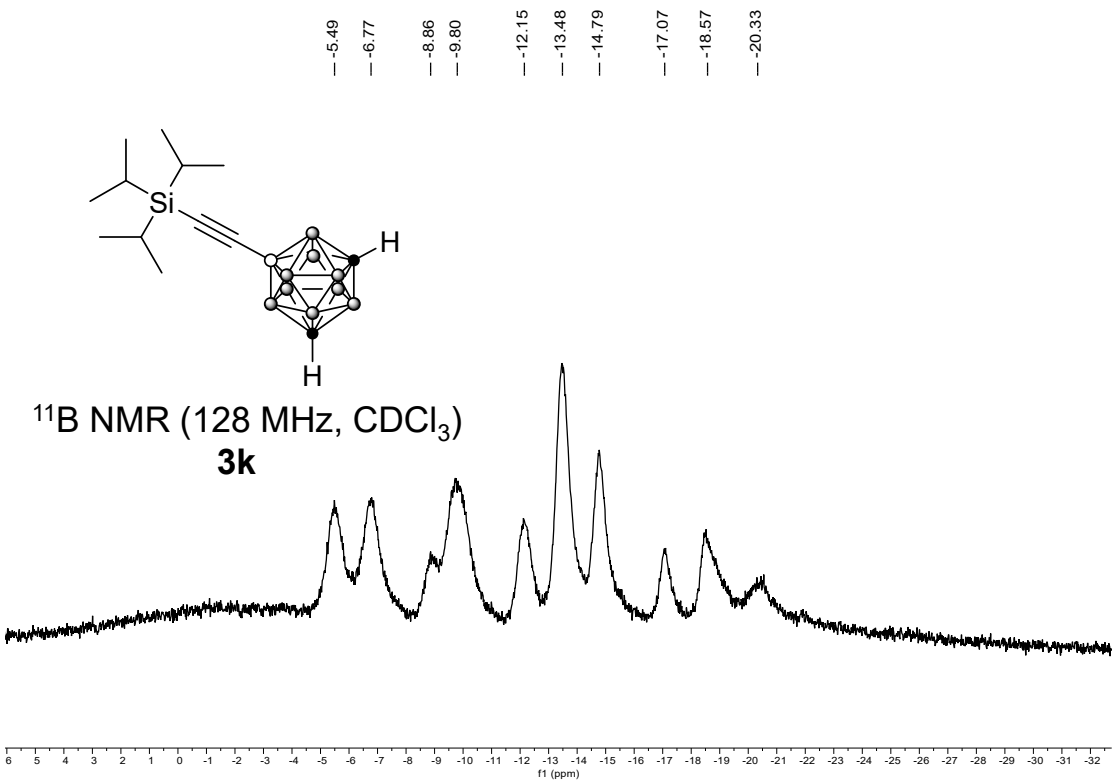
^{13}C NMR (101 MHz, $CDCl_3$)

3k



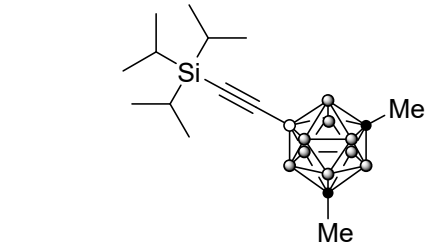
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

3k



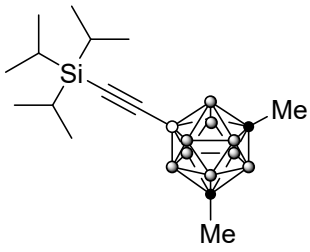
^{11}B NMR (128 MHz, $CDCl_3$)

3k



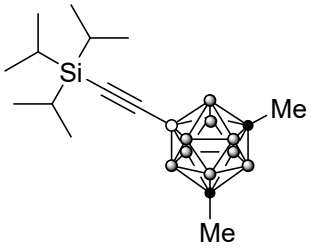
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3l



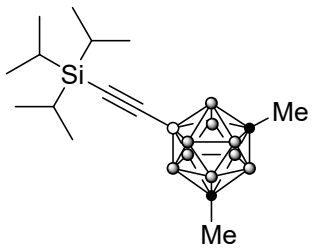
^{1}H NMR (400 MHz, $CDCl_3$)

3l



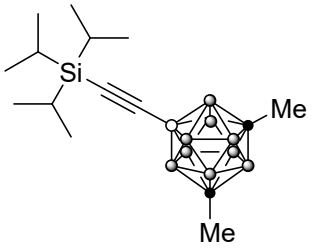
^{13}C NMR (101 MHz, $CDCl_3$)

3l



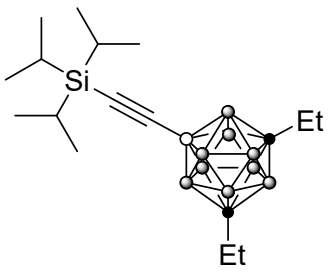
$^{11}B\{^1H\}$ NMR (128 MHz, $CDCl_3$)

3l



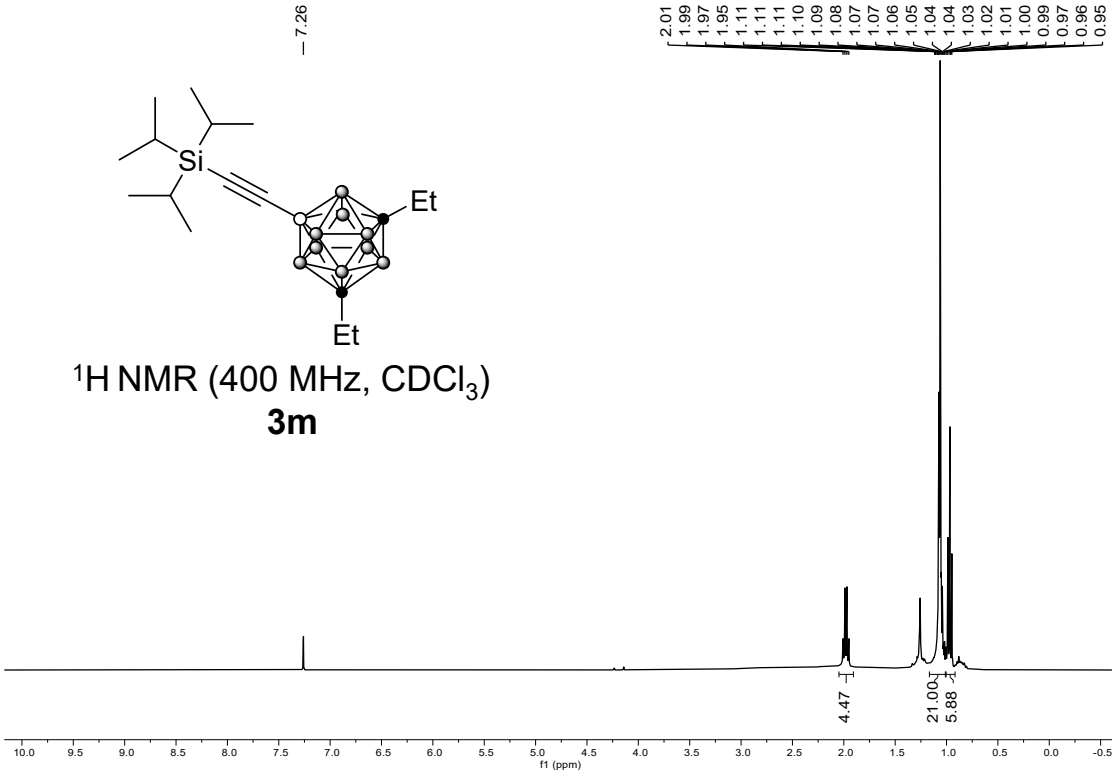
^{11}B NMR (128 MHz, $CDCl_3$)

3l



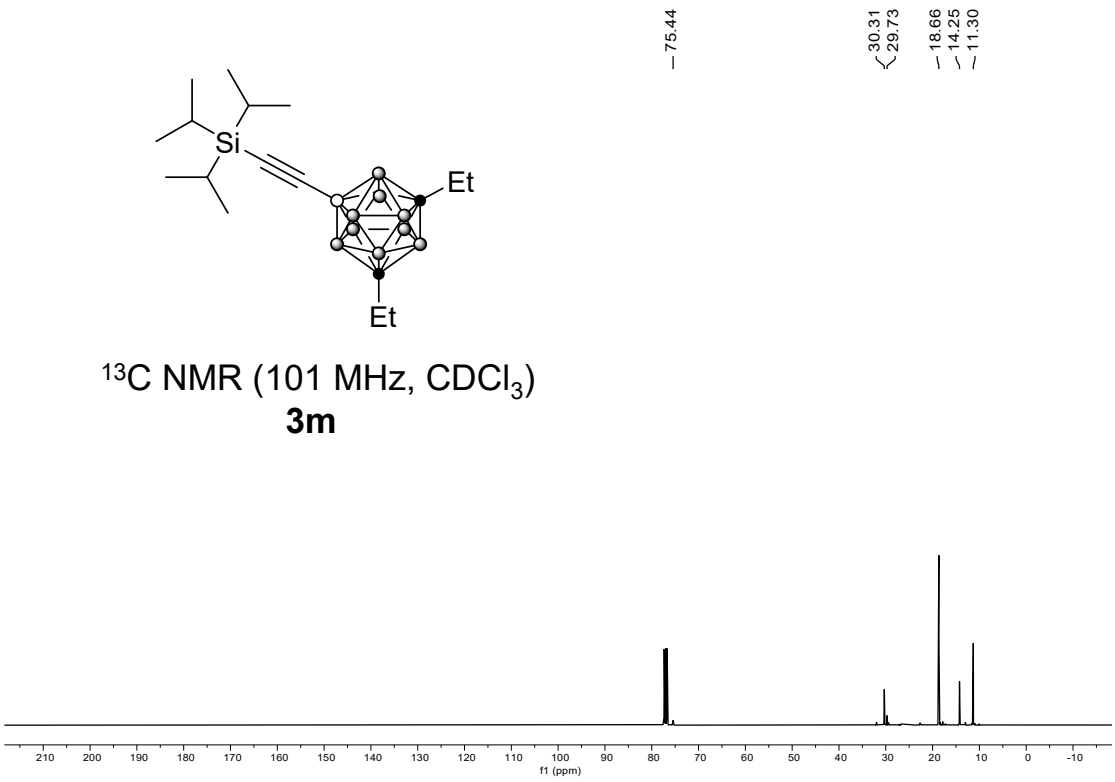
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3m



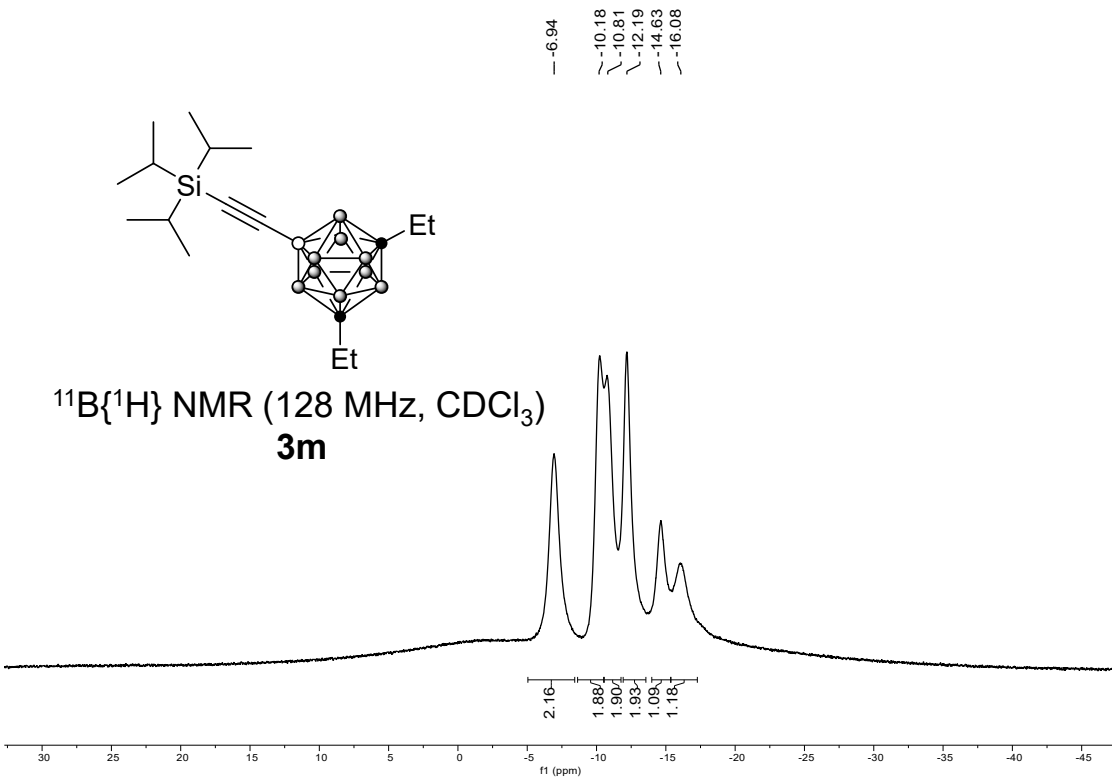
^{1}H NMR (400 MHz, $CDCl_3$)

3m



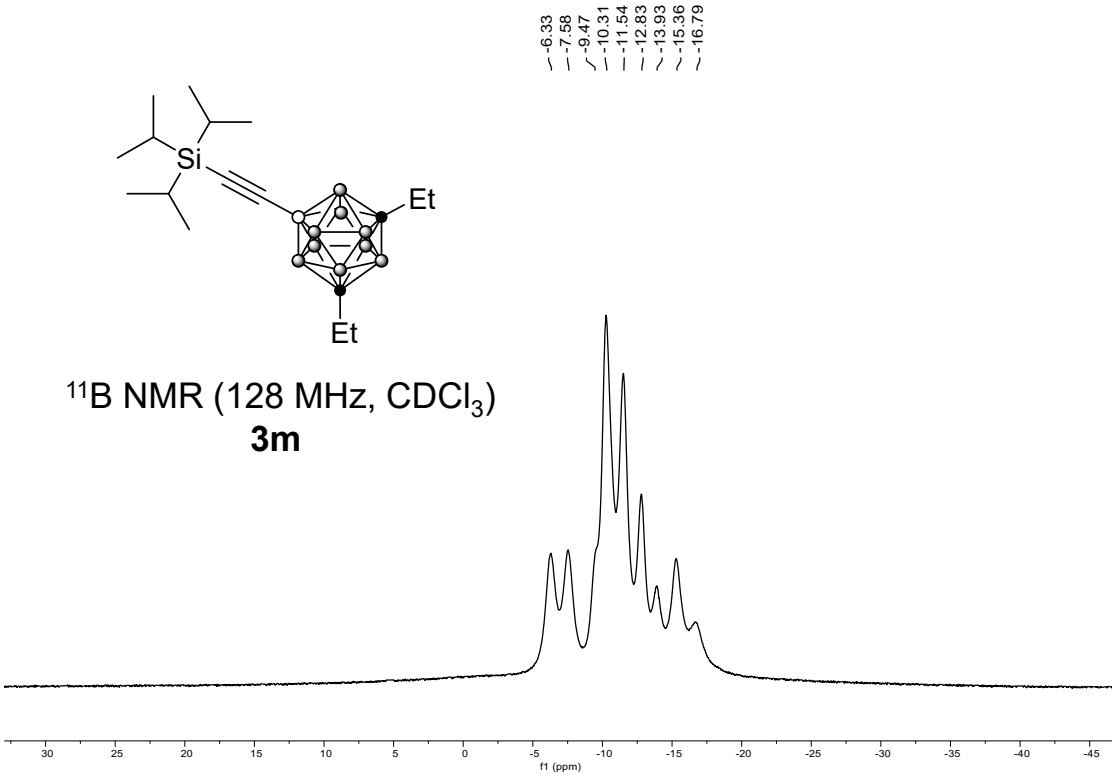
^{13}C NMR (101 MHz, $CDCl_3$)

3m



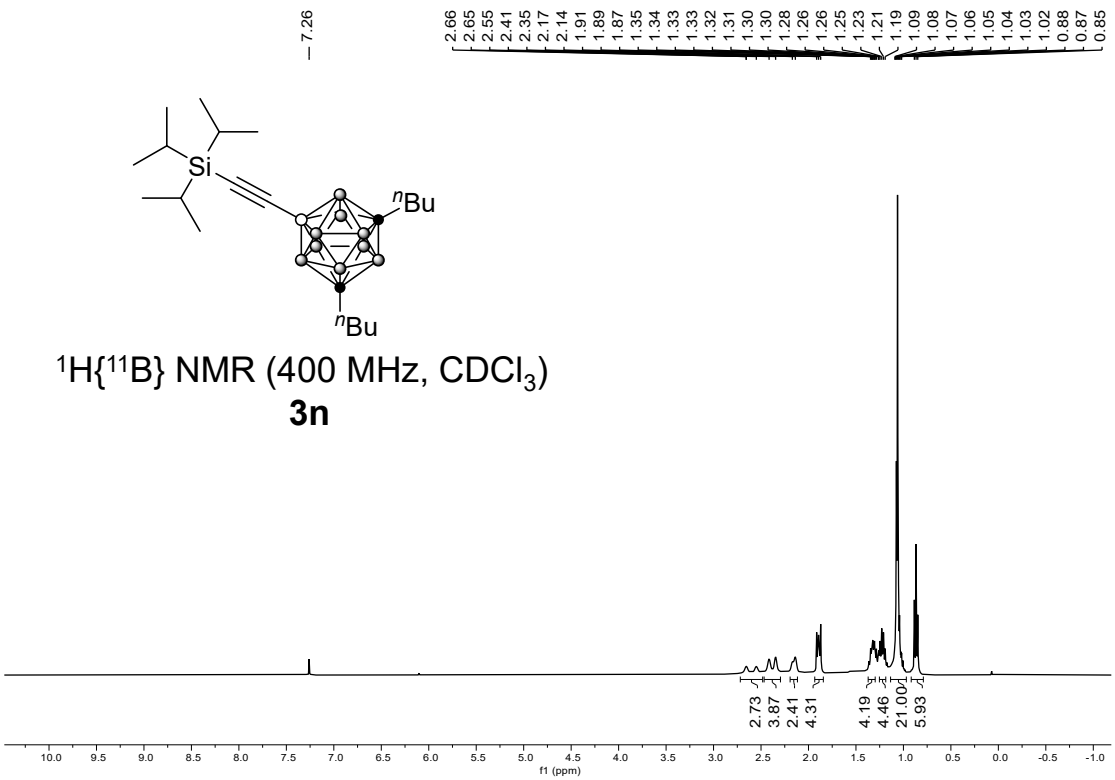
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

3m



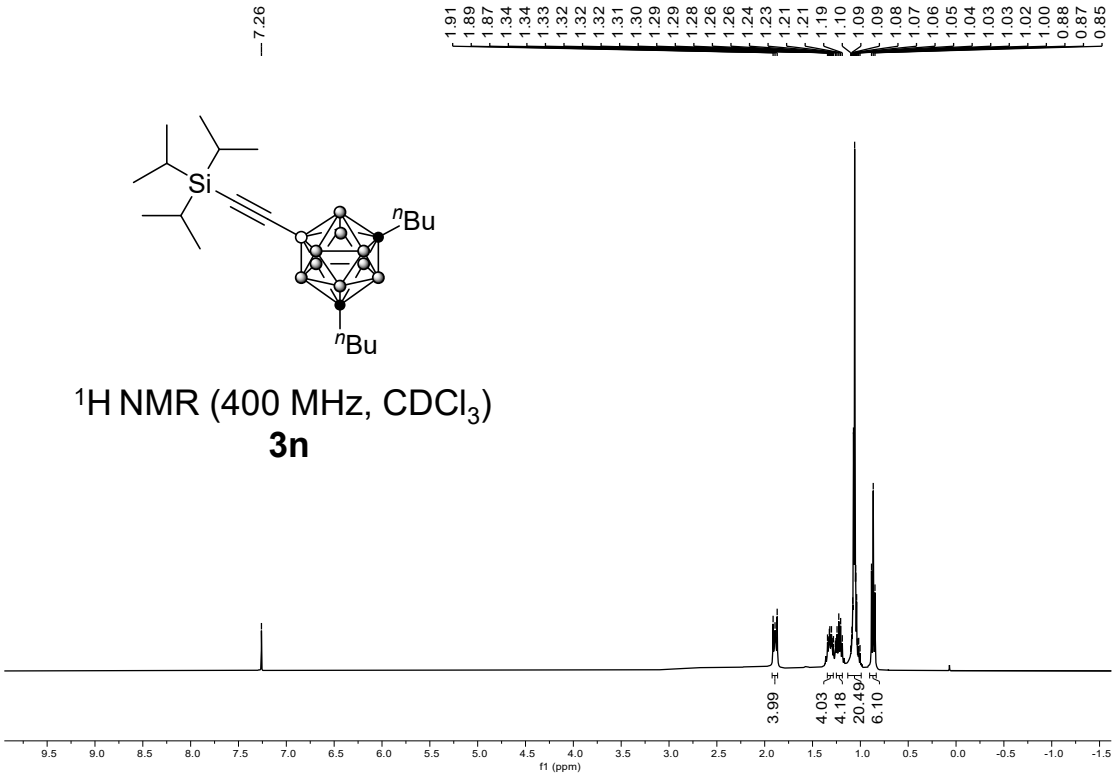
^{11}B NMR (128 MHz, $CDCl_3$)

3m



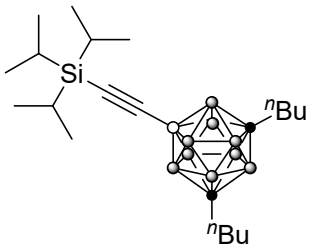
$^1H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3n



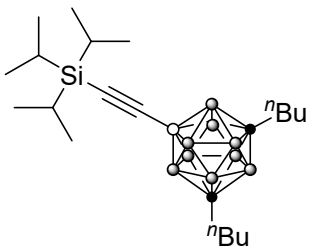
^1H NMR (400 MHz, $CDCl_3$)

3n



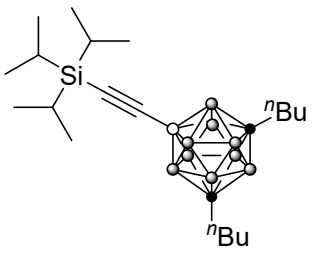
^{13}C NMR (101 MHz, $CDCl_3$)

3n



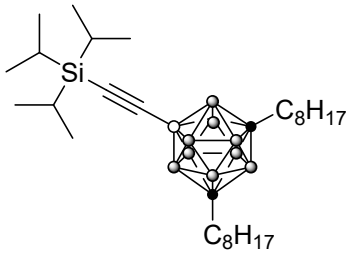
$^{11}B\{^1H\}$ NMR (128 MHz, $CDCl_3$)

3n



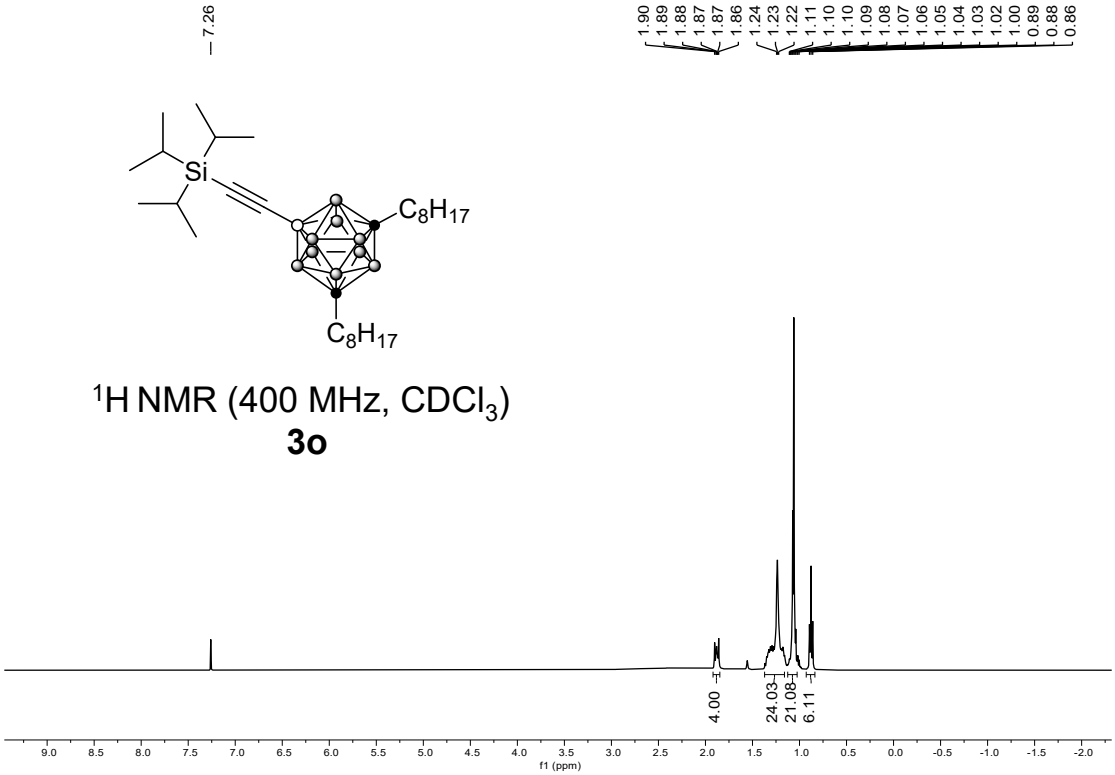
^{11}B NMR (128 MHz, $CDCl_3$)

3n



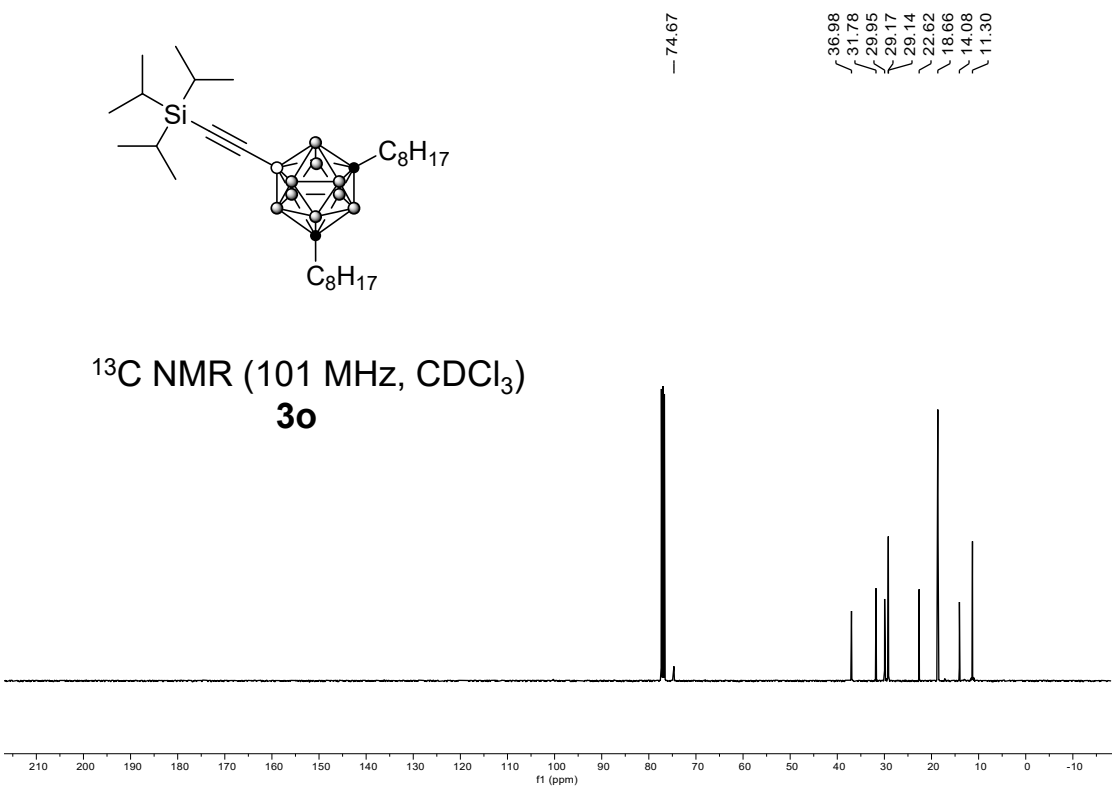
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3o



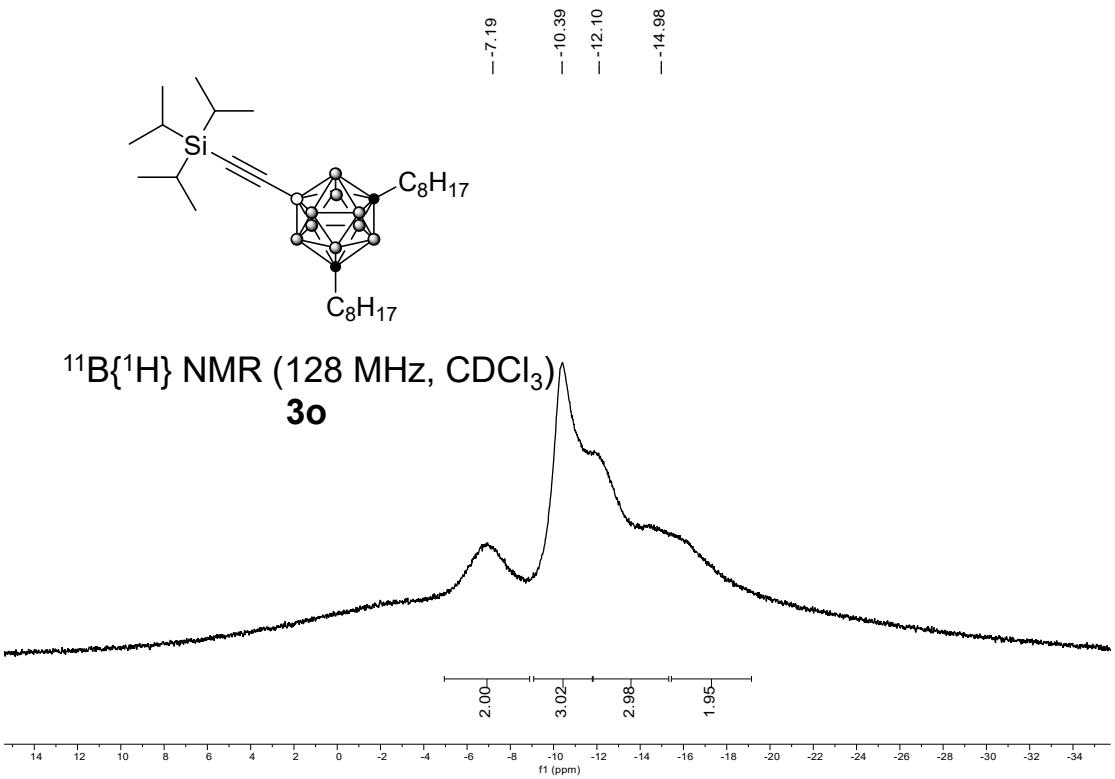
^{1}H NMR (400 MHz, $CDCl_3$)

3o



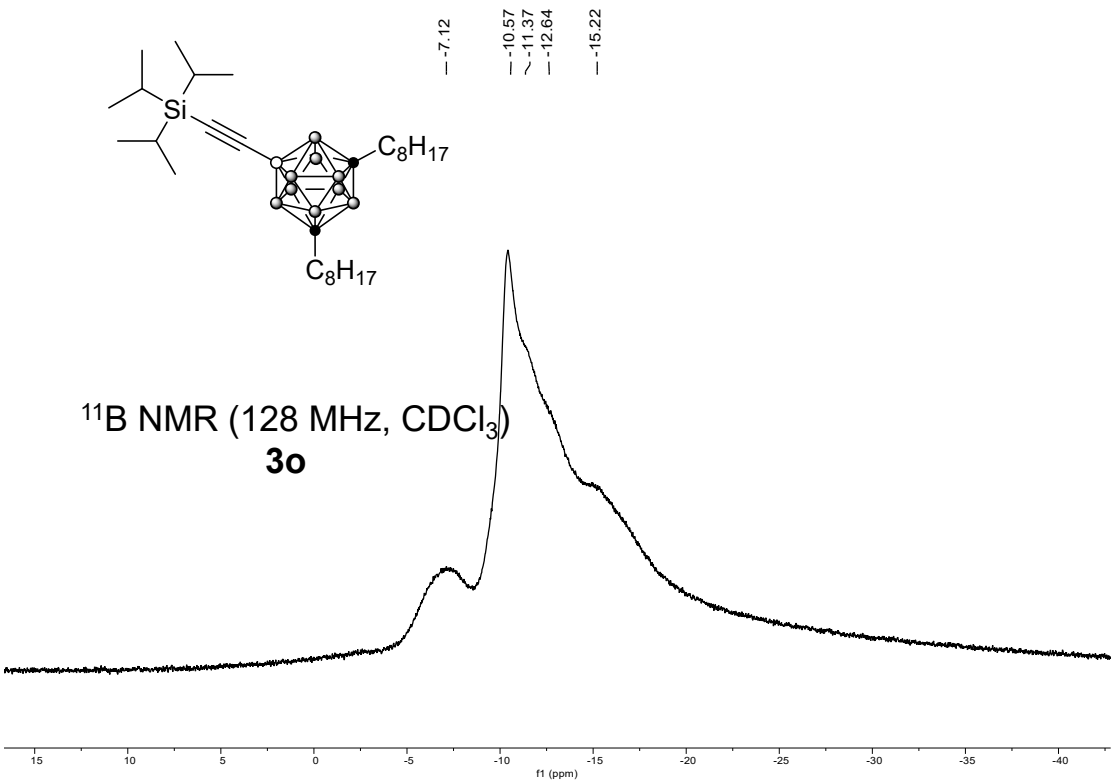
^{13}C NMR (101 MHz, $CDCl_3$)

3o



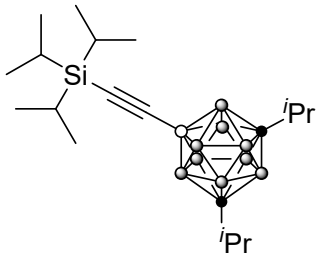
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

3o



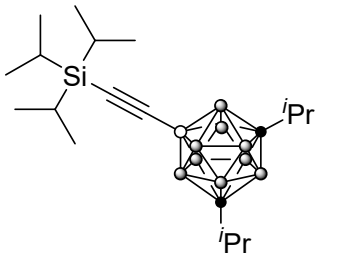
^{11}B NMR (128 MHz, $CDCl_3$)

3o



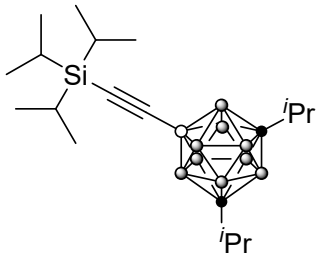
$^1H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3p



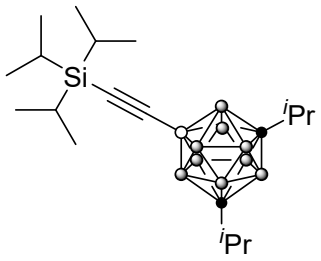
^1H NMR (400 MHz, $CDCl_3$)

3p



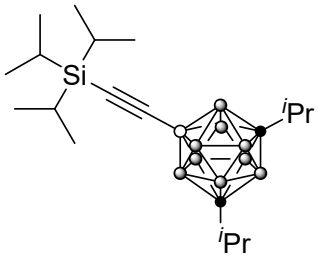
^{13}C NMR (101 MHz, $CDCl_3$)

3p



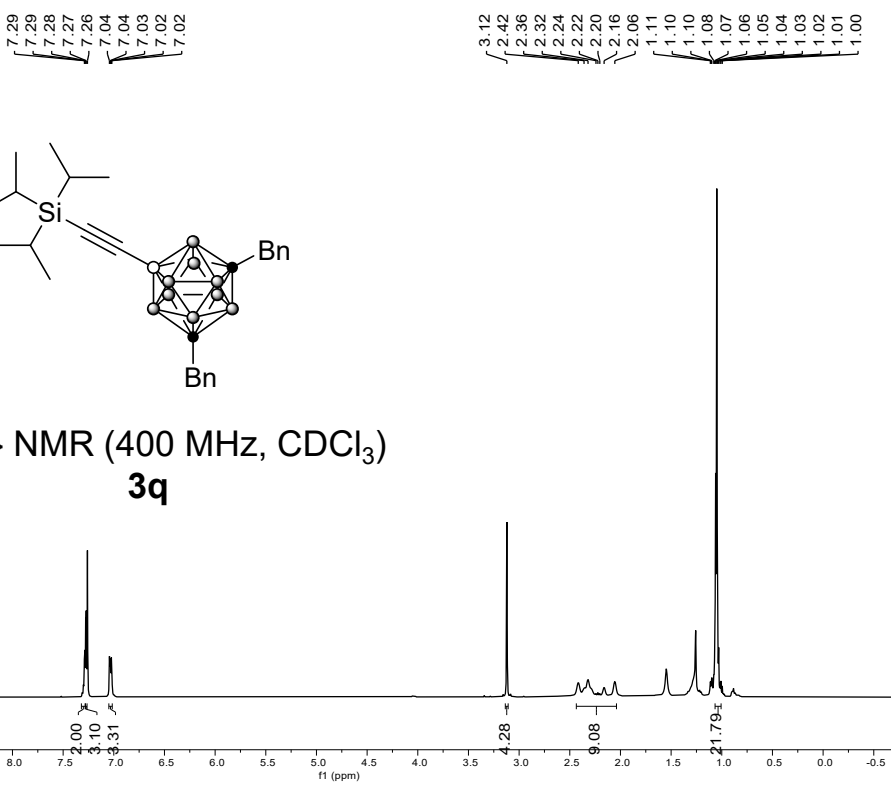
$^{11}B\{^1H\}$ NMR (128 MHz, $CDCl_3$)

3p



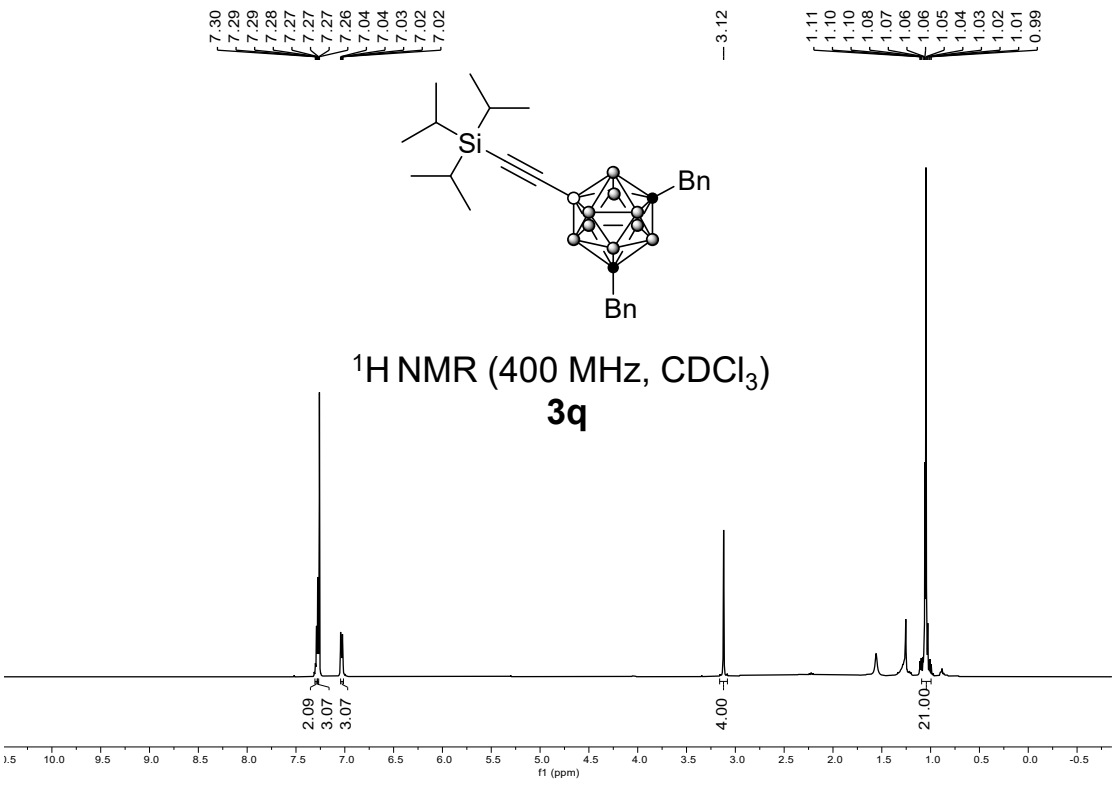
^{11}B NMR (128 MHz, $CDCl_3$)

3p



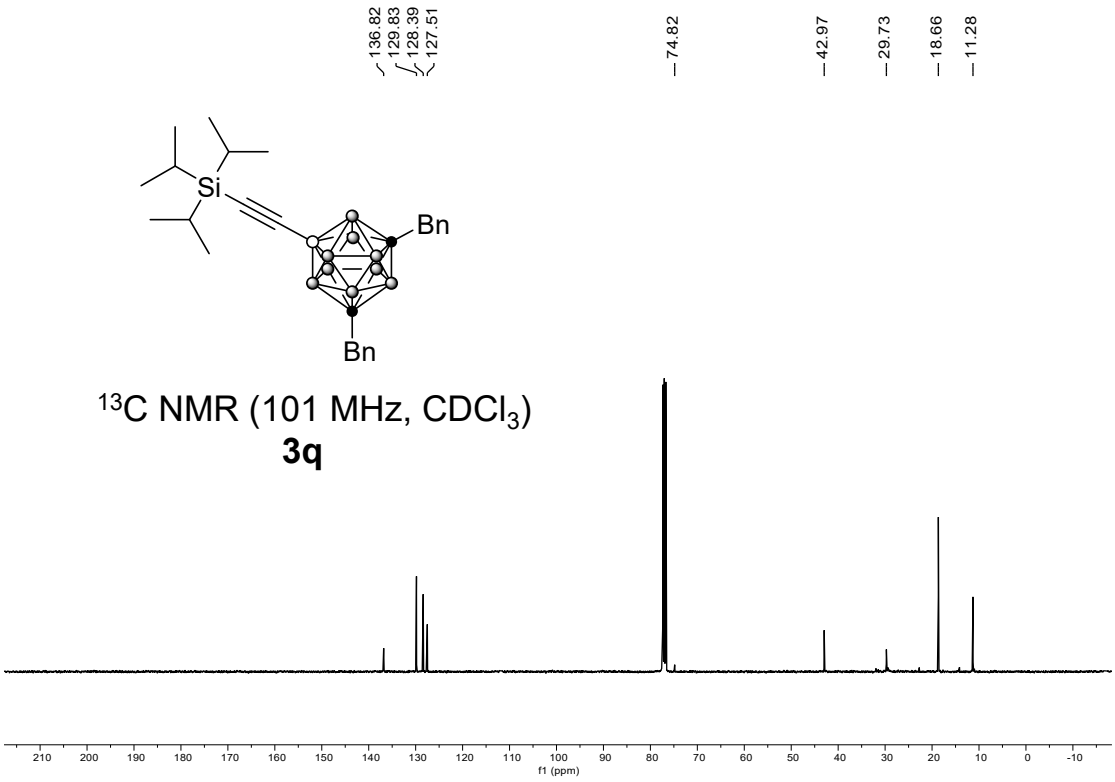
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3q



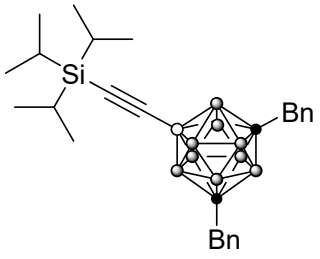
^{1}H NMR (400 MHz, $CDCl_3$)

3q



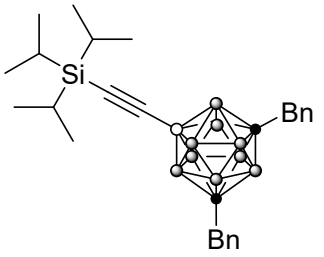
^{13}C NMR (101 MHz, $CDCl_3$)

3q



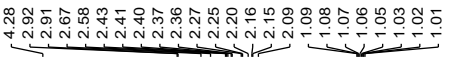
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

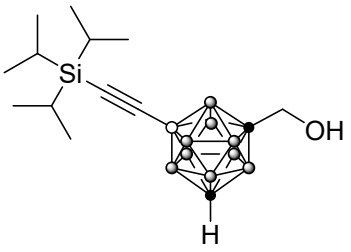
3q



^{11}B NMR (128 MHz, $CDCl_3$)

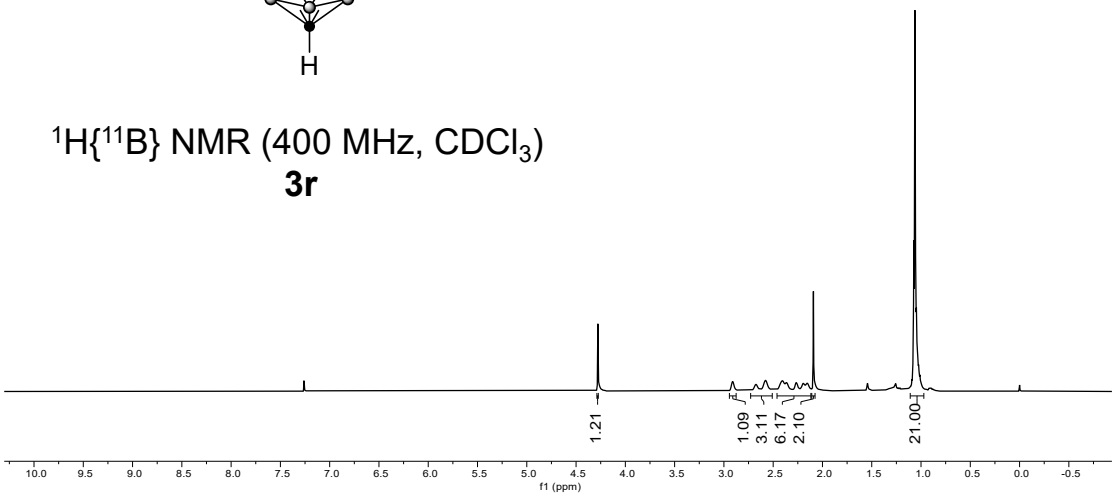
3q

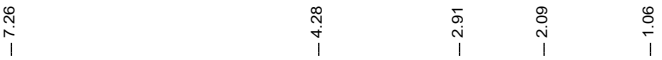


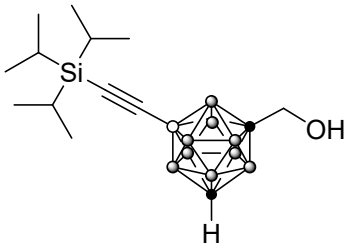


$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3r

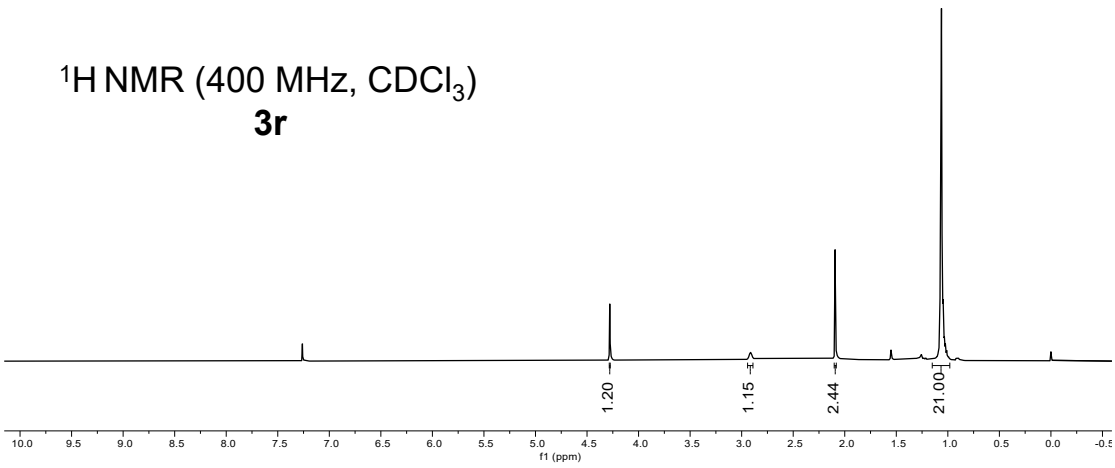


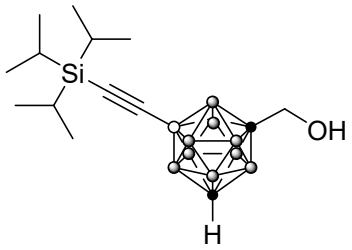




^{1}H NMR (400 MHz, $CDCl_3$)

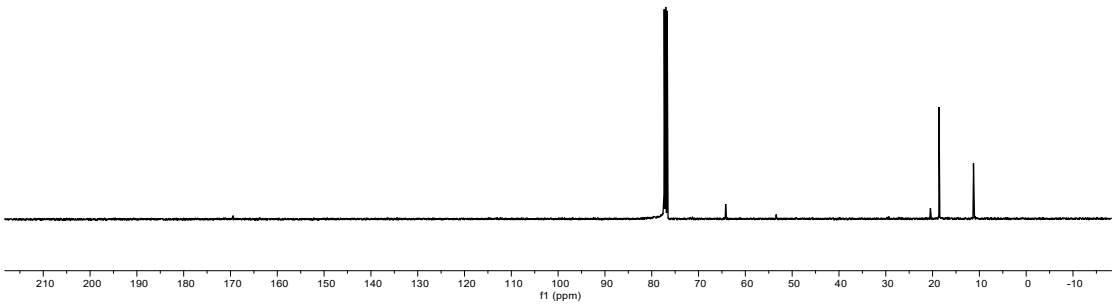
3r

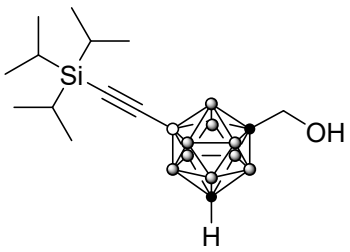


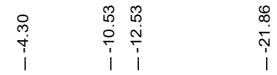


^{13}C NMR (101 MHz, $CDCl_3$)

3r

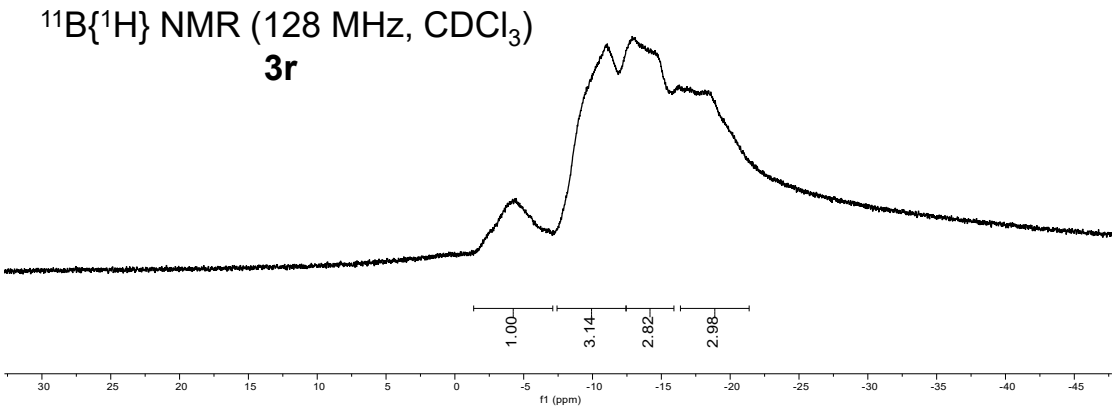


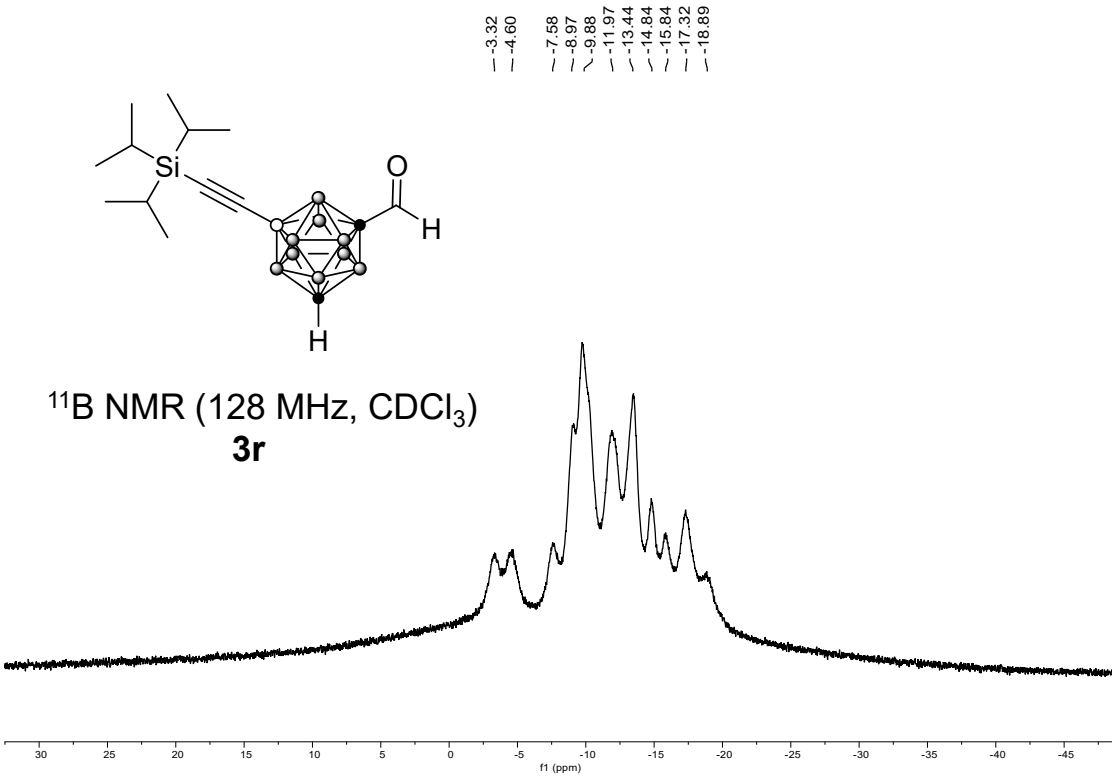




$^{11}B\{^1H\}$ NMR (128 MHz, $CDCl_3$)

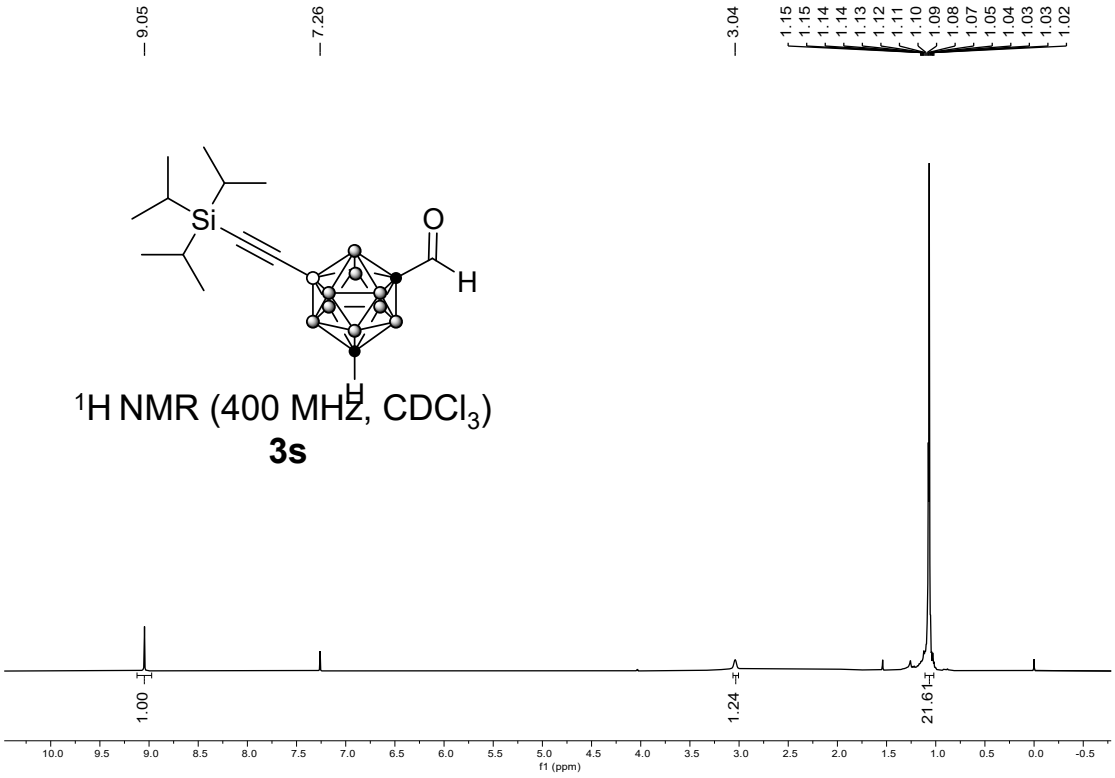
3r





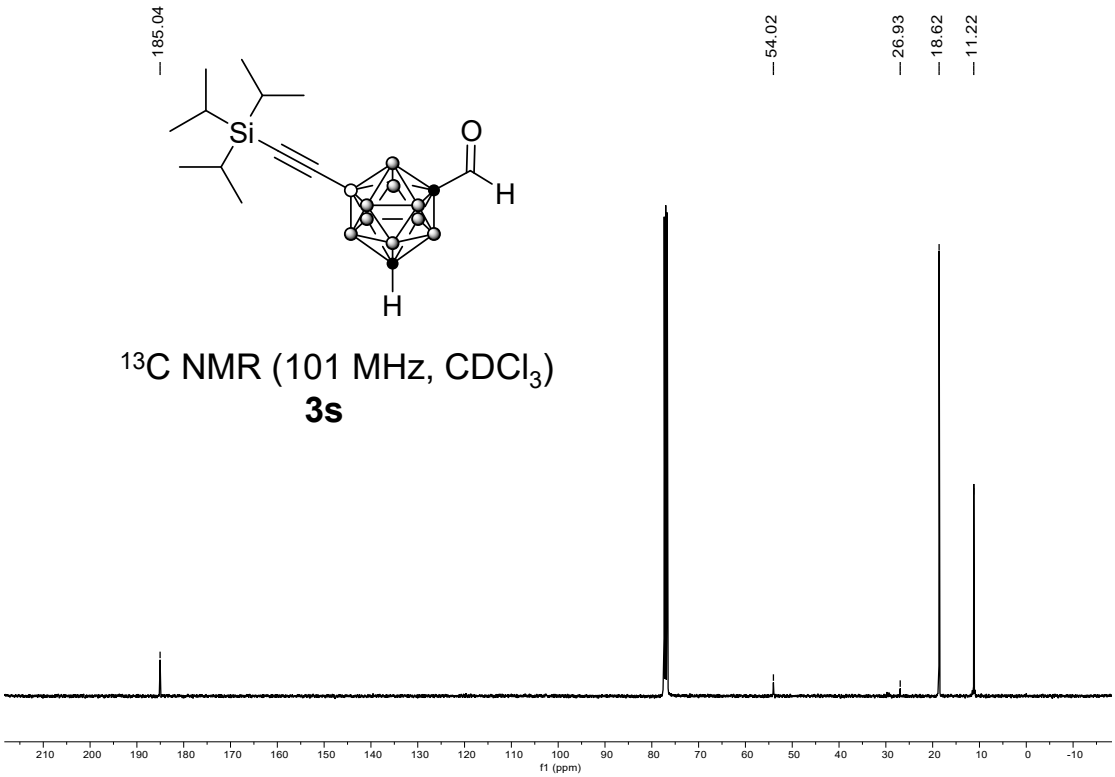
^{11}B NMR (128 MHz, $CDCl_3$)

3r



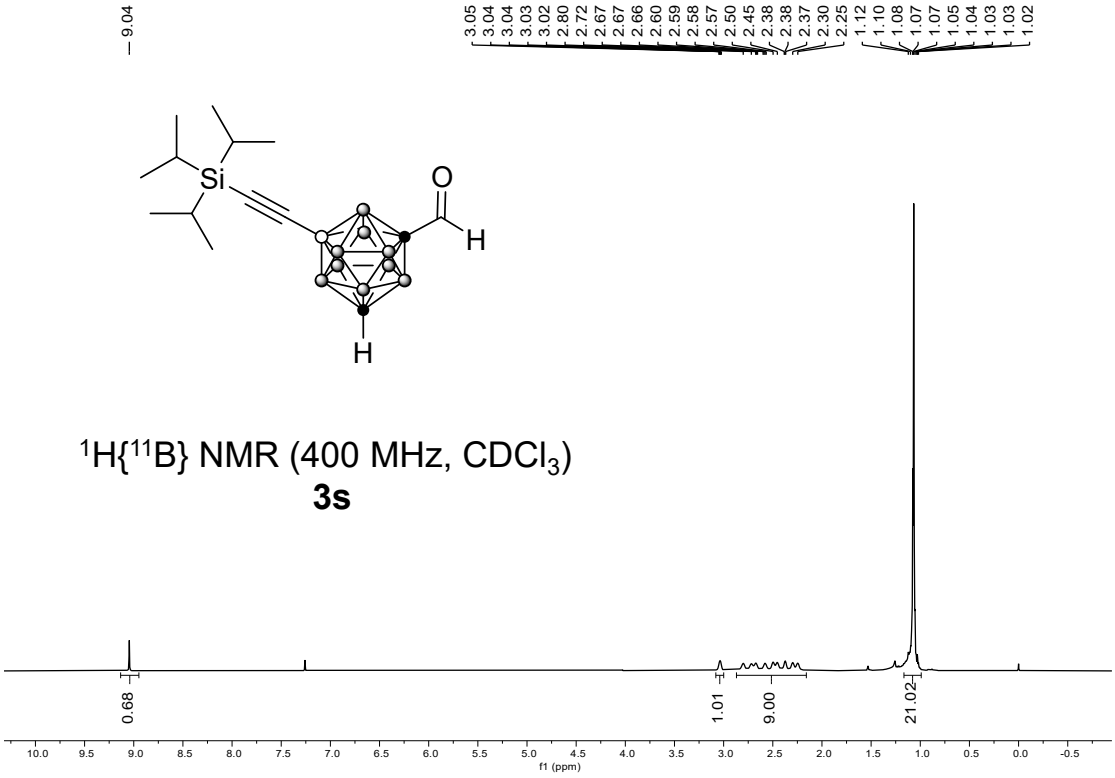
^{1}H NMR (400 MHZ, $CDCl_3$)

3s



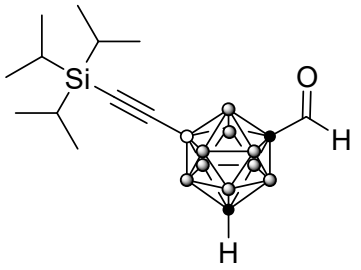
^{13}C NMR (101 MHz, $CDCl_3$)

3s



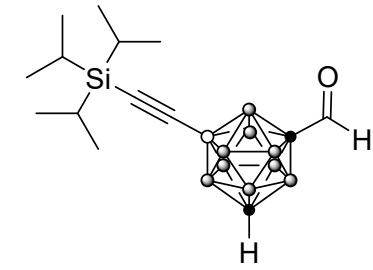
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3s



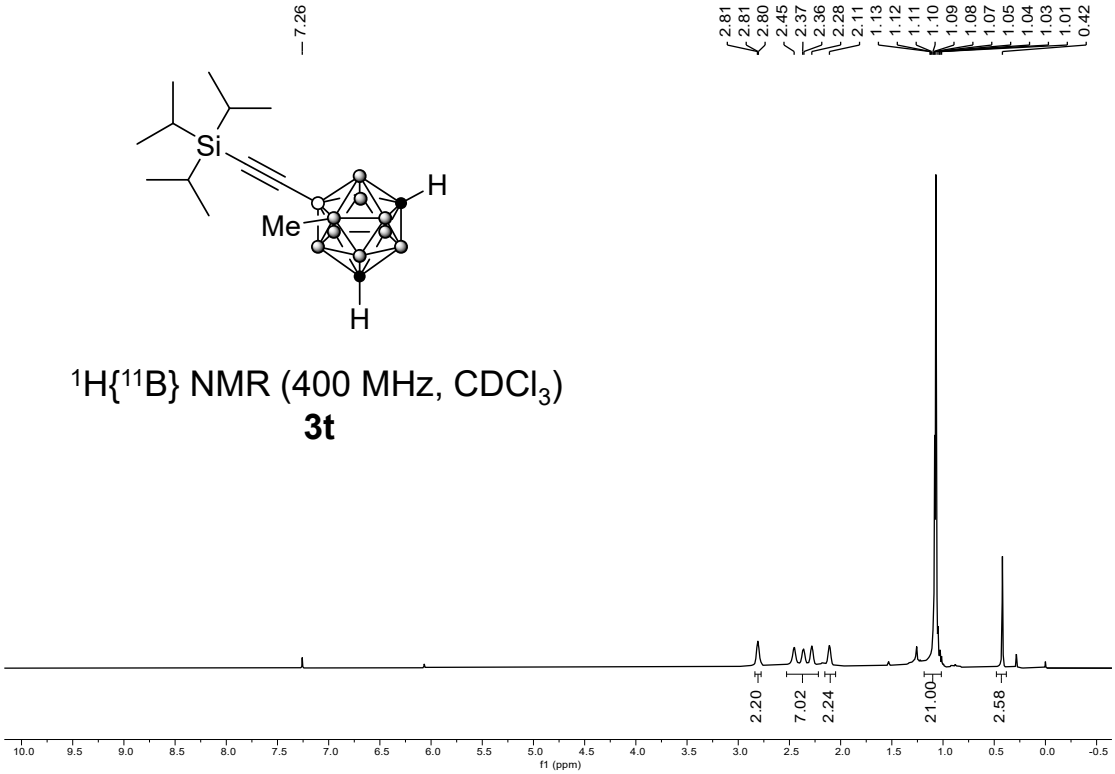
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

3s



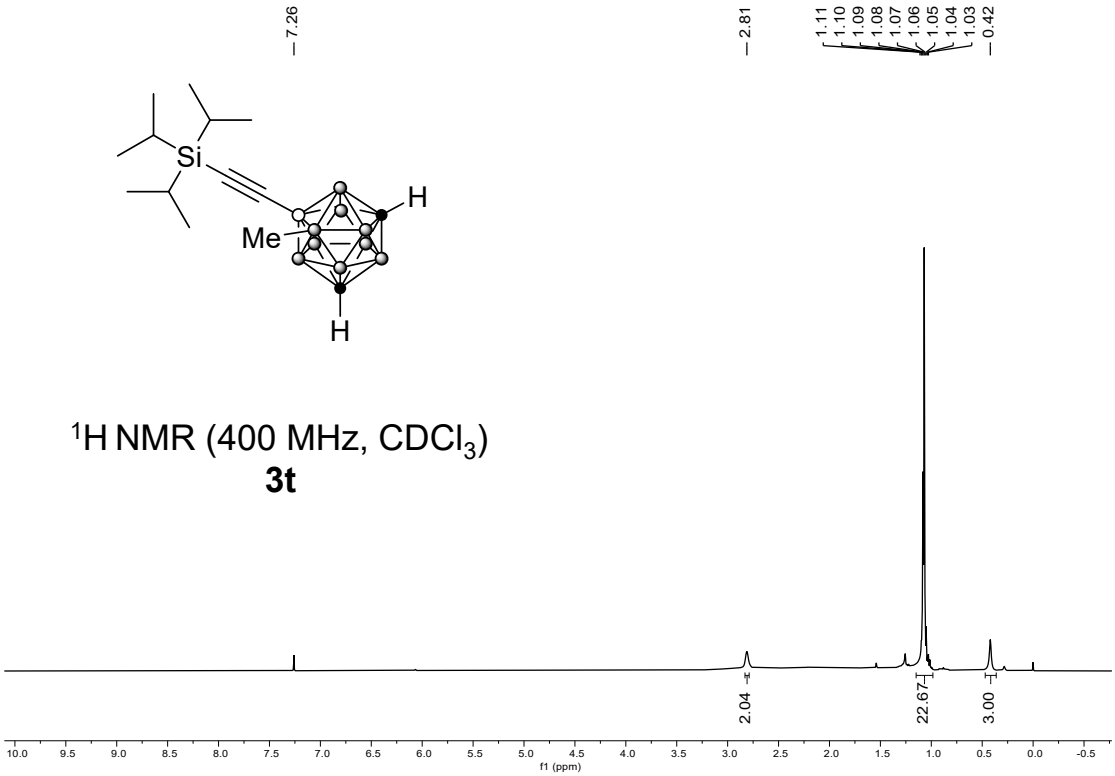
^{11}B NMR (128 MHz, $CDCl_3$)

3s



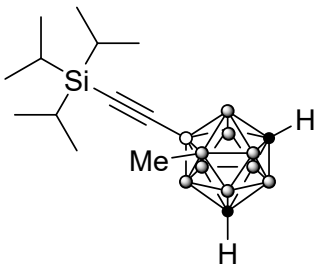
$^1H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

3t

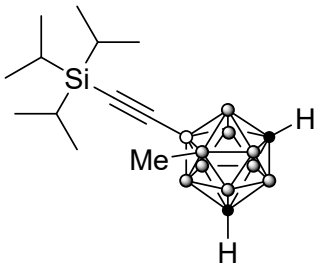


^1H NMR (400 MHz, $CDCl_3$)

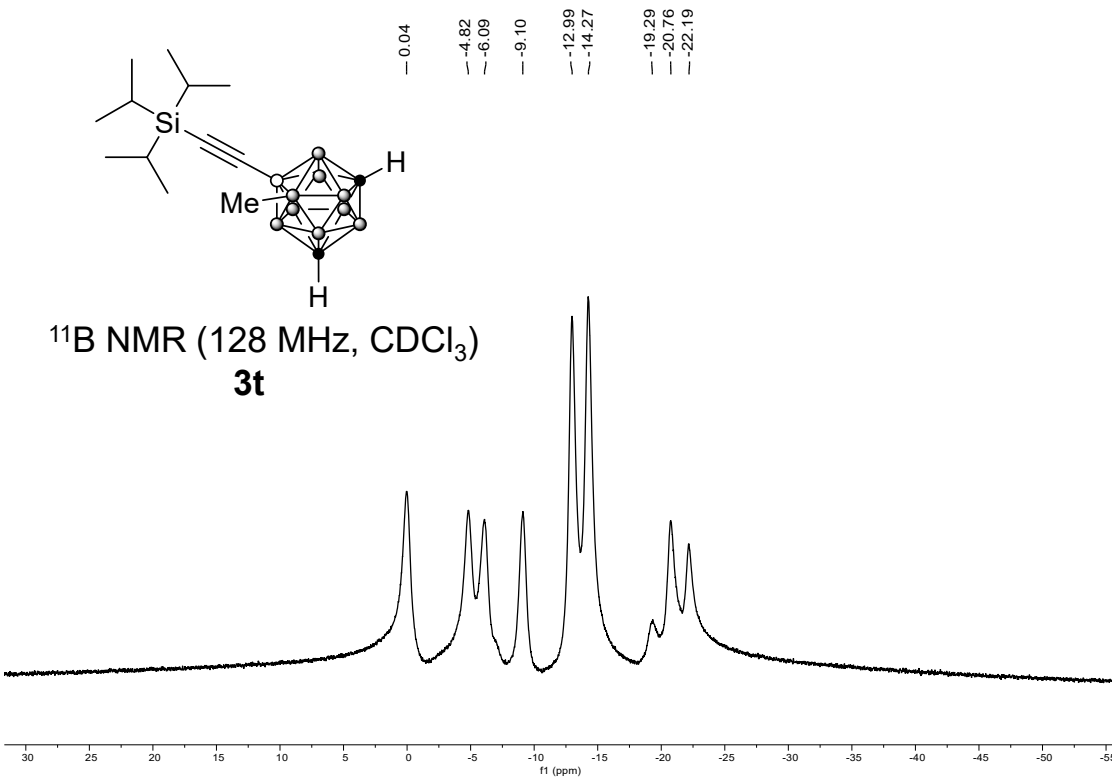
3t



^{13}C NMR (101 MHz, $CDCl_3$)
3t

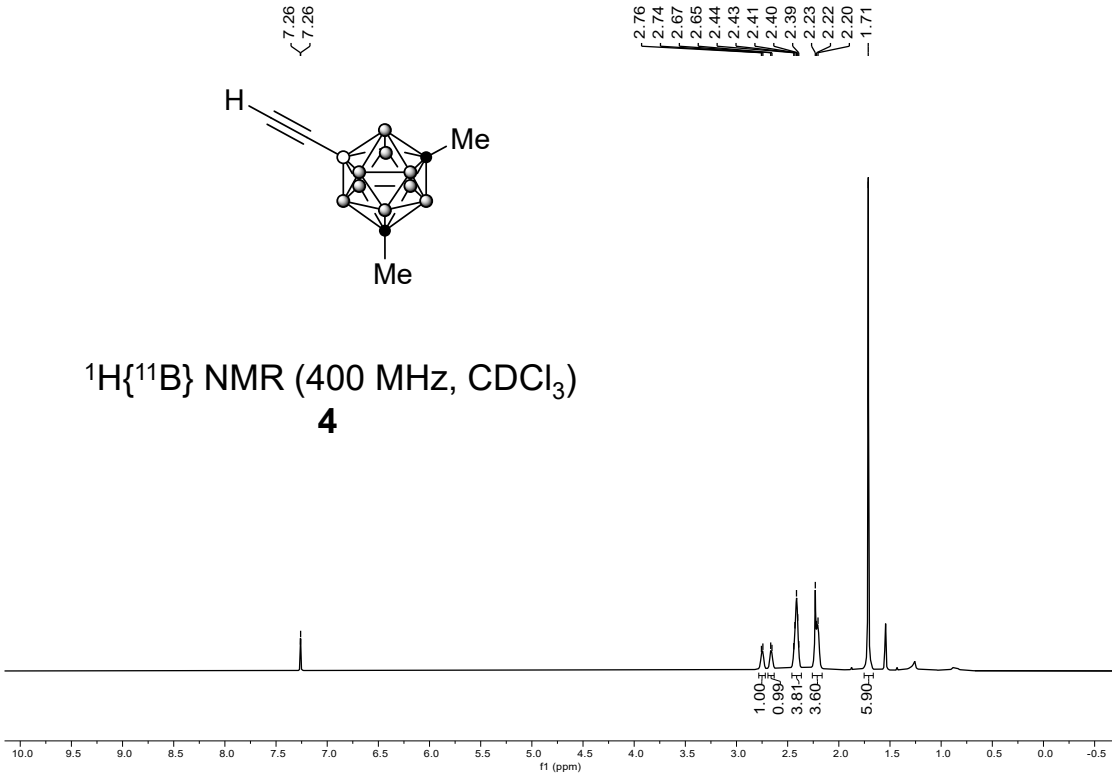


$^{11}B\{^1H\}$ NMR (128 MHz, $CDCl_3$)
3t



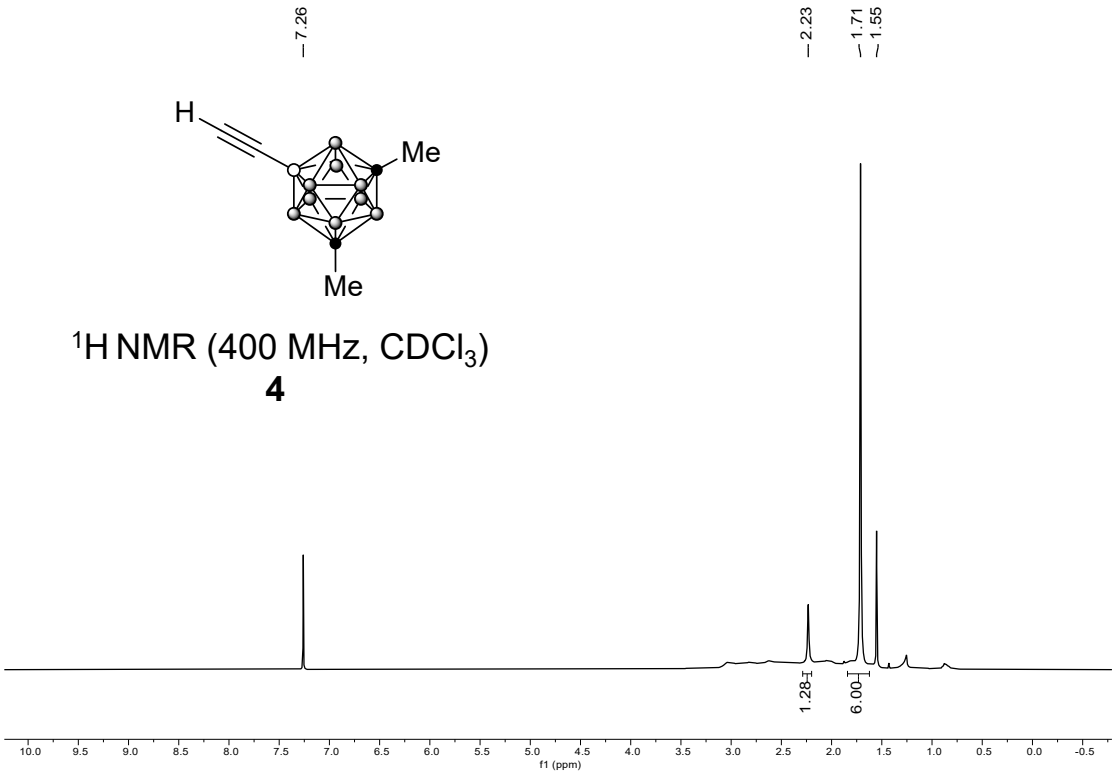
^{11}B NMR (128 MHz, $CDCl_3$)

3t



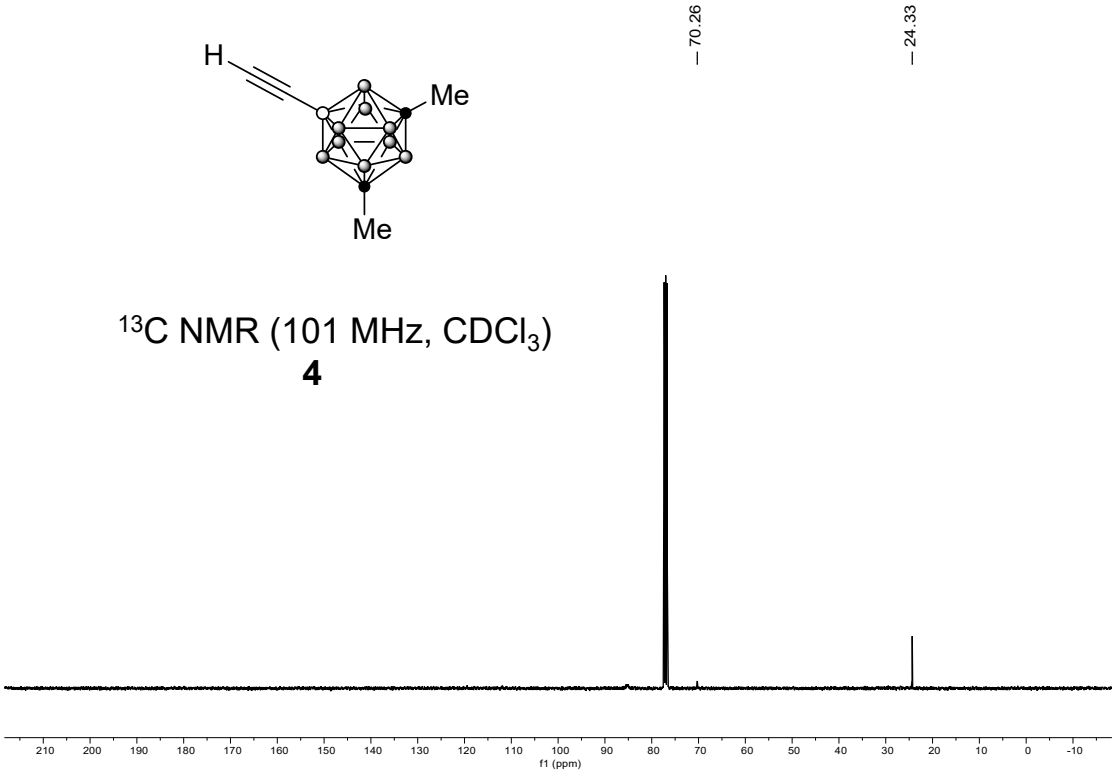
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

4



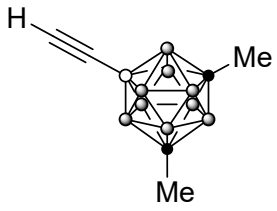
^{1}H NMR (400 MHz, $CDCl_3$)

4



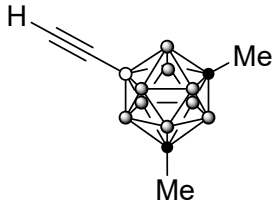
^{13}C NMR (101 MHz, $CDCl_3$)

4



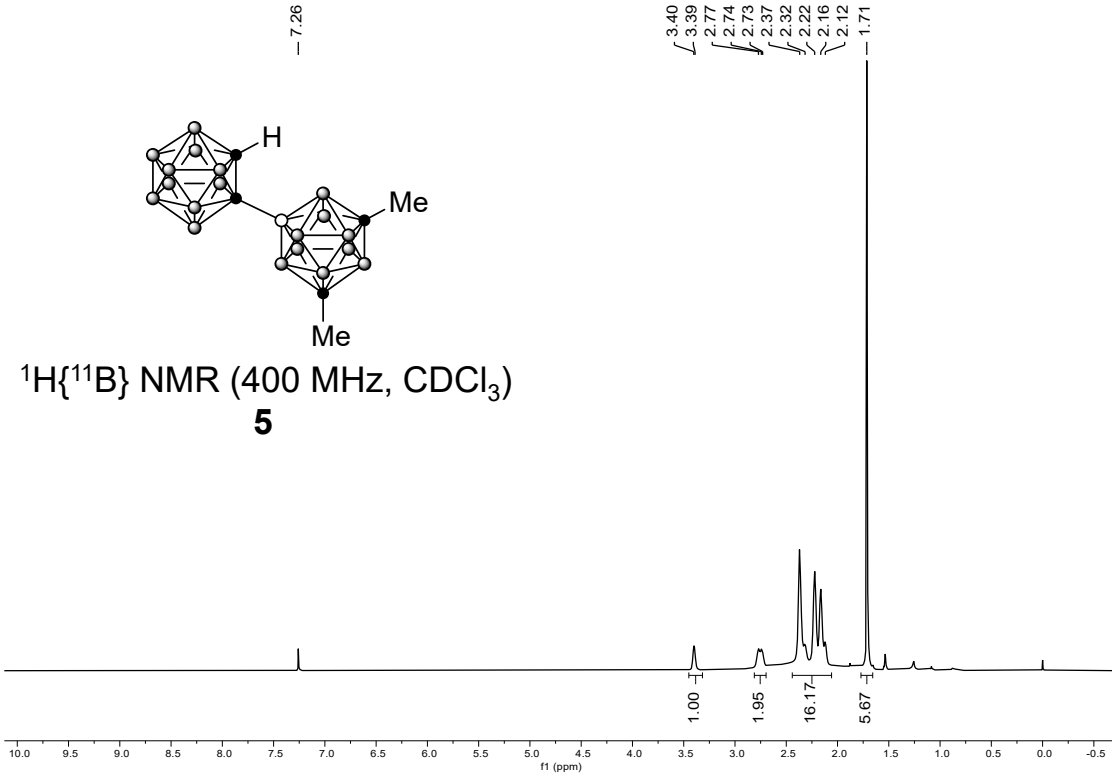
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

4



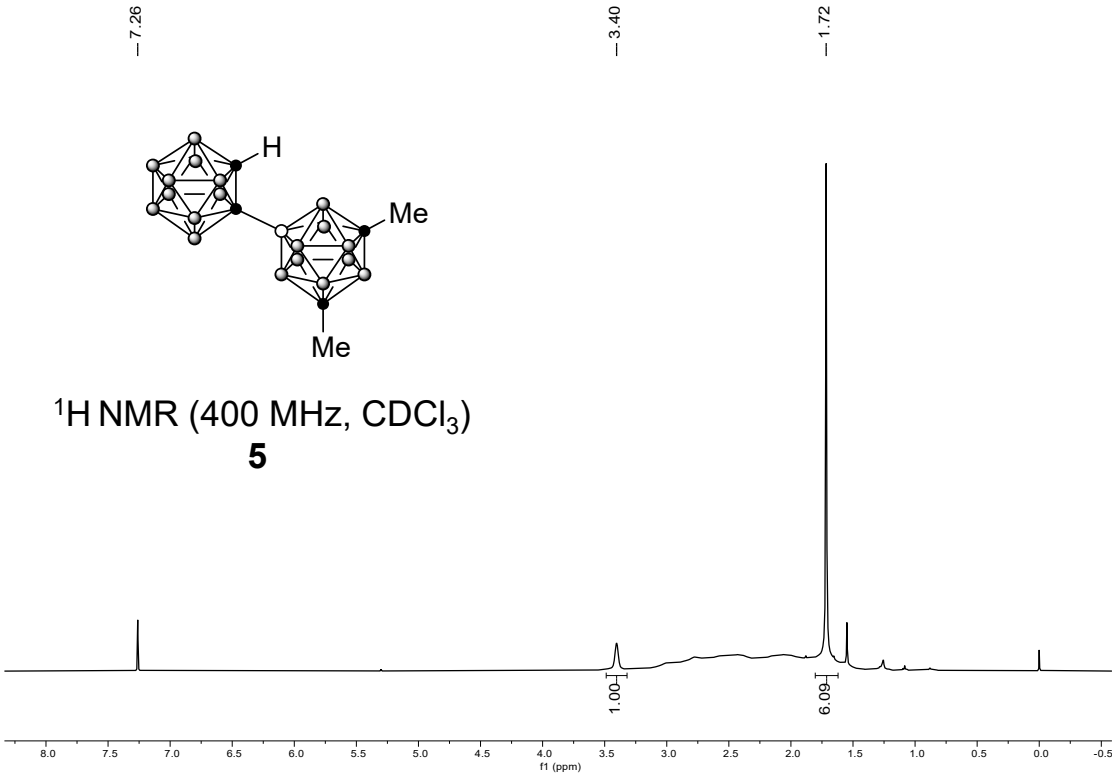
^{11}B NMR (128 MHz, $CDCl_3$)

4



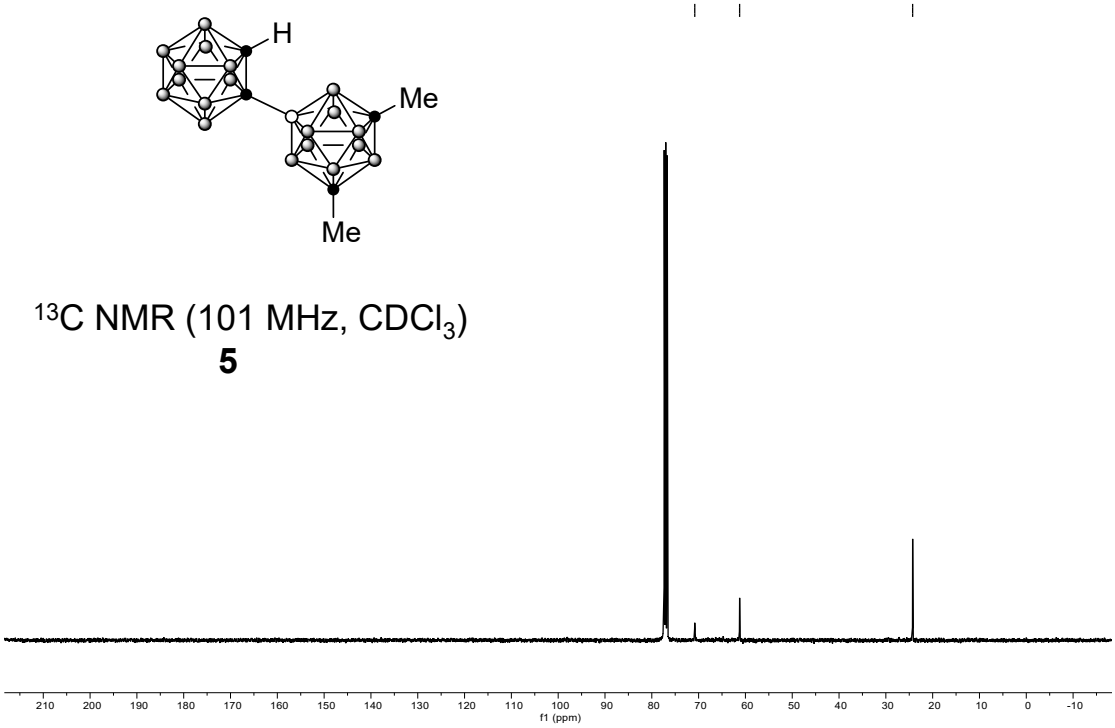
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

5



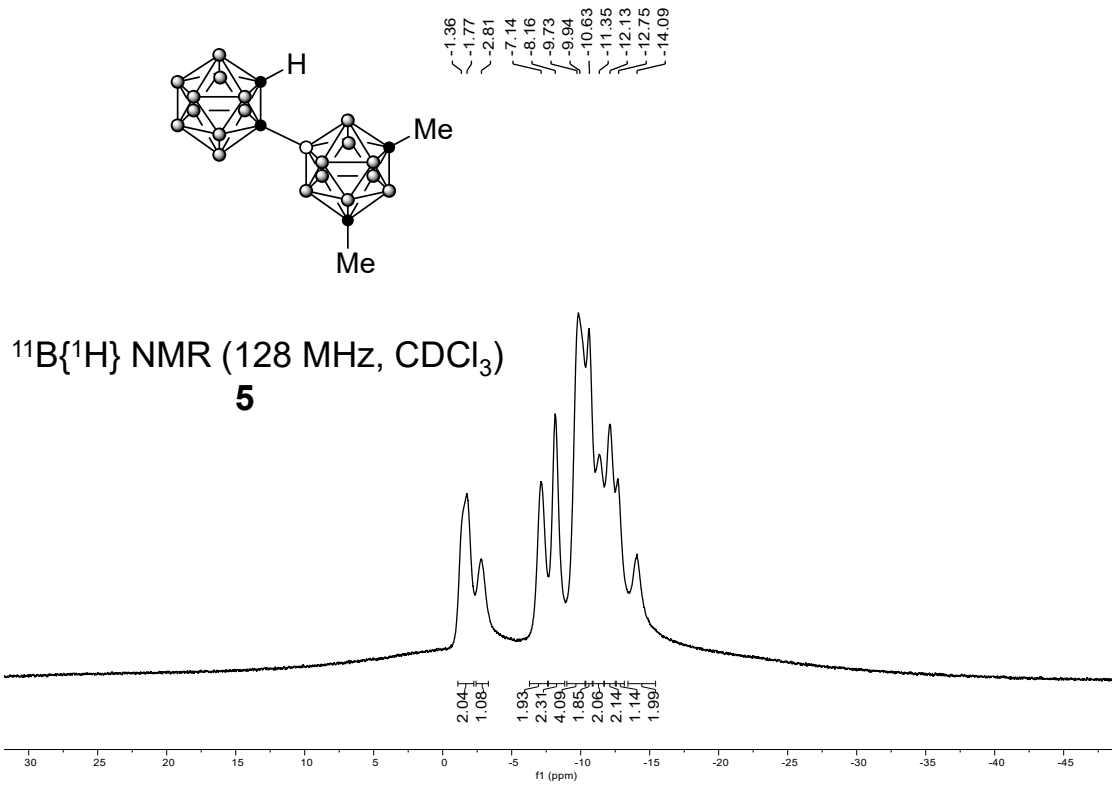
^{1}H NMR (400 MHz, $CDCl_3$)

5



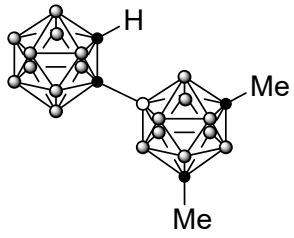
^{13}C NMR (101 MHz, $CDCl_3$)

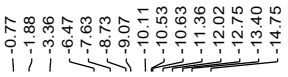
5



$^{11}B\{^1H\}$ NMR (128 MHz, $CDCl_3$)

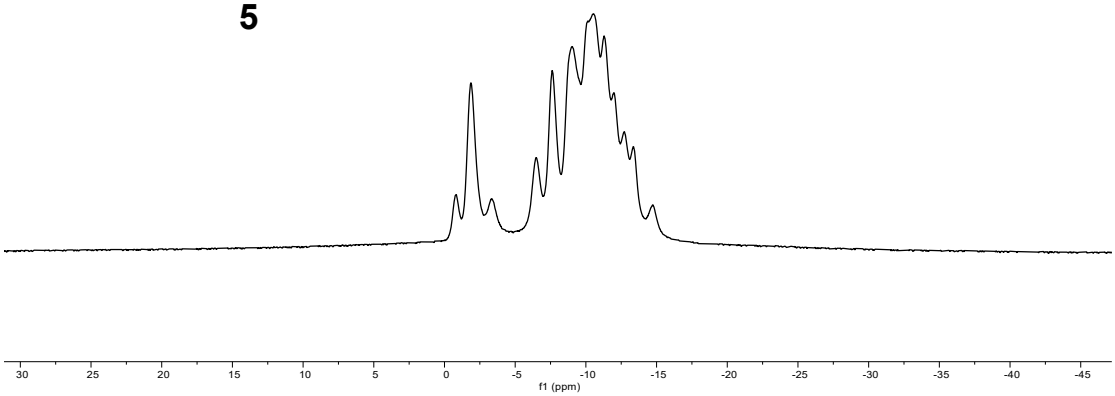
5

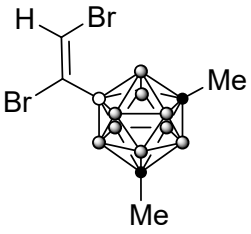




^{11}B NMR (128 MHz, $CDCl_3$)

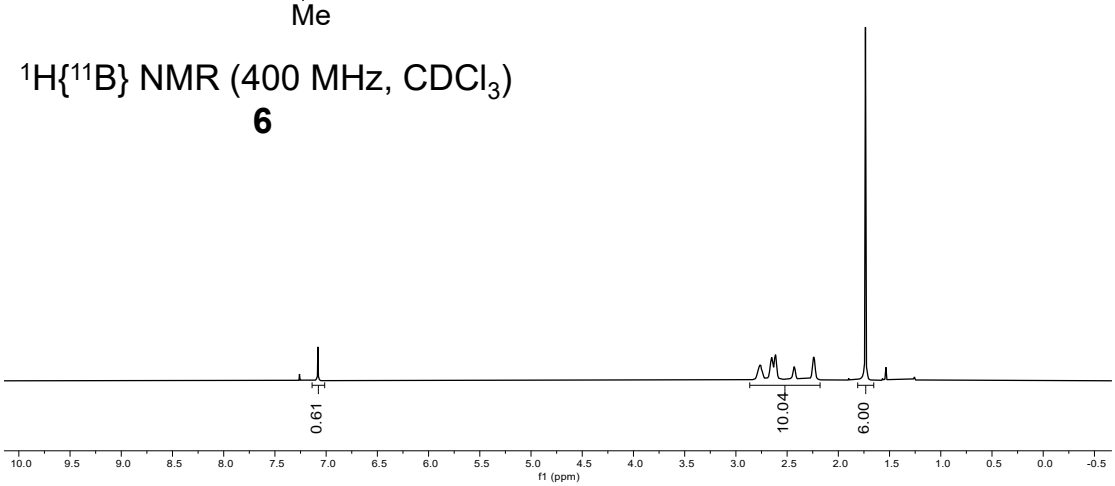
5

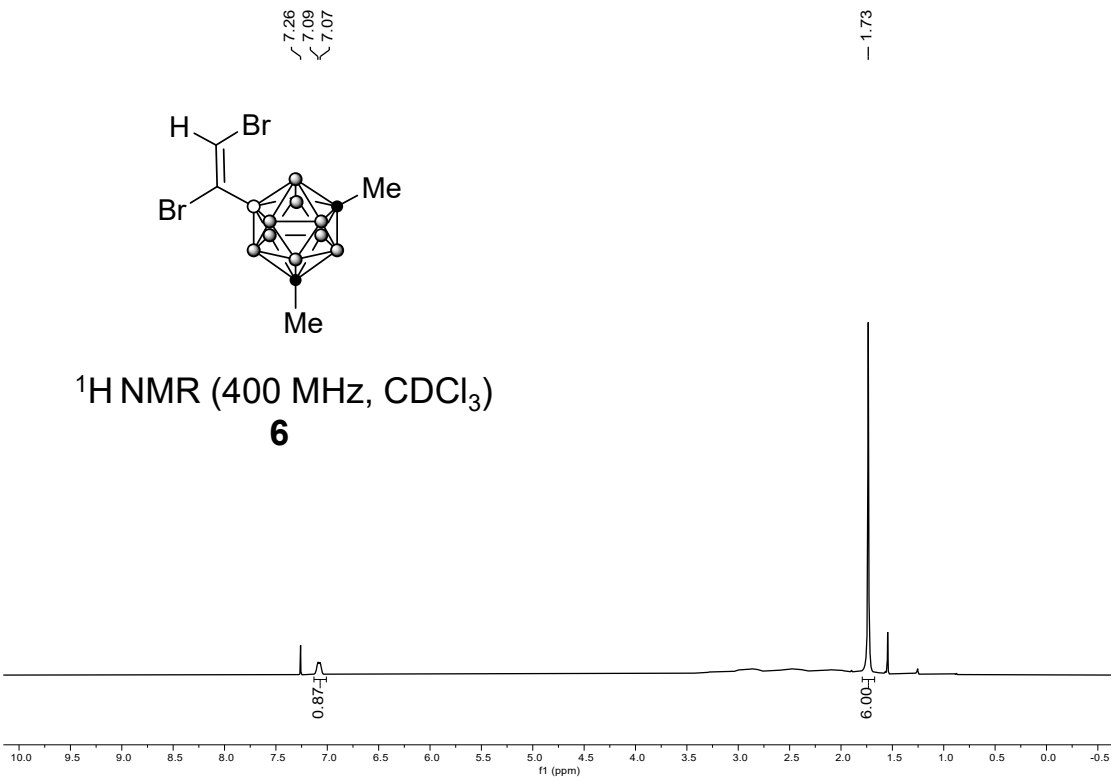




^{1}H{^{11}B} NMR (400 MHz, $CDCl_3$)

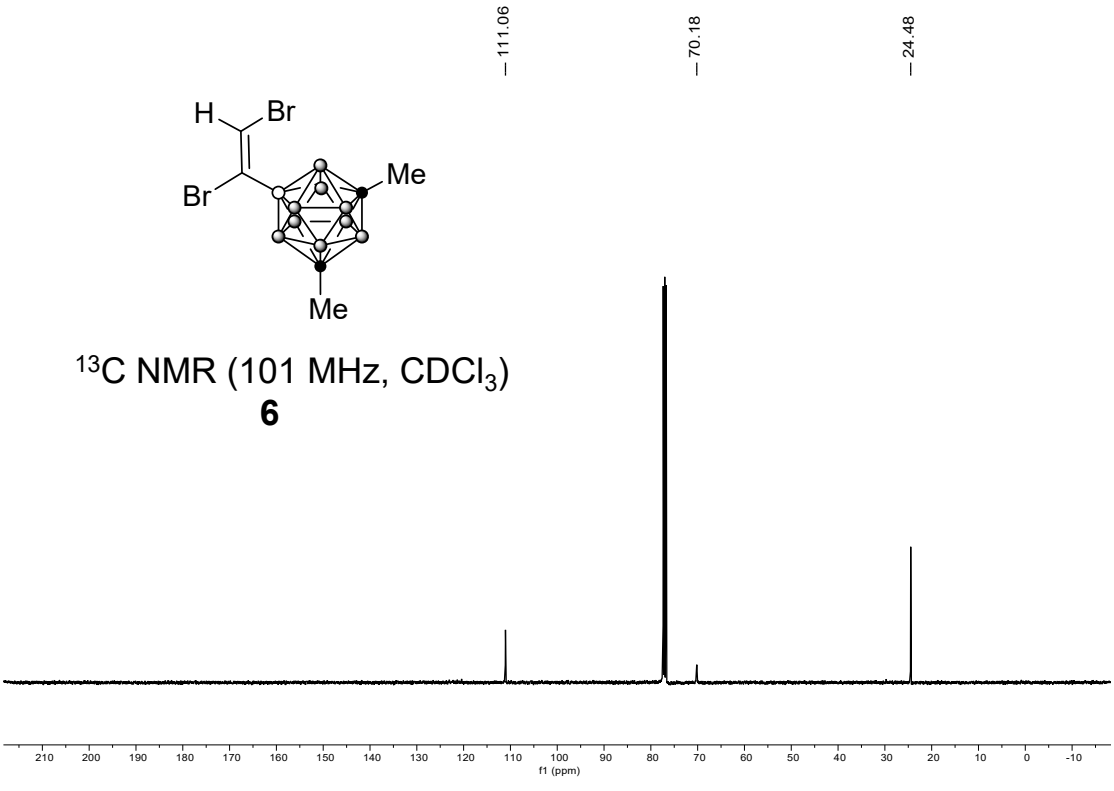
6





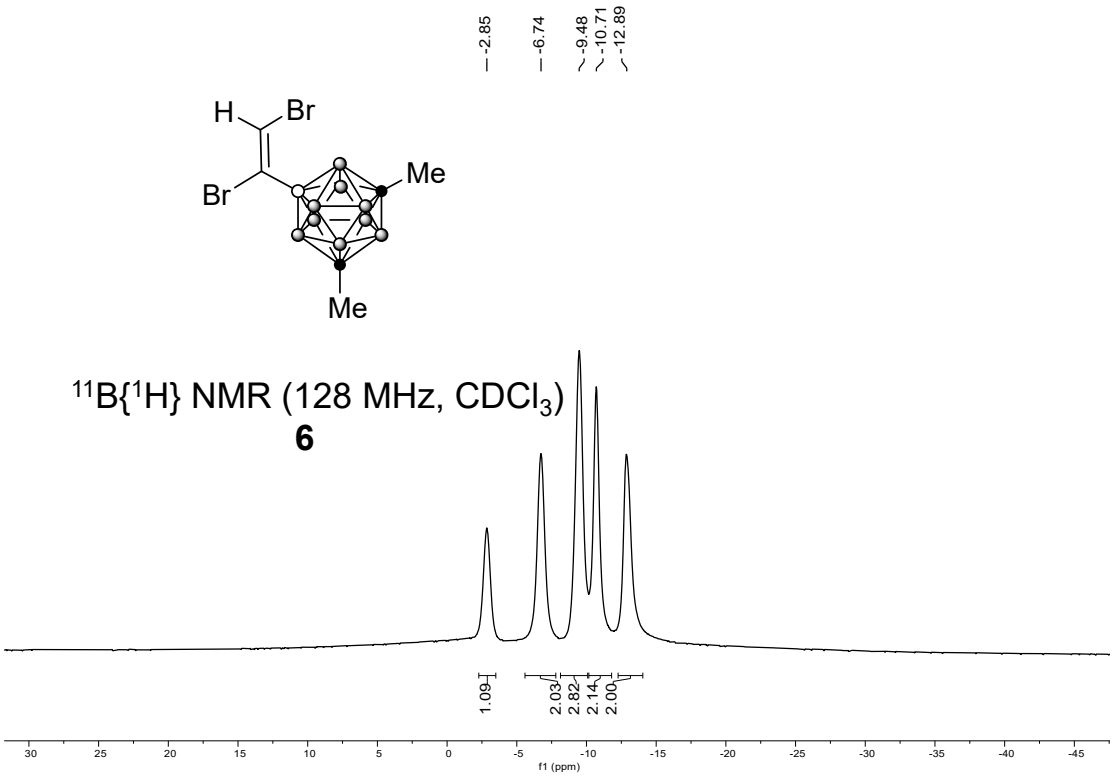
^{1}H NMR (400 MHz, $CDCl_3$)

6



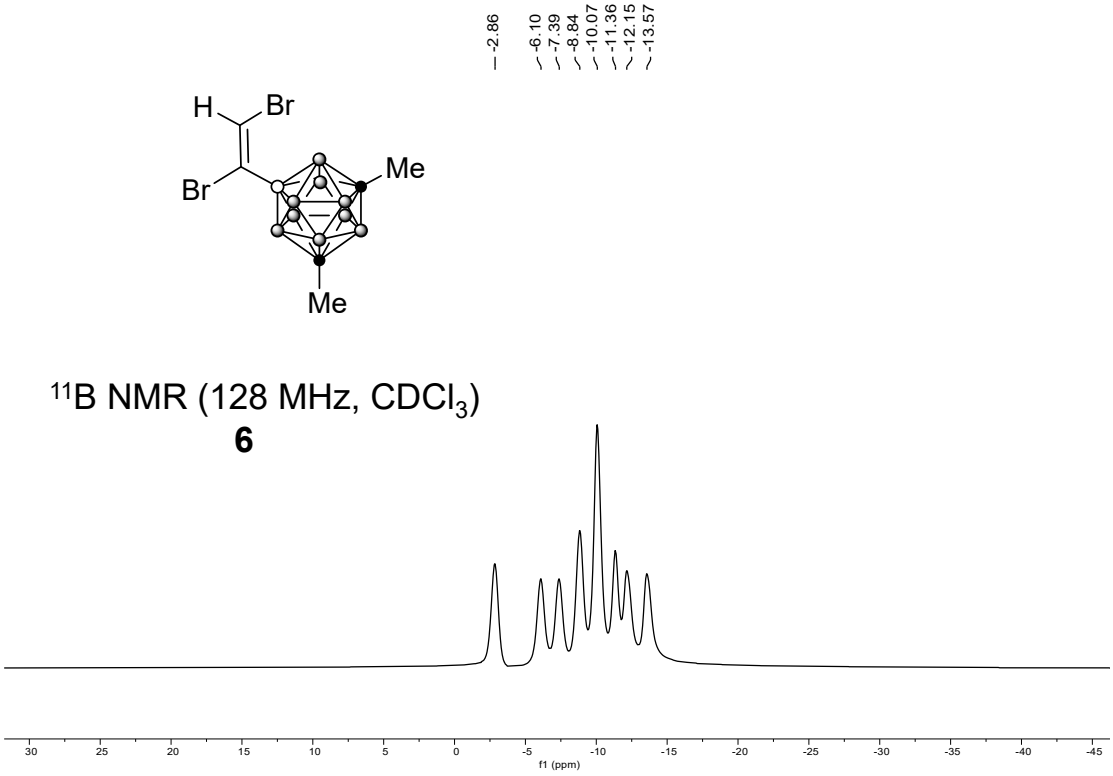
^{13}C NMR (101 MHz, $CDCl_3$)

6



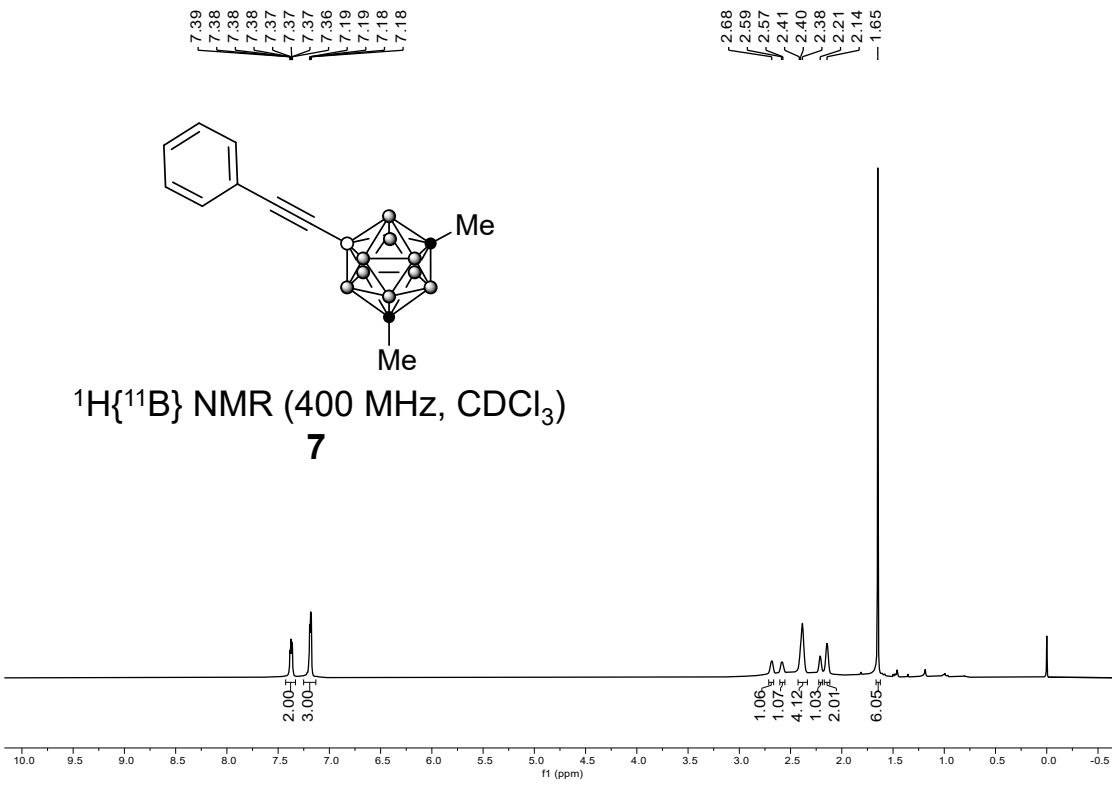
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

6



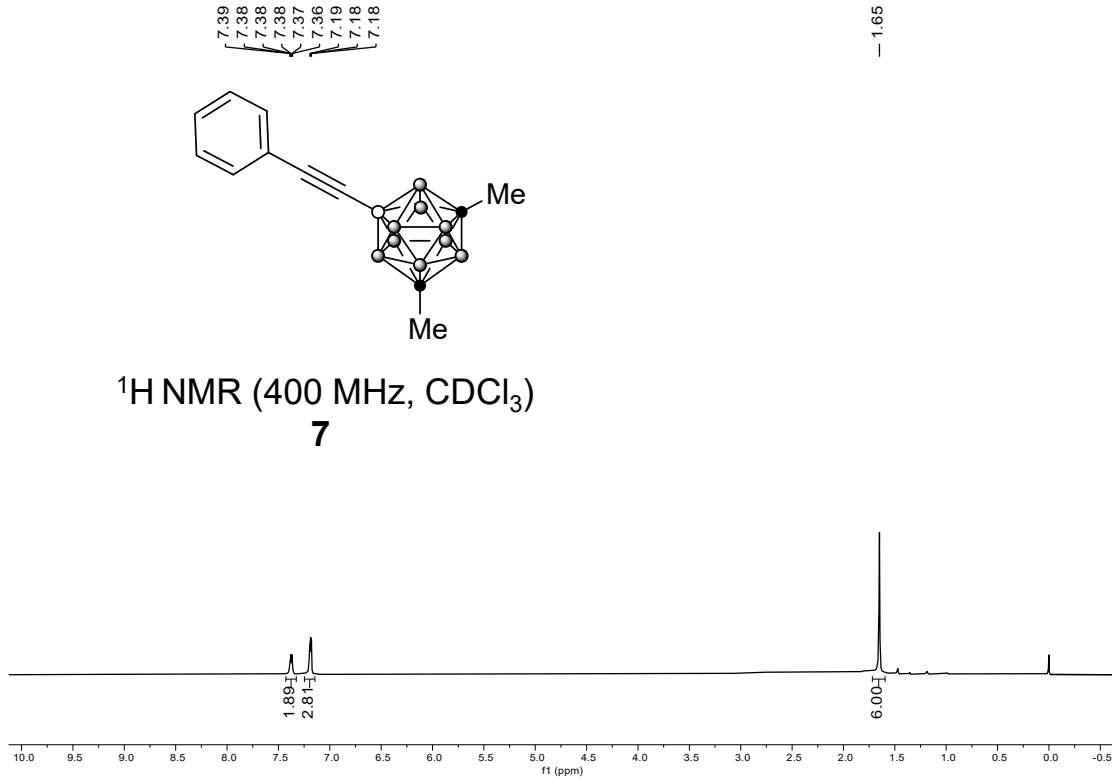
^{11}B NMR (128 MHz, $CDCl_3$)

6



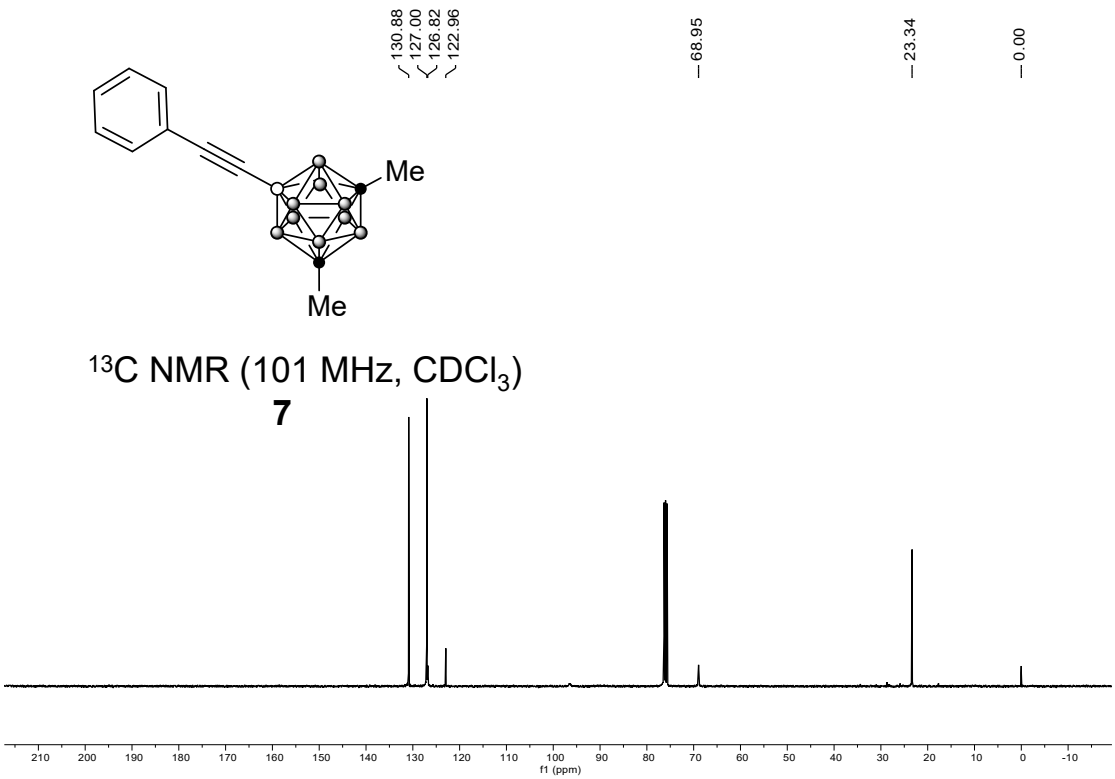
$^1H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

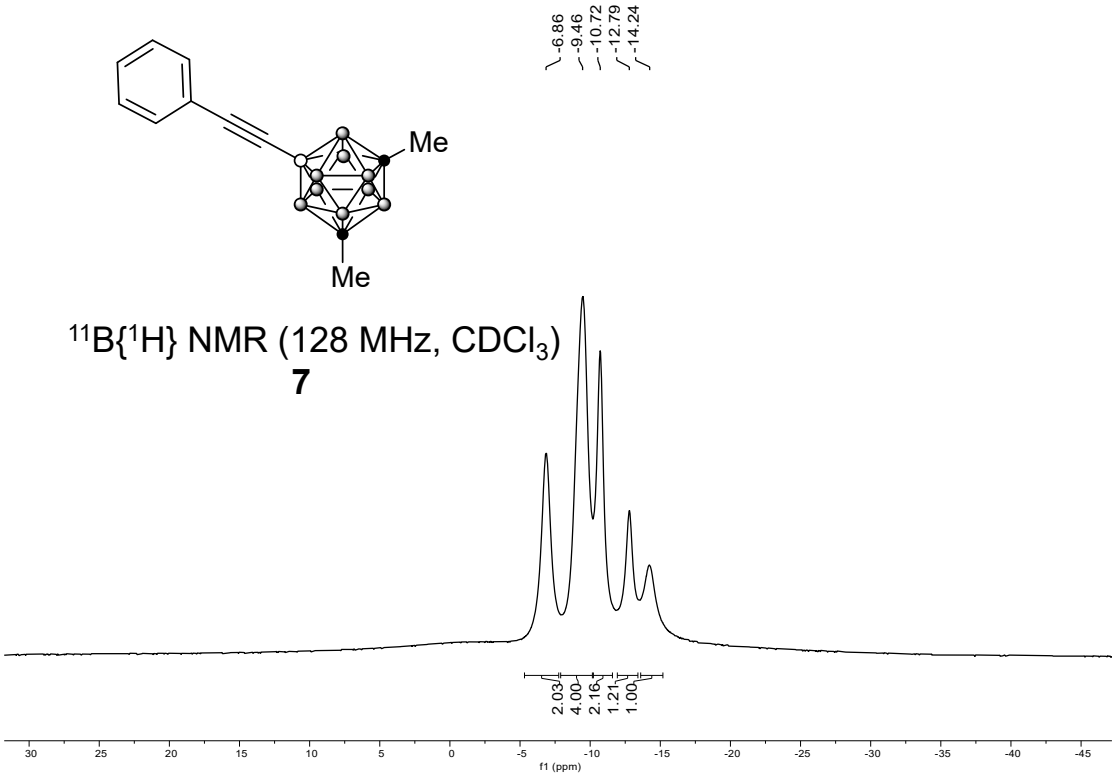
7

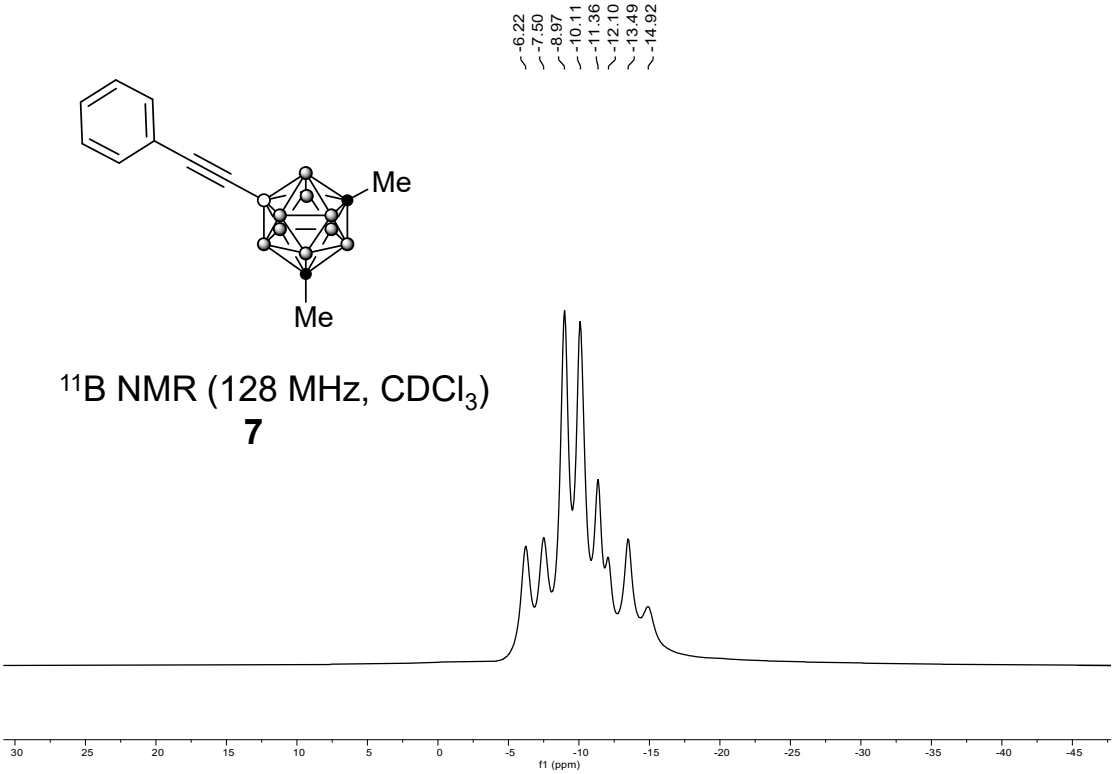


^1H NMR (400 MHz, $CDCl_3$)

7

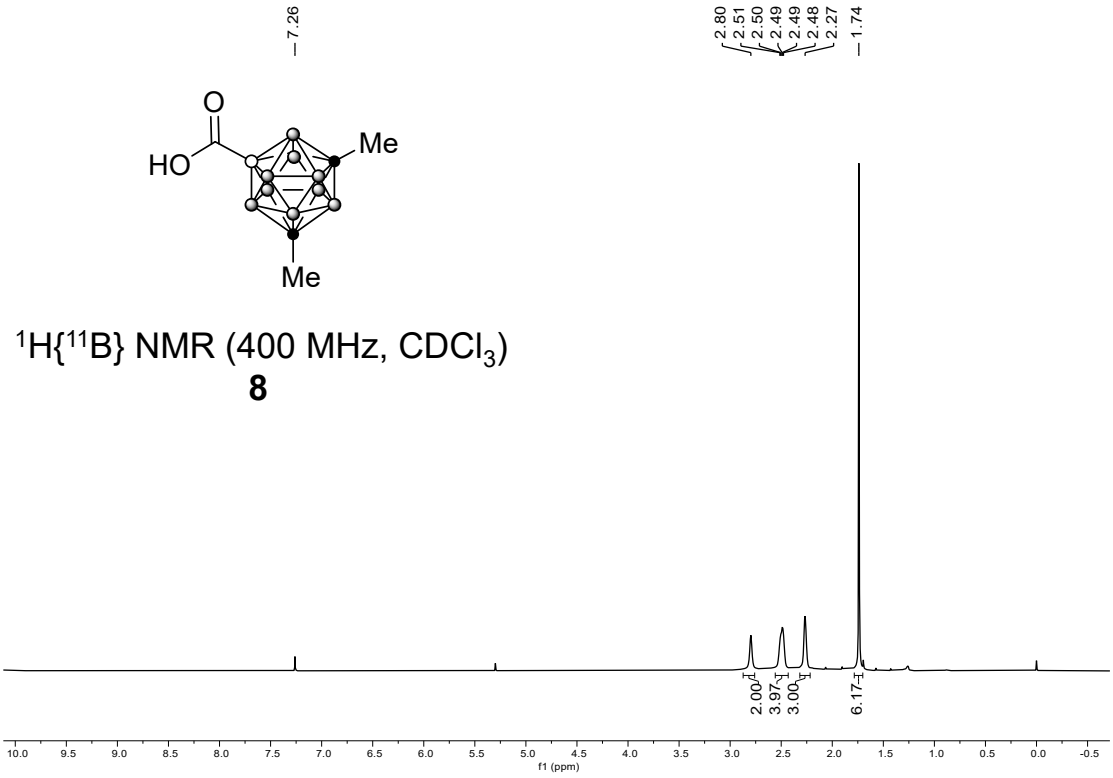

130.88
127.00
126.82
122.96
68.95
23.34
0.00
Me
Me
13C NMR (101 MHz, CDCl3)
7
f1 (ppm)


-6.86
-9.46
-10.72
-12.79
-14.24
Me
Me
11B{1H} NMR (128 MHz, CDCl3)
7
2.03
4.00
2.16
1.21
1.00
f1 (ppm)



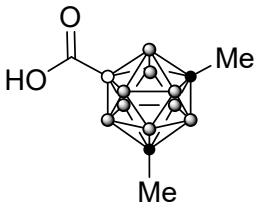
^{11}B NMR (128 MHz, $CDCl_3$)

7



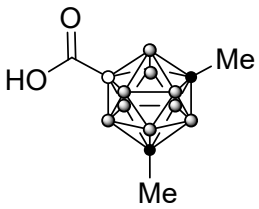
$^{1}H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

8



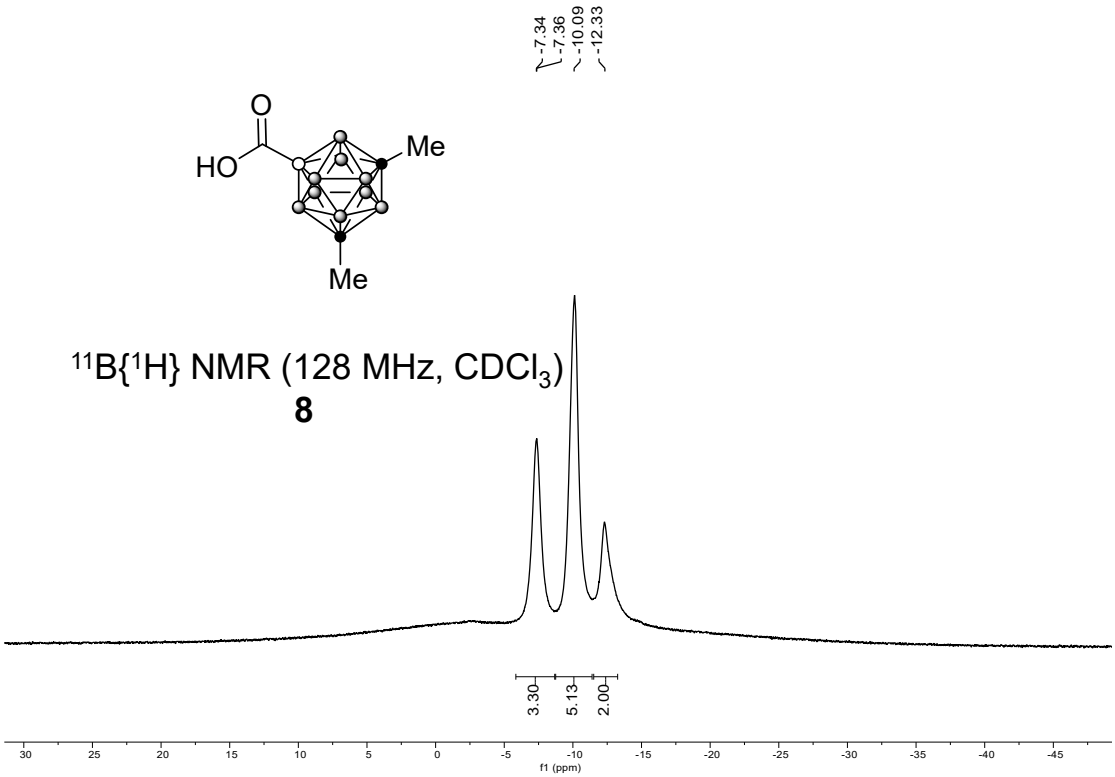
^{1}H NMR (400 MHz, $CDCl_3$)

8



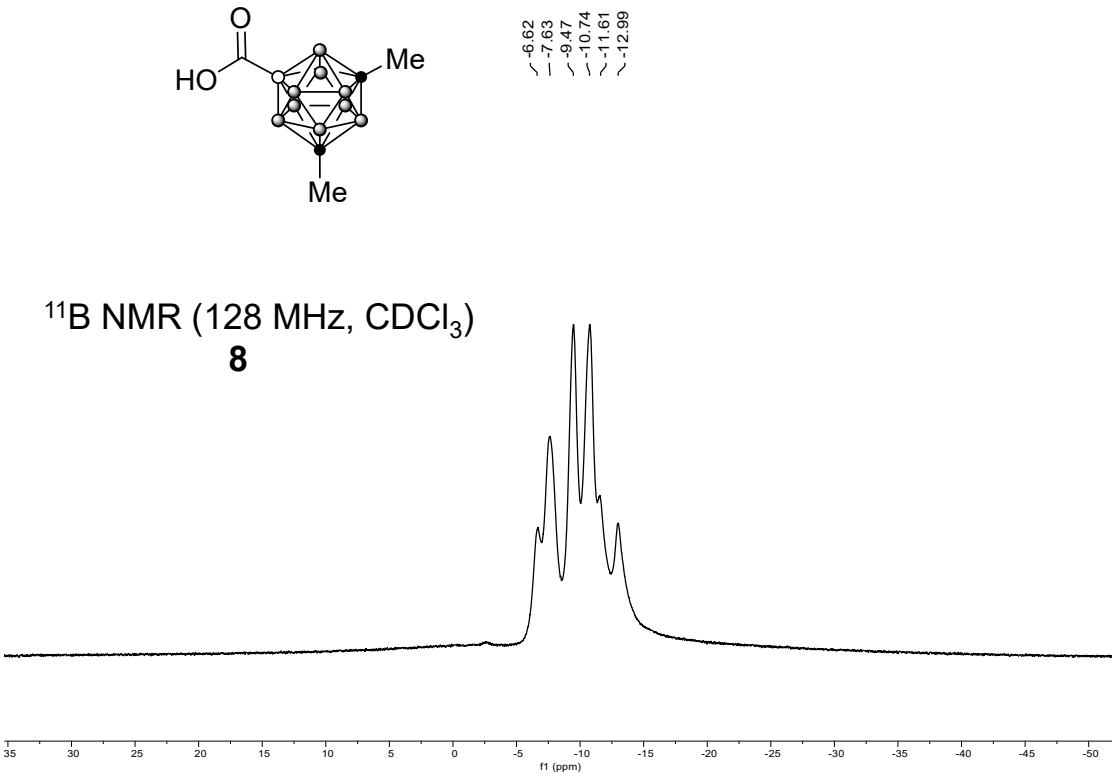
^{13}C NMR (101 MHz, $CDCl_3$)

8



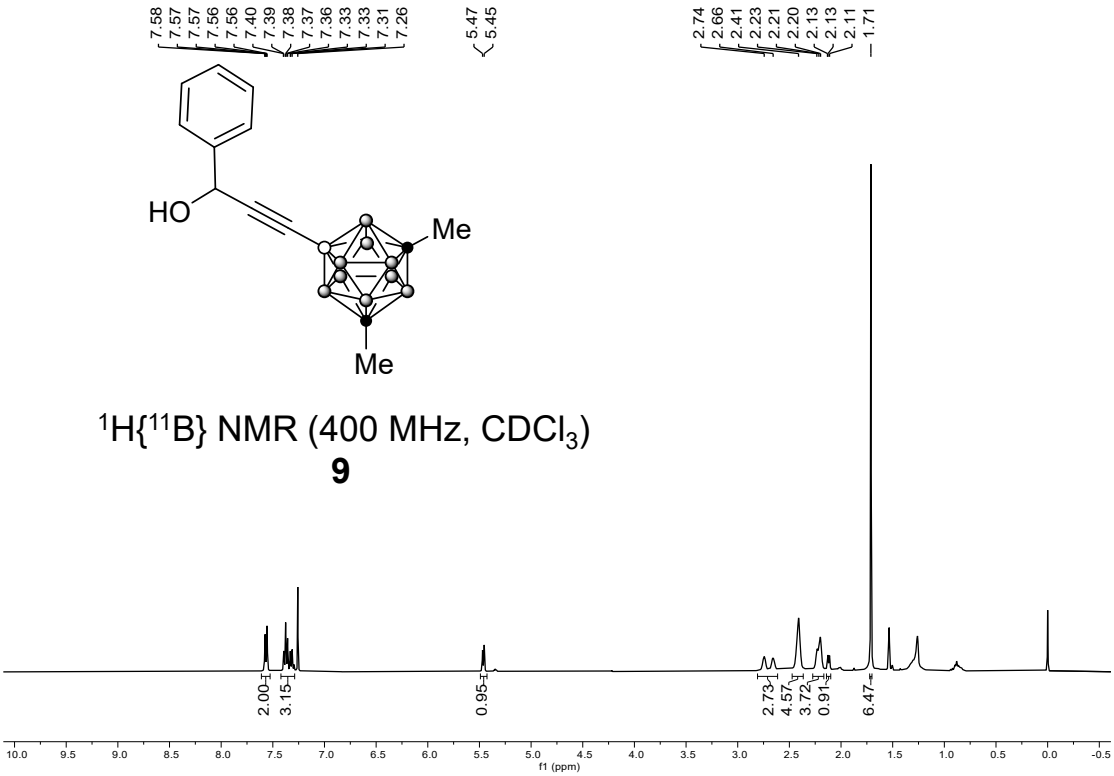
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

8



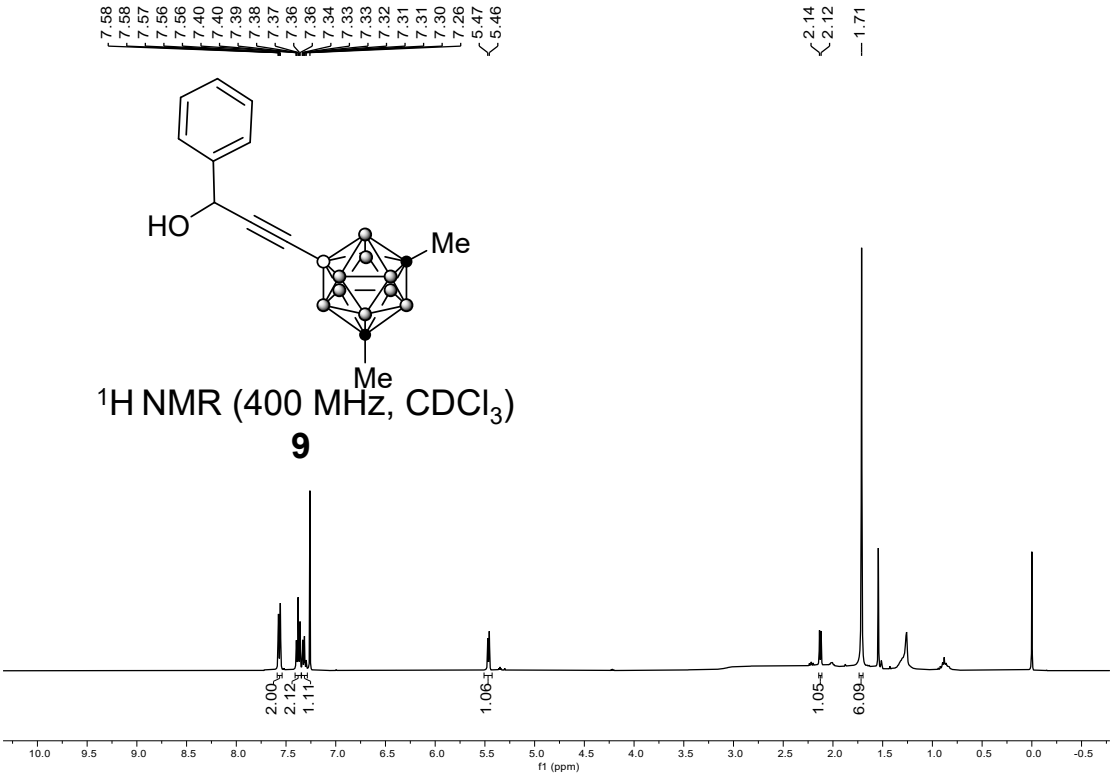
^{11}B NMR (128 MHz, $CDCl_3$)

8



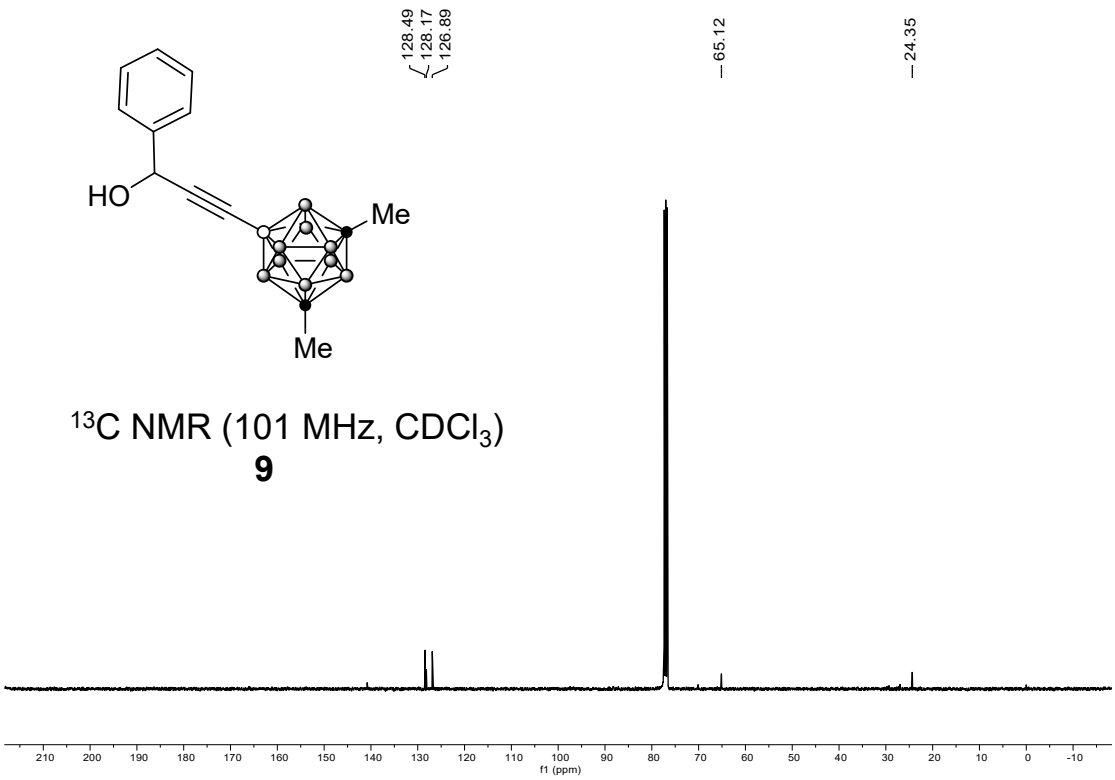
$^1H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

9



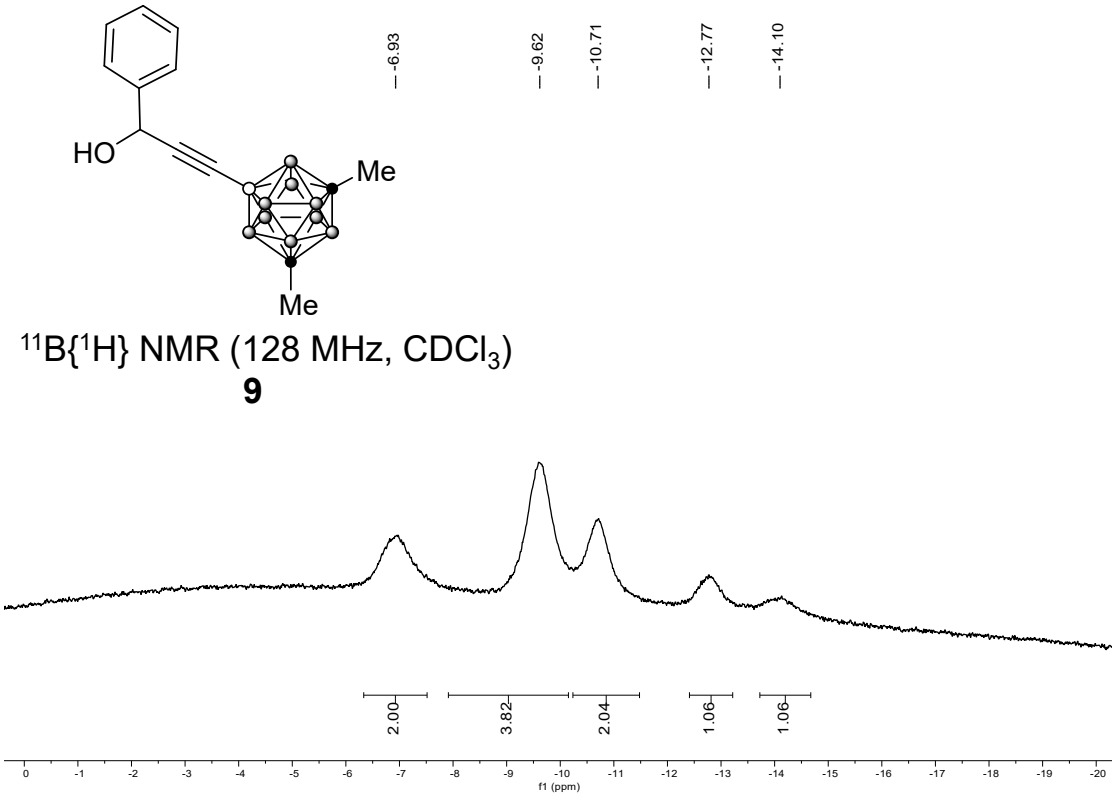
^1H NMR (400 MHz, $CDCl_3$)

9



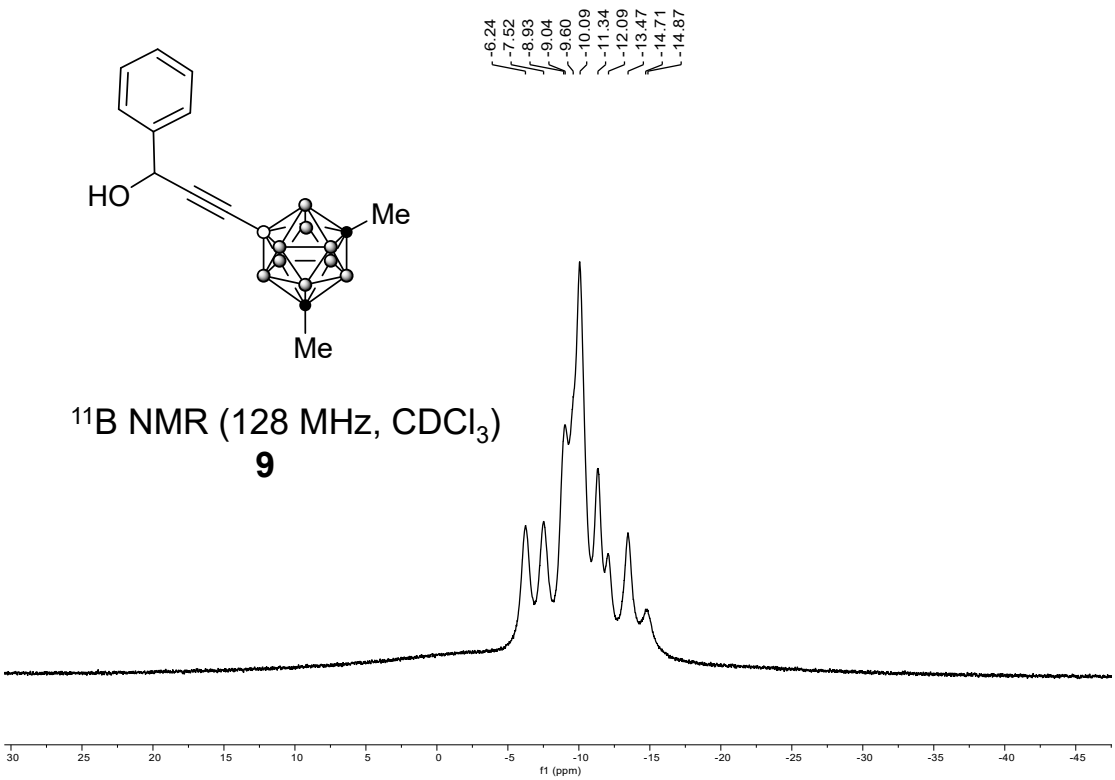
^{13}C NMR (101 MHz, $CDCl_3$)

9



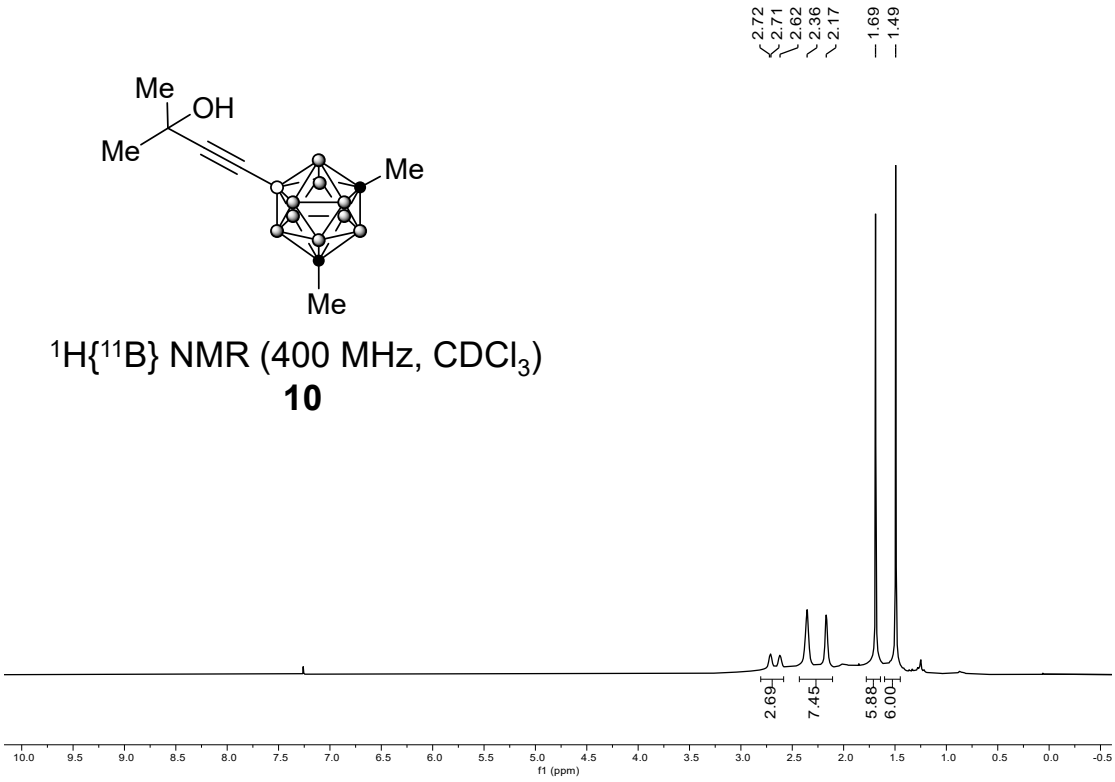
$^{11}B\{^1H\}$ NMR (128 MHz, $CDCl_3$)

9



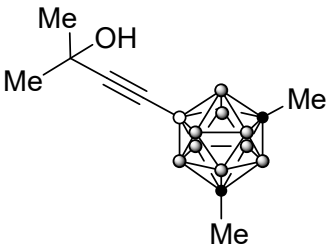
^{11}B NMR (128 MHz, $CDCl_3$)

9



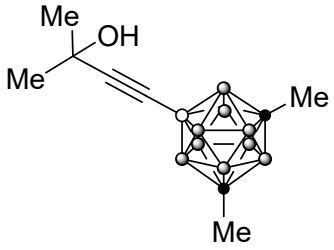
^{1}H{^{11}B} NMR (400 MHz, $CDCl_3$)

10



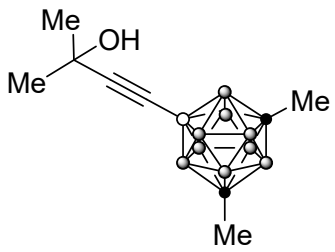
^{1}H NMR (400 MHz, $CDCl_3$)

10



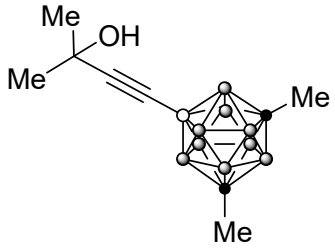
^{13}C NMR (101 MHz, $CDCl_3$)

10



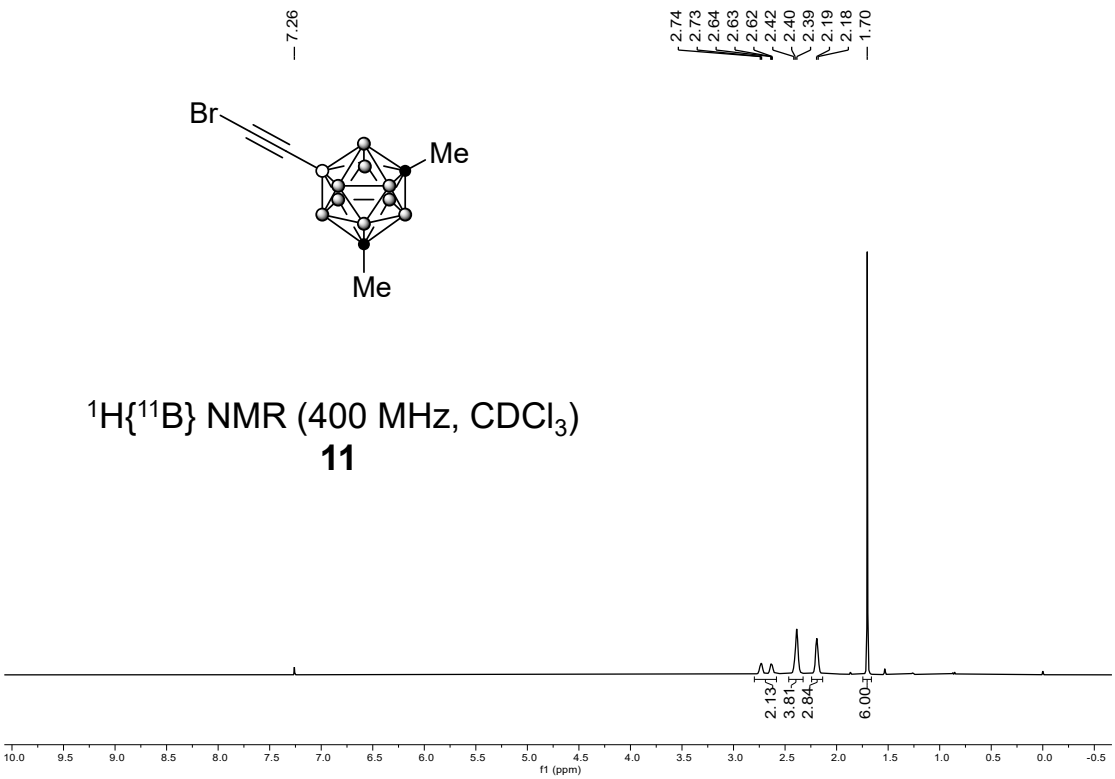
$^{11}B\{^{1}H\}$ NMR (128 MHz, $CDCl_3$)

10



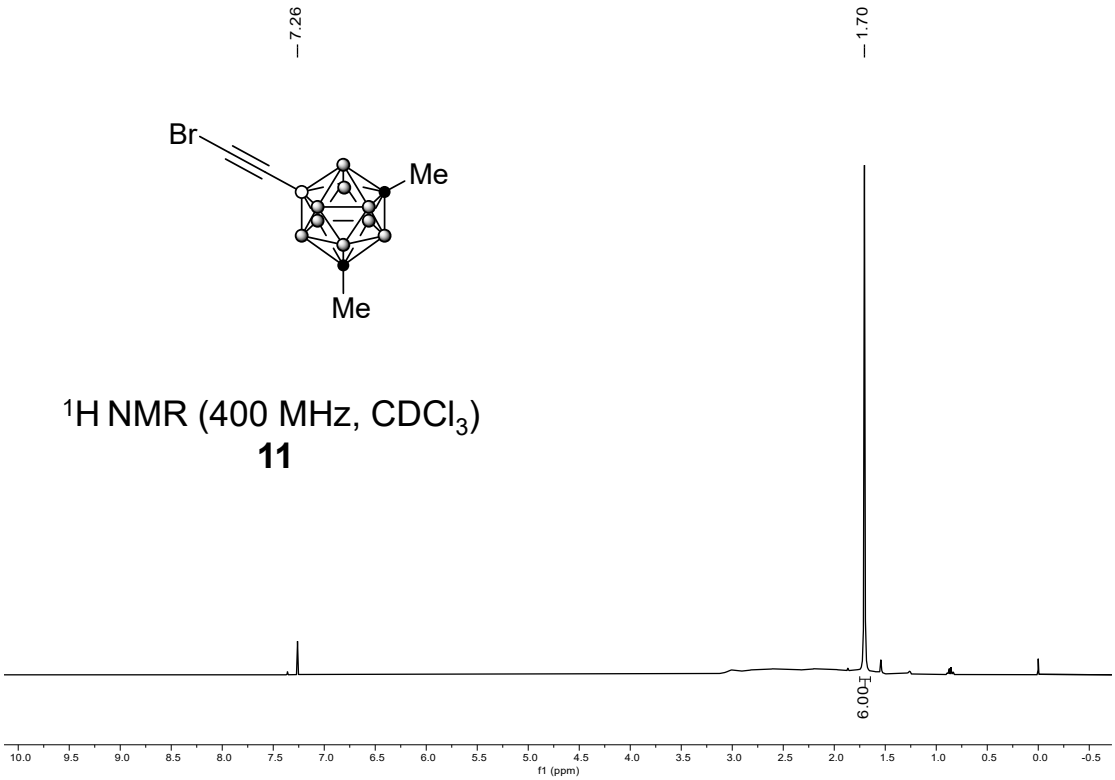
^{11}B NMR (128 MHz, $CDCl_3$)

10



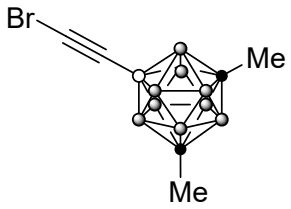
$^1H\{^{11}B\}$ NMR (400 MHz, $CDCl_3$)

11



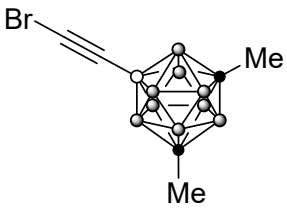
^1H NMR (400 MHz, $CDCl_3$)

11



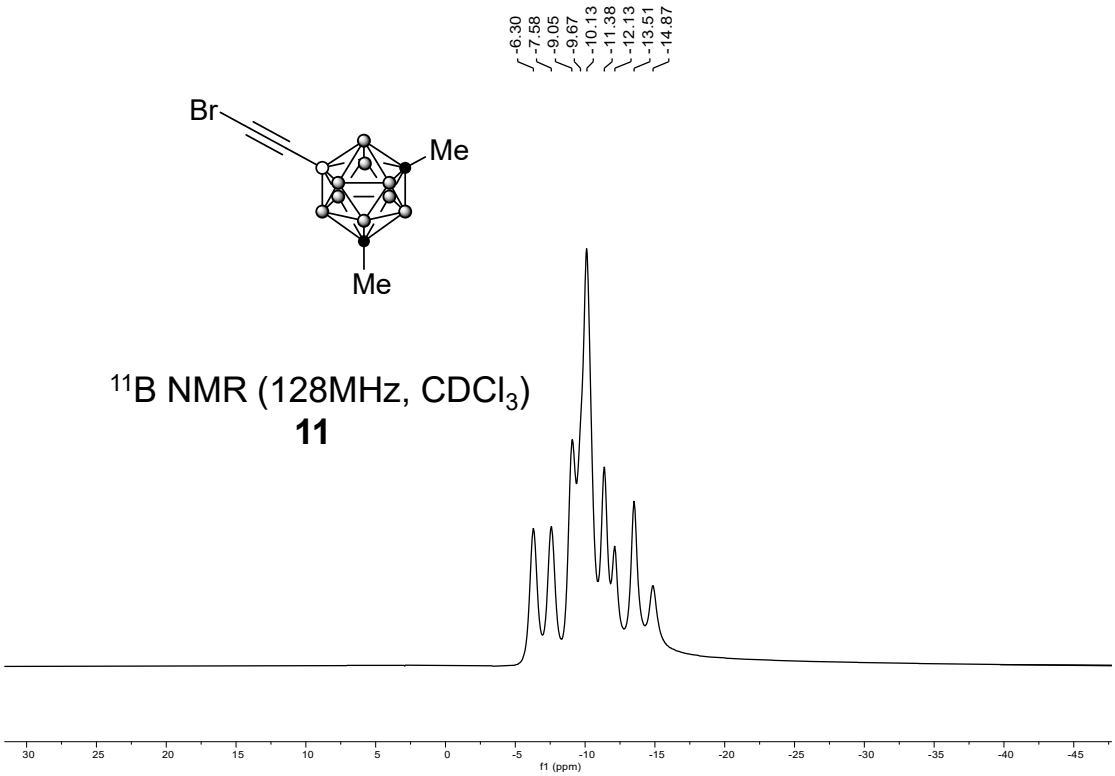
^{13}C NMR (101 MHz, $CDCl_3$)

11



$^{11}B\{^1H\}$ NMR (128MHz, $CDCl_3$)

11



^{11}B NMR (128MHz, $CDCl_3$)

11