Supplementary Information

Formal [4+1] Annulation of Fluorinated Sulfonium Salt with Cyclic Unsaturated Imines to Access CF_3-Substituted Pyrroles

Tao Chen,[a,] Aoning Wang,[a,] Linxue Zhang,[a] Chenlong Wei,[a] Juhui Huang,[a] Xiang Liu,*[,a] and Zhenqian Fu*[,a]

[a] Key Laboratory of Flexible Electronics (KLOFE) & Institute of Advanced Materials (IAM),, Nanjing Tech University (NanjingTech), 30 South Puzhu Road, Nanjing 211816, China
E-mail: iamzqfu@njtech.edu.cn ; iamxliu@njtech.edu.cn

1	General information
2	a) Procedure for the preparation of **1c-d, 1g-o** and **4a-l** (**4b** as an example)**.** b) General procedure for the reactions of **1** or **4** with **2** to synthesize product **3** or **5** (**3a** as an example). c) General procedure for the synthesis of product **6a-b** (**5a** as an example) and **7.** d) X-Ray Spectra of **3c.**
3	a) Characterizations of products. b) References.
4	^{1}H, ^{13}C and ^{19}F NMR spectra.

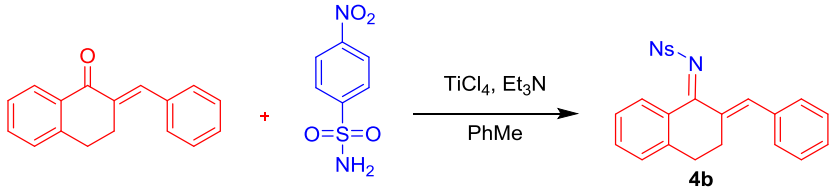
1. General Information

Commercially available materials were purchased from Alfa Aesar and Sigma-Aldrich. Toluene and DCM was dried over Pure Solv solvent purification system. THF was distilled over sodium. Other solvents were dried over 4Å molecular sieve prior use. Proton nuclear magnetic resonance (^{1}H NMR) spectra were recorded on a Bruker (400 MHz) spectrometer. Chemical shifts were recorded in parts per million (ppm, δ) relative to tetramethylsilane (δ 0.00) or chloroform (δ = 7.26, singlet). ^{1}H NMR splitting patterns are designated as singlet (s), doublet (d), triplet (t), quartet (q), dd (doublet of doublets), m (multiplets), and etc. All first-order splitting patterns were assigned on the basis of the appearance of the multiplet. Splitting patterns that could not be easily interpreted are designated as multiplet (m) or broad (br). Carbon nuclear magnetic resonance (^{13}C NMR) spectra were recorded on a Bruker (400 MHz) (100 MHz) spectrometer. ^{19}F NMR chemical shifts were determined relative to $CFCl_3$ as the external standard. High resolution mass spectral analysis (HRMS) was performed on a Waters Q–TOF Permier Spectrometer. Analytical thin-layer chromatography (TLC) was carried out on Merck 60 F254 pre-coated silica gel plate (0.2 mm thickness).

2. General procedure

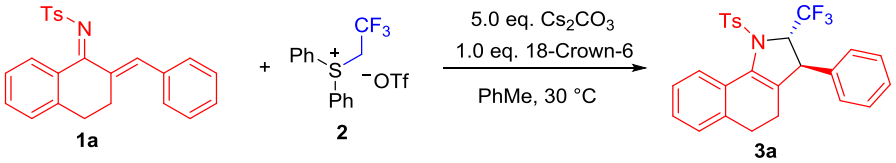
1a-b[1] and **1e-f** [2] were synthesized according to the literature. **1c-d, 1g-o** and **4a-l** were synthesized according to the procedure a). The product **3a-o** or **5a-l** were synthesized according to the procedure b). Diphenyl(2,2,2-trifluoroethyl)sulfonium triflate **2** were synthesized according to the literature. [3]

a) Procedure for the preparation of 1c-d, 1g-o and 4a-l (4b as an example).



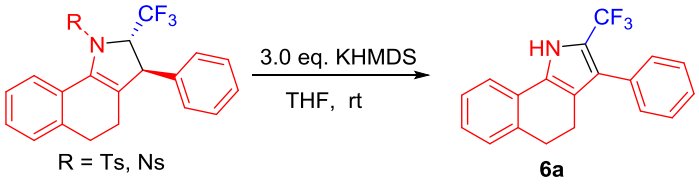
To the solution of chalcone (1.0 equiv. 3.0 mmol) and arylsulfonamide (1.5 equiv.) in dry PhMe (15 mL) was dropwise added $TiCl_4$ (1.5 equiv.) and Et_3N (2.0 equiv.) at 0 ℃ over 10 minutes. The reaction mixture was heated at reflux overnight. The solution was cooled to room temperature, quenched with water (20 mL), and extracted with DCM (3 × 30 mL). The combined organic phase was dried over $MgSO_4$ and concentrated. The residue was purified by flash chromatography on silica gel column (EtOAc/hexane = 1:10 as eluent) to afford the substrate **4b** as a yellow solid up to 80% yield.

b) General procedure for the reactions of 1 or 4 with 2 to synthesize product 3 or 5 (3a as an example):



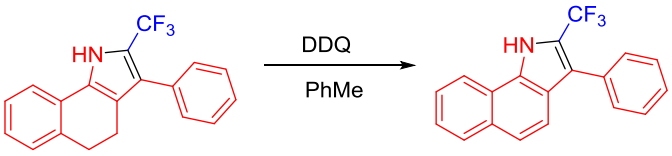
To a dried 10 mL Schlenk tube equipped with a magnetic stir bar was added **1a** (0.10 mmol, 38.7 mg), **2** (0.15 mmol, 62.8 mg), Cs_2CO_3 (0.50 mmol, 163.0 mg), 18-Crown-6 (0.10 mmol, 26.5 mg) and 3.0 equiv. water. To this mixture was added PhMe (1.0 mL) by via a micro syringe, then the reaction mixture was stirred at 30 ℃ until **1a** disappeared (detected by TLC), the residue was purified by silica gel column chromatography (10% v/v EA in hexane) to afford **3a** as a white solid in 79% yield.

c) General procedure for the synthesis of product 6a - b (6a as an example) and 7a:



To a solution of **3a** (0.10 mmol) in dry THF (2.0 mL), 0.30 mmol KHMDS was

added dropwise at rt under nitrogen atmosphere. The mixture was stirred at rt until completed by TLC. The mixture was quenched by NH_4Cl until PH is about 7. Then the crude residue was purified by silica gel column chromatography (20% v/v EA in hexane) to afford **6a** as a pale yellow solid in 85% yield.

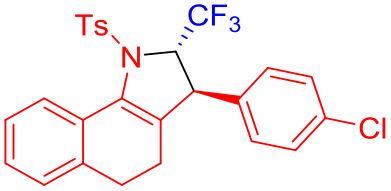


6a (>20:1 dr) **7a**; 93% yield

To a solution of **6a** (0.10 mmol, 31.3 mg) in dry PhMe (2.0 mL), 0.30 mmol DDQ was added. The mixture was stirred at 120 ℃ for 12 h. After the reaction completed, then the residue was purified by silica gel column chromatography (25% v/v EA in hexane) to afford **7a** as a pale yellow solid in 93% yield.

d) Stereochemistry determination *via* X-ray crystallographic analysis of prouduct 3c.

Prouduct **3c** was crystallized as a colorless crystal via vaporization of a hexane/ethyl acetate solution, and its absolute configuration was determined by x-ray structure analysis. **3c**: CDCC: 1997969 contains the supplementary crystallographic data that can be obtained free of charge from The Cambridge Crystallographic Data Centre via https://www.ccdc.cam.ac.uk/.



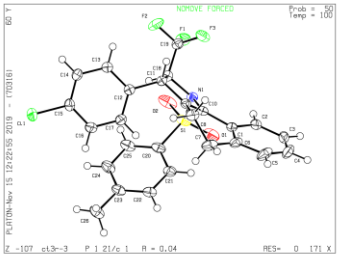
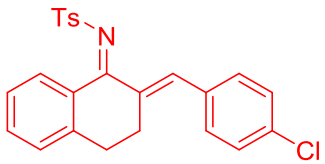


Fig 1. X-ray crystal structure of compound **3c**.

3. Characterizations of products, reference.

Structure of known compounds **1a-b** and **1e-f** were confirmed by NMR spectral comparison with literature data [1-3]. For compounds not reported before, ^{1}H NMR, ^{13}C NMR and ^{19}F NMR characterization and the corresponding spectra are provided.

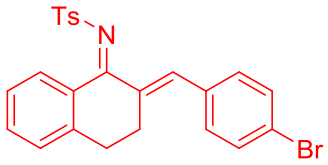
a) Characterizations of compounds 1c-d, 1g-o, 4a-l and Products 3a-o, 5a-l.



1c

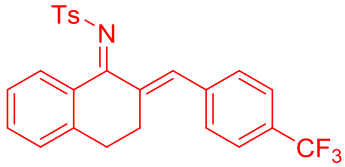
***N*-((*Z*)-2-((*E*)-4-chlorobenzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)-4-methylbenzenesulfonamide (1c):** 60% yield, yellow solid: mp 135.1-136.0 ^{o}C; ^{1}H NMR

(400 MHz, $CDCl_3$) δ = 8.15 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.94 (d, *J* = 8.4 Hz, 2H), 7.77 (s, 1H), 7.45 (td, *J* = 7.6, 1.6 Hz, 1H), 7.39 - 7.32 (m, 6H), 7.29 - 7.25 (m, 1H), 7.19 (d, *J* = 7.6 Hz, 1H), 3.01 - 2.96 (m, 4H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 174.6, 143.1, 142.9, 139.7, 137.3, 136.1, 134.5, 134.0, 133.7, 133.0, 130.9, 129.5, 128.9, 128.4, 127.1, 127.0, 30.8, 27.4, 21.7; HRMS(ESI) calcd for $C_{24}H_{20}ClNO_2S$ $(M+H)^+$: 422.0976, Found: 422.0979.



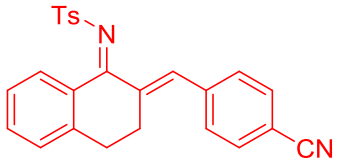
1d

***N*-((*Z*)-2-((*E*)-4-bromobenzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)-4-methylbenzenesulfonamide (1d):** 65% yield, yellow solid: mp 111.0-113.6 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.14 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.95 - 7.92 (m, 2H), 7.74 (s, 1H), 7.55 - 7.52 (m, 2H), 7.45 (td, *J* = 8.8, 1.6 Hz, 1H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.29 - 7.25 (m, 3H), 7.19 (d, *J* = 7.6 Hz, 1H), 3.00 – 2.97 (m, 2H), 2.95 – 2.92 (m, 2H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 174.6, 143.1, 142.9, 139.7, 136.2, 134.5, 133.7, 133.0, 131.8, 131.2, 129.5, 128.8, 128.4, 127.1, 127.0, 122.7, 30.8, 27.4, 21.7; HRMS(ESI) calcd for $C_{24}H_{20}BrNO_2S$ $(M+H)^+$: 466.0471, Found: 466.0473.



1g

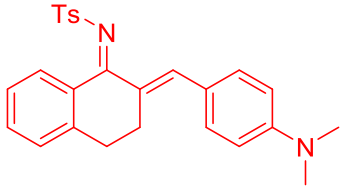
4-methyl-*N*-((*Z*)-2-((*E*)-4-(trifluoromethyl)benzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)benzenesulfonamide (1g): 72% yield, yellow solid: mp 131.6-133.4 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.13 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.94 (d, *J* = 8.4 Hz, 2H), 7.77 (s, 1H), 7.70 (d, *J* = 8.0 Hz, 2H), 7.52 - 7.45 (m, 3H), 7.34 (d, *J* = 8.0 Hz, 2H), 7.29 (d, *J* = 8.0 Hz, 1H), 7.21 (d, *J* = 7.6 Hz, 1H), 3.02 (t, *J* = 6.4 Hz, 2H), 2.93 (t, *J* = 6.4 Hz, 2H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 174.3, 143.3, 142.8, 140.3, 139.4, 138.2, 135.6, 133.9, 132.9, 132.4, 130.5, 129.6, 128.9, 128.3, 127.2, 127.1, 118.8, 111.8, 30.9, 27.5, 21.7; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -62.48 (s, 3F); HRMS(ESI) calcd for $C_{25}H_{21}F_3NO_2S$ $(M+H)^+$: 456.1240, Found: 456.1238.



1h

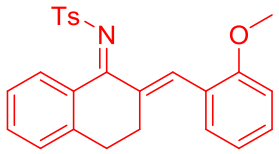
***N*-((*Z*)-2-((*E*)-4-cyanobenzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)-4-methylbenzenesulfonamide (1h):** 75% yield, yellow solid: mp 174.5-175.9 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.13 (d, *J* = 8.0 Hz, 1H), 7.94 (d, *J* = 8.0 Hz, 2H), 7.77 (s, 1H), 7.70 (d, *J* = 8.0 Hz, 2H), 7.52 - 7.45 (m, 3H), 7.34 (d, *J* = 8.0 Hz, 2H), 7.29 (d, *J* = 7.6 Hz, 1H), 7.21 (d, *J* = 7.6 Hz, 1H), 3.02 (t, *J* = 6.4 Hz, 2H), 2.93 (t, *J* = 6.0 Hz, 2H),

2.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 174.3, 143.3, 142.8, 140.3, 139.4, 138.2, 135.6, 133.9, 132.9, 132.4, 130.0, 129.6, 128.9, 128.3, 127.2, 127.0, 118.8, 111.8, 30.9, 27.5, 21.7; HRMS(ESI) calcd for $C_{25}H_{21}N_2O_2S$ $(M+H)^+$: 413.1318, Found: 413.1315.



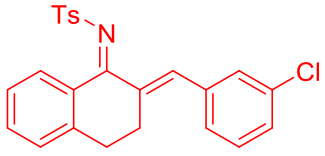
1i

***N*-((*Z*)-2-((*E*)-4-(dimethylamino)benzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)-4-methylbenzenesulfonamide (1i):** 78% yield, red solid: mp 135.1-137.2 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.17 (dt, *J* = 8.0, 1.2 Hz, 1H), 7.94 (d, *J* = 8.4 Hz, 2H), 7.90 (s, 1H), 7.44 - 7.40 (m, 3H), 7.30 (d, *J* = 8.4 Hz, 2H), 7.27 - 7.25 (m, 1H), 7.18 (d, *J* = 7.6 Hz, 1H), 6.70 (d, *J* = 8.4 Hz, 2H), 3.05 (t, *J* = 6.4 Hz, 2H), 3.03 (s, 6H), 2.91 (t, *J* = 6.4 Hz, 2H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 174.3, 150.9, 142.7, 142.5, 141.8, 140.5, 133.4, 133.1, 132.4, 130.7, 129.4, 128.9, 128.2, 126.9, 126.7, 123.5, 111.7, 40.3, 30.2, 27.6, 21.6; HRMS(ESI) calcd for $C_{26}H_{27}N_2O_2S$ $(M+H)^+$: 431.1788, Found: 431.1784.



1j

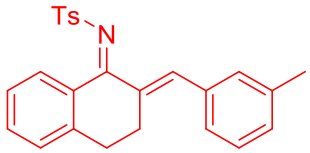
***N*-((*Z*)-2-((*E*)-2-methoxybenzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)-4-methylbenzenesulfonamide (1j):** 67% yield, yellow solid: mp 163.0-163.5 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.16 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.96 - 7.94 (m, 3H), 7.43 (td, *J* = 8.8, 1.2 Hz, 1H), 7.36 - 7.30 (m, 4H), 7.27 - 7.23 (m, 1H), 7.16 (d, *J* = 7.6 Hz, 1H), 6.98 (t, *J* = 7.2 Hz, 1H), 6.92 (d, *J* = 8.4 Hz, 1H), 3.83 (s, 3H), 2.98 - 2.91 (m, 4H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 174.9, 158.3, 143.2, 142.7, 140.1, 136.3, 134.8, 133.5, 133.1, 130.7, 130.4, 129.4, 128.7, 128.4, 127.1, 126.8, 124.7, 120.3, 110.8, 55.6, 30.8, 28.0, 21.7; HRMS(ESI) calcd for $C_{25}H_{24}NO_3S$ $(M+H)^+$: 418.1471, Found: 418.1476.



1k

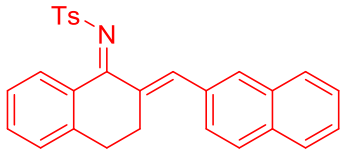
***N*-((*Z*)-2-((*E*)-3-chlorobenzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)-4-methylbenzenesulfonamide (1k):** 69% yield, yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.15 (d, *J* = 8.0 Hz, 1H), 7.93 (d, *J* = 7.2 Hz, 2H), 7.73 (s, 1H), 7.46 (t, *J* = 7.2 Hz, 1H),7.47 - 7.32 (m, 5H), 7.29 - 7.26 (m, 2H), 7.20 (d, *J* = 7.2 Hz, 1H), 3.01 - 2.92 (m, 4H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 174.5, 143.1, 142.9, 139.6, 137.3, 136.7, 134.5, 133.8, 130.0, 129.9, 129.5, 129.3, 128.9, 128.5, 128.3, 127.7, 127.1,

127.0, 30.9, 27.5, 21.7; HRMS(ESI) calcd for $C_{24}H_{21}ClNO_2S$ $(M+H)^+$: 422.0976, Found: 422.0977.



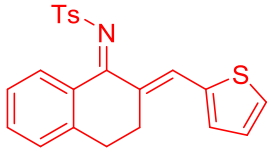
1l

4-methyl-*N*-((*Z*)-2-((*E*)-3-methylbenzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)benzenesulfonamide (1l): 70% yield, yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.16 (d, *J* = 8.0 Hz, 1H), 7.94 (d, *J* = 7.6 Hz, 2H), 7.82 (s, 1H), 7.44 (t, *J* = 7.6 Hz, 1H), 7.33 - 7.25 (m, 5H), 7.22 - 7.18 (m, 3H), 7.16 (d, *J* = 7.6 Hz, 1H), 2.98 (s, 4H), 2.44 (s, 3H), 2.38 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 174.9, 143.1, 142.9, 139.9, 139.2, 138.2, 135.5, 135.2, 133.6, 133.1, 130.4, 129.5, 129.4, 128.8, 128.5, 128.4, 127.0, 126.9, 126.6, 30.8, 27.5, 21.7, 21.5; HRMS(ESI) calcd for $C_{25}H_{24}NO_2S$ $(M+H)^+$: 402.1522, Found: 402.1526.



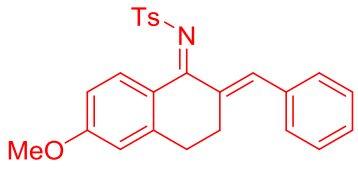
1m

4-methyl-*N*-((1*Z*,2*E*)-2-(naphthalen-2-ylmethylene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)benzenesulfonamide (1m): 78% yield, yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.19 (d, *J* = 8.0 Hz, 1H), 8.00 (s, 1H), 7.96 (d, *J* = 8.0 Hz, 2H), 7.89 - 7.84 (m, 4H), 7.53 - 7.49 (m, 3H), 7.46 (tt, *J* = 7.6, 2.0, 0.8 Hz, 1H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.29 (t, *J* = 8.0 Hz, 1H), 7.20 (d, *J* = 7.6 Hz, 1H), 3.07 (t, *J* = 6.4 Hz, 2H), 2.99 (t, *J* = 6.4 Hz, 2H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 174.8, 143.1, 139.8, 139.0, 135.7, 133.6, 133.2, 133.1 (d, *J* = 2.6 Hz), 129.5, 129.3, 128.8, 128.5, 128.2, 127.8, 127.1, 127.0, 126.8, 126.6, 30.8, 27.6, 21.7; HRMS(ESI) calcd for $C_{28}H_{24}NO_2S$ $(M+H)^+$: 438.1522, Found: 438.1516.



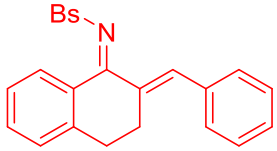
1n

4-methyl-N-((1*Z*,2*E*)-2-(thiophen-2-ylmethylene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)benzenesulfonamide (1n): 76% yield, pale yellow solid: mp 161.7-163.4 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.18 (d, *J* = 8.0 Hz, 1H), 8.02 (s, 1H), 7.93 (d, *J* = 8.4 Hz, 2H), 7.50 (d, *J* = 5.2 Hz, 1H), 7.45 (td, *J* = 8.8 Hz, 1H), 7.38 (d, *J* = 4.0 Hz, 1H), 7.32 - 7.28 (m, 3H), 7.23 (d, *J* = 7.6 Hz, 1H), 7.12 (dd, *J* = 5.2, 3.6 Hz, 1H), 3.07 - 2.99 (m, 4H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 173.8, 143.0, 142.5, 139.8, 138.7, 133.7, 133.2, 132.4, 131.1, 129.6, 129.5, 129.2, 128.2, 127.7, 127.0, 126.8, 29.4, 27.2, 21.7; HRMS(ESI) calcd for $C_{22}H_{20}NO_2S_2$ $(M+H)^+$: 394.0930, Found: 394.0934.



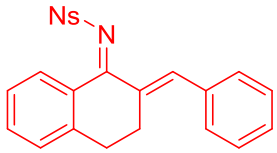
1o

***N*-((*Z*)-2-((*E*)-benzylidene)-6-methoxy-3,4-dihydronaphthalen-1(2*H*)-ylidene)-4-methylbenzenesulfonamide (1o):** 75% yield, yellow solid: mp 106.5-108.3 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.17 (d, *J* = 9.2 Hz, 1H), 7.93 (d, *J* = 8.4 Hz, 2H), 7.87 (s, 1H), 7.43 - 7.37 (m, 4H), 7.35 - 7.30 (m, 3H), 6.81 (dd, *J* = 9.2, 2.8 Hz, 1H), 6.66 (d, *J* = 2.8 Hz, 1H), 3.85 (s, 3H), 2.98 - 2.90 (m, 4H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 173.7, 164.1, 145.8, 142.7, 140.3, 138.8, 135.7, 135.5, 131.4, 129.7, 129.4, 128.6, 128.5, 126.9, 125.9, 113.6, 112.7, 55.6, 31.3, 27.5, 21.7; HRMS(ESI) calcd for $C_{25}H_{24}NO_3S$ $(M+H)^+$: 418.1471, Found: 418.1474.



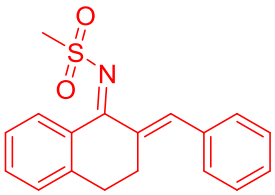
4a

***N*-((*Z*)-2-((*E*)-benzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)benzenesulfonamide (4a):** 70% yield, yellow solid: mp 104.9-105.3 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.17 (dd, *J* = 8.0, 1.2 Hz, 1H), 8.08 - 8.04 (m, 2H), 7.86 (s, 1H), 7.58 - 7.51 (m, 3H), 7.47 (td, *J* = 7.6, 1.2 Hz, 1H), 7.43 (d, *J* = 4.4 Hz, 4H), 7.38 - 7.33 (m, 1H), 7.30 - 7.28 (m, 1H), 7.20 (d, *J* = 7.6 Hz, 1H), 2.99 (s, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 175.2, 143.1, 142.7, 139.1, 135.6, 135.5, 133.7, 133.1, 132.3, 129.6, 128.9, 128.8, 128.6 (d, *J* = 4.0 Hz), 128.5, 128.4, 127.0, 126.9, 30.8, 27.4; HRMS(ESI) calcd for $C_{23}H_{20}NO_2S$ $(M+H)^+$: 374.1209, Found: 374.1205.



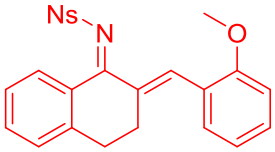
4b

N-((*Z*)-2-((*E*)-benzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)-4-nitrobenzenesulfonamide (4b): 80% yield, yellow solid: mp 161.4-162.7 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.39 (d, *J* = 8.8 Hz, 2H), 8.25 (d, *J* = 8.8 Hz, 2H), 8.09 (d, *J* = 8.0 Hz, 1H), 7.90 (s, 1H), 7.50 (t, *J* = 7.6 Hz, 1H), 7.45 - 7.41 (m, 4H), 7.40 - 7.35 (m, 1H), 7.29 (t, *J* = 7.6 Hz, 1H), 7.23 (d, *J* = 7.6 Hz, 1H), 3.07 - 2.99 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 176.7, 149.8, 148.4, 143.6, 140.2, 135.6, 135.3, 134.4, 132.6, 129.7, 129.0 (d, *J* = 4.3 Hz), 128.7, 128.5, 128.2, 127.1, 124.2, 30.7, 27.6; HRMS(ESI) calcd for $C_{23}H_{19}N_2O_4S$ $(M+H)^+$: 419.1060, Found: 419.1067.



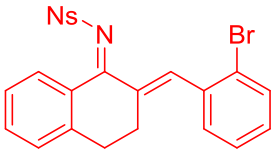
4c

***N*-((*Z*)-2-((*E*)-benzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)methanesulfonamide (4c):** 78% yield, yellow solid: mp 137.7-138.6 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.25 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.78 (s, 1H), 7.48 (td, *J* = 7.6, 1.6 Hz, 1H), 7.43 - 7.38 (m, 4H), 7.36 - 7.31 (m, 2H), 7.22 (d, *J* = 7.6 Hz, 1H), 3.28 (s, 3H), 2.99 (s, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 175.6, 143.1, 138.5, 135.6, 135.4, 133.6, 132.9, 129.6, 128.8, 128.6, 128.2, 126.9, 43.9, 30.8, 27.3; HRMS(ESI) calcd for $C_{18}H_{18}NO_2S$ $(M+H)^+$: 312.1053, Found: 312.1052.



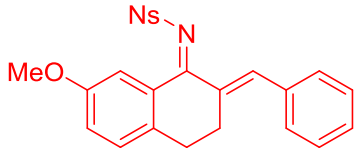
4d

***N*-((*Z*)-2-((*E*)-2-methoxybenzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)-4-nitrobenzenesulfonamide (4d):** 73% yield, yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.38 (d, *J* = 8.8 Hz, 2H), 8.25 (d, *J* = 8.8 Hz, 2H), 8.09 (d, *J* = 8.0 Hz, 1H), 8.03 (s, 1H), 7.48 (t, *J* = 7.6 Hz, 1H), 7.40 - 7.26 (m, 2H), 7.28 (d, *J* = 7.6 Hz, 1H), 7.20 (d, *J* = 7.6 Hz, 1H), 7.01 (t, *J* = 7.2 Hz, 1H), 6.95 (d, *J* = 8.4 Hz, 1H), 3.85 (s, 3H), 3.03 - 2.95 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 176.7, 158.4, 149.7, 148.7, 143.7, 137.6, 135.0, 134.3, 132.5, 130.9, 130.7, 128.9, 128.5, 128.2, 127.1, 124.4, 124.2, 120.4, 110.9, 55.7, 30.7, 28.2; HRMS(ESI) calcd for $C_{24}H_{21}N_2O_5S$ $(M+H)^+$: 449.1166, Found: 449.1169.



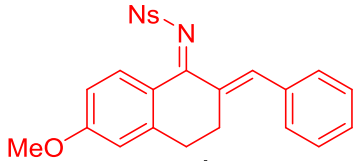
4e

***N*-((*Z*)-2-((*E*)-2-bromobenzylidene)-3,4-dihydronaphthalen-1(2*H*)-ylidene)-4-nitrobenzenesulfonamide (4e):** 69% yield, yellow solid: mp 201.1-202.6 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.40 (d, *J* = 8.4 Hz, 2H), 8.27 (d, *J* = 8.8 Hz, 2H), 8.10 (d, *J* = 8.4 Hz, 1H), 7.86 (s, 1H), 7.65 (d, *J* = 8.0 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 1H), 7.44 - 7.36 (m, 2H), 7.31 - 7.21 (m, 3H), 2.99 (t, *J* = 6.4 Hz, 2H), 2.89 (t, *J* = 6.0 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 176.3, 149.9, 148.4, 143.8, 138.9, 137.0, 136.0, 134.5, 133.0, 132.4, 131.0, 130.2, 129.1, 128.5, 128.2, 127.4, 127.2, 124.5, 124.2, 30.9, 28.2; HRMS(ESI) calcd for $C_{23}H_{18}BrN_2O_4S$ $(M+H)^+$: 497.0165, Found: 497.0160.



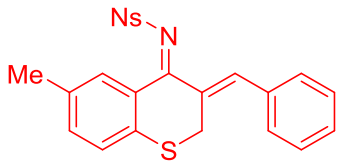
4f

***N*-((*Z*)-2-((*E*)-benzylidene)-7-methoxy-3,4-dihydronaphthalen-1(2*H*)-ylidene)-4-nitrobenzenesulfonamide (4f):** 72% yield, yellow solid: mp 155.2-155.6 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.39 - 8.36 (m, 2H), 8.26 - 8.23 (m, 2H), 7.86 (s, 1H), 7.58 (d, *J* = 2.8 Hz, 1H), 7.44 - 7.40 (m, 4H), 7.39 - 7.34 (m, 1H), 7.14 (d, *J* = 8.4 Hz, 1H), 7.07 (dd, *J* = 8.4, 2.8 Hz, 1H), 3.78 (s, 3H), 3.02 (t, *J* = 6.4 Hz, 2H), 2.94 (t, *J* = 6.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 176.7, 158.4, 149.8, 148.4, 140.1, 136.3, 135.7, 135.3, 133.4, 130.1, 129.7, 129.0, 128.7, 128.2, 124.2, 121.9, 11.2, 55.6, 29.9, 27.9; HRMS(ESI) calcd for $C_{24}H_{21}N_2O_5S$ $(M+H)^+$: 449.1166, Found: 449.1163.



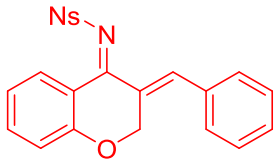
4g

***N*-((*Z*)-2-((*E*)-benzylidene)-6-methoxy-3,4-dihydronaphthalen-1(2*H*)-ylidene)-4-nitrobenzenesulfonamide (4g):** 75% yield, yellow solid: mp 119.2-120.0 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.37 (d, *J* = 9.2 Hz, 2H), 8.24 (d, *J* = 8.8 Hz, 2H), 8.10 (d, *J* = 8.8 Hz, 1H), 7.91 (s, 1H), 7.43 - 7.34 (m, 5H), 6.82 (dd, *J* = 9.6, 2.8 Hz, 1H), 6.68 (d, *J* = 3.6 Hz, 1H), 3.86 (s, 3H), 3.02 (d, *J* = 6.4 Hz, 2H), 2.95 (d, *J* = 6.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 175.3, 164.8, 149.6, 148.9, 146.5, 140.0, 135.6, 135.4, 131.5, 129.8, 128.9, 128.7, 128.0, 125.4, 124.2, 113.9, 112.9, 55.7, 31.2, 27.7; HRMS(ESI) calcd for $C_{24}H_{21}N_2O_5S$ $(M+H)^+$: 449.1166, Found: 449.1172.



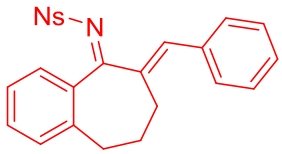
4h

N-((*Z*)-3-((*E*)-benzylidene)-6-methylthiochroman-4-ylidene)-4-nitrobenzenesulfonamide (4h): 72% yield, yellow solid: mp 144.8-145.5 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.40 (d, *J* = 8.8 Hz, 2H), 8.25 (d, *J* = 8.4 Hz, 2H), 7.90 (s, 1H), 7.72 (s, 1H), 7.50 - 7.44 (m, 4H), 7.39 (t, *J* = 7.6 Hz, 1H), 7.22 (d, *J* = 8.4 Hz, 1H), 7.15 (d, *J* = 8.0 Hz, 1H), 3.99 (s, 2H), 2.29 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 174.9, 150.0, 147.9, 140.1, 139.0, 135.5, 135.2, 134.7, 130.6, 130.1, 129.6, 129.5, 129.0, 128.4, 127.7, 124.3, 27.6, 21.0; HRMS(ESI) calcd for $C_{23}H_{19}N_2O_4S_2$ $(M+H)^+$: 451.0781, Found: 451.0782.



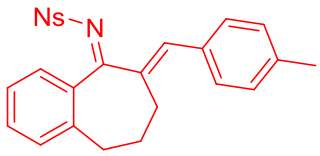
4i

N-((*Z*)-3-((*E*)-benzylidene)chroman-4-ylidene)-4-nitrobenzenesulfonamide (4i): 75% yield, yellow solid: mp 185.7-186.1 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 9.07 - 9.04 (m, 1H), 8.26 (d, *J* = 8.4 Hz, 2H), 8.07 (d, *J* = 8.4 Hz, 2H), 7.77 - 7.70 (m, 3H), 7.60 (s, 1H), 7.24 - 7.20 (m, 3H), 7.03 (d, *J* = 7.2 Hz, 2H), 3.97 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 163.5, 149.9, 149.3, 138.1, 137.9, 136.8, 133.0, 132.1, 129.1, 128.9, 128.2, 128.0, 127.4, 126.9, 126.7, 124.1, 40.0; HRMS(ESI) calcd for $C_{22}H_{16}N_2O_5S$ $(M+H)^+$: 421.0853, Found: 421.0850.



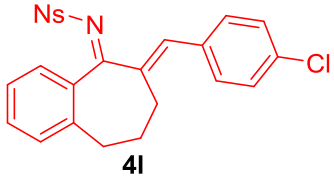
4j

N-((*Z*)-6-((*E*)-benzylidene)-6,7,8,9-tetrahydro-5*H*-benzo[7]annulen-5-ylidene)-4-nitrobenzenesulfonamide (4j): 77% yield, pale yellow solid : mp 140.5-142.6 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.33 (d, *J* = 8.8 Hz, 2H), 8.15 (d, *J* = 8.8 Hz, 2H), 7.85 (d, *J* = 7.6 Hz, 2H), 7.49 (td, *J* = 8.0, 1.2 Hz, 1H), 7.43 - 7.34 (m, 6H), 7.20 (d, *J* = 7.6 Hz, 1H), 2.79 (t, *J* = 6.8 Hz, 2H), 2.53 (s, 2H), 1.98 - 1.91 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 183.4, 149.9, 147.6, 141.7, 139.0, 138.9 (q, *J* = 4.2 Hz), 137.4, 135.9, 135.5, 132.9, 129.9, 129.7, 129.2, 129.1, 128.7, 128.4, 126.7, 124.1, 31.8 (d, *J* = 3.1 Hz), 27.1, 25.6; HRMS(ESI) calcd for $C_{24}H_{21}N_2O_4S$ $(M+H)^+$: 433.1217, Found: 433.1213.



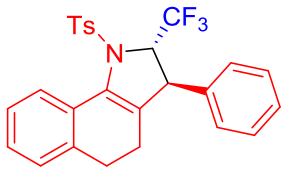
4k

N-((*Z*)-6-((*E*)-4-methylbenzylidene)-6,7,8,9-tetrahydro-5*H*-benzo[7]annulen-5-ylidene)-4-nitrobenzenesulfonamide (4k): 76% yield, yellow solid: mp 158.8-159.9 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.34 - 8.30 (m, 2H), 8.15 - 8.12 (m, 2H), 7.88 (s, 1H), 7.83 (d, *J* = 7.6 Hz, 1H), 7.48 (tt, *J* = 7.6, 1.6 Hz, 1H), 7.39 - 7.32 (m, 3H), 7.20 (t, *J* = 8.4 Hz, 3H), 2.76 (t, *J* = 6.8 Hz, 2H), 2.51 (s, 2H), 2.38 (s, 3H), 1.97 - 1.91 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 183.4, 149.8, 147.7, 139.7, 139.4, 136.4, 136.0, 132.8, 132.6, 129.9, 129.5, 128.4, 126.7, 124.1, 31.8, 27.1, 25.5, 21.5; HRMS(ESI) calcd for $C_{25}H_{23}N_2O_4S$ $(M+H)^+$: 447.1373, Found: 447.1370.



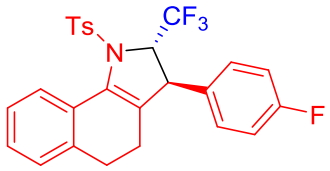
4l

N-((*Z*)-6-((*E*)-4-chlorobenzylidene)-6,7,8,9-tetrahydro-5*H*-benzo[7]annulen-5-ylidene)-4-nitrobenzenesulfonamide (4l): 70% yield, yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.34 (d, *J* = 8.8 Hz, 2H), 8.15 (d, *J* = 8.8 Hz, 2H), 7.84 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.73 (s, 1H), 7.49 (td, *J* = 7.6, 1.2 Hz, 1H), 7.39 - 7.33 (m, 5H), 7.20 (d, *J* = 7.6 Hz, 1H), 2.78 (t, *J* = 6.4 Hz, 2H), 2.52 (s, 2H), 1.96 - 1.89 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 174.5, 143.2, 143.0, 139.9, 137.9, 136.8, 136.4, 133.8, 132.9, 132.8, 131.1, 129.9, 129.5, 128.9, 128.3, 127.3, 127.0, 126.9, 124.5, 31.0, 28.1, 21.7; HRMS(ESI) calcd for $C_{24}H_{20}ClN_2O_4S$ $(M+H)^+$: 467.0827, Found: 467.0825.



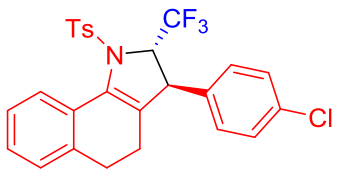
3a

3-phenyl-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3a): white solid: mp 205.7-206.2 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.88 (dd, *J* = 7.2, 1.6 Hz, 1H), 7.34 - 7.23 (m, 6H), 7.17 (tt, *J* = 6.8, 1.2 Hz, 1H), 7.12 - 7.04 (m, 4H), 6.49 - 6.46 (m, 2H), 4.50 (qd, *J* = 6.4, 3.2 Hz, 1H), 3.85 (t, *J* = 2.8 Hz, 1H), 2.91 - 2.76 (m, 2H), 2.46 (s, 3H), 2.24 - 2.02 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 144.6, 139.6, 139.1, 135.7, 132.3, 130.6, 129.9, 128.9, 128.8, 128.7, 128.6, 128.1, 127.4, 127.3, 127.1, 126.5, 125.7, 124.7 (d, *J* = 279.0 Hz), 70.1 (q, *J* = 31.0 Hz), 49.3, 29.2, 22.9, 21.8; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.17 (s, 3F); HRMS(ESI) calcd for $C_{26}H_{23}F_3NO_2S$ $(M+H)^+$: 470.1396, Found: 470.1403.



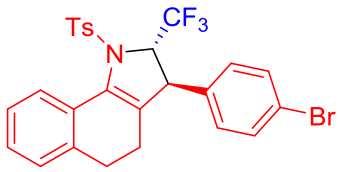
3b

3-(4-fluorophenyl)-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3b): white solid: mp 205.8-206.4 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.85 (dd, *J* = 6.8, 1.6 Hz, 1H), 7.34 - 7.25 (m, 4H), 7.26 - 7.23 (m, 1H), 7.15 (d, *J* = 8.0 Hz, 2H), 6.79 - 6.73 (m, 2H), 6.48 - 6.43 (m, 2H), 4.46 (qd, *J* = 7.2, 3.2 Hz, 1H), 3.83 (t, *J* = 2.4 Hz, 1H), 2.90 - 2.77 (m, 2H), 2.47 (s, 3H), 2.47 - 1.99 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 144.8, 139.7, 135.6, 134.9 (d, *J* = 2.9 Hz), 132.3, 130.3, 129.9, 129.0, 128.9, 128.7, 128.5, 128.3, 127.4, 126.5, 126.0, 125.8, 124.6, 115.9, 115.6, 124.7 (d, *J* = 278.0 Hz), 70.0 (q, *J* = 30.0 Hz), 48.6, 29.2, 22.9, 21.7; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -114.62 (s, 3F)，-78.20 (s, 1F); HRMS(ESI) calcd for $C_{26}H_{22}F_4NO_2S$ $(M+H)^+$: 488.1302, Found: 488.1303.



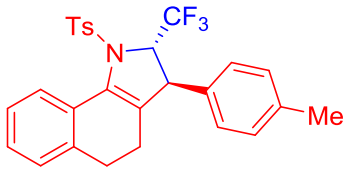
3c

3-(4-chlorophenyl)-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3c): white solid: mp 208.8-211.2 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.85 (dd, *J* = 7.2, 2.0 Hz, 1H), 7.33 - 7.26 (m, 4H), 7.26 - 7.23 (m, 1H), 7.13 (d, *J* = 8.4 Hz, 2H), 7.06 - 7.03 (m, 2H), 6.46 - 6.43 (m, 2H), 4.46 (qd, *J* = 7.2, 2.8 Hz, 1H), 3.81 (t, *J* = 2.8 Hz, 1H), 2.91 - 2.78 (m, 2H), 2.48 (s, 3H), 2.26 - 2.01 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 144.9, 140.0, 137.6, 135.6, 133.1, 132.3, 129.9, 129.8, 129.0, 128.7, 128.6, 128.5, 128.3, 127.4, 126.5, 125.8, 124.6 (d, *J* = 278.0 Hz), 70.0 (q, *J* = 31.0 Hz), 48.6, 29.1, 22.9, 21.7; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.21 (s, 3F); HRMS(ESI) calcd for $C_{26}H_{22}F_3ClNO_2S$ $(M+H)^+$: 504.1006, Found: 504.1015.



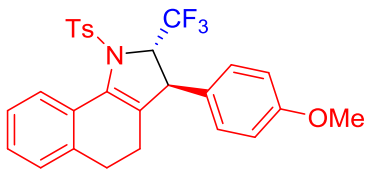
3d

3-(4-bromophenyl)-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3d): white oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.84 (dd, *J* = 6.8, 1.6 Hz, 1H), 7.33 - 7.26 (m, 4H), 7.26 - 7.23 (m, 1H), 7.20 (d, *J* = 8.4 Hz, 2H), 7.13 (d, *J* = 8.0 Hz, 2H), 6.40 (d, *J* = 8.4 Hz, 2H), 4.46 (qd, *J* = 7.2, 2.8 Hz, 1H), 3.79 (t, *J* = 2.4 Hz, 1H), 2.91 - 2.78 (m, 2H), 2.48 (s, 3H), 2.27 - 2.01 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 144.9, 140.0, 138.2, 135.6, 132.3, 132.0, 129.8, 128.9, 128.7, 128.4, 128.3, 127.3, 126.5, 125.8, 124.5 (d, *J* = 279.0 Hz), 34.1 (q, *J* = 31.0 Hz), 48.6, 29.1, 23.0, 21.8; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.24 (s, 3F); HRMS(ESI) calcd for $C_{26}H_{22}BrF_3NO_2S$ $(M+H)^+$: 548.0501, Found: 548.0505.



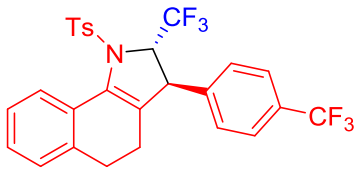
3e

3-(p-tolyl)-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3e): white solid: mp 190.5-193.3 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.85 (dd, *J* = 7.2, 1.6 Hz, 1H), 7.33 - 7.28 (m, 3H), 7.27 - 7.22 (m, 2H), 7.12 (d, *J* = 8.0 Hz, 2H), 6.87 (d, *J* = 8.0 Hz, 2H), 6.37 (d, *J* = 8.0 Hz, 2H), 4.48 (qd, *J* = 6.8, 2.8 Hz, 1H), 3.81 (t, *J* = 2.4 Hz, 1H), 2.89 - 2.75 (m, 2H), 2.47 (s, 3H), 2.31 (s, 3H), 2.23 - 2.01 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 144.6, 139.4, 136.8, 136.2, 135.7, 132.4, 130.9, 129.8, 129.5, 128.7, 128.2, 127.3, 127.2, 126.5, 125.7, 124.7 (d, *J* = 279.0 Hz), 70.2 (q, *J* = 31.0 Hz), 49.1, 29.2, 22.9, 21.8, 21.2; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.16 (s, 3F); HRMS(ESI) calcd for $C_{27}H_{25}F_3NO_2S$ $(M+H)^+$: 484.1553, Found: 484.1558.



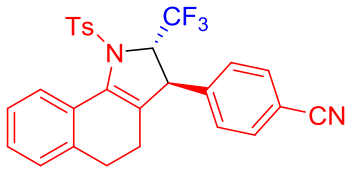
3f

3-(4-methoxyphenyl)-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3f): white solid: mp 184.1-186.6 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.85 (d, *J* = 7.6 Hz, 1H), 7.36 - 7.26 (m, 4H), 7.26 - 7.22 (m, 1H), 7.15 (d, *J* = 8.0 Hz, 2H), 6.60 (d, *J* = 8.8 Hz, 2H), 6.38 (d, *J* = 8.8 Hz, 2H), 4.45 (qd, *J* = 7.6, 3.6 Hz, 1H), 3.83 - 3.79 (m, 4H), 2.88 - 2.76 (m, 2H), 2.47 (s, 3H), 2.22 - 2.00 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 158.7, 144.5, 139.3, 135.6, 132.4, 131.2, 131.0, 129.9, 128.8, 128.7, 128.5, 127.3, 126.4, 125.7, 124.7 (d, *J* = 278.0 Hz), 114.2, 70.1 (q, *J* = 31.0 Hz), 55.3, 48.7, 29.2, 22.9, 21.8 ; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.15 (s, 3F); HRMS(ESI) calcd for $C_{27}H_{25}F_3NO_3S$ $(M+H)^+$: 500.1502, Found: 500.1507.



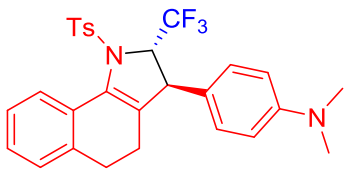
3g

1-tosyl-2-(trifluoromethyl)-3-(4-(trifluoromethyl)phenyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3g): white oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.87 (d, *J* = 6.8 Hz, 1H), 7.34 - 7.25 (m, 7H), 7.08 (d, *J* = 8.0 Hz, 2H), 6.66 (d, *J* = 8.4 Hz, 2H), 4.48 (qd, *J* = 6.8, 2.4 Hz, 1H), 3.90 (s, 1H), 2.96 - 2.82 (m, 2H), 2.45 (s, 3H), 2.30 - 2.04 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 145.0, 143.1, 140.4, 135.6, 132.2, 129.9, 129.4, 129.3 (d, *J* = 35.2 Hz), 128.7, 128.5, 128.3, 127.6, 127.4, 126.6, 125.9, 125.8 (q, *J* = 3.6 Hz), 124.0 (d, *J* = 271.0 Hz), 123.1, 69.9 (q, *J* = 31.0 Hz), 48.8, 29.1, 23.0, 21.6; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.26 (s, 3F), -62.52 (s, 3F); HRMS(ESI) calcd for $C_{27}H_{22}F_6NO_2S$ $(M+H)^+$: 538.1270, Found: 538.1275.



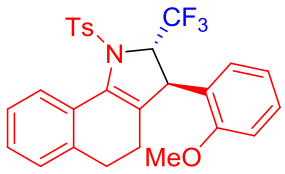
3h

1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indol-3-yl)benzonitrile (3h): white solid: mp 209.0-210.6 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.88 (d, *J* = 7.2 Hz, 1H), 7.34 - 7.23 (m, 6H), 7.14 (d, *J* = 7.6 Hz, 2H), 6.98 (t, *J* = 7.6 Hz, 1H), 6.71 (s, 1H), 6.48 (d, *J* = 7.6 Hz, 1H), 4.55 (qd, *J* = 7.2, 3.2 Hz, 1H), 3.82 (s, 1H), 2.88 - 2.80 (m, 2H), 2.46 (s, 3H), 2.24 - 2.02 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 145.0, 141.4, 140.2, 135.7, 132.2, 130.5 (d, *J* = 4.1 Hz), 130.4, 129.9, 129.4, 128.6, 128.5, 128.4, 127.4, 126.5, 126.1, 125.8, 124.6 (d, *J* = 279.0 Hz), 123.1, 69.9 (q, *J* = 31.0 Hz), 48.8, 29.1, 22.9, 22.1; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.17 (s, 3F); HRMS(ESI) calcd for $C_{27}H_{22}F_3N_2O_2S$ $(M+H)^+$: 494.1276, Found: 494.1277.



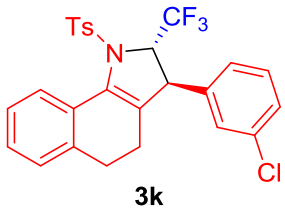
3i

N,N-dimethyl-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indol-3-yl)aniline (3i): white oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.86 (d, *J* = 7.6 Hz, 1H), 7.34 (d, *J* = 8.0 Hz, 2H), 7.31 - 7.21 (m, 3H), 7.16 (d, *J* = 7.6 Hz, 2H), 6.41 (d, *J* = 8.0 Hz, 2H), 6.30 (d, *J* = 8.0 Hz, 2H), 4.45 (qd, *J* = 7.2, 2.8 Hz, 1H), 3.78 (t, *J* = 2.8 Hz, 1H), 2.93 (s, 6H), 2.87 - 2.74 (m, 2H), 2.48 (s, 3H), 2.21 - 2.01 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 144.3, 138.9, 135.7, 132.5, 131.6, 129.9, 128.8, 128.1, 127.9, 127.3, 126.4, 125.6, 124.8 (d, *J* = 279.0 Hz), 112.8, 70.3 (q, *J* = 30.0 Hz), 48.8, 40.7, 29.2, 22.9, 21.8; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.09 (s, 3F); HRMS(ESI) calcd for $C_{28}H_{28}F_3N_2O_2S$ $(M+H)^+$: 513.1818, Found: 513.1818.



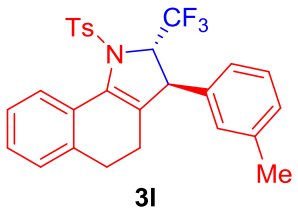
3j

3-(2-methoxyphenyl)-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3j): white solid: mp 174.4-175.6 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.84 (d, *J* = 7.2 Hz, 1H), 7.30 - 7.22 (m, 5H), 7.14 (td, *J* = 8.0, 2.0 Hz, 1H), 7.01 (d, *J* = 8.0 Hz, 2H), 6.80 (d, *J* = 8.4 Hz, 1H), 5.93 (d, *J* = 7.6 Hz, 1H), 4.61 (qd, *J* = 6.8, 2.0 Hz, 1H), 4.05 (t, *J* = 2.4 Hz, 1H), 3.83 (s, 3H), 2.95 - 2.77 (m, 2H), 2.40 (s, 3H), 2.27 - 2.05 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 156.8, 144.3, 139.4, 135.6, 133.2, 131.1, 129.7, 128.7, 128.3, 128.1, 127.9, 127.6, 127.3, 126.9, 126.5, 125.5, 124.8 (d, *J* = 276.0 Hz), 120.4, 110.0, 69.6 (q, *J* = 31.0 Hz), 55.2, 43.2, 29.1, 23.1, 21.7; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -77.62 (s, 3F); HRMS(ESI) calcd for $C_{27}H_{25}F_3NO_3S$ $(M+H)^+$: 500.1502, Found: 500.1504.



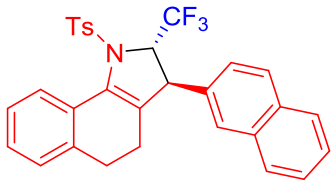
3k

3-(3-chlorophenyl)-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3k): white oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.89 (d, *J* = 7.2 Hz, 1H), 7.35 - 7.24 (m, 5H), 7.18 - 7.12 (m, 3H), 7.06 (t, *J* = 7.6 Hz, 1H), 6.52 (d, *J* = 7.6 Hz, 1H), 6.41 (t, *J* = 2.0 Hz, 1H), 4.53 (qd, *J* = 7.2, 3.2 Hz, 1H), 3.83 (t, *J* = 2.8 Hz, 1H), 2.89 - 2.81 (m, 2H), 2.45 (s, 3H), 2.25 - 2.02 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 145.1, 141.1, 140.2, 135.7, 134.8, 132.1, 130.2, 129.9, 129.4, 128.6, 128.5, 128.4, 127.6, 127.4, 127.3, 126.6, 125.8, 124.6 (d, *J* = 279.0 Hz), 69.9 (q, *J* = 30.0 Hz), 48.8, 29.1, 22.9, 22.0; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.19 (s, 3F); HRMS(ESI) calcd for $C_{26}H_{22}F_3ClNO_2S$ $(M+H)^+$: 504.1006, Found: 504.1014.



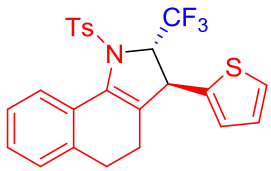
3l

3-(m-tolyl)-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3l): white solid: mp 185.3-186.0 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.87 (d, *J* = 7.6 Hz, 1H), 7.33 - 7.28 (m, 3H), 7.33 - 7.22 (m, 2H), 7.12 (d, *J* = 8.0 Hz, 2H), 6.99 (d, *J* = 7.6 Hz, 1H), 6.90 (t, *J* = 7.6 Hz, 1H), 6.54 (s, 1H), 6.09 (d, *J* = 7.2 Hz, 1H), 4.53 (qd, *J* = 7.2, 3.2 Hz, 1H), 3.82 (t, *J* = 2.8 Hz, 1H), 2.88 - 2.75 (m, 2H), 2.45 (s, 3H), 2.24 (s, 3H), 2.22 - 2.02 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 144.5, 139.4, 139.0, 138.5, 135.7, 132.5, 130.7, 129.8, 128.8, 128.7, 128.4, 128.1, 128.0, 127.3, 126.5, 125.6, 124.7 (d, *J* = 278.0 Hz), 124.1, 123.4, 70.1 (q, *J* = 31.0 Hz), 49.3, 29.2, 22.9, 21.8, 21.6; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.12 (s, 3F); HRMS(ESI) calcd for $C_{27}H_{25}F_3NO_2S$ $(M+H)^+$: 484.1553, Found: 484.1550.



3m

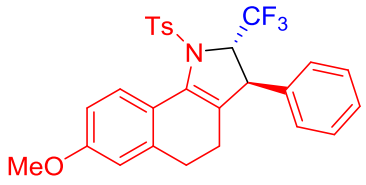
3-(naphthalen-2-yl)-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3m): white solid: mp 222.5-224.1 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.93 (d, *J* = 7.2 Hz, 1H), 7.80 (t, *J* = 5.2 Hz, 1H), 7.64 (d, *J* = 8.4 Hz, 1H), 7.50 - 7.46 (m, 3H), 7.36 - 7.24 (m, 5H), 6.92 (d, *J* = 8.0 Hz, 2H), 6.86 (s, 1H), 6.81 (dd, *J* = 8.4, 2.0 Hz, 1H), 4.66 (qd, *J* = 7.2, 2.8 Hz, 1H), 4.02 (t, *J* = 2.4 Hz, 1H), 3.00 - 2.82 (m, 2H), 2.26 - 2.16 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 144.7, 139.8, 136.6, 135.7, 133.1, 132.4, 130.4, 129.7, 128.9, 128.7, 128.2 (d, *J* = 3.0 Hz), 127.7, 127.4, 126.6, 126.4, 126.3, 126.1, 125.8, 125.4, 124.7 (d, *J* = 279.0 Hz), 70.1 (q, *J* = 31.0 Hz), 49.3, 29.2, 23.1, 21.7; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.13 (s, 3F); HRMS(ESI) calcd for $C_{30}H_{25}F_3NO_2S$ $(M+H)^+$: 520.1553, Found: 520.1552.



3n

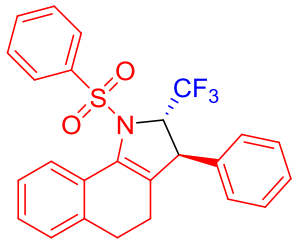
3-(thiophen-2-yl)-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3n): white oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.85 (dd, *J* = 7.2, 2.0 Hz, 1H), 7.31 - 7.24 (m, 5H), 7.11 - 7.09 (m, 3H), 6.68 (dd, *J* = 5.2, 3.6 Hz, 1H), 5.94 (dt, *J* = 3.6, 0.8 Hz, 1H), 4.62 (qd, *J* = 7.2, 2.4 Hz, 1H), 4.04 (d, *J* = 1.2 Hz, 1H), 2.88 - 2.78 (m, 2H), 2.42 (s, 3H), 2.27 - 2.21 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 144.6, 142.3, 139.4, 135.8, 132.1, 130.0, 129.8, 128.6, 128.4, 128.3, 127.3, 126.9, 126.5, 125.9,

125.1, 124.7 (d, J = 278.0 Hz), 124.6, 70.5 (q, J = 31.0 Hz), 44.3, 29.2, 22.9, 21.7; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.26 (s, 3F); HRMS(ESI) calcd for $C_{24}H_{21}F_3NO_2S_2$ $(M+H)^+$: 476.0960, Found: 476.0960.



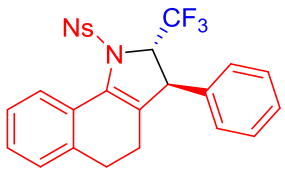
3o

7-methoxy-3-phenyl-1-tosyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (3o): white solid: mp 208.5-209.0 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.84 (d, J = 8.4 Hz, 1H), 7.30 - 7.27 (m, 2H), 7.16 (tt, J = 7.6, 1.2 Hz, 1H), 7.10 (d, J = 8.0 Hz, 2H), 7.07 - 7.03 (m, 2H), 6.85 - 6.80 (m, 2H), 6.44 (d, J = 6.8 Hz, 2H), 4.46 (qd, J = 7.2, 3.2 Hz, 1H), 3.86 (s, 3H), 3.83 (t, J = 2.8 Hz, 1H), 2.88 - 2.72 (m, 2H), 2.46 (s, 3H), 2.22 - 2.00 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 159.5, 144.5, 139.3, 137.8, 132.2, 129.9, 128.8, 128.7, 127.6, 127.3, 127.2, 127.0, 124.7 (d, J = 279.0 Hz), 121.6, 114.1, 110.5, 70.2 (q, J = 31.0 Hz), 55.4, 49.2, 29.6, 22.8, 21.8; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.19 (s, 3F); HRMS(ESI) calcd for $C_{27}H_{25}F_3NO_3S$ $(M+H)^+$: 500.1502, Found: 500.1500.



5a

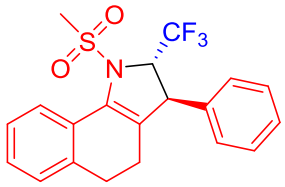
3-phenyl-1-(phenylsulfonyl)-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (5a): pale yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.86 (dd, J = 7.2, 1.6 Hz, 1H), 7.62 (tt, J = 7.6, 1.2 Hz, 1H), 7.44 - 7.42 (m, 2H), 7.37 - 7.23 (m, 5H), 7.16 (tt, J = 7.2, 1.2 Hz, 1H), 7.10 - 7.06 (m, 2H), 6.47 - 6.44 (m, 2H), 4.53 (qd, J = 7.2, 3.2 Hz, 1H), 3.86 (t, J = 2.8 Hz, 1H), 2.88 - 2.76 (m, 2H), 2.24 - 2.01 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 139.5, 139.0, 135.7, 135.5, 133.7, 130.7, 129.3, 129.1, 128.8, 128.6, 128.2, 127.4, 127.3, 126.5, 125.6, 124.7 (d, J = 280.0 Hz), 70.1 (q, J = 31.0 Hz), 49.4, 29.2, 22.9; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.17 (s, 3F); HRMS(ESI) calcd for $C_{25}H_{21}F_3NO_2S$ $(M+H)^+$: 456.1240, Found: 456.1242.



5b

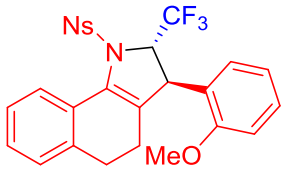
1-((4-nitrophenyl)sulfonyl)-3-phenyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (5b): pale yellow solid: mp 215.0-216.0 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.07 - 8.03 (m, 2H), 7.85 - 7.82 (m, 1H), 7.56 - 7.53 (m, 2H), 7.36 - 7.27

(m, 3H), 7.17 (tt, *J* = 7.2, 1.6 Hz, 1H), 7.06 - 7.02 (m, 2H), 6.54 (d, *J* = 7.2 Hz, 2H), 4.57 (qd, *J* = 6.8, 2.4 Hz, 1H), 3.90 (t, *J* = 2.4 Hz, 1H), 2.95 - 2.87 (m, 2H), 2.32 - 2.15 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 150.8, 140.5, 139.3, 138.8, 135.6, 131.4, 129.7, 129.1, 128.7, 127.0, 127.6, 127.5, 126.7, 125.6, 124.3 (d, *J* = 279.0 Hz), 124.2, 70.8 (q, *J* = 31.0 Hz), 48.6, 29.1, 23.3; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.35 (s, 3F); HRMS(ESI) calcd for $C_{25}H_{20}F_3N_2O_4S$ $(M+H)^+$: 501.1090, Found: 501.1098.



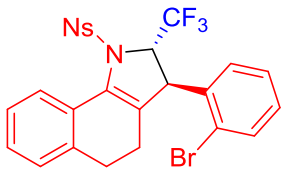
5c

1-(methylsulfonyl)-3-phenyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (5c): pale yellow solid: mp 221.3-224.1 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.56 (d, *J* = 7.2 Hz, 1H), 7.45 - 7.41 (m, 2H), 7.37 - 7.33 (m, 3H), 7.29 - 7.24 (m, 3H), 4.81 (q, *J* = 7.6 Hz, 1H), 4.00 (s, 1H), 3.12 - 3.03 (m, 1H), 3.01 (s, 3H), 2.89 - 2.84 (m, 1H), 2.41 - 2.25 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 139.1, 139.0, 135.7, 130.1, 129.5, 128.7, 127.8, 127.7, 126.5, 124.9 (d, *J* = 279.0 Hz), 124.3, 70.0 (q, *J* = 31.0 Hz), 49.9, 40.2, 29.0, 22.7; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.48 (s, 3F); HRMS(ESI) calcd for $C_{20}H_{19}F_3NO_2S$ $(M+H)^+$: 394.1083, Found: 394.1085.



5d

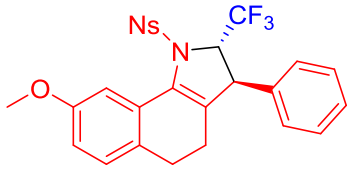
3-(2-methoxyphenyl)-1-((4-nitrophenyl)sulfonyl)-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (5d): pale yellow solid: mp 216.8-217.7 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.96 (d, *J* = 8.8 Hz, 2H), 7.85 (d, *J* = 6.8 Hz, 1H), 7.50 (d, *J* = 8.8 Hz, 2H), 7.35 - 7.26 (m, 3H), 7.14 (t, *J* = 8.8 Hz, 1H), 6.82 (d, *J* = 8.0 Hz, 1H), 6.28 (t, *J* = 7.2 Hz, 1H), 5.96 (d, *J* = 7.2 Hz, 1H), 4.68 (qd, *J* = 6.8, 1.6 Hz, 1H), 3.96 (s, 1H), 3.86 (s, 3H), 2.84 - 3.00 (m, 2H), 2.34 - 2.16 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 156.8, 150.7, 141.4, 139.0, 135.6, 132.0, 129.2, 128.7, 128.5, 128.0, 127.6, 126.8, 126.7, 126.5, 125.4, 124.5 (d, *J* = 281.0 Hz), 124.0, 120.1, 110.4, 69.8 (q, *J* = 31.0 Hz), 55.3, 43.6, 29.0, 23.4; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.33 (s, 3F); HRMS(ESI) calcd for $C_{26}H_{22}F_3N_2O_5S$ $(M+H)^+$: 531.1196, Found: 531.1196.



5e

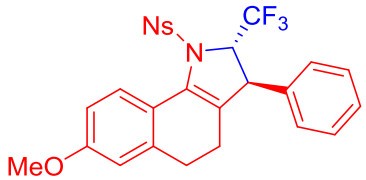
3-(2-bromophenyl)-1-((4-nitrophenyl)sulfonyl)-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (5e): pale yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.21

(d, *J* = 7.6 Hz, 2H), 7.80 (d, *J* = 7.6 Hz, 2H), 7.61 (d, *J* = 8.0 Hz, 1H), 7.42 (d, *J* = 7.6 Hz, 1H), 7.30 - 7.20 (m, 4H), 7.10 (t, *J* = 7.6 Hz, 1H), 6.88 (t, *J* = 7.6 Hz, 1H), 6.50 (d, *J* = 7.6 Hz, 1H), 4.87 (q, *J* = 6.4 Hz, 1H), 4.27 (s, 1H), 2.97 - 2.81 (m, 2H), 2.37 - 2.01 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 150.8, 143.5, 139.2, 137.3, 135.7, 134.0, 131.7, 129.6, 129.5, 128.9, 128.6, 127.8 (d, J = 3.5 Hz), 126.6, 124.6, 124.4 (d, J = 280.4 Hz), 124.3, 124.2, 69.3 (q, J = 32.0 Hz), 48.6, 29.1, 22.7; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -76.04 (s, 3F); HRMS(ESI) calcd for $C_{25}H_{19}BrF_3N_2O_4S$ $(M+H)^+$: 579.0196, Found: 579.0192.



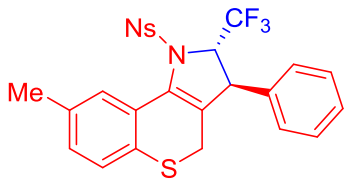
5f

8-methoxy-1-((4-nitrophenyl)sulfonyl)-3-phenyl-2-(trifluoromethyl)-2,3,4,5-tetra hydro-1*H*-benzo[g]indole (5f): pale yellow solid: mp 227.8-228.5 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.07 - 8.04 (m, 2H), 7.56 - 7.52 (m, 2H), 7.41 (d, *J* = 2.4 Hz, 1H), 7.19 - 7.15 (m, 2H), 7.06 - 7.02 (m, 2H), 6.86 (dd, *J* = 8.4, 2.8 Hz, 1H), 6.52 (d, *J* = 6.8 Hz, 2H), 4.57 (qd, *J* = 6.8, 2.4 Hz, 1H), 3.89 (t, *J* = 2.0 Hz, 1H), 3.87 (s, 3H), 2.85 - 2.74 (m, 2H), 2.29 - 2.13 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 158.3, 150.8, 140.6, 139.3, 138.8, 131.9, 129.7, 129.1, 128.7, 127.6, 126.7, 124.3 (d, *J* = 279.0 Hz), 124.2, 114.5, 111.2, 70.9 (q, *J* = 31.0 Hz), 55.6, 48.6, 28.2, 23.6; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.33 (s, 3F); HRMS(ESI) calcd for $C_{26}H_{22}F_3N_2O_5S$ $(M+H)^+$: 531.1196, Found: 531.1196.



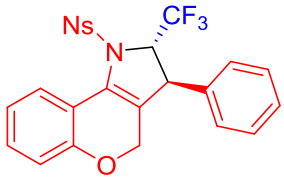
5g

7-methoxy-1-((4-nitrophenyl)sulfonyl)-3-phenyl-2-(trifluoromethyl)-2,3,4,5-tetra hydro-1*H*-benzo[g]indole (5g): pale yellow solid; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.04 (d, *J* = 8.8 Hz, 2H), 7.80 (d, *J* = 8.4 Hz, 1H), 7.52 (d, *J* = 8.4 Hz, 2H), 7.16 (t, *J* = 7.6 Hz, 1H), 7.04 - 7.01 (m, 2H), 6.85 (d, *J* = 7.6 Hz, 2H), 6.51 (d, *J* = 7.6 Hz, 2H), 4.54 (qd, *J* = 7.2, 2.4 Hz, 1H), 3.87 (s, 4H), 2.92 - 2.80 (m, 2H), 2.30 - 2.12 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 159.9, 150.7, 140.5, 139.0, 137.7, 129.7, 129.0, 128.2, 127.4, 127.1, 126.7, 124.3 (d, *J* = 279.0 Hz), 124.1,120.8, 114.4, 110.8, 70.9 (q, *J* = 31.0 Hz), 55.5, 48.4, 29.5, 23.1; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.33 (s, 3F); HRMS(ESI) calcd for $C_{26}H_{22}F_3N_2O_5S$ $(M+H)^+$: 531.1196, Found: 531.1199.



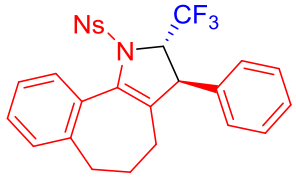
5h

8-methyl-1-((4-nitrophenyl)sulfonyl)-3-phenyl-2-(trifluoromethyl)-1,2,3,4-tetrahydrothiochromeno[4,3-b]pyrrole (5h): pale yellow solid: mp 213.5-218.0 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.05 (d, J = 8.4 Hz, 2H), 7.63 (s, 1H), 7.45 (d, J = 8.4 Hz, 2H), 7.37 (d, J = 8.0 Hz, 1H), 7.20 - 7.13 (m, 2H), 7.06 (t, J = 7.6 Hz, 2H), 6.71 (d, J = 7.2 Hz, 2H), 4.60 (q, J = 6.8 Hz, 1H), 3.98 (s, 1H), 3.63 (d, J = 16.0 Hz, 1H), 2.85 (d, J = 16.4 Hz, 1H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 150.9, 140.4, 137.7, 135.9, 130.2, 129.8, 129.3, 128.6, 128.5, 128.2, 127.8, 127.7, 126.8, 124.3, 124.2 (d, J = 279.0 Hz), 70.6 (q, J = 31.0 Hz), 49.0, 25.8, 21.3; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.38 (s, 3F); HRMS(ESI) calcd for $C_{25}H_{19}NaF_3N_2O_4S_2$ $(M+Na)^+$: 555.0631, Found: 555.0639.



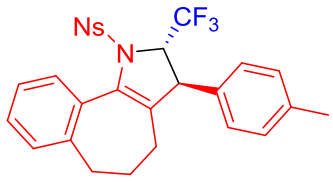
5i

1-((4-nitrophenyl)sulfonyl)-3-phenyl-2-(trifluoromethyl)-1,2,3,4-tetrahydrochromeno[4,3-b]pyrrole (5i): yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.06 (d, J = 7.6 Hz, 3H), 7.67 (s, 2H), 7.56 (t, J = 6.0 Hz, 1H), 7.43 - 7.32 (m, 2H), 3.80 (d, J = 16.8 Hz, 1H), 3.27 (d, J = 6.4 Hz, 1H), 2.94 (d, J = 16.8 Hz, 1H), 2.28 (t, J = 7.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 175.7, 149.7, 146.2, 136.8, 134.2, 128.7, 128.5, 128.0, 127.7, 126.9, 126.0, 124.5 (d, J = 273.0 Hz), 123.9, 34.0 (q, J = 41.0 Hz), 27.8, 27.7; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -58.31 (s, 3F); HRMS(ESI) calcd for C24H18F3N2O5S $(M+H)^+$: 503.0883, Found: 503.0880.



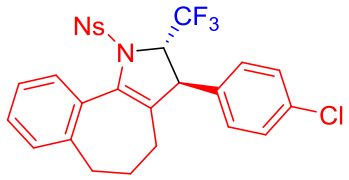
5j

1-((4-nitrophenyl)sulfonyl)-3-phenyl-2-(trifluoromethyl)-1,2,3,4,5,6-hexahydrobenzo[6,7]cyclohepta[1,2-b]pyrrole (5j): pale yellow solid: mp 220.5-223.0 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.12 (d, J = 8.4 Hz, 2H), 7.58 (d, J = 8.0 Hz, 2H), 7.31 - 7.23 (m, 6H), 7.09 (t, J = 7.6 Hz, 1H), 7.00 (d, J = 7.6 Hz, 2H), 4.83 (q, J = 7.6 Hz, 1H), 3.95 (s, 1H), 2.87 - 2.72 (m, 2H), 2.07 - 1.97 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 150.6, 143.6, 141.5, 139.1, 137.2, 131.2, 130.5, 129.8, 129.3, 129.2, 128.8, 128.6, 128.0, 127.3, 125.7, 124.7 (d, J = 279.0 Hz), 124.1, 68.2 (q, J = 31.0 Hz), 52.4, 32.9, 32.7, 24.0; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.44 (s, 3F); HRMS(ESI) calcd for $C_{26}H_{22}F_3N_2O_4S$ $(M+H)^+$: 515.1247, Found: 515.1246.



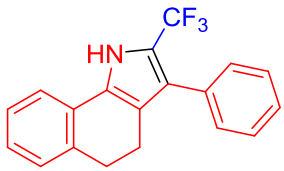
5k

1-((4-nitrophenyl)sulfonyl)-3-(p-tolyl)-2-(trifluoromethyl)-1,2,3,4,5,6-hexahydrobenzo[6,7]cyclohepta[1,2-b]pyrrole (5k): pale yellow solid: mp 131.2-132.5 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.11 (d, J = 8.8 Hz, 2H), 7.57 (d, J = 8.8 Hz, 2H), 7.29 - 7.24 (m, 3H), 7.10 (td, J = 7.2, 2.0 Hz, 1H), 7.03 (d, J = 8.0 Hz, 2H), 6.86 (d, J = 7.6 Hz, 2H), 4.78 (qd, J = 7.2, 2.4 Hz, 1H), 3.91 (s, 1H), 2.86 - 2.72 (m, 2H), 2.35 (s, 3H), 2.08 - 1.97 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 150.5, 143.5, 141.4, 137.9, 137.0, 136.2, 131.3, 130.7, 129.9, 129.7, 129.2, 128.7, 128.6, 127.1, 125.7, 124.7 (d, J = 279.0 Hz), 124.0, 68.5 (q, J = 31.0 Hz), 52.0, 32.9, 32.8, 24.0, 21.1; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.43 (s, 3F); HRMS(ESI) calcd for $C_{27}H_{24}F_3N_2O_4S$ $(M+H)^+$: 529.1403, Found: 529.1399.



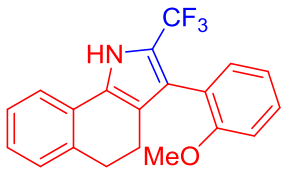
5l

3-(4-chlorophenyl)-1-((4-nitrophenyl)sulfonyl)-2-(trifluoromethyl)-1,2,3,4,5,6-hexahydrobenzo[6,7]cyclohepta[1,2-b]pyrrole (5l): pale yellow solid: mp 201.8-202.7 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.18 (d, J = 8.8 Hz, 2H), 7.63 (d, J = 8.8 Hz, 2H), 7.31 - 7.20 (m, 4H), 7.11 (d, J = 8.0 Hz, 2H), 6.99 - 6.93 (m, 2H), 4.90 (qd, J = 7.2, 2.0 Hz, 1H), 3.92 (s, 1H), 2.90 - 2.71 (m, 2H), 2.07 - 1.94 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 150.6, 144.2, 141.7, 137.5, 137.3, 134.2, 130.8, 130.3, 129.8, 129.6, 129.3, 128.9, 128.1, 125.5, 124.7 (d, J = 279.0 Hz), 124.0, 67.5 (q, J = 36.0 Hz), 52.0, 32.8, 32.5, 23.8; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.42 (s, 3F); HRMS(ESI) calcd for $C_{26}H_{21}ClF_3N_2O_4S$ $(M+H)^+$: 549.0857, Found: 549.0862.



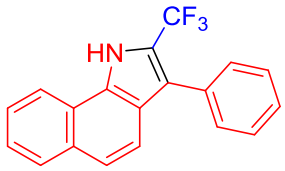
6a

3-phenyl-2-(trifluoromethyl)-2,3,4,5-tetrahydro-1*H*-benzo[g]indole (6a): pale yellow solid: mp 252.3-254.6 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 9.65 (s, 1H), 7.56 - 7.53 (m, 2H), 7.49 (t, J = 7.6 Hz, 2H), 7.41 - 7.35 (m, 2H), 7.29 - 7.25 (m, 2H), 7.24 - 7.20 (m, 1H), 2.97 - 2.93 (m, 2H), 2.87 - 2.83 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 136.4, 133.9, 133.5, 132.4, 128.9, 128.7, 128.4, 127.8 (d, J = 1.9 Hz), 127.3, 127.1 120.5, 118.9, 116.2, 97.9, 29.6, 20.7; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.27 (s, 3F); HRMS(ESI) calcd for $C_{19}H_{15}F_3N$ $(M+H)^+$: 314.1151, Found: 314.1149.



6b

3-(2-methoxyphenyl)-2-(trifluoromethyl)-4,5-dihydro-1*H*-benzo[g]indole (6b): pale yellow solid: mp 222.7-223.2 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 9.36 (s, 1H), 7.50 - 7.46 (m, 2H), 7.35 - 7.33 (m, 1H), 7.29 - 7.27 (m, 1H), 7.25 (s, 1H), 7.23 - 7.21 (m, 1H), 3.86 (s, 3H), 2.97 - 2.93 (m, 2H), 2.85 - 2.81 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ = 159.3, 136.4, 133.7, 129.6, 128.7, 127.8, 127.4, 127.0, 124.8, 120.4, 118.8, 116.3, 114.4, 97.7, 55.4, 29.6, 20.7; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.18 (s, 3F); HRMS(ESI) calcd for $C_{20}H_{17}F_3NO$ $(M+H)^+$:344.1257, Found: 344.1259.



7a

3-phenyl-2-(trifluoromethyl)-2,3-dihydro-1*H*-benzo[g]indole (7a): pale yellow solid: mp 188.9-190.5 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ = 9.79 (s, 1H), 8.18 (d, J = 8.4 Hz, 1H), 7.93 (d, J = 7.2 Hz, 1H), 7.63 - 7.58 (m, 4H), 7.56 -7.47 (m, 4H), 7.44 -7.39 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ =133.5, 132.4, 131.8, 130.7, 129.0, 128.0, 127.4, 126.2, 126.0, 124.1, 122.3, 121.6, 121.1, 120.6, 120.3; ^{19}F NMR (376 Hz, $CDCl_3$) δ = -78.37 (s, 3F); HRMS(ESI) calcd for $C_{19}H_{13}F_3N$ $(M+H)^+$: 312.0995, Found: 312.0990.

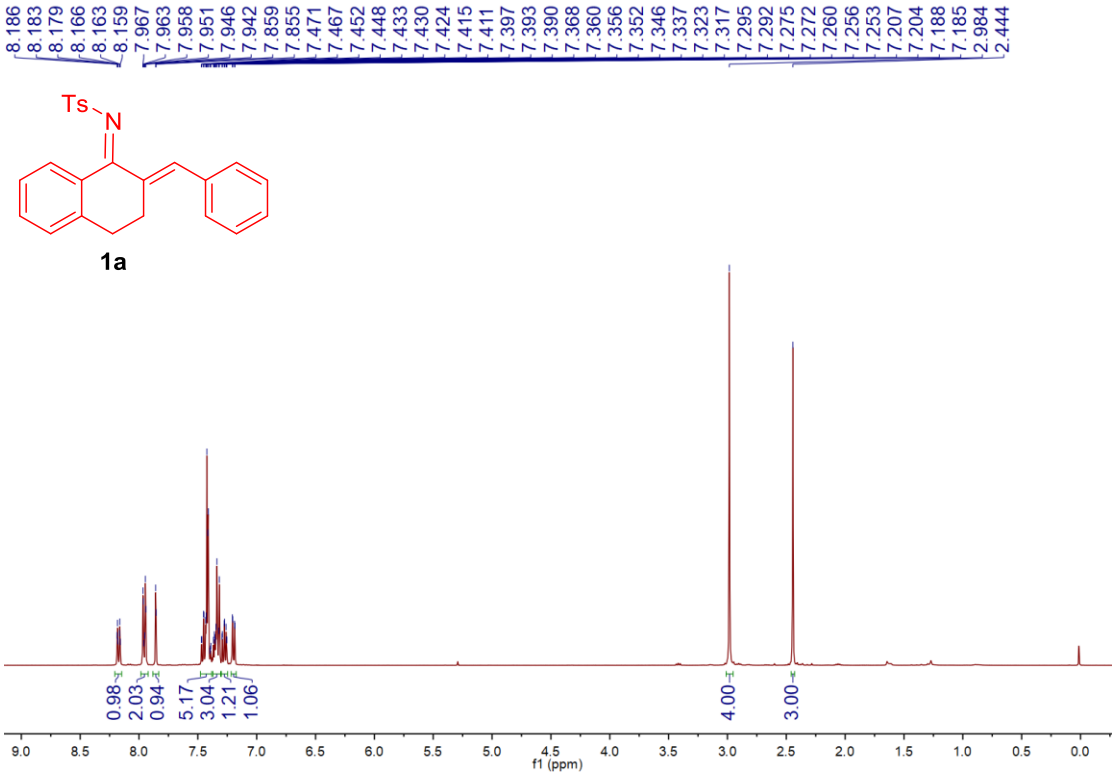
b) References

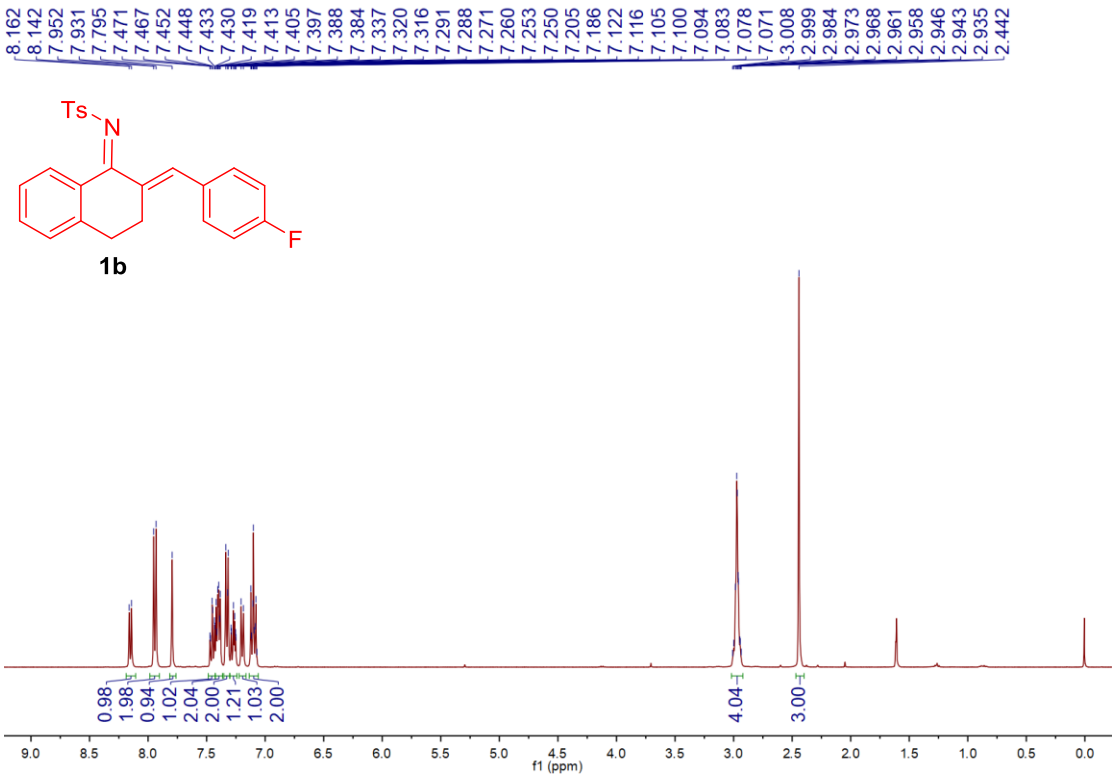
[1] J. Tian, R. Zhou, H. Y. Sun, H. B. Song, and Z. G. He, *J. Org. Chem.* **2011**, *76*, 7, 2374-2378.

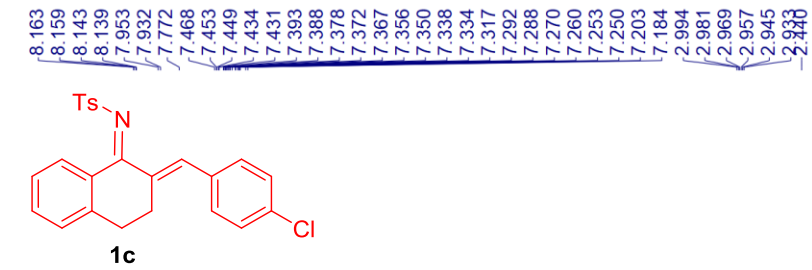
[2] S. P. Midya, E. Gopi, N. Satam, *Org. Biomol. Chem.* **2017**, *15*, 3616-3627.

[3] a) Y. Y. Duan, B. Zhou, J.-H. Lin, J.-C. Xiao, *Chem. Commun.* **2015**, *51*, 13127-13130. b) Q. X. Huang, Q. T. Zheng, Y. Y. Duan, J. H. Lin, J. C. Xiao, and X. Zhen, *J. Org. Chem.* **2017**, *82*, 8273-8281.

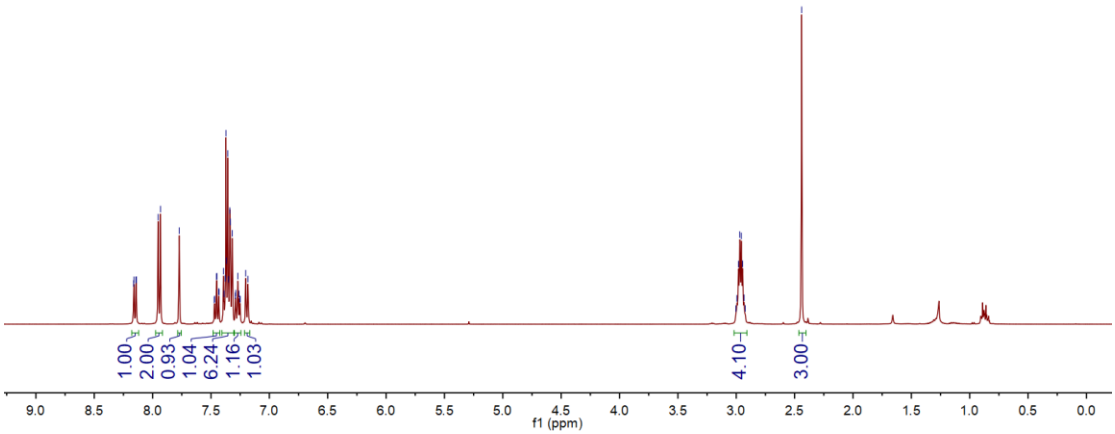
4. ^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra

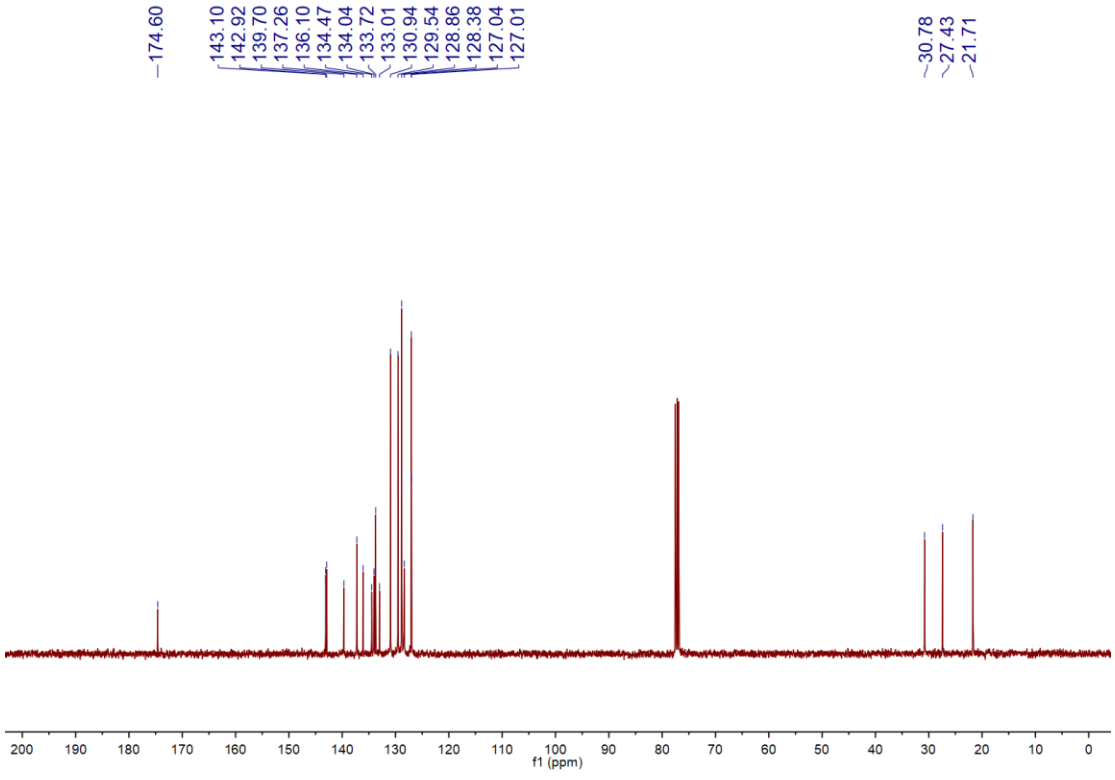





8.163
8.159
8.143
8.139
7.953
7.932
7.772
7.468
7.453
7.449
7.434
7.431
7.393
7.388
7.378
7.372
7.367
7.356
7.350
7.338
7.334
7.317
7.292
7.288
7.270
7.260
7.253
7.250
7.203
7.184
2.994
2.981
2.969
2.957
2.945
2.933
2.440
Ts
N
Cl

1c

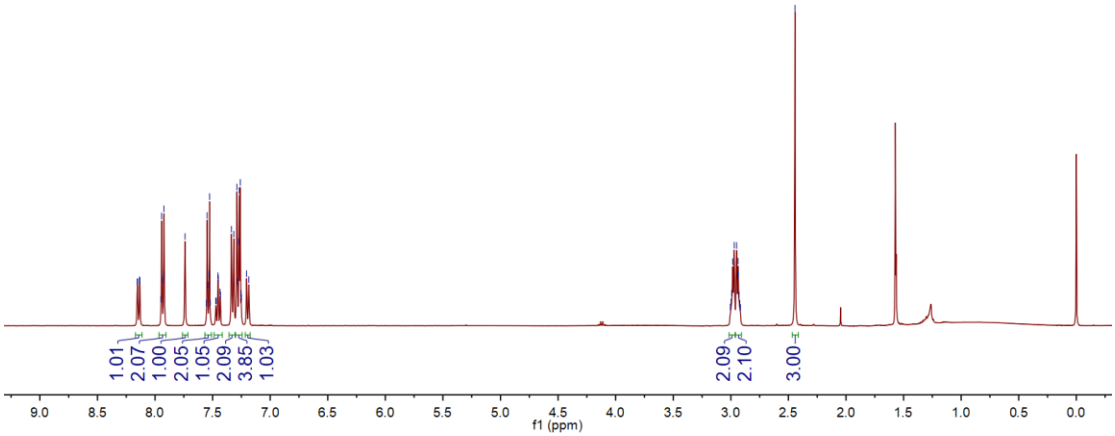

1.00
2.00
0.93
1.04
6.24
1.16
1.03
4.10
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

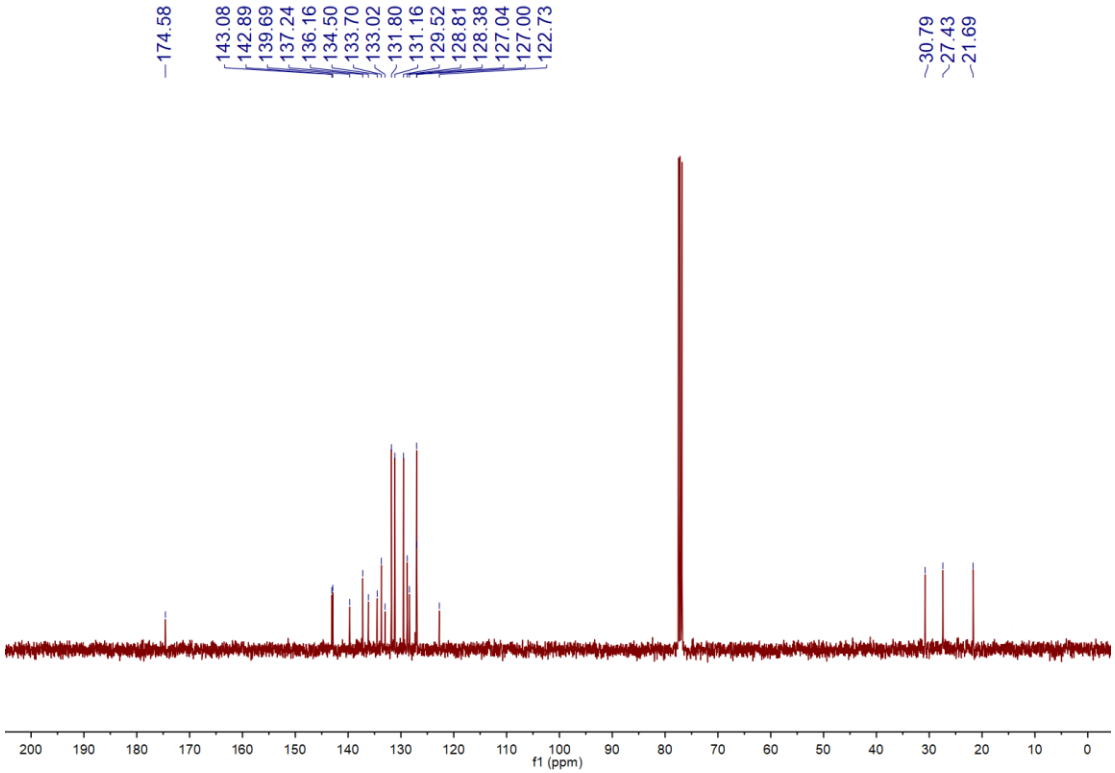

174.60
143.10
142.92
139.70
137.26
136.10
134.47
134.04
133.72
133.01
130.94
129.54
128.86
128.38
127.04
127.01
30.78
27.43
21.71
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

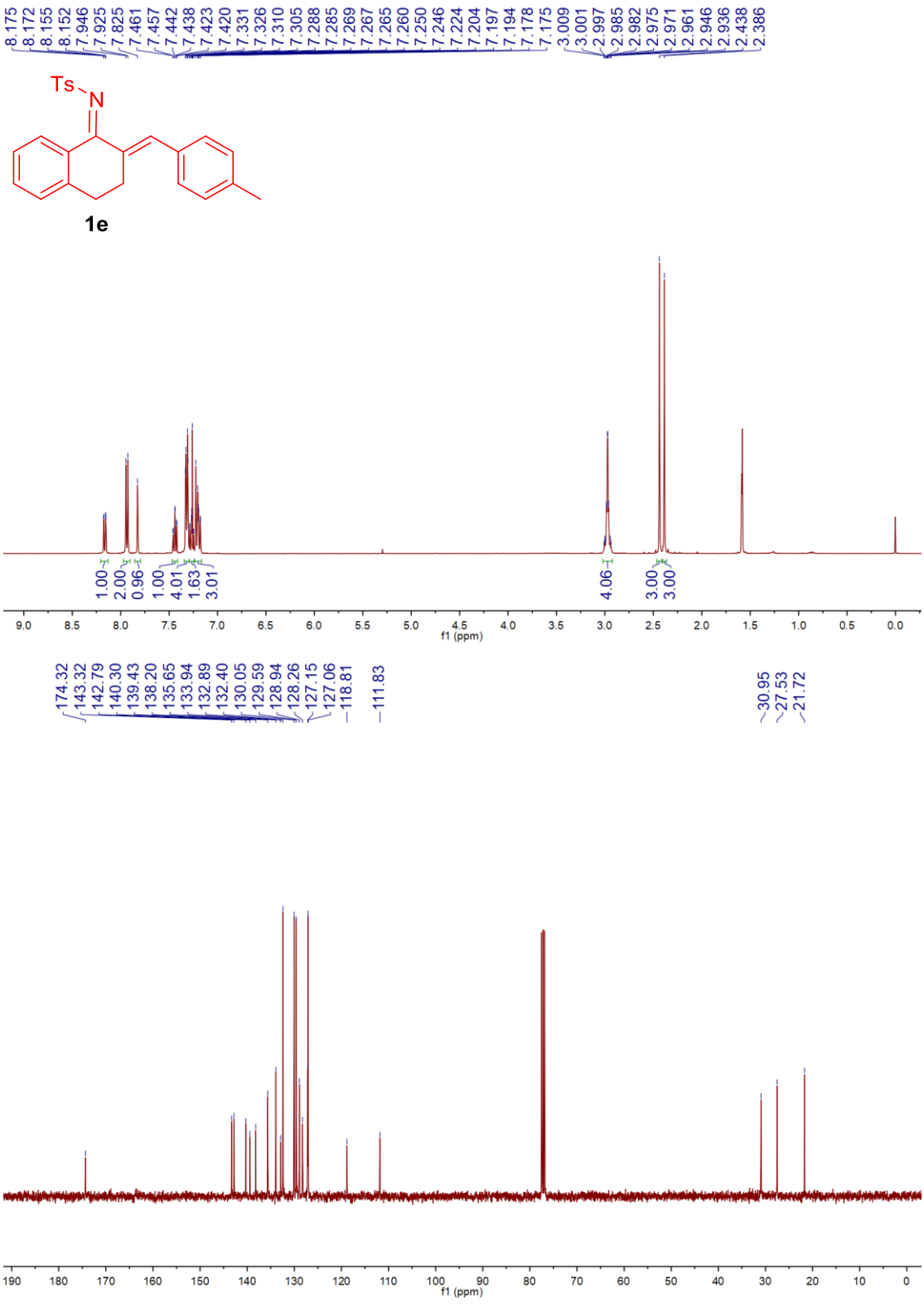

8.155
8.151
8.135
8.131
7.948
7.943
7.938
7.926
7.922
7.740
7.554
7.547
7.542
7.531
7.526
7.520
7.473
7.469
7.454
7.451
7.435
7.432
7.336
7.316
7.289
7.283
7.272
7.268
7.260
7.253
7.250
7.204
7.185
3.004
2.998
2.992
2.983
2.970
2.950
2.940
2.938
2.935
2.928
2.922
2.917
2.443

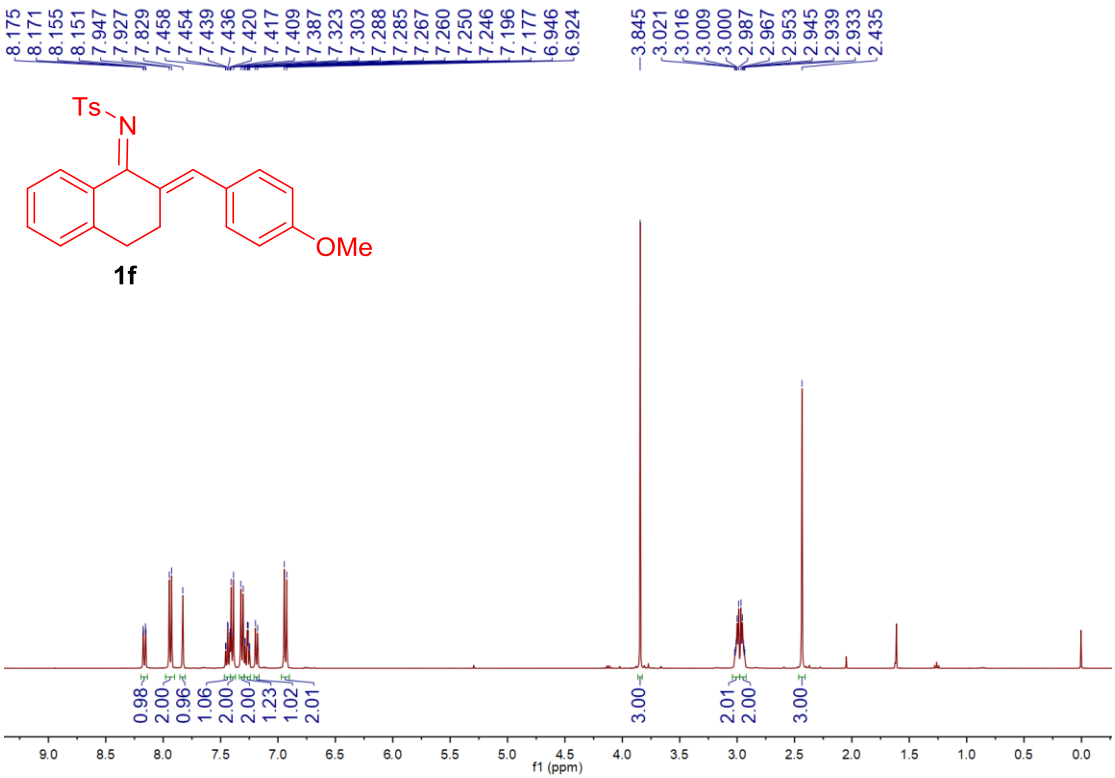
Ts
N
Br

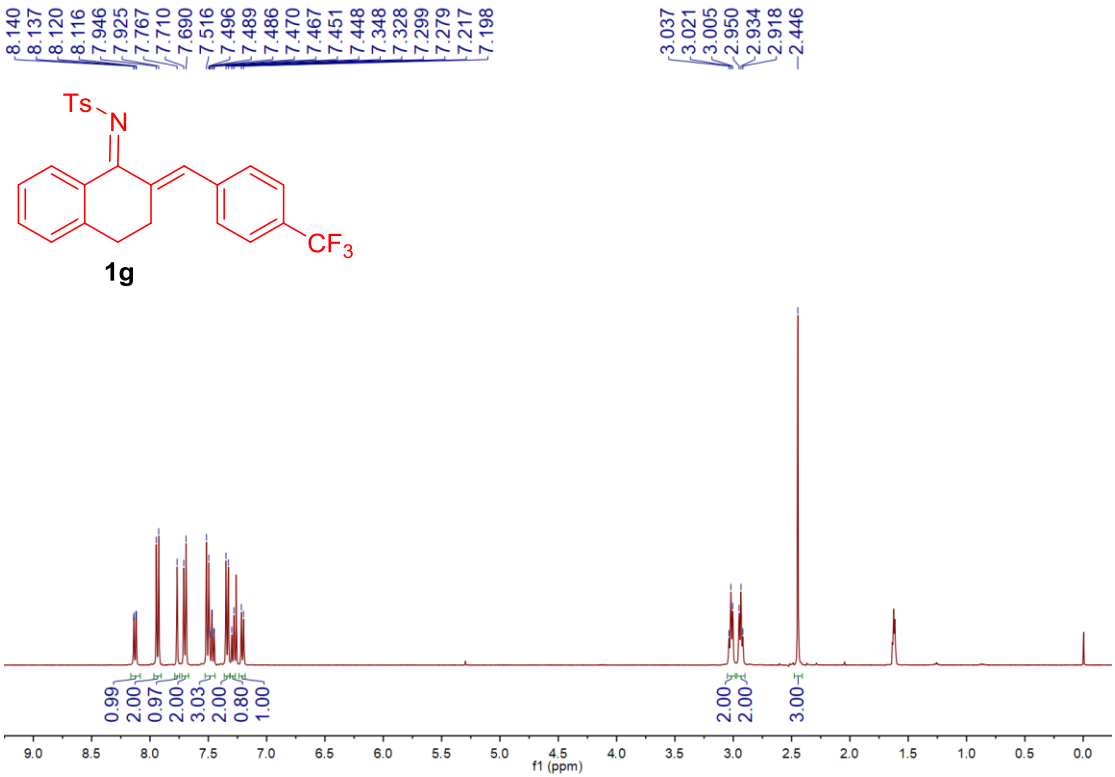
1d

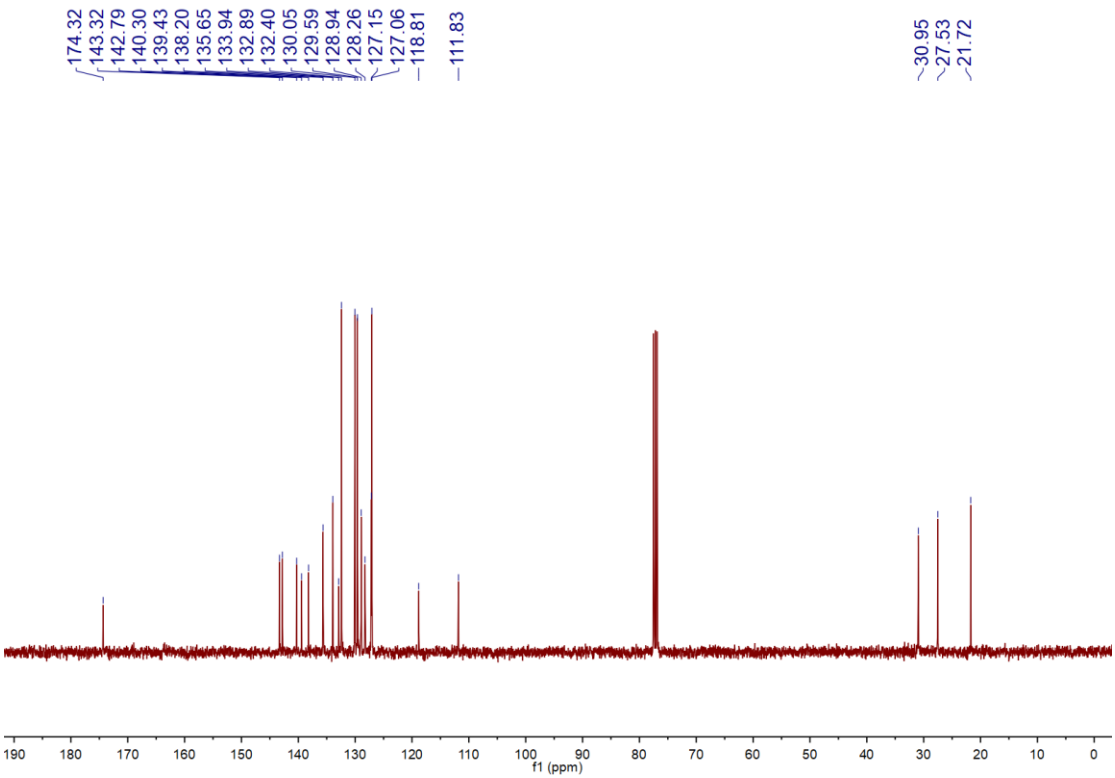

1.01
2.07
1.00
2.05
1.05
2.09
3.85
1.03
2.09
2.10
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

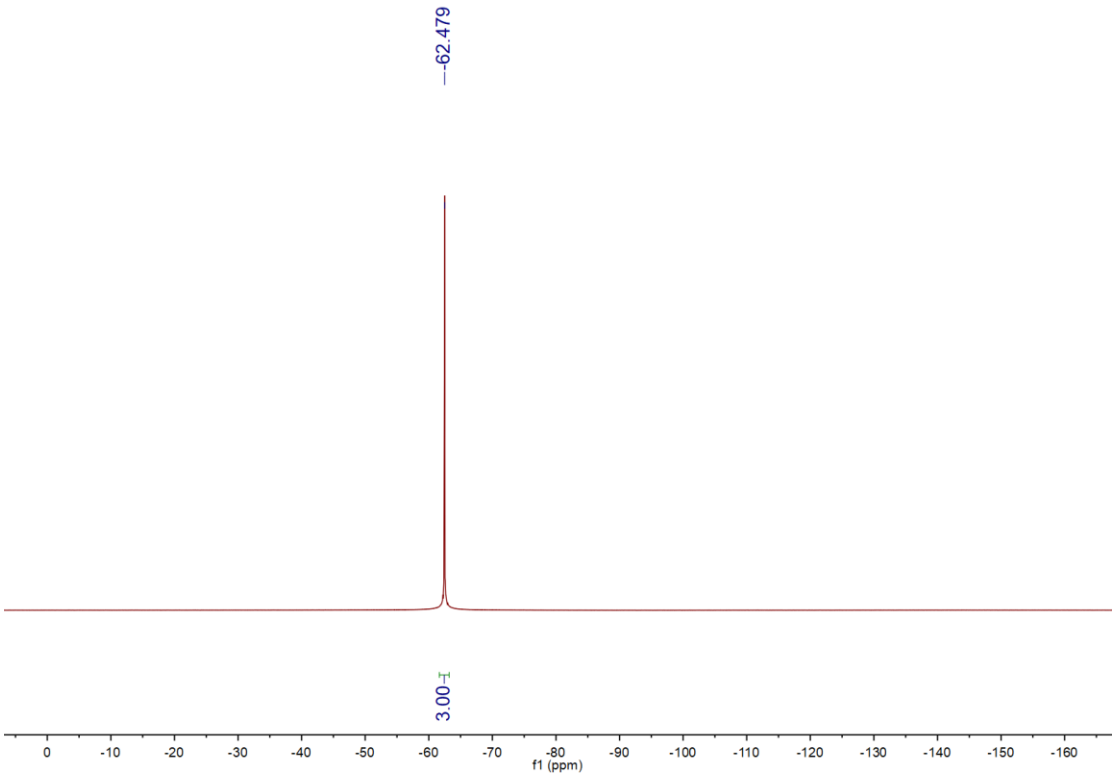

174.58
143.08
142.89
139.69
137.24
136.16
134.50
133.70
133.02
131.80
131.16
129.52
128.81
128.38
127.04
127.00
122.73
30.79
27.43
21.69
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

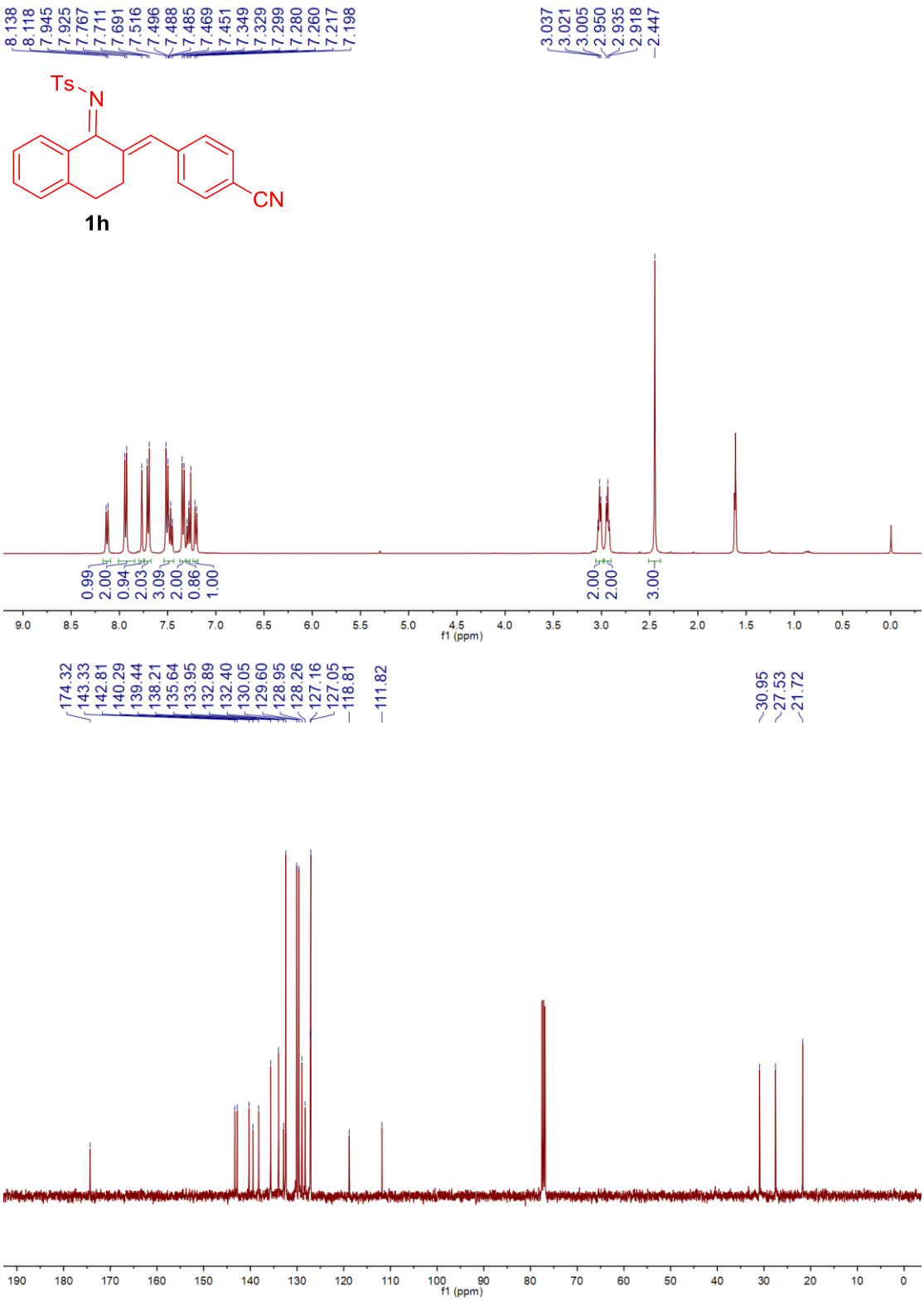

8.175
8.172
8.155
8.152
7.946
7.925
7.825
7.461
7.457
7.442
7.438
7.423
7.420
7.331
7.326
7.310
7.305
7.288
7.285
7.269
7.267
7.265
7.260
7.250
7.246
7.224
7.204
7.197
7.194
7.178
7.175
3.009
3.001
2.997
2.985
2.982
2.975
2.971
2.961
2.946
2.936
2.438
2.386
Ts
N
1e
1.00
2.00
0.96
1.00
4.01
1.63
3.01
4.06
3.00
3.00
f1 (ppm)
174.32
143.32
142.79
140.30
139.43
138.20
135.65
133.94
132.89
132.40
130.05
129.59
128.94
128.26
127.15
127.06
118.81
111.83
30.95
27.53
21.72
f1 (ppm)

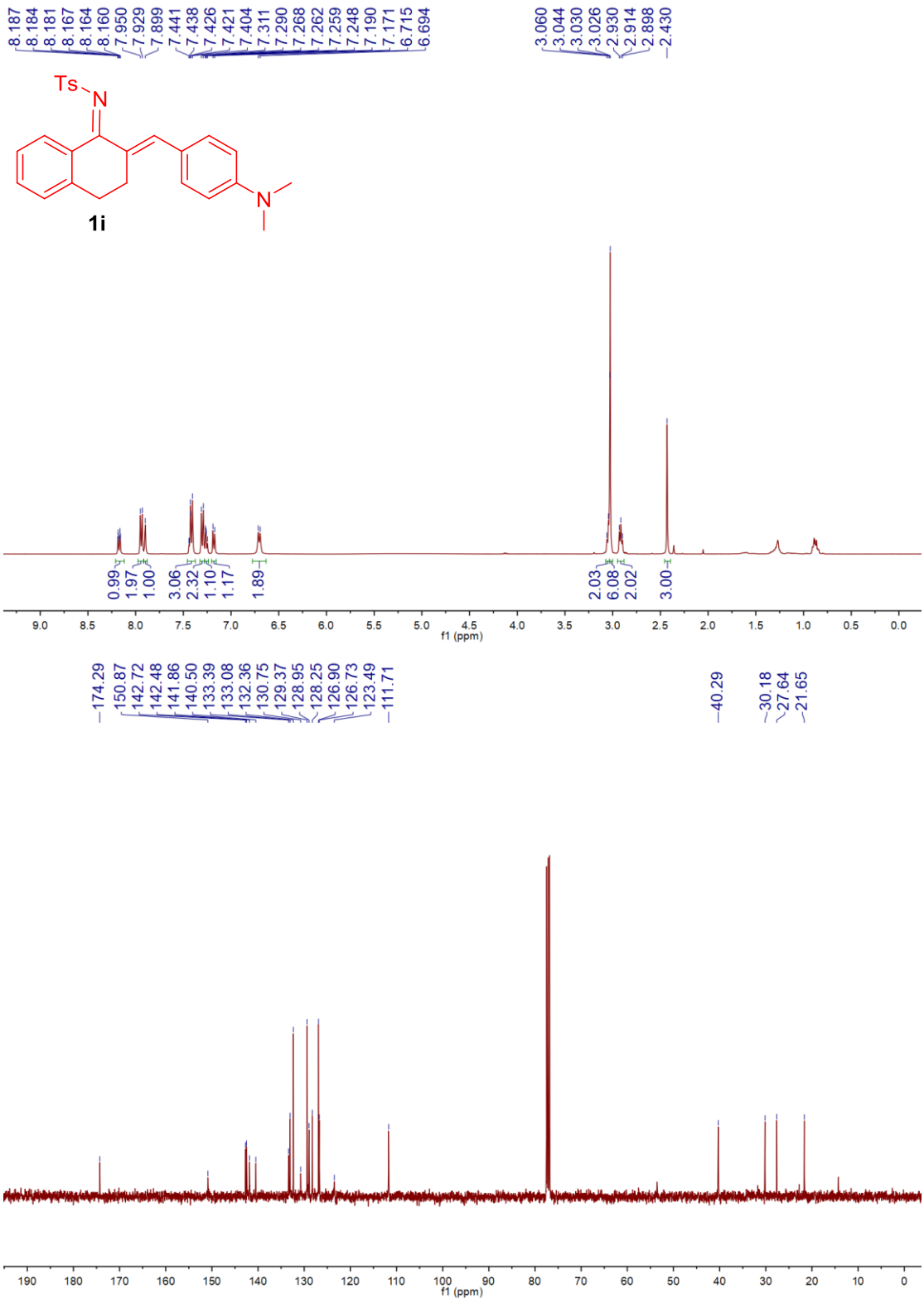

8.175
8.171
8.155
8.151
7.947
7.927
7.829
7.458
7.454
7.439
7.436
7.420
7.417
7.409
7.387
7.323
7.303
7.288
7.285
7.267
7.260
7.250
7.246
7.196
7.177
6.946
6.924
3.845
3.021
3.016
3.009
3.000
2.987
2.967
2.953
2.945
2.939
2.933
2.435
Ts
N
OMe
1f
0.98
2.00
0.96
1.06
2.00
2.00
1.23
1.02
2.01
3.00
2.01
2.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

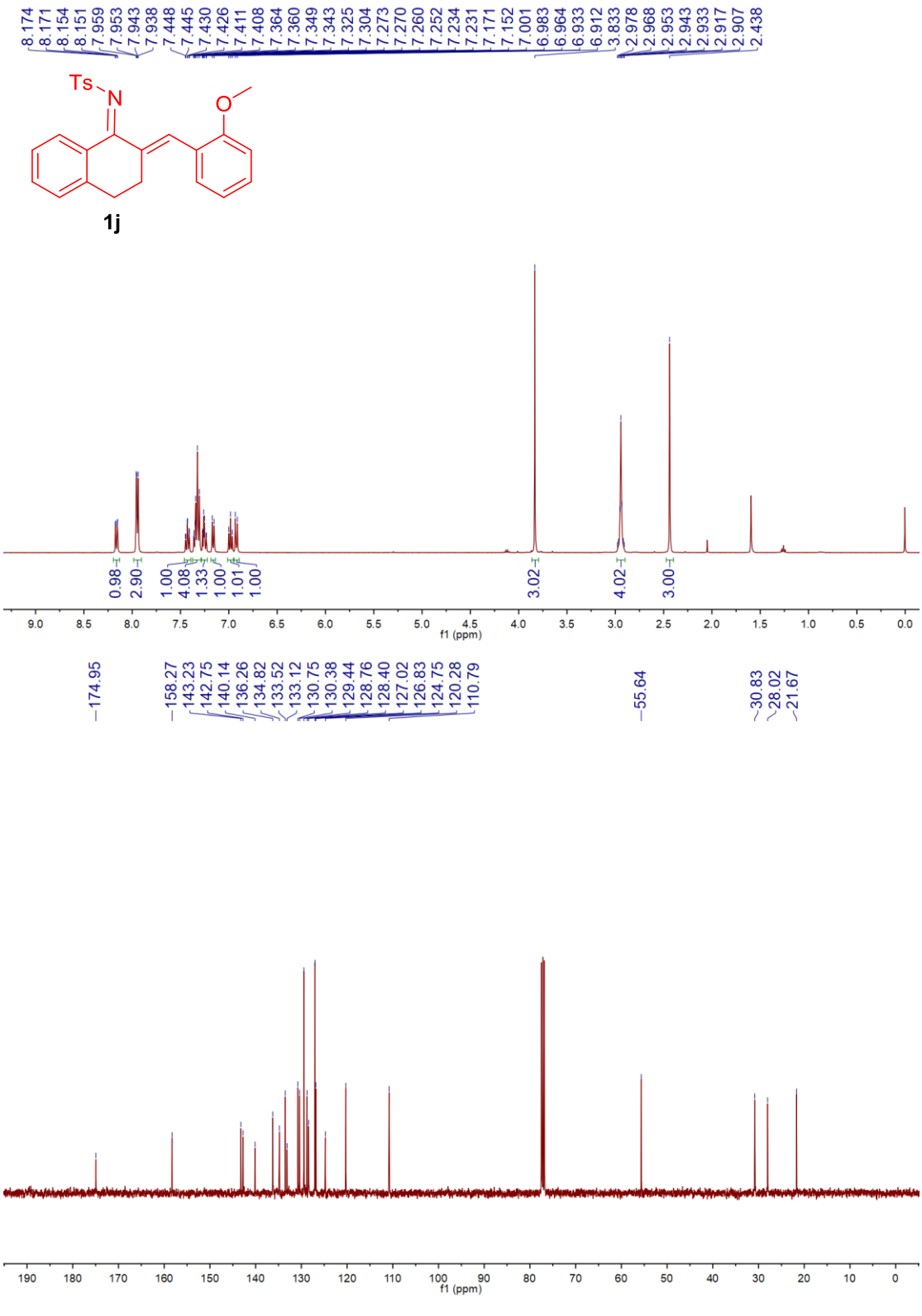

8.140
8.137
8.120
8.116
7.946
7.925
7.767
7.710
7.690
7.516
7.496
7.489
7.486
7.470
7.467
7.451
7.448
7.348
7.328
7.299
7.279
7.217
7.198
3.037
3.021
3.005
2.950
2.934
2.918
2.446
Ts
N
CF3
1g
0.99
2.00
0.97
2.00
3.03
2.00
0.80
1.00
2.00
2.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


174.32
143.32
142.79
140.30
139.43
138.20
135.65
133.94
132.89
132.40
130.05
129.59
128.94
128.26
127.15
127.06
118.81
111.83
30.95
27.53
21.72
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


62.479
3.00
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160
f1 (ppm)

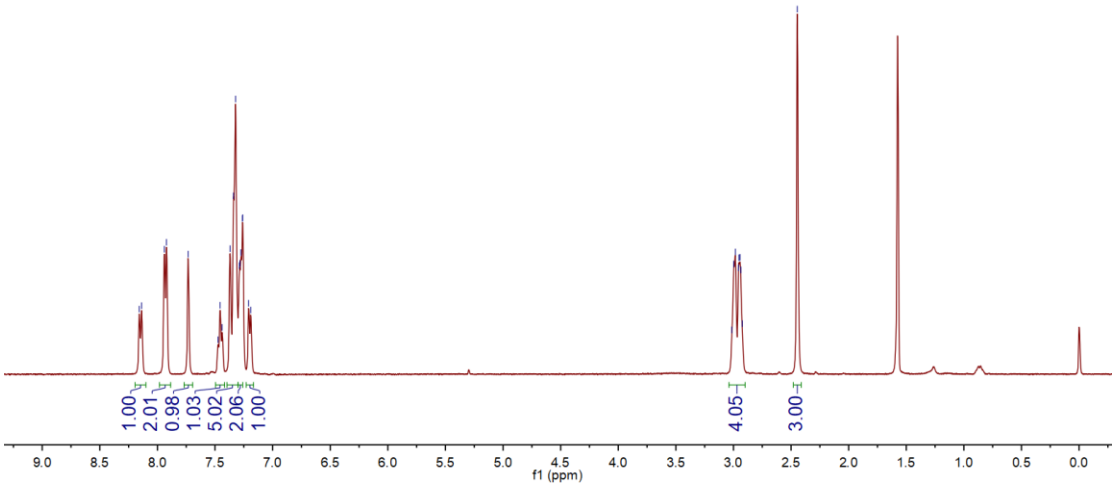

8.138
8.118
7.945
7.925
7.767
7.711
7.691
7.516
7.496
7.488
7.485
7.469
7.451
7.349
7.329
7.299
7.280
7.260
7.217
7.198
3.037
3.021
3.005
2.950
2.935
2.918
2.447
Ts
N
CN
1h
0.99
2.00
0.94
2.03
3.09
2.00
0.86
1.00
2.00
2.00
3.00
f1 (ppm)
174.32
143.33
142.81
140.29
139.44
138.21
135.64
133.95
132.89
132.40
130.05
129.60
128.95
128.26
127.16
127.05
118.81
111.82
30.95
27.53
21.72
f1 (ppm)

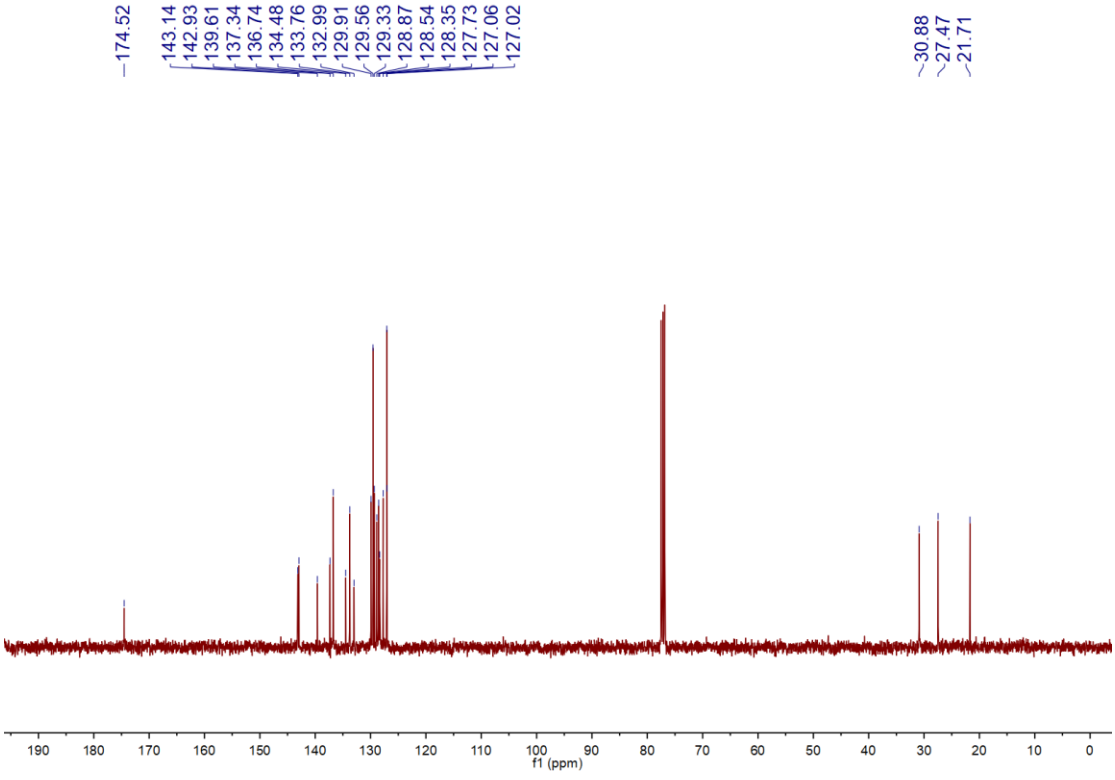

8.187
8.184
8.181
8.167
8.164
8.160
7.950
7.929
7.899
7.441
7.438
7.426
7.421
7.404
7.311
7.290
7.268
7.262
7.259
7.248
7.190
7.171
6.715
6.694
3.060
3.044
3.030
3.026
2.930
2.914
2.898
2.430
Ts
N
N
1i
0.99
1.97
1.00
3.06
2.32
1.10
1.17
1.89
2.03
6.08
2.02
3.00
f1 (ppm)
174.29
150.87
142.72
142.48
141.86
140.50
133.39
133.08
132.36
130.75
129.37
128.95
128.25
126.90
126.73
123.49
111.71
40.29
30.18
27.64
21.65
f1 (ppm)

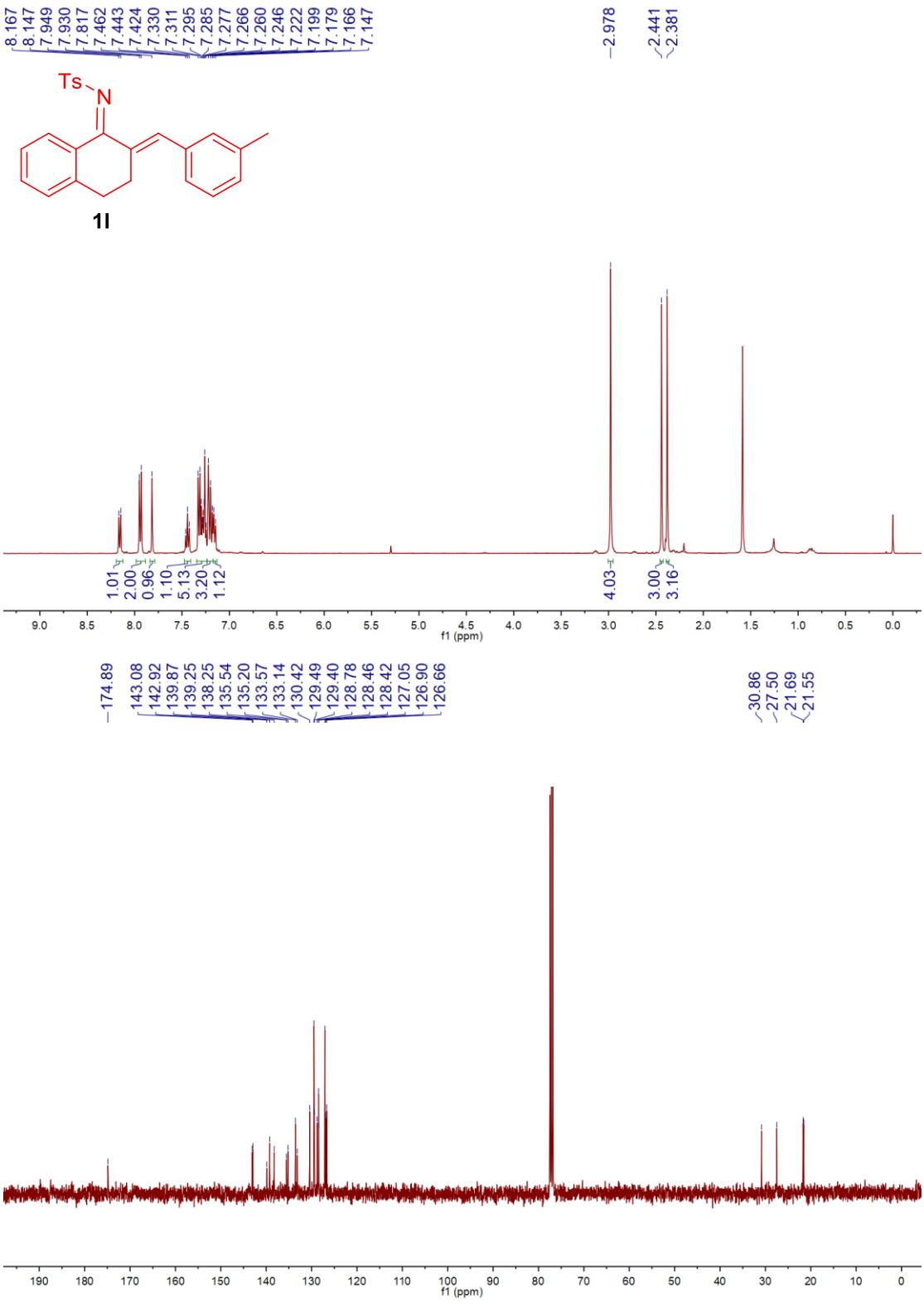

8.174
8.171
8.154
8.151
7.959
7.953
7.943
7.938
7.448
7.445
7.430
7.426
7.411
7.408
7.364
7.360
7.349
7.343
7.325
7.304
7.273
7.270
7.260
7.252
7.234
7.231
7.171
7.152
7.001
6.983
6.964
6.933
6.912
3.833
2.978
2.968
2.953
2.943
2.933
2.917
2.907
2.438
Ts
N
O
1j
0.98
2.90
1.00
4.08
1.33
1.00
1.01
1.00
3.02
4.02
3.00
f1 (ppm)
174.95
158.27
143.23
142.75
140.14
136.26
134.82
133.52
133.12
130.75
130.38
129.44
128.76
128.40
127.02
126.83
124.75
120.28
110.79
55.64
30.83
28.02
21.67
f1 (ppm)

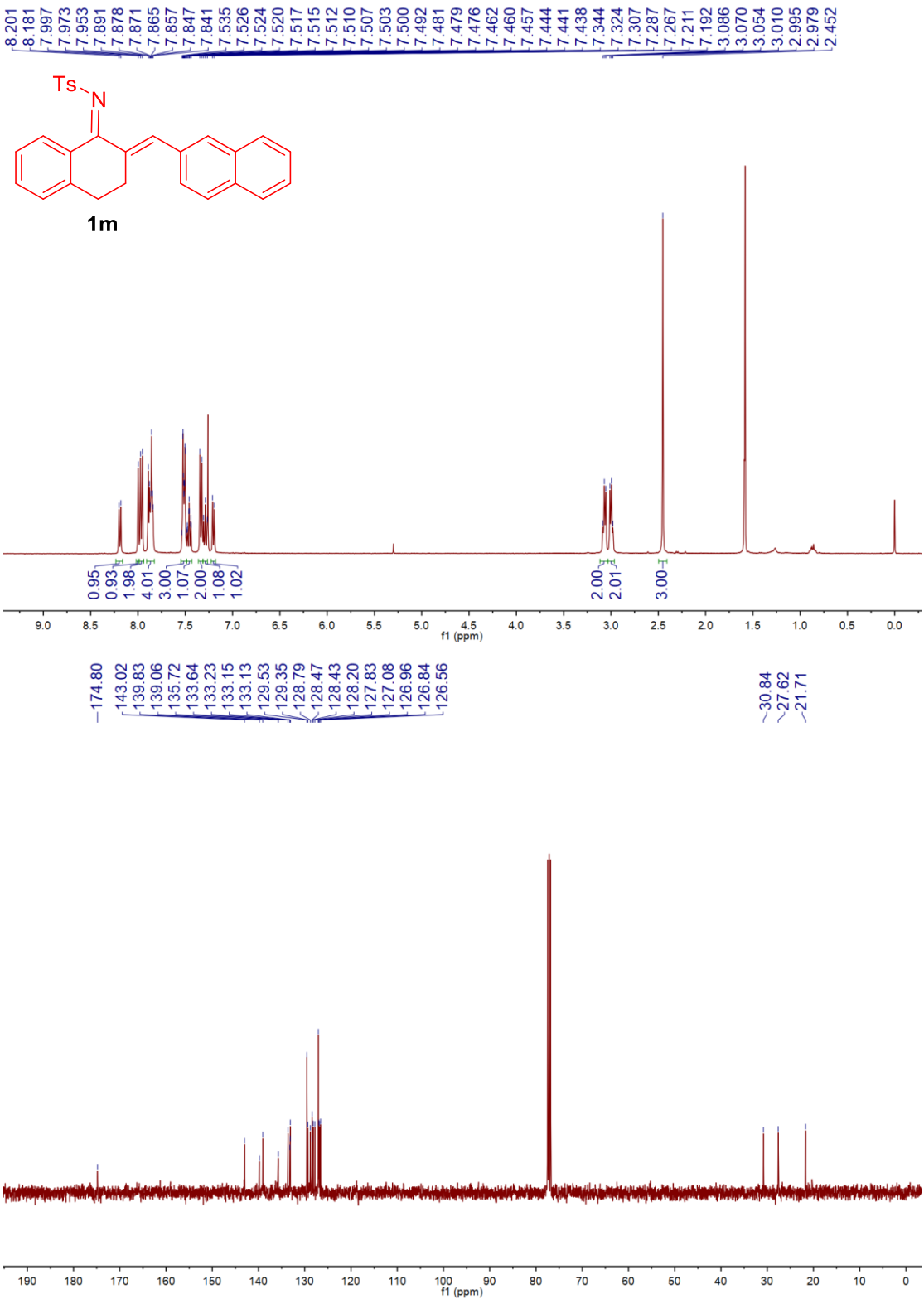

8.157
8.137
7.940
7.922
7.733
7.474
7.456
7.439
7.370
7.340
7.322
7.289
7.284
7.275
7.263
7.260
7.208
7.190
3.014
2.998
2.983
2.957
2.952
2.943
2.936
2.923
2.446
Ts
N
Cl

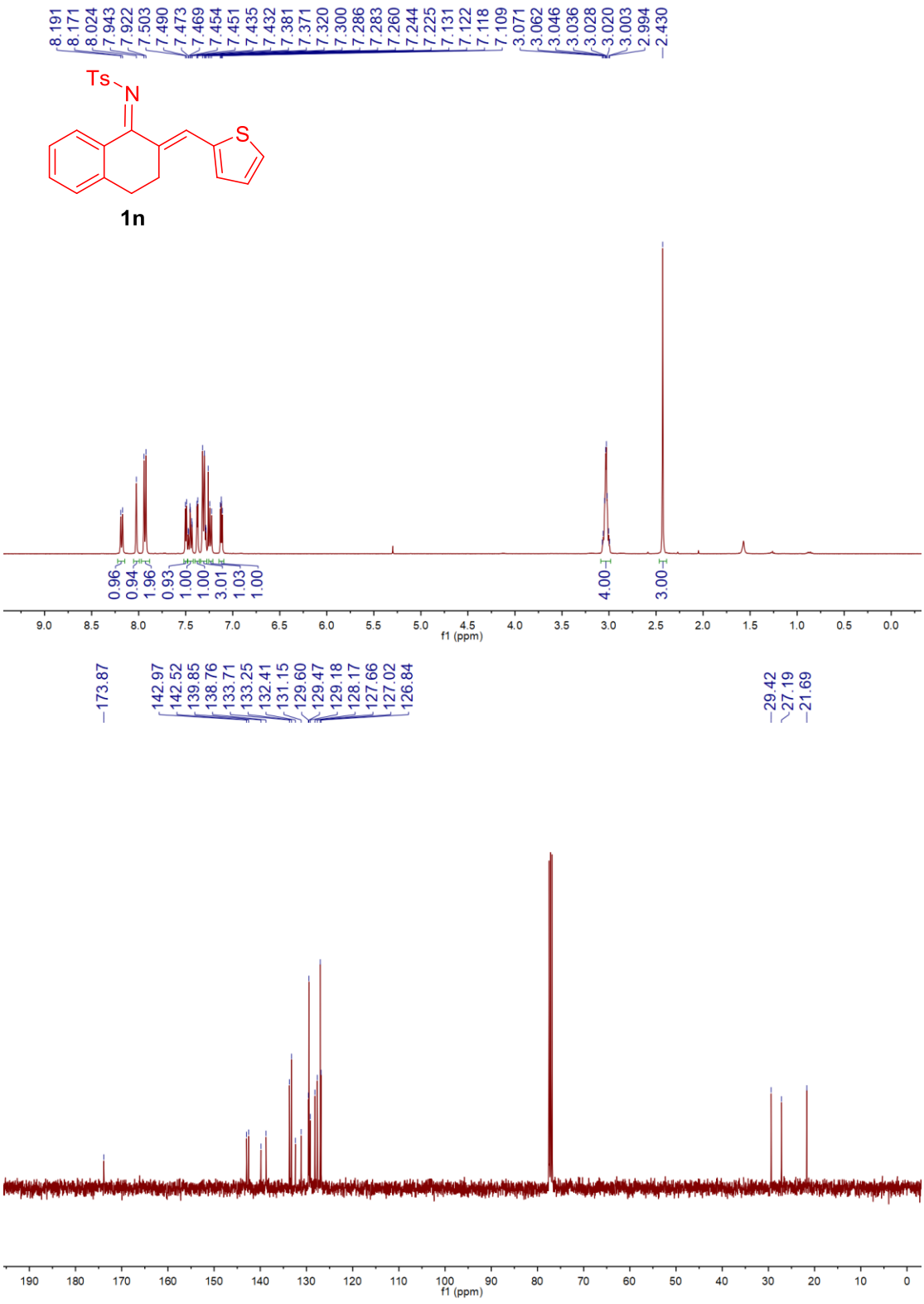
1k

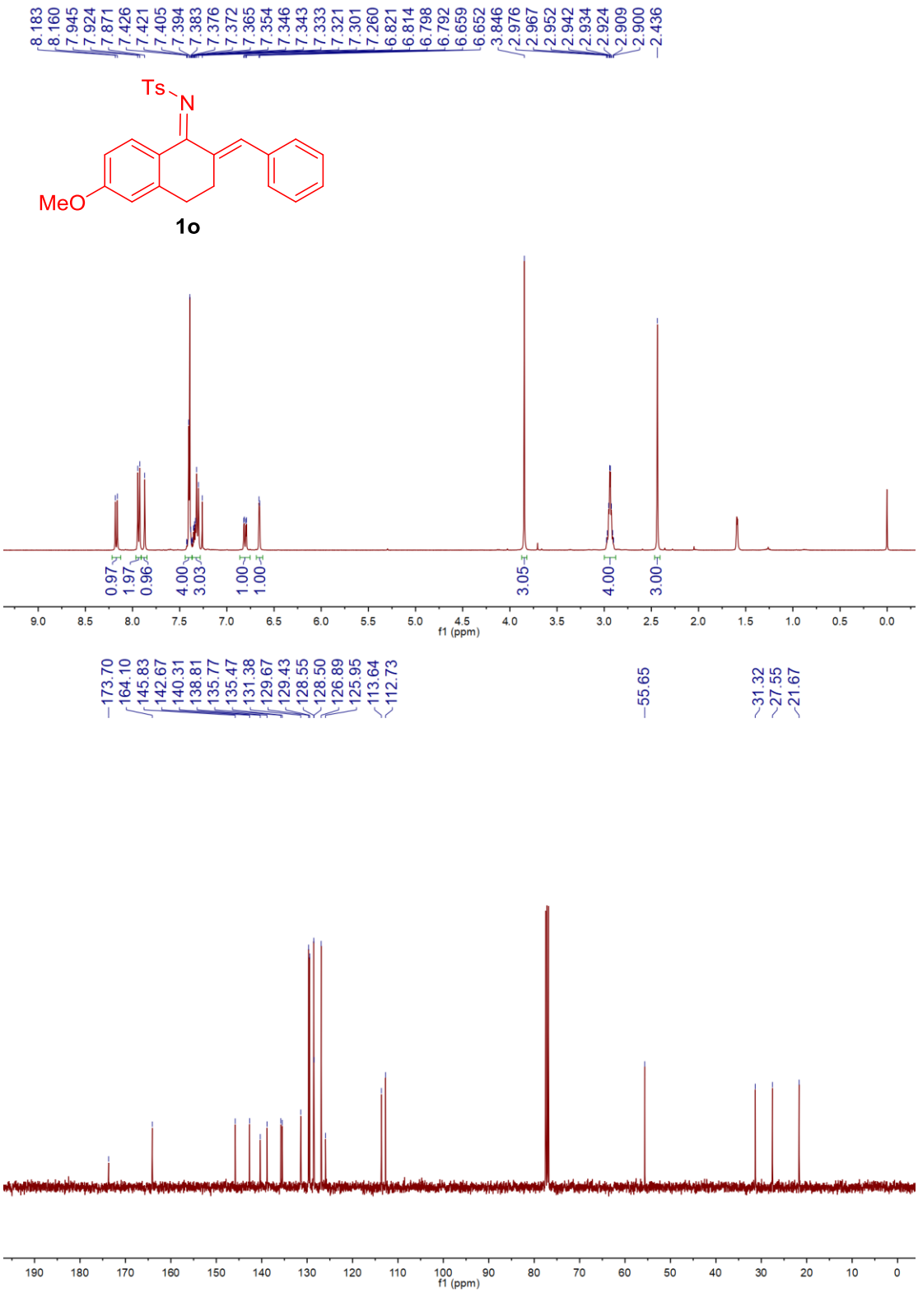

1.00
2.01
0.98
1.03
5.02
2.06
1.00
4.05
3.00
f1 (ppm)

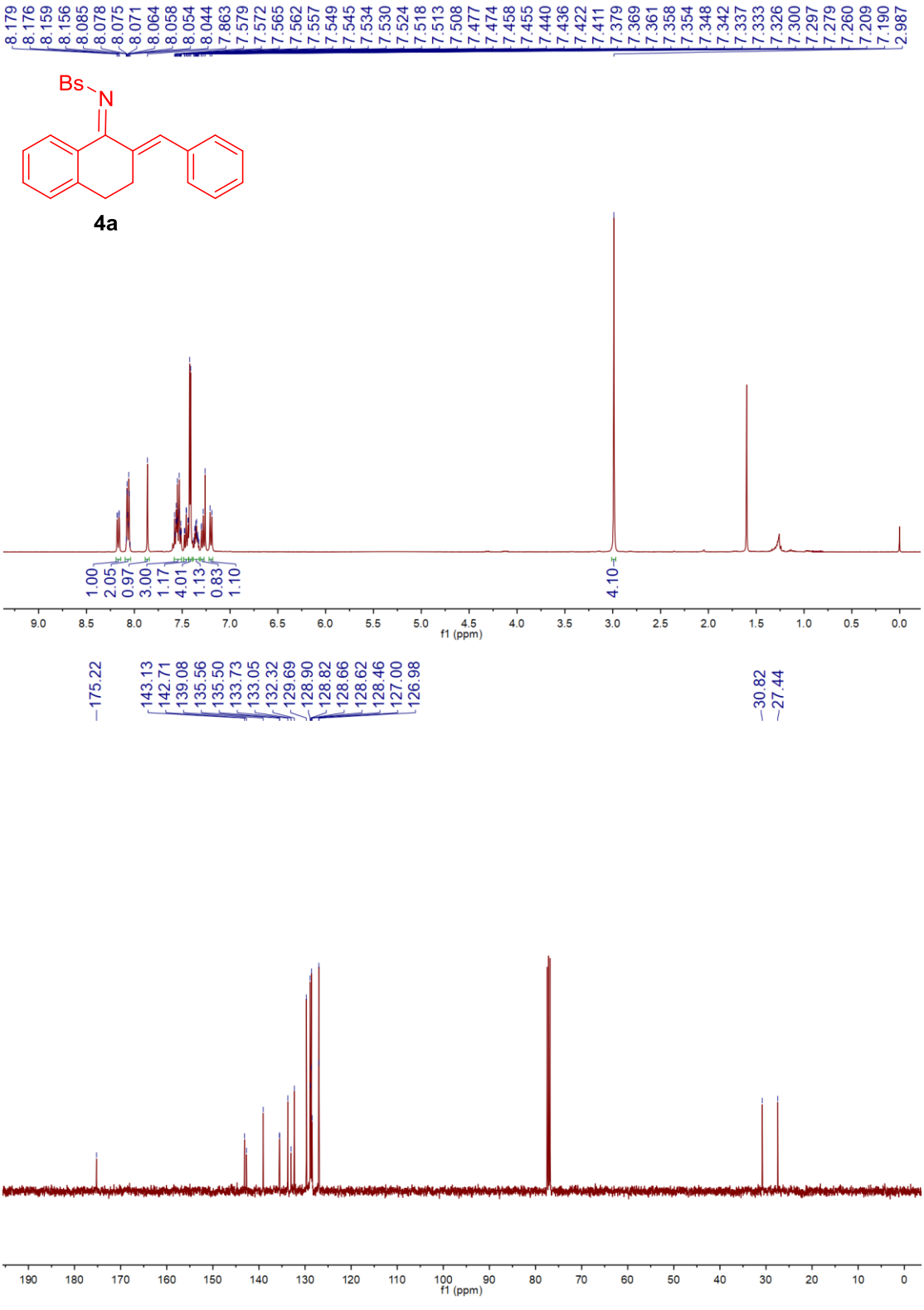

174.52
143.14
142.93
139.61
137.34
136.74
134.48
133.76
132.99
129.91
129.56
129.33
128.87
128.54
128.35
127.73
127.06
127.02
30.88
27.47
21.71
f1 (ppm)

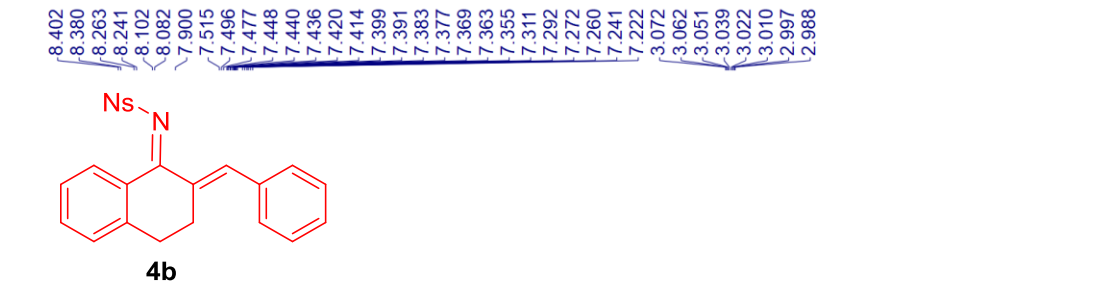

8.167
8.147
7.949
7.930
7.817
7.462
7.443
7.424
7.330
7.311
7.295
7.285
7.277
7.266
7.260
7.246
7.222
7.199
7.179
7.166
7.147
2.978
2.441
2.381
Ts
N
1l
1.01
2.00
0.96
1.10
5.13
3.20
1.12
4.03
3.00
3.16
f1 (ppm)
174.89
143.08
142.92
139.87
139.25
138.25
135.54
135.20
133.57
133.14
130.42
129.49
129.40
128.78
128.46
128.42
127.05
126.90
126.66
30.86
27.50
21.69
21.55
f1 (ppm)


8.201
8.181
7.997
7.973
7.953
7.891
7.878
7.871
7.865
7.857
7.847
7.841
7.535
7.526
7.524
7.520
7.517
7.515
7.512
7.510
7.507
7.503
7.500
7.492
7.481
7.479
7.476
7.462
7.460
7.457
7.444
7.441
7.438
7.344
7.324
7.307
7.287
7.267
7.211
7.192
3.086
3.070
3.054
3.010
2.995
2.979
2.452
Ts
N
1m
0.95
0.93
1.98
4.01
3.00
1.07
2.00
1.08
1.02
2.00
2.01
3.00
f1 (ppm)
174.80
143.02
139.83
139.06
135.72
133.64
133.23
133.15
133.13
129.53
129.35
128.79
128.47
128.43
128.20
127.83
127.08
126.96
126.84
126.56
30.84
27.62
21.71
f1 (ppm)

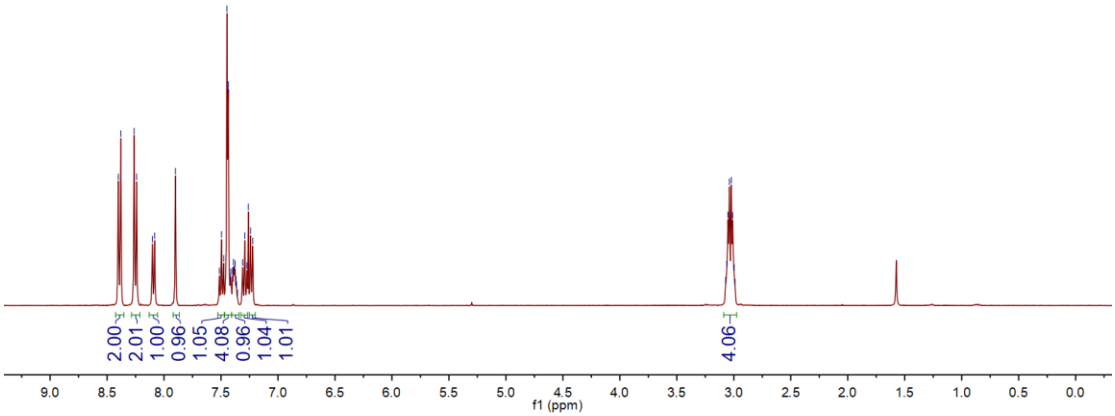

8.191
8.171
8.024
7.943
7.922
7.503
7.490
7.473
7.469
7.454
7.451
7.435
7.432
7.381
7.371
7.320
7.300
7.286
7.283
7.260
7.244
7.225
7.131
7.122
7.118
7.109
3.071
3.062
3.046
3.036
3.028
3.020
3.003
2.994
2.430
Ts
N
S
1n
0.96
0.94
1.96
0.93
1.00
1.00
3.01
1.03
1.00
4.00
3.00
f1 (ppm)
173.87
142.97
142.52
139.85
138.76
133.71
133.25
132.41
131.15
129.60
129.47
129.18
128.17
127.66
127.02
126.84
29.42
27.19
21.69
f1 (ppm)

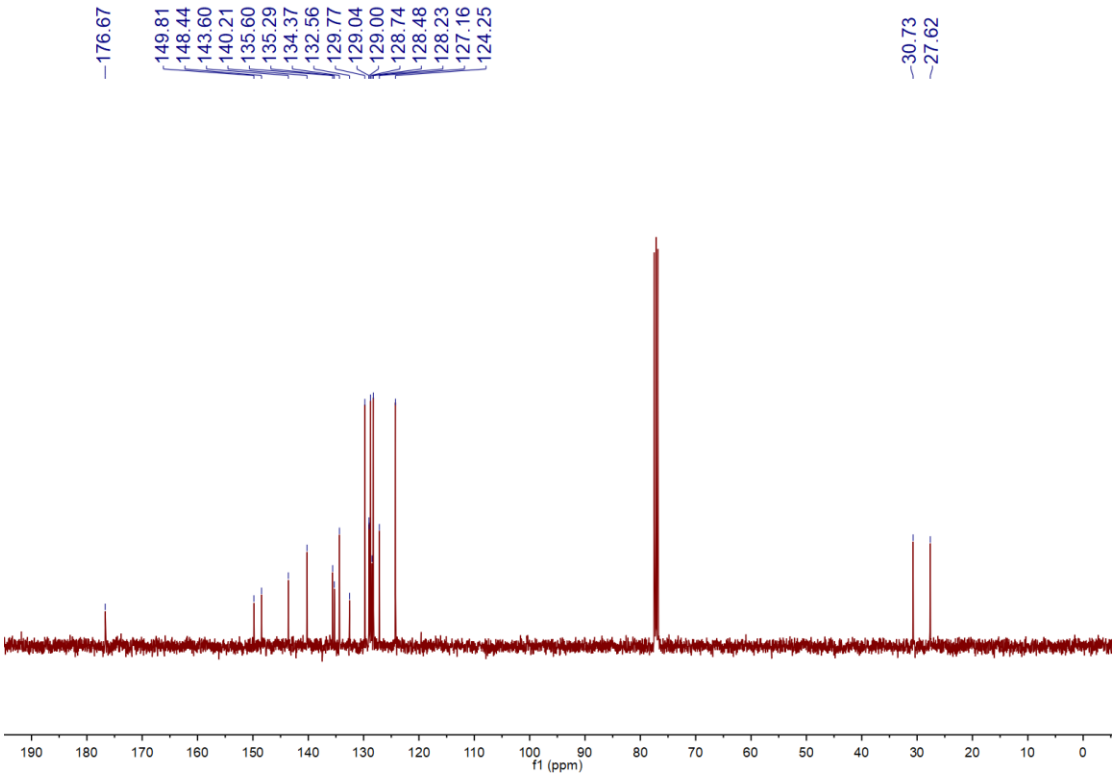

8.183
8.160
7.945
7.924
7.871
7.426
7.421
7.405
7.394
7.383
7.376
7.372
7.365
7.354
7.346
7.343
7.333
7.321
7.301
7.260
6.821
6.814
6.798
6.792
6.659
6.652
3.846
2.976
2.967
2.952
2.942
2.934
2.924
2.909
2.900
2.436
Ts
N
MeO
1o
0.97
1.97
0.96
4.00
3.03
1.00
1.00
3.05
4.00
3.00
f1 (ppm)
173.70
164.10
145.83
142.67
140.31
138.81
135.77
135.47
131.38
129.67
129.43
128.55
128.50
126.89
125.95
113.64
112.73
55.65
31.32
27.55
21.67
f1 (ppm)

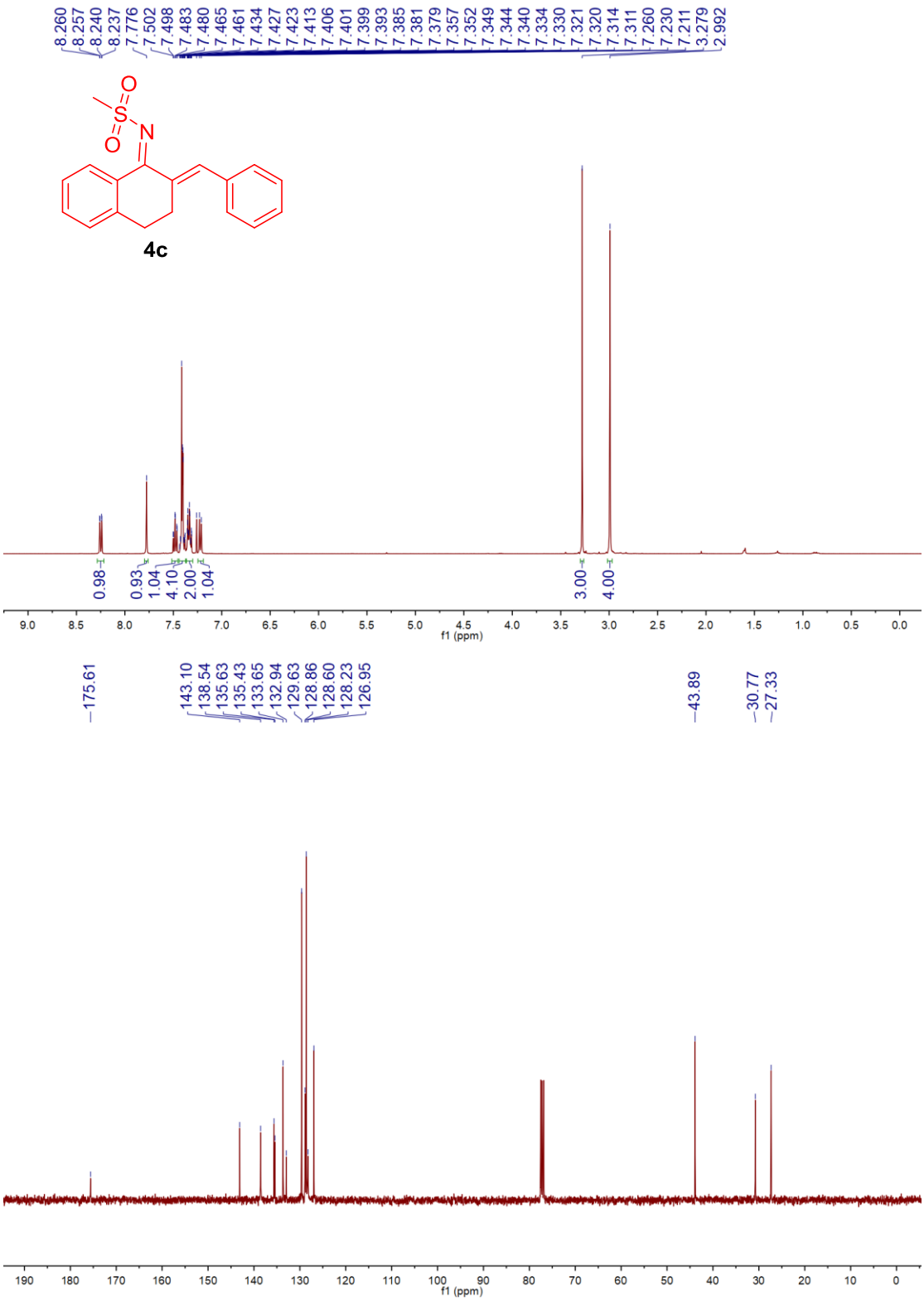

8.179
8.176
8.159
8.156
8.085
8.078
8.075
8.071
8.064
8.058
8.054
8.044
7.863
7.579
7.572
7.565
7.562
7.557
7.549
7.545
7.534
7.530
7.524
7.518
7.513
7.508
7.477
7.474
7.458
7.455
7.440
7.436
7.422
7.411
7.379
7.369
7.361
7.358
7.354
7.348
7.342
7.337
7.333
7.326
7.300
7.297
7.279
7.260
7.209
7.190
2.987
Bs
N
4a
1.00
2.05
0.97
3.00
1.17
4.01
1.13
0.83
1.10
4.10
f1 (ppm)
175.22
143.13
142.71
139.08
135.56
135.50
133.73
133.05
132.32
129.69
128.90
128.82
128.66
128.62
128.46
127.00
126.98
30.82
27.44
f1 (ppm)

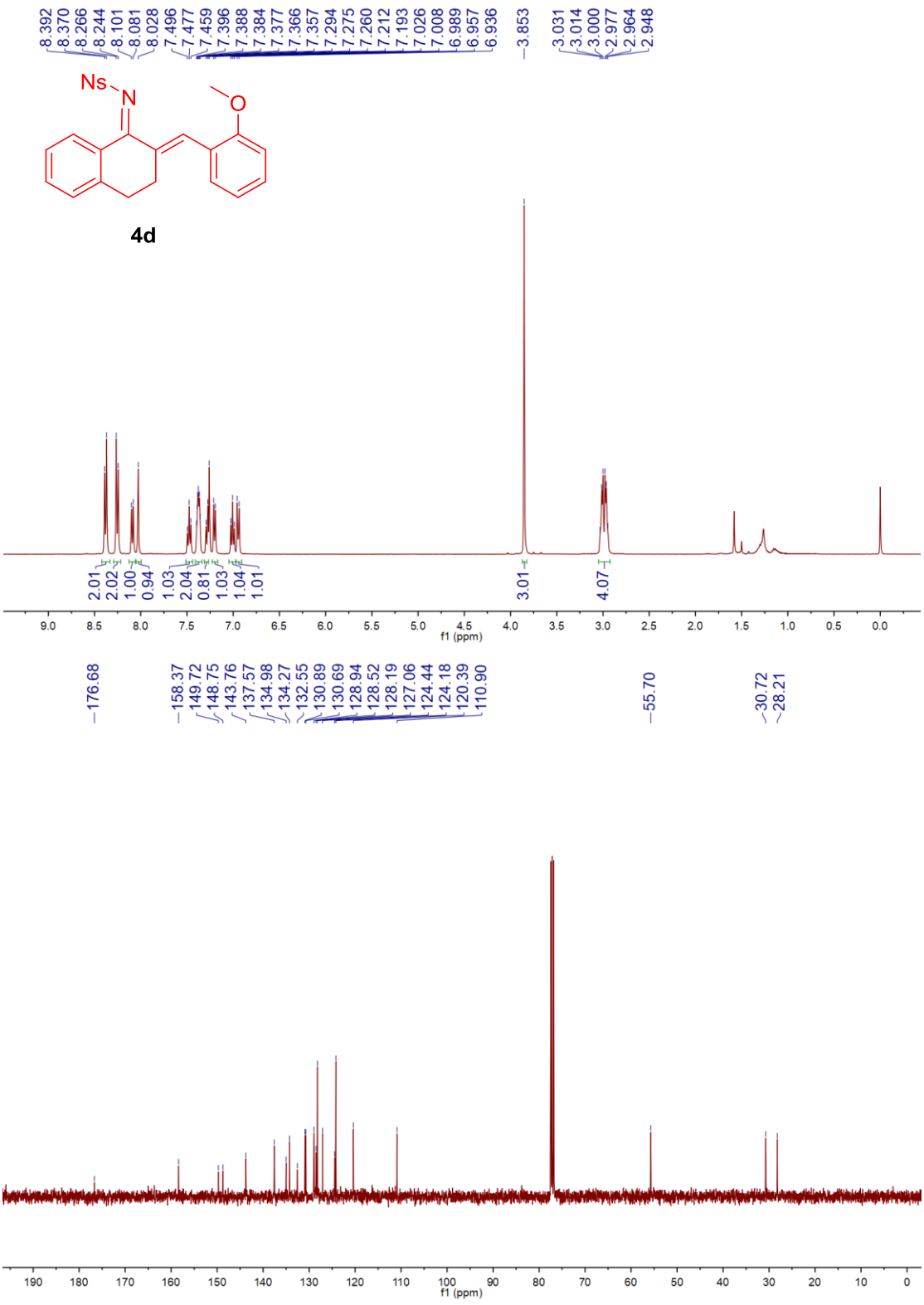

8.402
8.380
8.263
8.241
8.102
8.082
7.900
7.515
7.496
7.477
7.448
7.440
7.436
7.420
7.414
7.399
7.391
7.383
7.377
7.369
7.363
7.355
7.311
7.292
7.272
7.260
7.241
7.222
3.072
3.062
3.051
3.039
3.022
3.010
2.997
2.988
Ns
N

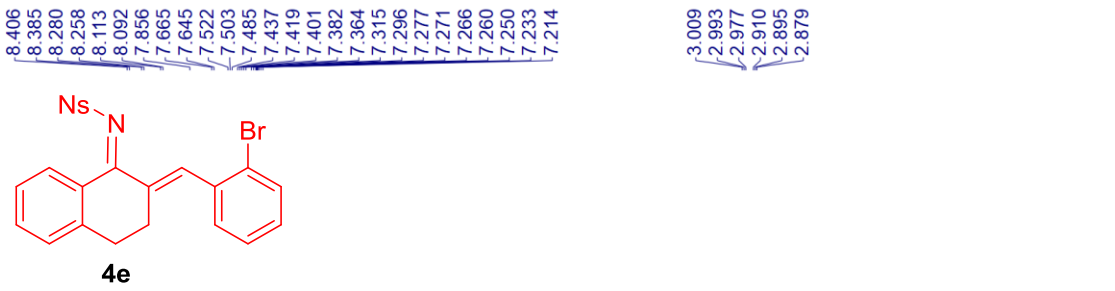
4b


2.00
2.01
1.00
0.96
1.05
4.08
0.96
1.04
1.01
4.06
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

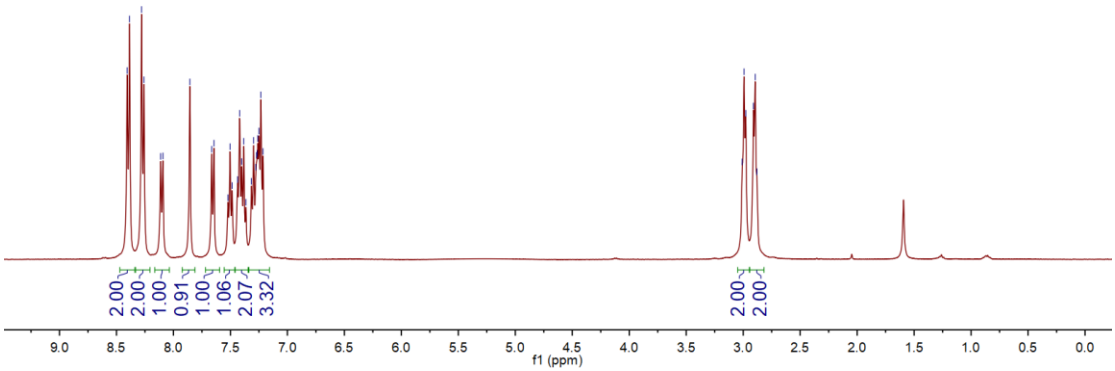

176.67
149.81
148.44
143.60
140.21
135.60
135.29
134.37
132.56
129.77
129.04
129.00
128.74
128.48
128.23
127.16
124.25
30.73
27.62
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

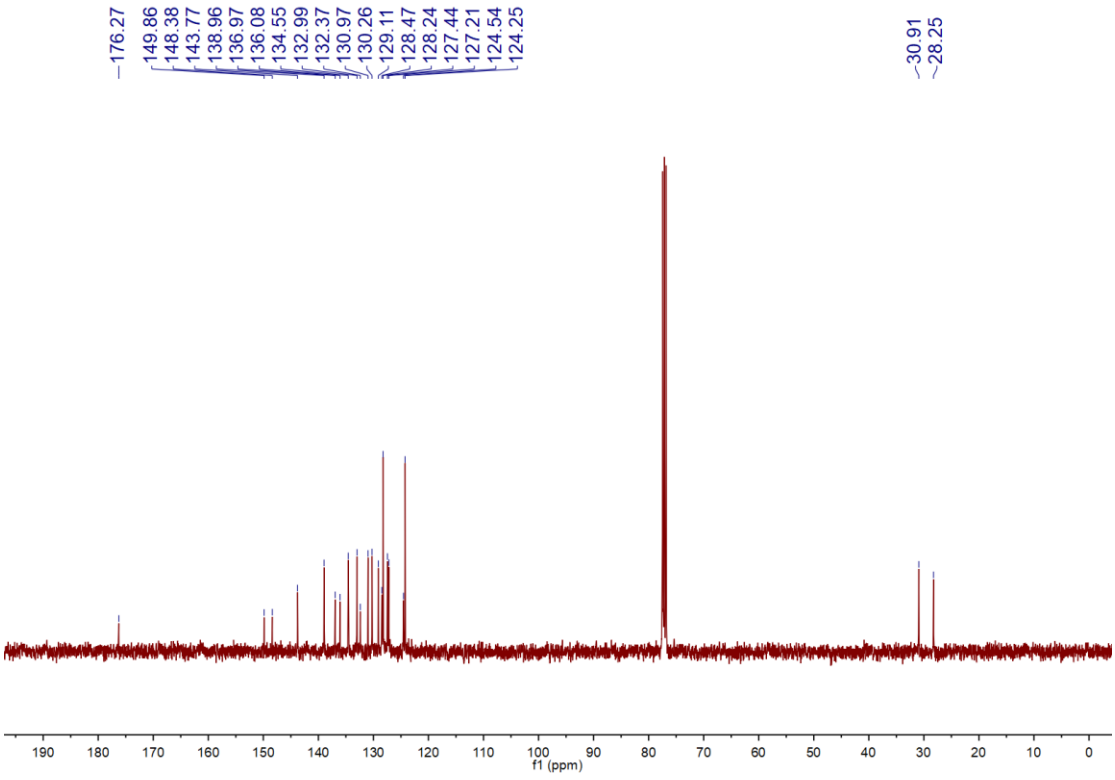

8.260
8.257
8.240
8.237
7.776
7.502
7.498
7.483
7.480
7.465
7.461
7.434
7.427
7.423
7.413
7.406
7.401
7.399
7.393
7.385
7.381
7.379
7.357
7.352
7.349
7.344
7.340
7.334
7.330
7.321
7.320
7.314
7.311
7.260
7.230
7.211
3.279
2.992
O
S
O
N
4c
0.98
0.93
1.04
4.10
2.00
1.04
3.00
4.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
175.61
143.10
138.54
135.63
135.43
133.65
132.94
129.63
128.86
128.60
128.23
126.95
43.89
30.77
27.33
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

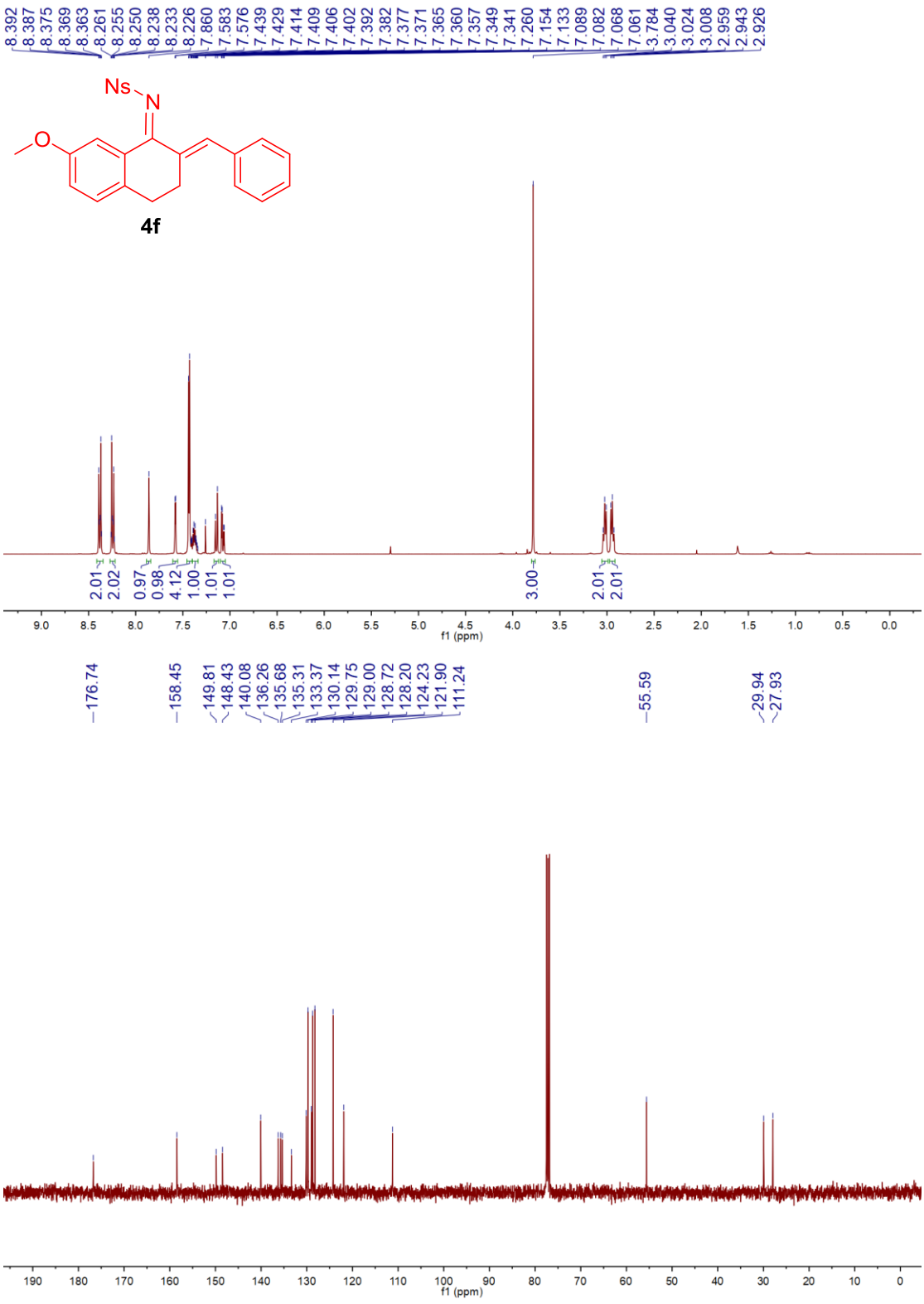

8.392
8.370
8.266
8.244
8.101
8.081
8.028
7.496
7.477
7.459
7.396
7.388
7.384
7.377
7.366
7.357
7.294
7.275
7.260
7.212
7.193
7.026
7.008
6.989
6.957
6.936
3.853
3.031
3.014
3.000
2.977
2.964
2.948
Ns
N
O
4d
2.01
2.02
1.00
0.94
1.03
2.04
0.81
1.03
1.04
1.01
3.01
4.07
f1 (ppm)
176.68
158.37
149.72
148.75
143.76
137.57
134.98
134.27
132.55
130.89
130.69
128.94
128.52
128.19
127.06
124.44
124.18
120.39
110.90
55.70
30.72
28.21
f1 (ppm)

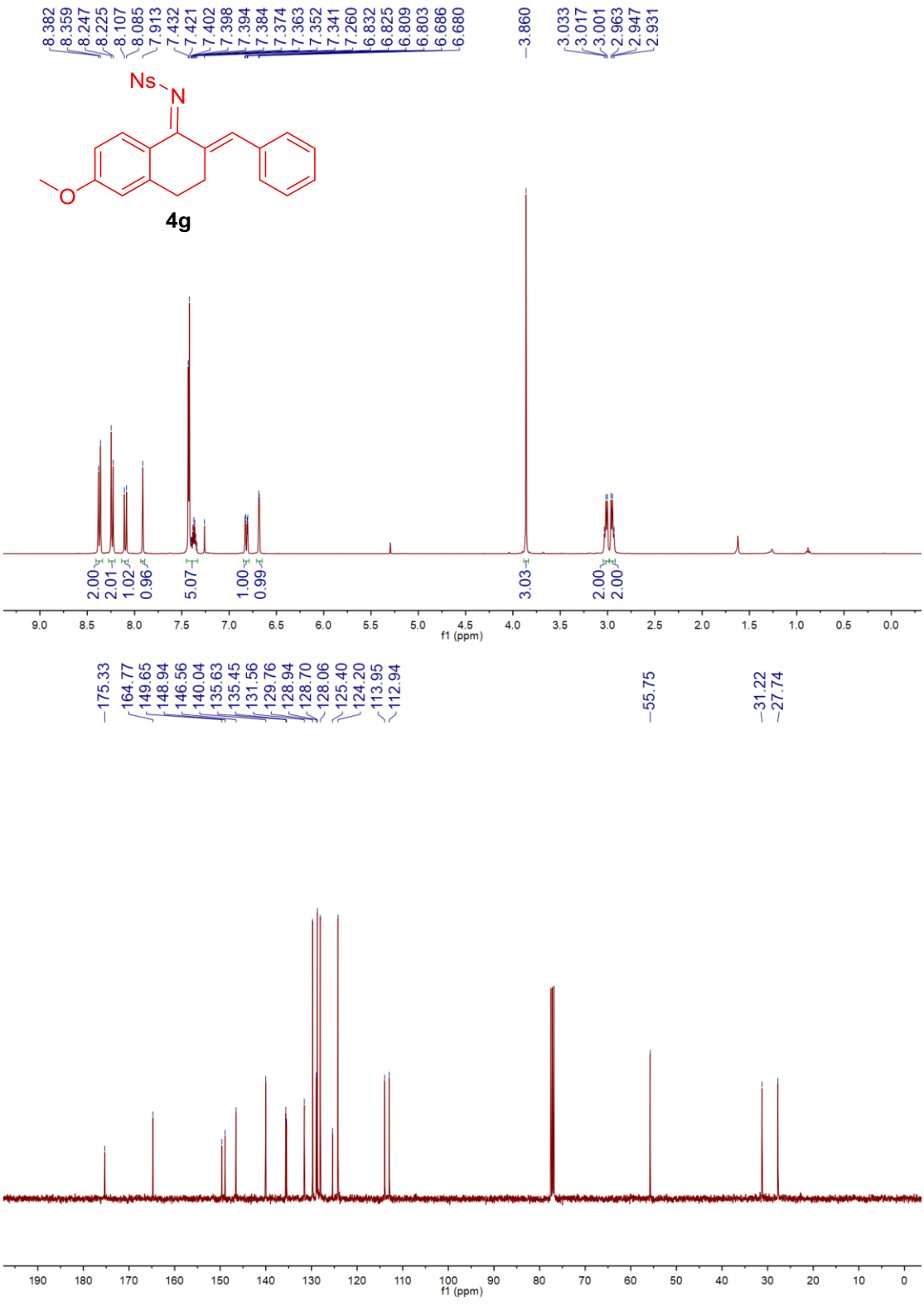

8.406
8.385
8.280
8.258
8.113
8.092
7.856
7.665
7.645
7.522
7.503
7.485
7.437
7.419
7.401
7.382
7.364
7.315
7.296
7.277
7.271
7.266
7.260
7.250
7.233
7.214
3.009
2.993
2.977
2.910
2.895
2.879
Ns
N
Br

4e


2.00
2.00
1.00
0.91
1.00
1.06
2.07
3.32
2.00
2.00
f1 (ppm)

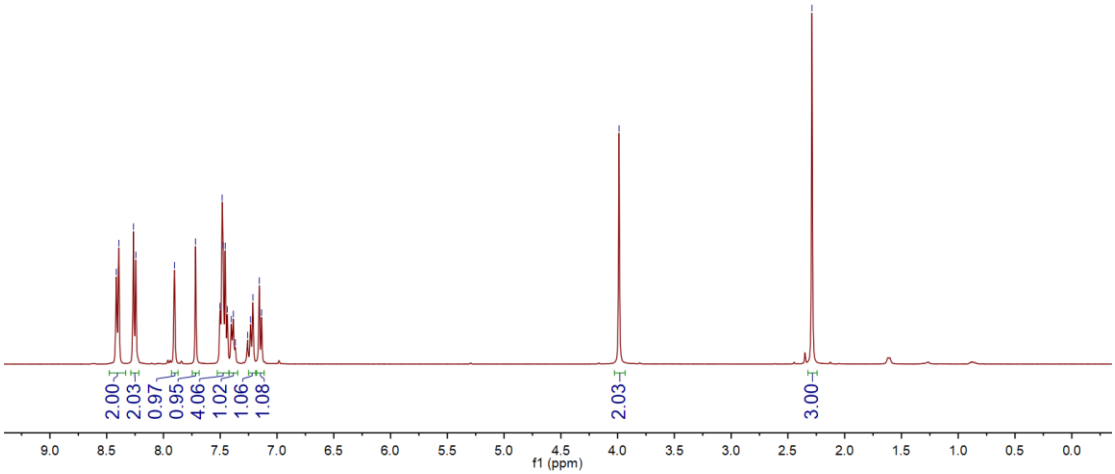

176.27
149.86
148.38
143.77
138.96
136.97
136.08
134.55
132.99
132.37
130.97
130.26
129.11
128.47
128.24
127.44
127.21
124.54
124.25
30.91
28.25
f1 (ppm)

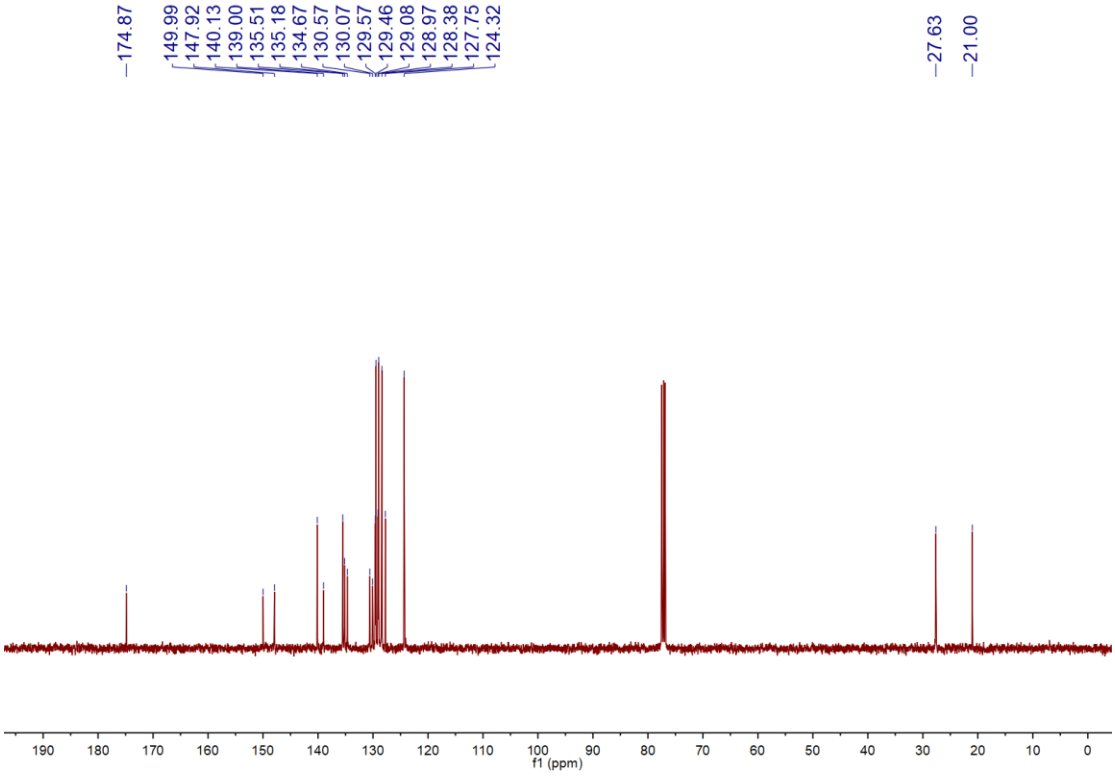

8.392
8.387
8.375
8.369
8.363
8.261
8.255
8.250
8.238
8.233
8.226
7.860
7.583
7.576
7.439
7.429
7.414
7.409
7.406
7.402
7.392
7.382
7.377
7.371
7.365
7.360
7.357
7.349
7.341
7.260
7.154
7.133
7.089
7.082
7.068
7.061
3.784
3.040
3.024
3.008
2.959
2.943
2.926
Ns
N
O
4f
2.01
2.02
0.97
0.98
4.12
1.00
1.01
1.01
3.00
2.01
2.01
f1 (ppm)
176.74
158.45
149.81
148.43
140.08
136.26
135.68
135.31
133.37
130.14
129.75
129.00
128.72
128.20
124.23
121.90
111.24
55.59
29.94
27.93
f1 (ppm)

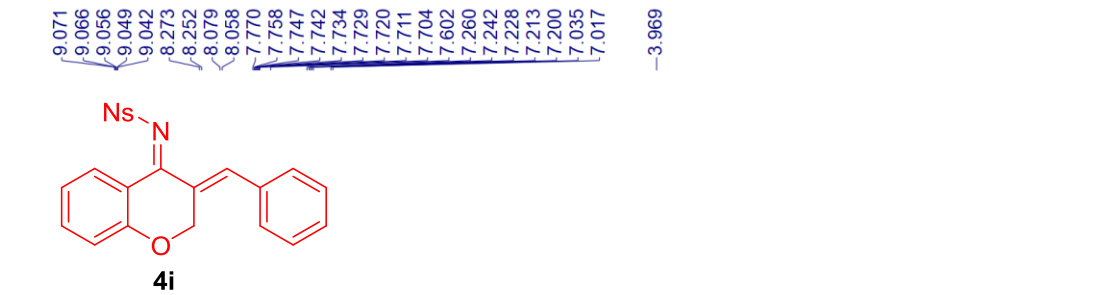

8.382
8.359
8.247
8.225
8.107
8.085
7.913
7.432
7.421
7.402
7.398
7.394
7.384
7.374
7.363
7.352
7.341
7.260
6.832
6.825
6.809
6.803
6.686
6.680
3.860
3.033
3.017
3.001
2.963
2.947
2.931
Ns
N
O
4g
2.00
2.01
1.02
0.96
5.07
1.00
0.99
3.03
2.00
2.00
f1 (ppm)
175.33
164.77
149.65
148.94
146.56
140.04
135.63
135.45
131.56
129.76
128.94
128.70
128.06
125.40
124.20
113.95
112.94
55.75
31.22
27.74
f1 (ppm)


8.416
8.394
8.265
8.244
7.903
7.717
7.502
7.483
7.474
7.456
7.437
7.403
7.385
7.367
7.260
7.233
7.212
7.156
7.136
3.987
2.288
Ns
N
S

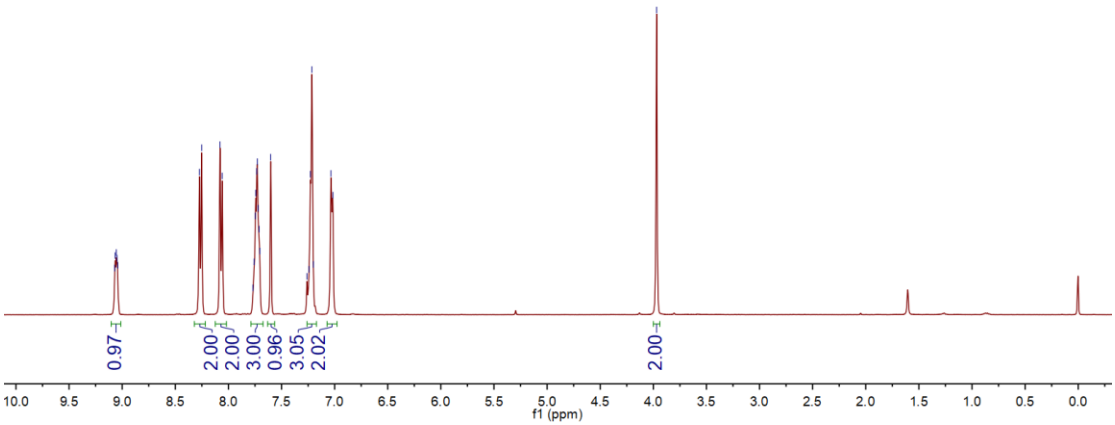
4h

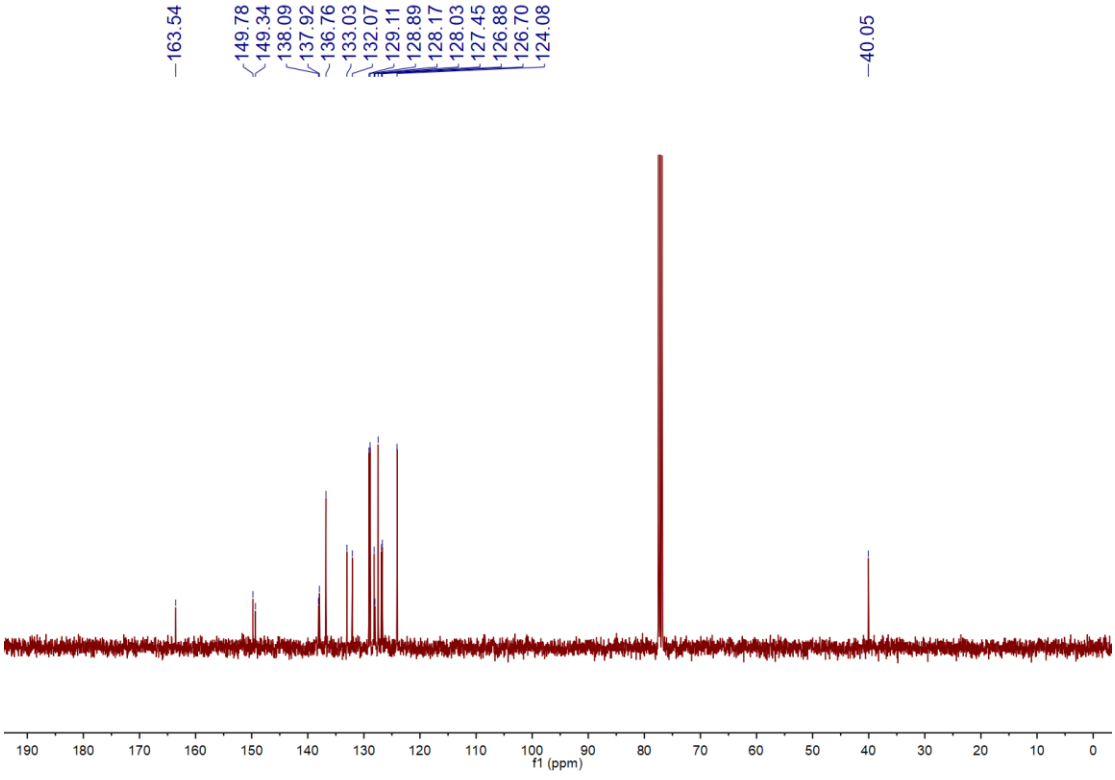

2.00
2.03
0.97
0.95
4.06
1.02
1.06
1.08
2.03
3.00
f1 (ppm)

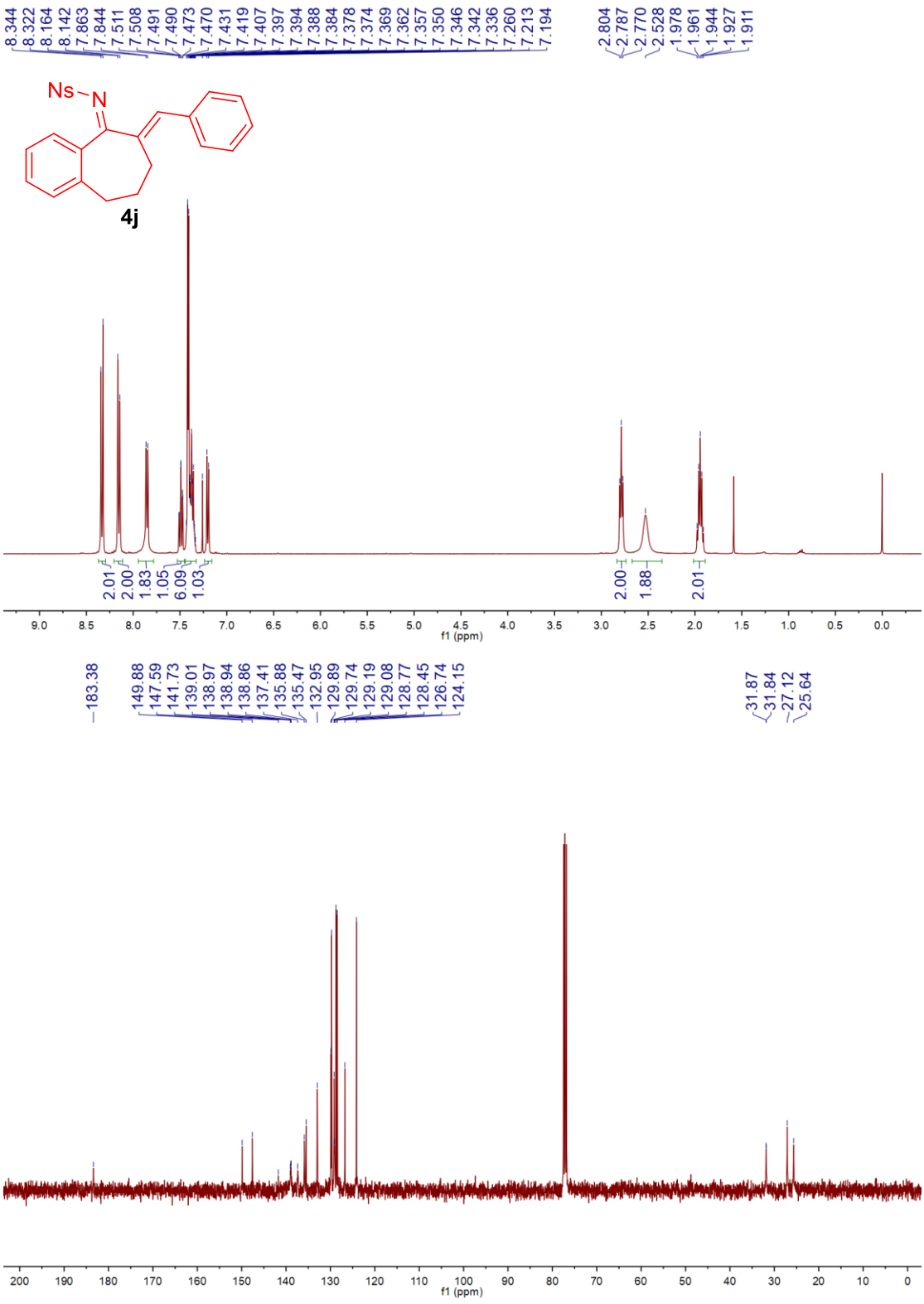

174.87
149.99
147.92
140.13
139.00
135.51
135.18
134.67
130.57
130.07
129.57
129.46
129.08
128.97
128.38
127.75
124.32
27.63
21.00
f1 (ppm)

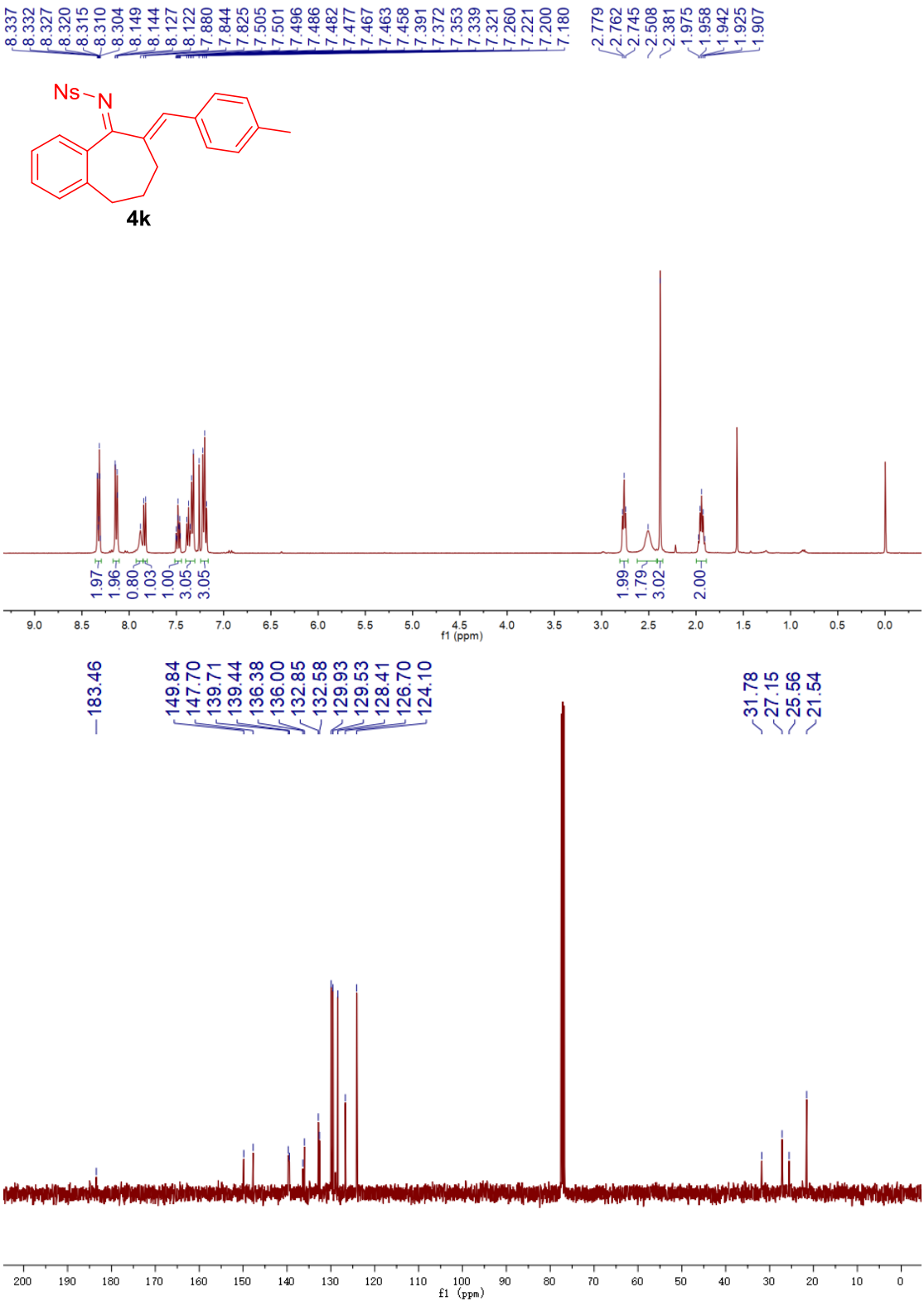

9.071
9.066
9.056
9.049
9.042
8.273
8.252
8.079
8.058
7.770
7.758
7.747
7.742
7.734
7.729
7.720
7.711
7.704
7.602
7.260
7.242
7.228
7.213
7.200
7.035
7.017
3.969
Ns
N
O

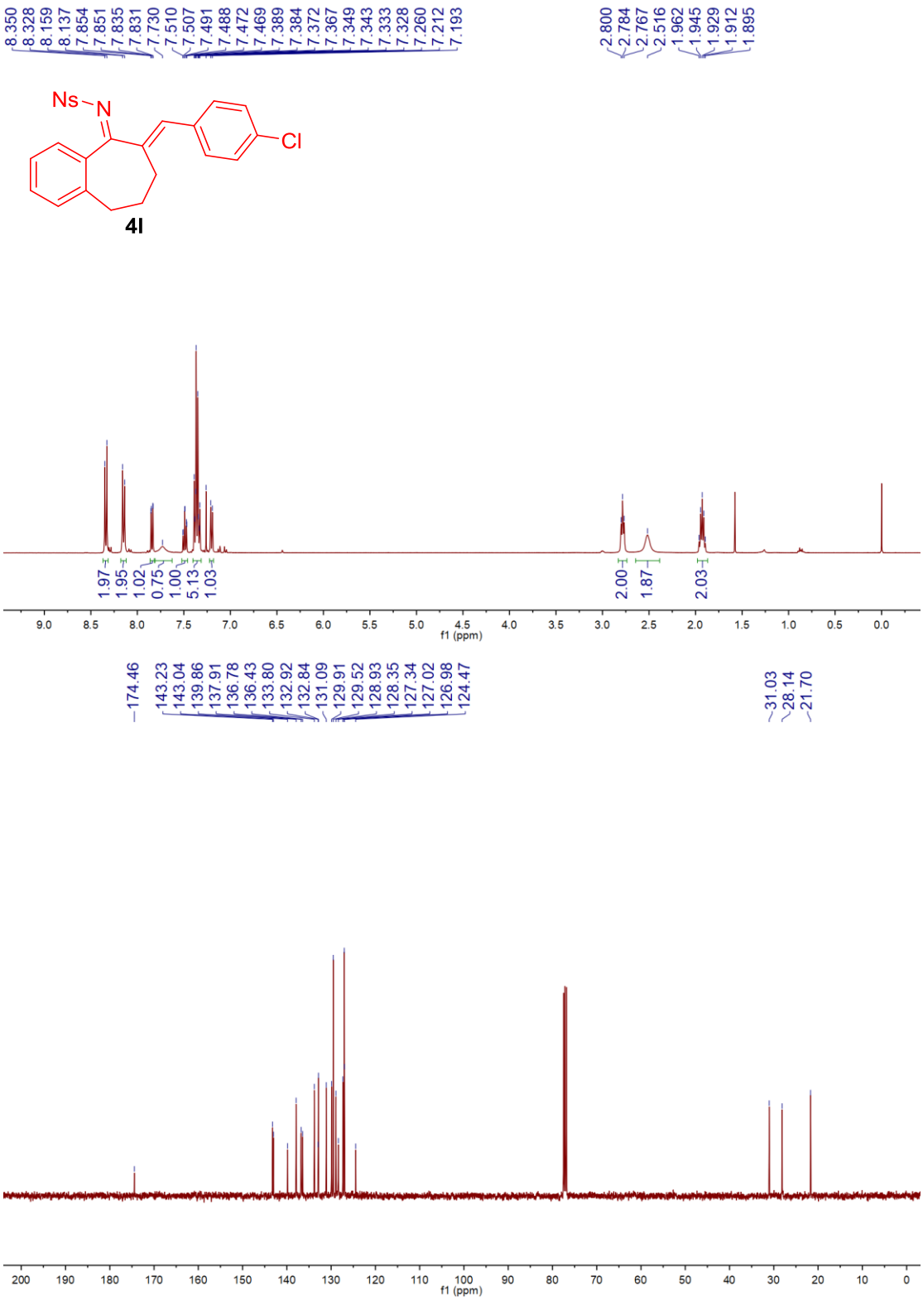
4i

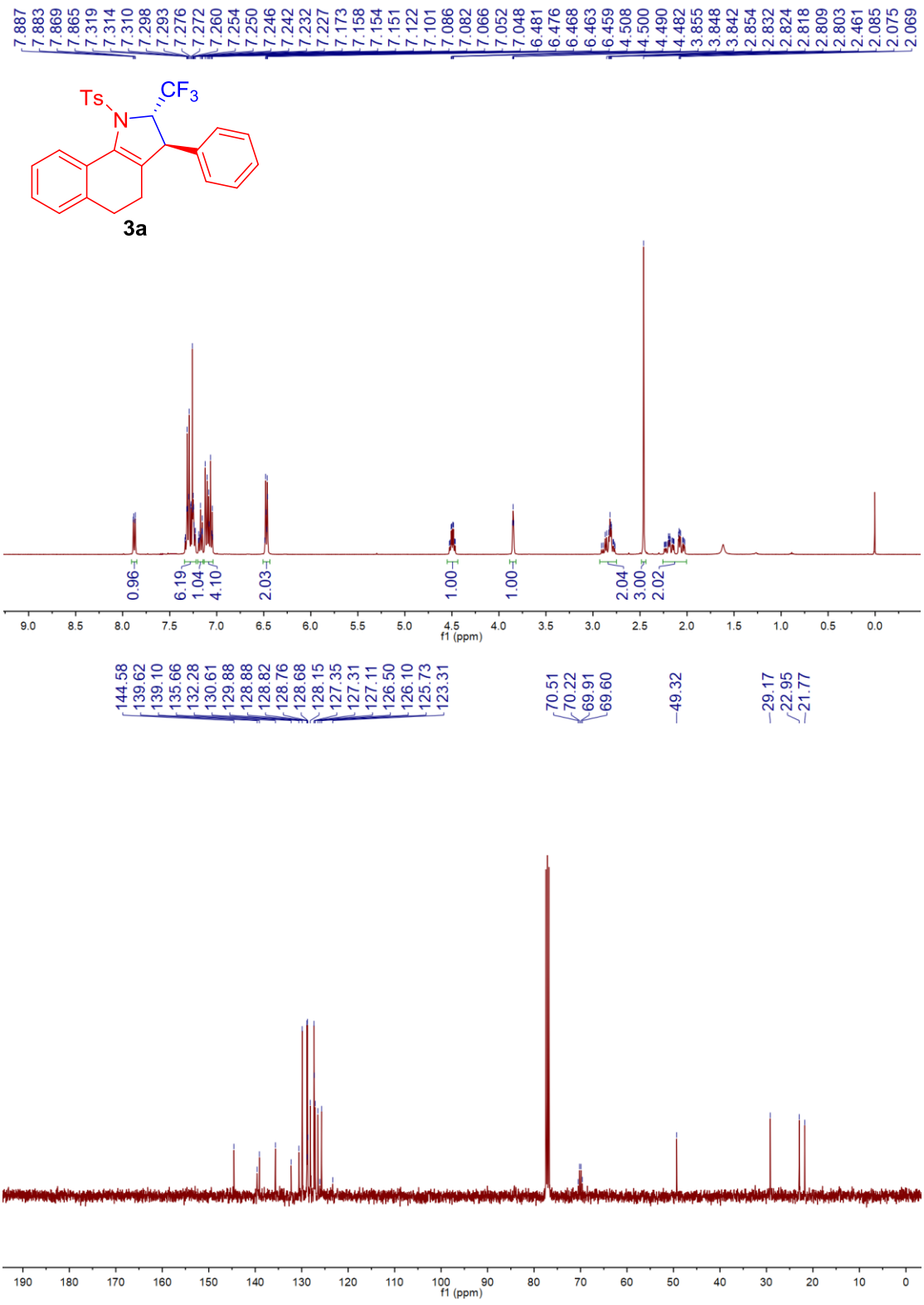

0.97
2.00
2.00
3.00
0.96
3.05
2.02
2.00
f1 (ppm)

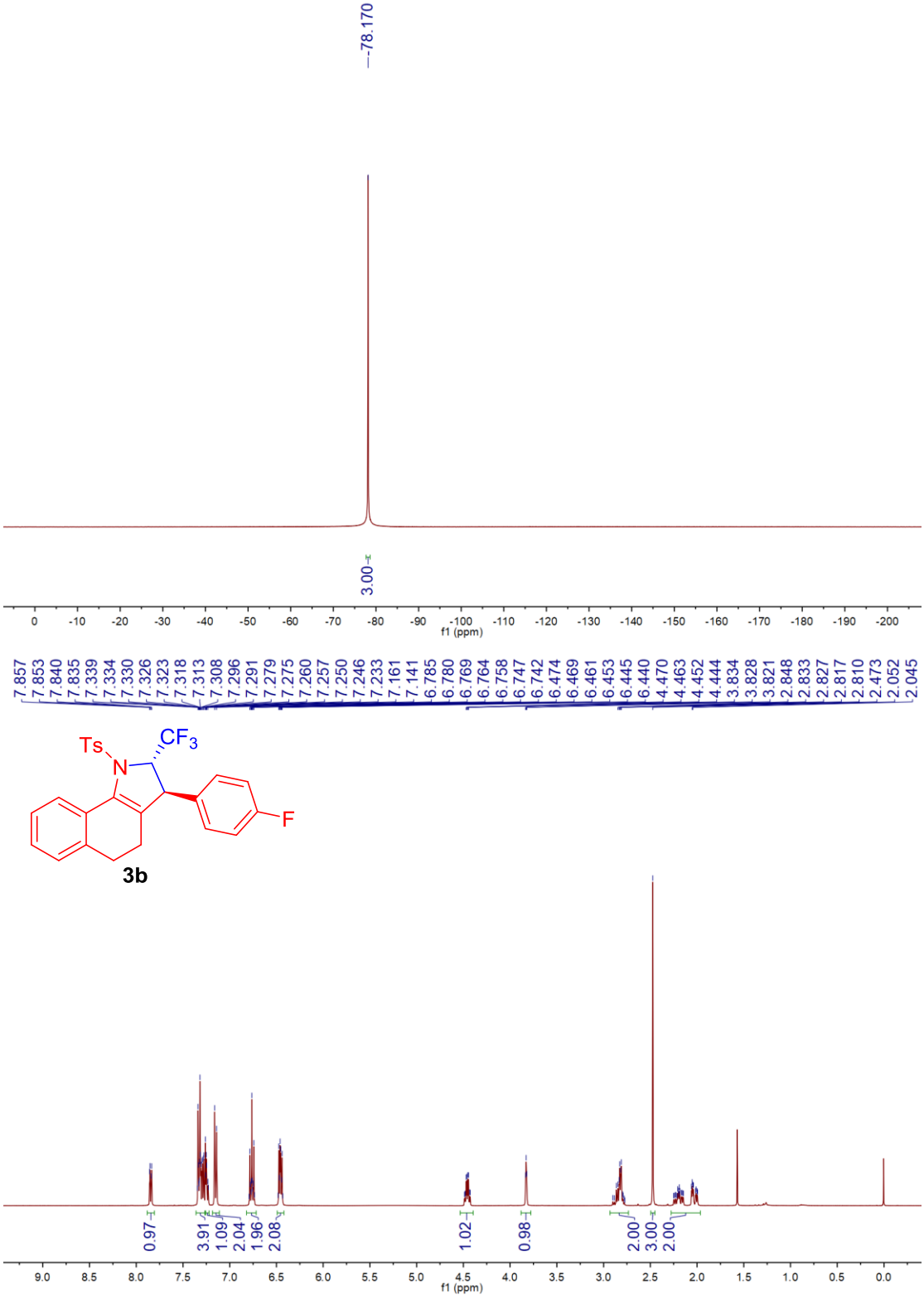

163.54
149.78
149.34
138.09
137.92
136.76
133.03
132.07
129.11
128.89
128.17
128.03
127.45
126.88
126.70
124.08
40.05
f1 (ppm)

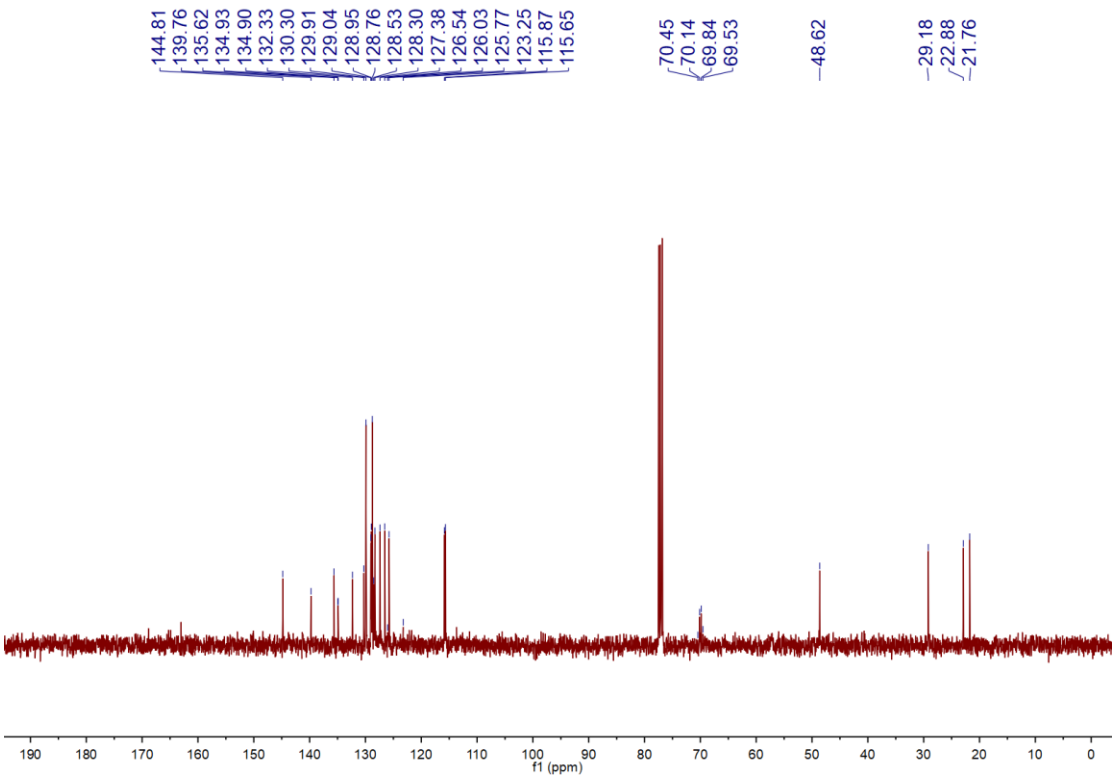

8.344
8.322
8.164
8.142
7.863
7.844
7.511
7.508
7.491
7.490
7.473
7.470
7.431
7.419
7.407
7.397
7.394
7.388
7.384
7.378
7.374
7.369
7.362
7.357
7.350
7.346
7.342
7.336
7.260
7.213
7.194
2.804
2.787
2.770
2.528
1.978
1.961
1.944
1.927
1.911
Ns
N
4j
2.01
2.00
1.83
1.05
6.09
1.03
2.00
1.88
2.01
f1 (ppm)
183.38
149.88
147.59
141.73
139.01
138.97
138.94
138.86
137.41
135.88
135.47
132.95
129.89
129.74
129.19
129.08
128.77
128.45
126.74
124.15
31.87
31.84
27.12
25.64
f1 (ppm)

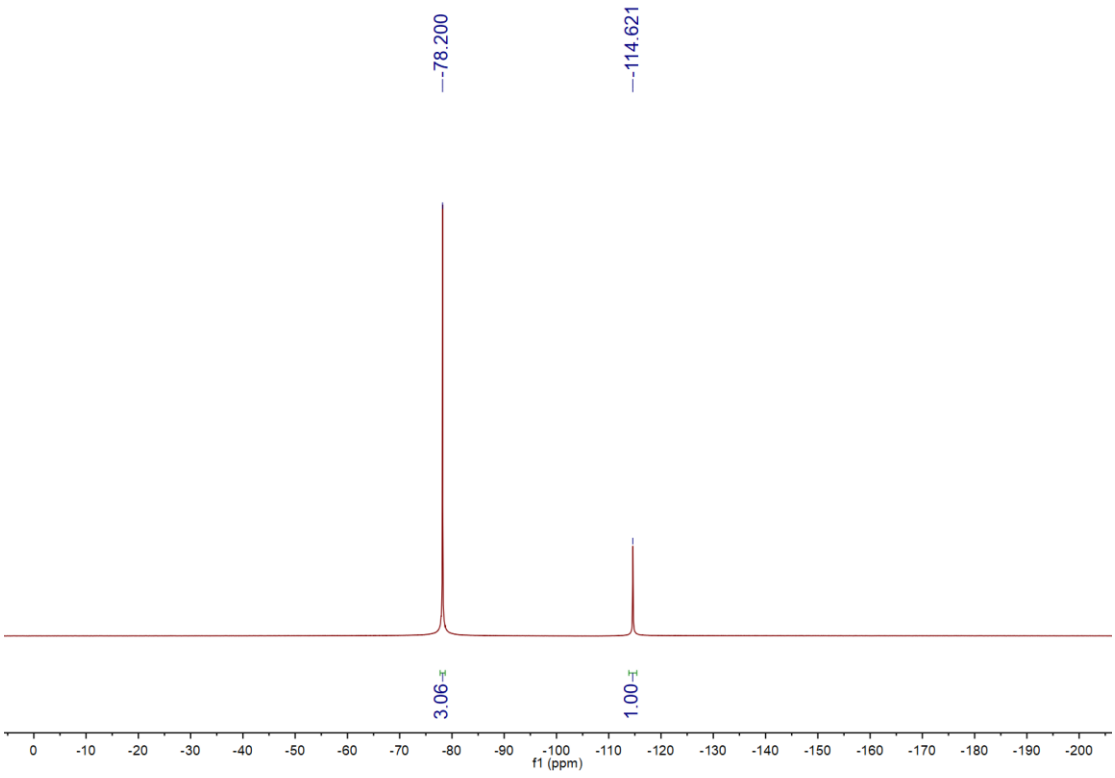

8.337
8.332
8.327
8.320
8.315
8.310
8.304
8.149
8.144
8.127
8.122
7.880
7.844
7.825
7.505
7.501
7.496
7.486
7.482
7.477
7.467
7.463
7.458
7.391
7.372
7.353
7.339
7.321
7.260
7.221
7.200
7.180
2.779
2.762
2.745
2.508
2.381
1.975
1.958
1.942
1.925
1.907
Ns
N
4k
1.97
1.96
0.80
1.03
1.00
3.05
3.05
1.99
1.79
3.02
2.00
f1 (ppm)
183.46
149.84
147.70
139.71
139.44
136.38
136.00
132.85
132.58
129.93
129.53
128.41
126.70
124.10
31.78
27.15
25.56
21.54
f1 (ppm)

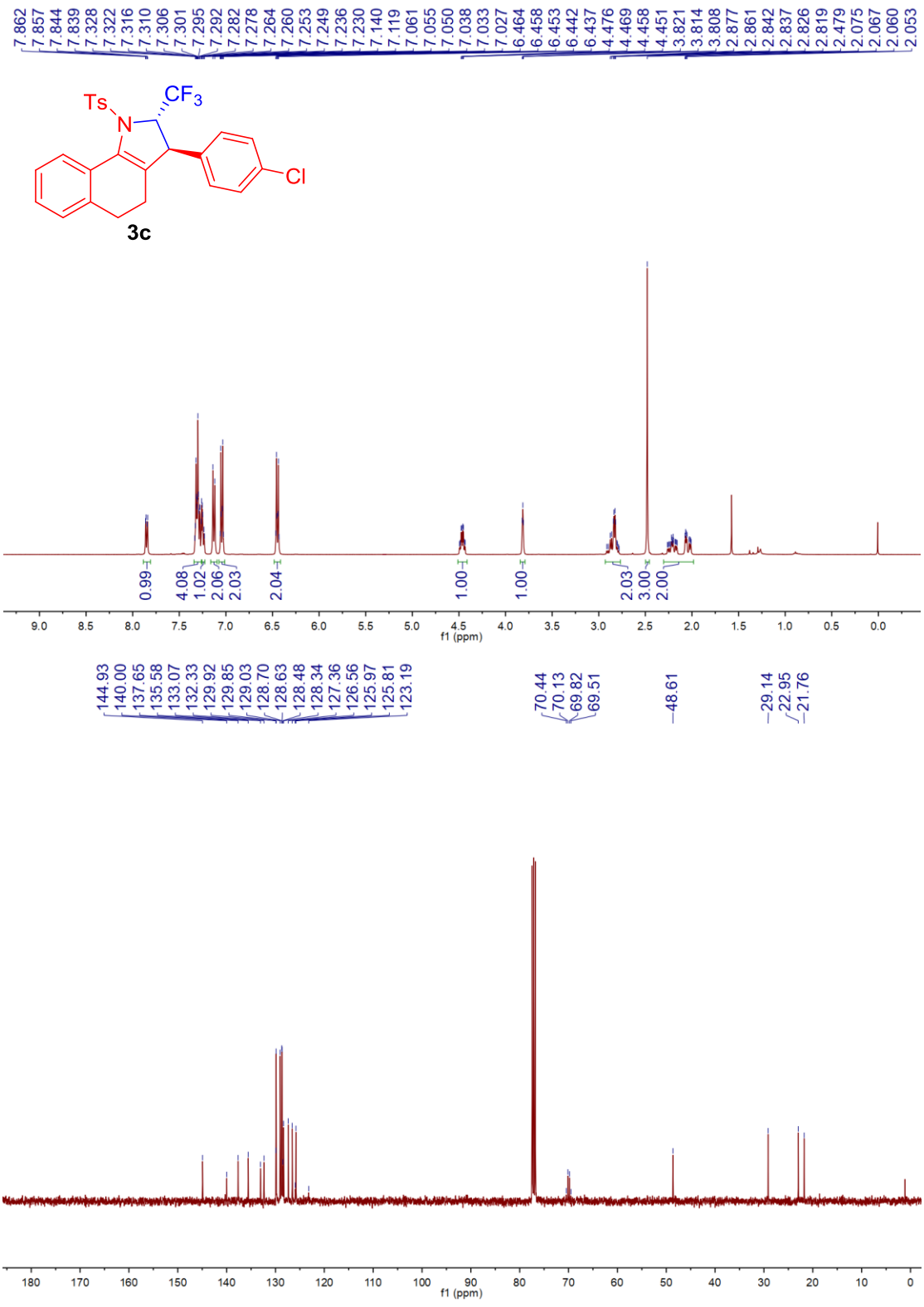

8.350
8.328
8.159
8.137
7.854
7.851
7.835
7.831
7.730
7.510
7.507
7.491
7.488
7.472
7.469
7.389
7.384
7.372
7.367
7.349
7.343
7.333
7.328
7.260
7.212
7.193
2.800
2.784
2.767
2.516
1.962
1.945
1.929
1.912
1.895
Ns
N
Cl
4l
1.97
1.95
1.02
0.75
1.00
5.13
1.03
2.00
1.87
2.03
f1 (ppm)
174.46
143.23
143.04
139.86
137.91
136.78
136.43
133.80
132.92
132.84
131.09
129.91
129.52
128.93
128.35
127.34
127.02
126.98
124.47
31.03
28.14
21.70
f1 (ppm)

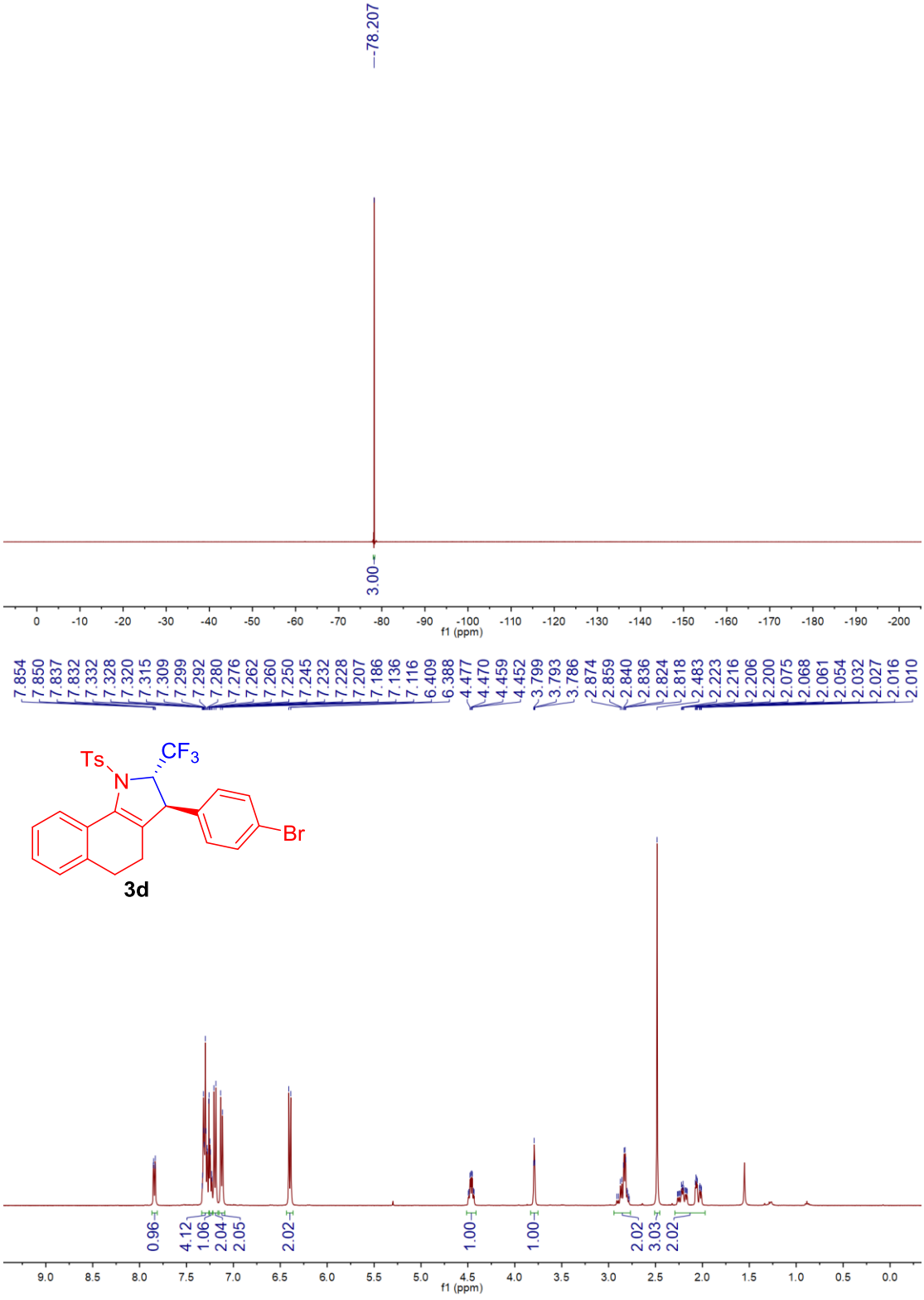

7.887
7.883
7.869
7.865
7.319
7.314
7.310
7.298
7.293
7.276
7.272
7.260
7.254
7.250
7.246
7.242
7.232
7.227
7.173
7.158
7.154
7.151
7.122
7.101
7.086
7.082
7.066
7.052
7.048
6.481
6.476
6.468
6.463
6.459
4.508
4.500
4.490
4.482
3.855
3.848
3.842
2.854
2.832
2.824
2.818
2.809
2.803
2.461
2.085
2.075
2.069
Ts
N
CF3
3a
0.96
6.19
1.04
4.10
2.03
1.00
1.00
2.04
3.00
2.02
f1 (ppm)
144.58
139.62
139.10
135.66
132.28
130.61
129.88
128.88
128.82
128.76
128.68
128.15
127.35
127.31
127.11
126.50
126.10
125.73
123.31
70.51
70.22
69.91
69.60
49.32
29.17
22.95
21.77
f1 (ppm)

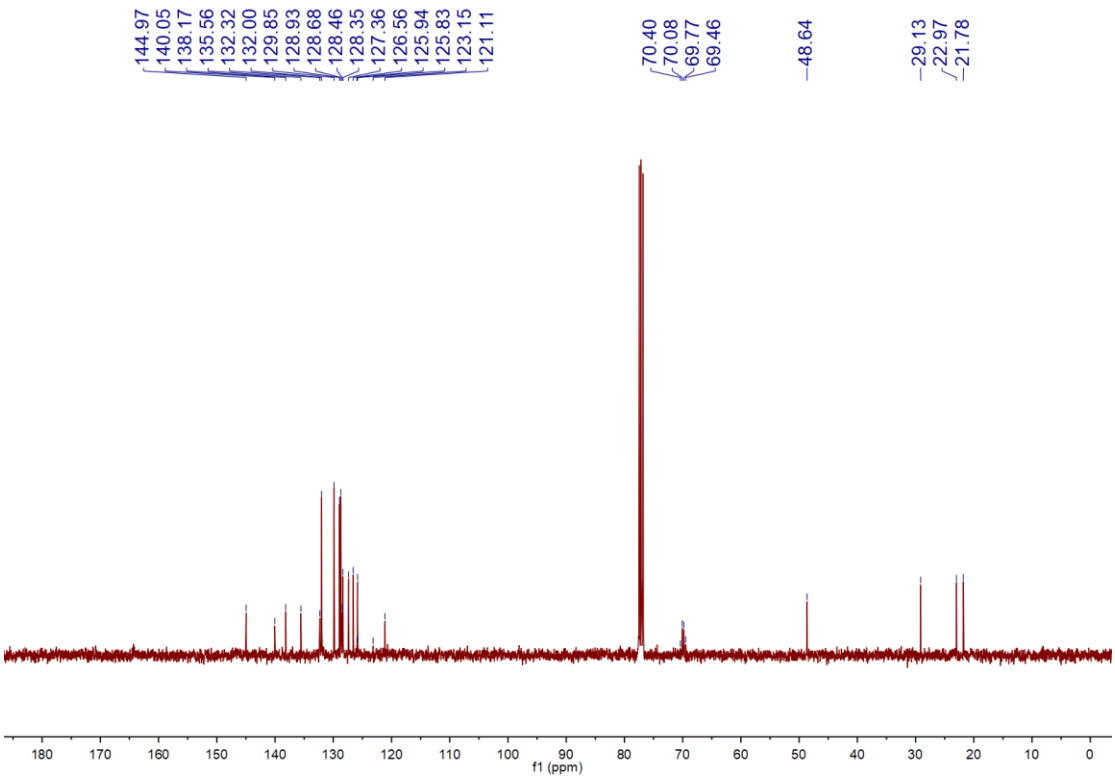

-78.170
3.00
f1 (ppm)
7.857
7.853
7.840
7.835
7.339
7.334
7.330
7.326
7.323
7.318
7.313
7.308
7.296
7.291
7.279
7.275
7.260
7.257
7.250
7.246
7.233
7.161
7.141
6.785
6.780
6.769
6.764
6.758
6.747
6.742
6.474
6.469
6.461
6.453
6.445
6.440
4.470
4.463
4.452
4.444
3.834
3.828
3.821
2.848
2.833
2.827
2.817
2.810
2.473
2.052
2.045
Ts
N
CF3
F
3b
0.97
3.91
1.09
2.04
1.96
2.08
1.02
0.98
2.00
3.00
2.00
f1 (ppm)

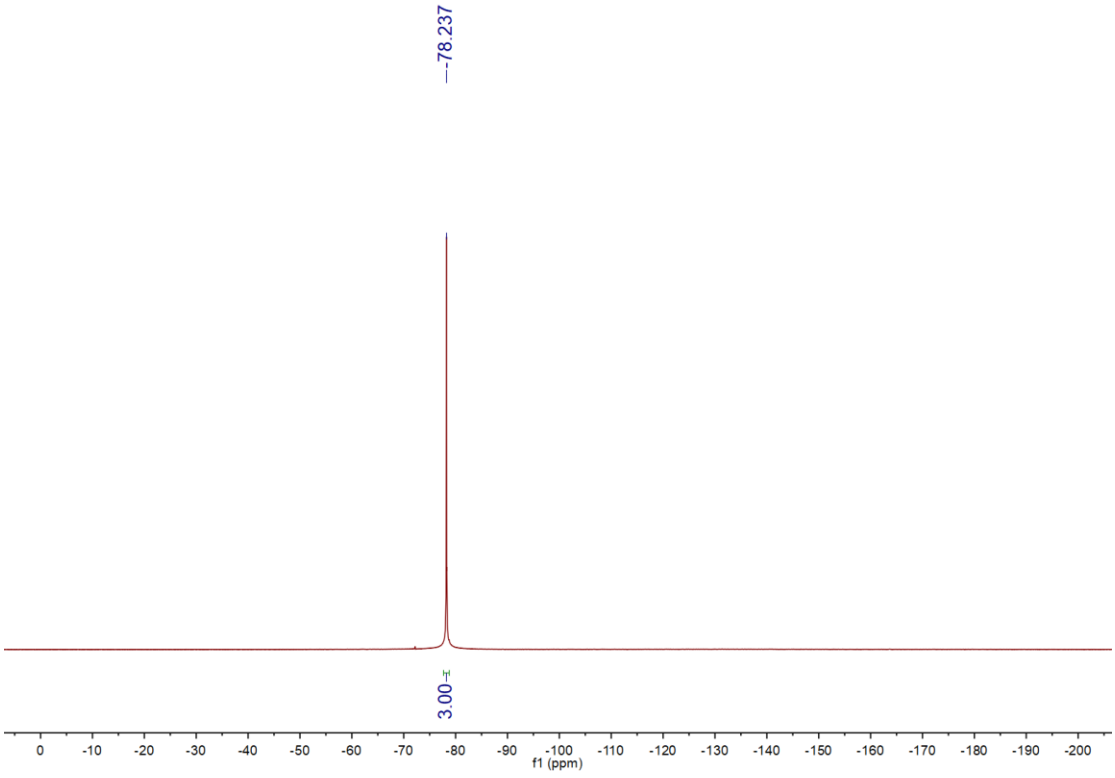

144.81
139.76
135.62
134.93
134.90
132.33
130.30
129.91
129.04
128.95
128.76
128.53
128.30
127.38
126.54
126.03
125.77
123.25
115.87
115.65
70.45
70.14
69.84
69.53
48.62
29.18
22.88
21.76
f1 (ppm)

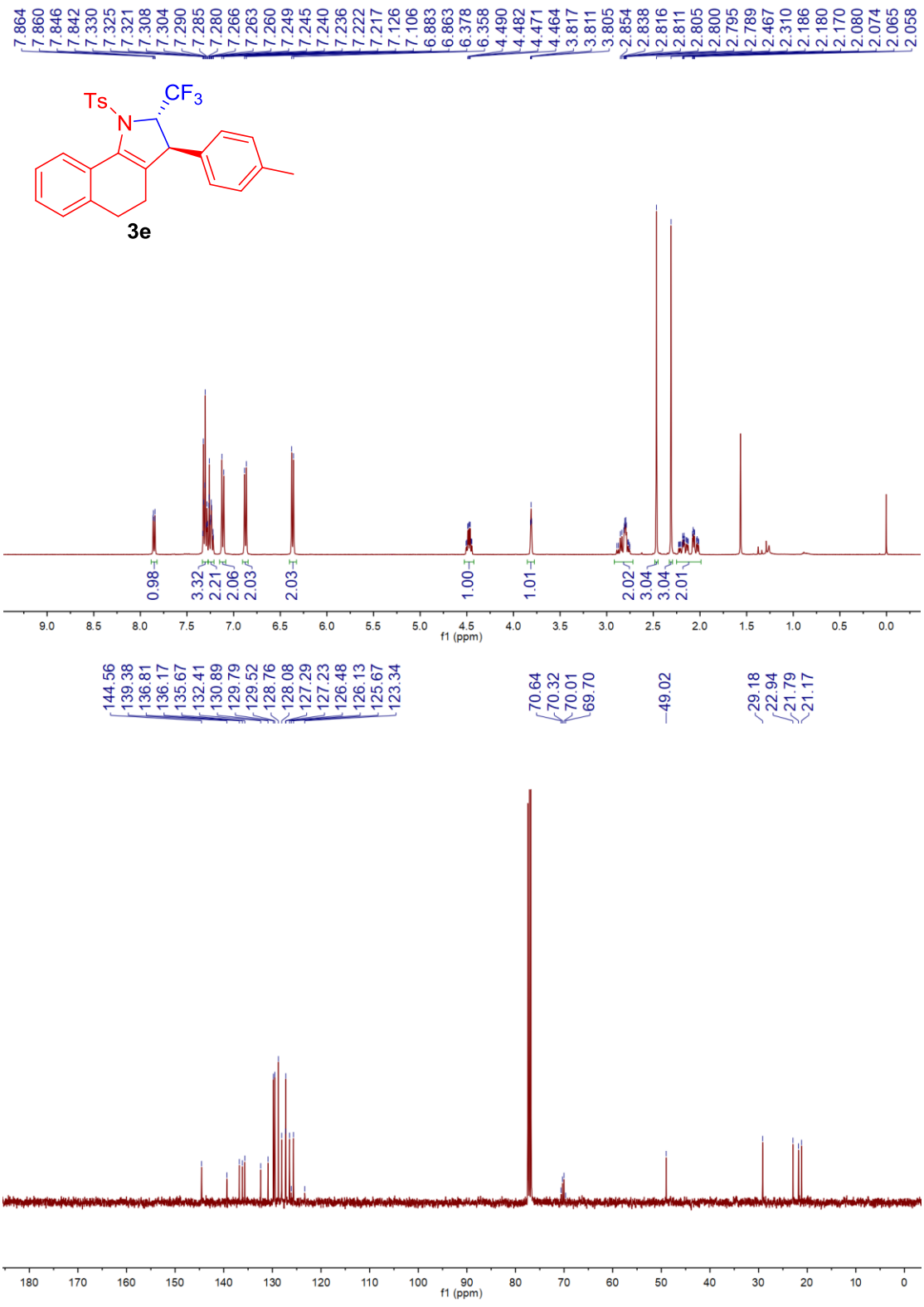

-78.200
-114.621
3.06
1.00
f1 (ppm)

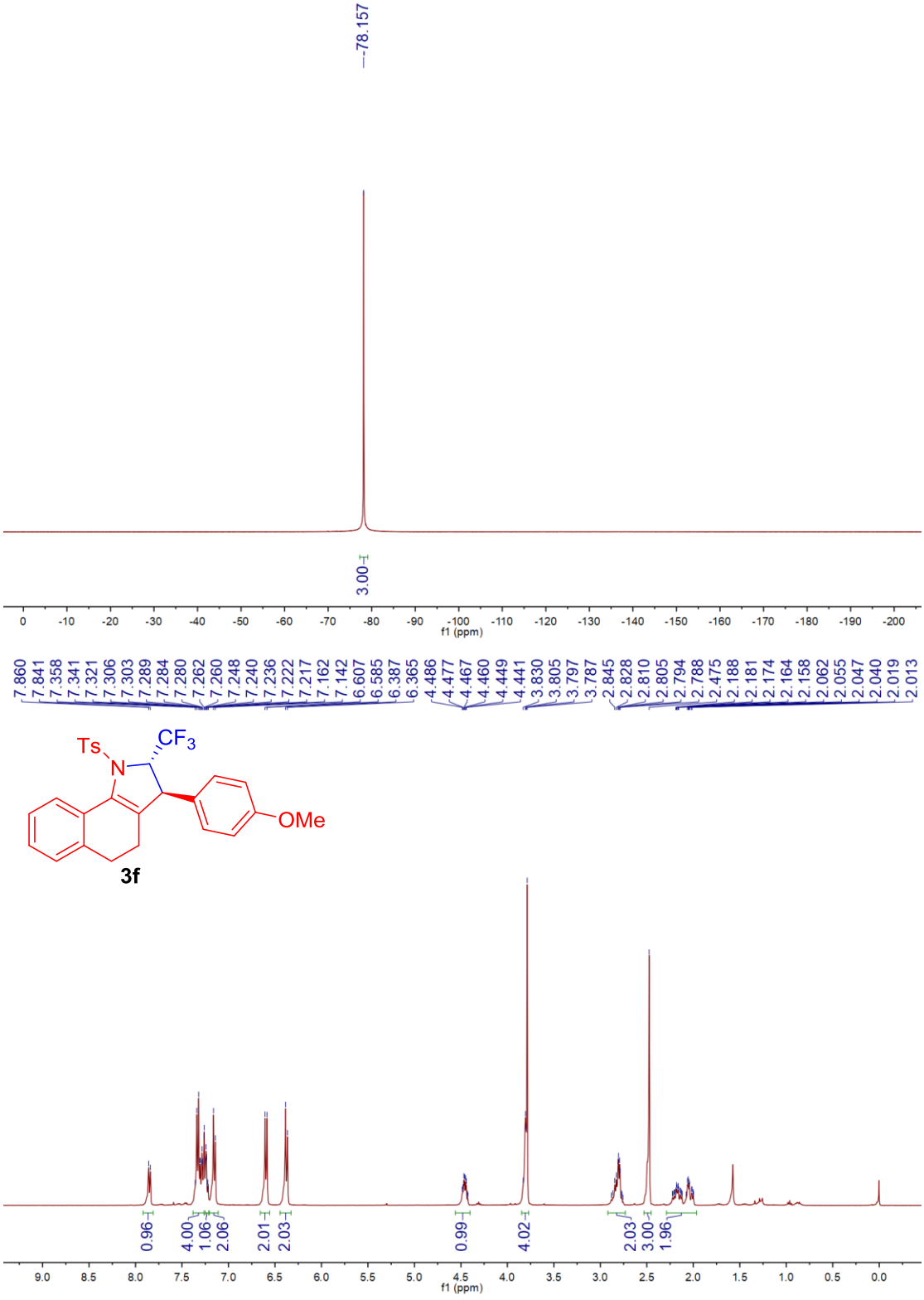

7.862
7.857
7.844
7.839
7.328
7.322
7.316
7.310
7.306
7.301
7.295
7.292
7.282
7.278
7.264
7.260
7.253
7.249
7.236
7.230
7.140
7.119
7.061
7.055
7.050
7.038
7.033
7.027
6.464
6.458
6.453
6.442
6.437
4.476
4.469
4.458
4.451
3.821
3.814
3.808
2.877
2.861
2.842
2.837
2.826
2.819
2.479
2.075
2.067
2.060
2.053
Ts
N
CF3
Cl
3c
0.99
4.08
1.02
2.06
2.03
2.04
1.00
1.00
2.03
3.00
2.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
144.93
140.00
137.65
135.58
133.07
132.33
129.92
129.85
129.03
128.70
128.63
128.48
128.34
127.36
126.56
125.97
125.81
123.19
70.44
70.13
69.82
69.51
48.61
29.14
22.95
21.76
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

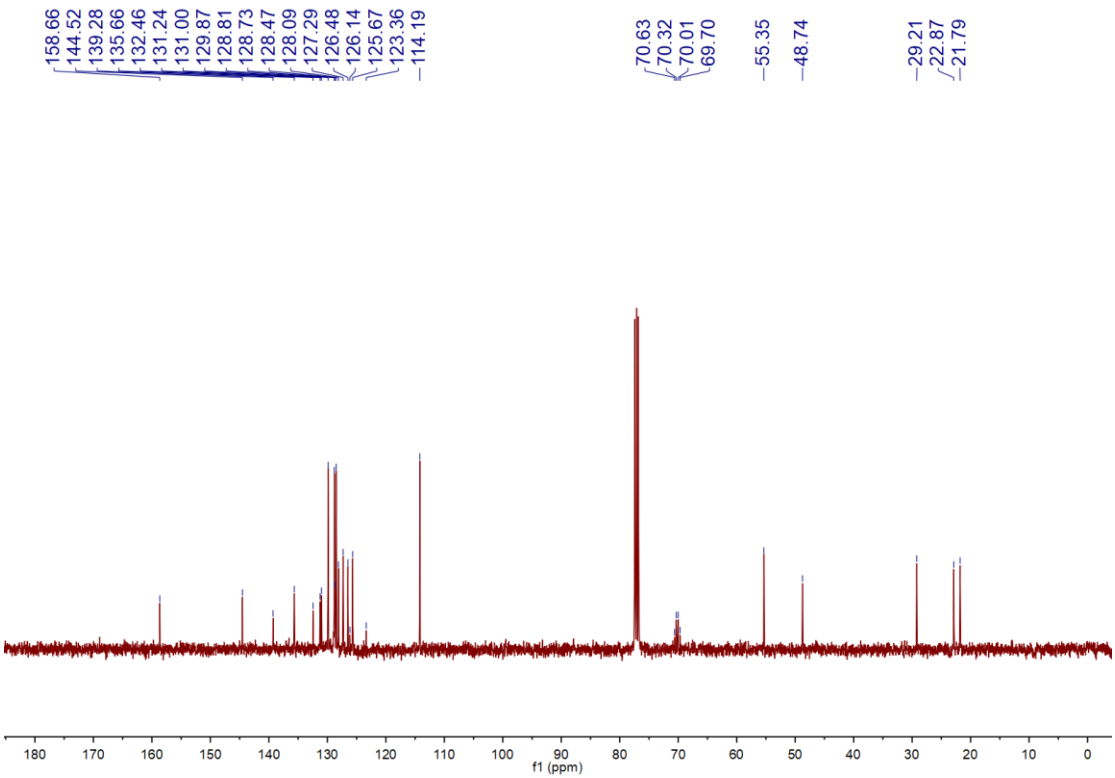

-78.207
3.00
f1 (ppm)
7.854
7.850
7.837
7.832
7.332
7.328
7.320
7.315
7.309
7.299
7.292
7.280
7.276
7.262
7.260
7.250
7.245
7.232
7.228
7.207
7.186
7.136
7.116
6.409
6.388
4.477
4.470
4.459
4.452
3.799
3.793
3.786
2.874
2.859
2.840
2.836
2.824
2.818
2.483
2.223
2.216
2.206
2.200
2.075
2.068
2.061
2.054
2.032
2.027
2.016
2.010
Ts
N
CF3
Br
3d
0.96
4.12
1.06
2.04
2.05
2.02
1.00
1.00
2.02
3.03
2.02
f1 (ppm)

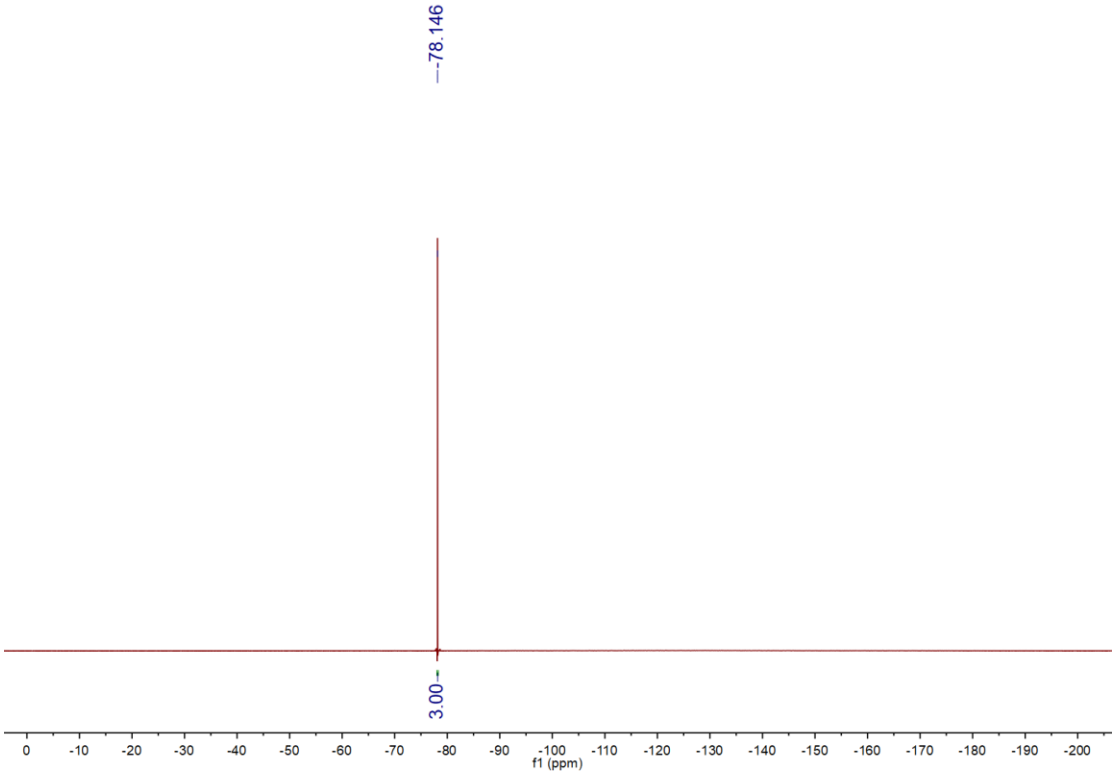

144.97
140.05
138.17
135.56
132.32
132.00
129.85
128.93
128.68
128.46
128.35
127.36
126.56
125.94
125.83
123.15
121.11
70.40
70.08
69.77
69.46
48.64
29.13
22.97
21.78
f1 (ppm)

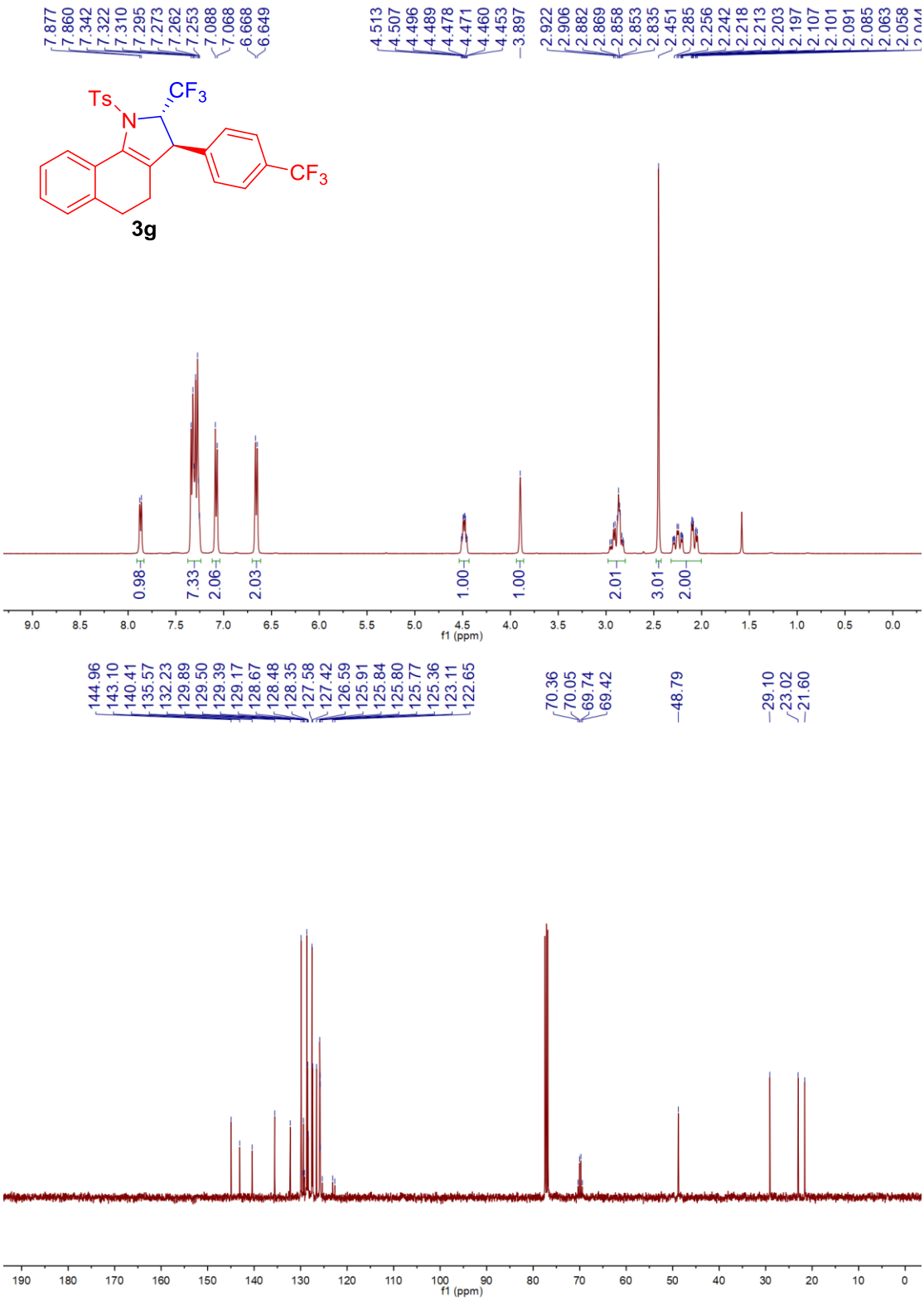

-78.237
3.00
f1 (ppm)

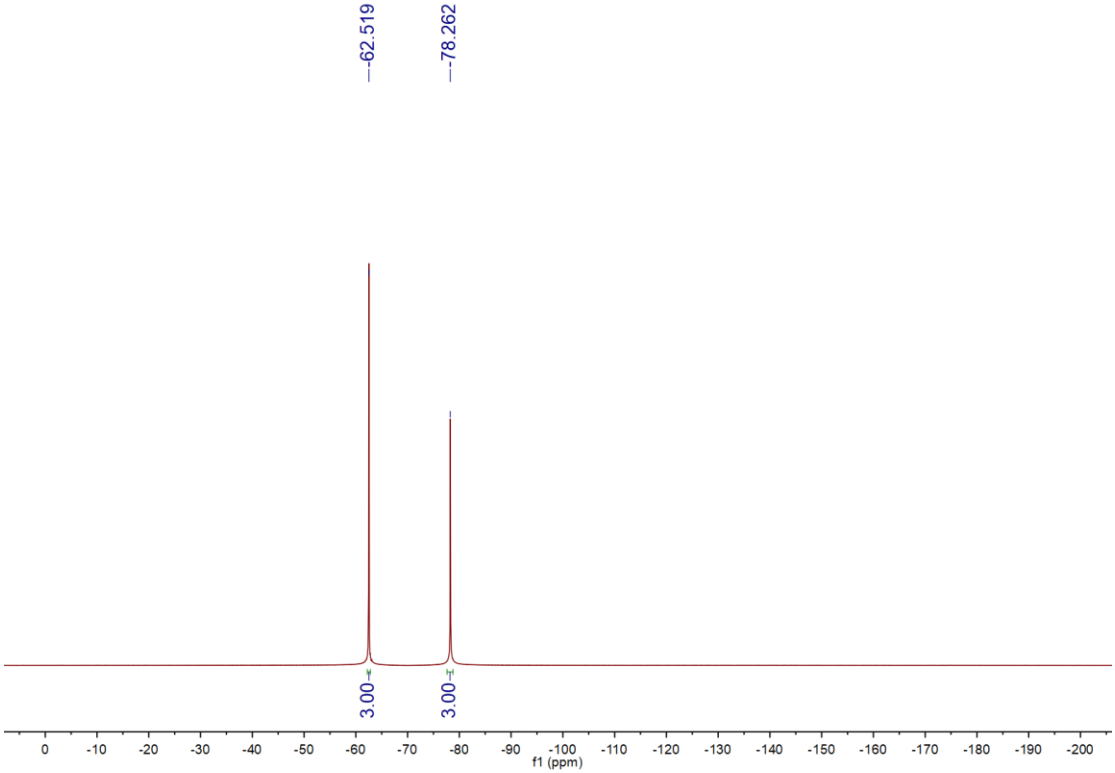

7.864
7.860
7.846
7.842
7.330
7.325
7.321
7.308
7.304
7.290
7.285
7.280
7.266
7.263
7.260
7.249
7.245
7.240
7.236
7.222
7.217
7.126
7.106
6.883
6.863
6.378
6.358
4.490
4.482
4.471
4.464
3.817
3.811
3.805
2.854
2.838
2.816
2.811
2.805
2.800
2.795
2.789
2.467
2.310
2.186
2.180
2.170
2.080
2.074
2.065
2.058
Ts
N
CF3
3e
0.98
3.32
2.21
2.06
2.03
2.03
1.00
1.01
2.02
3.04
3.04
2.01
f1 (ppm)
144.56
139.38
136.81
136.17
135.67
132.41
130.89
129.79
129.52
128.76
128.08
127.29
127.23
126.48
126.13
125.67
123.34
70.64
70.32
70.01
69.70
49.02
29.18
22.94
21.79
21.17
f1 (ppm)


-78.157
3.00
f1 (ppm)
7.860
7.841
7.358
7.341
7.321
7.306
7.303
7.289
7.284
7.280
7.262
7.260
7.248
7.240
7.236
7.222
7.217
7.162
7.142
6.607
6.585
6.387
6.365
4.486
4.477
4.467
4.460
4.449
4.441
3.830
3.805
3.797
3.787
2.845
2.828
2.810
2.805
2.794
2.788
2.475
2.188
2.181
2.174
2.164
2.158
2.062
2.055
2.047
2.040
2.019
2.013
Ts
N
CF3
OMe
3f
0.96
4.00
1.06
2.06
2.01
2.03
0.99
4.02
2.03
3.00
1.96
f1 (ppm)

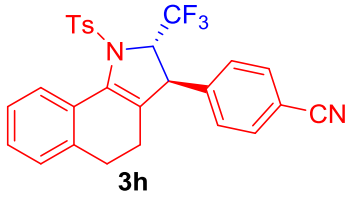

158.66
144.52
139.28
135.66
132.46
131.24
131.00
129.87
128.81
128.73
128.47
128.09
127.29
126.48
126.14
125.67
123.36
114.19
70.63
70.32
70.01
69.70
55.35
48.74
29.21
22.87
21.79
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-78.146
3.00
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200
f1 (ppm)

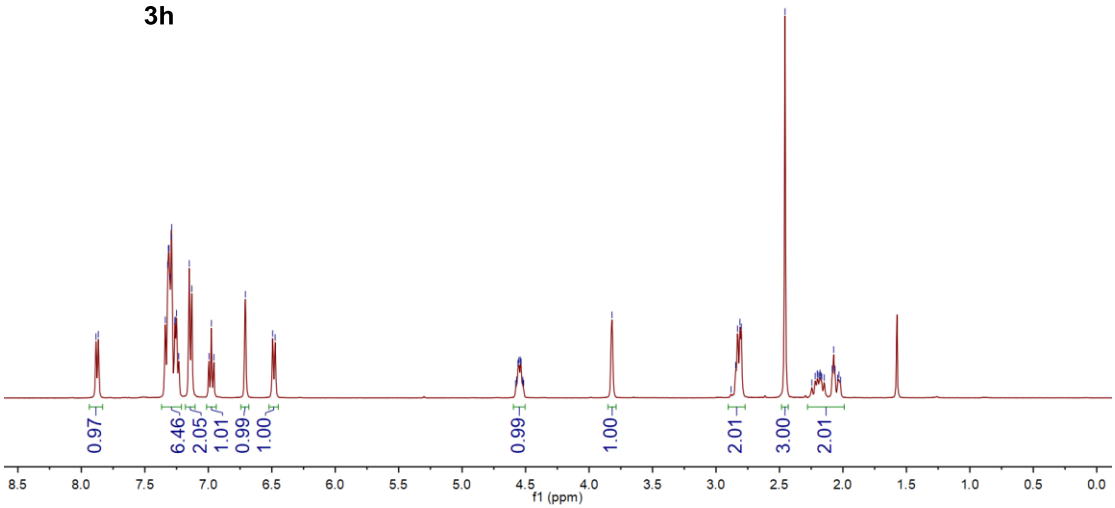

7.877
7.860
7.342
7.322
7.310
7.295
7.273
7.262
7.253
7.088
7.068
6.668
6.649
4.513
4.507
4.496
4.489
4.478
4.471
4.460
4.453
3.897
2.922
2.906
2.882
2.869
2.858
2.853
2.835
2.451
2.285
2.256
2.242
2.218
2.213
2.203
2.197
2.107
2.101
2.091
2.085
2.063
2.058
Ts
N
CF3
CF3
3g
0.98
7.33
2.06
2.03
1.00
1.00
2.01
3.01
2.00
f1 (ppm)
144.96
143.10
140.41
135.57
132.23
129.89
129.50
129.39
129.17
128.67
128.48
128.35
127.58
127.42
126.59
125.91
125.84
125.80
125.77
125.36
123.11
122.65
70.36
70.05
69.74
69.42
48.79
29.10
23.02
21.60
f1 (ppm)

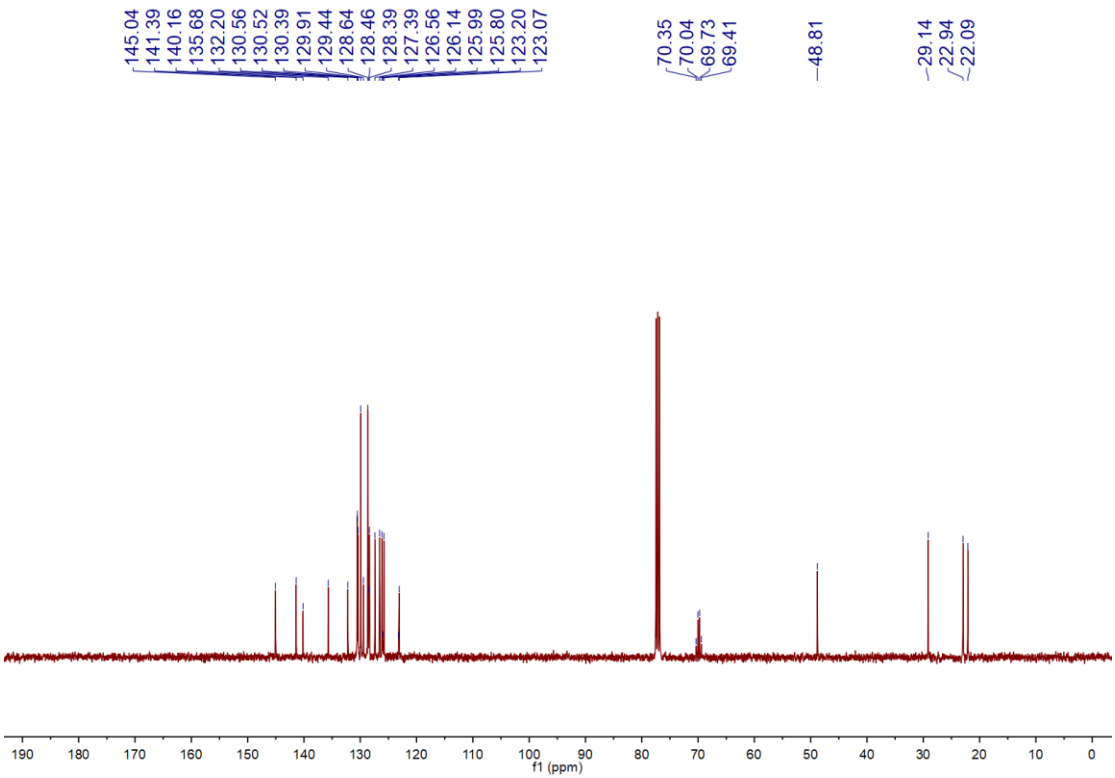

-62.519
-78.262
3.00
3.00
f1 (ppm)

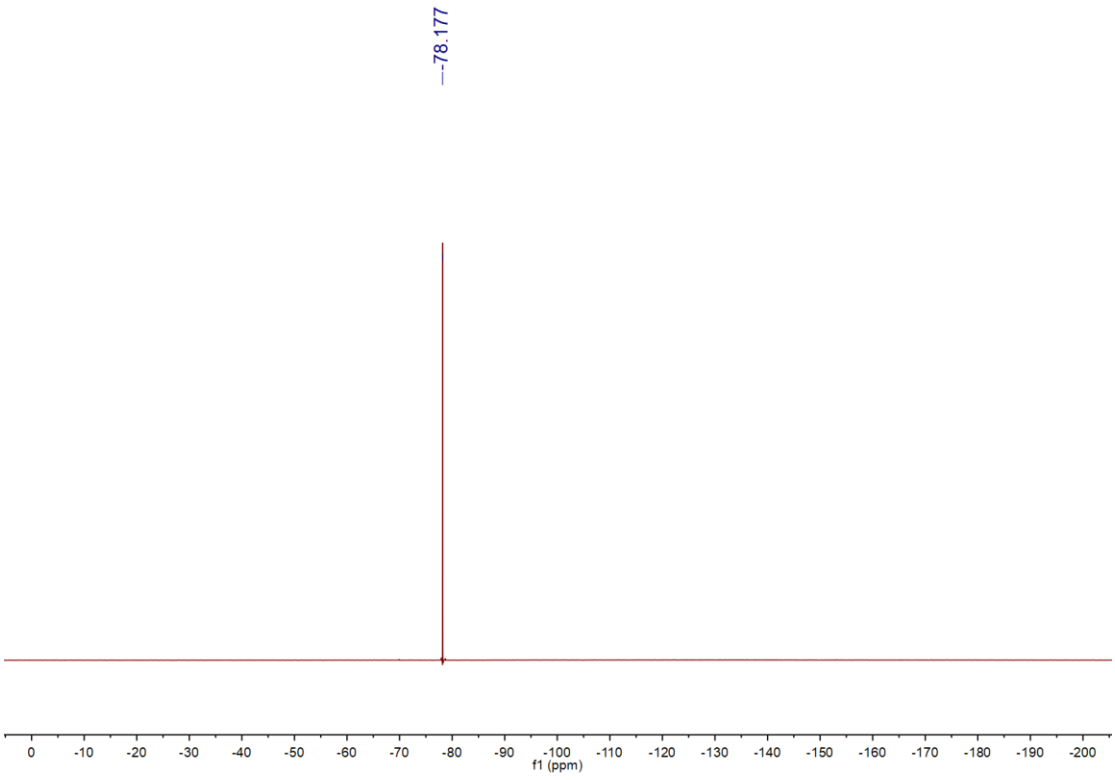

7.885
7.867
7.339
7.321
7.314
7.309
7.302
7.293
7.289
7.264
7.259
7.250
7.233
7.150
7.131
6.995
6.976
6.956
6.708
6.493
6.474
4.579
4.571
4.561
4.553
4.543
4.535
4.522
4.515
3.820
2.882
2.845
2.830
2.811
2.800
2.457
2.245
2.218
2.201
2.197
2.185
2.180
2.175
2.167
2.147
2.084
2.073
2.062
2.041
2.031
2.019

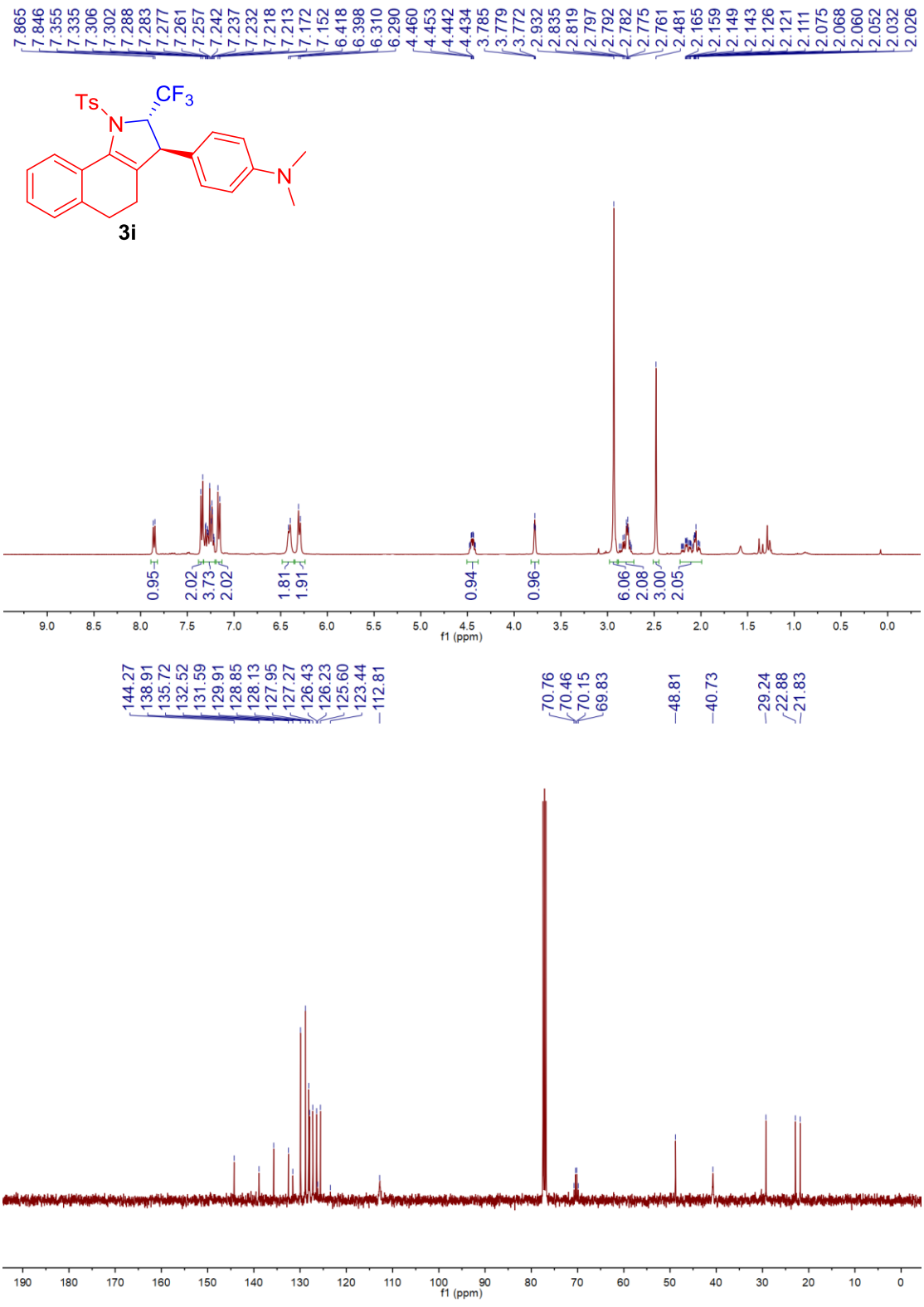

Ts
N
CF3
CN

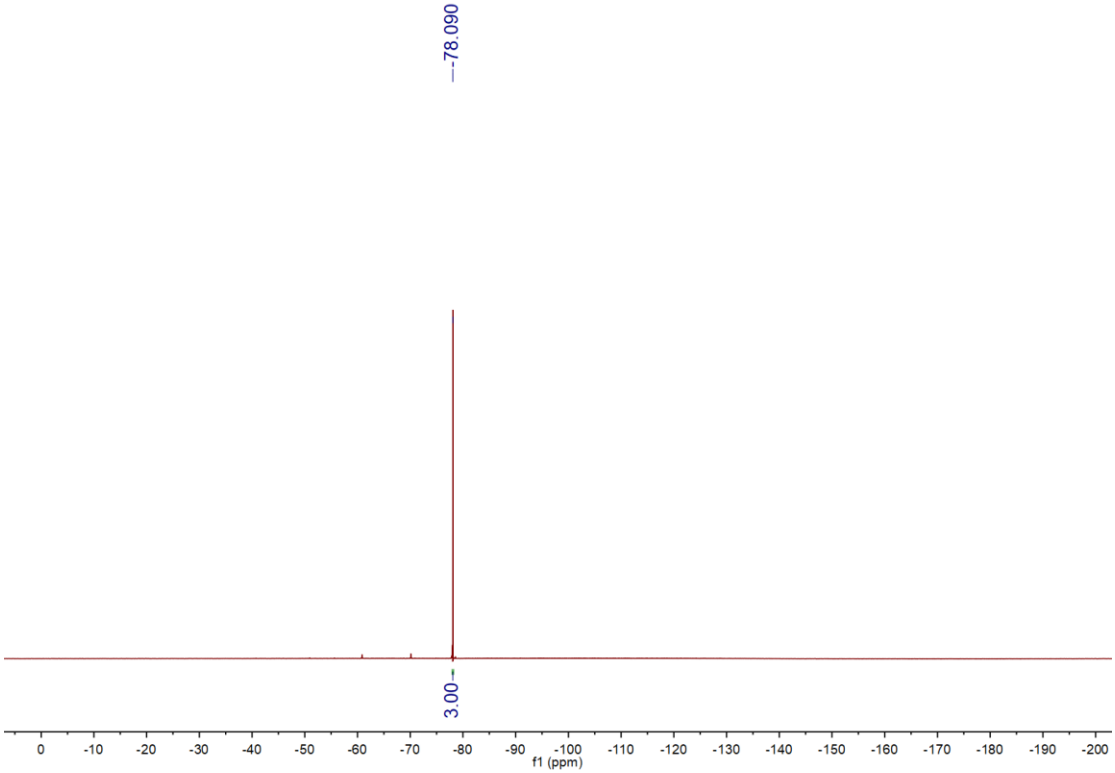
3h

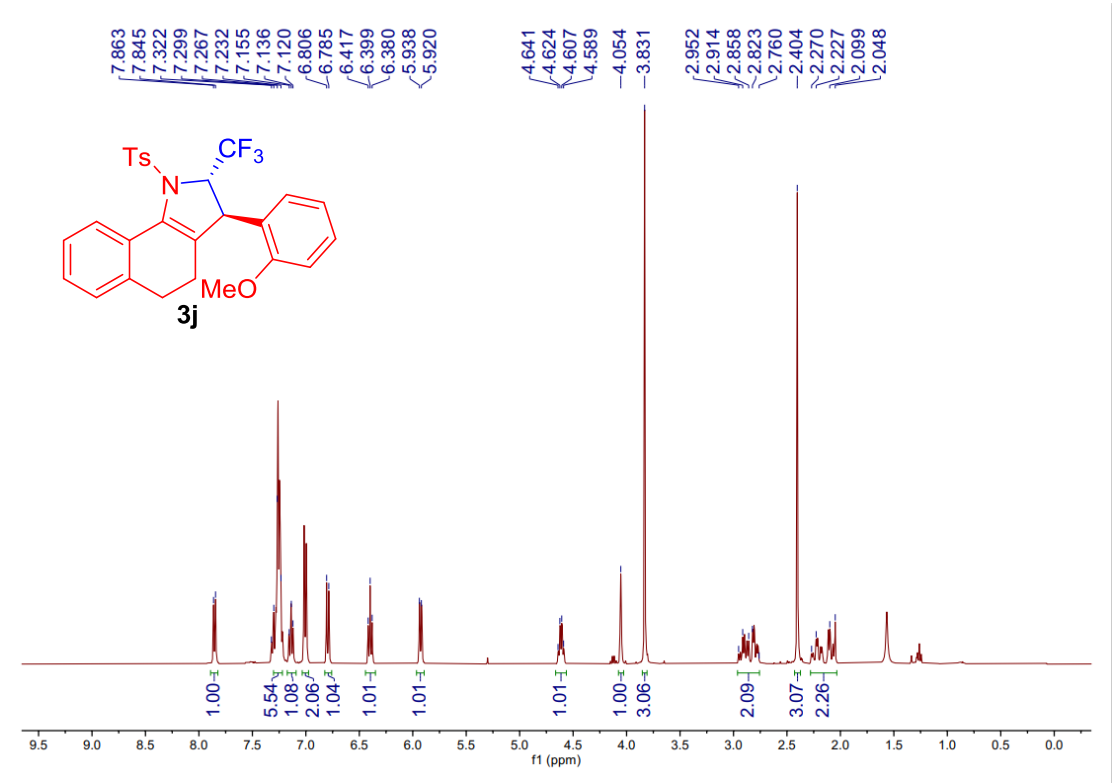

0.97
6.46
2.05
1.01
0.99
1.00
0.99
1.00
2.01
3.00
2.01
f1 (ppm)

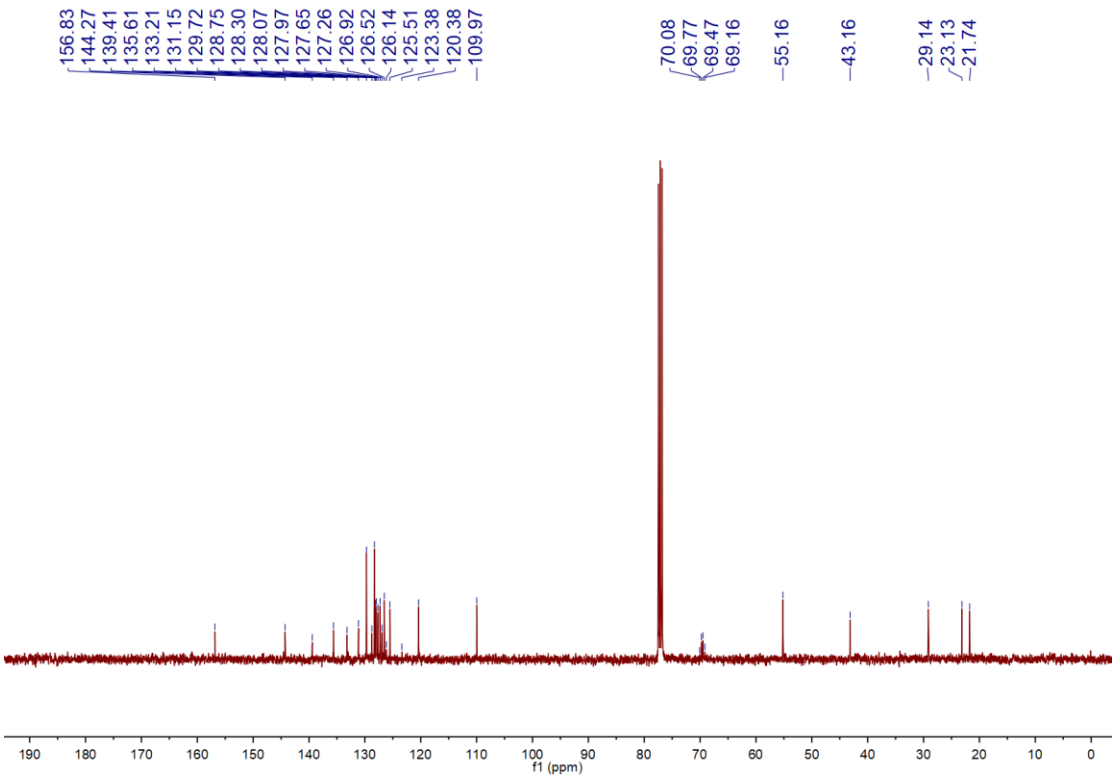

145.04
141.39
140.16
135.68
132.20
130.56
130.52
130.39
129.91
129.44
128.64
128.46
128.39
127.39
126.56
126.14
125.99
125.80
123.20
123.07
70.35
70.04
69.73
69.41
48.81
29.14
22.94
22.09
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

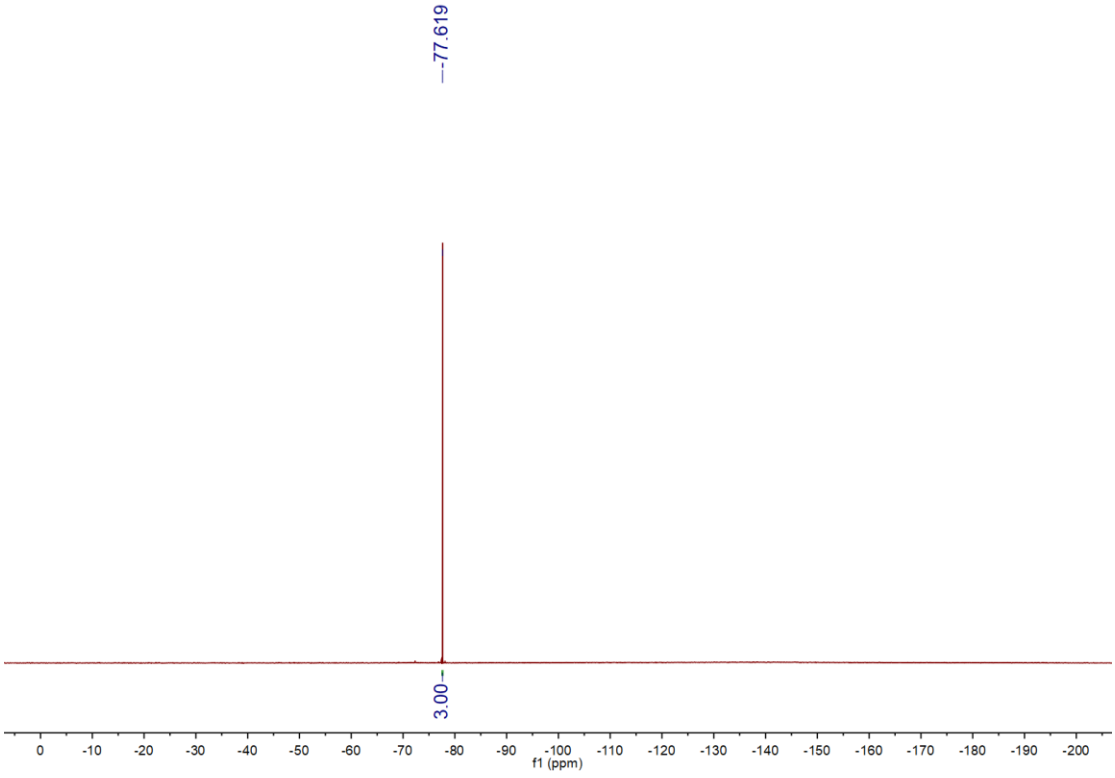

78.177
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200
f1 (ppm)

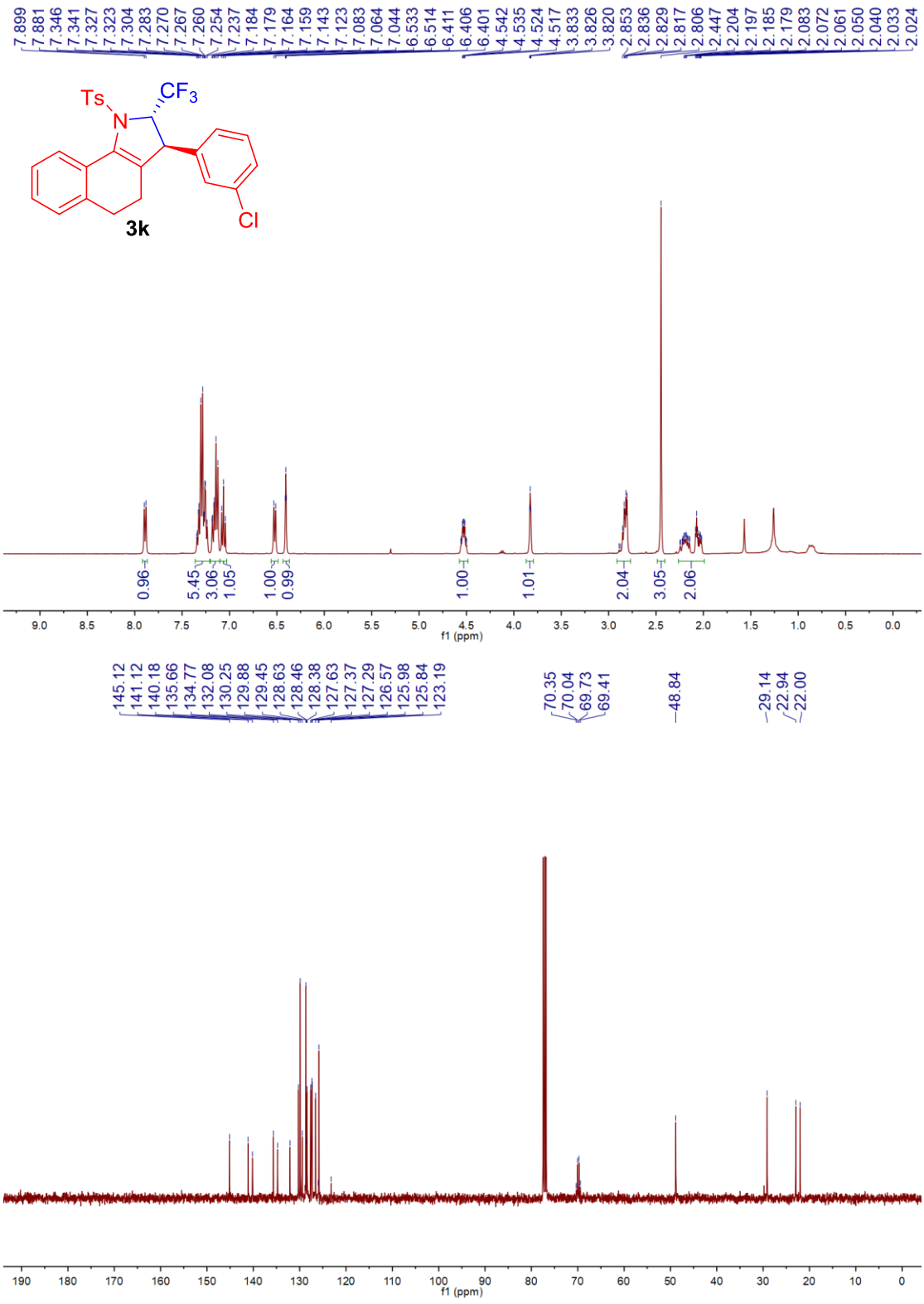

7.865
7.846
7.355
7.335
7.306
7.302
7.288
7.283
7.277
7.261
7.257
7.242
7.237
7.232
7.218
7.213
7.172
7.152
6.418
6.398
6.310
6.290
4.460
4.453
4.442
4.434
3.785
3.779
3.772
2.932
2.835
2.819
2.797
2.792
2.782
2.775
2.761
2.481
2.165
2.159
2.149
2.143
2.126
2.121
2.111
2.075
2.068
2.060
2.052
2.032
2.026
Ts
N
CF3
N
3i
0.95
2.02
3.73
2.02
1.81
1.91
0.94
0.96
6.06
2.08
3.00
2.05
f1 (ppm)
144.27
138.91
135.72
132.52
131.59
129.91
128.85
128.13
127.95
127.27
126.43
126.23
125.60
123.44
112.81
70.76
70.46
70.15
69.83
48.81
40.73
29.24
22.88
21.83
f1 (ppm)

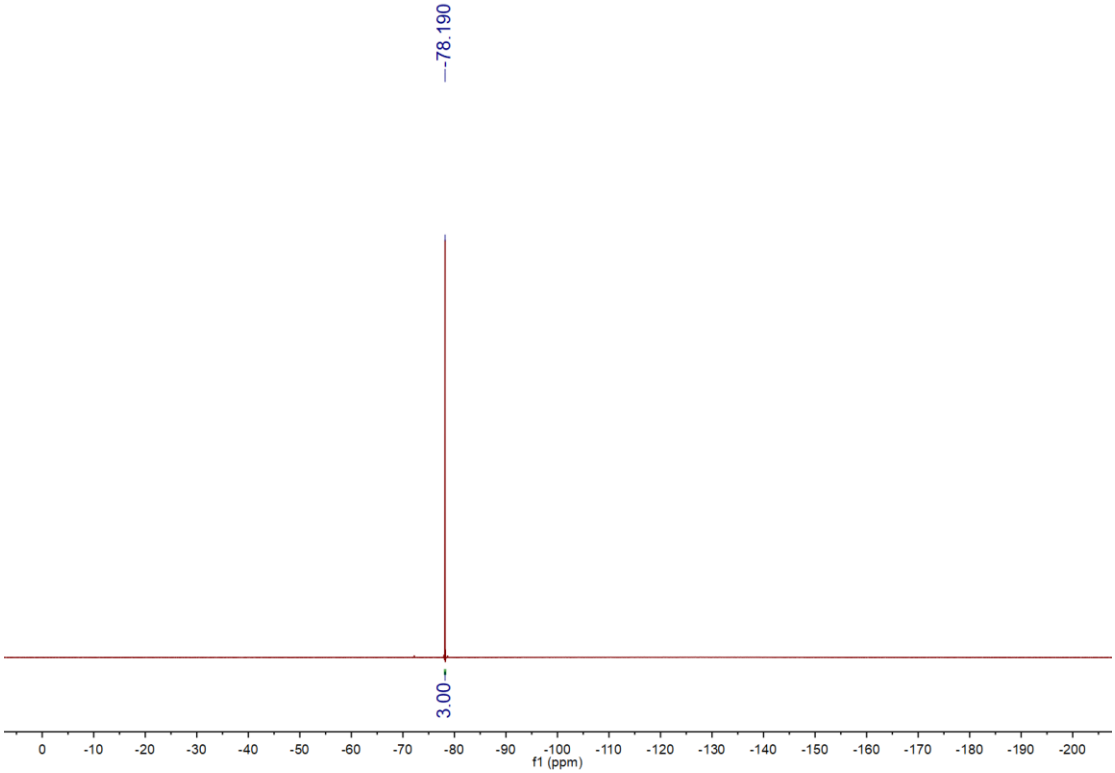

-78.090
3.00
f1 (ppm)

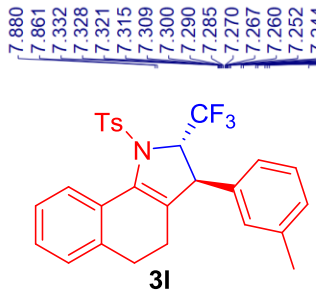

7.863
7.845
7.322
7.299
7.267
7.232
7.155
7.136
7.120
6.806
6.785
6.417
6.399
6.380
5.938
5.920
4.641
4.624
4.607
4.589
4.054
3.831
2.952
2.914
2.858
2.823
2.760
2.404
2.270
2.227
2.099
2.048
Ts
N
CF3
MeO
3j
1.00
5.54
1.08
2.06
1.04
1.01
1.01
1.01
1.00
3.06
2.09
3.07
2.26
f1 (ppm)


156.83
144.27
139.41
135.61
133.21
131.15
129.72
128.75
128.30
128.07
127.97
127.65
127.26
126.92
126.52
126.14
125.51
123.38
120.38
109.97
70.08
69.77
69.47
69.16
55.16
43.16
29.14
23.13
21.74
f1 (ppm)

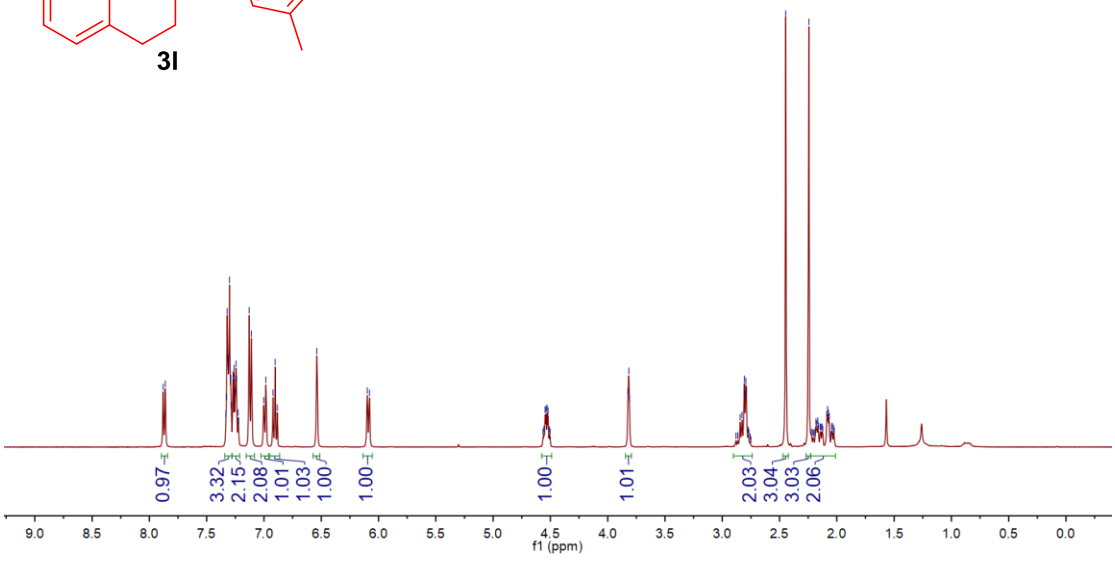

-77.619
3.00
f1 (ppm)

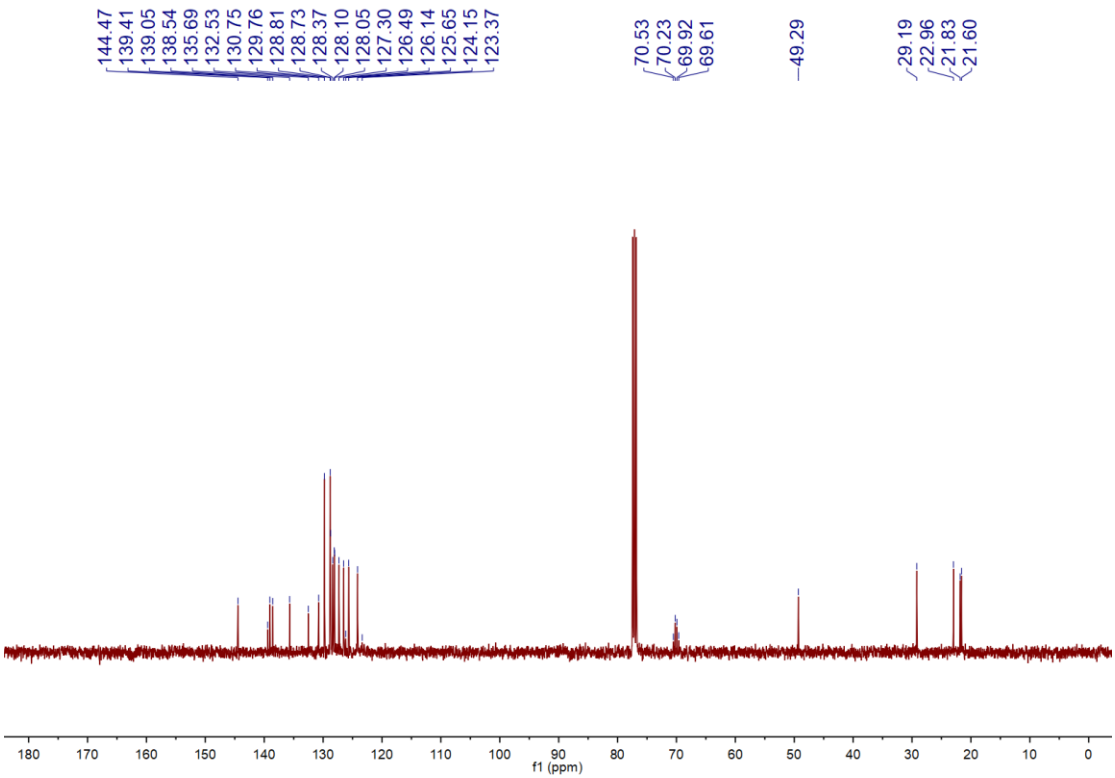

7.899
7.881
7.346
7.341
7.327
7.323
7.304
7.283
7.270
7.267
7.260
7.254
7.237
7.184
7.179
7.164
7.159
7.143
7.123
7.083
7.064
7.044
6.533
6.514
6.411
6.406
6.401
4.542
4.535
4.524
4.517
3.833
3.826
3.820
2.853
2.836
2.829
2.817
2.806
2.447
2.204
2.197
2.185
2.179
2.083
2.072
2.061
2.050
2.040
2.033
2.024
Ts
N
CF3
Cl
3k
0.96
5.45
3.06
1.05
1.00
0.99
1.00
1.01
2.04
3.05
2.06
f1 (ppm)
145.12
141.12
140.18
135.66
134.77
132.08
130.25
129.88
129.45
128.63
128.46
128.38
127.63
127.37
127.29
126.57
125.98
125.84
123.19
70.35
70.04
69.73
69.41
48.84
29.14
22.94
22.00
f1 (ppm)

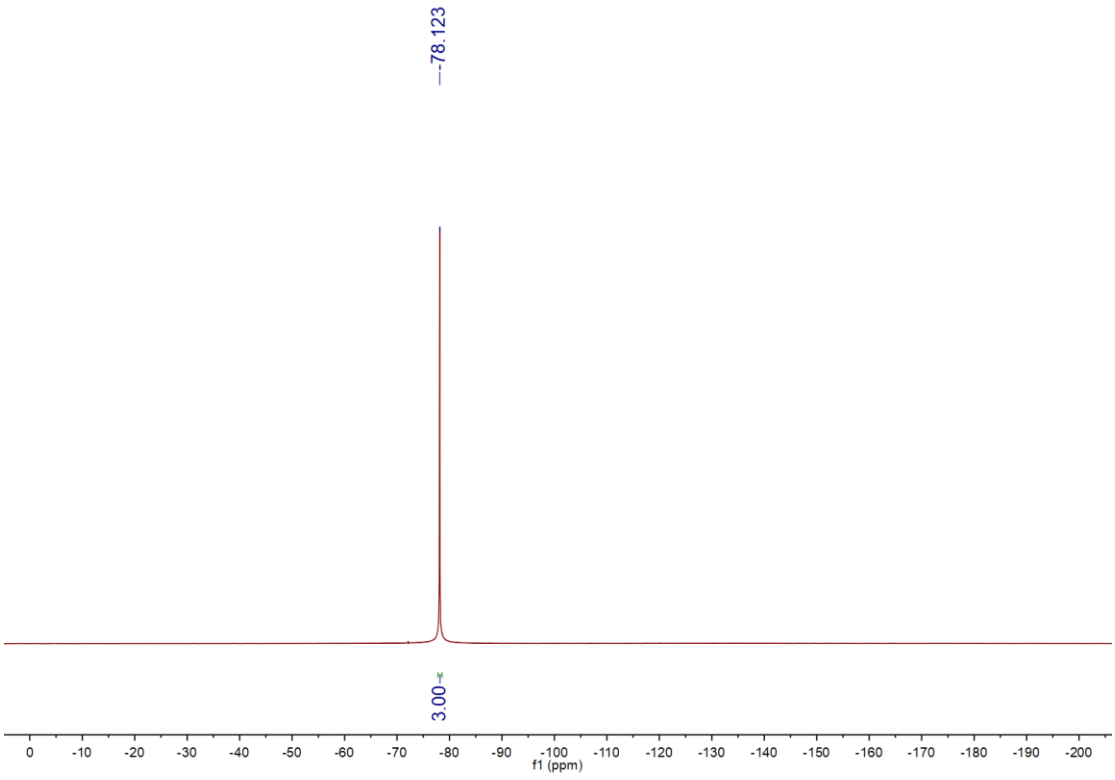

-78.190
3.00
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
f1 (ppm)


Ts
N
CF3

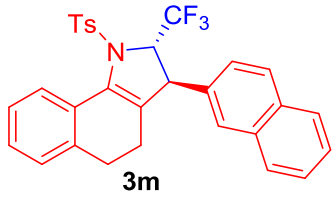
3l


0.97
3.32
2.15
2.08
1.01
1.03
1.00
1.00
1.00
1.01
2.03
3.04
3.03
2.06
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


144.47
139.41
139.05
138.54
135.69
132.53
130.75
129.76
128.81
128.73
128.37
128.10
128.05
127.30
126.49
126.14
125.65
124.15
123.37
70.53
70.23
69.92
69.61
49.29
29.19
22.96
21.83
21.60
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-78.123
3.00
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200
f1 (ppm)

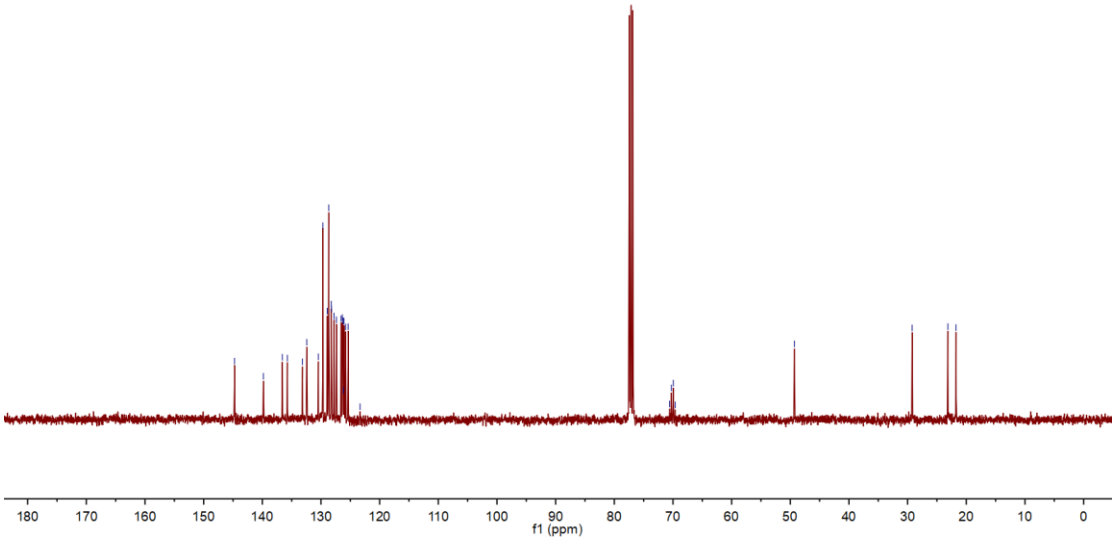

7.937
7.916
7.816
7.803
7.793
7.649
7.628
7.499
7.482
7.474
7.460
7.358
7.340
7.320
7.301
7.280
7.260
7.241
6.926
6.906
6.859
6.823
6.802
4.673
4.666
4.656
4.648
4.016
2.996
2.941
2.902
2.870
2.820
2.260
2.200
2.182
2.157

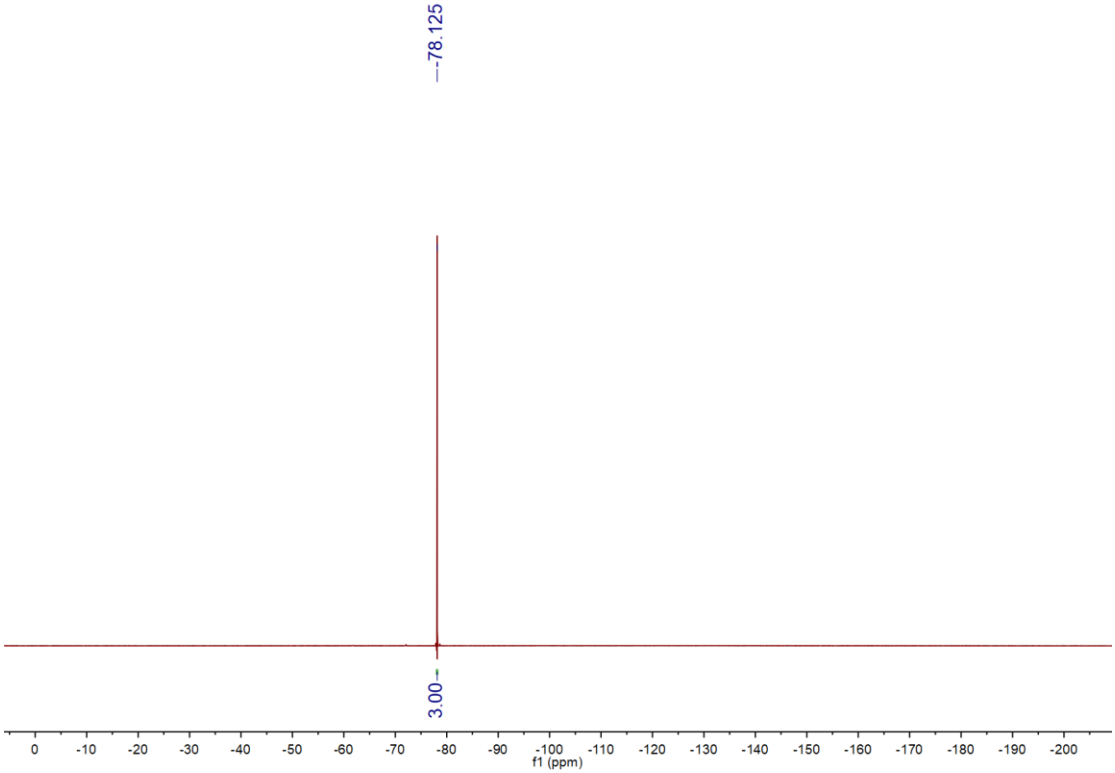

Ts
N
CF3

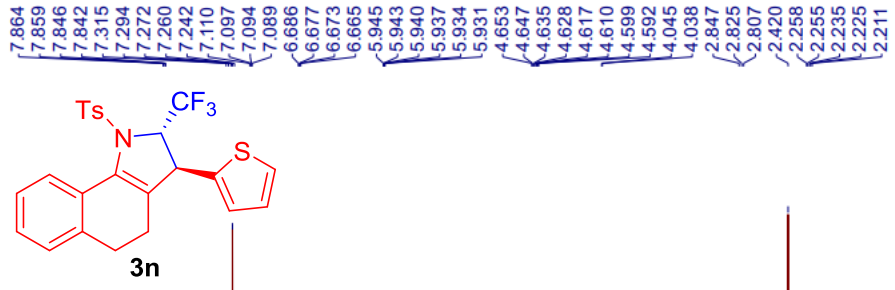
3m

1.00
1.02
1.00
3.10
5.26
2.03
1.01
1.00
1.00
1.01
2.04
4.96
f1 (ppm)


144.74
139.81
136.59
135.73
133.15
132.42
130.45
129.69
128.93
128.67
128.23
128.20
127.76
127.36
126.57
126.37
126.26
126.13
126.08
125.80
125.36
123.34
70.57
70.26
69.95
69.63
49.32
29.22
23.14
21.74

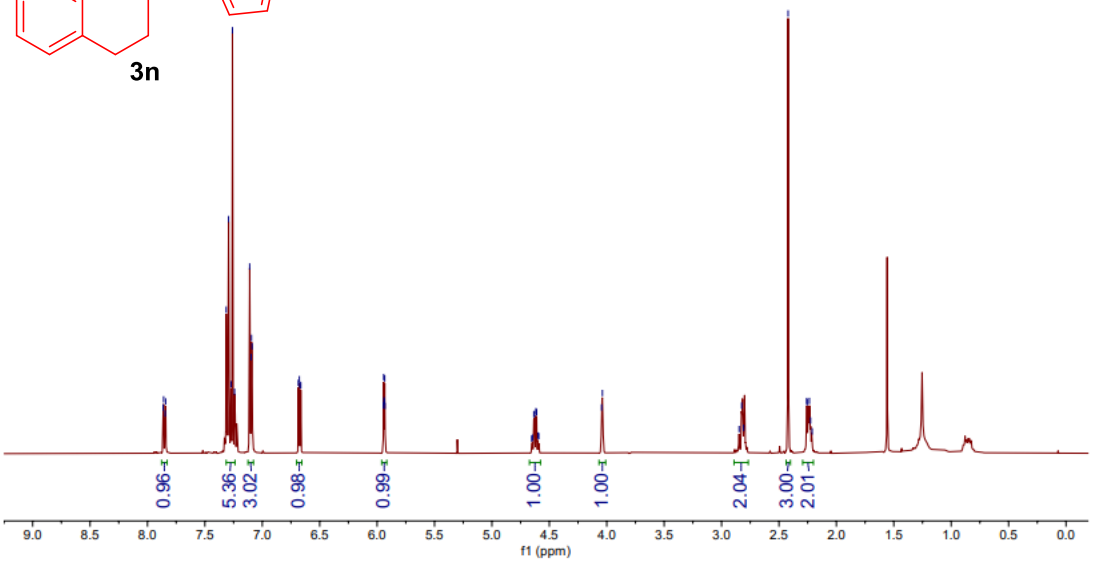

f1 (ppm)

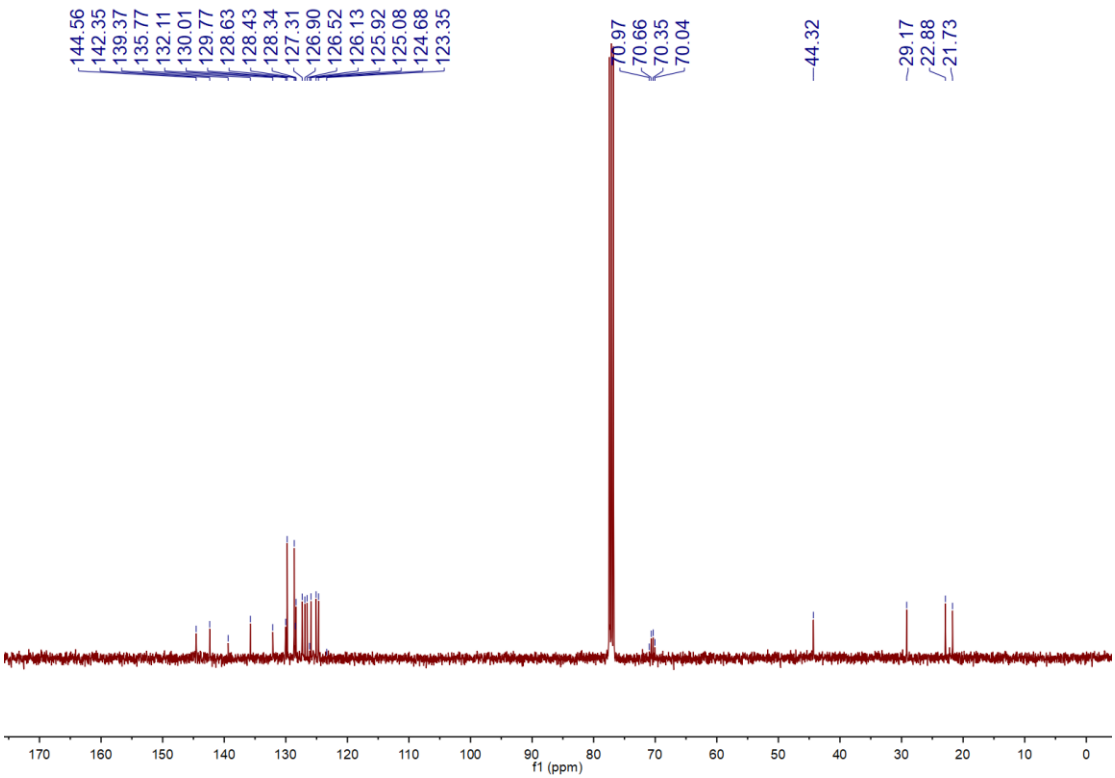

-78.125
3.00
f1 (ppm)

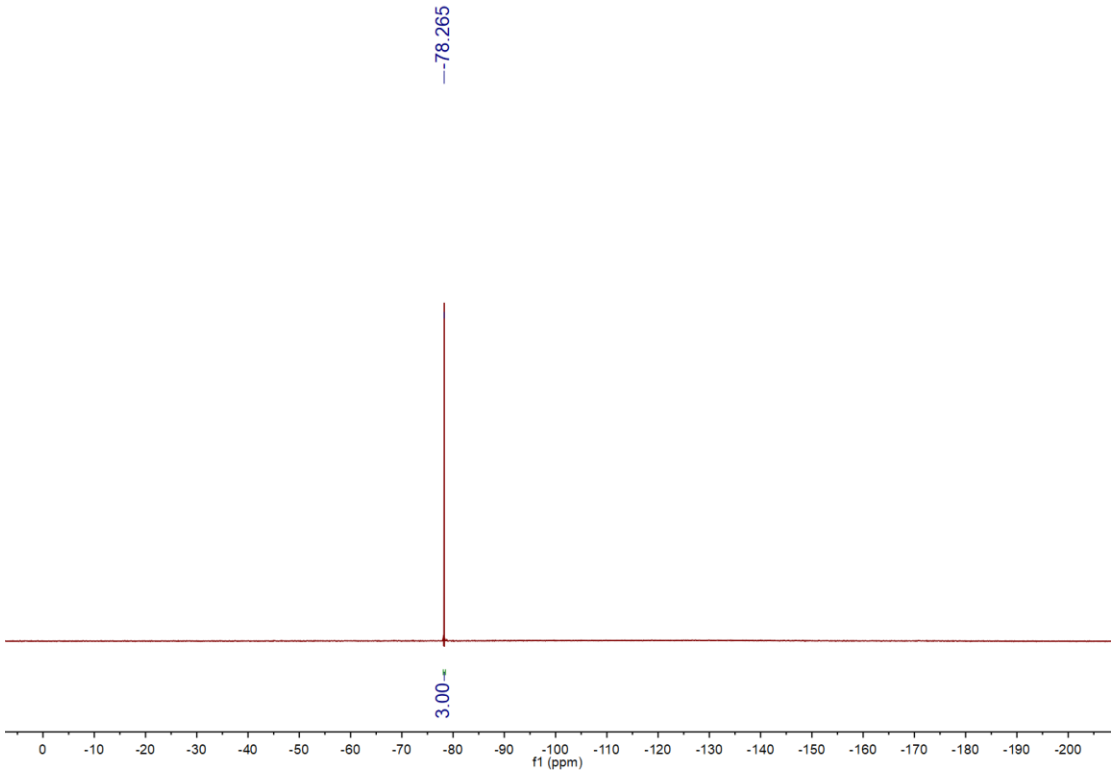

7.864
7.859
7.846
7.842
7.315
7.294
7.272
7.260
7.242
7.110
7.097
7.094
7.089
6.686
6.677
6.673
6.665
5.945
5.943
5.940
5.937
5.934
5.931
4.653
4.647
4.635
4.628
4.617
4.610
4.599
4.592
4.045
4.038
2.847
2.825
2.807
2.420
2.258
2.255
2.235
2.225
2.211

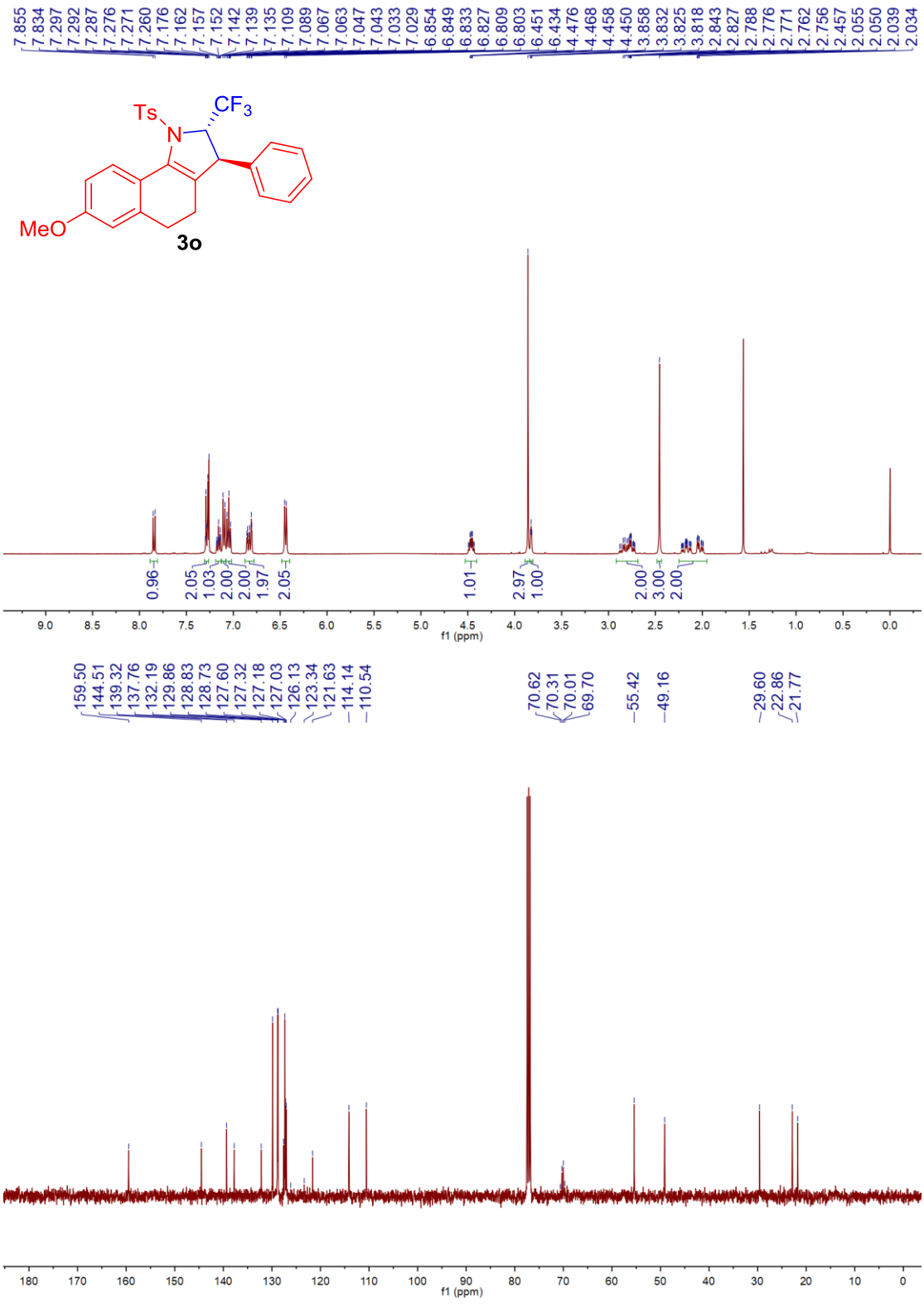
Ts
N
CF3
S

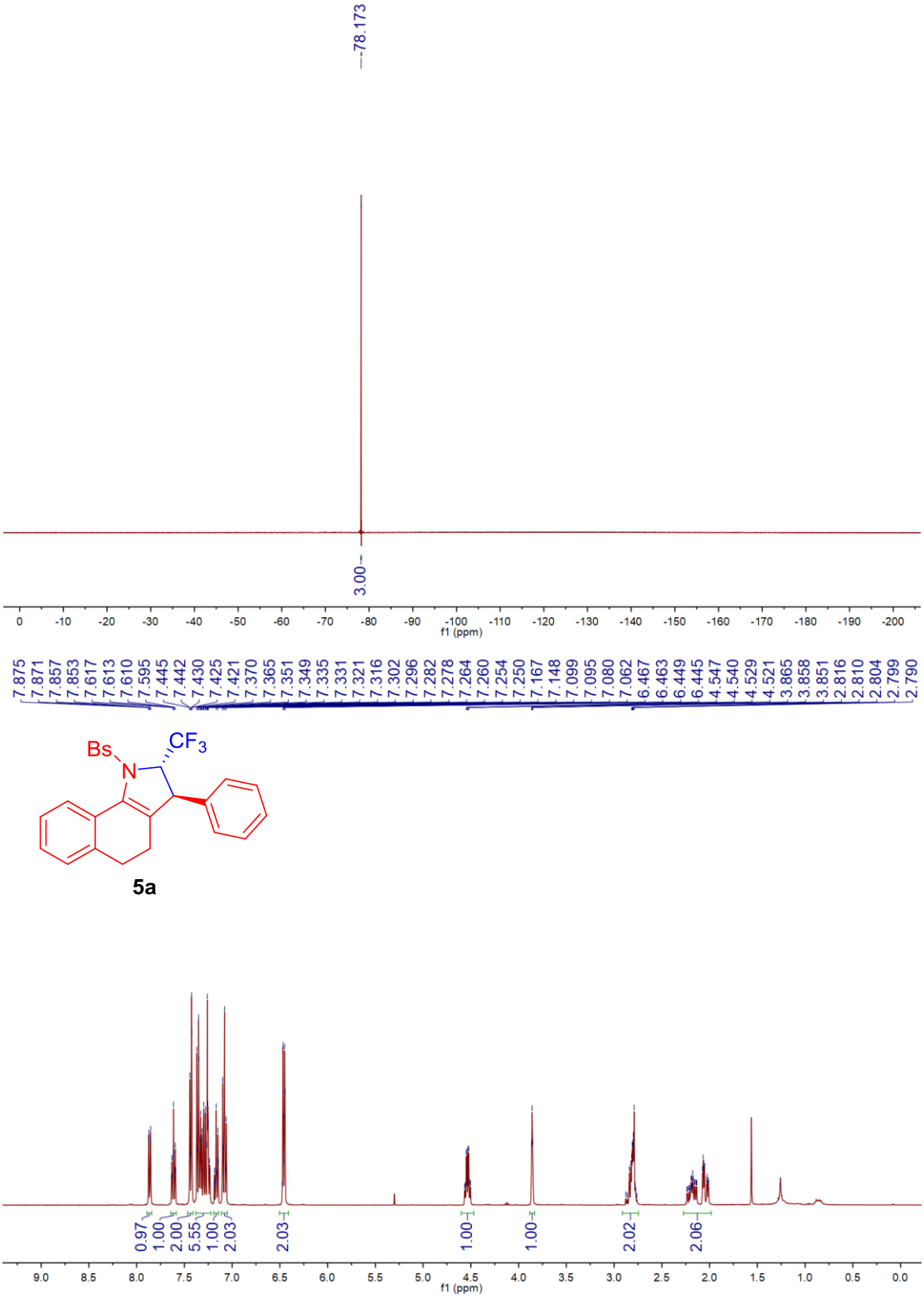
3n


0.96
5.36
3.02
0.98
0.99
1.00
1.00
2.04
3.00
2.01
f1 (ppm)

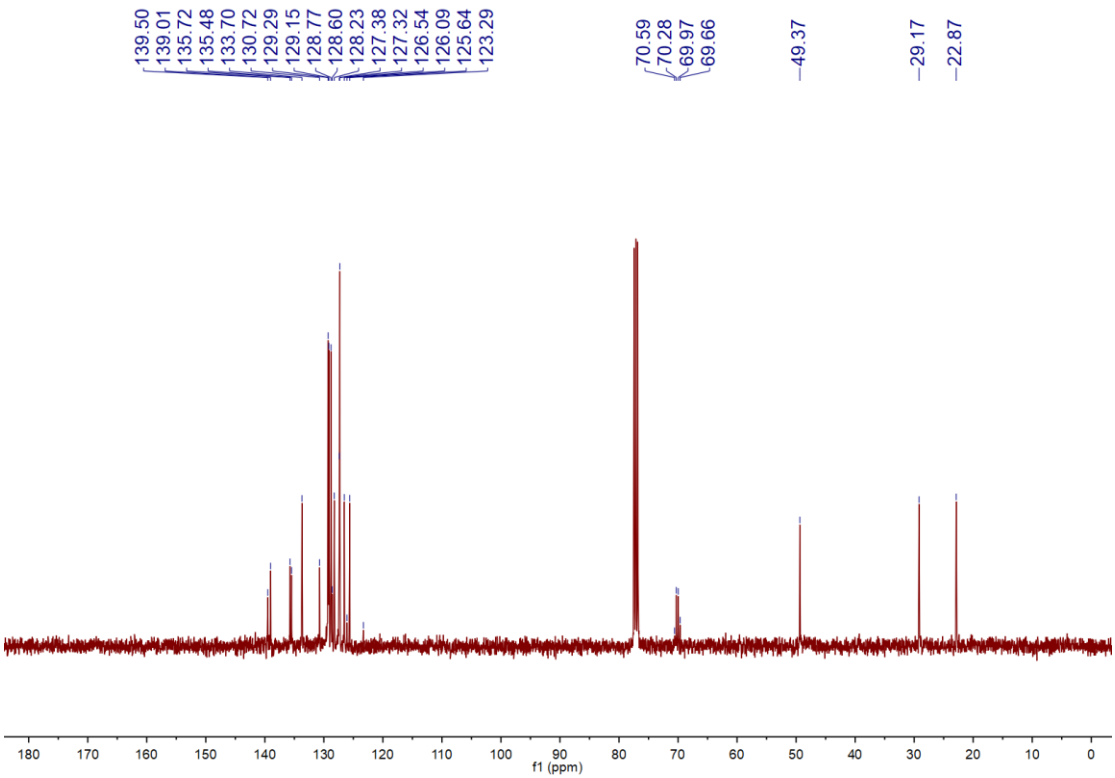

144.56
142.35
139.37
135.77
132.11
130.01
129.77
128.63
128.43
128.34
127.31
126.90
126.52
126.13
125.92
125.08
124.68
123.35
70.97
70.66
70.35
70.04
44.32
29.17
22.88
21.73
f1 (ppm)

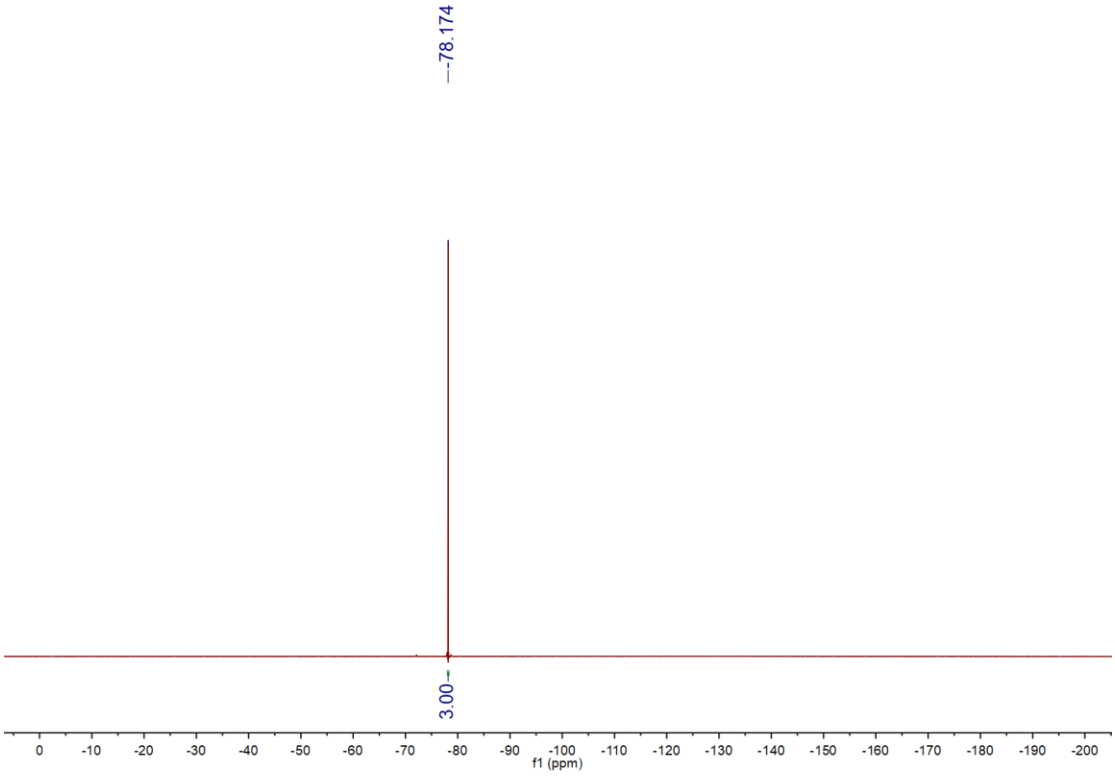

78.265
3.00
f1 (ppm)

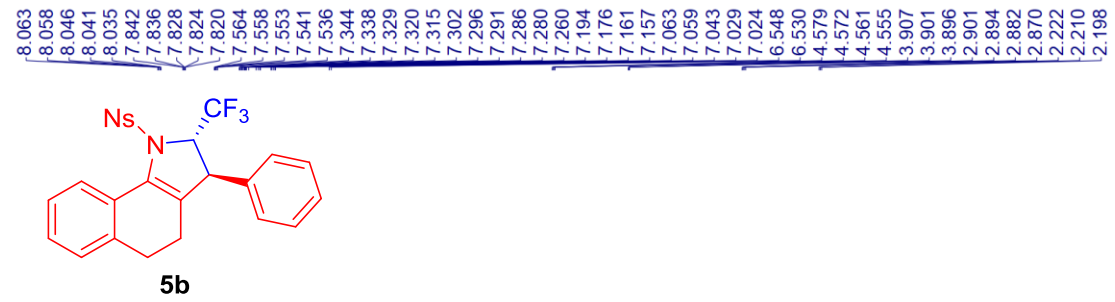

7.855
7.834
7.297
7.292
7.287
7.276
7.271
7.260
7.176
7.162
7.157
7.152
7.142
7.139
7.135
7.109
7.089
7.067
7.063
7.047
7.043
7.033
7.029
6.854
6.849
6.833
6.827
6.809
6.803
6.451
6.434
4.476
4.468
4.458
4.450
3.858
3.832
3.825
3.818
2.843
2.827
2.788
2.776
2.771
2.762
2.756
2.457
2.055
2.050
2.039
2.034
Ts
N
CF3
MeO
3o
0.96
2.05
1.03
2.00
2.00
1.97
2.05
1.01
2.97
1.00
2.00
3.00
2.00
f1 (ppm)
159.50
144.51
139.32
137.76
132.19
129.86
128.83
128.73
127.60
127.32
127.18
127.03
126.13
123.34
121.63
114.14
110.54
70.62
70.31
70.01
69.70
55.42
49.16
29.60
22.86
21.77
f1 (ppm)


-78.173
3.00
f1 (ppm)
7.875
7.871
7.857
7.853
7.617
7.613
7.610
7.595
7.445
7.442
7.430
7.425
7.421
7.370
7.365
7.351
7.349
7.335
7.331
7.321
7.316
7.302
7.296
7.282
7.278
7.264
7.260
7.254
7.250
7.167
7.148
7.099
7.095
7.080
7.062
6.467
6.463
6.449
6.445
4.547
4.540
4.529
4.521
3.865
3.858
3.851
2.816
2.810
2.804
2.799
2.790
Bs
N
CF3
0.97
1.00
2.00
5.55
1.00
2.03
2.03
1.00
1.00
2.02
2.06
f1 (ppm)

5a

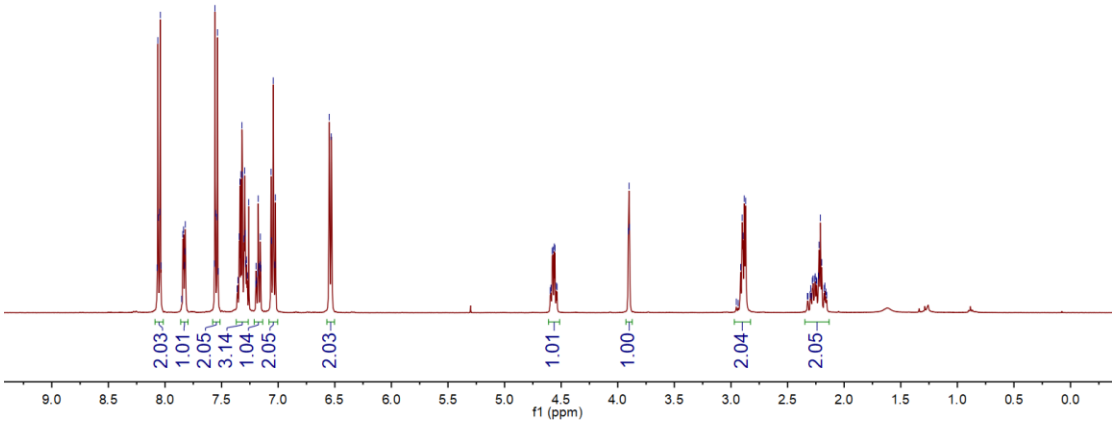

139.50
139.01
135.72
135.48
133.70
130.72
129.29
129.15
128.77
128.60
128.23
127.38
127.32
126.54
126.09
125.64
123.29
70.59
70.28
69.97
69.66
49.37
29.17
22.87
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-78.174
3.00
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200
f1 (ppm)

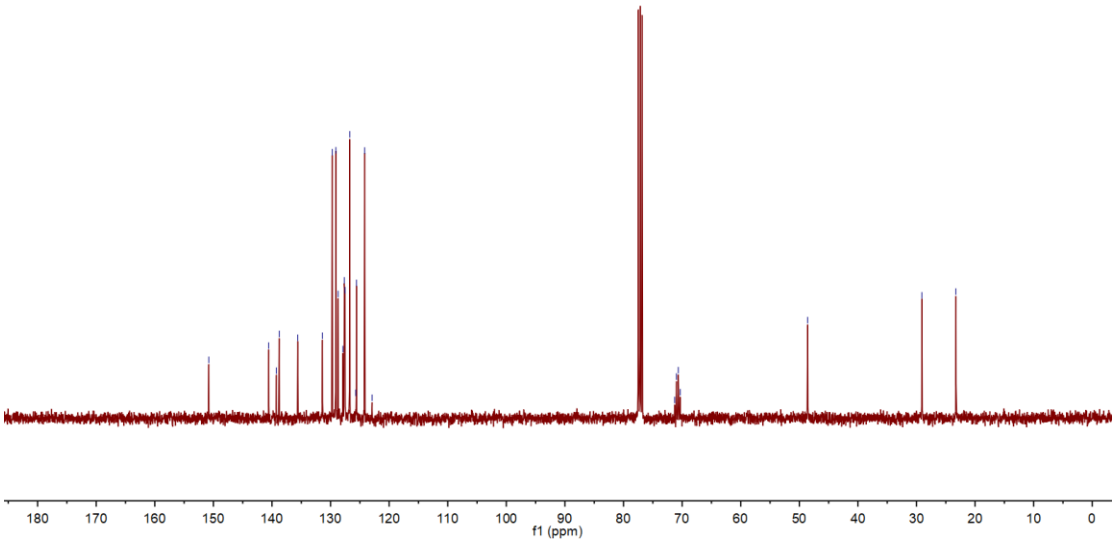

8.063
8.058
8.046
8.041
8.035
7.842
7.836
7.828
7.824
7.820
7.564
7.558
7.553
7.541
7.536
7.344
7.338
7.329
7.320
7.315
7.302
7.296
7.291
7.286
7.280
7.260
7.194
7.176
7.161
7.157
7.063
7.059
7.043
7.029
7.024
6.548
6.530
4.579
4.572
4.561
4.555
3.907
3.901
3.896
2.901
2.894
2.882
2.870
2.222
2.210
2.198

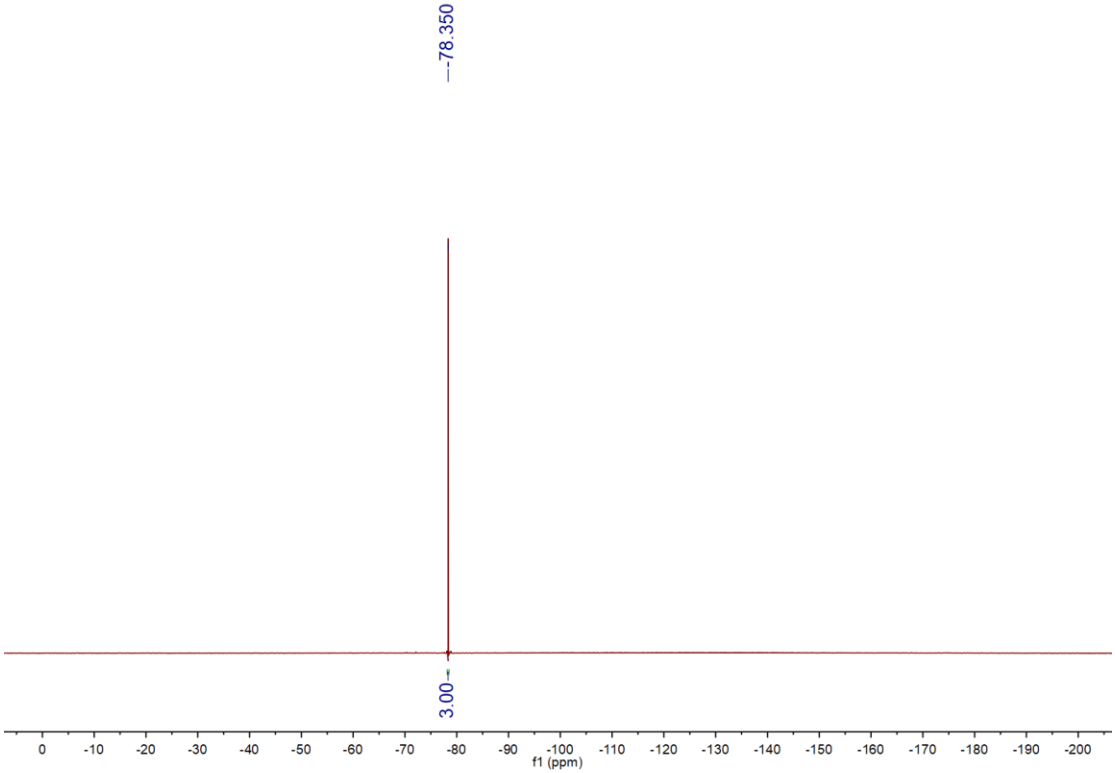
Ns
N
CF3

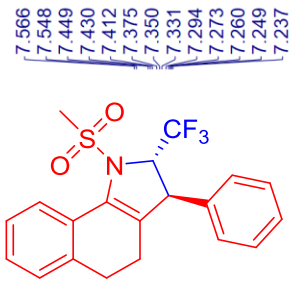
5b


2.03
1.01
2.05
3.14
1.04
2.05
2.03
1.01
1.00
2.04
2.05
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


150.79
140.56
139.26
138.77
135.60
131.40
129.72
129.09
128.71
127.88
127.66
127.54
126.74
125.70
125.58
124.20
122.92
71.28
70.96
70.65
70.34
48.57
29.07
23.27

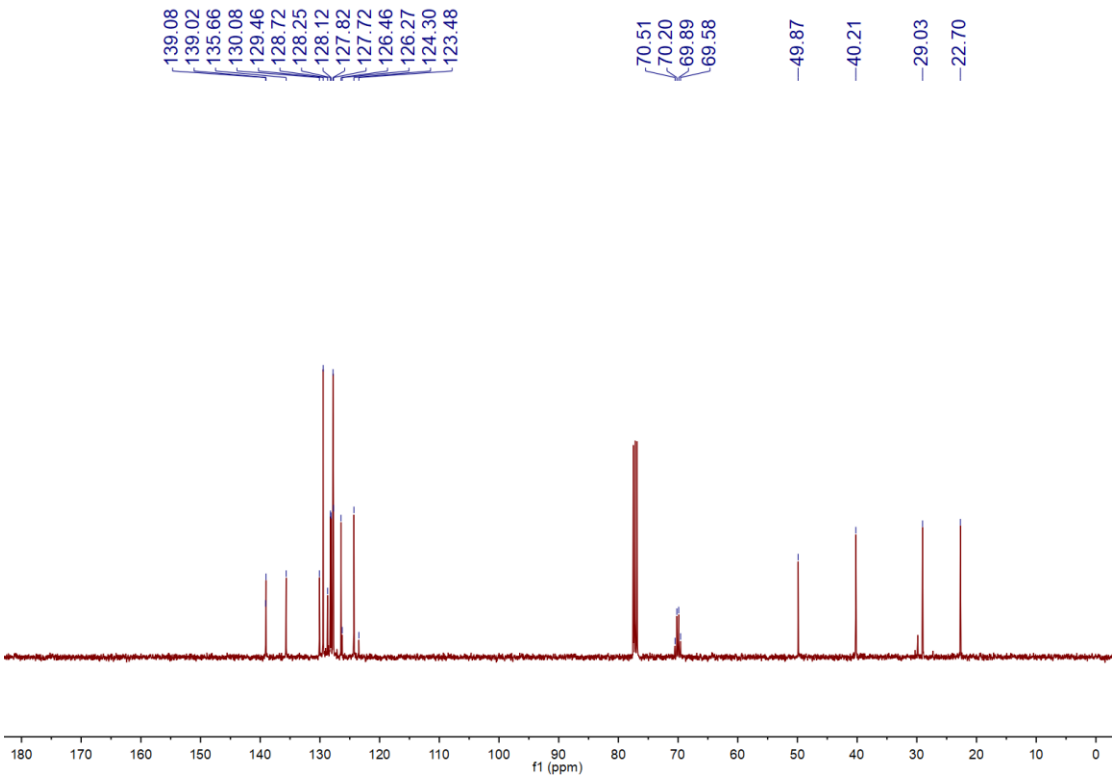

180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

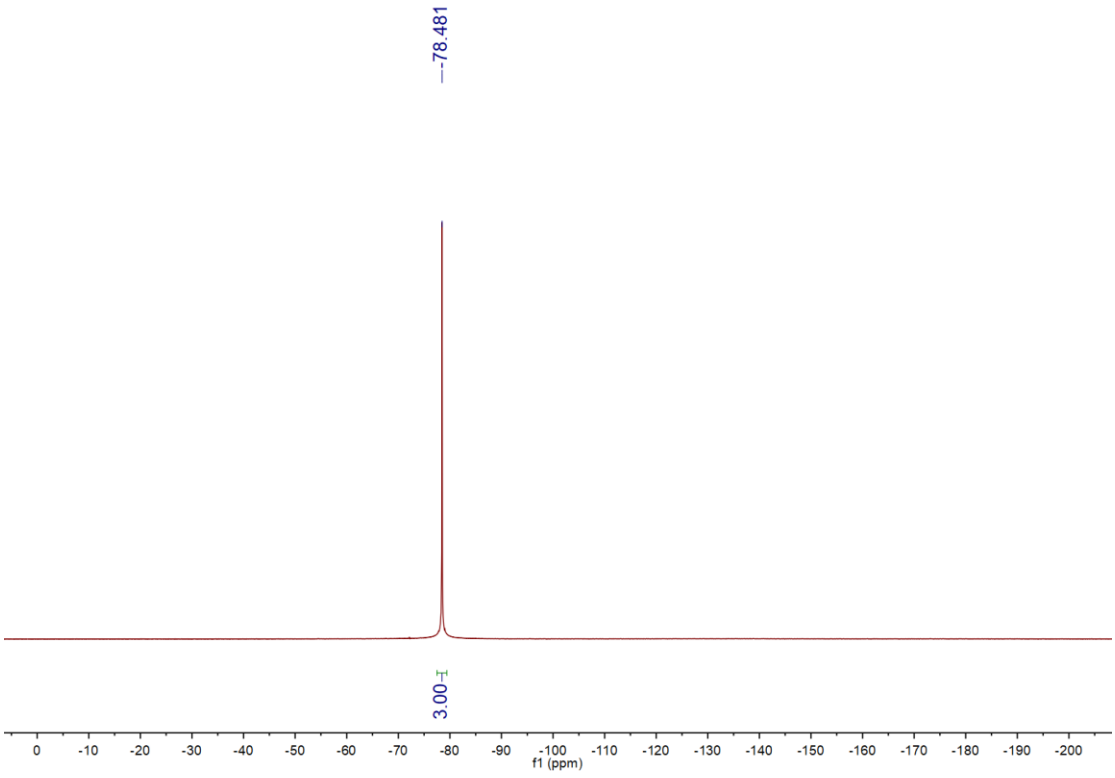

-78.350
3.00
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
f1 (ppm)

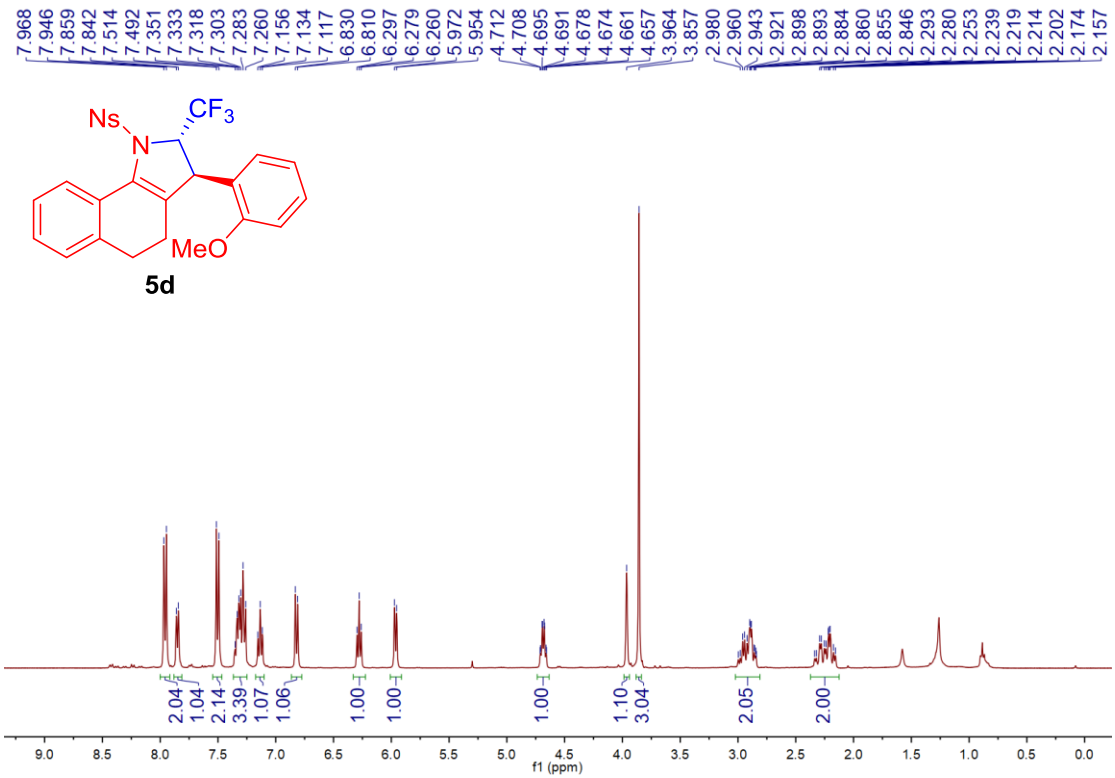

O
S
O
N
CF3

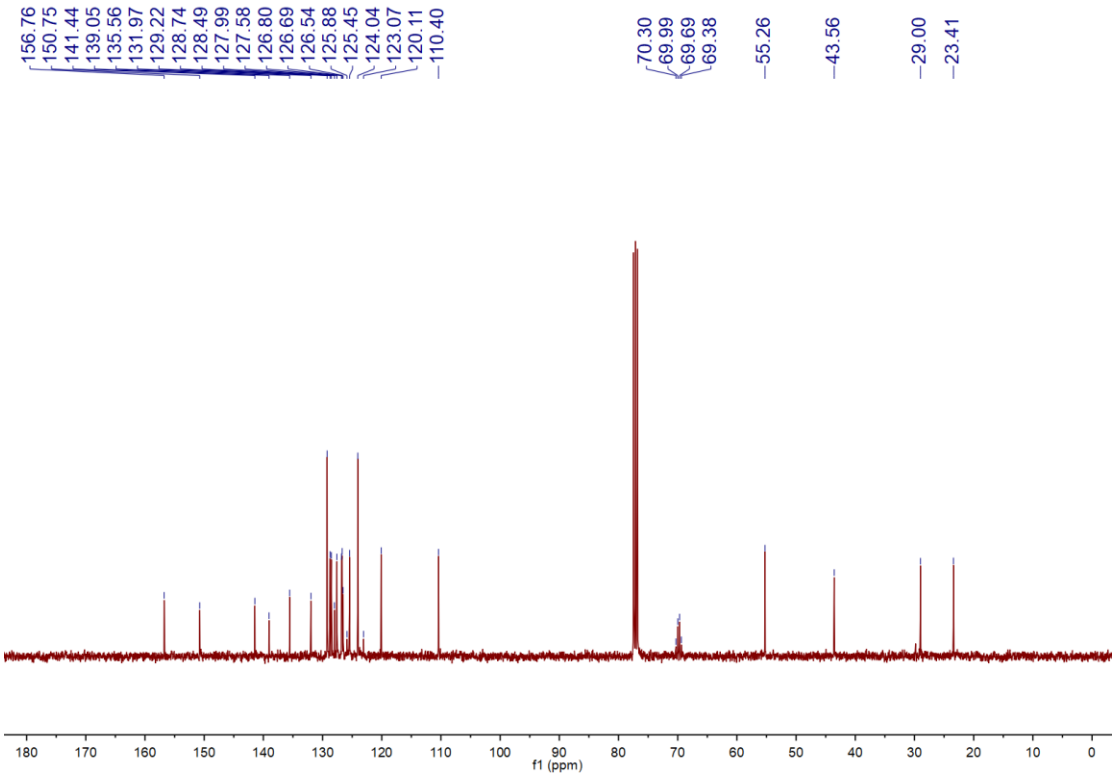
5c

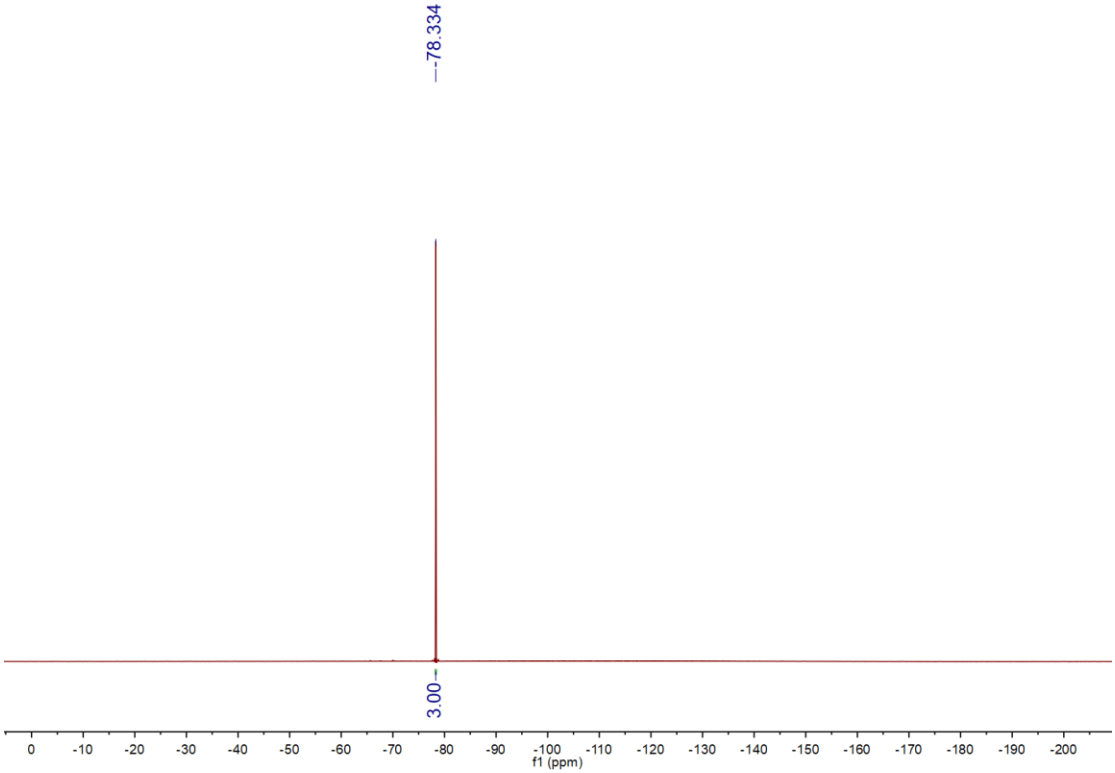
7.566
7.548
7.449
7.430
7.412
7.375
7.350
7.331
7.294
7.273
7.260
7.249
7.237
4.835
4.816
4.797
4.778
3.995
3.117
3.097
3.078
3.059
3.039
3.005
2.890
2.877
2.852
2.838
2.408
2.394
2.365
2.351
2.324
2.311
2.292
2.268
2.249
1.09
2.21
3.18
3.56
0.98
1.00
1.00
3.09
1.02
2.01
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

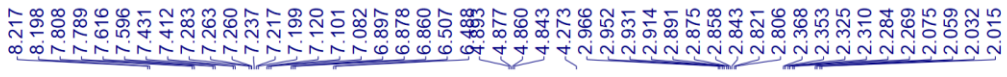

139.08
139.02
135.66
130.08
129.46
128.72
128.25
128.12
127.82
127.72
126.46
126.27
124.30
123.48
70.51
70.20
69.89
69.58
49.87
40.21
29.03
22.70
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

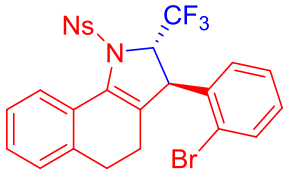

78.481
3.00
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200
f1 (ppm)


7.968
7.946
7.859
7.842
7.514
7.492
7.351
7.333
7.318
7.303
7.283
7.260
7.156
7.134
7.117
6.830
6.810
6.297
6.279
6.260
5.972
5.954
4.712
4.708
4.695
4.691
4.678
4.674
4.661
4.657
3.964
3.857
2.980
2.960
2.943
2.921
2.898
2.893
2.884
2.860
2.855
2.846
2.293
2.280
2.253
2.239
2.219
2.214
2.202
2.174
2.157
Ns
N
CF3
MeO
5d
2.04
1.04
2.14
3.39
1.07
1.06
1.00
1.00
1.00
1.10
3.04
2.05
2.00
f1 (ppm)

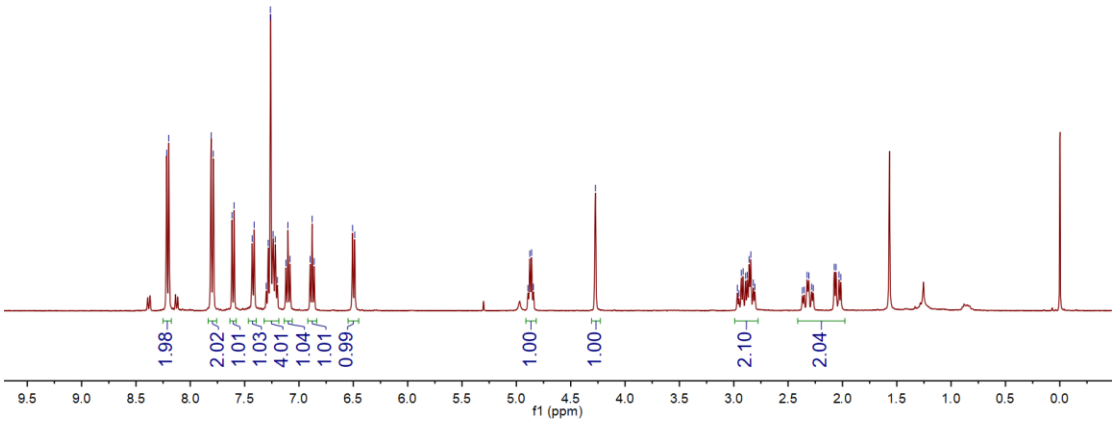

156.76
150.75
141.44
139.05
135.56
131.97
129.22
128.74
128.49
127.99
127.58
126.80
126.69
126.54
125.88
125.45
124.04
123.07
120.11
110.40
70.30
69.99
69.69
69.38
55.26
43.56
29.00
23.41
f1 (ppm)

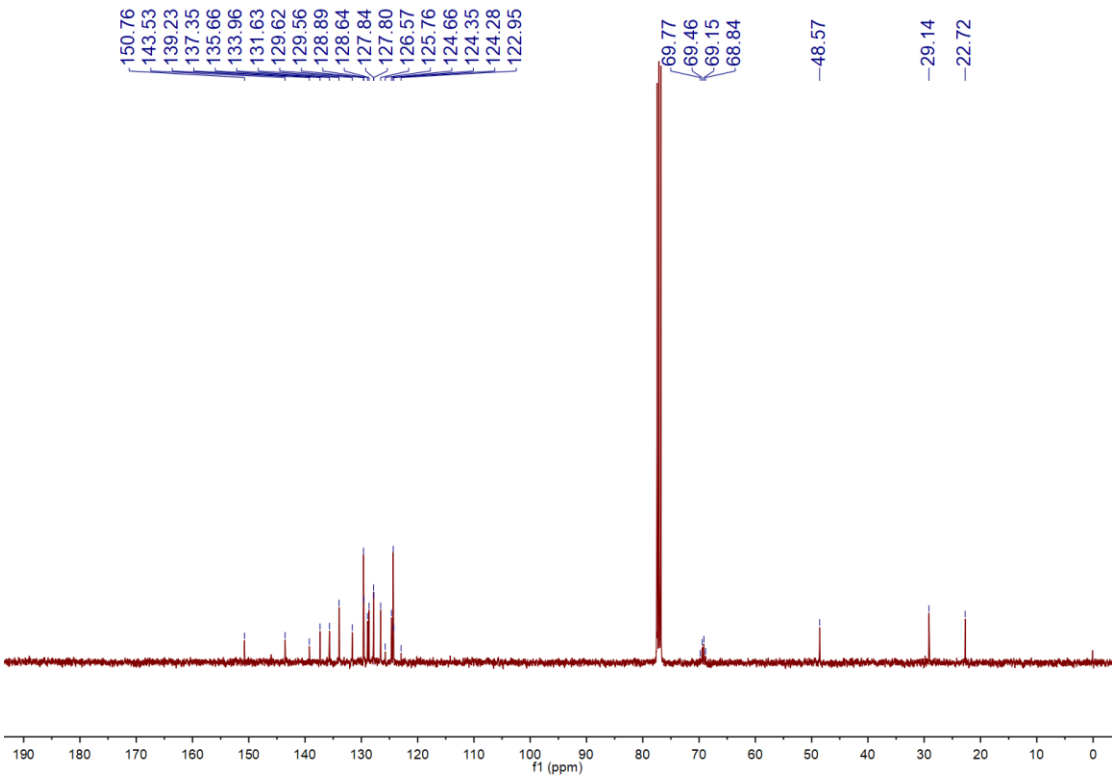

-78.334
3.00
f1 (ppm)

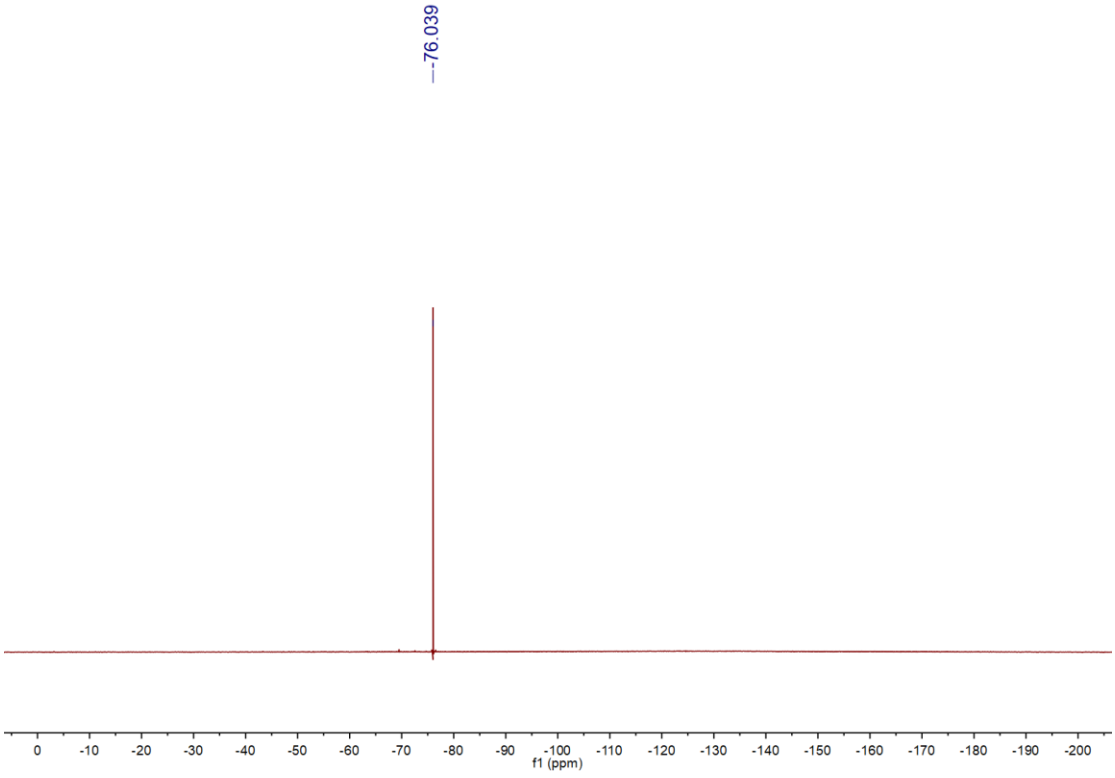

8.217
8.198
7.808
7.789
7.616
7.596
7.431
7.412
7.283
7.263
7.260
7.237
7.217
7.199
7.120
7.101
7.082
6.897
6.878
6.860
6.507
4.877
4.860
4.843
4.273
2.966
2.952
2.931
2.914
2.891
2.875
2.858
2.843
2.821
2.806
2.368
2.353
2.325
2.310
2.284
2.269
2.075
2.059
2.032
2.015

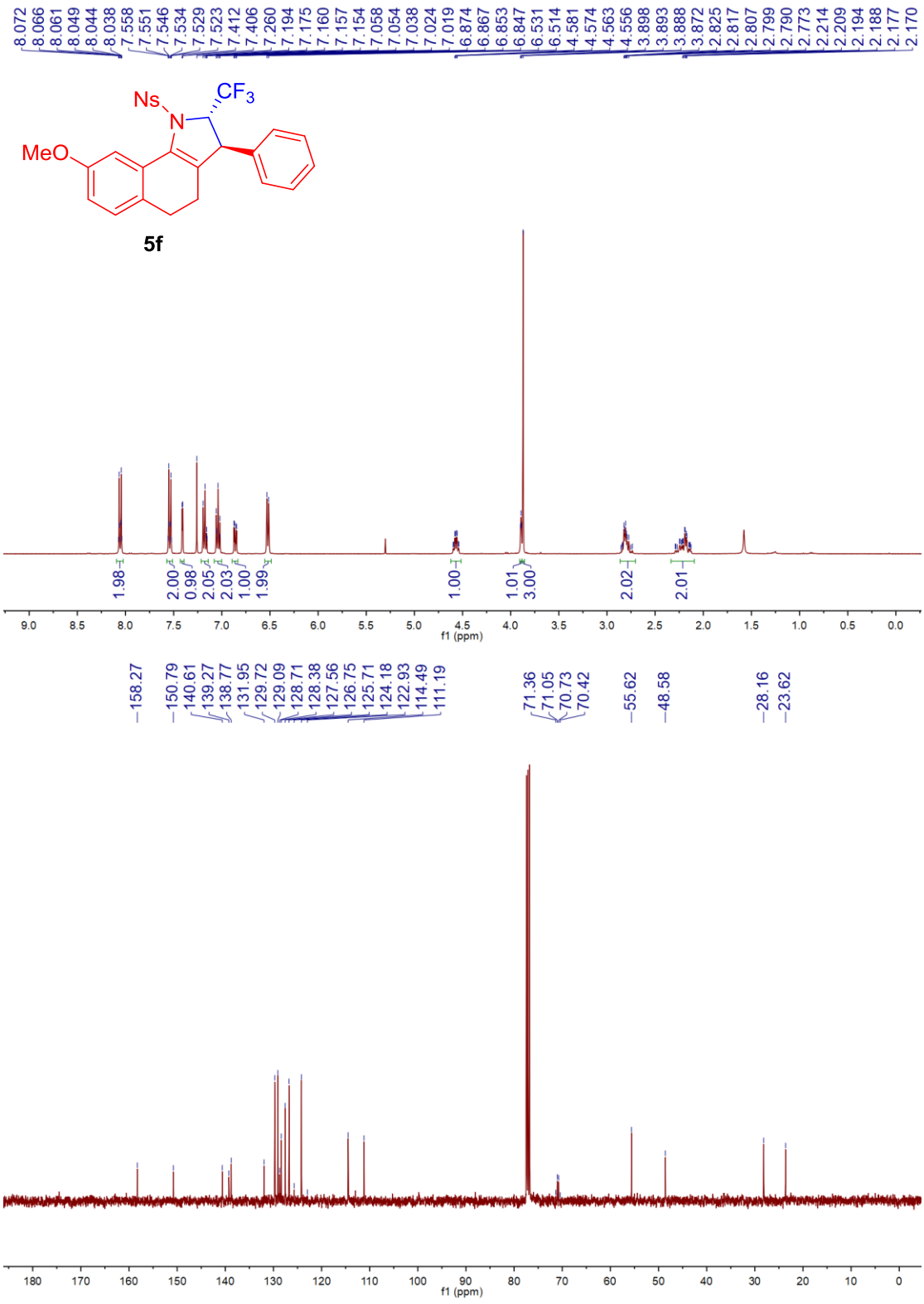

Ns
N
CF3
Br

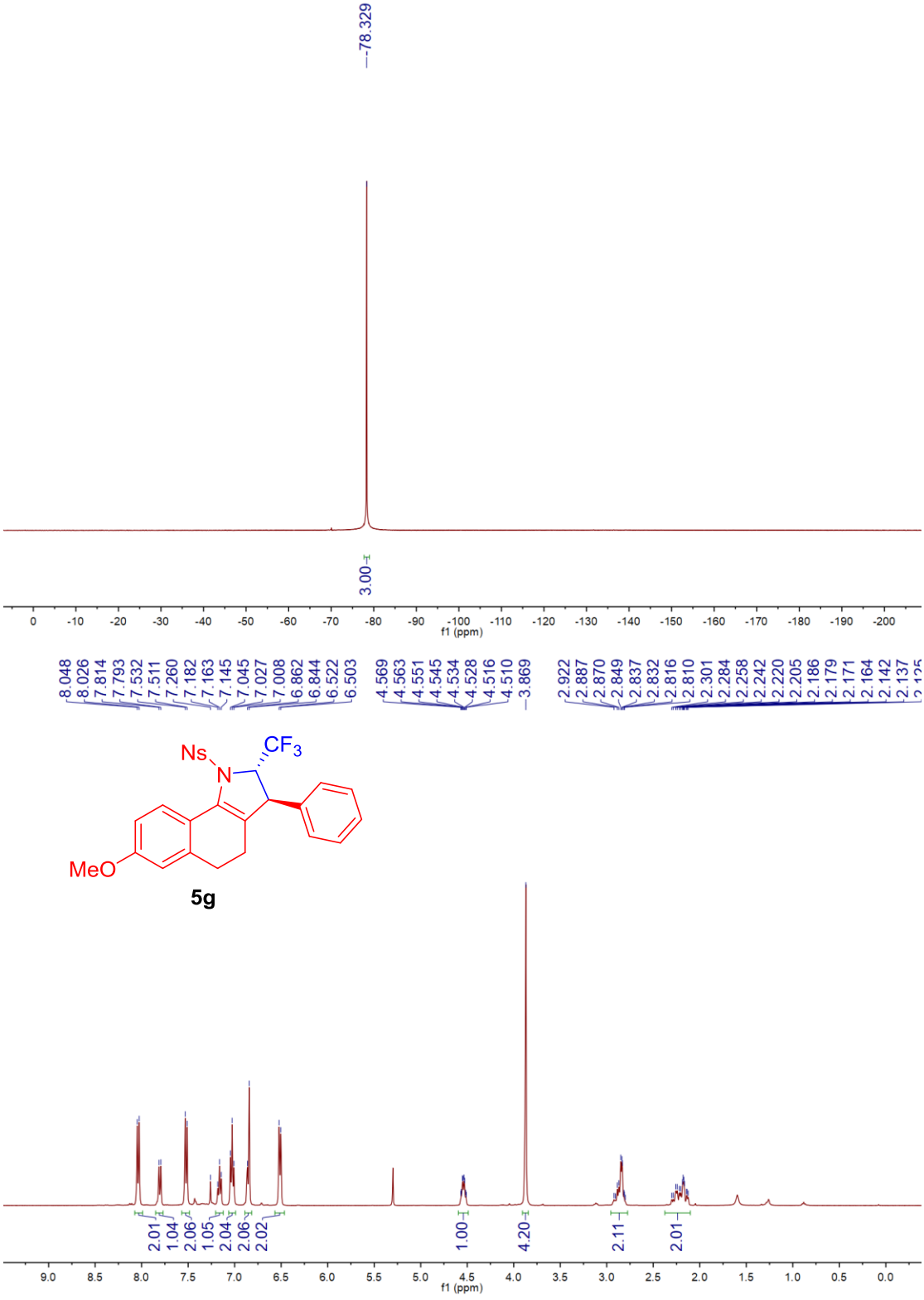
5e

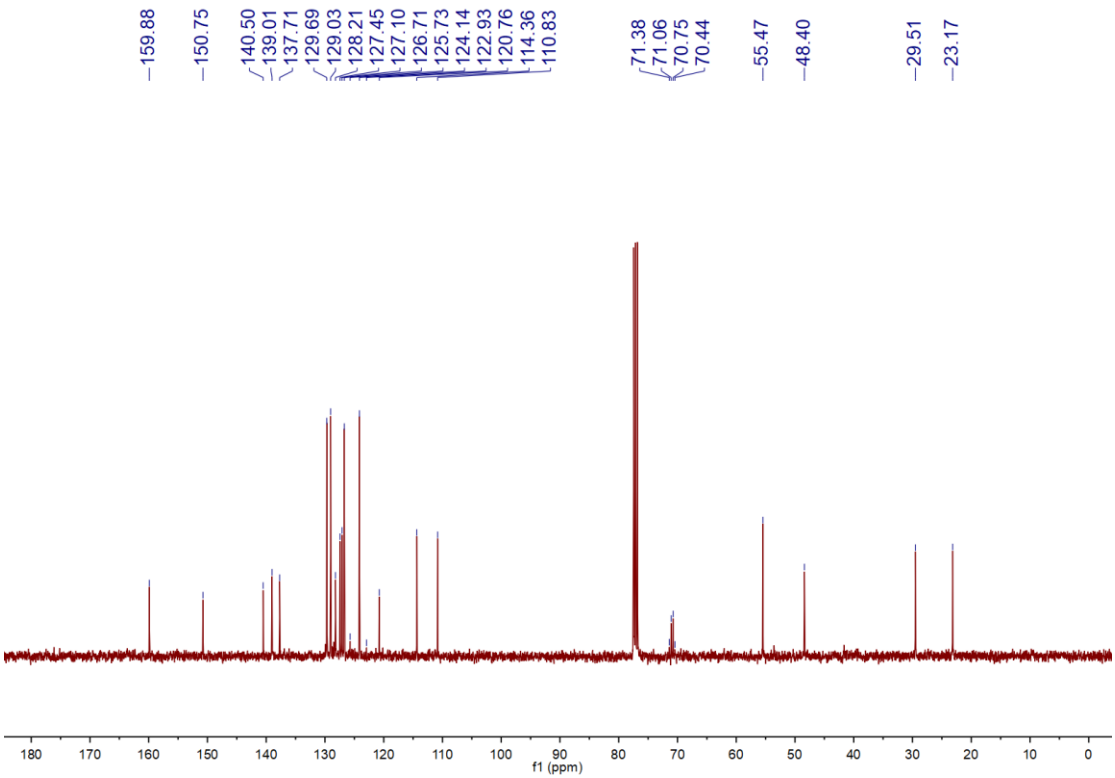

1.98
2.02
1.01
1.03
4.01
1.04
1.01
0.99
1.00
1.00
2.10
2.04
f1 (ppm)

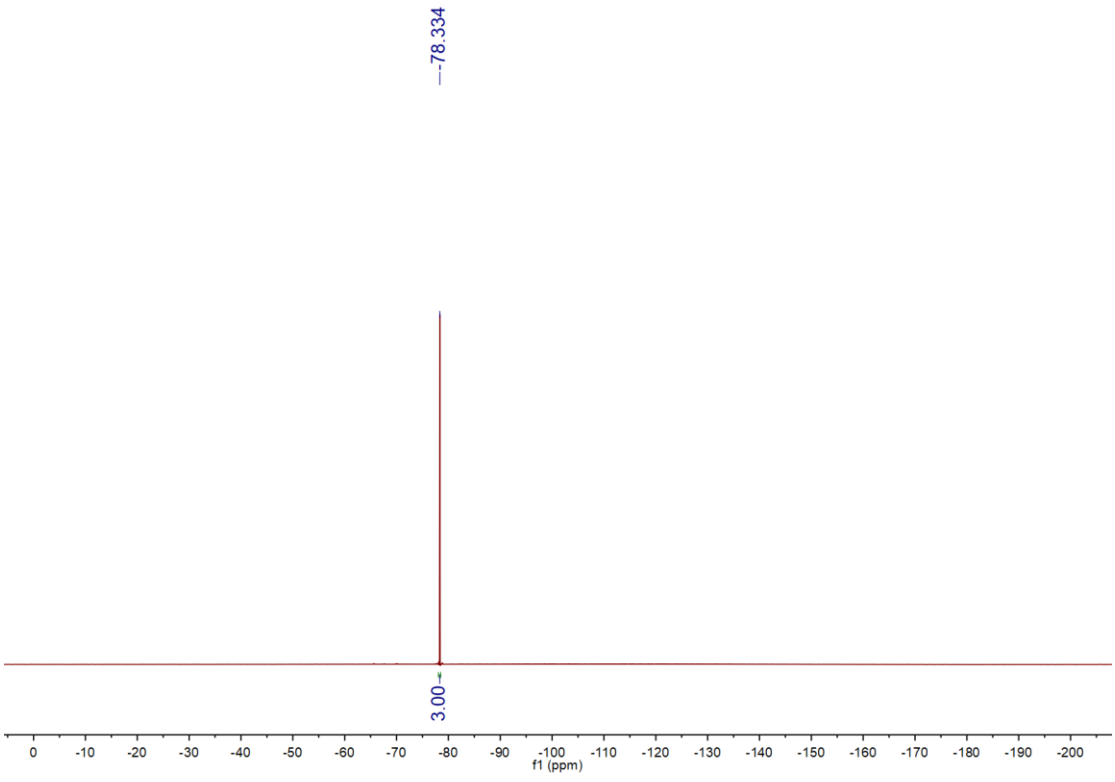

150.76
143.53
139.23
137.35
135.66
133.96
131.63
129.62
129.56
128.89
128.64
127.84
127.80
126.57
125.76
124.66
124.35
124.28
122.95
69.77
69.46
69.15
68.84
48.57
29.14
22.72
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

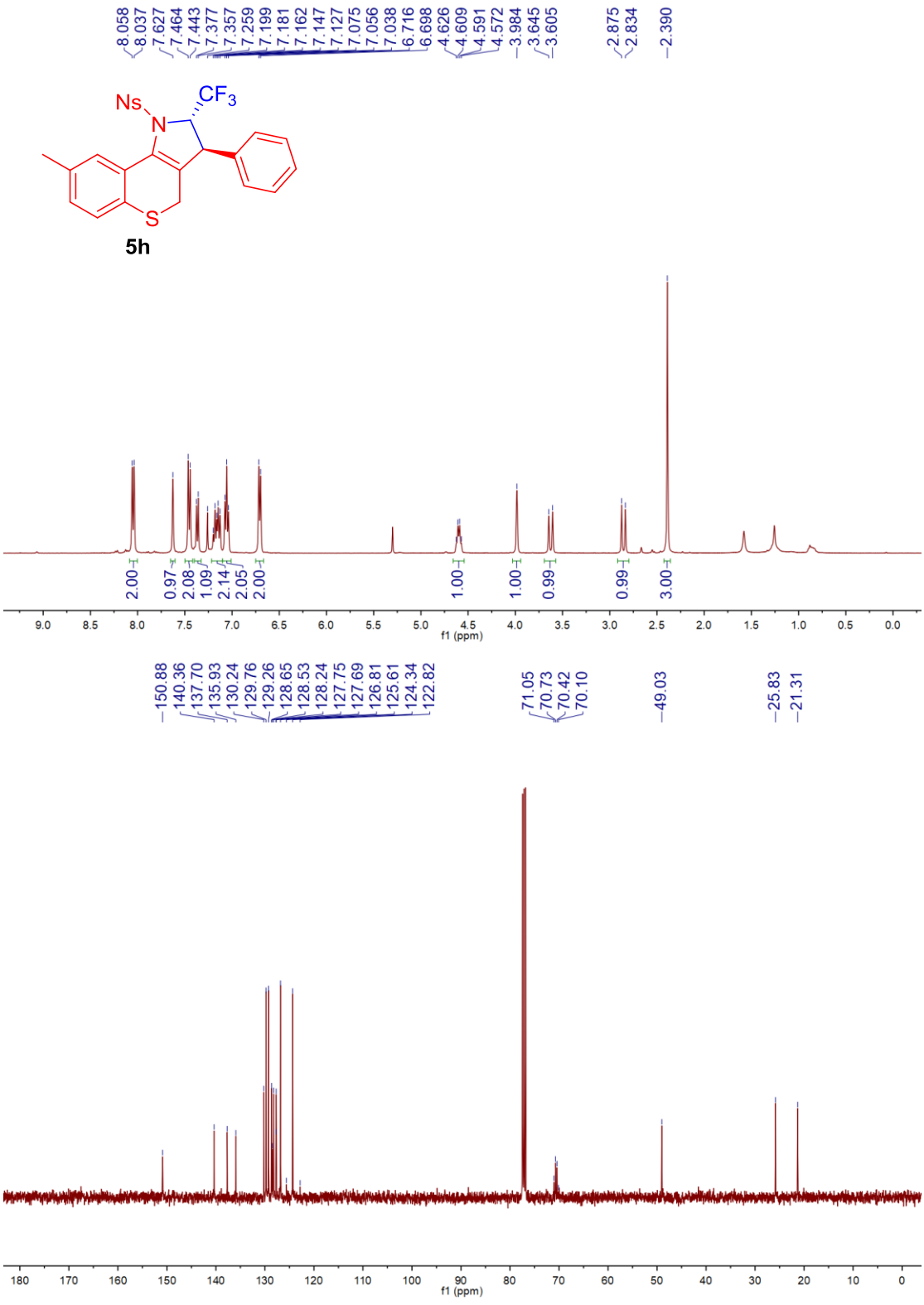

-76.039
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200
f1 (ppm)

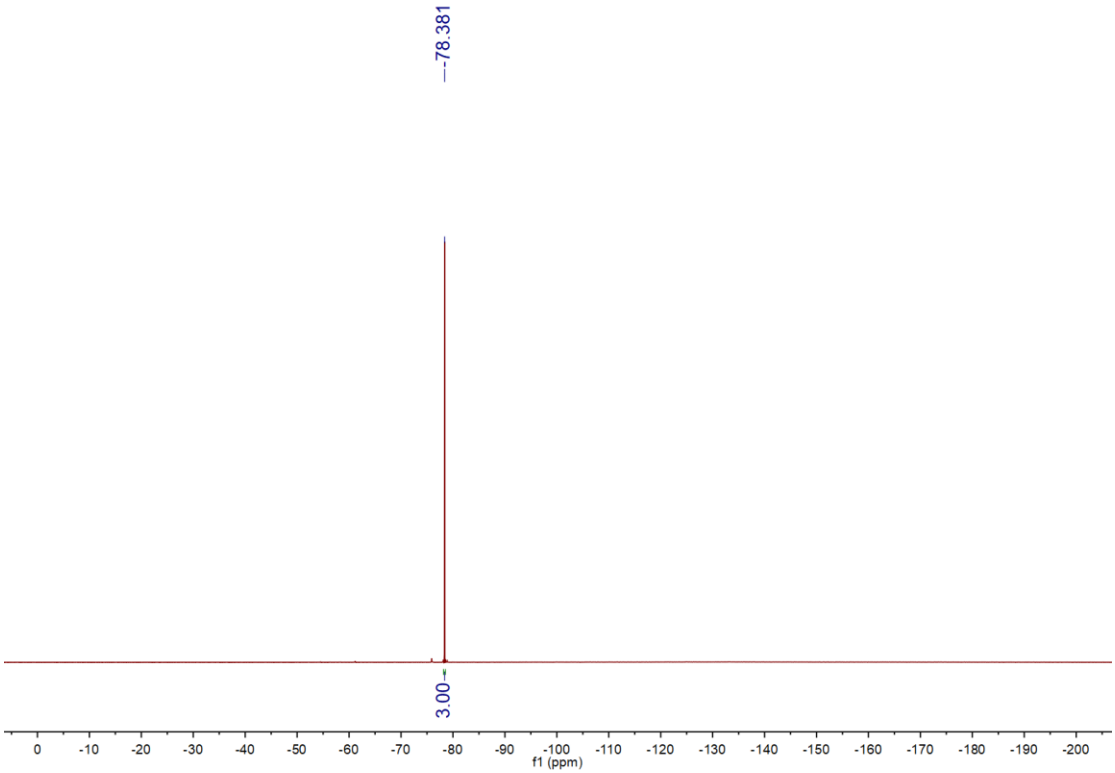

8.072
8.066
8.061
8.049
8.044
8.038
7.558
7.551
7.546
7.534
7.529
7.523
7.412
7.406
7.260
7.194
7.175
7.160
7.157
7.154
7.058
7.054
7.038
7.024
7.019
6.874
6.867
6.853
6.847
6.531
6.514
4.581
4.574
4.563
4.556
3.898
3.893
3.888
3.872
2.825
2.817
2.807
2.799
2.790
2.773
2.214
2.209
2.194
2.188
2.177
2.170
Ns
N
CF3
MeO
5f
1.98
2.00
0.98
2.05
2.03
1.00
1.99
1.00
1.01
3.00
2.02
2.01
f1 (ppm)
158.27
150.79
140.61
139.27
138.77
131.95
129.72
129.09
128.71
128.38
127.56
126.75
125.71
124.18
122.93
114.49
111.19
71.36
71.05
70.73
70.42
55.62
48.58
28.16
23.62
f1 (ppm)

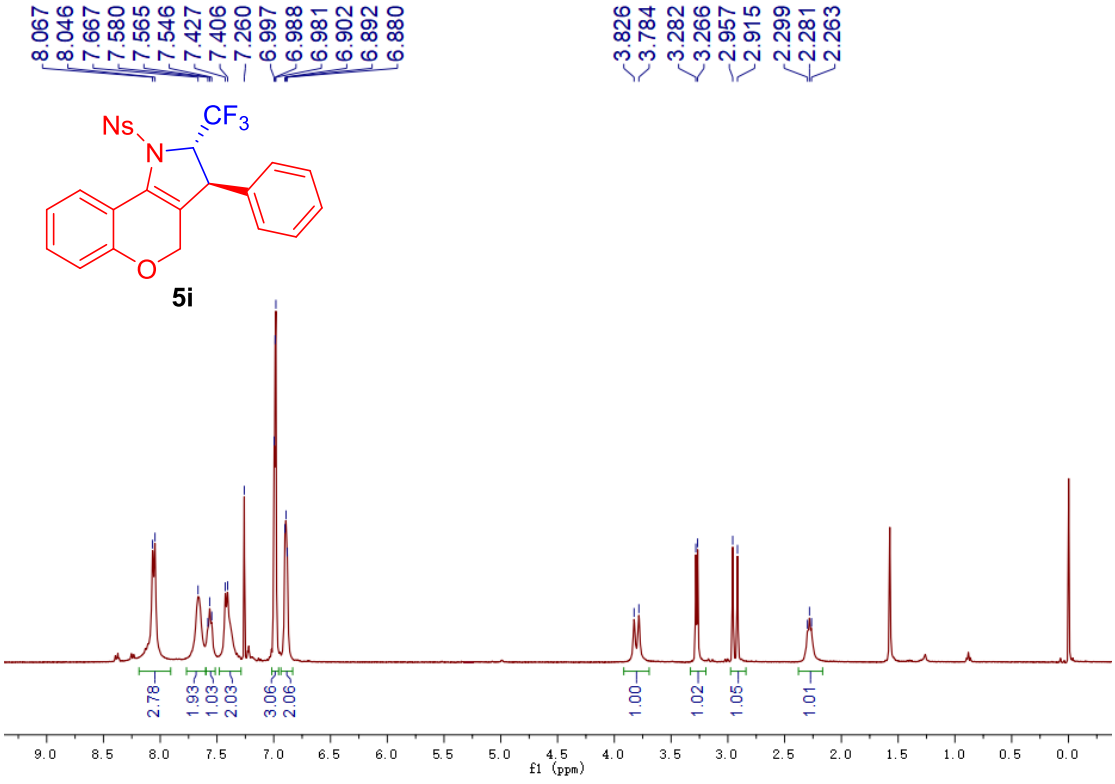

-78.329
3.00
f1 (ppm)
8.048
8.026
7.814
7.793
7.532
7.511
7.260
7.182
7.163
7.145
7.045
7.027
7.008
6.862
6.844
6.522
6.503
4.569
4.563
4.551
4.545
4.534
4.528
4.516
4.510
3.869
2.922
2.887
2.870
2.849
2.837
2.832
2.816
2.810
2.301
2.284
2.258
2.242
2.220
2.205
2.186
2.179
2.171
2.164
2.142
2.137
Ns
N
CF3
MeO
5g
2.01
1.04
2.06
1.05
2.04
2.06
2.02
1.00
4.20
2.11
2.01
f1 (ppm)


159.88
150.75
140.50
139.01
137.71
129.69
129.03
128.21
127.45
127.10
126.71
125.73
124.14
122.93
120.76
114.36
110.83
71.38
71.06
70.75
70.44
55.47
48.40
29.51
23.17
f1 (ppm)

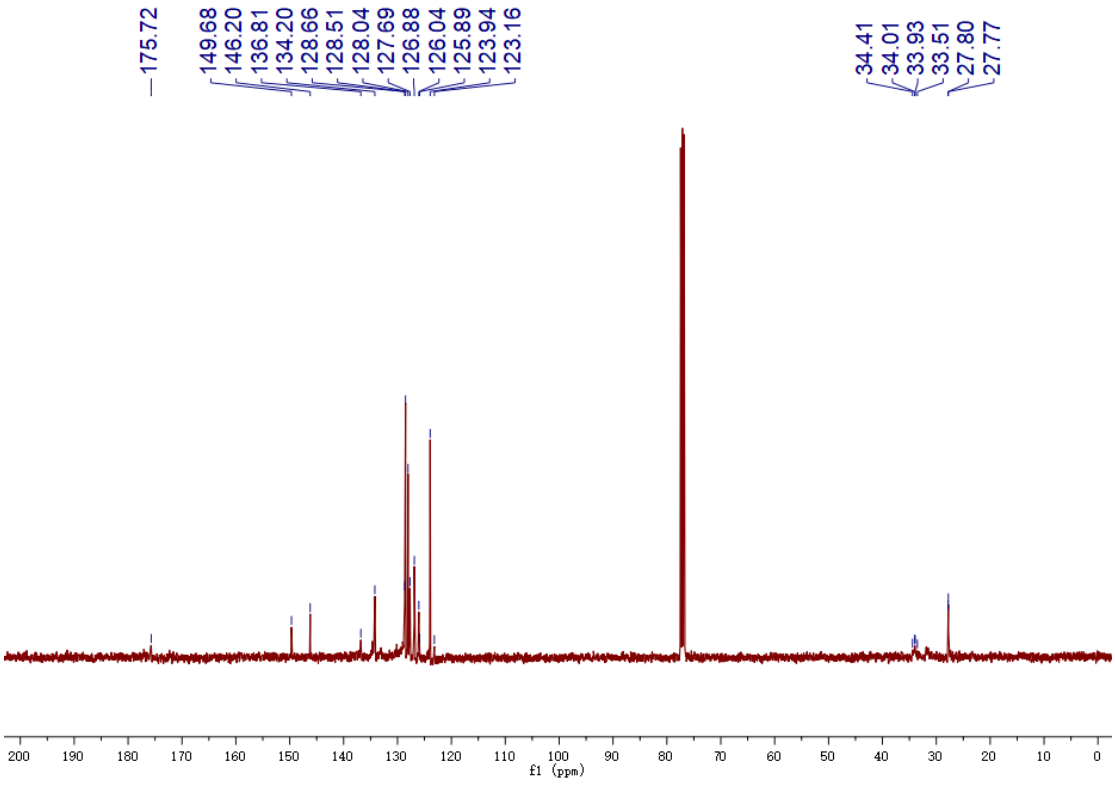

78.334
3.00
f1 (ppm)

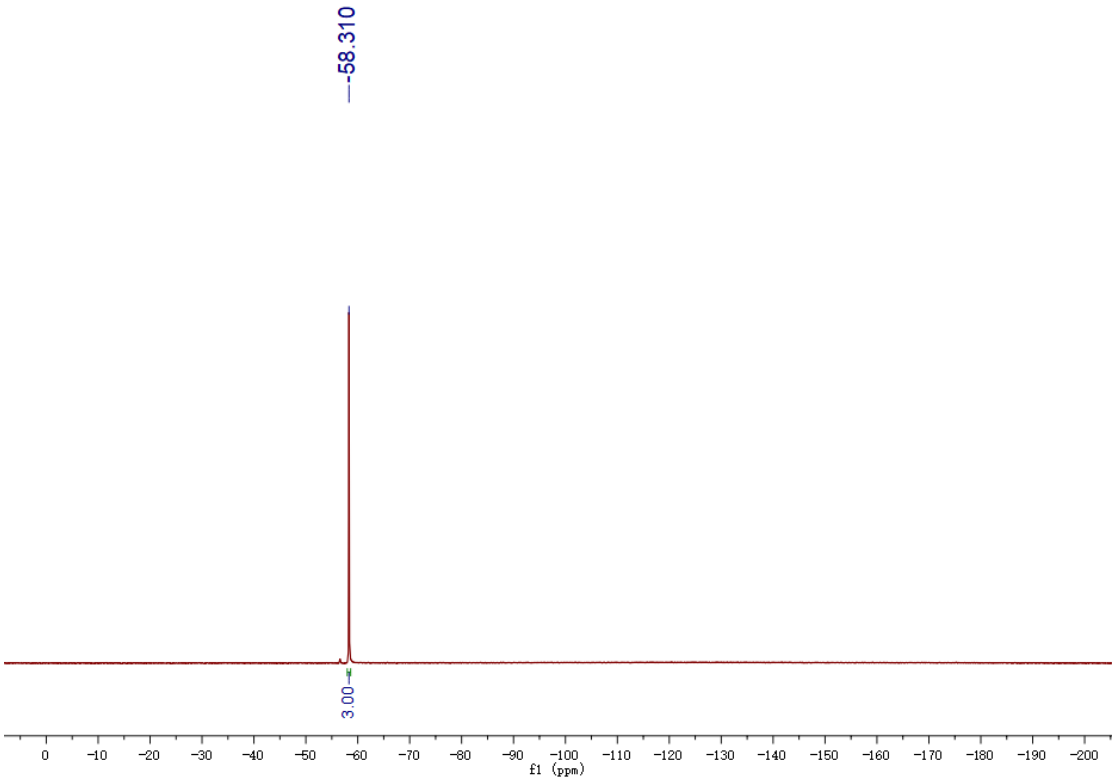

8.058
8.037
7.627
7.464
7.443
7.377
7.357
7.259
7.199
7.181
7.162
7.147
7.127
7.075
7.056
7.038
6.716
6.698
4.626
4.609
4.591
4.572
3.984
3.645
3.605
2.875
2.834
2.390
Ns
N
CF3
S
5h
2.00
0.97
2.08
1.09
2.14
2.05
2.00
1.00
1.00
0.99
0.99
3.00
f1 (ppm)
150.88
140.36
137.70
135.93
130.24
129.76
129.26
128.65
128.53
128.24
127.75
127.69
126.81
125.61
124.34
122.82
71.05
70.73
70.42
70.10
49.03
25.83
21.31
f1 (ppm)

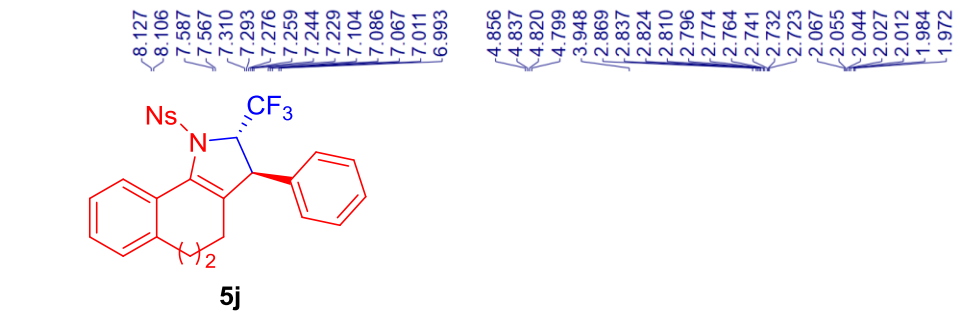

-78.381
3.00
f1 (ppm)


8.067
8.046
7.667
7.580
7.565
7.546
7.427
7.406
7.260
6.997
6.988
6.981
6.902
6.892
6.880
3.826
3.784
3.282
3.266
2.957
2.915
2.299
2.281
2.263
Ns
N
CF3
O
2.78
1.93
1.03
2.03
3.06
2.06
1.00
1.02
1.05
1.01
f1 (ppm)

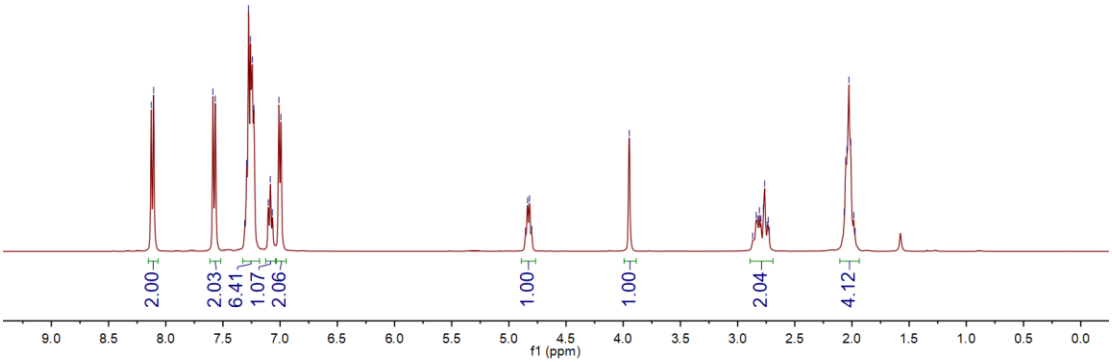
5i


175.72
149.68
146.20
136.81
134.20
128.66
128.51
128.04
127.69
126.88
126.04
125.89
123.94
123.16
34.41
34.01
33.93
33.51
27.80
27.77
f1 (ppm)

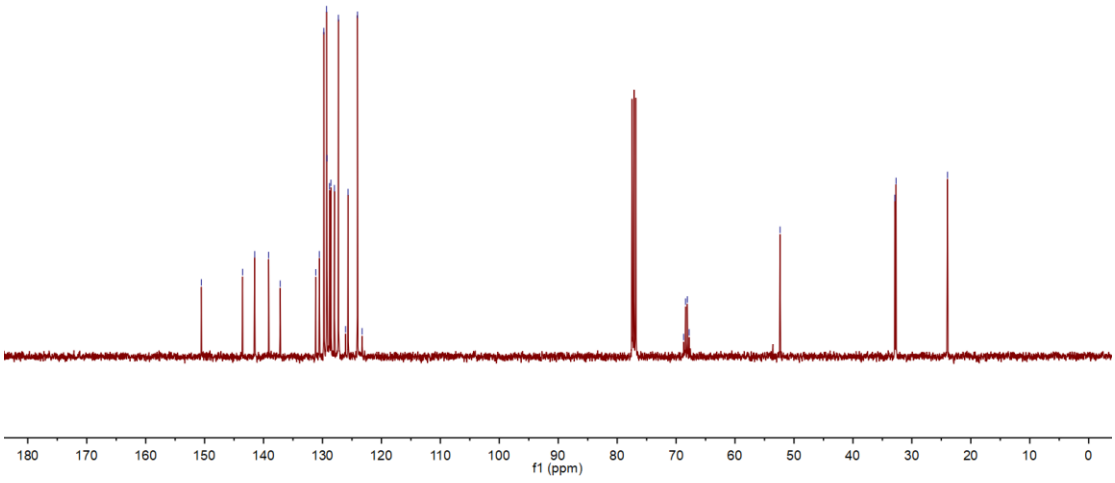

-58.310
3.00
f1 (ppm)

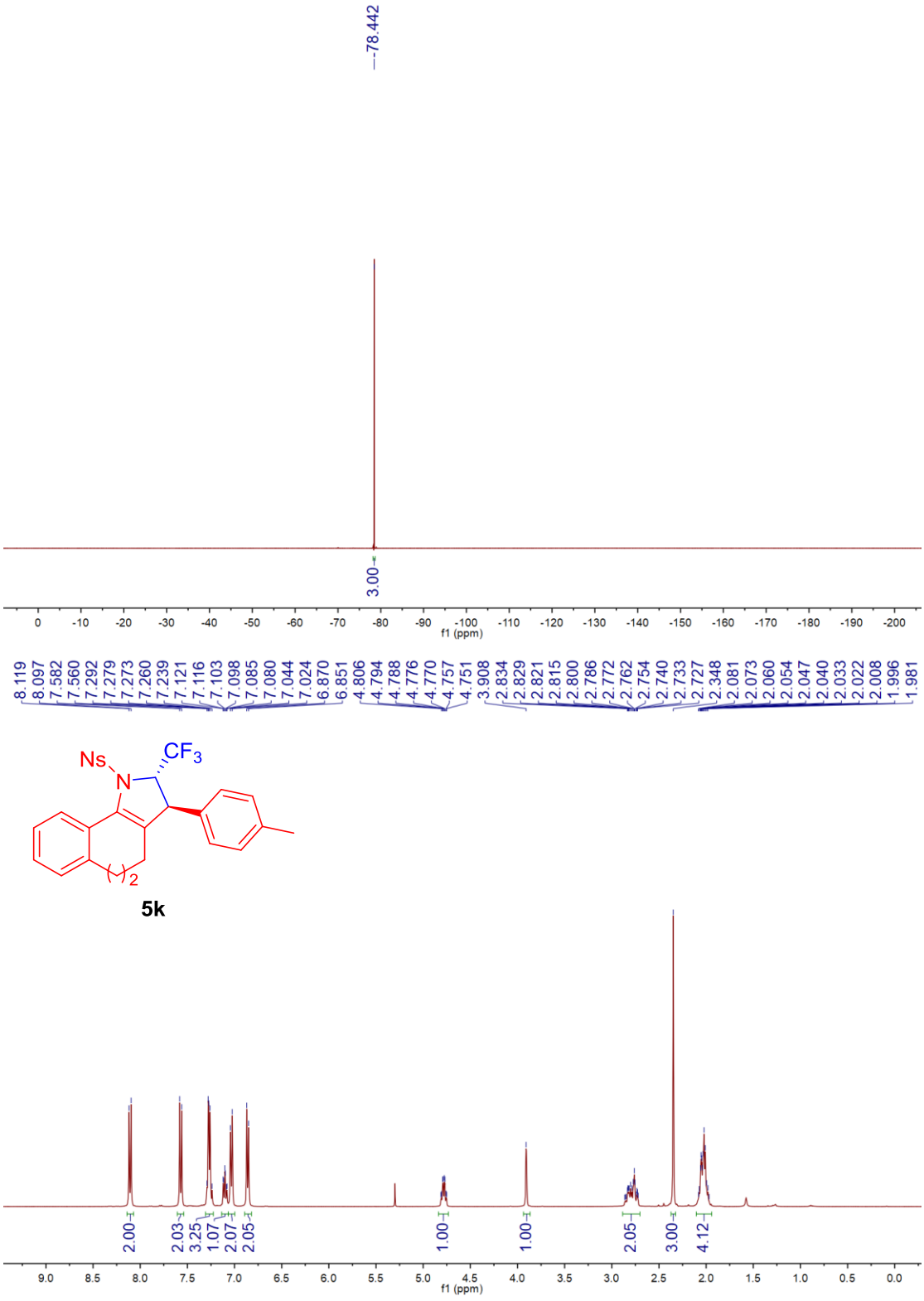

8.127
8.106
7.587
7.567
7.310
7.293
7.276
7.259
7.244
7.229
7.104
7.086
7.067
7.011
6.993
4.856
4.837
4.820
4.799
3.948
2.869
2.837
2.824
2.810
2.796
2.774
2.764
2.741
2.732
2.723
2.067
2.055
2.044
2.027
2.012
1.984
1.972
Ns
N
CF3
2

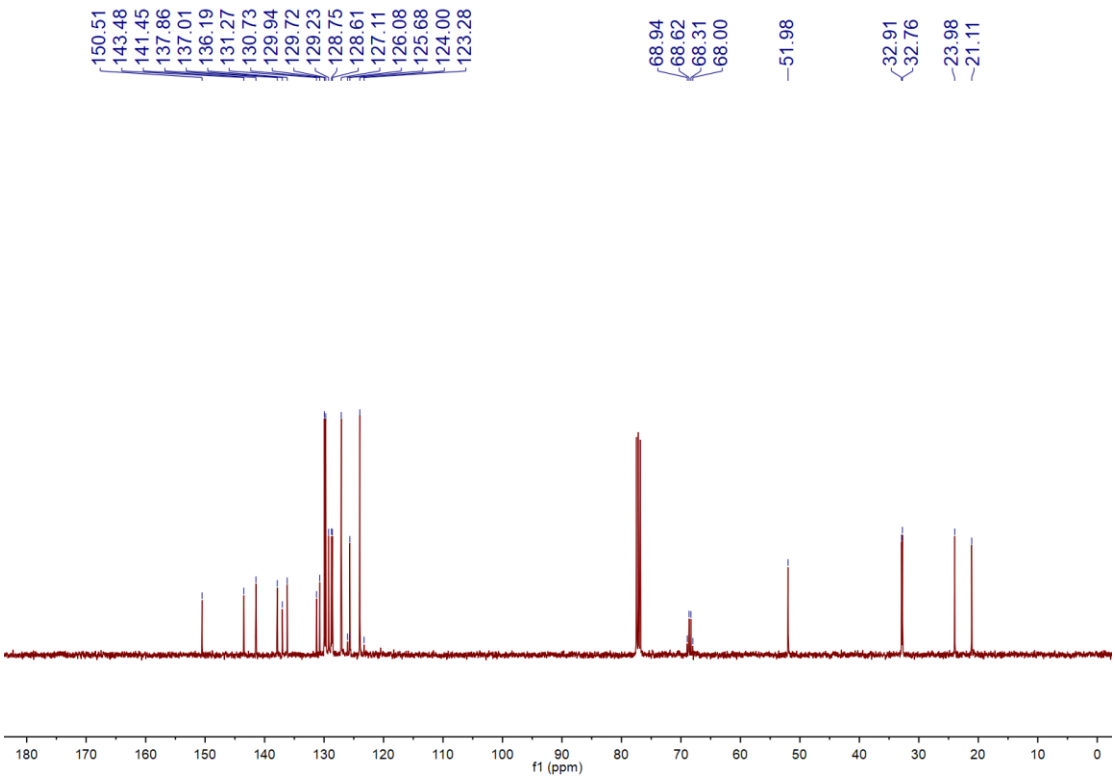
5j

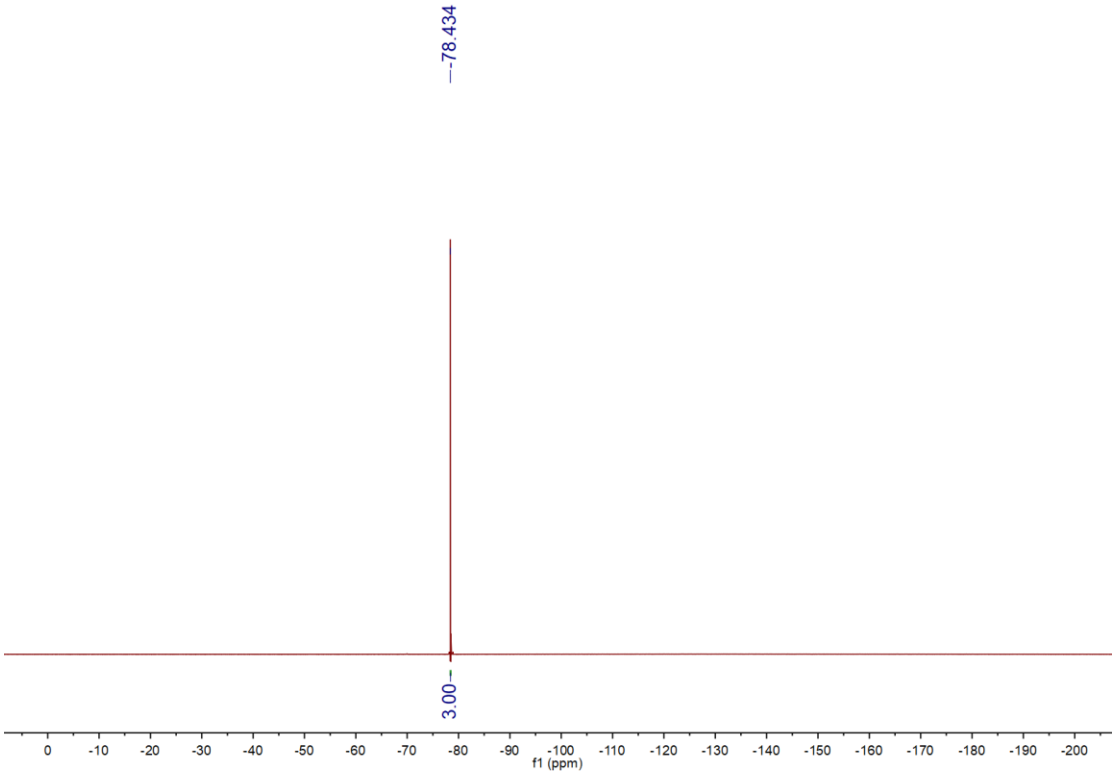

2.00
2.03
6.41
1.07
2.06
1.00
1.00
2.04
4.12
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

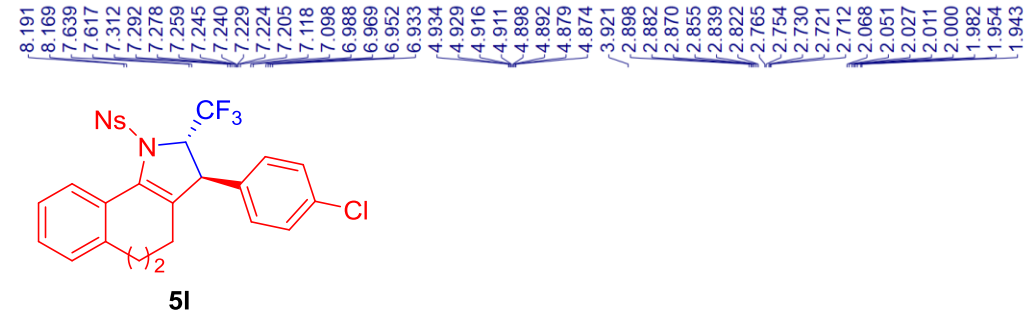

150.57
143.56
141.51
139.13
137.17
131.16
130.52
129.77
129.30
129.25
128.80
128.58
127.97
127.30
126.08
125.66
124.06
123.29
68.72
68.41
68.10
67.79
52.37
32.89
32.69
23.96


180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

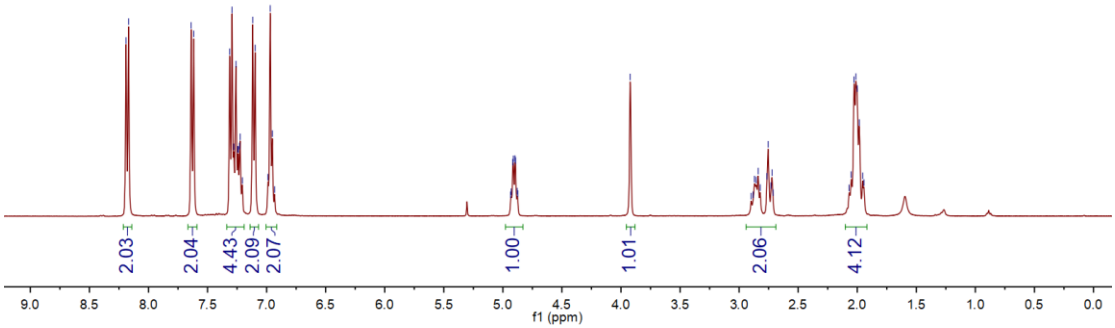

-78.442
3.00
f1 (ppm)
8.119
8.097
7.582
7.560
7.292
7.279
7.273
7.260
7.239
7.121
7.116
7.103
7.098
7.085
7.080
7.044
7.024
6.870
6.851
4.806
4.794
4.788
4.776
4.770
4.757
4.751
3.908
2.834
2.829
2.821
2.815
2.800
2.786
2.772
2.762
2.754
2.740
2.733
2.727
2.348
2.081
2.073
2.060
2.054
2.047
2.040
2.033
2.022
2.008
1.996
1.981
Ns
N
CF3
2
5k
2.00
2.03
3.25
1.07
2.07
2.05
1.00
1.00
2.05
3.00
4.12
f1 (ppm)

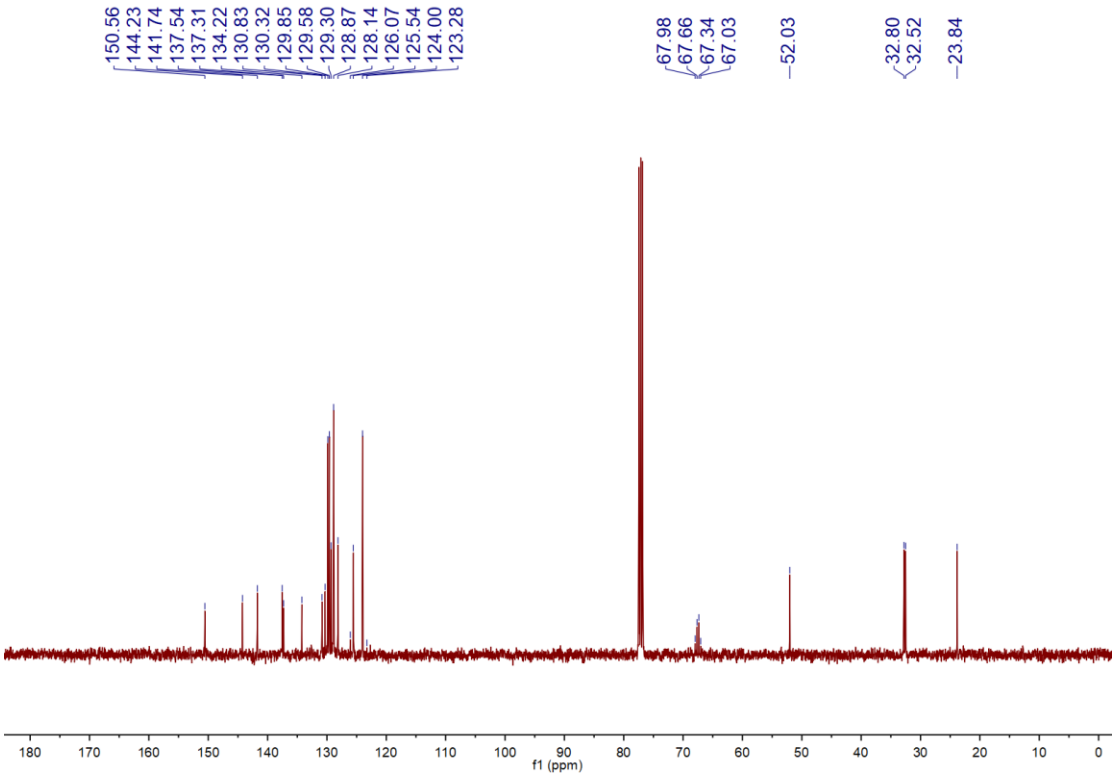

150.51
143.48
141.45
137.86
137.01
136.19
131.27
130.73
129.94
129.72
129.23
128.75
128.61
127.11
126.08
125.68
124.00
123.28
68.94
68.62
68.31
68.00
51.98
32.91
32.76
23.98
21.11
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

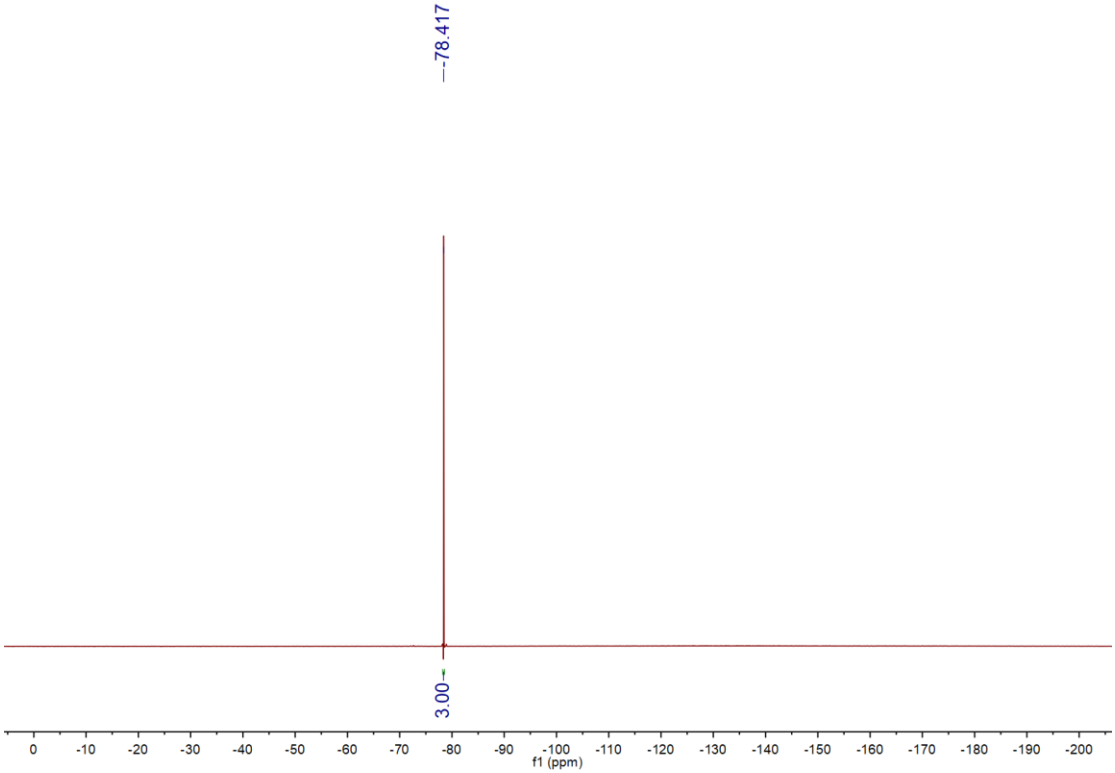

-78.434
3.00
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200
f1 (ppm)

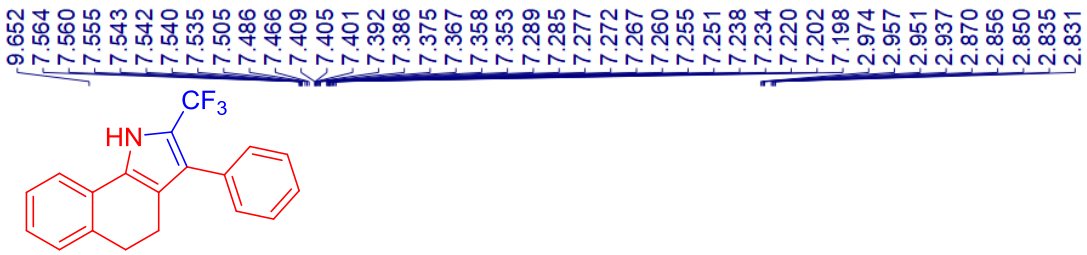

8.191
8.169
7.639
7.617
7.312
7.292
7.278
7.259
7.245
7.240
7.229
7.224
7.205
7.118
7.098
6.988
6.969
6.952
6.933
4.934
4.929
4.916
4.911
4.898
4.892
4.879
4.874
3.921
2.898
2.882
2.870
2.855
2.839
2.822
2.765
2.754
2.730
2.721
2.712
2.068
2.051
2.027
2.011
2.000
1.982
1.954
1.943
Ns
N
CF3
Cl
2

5l


2.03
2.04
4.43
2.09
2.07
1.00
1.01
2.06
4.12
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

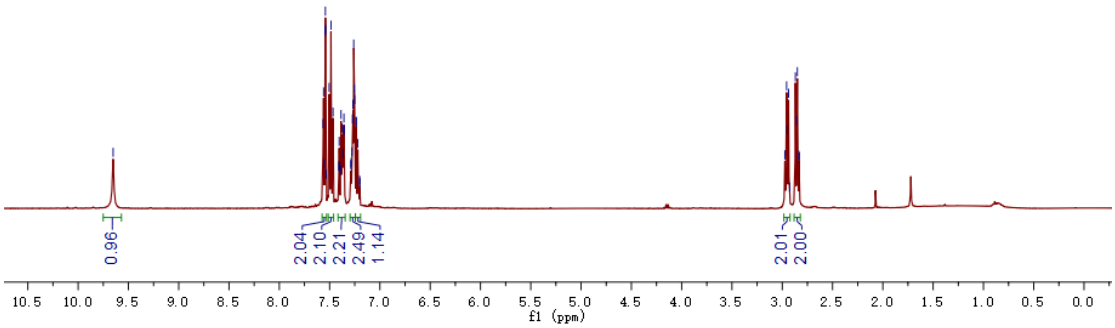

150.56
144.23
141.74
137.54
137.31
134.22
130.83
130.32
129.85
129.58
129.30
128.87
128.14
126.07
125.54
124.00
123.28
67.98
67.66
67.34
67.03
52.03
32.80
32.52
23.84
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

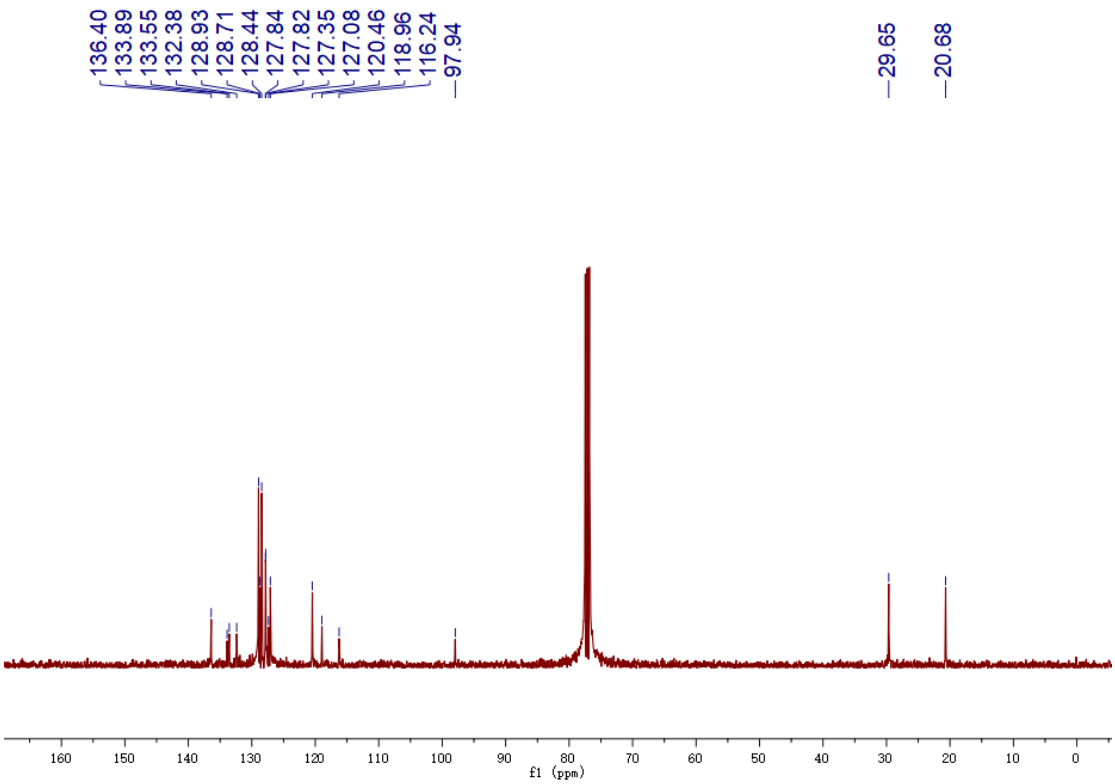

-78.417
3.00
f1 (ppm)

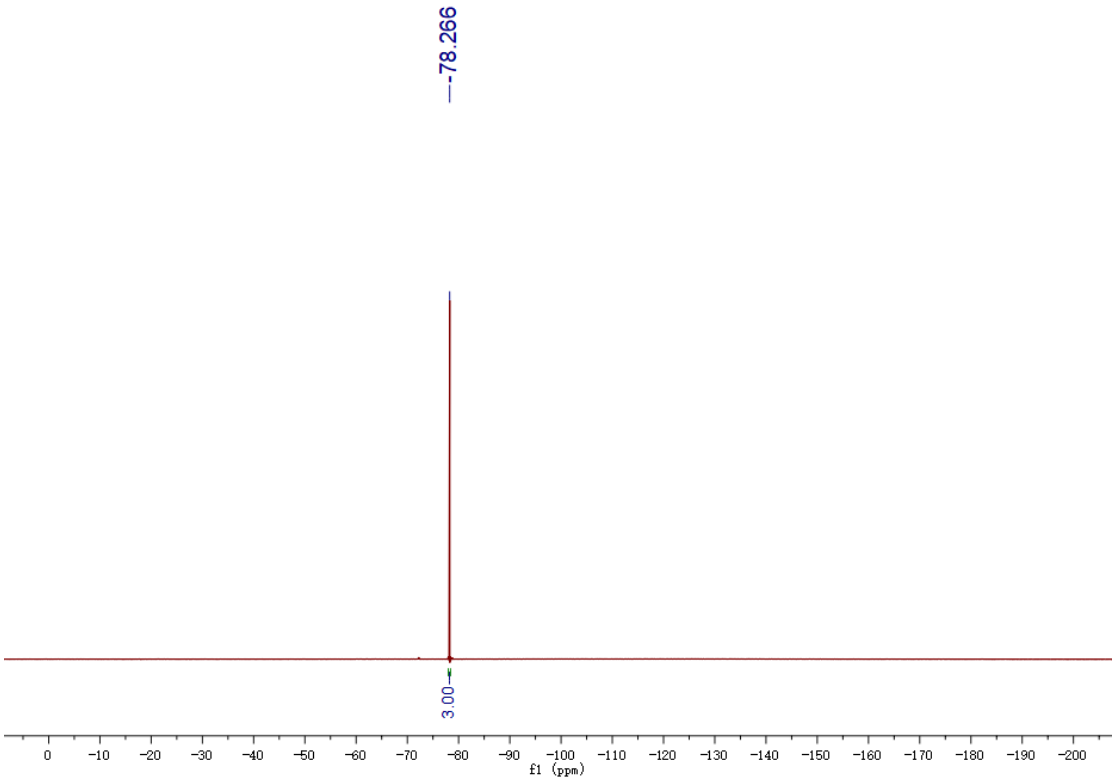

9.652
7.564
7.560
7.555
7.543
7.542
7.540
7.535
7.505
7.486
7.466
7.409
7.405
7.401
7.392
7.386
7.375
7.367
7.358
7.353
7.289
7.285
7.277
7.272
7.267
7.260
7.255
7.251
7.238
7.234
7.220
7.202
7.198
2.974
2.957
2.951
2.937
2.870
2.856
2.850
2.835
2.831

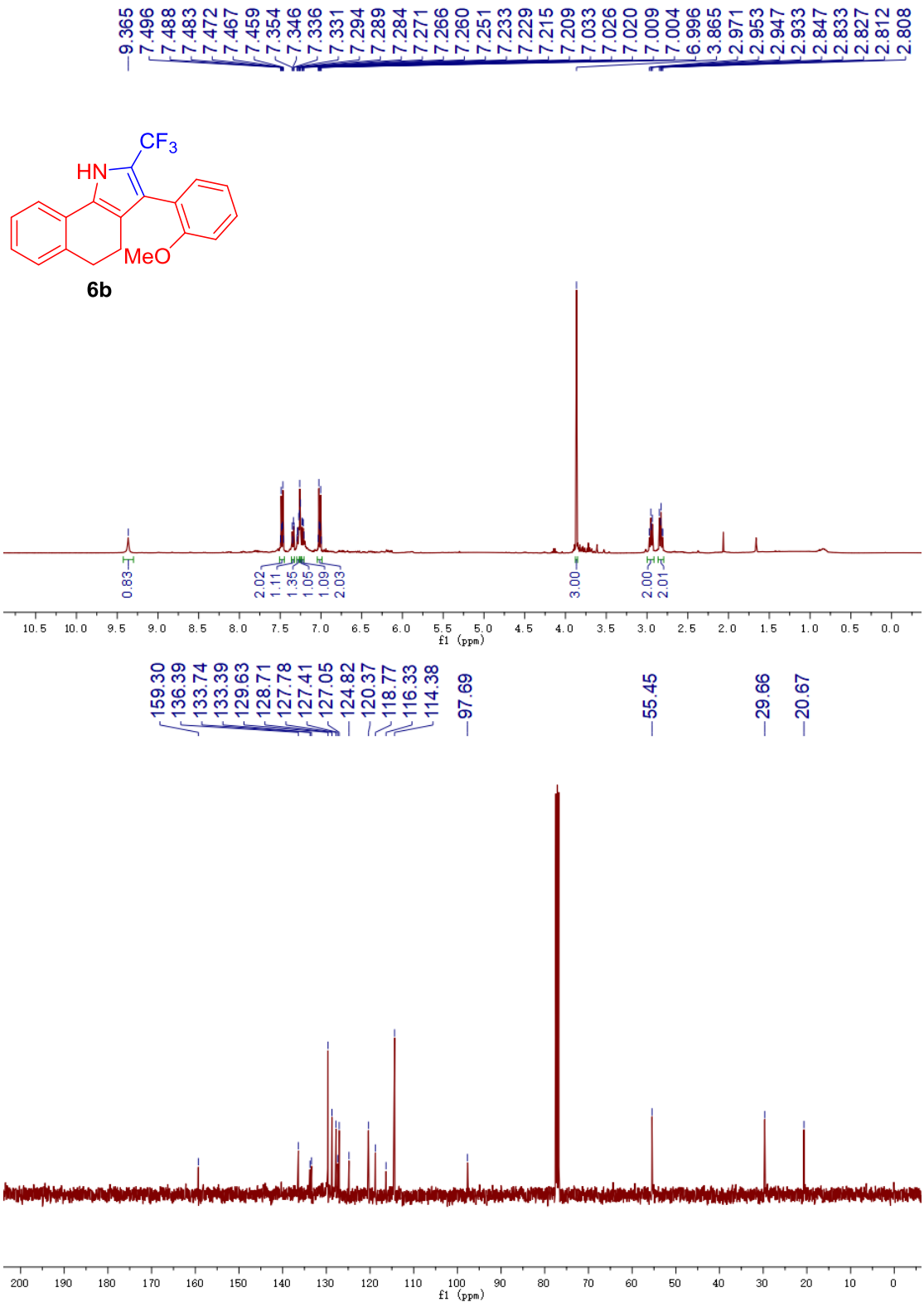
CF3
HN

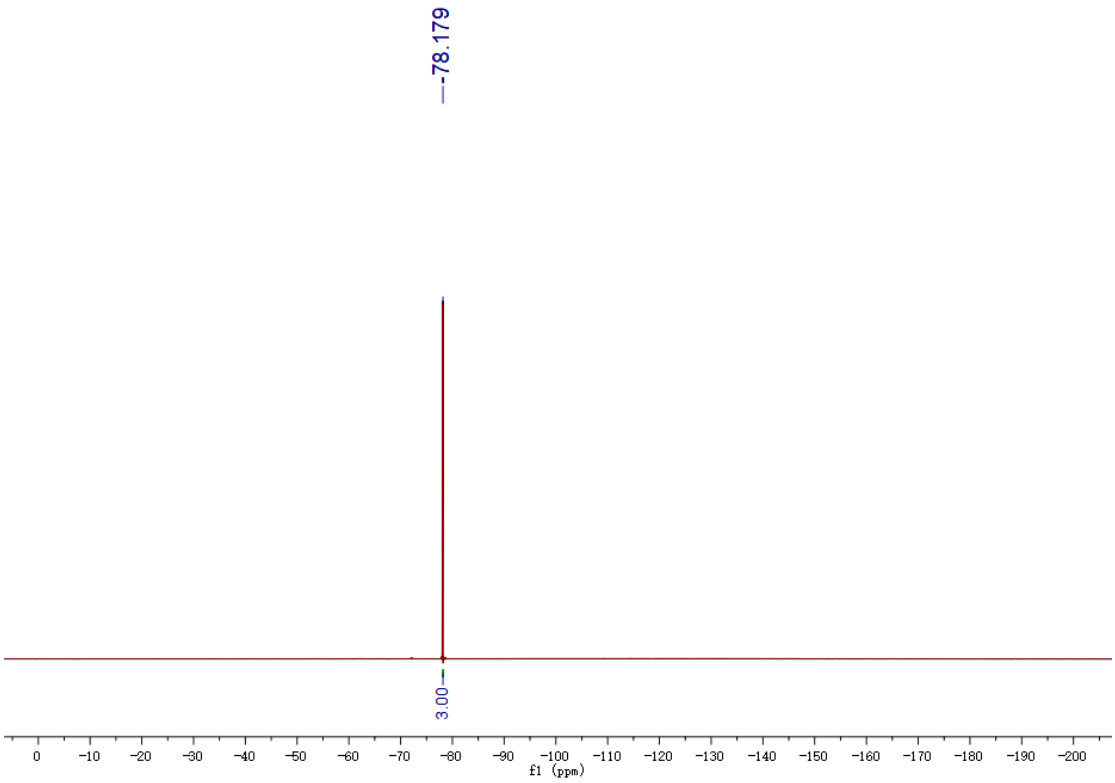
6a


0.96
2.04
2.10
2.21
2.49
1.14
2.01
2.00
f1 (ppm)


136.40
133.89
133.55
132.38
128.93
128.71
128.44
127.84
127.82
127.35
127.08
120.46
118.96
116.24
97.94
29.65
20.68
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


-78.266
3.00
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
f1 (ppm)

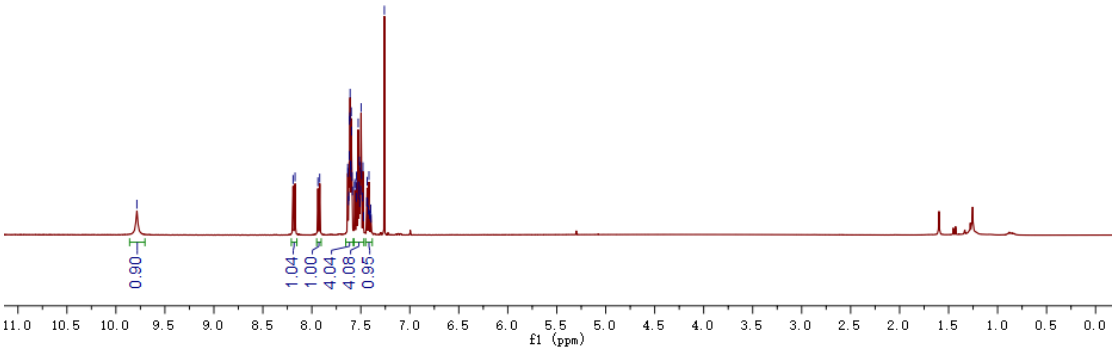

9.365
7.496
7.488
7.483
7.472
7.467
7.459
7.354
7.346
7.336
7.331
7.294
7.289
7.284
7.271
7.266
7.260
7.251
7.233
7.229
7.215
7.209
7.033
7.026
7.020
7.009
7.004
6.996
3.865
2.971
2.953
2.947
2.933
2.847
2.833
2.827
2.812
2.808
CF3
HN
MeO
6b
0.83
2.02
1.11
1.35
1.05
1.09
2.03
3.00
2.00
2.01
f1 (ppm)
159.30
136.39
133.74
133.39
129.63
128.71
127.78
127.41
127.05
124.82
120.37
118.77
116.33
114.38
97.69
55.45
29.66
20.67
f1 (ppm)

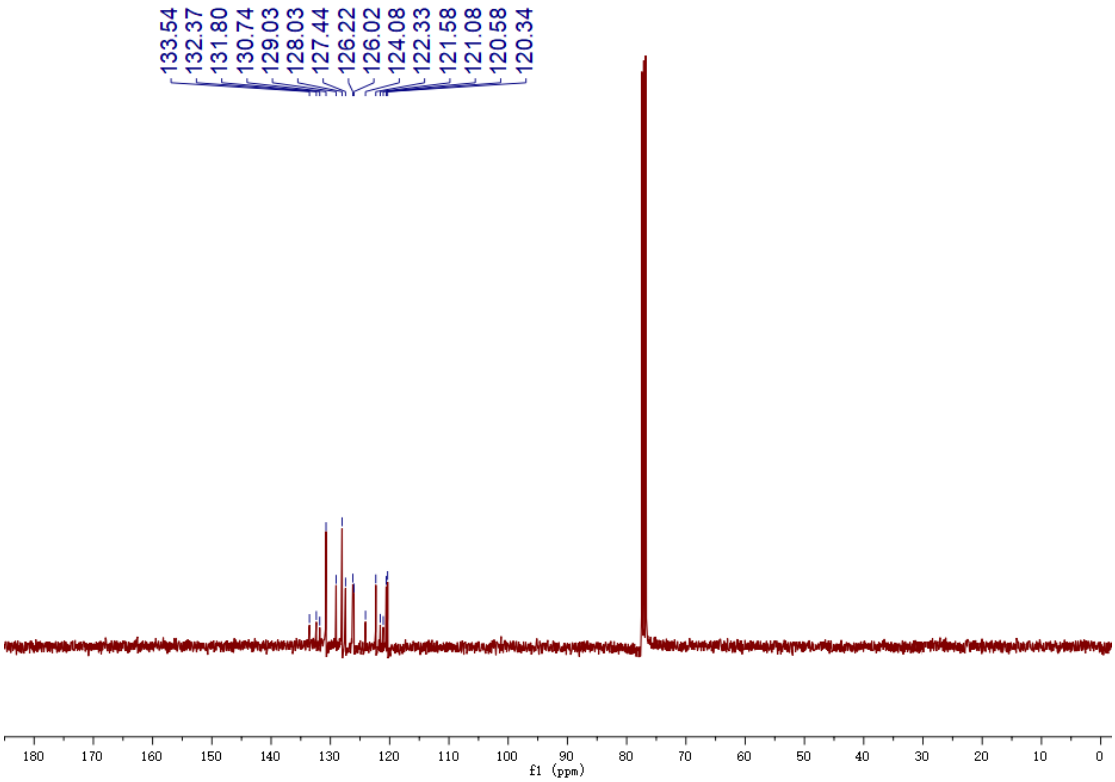

-78.179
3.00
f1 (ppm)

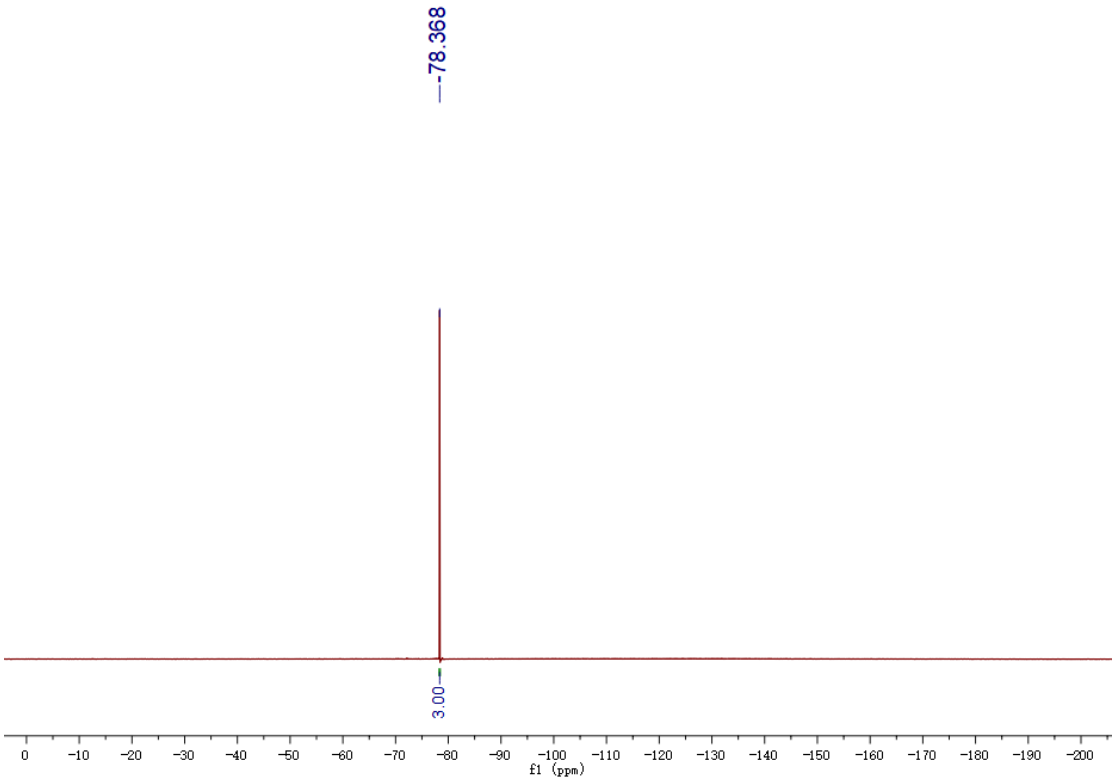

9.786
8.192
8.171
7.938
7.920
7.634
7.632
7.627
7.623
7.619
7.615
7.612
7.610
7.606
7.602
7.600
7.597
7.594
7.589
7.585
7.564
7.561
7.547
7.544
7.541
7.527
7.523
7.518
7.515
7.511
7.506
7.501
7.497
7.493
7.482
7.478
7.439
7.435
7.432
7.423
7.417
7.399
7.260

CF3
HN

7a


0.90
1.04
1.00
4.04
4.08
0.95
f1 (ppm)


133.54
132.37
131.80
130.74
129.03
128.03
127.44
126.22
126.02
124.08
122.33
121.58
121.08
120.58
120.34
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-78.368
3.00
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200
f1 (ppm)