Electronic Supplementary Information

Metal-Free and Site-Selective α-C-H Functionalization of Tetrahydrofuran Enabled by Photocatalytic Generation of Bromine Radical

Can-Ming Zhu,[a] Rong-Bin Liang,[a] Yonghong Xiao,[a] Wei Zhou,[a] Qing-Xiao Tong[a] and Jian-Ji Zhong*[a]

[a]Department of Chemistry and Key Laboratory for Preparation and Application of Ordered Structural Materials of Guangdong Province, Shantou University, and Chemistry and Chemical Engineering Guangdong Laboratory, Shantou, Guangdong 515063, P. R. China.

*E-mail: jjzhong@stu.edu.cn

Table of Contents

1. Experimental section

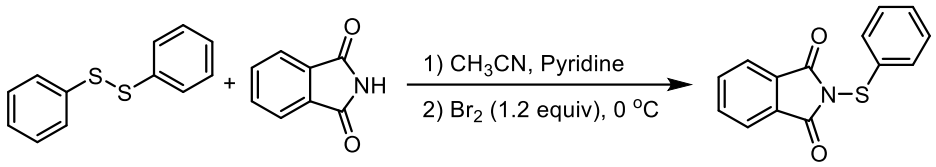
1) General information

All chemicals, unless otherwise noted, were purchased from commercial sources and were used without further purification. Unless stated otherwise, all reactions were carried out under air atmosphere. The substrates *N*-phenyl-sulfenyl phthalimides (**a**) and α-trifluoromethyl arylalkenes (**c**) were synthesized according to the literature methods with slight modification.[1-5] Irradiation with visible light was performed using blue LEDs (λ = 450 ± 10 nm) illumination instruments (The instruments were designed by ourselves and the actual output power density of the LEDs at 0.5 cm distance is 33.70 mW/cm^2 detected by CEL-NP2000-10 (Beijing Ceau Light Co. Ltd., China) light power meter). For irradiation, the material of the reaction vessel is common glass; the distance from the light source is about 0.5 cm.

The nuclear magnetic resonance spectra were recorded on the Bruker Ascend^{TM} 400 MHz NMR spectrometer with tetramethylsilane (TMS) as an internal standard. High resolution mass spectra were recorded using a Q Exactive mass spectrometer (Thermo Fisher Scientific, USA). Cyclic voltammogram experiments were measured on the CHI-Instrument CHI660E.

2) Preparation of of *N*-phenyl-sulfenyl phthalimides[1-3]

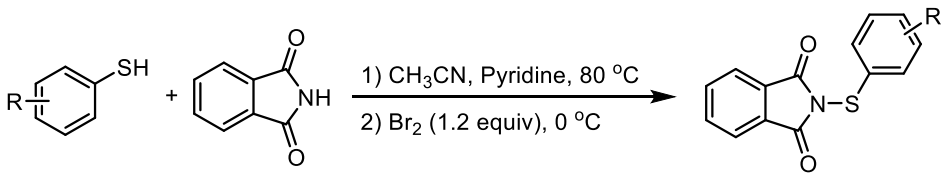
Method A:



A suspension of phthalimide (1.047 g, 10.0 mmol) and diphenyl disulfide (1.30 g, 6.0 mmol) in CH_3CN (5.0 mL) and pyridine (4.0 mL) were treated with a solution of Br_2 (615 μL in 5.0 mL CH_3CN, 12.0 mmol, 1.2 equiv) dropwise over 30 mins. Upon complete addition of Br_2 solution, the mixture was stirred for 1 h at 0 ℃, and was subsequently quenched by dropwise addition of CH_3OH (15.0 mL). Filtration of the suspension and washing of the precipitate with pre-cooled CH_3OH (0 ℃, 3 × 10.0 mL). Further purification was achieved by recrystallization in ethyl acetate through hot cooling to room temperature.

a1 was prepared according to the above procedure.

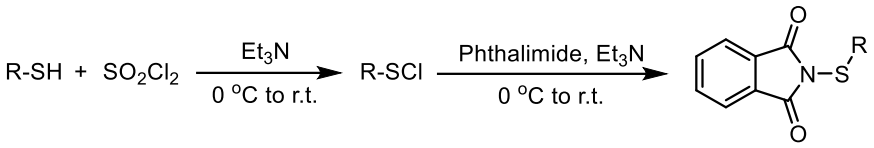
Method B:



A suspension of phthalimide (1.047 g, 10.0 mmol) and thiophenols (11.0 mmol, 1.1 equiv) in CH_3CN (5.0 mL) and pyridine (4.0 mL) was heated to 80 ℃ and then cooled to room temperature. The mixture was treated with a solution of Br_2 (615 μL in 5.0 mL CH_3CN, 12.0 mmol, 1.2 equiv) dropwise over 30 mins. Upon complete addition of Br_2 solution, the mixture was stirred for 1 h at 0 ℃ and was subsequently quenched by dropwise addition of H_2O (15.0 mL). Filtration of the suspension and washing of the precipitate with pre-cooled CH_3OH (0 ℃, 3 × 10.0 mL). Further purification was achieved by recrystallization in ethyl acetate through hot cooling to room temperature.

a2-a29 were prepared according to the above procedure.

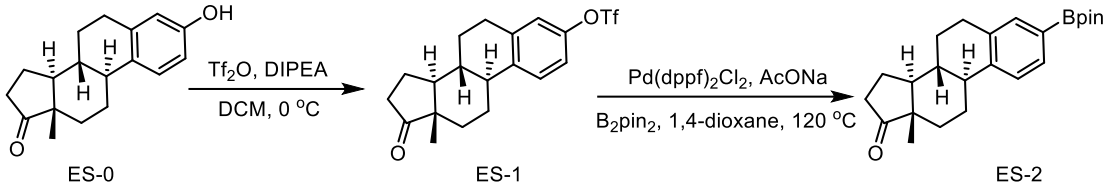
Method C:



Sulfuryl chloride (5 mmol in 10 mL CH_2Cl_2) was added dropwise via a dropping funnel to a solution of thiol (1.0 equiv) in CH_2Cl_2 (1.0 M) and Et_3N (0.1 mL) at 0 °C. After stirring for 15 min, the mixture was warmed to room temperature for 30 mins and then cooled to 0 °C. The resulting solution was transferred dropwise via cannula to a solution of phthalimide (1.0 equiv) in CH_2Cl_2 (1.0 M) and Et_3N (1.3 equiv) at 0 °C and the mixture was then warmed to room temperature over 1 h. The solution was diluted with H_2O, extracted with hot ethyl acetate before being dried over Na_2SO_4, and then concentrated to give crude product that was purified by recrystallization.

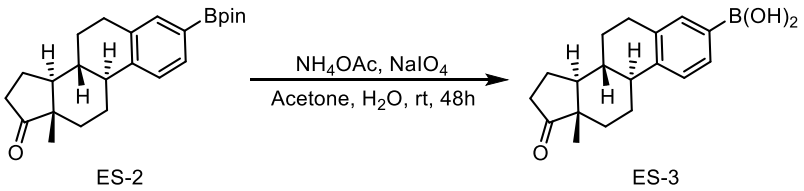
a30-a33 were prepared according to the above procedure.

3) Preparation of boronic acid of Estrone[4]



Estrone (10.0 mmol, 1.0 equiv., 2.70 g), and DIPEA (12.0 mmol, 1.2 equiv.) were dissolved in DCM (30.0 mL) in a two-neck flask with a stir bar under argon atmosphere. The reaction mixture was stirred at 0 °C, and Tf_2O (12.0 mmol, 1.2 equiv., 2.0 mL) was dropwise added into reaction system over 5 min. The reaction mixture was then allowed to warm to room temperature and stirred for 30 min. Upon completion, water (50.0 mL) was added to quench the reaction. The reaction mixture was then extracted with ethyl acetate (30.0 mL x 3). The combined organic extracts were dried with anhydrous $MgSO_4$ and concentrated under vacuum. The crude product was purified by flash column chromatography on silica gel to afford the corresponding trifluoromethanesulfonic ester **ES-1** (81%, 3.21 g).

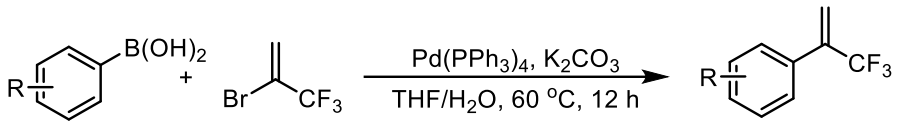
Trifluoromethanesulfonic ester **ES-1** (5.0 mmol, 1.0 equiv.), B_2pin_2 (10.0 mmol, 2.0 equiv., 2.7 g), $Pd(dppf)Cl_2$ (0.5 mmol, 10 mol%, 0.367 g), and AcONa (15.0 mmol, 3.0 equiv., 1.5 g) were dissolved in 1,4-dioxane (20.0 mL) in a two-neck flask with a stir bar under argon atmosphere. The reaction mixture was stirred at 120 °C for 8 h. Upon completion, water (50.0 mL) was added to quench the reaction. The reaction mixture was then extracted with ethyl acetate (30.0 mL x 3). The combined organic extracts were dried with anhydrous $MgSO_4$ and concentrated under vacuum. The desired product **ES-2** was obtained through silica gel chromatography.



ES-2 (2.0 mmol, 1.0 equiv., 0.76 g), NH_4OAc (12.0 mmol, 6.0 equiv., 0.92 g) and $NaIO_4$ (12.0 mmol, 6.0 equiv., 2.57 g) in acetone (50 mL) and water (20 mL) in a 200 mL round-bottom flask with a stir bar under argon atmosphere. Then the reaction

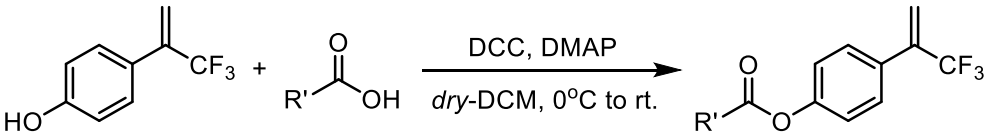
mixture was stirred at room temperature for 48 h. Upon completion, the resulting mixture was filtered through a pad of Celite. The filtrate was extracted with ethyl acetate (20.0 mL x 3). The combined organic layer was dried with anhydrous $MgSO_4$ and concentrated under vacuum. The corresponding boronic acid **ES-3** was obtained (57% yield) without further purification

4) Preparation of α-trifluoromethyl arylalkenes[5]



Arylboronic acid (10.0 mmol), $Pd(PPh_3)_4$ (0.3 mmol, 3 mol%), K_2CO_3 (2.0 M) were dissolved in THF (30.0 mL) in a two-neck flask under argon atmosphere. Then, 2-bromo-3,3,3-trifluoroprop-1-ene (20.0 mmol, 2.1 mL) was added dropwise into the mixture. The mixture was heated to 60 ℃ in an oil bath for at least 12 h. Then the mixed solution was extracted with ethyl acetate (3 × 15.0 mL). The organic layer was washed with brine (20.0 mL), dried over Na_2SO_4, and then concentrated under reduced pressure. The resulting residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 200/1) to afford the desired products.

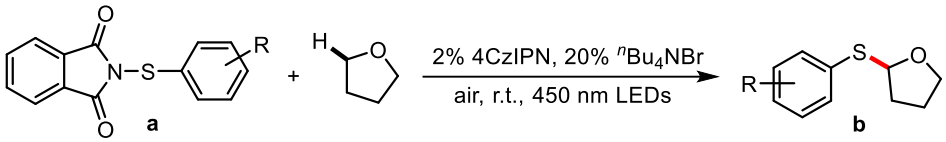
c1-c33, **c39** were prepared according to the above procedure.



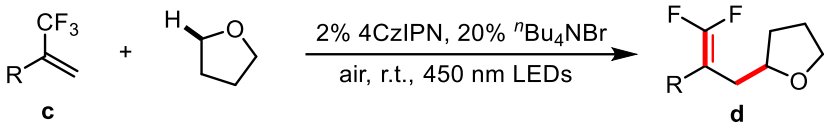
Carboxylic acid (2.2 mmol in dry DCM) was added dropwise via a dropping funnel to a solution of 4-(3,3,3-trifluoroprop-1-en-2-yl)phenol (2.0 mmol), DCC (2.2 mmol, 1.1 equiv.), DMAP (20 mol%) were dissolved in *dry*-DCM (10.0 mL) in a two-neck flask under argon atmosphere at 0 °C. After stirring for 5 min, the mixture was allowed to warm to room temperature over 3h. Upon completion, the resulting mixture was filtered through a pad of celite. The filtrate was concentrated under reduced pressure. The resulting residue was purified by silica gel column chromatography to afford the desired products.

c34-c38 were prepared according to the above procedure.

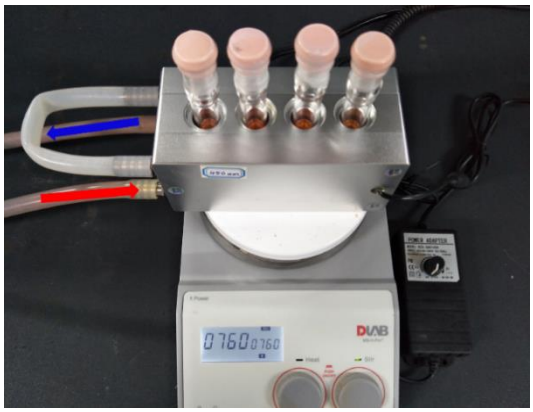
5) General procedure for the photochemical reactions

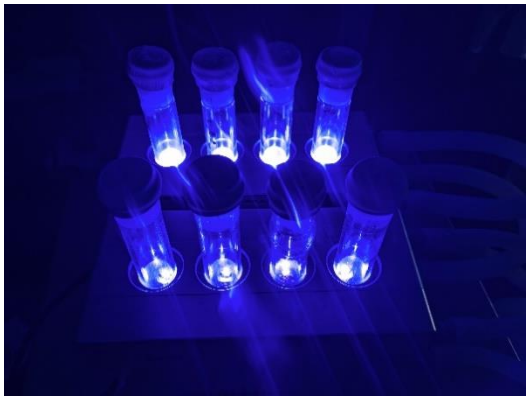


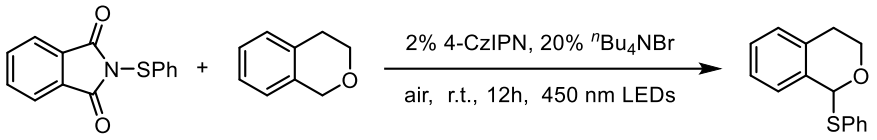
a (0.2 mmol), tetra-butyl ammonium bromide $^{n}Bu_4NBr$ (12.9 mg, 20 mol%), 4-CzIPN (3.1 mg, 2.0 mol%) were dissolved in 2.0 mL THF in a 10.0 mL flask equipped with magnetic stirring bar, then the reaction tube was irradiated by blue LEDs (λ = 450 ± 10 nm) at room temperature for 12 h. After reaction, the solvent was removed by rotary evaporation and purified by column-chromatography on silica gel using petroleum ether/ethyl acetate as the eluent to afford the desired product **b**.



c (0.2 mmol), tetra-butyl ammonium bromide $^{n}Bu_4NBr$ (12.9 mg, 20 mol%), 4-CzIPN (3.1 mg, 2 mol%) were dissolved in 2.0 mL THF in a 10.0 mL flask equipped with magnetic stirring bar, then the reaction tube was irradiated by blue LEDs (λ = 450 ± 10 nm) at room temperature for 12 h. After reaction, the solvent was removed by rotary evaporation and purified by column-chromatography on silica gel using petroleum ether/ethyl acetate as the eluent to afford the desired product **d**.

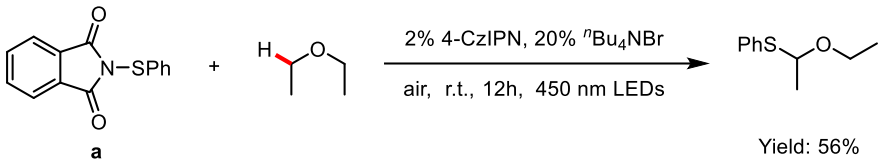






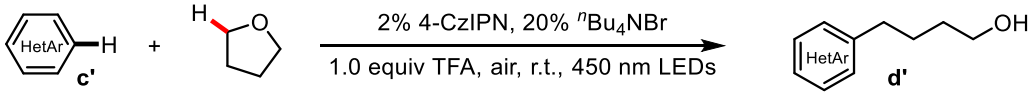
a, 0.2 mmol 0.3 mmol Yield: 52%

a (0.2 mmol), tetra-butyl ammonium bromide $^{n}Bu_4NBr$ (12.9 mg, 20 mol%), 4-CzIPN (3.1 mg, 2 mol%) and isochroman (0.3 mmol) were dissolved in 2.0 mL acetone in a 10.0 mL flask equipped with magnetic stirring bar, then the reaction tube was irradiated by blue LEDs (λ = 450 ± 10 nm) at room temperature for 12 h. After reaction, the solvent was removed by rotary evaporation and purified by column-chromatography on silica gel using petroleum ether/ethyl acetate as the eluent to afford the desired product **b34**.



a Yield: 56%

a (0.2 mmol), tetra-butyl ammonium bromide $^{n}Bu_4NBr$ (12.9 mg, 20 mol%), 4-CzIPN (3.1 mg, 2 mol%) were dissolved in 2.0 mL Diethyl ether in a 10.0 mL flask equipped with magnetic stirring bar, then the reaction tube was irradiated by blue LEDs (λ = 450 ± 10 nm) at room temperature for 12 h. After reaction, the solvent was removed by rotary evaporation and purified by column-chromatography on silica gel using petroleum ether/ethyl acetate as the eluent to afford the desired product **b35**.



c' **d'**

c' (0.2 mmol), tetra-butyl ammonium bromide $^{n}Bu_4NBr$ (12.9 mg, 20 mol%), 4-CzIPN (3.1 mg, 2 mol%) and Trifluoroacetic acid (1.0 equiv., 20 μL) were dissolved in 2.0 mL THF in a 10.0 mL flask equipped with magnetic stirring bar, then the reaction tube was irradiated by blue LEDs (λ = 450 ± 10 nm) at room temperature for 12 h. After reaction, the solvent was removed by rotary evaporation and purified by column-chromatography on silica gel using hexane/ethyl acetate as the eluent to afford the desired product **d'**.

6) Crystal structure determination of b15

A suitable crystal of **b15** was mounted with glue at the end of a glass fiber. Data collection for **b15** was performed on a Rigaku OD (Enhance Cu X-ray Source, Kα, λ = 1.54184 Å) with CCD Plate (XtaLAB Pro: Kappa single) under 293 K. Data were processed with the CrysAlisPro 1.171.39.7e (Rigaku Oxford Diffraction, 2015).

Structure was solved by ShelXT[6] in Olex2 1.5[7] and refined on F^2 using full-matrix least-squares (SHELXL-2018 in Olex2 1.5). Anisotropic thermal parameters were applied to all non-hydrogen atoms. The hydrogen atoms were generated geometrically. Crystal data and structure refinement parameters are summarized in Table S1. CCDC No. **2161362**.

Single crystals of **b15** were prepared in acetonitrile solution of **b15**. Colourless block crystals formed.

Table S1 Crystal data and structure refinements for b15

Compound	**b15**
Formula	C16H16OS
Formula weight	256.35
Temperature (K)	293(2) K
Crystal system	Monoclinic
Space group	$P2_1/n$
a/Å	6.0752(3)
b/Å	9.8777(5)
c/Å	22.1887(13)
β/°	91.536(5)
V/Å^3	1331.04(12)
Z	4
D_c/g cm^{-3}	1.279
reflns coll.	5767

unique reflns	2471
R_{int}	0.0235
R_1 [$I > 2\sigma(I)$]	0.0538
wR_2 [$I > 2\sigma(I)$]	0.1380
R_1 (all data)	0.0621
wR_2 (all data)	0.1429
GOF	1.069

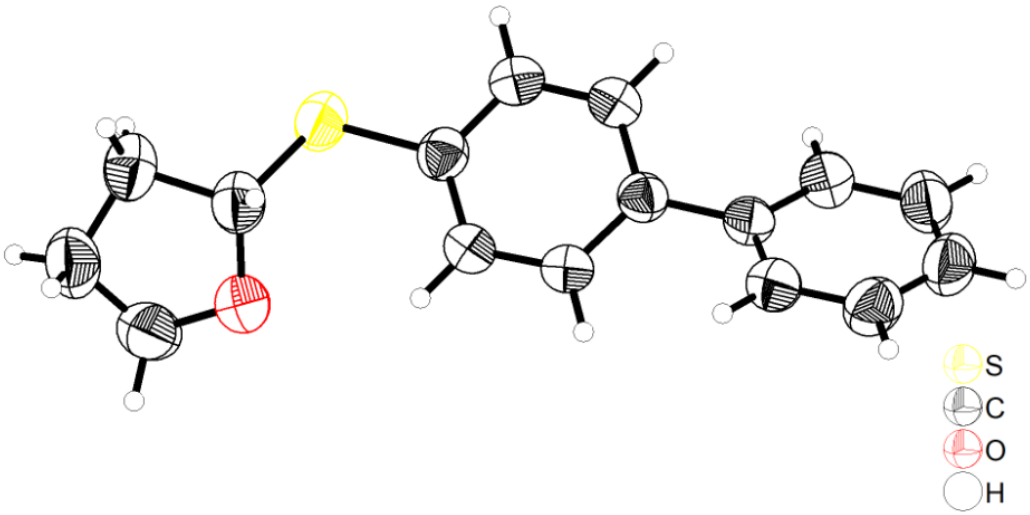


Figure S1. Molecular structure of **b15** with 50% thermal ellipsoid.

CCDC Number: 2161362

7) Luminescence quenching experiments

General procedure: The lumicescence quenching experiments were measured with excitation at 450 nm. A THF solution of 1×10^{-4} M 4-CzIPN and 1.0×10^{-1} M **a1** or $^{n}Bu_4NBr$ respectively were prepared. The experiments were conducted in 1.25 cm x 1.25 cm x 4.5 cm quartz cuvette at room temperature. Appropriate volume (the whole solution volume change < 5%) of the quencher **a1** or $^{n}Bu_4NBr$ was respectively injected to the THF solution (3.0 mL) of 1×10^{-4} M 4-CzIPN in the quartz cuvette by microsyringe.

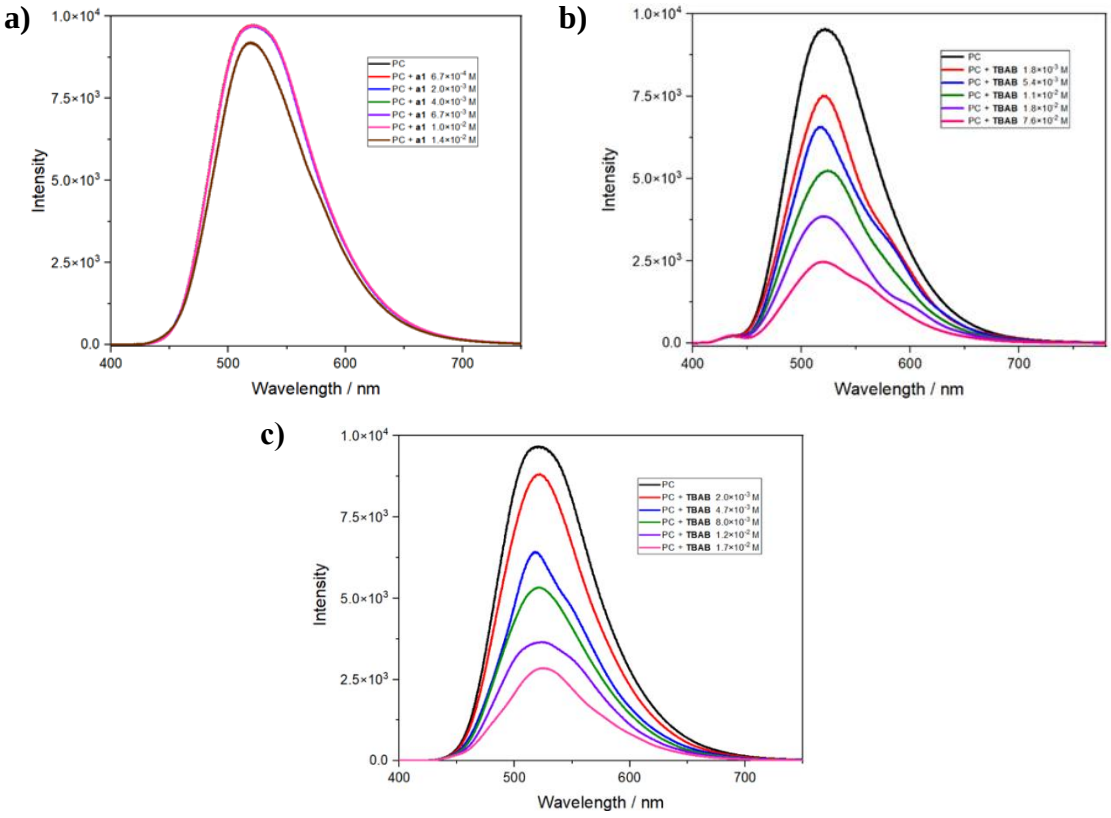
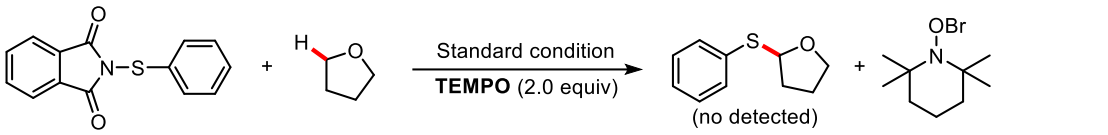


Figure S2. Luminescence quenching spectra of 4-CzIPN (1.0×10^{-4} M) **a)** by various concentration of **a1**; **b)** by various concentration of $^{n}Bu_4NBr$ under argon atmosphere; **c)** by various concentration of $^{n}Bu_4NBr$ under air atmosphere with excitation at 450 nm.

8) Radical inhibition experiment



detected by HRMS

HRMS (ES$^+$) Calcd [M+H]$^+$: 236.0645

found: 236.0648

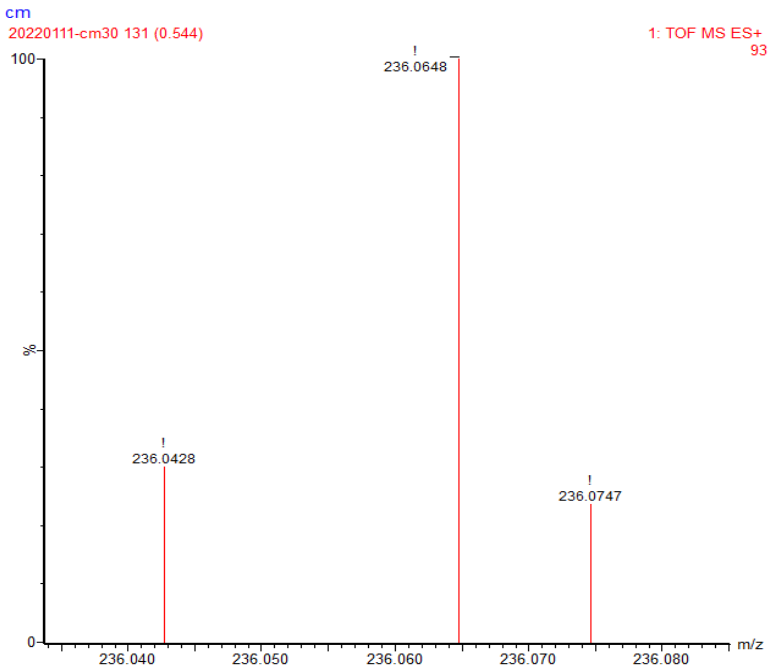
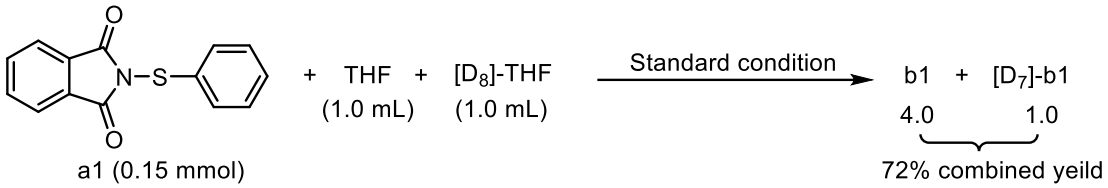
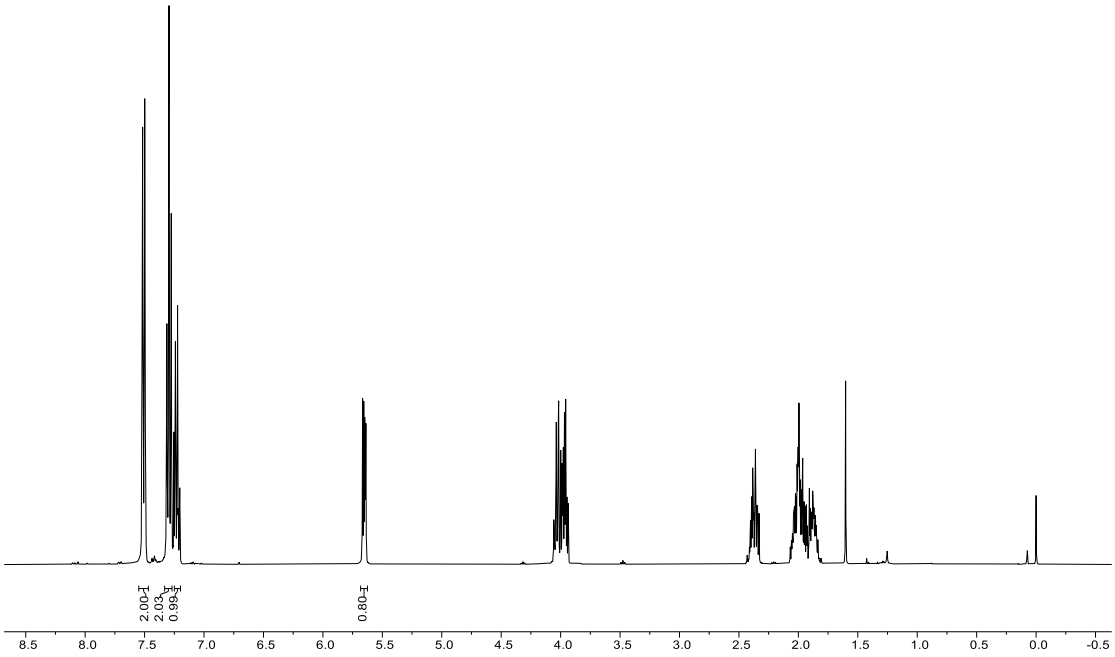


Figure S3. HRMS spectra for Radical inhibition experiment.

9) Kinetic isotope effect experiment



a1 (0.15 mmol), $^{n}Bu_4NBr$ (9.7 mg, 20 mol%), 4-CzIPN (2.4 mg, 2.0 mol%) were dissolved in THF/D_8-THF (1.0 mL/1.0 mL) in a 10.0 mL flask equipped with magnetic stirring bar, then the reaction tube was irradiated by blue LEDs (λ = 450 ± 10 nm) at room temperature for 8 h. After reaction, the solvent was removed by rotary evaporation and purified by column-chromatography on silica gel using petroleum ether/ethyl acetate as the eluent to afford the desired product **b1**.



k_H / k_D = 0.80/ (1-0.80) = 4.0

Figure S4. ^{1}H NMR spectra for kinetic isotope effect experiment.

10) References

1 S. E. Denmark, E. Hartmann, D. J. P. Kornfilt, H. Wang, *Nat. Chem.* 2014, **6**, 1056.

2 J. Klose, C. B. Reese, Q. Song, *Tetrahedron* 1997, **53**, 14411.

3 H. M. Gillis, L. Greene, A. Thompson, *Synlett*. 2009, **1**, 112.

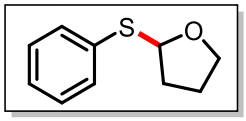
4 B. Du, C.-M. Chan, P.-Y. Lee, L.-H. Cheung, X. Xu, Z. Lin, W.-Y. Yu, *Nat. Commun.*, 2021, **12**, 412.

5 X. Lu, X.-X. Wang, T.-J. Gong, J.-J. Pi, S.-J. He, Y. Fu, *Chem. Sci.* 2019, **10**, 809.

6 G. M. Sheldrick, *Acta Cryst.* 2015, **A71**, 3.

7 O. V. Dolomanov, L. J. Bourhis, R. J. Gildea, J. A. K. Howard, H. Puschmann, *J. Appl. Crystallogr.* 2009, **42**, 339.

2. Characterization data of the products



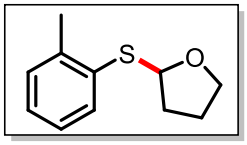
b1

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b1** as a colorless oil (33.5 mg, 93% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (d, *J* = 7.1 Hz, 2H), 7.28 (t, *J* = 7.4 Hz, 2H), 7.20 (t, *J* = 7.4 Hz, 1H), 5.64 (dd, *J* = 7.2, 3.8 Hz, 1H), 4.04 – 3.91 (m, 2H), 2.39 – 2.29 (m, 1H), 2.04 – 1.92 (m, 2H), 1.90 – 1.79 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 135.8, 131.0, 128.8, 126.8, 87.1, 67.3, 32.7, 24.9.

HRMS (EI) calculated for $C_{10}H_{12}OS$ $[M]^+$: 180.0604; Found: 180.0605



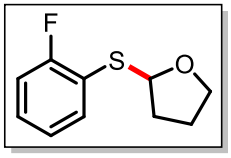
b2

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b2** as a colorless oil (30.3 mg, 78% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (d, *J* = 7.4 Hz, 1H), 7.16 (d, *J* = 6.3 Hz, 1H), 7.14 (d, *J* = 4.7 Hz, 1H), 7.13 – 7.09 (m, 1H), 5.63 (dd, *J* = 7.2, 3.7 Hz, 1H), 4.04 – 3.91 (m, 2H), 2.38 (s, 3H), 2.37 – 2.30 (m, 1H), 2.06 – 1.97 (m, 2H), 1.91 – 1.82 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 138.4, 135.2, 130.8, 130.0, 126.7, 126.5, 86.4, 67.4, 32.8, 24.9, 20.8.

HRMS (ESI) calculated for $C_{11}H_{14}OS$ $[M+H]^+$: 195.0839; Found: 195.0841



b3

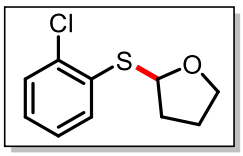
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b3** as a pale-yellow oil (33.3 mg, 84% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (td, *J* = 7.6, 1.8 Hz, 1H), 7.29 – 7.19 (m, 1H), 7.13 – 7.03 (m, 2H), 5.70 (dd, *J* = 7.1, 3.4 Hz, 1H), 4.07 – 3.93 (m, 2H), 2.42 – 2.33 (m, 1H), 2.12 – 1.97 (m, 2H), 1.93 – 1.84 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 161.5 (d, *J* = 245.9 Hz), 133.9, 129.0 (d, *J* = 7.8 Hz), 124.5 (d, *J* = 3.8 Hz), 122.3 (d, *J* = 17.9 Hz), 115.6 (d, *J* = 22.9 Hz), 86.4 (d, *J* = 7.8 Hz), 67.37, 32.70, 24.62.

^{19}F NMR (376 MHz, $CDCl_3$) δ -109.35 (s, 1F).

HRMS (ESI) calculated for $C_{10}H_{11}FOS$ $[M+H]^+$: 199.0588; Found: 199.0592



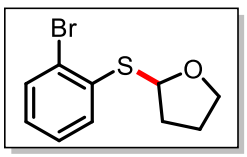
b4

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b4** as a pale-yellow oil (37.7 mg, 88% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (dd, *J* = 7.9, 1.6 Hz, 1H), 7.35 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.22 (td, *J* = 7.6, 1.5 Hz, 1H), 7.12 (td, *J* = 7.6, 1.6 Hz, 1H), 5.75 (dd, *J* = 7.2, 3.6 Hz, 1H), 4.04 – 3.94 (m, 2H), 2.46 – 2.37 (m, 1H), 2.12 – 2.00 (m, 2H), 1.94 – 1.85 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 135.5, 133.9, 130.7, 129.5, 127.2, 127.2, 85.5, 67.5, 32.6, 24.8.

HRMS (ESI) calculated for $C_{10}H_{11}ClOS$ $[M+H]^+$: 215.0292; Found: 215.0297



b5

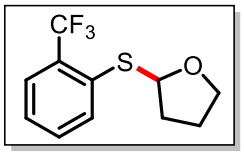
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b5** as a pale-yellow oil (42.8 mg, 83% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.55 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.29 (td, *J* = 7.6, 1.3 Hz, 1H), 7.06 (td, *J* = 7.7, 1.6 Hz, 1H), 5.78 (dd, *J* = 7.3,

3.6 Hz, 1H), 4.11 – 3.94 (m, 2H), 2.52 – 2.38 (m, 1H), 2.15 – 2.00 (m, 2H), 2.01 – 1.84 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 137.7, 132.8, 130.3, 127.9, 127.2, 123.9, 85.6, 67.5, 32.5, 24.8.

HRMS (ESI) calculated for $C_{10}H_{11}BrOS$ $[M+H]^+$: 258.9787; Found: 258.9783



b6

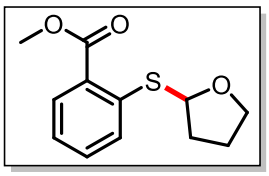
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b6** as a colorless oil (42.2 mg, 85% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 7.9 Hz, 1H), 7.66 (d, *J* = 7.9 Hz, 1H), 7.50 (t, *J* = 7.7 Hz, 1H), 7.32 (t, *J* = 7.7 Hz, 1H), 5.71 (dd, *J* = 7.2, 3.5 Hz, 1H), 4.10 – 3.96 (m, 2H), 2.48 – 2.36 (m, 1H), 2.13 – 2.01 (m, 2H), 1.97 – 1.86 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 135.6 (d, *J* = 1.8 Hz), 133.1 (d, *J* = 3.7 Hz), 132.0 (d, *J* = 1.9 Hz), 126.5 (q, *J* = 275.2 Hz), 126.4, 125.2, 122.5, 87.1, 67.4, 32.7, 24.7.

^{19}F NMR (376 MHz, $CDCl_3$) δ -60.62 (s, 3F).

HRMS (ESI) calculated for $C_{11}H_{11}F_3OS$ $[M+H]^+$: 249.0556; Found: 249.0559



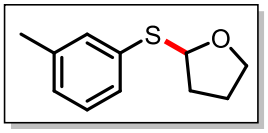
b7

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b7** as a colorless oil (38.6 mg, 81% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 8.7 Hz, 1H), 7.86 (d, *J* = 8.1 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 1H), 7.18 (t, *J* = 7.6 Hz, 1H), 5.75 (dd, *J* = 7.4, 3.9 Hz, 1H), 4.04 – 3.94 (m, 2H), 3.89 (s, 3H), 2.47 – 2.38 (m, 1H), 2.13 – 2.03 (m, 2H), 1.96 – 1.86 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 167.0, 141.1, 132.4, 130.9, 128.0, 124.6, 122.9, 84.5, 67.6, 52.1, 32.4, 25.1.

HRMS (ESI) calculated for $C_{12}H_{14}O_3S$ $[M+H]^+$: 239.0737; Found: 239.0731



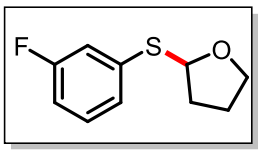
b8

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b8** as a colorless oil (32.2 mg, 83% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (s, 1H), 7.30 (d, *J* = 8.0 Hz, 1H), 7.17 (t, *J* = 7.6 Hz, 1H), 7.03 (d, *J* = 7.8 Hz, 1H), 5.64 (dd, *J* = 7.2, 3.9 Hz, 1H), 4.03 – 3.93 (m, 2H), 2.40 – 2.34 (m, 1H), 2.32 (s, 3H), 2.05 – 1.94 (m, 2H), 1.90 – 1.82 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 138.6, 135.4, 131.6, 128.7, 128.0, 127.7, 87.1, 67.3, 32.7, 24.9, 21.4.

HRMS (ESI) calculated for $C_{11}H_{14}OS$ $[M+H]^+$: 195.0839; Found: 195.0840



b9

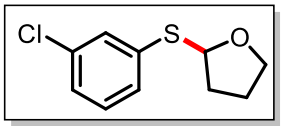
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b9** as a colorless oil (30.9 mg, 77% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 (d, *J* = 2.9 Hz, 1H), 7.24 (d, *J* = 3.1 Hz, 1H), 7.23 (d, *J* = 5.7 Hz, 1H), 6.94 – 6.85 (m, 1H), 5.68 (dd, *J* = 7.3, 3.9 Hz, 1H), 4.04 – 3.93 (m, 2H), 2.44 – 2.32 (m, 1H), 2.08 – 1.94 (m, 2H), 1.93 – 1.84 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 162.7 (d, *J* = 248.8 Hz), 138.3 (d, *J* = 3.0 Hz), 130.0 (d, *J* = 8.7 Hz), 125.9 (d, *J* = 3.2 Hz), 117.2 (d, *J* = 22.4 Hz), 113.5(d, *J* = 21.2 Hz), 86.8, 67.4, 32.6, 24.8.

^{19}F NMR (376 MHz, $CDCl_3$) δ -112.37 (s, 1F).

HRMS (ESI) calculated for $C_{10}H_{11}FOS$ $[M+H]^+$: 199.0588; Found: 199.0581



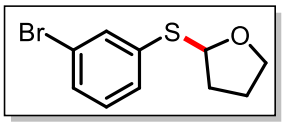
b10

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b10** as a pale-yellow oil (38.1 mg, 89% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 – 7.50 (m, 1H), 7.38 (dt, *J* = 6.9, 1.9 Hz, 1H), 7.25 – 7.21 (m, 1H), 7.20 – 7.18 (m, 1H), 5.68 (dd, *J* = 7.3, 3.8 Hz, 1H), 4.05 – 3.96 (m, 2H), 2.44 – 2.34 (m, 1H), 2.09 – 1.95 (m, 2H), 1.94 – 1.85 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 138.0, 134.5, 130.2, 129.8, 128.6, 126.7, 86.9, 67.4, 32.6, 24.8.

HRMS (ESI) calculated for $C_{10}H_{11}ClOS$ $[M+H]^+$: 215.0292; Found: 215.0297



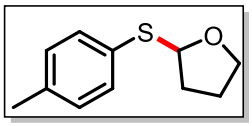
b11

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b11** as a pale-yellow oil (41.3 mg, 80% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (t, *J* = 1.8 Hz, 1H), 7.41 (d, *J* = 8.5 Hz, 1H), 7.34 (d, *J* = 8.9 Hz, 1H), 7.14 (t, *J* = 7.9 Hz, 1H), 5.66 (dd, *J* = 7.3, 3.8 Hz, 1H), 4.03 – 3.95 (m, 2H), 2.41 – 2.33 (m, 1H), 2.08 – 1.93 (m, 2H), 1.93 – 1.83 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 138.3, 133.0, 130.1, 129.7, 129.1, 122.6, 86.9, 67.4, 32.6, 24.8.

HRMS (ESI) calculated for $C_{10}H_{11}BrOS$ $[M+H]^+$: 258.9787; Found: 258.9778



b12

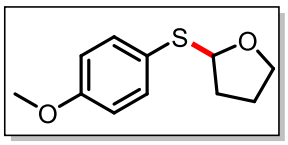
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 30/1, v/v) afforded **b12** as a colorless oil (32.6 mg, 84% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (d, *J* = 8.2 Hz, 2H), 7.10 (d, *J* = 7.9 Hz, 2H), 5.57

(dd, J = 7.2, 3.8 Hz, 1H), 4.05 – 3.90 (m, 2H), 2.38 – 2.32 (m, 1H), 2.31 (s, 3H), 2.05 – 1.92 (m, 2H), 1.91 – 1.82 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 137.0, 131.9, 131.8, 129.6, 87.6, 67.2, 33.6, 24.8, 21.1.

HRMS (ESI) calculated for $C_{11}H_{14}OS$ $[M+H]^+$: 195.0838; Found: 195.0843



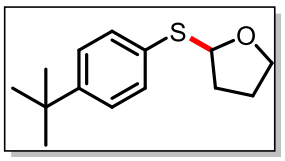
b13

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 30/1, v/v) afforded **b13** as a colorless oil (36.1 mg, 86% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 (d, J = 8.8 Hz, 2H), 6.84 (d, J = 8.8 Hz, 2H), 5.46 (dd, J = 7.2, 3.7 Hz, 1H), 4.06 – 3.96 (m, 1H), 3.92 (td, J = 8.1, 4.1 Hz, 1H), 3.78 (s, 3H), 2.34 – 2.26 (m, 1H), 2.02 – 1.92 (m, 2H), 1.88 – 1.79 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.4, 134.6, 125.6, 114.4, 88.2, 67.2, 55.3, 32.5, 24.8.

HRMS (ESI) calculated for $C_{11}H_{14}O_2S$ $[M+H]^+$: 211.0788; Found: 211.0786



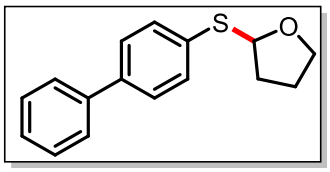
b14

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b14** as a colorless oil (42.5 mg, 90% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 (d, J = 8.4 Hz, 2H), 7.32 (d, J = 8.4 Hz, 2H), 5.61 (dd, J = 7.2, 3.9 Hz, 1H), 4.05 – 3.91 (m, 2H), 2.40 – 2.28 (m, 1H), 2.03 – 1.91 (m, 2H), 1.91 – 1.79 (m, 1H), 1.29 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 150.2, 132.0, 131.4, 126.0, 87.5, 67.3, 34.6, 32.7, 31.4, 25.0.

HRMS (ESI) calculated for $C_{14}H_{20}OS$ $[M+H]^+$: 237.1308; Found: 237.1312



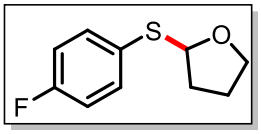
b15

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b15** as a white solid (35.3 mg, 69% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (dd, *J* = 3.9, 2.4 Hz, 2H), 7.56 (d, *J* = 3.2 Hz, 2H), 7.52 (d, *J* = 8.5 Hz, 2H), 7.42 (t, *J* = 7.5 Hz, 2H), 7.33 (t, *J* = 7.4 Hz, 1H), 5.69 (dd, *J* = 7.2, 3.8 Hz, 1H), 4.08 – 3.95 (m, 2H), 2.43 – 2.34 (m, 1H), 2.08 – 1.96 (m, 2H), 1.95 – 1.85 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 140.6, 139.8, 134.8, 131.4, 128.8, 127.5, 127.4, 127.0, 87.2, 67.4, 32.7, 24.9.

HRMS (ESI) calculated for $C_{16}H_{16}OS$ $[M+H]^+$: 257.0995; Found: 257.0999



b16

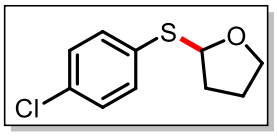
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b16** as a pale-yellow oil (36.4 mg, 92% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (dd, *J* = 8.8, 5.3 Hz, 2H), 7.00 (t, *J* = 8.7 Hz, 2H), 5.54 (dd, *J* = 7.2, 3.8 Hz, 1H), 4.08 – 3.89 (m, 2H), 2.41 – 2.28 (m, 1H), 2.06 – 1.92 (m, 2H), 1.91 – 1.82 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 162.3 (d, *J* = 247.8 Hz), 134.0 (d, *J* = 8.2 Hz), 130.4 (d, *J* = 3.4 Hz), 115.8 (d, *J* = 21.7 Hz), 87.8, 67.2, 32.5, 24.8.

^{19}F NMR (376 MHz, $CDCl_3$) δ -114.81 (s, 1F).

HRMS (ESI) calculated for $C_{10}H_{11}FOS$ $[M+H]^+$: 199.0588; Found: 199.0588



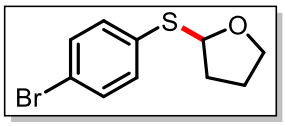
b17

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b17** as a pale-yellow oil (39.4 mg, 92% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (dd, *J* = 8.8, 5.3 Hz, 2H), 6.99 (t, *J* = 8.7 Hz, 2H), 5.53 (dd, *J* = 7.2, 3.8 Hz, 1H), 4.04 – 3.89 (m, 2H), 2.40 – 2.27 (m, 1H), 2.06 – 1.92 (m, 2H), 1.90 – 1.80 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 161.1, 134.0, 130.5, 116.0, 87.8, 67.2, 32.6, 24.8.

HRMS (ESI) calculated for $C_{10}H_{11}ClOS$ $[M+H]^+$: 215.0292; Found: 215.0300



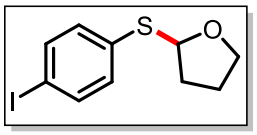
b18

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b18** as a pale-yellow oil (47.0 mg, 91% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (d, *J* = 8.7 Hz, 2H), 7.36 (d, *J* = 8.7 Hz, 2H), 5.60 (dd, *J* = 7.2, 3.8 Hz, 1H), 4.03 – 3.92 (m, 2H), 2.42 – 2.29 (m, 1H), 2.06 – 1.93 (m, 2H), 1.92 – 1.83 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 135.0, 132.6, 131.8, 120.9, 87.1, 67.3, 32.6, 24.8.

HRMS (ESI) calculated for $C_{10}H_{11}BrOS$ $[M+H]^+$: 258.9787; Found: 258.9785



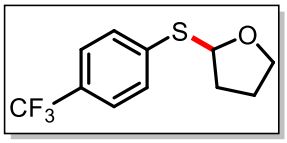
b19

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b19** as a yellow oil (54.5 mg, 89% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (d, *J* = 8.4 Hz, 2H), 7.22 (d, *J* = 8.4 Hz, 2H), 5.61 (dd, *J* = 7.3, 3.8 Hz, 1H), 4.02 – 3.92 (m, 2H), 2.40 – 2.30 (m, 1H), 2.05 – 1.92 (m, 2H), 1.90 – 1.82 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 137.6, 136.0, 132.6, 92.1, 87.0, 67.4, 32.6, 24.8.

HRMS (ESI) calculated for $C_{10}H_{11}IOS$ $[M+H]^+$: 306.9649; Found: 306.9439



b20

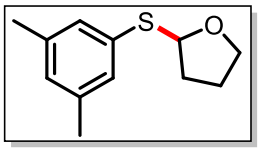
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b20** as a colorless oil (43.6 mg, 88% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (d, *J* = 8.2 Hz, 2H), 7.52 (d, *J* = 8.3 Hz, 2H), 5.75 (dd, *J* = 7.3, 3.8 Hz, 1H), 4.08 – 3.95 (m, 2H), 2.42 (tdd, *J* = 12.0, 5.2, 3.4 Hz, 1H), 2.10 – 1.97 (m, 2H), 1.96 – 1.86 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 141.48 (d, *J* = 1.5 Hz), 129.49, 128.2 (d, *J* = 32.5 Hz), 125.5 (q, *J* = 3.8 Hz), 122.8, 86.2, 67.4, 32.6, 24.8.

^{19}F NMR (376 MHz, $CDCl_3$) δ -62.49 (s, 3F).

HRMS (ESI) calculated for $C_{11}H_{11}F_3OS$ $[M+H]^+$: 249.0556; Found: 249.0552



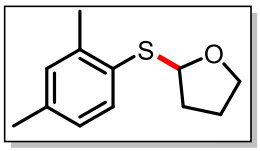
b22

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b22** as a colorless oil (36.2 mg, 87% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.12 (s, 2H), 6.85 (s, 1H), 5.65 (dd, *J* = 7.3, 4.0 Hz, 1H), 4.05 – 3.92 (m, 2H), 2.40 – 2.32 (m, 1H), 2.28 (s, 6H), 2.05 – 1.93 (m, 2H), 1.91 – 1.82 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 138.4, 135.2, 128.7, 128.5, 87.1, 67.3, 32.7, 24.9, 21.3.

HRMS (ESI) calculated for $C_{12}H_{16}OS$ $[M+H]^+$: 209.0995; Found: 209.0995



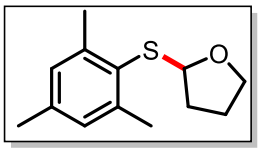
b23

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b23** as a colorless oil (34.1 mg, 82% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (d, *J* = 7.9 Hz, 1H), 7.01 (s, 1H), 6.97 (d, *J* = 8.5 Hz, 1H), 5.59 (dd, *J* = 7.1, 3.6 Hz, 1H), 4.08 – 3.94 (m, 2H), 2.37 (s, 3H), 2.36 – 2.30 (m, 1H), 2.28 (s, 3H), 2.08 – 1.95 (m, 2H), 1.91 – 1.80 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 139.1, 137.0, 132.2, 131.2, 131.0, 127.3, 86.9, 67.3, 32.7, 24.9, 21.0, 20.8.

HRMS (ESI) calculated for $C_{12}H_{16}OS$ $[M+H]^+$: 209.0995; Found: 209.1002



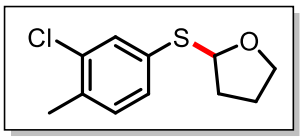
b24

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b24** as a colorless oil (23.1 mg, 52% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.96 (s, 2H), 5.40 – 5.31 (m, 1H), 4.06 – 3.87 (m, 2H), 2.53 (s, 6H), 2.37 – 2.29 (m, 1H), 2.27 (s, 3H), 2.13 – 1.97 (m, 2H), 1.90 – 1.82 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.2, 138.4, 129.1, 129.0, 88.1, 67.3, 32.9, 25.0, 22.3, 21.1.

HRMS (ESI) calculated for $C_{13}H_{18}OS$ $[M+H]^+$: 223.1152; Found: 223.1159



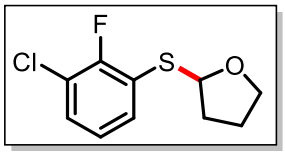
b25

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b25** as a colorless oil (28.3 mg, 65% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (d, *J* = 1.9 Hz, 1H), 7.31 (dd, *J* = 7.9, 1.9 Hz, 1H), 7.16 (d, *J* = 7.2 Hz, 1H), 5.62 (dd, *J* = 7.2, 3.8 Hz, 1H), 4.07 – 3.95 (m, 2H), 2.43 – 2.36 (m, 1H), 2.35 (s, 3H), 2.08 – 1.95 (m, 2H), 1.94 – 1.86 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 134.8, 134.5, 134.2, 131.6, 131.1, 129.7, 87.4, 67.3, 32.6, 24.8, 19.7.

HRMS (ESI) calculated for $C_{11}H_{13}ClOS$ $[M+H]^+$: 229.0449; Found: 229.0439



b26

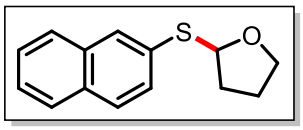
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b26** as a colorless oil (29.2 mg, 63% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (ddd, *J* = 8.0, 6.4, 1.7 Hz, 1H), 7.28 (ddd, *J* = 8.2, 6.8, 1.6 Hz, 1H), 7.03 (td, *J* = 8.0, 1.2 Hz, 1H), 5.71 (dd, *J* = 7.2, 3.4 Hz, 1H), 4.06 – 3.93 (m, 2H), 2.43 – 2.34 (m, 1H), 2.12 – 1.98 (m, 2H), 1.96 – 1.86 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 156.7 (d, *J* = 247.2 Hz), 131.6, 124.8, 124.6 (q, *J* = 4.5, 3.8 Hz), 121.4(d, *J* = 19.2 Hz), 86.4, 67.4, 32.7, 24.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -110.73 (s, 1F).

HRMS (ESI) calculated for $C_{13}H_{18}OS$ $[M+H]^+$: 233.0198; Found: 233.0190



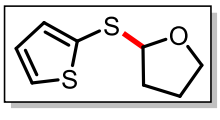
b27

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b27** as a pale-yellow oil (28.1 mg, 61% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (s, 1H), 7.81 (d, *J* = 6.8 Hz, 2H), 7.78 (d, *J* = 8.5 Hz, 1H), 7.58 (dd, *J* = 8.6, 1.8 Hz, 1H), 7.51 – 7.43 (m, 2H), 5.78 (dd, *J* = 7.2, 3.8 Hz, 1H), 4.12 – 3.98 (m, 2H), 2.49 – 2.37 (m, 1H), 2.11 – 2.00 (m, 2H), 1.98 – 1.87 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 133.7, 133.2, 132.2, 129.4, 128.7, 128.2, 127.7, 127.4, 126.4, 125.8, 87.2, 67.4, 32.7, 24.9.

HRMS (ESI) calculated for $C_{14}H_{14}OS$ $[M+H]^+$: 231.0839; Found: 231.0833



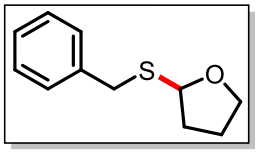
b28

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b28** as a colorless oil (17.5 mg, 47% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 (d, *J* = 5.4 Hz, 1H), 7.17 (d, *J* = 3.5 Hz, 1H), 7.00 (dd, *J* = 5.3, 3.6 Hz, 1H), 5.43 (dd, *J* = 7.2, 3.0 Hz, 1H), 4.07 – 3.92 (m, 2H), 2.34 – 2.25 (m, 1H), 2.04 – 1.92 (m, 2H), 1.93 – 1.81 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 134.3, 132.4, 129.9, 127.5, 89.5, 67.5, 32.1, 24.6.

HRMS (ESI) calculated for $C_8H_{10}OS_2$ $[M+H]^+$: 187.0246; Found: 187.0247



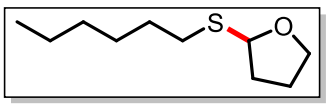
b29

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b29** as a colorless oil (28.3 mg, 73% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 (d, *J* = 7.6 Hz, 2H), 7.30 (d, *J* = 7.7 Hz, 2H), 7.26 (s, 1H), 5.22 (dd, *J* = 7.3, 3.6 Hz, 1H), 4.01 – 3.92 (m, 2H), 3.91 – 3.73 (m, 2H), 2.23 – 2.15 (m, 1H), 2.05 – 1.95 (m, 2H), 1.87 – 1.75 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 138.6, 129.0, 128.6, 126.9, 83.0, 66.8, 36.0, 31.0, 26.2.

HRMS (ESI) calculated for $C_{11}H_{14}OS$ $[M+H]^+$: 195.0839; Found: 195.0833



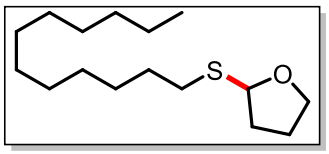
b30

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b30** as a colorless oil (26.3 mg, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 5.36 (dd, *J* = 7.3, 3.9 Hz, 1H), 3.98 – 3.86 (m, 2H), 2.73 – 2.54 (m, 2H), 2.32 – 2.22 (m, 1H), 2.04 – 1.94 (m, 1H), 1.89 – 1.78 (m, 2H), 1.67 – 1.58 (m, 2H), 1.42 – 1.35 (m, 2H), 1.33 – 1.26 (m, 4H), 0.88 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 84.5, 66.8, 32.7, 31.5, 31.3, 30.0, 28.8, 24.9, 22.6, 14.1.

HRMS (ESI) calculated for $C_{10}H_{20}OS$ $[M+H]^+$: 189.1308; Found: 189.1308



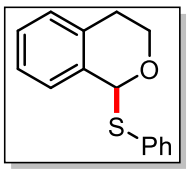
b31

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b31** as a colorless oil (29.9 mg, 55% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 5.36 (dd, *J* = 7.3, 3.9 Hz, 1H), 3.97 – 3.86 (m, 2H), 2.74 – 2.53 (m, 2H), 2.33 – 2.20 (m, 1H), 2.03 – 1.94 (m, 1H), 1.88 – 1.78 (m, 2H), 1.67 – 1.59 (m, 2H), 1.41 – 1.33 (m, 2H), 1.31 – 1.23 (m, 16H), 0.92 – 0.82 (t, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 84.4, 66.7, 32.6, 31.9, 31.2, 30.0, 29.65, 29.63, 29.60, 29.5, 29.3, 29.2, 29.0, 24.8, 22.3, 14.1.

HRMS (ESI) calculated for $C_{16}H_{32}OS$ $[M+H]^+$: 273.2247; Found: 273.2238



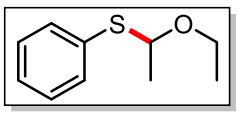
b34

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b34** as a colorless oil (25.2 mg, 52% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (d, *J* = 6.9 Hz, 2H), 7.35 (d, *J* = 7.0 Hz, 2H), 7.32 (s, 1H), 7.28 (d, *J* = 7.2 Hz, 1H), 7.24 – 7.16 (m, 2H), 7.12 (dd, *J* = 5.4, 3.6 Hz, 1H), 6.49 (s, 1H), 4.55 (td, *J* = 11.6, 3.2 Hz, 1H), 4.01 (dd, *J* = 10.9, 5.7 Hz, 1H), 3.11 (ddd, *J* = 16.7, 12.3, 6.3 Hz, 1H), 2.70 (dd, *J* = 16.0, 3.0 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 136.0, 133.9, 133.8, 131.2, 128.9, 128.8, 127.7, 127.2, 127.1, 126.1, 85.9, 58.2, 27.8.

HRMS (ESI) calculated for $C_{15}H_{14}OS$ $[M+H]^+$: 243.0839; Found: 243.0844



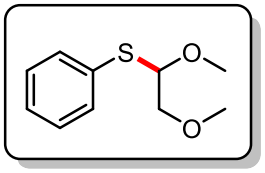
b35

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **b35** as a colorless oil (20.4 mg, 56% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (d, *J* = 9.5 Hz, 2H), 7.30 (d, *J* = 6.5 Hz, 2H), 7.28 (d, *J* = 4.5 Hz, 1H), 4.89 (q, *J* = 6.3 Hz, 1H), 4.02 – 3.90 (m, 1H), 3.56 – 3.44 (m, 1H), 1.50 (d, *J* = 6.3 Hz, 3H), 1.23 (t, *J* = 7.0 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 133.8, 128.7, 127.5, 84.5, 63.4, 22.7, 14.9.

HRMS (ESI) calculated for $C_{10}H_{14}OS$ $[M+H]^+$: 183.0839; Found: 183.0841



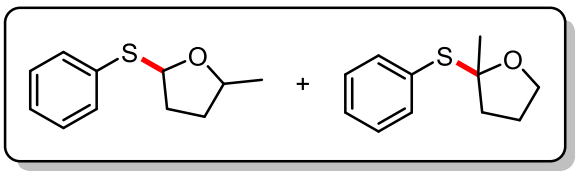
b36

Purification by column chromatography on silica gel (hexane/ethyl acetate = 50/1, v/v) afforded **b36** as a colorless oil (23.8 mg, 60% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.55 – 7.46 (m, 2H), 7.31 (dd, *J* = 5.1, 2.0 Hz, 3H), 4.76 (dd, *J* = 7.8, 4.1 Hz, 1H), 3.61 (dd, *J* = 10.6, 4.1 Hz, 1H), 3.56 (s, 3H), 3.53 (dd, *J* = 10.6, 7.8 Hz, 1H), 3.37 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 133.9, 132.3, 128.8, 127.9, 88.9, 74.7, 59.1, 56.3.

HRMS (ESI) calculated for $C_{10}H_{15}O_2S$ $[M+H]^+$: 199.0787; Found: 199.0788



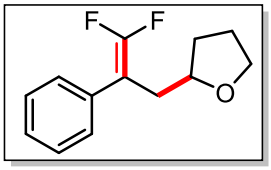
b37/ b37'

Due to the minimal polarity difference of **b37** and **b37'**, the isolation is difficult. Therefore, the mixture of **b37** and **b37'** was obtained. Purification by column chromatography on silica gel (hexane/ethyl acetate = 50/1, v/v) afforded the mixture of **b37/ b37'** as a colorless oil (34.5 mg, 89% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.53 (dt, *J* = 7.0, 2.9 Hz, 7H), 7.51 – 7.48 (m, 2H), 7.36 – 7.28 (m, 11H), 7.28 – 7.25 (m, 2H), 7.24 – 7.18 (m, 2H), 5.69 (dd, *J* = 7.4, 4.7 Hz, 1H), 5.48 (dd, *J* = 7.1, 4.0 Hz, 1H), 4.31 (dp, *J* = 8.7, 6.0 Hz, 1H), 4.24 – 4.17

(m, 1H), 4.17 – 4.10 (m, 3H), 4.02 (ddd, *J* = 10.1, 7.5, 4.4 Hz, 3H), 2.47 (dddd, *J* = 13.5, 9.7, 7.3, 3.9 Hz, 1H), 2.39 – 2.29 (m, 1H), 2.22 – 2.14 (m, 3H), 2.11 (ddd, *J* = 12.9, 6.6, 3.8 Hz, 5H), 2.06 – 2.03 (m, 1H), 2.01 – 1.96 (m, 4H), 1.96 – 1.91 (m, 3H), 1.73 – 1.62 (m, 1H), 1.55 (s, 9H), 1.50 – 1.38 (m, 1H), 1.35 (d, *J* = 6.2 Hz, 3H), 1.29 (d, *J* = 6.1 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 136.1, 135.5, 133.4, 131.6, 130.8, 128.8, 128.5, 128.1, 126.9, 126.6, 95.0, 87.1, 86.8, 74.5, 67.7, 39.5, 33.6, 33.2, 32.5, 28.2, 25.1, 22.0, 20.1.



d1

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d1** as a colorless oil (24.7 mg, 55% yield).

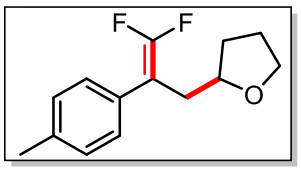
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 (d, *J* = 4.8 Hz, 4H), 7.30 – 7.22 (m, 1H), 3.90 – 3.75 (m, 2H), 3.73 – 3.63 (m, 1H), 2.71 (ddt, *J* = 14.2, 6.7, 2.4 Hz, 1H), 2.49 (ddt, *J* = 14.2, 6.8, 2.3 Hz, 1H), 1.93 – 1.84 (m, 2H), 1.83 – 1.75 (m, 1H), 1.52 – 1.43 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) *δ* 154.3 (t, *J*= 286.6 Hz), 133.6, 128.5, 128.4 (t, *J* = 3.2 Hz), 127.3, 90.1 (dd, *J* = 20.1, 16.6 Hz), 77.0 (t, *J* = 3.0 Hz), 67.8, 33.9, 30.9, 25.6

^{19}F NMR (376 MHz, Chloroform-*d*) δ -90.80 (s, 1F), -90.81 (s, 1F).

19F NMR (376 MHz, CDCl3) δ -90.72 (d, *J* = 42.8 Hz, 1F), -90.85 (d, *J* = 44.0 Hz, 1F)

HRMS (ESI) calculated for $C_{13}H_{14}F_2O$ $[M+H]^+$: 225.1086; Found: 225.1081



d2

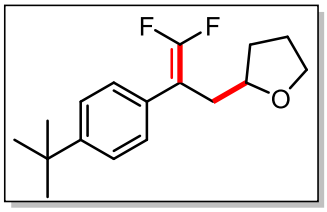
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d2** as a colorless oil (40.0 mg, 84% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.23 (d, *J* = 7.1 Hz, 2H), 7.16 (d, *J* = 8.0 Hz, 2H), 3.88 – 3.77 (m, 2H), 3.72 – 3.65 (m, 1H), 2.70 (ddt, *J* = 14.1, 6.6, 2.4 Hz, 1H), 2.47 (ddt, *J* = 14.2, 7.0, 2.3 Hz, 1H), 2.34 (s, 3H), 1.93 – 1.84 (m, 2H), 1.83 – 1.75 (m, 1H), 1.53 – 1.43 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.3 (t, *J* = 289.5 Hz), 137.2, 130.6, 129.3, 128.3 (t, *J* = 3.0 Hz), 89.9 (dd, *J* = 20.9, 15.4 Hz), 70.1, 67.9, 33.9, 30.9, 25.7, 21.2.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.96 (d, *J* = 43.2 Hz, 1F), -91.26 (d, *J* = 44.0Hz, 1F).

HRMS (ESI) calculated for $C_{14}H_{16}F_2O$ $[M+H]^+$: 239.1242; Found: 239.1240



d3

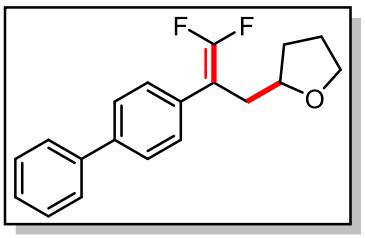
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d3** as a colorless oil (49.3 mg, 88% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.38 (m, 2H), 7.31 (d, *J* = 7.6 Hz, 2H), 3.95 – 3.81 (m, 2H), 3.78 – 3.68 (m, 1H), 2.74 (ddt, *J* = 14.1, 6.6, 2.5 Hz, 1H), 2.52 (ddt, *J* = 14.1, 6.9, 2.3 Hz, 1H), 1.98 – 1.89 (m, 2H), 1.88 – 1.80 (m, 1H), 1.58 – 1.48 (m, 1H), 1.35 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.3 (dd, *J* = 290.9, 287.8 Hz), 150.2, 130.4, 127.9 (t, *J* = 3.3 Hz), 125.4, 89.8 (dd, *J* = 20.3, 15.5 Hz), 77.0, 67.8, 34.5, 33.8, 31.3, 30.9, 25.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.81 (d, *J* = 41.7 Hz, 1F), -90.96 (d, *J* = 42.2 Hz, 1F).

HRMS (ESI) calculated for $C_{17}H_{22}F_2O$ $[M+H]^+$: 281.1712; Found: 281.1707



d4

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d4** as a colorless oil (53.9 mg, 90% yield).

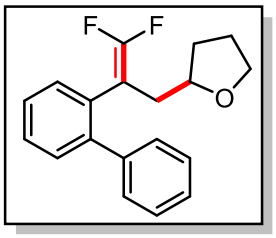
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 – 7.56 (m, 4H), 7.43 (t, *J* = 7.7 Hz, 4H), 7.34 (t, *J* = 7.3 Hz, 1H), 3.91 – 3.83 (m, 2H), 3.70 (td, *J* = 8.1, 5.9 Hz, 1H), 2.74 (ddt, *J* = 14.3, 6.7, 2.4 Hz, 1H), 2.53 (ddt, *J* = 14.3, 6.8, 2.3 Hz, 1H), 1.96 – 1.87 (m, 2H), 1.86 – 1.76 (m, 1H), 1.56 – 1.46 (m, 1H).

^{13}C NMR (400 MHz, $CDCl_3$) δ 154.4 (t, *J* = 290.1 Hz), 140.6, 140.1, 132.5, 128.8,

128.7 (t, J = 3.4 Hz), 127.4, 127.2, 127.0, 89.8 (t, J = 17.3 Hz), 67.8, 33.8, 31.0, 25.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.04 (d, J = 40.6 Hz, 1F), -90.16 (d, J = 40.6 Hz, 1F).

HRMS (ESI) calculated for $C_{19}H_{18}F_2O$ $[M+H]^+$: 301.1399; Found: 301.1392



d5

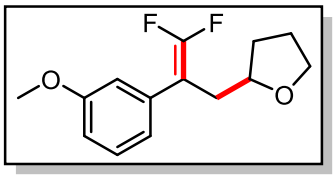
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d5** as a colorless oil (51.6 mg, 86% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.28 (m, 9H), 3.78 – 3.69 (m, 1H), 3.65 – 3.54 (m, 2H), 2.18 – 2.01 (m, 1H), 1.90 – 1.79 (m, 1H), 1.79 – 1.71 (m, 2H), 1.71 – 1.65 (m, 1H), 1.32 – 1.20 (m,1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.3 (t, J = 286.8 Hz), 141.6 (d, J = 2.9 Hz), 141.2, 131.9 (d, J = 4.9 Hz), 131.3, 130.4, 128.6 (d, J = 41.9 Hz), 127.4 (d, J = 5.6 Hz), 125.8, 120.4, 119.4, 110.7, 90.4 (dd, J = 22.0, 17.8 Hz), 67.7, 34.1, 30.9, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -89.35 (d, J = 43.1 Hz, 1F), -93.06 (d, J = 42.5 Hz, 1F).

HRMS (ESI) calculated for $C_{19}H_{18}F_2O$ $[M+H]^+$: 301.1399; Found: 301.1392



d6

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d6** as a colorless oil (34.6 mg, 68% yield).

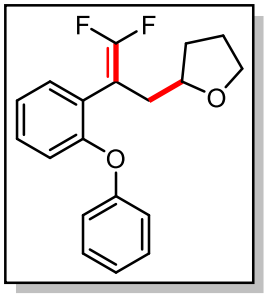
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 – 7.25 (m, 1H), 6.92 (d, J = 7.8 Hz, 1H), 6.89 (s, 1H), 6.82 (dd, J = 8.3, 2.3 Hz, 1H), 3.91 – 3.80 (m, 2H), 3.80 (s, 3H), 3.69 (td, J = 8.1, 5.9 Hz, 1H), 2.69 (ddt, J = 14.2, 6.7, 2.4 Hz, 1H), 2.47 (ddt, J = 14.2, 6.8, 2.4 Hz, 1H),

1.95 – 1.84 (m, 2H), 1.86 – 1.75 (m, 1H), 1.54 – 1.42 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.6, 154.4 (t, *J* = 288.4 Hz), 135.0 (t, *J* = 3.8 Hz), 129.6 (d, *J* = 275 Hz), 120.8 (t, *J* = 3.0 Hz), 114.4 (t, *J* = 3.3 Hz), 112.8, 90.1 (dd, *J* = 21.6, 14.5 Hz), 67.8, 55.3, 33.9, 31.0, 25.6, 8.1.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.02 (d, *J* = 41.0 Hz, 1F), -90.54 (d, *J* = 40.9 Hz, 1F).

HRMS (ESI) calculated for $C_{14}H_{16}F_2O_2$ $[M+H]^+$: 255.1192; Found: 255.1199



d7

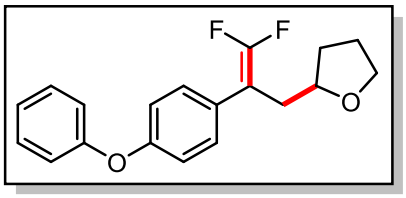
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d7** as a colorless oil (50.0 mg, 79% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 (d, *J* = 2.1 Hz, 1H), 7.31 – 7.27 (m, 2H), 7.27 – 7.21 (m, 1H), 7.12 – 7.04 (m, 2H), 6.96 – 6.92 (m, 2H), 6.90 (dd, *J* = 8.2, 1.2 Hz, 1H), 3.85 – 3.74 (m, 2H), 3.70 – 3.62 (m, 1H), 2.65 (ddt, *J* = 14.1, 6.5, 2.2 Hz, 1H), 2.47 (ddt, *J* = 14.1, 7.1, 2.1 Hz, 1H), 1.91 – 1.82 (m, 2H), 1.81 – 1.72 (m, 1H), 1.50 – 1.41 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 157.3, 154.9, 153.9 (t, *J* = 287.7 Hz), 131.8 (t, *J* = 2.3 Hz), 129.7, 129.3, 125.4, 123.6, 123.1, 119.3, 118.3, 86.6 (dd, *J* = 23.8, 17.6 Hz), 77.2, 67.7, 34.0, 30.9, 25.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -88.47 (d, *J* = 40.3 Hz, 1F), -92.32 (d, *J* = 40.2 Hz, 1F).

HRMS (ESI) calculated for $C_{19}H_{18}F_2O_2$ $[M+H]^+$: 317.1348; Found: 317.1346



d8

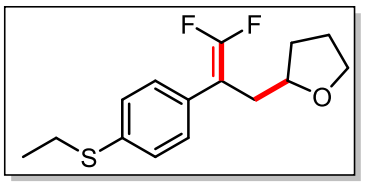
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d8** as a colorless oil (46.8 mg, 74% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 (dd, *J* = 8.6, 7.4 Hz, 2H), 7.30 (d, *J* = 8.5 Hz, 2H), 7.12 (t, *J* = 7.4 Hz, 1H), 7.03 (d, *J* = 7.5 Hz, 2H), 6.98 (d, *J* = 8.7 Hz, 2H), 3.89 – 3.79 (m, 2H), 3.70 (td, *J* = 8.1, 4.5 Hz, 1H), 2.67 (ddt, *J* = 14.2, 6.8, 2.4 Hz, 1H), 2.48 (ddt, *J* = 14.2, 6.7, 2.4 Hz, 1H), 1.98 – 1.85 (m, 2H), 1.89 – 1.76 (m, 1H), 1.55 – 1.44 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 156.8, 156.6, 154.2 (t, *J* = 290.5 Hz), 129.8, 129.7 (t, *J* = 3.2 Hz), 128.2, 123.5, 119.2, 118.5, 89.5 (dd, *J* = 20.2, 16.6 Hz), 77.0, 67.8, 34.0, 31.0, 25.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.88 (d, *J* = 42.9 Hz, 1F), -91.00 (d, *J* = 42.1 Hz, 1F)

HRMS (ESI) calculated for $C_{19}H_{18}F_2O_2$ $[M+H]^+$: 317.1348; Found: 317.1343



d9

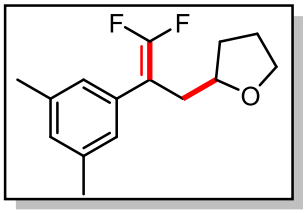
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d9** as a pale-yellow oil (35.7 mg, 63% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 (d, *J* = 8.8 Hz, 2H), 7.27 (d, *J* = 2.9 Hz, 2H), 3.88 – 3.77 (m, 2H), 3.72 – 3.65 (m, 1H), 2.95 (q, *J* = 7.4 Hz, 2H), 2.68 (ddt, *J* = 14.3, 6.7, 2.4 Hz, 1H), 2.48 (ddt, *J* = 14.2, 6.7, 2.4 Hz, 1H), 1.95 – 1.86 (m, 2H), 1.86 – 1.77 (m, 1H), 1.54 – 1.43 (m, 1H), 1.33 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.2, 154.3 (t, *J* = 290.2 Hz), 136.0, 130.9, 128.7 (t, *J* = 3.6 Hz), 128.6, 89.6 (t, *J* = 18.2 Hz), 67.8, 33.7, 30.9, 27.4, 25.6, 14.3.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.15 (s, 2F)

HRMS (ESI) calculated for $C_{15}H_{18}F_2OS$ $[M+H]^+$: 285.1120; Found: 285.1126



d10

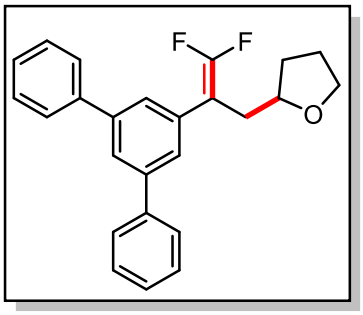
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d10** as a colorless oil (38.3 mg, 76% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.94 (s, 2H), 6.90 (s, 1H), 3.89 – 3.76 (m, 2H), 3.73 – 3.63 (m, 1H), 2.69 (ddt, *J* = 14.1, 6.6, 2.5 Hz, 1H), 2.45 (ddt, *J* = 14.1, 7.1, 2.3 Hz, 1H), 2.30 (s, 6H), 1.94 – 1.85 (m, 2H), 1.84 – 1.74 (m, 1H), 1.55 – 1.40 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.2 (dd, *J* = 289.8, 286.9 Hz), 137.9, 133.3, 129.1, 126.2 (t, *J* = 3.0 Hz), 90.10 (dd, *J* = 21.0, 15.0 Hz), 77.0, 67.8, 34.0, 30.9, 25.6, 21.3.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.86 (d, *J* = 42.9 Hz, 1F), -91.36 (d, *J* = 42.9 Hz, 1F).

HRMS (ESI) calculated for $C_{15}H_{18}F_2O$ $[M+H]^+$: 253.1399; Found: 253.1403



d11

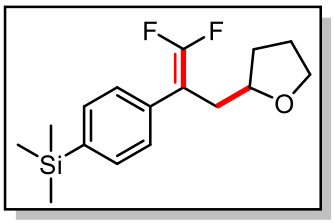
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d11** as a pale-yellow oil (52.6 mg, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (t, *J* = 1.8 Hz, 1H), 7.64 (d, *J* = 7.0 Hz, 4H), 7.54 (s, 2H), 7.46 (t, *J* = 7.6 Hz, 4H), 7.37 (t, *J* = 7.3 Hz, 2H), 3.93 – 3.84 (m, 2H), 3.70 (td, *J* = 8.1, 5.9 Hz, 1H), 2.79 (ddt, *J* = 14.2, 6.8, 2.3 Hz, 1H), 2.57 (ddt, *J* = 14.2, 6.7, 2.3 Hz, 1H), 1.98 – 1.86 (m, 2H), 1.86 – 1.76 (m, 1H), 1.57 – 1.47 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.56 (t, *J* = 289.1 Hz), 142.1, 140.9, 134.6, 128.9, 127.6, 127.4, 126.3 (t, *J* = 3.2 Hz), 125.31, 90.22 (dd, *J* = 21.6, 14.8 Hz), 77.0, 67.9, 34.1, 31.1, 25.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -89.82 (d, *J* = 40.6 Hz, 1F), -90.17 (d, *J* = 40.8 Hz, 1F).

HRMS (ESI) calculated for $C_{25}H_{22}F_2O$ $[M+H]^+$: 377.1712; Found: 377.1718



d12

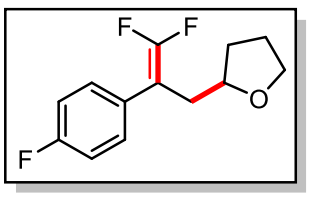
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d12** as a colorless oil (40.9 mg, 69% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (d, *J* = 8.1 Hz, 2H), 7.33 (d, *J* = 8.4 Hz, 2H), 3.89 – 3.78 (m, 2H), 3.68 (td, *J* = 8.1, 6.0 Hz, 1H), 2.71 (ddt, *J* = 14.2, 6.7, 2.4 Hz, 1H), 2.50 (ddt, *J* = 14.2, 6.9, 2.3 Hz, 1H), 1.93 – 1.85 (m, 2H), 1.83 – 1.74 (m, 1H), 0.26 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.4 (t, *J* = 289.2 Hz), 139.6, 133.9, 133.5, 127.6 (t, *J* = 3.1 Hz), 90.09 (t, *J* = 17.9 Hz), 77.0, 67.8, 33.8, 30.9, 25.6, -1.2.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.34 (s, 2F)

HRMS (ESI) calculated for $C_{16}H_{22}F_2OSi$ $[M+H]^+$: 297.1481; Found: 297.1489



d13

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d13** as a colorless oil (29.5 mg, 61% yield).

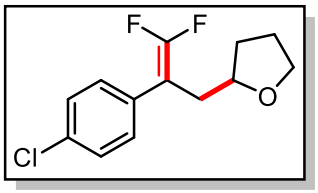
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 – 7.28 (m, 2H), 7.07 – 7.01 (m, 2H), 3.88 – 3.76 (m, 2H), 3.69 (td, *J* = 8.1, 5.9 Hz, 1H), 2.66 (ddt, *J* = 14.3, 6.9, 2.3 Hz, 1H), 2.47 (ddt,

J = 14.3, 6.5, 2.5 Hz, 1H), 1.95 – 1.87 (m,2H), 1.86 – 1.77 (m, 1H), 1.54 – 1.42 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 162.0 (d, *J* = 247.1 Hz), 154.3 (t, *J* = 292.8), 130.17 (dt, *J* = 7.6, 3.2 Hz), 129.6, 115.5 (d, *J* = 21.3 Hz), 89.44 (t, *J* = 18.3 Hz), 77.0, 67.9, 34.1, 31.0, 25.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.70 (s, 2F), -114.53 (s, 1F).

HRMS (ESI) calculated for $C_{13}H_{13}F_3O$ $[M+H]^+$: 243.0992; Found: 243.0993



d14

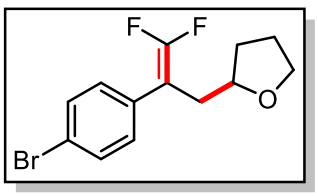
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d14** as a colorless oil (28.4 mg, 55% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (d, *J* = 8.8 Hz, 2H), 7.28 (d, *J* = 9.0 Hz, 2H), 3.87 – 3.76 (m, 2H), 3.68 (td, *J* = 8.1, 5.9 Hz, 1H), 2.65 (ddt, *J* = 14.3, 7.0, 2.3 Hz, 1H), 2.48 (ddt, *J* = 14.3, 6.5, 2.5 Hz, 1H), 1.96 – 1.84 (m, 2H), 1.87 – 1.75 (m, 1H), 1.52 – 1.43 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.3 (t, *J* = 290.6 Hz), 133.2, 132.1, 129.7 (t, *J* = 3.3 Hz), 128.6, 89.4 (dd, *J* = 20.3, 16.5 Hz), 76.90 (t, *J* = 2.9 Hz), 77.0, 67.8, 33.8, 31.0, 25.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -89.85 (d, *J* = 35.3 Hz, 1F), -89.98 (d, J = 39.9 Hz, 1F).

HRMS (ESI) calculated for $C_{13}H_{13}ClF_2O$ $[M+H]^+$: 259.0696; Found: 259.0690



d15

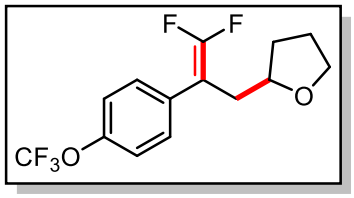
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d15** as a colorless oil (30.4 mg, 50% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (d, *J* = 8.5 Hz, 2H), 7.22 (d, *J* = 7.6 Hz, 2H), 3.88 – 3.76 (m, 2H), 3.69 (td, *J* = 8.1, 5.9 Hz, 1H), 2.65 (ddt, *J* = 14.4, 6.9, 2.3 Hz, 1H), 2.48 (ddt, *J* = 14.3, 6.4, 2.5 Hz, 1H), 1.95 – 1.86 (m, 2H), 1.86 – 1.77 (m, 1H), 1.52 – 1.43 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.2 (dd, *J* = 290.6, 288.6 Hz), 132.6 (dd, *J* = 3.5, 1.9 Hz), 131.6, 130.0 (t, *J* = 3.3 Hz), 121.3, 89.5 (dd, *J* = 21.0, 15.7 Hz), 77.0, 67.8, 33.7, 31.0, 25.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -89.68 (d, *J* = 39.5 Hz, 1F), -89.82 (d, *J* = 39.9 Hz, 1F).

HRMS (ESI) calculated for $C_{13}H_{13}BrF_2O$ $[M+H]^+$: 303.0191; Found: 303.0190



d16

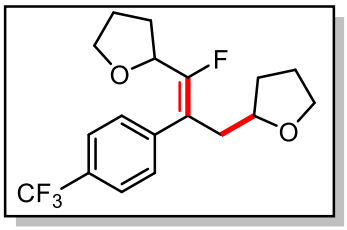
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d2** as a pale-yellow oil (37.0 mg, 60% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 (d, *J* = 7.8 Hz, 2H), 7.20 (d, *J* = 7.9 Hz, 2H), 3.88 – 3.77 (m, 2H), 3.70 (td, *J* = 8.2, 6.0 Hz, 1H), 2.66 (ddt, *J* = 14.3, 7.1, 2.3 Hz, 1H), 2.50 (ddt, *J* = 14.4, 6.3, 2.5 Hz, 1H), 1.96 – 1.88 (m, 2H), 1.87 – 1.79 (m, 1H), 1.54 – 1.45 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.4 (t, *J* = 291.6 Hz), 148.2, 132.4, 129.8 (t, *J* = 3.3 Hz), 121.7, 120.9, 119.2, 89.3 (dd, *J* = 21.8, 15.1 Hz), 67.8, 33.4, 31.0, 25.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -57.88 (s, 3F), -89.81 (d, *J* = 40.1 Hz, 1F), -90.00 (d, *J* = 40.1 Hz, 1F).

HRMS (ESI) calculated for $C_{14}H_{13}F_5O_2$ $[M+H]^+$: 309.0909; Found: 309.0902



d17

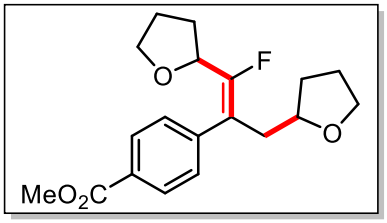
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20/1, v/v) afforded **d17** as a colorless oil (38.5 mg, 56% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (d, *J* = 7.9 Hz, 2H), 7.40 (t, *J* = 8.3 Hz, 2H), 4.40 – 4.25 (m, 1H), 3.98 – 3.91 (m, 1H), 3.85 – 3.62 (m, 4H), 2.75 (ddd, *J* = 13.6, 6.6, 3.0 Hz, 1H), 2.63 (tdd, *J* = 13.5, 7.0, 3.0 Hz, 1H), 2.11 – 1.98 (m, 2H), 1.94 – 1.76 (m, 5H), 1.59 – 1.39 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 157.0 (d, *J* = 260.8 Hz), 156.9 (d, *J* = 260.4 Hz), 141.8 (d, *J* = 8.1 Hz), 141.3 (d, *J* = 8.1 Hz), 129.6, 125.4 (t, *J* = 4.6 Hz), 119.4 (t, *J* = 18.0 Hz), 74.2 (d, *J* = 26.9 Hz), 69.1, 67.8 (d, *J* = 11.7 Hz), 36.4 (d, *J* = 4.2 Hz), 35.9 (d, *J* = 4.6 Hz), 31.0 (d, *J* = 22.6 Hz), 28.5, 26.8, 25.6 (d, *J* = 9.3 Hz).

^{19}F NMR (376 MHz, $CDCl_3$) δ -62.53 (d, *J* = 5.9 Hz, 3F), -125.37 (d, *J* = 29.6 Hz, 0.5F), -126.07 (d, *J* = 29.9 Hz, 0.5F).

HRMS (ESI) calculated for $C_{18}H_{20}F_4O_2$ $[M+H]^+$: 345.1473; Found: 345.1477



d18

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20/1, v/v) afforded **d18** as a colorless oil (34.7 mg, 52% yield).

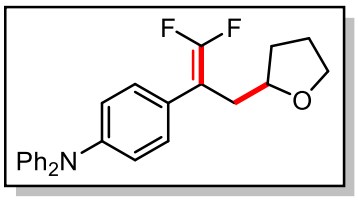
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (d, *J* = 7.9 Hz, 2H), 7.35 (t, *J* = 7.4 Hz, 2H), 4.43 – 4.28 (m, 1H), 3.98 – 3.93 (m, 1H), 3.92 (s, 3H), 3.86 – 3.81 (m, 1H), 3.80 – 3.76 (m, 1H), 3.75 – 3.60 (m, 2H), 2.77 (ddt, *J* = 13.3, 6.4, 3.2 Hz, 1H), 2.68 – 2.59 (m, 1H), 2.10 – 1.98 (m, 2H), 1.93 – 1.76 (m, 5H), 1.56 – 1.37 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 166.8 (d, *J* = 2.4 Hz), 156.8 (d, *J* = 260.7 Hz), 156.7

(d, J = 260.4 Hz), 142.8 (d, J = 8.3 Hz), 142.3 (d, J = 8.1 Hz), 129.6 (d, J = 4.5 Hz), 129.3, 119.6 (dd, J = 18.6, 12.9 Hz), 74.2 (d, J = 27.0 Hz), 69.1, 67.7 (d, J = 11.6 Hz), 52.2, 36.0 (dd, J = 39.5, 4.5 Hz), 30.9 (d, J = 19.6 Hz), 28.5, 26.8, 25.6 (d, J = 8.6 Hz).

^{19}F NMR (376 MHz, $CDCl_3$) δ -125.50 (d, J = 29.6 Hz, 0.5F), -126.20 (d, J = 29.7 Hz, 0.5F).

HRMS (ESI) calculated for $C_{19}H_{23}FO_4$ $[M+H]^+$: 335.1654; Found: 335.1661



d19

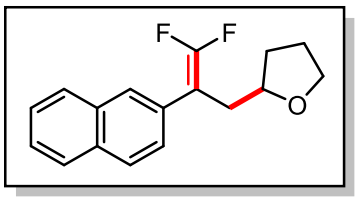
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d19** as a green oil (39.1 mg, 52% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 (dd, J = 8.5, 7.2 Hz, 4H), 7.23 (d, J = 7.6 Hz, 2H), 7.12 (d, J = 7.3 Hz, 4H), 7.05 (dd, J = 8.0, 6.3 Hz, 4H), 3.95 – 3.84 (m, 2H), 3.74 (td, J = 8.1, 5.9 Hz, 1H), 2.69 (ddt, J = 14.1, 6.6, 2.5 Hz, 1H), 2.50 (ddt, J = 14.1, 6.8, 2.3 Hz, 1H), 2.00 – 1.92 (m, 2H), 1.91 – 1.81 (m, 1H), 1.58 – 1.49 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.3 (t, J = 215.6 Hz), 147.6, 146.8, 129.3, 129.0 (t, J = 3.9 Hz), 127.05, 127.01, 124.55, 123.08 (d, J = 4.5 Hz), 114.50, 89.6 (dd, J = 20.6, 14.6 Hz), 67.8, 33.8, 31.0, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -90.70 (d, J = 42.8 Hz, 1F), -90.89 (d, J = 42.9 Hz, 1F).

HRMS (ESI) calculated for $C_{25}H_{23}F_2NO$ $[M+H]^+$: 392.1821; Found: 392.1826



d20

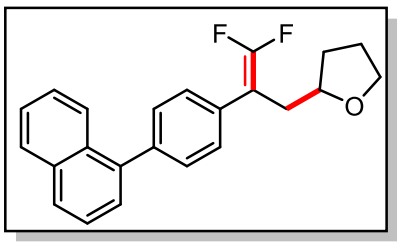
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d20** as a colorless oil (35.6 mg, 65% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (dd, *J* = 8.7, 2.4 Hz, 4H), 7.50 – 7.44 (m, 3H), 3.89 – 3.79 (m, 2H), 3.67 (td, *J* = 8.1, 6.0 Hz, 1H), 2.81 (ddt, *J* = 14.3, 6.7, 2.4 Hz, 1H), 2.59 (ddt, *J* = 14.3, 6.9, 2.3 Hz, 1H), 1.94 – 1.85 (m, 2H), 1.84 – 1.72 (m, 1H), 1.58 – 1.43 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.6 (dd, *J* = 290.6, 287.8 Hz), 133.3, 132.6, 131.0 (t, *J* = 3.5 Hz), 128.2, 128.0, 127.5 (t, *J* = 3.4 Hz), 127.5, 126.4, 126.2, 90.2 (dd, *J* = 21.3, 14.8 Hz), 77.3, 76.8, 67.9, 34.0, 31.0, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -90.12 (d, *J* = 40.3 Hz, 1F), -90.36 (d, *J* = 40.5 Hz, 1F).

HRMS (ESI) calculated for $C_{17}H_{16}F_2O$ $[M+H]^+$: 275.1242; Found: 275.1252



d21

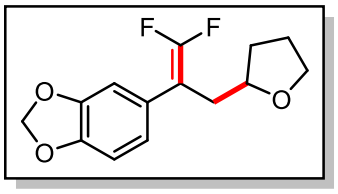
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d21** as a colorless oil (46.9 mg, 67% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 – 7.82 (m, 3H), 7.51 (d, *J* = 7.0 Hz, 1H), 7.49 – 7.45 (m, 5H), 7.42 (ddd, *J* = 8.6, 7.0, 1.5 Hz, 2H), 3.96 – 3.85 (m, 2H), 3.73 (td, *J* = 8.0, 5.9 Hz, 1H), 2.77 (ddt, *J* = 14.3, 6.8, 2.4 Hz, 1H), 2.57 (ddt, *J* = 14.3, 6.7, 2.3 Hz, 1H), 2.00 – 1.89 (m, 2H), 1.89 – 1.80 (m, 1H), 1.61 – 1.48 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.5 (t, *J* = 290.6 Hz) 139.8, 139.7, 133.9, 132.5, 131.6, 130.2, 128.4, 128.2 (t, *J* = 3.3 Hz), 77.1, 127.8, 127.0, 126.1, 126.0, 125.9, 125.4, 90.0 (dd, *J* = 19.4, 16.6 Hz), 67.9, 33.9, 31.1, 25.7.

^{19}F NMR (376 MHz, $CDCl_3$) δ -89.91, -90.01, -90.03, -90.14.

HRMS (ESI) calculated for $C_{23}H_{20}F_2O$ $[M+H]^+$: 351.1555; Found: 355.1547



d23

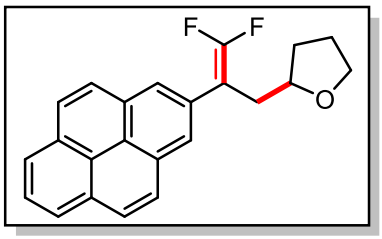
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d23** as a colorless oil (32.2 mg, 60% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.83 (s, 1H), 6.79 (s, 2H), 5.96 (s, 2H), 3.90 – 3.78 (m, 2H), 3.69 (td, *J* = 8.0, 5.9 Hz, 1H), 2.63 (ddt, *J* = 14.2, 6.8, 2.4 Hz, 1H), 2.43 (ddt, *J* = 14.2, 6.7, 2.4 Hz, 1H), 1.95 – 1.86 (m, 2H), 1.85 – 1.76 (m, 1H), 1.54 – 1.42 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.2 (t, *J* = 289.3 Hz), 147.8, 146.8, 127.2 (t, *J* = 3.7 Hz), 122.0 (t, *J* = 3.2 Hz), 109.0 (t, *J* = 3.3 Hz), 108.4, 101.2, 89.9 (dd, *J* = 22.0, 14.8 Hz), 77.0, 67.8, 34.2, 31.0, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -90.91 (d, *J* = 43.4 Hz, 1F), -91.38 (d, *J* = 43.3 Hz, 1F).

HRMS (ESI) calculated for $C_{14}H_{14}F_2O_3$ $[M+H]^+$: 269.0984; Found: 269.0980



d23

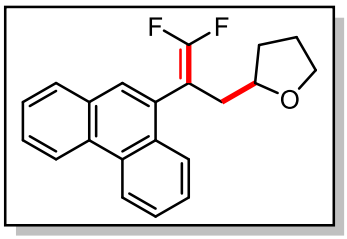
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d23** as a pale-yellow oil (48.7 mg, 70% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.21 (dd, *J* = 7.7, 4.3 Hz, 4H), 8.16 – 8.03 (m, 3H), 8.03 (t, *J* = 7.6 Hz, 2H). 3.93 (dt, *J* = 8.5, 6.6 Hz, 1H), 3.82 (p, *J* = 6.6 Hz, 1H), 3.72 (td, *J* = 8.0, 5.9 Hz, 1H), 3.08 – 2.97 (m, 1H), 2.70 (ddt, *J* = 14.0, 5.9, 2.7 Hz, 1H), 1.94 – 1.83 (m, 2H), 1.83 – 1.71 (m, 1H), 1.59 – 1.46 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.0 (t, *J* = 294.1 Hz), 139.56, 131.29, 131.09, 130.93, 128.04, 127.76, 127.29, 126.14, 125.79, 125.40, 125.28, 124.97, 124.76, 120.32, 119.34, 110.61, 88.6 (dd, *J* = 21.9, 18.7 Hz), 67.71, 36.19, 31.16, 25.62.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -87.32 (t, *J* = 36.7 Hz, 1F), -91.84 (d, *J* = 40.5 Hz, 1F).

HRMS (ESI) calculated for $C_{23}H_{18}F_2O$ $[M+H]^+$: 349.1399; Found: 349.1399



d24

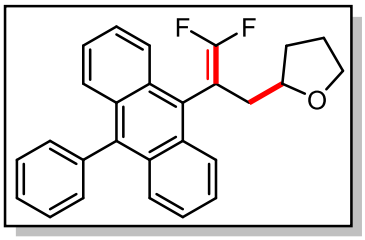
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d24** as a colorless oil (60.2 mg, 93% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.71 (dd, *J* = 21.5, 8.1 Hz, 2H), 8.10 – 7.84 (m, 2H), 7.76 – 7.68 (m, 1H), 7.68 – 7.62 (m, 3H), 7.62 – 7.57 (m, 1H), 3.93 – 3.76 (m, 2H), 3.74 – 3.61 (m, 1H), 2.92 – 2.76 (m, 1H), 2.64 – 2.41 (m, 1H), 1.98 – 1.82 (m, 2H), 1.81 – 1.72 (m, 1H), 1.57 – 1.39 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 131.4, 130.8, 130.3, 129.1, 128.8, 127.03, 126.9, 126.0, 125.6, 123.2, 123.0, 122.6, 88.2 (dd, *J* = 22.0, 18.9 Hz), 77.0, 67.7, 35.2, 31.2, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -87.23 (dd, *J* = 135.5, 41.0 Hz, 1F), -92.14 (dd, *J* = 63.1, 41.0 Hz, 1F).

HRMS (ESI) calculated for $C_{21}H_{18}F_2O$ $[M+H]^+$: 325.1398; Found: 325.1407



d25

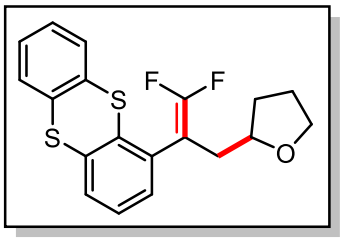
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d25** as a yellow oil (52.0 mg, 65% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.35 (d, *J* = 8.8 Hz, 1H), 8.08 (d, *J* = 8.8 Hz, 1H), 7.67 (t, *J* = 9.3 Hz, 2H), 7.62 – 7.46 (m, 5H), 7.43 (t, *J* = 7.1 Hz, 2H), 7.35 (dd, *J* = 8.8, 6.5 Hz, 2H), 3.94 (td, *J* = 7.8, 5.6 Hz, 1H), 3.71 (dq, *J* = 14.5, 7.1, 6.3 Hz, 2H), 2.99 (ddd, *J* = 14.1, 8.3, 2.3 Hz, 1H), 2.62 – 2.54 (m, 1H), 1.97 – 1.72 (m, 3H), 1.55 – 1.39 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.2 (dd, *J* = 291.6, 286.7 Hz), 138.8, 138.2, 131.3, 131.1, 130.4, 130.1 (d, *J* = 3.0 Hz), 129.9, 129.7, 129.6 (d, *J* = 3.2 Hz), 128.4, 128.4, 127.7, 127.6, 127.3, 127.0, 126.1, 125.9, 125.8, 125.4, 125.3, 125.0, 85.9 (dd, *J* = 22.1, 19.6 Hz), 67.5, 36.6, 31.3, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -85.96 (d, *J* = 38.8 Hz, 1F), -91.06 (d, *J* = 38.8 Hz, 1F).

HRMS (ESI) calculated for $C_{27}H_{22}F_2O$ $[M+H]^+$: 401.1712; Found: 401.1710



d26

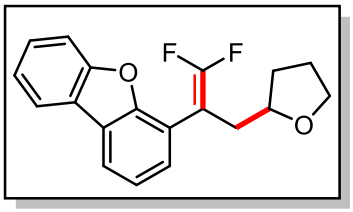
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d26** as a colorless oil (68.8 mg, 95% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 – 7.44 (m, 3H), 7.26 – 7.19 (m, 4H), 3.83 (q, *J* = 7.2, 6.8 Hz, 1H), 3.74 – 3.61 (m, 2H), 2.69 (dd, *J* = 14.1, 6.5 Hz, 1H), 2.49 (ddt, *J* = 14.1, 6.8, 2.4 Hz, 1H), 1.97 – 1.85 (m, 2H), 1.83 – 1.73 (m, 1H), 1.58 – 1.45 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.0 (t, *J* = 288.4 Hz), 136.3 (d, *J* = 9.5 Hz), 136.1, 135.4, 133.7, 129.5, 128.8, 128.6 (d, *J* = 6.9 Hz), 127.8 (d, *J* = 13.1 Hz), 127.3, 88.8 (dd, *J* = 23.7, 18.2 Hz), 67.7, 34.7, 31.1, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -88.66 (d, *J* = 42.8 Hz, 1F), -93.11 (d, *J* = 42.6 Hz, 1F).

HRMS (ESI) calculated for $C_{19}H_{16}F_2OS_2$ $[M+H]^+$: 363.0684; Found: 363.0677



d27

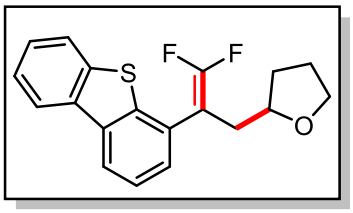
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d27** as a colorless oil (51.5 mg, 82% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (dd, *J* = 20.1, 8.3 Hz, 2H), 7.58 (d, *J* = 8.2 Hz, 1H), 7.48 – 7.42 (m, 1H), 7.38 (d, *J* = 7.1 Hz, 1H), 7.33 (td, *J* = 7.4, 3.2 Hz, 2H), 3.85 – 3.73 (m, 2H), 3.64 (tdd, *J* = 8.3, 5.9, 1.5 Hz, 1H), 2.93 (ddq, *J* = 14.0, 6.6, 2.4 Hz, 1H), 2.72 (ddq, *J* = 14.1, 7.0, 2.4 Hz, 1H), 1.93 – 1.81 (m, 2H), 1.79 – 1.70 (m, 1H), 1.56 – 1.43 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 156.1, 154.3 (t , *J* = 290.0 Hz), 153.8, 128.0 (t, *J* = 2.5 Hz), 127.4, 124.6, 124.1, 122.9 (d, *J* = 4.6 Hz), 120.7, 120.2, 118.1, 111.9, 86.0 (dd, *J* = 24.5, 16.6 Hz), 77.2 (t, *J* = 3.0 Hz), 67.8, 33.7, 30.9, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -87.13 (d, *J* = 36.8 Hz, 1F), -90.58 (d, *J* = 36.7 Hz, 1F).

HRMS (ESI) calculated for $C_{19}H_{16}F_2O_2$ $[M+H]^+$: 315.1192; Found: 315.1189



d28

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d28** as a colorless oil (61.4 mg, 93% yield).

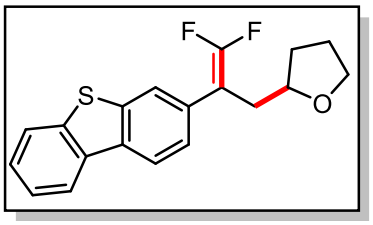
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 – 8.06 (m, 2H), 7.87 – 7.80 (m, 1H), 7.50 – 7.41 (m, 3H), 7.36 (d, *J* = 6.2 Hz, 1H), 3.87 – 3.72 (m, 2H), 3.66 (td, *J* = 7.9, 6.0 Hz, 1H), 2.81 (dddd, *J* = 14.1, 6.7, 2.6, 1.6 Hz, 1H), 2.60 (ddt, *J* = 14.1, 6.9, 2.4 Hz, 1H), 1.96 – 1.82 (m, 2H), 1.83 – 1.71 (m, 1H), 1.54 – 1.43 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 153.9 (t, *J* = 291.4 Hz), 139.8, 139.2, 135.9 (d, *J* =

26.6 Hz), 128.6 (d, *J* = 4.5 Hz), 127.8 (d, *J* = 1.9 Hz), 127.0, 124.8, 124.5, 122.8, 121.8, 121.1, 89.2 (dd, *J* = 23.2, 17.5 Hz), 76.9, 67.8, 34.0, 31.1, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -85.80 (d, *J* = 36.9 Hz, 1F), -90.86 (d, *J* = 36.3 Hz, 1F).

HRMS (ESI) calculated for $C_{19}H_{16}F_2OS$ $[M+H]^+$: 331.0963; Found: 331.0973



d29

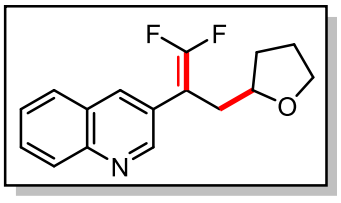
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d29** as a colorless oil (41.1 mg, 61% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 – 8.09 (m, 2H), 7.81 (dd, *J* = 8.8, 6.5 Hz, 2H), 7.47 – 7.39 (m, 3H), 3.90 – 3.80 (m, 2H), 3.68 (td, *J* = 8.2, 5.9 Hz, 1H), 2.80 (ddt, *J* = 14.3, 6.9, 2.3 Hz, 1H), 2.58 (ddt, *J* = 14.2, 6.6, 2.5 Hz, 1H), 1.96 – 1.83 (m, 2H), 1.83 – 1.74 (m, 1H), 1.55 – 1.45 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.4 (t, *J* = 288.8 Hz), 139.8, 138.5, 135.8, 135.3, 130.0, 127.0 (t, *J* = 3.1 Hz), 126.96, 124.5, 122.8, 121.7, 121.6 (t, *J* = 3.2 Hz), 90.2 (dd, *J* = 20.1, 16.5 Hz), 77.0 (t, *J* = 2.9 Hz), 67.8, 34.3, 31.0, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ –90.55 (d, *J* = 42.1 Hz, 1F), -90.68 (d, *J* = 40.8 Hz, 1F).

HRMS (ESI) calculated for $C_{19}H_{16}F_2OS$ $[M+H]^+$: 331.0963; Found: 331.0964



d30

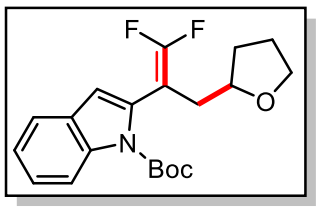
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d30** as a colorless oil (33.0 mg, 60% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.92 (s, 1H), 8.17 – 8.08 (m, 2H), 7.82 (d, *J* = 8.2 Hz, 1H), 7.72 (t, *J* = 7.9 Hz, 1H), 7.57 (t, *J* = 7.6 Hz, 1H), 3.88 – 3.80 (m, 2H), 3.69 (td, *J* = 8.0, 6.1 Hz, 1H), 2.83 – 2.73 (m, 1H), 2.70 – 2.61 (m, 1H), 1.95 – 1.88 (m, 2H), 1.86 – 1.80 (m, 1H), 1.58 – 1.48 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.8 (t, *J* = 292.8 Hz), 150.4, 147.1, 135.0, 129.6, 129.2, 127.8, 127.6, 127.0, 87.9 (dd, *J* = 22.9, 13.6 Hz), 76.9 (t, *J* = 2.9 Hz), 67.8, 33.7, 31.1, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -88.13 (d, *J* = 37.3 Hz, 1F), -88.97 (d, *J* = 37.0 Hz, 1F).

HRMS (ESI) calculated for $C_{16}H_{15}F_2NO$ $[M+H]^+$: 276.1195; Found: 276.1189



d31

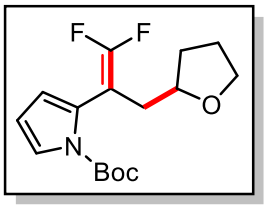
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d31** as a colorless oil (53.0 mg, 73% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.17 (d, *J* = 7.2 Hz, 1H), 7.51 (d, *J* = 7.7 Hz, 1H), 7.30 (t, *J* = 7.1 Hz, 1H), 7.22 (t, *J* = 7.5 Hz, 1H), 6.55 (s, 1H), 3.88 – 3.79 (m, 2H), 3.69 (td, *J* = 8.0, 6.0 Hz, 1H), 2.65 (dddd, *J* = 14.2, 6.9, 2.5, 1.3 Hz, 1H), 2.42 – 2.32 (m, 1H), 1.97 – 1.86 (m, 2H), 1.85 – 1.77 (m, 1H), 1.63 (s, 9H), 1.53 – 1.43 (m, 1H).

^{13}C NMR (101 MHz, CDCl3) δ 154.4 (t, *J* = 290.0 Hz), 149.8, 136.9, 131.0 (d, *J* = 7.9 Hz), 128.9, 124.5, 122.9, 120.6, 115.7, 111.5, 85.1 (dd, *J* = 28.3, 17.0 Hz), 84.0, 67.7, 34.6, 31.1, 28.1, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -87.04 (d, *J* = 36.5 Hz, 1F), -91.30 (d, *J* = 36.4 Hz, 1F).

HRMS (ESI) calculated for $C_{20}H_{23}F_2NO_3$ $[M+H]^+$: 364.1719; Found: 364.1712



d32

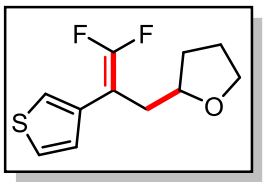
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d32** as a colorless oil (35.7 mg, 57% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (dd, *J* = 3.3, 1.9 Hz, 1H), 6.18 – 6.09 (m, 2H), 3.89 – 3.75 (m, 2H), 3.69 (td, *J* = 8.0, 6.0 Hz, 1H), 2.58 (dddd, *J* = 14.1, 6.6, 2.6, 1.6 Hz, 1H), 2.31 (ddt, *J* = 14.1, 7.0, 2.4 Hz, 1H), 1.97 – 1.87 (m, 2H), 1.86 – 1.79 (m, 1H), 1.57 (s, 9H), 1.50 – 1.41 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.4 (t, *J* = 296.7 q Hz), 151.4, 148.7, 125.0, 122.4, 115.5, 110.4, 84.0 (dd, *J* = 28.6, 17.5 Hz), 83.9, 67.6, 34.53, 30.92, 27.9, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -87.47 (d, *J* = 37.0 Hz, 1F), -91.41 (d, *J* = 36.9 Hz, 1F).

HRMS (ESI) calculated for $C_{16}H_{21}F_2NO_3$ $[M+H]^+$: 314.1563; Found: 314.1565



d33

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **d33** as a colorless oil (20.7 mg, 45% yield).

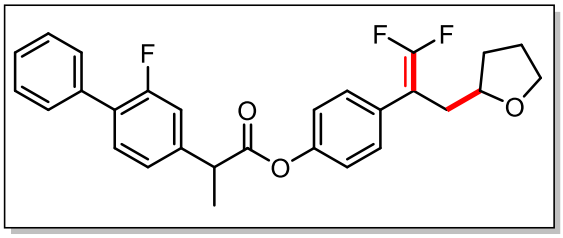
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 (dd, *J* = 5.1,3.0 Hz, 2H), 7.19 (ddd, *J* = 5.2, 2.3, 1.3 Hz, 1H), 4.03 – 3.85 (m, 2H), 3.72 (td, *J* = 8.0, 6.0 Hz, 1H), 2.67 (ddt, *J* = 14.3, 6.6, 2.6 Hz, 1H), 2.52 (dddd, *J* = 14.3, 6.8, 2.9, 1.4 Hz, 1H), 2.00 – 1.89 (m, 2H), 1.88 – 1.81 (m, 1H), 1.59 – 1.48 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.8 (t, *J* = 294.5 Hz) 133.7, 127.2, 127.1 (dd, *J* = 6.4, 2.4 Hz), 122.2 (t, *J* = 5.3 Hz), 86.4 (t, *J* = 13.6), 67.9, 33.4 (d, *J* = 2.1 Hz), 31.0, 25.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -86.39 (d, *J* = 38.6 Hz, 1F), -90.68 (d, *J* = 39.3

Hz, 1F).

HRMS (ESI) calculated for $C_{13}H_{14}F_2O$ $[M+H]^+$: 231.0650; Found: 231.0640



d34

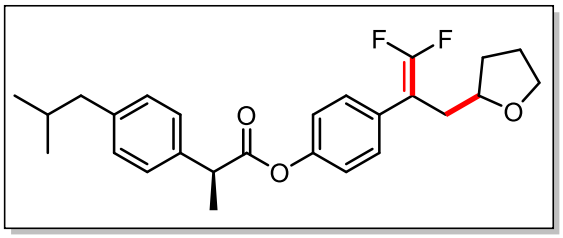
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20/1, v/v) afforded **d34** as a colorless oil (48.4 mg, 52% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.59 (d, *J* = 7.3 Hz, 2H), 7.48 (t, *J* = 7.5 Hz, 3H), 7.41 (d, *J* = 7.2 Hz, 1H), 7.37 (d, *J* =s 8.5 Hz, 2H), 7.32 – 7.26 (m, 1H), 7.29 – 7.22 (m, 1H), 7.07 (d, *J* = 8.7 Hz, 2H), 4.03 (q, *J* = 7.1 Hz, 1H), 3.99 – 3.76 (m, 2H), 3.71 (td, *J* = 8.1, 5.8 Hz, 1H), 2.70 (ddt, *J* = 14.3, 6.9, 2.3 Hz, 1H), 2.50 (ddt, *J* = 14.2, 6.5, 2.4 Hz, 1H), 1.98 – 1.88 (m, 2H), 1.88 – 1.78 (m, 1H), 1.69 (d, *J* = 7.2 Hz, 3H), 1.55 – 1.44 (m, 1H).

^{13}C NMR (101 MHz, CDCl3) δ 172.4, 159.8 (d, *J* = 248.8 Hz), 154.3 (t, *J* = 290.4 Hz), 149.8, 141.2 (d, *J* = 7.8 Hz), 135.4, 131.3, 131.0 (d, *J* = 3.8 Hz), 129.4 (t, *J* = 3.3 Hz), 129.0 (d, *J* = 3.0 Hz), 128.5, 128.2 (d, *J* = 13.4 Hz), 127.8, 123.6 (d, *J* = 3.3 Hz), 121.4, 115.4 (d, *J* = 23.8 Hz), 89.5 (dd, *J* = 20.2, 16.5 Hz), 67.8, 45.2, 33.9, 31.0, 25.6, 18.4.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.26 (s, 2F), -117.28 (s, 1F).

HRMS (ESI) calculated for $C_{28}H_{25}F_3O_3$ $[M+H]^+$: 467.1829; Found: 467.1831



d35

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10/1, v/v) afforded **d35** as a colorless oil (47.9 mg, 56% yield).

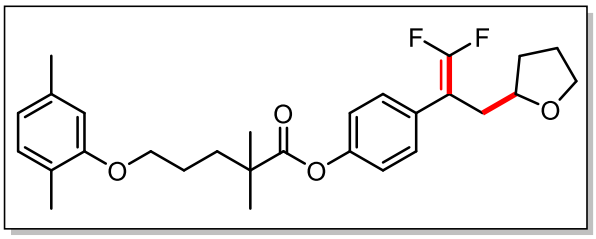
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.30 (dd, *J* = 8.4, 4.9 Hz, 4H), 7.14 (d, *J* = 7.7

Hz, 2H), 6.99 (d, J = 8.6 Hz, 2H), 3.93 (q, J = 7.1 Hz, 1H), 3.88 – 3.74 (m, 2H), 3.71 – 3.63 (m, 1H), 2.66 (ddt, J = 16.2, 6.5, 1.9 Hz, 1H), 2.47 (d, J = 7.2 Hz, 3H), 1.94 – 1.78 (m, 4H), 1.60 (d, J = 7.2 Hz, 3H), 1.51 – 1.39 (m, 1H), 0.91 (d, J = 6.6 Hz, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.2, 154.3 (t, J = 290.1 Hz), 145.0, 140.9, 137.2, 131.0, 130.8, 129.9, 129.6, 129.39 (t, J = 3.3 Hz), 127.3, 121.5, 89.5 (dd, J = 20.2, 16.5 Hz), 67.8, 45.2 (d, J = 20.8 Hz), 33.9, 31.0, 30.3, 26.7, 25.6, 22.5, 18.6.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -91.62 (d, J = 44.1 Hz, 1F), -91.78 (d, J = 44.2 Hz, 1F).

HRMS (ESI) calculated for $C_{26}H_{30}F_2O_3$ $[M+H]^+$: 429.2236; Found: 429.2233



d36

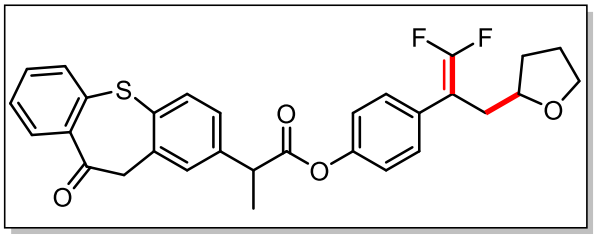
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10/1, v/v) afforded **d36** as a pale-yellow oil (47.2 mg, 50% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.33 (d, J = 8.3 Hz, 2H), 7.02 (d, J = 8.7 Hz, 2H), 6.99 (s, 1H), 6.66 (d, J = 7.5 Hz, 1H), 6.62 (s, 1H), 3.98 (s, 2H), 3.88 – 3.77 (m, 2H), 3.68 (td, J = 8.1, 5.8 Hz, 1H), 2.68 (ddt, J = 14.3, 6.9, 2.3 Hz, 1H), 2.47 (ddt, J = 14.2, 6.6, 2.4 Hz, 1H), 2.30 (s, 3H), 2.17 (s, 3H), 1.87 (s, 6H), 1.85 – 1.75 (m, 1H), 1.53 – 1.42 (m, 1H), 1.37 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 176.3, 156.9, 154.4 (t, J = 289.9 Hz), 150.1, 136.6, 131.0, 130.4, 129.5 (t, J = 3.3 Hz), 123.7, 121.6, 120.8, 112.0, 89.6 (t, J = 16.3 Hz), 77.3, 77.0, 67.8 (d, J = 3.2 Hz), 42.5, 37.2, 34.0, 31.0, 29.6 (d, J = 28.6 Hz), 25.6, 25.3 (d, J = 13.3 Hz), 21.5, 15.9.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.33 (d, J = 41.0 Hz, 1F), -90.40 (d, J = 41.2 Hz, 1F)

HRMS (ESI) calculated for $C_{28}H_{34}F_2O_4$ $[M+H]^+$: 473.2498; Found: 473.2450



d37

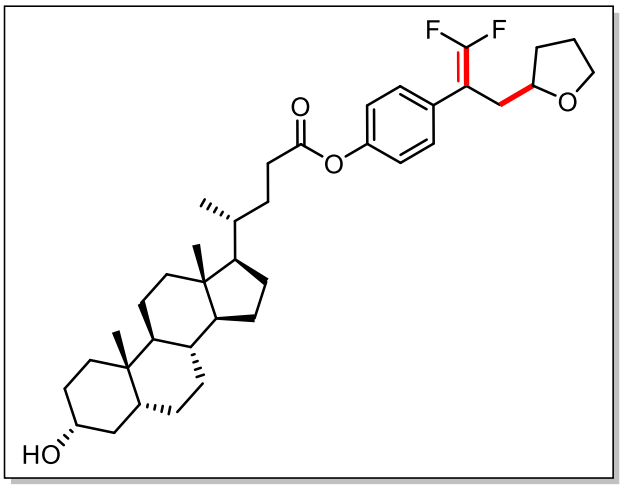
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 5/1, v/v) afforded **d37** as a colorless oil (57.2 mg, 55% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.21 (d, *J* = 7.8 Hz, 1H), 7.63 (dd, *J* = 16.3, 7.9 Hz, 2H), 7.48 (s, 1H), 7.43 (t, *J* = 7.1 Hz, 1H), 7.32 (t, *J* = 8.4 Hz, 3H), 7.26 (s, 1H), 6.98 (d, *J* = 8.4 Hz, 2H), 4.39 (s, 2H), 3.96 (q, *J* = 7.1 Hz, 1H), 3.88 – 3.70 (m, 2H), 3.72 – 3.62 (m, 1H), 2.65 (ddt, *J* = 14.2, 6.9, 2.3 Hz, 1H), 2.46 (ddt, *J* = 14.2, 6.5, 2.4 Hz, 1H), 1.94 – 1.81 (m, 2H), 1.84 – 1.71 (m, 1H), 1.60 (d, *J* = 7.1 Hz, 3H), 1.52 – 1.39 (m, 1H), 1.34 – 1.25 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 191.4, 172.4, 154.3 (t, *J* = 290.1 Hz), 149.7, 142.1, 140.2, 138.2, 136.2, 133.6, 132.6, 131.7 (d, *J* = 15.1 Hz), 131.2, 130.9, 129.4 (t, *J* = 3.3 Hz), 128.8, 127.0, 126.4, 125.8, 125.3, 121.4, 89.5 (t, *J* = 18.3 Hz), 67.8, 51.1, 45.3, 33.9, 31.0, 25.6, 18.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.25 (s, 2F).

HRMS (ESI) calculated for $C_{30}H_{26}F_2O_4S$ $[M+Na]^+$: 543.1413; Found: 543.1413



d38

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate =

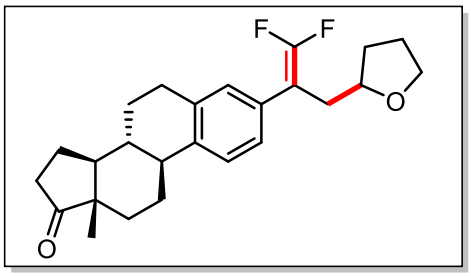
2/1, v/v) afforded **d38** as a pale-yellow oil (53.8 mg, 45% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.35 (d, *J* = 8.4 Hz, 2H), 7.07 (d, *J* = 8.6 Hz, 2H), 3.90 – 3.76 (m, 2H), 3.74 – 3.56 (m, 1H), 2.73 – 2.54 (m, 1H), 2.53 – 2.41 (m, 1H), 2.02 – 1.72 (m, 3H), 1.69 – 1.57 (m, 1H), 1.55 – 1.45 (m, 1H), 1.39 (q, *J* = 3.5 Hz, 1H), 1.34 – 1.03 (m, 3H), 0.98 (d, *J* = 6.2 Hz, 2H), 0.92 (s, 2H), 0.67 (s, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.7, 154.4, (t, *J* = 290.0 Hz), 150.0, 131.0, 129.4 (t, *J* = 3.3 Hz), 121.6, 89.5 (dd, *J* = 21.1, 16.2 Hz), 77.3, 76.9, 71.9, 67.8, 56.6, 56.0, 49.2, 42.8, 42.1, 40.5, 40.2, 36.5, 35.9, 35.4, 34.6, 33.9, 31.4, 31.0, 30.6, 28.3, 27.2, 26.5, 25.6, 24.3, 23.4, 20.9, 18.4, 12.1.

^{19}F NMR (376 MHz, $CDCl_3$) δ -90.23 (d, *J* = 41.0 Hz, 1F) -90.36 (d, *J* = 40.6 Hz, 1F).

HRMS (ESI) calculated for $C_{37}H_{52}F_2O_4$ $[M+H]^+$: 599.3907; Found: 599.3913



d39

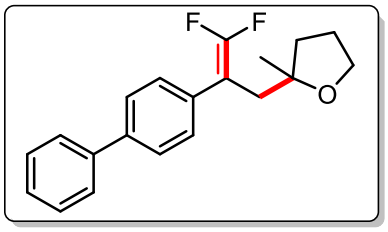
Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10/1, v/v) afforded **d39** as a colorless oil (48.1 mg, 60% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.27 (d, *J* = 6.1 Hz, 1H), 7.12 (d, *J* = 7.7 Hz, 1H), 7.07 (s, 1H), 3.92 – 3.77 (m, 2H), 3.70 (td, *J* = 8.1, 5.9 Hz, 1H), 2.91 (dd, *J* = 9.0, 4.3 Hz, 2H), 2.69 (ddt, *J* = 14.0, 6.6, 2.5 Hz, 1H), 2.55 – 2.40 (m, 3H), 2.30 (td, *J* = 10.5, 3.8 Hz, 1H), 2.11 – 1.79 (m, 7H), 1.71 – 1.60 (m, 2H), 1.58 – 1.51 (m, 3H), 1.49 – 1.44 (m, 2H), 0.91 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 220.9, 154.3 (t, *J* = 288.6 Hz), 139.0, 136.6, 130.9 (t, *J* = 3.2 Hz), 128.8, 125.7, 125.5, 110.3, 110.1, 89.8 (dd, *J* = 21.2, 15.0 Hz), 67.8, 50.6, 48.0, 44.4, 38.1, 35.9, 33.8, 31.6, 31.0, 29.4, 26.5, 25.6 (d, *J* = 3.0 Hz), 21.6, 13.9.

^{19}F NMR (376 MHz, Chloroform-*d*) δ - 90.54 (d, *J* = 43.6 Hz, 1F), -90.78 (d, *J* = 43.7 Hz, 1F).

HRMS (ESI) calculated for $C_{25}H_{30}F_2O_2$ $[M+Na]^+$: 423.2107; Found: 423.2109



d40

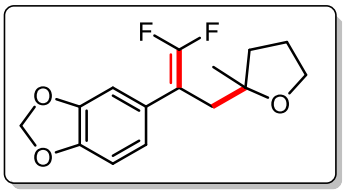
Purification by column chromatography on silica gel (hexane/ethyl acetate = 50/1, v/v) afforded **d40** as a colorless oil (44.0 mg, 70% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.62 – 7.54 (m, 3H), 7.41 (q, *J* = 7.0, 6.6 Hz, 3H), 7.32 (t, *J* = 7.3 Hz, 1H), 3.71 (dq, *J* = 33.0, 8.1, 7.5 Hz, 2H), 2.65 (q, *J* = 14.3 Hz, 1H), 1.85 (p, *J* = 7.1 Hz, 2H), 1.69 (dd, *J* = 12.5, 7.3 Hz, 1H), 1.51 (dt, *J* = 12.2, 7.3 Hz, 1H), 1.12 (s, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.8 (t, *J* = 289.5 Hz), 140.6, 139.8, 133.8 (dd, *J* = 5.0, 3.4 Hz), 128.8 (d, *J* = 3.6 Hz), 127.4, 127.1 (d, *J* = 3.7 Hz), 90.0 (dd, *J* = 21.3, 14.1 Hz), 83.1 (t, *J* = 3.3 Hz), 67.1, 38.4, 36.6, 26.3, 26.0.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -89.15 (d, *J* = 38.9 Hz, 1F), -90.66 (d, *J* = 38.9 Hz, 1F).

HRMS (ESI) calculated for $C_{20}H_{20}F_2O$ $[M+H]^+$: 315.1555; Found: 315.1558



d41

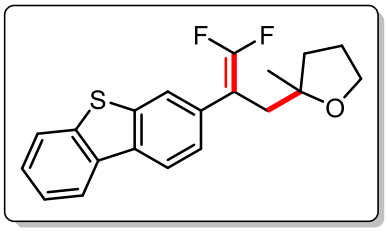
Purification by column chromatography on silica gel (hexane/ethyl acetate = 50/1, v/v) afforded **d41** as a colorless oil (34.9 mg, 62% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 6.79 (d, *J* = 9.9 Hz, 3H), 5.95 (s, 2H), 3.82 – 3.64 (m, 2H), 2.61 – 2.48 (m, 2H), 1.95 – 1.80 (m, 2H), 1.65 (dt, *J* = 12.4, 7.5 Hz, 1H), 1.49 (ddd, *J* = 12.4, 8.1, 6.5 Hz, 1H), 1.10 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.7 (t, *J* = 289.2 Hz), 147.6, 146.6, 128.5 (d, *J* = 4.2 Hz), 122.0 (t, *J* = 3.0 Hz), 109.0 (t, *J* = 3.0 Hz), 108.2, 101.1, 89.9 (dd, *J* = 21.8, 14.5 Hz), 82.9 (d, *J* = 3.3 Hz), 67.0, 38.8, 36.5, 26.2, 25.9.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -90.26 (d, *J* = 40.9 Hz, 1F), -91.26 (d, *J* = 40.8 Hz, 1F).

HRMS (ESI) calculated for $C_{15}H_{17}F_2O_3$ $[M+H]^+$: 283.1141; Found: 283.1139



d42

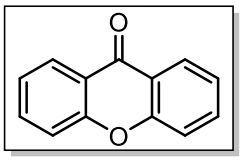
Purification by column chromatography on silica gel (hexane/ethyl acetate = 50/1, v/v) afforded **d42** as a colorless oil (41.3 mg, 60% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.20 – 8.08 (m, 2H), 7.87 – 7.77 (m, 2H), 7.47 – 7.37 (m, 3H), 3.71 (ddt, *J* = 29.1, 8.3, 6.8 Hz, 2H), 2.80 – 2.63 (m, 2H), 1.83 (p, *J* = 7.1 Hz, 2H), 1.66 (dt, *J* = 12.3, 7.5 Hz, 1H), 1.49 (dt, *J* = 12.4, 7.3 Hz, 1H), 1.11 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.9 (t, *J* = 291.6 Hz), 139.9, 138.3, 135.7, 135.3, 131.3 (dd, *J* = 5.2, 3.3 Hz), 127.2 (t, *J* = 2.9 Hz), 126.9, 124.4, 122.9, 122.6, 121.6, 121.5 (t, *J* = 3.0 Hz), 90.25 (dd, *J* = 21.6, 14.3 Hz), 83.1, 67.1, 39.0, 36.7, 26.3, 25.9.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -89.35 (d, *J* = 39.3 Hz, 1F), -90.93 (d, *J* = 39.5 Hz, 1F).

HRMS (ESI) calculated for $C_{20}H_{19}F_2OS$ $[M+H]^+$: 345.1120; Found: 345.1113



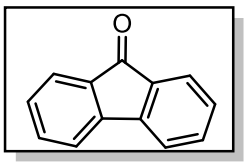
f1

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20/1, v/v) afforded **f1** as a white solid (38.9 mg, 99% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.32 (dd, *J* = 8.0, 1.7 Hz, 1H), 7.74 – 7.66 (m, 1H), 7.46 (d, *J* = 8.4 Hz, 1H), 7.36 (t, *J* = 7.5 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 177.2, 156.1, 134.8, 126.7, 123.9, 121.8, 118.0.

HRMS (EI) calculated for $C_{13}H_8O_2$ $[M]^+$: 196.0519; Found: 196.0519



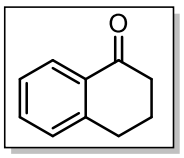
f2

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20/1, v/v) afforded **f2** as a white solid (33.4 mg, 93% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.63 (d, *J* = 7.3 Hz, 1H), 7.46 (q, *J* = 7.4 Hz, 2H), 7.27 (td, *J* = 7.1, 1.7 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 193.9, 144.4, 134.7, 134.1, 129.1, 124.3, 120.3.

HRMS (EI) calculated for $C_{13}H_8O$ $[M]^+$: 180.0570; Found: 180.0570



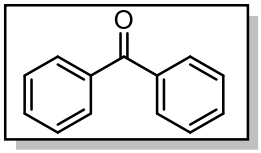
f3

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20/1, v/v) afforded **f3** as a white solid (18.3 mg, 62% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.03 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.47 (td, *J* = 7.5, 1.5 Hz, 1H), 7.30 (t, *J* = 7.0 Hz, 1H), 7.25 (d, *J* = 7.7 Hz, 1H), 2.97 (t, *J* = 6.1 Hz, 2H), 2.66 (dd, *J* = 7.3, 5.8 Hz, 2H), 2.14 (p, *J* = 6.5 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 198.4, 144.5, 133.4, 132.6, 128.8, 127.2, 126.6, 39.2, 29.7, 23.3.

HRMS (EI) calculated for $C_{10}H_{10}O$ $[M]^+$: 146.0627; Found: 146.0627



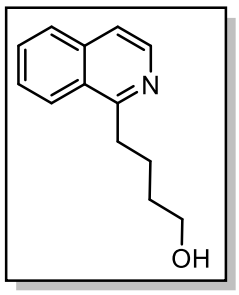
f4

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20/1, v/v) afforded **f4** as a white solid (16.4 mg, 45% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.81 (d, *J* = 6.8 Hz, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.48 (d, *J* = 15.3 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 196.8, 137.6, 132.4, 130.1, 128.3.

HRMS (EI) calculated for $C_{13}H_{10}O$ $[M]^+$: 182.0727; Found: 182.0727



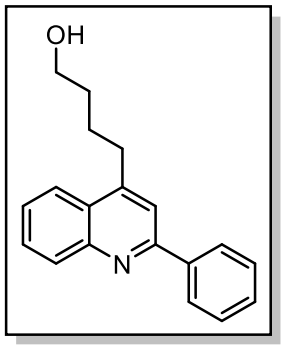
d'1

Purification by column chromatography on silica gel (hexane/ethyl acetate = 2/1, v/v) afforded **d'1** as a colorless oil (33.5 mg, 83% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.39 (d, *J* = 5.8 Hz, 1H), 8.16 (d, *J* = 8.4 Hz, 1H), 7.81 (d, *J* = 8.1 Hz, 1H), 7.63 (dt, *J* = 31.7, 6.9 Hz, 1H), 7.51 (d, *J* = 5.8 Hz, 1H), 3.72 (t, *J* = 6.2 Hz, 2H), 3.36 (t, *J* = 7.6 Hz, 2H), 3.28 – 3.03 (1H), 2.00 (p, *J* = 7.3 Hz, 2H), 1.74 (p, *J* = 6.4 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 161.8, 141.4, 136.3, 130.0, 127.4, 127.2, 127.0, 125.3, 119.4, 62.1, 34.3, 32.4, 25.3.

HRMS (ESI) calculated for $C_{13}H_{15}NO$ $[M+H]^+$: 202.1226; Found: 202.1222



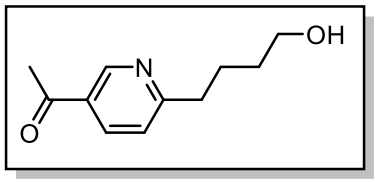
d'2

Purification by column chromatography on silica gel (hexane/ethyl acetate = 3/1, v/v) afforded **d'2** as a colorless oil (42.3 mg, 76% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.21 (d, *J* = 7.2 Hz, 1H), 8.11 (d, *J* = 5.1 Hz, 2H), 8.00 (d, *J* = 8.5 Hz, 1H), 7.71 (t, *J* = 6.9 Hz, 1H), 7.66 (s, 1H), 7.55 – 7.43 (m, 4H), 3.67 (t, *J* = 6.4 Hz, 2H), 3.10 (t, *J* = 7.7 Hz, 2H), 2.18 (1H), 1.85 (p, *J* = 7.6 Hz, 2H), 1.68 (dt, *J* = 13.2, 6.5 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 157.2, 148.9, 148.4, 139.8, 130.4, 130.0, 129.2, 128.8, 127.6, 126.5, 126.1, 123.4, 118.8, 62.4, 32.6, 32.2, 26.3.

HRMS (ESI) calculated for $C_{19}H_{19}NO$ $[M+H]^+$: 278.1539; Found: 278.1543



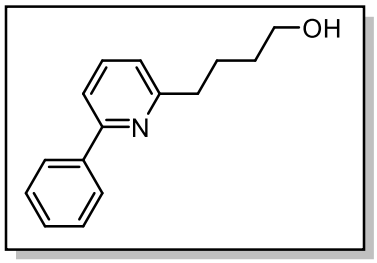
d'3

Purification by column chromatography on silica gel (hexane/ethyl acetate = 5/1, v/v) afforded **d'3** as a pale-yellow oil (17.0 mg, 44% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.05 (d, *J* = 2.3 Hz, 1H), 8.16 (dd, *J* = 8.2, 2.3 Hz, 1H), 7.29 (d, *J* = 8.0 Hz, 1H), 3.69 (t, *J* = 6.3 Hz, 2H), 2.91 (t, *J* = 7.7 Hz, 2H), 2.79 – 2.75 (1H), 2.62 (s, 3H), 1.86 (p, *J* = 7.5 Hz, 2H), 1.65 (dt, *J* = 13.0, 6.5 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 196.6, 166.9, 149.5, 136.1, 130.2, 122.9, 62.1, 37.8, 32.0, 26.6, 25.6.

HRMS (ESI) calculated for $C_{11}H_{15}NO_2$ $[M+H]^+$: 194.1176; Found: 194.1170



d'4

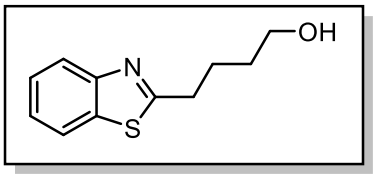
Purification by column chromatography on silica gel (hexane/ethyl acetate = 5/1, v/v) afforded **d'4** as a pale-yellow oil (15.5 mg, 34% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.95 (d, *J* = 7.0 Hz, 2H), 7.65 (t, *J* = 7.7 Hz, 1H), 7.51 (d, *J* = 7.8 Hz, 1H), 7.46 (t, *J* = 7.5 Hz, 2H), 7.39 (t, *J* = 7.3 Hz, 1H), 7.08

(d, *J* = 7.6 Hz, 1H), 3.66 (t, *J* = 6.4 Hz, 2H), 2.89 (t, *J* = 7.6 Hz, 2H), 2.57 – 2.28 (1H), 1.88 (p, *J* = 7.4 Hz, 2H), 1.65 (dt, *J* = 13.0, 6.6 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 161.9, 157.0, 139.7, 137.1, 128.8, 128.7, 127.1, 121.2, 118.1, 62.4, 37.6, 32.0, 25.9.

HRMS (ESI) calculated for $C_{15}H_{17}NO$ $[M+H]^+$: 228.1383; Found: 228.1375



d'5

Purification by column chromatography on silica gel (hexane/ethyl acetate = 2/1, v/v) afforded **d'5** as a pale-yellow oil (25.1mg, 61% yield).

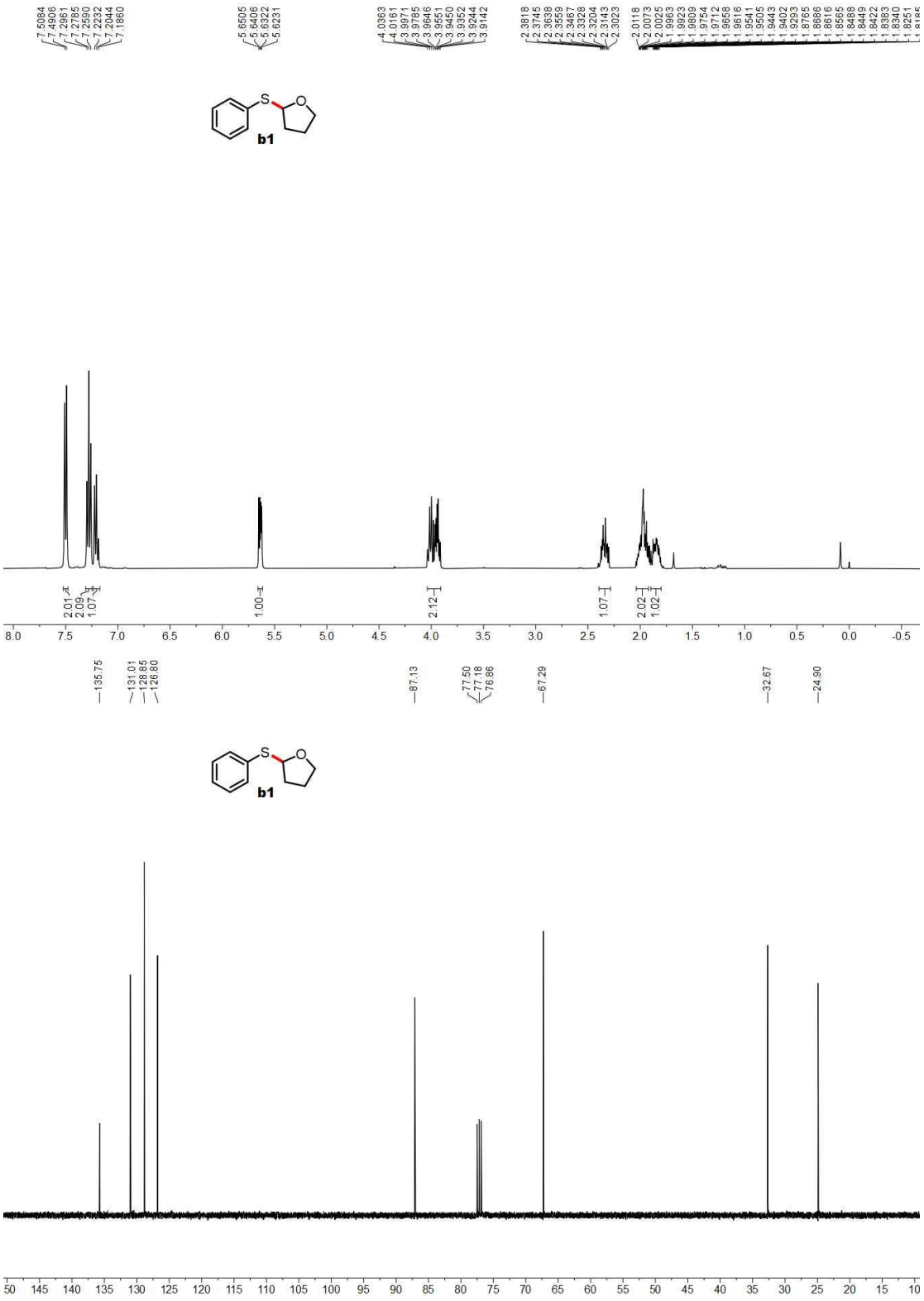
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.95 (d, *J* = 8.1 Hz, 1H), 7.82 (d, *J* = 8.0 Hz, 1H), 7.44 (dd, *J* = 8.3, 7.1 Hz, 1H), 7.34 (t, *J* = 7.6 Hz, 1H), 3.70 (t, *J* = 6.3 Hz, 2H), 3.15 (t, *J* = 7.5 Hz, 2H), 2.63 (1H), 1.98 (p, *J* = 7.5 Hz, 2H), 1.71 (dt, *J* = 13.2, 6.5 Hz, 2H).

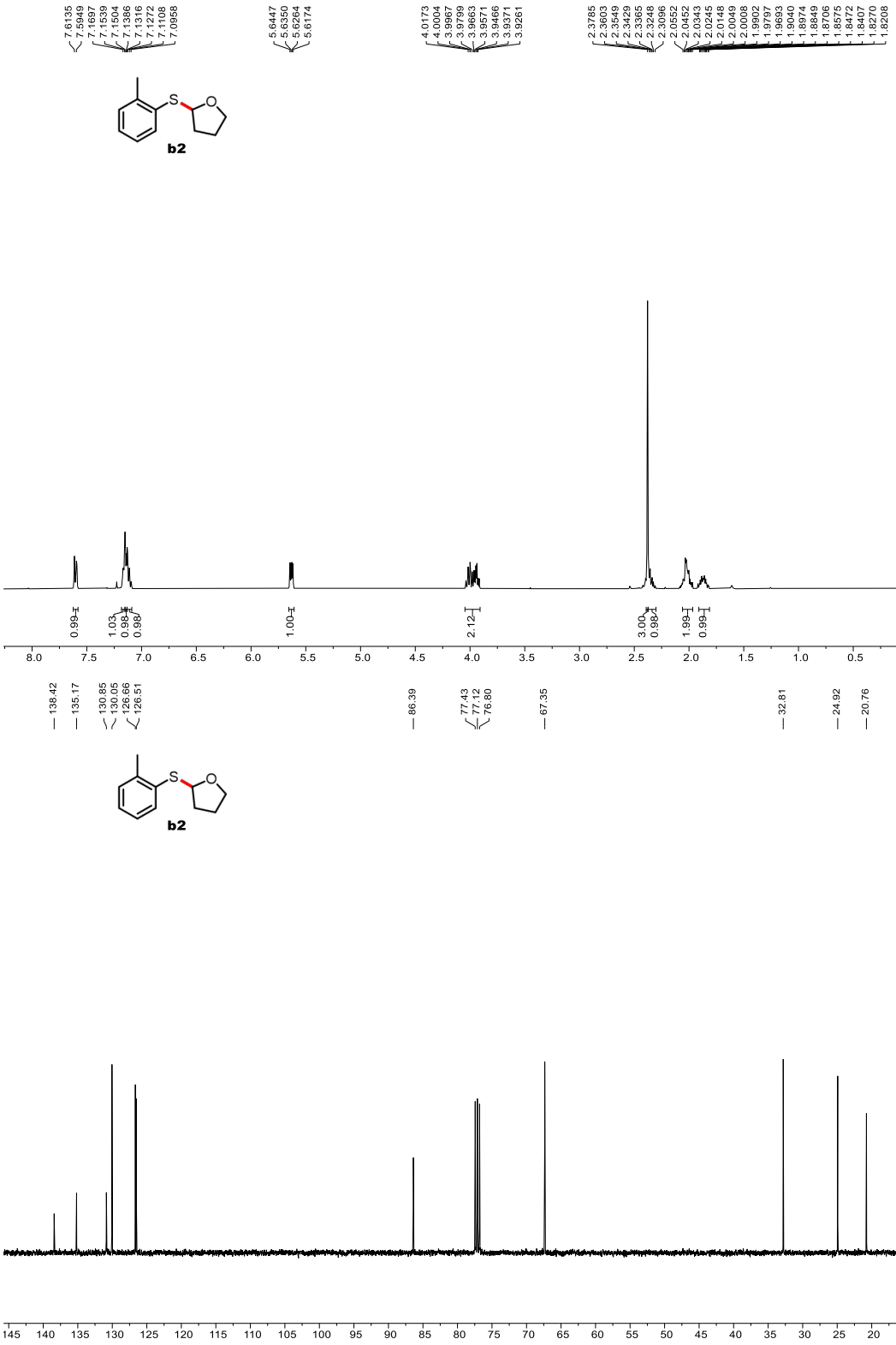
^{13}C NMR (101 MHz, $CDCl_3$) δ 172.2, 153.0, 135.0, 126.0, 124.8, 122.4, 121.5, 62.0, 33.8, 32.0, 25.7.

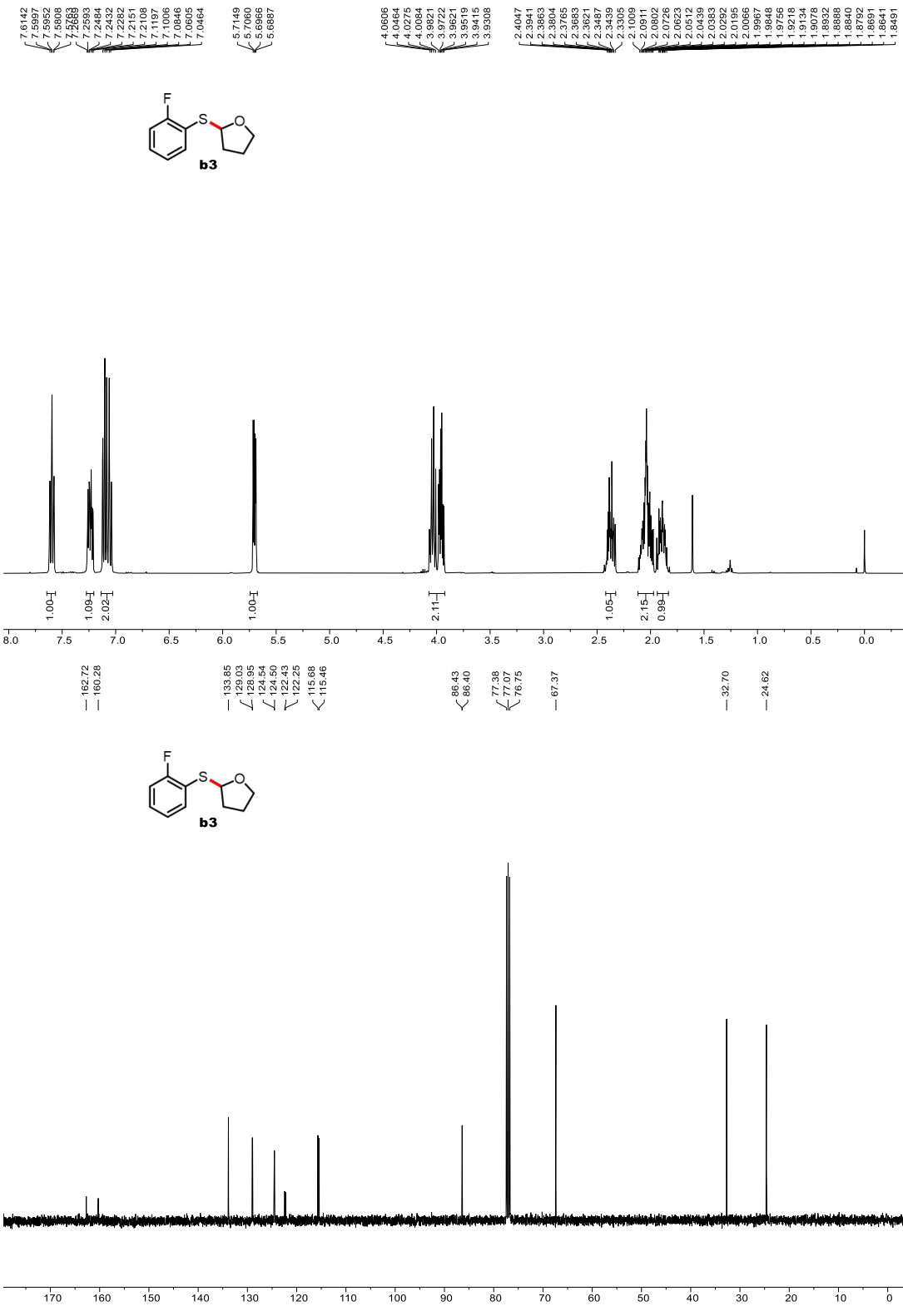
HRMS (ESI) calculated for $C_{11}H_{13}NOS$ $[M+H]^+$: 208.0791; Found: 208.0795

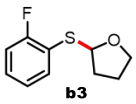
3. NMR spectra for the products

4.



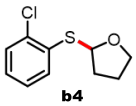

7.6135
7.5949
7.1697
7.1539
7.1504
7.1386
7.1316
7.1272
7.1108
7.0958
5.6447
5.6350
5.6264
5.6174
4.0173
4.0004
3.9967
3.9799
3.9663
3.9571
3.9466
3.9371
3.9261
2.3785
2.3603
2.3549
2.3429
2.3365
2.3248
2.3096
2.0552
2.0452
2.0343
2.0245
2.0148
2.0049
2.0008
1.9902
1.9797
1.9693
1.9040
1.8974
1.8849
1.8706
1.8575
1.8472
1.8407
1.8270
1.8208
S
O
b2
0.99
1.03
0.98
0.98
1.00
2.12
3.00
0.98
1.99
0.99
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
138.42
135.17
130.85
130.05
126.66
126.51
86.39
77.43
77.12
76.80
67.35
32.81
24.92
20.76
S
O
b2
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10


7.6142
7.5997
7.5952
7.5808
7.2593
7.2484
7.2432
7.2282
7.2151
7.2108
7.1197
7.1006
7.0846
7.0605
7.0464
5.7149
5.7060
5.6966
5.6887
4.0606
4.0464
4.0275
4.0084
3.9821
3.9722
3.9621
3.9519
3.9415
3.9308
2.4047
2.3941
2.3863
2.3804
2.3765
2.3683
2.3621
2.3487
2.3439
2.3305
2.1009
2.0911
2.0802
2.0726
2.0623
2.0512
2.0439
2.0383
2.0292
2.0195
2.0066
1.9967
1.9848
1.9756
1.9218
1.9134
1.9078
1.8932
1.8888
1.8840
1.8792
1.8691
1.8641
1.8491
F
S
O
b3
1.00
1.09
2.02
1.00
2.11
1.05
2.15
0.99
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
162.72
160.28
133.85
129.03
128.95
124.54
124.50
122.43
122.25
115.68
115.46
86.43
86.40
77.38
77.07
76.75
67.37
32.70
24.62
F
S
O
b3
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

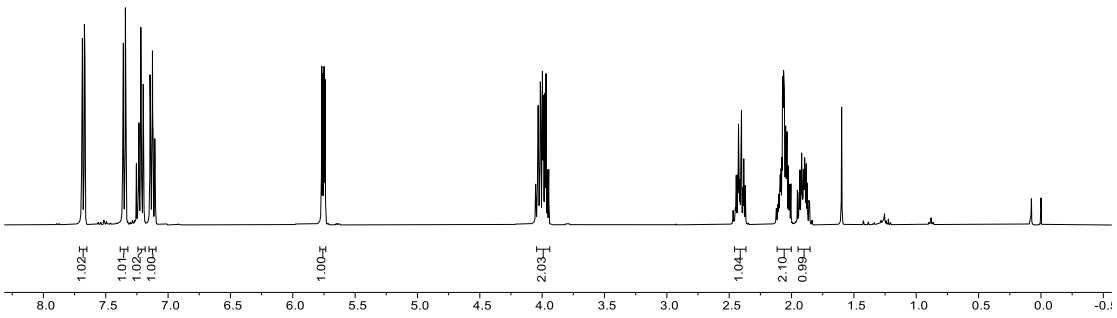

F
S
O

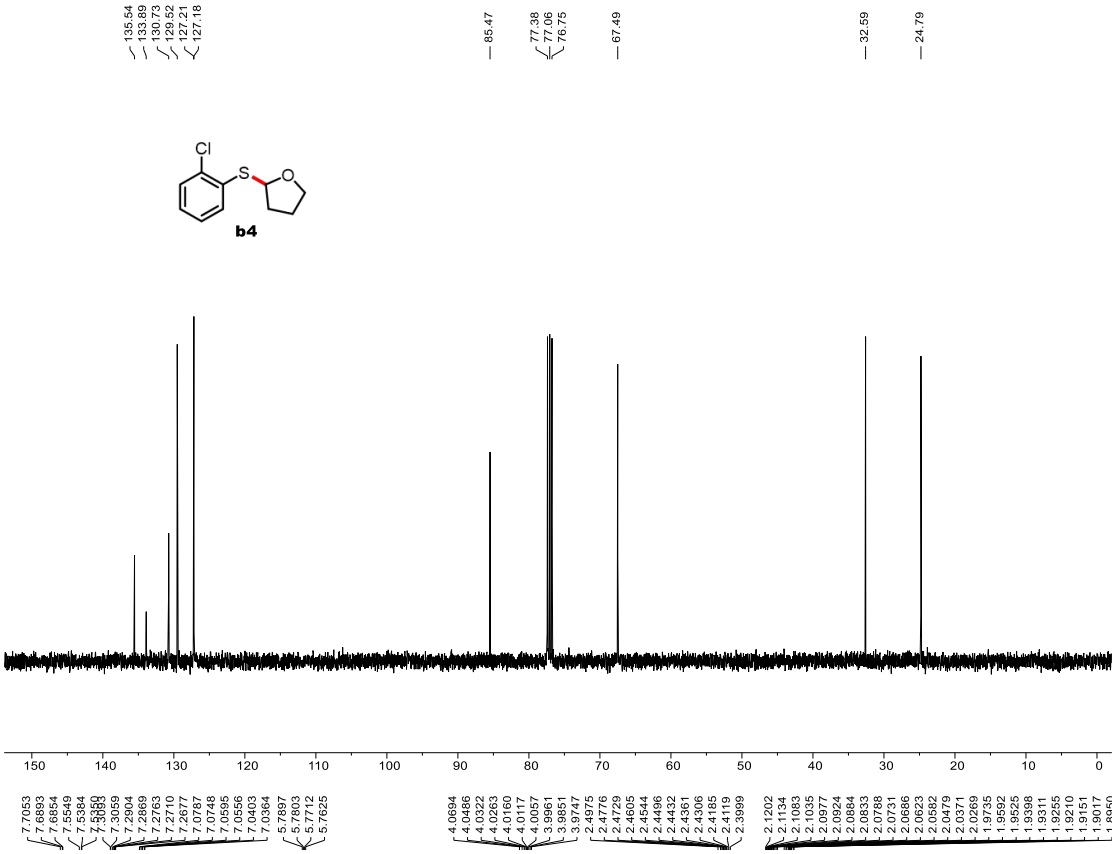
b3

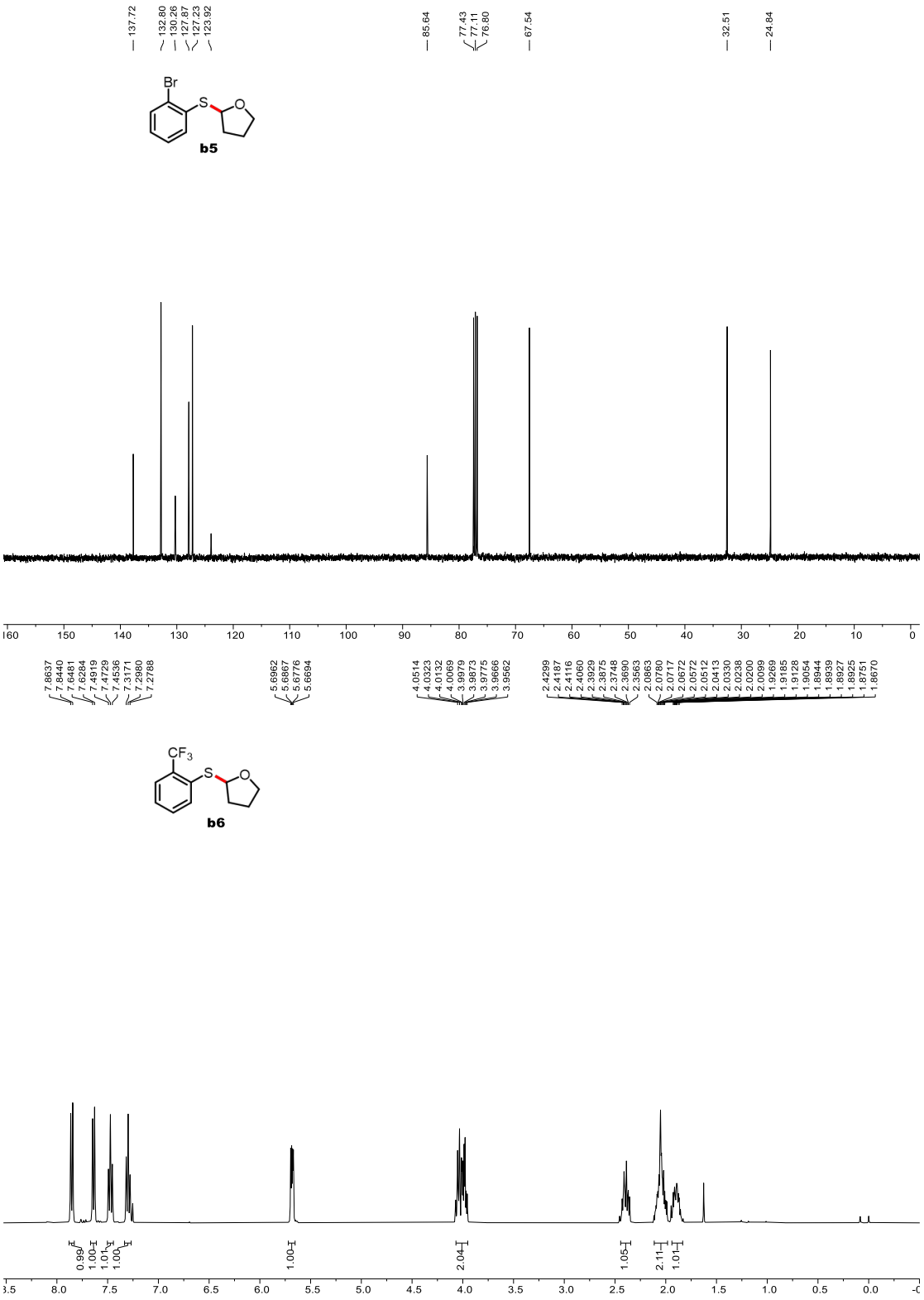
-109.352
1.00
0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100 -105 -110 -115 -120 -125 -130 -135 -140 -145
7.6911 7.6870 7.6713 7.6673 7.3623 7.3586 7.3425 7.3389 7.2373 7.2337 7.2185 7.2147 7.1991 7.1955 7.1448 7.1408 7.1255 7.1214 7.1065 7.1025 5.7675 5.7582 5.7491 5.7405
4.0322 4.0289 4.0154 4.0115 3.9992 3.9947 3.9887 3.9785 3.9690
2.4502 2.4438 2.4322 2.4254 2.4204 2.4151 2.4071 2.4015 2.3885 2.3832 2.3719
2.0939 2.0882 2.0838 2.0780 2.0725 2.0679 2.0635 2.0576 2.0471 2.0400 2.0364 2.0263 2.0154 2.0054 1.9324 1.9193 1.9149 1.9105 1.9049 1.9008 1.8914 1.8849 1.8811 1.8750

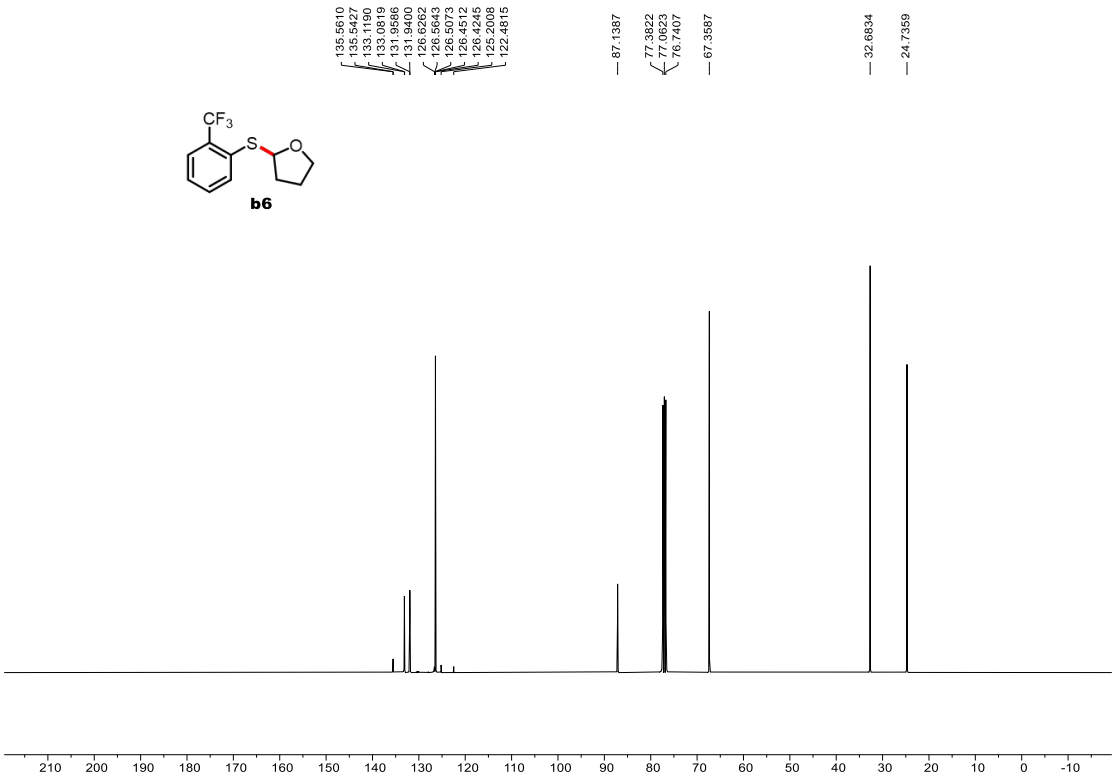

Cl
S
O

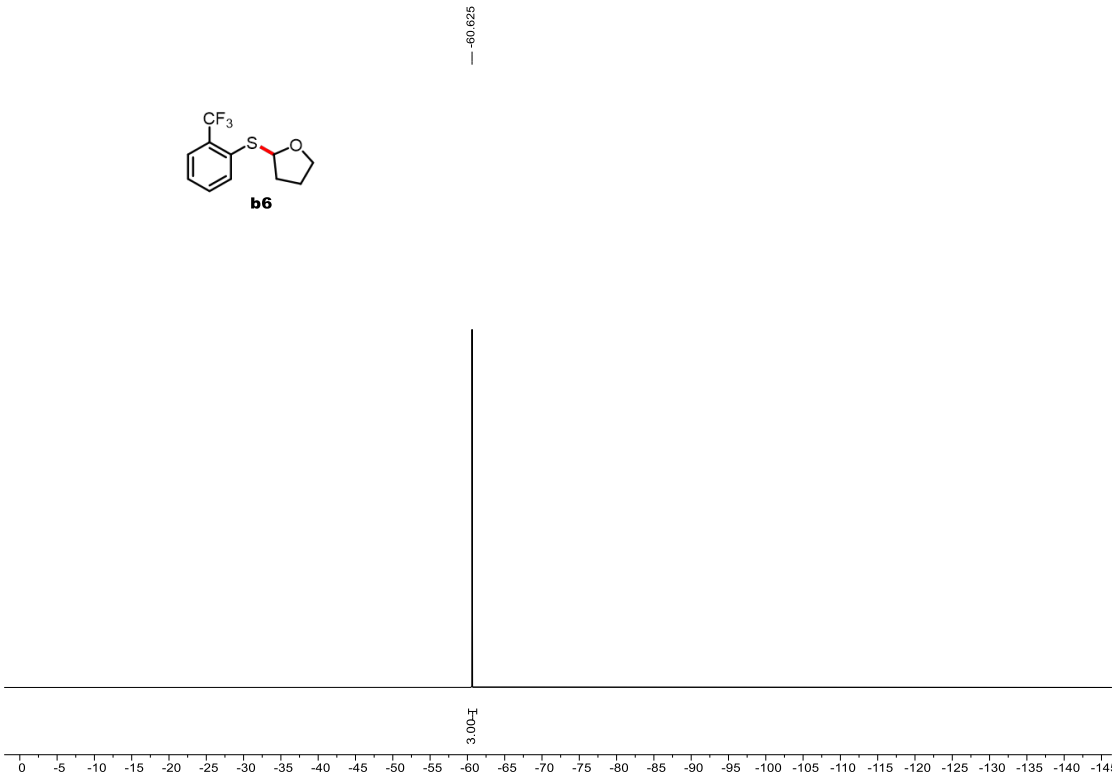
b4

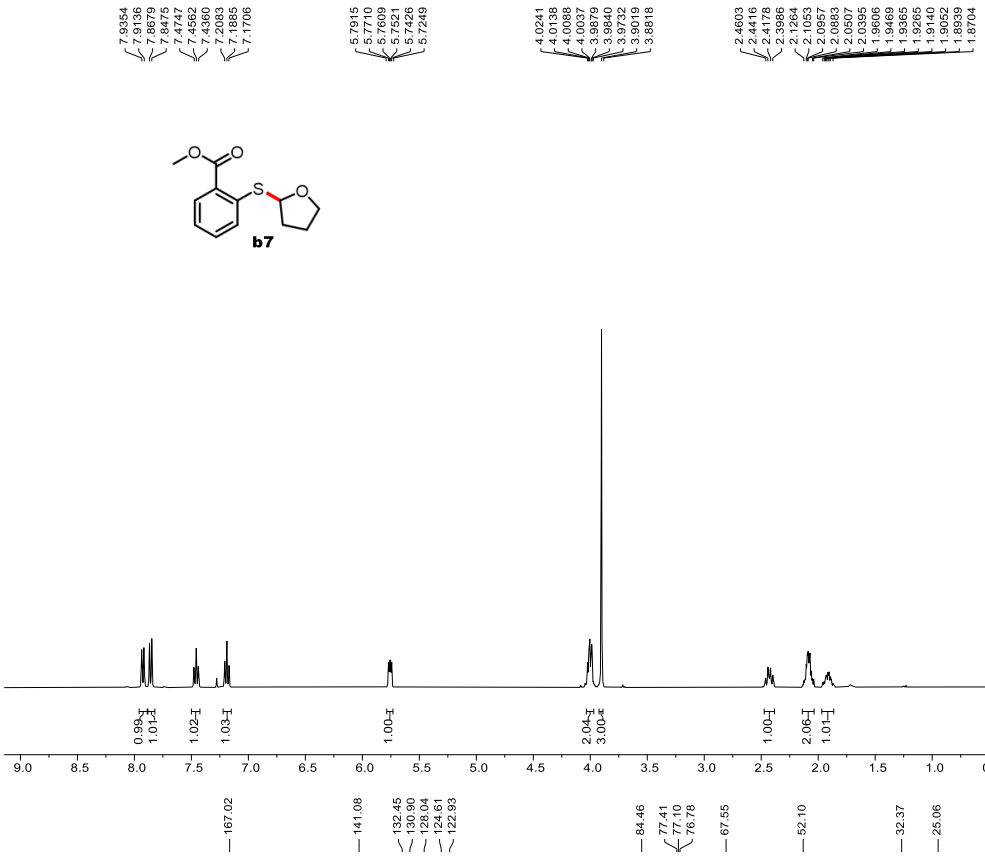

1.02
1.01
1.02
1.00
1.00
2.03
1.04
2.10
0.99
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

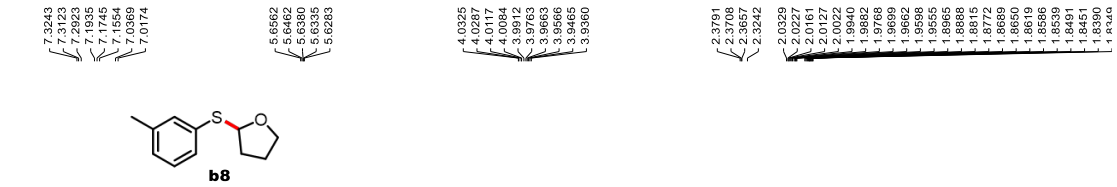

135.54
133.89
130.73
129.52
127.21
127.18
85.47
77.38
77.06
76.75
67.49
32.59
24.79
Cl
S
O
b4
7.7053
7.6893
7.6854
7.5549
7.5384
7.3059
7.2904
7.2869
7.2763
7.2710
7.2677
7.0787
7.0748
7.0595
7.0556
7.0403
7.0364
5.7897
5.7803
5.7712
5.7625
4.0694
4.0486
4.0322
4.0263
4.0160
4.0117
4.0057
3.9961
3.9851
3.9747
2.4975
2.4776
2.4729
2.4605
2.4544
2.4496
2.4432
2.4361
2.4306
2.4185
2.4119
2.3999
2.1202
2.1134
2.1083
2.1035
2.0977
2.0924
2.0884
2.0833
2.0731
2.0686
2.0623
2.0562
2.0479
2.0371
2.0269
1.9735
1.9592
1.9525
1.9398
1.9311
1.9255
1.9210
1.9151
1.9017
Br
S
O
b5
1.00
1.00
1.08
1.00
1.00
2.05
1.06
2.09
1.04

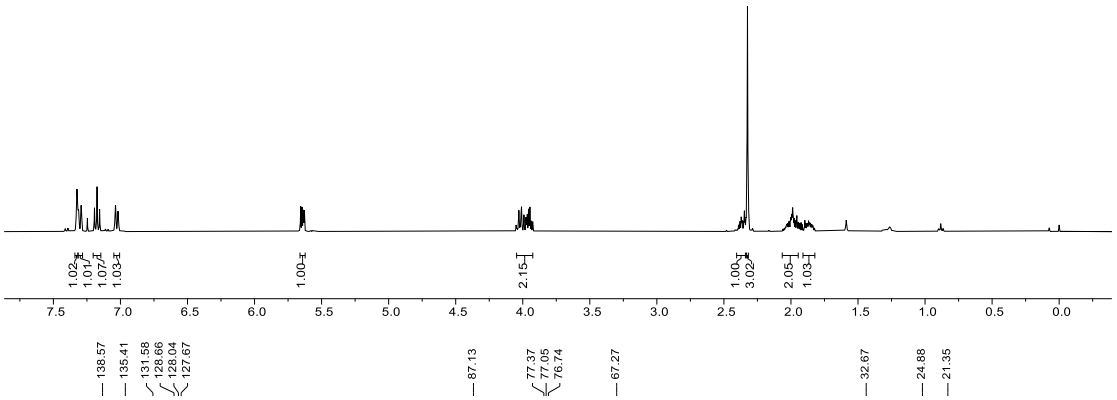

137.72
132.80
130.26
127.87
127.23
123.92
85.64
77.43
77.11
76.80
67.54
32.51
24.84
Br
S
O
b5
7.8637
7.8440
7.6481
7.6284
7.4919
7.4729
7.4536
7.3171
7.2980
7.2788
5.6962
5.6867
5.6776
5.6694
4.0514
4.0323
4.0132
4.0069
3.9979
3.9873
3.9775
3.9666
3.9562
2.4299
2.4187
2.4116
2.4060
2.3929
2.3875
2.3748
2.3690
2.3563
2.0863
2.0780
2.0717
2.0672
2.0572
2.0512
2.0413
2.0330
2.0238
2.0200
2.0089
1.9185
1.9128
1.9054
1.8944
1.8939
1.8927
1.8925
1.8751
1.8670
CF3
S
O
b6
0.99
1.00
1.01
1.00
1.00
2.04
1.05
2.11
1.01

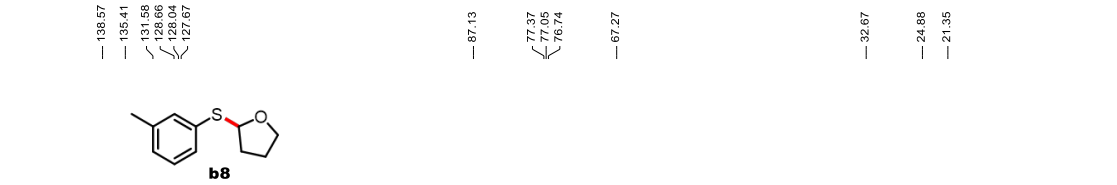

135.5610
135.5427
133.1190
133.0819
131.9586
131.9400
126.6262
126.5643
126.5073
126.4512
126.4245
125.2008
122.4815
87.1387
77.3822
77.0623
76.7407
67.3587
32.6834
24.7359
CF3
S
O
b6
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

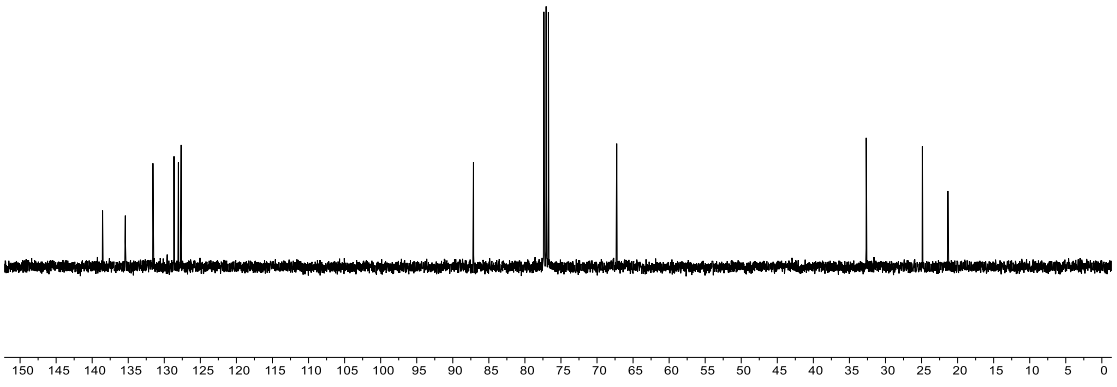

-60.625
CF3
S
O
b6
3.00
0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100 -105 -110 -115 -120 -125 -130 -135 -140


7.9354
7.9136
7.8679
7.8475
7.4747
7.4562
7.4360
7.2083
7.1885
7.1706
5.7915
5.7710
5.7609
5.7521
5.7426
5.7249
4.0241
4.0138
4.0088
4.0037
3.9879
3.9840
3.9732
3.9019
3.8818
2.4603
2.4416
2.4178
2.3986
2.1964
2.1053
2.0957
2.0883
2.0507
2.0395
1.9606
1.9469
1.9365
1.9265
1.9140
1.9052
1.8939
1.8704
b7
0.99
1.01
1.02
1.03
1.00
2.04
3.00
1.00
2.06
1.01
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
167.02
141.08
132.45
130.90
128.04
124.61
122.93
84.46
77.41
77.10
76.78
67.55
52.10
32.37
25.06
b7
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

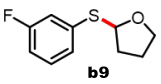

7.3243
7.3123
7.2923
7.1935
7.1745
7.1554
7.0369
7.0174
5.6562
5.6462
5.6380
5.6335
5.6283
4.0325
4.0287
4.0117
4.0084
3.9912
3.9763
3.9663
3.9566
3.9465
3.9360
2.3791
2.3708
2.3657
2.3242
2.0329
2.0227
2.0161
2.0127
2.0022
1.9940
1.9882
1.9768
1.9669
1.9662
1.9598
1.9555
1.8965
1.8888
1.8815
1.8772
1.8689
1.8650
1.8619
1.8586
1.8539
1.8491
1.8451
1.8390
S
O
b8


1.02
1.01
1.07
1.03
1.00
2.15
1.00
3.02
2.05
1.03
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

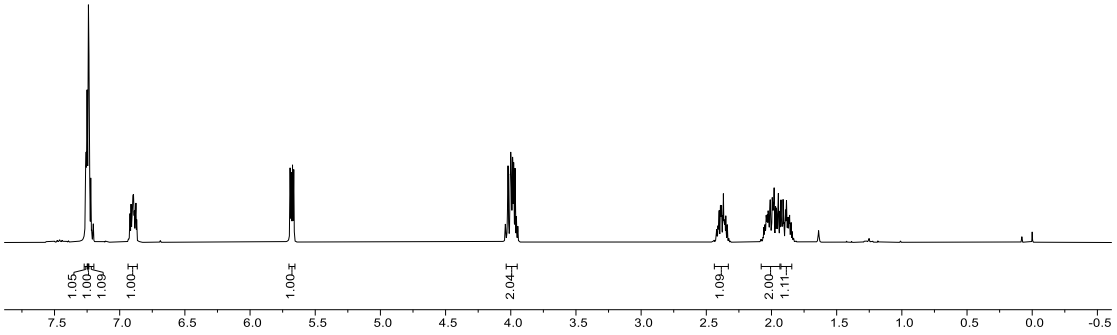

138.57
135.41
131.58
128.66
128.04
127.67
87.13
77.37
77.05
76.74
67.27
32.67
24.88
21.35
S
O
b8


150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0

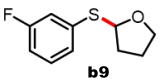

7.2575
7.2532
7.2504
7.2479
7.2402
7.2361
7.2306
6.9129
6.9055
6.8989
6.8942
6.8913
6.8873
6.8756
6.8695
5.6927
5.6828
5.6742
5.6648
4.0209
4.0047
4.0005
3.9970
3.9864
3.9839
3.9776
3.9672
3.9567
2.4211
2.4052
2.4013
2.3920
2.3878
2.3829
2.3737
2.3689
2.3619
2.3565
2.3504
2.3390
2.0315
2.0257
2.0145
2.0044
2.0001
1.9943
1.9894
1.9843
1.9797
1.9687
1.9622
1.9585
1.9520
1.9473
1.9362
1.9272
1.9179
1.9113
1.9080
1.8930
1.8881
1.8849
1.8610


F
S
O

b9

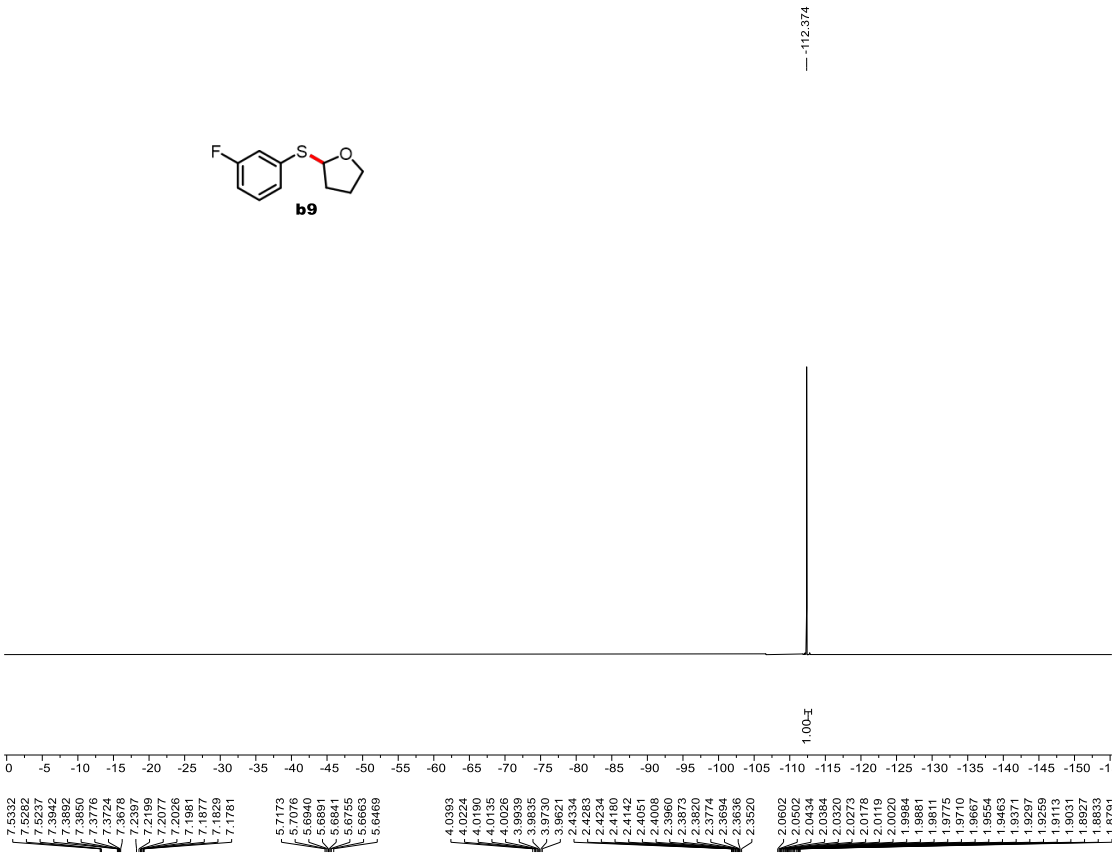

1.05
1.00
1.09
1.00
1.00
2.04
1.09
2.00
1.11
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

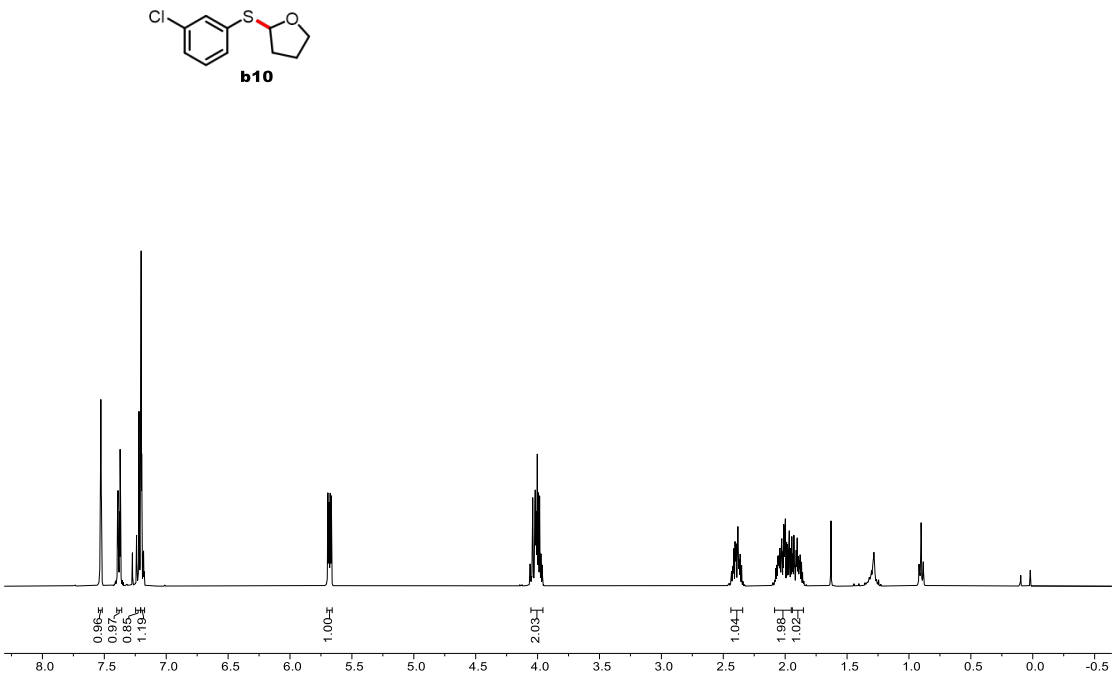

163.92
161.45
138.38
138.30
130.02
129.93
125.91
125.88
117.27
117.05
113.60
113.39
86.76
77.40
77.08
76.77
67.35
32.59
24.81

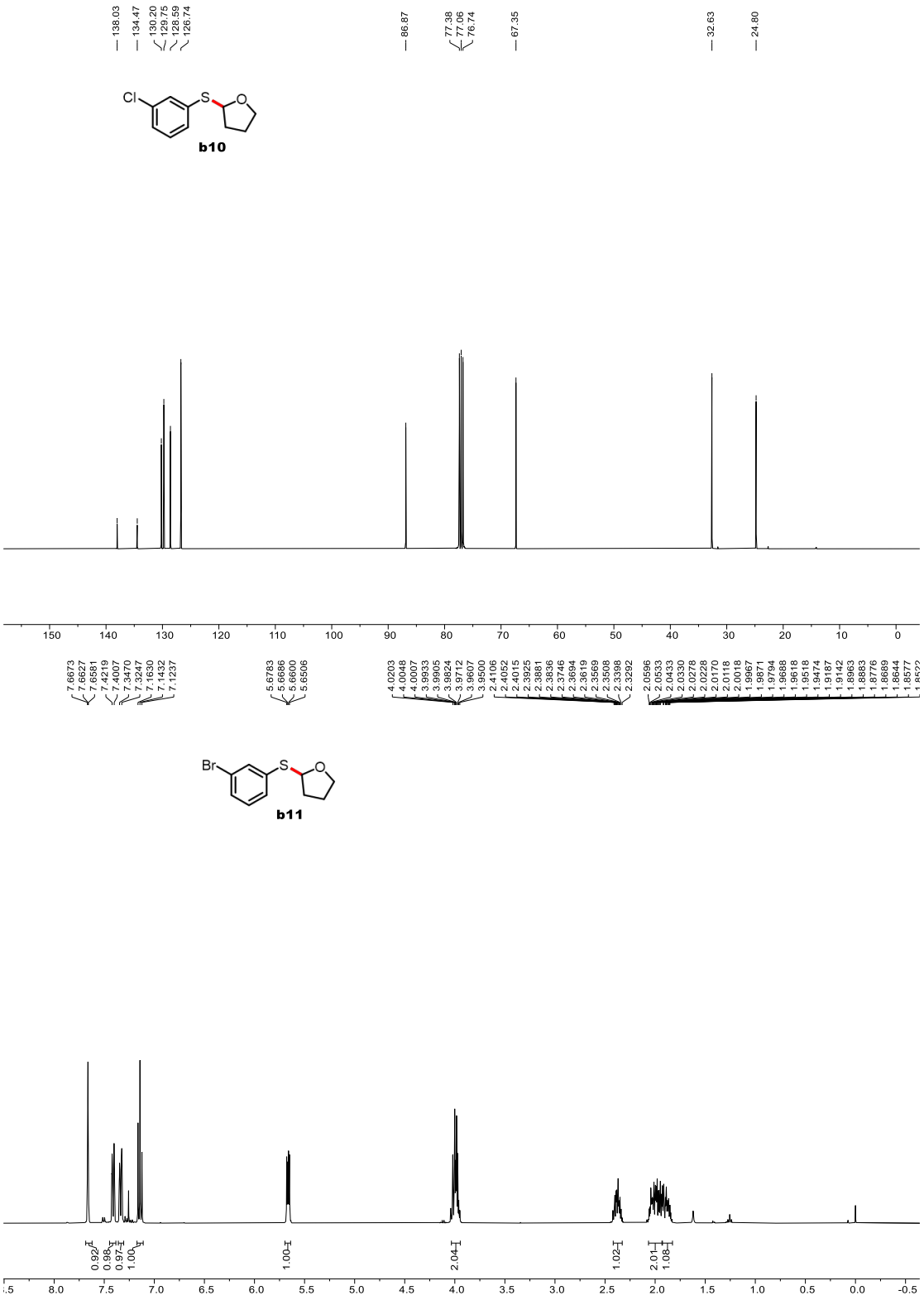

F
S
O

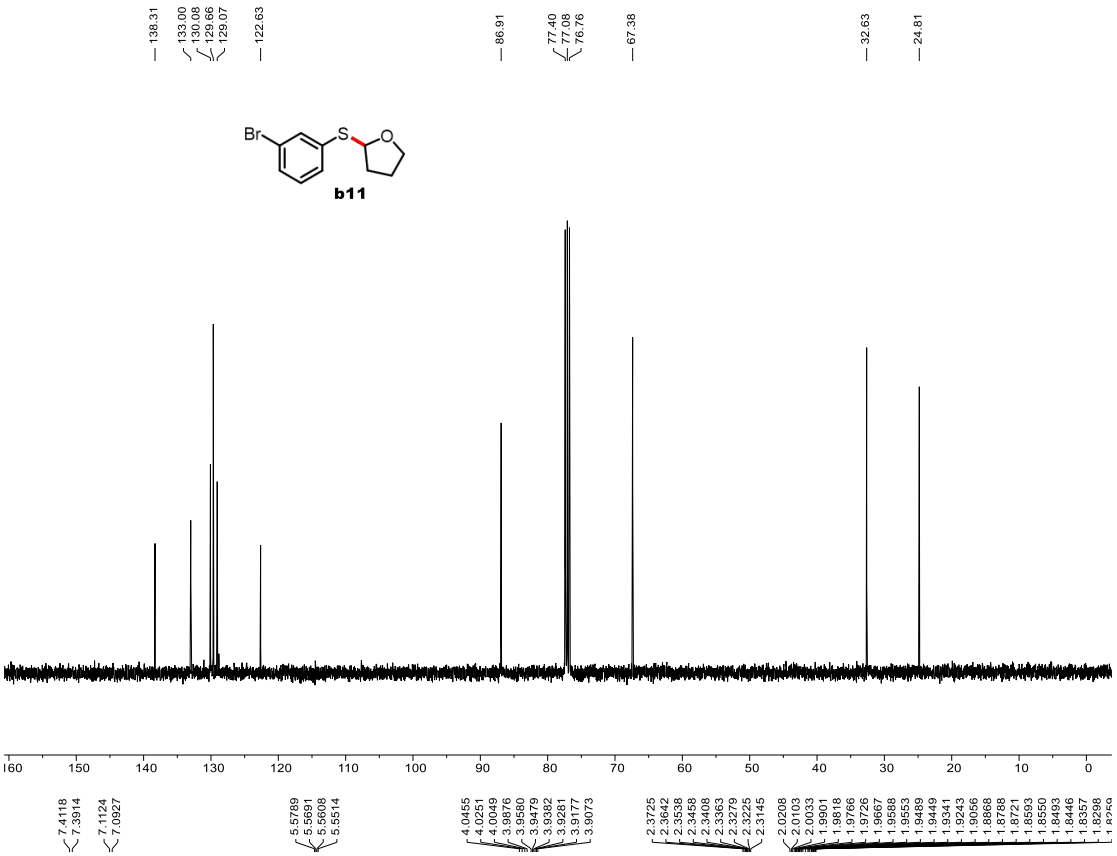
b9

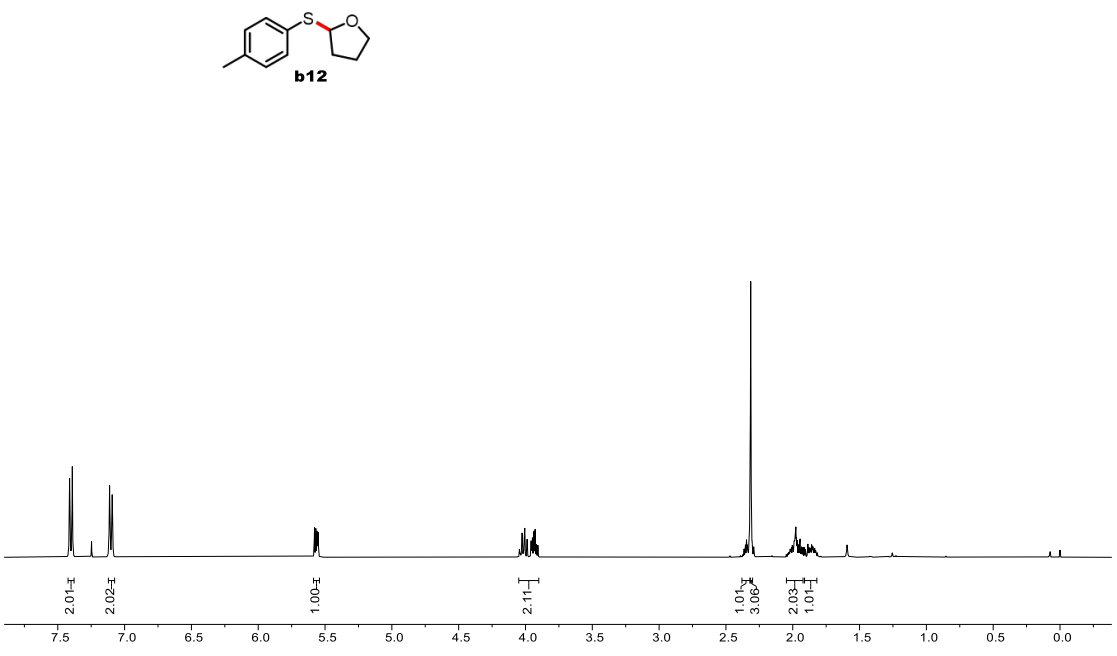
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

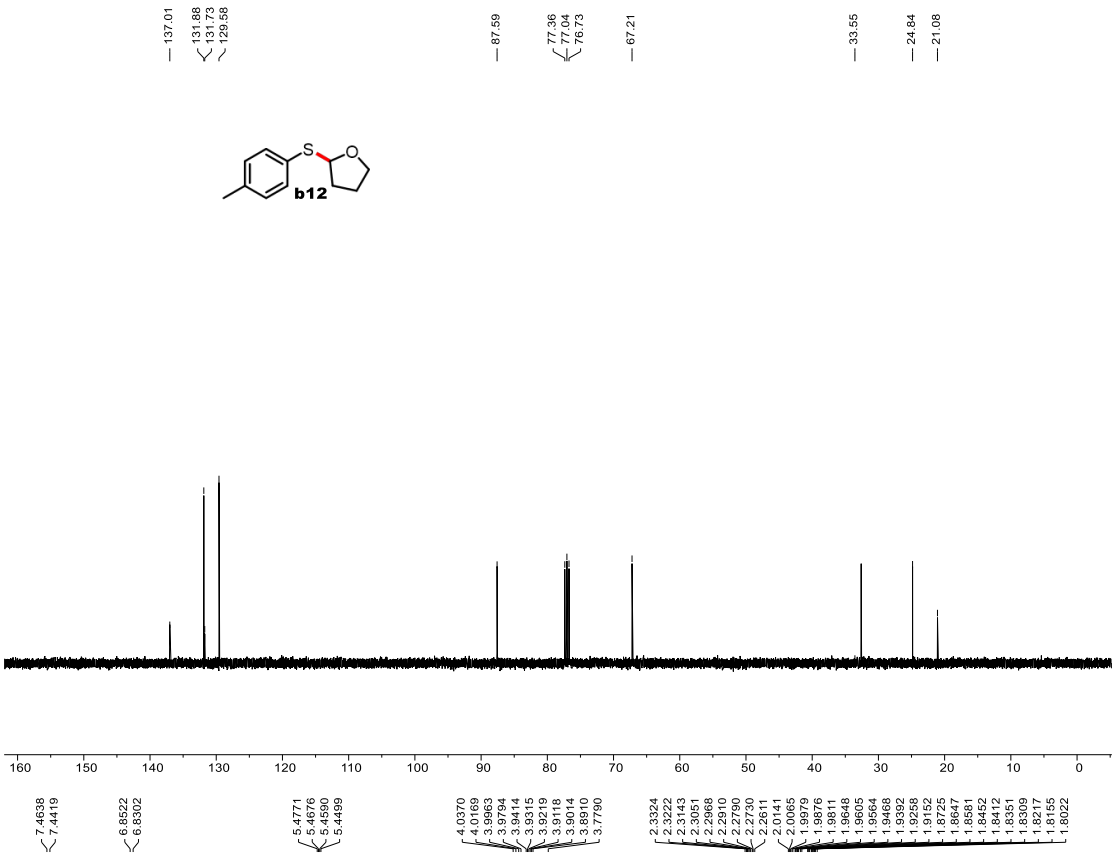

F
S
O
b9
-112.374
1.00
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
-145
-150
7.5332
7.5282
7.5237
7.3942
7.3892
7.3850
7.3776
7.3724
7.3678
7.2397
7.2199
7.2077
7.2026
7.1981
7.1877
7.1829
7.1781
5.7173
5.7076
5.6940
5.6891
5.6841
5.6755
5.6663
5.6469
4.0393
4.0224
4.0190
4.0135
4.0026
3.9939
3.9835
3.9730
3.9621
2.4334
2.4283
2.4234
2.4180
2.4142
2.4051
2.4008
2.3966
2.3873
2.3820
2.3774
2.3694
2.3636
2.3520
2.0602
2.0502
2.0434
2.0384
2.0320
2.0273
2.0178
2.0119
2.0030
1.9984
1.9881
1.9811
1.9775
1.9710
1.9667
1.9554
1.9463
1.9371
1.9297
1.9259
1.9113
1.9031
1.8927
1.8833

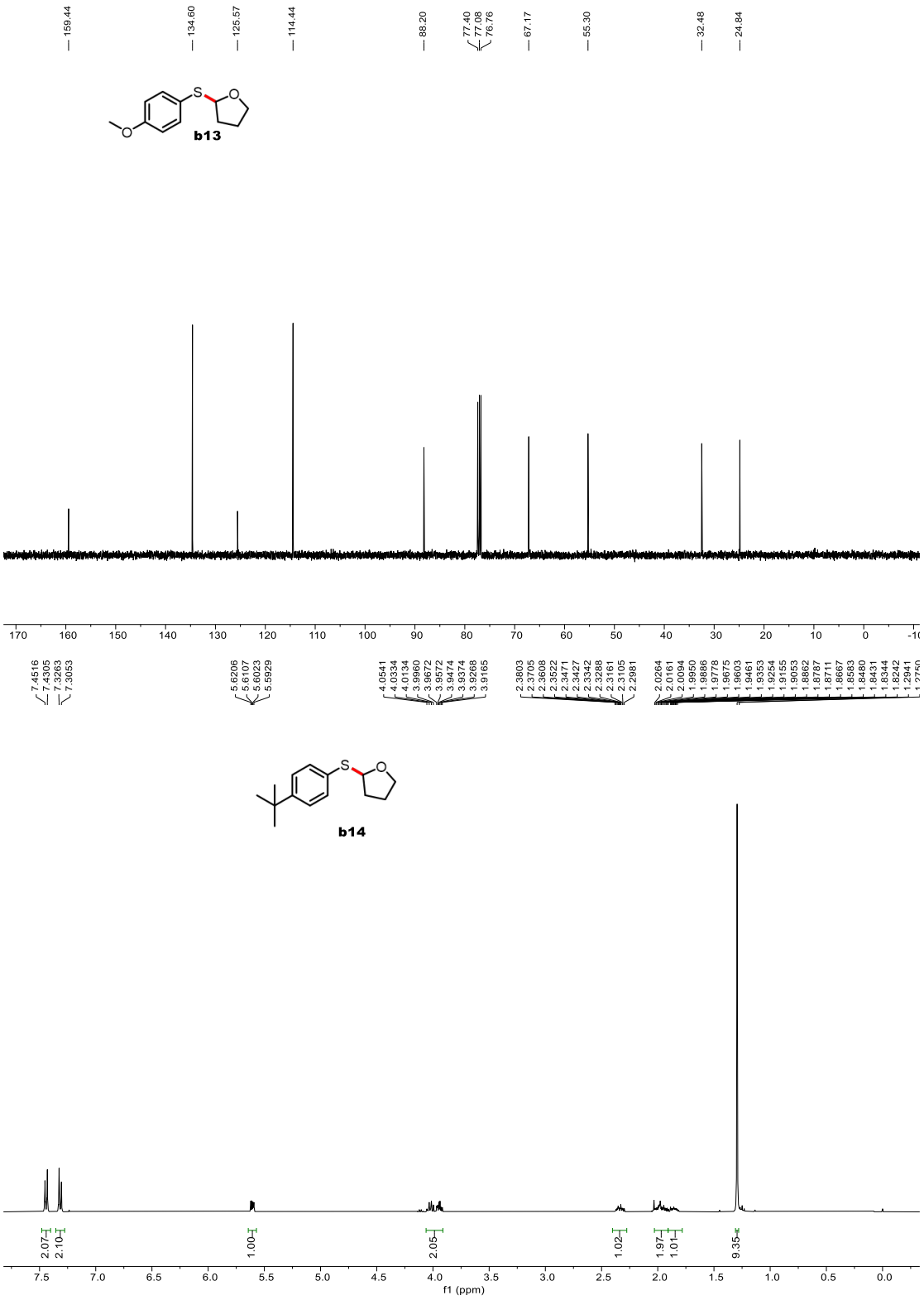

Cl
S
O
b10
0.96
0.97
0.85
1.19
1.00
2.03
1.04
1.98
1.02
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

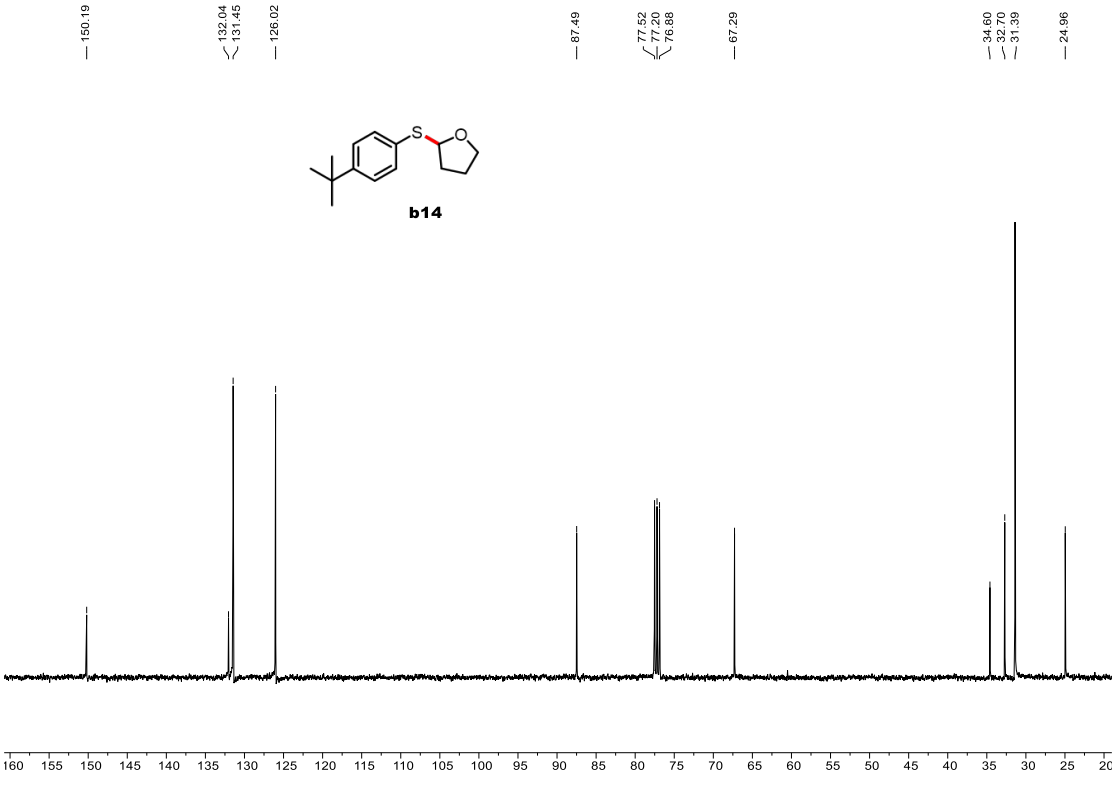

138.03
134.47
130.20
129.75
128.59
126.74
86.87
77.38
77.06
76.74
67.35
32.63
24.80
Cl
S
O
b10
7.6673
7.6627
7.6581
7.4219
7.4007
7.3470
7.3247
7.1630
7.1432
7.1237
5.6783
5.6686
5.6600
5.6506
4.0203
4.0048
4.0007
3.9933
3.9905
3.9824
3.9712
3.9607
3.9500
2.4106
2.4052
2.4015
2.3925
2.3881
2.3836
2.3746
2.3694
2.3619
2.3569
2.3508
2.3398
2.3292
2.0596
2.0533
2.0433
2.0330
2.0278
2.0228
2.0170
2.0118
1.9967
1.9871
1.9794
1.9688
1.9618
1.9518
1.9474
1.9187
1.9142
1.8963
1.8883
1.8776
1.8689
1.8644
1.8577
Br
S
O
b11
0.92
0.98
0.97
1.00
1.00
2.04
1.02
2.01
1.08

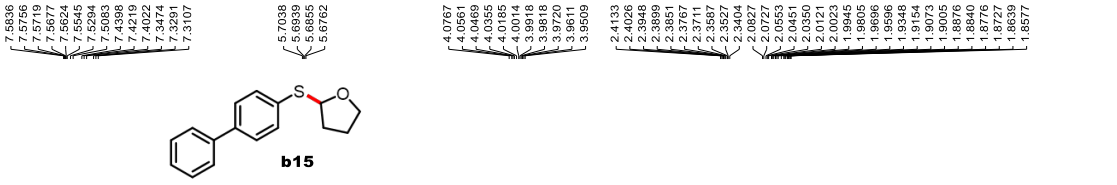

138.31
133.00
130.08
129.66
129.07
122.63
86.91
77.40
77.08
76.76
67.38
32.63
24.81
Br
S
O
b11
7.4118
7.3914
7.1124
7.0927
5.5789
5.5691
5.5608
5.5514
4.0455
4.0251
4.0049
3.9876
3.9580
3.9479
3.9382
3.9281
3.9177
3.9073
2.3725
2.3642
2.3538
2.3458
2.3408
2.3363
2.3279
2.3225
2.3145
2.0208
2.0103
2.0033
1.9901
1.9818
1.9766
1.9667
1.9568
1.9553
1.9489
1.9449
1.9341
1.9243
1.9056
1.8868
1.8788
1.8721
1.8593
1.8550
1.8493
1.8446
1.8357
1.8298

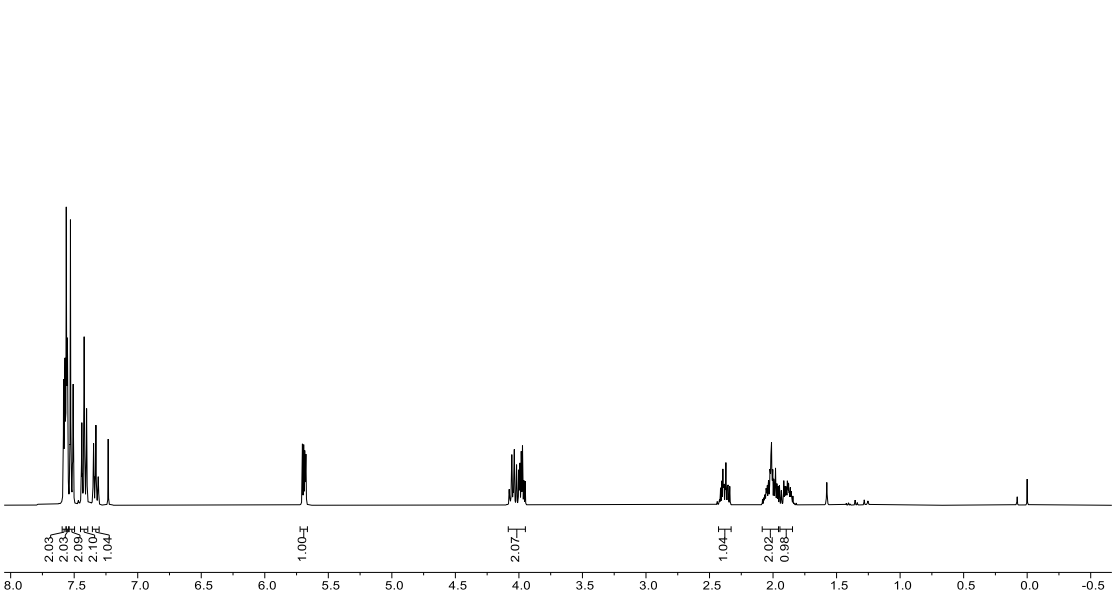

S
O
b12
2.01
2.02
1.00
2.11
1.01
3.06
2.03
1.01

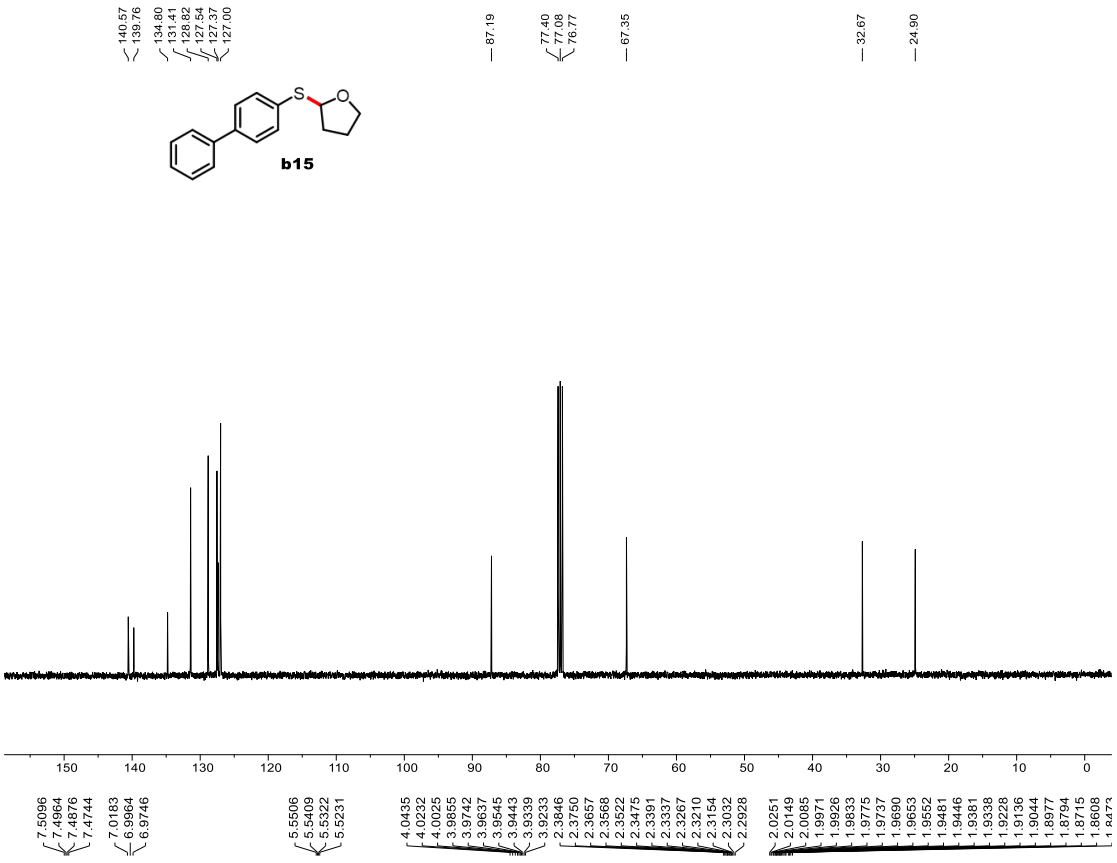

137.01
131.88
131.73
129.58
87.59
77.36
77.04
76.73
67.21
33.55
24.84
21.08
b12
7.4638
7.4419
6.8522
6.8302
5.4771
5.4676
5.4590
5.4499
4.0370
4.0169
3.9963
3.9794
3.9414
3.9315
3.9219
3.9118
3.9014
3.8910
3.7790
2.3324
2.3222
2.3143
2.3051
2.2968
2.2910
2.2790
2.2730
2.2611
2.0141
2.0065
1.9979
1.9876
1.9811
1.9648
1.9605
1.9564
1.9468
1.9392
1.9258
1.9152
1.8725
1.8647
1.8581
1.8452
1.8412
1.8351
1.8309
1.8217
1.8155
1.8022
b13
2.00
1.99
1.00
1.06
1.04
3.00
1.03
1.99
1.03

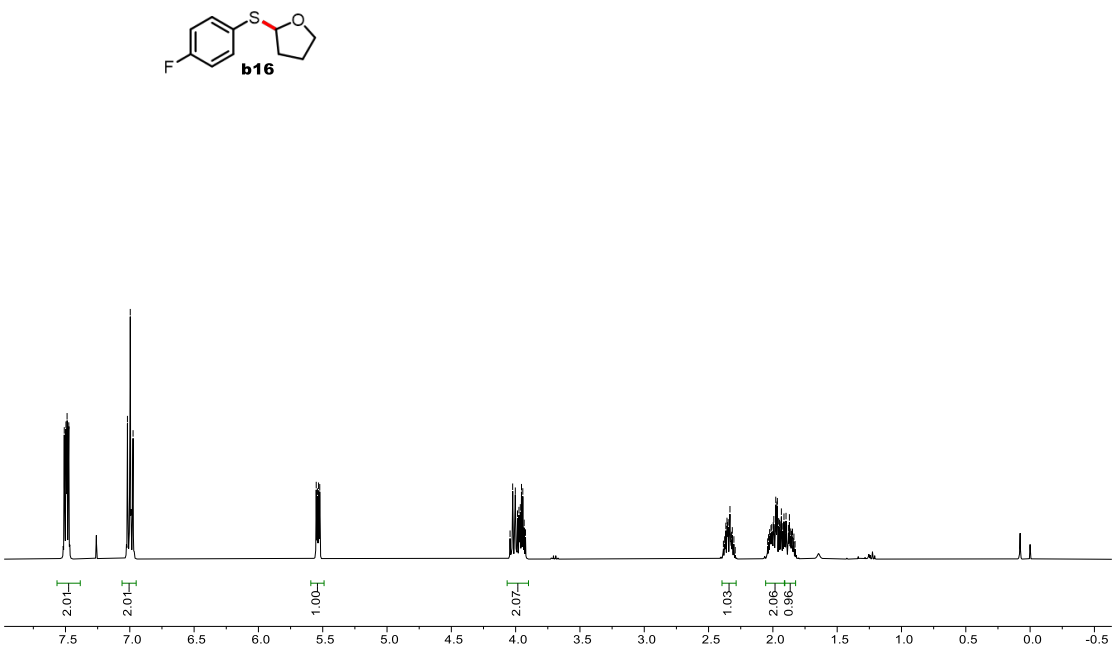

159.44
134.60
125.57
114.44
88.20
77.40
77.08
76.76
67.17
55.30
32.48
24.84
b13
7.4516
7.4305
7.3263
7.3053
5.6206
5.6107
5.6023
5.5929
4.0541
4.0334
4.0134
3.9960
3.9672
3.9572
3.9474
3.9374
3.9268
3.9165
2.3803
2.3705
2.3608
2.3522
2.3471
2.3427
2.3342
2.3248
2.3161
2.3105
2.2981
2.0264
2.0161
2.0094
1.9950
1.9866
1.9778
1.9675
1.9603
1.9461
1.9353
1.9254
1.9155
1.9053
1.8862
1.8787
1.8711
1.8667
1.8583
1.8480
1.8431
1.8344
1.8242
1.2941
b14
2.07
2.10
1.00
2.05
1.02
1.97
1.01
9.35
f1 (ppm)

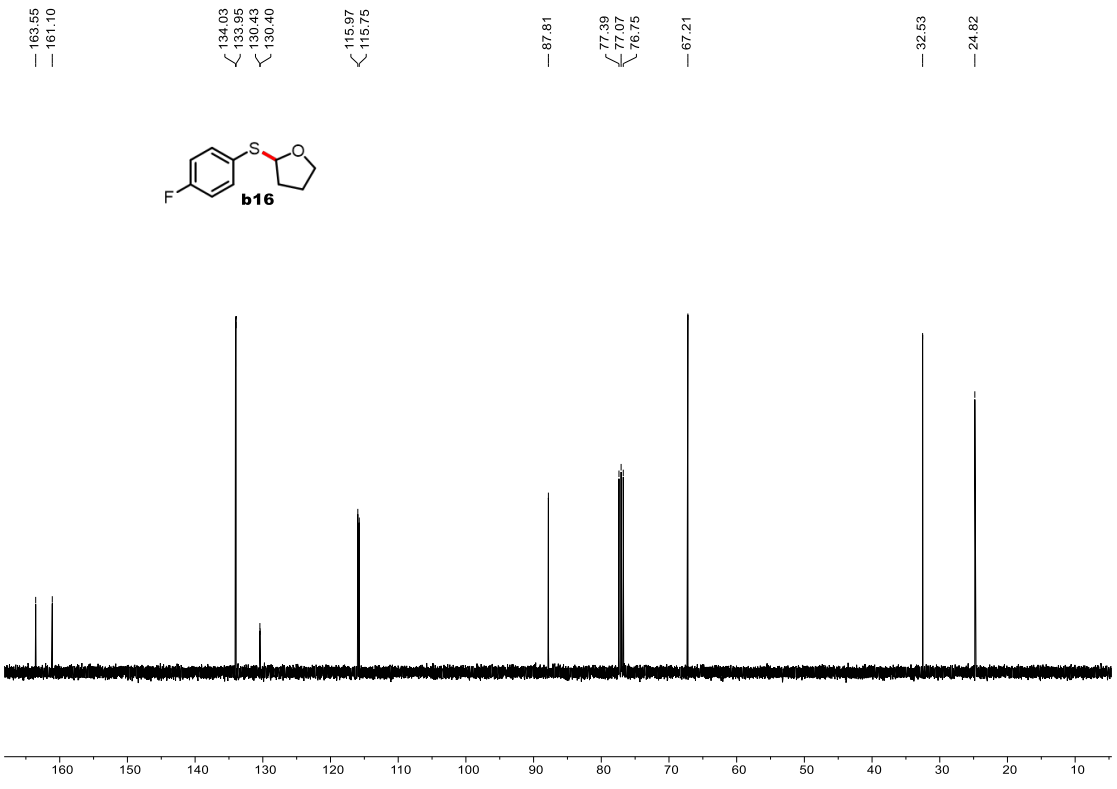

150.19
132.04
131.45
126.02
87.49
77.52
77.20
76.88
67.29
34.60
32.70
31.39
24.96
S
O
b14

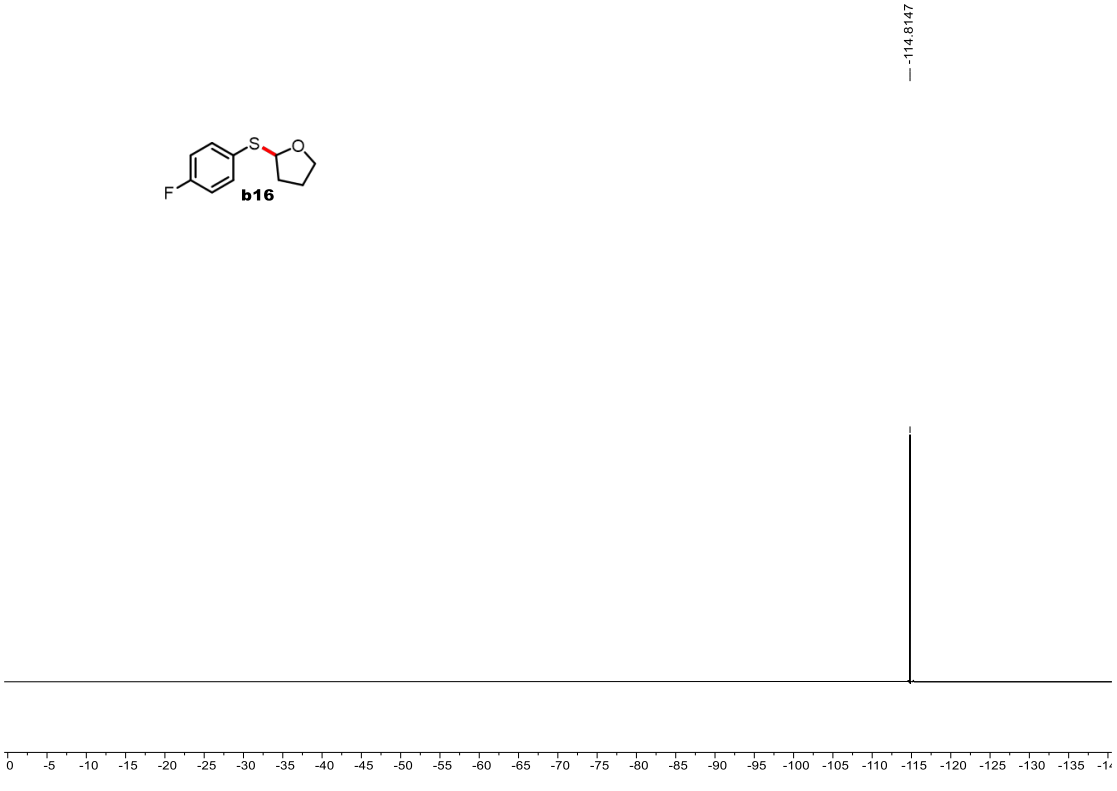

7.5836
7.5756
7.5719
7.5677
7.5624
7.5545
7.5294
7.5083
7.4398
7.4219
7.4022
7.3474
7.3291
7.3107
5.7038
5.6939
5.6855
5.6762
4.0767
4.0561
4.0469
4.0355
4.0185
4.0014
3.9918
3.9818
3.9720
3.9611
3.9509
2.4133
2.4026
2.3948
2.3899
2.3851
2.3767
2.3711
2.3587
2.3527
2.3404
2.0727
2.0553
2.0451
2.0350
2.0121
2.0023
1.9945
1.9805
1.9696
1.9596
1.9348
1.9154
1.9073
1.9005
1.8876
1.8840
1.8776
1.8727
1.8639
1.8577

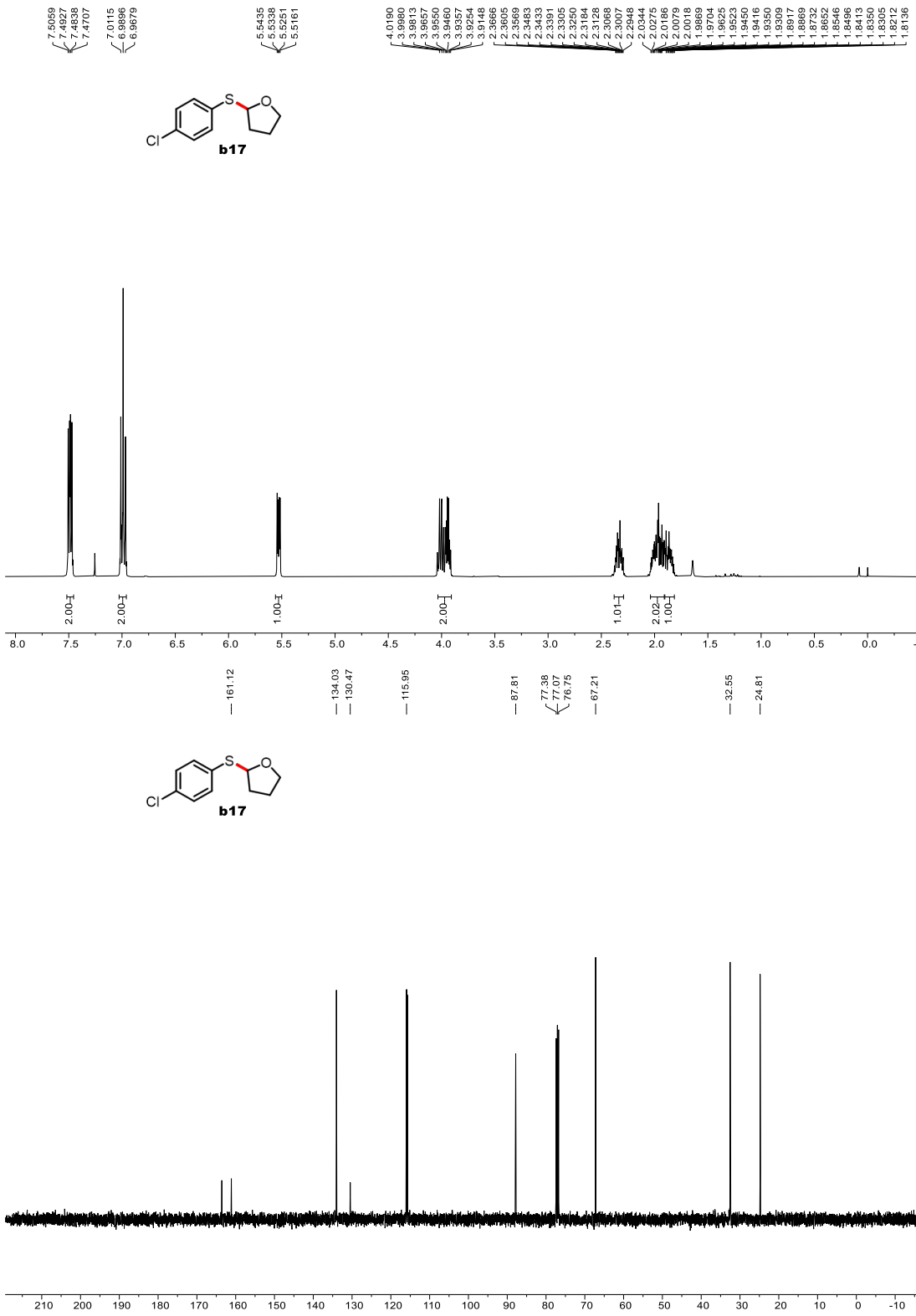

S
O
b15
2.03
2.03
2.09
2.10
1.04
1.00
2.07
1.04
2.02
0.98


140.57
139.76
134.80
131.41
128.82
127.54
127.37
127.00
87.19
77.40
77.08
76.77
67.35
32.67
24.90
S
O
b15
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
7.5096
7.4964
7.4876
7.4744
7.0183
6.9964
6.9746
5.5506
5.5409
5.5322
5.5231
4.0435
4.0232
4.0025
3.9855
3.9742
3.9637
3.9545
3.9443
3.9339
3.9233
2.3846
2.3750
2.3657
2.3568
2.3522
2.3475
2.3391
2.3337
2.3267
2.3210
2.3154
2.3032
2.2928
2.0251
2.0149
2.0085
1.9971
1.9926
1.9833
1.9775
1.9737
1.9690
1.9653
1.9552
1.9481
1.9446
1.9381
1.9338
1.9228
1.9136
1.9044
1.8977
1.8794
1.8715
1.8608


S
O
F
b16
2.01
2.01
1.00
2.07
1.03
2.06
0.96
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

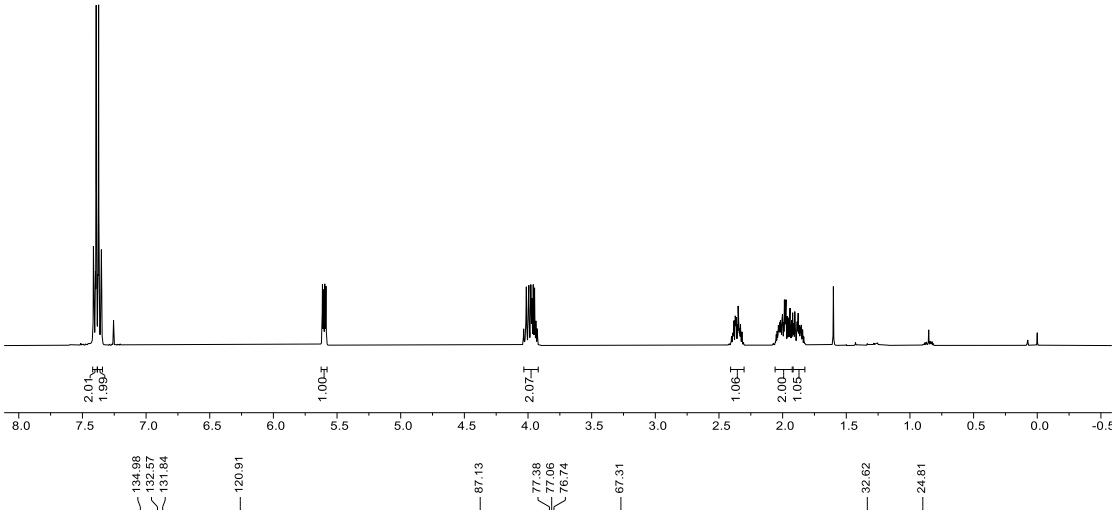

163.55
161.10
134.03
133.95
130.43
130.40
115.97
115.75
87.81
77.39
77.07
76.75
67.21
32.53
24.82
S
O
F
b16
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10


-114.8147
S
O
F
b16
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135

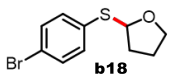

7.5059
7.4927
7.4838
7.4707
7.0115
6.9896
6.9679
5.5435
5.5338
5.5251
5.5161
4.0190
3.9980
3.9813
3.9657
3.9550
3.9460
3.9357
3.9254
3.9148
2.3666
2.3605
2.3569
2.3483
2.3433
2.3391
2.3305
2.3250
2.3184
2.3128
2.3068
2.3007
2.2944
2.0344
2.0275
2.0186
2.0079
2.0018
1.9869
1.9704
1.9625
1.9523
1.9450
1.9416
1.9350
1.9309
1.8917
1.8869
1.8732
1.8652
1.8546
1.8496
1.8413
1.8350
1.8305
1.8212
1.8136
S
O
Cl
b17
2.00
2.00
1.00
2.00
1.01
2.02
1.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
161.12
134.03
130.47
115.95
87.81
77.38
77.07
76.75
67.21
32.55
24.81
S
O
Cl
b17
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

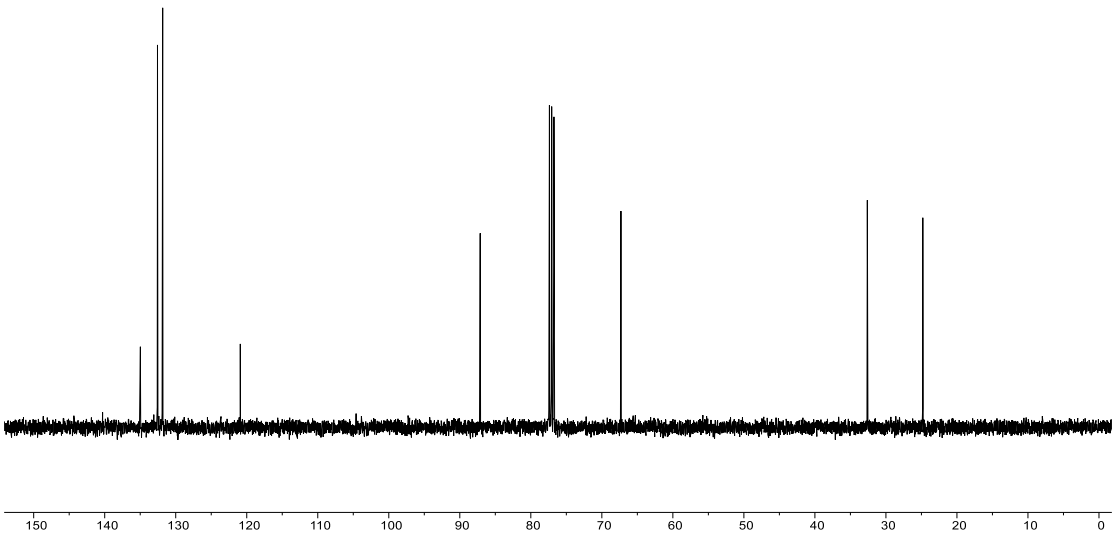

7.4136
7.4079
7.3977
7.3919
7.3870
7.3776
7.3728
7.3669
7.3565
7.3511
5.6147
5.6097
5.6050
5.5963
5.5871
4.0319
4.0234
4.0218
4.0168
4.0133
3.9986
3.9961
3.9929
3.9881
3.9834
3.9784
3.9760
3.9678
3.9589
3.9486
3.9381
3.9274
2.4007
2.3909
2.3817
2.3727
2.3683
2.3636
2.3549
2.3496
2.3370
2.3312
2.3188
2.3083
2.0498
2.0431
2.0341
2.0237
2.0175
2.0060
2.0012
1.9861
1.9734
1.9460
1.9417
1.9305
1.9119
1.9046
1.9007
1.8862
1.8781
1.8676
1.8625
1.8583
1.8541
1.8480
1.8430
1.8344

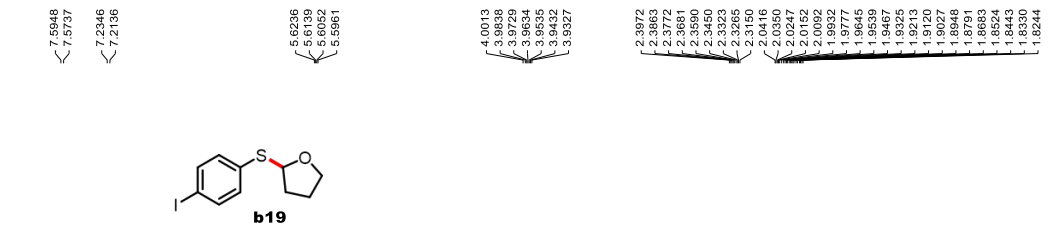
S
O
Br
b18


2.01
1.99
1.00
2.07
1.06
2.00
1.05
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

134.98
132.57
131.64
120.91
87.13
77.38
77.06
76.74
67.31
32.62
24.81

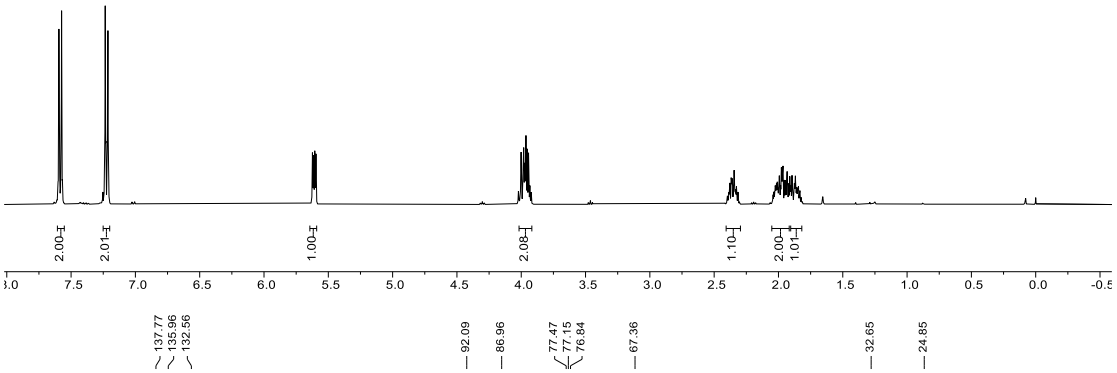

S
O
Br
b18


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

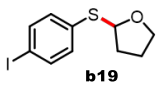

7.5948
7.5737
7.2346
7.2136
5.6236
5.6139
5.6052
5.5961
4.0013
3.9838
3.9729
3.9634
3.9535
3.9432
3.9327
2.3972
2.3863
2.3772
2.3681
2.3590
2.3450
2.3323
2.3265
2.3150
2.0416
2.0350
2.0247
2.0152
2.0092
1.9932
1.9777
1.9645
1.9539
1.9467
1.9325
1.9213
1.9120
1.9027
1.8948
1.8791
1.8683
1.8524
1.8443
1.8330
1.8244

S
O
I

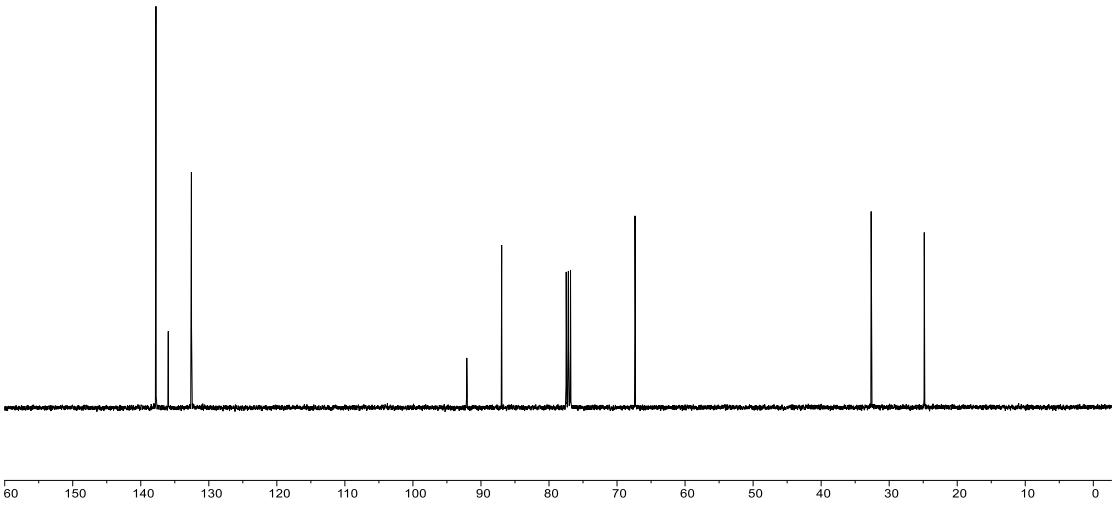
b19

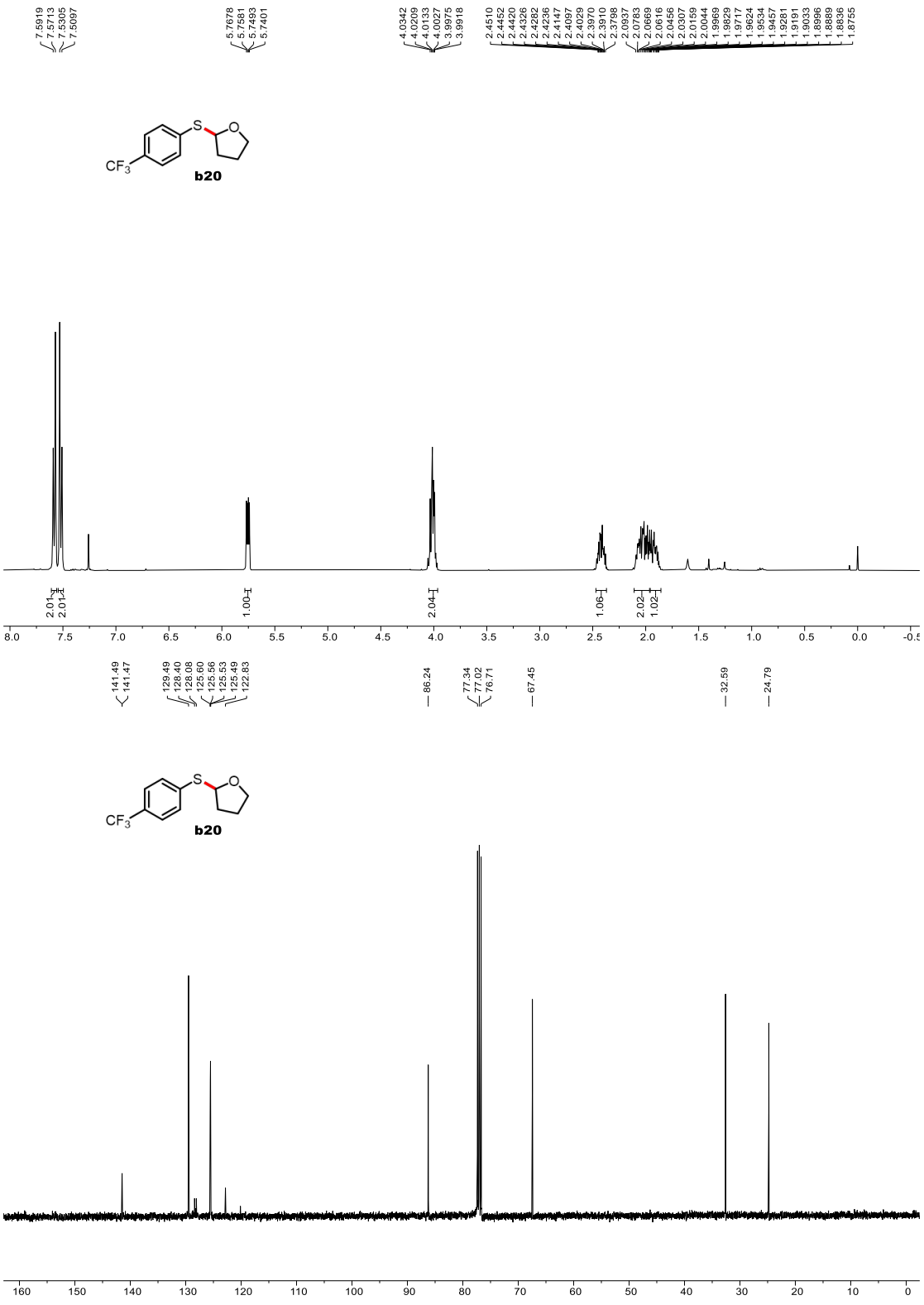

2.00
2.01
1.00
2.08
1.10
2.00
1.01
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

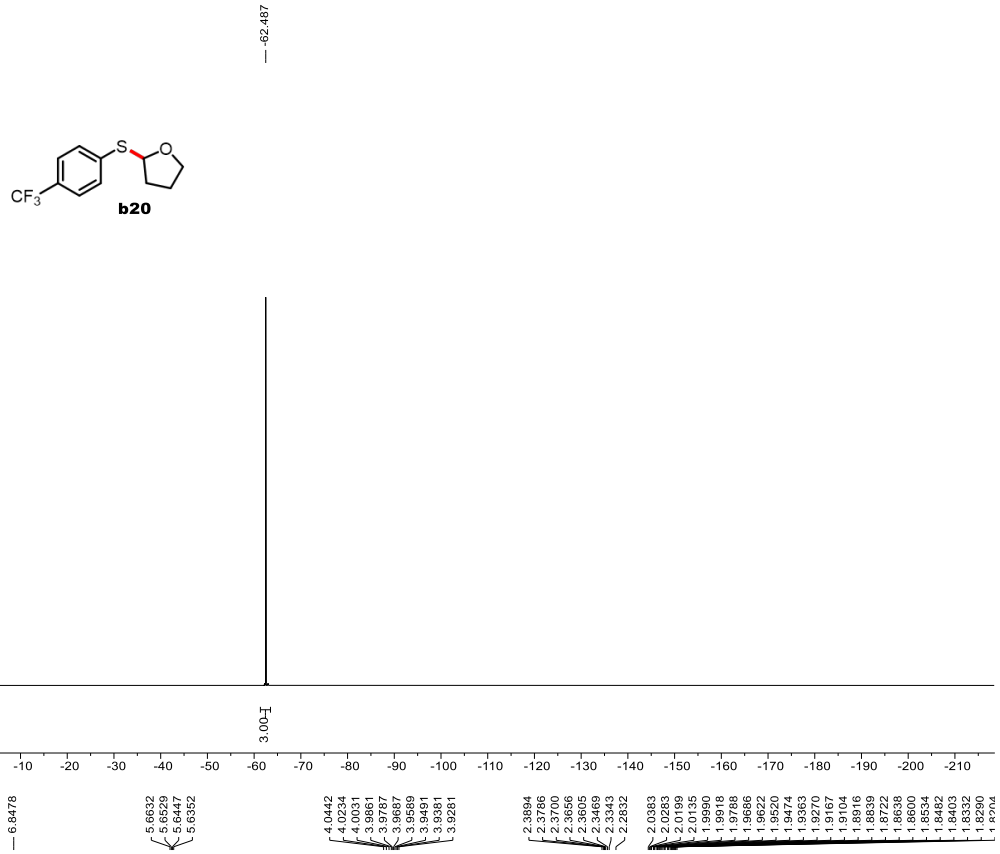
137.77
135.96
132.56
92.09
86.96
77.47
77.15
76.84
67.36
32.65
24.85

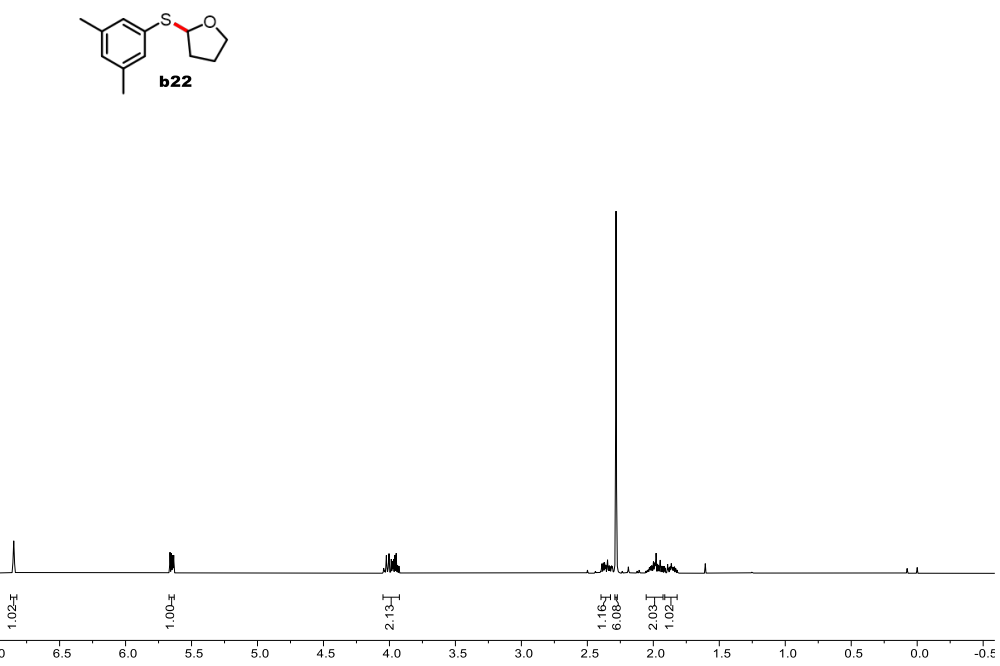

S
O
I

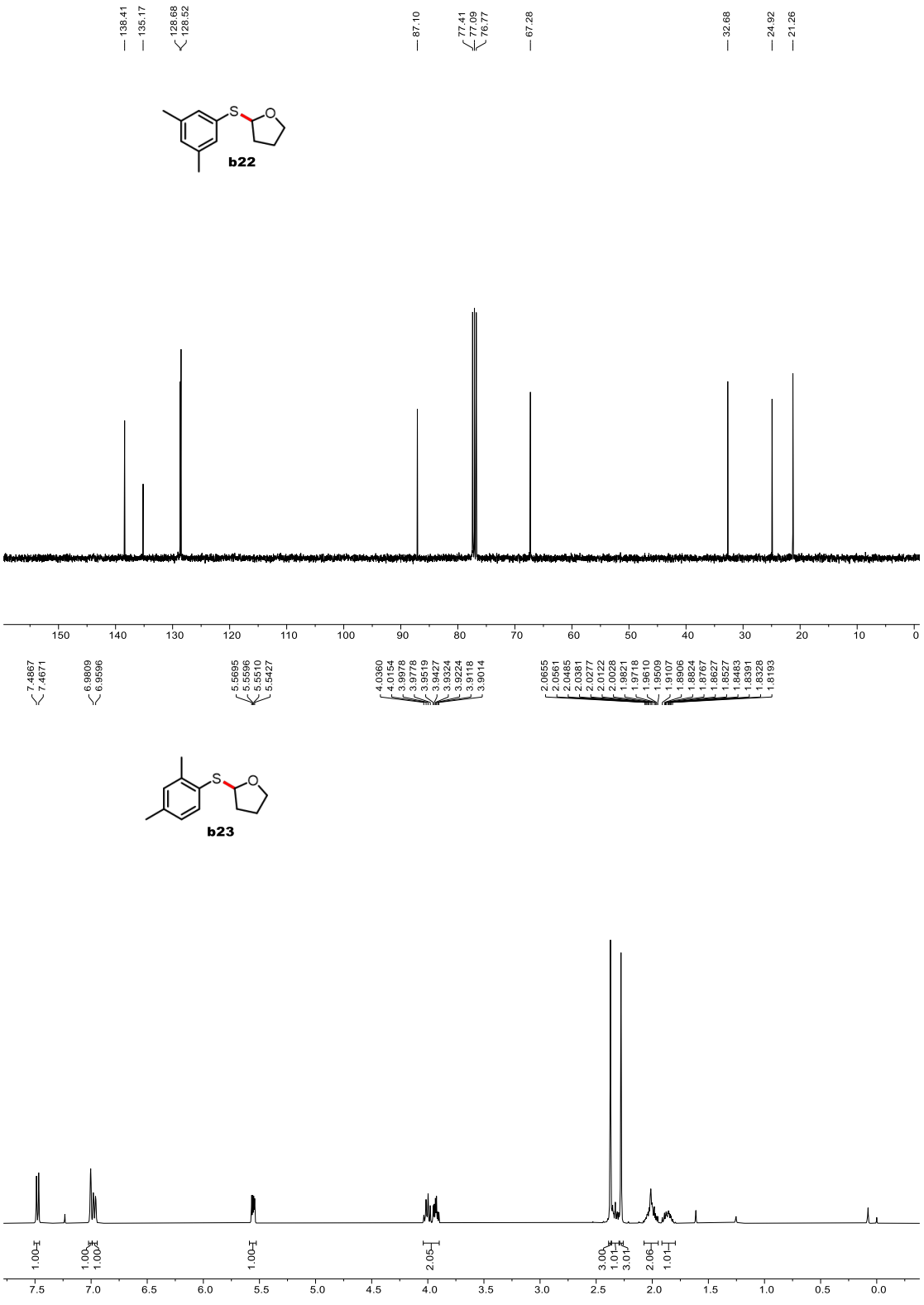
b19

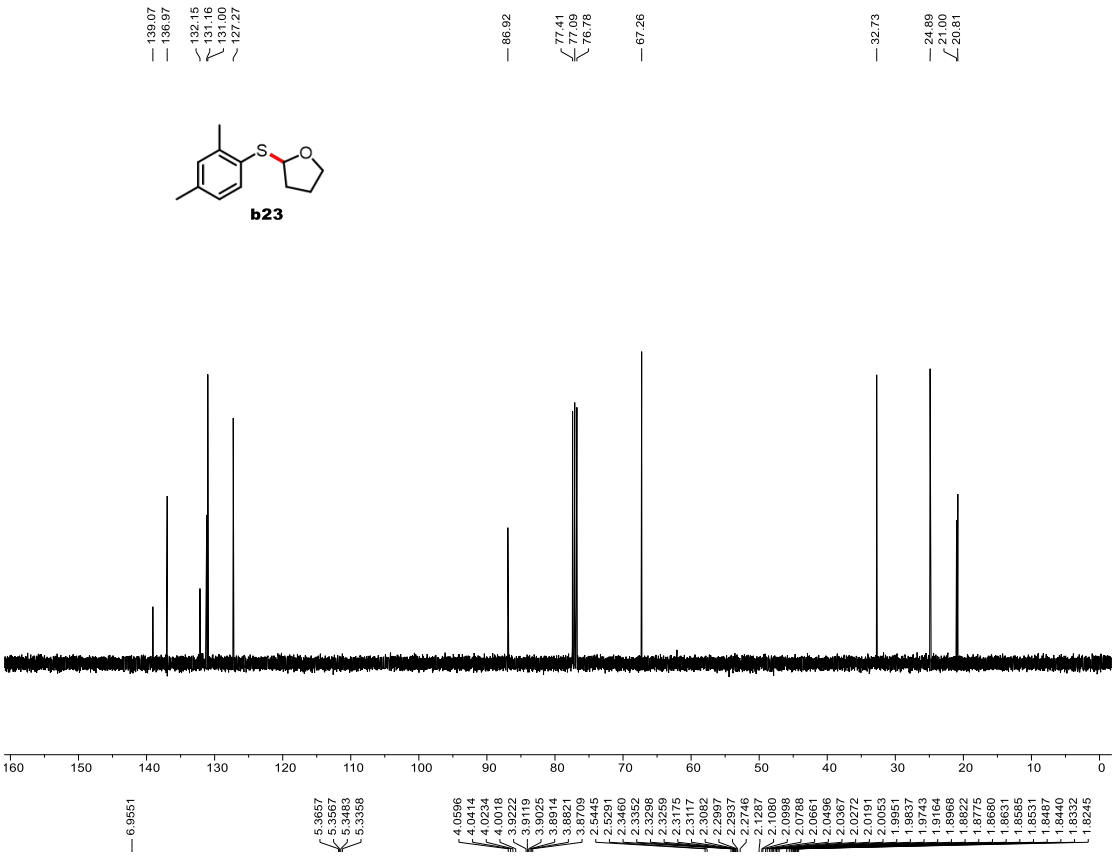

150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

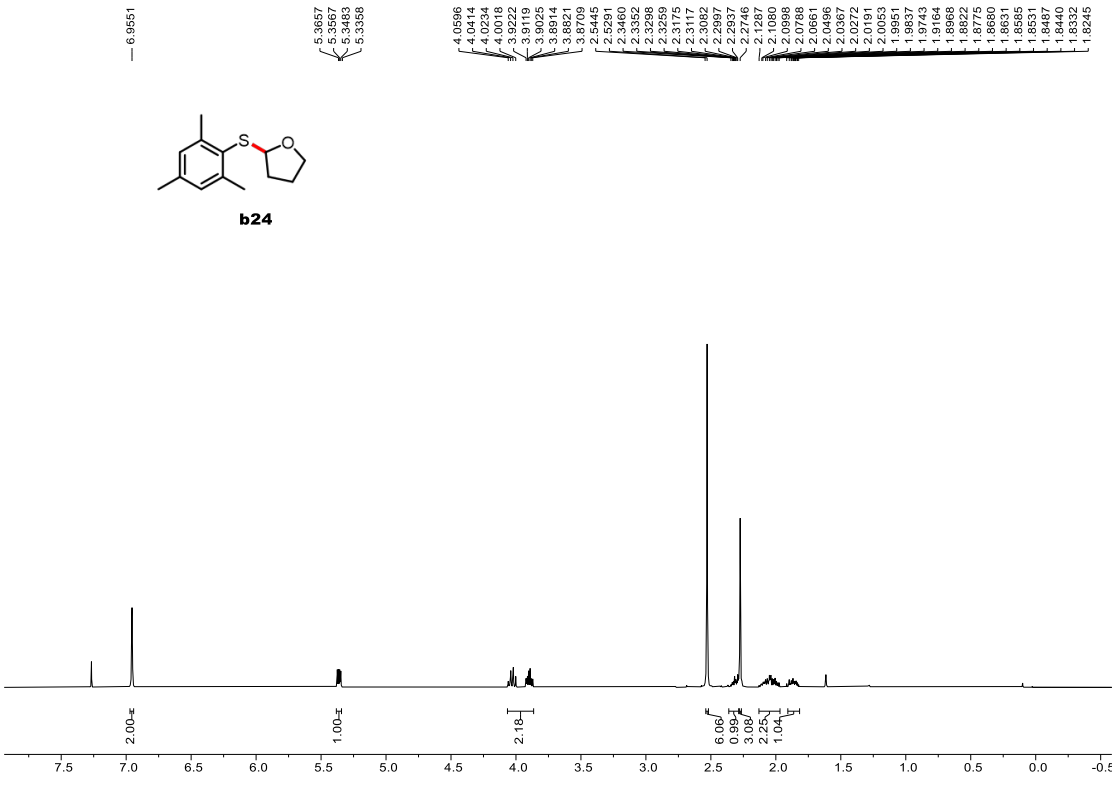

7.5919
7.5713
7.5305
7.5097
5.7678
5.7581
5.7493
5.7401
4.0342
4.0209
4.0133
4.0027
3.9775
3.9918
2.4510
2.4452
2.4420
2.4326
2.4282
2.4236
2.4147
2.4097
2.4029
2.3970
2.3910
2.3798
2.0937
2.0783
2.0669
2.0616
2.0456
2.0307
2.0159
2.0044
1.9969
1.9829
1.9717
1.9624
1.9454
1.9457
1.9281
1.9191
1.9033
1.8996
1.8889
1.8836
1.8755
S
O
CF3
b20
2.01
2.01
1.00
2.04
1.06
2.02
1.02
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
141.49
141.47
129.49
128.40
128.08
125.60
125.56
125.53
125.49
122.83
86.24
77.34
77.02
76.71
67.45
32.59
24.79
S
O
CF3
b20
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0


-62.487
S
O
CF3
b20
3.00
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
7.1234
6.8478
5.6632
5.6529
5.6447
5.6352
4.0442
4.0234
4.0031
3.9861
3.9787
3.9687
3.9589
3.9491
3.9381
3.9281
2.3894
2.3786
2.3700
2.3656
2.3605
2.3469
2.3343
2.2832
2.0383
2.0283
2.0199
2.0135
1.9990
1.9918
1.9788
1.9686
1.9522
1.9520
1.9474
1.9363
1.9270
1.9167
1.9104
1.8916
1.8839
1.8722
1.8638
1.8600
1.8534
1.8482
1.8403
1.8332
1.8290

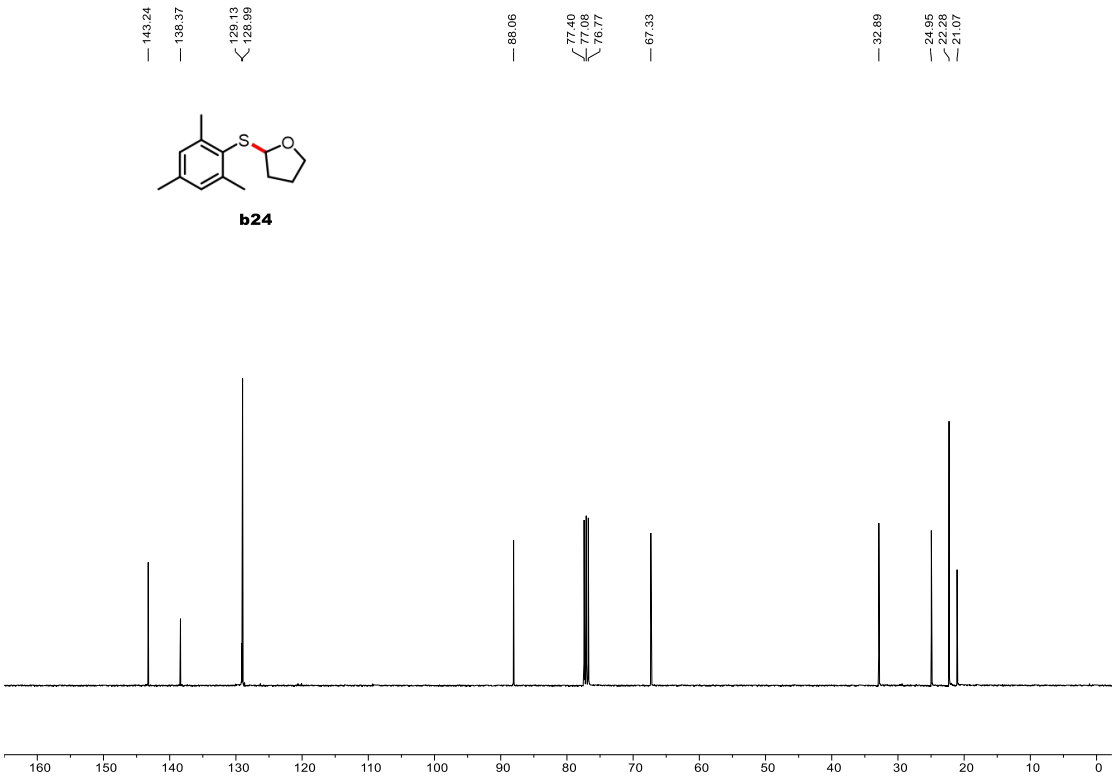

S
O
b22
2.00
1.02
1.00
2.13
1.16
6.08
2.03
1.02
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

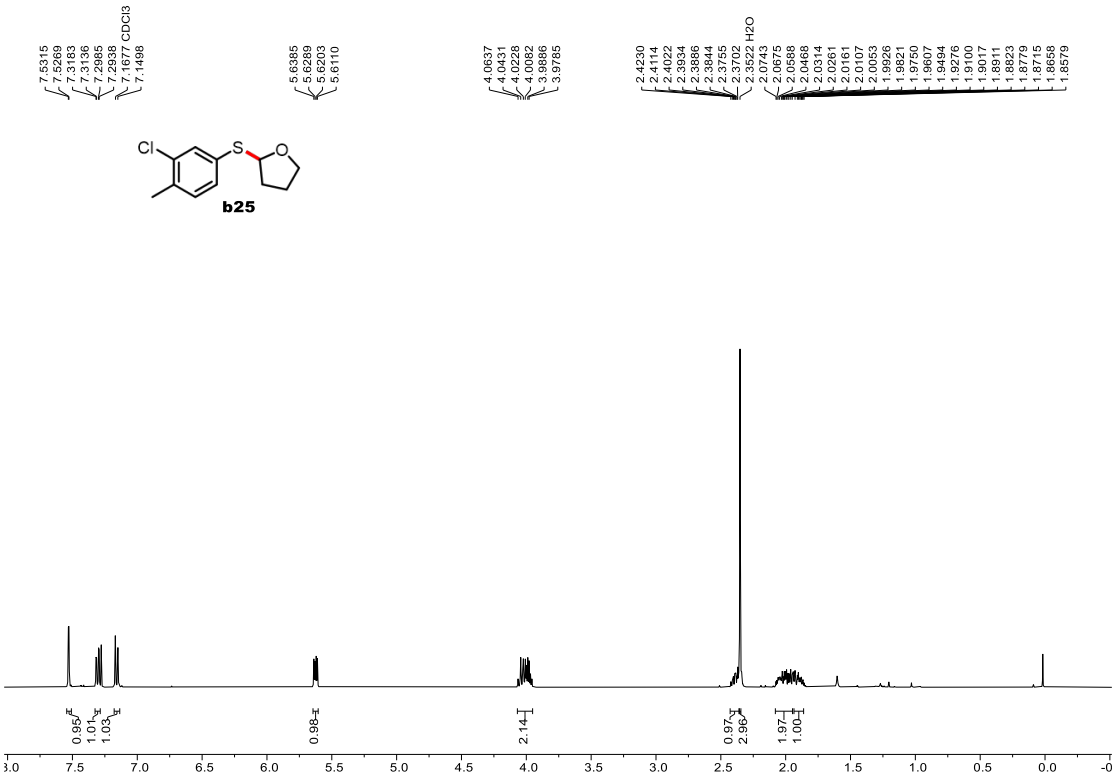

138.41
135.17
128.68
128.52
87.10
77.41
77.09
76.77
67.28
32.68
24.92
21.26
b22
7.4867
7.4671
6.9809
6.9596
5.5695
5.5596
5.5510
5.5427
4.0360
4.0154
3.9978
3.9778
3.9519
3.9427
3.9324
3.9224
3.9118
3.9014
2.0655
2.0561
2.0485
2.0381
2.0277
2.0122
2.0028
1.9821
1.9718
1.9610
1.9509
1.9107
1.8906
1.8824
1.8727
1.8627
1.8527
1.8483
1.8391
1.8328
1.8193
b23
1.00
1.00
1.00
1.00
2.05
3.00
1.01
3.01
2.06
1.01

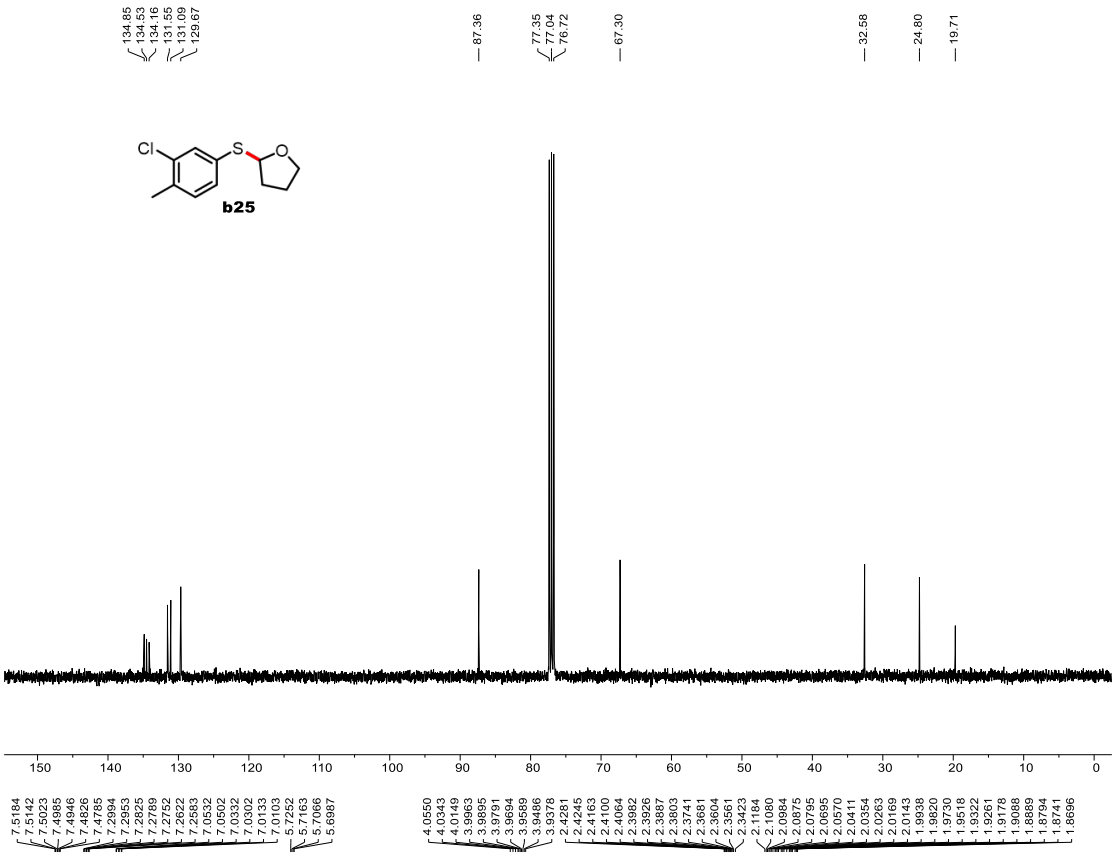

139.07
136.97
132.15
131.16
131.00
127.27
86.92
77.41
77.09
76.78
67.26
32.73
24.89
21.00
20.81
S
O
b23
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

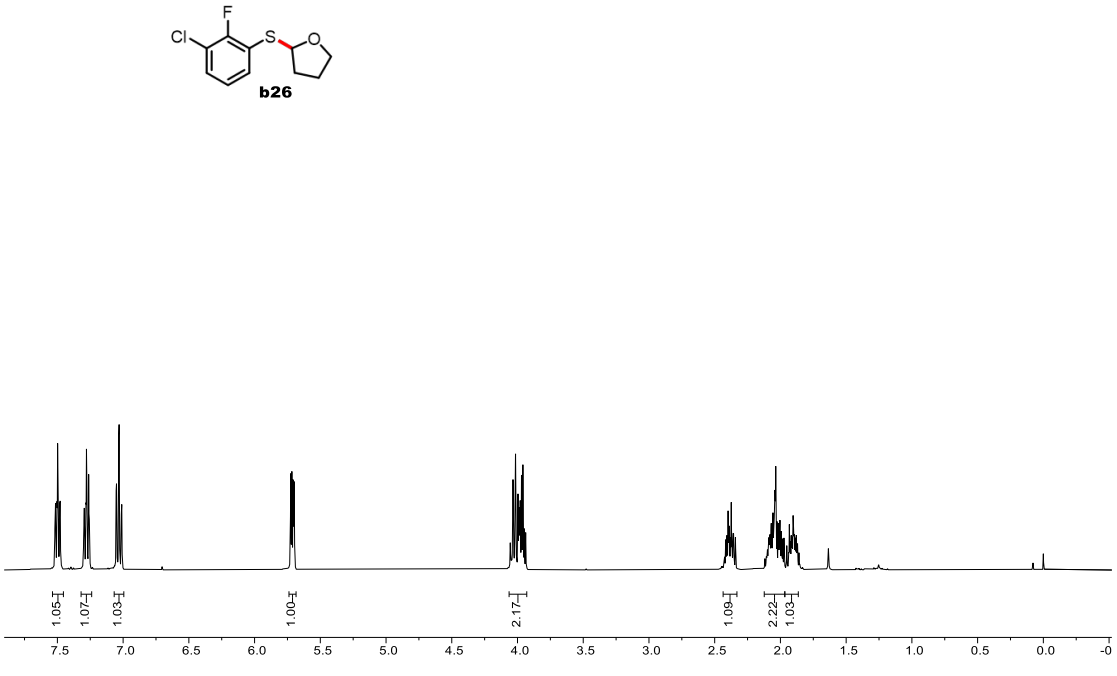

6.9551
5.3657
5.3567
5.3483
5.3358
4.0596
4.0414
4.0234
4.0018
3.9222
3.9119
3.9025
3.8914
3.8821
3.8709
2.5445
2.5291
2.3460
2.3352
2.3298
2.3259
2.3175
2.3117
2.3082
2.2997
2.2937
2.2746
2.1287
2.1080
2.0998
2.0788
2.0661
2.0496
2.0367
2.0272
2.0191
2.0053
1.9951
1.9837
1.9743
1.9164
1.8968
1.8822
1.8775
1.8680
1.8631
1.8585
1.8531
1.8477
1.8440
1.8332
1.8245
S
O
b24

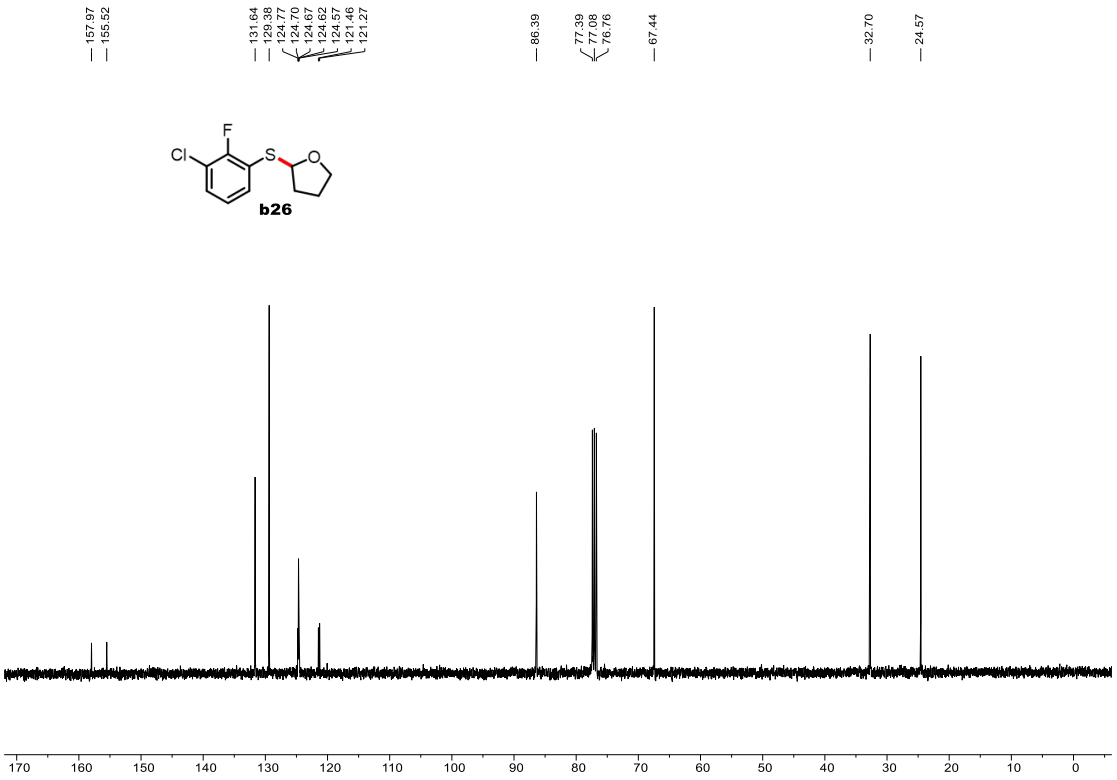
2.00
1.00
2.18
6.06
0.99
3.08
2.25
1.04
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

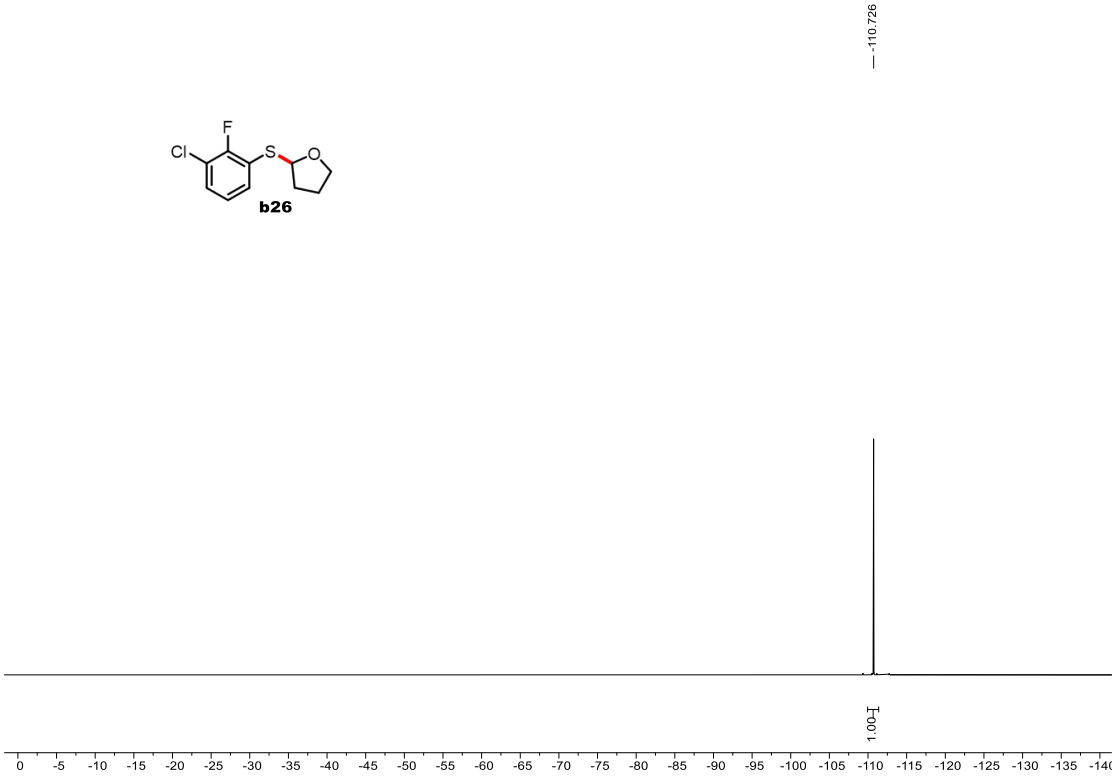

143.24
138.37
129.13
128.99
88.06
77.40
77.08
76.77
67.33
32.89
24.95
22.28
21.07
S
O
b24
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

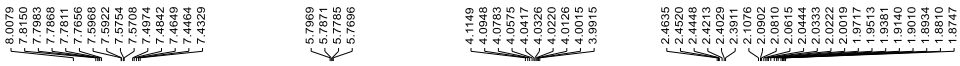

7.5315
7.5269
7.3183
7.3136
7.2985
7.2938
7.1677 CDCl3
7.1498
5.6385
5.6289
5.6203
5.6110
4.0637
4.0431
4.0228
4.0082
3.9986
3.9785
2.4230
2.4114
2.4022
2.3934
2.3886
2.3844
2.3755
2.3702
2.3522 H2O
2.0743
2.0675
2.0588
2.0468
2.0314
2.0261
2.0161
2.0107
2.0053
1.9926
1.9821
1.9750
1.9607
1.9494
1.9276
1.9100
1.9017
1.8911
1.8823
1.8779
1.8715
1.8658
1.8579
Cl
S
O
b25
0.95
1.01
1.03
0.98
2.14
0.97
2.96
1.97
1.00
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

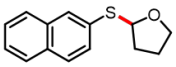

134.85
134.53
134.16
131.55
131.09
129.67
87.36
77.35
77.04
76.72
67.30
32.58
24.80
19.71
Cl
S
O
b25
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
7.5184
7.5142
7.5023
7.4985
7.4946
7.4826
7.4785
7.2994
7.2953
7.2825
7.2789
7.2752
7.2622
7.2583
7.0532
7.0502
7.0332
7.0302
7.0133
7.0103
5.7252
5.7163
5.7066
5.6987
4.0550
4.0343
4.0149
3.9963
3.9895
3.9791
3.9694
3.9589
3.9486
3.9378
2.4281
2.4245
2.4163
2.4100
2.4064
2.3982
2.3926
2.3887
2.3803
2.3741
2.3681
2.3604
2.3561
2.3423
2.1184
2.1080
2.0984
2.0875
2.0795
2.0695
2.0570
2.0411
2.0354
2.0263
2.0169
2.0143
1.9938
1.9820
1.9730
1.9518
1.9322
1.9261
1.9178
1.9088
1.8889
1.8794
1.8741
1.8696


F
Cl
S
O
b26
1.05
1.07
1.03
1.00
2.17
1.09
2.22
1.03
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0

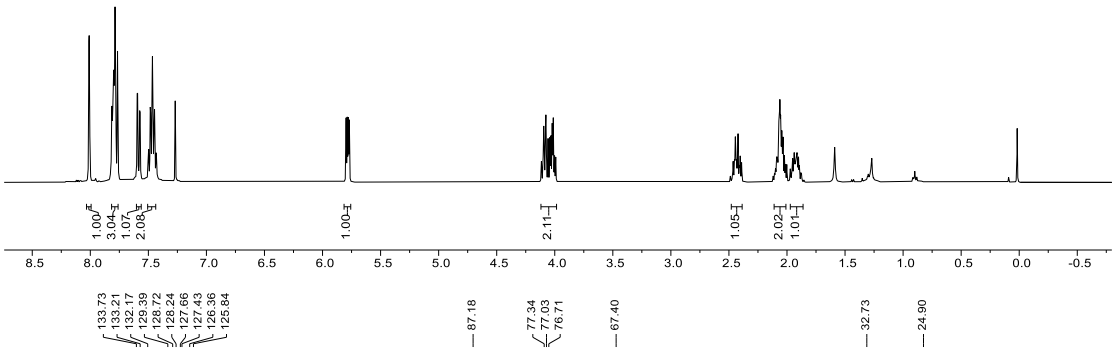

157.97
155.52
131.64
129.38
124.77
124.70
124.67
124.62
124.57
121.46
121.27
86.39
77.39
77.08
76.76
67.44
32.70
24.57
F
Cl
S
O
b26
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0


-110.726
F
Cl
S
O
b26
1.00
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135

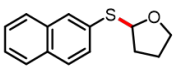

8.0079
7.8150
7.7983
7.7868
7.7811
7.7661
7.5968
7.5922
7.5754
7.5708
7.4974
7.4842
7.4649
7.4464
7.4329
5.7969
5.7871
5.7785
5.7696
4.1149
4.0948
4.0783
4.0575
4.0417
4.0326
4.0220
4.0126
4.0015
3.9915
2.4635
2.4520
2.4448
2.4213
2.4029
2.3911
2.1076
2.0902
2.0810
2.0615
2.0444
2.0333
2.0222
2.0019
1.9717
1.9513
1.9381
1.9140
1.9010
1.8934
1.8810
1.8747


S
O

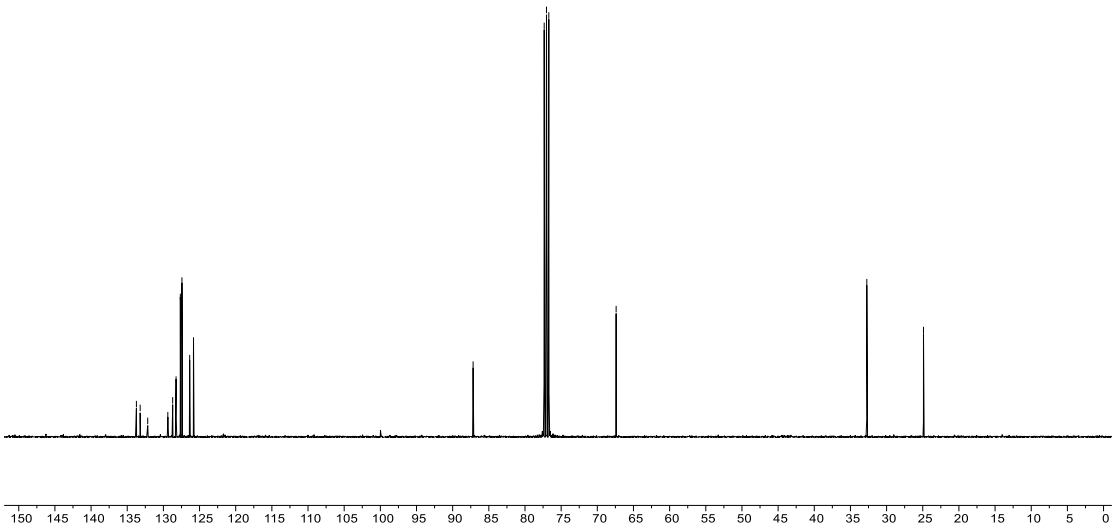
b27

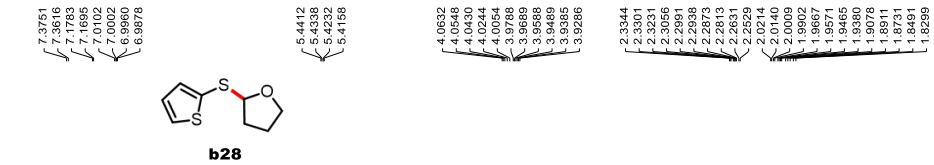

1.00
3.04
1.07
2.08
1.00
2.11
1.05
2.02
1.01
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

133.73
133.21
132.17
129.39
128.72
128.24
127.66
127.43
126.36
125.84
87.18
77.34
77.03
76.71
67.40
32.73
24.90

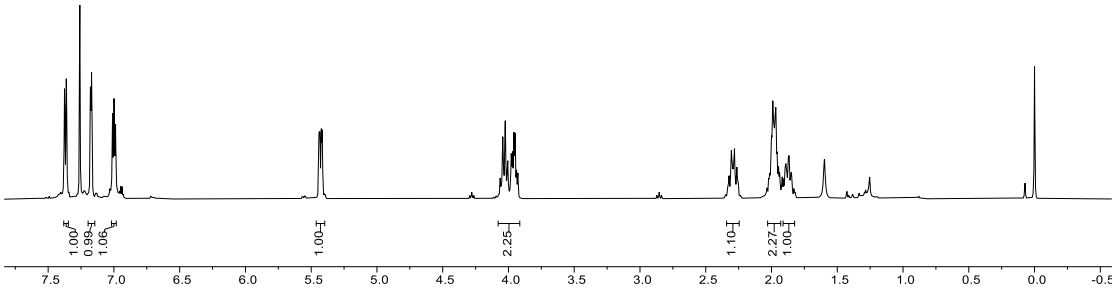

S
O

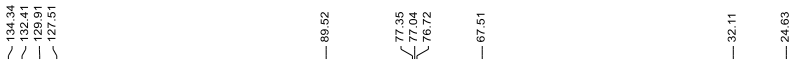
b27


150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0

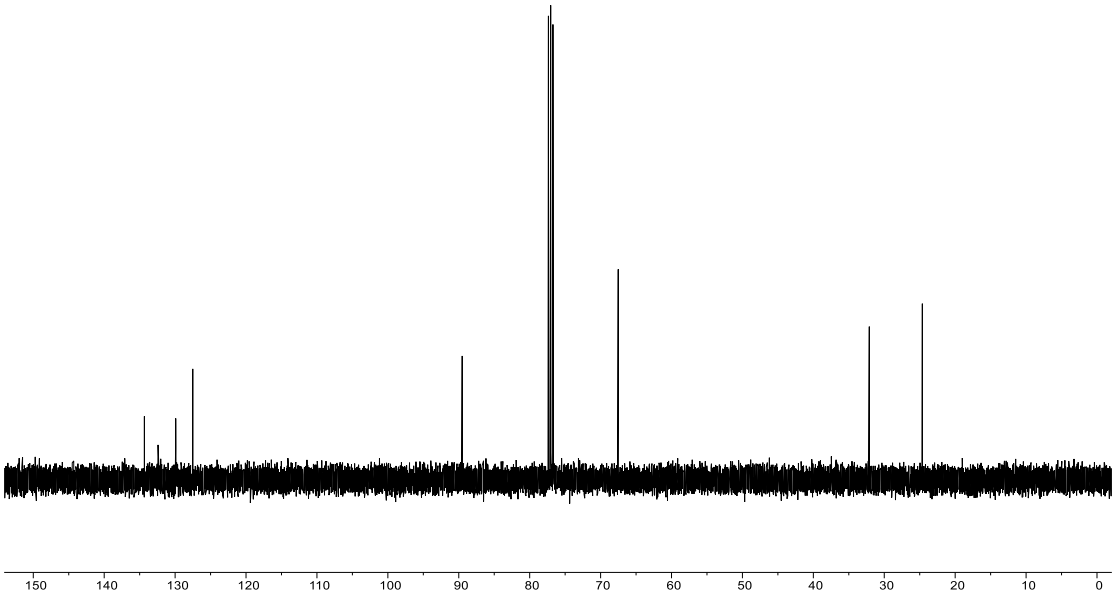

7.3751
7.3616
7.1783
7.1695
7.0102
7.0002
6.9960
6.9878
5.4412
5.4338
5.4232
5.4158
4.0632
4.0548
4.0430
4.0244
4.0054
3.9788
3.9689
3.9588
3.9489
3.9385
3.9286
2.3344
2.3301
2.3231
2.3056
2.2991
2.2938
2.2873
2.2813
2.2631
2.2529
2.0214
2.0140
2.0009
1.9902
1.9667
1.9571
1.9465
1.9380
1.9078
1.8911
1.8731
1.8491
1.8299

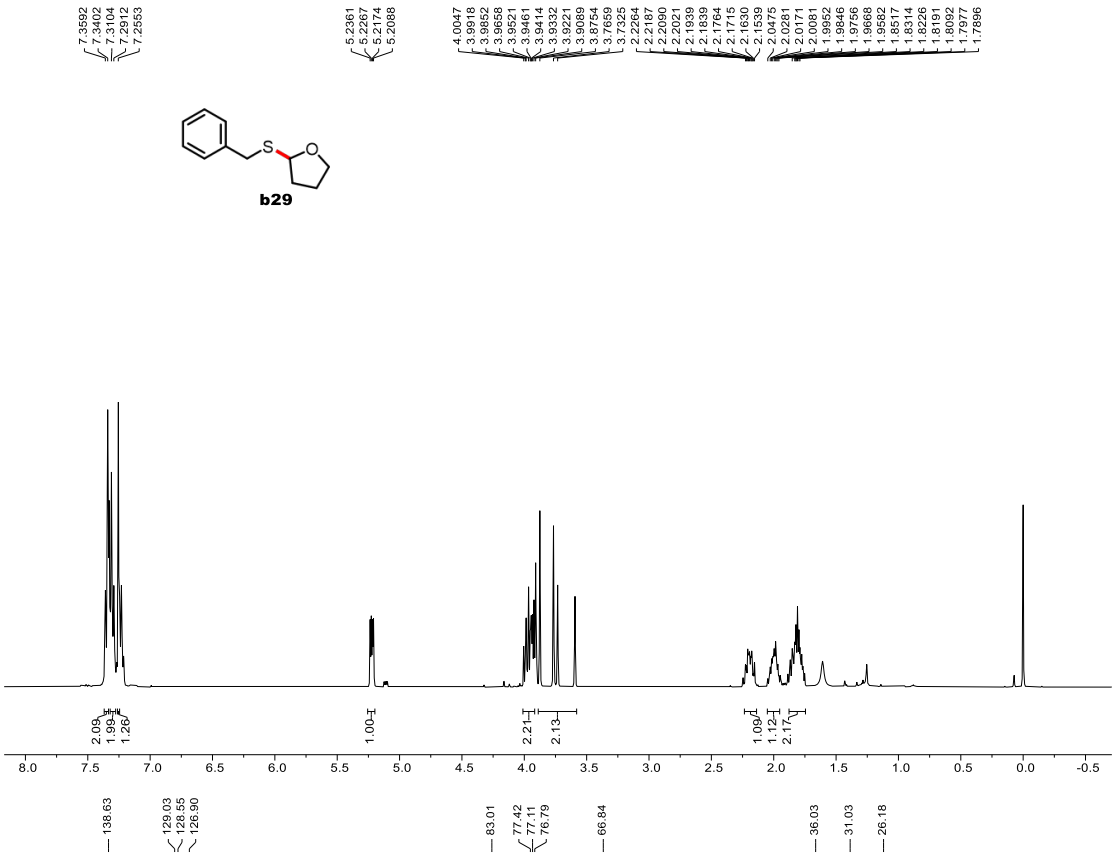
b28

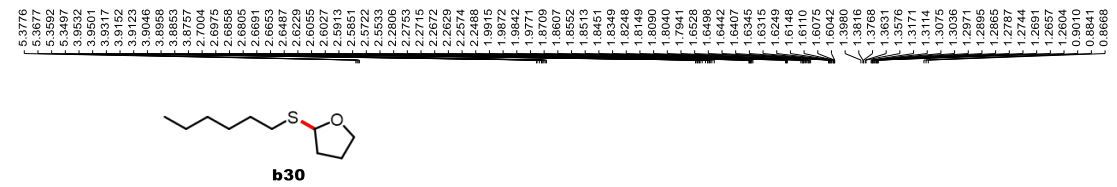

1.00
0.99
1.06
1.00
2.25
1.10
2.27
1.00
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0


134.34
132.41
129.91
127.51
89.52
77.35
77.04
76.72
67.51
32.11
24.63

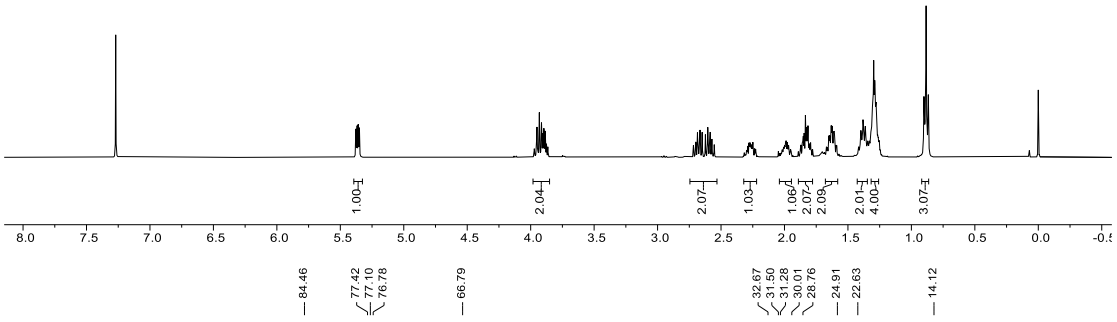
b28

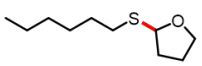

150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0


7.3592
7.3402
7.3104
7.2912
7.2553
5.2361
5.2267
5.2174
5.2088
4.0047
3.9918
3.9852
3.9658
3.9521
3.9461
3.9414
3.9332
3.9221
3.9089
3.8754
3.7659
3.7325
2.2264
2.2187
2.2090
2.2021
2.1939
2.1839
2.1764
2.1715
2.1630
2.1539
2.0475
2.0281
2.0171
2.0081
1.9952
1.9846
1.9756
1.9668
1.9582
1.8517
1.8314
1.8226
1.8191
1.8092
1.7977
1.7896
S
O
b29
2.09
1.99
1.26
1.00
2.21
2.13
1.09
1.12
2.17
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
138.63
129.03
128.55
126.90
83.01
77.42
77.11
76.79
66.84
36.03
31.03
26.18
S
O
b29
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

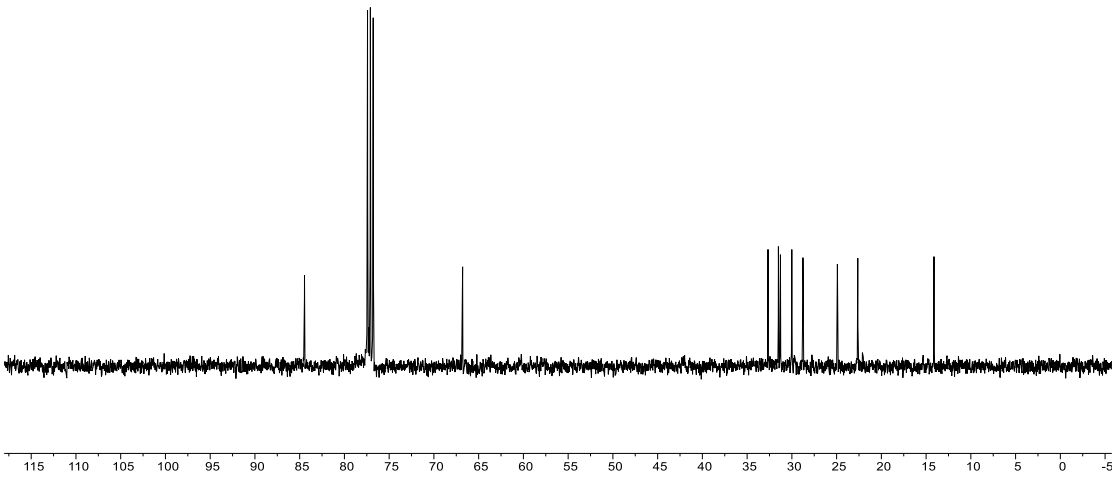


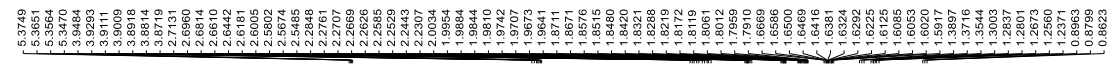
b30

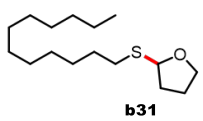




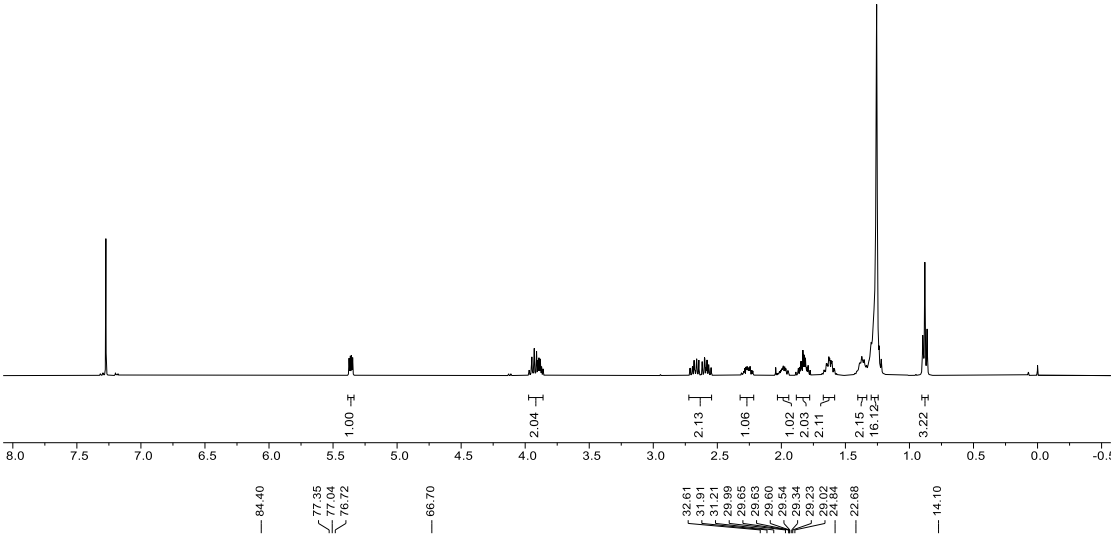
b30



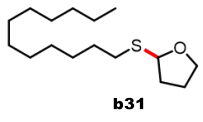

5.3749
5.3651
5.3564
5.3470
3.9484
3.9293
3.9111
3.9009
3.8918
3.8814
3.8719
2.7131
2.6960
2.6814
2.6610
2.6442
2.6181
2.6005
2.5802
2.5674
2.5485
2.2848
2.2761
2.2707
2.2669
2.2626
2.2585
2.2529
2.2443
2.2307
2.0034
1.9954
1.9884
1.9844
1.9810
1.9742
1.9707
1.9673
1.9641
1.8711
1.8671
1.8576
1.8515
1.8480
1.8420
1.8321
1.8288
1.8219
1.8172
1.8119
1.8061
1.8012
1.7959
1.7910
1.6669
1.6586
1.6500
1.6469
1.6416
1.6381
1.6324
1.6292
1.6225
1.6125
1.6085
1.6053
1.6020
1.5917
1.3897
1.3716
1.3544
1.3003
1.2837
1.2801
1.2673
1.2560
1.2371
0.8963
0.8799
0.8623


S
O

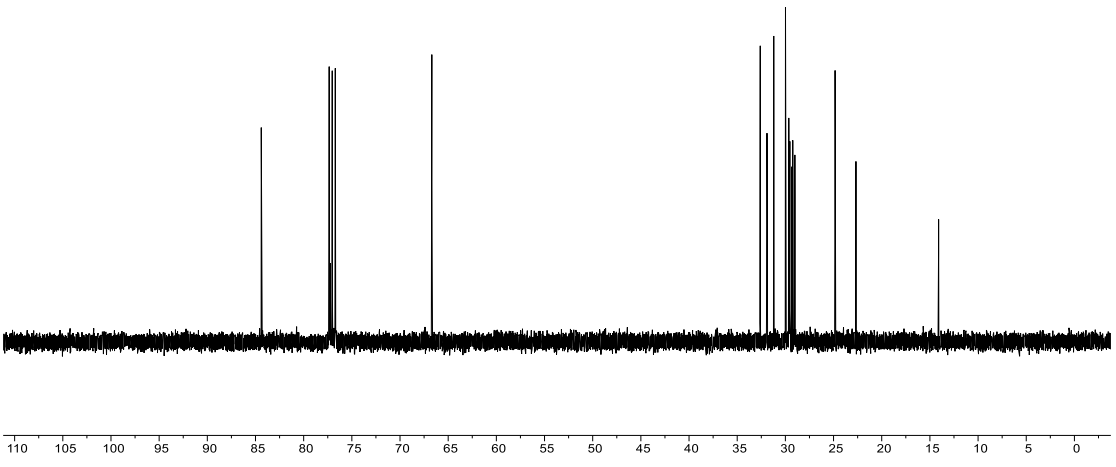
b31

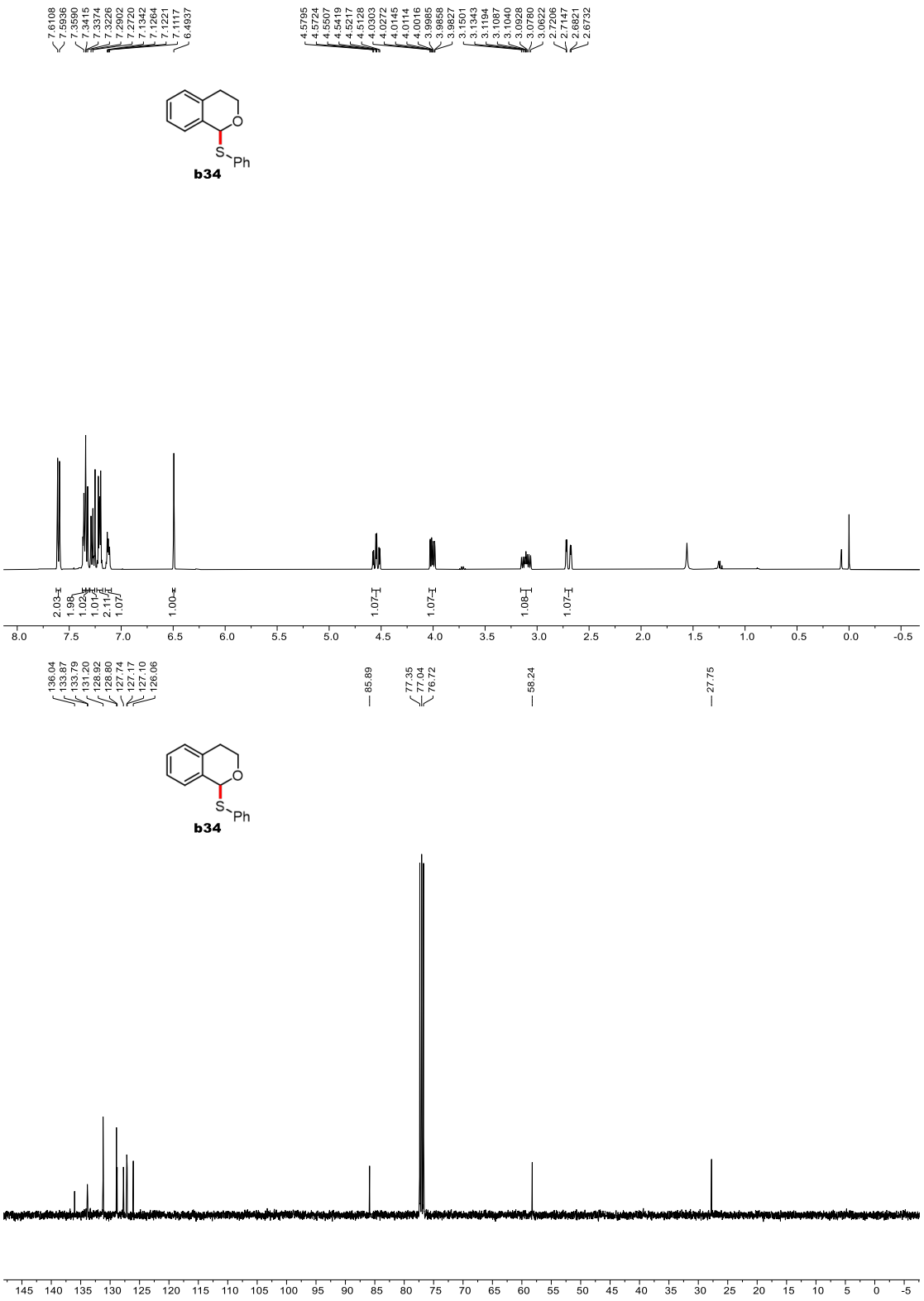

1.00
2.04
2.13
1.06
1.02
2.03
2.11
2.15
16.12
3.22
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

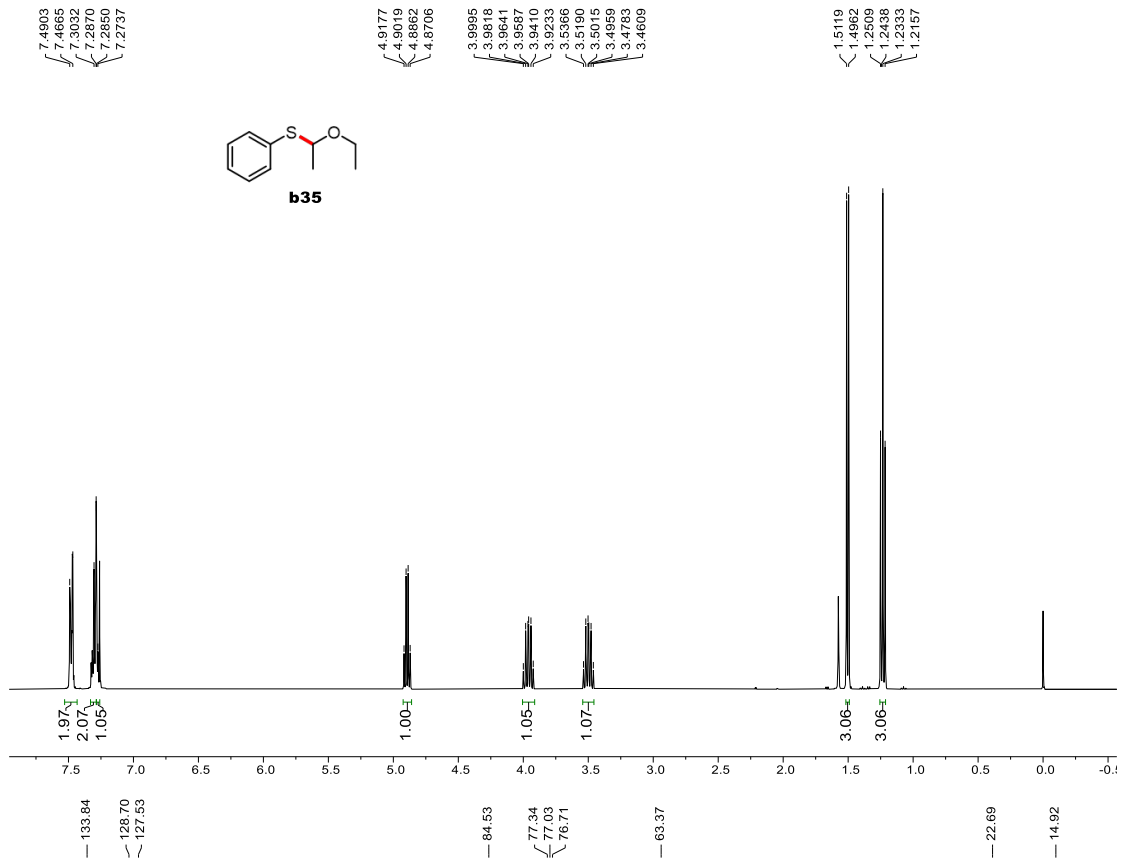
84.40
77.35
77.04
76.72
66.70
32.61
31.91
31.21
29.99
29.65
29.63
29.60
29.54
29.34
29.23
29.02
24.84
22.68
14.10

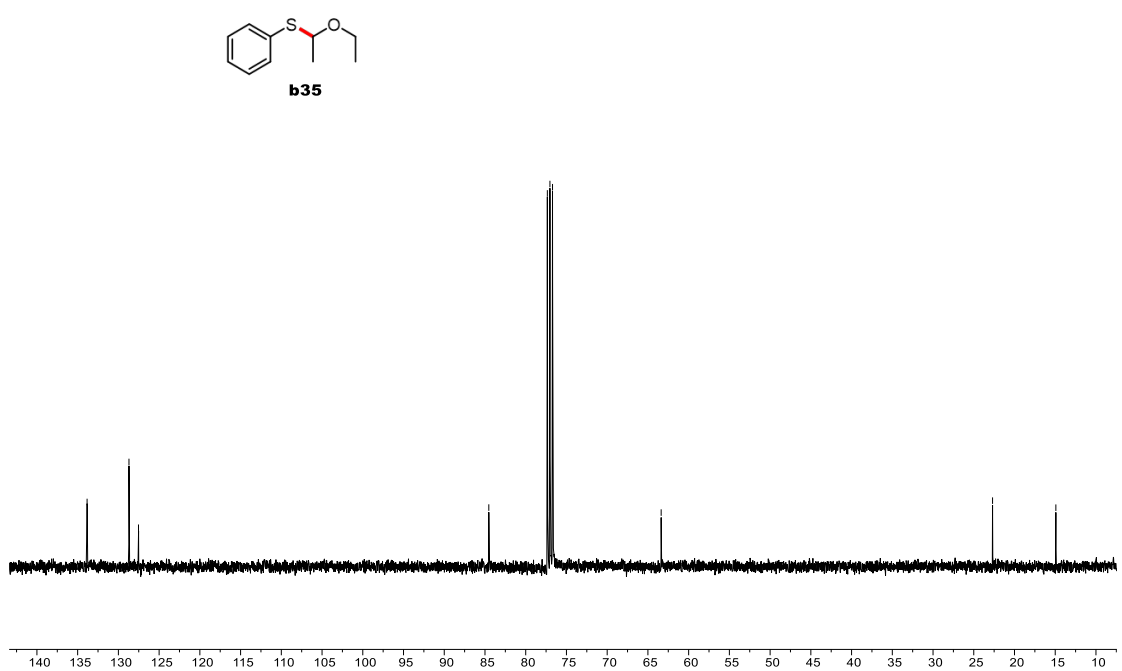

S
O

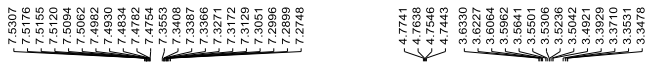
b31


110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0


7.6108
7.5936
7.3590
7.3415
7.3374
7.3226
7.2902
7.2720
7.1342
7.1264
7.1221
7.1117
6.4937
4.5795
4.5724
4.5507
4.5419
4.5217
4.5128
4.0303
4.0272
4.0145
4.0114
4.0016
3.9985
3.9858
3.9827
3.1501
3.1343
3.1194
3.1087
3.1040
3.0928
3.0780
3.0622
2.7206
2.7147
2.6921
2.6732
O
S
Ph
b34
2.03
1.98
1.02
1.01
2.11
1.07
1.00
1.07
1.07
1.08
1.07
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
136.04
133.87
133.79
131.20
128.92
128.80
127.74
127.17
127.10
126.06
85.89
77.35
77.04
76.72
58.24
27.75
O
S
Ph
b34
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5

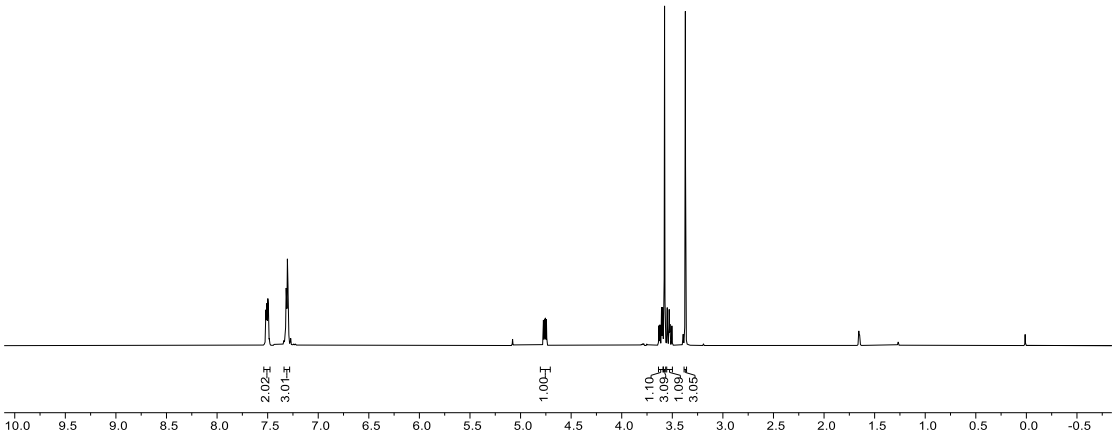

7.4903
7.4665
7.3032
7.2870
7.2850
7.2737
4.9177
4.9019
4.8862
4.8706
3.9995
3.9818
3.9641
3.9587
3.9410
3.9233
3.5366
3.5190
3.5015
3.4959
3.4783
3.4609
1.5119
1.4962
1.2509
1.2438
1.2333
1.2157
b35
1.97
2.07
1.05
1.00
1.05
1.07
3.06
3.06


133.84
128.70
127.53
84.53
77.34
77.03
76.71
63.37
22.69
14.92
b35


7.5307
7.5176
7.5155
7.5120
7.5094
7.5062
7.4982
7.4930
7.4834
7.4782
7.4754
7.3553
7.3408
7.3387
7.3366
7.3271
7.3172
7.3129
7.3051
7.2996
7.2899
7.2748
4.7741
4.7638
4.7546
4.7443
3.6330
3.6227
3.6064
3.5962
3.5641
3.5501
3.5306
3.5236
3.5042
3.4921
3.3929
3.3710
3.3531
3.3478


S
O
O

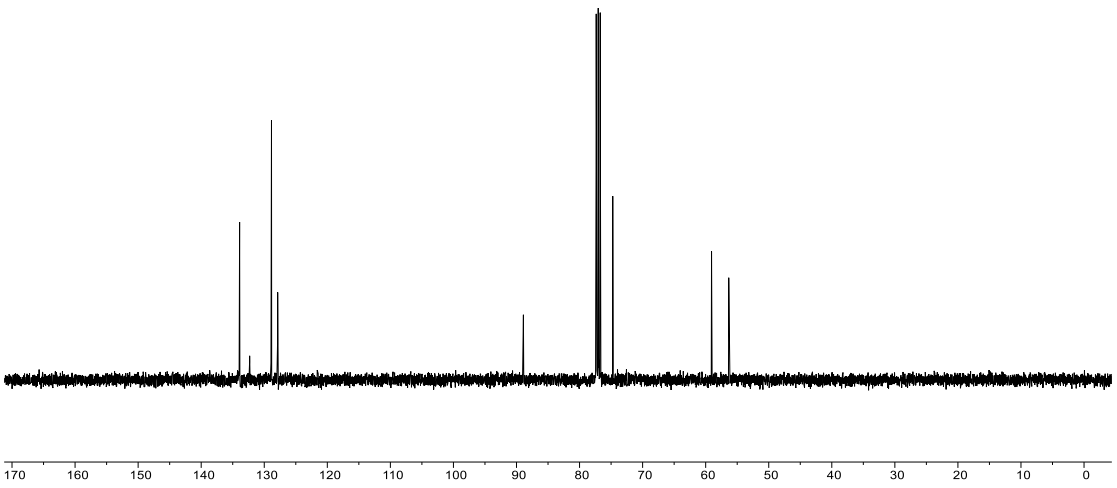
b36

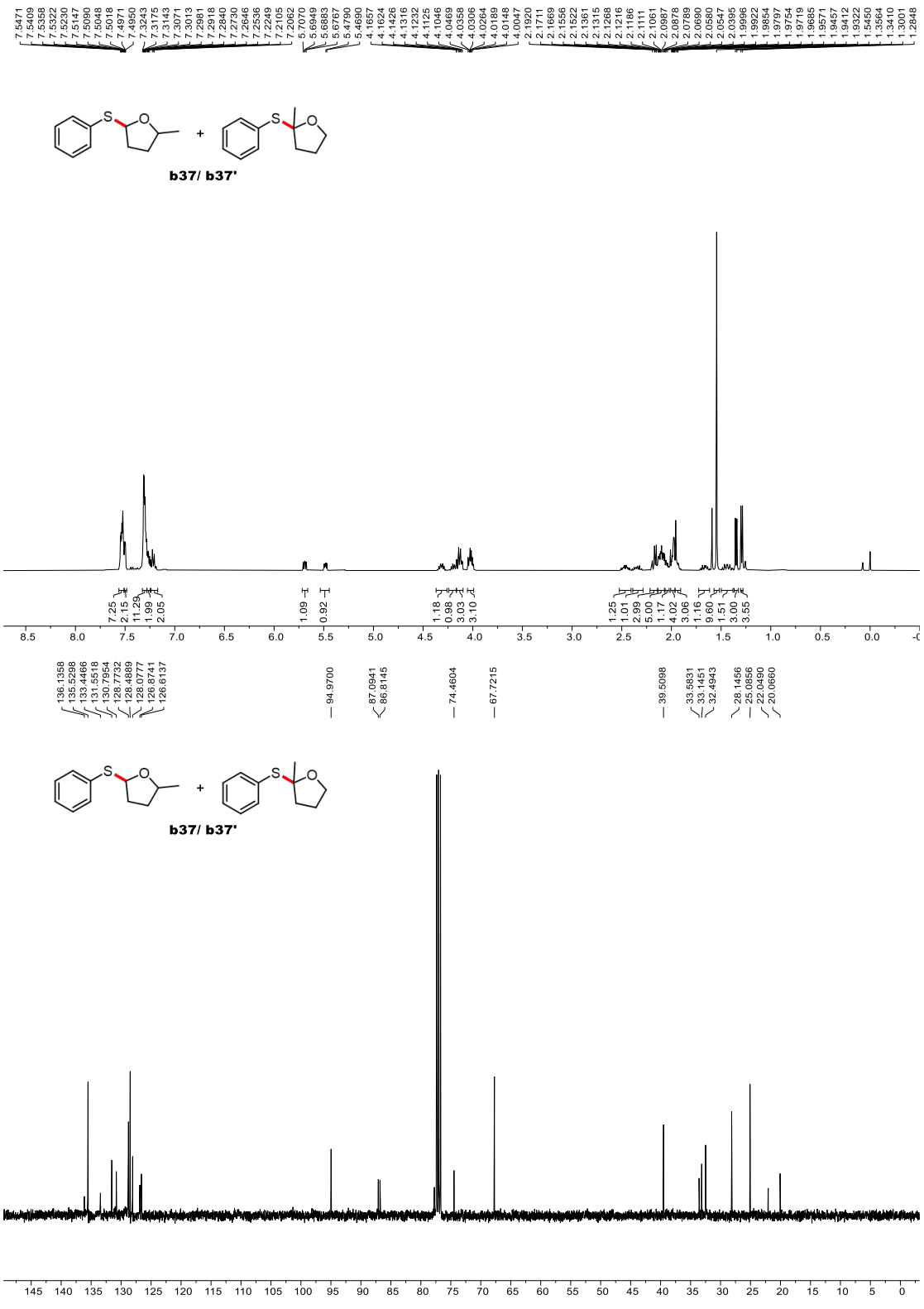

2.02
3.01
1.00
1.10
3.09
1.09
3.05
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5


133.9130
132.2988
128.8535
127.8735
88.9038
74.7351
59.0726
56.3415

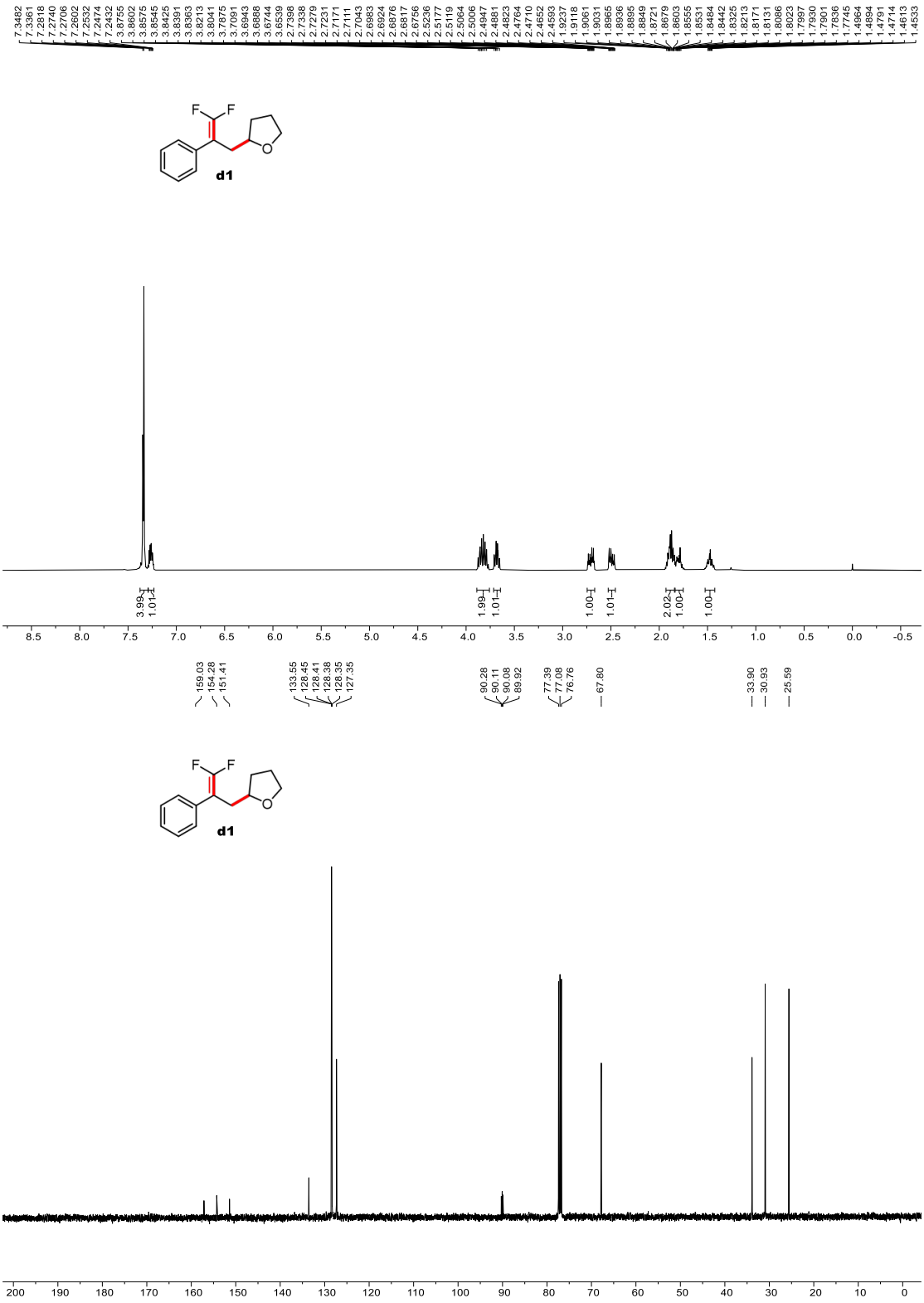

S
O
O

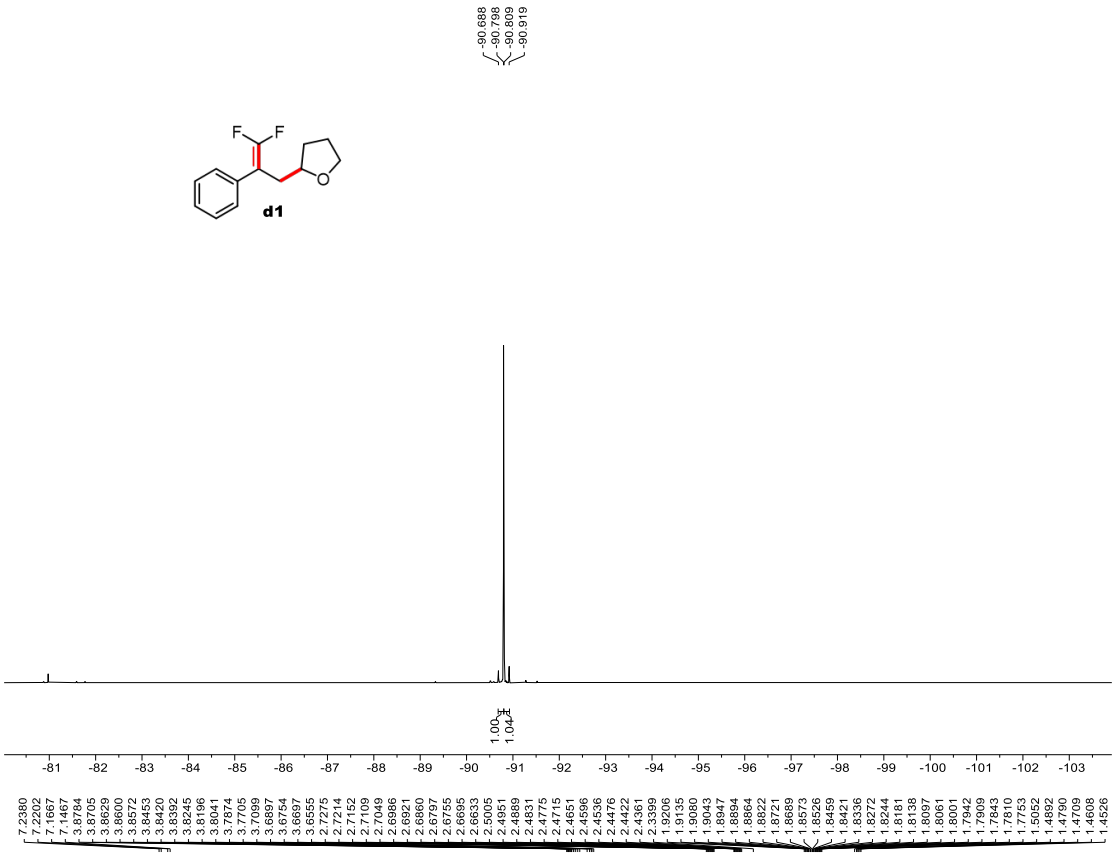
b36

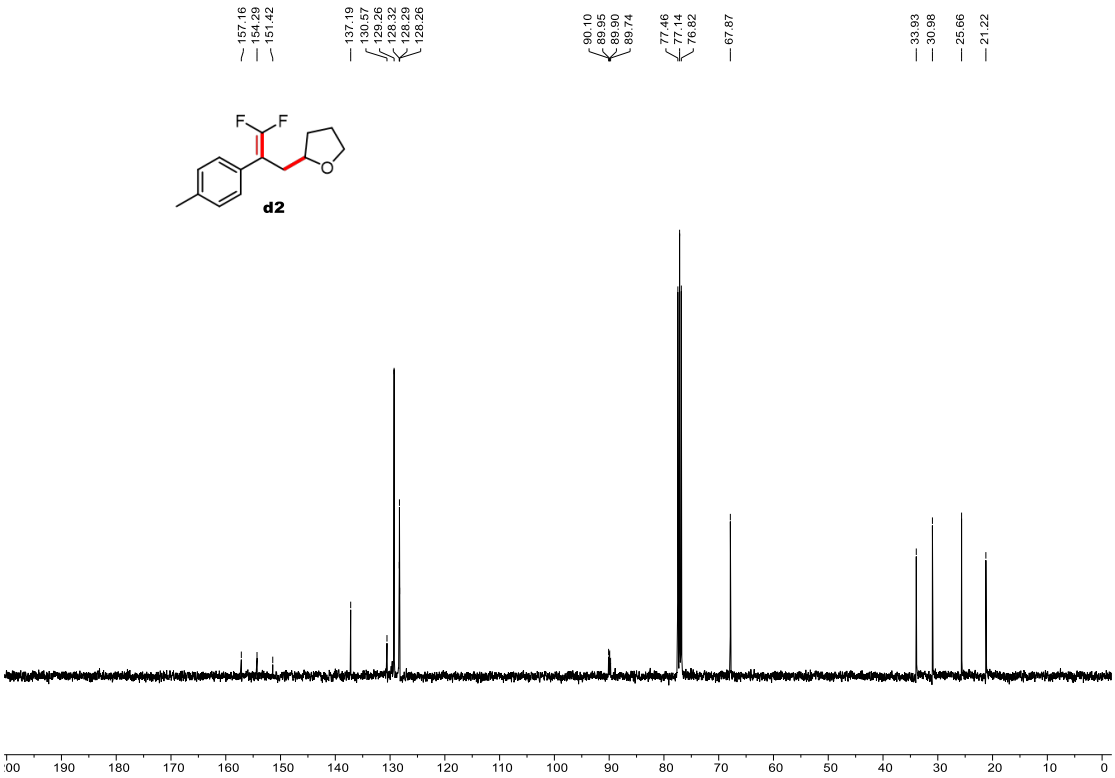

170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

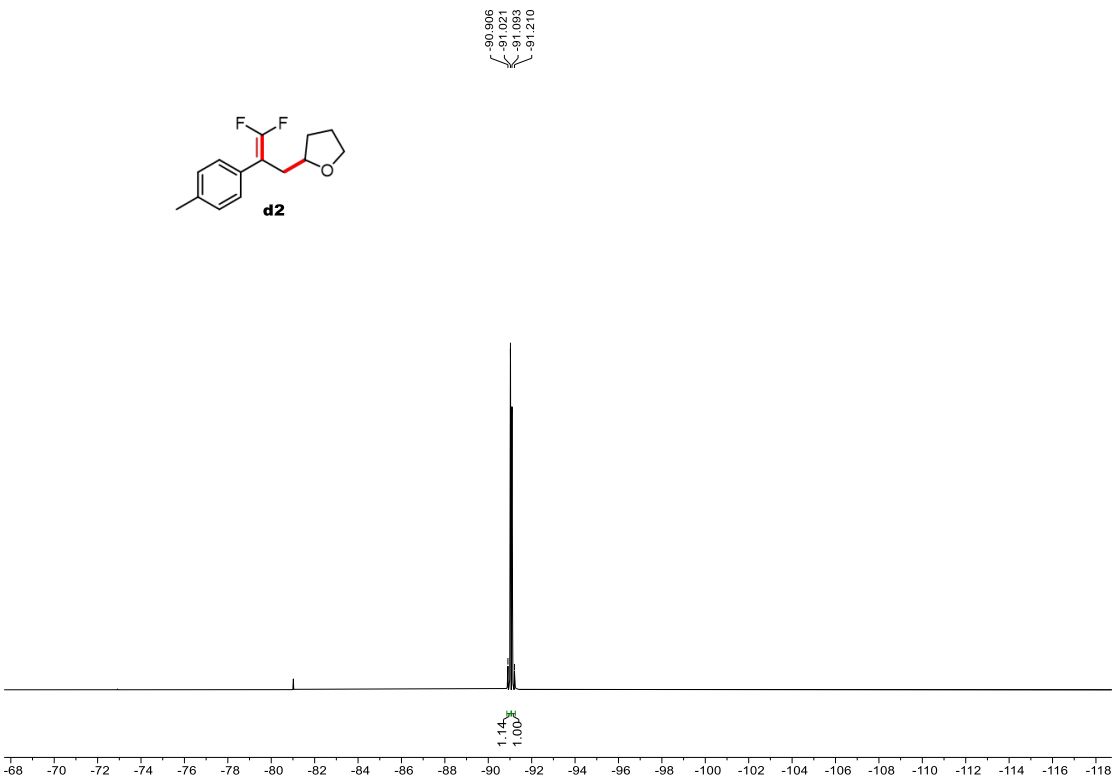


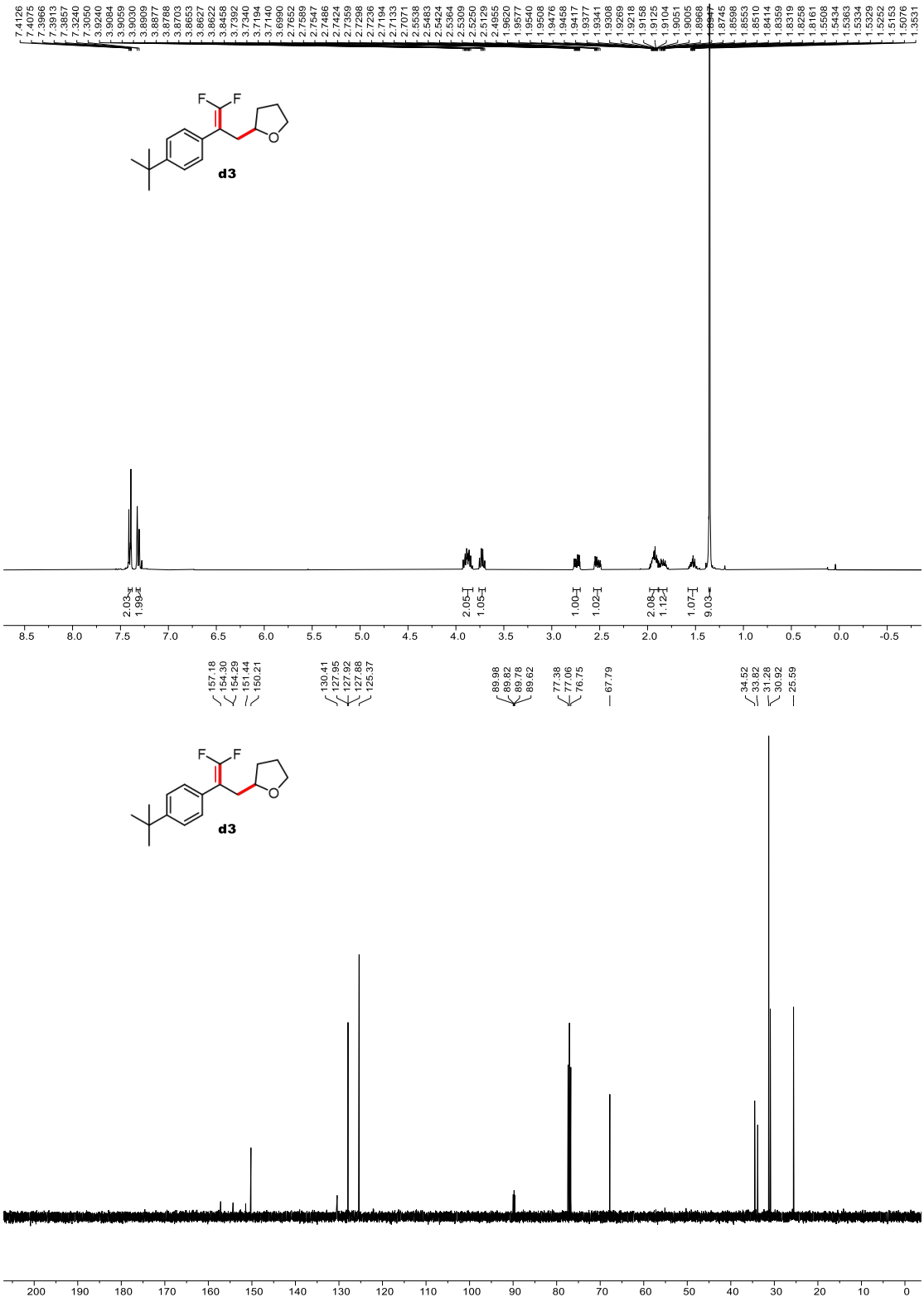
Due to the minimal polarity difference of **b37** and **b37'**, the isolation is difficult. Therefore, the mixture of **b37** and **b37'** was obtained.

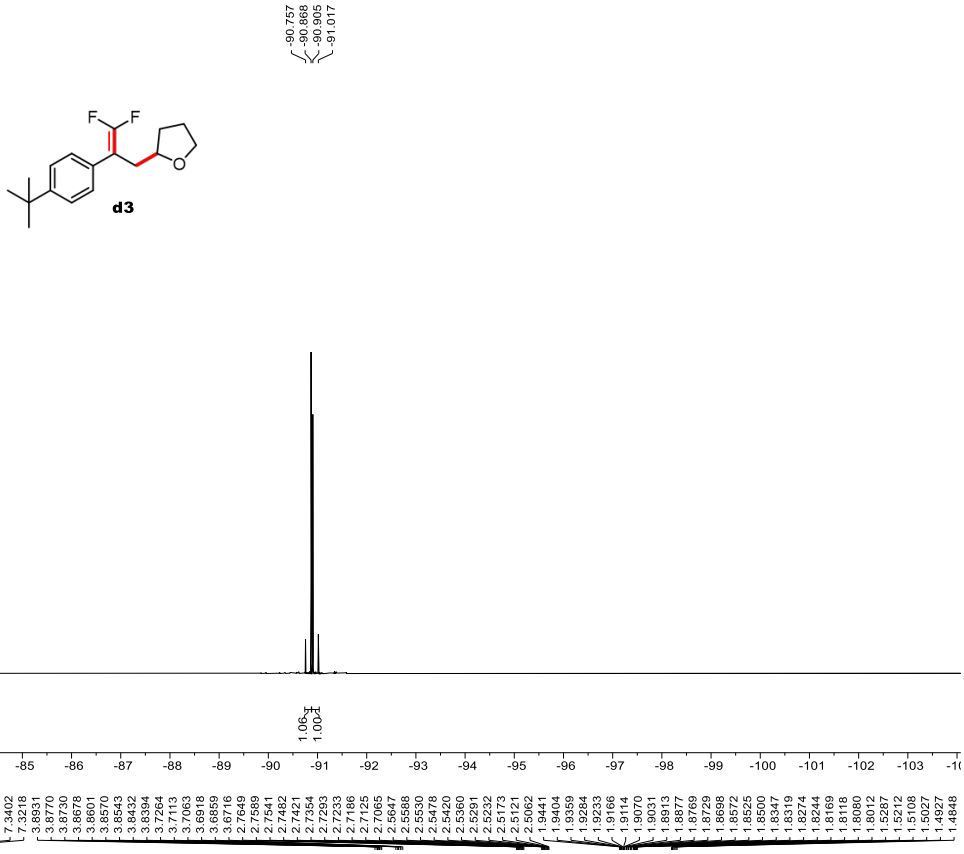

7.3482
7.3361
7.2818
7.2740
7.2706
7.2602
7.2532
7.2474
7.2432
3.8755
3.8602
3.8575
3.8545
3.8425
3.8391
3.8363
3.8213
3.8041
3.7875
3.7091
3.6943
3.6898
3.6744
3.6538
2.7398
2.7338
2.7279
2.7231
2.7171
2.7111
2.7043
2.6983
2.6924
2.6876
2.6817
2.6756
2.5236
2.5177
2.5119
2.5064
2.5006
2.4947
2.4881
2.4823
2.4764
2.4710
2.4652
2.4593
1.9237
1.9118
1.9061
1.9031
1.8965
1.8936
1.8895
1.8849
1.8721
1.8679
1.8603
1.8555
1.8531
1.8464
1.8442
1.8325
1.8213
1.8171
1.8131
1.8086
1.8023
1.7997
1.7930
1.7901
1.7836
1.7745
1.4964
1.4894
1.4791
1.4714
1.4613
1.4533
F
F
O
d1
3.99
1.01
1.99
1.01
1.00
1.01
2.02
1.00
1.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
159.03
154.28
151.41
133.55
128.45
128.41
128.38
128.35
127.35
90.28
90.11
90.08
89.92
77.39
77.08
76.76
67.80
33.90
30.93
25.59
F
F
O
d1
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

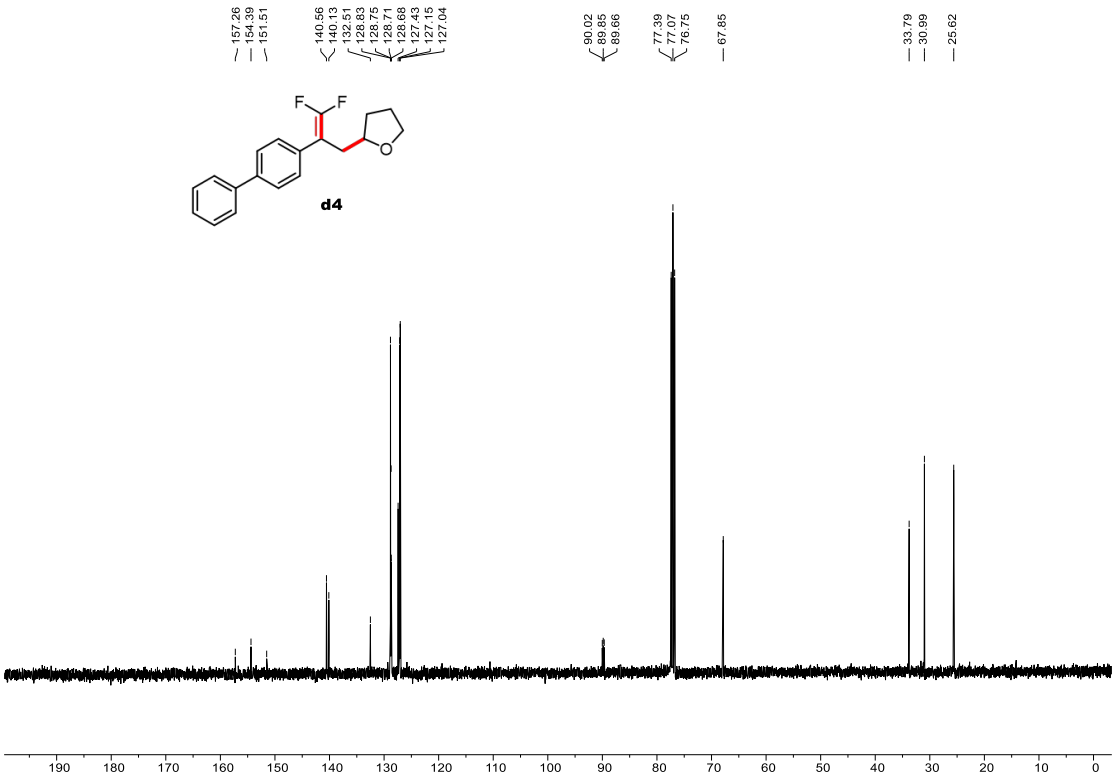

-90.688
-90.798
-90.809
-90.919
F
F
O
d1
1.00
1.04
-81
-82
-83
-84
-85
-86
-87
-88
-89
-90
-91
-92
-93
-94
-95
-96
-97
-98
-99
-100
-101
-102
-103
7.2380
7.2202
7.1667
7.1467
3.8784
3.8705
3.8629
3.8600
3.8572
3.8453
3.8420
3.8392
3.8245
3.8196
3.8041
3.7874
3.7705
3.7099
3.6897
3.6754
3.6697
3.5555
3.5375
2.7214
2.7152
2.7109
2.7049
2.6986
2.6921
2.6860
2.6797
2.6755
2.6695
2.6633
2.5005
2.4951
2.4889
2.4831
2.4775
2.4715
2.4651
2.4596
2.4536
2.4476
2.4422
2.4361
2.3399
1.9206
1.9135
1.9080
1.9043
1.8947
1.8894
1.8864
1.8822
1.8721
1.8689
1.8573
1.8526
1.8459
1.8421
1.8336
1.8272
1.8244
1.8161
1.8138
1.8097
1.8061
1.8001
1.7942
1.7909
1.7843
1.7810
1.7753
1.5052
1.4892
1.4790
1.4709
1.4608
1.4526
F
F
O
d2
2.01
2.07
2.04
1.05
1.00
1.05
3.02
2.10
1.05
1.02
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

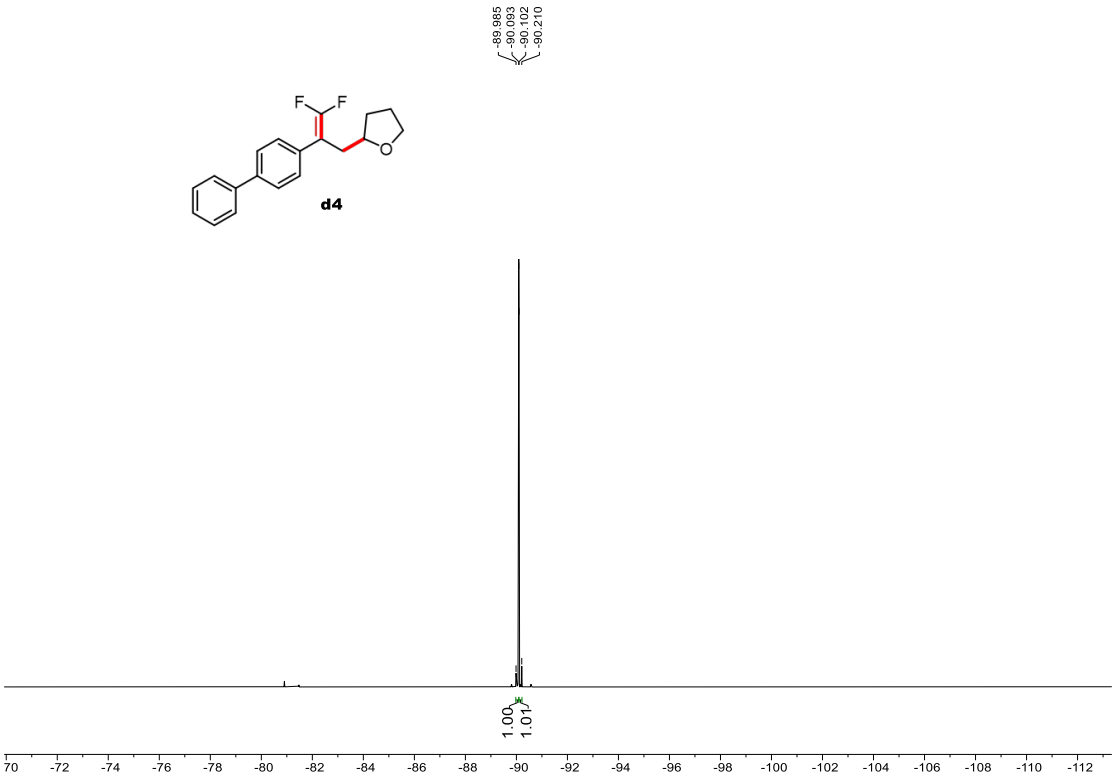

157.16
154.29
151.42
137.19
130.57
129.26
128.32
128.29
128.26
90.10
89.95
89.90
89.74
77.46
77.14
76.82
67.87
33.93
30.98
25.66
21.22
F
F
O
d2

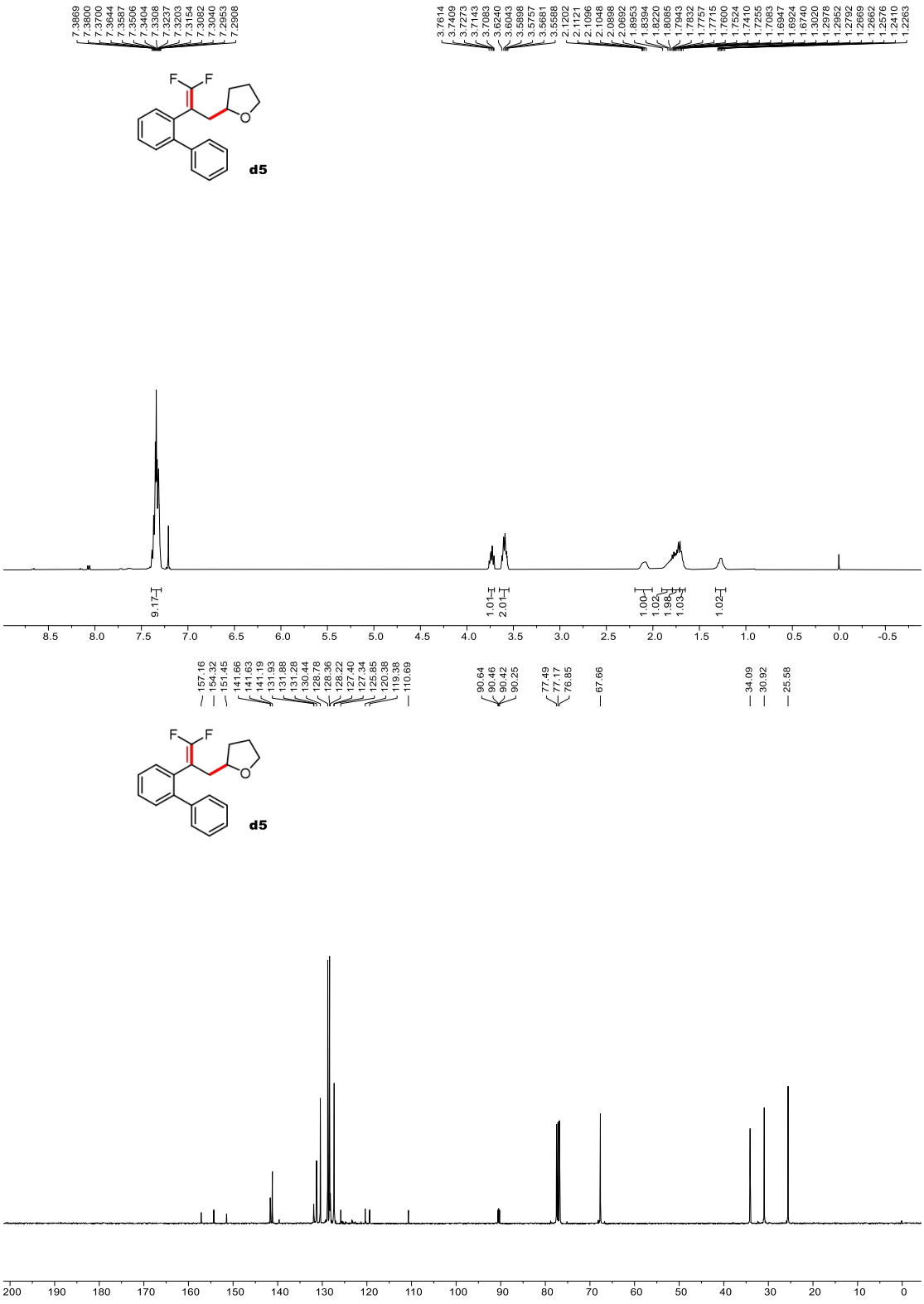

-90.906
-91.021
-91.093
-91.210
F
F
O
d2
1.14
1.00

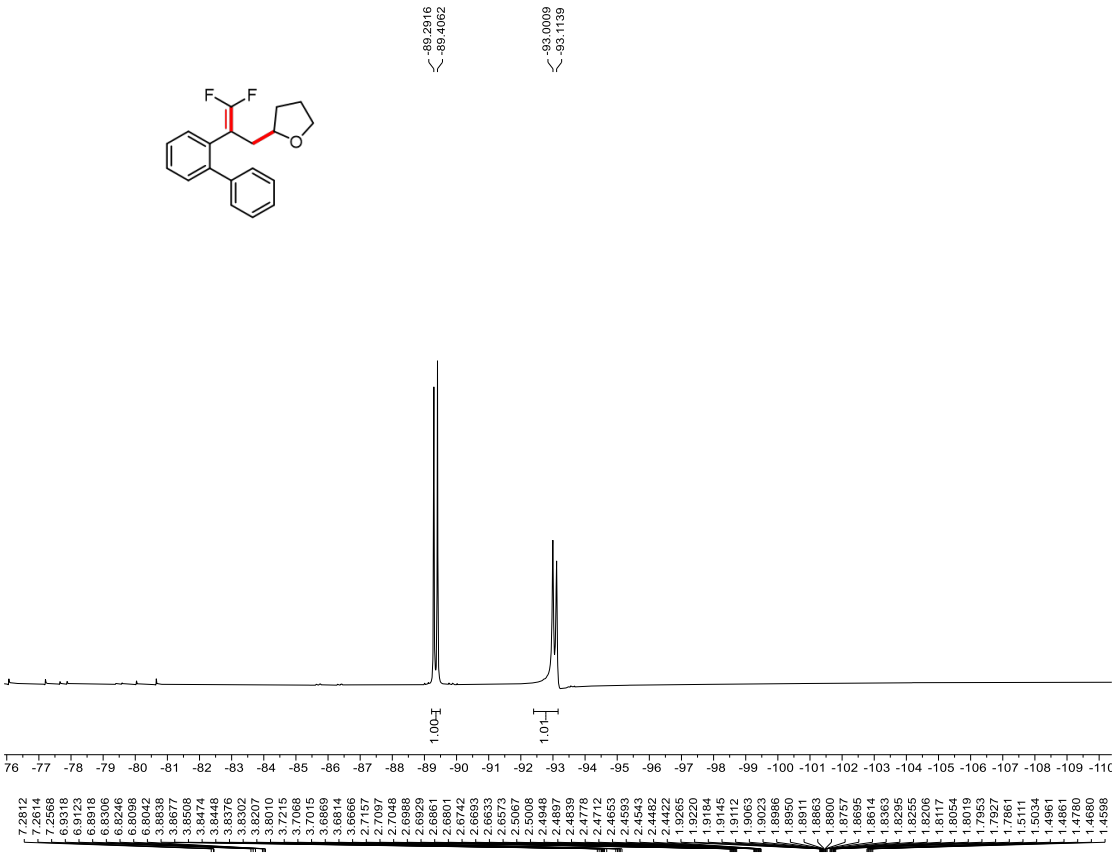

d3
d3

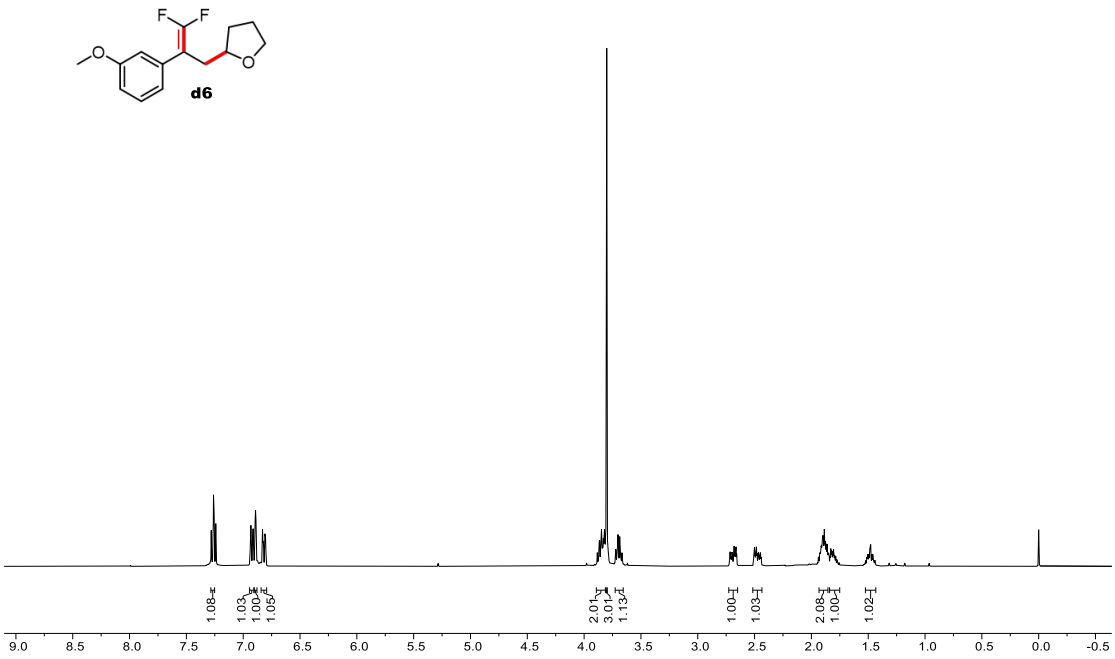

-90.757
-90.868
-90.905
-91.017
F
F
O
d3
1.06
1.00
-82 -83 -84 -85 -86 -87 -88 -89 -90 -91 -92 -93 -94 -95 -96 -97 -98 -99 -100 -101 -102 -103
7.6029 7.5991 7.5900 7.5852 7.5816 7.5690 7.4520 7.4333 7.4137 7.3586 7.3402 7.3218
3.8931 3.8770 3.8730 3.8678 3.8601 3.8570 3.8543 3.8432 3.8394 3.7264 3.7213 3.7063 3.6918 3.6859 3.6716 2.7649 2.7589 2.7541 2.7482 2.7421 2.7354 2.7293 2.7233 2.7186 2.7125 2.7065 2.5647 2.5588 2.5530 2.5478 2.5420 2.5360 2.5291 2.5232 2.5173 2.5121 2.5062 1.9441 1.9404 1.9359 1.9284 1.9233 1.9166 1.9114 1.9070 1.9031 1.8913 1.8877 1.8769 1.8729 1.8698 1.8572 1.8525 1.8500 1.8347 1.8319 1.8274 1.8244 1.8169 1.8118 1.8080 1.8012 1.5287 1.5212 1.5108 1.5027 1.4927 1.4848
F
F
O
d4
4.08
4.02
1.04
2.00
1.05
1.00
1.00
2.04
1.02
1.03
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

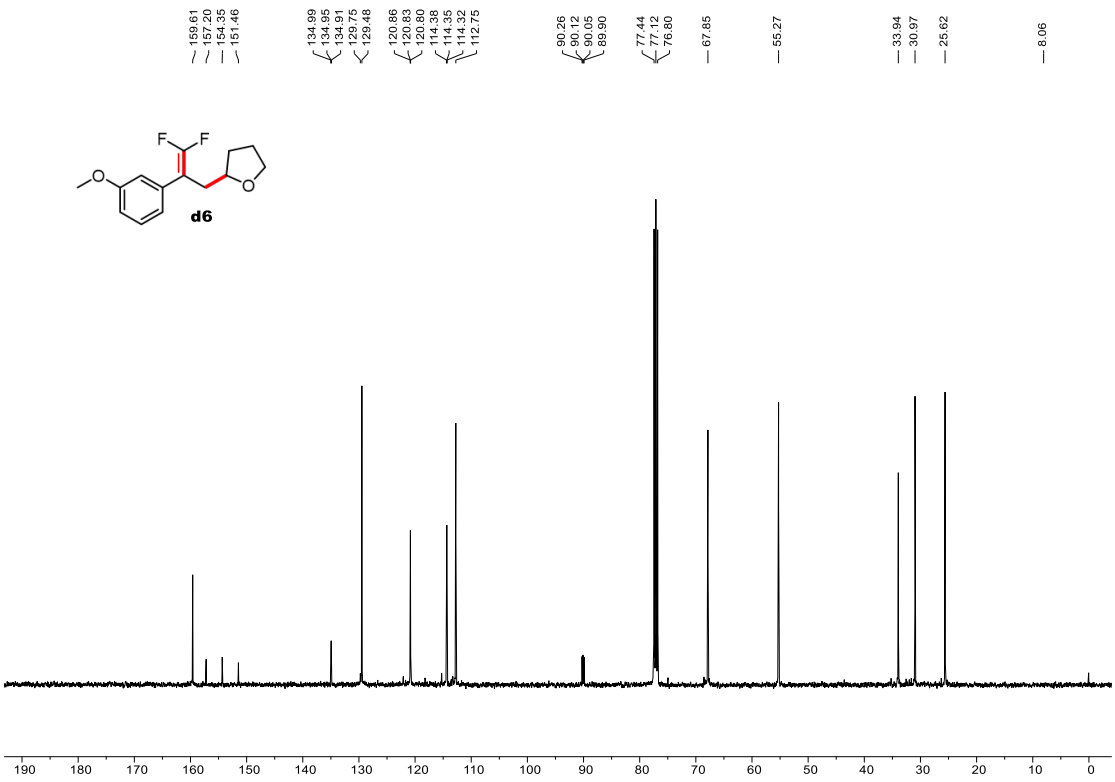

157.26
154.39
151.51
140.56
140.13
132.51
128.83
128.75
128.71
128.68
127.43
127.15
127.04
90.02
89.85
89.66
77.39
77.07
76.75
67.85
33.79
30.99
25.62
F
F
O
d4
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

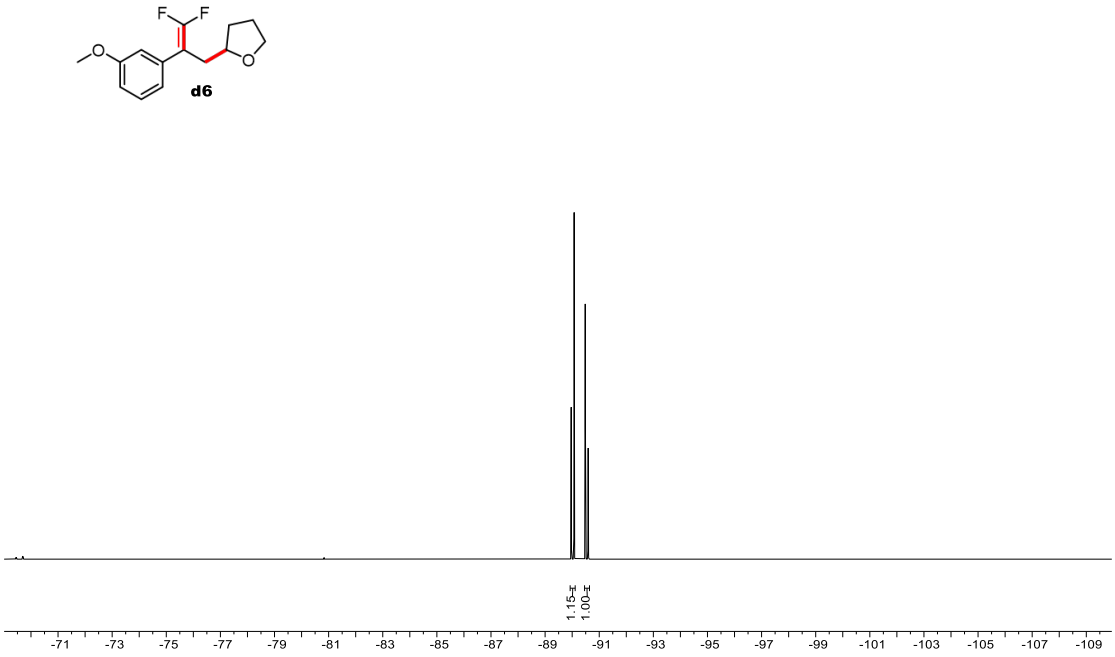

-89.985
-90.093
-90.102
-90.210
F
F
O
d4
1.00
1.01
70
-72
-74
-76
-78
-80
-82
-84
-86
-88
-90
-92
-94
-96
-98
-100
-102
-104
-106
-108
-110
-112

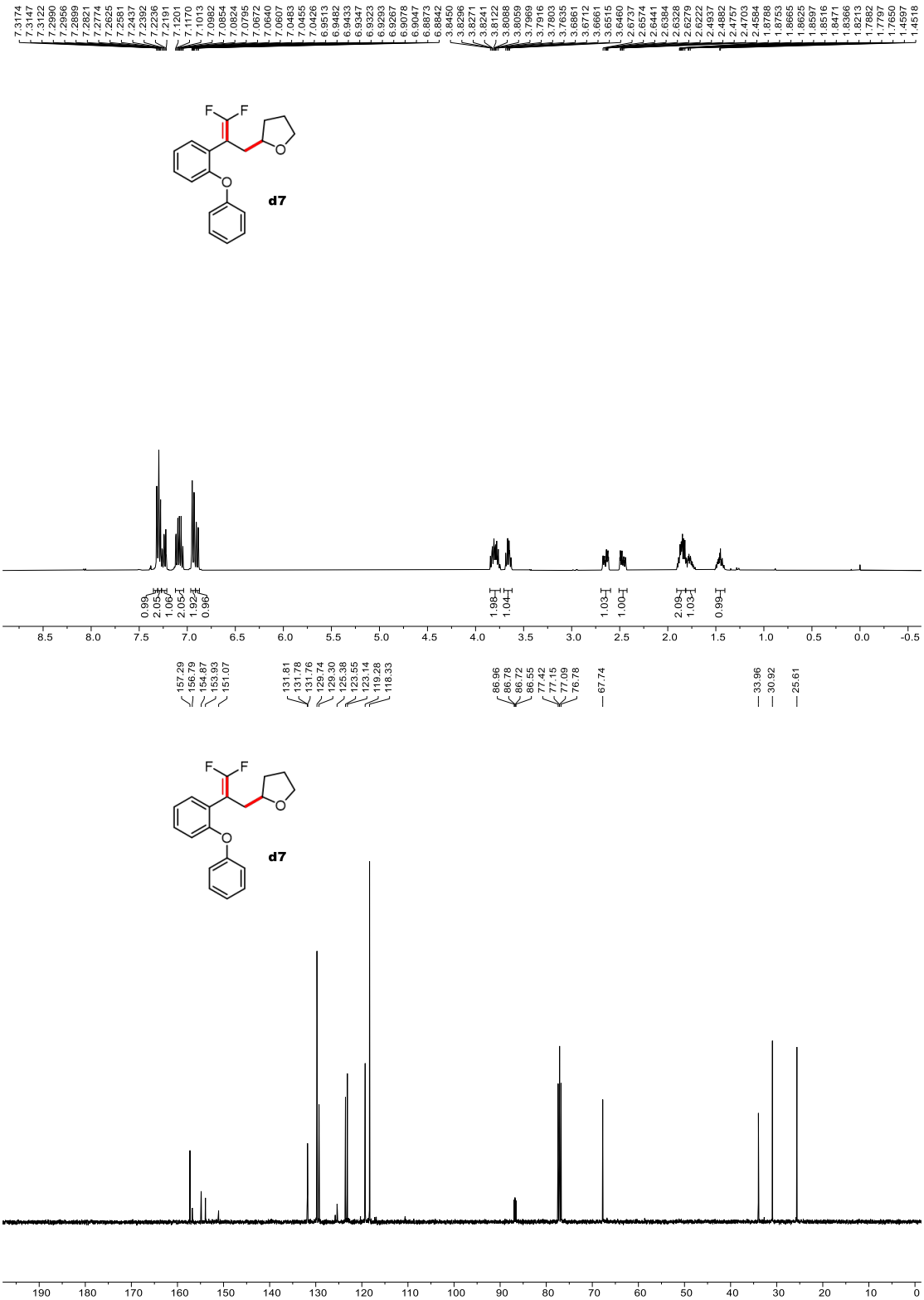

7.3869
7.3800
7.3700
7.3644
7.3587
7.3506
7.3404
7.3308
7.3237
7.3203
7.3154
7.3082
7.3040
7.2953
7.2908
3.7614
3.7409
3.7273
3.7143
3.7083
3.6240
3.6043
3.5898
3.5757
3.5681
3.5588
2.1202
2.1121
2.1096
2.1048
2.0898
2.0692
1.8953
1.8394
1.8220
1.8085
1.7943
1.7832
1.7757
1.7715
1.7600
1.7524
1.7410
1.7255
1.7083
1.6947
1.6924
1.6740
1.3020
1.2978
1.2952
1.2792
1.2669
1.2562
1.2576
1.2411
1.2263
F
F
O
d5
9.17
1.01
2.01
1.00
1.02
1.98
1.03
1.02
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
157.16
154.32
151.45
141.66
141.63
141.19
131.93
131.88
131.28
130.44
128.78
128.36
128.22
127.40
127.34
125.85
125.38
119.38
110.69
90.64
90.46
90.42
90.25
77.49
77.17
76.85
67.66
34.09
30.92
25.58
F
F
O
d5
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

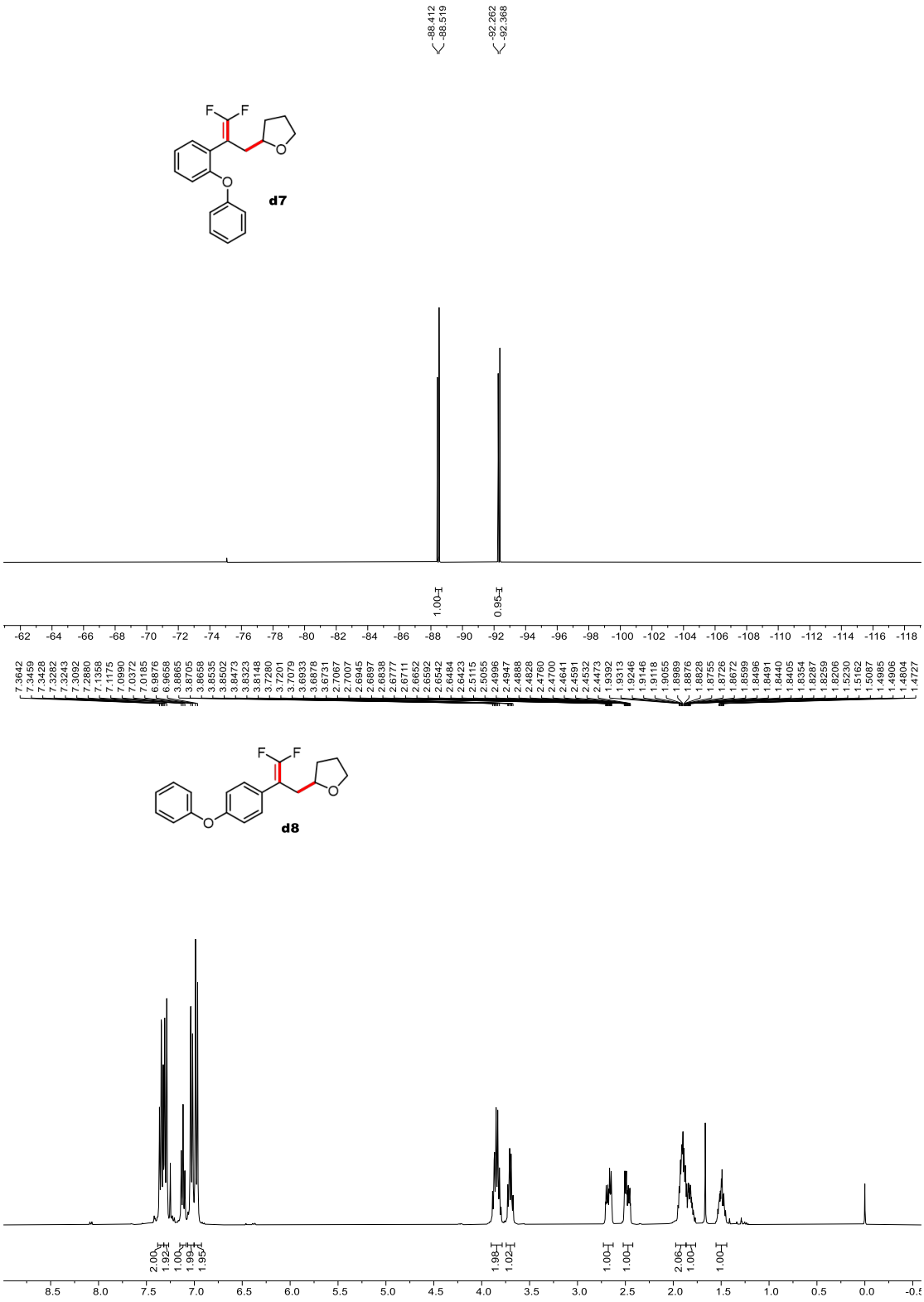

-89.2916
-89.4062
-93.0009
-93.1139
F
F
O
1.00
1.01
-76 -77 -78 -79 -80 -81 -82 -83 -84 -85 -86 -87 -88 -89 -90 -91 -92 -93 -94 -95 -96 -97 -98 -99 -100 -101 -102 -103 -104 -105 -106 -107 -108 -109 -110

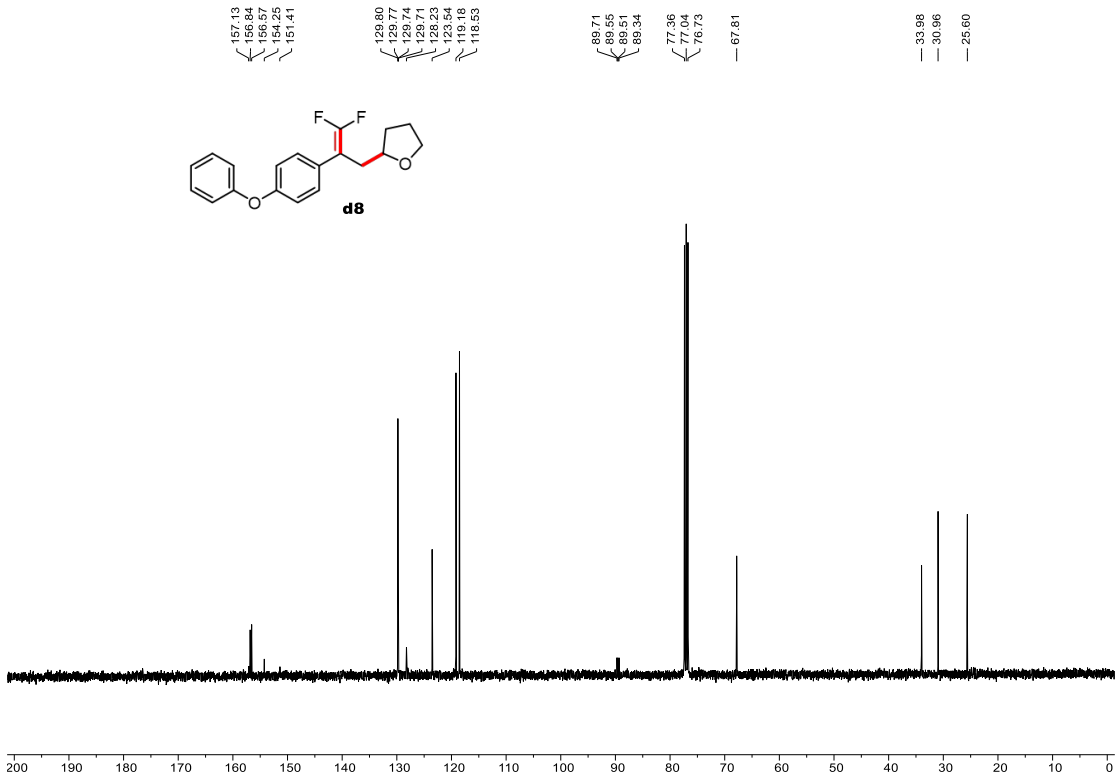

F
F
O
d6
1.08
1.03
1.00
1.05
2.01
3.01
1.13
1.00
1.03
2.08
1.00
1.02
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

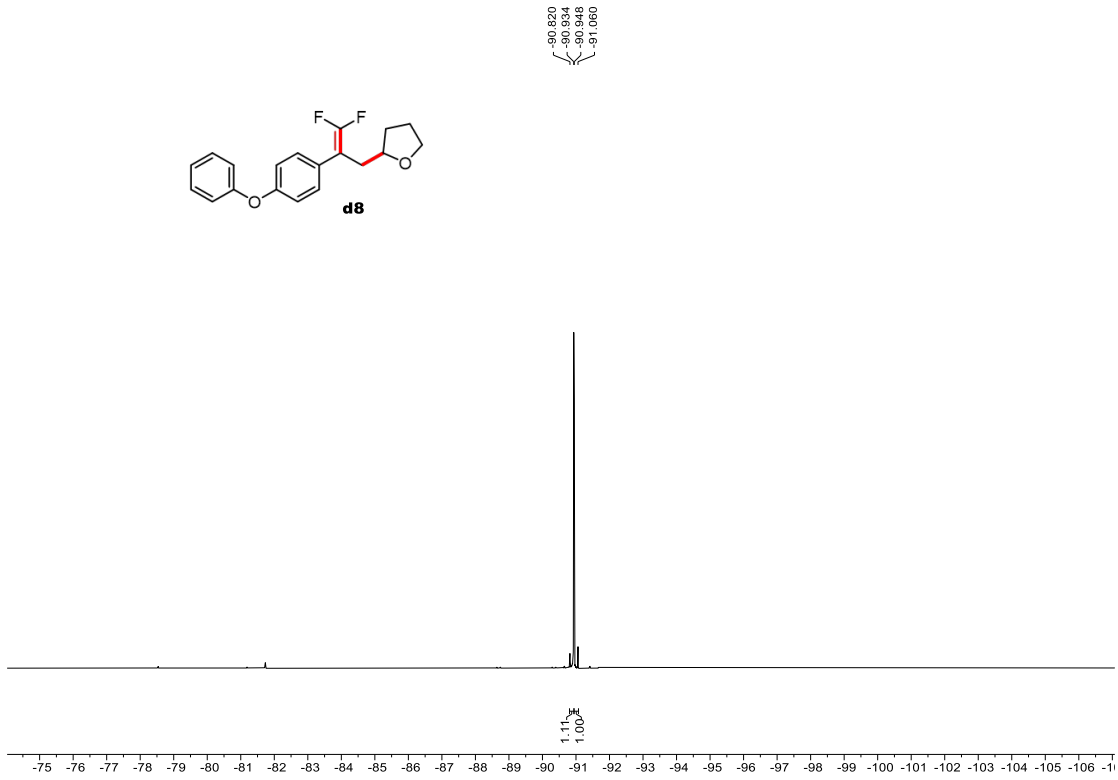

159.61
157.20
154.35
151.46
134.99
134.95
134.91
129.75
129.48
120.86
120.83
120.80
114.38
114.35
114.32
112.75
90.26
90.12
90.05
89.90
77.44
77.12
76.80
67.85
55.27
33.94
30.97
25.62
8.06
F
F
O
O
d6
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

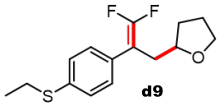

-89.964
-90.073
-90.483
-90.592
F
F
O
O
d6
1.15
1.00
-71
-73
-75
-77
-79
-81
-83
-85
-87
-89
-91
-93
-95
-97
-99
-101
-103
-105
-107
-109

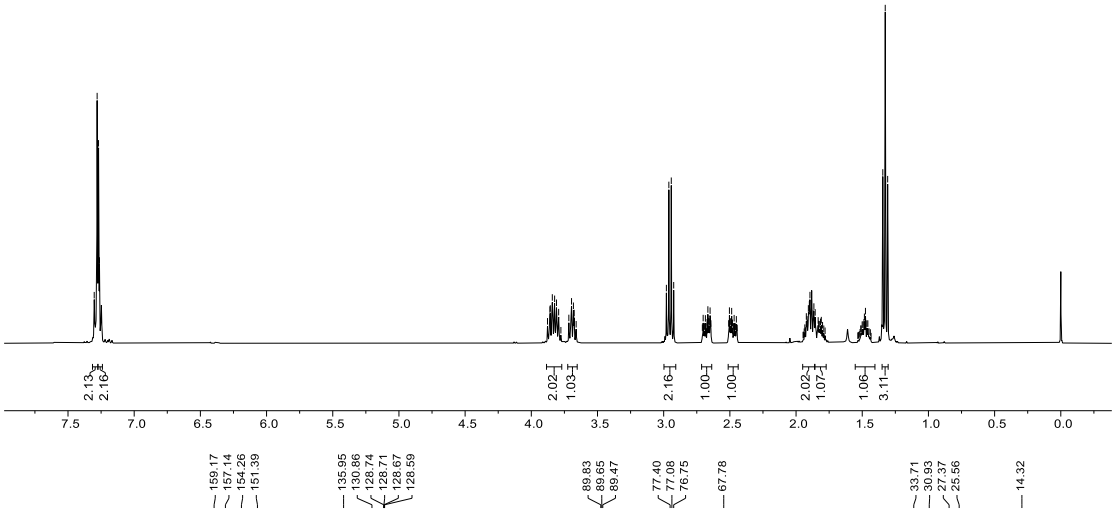

7.3174
7.3147
7.3122
7.2990
7.2956
7.2899
7.2821
7.2774
7.2625
7.2581
7.2437
7.2392
7.2236
7.2191
7.1201
7.1170
7.1013
7.0982
7.0854
7.0824
7.0795
7.0672
7.0640
7.0607
7.0483
7.0455
7.0426
6.9513
6.9482
6.9433
6.9347
6.9323
6.9293
6.9267
6.9078
6.9047
6.8873
6.8842
3.8450
3.8296
3.8271
3.8241
3.8122
3.8088
3.8059
3.7969
3.7916
3.7803
3.7635
3.6861
3.6712
3.6661
3.6515
3.6460
2.6737
2.6574
2.6441
2.6384
2.6328
2.6279
2.6222
2.4937
2.4882
2.4757
2.4703
2.4584
1.8788
1.8753
1.8665
1.8625
1.8597
1.8516
1.8471
1.8366
1.8213
1.7882
1.7797
1.7650
1.4597
1.4518
F
F
O
O
d7
0.99
2.05
1.06
2.05
1.92
0.96
1.98
1.04
1.03
1.00
2.09
1.03
0.99
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
157.29
156.79
154.87
153.93
151.07
131.81
131.78
131.76
129.74
129.30
125.38
123.55
123.14
119.28
118.33
86.96
86.78
86.72
86.55
77.42
77.15
77.09
76.78
67.74
33.96
30.92
25.61
F
F
O
O
d7
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0


-88.412
-88.519
-92.262
-92.368
F
F
O
O
d7
1.00
0.95
-62 -64 -66 -68 -70 -72 -74 -76 -78 -80 -82 -84 -86 -88 -90 -92 -94 -96 -98 -100 -102 -104 -106 -108 -110 -112 -114 -116 -118
7.3642 7.3459 7.3428 7.3282 7.3243 7.3092 7.2880 7.1358 7.1175 7.0990 7.0372 7.0185 6.9876 6.9658 3.8865 3.8705 3.8658 3.8535 3.8502 3.8473 3.8323 3.5148 3.7280 3.7201 3.7079 3.6933 3.6878 3.6731 2.7067 2.7007 2.6945 2.6897 2.6838 2.6777 2.6711 2.6652 2.6592 2.6542 2.6484 2.6423 2.5115 2.5055 2.4996 2.4947 2.4888 2.4828 2.4760 2.4700 2.4641 2.4591 2.4532 2.4473 1.9392 1.9313 1.9246 1.9146 1.9118 1.9055 1.8989 1.8876 1.8828 1.8755 1.8726 1.8672 1.8599 1.8496 1.8441 1.8440 1.8405 1.8354 1.8287 1.8259 1.8206 1.5230 1.5162 1.5087 1.4985 1.4906 1.4804 1.4727
F
F
O
O
d8
2.00
1.92
1.00
1.99
1.95
1.98
1.02
1.00
1.00
2.06
1.00
1.00
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

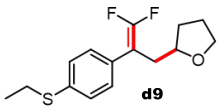

157.13
156.84
156.57
154.25
151.41
129.80
129.77
129.74
129.71
128.23
123.54
119.18
118.53
89.71
89.55
89.51
89.34
77.36
77.04
76.73
67.81
33.98
30.96
25.60
F
F
O
O
d8
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

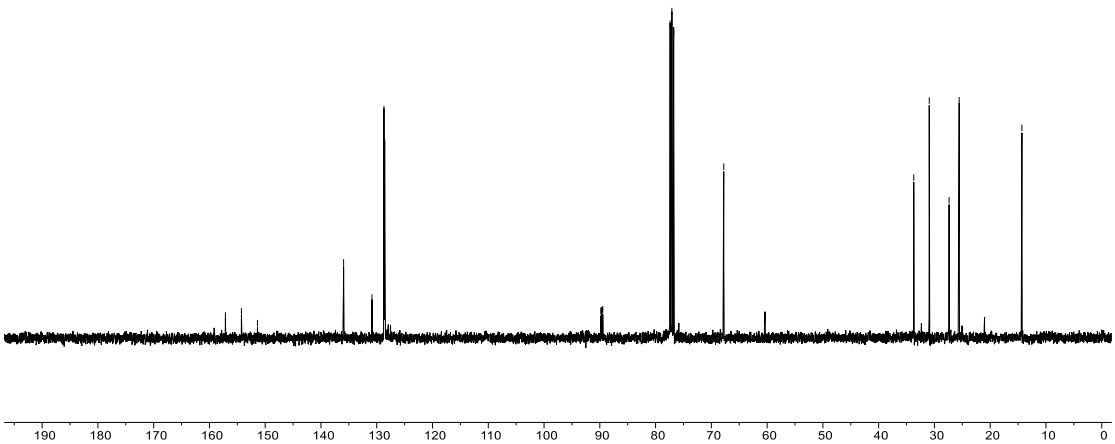

-90.820
-90.934
-90.948
-91.060
F
F
O
O
d8
1.11
1.00
-75
-76
-77
-78
-79
-80
-81
-82
-83
-84
-85
-86
-87
-88
-89
-90
-91
-92
-93
-94
-95
-96
-97
-98
-99
-100
-101
-102
-103
-104
-105
-106

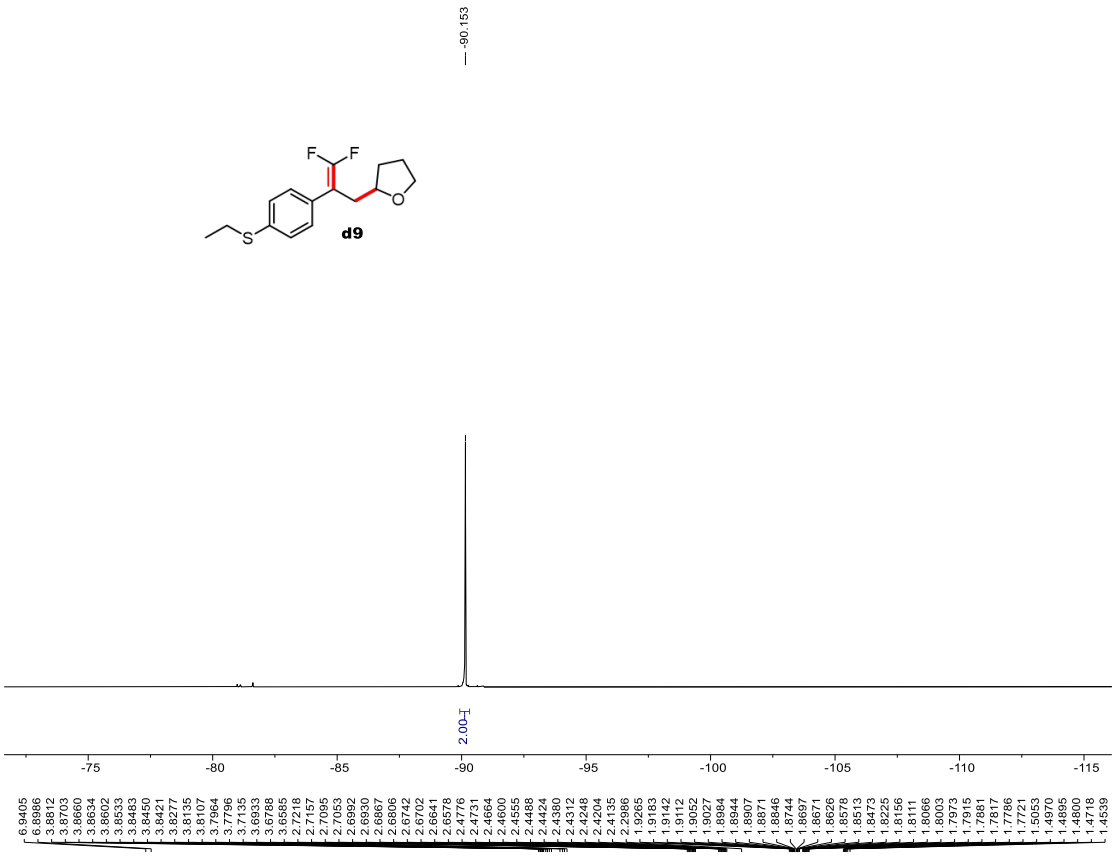

F
F
O
S
d9

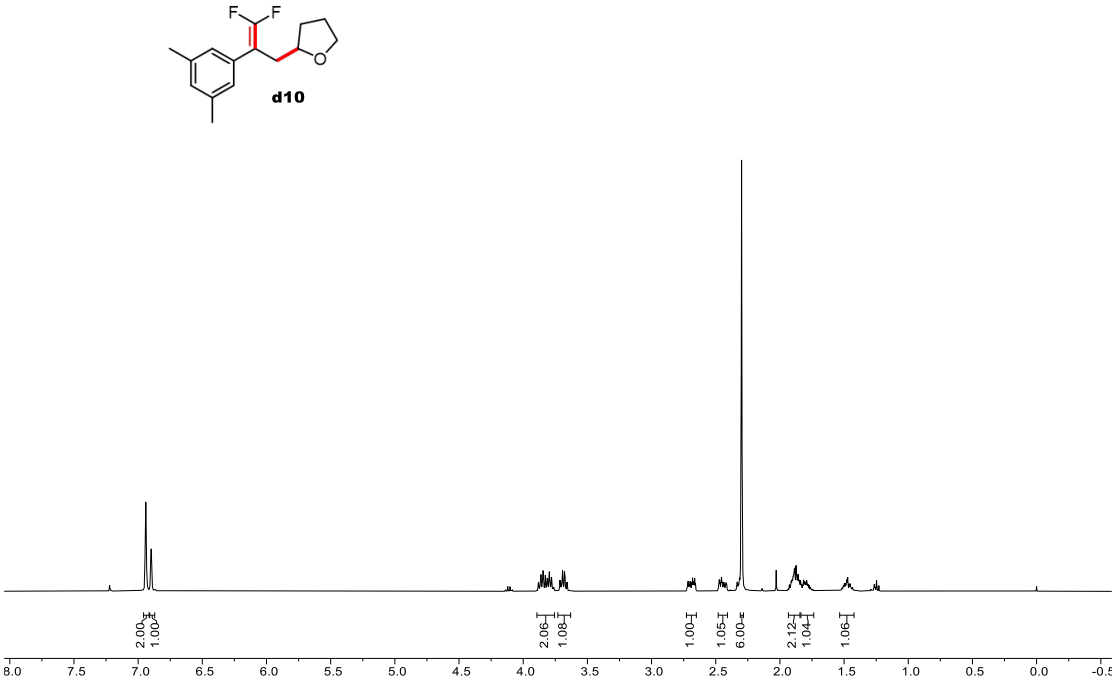

2.13
2.16
2.02
1.03
2.16
1.00
1.00
2.02
1.07
1.06
3.11
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

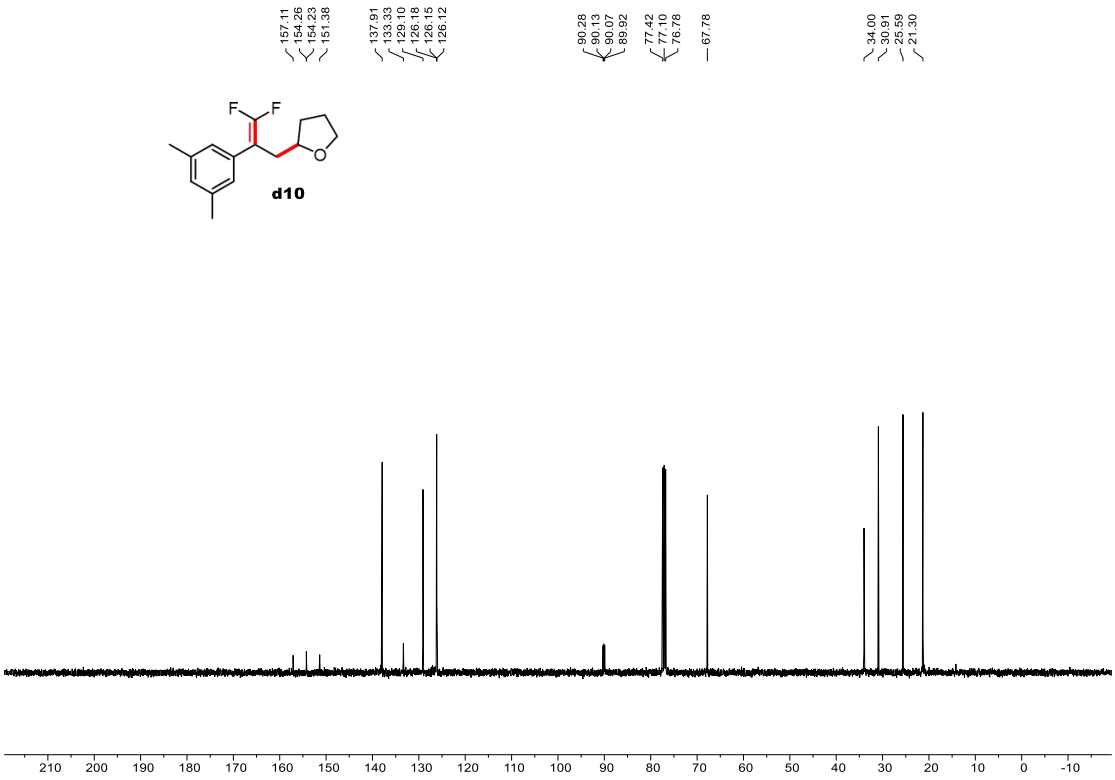
159.17
157.14
154.26
151.39
135.95
130.86
128.74
128.71
128.67
128.59
89.83
89.65
89.47
77.40
77.08
76.75
67.78
33.71
30.93
27.37
25.56
14.32

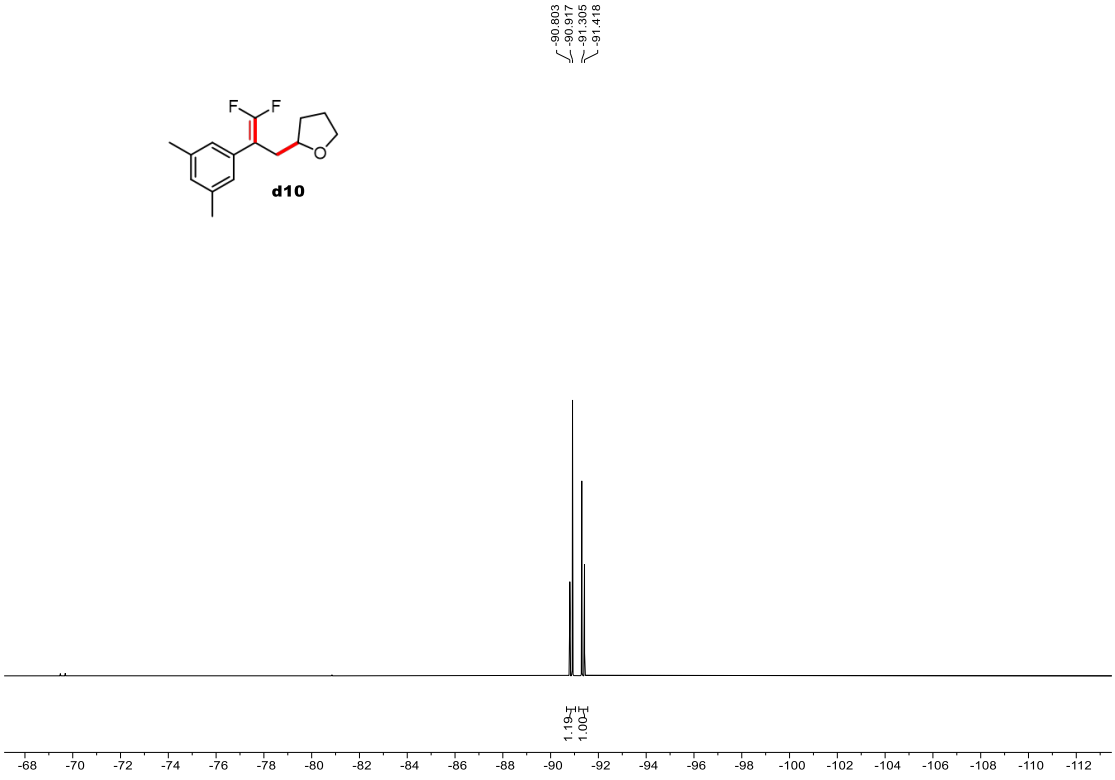

F
F
O
S
d9

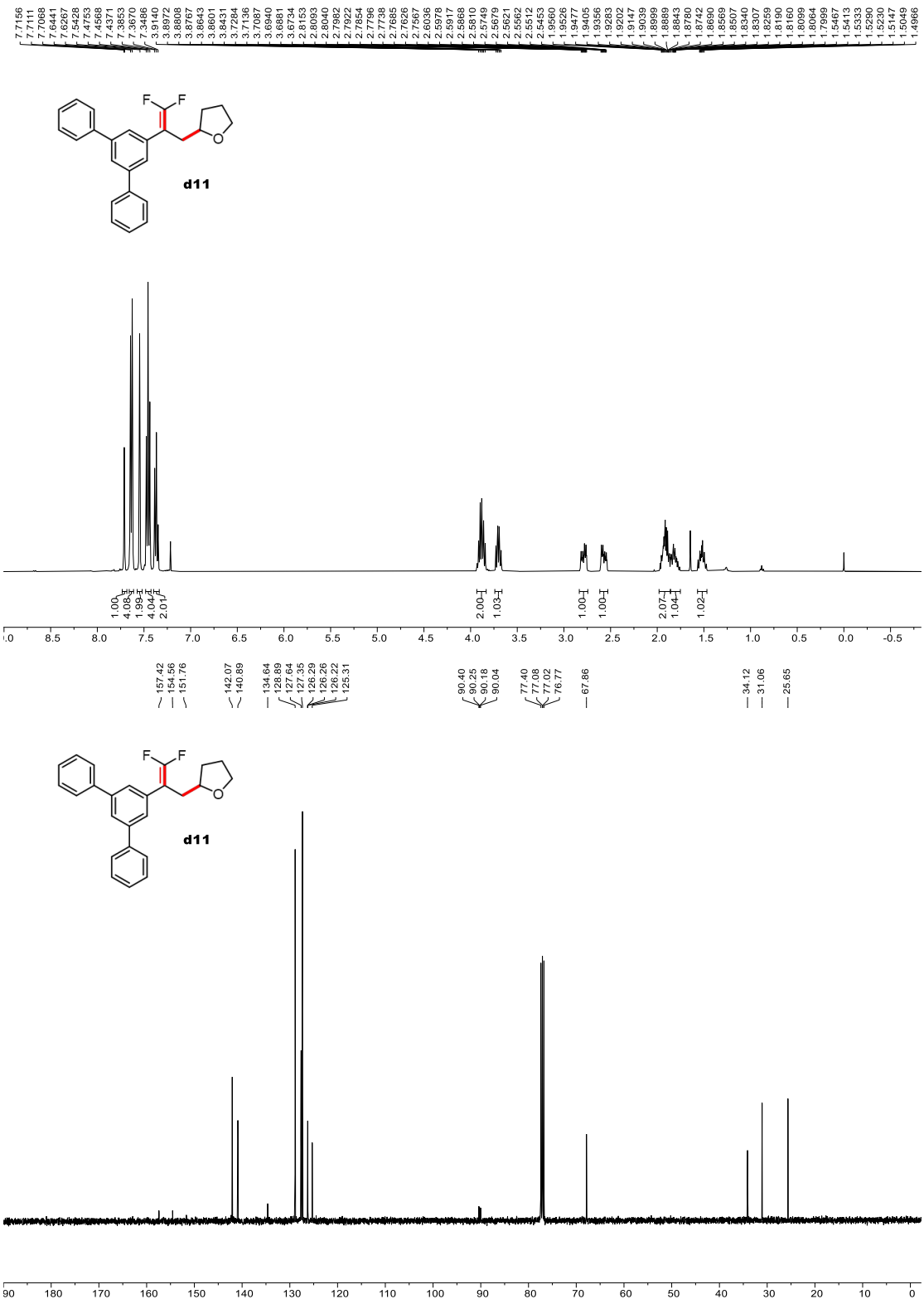

190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

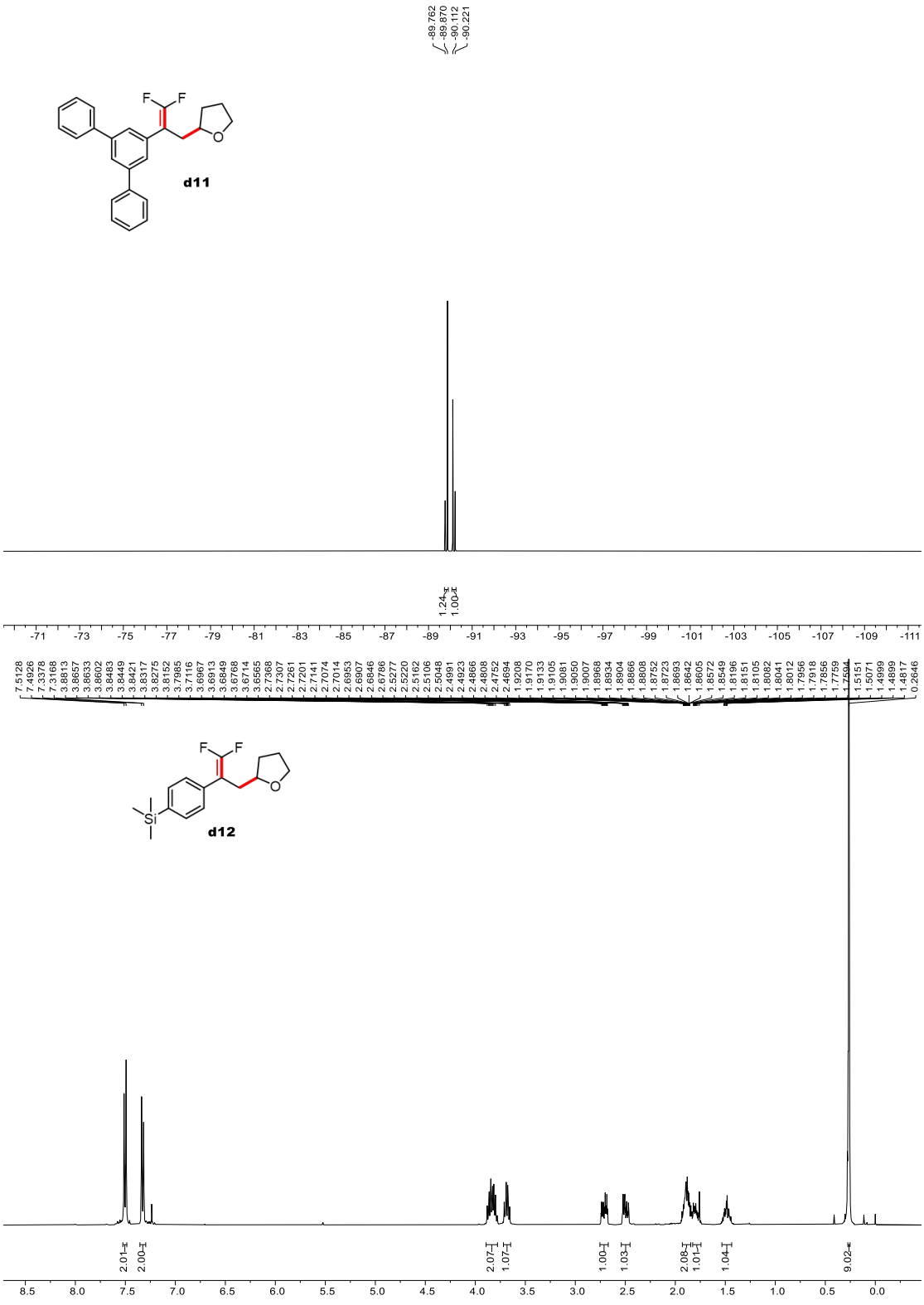

-90.153
F
F
O
S
d9
2.00
-75
-80
-85
-90
-95
-100
-105
-110
-115
6.9405
6.8986
3.8812
3.8703
3.8660
3.8634
3.8602
3.8533
3.8483
3.8450
3.8421
3.8277
3.8135
3.8107
3.7964
3.7796
3.7135
3.6933
3.6788
3.6585
2.7218
2.7157
2.7095
2.7053
2.6992
2.6930
2.6867
2.6806
2.6742
2.6702
2.6641
2.6578
2.4776
2.4731
2.4664
2.4600
2.4555
2.4488
2.4424
2.4380
2.4312
2.4248
2.4204
2.4135
2.2986
1.9265
1.9183
1.9142
1.9112
1.9052
1.9027
1.8984
1.8944
1.8907
1.8871
1.8846
1.8744
1.8697
1.8671
1.8626
1.8578
1.8513
1.8473
1.8225
1.8156
1.8111
1.8066
1.8003
1.7973
1.7915
1.7881
1.7817
1.7786
1.7721
1.5053
1.4970
1.4895
1.4800
1.4718
1.4539

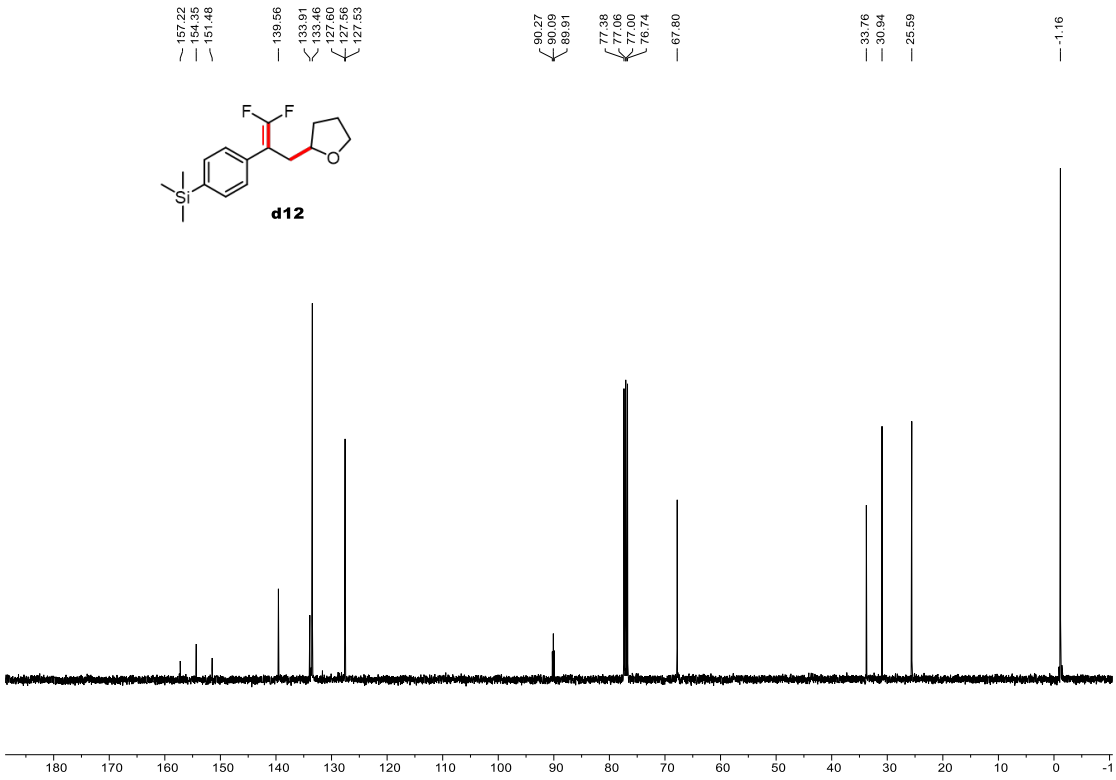

F
F
O
d10
2.00
1.00
2.06
1.08
1.00
1.05
6.00
2.12
1.04
1.06
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

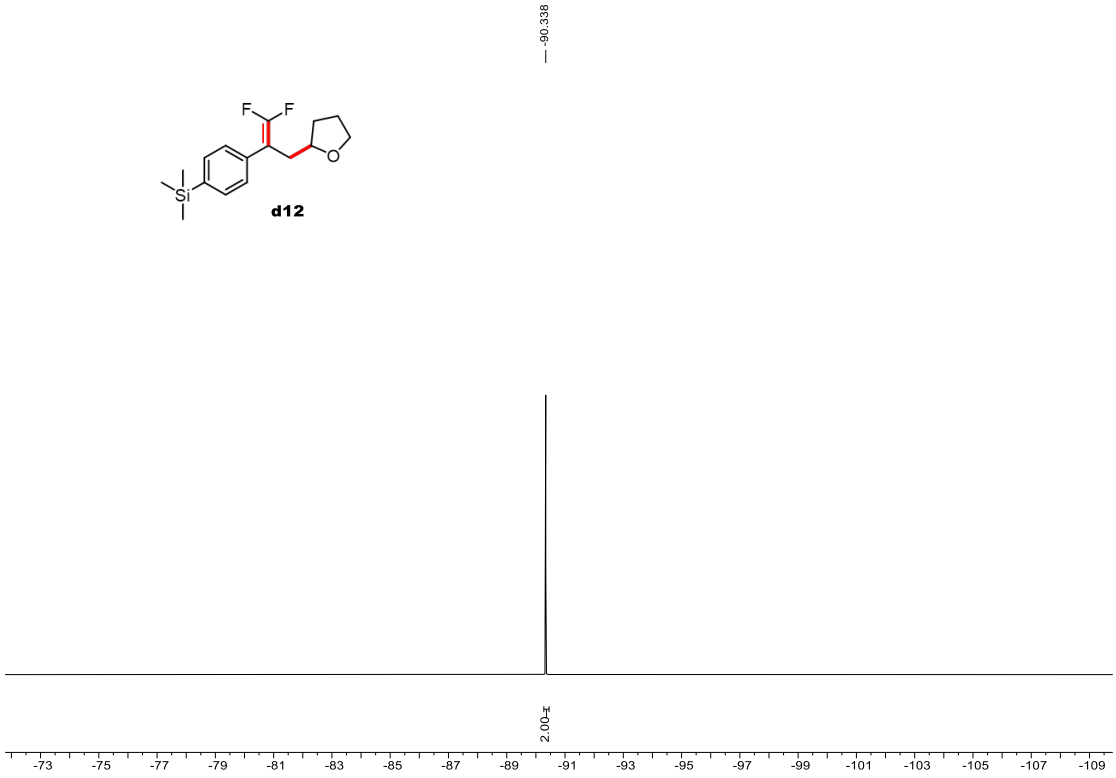

157.11
154.26
154.23
151.38
137.91
133.33
129.10
126.18
126.15
126.12
90.28
90.13
90.07
89.92
77.42
77.10
76.78
67.78
34.00
30.91
25.59
21.30
F
F
O
d10
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10


-90.803
-90.917
-91.305
-91.418
F
F
O
d10
1.19
1.00
-68 -70 -72 -74 -76 -78 -80 -82 -84 -86 -88 -90 -92 -94 -96 -98 -100 -102 -104 -106 -108 -110 -112

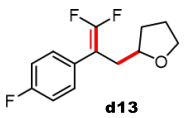

d11
d11


-89.762
-89.870
-90.112
-90.221
F
F
O
d11
1.24
1.00
-71 -73 -75 -77 -79 -81 -83 -85 -87 -89 -91 -93 -95 -97 -99 -101 -103 -105 -107 -109 -111
7.5128
7.4926
7.3378
7.3168
3.8813
3.8657
3.8633
3.8602
3.8483
3.8449
3.8421
3.8317
3.8275
3.8152
3.7985
3.7716
3.6967
3.6913
3.6849
3.6768
3.6714
3.5565
2.7369
2.7307
2.7261
2.7201
2.7141
2.7074
2.7014
2.6953
2.6907
2.6846
2.6786
2.5277
2.5220
2.5162
2.5106
2.5048
2.4991
2.4923
2.4866
2.4808
2.4752
2.4694
1.9208
1.9170
1.9133
1.9105
1.9081
1.9050
1.9007
1.8968
1.8934
1.8904
1.8866
1.8808
1.8752
1.8723
1.8693
1.8642
1.8605
1.8572
1.8549
1.8196
1.8151
1.8105
1.8052
1.8041
1.8012
1.7956
1.7918
1.7856
1.7759
1.7594
1.5151
1.5071
1.4999
1.4899
1.4817
0.2646
F
F
O
Si
d12
2.01
2.00
2.07
1.07
1.00
1.03
2.08
1.01
1.04
9.02
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

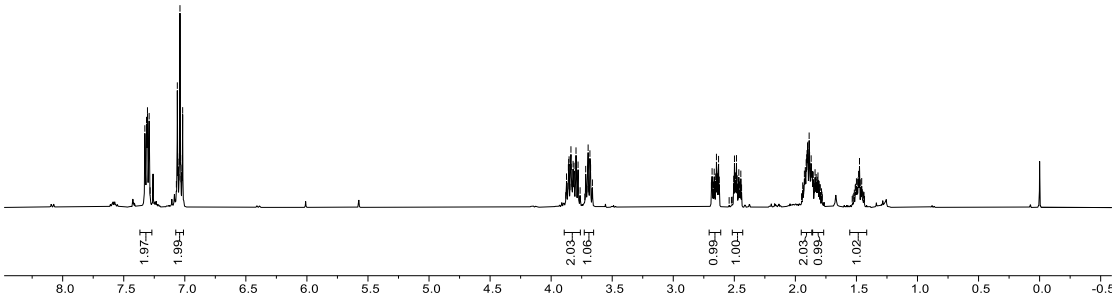

157.22
154.35
151.48
139.56
133.91
133.46
127.60
127.56
127.53
90.27
90.09
89.91
77.38
77.06
77.00
76.74
67.80
33.76
30.94
25.59
-1.16
F
F
O
Si
d12
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

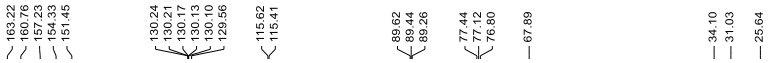

-90.338
F
F
O
Si
d12
2.00
-73
-75
-77
-79
-81
-83
-85
-87
-89
-91
-93
-95
-97
-99
-101
-103
-105
-107
-109

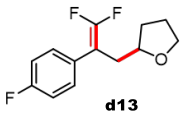

7.3272
7.3219
7.3135
7.3056
7.2970
7.2919
7.0689
7.0612
7.0555
7.0476
7.0445
7.0394
7.0341
7.0312
7.0229
7.0176
3.8744
3.8590
3.8562
3.8532
3.8415
3.8379
3.8352
3.8307
3.8205
3.8128
3.7964
3.7797
3.7173
3.7025
3.6971
3.6825
3.6769
3.6620
2.6821
2.6647
2.6521
2.6463
2.6405
2.6349
2.6290
2.6232
2.5050
2.4988
2.4927
2.4886
2.4825
2.4764
2.4631
2.4467
1.9262
1.9189
1.9166
1.9116
1.9075
1.9044
1.9006
1.8983
1.8952
1.8874
1.8836
1.8810
1.8766
1.8709
1.8536
1.8348
1.8246
1.8200
1.8237
1.8207
1.8151
1.8114
1.8052
1.5000
1.4930
1.4865
1.4826
1.4750
1.4649
1.4569


F
F
F
O

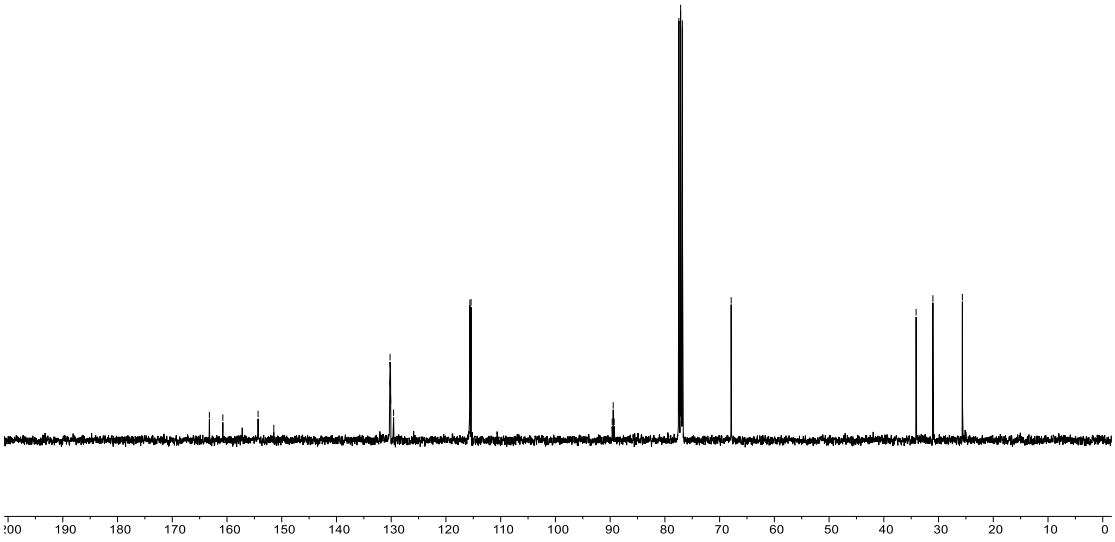
d13

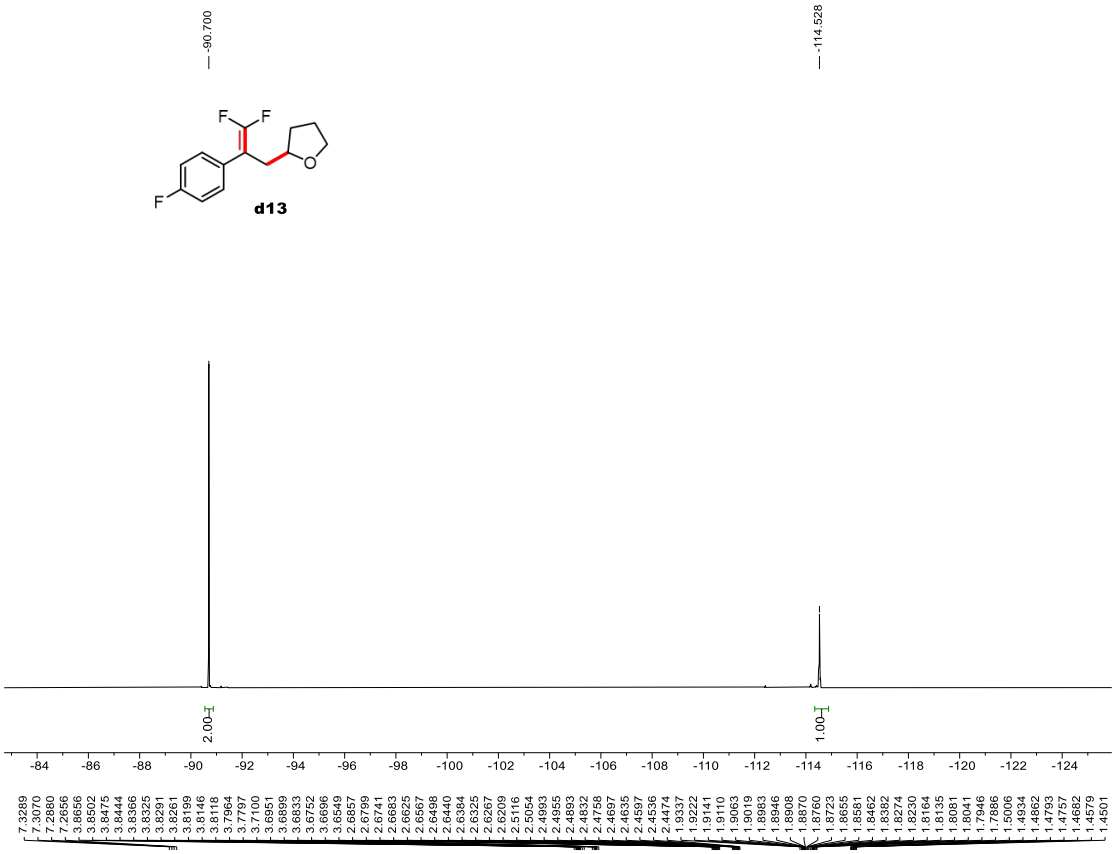

1.97
1.99
2.03
1.06
0.99
1.00
2.03
0.99
1.02
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

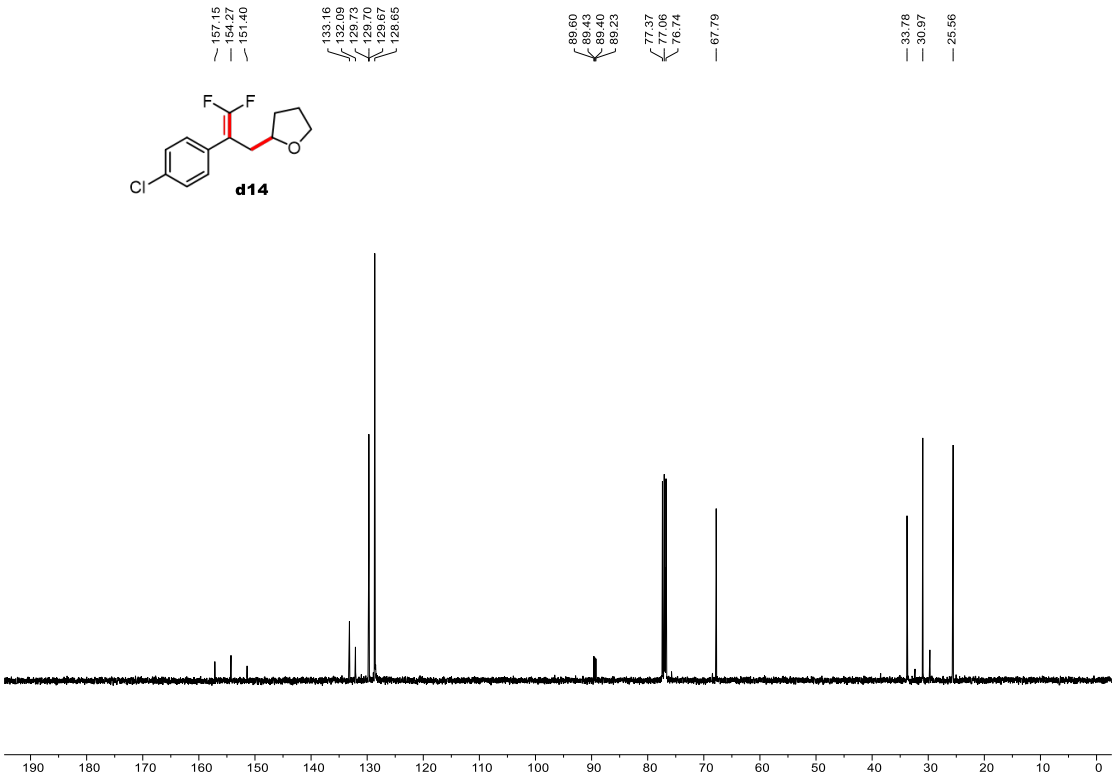

163.22
160.76
157.23
154.33
151.45
130.24
130.21
130.17
130.13
130.10
129.56
115.62
115.41
89.62
89.44
89.26
77.44
77.12
76.80
67.89
34.10
31.03
25.64

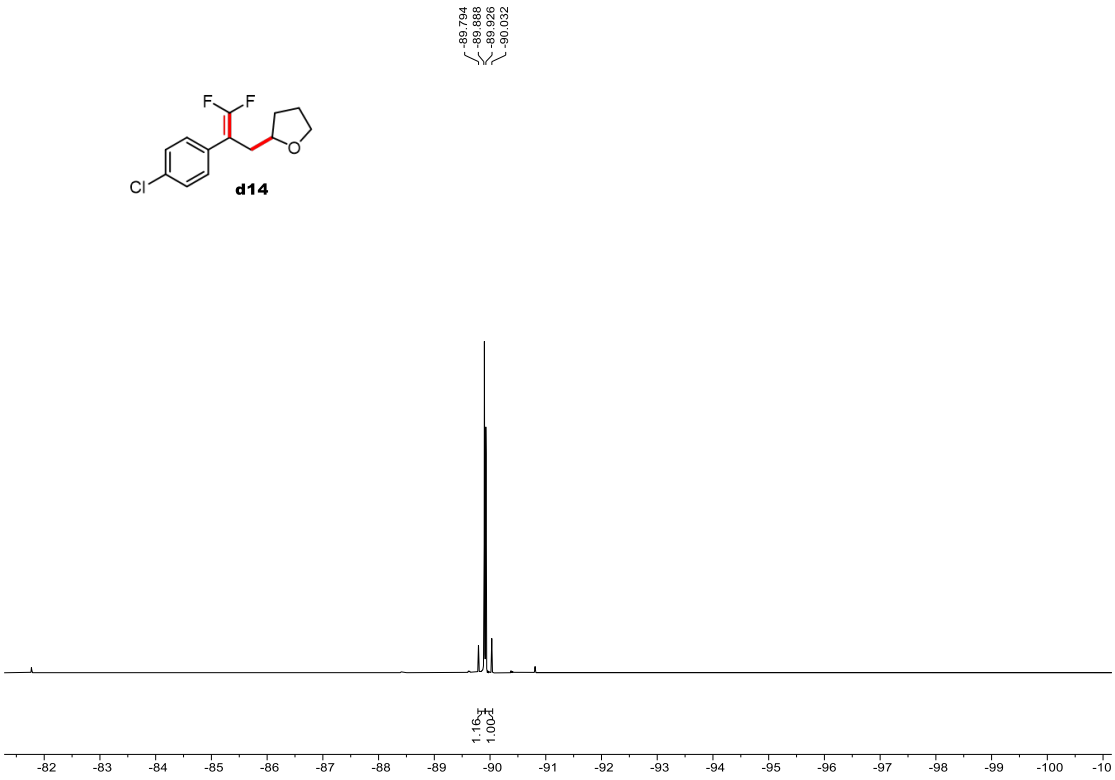

F
F
F
O

d13

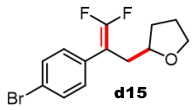

200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

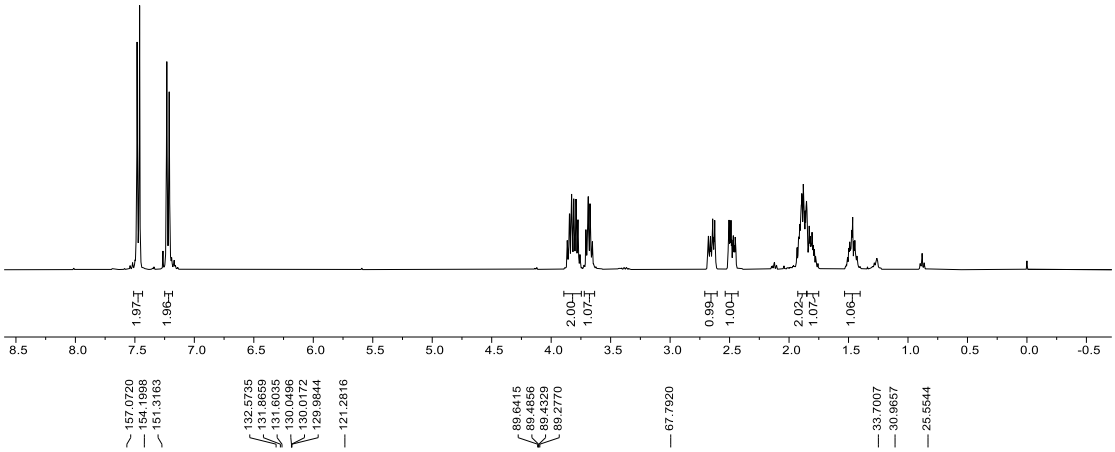

-90.700
-114.528
F
F
F
O
d13
2.00
1.00
-84
-86
-88
-90
-92
-94
-96
-98
-100
-102
-104
-106
-108
-110
-112
-114
-116
-118
-120
-122
-124
7.3289
7.3070
7.2880
7.2656
3.8656
3.8502
3.8475
3.8444
3.8366
3.8325
3.8291
3.8261
3.8199
3.8146
3.8118
3.7964
3.7797
3.7100
3.6951
3.6899
3.6853
3.6752
3.6696
3.6549
3.6857
2.6799
2.6741
2.6683
2.6625
2.6567
2.6498
2.6440
2.6384
2.6325
2.6267
2.6209
2.5116
2.5054
2.4993
2.4955
2.4893
2.4832
2.4758
2.4697
2.4635
2.4597
2.4536
2.4474
1.9337
1.9222
1.9141
1.9110
1.9063
1.9019
1.8983
1.8946
1.8908
1.8870
1.8760
1.8723
1.8655
1.8581
1.8462
1.8382
1.8274
1.8230
1.8164
1.8135
1.8081
1.8041
1.7946
1.7886
1.5006
1.4934
1.4862
1.4793
1.4757
1.4682
1.4579
1.4501
F
F
Cl
O
d14
2.01
2.05
2.00
1.06
1.00
1.03
2.13
1.06
1.03
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5


157.15
154.27
151.40
133.16
132.09
129.73
129.70
129.67
128.65
89.60
89.43
89.40
89.23
77.37
77.06
76.74
67.79
33.78
30.97
25.56
F
F
O
Cl
d14
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

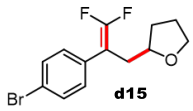

-89.794
-89.888
-89.926
-90.032
F
F
O
Cl
d14
1.16
1.00
-82
-83
-84
-85
-86
-87
-88
-89
-90
-91
-92
-93
-94
-95
-96
-97
-98
-99
-100
-10

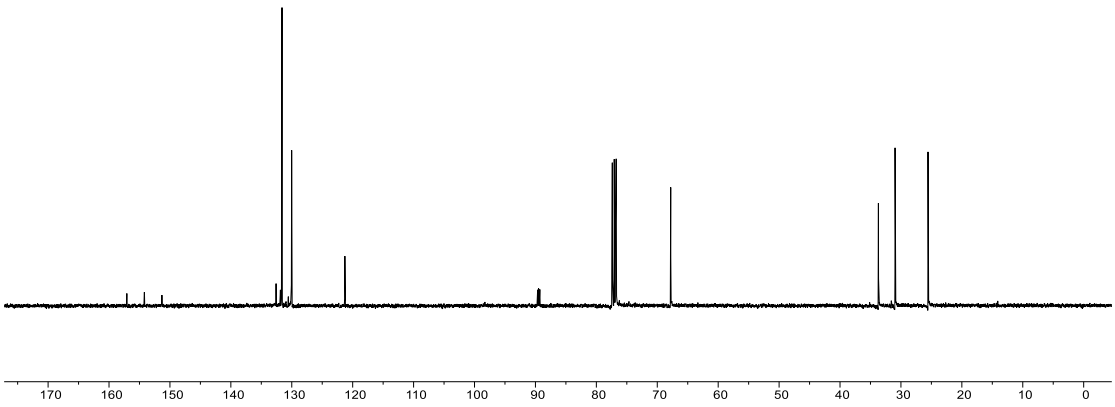

7.4814
7.4601
7.2306
7.2120
3.8646
3.8492
3.8467
3.8436
3.8316
3.8281
3.8249
3.8106
3.8068
3.7911
3.7744
3.7577
3.7082
3.6995
3.6932
3.6883
3.6613
3.6735
3.6579
3.6564
3.6532
2.6837
2.6780
2.6722
2.6662
2.6606
2.6548
2.6479
2.6421
2.6364
2.6304
2.6247
2.6190
2.5106
2.5045
2.4981
2.4946
2.4883
2.4821
2.4748
2.4685
2.4623
2.4588
2.4526
2.4464
1.9205
1.9167
1.9098
1.9042
1.9002
1.8968
1.8931
1.8898
1.8803
1.8743
1.8700
1.8637
1.8535
1.8304
1.8262
1.8215
1.8151
1.8124
1.8066
1.8028
1.7965
1.7936
1.7871
1.4981
1.4901
1.4830
1.4728
1.4649
1.4548
1.4468
1.4417

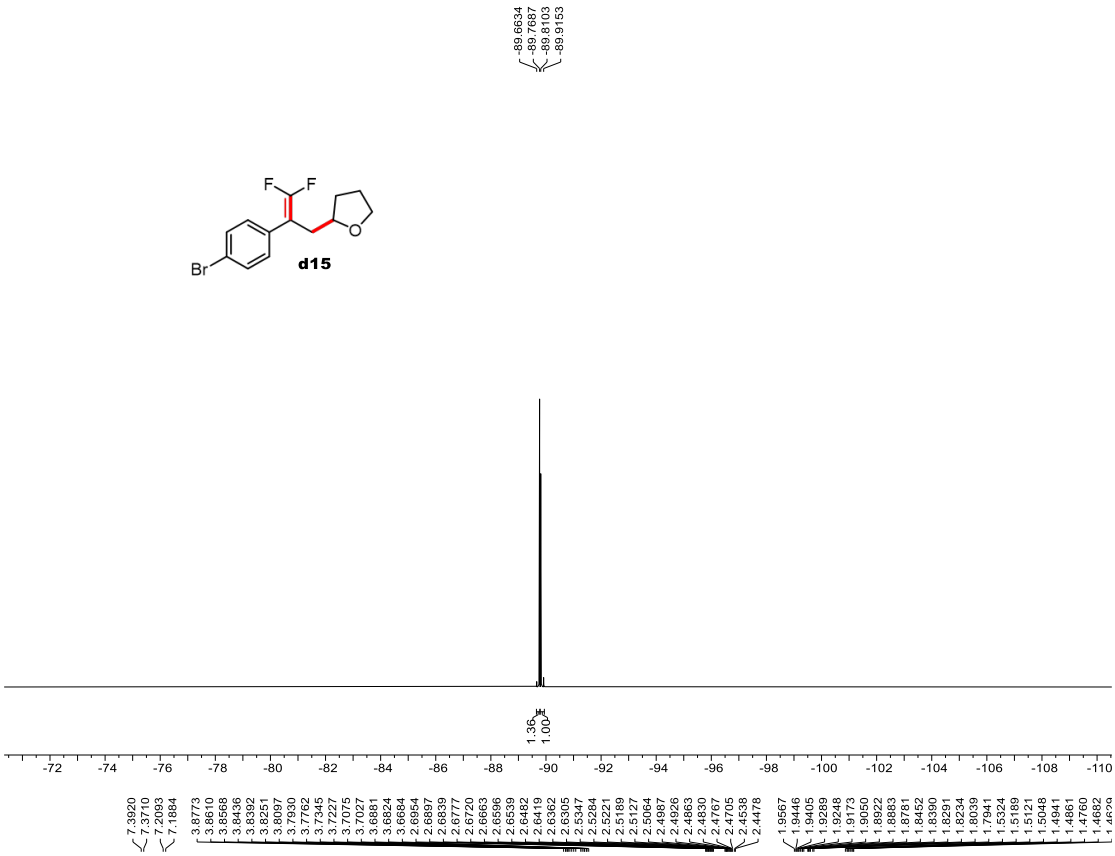

F
F
O
Br
d15

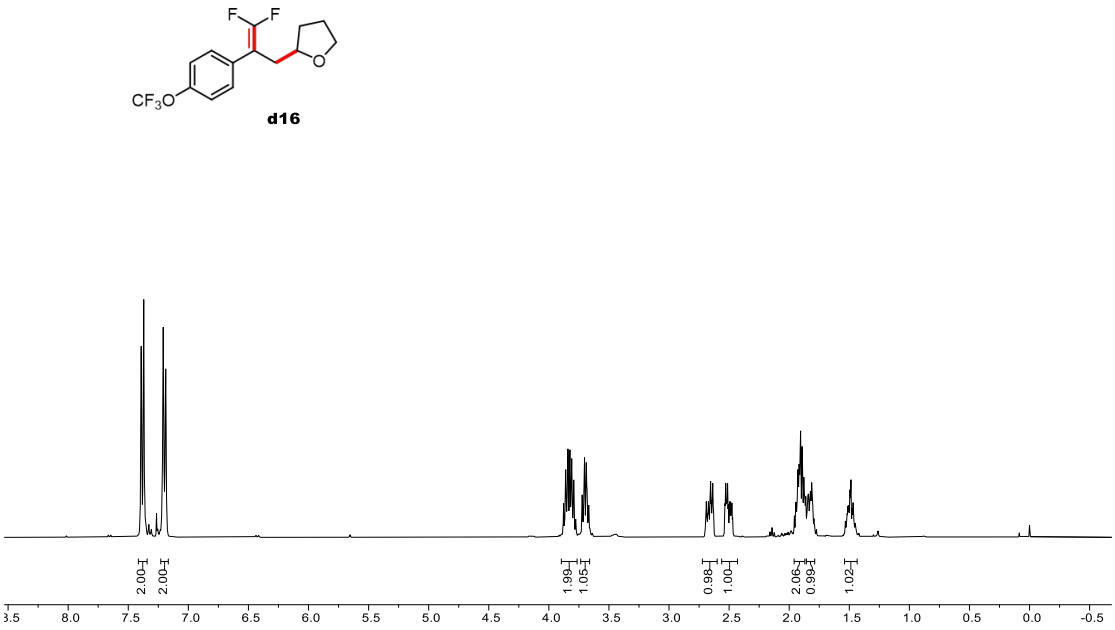

1.97
1.96
2.00
1.07
0.99
1.00
2.02
1.07
1.06
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

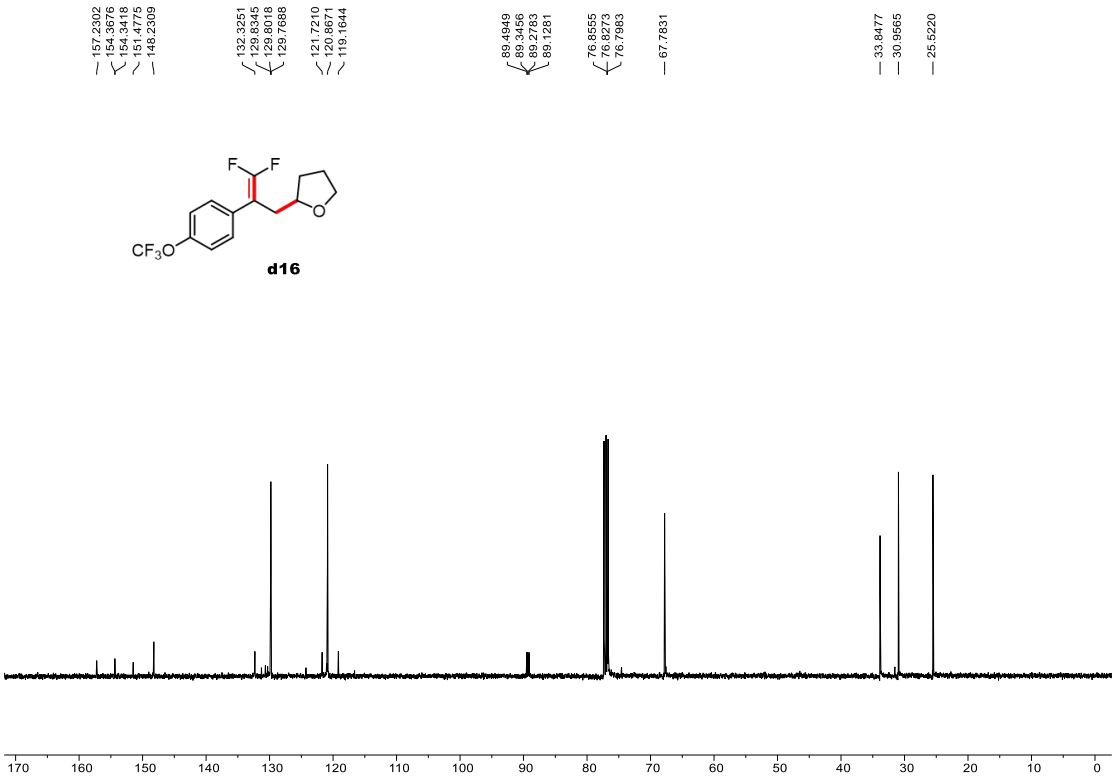
157.0720
154.1998
151.3163
132.5735
131.8659
131.6035
130.0496
130.0172
129.9844
121.2816
89.6415
89.4856
89.4329
89.2770
67.7920
33.7007
30.9657
25.5544

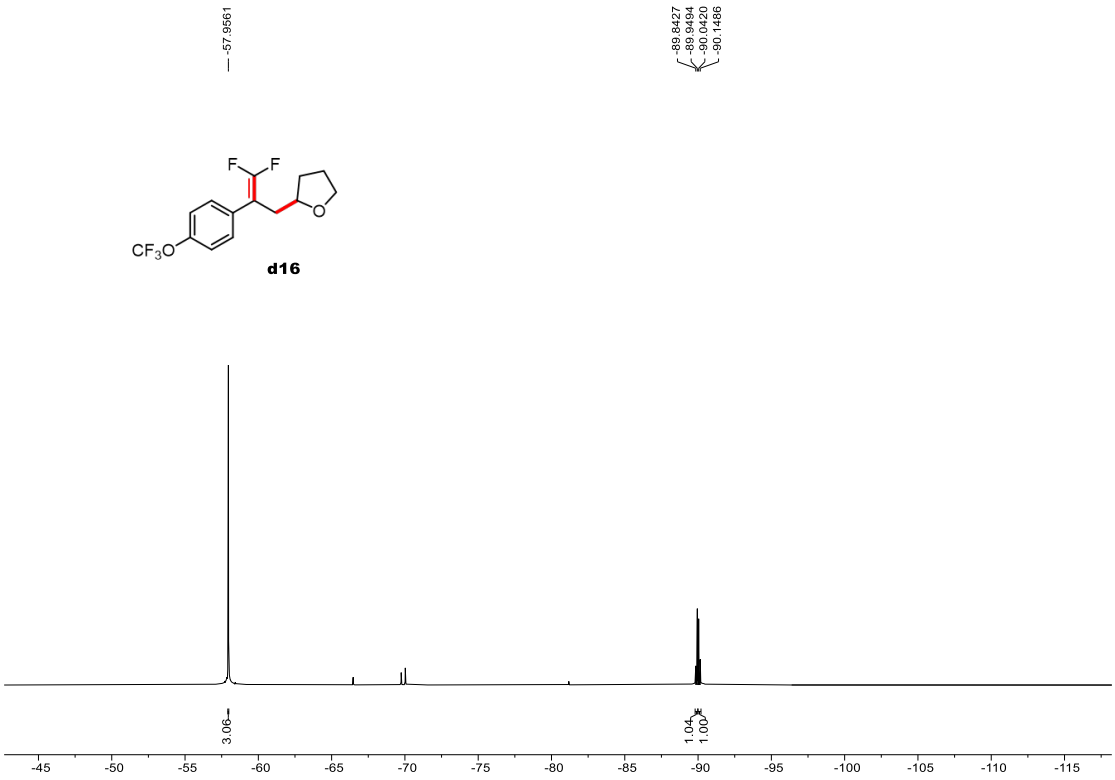

F
F
O
Br
d15


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

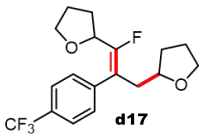

-89.6634
-89.7687
-89.8103
-89.9153
F
F
Br
O
d15
1.36
1.00
-72 -74 -76 -78 -80 -82 -84 -86 -88 -90 -92 -94 -96 -98 -100 -102 -104 -106 -108 -110
7.3920
7.3710
7.2093
7.1884
3.8773
3.8610
3.8568
3.8436
3.8392
3.8251
3.8097
3.7930
3.7762
3.7345
3.7227
3.7075
3.7027
3.6881
3.6824
3.6684
2.6954
2.6897
2.6839
2.6777
2.6720
2.6663
2.6596
2.6539
2.6482
2.6419
2.6362
2.6305
2.5347
2.5284
2.5221
2.5189
2.5127
2.5064
2.4987
2.4926
2.4863
2.4800
2.4737
2.4705
2.4538
2.4478
1.9567
1.9446
1.9405
1.9289
1.9248
1.9173
1.9050
1.8922
1.8883
1.8781
1.8452
1.8390
1.8291
1.8234
1.8039
1.7941
1.5324
1.5189
1.5121
1.5048
1.4941
1.4861
1.4760
1.4682


F
F
CF3O
O
d16
2.00
2.00
1.99
1.05
0.98
1.00
2.06
0.99
1.02
3.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

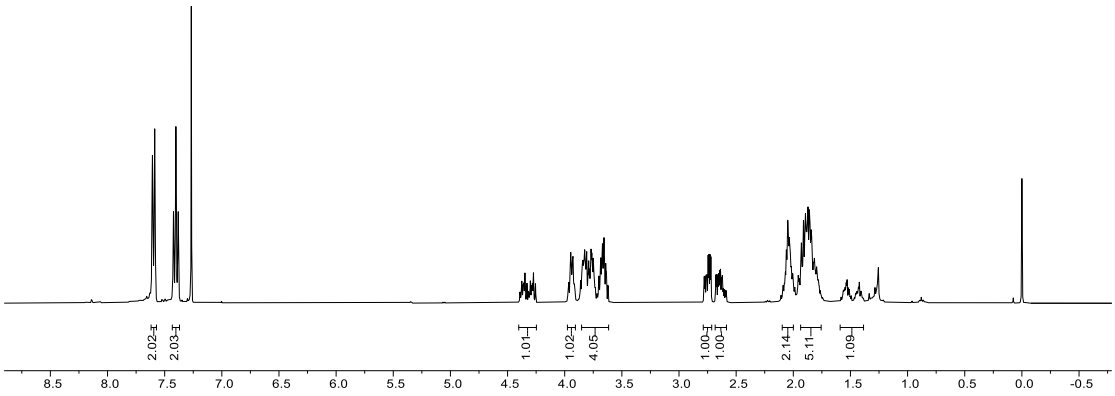

157.2302
154.3676
154.3418
151.4775
148.2309
132.3251
129.8345
129.8018
129.7688
121.7210
120.8671
119.1644
89.4949
89.3466
89.2783
89.1281
76.8555
76.8273
76.7983
67.7831
33.8477
30.9565
25.5220
F
F
O
CF3O
d16
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0


-57.9561
-89.8427
-89.9494
-90.0420
-90.1486
F
F
O
CF3O
d16
3.06
1.04
1.00
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
-105
-110
-115

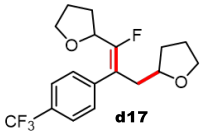

7.6067
7.5869
7.4230
7.4019
7.3814
4.3753
4.3576
4.3480
4.3301
4.3007
4.2829
4.2734
3.9645
3.9533
3.9469
3.9326
3.9269
3.9164
3.8508
3.8458
3.8397
3.8239
3.8203
3.8244
3.8155
3.8076
3.7945
3.7900
3.7826
3.7750
3.7696
3.7628
3.7577
3.7506
3.7437
3.7388
3.7015
3.6903
3.6849
3.6764
3.6697
3.6562
3.6501
3.6414
3.6362
2.7792
2.7716
2.7626
2.7551
2.7452
2.7376
2.7287
2.7211
2.6775
2.6704
2.6592
2.6522
2.6447
2.6372
2.6290
2.6210
2.0784
2.0431
2.0347
2.0261
2.0169
2.0047
1.9107
1.8990
1.8940
1.8899
1.8842
1.8777
1.8713
1.8600
1.8545
1.8433
1.5361
1.5290
1.4221


F
O
O
CF3

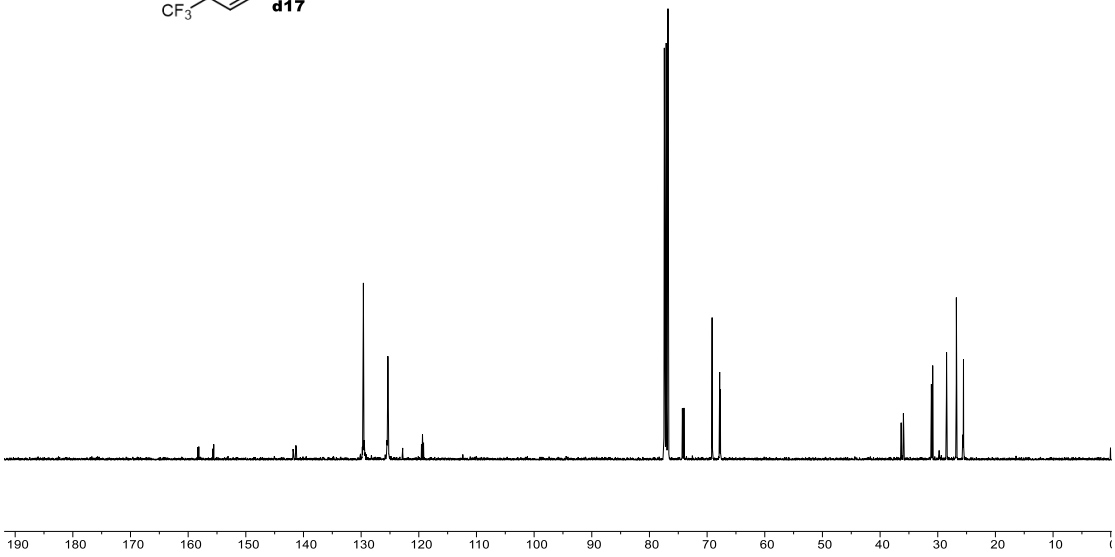
d17

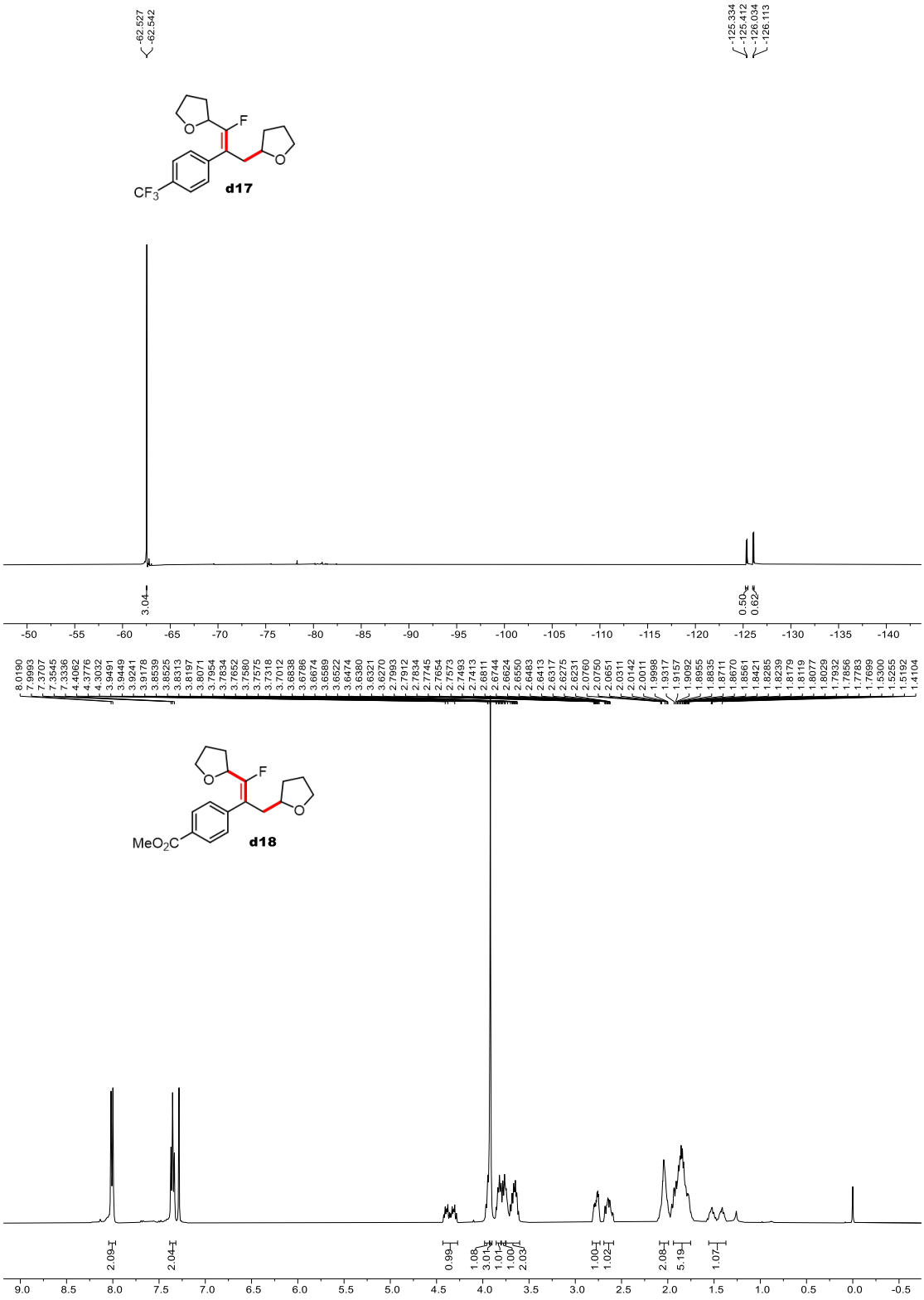

2.02
2.03
1.01
1.02
4.05
1.00
1.00
2.14
5.11
1.09
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

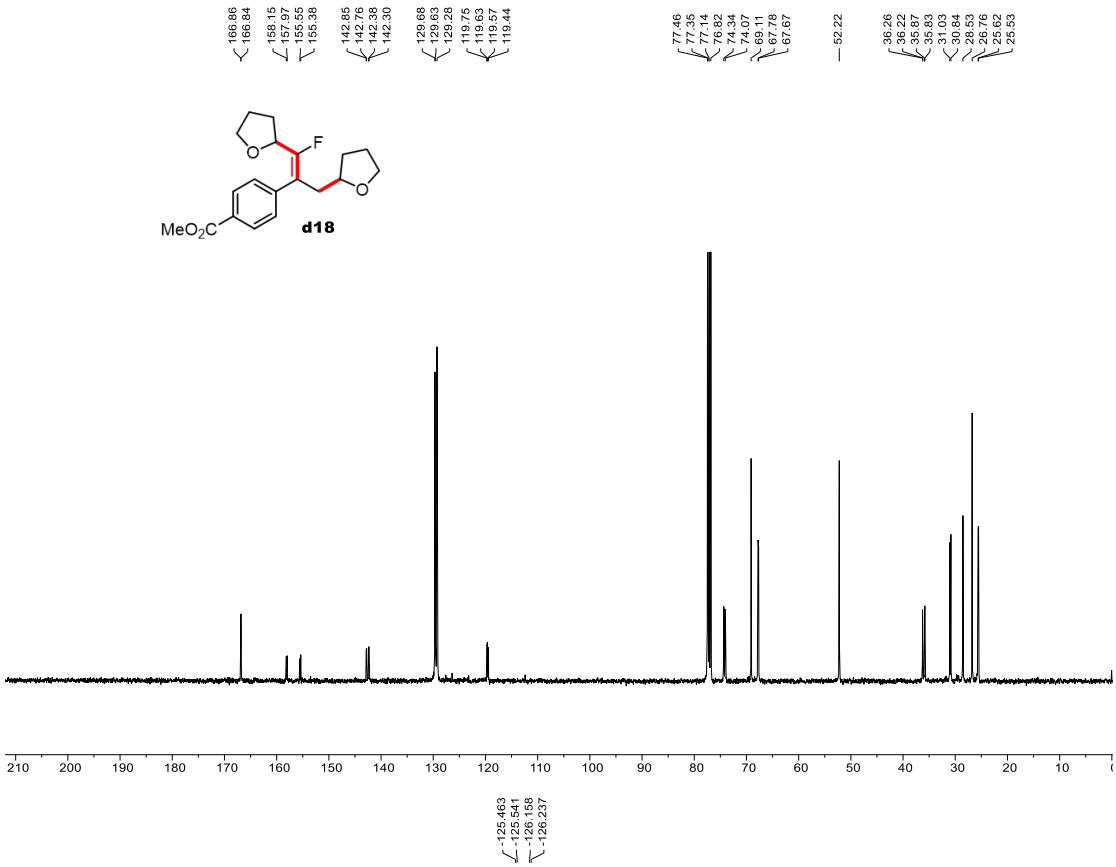

158.31
158.15
155.72
155.56
141.82
141.74
141.33
141.25
129.61
125.40
125.36
125.31
119.54
119.36
119.18
77.42
77.10
76.78
74.28
74.01
69.14
67.82
67.70
36.37
36.33
35.96
35.91
31.10
30.88
28.48
26.78
25.63
25.54

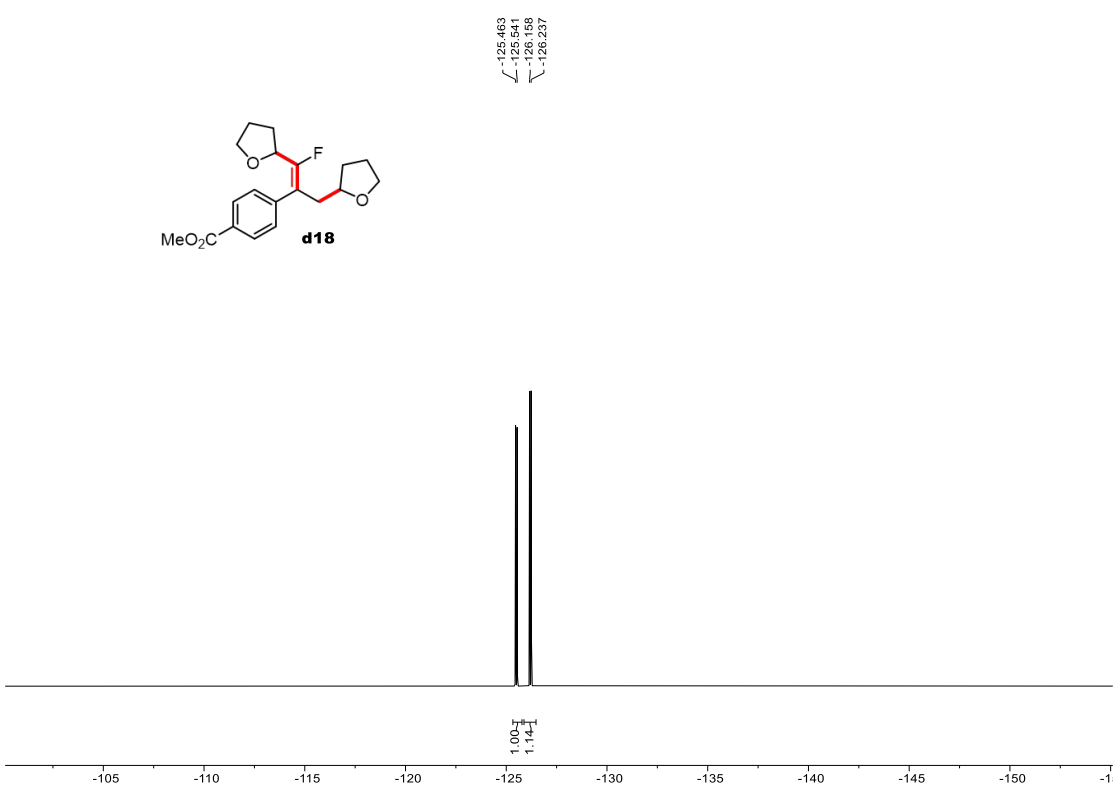

F
O
O
CF3

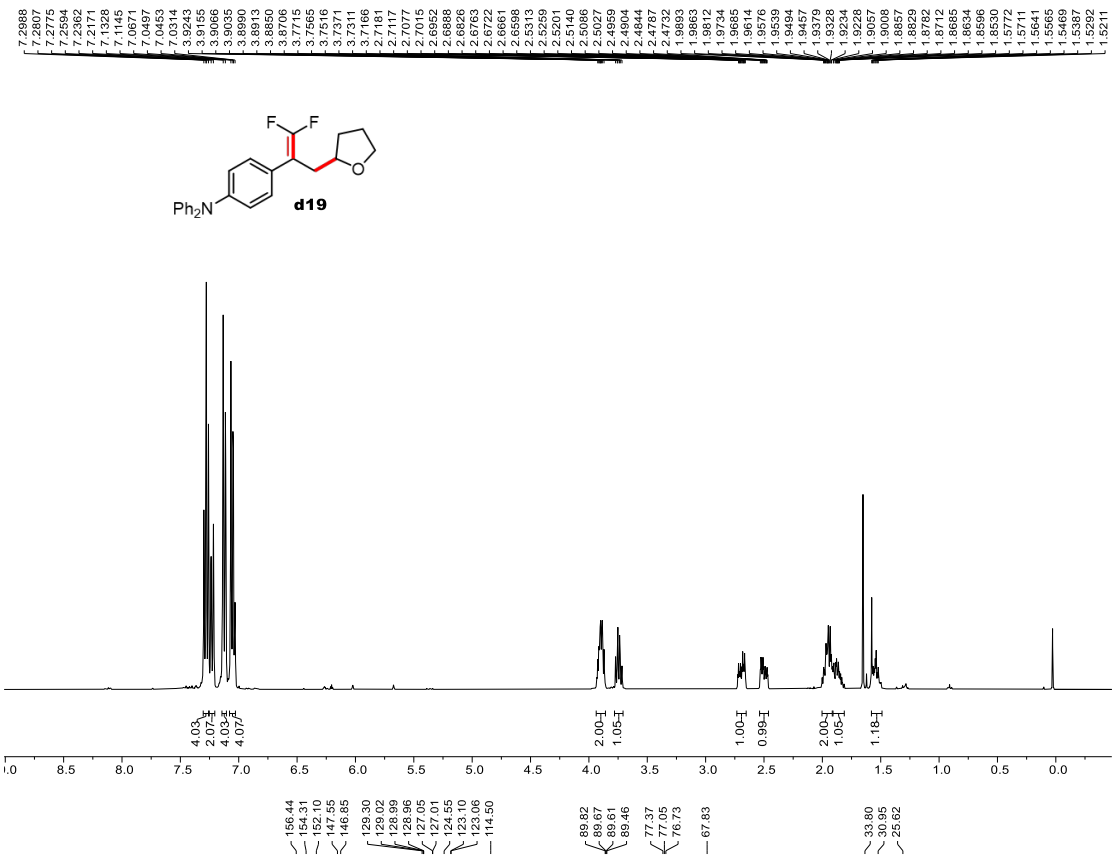
d17

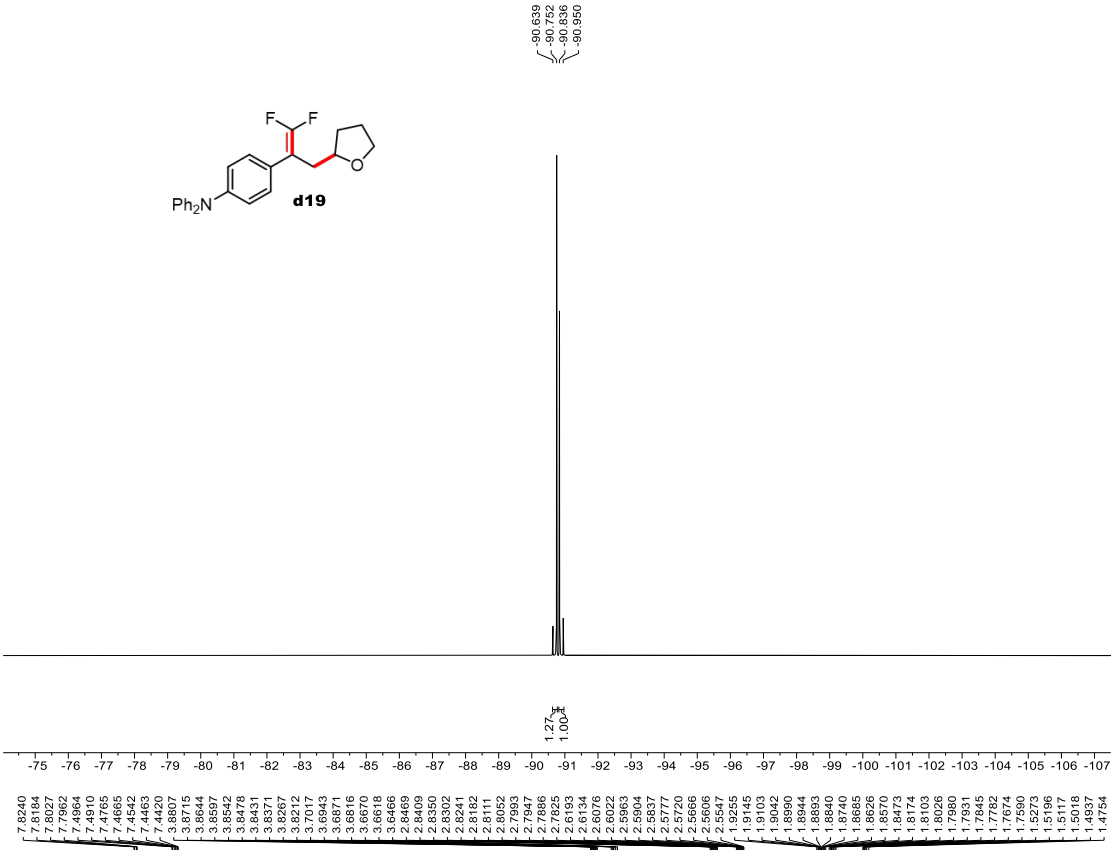

190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

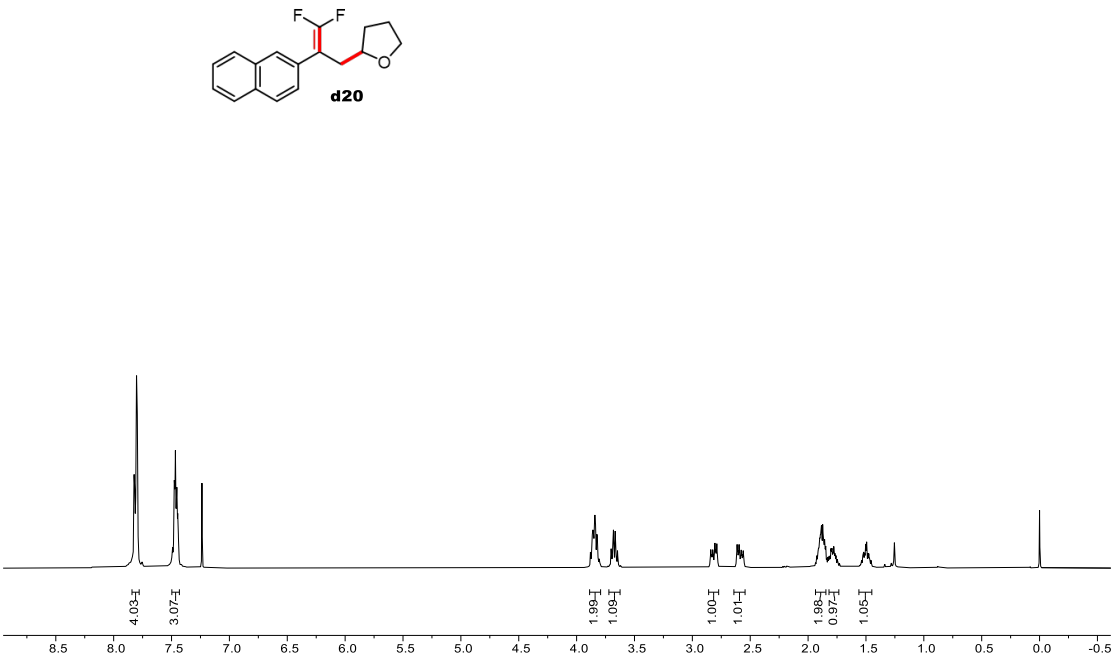

-62.527
-62.542
-125.334
-125.412
-126.034
-126.113
F
O
O
CF3
d17
3.04
0.50
0.62
-50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100 -105 -110 -115 -120 -125 -130 -135 -140
8.0190 7.9993 7.3707 7.3545 7.3336 4.4062 4.3776 4.3032 3.9491 3.9449 3.9241 3.9178 3.8539 3.8525 3.8313 3.8197 3.8071 3.7954 3.7834 3.7682 3.7580 3.7575 3.7518 3.7012 3.6838 3.6786 3.6674 3.6589 3.6522 3.6474 3.6380 3.6321 3.6270 2.7993 2.7912 2.7834 2.7745 2.7654 2.7573 2.7493 2.7413 2.6811 2.6744 2.6624 2.6550 2.6483 2.6413 2.6317 2.6275 2.6231 2.0760 2.0750 2.0651 2.0311 2.0142 2.0011 1.9998 1.9317 1.9157 1.9092 1.8955 1.8835 1.8711 1.8670 1.8561 1.8421 1.8255 1.8239 1.8179 1.8119 1.8077 1.8029 1.7932 1.7856 1.7783 1.7699 1.5300 1.5255 1.5192 1.4104
O
O
F
MeO2C
d18
2.09
2.04
0.99
1.08
3.01
1.01
1.00
2.03
1.00
1.02
2.08
5.19
1.07
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

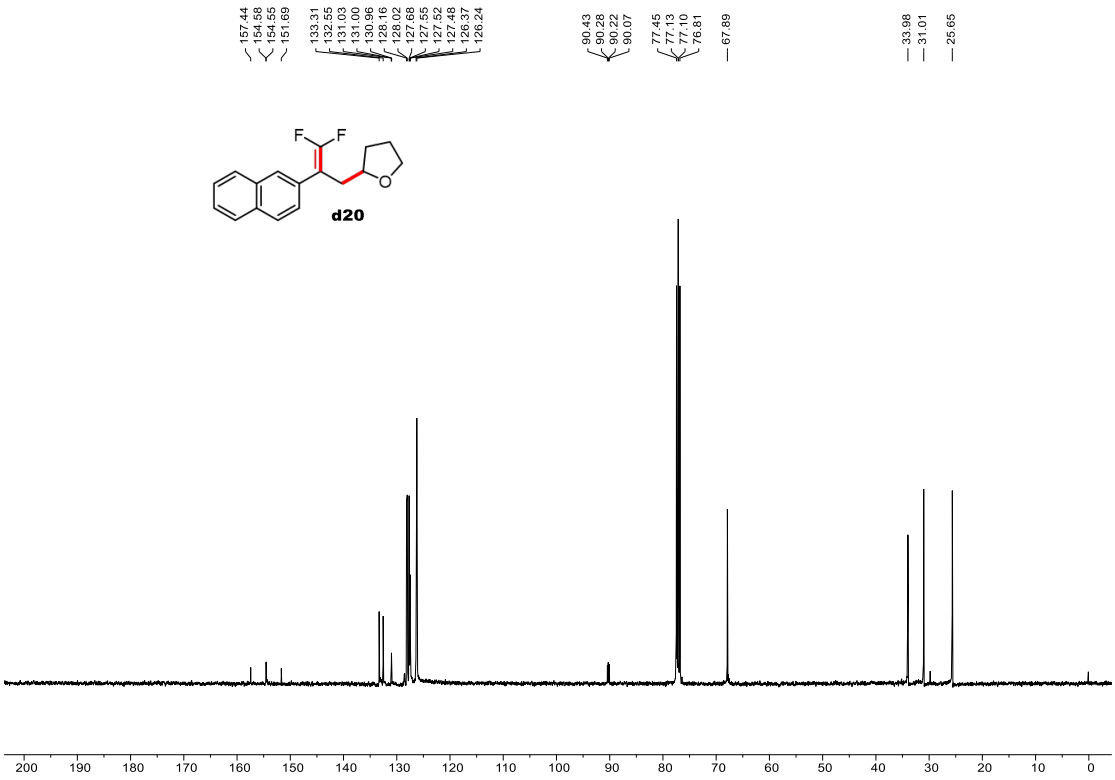

166.86
166.84
158.15
157.97
155.55
155.38
142.85
142.76
142.38
142.30
129.68
129.63
129.28
119.75
119.63
119.57
119.44
77.46
77.35
77.14
76.82
74.34
74.07
69.11
67.78
67.67
52.22
36.26
36.22
35.87
35.83
31.03
30.84
28.53
26.76
25.62
25.53
F
O
O
MeO2C
d18
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

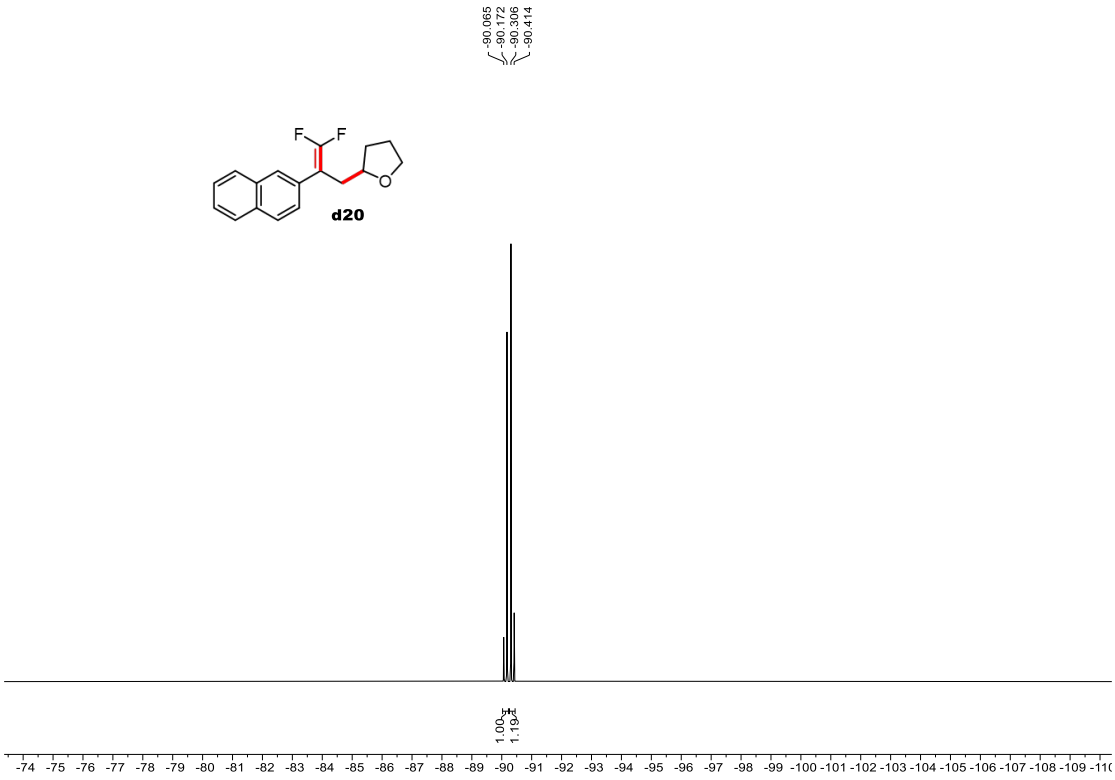

-125.463
-125.541
-126.158
-126.237
F
O
O
MeO2C
d18
1.00
1.14
-105
-110
-115
-120
-125
-130
-135
-140
-145
-150

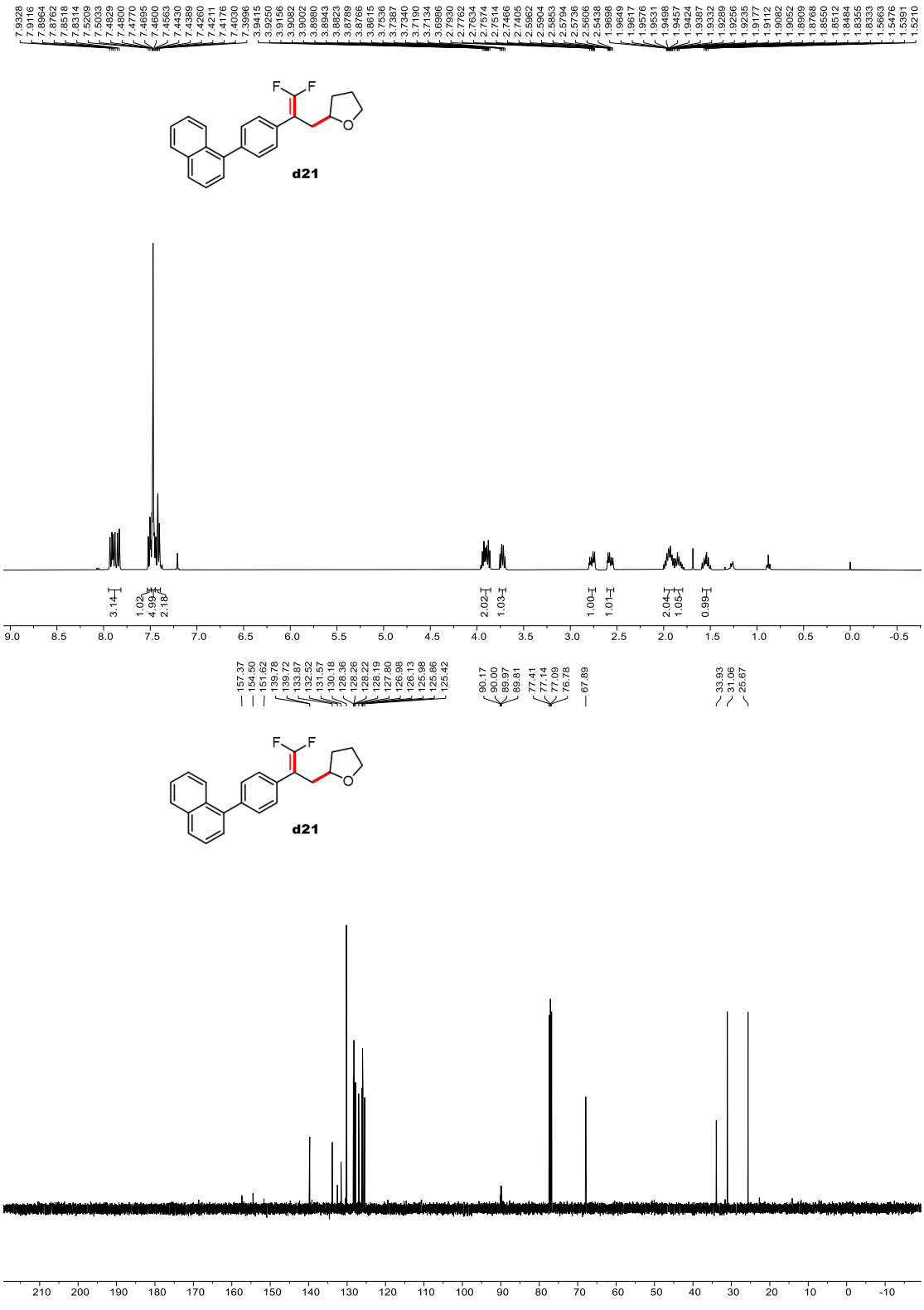

7.2988
7.2807
7.2775
7.2594
7.2362
7.2171
7.1328
7.1145
7.0671
7.0497
7.0453
7.0314
3.9243
3.9155
3.9066
3.9035
3.8990
3.8913
3.8850
3.8706
3.7715
3.7565
3.7516
3.7371
3.7311
3.7166
2.7181
2.7117
2.7077
2.7015
2.6952
2.6888
2.6826
2.6763
2.6722
2.6661
2.6598
2.5313
2.5259
2.5201
2.5140
2.5086
2.5027
2.4959
2.4904
2.4844
2.4787
2.4732
1.9893
1.9863
1.9812
1.9734
1.9685
1.9614
1.9576
1.9539
1.9494
1.9457
1.9379
1.9328
1.9234
1.9228
1.9057
1.9008
1.8857
1.8829
1.8752
1.8712
1.8685
1.8634
1.8596
1.8530
1.5772
1.5711
1.5641
1.5565
1.5469
1.5387
1.5292
1.5211
F
F
O
Ph2N
d19
4.03
2.07
4.03
4.07
2.00
1.05
1.00
0.99
2.00
1.05
1.18
156.44
154.31
152.10
147.55
146.85
129.30
129.02
128.99
128.96
127.05
127.01
124.55
123.10
123.06
114.50
89.82
89.67
89.61
89.46
77.37
77.05
76.73
67.83
33.80
30.95
25.62

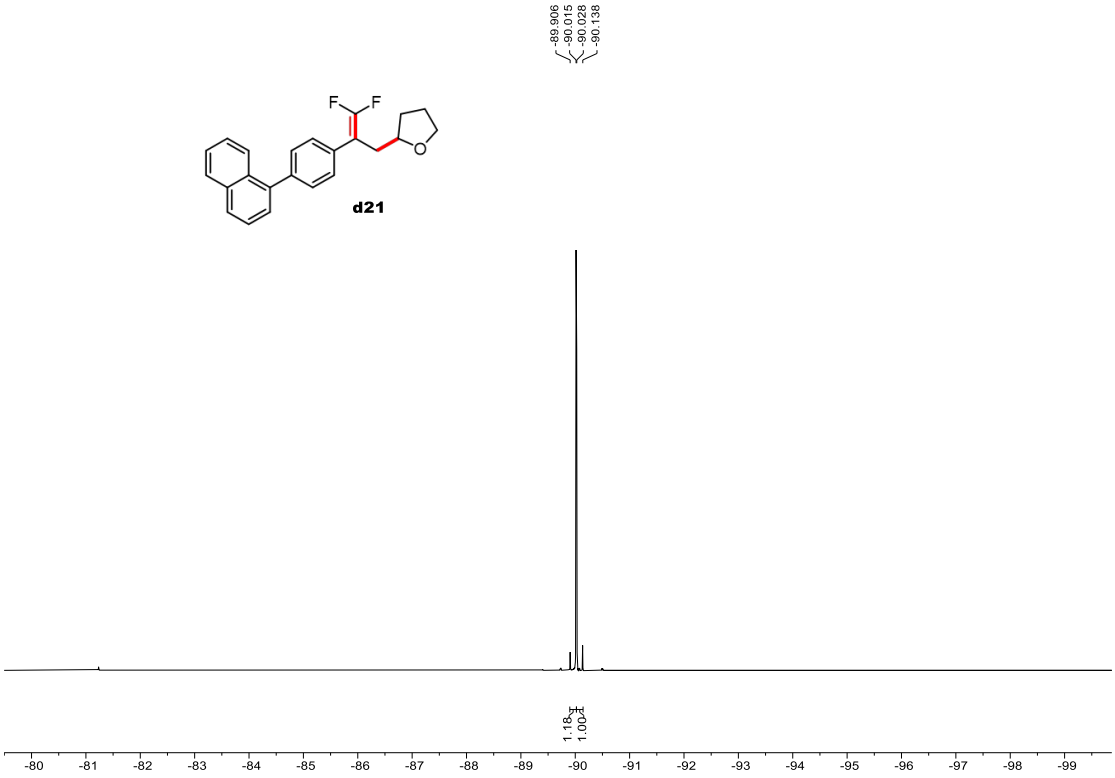

-90.639
-90.752
-90.836
-90.950
F
F
Ph2N
d19
1.27
1.00
-75 -76 -77 -78 -79 -80 -81 -82 -83 -84 -85 -86 -87 -88 -89 -90 -91 -92 -93 -94 -95 -96 -97 -98 -99 -100 -101 -102 -103 -104 -105 -106 -107


F
F
d20
4.03
3.07
1.96
1.09
1.00
1.01
1.98
0.97
1.05
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

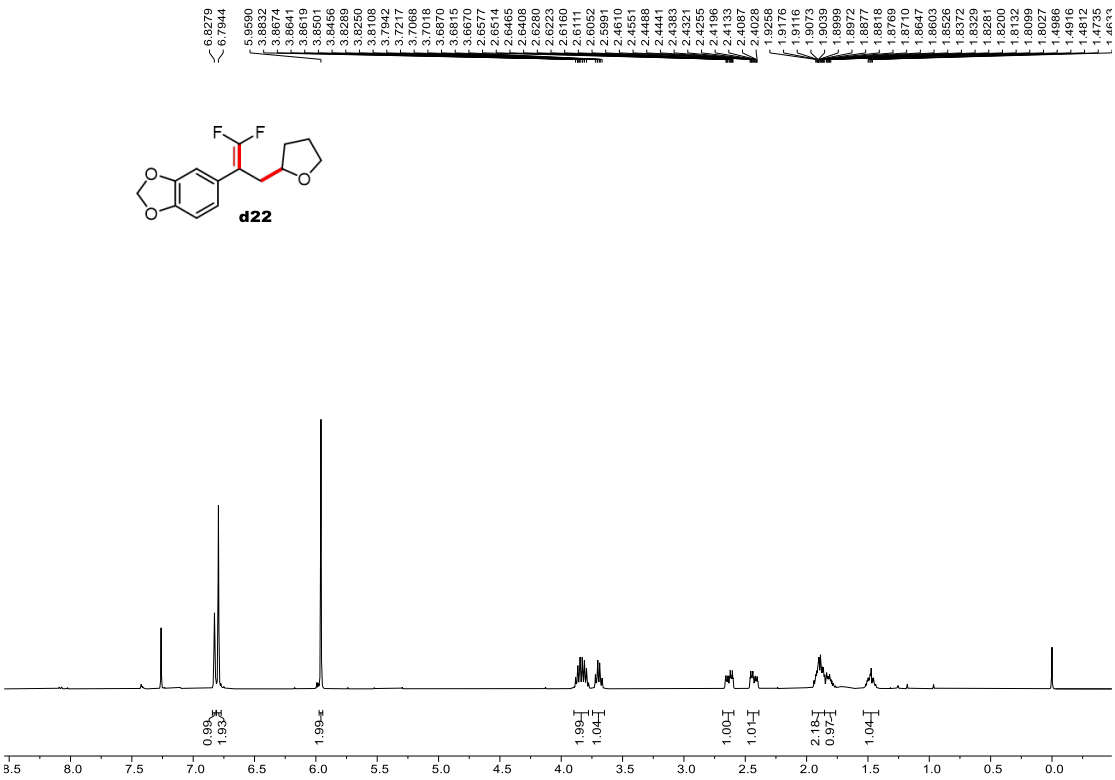

157.44
154.58
154.55
151.69
133.31
132.55
131.03
131.00
130.96
128.16
128.02
127.68
127.55
127.52
127.48
126.37
126.24
90.43
90.28
90.22
90.07
77.45
77.13
77.10
76.81
67.89
33.98
31.01
25.65
F
F
O
d20
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

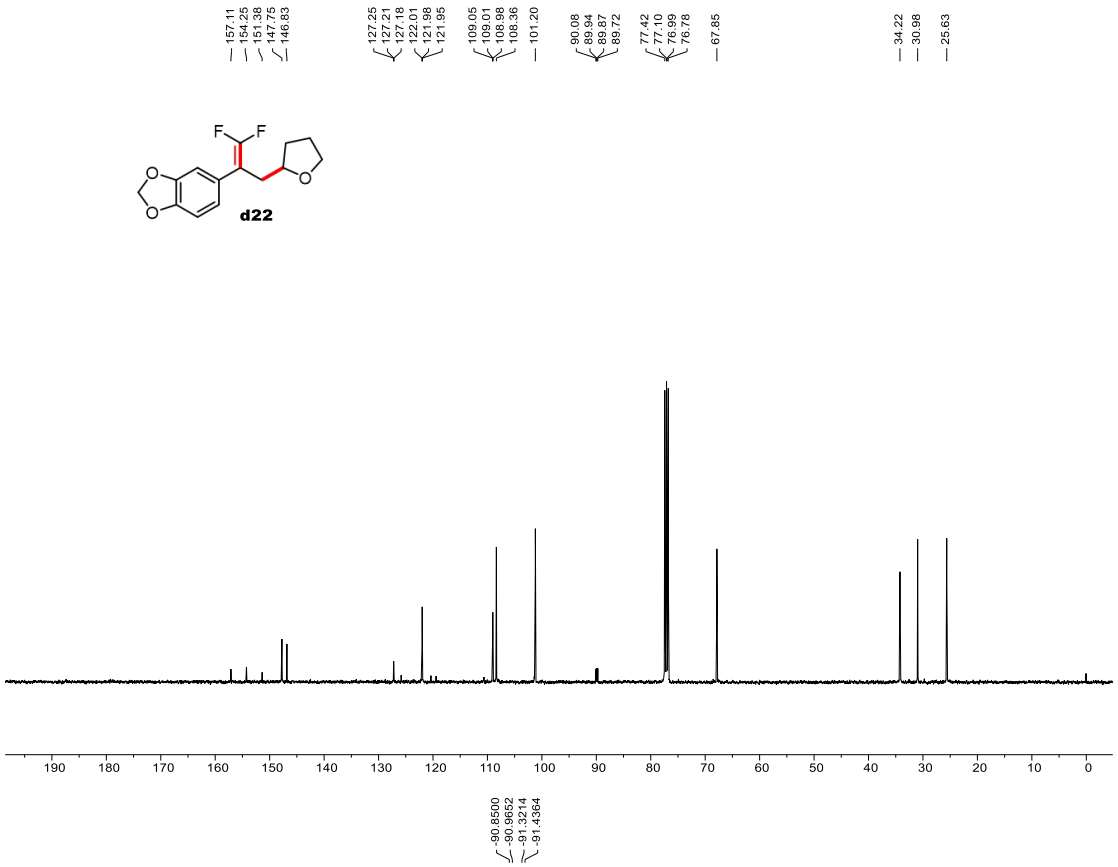

-90.065
-90.172
-90.306
-90.414
F
F
O
d20
1.00
1.19
-74
-75
-76
-77
-78
-79
-80
-81
-82
-83
-84
-85
-86
-87
-88
-89
-90
-91
-92
-93
-94
-95
-96
-97
-98
-99
-100
-101
-102
-103
-104
-105
-106
-107
-108
-109
-110

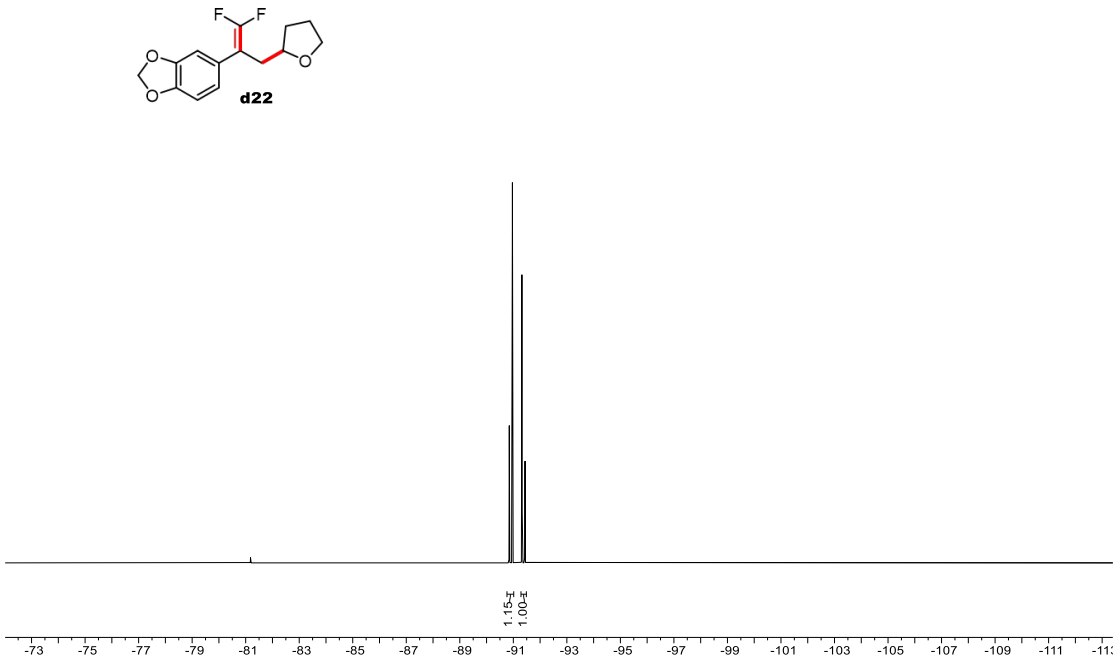

7.9328
7.9116
7.8964
7.8762
7.8518
7.8314
7.5209
7.5033
7.4829
7.4800
7.4770
7.4695
7.4600
7.4563
7.4430
7.4389
7.4260
7.4211
7.4176
7.4030
7.3996
3.9415
3.9250
3.9156
3.9082
3.9002
3.8980
3.8943
3.8823
3.8789
3.8766
3.8615
3.7536
3.7387
3.7340
3.7190
3.7134
3.6986
2.7930
2.7762
2.7634
2.7574
2.7514
2.7466
2.7405
2.5962
2.5904
2.5853
2.5794
2.5736
2.5606
2.5438
1.9698
1.9649
1.9617
1.9576
1.9531
1.9498
1.9457
1.9424
1.9387
1.9332
1.9289
1.9256
1.9235
1.9177
1.9112
1.9082
1.9052
1.8908
1.8768
1.8550
1.8512
1.8484
1.8355
1.8333
1.5663
1.5476
1.5391
1.5210
F
F
O
d21
3.14
1.02
4.99
2.18
2.02
1.03
1.00
1.01
2.04
1.05
0.99
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
157.37
154.50
151.62
139.78
139.72
133.87
132.52
131.57
130.18
128.36
128.26
128.22
128.19
127.80
126.98
126.13
125.98
125.86
125.42
90.17
90.00
89.97
89.81
77.41
77.14
77.09
76.78
67.89
33.93
31.06
25.67
F
F
O
d21
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10


-89.906
-90.015
-90.028
-90.138
F
F
O
d21
1.18
1.00
-80
-81
-82
-83
-84
-85
-86
-87
-88
-89
-90
-91
-92
-93
-94
-95
-96
-97
-98
-99

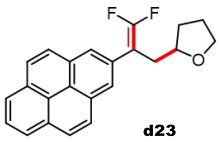
=


6.8279
6.7944
5.9590
3.8832
3.8674
3.8641
3.8619
3.8501
3.8456
3.8289
3.8250
3.8108
3.7942
3.7217
3.7068
3.7018
3.6870
3.6815
3.6670
2.6577
2.6514
2.6465
2.6408
2.6280
2.6223
2.6160
2.6111
2.6052
2.5941
2.4610
2.4551
2.4488
2.4441
2.4383
2.4321
2.4255
2.4196
2.4133
2.4087
2.4028
1.9258
1.9176
1.9116
1.9073
1.9039
1.8999
1.8972
1.8877
1.8818
1.8769
1.8710
1.8647
1.8603
1.8526
1.8372
1.8329
1.8281
1.8200
1.8132
1.8099
1.8027
1.4986
1.4916
1.4812
1.4735
F
F
O
O
O
d22
0.99
1.93
1.99
1.99
1.04
1.00
1.01
2.18
0.97
1.04
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

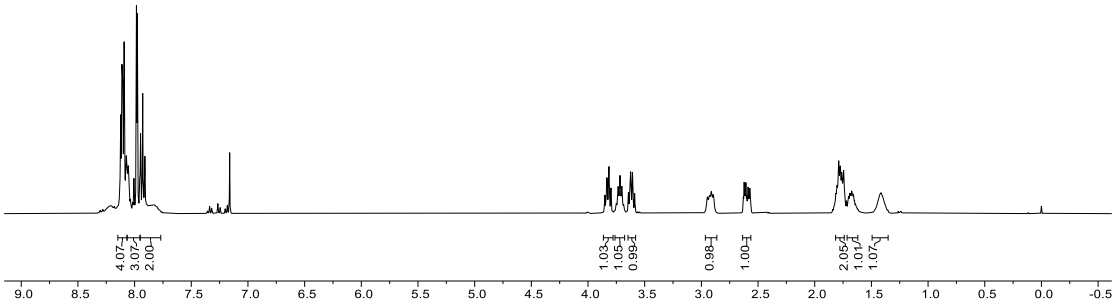

157.11
154.25
151.38
147.75
146.83
127.25
127.21
127.18
122.01
121.98
121.95
109.05
109.01
108.98
108.36
101.20
90.08
89.94
89.87
89.72
77.42
77.10
76.99
76.78
67.85
34.22
30.98
25.63
F
F
O
O
O
d22
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

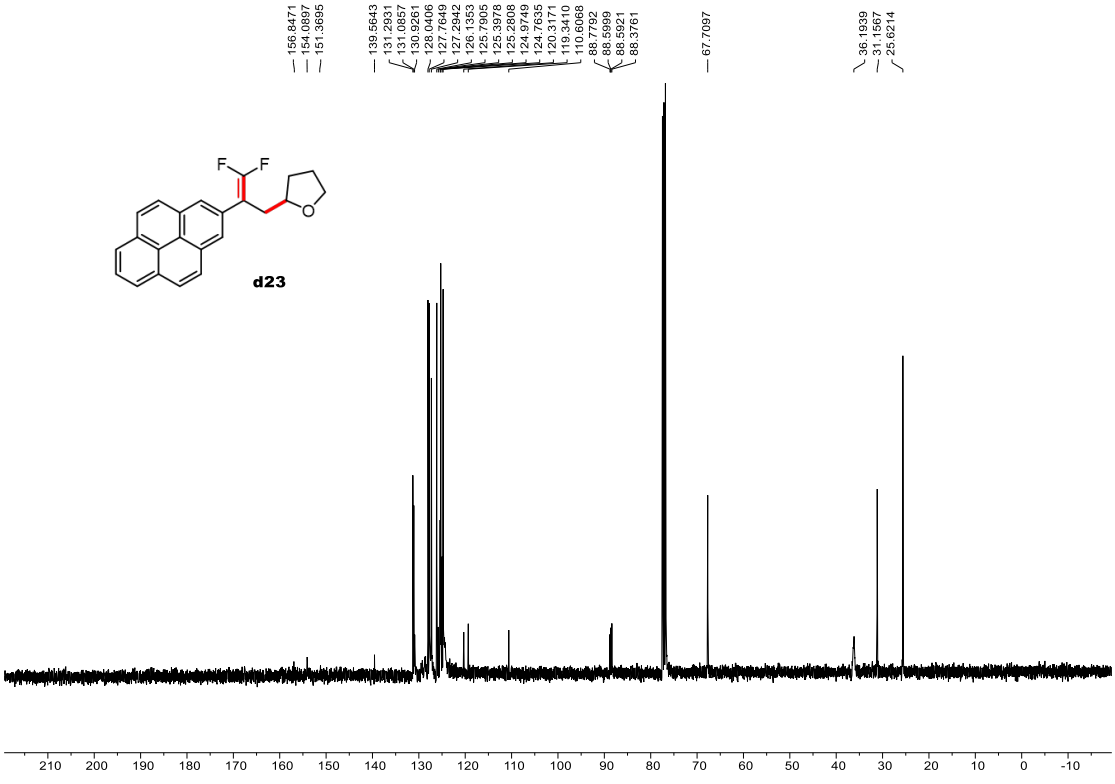

-90.8500
-90.9652
-91.3214
-91.4364
F
F
O
O
O
d22
1.15
1.00
-73
-75
-77
-79
-81
-83
-85
-87
-89
-91
-93
-95
-97
-99
-101
-103
-105
-107
-109
-111


8.1223
8.1117
8.1031
8.0923
8.0728
8.0638
8.0541
8.0368
8.0060
7.9837
7.9759
7.9525
7.9475
7.9285
7.9094
3.8738
3.8513
3.8356
3.8303
3.8187
3.8147
3.7975
3.7810
3.7777
3.7679
3.7511
3.7346
3.7180
3.7013
3.6847
3.6436
3.6355
3.6289
3.6236
3.6084
3.6034
3.5884
2.9497
2.9436
2.9325
2.9269
2.9146
2.9089
2.8960
2.8904
2.6294
2.6225
2.6148
2.6072
2.6003
2.5943
2.5876
2.5800
2.5721
1.8140
1.8035
1.7883
1.7774
1.7730
1.7622
1.7495
1.7444
1.7010
1.6921
1.6839
1.6738
1.6677
1.6650
1.6583
1.4270
1.4172
1.4123


F
F
O

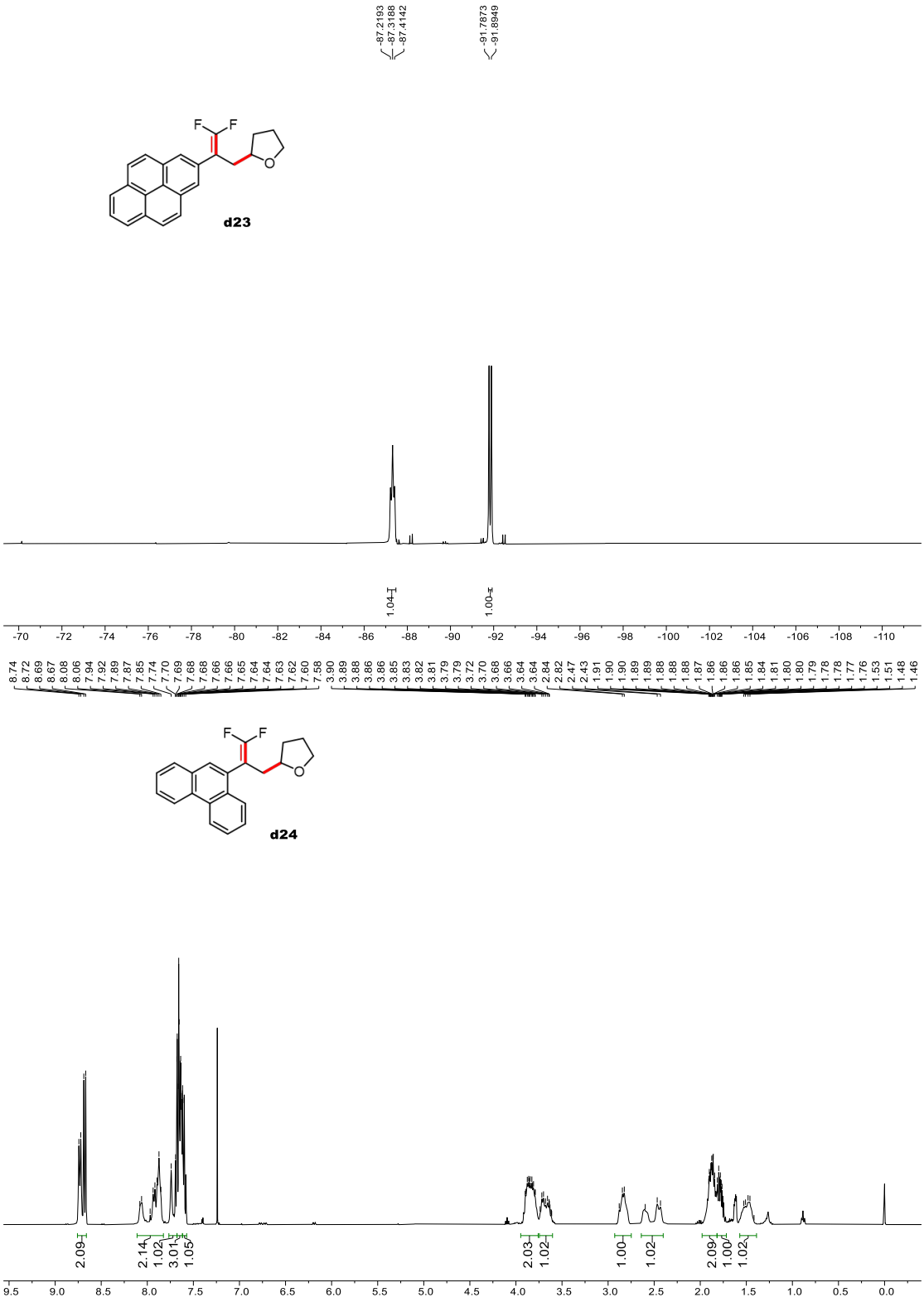
d23

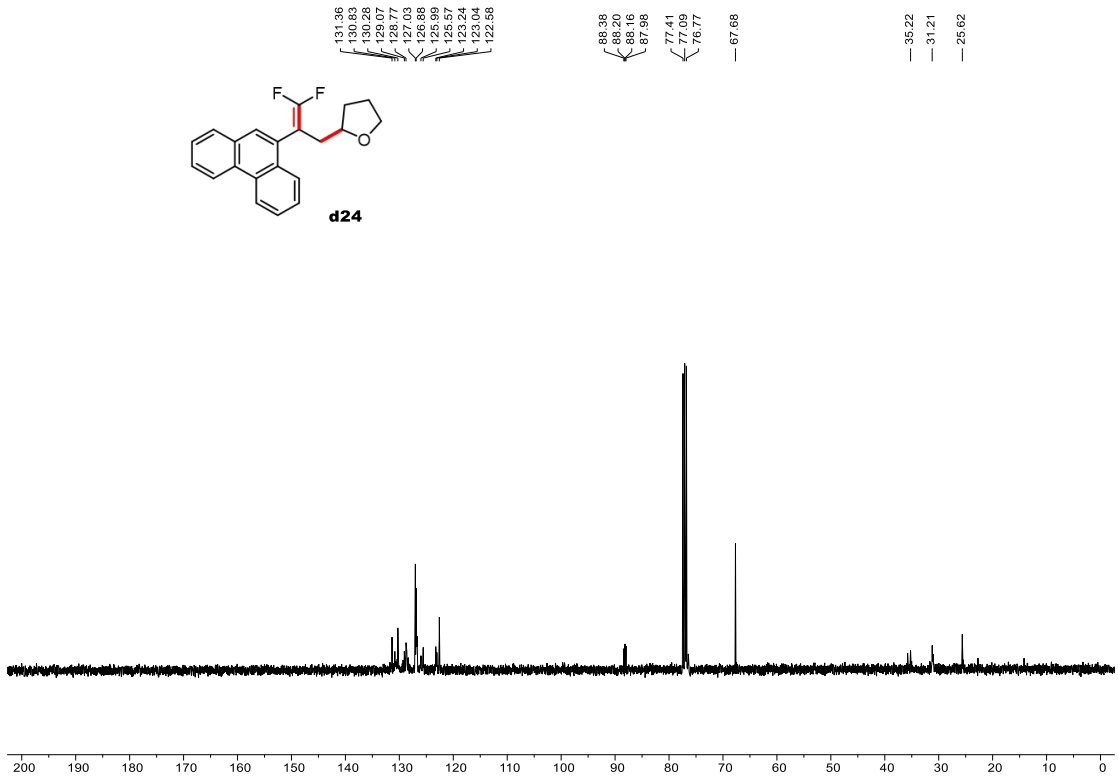

4.07
3.07
2.00
1.03
1.05
0.99
0.98
1.00
2.05
1.01
1.07
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

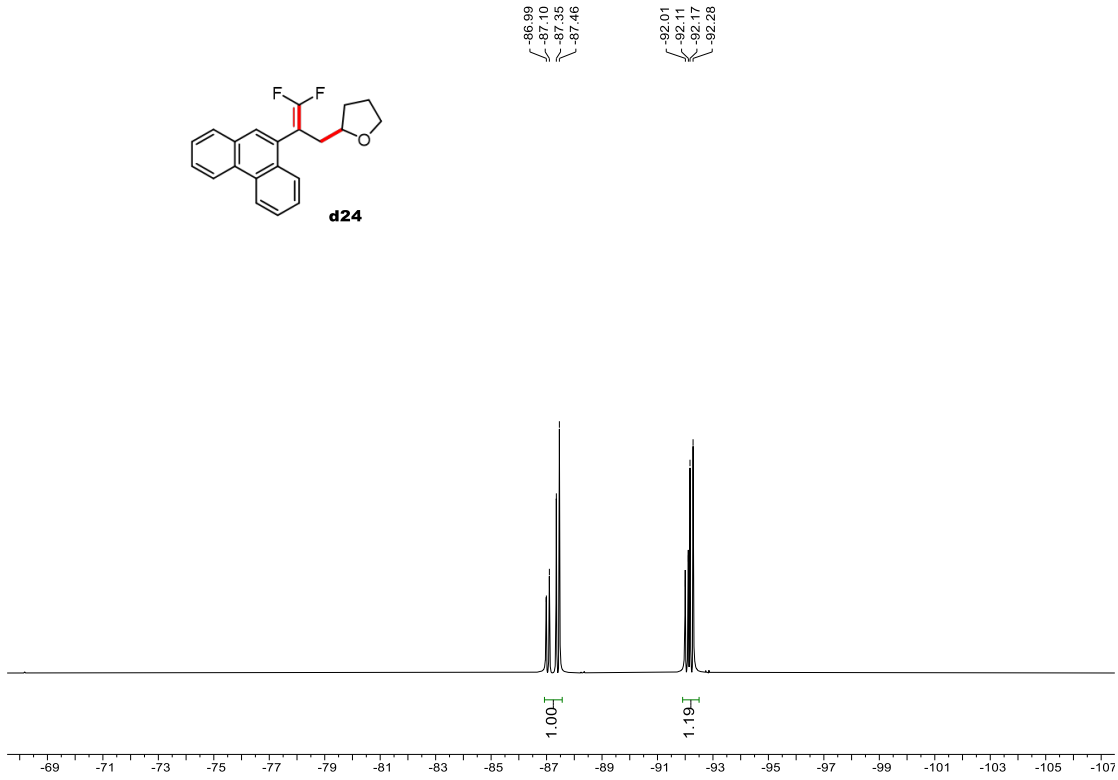

156.8471
154.0897
151.3695
139.5643
131.2931
131.0857
130.9261
128.0406
127.7649
127.2942
126.1353
125.7905
125.3978
125.2808
124.9749
124.7635
120.3171
119.3410
110.6068
88.7792
88.5999
88.5921
88.3761
67.7097
36.1939
31.1567
25.6214
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

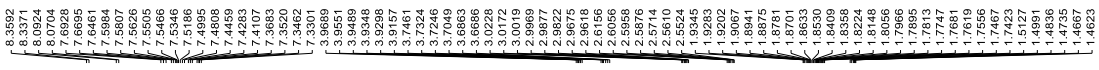
F
F
O

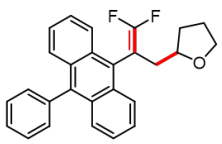
d23


-87.2193
-87.3188
-87.4142
-91.7873
-91.8949
F
F
O
d23
1.04
1.00
-70 -72 -74 -76 -78 -80 -82 -84 -86 -88 -90 -92 -94 -96 -98 -100 -102 -104 -106 -108 -110
8.74 8.72 8.69 8.67 8.08 8.06 7.94 7.92 7.89 7.87 7.85 7.74 7.70 7.69 7.68 7.68 7.66 7.66 7.65 7.64 7.64 7.63 7.62 7.60 7.58
3.90 3.89 3.88 3.86 3.86 3.85 3.83 3.82 3.81 3.79 3.79 3.72 3.70 3.68 3.66 3.64 3.64 2.84 2.82 2.47 2.43 1.91 1.90 1.90 1.89 1.89 1.88 1.88 1.88 1.87 1.86 1.86 1.86 1.85 1.84 1.81 1.80 1.80 1.79 1.78 1.78 1.77 1.76 1.53 1.51 1.48 1.46
F
F
O
d24
2.09
2.14
1.02
3.01
1.05
2.03
1.02
1.00
1.02
2.09
1.00
1.02
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

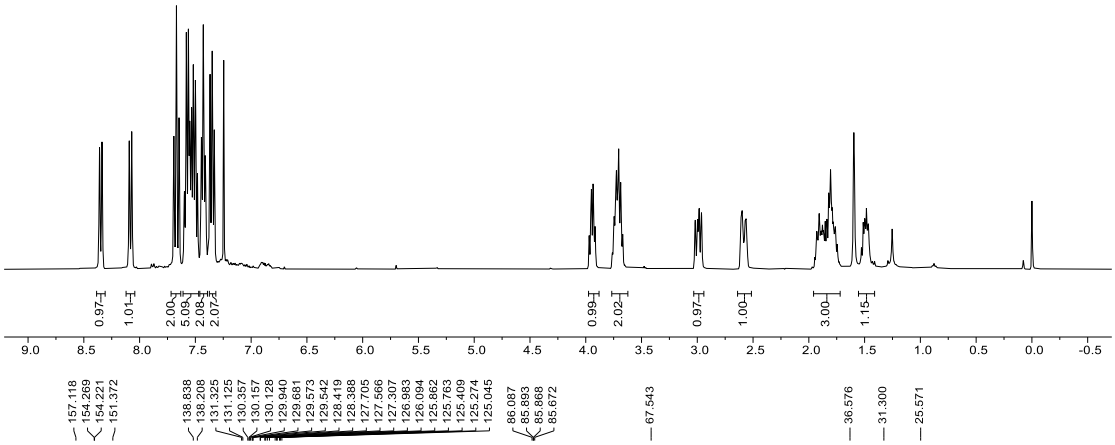

131.36
130.83
130.28
129.07
128.77
127.03
126.88
125.99
125.57
123.24
123.04
122.58
88.38
88.20
88.16
87.98
77.41
77.09
76.77
67.68
35.22
31.21
25.62
F
F
O
d24
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

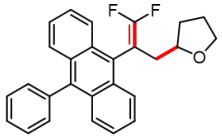

-86.99
-87.10
-87.35
-87.46
-92.01
-92.11
-92.17
-92.28
F
F
O
d24
1.00
1.19
-69
-71
-73
-75
-77
-79
-81
-83
-85
-87
-89
-91
-93
-95
-97
-99
-101
-103
-105
-107



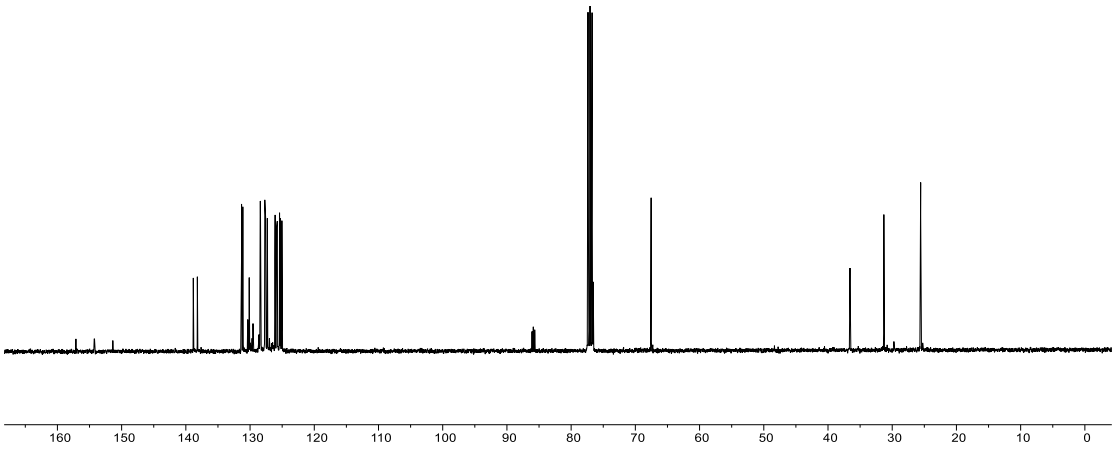


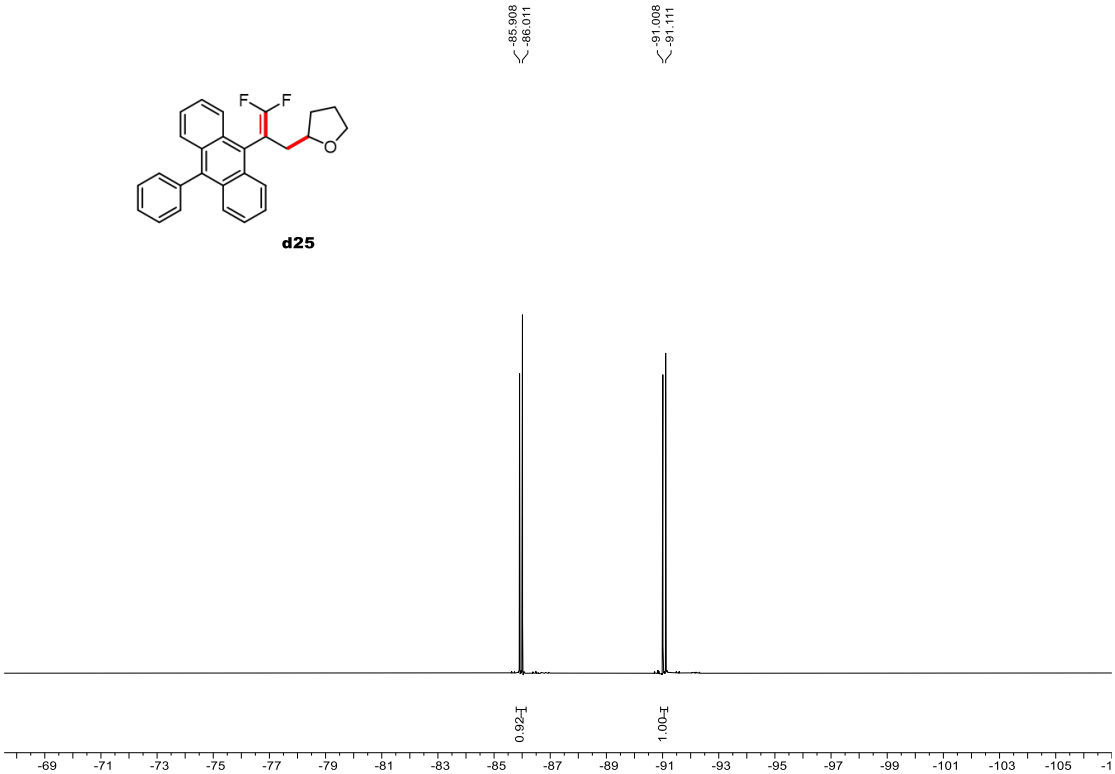
d25

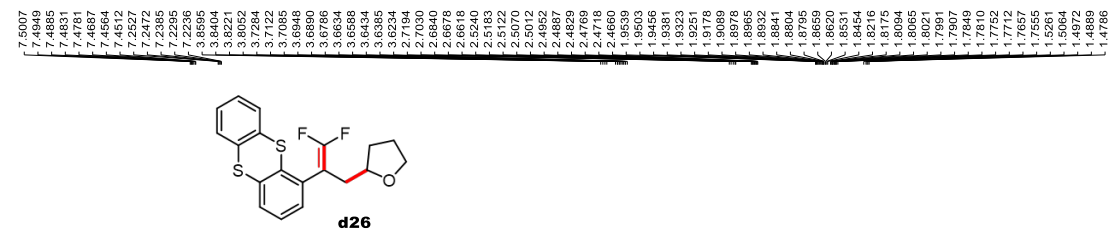




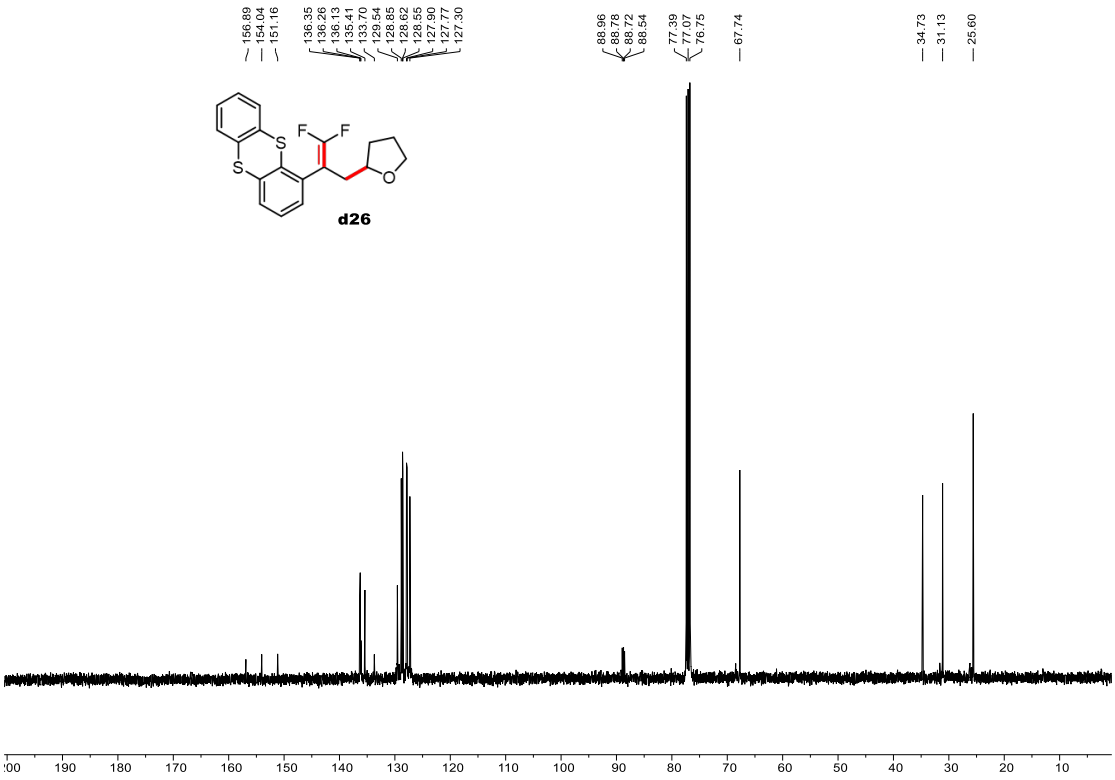
d25

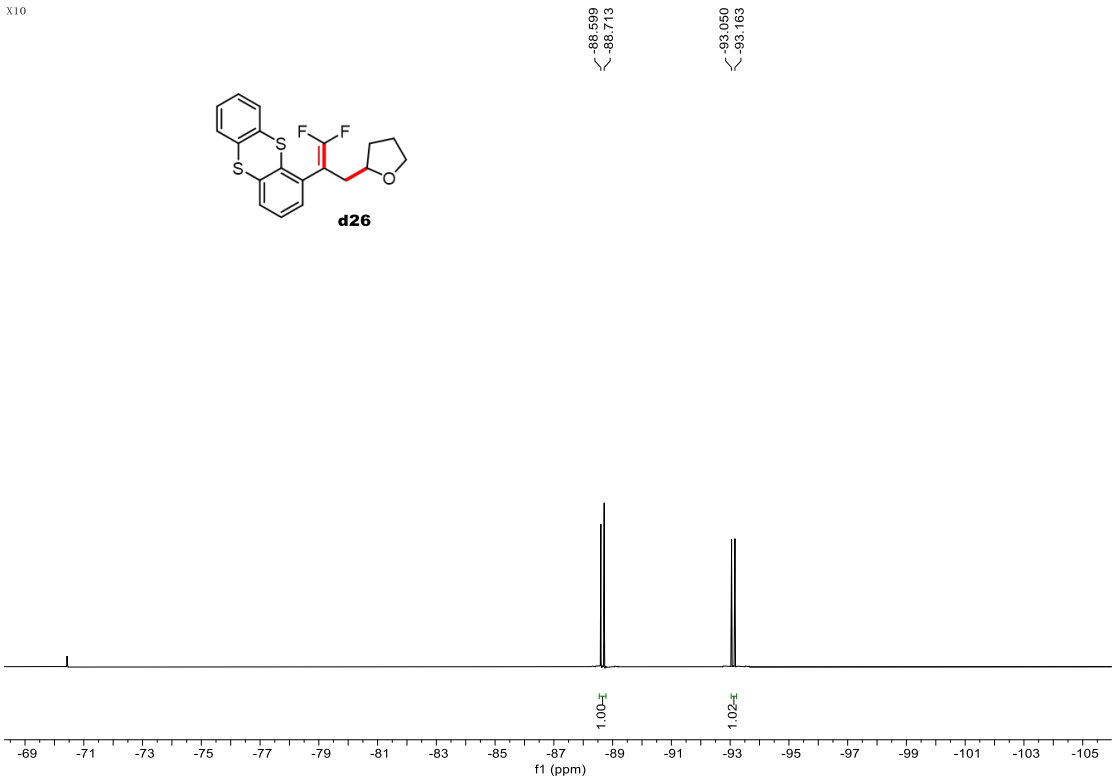


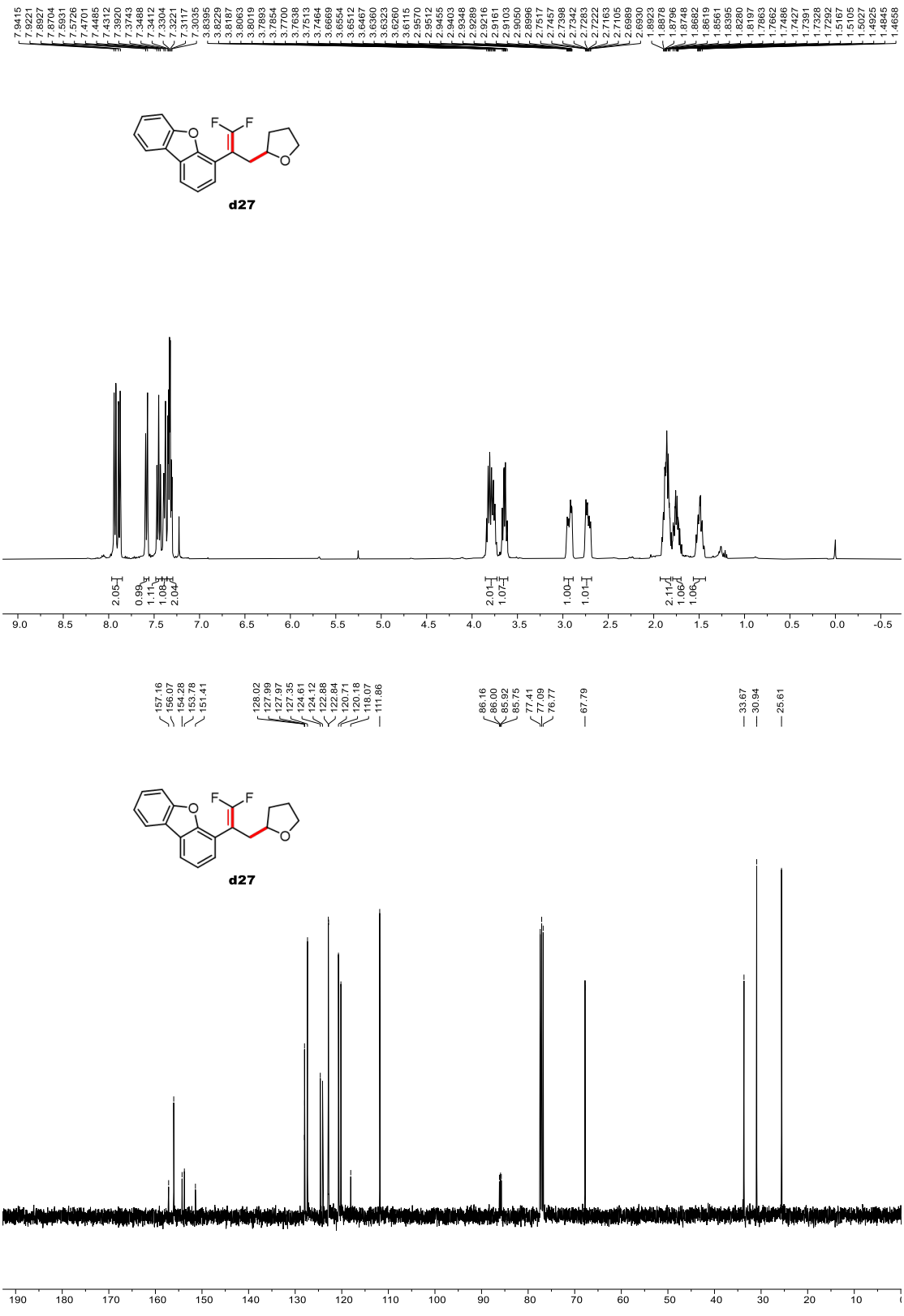

-85.908
-86.011
-91.008
-91.111
F
F
O
d25
0.92
1.00
-69 -71 -73 -75 -77 -79 -81 -83 -85 -87 -89 -91 -93 -95 -97 -99 -101 -103 -105 -1

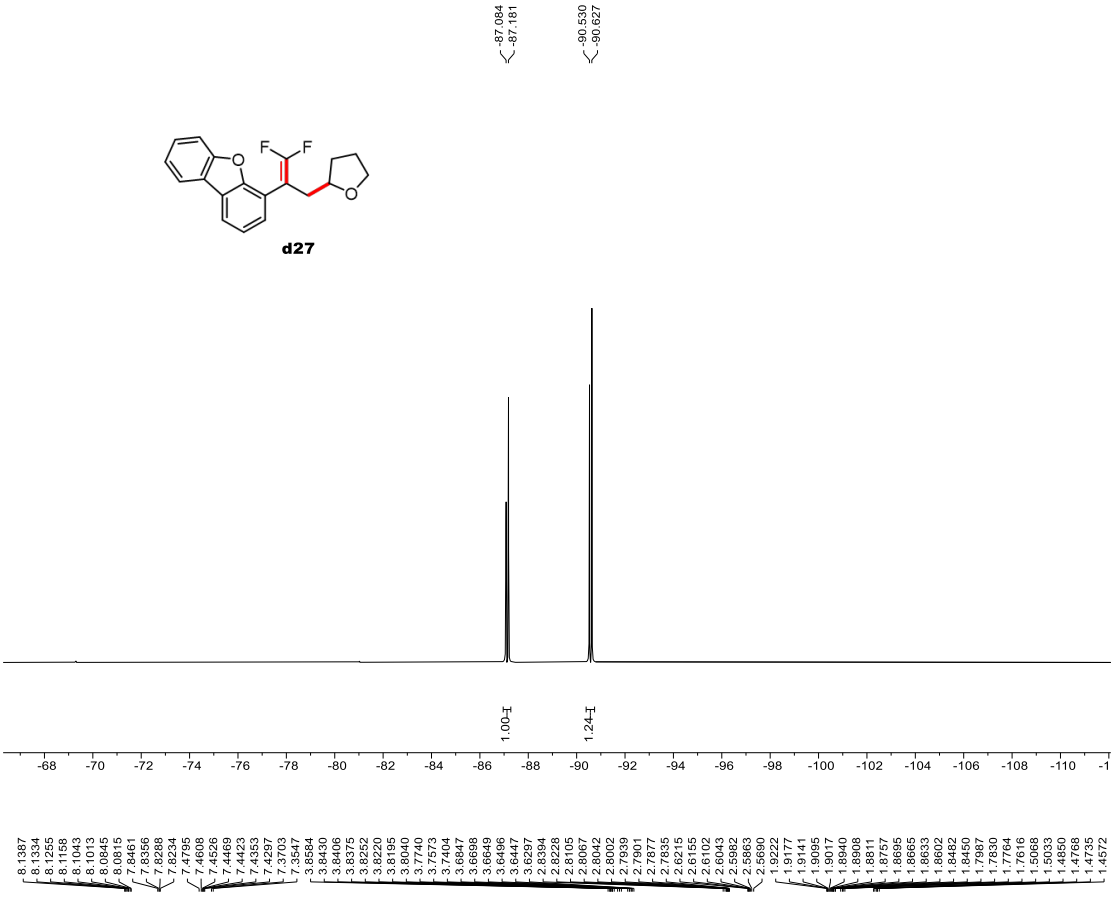

7.5007 7.4949 7.4885 7.4831 7.4781 7.4687 7.4564 7.4512 7.2527 7.2472 7.2385 7.2295 7.2236 3.8595 3.8404 3.8221 3.8052 3.7284 3.7122 3.7065 3.6948 3.6890 3.6756 3.6654 3.6588 3.6434 3.6385 3.6234 2.7194 2.7030 2.6840 2.6678 2.6618 2.5240 2.5183 2.5122 2.5070 2.5012 2.4952 2.4887 2.4829 2.4769 2.4718 2.4660 1.9539 1.9503 1.9456 1.9381 1.9323 1.9251 1.9178 1.9089 1.8978 1.8965 1.8932 1.8841 1.8804 1.8795 1.8659 1.8620 1.8531 1.8454 1.8216 1.8175 1.8094 1.8065 1.7941 1.7907 1.7849 1.7810 1.7752 1.7712 1.7657 1.7555 1.5261 1.5064 1.4972 1.4889 1.4786

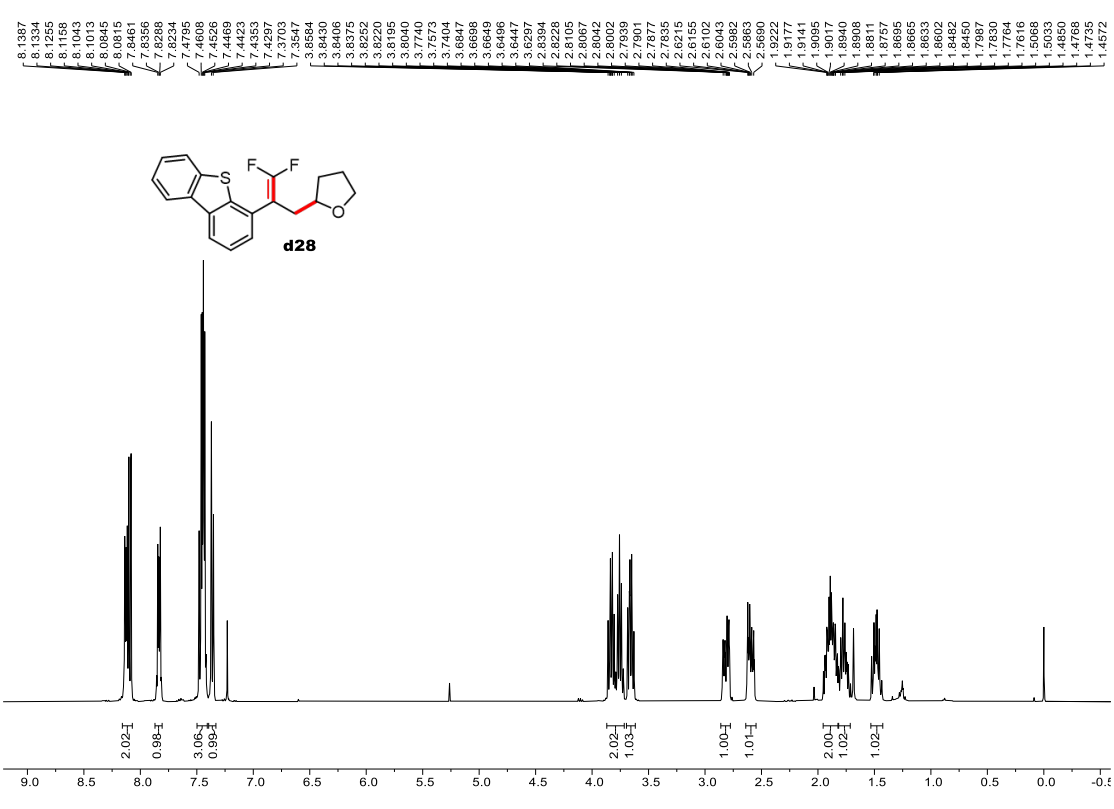
S
S
F
F
O
d26
3.13
4.16
1.11
2.08
1.00
1.02
2.08
1.19
1.04
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

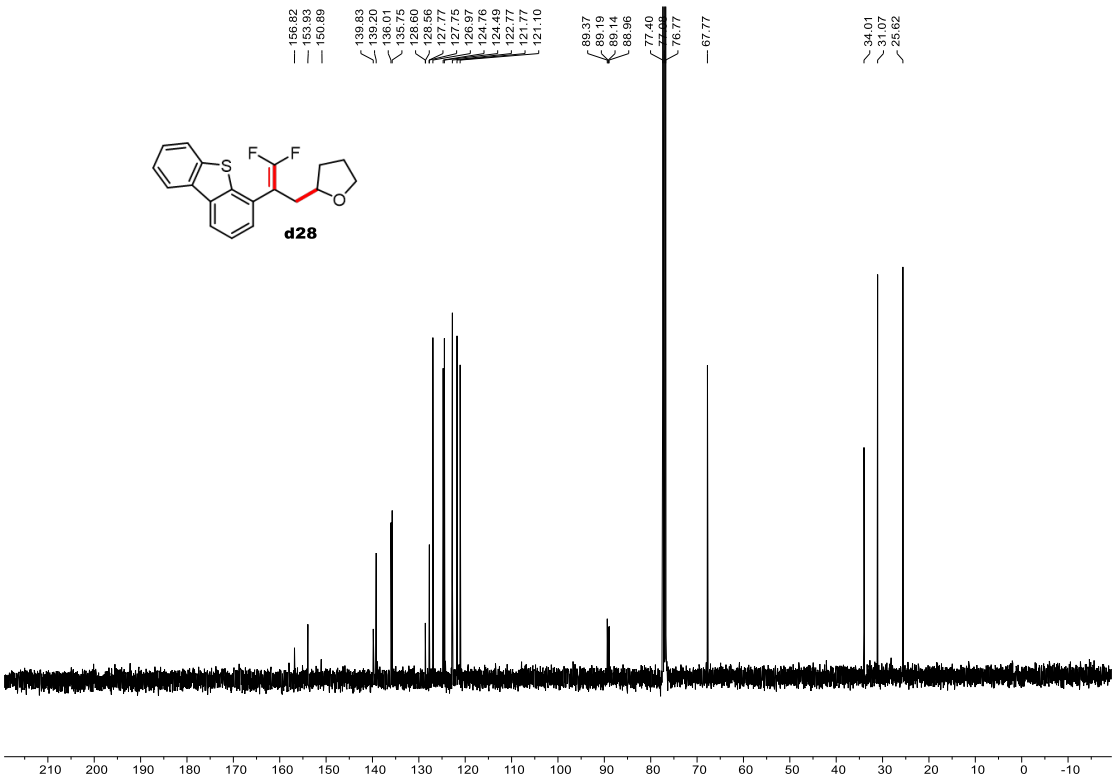

156.89
154.04
151.16
136.35
136.26
136.13
135.41
133.70
129.54
128.85
128.62
128.55
127.90
127.77
127.30
88.96
88.78
88.72
88.54
77.39
77.07
76.75
67.74
34.73
31.13
25.60
F
F
S
S
O
d26
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

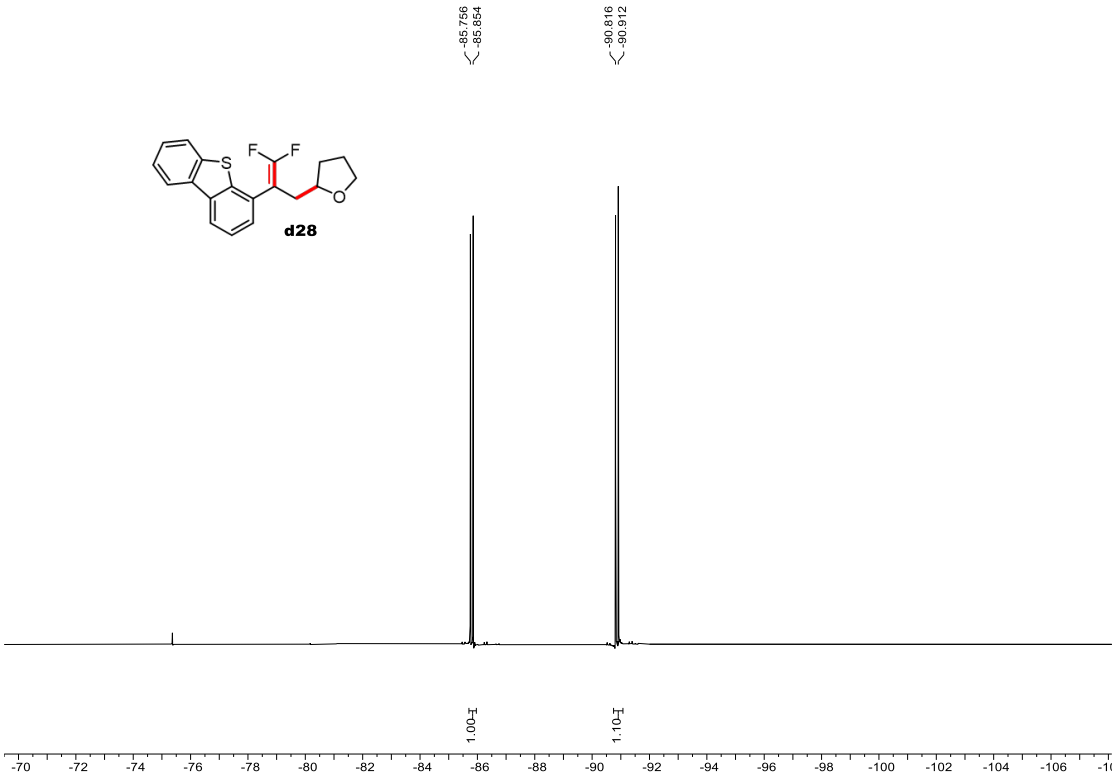

X10
-88.599
-88.713
-93.050
-93.163
F
F
S
S
O
d26
1.00
1.02
-69
-71
-73
-75
-77
-79
-81
-83
-85
-87
-89
-91
-93
-95
-97
-99
-101
-103
-105
f1 (ppm)

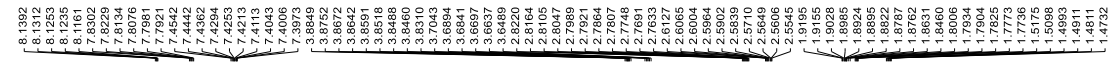

7.9415
7.9221
7.8927
7.8704
7.5931
7.5726
7.4701
7.4485
7.4312
7.3920
7.3743
7.3488
7.3412
7.3304
7.3221
7.3117
7.3035
3.8395
3.8229
3.8187
3.8063
3.8019
3.7893
3.7854
3.7700
3.7638
3.7513
3.7464
3.6669
3.6554
3.6512
3.6467
3.6360
3.6323
3.6260
3.6115
2.9570
2.9512
2.9455
2.9403
2.9348
2.9289
2.9216
2.9161
2.9103
2.9050
2.8996
2.7517
2.7457
2.7398
2.7342
2.7283
2.7222
2.7163
2.7105
2.6989
2.6930
1.8923
1.8878
1.8796
1.8748
1.8682
1.8619
1.8561
1.8395
1.8290
1.8197
1.7963
1.7663
1.7486
1.7427
1.7391
1.7328
1.7292
1.5167
1.5105
1.5027
1.4925
1.4845
1.4658
F
F
O
O
d27
2.05
0.99
1.11
1.08
2.04
2.01
1.07
1.00
1.01
2.11
1.06
1.06
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
-0.5
157.16
156.07
154.28
153.78
151.41
128.02
127.99
127.97
127.35
124.61
124.12
122.88
122.84
120.71
120.18
118.07
111.86
86.16
86.00
85.92
85.75
77.41
77.09
76.77
67.79
33.67
30.94
25.61
F
F
O
O
d27
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

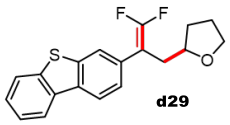

-87.084
-87.181
-90.530
-90.627
F
F
O
O
d27
1.00
1.24
-68 -70 -72 -74 -76 -78 -80 -82 -84 -86 -88 -90 -92 -94 -96 -98 -100 -102 -104 -106 -108 -110


S
F
F
O
d28
2.02
0.98
3.06
0.99
2.02
1.03
1.00
1.01
2.00
1.02
1.02
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

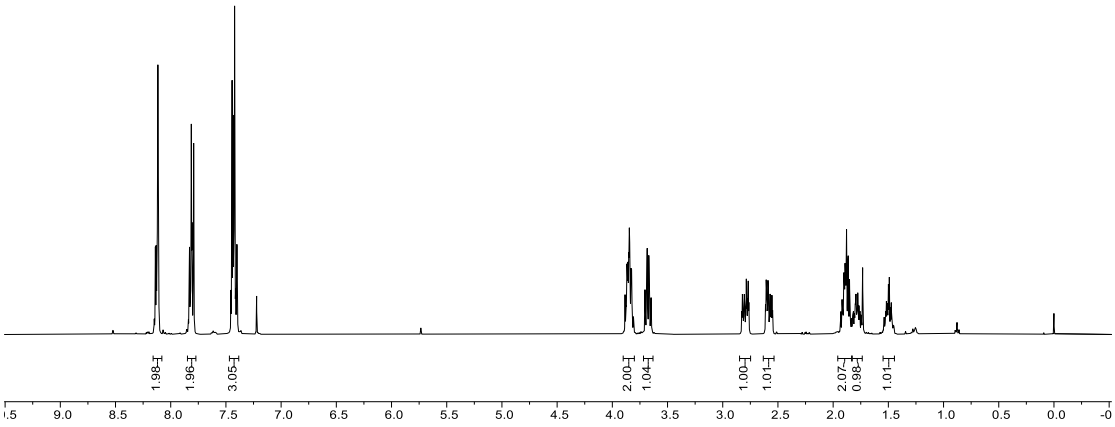

156.82
153.93
150.89
139.83
139.20
136.01
135.75
128.60
128.56
127.77
127.75
126.97
124.76
124.49
122.77
121.77
121.10
89.37
89.19
89.14
88.96
77.40
76.77
67.77
34.01
31.07
25.62
F
F
S
O
d28
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

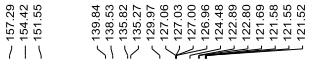

-85.756
-85.854
-90.816
-90.912
F
F
S
O
d28
1.00
1.10
-70
-72
-74
-76
-78
-80
-82
-84
-86
-88
-90
-92
-94
-96
-98
-100
-102
-104
-106

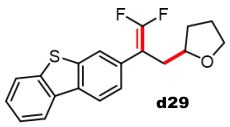




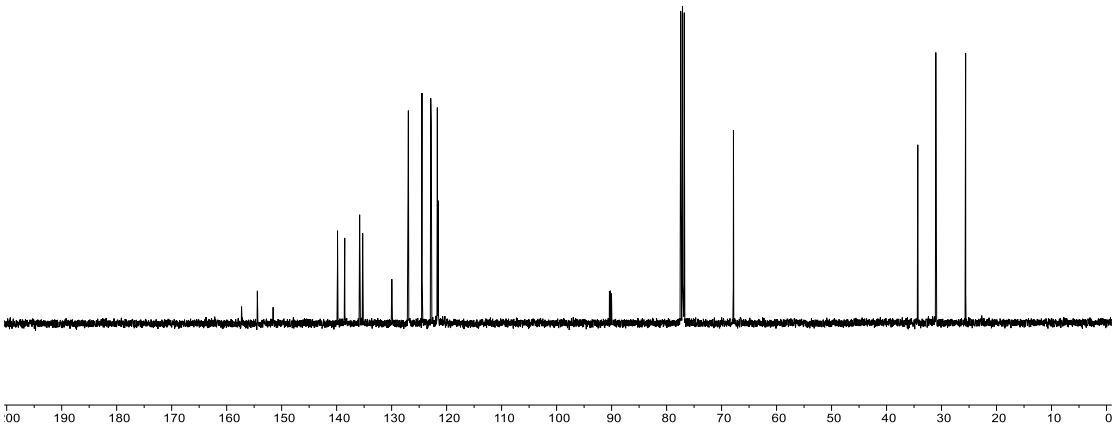
d29

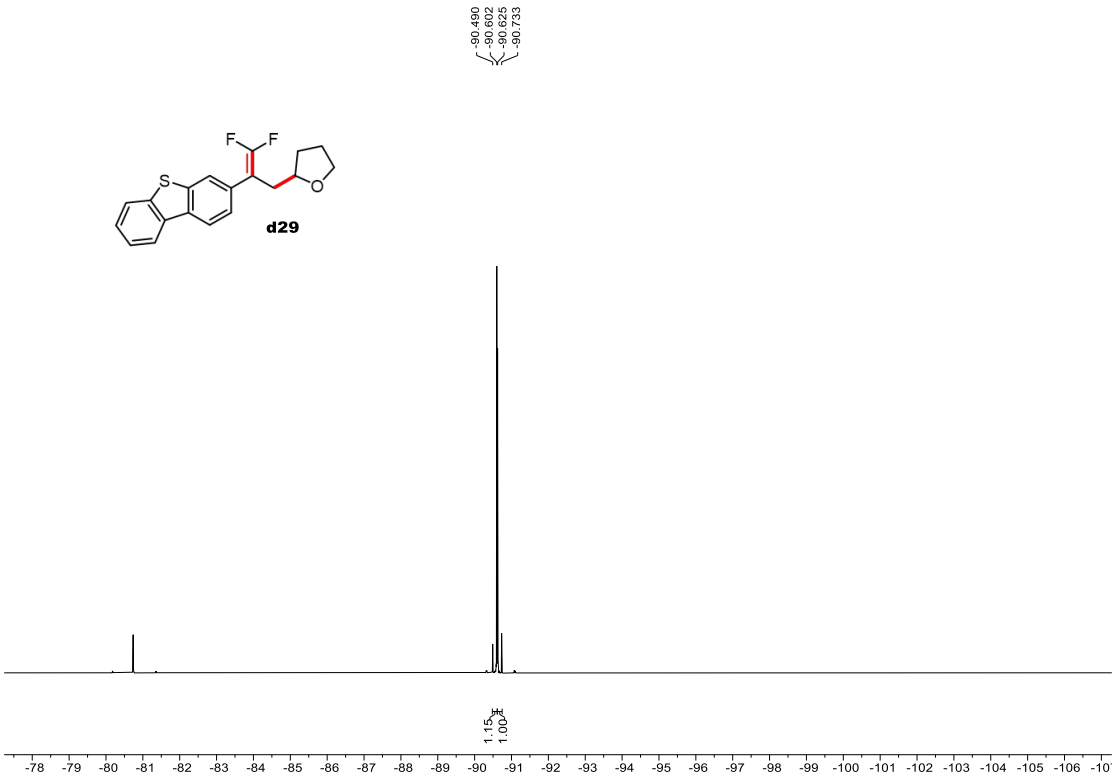


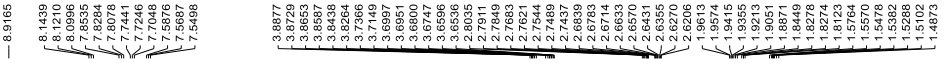


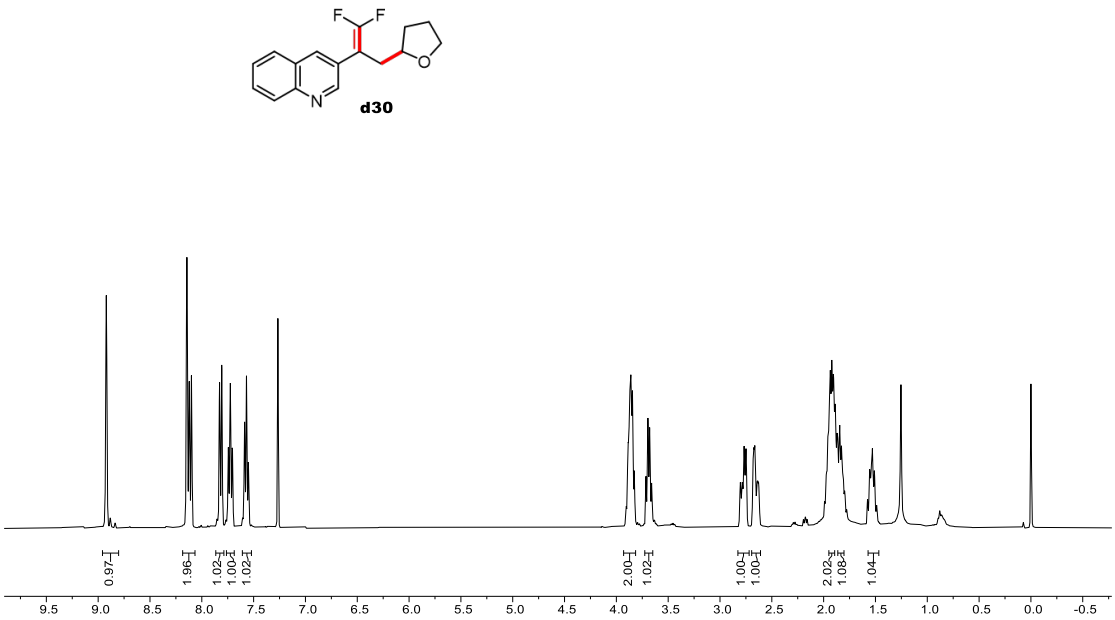


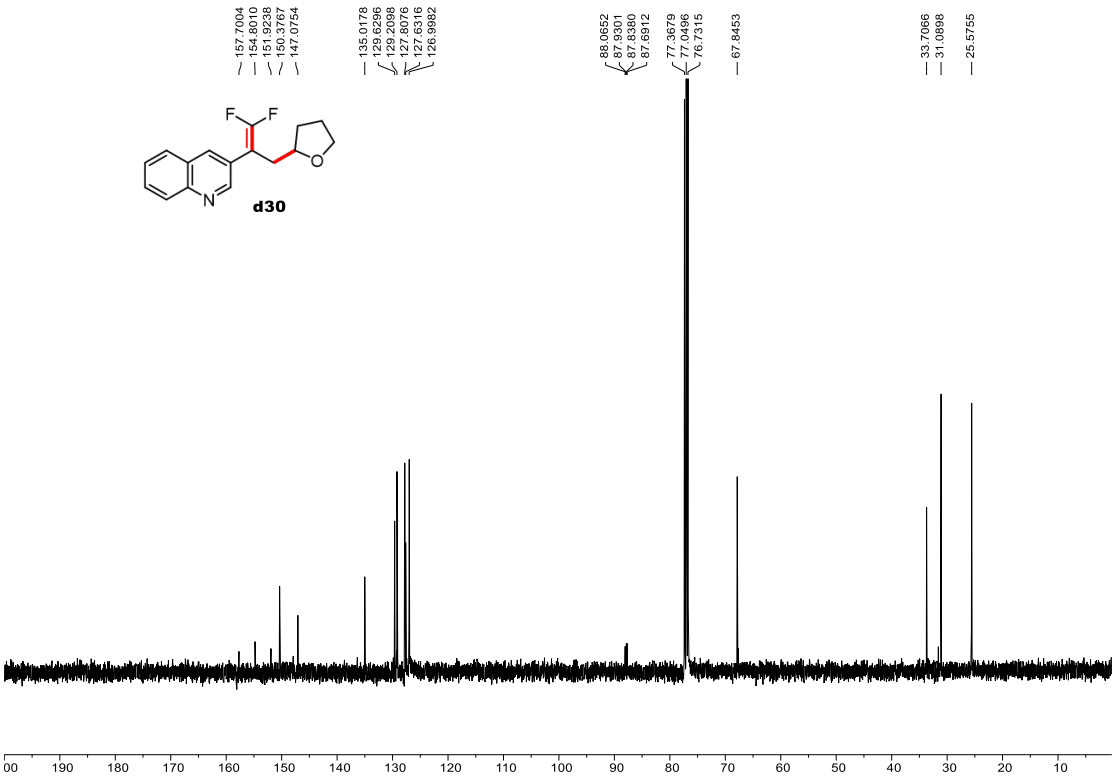
d29

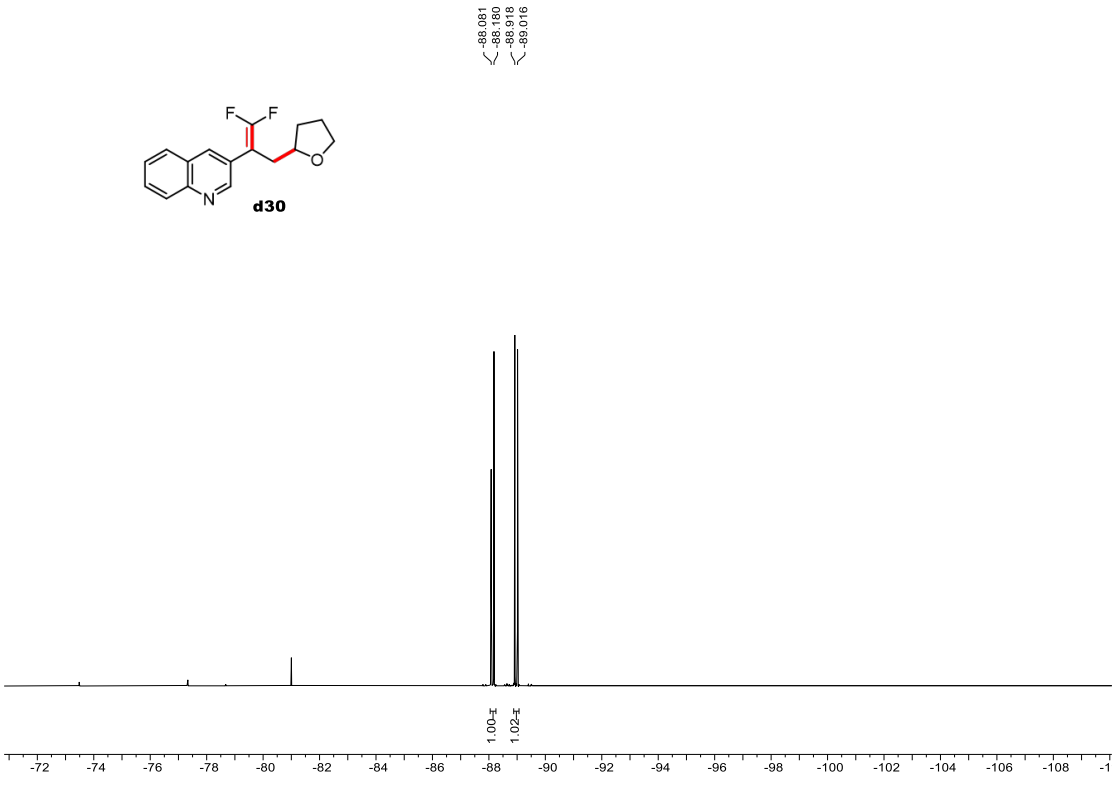


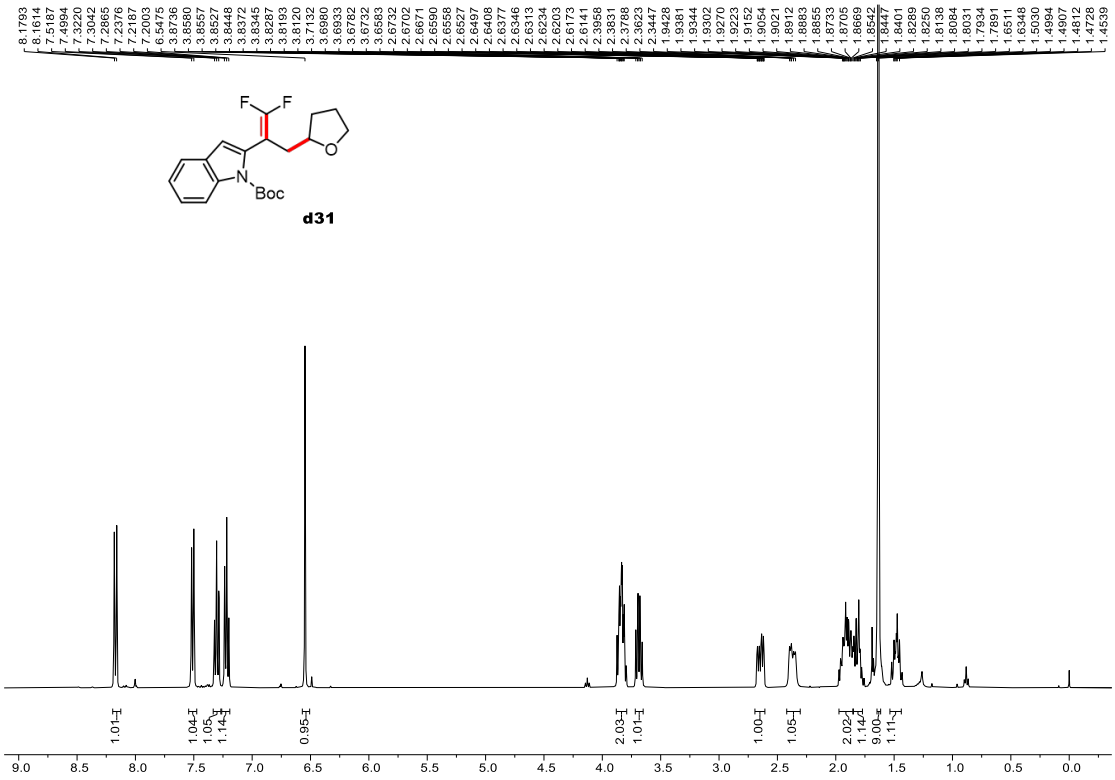

-90.490
-90.602
-90.625
-90.733
F
F
S
O
d29
1.15
1.00
-78 -79 -80 -81 -82 -83 -84 -85 -86 -87 -88 -89 -90 -91 -92 -93 -94 -95 -96 -97 -98 -99 -100 -101 -102 -103 -104 -105 -106

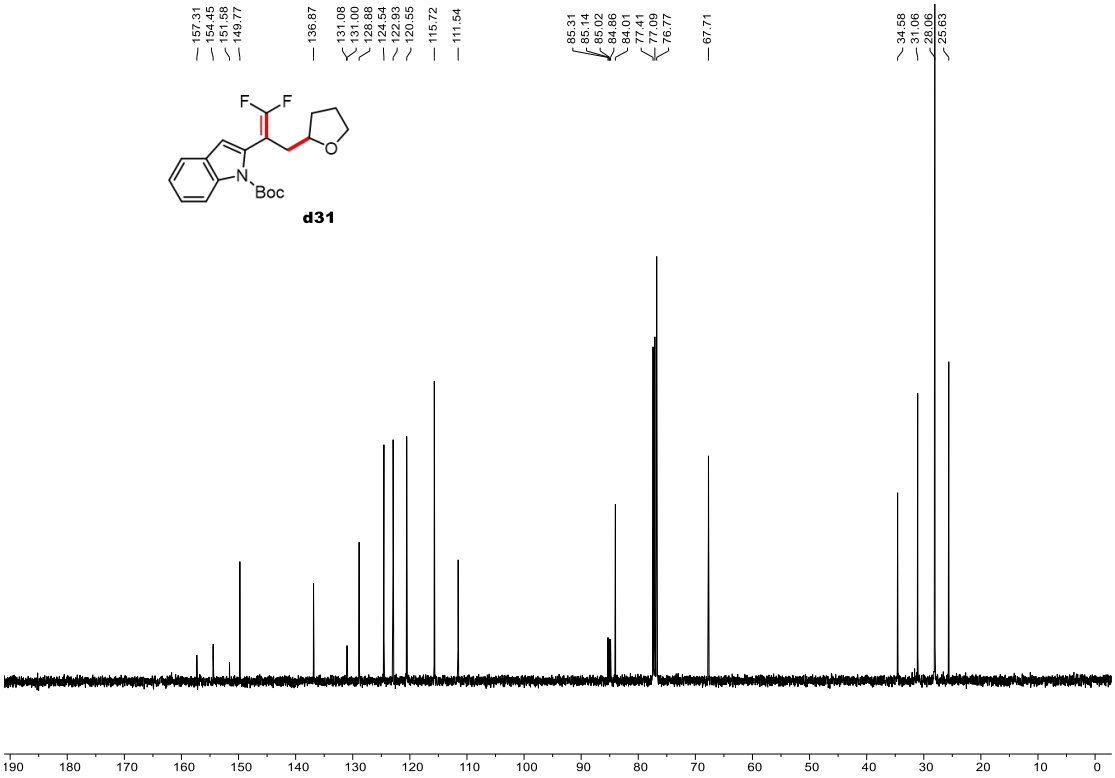

8.9165
8.1439
8.1210
8.0996
7.8535
7.8284
7.8078
7.7441
7.7246
7.7048
7.5876
7.5687
7.5498
3.8877
3.8729
3.8653
3.8587
3.8438
3.8264
3.7366
3.7149
3.6997
3.6951
3.6800
3.6747
3.6596
3.6536
2.8035
2.7911
2.7849
2.7683
2.7621
2.7544
2.7489
2.7437
2.6839
2.6783
2.6714
2.6633
2.6570
2.6431
2.6355
2.6270
2.6206
1.9613
1.9574
1.9415
1.9355
1.9213
1.9051
1.8871
1.8449
1.8278
1.8274
1.8123
1.5764
1.5570
1.5478
1.5382
1.5288
1.5102
1.4873

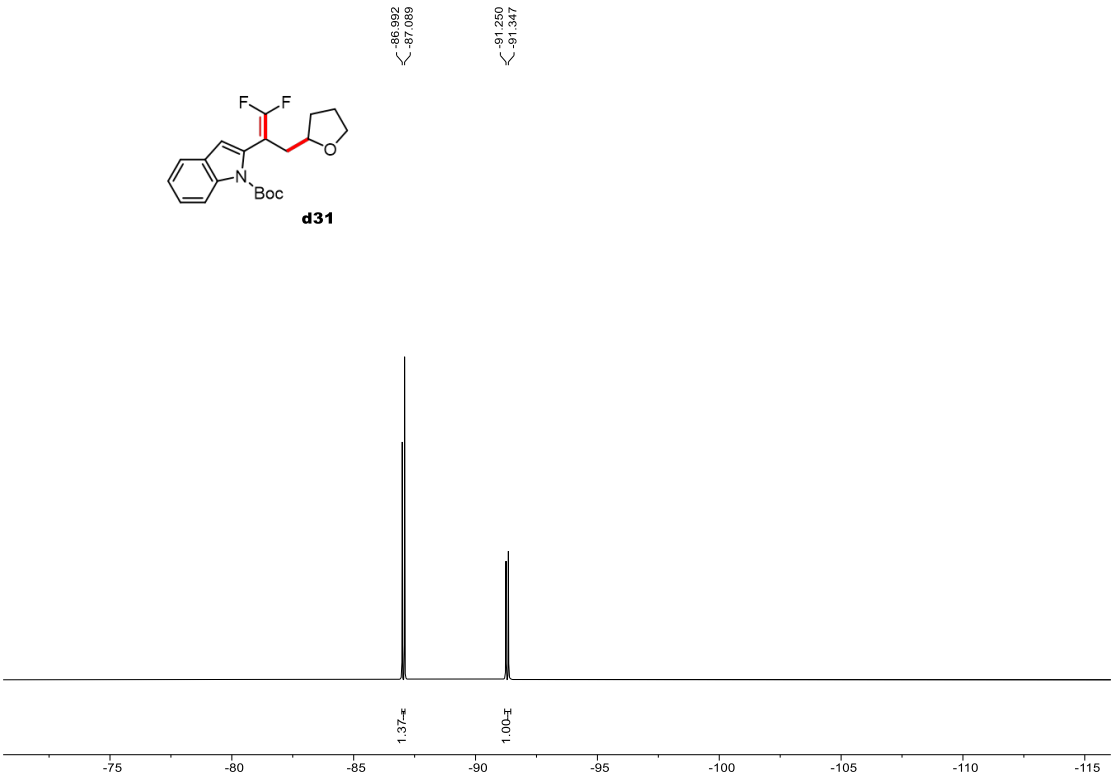

F
F
O
N
d30
0.97
1.96
1.02
1.00
1.02
2.00
1.02
1.00
1.00
2.02
1.08
1.04
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

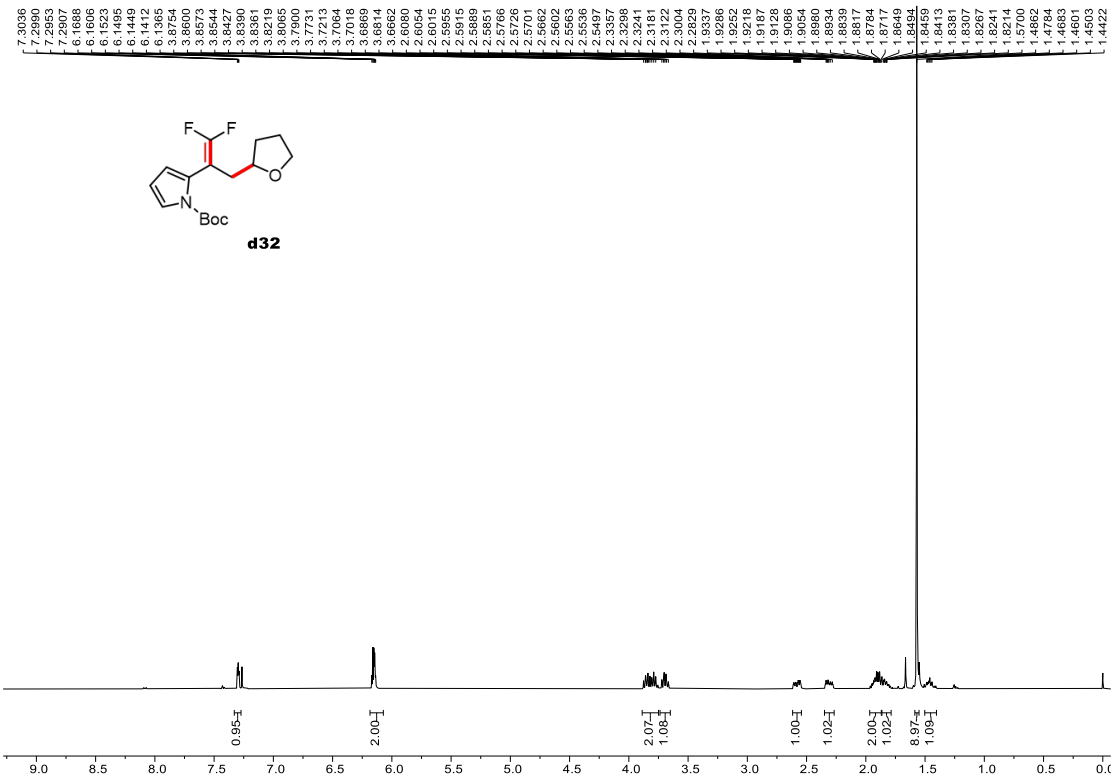

157.7004
154.8010
151.9238
150.3767
147.0754
135.0178
129.6296
129.2098
127.8076
127.6316
126.9982
88.0652
87.9301
87.8390
87.6912
77.3679
77.0496
76.7315
67.8453
33.7066
31.0898
25.5755
F
F
O
N
d30
00 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10

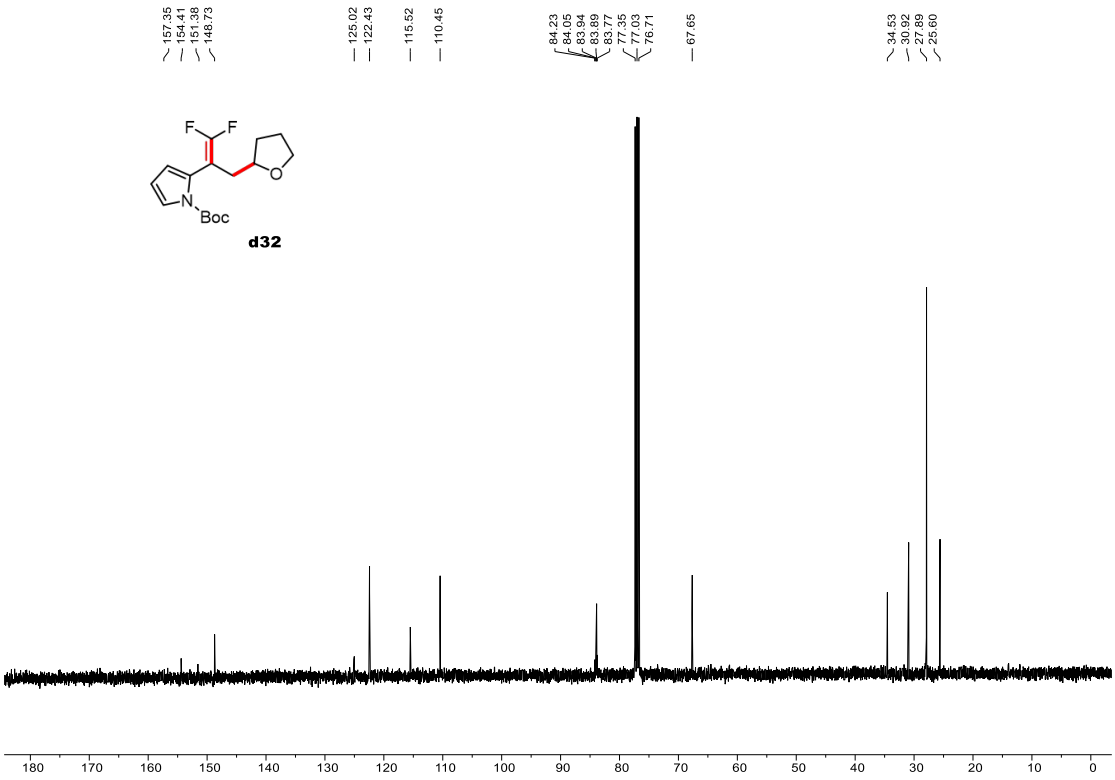

-88.081
-88.180
-88.918
-89.016
F
F
O
N
d30
1.00
1.02
-72 -74 -76 -78 -80 -82 -84 -86 -88 -90 -92 -94 -96 -98 -100 -102 -104 -106 -108 -1

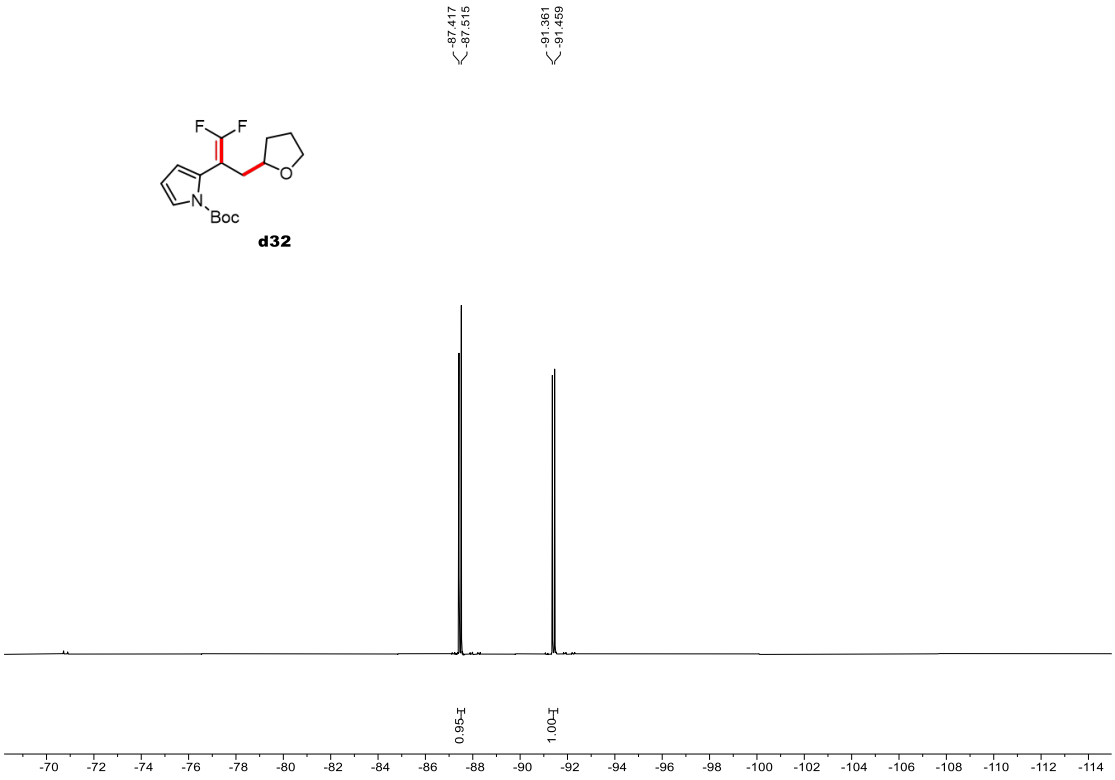

F
F
O
N
Boc
d31


F
F
O
N
Boc
d31

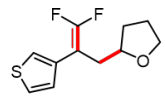

-86.992
-87.089
-91.250
-91.347
F
F
O
N
Boc
d31
1.37
1.00
-75
-80
-85
-90
-95
-100
-105
-110
-115


7.3036
7.2990
7.2953
7.2907
6.1688
6.1606
6.1523
6.1495
6.1449
6.1412
6.1365
3.8754
3.8600
3.8573
3.8544
3.8427
3.8390
3.8361
3.8219
3.8065
3.7900
3.7731
3.7643
3.7064
3.7018
3.6869
3.6814
3.6662
2.6080
2.6054
2.6015
2.5955
2.5915
2.5889
2.5851
2.5766
2.5726
2.5701
2.5662
2.5602
2.5563
2.5536
2.5497
2.3357
2.3298
2.3241
2.3181
2.3122
2.3004
2.2829
1.9337
1.9286
1.9252
1.9218
1.9187
1.9128
1.9086
1.9054
1.8980
1.8934
1.8839
1.8817
1.8784
1.8717
1.8649
1.8494
1.8419
1.8413
1.8381
1.8307
1.8267
1.8241
1.8214
1.5700
1.4862
1.4784
1.4683
1.4601
1.4503
1.4422
F
F
O
N
Boc
d32
0.95
2.00
2.07
1.08
1.00
1.02
2.00
1.02
8.97
1.09
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

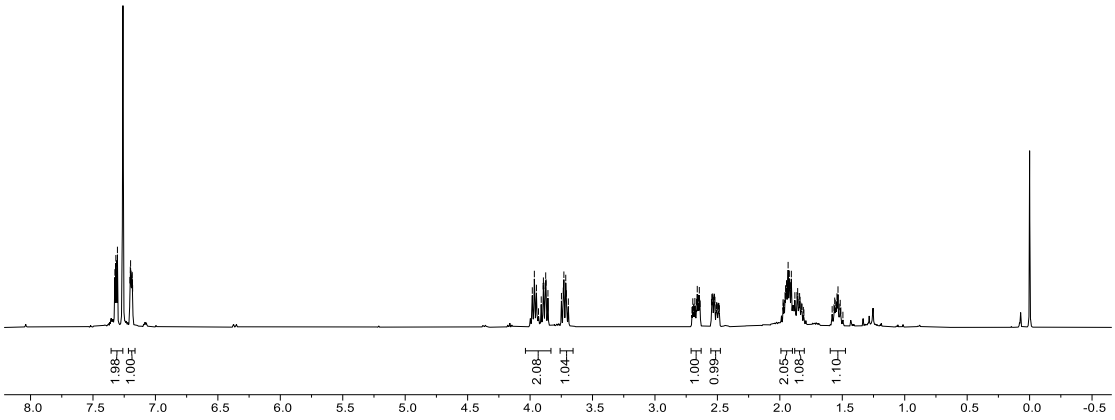

157.35
154.41
151.38
148.73
125.02
122.43
115.52
110.45
84.23
84.05
83.94
83.89
83.77
77.35
77.03
76.71
67.65
34.53
30.92
27.89
25.60
F
F
O
N
Boc
d32
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

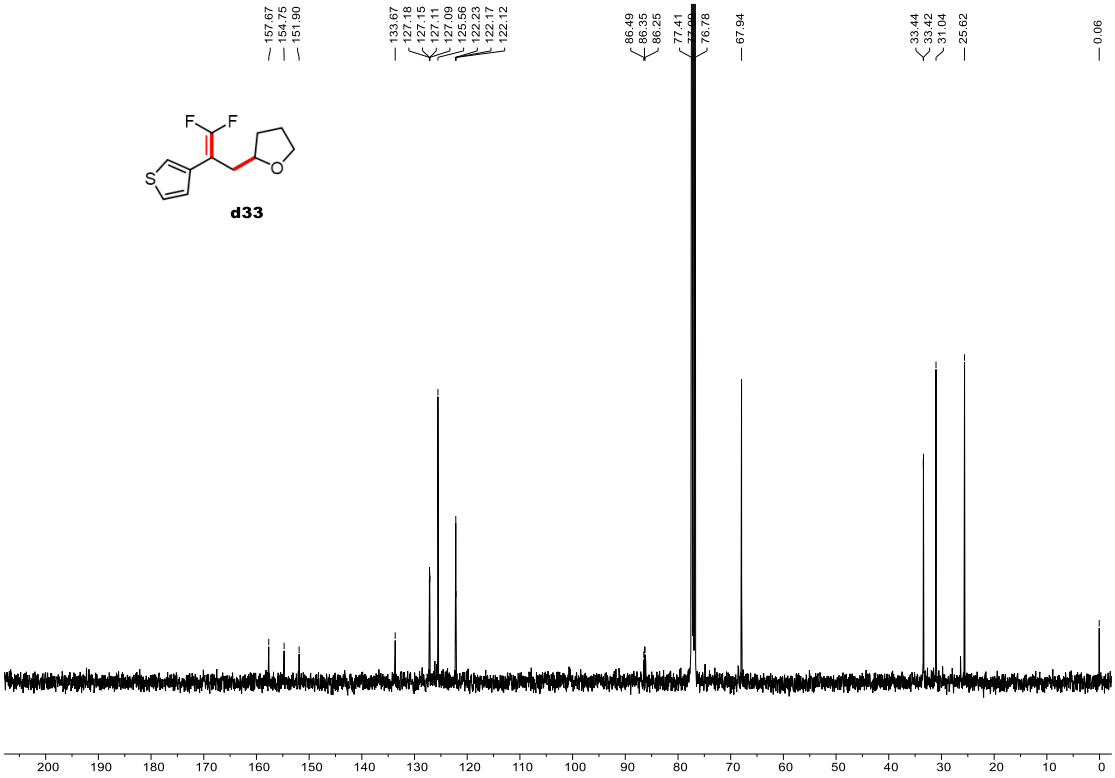

-87.417
-87.515
-91.361
-91.459
F
F
O
N
Boc
d32
0.95
1.00
-70
-72
-74
-76
-78
-80
-82
-84
-86
-88
-90
-92
-94
-96
-98
-100
-102
-104
-106
-108
-110
-112
-114


7.3245
7.3169
7.3117
7.3042
7.2044
7.2012
7.1989
7.1955
7.1919
7.1885
7.1861
7.1826
3.9822
3.9657
3.9490
3.9107
3.8956
3.8933
3.8903
3.8782
3.8748
3.8721
3.8570
3.7487
3.7341
3.7293
3.7144
3.7092
3.6937
2.6970
2.6872
2.6805
2.6677
2.6613
2.6548
2.6515
2.6448
2.6383
2.5475
2.5440
2.5405
2.5367
2.5306
2.5272
2.5235
2.5197
2.5084
2.5047
2.5010
2.4914
2.4878
1.9745
1.9714
1.9711
1.9658
1.9586
1.9537
1.9506
1.9465
1.9337
1.9240
1.9188
1.9184
1.9114
1.9080
1.8796
1.8671
1.8573
1.8555
1.8472
1.8418
1.8380
1.8311
1.8220
1.5607
1.5522
1.5425
1.5343
1.5248
1.5164


F
F
S
O

d33

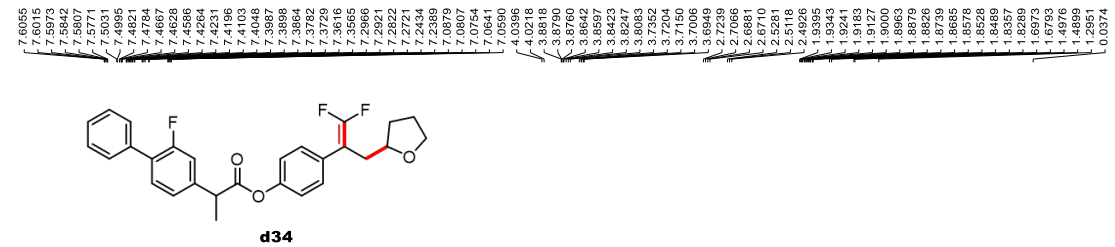

1.98
1.00
2.08
1.04
1.00
0.99
2.05
1.08
1.10
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5


157.67
154.75
151.90
133.67
127.18
127.15
127.11
127.09
125.56
122.23
122.17
122.12
86.49
86.35
86.25
77.41
77.00
76.78
67.94
33.44
33.42
31.04
25.62
0.06
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

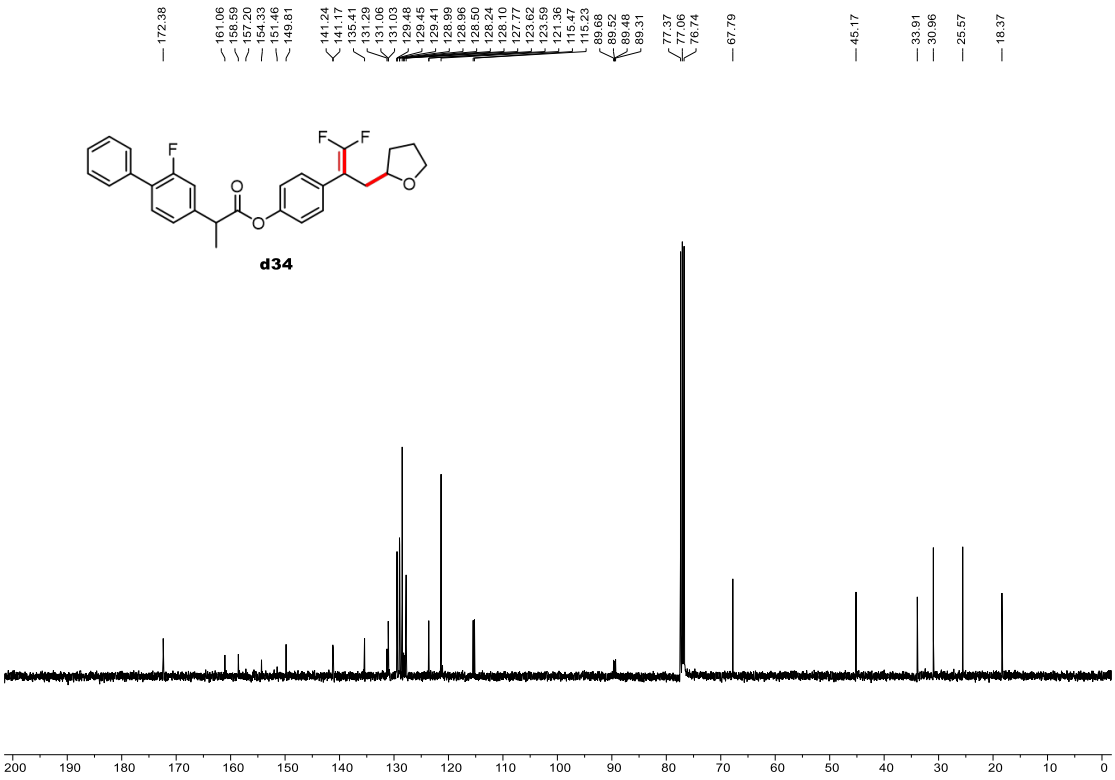
F
F
S
O

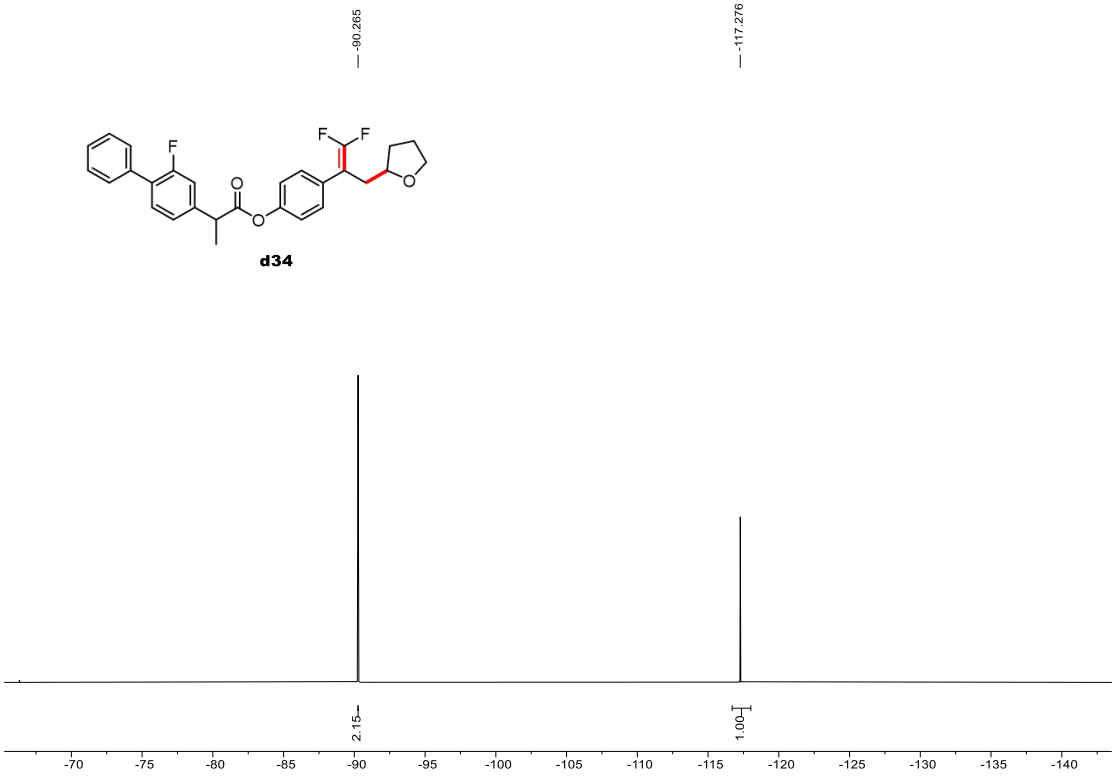
d33

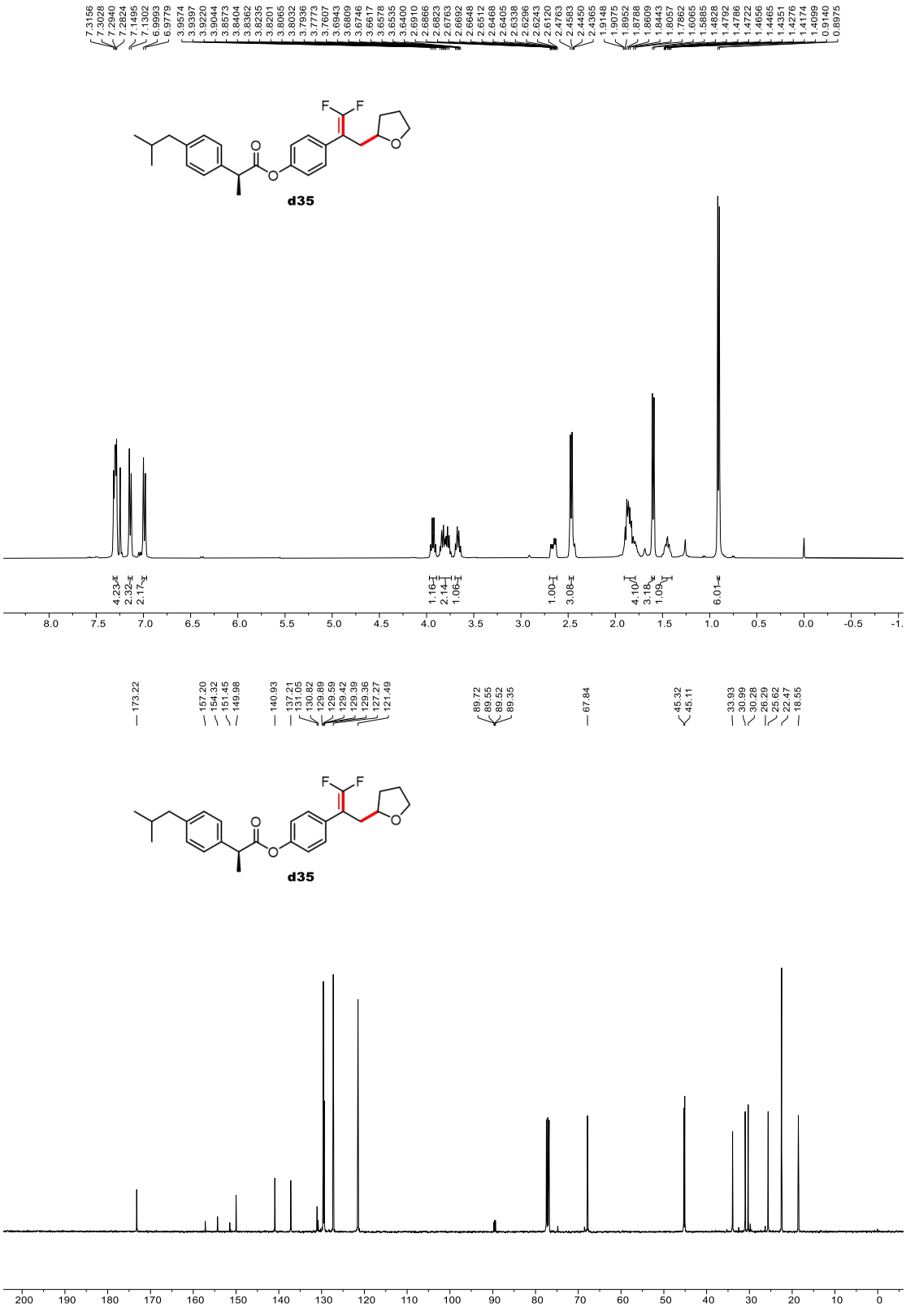

-86.341
-86.444
-90.627
-90.731
F
F
S
O
d33
1.00
0.93
-70 -72 -74 -76 -78 -80 -82 -84 -86 -88 -90 -92 -94 -96 -98 -100 -102 -104 -106 -108 -110

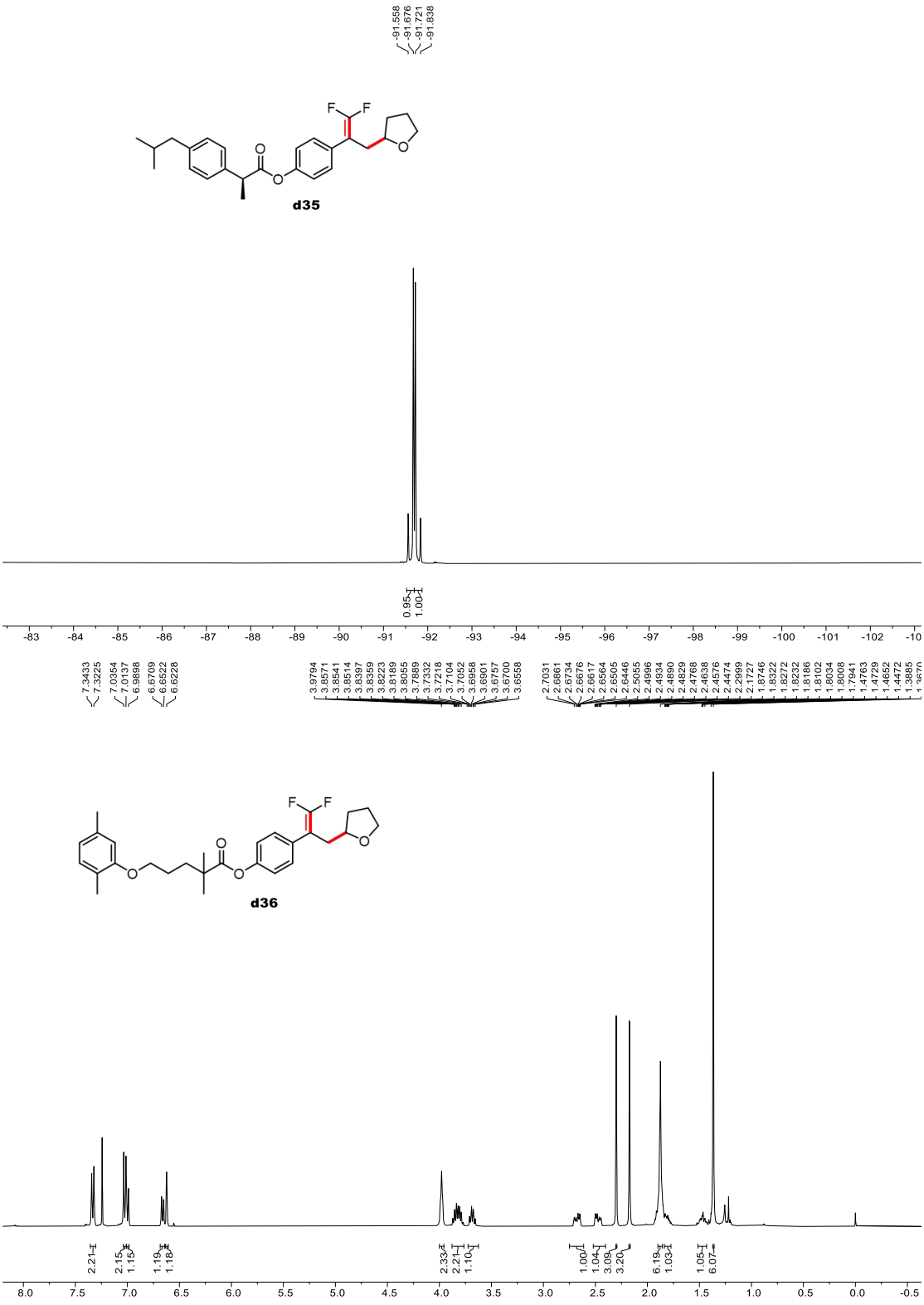

7.6055 7.6015 7.5973 7.5842 7.5807 7.5771 7.5031 7.4995 7.4821 7.4784 7.4667 7.4628 7.4586 7.4264 7.4231 7.4196 7.4103 7.4046 7.3987 7.3888 7.3864 7.3792 7.3729 7.3616 7.3565 7.2966 7.2921 7.2822 7.2721 7.2434 7.2389 7.0879 7.0807 7.0754 7.0641 7.0590
4.0396 4.0218 3.8818 3.8790 3.8760 3.8642 3.8597 3.8423 3.8247 3.8083 3.7352 3.7204 3.7150 3.7006 3.6949 2.7239 2.7066 2.6881 2.6710 2.5281 2.5118 2.4926 1.9395 1.9343 1.9241 1.9183 1.9127 1.9000 1.8963 1.8879 1.8826 1.8739 1.8685 1.8578 1.8528 1.8489 1.8357 1.8289 1.6973 1.6793 1.4976 1.4899 1.2951 0.0374

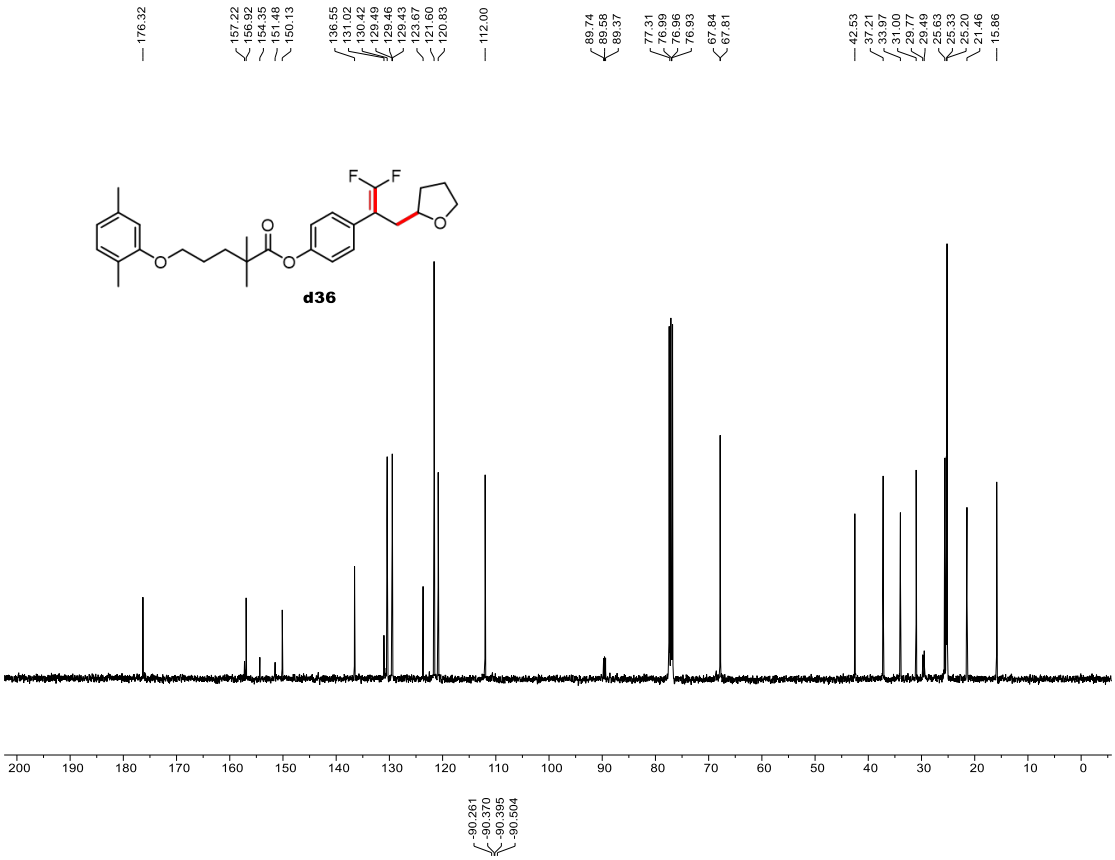
F
F
F
O
O
d34
2.07 3.15 0.99 2.11 1.06 1.04 2.01
1.12 2.07 1.13
1.00 1.01
2.04 1.05 3.10 1.17
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5


172.38
161.06
158.59
157.20
154.33
151.46
149.81
141.24
141.17
135.41
131.09
131.03
129.48
129.45
129.41
128.99
128.96
128.50
128.24
128.10
127.77
123.62
123.59
121.36
115.47
115.23
89.68
89.52
89.48
89.31
77.37
77.06
76.74
67.79
45.17
33.91
30.96
25.57
18.37
F
F
F
O
O
O
d34
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

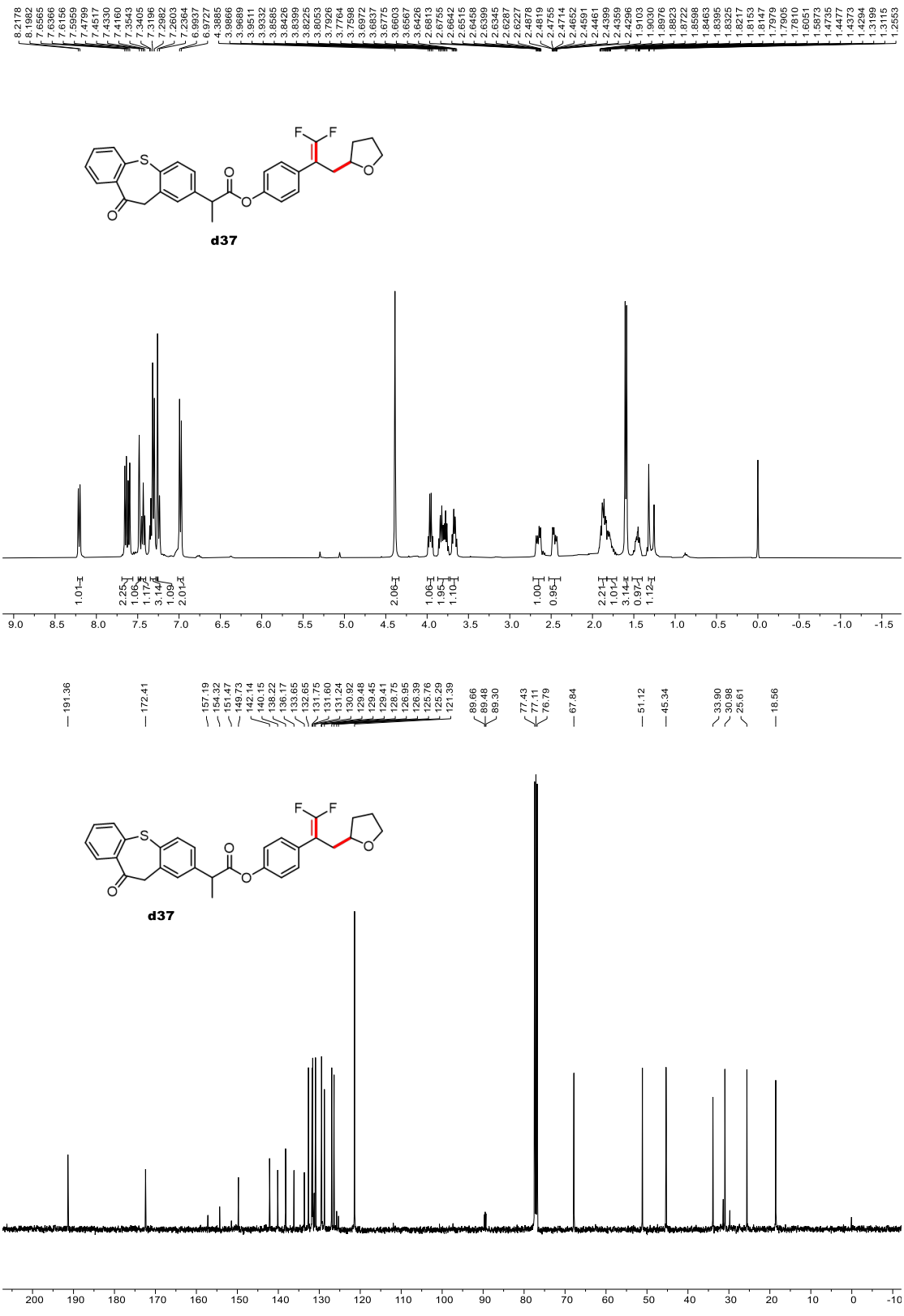

-90.265
-117.276
F
F
F
O
O
O
d34
2.15
1.00
-70
-75
-80
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140

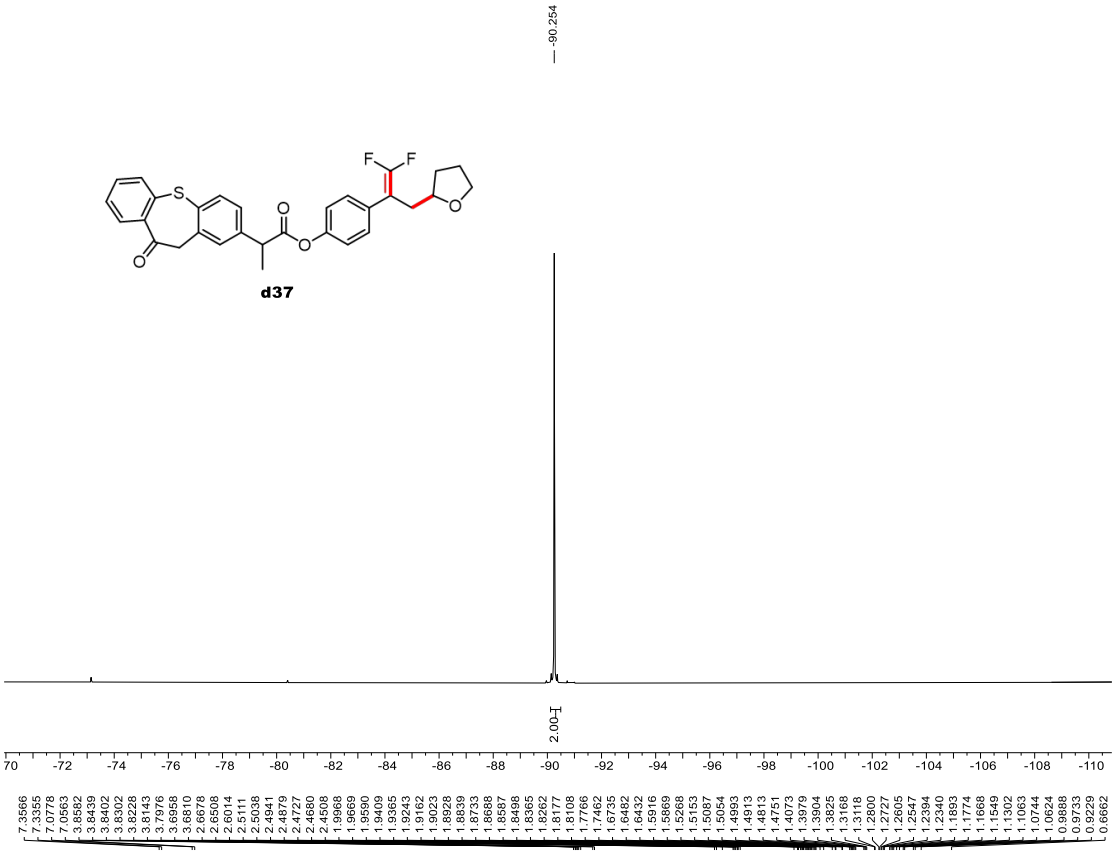

7.3156
7.3028
7.2940
7.2824
7.1495
7.1302
6.9993
6.9779
3.9574
3.9397
3.9220
3.9044
3.8573
3.8404
3.8362
3.8235
3.8201
3.8065
3.8032
3.7936
3.7773
3.7607
3.6943
3.6809
3.6746
3.6617
3.6578
3.6535
3.6400
2.6910
2.6886
2.6823
2.6763
2.6692
2.6648
2.6512
2.6468
2.6405
2.6338
2.6296
2.6243
2.6210
2.4763
2.4583
2.4450
2.4365
1.9148
1.9075
1.8952
1.8788
1.8609
1.8443
1.8057
1.7862
1.6065
1.5885
1.4828
1.4792
1.4786
1.4722
1.4656
1.4465
1.4351
1.4276
1.4174
1.4099
0.9140
0.8975
F
F
O
O
d35
4.23
2.32
2.17
1.16
2.14
1.06
1.00
3.08
4.10
3.18
1.09
6.01
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
173.22
157.20
154.32
151.45
149.98
140.93
137.21
131.05
130.82
129.89
129.59
129.42
129.39
129.36
127.27
121.49
89.72
89.55
89.52
89.35
67.84
45.32
45.11
33.93
30.99
30.28
26.29
25.62
23.47
18.55
F
F
O
O
d35
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

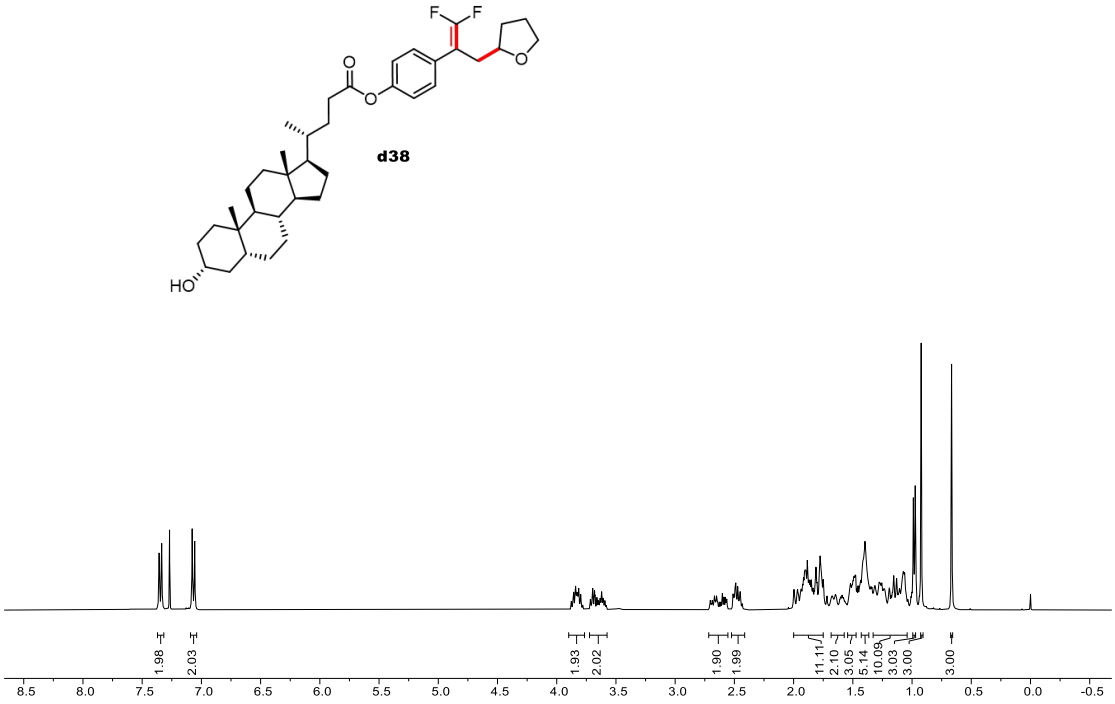

-91.558
-91.576
-91.721
-91.838
d35
0.95
1.00
-83 -84 -85 -86 -87 -88 -89 -90 -91 -92 -93 -94 -95 -96 -97 -98 -99 -100 -101 -102 -10
7.3433
7.3225
7.0354
7.0137
6.9898
6.6709
6.6522
6.6228
3.9794
3.8571
3.8541
3.8514
3.8397
3.8359
3.8223
3.8189
3.8055
3.7889
3.7332
3.7218
3.7104
3.7052
3.6958
3.6901
3.6757
3.6700
3.6558
2.7031
2.6861
2.6734
2.6676
2.6617
2.6564
2.6505
2.6446
2.5055
2.4996
2.4934
2.4890
2.4829
2.4768
2.4638
2.4576
2.4474
2.2999
2.1727
1.8746
1.8322
1.8272
1.8232
1.8186
1.8102
1.8034
1.8008
1.7941
1.4763
1.4729
1.4652
1.4472
1.3885
d36
2.21
2.15
1.15
1.19
1.18
2.33
2.21
1.10
1.00
1.04
3.09
3.20
6.19
1.03
1.05
6.07
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

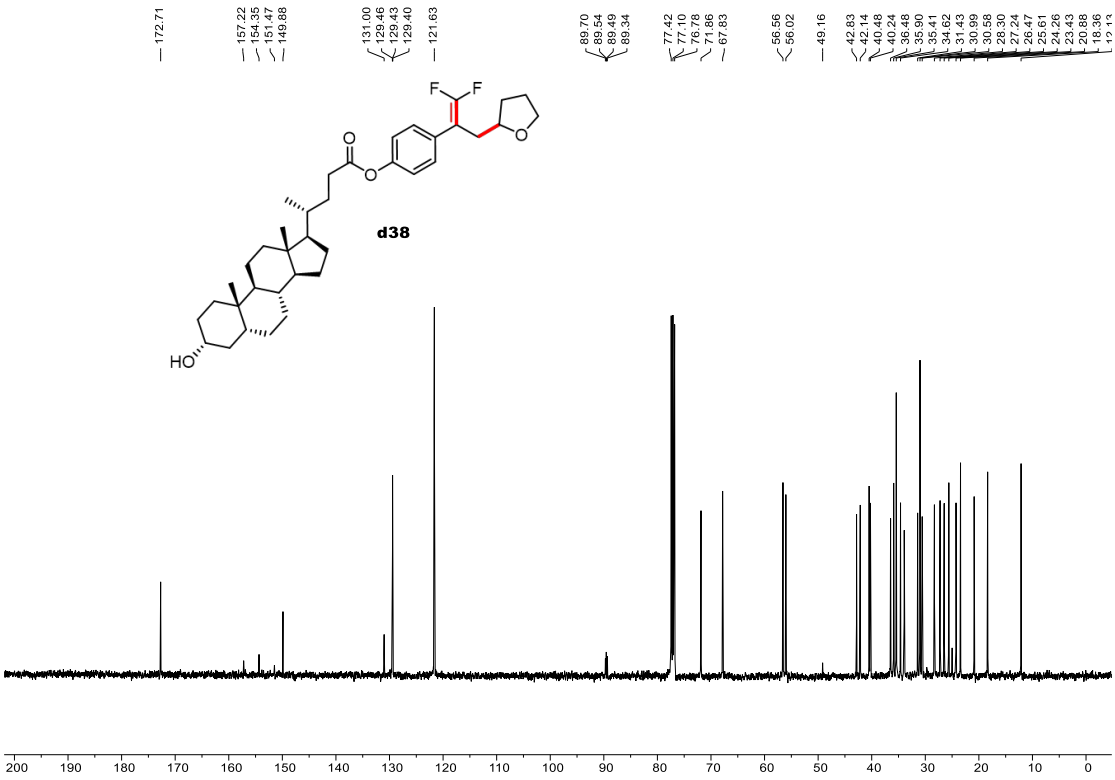

176.32
157.22
156.92
154.35
151.48
150.13
136.55
131.02
130.42
129.49
129.46
129.43
123.67
121.60
120.83
112.00
89.74
89.58
89.37
77.31
76.99
76.96
76.93
67.84
67.81
42.53
37.21
33.97
31.00
29.77
29.49
25.63
25.33
25.20
21.46
15.86
F
F
O
O
O
d36
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

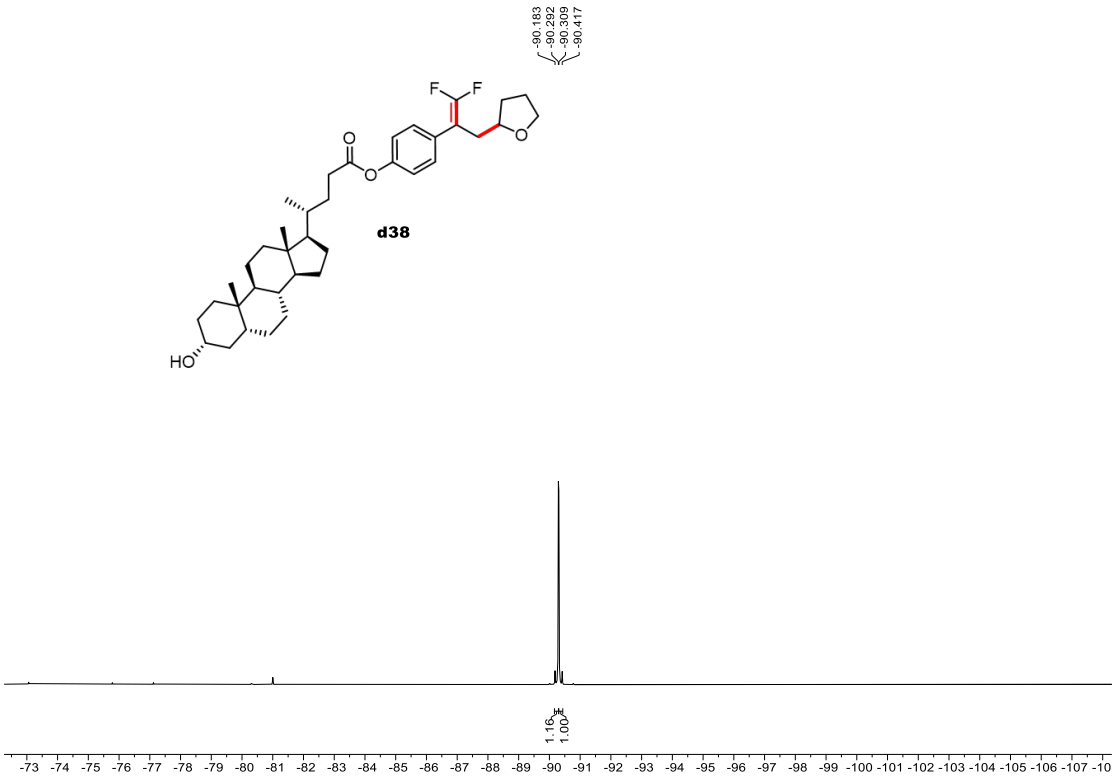

-90.261
-90.370
-90.395
-90.504
F
F
O
O
O
d36
1.00
1.06
-70
-72
-74
-76
-78
-80
-82
-84
-86
-88
-90
-92
-94
-96
-98
-100
-102
-104
-106
-108
-110
-112
-114

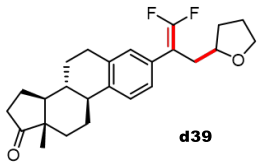

d37
d37


-90.254
F
F
S
O
O
O
d37
2.00
70 -72 -74 -76 -78 -80 -82 -84 -86 -88 -90 -92 -94 -96 -98 -100 -102 -104 -106 -108 -110

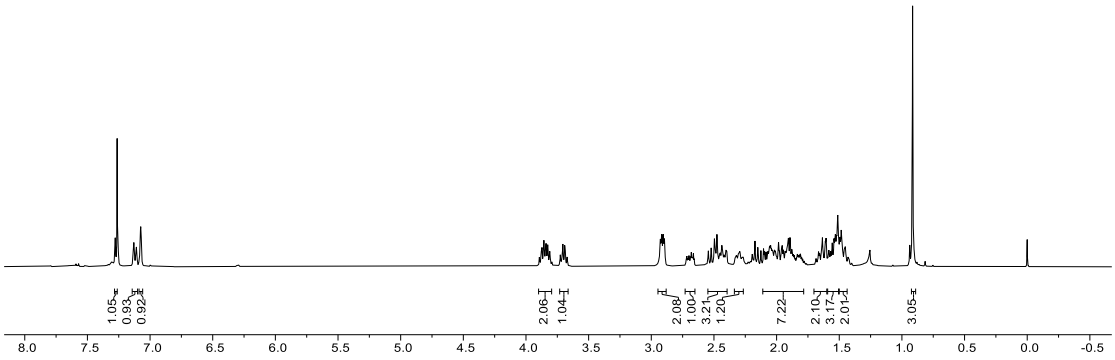

F
F
O
O
d38
HO
1.98
2.03
1.93
2.02
1.90
1.99
11.11
2.10
3.05
5.14
10.09
3.03
3.00
3.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

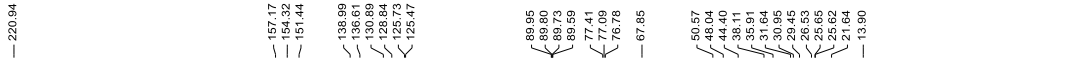

172.71
157.22
154.35
151.47
149.88
131.00
129.46
129.43
129.40
121.63
89.70
89.54
89.49
89.34
77.42
77.10
76.78
71.86
67.83
56.56
56.02
49.16
42.83
42.14
40.48
40.24
36.48
35.90
35.41
34.62
31.43
30.99
30.58
28.30
27.24
26.47
25.61
24.26
23.43
20.88
18.36
F
F
O
O
HO
d38
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

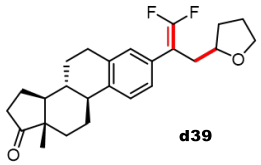

-90.183
-90.292
-90.309
-90.417
F
F
O
O
HO
d38
1.16
1.00
-73
-74
-75
-76
-77
-78
-79
-80
-81
-82
-83
-84
-85
-86
-87
-88
-89
-90
-91
-92
-93
-94
-95
-96
-97
-98
-99
-100
-101
-102
-103
-104
-105
-106
-107
-10


F
F
O
O

d39

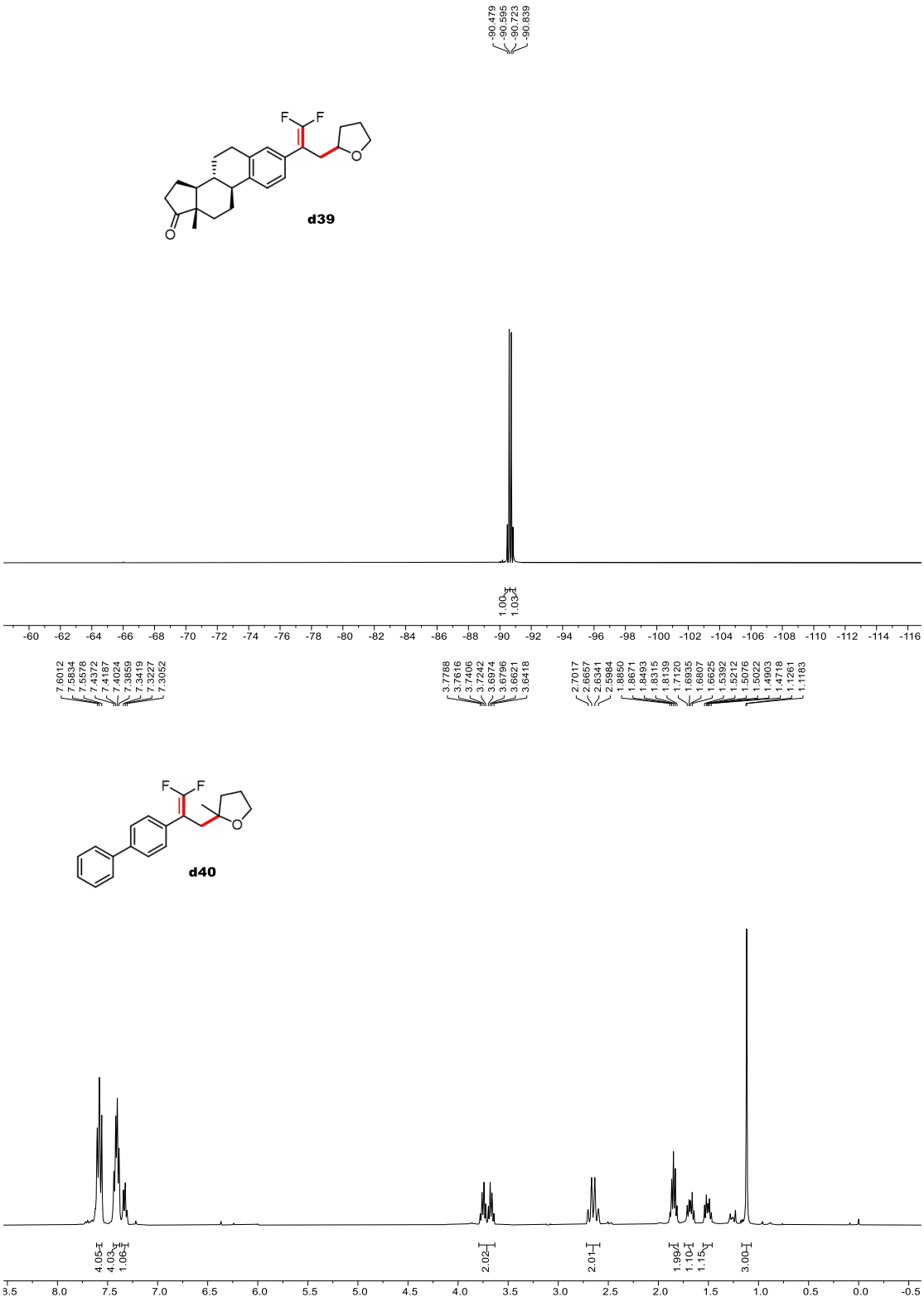

1.05
0.93
0.92
2.06
1.04
2.08
1.00
3.21
1.20
7.22
2.10
3.17
2.01
3.05
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

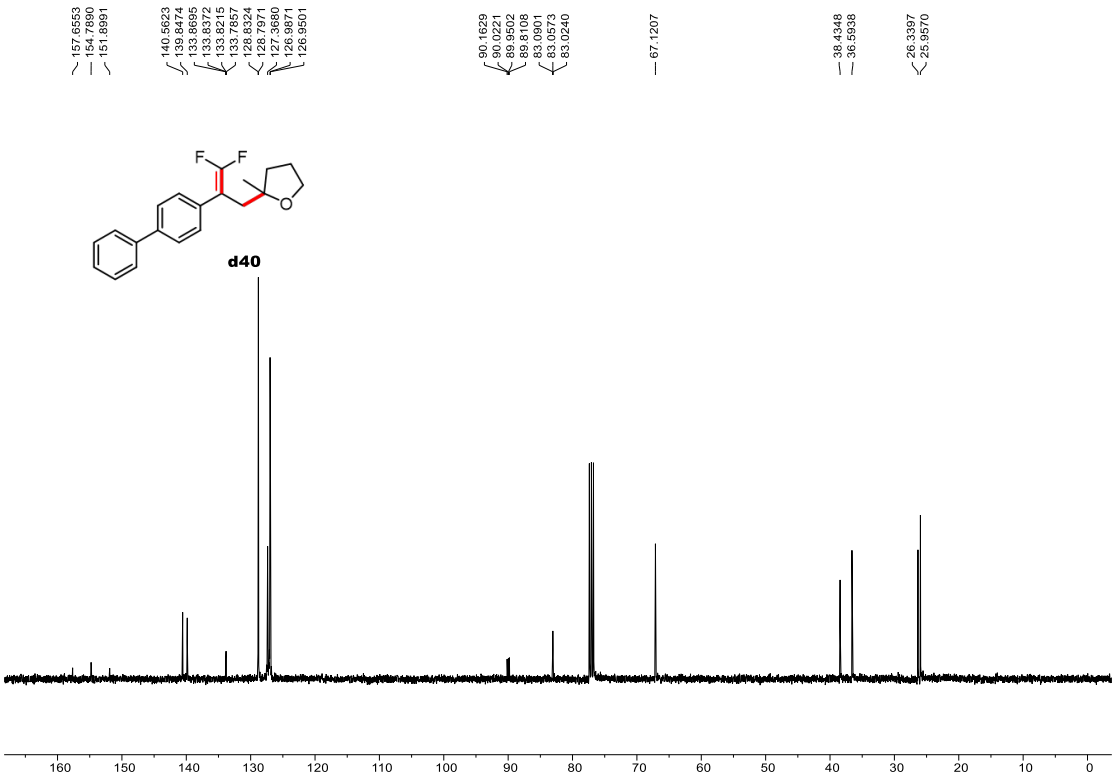


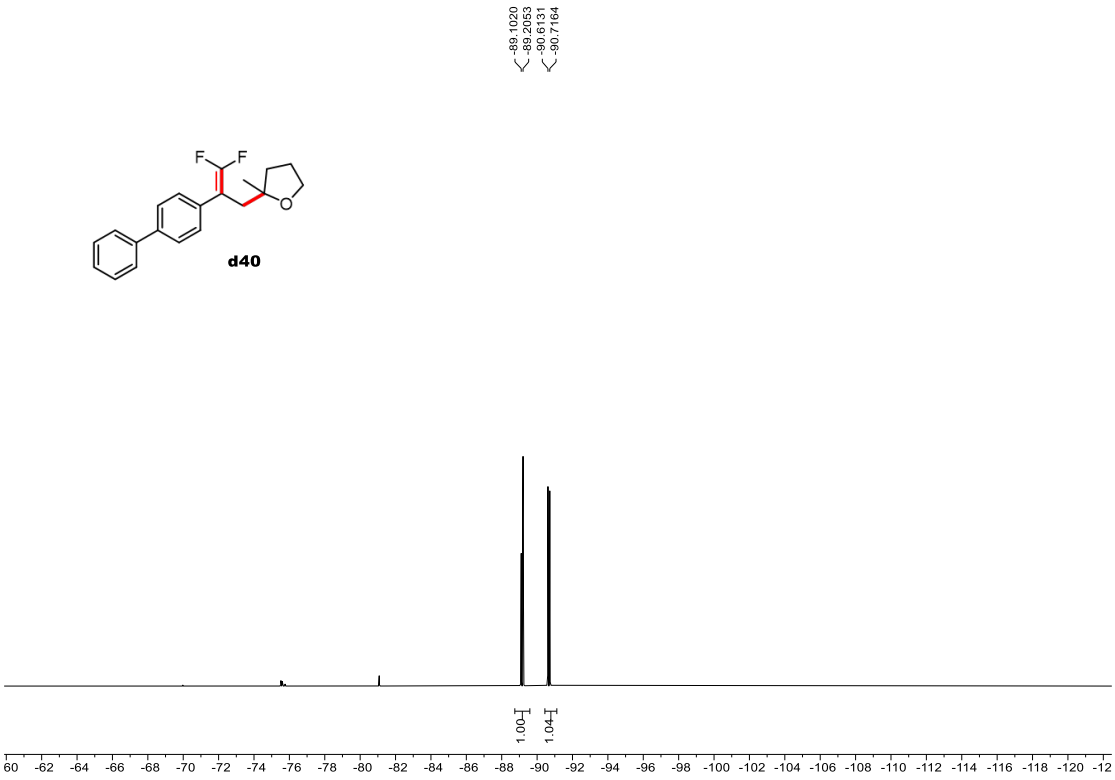

F
F
O
O

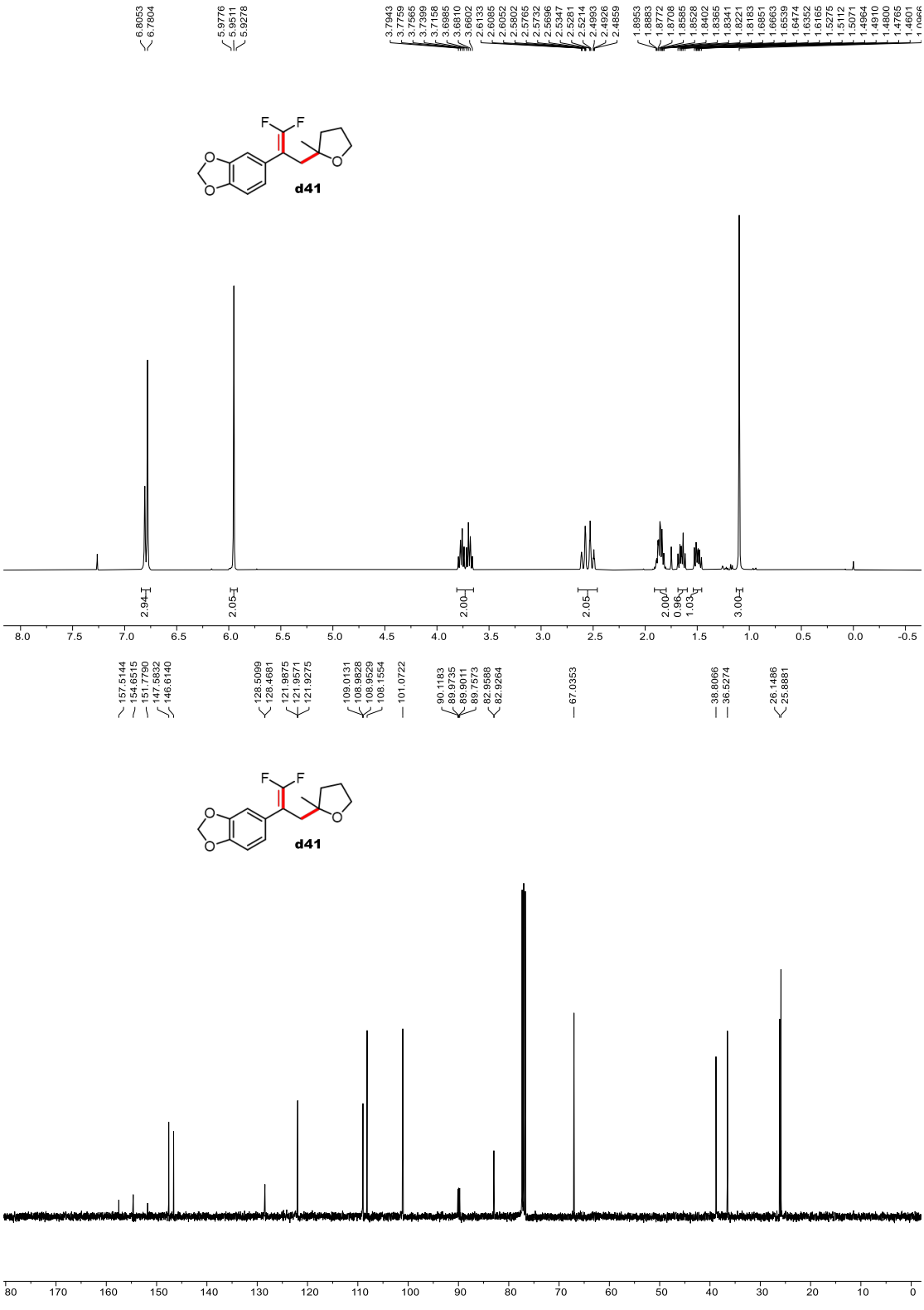
d39

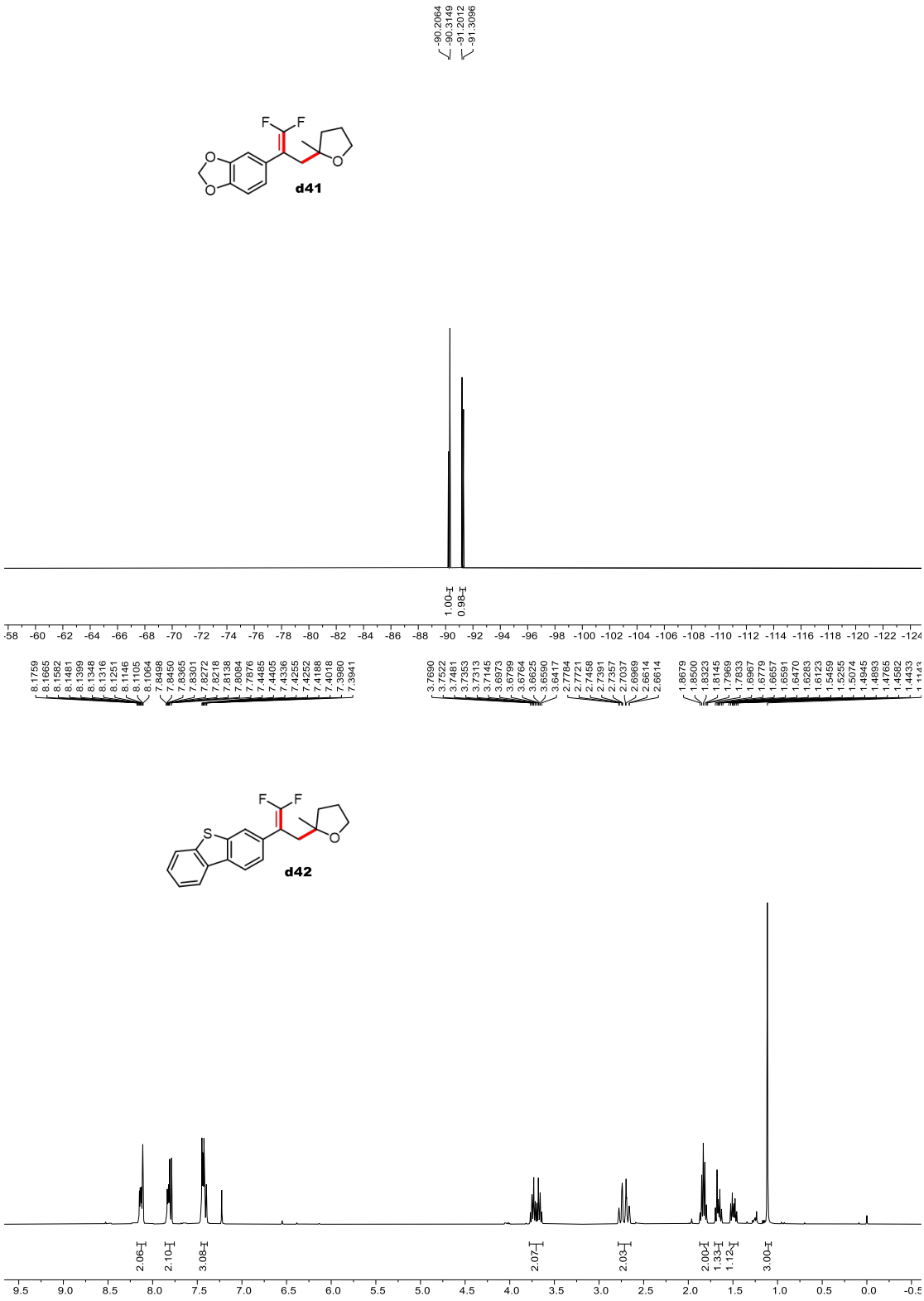
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30

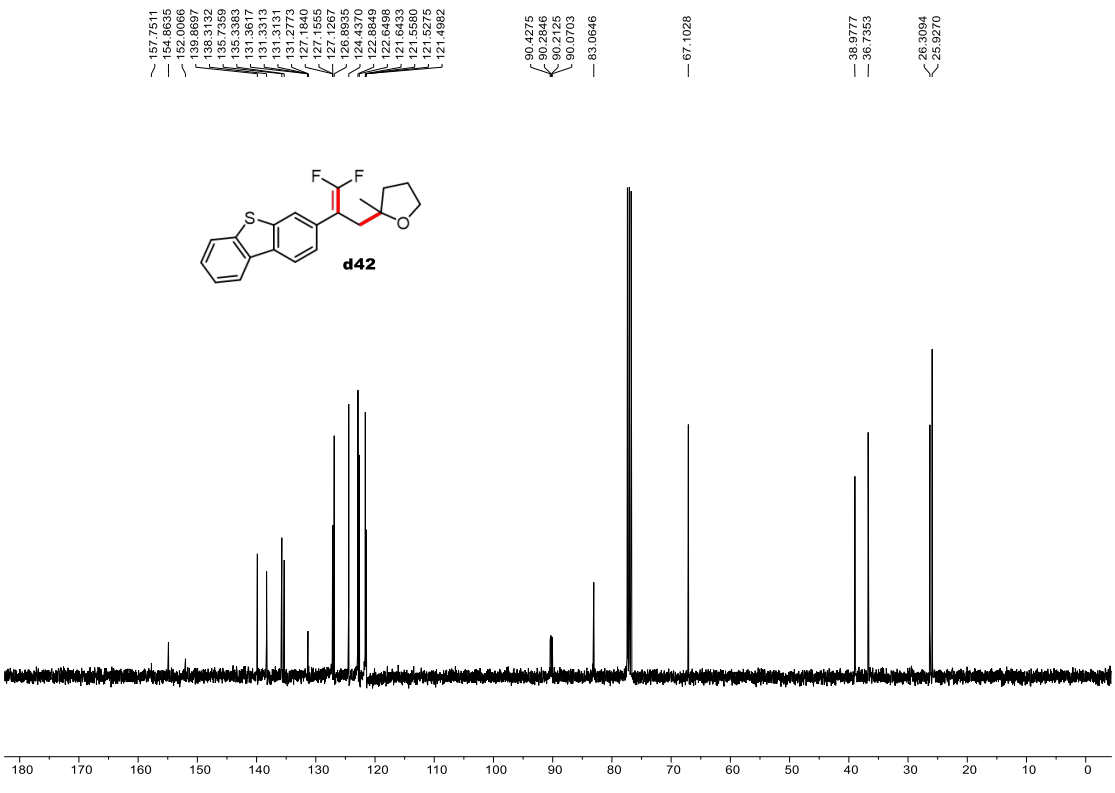

-90.479
-90.595
-90.723
-90.839
F
F
O
O
d39
1.00
1.03
-60 -62 -64 -66 -68 -70 -72 -74 -76 -78 -80 -82 -84 -86 -88 -90 -92 -94 -96 -98 -100 -102 -104 -106 -108 -110 -112 -114 -116
7.6012
7.5834
7.5578
7.4372
7.4187
7.4024
7.3859
7.3419
7.3227
7.3052
3.7788
3.7616
3.7406
3.7242
3.6974
3.6796
3.6621
3.6418
2.7017
2.6657
2.6341
2.5984
1.8850
1.8671
1.8493
1.8315
1.8139
1.7120
1.6935
1.6807
1.6625
1.5392
1.5212
1.5076
1.5022
1.4903
1.4718
1.1261
1.1163
F
F
O
d40
4.05
4.03
1.06
2.02
2.01
1.99
1.10
1.15
3.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5


157.6553
154.7890
151.8991
140.5623
139.8474
133.8695
133.8372
133.8215
133.7857
128.8324
128.7971
127.3680
126.9871
126.9501
90.1629
90.0221
89.9502
89.8108
83.0901
83.0573
83.0240
67.1207
38.4348
36.5938
26.3397
25.9570
F
F
O
d40
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

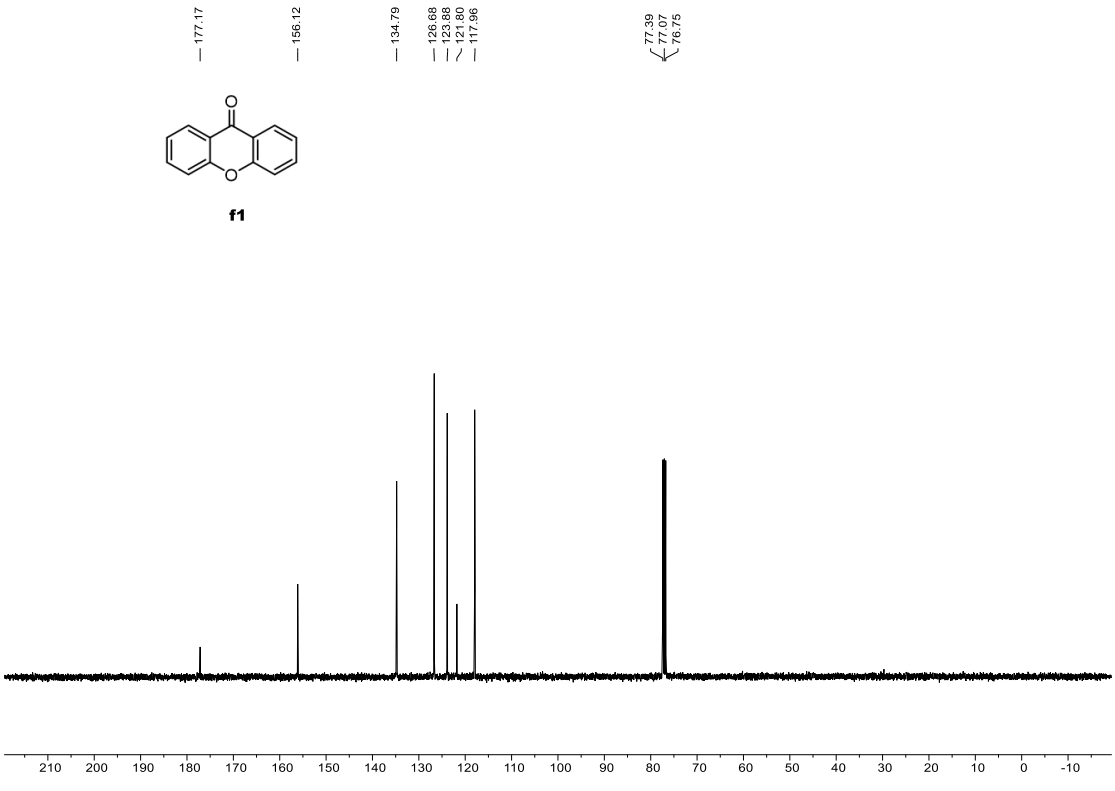

-89.1020
-89.2053
-90.6131
-90.7164
F
F
O
d40
1.00
1.04
60
-62
-64
-66
-68
-70
-72
-74
-76
-78
-80
-82
-84
-86
-88
-90
-92
-94
-96
-98
-100
-102
-104
-106
-108
-110
-112
-114
-116
-118
-120
-12

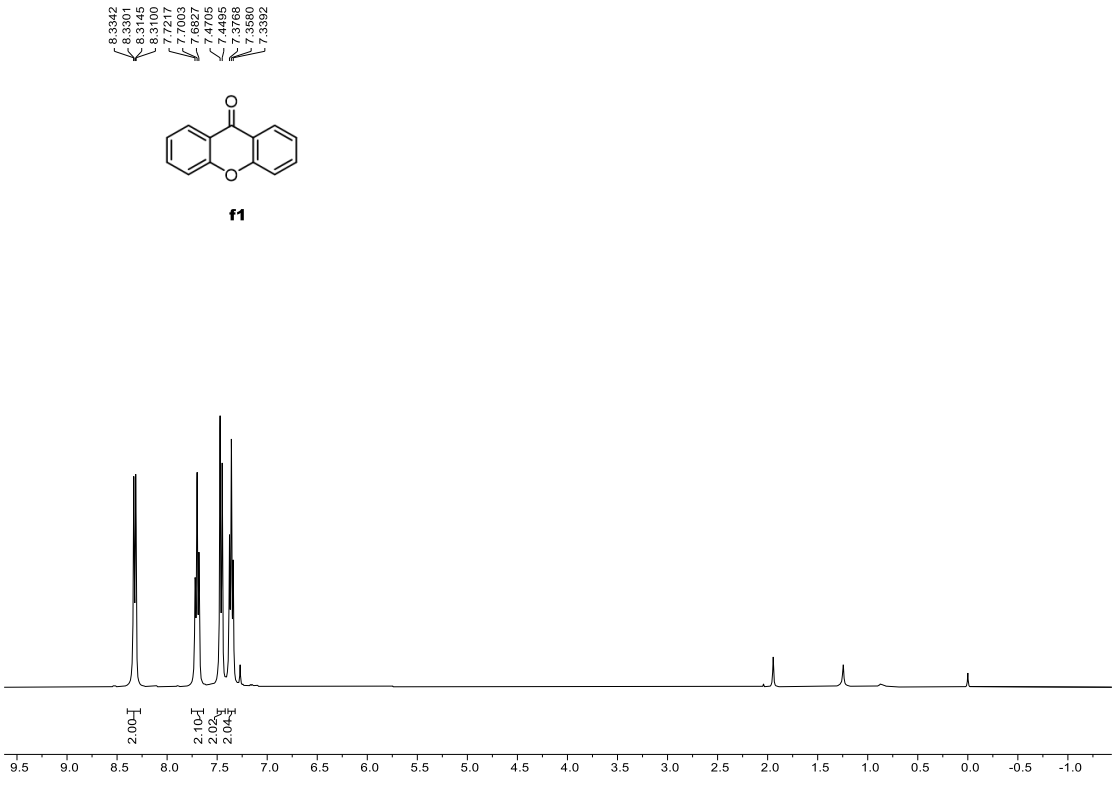

6.8053
6.7804
5.9776
5.9511
5.9278
3.7943
3.7759
3.7565
3.7399
3.7158
3.6985
3.6810
3.6602
2.6133
2.6085
2.6052
2.5802
2.5765
2.5732
2.5696
2.5547
2.5281
2.5214
2.4993
2.4926
2.4859
1.8953
1.8883
1.8772
1.8708
1.8585
1.8528
1.8402
1.8365
1.8341
1.8221
1.8183
1.6851
1.6663
1.6539
1.6474
1.6352
1.6165
1.5275
1.5112
1.5071
1.4964
1.4910
1.4800
1.4765
1.4601
F
F
O
O
O
d41
2.94
2.05
2.00
2.05
2.00
0.96
1.03
3.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
157.5144
154.6515
151.7790
147.5832
146.6140
128.5099
128.4681
121.9875
121.9571
121.9275
109.0131
108.9828
108.9529
108.1554
101.0722
90.1183
89.9735
89.9011
89.7573
82.9588
82.9264
67.0353
38.8066
36.5274
26.1486
25.8881
F
F
O
O
O
d41
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

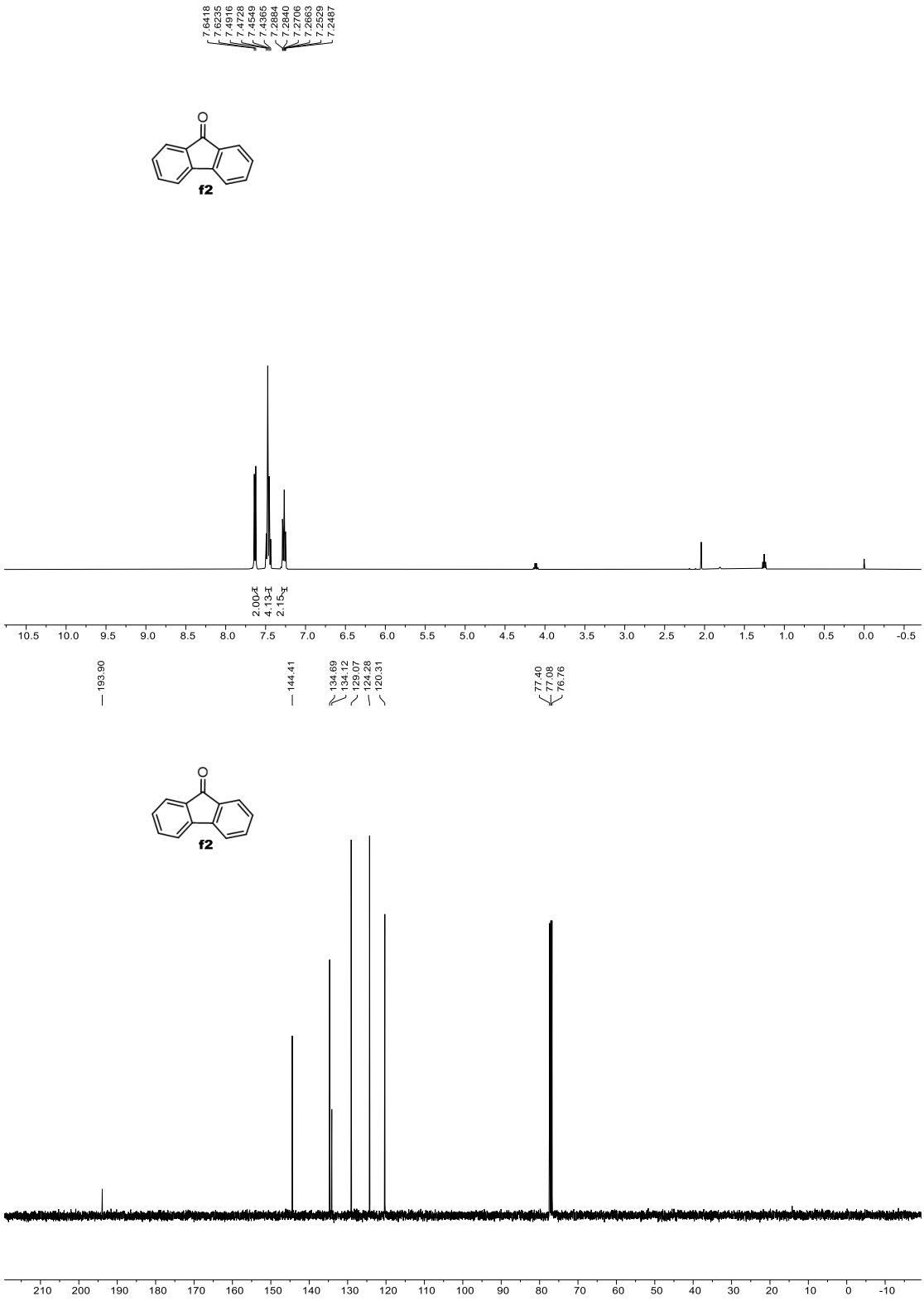

-90.2064
-90.3149
-91.2012
-91.3096
F
F
O
O
O
d41
1.00
0.98
-58 -60 -62 -64 -66 -68 -70 -72 -74 -76 -78 -80 -82 -84 -86 -88 -90 -92 -94 -96 -98 -100 -102 -104 -106 -108 -110 -112 -114 -116 -118 -120 -122 -124
8.1759 8.1665 8.1582 8.1481 8.1399 8.1348 8.1316 8.1251 8.1146 8.1105 8.1064 7.8498 7.8450 7.8365 7.8301 7.8272 7.8218 7.8138 7.8084 7.7876 7.4485 7.4405 7.4336 7.4255 7.4252 7.4188 7.4018 7.3980 7.3941
3.7690 3.7522 3.7481 3.7353 3.7313 3.7145 3.6973 3.6799 3.6764 3.6625 3.6590 3.6417 2.7784 2.7721 2.7458 2.7391 2.7357 2.7037 2.6969 2.6614 2.6614
1.8679 1.8500 1.8323 1.8145 1.7969 1.7833 1.6967 1.6779 1.6657 1.6591 1.6470 1.6283 1.6123 1.5459 1.5255 1.5074 1.4945 1.4893 1.4765 1.4582 1.4433
F
F
S
O
d42
2.06
2.10
3.08
2.07
2.03
2.00
1.33
1.12
3.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

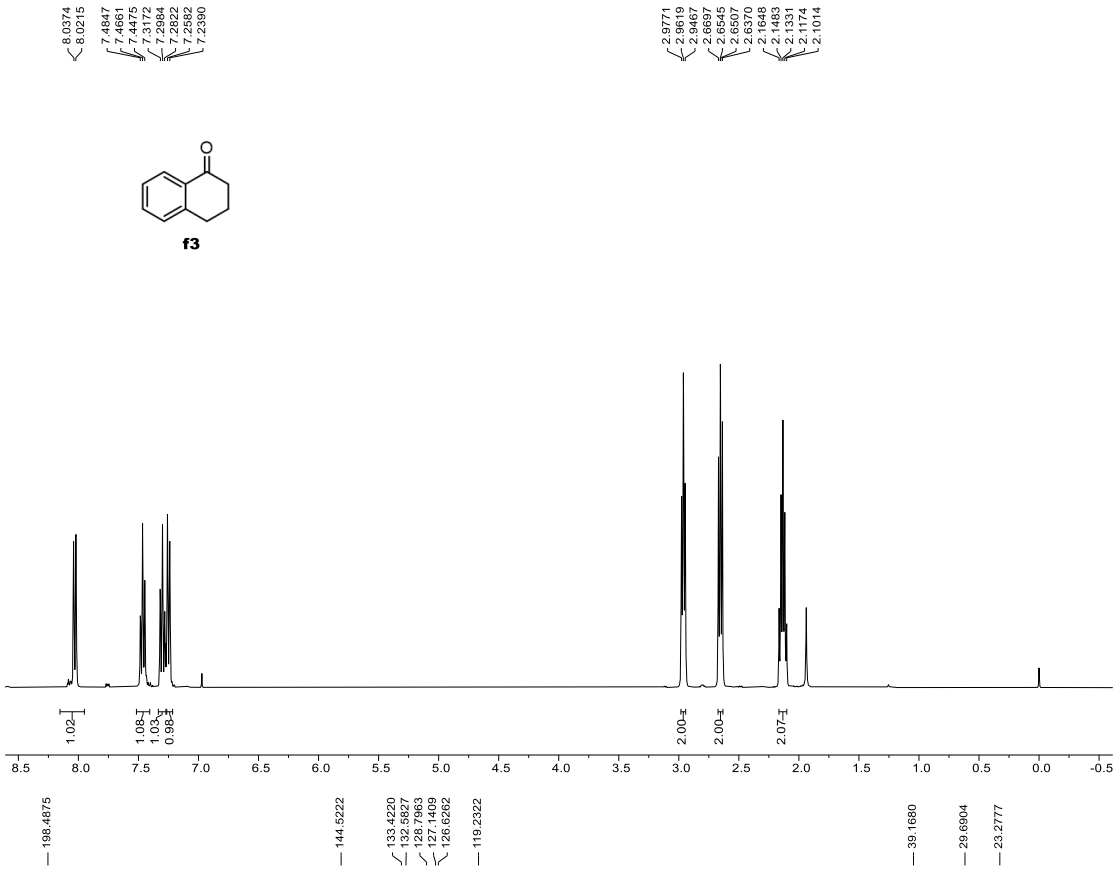

157.7511
154.8635
152.0066
139.8697
138.3132
135.7359
135.3383
131.3617
131.3313
131.3131
131.2773
127.1840
127.1555
127.1267
126.8935
124.4370
122.8849
122.6498
121.6433
121.5580
121.5275
121.4982
90.4275
90.2846
90.2125
90.0703
83.0646
67.1028
38.9777
36.7353
26.3094
25.9270
F
F
S
O
d42
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

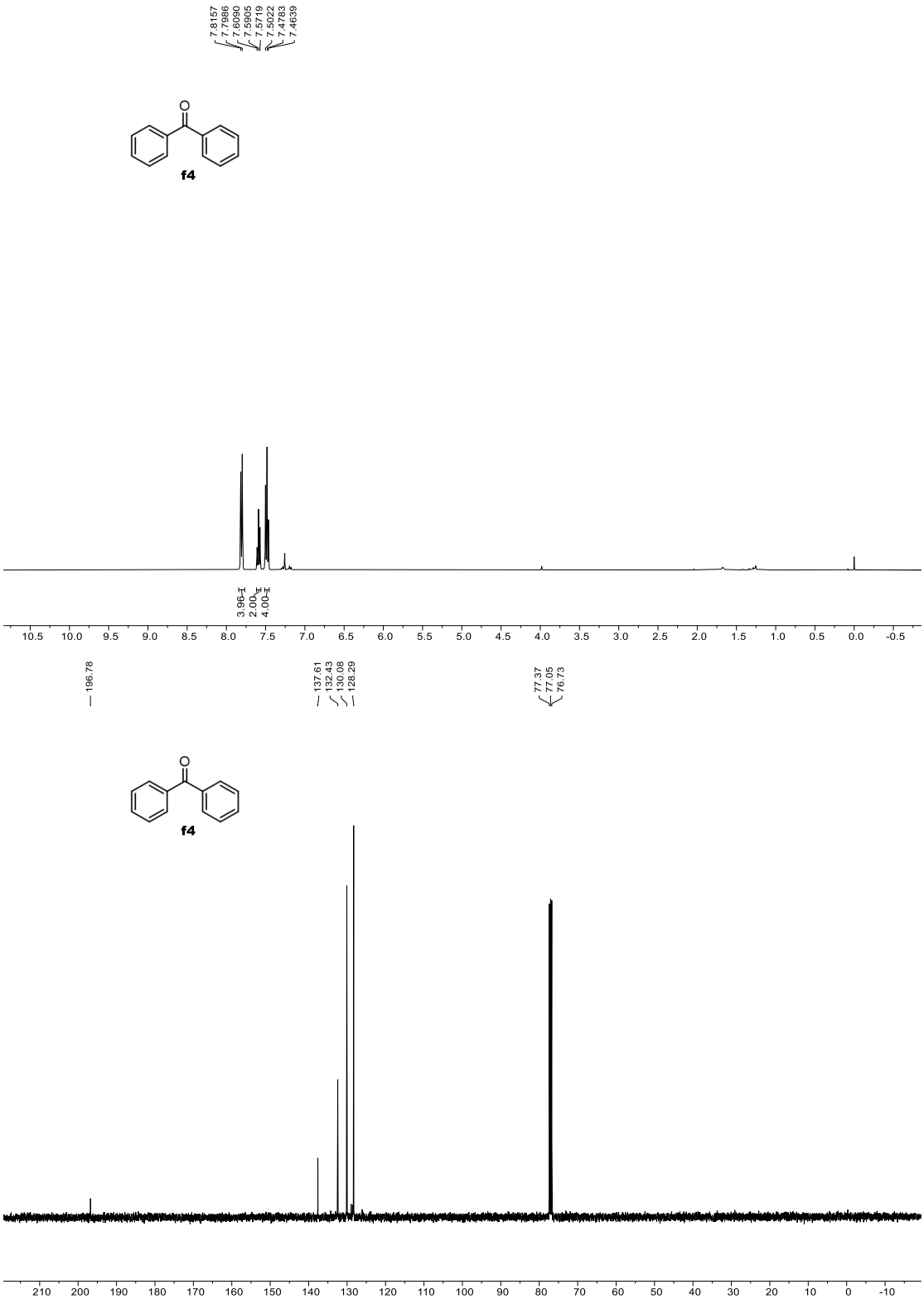

-89.3006
-89.4050
-90.8813
-90.9862
F
F
S
O
d42
1.00
1.05
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
-105
-110
-115
-120
-1

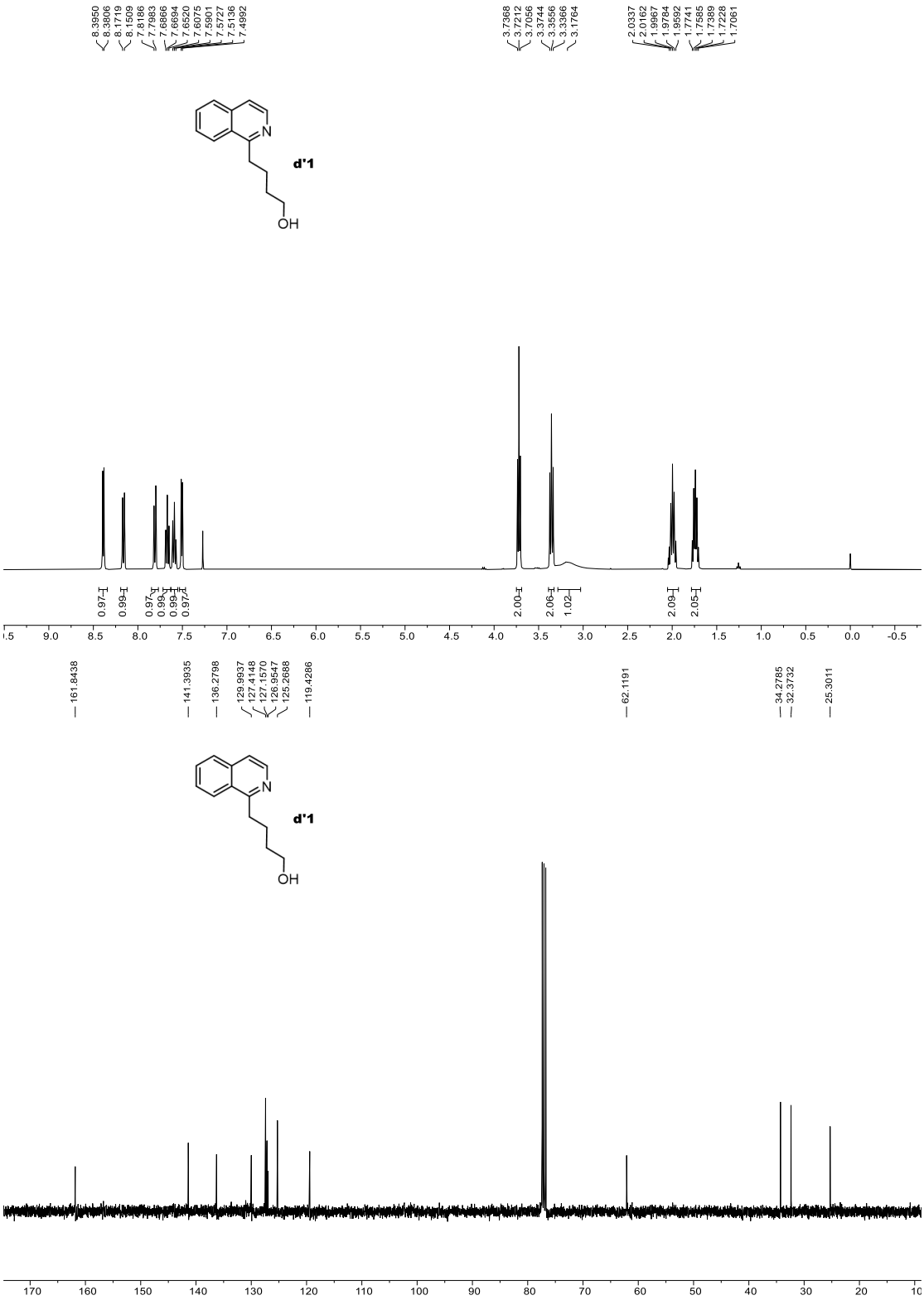

177.17
156.12
134.79
126.68
123.88
121.80
117.96
77.39
77.07
76.75
f1
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

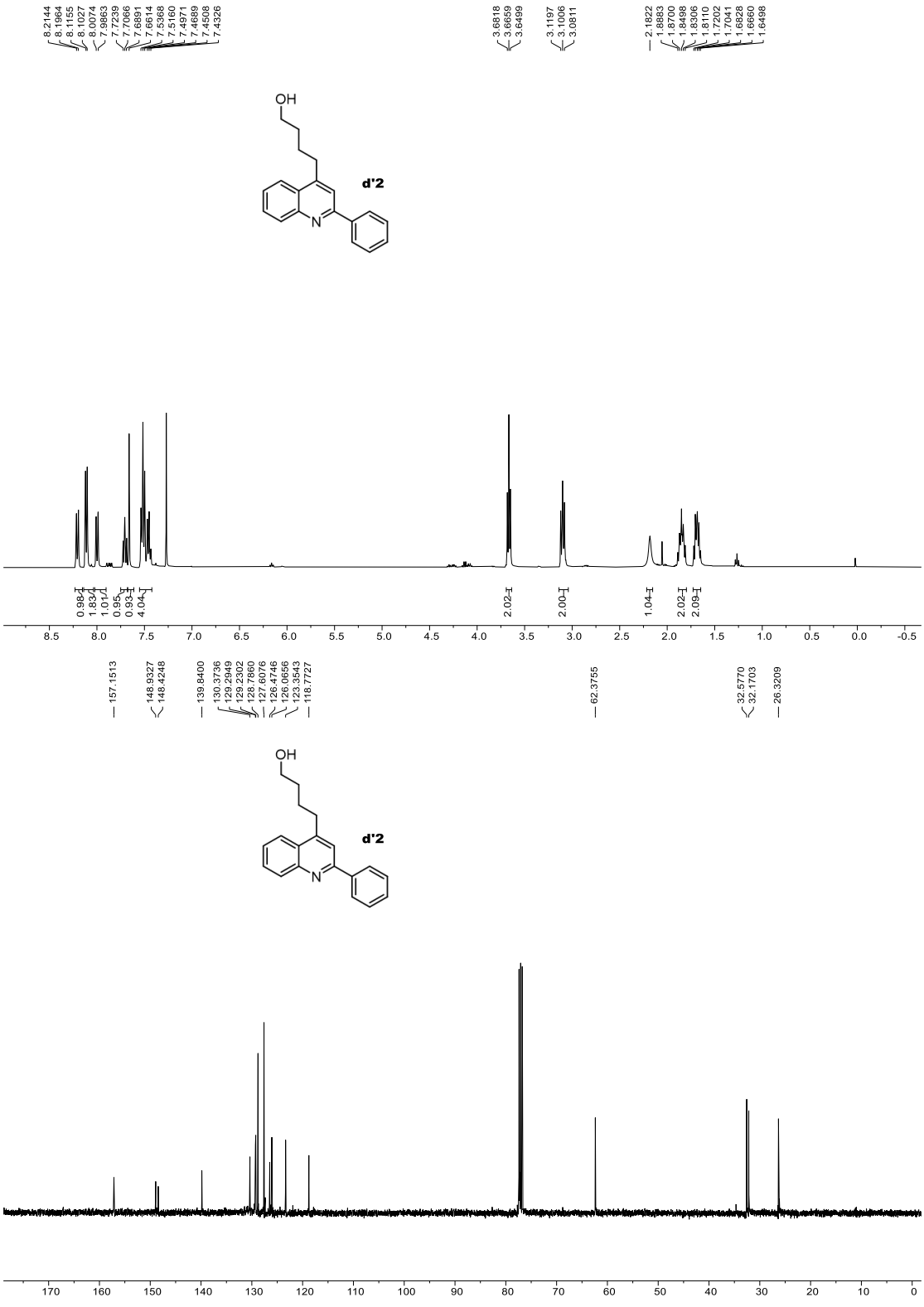

8.3342
8.3301
8.3145
8.3100
7.7217
7.7003
7.6827
7.4705
7.4495
7.3768
7.3580
7.3392
f1
2.00
2.10
2.02
2.04
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0

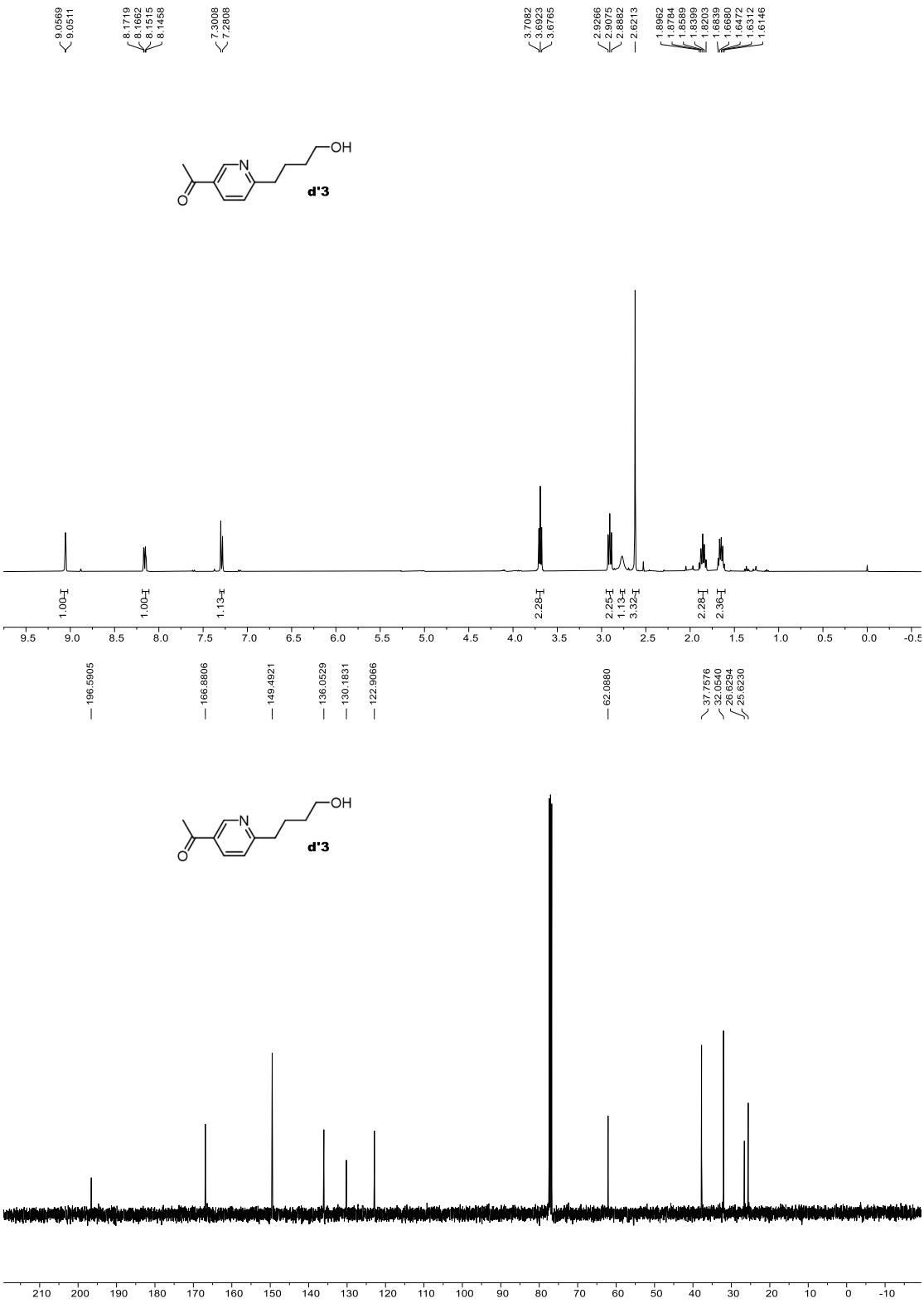

7.6418
7.6235
7.4916
7.4728
7.4549
7.4365
7.2884
7.2840
7.2706
7.2663
7.2529
7.2487
f2
2.00
4.13
2.15
193.90
144.41
134.69
134.12
129.07
124.28
120.31
77.40
77.08
76.76
f2

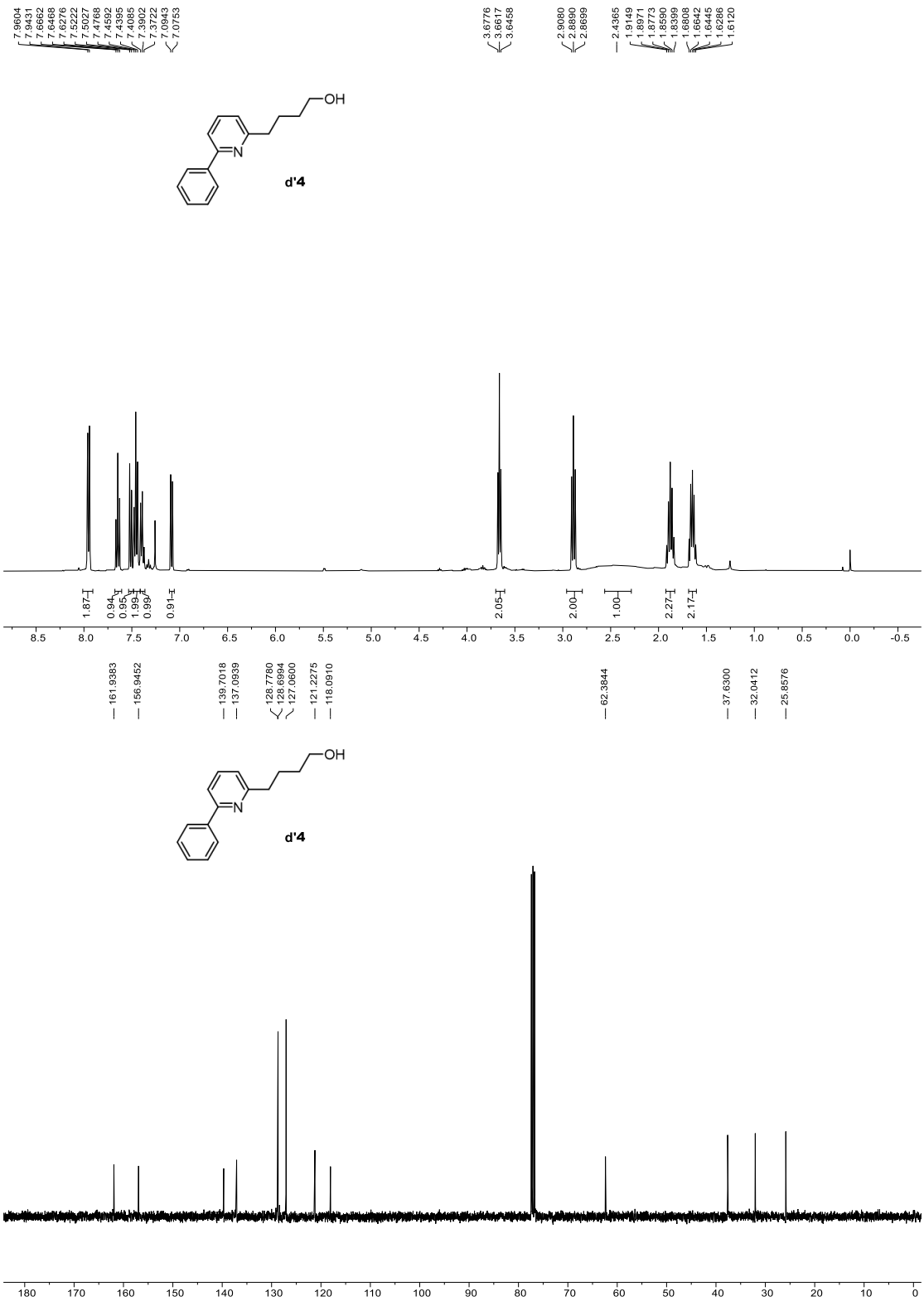

8.0374
8.0215
7.4847
7.4661
7.4475
7.3172
7.2984
7.2822
7.2582
7.2390
2.9771
2.9619
2.9467
2.6697
2.6545
2.6507
2.6370
2.1648
2.1483
2.1331
2.1174
2.1014
f3
1.02
1.08
1.03
0.98
2.00
2.00
2.07
198.4875
144.5222
133.4220
132.5827
128.7963
127.1409
126.6262
119.2322
39.1680
29.6904
23.2777
f3

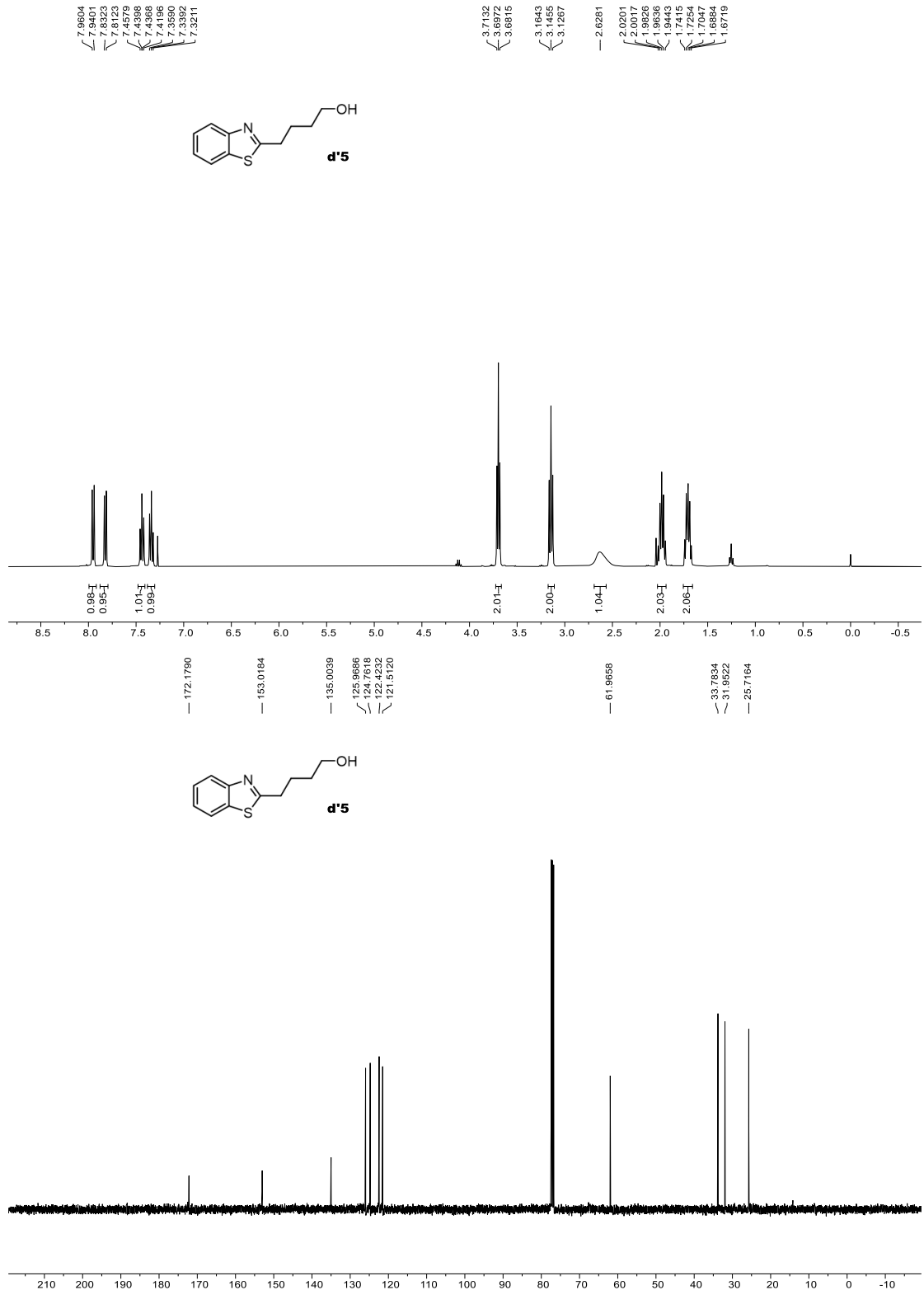

7.8157
7.7986
7.6090
7.5905
7.5719
7.5022
7.4783
7.4639
f4
3.96
2.00
4.00
196.78
137.61
132.43
130.08
128.29
77.37
77.05
76.73
f4


8.3950
8.3806
8.1719
8.1579
8.1496
7.7983
7.6866
7.6694
7.6520
7.6075
7.5901
7.5727
7.5136
7.4992
3.7368
3.7212
3.7056
3.3744
3.3556
3.3366
3.1764
2.0337
2.0162
1.9967
1.9784
1.9592
1.7741
1.7585
1.7389
1.7228
1.7061
N
OH
d'1
0.97
0.99
0.97
0.99
0.99
0.97
2.00
2.06
1.02
2.09
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
-0.5
161.8438
141.3935
136.2798
129.9937
127.4148
127.1570
126.9547
125.2688
119.4286
62.1191
34.2785
32.3732
25.3011
N
OH
d'1
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10


8.2144
8.1964
8.1155
8.1027
8.0074
7.9863
7.7239
7.7066
7.6891
7.6614
7.5368
7.5160
7.4971
7.4689
7.4508
7.4326
3.6818
3.6659
3.6499
3.1197
3.1006
3.0811
2.1822
1.8883
1.8700
1.8498
1.8306
1.8110
1.7202
1.7041
1.6828
1.6660
1.6498
OH
d'2
N
0.98
1.83
1.01
0.95
0.93
4.04
2.02
2.00
1.04
2.02
2.09
157.1513
148.9327
148.4248
139.8400
130.3736
129.2949
129.2302
128.7860
127.6076
126.4746
126.0656
123.3543
118.7727
62.3755
32.5770
32.1703
26.3209
OH
d'2
N


9.0569
9.0511
8.1719
8.1662
8.1515
8.1458
7.3008
7.2808
3.7082
3.6923
3.6765
2.9266
2.9075
2.8882
2.6213
1.8962
1.8784
1.8589
1.8399
1.8203
1.6839
1.6680
1.6472
1.6312
1.6146
OH
N
O
d'3
1.00
1.00
1.13
2.28
2.25
1.13
3.32
2.28
2.36
196.5905
166.8806
149.4921
136.0529
130.1831
122.9066
62.0880
37.7576
32.0540
26.6294
25.6230
OH
N
O
d'3


7.9604
7.9431
7.6662
7.6468
7.6276
7.5222
7.5027
7.4768
7.4592
7.4395
7.4085
7.3902
7.3722
7.0943
7.0753
3.6776
3.6617
3.6458
2.9080
2.8890
2.8699
2.4365
1.9149
1.8971
1.8773
1.8590
1.8398
1.6808
1.6642
1.6445
1.6286
1.6120
OH
N
d'4
1.87
0.94
0.95
1.99
0.99
0.91
2.05
2.00
1.00
2.27
2.17
161.9383
156.9452
139.7018
137.0939
128.7780
128.6984
127.0600
121.2275
118.0910
62.3844
37.6300
32.0412
25.8576
OH
N
d'4


7.9604
7.9401
7.8323
7.8123
7.4579
7.4398
7.4368
7.4196
7.3590
7.3392
7.3211
3.7132
3.6972
3.6815
3.1643
3.1455
3.1267
2.6281
2.0201
2.0017
1.9826
1.9636
1.9443
1.7415
1.7254
1.7047
1.6884
1.6719
OH
N
S
d'5
0.98
0.95
1.01
0.99
2.01
2.00
1.04
2.03
2.06
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
172.1790
153.0184
135.0039
125.9686
124.7618
122.4232
121.5120
61.9658
33.7834
31.9522
25.7164
OH
N
S
d'5
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10