Electronic Supplementary Material (ESI) for ChemComm.

Copper-catalyzed intermolecular and regioselective aminofluorination of Styrenes: Facile access to β-fluoro-*N*-protected phenethylamines

Jorge Saavedra-Olavarría, Gean C. Arteaga, Jhon J. López and Edwin G. Pérez.

Supporting Information

Table of Contents

1. Experimental Section

1.1. General

All solvents and all deuterated solvents were purchased from Merck, reagents from Aldrich, Merck and AK Scientific. Column chromatography was performed with silica gel (Merck, type 60, 0.063-0.2 mm). NMR spectra were recorded on a Bruker Avance 400 MHz spectrometer. All chemical shifts in NMR experiments were reported as ppm downfield from TMS. The following calibrations were used: $CDCl_3$ δ= 7.26 and 77.0 ppm. Infrared spectra were recorded on a JASCO FT/IR-400 spectrophotometer. HPLC-HR-MS experiments were performed on an Exactive Plus Orbitrap MS (Thermo Scientific). The accurate mass measurements were performed at a resolution of 140.000. Melting points were determined on a Reichert Galen III hot plate microscope apparatus and are uncorrected.

1.2. General procedure for the Aminofluorination of Styrenes

In a 10 mL vial, $Cu(MeCN)_4BF_4$ (32 mg, 0.1 mmol), neocuproin (21 mg 0.1 mmol), 1,2-dichloroethane (3.0 mL) were stirred for 3 min and Ph-I=N-Ts (560 mg, 1.5 mmol) was added to the red solution. The suspension was stirred for 3 min and Et_3N•3HF (0.97 mL, 6 mmol) was added. A clear green solution is obtained. Styrene (**1a**, 104 mg, 1 mmol) and $Mo(CO)_6$ (65 mg, 0.25 mmol) were then added. The mixture was heated to 70 °C (oil bath) for 15 min. Gas was evolved during the reaction and a red solution was obtained. The mixture was added to silica gel (5 g), the solvent was removed under reduced pressure, and the powder was placed on the top of a chromatographic column. The column was eluted with a gradient of petroleum ether/ethyl acetate (4:1) affording the product **2a** (209 mg, 71%).

1.3. Protocols for *N*-alkylation of fluorosulfonamides 2a, 2c, 3a, 3d, 3e and 3g.

Conditions A, basic alkylation.

A flame-dried, 25-mL, round-bottomed flask fitted with a magnetic stirbar is charged with **2a** (147 mg, 0.5 mmol) and anhydrous DMF (10 mL). The solution is stirred at 0 °C and NaH (13 mg, 0.55 mmol) was added in one portion. The suspension was stirred at 0 °C for 0.5 h and then at room temperature for 0.5 h. The suspension was cooled at 0 °C and benzyl chloride (70 mg, 0.55 mmol) in anhydrous DMF (5 mL) was added dropwise over 5 min. The mixture was warmed to room temperature and stirred for 2 h. After that, ice (10 g) was added and the mixture was extracted with $(Et)_2O$ (3 x 15 mL). The combined organic phase was washed with H_2O (2 x 10 mL), dried over anhydrous Na_2SO_4, filtered, and evaporated to give the crude product. The residue was directly loaded on silica gel and purified (hexane/EtOAc = 15/1) to give **4a** (155 mg, 81 %) as a pale yellow solid.

Conditions B, Mitsunobu alkylation.

A flame-dried, 25-mL, round-bottomed flask fitted with a magnetic stirbar is charged with **2a** (147 mg, 0.5 mmol), anhydrous THF (10 mL), triphenylphosphine (184 mg, 0.7 mmol) and benzyl alcohol (76 mg, 0.7 mmol). The solution is cooled at 0°C and DEAD (174 mg, 1 mmol) in anhydrous THF (5 mL) was added dropwise over 10 min. The mixture was stirred at 0 °C for 2 h. The mixture was concentrated to dryness and The residue was directly loaded on silica gel and purified (hexane/EtOAc = 15/1) to give **4a** (105 mg, 55 %) as a pale yellow solid.

1.4. Protocols for Deprotection of tosyl and Nosyl groups

Conditions A.[1]

To a suspension of Mg (40 mg, 1.6 mmol) in anhydrous MeOH (5 mL) was added *N*-benzyl-*N*-(2-fluoro-2-phenylethyl)-4-methylbenzenesulfonamide (**4a**, 115 mg, 0.3 mmol). The resulting suspension was sonicated for 1 h until consumption of the starting material (reaction minitored by TLC) was complete. The reaction was then diluted with brine (5 mL) and extracted with CH_2Cl_2 (3 × 5 mL). The organic layer was dried over anhydrous $MgSO_4$ and evaporated. The resulting residue was purified by flash chromatography (silica gel, DCM/MeOH, 99/1) afforded the pure product **5a** as a colorless liquid, 55 mg (80% yield).

Conditions B. [2]

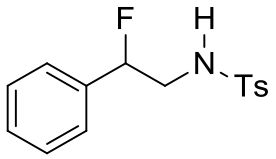
A solution of *N*-benzyl-*N*-(2-(4-chlorophenyl)-2-fluoroethyl)-2-nitrobenzenesulfonamide (**4i**, 135 mg, 0.3 mmol) in dry DMF (1 mL) was added to a solution of DBU (274 mg, 1.8 mmol) and 2-mercaptoethanol (140 mg, 1.8 mmol) in DMF (2 mL). The reaction mixture was stirred for 12 h, diluited with water (10 mL) and extracted with ether (3 x 5 mL). The organic phase was washed with water (3 × 10 mL), dried (anhydrous $MgSO_4$), and evaporated to afford the crude product. Purification by flash chromatography (silica gel, DCM/MeOH, 99/1) afforded the pure product **5b** as a colorless liquid, 51 mg (65% yield).

References.

[1] a) B. Nyasse, L. Grehn, U. Ragnarsson, *Chem. Commun.* **1997**, 1017; b) D. A. Alonso, P. G. Andersson, *J. Org. Chem*. **1998**, *63*, 9455.

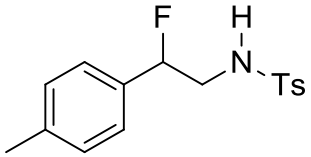
[2] a) T. Kan, T. Fukuyama, *Chem. Commun*. **2004**, 353; b) R. De Marco, M. L. Di Gioia, A. Leggio, A. Liguori, M. C. Viscomi, *Eur. J. Org. Chem.* **2009**, 3795.

2. Analytical data of New Compounds.



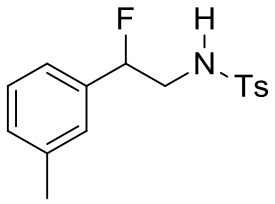
***N*-(2-Fluoro-2-phenylethyl)-*N*-tolylsulfonamide (2a)**

Pale yellow solid; mp: 83-85 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 8.0 Hz, 2H), 7.29 – 7.14 (m, 7H), 5.38 (ddd, *J* = 48.1, 8.3, 3.4 Hz, 1H), 5.16 (dd, *J* = 7.8, 4.8 Hz, 1H), 3.32 – 3.17 (m, 2H), 2.31 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.69, 136.90, 136.51 (d, *J* = 19.5 Hz), 129.85, 129.04 (d, *J* = 1.6 Hz), 128.70, 127.07, 125.60, 125.54, 92.76 (d, *J* = 174.1 Hz), 48.62 (d, *J* = 25.2 Hz), 21.52. ^{19}F NMR (376 MHz, $CDCl_3$) δ -182.75 (ddd *J* = 46.9, 30.2, 16.8 Hz). IR (film) v (cm^{-1}) 3301, 3089, 2938, 2360, 1927, 1598, 1455, 1305, 1288, 1092, 916, 698. HRMS: *m/z* $[M+H]^+$ Calcd. for $C_{15}H_{17}FNO_2S$: 294.0959, Found: 294.0927.



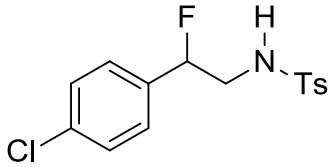
***N*-(2-fluoro-2-(*p*-tolyl)ethyl)-4-methylbenzenesulfonamide (2b).**

Colorless solid; mp: 115-118 °C ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.44 (d, *J* = 8.9 Hz, 2H), 8.11 (d, *J* = 8.9 Hz, 2H), 7.26 (d, *J* = 8.2 Hz, 2H), 7.22 (d, *J* = 8.2 Hz, 2H), 5.59 (ddd, *J* = 47.7, 7.8, 3.4 Hz, 1H), 5.16 (dd, *J* = 7.4, 4.7 Hz, 1H), 3.75 – 3.40 (m, 2H), 2.45 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 150.10, 145.87, 139.37, 132.86 (d, *J* = 19.8 Hz), 129.48, 128.23, 125.46, 125.39, 124.42, 92.47 (d, *J* = 174.3 Hz), 48.57 (d, *J* = 25.2 Hz), 21.18. ^{19}F NMR (376 MHz, $CDCl_3$) δ -181.54 (ddd, *J* = 46.4, 30.0, 16.5 Hz). IR (film) v (cm^{-1}) 3267, 3037, 2921, 2854, 2360,1916, 1597, 1434, 1254, 1092, 809, 775. HRMS: *m/z* $[M+H]^+$ Calcd. for $C_{16}H_{19}FNO_2S$: 308.1115. Found: 308.1079.



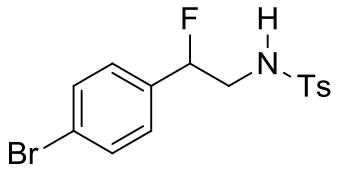
***N*-(2-fluoro-2-(m-tolyl)ethyl)-4-methylbenzenesulfonamide (2c).**

Colorless solid; mp: 93-97 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.3 Hz, 2H), 7.48 (d, *J* = 8.1 Hz, 2H), 7.45 – 7.37 (m, 1H), 7.32 (d, *J* = 7.5 Hz, 1H), 7.22 (d, *J* = 7.8 Hz, 2H), 5.63 (ddd, *J* = 48.2, 8.4, 3.4 Hz, 1H), 5.27 (dd, *J* = 8.1, 4.4 Hz, 1H), 3.71 – 3.31 (m, 2H), 2.60 (s, 3H), 2.51 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.69, 138.51, 136.93, 136.39 (d, *J* = 19.2 Hz), 129.84, 128.63, 127.08, 126.19 (d, *J* = 6.8 Hz), 122.61 (d, *J* = 6.9 Hz), 92.81 (d, *J* = 173.8 Hz), 48.64 (d, *J* = 25.2 Hz). 21.54, 21.37. ^{19}F NMR (376 MHz, $CDCl_3$) δ -182.65 (dd, *J* = 47.0, 30.3, 16.7 Hz). IR (film) v (cm^{-1}) 3265, 3030, 2911, 2859, 2370,1914, 1597, 1433, 1251, 1092, 799. HRMS: *m/z* $[[M+H]^+$ Calcd. for $C_{16}H_{19}FNO_2S$: 308.1115 Found: 308.1089.



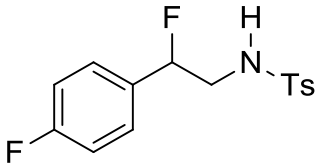
***N*-(2-(4-chlorophenyl)-2-fluoroethyl)-4-methylbenzenesulfonamide (2d).**

Yellow solid; mp: 139-141 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8.1 Hz, 2H), 7.23 (t, *J* = 7.3 Hz, 4H), 7.10 (d, *J* = 8.3 Hz, 2H), 5.40 (ddd, *J* = 47.6, 8.0, 3.5 Hz, 1H), 4.89 (dd, *J* = 7.9, 4.8 Hz, 1H), 3.43 – 3.09 (m, 2H), 2.35 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.83, 136.79, 135.00, 134.80, 129.86, 128.92, 127.01, 126.92 (d, *J* = 7.0 Hz), 92.09 (d, *J* = 174.7 Hz), 48.43 (d, *J* = 25.1 Hz), 21.55. ^{19}F NMR (376 MHz, $CDCl_3$) δ -183.19 (ddd, *J* = 46.4, 28.8, 17.7 Hz). IR (film) v (cm^{-1}) 3269, 3070, 2923, 2853, 2360, 1599, 1433, 1326, 1251, 1090, 820, 713. HRMS: *m/z* $[M+H]^+$ Calcd. for $C_{15}H_{16}ClFNO_2S$: 328.0569. Found: 328.0534.



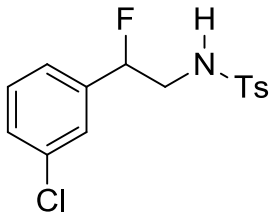
***N*-(2-(4-bromophenyl)-2-fluoroethyl)-4-methylbenzenesulfonamide (2e).**

Colorless crystals; mp: 149-153 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.2 Hz, 2H), 7.57 (d, *J* = 8.2 Hz, 2H), 7.40 (d, *J* = 8.1 Hz, 2H), 7.22 (d, *J* = 8.3 Hz, 2H), 5.56 (ddd, *J* = 47.6, 8.0, 3.5 Hz, 1H), 5.17 (m, 1H), 3.67 – 3.19 (m, 2H), 2.53 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.83, 136.77, 135.45 (d, *J* = 20.0 Hz), 131.86, 129.87, 127.20 (d, *J* = 7.0 Hz), 127.01, 123.12, 92.11 (d, *J* = 174.8 Hz), 48.35 (d, *J* = 25.1 Hz), 21.56. ^{19}F NMR (376 MHz, $CDCl_3$) δ -183.82 (ddd, *J* = 46.6, 28.9, 17.8 Hz). IR (film) v (cm^{-1}) 3274, 2916, 2360, 1653, 1373, 1274, 1163, 1092, 1055, 915, 813. HRMS: *m/z* $[[M+H]^+$ Calcd. for $C_{15}H_{16}BrFNO_2S$: 372.0064. Found: 372.0042.



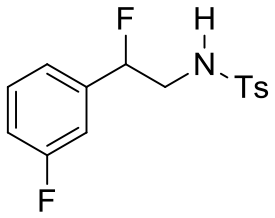
***N*-(2-fluoro-2-(4-fluorophenyl)ethyl)-4-methylbenzenesulfonamide (2f).**

Pale yellow solid; mp: 116-119 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 8.2 Hz, 2H), 7.22 (d, *J* = 8.1 Hz, 2H), 7.15 (dd, *J* = 8.2, 5.4 Hz, 2H), 6.95 (t, *J* = 8.6 Hz, 2H), 5.39 (ddd, *J* = 47.6, 8.1, 3.6 Hz, 1H), 5.05 (dd, *J* = 7.8, 4.9 Hz, 1H), 3.46 – 3.07 (m, 2H), 2.34 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 164.26, 161.79, 143.80, 136.82, 132.31 (dd, *J* = 20.1, 3.3 Hz), 129.86, 127.57 (dd, *J* = 8.3, 6.8 Hz), 127.03, 115.71 (d, *J* = 21.8 Hz), 92.18 (d, *J* = 174.1 Hz), 48.49 (d, *J* = 25.7 Hz), 21.52. ^{19}F NMR (376 MHz, $CDCl_3$) δ -112.25 (ddd, *J* = 8.5, 5.9, 3.0 Hz), -181.13 (ddd, *J* = 46.1, 29.2, 17.0 Hz). IR (film) v (cm^{-1}) 3275, 3072, 2925, 2360, 1601, 1514, 1327, 1227, 1159, 902, 883, 778. HRMS: *m/z* $[[M+H]^+$ Calcd. for $C_{15}H_{16}F_2NO_2S$: 312.0865 Found: 312.0836.



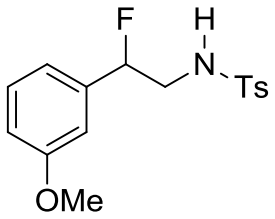
***N*-(2-(3-chlorophenyl)-2-fluoroethyl)-4-methylbenzenesulfonamide (2g).**

White solid; mp: 83-86 °C ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 8.2 Hz, 2H), 7.23 (t, *J* = 6.8 Hz, 4H), 7.16 (s, 1H), 7.06 (d, *J* = 6.8 Hz, 1H), 5.40 (ddd, *J* = 47.7, 8.1, 3.4 Hz, 1H), 5.01 (dd, *J* = 8.1, 4.7 Hz, 1H), 3.47 – 3.15 (m, 2H), 2.36 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.84, 138.45 (d, *J* = 19.9 Hz), 136.77, 134.73, 130.05, 129.89, 129.15 (d, *J* = 1.3 Hz), 127.02, 125.66 (d, *J* = 7.8 Hz), 123.65 (d, *J* = 7.0 Hz), 91.96 (d, *J* = 175.7 Hz), 48.44 (d, *J* = 24.8 Hz), 21.55. ^{19}F NMR (376 MHz, $CDCl_3$) δ -184.44 (ddd, *J* = 46.9, 29.5, 17.4 Hz). IR (film) v (cm^{-1}) 3300, 3033, 2934, 2360, 1597, 1480,1288, 1184, 1093, 934, 889, 781. HRMS: *m/z* $[[M+H]^+$ Calcd. for $C_{15}H_{16}ClFNO_2S$: 328.0569 Found: 328.0537.



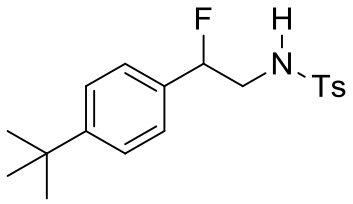
***N*-(2-fluoro-2-(3-fluorophenyl)ethyl)-4-methylbenzenesulfonamide (2h).**

Colorless solid; mp: 86-89 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8.2 Hz, 2H), 7.22 (d, *J* = 8.1 Hz, 3H), 6.95 (dd, *J* = 10.9, 5.1 Hz, 2H), 6.86 (d, *J* = 9.3 Hz, 1H), 5.40 (ddd, *J* = 47.8, 8.2, 3.3 Hz, 1H), 4.82 (dd, *J* = 8.1, 4.4 Hz, 1H), 3.45 – 3.11 (m, 2H), 2.34 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.85 (d, *J* = 247.3 Hz), 143.86, 139.46 – 138.28 (m), 136.80, 130.44 (d, *J* = 8.1 Hz), 129.88, 127.03, 121.06 (dd, *J* = 7.2, 3.1 Hz), 115.97 (d, *J* = 22.3 Hz), 112.58 (dd, *J* = 22.8, 7.9 Hz), 91.98 (d, *J* = 175.6 Hz), 48.47 (d, *J* = 24.7 Hz), 21.53. ^{19}F NMR (376 MHz, $CDCl_3$) δ -111.69 (td, *J* = 9.0, 5.8 Hz), -184.42 (ddd, *J* = 46.9, 29.7, 17.3 Hz). IR (film) v (cm^{-1}) 3300, 2925, 2855, 2360, 1657, 1596, 1492, 1327, 1287, 1230, 1109, 835. HRMS: *m/z* $[[M+H]^+$ Calcd. for $C_{15}H_{16}F_2NO_2S$: 312.0865 Found: 312.0852.



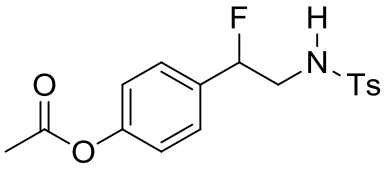
***N*-(2-fluoro-2-(3-methoxyphenyl)ethyl)-4-methylbenzenesulfonamide (2i).**

waxy solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 8.3 Hz, 2H), 7.22 (d, *J* = 8.1 Hz, 2H), 7.18 (t, *J* = 3.9 Hz, 1H), 6.79 (dd, *J* = 8.3, 2.5 Hz, 1H), 6.73 (d, *J* = 7.6 Hz, 1H), 6.70 (d, *J* = 1.6 Hz, 1H), 5.37 (ddd, *J* = 48.1, 8.3, 3.4 Hz, 1H), 4.85 (dd, *J* = 8.2, 4.2 Hz, 1H), 3.70 (s, 3H), 3.46 – 3.11 (m, 2H), 2.34 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.84, 143.74, 137.94 (d, *J* = 19.5 Hz), 136.87, 129.87, 129.85, 127.05, 117.64 (d, *J* = 7.0 Hz), 114.53, 111.05 (d, *J* = 7.7 Hz), 92.56 (d, *J* = 174.6 Hz), 55.30, 48.59 (d, *J* = 25.1 Hz), 21.53. ^{19}F NMR (376 MHz, $CDCl_3$) δ -183.44 (ddd, *J* = 47.3, 30.3, 17.1 Hz). IR (film) v (cm^{-1}) 3432, 2923, 2360, 2341, 1598, 1492, 1327, 1160, 1043, 814, 698. HRMS: *m/z* $[[M+H]^+$ Calcd. for $C_{16}H_{19}FNO_3S$: 324.1064 Found: 324.1033.



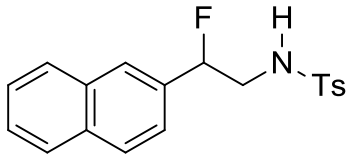
***N*-(2-(4-(*tert*-butyl)phenyl)-2-fluoroethyl)-4-methylbenzenesulfonamide (2j).**

Yellow solid; mp: 129-132 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (d, *J* = 8.3 Hz, 2H), 7.24 (d, *J* = 8.2 Hz, 2H), 7.17 (d, *J* = 8.2 Hz, 2H), 7.05 (d, *J* = 8.1 Hz, 2H), 5.32 (ddd, *J* = 48.2, 8.4, 3.5 Hz, 1H), 4.87 (dd, *J* = 8.3, 4.4 Hz, 1H), 3.39 – 3.07 (m, 2H), 2.29 (s, 3H), 1.17 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.29 (d, *J* = 1.8 Hz), 152.28, 143.70, 133.37 (d, *J* = 19.6 Hz), 133.28, 129.84, 127.10, 125.65, 125.43 (d, *J* = 6.5 Hz), 92.67 (d, *J* = 173.1 Hz), 48.52 (d, *J* = 25.5 Hz), 34.67, 31.25, 21.54. ^{19}F NMR (376 MHz, $CDCl_3$) δ -181.43 (ddd, *J* = 46.8, 30.4, 16.5 Hz). IR (film) v (cm^{-1}) 3267,2961, 2866, 2360, 1598, 1424, 1322, 1286, 1160, 1019, 863, 708. HRMS: *m/z* $[M+H]^+$ Calcd. for $C_{19}H_{25}FNO_2S$: 350.1585. Found: 350.1546.



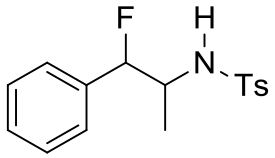
4-(1-fluoro-2-(4-methylphenylsulfonamido)ethyl)phenyl acetate (2k).

Pale yellow solid, 116-118 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.0 Hz, 2H), 7.28 (d, *J* = 8.0 Hz, 2H), 7.24 (d, *J* = 8.3 Hz, 2H), 7.05 (d, *J* = 8.3 Hz, 2H), 5.46 (ddd, *J* = 47.9, 8.3, 3.2 Hz, 1H), 5.02 (dd, *J* = 7.9, 4.5 Hz, 1H), 3.50 – 3.13 (m, 2H), 2.40 (s, 3H), 2.27 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.35, 151.08, 143.77, 136.79, 134.03 (d, *J* = 20.0 Hz), 129.87, 127.06, 126.79 (d, *J* = 6.9 Hz), 121.96, 92.29 (d, *J* = 174.4 Hz), 48.58 (d, *J* = 25.3 Hz), 21.53, 21.10. ^{19}F NMR (376 MHz, $CDCl_3$) δ -182.43 (ddd, *J* = 45.2, 29.0, 16.2 Hz). IR (film) v (cm^{-1}) 3310, 2938, 2360, 1762, 1597, 1327, 1288, 1158, 1073, 948, 849, 778. HRMS: *m/z* $[[M+H]^+$ Calcd. for $C_{18}H_{19}FNO_4S$: 352.1014 Found: 352.0984.



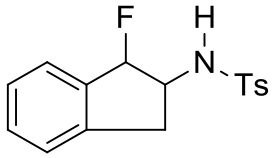
***N*-(2-fluoro-2-(naphthalen-2-yl)ethyl)-4-methylbenzenesulfonamide (2l).**

White solid; mp: 113-116 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 – 7.76 (m, 3H), 7.71 (d, *J* = 8.1 Hz, 2H), 7.49 (dd, *J* = 6.3, 3.2 Hz, 2H), 7.31 (dd, *J* = 8.5, 1.2 Hz, 1H), 7.22 (d, *J* = 8.1 Hz, 2H), 5.64 (ddd, *J* = 47.8, 8.0, 3.6 Hz, 1H), 5.14 (dd, *J* = 7.9, 4.8 Hz, 1H), 3.60 – 3.22 (m, 2H), 2.37 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.68, 136.87, 133.79 (d, *J* = 19.4 Hz), 133.47 (d, *J* = 1.0 Hz), 132.93, 129.80, 128.68, 128.14, 127.78, 127.04, 126.70, 126.64, 122.72 (d, *J* = 6.1 Hz), 92.89 (d, *J* = 174.4 Hz), 48.56 (d, *J* = 25.4 Hz).21.53. ^{19}F NMR (376 MHz, $CDCl_3$) δ -182.67 (ddd, *J* = 46.5, 29.1, 17.4 Hz). IR (film) v (cm^{-1}) 3262, 2947, 2360, 1597, 1492, 1448, 1331, 1264, 1331, 1264, 953, 864. HRMS: *m/z* $[[M-H]^+$ Calcd. for $C_{19}H_{19}FNO_2S$: 344.1115 Found: 344.1096.



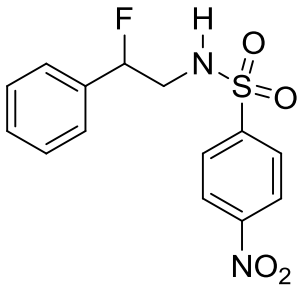
N-(1-fluoro-1-phenylpropan-2-yl)-4-methylbenzenesulfonamide (2m).

Waxy solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.3 Hz, 2H), 7.32 – 7.18 (m, 5H), 7.18 – 7.10 (m, 2H), 5.43 (dd, *J* = 47.1, 3.0 Hz, 1H), 5.32 (d, *J* = 9.0 Hz, 1H), 3.82 – 3.53 (m, 2H), 2.33 (s, 3H), 0.91 (d, *J* = 6.9 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.50, 138.04, 136.70 (d, *J* = 20.3 Hz), 129.81, 129.63, 128.47, 128.46, 128.33, 127.00, 125.16 (d, *J* = 8.5 Hz), 95.48 (d, *J* = 179.1 Hz), 54.13 (d, *J* = 23.5 Hz), 21.52, 14.28 (d, *J* = 6.1 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -186.50 (ddd, *J* = 45.8, 15.6 Hz), -198.76 (dd, *J* = 47.1, 24.6 Hz). IR (film) v (cm^{-1}) 3258, 2980, 2877, 2360, 1655, 1496, 1380, 1331, 1289, 1122, 957, 852. HRMS: *m/z* $[[M+H]^+$ Calcd. for $C_{16}H_{19}FNO_2S$: 308.1115 Found: 308.1093.



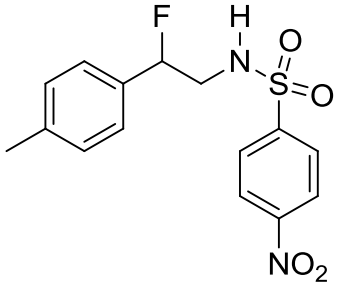
***N*-(1-fluoro-2,3-dihydro-1H-inden-2-yl)-4-methylbenzenesulfonamide (2n).**

Waxy solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.2 Hz, 2H), 7.31 – 7.18 (m, 4H), 7.11 (dd, *J* = 15.7, 7.8 Hz, 2H), 5.34 (d, *J* = 9.9 Hz, 1H), 5.20 (dd, *J* = 57.8, 4.6 Hz, 1H), 4.08 – 3.88 (m, 1H), 2.98 (dd, *J* = 15.8, 7.7 Hz, 1H), 2.86 – 2.72 (m, 1H), 2.33 (3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.76, 142.29 (d, *J* = 5.3 Hz), 136.78 (d, *J* = 15.4 Hz), 131.05 (d, *J* = 4.5 Hz), 129.89, 127.51 (d, *J* = 3.7 Hz), 127.16, 126.43 (d, *J* = 2.6 Hz), 125.10 (d, *J* = 3.0 Hz), 93.61 (d, *J* = 178.4 Hz), 55.82 (d, *J* = 20.4 Hz), 36.84, 21.61. ^{19}F NMR (376 MHz, $CDCl_3$) δ -177.89 (ddd, *J* = 58.0, 24.5 Hz). HRMS: *m/z* $[[M+H]^+$ Calcd. for $C_{16}H_{17}FNO_2S$: 306.0959 Found: 306.0922.



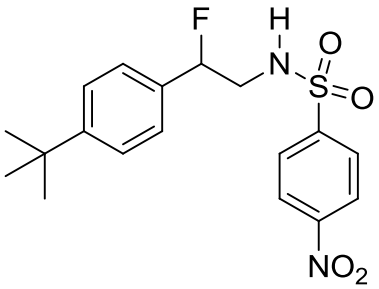
***N*-(2-fluoro-2-phenylethyl)-4-nitrobenzenesulfonamide (3a).**

Pale yellow solid; mp: 126-130 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21 (d, *J* = 8.7 Hz, 2H), 7.90 (d, *J* = 8.7 Hz, 2H), 7.40 – 7.19 (m, 3H), 7.13 (dd, *J* = 8.1, 4.7 Hz, 2H), 5.42 (ddd, *J* = 47.8, 7.9, 3.1 Hz, 1H), 5.18 (dd, *J* = 7.5, 4.5 Hz, 1H), 3.55 – 3.12 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 150.12, 145.81, 135.92 (d, *J* = 19.6 Hz), 129.28, 128.83, 128.24, 125.42 (d, *J* = 7.0 Hz), 124.46, 92.56 (d, *J* = 174.9 Hz), 48.61 (d, *J* = 24.7 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -183.39 (ddd, *J* = 46.8, 28.6, 18.3 Hz). IR (film) ν (cm^{-1}) 3280, 3104, 3039, 2924, 2360, 1944, 1697, 1478, 1373, 1241, 1089, 889. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{14}H_{13}FN_2O_4S$, 323.0507 Found: 323.0474.



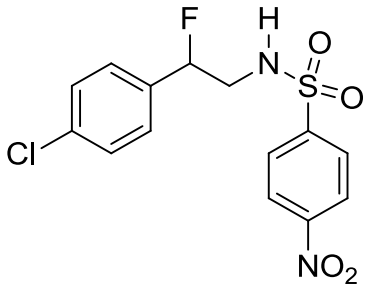
***N*-(2-fluoro-2-(*p*-tolyl)ethyl)-4-nitrobenzenesulfonamide (3b).**

Pale yellow solid; mp: 151-154. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.44 (d, *J* = 8.9 Hz, 2H), 8.11 (d, *J* = 8.9 Hz, 2H), 7.26 (d, *J* = 8.2 Hz, 2H), 7.22 (d, *J* = 8.2 Hz, 2H), 5.59 (ddd, *J* = 47.7, 7.8, 3.4 Hz, 1H), 5.16 (dd, *J* = 7.4, 4.7 Hz, 1H), 3.75 – 3.32 (m, 2H), 2.45 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 150.10, 145.87, 139.37, 132.86 (d, *J* = 19.8 Hz), 129.48, 128.23, 125.43 (d, *J* = 6.8 Hz), 124.42, 92.47 (d, *J* = 174.3 Hz), 48.57 (d, *J* = 25.2 Hz), 21.18. ^{19}F NMR (376 MHz, $CDCl_3$) δ -182.09 (ddd, *J* = 46.4, 28.0, 18.4 Hz). IR (film) ν (cm^{-1}) 3272, 3113, 2948, 2360, 1615, 1533, 1402, 1252, 1165, 1091, 907, 826. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{15}H_{14}FN_2O_4S$: 337.0664 Found: 337.0656.



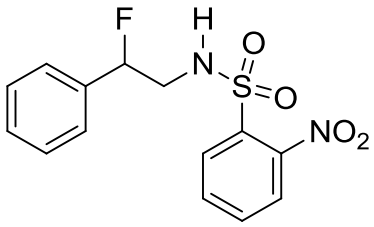
***N*-(2-(4-(*tert*-butyl)phenyl)-2-fluoroethyl)-4-nitrobenzenesulfonamide (3c).**

Pale yellow solid; mp: 158-160 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 (d, *J* = 8.9 Hz, 1H), 7.89 (d, *J* = 8.9 Hz, 1H), 7.24 (d, *J* = 8.1 Hz, 1H), 7.03 (d, *J* = 8.2 Hz, 1H), 5.35 (ddd, *J* = 47.9, 8.1, 3.3 Hz, 1H), 5.01 (dd, *J* = 8.0, 4.4 Hz, 1H), 3.48 – 3.08 (m, 1H), 1.15 (s, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.62 (d, *J* = 1.8 Hz), 150.15, 145.85, 132.81 (d, *J* = 19.7 Hz), 128.29, 125.80, 125.32 (d, *J* = 6.6 Hz), 124.46, 92.52 (d, *J* = 174.1 Hz), 48.53 (d, *J* = 25.1 Hz), 34.70, 31.23. ^{19}F NMR (376 MHz, $CDCl_3$) δ -181.67 (ddd, *J* = 46.7, 29.1, 17.6 Hz). IR (film) v (cm^{-1}) 3279, 3107, 2959, 2868, 2360, 1607, 1530, 1465, 1310, 1165, 1010, 882. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{18}H_{2o}FN_2O_4S$: 379.1133 Found: 379.1122.



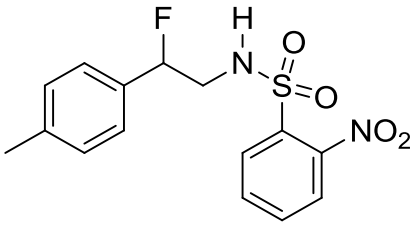
***N*-(2-(4-chlorophenyl)-2-fluoroethyl)-4-nitrobenzenesulfonamide (3d).**

White solid; mp: 138-141 °C. ^{1}H NMR (200 MHz, $CDCl_3$) δ 8.36 (d, *J* = 8.8 Hz, 2H), 8.01 (d, *J* = 8.9 Hz, 2H), 7.35 (d, *J* = 8.2 Hz, 2H), 7.19 (d, *J* = 8.6 Hz, 2H), 5.55 (ddd, *J* = 47.6, 7.7, 3.4 Hz, 1H), 5.27 – 4.94 (m, 1H), 3.77 – 2.91 (m, 2H).^{13}C NMR (101 MHz, $CDCl_3$) δ 150.12, 145.84, 135.23, 134.44 (d, *J* = 20.1 Hz), 129.03, 128.17, 126.82 (d, *J* = 7.1 Hz), 124.46, 92.00 (d, *J* = 175.6 Hz), 48.48 (d, *J* = 24.8 Hz).^{19}F NMR (376 MHz, $CDCl_3$) δ -183.81 (ddd, *J* = 46.6, 27.8, 18.9 Hz). IR (film) v (cm^{-1}) 3271, 3099, 2915, 2360, 1607, 1542, 1330, 1254, 1165, 964, 911, 714. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{148}H_{11}ClFN_2O_4S$: 357.0117 Found: 357.0088.



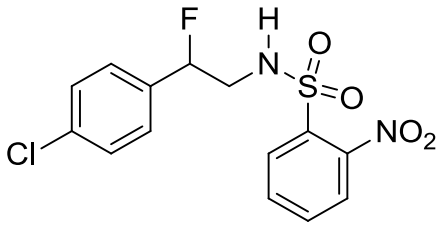
***N*-(2-fluoro-2-phenylethyl)-2-nitrobenzenesulfonamide (3e).**

Pale yellow solid; mp: 105-108 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 – 7.94 (m, 1H), 7.83 – 7.72 (m, 1H), 7.69 – 7.56 (m, 2H), 7.24 (dd, *J* = 5.3, 1.3 Hz, 3H), 7.20 – 7.09 (m, 2H), 5.82 – 5.62 (m, 1H), 5.45 (ddd, *J* = 47.8, 7.9, 3.3 Hz, 1H), 3.69 – 3.27 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 147.89 (s), 136.12 (d, *J* = 19.6 Hz), 133.91 (s), 133.73 (s), 133.00 (s), 130.77 (s), 129.18 (s), 128.76 (s), 125.49 (d, *J* = 7.6 Hz), 125.38 (s), 92.55 (d, *J* = 175.3 Hz), 49.18 (d, *J* = 24.8 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -183.22 (ddd, *J* = 46.6, 28.7, 18.1 Hz). IR (film) v (cm^{-1}) 3353, 2953, 2359, 1535, 1445, 1350, 1201, 1127, 927, 879, 770. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{14}H_{12}FN_2O_4S$: 323.0507 Found: 323.0497.



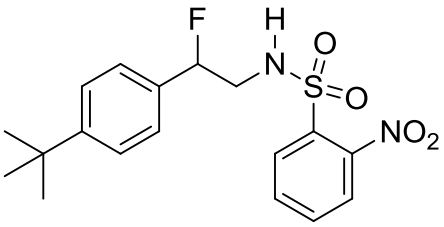
***N*-(2-fluoro-2-(p-tolyl)ethyl)-2-nitrobenzenesulfonamide (3f).**

Pale yellow solid; mp: 105-108 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 (d, *J* = 9.2 Hz, 1H), 7.94 (d, *J* = 9.2 Hz, 1H), 7.88 – 7.75 (m, 2H), 7.23 (s, 4H), 5.91 (dd, *J* = 7.1, 5.1 Hz, 1H), 5.61 (ddd, *J* = 47.8, 7.8, 3.4 Hz, 1H), 3.91 – 3.42 (m, 2H), 2.41 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 147.83, 139.11 (d, *J* = 1.8 Hz), 133.81, 133.75, 133.25, 133.05, 130.76, 129.41, 125.56, 125.49 (d, *J* = 1.3 Hz), 92.56 (d, *J* = 174.4 Hz), 49.12 (d, *J* = 25.3 Hz), 21.20. ^{19}F NMR (376 MHz, $CDCl_3$) δ -181.30 (ddd, *J* = 47.8, 28.4, 18.4 Hz). IR (film) v (cm^{-1}) 3355, 2952, 2360, 1616, 1441, 1347, 1242, 1125, 1056, 905, 816. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{15}H_{14}FN_2O_4S$: 337.0664 Found: 337.0647.



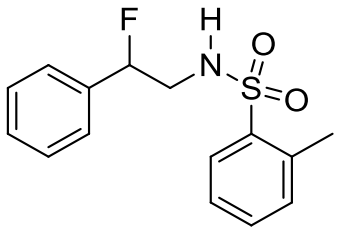
***N*-(2-(4-chlorophenyl)-2-fluoroethyl)-2-nitrobenzenesulfonamide (3g).**

Pale yellow solid; mp: 111-114 °C ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (d, *J* = 8.5 Hz, 1H), 7.82 (d, *J* = 8.3 Hz, 1H), 7.77 – 7.62 (m, 2H), 7.24 (d, *J* = 8.4 Hz, 2H), 7.18 (d, *J* = 8.4 Hz, 2H), 5.87 (dd, *J* = 7.1, 5.1 Hz, 1H),5.54 (ddd, *J* = 47.3, 7.3, 3.3 Hz, 1H), 3.57 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 147.69, 134.88, 134.67, 133.83, 133.71, 133.15, 130.62, 128.87, 126.97 (d, *J* = 7.2 Hz), 125.45, 91.94 (d, *J* = 175.7 Hz), 48.92 (d, *J* = 24.8 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -183.43 (ddd, *J* = 46.5, 27.0, 19.6 Hz). IR (film) v (cm^{-1}) 3344, 3097, 2930, 2360, 1567, 1422, 1202, 1160, 1055, 912, 827, 787. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{14}H_{11}ClFN_2O_4S$: 357.0111 Found: 357.0111.



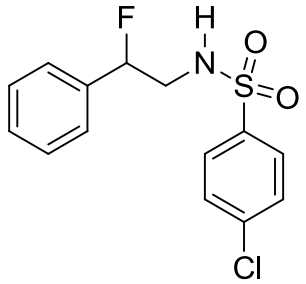
***N*-(2-(4-(tert-butyl)phenyl)-2-fluoroethyl)-2-nitrobenzenesulfonamide (3h).**

Pale yellow waxy solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (dd, *J* = 5.8, 3.4 Hz, 1H), 7.71 (dd, *J* = 5.7, 3.6 Hz, 1H), 7.58 (dd, *J* = 5.9, 3.4 Hz, 2H), 7.24 (d, *J* = 8.2 Hz, 2H), 7.07 (d, *J* = 8.2 Hz, 2H), 5.72 (dd, *J* = 7.1, 5.1 Hz, 1H), 5.40 (ddd, *J* = 48.0, 8.1, 3.3 Hz, 1H), 3.60 – 3.22 (m, 2H), 1.16 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.35 (d, *J* = 1.7 Hz), 147.89, 133.92, 133.70, 133.28, 133.08, 130.84, 125.72, 125.57 – 125.18 (m), 92.60 (d, *J* = 174.3 Hz), 49.08 (d, *J* = 25.1 Hz), 34.68, 31.27. ^{19}F NMR (376 MHz, $CDCl_3$) δ -181.02 (ddd, *J* = 47.1, 29.5, 17.6 Hz). IR (film) v (cm^{-1}) 3373, 2962, 2361, 1594, 1541, 1442, 1362, 1243, 1168, 1057, 836, 783. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{18}H_{20}FN_2O_4S$: 379.1133 Found: 379.1120.



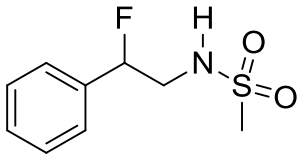
***N*-(2-fluoro-2-phenylethyl)-2-methylbenzenesulfonamide (3i).**

Waxy solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.4 Hz, 1H), 7.36 (t, *J* = 7.5 Hz, 1H), 7.30 – 7.17 (m, 5H), 7.15 – 7.05 (m, 2H), 5.35 (ddd, *J* = 48.1, 8.1, 3.6 Hz, 1H), 5.16 (dd, *J* = 7.5, 4.9 Hz, 1H), 3.51 – 3.11 (m, 2H), 2.53 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.81, 137.21, 136.41 (d, *J* = 19.5 Hz), 133.01, 132.74, 129.34, 129.08, 129.06, 128.72, 126.25, 125.50 (d, *J* = 7.0 Hz), 92.71 (d, *J* = 174.0 Hz), 48.41 (d, *J* = 25.2 Hz), 20.22. ^{19}F NMR (376 MHz, $CDCl_3$) δ -183.98 (ddd, *J* = 47,0, 29.5, 17.5 Hz). IR (film) v (cm^{-1}) 3388, 2917, 2360, 1639, 1423, 1255, 1054, 918, 874, 771, 698. HRMS: *m/z* $[M+H]^+$ Calcd. for $C_{15}H_{17}FNO_2S$: 294.0959 Found: 294.0932.



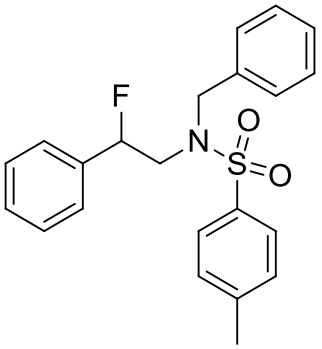
4-chloro-*N*-(2-fluoro-2-phenylethyl)benzenesulfonamide (3j).

White solid; mp: 126-129 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 8.6 Hz, 2H), 7.35 (d, *J* = 8.6 Hz, 2H), 7.24 (dd, *J* = 4.9, 1.6 Hz, 3H), 7.17 – 7.09 (m, 2H), 5.39 (ddd, *J* = 48.0, 8.2, 3.4 Hz, 1H), 5.10 (dd, *J* = 7.9, 4.7 Hz, 1H), 3.51 – 2.98 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 139.37, 138.42, 136.22 (d, *J* = 19.5 Hz), 129.52, 129.17, 129.15, 128.77, 128.49, 125.51 (d, *J* = 7.0 Hz), 92.66 (d, *J* = 174.4 Hz), 48.57 (d, *J* = 25.0 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -183.02 (ddd, *J* = 46.8, 29.5, 17.4 Hz). IR (film) v (cm^{-1}) 3277, 3092, 2926, 2852, 2360, 1587, 1496, 1453, 1398, 1279, 1160, 904. HRMS: *m/z* $[M+H]^+$ Calcd. for $C_{14}H_{12}ClFNO_2S$: 314.0413 Found: 314.0398.



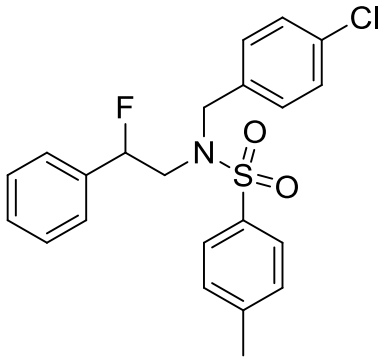
***N*-(2-fluoro-2-phenylethyl)methanesulfonamide (3k).**

Brown liquid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 (dt, *J* = 12.9, 5.7 Hz, 5H), 5.33 (ddd, *J* = 48.0, 6.8, 4.4 Hz, 1H), 5.14 (t, *J* = 6.2 Hz, 1H), 3.61 – 3.27 (m, 2H), 2.78 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 136.56 (d, *J* = 19.6 Hz), 129.10 (d, *J* = 1.5 Hz), 128.78, 125.63 (d, *J* = 7.0 Hz), 93.18 (d, *J* = 174.4 Hz), 48.60 (d, *J* = 24.7 Hz), 40.83 (d, *J* = 1.4 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -182.63 – -183.05 (m). IR (film) v (cm^{-1}) 2981, 3072, 2925, 2362, 1912, 1611, 1450, 1300, 1299, 1092, 910, 690. HRMS: *m/z* $[M+H]^+$ Calcd. for $C_9H_{13}FNO_2S$: 218.0646 Found: 218.0617.



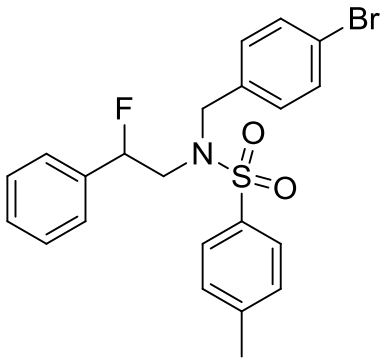
***N*-benzyl-*N*-(2-fluoro-2-phenylethyl)-4-methylbenzenesulfonamide (4a).**

Pale yellow solid; mp: 96-99 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.1 Hz, 2H), 7.23 (m, 8H), 7.15 – 7.03 (m, 4H), 5.46 (ddd, *J* = 48.7, 7.2, 4.6 Hz, 1H), 4.41 (q, *J* = 15.0 Hz, 2H), 3.54 – 3.26 (m, 2H), 2.36 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.55, 137.41, 137.33, 135.67, 129.81, 128.79 (d, *J* = 1.4 Hz), 128.65, 128.60, 127.91, 127.29, 125.43 (d, *J* = 7.0 Hz), 93.33 (d, *J* = 176.1 Hz), 52.39 (d, *J* = 2.1 Hz), 52.31 (d, *J* = 25.7 Hz), 21.56. ^{19}F NMR (376 MHz, $CDCl_3$) δ -180.28 – -180.77 (m). IR (film) ν (cm^{-1}) 3447, 3089, 2360, 1598, 1495, 1454, 1370, 1253, 1189, 881, 774. HRMS: *m/z* $[M+H]^+$ Calcd. for $C_{22}H_{23}FNO_2S$: 384.1428 Found: 384.1395.



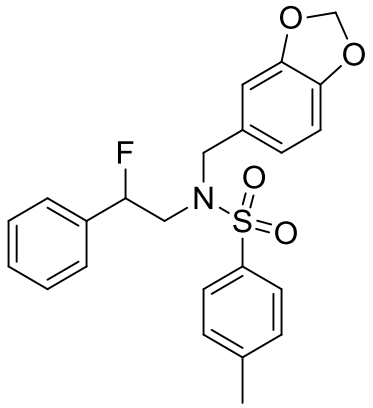
***N*-(4-chlorobenzyl)-*N*-(2-fluoro-2-phenylethyl)-4-methylbenzenesulfonamide (4b).**

White solid; mp: 130-133 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 8.1 Hz, 2H), 7.24 (d, *J* = 7.1 Hz, 5H), 7.17 (d, *J* = 8.3 Hz, 2H), 7.08 (t, *J* = 8.0 Hz, 4H), 5.47 (ddd, *J* = 48.7, 8.3, 3.0 Hz, 1H), 4.36 (q, *J* = 15.2 Hz, 2H), 3.58 – 3.20 (m, 2H), 2.35 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.80, 137.13 (d, *J* = 7.4 Hz), 136.98, 134.41, 133.74, 129.92, 128.91 (d, *J* = 1.3 Hz), 128.79, 128.67, 127.26, 125.44 (d, *J* = 6.9 Hz), 93.42 (d, *J* = 175.8 Hz), 52.65 (d, *J* = 25.8 Hz), 51.94 (d, *J* = 2.1 Hz), 21.57. ^{19}F NMR (376 MHz, $CDCl_3$) δ -179.89 (ddd, *J* = 47.5, 32.1, 15.5 Hz). IR (film) ν (cm^{-1}) 3064, 2929, 2360, 1800, 1648, 1597, 1490, 1362, 1202, 1155, 914, 815. HRMS: *m/z* $[M+H]^+$ Calcd. for $C_{22}H_{22}ClFNO_2S$: 418.1039 Found: 418.1010.



_N_-(4-bromobenzyl)-_N_-(2-fluoro-2-phenylethyl)-4-methylbenzenesulfonamide (4c).

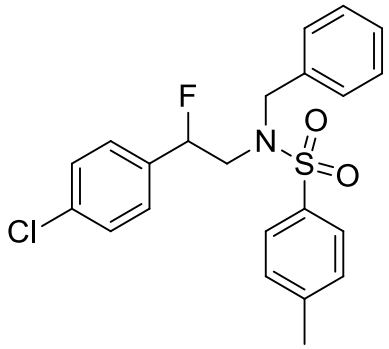
White solid; mp: 98-101 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 8.0 Hz, 2H), 7.32 (d, *J* = 8.1 Hz, 2H), 7.24 (d, *J* = 7.0 Hz, 5H), 7.13 – 7.06 (m, 2H), 7.00 (d, *J* = 8.1 Hz, 2H), 5.47 (ddd, *J* = 48.6, 8.4, 2.9 Hz, 1H), 4.34 (q, *J* = 15.3 Hz, 2H), 3.56 – 3.22 (m, 2H), 2.36 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.78, 137.14, 137.03 (d, *J* = 15.6 Hz), 134.90, 131.74, 130.23, 129.91, 128.89, 128.64 (d, *J* = 5.7 Hz), 127.25, 125.42 (d, *J* = 7.0 Hz), 121.90, 93.45 (d, *J* = 175.8 Hz), 52.62 (d, *J* = 25.8 Hz), 51.98 (d, *J* = 2.3 Hz), 21.58. ^{19}F NMR (376 MHz, $CDCl_3$) δ -179.93 (ddd, *J* = 47.5, 32.3, 15.2 Hz). IR (film) v (cm^{-1}) 3442, 3066, 2360, 1596, 1488, 1375, 1292, 967, 857, 774. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{22}H_{20}BrFNO_2S$: 460.0387 Found: 460.0363.



_N_-(benzo[d][1,3]dioxol-5-ylmethyl)-_N_-(2-fluoro-2-phenylethyl)-4-methylbenzenesulfonamide (4d).

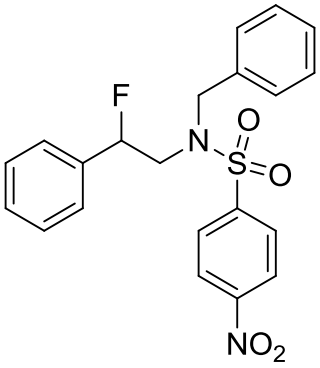
White solid; mp: 98-101 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 8.1 Hz, 2H), 7.24 (d, *J* = 7.2 Hz, 5H), 7.14 – 7.05 (m, 2H), 6.63 (d, *J* = 7.7 Hz, 1H), 6.57 (d, *J* = 9.6 Hz, 2H), 5.84 (s, 2H), 5.61 – 5.30 (m, 1H), 4.28 (dd, *J* = 38.6, 14.8 Hz, 2H), 3.52 – 3.28 (m, 2H), 2.36 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 148.03, 147.40, 143.59, 137.35, 137.14, 129.82, 129.35, 128.81, 128.58, 127.25, 125.46 (d, *J* = 7.0

Hz), 122.21, 101.13, 93.34 (d, *J* = 175.8 Hz), 52.23 (d, *J* = 2.1 Hz), 52.04 (d, *J* = 26.0 Hz), 21.55. ^{19}F NMR (376 MHz, $CDCl_3$) δ -180.14 – -180.48 (m). IR (film) v (cm^{-1}) 2954, 2360, 2341, 1734, 1598, 1505, 1498, 1447, 1330, 1256, 1101, 987. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{23}H_{21}FNO_4S$: 426.1181 Found: 426.1170.



_N_-benzyl-_N_-(2-(4-chlorophenyl)-2-fluoroethyl)-4-methylbenzenesulfonamide (4e).

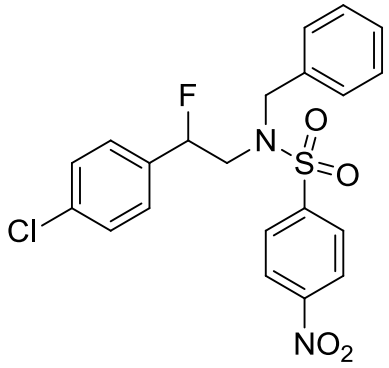
White solid; mp: 105-108 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.2 Hz, 2H), 7.27 (d, *J* = 8.1 Hz, 2H), 7.25 – 7.19 (m, 5H), 7.18 – 7.09 (m, 2H), 7.04 (d, *J* = 8.2 Hz, 2H), 5.67 – 5.35 (m, 1H), 4.40 (dd, *J* = 45.7, 14.9 Hz, 2H), 3.54 – 3.29 (m, 2H), 2.40 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.71, 136.98, 135.69 (d, *J* = 19.9 Hz), 135.47, 134.66 (d, *J* = 1.9 Hz), 129.86, 128.78, 128.68, 128.62, 127.98, 127.30, 126.92 (d, *J* = 7.0 Hz), 92.70 (d, *J* = 176.3 Hz), 52.69 (d, *J* = 1.7 Hz), 52.31 (d, *J* = 26.7 Hz), 21.57. ^{19}F NMR (376 MHz, $CDCl_3$) δ -180.22 – -180.64 (m). IR (film) v (cm^{-1}) 3065, 2954, 2922, 2361, 1663, 1599, 1492, 1339, 1273, 1248, 1123, 929. HRMS: *m/z* $[M+H]^+$ Calcd. for $C_{22}H_{22}ClFNO_2S$: 418.1039 Found: 418.1007.



_N_-benzyl-_N_-(2-fluoro-2-phenylethyl)-4-nitrobenzenesulfonamide (4f).

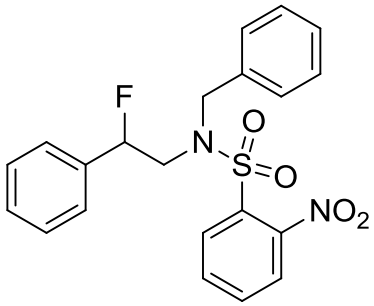
White solid; mp: 102-104 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.22 (d, *J* = 8.8 Hz, 2H), 7.89 (d, *J* = 8.8 Hz, 2H), 7.31 – 7.18 (m, 6H), 7.17 – 7.10 (m, 2H), 7.11 – 7.04 (m,

2H), 5.44 (ddd, *J* = 48.8, 9.0, 2.6 Hz, 1H), 4.48 (q, *J* = 15.1 Hz, 2H), 3.58 (td, *J* = 15.2, 9.0 Hz, 1H), 3.41 (ddd, *J* = 32.6, 15.8, 2.7 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 149.92, 146.33, 136.55 (d, *J* = 19.5 Hz), 134.70, 129.10 (d, *J* = 1.5 Hz), 128.90, 128.76, 128.56, 128.39, 125.36 (d, *J* = 6.9 Hz), 124.29, 92.73 (d, *J* = 176.8 Hz), 52.35 (d, *J* = 16.8 Hz), 52.21 (d, *J* = 6.2 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -180.48 (ddd, *J* = 48.0, 33.0, 15.0 Hz). IR (film) ν (cm^{-1}) 3066, 2922, 2854, 2361, 1808, 1690, 1543, 1476, 1349, 1312, 1208, 989. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{21}H_{18}FN_2O_4S$: 413.0977 Found: 413.0971.



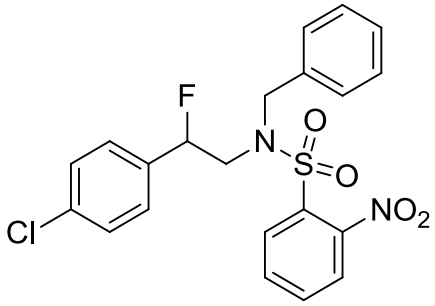
_N_-benzyl-_N_-(2-(4-chlorophenyl)-2-fluoroethyl)-4-nitrobenzenesulfonamide (4g).

White solid; mp: 153-155 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.25 (d, *J* = 8.8 Hz, 2H), 7.90 (d, *J* = 8.8 Hz, 2H), 7.22 (m, 5H), 7.12 (m, 2H), 7.03 (d, *J* = 8.2 Hz, 2H), 5.45 (ddd, *J* = 48.4, 8.7, 2.7 Hz, 1H), 4.47 (s, 2H), 3.55 (td, *J* = 15.1, 8.8 Hz, 1H), 3.38 (ddd, *J* = 31.6, 15.7, 2.9 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 149.98, 146.06, 135.07 (d, *J* = 5.1 Hz), 134.90, 134.51, 128.95 (d, *J* = 4.4 Hz), 128.54, 128.44, 128.39, 126.77 (d, *J* = 7.0 Hz), 124.33, 92.24 (d, *J* = 177.3 Hz), 52.49 (d, *J* = 1.8 Hz), 52.31 (d, *J* = 25.6 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -180.64 (ddd, *J* = 47.4, 32.3, 15.2 Hz). IR (film) ν (cm^{-1}) 3092, 2922, 2854, 2361, 1604, 1587, 1527, 1349, 1270, 1161, 1109, 855. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{21}H_{17}ClFN_2O_4S$: 447.1355 Found: 447.1337.



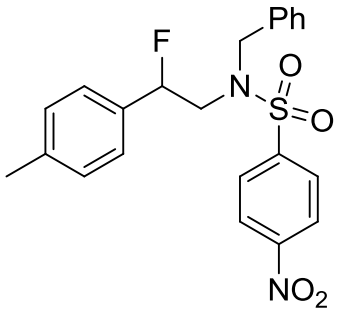
***N*-benzyl-*N*-(2-fluoro-2-phenylethyl)-2-nitrobenzenesulfonamide (4h).**

White solid; mp: 99-102 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.5 Hz, 1H), 7.71 – 7.52 (m, 3H), 7.23 (qdd, *J* = 14.1, 11.8, 6.6 Hz, 11H), 5.56 (ddd, *J* = 48.9, 7.5, 4.2 Hz, 1H), 4.67 (s, 2H), 3.65 – 3.60 (m, 1H), 3.56 (dd, *J* = 5.8, 3.7 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.60, 147.89, 136.76 (d, *J* = 19.5 Hz), 135.04, 133.90, 133.71, 131.87, 131.00, 128.99 (d, *J* = 1.4 Hz), 128.82, 128.68, 128.49, 128.14, 125.43 (d, *J* = 7.0 Hz), 124.35, 93.34 (d, *J* = 176.4 Hz), 52.33 (d, *J* = 2.6 Hz), 52.08 (d, *J* = 24.4 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -180.43 – -180.99 (m). IR (film) v (cm^{-1}) 3338, 3075, 3035, 2921, 2360, 1855, 1588, 1454, 1379, 1258, 1136, 126. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{21}H_{18}FN_2O_4S$: 413.0977 Found: 413.0963.



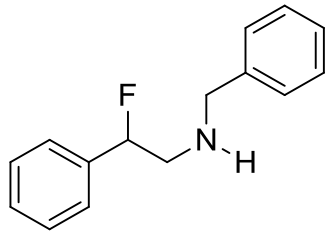
***N*-benzyl-*N*-(2-(4-chlorophenyl)-2-fluoroethyl)-2-nitrobenzenesulfonamide (4i).**

Pale yellow solid m.p. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (d, *J* = 7.9 Hz, 1H), 7.73 – 7.50 (m, 3H), 7.20 (dt, *J* = 7.5, 5.5 Hz, 7H), 7.09 (d, *J* = 8.2 Hz, 2H), 5.68 – 5.38 (m, 1H), 4.66 (s, 2H), 3.67 – 3.51 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 147.83, 135.26 (d, *J* = 20.0 Hz), 134.86, 134.80 (d, *J* = 1.9 Hz), 133.75, 133.70, 131.90, 130.99, 128.85, 128.20, 126.88 (d, *J* = 7.1 Hz), 124.35, 92.82 (d, *J* = 177.0 Hz), 52.47 (d, *J* = 2.7 Hz), 51.98 (d, *J* = 24.7 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -181.01 (ddd, *J* = 47.8, 30.1, 17.8 Hz). IR v (cm^{-1}) 3423, 2924, 2360, 2341, 1543, 1495, 1439, 1206, 1091, 937, 851, 777. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{21}H_{17}ClFN_2O_4S$: 447.1355 Found: 447.1332.



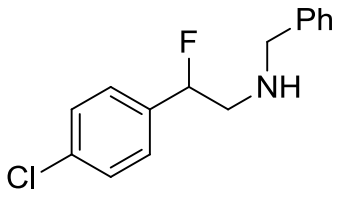
_N_-benzyl-_N_-(2-fluoro-2-(_p_-tolyl)ethyl)-4-nitrobenzenesulfonamide (4j).

Pale yellow solid m.p. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.22 (d, *J* = 8.5 Hz, 2H), 7.90 (d, *J* = 8.5 Hz, 2H), 7.24 (d, *J* = 4.9 Hz, 3H), 7.20 – 7.13 (m, 2H), 7.06 (d, *J* = 7.8 Hz, 2H), 6.98 (d, *J* = 7.8 Hz, 2H), 5.42 (dd, *J* = 48.7, 7.5 Hz, 1H), 4.50 (q, *J* = 15.1 Hz, 2H), 3.61 (td, *J* = 15.0, 9.0 Hz, 1H), 3.40 (dd, *J* = 30.7, 15.5 Hz, 1H), 2.26 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 149.88, 146.36, 139.11 (d, *J* = 1.7 Hz), 134.77, 133.55 (d, *J* = 19.6 Hz), 129.40, 128.88, 128.56, 128.39, 128.34, 125.44 (d, *J* = 6.6 Hz), 124.27, 92.64 (d, *J* = 176.0 Hz), 21.20. ^{19}F NMR (376 MHz, $CDCl_3$) δ -178.60 (ddd, *J* = 47.5, 32.7, 14.9 Hz). IR ν (cm^{-1}) 3093, 2921, 2360, 1805, 1588, 1530, 1477, 1349, 1256, 1085, 881, 766. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{22}H_{20}FN_2O_4S$: 429.1279 Found: 429.1266.



***N*-benzyl-2-fluoro-2-phenylethanamine (5a).**

Brown liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.07 (m, 10H), 5.53 (ddd, *J* = 48.7, 8.6, 3.2 Hz, 1H), 3.78 (s, 2H), 3.04 (ddd, *J* = 16.5, 13.3, 8.6 Hz, 1H), 2.83 (ddd, *J* = 31.8, 13.3, 3.2 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 139.92, 138.42 (d, *J* = 19.5 Hz), 128.52, 128.50, 128.13, 127.11, 125.61 (d, *J* = 7.0 Hz), 93.98 (d, *J* = 171.1 Hz), 54.96 (d, *J* = 24.0 Hz), 53.68. ^{19}F NMR (376 MHz, $CDCl_3$) δ -182.02 (dd, *J* = 48.4, 31.9, 16.6 Hz). IR ν (cm^{-1}) 3447, 3089, 2360, 1598, 1495, 1454, 1370, 1253, 1189, 881, 774. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{15}H_{17}FN$: 230.1340 Found: 230.1321.

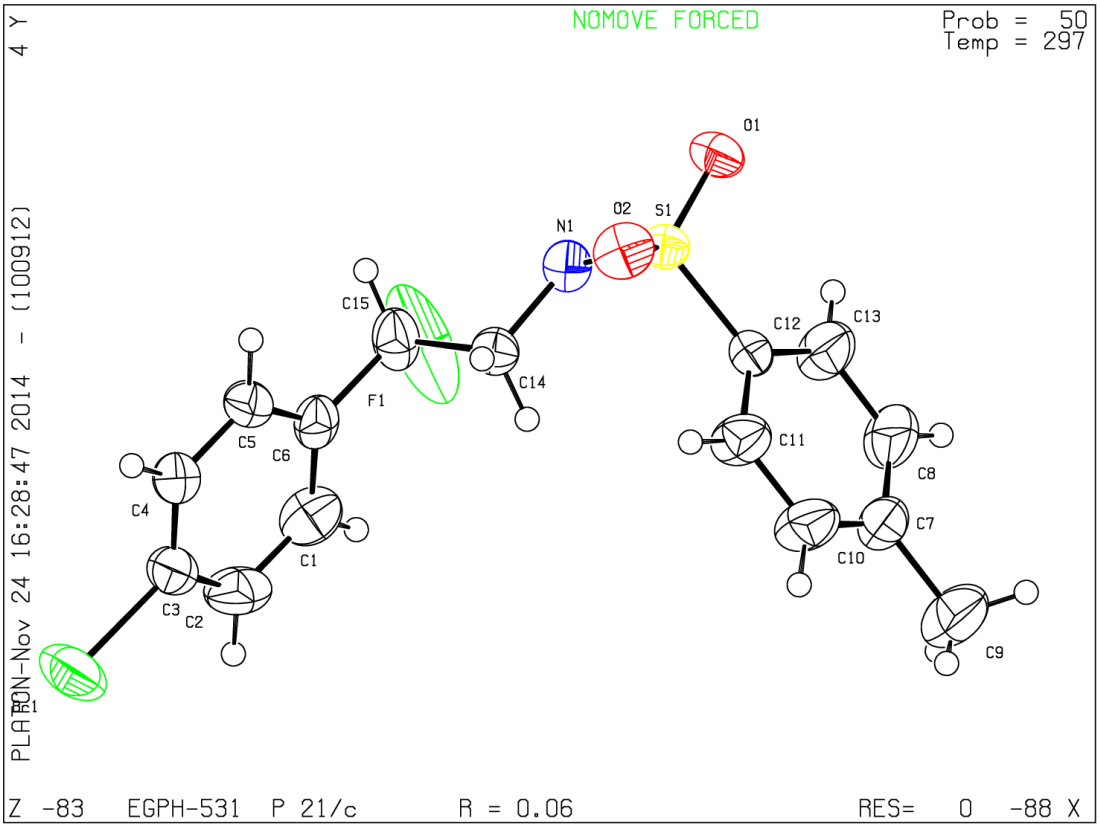


***N*-benzyl-2-(4-chlorophenyl)-2-fluoroethanamine (5b).**

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 (dt, *J* = 12.7, 4.9 Hz, 6H), 7.17 (d, *J* = 8.7 Hz, 3H), 5.49 (ddd, *J* = 48.4, 8.4, 3.3 Hz, 1H), 3.77 (s, 2H), 3.00 (ddd, *J* = 16.9, 13.3, 8.4 Hz, 1H), 2.89 – 2.71 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 139.77, 136.93 (d, *J* = 20.0 Hz), 134.35 (d, *J* = 2.1 Hz), 128.72, 128.54, 128.13, 127.19, 127.04 (d, *J* = 7.0 Hz), 93.29 (d, *J* = 172.0 Hz), 54.74 (d, *J* = 23.9 Hz), 53.66. ^{19}F NMR (376 MHz, $CDCl_3$) δ -182.17 (ddd, *J* = 48.1, 31.2, 17.0 Hz). IR ν (cm^{-1}) 3331, 2917, 2848, 1738, 1600, 1494, 1453, 1092, 1015, 908, 828, 734. HRMS: *m/z* $[M-H]^-$ Calcd. for $C_{15}H_{16}ClFN$: 264.0950 Found: 264.0933.

3. X-Ray Analytical Data for Compound 2e

Figure 1. X-ray structure of **2e**. C gray, H white, N blue, O red, S yellow, Br purple, F green.



Bond precision: C-C = 0.0064 A Wavelength=0.71073

Cell: a=11.571(2) b=5.2088(10) c=26.139(5)

α=90 β=93.278(2) γ=90

Temperature: 297 K

	Calculated	Reported
Volume	1572.9(5)	1572.9(5)
Space group	P 21/c	P 21/c
Hall group	-P 2ybc	-P 2ybc
Moiety formula	C15 H15 Br F N O2 S	C15 H15 Br F N O2 S
Sum formula	C15 H15 Br F N O2 S	C15 H15 Br F N O2 S
Mr	372.24	372.24
Dx,g cm-3	1.572	1.572
Z	4	4
Mu (mm-1)	2.759	2.759
F000	752.0	752.0
F000'	751.68	

h,k,lmax	15,6,35	15,6,35
Nref	3927	3927
Tmin,Tmax	0.337,0.516	0.337,0.516
Tmin'	0.049	

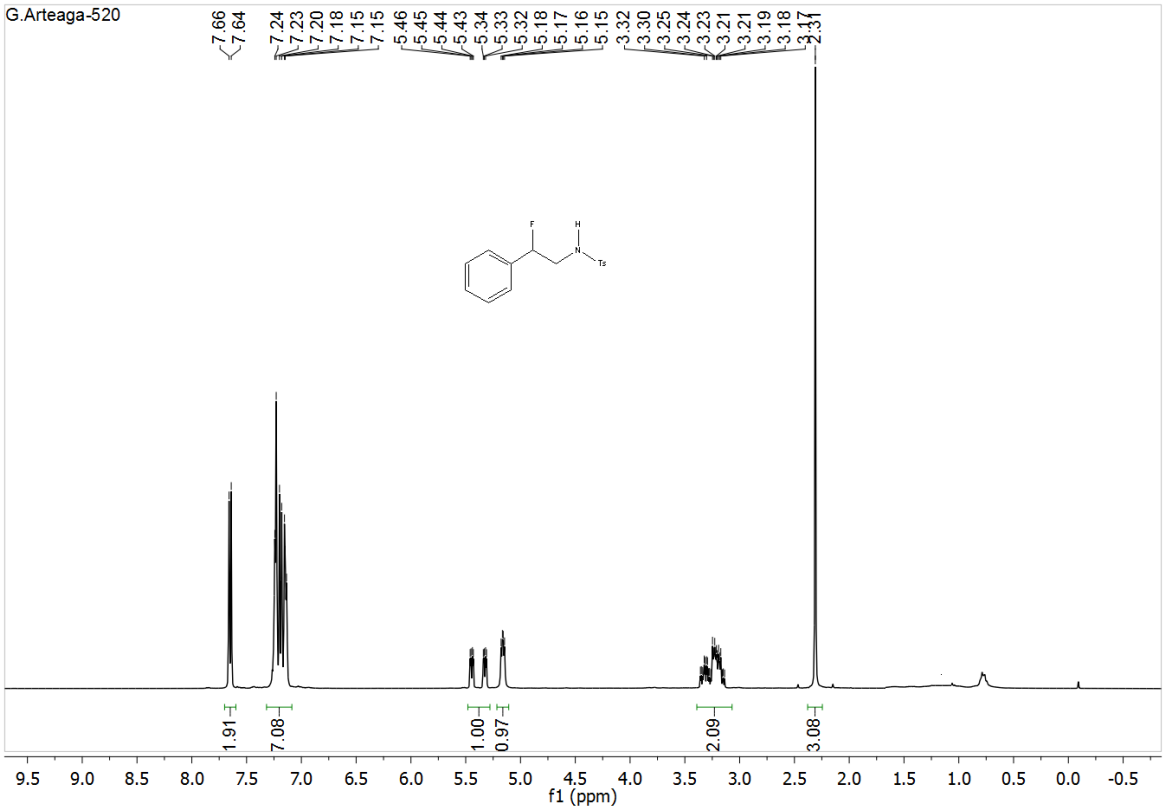
Correction method= MULTI-SCAN

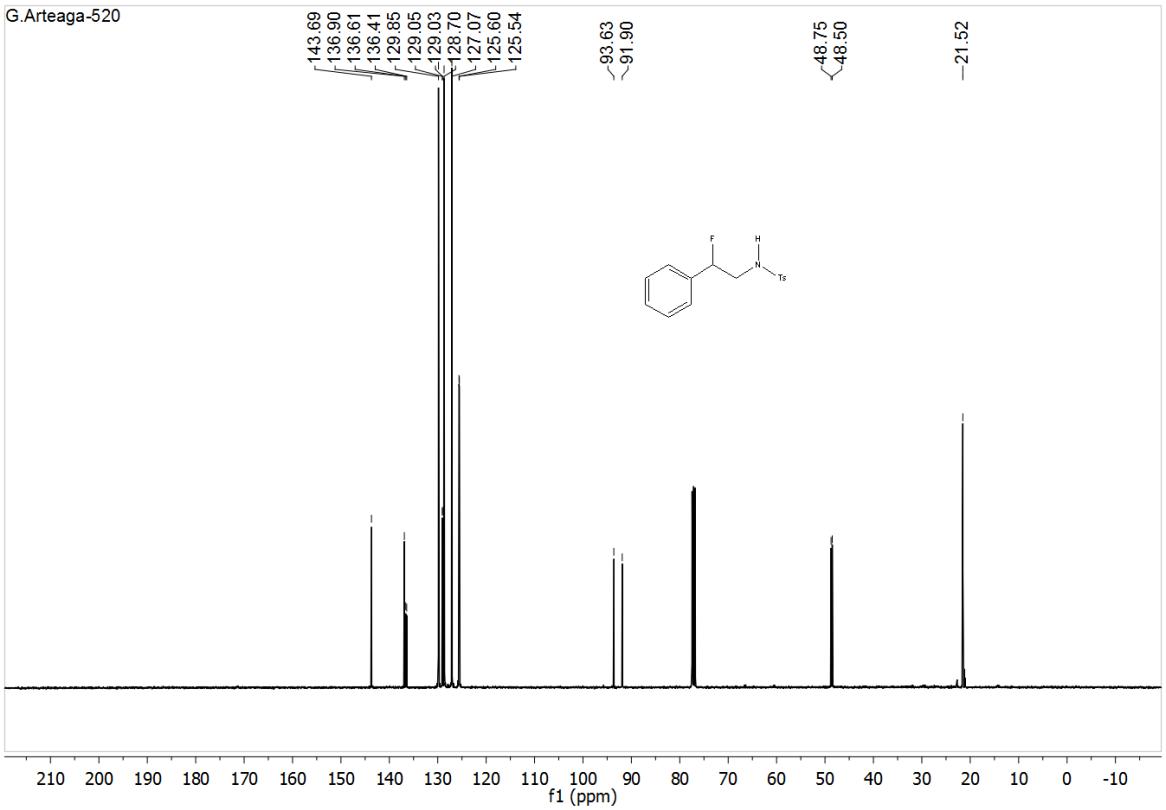
Data completeness= 1.000 Theta(max)= 28.420

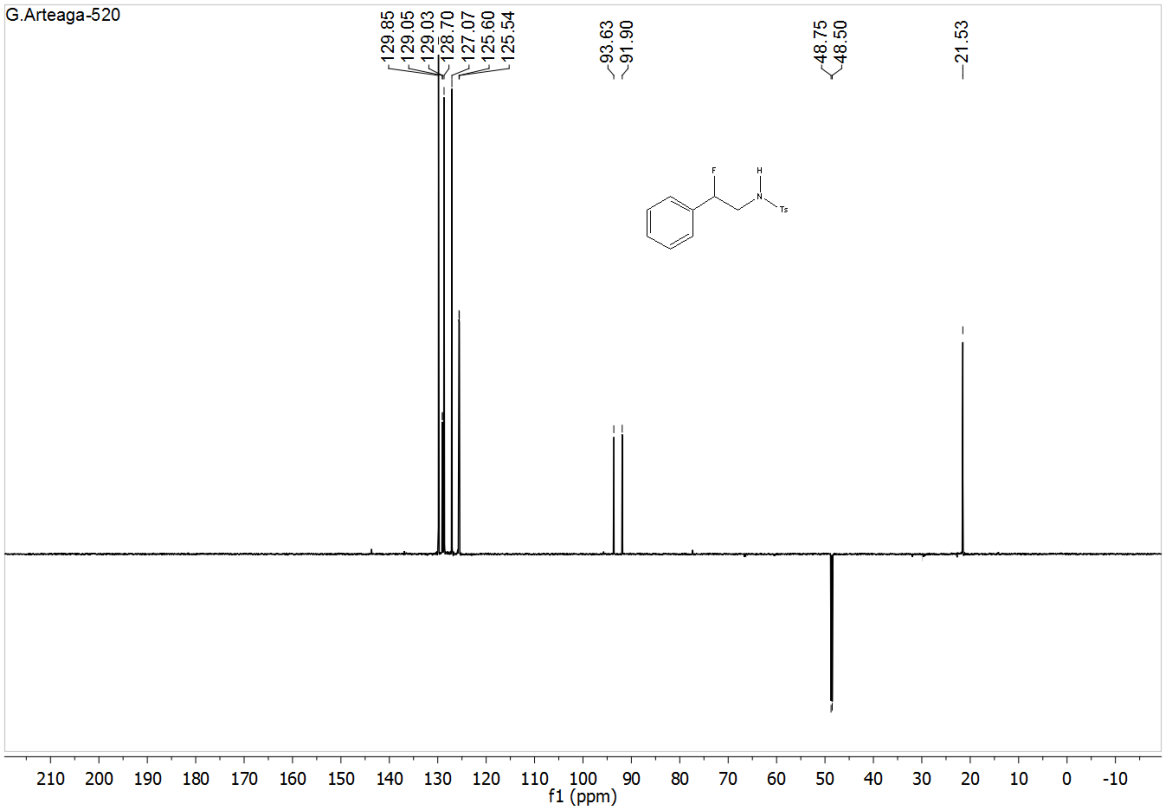
R(reflections)= 0.0581(2329) wR2(reflections)= 0.1757(3098)

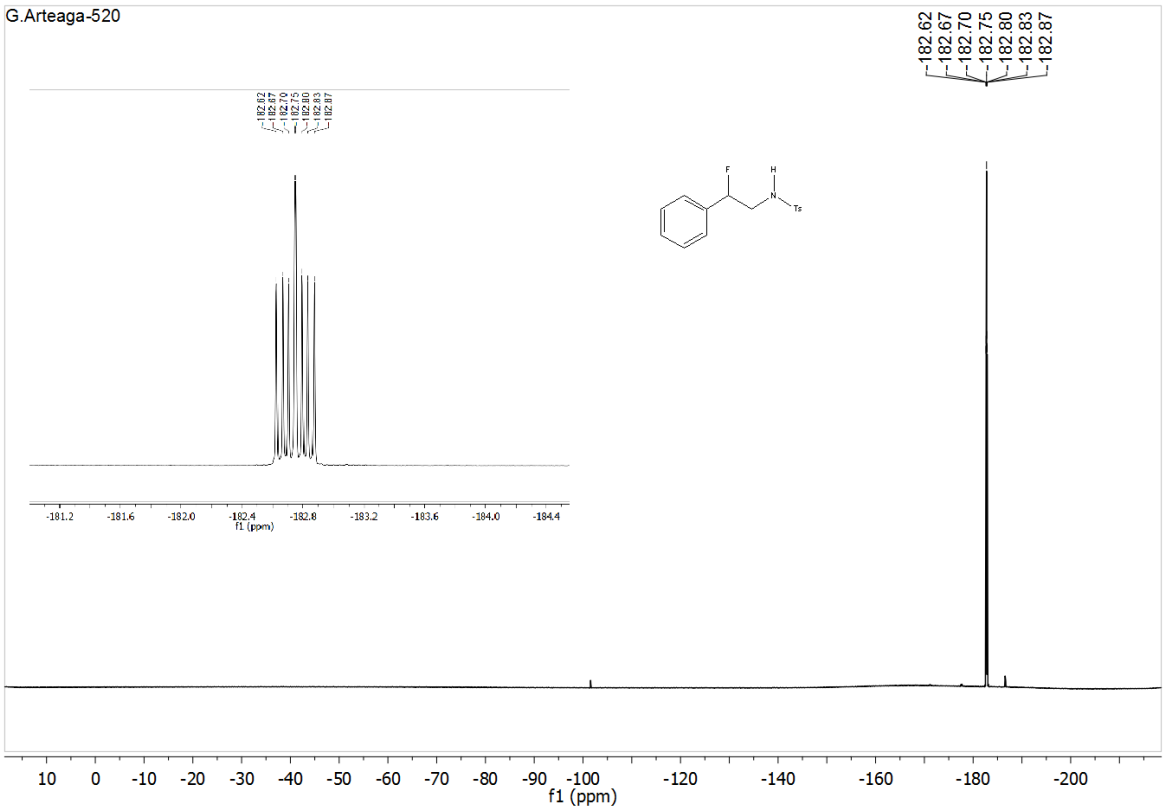
S = 1.230 Npar= 195

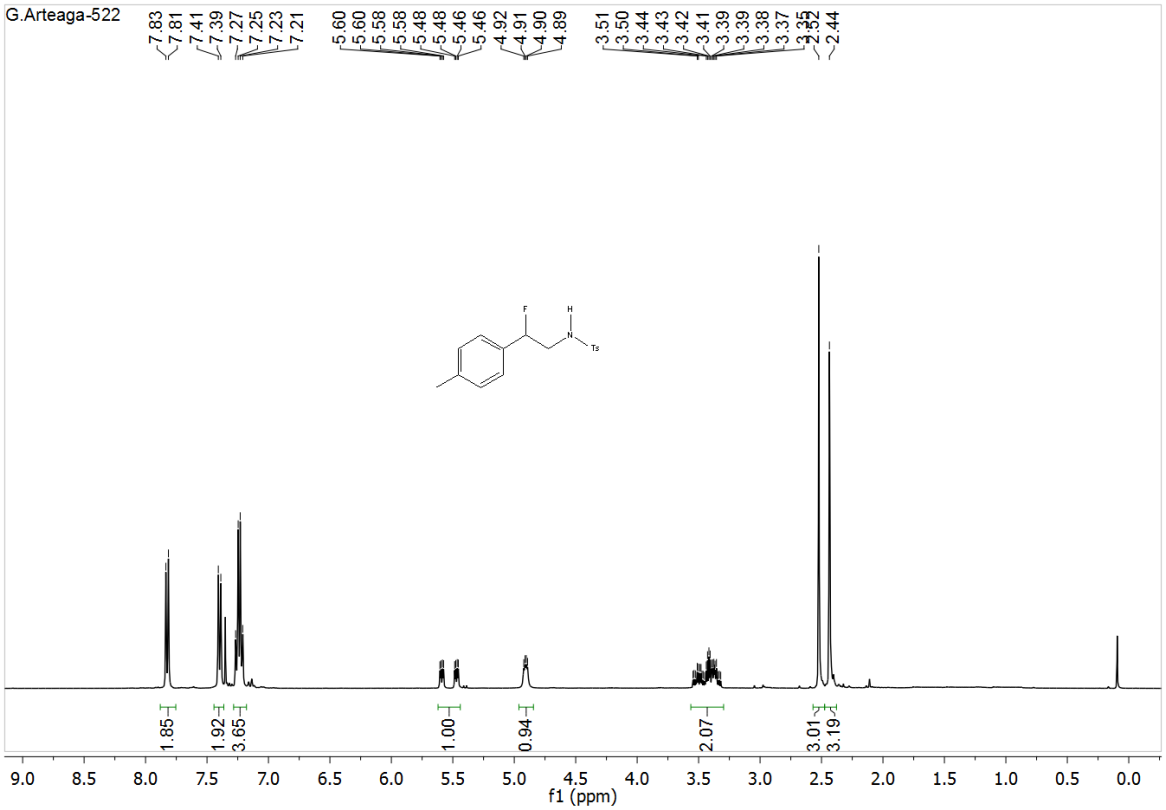
4. Spectral Characterization of Products

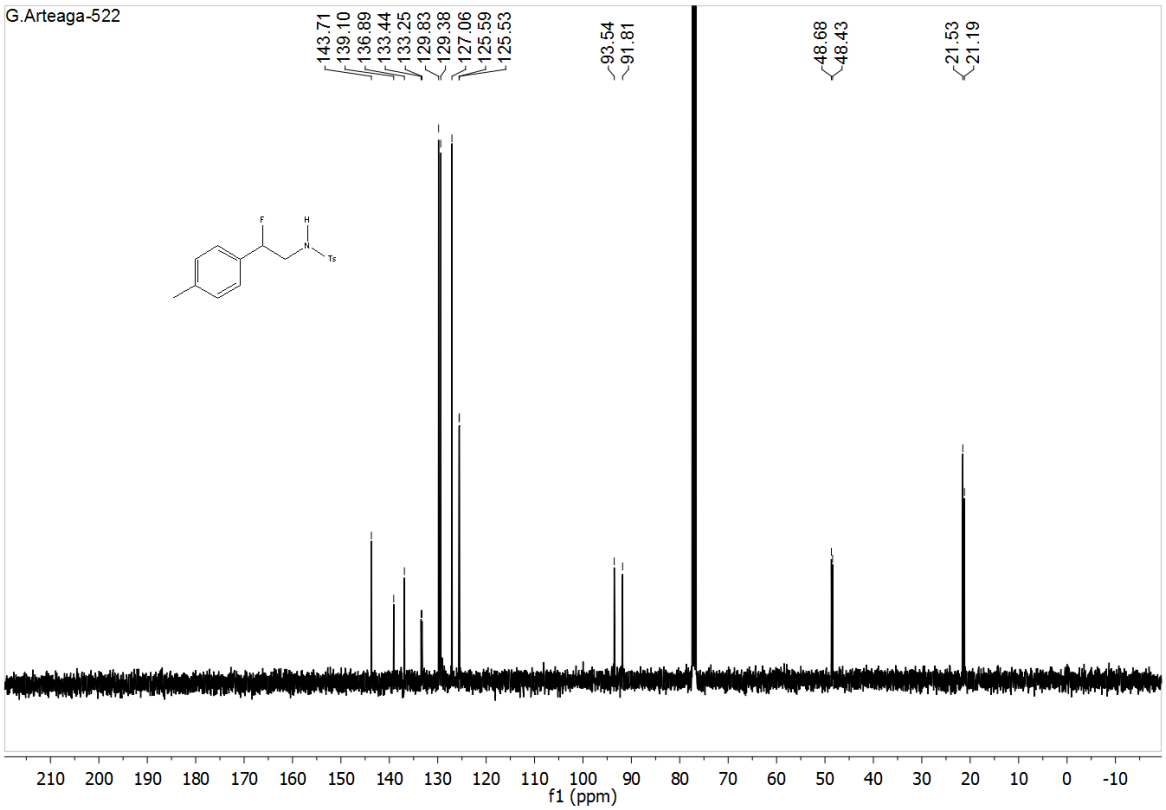

G.Arteaga-520
7.66
7.64
7.24
7.23
7.20
7.18
7.15
7.15
5.46
5.45
5.44
5.43
5.34
5.33
5.32
5.18
5.17
5.16
5.15
3.32
3.30
3.25
3.24
3.23
3.21
3.21
3.19
3.18
3.17
2.31
1.91
7.08
1.00
0.97
2.09
3.08
f1 (ppm)

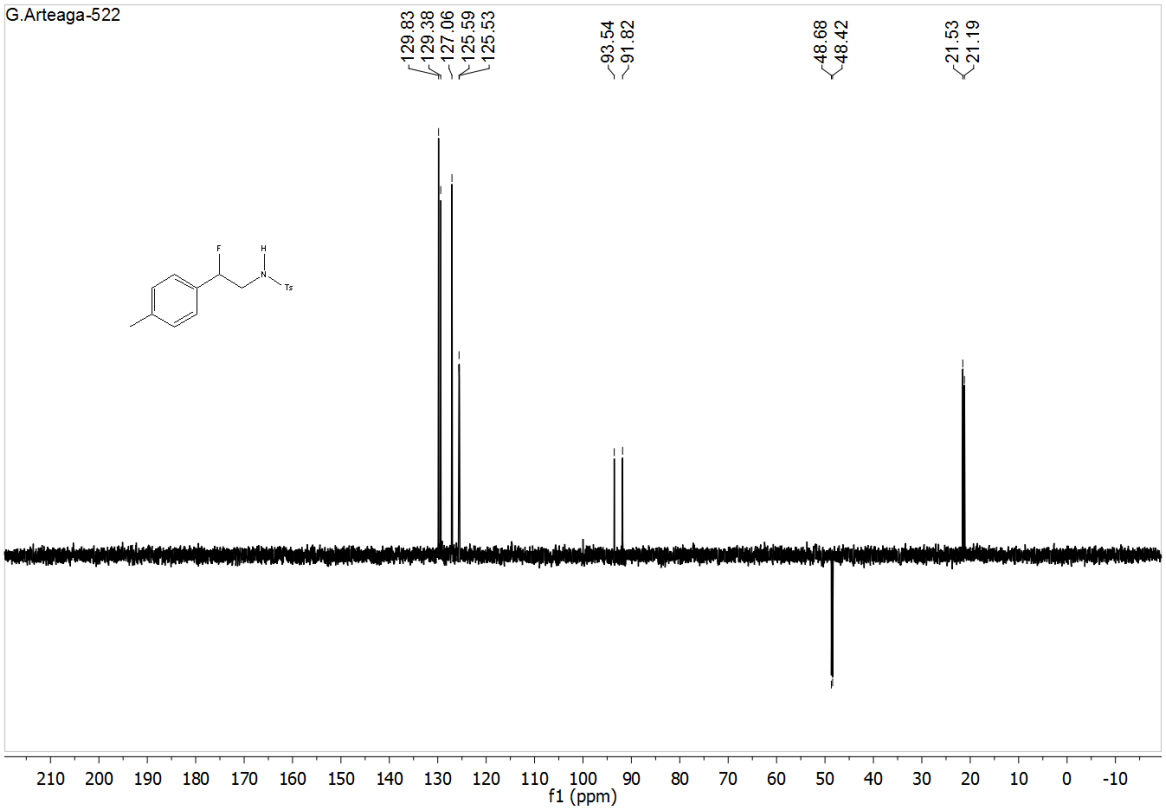

G.Arteaga-520
143.69
136.90
136.61
136.41
129.85
129.05
129.03
128.70
127.07
125.60
125.54
93.63
91.90
48.75
48.50
21.52
f1 (ppm)

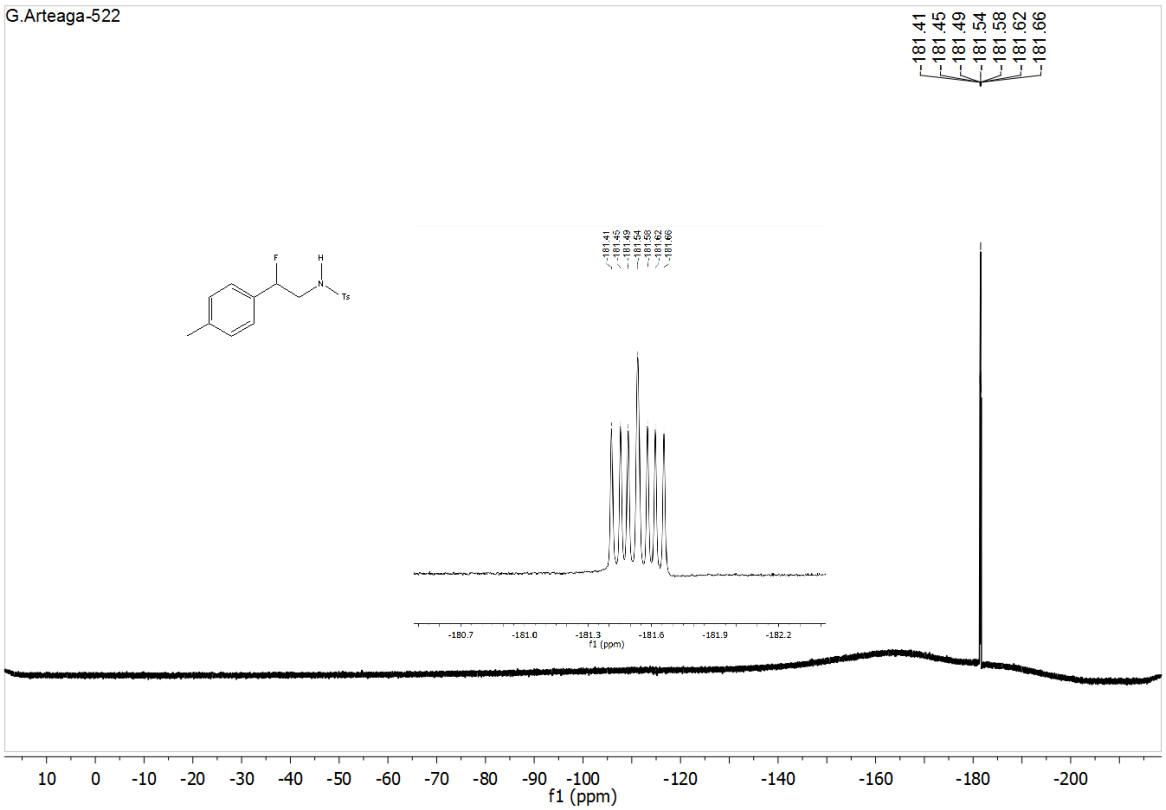

G.Arteaga-520
129.85
129.05
129.03
128.70
127.07
125.60
125.54
93.63
91.90
48.75
48.50
21.53
f1 (ppm)

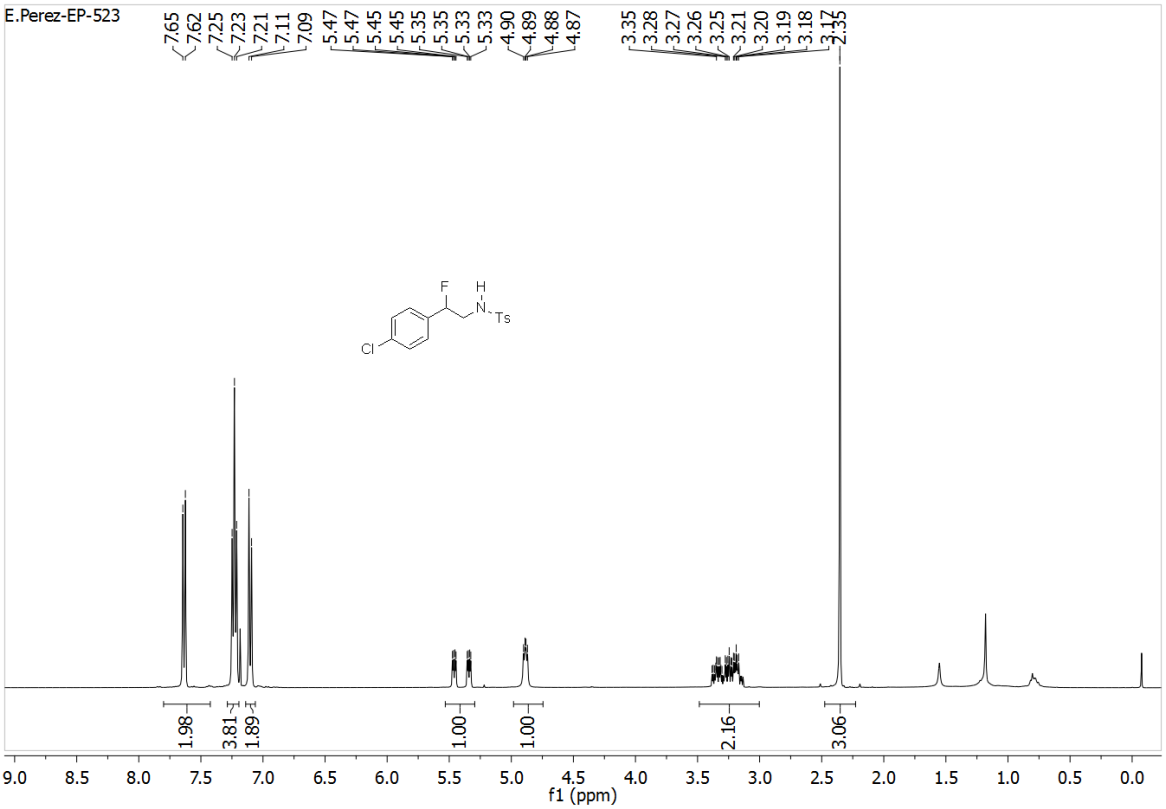

G.Arteaga-520
182.62
182.67
182.70
182.75
182.80
182.83
182.87
f1 (ppm)

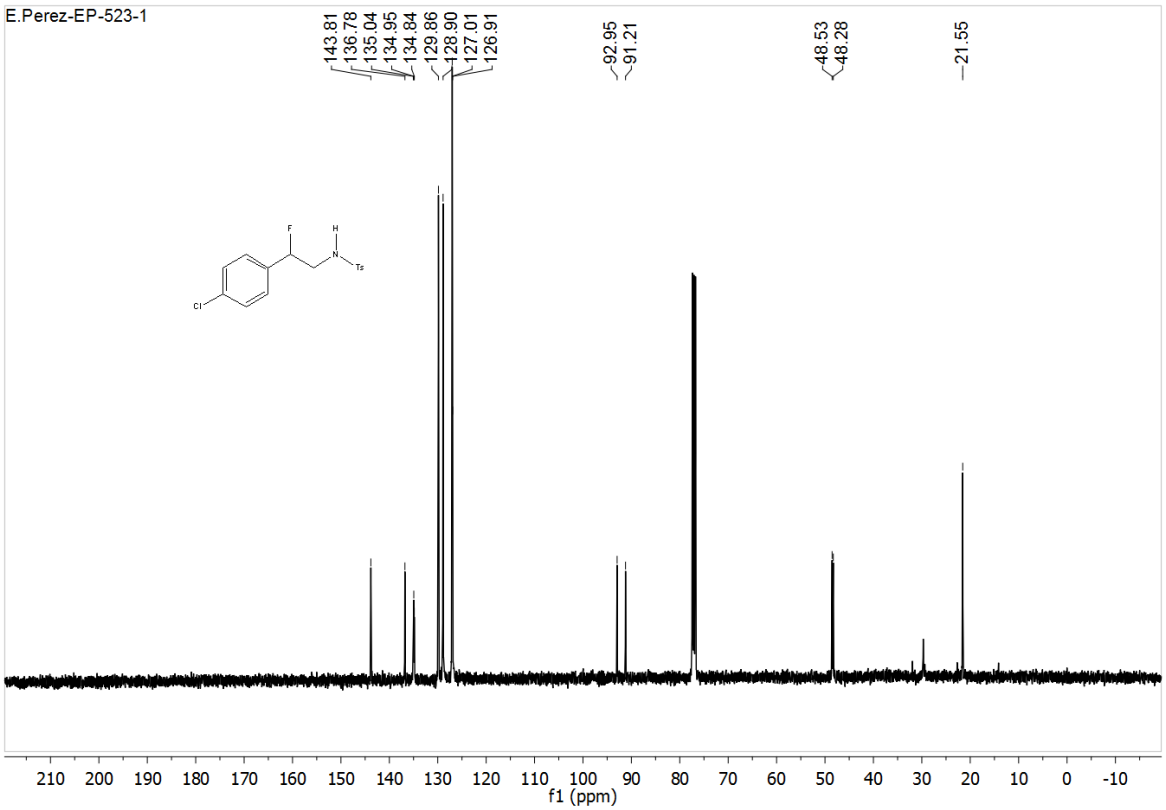

G.Arteaga-522
7.83
7.81
7.41
7.39
7.27
7.25
7.23
7.21
5.60
5.60
5.58
5.58
5.48
5.48
5.46
5.46
4.92
4.91
4.90
4.89
3.51
3.50
3.44
3.43
3.42
3.41
3.39
3.39
3.38
3.37
2.44
1.85
1.92
3.65
1.00
0.94
2.07
3.01
3.19
f1 (ppm)

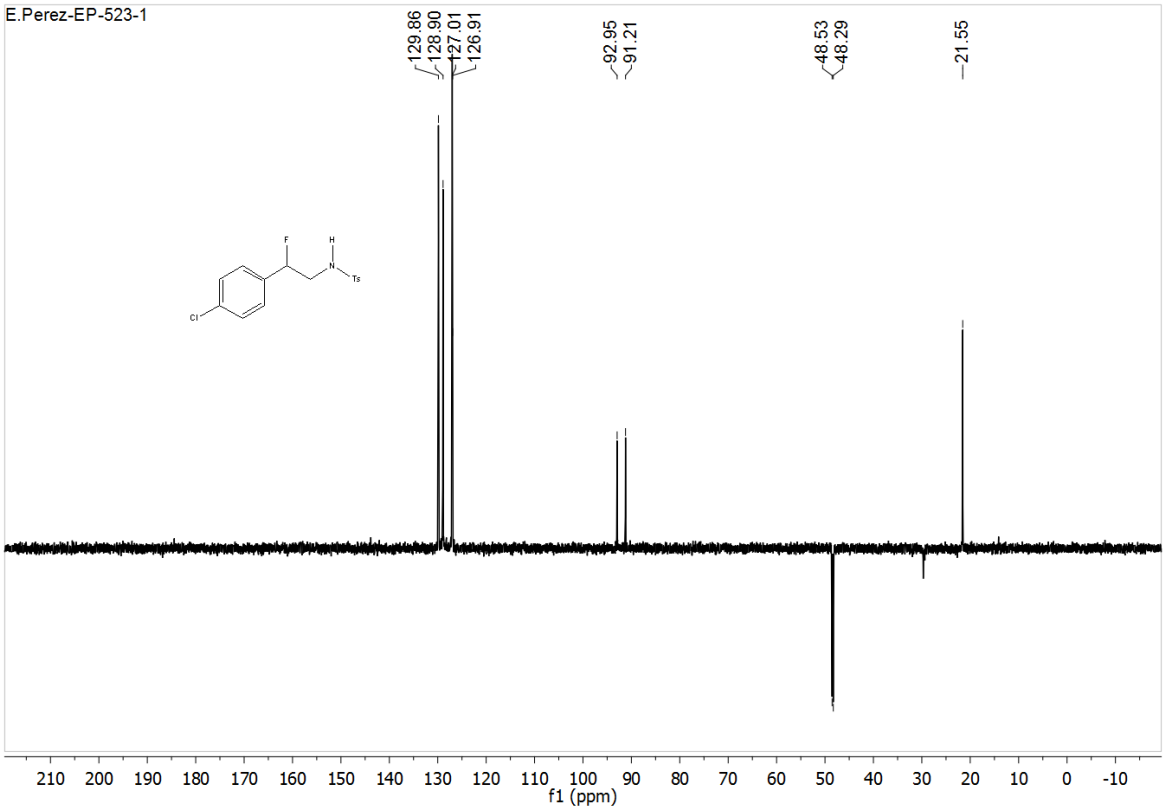

G.Arteaga-522
143.71
139.10
136.89
133.44
133.25
129.83
129.38
127.06
125.59
125.53
93.54
91.81
48.68
48.43
21.53
21.19
f1 (ppm)

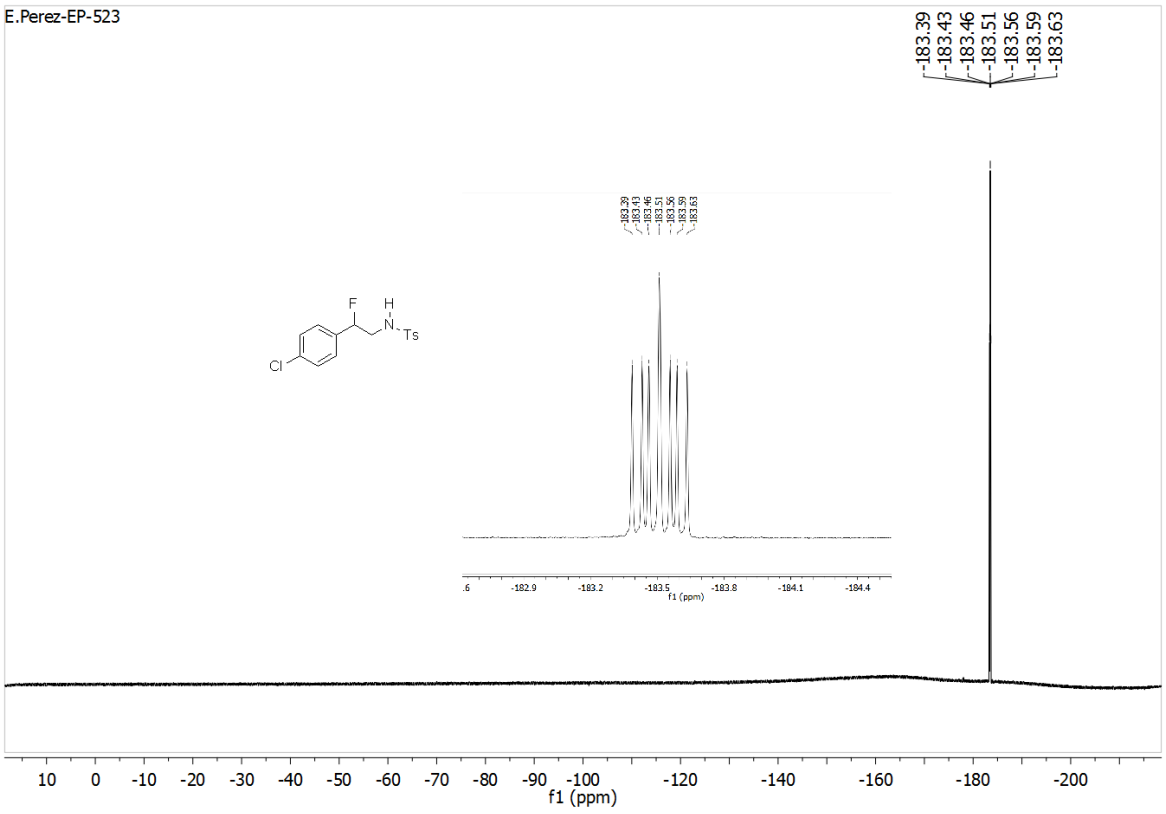

G.Arteaga-522
129.83
129.38
127.06
125.59
125.53
93.54
91.82
48.68
48.42
21.53
21.19
F
H
N
Ts
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

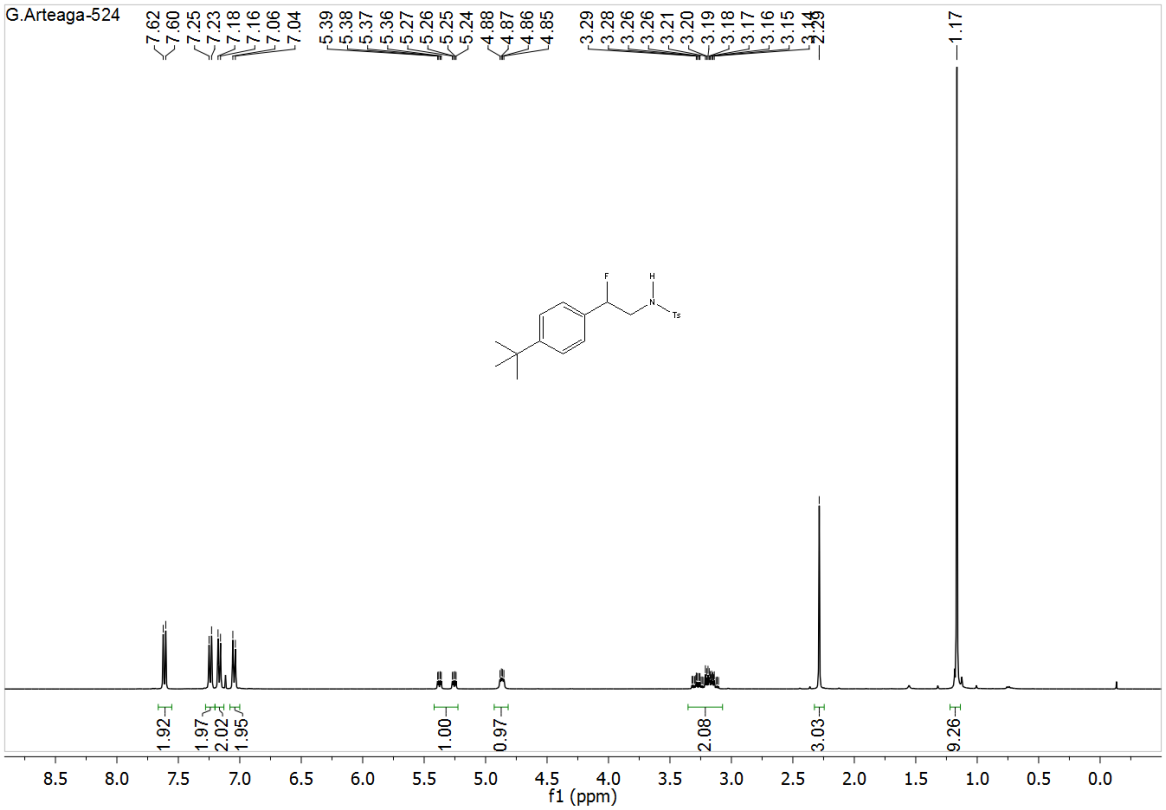

G.Arteaga-522
181.41
181.45
181.49
181.54
181.58
181.62
181.66
F
H
N
Ts
-180.7
-181.0
-181.3
-181.6
-181.9
-182.2
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

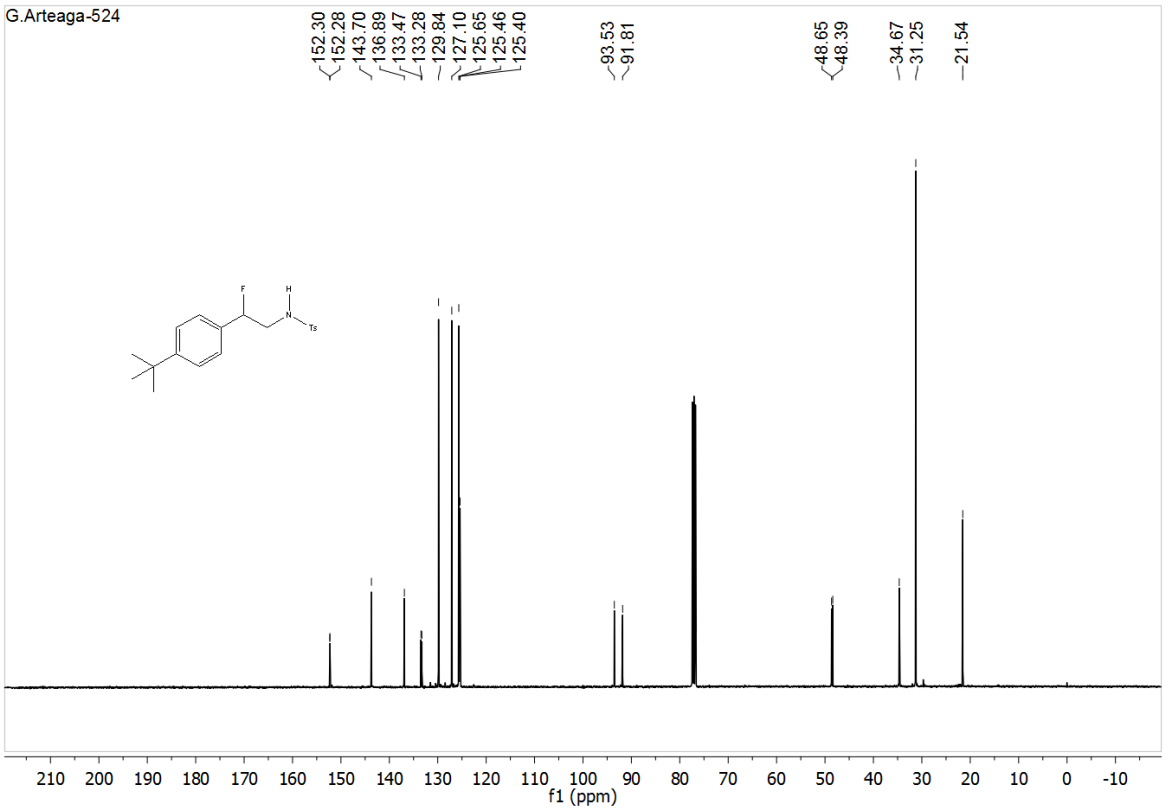

E.Perez-EP-523
7.65
7.62
7.25
7.23
7.21
7.11
7.09
5.47
5.47
5.45
5.45
5.35
5.35
5.33
5.33
4.90
4.89
4.88
4.87
3.35
3.28
3.27
3.26
3.25
3.21
3.20
3.19
3.18
3.17
2.35
F
H
N
Ts
Cl
1.98
3.81
1.89
1.00
1.00
2.16
3.06
f1 (ppm)

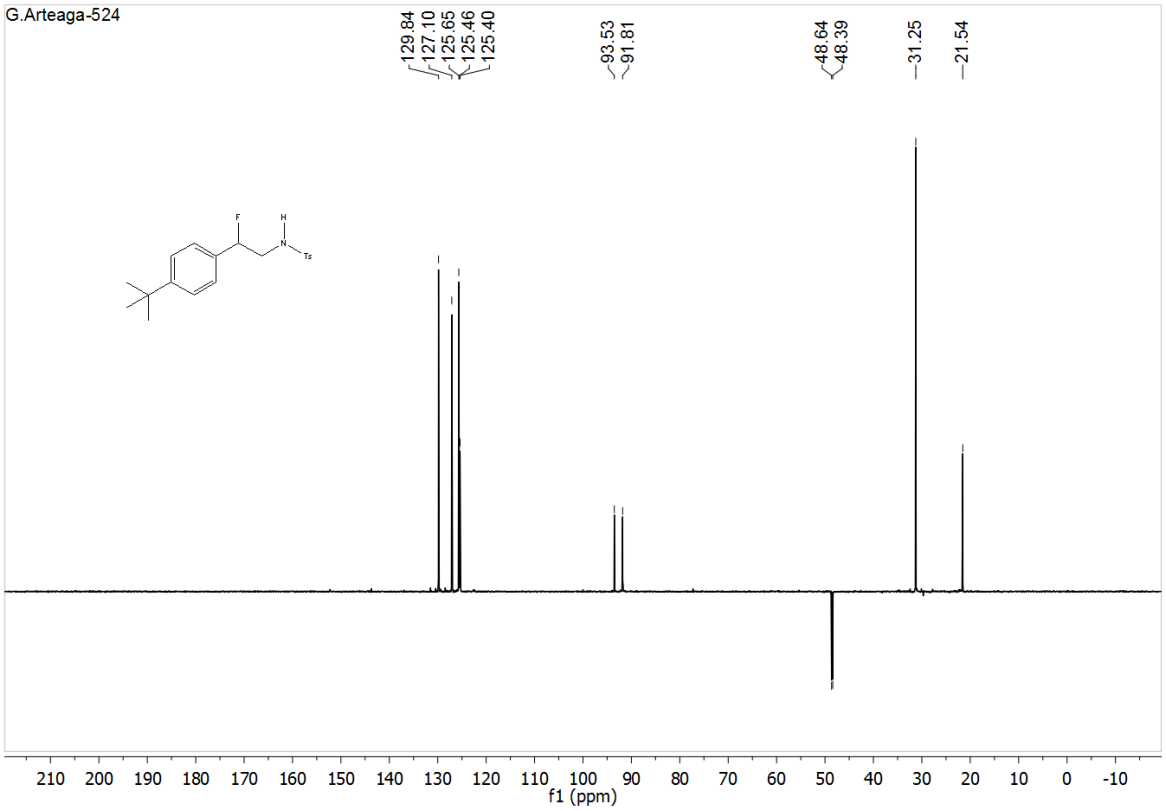

E.Perez-EP-523-1
143.81
136.78
135.04
134.95
134.84
129.86
128.90
127.01
126.91
92.95
91.21
48.53
48.28
21.55
F
H
N
Ts
Cl
f1 (ppm)

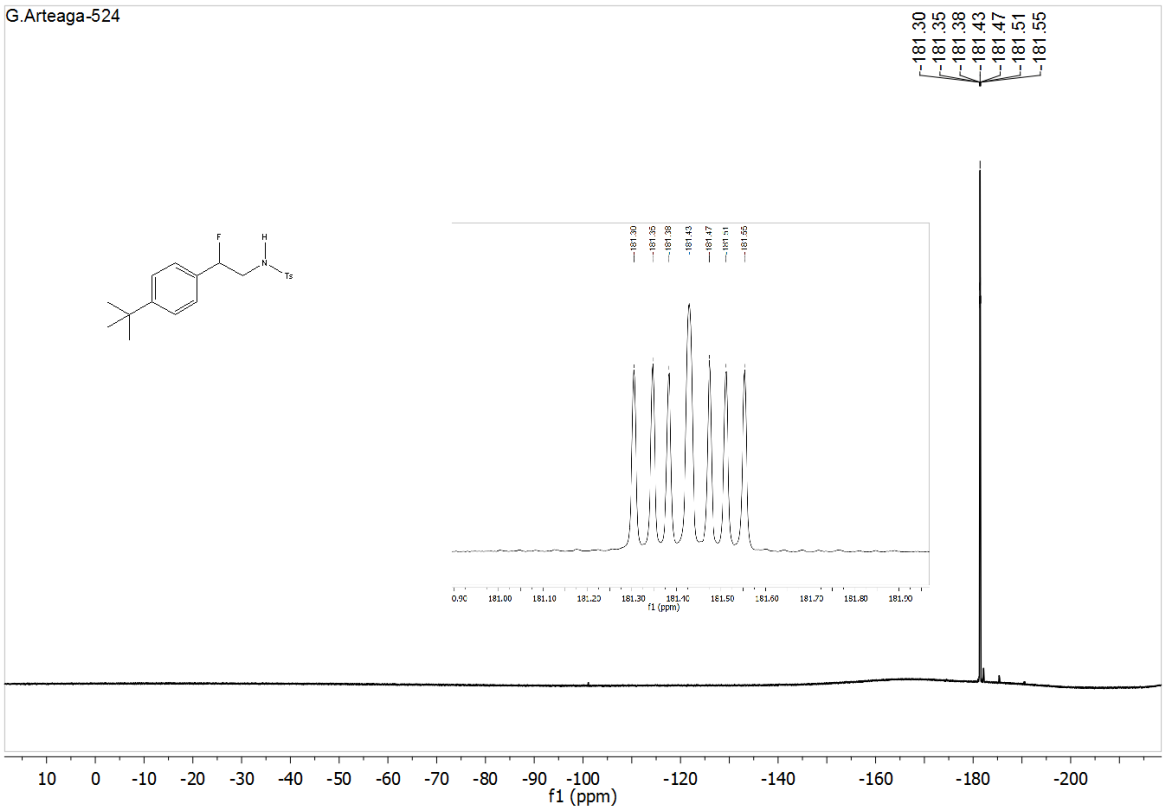

E.Perez-EP-523-1
129.86
128.90
127.01
126.91
92.95
91.21
48.53
48.29
21.55
F
H
N
Ts
Cl
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

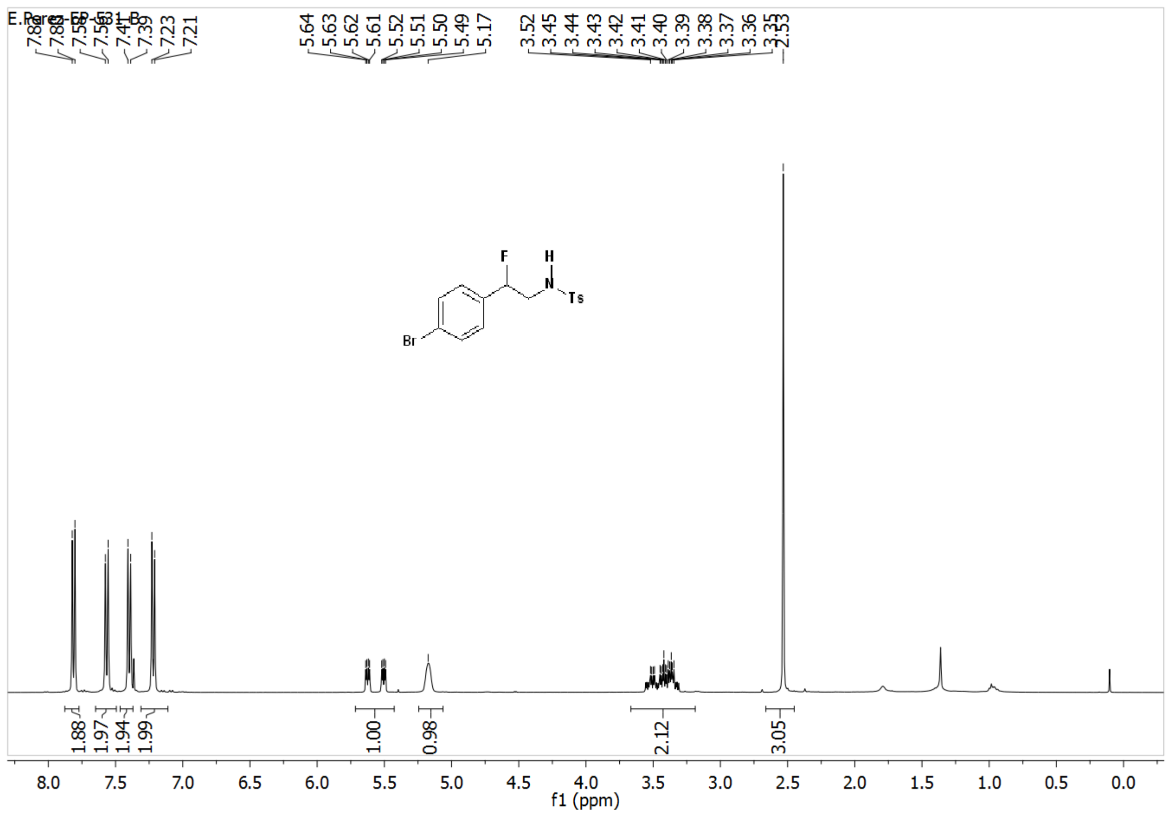

E.Perez-EP-523
-183.39
-183.43
-183.46
-183.51
-183.56
-183.59
-183.63
F
H
N
TS
Cl
-182.9
-183.2
-183.5
-183.8
-184.1
-184.4
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

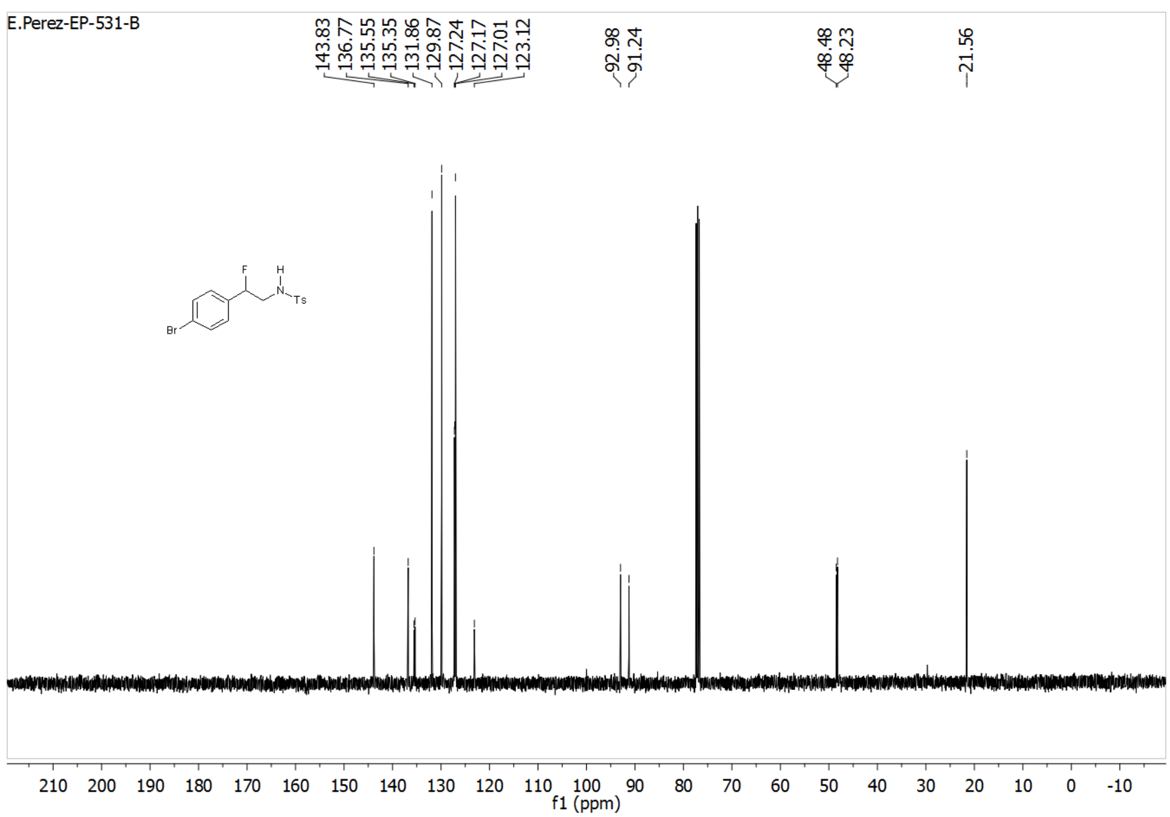

G.Arteaga-524
7.62
7.60
7.25
7.23
7.18
7.16
7.06
7.04
5.39
5.38
5.37
5.36
5.27
5.26
5.25
5.24
4.88
4.87
4.86
4.85
3.29
3.28
3.26
3.26
3.21
3.20
3.19
3.18
3.17
3.16
3.15
1.17
1.92
1.97
2.02
1.95
1.00
0.97
2.08
3.03
9.26
f1 (ppm)

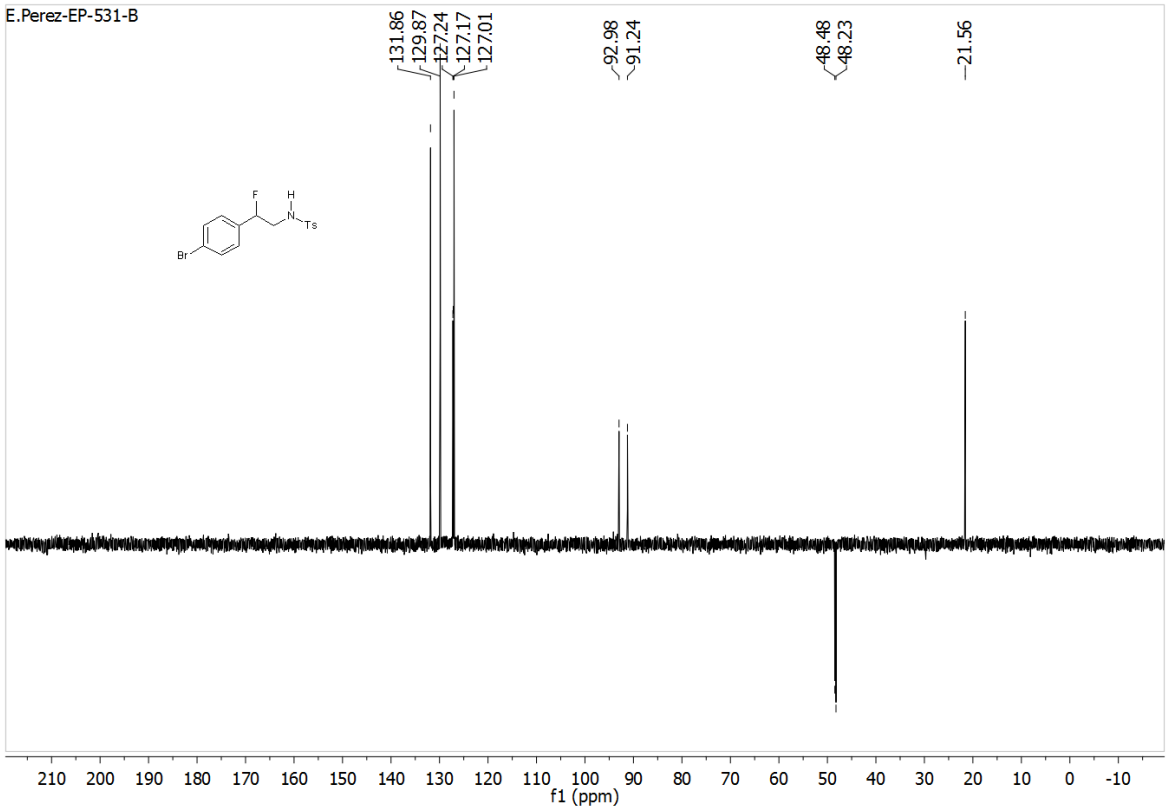

G.Arteaga-524
152.30
152.28
143.70
136.89
133.47
133.28
129.84
127.10
125.65
125.46
125.40
93.53
91.81
48.65
48.39
34.67
31.25
21.54
f1 (ppm)

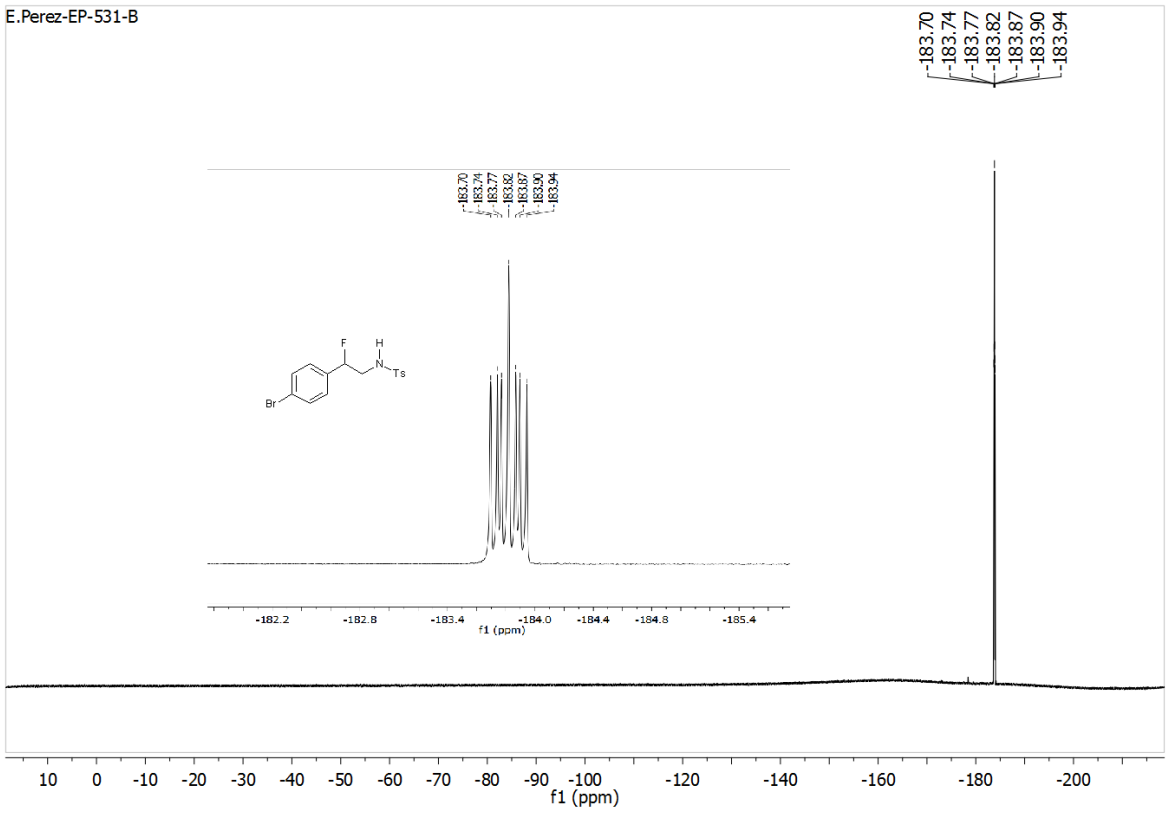

G.Arteaga-524
129.84
127.10
125.65
125.46
125.40
93.53
91.81
48.64
48.39
31.25
21.54
f1 (ppm)

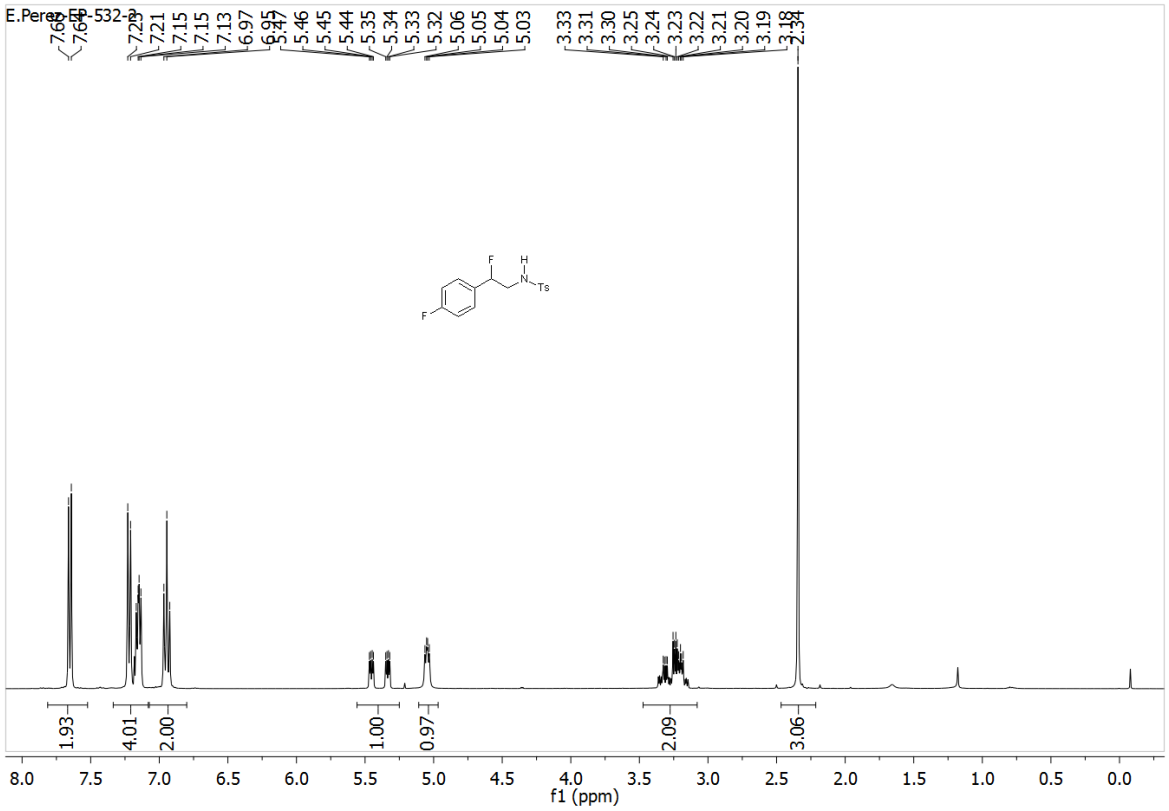

G.Arteaga-524
181.30
181.35
181.38
181.43
181.47
181.51
181.55
f1 (ppm)

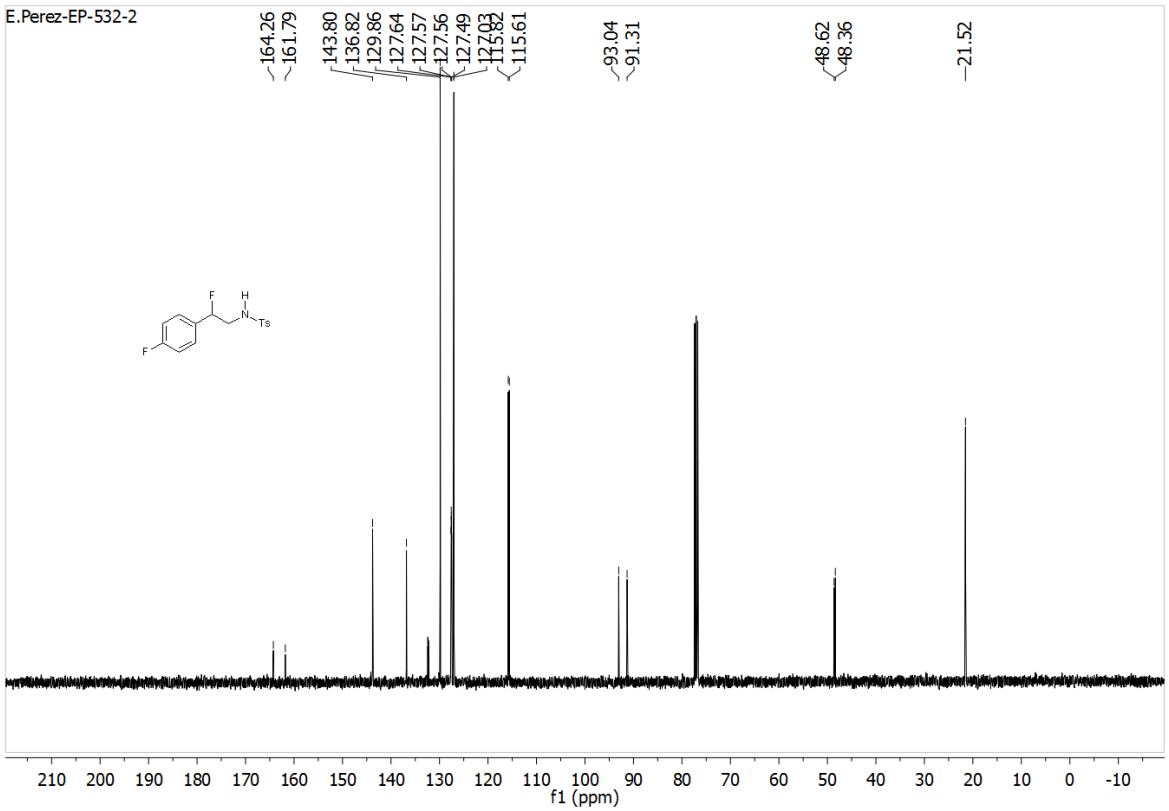

E.Perez-EP-531-B
7.41
7.39
7.23
7.21
5.64
5.63
5.62
5.61
5.52
5.51
5.50
5.49
5.17
3.52
3.45
3.44
3.43
3.42
3.41
3.40
3.39
3.38
3.37
3.36
3.35
2.53
F
H
N
Ts
Br
1.88
1.97
1.94
1.99
1.00
0.98
2.12
3.05
f1 (ppm)

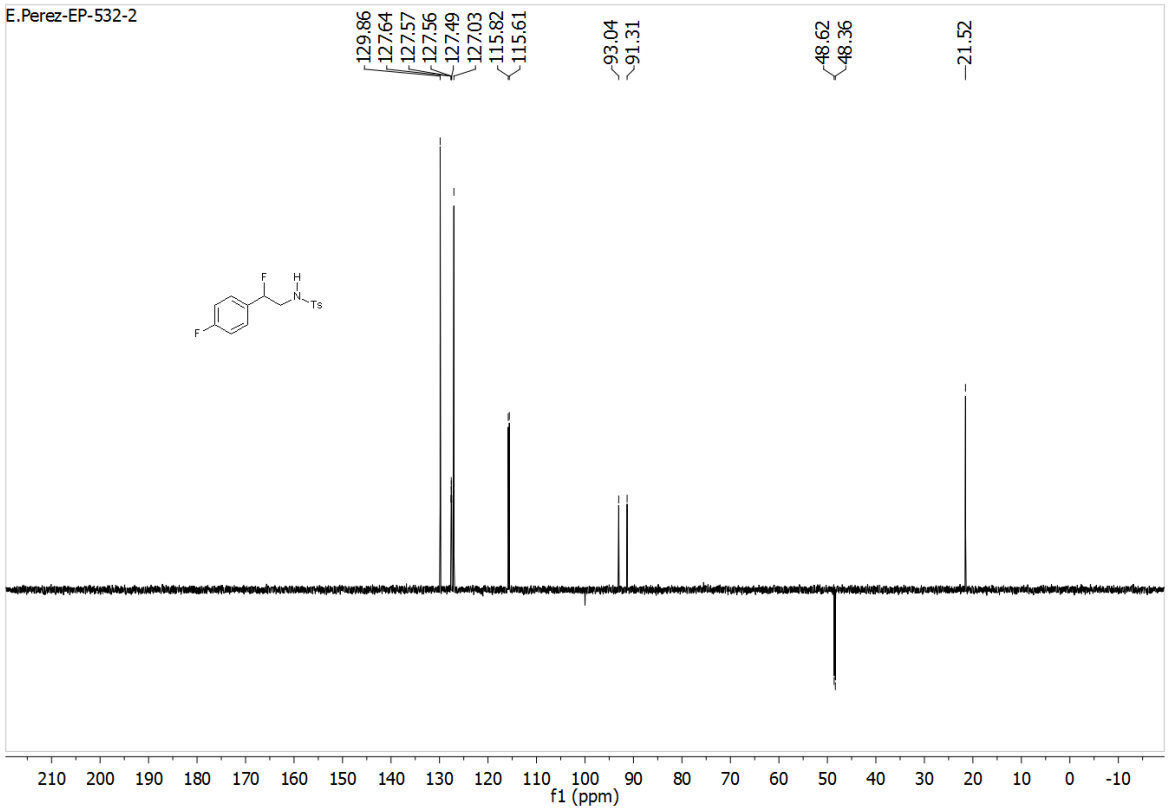

E.Perez-EP-531-B
143.83
136.77
135.55
135.35
131.86
129.87
127.24
127.17
127.01
123.12
92.98
91.24
48.48
48.23
21.56
F
H
N
Ts
Br
f1 (ppm)

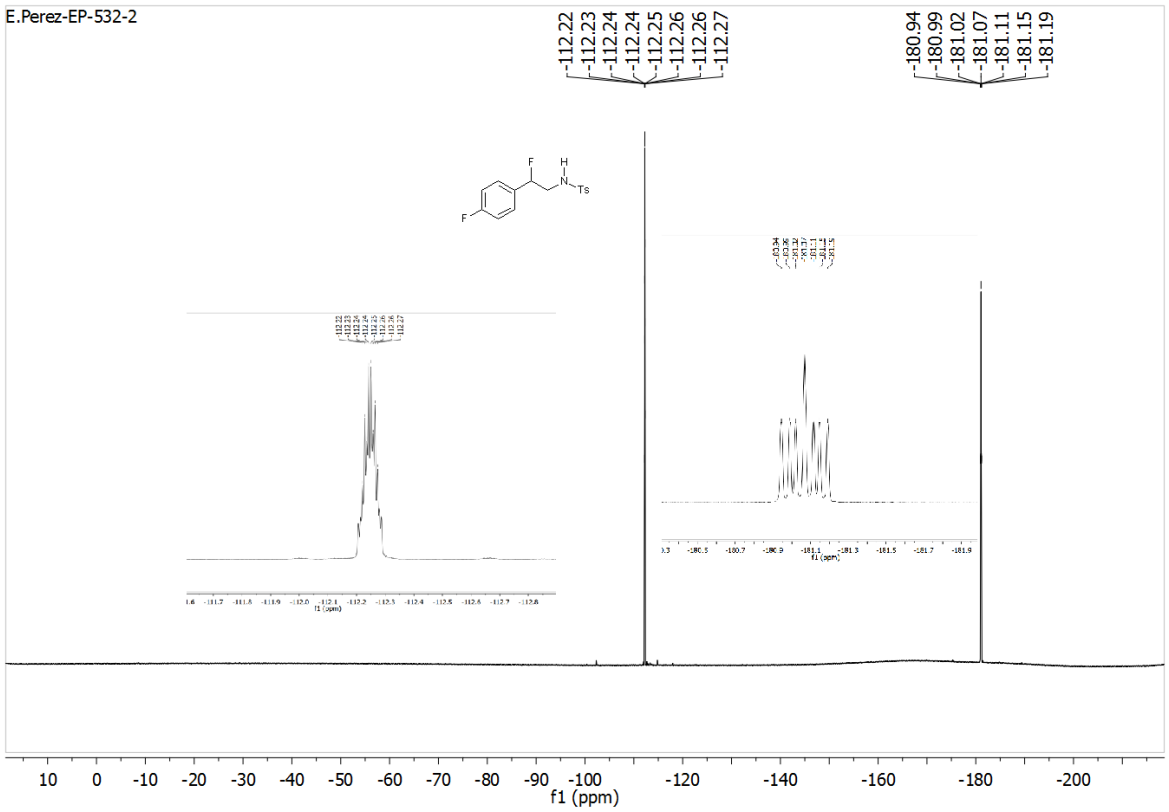

E.Perez-EP-531-B
131.86
129.87
127.24
127.17
127.01
92.98
91.24
48.48
48.23
21.56
F
H
N
Ts
Br
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

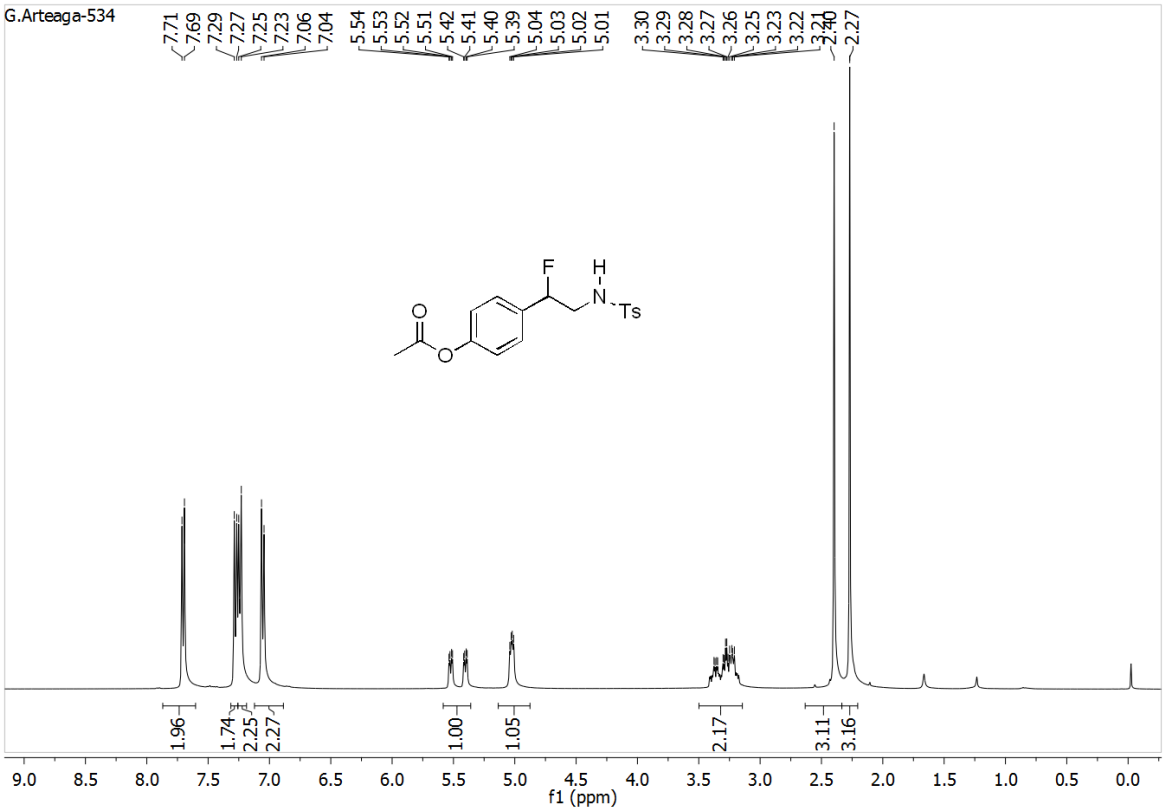

E.Perez-EP-531-B
-183.70
-183.74
-183.77
-183.82
-183.87
-183.90
-183.94
F
H
N
Ts
Br
-182.2 -182.8 -183.4 -184.0 -184.4 -184.8 -185.4
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

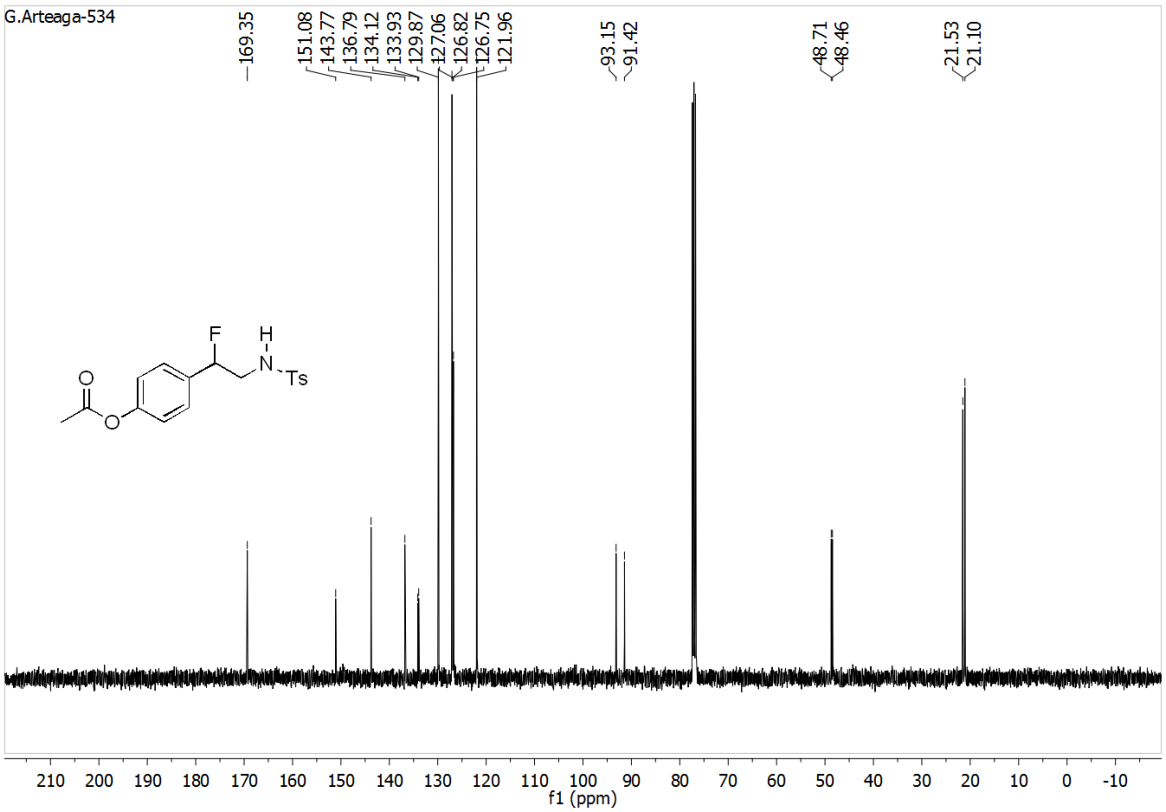

E.Perez-EP-532-2
7.69
7.64
7.29
7.21
7.15
7.15
7.13
6.97
6.95
6.95
5.46
5.45
5.44
5.35
5.34
5.33
5.32
5.06
5.05
5.04
5.03
3.33
3.31
3.30
3.25
3.24
3.23
3.22
3.21
3.20
3.19
3.18
2.34
F
H
N
Ts
F
1.93
4.01
2.00
1.00
0.97
2.09
3.06
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

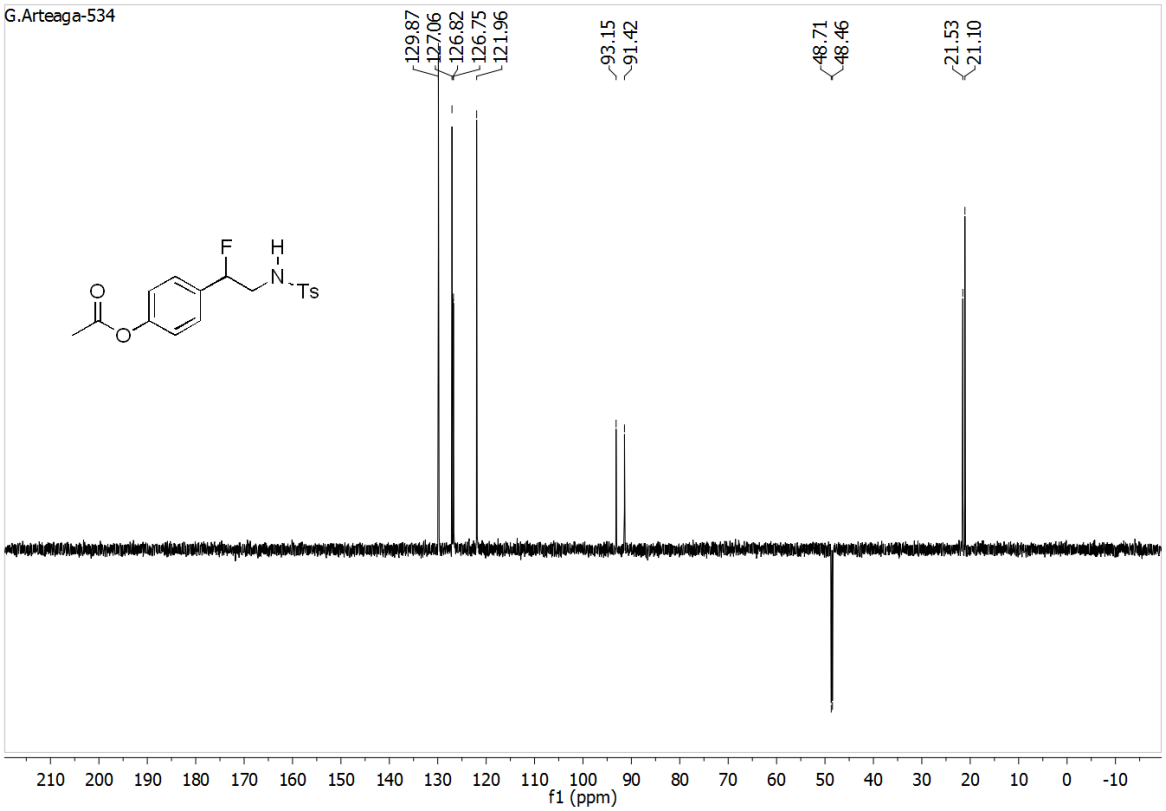

E.Perez-EP-532-2
164.26
161.79
143.80
136.82
129.86
127.64
127.57
127.56
127.49
127.03
115.82
115.61
93.04
91.31
48.62
48.36
21.52
F
H
N
Ts
F
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

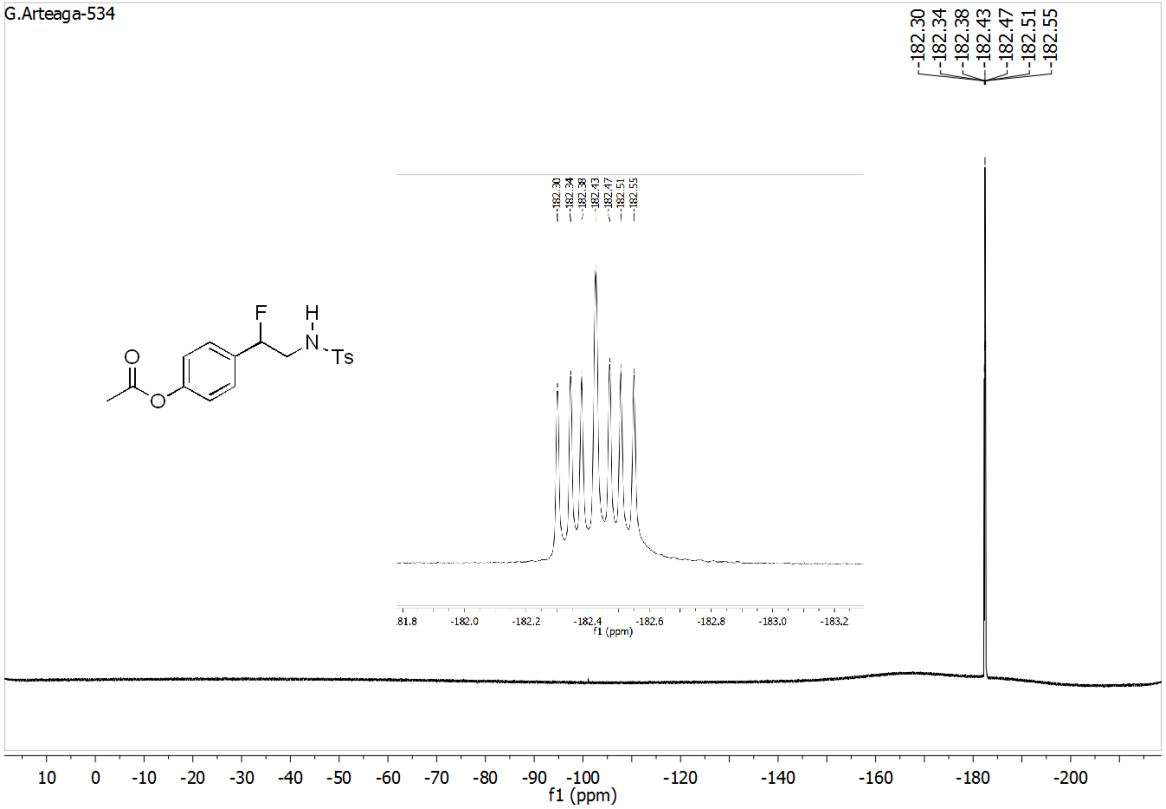

E.Perez-EP-532-2
129.86
127.64
127.57
127.56
127.49
127.03
115.82
115.61
93.04
91.31
48.62
48.36
21.52
F
H
N
Ts
F
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

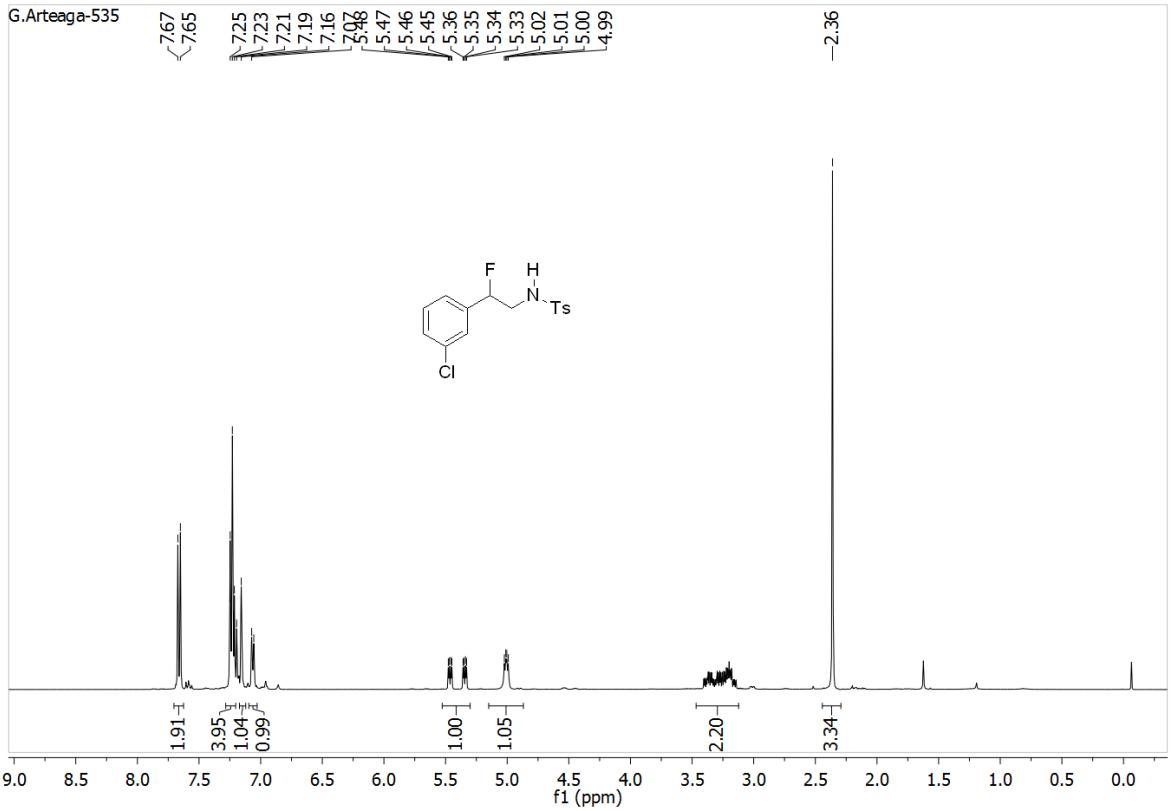

E.Perez-EP-532-2
-112.22
-112.23
-112.24
-112.24
-112.25
-112.26
-112.26
-112.27
-180.94
-180.99
-181.02
-181.07
-181.11
-181.15
-181.19
F
H
N
Ts
F
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

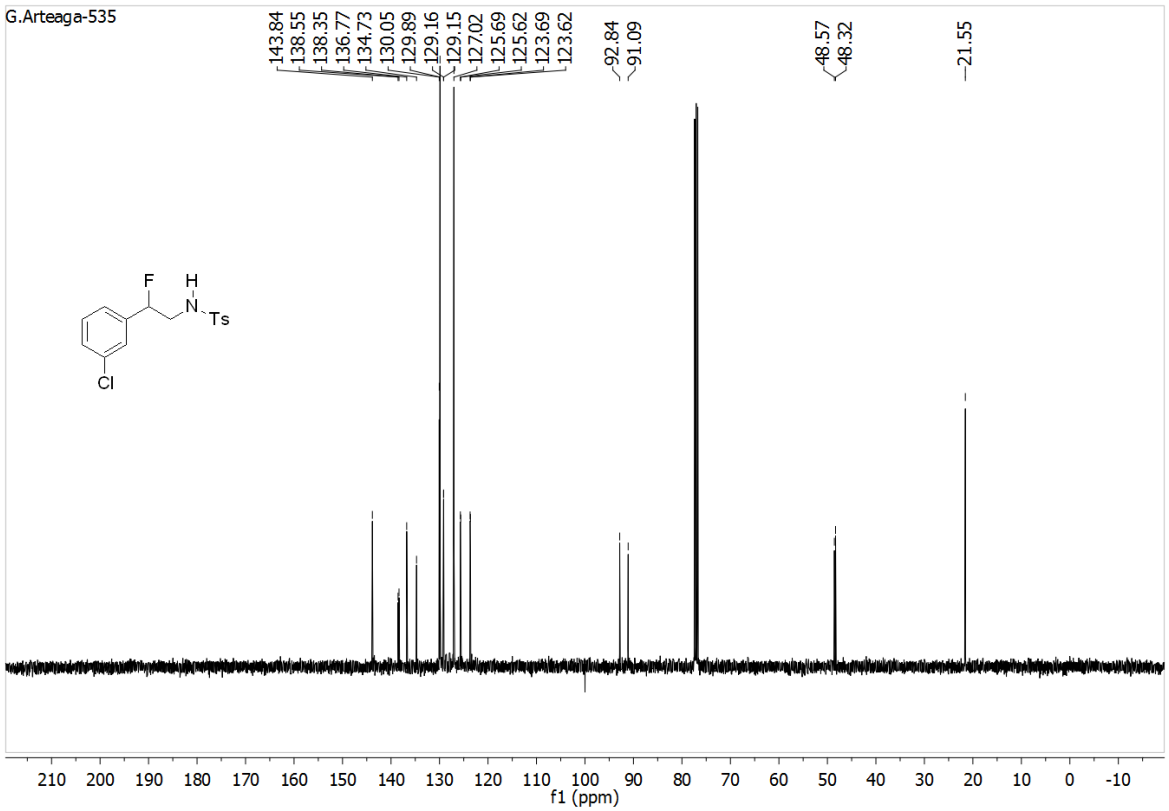

G.Arteaga-534
7.71
7.69
7.29
7.27
7.25
7.23
7.06
7.04
5.54
5.53
5.52
5.51
5.42
5.41
5.40
5.39
5.04
5.03
5.02
5.01
3.30
3.29
3.28
3.27
3.26
3.25
3.23
3.22
3.21
2.40
2.27
F
H
N
Ts
O
O
1.96
1.74
2.25
2.27
1.00
1.05
2.17
3.11
3.16
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

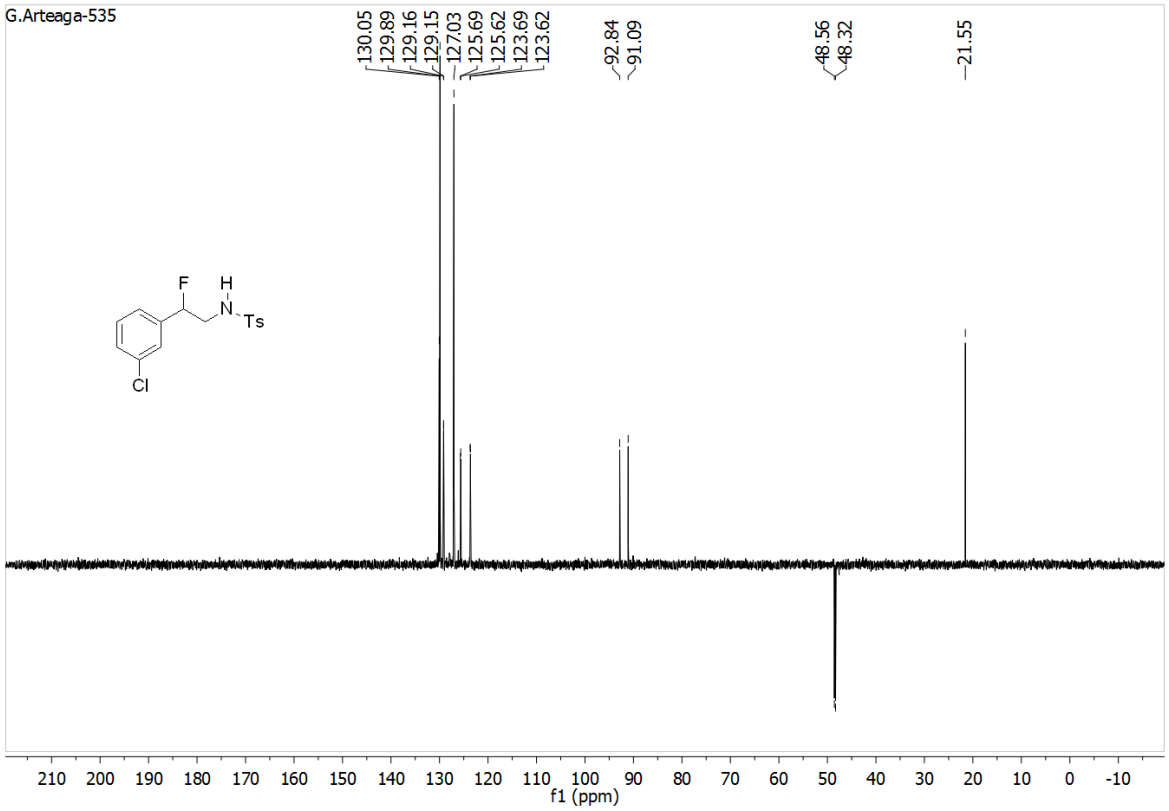

G.Arteaga-534
169.35
151.08
143.77
136.79
134.12
133.93
129.87
127.06
126.82
126.75
121.96
93.15
91.42
48.71
48.46
21.53
21.10
F
H
N
Ts
O
O
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

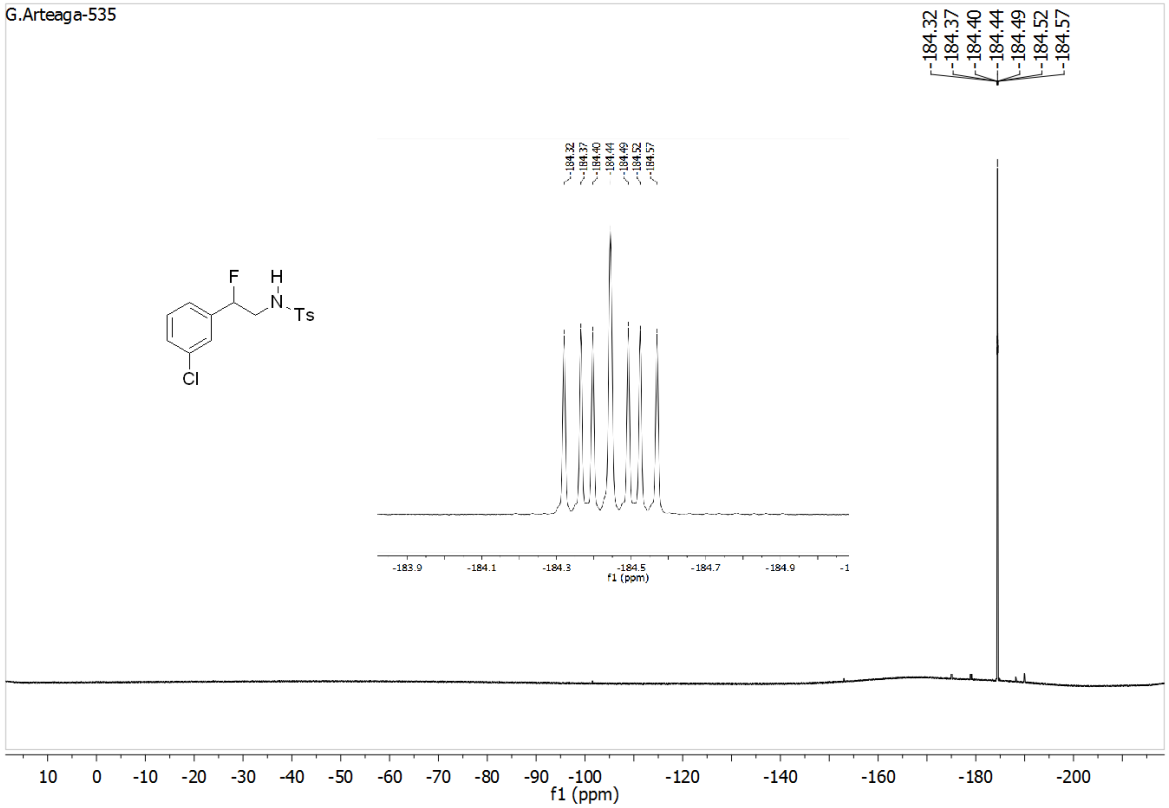

G.Arteaga-534
129.87
127.06
126.82
126.75
121.96
93.15
91.42
48.71
48.46
21.53
21.10
F
H
N
Ts
O
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

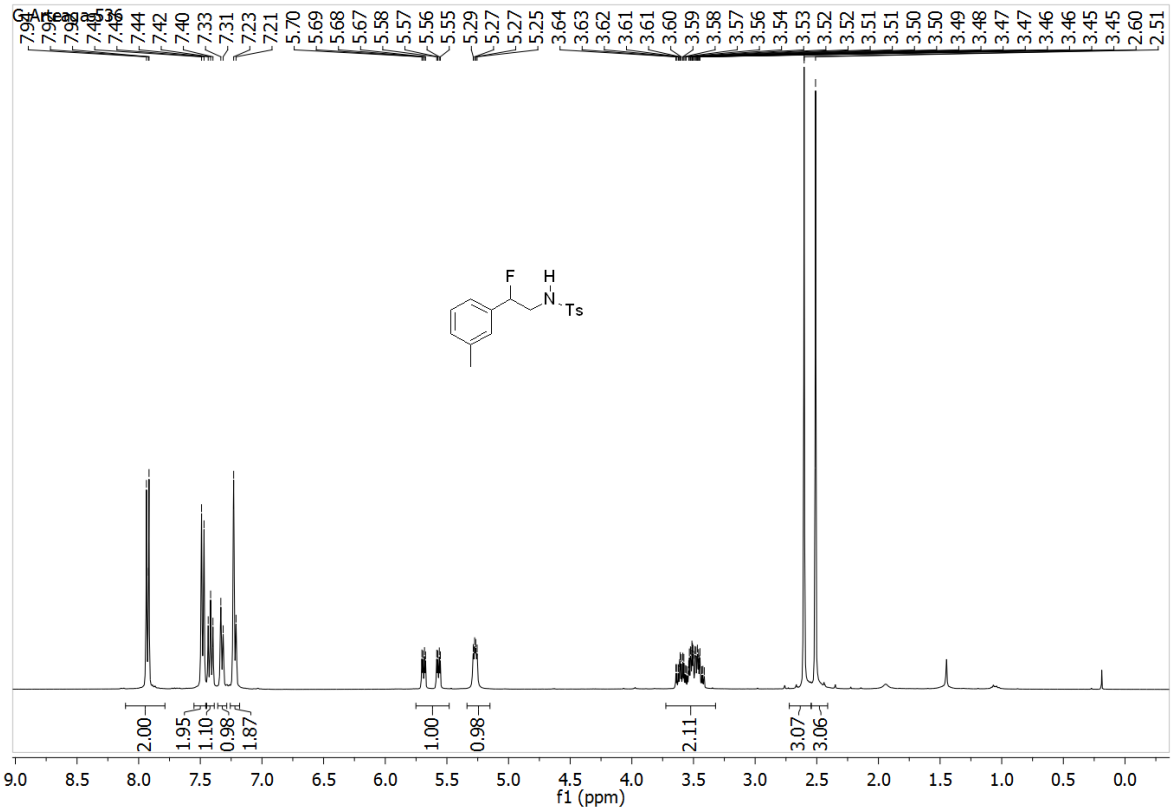

G.Arteaga-534
-182.30
-182.34
-182.38
-182.43
-182.47
-182.51
-182.55
F
H
N
Ts
O
O
81.8 -182.0 -182.2 -182.4 -182.6 -182.8 -183.0 -183.2
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

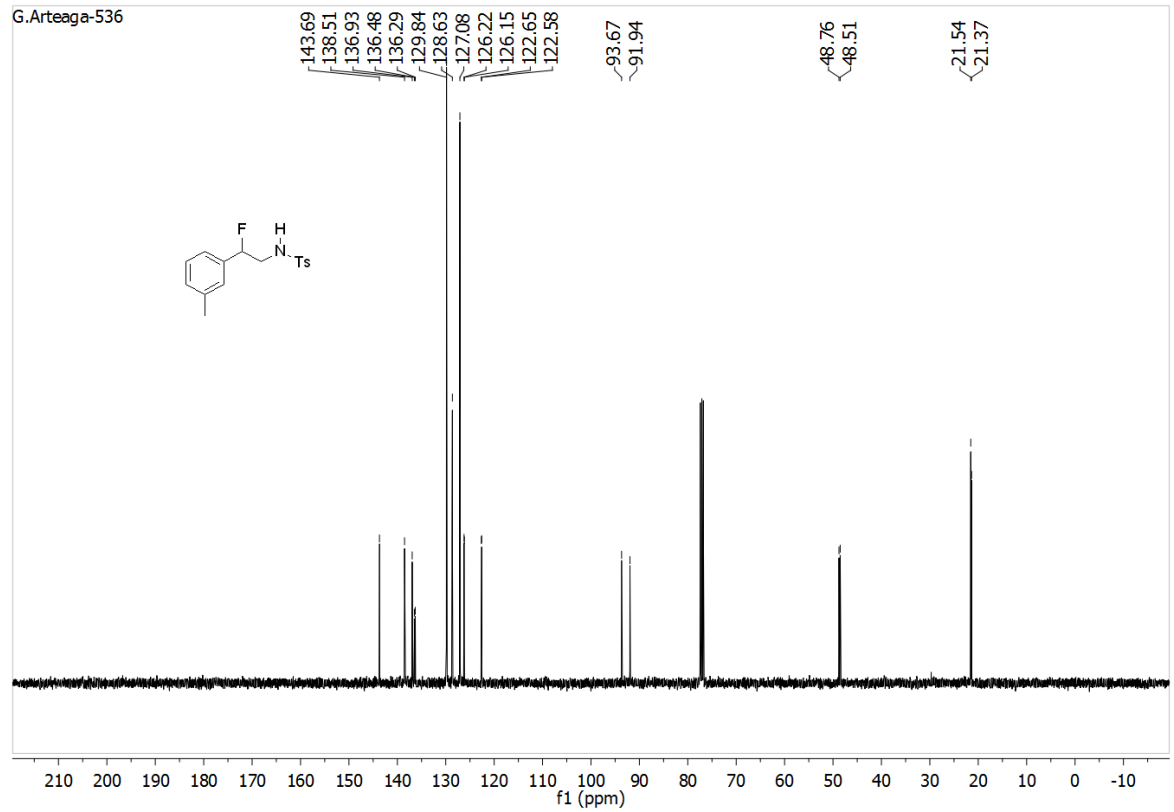

G.Arteaga-535
7.67
7.65
7.25
7.23
7.21
7.19
7.16
7.07
5.48
5.47
5.46
5.45
5.36
5.35
5.34
5.33
5.02
5.01
5.00
4.99
2.36
F
H
N
Ts
Cl
1.91
3.95
1.04
0.99
1.00
1.05
2.20
3.34
f1 (ppm)

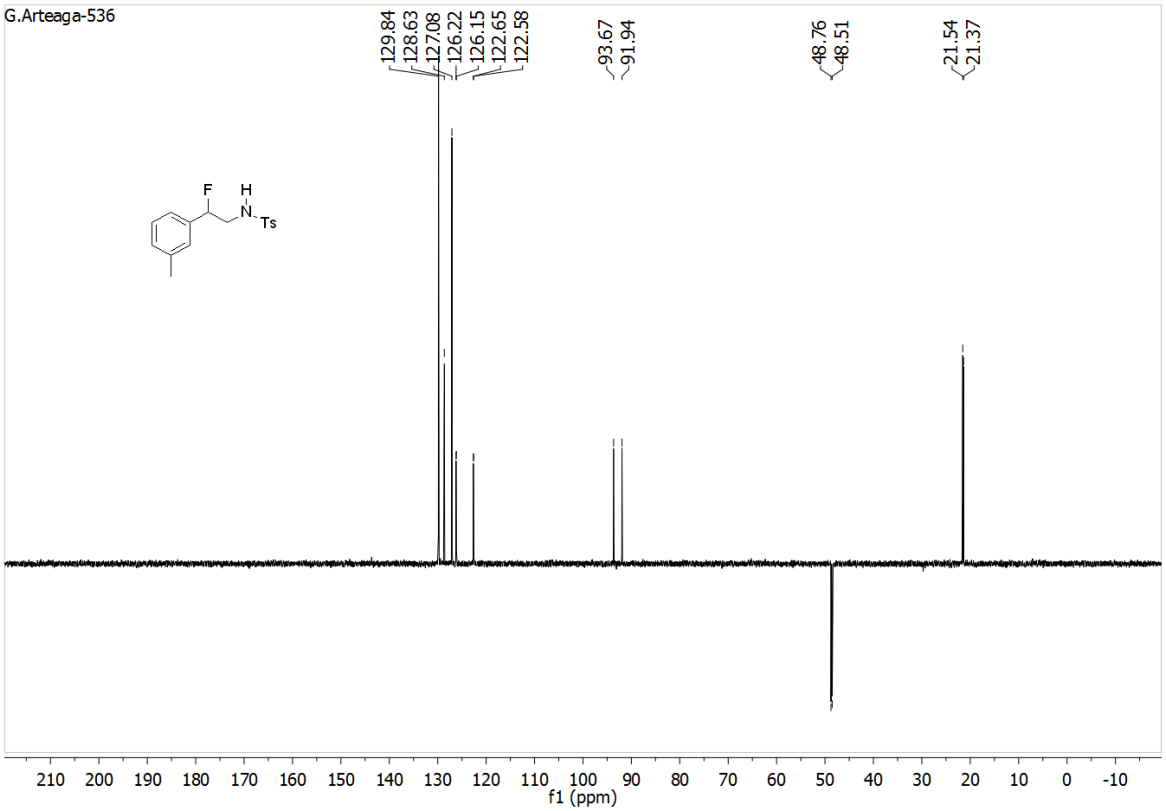

G.Arteaga-535
143.84
138.55
138.35
136.77
134.73
130.05
129.89
129.16
129.15
127.02
125.69
125.62
123.69
123.62
92.84
91.09
48.57
48.32
21.55
F
H
N
Ts
Cl
f1 (ppm)

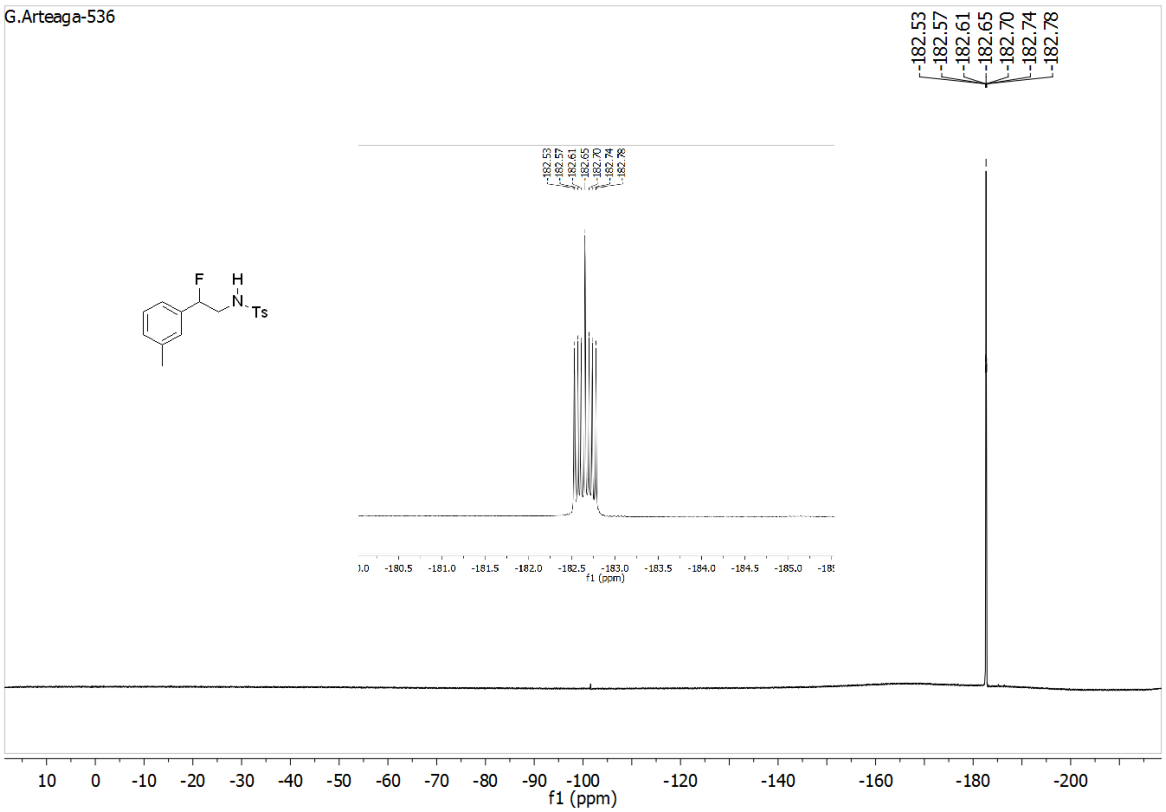

G.Arteaga-535
130.05
129.89
129.16
129.15
127.03
125.69
125.62
123.69
123.62
92.84
91.09
48.56
48.32
21.55
F
H
N
Ts
Cl
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

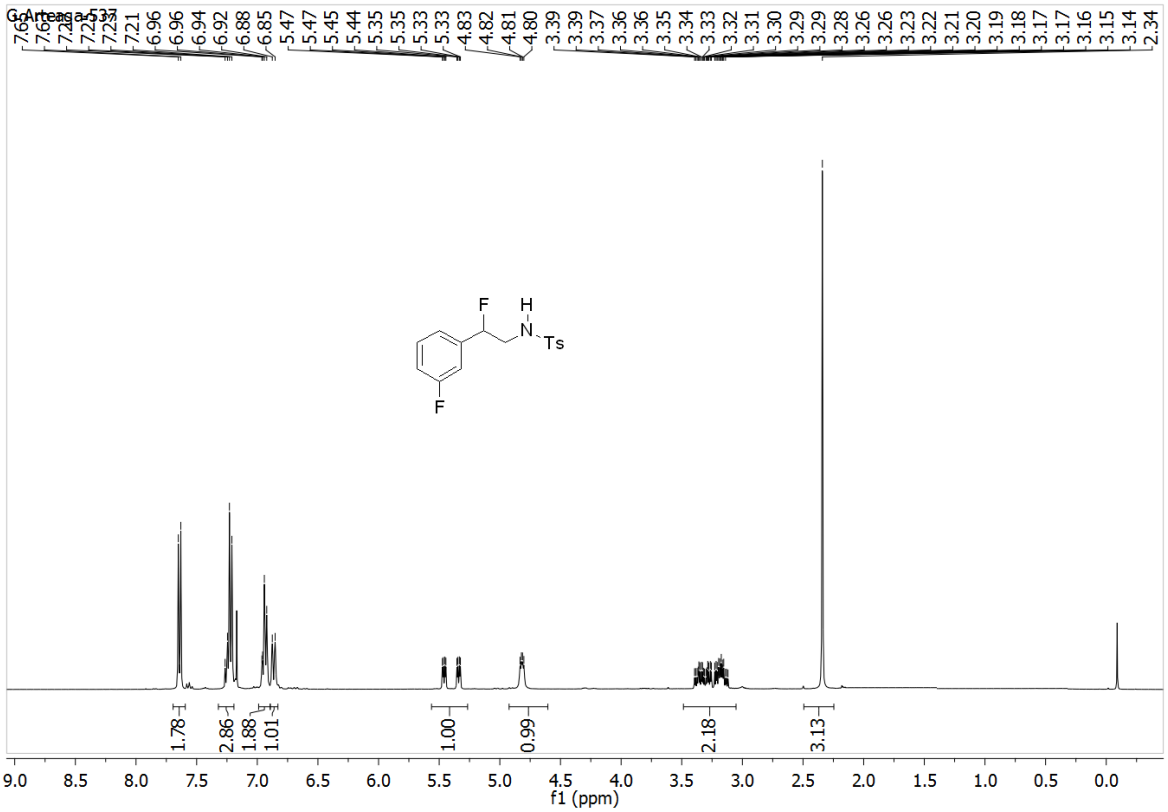

G.Arteaga-535
184.32
184.37
184.40
184.44
184.49
184.52
184.57
F
H
N
Ts
Cl
-183.9 -184.1 -184.3 -184.5 -184.7 -184.9 -1
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

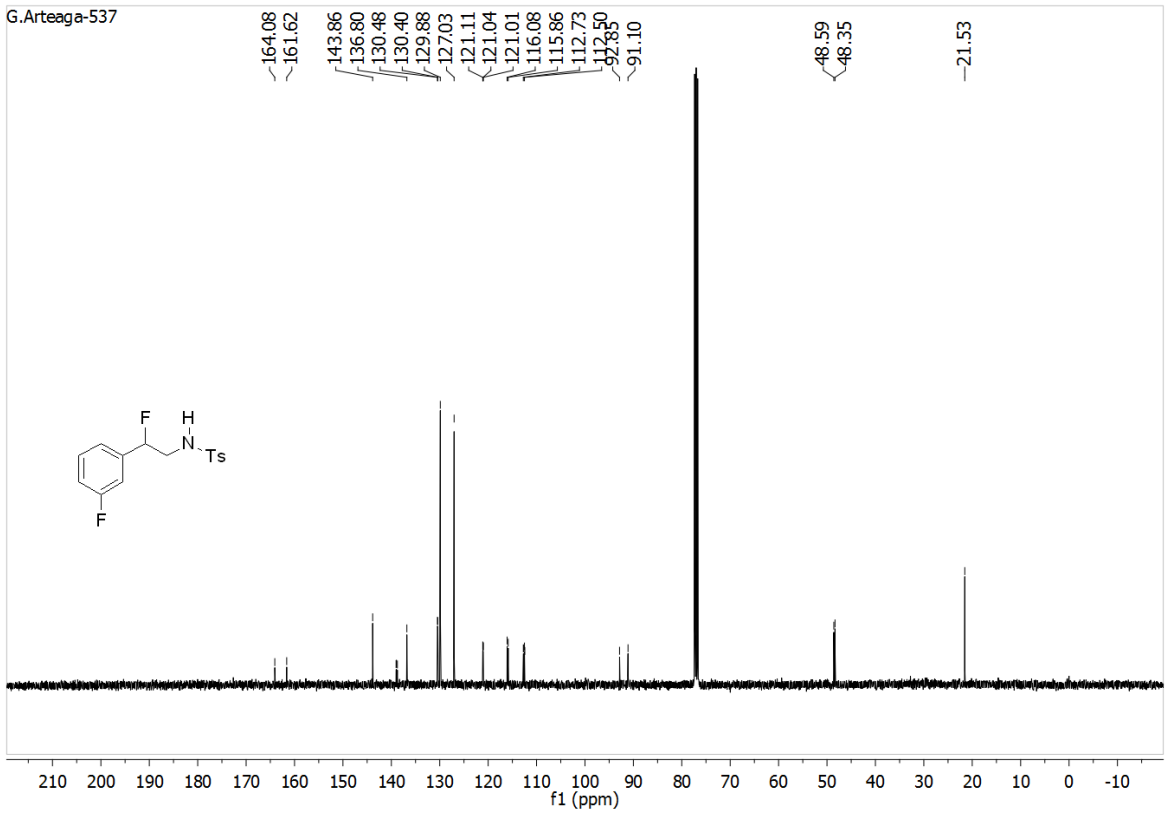

G.Arteaga-536
F
H
N
Ts
2.00
1.95
1.10
0.98
1.87
1.00
0.98
2.11
3.07
3.06
f1 (ppm)

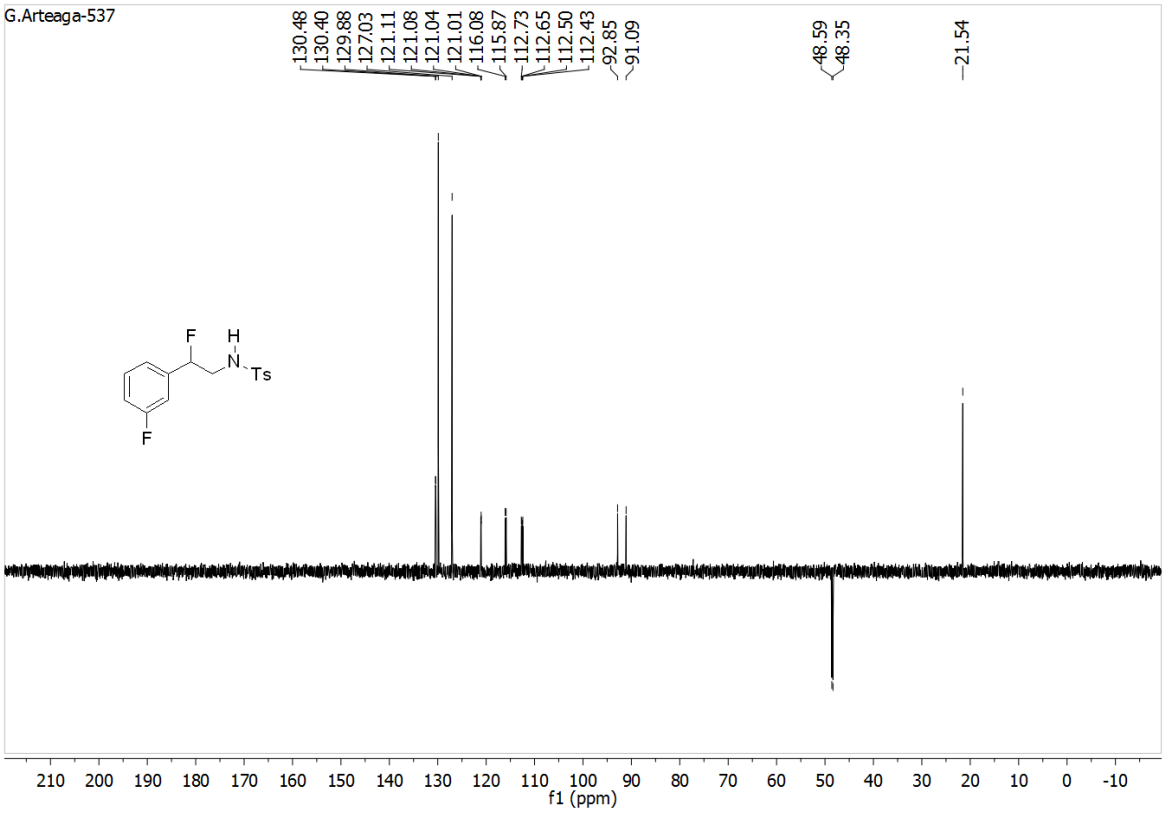

G.Arteaga-536
143.69
138.51
136.93
136.48
136.29
129.84
128.63
127.08
126.22
126.15
122.65
122.58
93.67
91.94
48.76
48.51
21.54
21.37
F
H
N
Ts
f1 (ppm)

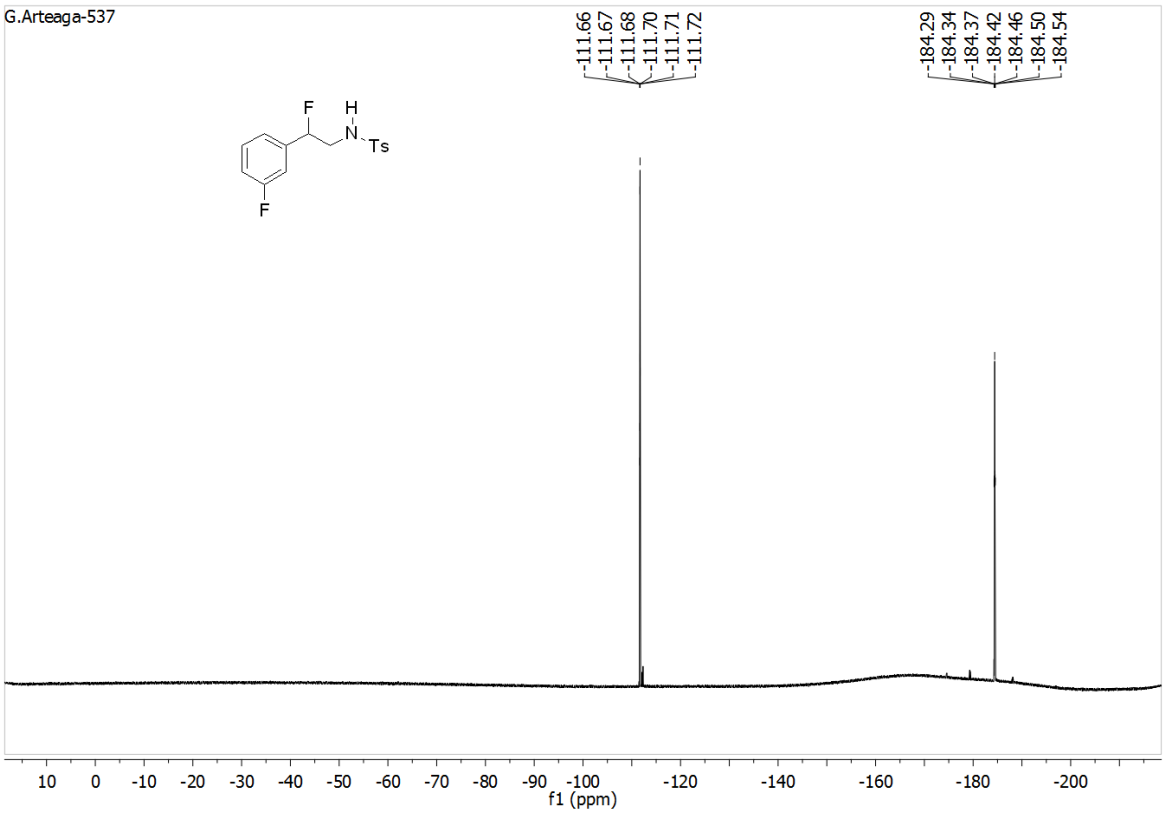

G.Arteaga-536
129.84
128.63
127.08
126.22
126.15
122.65
122.58
93.67
91.94
48.76
48.51
21.54
21.37
F
H
N
Ts
f1 (ppm)

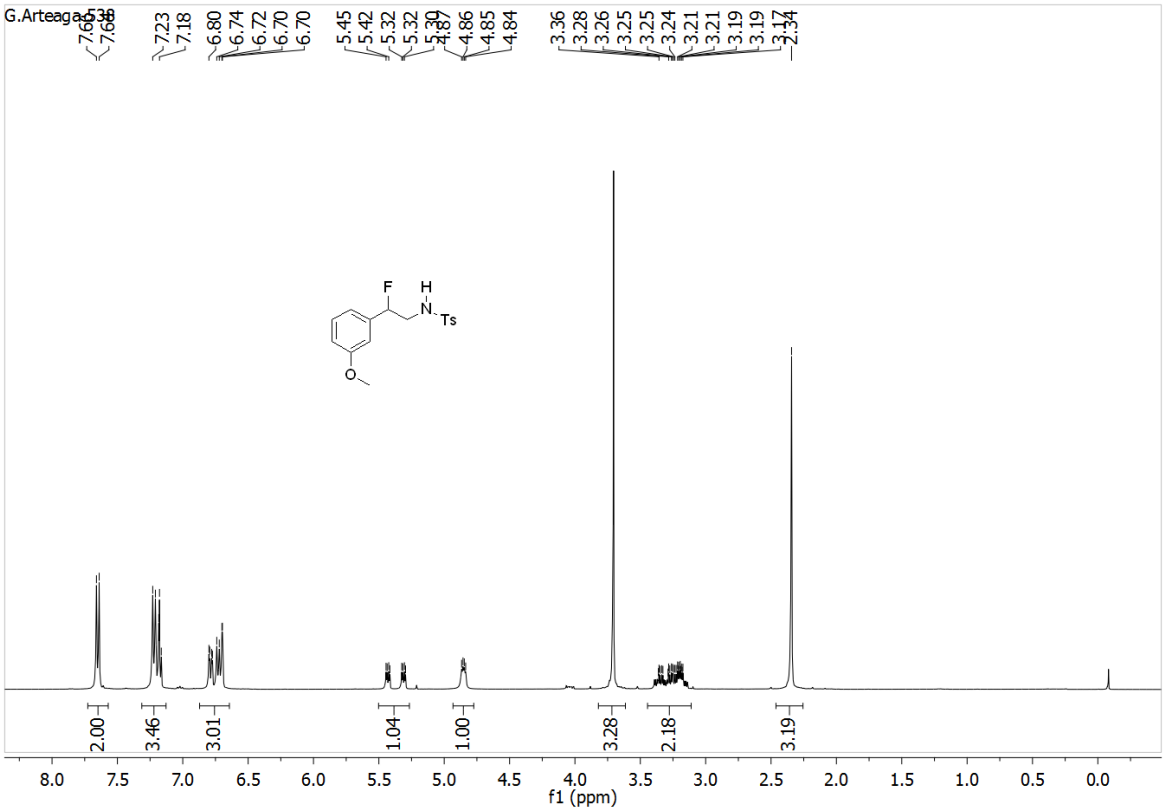

G.Arteaga-536
-182.53
-182.57
-182.61
-182.65
-182.70
-182.74
-182.78
F
H
N
Ts
f1 (ppm)

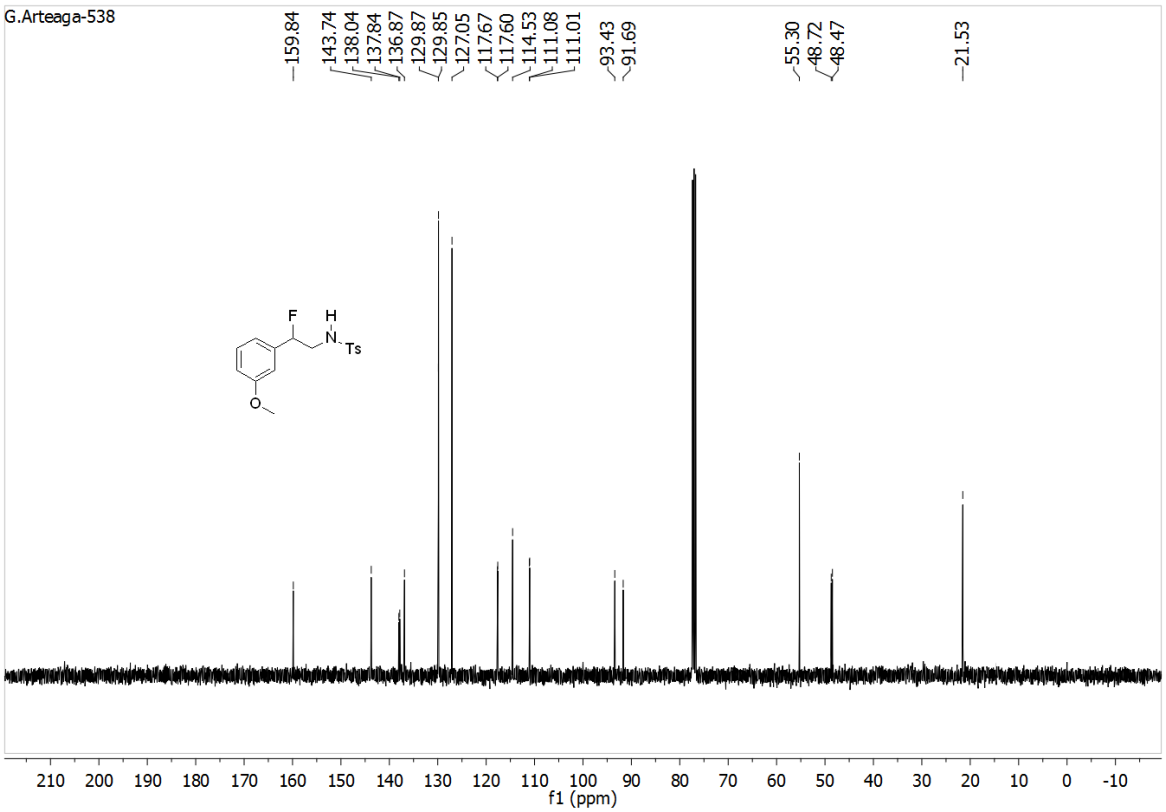

G.Arteaga-537
F
H
N
Ts
F
1.78
2.86
1.88
1.01
1.00
0.99
2.18
3.13
f1 (ppm)

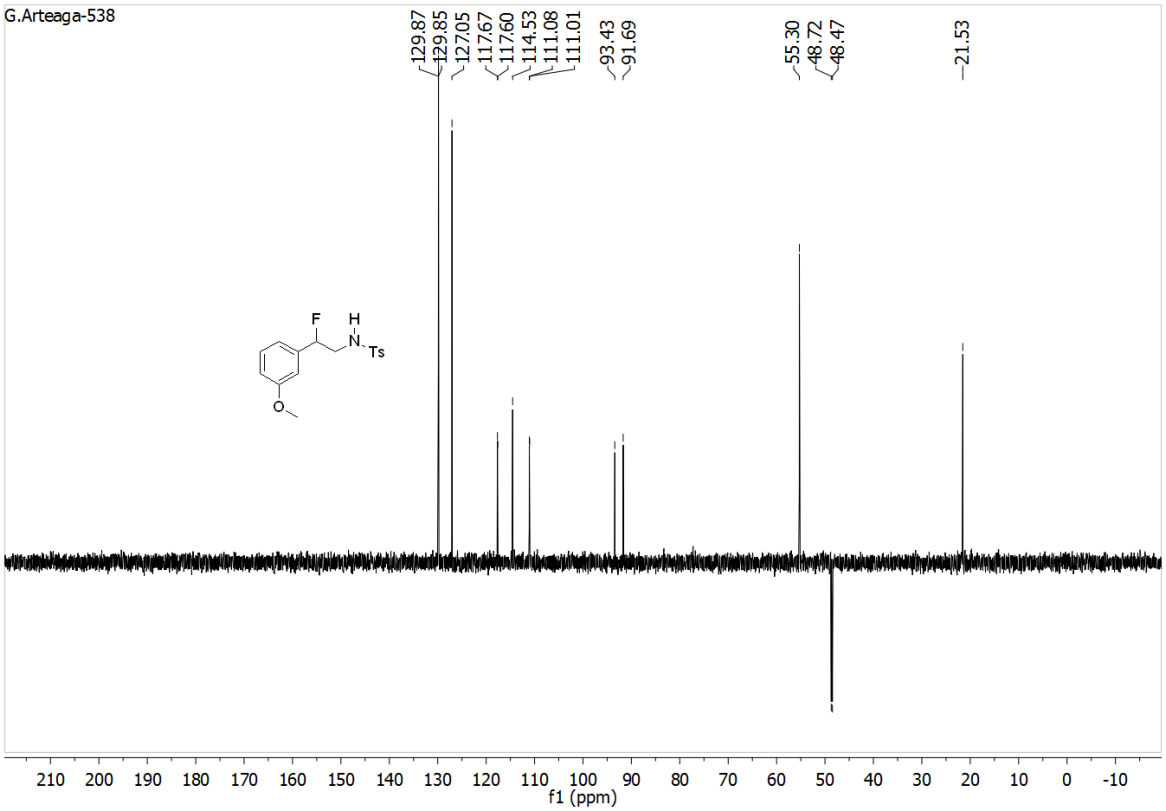

G.Arteaga-537
164.08
161.62
143.86
136.80
130.48
130.40
129.88
127.03
121.11
121.04
121.01
116.08
115.86
112.73
112.50
92.85
91.10
48.59
48.35
21.53
F
H
N
Ts
F
f1 (ppm)

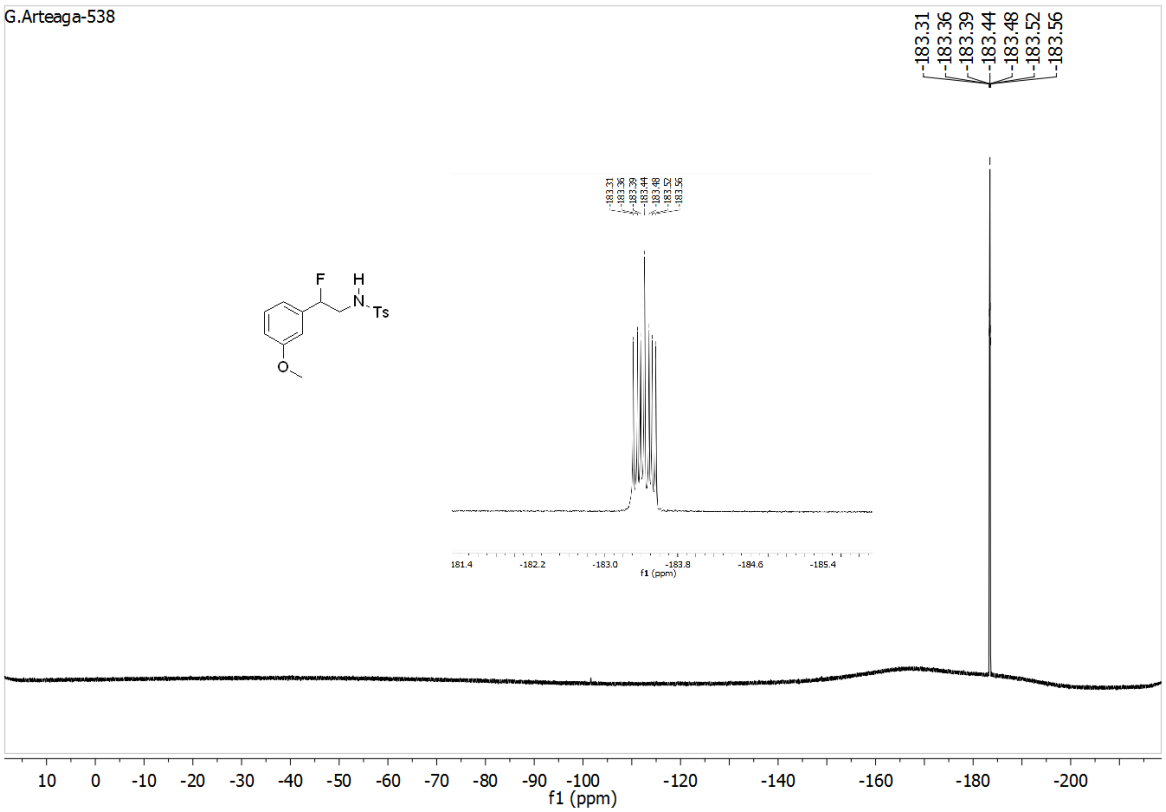

G.Arteaga-537
130.48
130.40
129.88
127.03
121.11
121.08
121.04
121.01
116.08
115.87
112.73
112.65
112.50
112.43
92.85
91.09
48.59
48.35
21.54
F
H
N
Ts
F
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

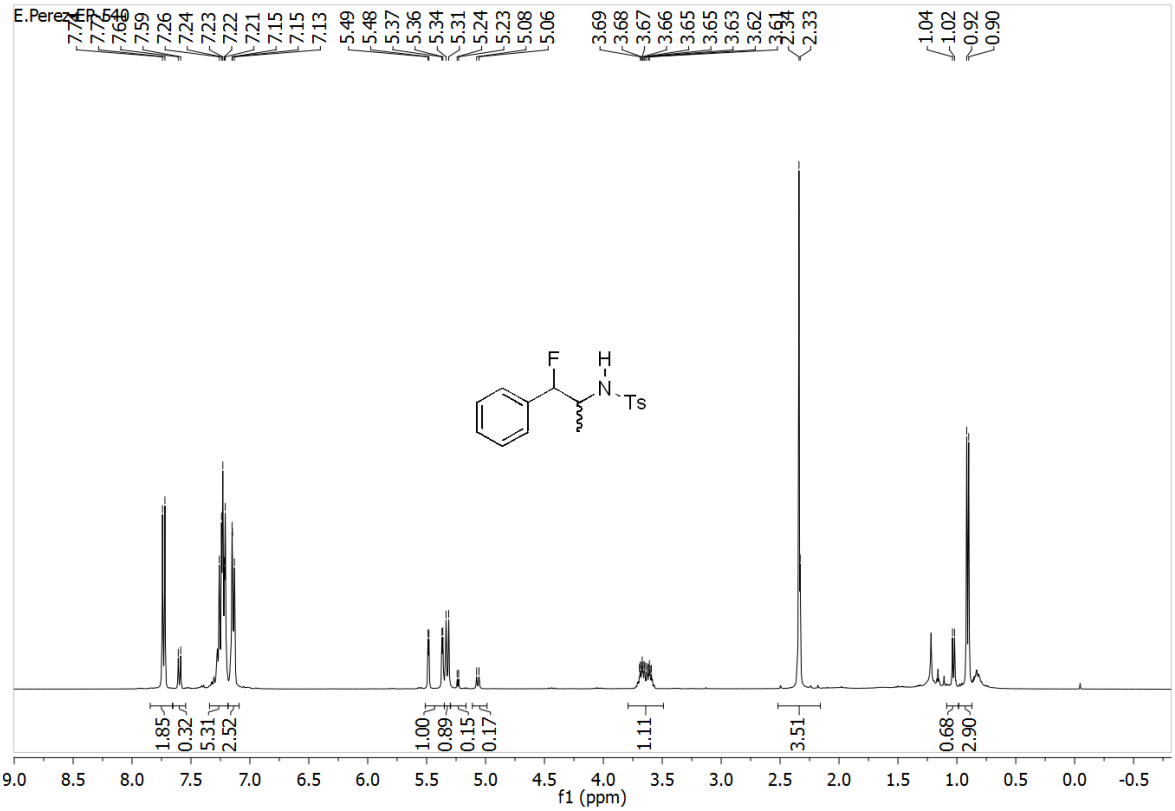

G.Arteaga-537
-111.66
-111.67
-111.68
-111.70
-111.71
-111.72
-184.29
-184.34
-184.37
-184.42
-184.46
-184.50
-184.54
F
H
N
Ts
F
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

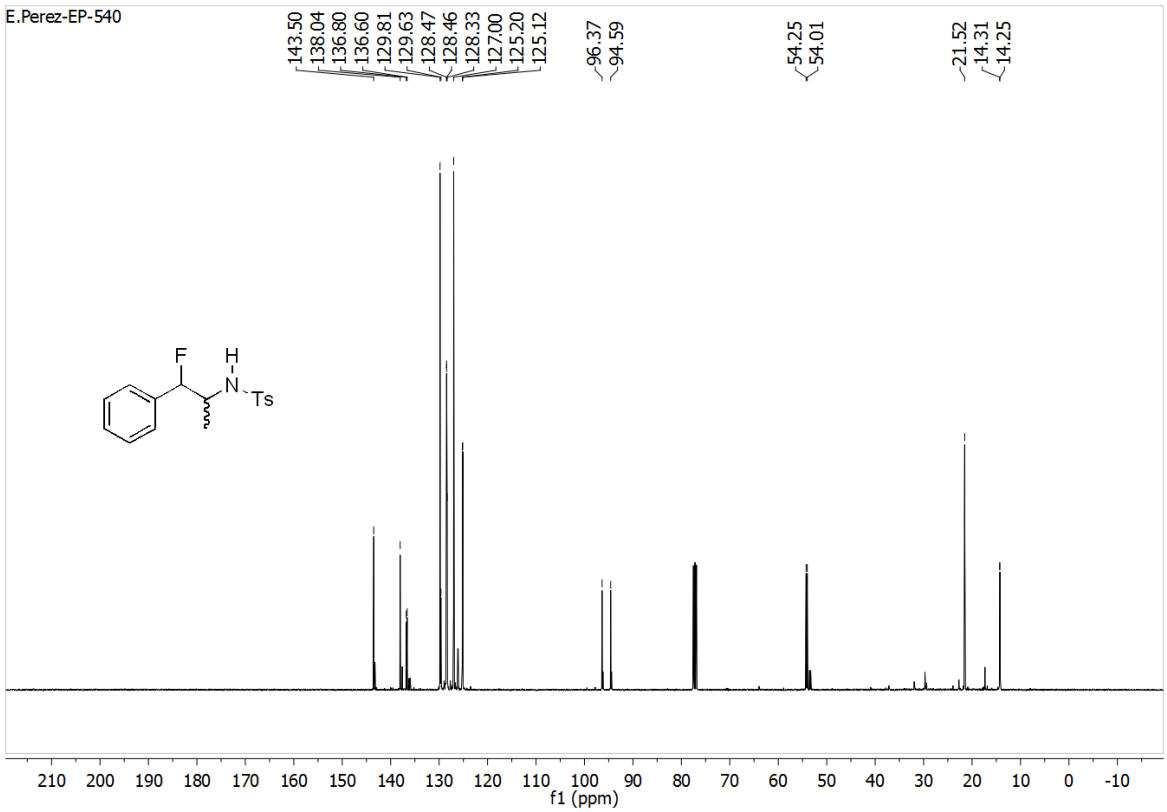

G.Arteaga-538
7.68
7.66
7.23
7.18
6.80
6.74
6.72
6.70
6.70
5.45
5.42
5.32
5.32
5.30
4.87
4.86
4.85
4.84
3.36
3.28
3.26
3.25
3.25
3.24
3.21
3.21
3.19
3.19
3.17
2.34
F
H
N
Ts
O
2.00
3.46
3.01
1.04
1.00
3.28
2.18
3.19
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

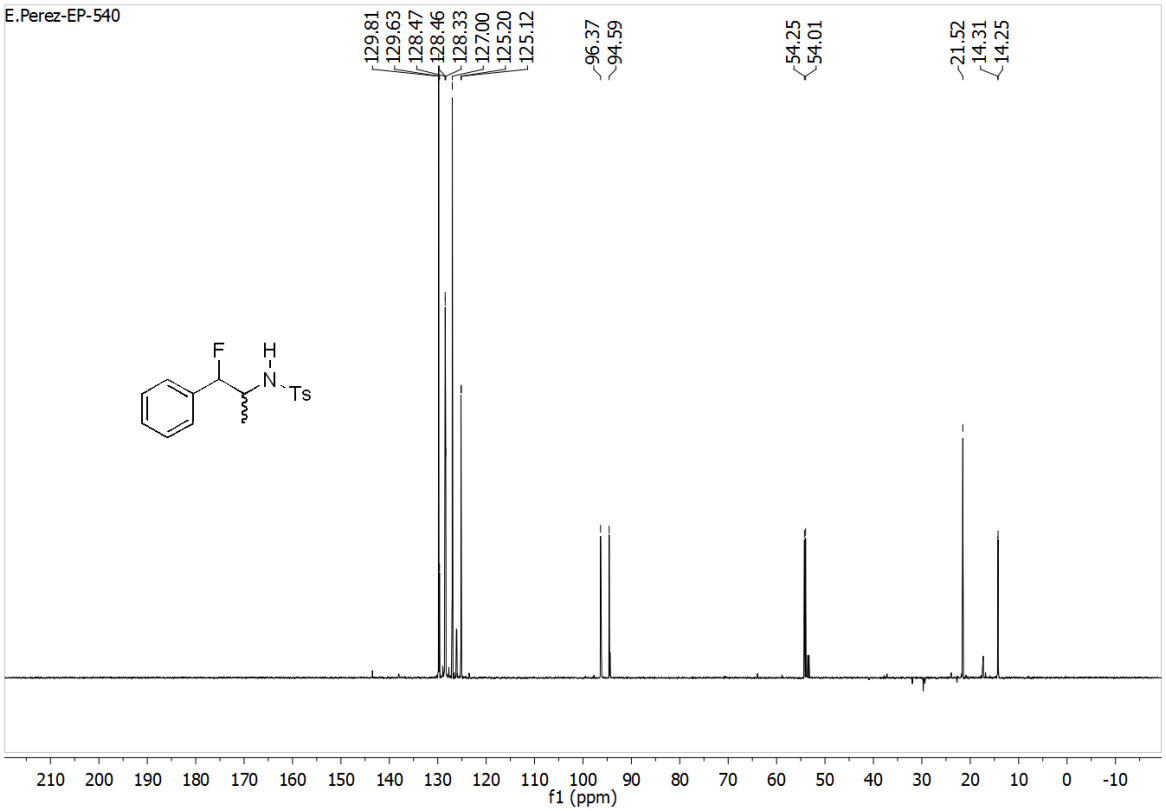

G.Arteaga-538
159.84
143.74
138.04
137.84
136.87
129.87
129.85
127.05
117.67
117.60
114.53
111.08
111.01
93.43
91.69
55.30
48.72
48.47
21.53
F
H
N
Ts
O
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

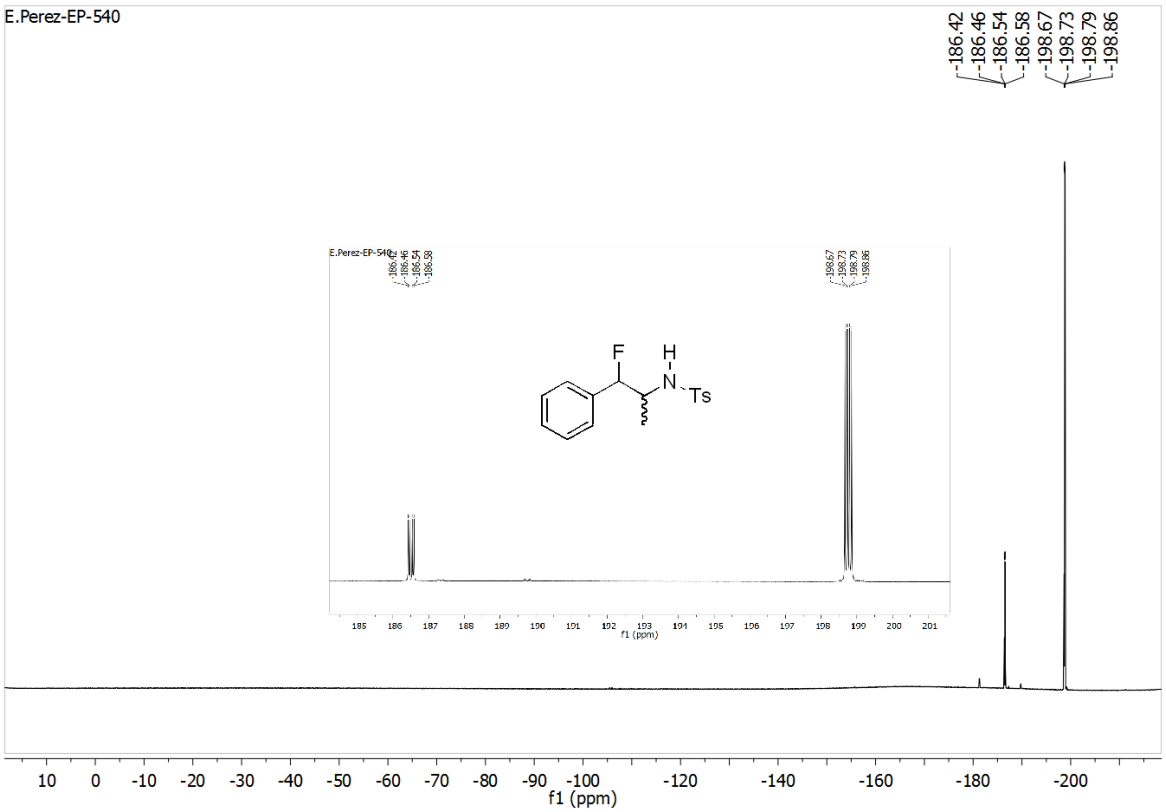

G.Arteaga-538
129.87
129.85
127.05
117.67
117.60
114.53
111.08
111.01
93.43
91.69
55.30
48.72
48.47
21.53
F
H
N
Ts
O
f1 (ppm)

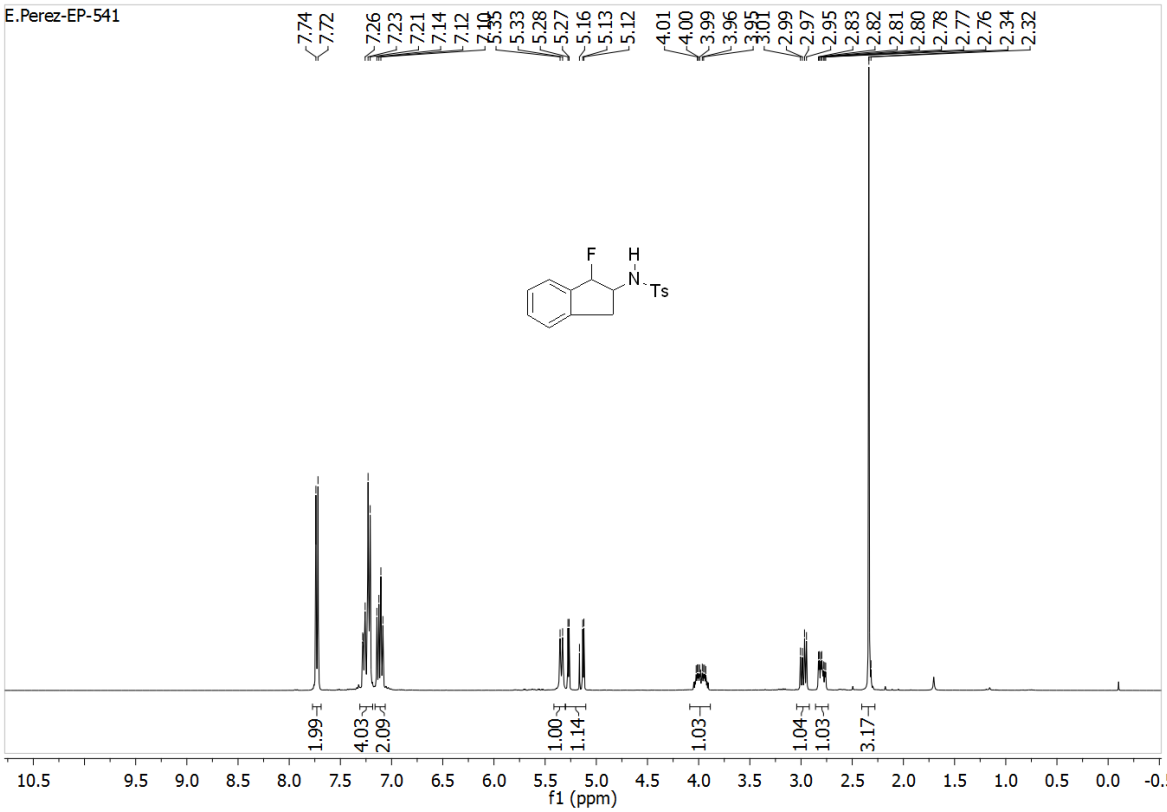

G.Arteaga-538
-183.31
-183.36
-183.39
-183.44
-183.48
-183.52
-183.56
F
H
N
Ts
O
f1 (ppm)

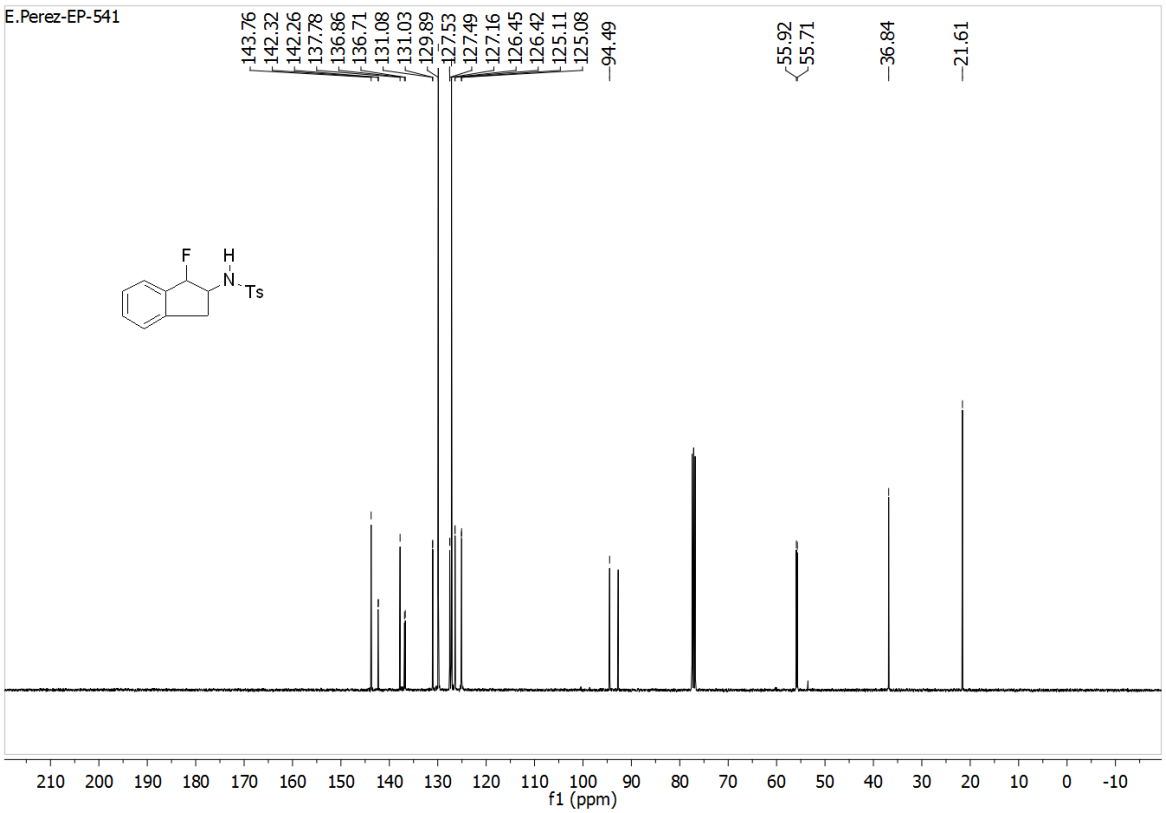

E.Perez-EP-540
7.74
7.72
7.68
7.59
7.26
7.24
7.23
7.22
7.21
7.15
7.15
7.13
5.49
5.48
5.37
5.36
5.34
5.31
5.24
5.23
5.08
5.06
3.69
3.68
3.67
3.66
3.65
3.65
3.63
3.62
3.61
3.34
2.33
1.04
1.02
0.92
0.90
F
H
N
Ts
1.85
0.32
5.31
2.52
1.00
0.89
0.15
0.17
1.11
3.51
0.68
2.90
f1 (ppm)

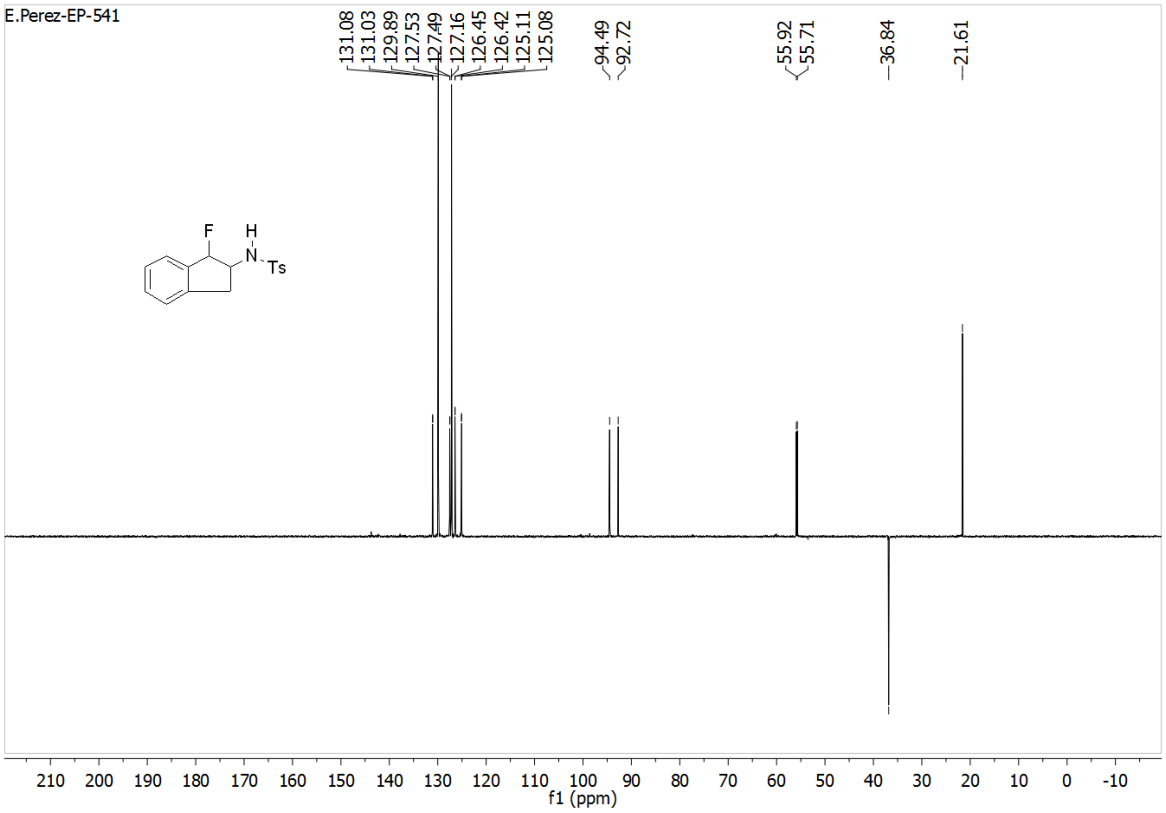

E.Perez-EP-540
143.50
138.04
136.80
136.60
129.81
129.63
128.47
128.46
128.33
127.00
125.20
125.12
96.37
94.59
54.25
54.01
21.52
14.31
14.25
F
H
N
Ts
f1 (ppm)

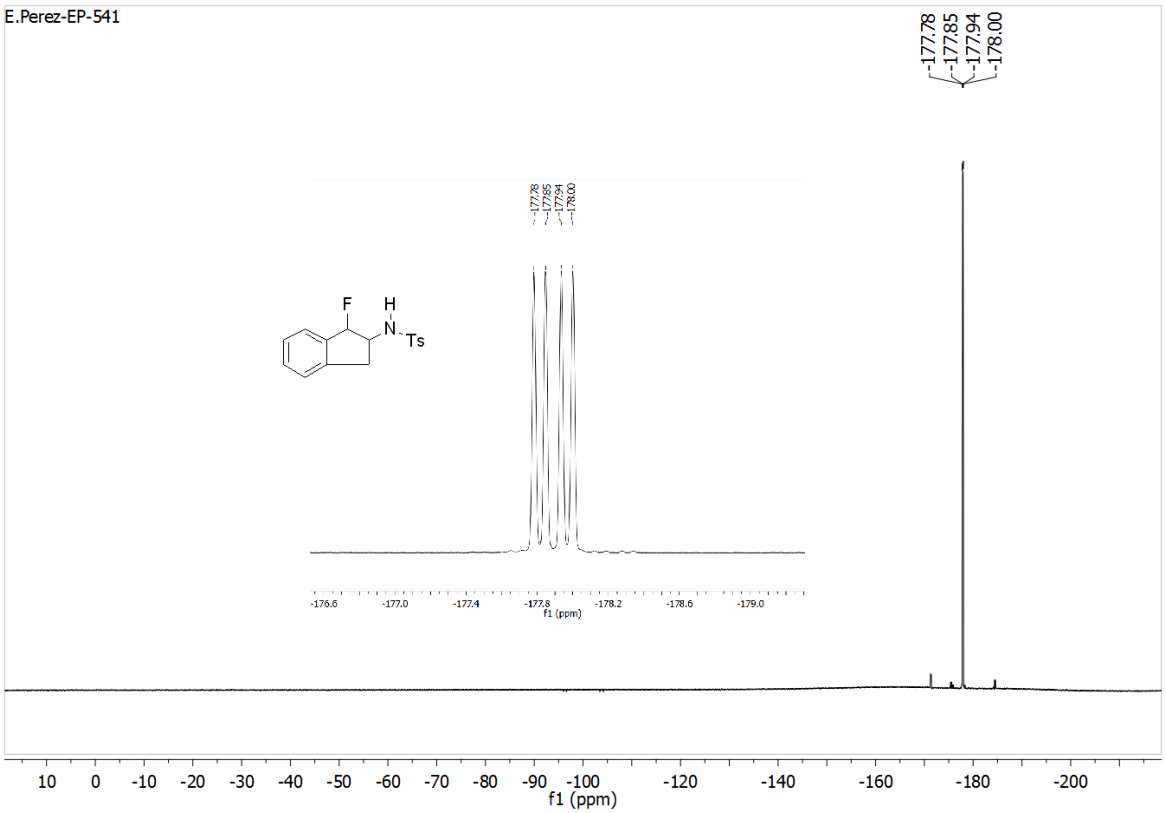

E.Perez-EP-540
129.81
129.63
128.47
128.46
128.33
127.00
125.20
125.12
96.37
94.59
54.25
54.01
21.52
14.31
14.25
F
H
N
Ts
f1 (ppm)

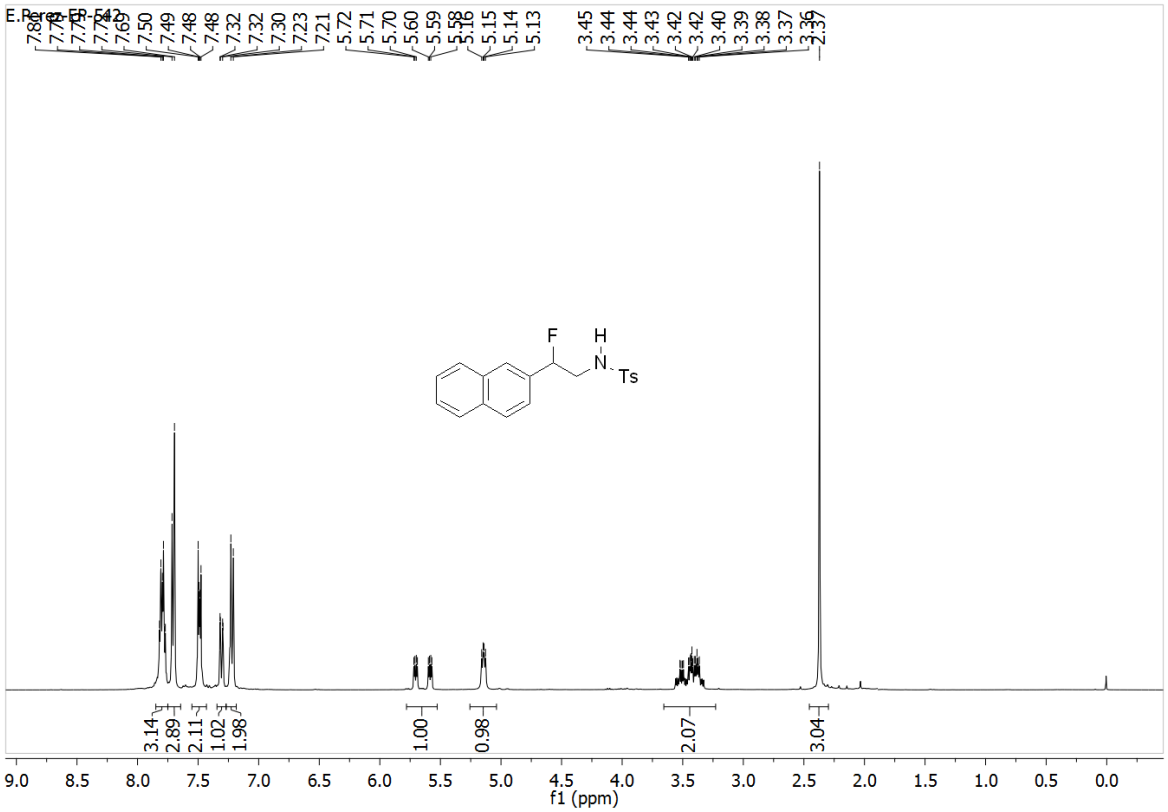

E.Perez-EP-540
-186.42
-186.46
-186.54
-186.58
-198.67
-198.73
-198.79
-198.86
F
H
N
Ts
f1 (ppm)

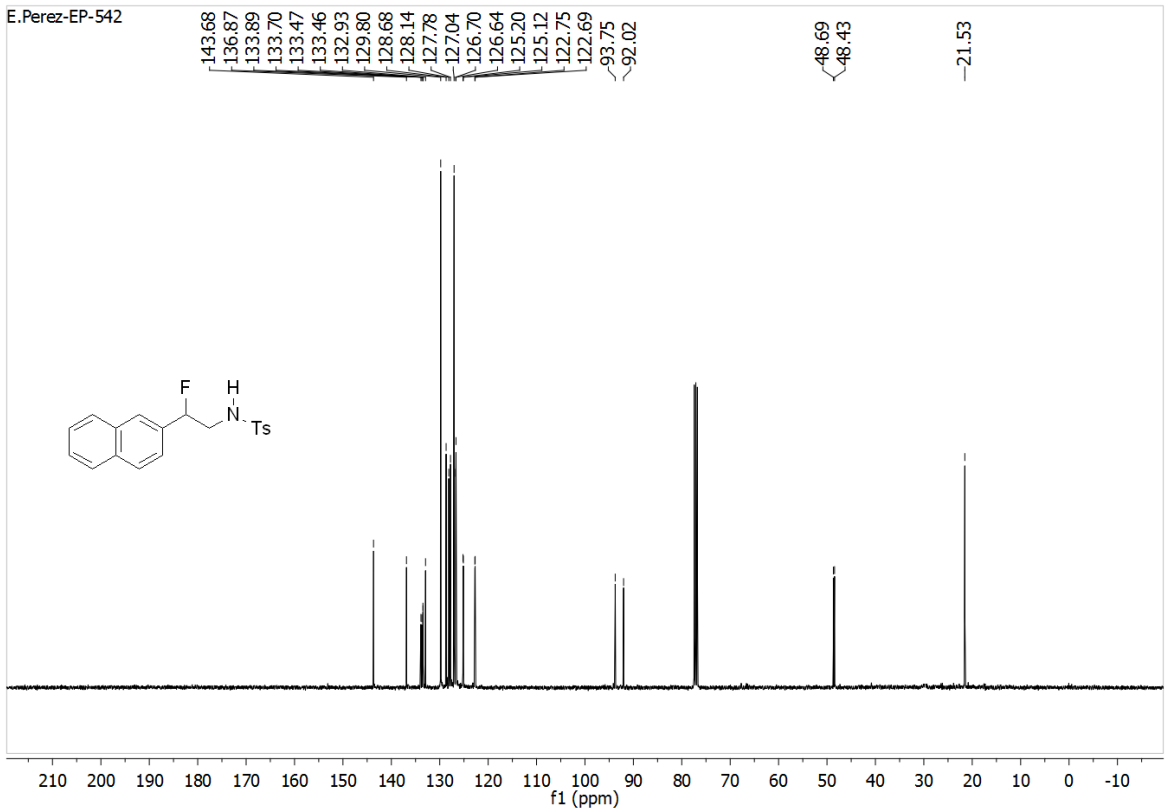

E.Perez-EP-541
7.74
7.72
7.26
7.23
7.21
7.14
7.12
5.33
5.28
5.27
5.16
5.13
5.12
4.01
4.00
3.99
3.96
3.01
2.99
2.97
2.95
2.83
2.82
2.81
2.80
2.78
2.77
2.76
2.34
2.32
F
H
N
Ts
1.99
4.03
2.09
1.00
1.14
1.03
1.04
1.03
3.17
f1 (ppm)

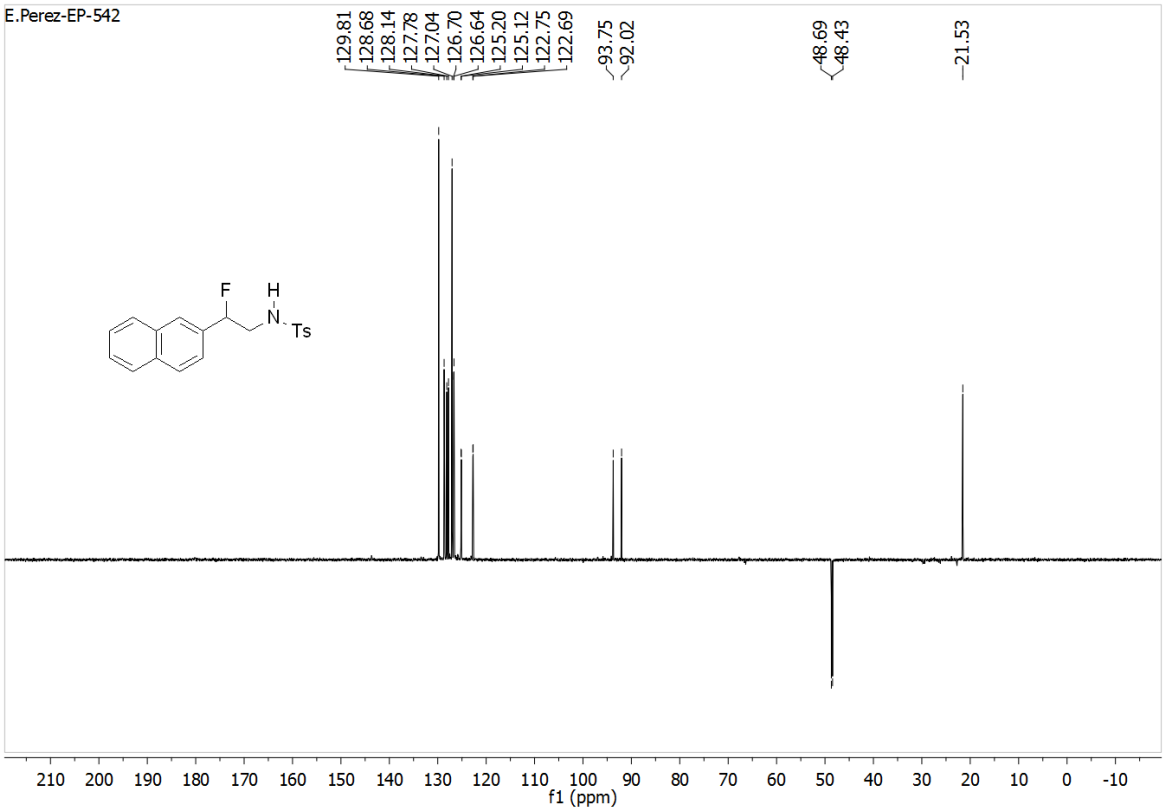

E.Perez-EP-541
143.76
142.32
142.26
137.78
136.86
136.71
131.08
131.03
129.89
127.53
127.49
127.16
126.45
126.42
125.11
125.08
94.49
55.92
55.71
36.84
21.61
F
H
N
Ts
f1 (ppm)

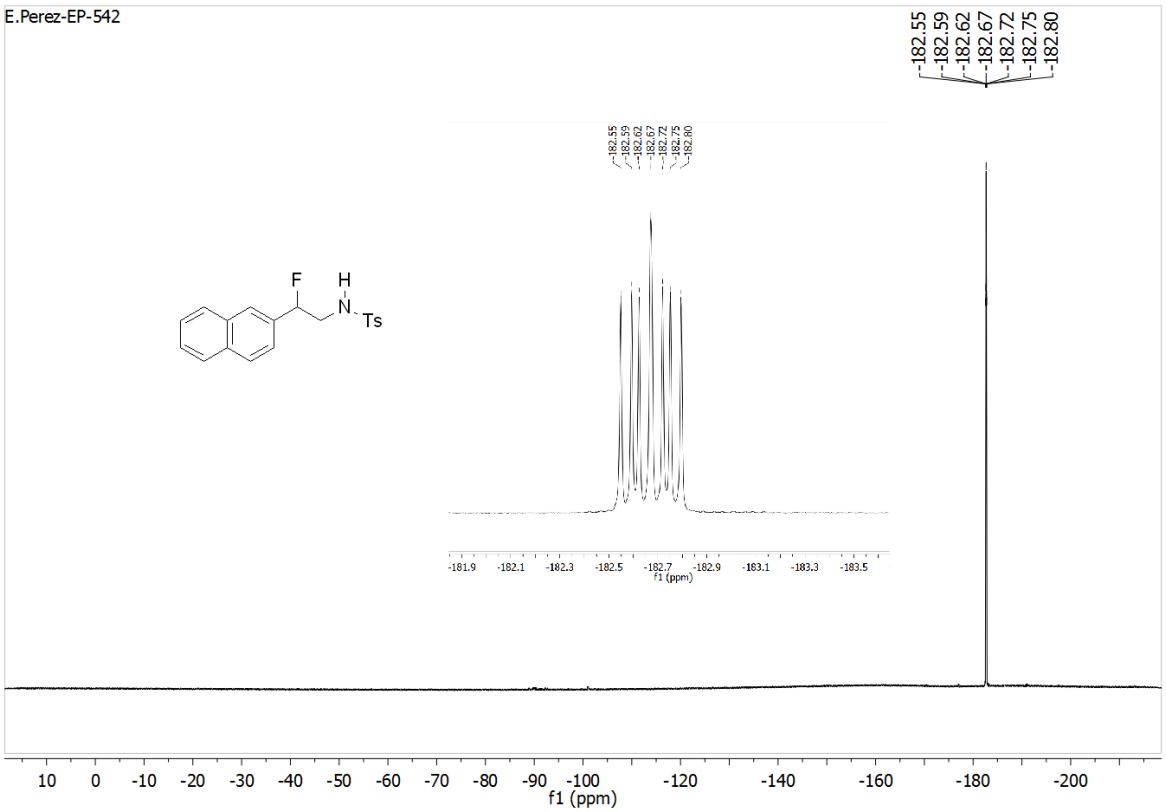

E.Perez-EP-541
131.08
131.03
129.89
127.53
127.49
127.16
126.45
126.42
125.11
125.08
94.49
92.72
55.92
55.71
36.84
21.61
F
H
N
Ts
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

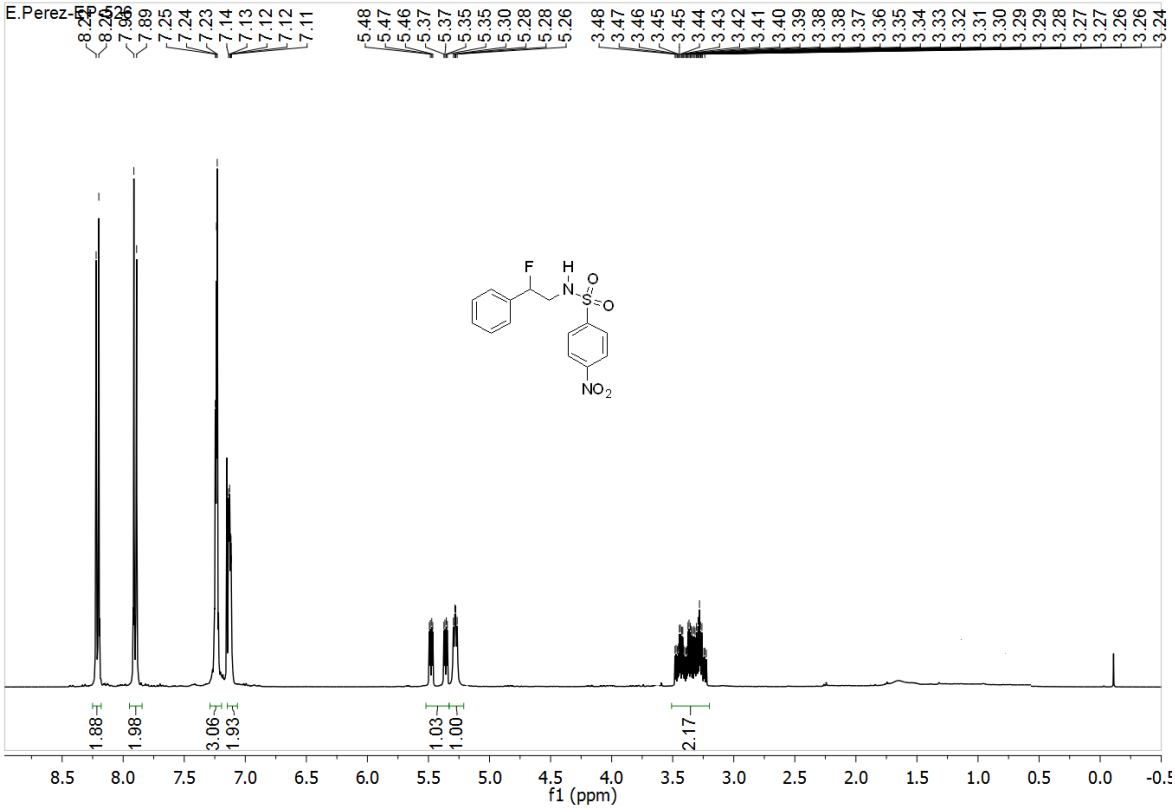

E.Perez-EP-541
-177.78
-177.85
-177.94
-178.00
F
H
N
Ts
-176.6 -177.0 -177.4 -177.8 -178.2 -178.6 -179.0
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

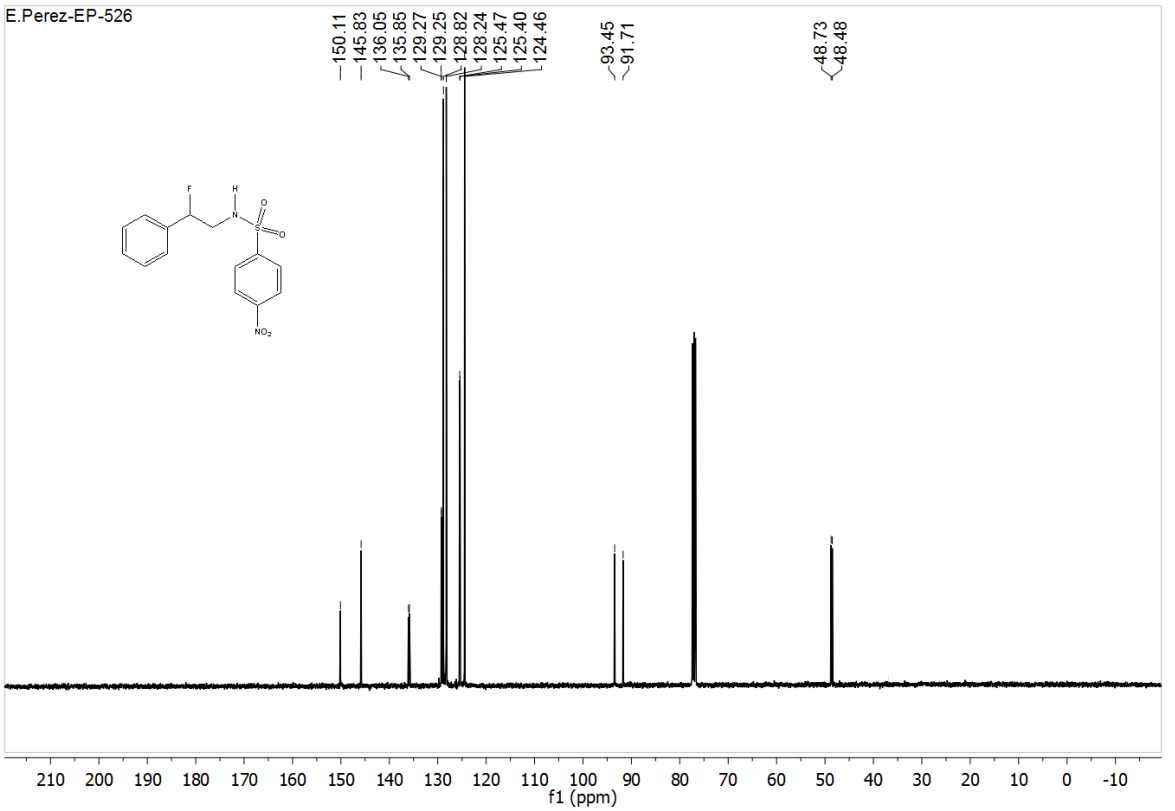

E.Perez-EP-542
F
H
N
Ts
f1 (ppm)

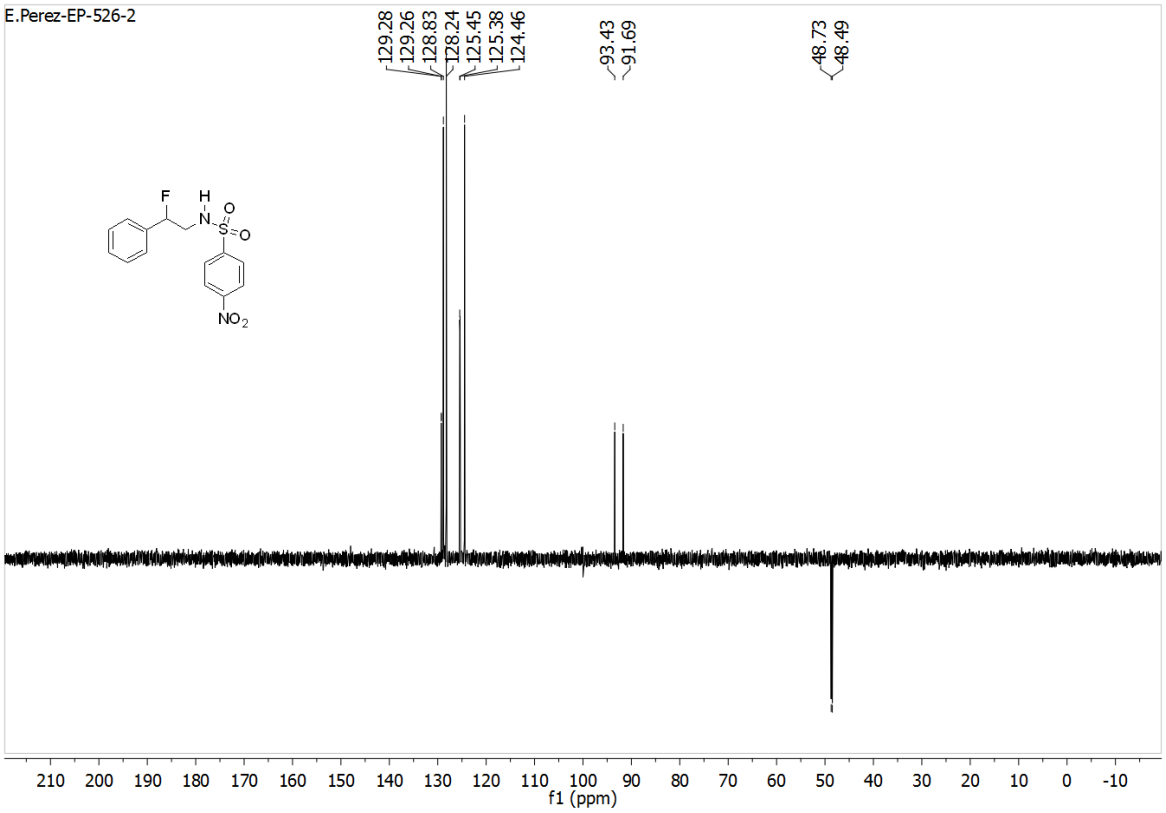

E.Perez-EP-542
F
H
N
Ts
f1 (ppm)

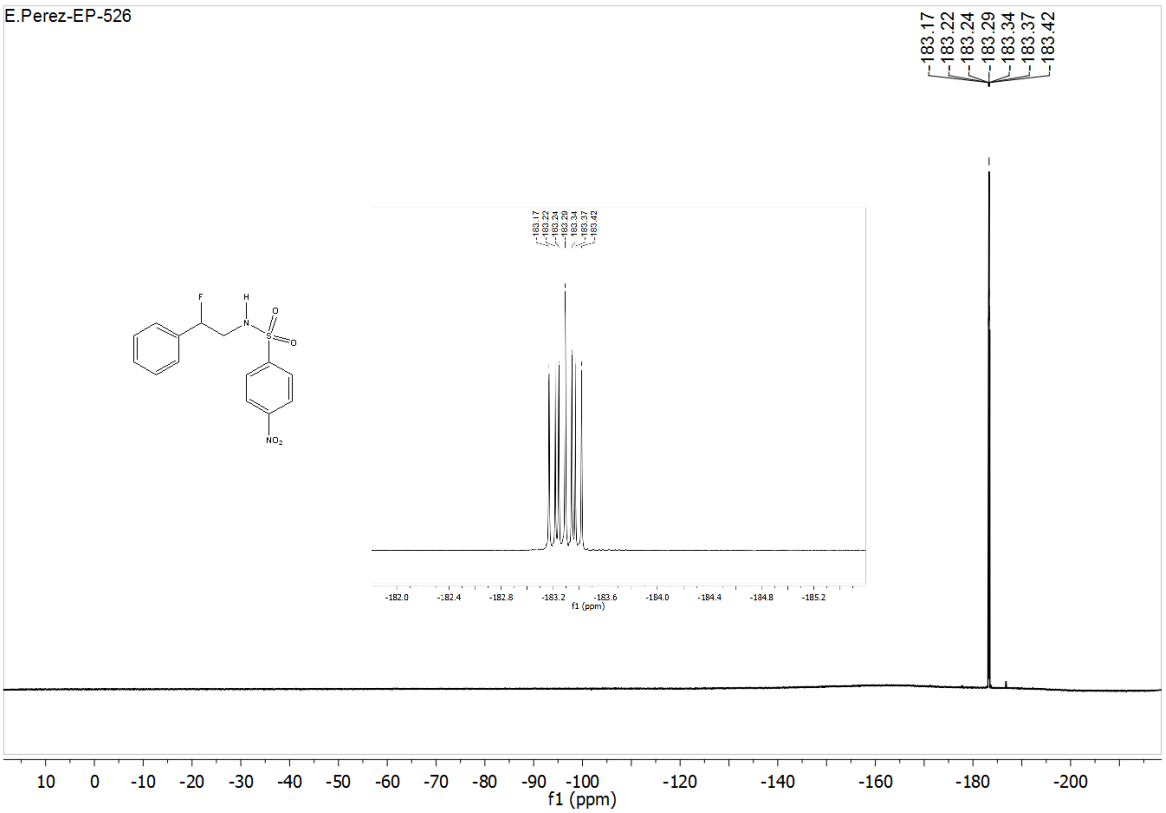

E.Perez-EP-542
129.81
128.68
128.14
127.78
127.04
126.70
126.64
125.20
125.12
122.75
122.69
93.75
92.02
48.69
48.43
21.53
F
H
N
Ts
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

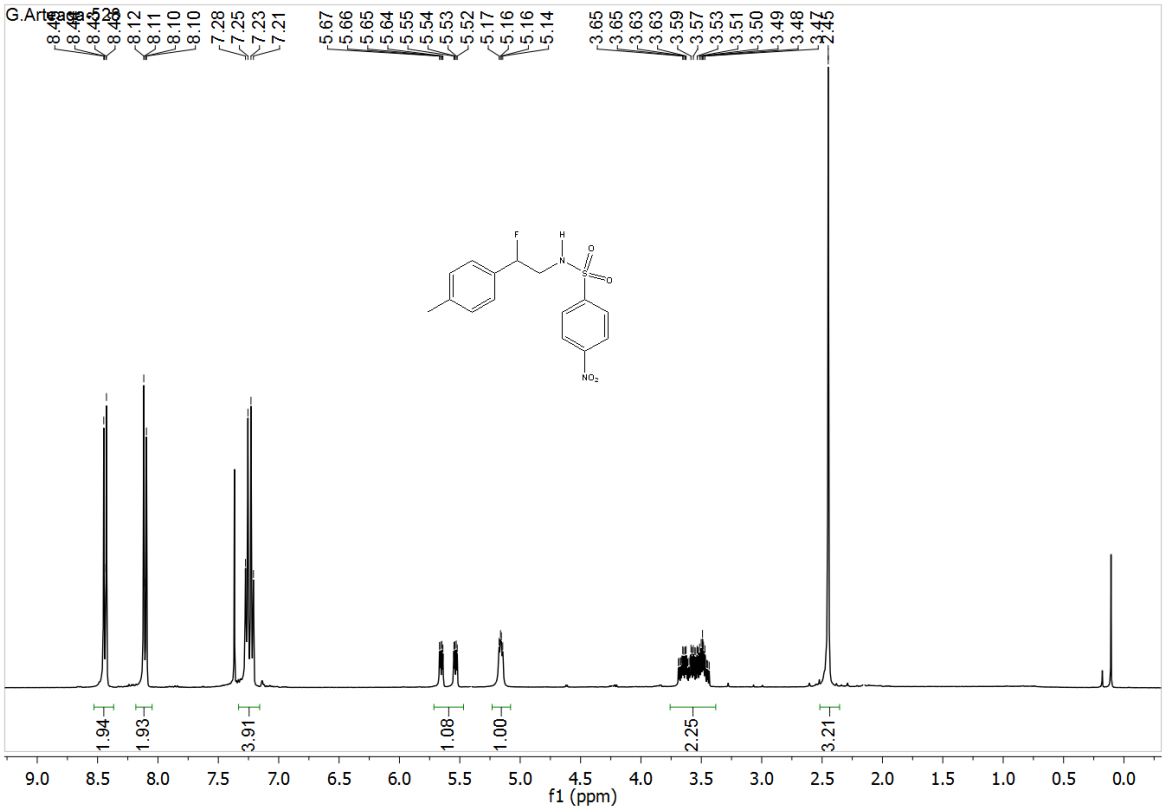

E.Perez-EP-542
-182.55
-182.59
-182.62
-182.67
-182.72
-182.75
-182.80
F
H
N
Ts
-181.9 -182.1 -182.3 -182.5 -182.7 -182.9 -183.1 -183.3 -183.5
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

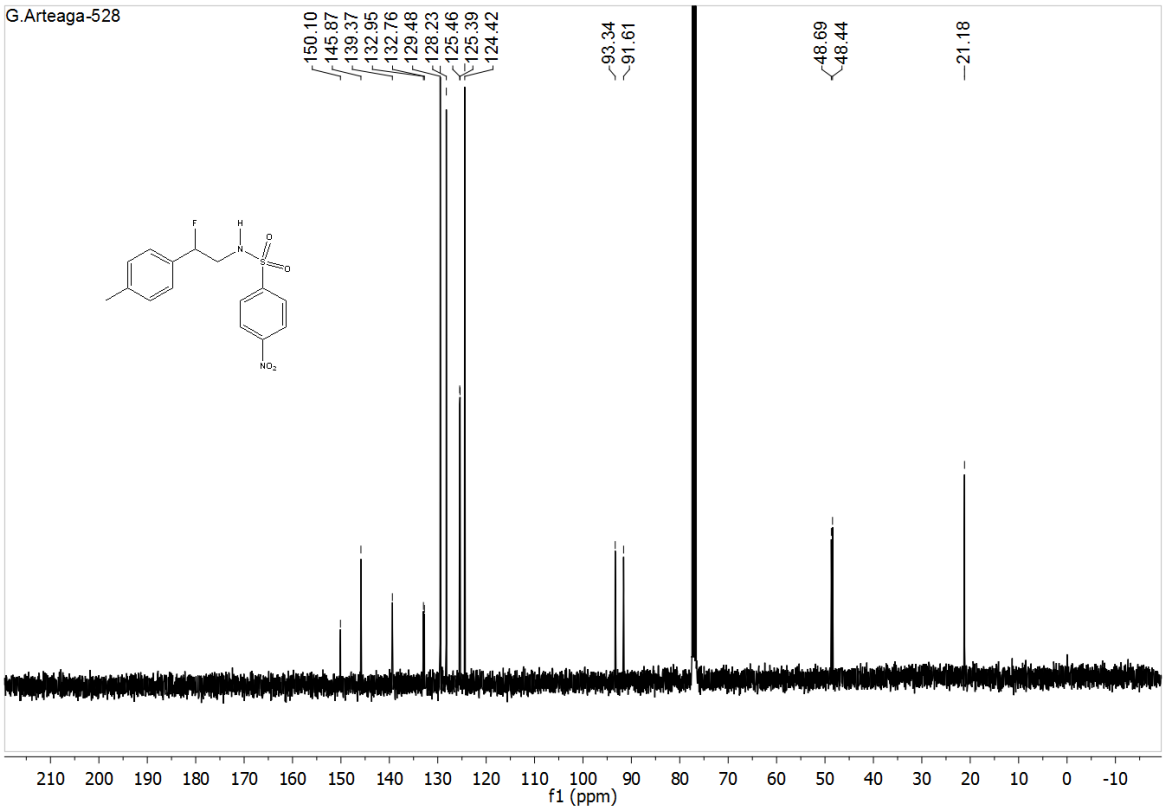

E.Perez-EP-526
8.22
8.20
7.99
7.89
7.25
7.24
7.23
7.14
7.13
7.12
7.12
7.11
5.48
5.47
5.46
5.37
5.37
5.35
5.35
5.30
5.28
5.28
5.26
3.48
3.47
3.46
3.45
3.45
3.44
3.43
3.42
3.41
3.40
3.39
3.38
3.38
3.37
3.36
3.35
3.34
3.33
3.32
3.31
3.30
3.29
3.29
3.28
3.27
3.27
3.26
3.26
3.24
F
H
N
S
O
O
NO2
1.88
1.98
3.06
1.93
1.03
1.00
2.17
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

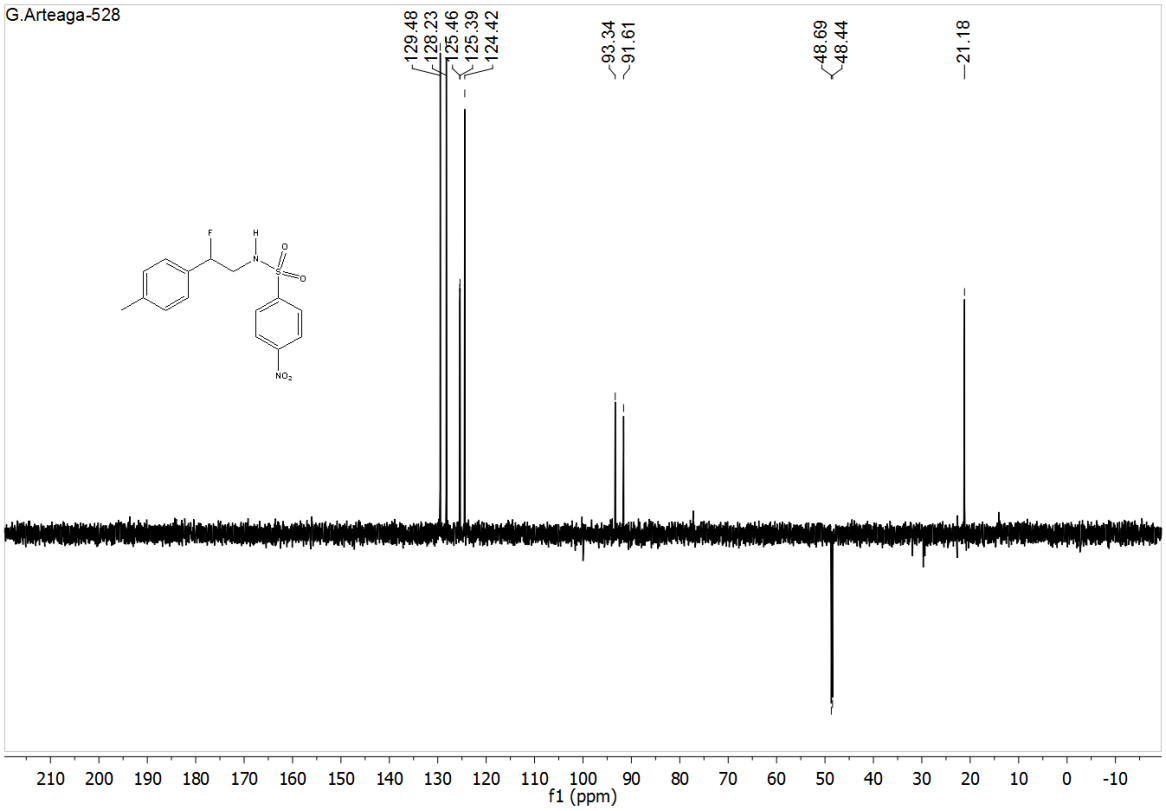

E.Perez-EP-526
150.11
145.83
136.05
135.85
129.27
129.25
128.82
128.24
125.47
125.40
124.46
93.45
91.71
48.73
48.48
F
H
N
S
O
O
NO2
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

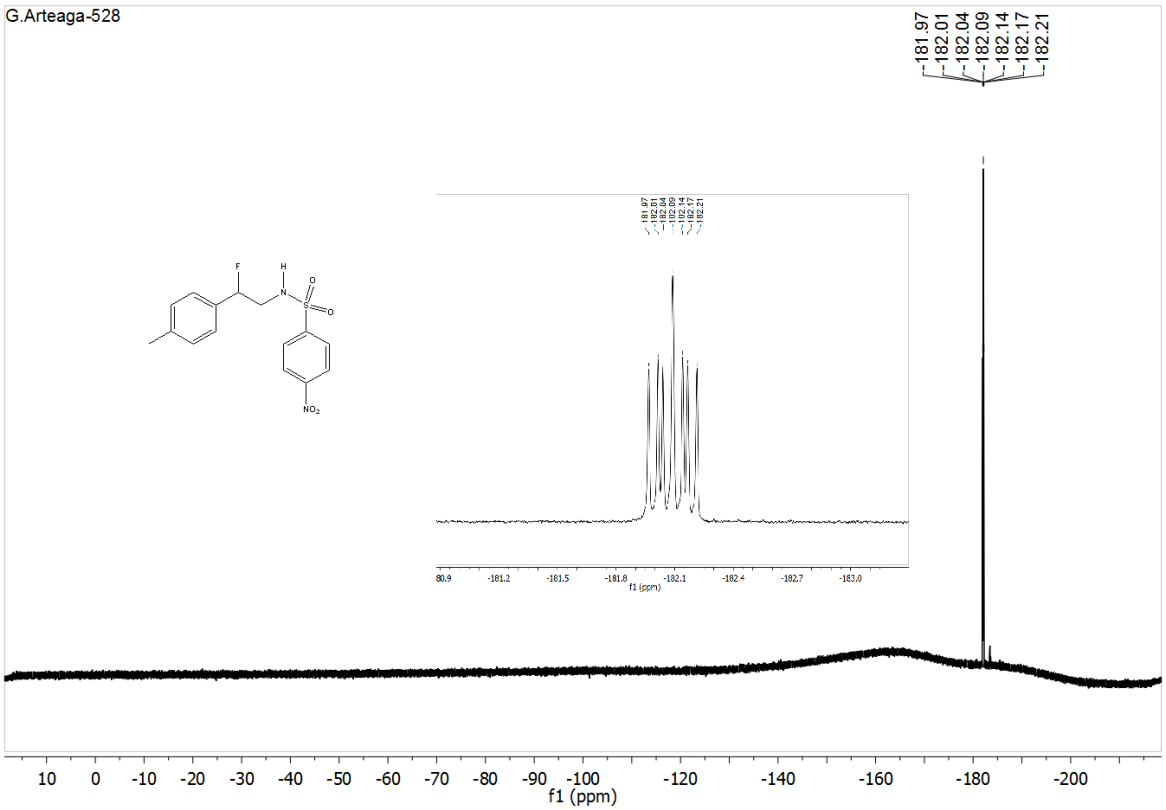

E.Perez-EP-526-2
129.28
129.26
128.83
128.24
125.45
125.38
124.46
93.43
91.69
48.73
48.49
F
H
N
O
S
O
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

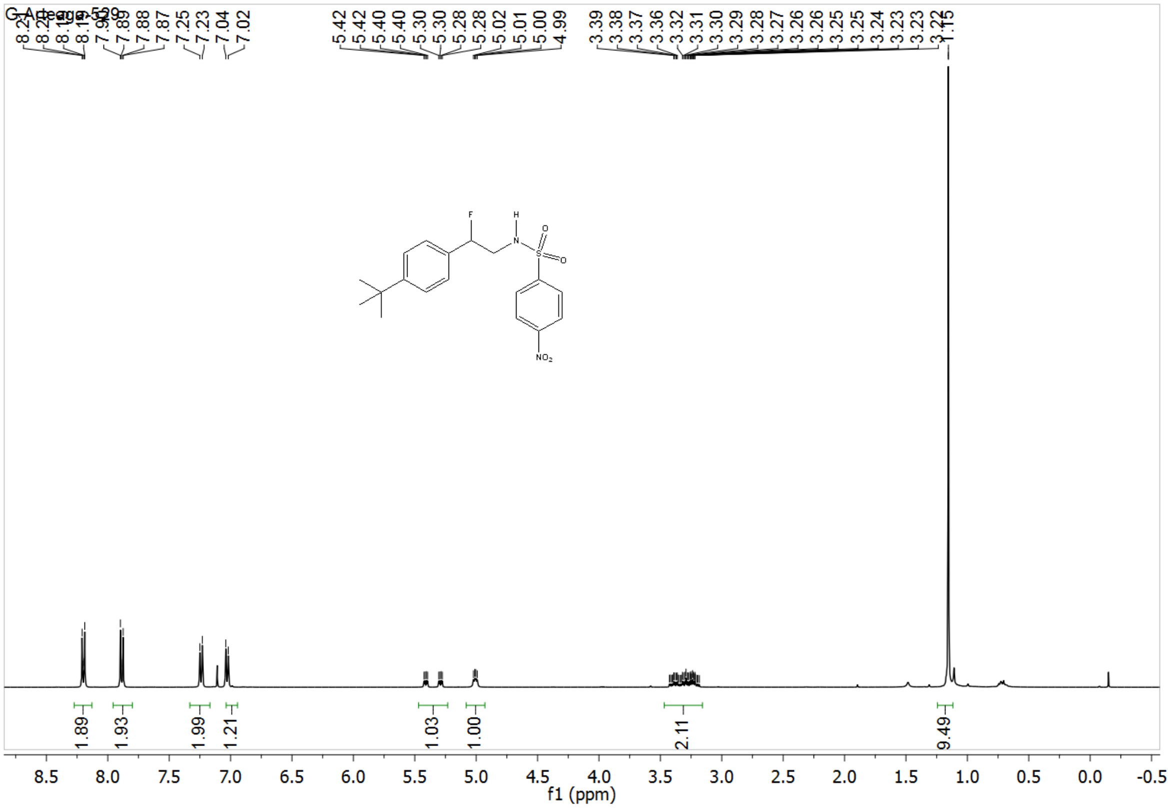

E.Perez-EP-526
183.17
183.22
183.24
183.29
183.34
183.37
183.42
F
H
N
O
S
O
NO2
-182.0 -182.4 -182.8 -183.2 -183.6 -184.0 -184.4 -184.8 -185.2
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

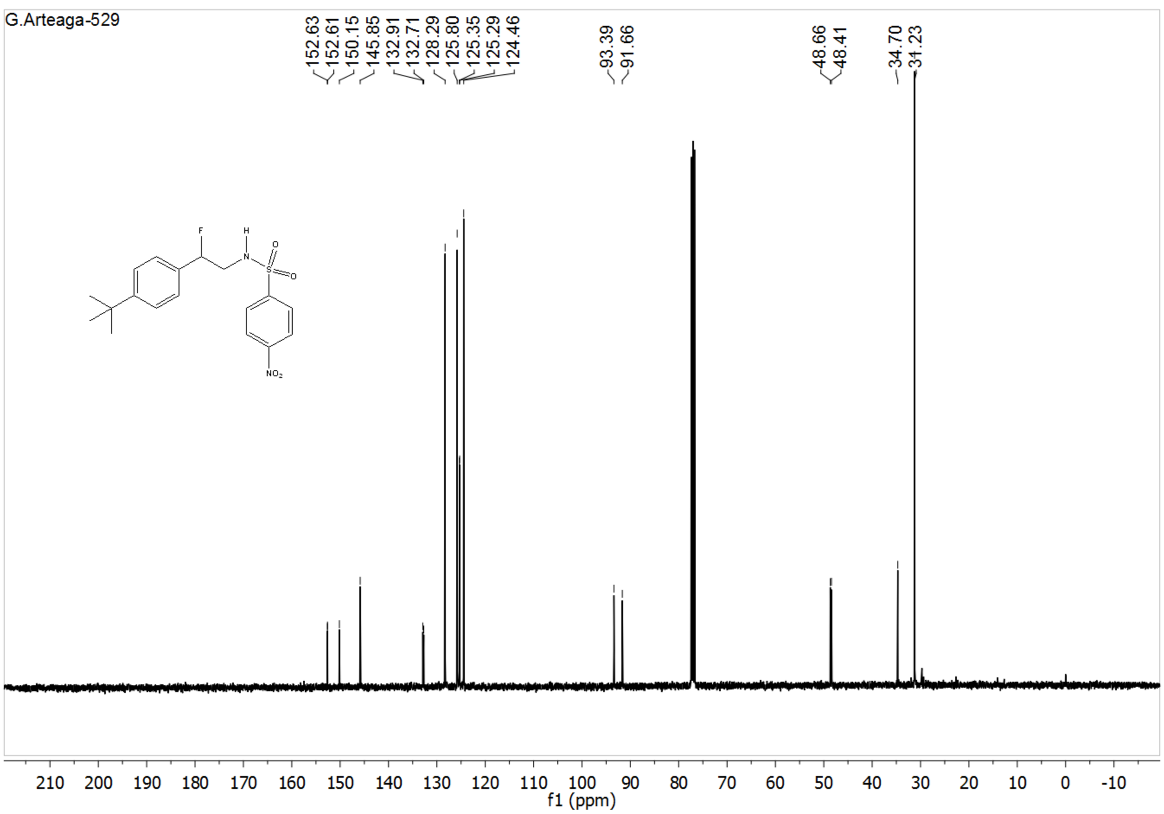

G.Arteaga-528
8.46
8.45
8.45
8.12
8.11
8.10
8.10
7.28
7.25
7.23
7.21
5.67
5.66
5.65
5.64
5.55
5.54
5.53
5.52
5.17
5.16
5.14
3.65
3.65
3.63
3.63
3.59
3.57
3.53
3.51
3.50
3.49
3.48
3.47
3.45
2.45
1.94
1.93
3.91
1.08
1.00
2.25
3.21
f1 (ppm)

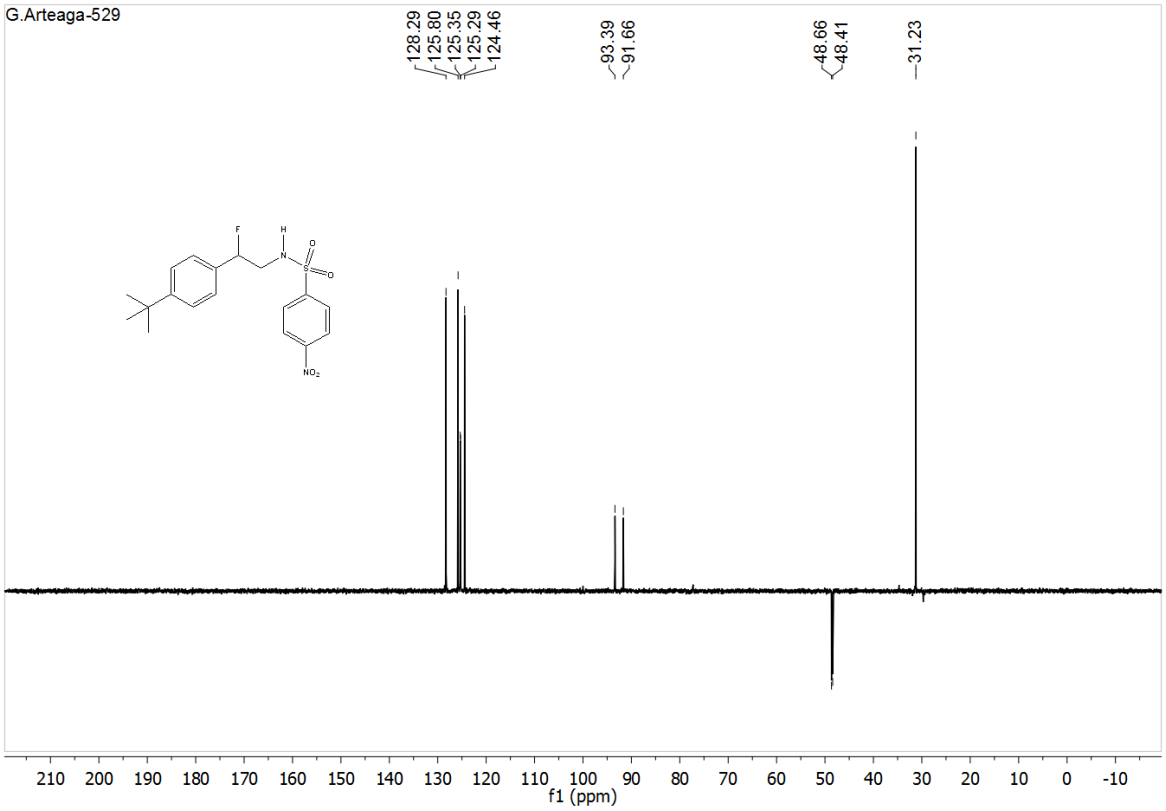

G.Arteaga-528
150.10
145.87
139.37
132.95
132.76
129.48
128.23
125.46
125.39
124.42
93.34
91.61
48.69
48.44
21.18
f1 (ppm)

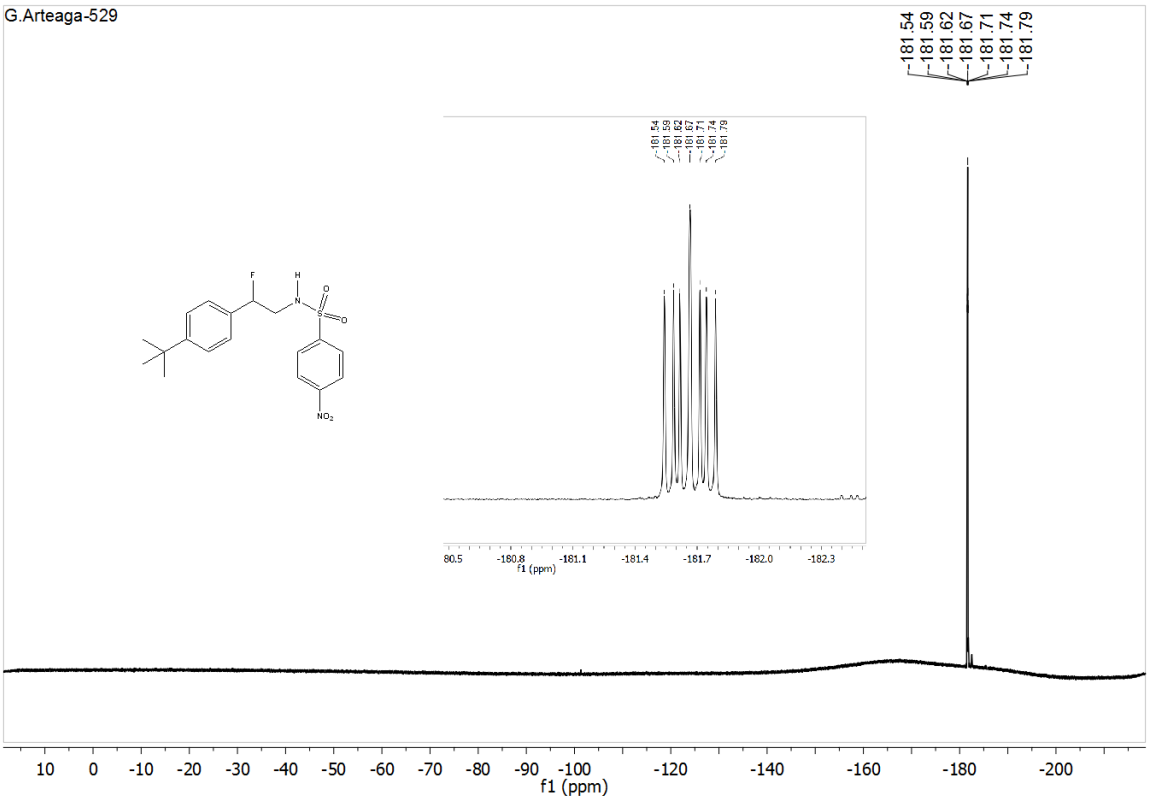

G.Arteaga-528
129.48
128.23
125.46
125.39
124.42
93.34
91.61
48.69
48.44
21.18
f1 (ppm)

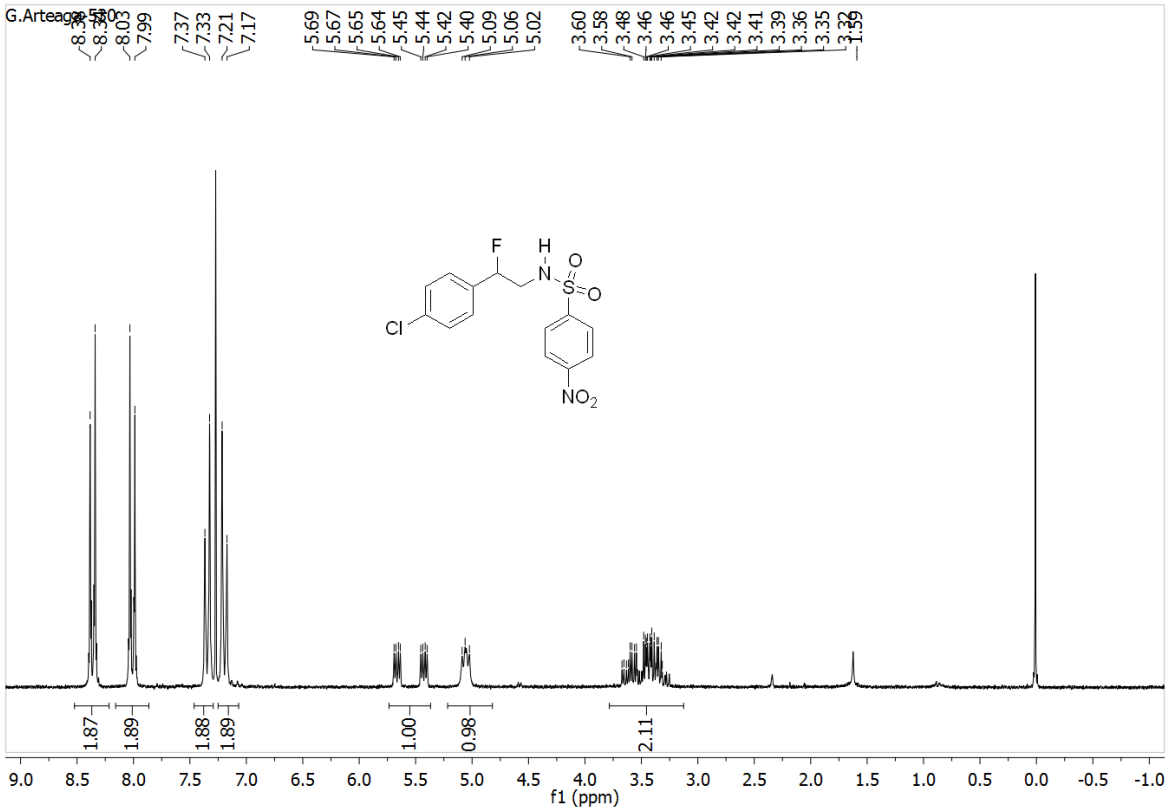

G.Arteaga-528
181.97
182.01
182.04
182.09
182.14
182.17
182.21
f1 (ppm)

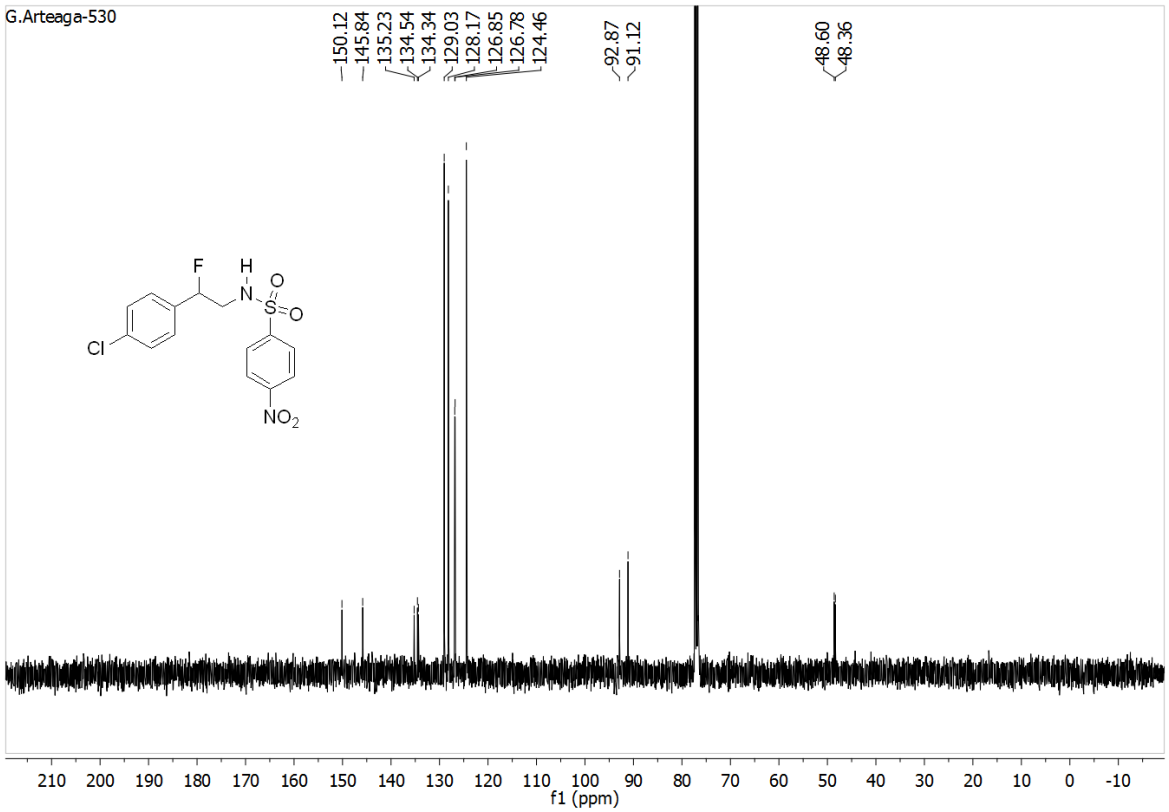

G.Arteaga-529
7.89
7.88
7.87
7.25
7.23
7.04
7.02
5.42
5.42
5.40
5.40
5.30
5.30
5.28
5.28
5.02
5.01
5.00
4.99
3.39
3.38
3.37
3.36
3.32
3.31
3.30
3.29
3.28
3.27
3.26
3.26
3.25
3.25
3.24
3.23
3.23
3.22
1.15
F
H
N
S
O
O
NO2
1.89
1.93
1.99
1.21
1.03
1.00
2.11
9.49
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

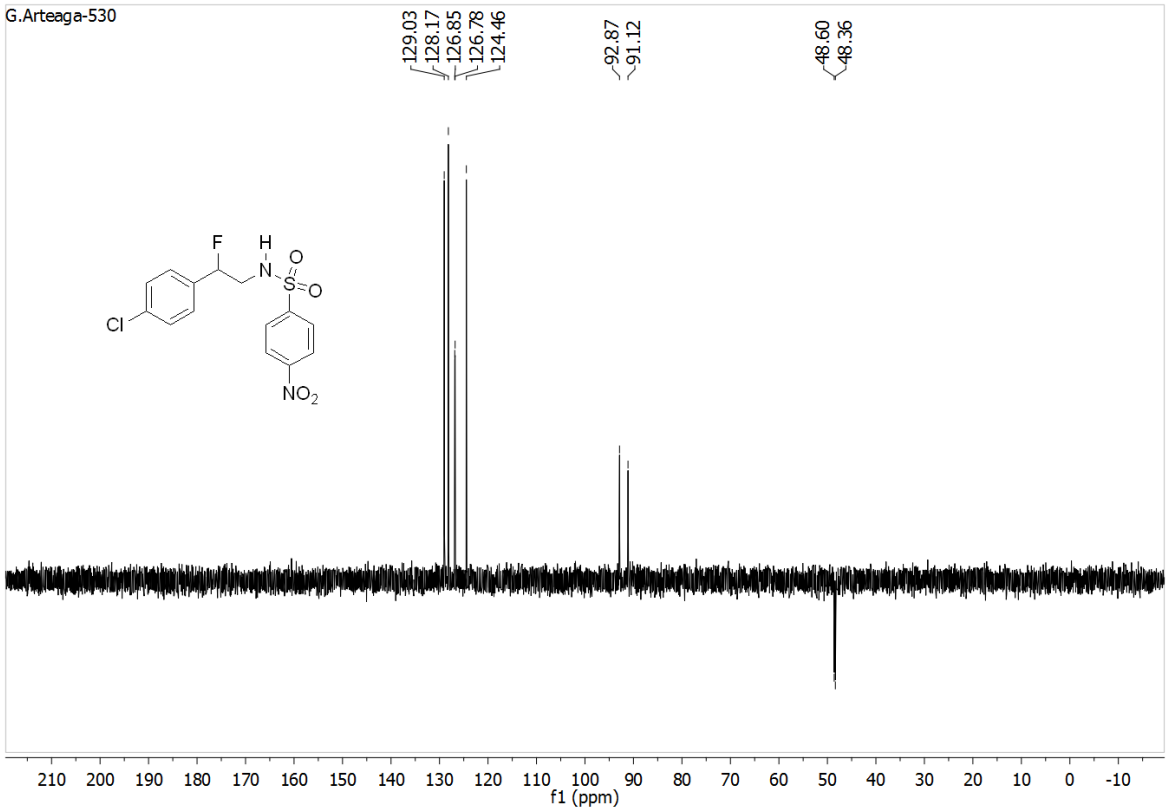

G.Arteaga-529
152.63
152.61
150.15
145.85
132.91
132.71
128.29
125.80
125.35
125.29
124.46
93.39
91.66
48.66
48.41
34.70
31.23
F
H
N
S
O
O
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

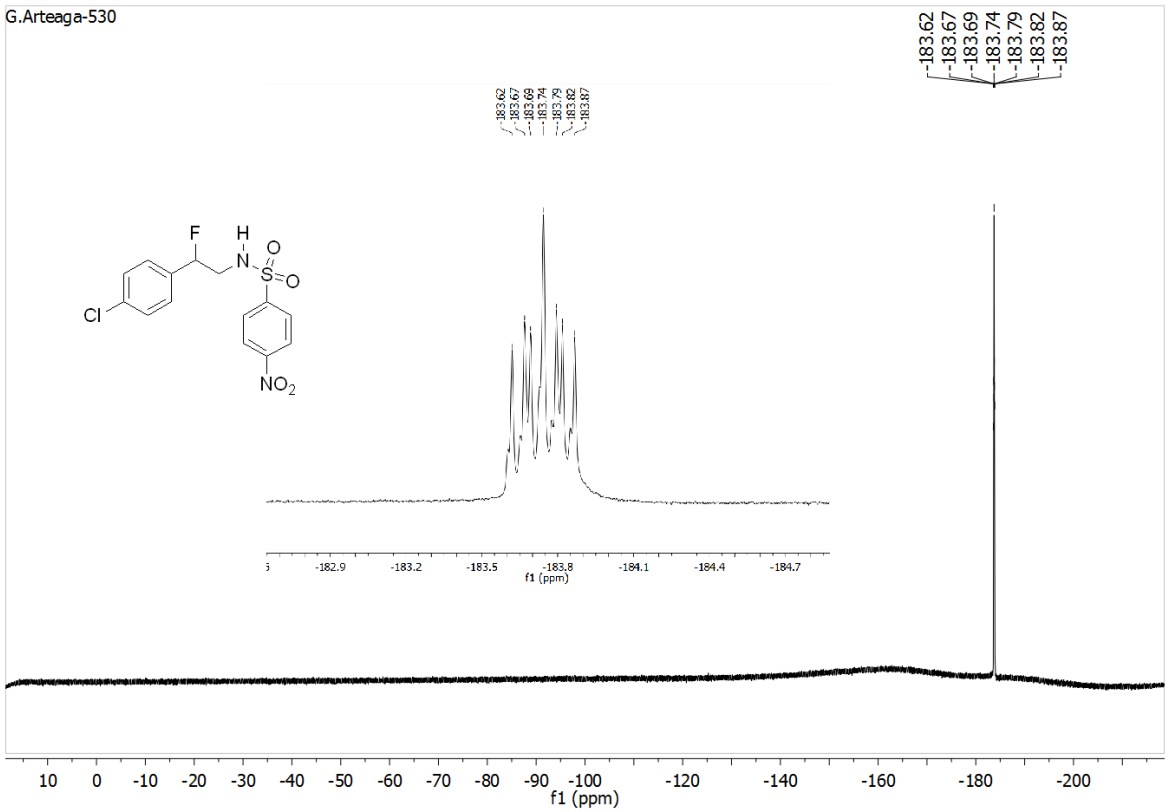

G.Arteaga-529
128.29
125.80
125.35
125.29
124.46
93.39
91.66
48.66
48.41
31.23
f1 (ppm)

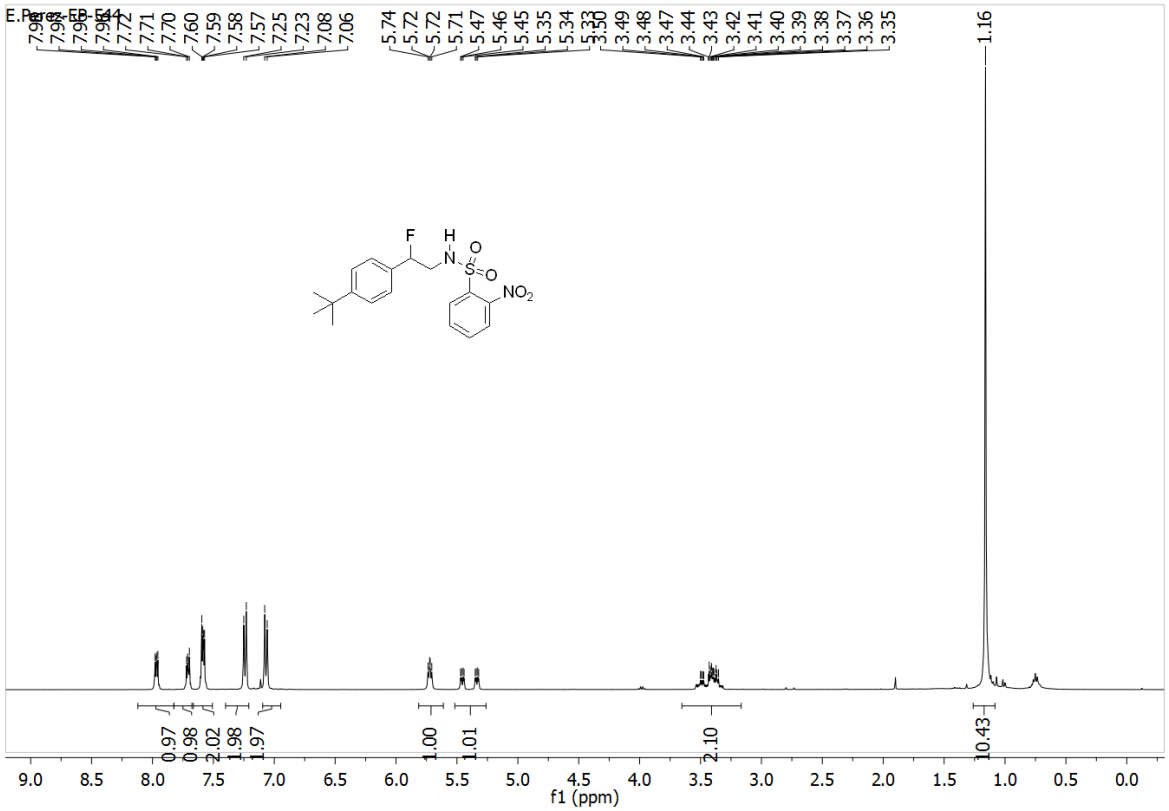

G.Arteaga-529
181.54
181.59
181.62
181.67
181.71
181.74
181.79
f1 (ppm)

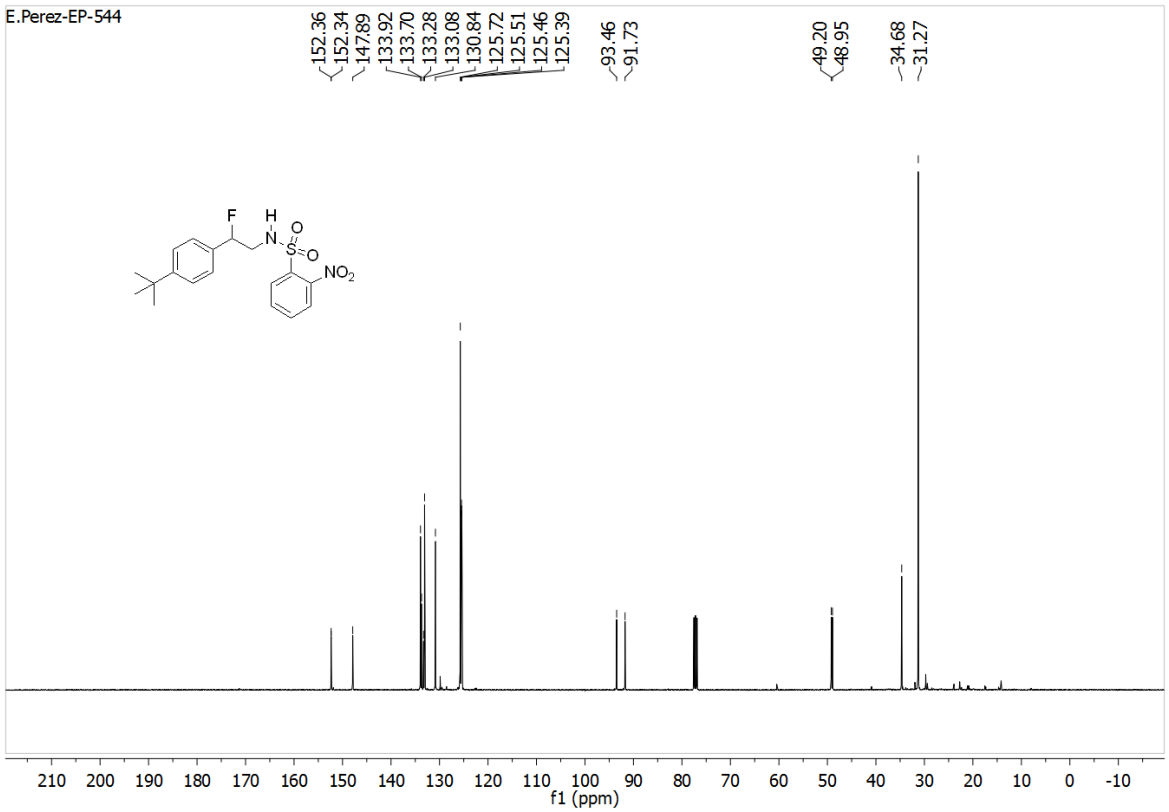

G.Arteaga-530
8.34
8.03
7.99
7.37
7.33
7.21
7.17
5.69
5.67
5.65
5.64
5.45
5.44
5.42
5.40
5.09
5.06
5.02
3.60
3.58
3.48
3.46
3.46
3.45
3.42
3.42
3.41
3.39
3.36
3.35
3.32
1.59
F
H
N
O
S
O
Cl
NO2
1.87
1.89
1.88
1.89
1.00
0.98
2.11
f1 (ppm)

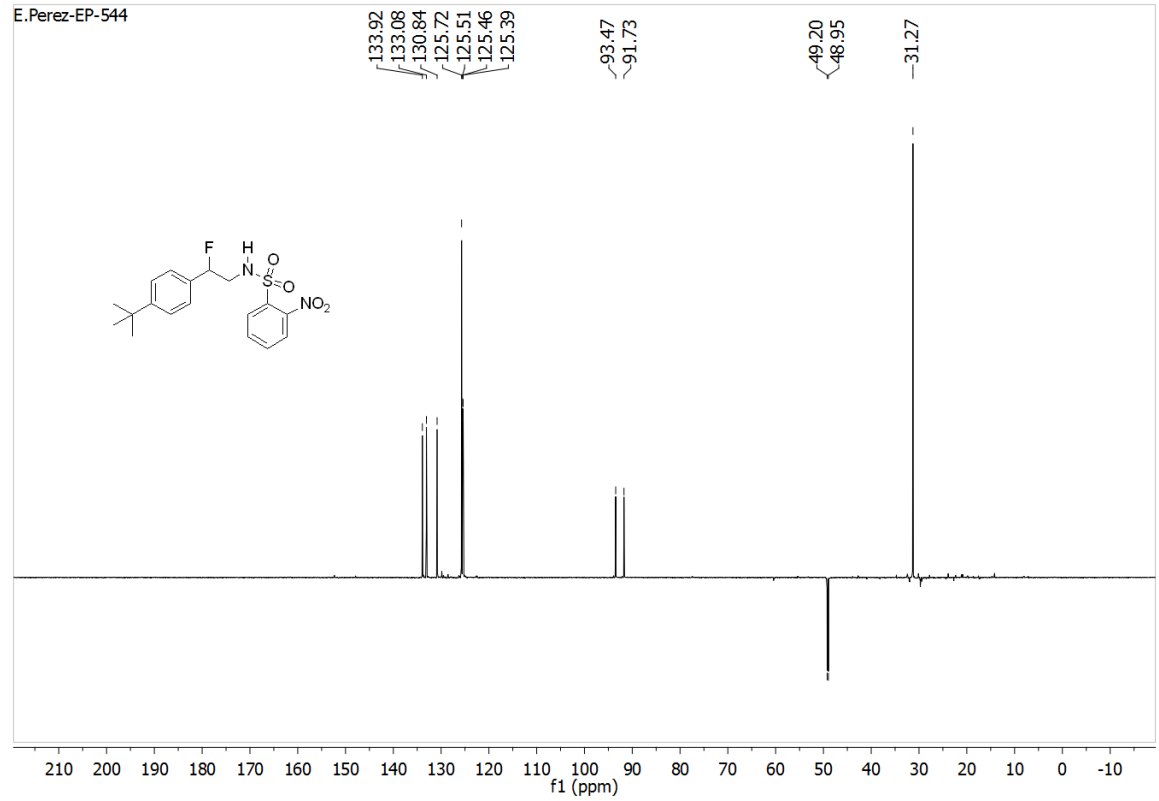

G.Arteaga-530
150.12
145.84
135.23
134.54
134.34
129.03
128.17
126.85
126.78
124.46
92.87
91.12
48.60
48.36
F
H
N
O
S
O
Cl
NO2
f1 (ppm)

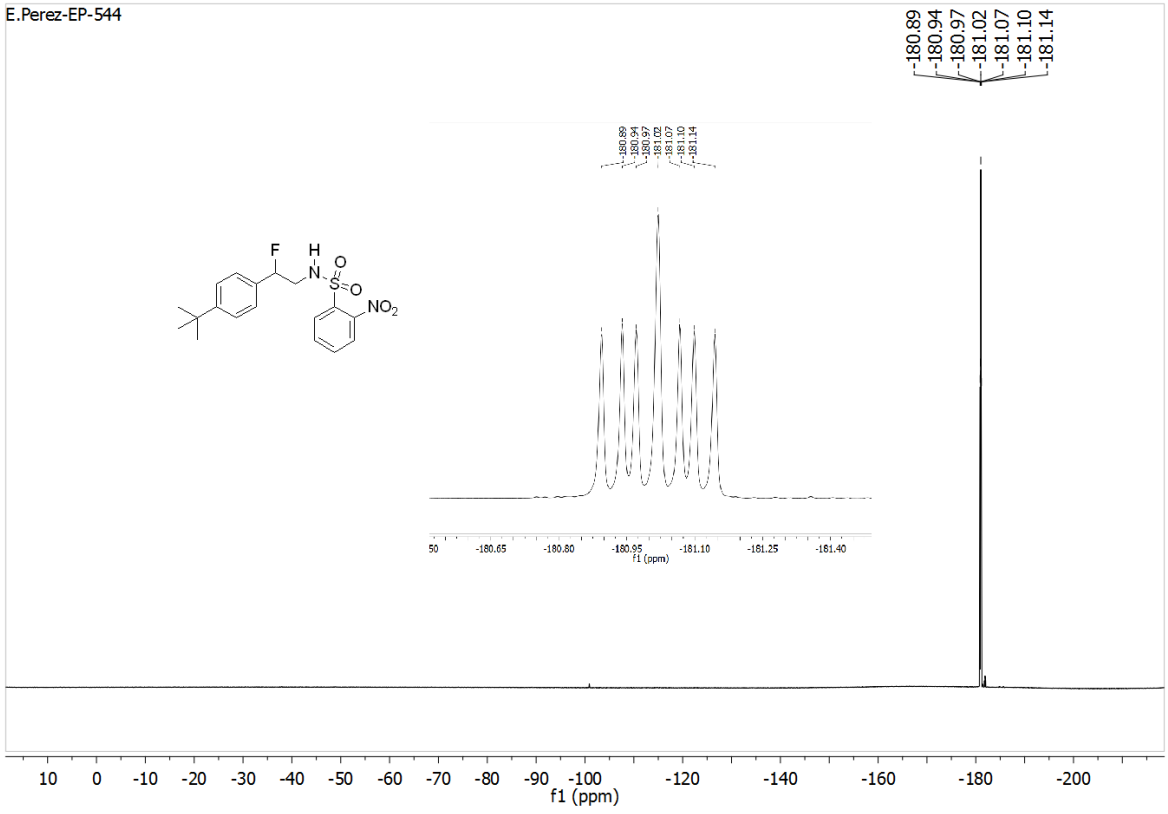

G.Arteaga-530
129.03
128.17
126.85
126.78
124.46
92.87
91.12
48.60
48.36
F
H
N
O
S
O
Cl
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

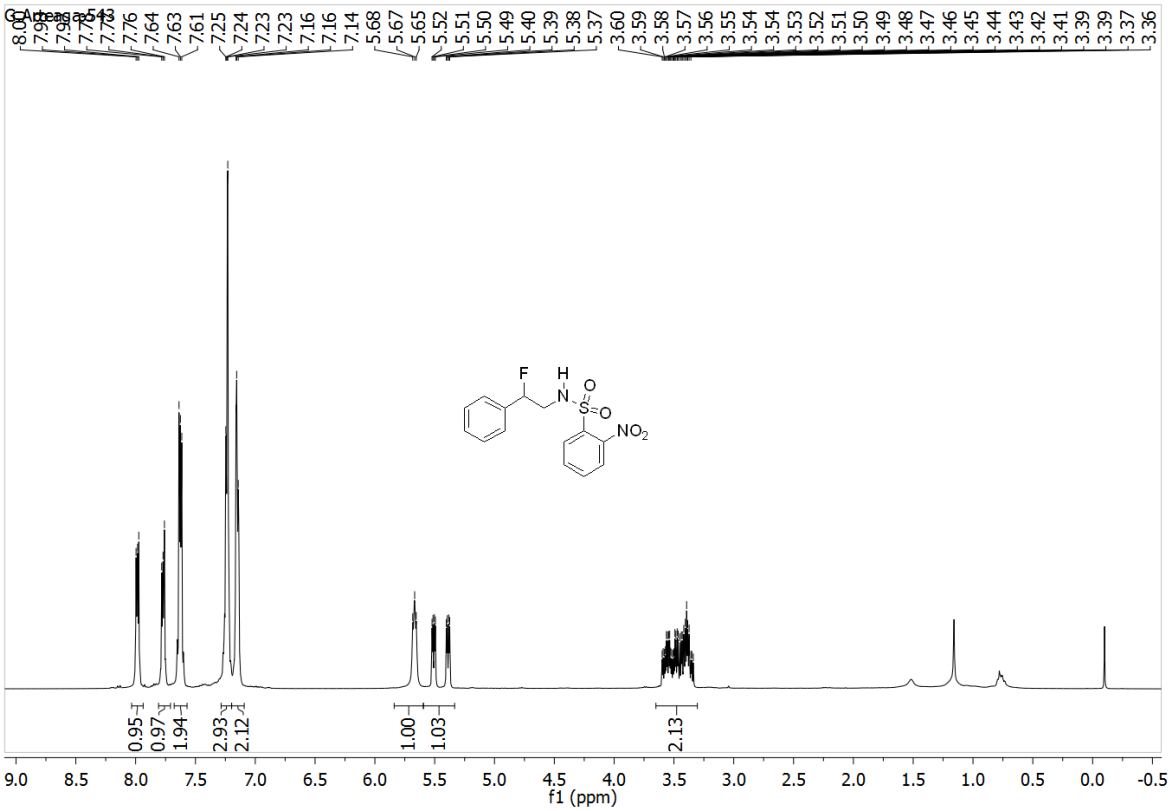

G.Arteaga-530
-183.62
-183.67
-183.69
-183.74
-183.79
-183.82
-183.87
F
H
N
O
S
O
Cl
NO2
-182.9
-183.2
-183.5
-183.8
-184.1
-184.4
-184.7
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

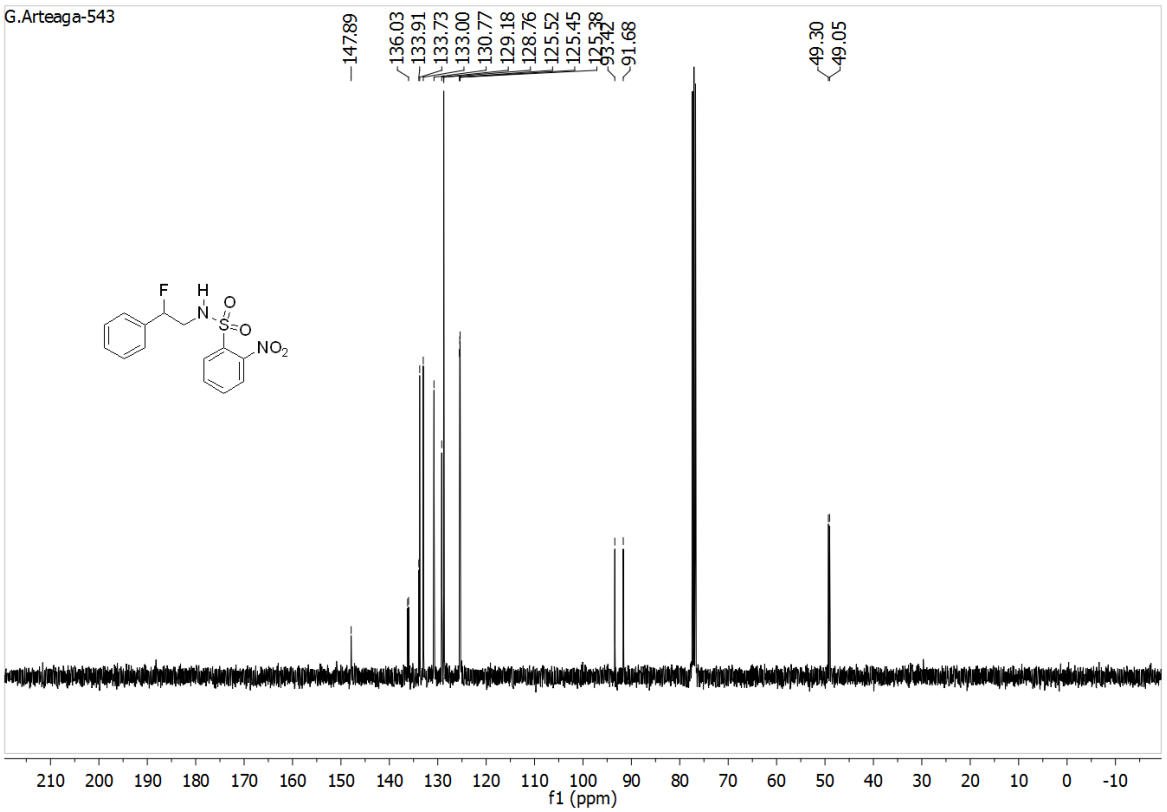

E.Perez-EP-544
7.96
7.96
7.96
7.96
7.72
7.71
7.70
7.60
7.59
7.58
7.57
7.25
7.23
7.08
7.06
5.74
5.72
5.72
5.71
5.47
5.46
5.45
5.35
5.34
5.33
3.50
3.49
3.48
3.47
3.44
3.43
3.42
3.41
3.40
3.39
3.38
3.37
3.36
3.35
1.16
F
H
N
O
S
O
NO2
0.97
0.98
2.02
1.98
1.97
1.00
1.01
2.10
10.43
f1 (ppm)

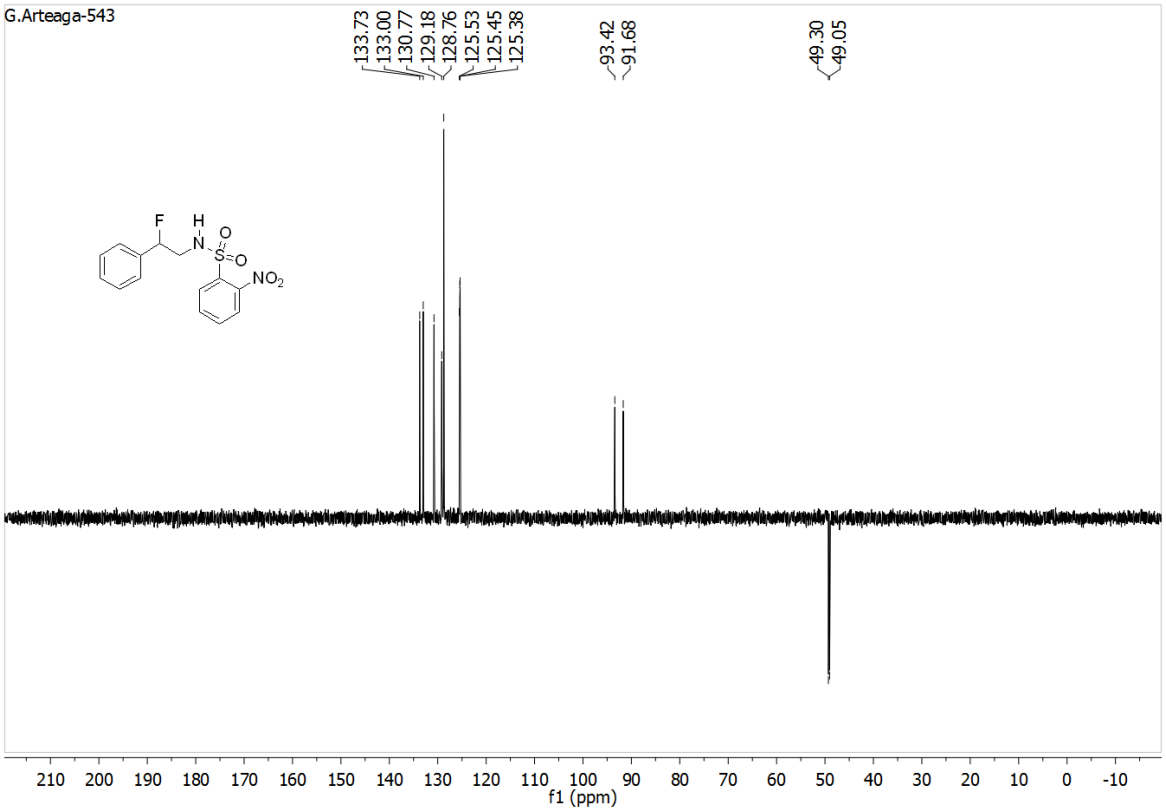

E.Perez-EP-544
152.36
152.34
147.89
133.92
133.70
133.28
133.08
130.84
125.72
125.51
125.46
125.39
93.46
91.73
49.20
48.95
34.68
31.27
F
H
N
O
S
O
NO2
f1 (ppm)

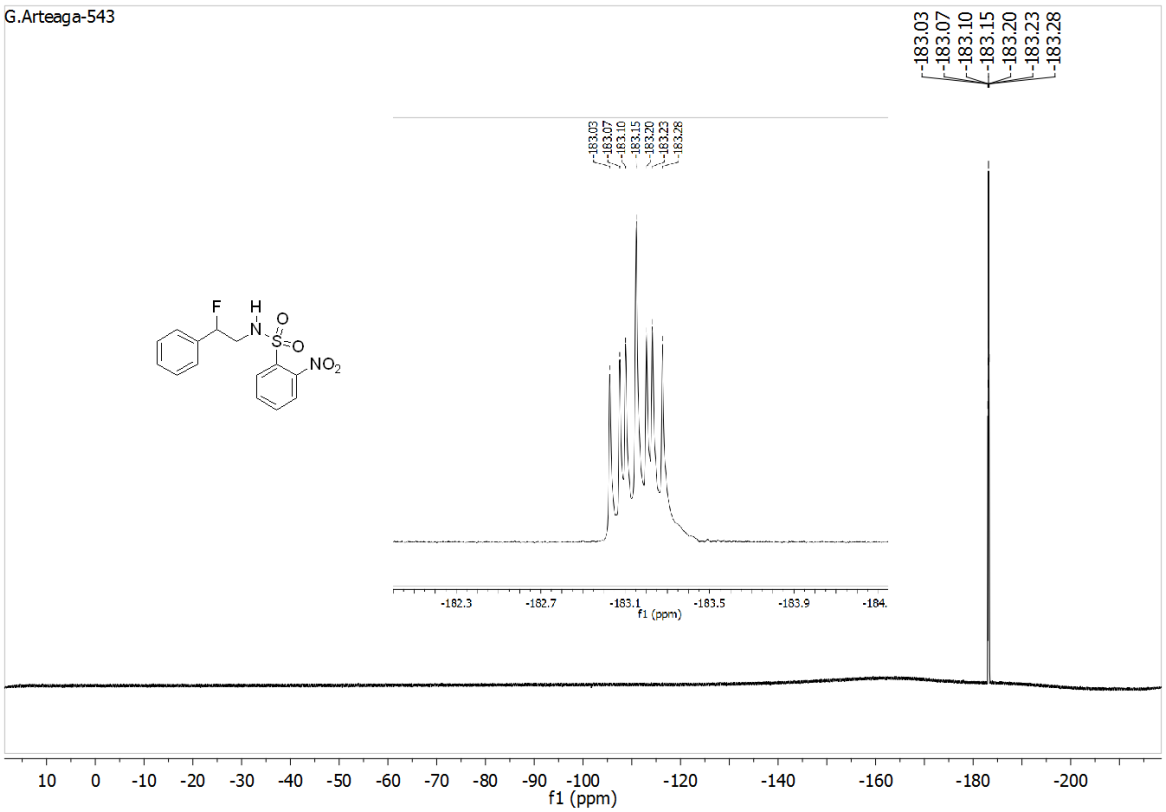

E.Perez-EP-544
133.92
133.08
130.84
125.72
125.51
125.46
125.39
93.47
91.73
49.20
48.95
31.27
F
H
N
O
S
O
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

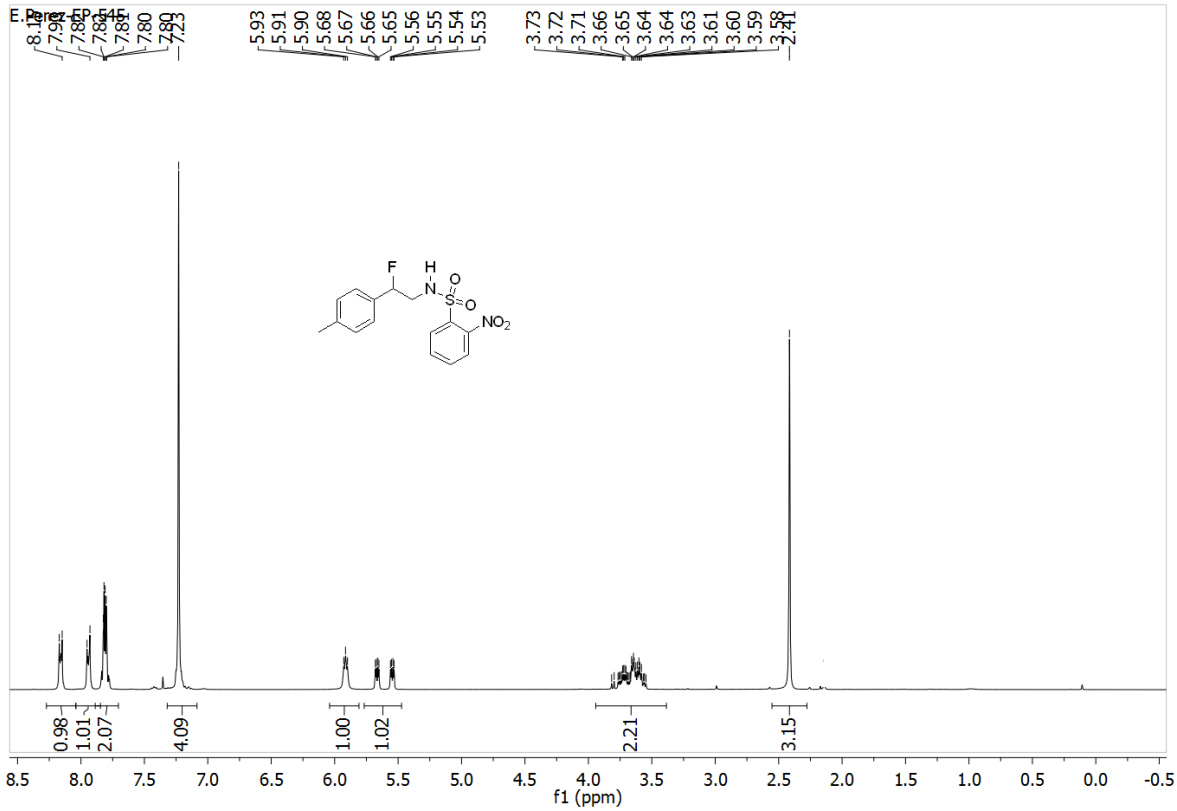

E.Perez-EP-544
-180.89
-180.94
-180.97
-181.02
-181.07
-181.10
-181.14
F
H
N
O
S
O
NO2
50 -180.65 -180.80 -180.95 -181.10 -181.25 -181.40
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

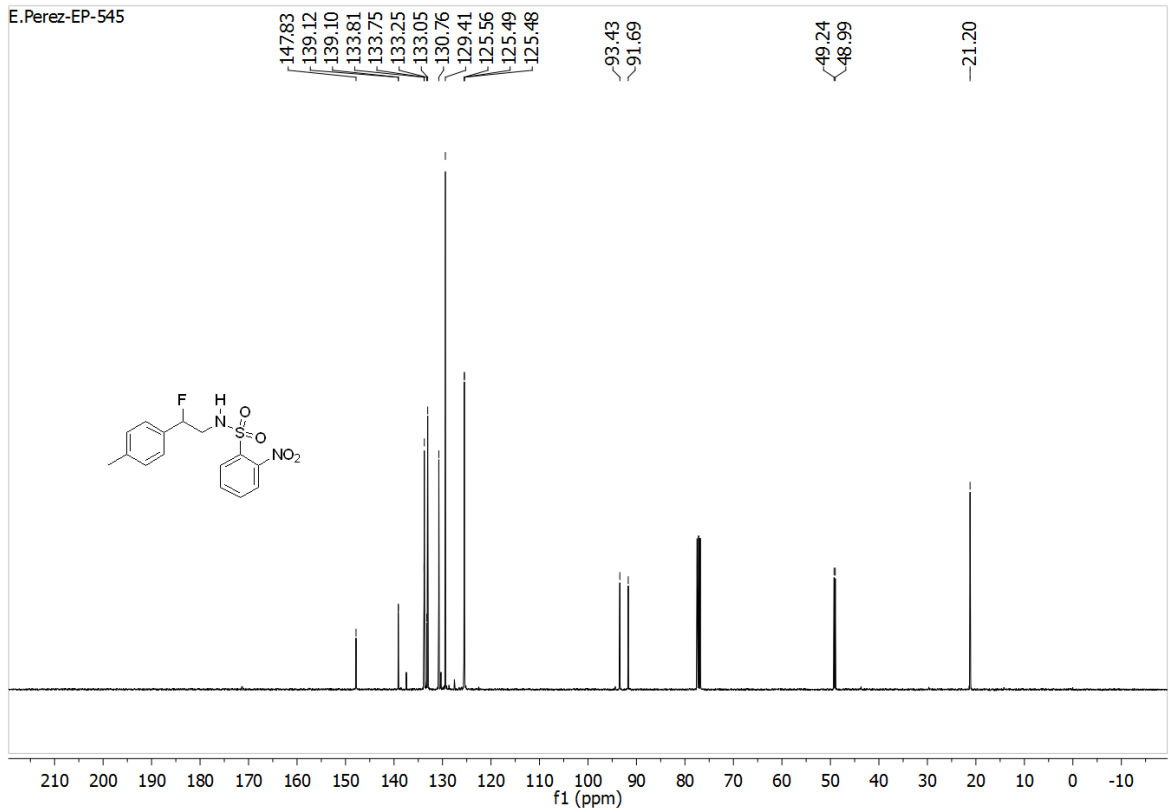

G.Arteaga-543
8.00 7.99 7.98 7.78 7.77 7.76 7.64 7.63 7.61 7.25 7.24 7.23 7.23 7.16 7.16 7.14 5.68 5.67 5.65 5.52 5.51 5.50 5.49 5.40 5.39 5.38 5.37 3.60 3.59 3.58 3.57 3.56 3.55 3.54 3.54 3.53 3.52 3.51 3.50 3.49 3.48 3.47 3.46 3.45 3.44 3.43 3.42 3.41 3.39 3.39 3.37 3.36
F
H
N
S
O
O
NO2
0.95 0.97 1.94 2.93 2.12 1.00 1.03 2.13
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
f1 (ppm)

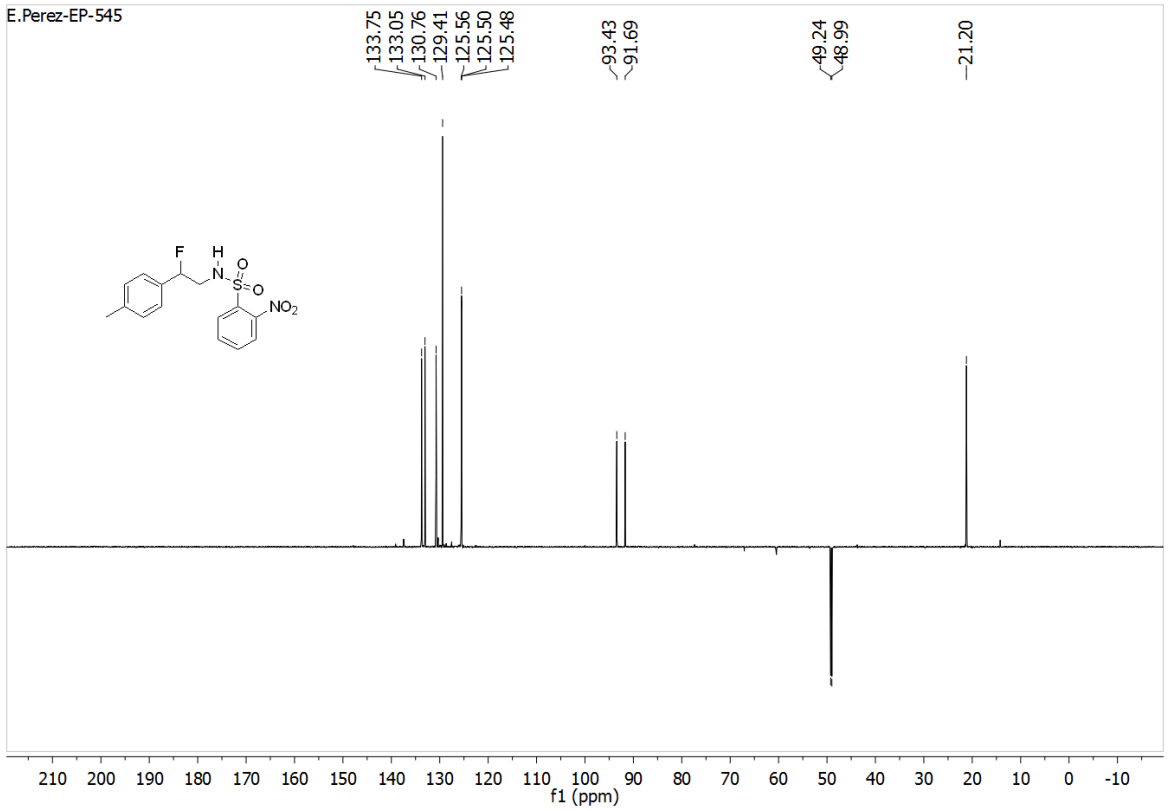

G.Arteaga-543
147.89 136.03 133.91 133.73 133.00 130.77 129.18 128.76 125.52 125.45 125.38 93.42 91.68 49.30 49.05
F
H
N
S
O
O
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

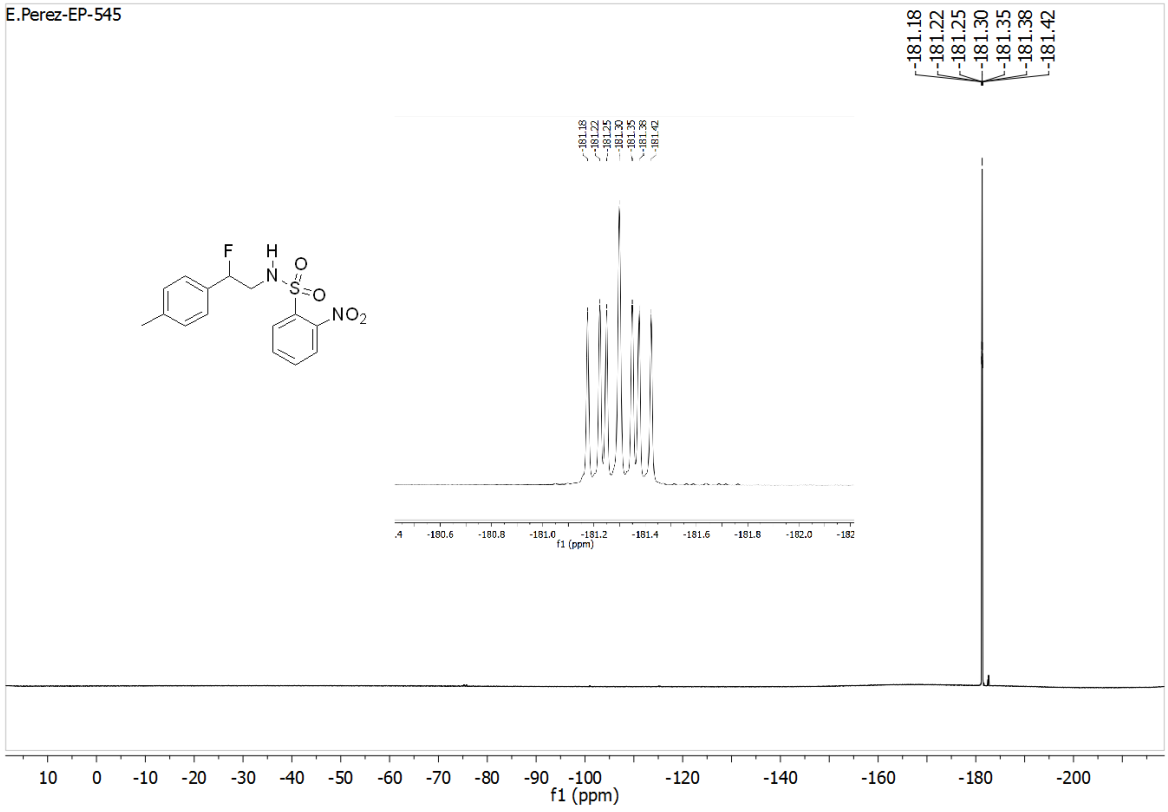

G.Arteaga-543
133.73
133.00
130.77
129.18
128.76
125.53
125.45
125.38
93.42
91.68
49.30
49.05
F
H
N
S
O
O
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

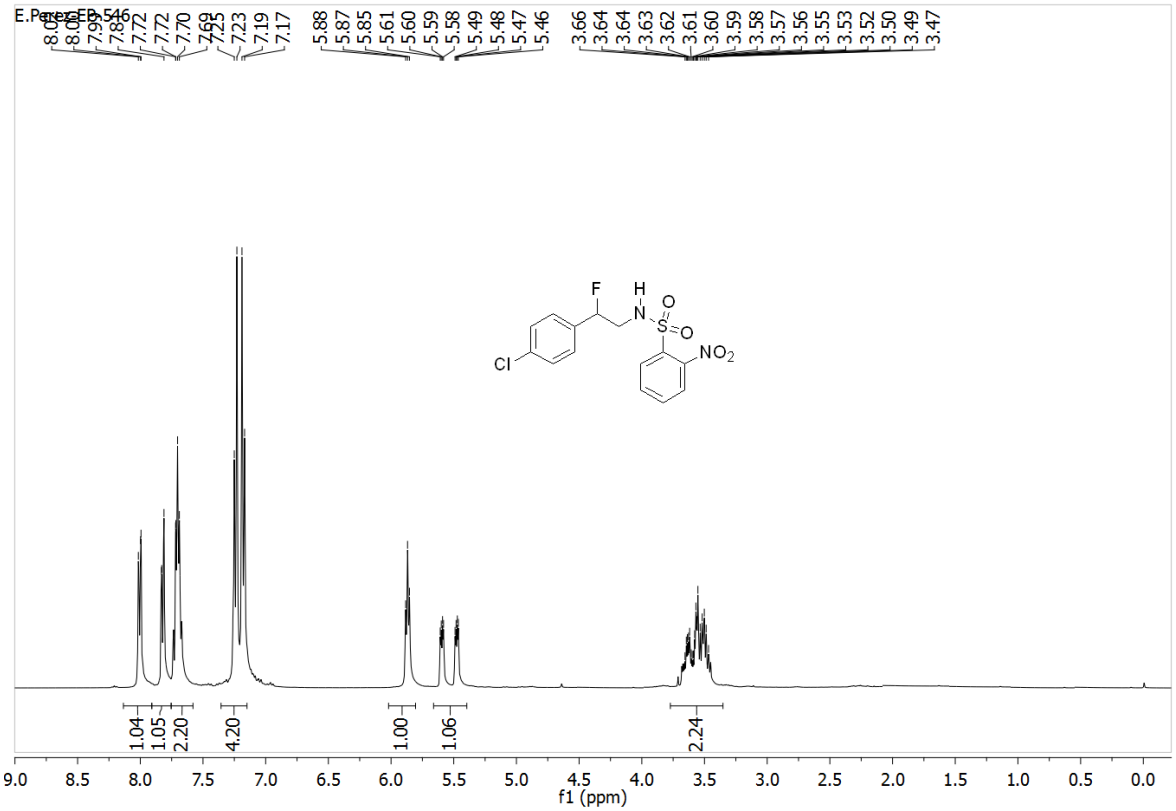

G.Arteaga-543
-183.03
-183.07
-183.10
-183.15
-183.20
-183.23
-183.28
F
H
N
S
O
O
NO2
-182.3
-182.7
-183.1
-183.5
-183.9
-184.
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

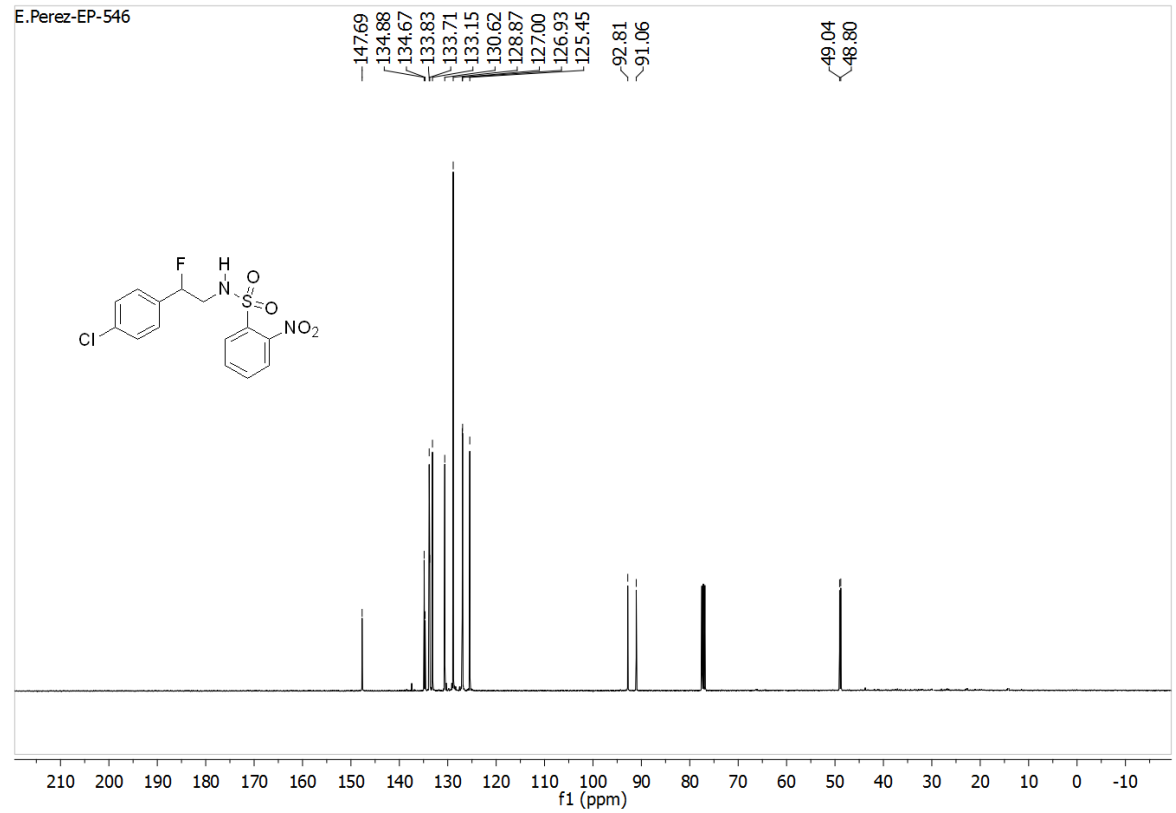

E.Perez-EP-545
8.12
7.94
7.82
7.82
7.81
7.80
7.80
7.23
5.93
5.91
5.90
5.68
5.67
5.66
5.65
5.56
5.55
5.54
5.53
3.73
3.72
3.71
3.66
3.65
3.64
3.64
3.63
3.61
3.60
3.59
3.58
2.41
F
H
N
S
O
O
NO2
0.98
1.01
2.07
4.09
1.00
1.02
2.21
3.15
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

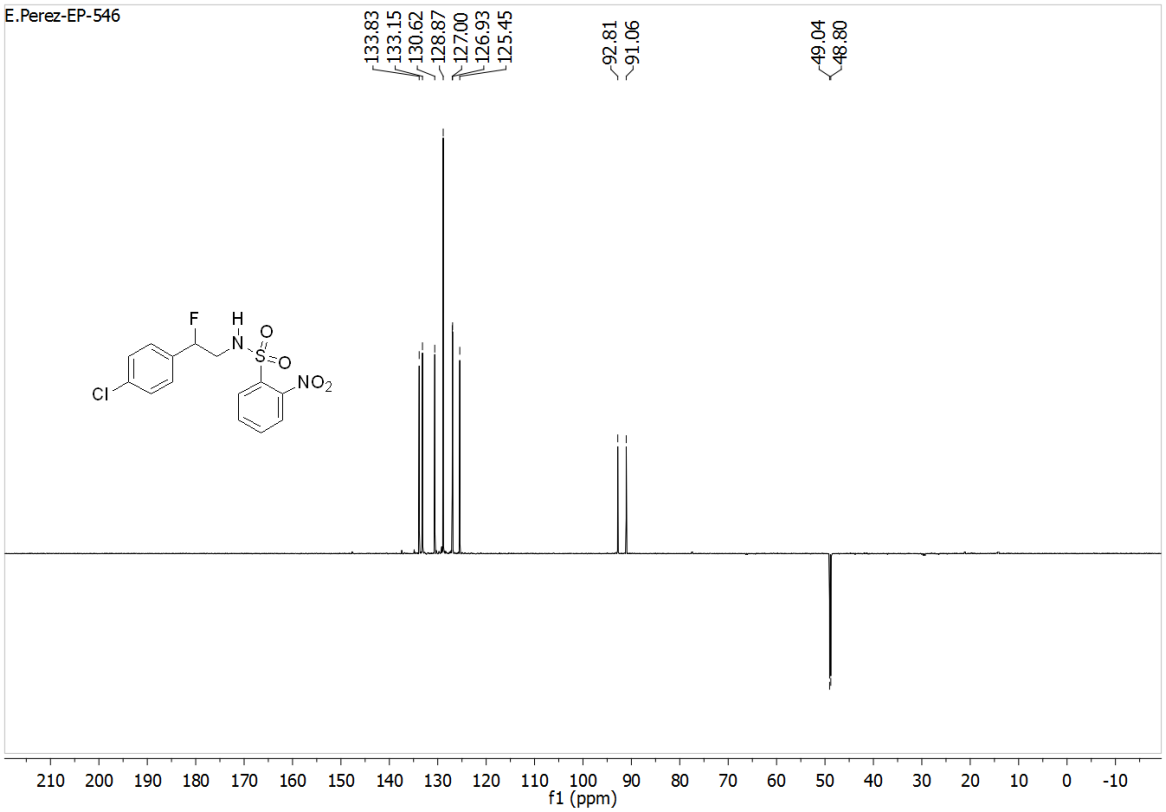

E.Perez-EP-545
147.83
139.12
139.10
133.81
133.75
133.25
133.05
130.76
129.41
125.56
125.49
125.48
93.43
91.69
49.24
48.99
21.20
F
H
N
S
O
O
NO2
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

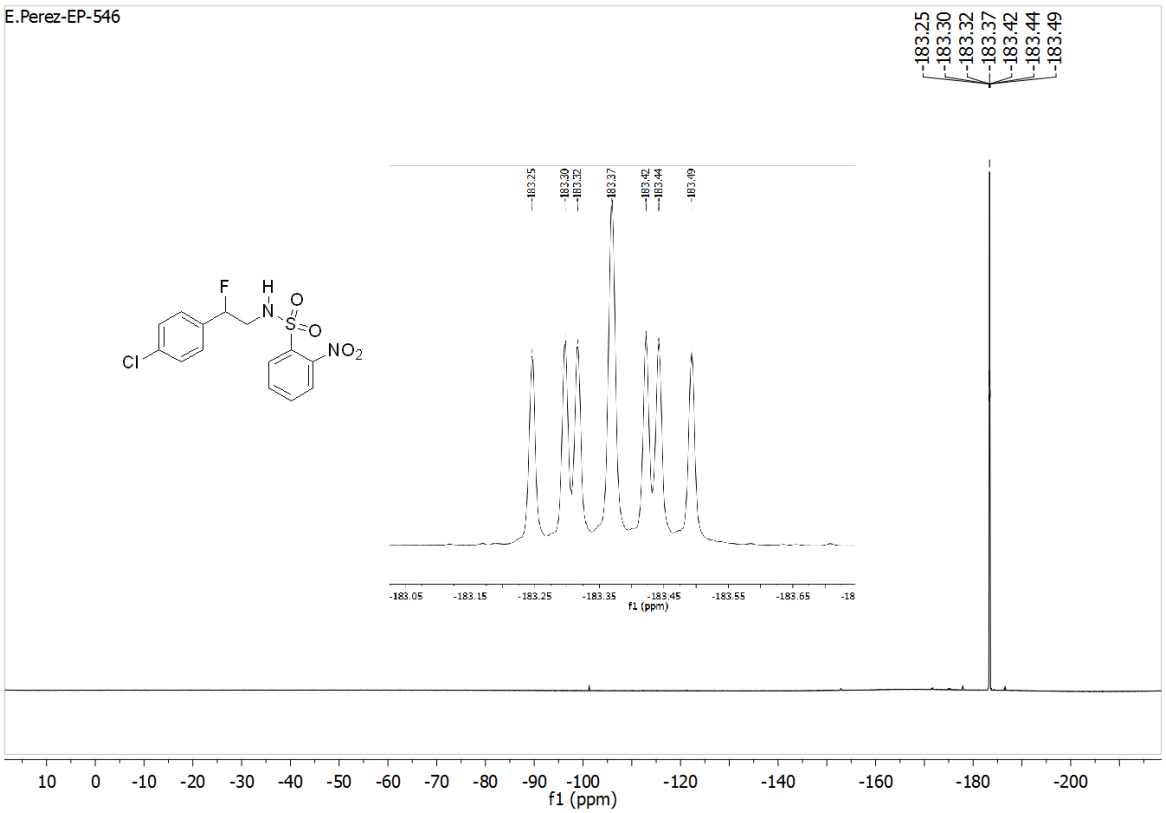

E.Perez-EP-545
133.75
133.05
130.76
129.41
125.56
125.50
125.48
93.43
91.69
49.24
48.99
21.20
F
H
N
O
S
O
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

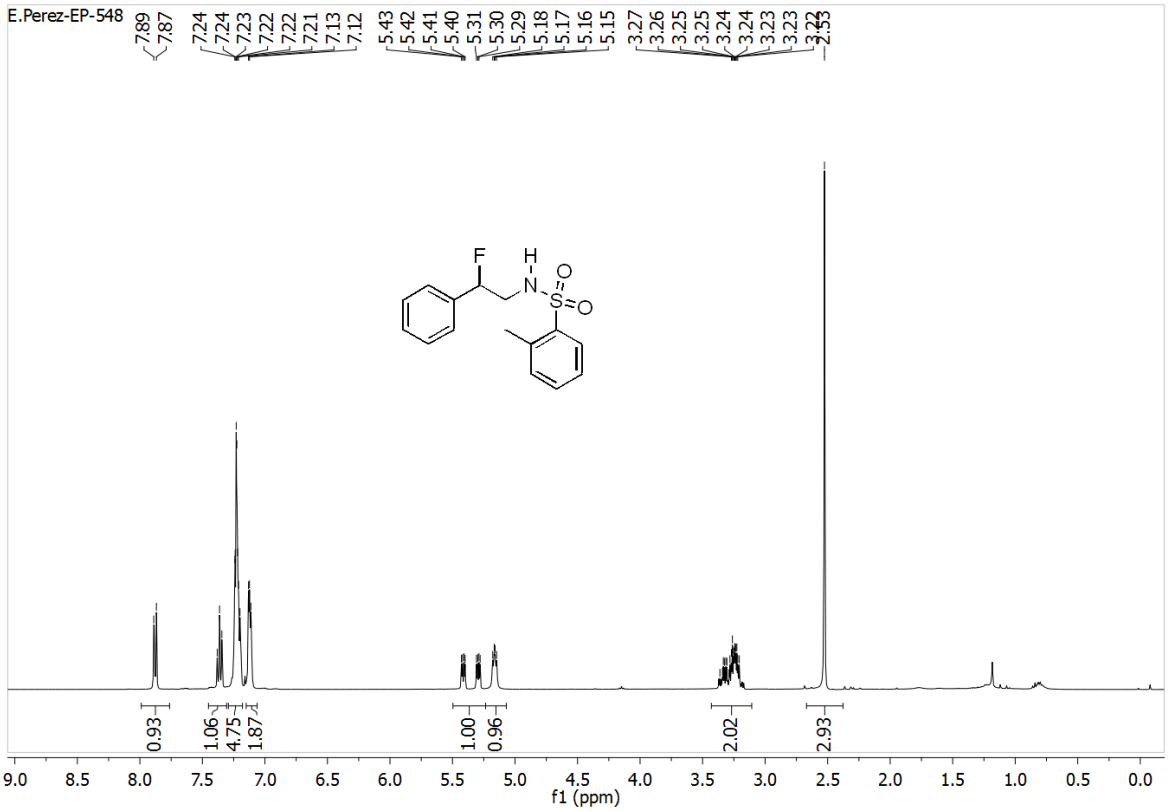

E.Perez-EP-545
-181.18
-181.22
-181.25
-181.30
-181.35
-181.38
-181.42
F
H
N
O
S
O
NO2
-180.6 -180.8 -181.0 -181.2 -181.4 -181.6 -181.8 -182.0
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

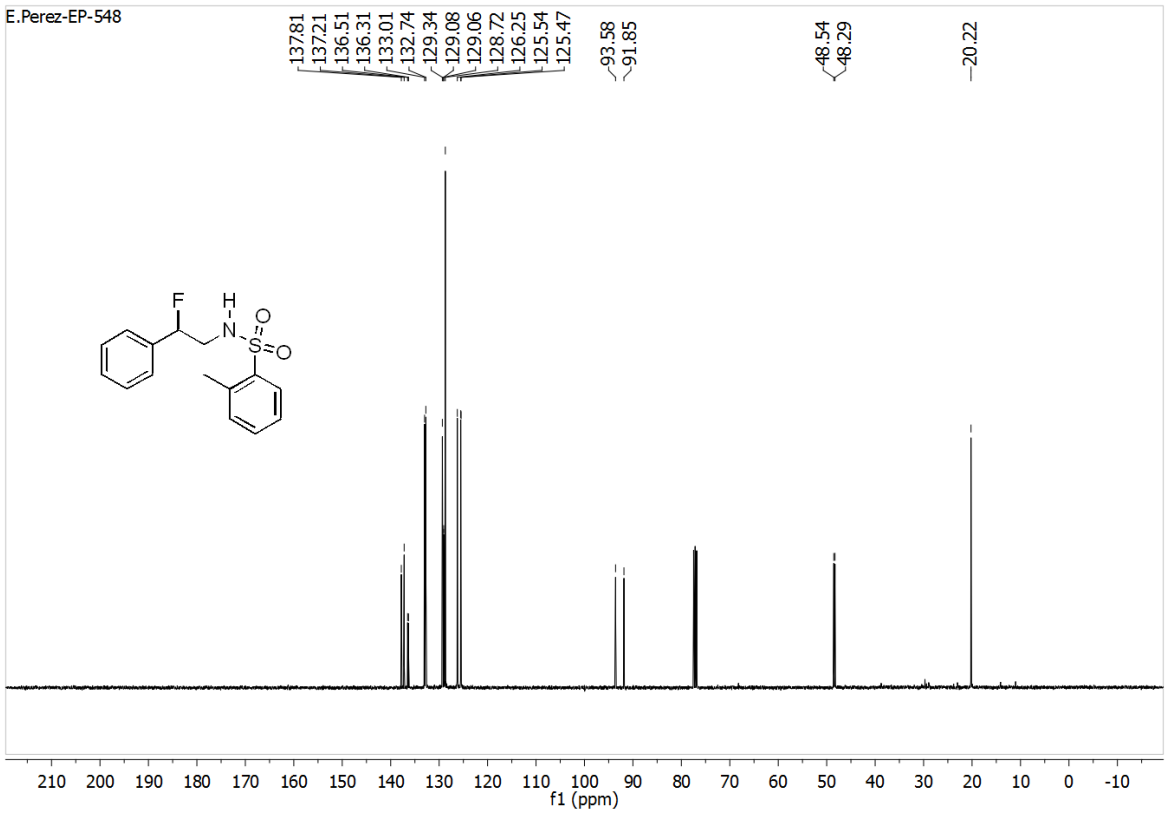

E.Perez-EP-546
8.07
8.06
7.99
7.85
7.72
7.72
7.70
7.69
7.25
7.23
7.19
7.17
5.88
5.87
5.85
5.61
5.60
5.59
5.58
5.49
5.48
5.47
5.46
3.66
3.64
3.64
3.63
3.62
3.61
3.60
3.59
3.58
3.57
3.56
3.55
3.53
3.52
3.50
3.49
3.47
F
H
N
O
S
O
Cl
NO2
1.04
1.05
2.20
4.20
1.00
1.06
2.24
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

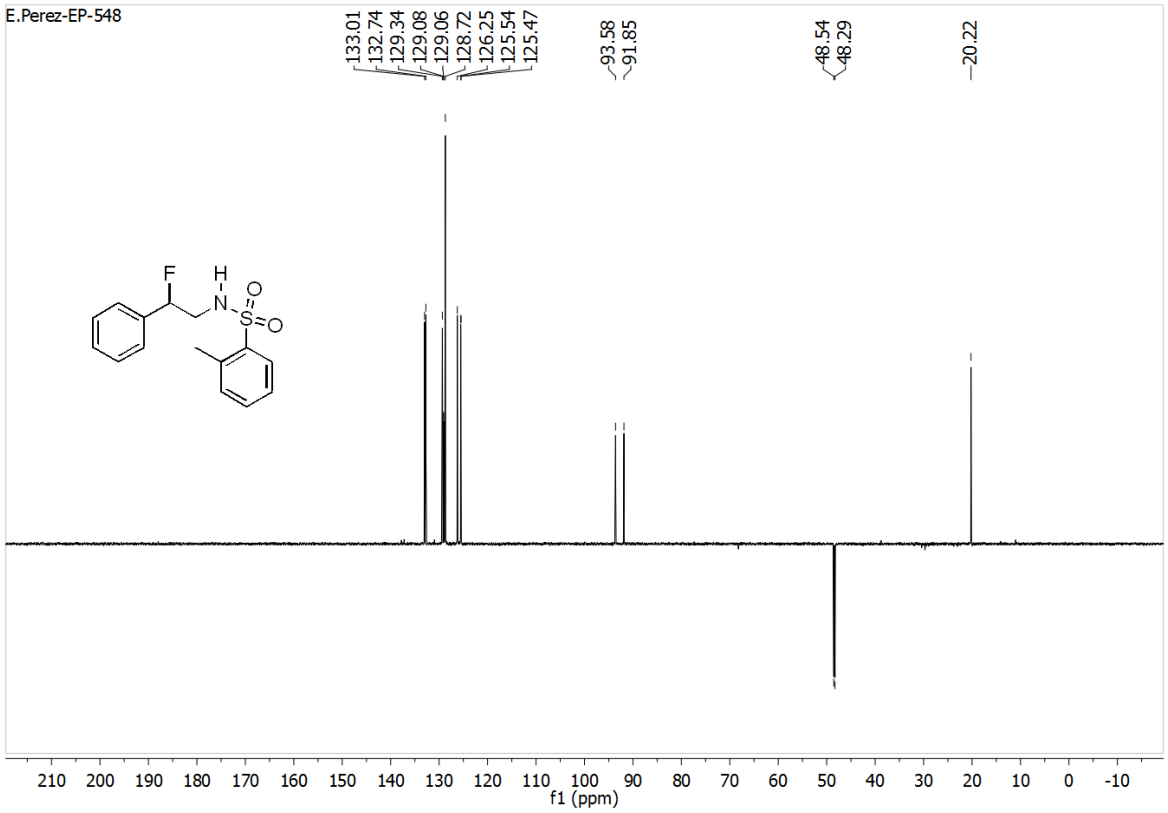

E.Perez-EP-546
147.69
134.88
134.67
133.83
133.71
133.15
130.62
128.87
127.00
126.93
125.45
92.81
91.06
49.04
48.80
F
H
N
O
S
O
Cl
NO2
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

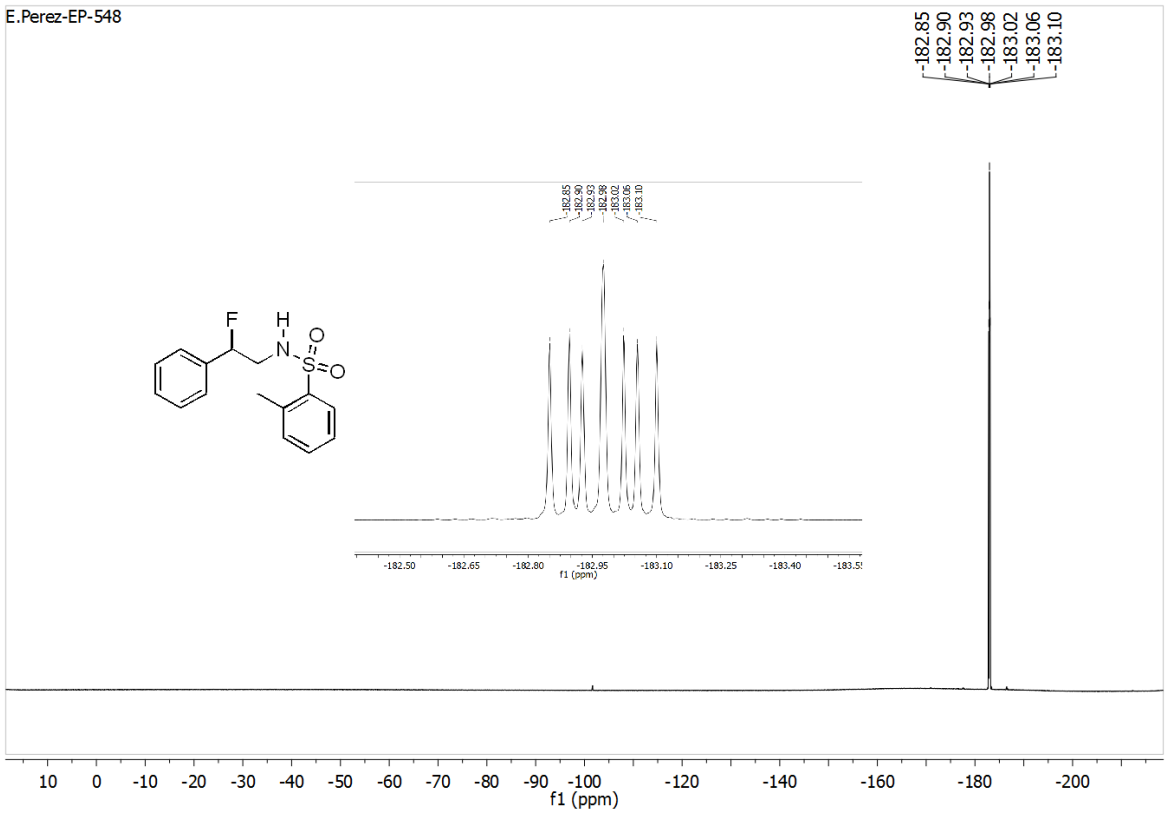

E.Perez-EP-546
133.83
133.15
130.62
128.87
127.00
126.93
125.45
92.81
91.06
49.04
48.80
F
H
N
O
S
O
Cl
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

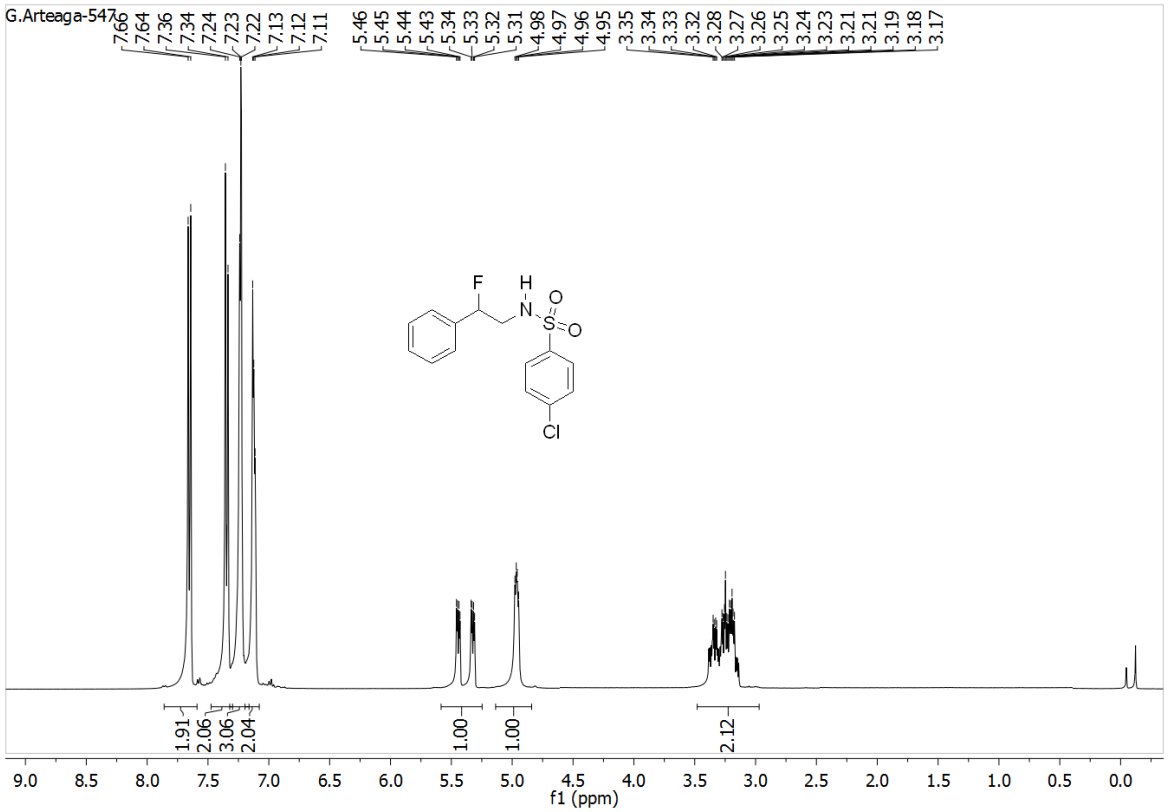

E.Perez-EP-546
-183.25
-183.30
-183.32
-183.37
-183.42
-183.44
-183.49
F
H
N
O
S
O
Cl
NO2
-183.05 -183.15 -183.25 -183.35 -183.45 -183.55 -183.65 -18
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

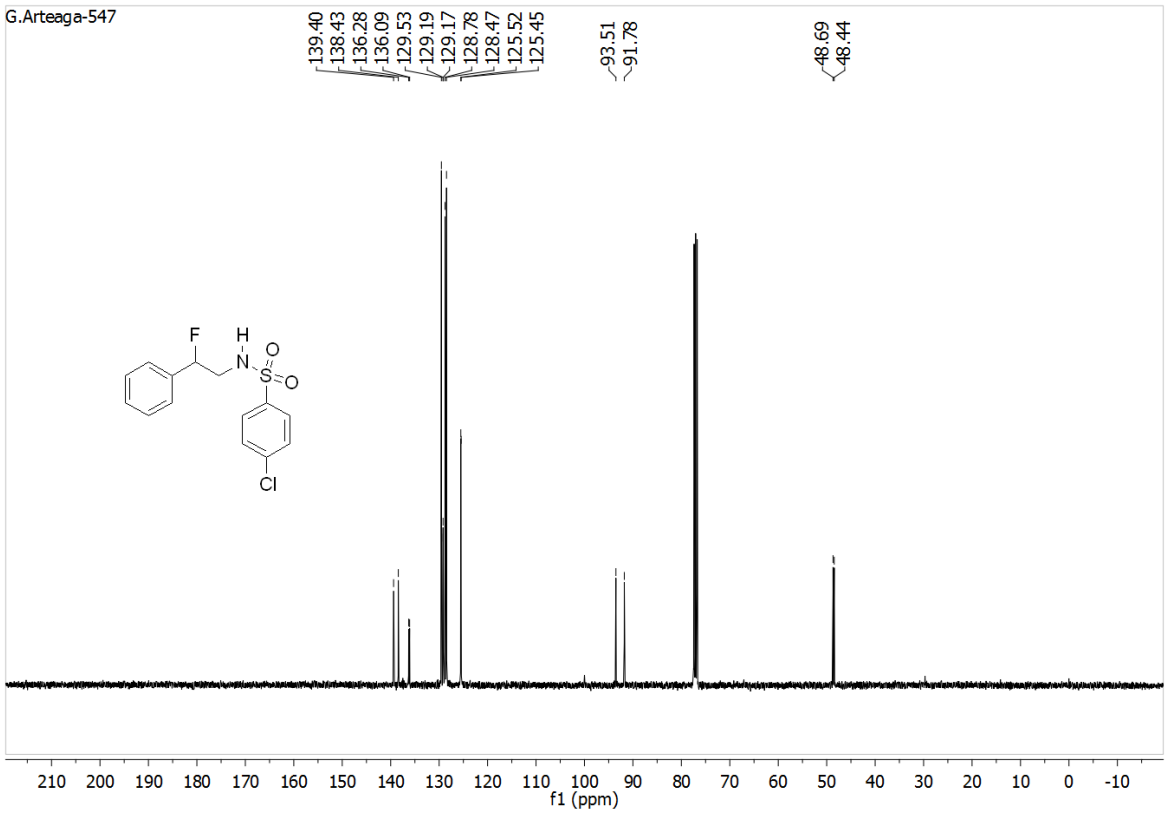

E.Perez-EP-548
7.89
7.87
7.24
7.24
7.23
7.22
7.22
7.21
7.13
7.12
5.43
5.42
5.41
5.40
5.31
5.30
5.29
5.18
5.17
5.16
5.15
3.27
3.26
3.25
3.25
3.24
3.24
3.23
3.23
2.53
F
H
N
S
O
O
0.93
1.06
4.75
1.87
1.00
0.96
2.02
2.93
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

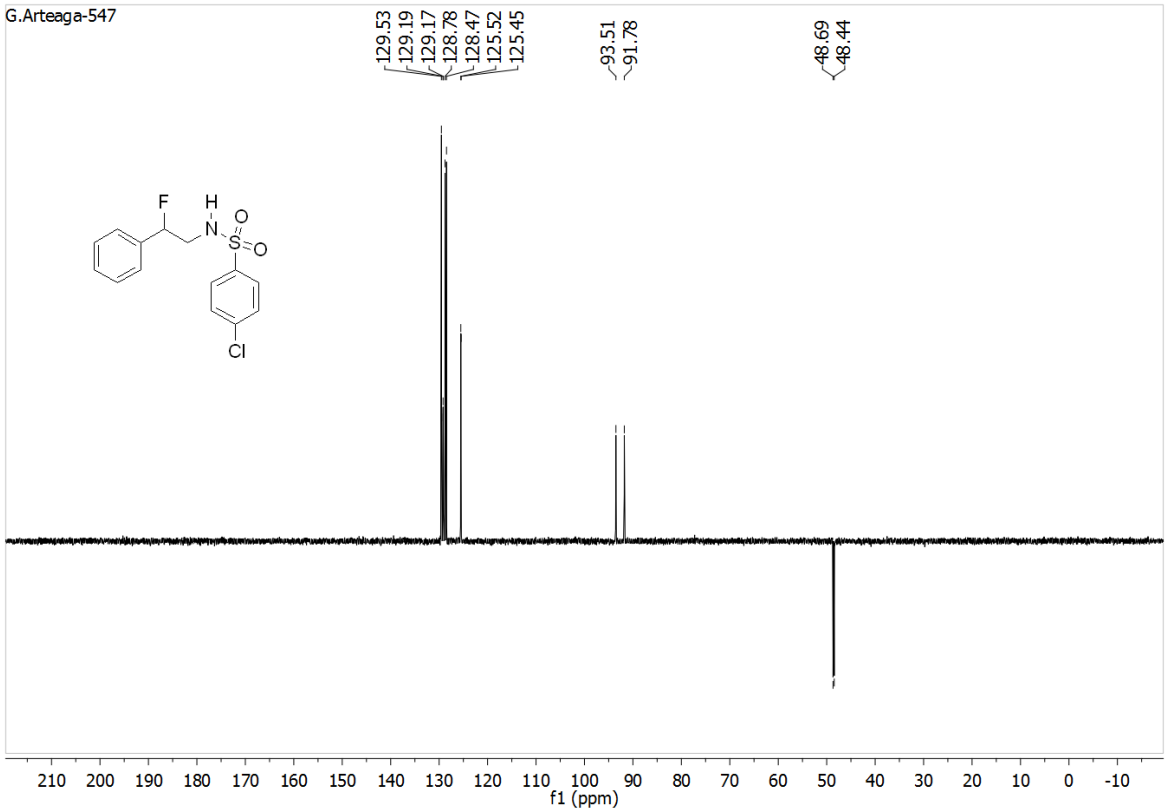

E.Perez-EP-548
137.81
137.21
136.51
136.31
133.01
132.74
129.34
129.08
129.06
128.72
126.25
125.54
125.47
93.58
91.85
48.54
48.29
20.22
F
H
N
S
O
O
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

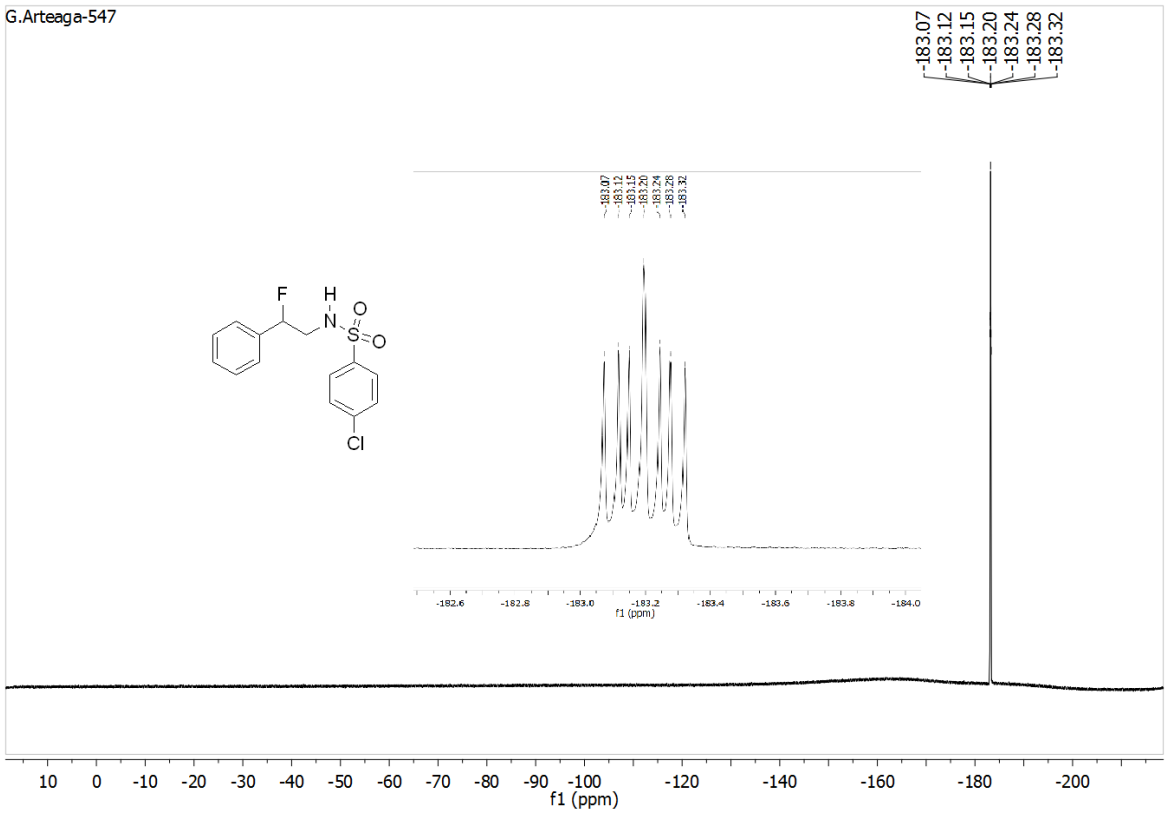

E.Perez-EP-548
133.01
132.74
129.34
129.08
129.06
128.72
126.25
125.54
125.47
93.58
91.85
48.54
48.29
20.22
F
H
N
O
S
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

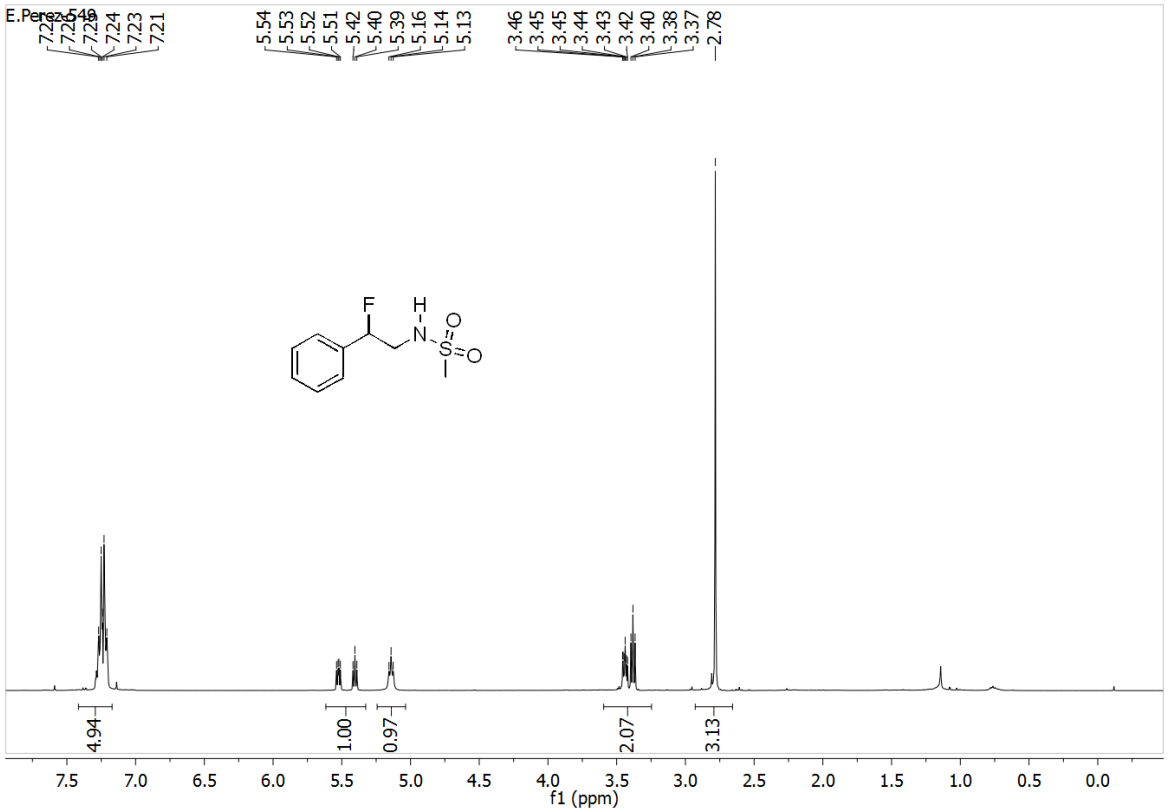

E.Perez-EP-548
-182.85
-182.90
-182.93
-182.98
-183.02
-183.06
-183.10
F
H
N
O
S
O
-182.50 -182.65 -182.80 -182.95 -183.10 -183.25 -183.40
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

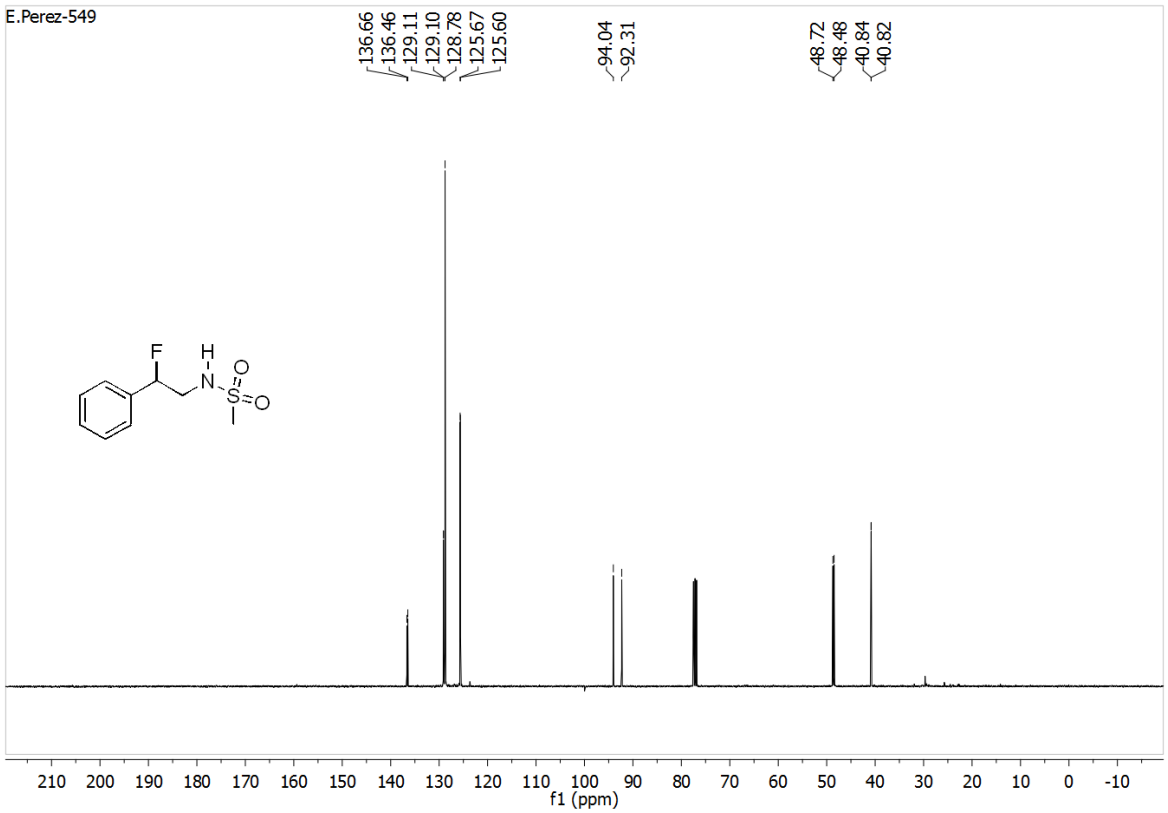

G.Arteaga-547
7.66
7.64
7.36
7.34
7.24
7.23
7.22
7.13
7.12
7.11
5.46
5.45
5.44
5.43
5.34
5.33
5.32
5.31
4.98
4.97
4.96
4.95
3.35
3.34
3.33
3.32
3.28
3.27
3.26
3.25
3.24
3.23
3.21
3.21
3.19
3.18
3.17
F
H
N
O
S
O
Cl
1.91
2.06
3.06
2.04
1.00
1.00
2.12
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

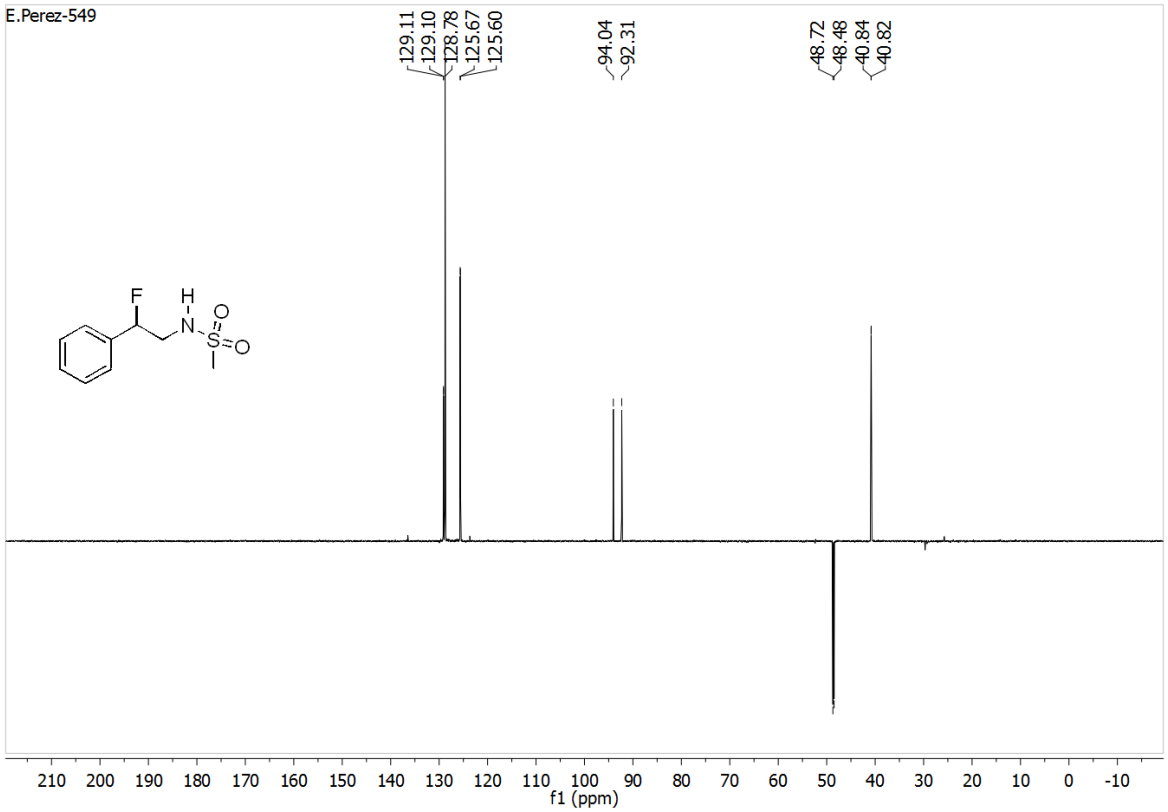

G.Arteaga-547
139.40
138.43
136.28
136.09
129.53
129.19
129.17
128.78
128.47
125.52
125.45
93.51
91.78
48.69
48.44
F
H
N
O
S
O
Cl
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

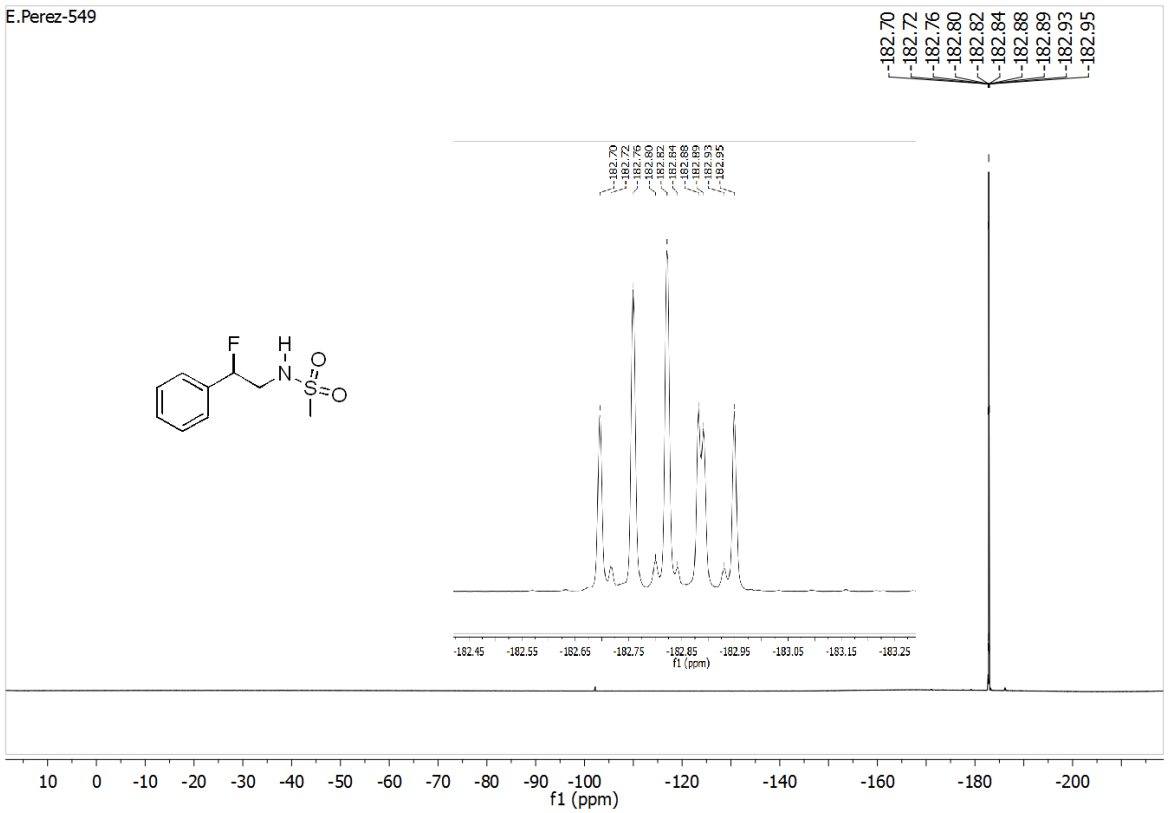

G.Arteaga-547
129.53
129.19
129.17
128.78
128.47
125.52
125.45
93.51
91.78
48.69
48.44
F
H
N
O
S
O
Cl
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

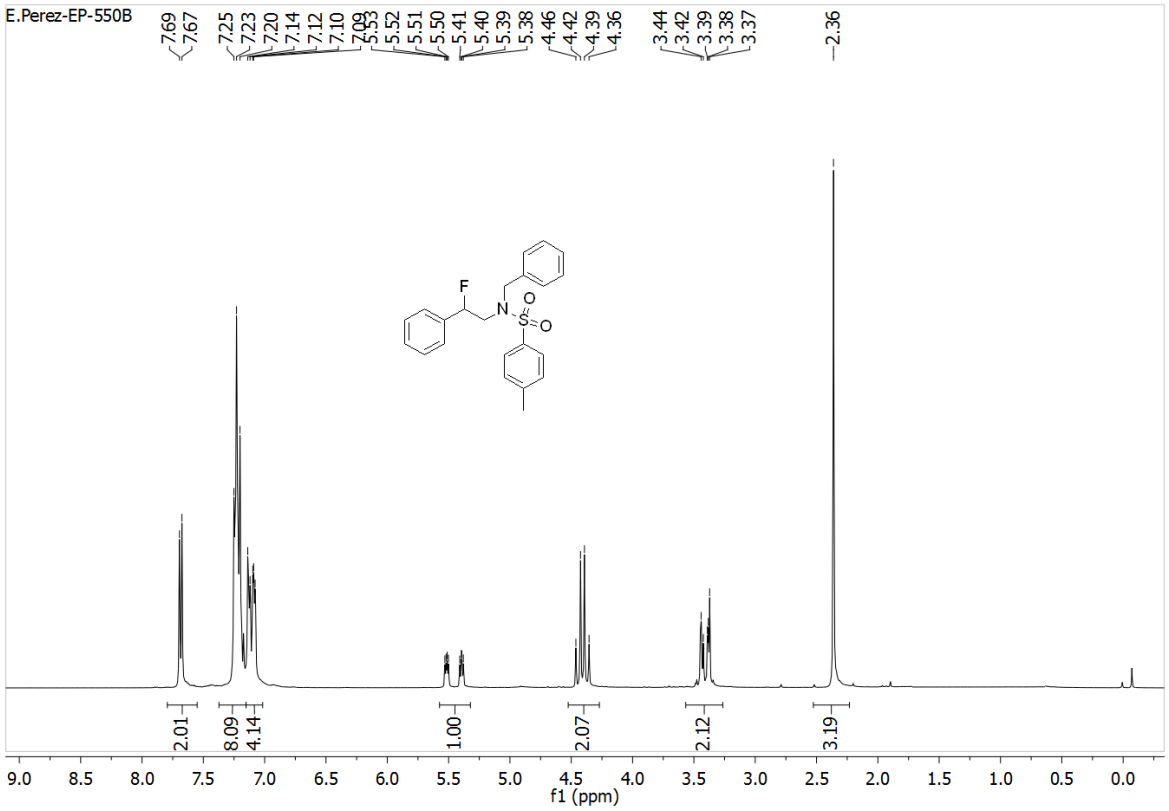

G.Arteaga-547
-183.07
-183.12
-183.15
-183.20
-183.24
-183.28
-183.32
F
H
N
O
S
O
Cl
-182.6 -182.8 -183.0 -183.2 -183.4 -183.6 -183.8 -184.0
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

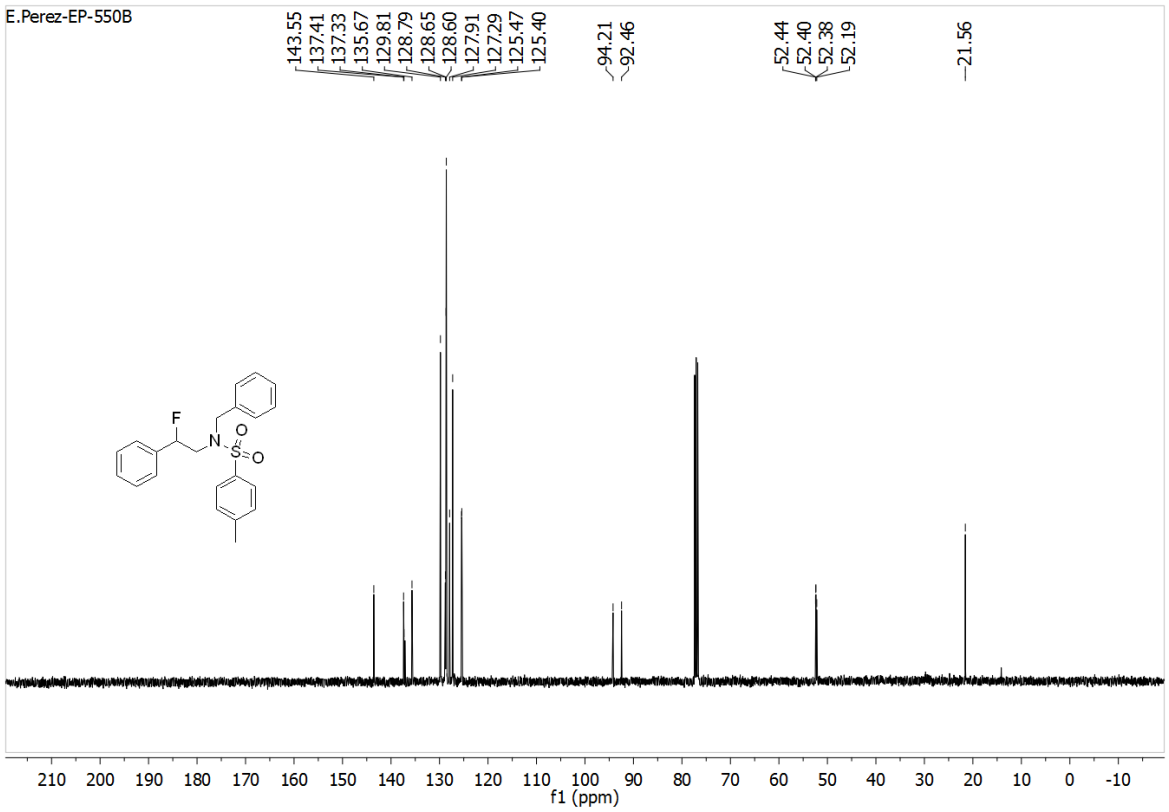

E.Perez-549
7.27
7.26
7.25
7.24
7.23
7.21
5.54
5.53
5.52
5.51
5.42
5.40
5.39
5.16
5.14
5.13
3.46
3.45
3.44
3.43
3.42
3.40
3.38
3.37
2.78
F
H
N
S
O
O
4.94
1.00
0.97
2.07
3.13
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

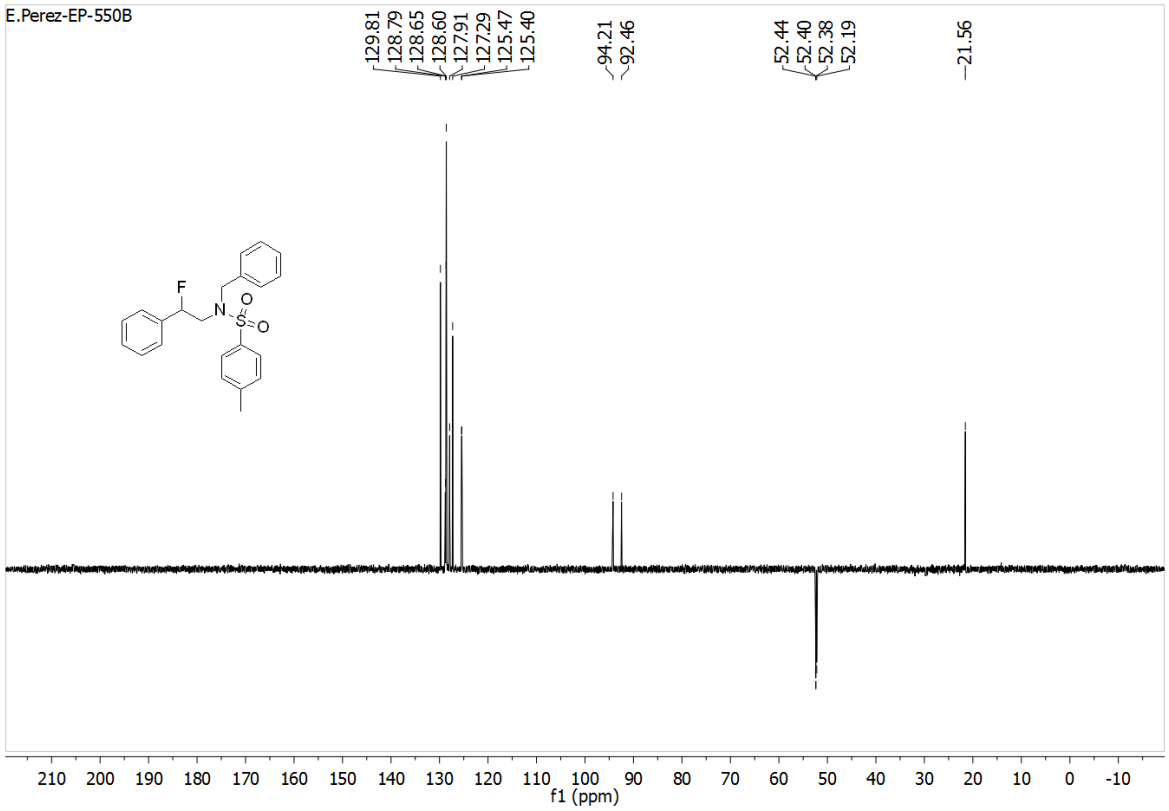

E.Perez-549
136.66
136.46
129.11
129.10
128.78
125.67
125.60
94.04
92.31
48.72
48.48
40.84
40.82
F
H
N
S
O
O
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

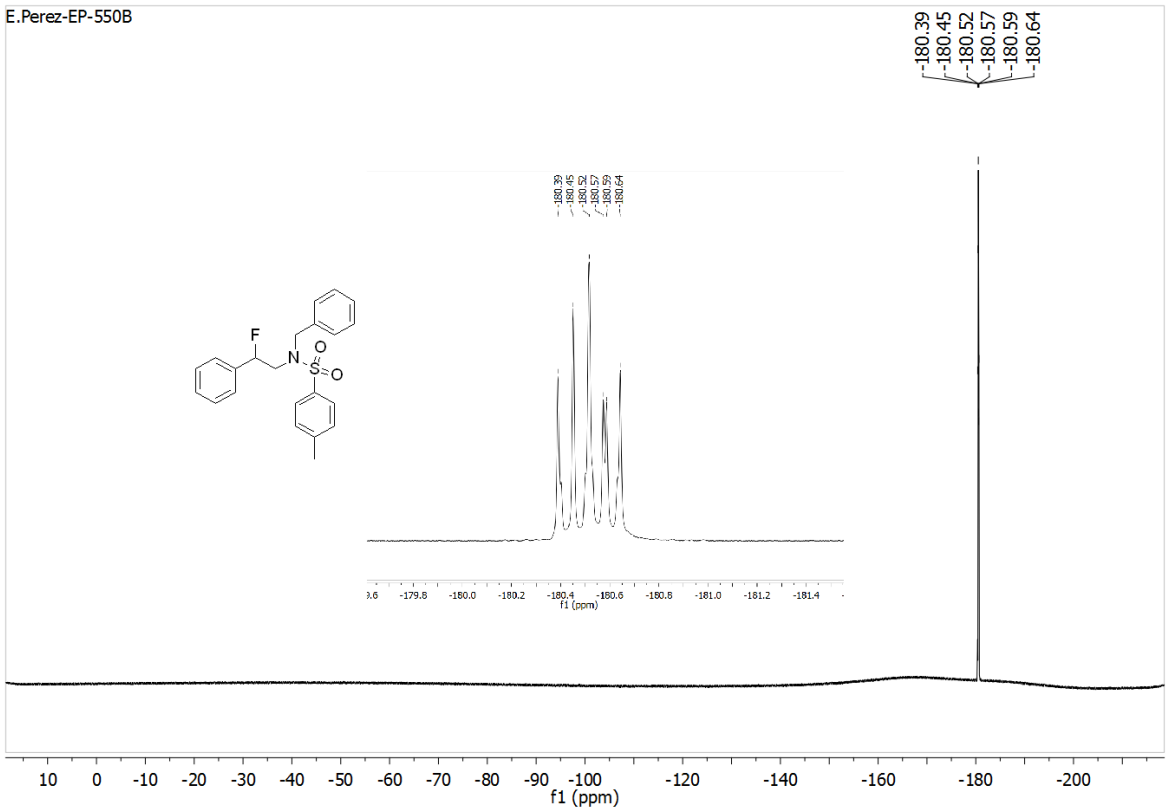

E.Perez-549
129.11
129.10
128.78
125.67
125.60
94.04
92.31
48.72
48.48
40.84
40.82
F
H
N
S
O
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

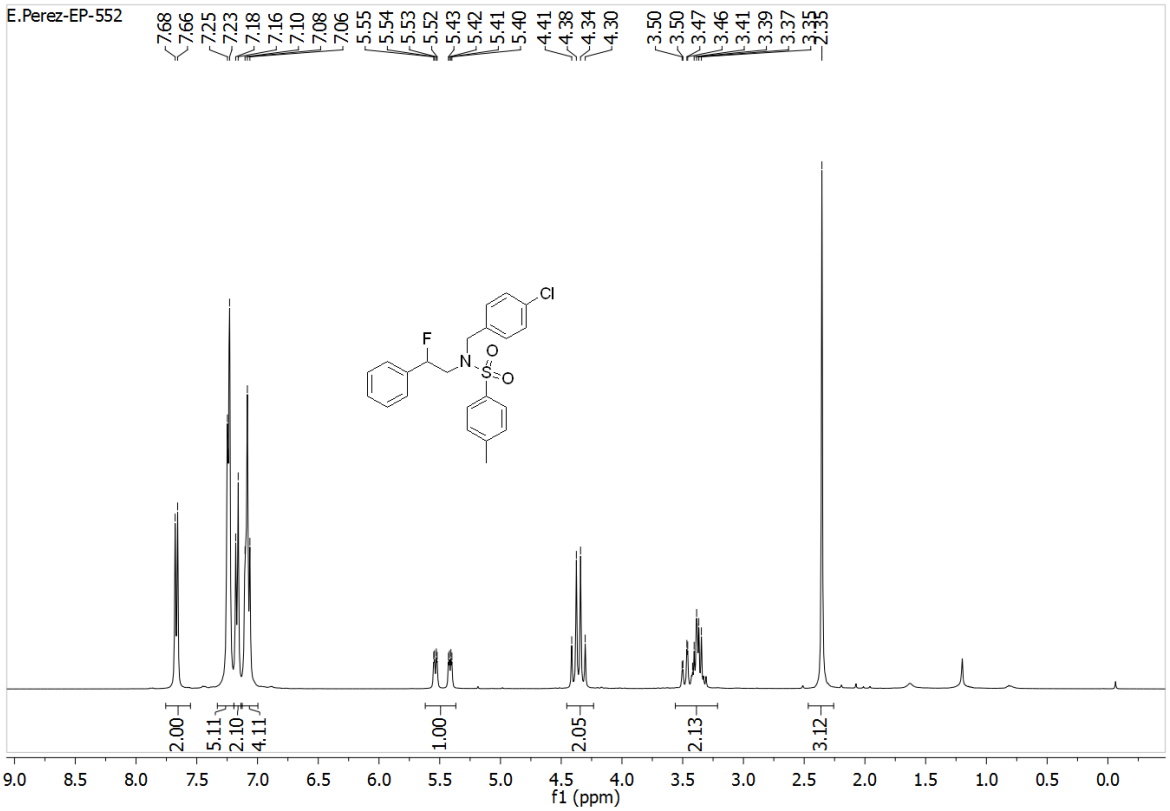

E.Perez-549
-182.70
-182.72
-182.76
-182.80
-182.82
-182.84
-182.88
-182.89
-182.93
-182.95
F
H
N
S
O
O
-182.45 -182.55 -182.65 -182.75 -182.85 -182.95 -183.05 -183.15 -183.25
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

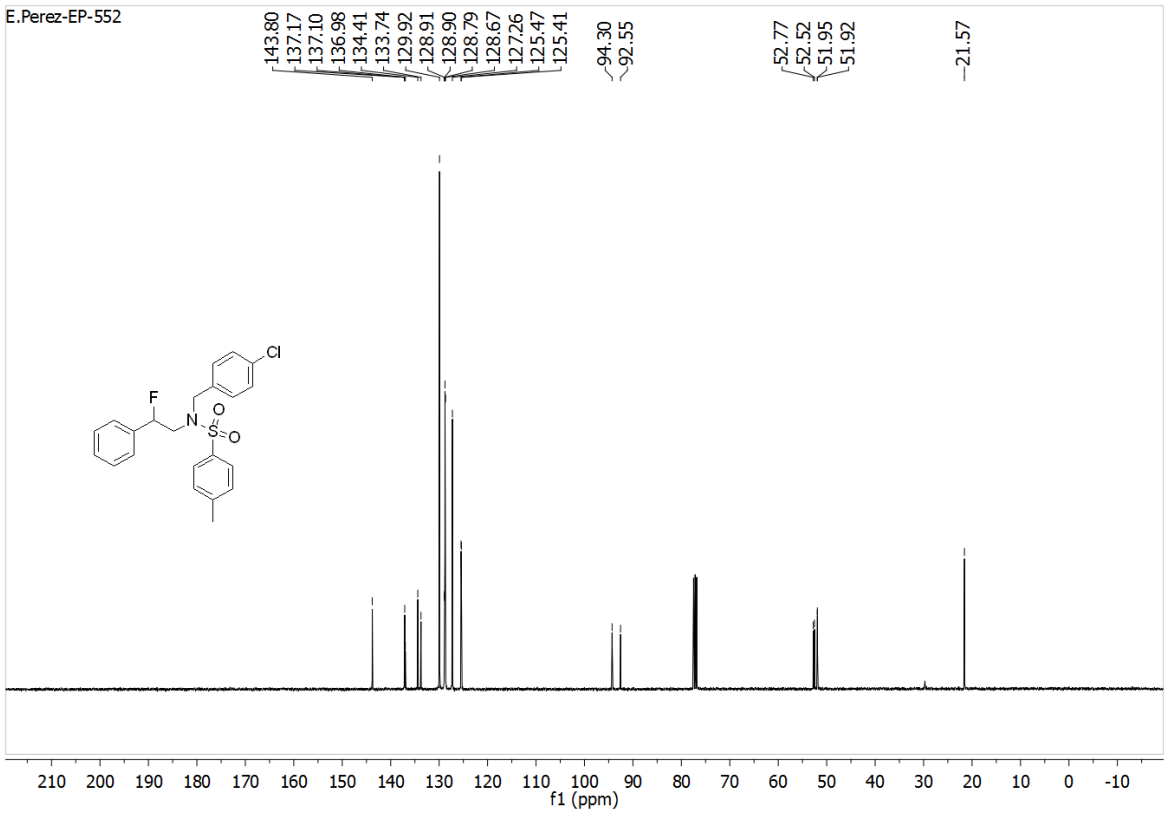

E.Perez-EP-550B
7.69
7.67
7.25
7.23
7.20
7.14
7.12
7.10
7.09
5.53
5.52
5.51
5.50
5.41
5.40
5.39
5.38
4.46
4.42
4.39
4.36
3.44
3.42
3.39
3.38
3.37
2.36
F
N
O
S
O
2.01
8.09
4.14
1.00
2.07
2.12
3.19
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

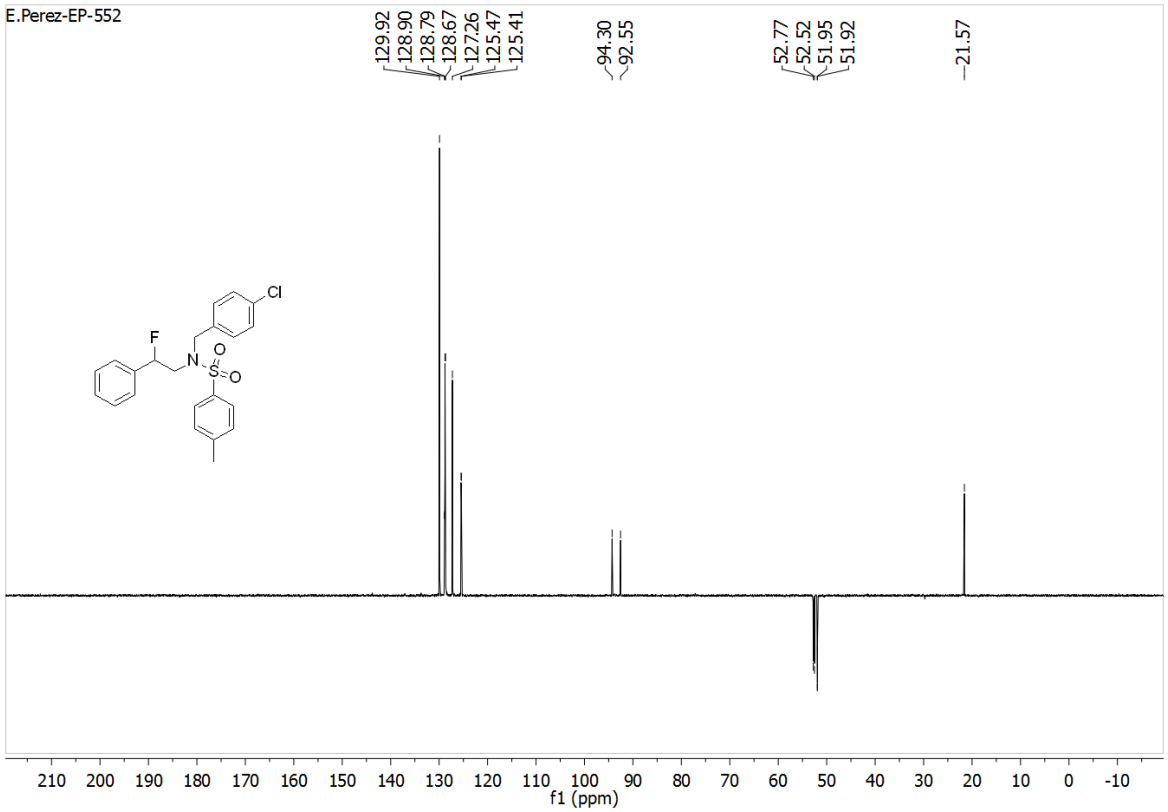

E.Perez-EP-550B
143.55
137.41
137.33
135.67
129.81
128.79
128.65
128.60
127.91
127.29
125.47
125.40
94.21
92.46
52.44
52.40
52.38
52.19
21.56
F
N
O
S
O
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

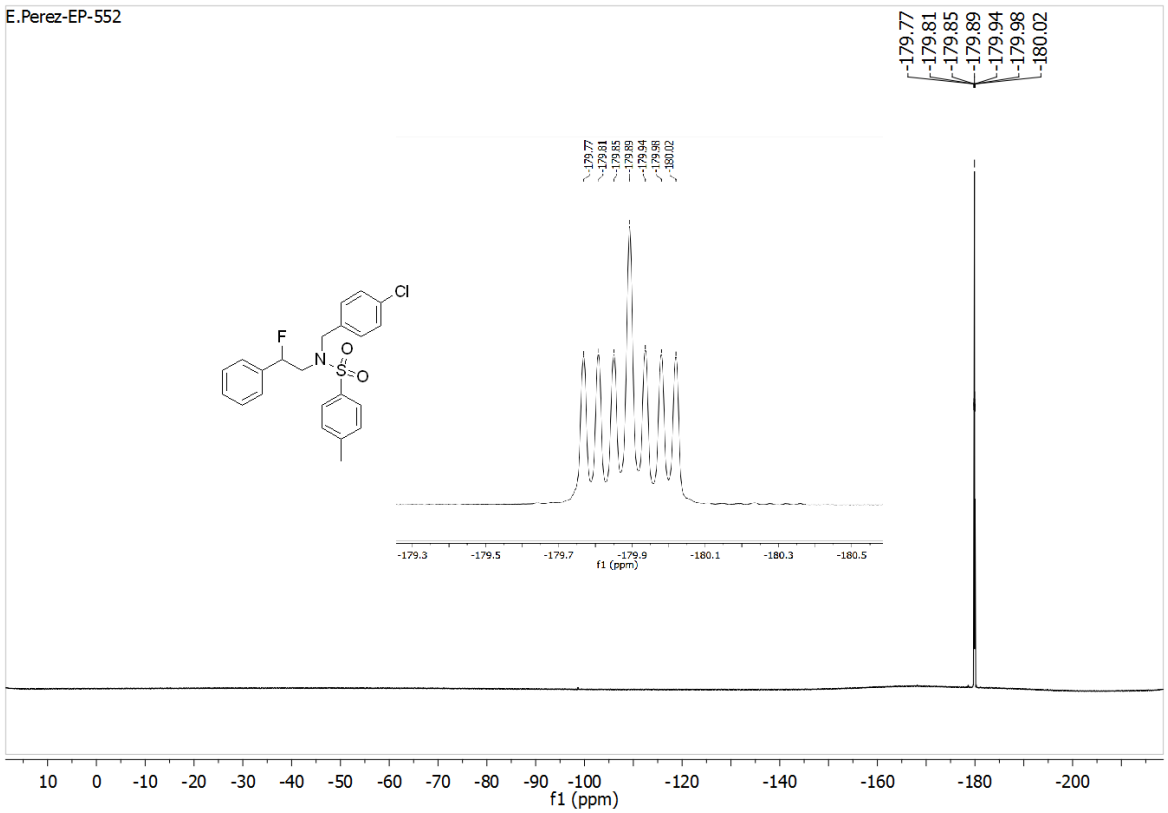

E.Perez-EP-550B
129.81
128.79
128.65
128.60
127.91
127.29
125.47
125.40
94.21
92.46
52.44
52.40
52.38
52.19
21.56
F
N
O
S
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

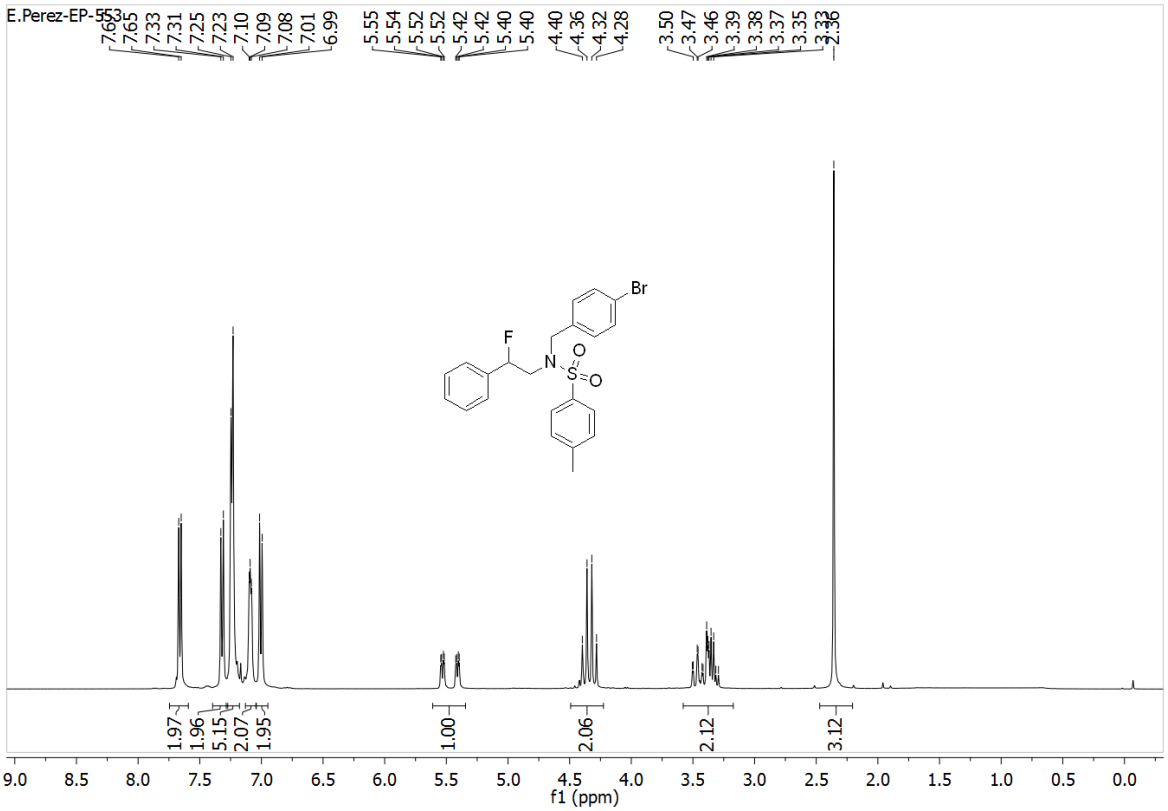

E.Perez-EP-550B
-180.39
-180.45
-180.52
-180.57
-180.59
-180.64
F
N
O
S
O
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

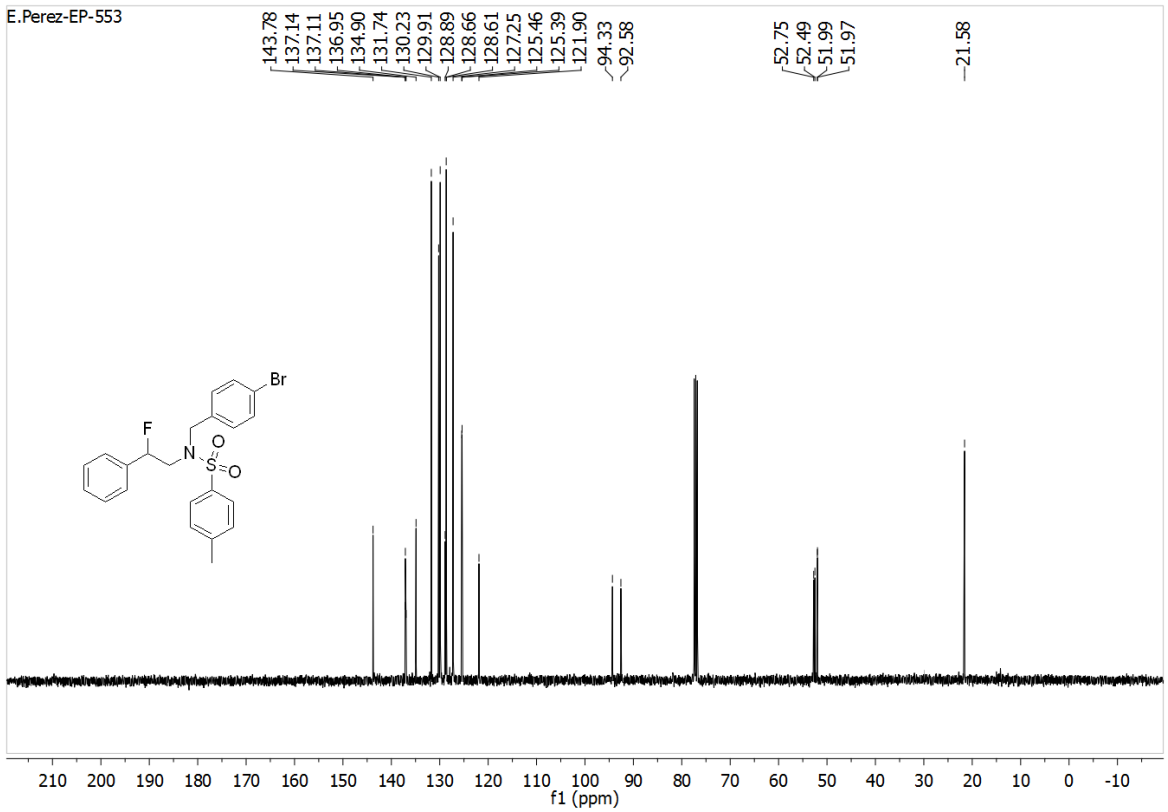

E.Perez-EP-552
7.68
7.66
7.25
7.23
7.18
7.16
7.10
7.08
7.06
5.55
5.54
5.53
5.52
5.43
5.42
5.41
5.40
4.41
4.38
4.34
4.30
3.50
3.50
3.47
3.46
3.41
3.39
3.37
3.35
2.35
Cl
F
N
O
S
O
2.00
5.11
2.10
4.11
1.00
2.05
2.13
3.12
f1 (ppm)

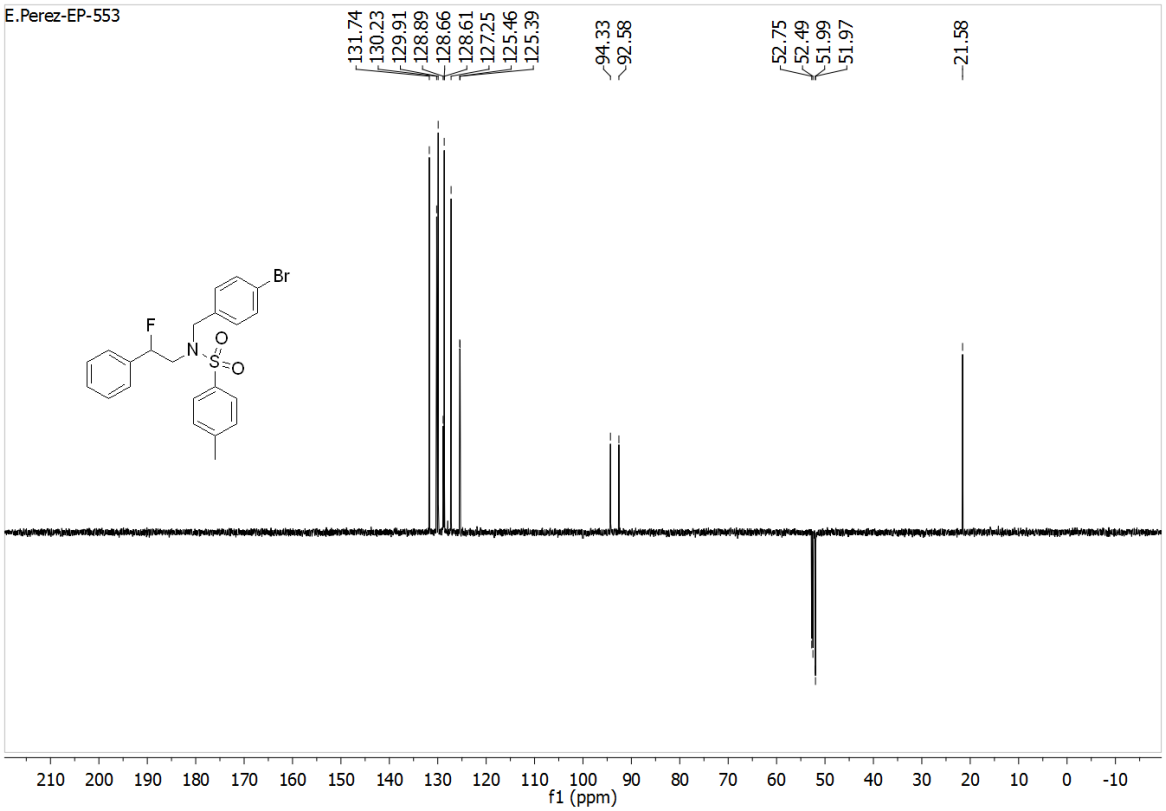

E.Perez-EP-552
143.80
137.17
137.10
136.98
134.41
133.74
129.92
128.91
128.90
128.79
128.67
127.26
125.47
125.41
94.30
92.55
52.77
52.52
51.95
51.92
21.57
Cl
F
N
O
S
O
f1 (ppm)

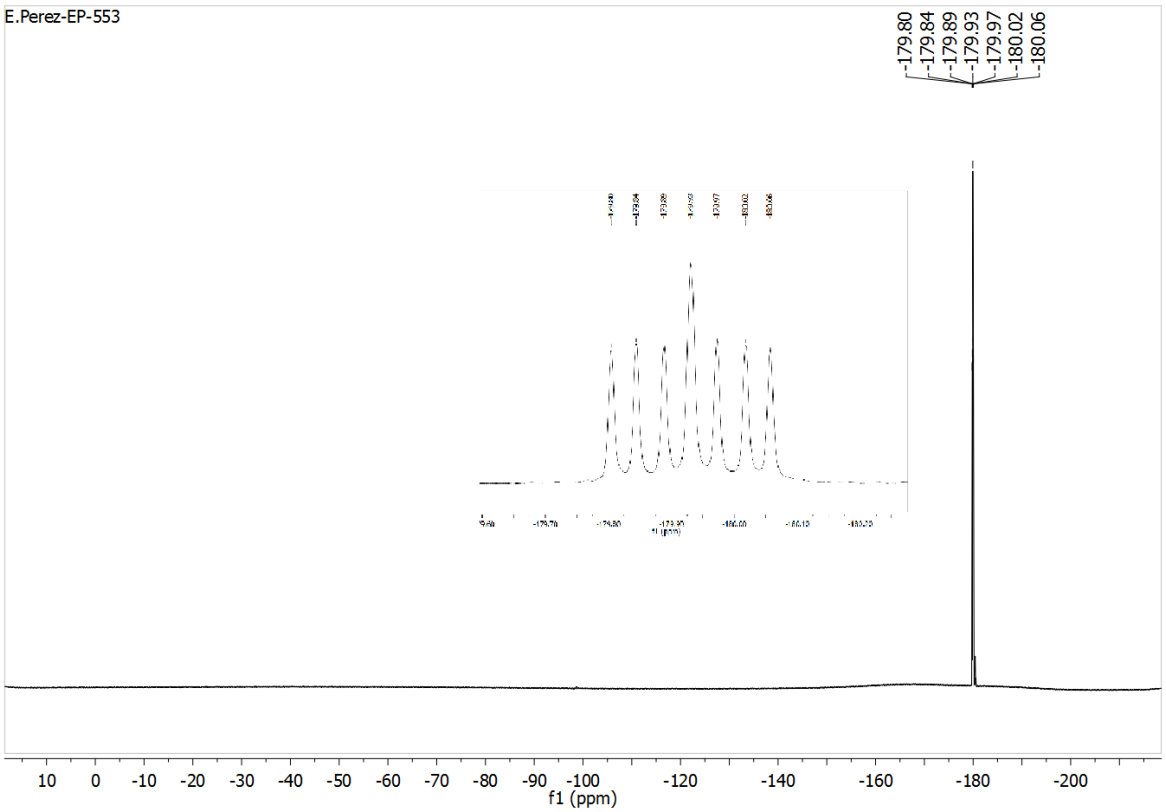

E.Perez-EP-552
129.92
128.90
128.79
128.67
127.26
125.47
125.41
94.30
92.55
52.77
52.52
51.95
51.92
21.57
Cl
F
N
O
S
O
f1 (ppm)

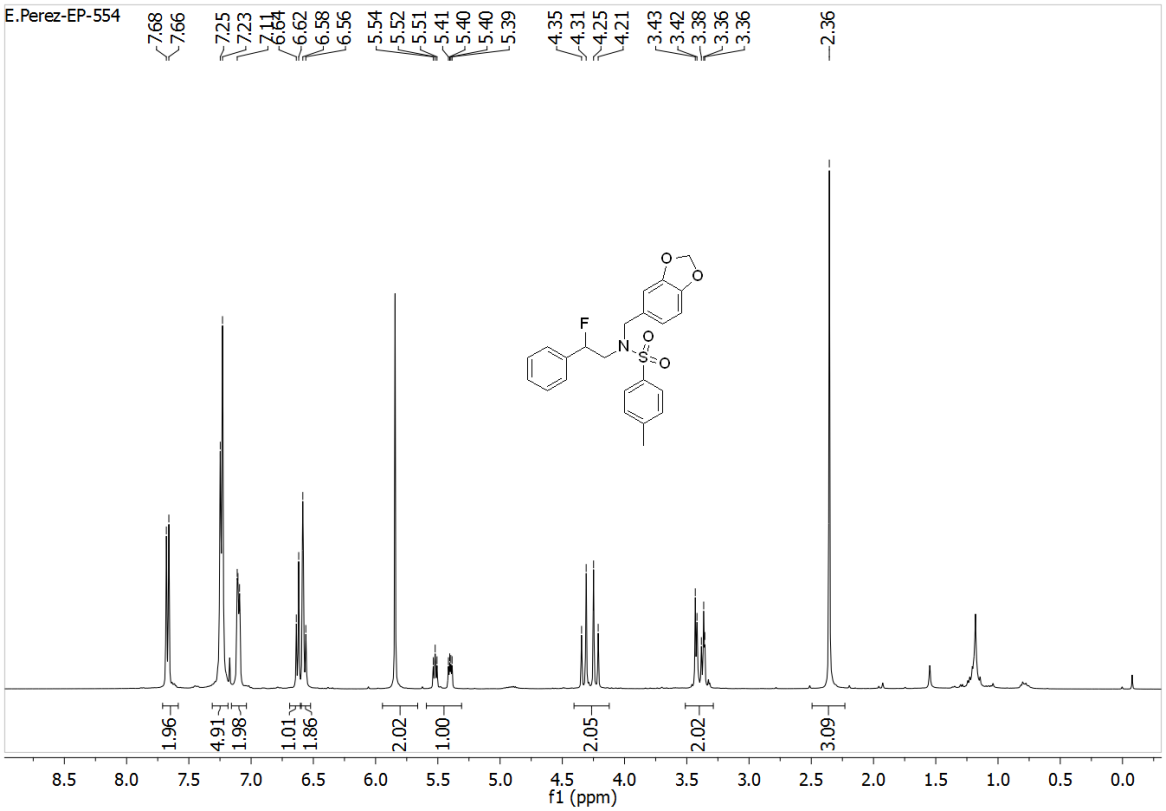

E.Perez-EP-552
-179.77
-179.81
-179.85
-179.89
-179.94
-179.98
-180.02
Cl
F
N
O
S
O
f1 (ppm)

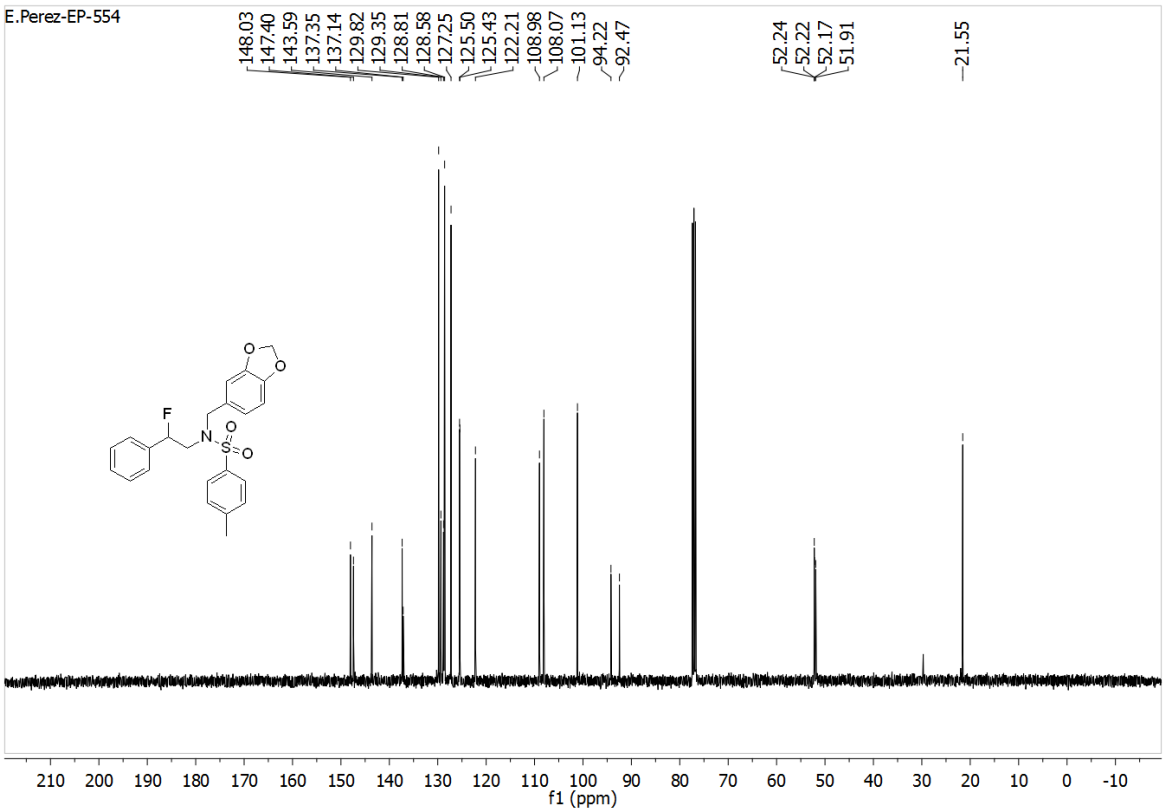

E.Perez-EP-553
7.68
7.65
7.33
7.31
7.25
7.23
7.10
7.09
7.08
7.01
6.99
5.55
5.54
5.52
5.52
5.42
5.42
5.40
5.40
4.40
4.36
4.32
4.28
3.50
3.47
3.46
3.39
3.38
3.37
3.35
2.36
Br
F
N
O
S
O
1.97
1.96
5.15
2.07
1.95
1.00
2.06
2.12
3.12
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

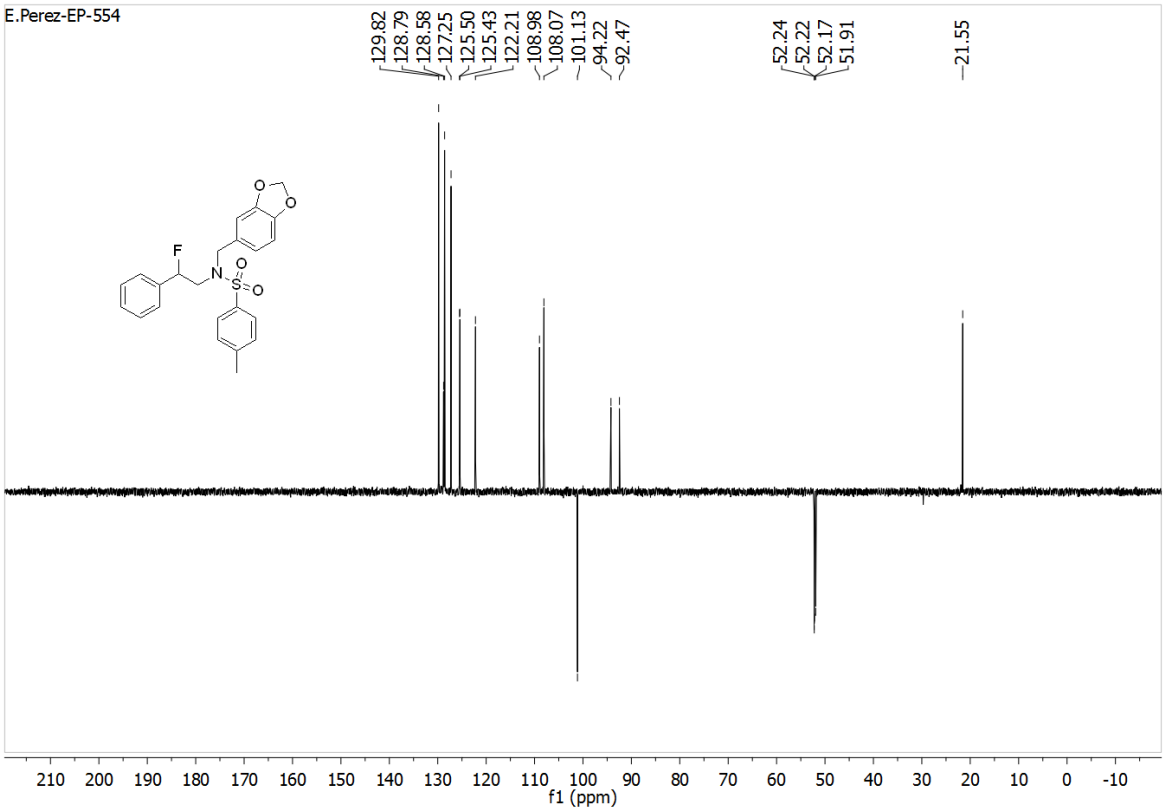

E.Perez-EP-553
143.78
137.14
137.11
136.95
134.90
131.74
130.23
129.91
128.89
128.66
128.61
127.25
125.46
125.39
121.90
94.33
92.58
52.75
52.49
51.99
51.97
21.58
Br
F
N
O
S
O
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

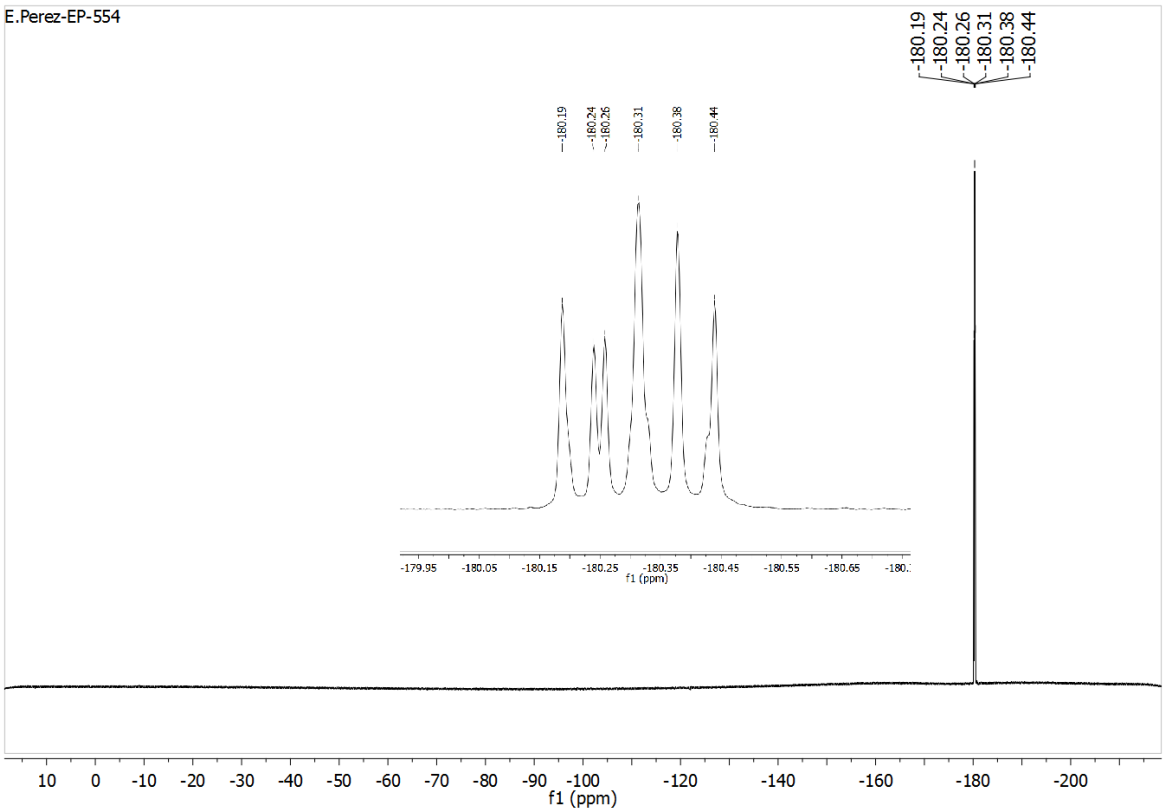

E.Perez-EP-553
131.74
130.23
129.91
128.89
128.66
128.61
127.25
125.46
125.39
94.33
92.58
52.75
52.49
51.99
51.97
21.58
Br
F
N
O
S
O
f1 (ppm)

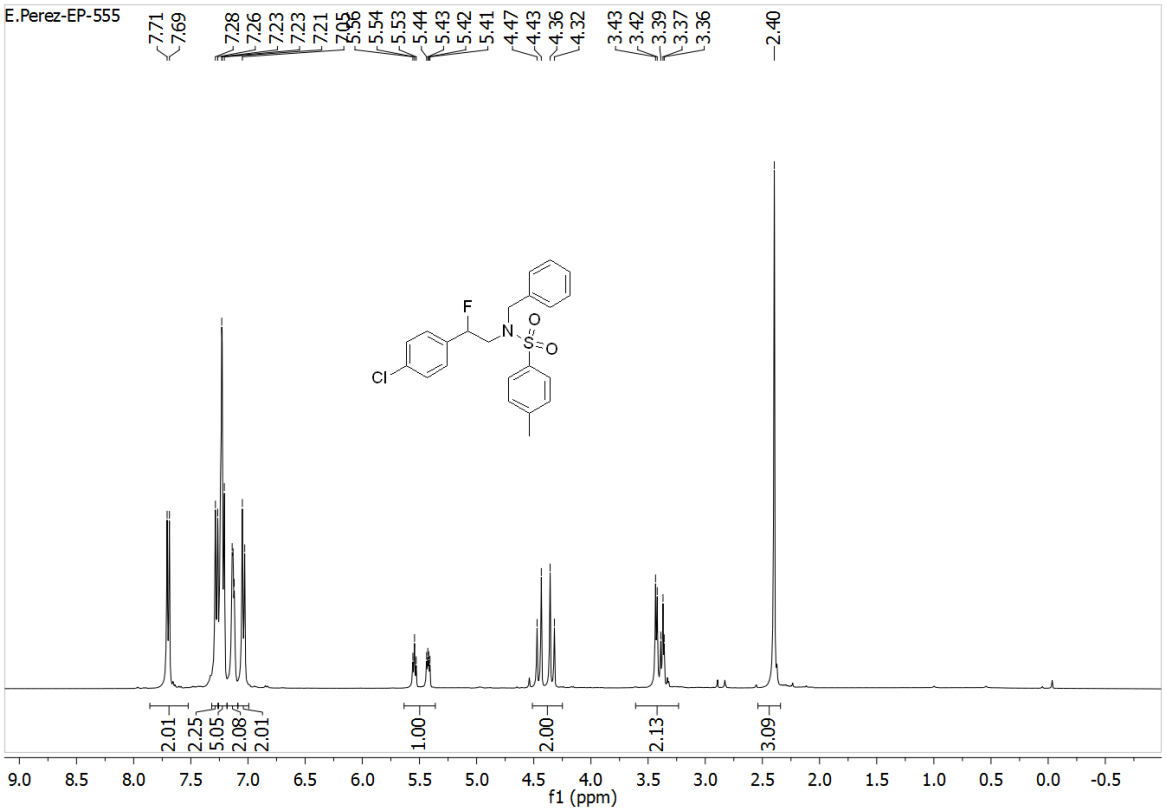

E.Perez-EP-553
-179.80
-179.84
-179.89
-179.93
-179.97
-180.02
-180.06
f1 (ppm)

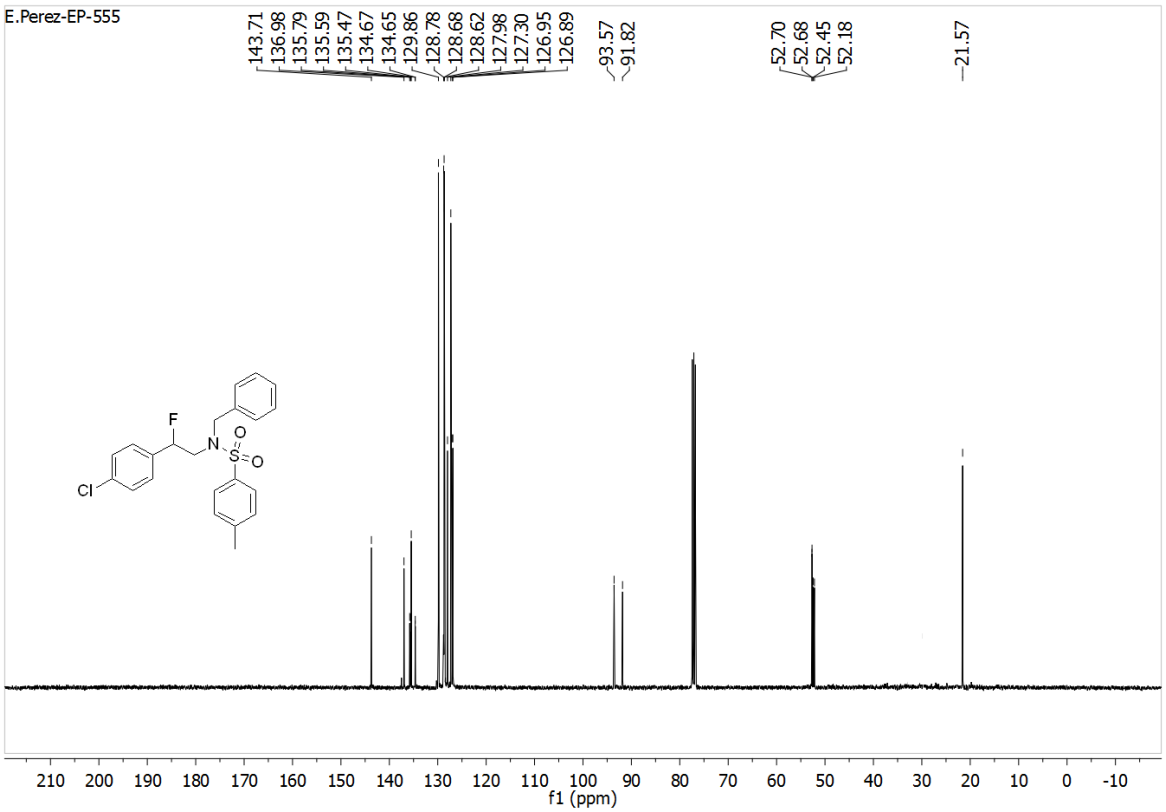

E.Perez-EP-554
7.68
7.66
7.25
7.23
7.11
6.64
6.62
6.58
6.56
5.54
5.52
5.51
5.41
5.40
5.40
5.39
4.35
4.31
4.25
4.21
3.43
3.42
3.38
3.36
3.36
2.36
1.96
4.91
1.98
1.01
1.86
2.02
1.00
2.05
2.02
3.09
f1 (ppm)

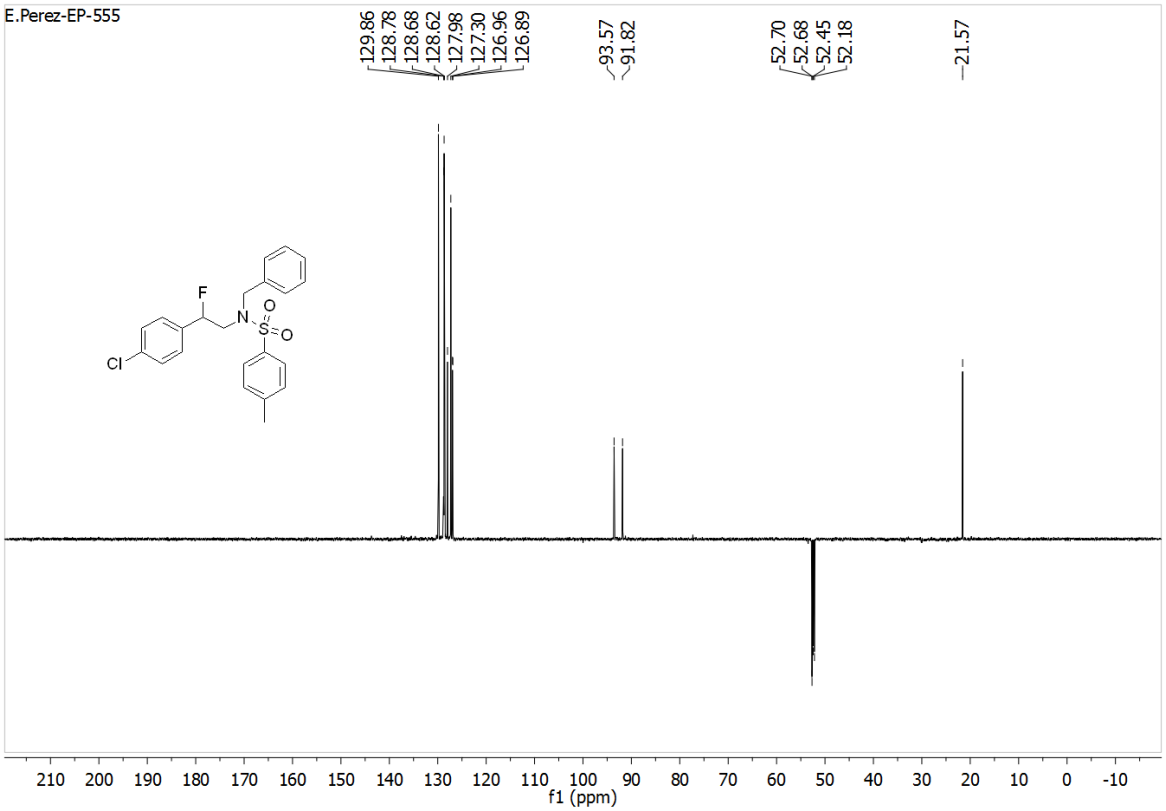

E.Perez-EP-554
148.03
147.40
143.59
137.35
137.14
129.82
129.35
128.81
128.58
127.25
125.50
125.43
122.21
108.98
108.07
101.13
94.22
92.47
52.24
52.22
52.17
51.91
21.55
f1 (ppm)

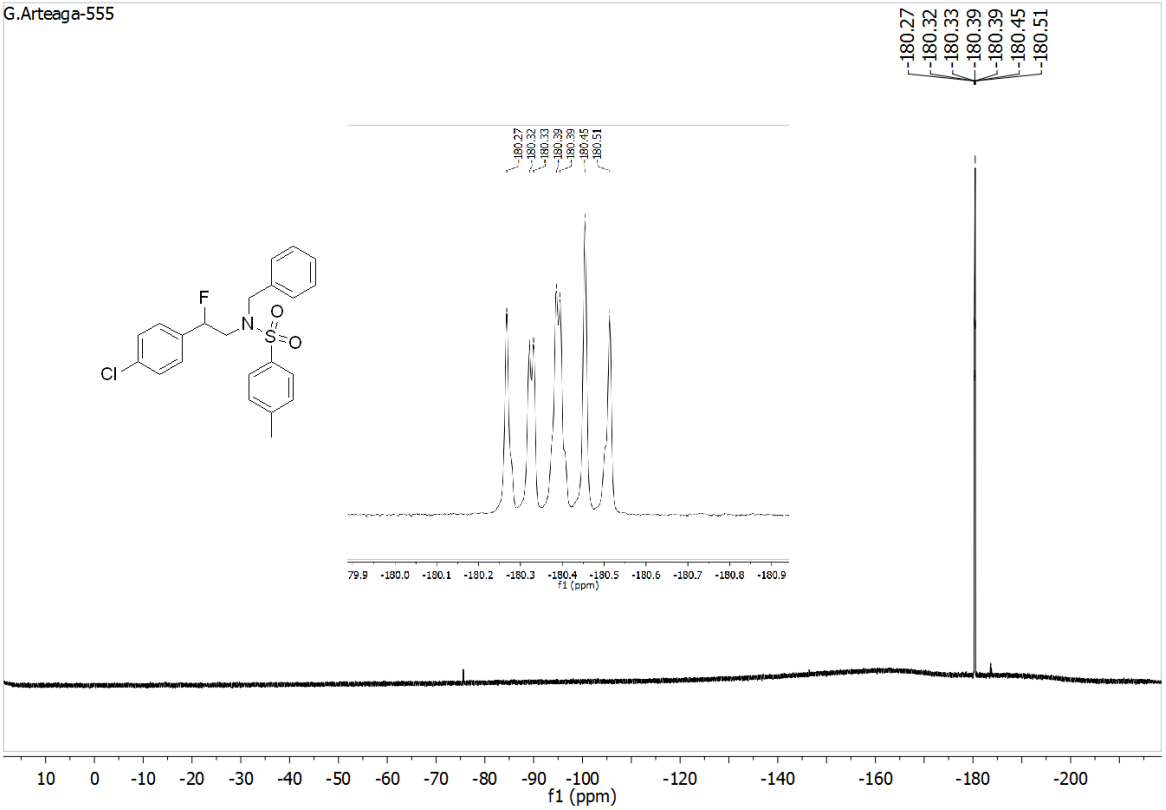

E.Perez-EP-554
129.82
128.79
128.58
127.25
125.50
125.43
122.21
108.98
108.07
101.13
94.22
92.47
52.24
52.22
52.17
51.91
21.55
F
N
O
S
O
O
O
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

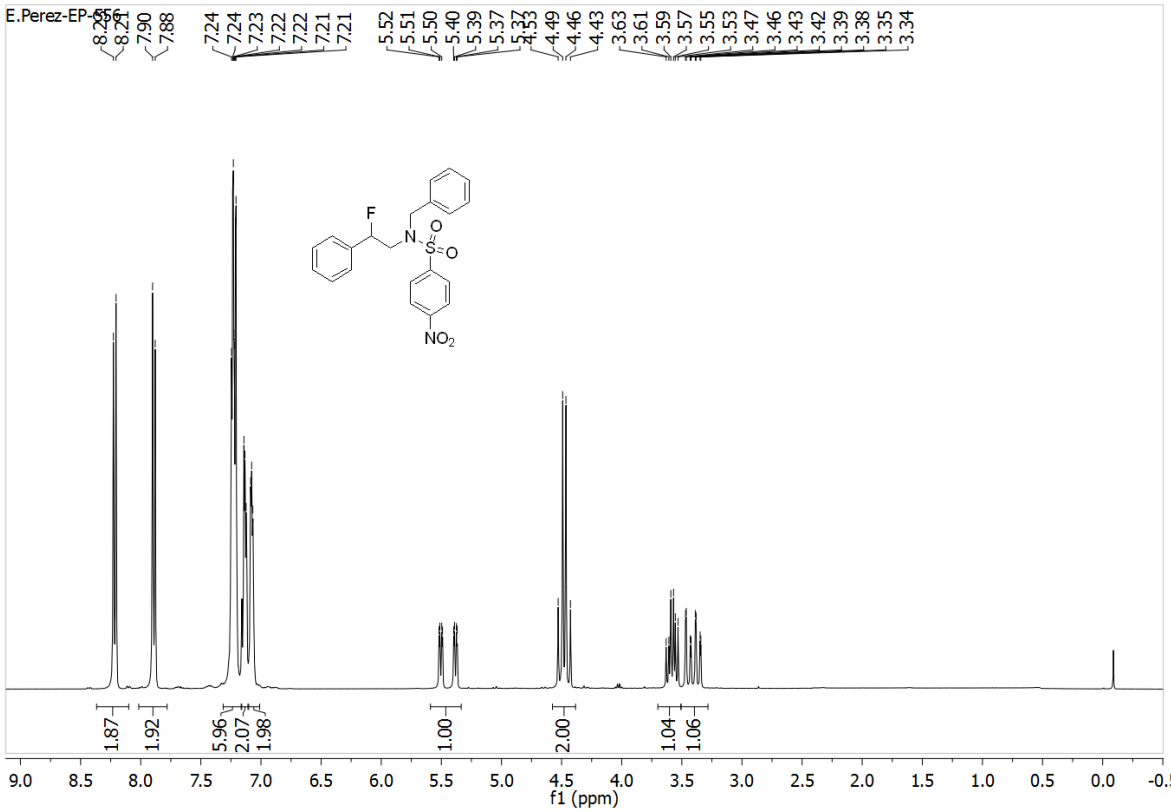

E.Perez-EP-554
-180.19
-180.24
-180.26
-180.31
-180.38
-180.44
-179.95 -180.05 -180.15 -180.25 -180.35 -180.45 -180.55 -180.65
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

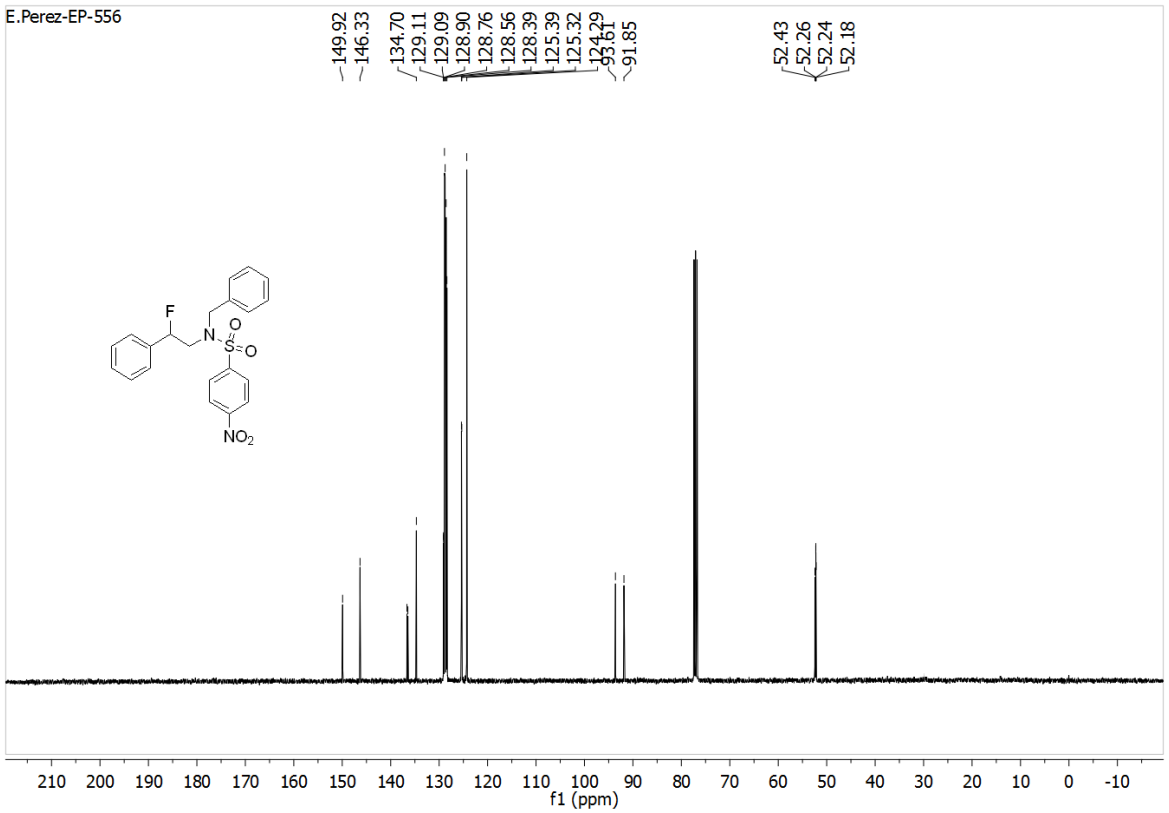

E.Perez-EP-555
7.71
7.69
7.28
7.26
7.23
7.23
7.21
7.05
5.56
5.54
5.53
5.44
5.43
5.42
5.41
4.47
4.43
4.36
4.32
3.43
3.42
3.39
3.37
3.36
2.40
F
Cl
N
S
O
O
2.01
2.25
5.05
2.08
2.01
1.00
2.00
2.13
3.09
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

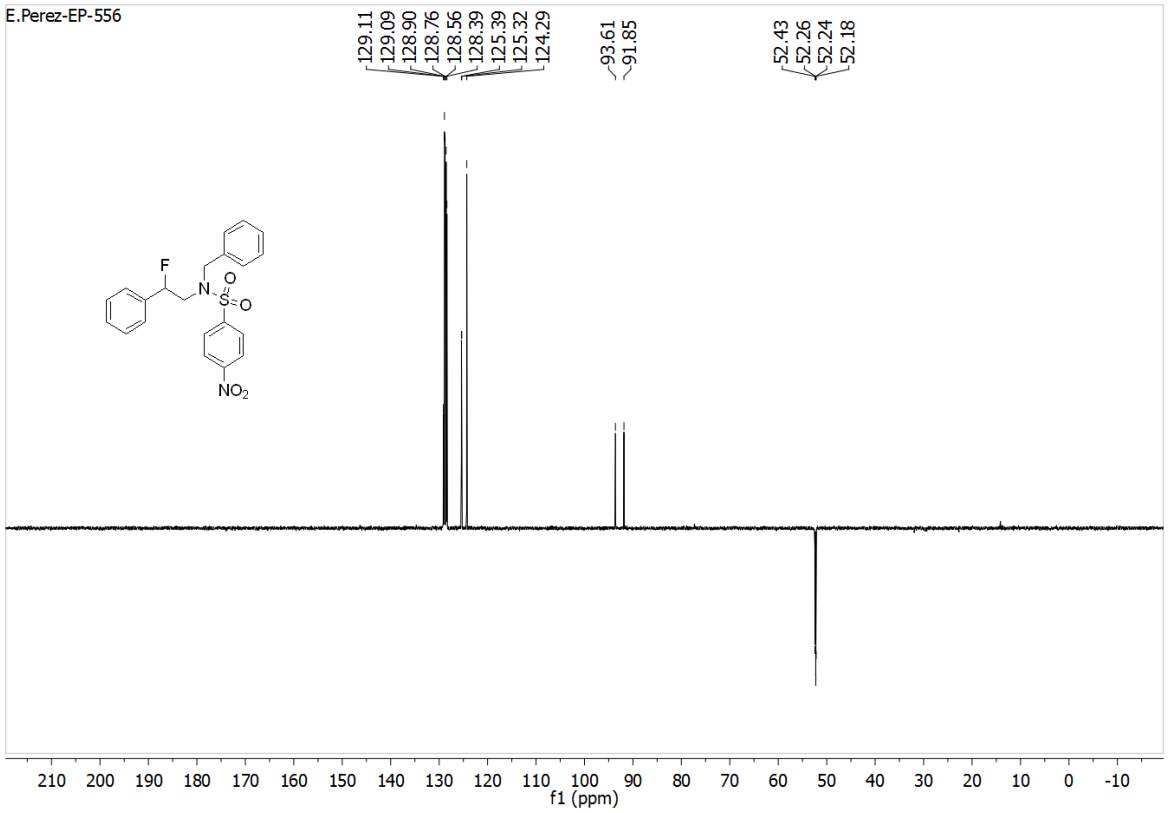

E.Perez-EP-555
143.71
136.98
135.79
135.59
135.47
134.67
134.65
129.86
128.78
128.68
128.62
127.98
127.30
126.95
126.89
93.57
91.82
52.70
52.68
52.45
52.18
21.57
F
Cl
N
S
O
O
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

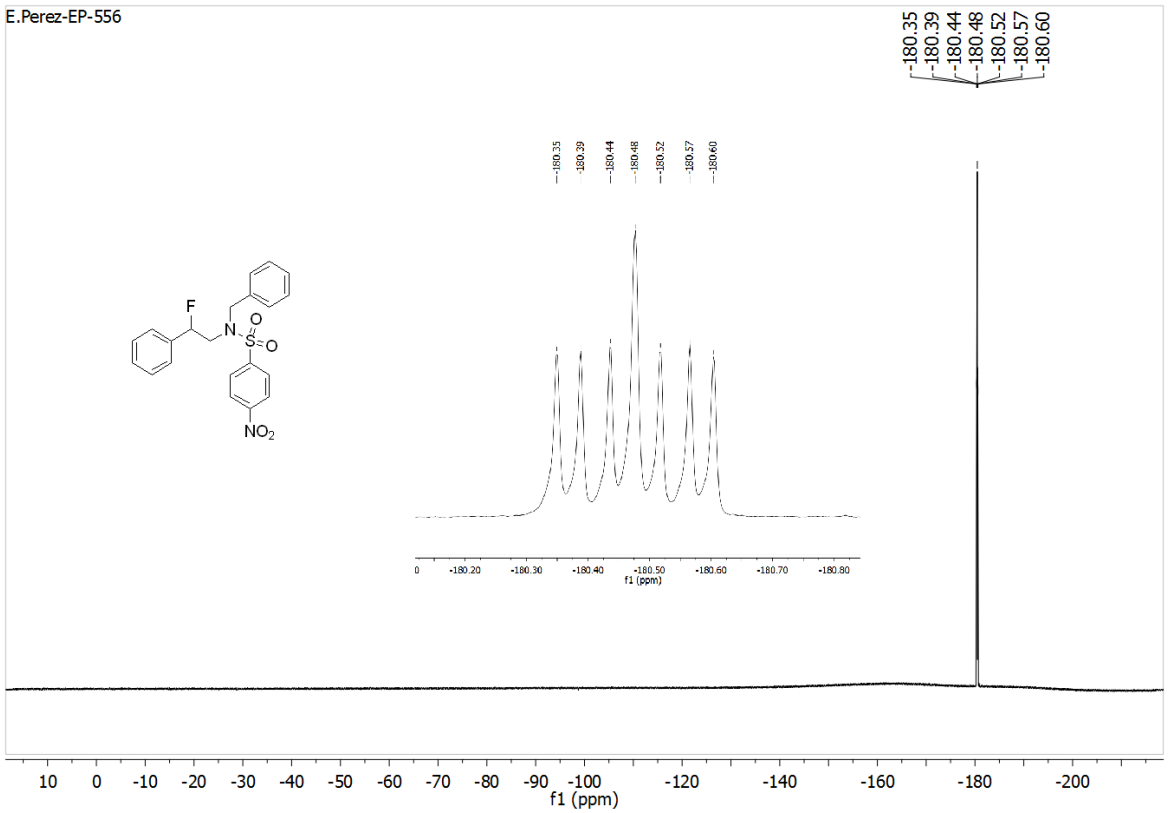

E.Perez-EP-555
129.86
128.78
128.68
128.62
127.98
127.30
126.96
126.89
93.57
91.82
52.70
52.68
52.45
52.18
21.57
F
N
O
S
O
Cl
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

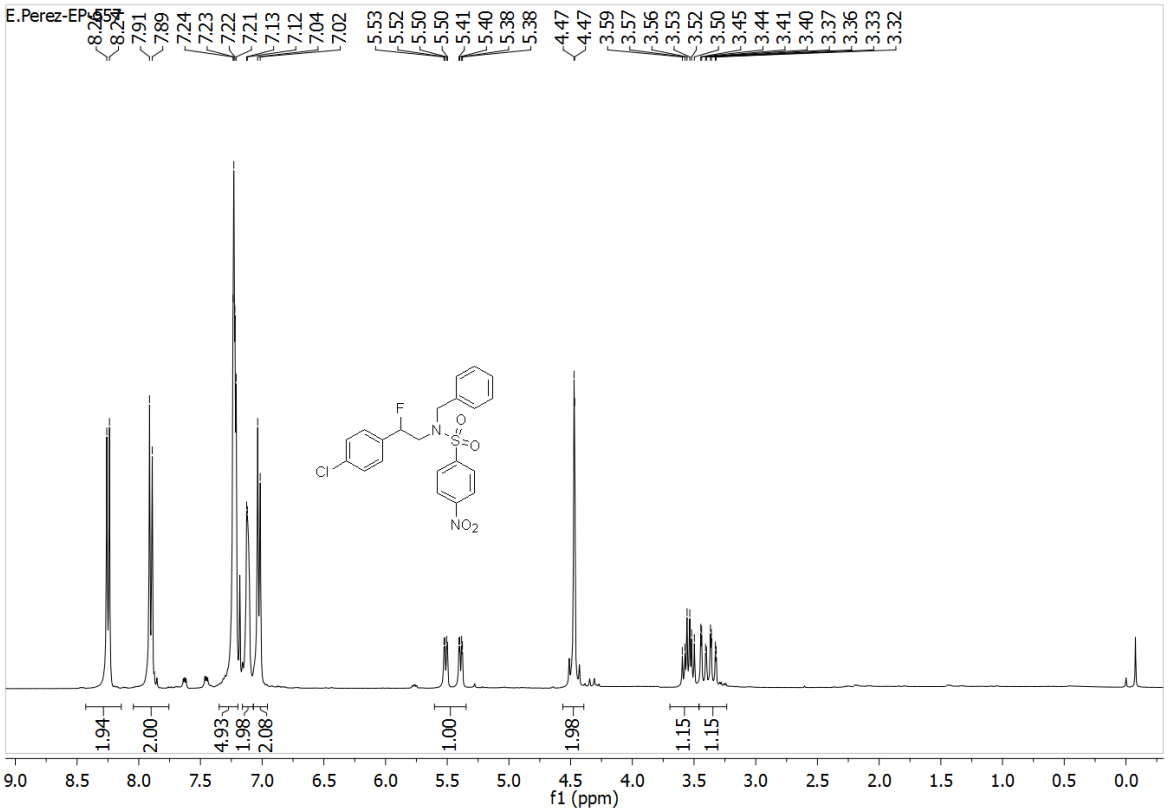

G.Arteaga-555
-180.27
-180.32
-180.33
-180.39
-180.39
-180.45
-180.51
F
N
O
S
O
Cl
79.9 -180.0 -180.1 -180.2 -180.3 -180.4 -180.5 -180.6 -180.7 -180.8 -180.9
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

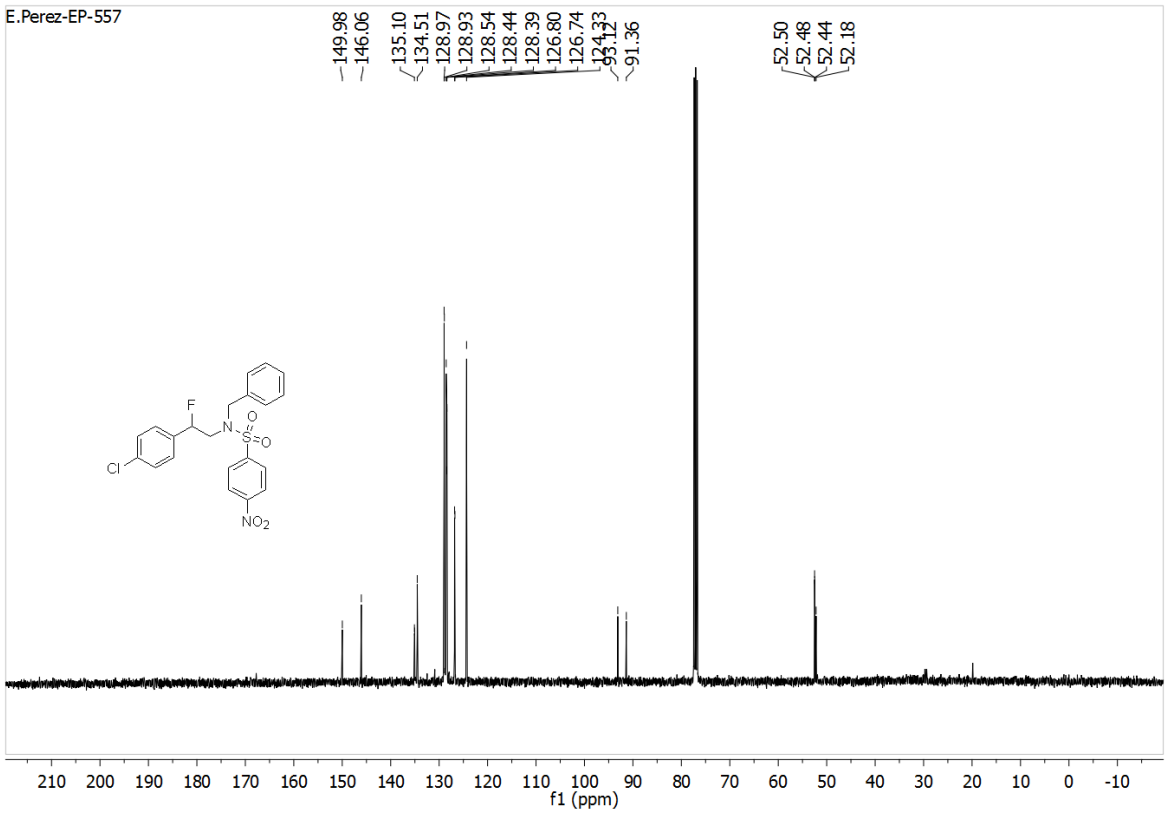

E.Perez-EP-556
8.23
8.21
7.90
7.88
7.24
7.24
7.23
7.22
7.22
7.21
7.21
5.52
5.51
5.50
5.40
5.39
5.37
5.37
4.53
4.49
4.46
4.43
3.63
3.61
3.59
3.57
3.55
3.53
3.47
3.46
3.43
3.42
3.39
3.38
3.35
3.34
F
N
O
S
O
NO2
1.87
1.92
5.96
2.07
1.98
1.00
2.00
1.04
1.06
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

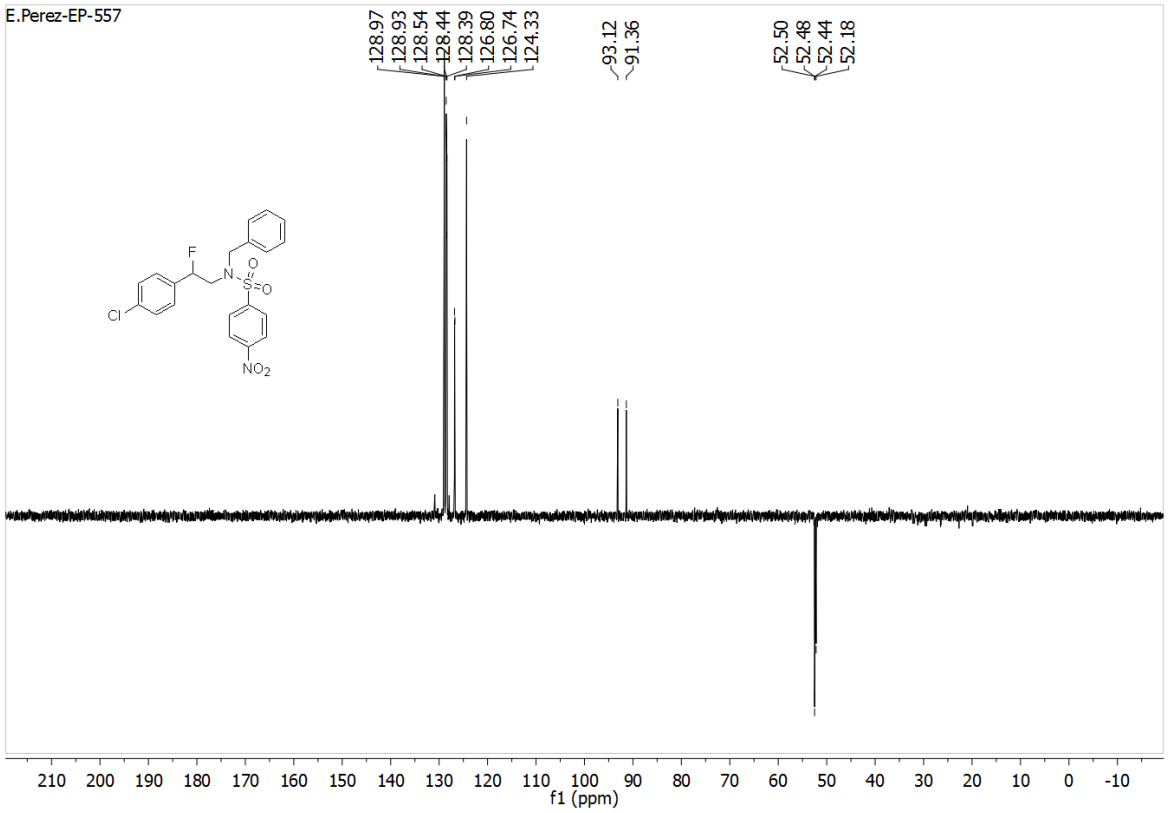

E.Perez-EP-556
149.92
146.33
134.70
129.11
129.09
128.90
128.76
128.56
128.39
125.39
125.32
124.29
93.61
91.85
52.43
52.26
52.24
52.18
F
N
O
S
O
NO2
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

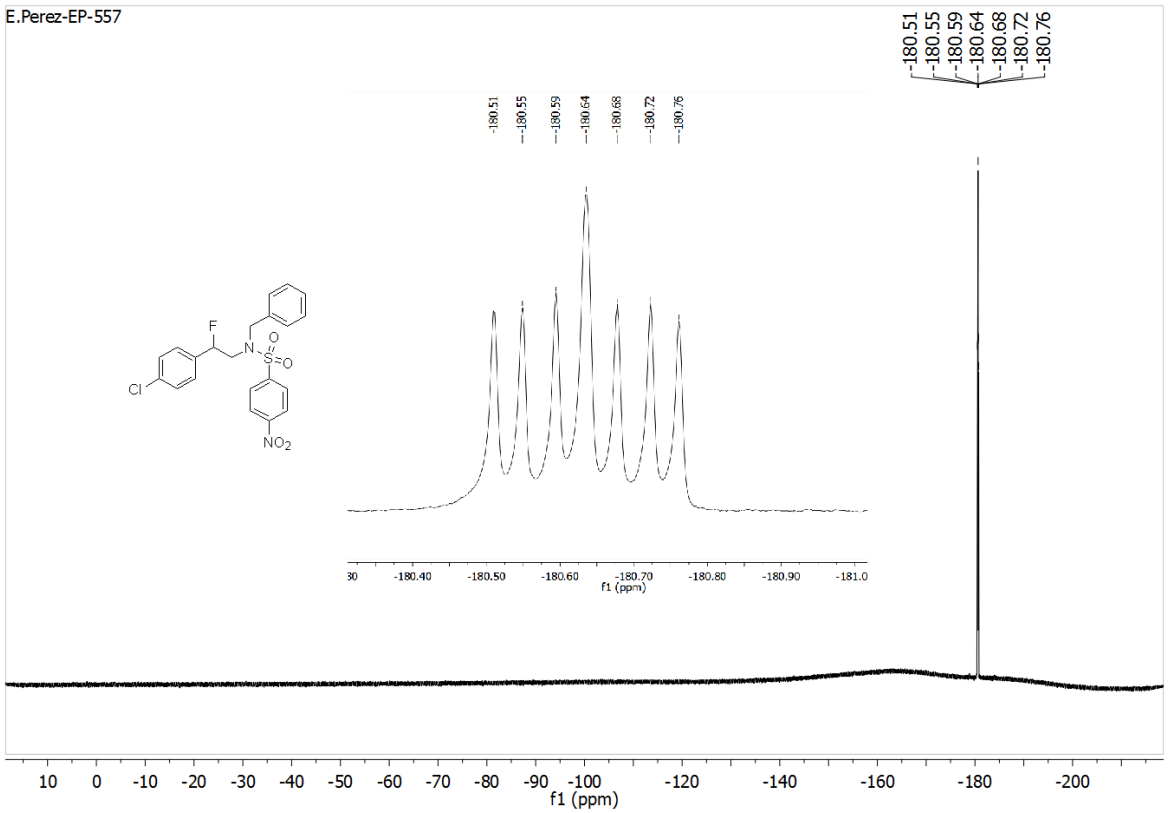

E.Perez-EP-556
129.11
129.09
128.90
128.76
128.56
128.39
125.39
125.32
124.29
93.61
91.85
52.43
52.26
52.24
52.18
F
N
O
S
O
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

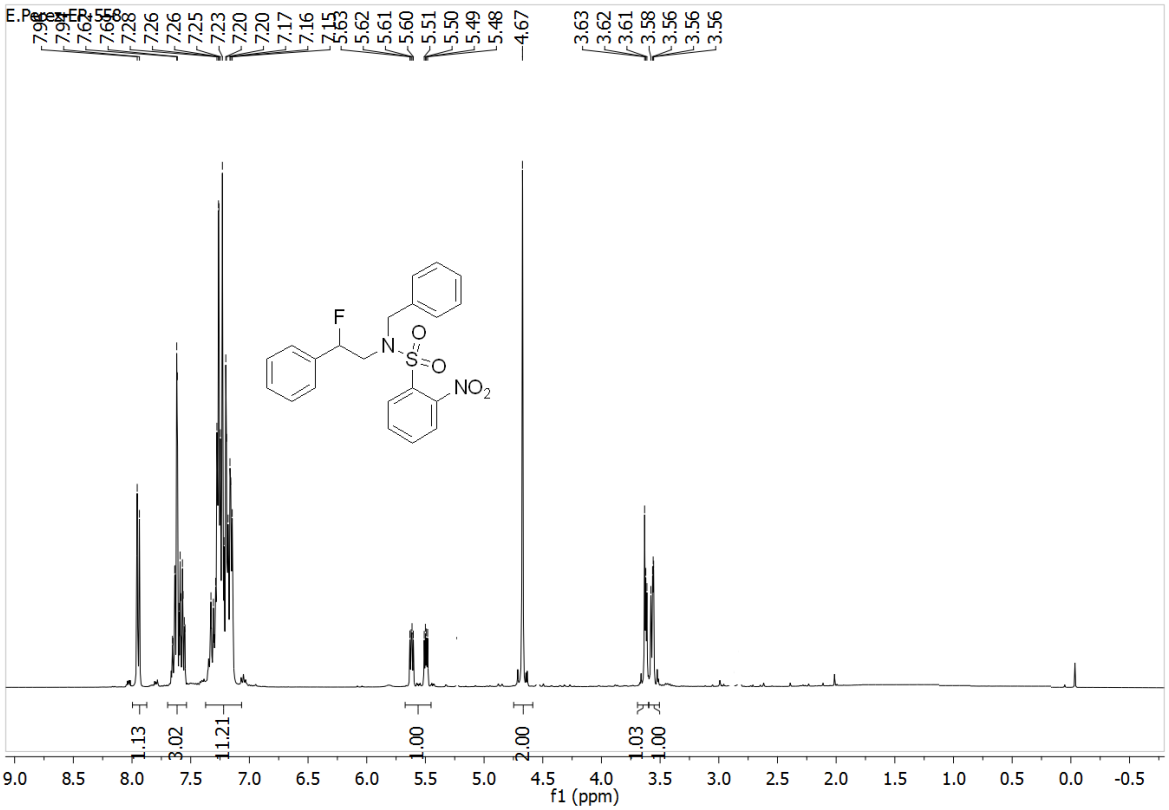

E.Perez-EP-556
-180.35
-180.39
-180.44
-180.48
-180.52
-180.57
-180.60
F
N
O
S
O
NO2
0 -180.20 -180.30 -180.40 -180.50 -180.60 -180.70 -180.80
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

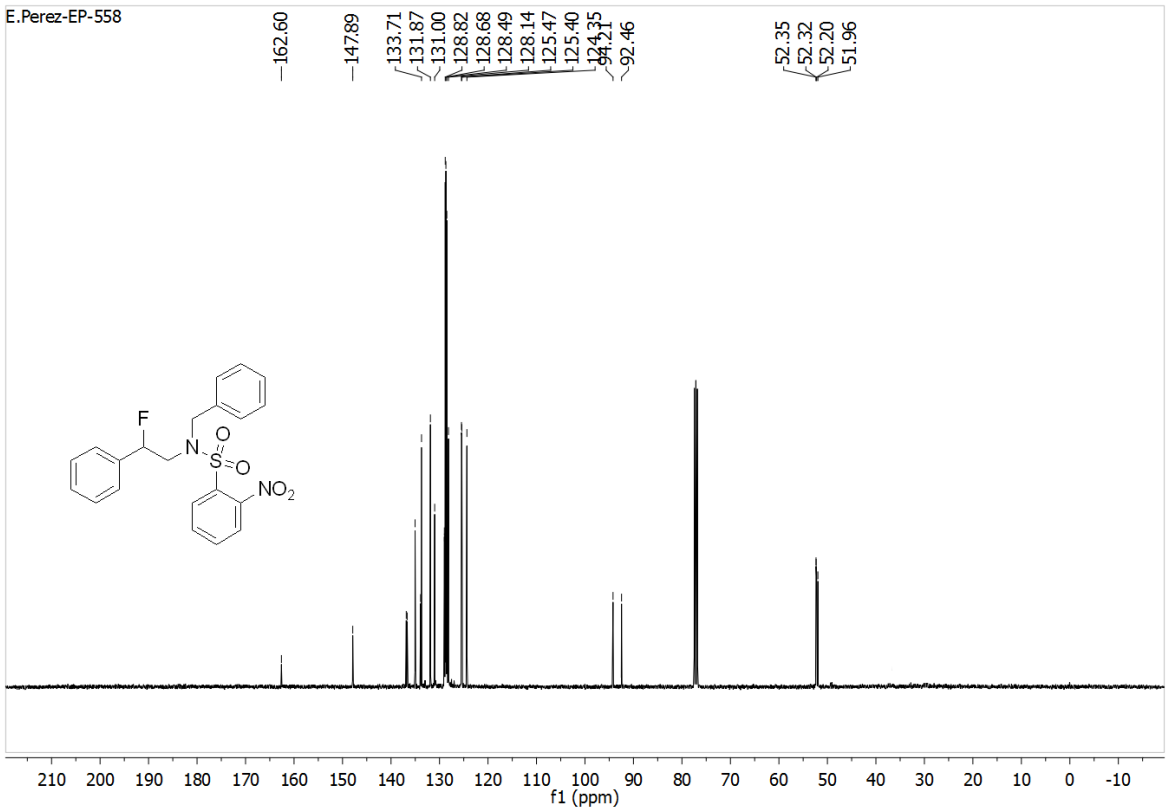

E.Perez-EP-557
8.26
8.24
7.91
7.89
7.24
7.23
7.22
7.21
7.13
7.12
7.04
7.02
5.53
5.52
5.50
5.50
5.41
5.40
5.38
5.38
4.47
4.47
3.59
3.57
3.56
3.53
3.52
3.50
3.45
3.44
3.41
3.40
3.37
3.36
3.33
3.32
F
N
O
S
O
Cl
NO2
1.94
2.00
4.93
1.98
2.08
1.00
1.98
1.15
1.15
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

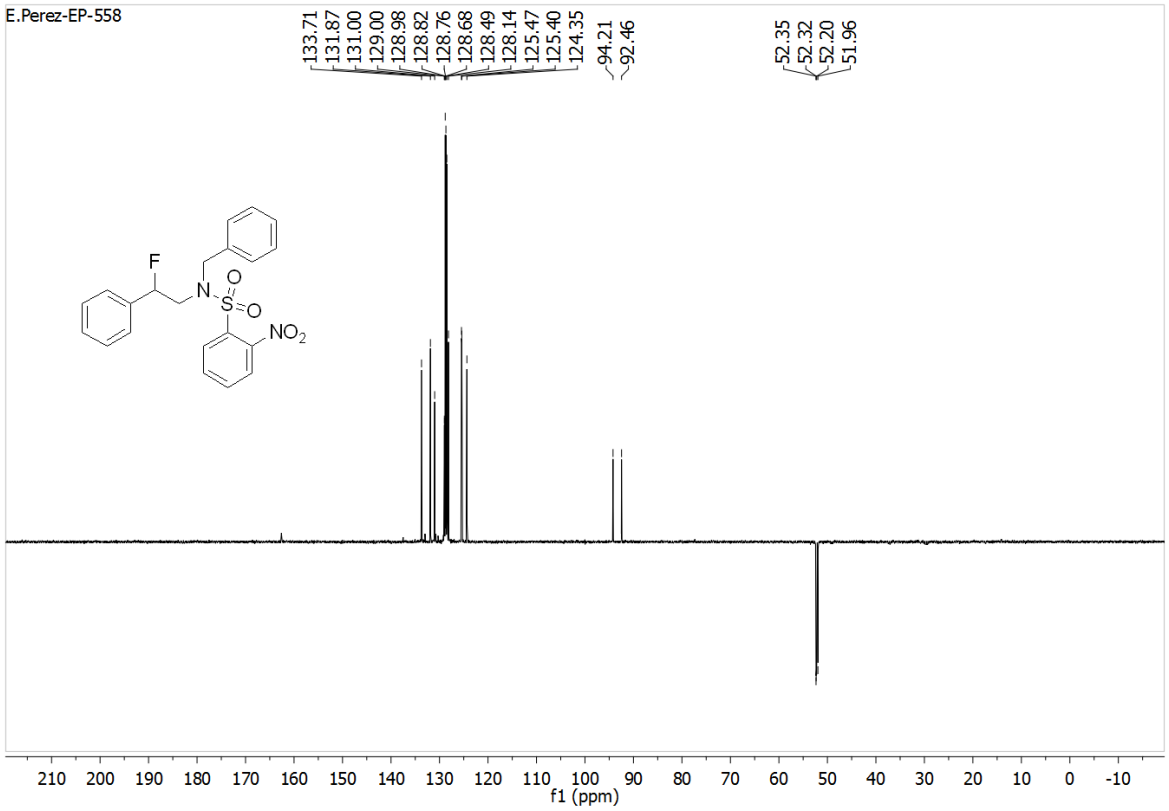

E.Perez-EP-557
149.98
146.06
135.10
134.51
128.97
128.93
128.54
128.44
128.39
126.80
126.74
124.33
93.12
91.36
52.50
52.48
52.44
52.18
F
N
O
S
O
Cl
NO2
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

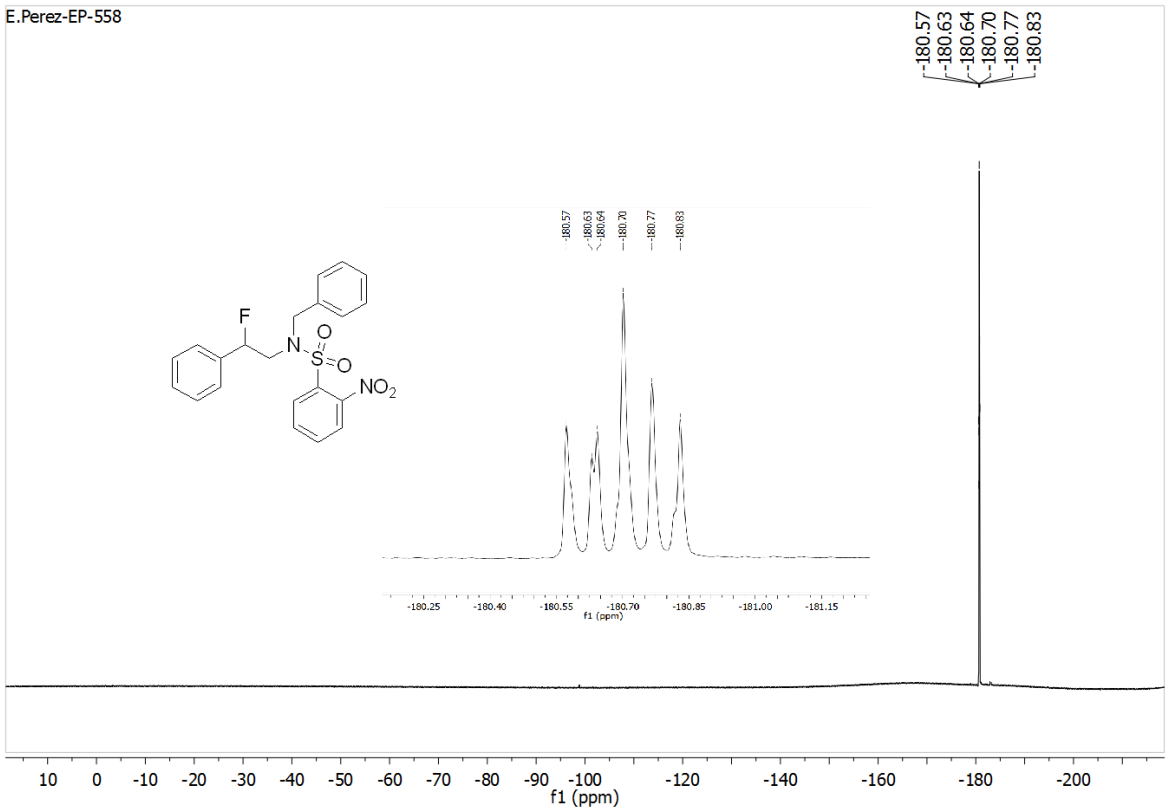

E.Perez-EP-557
128.97
128.93
128.54
128.44
128.39
126.80
126.74
124.33
93.12
91.36
52.50
52.48
52.44
52.18
F
Cl
N
O
S
O
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

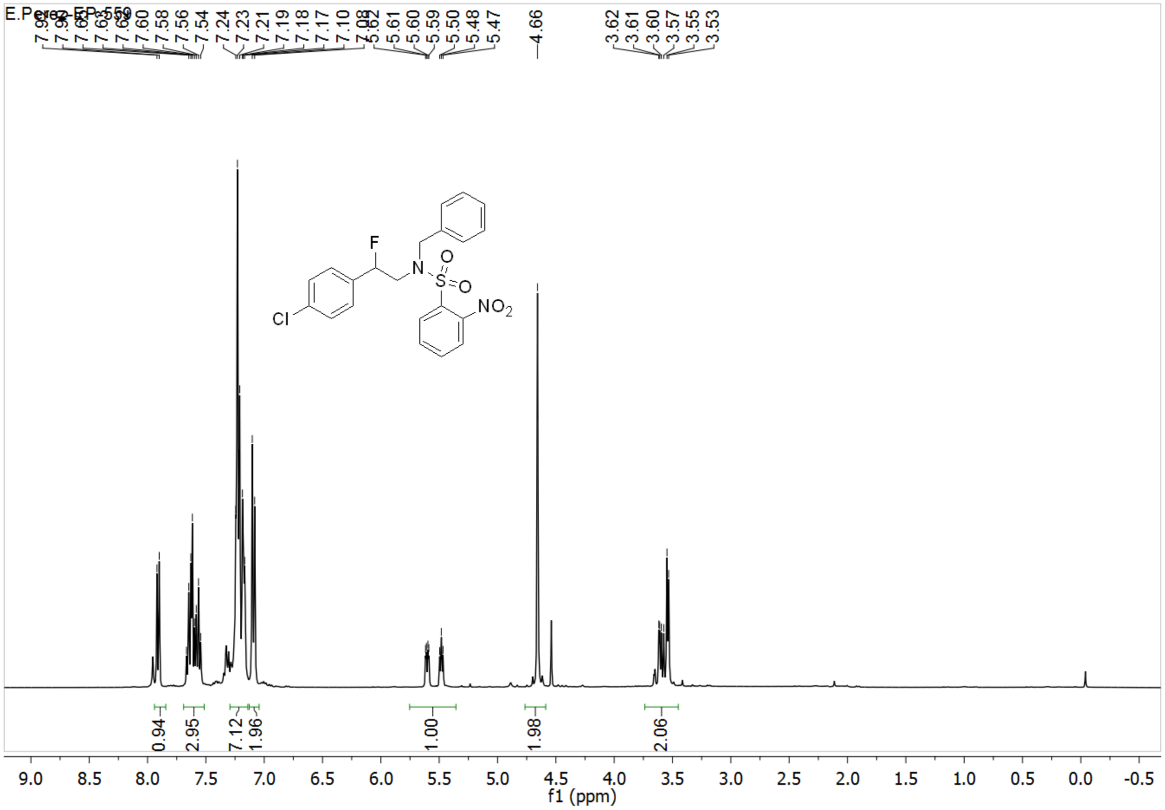

E.Perez-EP-557
-180.51
-180.55
-180.59
-180.64
-180.68
-180.72
-180.76
F
Cl
N
O
S
O
NO2
-180.40
-180.50
-180.60
-180.70
-180.80
-180.90
-181.0
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

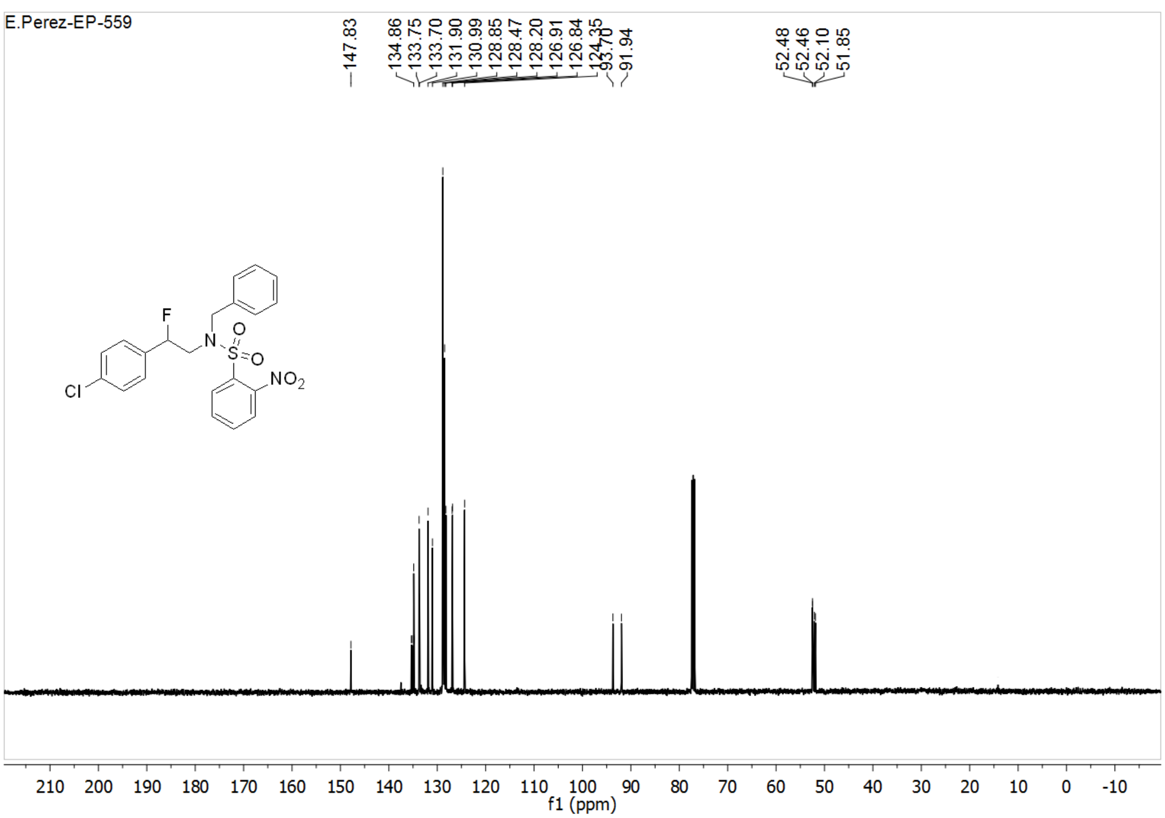

E.Perez-EP-558
7.96
7.94
7.62
7.60
7.28
7.26
7.26
7.25
7.23
7.20
7.20
7.17
7.16
7.15
5.63
5.62
5.61
5.60
5.51
5.50
5.49
5.48
4.67
3.63
3.62
3.61
3.58
3.56
3.56
3.56
F
N
O
S
O
NO2
1.13
3.02
11.21
1.00
2.00
1.03
1.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

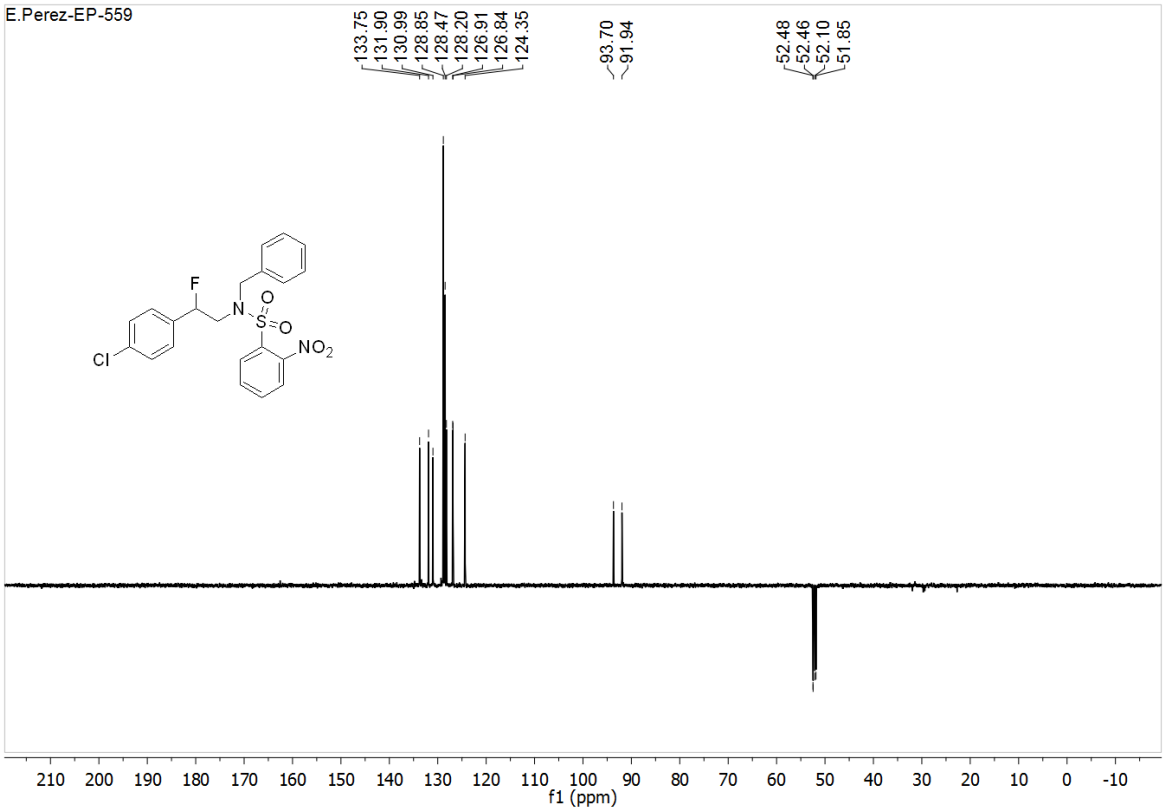

E.Perez-EP-558
162.60
147.89
133.71
131.87
131.00
128.82
128.68
128.49
128.14
125.47
125.40
124.35
94.21
92.46
52.35
52.32
52.20
51.96
F
N
O
S
O
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

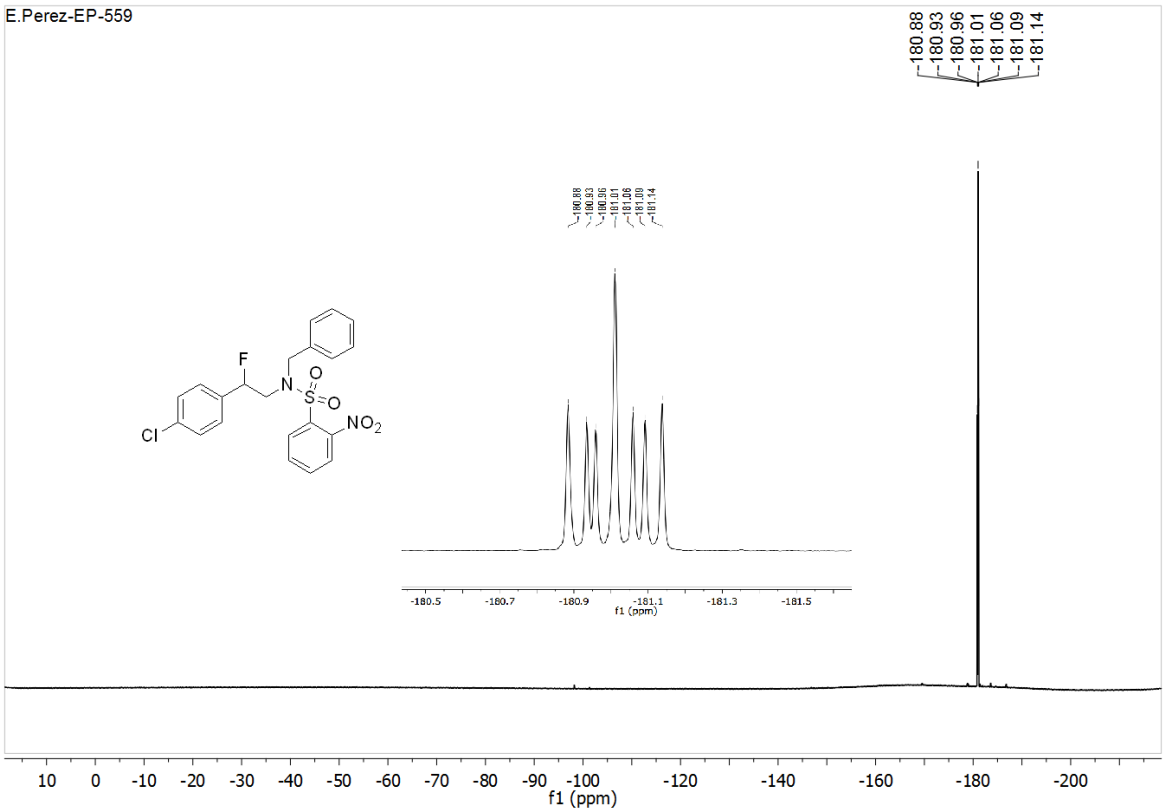

E.Perez-EP-558
133.71
131.87
131.00
129.00
128.98
128.82
128.76
128.68
128.49
128.14
125.47
125.40
124.35
94.21
92.46
52.35
52.32
52.20
51.96
F
N
O
S
O
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

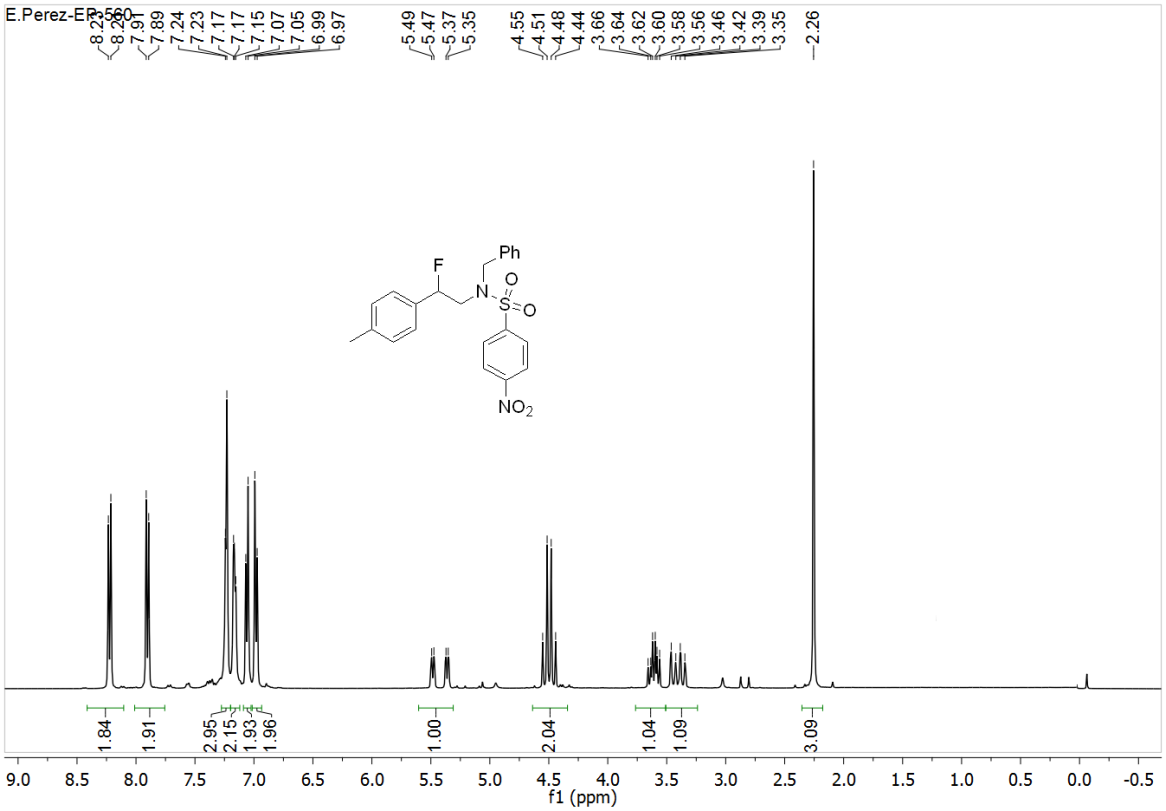

E.Perez-EP-558
-180.57
-180.63
-180.64
-180.70
-180.77
-180.83
F
N
O
S
O
NO2
-180.25 -180.40 -180.55 -180.70 -180.85 -181.00 -181.15
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

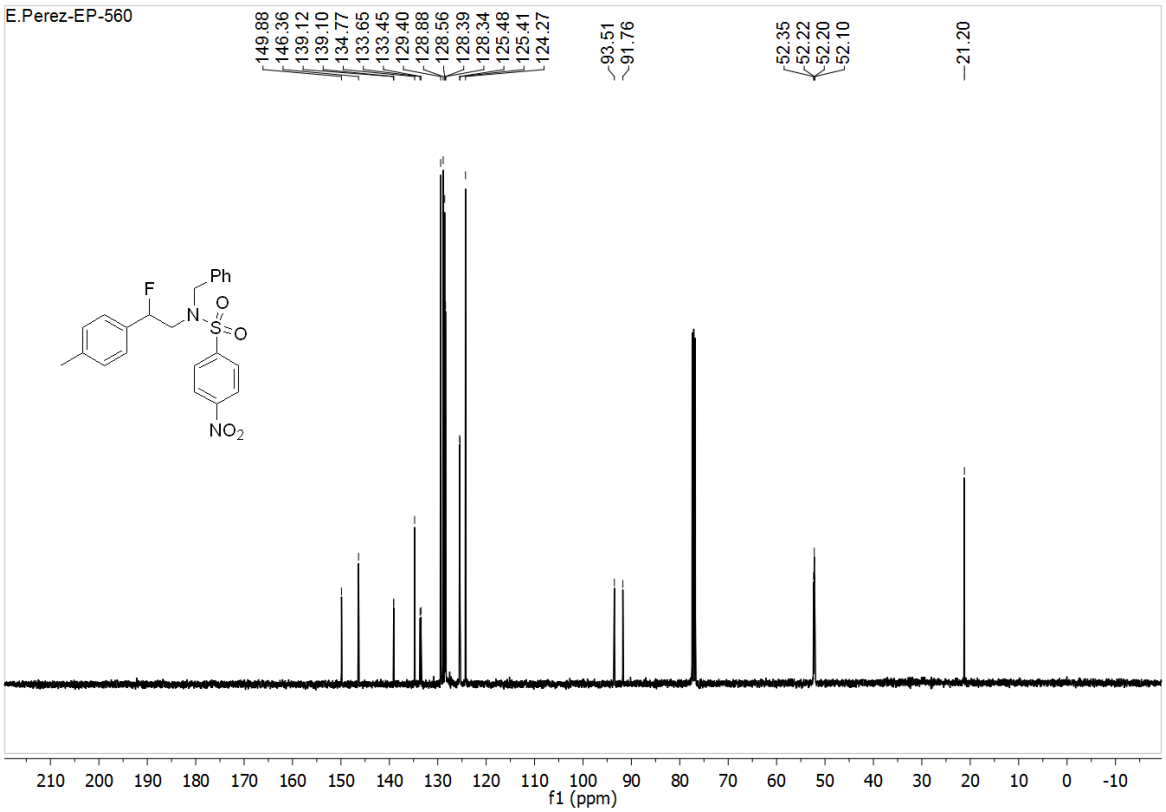

E.Perez-EP-559
7.62
7.60
7.58
7.56
7.54
7.24
7.23
7.21
7.19
7.18
7.17
7.10
5.61
5.60
5.59
5.50
5.48
5.47
4.66
3.62
3.61
3.60
3.57
3.55
3.53
F
N
S
O
O
NO2
Cl
0.94
2.95
7.12
1.96
1.00
1.98
2.06
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

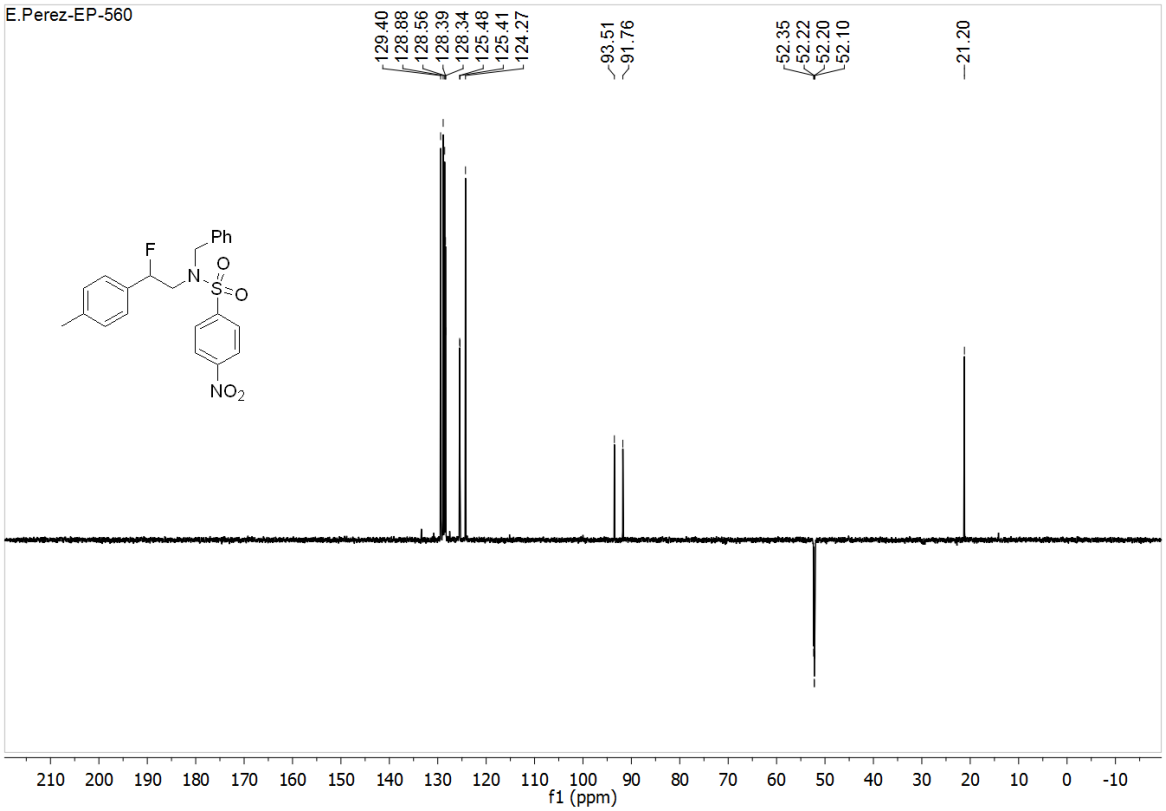

E.Perez-EP-559
147.83
134.86
133.75
133.70
131.90
130.99
128.85
128.47
128.20
126.91
126.84
124.35
93.70
91.94
52.48
52.46
52.10
51.85
F
N
S
O
O
NO2
Cl
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

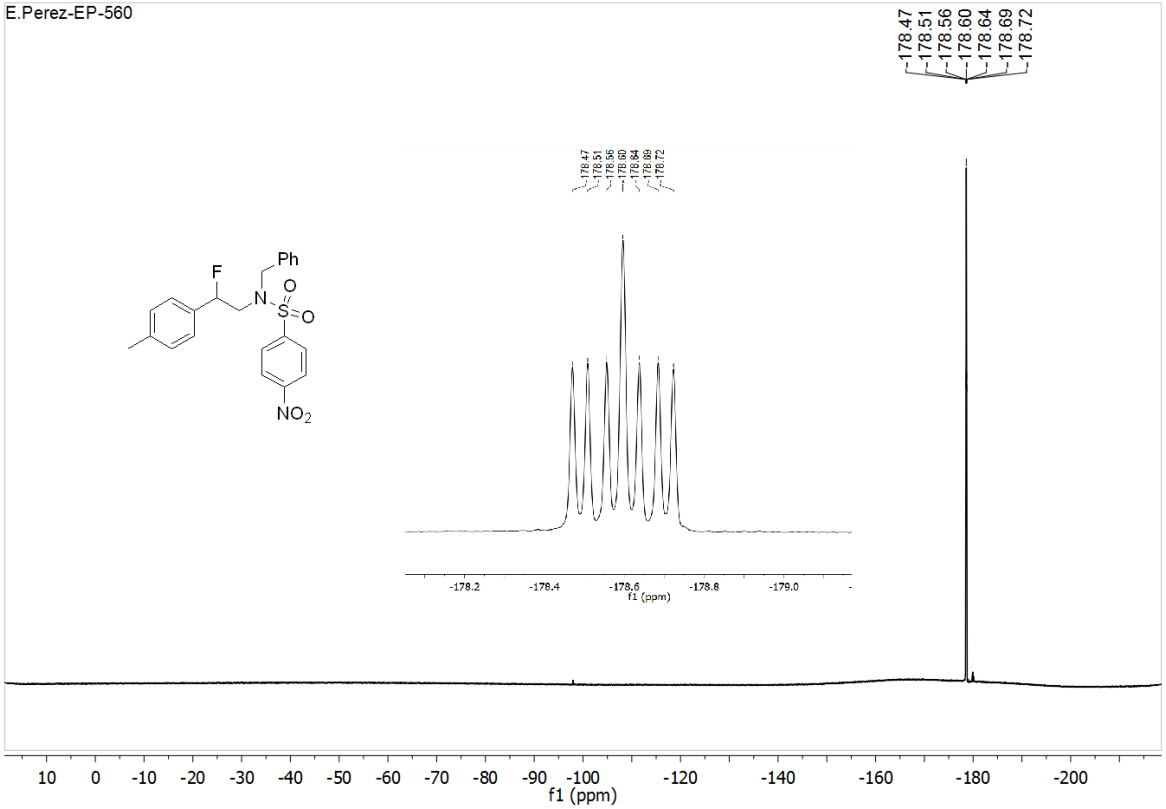

E.Perez-EP-559
133.75
131.90
130.99
128.85
128.47
128.20
126.91
126.84
124.35
93.70
91.94
52.48
52.46
52.10
51.85
F
N
O
S
O
Cl
NO2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

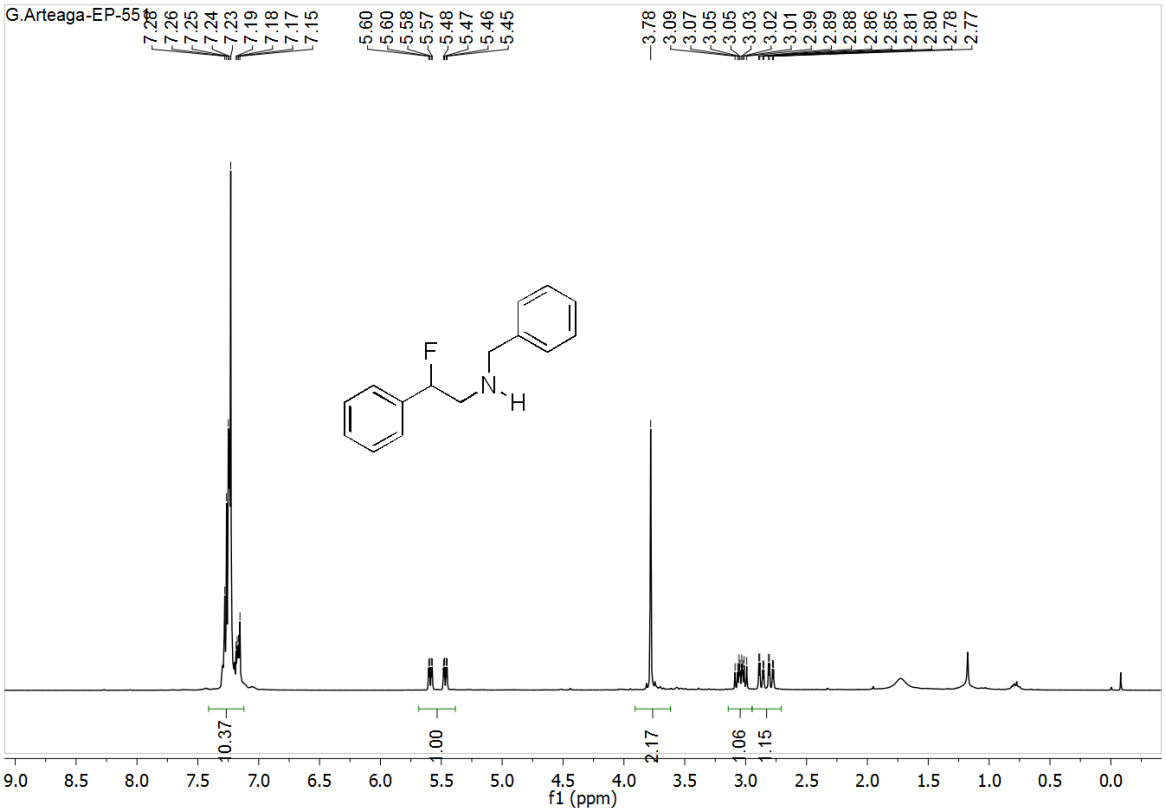

E.Perez-EP-559
180.88
180.93
180.96
181.01
181.06
181.09
181.14
F
N
O
S
O
Cl
NO2
-180.5
-180.7
-180.9
-181.1
-181.3
-181.5
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

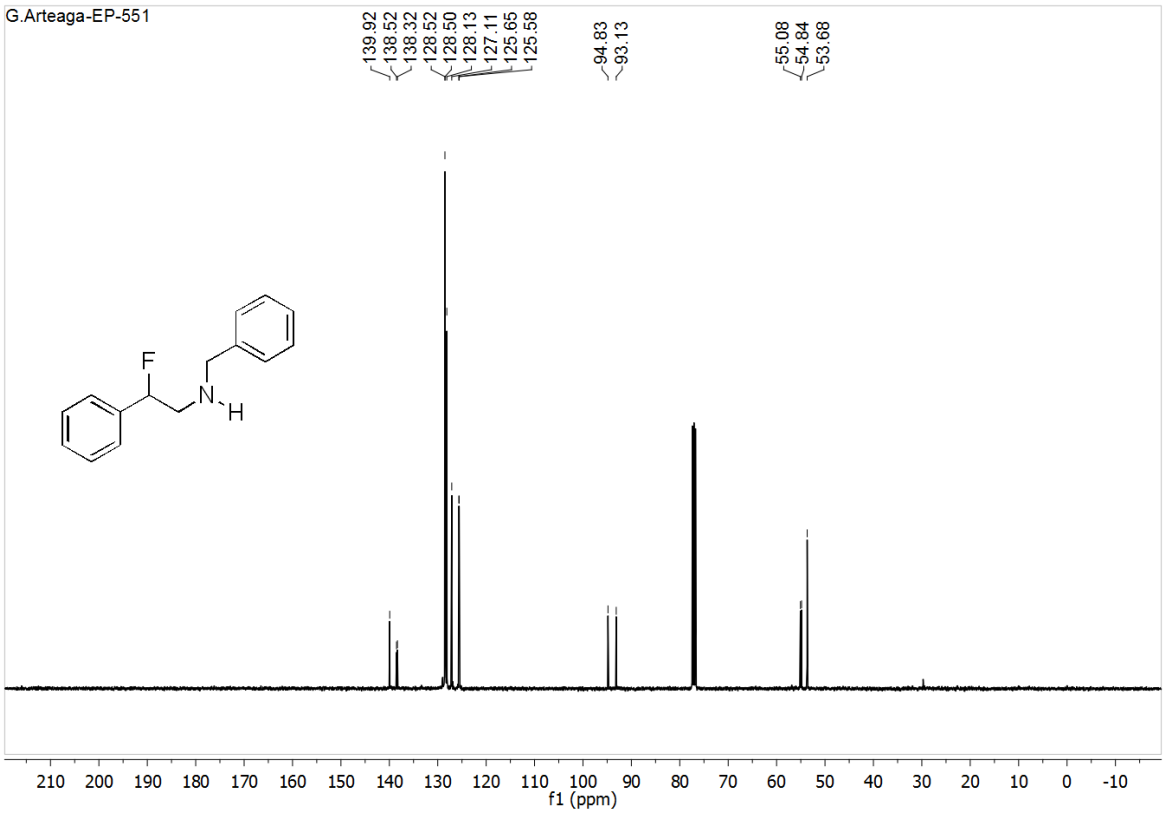

E.Perez-EP-560
8.23
8.20
7.91
7.89
7.24
7.23
7.17
7.17
7.15
7.07
7.05
6.99
6.97
5.49
5.47
5.37
5.35
4.55
4.51
4.48
4.44
3.66
3.64
3.62
3.60
3.58
3.56
3.46
3.42
3.39
3.35
2.26
F
Ph
N
O
S
O
NO2
1.84
1.91
2.95
2.15
1.93
1.96
1.00
2.04
1.04
1.09
3.09
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

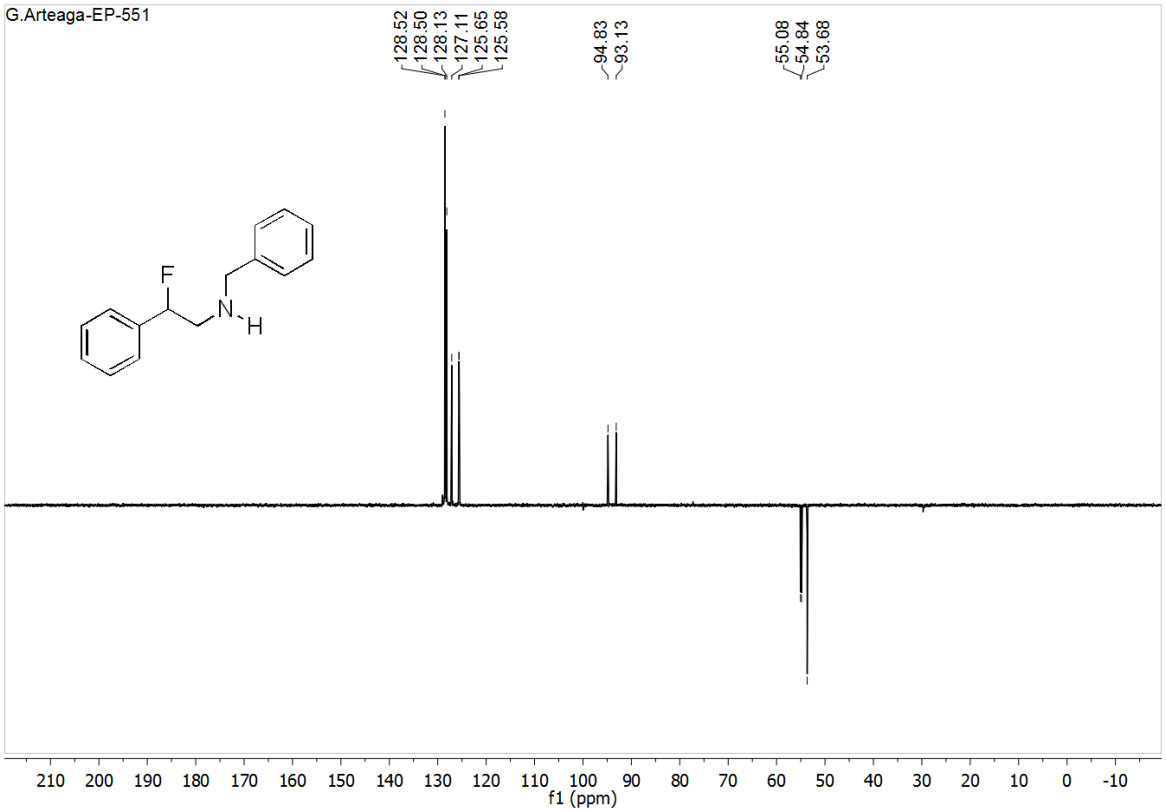

E.Perez-EP-560
149.88
146.36
139.12
139.10
134.77
133.65
133.45
129.40
128.88
128.56
128.39
128.34
125.48
125.41
124.27
93.51
91.76
52.35
52.22
52.20
52.10
21.20
F
Ph
N
O
S
O
NO2
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

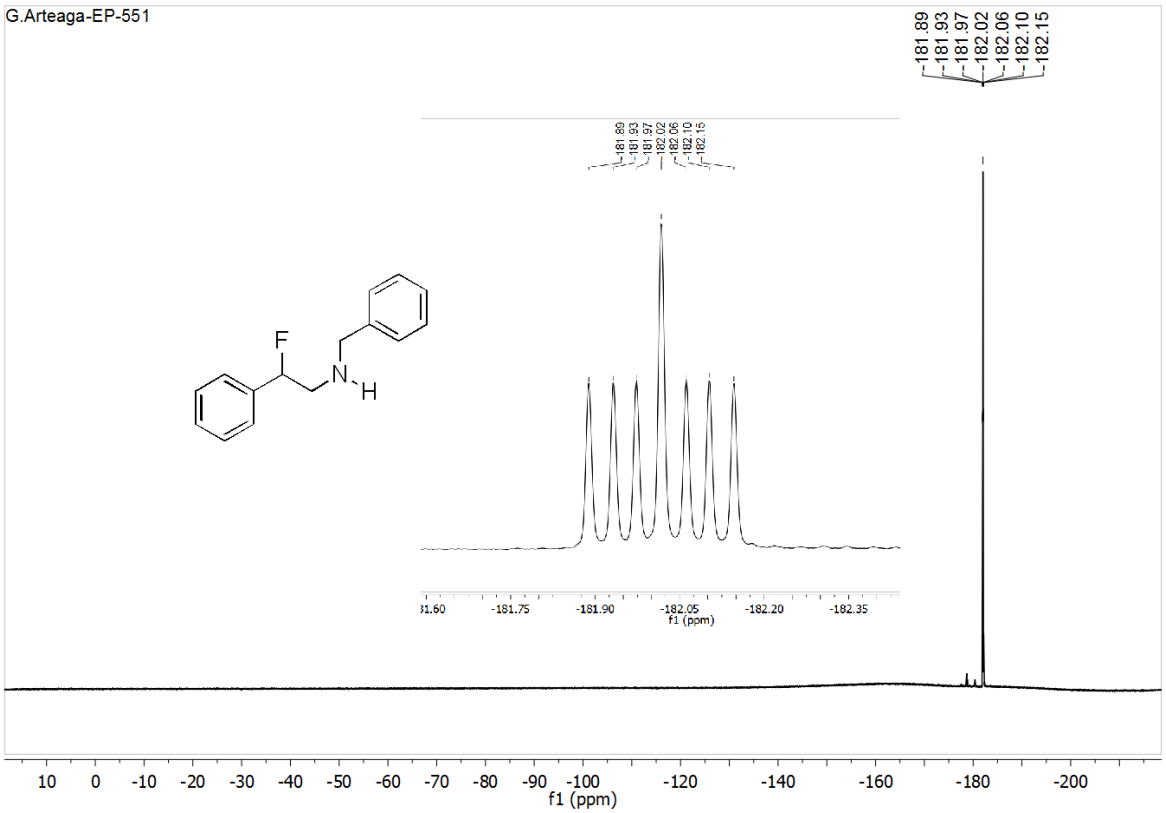

E.Perez-EP-560
129.40
128.88
128.56
128.39
128.34
125.48
125.41
124.27
93.51
91.76
52.35
52.22
52.20
52.10
21.20
F
Ph
N
O
S
O
NO2
f1 (ppm)

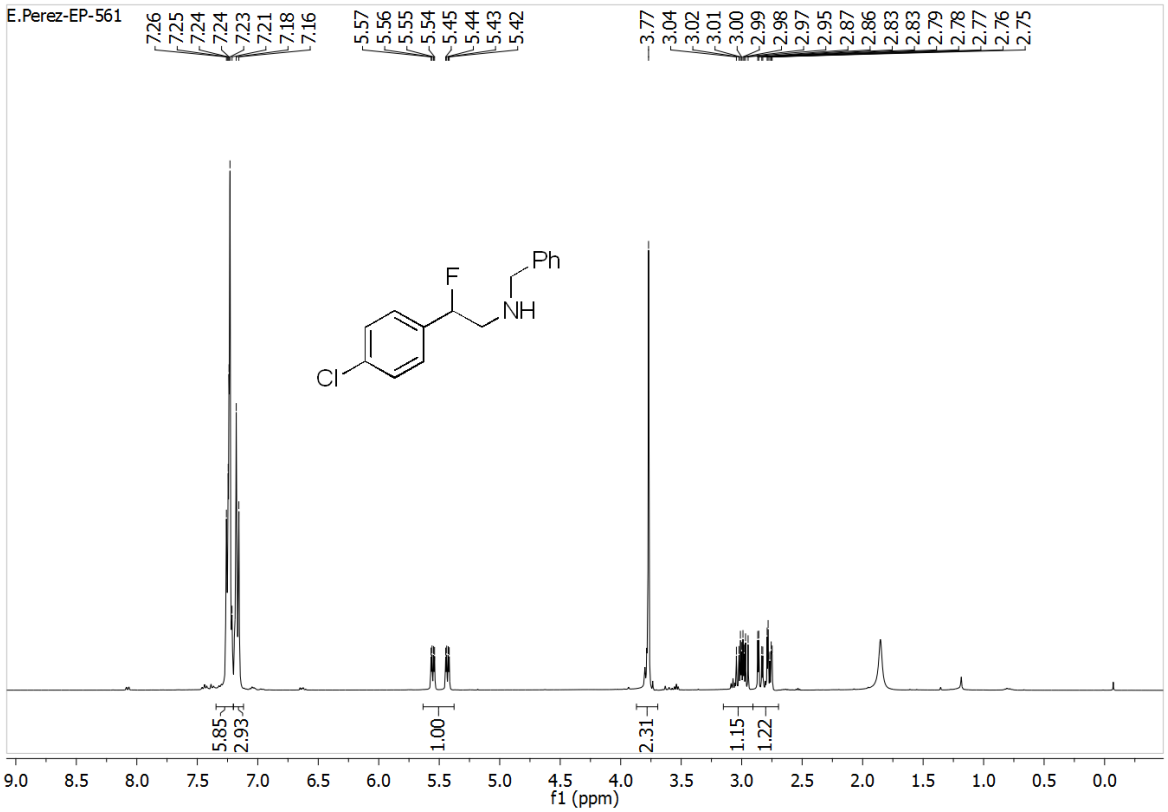

E.Perez-EP-560
178.47
178.51
178.56
178.60
178.64
178.69
178.72
F
Ph
N
O
S
O
NO2
f1 (ppm)

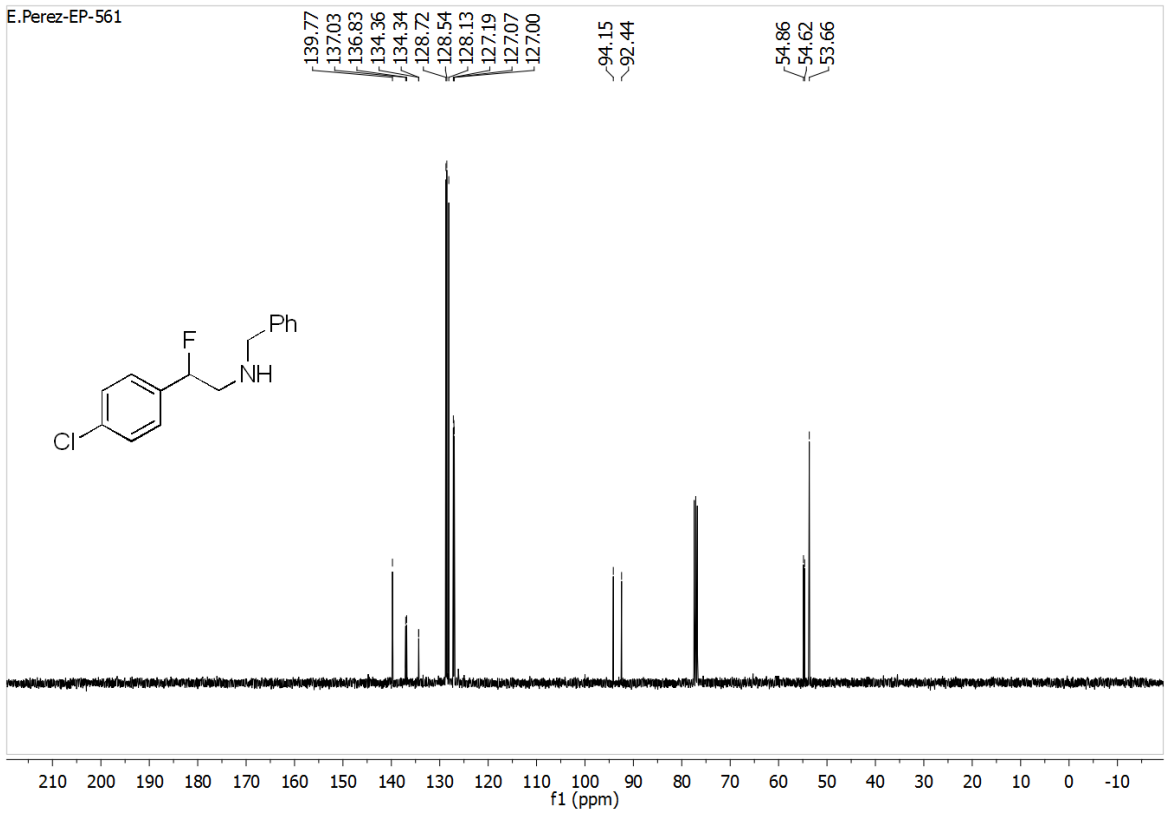

G.Arteaga-EP-551
7.28
7.26
7.25
7.24
7.23
7.19
7.18
7.17
7.15
5.60
5.58
5.57
5.48
5.47
5.46
5.45
3.78
3.09
3.07
3.05
3.05
3.03
3.02
3.01
2.99
2.89
2.88
2.86
2.85
2.81
2.80
2.78
2.77
F
N
H
10.37
1.00
2.17
1.06
1.15
f1 (ppm)

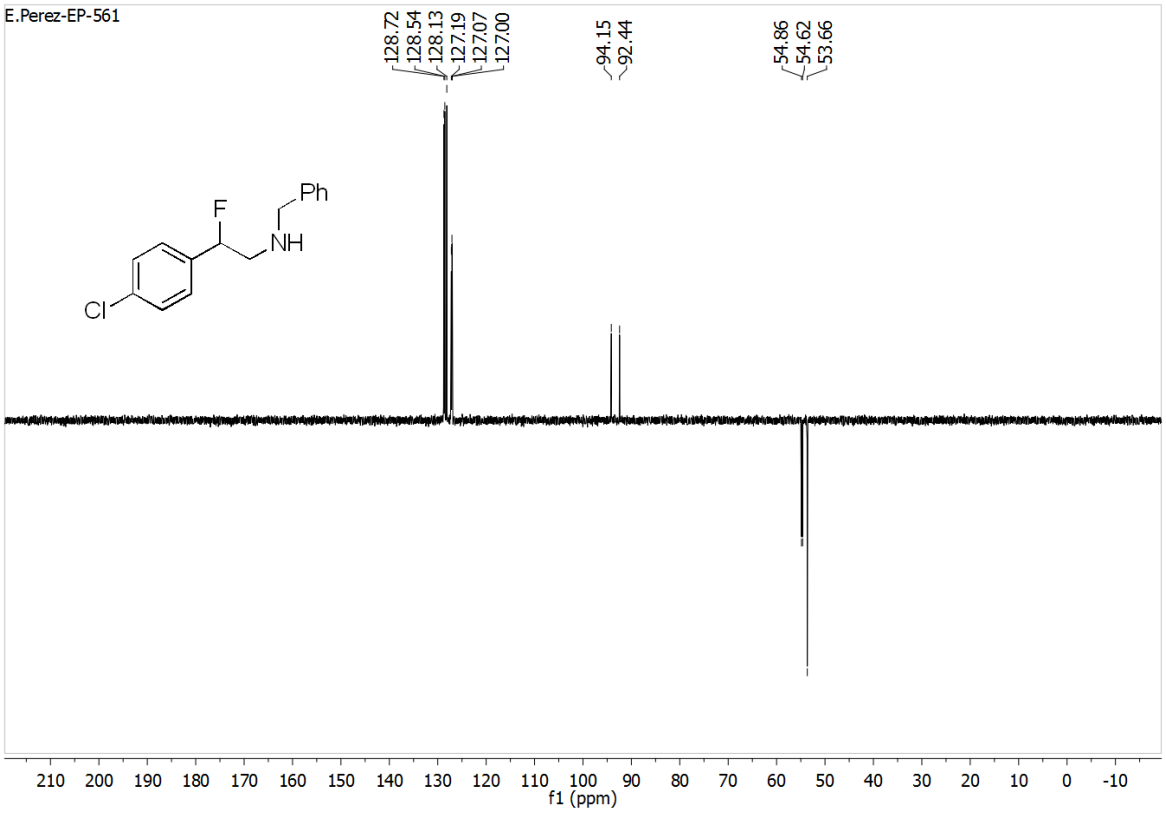

G.Arteaga-EP-551
139.92
138.52
138.32
128.52
128.50
128.13
127.11
125.65
125.58
94.83
93.13
55.08
54.84
53.68
F
N
H
f1 (ppm)

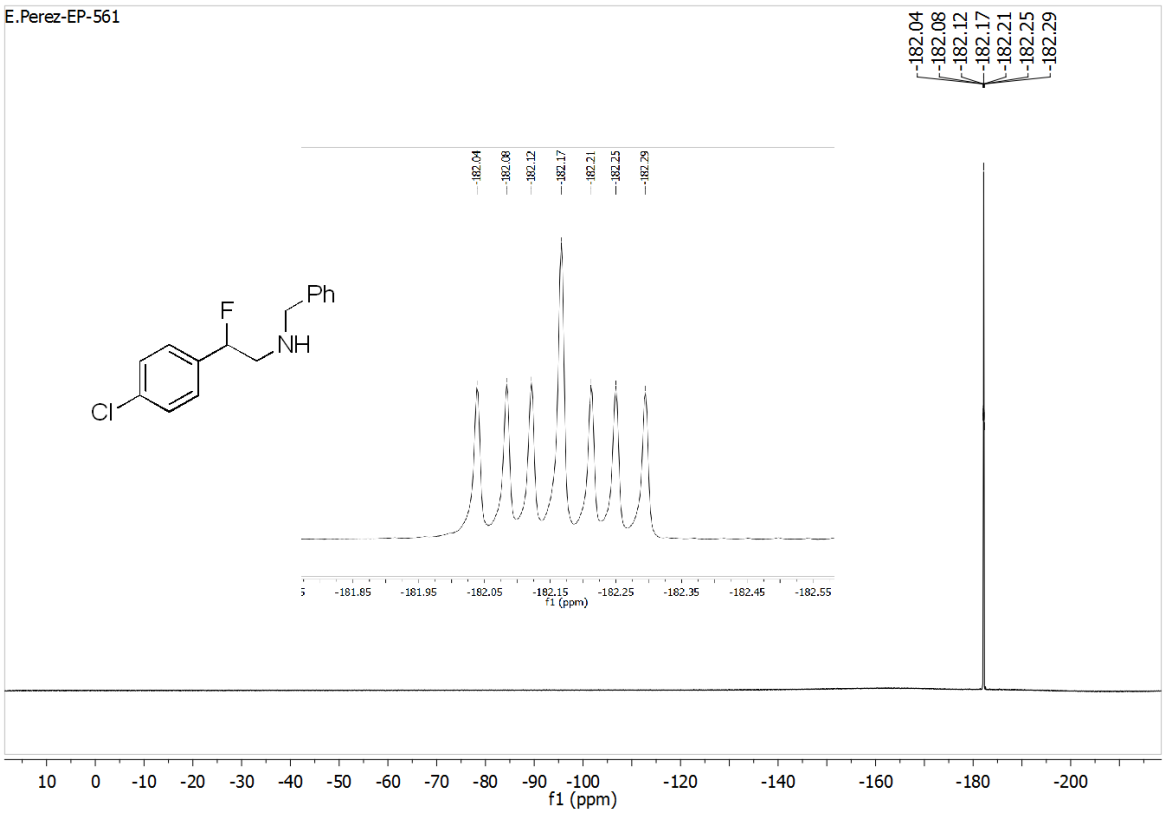

G.Arteaga-EP-551
128.52
128.50
128.13
127.11
125.65
125.58
94.83
93.13
55.08
54.84
53.68
F
N
H
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


G.Arteaga-EP-551
-181.89
-181.93
-181.97
-182.02
-182.06
-182.10
-182.15
F
N
H
-181.60
-181.75
-181.90
-182.05
-182.20
-182.35
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)


E.Perez-EP-561
7.26
7.25
7.24
7.24
7.23
7.21
7.18
7.16
5.57
5.56
5.55
5.54
5.45
5.44
5.43
5.42
3.77
3.04
3.02
3.01
3.00
2.99
2.98
2.97
2.95
2.87
2.86
2.83
2.83
2.79
2.78
2.77
2.76
2.75
F
Ph
NH
Cl
5.85
2.93
1.00
2.31
1.15
1.22
f1 (ppm)


E.Perez-EP-561
139.77
137.03
136.83
134.36
134.34
128.72
128.54
128.13
127.19
127.07
127.00
94.15
92.44
54.86
54.62
53.66
F
Ph
NH
Cl
f1 (ppm)


E.Perez-EP-561
128.72
128.54
128.13
127.19
127.07
127.00
94.15
92.44
54.86
54.62
53.66
F
Ph
NH
Cl
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


E.Perez-EP-561
-182.04
-182.08
-182.12
-182.17
-182.21
-182.25
-182.29
F
Ph
NH
Cl
-181.85 -181.95 -182.05 -182.15 -182.25 -182.35 -182.45 -182.55
f1 (ppm)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)