Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

Cascade Intramolecular Rearrangement/Cycloaddition of Nitrocyclopropanes Carboxylate with Alkynes/Alkenes: Access to Uncommon Bi(hetero)cyclic Systems

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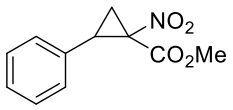
Table of Contents

1. General Information

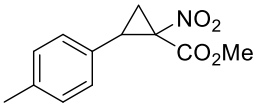
All reactions were carried out under inert atmosphere using oven dried glassware. All solvents and reagents were obtained from commercial sources and were purified using standard procedure prior to use. Analytical thin-layer chromatography (TLC) was performed on using pre-coated aluminium-backed plates (Merck Kieselgel 60 F254) and visualized by UV radiation and *p*-Anisaldehyde stains and heat as developing agents. Flash column chromatography was performed on silica gel (230–400 mesh). Organic solutions were concentrated under reduced pressure on Heidolph rotary evaporator. ^{1}H and ^{13}C-NMR spectra were recorded on a JEOL JNM ECS-400 instrument running at 400 MHz. Chemical shifts (δ) are reported in ppm relative to residual solvent signals ($CHCl_3$, 7.26 ppm for ^{1}H NMR, $CDCl_3$, 77.0 ppm for ^{13}C NMR). All coupling constants are given in absolute values and are expressed in Hz. Data are reported as follows: chemical shift, multiplicity (br = broad singlet, s = singlet, d = doublet, dd = doublet of doublets, t = triplet, q = quartet, ddd = doublet of doublet of doublet, td = triplet of doublet, m = multiplet.

2. General procedure for synthesis of nitrocyclopropane carboxylates (1)

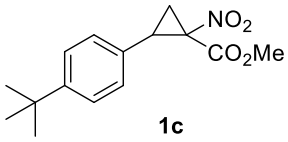
***Various Nitrocyclopropane carboxylates*:**



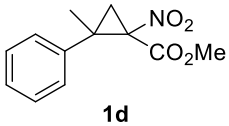
1a



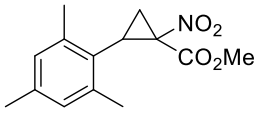
1b



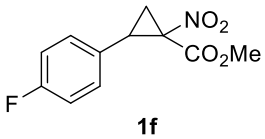
1c



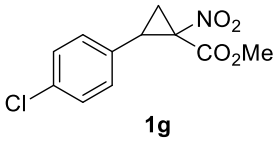
1d



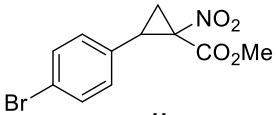
1e



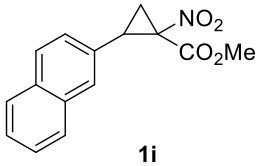
1f



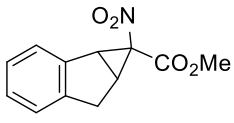
1g



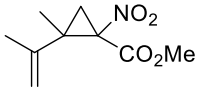
1h



1i

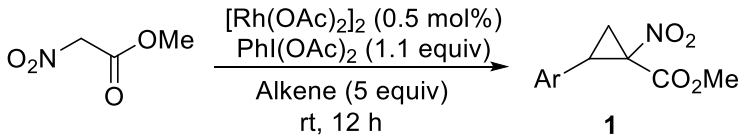


1j



1k

General Procedure[1b]



A round-bottomed flask was charged successively with $[Rh(OAc)_2]_2$ (0.003 g, 0.005 mmol, 0.5 mol%), the appropriate alkene (0.874 g, 5 mmol), and methyl nitro acetate [$O_2NCH_2CO_2Me$] (0.200 g, 1 mmol) to give a homogeneous solution. $PhI(OAc)_2$ (0.591 g, 1.1 mmol) was added in one portion, and the mixture was stirred for 12 h. The crude reaction mixture was treated with a saturated NaCl solution (10 mL) and extracted with DCM (3 x 10 mL), dried over Na_2SO_4, filtered and concentrated under reduced pressure. The resulting crude residue was then purified by column chromatography (silica gel) to get the desired nitrocyclopropane carboxylates (**1a-1k**).

Methyl 1-nitro-2-phenylcyclopropanecarboxylate (1a)[1a]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.35-7.28 (m, 3H), 7.23-7.17 (m, 2H), 3.77 (t, *J* = 9.91 Hz, 1H), 3.50 (s, 3H), 2.45 (dd, *J* = 9.12, 6.41 Hz, 1H), 2.29 (dd, *J* =10.73, 6.62 Hz, 1H).

Methyl 1-nitro-2-(*p*-tolyl)cyclopropanecarboxylate (1b)[1c]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.14-7.04 (m, 4H) 3.72 (t, *J* = 9.84 Hz, 1H) 3.51 (s, 3H) 2.41 (dd, *J* = 9.2, 6.45 Hz, 1H), 2.31 (s, 3H) 2.19 (dd, *J* = 10.8, 6.45 Hz, 1H).

Methyl 2-(4-(*tert*-butyl)phenyl)-1-nitrocyclopropanecarboxylate (1c) [1c]

^{1}H NMR: (400 MHz, $CDCl_3$): δ 7.25 (d, *J* = 8.2 Hz, 2H), 7.04 (d, *J* = 8.5 Hz, 2H), 3.66 (t, *J* = 9.84 Hz, 1H), 3.43 (s, 3H), 2.36 (dd, *J*= 9.12, 6.76 Hz, 1H), 2.13 (dd, *J* = 10.86, 6.45 Hz, 1H), 1.21(s, 9H).

Methyl 2-methyl-1-nitro-2-phenylcyclopropanecarboxylate (1d) [1a]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.36-7.26 (m, 5H), 3.48 (s, 3H), 2.41 (d, *J* = 6.84 Hz, 1H), 2.16 (d, *J* = 6.84 Hz, 1H), 1.53 (s, 3H).

Methyl 2-mesityl-1-nitrocyclopropane-1-carboxylate (1e) [1c]

^{1}H NMR (400 MHz, $CDCl_3$): δ 6.80 (s, 2H) 3.59-3.50 (m, 4H) 2.55 (dd, J = 9.82, 6.28 Hz, 1H) 2.41 (dd, J = 11.03, 6.35 Hz, 1H) 2.30 (s, 6H) 2.23 (s, 3H).

Methyl 2-(4-fluorophenyl)-1-nitrocyclopropanecarboxylate (1f) [1a]

^{1}H NMR (250 MHz, $CDCl_3$): δ 7.45 (d, J = 8.59 Hz, 2H), 7.08 (d, J = 8.43 Hz, 2H), 3.70 (t, J = 9.70 Hz, 1H), 3.56 (s, 3H), 2.41 (dd, J = 9.04, 6.76 Hz, 1H), 2.23 (dd, J = 10.72, 6.60 Hz, 1H).

Methyl 2-(4-chlorophenyl)-1-nitrocyclopropanecarboxylate (1g) [1c]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.29 (d, J = 8.15 Hz, 2H), 7.14 (d, J = 8.15 Hz, 2H), 3.72 (t, J = 10.0 Hz, 1H), 3.55 (s, 3H), 2.41 (dd, J = 9.01, 6.83 Hz, 1H), 2.23 (dd, J = 10.72, 6.52 Hz, 1H)**.**

Methyl 2-(4-bromophenyl)-1-nitrocyclopropanecarboxylate (1h) [1d]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.45 (d, J = 8.09 Hz, 2H), 7.08 (d, J = 8.53 Hz, 2H), 3.70 (t, J = 10.0 Hz, 1H), 3.56 (s, 3 H), 2.40 (dd, J = 9.12, 6.62 Hz, 1H), 2.23 (dd, J = 10.74, 6.76 Hz, 1H).

Methyl 2-(naphthalen-2-yl)-1-nitrocyclopropanecarboxylate (1i) [1c]

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.14 (d, J = 8.04 Hz, 1H), 7.88-7.79 (m, 2H), 7.61-7.50 (m, 2H), 7.41 (t, J = 8.04 Hz, 1H), 7.28 (d, J = 7.40 Hz, 1H), 4.16 (t, J = 10.0 Hz, 1H) 3.22 (s, 3H) 2.67 (dd, J = 9.25, 6.29 Hz, 1H) 2.34 (dd, J = 10.63, 6.75 Hz, 1H).

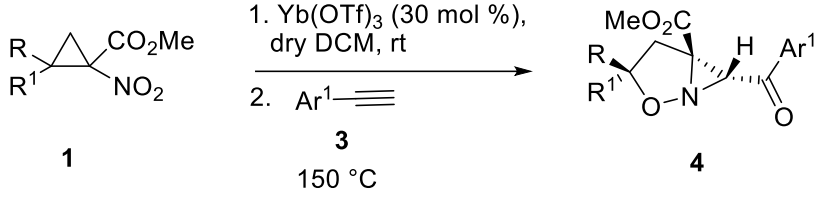
Methyl 1-nitro-1, 1a, 6, 6a-tetrahydrocyclopropa[a]indene-1-carboxylate (1j) [1c]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.45-7.40 (m, 1H), 7.24-7.15 (m, 3H), 3.83 (d, J = 7.35 Hz, 1H), 3.44(t, J = 6.07 Hz, 2H), 3.41 (s, 3H), 3.13 (t, J = 6.59 Hz, 1H).

Methyl 2-methyl-1-nitro-2-(prop-1-en-2-yl)cyclopropane-1-carboxylate (1k) [1c]

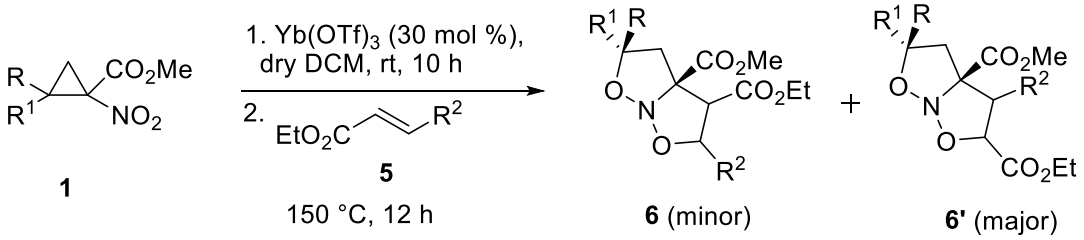
^{1}H NMR (400 MHz, $CDCl_3$): δ 5.00-4.98 (m, 1H), 4.94 (s, 1H), 3.77 (s, 3H), 2.14 (d, J = 6.69 Hz, 1H), 1.98 (d, J = 6.69 Hz, 1H), 1.77 (s, 3H), 1.34 (s, 3H).

3. General procedure for the synthesis of aziridinoisoxazoles (4) from nitrocyclopropane carboxylate (1):



To a round bottom flask equipped with a magnetic stir bar was added nitrocyclopropane carboxylates **1** (1 equiv) and Lewis acid (0.3 equiv) under nitrogen atmosphere. Dry DCM (1 mL) was added as a solvent to the reaction mixture and stirred at room temperature until consumption of starting material in to cyclic nitronate **2** (as monitored by TLC). After that, added the phenyl acetylene **3** (10 equiv) and the reaction mixture was allowed to stir at 150 °C until the consumption of starting material. The reaction mixture was passed through a small pad of celite and the solvent was evaporated in a rotary evaporator. The crude mixture was further purified by flash column chromatography on silica gel (230–400 mesh) using EtOAc/hexane as the eluent.

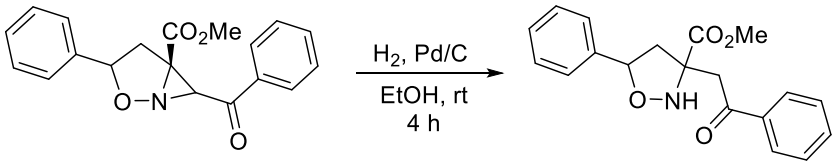
4. General procedure for the synthesis of isoxazolo-isoxazoles (6) from nitrocyclopropane carboxylate (1):



To a round bottom flask equipped with a magnetic stir bar was added nitrocyclopropane carboxylates **1** (1 equiv) and Lewis acid (0.3 equiv) under nitrogen atmosphere. Dry DCM (2 mL) was added as a solvent to the reaction mixture and stirred at room temperature until consumption of starting material into cyclic nitronate **2** (as monitored by TLC). After that, added the ethyl acrylate **5a** and ethyl cinnamate **5b** (10 equiv) and the reaction mixture was allowed to stir at 150 °C until the consumption of starting material. The reaction mixture was passed through a small pad of celite and the solvent was evaporated in a rotary evaporator. The crude mixture was further

purified by flash column chromatography on silica gel (230–400 mesh) using EtOAc/hexane as the eluent.

5. General procedure for the N-O bond cleavage of compound (4aa)[2]



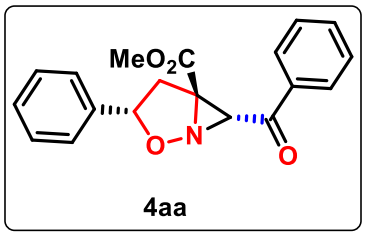
4aa **7aa**

To the solution of **4aa** (0.050 g, 0.15 mmol) in ethanol (3 ml) was added 10% Pd/C and then hydrogenated at 45 psi for C-N bond cleavage. The reaction was monitored by TLC. After completion of the reaction, the mixture was filtered over a bed of celite, washed with ethanol (5 ml) and concentrated in vacuo. The crude product was further purified by column chromatography on silica gel (230–400 mesh) using 20% ethyl acetate/hexane (3:7 *v/v*) as eluent to afford **7aa** with 67% yield.

6. Experimental characterization data

6.1.Experimental characterization data for aziridinoisoxazoles (4)

(3S*,5R*,6R*)-methyl 6-benzoyl-3-phenyl-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate(4aa):



4aa

Reaction time: 32 h (T_1 = 10 h, T_2 = 22 h)

1a (0.100 g, 0.45 mmol), **3a** (0.46 g, 4.5 mmol), **4aa** (0.099 g, 0.31 mmol)

Nature: Colorless semisolid

Yield: 68 %

R_f -value: 0.56 (25% EtOAc/Hexane)

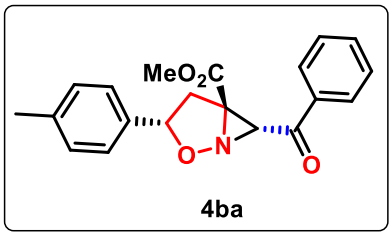
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.23-8.20 (m, 2H), 7.58-7.53 (m, 1H), 7.48-7.43 (m, 2H), 7.17-7.11 (m, 3H), 7.00-6.96 (m, 2H), 5.55 (dd, *J* = 10.63, 6.06 Hz, 1H), 4.11 (s, 1H), 3.79 (s, 1H), 3.22 (dd, *J* = 12.80, 6.05 Hz, 1H), 3.05 (dd, *J* = 12.72, 10.63 Hz, 1H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 190.7, 168.8, 135.2, 134.3, 129.1, 128.9, 128.8, 128.5, 127.0, 92.9, 61.2, 53.4, 34.2.

IR (KBr, cm^{-1}): 3357, 2923, 2852, 1667, 1594, 1494, 1449, 1399, 1314, 1228, 1178, 1057, 976, 938, 867, 748, 699, 611, 568.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{19}H_{18}NO_4$ $[M+H]^+$ 324.1230; found 324.1222.

(3S*,5R*,6R*)-methyl 6-benzoyl-3-(p-tolyl)-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate (4ba):



4ba

Reaction time: 28 h (T_1 = 09 h, T_2 = 19 h)

1b (0.100 g, 0.42 mmol), **3a** (0.43 g, 4.2 mmol), **4ba** (0.099 g, 0.029 mmol)

Nature: yellow viscous liquid

Yield: 70 %

R_f -value: 0.60 (25% EtOAc/Hexane)

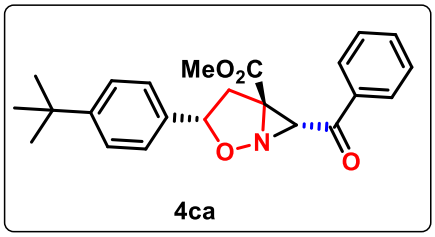
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.30-8.26 (m, 2H), 7.64-7.59 (m, 1H), 7.54-7.48 (m, 2H), 7.02 (d, *J* = 7.91 Hz, 2H), 6.95 (d, *J* = 8.02 Hz, 2H), 5.58 (dd, *J* = 10.73, 6.17 Hz, 1H), 4.16 (s, 1H), 3.85 (s, 3H), 3.26 (dd, *J* = 12.88, 6.10 Hz, 1H), 3.12 (dd, *J* = 12.78, 10.87 Hz, 1H), 2.25 (s, 3H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 190.7, 168.8, 138.7, 134.3, 132.1, 129.2, 129.1, 128.9, 127.1, 92.3, 61.2, 57.5, 53.4, 34.1, 21.2.

IR (KBr, cm^{-1}): 2953,2922, 1737, 1684, 1596, 1581, 1518, 1449, 1438, 1372, 1302, 1256, 1225, 1196, 1175, 1137, 1070, 1045, 1001, 924, 889, 814, 785, 771, 719, 688, 606.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{20}H_{20}NO_4$ $[M+H]^+$ 338.1387; found 338.1387.

(3S*,5R*,6R*)-methyl 6-benzoyl-3-(4-(tert-butyl)phenyl)-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate (4ca):



Reaction time: 32 h (T_1 = 10 h, T_2 = 22 h)

1c (0.100 g, 0.36 mmol), **3a** (0.36 g, 3.6 mmol), **4ca** (0.098 g, 0.26 mmol)

Nature: colorless viscous liquid

Yield: 72 %

R_f -value: 0.57 (EtOAc/Hexane) 2:10 (v/v).

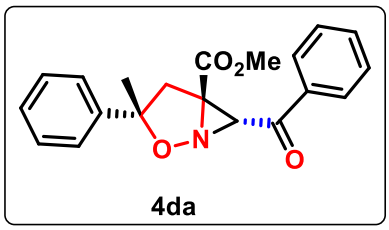
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.31-8.27 (m, 2H), 7.64-7.59 (m, 1H), 7.55-7.49 (m, 2H), 7.26-7.21 (m, 2H), 7.02-6.98 (m, 2H), 5.59 (dd, *J* = 10.90, 5.96 Hz, 1H), 4.16. (s, 1H), 3.85 (s, 3H), 3.25 (dd, *J* = 12.71, 5.96 Hz, 1H), 3.13 (dd, *J* = 12.78, 10.74 Hz, 1H), 1.23 (s, 9H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 190.7, 168.8, 151.9, 134.3, 132.1, 129.2, 128.9, 126.9, 125.5, 92.9, 61.2, 57.6, 53.4, 34.2, 31.2.

IR (KBr, cm^{-1}): 2598, 2868, 1738, 1685, 1597, 1581, 1553, 1450, 1362, 1302, 1255, 1175, 1138, 1109, 1071, 999, 925, 891, 830, 778, 722, 704, 687, 572.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{23}H_{26}NO_4$ $[M+H]^+$ 380.1856; found 380.1838.

(3S*,5R*,6R*)-methyl 6-benzoyl-3-methyl-3-phenyl-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate (4da):



Reaction time: 28 h (T_1 = 10 h, T_2 = 18 h)

1d (0.100 g, 0.43 mmol), **3a** (0.44 g, 4.3 mmol), **4da** (0.101 g, 0.30 mmol)

Nature: yellow semisolid

Yield: 70 %,

R_f -value: 0.60 (25% EtOAc/Hexane)

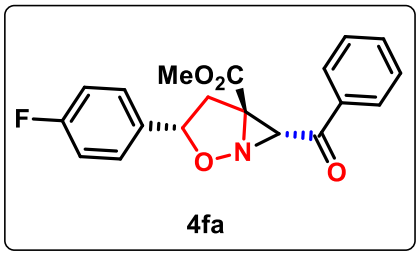
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.19-8.16 (m, 2H), 7.66-7.62 (m, 1H), 7.55-7.50 (m, 2H), 7.15-711 (m, 3H), 6.89-6.85 (m, 2H), 4.13 (s, 1H), 3.87 (s, 1H), 3.22 (d, *J* = 12.62 Hz,1H), 3.08 (d, *J* = 12.73 Hz, 1H), 1.70 (s, 1H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 190.5, 169.0, 142.4, 136.2, 134.1, 129.1, 128.8, 128.1, 127.2, 97.5, 60.7, 53.5, 39.1, 29.8, 27.6.

IR (KBr, cm^{-1}): 2977, 2954, 2925, 1736, 1683, 1597, 1580, 1495, 1447, 1396, 1374, 1302, 1252, 1225, 1204, 1160, 1084, 1043, 1018, 949, 887, 865, 823, 759, 720, 689, 553.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{20}H_{20}NO_4$ $[M+H]^+$ 338.1387; found 338.1388.

(3S*,5R*,6R*)-methyl 6-benzoyl-3-(4-fluorophenyl)-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate (4fa):



4fa

Reaction time: 31 h (T_1 = 10 h, T_2 = 21 h)

1f (0.100 g, 0.42 mmol), **3a** (0.43 g, 4.2 mmol), **4fa** (0.089 g, 0.26 mmol)

Nature: colorless viscous liquid

Yield: 62 %

R_f value: 0.58 (25% EtOAc/Hexane)

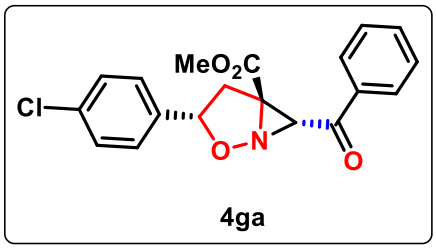
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.26 (d, *J* = 8.24 Hz, 2H), 7.65-7.60 (m, 1H), 7.55-7.49 (m, 2H), 7.07-7.02 (m, 2H), 6.93-6.87 (m, 2H), 5.59 (dd, *J* = 10.55, 6.03 Hz, 1H), 4.18 (s, 1H), 3.86 (s, 3H), 3.28 (dd, *J* = 12.69, 6.11 Hz, 1H), 3.12 (dd, *J* = 13.09, 10.39 Hz, 1H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 190.8, 168.6, 136.1, 134.4, 129.1, 129.0, 128.9, 115.66, 115.4, 92.2, 61.0, 57.6, 53.5, 34.2.

IR (KBr, cm^{-1}): 2954, 2923, 2853, 1738, 1685, 1599, 1512, 1450, 1294, 1257, 1225, 836, 775, 720, 689, 605, 535.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{19}H_{17}FNO_4$ $[M+H]^+$ 342.1136; found 342.1115.

(3S*,5R*,6R*)-methyl 6-benzoyl-3-(4-chlorophenyl)-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate (4ga):



Reaction time: 32 h (T_1 = 10 h, T_2 = 22 h)

1g (0.100 g, 0.39 mmol), **3a** (0.39 g, 3.9 mmol), **4ga** (0.089 g, 0.25 mmol)

Nature: colorless viscous liquid

Yield: 64 %

R_f value: 0.61 (25% EtOAc/Hexane)

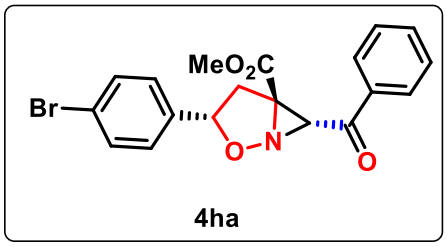
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.28-8.25 (m, 2H), 7.66-7.611 (m, 1H), 7.56-7.51 (m, 2H), 7.20-7.17 (m, 2H), 7.0- 6.96 (m, 2H), 5.59 (dd, *J* = 10.48, 6.21 Hz, 1H), 4.18 (s, 1H), 3.86 (s, 3H), 3.29 (dd, *J* = 12.88, 6.27 Hz, 1H), 3.10 (dd, *J* = 12.82, 10.81 Hz, 1H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 190.7, 168.6, 136.1, 134.6, 134.4, 129.1, 129.0, 128.8, 128.3, 91.9, 61.0, 57.6, 53.5, 34.2, 29.8.

IR (KBr, cm^{-1}): 2953, 2923, 2853, 1737, 1683, 1596, 1580, 1493, 1450, 1413, 1298, 1225, 1174, 1136, 965, 925, 890, 865, 822, 778, 724, 686, 633, 588,.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{19}H_{17}ClNO_4$ $[M+H]^+$ 358.0841; found 358.0826.

(3S*,5R*,6R*)-methyl 6-benzoyl-3-(4-bromophenyl)-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate (4ha):



Reaction time: 34 h (T_1 = 10 h, T_2 = 24 h)

1h (0.100 g, 0.33 mmol), **3a** (0.33 g, 3.3 mmol), **4ha** (0.086 g, 0.21 mmol)

Nature: yellow viscous liquid

Yield: 65 %

R_f value: 0.62 (25% EtOAc/Hexane)

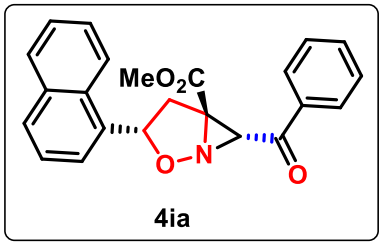
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.28-8.24 (m, 2H), 7.66-7.61 (m, 1H), 7.56-7.51 (m, 2H), 7.34 (d, *J* = 8.32 Hz, 2H), 6.91 (d, *J* = 8.46 Hz, 2H), 5.57 (dd, *J* = 10.70, 5.97 Hz, 1H), 4.18 (s, 1H), 3.86 (s, 3H), 3.29 (dd, *J* = 12.88, 5.97 Hz, 1H), 3.09 (dd, *J* = 12.82, 10.76 Hz, 1H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 190.7, 168.6, 134.4, 131.7, 129.1, 129.0, 128.8, 128.6, 128.3, 91.9, 61.0, 57.6, 53.5, 34.2, 29.8.

IR (KBr, cm^{-1}): 2954, 2923, 2852, 1737, 1684, 1597, 1495, 1448, 1303, 1205, 761, 720, 691, 553.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{19}H_{17}BrNO_4$ $[M+H]^+$ 402.0335; found 402.0341.

(3S*,5R*,6R*)-methyl 6-benzoyl-3-(naphthalen-1-yl)-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate (4ia):



4ia

Reaction time: 30 h (T_1 = 09 h, T_2 = 21 h)

1i (0.100 g, 0.37 mmol), **3a** (0.37 g, 3.7 mmol), **4ia** (0.091g, 0.24 mmol)

Nature: colorless viscous liquid,

Yield: 66 %

R_f -value: 0.65 (25% EtOAc/Hexane)

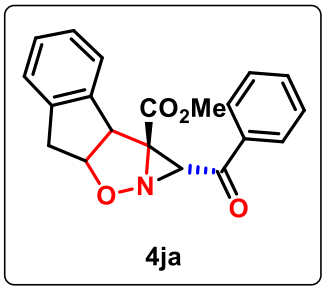
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.32-8.28 (m, 2H), 7.91-7.87 (m, 1H), 7.82-7.78 (m, 1H), 7.72-7.64 (m, 2H), 7.59-7.43 (m, 4H), 7.22 (t, *J* = 7.80 Hz, 1H), 6.98 (d, *J* = 7.43 Hz, 1H), 6.40 (dd, *J* = 10.49, 6.23 Hz, 1H), 4.22 (s, 1H), 3.90 (s, 3H), 3.57 (dd, *J* = 12.86, 6.09 Hz, 1H), 3.10 (dd, *J* = 12.86, 10.70 Hz, 1H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 190.5, 168.8, 129.2, 129.0, 128.8, 128.6, 126.4, 125.7, 125.4, 122.8, 88.7, 61.12, 57.6, 53.5, 33.44.

IR (KBr, cm^{-1}): 2953, 2922, 2851, 1734, 1684, 1596, 1511, 1449, 1303, 1249, 1221, 1198, 1179, 1066, 1040, 992, 909, 799, 777, 730, 646, 560, 495.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{23}H_{20}NO_4$ $[M+H]^+$ 374.1387; found 374.1382.

(1R*,8cR*)-methyl 1-benzoyl-3a,4,8b,8c-tetrahydro-1*H*-azirino[1,2-b]indeno[1,2-d]isoxazole-8c-carboxylate (4ja):



4ja

Reaction time: 32 h (T_1 = 09 h, T_2 = 23 h)

1j (0.100 g, 0.42 mmol), **3a** (0.43 g, 4.2 mmol), **4ja** (0.098 g, 0.29 mmol)

Nature: colorless viscous liquid

Yield: 70 %

R_f value: 0.55 (25% EtOAc/Hexane)

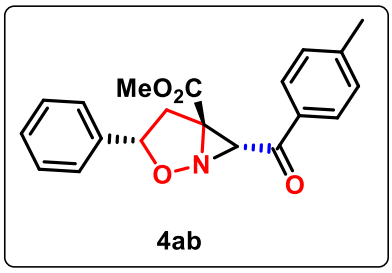
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.03-7.99 (m, 2H), 7.65-7.61 (m, 1H), 7.51 (t, J = 7.91 Hz, 2H), 7.37-7.27 (m, 3H), 7.25-7.22 (m, 1H), 6.28 (d, J = 8.72 Hz, 1H), 4.08 (s, 1H), 3.70 (s, 1H), 3.36-3.26 (m, 2H), 2.96 (s, 1H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 189.8, 167.6, 142.3, 134.1, 129.8, 129.3, 128.6, 127.3, 125.1, 124.7, 93.0, 87.1, 58.2, 53.2, 42.6, 33.7.

IR (KBr, cm^{-1}): 2954, 2921, 2851, 1729, 1682, 1597, 1481, 1436, 1364, 1323, 1286, 1252, 1211, 1175, 980, 948, 933, 902, 869, 744, 699, 648, 603, 570.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{20}H_{18}NO_4$ $[M+H]^+$ 336.1230; found 336.1212.

Methyl (3S*,5R*,6R*)-6-(4-methylbenzoyl)-3-phenyl-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate (4ab):



4ab

Reaction time: 30 h (T_1 = 10 h, T_2 = 20 h)

1a (0.100 g, 0.45 mmol), **3b** (0.52 g, 4.5 mmol), **4ab** (0.103 g, 0.31 mmol)

Nature: yellow viscous liquid

Yield: 68 %

R_f value: 0.57 (25% EtOAc/Hexane)

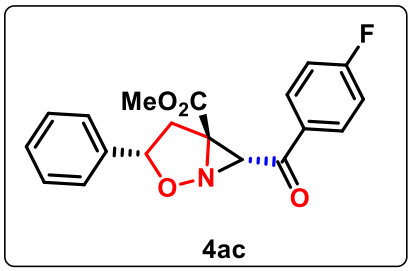
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.18 (d, J = 8.11 Hz, 2H), 7.32 (d, J = 7.86 Hz, 2H), 7.23-7.17 (m, 3H), 7.07-7.20 (m, 2H), 5.60 (dd, J = 10.60, 5.98 Hz, 1H), 4.16 (s, 1H), 3.85 (s, 3H), 3.28 (dd, J = 12.85, 5.86 Hz, 1H), 3.11 (dd, J = 12.85, 10.73 Hz, 1H), 2.42 (s, 3H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 190.3, 168.8, 145.4, 135.3, 133.8, 129.7, 129.2, 128.8, 128.5, 127.0, 92.9, 61.3, 57.5, 53.4, 34.3, 21.9.

IR (KBr, cm^{-1}): 3054, 2987, 1739, 1687, 1600, 1513, 1263, 895, 733.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{20}H_{20}NO_4$ $[M+H]^+$ 338.1392; found 338.1369.

Methyl (3S*,5R*,6R*)-6-(4-fluorobenzoyl)-3-phenyl-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate (4ac):



4ac

Reaction time: 32 h (T_1 = 10 h, T_2 = 22 h)

1a (0.05 g, 0.22 mmol), **3c** (0.26 g, 2.2 mmol), **4ac** (0.053 g, 0.155 mmol)

Nature: colorless semisolid

Yield: 70 %

R_f value: 0.60 (25% EtOAc/Hexane)

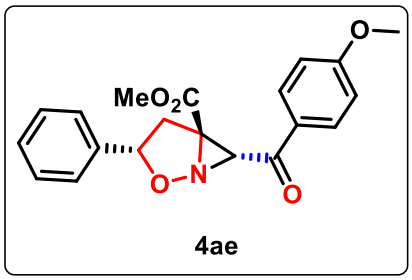
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.31 (d, J = 8.11 Hz, 2H), 7.24-7.16 (m, 5H), 7.05-7.01 (m, 2H), 5.61 (dd, J = 10.60, 5.98 Hz, 1H), 4.13 (s, 1H), 3.86 (s, 3H), 3.29 (dd, J = 12.85, 5.86 Hz, 1H), 3.10 (dd, J = 12.85, 10.73 Hz, 1H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 189.1, 168.6, 135.1, 132.0, 131.9, 128.9, 128.6, 127.0, 116.3, 116.1, 92.9, 61.1, 57.6, 53.5, 34.2.

IR (KBr, cm^{-1}): 3057, 2955, 1736, 1686, 1597, 1263, 1156, 844, 736.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{19}H_{17}FNO_4$ $[M+H]^+$ 342.1136; found 342.1120.

Methyl (3S*,5R*,6R*)-6-(4-methoxybenzoyl)-3-phenyl-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate (4ae):



Reaction time: 28 h (T_1 = 10 h, T_2 = 18 h)

1a (0.05 g, 0.22 mmol), **3e** (0.29 g, 2.2 mmol), **4ae** (0.054 g, 0.154 mmol)

Nature: colorless semisolid

Yield: 70 %

R_f value: 0.65 (25% EtOAc/Hexane)

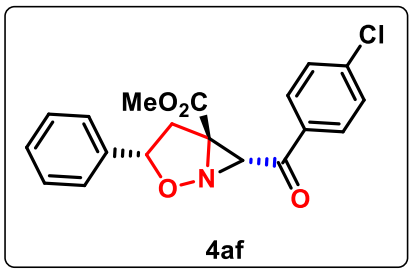
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.25 (d, *J* = 8.70 Hz, 2H), 7.31-7.23 (m, 5H), 7.00 (d, *J* = 8.60 Hz, 2H), 4.95 (t, *J* = 7.21 Hz, 1H), 3.90 (s, 1H), 3.89 (s, 3H), 3.80 (s, 3H), 3.54 (dd, *J* = 12.95, 7.91 Hz, 1H), 3.05 (dd, *J* = 13.25, 6.72 Hz, 1H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 189.9, 168.6, 164.6, 139.7, 131.9, 131.4, 128.6, 128.2, 126.0, 114.2, 87.0, 55.7, 55.5, 54.4, 53.3, 36.7.

IR (KBr, cm^{-1}): 2954, 2840, 1735, 1669, 1598, 1314, 1259, 1163, 838, 746.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{20}H_{20}NO_5$ $[M+H]^+$ 354.1341; found 354.1367.

Methyl (3S*,5R*,6R*)-6-(4-chlorobenzoyl)-3-phenyl-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate (4af):



Reaction time: 32 h (T_1 = 10 h, T_2 = 22 h)

1a (0.05 g, 0.22 mmol), **3f** (0.30 g, 2.2 mmol), **4af** (0.059 g, 0.165 mmol)

Nature: colorless semisolid

Yield: 75 %

R_f value: 0.60 (25% EtOAc/Hexane)

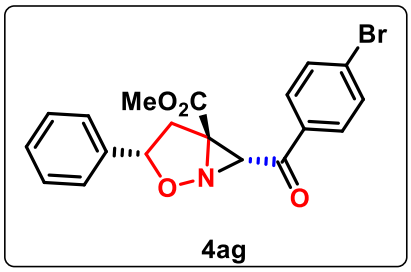
^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.00 (d, J = 8.68 Hz, 2H), 7.48 (d, J = 8.68 Hz, 2H), 7.44-7.39 (m, 2H), 7.38-7.32 (m, 2H), 7.30-7.26 (m, 1H), 5.93 (dd, J = 9.48, 5.46 Hz, 1H), 3.69 (s, 3H), 3.50-3.42 (m, 1H), 3.26 (s, 1H), 2.54 (dd, J = 13.26, 5.70 Hz, 1H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 189.0, 167.3, 142.0, 140.6, 133.1, 131.1, 129.1, 128.5, 127.9, 126.4, 86.6, 77.2, 54.7, 53.2, 37.5.

IR (KBr, cm^{-1}): 3250, 3036, 2953, 1732, 1686, 1587, 1438, 1244, 1219, 1173, 876, 741.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{19}H_{17}ClNO_4$ $[M+H]^+$ 358.0846; found 358.0870.

Methyl (3S*,5R*,6R*)-6-(4-bromobenzoyl)-3-phenyl-2-oxa-1-azabicyclo[3.1.0]hexane-5-carboxylate (4ag):



4ag

Reaction time: 30 h (T_1 = 10 h, T_2 = 20 h)

1a (0.05 g, 0.22 mmol), **3g** (0.40 g, 2.2 mmol), **4ag** (0.065 g, 0.162 mmol)

Nature: colorless semisolid

Yield: 74 %

R_f value: 0.60 (25% EtOAc/Hexane)

^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.14 (d, J = 8.60 Hz, 2H), 7.67 (d, J = 8.60 Hz, 2H), 7.24-7.17 (m, 3H), 7.05-6.99 (m, 2H), 5.61 (dd, J = 10.81, 5.92 Hz, 1H), 4.13 (s, 1H), 3.86 (s, 3H), 3.29 (dd, J = 12.79, 6.07 Hz, 1H), 3.08 (dd, J = 12.63, 10.73 Hz, 1H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 189.8, 168.5, 135.0, 134.9, 132.3, 130.6, 129.7, 128.9, 128.6, 127.0, 92.9, 61.0, 57.6, 53.5, 34.1.

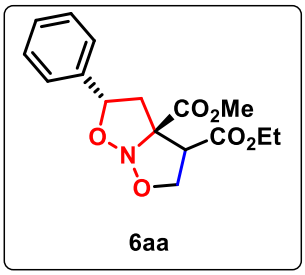
IR (KBr, cm^{-1}): 2971, 2252, 1736, 1686, 1586, 1379, 1255, 904, 725, 649.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{19}H_{17}BrNO_4$ $[M+H]^+$ 402.0341; found 402.0359.

6.2.Experimental characterization data for isoxazolo-isoxazoles (6)

As mentioned in the cycloaddition reaction, two diastereomers have been formed for both the regioisomers. These diastereomers are very close in polarity, thus difficult to separate from the column. The diastereomeric mixture was separated from the column as such. ^{1}H NMR of the mixture has been reported herein, peaks for the major diastereoisomer has been mentioned in the characterization data.

3-Ethyl 3a-methyl (3aR*,5S*)-5-phenyltetrahydro-3a*H*-isoxazolo[2,3-*b*]isoxazole-3,3a-dicarboxylate (6aa):



6aa

Reaction time: 22 h (T_1 = 10 h, T_2 = 12 h)

1a (0.100 g, 0.45 mmol), **5a** (0.45 g, 4.5 mmol), **6aa** (0.030 g, 0.090 mmol)

Nature: Offwhite semisolid

Yield: 20 %

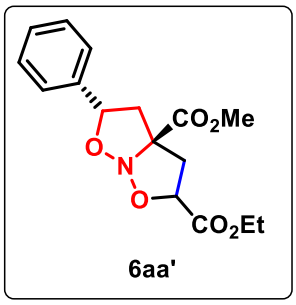
R_f value: 0.47 (25% EtOAc/Hexane)

^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.44-7.29 (m, 5H), 5.63 (dd, *J* = 9.72, 6.44 Hz, 1H), 4.79 (dd, *J* = 8.41, 6.11 Hz, 1H), 4.28 (q, *J* = 7.09 Hz, 2H), 3.84 (s, 3H), 3.25 (dd, *J* = 13.14, 8.47 Hz, 1H), 2.88 (dd, *J* = 12.74, 9.79 Hz, 1H), 2.74 (dd, *J* = 13.14, 6.24 Hz, 1H), 2.64 (dd, *J* = 12.81, 6.57 Hz, 1H), 1.32 (t, *J* = 7.36 Hz, 3H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 170.3, 169.7, 137.5, 128.7, 127.0, 83.16, 83.14, 76.7, 62.0, 53.6, 44.7, 39.5, 14.2.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{16}H_{20}NO_6$ $[M+H]^+$ 322.1291; found 322.1281.

2-Ethyl 3a-methyl (3aR*,5S*)-5-phenyltetrahydro-3a*H*-isoxazolo[2,3-*b*]isoxazole-2,3a-dicarboxylate (6aa'):



Reaction time: 22 h (T_1 = 10 h, T_2 = 12 h)

1a (0.100 g, 0.45 mmol), **5a** (0.45 g, 4.5 mmol), **6aa'** (0.086 g, 0.27 mmol)

Nature: Offwhite semisolid

Yield: 60 %

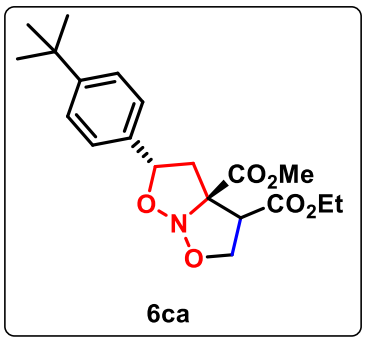
R_f value: 0.46 (25% EtOAc/Hexane)

^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.43-7.29 (m, 5H), 5.33-5.27 (m, 1H), 5.10 (t, J = 8.13 Hz, 1H), 4.27 (q, J = 7.24 Hz, 2H), 3.85 (s, 3H), 3.23 (dd, J = 12.76, 6.85 Hz, 1H), 3.07 (dd, J = 12.91, 8.47 Hz, 1H), 2.62 (dd, J = 12.86, 7.64 Hz, 1H), 2.28 (dd, J = 12.86, 9.61 Hz, 1H), 1.32 (t, J = 7.09 Hz, 3H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 170.0, 169.2, 138.1, 128.7, 126.3, 83.0, 81.7, 77.6, 62.0, 53.6, 44.8, 39.9, 14.2.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{16}H_{20}NO_6$ $[M+H]^+$ 322.1291; found 322.1287.

3-Ethyl 3a-methyl (3aR*,5S*)-5-(4-(*tert*-butyl)phenyl)tetrahydro-3a*H*-isoxazolo[2,3-*b*]isoxazole-3,3a-dicarboxylate (6ca):



Reaction time: 22 h (T_1 = 10 h, T_2 = 12 h)

1c (0.100 g, 0.36 mmol), **5a** (0.36 g, 3.6 mmol), **6ca** (0.027 g, 0.072 mmol)

Nature: white semisolid

Yield: 20 %

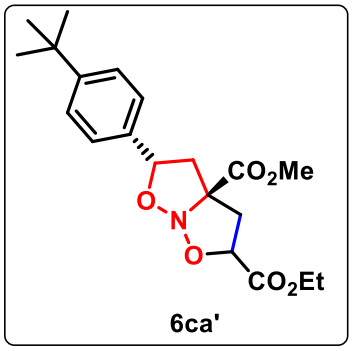
R_f value: 0.46 (25% EtOAc/Hexane)

^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.37-7.27 (m, 4H), 5.57 (dd, *J* = 9.87, 6.28 Hz, 1H), 4.73 (dd, *J* = 8.33, 6.28 Hz, 1H), 4.23 (q, *J* = 7.05 Hz, 2H), 3.80 (s, 3H), 3.21 (dd, *J* = 13.08, 8.46 Hz, 1H), 2.85 (dd, *J* = 12.82, 10.13 Hz, 1H), 2.68 (dd, *J* = 13.08, 6.41 Hz, 1H), 2.56 (dd, *J* = 12.82, 6.28 Hz, 1H), 1.30-1.25 (m, 12H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 170.4, 169.7, 151.8, 134.2, 126.9, 125.6, 83.2, 83.1, 76.4, 62.0, 53.6, 44.5, 39.7, 34.7, 31.3, 14.2.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{20}H_{28}NO_6$ $[M+H]^+$ 378.1917; found 378.1897.

2-Ethyl 3a-methyl (3aR*,5S*)-5-(4-(*tert*-butyl)phenyl)tetrahydro-3a*H*-isoxazolo[2,3-*b*]isoxazole-2,3a-dicarboxylate (6ca'):



6ca'

Reaction time: 22 h (T_1 = 10 h, T_2 = 12 h)

1c (0.100 g, 0.36 mmol), **5a** (0.36 g, 3.6 mmol), **6ca'** (0.078 g, 0.20 mmol)

Nature: white semisolid

Yield: 58 %

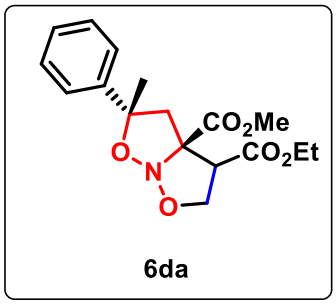
R_f value: 0.45 (25% EtOAc/Hexane)

^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.38-7.27 (m, 4H), 5.25 (dd, *J* = 9.34, 6.65 Hz, 1H), 5.08 (t, *J* = 7.64 Hz, 1H), 4.24 (q, *J* = 7.22 Hz, 2H), 3.82 (s, 3H), 3.17 (dd, *J* = 12.60, 6.79 Hz, 1H), 3.04 (dd, *J* = 12.60, 8.64 Hz, 1H), 2.62-2.55 (m, 1H), 2.26 (dd, *J* = 12.74, 9.34 Hz, 1H), 1.32-1.26 (m, 12H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 170.1, 169.2, 151.5, 134.9, 126.2, 125.6, 83.0, 81.4, 77.7, 61.9, 53.5, 44.6, 40.0, 34.6, 31.3, 14.2.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{20}H_{28}NO_6$ $[M+H]^+$ 378.1917; found 378.1892.

3-Ethyl 3a-methyl (3aR*,5S*)-5-methyl-5-phenyltetrahydro-3a*H*-isoxazolo[2,3-*b*]isoxazole-3,3a-dicarboxylate (6da):



6da

Reaction time: 22 h (T_1 = 10 h, T_2 = 12 h)

1d (0.100 g, 0.42 mmol), **5a** (0.42 g, 4.2 mmol), **6da** (0.030 g, 0.088 mmol)

Nature: coloreless viscous liquid

Yield: 21 %

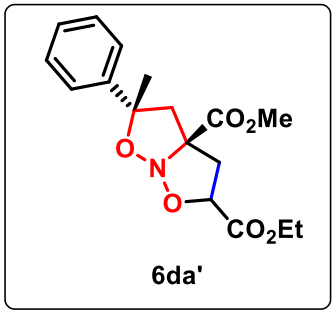
R_f value: 0.48 (25% EtOAc/Hexane)

^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.40-7.37 (m, 2H), 7.27-7.22 (m, 3H), 4.90 (dd, *J* = 9.02, 4.05 Hz, 1H), 4.23 (q, *J* = 6.89 Hz, 2H), 3.48 (s, 3H), 3.21 (d, *J* = 12.58 Hz, 1H), 2.99-2.82 (m, 2H), 2.71 (d, *J* = 12.85 Hz, 1H), 1.54 (s, 3H), 1.28 (t, *J* = 7.04 Hz, 3H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 170.7, 170.3, 146.2, 128.2, 126.8, 124.5, 84.6, 83.5, 80.5, 61.9, 53.2, 49.2, 39.2, 29.6, 14.2.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{17}H_{22}NO_6$ $[M+H]^+$ 336.1442; found 336.1424.

2-Ethyl 3a-methyl (3aR*,5S*)-5-methyl-5-phenyltetrahydro-3a*H*-isoxazolo[2,3-*b*]isoxazole-2,3a-dicarboxylate (6da'):



6da'

Reaction time: 22 h (T_1 = 10 h, T_2 = 12 h)

1d (0.100 g, 0.42 mmol), **5a** (0.42 g, 4.2 mmol), **6da'** (0.086 g, 0.25 mmol)

Nature: coloreless viscous liquid

Yield: 61 %

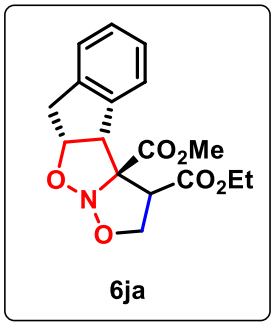
R_f value: 0.47 (25% EtOAc/Hexane)

^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.44-7.38 (m, 2H), 7.34-7.26 (m, 3H), 5.12 (t, *J* = 7.90 Hz, 1H), 4.28-4.21 (m, 2H), 3.47 (s, 3H), 3.32 (d, *J* = 12.76 Hz, 1H), 2.95-2.88 (m, 1H), 2.73-2.64 (m, 1H), 2.52 (d, *J* = 12.83 Hz, 1H), 1.69 (s, 3H), 1.29 (t, *J* = 7.04 Hz, 3H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 170.1, 169.2, 145.2, 128.2, 127.0, 124.6, 86.0, 82.8, 78.0, 61.9, 53.0, 49.6, 41.1, 30.1, 41.1.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{17}H_{22}NO_6$ $[M+H]^+$ 336.1442; found 336.1419.

3-Ethyl 3a-methyl (3aR*,3bR*,8aR*)-2,3,8,8a-tetrahydroindeno[1,2-*d*]isoxazolo[2,3-*b*]isoxazole-3,3a(3b*H*)-dicarboxylate (6ja):



6ja

Reaction time: 22 h (T_1 = 10 h, T_2 = 12 h)

1j (0.100 g, 0.42 mmol), **5a** (0.42 g, 4.2 mmol), **6ja** (0.028 g, 0.084 mmol)

Nature: white semisolid

Yield: 20 %

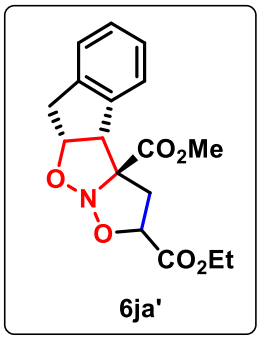
R_f value: 0.46 (25% EtOAc/Hexane)

^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.36-7.20 (m, 4H), 5.66 (d, *J* = 8.09 Hz, 1H), 4.67 (dd, *J* = 9.84, 5.37 Hz, 1H), 4.11 (q, *J* = 7.32 Hz, 2H), 3.85-3.79 (m, 1H), 3.77 (s, 3H), 3.23-3.14 (m 1H), 3.02-2.94 (m, 1H), 2.74 (dd, *J* = 12.84, 5.30 Hz, 1H), 2.27 (dd, *J* = 12.84, 10.11 Hz, 1H), 1.20-1.15 (m, 3H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 170.5, 169.4, 141.9, 140.1, 129.7, 127.7, 125.8, 124.8, 86.0, 85.7, 80.2, 61.7, 53.5, 48.1, 33.8, 29.7, 14.1.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{17}H_{20}NO_6$ $[M+H]^+$ 334.1291; found 334.1262.

2-Ethyl 3a-methyl (3aR*,3bR*,8aR*)-2,3,8,8a-tetrahydroindeno[1,2-*d*]isoxazolo[2,3-*b*]isoxazole-2,3a(3b*H*)-dicarboxylate (6ja'):



Reaction time: 22 h (T_1 = 10 h, T_2 = 12 h)

1j (0.100 g, 0.42 mmol), **5a** (0.42 g, 4.2 mmol), **6ja'** (0.084 g, 0.252 mmol)

Nature: white semisolid

Yield: 60 %

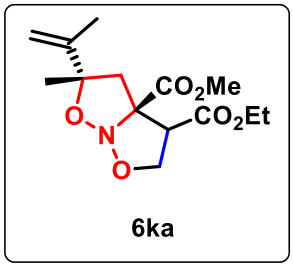
R_f value: 0.45 (25% EtOAc/Hexane)

^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.39-7.35 (m, 1H), 7.28-7.11 (m, 3H), 5.81 (d, *J* = 6.52 Hz, 1H), 5.01 (dd, *J* = 8.22, 6.80 Hz, 1H), 4.18 (q, *J* = 6.99 Hz, 2H), 3.73 (s, 3H), 3.61-3.54 (m, 1H), 3.18-3.09 (m, 1H), 3.05 (dd, *J* = 13.23, 6.61 Hz, 1H), 2.99-2.91 (m, 1H), 2.78 (dd, *J* = 13.32, 8.50 Hz, 1H), 1.24 (t, *J* = 6.99 Hz, 3H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 169.9, 169.2, 142.4, 138.8, 129.9, 127.4, 125.9, 124.7, 88.0, 86.4, 78.9, 61.9, 53.4, 52.9, 41.6, 34.7, 14.1.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{17}H_{20}NO_6$ $[M+H]^+$ 334.1291; found 334.1282.

3-Ethyl 3a-methyl (3aR*,5S*)-5-methyl-5-(prop-1-en-2-yl)tetrahydro-3a*H*-isoxazolo[2,3-*b*]isoxazole-3,3a-dicarboxylate (6ka):



Reaction time: 22 h (T_1 = 10 h, T_2 = 12 h)

1k (0.100 g, 0.50 mmol), **5a** (0.50 g, 5.0 mmol), **6ka** (0.028 g, 0.095 mmol)

Nature: offwhite semisolid

Yield: 19 %

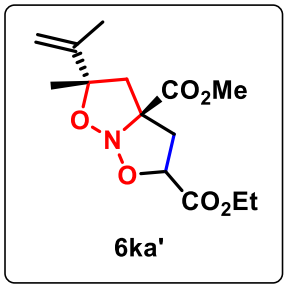
R_f value: 0.48 (25% EtOAc/Hexane)

^{1}H-NMR (400 MHz, $CDCl_3$): δ 4.94-4.88 (m, 1H), 4.82-4.75 (m, 2H), 4.29-4.18 (m, 2H), 3.74 (s, 3H), 3.11 (d, *J* = 12.79 Hz, 1H), 2.92 (dd, *J* = 12.79, 8.63 Hz, 1H), 2.83 (dd, *J* = 12.33, 4.16 Hz, 1H), 2.40 (d, *J* = 12.79 Hz, 1H), 1.77 (s, 3H), 1.42 (s, 3H), 1.34-1.27 (m, 3H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 170.6, 170.3, 147.3, 110.3, 86.3, 83.2, 79.7, 61.8, 53.3, 45.6, 39.4, 26.0, 18.9, 14.2.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{14}H_{22}NO_6$ $[M+H]^+$ 300.1447; found 300.1460

2-Ethyl 3a-methyl (3aR*,5S*)-5-methyl-5-(prop-1-en-2-yl)tetrahydro-3a*H*-isoxazolo[2,3-*b*]isoxazole-2,3a-dicarboxylate (6ka'):



Reaction time: 22 h (T_1 = 10 h, T_2 = 12 h)

1k (0.100 g, 0.50 mmol), **5a** (0.50 g, 5.0 mmol), **6ka'** (0.084 g, 0.28 mmol)

Nature: offwhite semisolid

Yield: 56 %

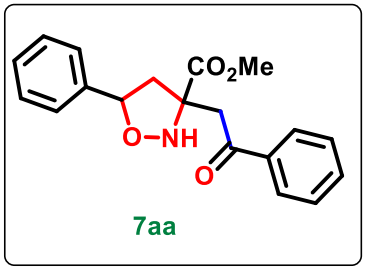
R_f value: 0.47 (25% EtOAc/Hexane)

^{1}H-NMR (400 MHz, $CDCl_3$): δ 5.09-4.99 (m, 2H), 4.83-4.78 (m, 1H), 4.29-4.19 (m, 2H), 3.73 (s, 3H), 3.19 (d, *J* = 12.91 Hz, 1H), 2.91-2.80 (m, 1H), 2.68-2.58 (m, 1H), 2.17 (d, *J* = 12.91 Hz, 1H), 1.77 (s, 3H), 1.51 (s, 3H), 1.32-1.26 (m, 3H).

^{13}C-NMR (100 MHz, $CDCl_3$): δ 170.5, 169.4, 146.8, 110.7, 87.7, 82.6, 77.3, 61.9, 53.2, 46.0, 41.2, 26.6, 18.9, 14.1.

HRMS (ESI, Q-TOF) m/z: calcd for $C_{14}H_{22}NO_6$ $[M+H]^+$ 300.1447; found 300.1450

Methyl 3-(2-oxo-2-phenylethyl)-5-phenylisoxazolidine-3-carboxylate (7aa):



Reaction time: 4 h

4aa (0.050 g, 0.15 mmol), **7aa** (0.035 mg, 0.10 mmol)

Nature: yellow semisolid

Yield: 67 %

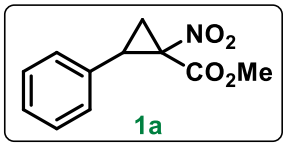
R_f value: 0.42 (25% EtOAc/Hexane)

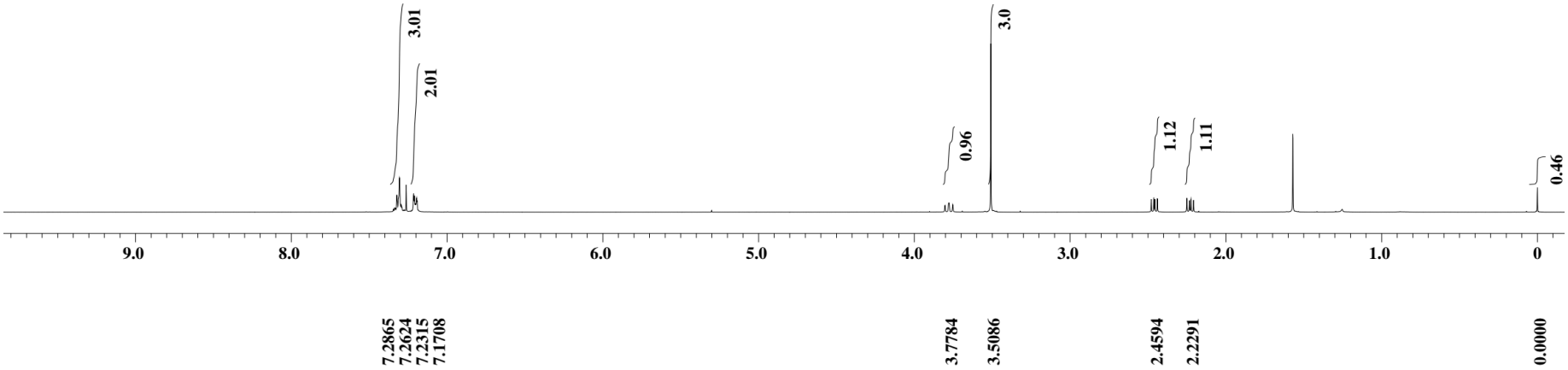
^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.97-7.93 (m, 2H), 7.60-7.55 (m, 1H), 7.49-7.43 (m, 2H), 7.39-7.29 (m, 5H), 6.79 (s, 1H), 4.96 (dd, J = 9.95, 6.35 Hz, 1H), 3.82 (s, 3H), 3.77 (d, J = 17.60 Hz, 1H), 3.66 (d, J = 17.56 Hz, 1H), 2.93 (dd, J = 12.89, 6.73 Hz, 1H), 2.32 (dd, J = 12.86, 9.98 Hz, 1H).

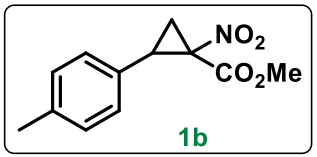
^{13}C-NMR (100 MHz, $CDCl_3$): δ 196.9, 174.1, 136.2, 133.5, 128.7, 128.4, 128.2, 126.4, 83.8, 68.2, 53.1, 49.2, 29.8.

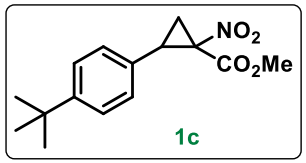
D Mass (ESI, Q-TOF) m/z: calcd for $C_{19}H_{20}NO_4$ $[M+H]^+$ 326.1387; found 326.13.

7. Copies of NMR, IR and HRMS spectra for the final products and post functionalization reaction





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CO2Me
1c

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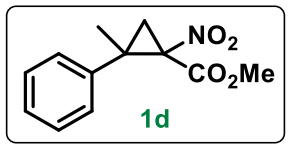
2.15
1
3.03
1.15
1.12
9.26
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.2532
7.0494
3.6656
3.4319
2.3620
2.1398
1.2199
-0.0000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CO2Me
1d

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1
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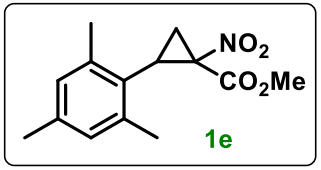
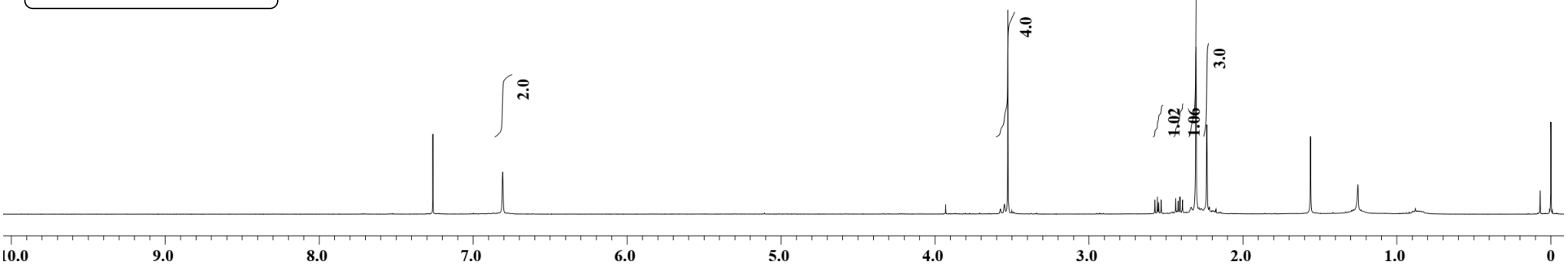
3.0
0.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.3695
7.2630
7.2607
3.4886
2.4176
2.1678
1.5367
0.0000





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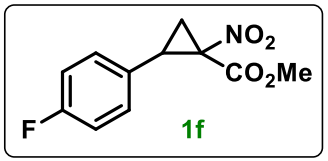
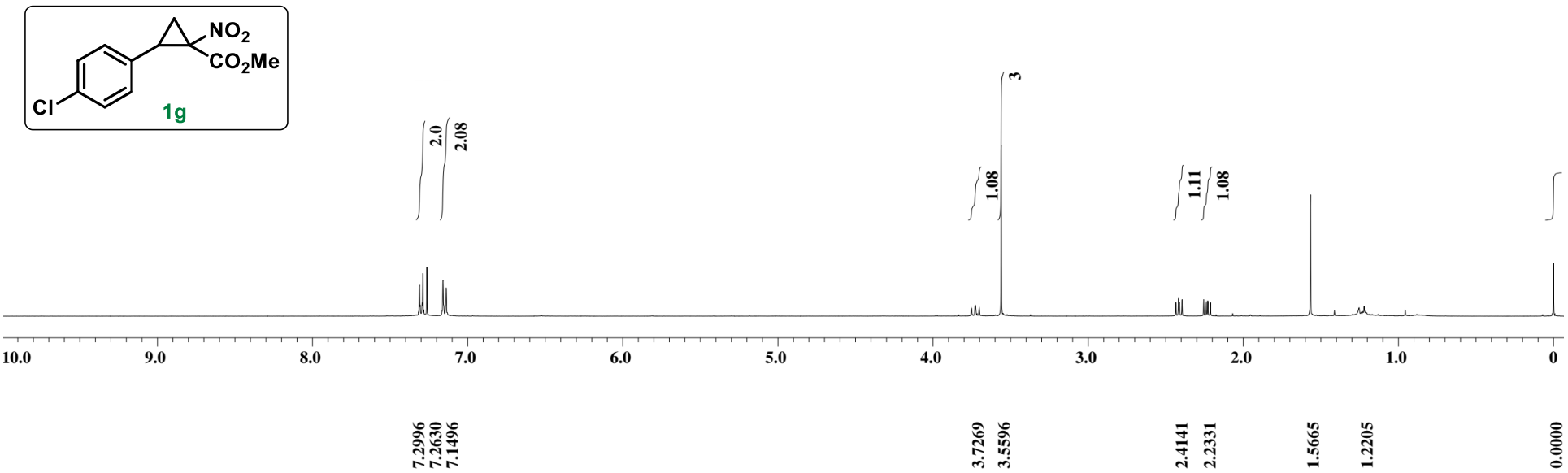
6.8397
6.7859
3.5900
3.5029
2.5522
2.4158
2.3059
2.2349



7.4543
7.2630
7.0877
3.7085
3.5642
2.4118
2.2331
1.5619
0.0000


NO2
CO2Me
Cl
1g
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2.08
1.08
3
1.11
1.08
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.2996
7.2630
7.1496
3.7269
3.5596
2.4141
2.2331
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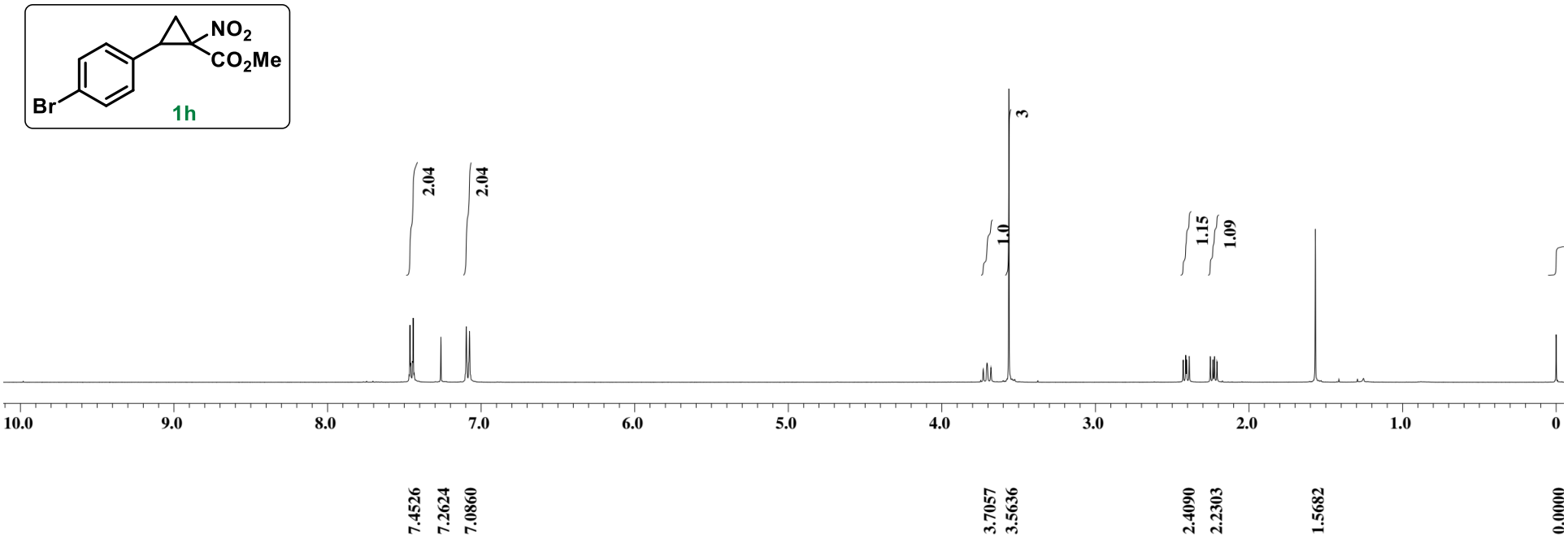
1.2205
0.0000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CO2Me
Br
1h
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2.04
1.0
3
1.15
1.09
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
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7.2624
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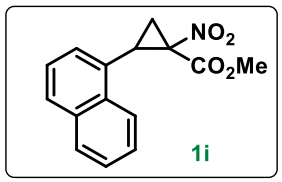
0.0000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CO2Me
1i

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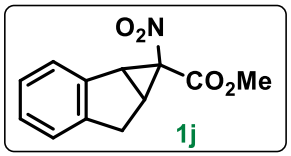
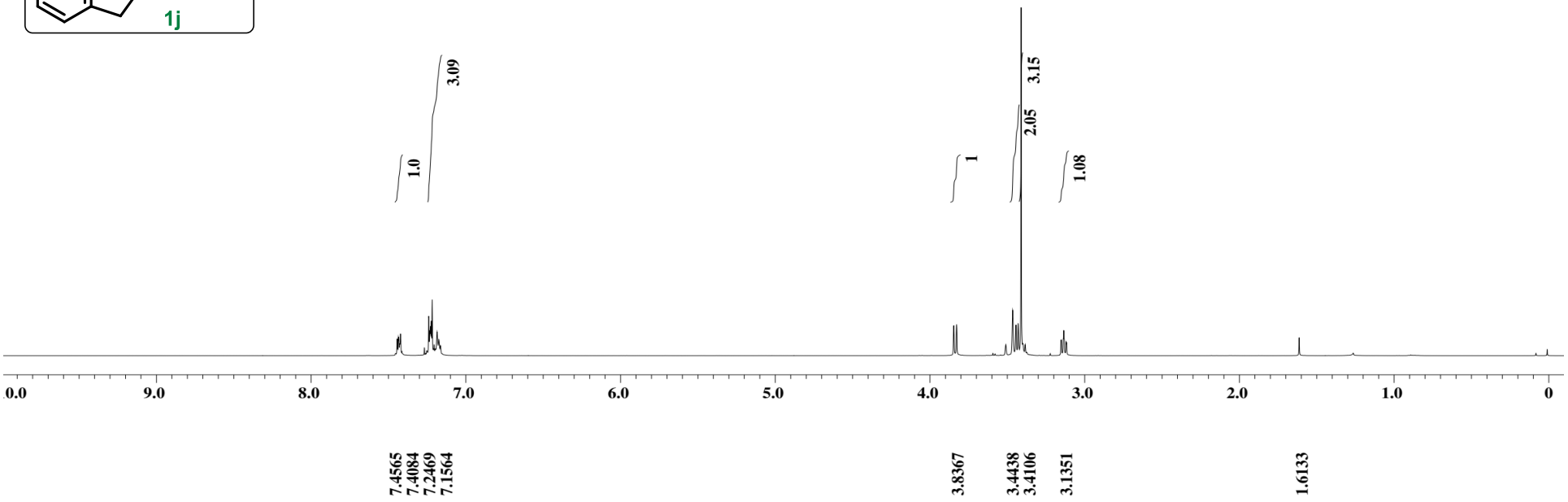
2.01
1.05
0.95
1
3.01
1.03
1.06
0.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
8.1410
7.8856
7.7996
7.6106
7.5030
7.4193
7.2819
7.2601
4.1673
3.2246
2.6724
2.3494
1.5510
-0.0000


O2N
CO2Me
1j


1.0
3.09
1
2.05
3.15
1.08
0.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
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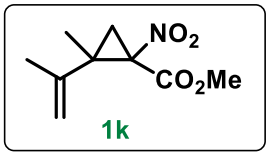
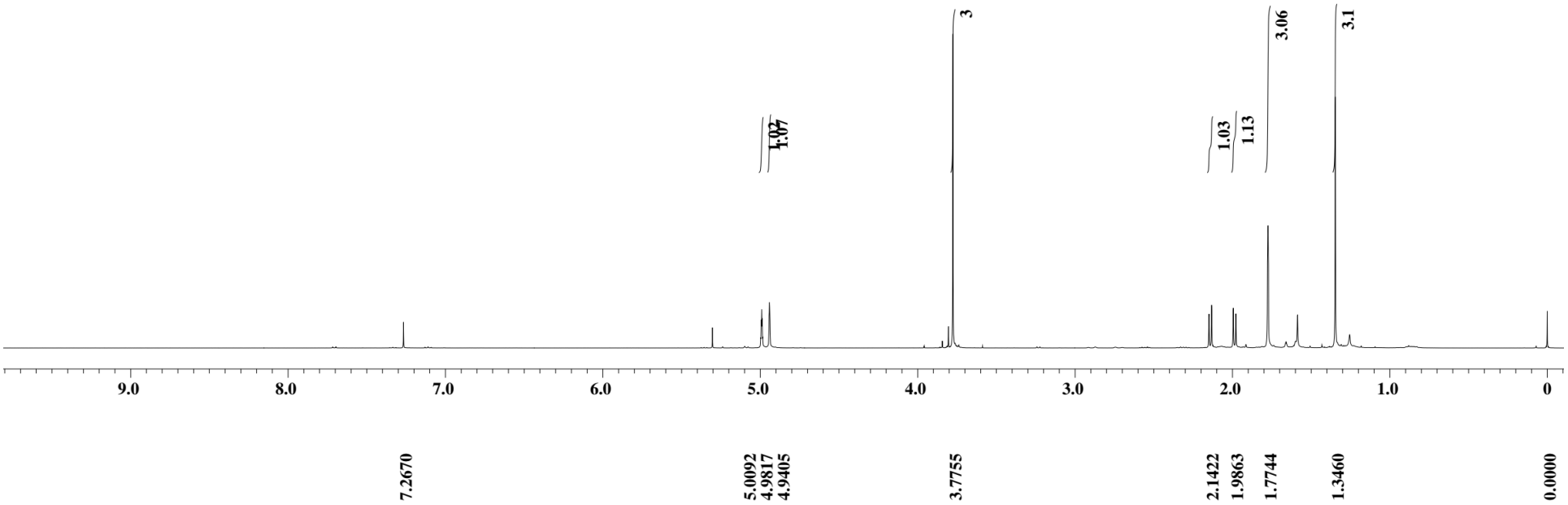
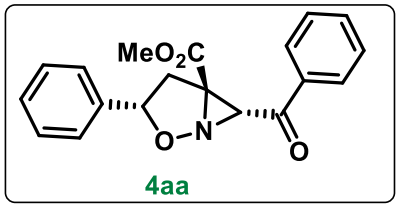
7.4084
7.2469
7.1564
3.8367
3.4438
3.4106
3.1351
1.6133

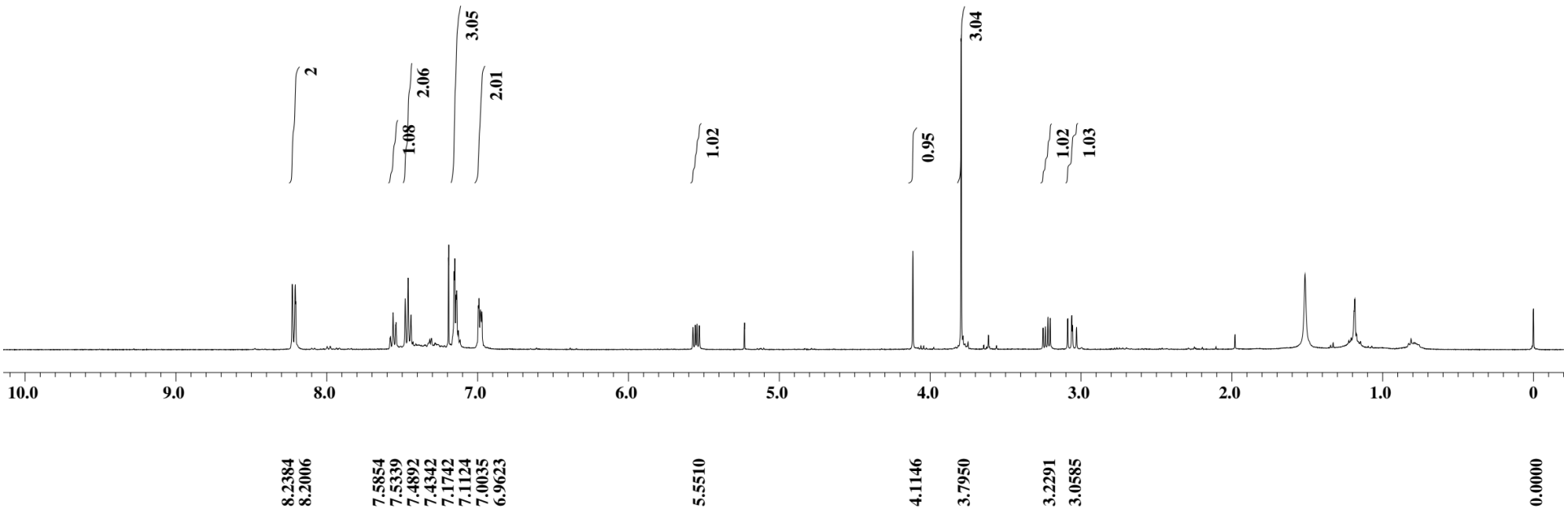

NO2
CO2Me
1k


3
3.06
3.1
1.03
1.13
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.2670
5.0092
4.9817
4.9405
3.7755
2.1422
1.9863
1.7744
1.3460
0.0000

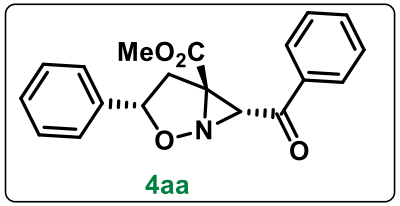
^{1}H-NMR ($CDCl_3$, 400 MHz)



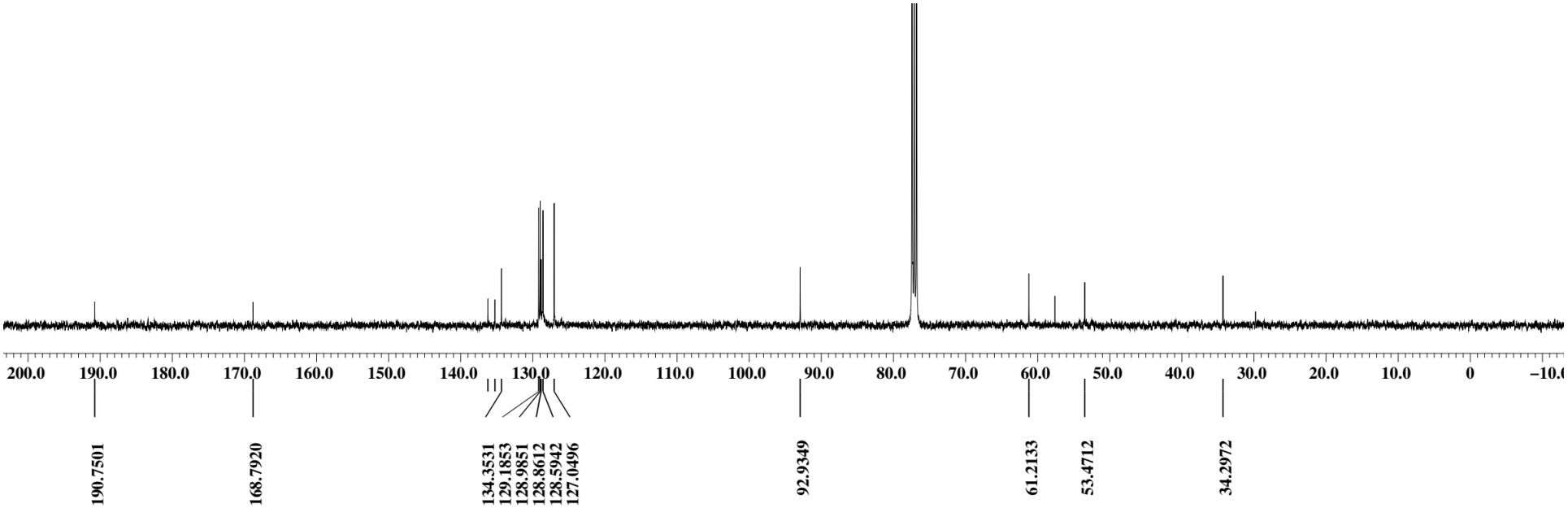
4aa



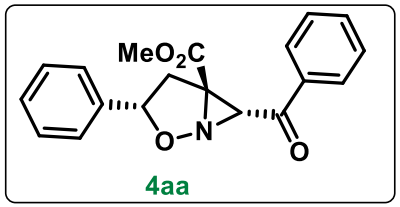
^{13}C-NMR ($CDCl_3$, 100 MHz)



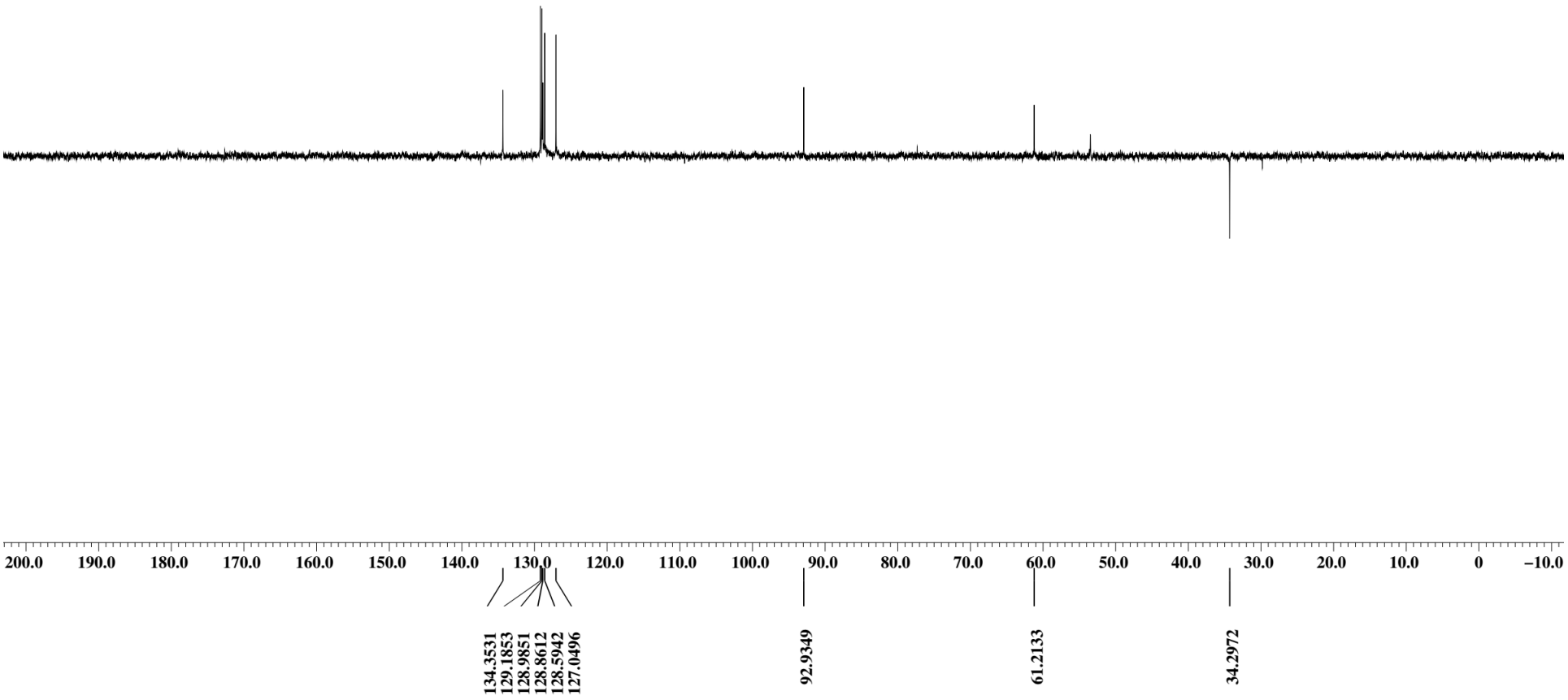
4aa



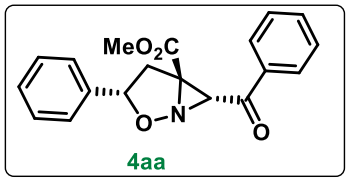
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



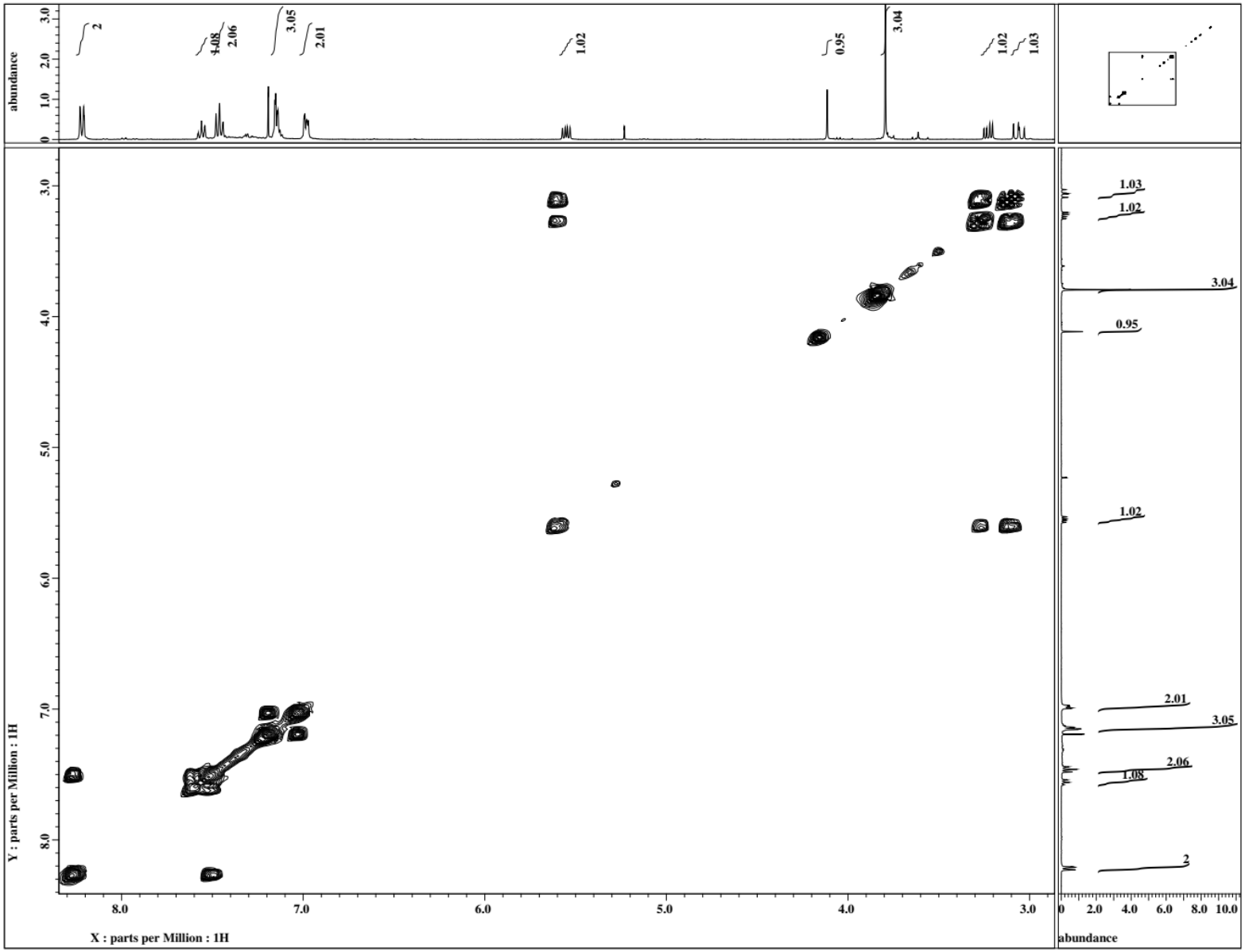
4aa



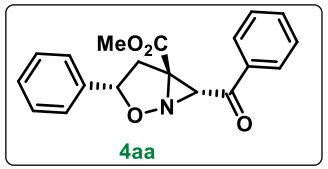
^{1}H COSY-NMR ($CDCl_3$, 400 MHz)



4aa



^{1}H-^{13}C DEPT HETCOR NMR ($CDCl_3$, 400 MHz, 100MHz)



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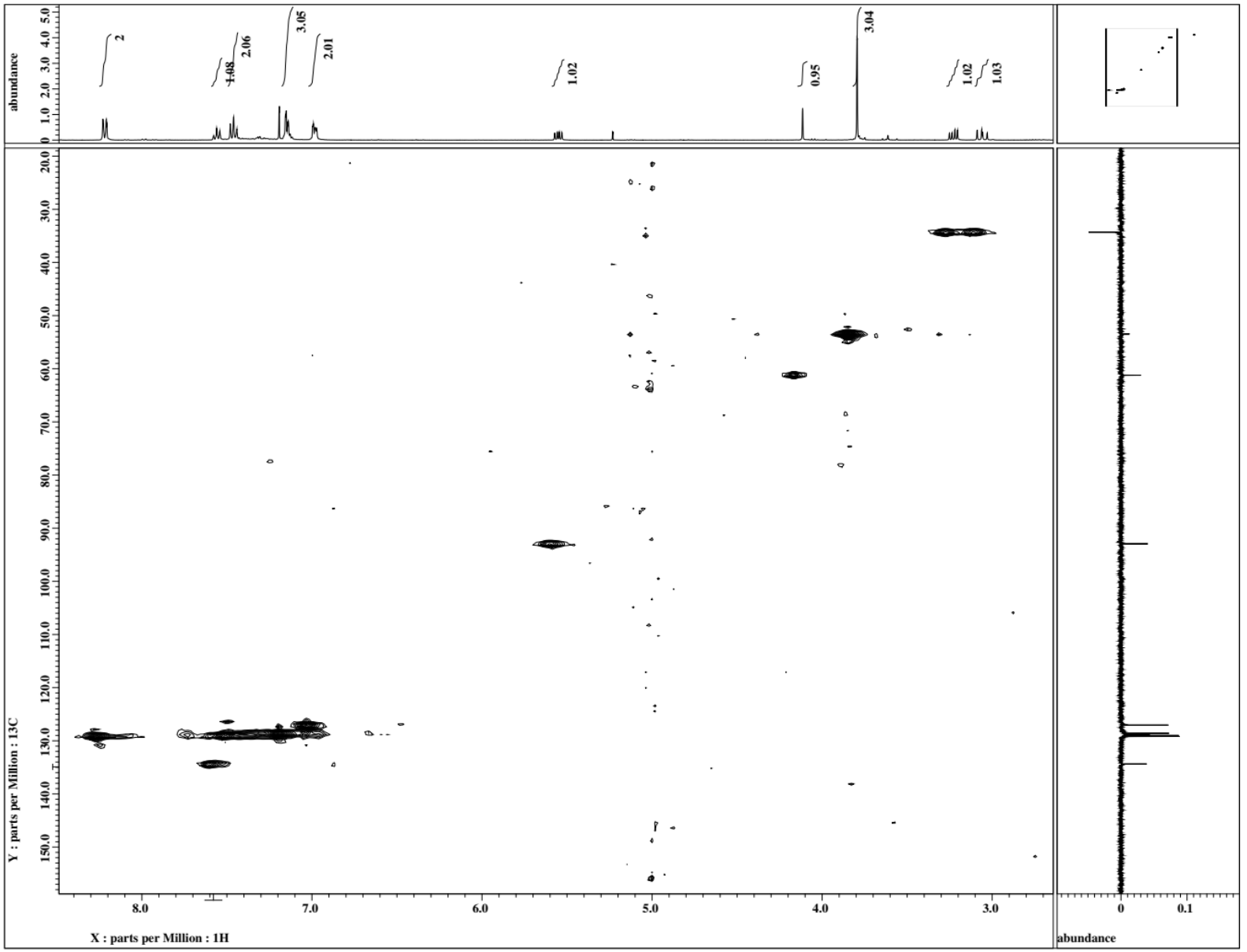
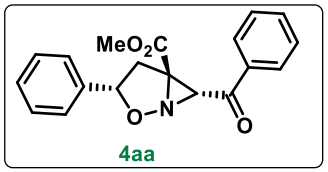
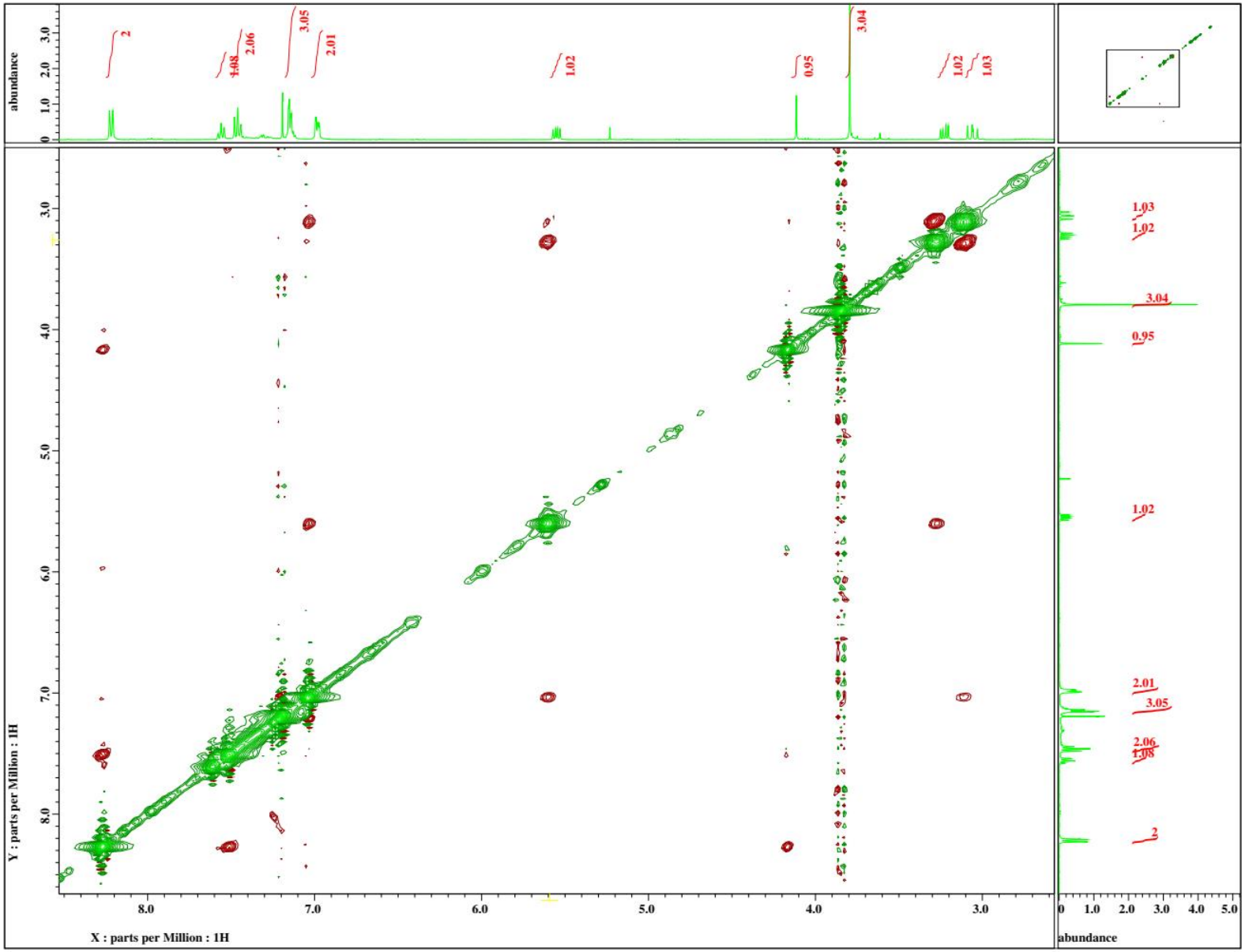


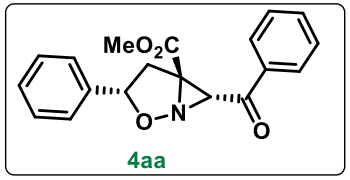
^{1}H NOE-NMR ($CDCl_3$, 400 MHz)



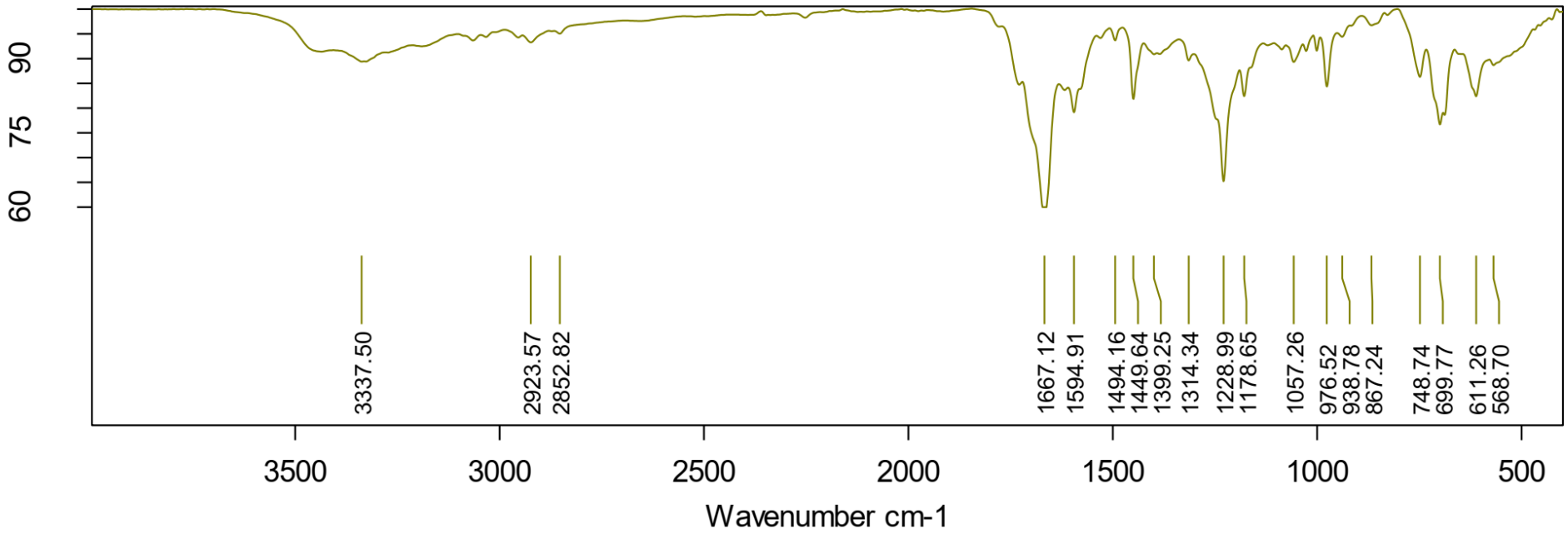
4aa



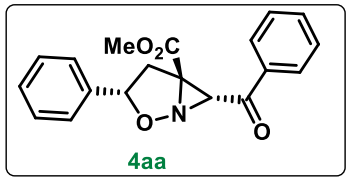
FT-IR Spectra



4aa



HRMS



4aa

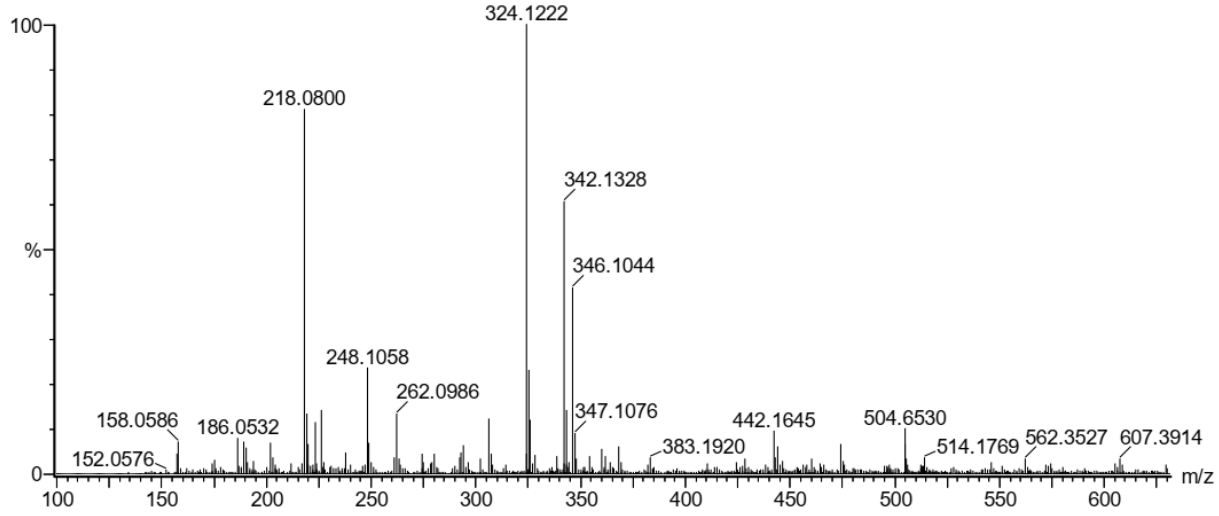
Elemental Composition Report

Single Mass Analysis

Tolerance = 15.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

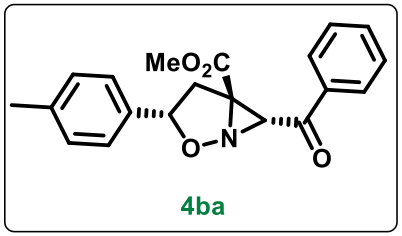
Monoisotopic Mass, Even Electron Ions
27 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-25 H: 15-30 N: 0-3 O: 0-4

Sample Name : 08-04-163-A IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
300519-08-04-163-A 13 (0.140) AM (Cen,4, 85.00, Ar,10000.0,0.00,0.00); Sm (SG, 1x3.00); Cm (13:19) 1: TOF MS ES+
6.13e+007

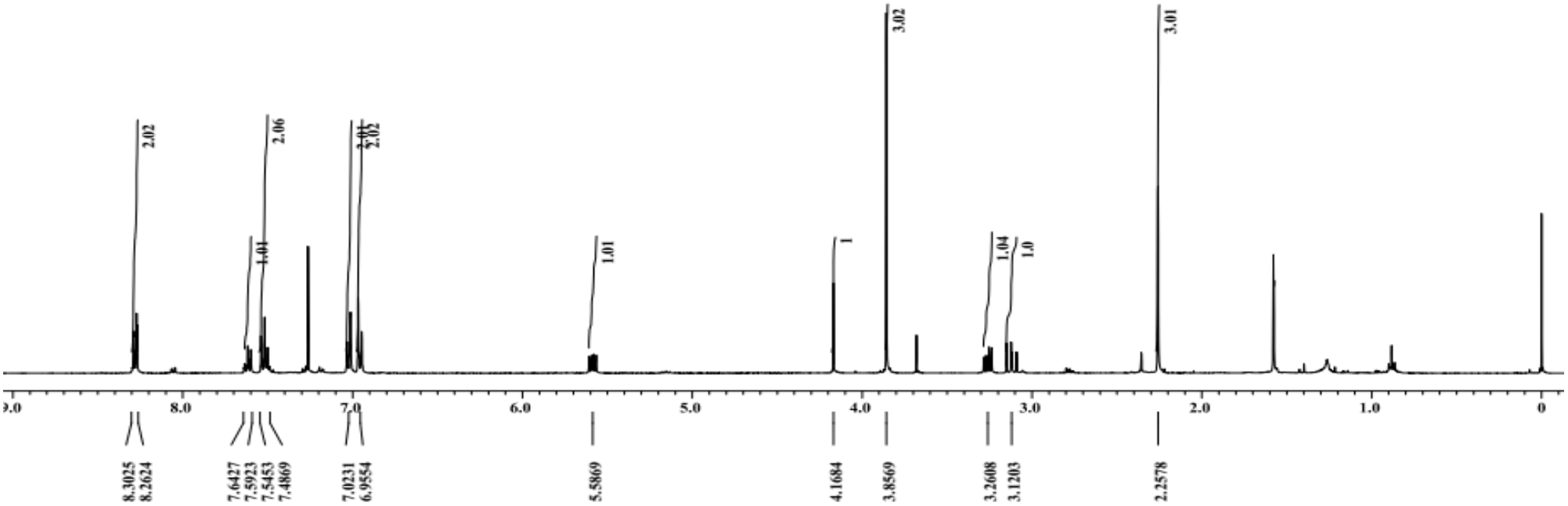


Minimum:				-1.5				
Maximum:		5.0	15.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
324.1222	324.1236	-1.4	-4.3	11.5	1265.0	n/a	n/a	C19 H18 N O4

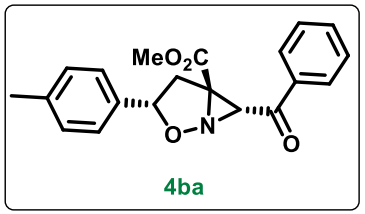
^{1}H-NMR ($CDCl_3$, 400 MHz)



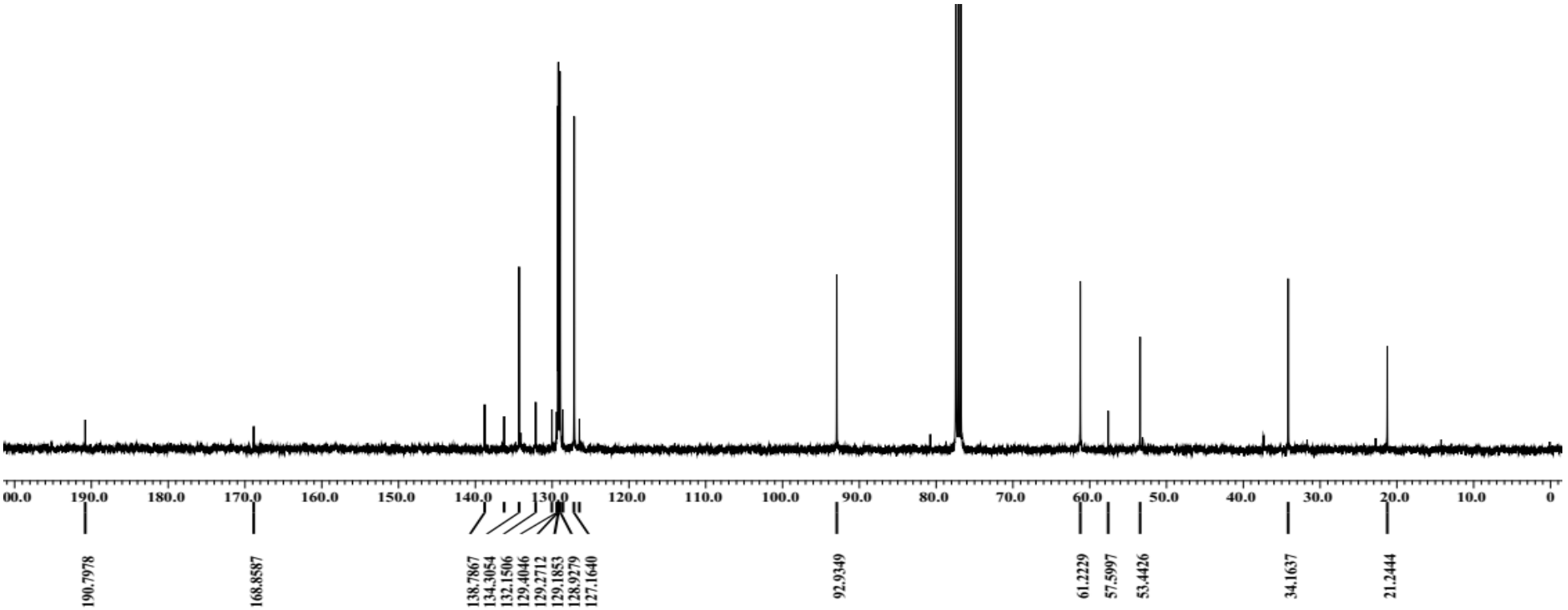
4ba



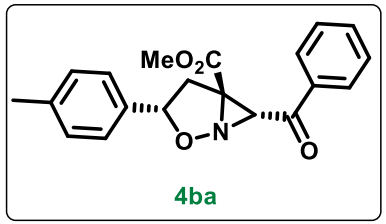
^{13}C-NMR ($CDCl_3$, 100 MHz)



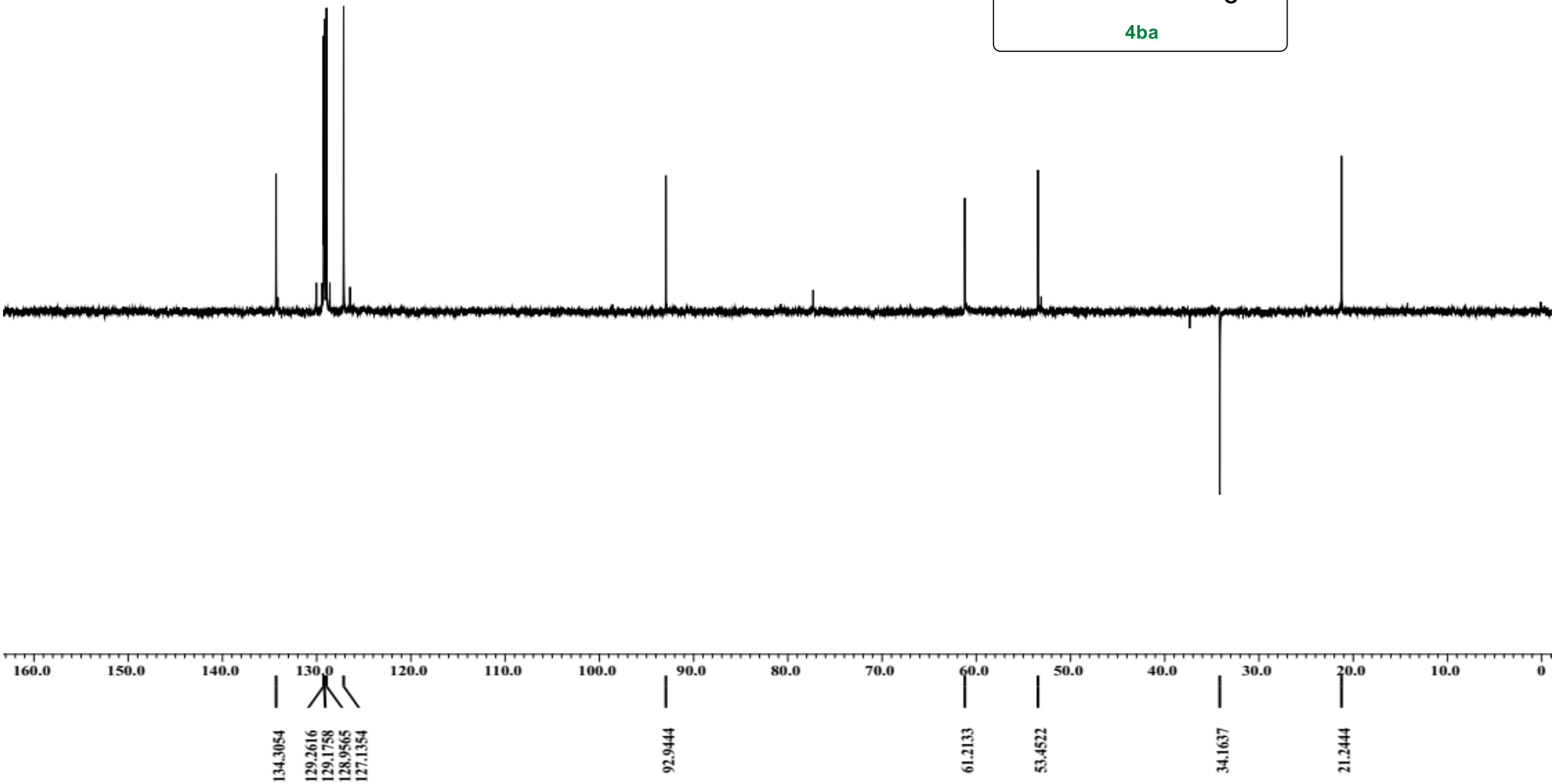
4ba



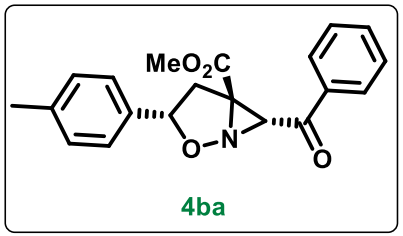
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



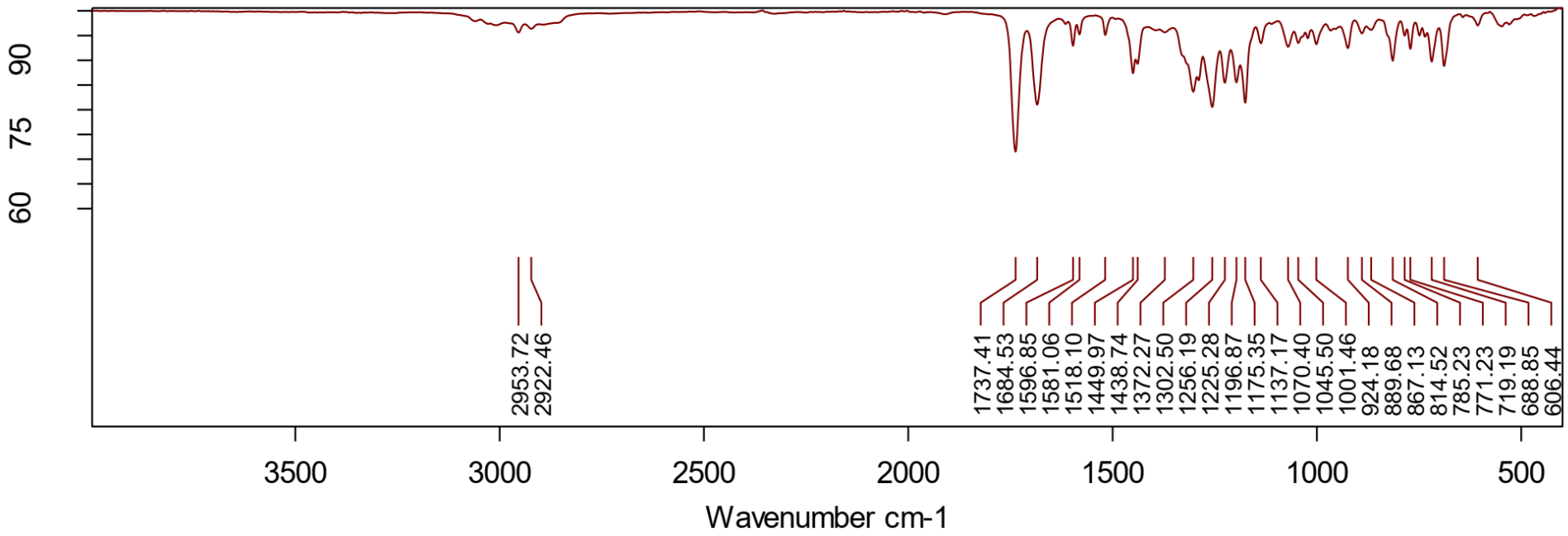
4ba



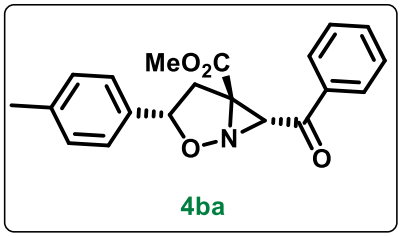
FT-IR Spectra



4ba



HRMS



4ba

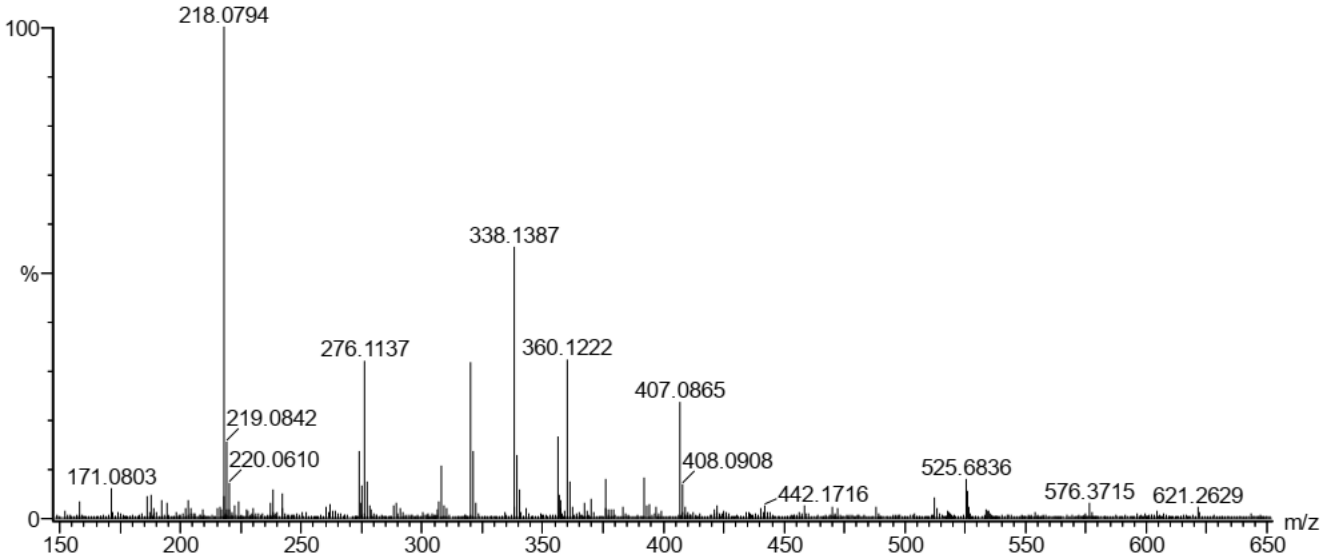
Elemental Composition Report

Single Mass Analysis

Tolerance = 5.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

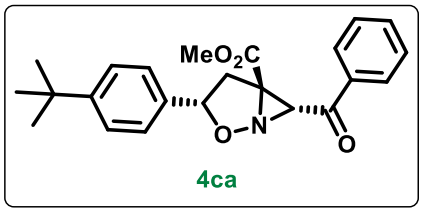
Monoisotopic Mass, Even Electron Ions
25 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-25 H: 15-30 N: 0-3 O: 0-4

Sample Name : 08-04-197 IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
300519-08-04-197 17 (0.174) AM (Top,4, Ar,10000.0,0.00,0.00); Cm (17:20) 1: TOF MS ES+
1.48e+007

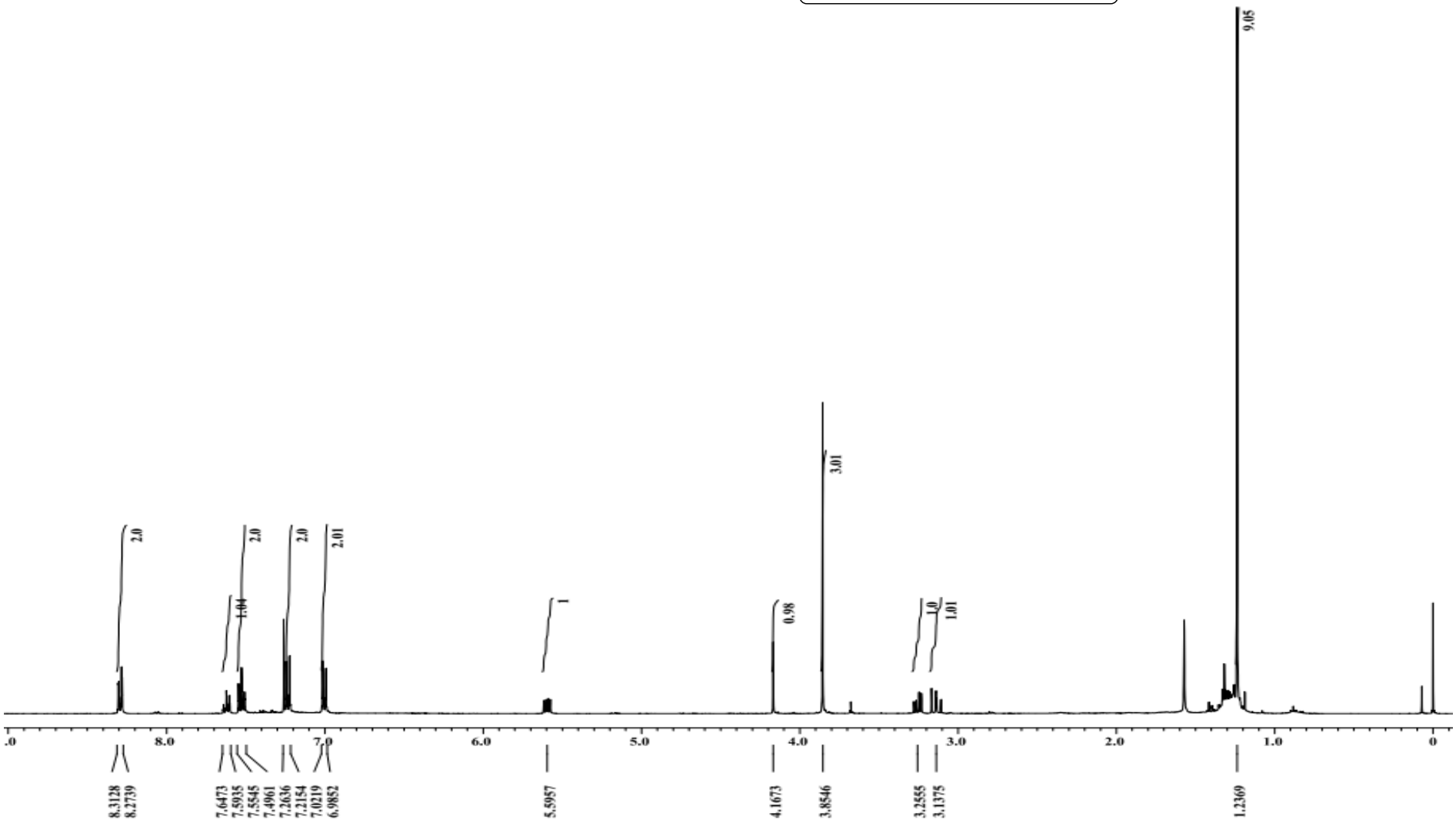


Minimum:				-1.5				
Maximum:		5.0	5.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
338.1387	338.1392	-0.5	-1.5	11.5	649.4	n/a	n/a	C20 H20 N O4

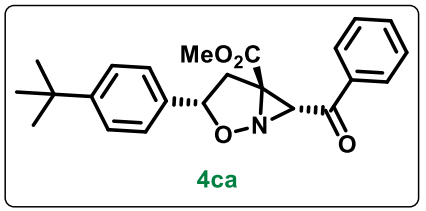
^{1}H-NMR ($CDCl_3$, 400 MHz)



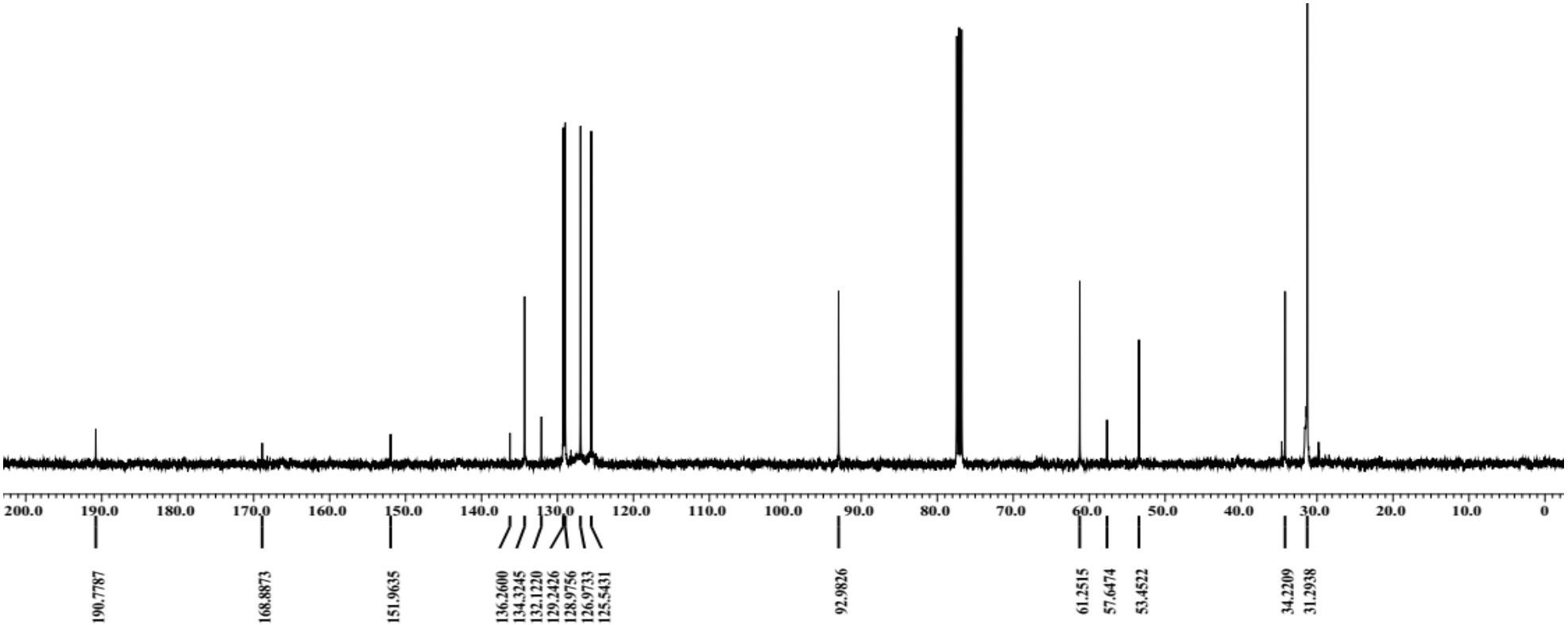
4ca



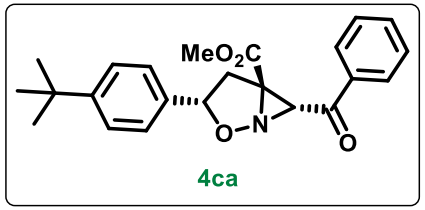
^{13}C-NMR ($CDCl_3$, 100 MHz)



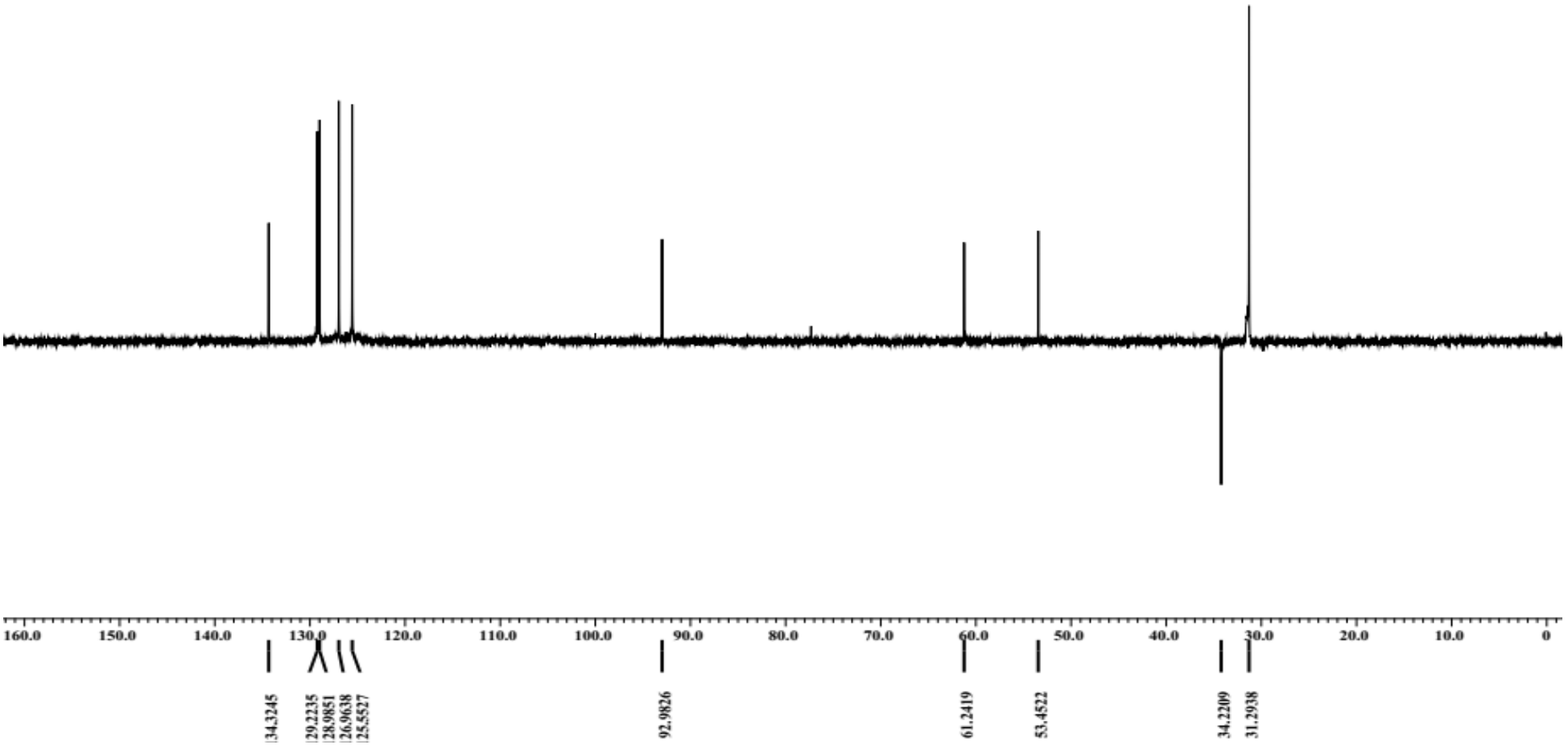
4ca



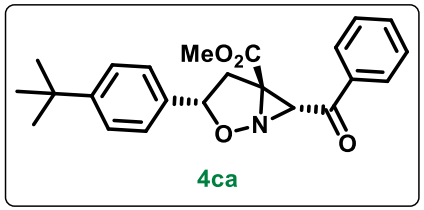
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



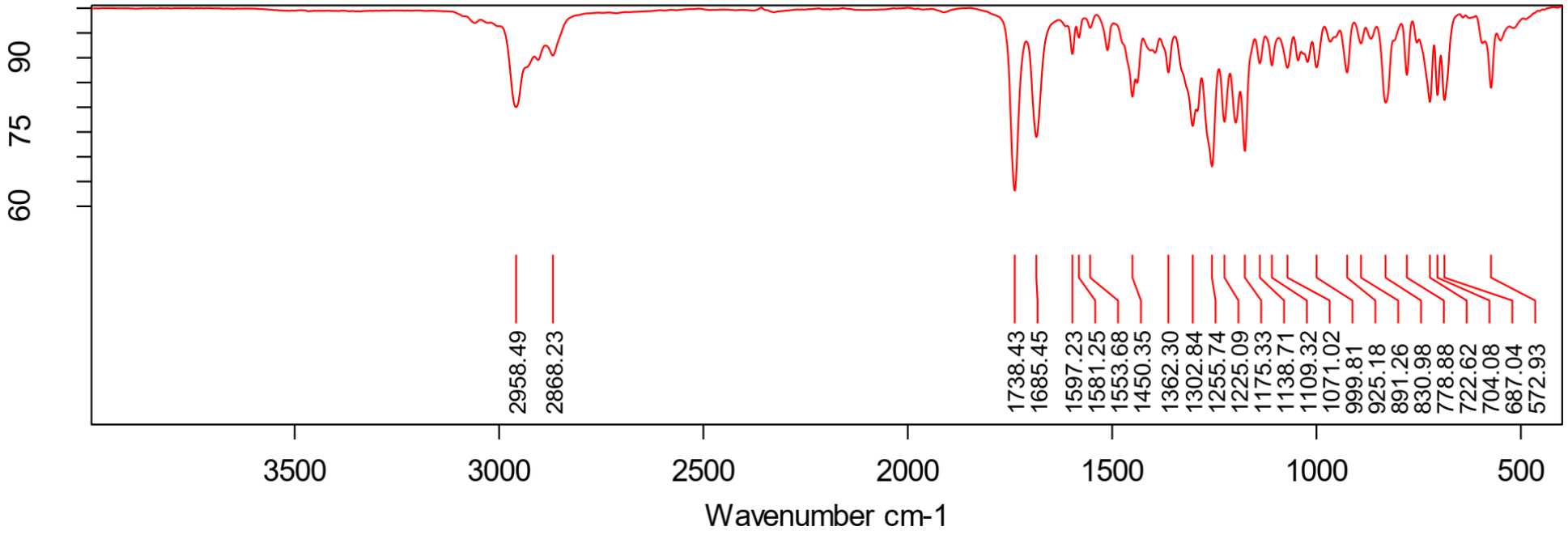
4ca



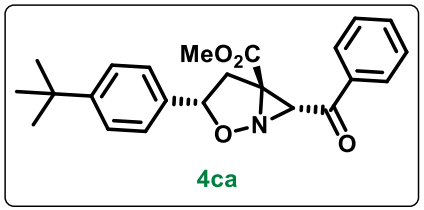
FT-IR Spectra



4ca



HRMS



4ca

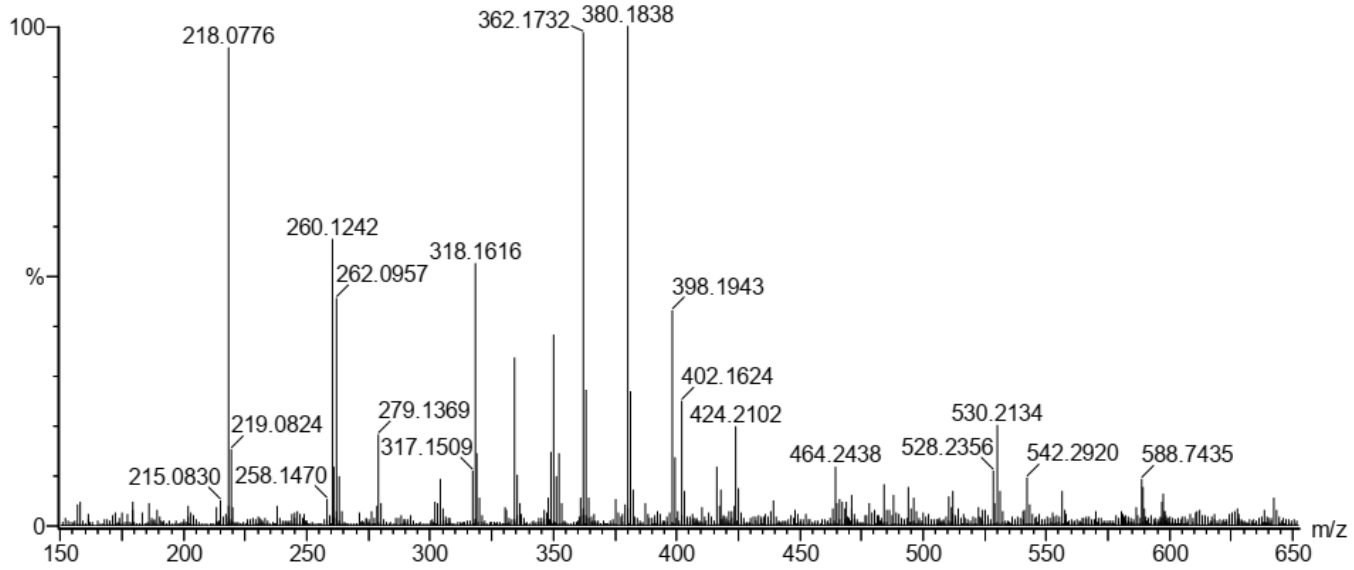
Elemental Composition Report

Single Mass Analysis

Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

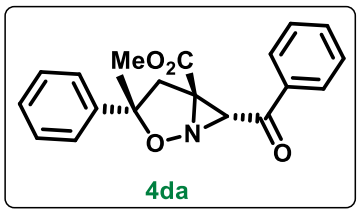
Monoisotopic Mass, Even Electron Ions
20 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-25 H: 8-30 N: 0-3 O: 0-4

Sample Name : 08-04-170 IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
300519-08-04-170 12 (0.131) AM (Top,4, Ar,10000.0,0.00,0.00); Cm (9:18) 1: TOF MS ES+
1.02e+008

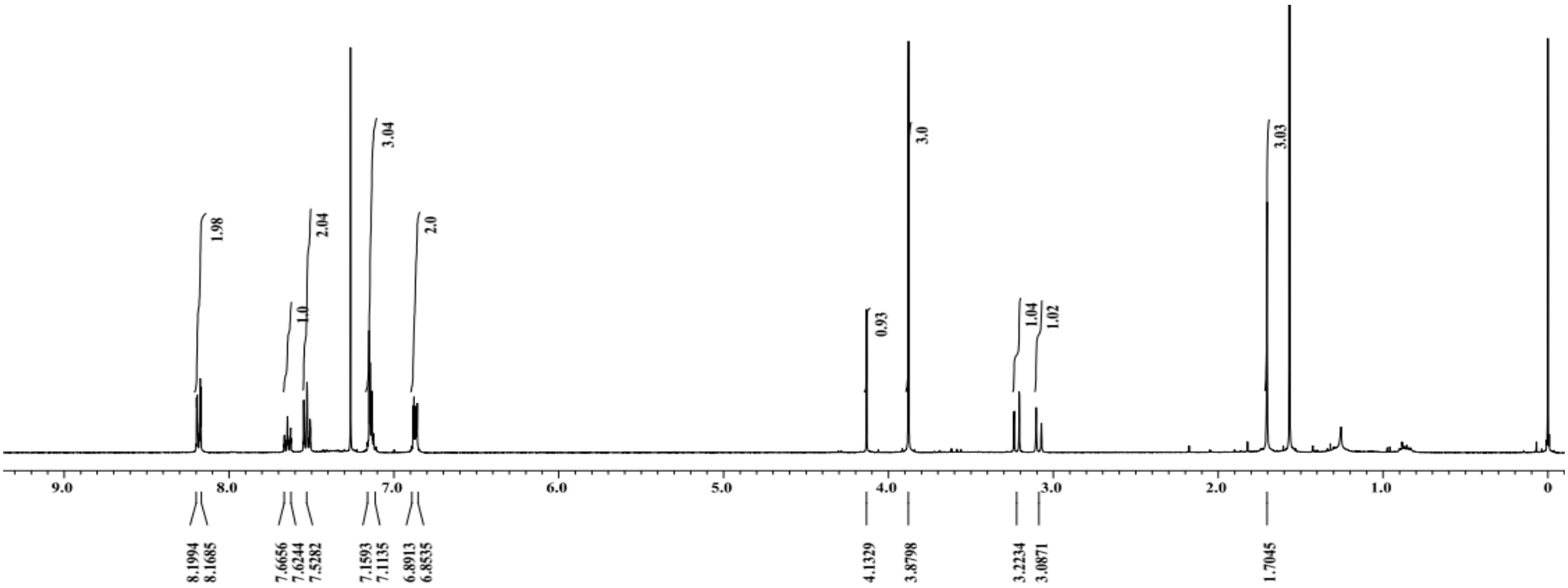


Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
380.1838	380.1862	-2.4	-6.3	11.5	881.1	n/a	n/a	C23 H26 N O4

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



4da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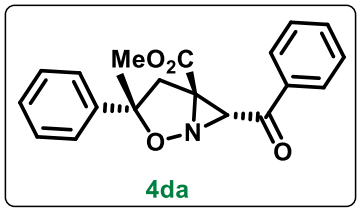
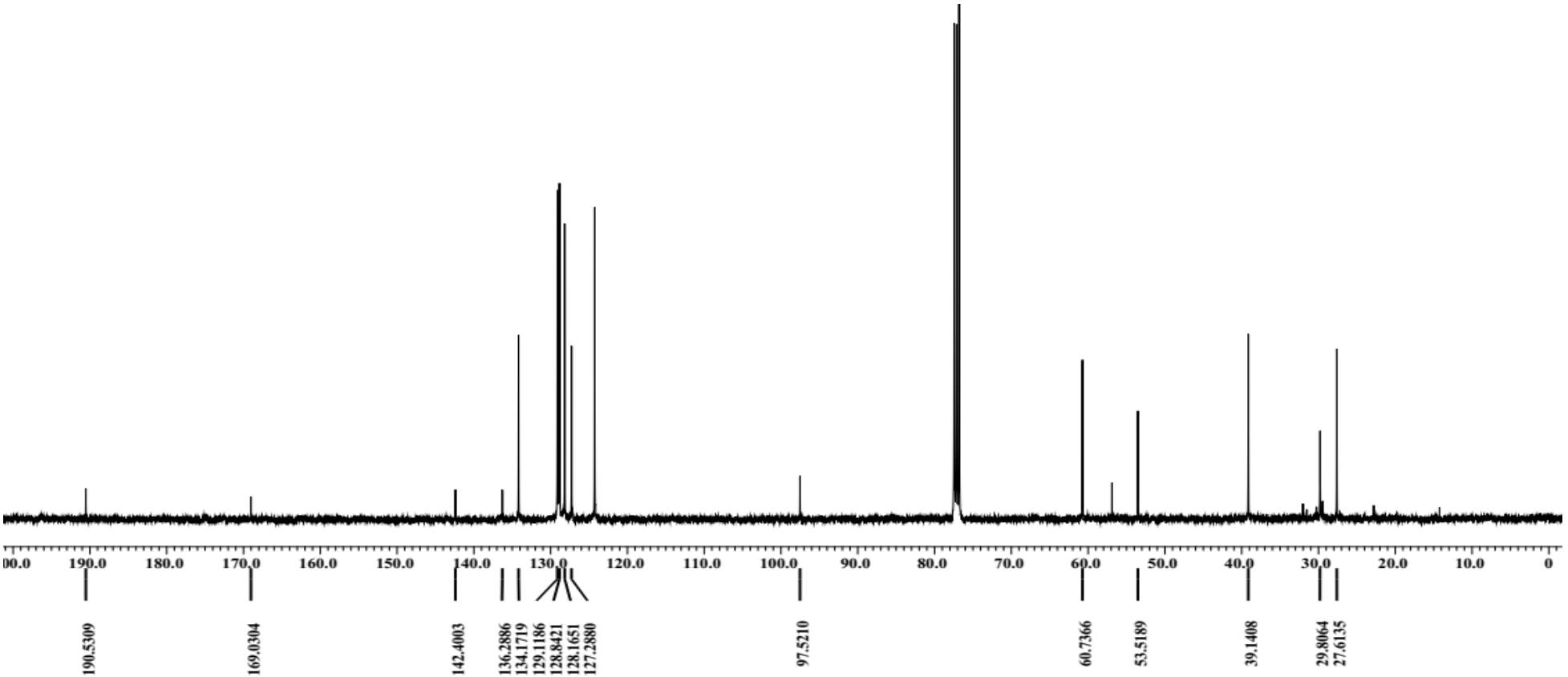
2.04
3.04
2.0
0.93
3.0
1.04
1.02
3.03
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
8.1994
8.1685
7.6656
7.6244
7.5282
7.1593
7.1135
6.8913
6.8535
4.1329
3.8798
3.2234
3.0871
1.7045

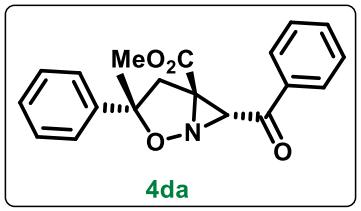
^{13}C-NMR ($CDCl_3$, 100 MHz)



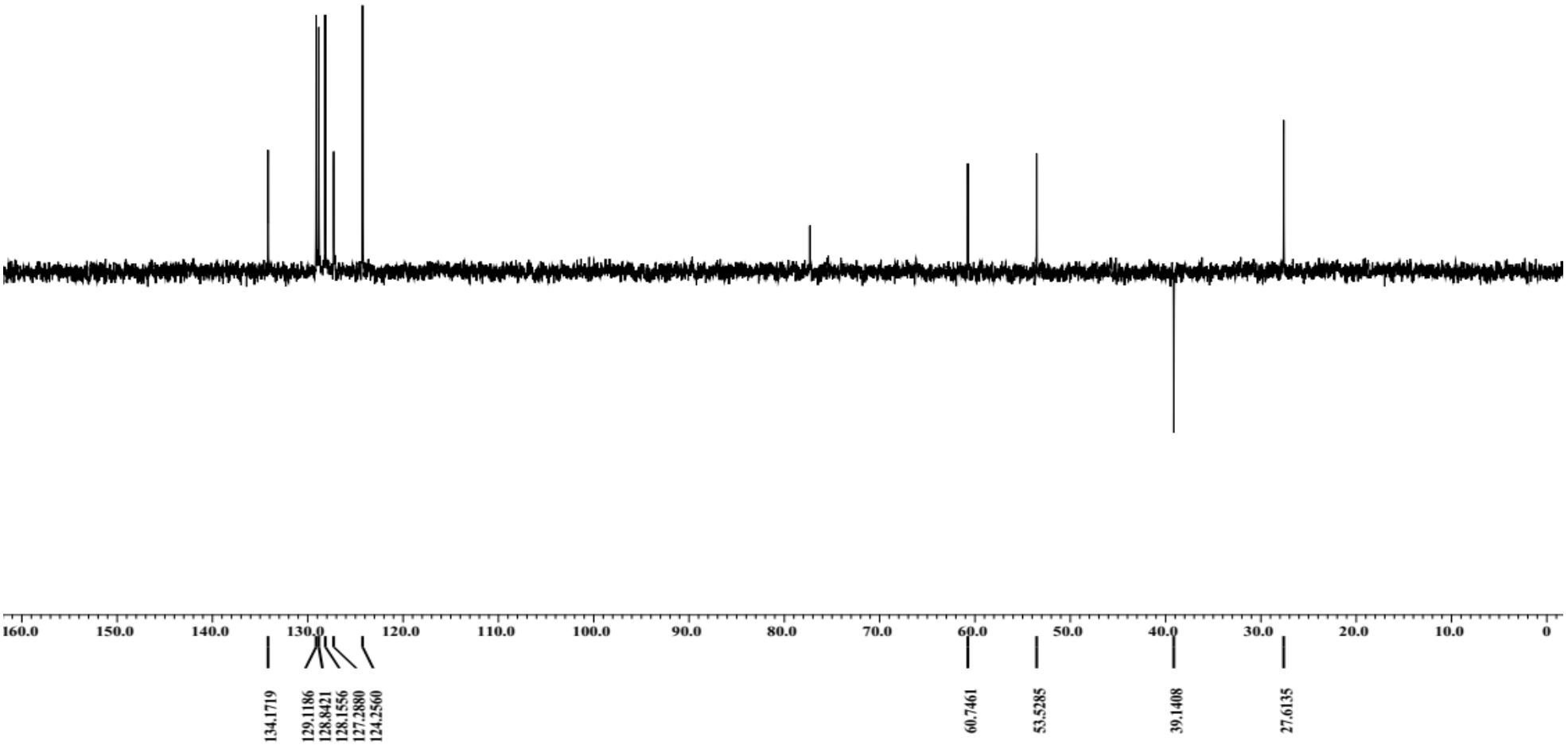
4da



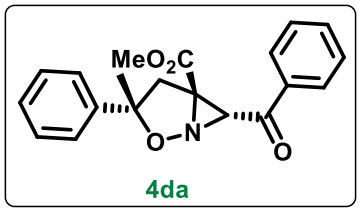
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



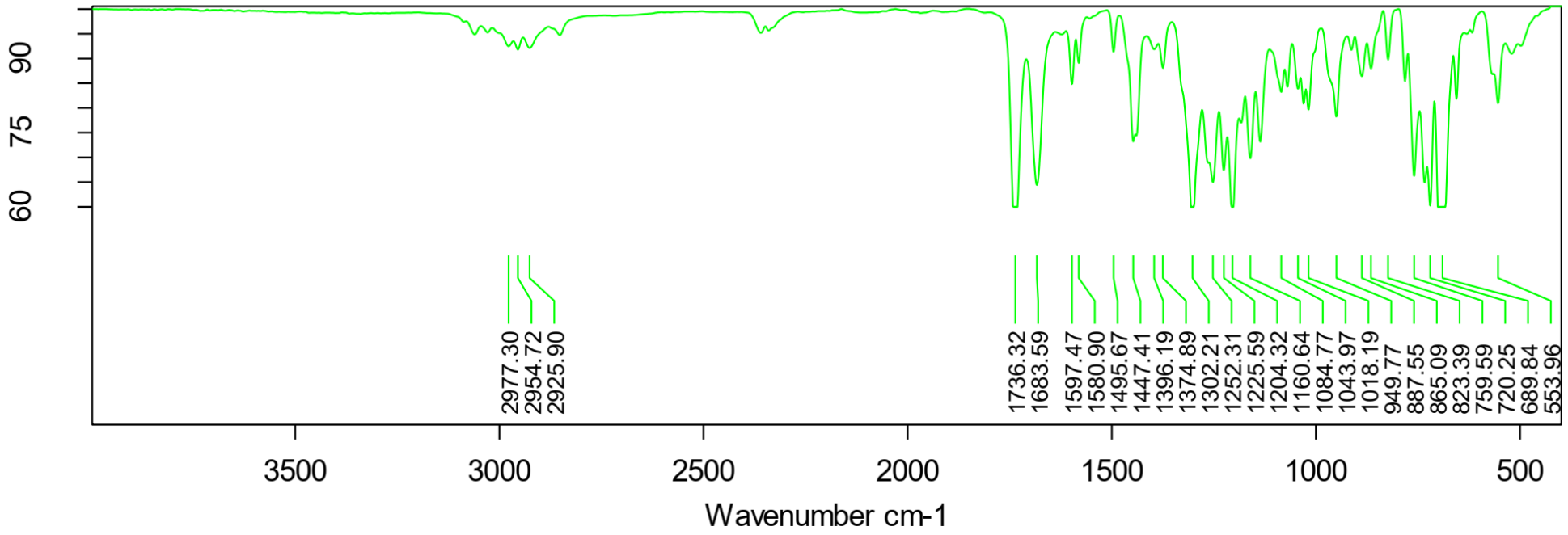
4da



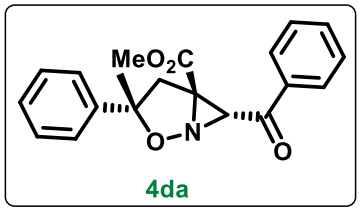
FT-IR Spectra



4da



HRMS



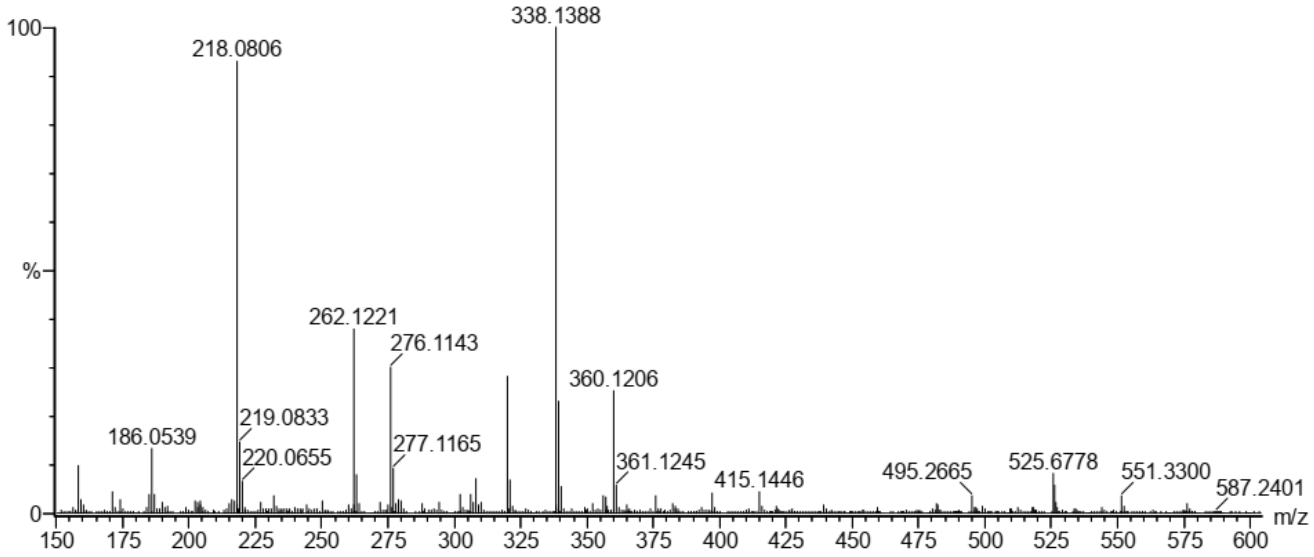
Elemental Composition Report

Single Mass Analysis

Tolerance = 5.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

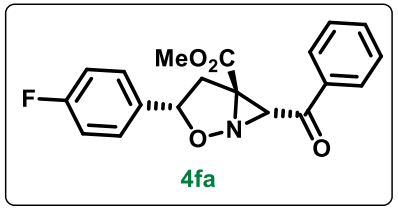
Monoisotopic Mass, Even Electron Ions
25 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-25 H: 15-30 N: 0-3 O: 0-4

Sample Name : 19-01-073 IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
300519-19-01-073 14 (0.148) AM (Cen,4, 85.00, Ar,10000.0,0.00,0.00); Sm (SG, 1x3.00); Cm (14:18) 1: TOF MS ES+
7.52e+007

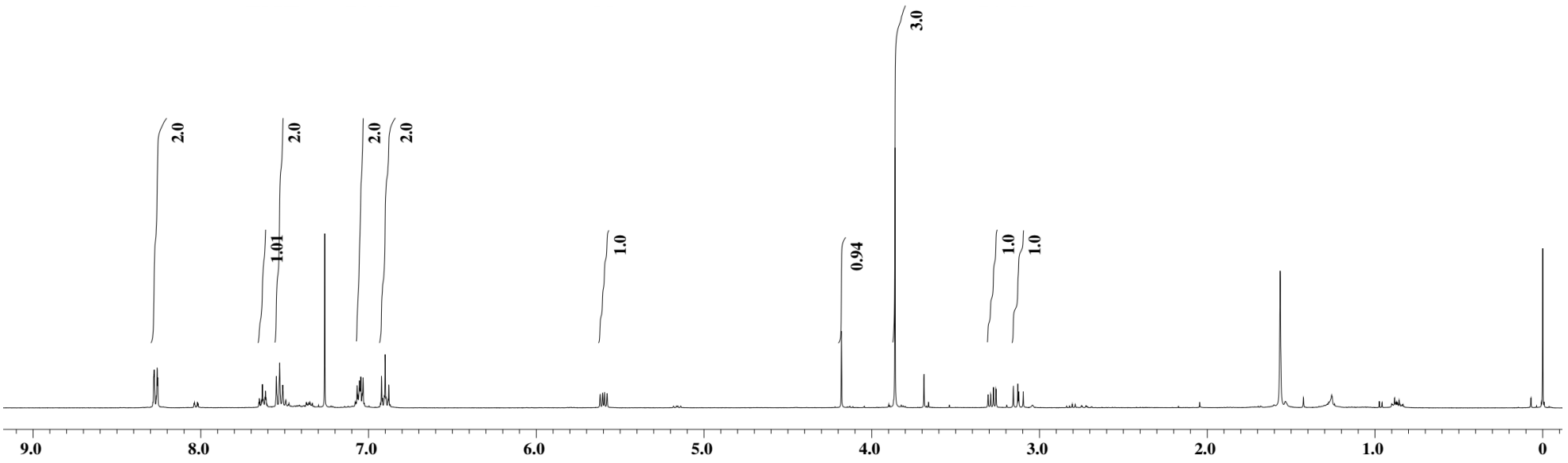


Minimum:				-1.5				
Maximum:		5.0	5.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
338.1388	338.1392	-0.4	-1.2	11.5	1035.1	n/a	n/a	C20 H20 N O4

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



4fa



8.2699
7.6559
7.6066
7.5585
7.4932
7.0797
7.0236
6.9331
6.8724
5.6261
5.5711
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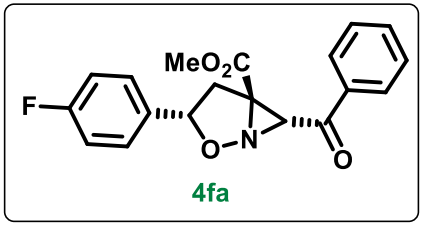
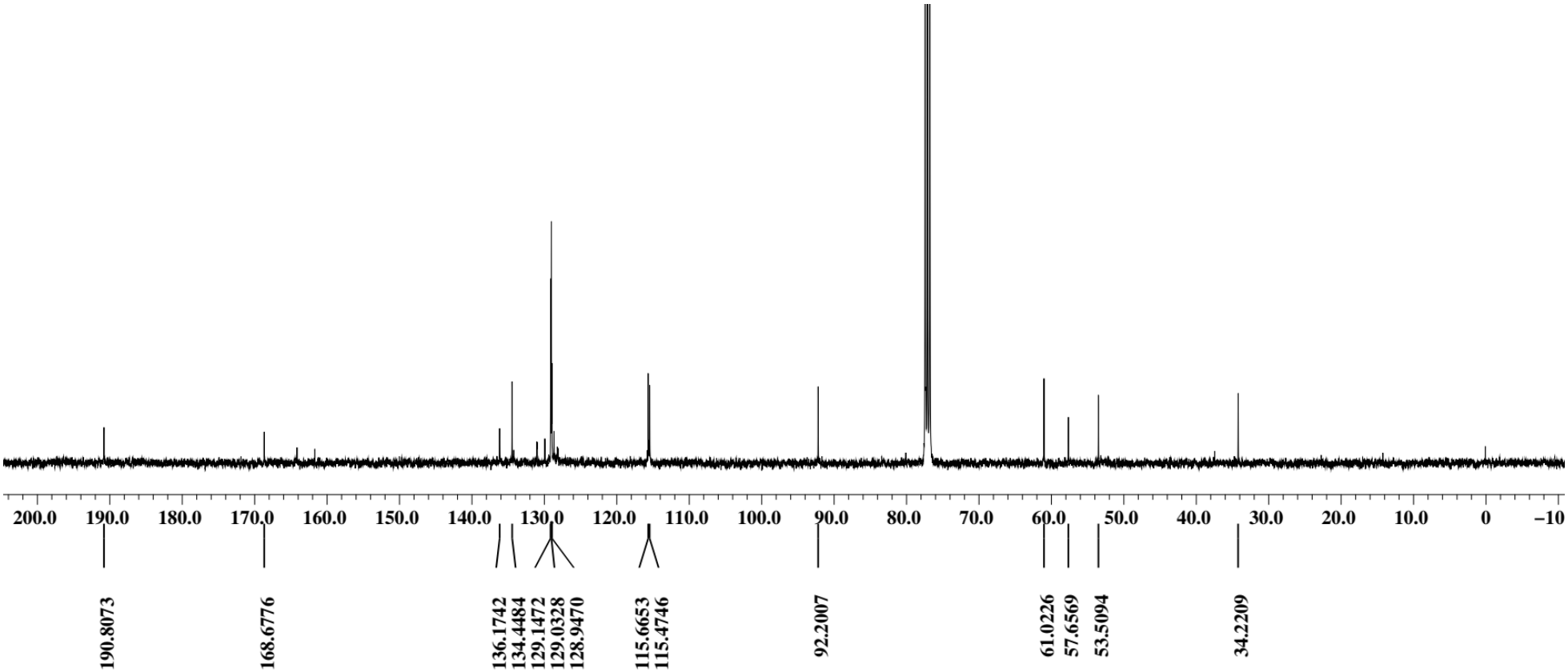
3.8609
3.3145
3.2526
3.1644
3.0900

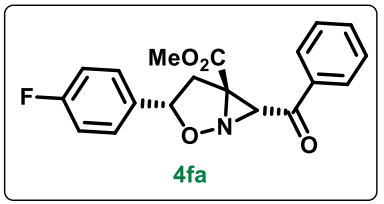
^{13}C-NMR ($CDCl_3$, 100 MHz)



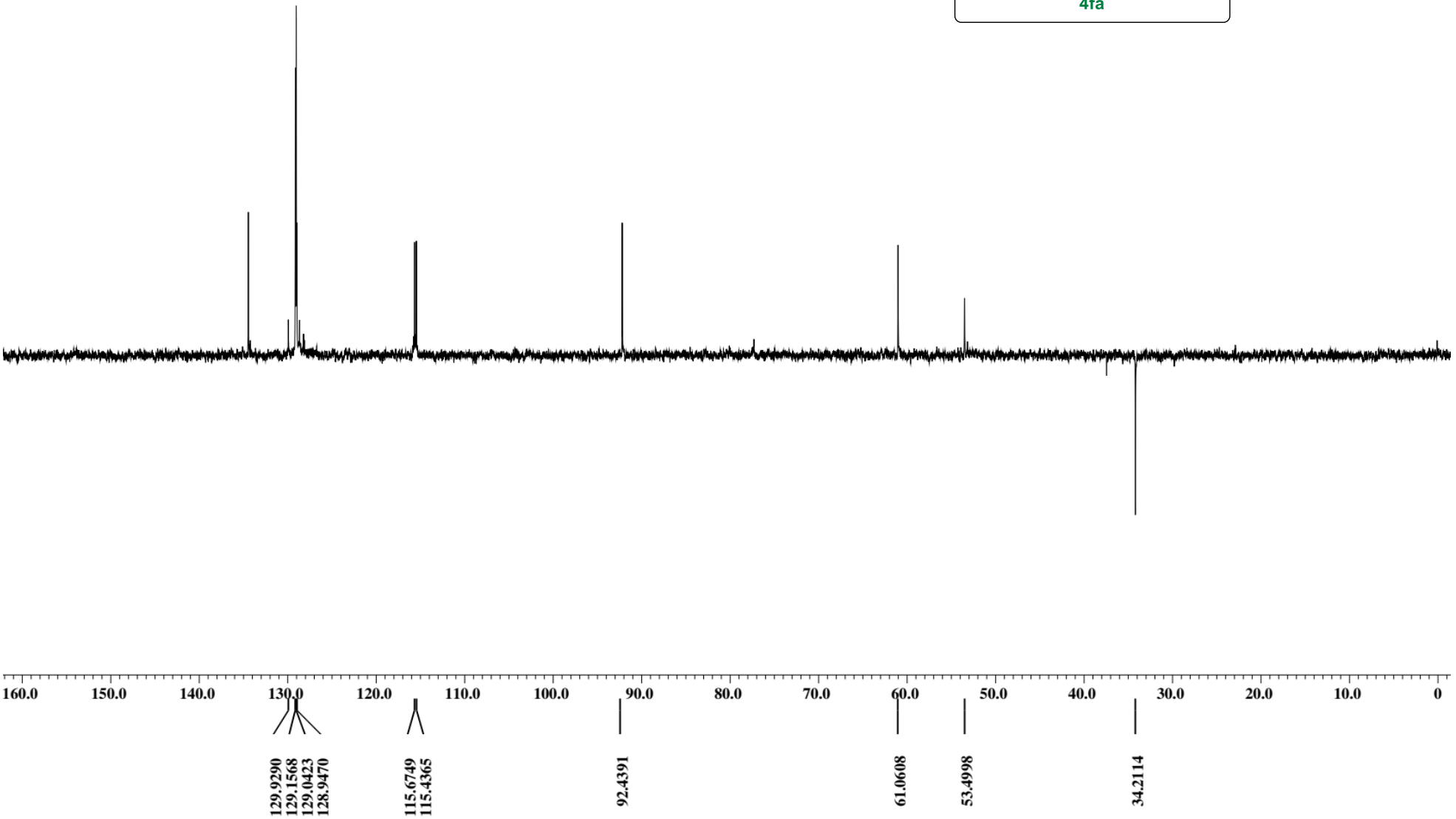
4fa



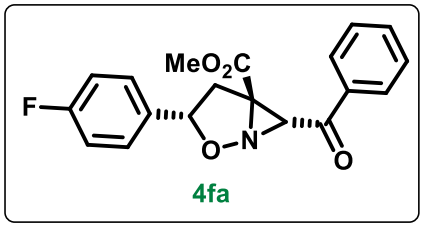
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



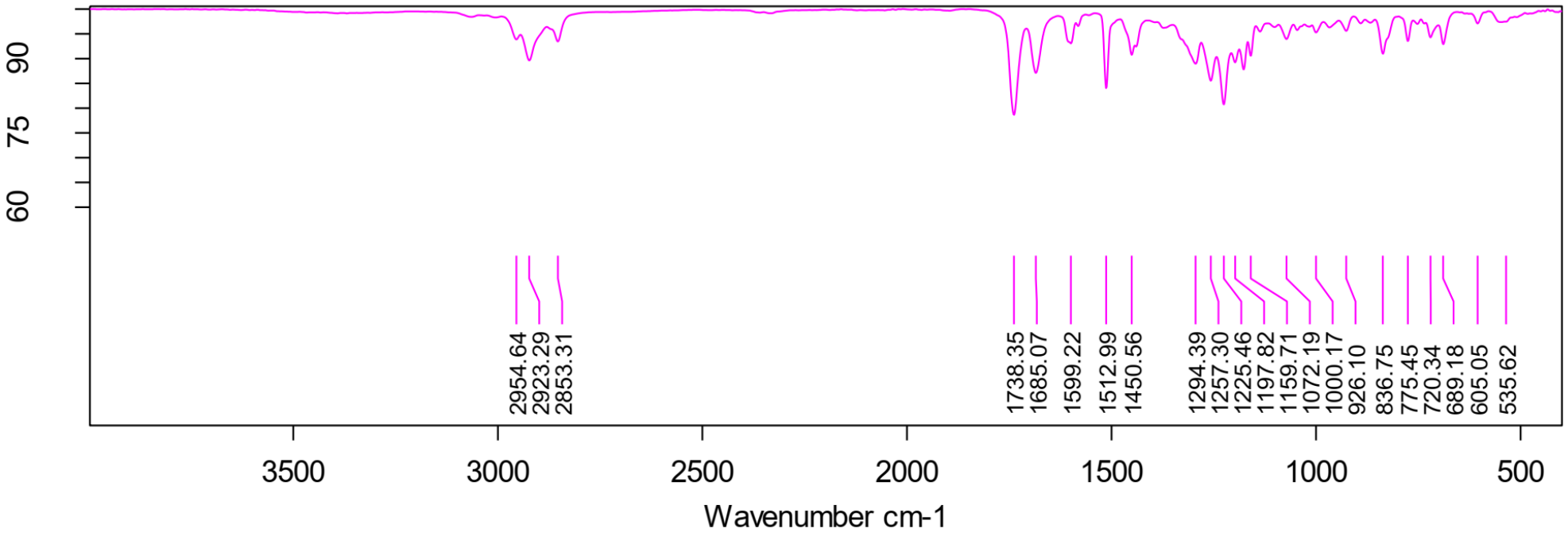
4fa



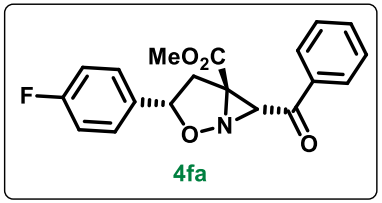
FT-IR Spectra



4fa



HRMS



4fa

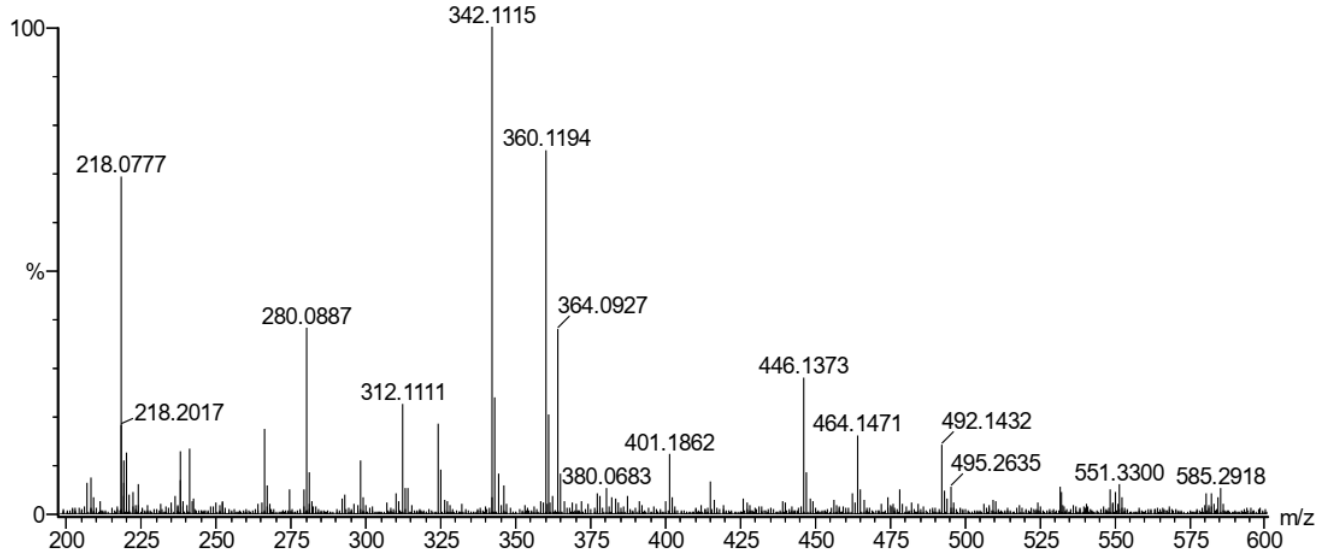
Elemental Composition Report

Single Mass Analysis

Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

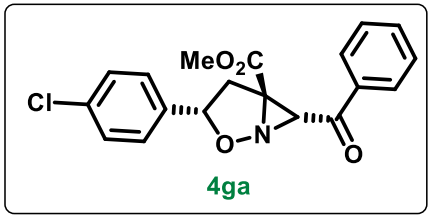
Monoisotopic Mass, Even Electron Ions
28 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-20 H: 15-30 N: 0-3 O: 0-4 F: 0-1

Sample Name : 08-04-207-R IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
300519-08-04-207-R 14 (0.148) AM (Top,4, Ar,10000.0,0.00,0.00); Sm (SG, 1x3.00); Cm (14:19) 1: TOF MS ES+
1.33e+007

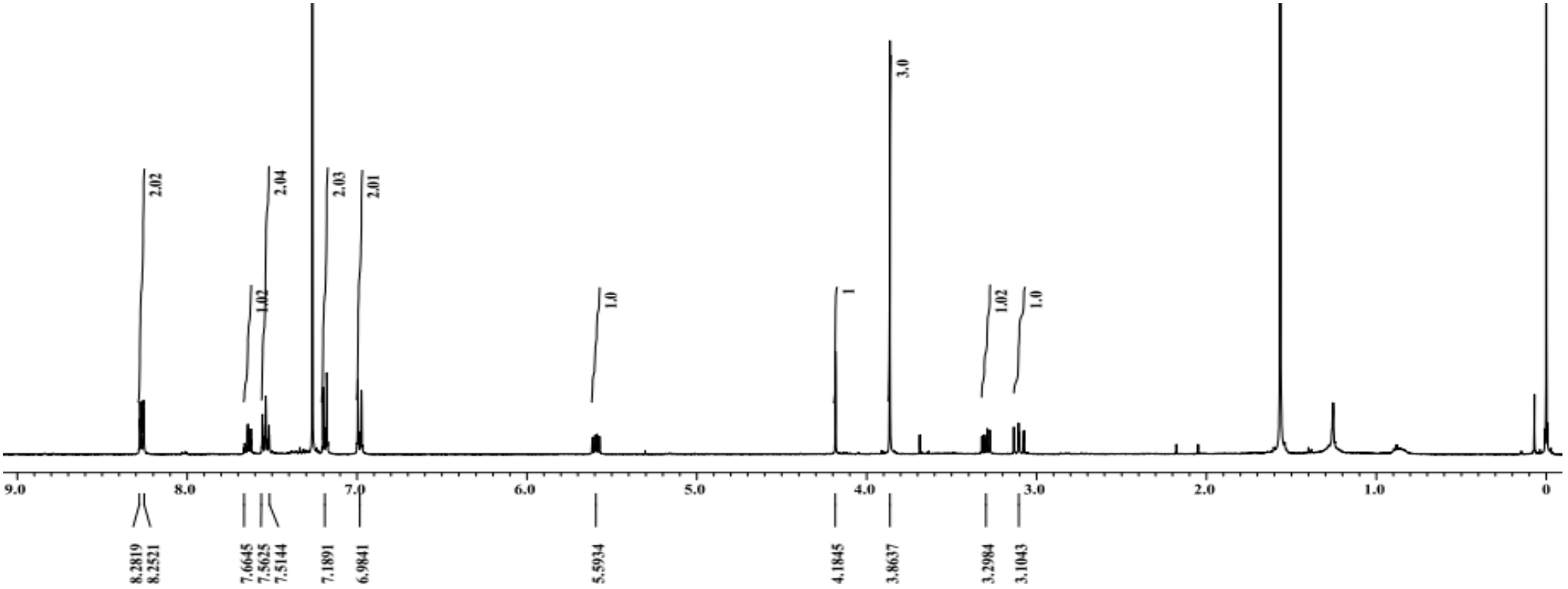


Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
342.1115	342.1142	-2.7	-7.9	11.5	1229.0	n/a	n/a	C19 H17 N O4 F

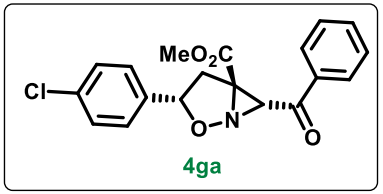
^{1}H-NMR ($CDCl_3$, 400 MHz)



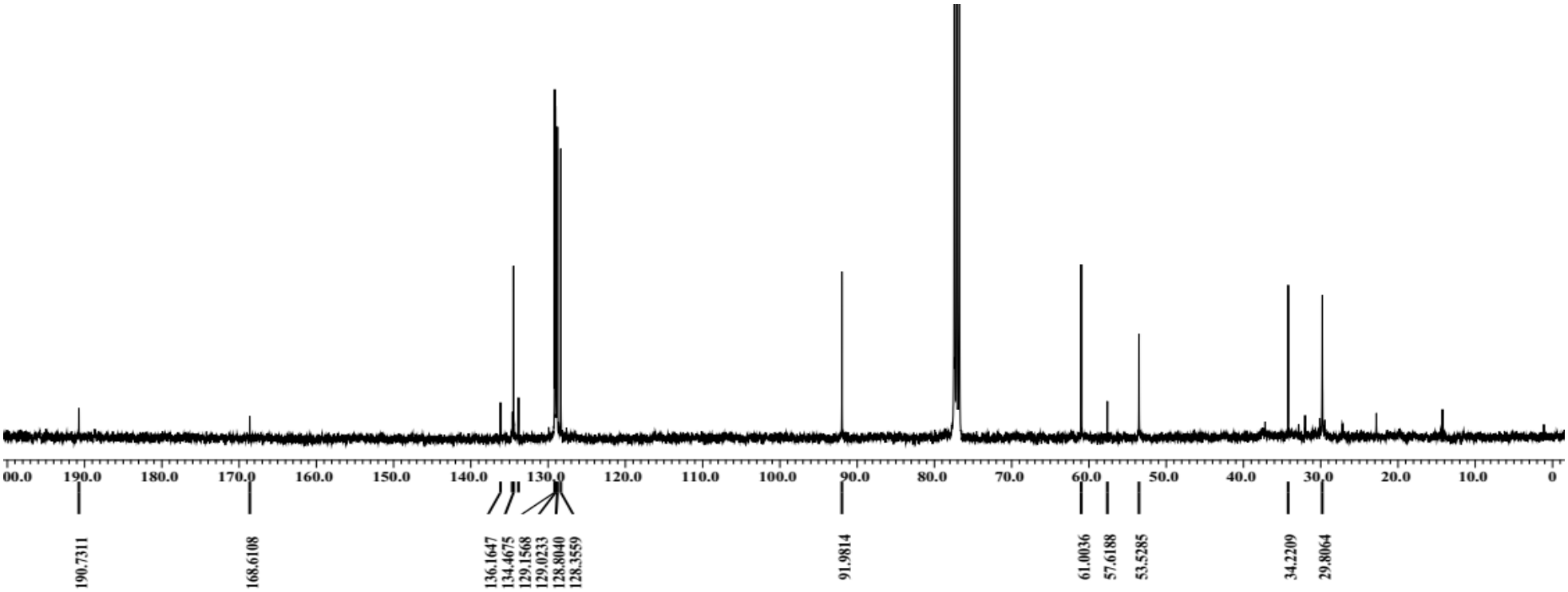
4ga



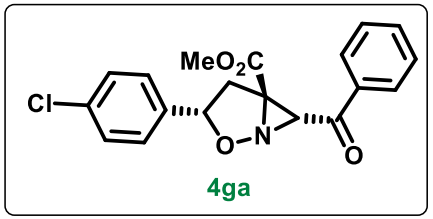
^{13}C-NMR ($CDCl_3$, 100 MHz)



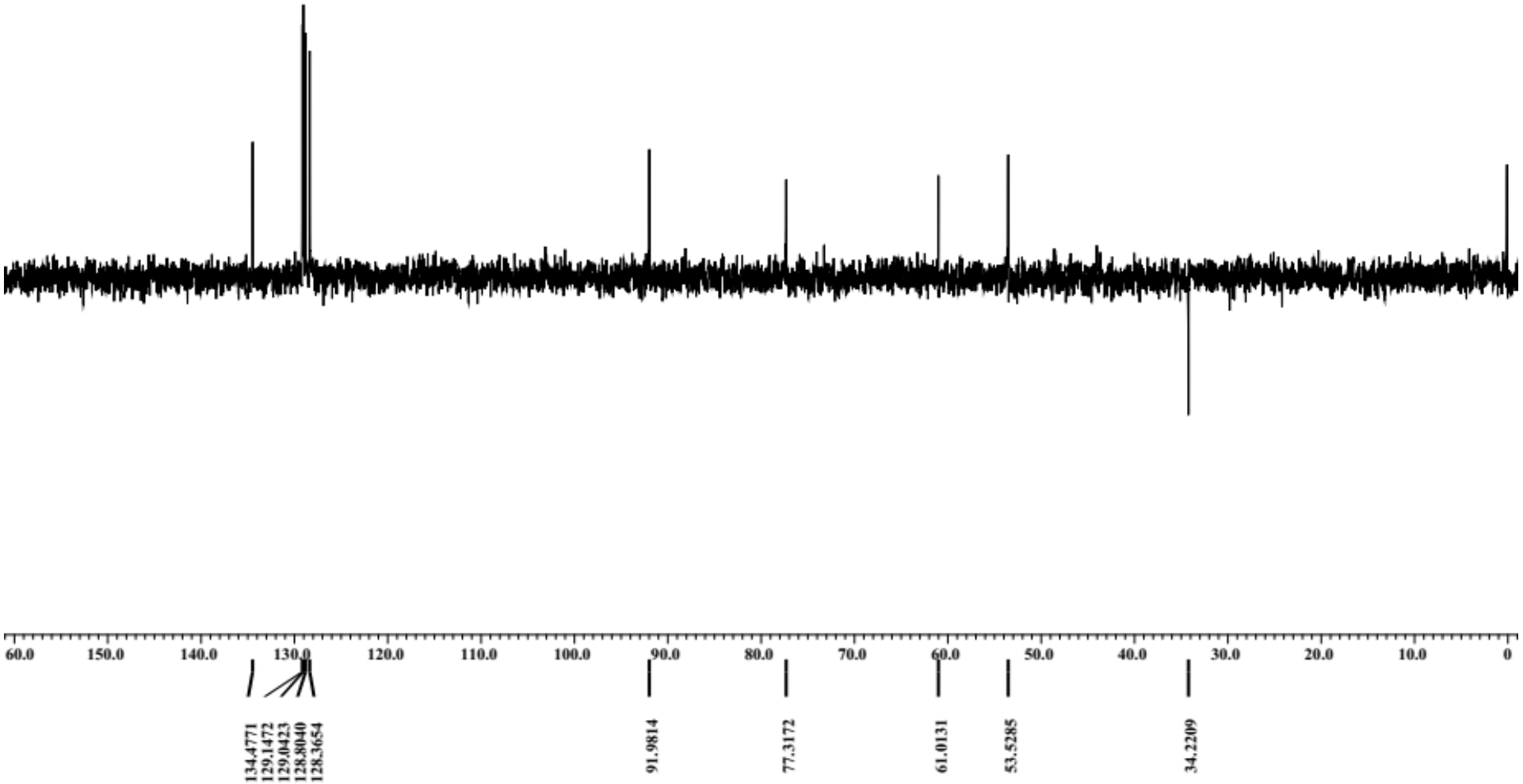
4ga



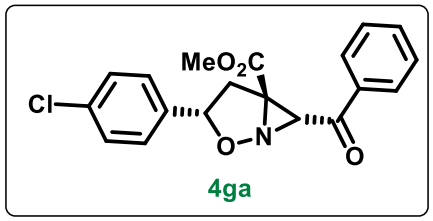
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



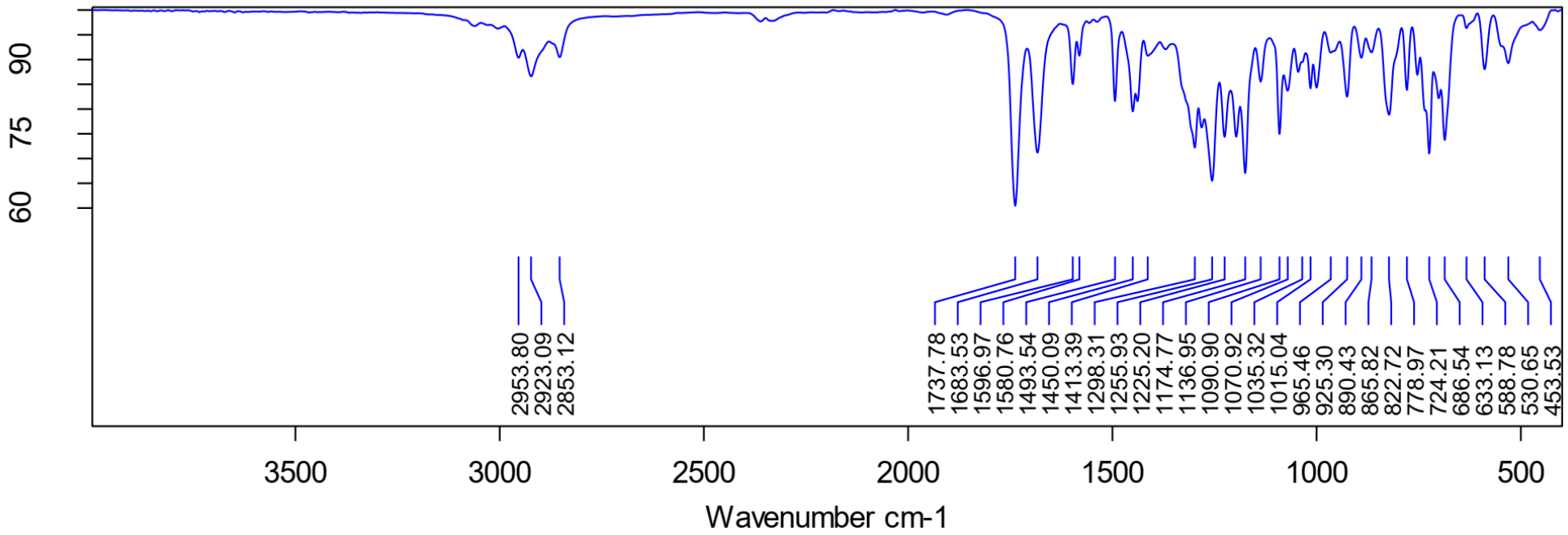
4ga



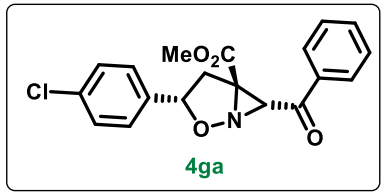
FT-IR Spectra



4ga



HRMS



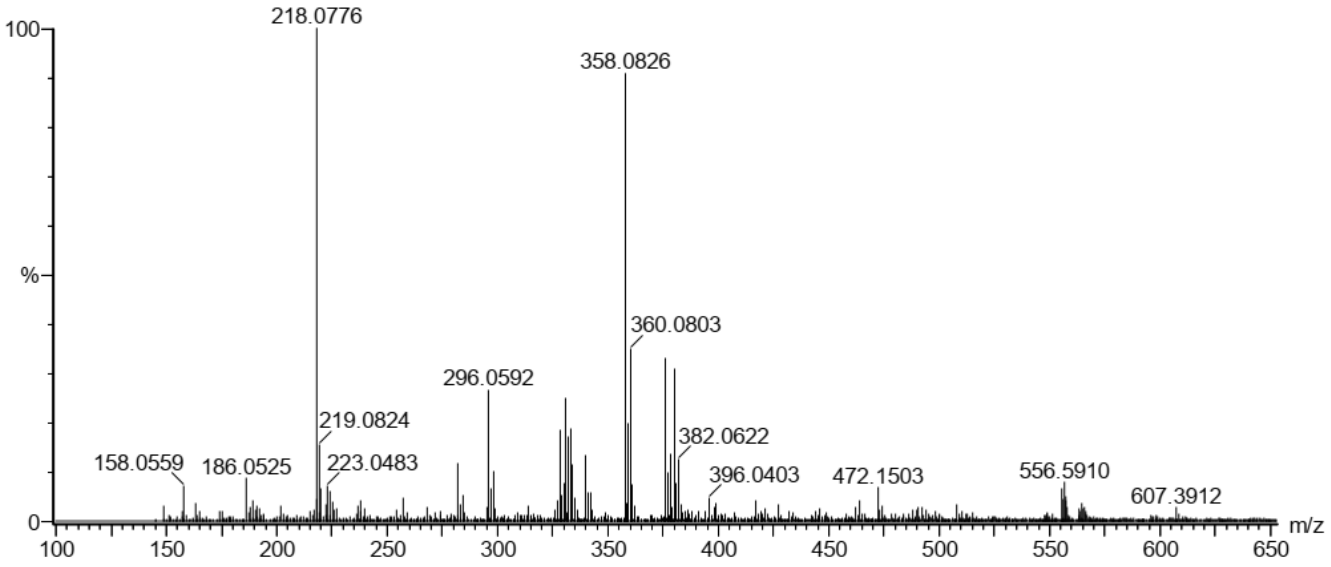
Elemental Composition Report

Single Mass Analysis

Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

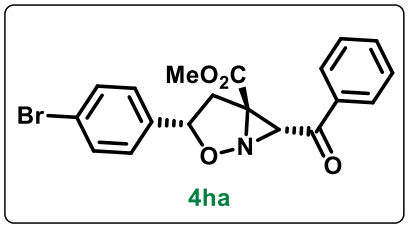
Monoisotopic Mass, Even Electron Ions
29 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-20 H: 15-30 N: 0-3 O: 0-4 Cl: 0-1

Sample Name : 08-04-202-PR IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
300519-08-04-202-PR 12 (0.131) AM (Top,4, Ar,10000.0,0.00,0.00); Sm (SG, 1x3.00); Cm (9:17) 1: TOF MS ES+
5.52e+007

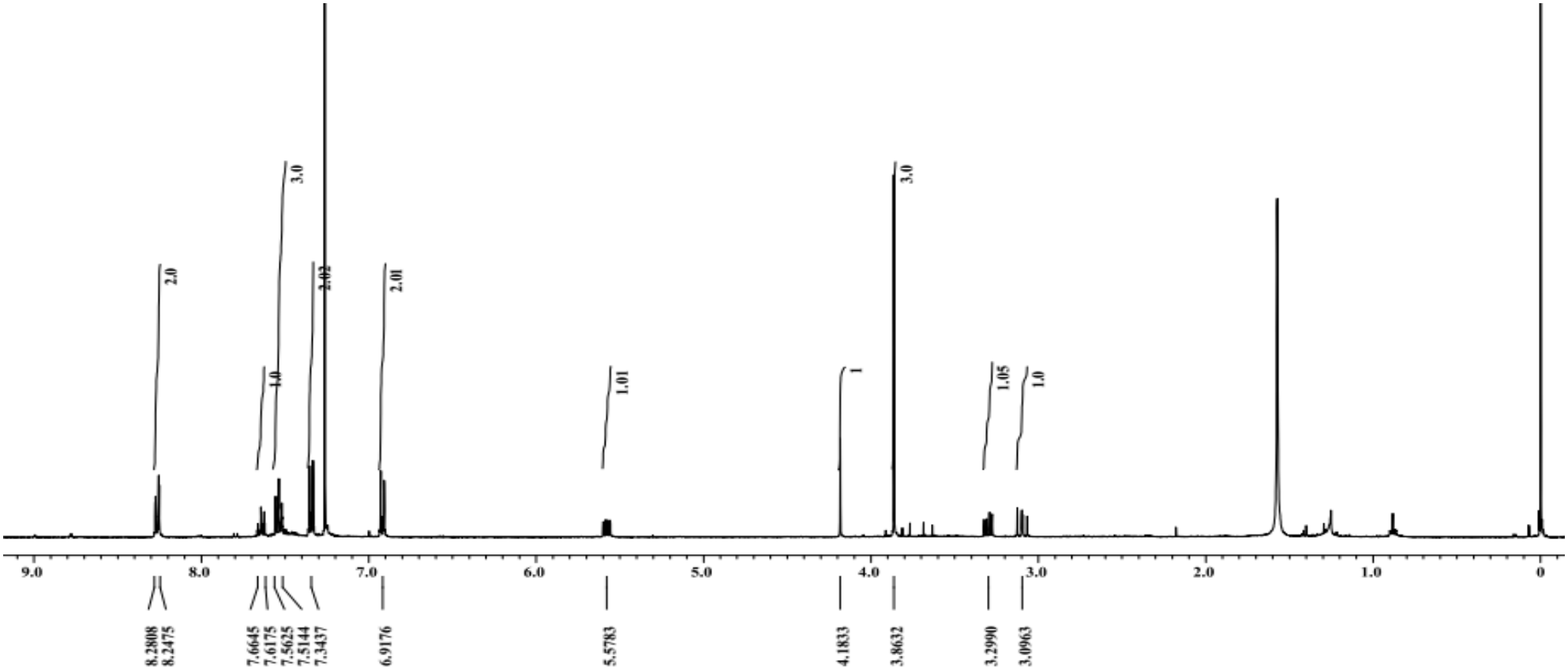


Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
358.0826	358.0846	-2.0	-5.6	11.5	1122.8	n/a	n/a	C19 H17 N O4 Cl

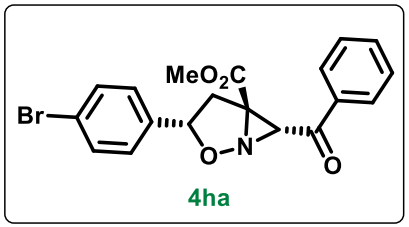
^{1}H-NMR ($CDCl_3$, 400 MHz)



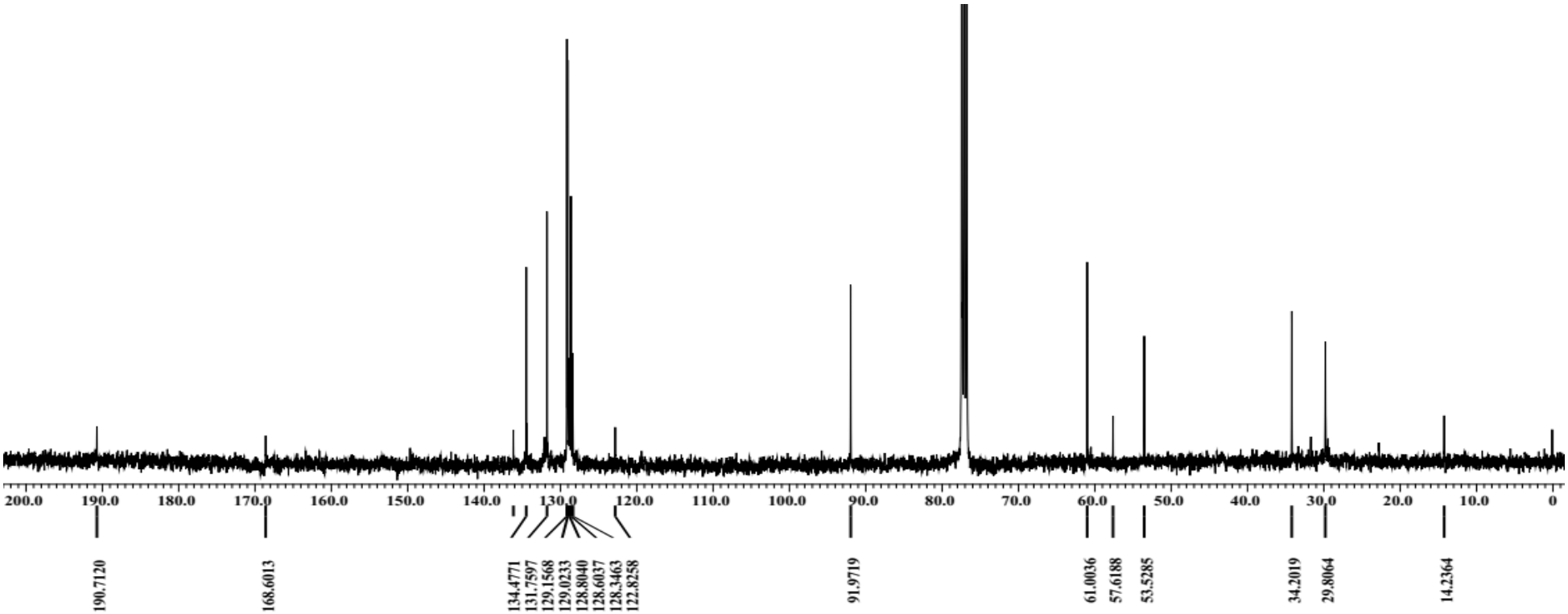
4ha



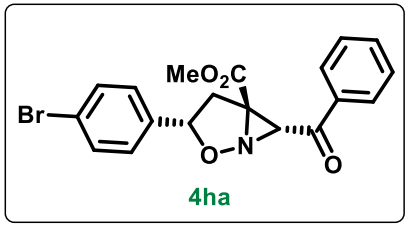
^{13}C-NMR ($CDCl_3$, 100 MHz)



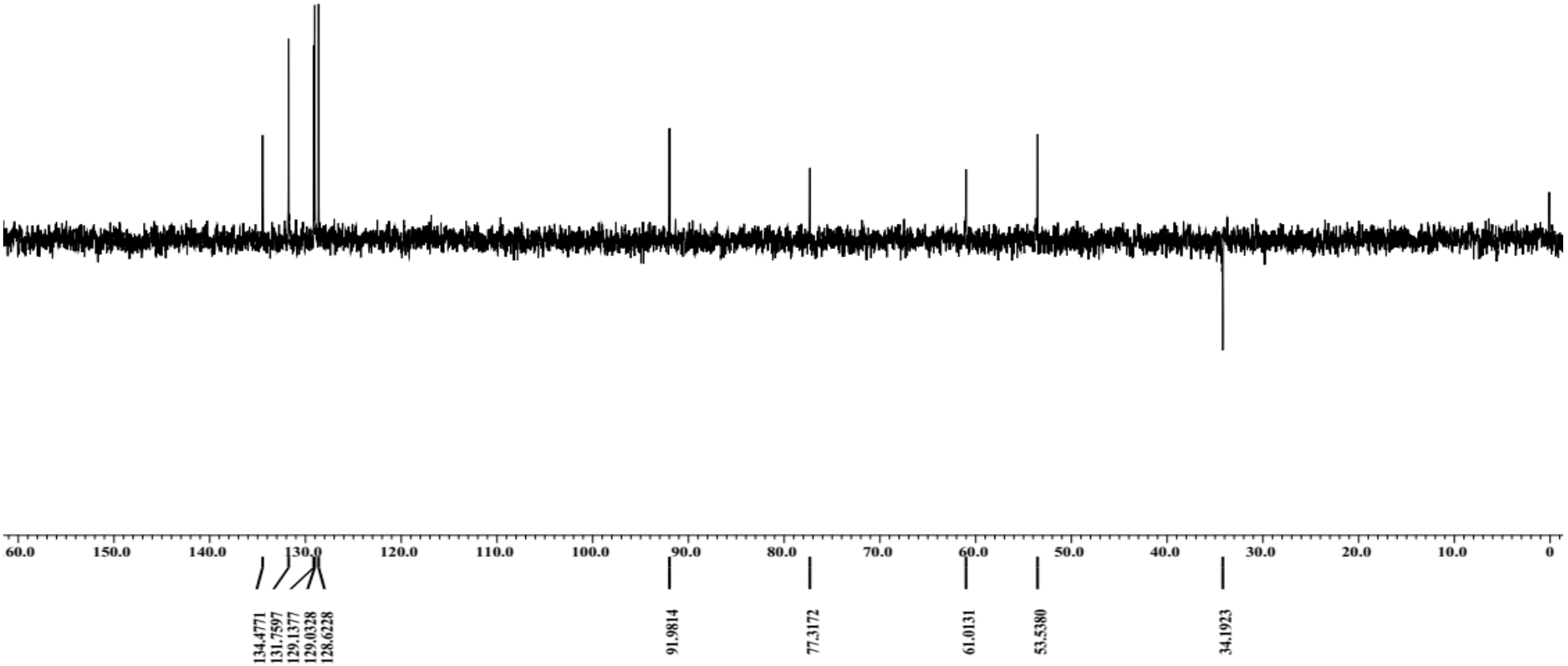
4ha



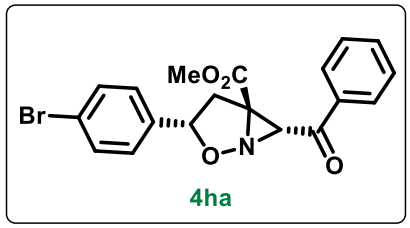
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



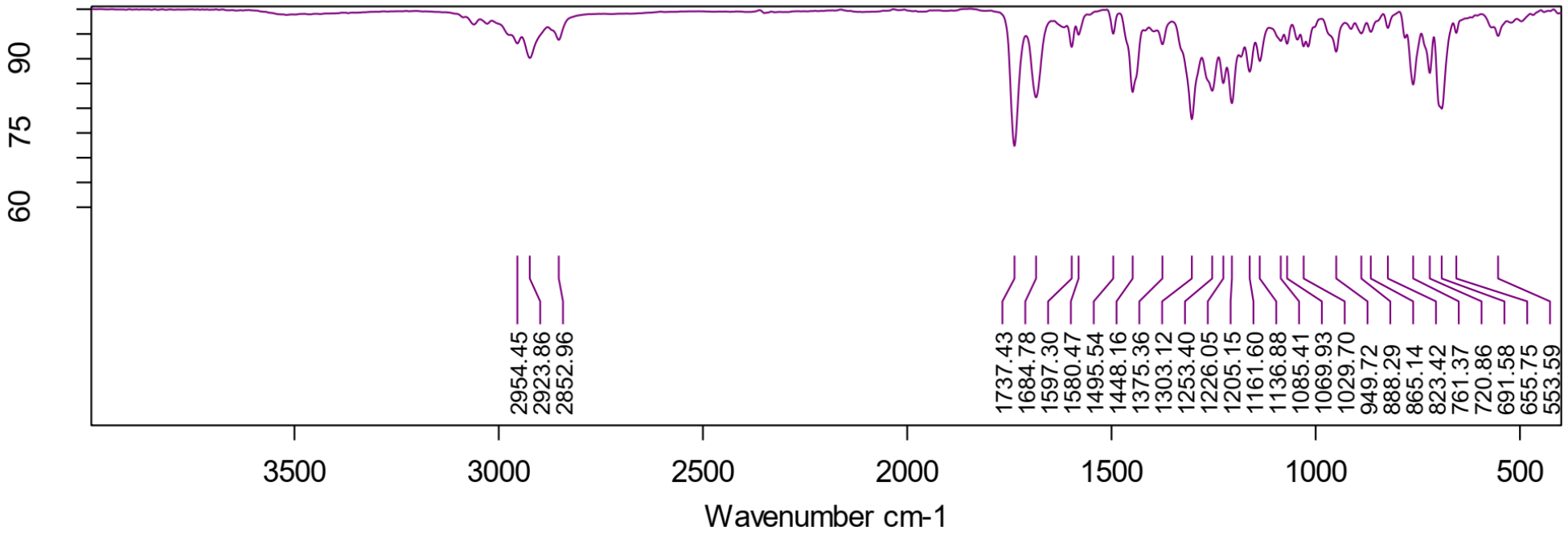
4ha



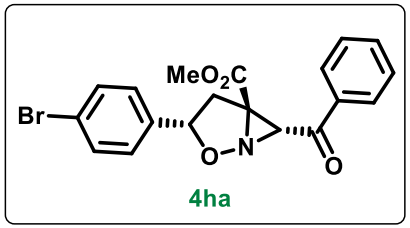
FT-IR Spectra



4ha



HRMS



4ha

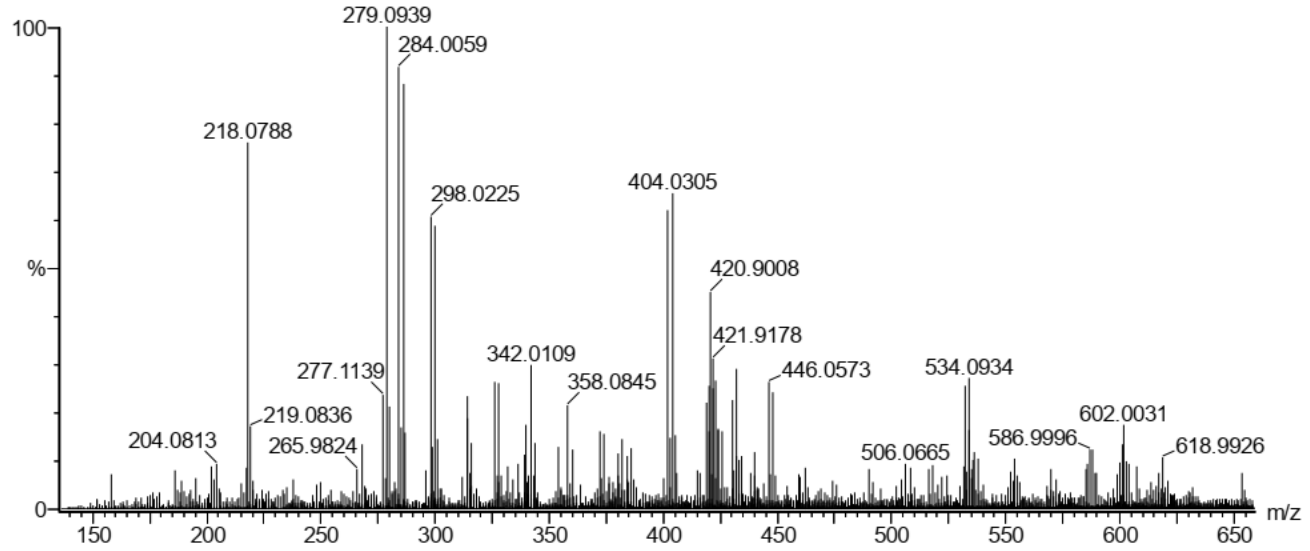
Elemental Composition Report

Single Mass Analysis

Tolerance = 5.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

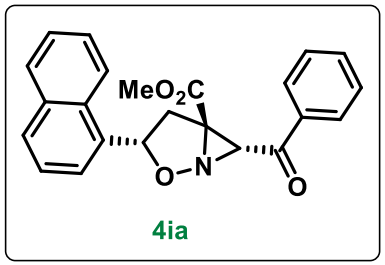
Monoisotopic Mass, Even Electron Ions
61 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-25 H: 15-30 N: 0-3 O: 0-4 Br: 0-2

Sample Name : 08-04-187 IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
300519-08-04-187 12 (0.131) AM (Top,4, Ar,10000.0,0.00,0.00); Sm (SG, 1x3.00); Cm (8:18) 1: TOF MS ES+
5.49e+007

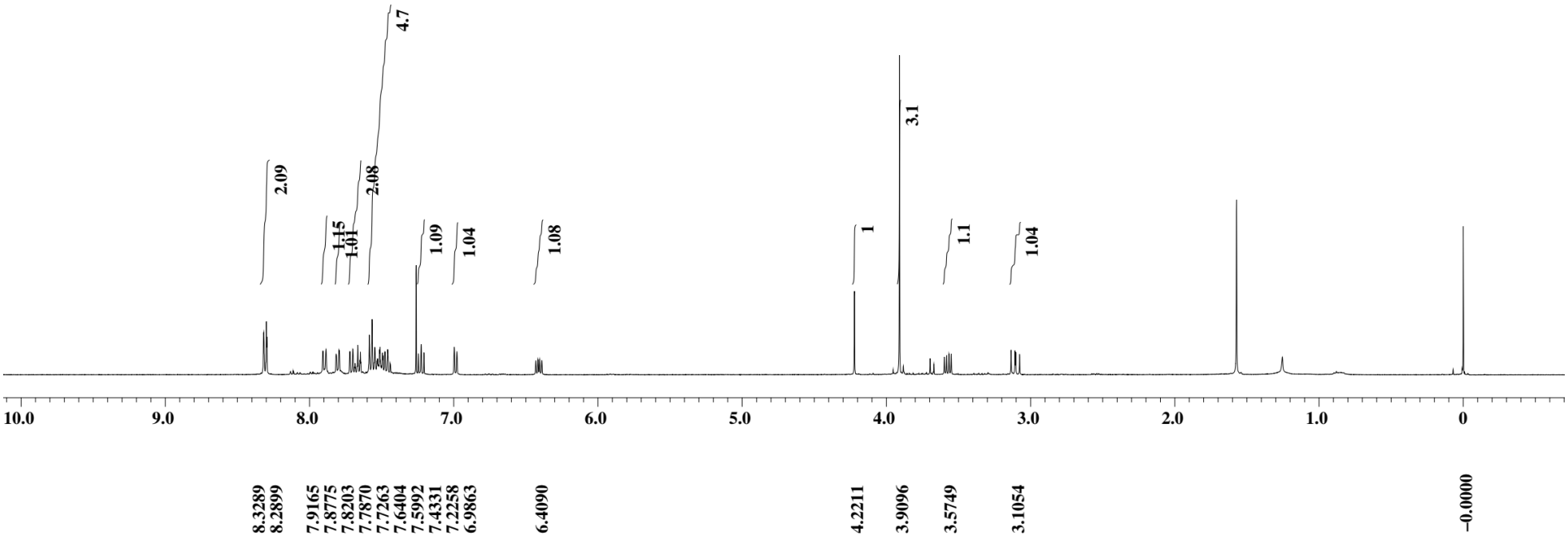


Minimum:				-1.5				
Maximum:		5.0	5.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
402.0332	402.0341	-0.9	-2.2	11.5	1084.1	n/a	n/a	C19 H17 N O4 Br

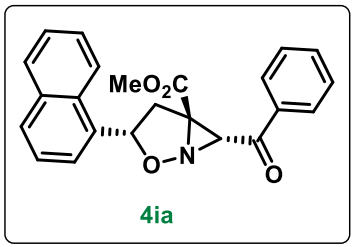
^{1}H-NMR ($CDCl_3$, 400 MHz)



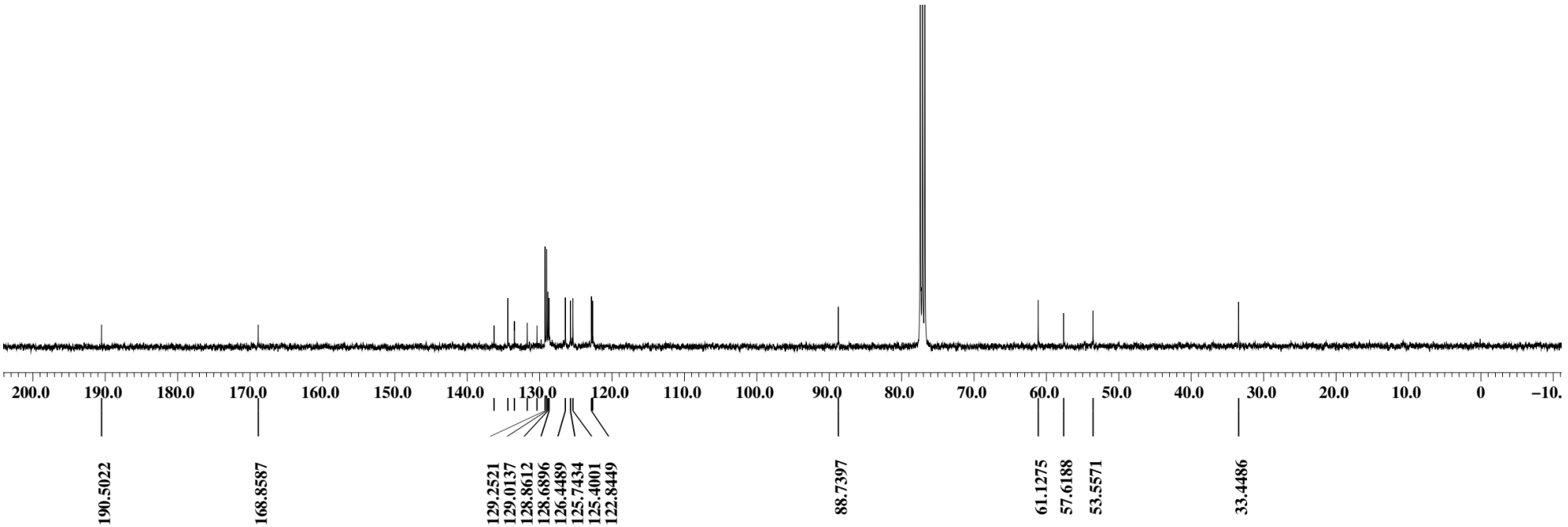
4ia



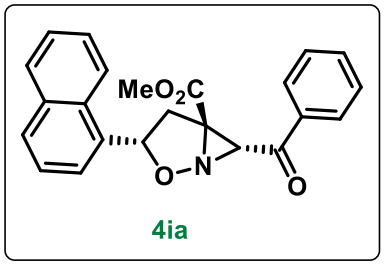
^{13}C-NMR ($CDCl_3$, 100 MHz)



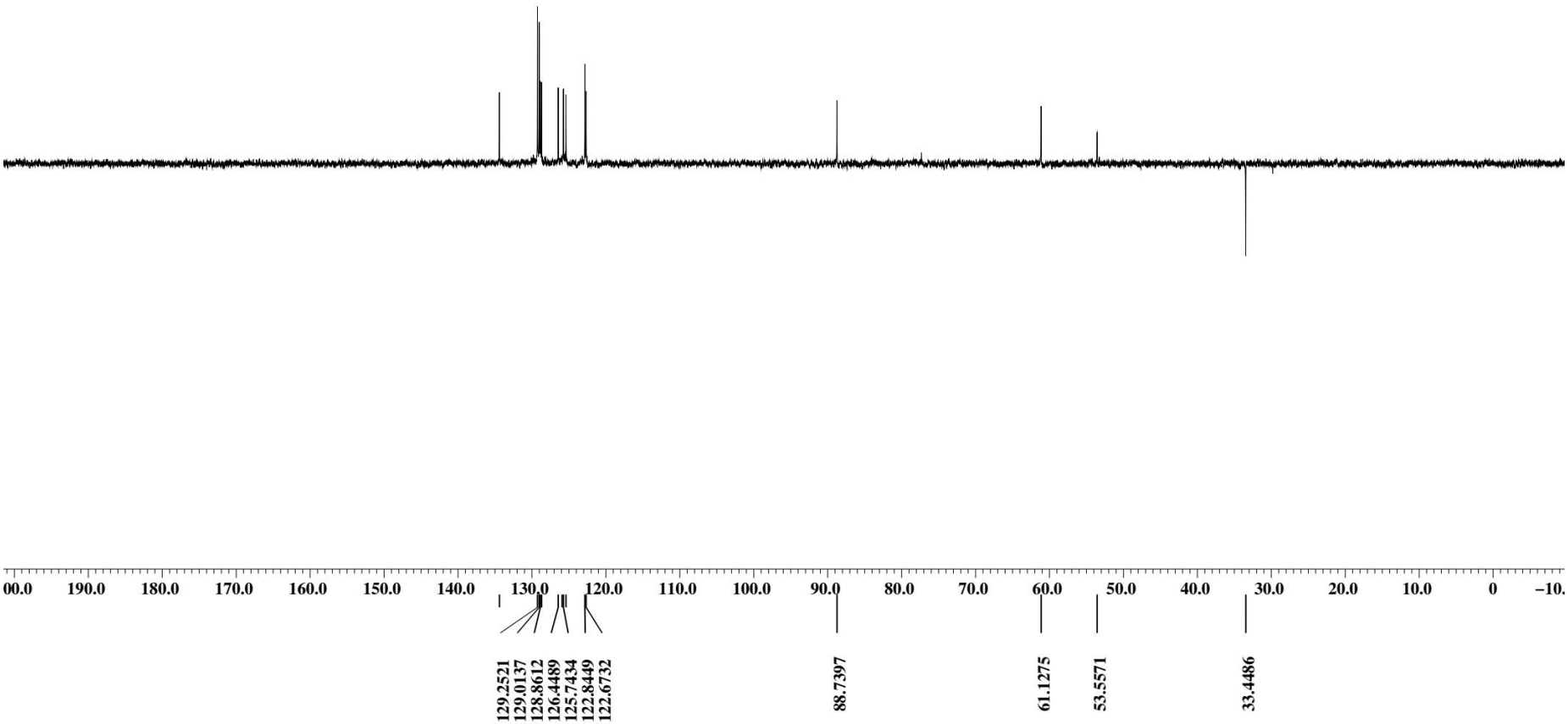
4ia



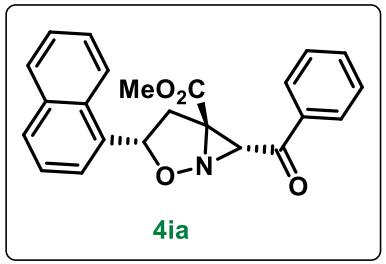
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



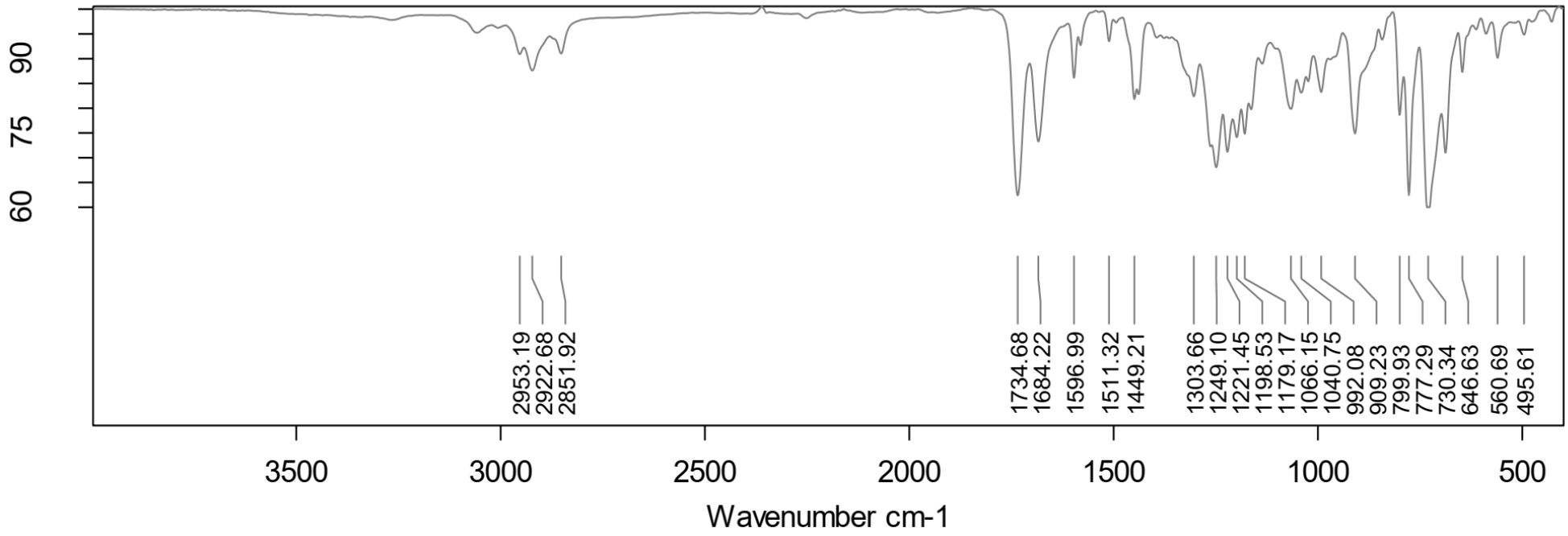
4ia



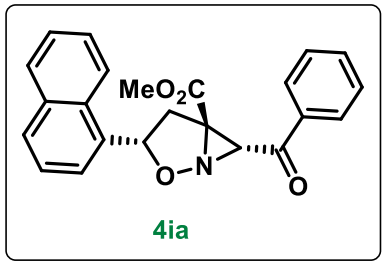
FT-IR Spectra



4ia



HRMS



4ia

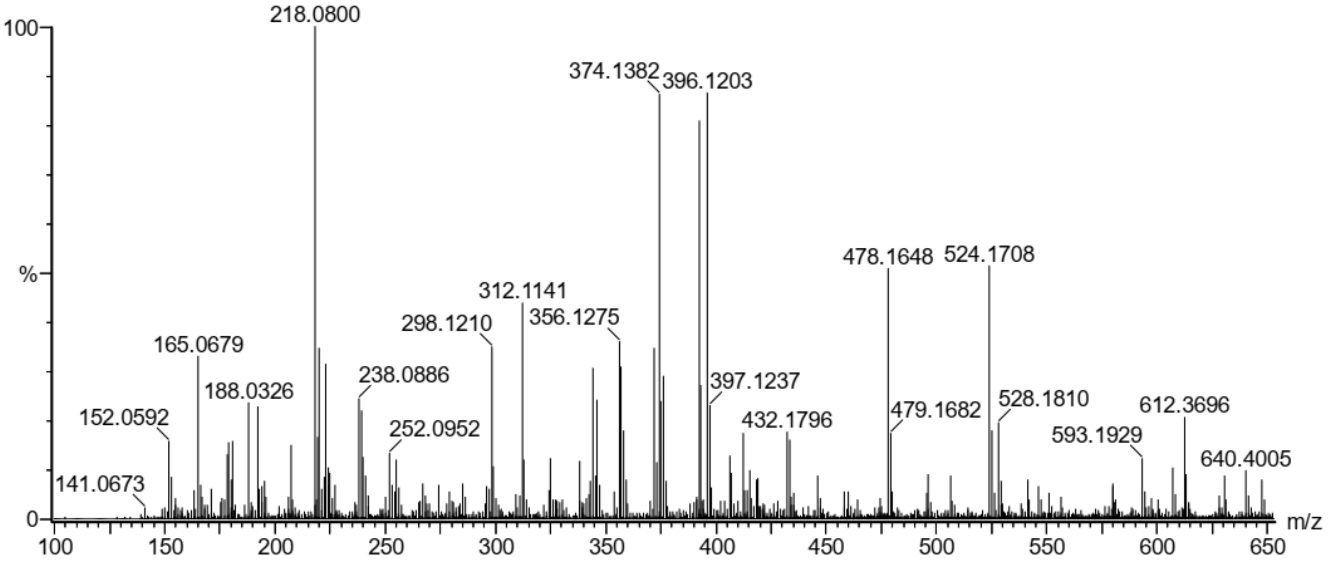
Elemental Composition Report

Single Mass Analysis

Tolerance = 15.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

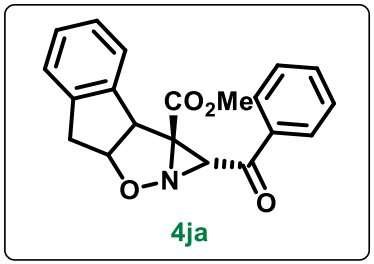
Monoisotopic Mass, Even Electron Ions
17 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-25 H: 15-30 N: 0-3 O: 0-4

Sample Name : 08-04-Naph IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
300519-08-04-Naph 15 (0.157) AM (Cen,4, 85.00, Ar,10000.0,0.00,0.00); Sm (SG, 1x3.00); Cm (15:18) 1: TOF MS ES+
6.03e+006

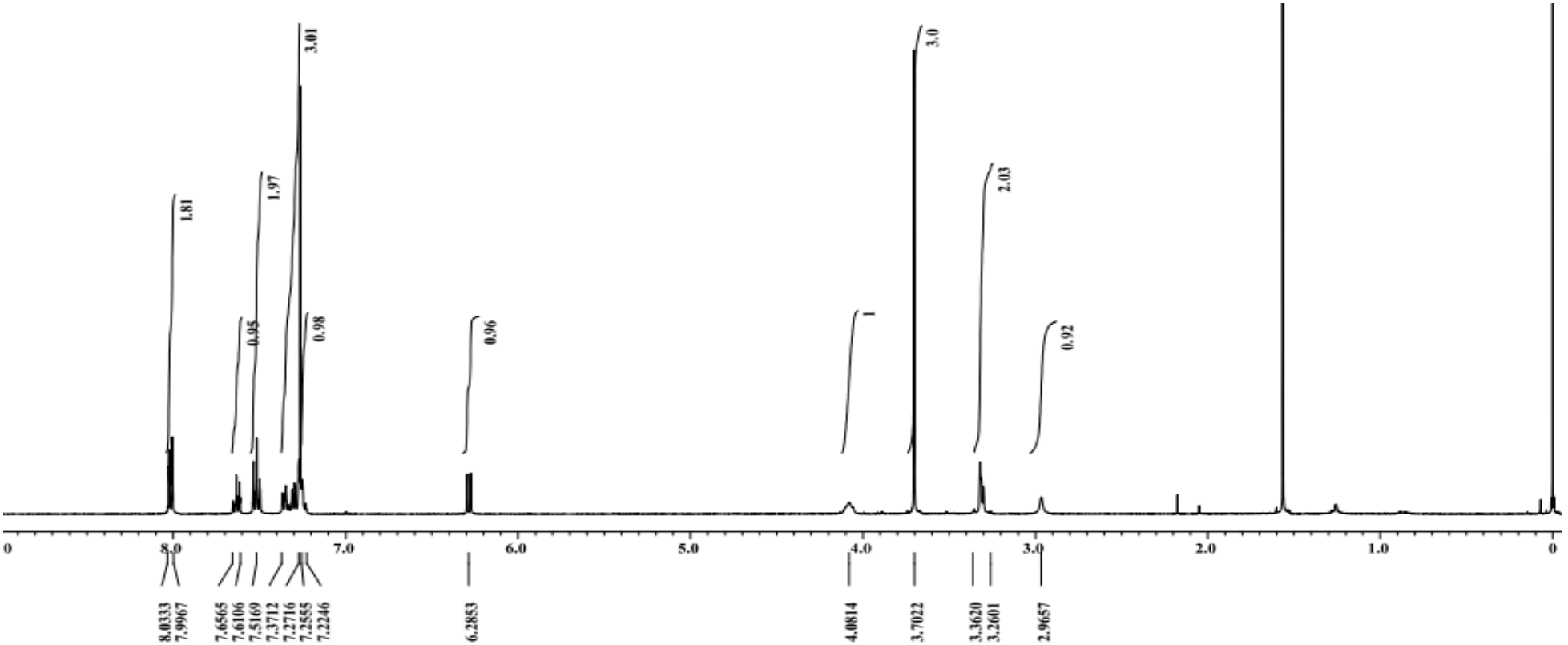


Minimum:				-1.5				
Maximum:		5.0	15.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
374.1382	374.1392	-1.0	-2.7	14.5	1049.2	n/a	n/a	C23 H20 N O4

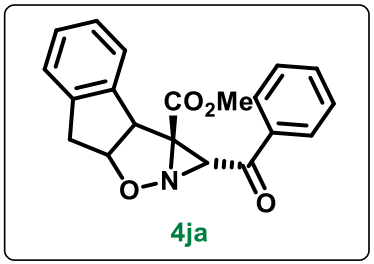
^{1}H-NMR ($CDCl_3$, 400 MHz)



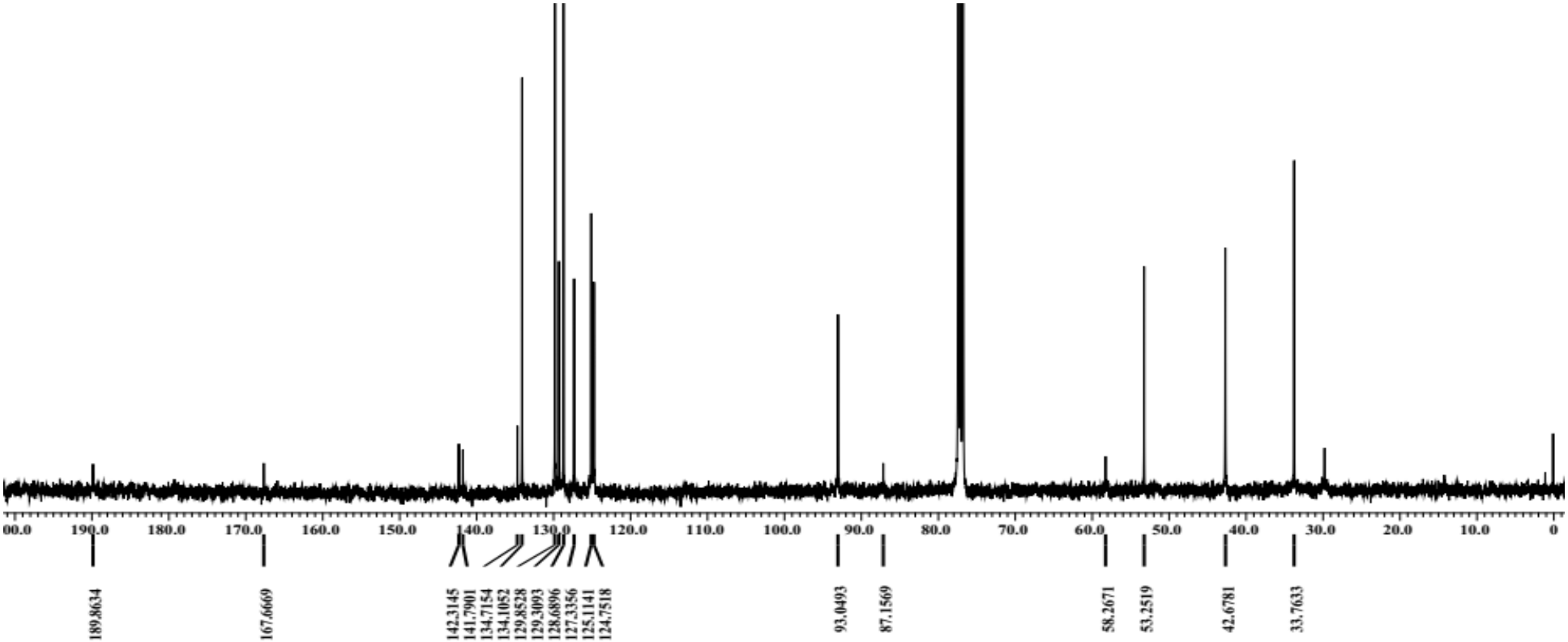
4ja



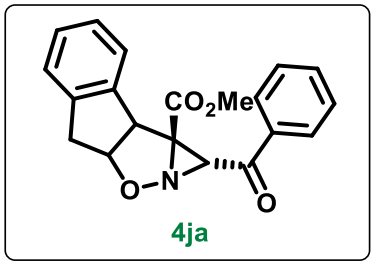
^{13}C-NMR ($CDCl_3$, 100 MHz)



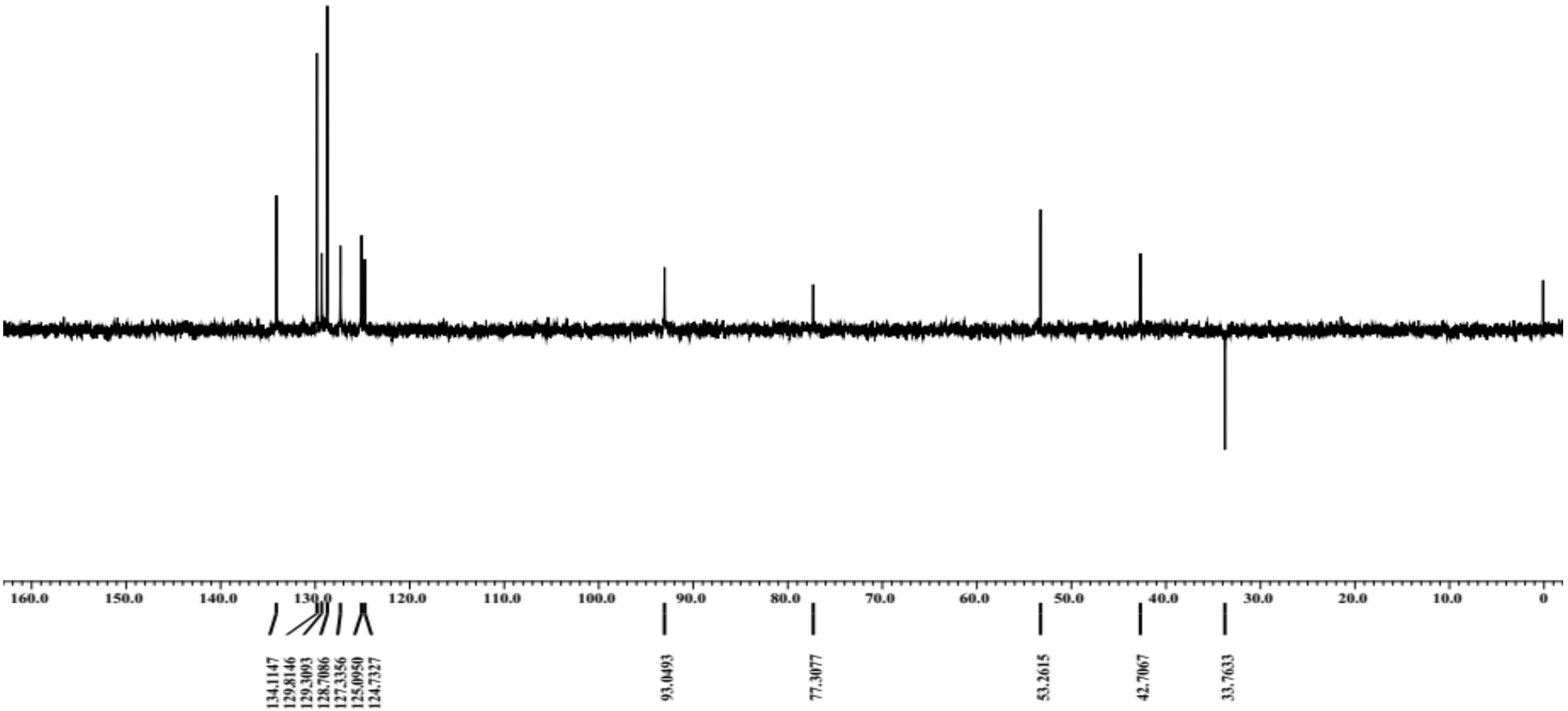
4ja



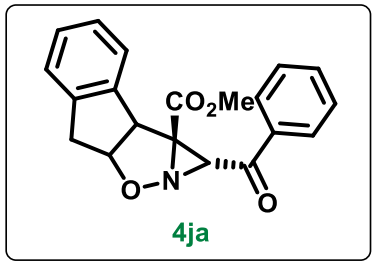
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



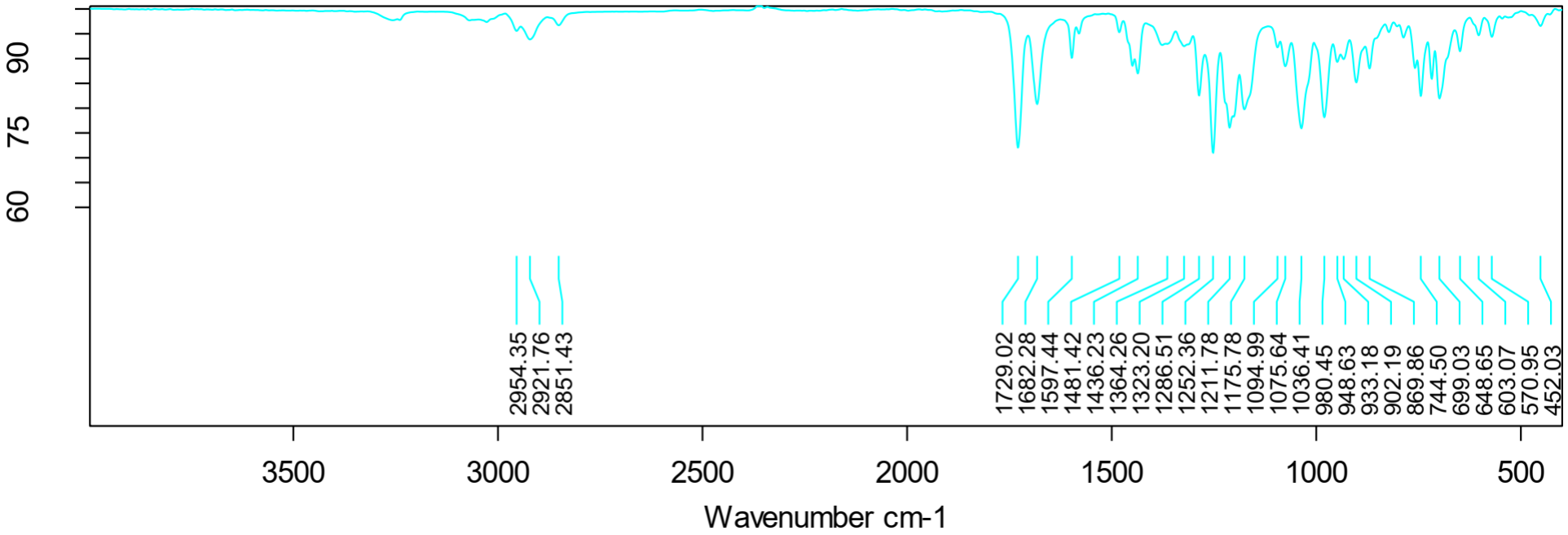
4ja



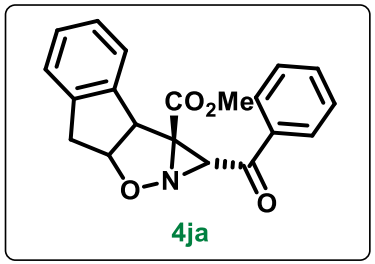
FT-IR Spectra



4ja



HRMS



4ja

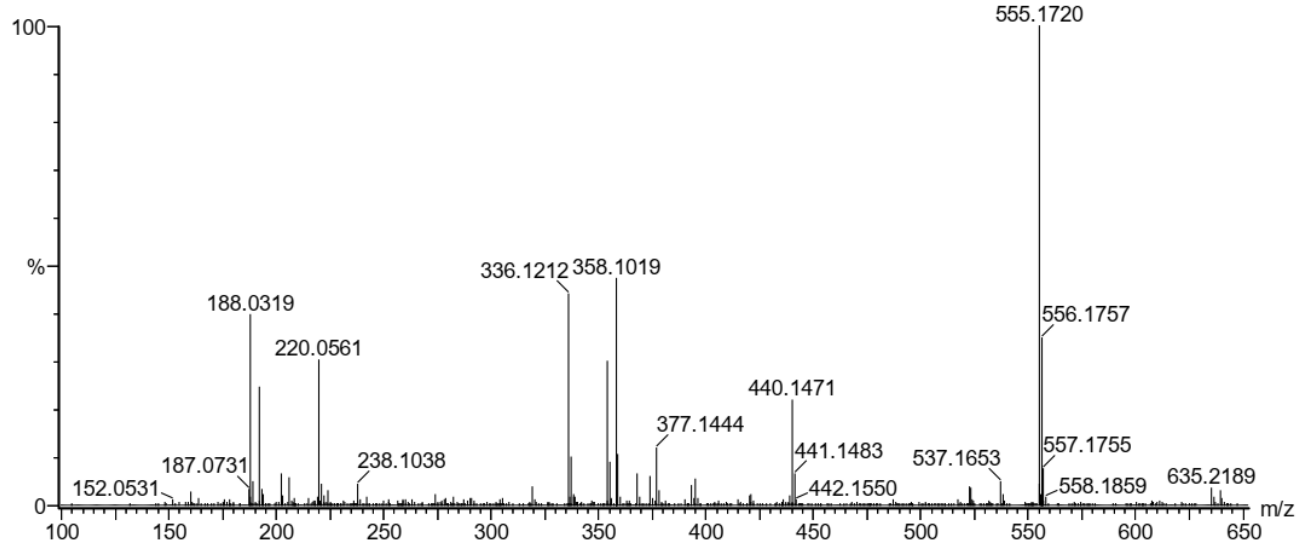
Elemental Composition Report

Single Mass Analysis

Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

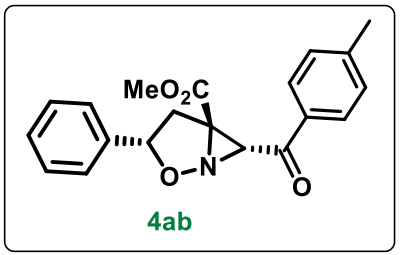
Monoisotopic Mass, Even Electron Ions
15 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-20 H: 15-30 N: 0-3 O: 0-4

Sample Name : 08-04-218 IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
300519-08-04-218 15 (0.157) AM (Top,4, Ar,10000.0,0.00,0.00); Sm (SG, 1x3.00); Cm (15:23) 1: TOF MS ES+
3.62e+007

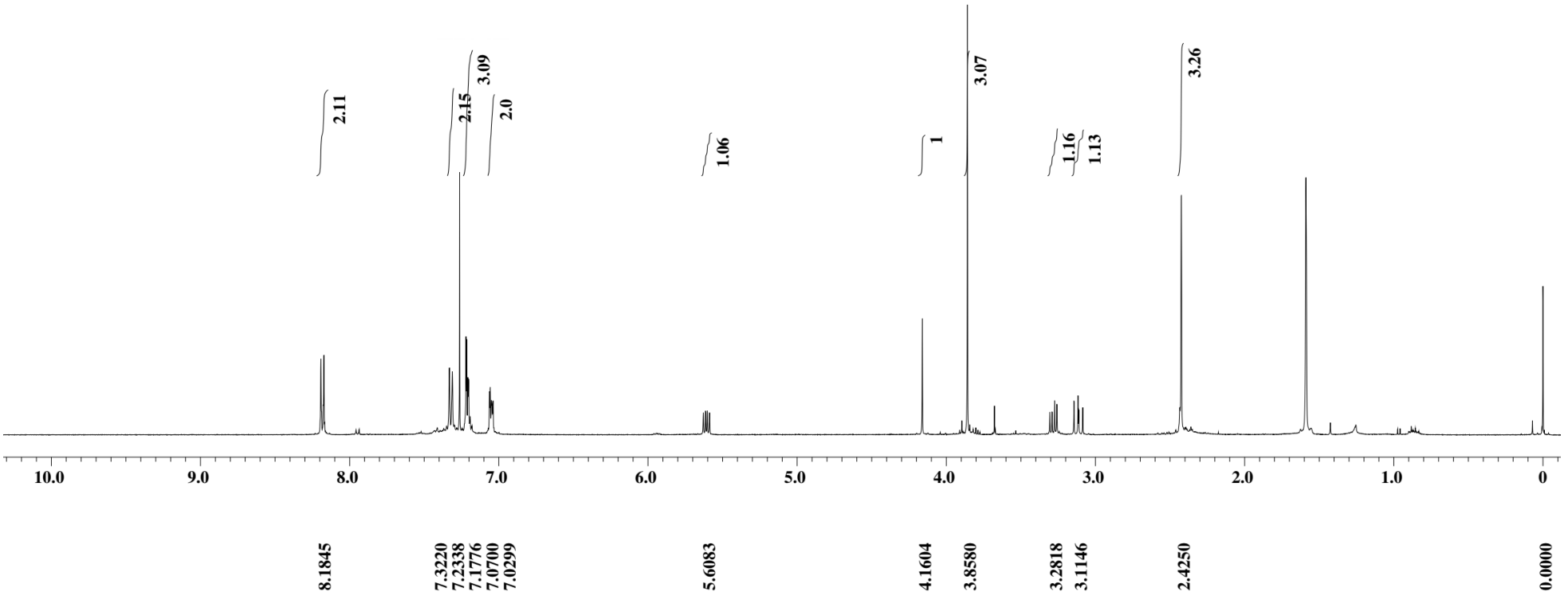


Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
336.1212	336.1236	-2.4	-7.1	12.5	1133.8	n/a	n/a	C20 H18 N O4

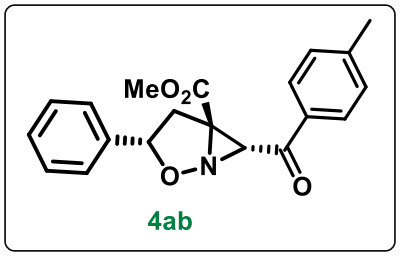
^{1}H-NMR ($CDCl_3$, 400 MHz)



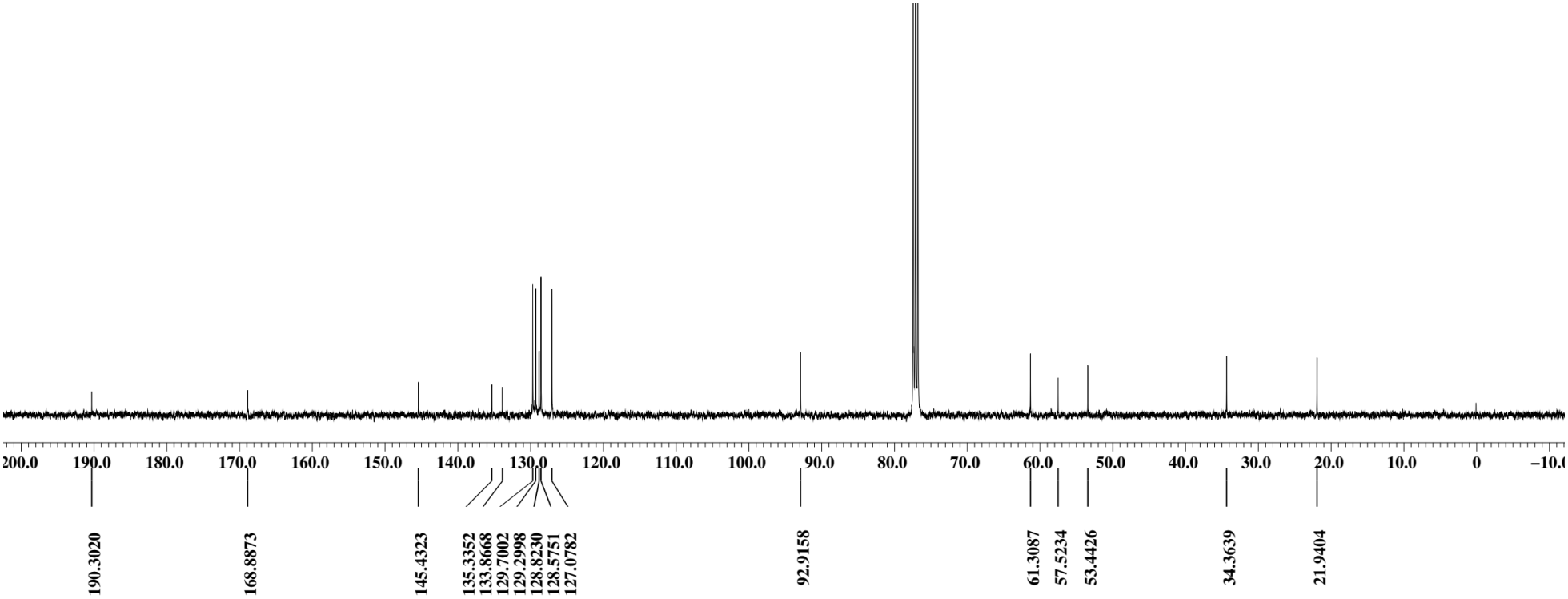
4ab



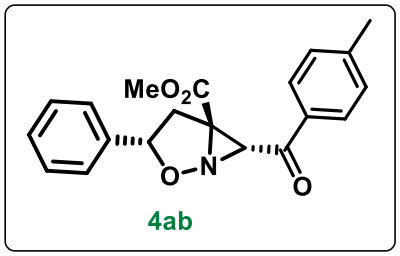
^{13}C-NMR ($CDCl_3$, 100 MHz)



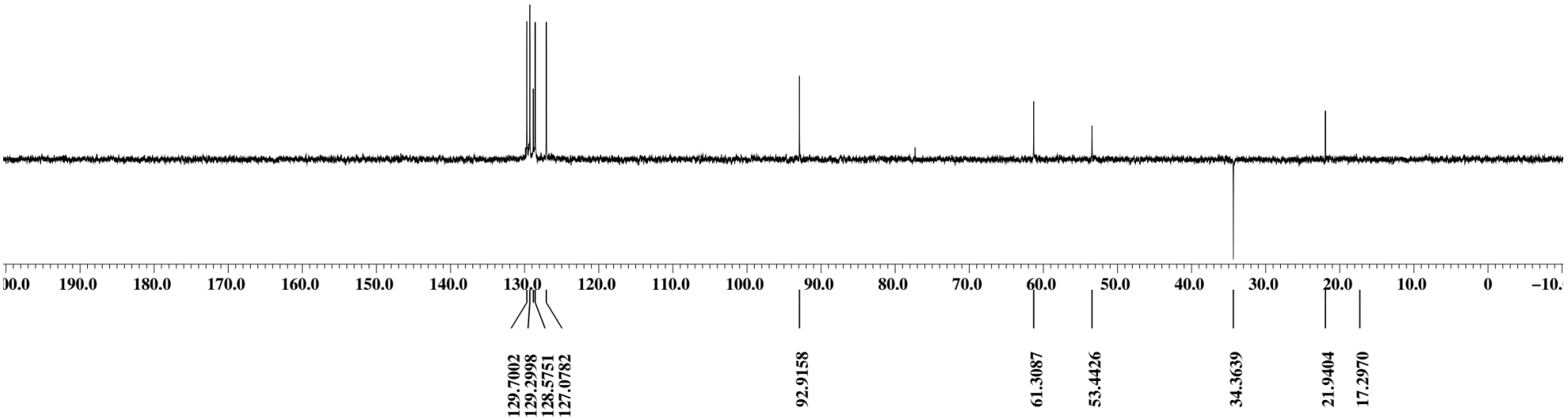
4ab



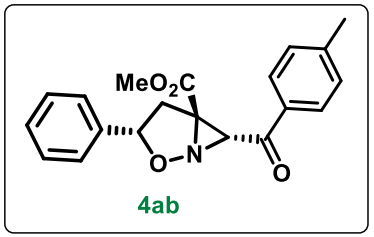
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



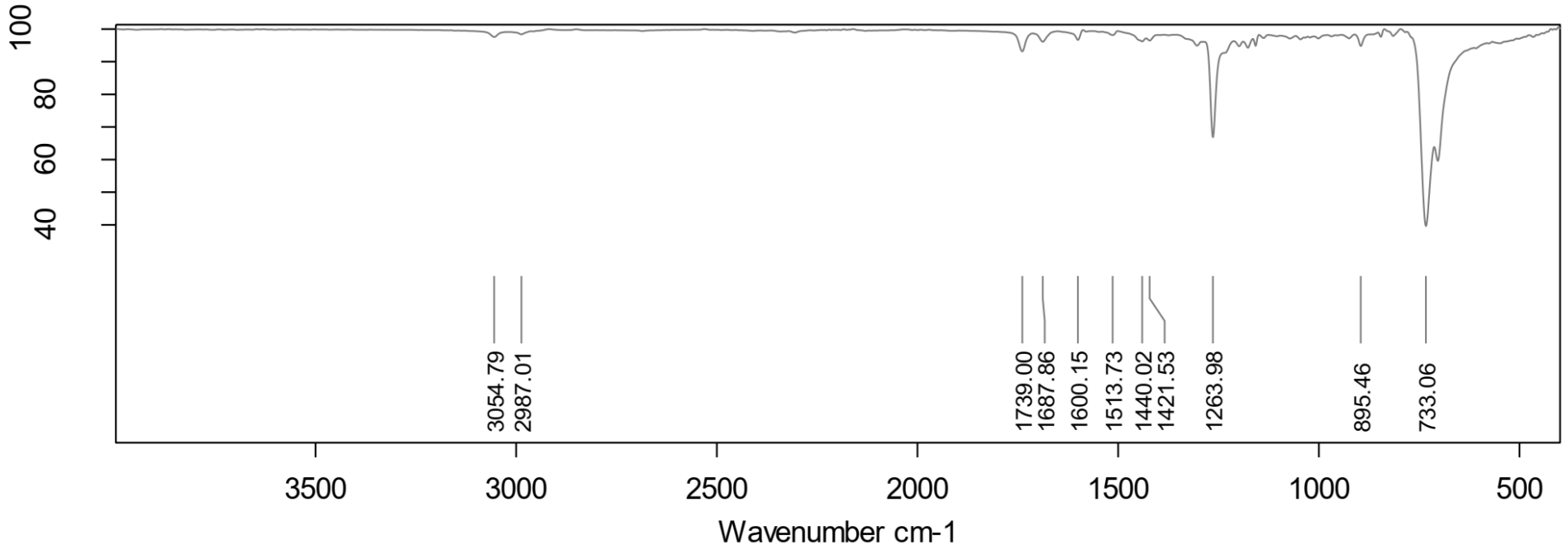
4ab



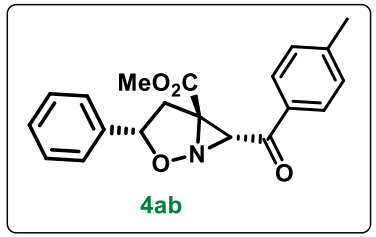
FT-IR Spectra



4ab



HRMS



4ab

Elemental Composition Report

Single Mass Analysis

Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 6

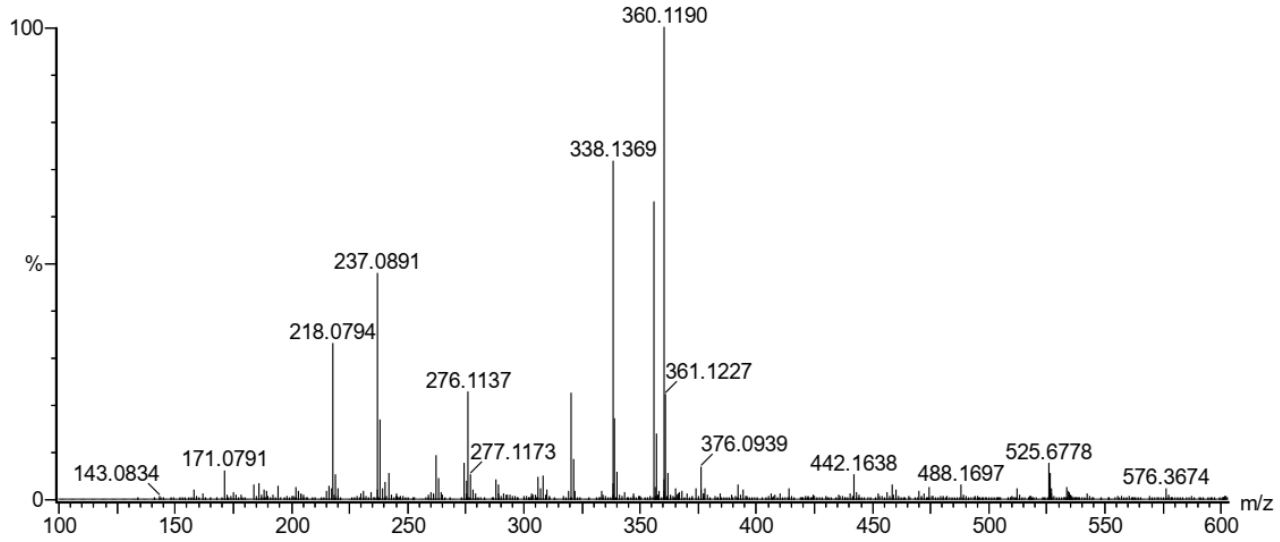
Monoisotopic Mass, Even Electron Ions
74 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 15-25 H: 10-25 N: 1-2 O: 0-5 Se: 0-1 Br: 0-2

Sample Name : 17-02-4ab
Test Name : HRMS-1
191020-17-02-4ab 12 (0.131)

IITRPR

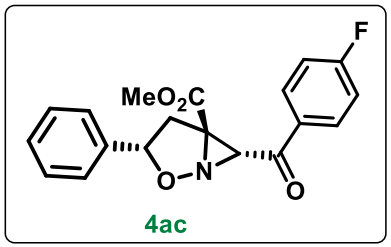
UPLC-XEVOG2XSQTOF

1: TOF MS ES+
1.46e+008

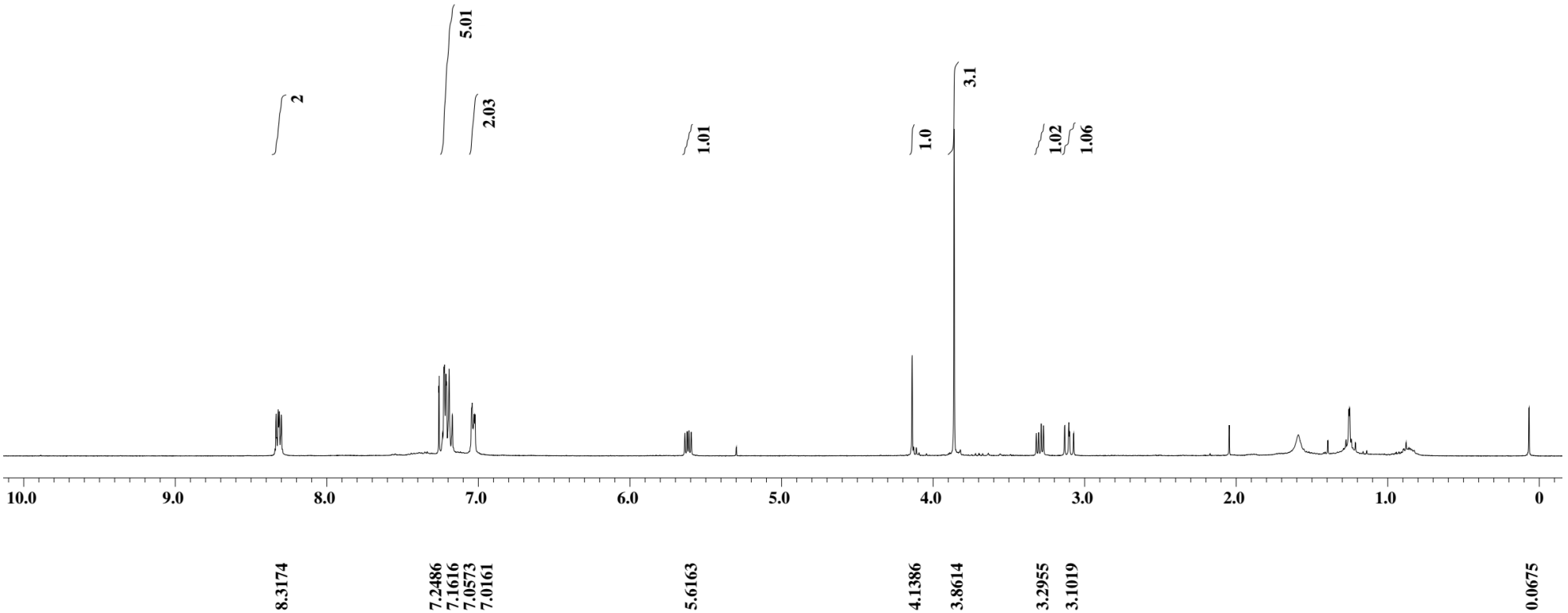


Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
338.1369	338.1392	-2.3	-6.8	11.5	1705.9	n/a	n/a	C20 H20 N O4

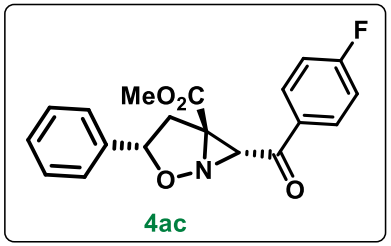
^{1}H-NMR ($CDCl_3$, 400 MHz)



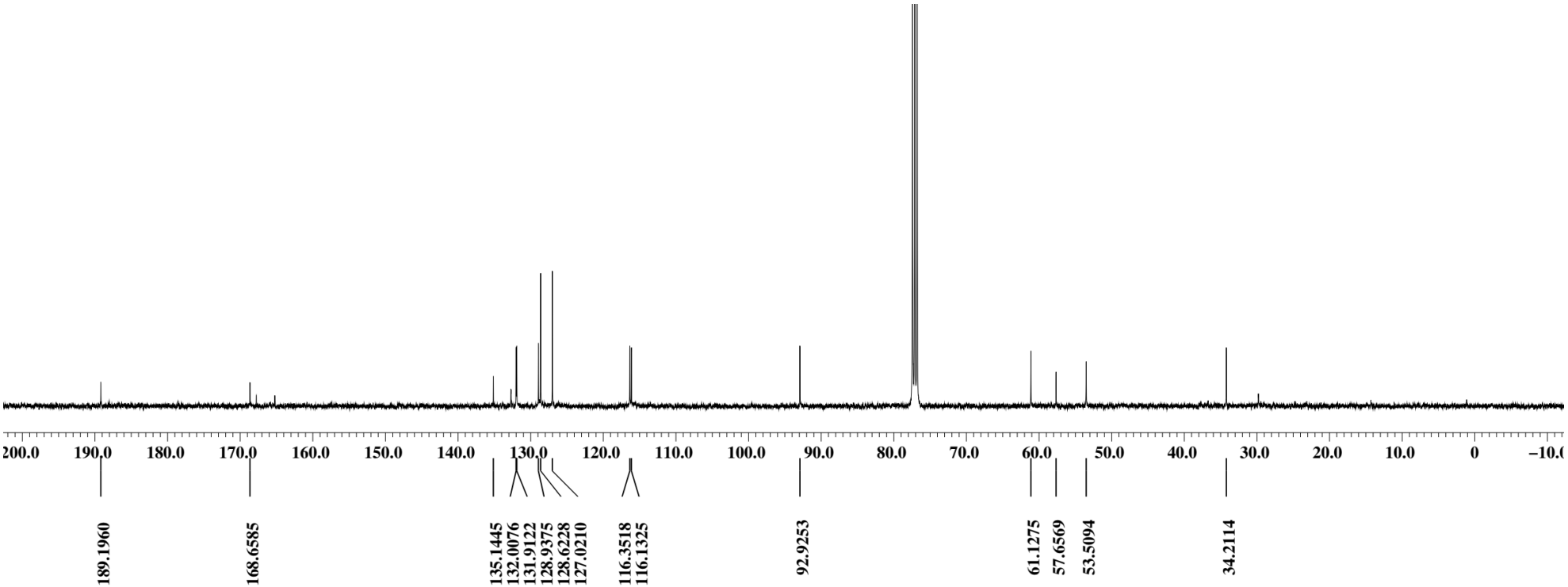
4ac



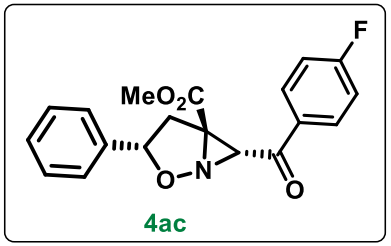
^{13}C-NMR ($CDCl_3$, 100 MHz)



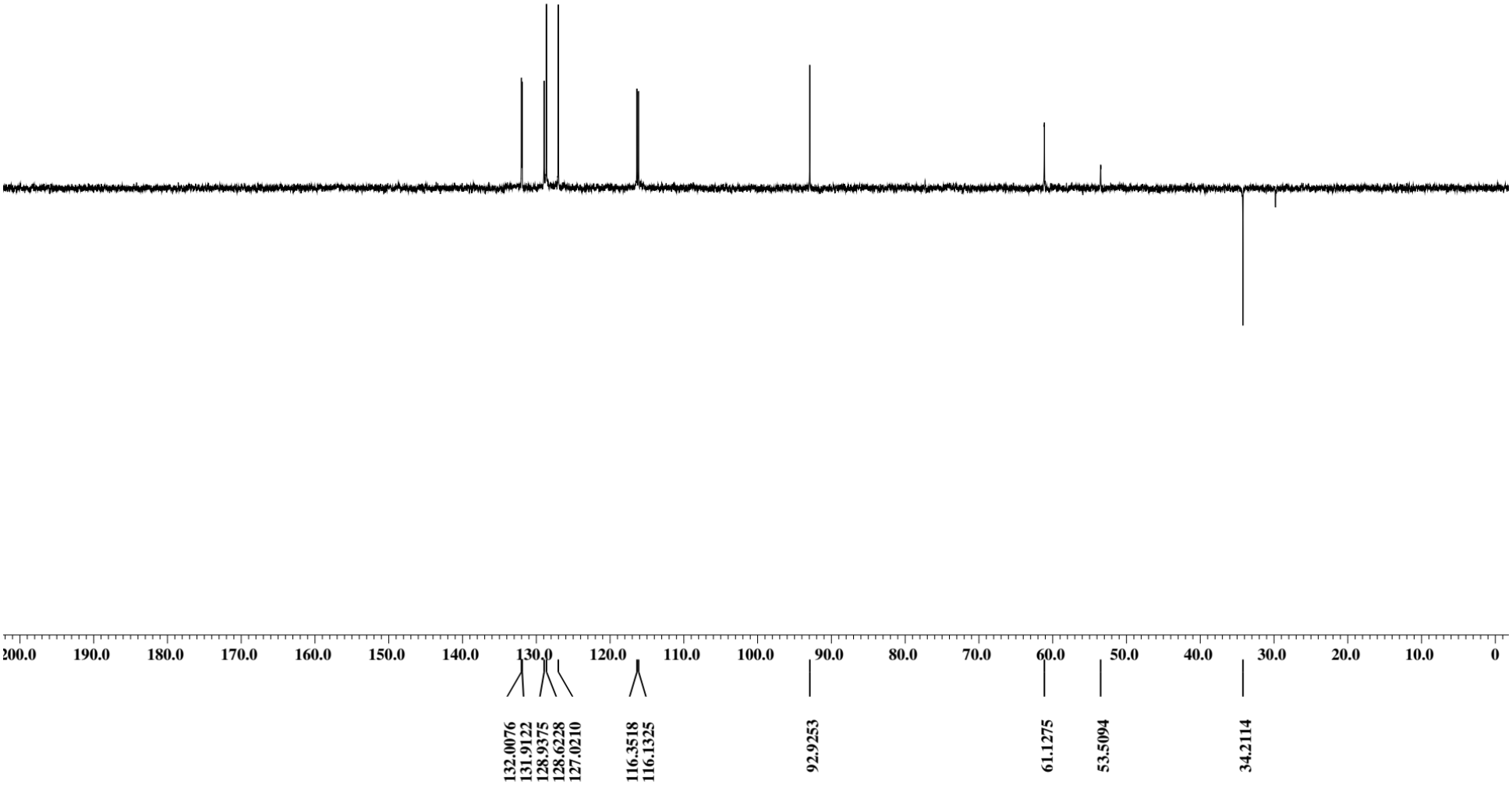
4ac



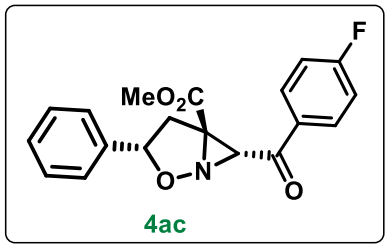
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



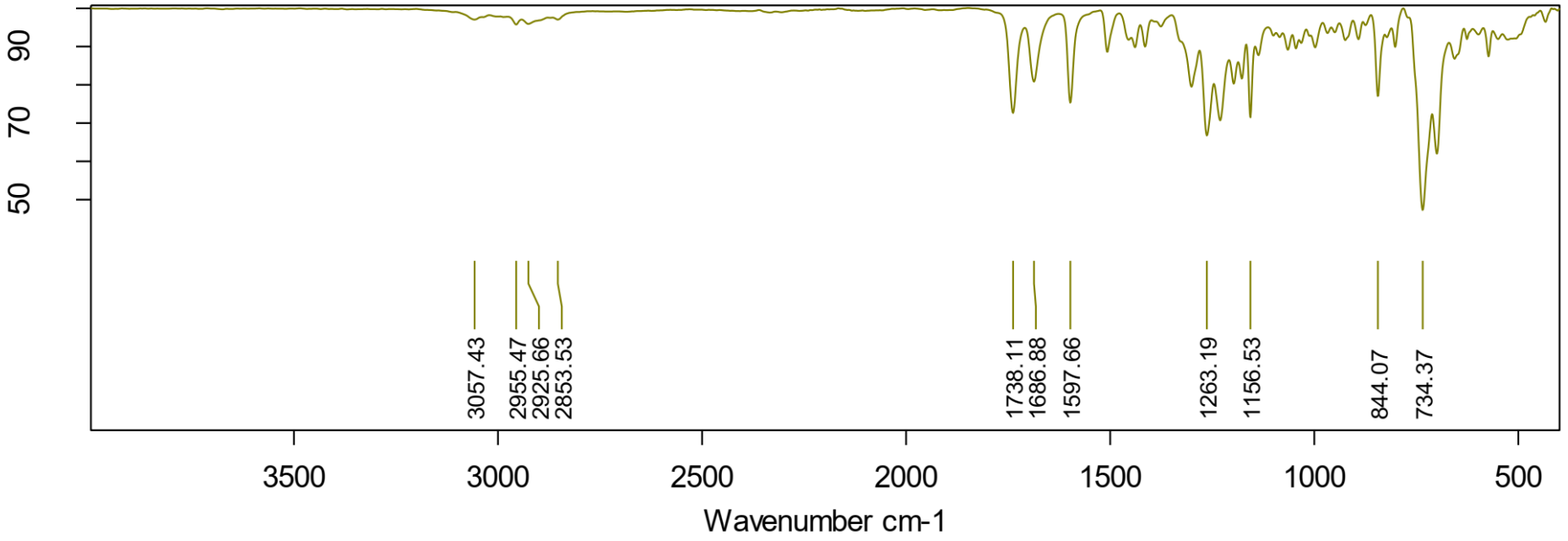
4ac



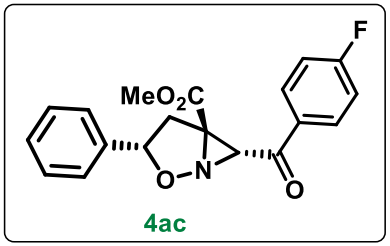
FT-IR Spectra



4ac



HRMS



4ac

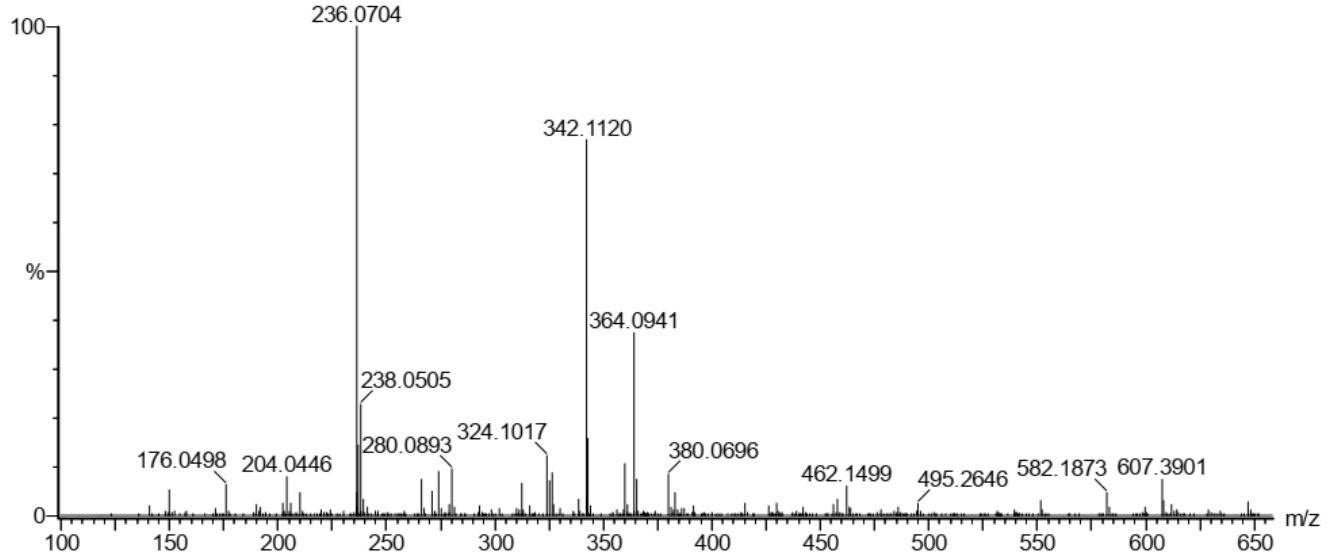
Elemental Composition Report

Single Mass Analysis

Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 5

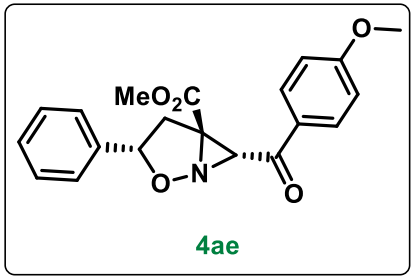
Monoisotopic Mass, Even Electron Ions
38 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-21 H: 10-30 N: 0-2 O: 0-5 F: 0-1

Sample Name : 17-02-20-B IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
240220-17-02-20-B 16 (0.165) 1: TOF MS ES+
1.81e+007

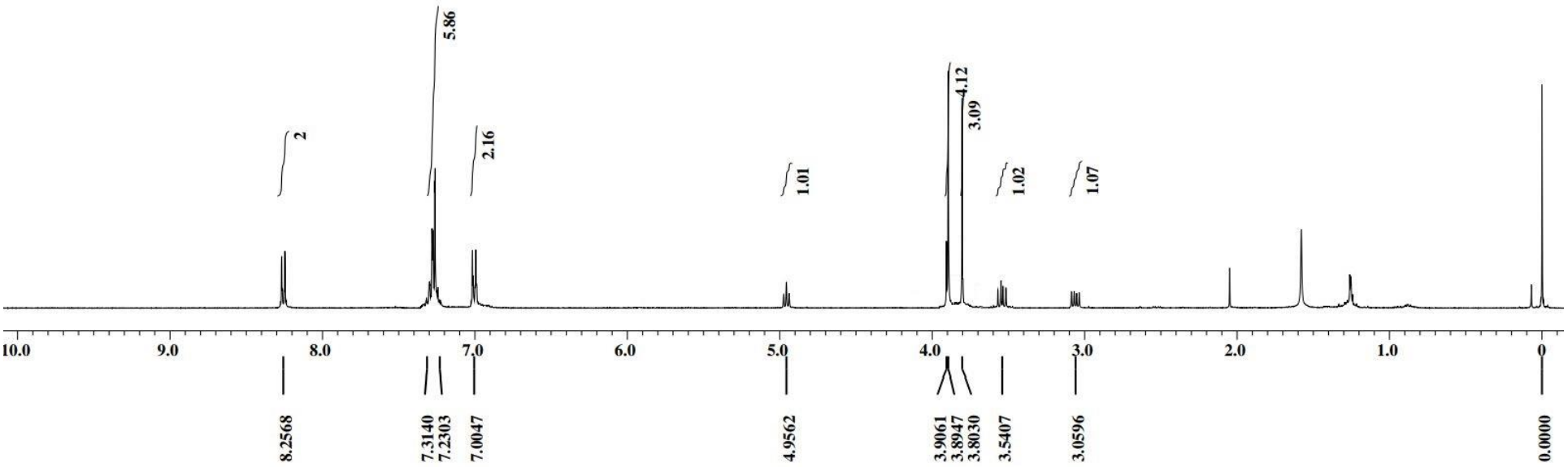


Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
342.1120	342.1142	-2.2	-6.4	11.5	1353.7	n/a	n/a	C19 H17 N O4 F

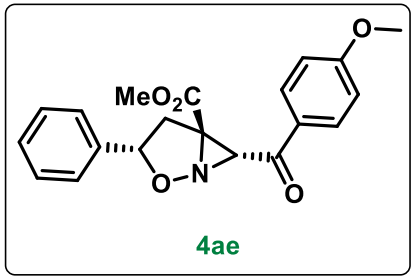
^{1}H-NMR ($CDCl_3$, 400 MHz)



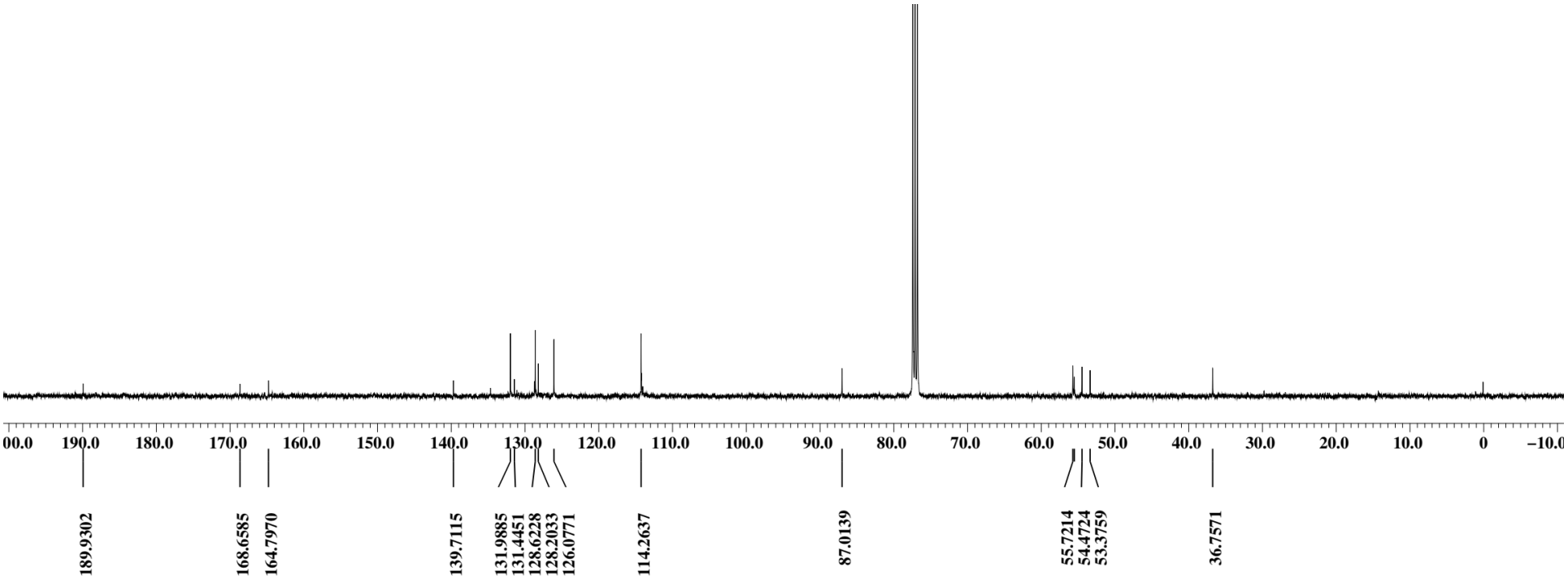
4ae



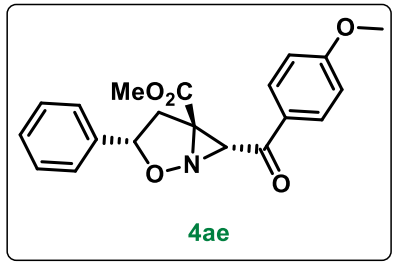
^{13}C-NMR ($CDCl_3$, 100 MHz)



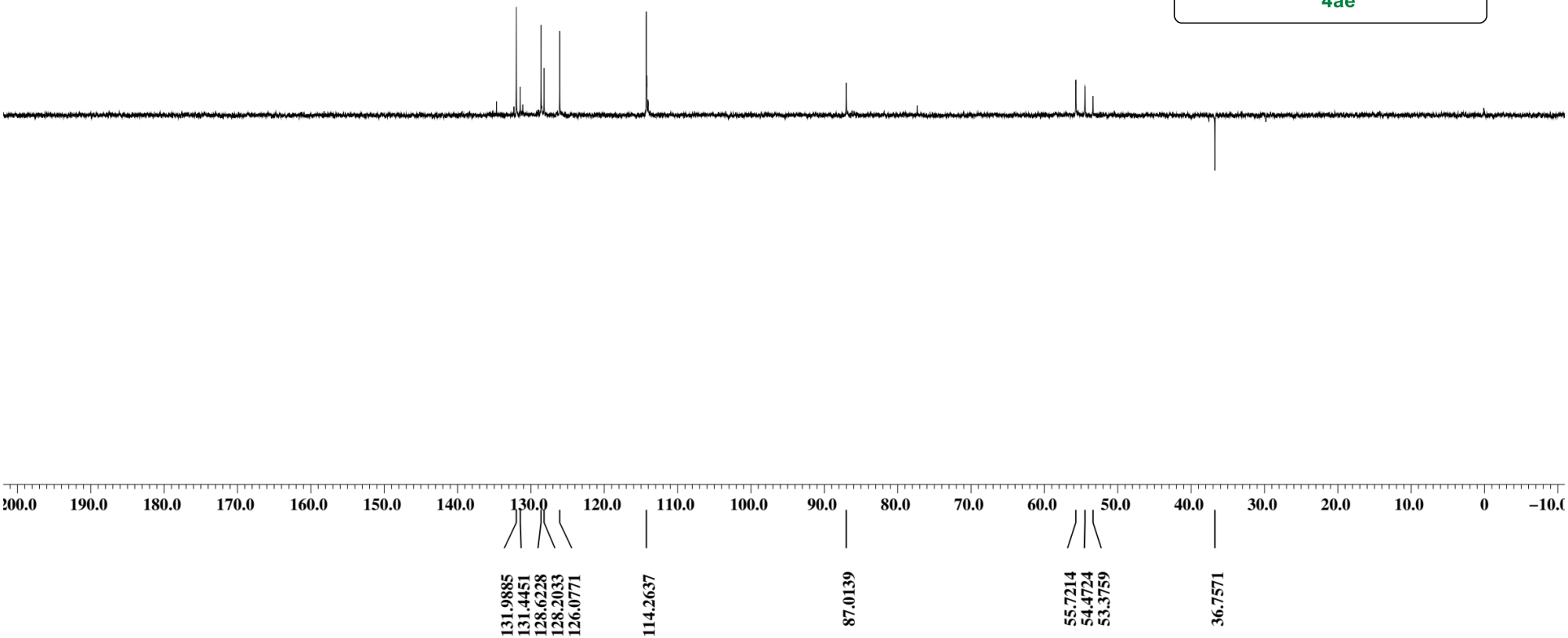
4ae



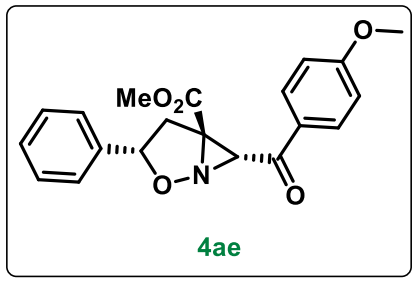
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



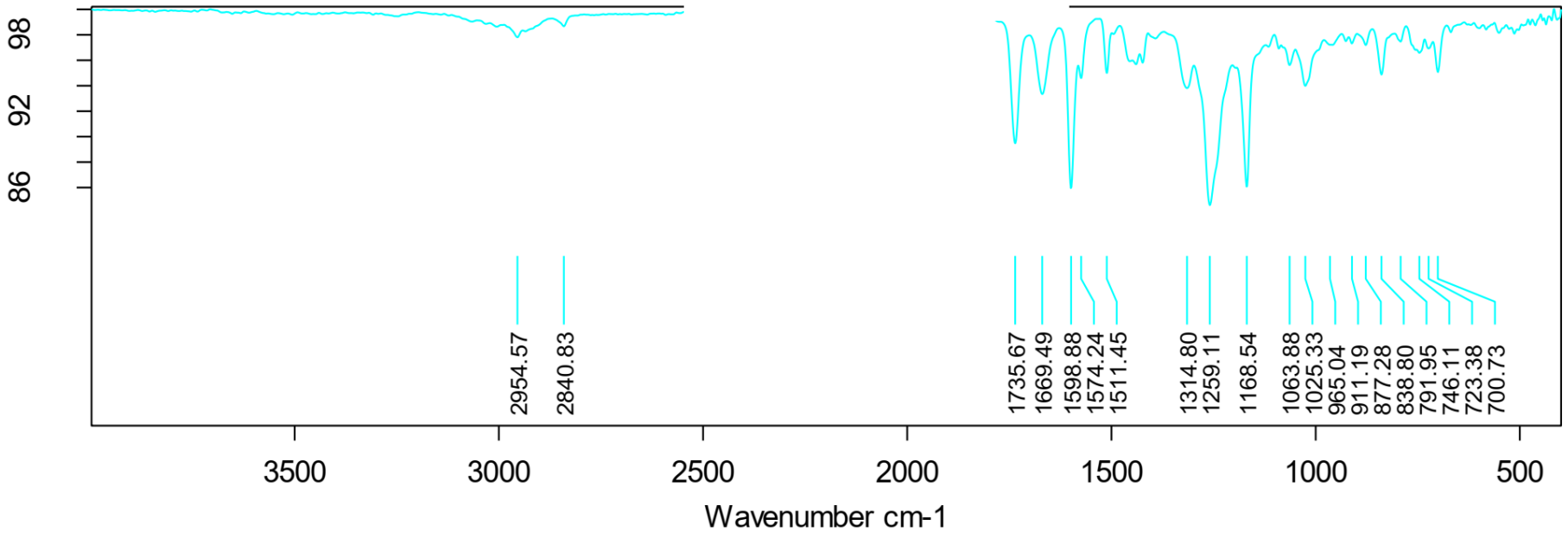
4ae



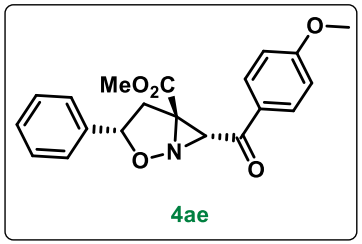
FT-IR Spectra



4ae



HRMS



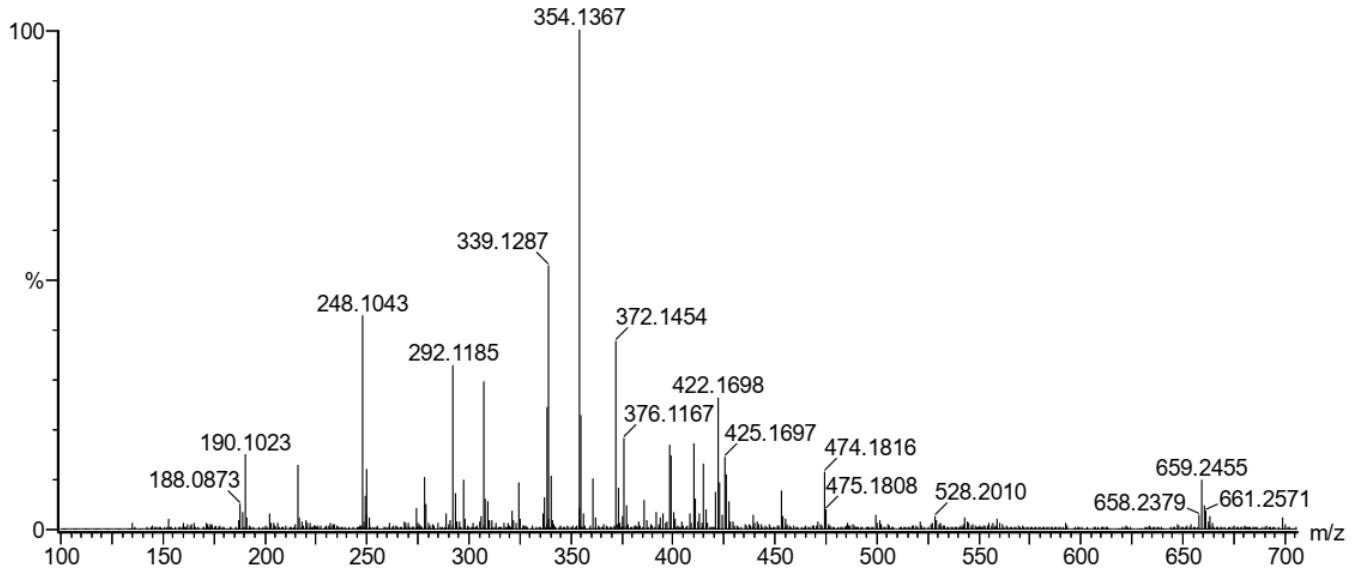
Elemental Composition Report

Single Mass Analysis

Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 5

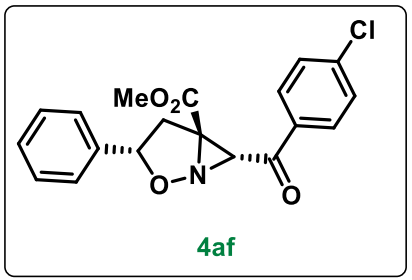
Monoisotopic Mass, Even Electron Ions
12 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 10-25 H: 15-25 N: 0-2 O: 0-5

Sample Name : 17-02-108 IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
150121-17-02-108 16 (0.165) 1: TOF MS ES+
3.95e+007

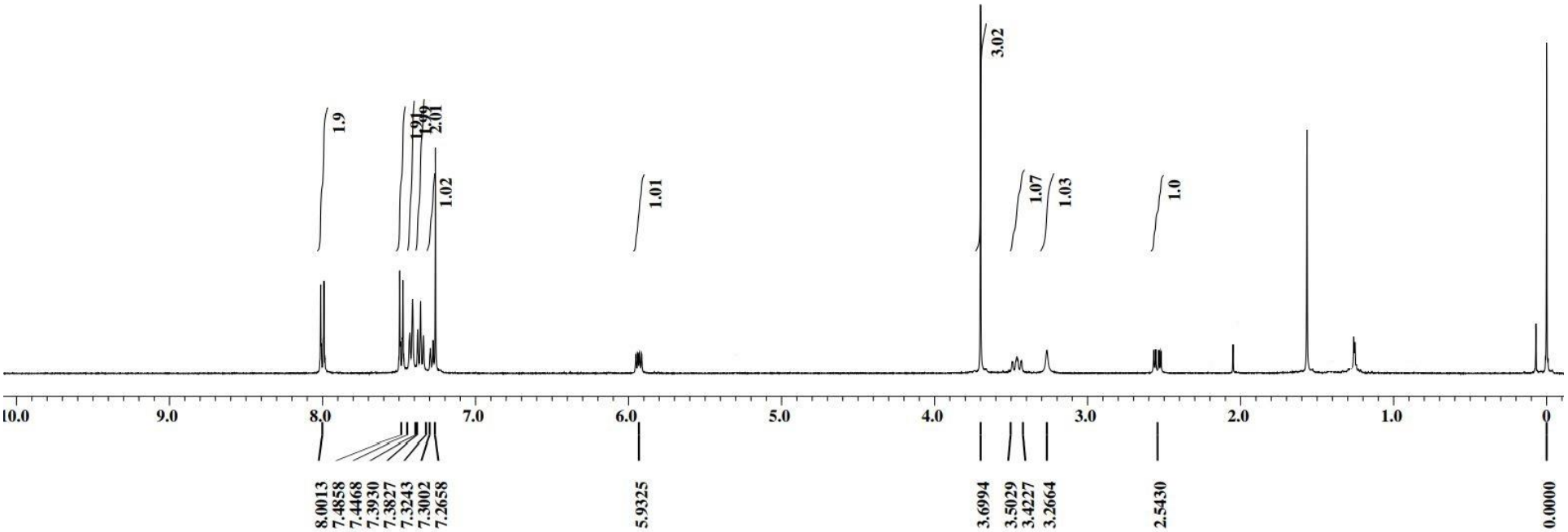


Minimum:				-1.5				
Maximum:		2.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
354.1367	354.1341	2.6	7.3	11.5	1471.1	n/a	n/a	C20 H20 N O5

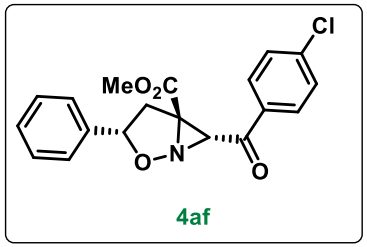
^{1}H-NMR ($CDCl_3$, 400 MHz)



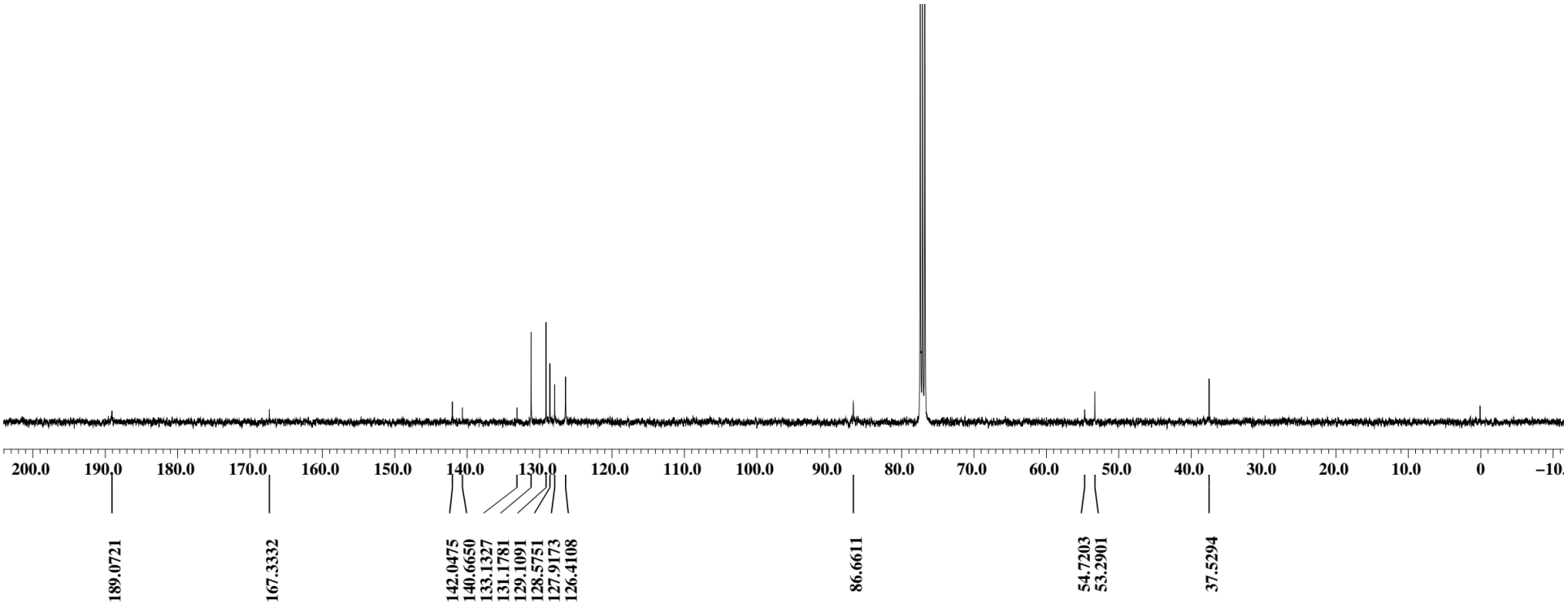
4af



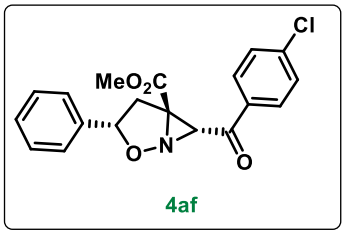
^{13}C-NMR ($CDCl_3$, 100 MHz)



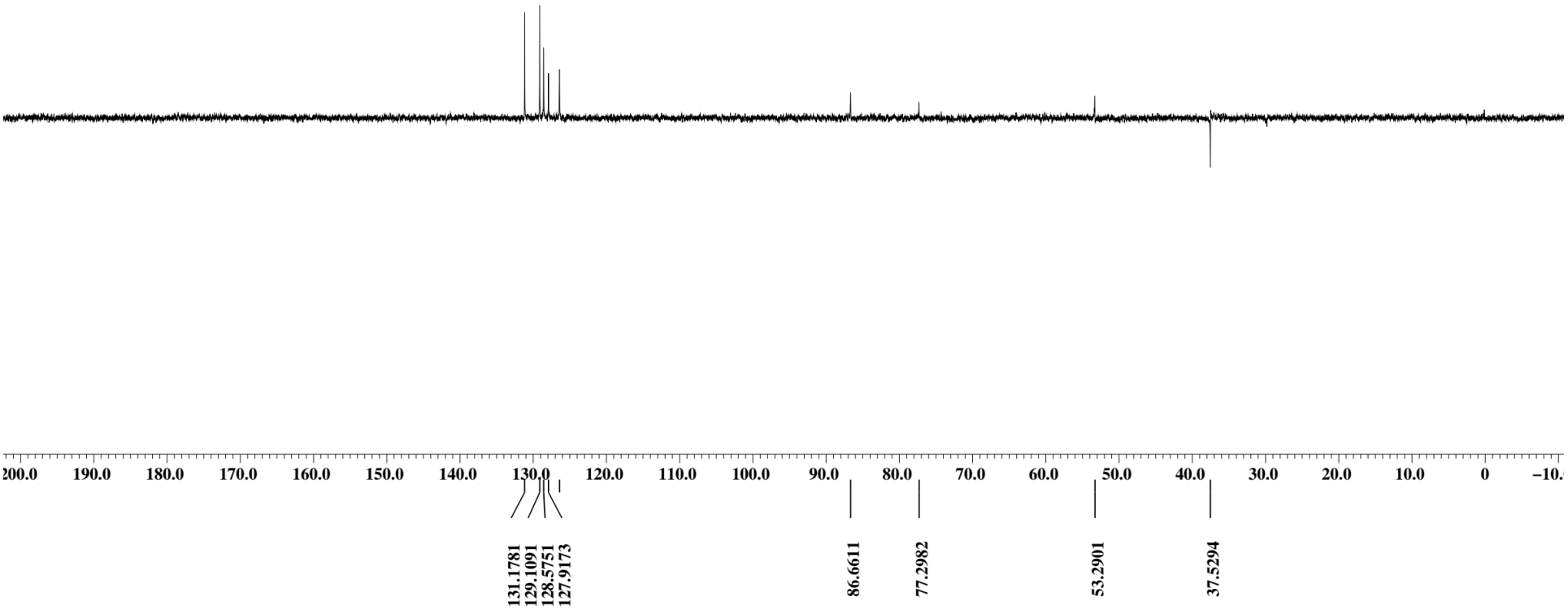
4af



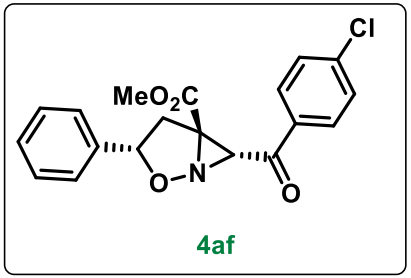
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



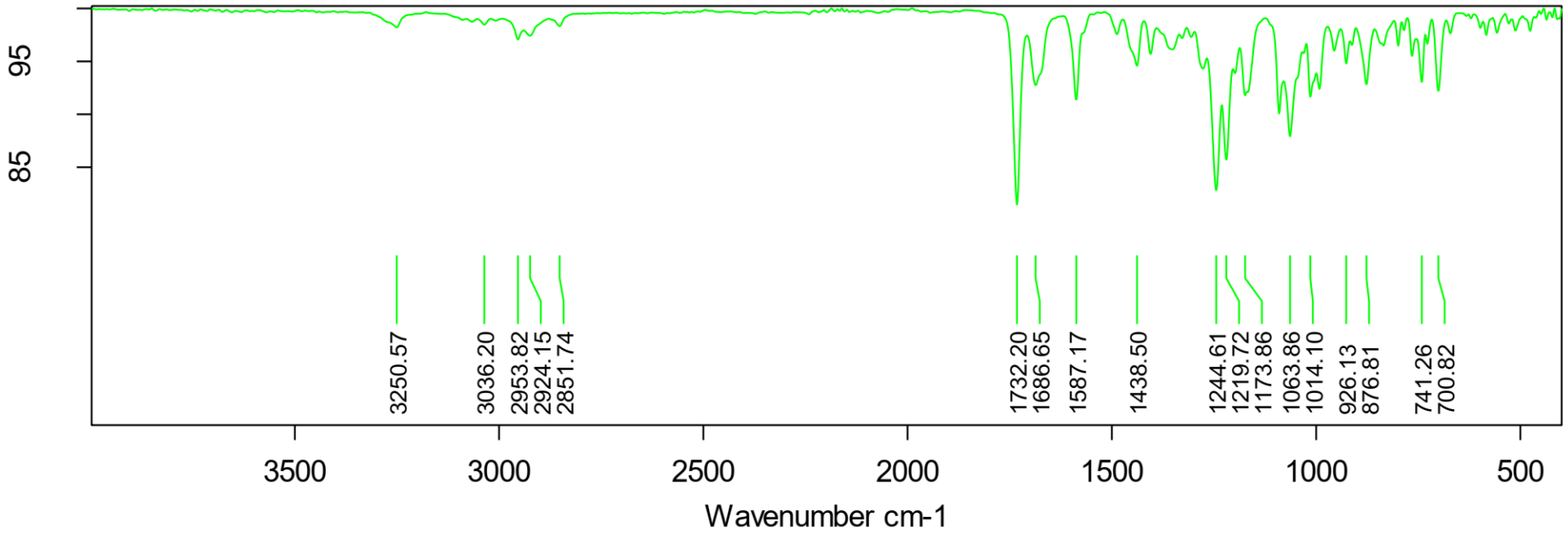
4af



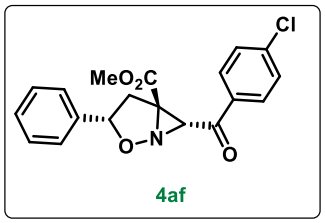
FT-IR Spectra



4af



HRMS



4af

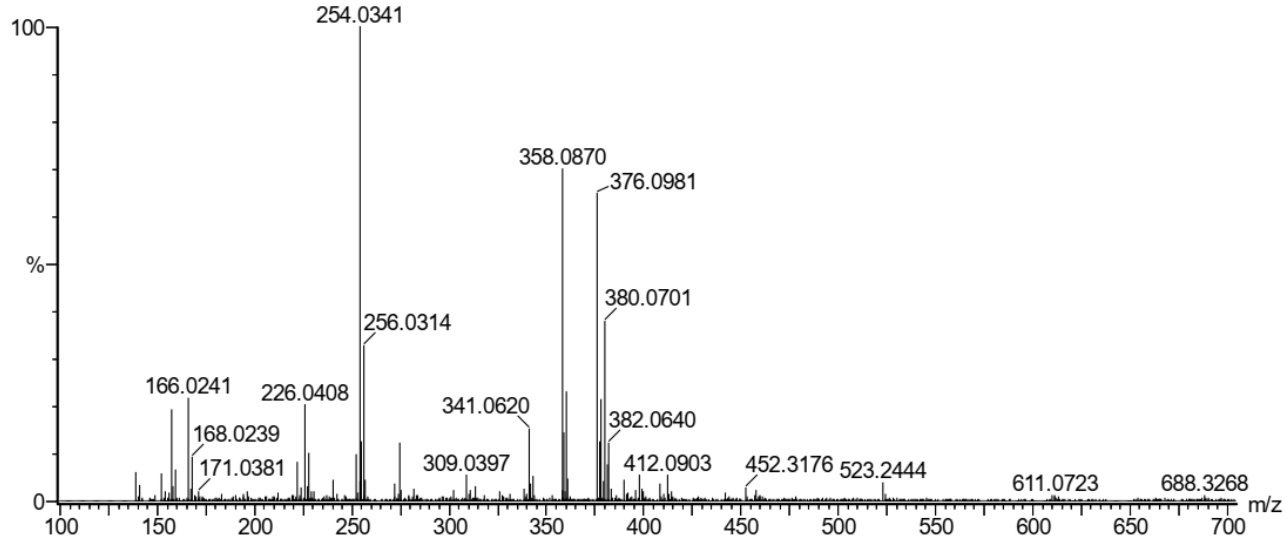
Elemental Composition Report

Single Mass Analysis

Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 5

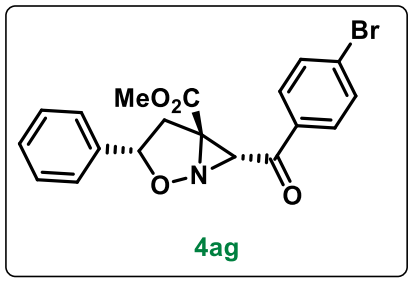
Monoisotopic Mass, Even Electron Ions
35 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 10-25 H: 15-30 N: 0-2 O: 0-4 Cl: 0-1

Sample Name : 17-02-109-B IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
150121-17-02-109-B 16 (0.165) 1: TOF MS ES+
2.07e+007

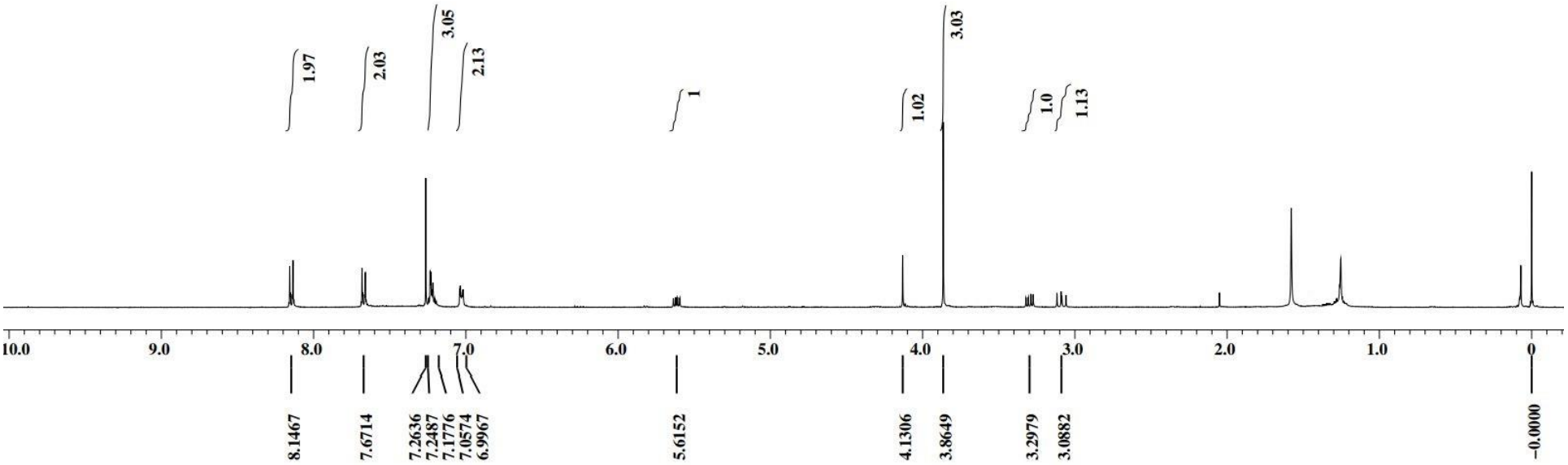


Minimum:				-1.5				
Maximum:		2.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
358.0870	358.0846	2.4	6.7	11.5	1800.8	n/a	n/a	C19 H17 N O4 Cl

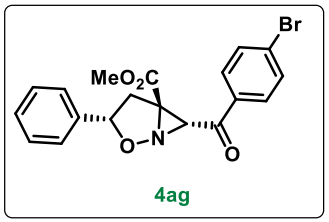
^{1}H-NMR ($CDCl_3$, 400 MHz)



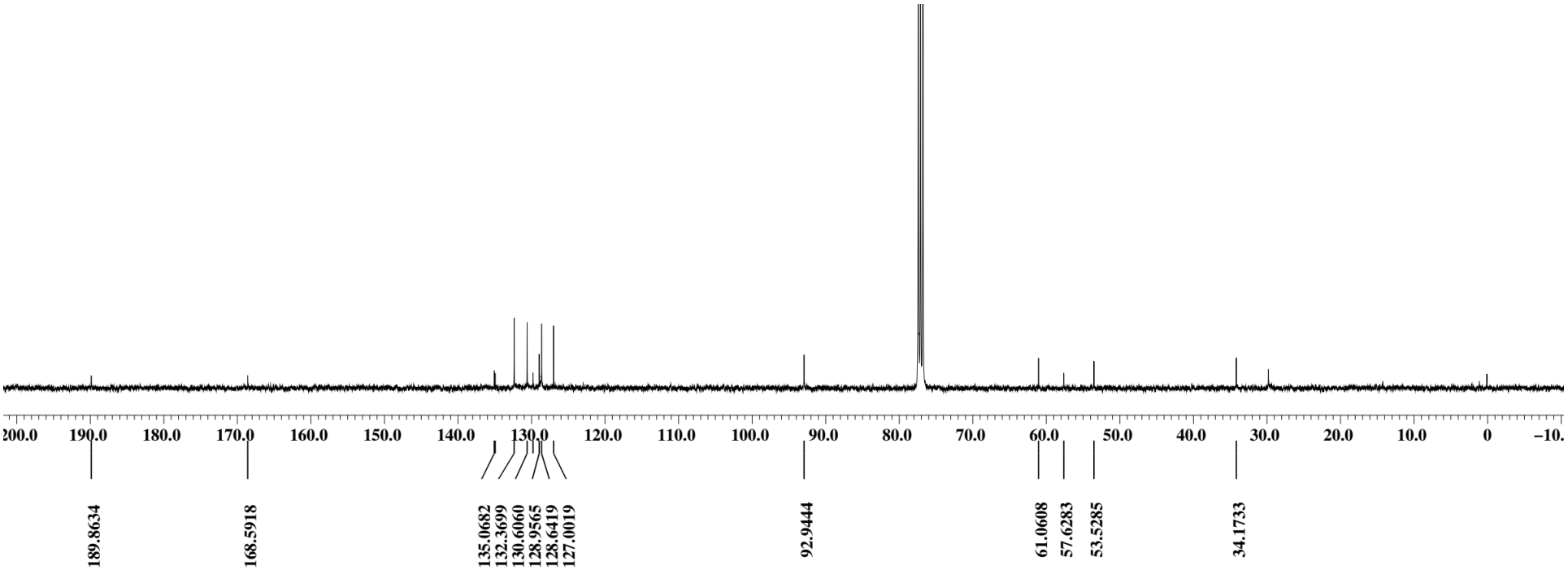
4ag



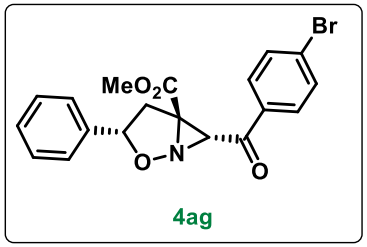
^{13}C-NMR ($CDCl_3$, 100 MHz)



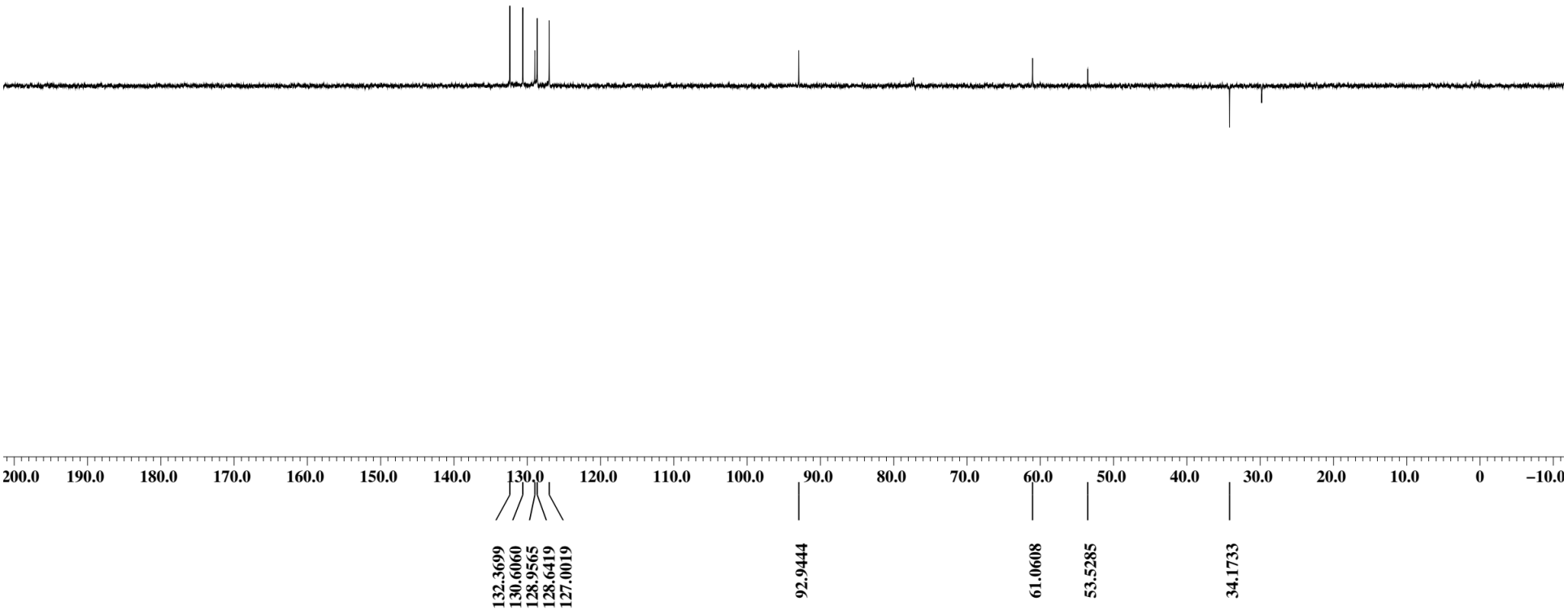
4ag



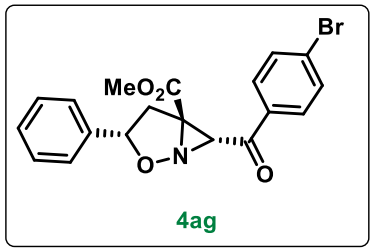
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



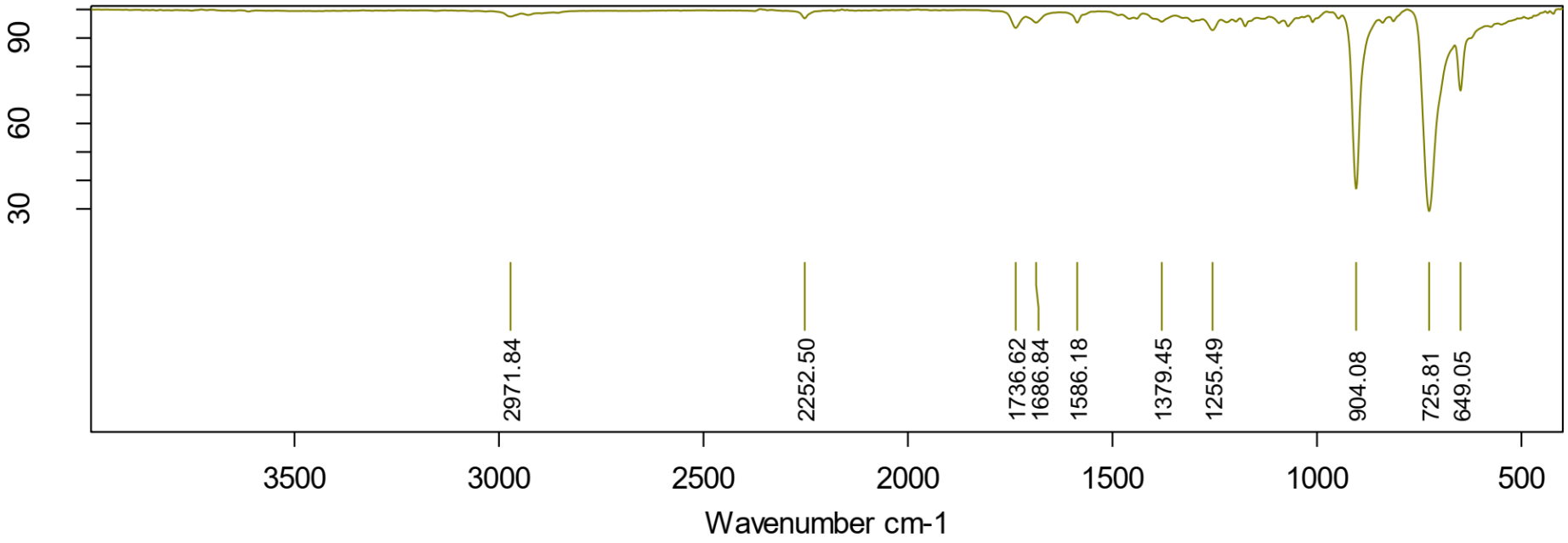
4ag



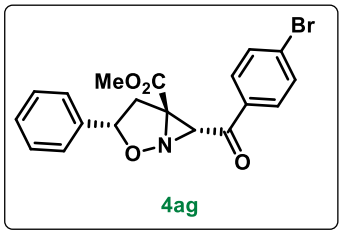
FT-IR Spectra



4ag



HRMS



4ag

Elemental Composition Report

Single Mass Analysis

Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 5

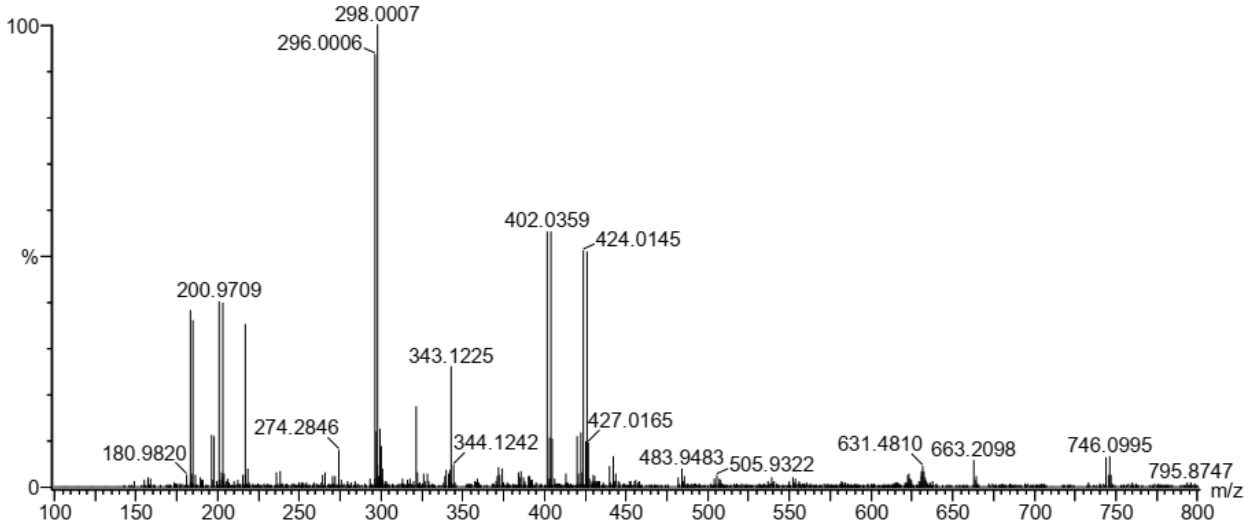
Monoisotopic Mass, Even Electron Ions
58 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 10-25 H: 15-30 N: 0-2 O: 0-5 Br: 0-2

Sample Name : 17-02-110-B
Test Name : HRMS-1
150121-17-02-110-B 12 (0.131)

IITRPR

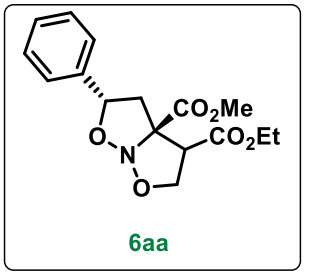
XEVO G2-XS QTOF

1: TOF MS ES+
1.34e+008

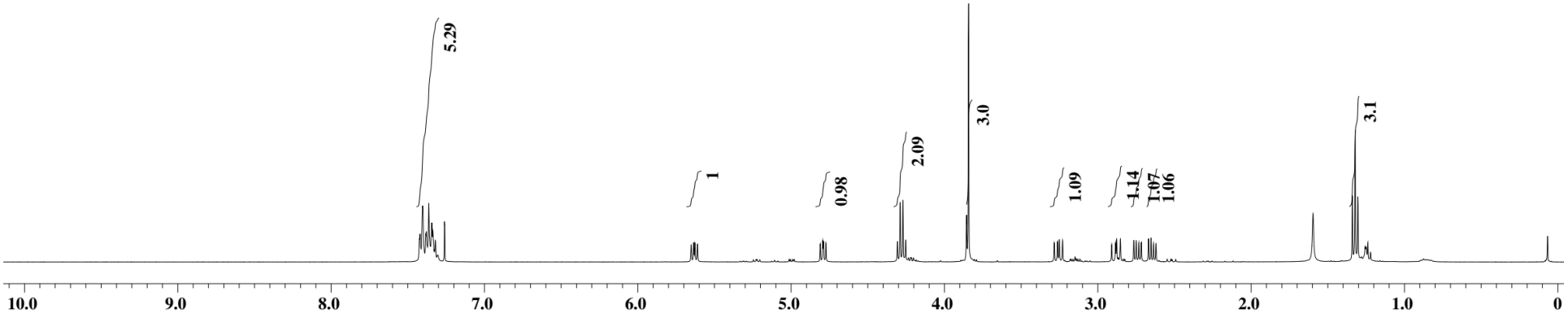


Minimum:				-1.5				
Maximum:		2.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
402.0359	402.0341	1.8	4.5	11.5	1812.5	n/a	n/a	C19 H17 N O4 Br

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

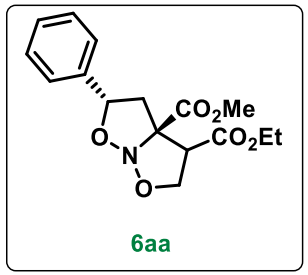


6aa

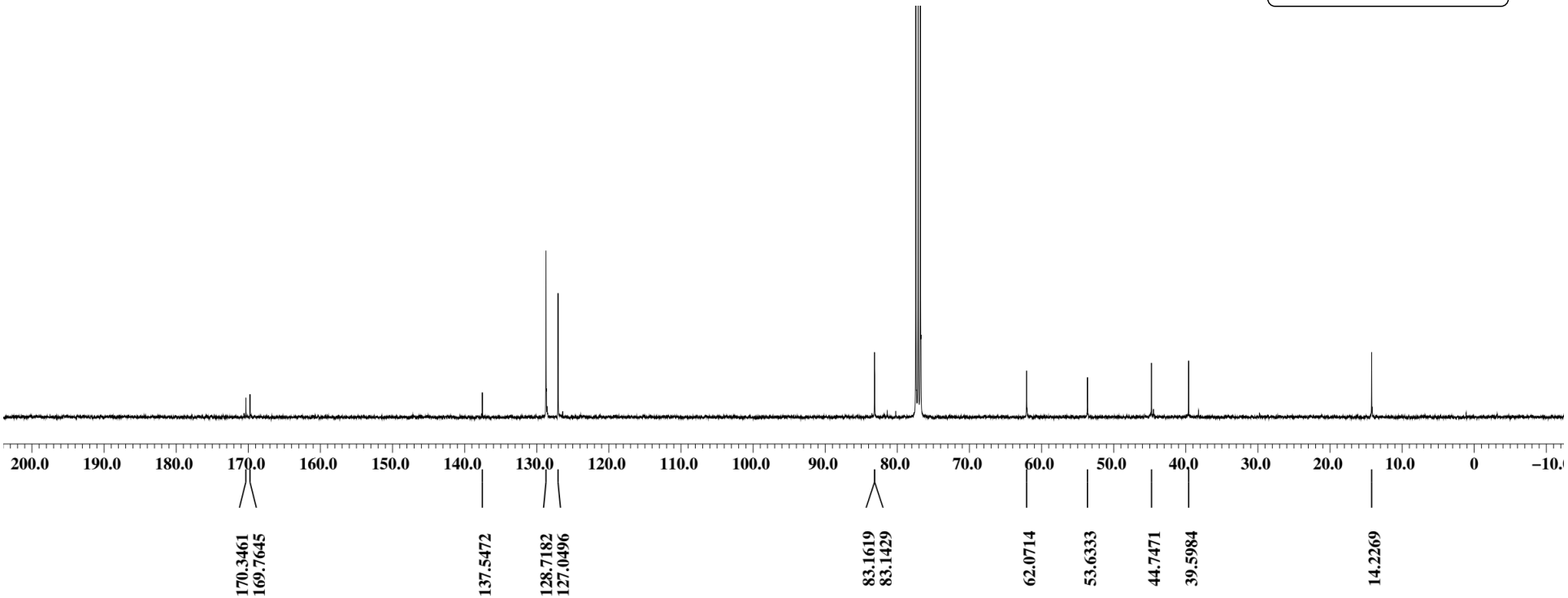


7.4422
7.2956
5.6312
4.7916
4.2807
3.8431
3.2566
2.8809
2.7411
2.6449
1.3230

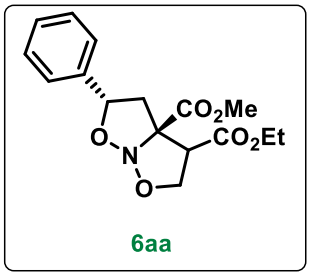
^{13}C-NMR ($CDCl_3$, 100 MHz)



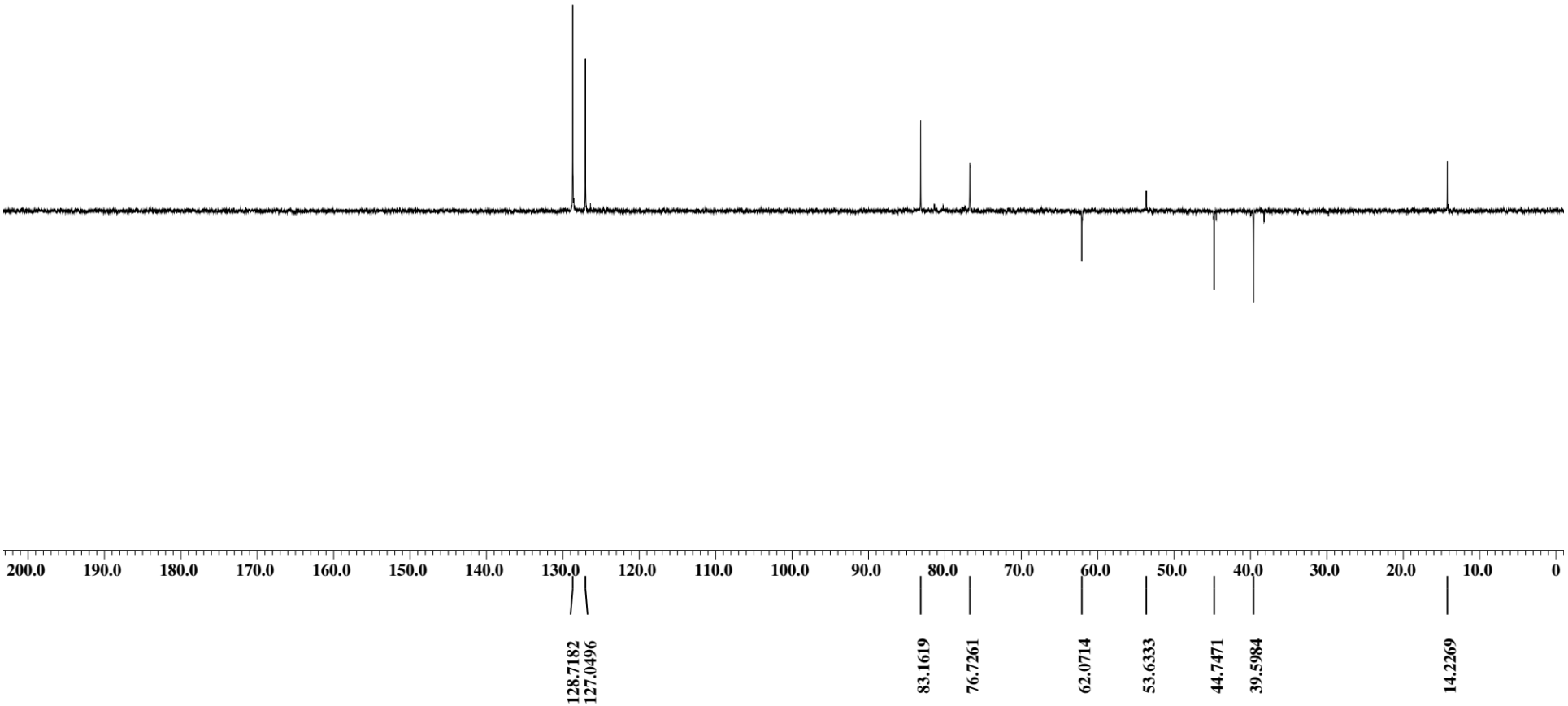
6aa



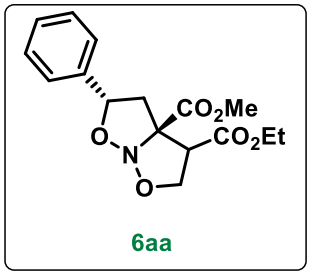
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



6aa



HRMS



6aa

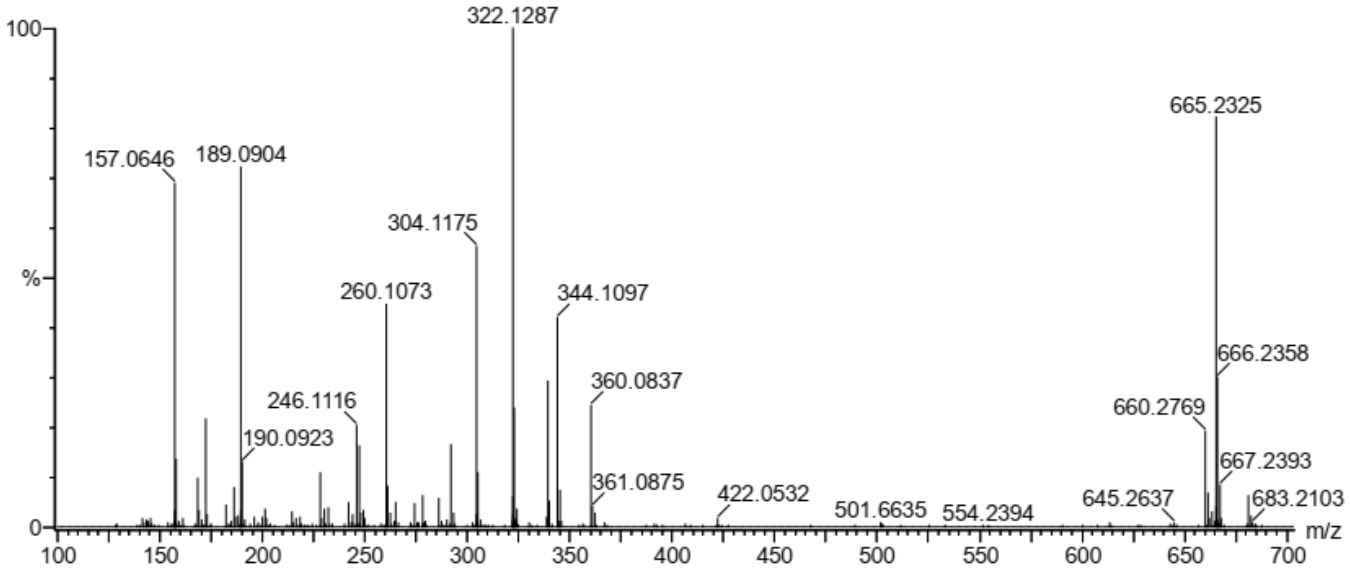
Elemental Composition Report

Single Mass Analysis

Tolerance = 5.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 5

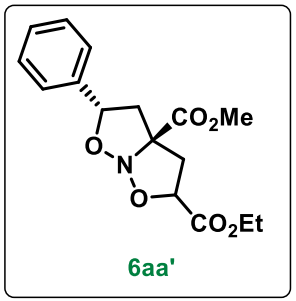
Monoisotopic Mass, Even Electron Ions
26 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-21 H: 10-30 N: 0-2 O: 0-6

Sample Name : 17-02-15-B IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
240220-17-02-15-B 17 (0.174) 1: TOF MS ES+
4.96e+007

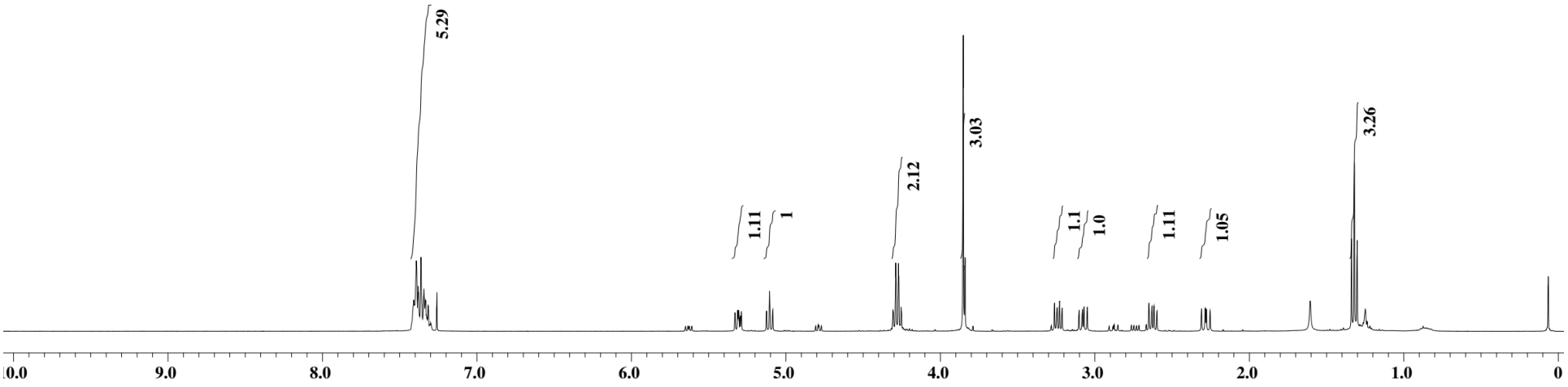


Minimum:				-1.5				
Maximum:		5.0	5.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
322.1287	322.1291	-0.4	-1.2	7.5	1864.2	n/a	n/a	C16 H20 N O6

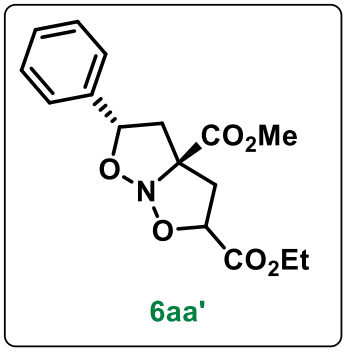
^{1}H-NMR ($CDCl_3$, 400 MHz)

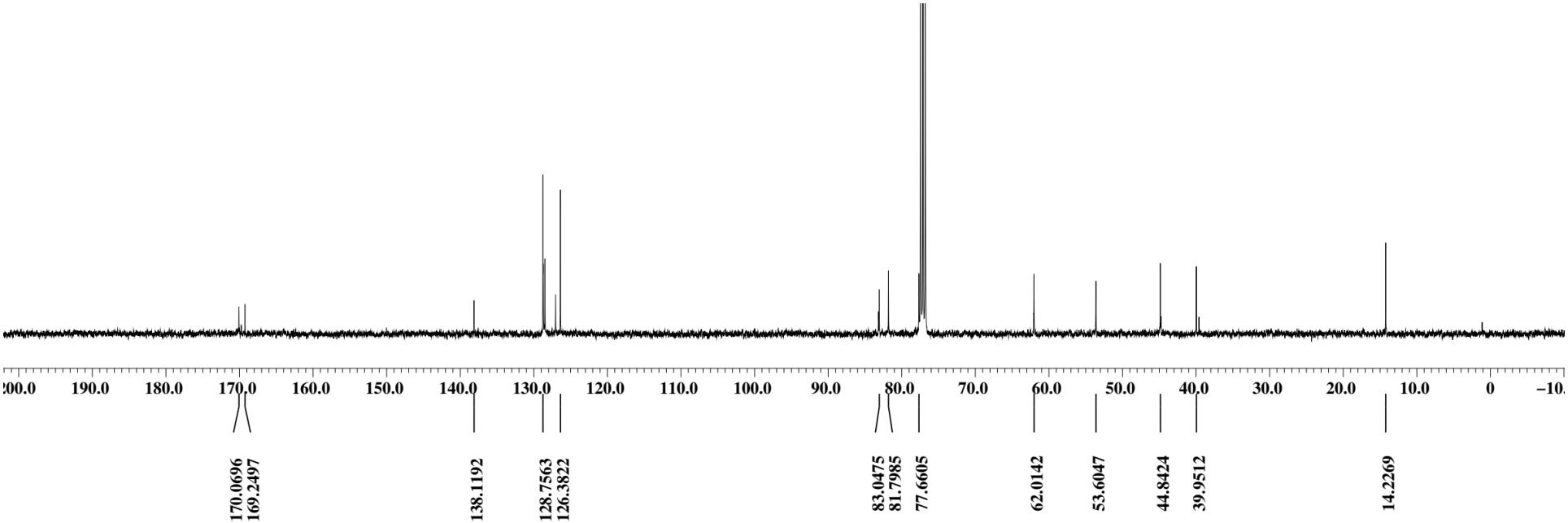


6aa'

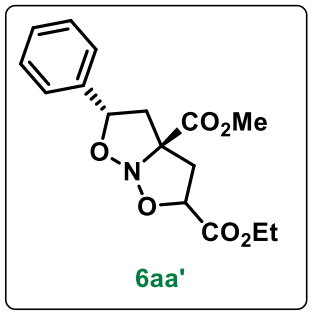


^{13}C-NMR ($CDCl_3$, 100 MHz)

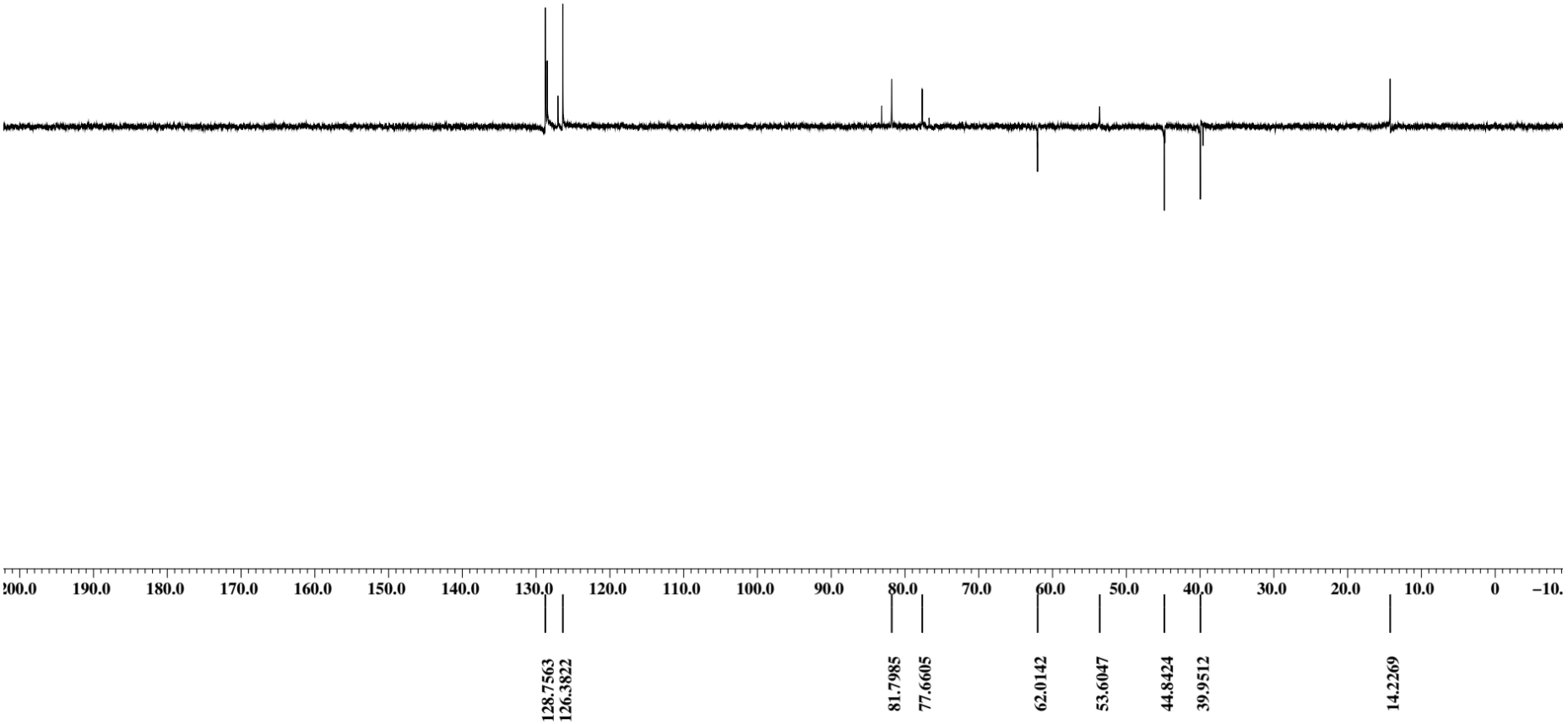




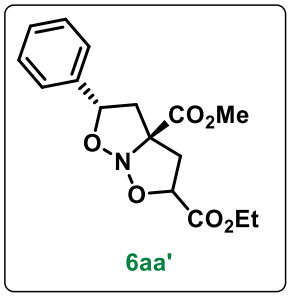
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



6aa'



HRMS



6aa'

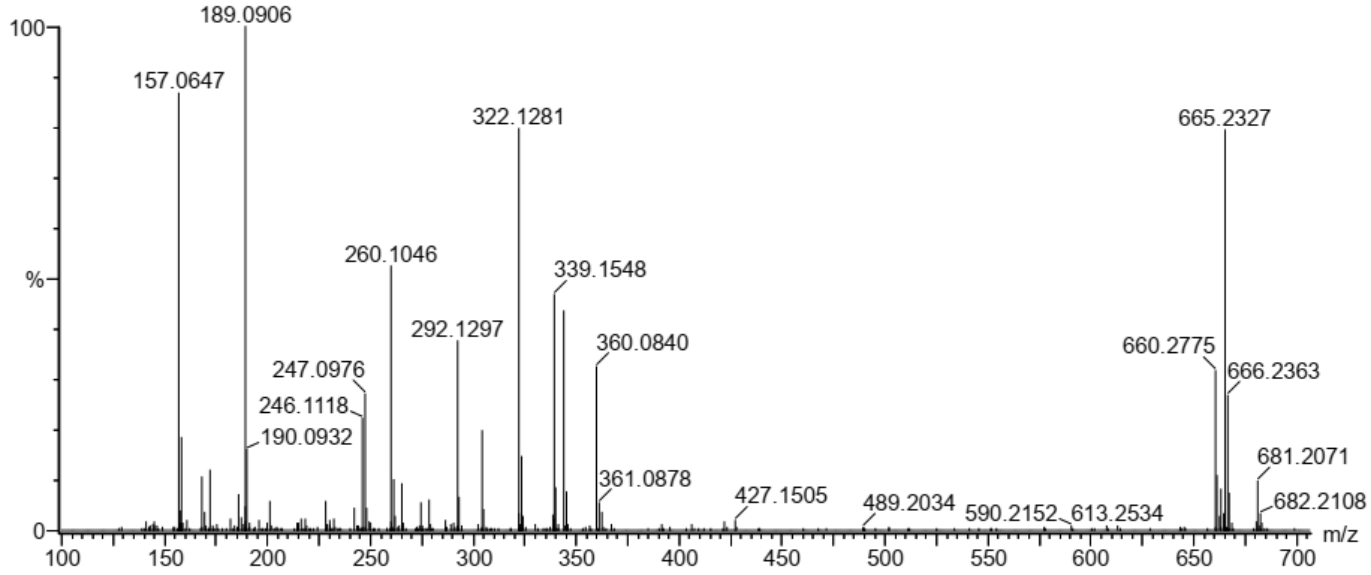
Elemental Composition Report

Single Mass Analysis

Tolerance = 5.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 5

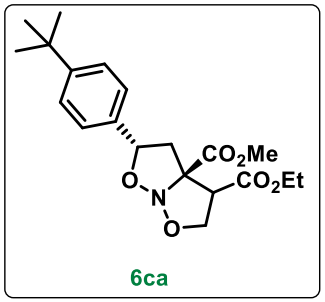
Monoisotopic Mass, Even Electron Ions
26 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-21 H: 10-30 N: 0-2 O: 0-6

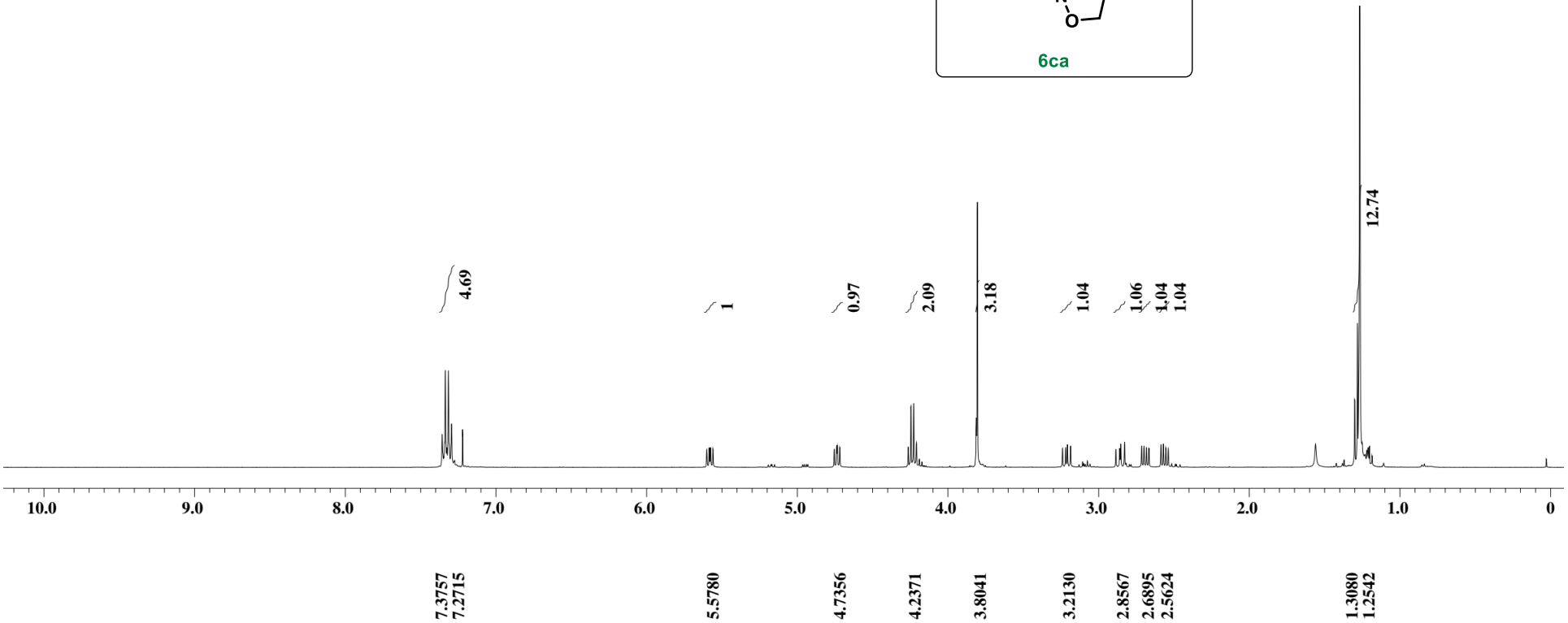
Sample Name : 17-02-15-A IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
240220-17-02-15-A 18 (0.183) 1: TOF MS ES+
3.39e+007



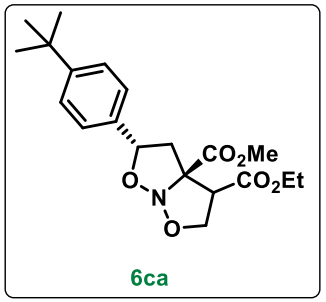
Minimum:				-1.5				
Maximum:		5.0	5.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
322.1281	322.1291	-1.0	-3.1	7.5	1645.6	n/a	n/a	C16 H20 N O6

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

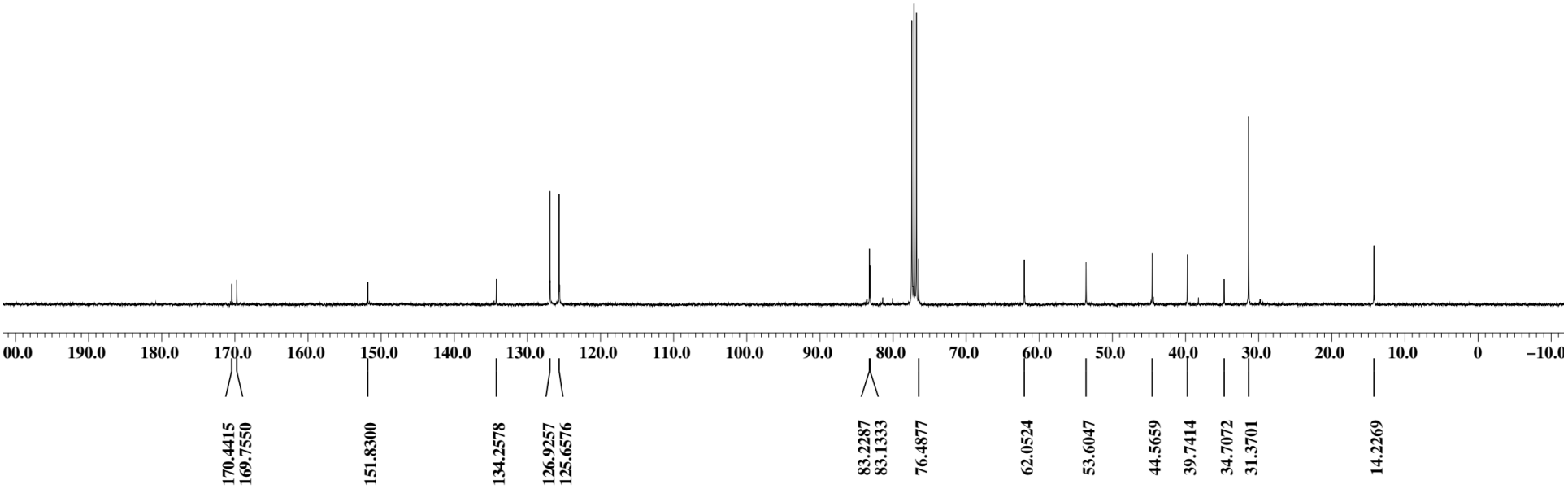




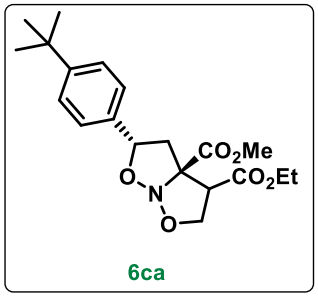
^{13}C-NMR ($CDCl_3$, 100 MHz)



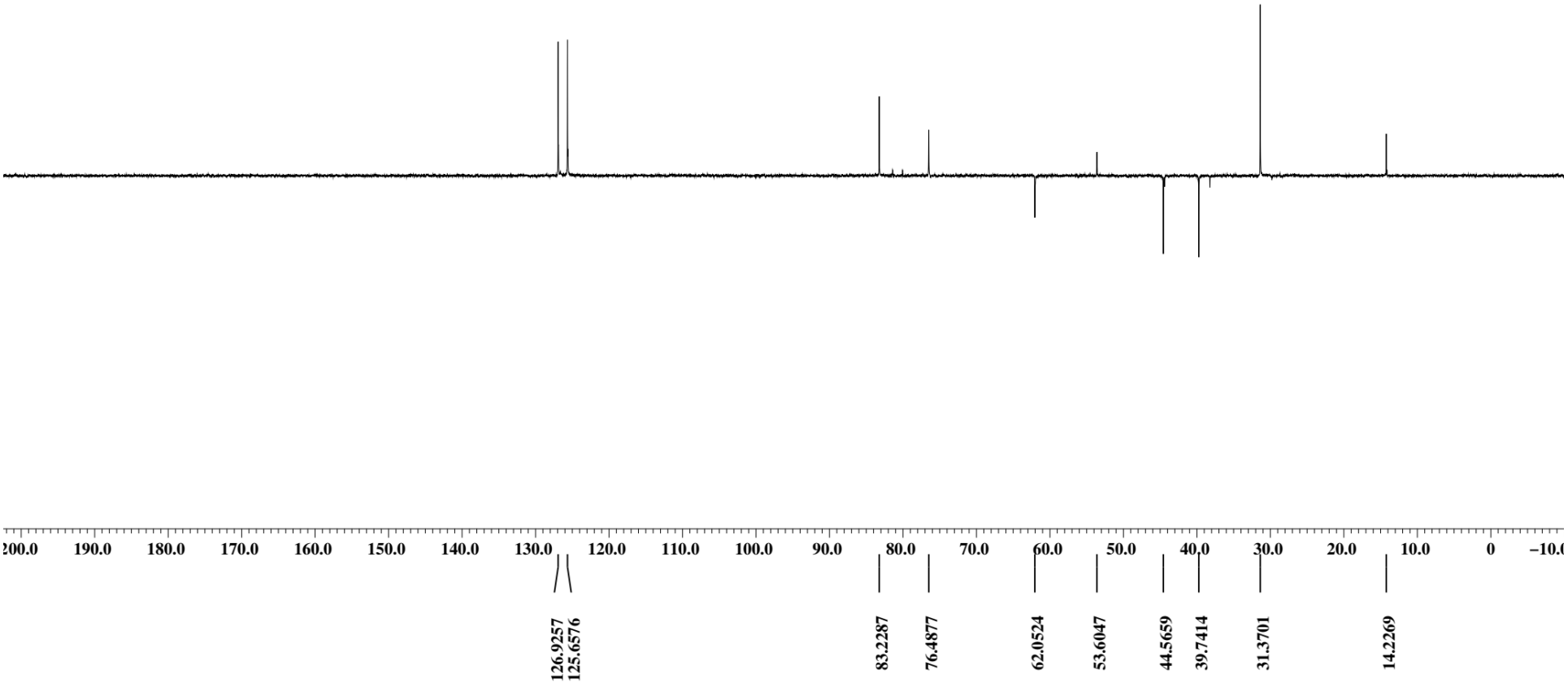
6ca



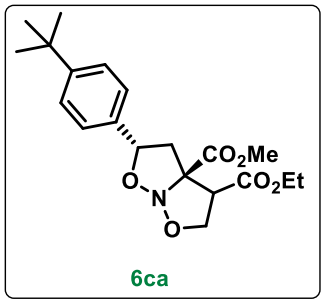
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



6ca



HRMS



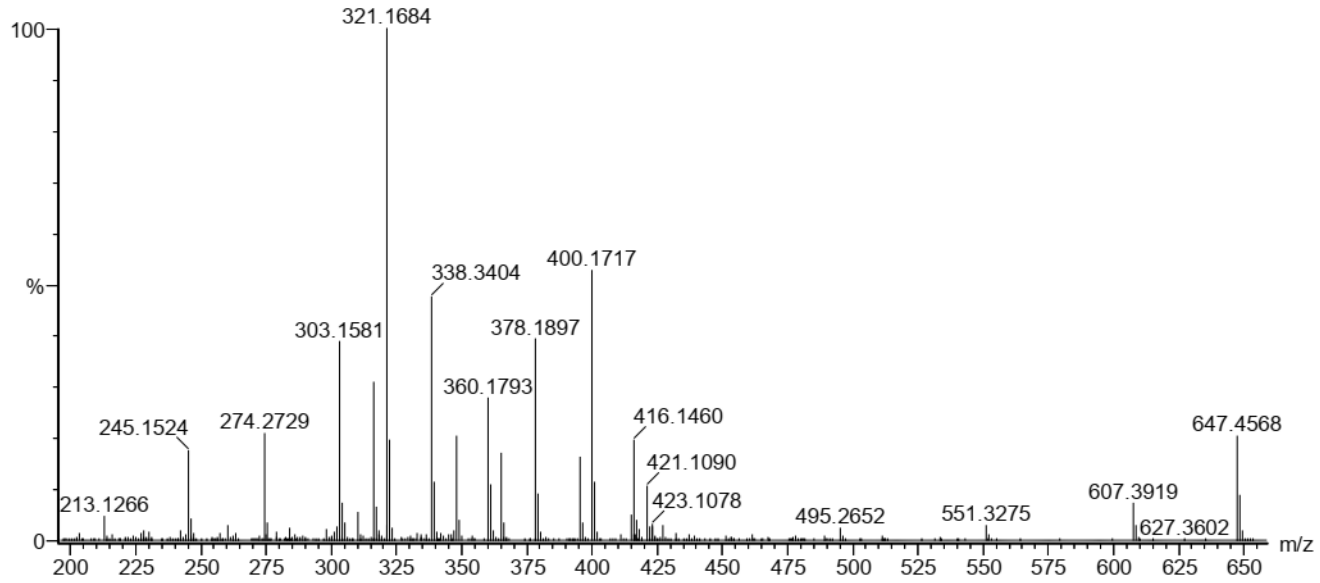
Elemental Composition Report

Single Mass Analysis

Tolerance = 7.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

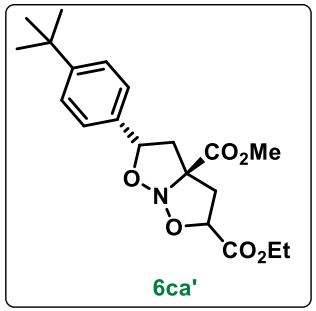
Monoisotopic Mass, Even Electron Ions
105 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 6-30 H: 5-35 N: 0-2 O: 0-6 I: 0-1

19-01-370-N-5 IITRPR UPLC-XEVOG2XSQTOF
090320-19-01-370-N-5 20 (0.211) AM2 (Ar,16000.0,0.00,0.00); Cm (20:36) 1: TOF MS ES+
3.64e+007

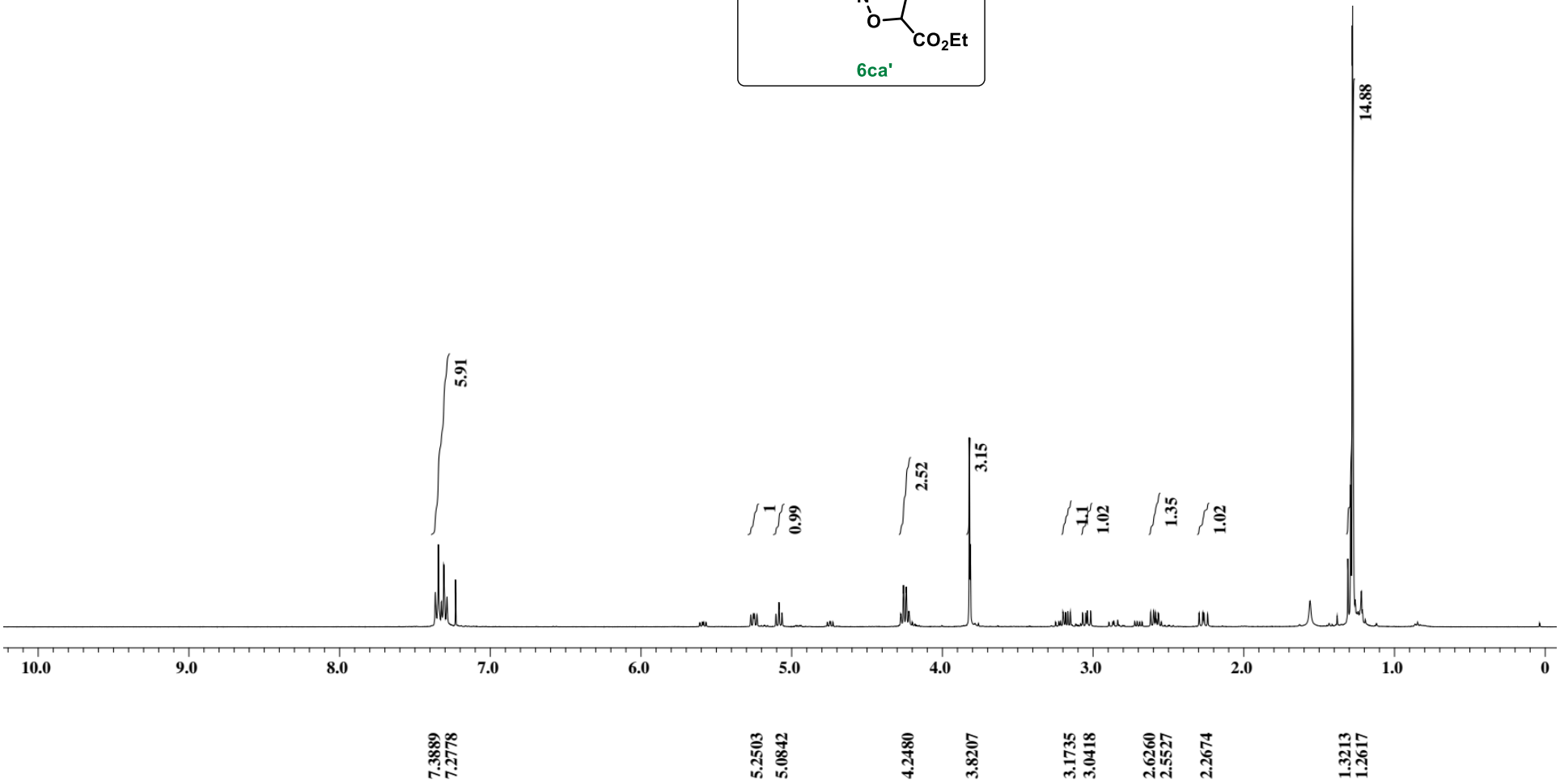


Minimum:				-1.5				
Maximum:		5.0	7.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
378.1897	378.1917	-2.0	-5.3	7.5	657.8	n/a	n/a	C20 H28 N O6

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

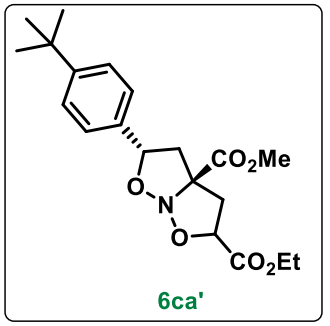


6ca'

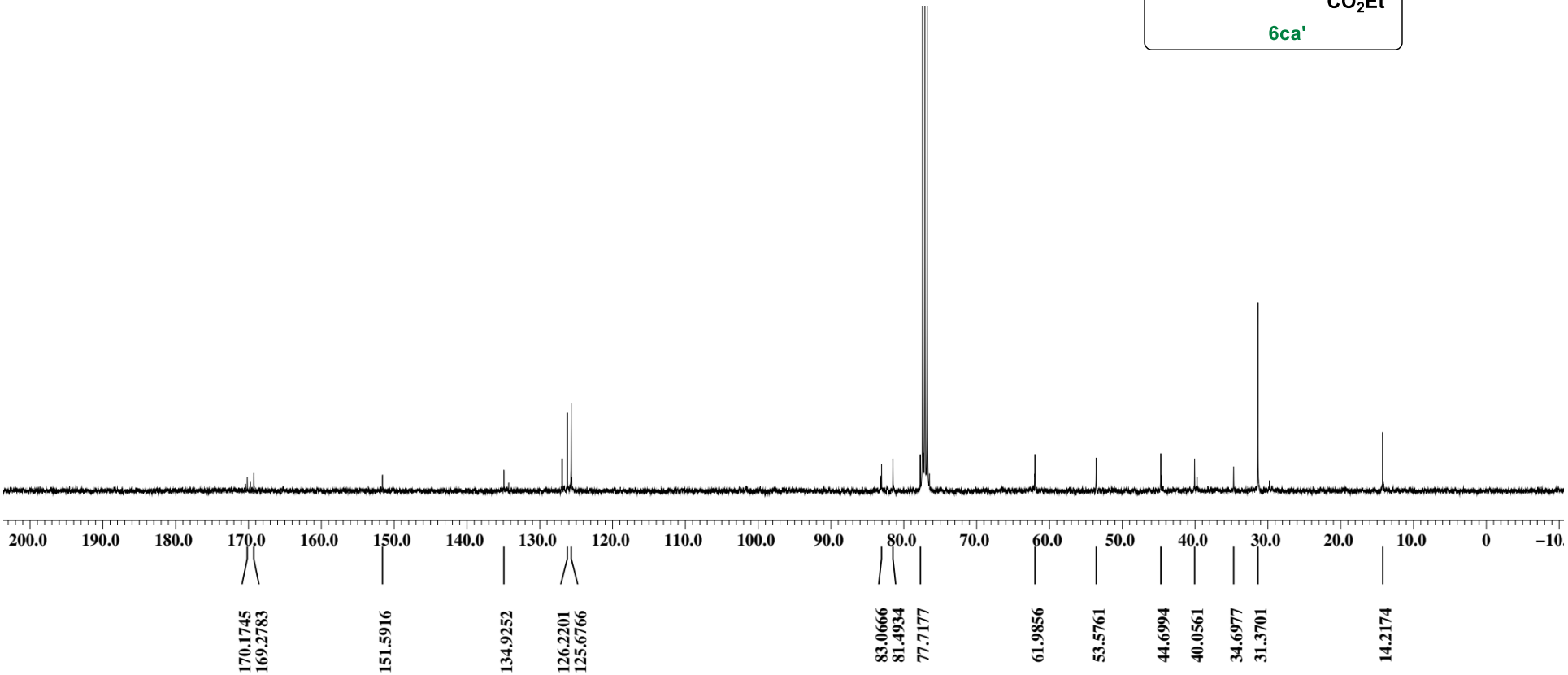


7.3889
7.2778
5.2503
5.0842
4.2480
3.8207
3.1735
3.0418
2.6260
2.5527
2.2674
1.3213
1.2617

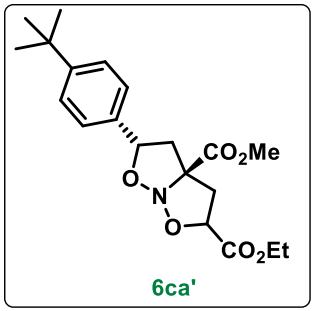
^{13}C-NMR ($CDCl_3$, 100 MHz)



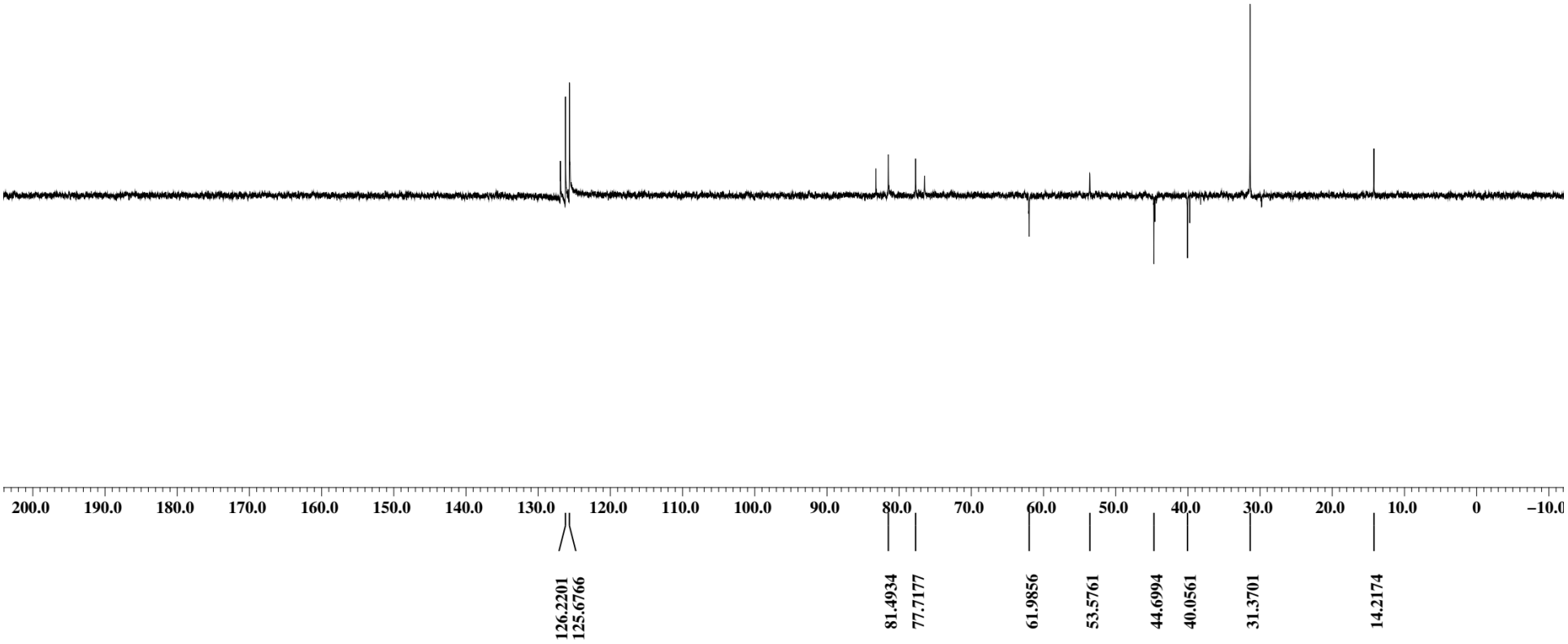
6ca'



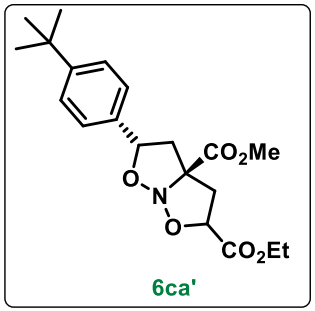
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



6ca'



HRMS



6ca'

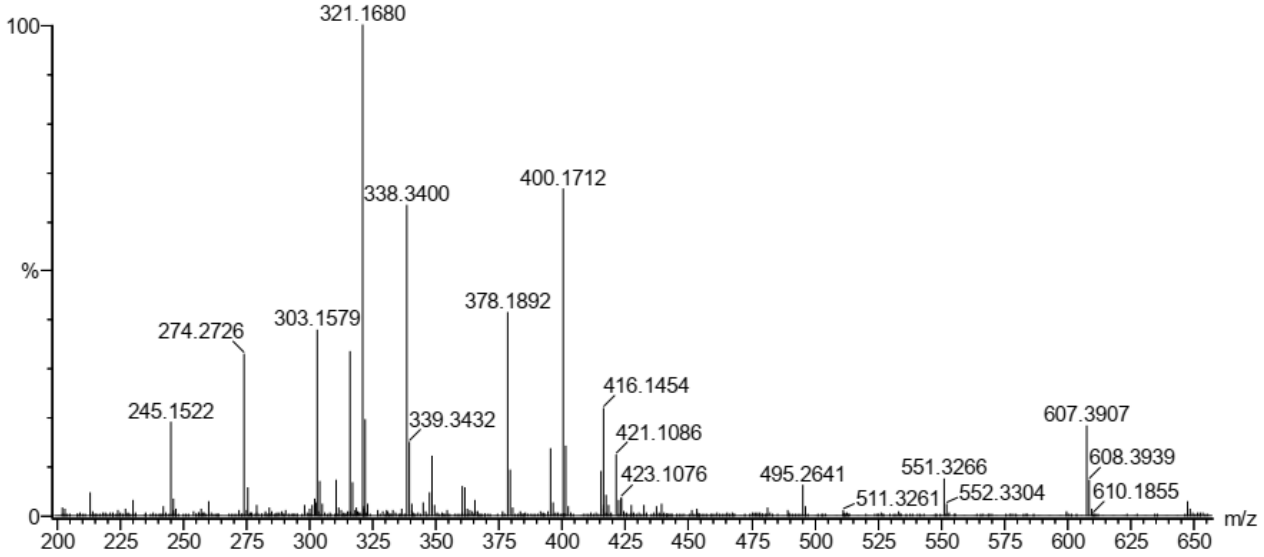
Elemental Composition Report

Single Mass Analysis

Tolerance = 7.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

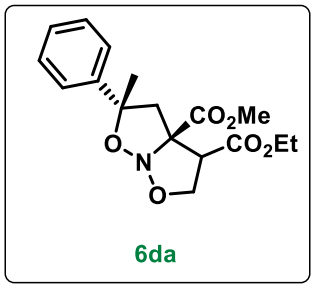
Monoisotopic Mass, Even Electron Ions
105 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 6-30 H: 5-35 N: 0-2 O: 0-6 I: 0-1

19-01-370-N-9 IITRPR UPLC-XEVOG2XSQTOF
090320-19-01-370-N-9 19 (0.203) AM2 (Ar,16000.0,0.00,0.00); Cm (19:27) 1: TOF MS ES+
1.47e+007

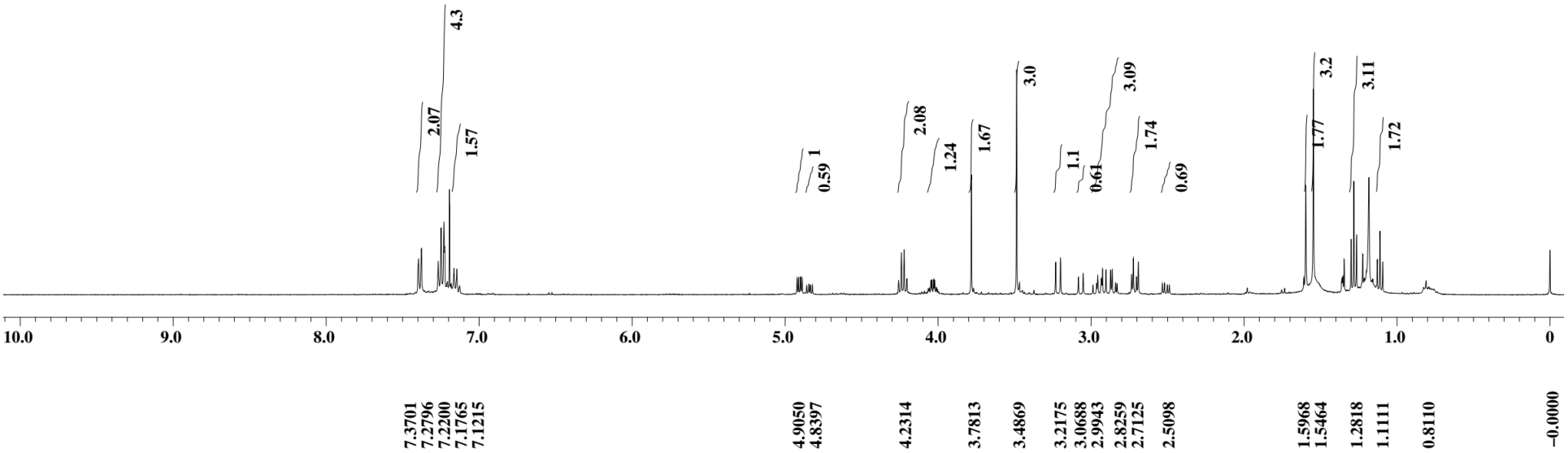


Minimum:				-1.5				
Maximum:		5.0	7.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
378.1892	378.1917	-2.5	-6.6	7.5	631.2	n/a	n/a	C20 H28 N O6

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

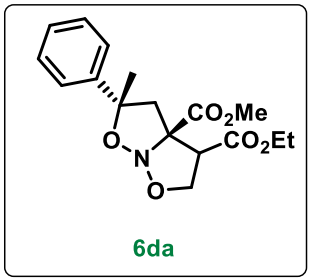


6da

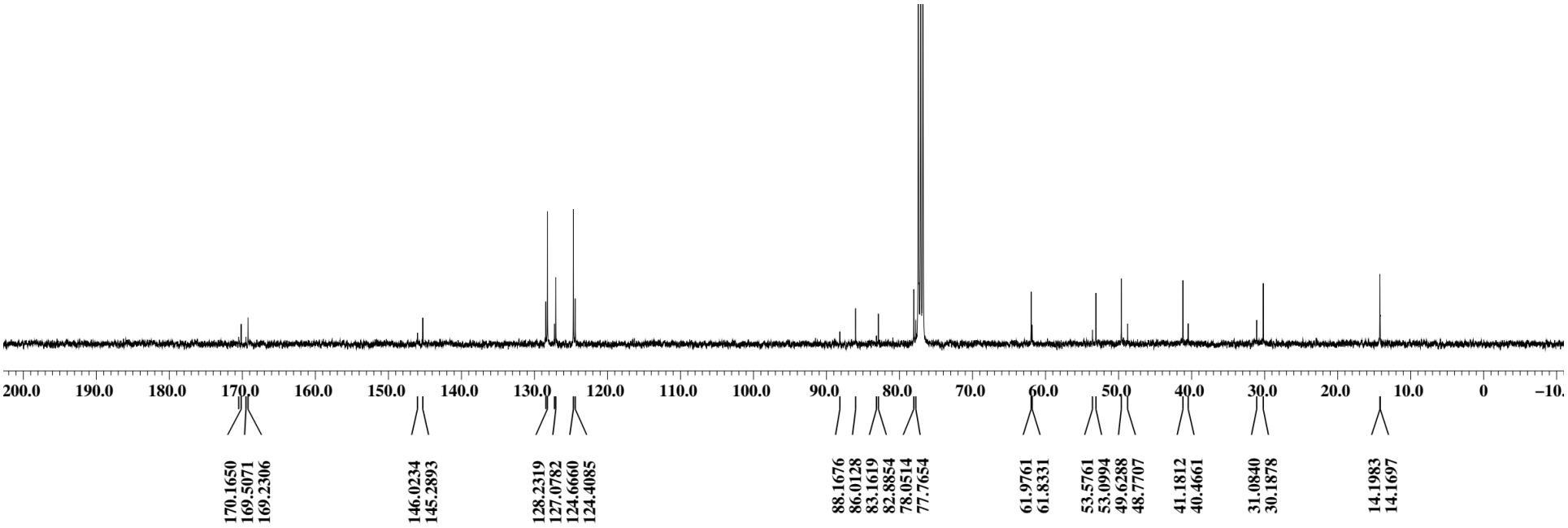


7.3701, 7.2796, 7.2200, 7.1765, 7.1215, 4.9050, 4.8397, 4.2314, 3.7813, 3.4869, 3.2175, 3.0688, 2.9943, 2.8259, 2.7125, 2.5098, 1.5968, 1.5464, 1.2818, 1.1111, 0.8110, −0.0000

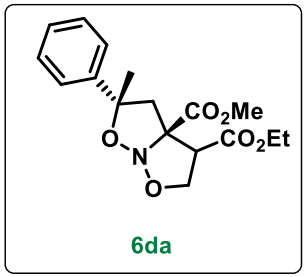
^{13}C-NMR ($CDCl_3$, 100 MHz)



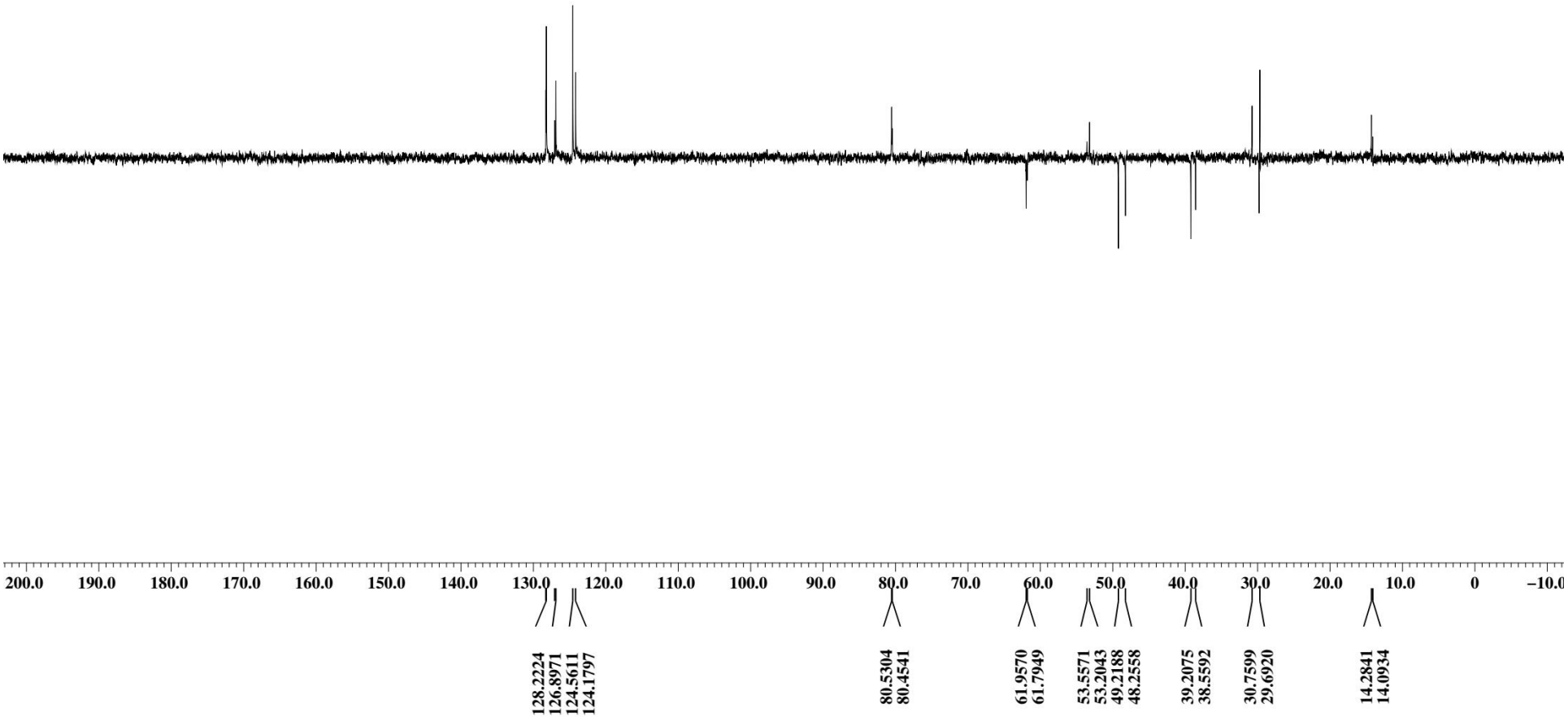
6da



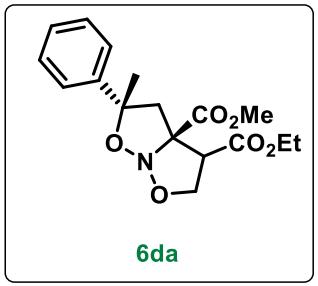
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



6da



HRMS



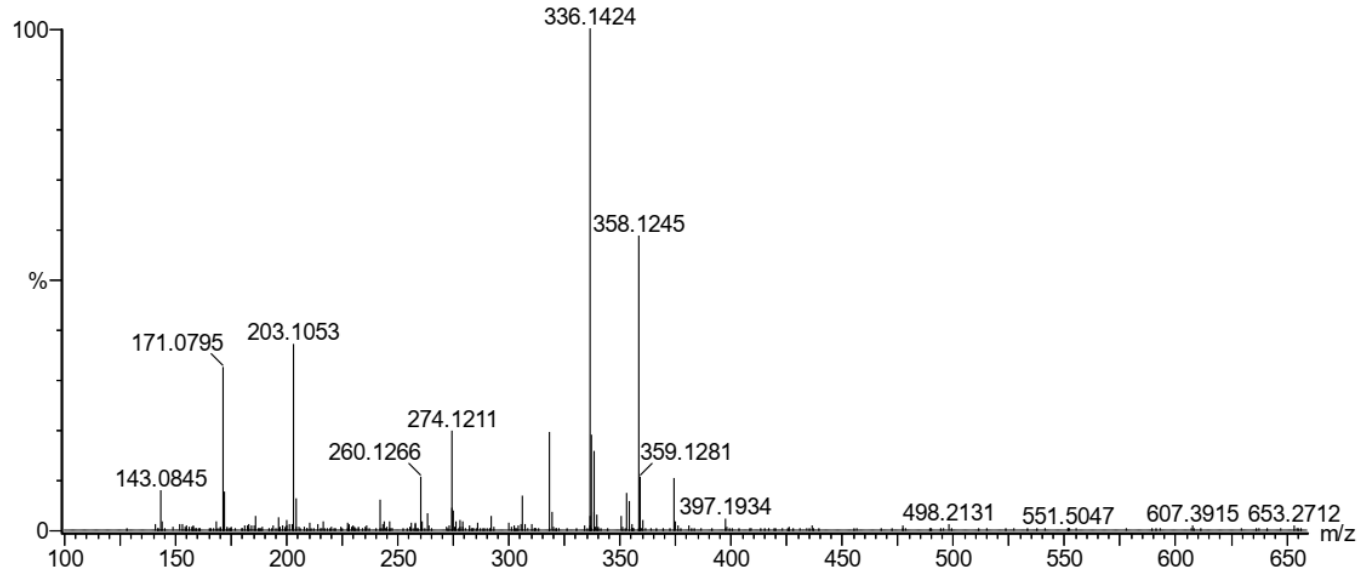
Elemental Composition Report

Single Mass Analysis

Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 5

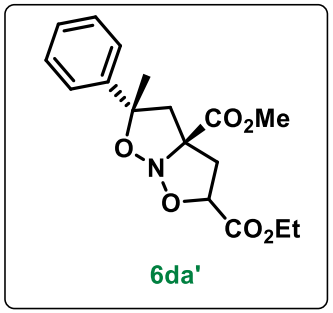
Monoisotopic Mass, Odd and Even Electron Ions
48 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-30 H: 10-30 N: 0-2 O: 0-8

Sample Name : 17-02-12-A IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
140220-17-02-12-A 19 (0.203) 1: TOF MS ES+
7.12e+006

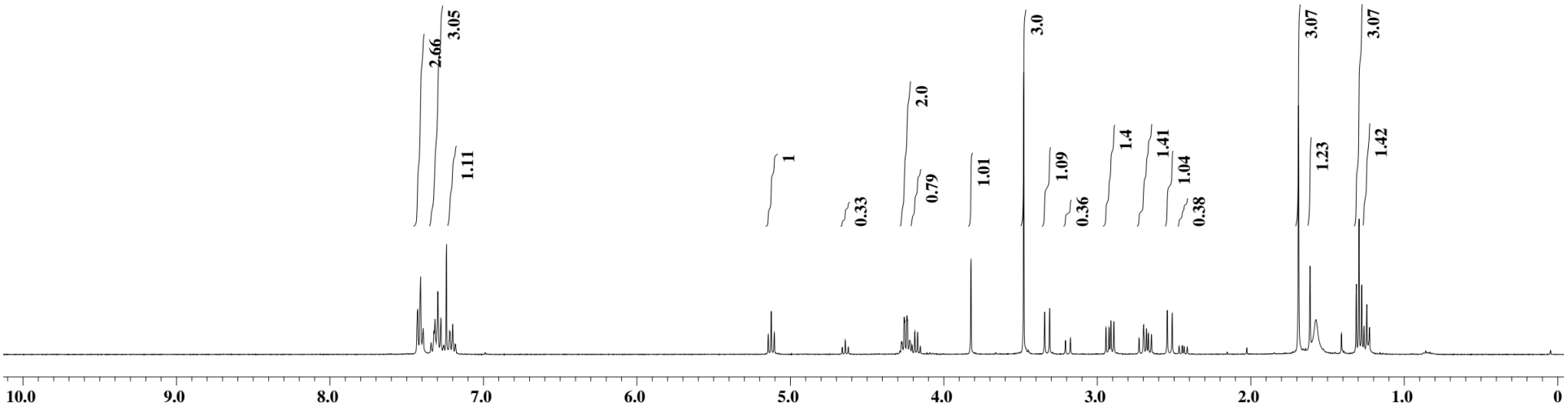


Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
336.1424	336.1447	-2.3	-6.8	7.5	1302.3	n/a	n/a	C17 H22 N O6

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

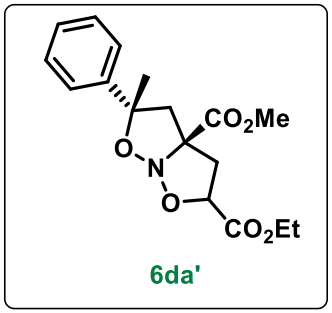


6da'

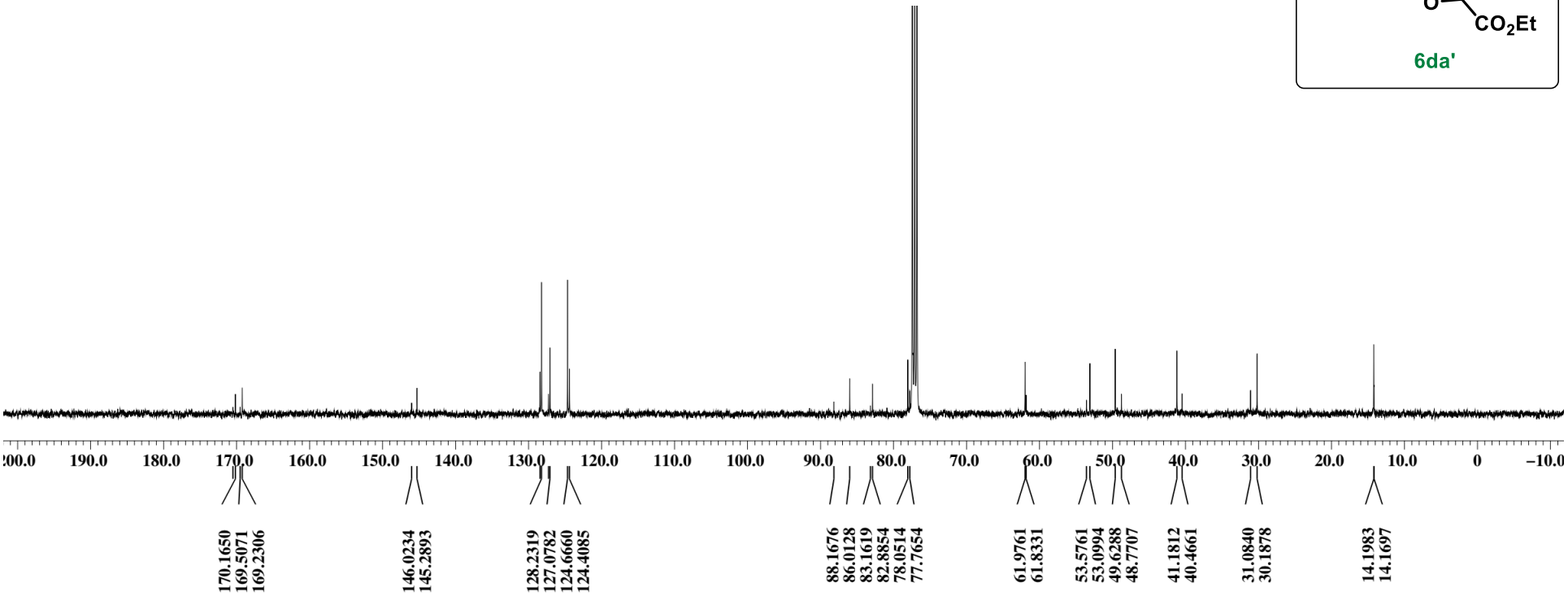


7.4450
7.3843
7.3465
7.2285
7.1759
5.1254
4.6424
4.2823
4.2159
4.2113
4.1483
3.8230
3.4794
3.3270
3.1930
2.9547
2.8871
2.7336
2.6409
2.5286
2.4392
1.6901
1.6133
1.2960
1.2445

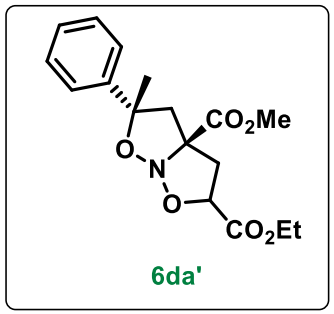
^{13}C-NMR ($CDCl_3$, 100 MHz)



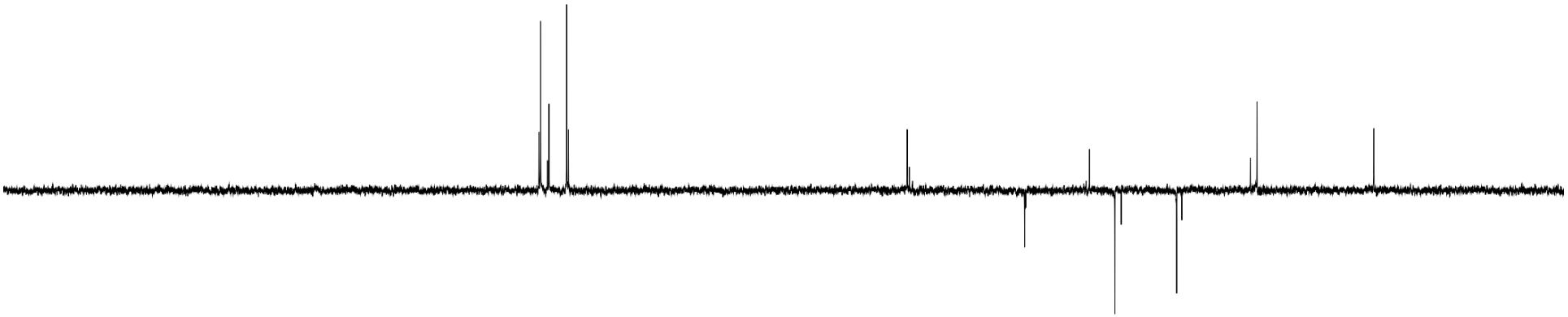
6da'

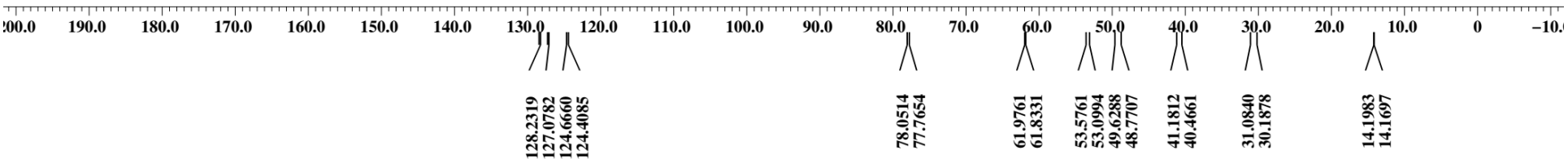


^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



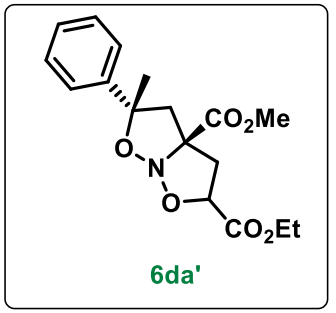
6da'





128.2319
127.0782
124.6660
124.4085
78.0514
77.7654
61.9761
61.8331
53.5761
53.0994
49.6288
48.7707
41.1812
40.4661
31.0840
30.1878
14.1983
14.1697

HRMS



6da'

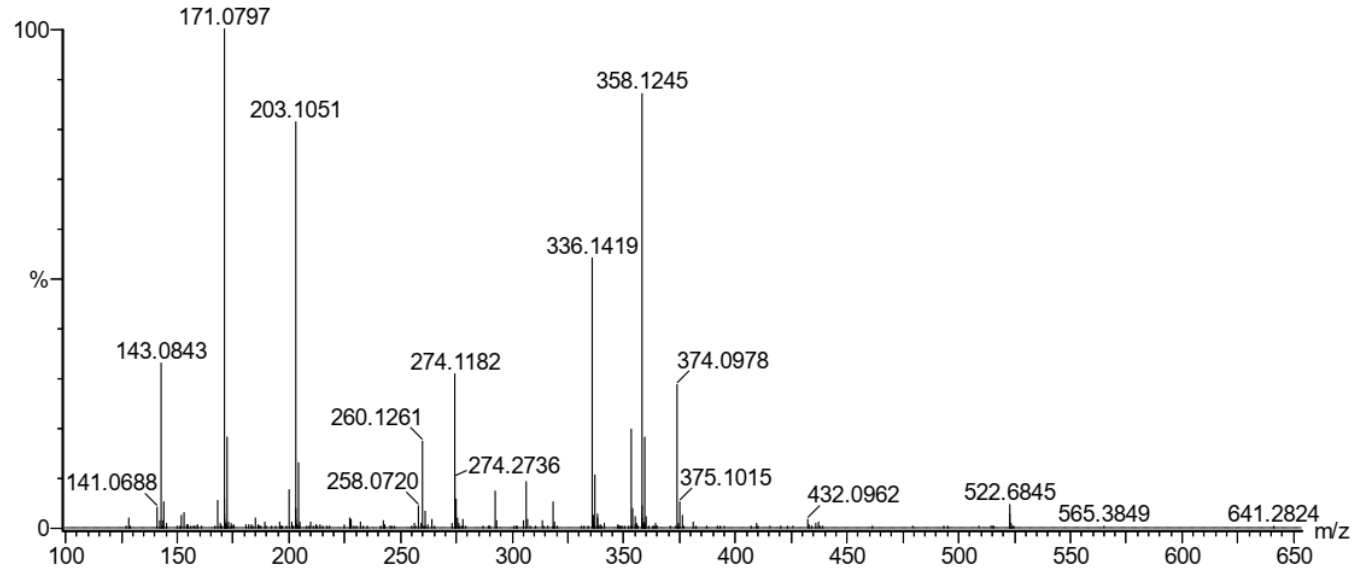
Elemental Composition Report

Single Mass Analysis

Tolerance = 9.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 5

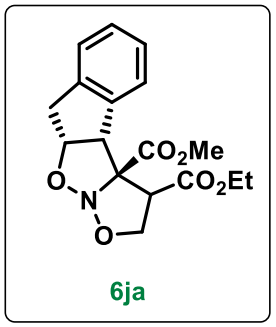
Monoisotopic Mass, Even Electron Ions
48 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-30 H: 10-30 N: 0-2 O: 0-8

Sample Name : 17-02-12-B IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
140220-17-02-12-B 12 (0.131) 1: TOF MS ES+
1.09e+008

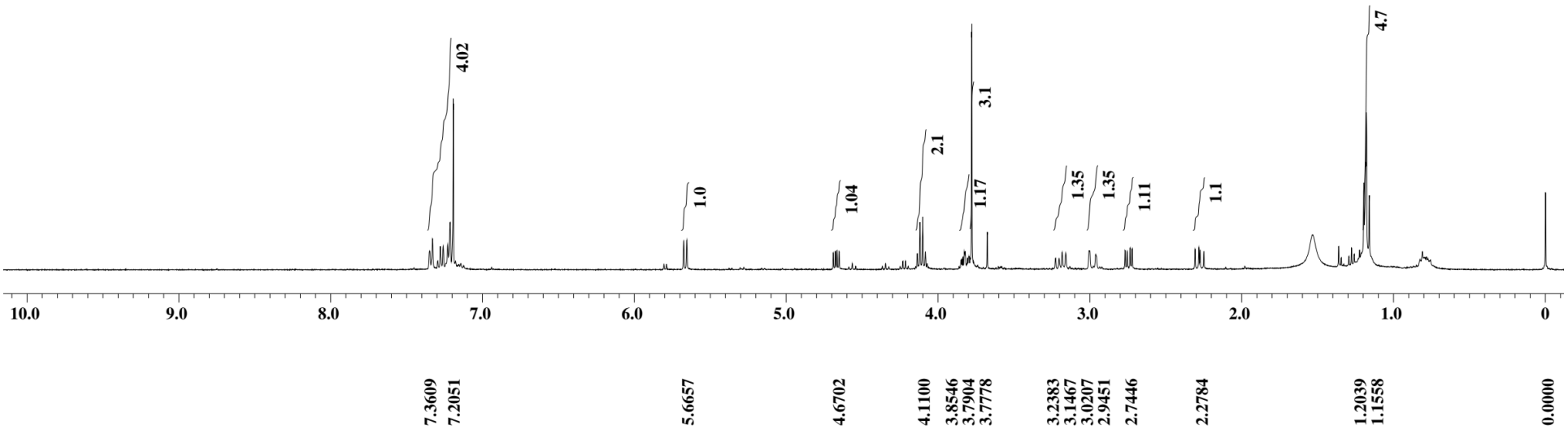


Minimum:				-1.5				
Maximum:		5.0	9.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
336.1419	336.1447	-2.8	-8.3	7.5	1630.9	n/a	n/a	C17 H22 N O6

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

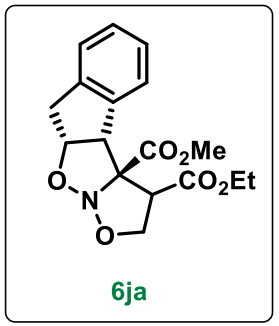


6ja

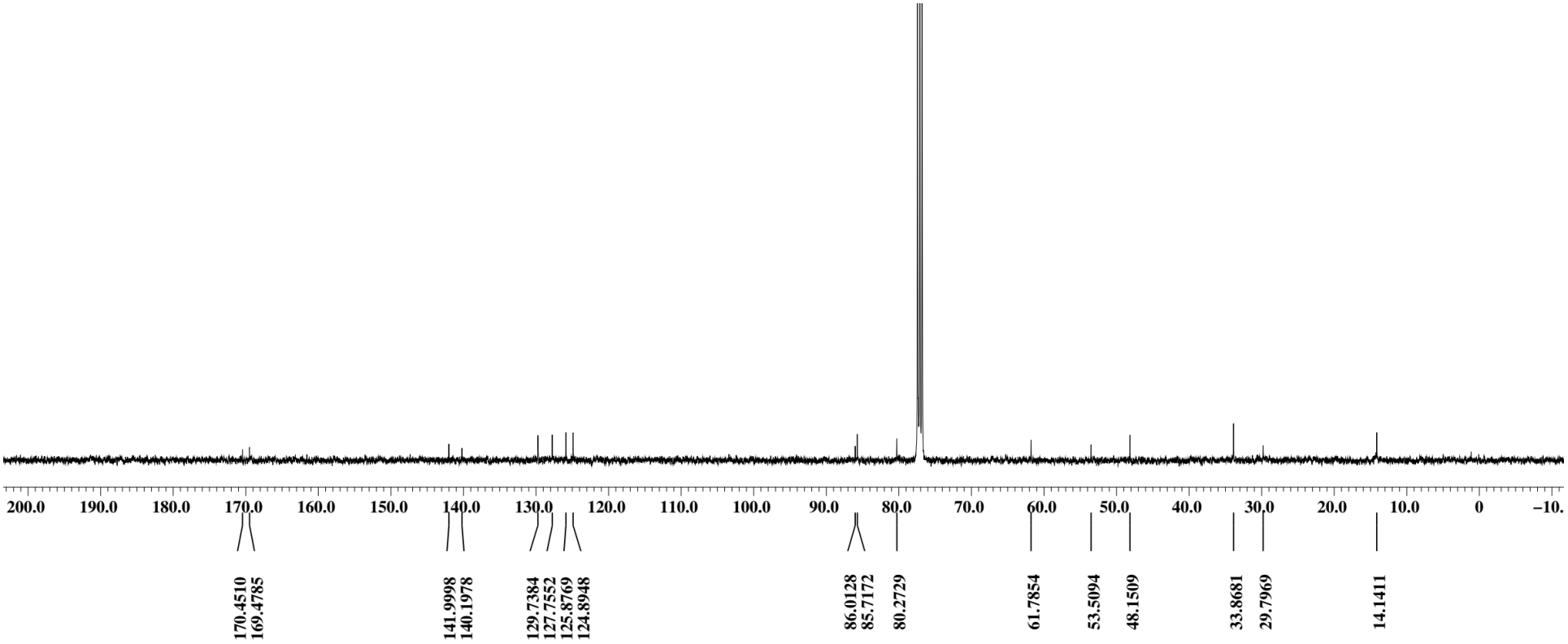


7.3609 7.2051 5.6657 4.6702 4.1100 3.8546 3.7904 3.7778 3.2383 3.1467 3.0207 2.9451 2.7446 2.2784 1.2039 1.1558 0.0000

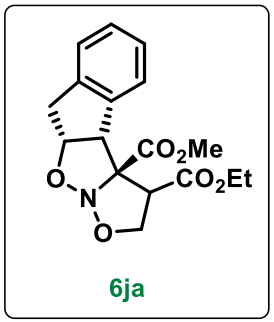
^{13}C-NMR ($CDCl_3$, 100 MHz)



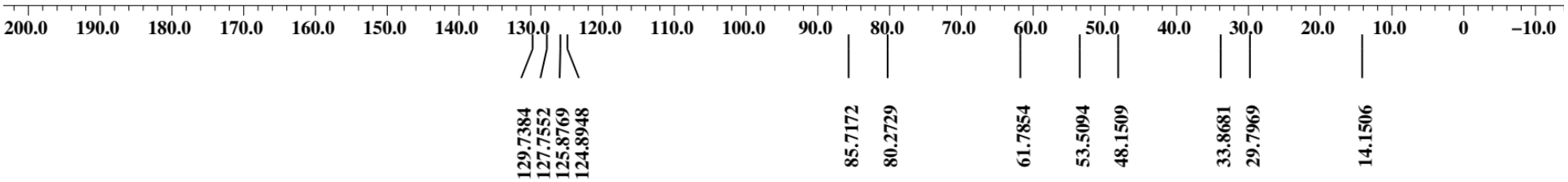
6ja



^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)

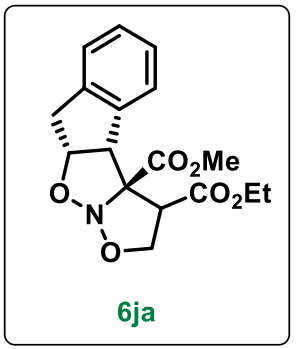


6ja



129.7384
127.7552
125.8769
124.8948
85.7172
80.2729
61.7854
53.5094
48.1509
33.8681
29.7969
14.1506

HRMS



6ja

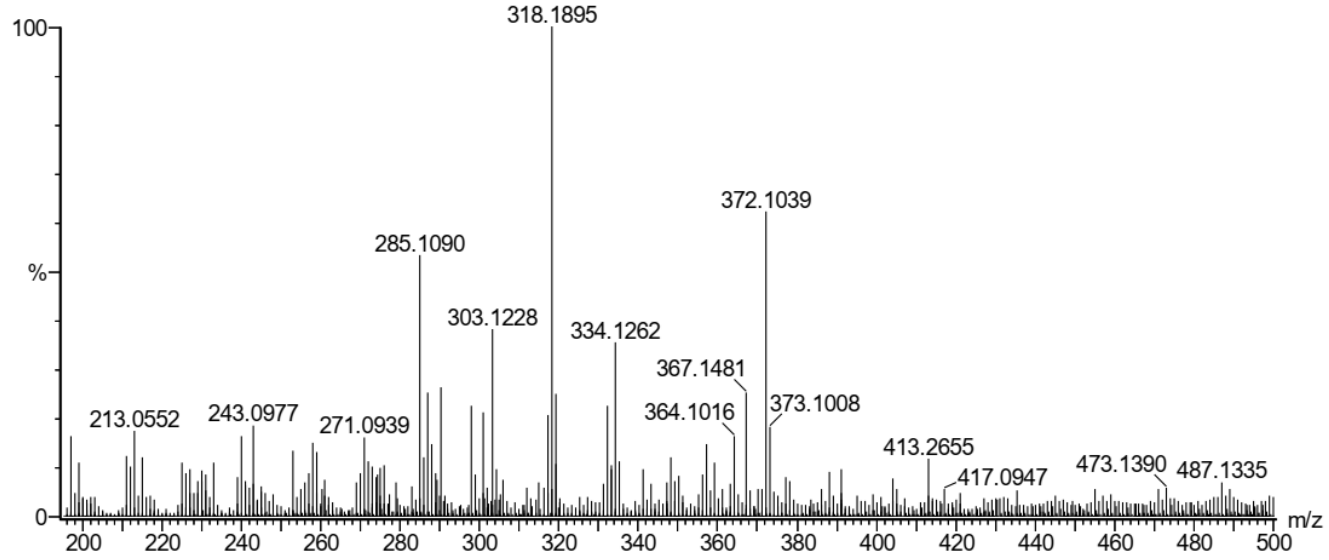
Elemental Composition Report

Single Mass Analysis

Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 6

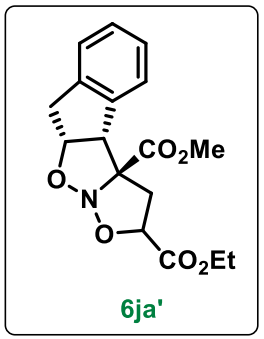
Monoisotopic Mass, Even Electron Ions
19 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 15-25 H: 17-25 N: 1-2 O: 0-6 Se: 0-1

Sample Name : 17-02-6ja IITRPR UPLC-XEVOG2XSQTOF
Test Name : HRMS-1
191020-17-02-6ja 12 (0.131) 1: TOF MS ES+
2.88e+007

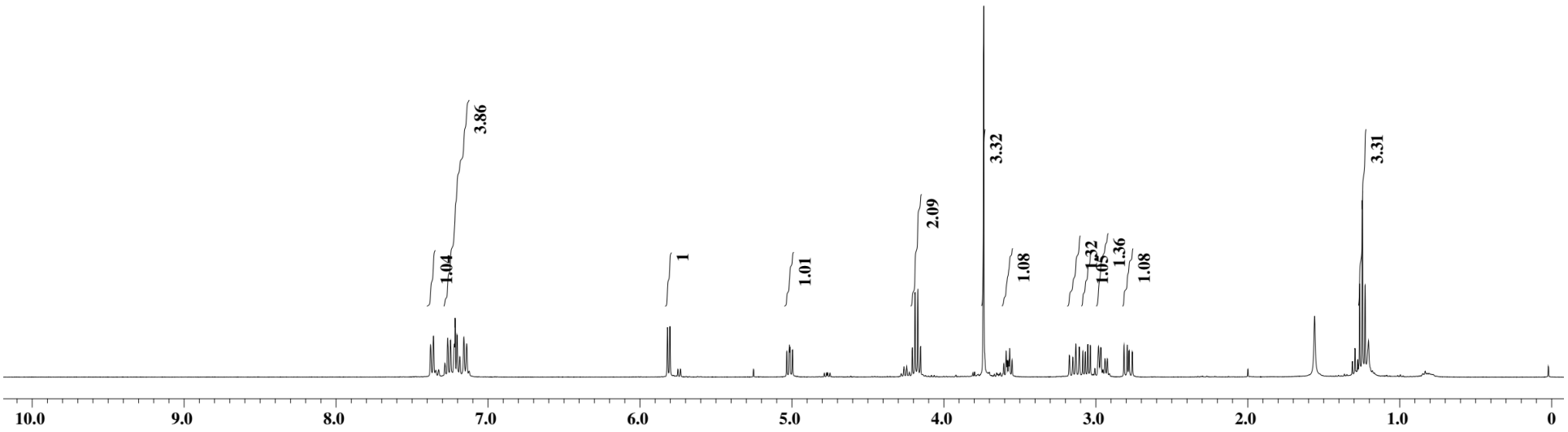


Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
334.1262	334.1291	-2.9	-8.7	8.5	1618.7	n/a	n/a	C17 H20 N O6

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

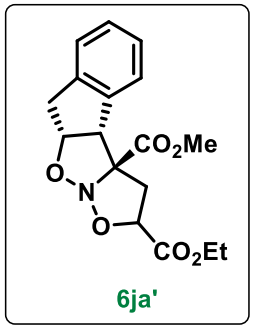


6ja'

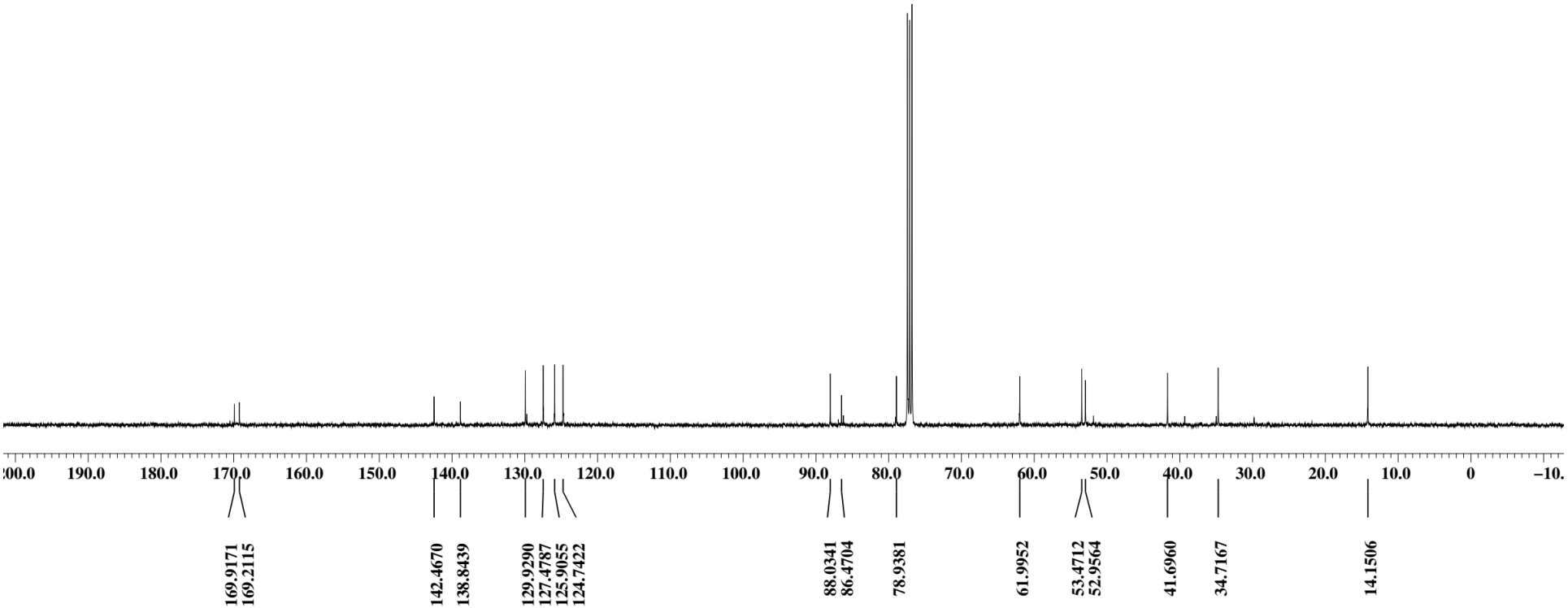


7.3978
7.3520
7.2890
7.1183
5.8101
5.0152
4.1801
3.7380
3.6188
3.5455
3.1870
3.0988
3.0919
3.0312
2.9922
2.9166
2.7872
1.2442

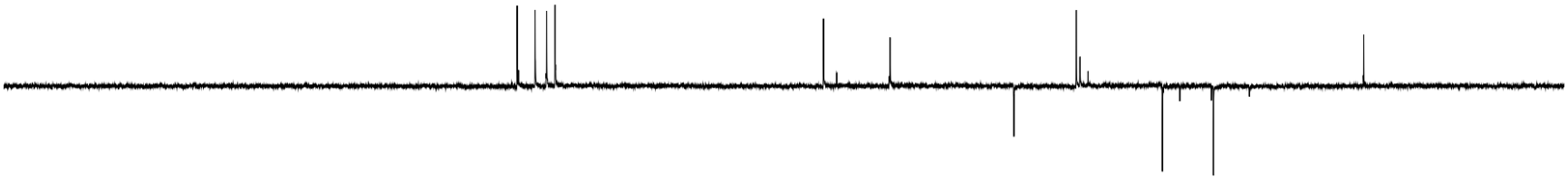
^{13}C-NMR ($CDCl_3$, 100 MHz)

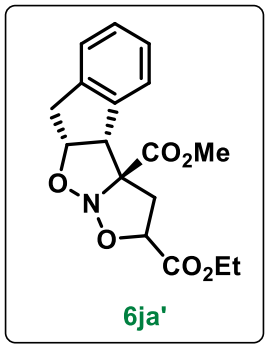


6ja'

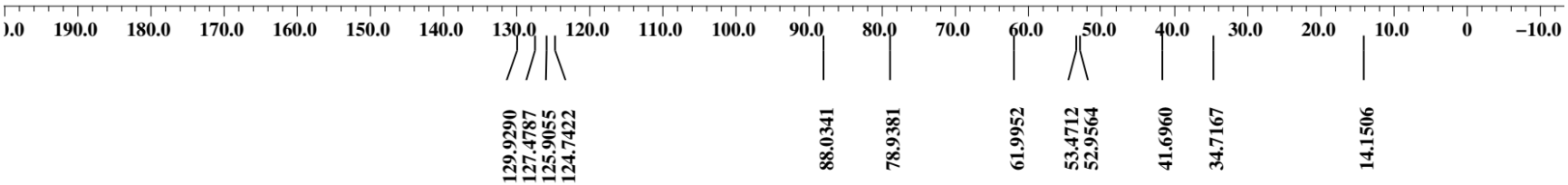


^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)

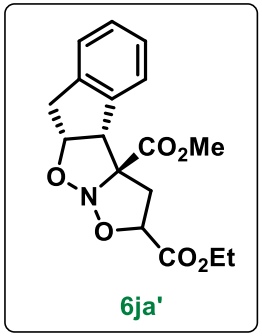




6ja'



HRMS



6ja'

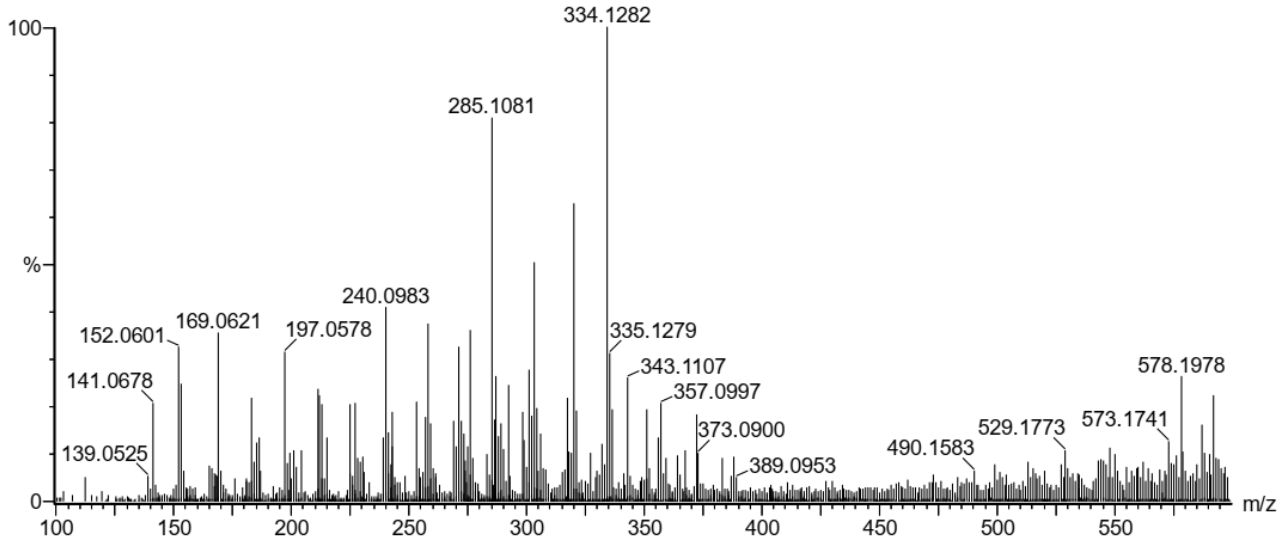
Elemental Composition Report

Single Mass Analysis

Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 6

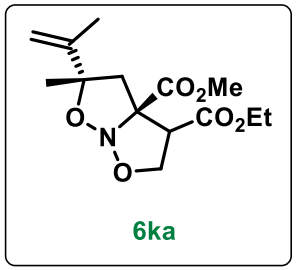
Monoisotopic Mass, Even Electron Ions
82 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 15-25 H: 11-25 N: 1-2 O: 0-6 Se: 0-1 Br: 0-2

Sample Name : 17-02-6JA- IITRPR UPLC-XEVOG2XSQTOF
Test Name : HRMS-1
191020-17-02-6JA- 12 (0.131) 1: TOF MS ES+
5.49e+007

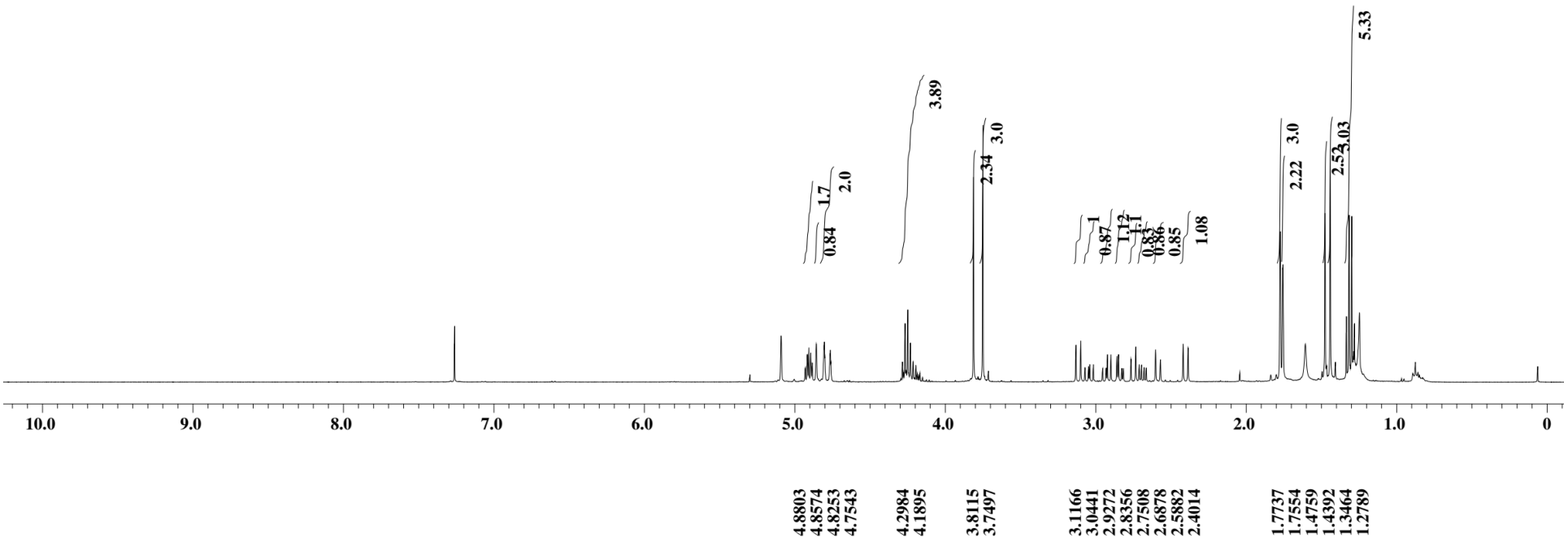


Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
334.1282	334.1291	-0.9	-2.7	8.5	643.9	n/a	n/a	C17 H20 N O6

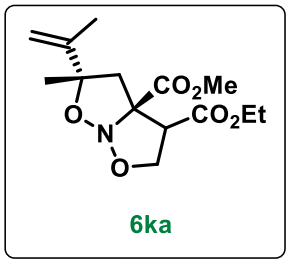
^{1}H-NMR ($CDCl_3$, 400 MHz)



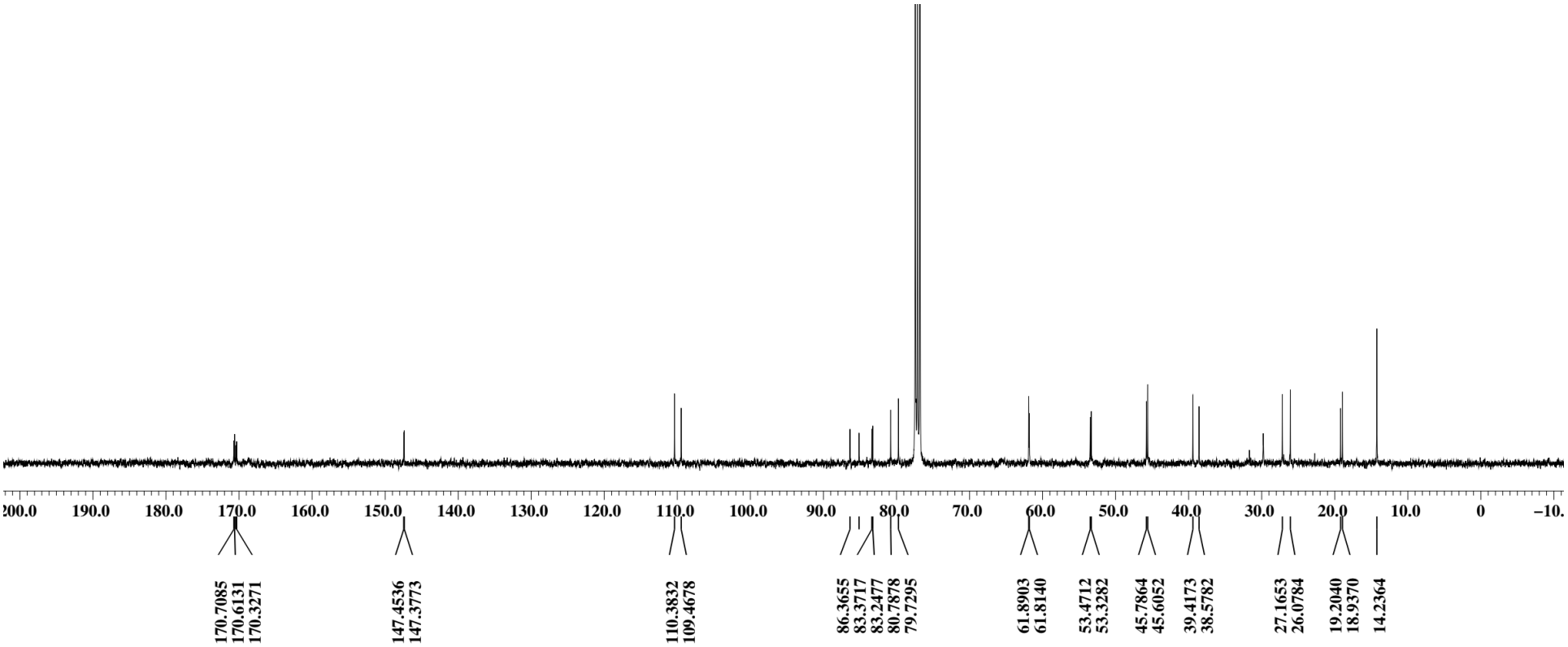
6ka



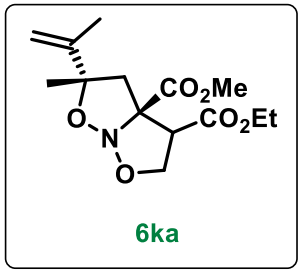
^{13}C-NMR ($CDCl_3$, 100 MHz)



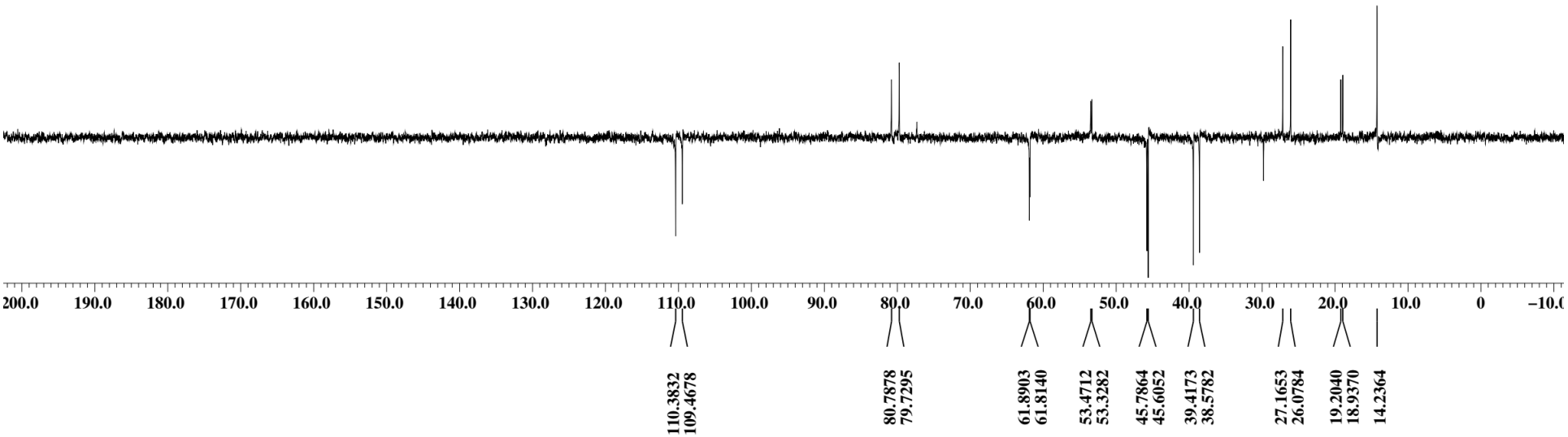
6ka



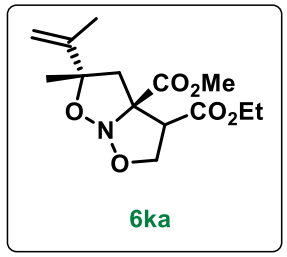
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



6ka



HRMS



6ka

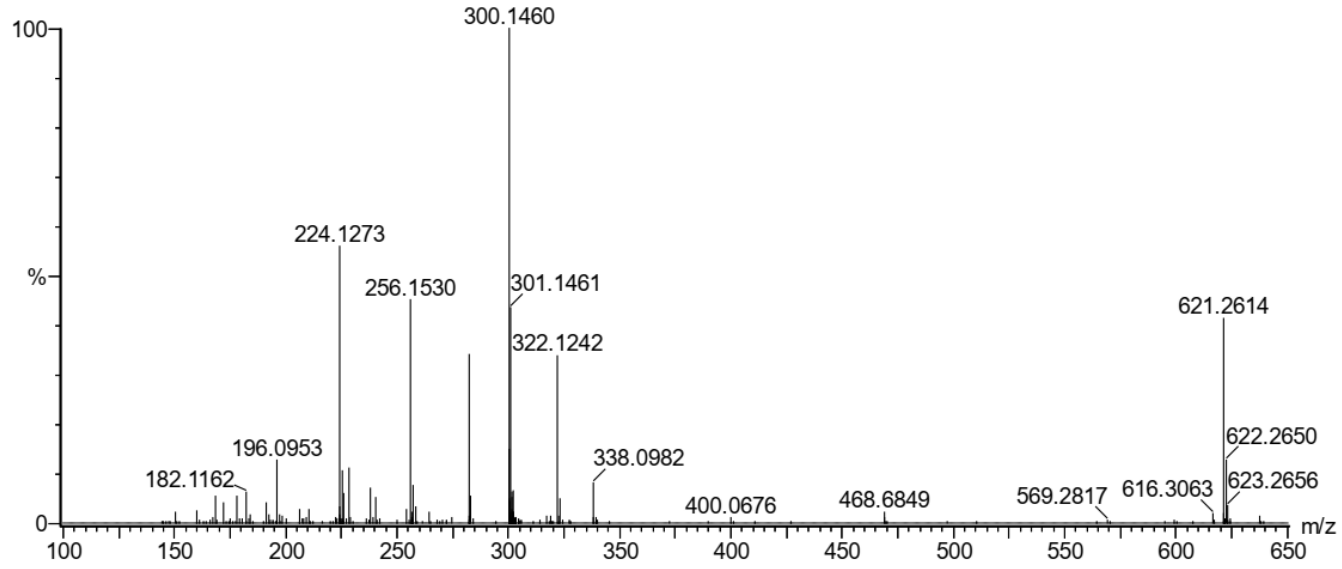
Elemental Composition Report

Single Mass Analysis

Tolerance = 9.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 5

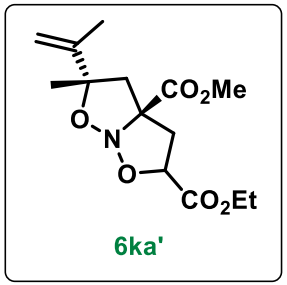
Monoisotopic Mass, Even Electron Ions
86 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-25 H: 10-30 N: 0-2 O: 0-8 Na: 0-1

Sample Name : 17-02-14-A IITRPR XEVO G2-XS QTOF
Test Name : HRMS-1
140220-17-02-14-A 17 (0.174) 1: TOF MS ES+
5.41e+007

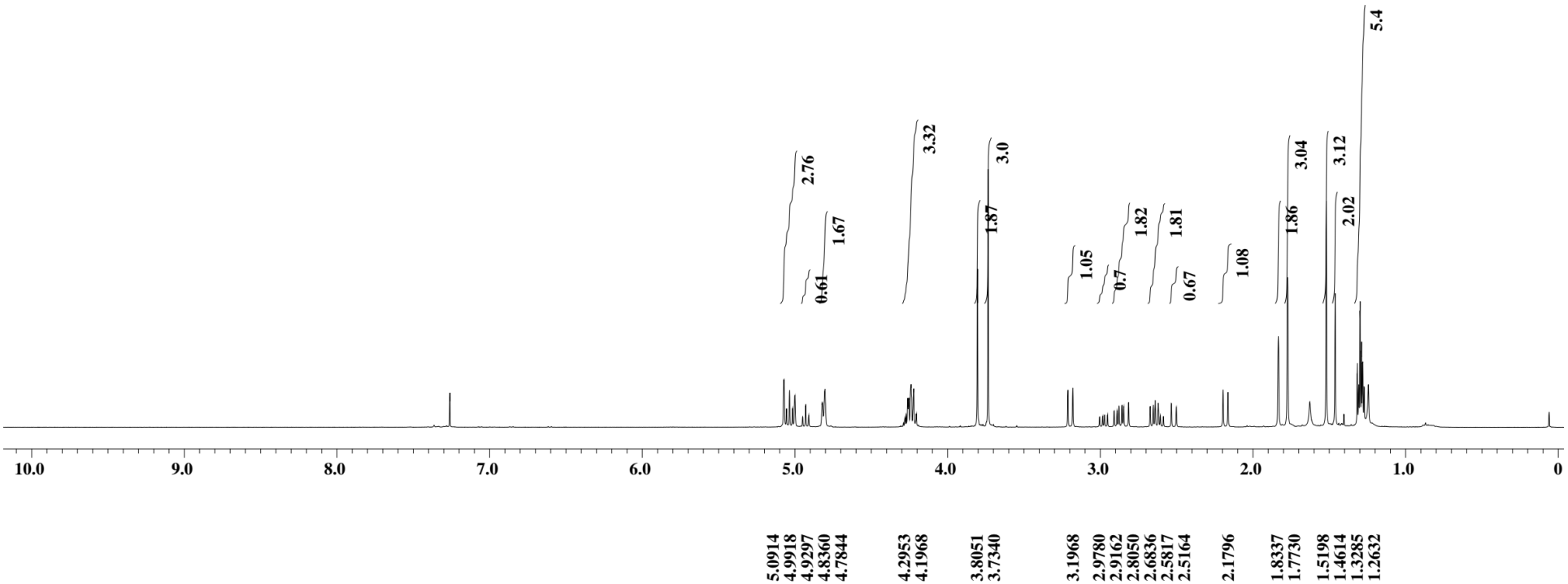


Minimum:				-1.5				
Maximum:		5.0	9.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
300.1460	300.1447	1.3	4.3	4.5	1990.8	n/a	n/a	C14 H22 N O6

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

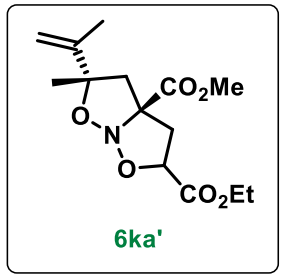


6ka'

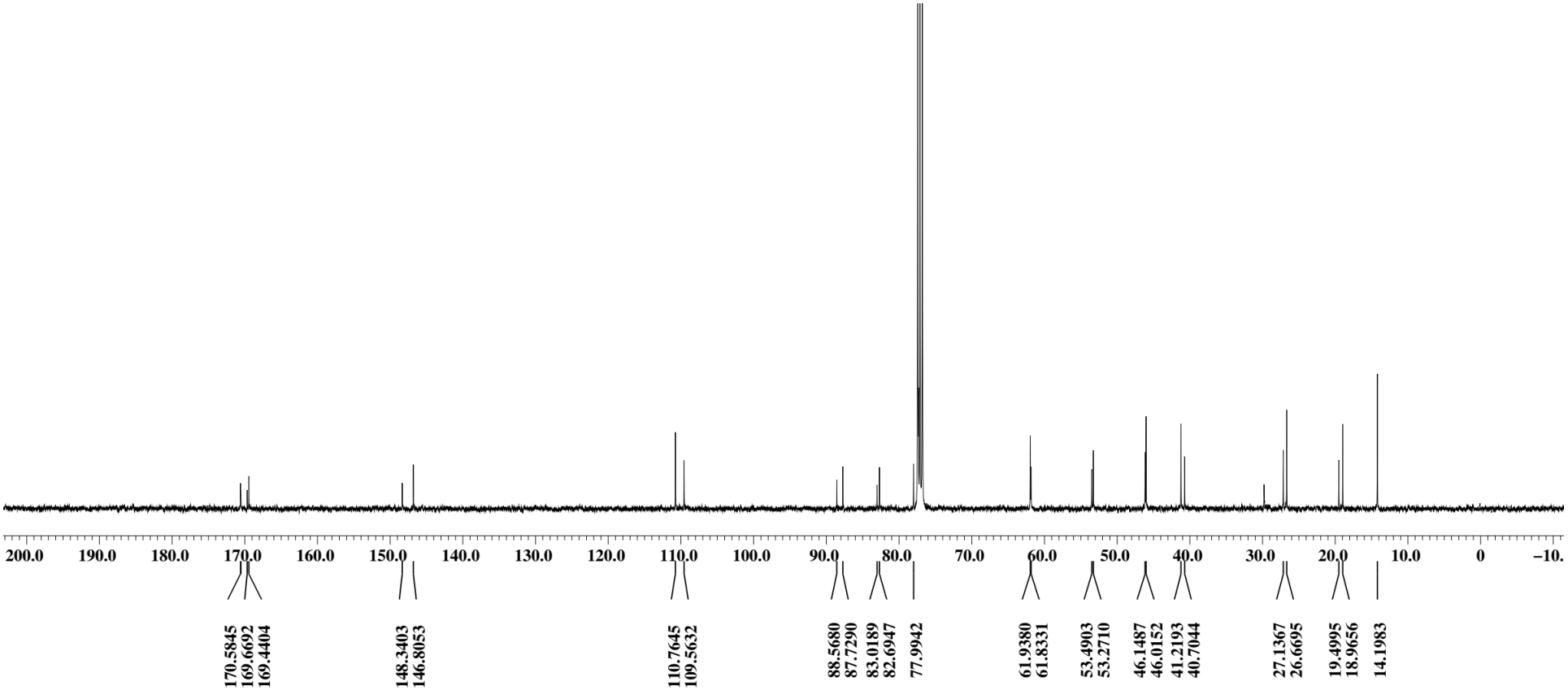


5.0914 4.9918 4.9297 4.8360 4.7844 4.2953 4.1968 3.8051 3.7340 3.1968 2.9780 2.9162 2.8050 2.6836 2.5817 2.5164 2.1796 1.8337 1.7730 1.5198 1.4614 1.3285 1.2632

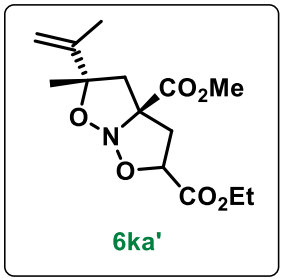
^{13}C-NMR ($CDCl_3$, 100 MHz)



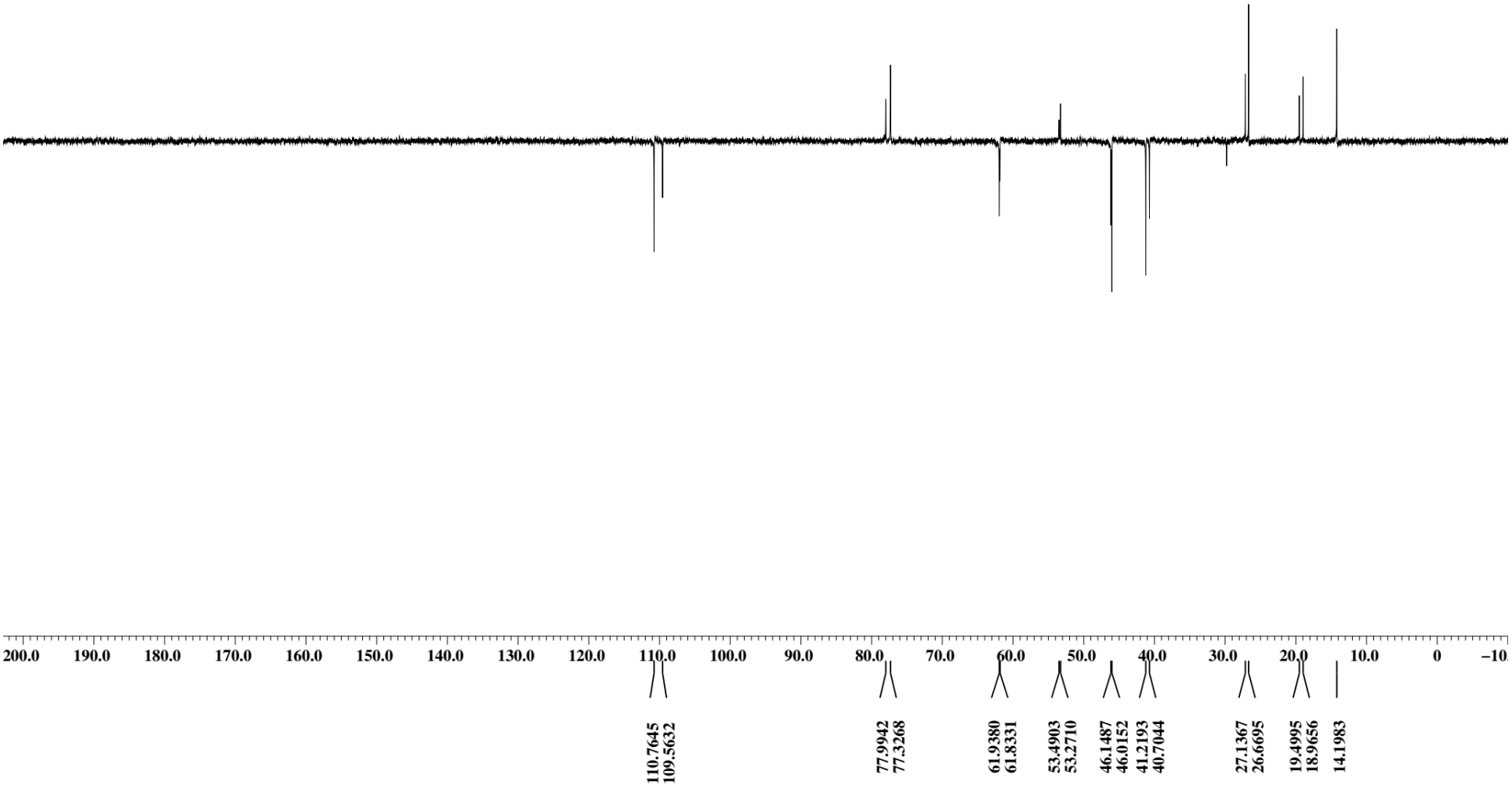
6ka'



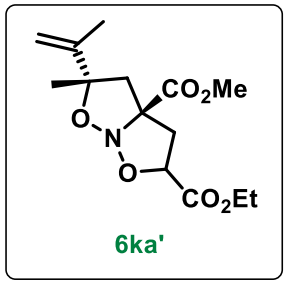
^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



6ka'



HRMS



6ka'

Elemental Composition Report

Single Mass Analysis

Tolerance = 5.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 5

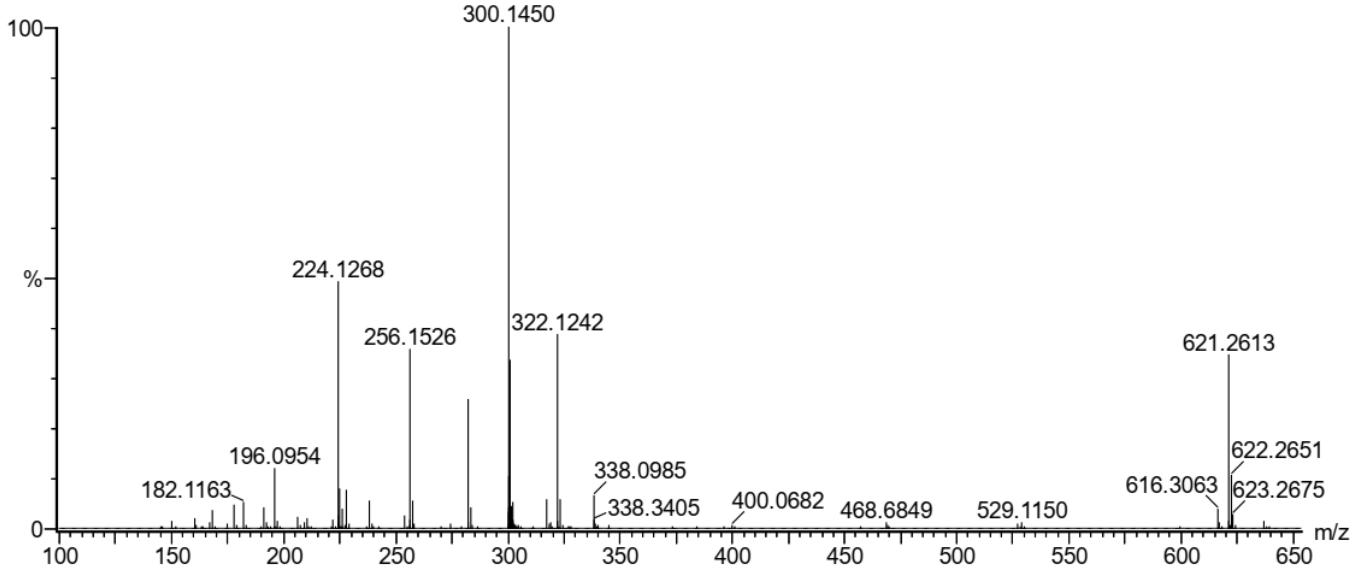
Monoisotopic Mass, Even Electron Ions
86 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 11-25 H: 10-30 N: 0-2 O: 0-8 Na: 0-1

Sample Name : 17-02-14-B
Test Name : HRMS-1
140220-17-02-14-B 17 (0.174)

IITRPR

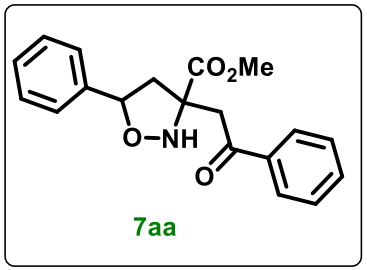
XEVO G2-XS QTOF

1: TOF MS ES+
4.27e+007

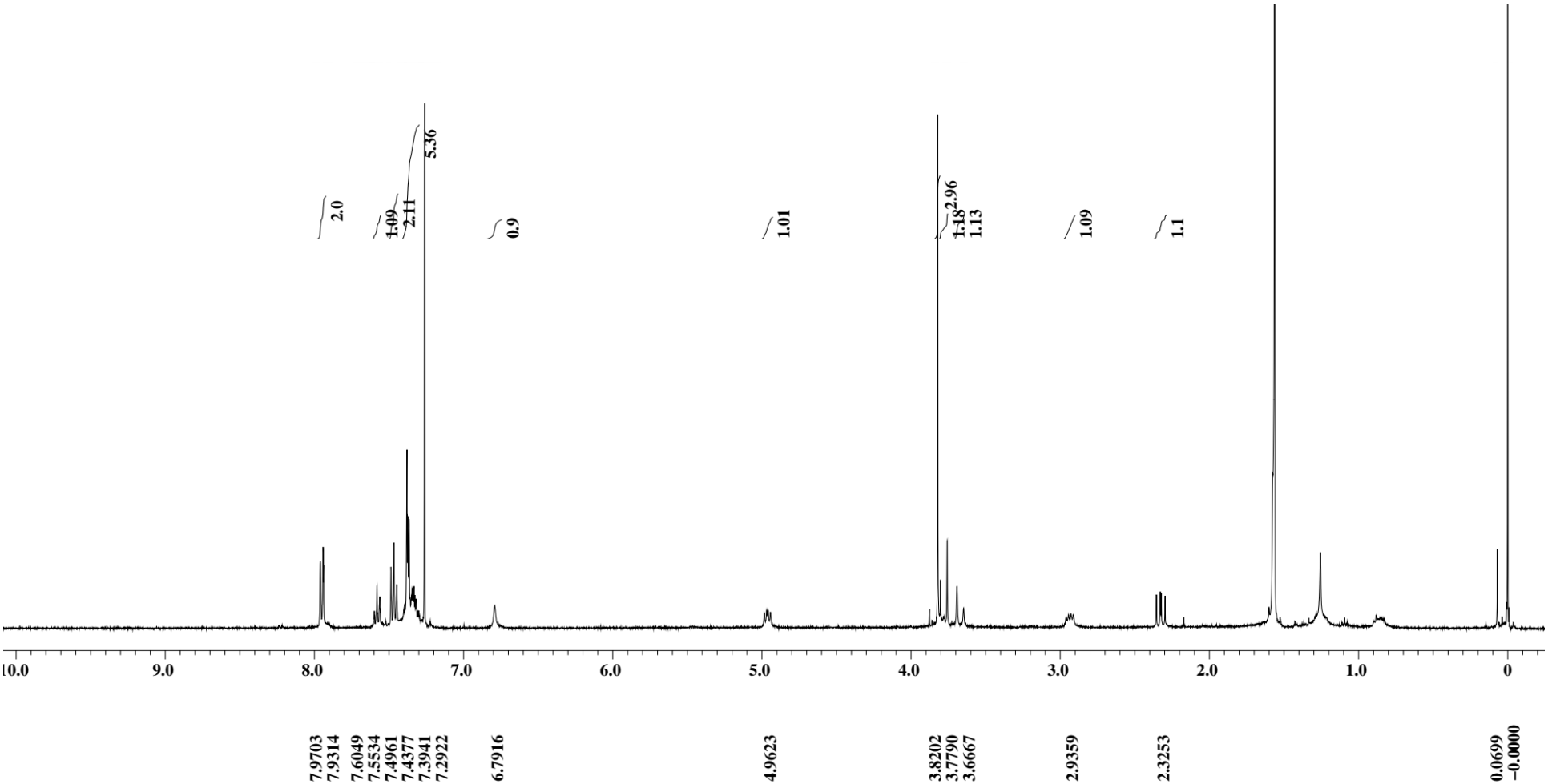


Minimum:				-1.5				
Maximum:		5.0	5.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
300.1450	300.1447	0.3	1.0	4.5	1836.8	n/a	n/a	C14 H22 N O6

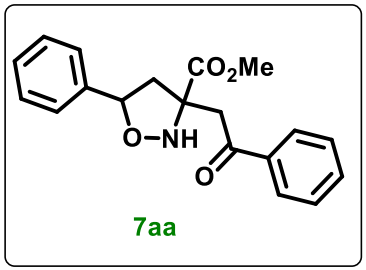
^{1}H-NMR ($CDCl_3$, 400 MHz)



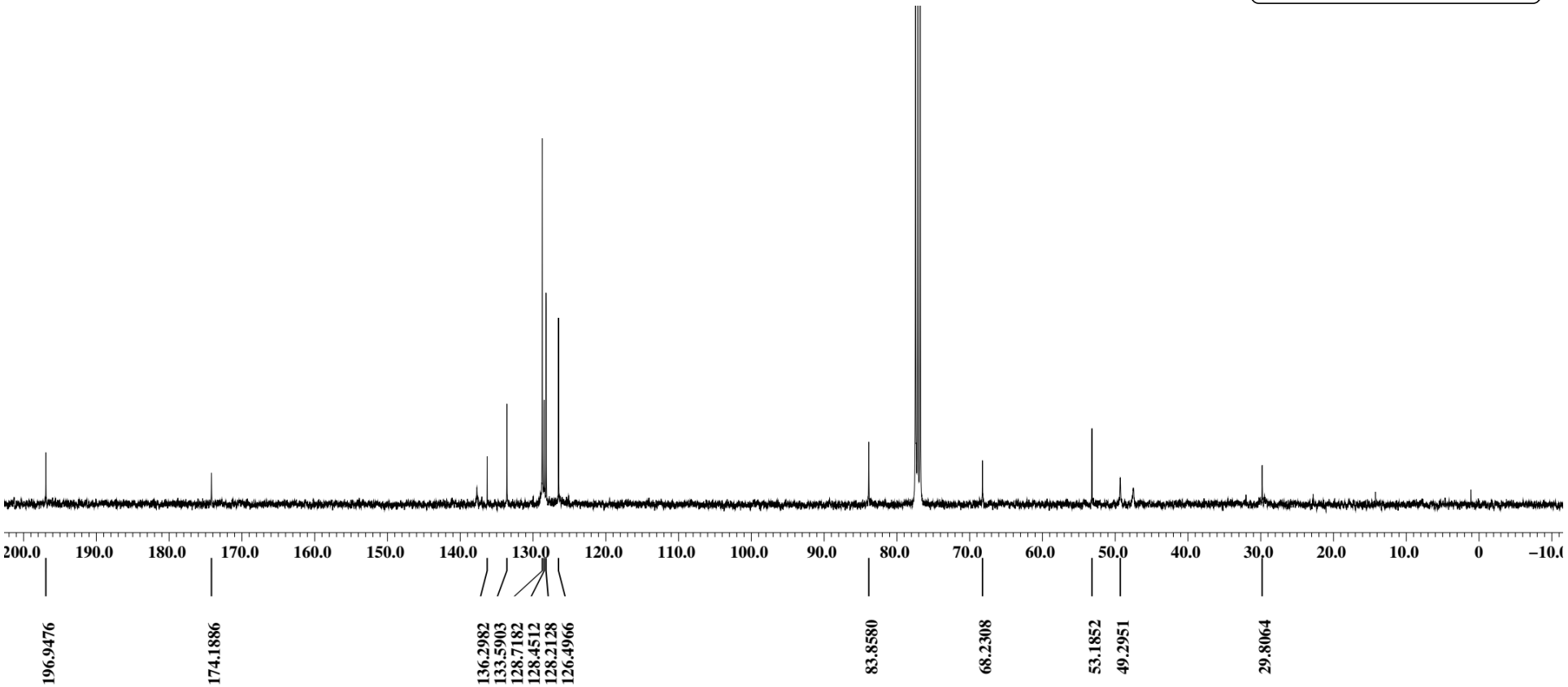
7aa



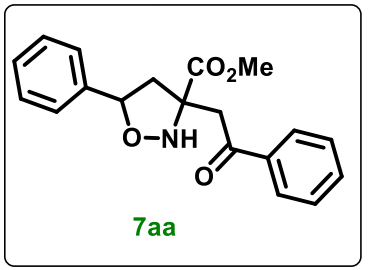
^{13}C-NMR ($CDCl_3$, 100 MHz)



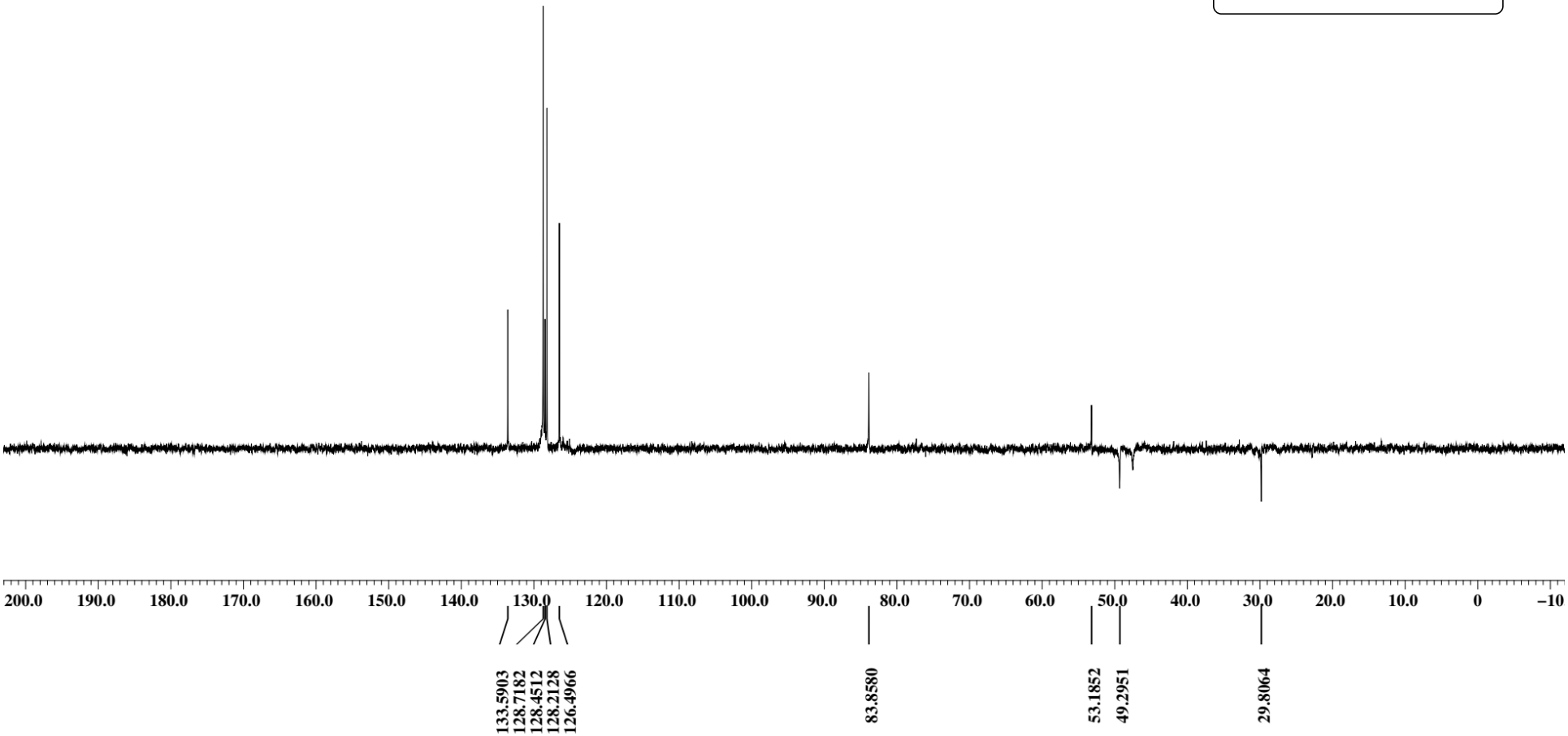
7aa



^{13}C DEPT-NMR ($CDCl_3$, 100 MHz)



7aa



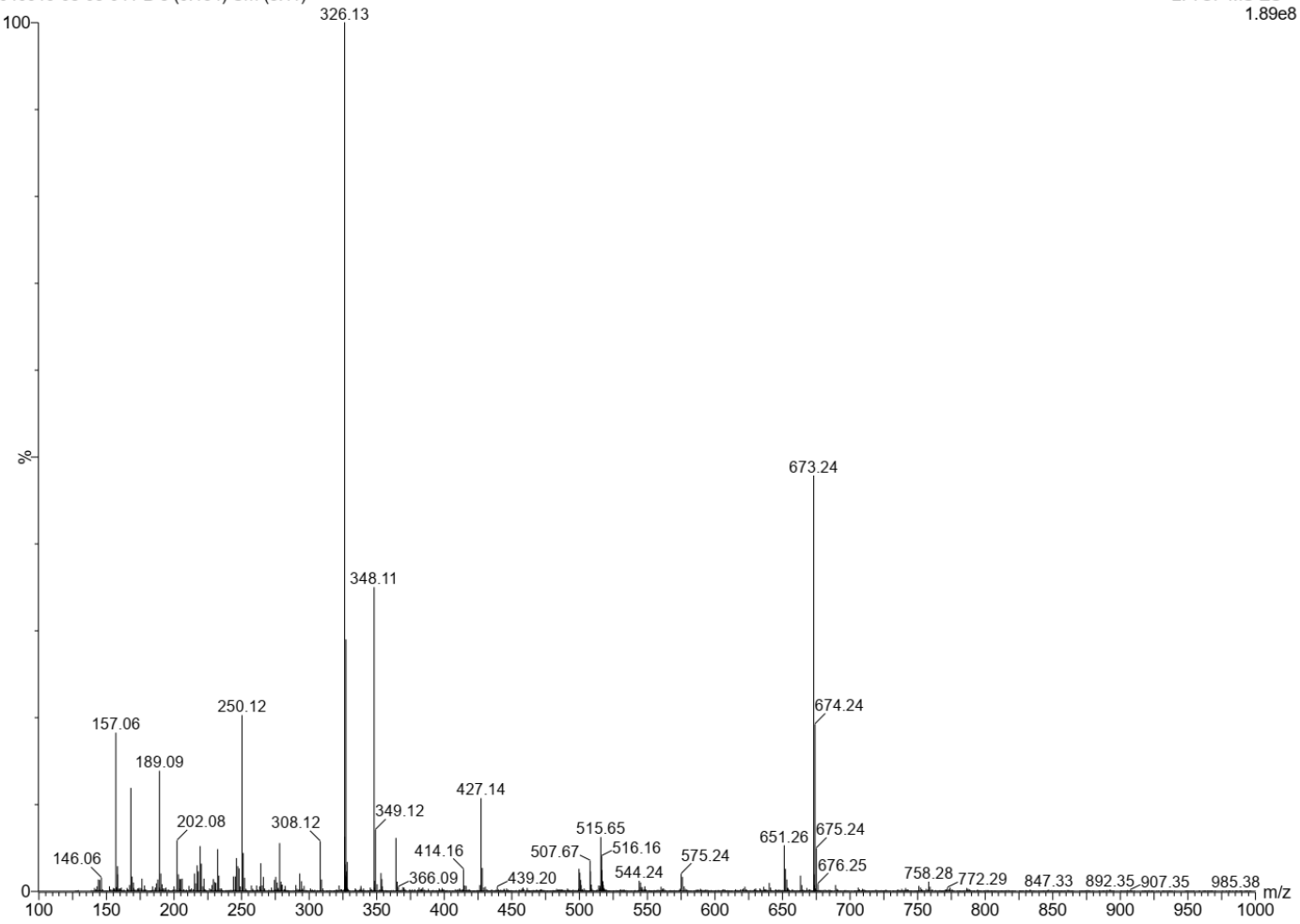
ESI-MS

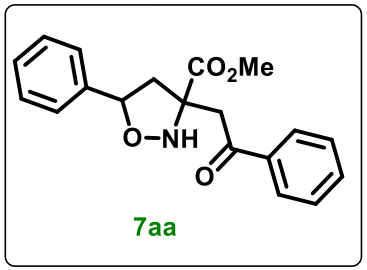
Sample Name : 08-05-041-B
Test Name : D MASS-1
040919-08-05-041-B 8 (0.154) Cm (8:11)

IITRPR

XEVO G2-XS QTOF

2: TOF MS ES+
1.89e8





7aa

8. Single crystal X-ray data of 2a and 4aa

For the determination of X-ray crystal structures of **2a** and **4aa** a single crystal was selected and mounted with paratone oil on a glass fiber using gum. The data was collected at 298K on a CMOS based Bruker D8 Venture PHOTON 100 diffractometer equipped with INCOATEC micro-focus source with graphite monochromatic Mo Kα radiation (λ = 0.71073 Å) operation at 50 kV and 30 mA. For the integration of diffraction profiles SAINT program[3] was used. Absorption correction was done applying SADABS program. [4] The crystal structure was solved by SIR 92[5] and refined by full matrix least square method using SHELXL-97[6] WinGX system, Ver 1.70.01. [7] All the non-hydrogen atoms in the structure were located the Fourier map and refined anisotropically. The hydrogen atoms were fixed by HFIX in their ideal positions and refined using riding model with isotropic thermal parameters. The crystal structure (excluding structure factor) has been deposited to Cambridge Crystallographic Data Centre and allocated deposition number**: 2a: CCDC 2003588** and **4aa: CCDC 1941859**. [8]

Sample preparation: Solvent used: Mixture of HPLC grade Isopropanol (IPA) and Hexane (3:7);

Method used: Recrystallization using solvent evaporation technique (slow evaporation at room temperature).

9. X-ray data of 2a

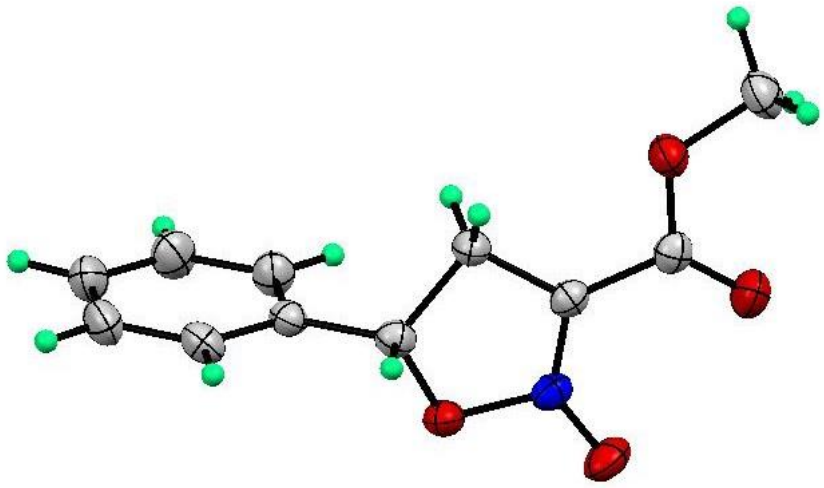


Figure S1. X-ray crystal structure of compound **2a** with 50% probability level.

CCDC No.	2003588
Formula	$C_{11}H_{11}NO_4$
Formula weight	221.21
Crystal System	Monoclinic

Space group	P21/c
a, b, c (Å)	11.2819(7) 8.8634(5) 10.5907(6)
α, β, γ (°)	90 93.721(2) 90
V ($Å^3$)	1056.80(11)
Z	4
Calculated Density (g/cm^3)	1.390
Absorption coefficient (mm^{-1})	0.107
F(000)	464
Temperature (K)	298
Crystal Size (mm^3)	0.22 x 0.26 x 0.34
Theta range for data collection:	2.9 to 28.4
λ (Mo K_α)(Å)	0.71073
Total data	27564
Unique data	2626
R(int)	0.026
data [I > 2σ(I)]	2150
R indices (all data)	R = 0.0405, wR_2 = 0.1168,
S	1.05

Table S1: Selected bond lengths [Å] of **2a**

Atoms	**Bond lengths [Å]**	**Atoms**	**Bond lengths [Å]**
O1-C1	1.448(2)	C8-C9	1.379(2)
O1-C2	1.3318(17)	C9-C10	1.367(2)
O2-C2	1.2016(17)	C10-C11	1.390(2)
O3-N1	1.2301(15)	C1-H1A	1.05(2)
O4-N1	1.4292(14)	C1-H1B	0.93(3)
O4-C5	1.4696(16)	C1-H1C	0.92(2)
N1-C3	1.3053(16)	C4-H4A	0.982(17)
C2-C3	1.4617(18)	C4-H4B	0.958(16)
C3-C4	1.4840(18)	C5-H5	0.963(14)
C4-C5	1.5293(18)	C7-H7	0.972(17)
C5-C6	1.5023(17)	C8-H8	0.94(2)
C6-C7	1.3894(19)	C9-H9	0.985(18)
C6-C11	1.3827(19)	C10-H10	0.94(2)

C7-C8	1.386(2)	C11-H11	0.936(17)

Table S2: Selected bond angles [°] of **2a**

Atoms	Bond angles[°]	Atoms	Bond angles[°]
C1-O1-C2	116.47(11)	O1-C1-H1B	111.3(14)
N1-O4-C5	105.87(9)	O1-C1-H1C	109.3(14)
O3-N1-O4	114.45(10)	H1A-C1-H1B	113.8(19)
O3-N1-C3	133.72(11)	H1A-C1-H1C	107(2)
O4-N1-C3	111.77(10)	H1B-C1-H1C	111(2)
O1-C2-O2	124.81(12)	C3-C4-H4A	111.7(9)
O1-C2-C3	108.55(11)	C3-C4-H4B	109.7(9)
O2-C2-C3	126.63(12)	C5-C4-H4A	111.4(9)
N1-C3-C2	120.79(11)	C5-C4-H4B	111.4(9)
N1-C3-C4	111.13(11)	H4A-C4-H4B	110.3(13)
C2-C3-C4	127.80(11)	O4-C5-H5	106.3(9)
C3-C4-C5	102.08(10)	C4-C5-H5	111.2(8)
O4-C5-C4	104.48(10)	C6-C5-H5	109.9(8)
O4-C5-C6	108.08(10)	C6-C7-H7	120.2(10)
C4-C5-C6	116.30(10)	C8-C7-H7	119.9(10)
C5-C6-C7	120.99(11)	C7-C8-H8	119.8(12)
C5-C6-C11	119.79(11)	C9-C8-H8	119.9(12)
C7-C6-C11	119.22(12)	C8-C9-H9	119.3(11)
C6-C7-C8	119.93(14)	C10-C9-H9	120.5(10)
C7-C8-C9	120.22(15)	C9-C10-H10	121.1(14)
C8-C9-C10	120.17(15)	C11-C10-H10	118.8(14)
C9-C10-C11	120.06(15)	C6-C11-H11	119.3(10)
C6-C11-C10	120.39(13)	C10-C11-H11	120.3(10)
O1-C1-H1A	104.1(13)		

10. X-ray data of 4aa

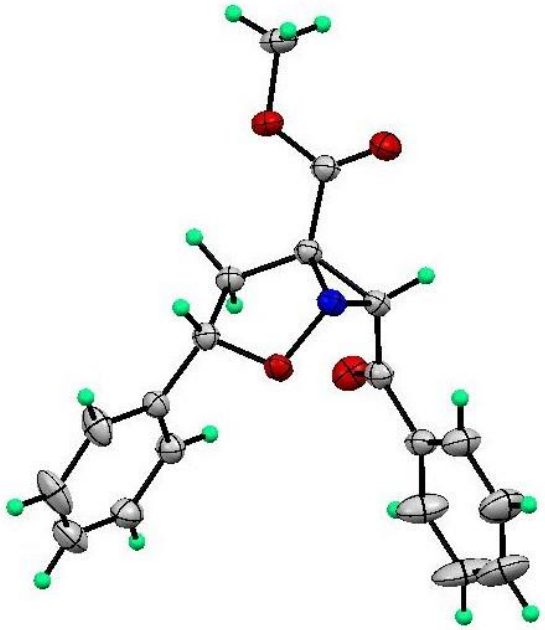


Figure S2. X-ray crystal structure of compound **4aa** with 50% probability level.

CCDC No.	CCDC 1941859
Formula	$C_{19}H_{17}NO_4$
Formula weight	323.33
Crystal System	monoclinic
Space group	P21/n
a, b, c (Å)	8.752(5) 15.203(5) 12.876(5)
α, β, γ (°)	90 105.763(5) 90
V ($Å^3$)	1648.8(13)
Z	4
Calculated Density (g/cm^3)	1.303
Absorption coefficient (mm^{-1})	0.092
F(000)	680
Temperature (K)	298
Crystal Size (mm^3)	0.17 x 0.27 x 0.32
Theta range for data collection:	2.9 to 29.1
λ (Mo $K_α$)(Å)	0.71073
Total data	16629
Unique data	4357
R(int)	0.052
data [I > 2σ(I)]	3048

R indices (all data)	R = 0.0584, wR_2 = 0.1355
S	1.10

Table S3: Selected bond lengths [Å] of **4aa**

Atoms	Bond lengths [Å]	Atoms	Bond lengths [Å]
O(1)-C(8)	1.322(2)	C(6)-C(10)	1.506(3)
O(1)-C(19)	1.455(3)	C(7)-C(8)	1.503(2)
O(2)-C(8)	1.202(2)	C(7)-C(9)	1.516(3)
O(3)-N(1)	1.460(2)	C(7)-C(11)	1.484(3)
O(3)-C(10)	1.452(2)	C(9)-C(10)	1.525(3)
O(4)-C(12)	1.217(2)	C(11)-C(12)	1.505(3)
N(1)-C(7)	1.526(2)	C(12)-C(13)	1.480(3)
N(1)-C(11)	1.490(3)	C(13)-C(14)	1.371(3)
C(1)-C(2)	1.390(4)	C(13)-C(18)	1.373(3)
C(1)-C(6)	1.379(3)	C(14)-C(15)	1.387(4)
C(2)-C(4)	1.369(4)	C(15)-C(16)	1.359(6
C(3)-C(4)	1.361(4)	C(16)-C(17)	1.346(4)
C(3)-C(5)	1.380(3)	C(17)-C(18)	1.379(4)
C(5)-C(6)	1.387(3)		

Table S4: Selected bond angles [°] of **4aa**

Atoms	Bond angles[°]	Atoms	Bond angles[°]
C(8)-O(1)-C(19)	116.28(16)	O(1)-C(8)-C(7)	112.14(15)
N(1)-O(3)-C(10)	106.32(11)	O(2)-C(8)-C(7)	123.16(16)
O(3)-N(1)-C(7)	102.77(12)	C(7)-C(9)-C(10)	102.72(14)
O(3)-N(1)-C(11)	105.53(12)	O(3)-C(10)-C(6)	106.51(13)
C(7)-N(1)-C(11)	58.92(11)	O(3)-C(10)-C(9)	103.67(14)
C(2)-C(1)-C(6)	120.2(2)	C(6)-C(10)-C(9)	119.05(15)
C(1)-C(2)-C(4)	120.5(2)	N(1)-C(11)-C(7)	61.77(11)
C(1)-C(6)-C(10)	120.4(2)	N(1)-C(11)-C(12)	120.40(14)
C(2)-C(4)-C(3)	119.7(2)	C(7)-C(11)-C(12)	122.92(16)
C(3)-C(5)-C(6)	120.86(19)	O(4)-C(12)-C(11)	119.76(16)
C(1)-C(6)-C(5)	118.38(17)	C(4)-C(12)-C(13)	122.19(16)
C(1)-C(6)-C(10)	119.59(17)	C(11)-C(12)-C(13)	117.95(16)

C(5)-C(6)-C(10)	121.93(16)	C(12)-C(13)-C(14)	118.3(2)
N(1)-C(7)-C(8)	111.47(14)	C(12)-C(13)-C(18)	118.3(2)
N(1)-C(7)-C(9)	107.76(13)	C(14)-C(13)-C(18)	118.7(2)
N(1)-C(7)-C(11)	59.31(11)	C(13)-C(14)-C(15)	119.9(3)
C(8)-C(7)-C(9)	122.37(14)	C(14)-C(15)-C(16)	120.7(3)
C(8)-C(7)-C(11)	115.37(14)	C(15)-C(16)-C(17)	119.4(3)
C(9)-C(7)-C(11)	120.58(14)	C(16)-C(17)-C(18)	120.9(3)
O(1)-C(8)-O(2)	120.58(14)	C(13)-C(18)-C(17)	120.4(2)

11. References

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[8] CCDC 2003588 and CCDC 1941859 contains supplementary crystallographic data for the compounds **2a** and **4aa** respectively.