Supporting Information

Flow Synthesis of Ethyl Isocyanoacetate Enabling the Telescoped Synthesis of 1,2,4-Triazoles and Pyrrolo[1,2-*c*]pyrimidines

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1. Materials and methods:

Unless otherwise stated, all solvents were purchased from Fisher Scientific and used without further purification. Substrates and reagents were purchased from Alfa Aesar or Sigma Aldrich and used as received.

^{1}H-NMR spectra were recorded on either Bruker Avance-400, Varian VNMRS-600 or Varian VNMRS-700 instruments and are reported relative to residual solvent: $CHCl_3$ (δ 7.26 ppm) or DMSO (δ 2.50 ppm). ^{13}C-NMR spectra were recorded on the same instruments and are reported relative to $CHCl_3$ (δ 77.16 ppm) or DMSO (δ 39.52 ppm). Data for ^{1}H-NMR are reported as follows: chemical shift (δ/ ppm) (integration, multiplicity, coupling constant (Hz)). Multiplicities are reported as follows: s = singlet, d = doublet, t = triplet, q = quartet, p = pentet, m = multiplet, br. s = broad singlet, app = apparent. Data for ^{13}C-NMR are reported in terms of chemical shift (δ/ ppm) and multiplicity (C, CH, CH_2 or CH_3). Data for ^{19}F-NMR were recorded on the above instruments at a frequency of 376 MHz using $CFCl_3$ as external standard. DEPT-135, COSY, HSQC, HMBC and NOESY experiments were used in the structural assignment. IR spectra were obtained by use of a Perkin Elmer RX1 spectrometer (neat, ATR sampling) with the intensities of the characteristic signals being reported as weak (w, <20% of tallest signal), medium (m, 21-70% of tallest signal) or strong (s, >71% of tallest signal). Low and high resolution mass spectrometry was performed using the indicated techniques on either Waters LCT Premier XE or Waters TQD instruments equipped with Acquity UPLC and a lock-mass electrospray ion source. For accurate mass measurements the deviation from the calculated formula is reported in ppm. Melting points were recorded on an Optimelt automated melting point system with a heating rate of 1 °C/min and are uncorrected. HPLC purification was accomplished using a PerkinElmer Series-200 instrument equipped with a Waters XBridge™ preparative C18 column (5 μm, 19x100 mm, 7 mL/min) with a gradient of MeCN/water (start 40:60 to 95/5 over 10 min, remaining at 95/5 for 5 min and returning to 60/40 over 2 min). Single crystal X-ray data were collected at 120.0K on a Bruker SMART 6000 (sealed tube, graphite monochromator) (compounds **7h** and **SI12f'**) and Bruker D8 Venture (Photon 100 CMOS detector, IμS microsource, focusing mirrors) (compounds **12a, 12f** and **12i**) diffractometers (λMoKα, λ=0.71073Å) equipped with Cryostream (Oxford Cryosystems) open flow nitrogen cryostates. The structures were solved by direct methods and refined by full-matrix least squares on F^2 for all data using SHELX [G.M. Sheldrick, *Acta Cryst*. (2008), A64, 112-122] and OLEX2 [O. V. Dolomanov, L. J. Bourhis, R. J. Gildea, J. A. K. Howard and H. Puschmann, *J. Appl. Cryst*. (2009), 42, 339-341] software. All non-hydrogen atoms were refined with anisotropic displacement parameters, the H-atoms in the structures **12a**, **12f** and **12i** were placed in calculated positions and refined in "riding" mode. The H atoms in the other structures were found in the difference Fourier maps and refined isotropically. Crystallographic data and parameters of the refinement are given in **Table 1.** Crystallographic data for the structures have been deposited with the Cambridge Crystallographic Data Centre as supplementary publication CCDC-1039437-1039441.

2. Experimental procedure for the synthesis of ethyl isocyanoacetate 3:

Small scale procedure: A solution containing *N*-formyl glycine ethyl ester (**1**, 1.31 g, 10 mmol), DIPEA (2.62 g, 20 mmol) and DMAP (0.45 g, 3 mmol) in dry DCM (10 mL) was loaded in a sample loop and combined with a second stream containing triphosgene (**2**, 0.98 g, 3.3 mmol) also dissolved in dry DCM (10 mL) at individual channel flow rates of 0.5 mL/min. The combined stream was directed into two linked 10 mL FEP reactor vessels to achieve a 20 minutes residence time at ambient temperature. The output was collect and the solvent was carefully evaporated to 80% of its total volume. The crude material was filtered through silica (5 g) and washed with DCM (2 × 10 mL) to obtain the salt-free product. The desired product **3** was obtained as dark yellow oil after evaporation of the organic phase (1.03 g, 91 % isolated yield, >97% purity by ^{1}H NMR).
In an analogous fashion this procedure was used in order to prepare compound **3** on 100 mmol run scale by using stock solutions of the starting materials and pumping them directly through the HPLC pump head rather than by delivery through the sample loops.

^{1}H NMR (400 MHz, $CDCl_3$) δ 4.28 (2H, q, J = 7.2 Hz), 4.22 (2H, s), 1.32 (3H, t, J = 7.2 Hz). ^{13}C NMR (101 MHz, $CDCl_3$) δ 164.0 (C), 161.4 (C), 62.9 (CH_2), 43.6 (CH_2), 14.2 (CH_3). IR (neat): ν 2984.4 (w), 2162.3 (s), 1748.1 (s), 1424.0 (w), 1373.8 (s), 1204.2 (s), 1097.2 (w), 1028.3 (s), 991.9 (m). This data was consistent with published data [I. Ugi, U. Fetzer, U. Eholzer, H. Knupfer and K. Offermann, *Angew. Chem. Int. Ed.* **1965,** *4*, 472-484].

3. Experimental procedure for the synthesis of 1,2,4-triazoles 7a-h:

Stock solutions of starting materials were prepared as follows:
Solution 1; *N*-formyl glycine ethyl ester (**1**, 6.55 g, 50 mmol, 1 M), DIPEA (13.1 g, 100 mmol) and DMAP (2.25 g, 15 mmol) in dry DCM (50 mL). *Solution 2*; triphosgene (**2**, 4.91 g, 16.5 mmol, 0.165 M) dissolved in dry DCM (50 mL). *Solution 3*; tert-butyl nitrite (**5**, 6.19 g, ~54 mmol; 90% purity, 1.08 M) in MeCN (50 mL). *Solution 5*; Potassium carbonate (43.2 g, 313 mmol, 0.313 M) in water (1000 mL). Variable aniline starting material solution scale up (*Solution 4*); aniline (**4**, 50 mmol) in MeCN (50 mL).

For small scale reactions a Uniqsis FlowSyn with an ALF delivery and automated control system was used to fill sample loops and deriver the reagents from a sample rack to the reactor. For larger scale reactions reagents were pumped directly through the pump heads from stock bottles.

Solutions 1 and 2 were pumped (Vapourtec R2+) at 0.25 ml/min per channel to unite and enter a flow coil (10 mL, Vapourtec FEP, 20 min residence time) maintained at ambient temperature. Simultaneously, solutions 3 and 5 were pumped at 0.25 mL/min per channel (Uniqsis Flowsyn) and combined before entering a flow coil (5 mL, Vapourtec FEP, 10

min residence time) also maintained at ambient temperature. The outputs from these two flow streams were similarly combined to enter a short residence coil (2.5 mL FEP, 2.5 min residence time) and then in succession diluted with an addition stream of pure ethanol (1 mL/min flow rate) followed by an aqueous feed of potassium carbonate (2 mL/min flow rate). A static mixer (316 Stainless Steel - Series 70 Rockingham systems Part No. 070-327) was placed in-line to thoroughly blend the flow stream before it passed into a heated reaction coil (2 x 52 mL polar bear plus units, 26 min residence time) maintained at 75 °C. The total reactor output for was collected and worked up by evaporation of the solvent followed by neutralisation with dilute hydrochloric acid (1 M) and partitioning into ethyl acetate. The products were isolated in high yield and purity after solvent evaporation and trituration of the crude product with a mixture of diethyl ether/ethanol 15:1.

4. Experimental procedure for the functionalisation of 1,2,4-triazole 7h:

Synthesis of ethyl 5-bromo-1-(4-chlorophenyl)-1*H*-1,2,4-triazole-3-carboxylate (8):

To a 50 mL round bottom flask containing dry THF (10 mL) were added **7h** (1.25 g, 5.0 mmol), NBS (4.0 g, 22.5 mmol) and NaH (0.6 g, 15.0 mol, 60% in paraffin oil). The resulting thick suspension was stirred for 10 h at room temperature at which point complete consumption of starting material was indicated by thin layer chromatography. After quenching the reaction mixture by careful addition of saturated ammonium chloride solution and extractive workup (DCM/water, 3x10 mL) the crude reaction product was obtained which was further purified by column chromatography on silica gel (hexane/EtOAc 0-25%) giving the title compound as colourless crystalline solid after removal of solvents under reduced pressure (1.37 g, 83%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (2H, d, *J* = 8.0 Hz), 7.45 (2H, d, *J* = 8.0 Hz), 4.43 (2H, q, *J* = 7.2 Hz), 1.36 (3H, t, *J* = 7.2 Hz). ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.6 (C), 155.7 (C), 136.3 (C), 134.4 (C), 130.3 (C), 129.7 (2CH), 126.7 (2CH), 62.4 (CH_2), 14.2 (CH_3). IR (neat) ν 2987.4 (w), 1724.9 (s), 1485.0 (s), 1428.1 (s), 1341.4 (s), 1217.3 (s), 1089.8 (s), 995.5 (s), 839.0 (s), 685.1 (s), 517.8 (s) cm^{-1}. LC-MS (ESI) 329.9 m/z (M+H). HR-MS (ESI) calculated for $C_{11}H_{10}N_3O_2ClBr$ 329.9645, found 329.9645 (M+H, Δ = 0.0 ppm). Melting range: 107.1-109.6 °C.

Synthesis of Suzuki cross coupling products 9a-9e from 8:

Exemplary procedure for preparing Suzuki product **9e**: In a microwave vial containing dry toluene (2 ml) were combined **8** (165 mg, 0.5 mmol), 3,4-dimethoxyphenyl boronic acid (137 mg, 0.75 mmol), K_2CO_3 (173 mg, 1.25 mmol) and $Pd(PPh_3)_4$ (20 mg, 0.017 mmol). Using a Biotage Initiator microwave this reaction mixture was heated at 120 °C for 10h. After cooling to ambient temperature the reaction mixture was extracted with DCM/water (3x10 mL) yielding the crude product after drying of the combined organic layers over Na_2SO_4, filtration and removal of

the volatiles under reduced pressure. Final purification was accomplished by either silica column chromatography (10-30% EtOAc/hexanes) or HPLC (40/60 MeCN/water to 95/5 MeCN/water) to yield **9e** (white solid, yield 63%). In analogy compounds **9a-9d** were prepared and isolated.

Ethyl 1-(4-chlorophenyl)-5-(4'propoxy-[1,1'-biphenyl]-4-yl)-1*H*-1,2,4-triazole-3-carboxylate 9a: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55-7.58 (4H, m), 7.52 (2H, d, *J* = 8.0 Hz), 7.44 (2H, d, *J* = 8.0 Hz), 7.38 (2H, d, *J* = 8.0 Hz), 6.96 (2H, d, *J* = 8.0 Hz), 4.54 (2H, q, *J* = 7.2 Hz), 3.96 (2H, t, *J* = 8.0 Hz), 1.83 (2H, sextet, *J* = 8.0 Hz), 1.46 (3H, t, *J* = 7.2 Hz), 1.05 (3H, t, *J* = 8.0 Hz). ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.9 (C), 159.4 (C), 155.6 (C), 154.8 (C), 143.1 (C), 136.2 (C), 135.6 (C), 131.7 (C), 129.8 (2CH), 129.5 (2CH), 128.1 (2CH), 126.9 (2CH), 126.7 (2CH), 124.5 (C), 115.0 (2CH), 69.6 (CH_2), 62.2 (CH_2), 22.6 (CH_2), 14.4 (CH_3), 10.5 (CH_3). IR (neat) ν/cm^{-1} 2966 (w), 1736 (s), 1606 (m), 1498 (m), 1468 (s), 1198 (s), 1086 (m), 989 (m), 824 (s), 732 (s). LC-MS (ESI) m/z 462.0 (M+H). HR-MS (ESI) calculated for $C_{26}H_{25}N_3O_3Cl$ 462.1584, found 462.1580 (M+H, Δ = -0.9 ppm).

Ethyl 1-(4-chlorophenyl)-5-(3-(trifluoromethyl)phenyl)-1*H*-1,2,4-triazole-3-carboxylate 9b:^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (1H, s), 7.71 (1H, d, *J* = 8.0 Hz), 7.60 (1H, d, *J* = 8.0 Hz), 7.50 (1H, d, *J* = 8.0 Hz), 7.46 (2H, d, *J* = 8.4 Hz), 7.34 (2H, d, *J* = 8.4 Hz), 4.55 (2H, q, *J* = 7.2 Hz), 1.47 (3H, t, *J* = 7.2 Hz). ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.6 (C), 154.9 (C), 154.2 (C), 136.1 (C), 135.6 (C), 132.0 (CH), 131.6 (C-CF_3, q, *J* = 32 Hz), 130.0 (2CH), 129.3 (CH), 127.5 (CH, q, *J* = 4 Hz), 127.4 (C), 126.8 (2CH), 126.3 (CH, q, *J* = 4 Hz), 123.4 (CF_3, q, *J* = 272 Hz), 62.4 (CH_2), 14.3 (CH_3). ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.0 (s). IR (neat) ν/cm^{-1} 2984 (w), 1737 (s), 1499 (m), 1325 (s), 1205 (s), 1167 (s), 1126 (s), 1073 (s), 999 (s), 836 (s), 704 (s). LC-MS (ESI) m/z 396.5 (M+H). HR-MS (ESI) calculated for $C_{19}H_{14}N_3O_2ClF_3$ 396.0727, found 396.0721(M+H, Δ = -0.3 ppm).

Ethyl 1-(4-chlorophenyl)-5-(2-isopropylphenyl)-1*H*-1,2,4-triazole-3-carboxylate 9c: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44-7.50 (1H, m), 7.35 (1H, d, *J* = 8.0 Hz), 7.29 (2H, d, *J* = 8.0 Hz), 7.20-7.30 (4H, m), 4.54 (2H, q, *J* = 7.2 Hz), 2.63 (1H, septet, *J* = 8.0 Hz), 1.47 (3H, t, *J* = 7.2 Hz), 0.96 (6H, d, *J* = 8.0 Hz). ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.9 (C), 155.6 (C), 154.6 (C), 148.1 (C), 135.6 (C), 134.8 (C), 131.2 (CH), 130.3 (CH), 129.4 (2CH), 126.2 (CH), 126.1 (CH), 126.0 (C), 125.0 (2CH), 62.2 (CH_2), 30.5 (CH), 23.6 ($2CH_3$), 14.4 (CH_3). IR (neat) ν/cm^{-1} 2965 (w), 1737, 1498 (s), 1472 (s), 1383 (m), 1198 (s), 1166 (s), 1090 (s), 990 (s), 833 (s), 730 (s). LC-MS (ESI) m/z 370.1 (M+H). HR-MS (ESI) calculated for $C_{20}H_{21}N_3O_2Cl$ 370.1322, found 370.1318 (M+H, Δ = -1.1 ppm).

Ethyl 1-(4-chlorophenyl)-5-(2-methoxypyridin-3-yl)-1*H*-1,2,4-triazole-3-carboxylate 9d: ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.29 (1H, dd, *J* = 1.6, 5.2 Hz), 7.99 (1H, dd, *J* = 2.0, 8.0 Hz), 7.35 (2H, d, *J* = 8.0 Hz), 7.26 (2H, d, *J* = 8.0 Hz), 7.03 (1H, dd, *J* = 4.8, 8.0 Hz), 4.53 (2H, q, *J* = 7.2 Hz), 3.51 (3H, s), 1.45 (3H, t, *J* = 7.2 Hz). ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.1 (C), 159.7 (C), 154.8 (C), 152.3 (C), 150.0 (CH), 140.8 (CH), 136.7 (C), 134.9 (C), 129.3 (2CH), 124.8 (2CH), 116.9 (CH), 111.1 (C), 62.2 (CH_2), 53.2 (CH_3), 14.4 (CH_3). IR (neat) ν/cm^{-1} 2965 (w), 1737 (m),

1579 (m), 1499 (s), 1469 (s), 1402 (s), 1204 (s), 1095 (m), 1017 (s), 989 (s), 909 (s), 727 (s). LC-MS (ESI) m/z 359.0 (M+H). HR-MS (ESI) calculated for $C_{17}H_{16}N_4O_3Cl$ 359.0911, found 359.0910 (M+H, Δ = -0.3 ppm).

Ethyl 1-(4-chlorophenyl)-5-(3,4-dimethoxyphenyl)-1*H*-1,2,4-triazole-3-carboxylate 9e: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 (2H, d, *J* = 8.0 Hz), 7.35 (2H, d, *J* = 8.0 Hz), 7.15 (1H, d, *J* = 2.4 Hz), 6.93 (1H, dd, *J* = 2.4, 8.4 Hz), 6.77 (1H, d, *J* = 8.4 Hz), 4.50 (2H, q, *J* = 7.2 Hz), 3.87 (3H, s), 3.78 (3H, s), 1.44 (3H, t, *J* = 7.2 Hz). ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.0 (C), 155.6 (C), 154.5 (C), 151.0 (C), 149.0 (C), 136.4 (C), 135.5 (C), 129.7 (2CH), 127.0 (2CH), 122.3 (CH), 118.8 (C), 112.0 (CH), 110.8 (CH), 62.2 (CH_2), 56.0 (CH_3), 55.9 (CH_3), 14.3 (CH_3). IR (neat) ν/cm^{-1} 2928 (w), 1737 (s), 1498 (s), 1257 (m), 1204 (s), 1087 (m), 1024 (s), 729 (s). LC-MS (ESI) 388.0 m/z (M+H). HR-MS (ESI) calculated for $C_{19}H_{19}N_3O_4Cl$ 388.1064, found 388.1073 (M+H, Δ = 2.3 ppm).

5. Experimental procedure for the synthesis ethyl pyrrolo[1,2-*c*]pyrimidine-3-carboxylate 11:

Representative flow procedure: Solution **A** was prepared by dissolving *N*-formyl glycine ethyl ester (**1**, 1 equiv., 1 M), DIPEA (2 equiv.) and DMAP (0.3 equiv.) in dry DCM. Solution **B** consisted of triphosgene (**2**, 0.33 equiv., 0.33 M) dissolved in dry DCM and solution **C** was prepared by dissolving 2-pyrrolecarbaldehyde (1 equiv., 0.5 M) and piperidine (6 equiv.) in dry DCM. In order to prepare ethyl isocyanoacetate *in situ*, solutions **A** and **B** were pumped at 0.5 mL/min each and directed into a flow reactor (10 mL and 5 mL coil reactors in series) held at ambient temperature providing a residence time of 15 minutes. Upon exiting this section the ethyl isocyanoacetate reagent stream was combined with solution **C** (pumped at 1 mL/min) via a T-mixing piece leading into a subsequent flow reactor maintained at 85 °C (52 mL Polar Bear plus reactor; residence time 26 minutes). Using a fourth pump (0.5 mL/min) a stream of water was combined with the crude reaction stream in order to dissolve salts that formed during the course of the reaction sequence. After collecting the reaction product, extractive work-up (DCM/water, crude yield 85%) followed by chromatography using a ISOLERA chromatography system with a gradient sequence (Hex:EA 20:80 or a stepwise ISOLERA gradient: 0; 0-10%; 10-35%; 35-50%; 50-70%) delivers the target compound after evaporation of the volatiles with an isolated yield of 78%. Compound description: yellow waxy solid. Mp 68.5-69.7 °C. ^{1}H NMR (700 MHz, $CDCl_3$) δ 8.74 (s, 1H), 8.08 (s, 1H), 7.42 (d, *J* = 2.8 Hz, 1H), 6.85 (dd, *J* = 3.9, 2.8 Hz), 6.62 (d, *J* = 3.9 Hz, 1H), 4.32 (q, *J* = 7.2 Hz, 2H), 1.31 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 165.0 (C), 137.8 (CH), 130.5 (C), 130.4 (C), 117.67 (CH), 117.66 (CH), 113.5 (CH), 105.0 (CH), 61.3 (CH_2), 14.3 (CH_3). IR (neat): 2985.2 (w), 1703.5 (s), 1537.9 (m), 1453.8 (s), 1434.6 (s), 1351.8 (s), 1270.5 (s), 1204.4 (s), 1083.6 (s), 1020.3 (s), 936.2 (s), 894.0 (s), 795.8 (s), 775.4 (s), 733.5 (s), 613.1 (s) cm^{-1}. LC-MS (ESI): 213.0 (M+Na); HRMS (ESI): calculated for $C_{10}H_{11}N_2O_2$ 191.0821, found 191.0813 (M+H, Δ = -4.2 ppm).

6. Experimental procedures for difunctionalisation reactions of ethyl pyrrolo[1,2-*c*]pyrimidine-3-carboxylate 11 towards compounds 12a-i

Halogenation reactions of substrate **11**:

Ethyl pyrrolo[1,2-*c*]pyrimidine-3-carboxylate **11** (190 mg, 1.0 mmol) was dissolved in $CHCl_3$ (4 mL, 0.25 M) at ambient temperature. To this solution was added the appropriate halogenating agent (NCS, NBS or NIS) in stoichiometric amounts (1.0 mmol). The reaction mixture was stirred at ambient temperature and monitored by tlc to reach complete consumption of starting material in typically 2-3 hours. After aqueous extraction the organic layers were combined, dried over anhydrous sodium sulfate, filtered and evaporated under reduced pressure to yield monohalo-derivatives of **11**. For the synthesis of **12e** 2.0 equiv. of NBS (0.5 M in $CHCl_3$) were used. ^{1}H NMR spectroscopy was used to verify the presence of monofunctionalised products as well as the high purity of the sample (>90%). These materials were used directly in the subsequent step without further purification.

Nitration of substrate **11**:

A solution of **11** (190 mg, 1.0 mmol) in CH_2Cl_2 (0.5 M) was slowly added to a mixture containing KNO_3 (1.2 mmol) in CH_2Cl_2 (2 mL) and conc. H_2SO_4 (0.2 mL) maintained at 0 °C. This mixture was stirred under cooling for 30 min followed by a further 60 min at ambient temperature. Upon complete consumption of substrate **11** the reaction mixture was extracted with CH_2Cl_2 and water (3x15 mL). The combined organic layers were dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure to yield the crude nitration product as a yellow solid. ^{1}H NMR revealed a mixture of two mono-nitration products (~1:1 ratio) that could be separated by silica gel chromatography (15% EtOAc/hexane). In order to prepare the dinitro product **12d** the same procedure can be used utilizing employing 2.2 equiv. KNO_3.

Trifluoroacetylisation of substrate **11**:

At ambient temperature trifluoroacetic anhydride (1.0 mmol) was added to a solution of **11** (190 mg, 1.0 mmol) in $CHCl_3$ (0.25 M) and DMAP (25 mg). The reaction mixture was then warmed to 50°C and stirred at this temperature for 12h. After aqueous extraction the desired product was obtained after evaporation of the volatiles as a light yellow solid. Residual sm can be easily separated by column chromatography (15% EtOAc/hexane). The resulting ethyl 7-(2,2,2-trifluoroacetyl)pyrrolo[1,2-*c*]pyrimidine-3-carboxylate was crystalised and single crystal X-ray diffraction experiments were used to confirm the connectivity of this product **SI12f'** and this structure has been deposited as CCDC 1039437.

Formylation of substrate **11**:

A solution of substrate **11** was prepared in $CHCl_3$ (0.3M, 3.3 mL) at ambient temperature. To this was added Vilsmeyer reagent (1.1 equiv.). After 2 h a second portion of Vilsmeier reagent was added (1.1 equiv.) that was needed as the quality of this commercial reagent was found to only lead to 50% conversion of **11** initially. After a total of 4 h tlc confirmed complete consumption of **11**. Clean mono-formylated product was isolated after aqueous extraction (3 × 10 mL) and removal of the solvents under reduced pressure. Using ^{1}H NMR spectroscopy revealed the presence of a single formylated product that did not require any further purification.

Synthesis of **12a**:

To a solution of ethyl 7-chloropyrrolo[1,2-*c*]pyrimidine-3-carboxylate (1 mmol) in DCM (2 mL) was added conc. H_2SO_4 (0.2 mL) and conc. HNO_3 (0.2 mL). This mixture was stirred at room temperature until all starting material was consumed (~4 h). The resulting mixture was neutralised with aqueous K_2CO_3 and subsequently extracted (DCM/water, 3 × 10 mL) to yield the crude product as a brown solid after evaporation of the solvent. Final purification was accomplished by silica gel chromatography using EtOAc/hexanes (10-20% EtOAc) as eluent. The connectivity of this structure was confirmed by X-ray crystallography (CCDC 1039441).

Synthesis of **12b**:

To a solution of ethyl 7-chloropyrrolo[1,2-*c*]pyrimidine-3-carboxylate (1 mmol) in $CHCl_3$ (2 mL) was added NBS (1.1 equiv.) and the resulting mixture was stirred at 45 °C for 10 h to reach full consumption of the starting material (monitored by tlc). The crude reaction product was directly extracted with water (3 × 10 mL) delivering the crude product after removal of the volatiles as light brown solid that was further purified by passing over a plug of silica (3 g, 20% EtOAc/hexanes as eluent).

Synthesis of **12c**:

To a solution of ethyl 7-bromopyrrolo[1,2-*c*]pyrimidine-3-carboxylate (1 mmol) in $CHCl_3$ (2 mL) was added NCS (1.1 equiv.) and the resulting mixture was stirred at 45 °C for 14 h to reach full consumption of the starting material (monitored by tlc). The crude reaction product was directly extracted with water (3 × 10 mL) delivering the crude product after removal of the volatiles as light brown solid that was further purified by passing over a plug of silica (3 g, 20% EtOAc/hexanes as eluent).

Synthesis of **12d** and **12e**: see sections on nitration and bromination of **11** above.

Synthesis of **12f**:

To a solution of ethyl 7-(2,2,2-trifluoroacetyl)pyrrolo[1,2-*c*]pyrimidine-3-carboxylate (0.5 mmol) prepared in $CHCl_3$ (2 mL) was added NBS (1.5 equiv.). The resulting mixture was stirred at 50 °C for 24 h to reach full conversion of the starting material. Direct extraction with DCM/water (3 × 10 mL) and removal of the solvents at reduced pressure yielded the crude product which was further purified by silica column chromatography (10-30% EtOAc/hexanes) whose structure was unambiguously confirmed by single crystal X-ray diffraction (CCDC 1039439).

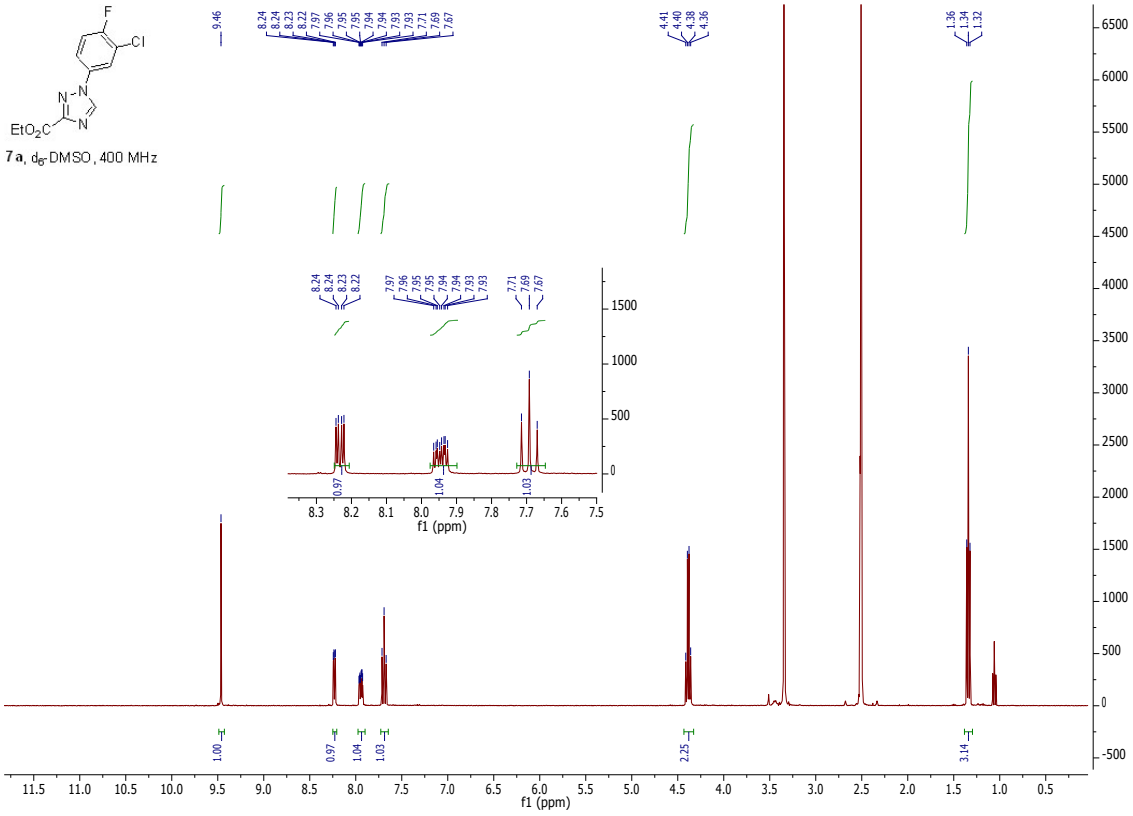
Synthesis of **12g**:

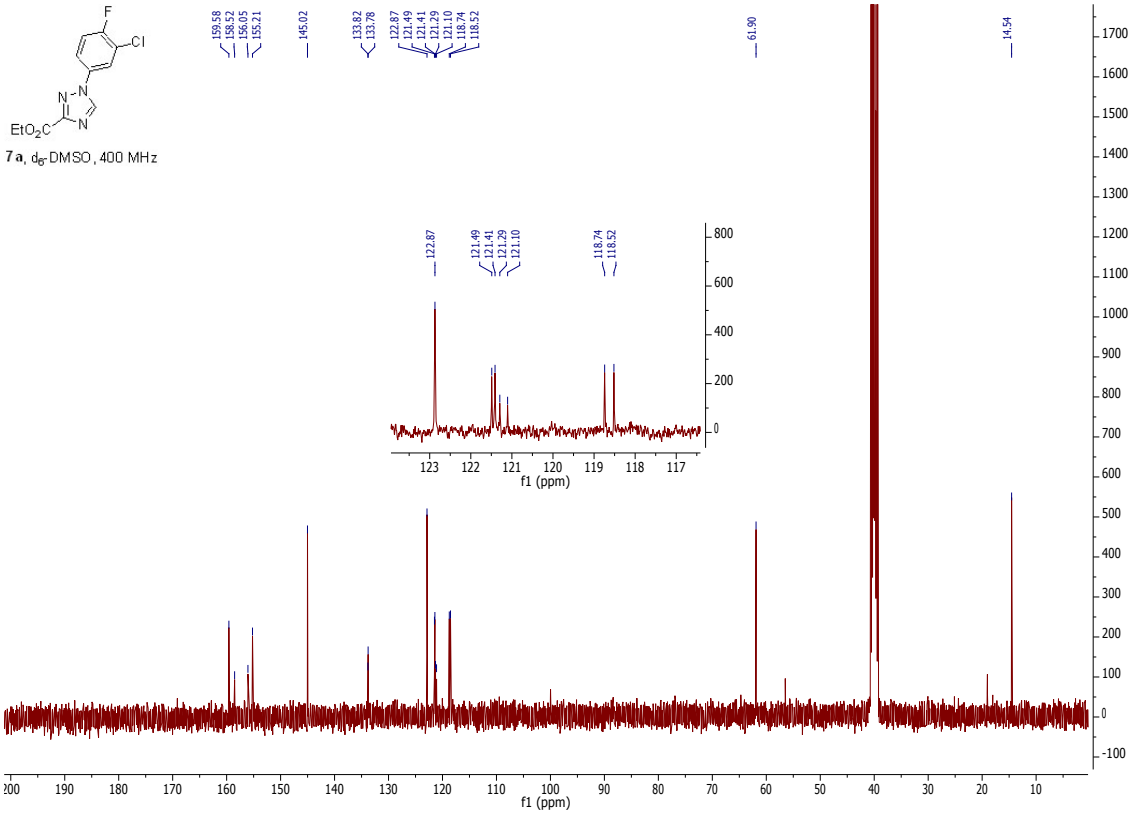
To a solution of ethyl 7-formylpyrrolo[1,2-*c*]pyrimidine-3-carboxylate (0.5 mmol) in $CHCl_3$ (2 mL) was added NIS (1.0 equiv.) in one portion. The resulting mixture was stirred at 40 °C for 12 h at which point tlc analysis indicated full conversion of the starting material. Direct extractive workup (DCM/water, 3 × 10 mL) furnished the crude product, which was further purified by silica column chromatography (10-25% EtOAc/hexanes).

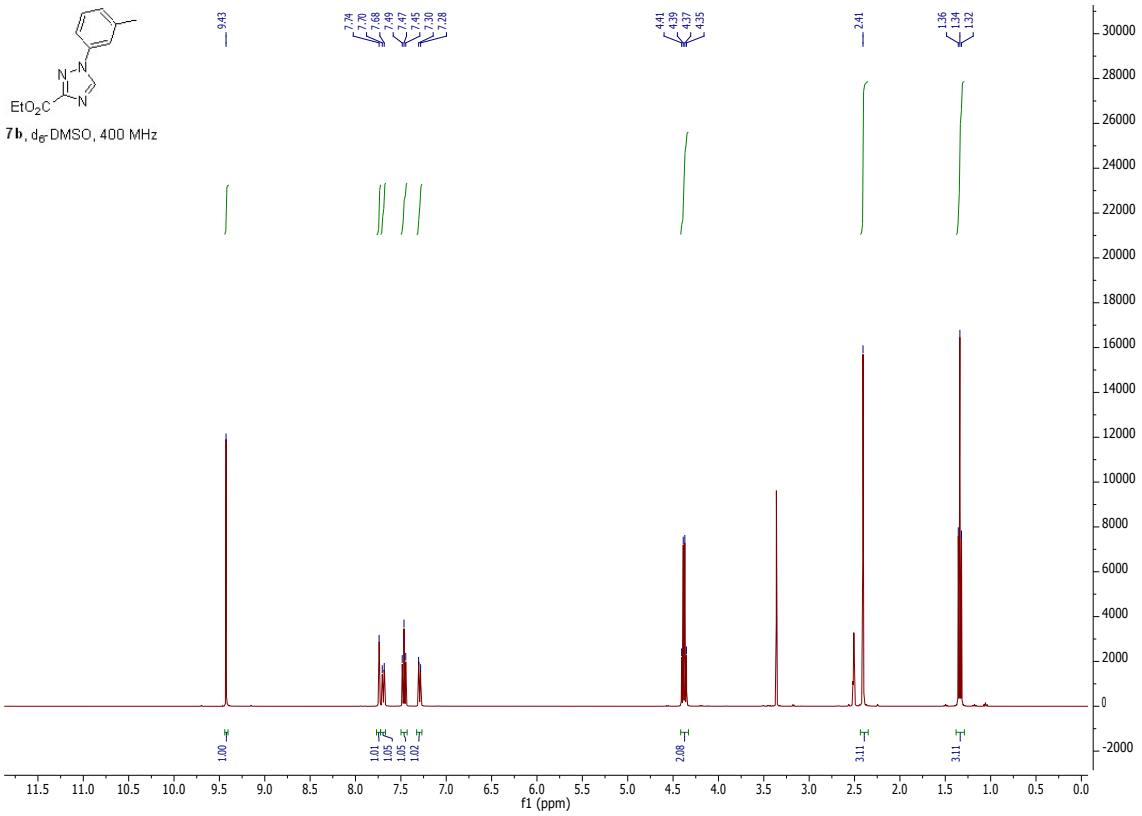
Synthesis of **12h** and **12i**:

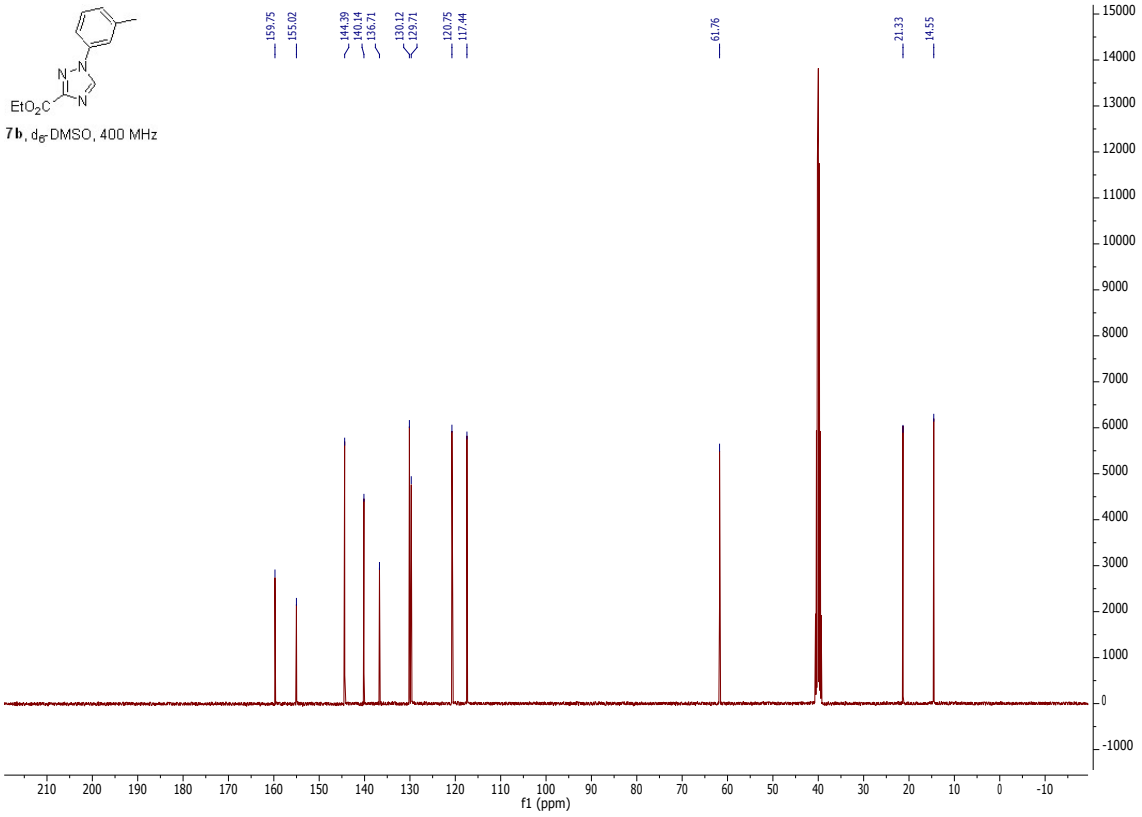
To a solution of ethyl 7-iodopyrrolo[1,2-*c*]pyrimidine-3-carboxylate (1 mmol) in $CHCl_3$ (2 mL) was added conc. H_2SO_4 (0.2 mL) and conc. HNO_3 (0.2 mL). The resulting mixture was stirred at room temperature for 4 h at which point tlc analysis indicated full conversion of starting material and the presence of two new products. After neutralization with aq. K_2CO_3 and extractive workup the crude product was dry-loaded onto silica gel (0.3 g) and placed on top of a silica column (6 g). Elution with 10-30% EtOAc/hexanes delivered both **12h** and **12i** as individual products. The connectivity of **12i** was further confirmed by single crystal X-ray diffraction (CCDC1039440).

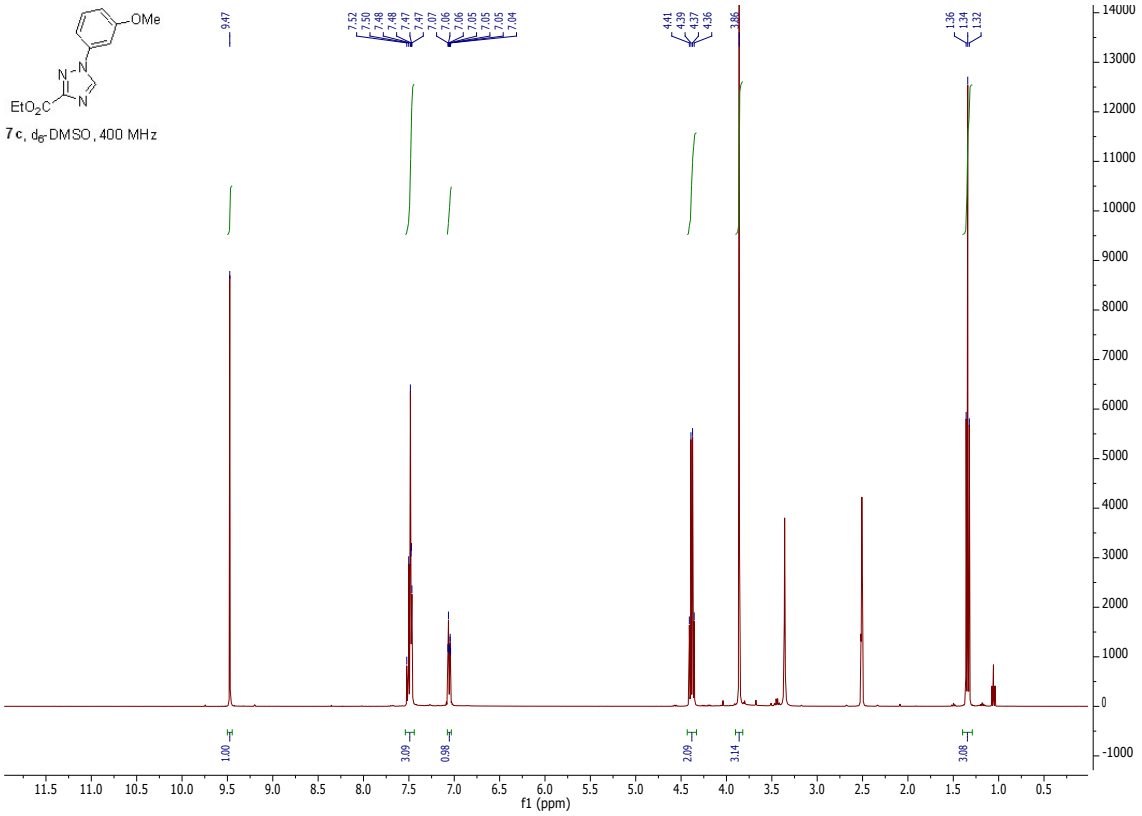
7. NMR-Spectra of compounds 7a-h:

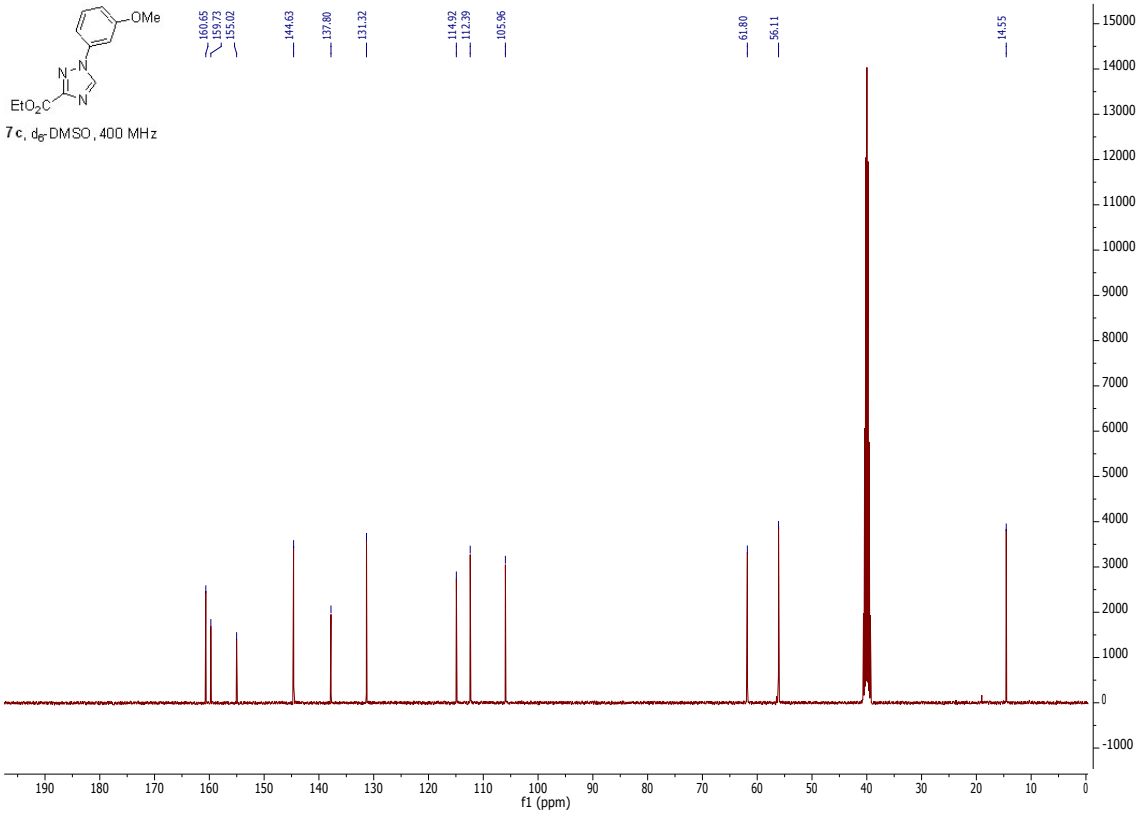


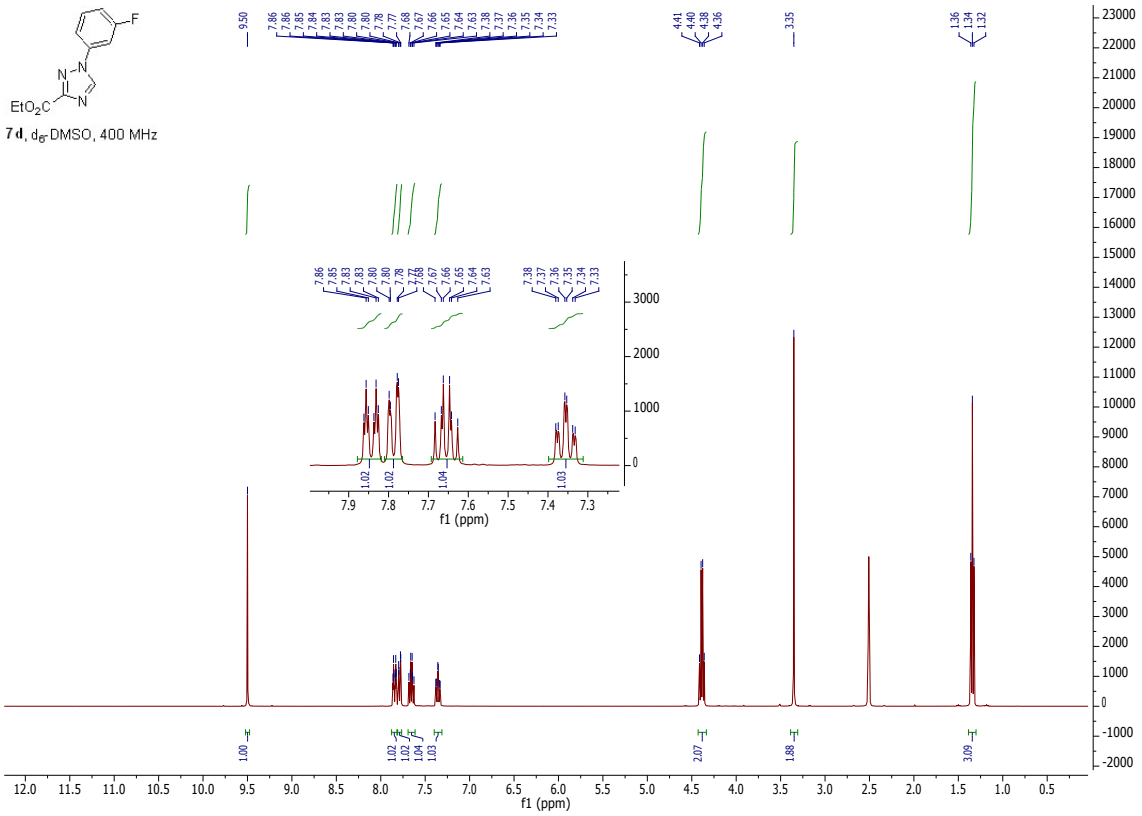


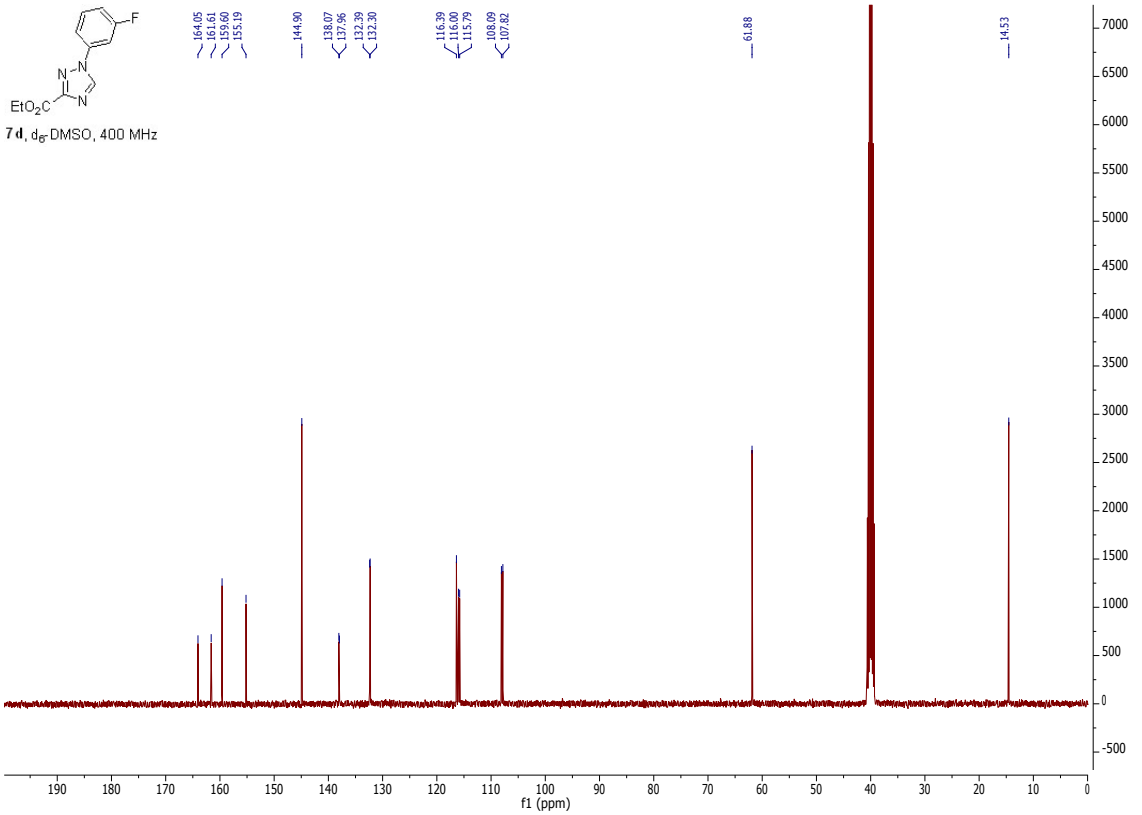

9.43
7.74
7.70
7.68
7.49
7.47
7.45
7.30
7.28
4.41
4.39
4.37
4.35
2.41
1.36
1.34
1.32
EtO2C
7b, d6-DMSO, 400 MHz
1.00
1.01
1.05
1.05
1.02
2.08
3.11
3.11
f1 (ppm)

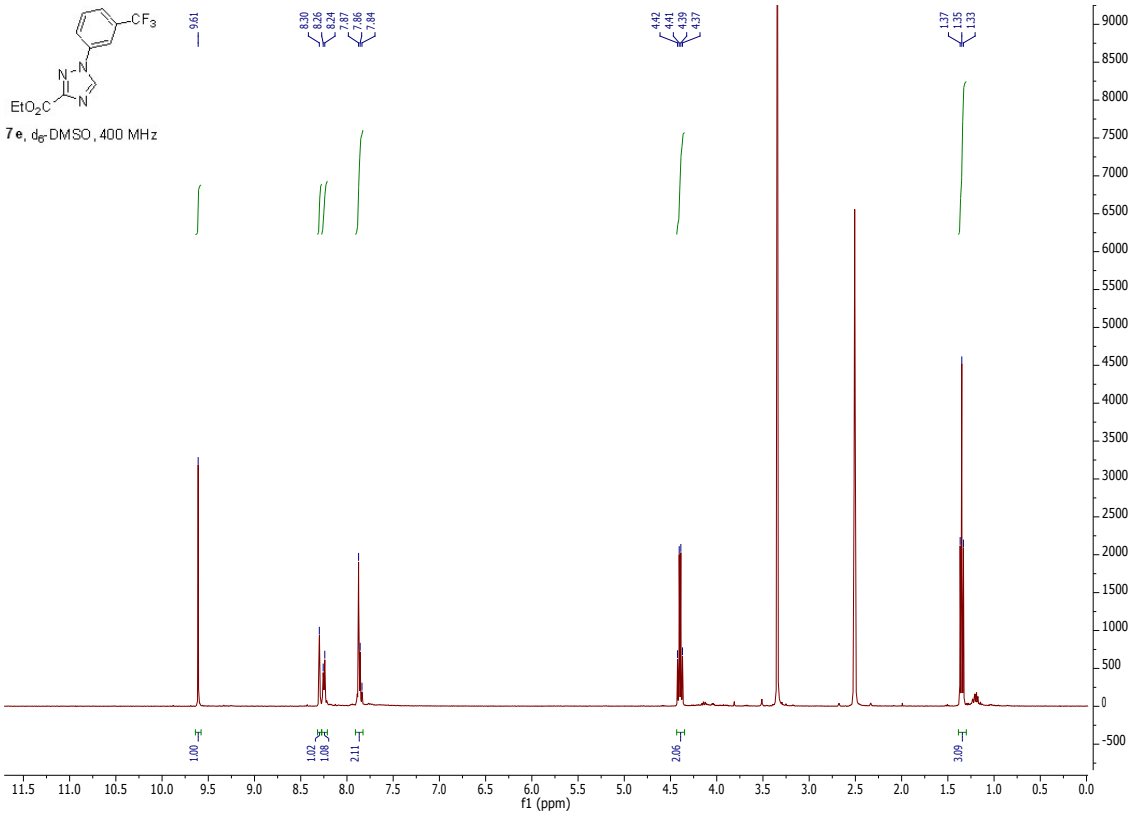

159.75
155.02
144.39
140.14
136.71
130.12
129.71
120.75
117.44
61.76
21.33
14.55
EtO2C
7b, d6-DMSO, 400 MHz
f1 (ppm)

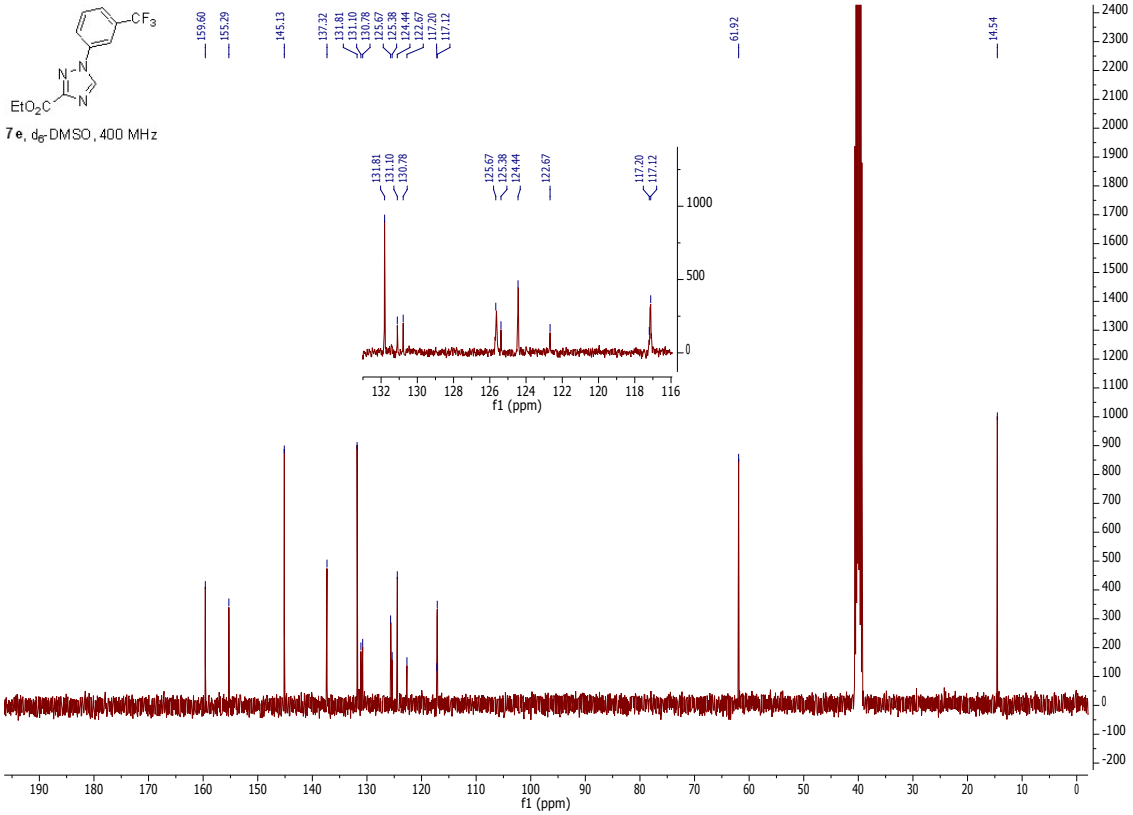

OMe
N
N
N
EtO2C
7c, d6-DMSO, 400 MHz
9.47
7.52
7.50
7.48
7.47
7.47
7.07
7.06
7.06
7.05
7.05
7.05
7.04
4.41
4.39
4.37
4.36
3.86
1.36
1.34
1.32
1.00
3.09
0.98
2.09
3.14
3.08
f1 (ppm)

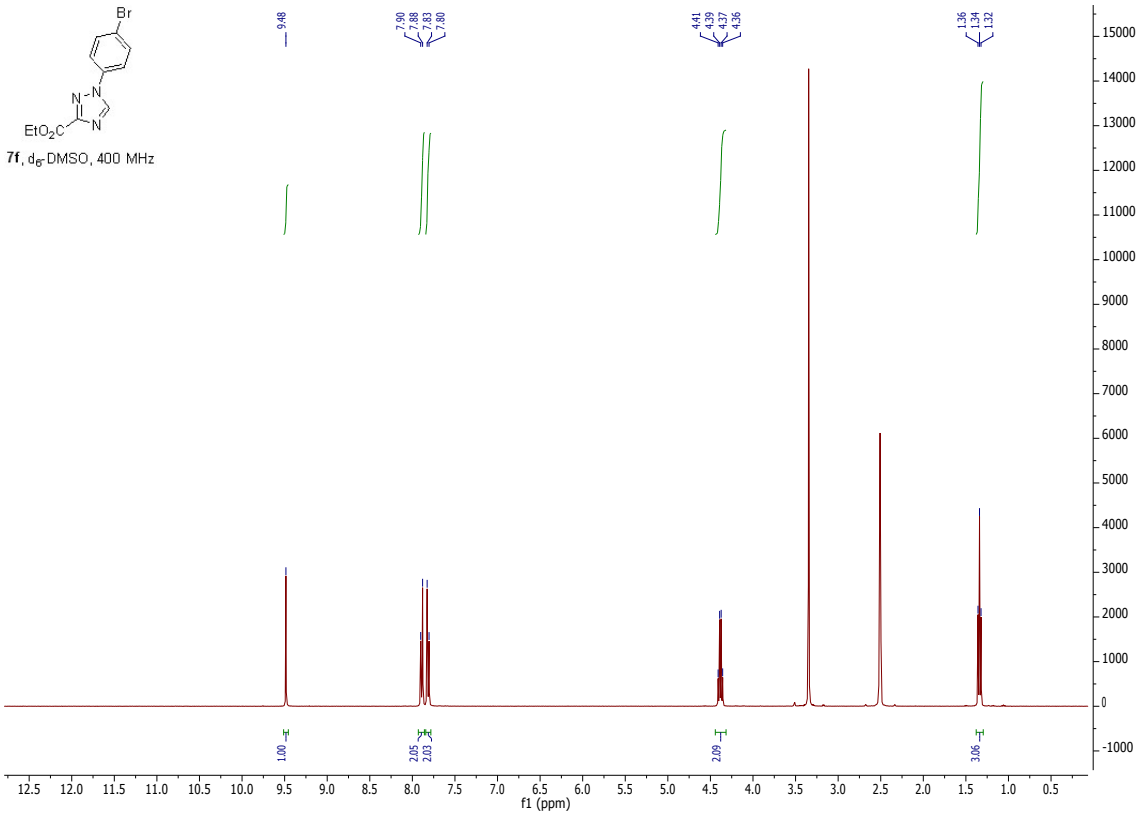

OMe
N
N
N
EtO2C
7c, d6-DMSO, 400 MHz
160.65
159.73
155.02
144.63
137.80
131.32
114.92
112.39
105.96
61.80
56.11
14.55
f1 (ppm)

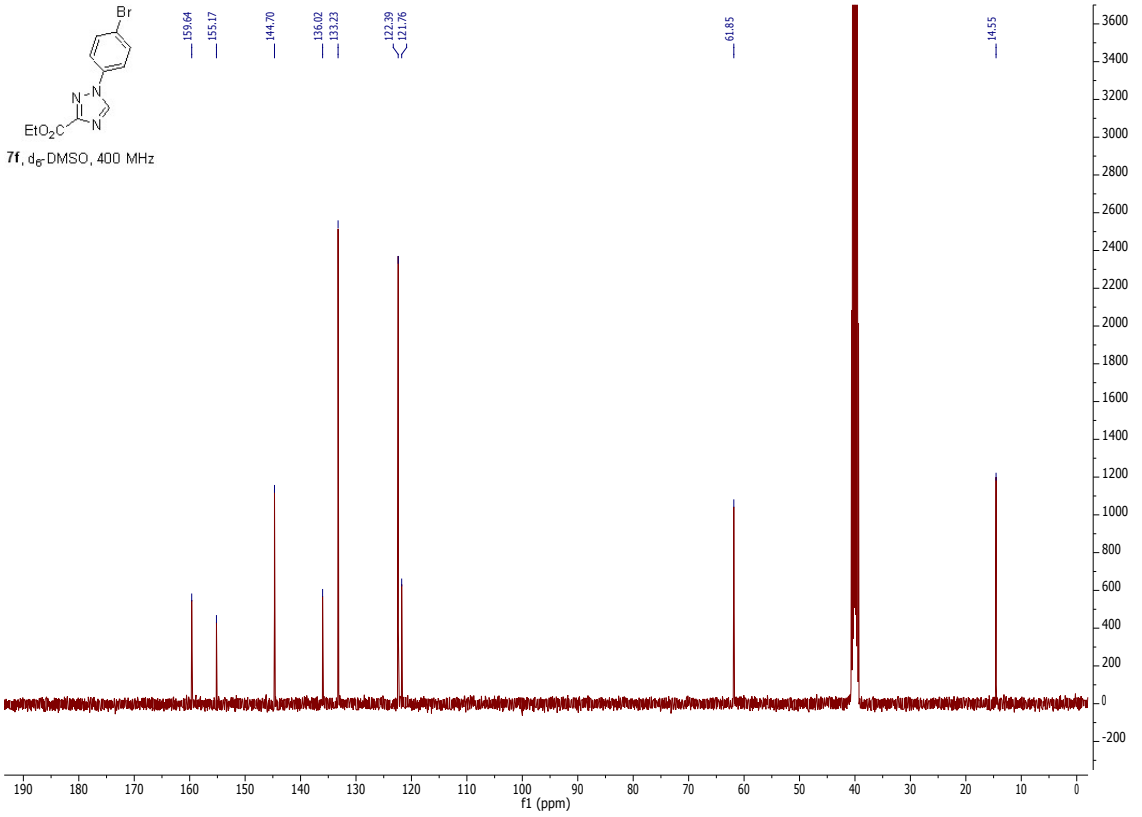

7 d, d6-DMSO, 400 MHz
9.50
7.86
7.85
7.83
7.80
7.78
7.77
7.68
7.67
7.66
7.65
7.64
7.63
7.38
7.37
7.36
7.35
7.34
7.33
4.41
4.40
4.38
4.36
3.35
1.36
1.34
1.32
1.00
1.02
1.02
1.04
1.03
2.07
1.88
3.09
f1 (ppm)

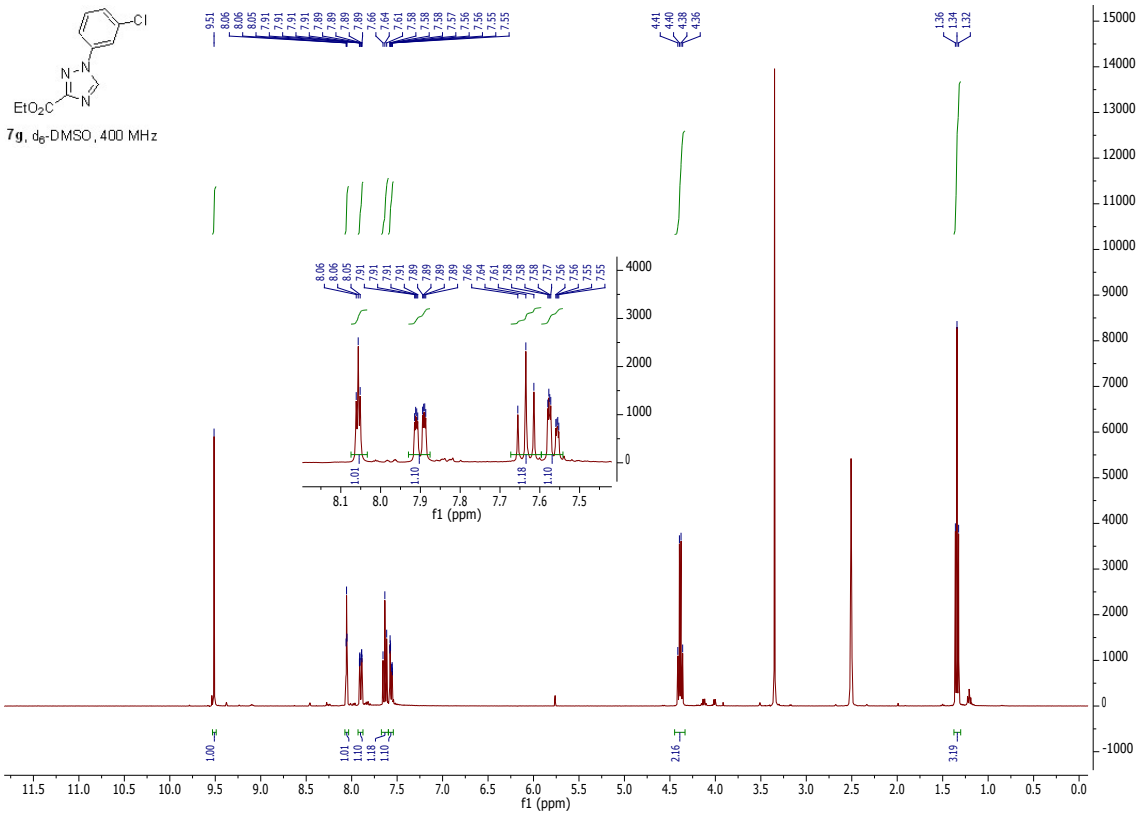

7 d, d6-DMSO, 400 MHz
164.05
161.61
159.60
155.19
144.90
138.07
137.96
132.39
132.30
116.39
116.00
115.79
108.09
107.82
61.88
14.53
f1 (ppm)

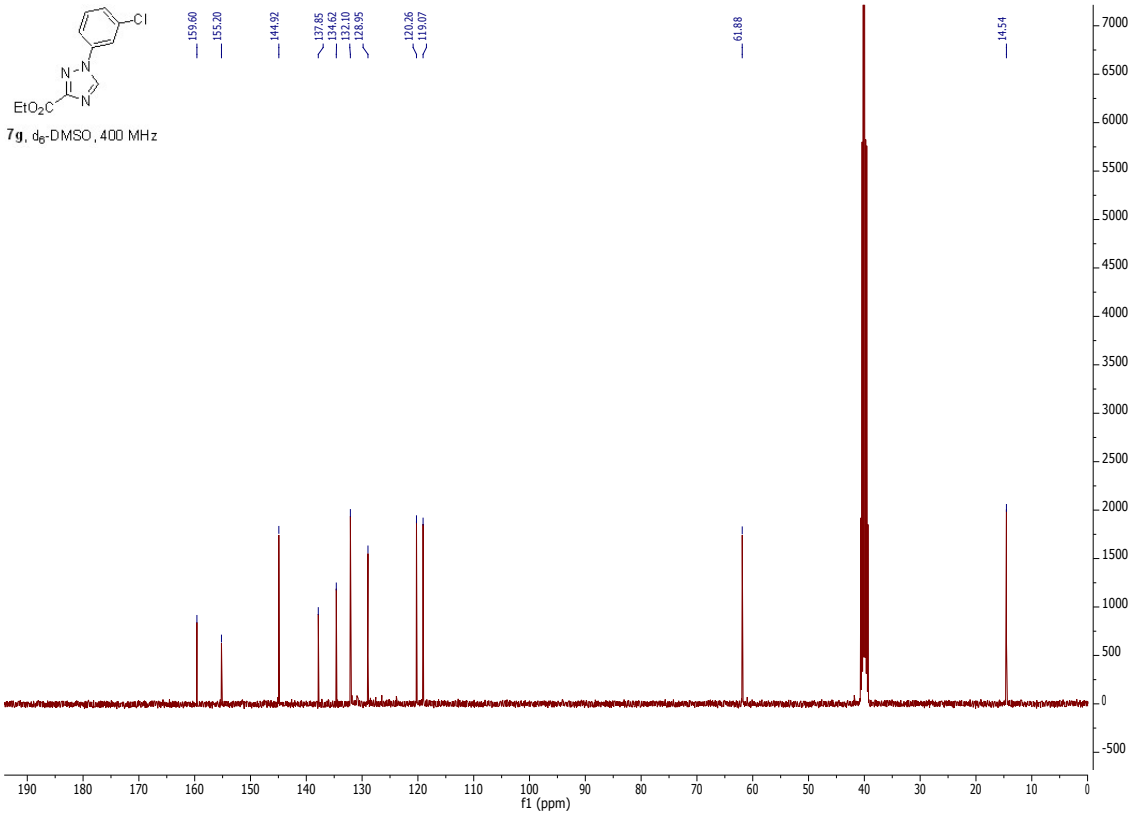

7e, d6-DMSO, 400 MHz
9.61
8.30
8.26
8.24
7.87
7.86
7.84
4.42
4.41
4.39
4.37
1.37
1.35
1.33
1.00
1.02
1.08
2.11
2.06
3.09
f1 (ppm)

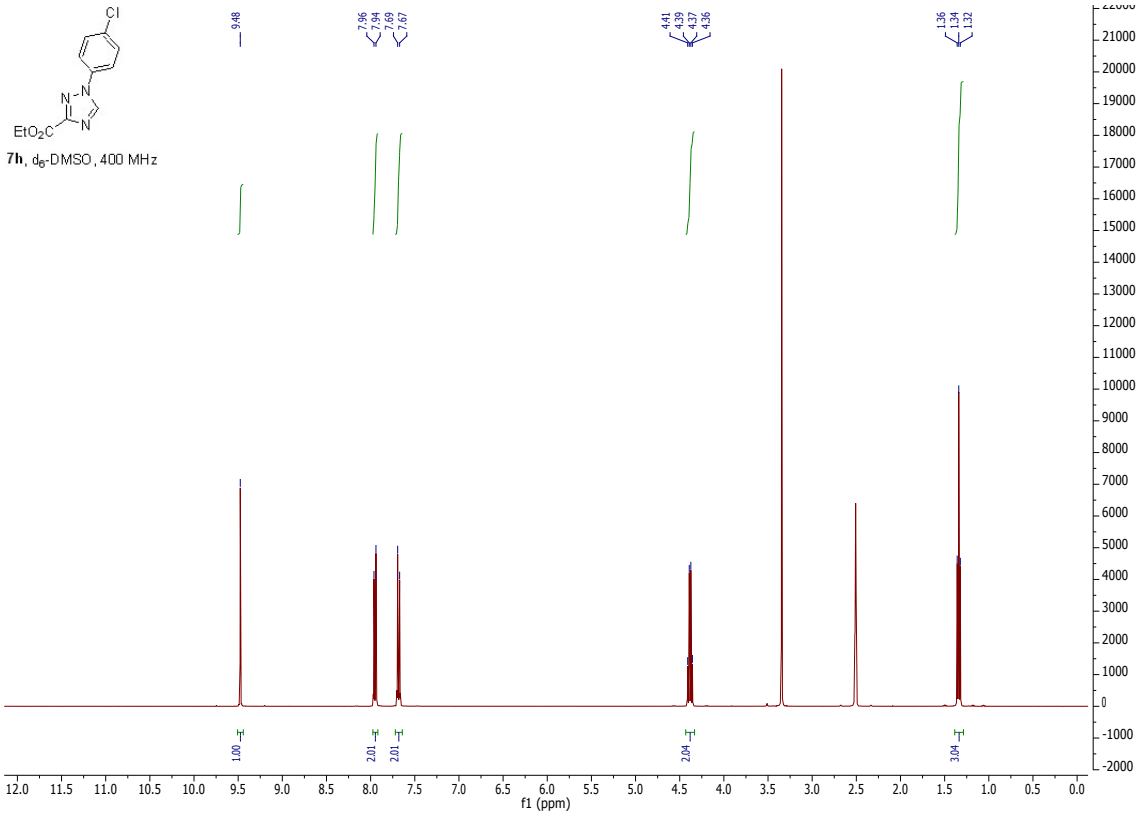

7e, d6-DMSO, 400 MHz
159.60
155.29
145.13
137.32
131.81
131.10
130.78
125.67
125.38
124.44
122.67
117.20
117.12
61.92
14.54
f1 (ppm)

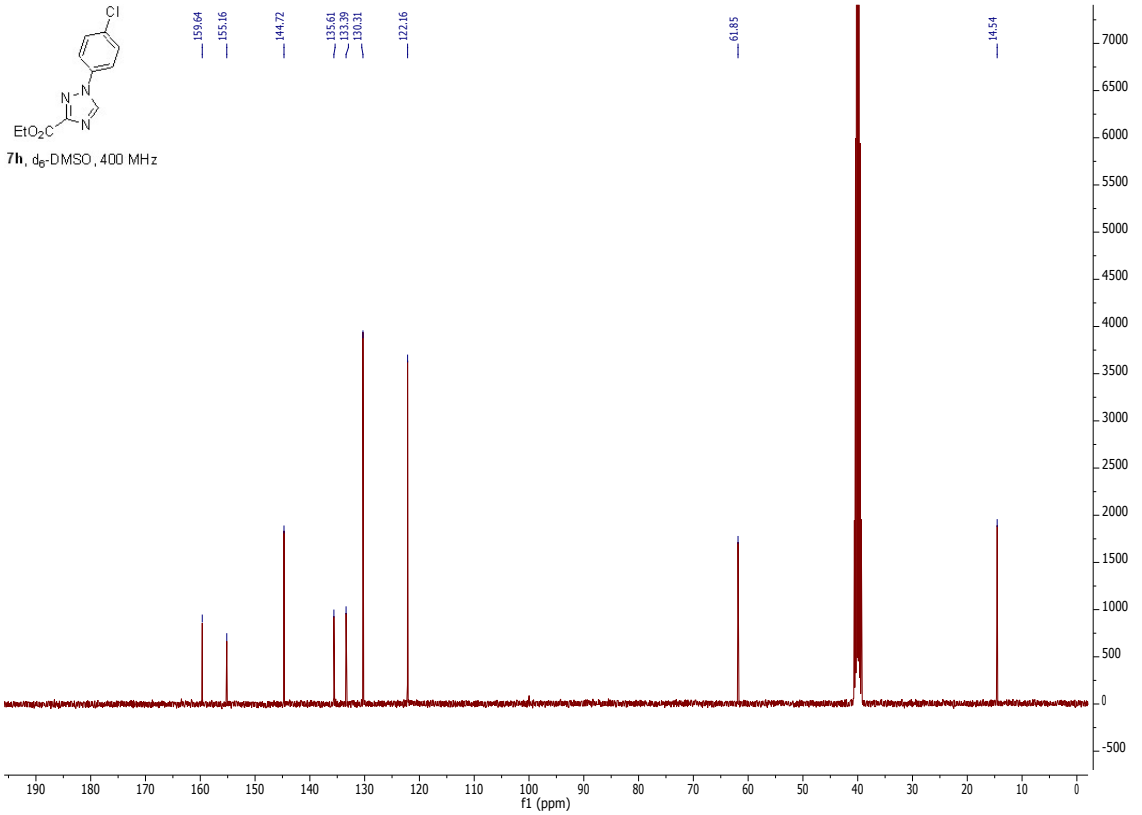

Br
N
N
N
EtO2C
7f, d6-DMSO, 400 MHz
9.48
7.90
7.88
7.83
7.80
4.41
4.39
4.37
4.36
1.36
1.34
1.32
1.00
2.05
2.03
2.09
3.06
f1 (ppm)


Br
N
N
N
EtO2C
7f, d6-DMSO, 400 MHz
159.64
155.17
144.70
136.02
133.23
122.39
121.76
61.85
14.55
f1 (ppm)

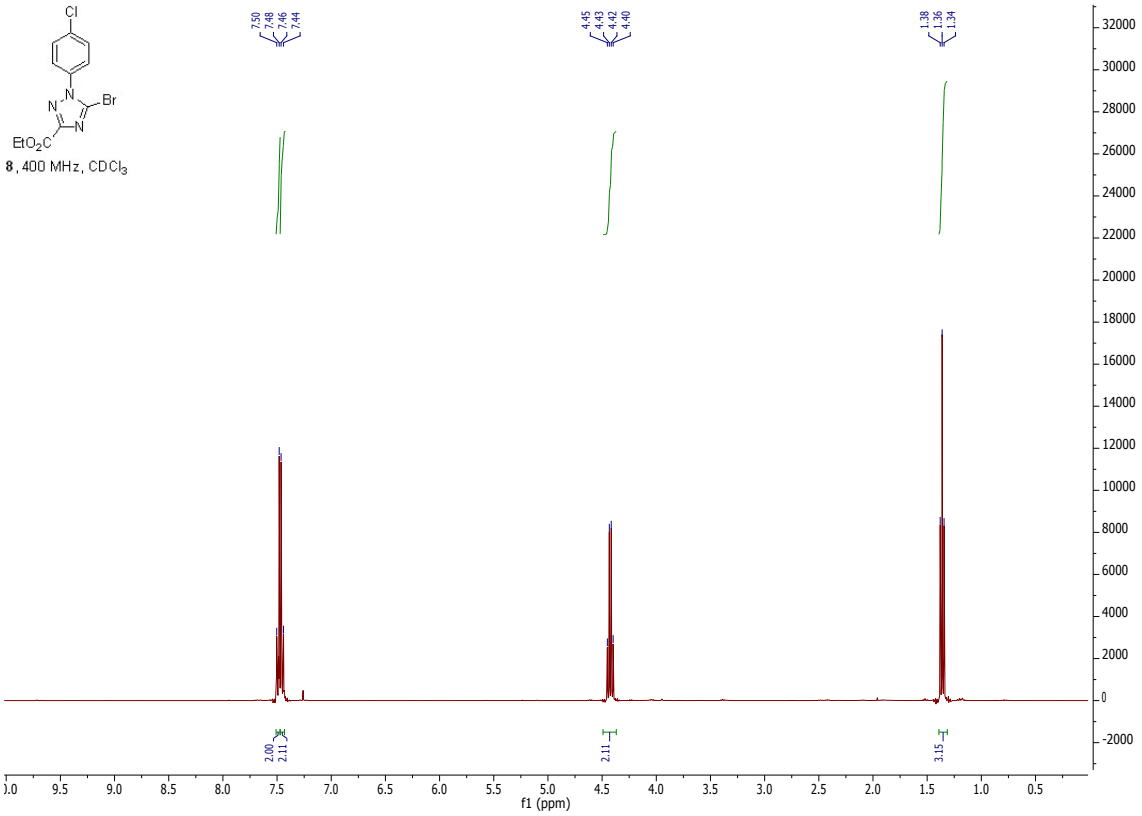

7g, d6-DMSO, 400 MHz
f1 (ppm)

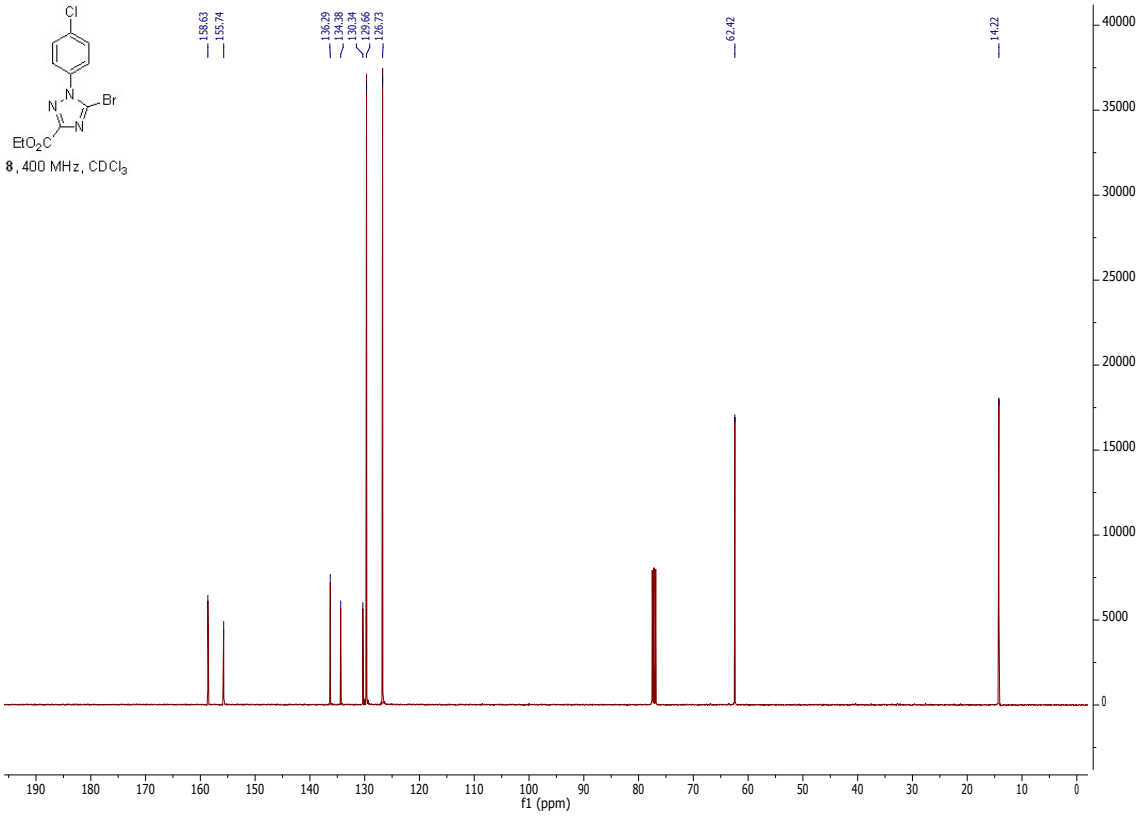

7g, d6-DMSO, 400 MHz
f1 (ppm)

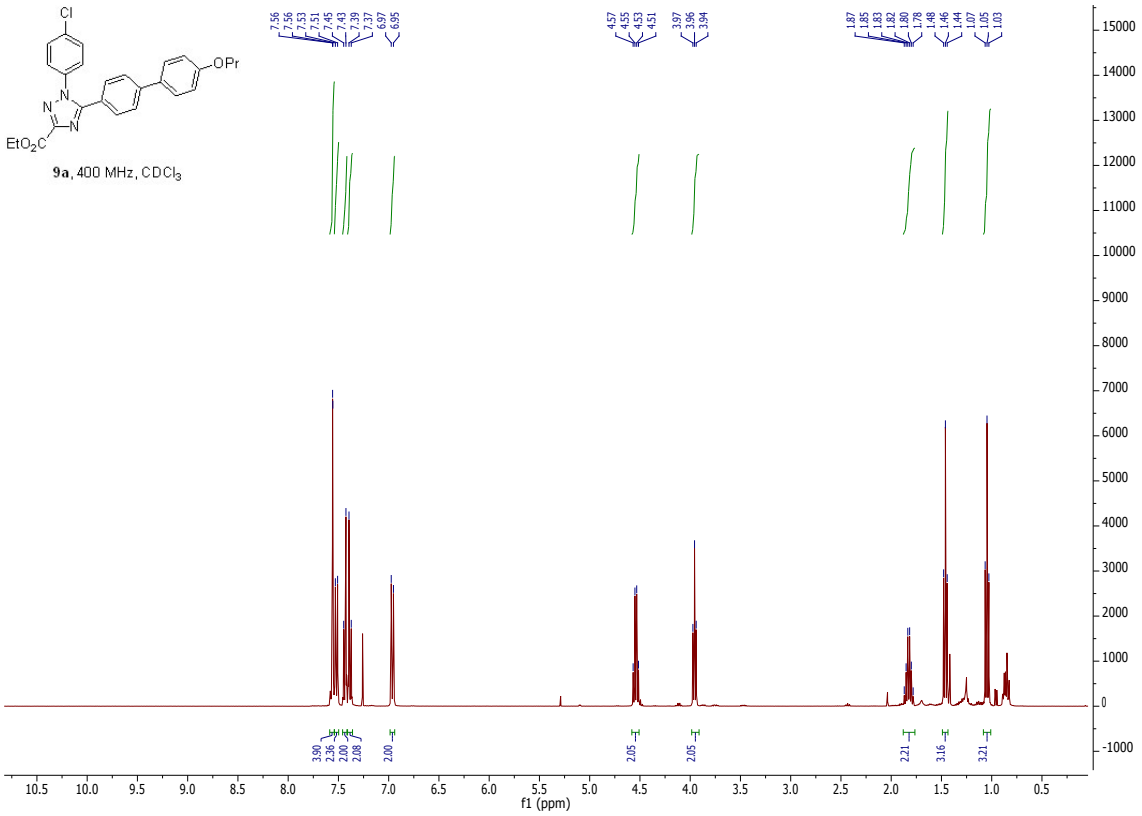

Cl
N
N
N
EtO2C
7h, d6-DMSO, 400 MHz
9.48
7.96
7.94
7.69
7.67
4.41
4.39
4.37
4.36
1.36
1.34
1.32
1.00
2.01
2.01
2.04
3.04
f1 (ppm)

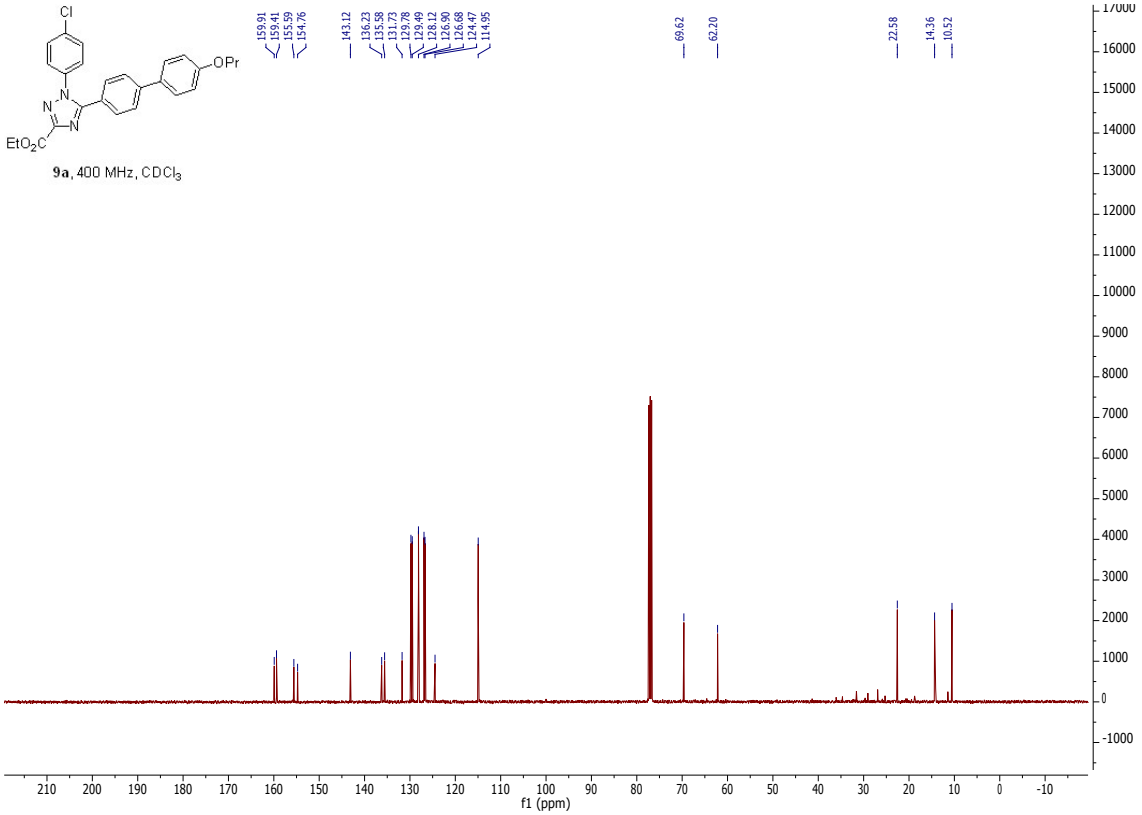

Cl
N
N
N
EtO2C
7h, d6-DMSO, 400 MHz
159.64
155.16
144.72
135.61
133.39
130.31
122.16
61.85
14.54
f1 (ppm)

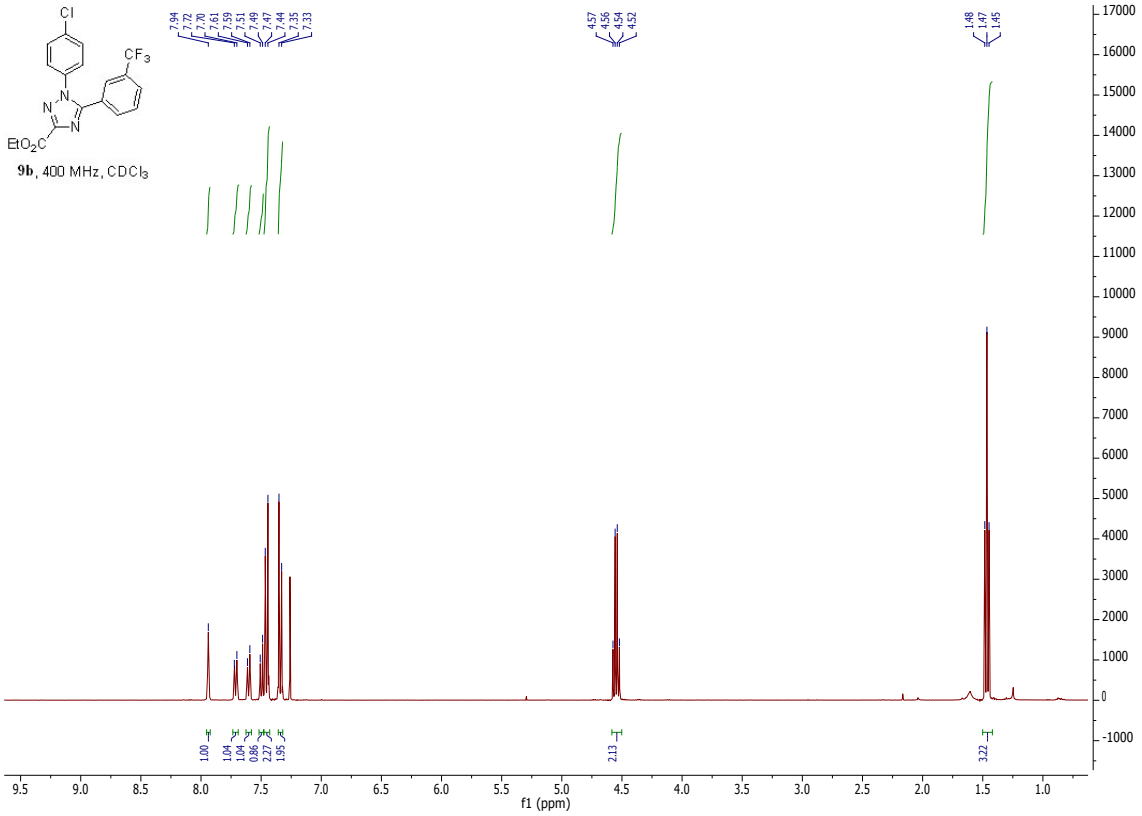
8. NMR-Spectra of compounds **8,** and **9a-e:**

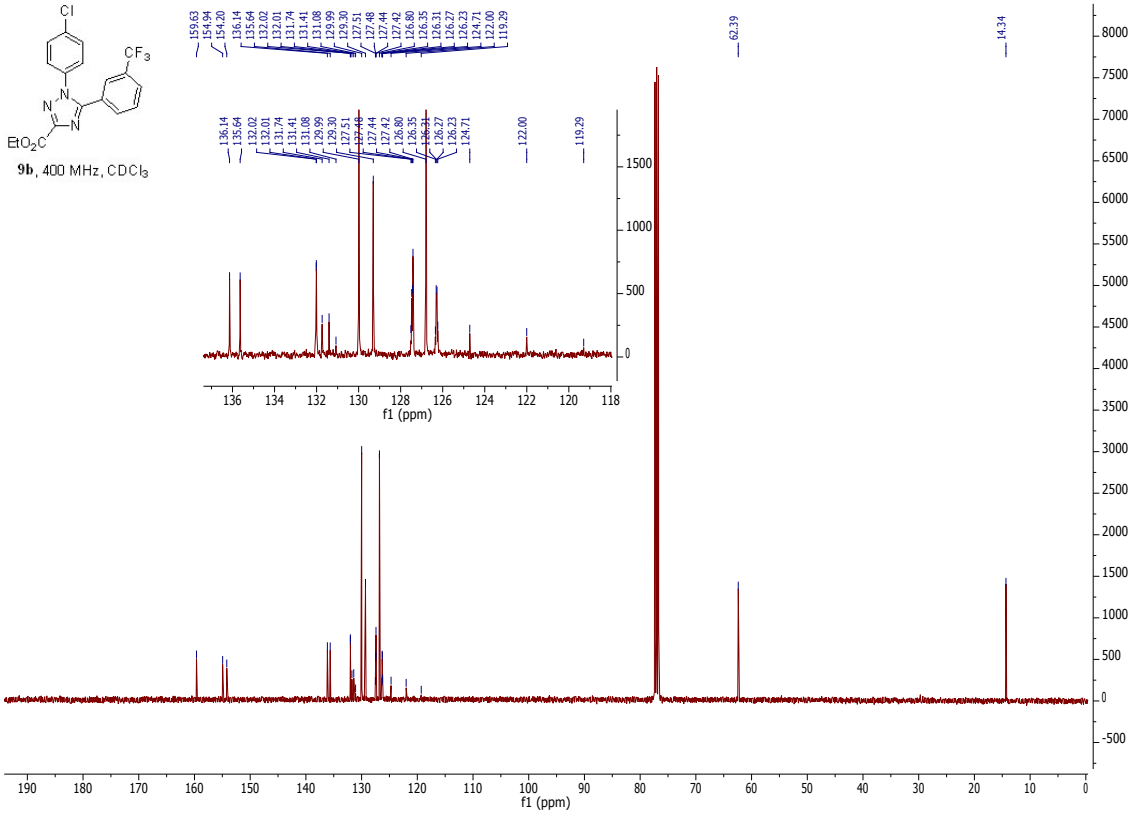


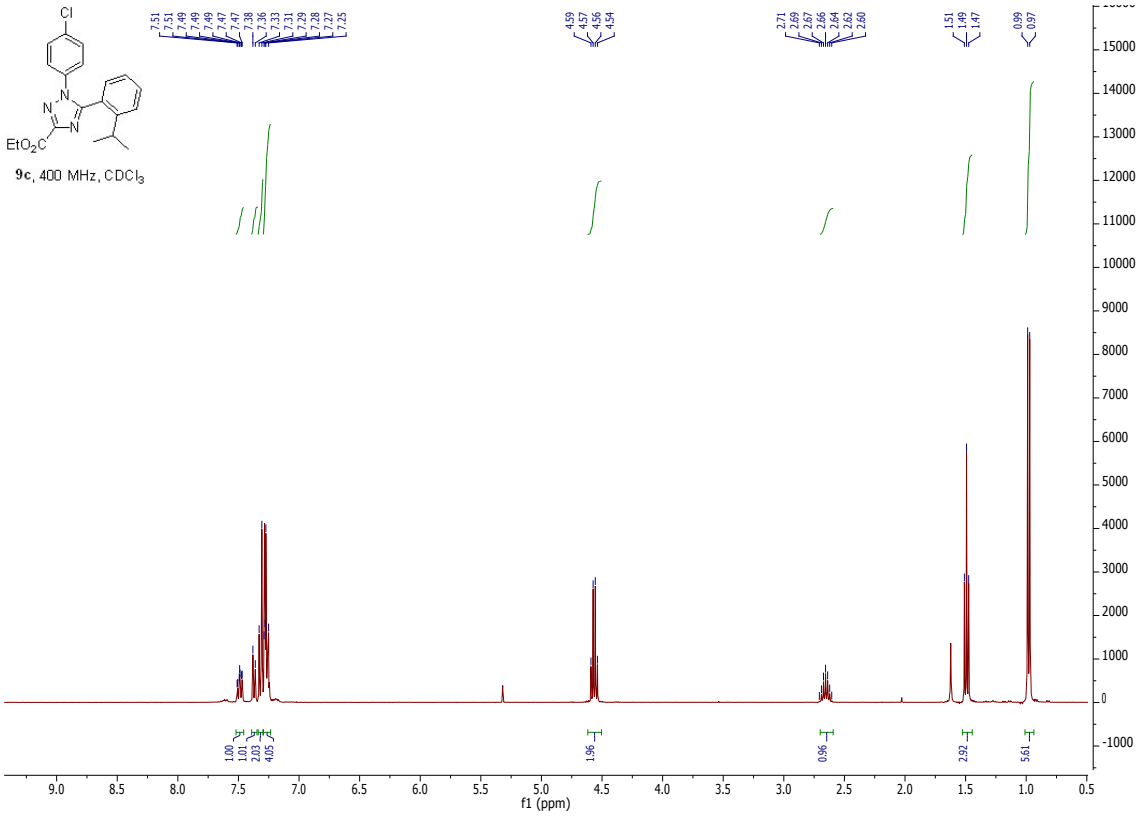


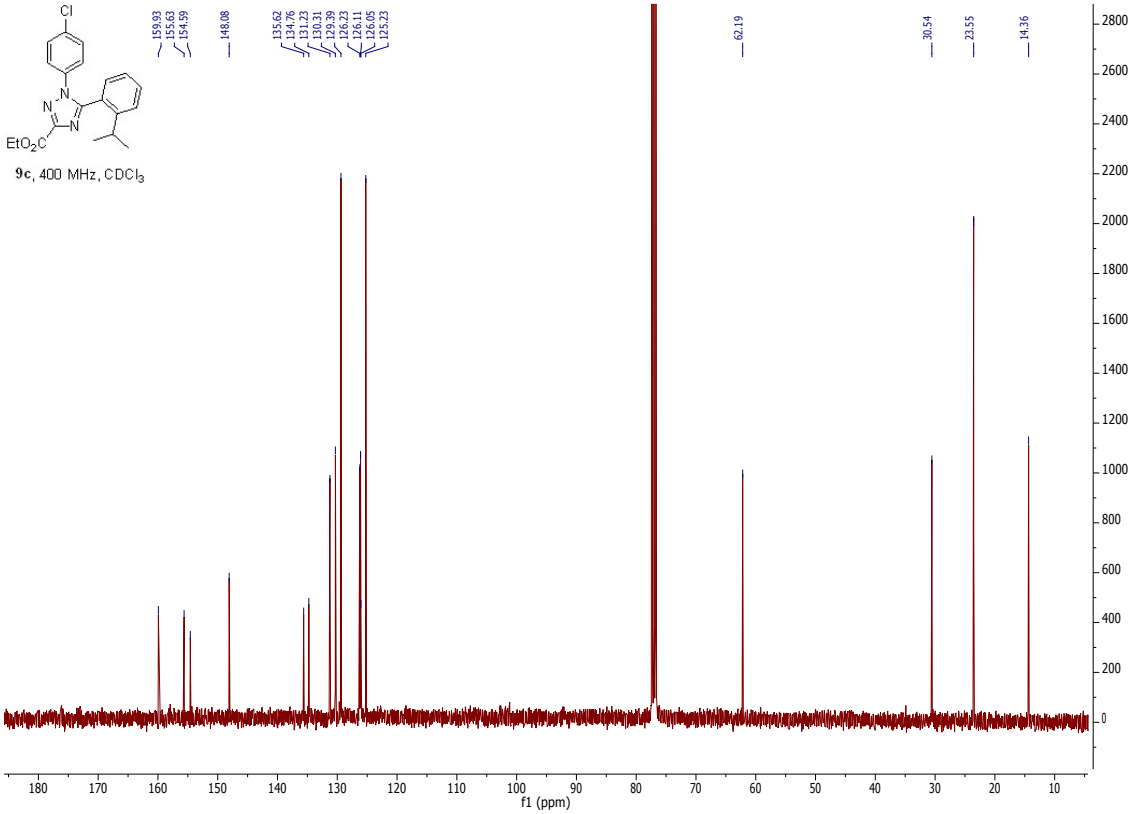

Cl
OPr
N
N
N
EtO2C
9a, 400 MHz, CDCl3
7.56
7.56
7.53
7.51
7.45
7.43
7.39
7.37
6.97
6.95
4.57
4.55
4.53
4.51
3.97
3.96
3.94
1.87
1.85
1.83
1.82
1.80
1.78
1.48
1.46
1.44
1.07
1.05
1.03
3.90
2.36
2.00
2.08
2.00
2.05
2.05
2.21
3.16
3.21
f1 (ppm)

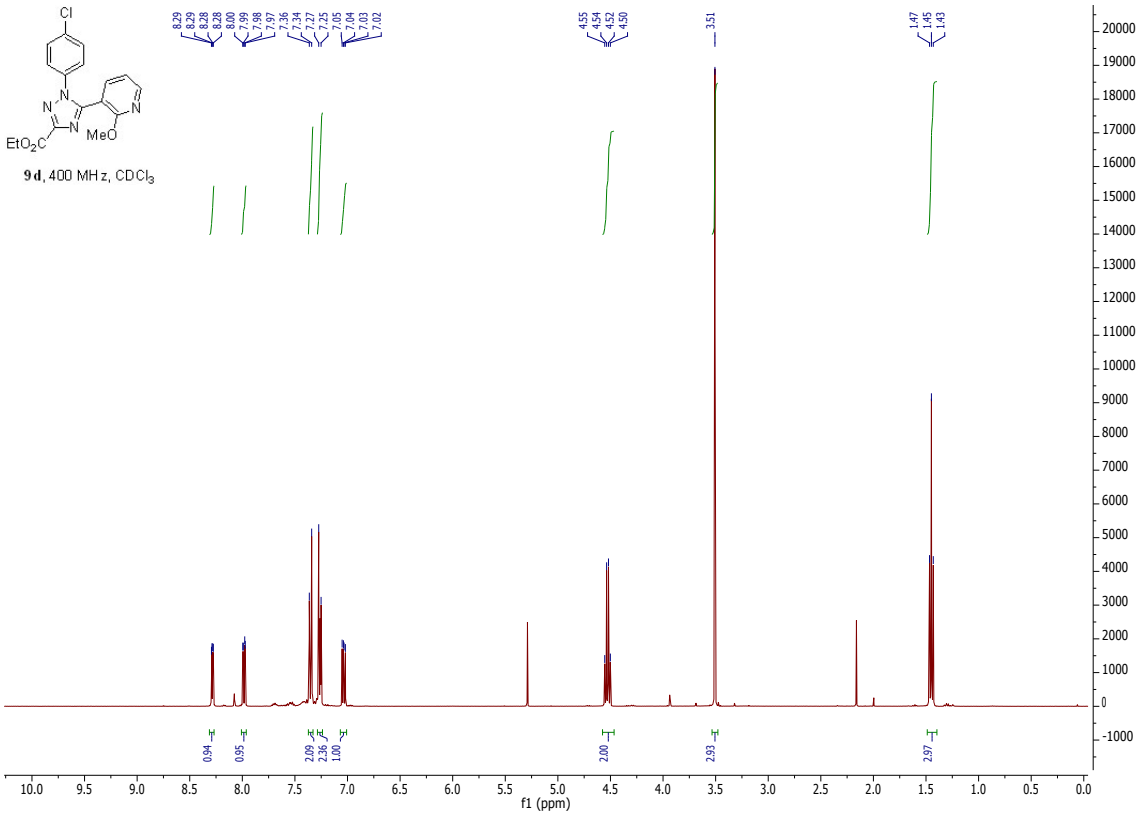

Cl
OPr
N
N
N
EtO2C
9a, 400 MHz, CDCl3
159.91
159.41
155.59
154.76
143.12
136.23
135.58
131.73
129.78
129.49
128.12
126.90
126.68
124.47
114.95
69.62
62.20
22.58
14.36
10.52
f1 (ppm)

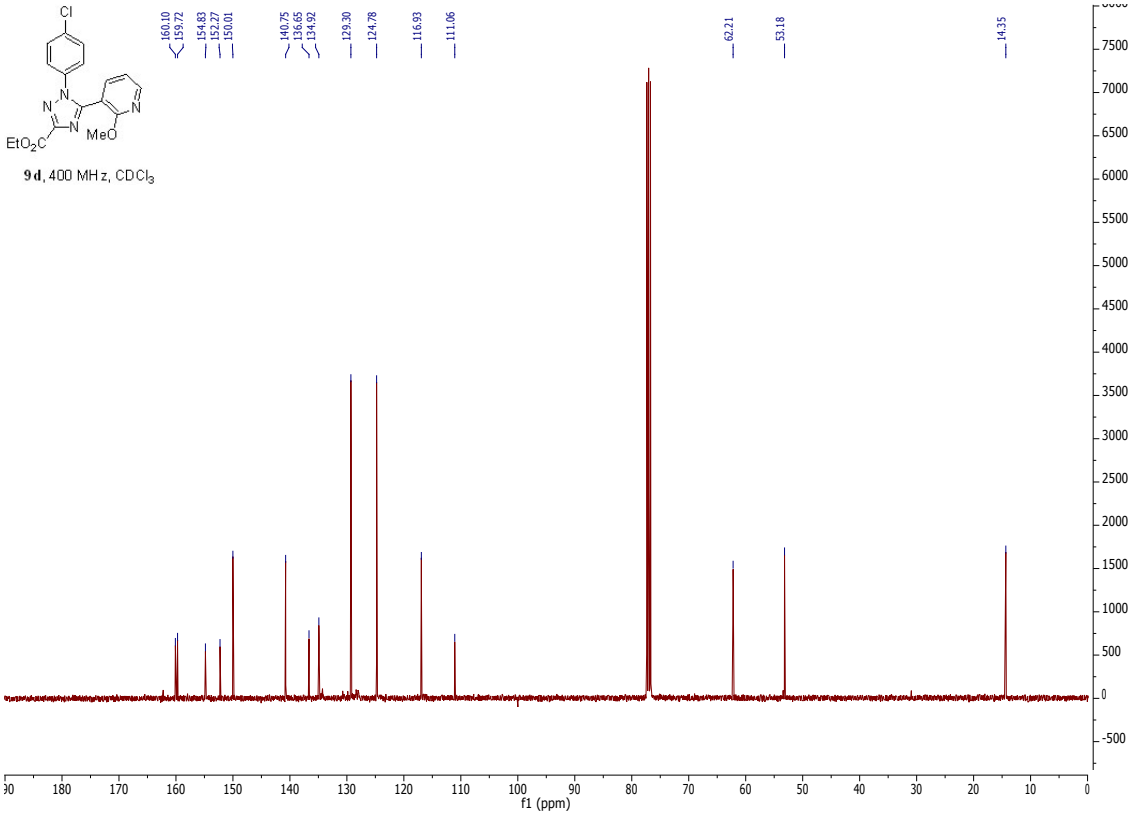

Cl
CF3
EtO2C
9b, 400 MHz, CDCl3
7.94
7.72
7.70
7.61
7.59
7.51
7.49
7.47
7.44
7.35
7.33
4.57
4.56
4.54
4.52
1.48
1.47
1.45
1.00
1.04
1.04
0.86
2.27
1.95
2.13
3.22
f1 (ppm)

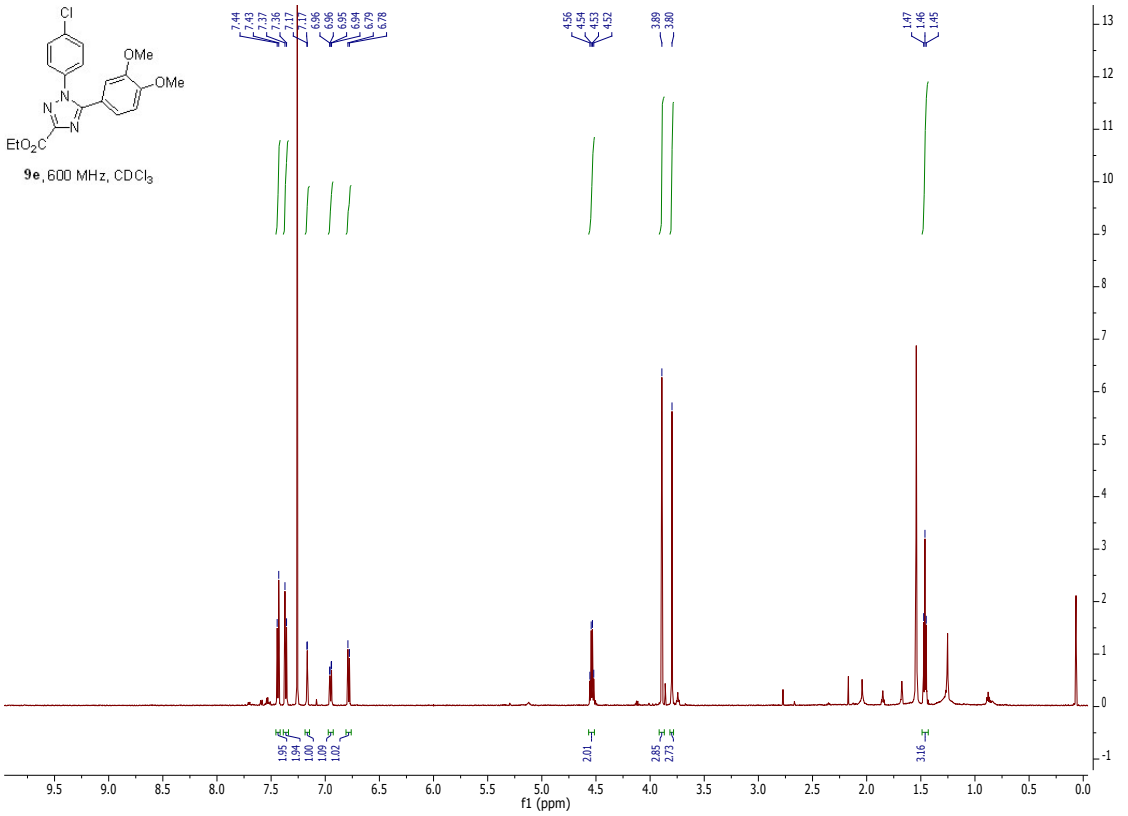

Cl
CF3
EtO2C
9b, 400 MHz, CDCl3
159.63
154.94
154.20
136.14
135.64
132.02
132.01
131.74
131.41
131.08
129.99
129.30
127.51
127.48
127.44
127.42
126.80
126.35
126.31
126.27
126.23
124.71
122.00
119.29
62.39
14.34
f1 (ppm)

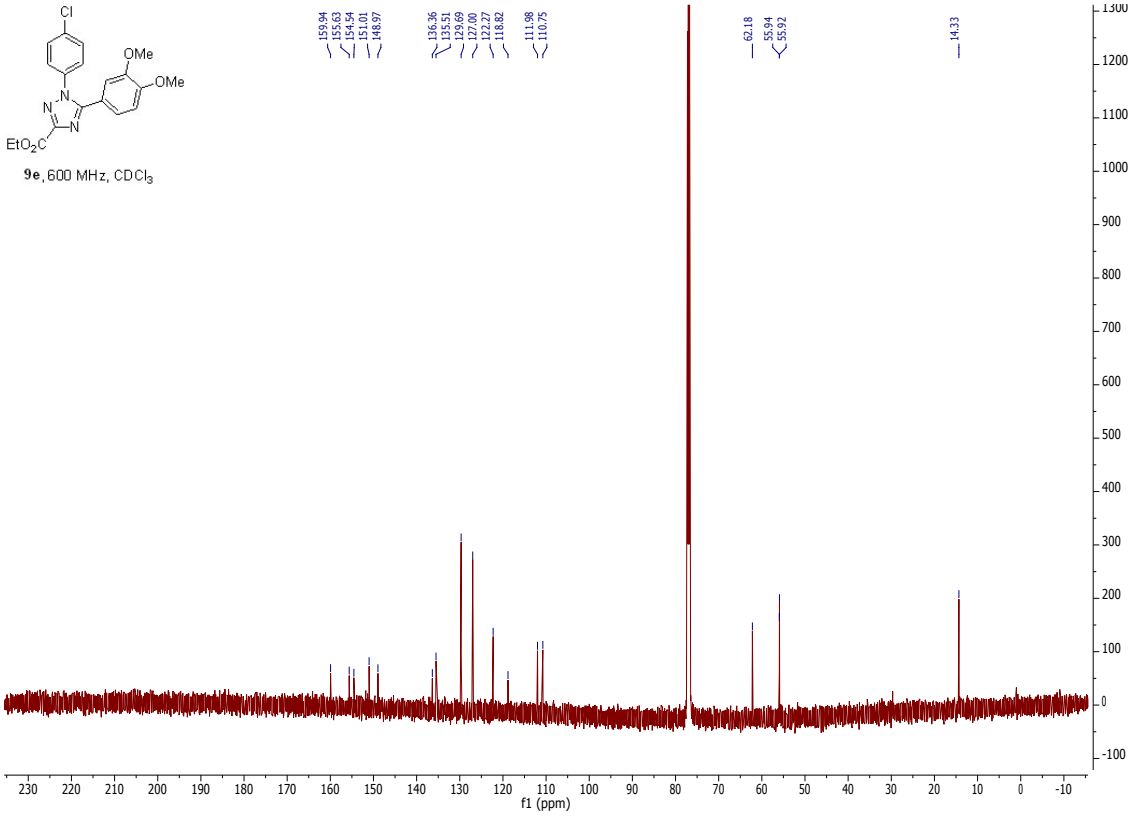

Cl
EtO2C
9c, 400 MHz, CDCl3
7.51
7.51
7.49
7.49
7.49
7.47
7.47
7.38
7.36
7.33
7.31
7.29
7.28
7.27
7.25
4.59
4.57
4.56
4.54
2.71
2.69
2.67
2.66
2.64
2.62
2.60
1.51
1.49
1.47
0.99
0.97
1.00
1.01
2.03
4.05
1.96
0.96
2.92
5.61
f1 (ppm)


Cl
EtO2C
9c, 400 MHz, CDCl3
159.93
155.63
154.59
148.08
135.62
134.76
131.23
130.31
129.39
126.23
126.11
125.65
125.23
62.19
30.54
23.55
14.36
f1 (ppm)

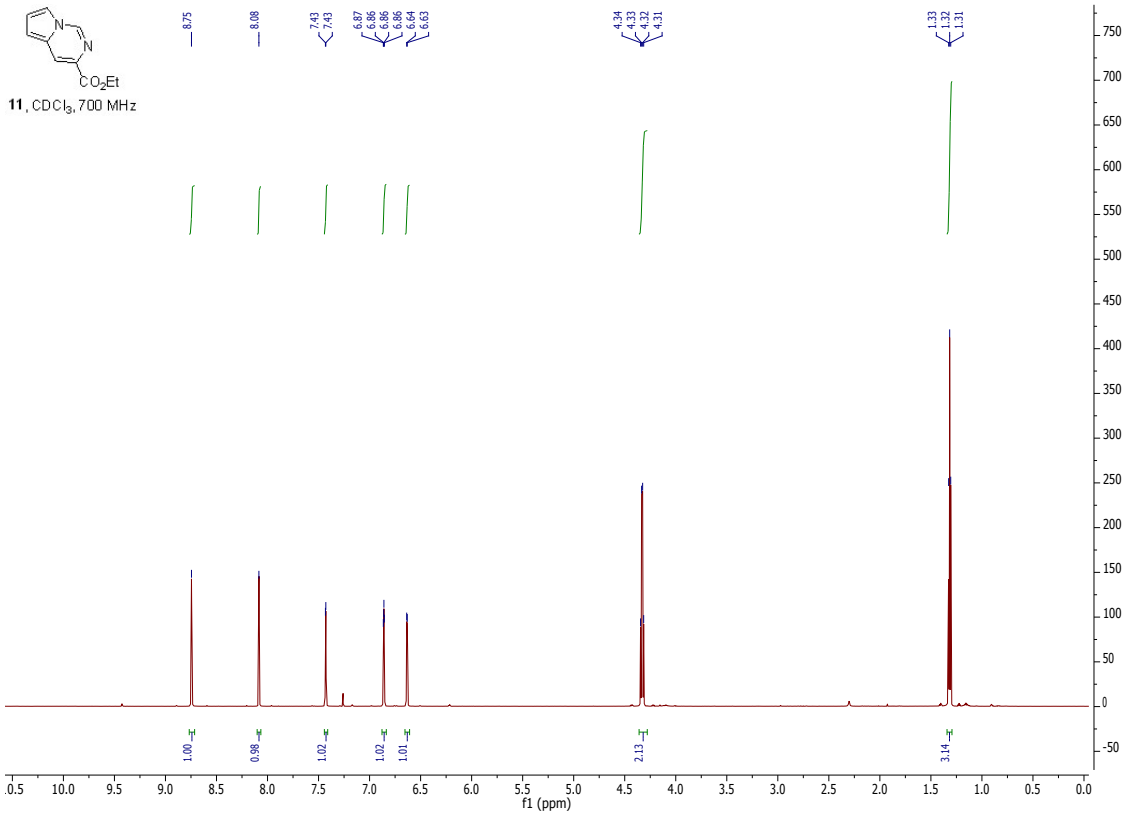

Cl
N
N
N
N
MeO
EtO2C
9d, 400 MHz, CDCl3
8.29
8.29
8.28
8.28
8.00
7.99
7.98
7.97
7.36
7.34
7.27
7.25
7.05
7.04
7.03
7.02
4.55
4.54
4.52
4.50
3.51
1.47
1.45
1.43
0.94
0.95
2.09
2.36
1.00
2.00
2.93
2.97
f1 (ppm)

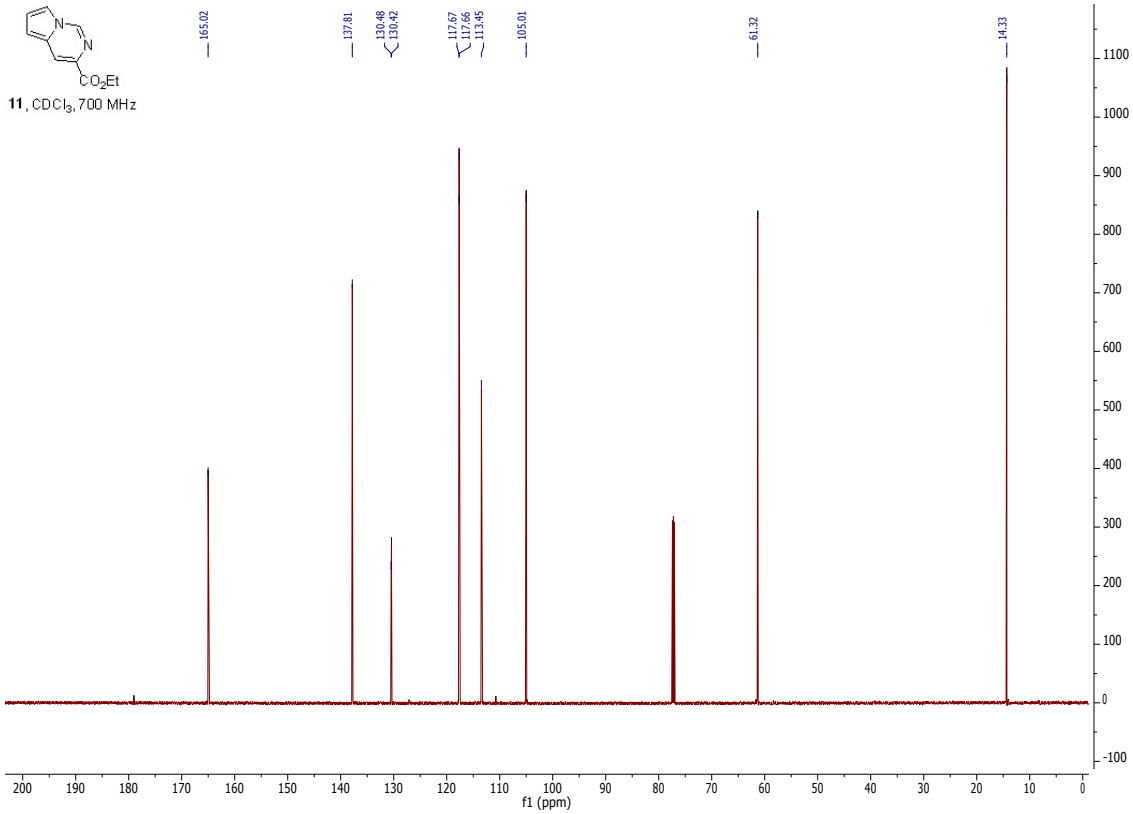

Cl
N
N
N
N
MeO
EtO2C
9d, 400 MHz, CDCl3
160.10
159.72
154.83
152.27
150.01
140.75
136.65
134.92
129.30
124.78
116.93
111.06
62.21
53.18
14.35
f1 (ppm)

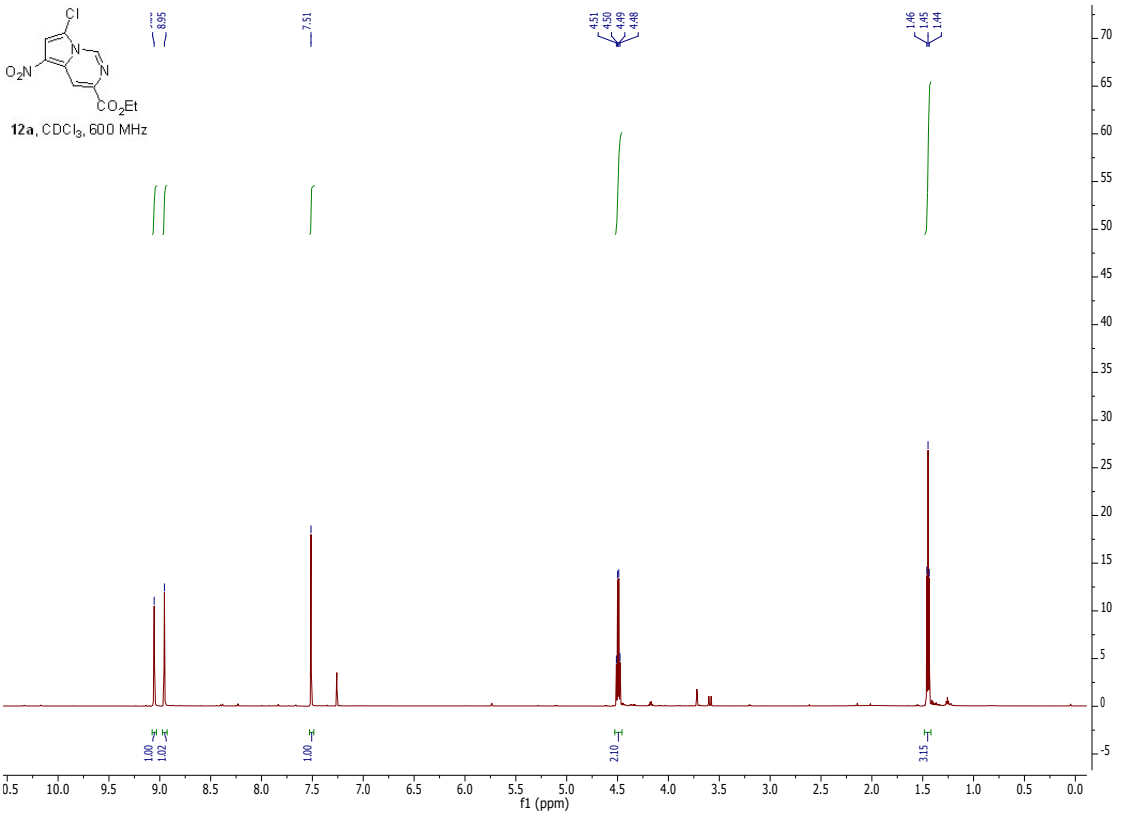

Cl
OMe
OMe
N
N
N
EtO2C
9e, 600 MHz, CDCl3
7.44
7.43
7.37
7.36
7.17
7.17
6.96
6.96
6.95
6.94
6.79
6.78
4.56
4.54
4.53
4.52
3.89
3.80
1.47
1.46
1.45
1.95
1.94
1.00
1.09
1.02
2.01
2.85
2.73
3.16
f1 (ppm)

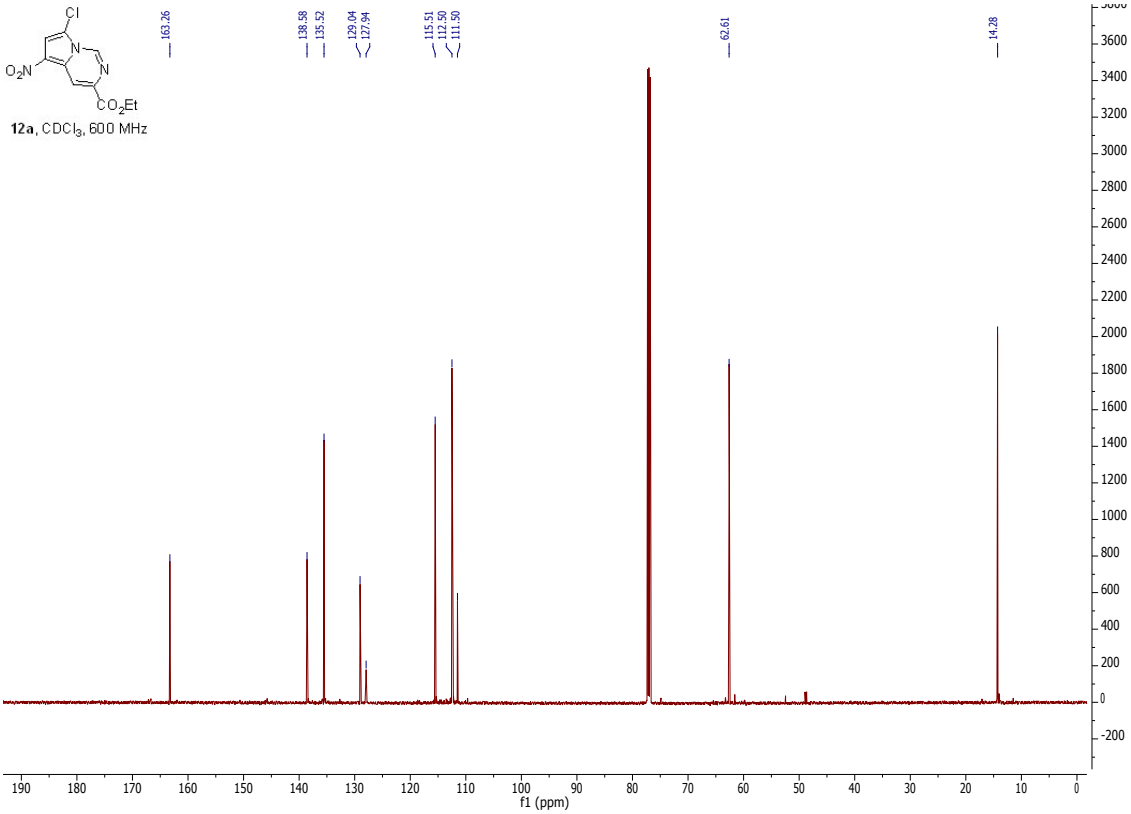

Cl
OMe
OMe
N
N
N
EtO2C
9e, 600 MHz, CDCl3
159.94
155.63
154.54
151.01
148.97
136.36
135.51
129.69
127.00
122.27
118.82
111.98
110.75
62.18
55.94
55.92
14.33
f1 (ppm)

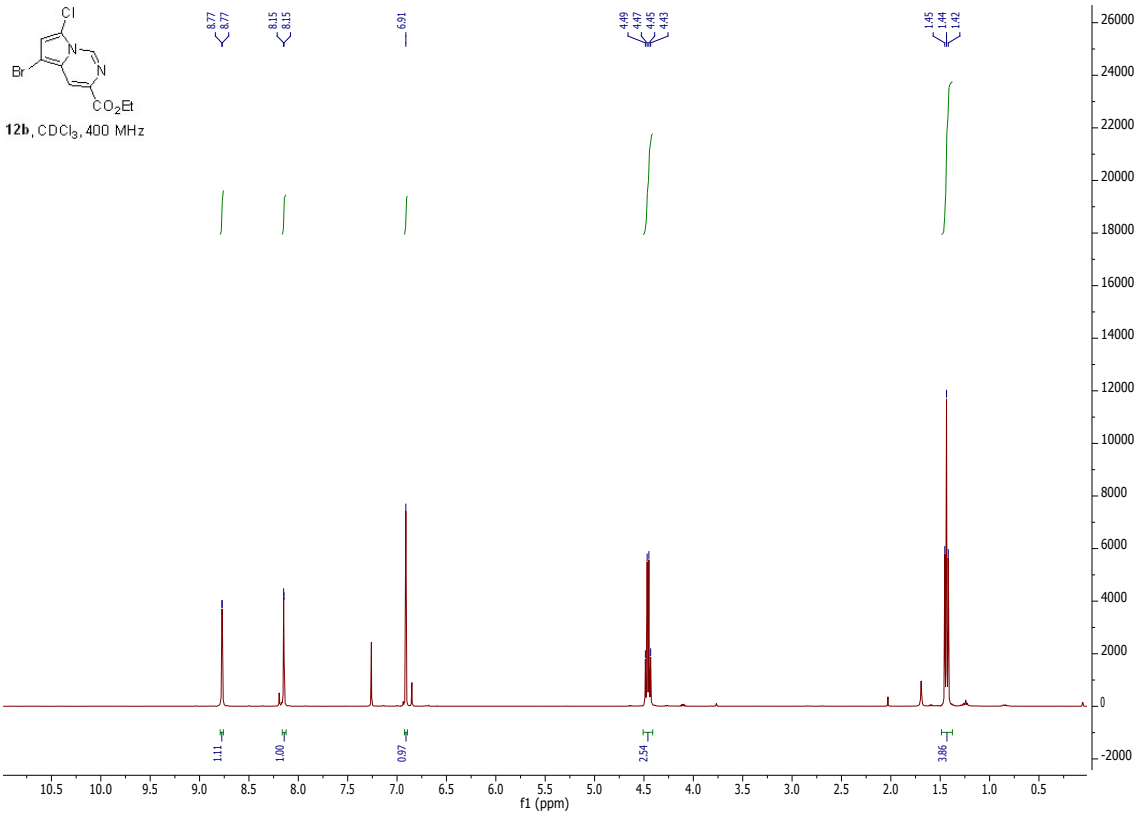
9. NMR-Spectra of compounds **11,** and **12a-i:**

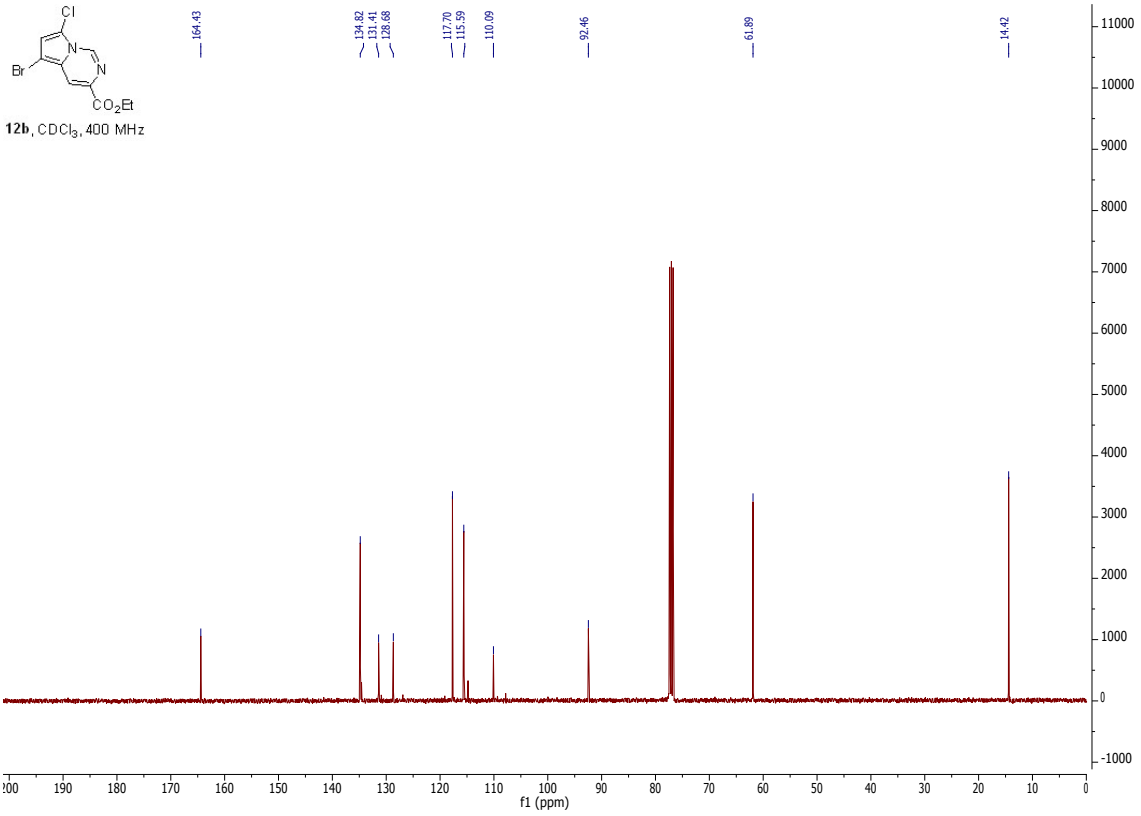


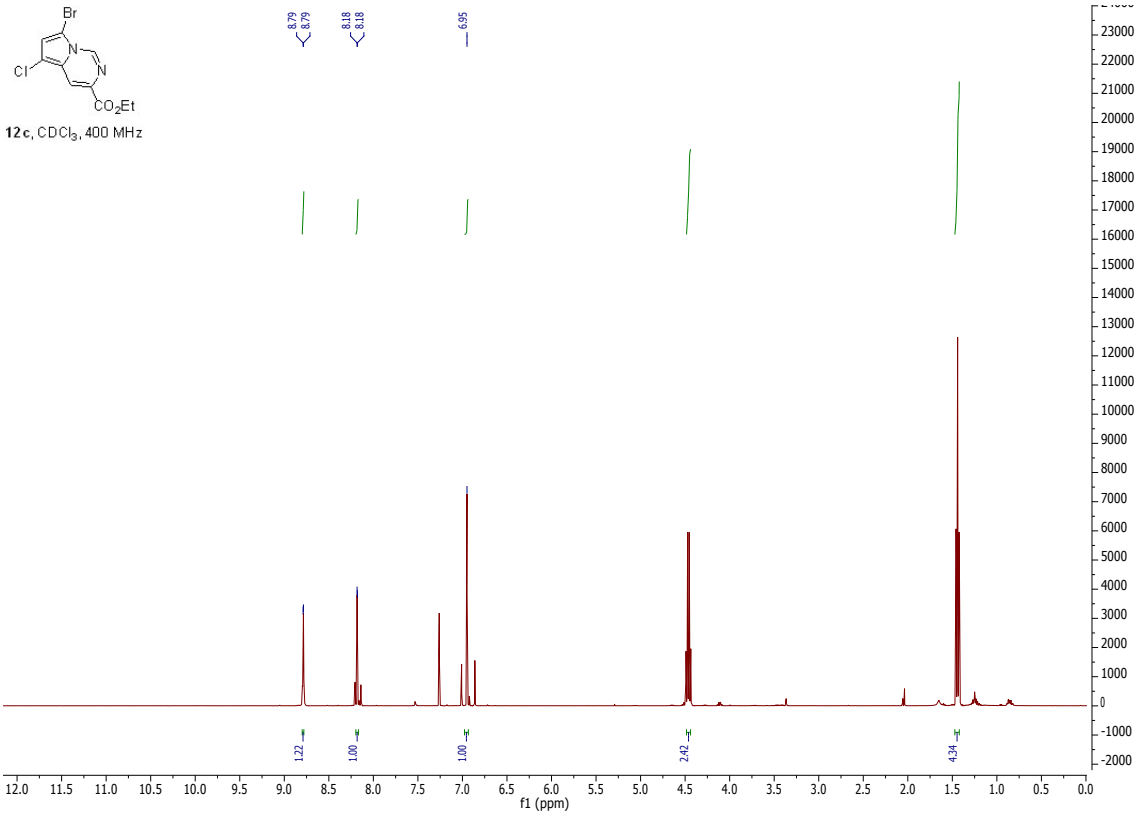


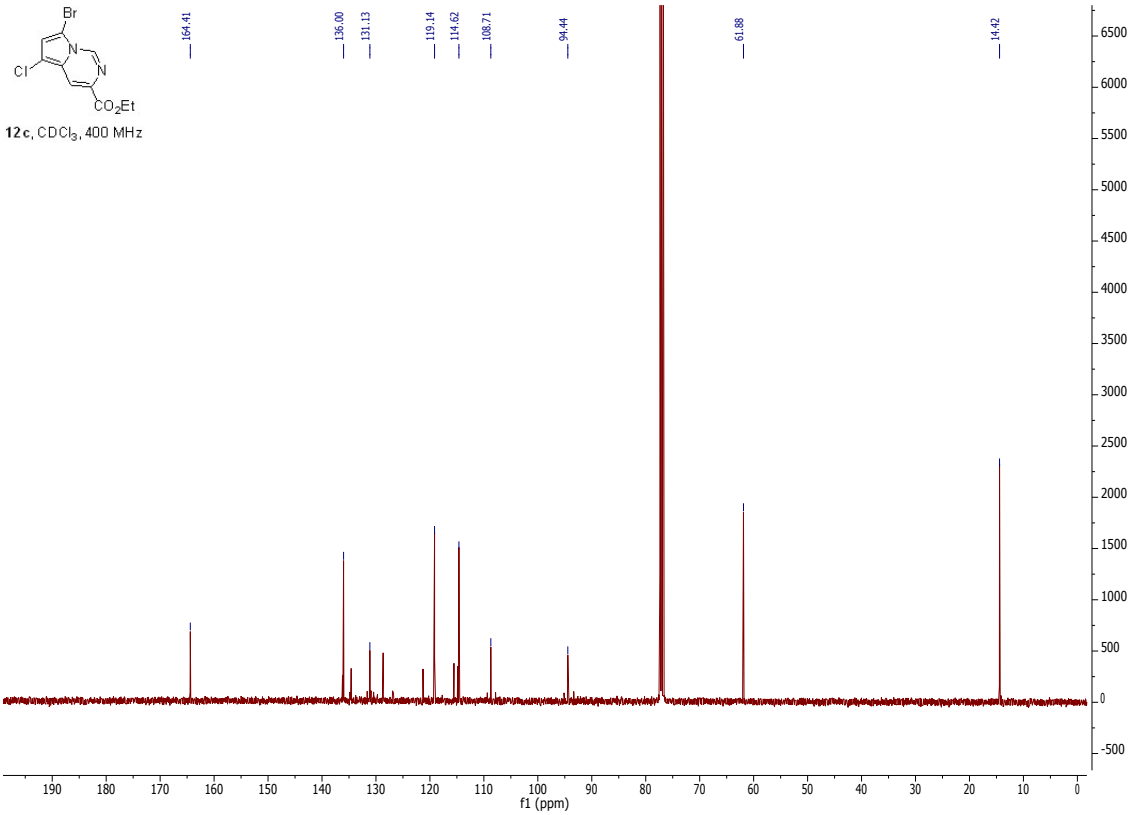

12a, CDCl3, 600 MHz
8.95
7.51
4.51
4.50
4.49
4.48
1.46
1.45
1.44
1.00
1.02
1.00
2.10
3.15
f1 (ppm)

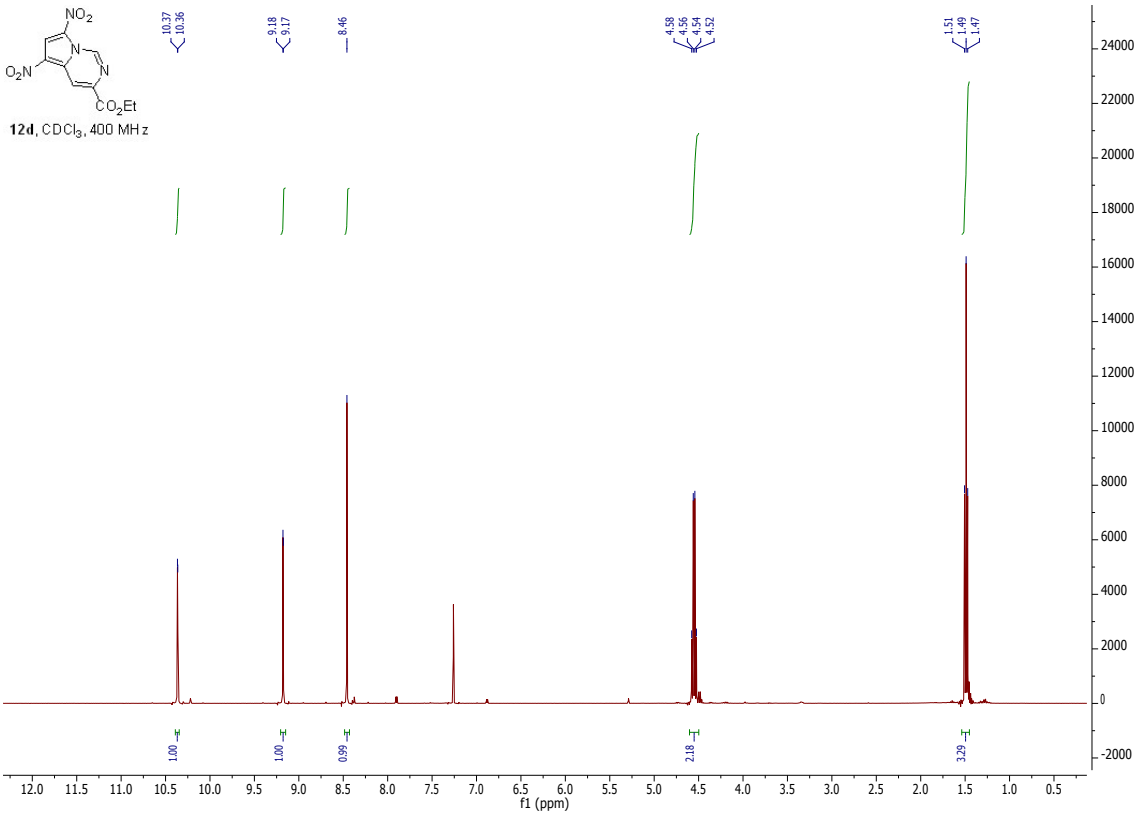

12a, CDCl3, 600 MHz
163.26
138.58
135.52
129.04
127.94
115.51
112.50
111.50
62.61
14.28
f1 (ppm)

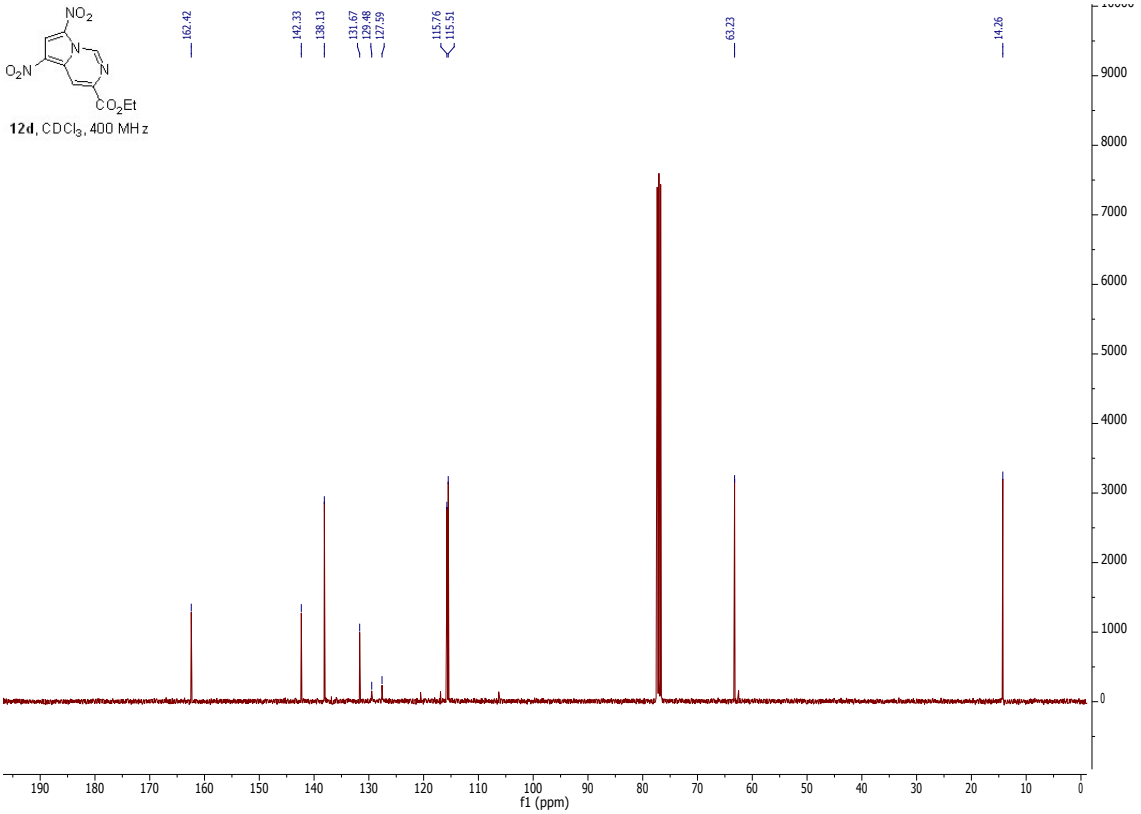

12b, CDCl3, 400 MHz
8.77
8.77
8.15
8.15
6.91
4.49
4.47
4.45
4.43
1.45
1.44
1.42
1.11
1.00
0.97
2.54
3.86
f1 (ppm)

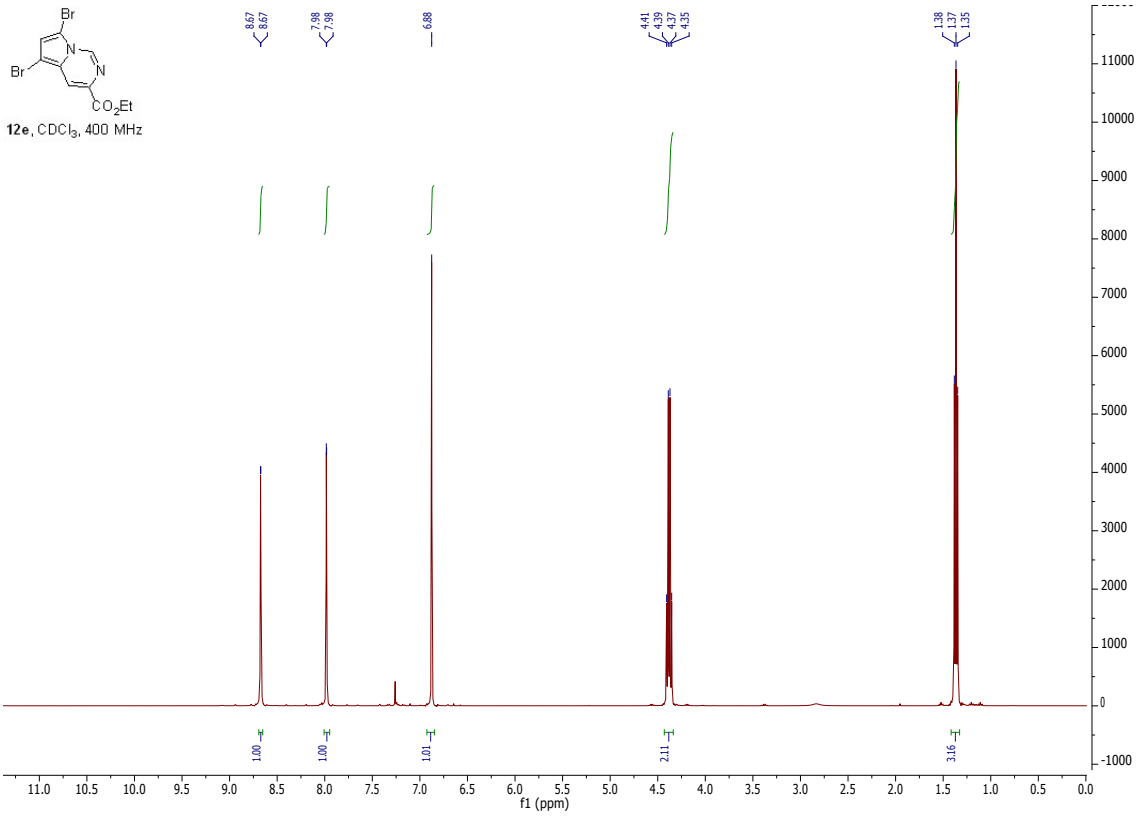

12b, CDCl3, 400 MHz
164.43
134.82
131.41
128.68
117.70
115.59
110.09
92.46
61.89
14.42
f1 (ppm)

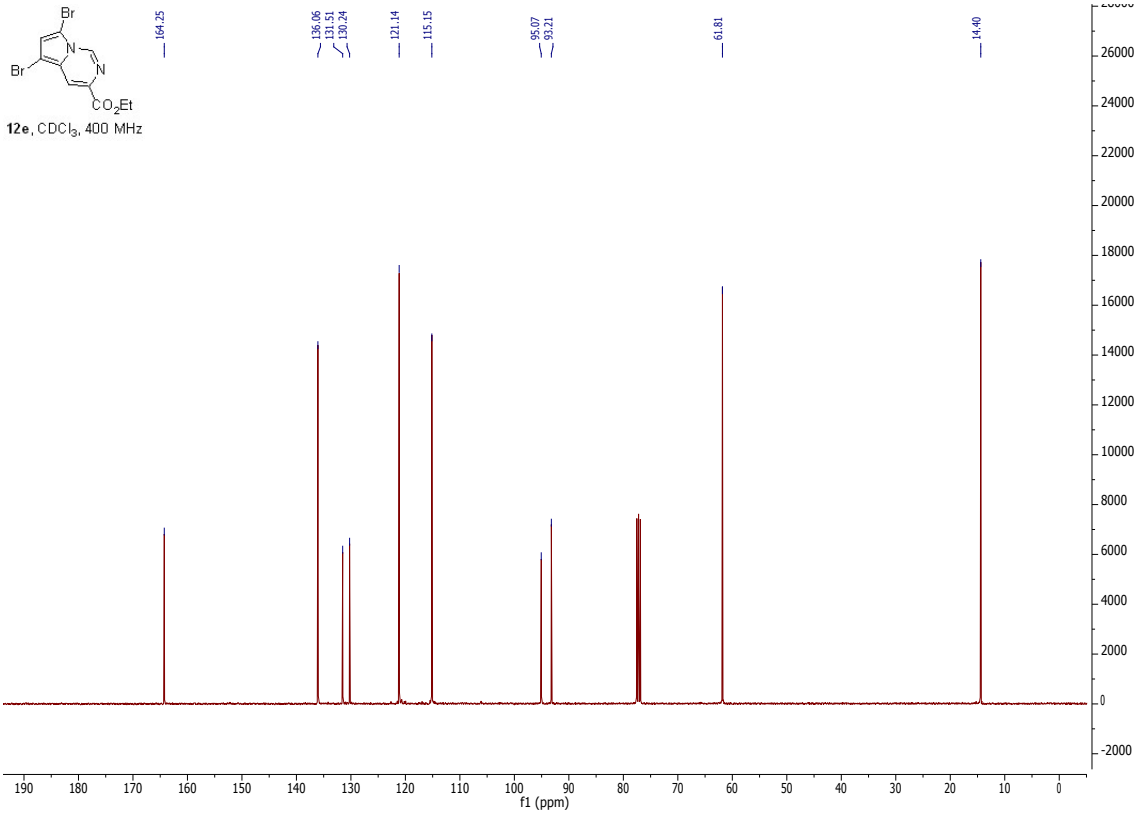

Br
Cl
N
N
CO2Et
12c, CDCl3, 400 MHz
8.79
8.79
8.18
8.18
6.95
1.22
1.00
1.00
2.42
4.34
f1 (ppm)

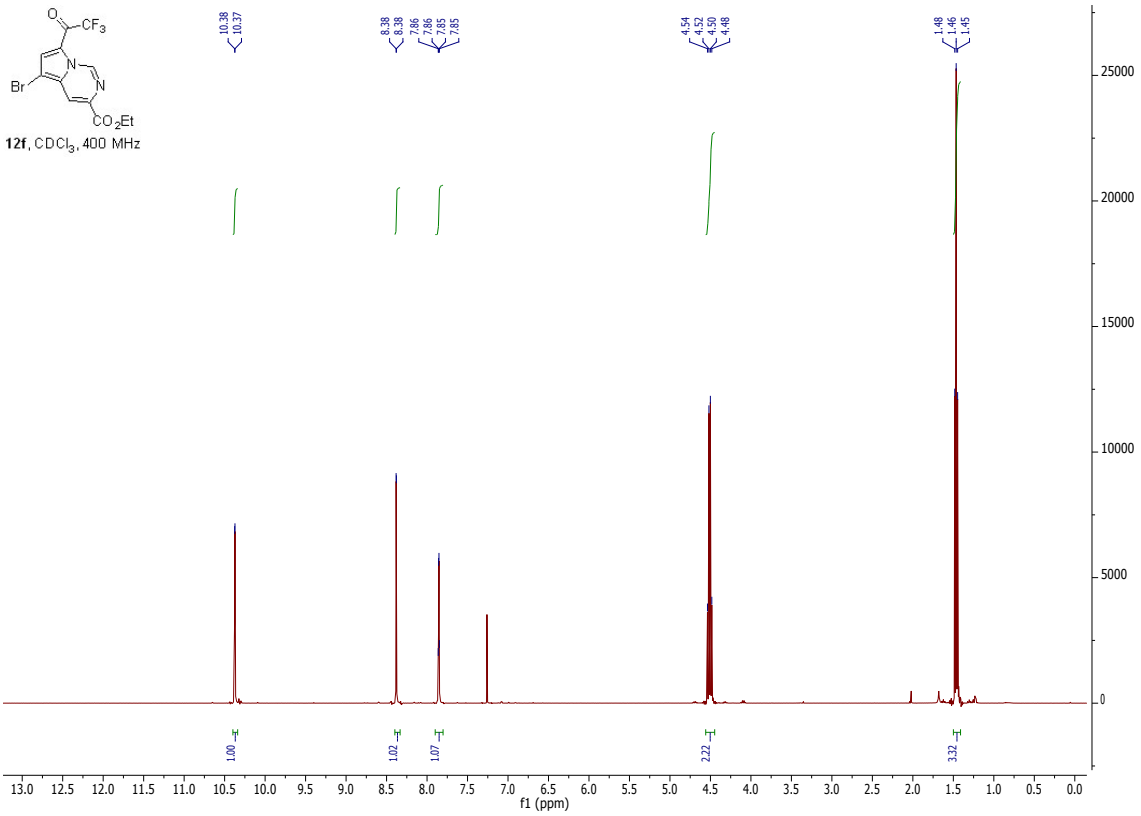

Br
Cl
N
N
CO2Et
12c, CDCl3, 400 MHz
164.41
136.00
131.13
119.14
114.62
108.71
94.44
61.88
14.42
f1 (ppm)

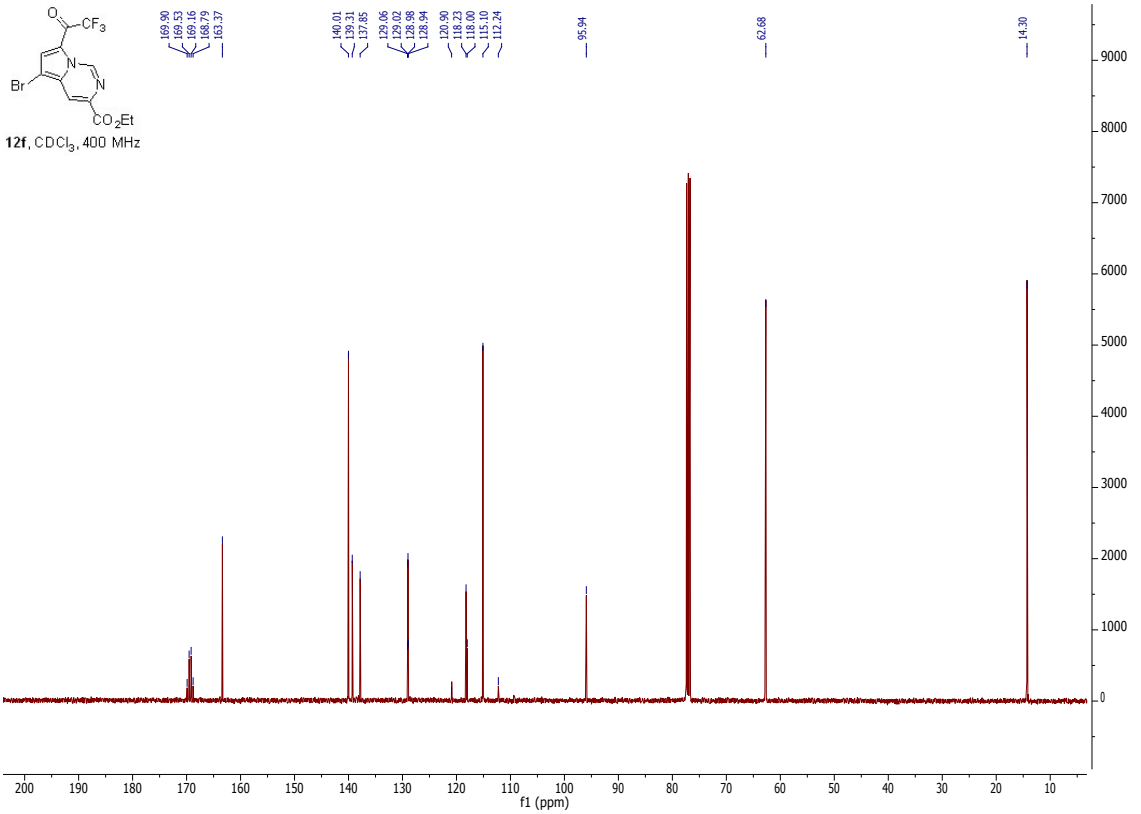

12d, CDCl3, 400 MHz
10.37
10.36
9.18
9.17
8.46
4.58
4.56
4.54
4.52
1.51
1.49
1.47
1.00
1.00
0.99
2.18
3.29
f1 (ppm)

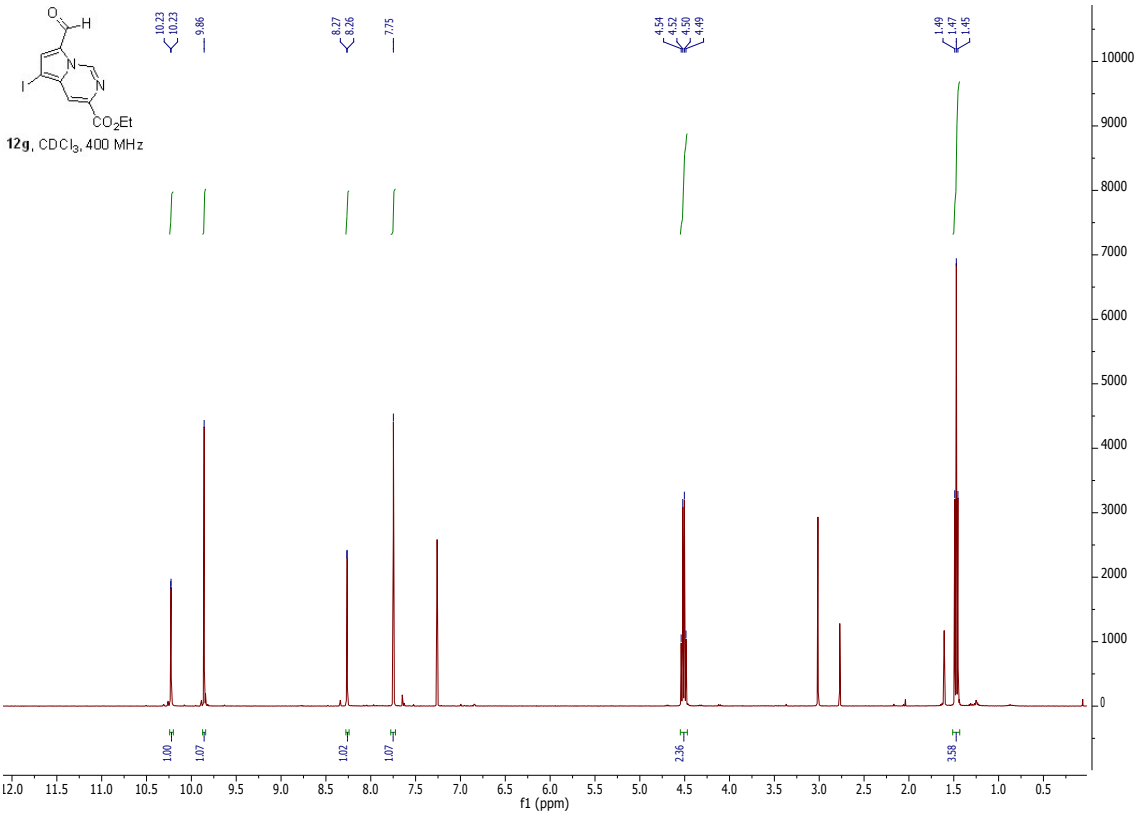

12d, CDCl3, 400 MHz
162.42
142.33
138.13
131.67
129.48
127.59
115.76
115.51
63.23
14.26
f1 (ppm)

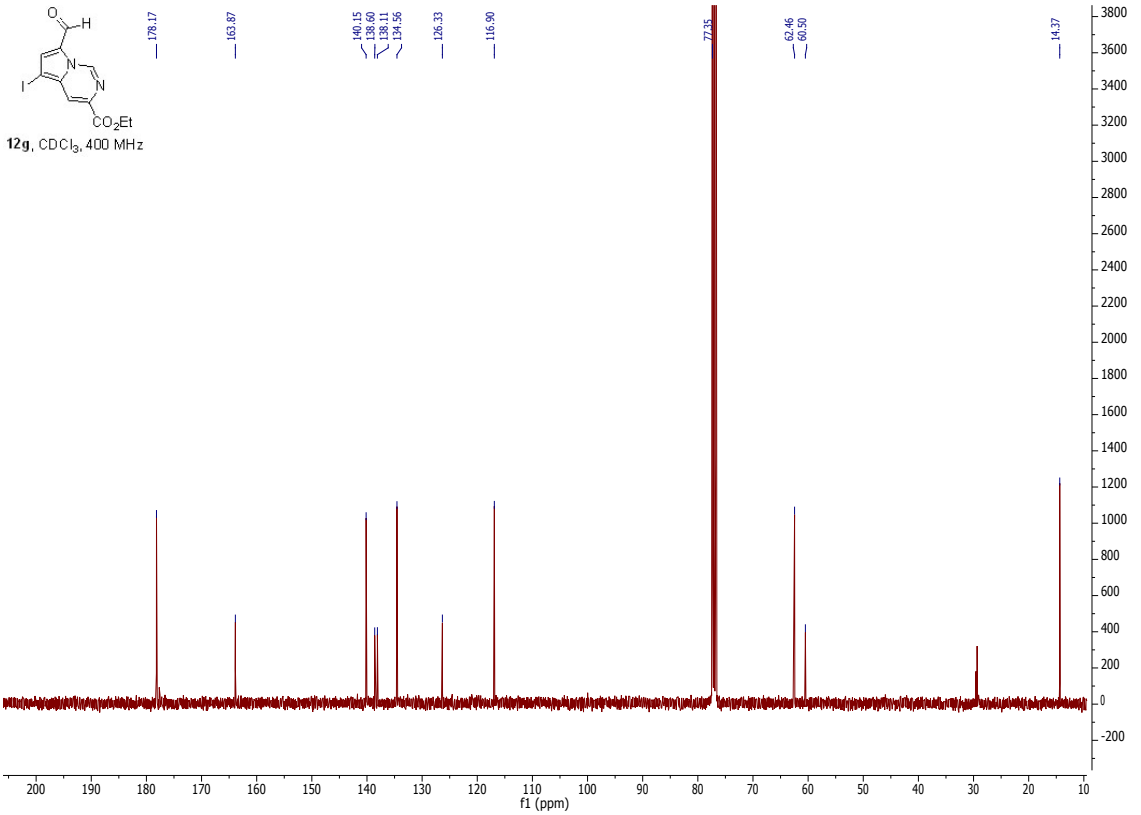

Br
Br
N
N
CO2Et
12e, CDCl3, 400 MHz
8.67
8.67
7.98
7.98
6.88
4.41
4.39
4.37
4.35
1.38
1.37
1.35
1.00
1.00
1.01
2.11
3.16
f1 (ppm)

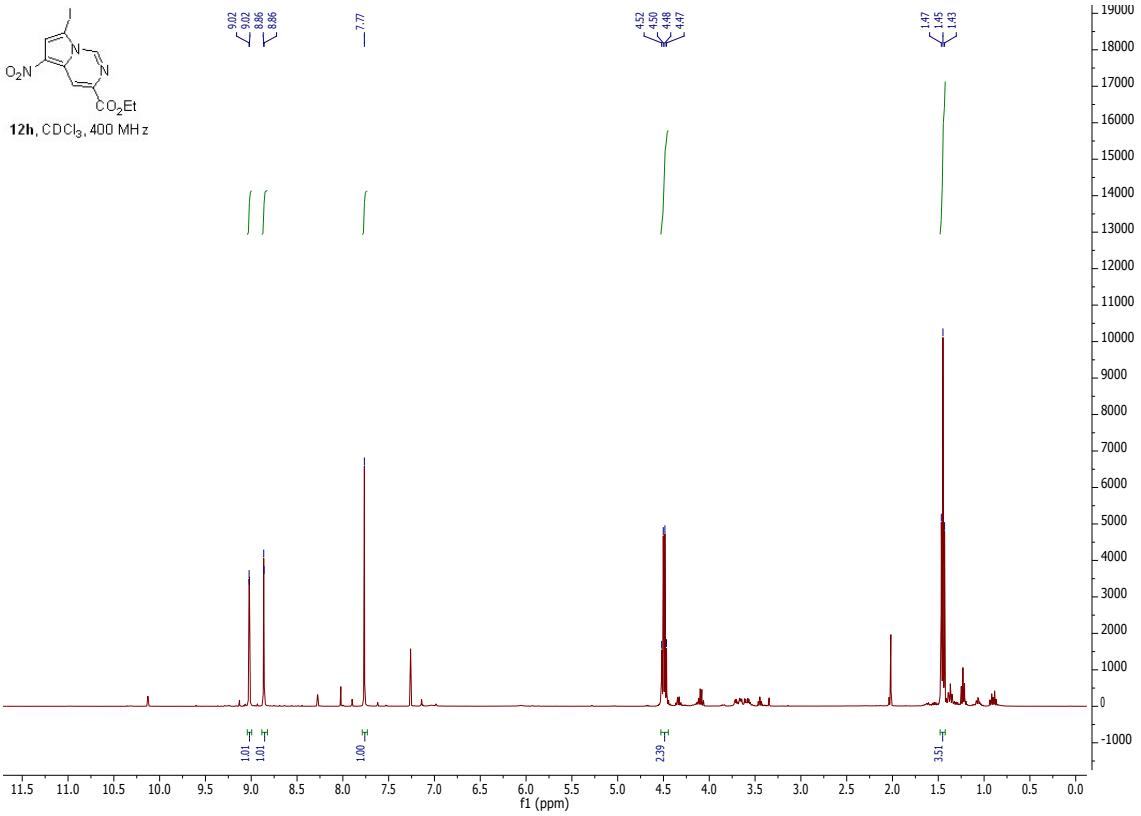

Br
Br
N
N
CO2Et
12e, CDCl3, 400 MHz
164.25
136.06
131.51
130.24
121.14
115.15
95.07
93.21
61.81
14.40
f1 (ppm)

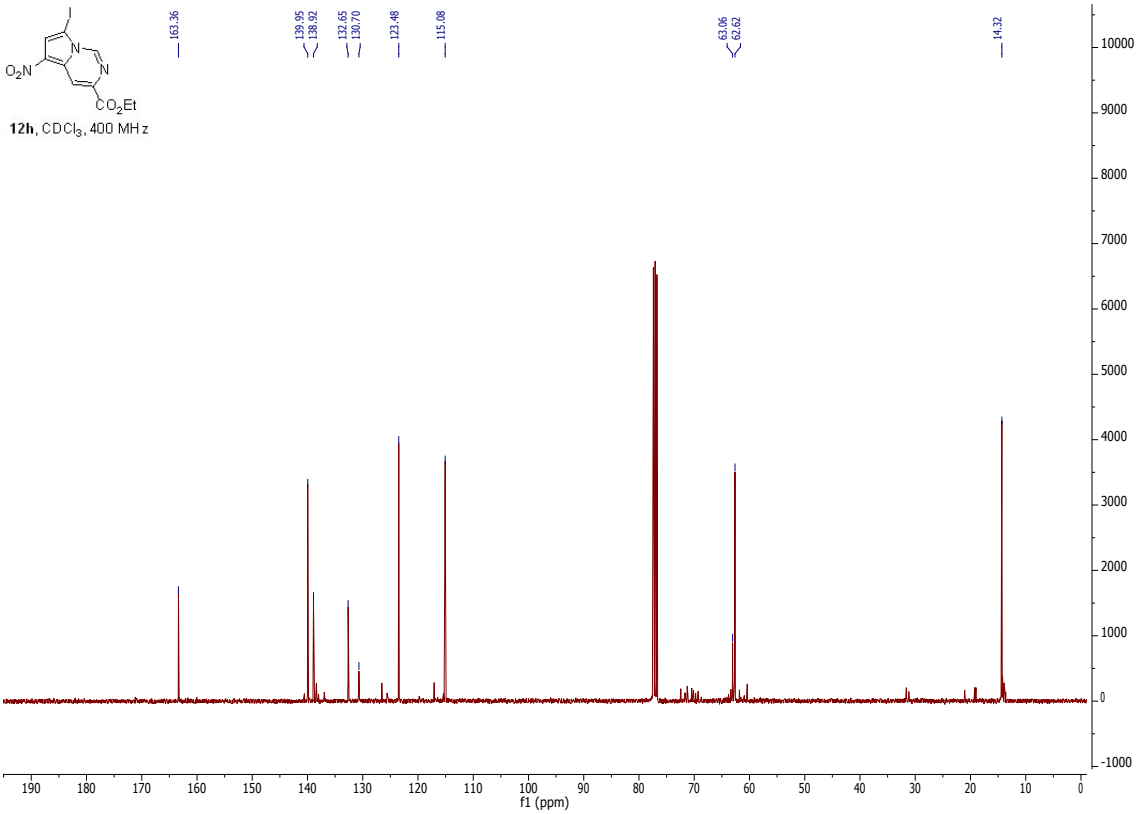

12f, CDCl3, 400 MHz
10.38
10.37
8.38
8.38
7.86
7.86
7.85
7.85
4.54
4.52
4.50
4.48
1.48
1.46
1.45
1.00
1.02
1.07
2.22
3.32
f1 (ppm)

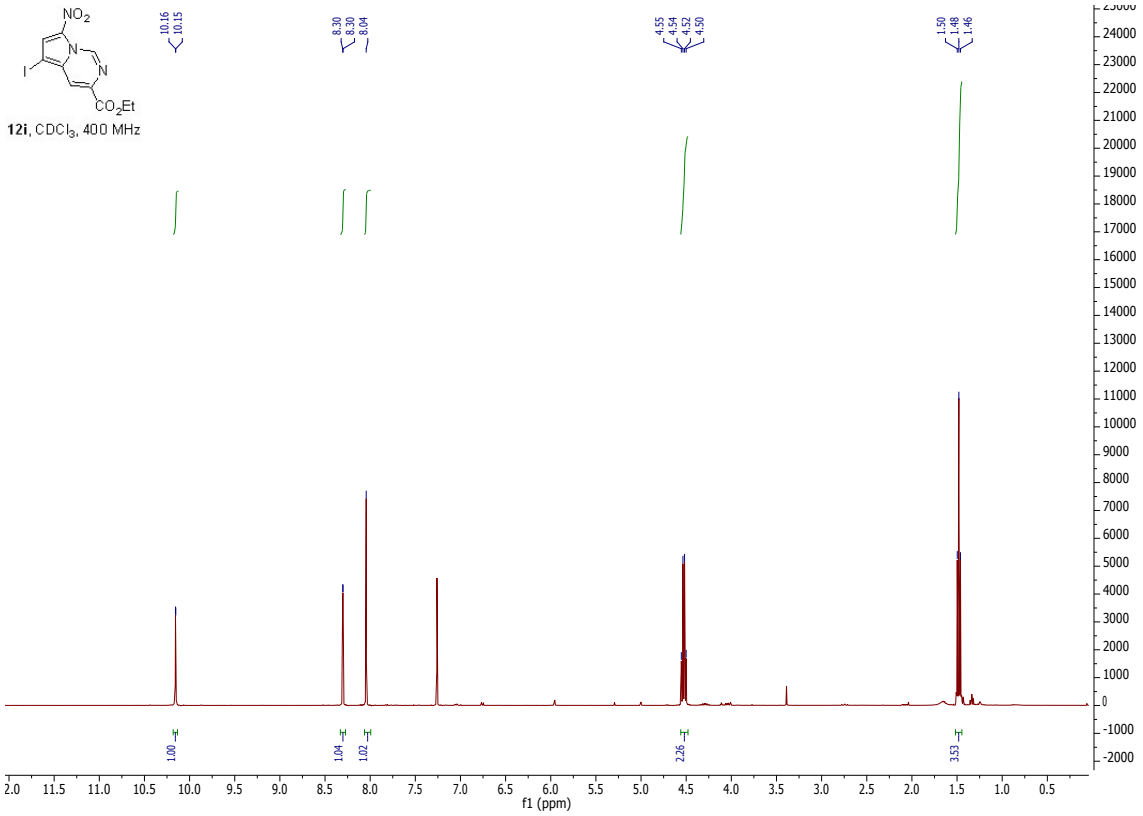

12f, CDCl3, 400 MHz
169.90
169.53
169.16
168.79
163.37
140.01
139.31
137.85
129.06
129.02
126.98
126.94
120.90
118.23
118.00
115.10
112.24
95.94
62.68
14.30
f1 (ppm)

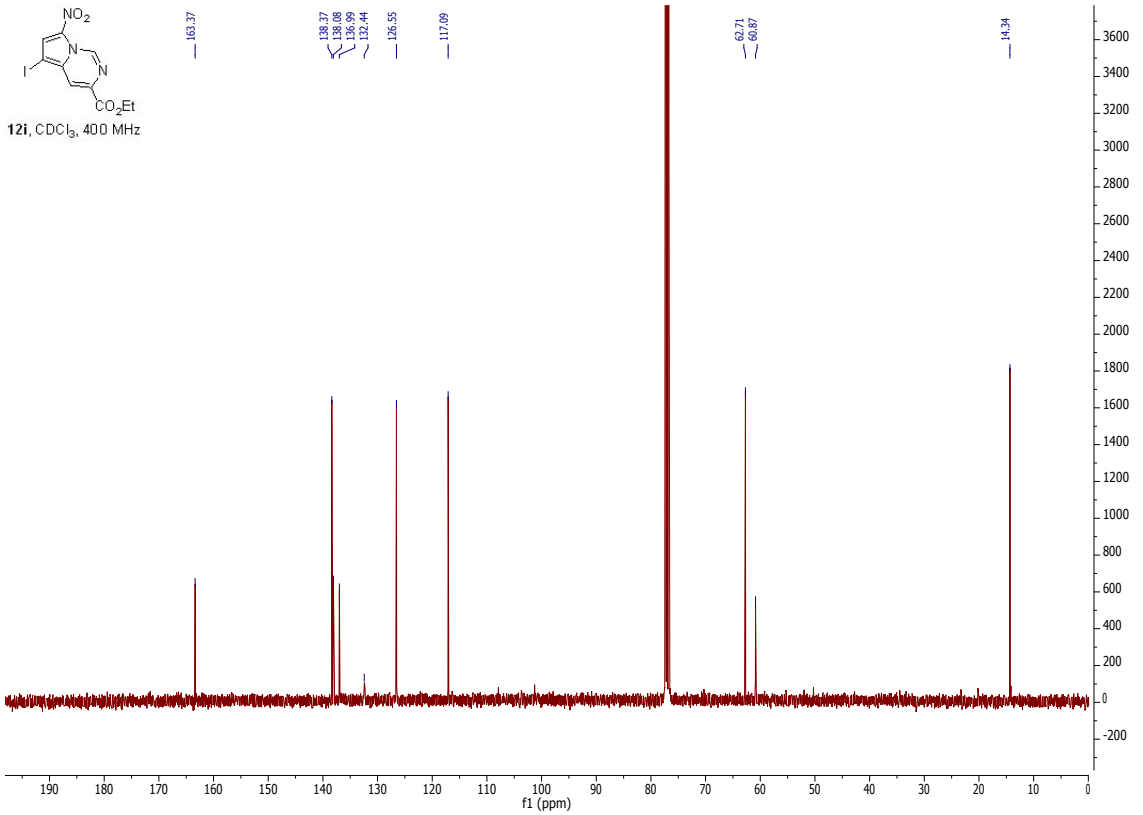

12g, CDCl3, 400 MHz
10.23
10.23
9.86
8.27
8.26
7.75
4.54
4.52
4.50
4.49
1.49
1.47
1.45
1.00
1.07
1.02
1.07
2.36
3.58
f1 (ppm)


12g, CDCl3, 400 MHz
178.17
163.87
140.15
139.60
138.11
134.56
126.33
116.90
77.35
62.46
60.50
14.37
f1 (ppm)


12h, CDCl3, 400 MHz
9.02
9.02
8.86
8.86
7.77
4.52
4.50
4.48
4.47
1.47
1.45
1.43
1.01
1.01
1.00
2.39
3.51
f1 (ppm)


12h, CDCl3, 400 MHz
163.36
139.95
138.92
132.65
130.70
123.48
115.08
63.06
62.62
14.32
f1 (ppm)


12i, CDCl3, 400 MHz
10.16
10.15
8.30
8.30
8.04
4.55
4.54
4.52
4.50
1.50
1.48
1.46
1.00
1.04
1.02
2.26
3.53
f1 (ppm)


12i, CDCl3, 400 MHz
163.37
138.37
138.08
136.99
132.44
126.55
117.09
62.71
60.87
14.34
f1 (ppm)

10. Experimental details for single crystal X-ray analysis:

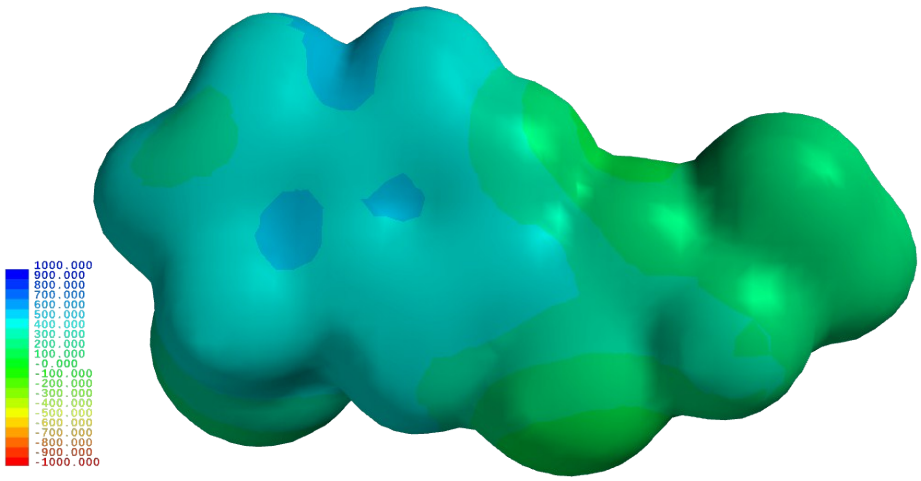
Table 1 Crystal data and structure refinement

Identification code	14srv265; **12i**	14srv235; **12f**	192B; **12a**	14srv167; **7h**	13srv320; **SI12f'**
Empirical formula	$C_{10}H_8IN_3O_4$	$C_{12}H_8N_2O_3F_3Br$	$C_{10}H_8ClN_3O_4$	$C_{11}H_{10}N_3O_2Cl$	$C_{12}H_9F_3N_2O_3$
Formula weight	361.09	377.12	269.64	251.67	286.21
Temperature/K	120.0	120.0	120.0	120.0	120
Crystal system	monoclinic	triclinic	triclinic	monoclinic	orthorhombic
Space group	$P2_1/c$	P-1	P-1	$P2_1$	Pbca
a/Å	14.7611(3)	6.79290(10)	6.3391(12)	8.0883(3)	12.5161(10)
b/Å	4.6408(3)	9.5186(2)	7.7064(15)	7.0136(3)	14.0082(11)
c/Å	17.1279(3)	10.3220(2)	12.819(2)	10.3616(4)	27.051(2)
α/°	90.00	102.643(3)	93.164(6)	90.00	90
β/°	90.424(2)	91.759(3)	102.778(6)	107.9650(10)	90
γ/°	90.00	104.107(3)	113.261(6)	90.00	90
Volume/$Å^3$	1173.29(8)	629.09(2)	553.93(18)	559.14(4)	4742.7(7)
Z	4	2	2	2	16
$\rho_{calc}g/cm^3$	2.044	1.928	1.617	1.495	1.603
μ/mm^{-1}	2.741	3.317	0.356	0.334	0.147
F(000)	696.0	360.0	276.0	260.0	2336.0
Crystal size/mm^3	0.56 × 0.14 × 0.07	0.424 × 0.249 × 0.187	0.28 × 0.22 × 0.02	0.4 × 0.22 × 0.14	0.63 × 0.46 × 0.33
2Θ range for data collection/°	4.76 to 60	4.54 to 56	7.14 to 58	4.14 to 58	3.012 to 49.998°
Index ranges	$-20 \le h \le 20$, $-6 \le k \le 6$, $-24 \le l \le 24$	$-8 \le h \le 8$, $-12 \le k \le 12$, $-13 \le l \le 13$	$-8 \le h \le 8$, $-10 \le k \le 10$, $-17 \le l \le 17$	$-11 \le h \le 11$, $-9 \le k \le 9$, $-14 \le l \le 14$	$-14 \le h \le 14$, $-16 \le k \le 16$, $-32 \le l \le 32$
Reflections collected	17049	10397	9387	6930	37987
Independent reflections, R_{int}, R_{sigma}	3436, 0.0632, 0.0474	3027, 0.0641, 0.0558	2696, 0.0929, 0.0912	2957, 0.0399, 0.0402	4178, 0.0371, 0.0214

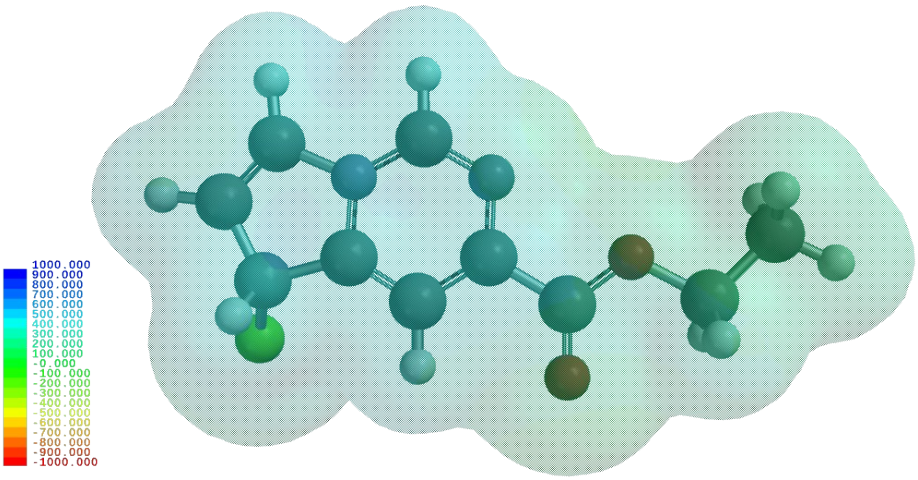
Data/restraints/parameters	3436/0/164	3027/0/191	2696/0/164	2957/1/194	4178/0/365
Goodness-of-fit on F^2	1.036	1.101	1.024	1.088	1.209
Final R_1/wR_2 indexes [I≥2σ (I)]	0.0320, 0.0742	0.0507, 0.1256	0.0889, 0.2074	0.0404, 0.1009	0.0665, 0.1543
Final R_1/wR_2 indexes [all data]	0.0384, 0.0774	0.0528, 0.1275	0.1213, 0.2298	0.0453, 0.1052	0.0778, 0.1646
Diff. peak/hole/ e $Å^{-3}$	2.01/-0.66	1.84/-0.99	1.90/-1.31	0.51/-0.31	0.49/-0.31

11. DFT calculations:

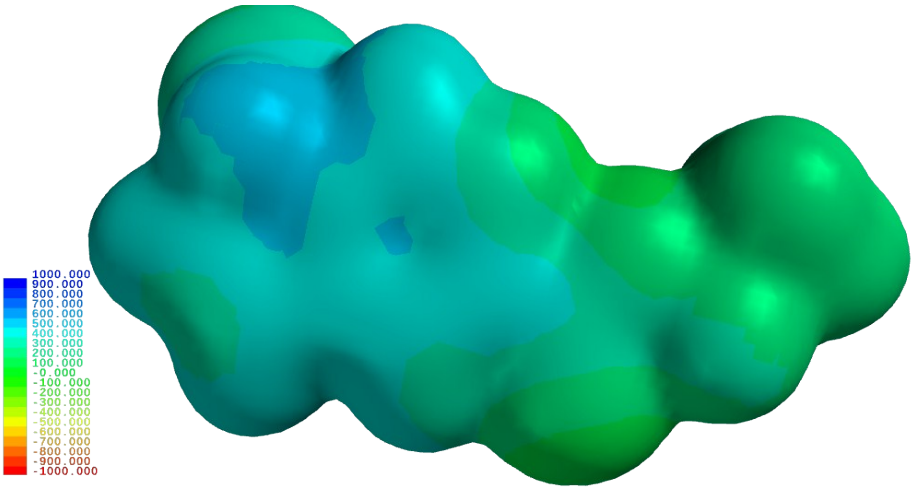
Electronic Surface Potentials attained from DFT calculations



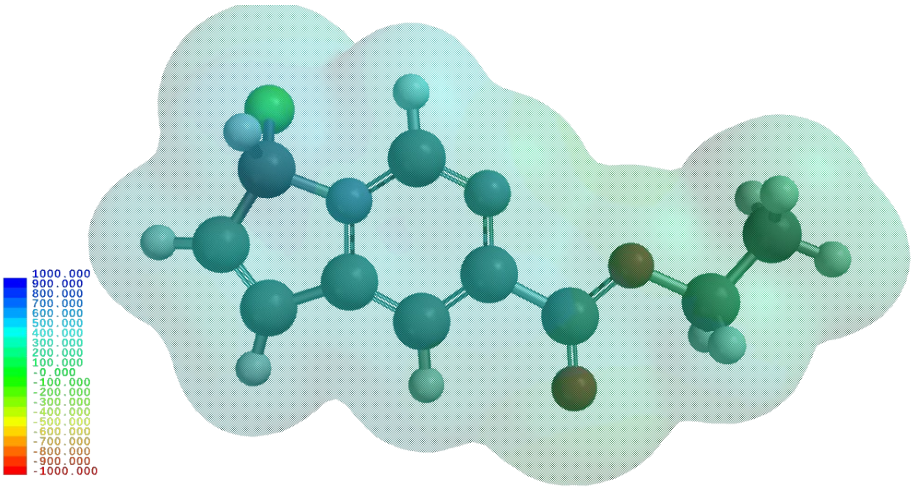
5ClH_py_py_PCM_fukui_ESP_solid (**5-Cl INT**)



5ClH_py_py_PCM_fukui_ESP (**5-Cl INT**)



7ClH_py_py_PCM_fukui_ESP_solid (**7-Cl INT**)



7ClH_py_py_PCM_fukui_ESP (**7-Cl INT**)

12. DFT calculations energy Table 2:

Table 2. Total Electronic Energies[a] (E, in a.u.) of all stationary points discussed in the main text for the compounds.

Structure	E	ΔZPE	G	NIMAG (ν)
Pyrrolopyrimidine	-647.004044411	0.190079	-646.853104	0
7-ClH*	-1107.00500394	0.193520	-1106.853212	0
7-Cl	-1106.60290081	0.180933	-1106.462740	0
5-ClH*	-1106.99936544	0.193153	-1106.848067	0
5-Cl	-1106.60471320	0.180405	-1106.465793	0
7-BrH*	-3220.97406844	0.193305	-3220.823035	0
7-Br	-3220.57004760	0.179910	-3220.432131	0
5-BrH*	-3220.96961194	0.192286	-3220.820449	0
5-Br	-3220.57253380	0.180675	-3220.433498	0
7-IH*	-942.431970713	0.192938	-942.281993	0
7-I	-942.024503083	0.179430	-941.888531	0
5-IH*	-942.429091879	0.192162	-942.280774	0
5-I	-942.027288745	0.179947	-941.890743	0

13. DFT calculations Z-matrix of all the stationary points of the reaction profiles:

Cartesian coordinates optimized at the M062x/6-311++G(2df,2pd) of all the stationary points discussed in the main text.

Pyrrolopyrimidine

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	-1.166452	-1.587171	0.000060
2	1	0	-0.581139	2.171410	-0.000084
3	6	0	0.238368	0.211684	-0.000024
4	6	0	-0.782491	1.110773	-0.000042
5	6	0	-3.372830	1.184251	-0.000007
6	6	0	-4.292545	0.115061	0.000043
7	6	0	-3.594039	-1.070194	0.000074
8	6	0	-2.107951	0.631382	-0.000005
9	1	0	-1.374978	-2.649958	0.000100
10	1	0	-3.926732	-2.093279	0.000113
11	1	0	-5.366203	0.196642	0.000055
12	1	0	-3.593706	2.237304	-0.000041
13	7	0	0.040161	-1.151691	0.000029
14	7	0	-2.262354	-0.763997	0.000046
15	6	0	1.637715	0.724460	-0.000066
16	8	0	1.907852	1.902437	-0.000135
17	8	0	2.548756	-0.239694	-0.000004
18	6	0	3.921067	0.186933	-0.000046
19	6	0	4.779514	-1.053478	0.000071
20	1	0	4.093389	0.802960	0.882031
21	1	0	4.093384	0.802788	-0.882245
22	1	0	5.830666	-0.769692	0.000030
23	1	0	4.582847	-1.656165	0.885089
24	1	0	4.582825	-1.656348	-0.884818

7-ClH*

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	1.334857	1.126753	0.052636
2	6	0	-0.002796	1.433263	-0.096784
3	6	0	-0.897065	0.390864	0.078338

4	6	0	0.737932	-1.106641	0.531974
5	6	0	3.120765	-0.284917	0.514409
6	6	0	3.589432	1.100699	0.204955
7	6	0	2.557602	1.904144	-0.052722
8	1	0	-0.339127	2.428710	-0.340078
9	1	0	1.089787	-2.098722	0.784284
10	1	0	4.638398	1.348747	0.208390
11	1	0	2.576590	2.951721	-0.300542
12	7	0	-0.535945	-0.860459	0.386833
13	7	0	1.661546	-0.148759	0.370409
14	6	0	-2.372473	0.696283	-0.092860
15	8	0	-2.746573	1.815875	-0.316068
16	8	0	-3.126728	-0.367956	0.024739
17	6	0	-4.549028	-0.159618	-0.143292
18	6	0	-5.220843	-1.501087	-0.011844
19	1	0	-4.708087	0.290230	-1.122160
20	1	0	-4.876971	0.546319	0.618337
21	1	0	-6.294315	-1.377708	-0.142936
22	1	0	-4.856652	-2.190451	-0.771223
23	1	0	-5.039462	-1.930473	0.971627
24	17	0	3.751287	-1.498852	-0.606632
25	1	0	3.354861	-0.605167	1.528113

7-Cl

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	-1.335385	1.254789	-0.000151
2	6	0	0.051971	1.495193	-0.000135
3	6	0	0.901505	0.432504	0.000024
4	6	0	-0.791366	-1.101773	0.000155
5	6	0	-3.091032	-0.144294	-0.000040
6	6	0	-3.581082	1.139292	-0.000208
7	6	0	-2.482841	2.021596	-0.000280
8	1	0	0.432244	2.505646	-0.000244
9	1	0	-1.179923	-2.111496	0.000266
10	1	0	-4.626353	1.396453	-0.000272
11	1	0	-2.515024	3.096747	-0.000411
12	7	0	0.470301	-0.874590	0.000169
13	7	0	-1.728047	-0.095998	0.000002
14	6	0	2.369951	0.693087	0.000038
15	8	0	2.839425	1.806093	-0.000117
16	8	0	3.097163	-0.415377	0.000104
17	6	0	4.522878	-0.235101	0.000022
18	6	0	5.154067	-1.604847	0.000090
19	1	0	4.799087	0.342257	0.881842

20	1	0	4.798995	0.342126	-0.881911
21	1	0	6.238168	-1.504899	0.000018
22	1	0	4.858437	-2.165791	0.885112
23	1	0	4.858332	-2.165926	-0.884811
24	17	0	-3.921437	-1.633494	0.000131

5-ClH*

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	-1.537521	0.022225	0.316472
2	6	0	-0.360799	-0.672069	0.370177
3	6	0	0.796727	0.062331	0.123433
4	6	0	-0.354748	1.988715	-0.195552
5	6	0	-2.841162	1.878943	0.004991
6	6	0	-3.700325	0.908225	0.272707
7	6	0	-2.968693	-0.375594	0.523599
8	1	0	-0.323540	-1.728806	0.586592
9	1	0	-0.405112	3.046317	-0.414776
10	1	0	-2.979036	2.923971	-0.212462
11	1	0	-4.771864	0.999342	0.322267
12	7	0	0.795195	1.364013	-0.151781
13	7	0	-1.510011	1.344681	0.029256
14	6	0	2.120454	-0.673089	0.177842
15	8	0	2.159220	-1.847102	0.430032
16	8	0	3.143131	0.105652	-0.072036
17	6	0	4.445621	-0.525207	-0.035747
18	6	0	5.470320	0.537924	-0.332164
19	1	0	4.451187	-1.325798	-0.774001
20	1	0	4.577341	-0.964897	0.951701
21	1	0	6.464079	0.095013	-0.302616
22	1	0	5.310596	0.964724	-1.320516
23	1	0	5.424059	1.333953	0.408556
24	17	0	-3.438824	-1.678596	-0.596521
25	1	0	-3.122062	-0.751364	1.535267

5-Cl

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	1.601138	0.058465	0.000028

2	6	0	0.390444	-0.659323	0.000132
3	6	0	-0.773202	0.043998	0.000224
4	6	0	0.284701	2.069104	0.000112
5	6	0	2.767377	1.996164	-0.000087
6	6	0	3.673102	0.961871	-0.000146
7	6	0	2.947070	-0.243453	-0.000078
8	1	0	0.388925	-1.739116	0.000147
9	1	0	0.300961	3.151955	0.000101
10	1	0	2.912949	3.061553	-0.000110
11	1	0	4.744963	1.058571	-0.000229
12	7	0	-0.821272	1.421564	0.000209
13	7	0	1.512862	1.456058	0.000020
14	6	0	-2.060499	-0.710115	0.000356
15	8	0	-2.113585	-1.916772	0.000119
16	8	0	-3.126902	0.076895	0.000110
17	6	0	-4.401510	-0.588119	-0.000130
18	6	0	-5.469826	0.476141	-0.000389
19	1	0	-4.458686	-1.225461	0.881821
20	1	0	-4.458325	-1.225527	-0.882056
21	1	0	-6.451310	0.004889	-0.000586
22	1	0	-5.388711	1.104965	0.884712
23	1	0	-5.388331	1.104912	-0.885493
24	17	0	3.595739	-1.832322	-0.000111

7-BrH*

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	0.685229	1.422993	0.065934
2	6	0	-0.666414	1.585255	-0.169173
3	6	0	-1.470433	0.485020	0.068128
4	6	0	0.269799	-0.808419	0.717890
5	6	0	2.563244	0.233677	0.721791
6	6	0	2.918343	1.627047	0.330427
7	6	0	1.831965	2.304526	-0.046279
8	1	0	-1.077745	2.519038	-0.518431
9	1	0	0.698258	-1.739095	1.067138
10	1	0	3.936218	1.978808	0.369169
11	1	0	1.769025	3.326194	-0.379455
12	7	0	-1.012174	-0.695397	0.505051
13	7	0	1.111873	0.215053	0.508114
14	6	0	-2.958785	0.635935	-0.178174
15	8	0	-3.421765	1.689285	-0.523924
16	8	0	-3.621133	-0.475405	0.026889
17	6	0	-5.051473	-0.408741	-0.183653
18	6	0	-5.610863	-1.783475	0.072272

19	1	0	-5.225509	-0.072677	-1.204675
20	1	0	-5.455079	0.337427	0.499172
21	1	0	-6.689666	-1.762816	-0.070416
22	1	0	-5.184592	-2.508491	-0.618489
23	1	0	-5.402515	-2.101163	1.092133
24	1	0	2.791240	-0.012382	1.755797
25	35	0	3.440628	-1.087897	-0.385794

7-Br

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	-0.617555	1.577758	-0.000066
2	6	0	0.787038	1.668859	-0.000157
3	6	0	1.517963	0.521856	-0.000161
4	6	0	-0.329394	-0.821630	-0.000001
5	6	0	-2.516016	0.377983	0.000064
6	6	0	-2.861240	1.708283	0.000044
7	6	0	-1.673891	2.465634	-0.000032
8	1	0	1.273015	2.632984	-0.000230
9	1	0	-0.823633	-1.784308	0.000068
10	1	0	-3.871295	2.079971	0.000074
11	1	0	-1.588494	3.537979	-0.000070
12	7	0	0.949698	-0.731279	-0.000077
13	7	0	-1.154812	0.277419	0.000003
14	6	0	3.005527	0.626228	-0.000260
15	8	0	3.588997	1.684025	-0.000261
16	8	0	3.612479	-0.551975	-0.000040
17	6	0	5.049851	-0.519390	0.000056
18	6	0	5.538005	-1.946282	0.000331
19	1	0	5.383028	0.027149	0.881894
20	1	0	5.383154	0.026855	-0.881915
21	1	0	6.626626	-1.957571	0.000417
22	1	0	5.186571	-2.473659	0.885515
23	1	0	5.186708	-2.473956	-0.884730
24	35	0	-3.609526	-1.127160	0.000085

5-BrH*

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	-1.018685	0.404393	0.449953
2	6	0	0.088913	-0.396139	0.537131

3	6	0	1.296413	0.183049	0.160684
4	6	0	0.324092	2.167261	-0.341608
5	6	0	-2.140692	2.349265	0.005928
6	6	0	-3.074955	1.509601	0.427935
7	6	0	-2.465843	0.183577	0.749694
8	1	0	0.036161	-1.420738	0.872772
9	1	0	0.362508	3.192219	-0.683203
10	1	0	-2.184849	3.375123	-0.316681
11	1	0	-4.125462	1.722090	0.529105
12	7	0	1.407138	1.437208	-0.272990
13	7	0	-0.875101	1.677886	0.013609
14	6	0	2.545808	-0.669035	0.251249
15	8	0	2.486134	-1.810448	0.621494
16	8	0	3.626315	-0.020105	-0.105009
17	6	0	4.865908	-0.764313	-0.039090
18	6	0	5.973942	0.166682	-0.456029
19	1	0	4.775703	-1.624734	-0.700473
20	1	0	4.987206	-1.124268	0.981408
21	1	0	6.922657	-0.365223	-0.415596
22	1	0	5.818718	0.520951	-1.473243
23	1	0	6.029044	1.023873	0.212304
24	1	0	-2.627593	-0.144858	1.773901
25	35	0	-3.171067	-1.232049	-0.387760

5-Br

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	1.053021	0.469360	-0.000035
2	6	0	-0.061820	-0.390355	-0.000065
3	6	0	-1.302692	0.165892	0.000075
4	6	0	-0.500549	2.304010	0.000269
5	6	0	1.971560	2.536797	0.000149
6	6	0	2.997227	1.621620	-0.000028
7	6	0	2.425955	0.335364	-0.000136
8	1	0	0.068365	-1.462347	-0.000197
9	1	0	-0.617308	3.380581	0.000399
10	1	0	1.983705	3.612097	0.000274
11	1	0	4.048900	1.850498	-0.000069
12	7	0	-1.519070	1.526146	0.000244
13	7	0	0.792993	1.845665	0.000137
14	6	0	-2.489857	-0.737981	0.000040
15	8	0	-2.398483	-1.942251	-0.000096
16	8	0	-3.642064	-0.083431	0.000245
17	6	0	-4.829450	-0.893911	0.000259
18	6	0	-6.014976	0.038348	0.000556
19	1	0	-4.812214	-1.533279	0.882240

20	1	0	-4.812431	-1.532993	-0.881934
21	1	0	-6.934838	-0.544012	0.000582
22	1	0	-6.006615	0.672132	0.885695
23	1	0	-6.006843	0.672412	-0.884384
24	35	0	3.343020	-1.291633	-0.000370

7-IH*

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	0.144371	1.600045	0.090895
2	6	0	-1.202647	1.659293	-0.222144
3	6	0	-1.949043	0.528259	0.043429
4	6	0	-0.167823	-0.616660	0.845188
5	6	0	2.056027	0.565325	0.882981
6	6	0	2.338482	1.960288	0.463402
7	6	0	1.232233	2.547372	-0.007436
8	1	0	-1.650372	2.543847	-0.646751
9	1	0	0.297945	-1.500847	1.260792
10	1	0	3.325666	2.385991	0.542722
11	1	0	1.123570	3.545594	-0.395466
12	7	0	-1.441014	-0.594502	0.573245
13	7	0	0.624136	0.445513	0.617216
14	6	0	-3.427958	0.562768	-0.285030
15	8	0	-3.926617	1.531036	-0.792502
16	8	0	-4.043777	-0.546159	0.044636
17	6	0	-5.461004	-0.596694	-0.240044
18	6	0	-5.967529	-1.935677	0.228836
19	1	0	-5.593001	-0.454702	-1.311702
20	1	0	-5.939179	0.232434	0.279195
21	1	0	-7.034764	-2.006108	0.027340
22	1	0	-5.462042	-2.744785	-0.295030
23	1	0	-5.808726	-2.054598	1.299003
24	1	0	2.279340	0.335809	1.921392
25	53	0	3.176834	-0.844616	-0.298722

7-I

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	-0.010826	1.768489	-0.000106
2	6	0	1.397075	1.761228	-0.000140
3	6	0	2.046094	0.565899	-0.000102

4	6	0	0.107723	-0.641770	-0.000006
5	6	0	-1.994930	0.703843	-0.000011
6	6	0	-2.237066	2.059168	-0.000064
7	6	0	-1.000026	2.730535	-0.000121
8	1	0	1.948650	2.689366	-0.000194
9	1	0	-0.450810	-1.568673	0.000044
10	1	0	-3.216533	2.505803	-0.000060
11	1	0	-0.837054	3.793964	-0.000168
12	7	0	1.390104	-0.643008	-0.000036
13	7	0	-0.641449	0.510176	-0.000037
14	6	0	3.537335	0.562731	-0.000138
15	8	0	4.197003	1.574963	-0.000217
16	8	0	4.055295	-0.657049	-0.000011
17	6	0	5.490416	-0.736772	0.000009
18	6	0	5.861605	-2.198793	0.000249
19	1	0	5.866422	-0.219343	0.882111
20	1	0	5.866431	-0.219632	-0.882259
21	1	0	6.945571	-2.299786	0.000268
22	1	0	5.467403	-2.695183	0.885299
23	1	0	5.467409	-2.695472	-0.884643
24	53	0	-3.349073	-0.851922	0.000085

5-IH*

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	-0.558668	0.661132	0.535505
2	6	0	0.503210	-0.200648	0.660736
3	6	0	1.729626	0.260000	0.201537
4	6	0	0.872621	2.254204	-0.450561
5	6	0	-1.550782	2.645080	-0.020618
6	6	0	-2.521020	1.913067	0.514119
7	6	0	-1.998082	0.572442	0.893668
8	1	0	0.397267	-1.186665	1.087746
9	1	0	0.962849	3.239480	-0.886565
10	1	0	-1.537004	3.642730	-0.423715
11	1	0	-3.544612	2.216925	0.649898
12	7	0	1.905674	1.462645	-0.350613
13	7	0	-0.344354	1.882546	-0.012986
14	6	0	2.923932	-0.660393	0.336524
15	8	0	2.808934	-1.752105	0.825647
16	8	0	4.028545	-0.127554	-0.125461
17	6	0	5.217845	-0.945872	-0.027256
18	6	0	6.354860	-0.162168	-0.628483
19	1	0	5.029206	-1.877840	-0.557919
20	1	0	5.381778	-1.174557	1.024787
21	1	0	7.267549	-0.752455	-0.571499

22	1	0	6.155049	0.065321	-1.673896
23	1	0	6.510816	0.769478	-0.088012
24	1	0	-2.172093	0.273237	1.923423
25	53	0	-2.941908	-0.973883	-0.294935

5-I

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	0.562045	0.734608	0.000017
2	6	0	-0.476285	-0.216677	-0.000013
3	6	0	-1.761282	0.228236	0.000120
4	6	0	-1.148236	2.427441	0.000312
5	6	0	1.293094	2.875002	0.000194
6	6	0	2.394343	2.052555	0.000024
7	6	0	1.942486	0.717204	-0.000076
8	1	0	-0.256513	-1.274263	-0.000145
9	1	0	-1.357349	3.489907	0.000438
10	1	0	1.210229	3.947462	0.000312
11	1	0	3.420200	2.379190	-0.000017
12	7	0	-2.096111	1.564146	0.000286
13	7	0	0.179633	2.082827	0.000184
14	6	0	-2.864768	-0.776036	0.000084
15	8	0	-2.668689	-1.967699	-0.000068
16	8	0	-4.069796	-0.224390	0.000302
17	6	0	-5.183007	-1.133620	0.000322
18	6	0	-6.443048	-0.304222	0.000588
19	1	0	-5.112255	-1.769316	0.882425
20	1	0	-5.112477	-1.769081	-0.881970
21	1	0	-7.311669	-0.960455	0.000607
22	1	0	-6.486331	0.328305	0.885638
23	1	0	-6.486548	0.328538	-0.884285
24	53	0	3.111771	-0.987157	-0.000332