Electronic Supplementary Information

Regioselective C-3-alkylation of quinoxalin-2(1*H*)-ones *via* C-N bond cleavage of alkyl amine derived Katritzky salts enabled by continuous-flow photoredoxcatalysis

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1) General Information:

All the reagents, chemicals and common laboratory solvents (LR grade) were purchased from Sigma-Aldrich or Alfa Aesar or TCI chemicals through domestic suppliers and were used as received without any further purification unless otherwise noted. Analytical thin layer chromatography (TLC) was performed with E. Merck silica gel 60 F aluminium plates and visualized under UV 254 nm radiation. NMR spectra were measured with 300 MHz, 500 MHz and 100 MHz spectrometer at RT in $CDCl_3$ and DMSO-d_6. Chemical shifts are reported in δ units, parts per million (ppm) downfield from TMS. Coupling constants (J) are in hertz (Hz) and are unadjusted; therefore, due to limits in resolution, in some cases there are small differences (<1 Hz) in the measured J value of the same coupling constant determined from different signals. Splitting patterns are designed as follows: s, singlet; d, doublet; t, triplet; dd, doublet of doublets; m, multiplet; High-resolution mass spectra (HR-MS) were recorded using Q-TOF multimode source. The 3 W blue LED light strip commonly used for domestic lighting was used for our study. The syringe pumps, visible light transparent capillaries (PFA capillaries, id = 500 μm), and fittings were obtained from commercial suppliers. The reactions were monitored using thin layer chromatography (TLC) visualized under UV irradiation and iodine. Generally, reactions were run under nitrogen atmosphere. Acme's silica gel (100-200 mesh) was used for column chromatography (approximately 20 gr per one gram of crude material). For all compounds, we have determined the ^{1}H and ^{13}C {^{1}H} NMR spectrum. For unknown compounds, we have included HRMS data along with ^{1}H and ^{13}C {1H} NMR.

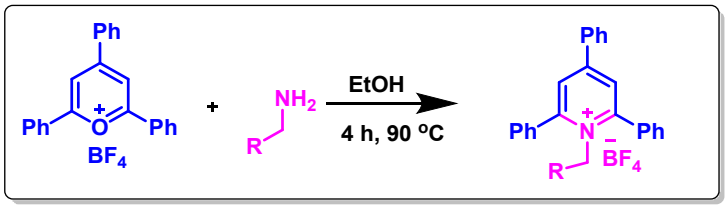
2)Experimental procedures:

a) Preparation of Katritzky salt:

General experimental procedure for the synthesis of Katritzky salts: All the Katritzky salts were synthesized from corresponding *amines or Aminoacid esters* and triphenylpyryliumtetrafluoroborate according to previous reported procedures.[1-3]

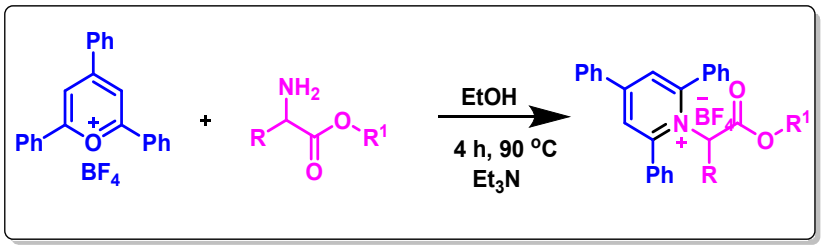
General Procedure A (primary alkyl pyridinium salts): 2,4,6-triphenylpyryliumtetrafluoroborate (1.0 equiv) and a primaryamine (1.2 equiv) were added to a Schlenkcontaining a stirring bar. This was followed by addition of dry EtOH (1.0 M),

resultingin a colour change from yellow to black orange. The mixture was then stirred and heatedat reflux in an oil bath at 90 ºC for 5h. At that time, the mixture was allowed to cool toroom temperature. Et_2O was then added (15 mL) and shaken vigorously, forming a solidprecipitate. The solid thus obtained was filtered, washed with Et_2O (2x15 mL) and driedunder high vacuum. If the pyridinium salt failed to precipitate, it was subjected to flashcolumn chromatography, eluting with CH_2Cl_2/Acetone mixtures.



Scheme S1.

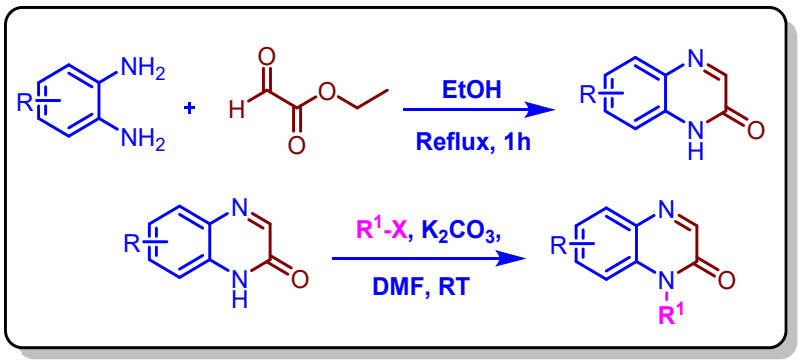
General Procedure B: The corresponding amino acid ester (1.2 equiv) was weighed into a reaction tube before EtOH (1.0 M) and Et_3N (1.2 equiv) were added successively. The resulting suspension was stirred at room temperature for 30 min and then 2,4,6-triphenylpyrylium tetrafluoroborate (1.0 equiv) was added in one portion. The (dark red) reaction mixture was then heated at reflux for 4 h. The reaction was then allowed to cool to room temperature before Et_2O was added and the mixture was stirred for 1 h. The resulting solid was collected by filtration and thoroughly washed with H_2O and Et_2O. The remaining solid was then dried under reduced pressure to afford the pyridinium salt without further purification. If precipitation did not take place, the solvent was removed under reduced pressure. The crude product was then dissolved in CH_2Cl_2 (20 mL), washed with H_2O (3 × 20 mL) and concentrated under reduced pressure. The crude product was then purified by column chromatography (SiO_2, eluting with a gradient of acetone in CH_2Cl_2) to afford the pyridinium salt product.



Scheme S2.

b) Preparation of Quinoxalin-2(1*H*)-ones:[4]

A mixture of substituted o-phenylenediamine (5 mmol), ethyl 2- oxoacetate (6 mmol), and ethanol (20 mL) was taken in a dried round-bottom flask. The mixture was stirred at reflux for 1 h. After cooling, the precipitated solid was filtered, washed with ethanol, and dried to afford N-free protected quinoxalin-2(1*H*)-ones. The N-free protected quinoxalin-2(1*H*)-ones were dissolved in DMF (20 mL), followed by the addition of potassium carbonate (1.2 equiv) and corresponding halogenoalkane (1.6 *equiv*). The mixture was then stirred at room temperature overnight. After the reaction was completed, EtOAc and water were added. The aqueous layer was extracted twice with EtOAc. The combined organic layers were washed with a saturated solution of NH_4Cl, dried over $MgSO_4$, filtered, and evaporated under reduced pressure. The residue is purified by flash chromatography over silica gel to afford the desired quinoxalin-2(1*H*)-ones. chromatography.



Scheme S3.

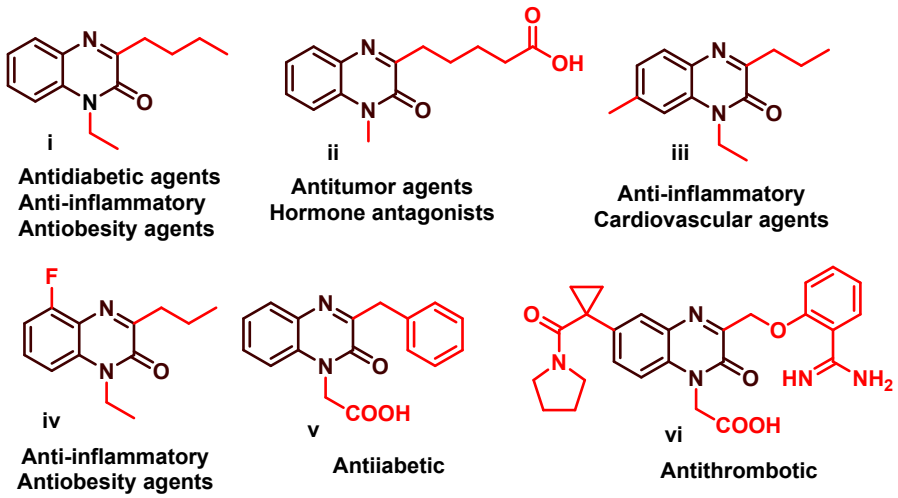
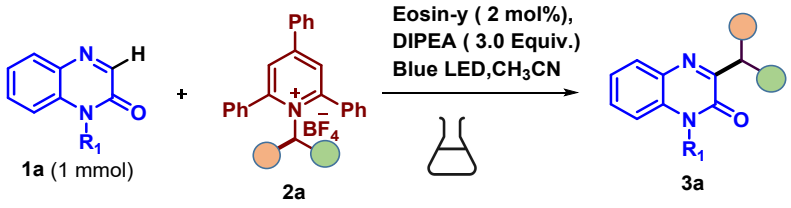


Figure S1: Selected biological structures bearing a 3-alkylquinoxalin-2(1*H*)-one unit.

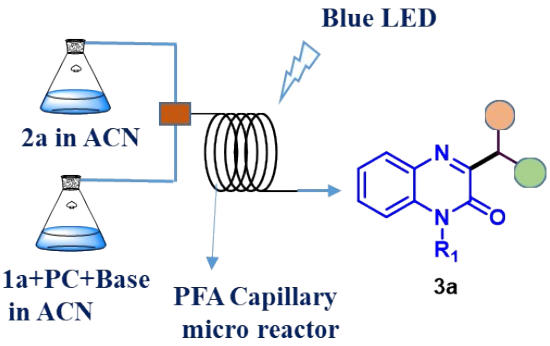
3) Visible-light-induced C-3-alkylation of Quinoxalin-2(1*H*)-ones *via* C-N bond cleavage of amine/amino acid-derived Katritzky salts in batch:

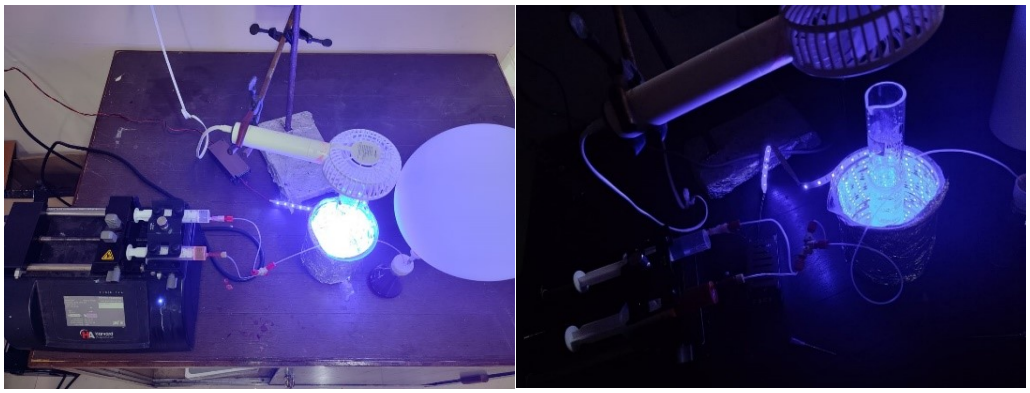
In a 10 mL snap vial equipped with magnetic stirring bar the Eosin-y (2 mol %), Quinoxalin-2(1*H*)-one **1** (100 mg, 1 equiv.) and amine/amino acid-derived Katritzky salt **2** (205 mg, 1 equiv.) were dissolved in 3 mL of ACN then slowly added the DIPEA (3 equiv.) to the reaction mixture under nitrogen atmosphere. The snap vial was stirred at room temperature under blue light irradiation (LED, λmax = 445 ± 10 nm, 3.0 W) at a distance of approximately 3.0 cm from the LED. The resulting reaction mixture was irradiated with blue LED light source at room temperature with cooling by fan. The progress of the reaction was monitored by TLC. After completion, the reaction mixture was transferred to a separating funnel, diluted with ethyl acetate and washed with 15 mL of water. The aqueous layer was washed three times with ethyl acetate. The combined organic layers were dried over Na_2SO_4, filtered and concentrated in vacuum. Purification of the crude product was achieved by column chromatography using petrol ether/ethyl acetate as an eluent.



Scheme S4.

4) Visible-light-induced C-3-alkylation of Quinoxalin-2(1*H*)-ones *via* C-N bond cleavage of amine/amino acid-derived Katritzky salts in continuous-flow micro reactor: A continuous flow set up was arranged employing two syringes, T-mixer, PFA (id = 500 μm, length = 2.5 m) capillary micro reactor and a syringe pump. Initially, the amine/amino acid derived Katritzky salt (dissolved in 1.5 mL in ACN) and quinoxalin-2(1*H*)-ones, photo-catalyst, base (dissolved in 1.5 mL in ACN) under nitrogen atmosphere were transferred into two 5 mL NORM-JECT plastic syringes and introduced into the photo micro reactor through a syringe pump which were passing through T- mixer and further passing this solution into visible light transparent PFA capillary tubing which was wrapped over a glass test tube and this capillary wrapped test tube was subjected to irradiate with blue LED light source. The flow rate was set to 300 μLmin^{-1}, thus resulting in 0.81 min of residence time. After reaching steady state, a product sample was collected at the end of reactor in a vial. The volume collected was measured and the sample was then diluted with water and extracted with ether (x 3). The organic layer was washed with brine, dried with Na_2SO_4 and evaporated under reduced pressure. The resulting crude compound was absorbed on silica gel and purified via column chromatography (EtOAc/Hexane, varying ratios). The isolated compound was analyzed by NMR.





Scheme S5.

5) Additional experiments to support the mechanism:

a) Radical Trapping Experiment:

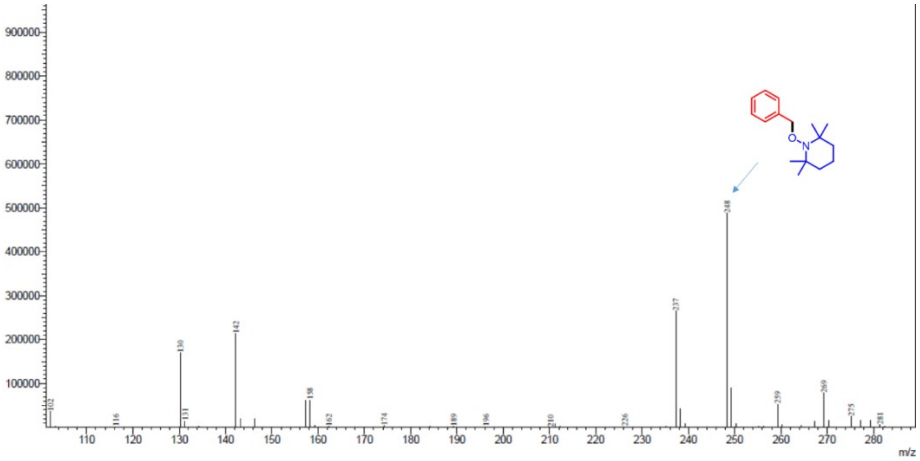


Fig. S2

b) UV-Vis data and fluorescence spectra:

To know the quenching property, we have conducted the UV-Vis and Photoluminescence studies. UV-Vis data and fluorescence spectra were recorded in a 1 cm path length quartz cell on a Shimadzu UV-vis to near IR 3600 spectrometer and a Fluorolog 3, J.Y. Horiba fluorescence spectrometer, respectively. The excitation wavelength of **1a** (**A2**), **2a** (**B2**), DIPEA (**C2**) is around 390 nm and quencher Eosin-y is 520 nm. We have prepared the different concentration solutions including 0.0001 M, 0.0003 M, 0.0006 M and 0.0009 M solution for Photoluminescence, the emission wavelength is observed at 390 nm for **A2**, 470 nm for **B2** and 440 nm for **C2**.

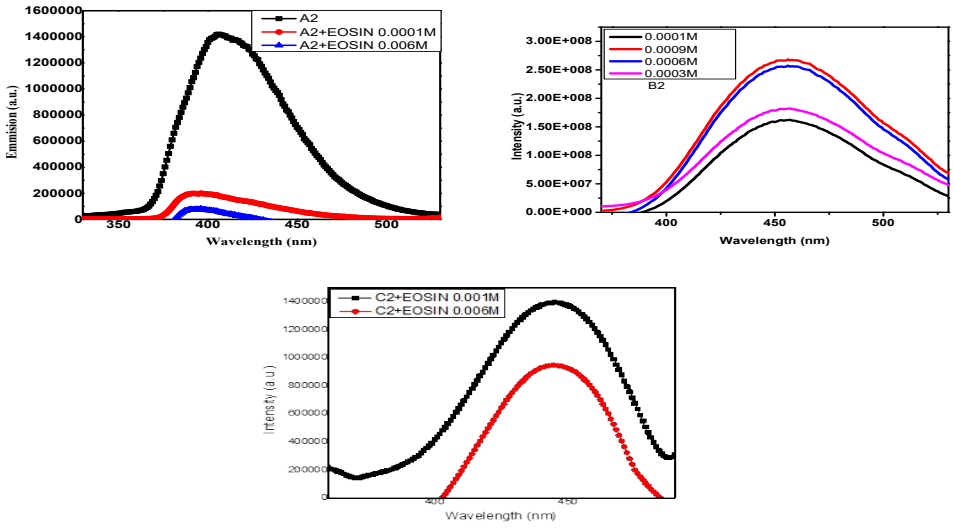


Fig. S3

Characterization data:

3a. 1,3-Dibenzylquinoxalin-2(1*H*)-one:[5] Prepared according to the general procedure as described above in 72% yield (101 mg); It was purified by flash chromatography (30% EtOAc/hexane; R_f = 0.5) to afford **3a** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.85 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.51 – 7.47 (m, 2H), 7.41– 7.36 (m, 1H), 7.34 – 7.27 (m, 4H), 7.26 – 7.25 (m, 2H), 7.23 (dd, *J* = 7.3, 2.1 Hz, 2H), 7.21 – 7.17 (m, 2H), 5.45 (s, 2H), 4.33 (s, 2H). **^{13}C {1 H} NMR (100 MHz, $CDCl_3$):** δ 159.5, 154.9, 137.1, 135.2, 133.0, 132.7, 130.1, 129.9, 129.6, 129.0, 128.5, 127.7, 126.9, 126.7, 123.7, 114.4, 46.0, 40.8. **IR:** 1651, 1597, 1493, 1459, 1304, 1187, 749, 701 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{17}H_{17}N_2O$: 327.1490 ($[M+H]^+$), found: 327.1491.

3b. 3-Benzyl-1-methylquinoxalin-2(1*H*)-one:[5] Prepared according to the general procedure as described above in 70% yield (109 mg); It was purified by flash chromatography (30% EtOAc/hexane; R_f = 0.5) to afford **3b** as white solid **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.85 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.53 – 7.46 (m, 3H), 7.35 – 7.17 (m, 5H), 4.26 (s, 2H), 3.65 (s, 3H). **^{13}C {1 H} NMR (100 MHz, $CDCl_3$):** δ 159.3, 154.7, 137.1, 133.4, 132.8, 130.0, 129.9, 129.6, 128.4, 126.6, 123.6, 113.6, 40.8, 29.1. **IR:** 3030, 2927, 2855, 1657, 1603, 1466, 1420, 1311, 1218, 1098, 760, 704 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{16}H_{15}N_2O$: 251.1179 ($[M+H]^+$), found: 251.1182.

3c. 1,3-Dibenzyl-6,7-dimethylquinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 90% yield (120 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3c** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.60 (s, 1H), 7.47 (d, *J* = 7.5 Hz, 2H), 7.31 – 7.26 (m, 4H), 7.24 – 7.17 (m, 4H), 6.97 (s, 1H), 5.41 (s, 2H), 4.29 (s, 2H), 2.28 (s, 3H), 2.26 (s, 3H). **^{13}C {1 H} NMR (100 MHz, $CDCl_3$):** δ 158.2, 154.9, 139.7, 137.4, 135.5, 132.6, 131.5, 130.7, 130.2, 129.6, 128.9, 128.4, 127.6, 126.9, 126.5, 114.9, 45.9, 40.7, 20.6, 19.2. **IR:** 3054, 3015, 2937, 1739, 1621, 1592, 1461, 1350, 1313, 1261, 1216, 1015, 753, 704 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{24}H_{23}N_2O$: 355.1794 ($[M+H]^+$), found: 355.1804. **Mp** :130 – 132 ^oC.

3d. **3-Benzyl-6-fluoro-1-methylquinoxalin-2(1*H*)-one:**[5] Prepared according to the general procedure as described above in 66% yield (100 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3d** as white solid.**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.55 (dd, *J* = 8.8, 2.8 Hz, 1H), 7.45 (d, *J* = 7.2 Hz, 2H), 7.31 – 7.30(m, 1H), 7.29 – 7.26 (m, 2H),

7.25-7.20 (m, 2H), 4.26 (s, 2H), 3.66 (s, 3H). **^{13}C {1 H} NMR (100 MHz, $CDCl_3$):** δ 160.9, 158.7 (d, *J* = 243.4 Hz), 154.4, 136.7, 133.4 (d, *J* = 11.2 Hz), 130.0, 129.6, 128.5, 126.7, 117.6 (d, *J* = 23.9 Hz), 115.4 (d, *J* = 22.5 Hz), 114.6 (d, *J* = 8.8 Hz), 40.8, 29.4. **IR:** 3070, 3031, 2924, 2854, 1657, 1499, 1463, 1423, 1271, 1217, 1167, 1127, 814, 757, 701 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{16}H_{14}FN_2O$: 269.1075 ($[M+H]^+$), found: 269.1084.

3e. **1,3-Dibenzyl-6-fluoroquinoxalin-2(1*H*)-one:** Prepared according to the general procedure as described above in 85% yield (115 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3e** as white solid .**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.54 (dd, *J* = 8.8, 2.7 Hz, 1H), 7.49 – 7.46 (m, 2H), 7.33 – 7.28 (m, 5H), 7.24 (t, *J* = 3.1 Hz, 1H), 7.19 – 7.12 (m, 4H), 5.44 (s, 2H), 4.32 (s, 2H). **^{13}C {1 H} NMR (125 MHz, $CDCl_3$):** δ 161.0, 158.6 (d, *J* = 243.8 Hz), 154.5, 136.7, 135.0, 133.7 (d, *J* = 11.2 Hz), 129.6, 129.2, 129.0, 128.5, 127.8, 126.8, 126.8, 117.6 (d, *J* = 23.9 Hz), 115.6 (d, *J* = 9.0 Hz), 115.4 (d, *J* = 4.5 Hz), 46.2, 40.8. **IR:** 1651, 1420, 1271, 1187, 800, 749, 703 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{22}H_{18}FN_2O$: 345.1389 ($[M+H]^+$), found: 345.1397. **Mp**: 128 – 130 °C.

3f. 3-Benzyl-1-(prop-2-yn-1-yl) quinoxalin-2(1*H*)-one:[5] Prepared according to the general procedure as described above in 88% yield (131 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3f** as white solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.86 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.57 - 7.53 (m, 1H), 7.47 – 7.42 (m, 3H), 7.37 – 7.34 (m, 1H), 7.31 – 7.28 (m, 2H), 7.23 – 7.20 (m, 1H), 5.01 (s, 2H), 4.27 (s, 2H), 2.26 (t, *J* = 2.5 Hz, 1H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 159.2, 153.7, 136.8, 133.0, 131.8, 130.1, 130.0, 129.6, 128.4, 126.7, 124.0, 114.1, 76.8, 73.3, 40.7, 31.6. **IR**: 3261, 1653, 1601, 1465, 1438, 1306, 757, 701 cm^{-1}. **HRMS:** (ESI) exact mass calculated for C_{18} $H_{15}ON_2$: 275.1176 ($[M+H]^+$), found: 275.1178.

3g. 3-benzyl-1-(2-oxo-2-phenylethyl) quinoxalin-2(1*H*)-one:[5] Prepared according to the general procedure as described above in 76% yield (90 mg); It was purified by flash chromatography (40% EtOAC/ hexane; R_f = 0.5) to afford **3g** as yellow solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 8.05 – 8.03 (m, 2H), 7.89 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.68-7.64 (m, 1H), 7.54 – 7.51 (m, 2H), 7.47 – 7.40 (m, 3H), 7.33 – 7.28 (m, 3H), 7.23 – 7.20 (m, 1H), 6.92 (dd, *J* = 8.4, 0.9 Hz, 1H), 5.69 (s, 2H), 4.29 (s, 2H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 191.2, 159.0, 154.5, 137.0, 134.6, 134.3, 133.0, 132.8, 130.3, 130.0, 129.5, 129.0, 128.4, 128.2, 126.6, 123.8, 113.5, 48.6, 40.7. **IR:** 3828, 3761, 3730, 3670, 3315, 3191, 1698, 1657, 1602, 1231, 758, 697 cm^{-1}. **HRMS:** (ESI) m/z calculated for $C_{23}H_{19}N_2O_2$: 355.1440 ($[M+H]^+$), found: 355.1441.

3h. Ethyl 2-(3-benzyl-2-oxoquinoxalin-1(2*H*)-yl) acetate:[5] Prepared according to the general procedure as described above in 90% yield (125 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3h** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.86 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.50 – 7.43 (m, 3H), 7.35 – 7.19 (m, 4H), 7.03 (d, *J* = 7.7 Hz, 1H), 4.97 (s, 2H), 4.27 (s, 2H), 4.22 (q, *J* = 7.1 Hz, 2H), 1.23 (t, *J* = 7.1 Hz, 3H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 167.1, 159.1, 154.4, 136.9, 132.8, 132.5, 130.3, 130.1, 129.5, 128.4, 126.6, 123.9, 113.0, 62.1, 43.6, 40.7, 14.1. **IR:** 2920, 2830, 1740, 1083, 780, 699 cm^{-1}. **HRMS:** (ESI) exact mass calculated for $C_{19}H_{19}O_3N_2$: 323.1389 ($[M+H]^+$), found: 323.1390.

3i. 1-Methyl-3-(2-methylbenzyl)quinoxalin-2(1*H*)-one:[6] Prepared according to the general procedure as described above in 58% yield (95.7 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3i** as white solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.81 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.54-7.50 (m, 1H), 7.34 – 7.32 (m, 2H), 7.30 – 7.27 (m, 1H), 7.19 – 7.15 (m, 1H), 7.14 – 7.10 (m, 2H), 4.28 (s, 2H), 3.69 (s, 3H), 2.46 (s, 3H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 159.2, 154.8, 137.4, 135.5, 133.2, 132.7, 130.3, 130.1, 130.0, 129.8, 126.7, 125.8, 123.5, 113.5, 37.9, 29.1, 20.1. **IR:** 3235, 3063, 3039, 3023, 2974, 2926, 2853, 1683, 1556, 1496, 1463, 1310, 756 cm^{-1}. **HRMS:** (ESI) exact mass calculated for $C_{17}H_{17}N_2O$: 265.1325 ($[M+H]^+$), found: 265.1335.

3j. 1-Benzyl-3-(2-methylbenzyl) quinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 69% yield (99 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3j** as white solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.81 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.40 – 7.34 (m, 2H), 7.32 – 7.26 (m, 3H), 7.25 – 7.19 (m, 5H), 7.16 – 7.14 (m, 2H), 5.48 (s, 2H), 4.35 (s, 2H), 2.47 (s, 3H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 159.3, 154.9, 137.4, 135.6, 135.3, 133.0, 132.6, 130.4, 130.2, 130.1, 129.8, 129.0, 127.7, 126.9, 126.8, 125.9, 123.6, 114.4, 46.0, 37.9, 20.1. **IR:** 1651, 1493, 1420, 1300, 1180, 840, 700 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{23}H_{21}N_2O$: 341.1637 ($[M+H]^+$), found: 341.1648. **Mp** :118 – 120 ^{o}C.

3k. 3-(4-Chlorobenzyl)-1,6,7-trimethylquinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 70% yield (116 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3k** as white solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.59 (s, 1H), 7.39 – 7.38 (m, 1H), 7.37 – 7.36 (m, 1H), 7.25 – 7.24 (m, 1H), 7.23 (m, 1H), 7.04 (s, 1H), 4.19 (s, 2H), 3.64 (s, 3H), 2.40 (s, 3H), 2.34 (s, 3H). **^{13}C {1H} NMR**

(100 MHz, $CDCl_3$): δ 157.5, 154.7, 139.9, 135.8, 132.6, 132.4, 131.4, 131.1, 130.9, 130.0, 128.5, 114.2, 40.1, 29.1, 20.6, 19.2. **IR:** 3064, 3030, 2921, 1741, 1655, 1622, 1461, 1310, 1141, 1023, 813, 702, 638 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{18}H_{18}ClN_2O$: 313.1092 ($[M+H]^+$), found: 313.1102. **Mp** :160 – 162 °C.

3l. 1-Benzyl-3-(3-chlorobenzyl)-6-fluoroquinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 75% yield (111 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3l** as white solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.55 (dd, *J* = 8.7, 2.6 Hz, 1H), 7.45 (s, 1H), 7.36 (d, *J* = 7.3 Hz, 1H), 7.29 (m, 3H), 7.25-7.20 (m, 2H), 7.18-7.13 (m, 4H), 5.45 (s, 2H), 4.29 (s, 2H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 160.2, 158.7 (d, *J* = 244.1 Hz) 154.4, 138.7, 134.9, 134.2, 133.6 (d, *J* = 11.2 Hz), 129.7, 129.6, 129.3, 129.0, 127.9, 127.0, 126.8, 117.9 (d, *J* = 24.0 Hz), 115.7 (d, *J* = 9.8 Hz), 115.5 (d, *J* = 3.7 Hz), 46.3, 40.3. **IR:** 1656, 1595, 1573, 1432, 1302, 1232, 1185, 1138, 1079, 875, 808, 772, 696 cm^{-1}. **HRMS:** (ESI) exact mass calculated for $C_{22}H_{17}ClFN_2O$:379.0997 ($[M+H]^+$), found: 379.1008. **Mp** :108 – 110 °C.

3m. 3-(3-Chlorobenzyl)-1,6,7-trimethylquinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 65% yield (107 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3m** as white solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.59 (s, 1H), 7.42 (s, 1H), 7.33 (d, *J* = 7.4 Hz, 1H), 7.22 – 7.15 (m, 2H), 7.03 (s, 1H), 4.20 (s, 2H), 3.63 (s, 3H), 2.39 (s, 3H), 2.34 (s, 3H). **^{13}C {1H} NMR (125 MHz, $CDCl_3$):** δ 157.2, 154.7, 139.9, 139.4, 134.1, 132.6, 131.4, 131.1, 130.1, 129.6, 129.5, 127.8, 126.7, 114.2, 40.3, 29.1, 20.6, 19.2. **IR:** 3438, 3139, 3115, 3065, 2972, 2845, 2650, 2605, 1742, 1654, 1621, 1585, 1470, 1088, 776, 696 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{18}H_{18}ClN_2O$: 313.1092 ($[M+H]^+$), found: 313.1101. **Mp** :135 – 137 °C.

3n. **1-Benzyl-3-(3,4-dichlorobenzyl)-6,7-dimethylquinoxalin-2(1*H*)-one**: Prepared according to the general procedure as described above in 78% yield (124 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3n** as white solid.**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.60 (s, 1H), 7.54 (d, *J* = 1.6 Hz, 1H), 7.36 (d, *J* = 8.2 Hz, 1H), 7.30 (dd, *J* = 8.2, 4.6 Hz, 3H), 7.25 – 7.18 (m, 3H), 7.01 (s, 1H), 5.43 (s, 2H), 4.23 (s, 2H), 2.30 (s, 3H), 2.29 (s, 3H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 156.8, 154.7, 140.1, 137.6, 135.2, 132.8, 132.1, 131.3, 130.6, 130.2, 130.1, 129.0, 128.9, 127.6, 126.7, 114.9, 45.8, 39.6, 20.5, 19.1. **IR:**

2926, 2856, 1654, 1621, 1464, 850 cm^{-1}. **HRMS:** (ESI) exact mass calculated for $C_{24}H_{21}Cl_2N_2O$: 423.1012 ($[M+H]^+$), found: 423.1025. **Mp**: 153 – 155 °C.

3o. 3-(4-(*tert*-Butyl)benzyl)-1-methylquinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 85% yield (162 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3o** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.79 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.46 – 7.42(m, 1H), 7.37 – 7.31 (m, 2H), 7.30 – 7.22 (m, 3H), 7.21 – 7.17 (m, 1H), 4.16 (s, 2H), 3.59 (s, 3H), 1.21 (s, 9H). **^{13}C {1H} NMR (125 MHz, $CDCl_3$):** δ 159.5, 154.7, 149.3, 133.9, 133.3, 132.8, 129.9, 129.8, 129.2, 125.3, 123.5, 113.5, 40.3, 34.4, 31.4, 29.1. **IR:** 2961, 2866, 1659, 1515, 1471, 1311, 1100, 761 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{20}H_{23}N_2O$: 307.1787 ($[M+H]^+$), found: 307.1804. **Mp**: 128-130 °C.

3p. 1-Benzyl-3-(2,6-difluorobenzyl)-6,7-dimethylquinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 75% yield (110 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3p** as white solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.56 (s, 1H), 7.32 – 7.27 (m, 2H), 7.25-7.21 (m, 3H), 7.09-7.05 (m, 1H), 7.04 – 6.99 (m, 2H), 6.93-6.88 (m, 1H), 5.46 (s, 2H), 4.32 (s, 2H), 2.29 (s, 3H), 2.28 (s, 3H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 158.6, 158.5 (d, *J* = 241.2 Hz), 155.5 (d, *J* = 155.3 Hz), 140.0, 135.4, 132.7, 131.0 (d, *J* = 72.0 Hz), 130.3, 128.9, 127.6, 126.9, 126.2 (dd, *J* = 18.5, 8.1 Hz), 117.8 (dd, *J* = 24.2, 4.5 Hz), 116.2 (dd, *J* = 25.2, 8.8 Hz), 114.9, 114.5 (dd, *J* = 24.0, 8.5 Hz), 45.9, 33.6, 20.6, 19.1. **IR:** 3398, 3352, 3177, 3056, 2920, 1741, 1660, 1500, 1457, 1274, 1213, 876, 816, 770, 698 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{24}H_{21}F_2N_2O$: 391.1608 ($[M+H]^+$), found: 391.1616. **Mp** :140 – 142 °C.

3q. 1-Benzyl-3-(4-(*tert*-butyl)phenyl)-6,7-dimethylquinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 90% yield (139 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3q** as white solid .**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.61 (s, 1H), 7.41 (d, *J* = 8.3 Hz, 2H), 7.33 – 7.30 (m, 2H), 7.30-7.28 (m, 1H), 7.27 (t, *J* = 1.7 Hz, 1H), 7.25 – 7.22 (m, 1H), 7.19 (d, *J* = 7.0 Hz, 2H), 6.97 (s, 1H), 5.42 (s, 2H), 4.26 (s, 2H), 2.29 (s, 3H), 2.27 (s, 3H),1.29 (s, 9H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 158.4, 155.0, 149.2, 139.5, 135.5, 134.3, 132.6, 131.5, 130.7, 130.1, 129.2, 128.9, 127.6, 126.9, 125.3, 114.8, 45.8, 40.2, 34.4, 31.4, 20.6, 19.1. **IR:** 2963, 1656, 1621, 761, 758

cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{28}H_{30}N_2O$: 411.2411 ($[M+H]^+$), found: 411.2430. **Mp** :161 – 163 °C.

3r. 1-Benzyl-3-(4-chlorobenzyl)-6,7-dimethylquinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 68% yield (103 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3r** as white solid**. ^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.86 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.46 (d, *J* = 1.6 Hz, 1H), 7.43 – 7.35 (m, 2H), 7.32 – 7.28 (m, 3H), 7.24 – 7.18 (m, 6H), 5.47 (s, 2H), 4.29 (s, 2H). **^{13}C {1H} NMR (125 MHz, $CDCl_3$):** δ 158.6, 154.7, 139.0, 135.1, 134.1, 132.9, 132.6, 130.1, 129.6, 129.4, 128.9, 127.7, 127.7, 126.8, 123.7, 114.4, 46.0, 40.3. **IR:** 2924, 2855, 1598, 1465, 1307, 1192, 1106, 1083, 754, 699 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{22}H_{18}ClN_2O$: 361.1094 ($[M+H]^+$), found: 361.1102. **Mp** :130 – 132 °C.

3s. 3-(2,6-Difluorobenzyl)-1,6,7-trimethylquinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 70% yield (116 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3s** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.57 (s, 1H), 7.06 – 6.97 (m, 3H), 6.91-6.86 (m, 1H), 4.26 (s, 2H), 3.68 (s, 3H), 2.41 (s, 3H), 2.33 (s, 3H). **^{13}C {1H} NMR (125 MHz, $CDCl_3$):** δ 158.5(d, *J* = 241.9 Hz), 157.3 (d, *J* = 242.3 Hz), 156.1, 154.7,140.0, 132.6, 131.3, 131.1, 130.2, 126.2 (dd, *J* = 18.5, 8.1 Hz), 117.8 (dd, *J* = 24.2, 4.5Hz), 116.1 (dd, *J* = 25.2, 8.8 Hz), 114.5 (dd, *J* = 24.0, 8.5 Hz), 114.2, 33.6, 29.1, 20.6,19.1. **IR:** 2900, 1741, 1660, 1450, 856, 810, 750, 690 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{18}H_{17}F_2N_2O$: 315.1292 ($[M+H]^+$), found: 315.1303. **Mp**: 155 – 157 °C.

3t. 1-Benzyl-3-(2,6-difluorobenzyl)-6-fluoroquinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 57% yield (76 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3t** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.49 (dd, *J* = 8.7, 2.7 Hz, 1H), 7.34-7.26 (m, 3H), 7.21 – 7.12 (m, 4H), 7.10 – 7.00 (m, 2H), 6.96 - 6.90 (m, 1H), 5.48 (s, 2H), 4.35 (s, 2H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 159.2, 159.1 (d, *J* = 115.0 Hz), 158.7 (d, *J* = 244.2 Hz), 156.7 (d, *J* = 115.6 Hz), 154.4, 134.9, 133.5 (d, *J* = 11.2 Hz), 129.2, 129.1, 127.9, 126.8, 125.5 (dd, *J* = 18.6, 8.1 Hz), 117.9 (d, *J* = 23.9 Hz), 116.2 (dd, *J* = 25.2, 8.7 Hz), 115.6 (dd, *J* = 15.5, 11.1 Hz), 114.8 (dd, *J* = 24.0, 8.5 Hz), 46.3, 33.8. **IR:** 2920, 1740, 1660, 760, 750, 707, 690 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{22}H_{16}F_3N_2O$: 381.1197 ($[M+H]^+$), found: 381.1209. **Mp**: 141 – 143 °C.

3u. 1-benzyl-3-(4-chlorobenzyl)-6,7-dimethylquinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 71% yield (104 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3u** as white solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.60 (s, 1H), 7.40 (d, *J* = 8.4 Hz, 2H), 7.31 – 7.27 (m, 3H), 7.25 – 7.23 (m, 2H), 7.18 (d, *J* = 7.0 Hz, 2H), 6.99 (s, 1H), 5.43 (s, 2H), 4.25 (s, 2H), 2.30 (s, 3H), 2.28 (s, 3H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 157.6, 154.8, 139.9, 135.9, 135.4, 132.7, 132.4, 131.4, 130.9, 130.7, 130.2, 128.9, 128.5, 127.6, 126.8, 114.9, 45.9, 40.0, 20.6, 19.2. **IR:** 2972, 2845, 1742, 1654, 1585, 1465, 1080, 720, 690, 621 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{24}H_{22}ClN_2O$: 389.1409 ($[M+H]^+$), found: 389.1415. **Mp**: 147-149 ^{o}C.

3v. 3-(2,6-Difluorobenzyl)-6-fluoro-1-methylquinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 60% yield (102 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3v** as white solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.51 (dd, *J* = 8.7, 2.7 Hz, 1H), 7.32 – 7.27 (m, 1H), 7.25 (d, *J* = 5.1 Hz, 1H), 7.07 – 6.99 (m, 2H), 6.91 (m, 1H), 4.28 (s, 2H), 3.70 (s, 3H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 159.1 (d, *J* = 116.9 Hz), 158.7 (d, *J* = 243.9 Hz), 159.1, 156.7 (d, *J* = 117.5 Hz), 154.2, 133.2 (d, *J* = 11.2 Hz), 129.9, 125.5 (dd, *J* = 18.5, 8.1 Hz), 117.9 (d, *J* = 24.0 Hz), 116.2 (dd, *J* = 25.2, 8.7 Hz), 115.6 (d, *J* = 22.5 Hz), 114.8 (dd, *J* = 19.3, 8.6 Hz), 33.8, 29.4. **IR:** 3843, 3796, 2927, 1659, 1501, 876 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{16}H_{11}F_3N_2O$: 305.0894 ($[M+H]^+$), found: 305.0896. **Mp**:130 – 132 ^{o}C.

3w. 1-Methyl-3-(naphthalen-1-ylmethyl) quinoxalin-2(1*H*)-one:[6] Prepared according to the general procedure as described above in 65% yield (124 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **3w** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.39 (d, *J* = 8.4 Hz, 1H), 7.83 (d, *J* = 8.6 Hz, 1H), 7.78 – 7.74 (m, 2H), 7.63 (d, *J* = 7.0 Hz, 1H), 7.52 – 7.41 (m, 4H), 7.28 (d, *J* = 7.6 Hz, 1H), 7.22 (d, *J* = 8.4 Hz, 1H), 4.74 (s, 2H), 3.65 (s, 3H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 159.0, 154.8, 133.9, 133.4, 133.2, 132.7, 132.6, 130.1, 129.9, 128.6, 128.3, 127.4, 125.9, 125.5, 125.4, 124.9, 123.5, 113.5, 37.8, 29.2. **IR:** 3557, 3400, 3123, 2929, 1780, 1744, 1657, 1601, 1467, 1092, 771, 646, 630 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{20}H_{17}N_2O$: 301.1325 ($[M+H]^+$), found: 301.1335.

3x. 1-Benzyl-6-fluoro-3-(pyridin-3-ylmethyl) quinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 65% yield (88 mg); It was purified by flash chromatography (40% EtOAc/hexane; R_f = 0.5) to afford **3x** as white solid. **^{1}H NMR (400**

MHz, $CDCl_3$): δ 8.72 (s, 1H), 8.50 (d, *J* = 4.5 Hz, 1H), 7.82 – 7.79 (m, 1H), 7.52 (dd, *J* = 8.6, 2.3 Hz, 1H), 7.33 – 7.28 (m, 3H), 7.25 (d, *J* = 4.4 Hz, 1H), 7.20 – 7.13 (m, 4H), 5.46 (s, 2H), 4.32 (s, 2H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ158.7 (d, *J* = 244.4 Hz), 154.4, 150.8, 148.1, 137.3, 134.8, 133.5 (d, *J* = 11.1 Hz), 132.4, 129.2, 129.1, 127.9, 127.0, 126.7, 123.4, 118.0 (d, *J* = 24.0 Hz), 115.7 (d, *J* = 3.5 Hz), 115.5 (d, *J* = 10.0 Hz), 46.3, 37.9. **IR:** 3785, 3059, 2966, 2928, 2862, 1659, 1496, 1273, 761, 707 cm^{-1}. **HRMS:** (ESI) exact mass calculated for $C_{21}H_{17}FN_3O$: 346.1335 ($[M+H]^+$), found: 346.1350. **Mp**:156 – 158 °C.

3ab. 3-(2-methylbenzyl)-1-(prop-2-yn-1-yl)quinoxalin-2(1*H*)-one : Prepared according to the general procedure as described above in 65% yield (105 mg); It was purified by flash chromatography (20% EtOAC/ hexane; R_f = 0.5) to afford **3ab** as white solid. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.87 (d, *J* = 8.0 Hz, 1H), 7.61 – 7.55 (m, 1H), 7.47 (dd, *J* = 8.4, 0.9 Hz, 1H), 7.41 – 7.34 (m, 2H), 7.24 – 7.14 (m, 3H), 5.06 (d, *J* = 2.5 Hz, 2H), 4.32 (s, 2H), 2.48 (s, 3H), 2.29 (t, *J* = 2.5 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 159.0, 153.8, 137.4, 135.3, 132.9, 131.7, 130.3, 130.2, 129.9, 126.8, 125.8, 123.9, 114.1, 73.3, 37.9, 31.6, 20.1.**IR:** 3289, 1663, 1308, 756, 668, 580. **HRMS:** (ESI) m/z calculated for $C_{19}H_{17}N_2O$: 289.1327 ($[M+H]^+$), found: 289.1328; **Mp**: 121 – 123 °C.

3ac. 3-(4-(*tert*-butyl)benzyl)-1-(prop-2-yn-1-yl)quinoxalin-2(1*H*)-one: Prepared according to the general procedure as described above in 66% yield (120 mg); It was purified by flash chromatography (20% EtOAC/ hexane; R_f = 0.5) to afford **3ac** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.92 (d, *J* = 8.0 Hz, 1H), 7.61 – 7.54 (m, 1H), 7.49 – 7.42 (m, 3H), 7.41 – 7.33 (m, 3H), 5.04 (d, *J* = 2.5 Hz, 2H), 4.27 (s, 2H), 2.29 (t, *J* = 2.5 Hz, 1H), 1.33 – 1.30 (s, 9H). **^{13}C NMR (125 MHz, $CDCl_3$)** δ 159.4, 153.8, 149.4, 133.7, 133.0, 131.8, 130.1, 129.9, 129.2, 125.4, 124.0, 114.1, 73.3, 40.2, 34.4, 31.6, 31.4. **IR:** 3686, 3305, 3022, 2403, 1423, 1214, 740, 670. **HRMS:** (ESI) m/z calculated for $C_{22}H_{23}N_2O$: 331.1805 ($[M+H]^+$), found: 331.1796; **Mp**: 145 – 146 °C.

4a. Methyl-3-(4-nitrophenyl)-2-(3-oxo-4-(prop-2-yn-1-yl)-3,4-dihydroquinoxalin-2-yl)propanoate: Prepared according to the general procedure as described above in 60% yield (127 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **4a** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.12 – 8.09 (m, 2H), 7.89 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.65-7.60 (m, 1H), 7.49 – 7.46 (m, 3H), 7.43 – 7.39 (m, 1H), 5.10 - 4.96 (m, 2H), 4.62 (t, *J* = 7.5 Hz, 1H), 3.69 (s, 3H), 3.54 (dd, *J* = 7.4, 3.1 Hz, 2H), 2.30 (t, *J* = 2.5 Hz, 1H). **^{13}C {1H}**

NMR (100 MHz, $CDCl_3$): δ 171.2, 155.8, 153.3, 146.9, 146.7, 132.6, 131.7, 130.9, 130.5, 130.1, 124.3, 123.6, 114.3, 76.4, 73.5, 52.5, 50.2, 35.0, 31.7. **IR:** 3869, 3679, 3926, 2924, 1661, 1465, 1440, 1349, 1304, 1222, 1174, 802, 705, 699 cm^{-1}. **HRMS:** (ESI) exact mass calculated for $C_{21}H_{18}O_5N_3$: 392.1244 ($[M+H]^+$), found: 392.1241. **Mp**:162 – 164 °C.

4b. Ethyl 2-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)-3-phenylpropanoate: Prepared according to the general procedure as described above in 62% yield (130 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford **4b** as white solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.87 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.44 – 7.40 (m, 1H), 7.30 (t, *J* = 7.2 Hz, 3H), 7.26 – 7.21 (m, 4H), 5.53-5.46 (m, 2H), 4.28 (q, *J* = 7.2 Hz, 1H), 4.22 - 4.20 (m, 2H), 1.66, 1.64 (two s, 3H), 1.23 (t, *J* = 7.1 Hz, 3H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 172.8, 158.5, 154.4, 135.2, 132.9, 132.6, 130.4, 130.2, 128.9, 127.7, 126.9, 123.7, 114.4, 61.1, 45.9, 44.4, 14.3, 14.2. **IR:** 2925, 2857, 1744, 1655, 1599, 1461, 1461, 1378, 1304, 1259, 1199, 1025, 751, 702 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{20}H_{21}N_2O_3$: 337.1527 ($[M+H]^+$), found: 337.1546. **Mp**: 84 – 86 °C.

4c. Ethyl-3-phenyl-2-(4,6,7-trimethyl-3-oxo-3,4-dihydroquinoxalin-2-yl) propanoate: Prepared according to the general procedure as described above in 54% yield (100 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford as white solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.63 (s, 1H), 7.28 (d, *J* = 7.3 Hz, 2H), 7.21 (t, *J* = 7.6 Hz, 2H), 7.13 (t, *J* = 7.3 Hz, 1H), 7.04 (s, 1H), 4.59 (t, *J* = 7.5 Hz, 1H), 3.64 (s, 3H), 3.63 (s, 3H), 3.49 – 3.39 (m, 2H), 2.39 (s, 3H), 2.33 (s, 3H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 172.2, 155.3, 154.5, 140.3, 139.3, 132.7, 131.2, 131.0, 130.4, 129.2, 128.3, 126.2, 114.2, 52.2, 50.7, 35.3, 29.1, 20.6, 19.2. **IR:** 2920, 1740, 1089, 770, 690 cm^{-1}. **HRMS:** (ESI) *m/z* calculated for $C_{21}H_{23}N_2O_3$: 351.1687 ($[M+H]^+$), found: 351.1703. **Mp**:105– 107 °C.

4d. Ethyl 2-(4-benzyl-3-oxo-3,4-dihydroquinoxalin-2-yl)-3-phenylpropanoate: Prepared according to the general procedure as described above in 64% yield (111 mg); It was purified by flash chromatography (20% EtOAc/hexane; R_f = 0.5) to afford as white solid. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.88 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.43-7.39 (m, 1H), 7.31 – 7.28 (m, 5H), 7.25 – 7.20 (m, 4H), 7.18 – 7.13 (m, 3H), 5.47 (dd, *J* = 35.2, 15.7 Hz, 2H), 4.67 – 4.64 (m, 1H), 4.19 – 4.11 (m, 2H), 3.55 – 3.46 (m, 2H), 1.16 (t, *J* = 7.1 Hz, 3H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 172.8, 158.5, 154.4, 135.2, 132.9, 132.6, 130.4, 130.2, 129.3, 128.9, 128.3, 127.7, 126.9, 126.8, 123.7, 114.4, 61.1, 45.9, 44.4, 14.3, 14.2. **IR:** 2920, 2830, 1740, 1655, 1450,

1300, 1250, 1020, 749, 702 cm^{-1}. **HRMS:** (ESI) exact mass calculated for $C_{26}H_{25}N_2O_3$: 413.1832 ($[M+H]^+$), found: 413.1859. **Mp**: 90 – 92 °C.

4e. 3-(4-(3-benzyl-2-oxoquinoxalin-1(2*H*)-yl) butoxy)-4-methoxybenzaldehyde: Prepared according to the general procedure as described above in 80% yield (100 mg); It was purified by flash chromatography (50% EtOAC/ hexane; R_f = 0.5) to afford **4e** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.85 (s, 1H), 7.86 (dd, *J* = 8.0, 1.3 Hz, 1H), 7.49-7.45 (m, 4H), 7.40 (d, *J* = 1.8 Hz, 1H), 7.35 – 7.27 (m, 4H), 7.20 (t, *J* = 7.3 Hz, 1H), 6.97 (d, *J* = 8.2 Hz, 1H), 4.34 (t, *J* = 7.2 Hz, 2H), 4.26 (s, 2H), 4.14 (t, *J* = 5.7 Hz, 2H), 3.90 (s, 3H), 2.04 – 1.90 (m, 4H). **^{13}C {1H} NMR (100 MHz, $CDCl_3$):** δ 190.9, 159.3, 154.9, 154.5, 148.9, 137.1, 133.1, 132.5, 130.2, 130.1, 129.8, 129.5, 128.4, 126.9, 126.6, 123.4, 113.7, 110.7, 68.5, 56.1, 42.1, 40.7, 26.4, 24.2. **IR:** 2951, 1685, 1651, 1595, 1271, 1134, 758 cm^{-1}. **HRMS:** (ESI) m/z calculated for $C_{27}H_{27}N_2O_4$: 443.1963 ($[M+H]^+$), found: 443.1963. **Mp**:101 – 103 °C.

4f. 2-(4-(3-benzyl-2-oxoquinoxalin-1(2*H*)-yl) butoxy)-3-methoxybenzaldehyde: Prepared according to the general procedure as described above in 80% yield (100 mg); It was purified by flash chromatography (50% EtOAC/ hexane; R_f = 0.5) to afford **4f** as yellow solid.**^{1}H NMR (500 MHz, $CDCl_3$):** δ 10.40 (s, 1H), 7.86 (dd, *J* = 8.0, 1.3 Hz, 1H), 7.53 – 7.49 (m, 1H), 7.46 (d, *J* = 7.3 Hz, 2H), 7.41 (t, *J* = 4.1 Hz, 1H), 7.36 – 7.27 (m, 4H), 7.20 (t, *J* = 7.4 Hz, 1H), 7.13 (d, *J* = 4.2 Hz, 2H), 4.32 (t, 2H), 4.27 (s, 2H), 4.16 (t, *J* = 5.9 Hz, 2H), 3.86 (s, 3H), 2.01 – 1.91 (m, 4H). **^{13}C {1H} NMR (125 MHz, $CDCl_3$):** δ 190.1, 159.3, 154.5, 153.0, 151.6, 137.1, 133.1, 132.5, 130.3, 129.9, 129.5, 128.4, 126.6, 124.2, 123.5, 119.3, 118.0, 113.6, 74.1, 56.0, 42.1, 40.7, 27.5, 24.0. **IR:** 2952, 1689, 1655, 1598, 1479, 1263, 761 cm^{-1}. **HRMS:** (ESI) m/z calculated for $C_{27}H_{27}N_2O_4$: 443.1966 ($[M+H]^+$), found: 443.1966. **Mp**: 96 – 98 °C.

4g. 2-(3-benzyl-2-oxoquinoxalin-1(2*H*)-yl) acetic acid:[7] Prepared according to the general procedure as described above in 80% yield (85 mg); It was purified by flash chromatography (20% MeoH/DCM; R_f = 0.5) to afford **4g** as white solid. **^{1}H NMR (500 MHz, DMSO-d6):** δ 7.81 (d, *J* = 7.8 Hz, 1H), 7.58 (t, *J* = 7.5 Hz, 1H), 7.47 (d, *J* = 8.3 Hz, 1H), 7.36 (dd, *J* = 19.4, 7.4 Hz, 3H), 7.29 (t, *J* = 7.4 Hz, 2H), 7.21 (t, *J* = 7.0 Hz, 1H), 5.00 (s, 2H), 4.16 (s, 2H). **^{13}C {1H} NMR (125 MHz, DMSO-d6):** δ 168.7, 158.6, 153.8, 137.1, 132.5, 131.9, 130.2, 129.2, 129.1, 128.3, 126.4, 123.6, 114.6, 43.7. **IR:** 3595, 3487, 3420, 3353, 3257, 1730, 1651, 1600, 1224, 756 cm^{-1}. **HRMS:** (ESI) m/z calculated for $C_{17}H_{15}N_2O_3$: 295.1076 ($[M+H]^+$), found: 295.1077.

4h. 3-((2,3-dihydro-1*H*-inden-2-yl)methyl)-1-ethynylquinoxalin-2(1*H*)-one:

Prepared according to the general procedure as described above in 73% yield (60 mg); It was purified by flash chromatography (20% EtOAC/ hexane; R_f = 0.5) to afford **4h** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.86 (d, *J* = 7.6 Hz, 1H), 7.58 (t, *J* = 7.7 Hz, 1H), 7.49 (d, *J* = 8.3 Hz, 1H), 7.38 (t, *J* = 7.6 Hz, 1H), 7.28 – 7.25 (m, 2H), 7.21 – 7.17 (m, 2H), 5.11 (d, J = 2.4 Hz, 2H), 4.39 - 4.30 (m, 1H), 3.51 – 3.39 (m, 4H), 2.32 (t, *J* = 2.3 Hz, 1H).**^{13}C NMR (125 MHz, $CDCl_3$)** δ 161.8, 153.9, 142.5, 132.8, 131.6, 130.2, 129.8, 126.4, 124.4, 123.9, 114.1, 73.2, 42.8, 37.1, 31.5. **IR:** 3878, 3649, 3479, 3334, 2803, 2678, 2355, 1968, 1885, 1547, 850 cm^{-1}. **HRMS:** (ESI) m/z calculated for $C_{20}H_{17}N_2O$: 301.1335 ($[M+H]^+$), found: 301.1378; **Mp**: 208 – 209 °C.

4i. Ethyl 2-(3-(2,3-dihydro-1*H*-inden-2-yl)-2-oxoquinoxalin-1(2*H*)-yl)acetate:

Prepared according to the general procedure as described above in 70% yield (60 mg); It was purified by flash chromatography (20% EtOAC/ hexane; R_f = 0.5) to afford **4i** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.87 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.54 - 7.49 (m, 1H), 7.37 – 7.33 (m, 1H), 7.28 – 7.25 (m, 2H), 7.21 – 7.17 (m, 2H), 7.09 (d, *J* = 7.6 Hz, 1H), 5.08 (s, 2H), 4.38 – 4.26 (m, 3H), 3.53 – 3.40 (m, 4H), 1.31 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (75 MHz, $CDCl_3$)** δ 167.2, 161.7, 154.5, 142.5, 132.6, 132.2, 130.3, 129.9, 126.3, 124.4, 123.9, 113.0, 62.1, 45.7, 43.6, 42.7, 37.0, 14.2. **IR:** 3684, 3020, 2406, 1533, 1215, 740, 669. 581 cm^{-1}. **HRMS:** (ESI) m/z calculated for $C_{21}H_{21}N_2O_3$: 349.1547 ($[M+H]^+$), found: 349.1537; **Mp**: 181 – 182 °C.

4j. 3-(4-(3-(2,3-dihydro-1*H*-inden-2-yl)-2-oxoquinoxalin-1(2*H*)-yl)butyl)-4-methoxybenzaldehyde: Prepared according to the general procedure as described above in 75% yield (100 mg); It was purified by flash chromatography (20% EtOAC/ hexane; R_f = 0.5) to afford **4j** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 10.46 (s, 1H), 7.86 (dd, *J* = 8.0, 1.3 Hz, 1H), 7.56 -7.52 (m, 1H), 7.47 – 7.40 (m, 2H), 7.36 – 7.32 (m, 1H), 7.29 – 7.26 (m, 2H), 7.19 – 7.14 (m, 4H), 4.44 - 4.30 (m, 3H), 4.23 (t, *J* = 5.9 Hz, 2H), 3.91 (s, 3H), 3.52 – 3.40 (m, 4H), 2.11 – 1.98 (m, 4H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 190.1, 161.8, 154.7, 153.0, 151.6, 142.6, 132.9, 132.2, 130.3, 130.0, 129.7, 126.3, 124.4, 124.3, 123.4, 119.4, 118.0, 113.5, 74.1, 56.1, 42.7, 42.00, 37.1, 27.6, 24.1. **IR:** 3917, 3690, 3586, 3024, 2406, 1215, 740, 670 cm^{-1}. **HRMS:** (ESI) m/z calculated for $C_{29}H_{29}N_2O_3$: 469.2122 ($[M+H]^+$), found: 469.2118; **Mp**: 129 – 130 °C.

4k. 3-cyclopentyl-1-(prop-2-yn-1-yl)quinoxalin-2(1*H*)-one:

Prepared according to the general procedure as described above in 70% yield (90 mg); It was purified by flash chromatography (10% EtOAC/ hexane; R_f = 0.5) to afford **4k** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.77 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.49 - 7.44 (m, 1H), 7.37 (dd, *J* = 8.4, 1.1 Hz, 1H), 7.30 – 7.26 (m, 1H), 4.99 (d, *J* = 2.5 Hz, 2H), 3.68 - 3.60 (m, 1H), 2.21 (t, *J* = 2.5 Hz, 1H), 2.04 – 1.95 (m, 2H), 1.90 – 1.60 (m, 6H). **^{13}C NMR (125 MHz, $CDCl_3$)** δ 163.7, 154.0, 132.9, 131.5, 129.9, 129.4, 123.8, 114.0, 73.1, 42.7, 38.9, 31.5, 30.9, 26.0. IR: 3858, 3687, 3304, 3025, 2364, 1425, 1215, 740, 669 cm^{-1}. HRMS: (ESI) m/z calculated for $C_{16}H_{17}N_2O$: 253.1335 ($[M+H]^+$), found: 253.1328; **Mp**: 116 – 118 ^{o}C.

4l. 3-isopropyl-1-(prop-2-yn-1-yl)quinoxalin-2(1*H*)-one:[8]

Prepared according to the general procedure as described above in 80% yield (95 mg); It was purified by flash chromatography (20% EtOAC/ hexane; R_f = 0.5) to afford **4l** as white solid. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.86 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.56 – 7.53 (m, 1H), 7.44 (dd, *J* = 8.4, 1.1 Hz, 1H), 7.37 – 7.34 (m, 1H), 5.06 (d, *J* = 2.5 Hz, 2H), 3.67 – 3.58 (m, 1H), 2.29 (t, *J* = 2.5 Hz, 1H), 1.32 (d, *J* = 6.8 Hz, 6H). **^{13}C NMR (75 MHz, $CDCl_3$)** δ 164.9, 153.5, 132.9, 131.5, 130.0, 129.6, 123.8, 114.0, 73.1, 31.5, 31.3, 20.2. **IR.** 3688, 3529, 3021, 2362, 1426, 1214, 670 cm^{-1}. **HRMS:** (ESI) m/z calculated for $C_{14}H_{15}N_2O$: 227.1179 ($[M+H]^+$), found: 227.1169; **Mp**: 140 – 141 ^{o}C.

4m. 3-cyclohexyl-1-(prop-2-yn-1-yl)quinoxalin-2(1*H*)-one :[9]

Prepared according to the general procedure as described above in 70% yield (100 mg); It was purified by flash chromatography (10% EtOAC/ hexane; R_f = 0.5) to afford **4m** as white solid. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.86 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.56 - 7.52 (m, 1H), 7.43 (dd, *J* = 8.4, 1.1 Hz, 1H), 7.37 – 7.33 (m, 1H), 5.05 (d, *J* = 2.5 Hz, 2H), 3.37 – 3.30 (m, 1H), 2.28 (t, *J* = 2.5 Hz, 1H), 1.98 – 1.84 (m, 5H), 1.63 – 1.25 (m, 5H). **^{13}C NMR (75 MHz, $CDCl_3$)** δ 153.5, 133.1, 131.3, 129.9, 129.5, 123.8, 114.0, 73.1, 40.8, 31.5, 30.6, 26.3, 26.1. **IR:** 3685, 3600, 3024, 2366, 1519, 1214, 740 cm^{-1}. **HRMS**: (ESI) m/z calculated for $C_{17}H_{19}N_2O$: 267.1492 ($[M+H]^+$), found: 267.1480; **Mp**: 127 – 129 ^{o}C.

4n. 1-benzyl-3-(2,3-dihydro-1*H*-inden-2-yl)quinoxalin-2(1*H*)-one :

Prepared according to the general procedure as described above in 65% yield (85 mg); It was purified by flash chromatography (20% EtOAC/ hexane; R_f = 0.5) to afford **4n** as white solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 (dd, *J* = 7.9, 1.4 Hz, 1H), 7.42 – 7.37 (m, 1H), 7.35 – 7.24 (m, 9H), 7.19 – 7.15 (m, 2H), 5.53 (s, 2H), 4.42 – 4.34 (m, 1H), 3.53 – 3.41 (m, 4H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 162.0, 155.0, 142.6, 135.4, 132.9, 132.4, 130.1, 129.7, 129.0, 127.7, 126.9, 126.3, 124.4, 123.6, 114.3, 45.9, 42.7, 37.1. **IR**: 2972, 2845, 2406, 1215, 740, 670 cm^{-1}. **HRMS:** (ESI) m/z calculated for $C_{24}H_{21}N_2O$: 353.1648 ($[M+H]^+$), found: 353.1637; **Mp**: 154 – 156 °C.

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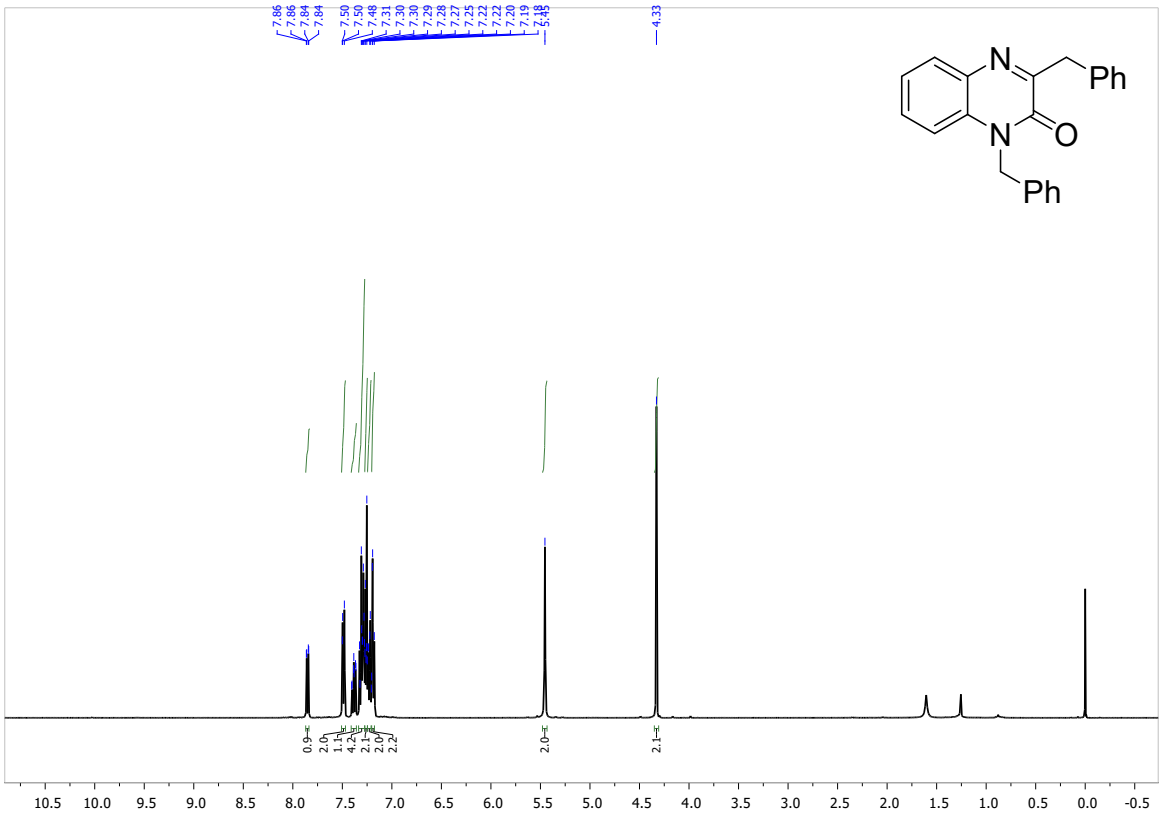
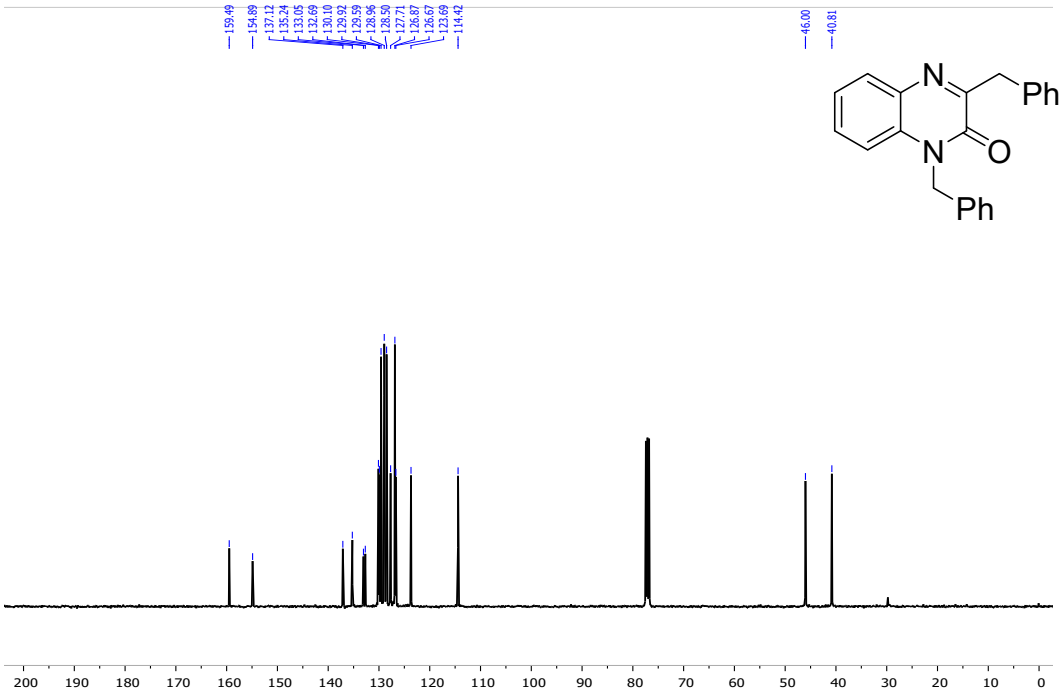
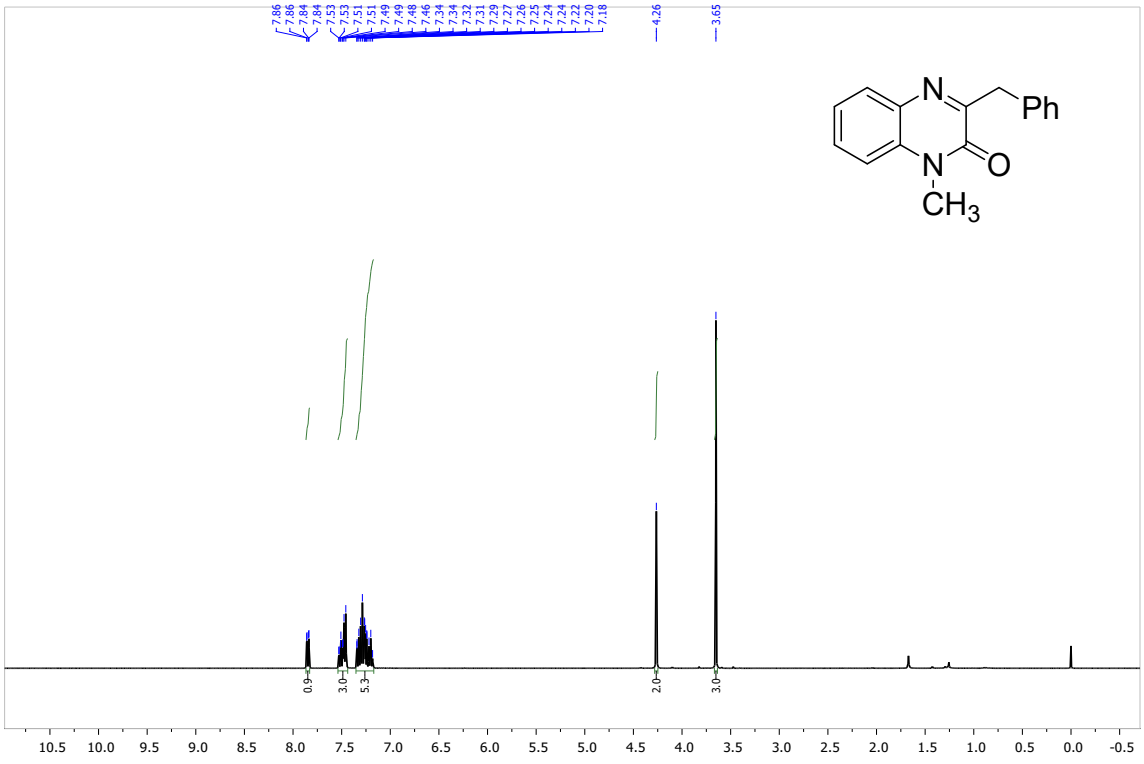
8. Copies of ^{1}H/^{13}C NMR spectra:



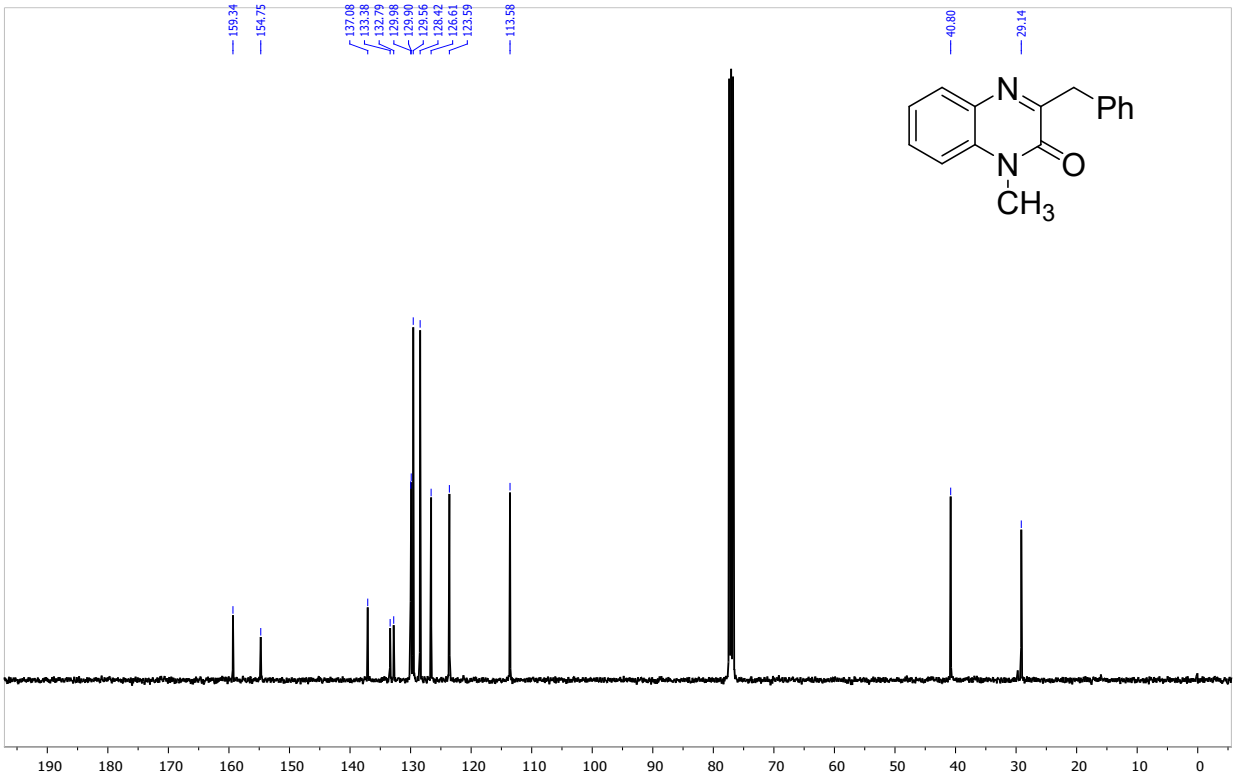
^{1}H NMR spectra of **3a** (400 MHz, $CDCl_3$)



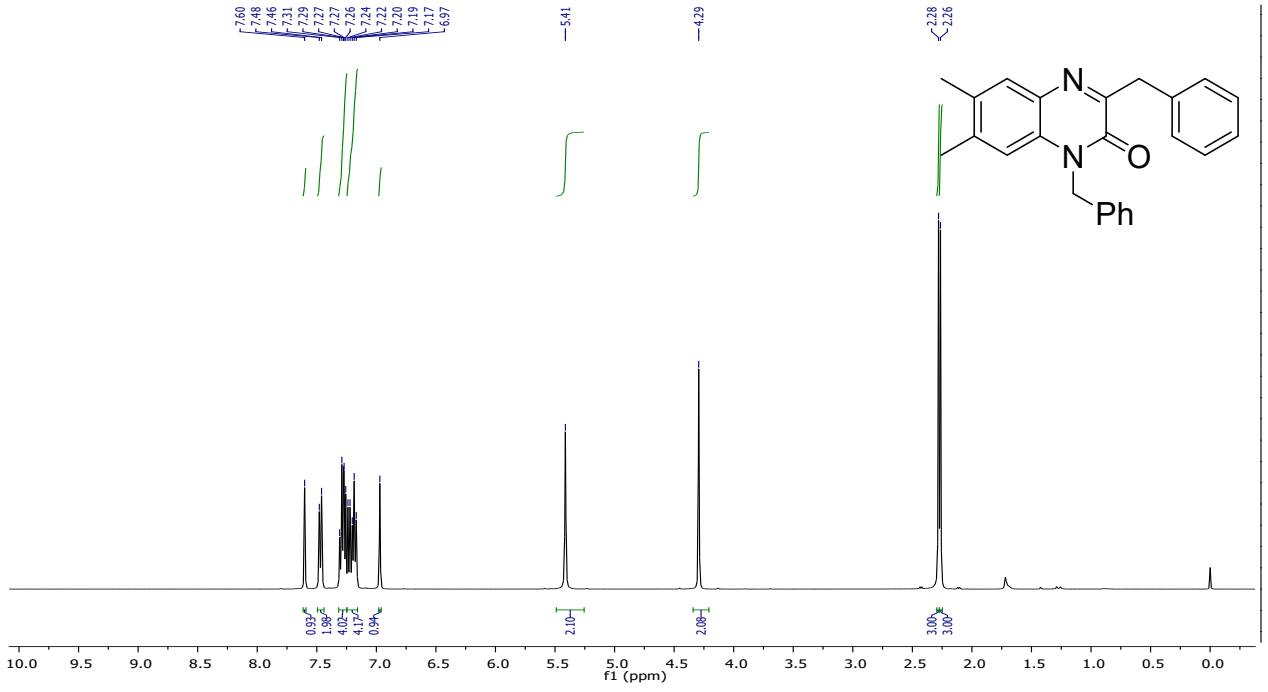
^{13}C{1H}NMR spectra of **3a** (100 MHz, $CDCl_3$)



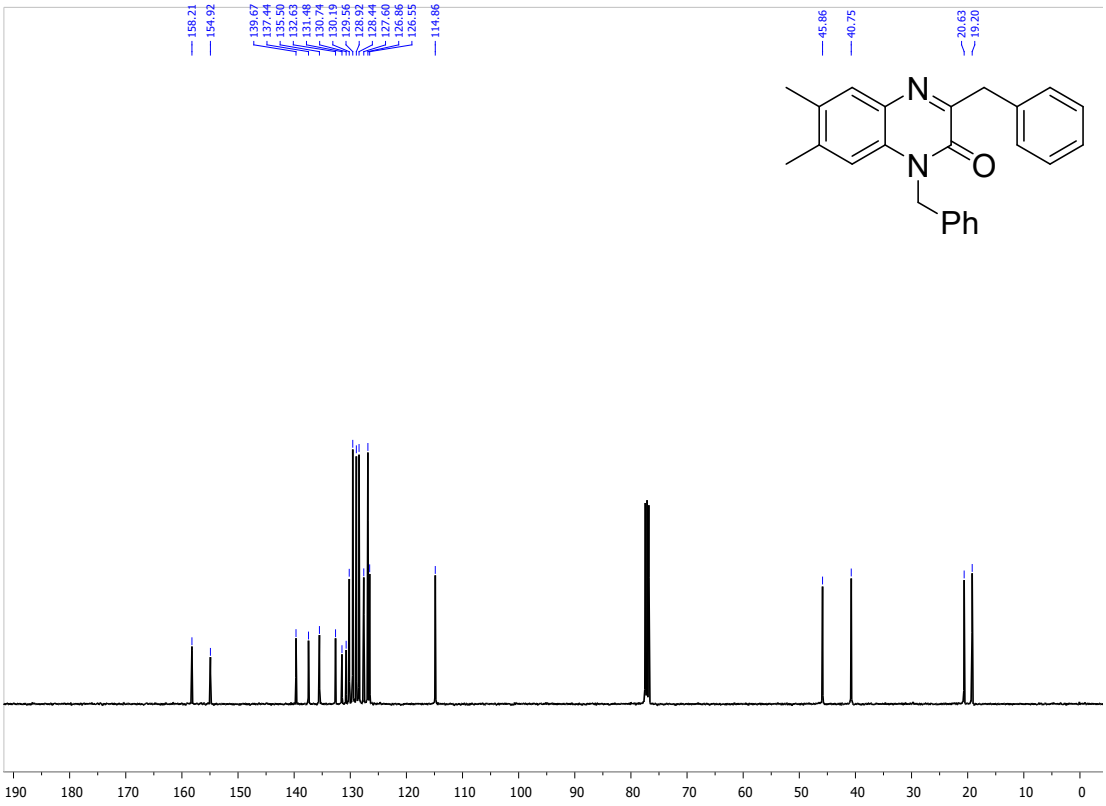
^{1}H NMR spectra of **3b** (400 MHz, $CDCl_3$)



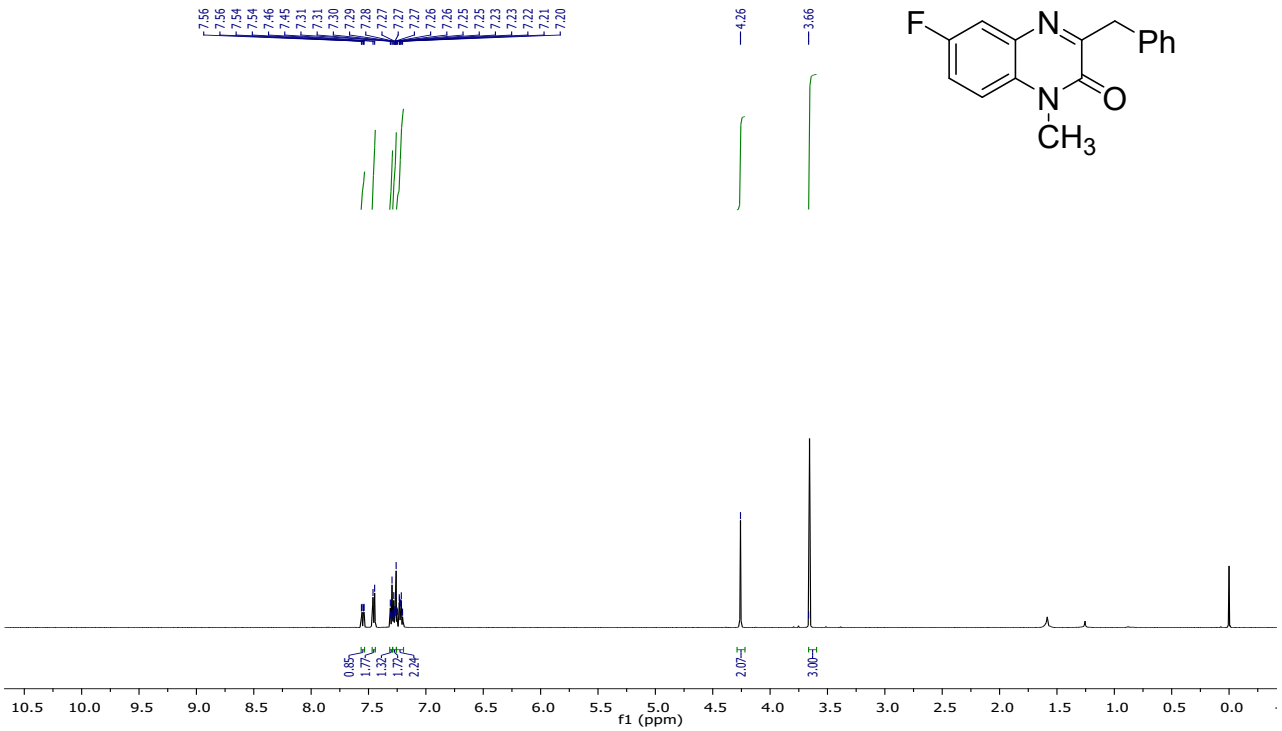
^{13}C NMR spectra of **3b** (100 MHz, $CDCl_3$)



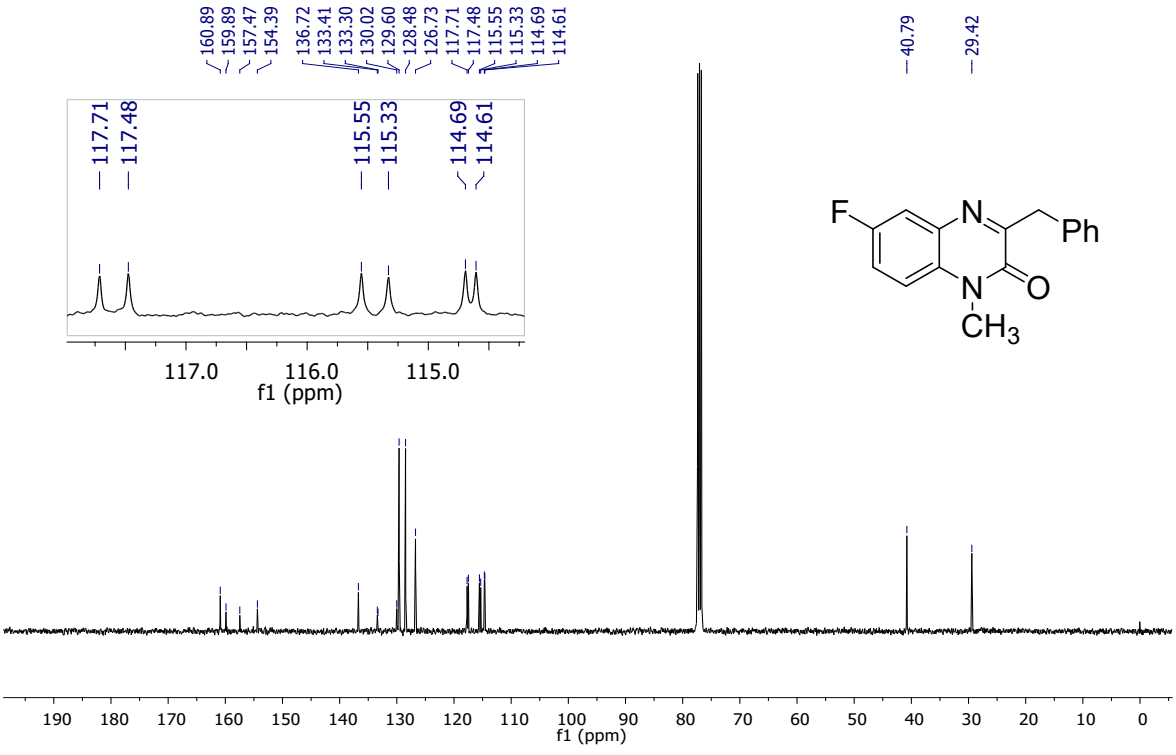
^{1}H NMR spectra of **3c** (400 MHz, $CDCl_3$)



^{13}C NMR spectra of **3c** (100 MHz, $CDCl_3$)



^{1}H NMR spectra of **3d** (500 MHz, $CDCl_3$)



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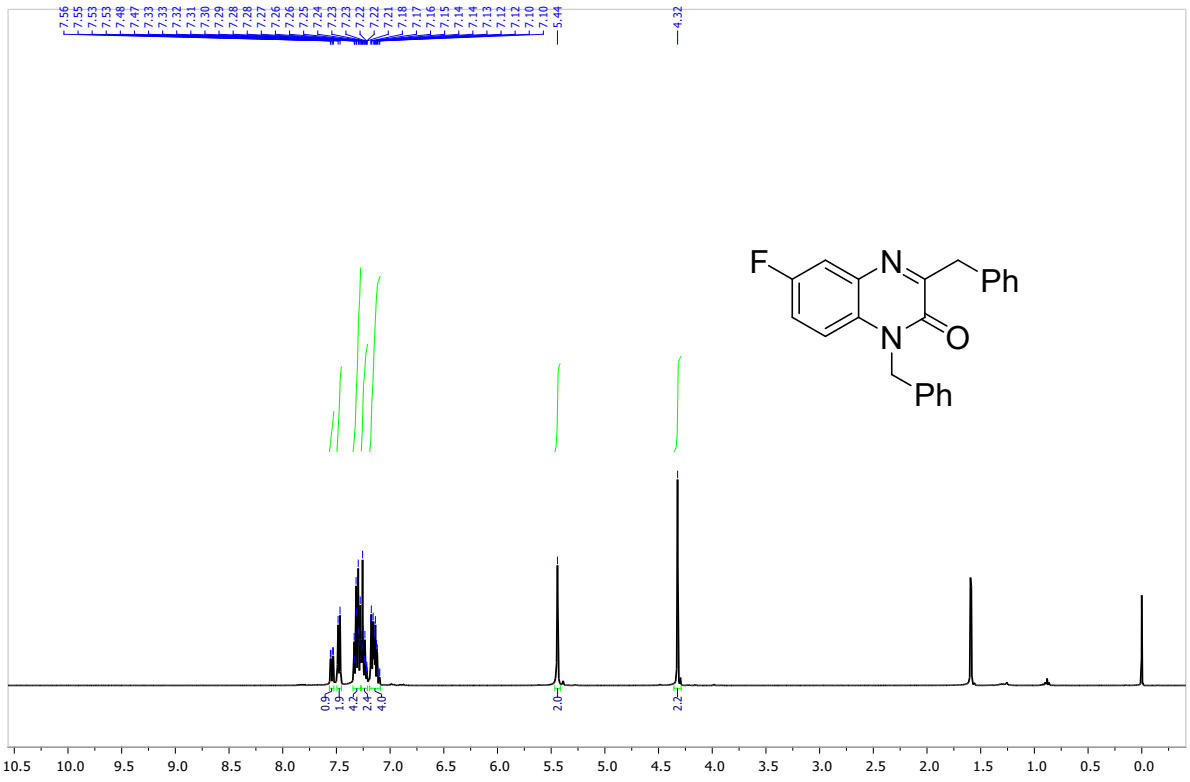

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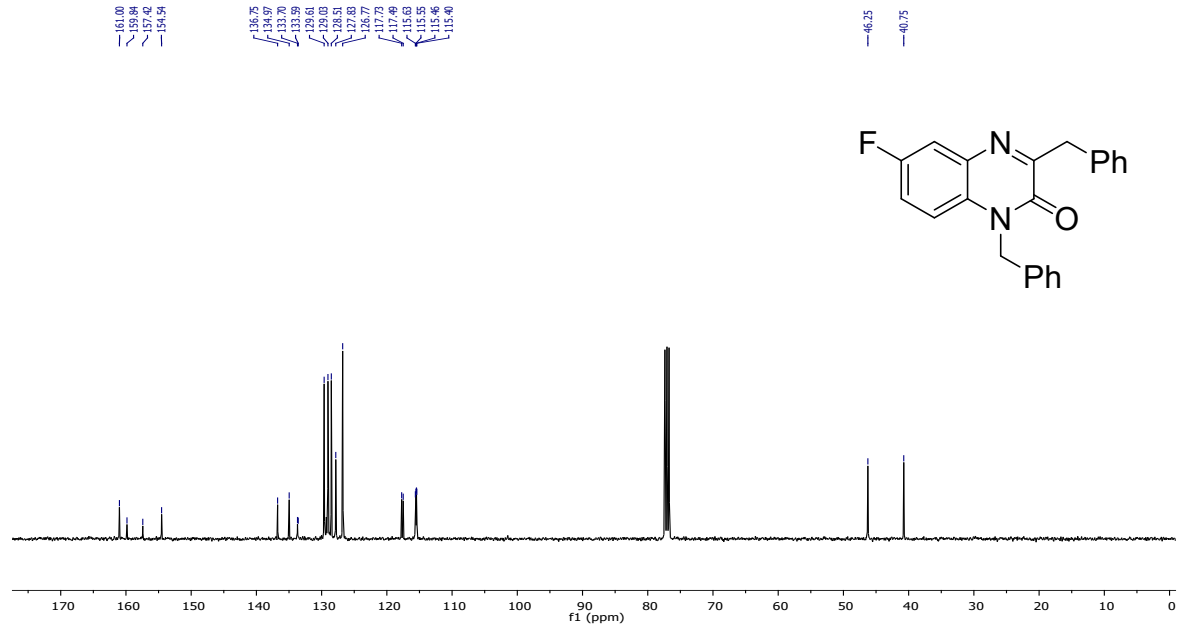
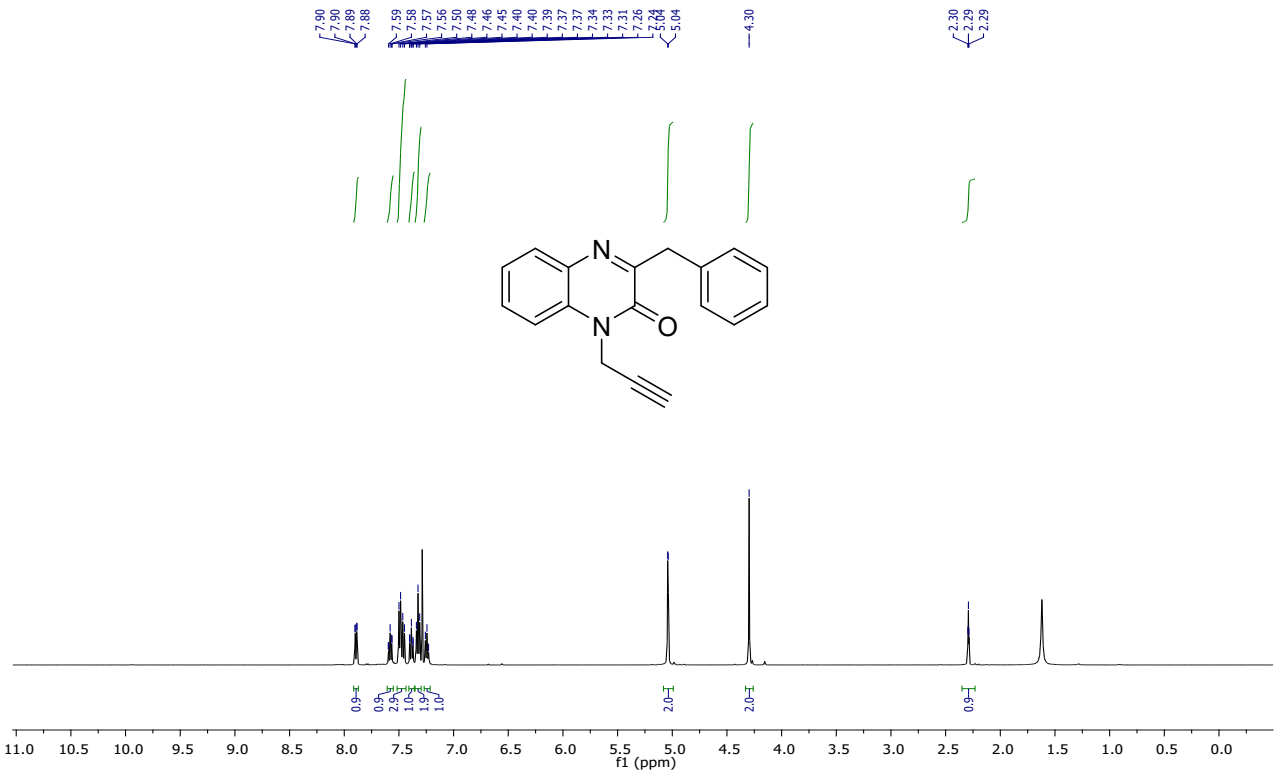
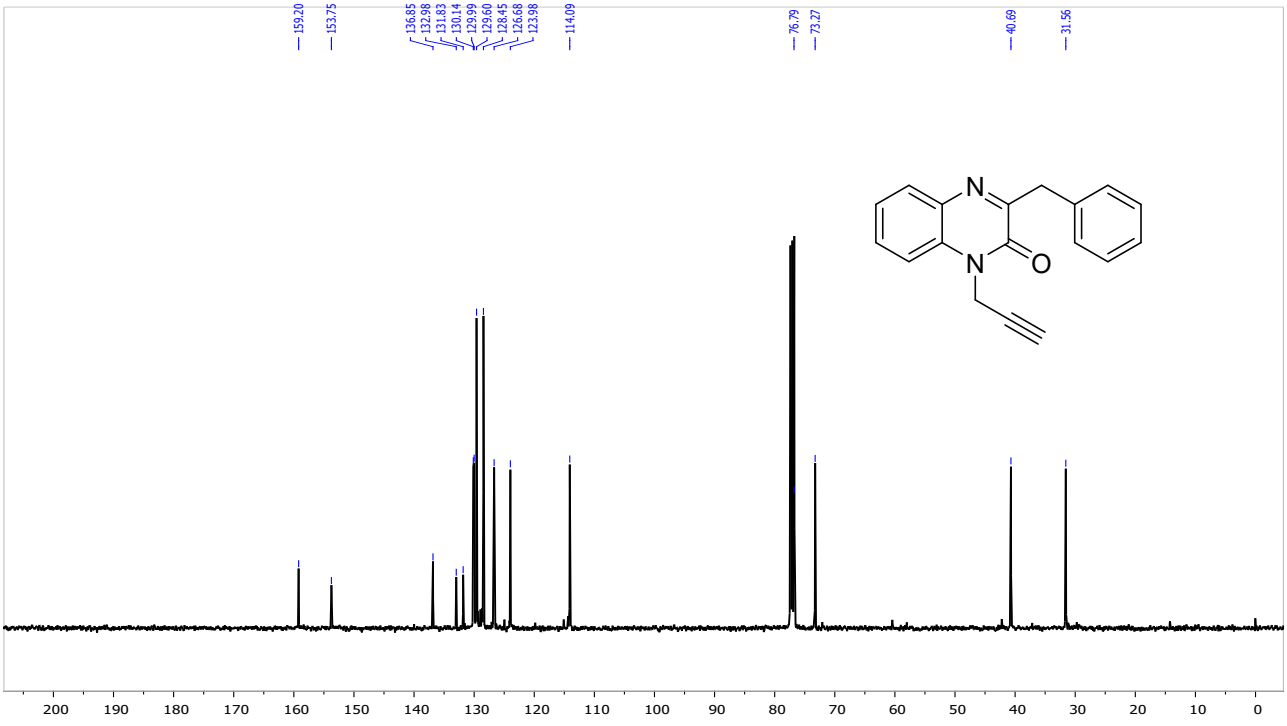


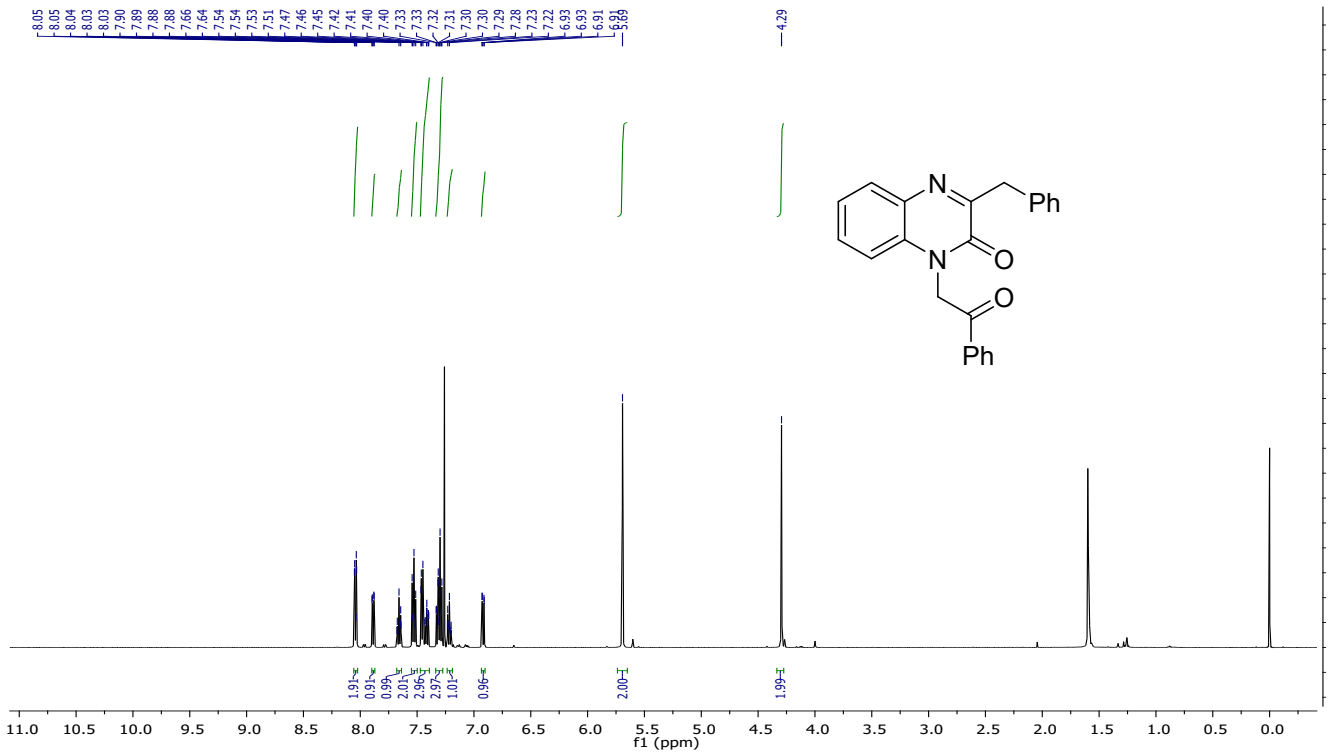
^{13}C NMR spectra of **3e** (125 MHz, $CDCl_3$)



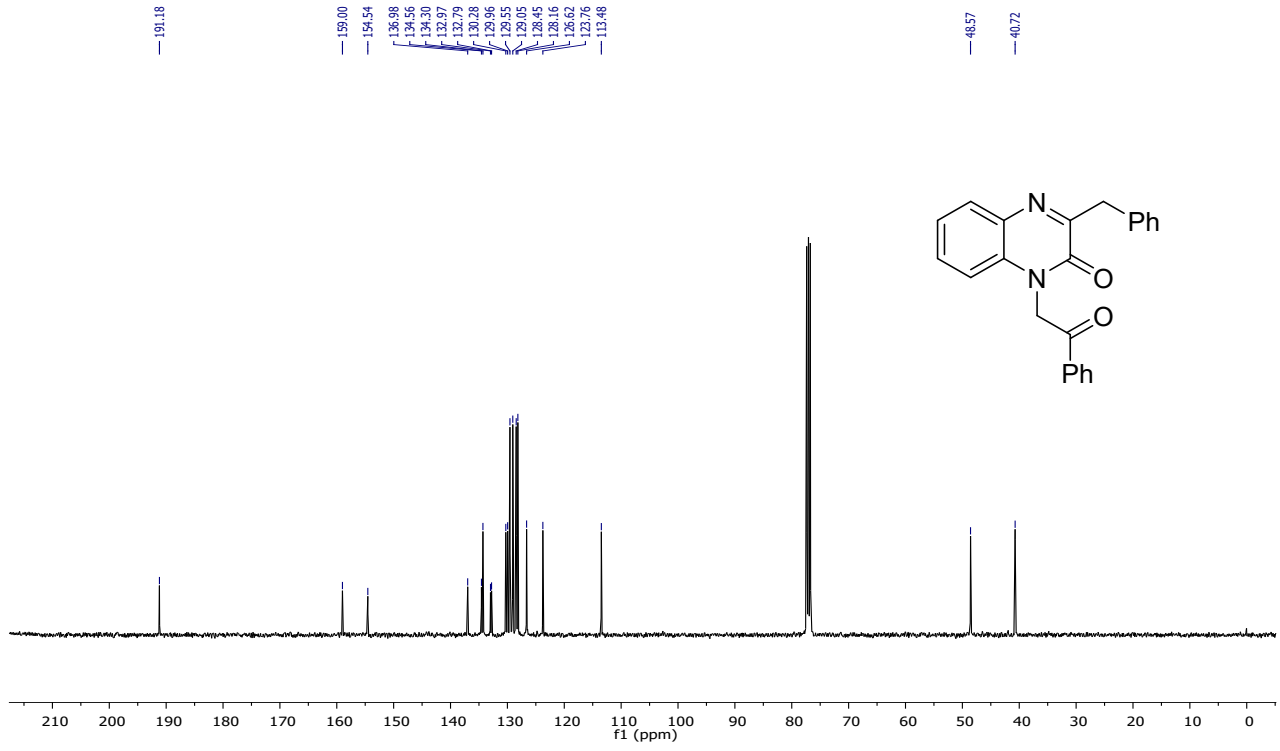
^{1}H NMR spectra of **3f** (500 MHz, $CDCl_3$)



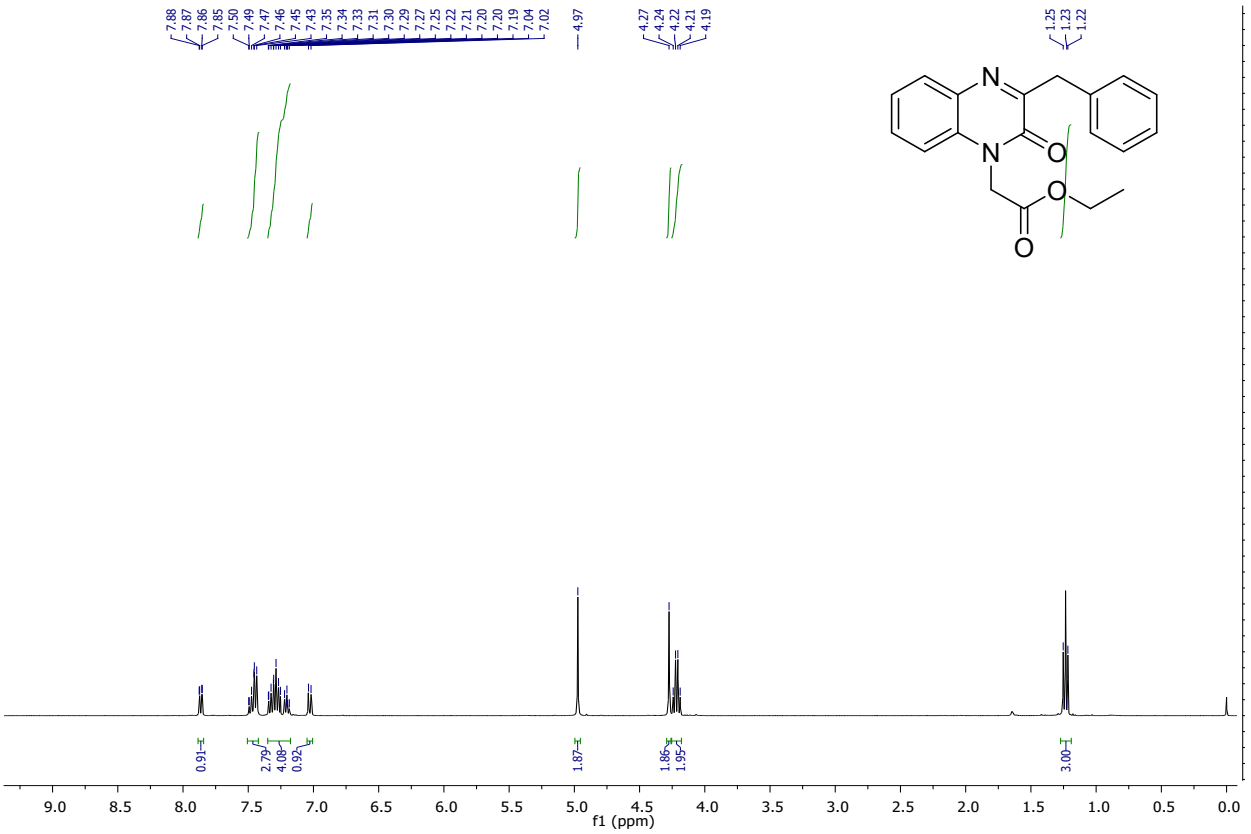
^{13}C{1H}NMR spectra of **3f** (100 MHz, $CDCl_3$)



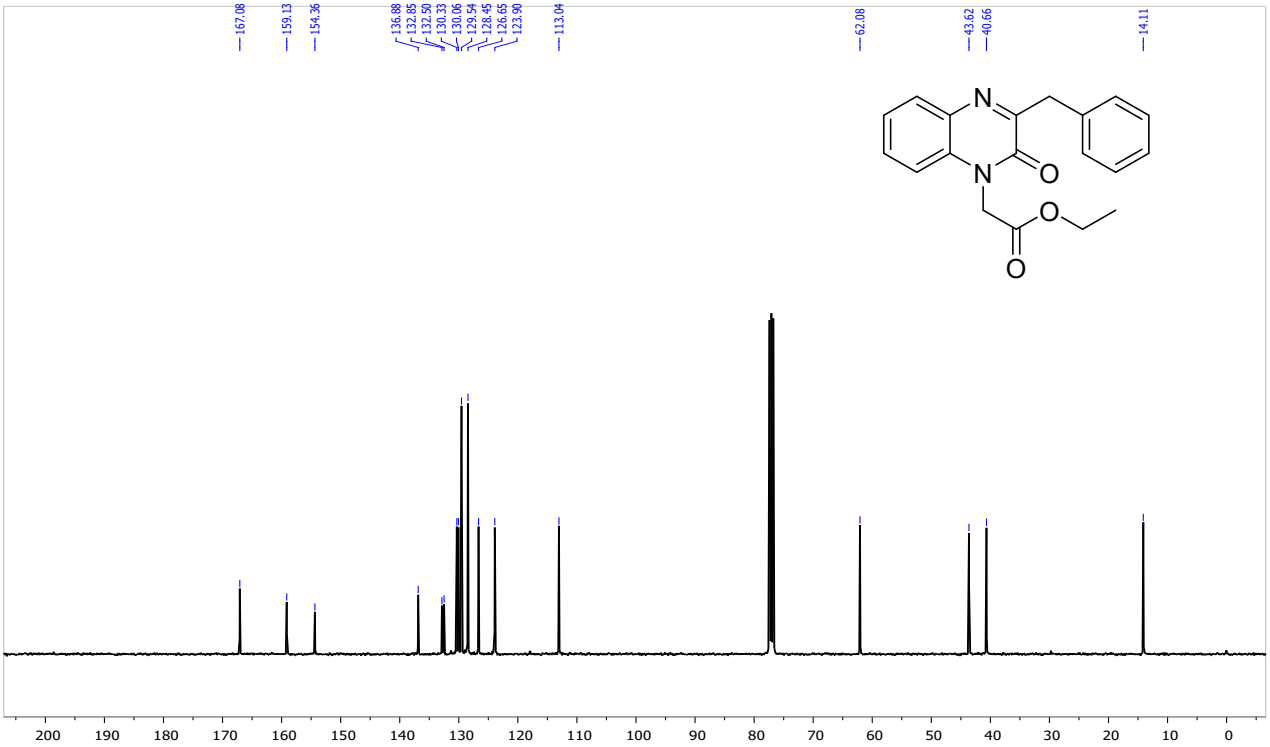
^{1}H NMR spectra of **3g** (500 MHz, $CDCl_3$)



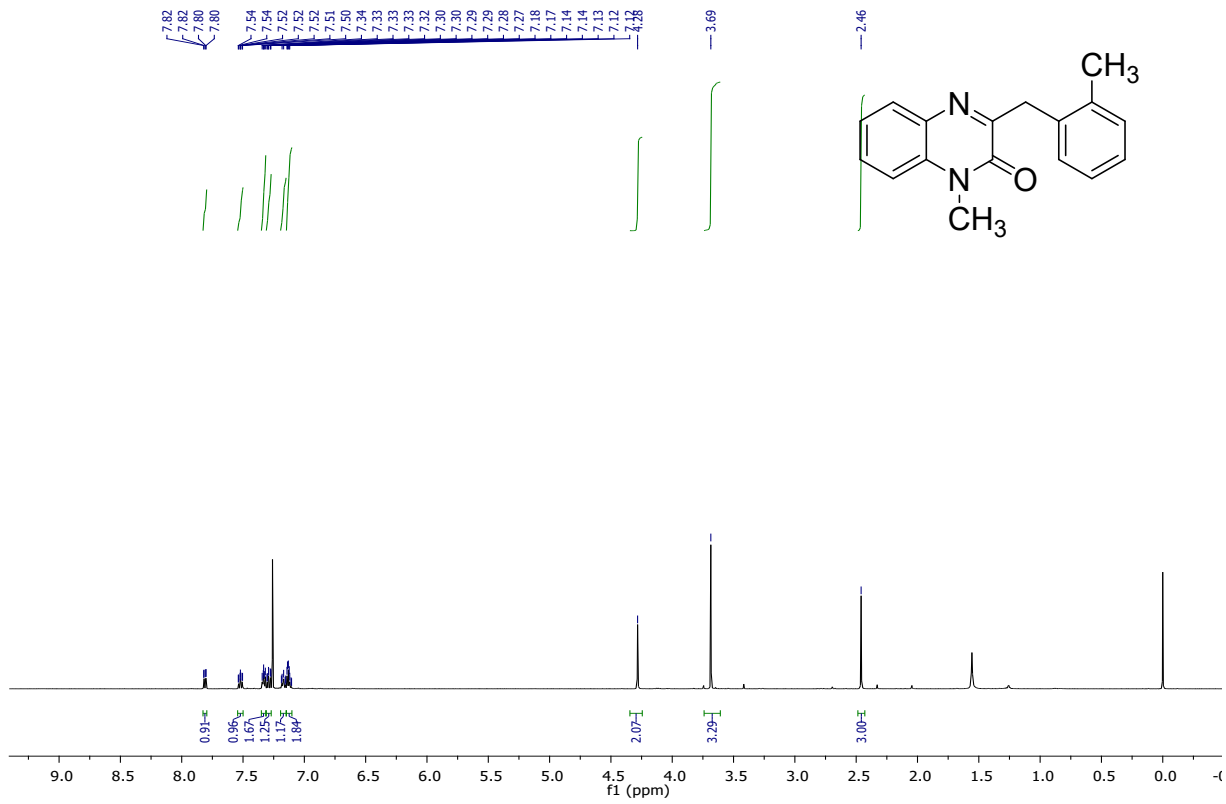
^{13}C{1H}NMR spectra of **3g** (100 MHz, $CDCl_3$)



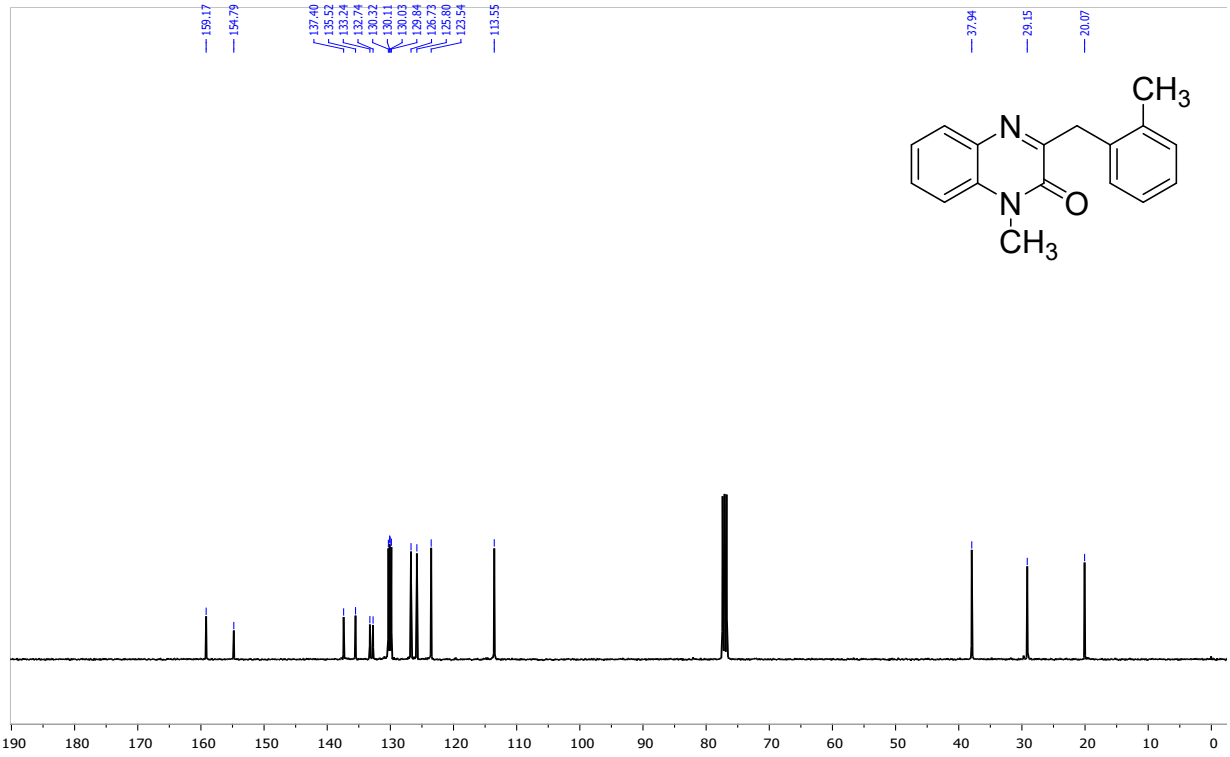
^{1}H NMR spectra of **3h** (400 MHz, $CDCl_3$)



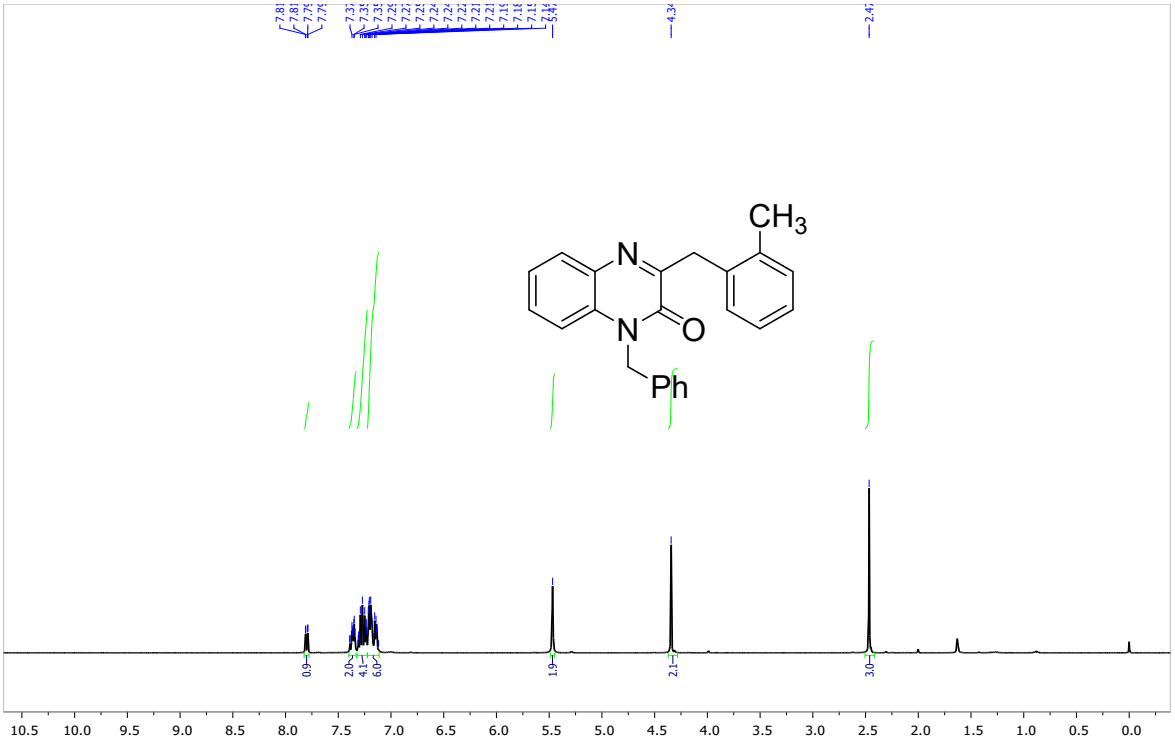
^{13}C{1H}NMR spectra of **3h** (100 MHz, $CDCl_3$)



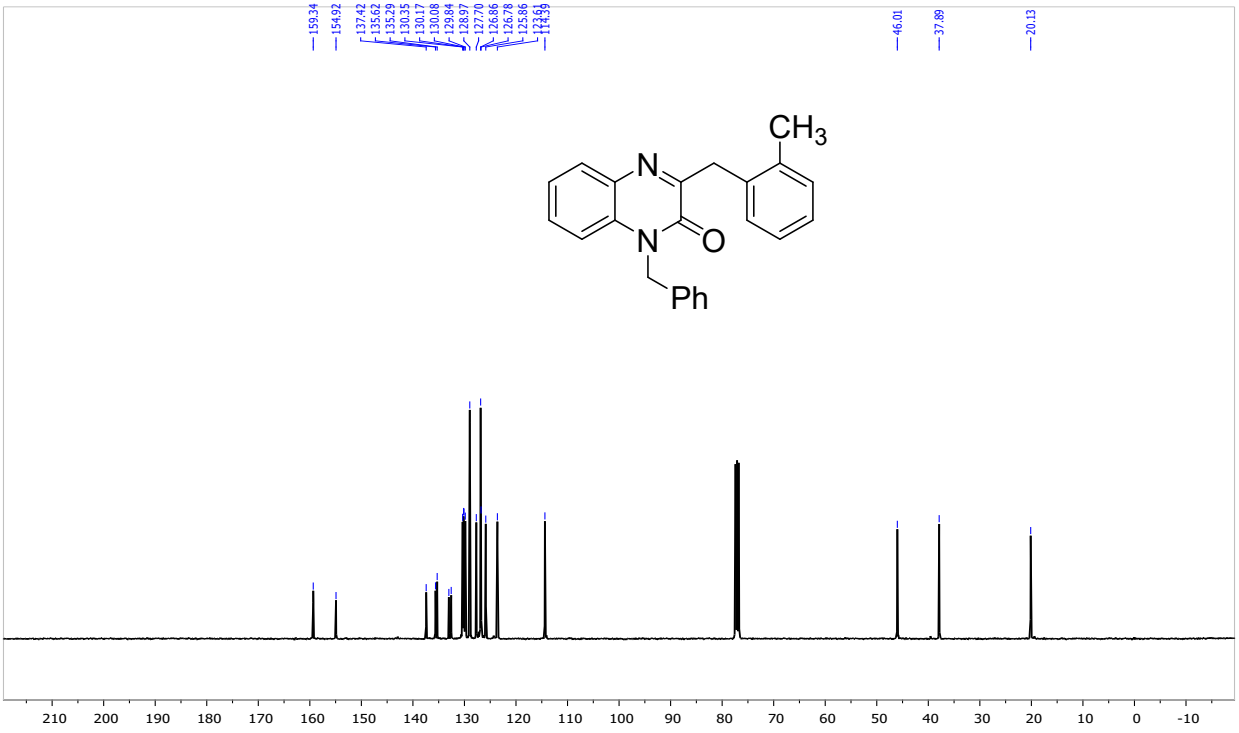
^{1}H NMR spectra of **3i** (500 MHz, $CDCl_3$)



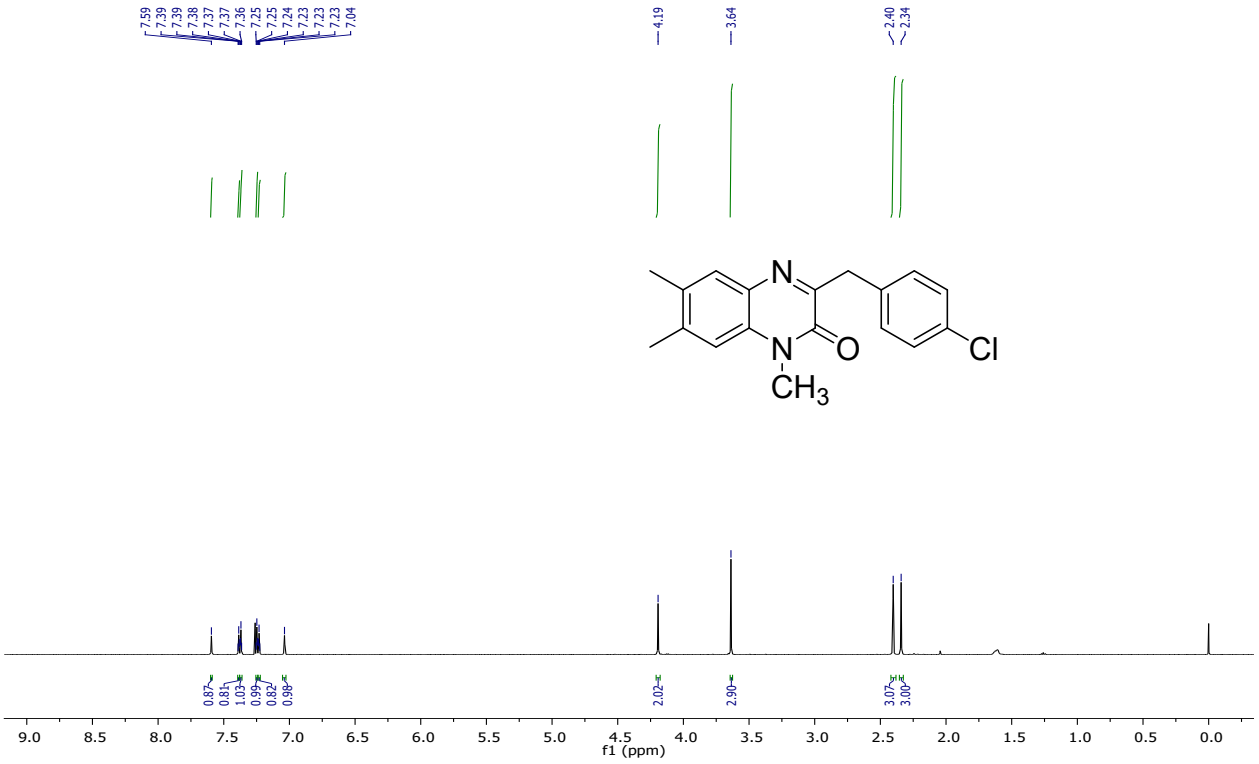
^{13}C{1H}NMR spectra of **3i** (100 MHz, $CDCl_3$)



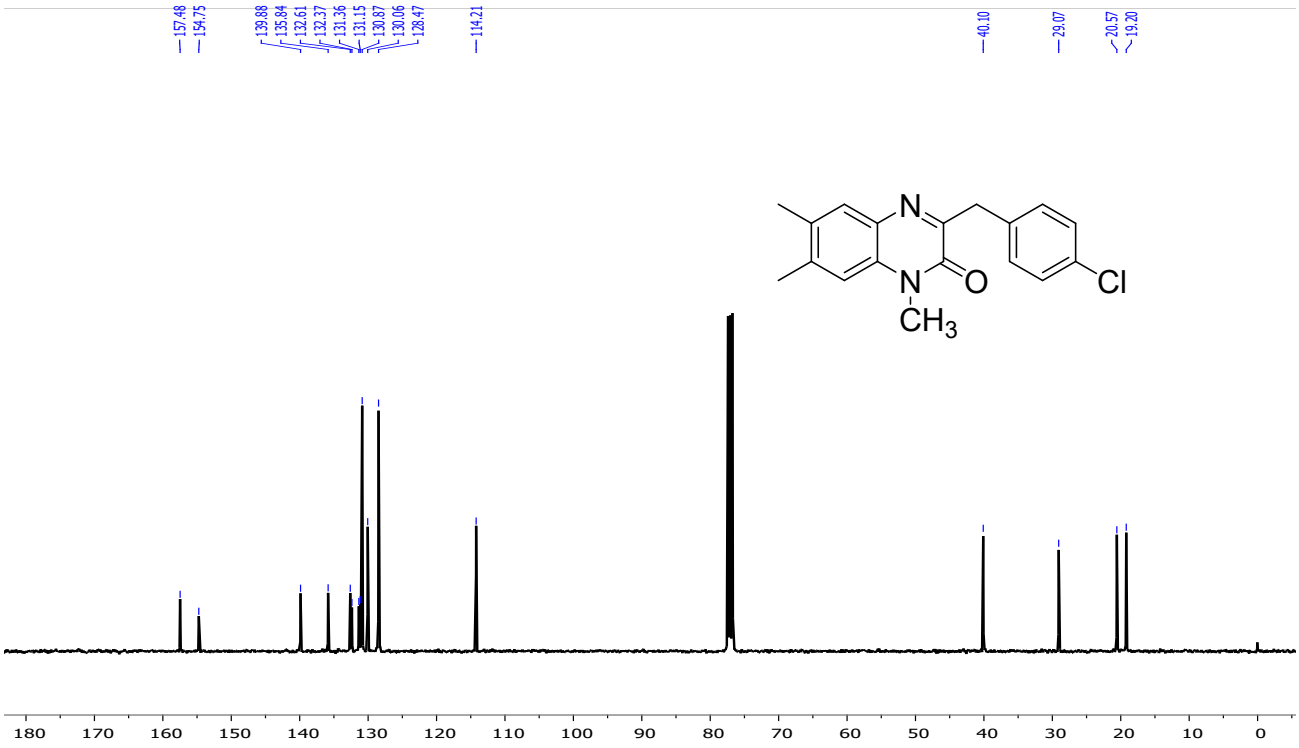
^{1}H NMR spectra of **3j** (500 MHz, $CDCl_3$)



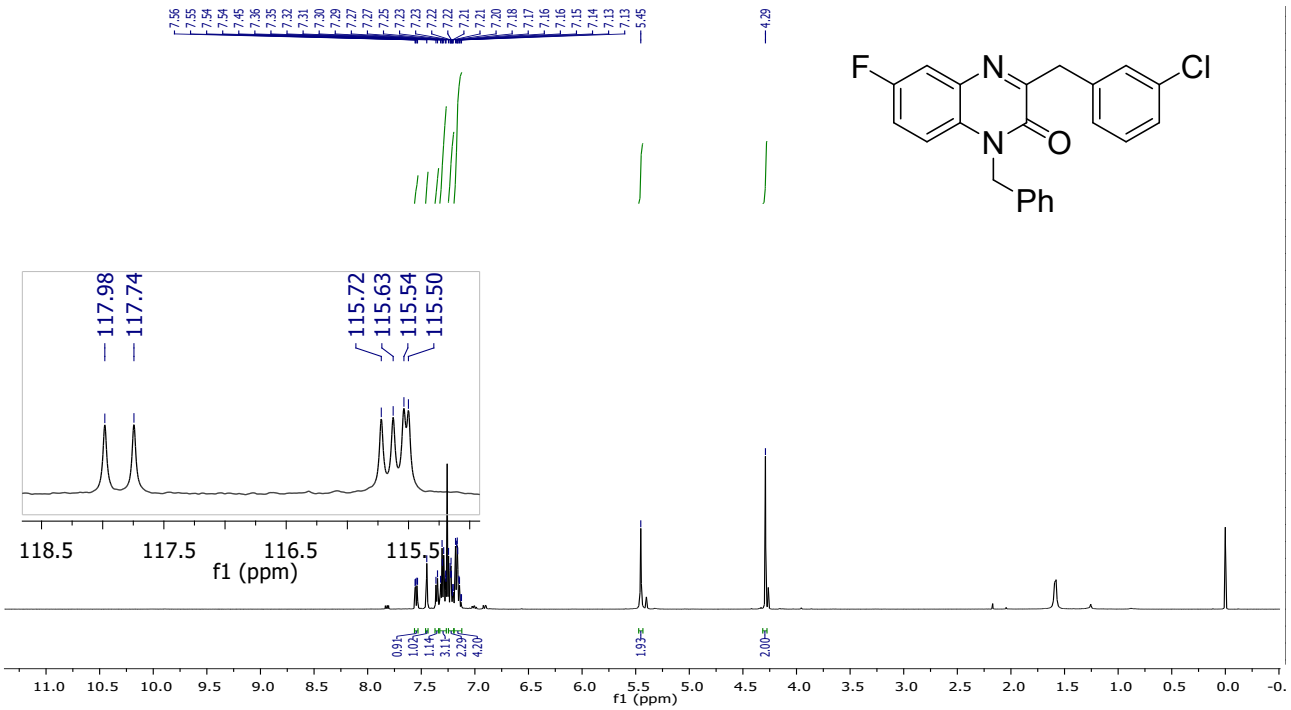
^{13}C{1H}NMR spectra of **3j** (100 MHz, $CDCl_3$)



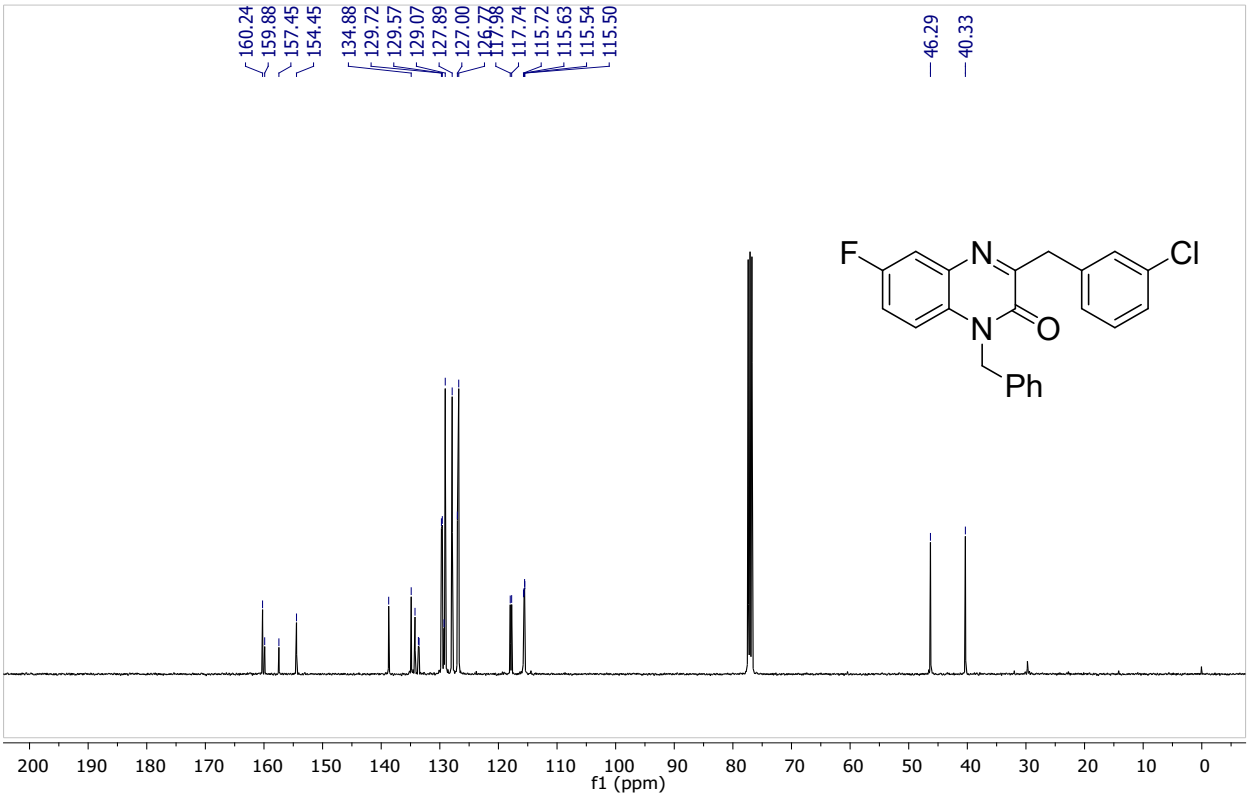
^{1}H NMR spectra of **3k** (500 MHz, $CDCl_3$)



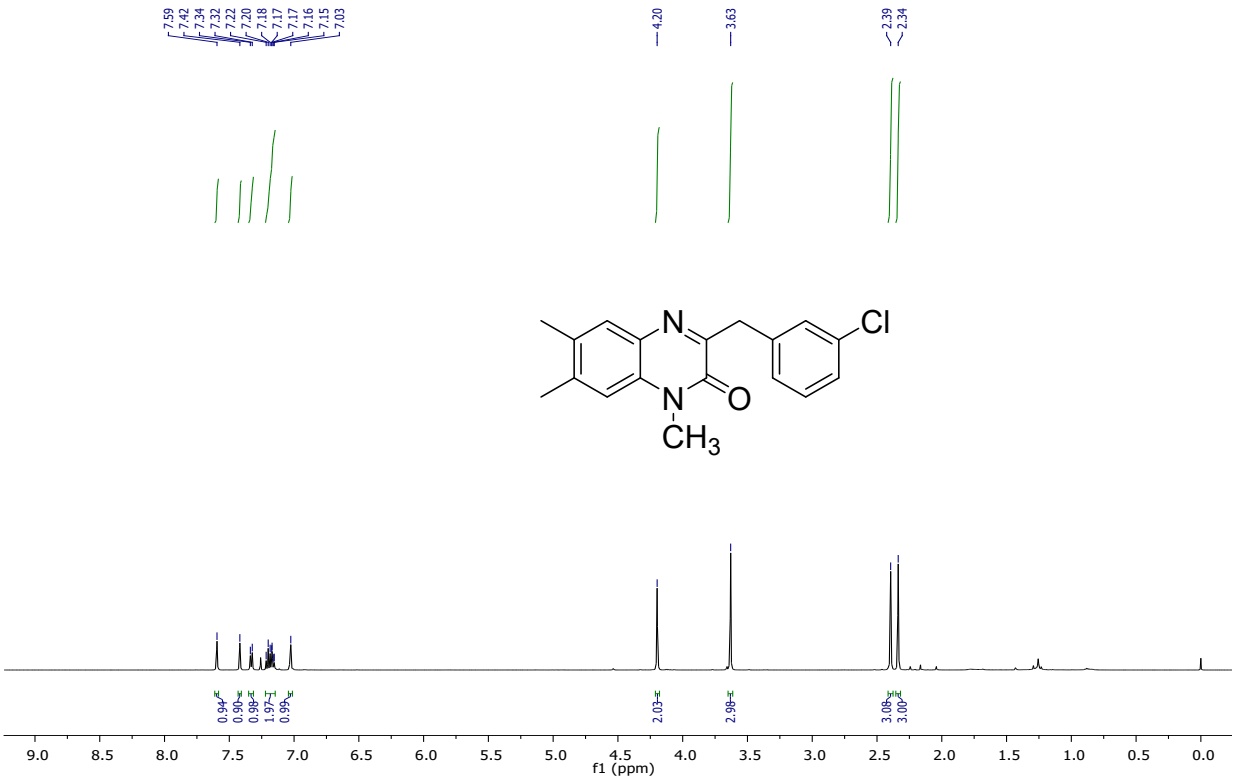
^{13}C{1H}NMR spectra of **3k** (100 MHz, $CDCl_3$)



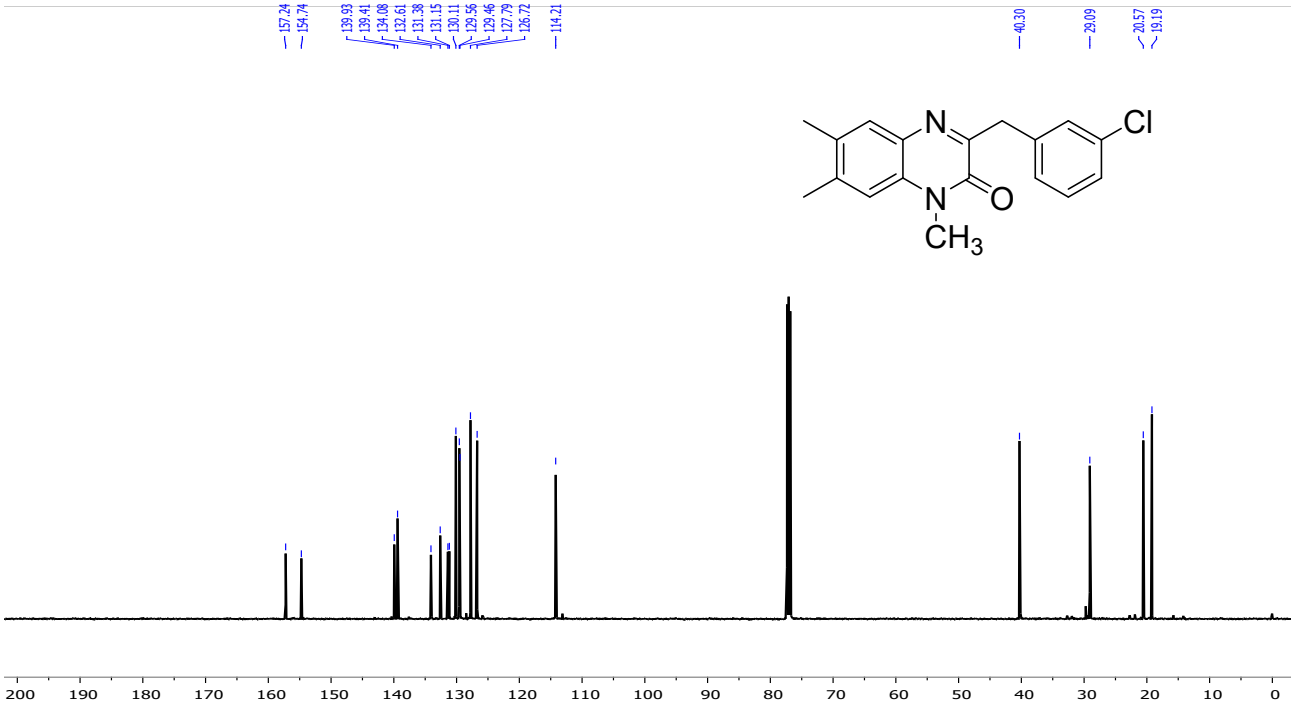
^{1}H NMR spectra of **3l** (500 MHz, $CDCl_3$)



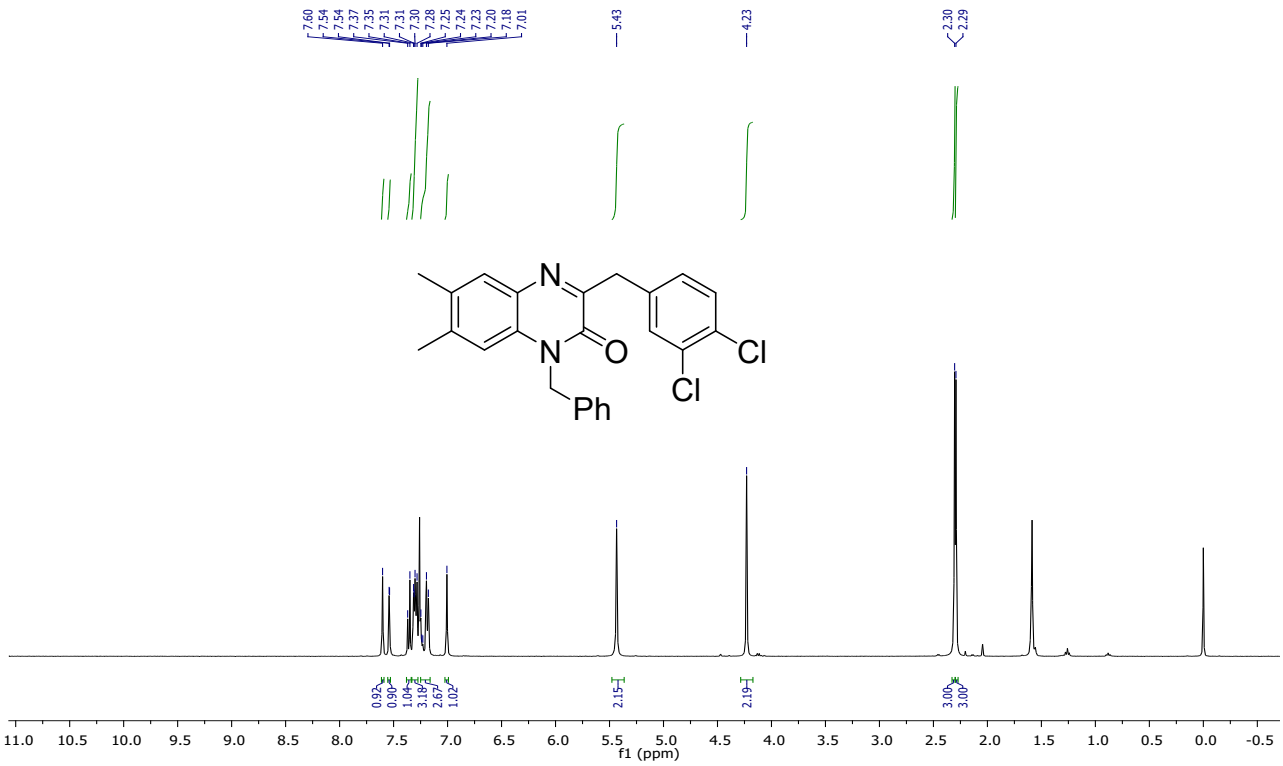
^{13}C{1H}NMR spectra of **3l** (100 MHz, $CDCl_3$)



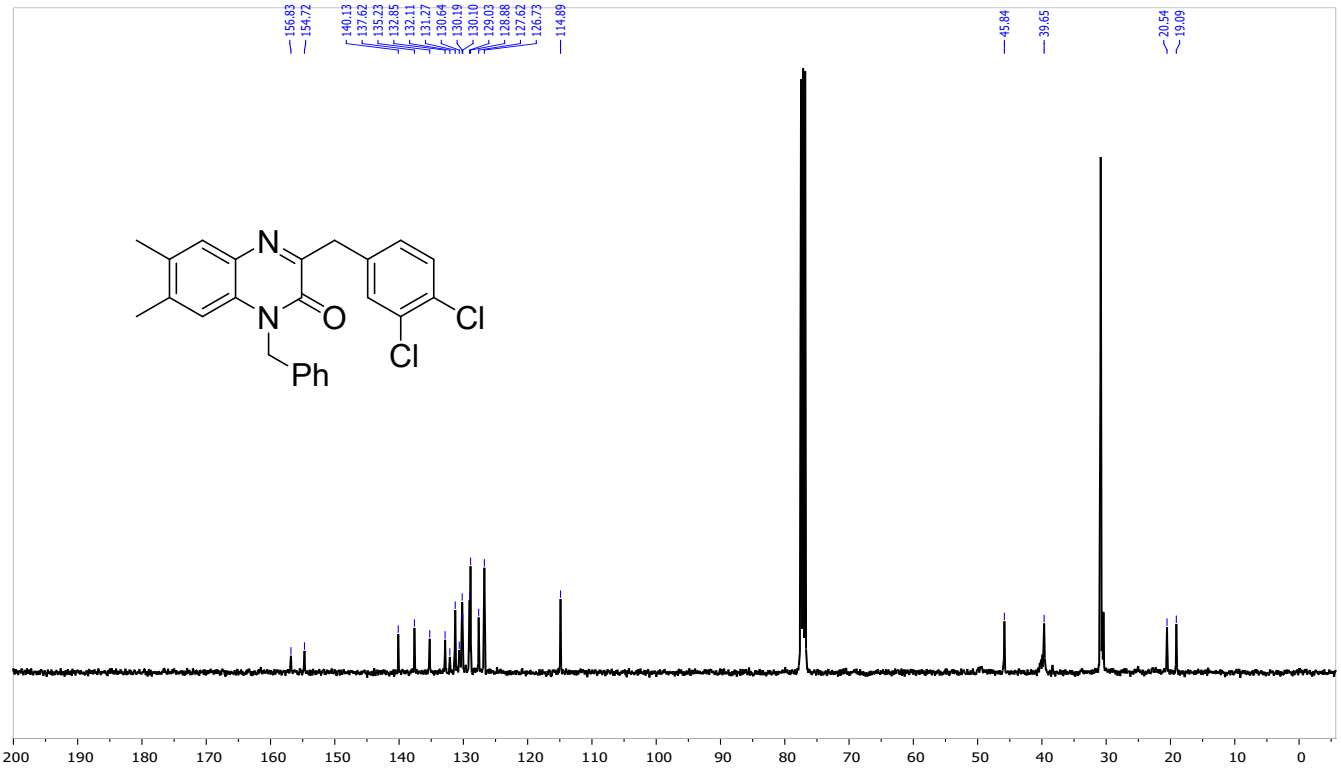
^{1}H NMR spectra of **3m** (500 MHz, $CDCl_3$)



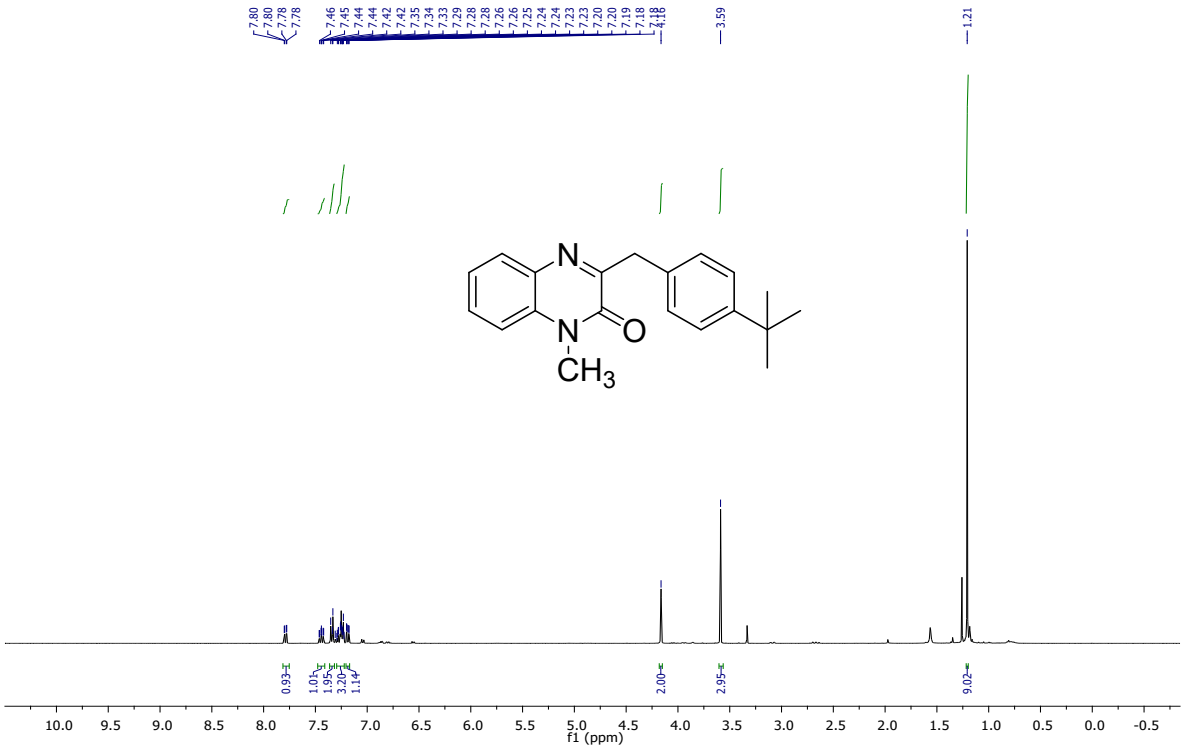
^{13}C{1H}NMR spectra of **3m** (125 MHz, $CDCl_3$)



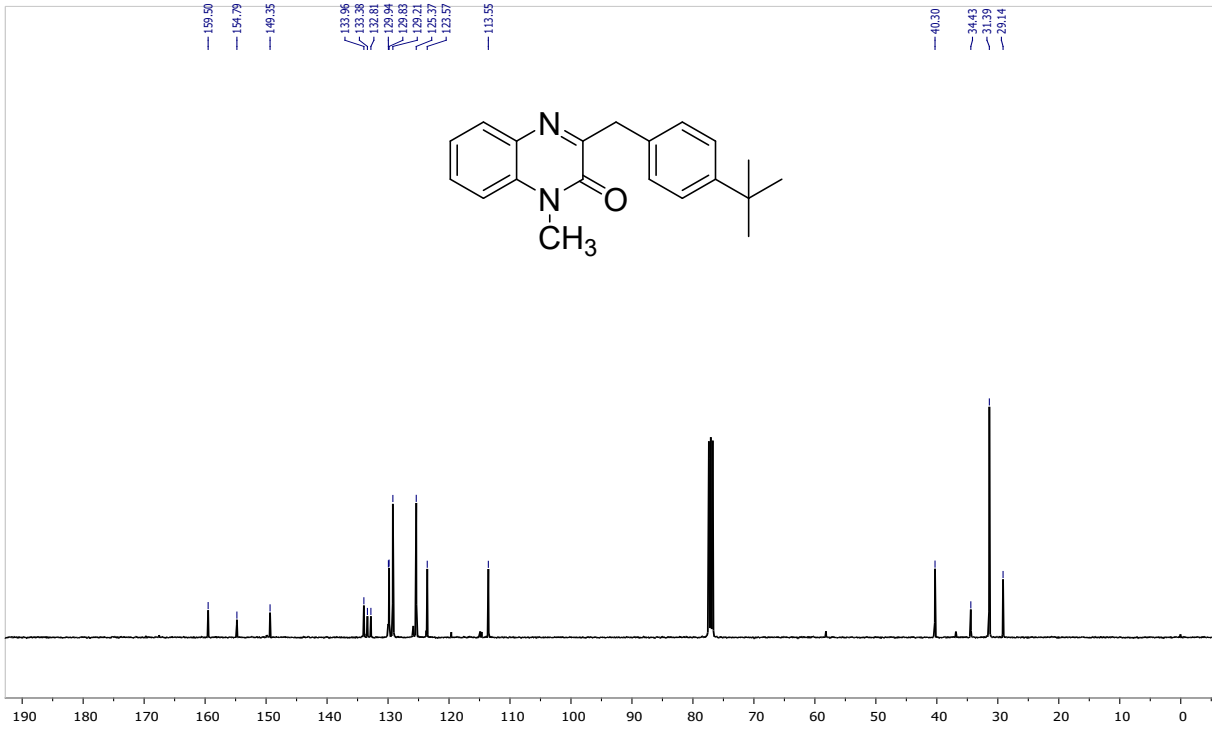
^{1}H NMR spectra of **3n** (400 MHz, $CDCl_3$)



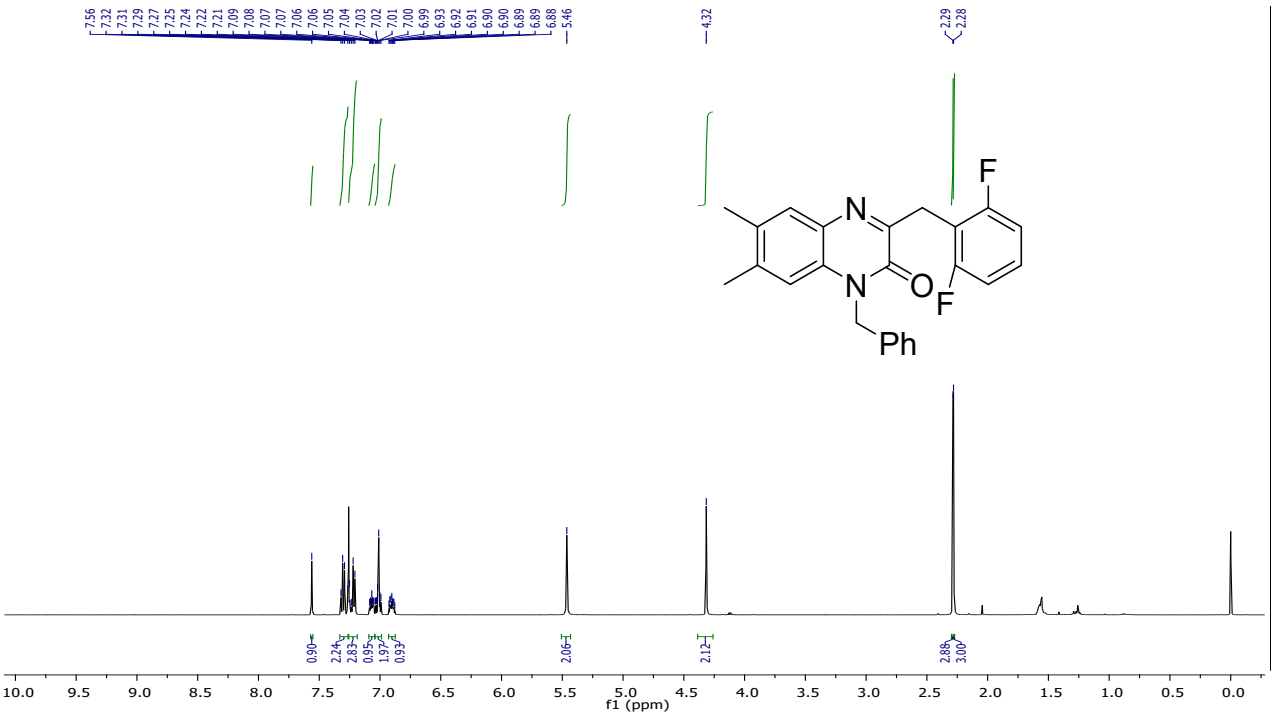
^{13}C{1H}NMR spectra of **3n** (100 MHz, $CDCl_3$)



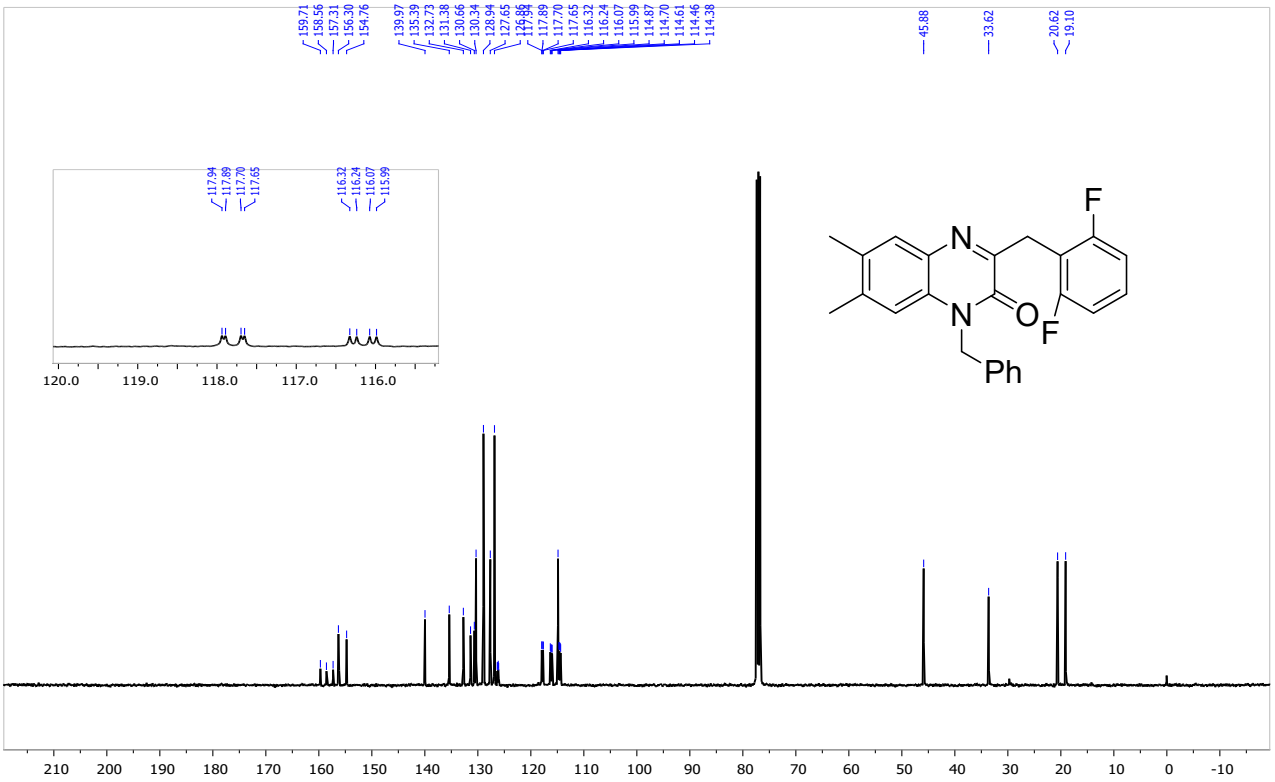
^{1}H NMR spectra of **3o** (400 MHz, $CDCl_3$)



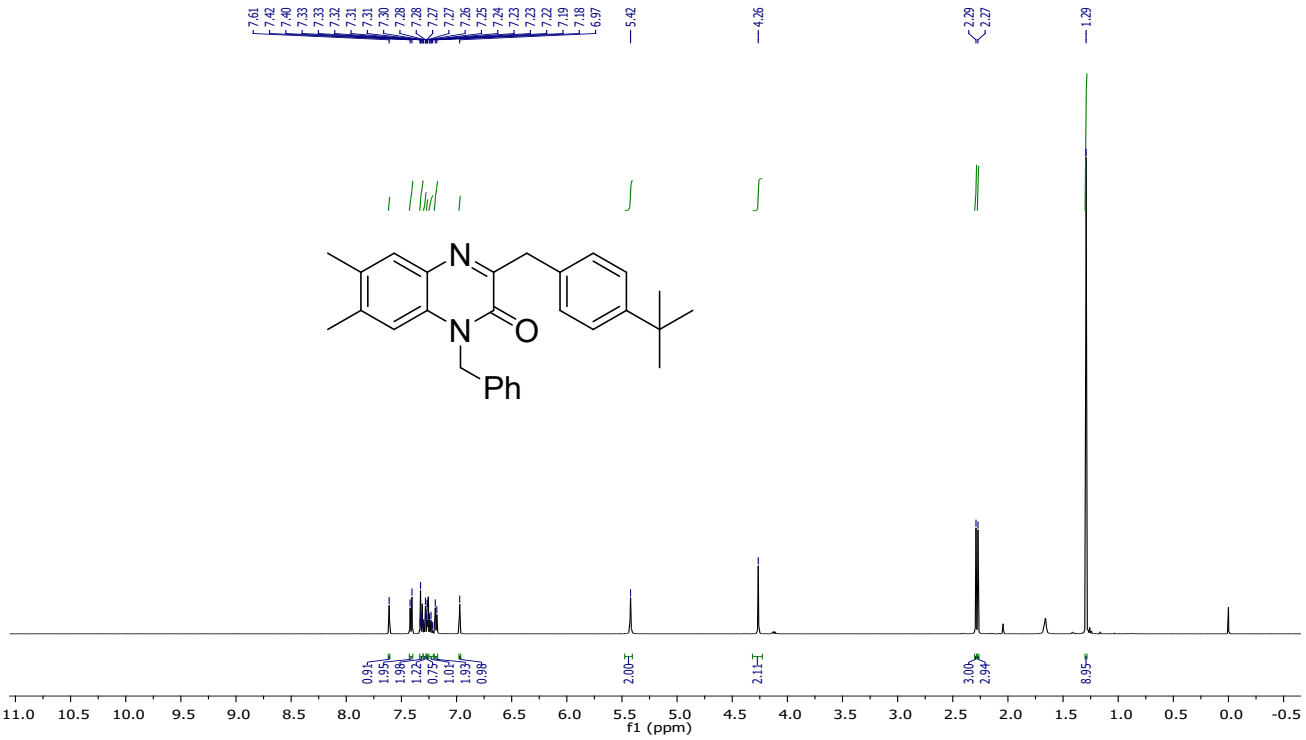
^{13}C NMR spectra of **3o** (125 MHz, $CDCl_3$)



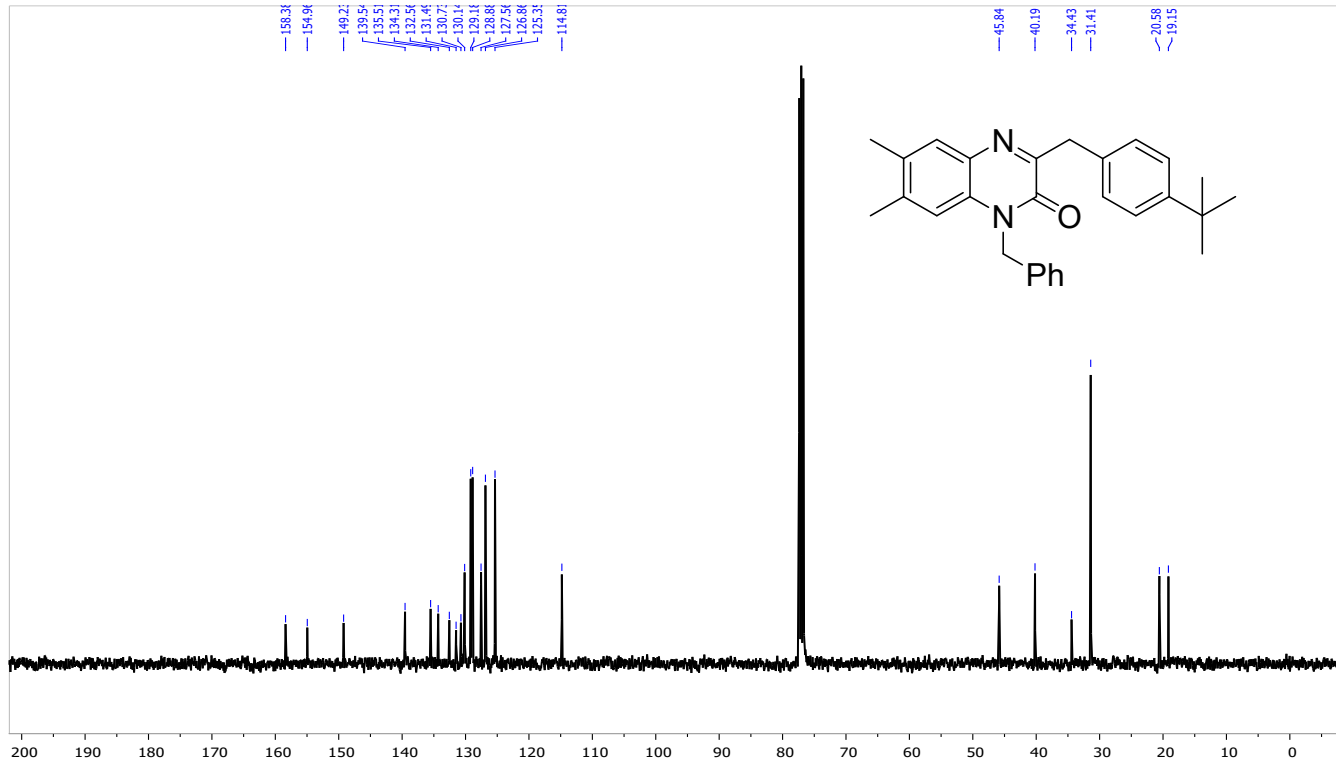
^{1}H NMR spectra of **3p** (500 MHz, $CDCl_3$)



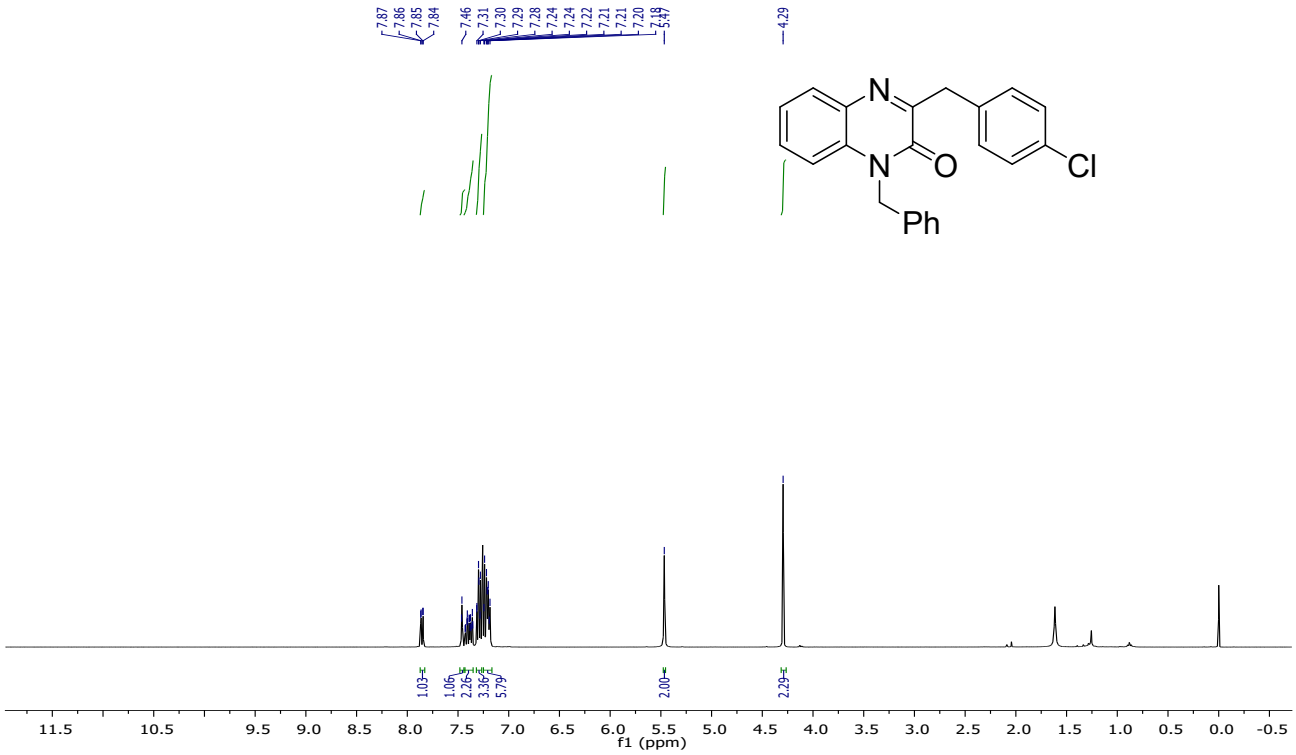
^{13}C{1H}NMR spectra of **3p** (100 MHz, $CDCl_3$)



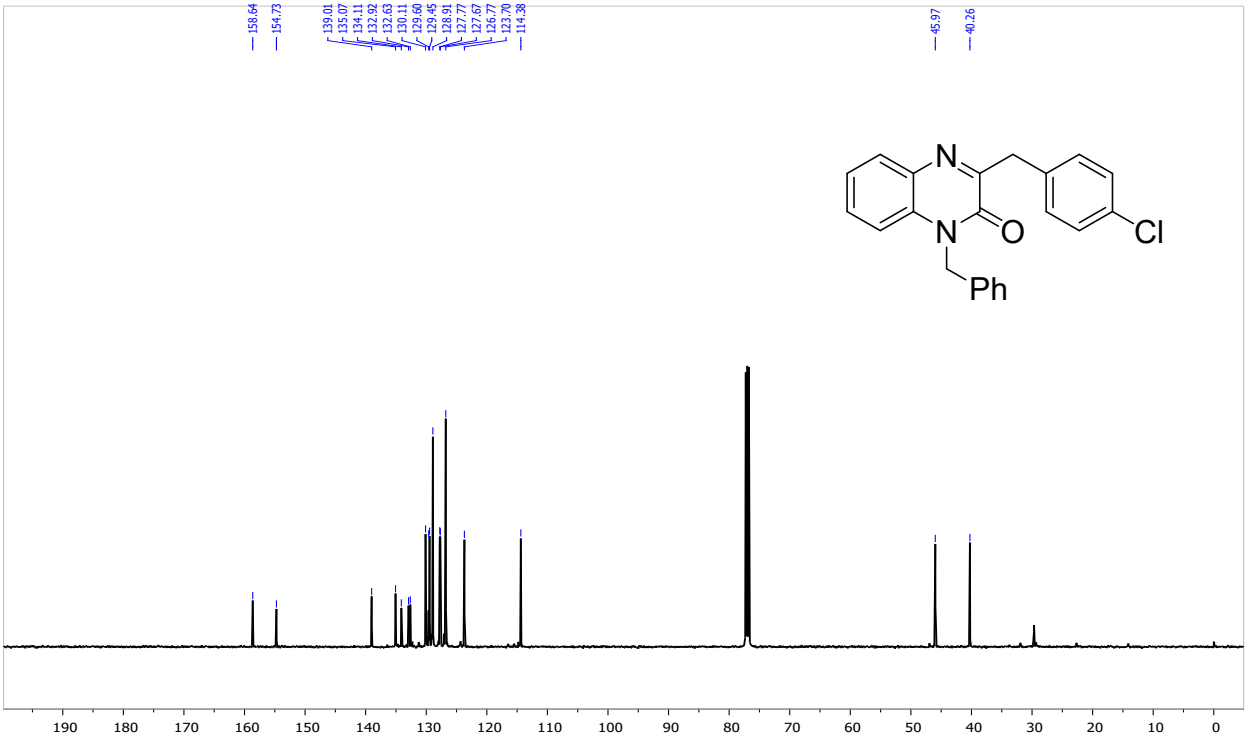
^{1}H NMR spectra of **3q** (500 MHz, $CDCl_3$)



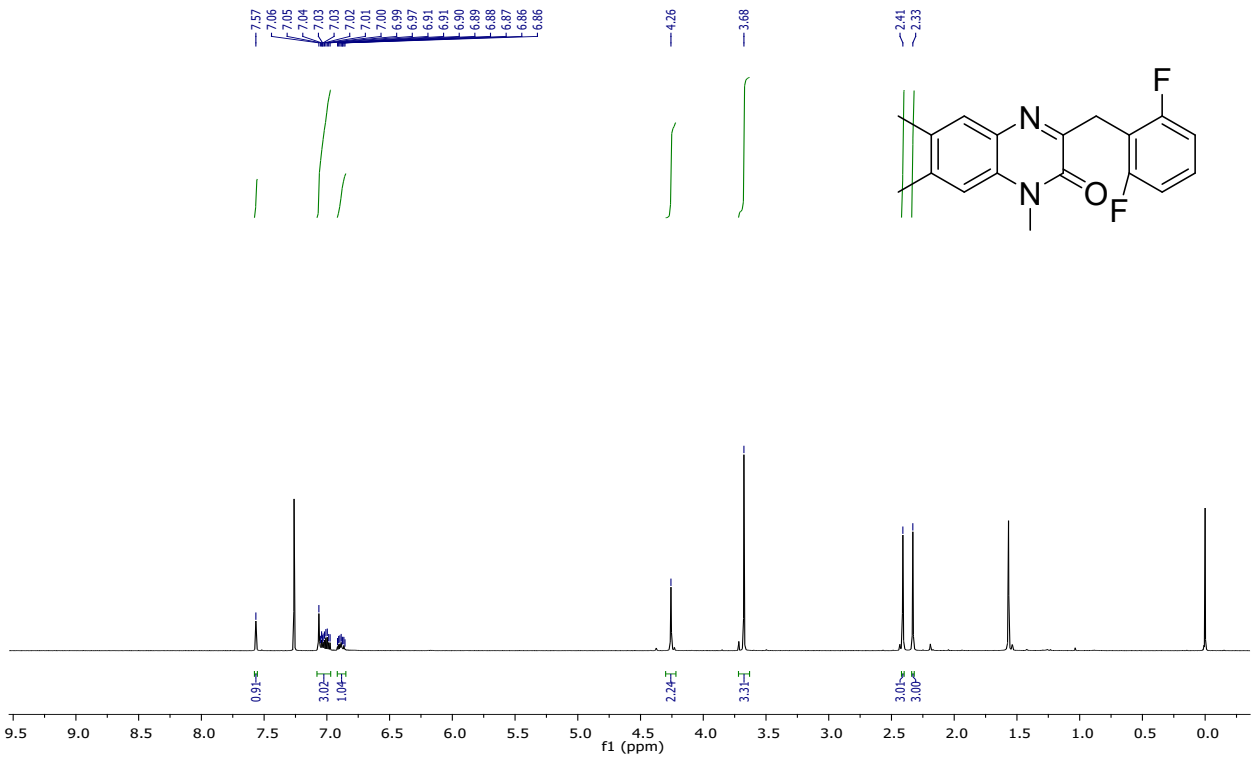
^{13}C{1H}NMR spectra of **3q** (100 MHz, $CDCl_3$)



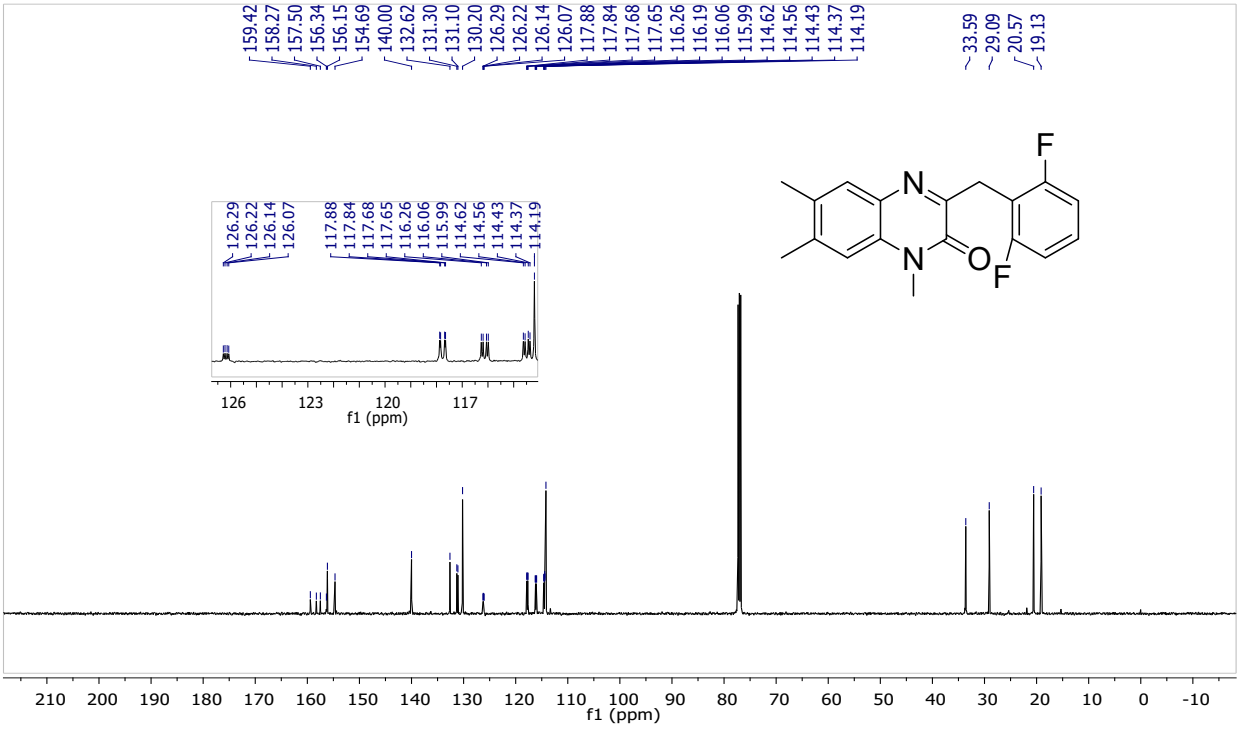
^{1}H NMR spectra of **3r** (400 MHz, $CDCl_3$)



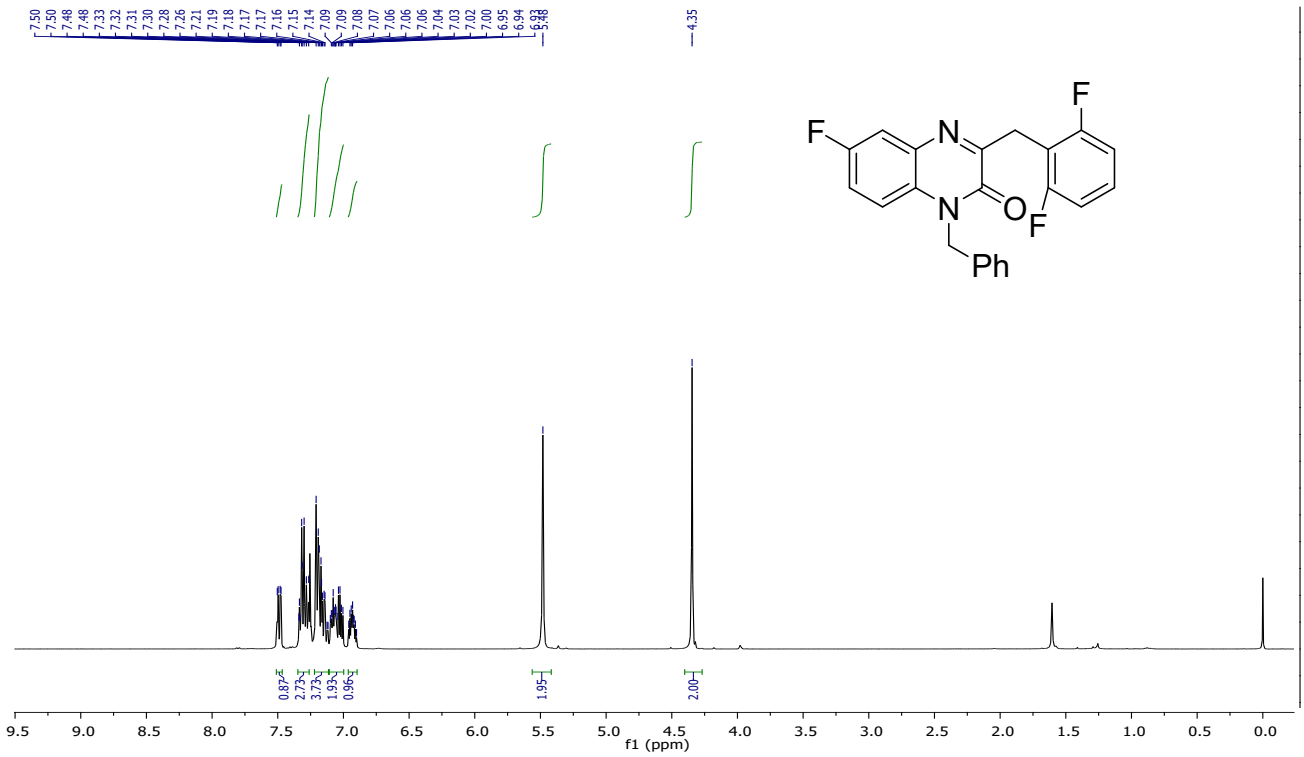
^{13}C{1H}NMR spectra of **3r** (125 MHz, $CDCl_3$)



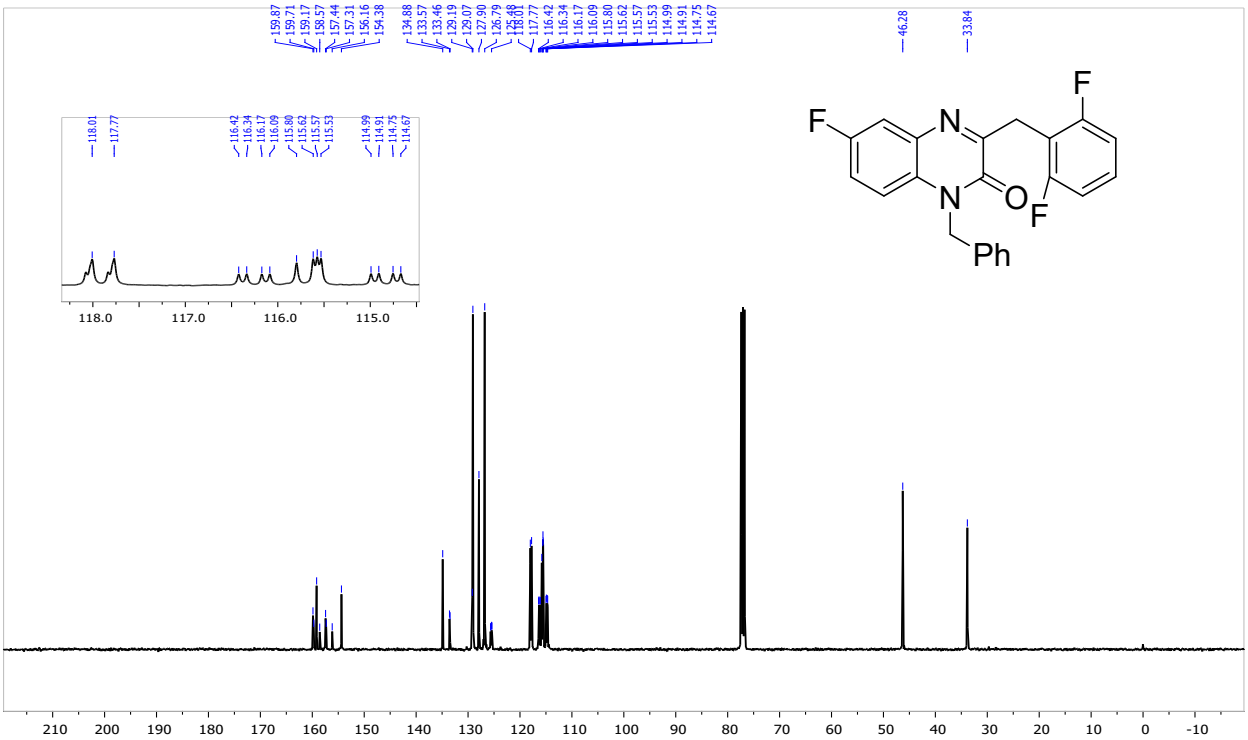
^{1}H NMR spectra of **3s** (400 MHz, $CDCl_3$)



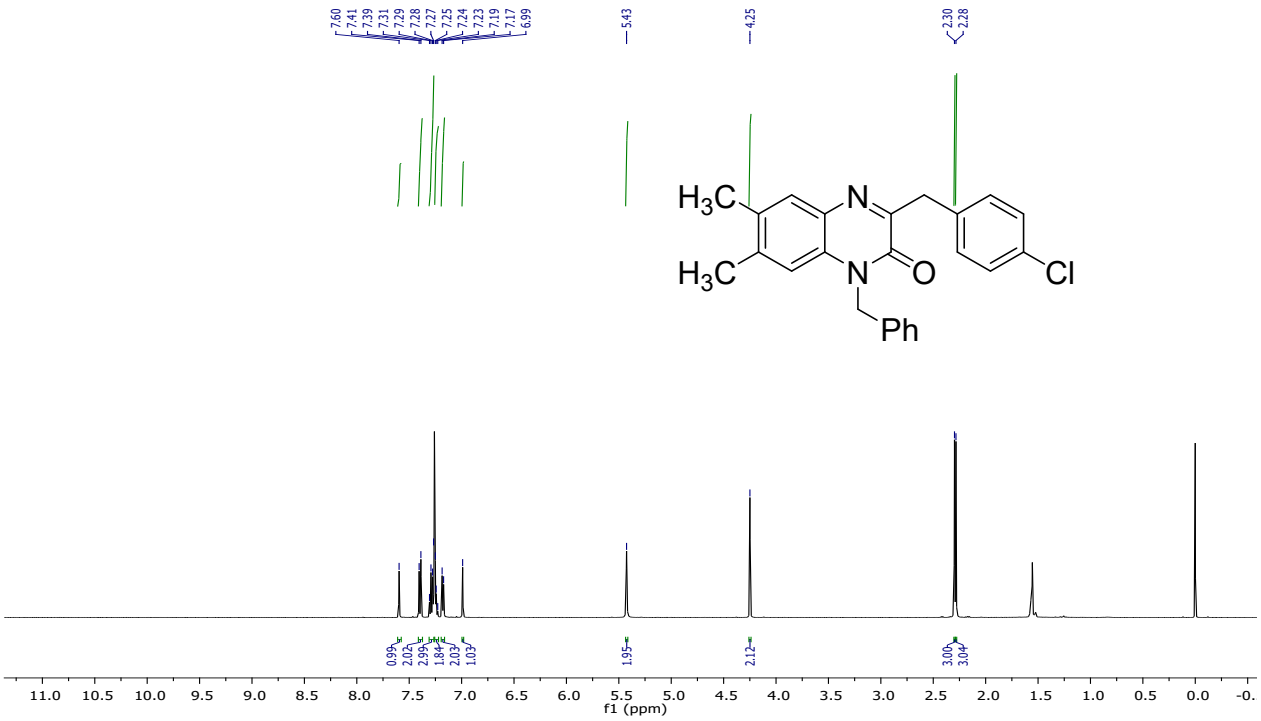
^{13}C{1H}NMR spectra of **3s** (125MHz, $CDCl_3$)



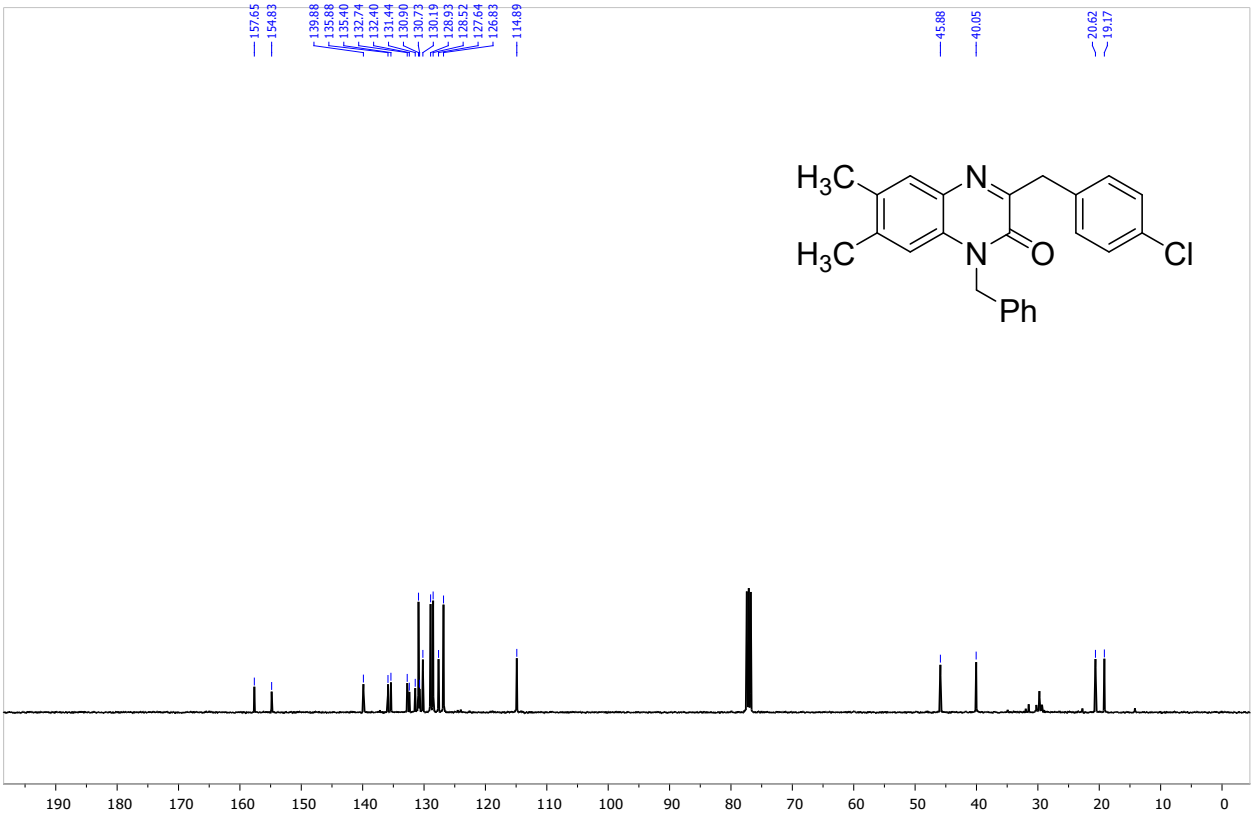
^{1}H NMR spectra of **3t** (400 MHz, $CDCl_3$)



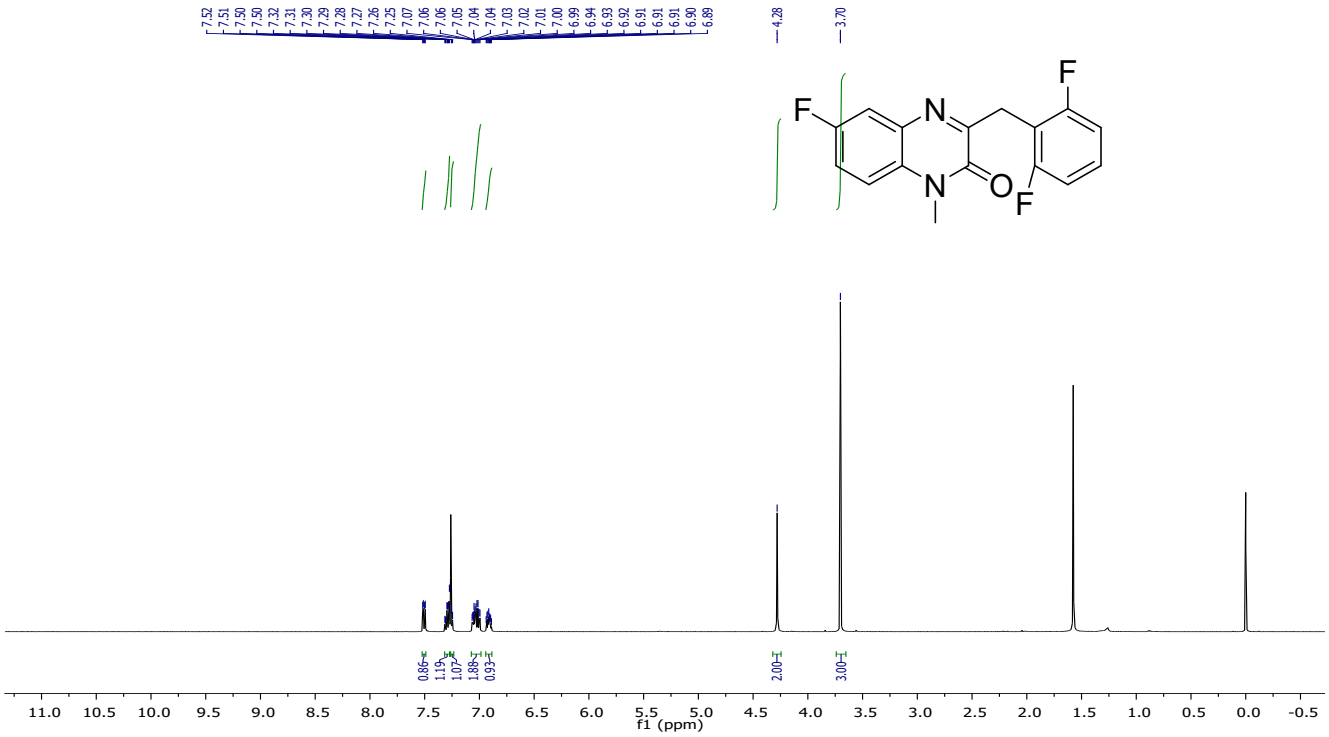
^{13}C{1H}NMR spectra of **3t** (100 MHz, $CDCl_3$)



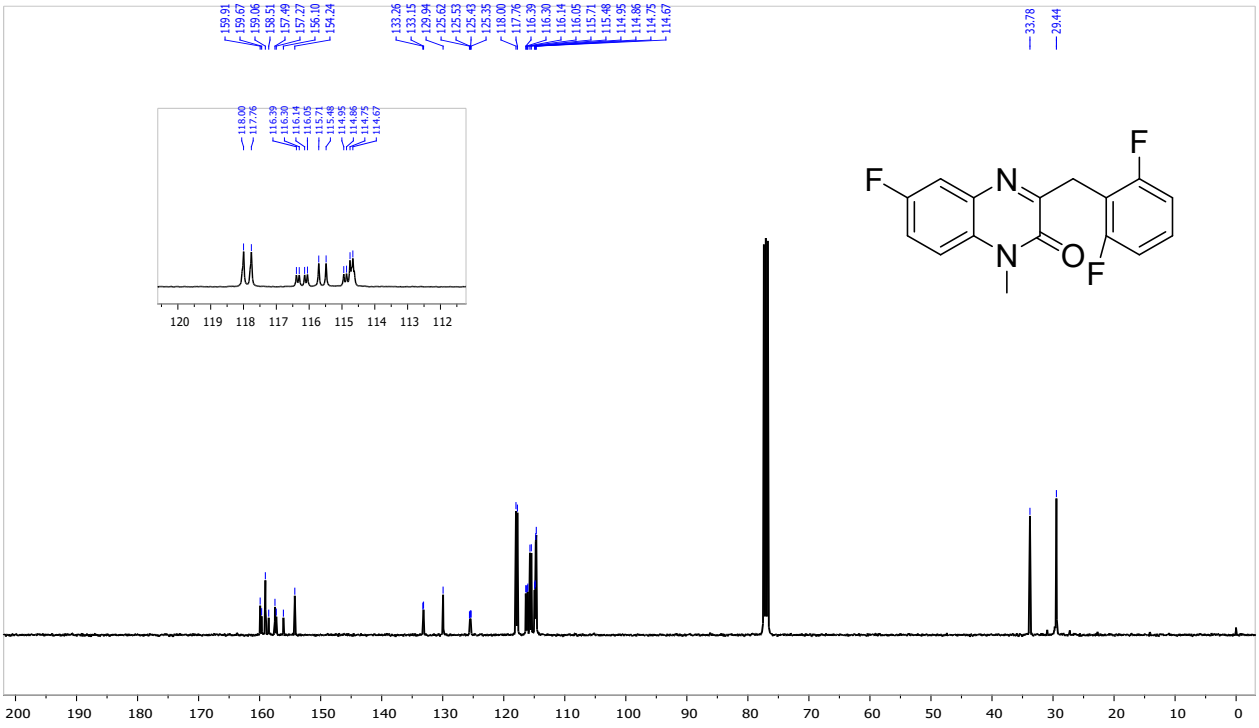
^{1}H NMR spectra of **3u** (500 MHz, $CDCl_3$)



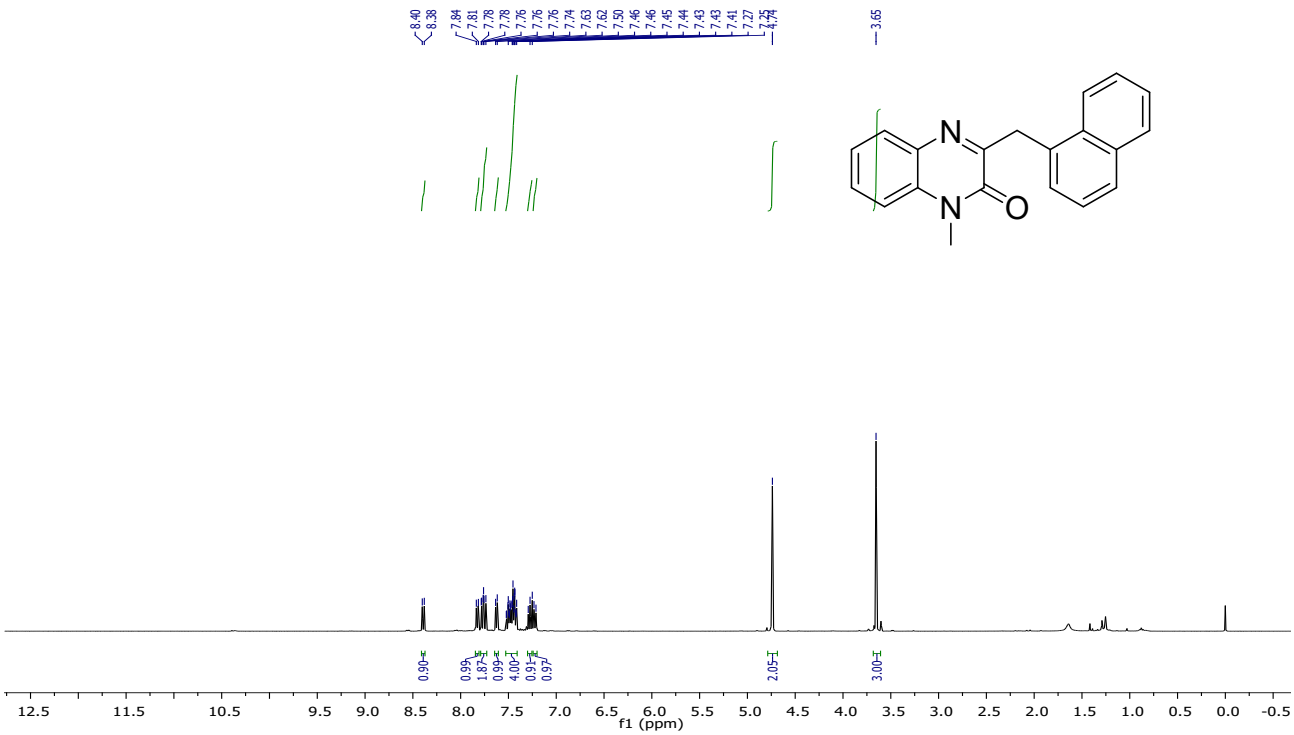
^{13}C{1H}NMR spectra of **3u** (100 MHz, $CDCl_3$)



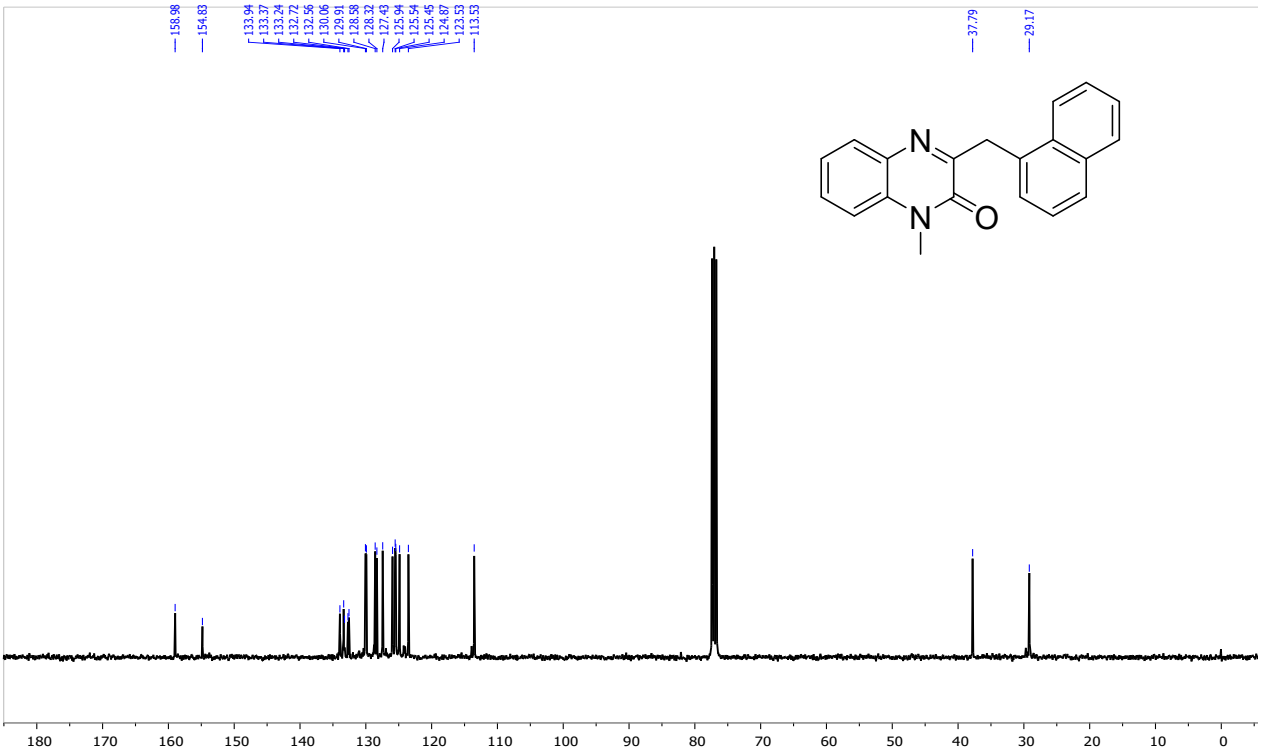
^{1}H NMR spectra of **3v** (500 MHz, $CDCl_3$)



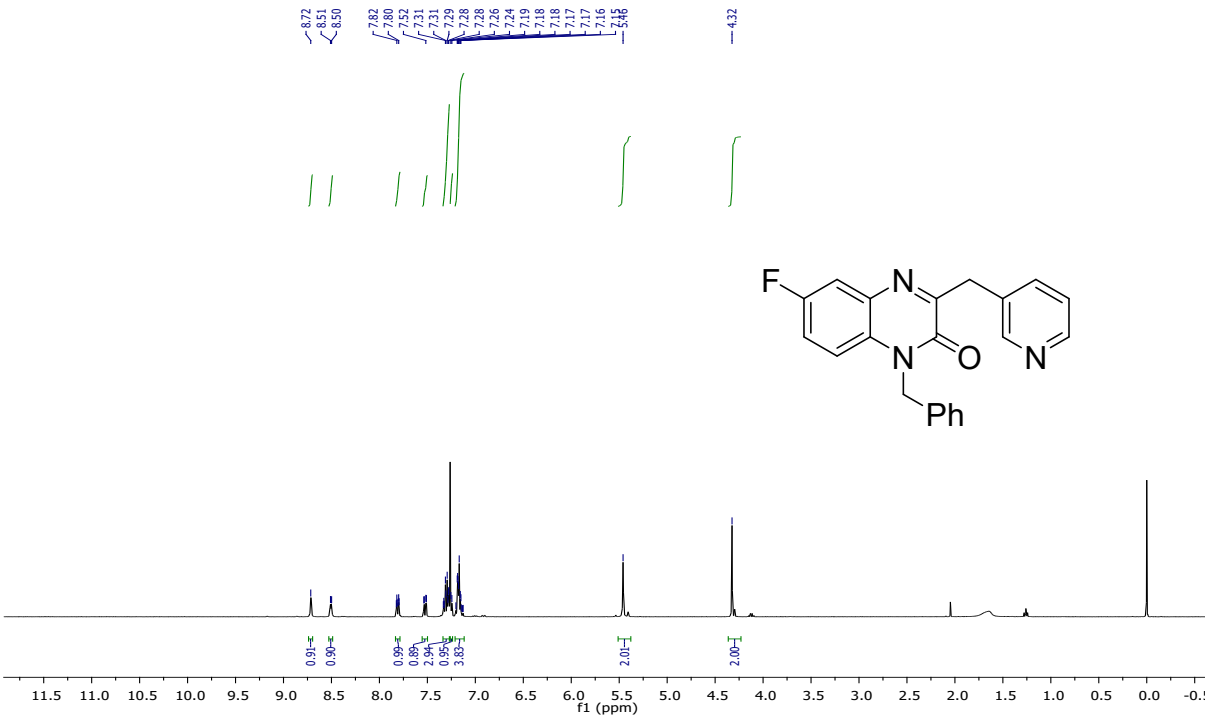
^{13}C{1H}NMR spectra of **3v** (100 MHz, $CDCl_3$)



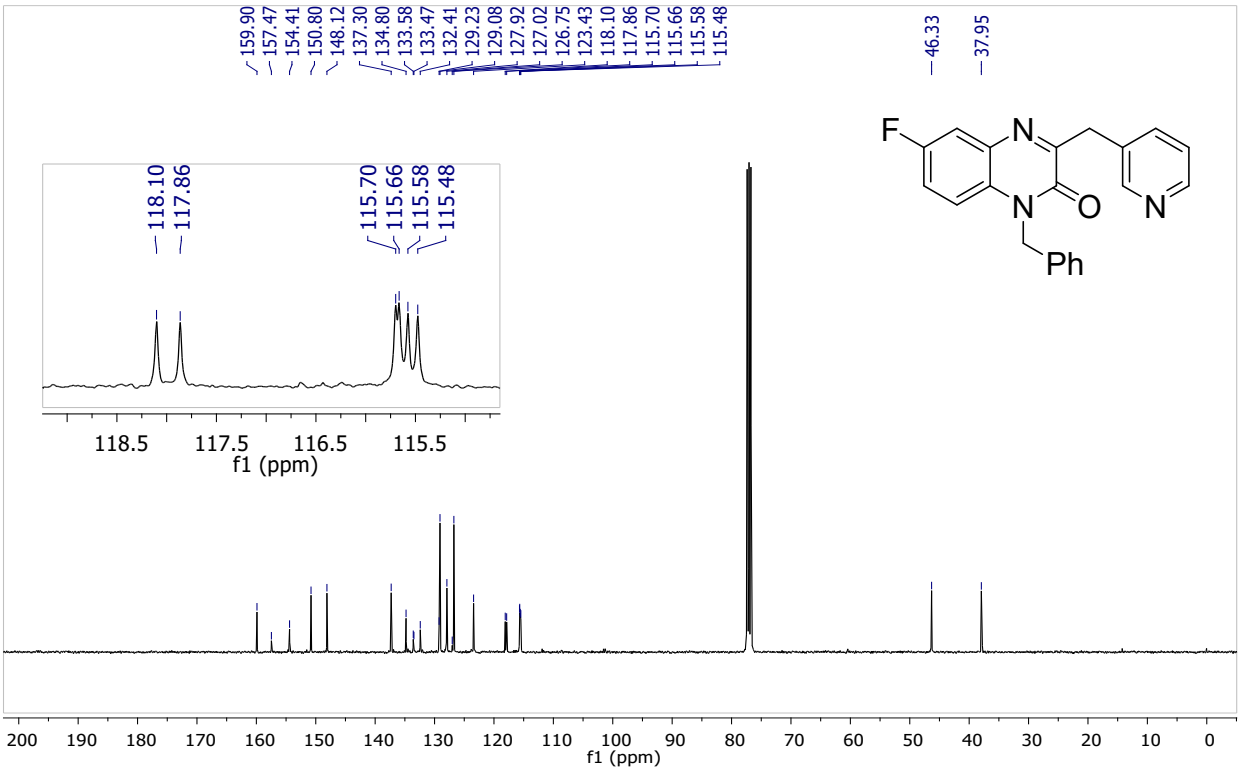
^{1}H NMR spectra of **3w** (400 MHz, $CDCl_3$)



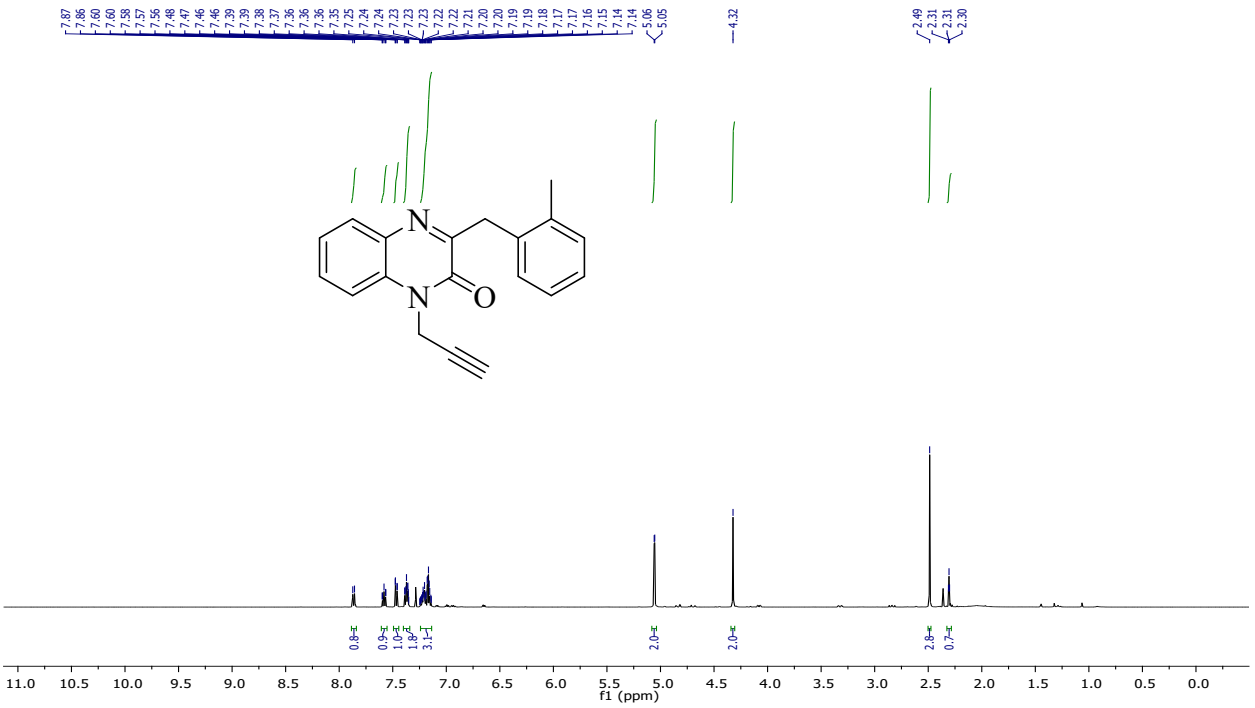
^{13}C{1H}NMR spectra of **3w** (100 MHz, $CDCl_3$)



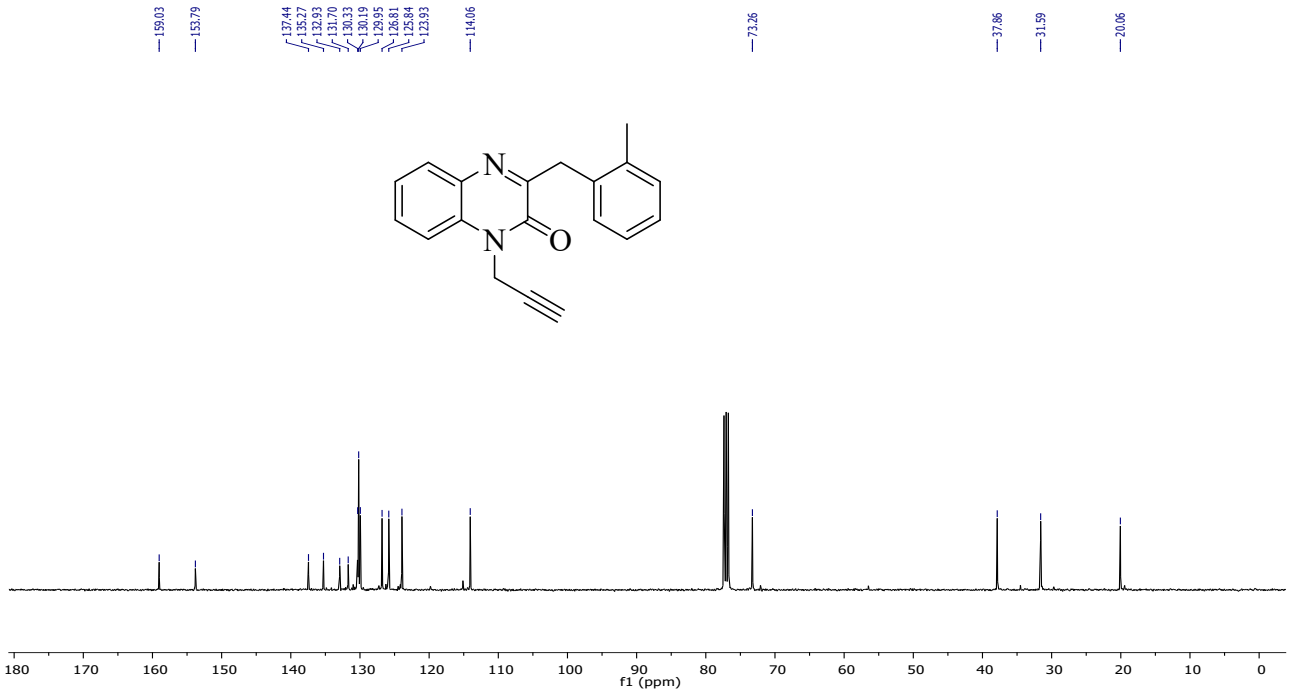
^{1}H NMR spectra of **3x** (400 MHz, $CDCl_3$)



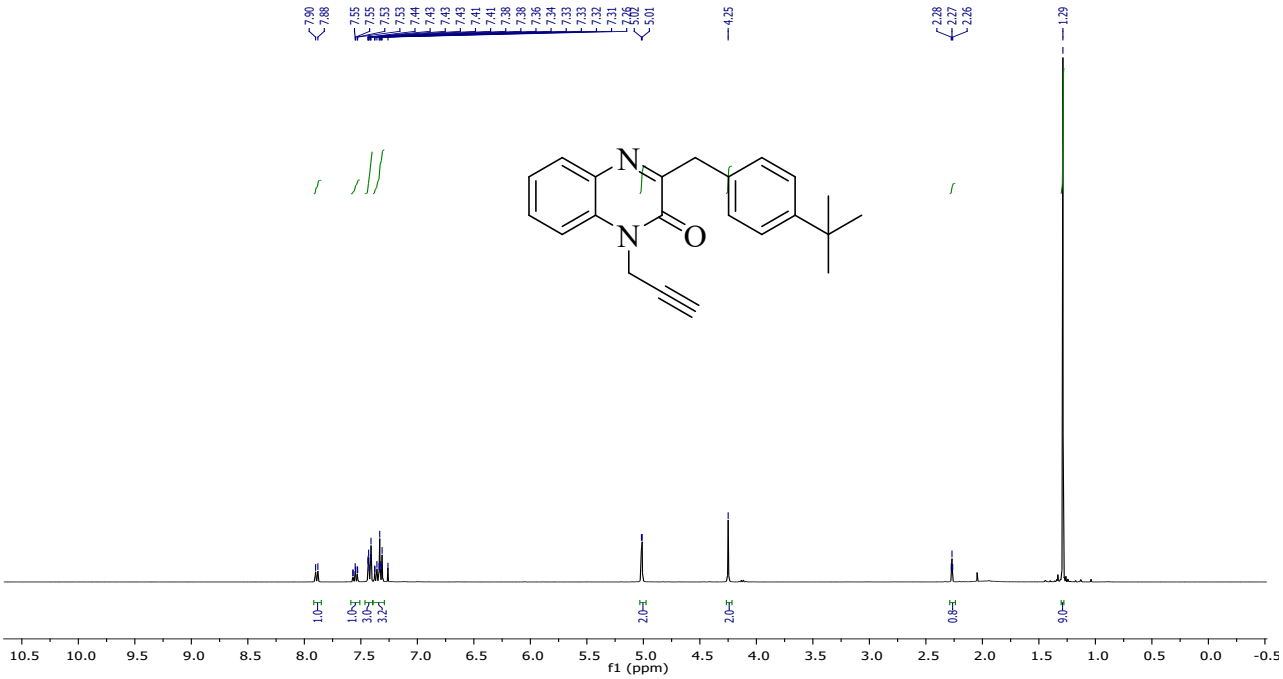
^{13}C{1H}NMR spectra of **3x** (100 MHz, $CDCl_3$)



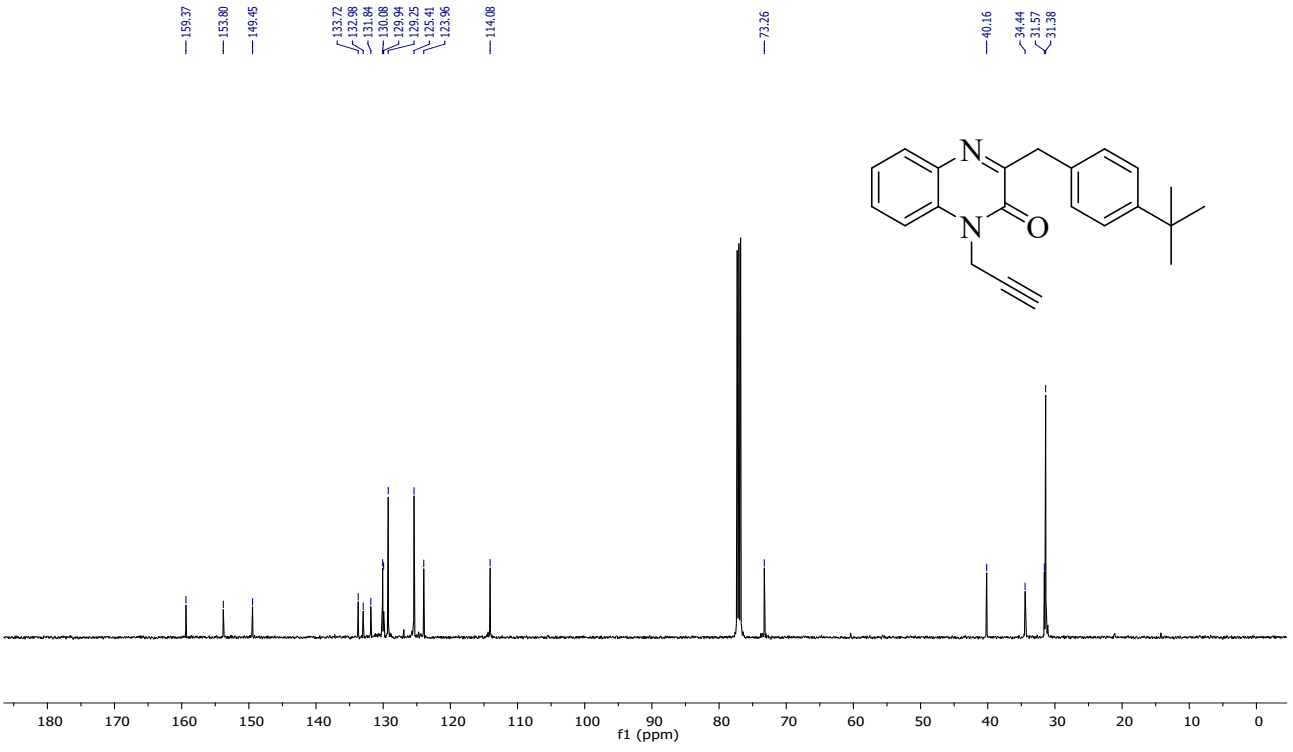
^{1}H NMR spectra of 3ab (500 MHz, $CDCl_3$)



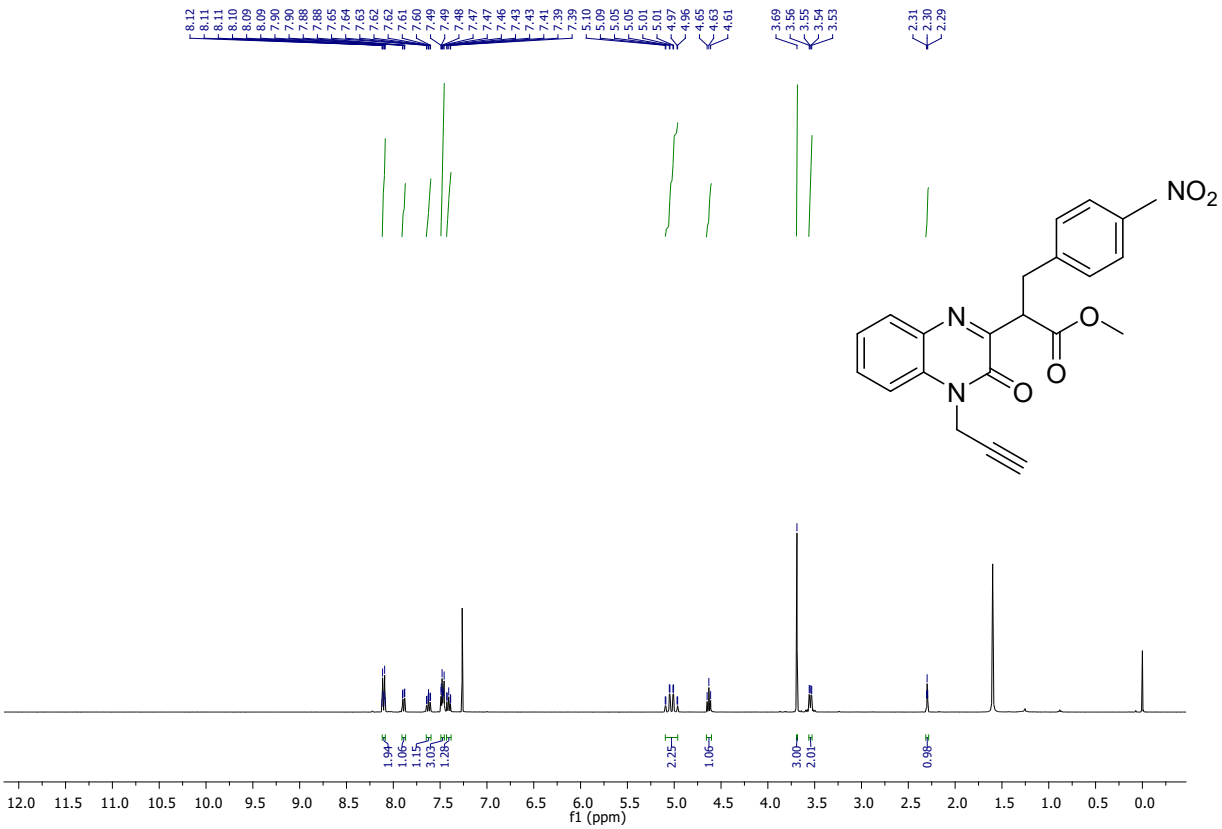
^{13}C NMR spectra of 3ab (100 MHz, $CDCl_3$)



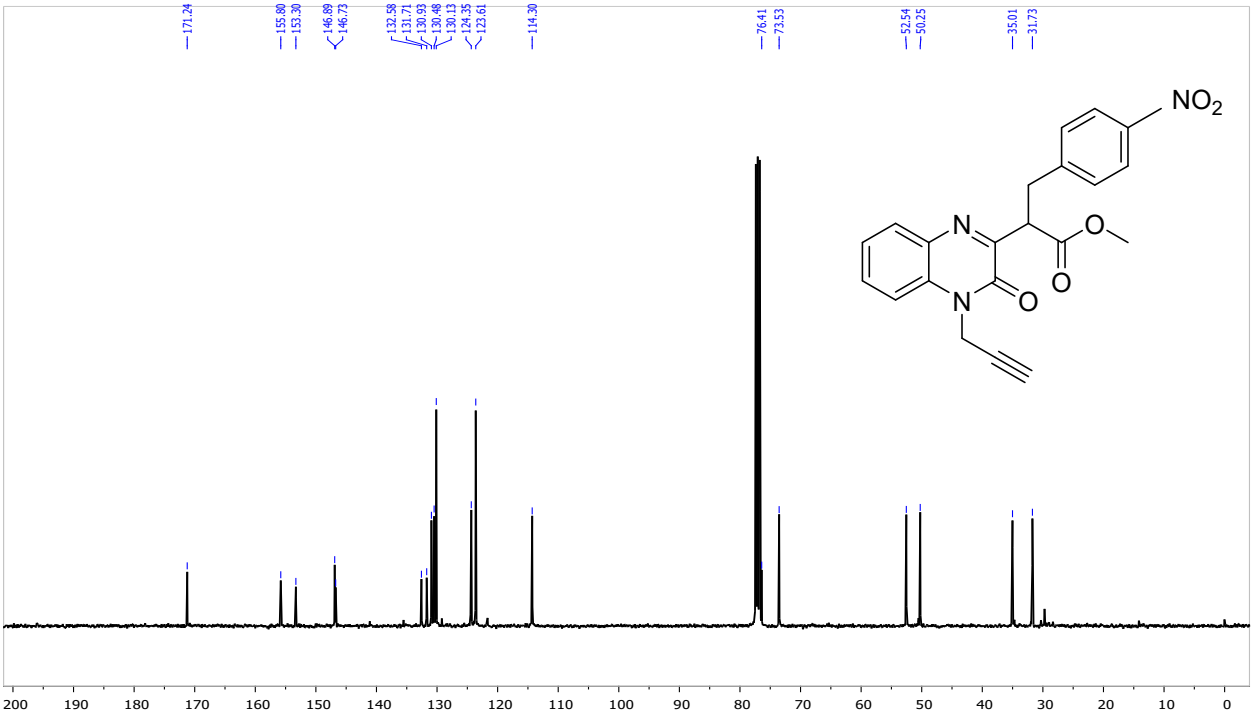
^{1}H NMR spectra of 3ac (400 MHz, $CDCl_3$)



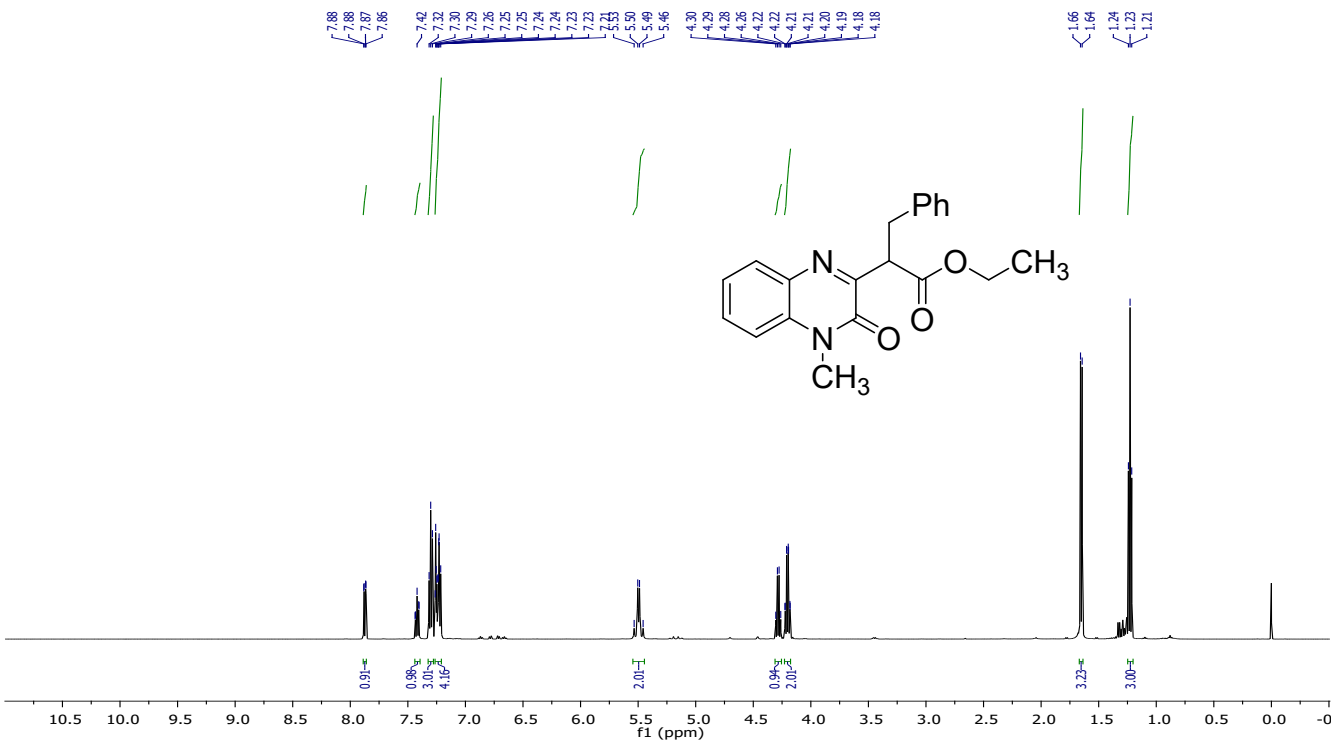
^{13}C NMR spectra of 3ac (125 MHz, $CDCl_3$)



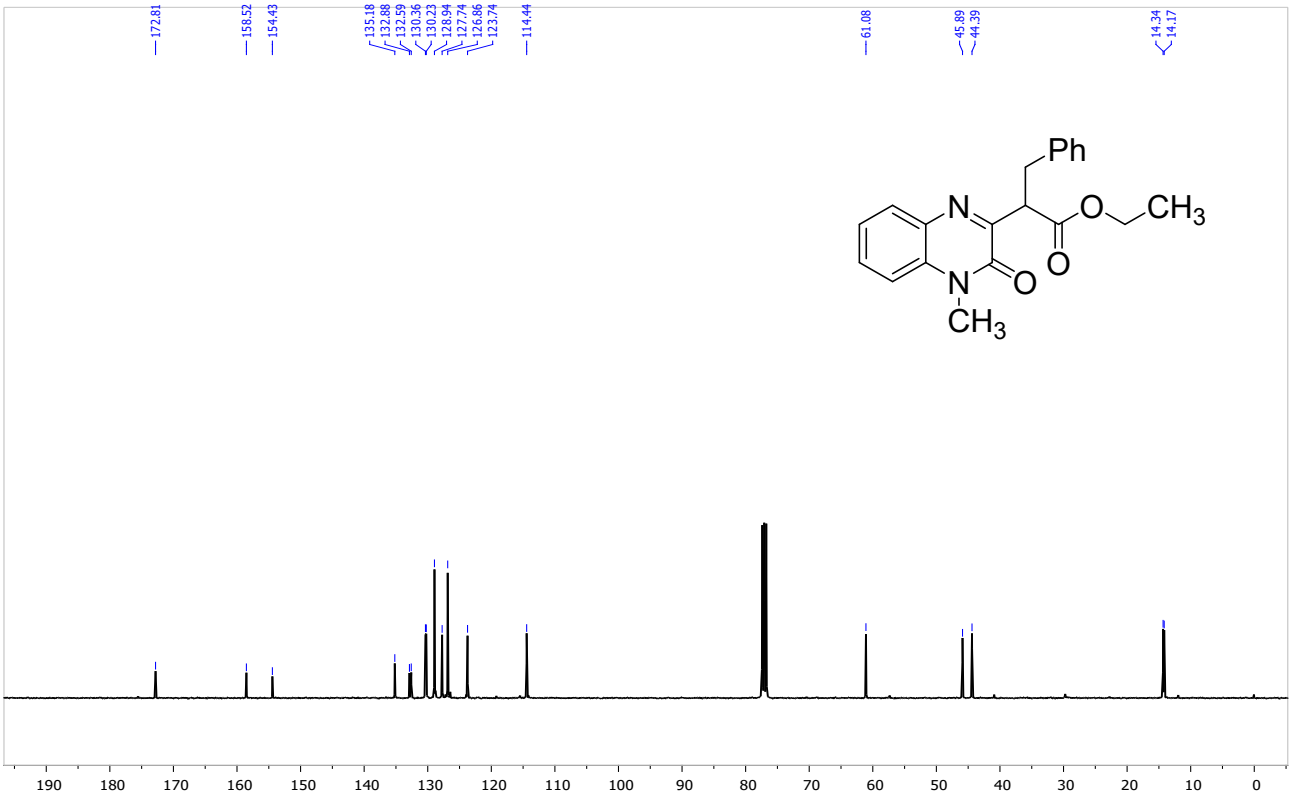
^{1}H NMR spectra of **4a** (400 MHz, $CDCl_3$)



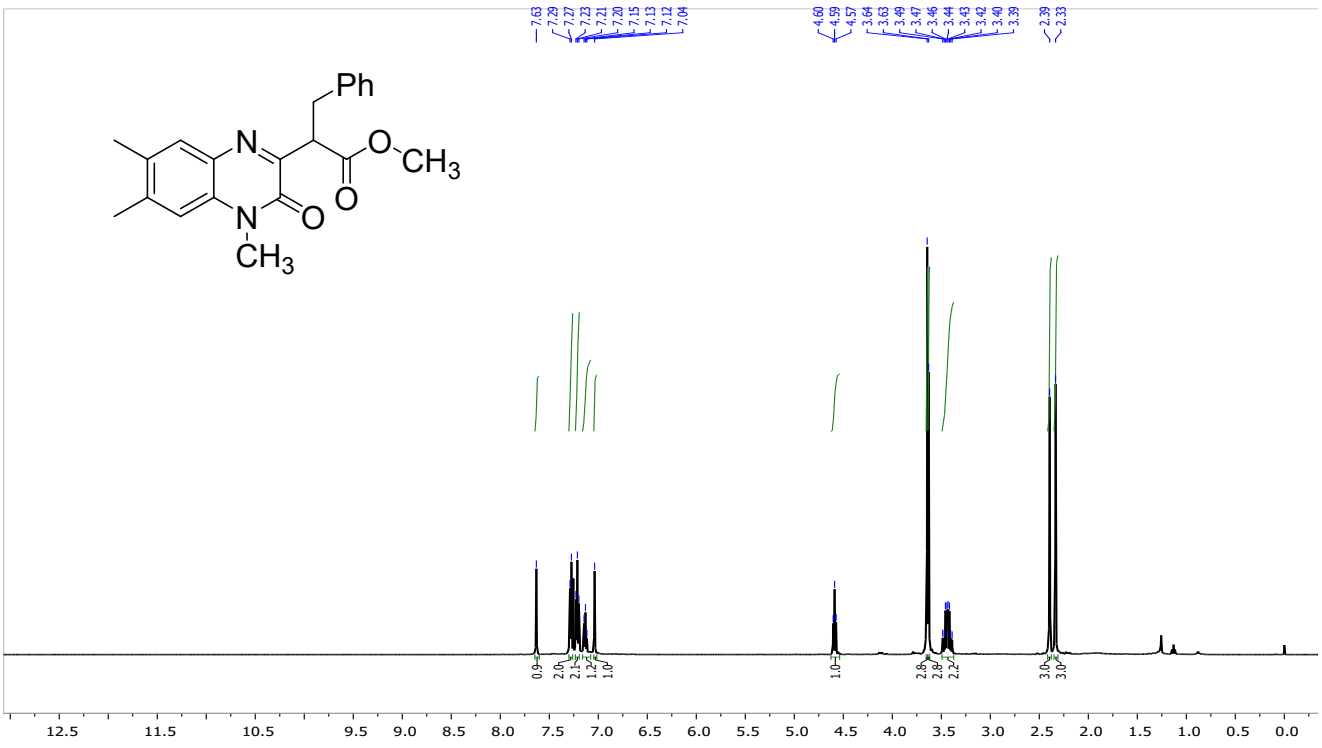
^{13}C{1H}NMR spectra of **4a** (100 MHz, $CDCl_3$)



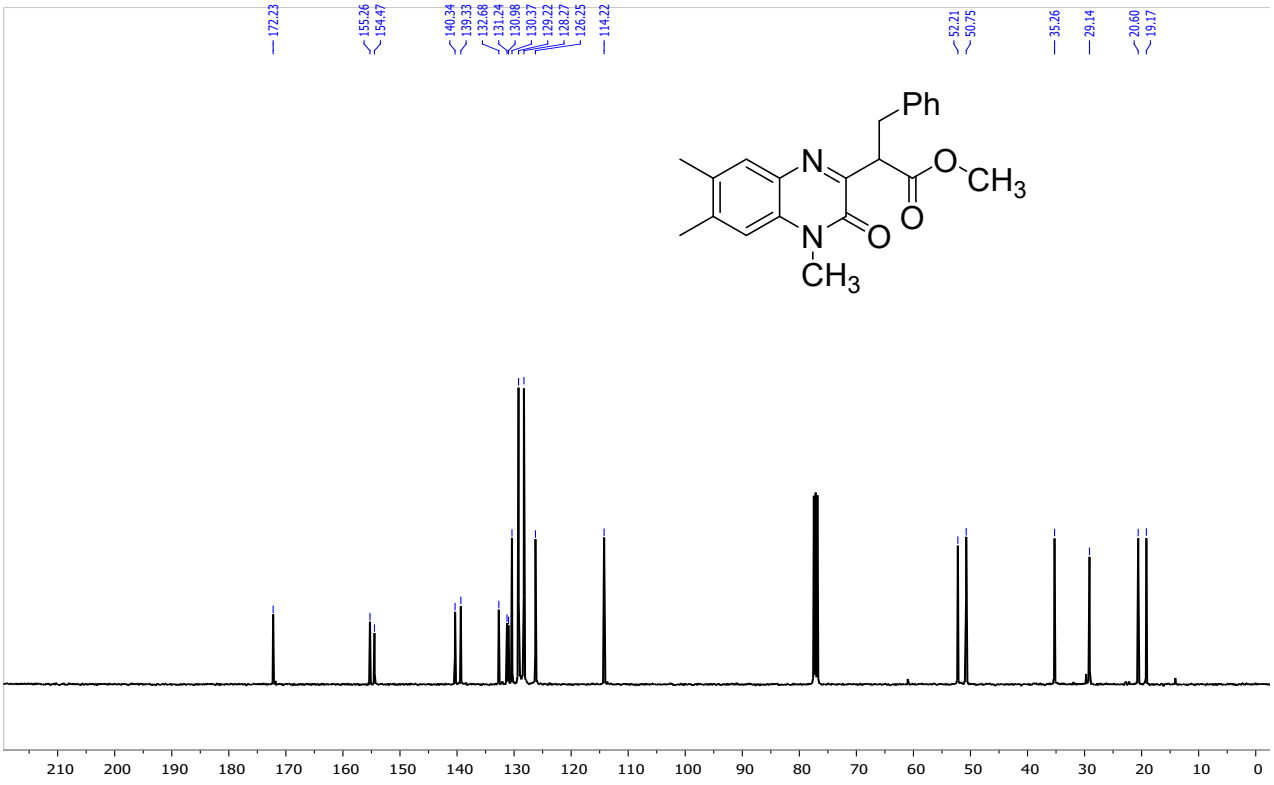
^{1}H NMR spectra of **4b** (500 MHz, $CDCl_3$)



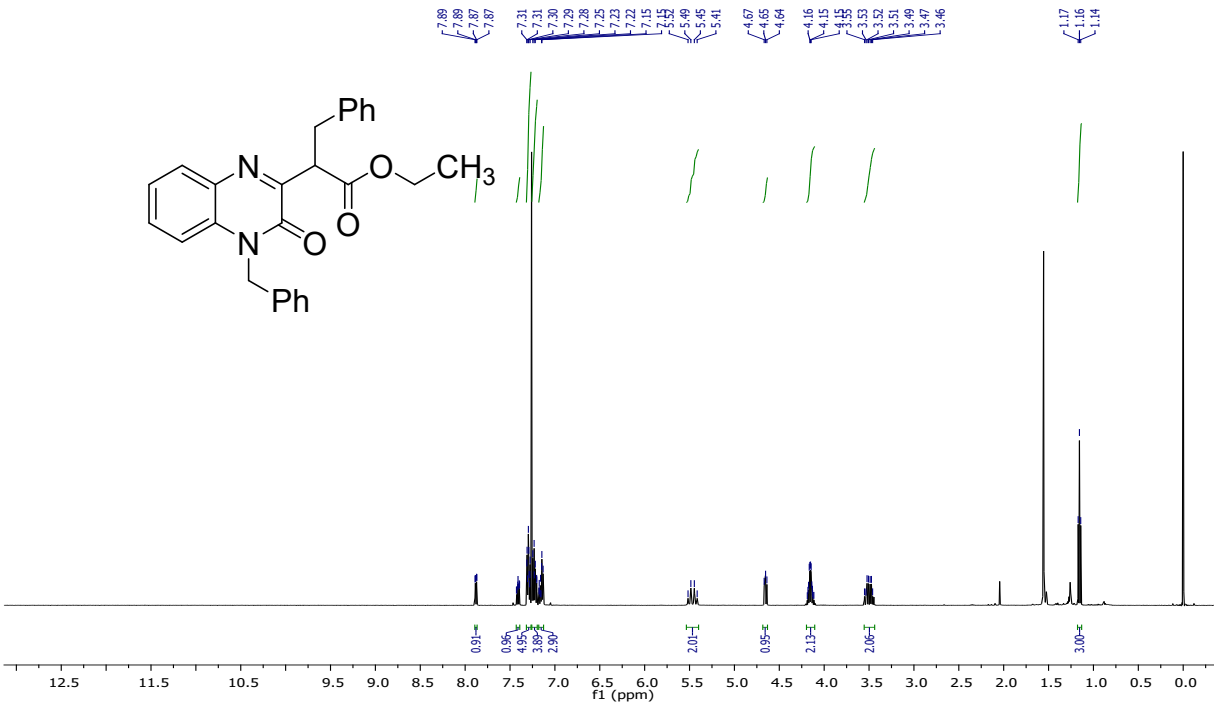
^{13}C{1H}NMR spectra of **4b** (100 MHz, $CDCl_3$)



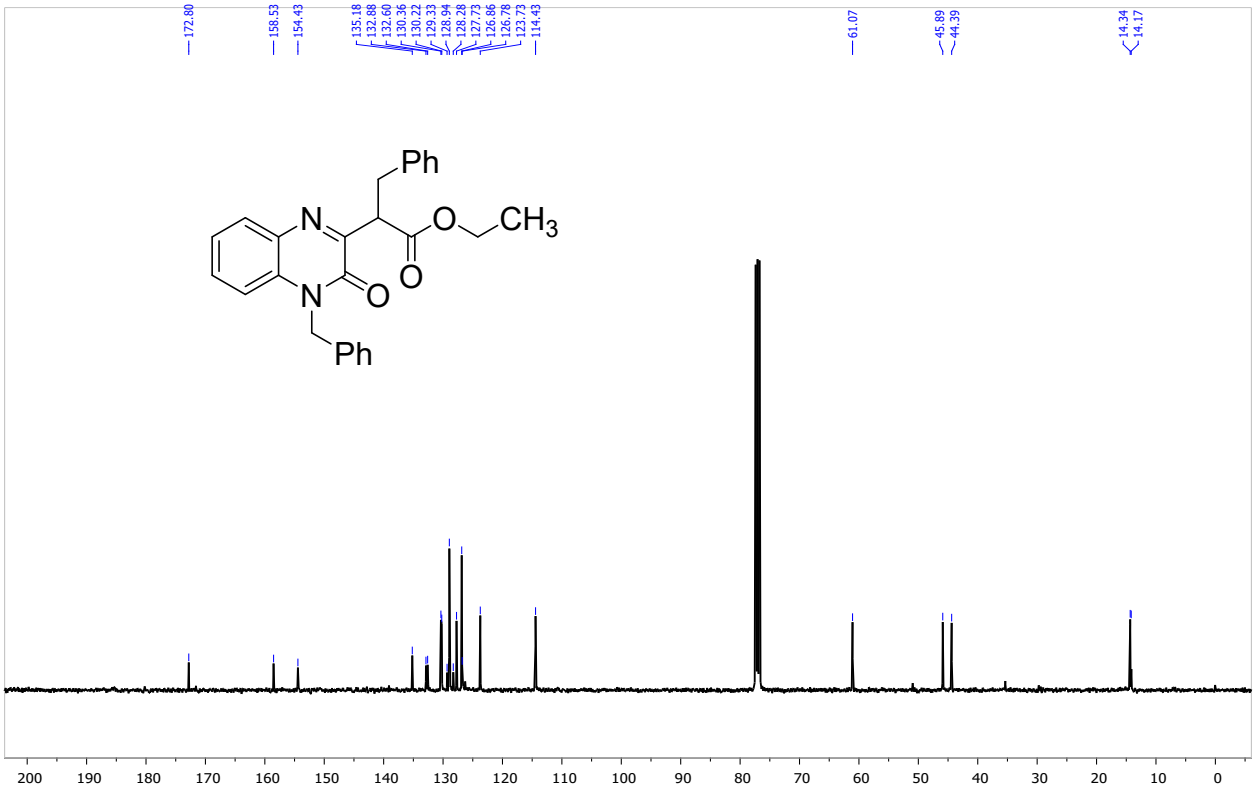
^{1}H NMR spectra of **4c** (500 MHz, $CDCl_3$)



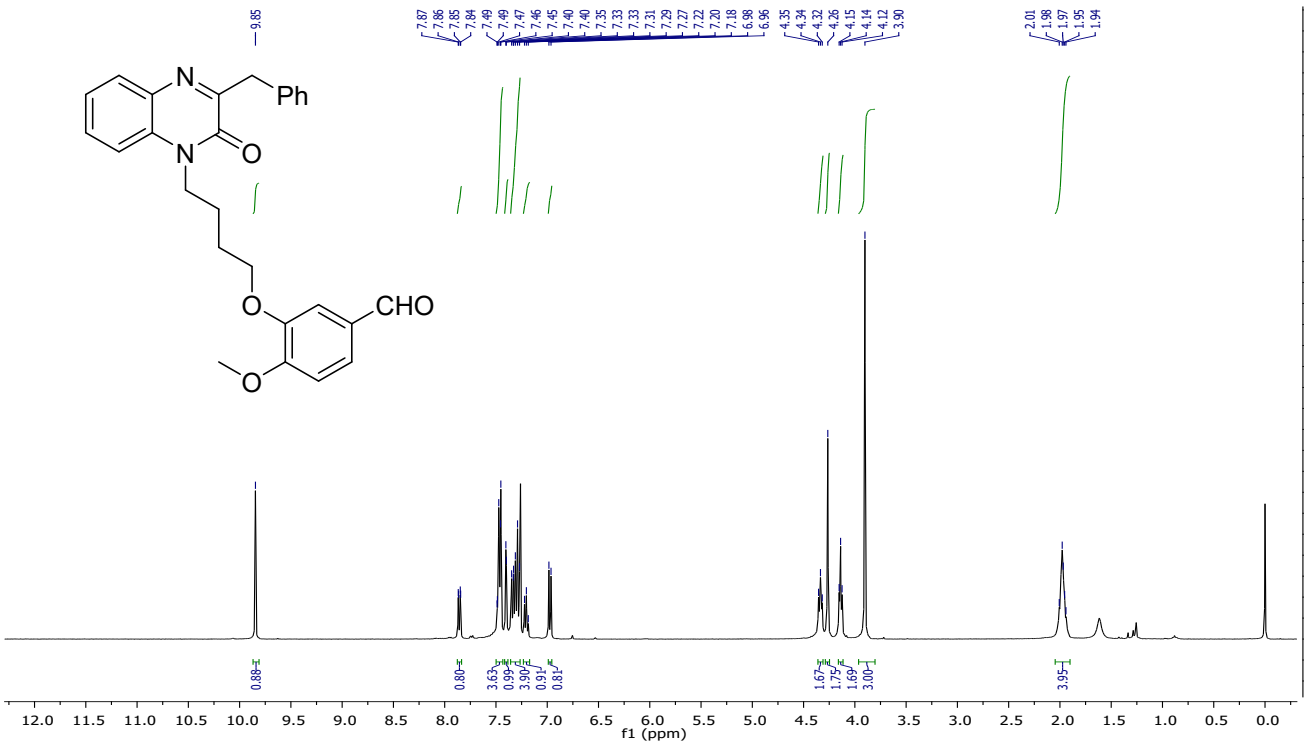
^{13}C{1H}NMR spectra of **4c** (100 MHz, $CDCl_3$)



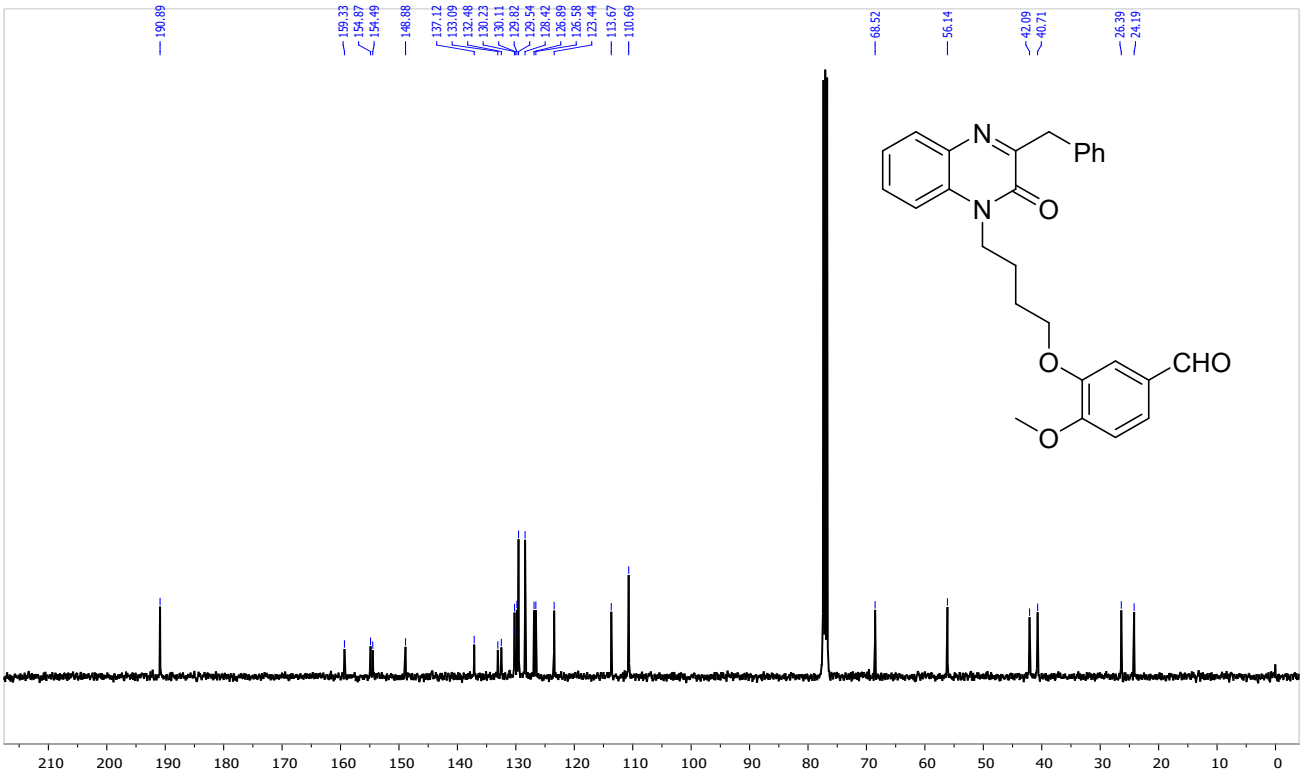
^{1}H NMR spectra of **4d** (500 MHz, $CDCl_3$)



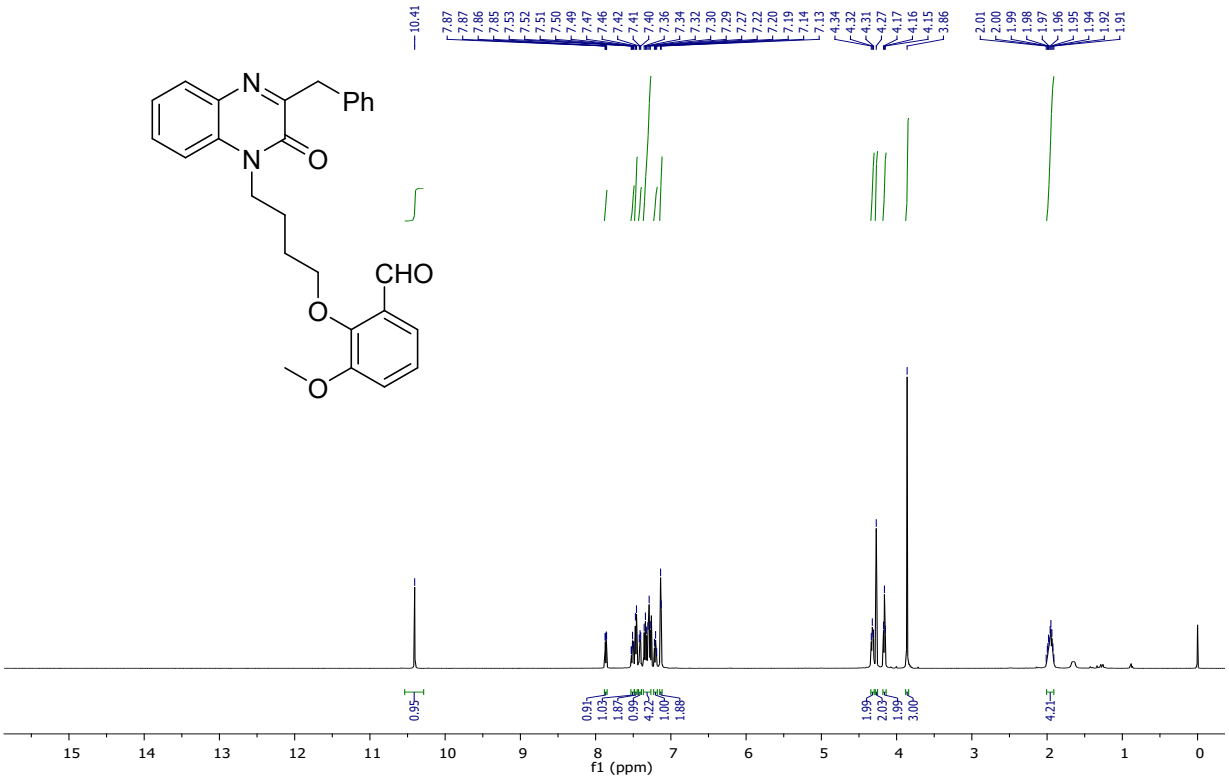
^{13}C{1H}NMR spectra of **4d** (100 MHz, $CDCl_3$)



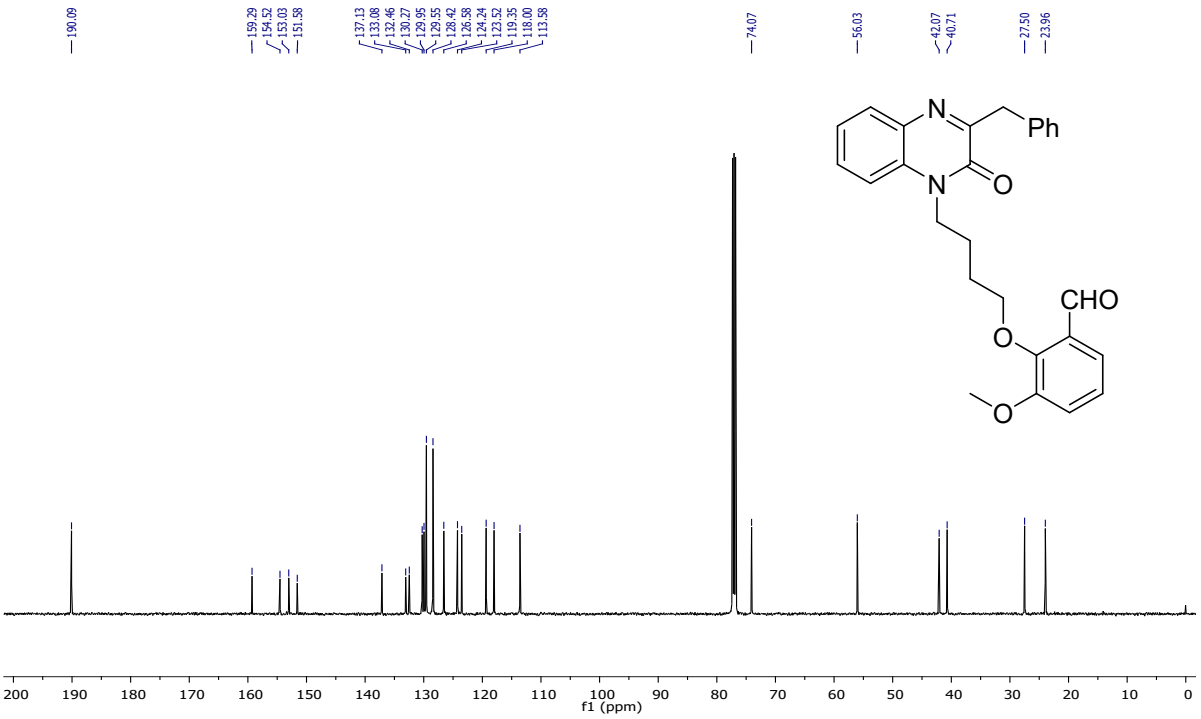
^{1}H NMR spectra of **4e** (400 MHz, $CDCl_3$)



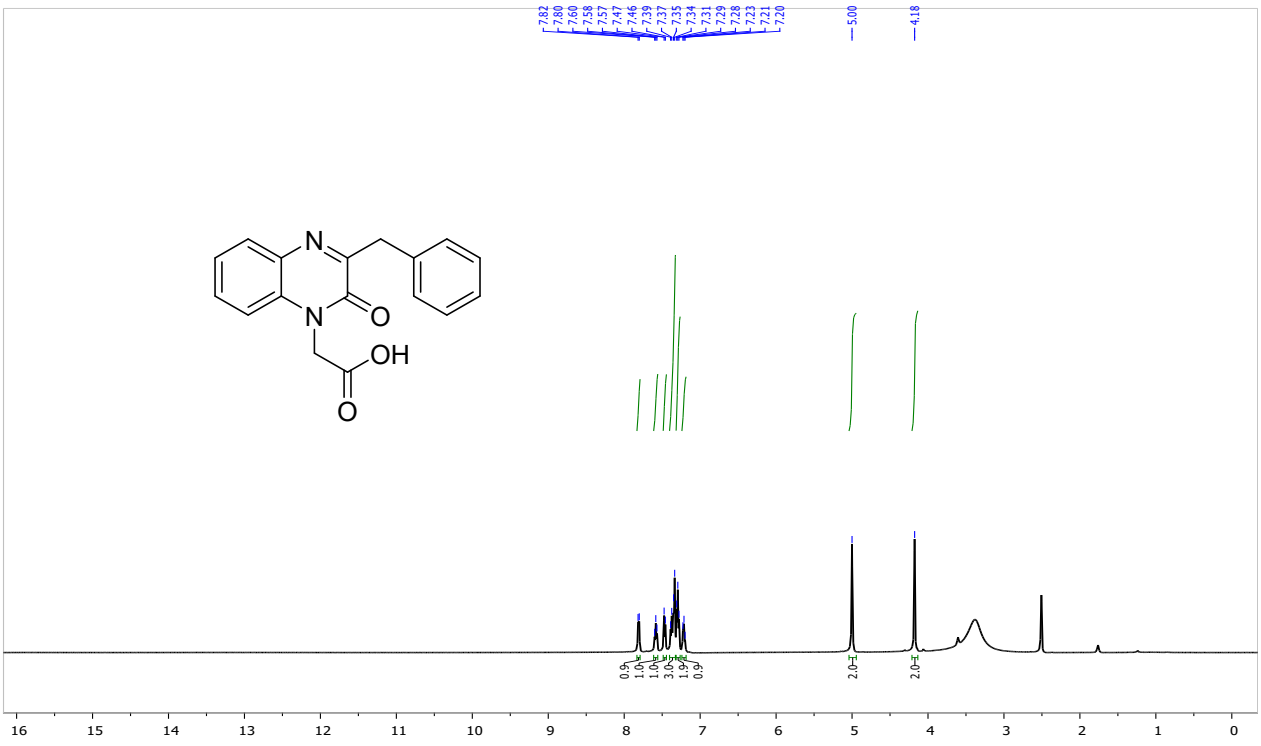
^{13}C{1H}NMR spectra of **4e** (100 MHz, $CDCl_3$)



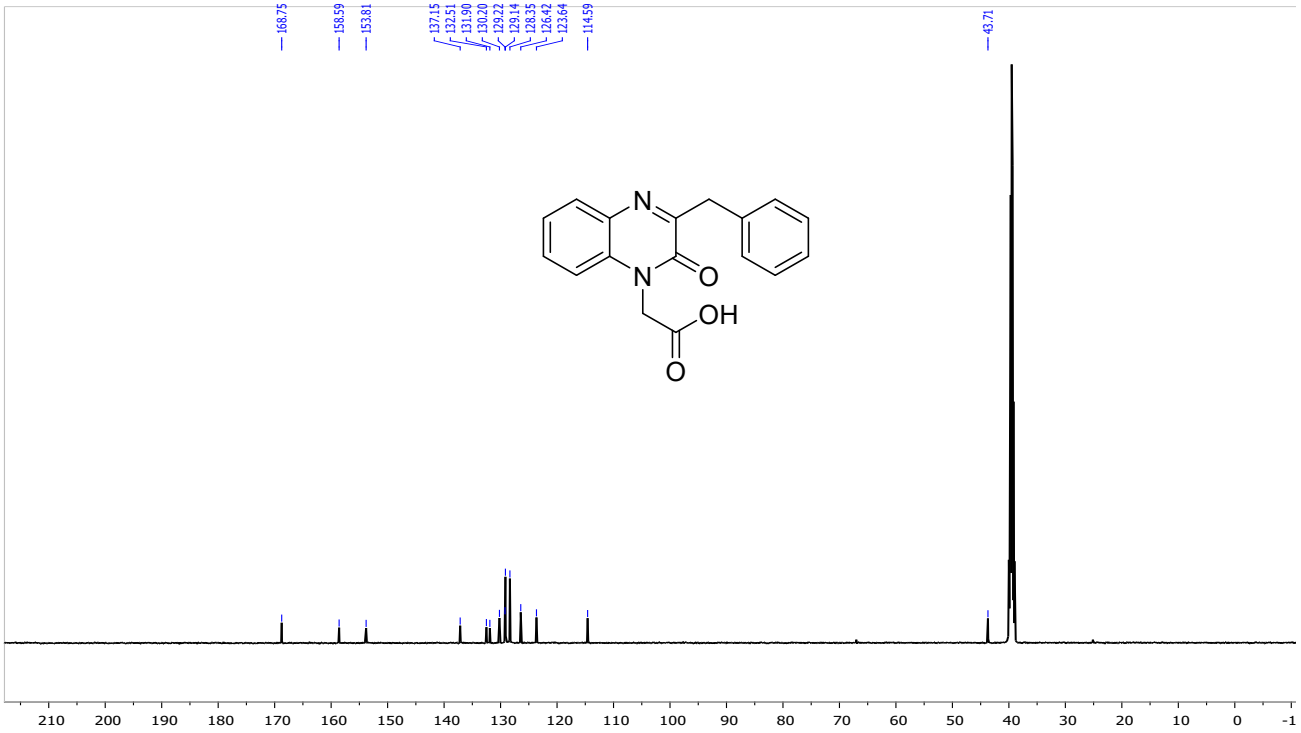
^{1}H NMR spectra of **4f** (500 MHz, $CDCl_3$)



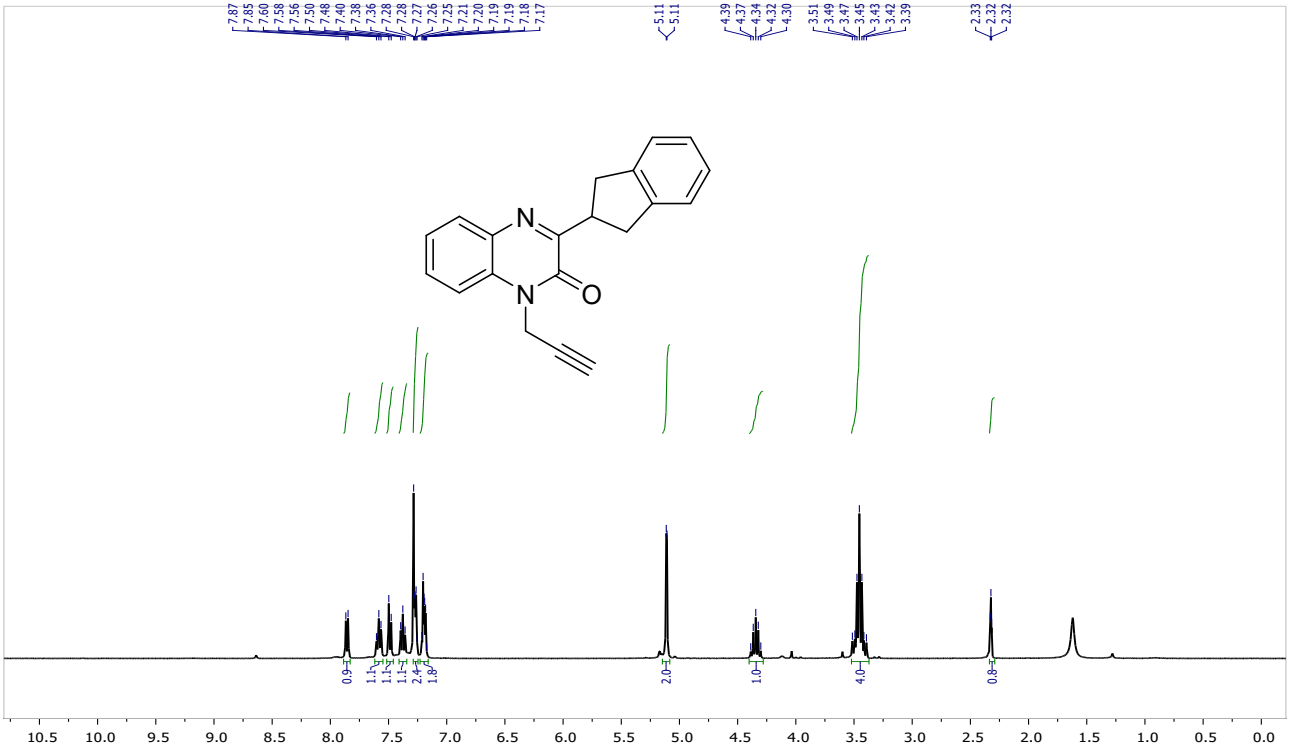
^{13}C{1H}NMR spectra of **4f** (125 MHz, $CDCl_3$)



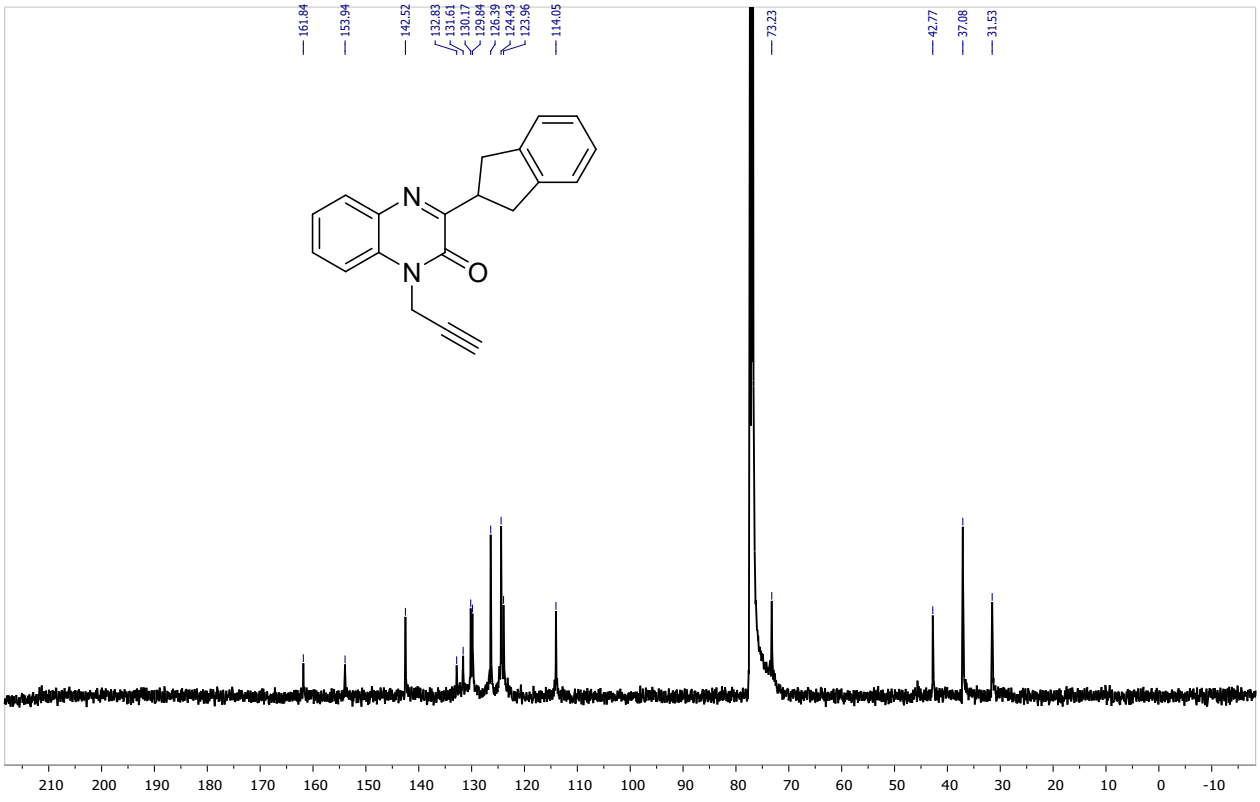
^{1}H NMR spectra of **4g** (500 MHz,DMSO- d_6)



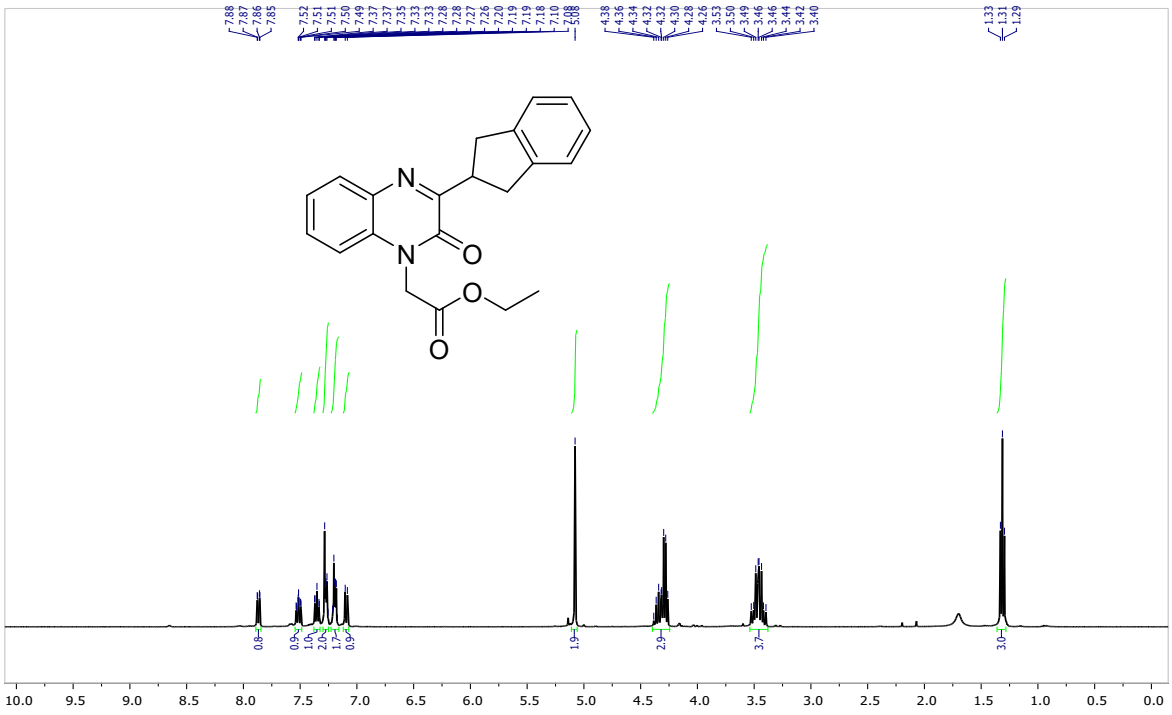
^{13}CNMR spectra of **4g** (125 MHz,DMSO- d_6)



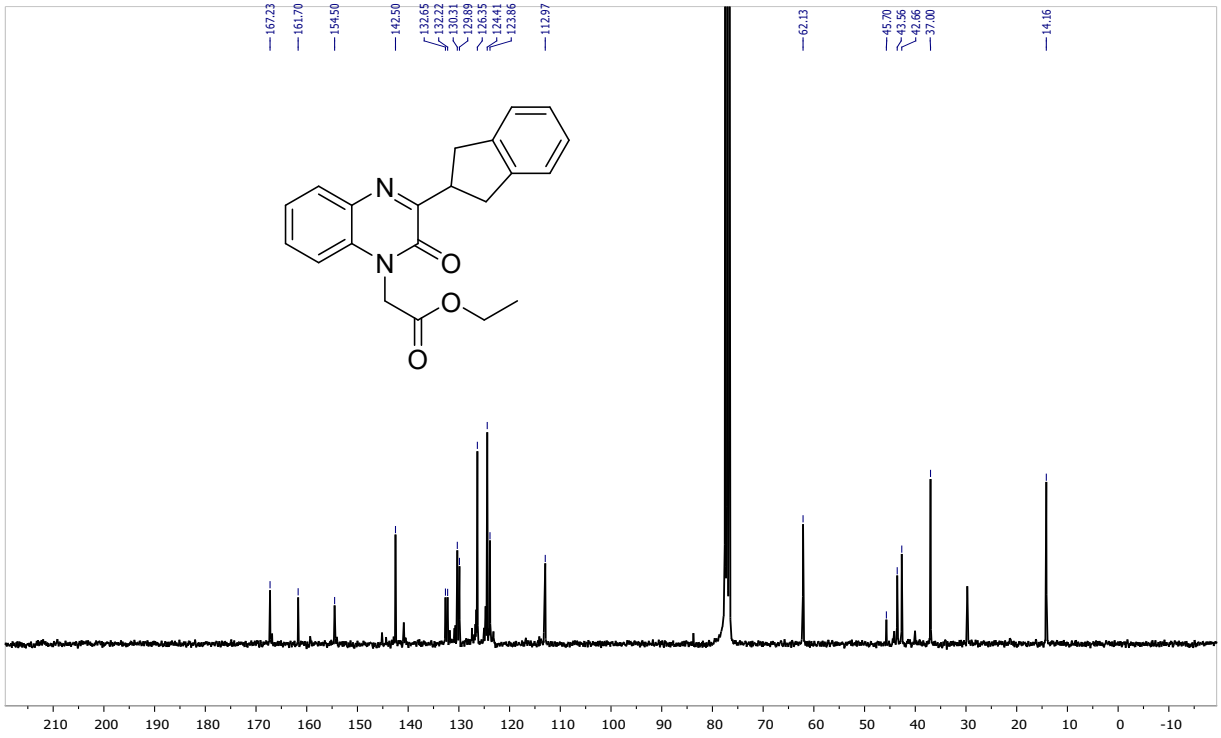
^{1}H NMR spectra of 4h (400 MHz, $CDCl_3$)



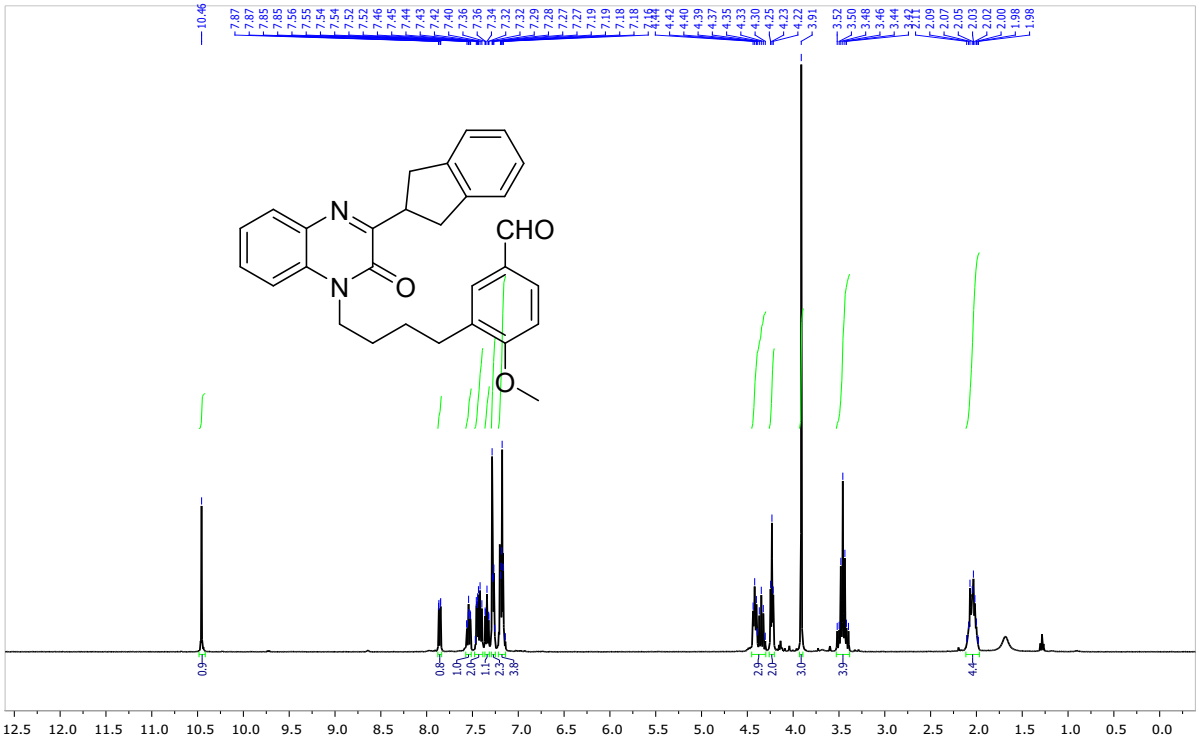
^{13}C NMR spectra of 4h (125 MHz, $CDCl_3$)



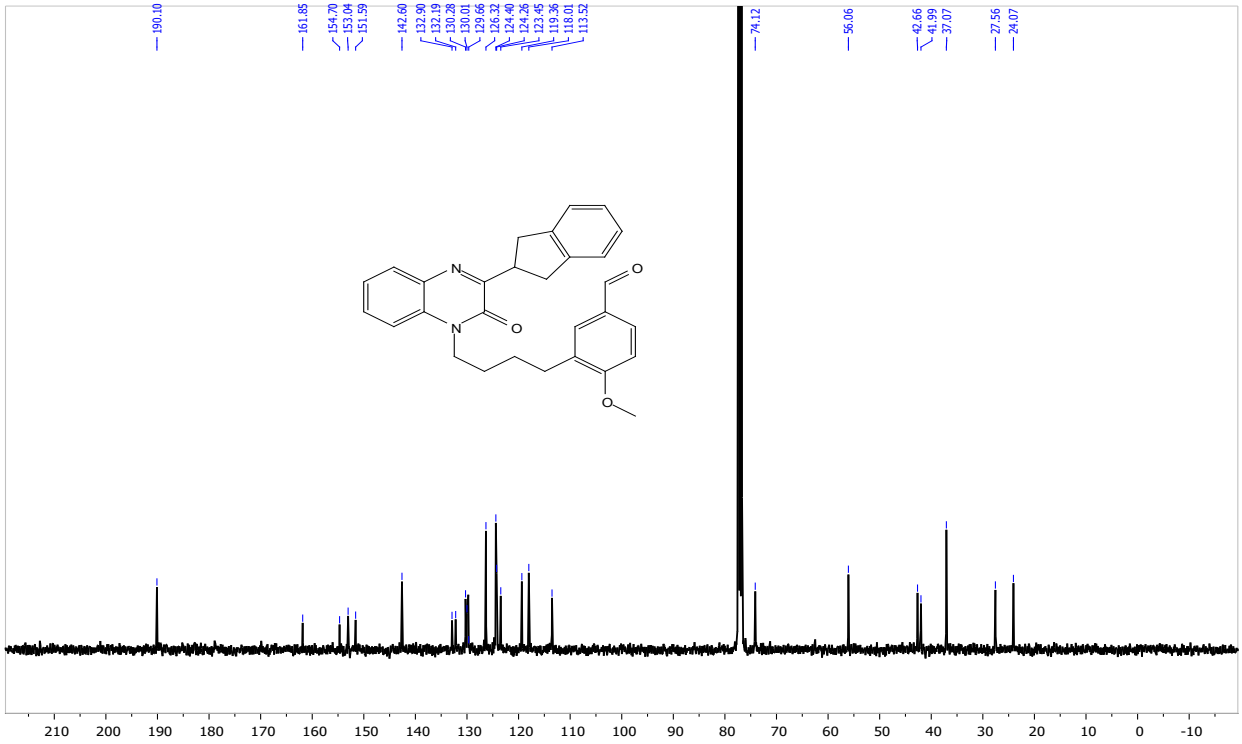
^{1}H NMR spectra of 4i (400 MHz, $CDCl_3$)



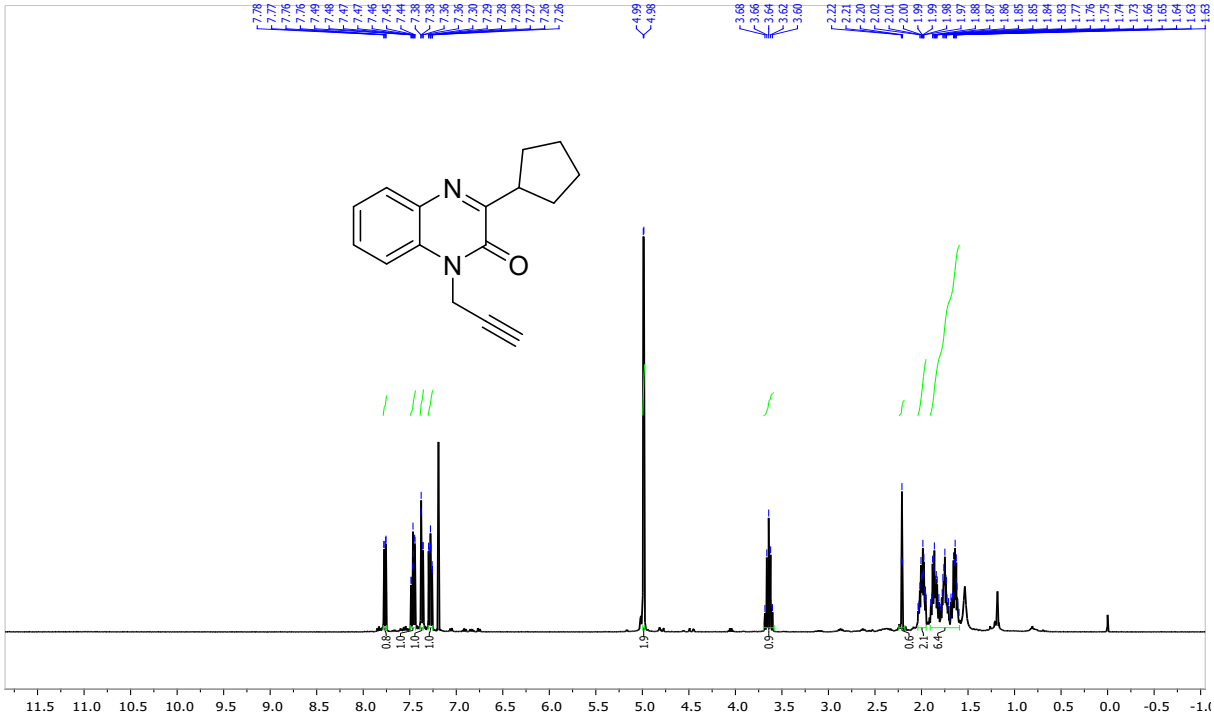
^{13}C NMR spectra of 4i (75 MHz, $CDCl_3$)



^{1}H NMR spectra of 4j (400 MHz, $CDCl_3$)

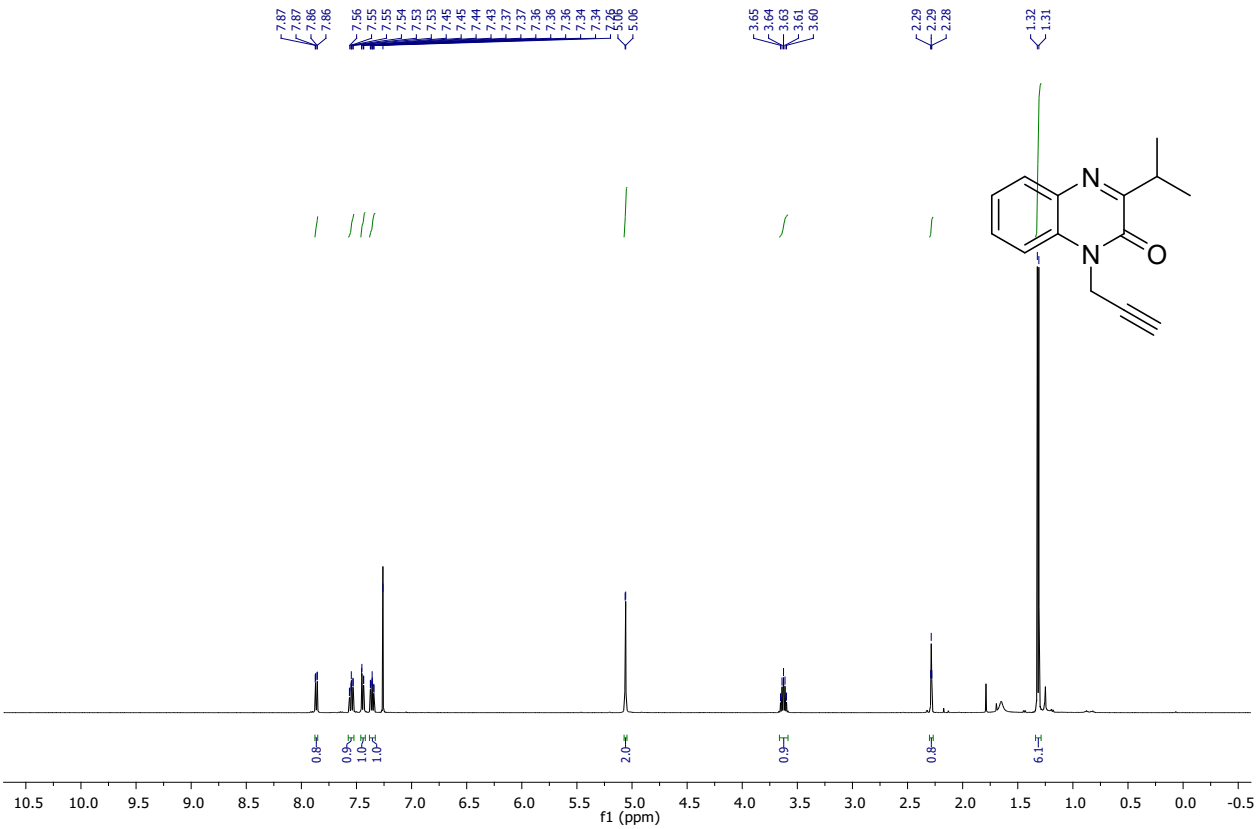


^{13}C NMR spectra of 4j (100MHz, $CDCl_3$)

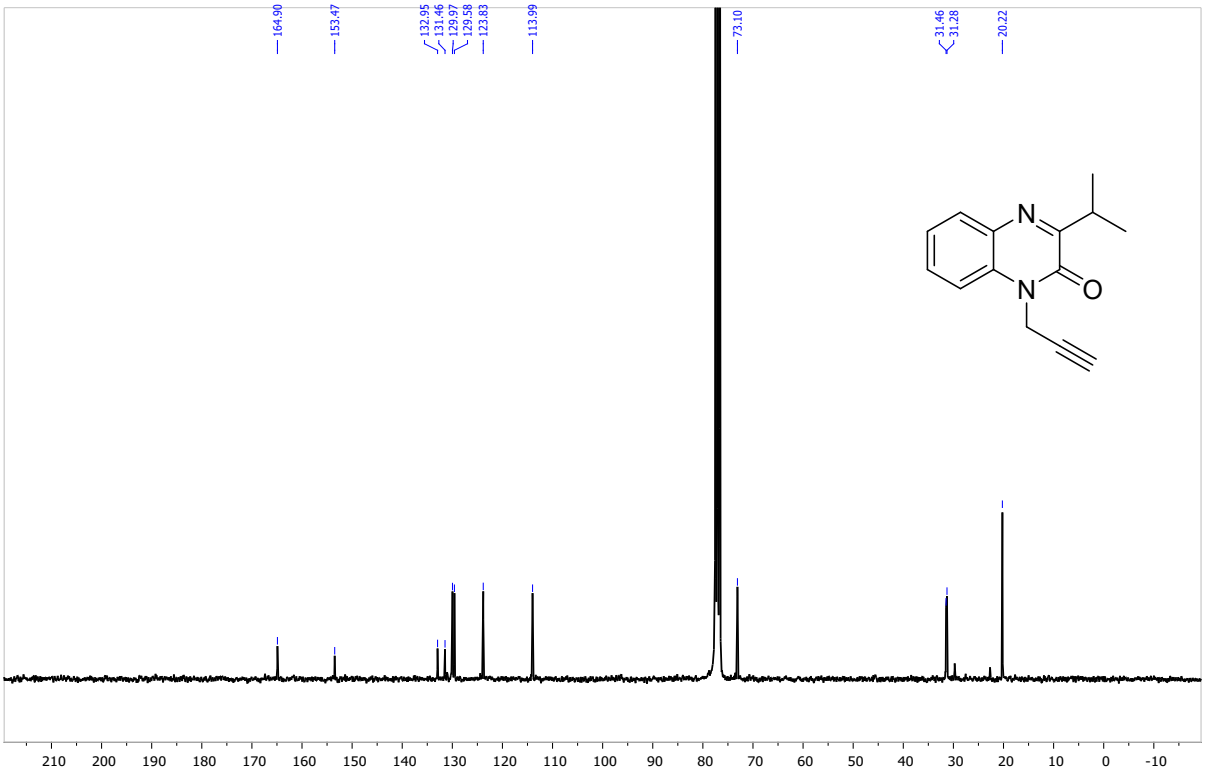


^{1}H NMR spectra of 4k (400 MHz, $CDCl_3$)

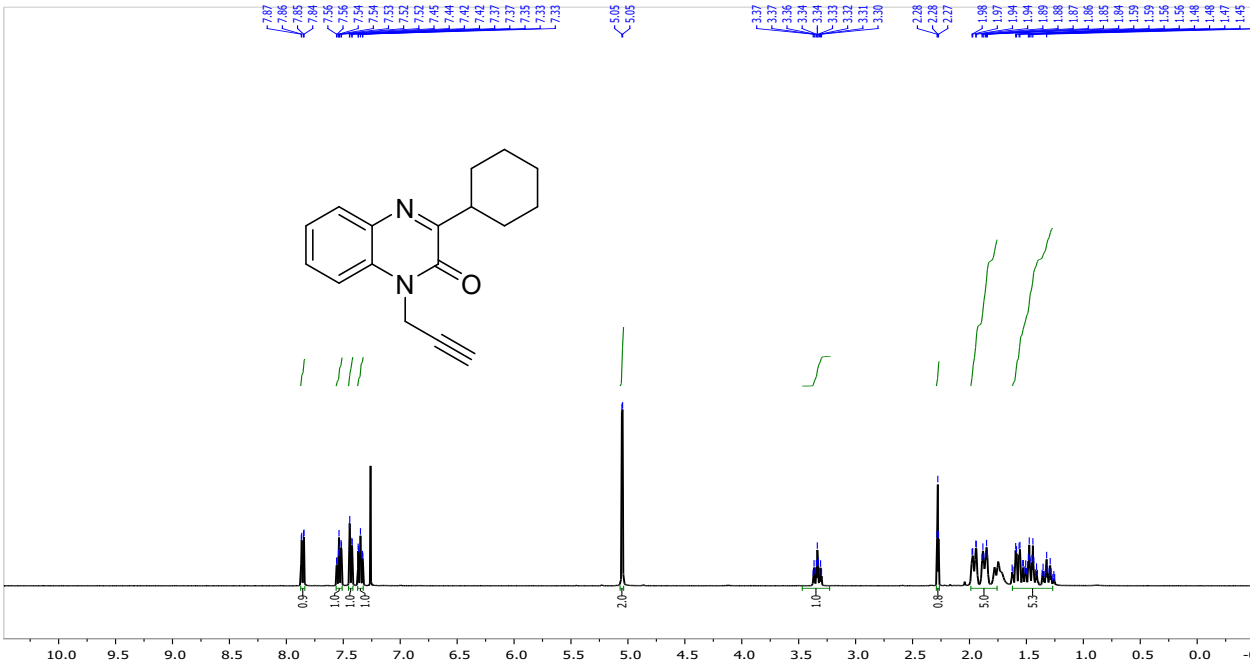
^{13}C NMR spectra of 4j (125 MHz, $CDCl_3$)



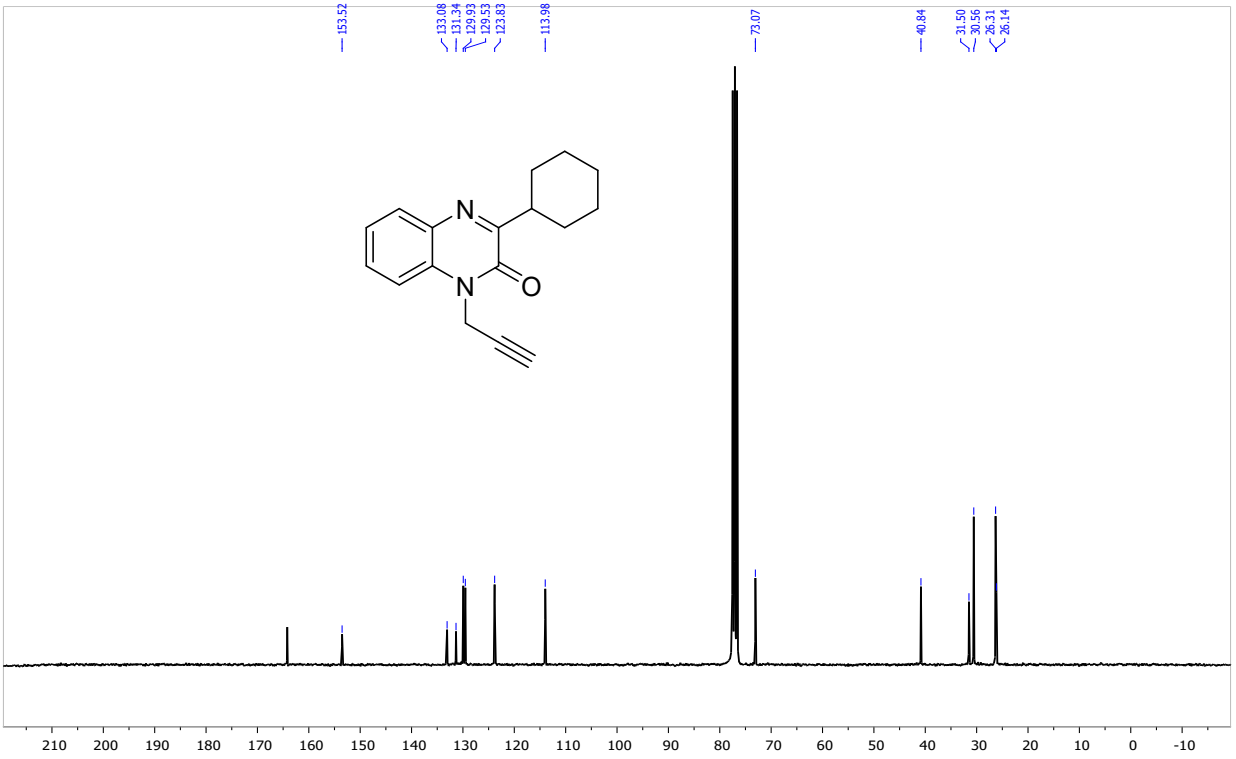
^{1}H NMR spectra of 4l (500 MHz, $CDCl_3$)



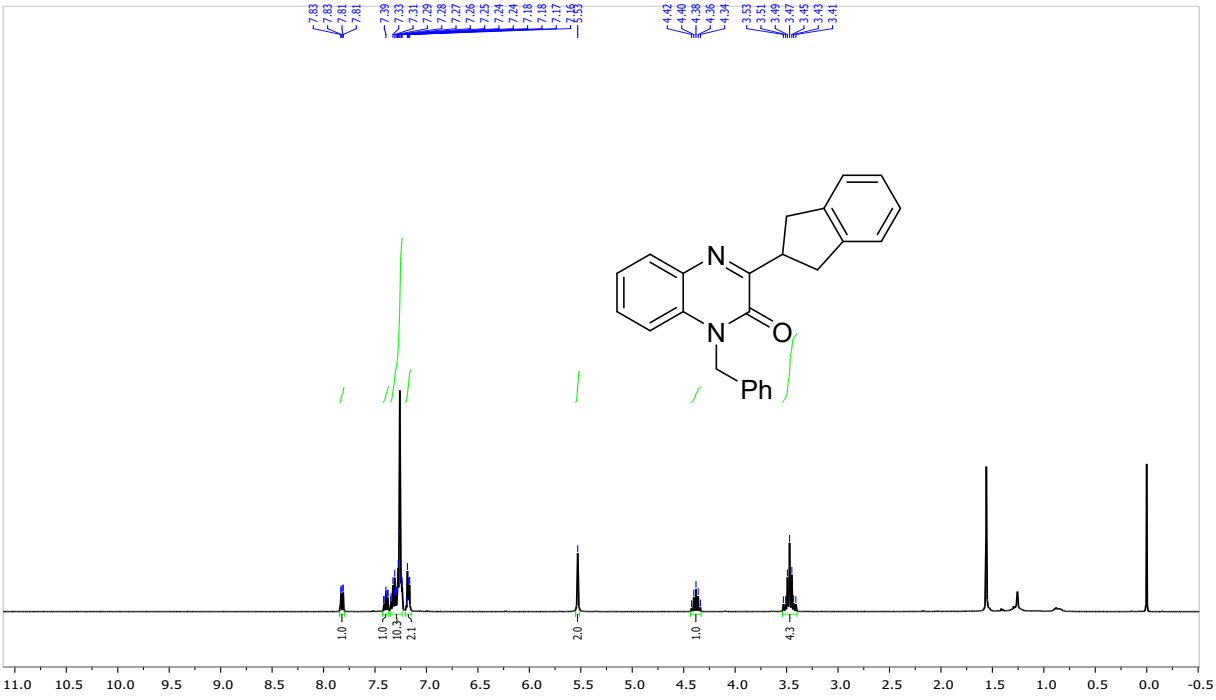
^{13}C NMR spectra of 4l (75 MHz, $CDCl_3$)



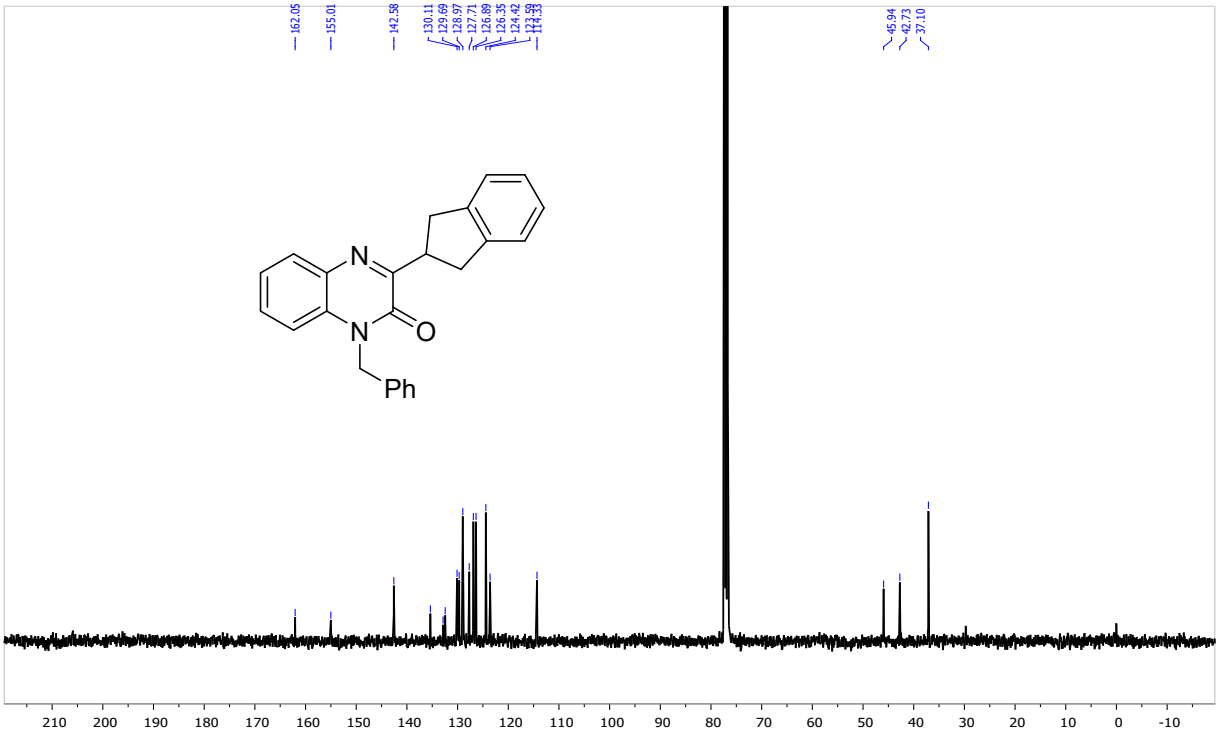
^{1}H NMR spectra of 4m (400 MHz, $CDCl_3$)



^{13}C NMR spectra of 4m (75 MHz, $CDCl_3$)



^{1}H NMR spectra of 4n (400 MHz, $CDCl_3$)



^{13}CNMR spectra of 4n (100 MHz, $CDCl_3$)