Electronic Supplementary Information

PIFA-mediated intramolecular *N*-arylation of 2-aminoquinoxalines to afford indolo[2,3-*b*]quinoxaline derivatives

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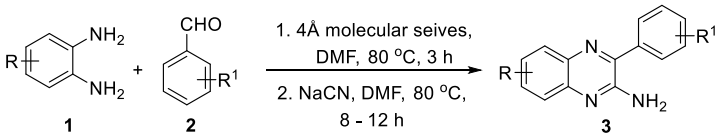
General information

All reactions were performed by using standard vial technique with rubber septum. All solids were weighed in air. Chemicals like *o*-phenylene diamine, substituted aryl aldehydes, sodium cyanide, 4Å molecular sieves, *p*-tosyl chloride, DMAP (*N*,*N*- dimethyl amino pyridine), PIDA (phenyliodine(III) diacetate), PIFA (phenyliodine bis(trifluoroacetate) were purchased from Aldrich, spectrochem, alfa aesar, TCI and used as such. Solvents like HFIP, TFE, MeOH, dioxane and pyridine were purchased from TCI and spectrochem and used without drying. Dried DMF, toluene, THF, DCM and DCE were used. All other reagents were purchased from common suppliers and used without further purification. Flash chromatography was performed using a Merck silica gel (230−400 mesh). Fractions were monitored by thin-layer chromatography (TLC) on precoated silica gel 60 F_{254} plates (Merck & Co.) and were visualized by a UV light. Nuclear magnetic resonance (NMR) spectroscopy data were recorded using Bruker ARX 400 and 700 spectrometers. ^{13}C and ^{1}H NMR spectra were recorded in $CDCl_3$ and DMSO-d_6 referenced according to signal of deutero solvent. Electrospray ionization high-resolution mass spectrometry (ESI HR-MS) measurements were performed using a Bruker micrOTOF-Q II mass-spectrometer and Waters Xevo-G2-XS QTof. The ^{1}H and ^{13}C spectra of the compounds **4** were recorded in various solvents such as $CDCl_3$, DMSO-d_6, methanol-d_4 and acetic acid-d_4, to get a good shimming. However, the spectra of these solvents were not clear. Hence HRMS was used to characterize the compounds **4**. The corresponding mass spectra of the compounds 4 are attached below. The X-ray quality crystals for the compounds **5a** and **6t** were grown by slow diffusion of *n*-hexane over CH_2Cl_2 solution. Single-crystal X-ray diffraction data was collected on a Rigaku SuperNova fine-focused dual diffractometer, with Cu Kα radiation (λ = 1.54178 Å) or Mo-Kα radiation (0.71073 Å) equipped with a PILATUS200K detector.

Table S1: Synthesis of 3-arylquinoxalin-2-amine **3**



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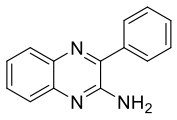
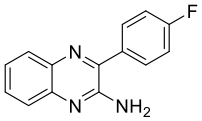
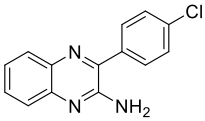


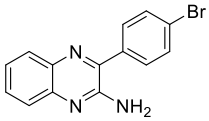
3a, 72%



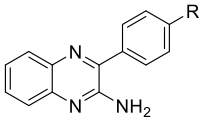
3b, 60%



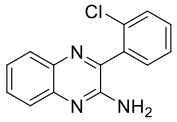
3c, 41%



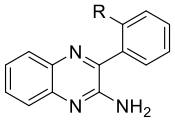
3d, 47%



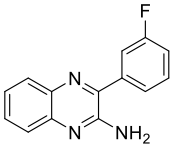
3e, R = Me, 54%
3f, R = OMe, 53%



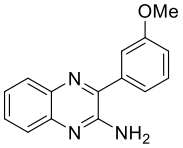
3g, 57%



3h, R = Me, 61%
3i, R = OMe 52%



3j, 64%



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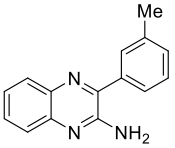

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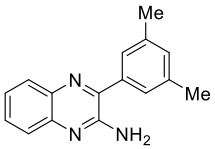
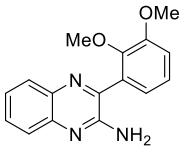


3m, 67%



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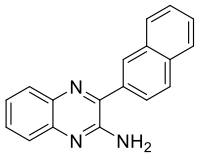
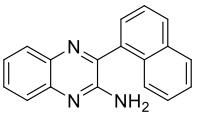
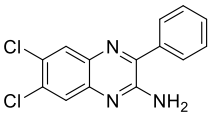


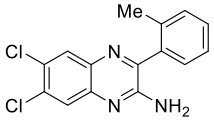
3o, 77%



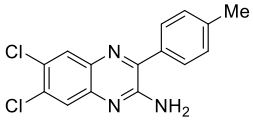
3p, 64%



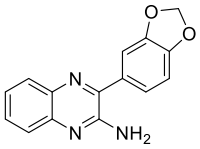
3q, 57%



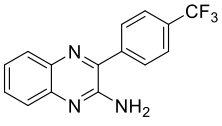
3r, 49%



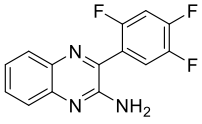
3s, 41%



3t, R = H, 68%
3u, R = Cl, 42%

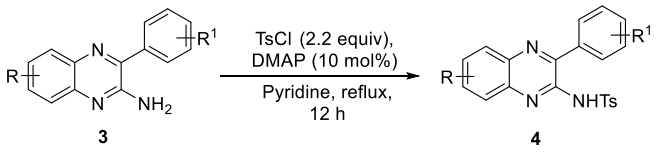


3v, 46%

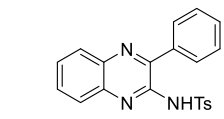


3w, 39%

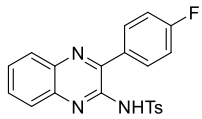
Table S2: Synthesis of tosylated 3-arylquinoxalin-2-amine **4**



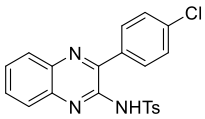
3 **4**



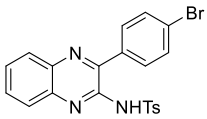
4a, 76%



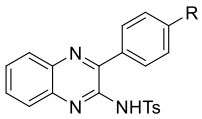
4b, 70%



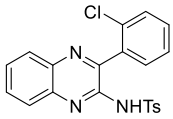
4c, 64%



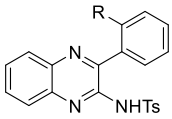
4d, 59%



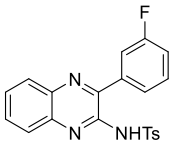
4e, R = Me, 68%
4f, R = OMe, 67%



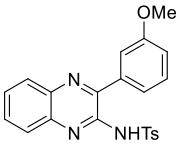
4g, 59%



4h, R = Me, 68%
4i, R = OMe, 64%



4j, 70%



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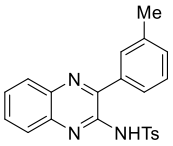
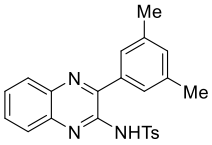
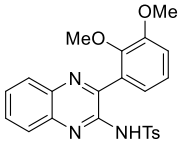


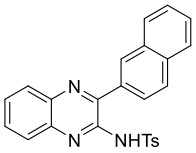
4l, 59%



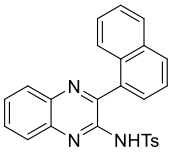
4m, 60%



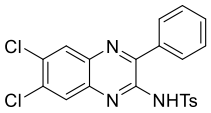
4n, 54%



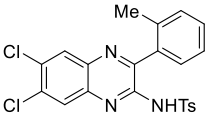
4o, 69%



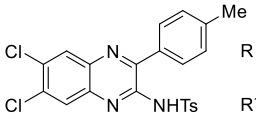
4p, 63%



4q, 50%



4r, 52%



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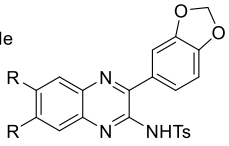
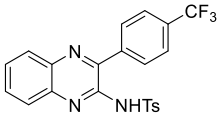
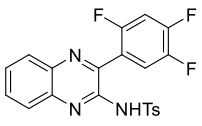


4t, R = H, 68%
4u, R = Cl, 38%



4v, 51%

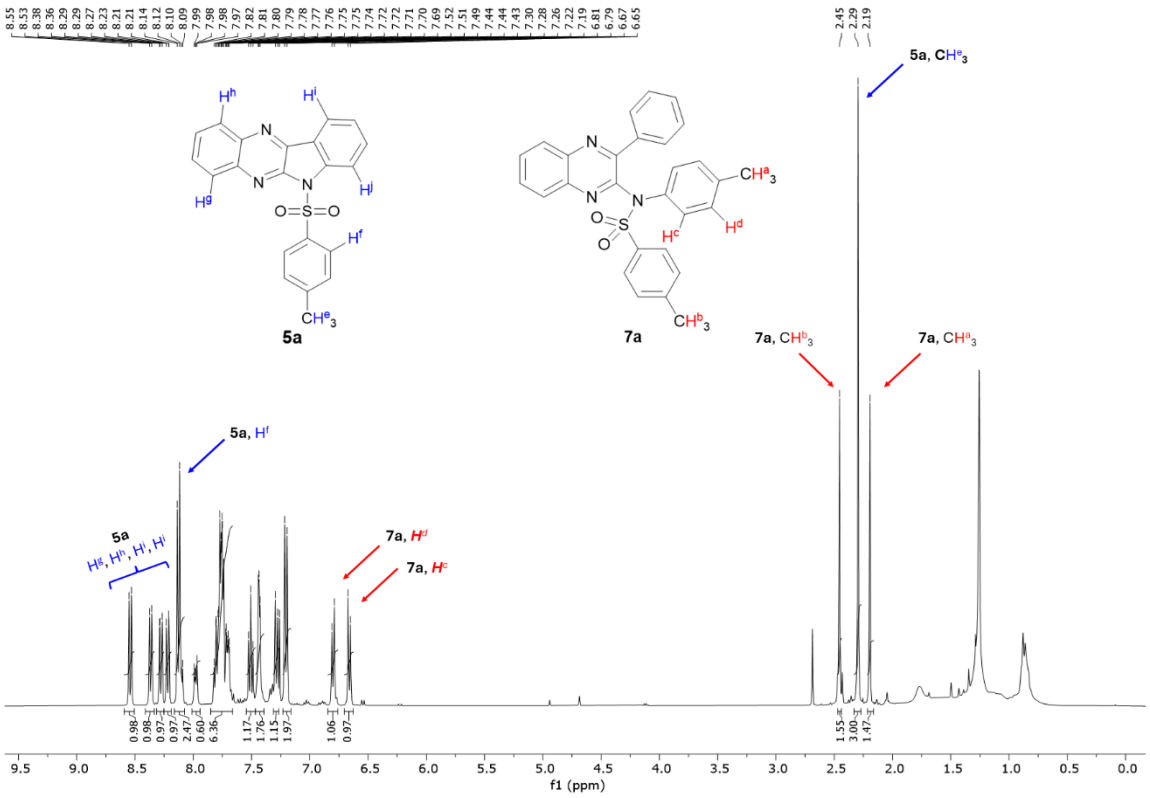


4w, 43%

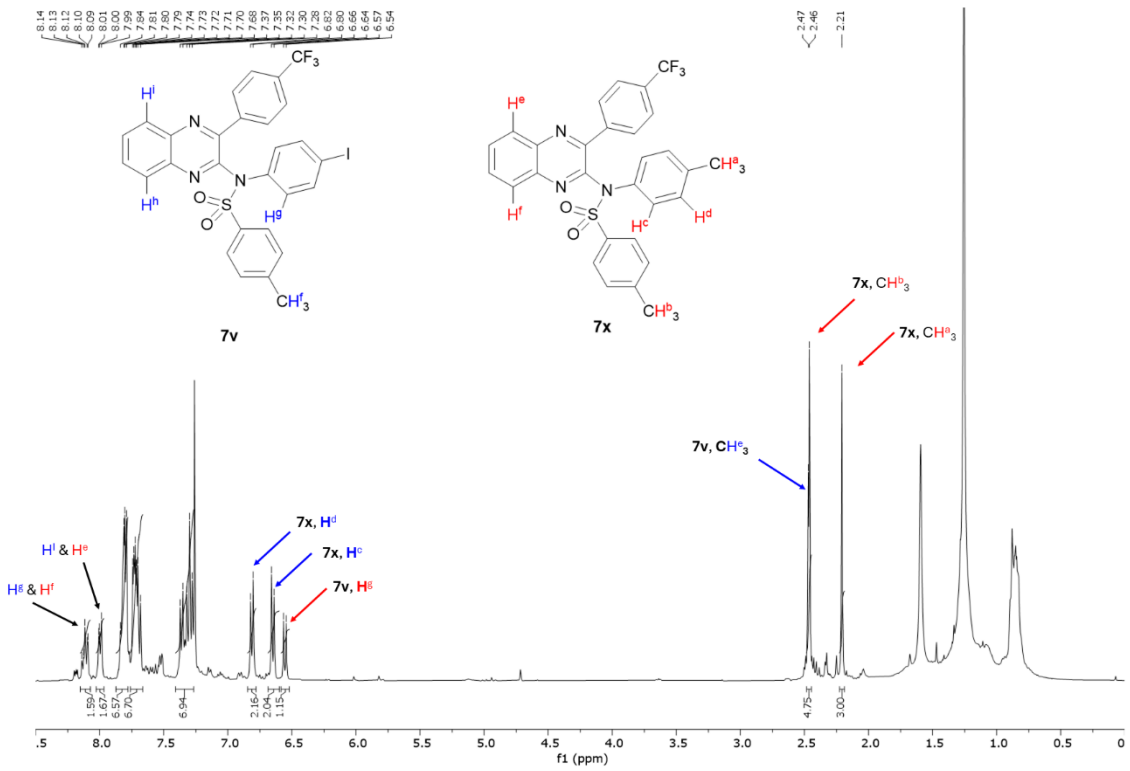
Procedure for competitive reactions of 4a and 4v with toluene:

To an 8 mL vial, toluene (80 μL, 1.5 equiv) along with HFIP (2mL) was taken, and the tosylated 3-arylquinoxalin-2-amine **4a** or **4v** (0.5 mmol) was added followed by PIFA (0.473 g, 2.2 equiv) and stirred at room temperature. After the completion of the starting material, the reaction mixture was added to water and extracted with EtOAc and the combined organic layers were dried over Na_2SO_4 and concentrated.

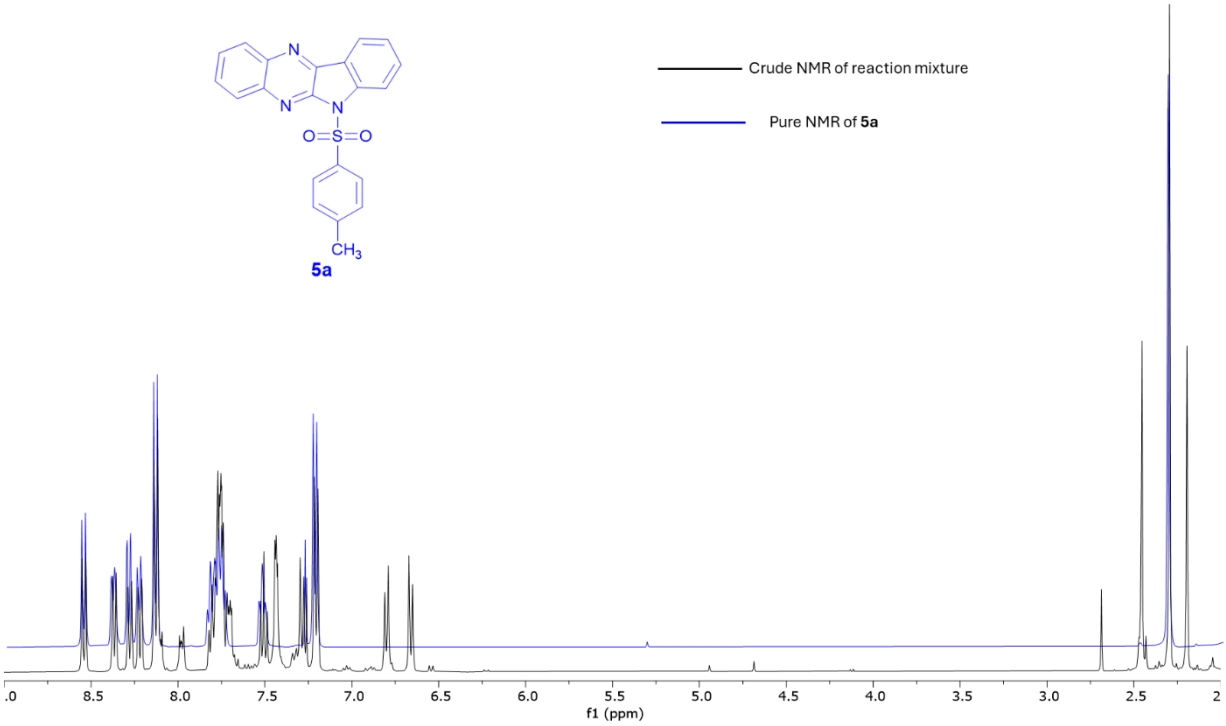
Crude ^{1}H NMR spectra (400 MHz, $CDCl_3$) for competitive reaction of 4a with toluene



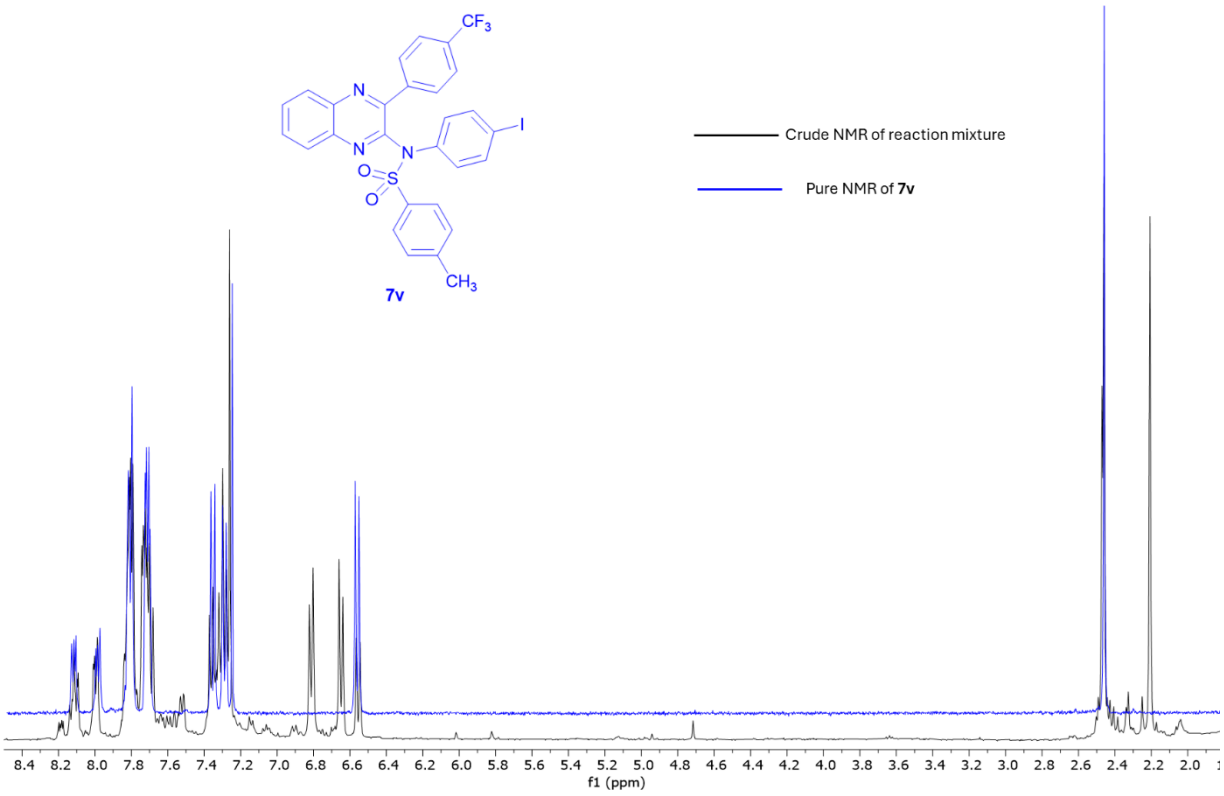
Crude ^{1}H NMR spectra (400 MHz, $CDCl_3$) for competitive reaction of 4v with toluene



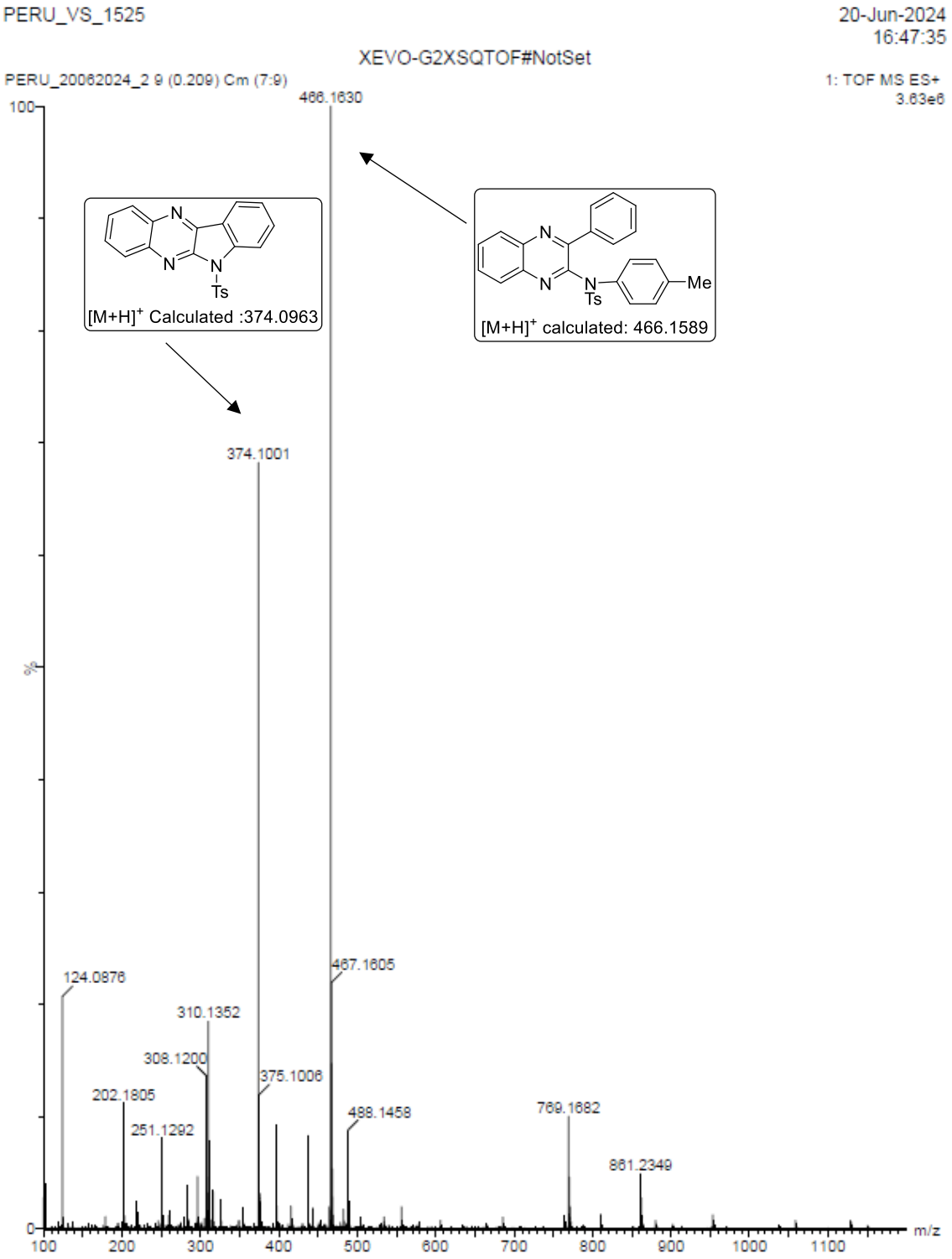
Overlay of the crude ^{1}H NMR spectra (400 MHz, $CDCl_3$) from the competitive reaction of 4a with toluene and Isolated 5a



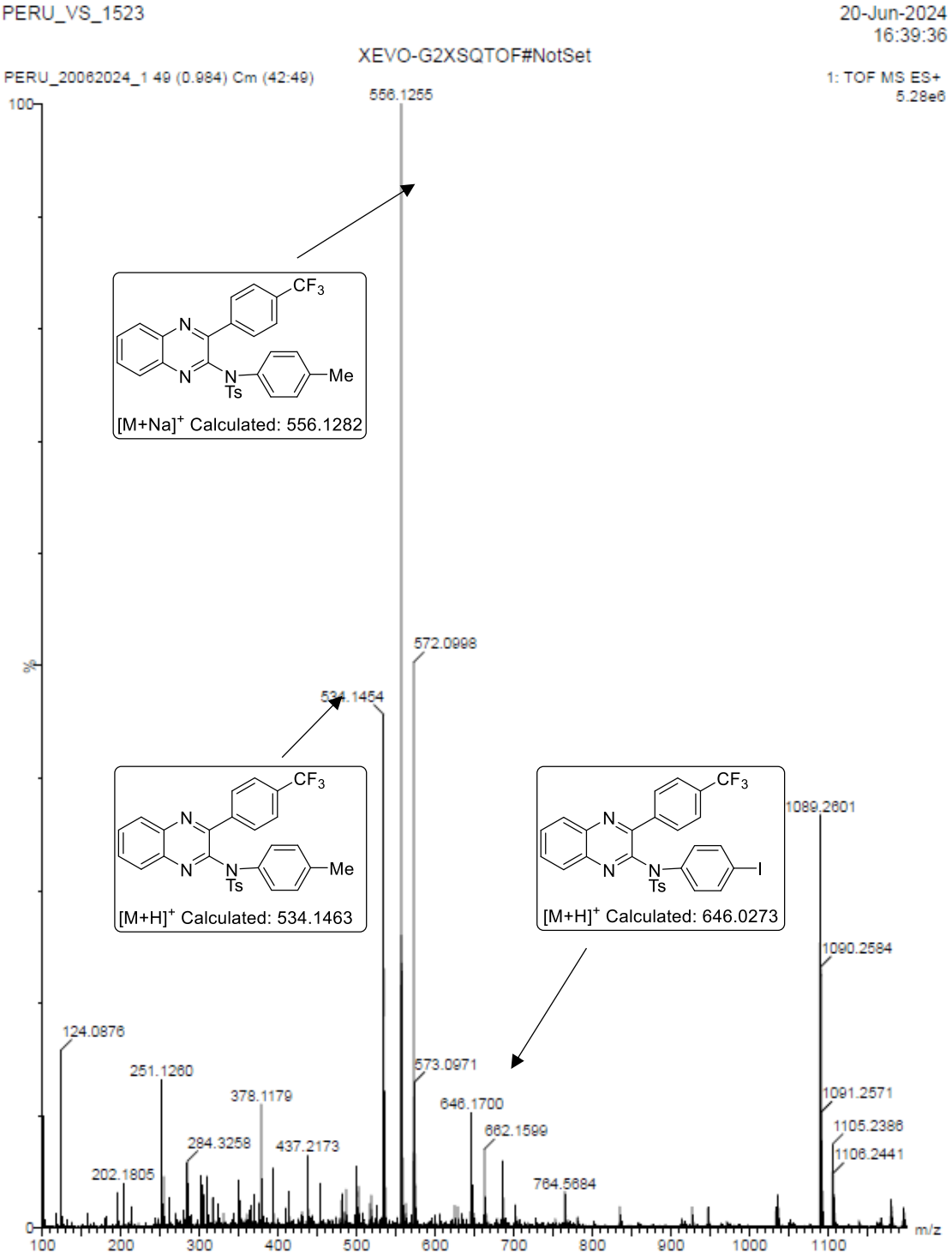
Overlay of the crude ^{1}H NMR spectra (400 MHz, $CDCl_3$) from the competitive reaction of 4v with toluene and Isolated 7v



ESI Mass spectra for competitive reaction of 4a with toluene



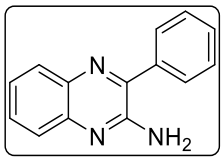
ESI Mass spectra for competitive reaction of 4v with toluene



General procedure for synthesis of 3-arylquinoxalin-2-amine 3[1]

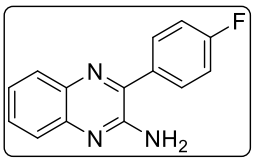
Substituted 1,2-phenylenediamine **1** (5 mmol), aryl aldehyde **2** (5.5 mmol, 1.1 equiv) and the molecular sieves (0.25 g) were dissolved in dimethylformamide (20 mL). The reaction mixture was stirred at 80 °C in an open flask. The reaction was monitored by TLC. After the complete consumption of the reaction, NaCN (0.294, 5.5 mmol; 1.1 equiv) was added to the reaction mixture. After completion of the reaction, reaction mixture was cooled to room temperature, and poured into ice and extracted with EtOAc (3 x 200 mL). The combined organic layers were dried over Na_2SO_4 and concentrated. The crude product was purified by column chromatography on silica using hexane and ethyl acetate as eluent.

3-Phenylquinoxalin-2-amine (3a)[1]



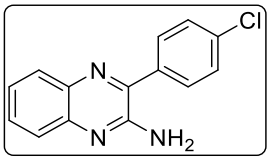
Reaction Time: 6 h; Yield: 72% (1.59 g); Nature of compound: Pale brown solid; Melting Point: 161 – 163 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3464, 2894, 2107, 1665, 1223, 786. ^{1}H NMR (400 MHz, DMSO) δ 7.82 – 7.76 (m, 3H), 7.58 – 7.53 (m, 5H), 7.39 – 7.35 (m, 1H), 6.55 (s, 2H). $^{13}C\{^1H\}$ NMR (100 MHz, DMSO) δ 151.9, 146.2, 141.8, 137.5, 137.3, 130.1, 129.8, 129.2, 128.9, 128.8, 125.5, 124.5. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{14}H_{12}N_3$ 222.1031; Found 222.1029

3-(4-Fluorophenyl)quinoxalin-2-amine (3b)[2]



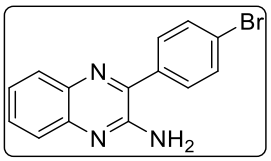
Reaction Time: 6 h; Yield: 60% (1.44 g); Nature of compound: Pale brown solid; Melting Point: 174 – 176 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3445, 3005, 2078, 1635, 1230, 780. ^{1}H NMR (400 MHz, DMSO) δ 7.83 – 7.79 (m, 3H), 7.57 – 7.56 (m, 2H), 7.38 – 7.34 (m, 3H), 6.60 (s, 2H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 163.1(d, *J* = 244.5 Hz), 151.9, 145.4, 141.8, 137.2, 133.9 (d, *J* = 3 Hz), 131.3 (d, *J* = 8.6 Hz), 130.1, 128.9, 125.5, 124.5, 116.1 (d, *J* = 21 Hz). ^{19}F NMR (377 MHz, DMSO) δ -112.1. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{14}H_{11}FN_3$ 240.0932; Found 240.0956

3-(4-Chlorophenyl)quinoxalin-2-amine (3c)[1]



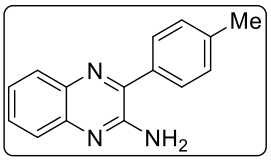
Reaction Time: 6 h; Yield: 41% (1.05 g); Nature of compound: Pale brown solid; Melting Point: 188 – 190 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3459, 2914, 2074, 1638, 1214, 777. ^{1}H NMR (400 MHz, DMSO) δ 7.82 – 7.78 (m, 3H), 7.60 – 7.57 (m, 4H), 7.39 – 7.35 (m, 1H), 6.64 (s, 2H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 151.9, 145.1, 141.9, 137.2, 136.4, 134.5, 130.9, 130.3, 129.2, 128.9, 125.5, 124.5. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{14}H_{11}ClN_3$ 256.0641; Found 256.0652

3-(4-Bromophenyl)quinoxalin-2-amine (3d)[2]



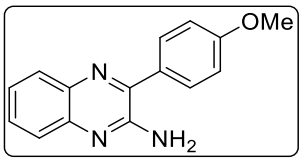
Reaction Time: 6 h; Yield: 47% (1.41 g); Nature of compound: Pale brown solid; Melting Point: 204 – 206 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3432, 2856, 2087, 1635, 1220, 784. ^{1}H NMR (400 MHz, DMSO) δ 7.80 (d, *J* = 8 Hz, 1H), 7.73 (s, 4H), 7.58 – 7.57 (m, 2H), 7.39 – 7.36 (m, 1H), 6.64 (s, 2H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 151.9, 145.1, 141.9, 137.2, 136.8, 132.1, 131.1, 130.3, 128.9, 125.5, 124.5, 123.2. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{14}H_{11}N_3Br$ 300.0131 and 302.0111; Found 300.0104 and 302.0084

3-(*p*-Tolyl)quinoxalin-2-amine (3e)[1]



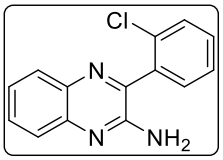
Reaction Time: 6 h; Yield: 54% (1.10 g); Nature of compound: Pale brown solid; Melting Point: 167 – 169 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3438, 3021, 2093, 1631, 1217, 778. ^{1}H NMR (400 MHz, DMSO) δ 7.79 (d, *J* = 7.2 Hz, 1H), 7.67 (d, *J* = 6.8 Hz, 2H), 7.56 (s, 2H), 7.35 (d, *J* = 6 Hz, 3H), 6.56 (s, 2H), 2.40 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 151.9, 146.2, 141.7, 139.3, 137.3, 134.7, 129.9, 129.8, 128.9, 128.8, 125.5, 124.4, 21.5. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{14}N_3$ 236.1188; Found 236.1201

3-(4-Methoxyphenyl)quinoxalin-2-amine (3f)[1]



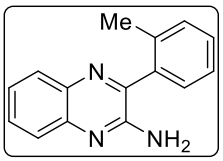
Reaction Time: 10 h; Yield: 53% (1.34 g); Nature of compound: Pale brown solid; Melting Point: 152 – 154 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3484, 3010, 2063, 1637, 1234, 769. ^{1}H NMR (400 MHz, DMSO) δ 7.80 – 7.74 (m, 3H), 7.58 – 7.52 (m, 2H), 7.35 (t, *J* = 7.6 Hz, 1H), 7.09 (d, *J* = 8.8 Hz, 2H), 6.56 (s, 2H), 3.83 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 160.6, 152.0, 145.9, 141.6, 137.4, 130.4, 129.8, 129.7, 128.8, 125.4, 124.4, 114.6, 55.8. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{14}N_3O$ 252.1137; Found 252.1147

3-(2-Chlorophenyl)quinoxalin-2-amine (3g)[1]



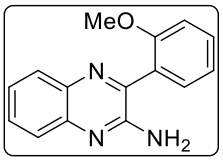
Reaction Time: 6 h; Yield: 57% (1.46 g); Nature of compound: Pale brown solid; Melting Point: 180 – 182 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3451, 3012, 2099, 1664, 1231, 777. ^{1}H NMR (400 MHz, DMSO) δ 7.80 (d, *J* = 8.1 Hz, 1H), 7.62 (d, *J* = 7.5 Hz, 3H), 7.58 – 7.46 (m, 3H), 7.40 – 7.32 (m, 1H), 6.50 (s, 2H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 151.6, 144.8, 141.9, 136.1, 135.7, 132.1, 130.9, 130.8, 129.9, 129.7, 128.5, 127.7, 125.2, 123.8. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{14}H_{11}ClN_3$ 256.0641; Found 256.0618

3-(*o*-Tolyl)quinoxalin-2-amine (3h)



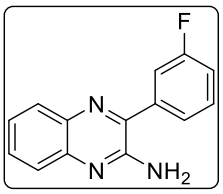
Reaction Time: 6 h; Yield: 61% (1.44 g); Nature of compound: Pale brown solid; Melting Point: 164 – 166 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3401, 3083, 2067, 1697, 1236, 771. ^{1}H NMR (400 MHz, DMSO) δ 7.78 (d, *J* = 8 Hz, 1H), 7.61 – 7.56 (m, 2H), 7.40 – 7.33 (m, 5H), 6.37 (s, 2H), 2.15 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 152.2, 147.5, 142.1, 136.9, 136.8, 136.4, 131.0, 130.0, 129.4, 129.3, 128.9, 126.6, 125.6, 124.3, 19.4. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{14}N_3$ 236.1188; Found 236.1205

3-(2-Methoxyphenyl)quinoxalin-2-amine (3i)[1]



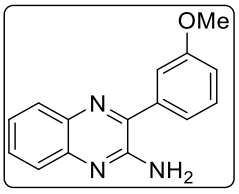
Reaction Time: 9 h; Yield: 52% (1.31 g); Nature of compound: Pale brown solid; Melting Point: 186 – 188 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3445, 2919, 2088, 1638, 1227, 775. ^{1}H NMR (400 MHz, DMSO) δ 7.77 (d, *J* = 8.4 Hz, 1H), 7.58 – 7.57 (m, 2H), 7.50 (t, *J* = 7.6 Hz, 1H), 7.37 – 7.33 (m, 2H), 7.18 (d, *J* = 8 Hz, 1H), 7.10 (t, *J* = 7.6 Hz, 1H), 6.27 (s, 2H), 3.77 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 157.4, 152.6, 145.9, 142.0, 136.9, 131.1, 131.0, 129.9, 128.8, 126.3, 125.5, 124.1, 121.2, 112.3, 55.9. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{14}N_3O$ 252.1131; Found 252.1310

3-(3-Fluorophenyl)quinoxalin-2-amine (3j)



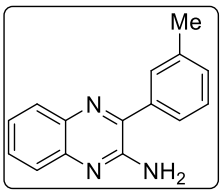
Reaction Time: 6 h; Yield: 64% (1.54 g); Nature of compound: Pale brown solid; Melting Point: 174 – 176 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3429, 2391, 2074, 1644, 1214, 768. ^{1}H NMR (400 MHz, DMSO) δ 7.81 (d, *J* = 8.4 Hz, 1H), 7.58 – 7.55 (m, 5H), 7.39 – 7.34 (m, 2H), 6.66 (s, 2H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 162.6 (d, *J* = 242.5 Hz), 151.8, 144.8, 141.9, 139.8 (d, *J* = 7.7 Hz), 137.1, 131.3 (d, *J* = 8.4 Hz), 130.3, 129.0, 125.6, 125.1 (d, *J* = 2.7 Hz), 124.6, 116.6 (d, *J* = 20.8 Hz), 115.9 (d, *J* = 21.9 Hz). ^{19}F NMR (377 MHz, DMSO) δ -112.5. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{14}H_{11}FN_3$ 240.0932; Found 240.0948

3-(3-Methoxyphenyl)quinoxalin-2-amine (3k)



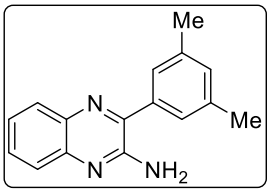
Reaction Time: 10 h; Yield: 58% (1.46 g); Nature of compound: Pale brown solid; Melting Point: 168 – 170 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3442, 2929, 2049, 1631, 1217, 774. ^{1}H NMR (400 MHz, DMSO) δ 7.81 (d, *J* = 8 Hz, 1H), 7.59 – 7.57 (m, 2H), 7.46 (t, *J* = 7.6 Hz, 1H), 7.36 (t, *J* = 6.4 Hz, 1H), 7.33 – 7.29 (m, 2H), 7.08 (d, *J* = 8 Hz, 1H), 6.59 (s, 2H), 3.83 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 159.8, 151.9, 146.0, 141.9, 138.8, 137.2, 130.4, 130.1, 128.9, 125.5, 124.5, 121.1, 115.7, 114.1, 55.7. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{14}N_3O$ 252.1131; Found 252.1106

3-(*m*-Tolyl)quinoxalin-2-amine (3l)



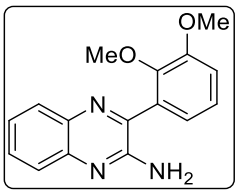
Reaction Time: 6 h; Yield: 74% (1.74 g); Nature of compound: Pale brown solid; Melting Point: 135 – 138 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3429, 2040, 1644, 1223, 819, 774. ^{1}H NMR (400 MHz, DMSO) δ 7.81 (d, *J* = 8 Hz, 1H), 7.57 – 7.54 (m, 4H), 7.42 (t, *J* = 7.6 Hz, 1H), 7.38 – 7.32 (m, 2H), 6.56 (s, 2H), 2.40 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 151.9, 146.3, 141.8, 138.5, 137.4, 137.3, 130.4, 130.0, 129.4, 129.1, 128.9, 125.9, 125.5, 124.4, 21.6. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{14}N_3$ 236.1188; Found 236.1173

3-(3,5-Dimethylphenyl)quinoxalin-2-amine (3m)



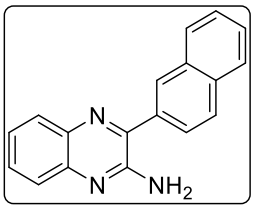
Reaction Time: 6 h; Yield: 67% (1.82 g); Nature of compound: Pale brown solid; Melting Point: 174 – 176 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3439, 3029, 2093, 1632, 1236, 770. ^{1}H NMR (400 MHz, DMSO) δ 7.80 (d, *J* = 8.0 Hz, 1H), 7.56 (s, 2H), 7.34 (s, 3H), 7.13 (s, 1H), 6.57 (s, 2H), 2.35 (s, 6H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 151.5, 146.0, 141.3, 137.8, 136.9, 136.8, 130.7, 129.5, 128.4, 126.1, 125.0, 123.9, 21.0. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{16}H_{16}N_3$ 272.1164; Found 272.1158

3-(2,3-Dimethoxyphenyl)quinoxalin-2-amine (3n)



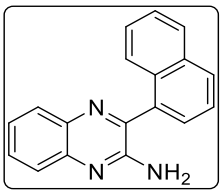
Reaction Time: 12 h; Yield: 59% (1.66 g); Nature of compound: Pale white solid; Melting Point: 179 – 181 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3425, 2100, 1631, 1535, 1235, 1073, 772. ^{1}H NMR (400 MHz, DMSO) δ 7.77 (d, *J* = 8.1 Hz, 1H), 7.57 (d, *J* = 4.3 Hz, 2H), 7.40 – 7.31 (m, 1H), 7.25 – 7.15 (m, 2H), 6.92 (dd, *J* = 5.4, 3.7 Hz, 1H), 6.34 (s, 2H), 3.87 (s, 3H), 3.66 (s, 3H). ^{13}C{^{1}H} NMR (175 MHz, DMSO) δ 153.0, 152.5, 147.0, 145.5, 142.1, 136.7, 131.6, 130.0, 128.9, 125.5, 124.9, 124.2, 121.9, 114.3, 61.1, 56.2. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{16}H_{16}N_3O_2$ 282.1242; Found 282.1224

3-(Naphthalen-2-yl)quinoxalin-2-amine (3o)[1]



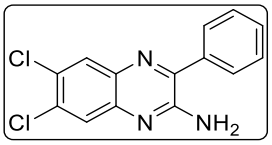
Reaction Time: 6 h; Yield: 77% (2.09 g); Nature of compound: Pale brown solid; Melting Point: 202 – 204 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν(cm^{-1}) = 3448, 2087, 1638, 1226, 784. ^{1}H NMR (400 MHz, DMSO) δ 8.37 (s, 1H), 8.08 – 8.04 (m, 2H), 8.01 – 7.98 (m, 1H), 7.89 – 7.85 (m, 2H), 7.63 – 7.56 (m, 4H), 7.40 – 7.36 (m, 1H), 6.72 (s, 2H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 152.1, 146.1, 141.9, 137.4, 134.9, 133.7, 133.2, 130.1, 129.1, 128.9, 128.8, 128.3, 128.1, 127.4, 126.9, 126.6, 125.6, 124.5. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{18}H_{14}N_3$ 272.1188; Found 272.1162

3-(Naphthalen-1-yl)quinoxalin-2-amine (3p)[1]



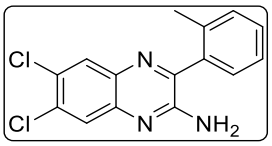
Reaction Time: 6 h; Yield: 64% (1.73 g); Nature of compound: White solid; Melting Point: 170 – 172 ºC; R_f: 0.20 in 30% ethyl acetate in hexanes; IR (KBr): ν(cm^{-1}) = 3449, 2085, 1631, 1229, 780. ^{1}H NMR (400 MHz, DMSO) δ 8.14 – 8.01 (m, 2H), 7.82 (d, *J* = 8.0 Hz, 1H), 7.73 – 7.59 (m, 4H), 7.60 - 7.45 (m, 3H), 7.40 (t, *J* = 7.2 Hz, 1H), 6.42 (s, 2H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 152.3, 146.0, 141.8, 136.5, 134.1, 133.5, 130.9, 129.8, 129.3, 128.6, 128.5, 127.0, 126.7, 126.2, 125.8, 125.3, 124.9, 123.9. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{18}H_{14}N_3$ 272.1188; Found 272.1172

6,7-Dichloro-3-phenylquinoxalin-2-amine (3q)[1]



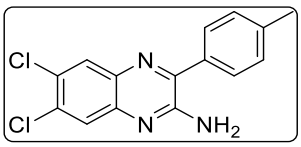
Reaction Time: 6 h; Yield: 57% (1.65 g); Nature of compound: Pale brown solid; Melting Point: 220 – 222 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3467, 3097, 2363, 1641, 1214, 778. ^{1}H NMR (400 MHz, DMSO) δ 8.03(s, 1H), 7.75(s, 3H), 7.54(s, 3H), 6.97(s, 2H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 152.2, 147.5, 140.9, 136.3, 135.7, 131.9, 129.8, 129.1, 128.8, 128.4, 125.7, 125.6. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{14}H_{10}Cl_2N_3$ 290.0252; Found 290.0257

6,7-Dichloro-3-(*o*-tolyl)quinoxalin-2-amine (3r)



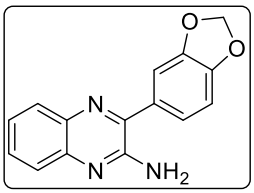
Reaction Time: 6 h; Yield: 49% (1.48 g); Nature of compound: Pale brown solid; Melting Point: 174 – 176 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3459, 2885, 2315, 1693, 1115, 783. ^{1}H NMR (400 MHz, DMSO) δ 8.02 (s, 1H), 7.77 (d, *J* = 14.6 Hz, 1H), 7.38 (ddd, *J* = 17.1, 10.5, 5.8 Hz, 4H), 6.71 (s, 2H), 2.14 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 152.5, 148.9, 141.2, 135.9, 135.6, 135.3, 131.9, 130.6, 129.3, 129.2, 128.7, 126.2, 125.8, 125.5, 18.9. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{12}Cl_2N_3$ 304.0408; Found 304.0421

6,7-Dichloro-3-(*p*-tolyl)quinoxalin-2-amine (3s)



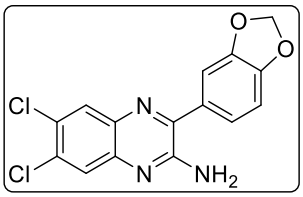
Reaction Time: 6 h; Yield: 41% (1.25 g); Nature of compound: Pale brown solid; Melting Point: 209 – 211 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3468, 2887, 2319, 1656, 1125, 779. ^{1}H NMR (400 MHz, DMSO) δ 8.00 (s, 1H), 7.74 (s, 1H), 7.65 (d, *J* = 8.0 Hz, 2H), 7.34 (d, *J* = 7.9 Hz, 2H), 6.92 (s, 2H), 2.39 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 152.2, 147.5, 140.8, 139.4, 135.8, 133.5, 131.7, 129.3, 129.1, 128.3, 125.6, 125.5, 20.9. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{12}Cl_2N_3$ 304.0408; Found 304.0391

3-(Benzo[*d*][1,3]dioxol-5-yl)quinoxalin-2-amine (3t)



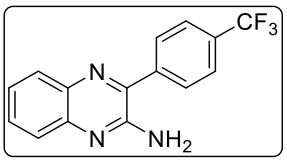
Reaction Time: 6 h; Yield: 68% (1.80 g); Nature of compound: Pale brown solid; Melting Point: 152 – 154 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3419, 2093, 1641, 1528, 1223, 1069, 781. ^{1}H NMR (400 MHz, DMSO) δ 7.78 (d, *J* = 8.1 Hz, 1H), 7.55 (d, *J* = 3.3 Hz, 2H), 7.36 (d, *J* = 3.7 Hz, 1H), 7.28 (s, 2H), 7.06 (d, *J* = 8.4 Hz, 1H), 6.57 (s, 2H), 6.11 (s, 2H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 151.9, 148.6, 147.9, 145.8, 141.7, 137.2, 131.3, 129.9, 128.8, 125.4, 124.4, 123.1, 109.3, 109.0, 101.7. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{12}N_3O_2$ 266.0930; Found 266.0919

3-(benzo[d][1,3]dioxol-5-yl)-6,7-dichloroquinoxalin-2-amine (3u)



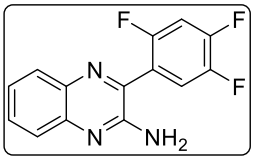
Reaction Time: 6 h; Yield: 42% (1.40 g); Nature of compound: Pale brown solid; Melting Point: 208-210 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3454, 2852, 2352, 1653, 1175, 783. ^{1}H NMR (700 MHz, DMSO) δ 8.00 (s, 1H), 7.73 (s, 1H), 7.27 (s, 2H), 7.06 (d, *J* = 7.3 Hz, 1H), 6.95 (s, 2H), 6.12 (s, 2H). ^{13}C{^{1}H} NMR (175 MHz, DMSO) δ 152.7, 149.0, 147.9, 147.5, 141.2, 136.1, 132.1, 130.5, 129.5, 126.1, 125.9, 123.3, 109.3, 109.1, 101.9. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{10}N_3Cl_2O_2$ 334.0150; Found 334.0140

3-(4-(Trifluoromethyl)phenyl)quinoxalin-2-amine (3v)



Reaction Time: 6 h; Yield: 46% (1.32 g); Nature of compound: Pale white solid; Melting Point: 201 – 203 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3440, 2096, 1644, 1524, 1229, 1064, 770. ^{1}H NMR (400 MHz, DMSO) δ 7.99 (d, *J* = 8.1 Hz, 2H), 7.90 (d, *J* = 8.2 Hz, 2H), 7.83 (d, *J* = 8.2 Hz, 1H), 7.60 (d, *J* = 3.7 Hz, 2H), 7.39 (dt, *J* = 8.3, 4.2 Hz, 1H), 6.74 (s, 2H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 151.9, 144.8, 142.1, 141.6, 137.1, 130.5, 129.98 (q, *J* = 30 Hz), 129.1, 129.0, 126.1 (q, *J* = 3.4 Hz), 126.3 (q, *J* = 270 Hz) 125.6, 124.6. ^{19}F NMR (377 MHz, DMSO) δ -61.2. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{11}F_3N_3$ 290.0905; Found 290.0919

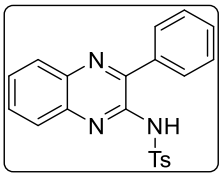
3-(2,4,5-Trifluorophenyl)quinoxalin-2-amine (3w)



Reaction Time: 6 h; Yield: 39% (1.07 g); Nature of compound: Pale white solid; Melting Point: 216 – 218 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3425, 2102, 1643, 1534, 1223, 1069, 771. ^{1}H NMR (400 MHz, DMSO) δ 7.82 - 7.69 (m, 3H), 7.63 - 7.59 (m, 2H), 7.40 - 7.38 (m, 1H), 6.73 (s, 2H). ^{13}C{^{1}H} NMR (175 MHz, DMSO) δ 155.4 (dd, *J* = 245, 10.3 Hz), 151.9, 149.9 (dt, *J* = 248, 13.3 Hz), 146.4 (ddd, *J* = 240, 11.5, 1.9 Hz), 141.9, 139.9, 136.1, 130.3, 128.6, 125.2, 124.0, 121.5 (dd, *J* = 18.2, 4.2 Hz), 119.3 (dd, *J* = 20.0, 4.2 Hz), 106.9 (dd, *J* = 28.5, 21.5 Hz). ^{19}F NMR (377 MHz, $CDCl_3$) δ -111.5 (dd, *J* = 15.5, 5.6 Hz), -

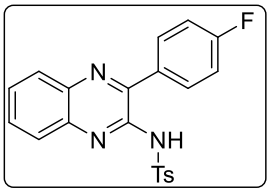
128.5 (dd, *J* = 23.4, 5.3 Hz), -138.1 (dd, *J* = 22.6, 15.1 Hz). HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{14}H_9F_3N_3$ 276.0749; Found 276.0725

4-Methyl-*N*-(3-phenylquinoxalin-2-yl)benzenesulfonamide (4a)



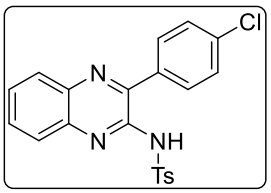
Reaction Time: 12 h; Yield: 76% (0.571 g); Nature of compound: White solid; Melting Point: 263 – 265 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3442, 2914, 2069, 1626, 1373, 1274, 808. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{18}N_3O_2S$ 376.1120; Found 376.1122

***N*-(3-(4-Fluorophenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4b)**



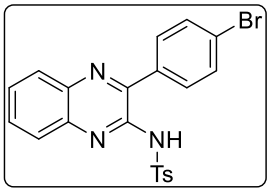
Reaction Time: 12 h; Yield: 70% (0.551 g); Nature of compound: White solid; Melting Point: 194 – 196 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3439, 2919, 2360, 1648, 1218, 778. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{17}FN_3O_2S$ 394.1025; Found 394.1027

***N*-(3-(4-Chlorophenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4c)**



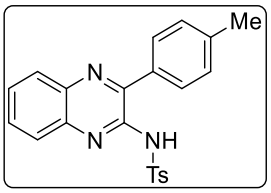
Reaction Time: 12 h; Yield: 64% (0.524 g); Nature of compound: White solid; Melting Point: 210 – 212 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3439, 2049, 1632, 1214, 774. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{17}ClN_3O_2S$ 410.0725; Found 410.0708

***N*-(3-(4-Bromophenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4d)**



Reaction Time: 12 h; Yield: 59% (0.535 g); Nature of compound: White solid; Melting Point: 290 – 290 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3448, 2923, 2084, 1635, 1224, 771. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{17}BrN_3O_2S$ 454.0219 and 456.0199; Found 454.0218 and 456.0194.

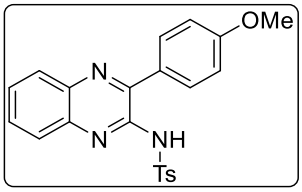
4-Methyl-*N*-(3-(*p*-tolyl)quinoxalin-2-yl)benzenesulfonamide (4e)



Reaction Time: 12 h; Yield: 68% (0.531 g); Nature of compound: White solid; Melting Point: 295 – 297 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3442, 3005, 2407,

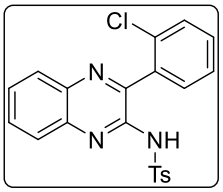
1644, 1271, 771. HRMS (ESI) *m/z*: $[M+Na]^+$ Calcd for $C_{22}H_{19}N_3O_2SNa$ 412.1096; Found 412.1093

_N_-(3-(4-Methoxyphenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4f)



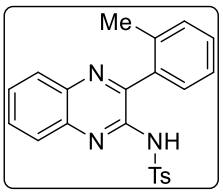
Reaction Time: 12 h; Yield: 67% (0.543 g); Nature of compound: White solid; Melting Point: 184 – 186 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3445, 2993, 2398, 1641, 1221, 771. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{20}N_3O_3S$ 406.1220; Found 406.1231

_N_-(3-(2-Chlorophenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4g)



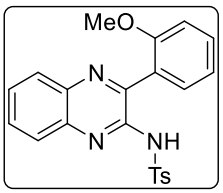
Reaction Time: 12 h; Yield: 59% (0.483 g); Nature of compound: White solid; Melting Point: 215 – 217 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3436, 3002, 2322, 2084, 1638, 1382, 771. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{17}ClN_3O_2S$ 410.0730; Found 410.0721

4-Methyl-*N*-(3-(*o*-tolyl)quinoxalin-2-yl)benzenesulfonamide (4h)



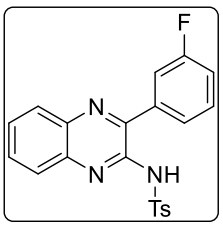
Reaction Time: 12 h; Yield: 68% (0.529 g); Nature of compound: White solid; Melting Point: 214 – 216 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3435, 3002, 2081, 1644, 1217, 774. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{20}N_3O_2S$ 390.1276; Found 390.1306

***N*-(3-(2-Methoxyphenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4i)**



Reaction Time: 12 h; Yield: 64% (0.519 g); Nature of compound: White solid; Melting Point: 170 – 172 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3429, 3017, 2354, 1644, 1223, 778. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{20}N_3O_3S$ 406.1220; Found 406.1209

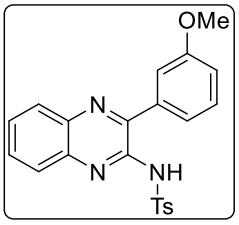
***N*-(3-(3-Fluorophenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4j)**



Reaction Time: 12 h; Yield: 70% (0.582 g); Nature of compound: White solid; Melting Point: 189 – 191 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) =3439, 2071, 1638,

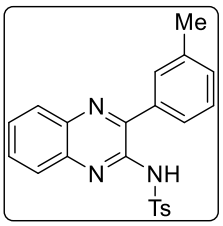
1221, 774. HRMS (ESI) *m/z*: $[M+Na]^+$ Calcd for $C_{21}H_{16}FNaN_3O_2S$ 416.0839; Found 416.0828

_N_-(3-(3-Methoxyphenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4k)



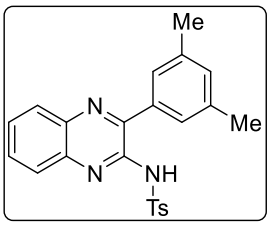
Reaction Time: 12 h; Yield: 76% (0.650 g); Nature of compound: White solid; Melting Point: 167 – 169 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3442, 2852, 2359, 1634, 1136, 782. HRMS (ESI) *m/z*: $[M+Na]^+$ Calcd for $C_{22}H_{19}NaN_3O_3S$ 428.1039; Found 428.1011

4-Methyl-_N_-(3-(_m_-tolyl)quinoxalin-2-yl)benzenesulfonamide (4l)



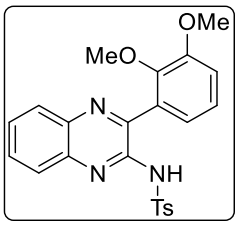
Reaction Time: 12 h; Yield: 59% (0.459 g); Nature of compound: White solid; Melting Point: 182 – 184 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3432, 2959, 2366, 2081, 1631, 1217, 784. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{20}N_3O_2S$ 390.1276; Found 390.1266

***N*-(3-(3,5-Dimethylphenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4m)**



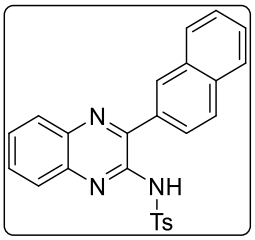
Reaction Time: 12 h; Yield: 60% (0.485 g); Nature of compound: White solid; Melting Point: 138 – 140 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3448, 2923, 1612, 1227, 775. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{23}H_{22}N_3O_2S$ 404.1433; Found 404.1436

***N*-(3-(2,3-Dimethoxyphenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4n)**



Reaction Time: 12 h; Yield: 54% (0.235 g); Nature of compound: White solid; Melting Point: 186 – 188 ºC; R_f: 0.19 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3445, 2922, 1609, 1229, 782. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{23}H_{22}N_3O_4S$ 436.1331; Found 436.1347

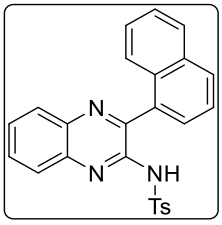
4-Methyl-*N*-(3-(naphthalen-2-yl)quinoxalin-2-yl)benzenesulfonamide (4o)



Reaction Time: 12 h; Yield: 69% (0.588 g); Nature of compound: White solid; Melting Point: 120 – 122 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3512, 2265, 1694,

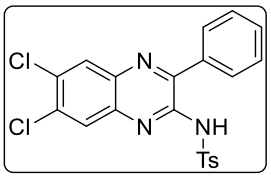
1298, 1201, 770. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{25}H_{20}N_3O_2S$ 426.1276; Found 426.1272

4-Methyl-*N*-(3-(naphthalen-1-yl)quinoxali*N*-2-yl)benzenesulfonamide (4p)



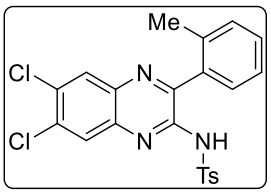
Reaction Time: 12 h; Yield: 63% (0.537 g); Nature of compound: White solid; Melting Point: 166 – 168 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3449, 2927, 2359, 1996, 1611, 1076, 776. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{25}H_{20}N_3O_2S$ 426.1276; Found 426.1266

***N*-(6,7-Dichloro-3-phenylquinoxalin-2-yl)-4-methylbenzenesulfonamide (4q)**



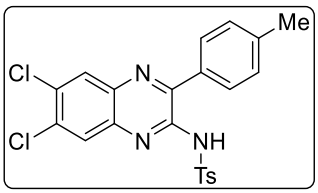
Reaction Time: 12 h; Yield: 50% (0.444 g); Nature of compound: White solid; Melting Point: 212 – 214 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3449, 2916, 2089, 1628, 1374, 1279, 801. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{16}Cl_2N_3O_2S$ 444.0340; Found 444.0320

***N*-(6,7-Dichloro-3-(*o*-tolyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4r)**



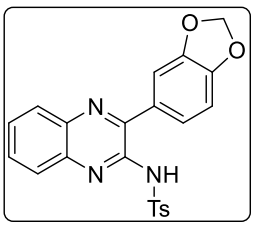
Reaction Time: 12 h; Yield: 52% (0.197 g); Nature of compound: White solid; Melting Point: 273 – 275 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3478, 2323, 1684, 1320, 1159, 786. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{18}Cl_2N_3O_2S$ 458.0497; Found 458.0474

***N*-(6,7-Dichloro-3-(*p*-tolyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4s)**



Reaction Time: 12 h; Yield: 64% (0.586 g); Nature of compound: White solid; Melting Point: 289 – 291 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3440, 2349, 1656, 1396, 1136, 785. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{18}Cl_2N_3O_2S$ 458.0497; Found 458.0490

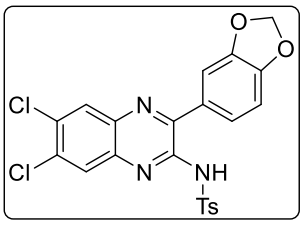
***N*-(3-(Benzo[*d*][1,3]dioxol-5-yl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4t)**



Reaction Time: 12 h; Yield: 68% (0.572 g); Nature of compound: White solid; Melting Point: 197 – 199 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3429, 2932, 2091,

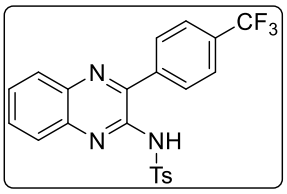
1635, 1227, 781. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{18}N_3O_4S$ 420.1018; Found 420.0994

_N_-(3-(benzo[_d_][1,3]dioxol-5-yl)-6,7-dichloroquinoxalin-2-yl)-4-methylbenzenesulfonamide (4u)



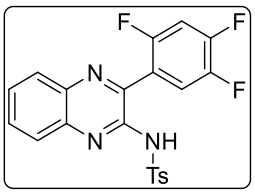
Reaction Time: 12 h; Yield: 38% (0.370 g); Nature of compound: White solid; Melting Point: 244-246 ºC; R_f: 0.23 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3415, 2320, 1689, 1392, 1165, 776. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{15}Cl_2N_3O_4S$ 488.0239; Found 488.0222

4-Methyl-_N_-(3-(4-(trifluoromethyl)phenyl)quinoxalin-2-yl)benzenesulfonamide (4v)



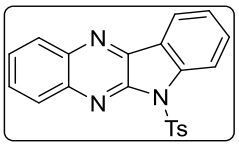
Reaction Time: 12 h; Yield: 51% (0.226 g); Nature of compound: yellow solid; Melting Point: 277 - 279 ºC; R_f: 0.20 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3442, 2361, 1646, 1378, 1140, 778. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{17}F_3N_3O_2S$ 444.0994; Found 444.1009

4-Methyl-*N*-(3-(2,4,5-trifluorophenyl)quinoxalin-2-yl)benzenesulfonamide (4w)



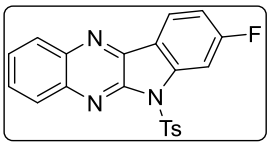
Reaction Time: 12 h; Yield: 43% (0.180 g); Nature of compound: pale yellow solid; Melting Point: 259 – 261 ºC; R_f: 0.26 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3430, 2352, 1657, 1396, 1129, 763. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{15}F_3N_3O_2S$ 430.0837; Found 430.0859

6-Tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5a)[3]



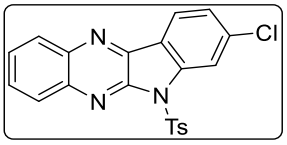
Reaction time: 1 h; Yield: 90% (0.169 g, 0.5 mmol), 84% (0.626 g, 2 mmol); Nature of compound: White solid; Melting Point: 146 – 147 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3422, 2999, 2356, 1868, 1229, 776. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53 (d, *J* = 8.5 Hz, 1H), 8.37 (d, *J* = 7.5 Hz, 1H), 8.27 (d, *J* = 8.1 Hz, 1H), 8.22 (d, *J* = 8.1 Hz, 1H), 8.12 (d, *J* = 8.3 Hz, 2H), 7.77 (tt, *J* = 8.4, 7.1 Hz, 3H), 7.51 (t, *J* = 7.2 Hz, 1H), 7.20 (d, *J* = 8.2 Hz, 2H), 2.30 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 145.6, 144.7, 141.7, 140.6, 140.5, 140.1, 135.3, 132.1, 129.7, 129.5, 129.1, 129.0, 128.5, 127.9, 124.7, 122.4, 121.9, 115.2, 21.6. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{16}N_3O_2S$ 374.0963; Found 374.0944.

8-Fluoro-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5b)



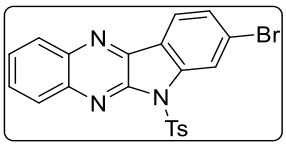
Reaction time: 1 h; Yield: 75% (0.147 g); Nature of compound: White solid; Melting Point: 293 – 295 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3445, 2922, 2362, 1606, 1154, 779. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.34 – 8.28 (m, 3H), 8.21 (d, *J* = 8 Hz, 1H), 8.17 (d, *J* = 8 Hz, 2H), 7.82 – 7.78 (m, 2H), 7.27 – 7.23 (m, 3H), 2.34 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 165.0 (d, *J* =249.3 Hz), 145.9, 144.8, 142.6 (d, *J* = 13.1 Hz), 140.7, 139.7 (d, *J* = 2.8 Hz), 135.1, 129.8, 129.5, 129.1, 129.0, 128.6, 128.1, 123.8 (d, *J* = 107 Hz), 118.2 (d, *J* = 2.1 Hz), 112.7 (d, *J* = 23.9 Hz), 103.4, 103.1, 21.6. ^{19}F NMR (377 MHz, $CDCl_3$) δ -103.7. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{15}FN_3O_2S$ 392.0869; Found 392.0859

8-Chloro-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5c)[3]



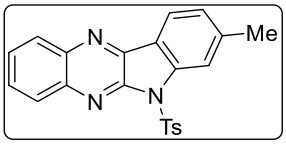
Reaction Time: 1 h; Yield: 67% (0.136 g); Nature of compound: White solid; Melting Point: 210 – 212 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3440, 2919, 2401, 1633, 1177, 775. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.60 (s, 1H), 8.31 – 8.29 (m, 2H), 8.26 – 8.17 (m, 3H), 7.84 – 7.79 (m, 2H), 7.51 (d, *J* = 7.6 Hz, 1H), 7.27 (d, *J* = 8.4 Hz, 2H), 2.35 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 145.9, 144.7, 142.0, 140.8, 140.0, 139.5, 138.1, 135.1, 129.8 (2C), 129.1 (2C), 128.7, 128.1, 125.3, 123.1, 120.5, 115.5, 21.6. HRMS (ESI) *m/z*: $[M+Na]^+$ Calcd for $C_{21}H_{14}ClNaN_3O_2S$ 430.0387; Found 430.0385

8-Bromo-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5d)



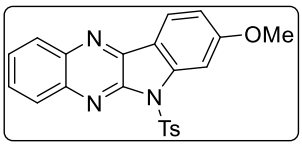
Reaction Time: 1 h; Yield: 70% (0.157 g); Nature of compound: White solid; Melting Point: 252 – 254 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3425, 2362, 2335, 1173, 1703, 774. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.76 (s, 1H), 8.28 (d, *J* = 8 Hz, 1H), 8.22 (d, *J* = 8 Hz, 2H), 8.18 (d, *J* = 8 Hz, 2H), 7.85 – 7.77 (m, 2H), 7.66 (d, *J* = 8 Hz, 1H), 7.29 – 7.26 (m, 2H), 2.34 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 145.9, 144.5, 142.0, 140.8, 140.1, 139.6, 135.0, 129.78, 129.76, 129.15, 129.13, 128.7, 128.1, 128.0, 126.2, 123.3, 120.9, 118.4, 21.7. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{15}BrN_3O_2S$ 452.0063 and 454.0043; Found 452.0077 and 454.0058

8-Methyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5e)[3]



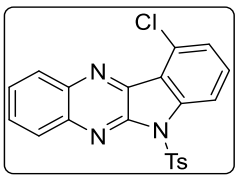
Reaction Time: 40 min; Yield: 89% (0.172 g); Nature of compound: White solid; Melting Point: 229 – 231 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3429, 2919, 2071, 1631, 1226, 778. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (s, 1H), 8.25 – 8.17 (m, 3H), 8.13 (d, *J* = 8 Hz, 2H), 7.79 – 7.72 (m, 2H), 7.32 (d, *J* = 8 Hz, 1H), 7.21 (d, *J* = 7.6 Hz, 2H), 2.63 (s, 3H), 2.30 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 145.5, 144.9, 143.3, 142.1, 140.6(2C), 139.8, 135.4, 129.6, 129.16, 129.10, 128.9, 128.3, 127.9, 125.9, 122.1, 119.6, 115.4, 22.9, 21.6. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{18}N_3O_2S$ 388.1114; Found 388.1139

8-Methoxy-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5f)[3]



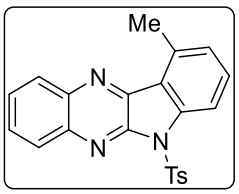
Reaction Time: 40 min; Yield: 94% (0.189 g); Nature of compound: White solid; Melting Point: 219 – 221 ºC. 185−186 ºC; R_f: 0.25 in 10% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3467, 2983, 2378, 1894, 1159, 773. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.22 – 8.20 (m, 2H), 8.15 – 8.10 (m, 3H), 8.06 (s, 1H), 7.74 – 7.71 (m, 2H), 7.20 (d, *J* = 8 Hz, 2H), 7.05 (d, *J* = 8.4 Hz, 1H), 4.02 (s, 3H), 2.30 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 163.3, 145.6, 144.9, 143.6, 140.6, 140.5, 139.2, 135.2, 129.7, 129.1, 128.8, 128.7, 128.3, 127.9, 123.4, 114.9, 112.6, 99.9, 56.0, 21.6. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{18}N_3O_3S$ 404.1063; Found 404.1091

10-Chloro-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5g)



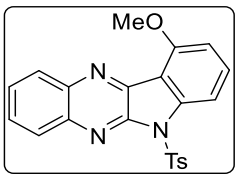
Reaction Time: 1.5 h; Yield: 69% (0.141 g); Nature of compound: White solid; Melting Point: 231 – 233 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3457, 2961, 2359, 1869, 1214, 783. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 (d, *J* = 8.4 Hz, 1H), 8.30 (d, *J* = 8.4 Hz, 1H), 8.26 (d, *J* = 8 Hz, 1H), 8.11 (d, *J* = 8.4 Hz, 2H), 7.83 – 7.77 (m, 2H), 7.64 (t, *J* = 8.4 Hz, 1H), 7.48 (d, *J* = 8 Hz, 1H), 7.21 (d, *J* = 8 Hz, 2H), 2.31 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 145.8, 144.2, 142.5, 140.8, 139.6, 139.4, 135.0, 131.8, 130.7, 130.1, 129.9, 129.7, 128.9, 128.4, 128.0, 125.9, 119.3, 113.3, 21.6. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{15}ClN_3O_2S$ 408.0568; Found 408.0568

10-Methyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5h)



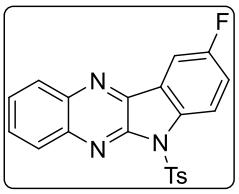
Reaction Time: 40 min; Yield: 89% (0.171 g); Nature of compound: White solid; Melting Point: 203 – 205 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3426, 2992, 2366, 1862, 1223, 780. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.40 (d, *J* = 8.4 Hz, 1H), 8.27 (d, 8 Hz, 1H), 8.23 (d, 8.4 Hz, 1H), 8.14 (d, *J* = 8 Hz, 2H), 7.81 – 7.73 (m, 2H), 7.61 (t, *J* = 8 Hz, 1H), 7.28 (d, *J* = 7.2 Hz, 1H), 7.21 (d, *J* = 8.0 Hz, 2H), 3.07 (s, 3H), 2.31 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 145.4, 144.5, 141.9, 141.8, 140.8, 139.2, 137.5, 135.4, 131.2, 129.6, 129.5, 129.2, 128.9, 128.0, 127.9, 126.2, 120.1, 112.2, 21.6, 19.6. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{18}N_3O_2S$ 388.1114; Found 388.1121

10-Methoxy-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5i)



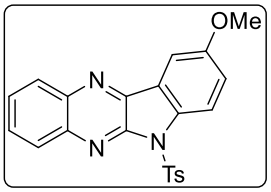
Reaction Time: 40 min; Yield: 77% (0.156 g); Nature of compound: White solid; Melting Point: 209 – 211 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3465, 2989, 2363, 1896, 1268, 786. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.29 – 8.23 (m, 4H), 7.97 (d, *J* = 7.2 Hz, 1H), 7.80 – 7.96 (m, 2H), 7.45 – 7.36 (m, 3H), 7.19 (d, *J* = 7.6 Hz, 1H), 3.93 (s, 3H), 2.44 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 149.1, 147.4, 144.5, 141.7, 140.8, 140.3, 137.7, 131.7, 129.5, 129.4, 129.3, 129.1, 128.6, 127.8, 126.2, 125.6, 115.5, 114.5, 56.1, 21.7. HRMS (ESI) *m/z*: $[M+Na]^+$ Calcd for $C_{22}H_{17}NaN_3O_3S$ 426.0883; Found 426.0859

9-Fluoro-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5j):



Reaction time: 1 h; Yield: 87% (0.162 g); Nature of compound: White solid; Melting Point: 241 – 243 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3439, 3012, 2069, 1641, 1221, 774. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53-8.49 (m, 1H), 8.27 (d, *J* = 8.4 Hz, 1H), 8.21 (d, *J* = 8.0 Hz, 1H), 8.09 (d, *J* = 7.6 Hz, 2H), 8.02 (d, *J* = 6.0 Hz, 1H), 7.84-7.75 (m, 2H), 7.45 (t, *J* = 8.0 Hz, 1H), 7.21 (d, *J* = 7.6 Hz, 2H), 2.30 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 159.9 (d, *J* = 243.4 Hz), 145.7, 145.1, 140.7, 140.3, 139.8 (d, *J* = 3.7 Hz) , 137.7 (d, *J* = 1.4 Hz), 135.1, 129.9, 129.7, 129.3, 129.2, 128.6, 127.9, 123.4 (d, *J* = 9.2 Hz), 119.4 (d, *J* = 24.4 Hz), 116.6 (d, *J* = 8.2 Hz), 108.5 (d, *J* = 24.4 Hz), 21.6. ^{19}F NMR (377 MHz, $CDCl_3$) δ -115.05. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{15}FN_3O_2S$ 392.0864; Found 392.0867

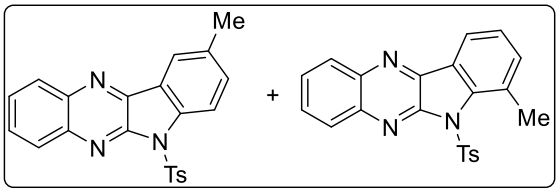
9-Methoxy-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5k)



Reaction Time: 1 h; Yield: 79% (0.159 g); Nature of compound: White solid; Melting Point: 174 – 176 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3426, 2926, 2401, 1873, 1189, 776. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.42 (d, *J* = 8.8 Hz, 1H), 8.27 (d, *J* = 7.2 Hz, 1H), 8.20 (d, *J* = 7.2 Hz, 1H), 8.06 (d, *J* = 7.2 Hz, 2H), 7.79 – 7.75 (m, 3H), 7.31 (d, *J* = 8 Hz, 1H), 7.17 (d, *J* = 6.8 Hz, 2H), 3.95 (s, 3H), 2.28 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 157.2, 145.4, 145.2, 140.6 (2C), 140.1, 135.9, 135.2, 129.6, 129.5, 129.2, 129.0, 128.4, 127.8,

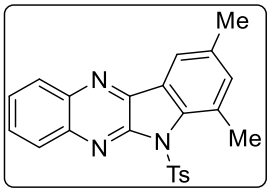
122.9, 120.8, 116.5, 104.3, 55.9, 21.6. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{18}N_3O_3S$ 404.1063; Found 404.1078

7-Methyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline/9-methyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (1:1) (5l)



Reaction Time: 1 h; Yield: 82% (1:1) (0.160 g); Nature of compound: White solid; Melting Point: 181 – 183 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3429, 2941, 2074, 1625, 1214, 771. ^1H NMR (400 MHz, $CDCl_3$) (1:1 regioisomers) δ 8.39 (d, *J* = 8.4 Hz, 1H), 8.26 (d, *J* = 8 Hz, 1H), 8.21 – 8.18 (m, 2H), 8.15 -8.07 (m, 5H), 7.80 – 7.71 (m, 6H), 7.53 (d, *J* = 8 Hz, 2H), 7.44 (t, *J* = 7.2 Hz, 1H), 7.18 (d, *J* = 8.4 Hz, 2H), 7.06 (d, *J* = 8 Hz, 2H), 2.81 (s, 3H), 2.53 (s, 3H), 2.28 (s, 3H), 2.25 (s, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$) (1:1 regioisomers) δ 148.4, 145.4, 144.9, 143.2, 142.5, 141.0, 140.6, 140.6, 140.0, 139.9, 139.8, 135.3 (2C), 135.3, 134.8, 134.6, 133.2 (2C), 130.5, 129.6, 129.5, 129.4, 129.3, 129.1, 129.0, 128.9, 128.8, 128.3, 127.9, 127.8, 126.2, 126.1, 122.3, 122.1, 119.7, 114.9, 22.0, 21.6, 21.5, 21.1. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{18}N_3O_2S$ 388.1114; Found 388.1104

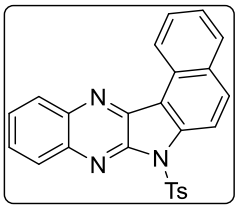
7,9-Dimethyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5m)



Reaction Time: 1 h; Yield: 74% (0.148 g); Nature of compound: White solid; Melting Point: 244 – 246 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3442, 2999, 1648,

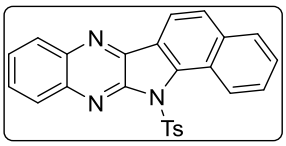
1230, 774. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 (d, *J* = 7.6 Hz, 1H), 8.10 (d, *J* = 8.0 Hz, 1H), 7.88 (s, 1H), 7.73 (t, *J* = 7.3 Hz, 2H), 7.76 – 7.69 (m, 2H), 7.33 (s, 1H), 7.02 (d, *J* = 8.0 Hz, 2H), 2.76 (s, 3H), 2.48 (s, 3H), 2.22 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 148.9, 144.9, 143.4, 141.1, 140.7, 140.0, 136.5, 136.3, 134.7, 130.3, 129.5, 129.3, 129.2, 129.0, 128.9, 127.9, 126.4, 119.9, 21.9, 21.6, 21.1. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{23}H_{20}N_3O_2S$ 402.1271; Found 402.1292

7-Tosyl-7*H*-benzo[4,5]indolo[2,3-*b*]quinoxaline (5o)[3]



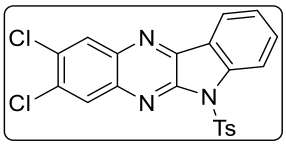
Reaction Time: 40 min; Yield: 89% (0.188 g); Nature of compound: brown solid; Melting Point: 241 – 243 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3435, 3005, 2081, 1638, 1214, 774. ^{1}H NMR (700 MHz, $CDCl_3$) δ 8.93 (d, *J* = 8.4 Hz, 1H), 8.28 (d, *J* = 8.4 Hz, 1H), 8.20 (d, *J* = 8.4 Hz, 1H), 8.15 (d, *J* = 8.4 Hz, 1H), 7.99 (d, *J* = 7.7 Hz, 1H), 7.97(d, *J* = 8.4 Hz, 1H), 7.79 – 7.76 (m, 2H), 7.71 (d, *J* = 7.7 Hz, 1H), 7.66 (t, *J* = 7.7 Hz, 1H), 7.42 (d, *J* = 8.4 Hz, 2H), 6.91 (d, *J* = 8.4 Hz, 2H), 2.16 (s, 3H). ^{13}C{^{1}H} NMR (175 MHz, $CDCl_3$) δ 148.6, 145.2, 143.1, 141.4, 141.3, 139.7, 136.3, 133.2, 129.5, 129.3, 129.2, 129.1, 128.9, 128.6, 128.3, 128.0, 127.8, 127.7, 126.5, 125.6, 123.4, 117.9, 21.5. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{25}H_{18}N_3O_2S$ 424.1120; Found 424.1113

13-Tosyl-13*H*-benzo[6,7]indolo[2,3-b]quinoxaline (5p)[3]



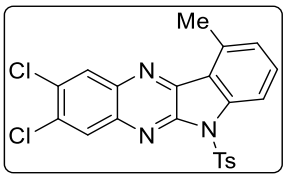
Reaction Time: 40 min; Yield; 83% (0.175 g); Nature of compound: brown solid; Melting Point: 209 – 211 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3433, 3012, 2075, 1638, 1219, 780. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.62 (d, *J* = 8.1 Hz, 1H), 8.73 (d, *J* = 9.1 Hz, 1H), 8.32 (dd, *J* = 8.8, 6.4 Hz, 2H), 8.17 (d, *J* = 9.2 Hz, 1H), 8.12 (d, *J* = 8.3 Hz, 2H), 8.01 (d, *J* = 8.1 Hz, 1H), 7.85 – 7.73 (m, 3H), 7.60 (t, *J* = 7.2 Hz, 1H), 7.18 (d, *J* = 8.2 Hz, 2H), 2.27 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 145.6, 144.2, 141.4, 141.1, 139.1, 135.3, 133.0, 130.5, 129.7, 129.4, 129.2, 129.1, 128.9 (2C), 128.8, 128.6, 128.4, 127.9, 125.9, 125.2, 115.4, 114.4, 21.6. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{25}H_{18}N_3O_2S$ 424.1120; Found 424.1130

2,3-Dichloro-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5q)[3]



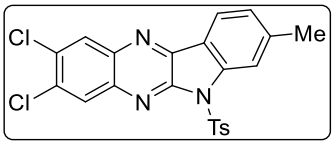
Reaction Time: 1.5 h; Yield: 73% (0.161 g); Nature of compound: White solid; Melting Point: 260 – 262 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3543, 2351, 1691, 1221, 775. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.55 (d, *J* = 8.5 Hz, 1H), 8.41 (s, 1H), 8.36 (d, *J* = 8.4 Hz, 2H), 8.13 (d, *J* = 8.1 Hz, 2H), 7.80 (t, *J* = 7.7 Hz, 1H), 7.55 (t, *J* = 7.3 Hz, 1H), 7.28 (s, 2H), 2.35 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) 145.9, 144.9, 142.1, 141.4, 139.3, 138.7, 135.1, 133.9, 132.8(2C), 129.8, 129.6, 129.5, 127.9, 124.9, 122.8, 121.4, 115.2, 21.7. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{14}Cl_2N_3O_2S$ 442.0184; Found 442.0180

2,3-Dichloro-10-methyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5r)



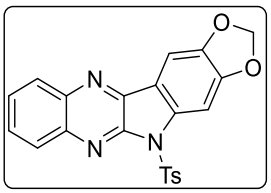
Reaction Time: 1.5 h; Yield: 72% (0.165 g); Nature of compound: White solid; Melting Point: 229 – 231 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3501, 2963, 2375, 1861, 1198, 778. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (t, *J* = 9.7 Hz, 3H), 8.09 (d, *J* = 8.3 Hz, 2H), 7.62 (t, *J* = 8.0 Hz, 1H), 7.24 – 7.19 (m, 3H), 2.99 (s, 3H), 2.32 (s, 3H). ^{13}C{^{1}H} NMR (175 MHz, $CDCl_3$) δ 145.7, 144.8, 142.8, 142.1, 139.3, 137.9, 137.8, 135.2, 133.6, 132.3, 131.9, 129.9, 129.7, 129.4, 127.9, 126.4, 119.4, 112.3, 21.6, 19.6. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{16}Cl_2N_3O_2S$ 456.0340; Found 456.0323

2,3-Dichloro-8-methyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5s)



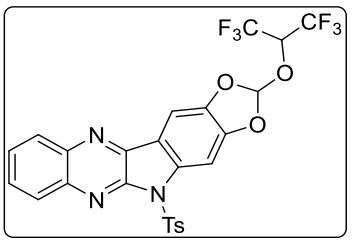
Reaction Time: 1.5 h; Yield: 67% (0.152 g); Nature of compound: White solid; Melting Point: 240 – 242 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3439, 2967, 2297, 1810, 1268, 773. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (s, 2H), 8.28 (s, 1H), 8.19 (d, *J* = 7.6 Hz, 1H), 8.13 (d, *J* = 7.6 Hz, 2H), 7.34 (d, *J* = 8 Hz, 1H), 7.27 (d, *J* = 8.8 Hz, 2H), 2.66 (s, 3H), 2.43 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 145.8, 144.2, 142.5, 141.7, 141.5, 139.2, 138.4, 135.2, 133.5, 132.5, 129.8, 129.5, 129.4, 127.9, 126.2, 122.4, 118.9, 115.4, 22.9, 21.7. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{16}Cl_2N_3O_2S$ 456.0340; Found 456.0336

5-Tosyl-5*H*-[1,3]dioxolo[4',5':5,6]indolo[2,3-*b*]quinoxaline (5t)[3]



Reaction Time: 40 min; Yield: 79% (0.164 g); Nature of compound: white solid; Melting Point: 243 – 244 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3439, 2963, 2389, 1898, 1253, 772. ^{1}H NMR (400 MHz, CDCl3) δ 8.24 (d, *J* = 7.7 Hz, 1H), 8.15 (d, *J* = 7.4 Hz, 1H), 8.06 (d, *J* = 8.0 Hz, 3H), 7.75 (s, 2H), 7.68 (s, 1H), 7.19 (d, *J* = 7.8 Hz, 2H), 6.16 (s, 2H), 2.30 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 151.9, 146.0, 145.7, 144.9, 140.8, 140.6, 139.4, 138.2, 135.2, 129.8, 129.3, 128.9, 128.8, 128.6, 127.9, 115.8, 102.5, 101.0, 97.5, 21.8. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{16}N_3O_4S$ 418.0862; Found 418.0874

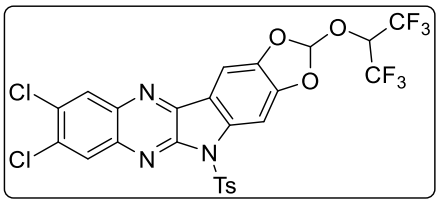
2-((1,1,1,3,3,3-Hexafluoropropan-2-yl)oxy)-5-tosyl-5*H*-[1,3]dioxolo[4',5':5,6]indolo[2,3-*b*]quinoxaline (6t)



Reaction Time: 40 min; Yield: 78% (0.227 g); Nature of compound: yellow solid; Melting Point: 228 – 230 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3448, 2369, 2078, 1638, 1223, 780. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.25 (d, *J* = 8.6 Hz, 2H), 8.17 (d, *J* = 7.9 Hz, 1H), 8.10 (d, *J* = 8.0 Hz, 2H), 7.88 (s, 1H), 7.83 – 7.71 (m, 2H), 7.22 (d, *J* = 8.0 Hz, 2H), 7.14 (s, 1H), 4.68 (dt, *J* = 11.2, 5.5 Hz, 1H), 2.31 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 148.2, 145.8, 144.6, 142.6, 140.7, 139.8, 139.5, 138.2, 134.9, 129.7, 129.4, 129.1, 128.9, 128.6, 127.9, 122.1 (q, *J* = 289), 122.0, 118.4, 116.9, 102.2, 98.1, 69.8 (q, *J* = 33.9 Hz), 21.6. ^{19}F

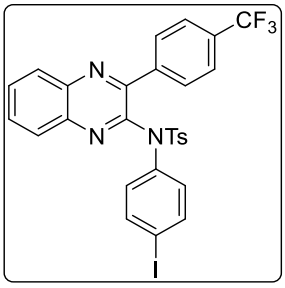
NMR (377 MHz, $CDCl_3$) δ -73.37. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{25}H_{16}F_6N_3O_5S$ 584.0715; Found 584.0709

8,9-dichloro-2-((1,1,1,3,3,3-hexafluoropropan-2-yl)oxy)-5-tosyl-5H-[1,3]dioxolo[4',5':5,6]indolo[2,3-b]quinoxaline (6u)



Reaction Time: 40 min; Yield: 48% (0.312 g); Nature of compound: Yellow solid; Melting Point: 248-250 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3521, 2823, 2331, 1821, 1297, 783. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (s, 1H), 8.27 (s, 1H), 8.24 (s, 1H), 8.09 (d, *J* = 8.3 Hz, 2H), 7.86 (s, 1H), 7.27 – 7.25 (m, 2H), 7.15 (s, 1H), 4.69 – 4.64 (m, 1H), 2.34 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.7, 146.1, 144.8, 142.8, 140.7, 139.3, 138.7, 138.1, 134.8, 133.7, 132.9, 129.9, 129.5, 129.4, 127.9, 118.5, 116.3, 102.5, 98.1, 21.7. ^{19}F NMR (377 MHz, $CDCl_3$) δ -73.37. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{25}H_{13}Cl_2F_6N_3O_5S$ 651.9935; Found 651.9916

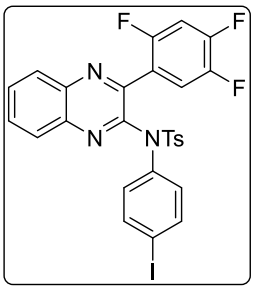
***N*-(4-Iodophenyl)-4-methyl-*N*-(3-(4-(trifluoromethyl)phenyl)quinoxalin-2-yl)benzenesulfonamide (7v)**



Reaction Time: 1 h; Yield: 49% (0.158 g); Nature of compound: White solid; Melting Point: 173 – 175 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3427, 2934, 2366,

1862, 1231, 782. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.23 – 8.07 (m, 1H), 8.05 – 7.95 (m, 1H), 7.83 - 7.81 (m, 4H), 7.74 - 7.71 (m, 4H), 7.37 (d, *J* = 8.5 Hz, 2H), 7.30 (d, *J* = 8.1 Hz, 2H), 6.57 (d, *J* = 8.5 Hz, 2H), 2.47 (s, 3H). ^{13}C{^{1}H} NMR (175 MHz, $CDCl_3$) δ 151.9, 147.6, 144.3, 141.2, 140.3, 140.1, 138.2, 137.9, 135.8, 131.3 (q, *J* = 34 Hz), 130.9, 130.8, 130.3, 129.7, 129.4, 129.3, 129.0, 128.6, 125.5 (q, *J* = 270 Hz), 125.4 (q, *J* = 3.1 Hz), 93.8, 21.7. ^{19}F NMR (377 MHz, $CDCl_3$) δ -62.8. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{28}H_{20}F_3IN_3O_2S$ 646.0273; Found 646.0289

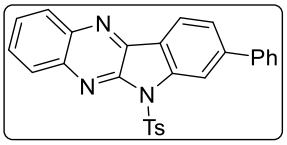
_N_-(4-Iodophenyl)-4-methyl-_N_-(3-(2,4,5-trifluorophenyl)quinoxalin-2-yl)benzenesulfonamide (7w)



Reaction Time: 1 h; Yield: 42% (0.132 g); Nature of compound: White solid; Melting Point: 219 – 221 ºC; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3427, 2934, 2366, 1862, 1231, 782. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.11 (d, *J* = 7.6 Hz, 1H), 8.05 – 7.99 (m, 1H), 7.89 – 7.79 (m, 2H), 7.70 (d, *J* = 8.2 Hz, 2H), 7.45 (d, *J* = 8.5 Hz, 2H), 7.29 (d, *J* = 8.1 Hz, 2H), 7.25 – 7.18 (m, 1H), 6.98 (dd, *J* = 15.8, 9.1 Hz, 1H), 6.16 (d, *J* = 8.5 Hz, 2H), 2.45 (s, 3H). ^{13}C NMR (175 MHz, $CDCl_3$) δ 155.3 (dd, *J* = 251.1, 9.7 Hz), 150.9 (dd, *J* = 253.9, 11.2 Hz), 148.1, 147.0, 146.9 (dd, *J* = 246.7, 12.2 Hz), 144.3, 140.8, 140.4, 138.4, 138.0, 135.6, 131.3, 130.8, 130.1, 129.4, 129.3, 129.0, 128.6, 121.1 (dd, *J* = 22.5, 4.1 Hz), 119.1 (d, *J* = 21.5 Hz), 105.9 (dd, *J* = 27.1, 21.0 Hz), 93.8, 21.7. ^{19}F NMR (377 MHz, $CDCl_3$) δ 114.9 (dd, *J* = 14.7 Hz, 4.5 Hz), 130.6 (dd, *J* = 21.5 Hz, 5.3 Hz), 141.7 (dd, *J* = 21.0 MHz, 14.7 Hz). HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{27}H_{18}F_3IN_3O_2S$ 632.0117; Found 632.0105

Procedure for synthesis of Suzuki coupling reaction of 5d with phenyl boronic acid[3]:

To a sealed tube containing bis(triphenylphosphine)palladium dichloride (8 mg, 6 mol%), potassium carbonate (0.083 g, 0.6 mmol, 3 equiv), and phenyl boronic acid (0.029 g, 0.24 mmol, 1.2 equiv) in 3:1 dioxane:water as solvent, 8-bromo-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline **5d** (0.090 g, 0.2 mmol) was added and kept at 100 ºC for 24 h. After the completion of the reaction, the reaction mixture was diluted with ethyl acetate, washed with water, brine, and dried over Na_2SO_4. The solvent was evaporated and the crude product was purified by flash chromatography on silica gel.



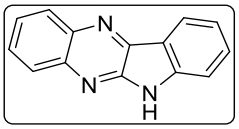
Reaction Time: 24 h; Yield: 78% (0.069 g); Nature of compound: yellow solid; Melting Point: 219 – 220 °C; R_f: 0.2 in 5% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3427, 2934, 2366, 1862, 1231, 782. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.66 – 8.54 (m, 2H), 8.29 (d, *J* = 8.0 Hz, 1H), 8.27 – 8.19 (m, 1H), 8.14 (d, *J* = 8.3 Hz, 2H), 7.98 (dd, *J* = 8.8, 1.7 Hz, 1H), 7.89 – 7.75 (m, 2H), 7.73 (d, *J* = 7.4 Hz, 2H), 7.50 (t, *J* = 7.6 Hz, 2H), 7.41 (d, *J* = 7.4 Hz, 1H), 7.22 (d, *J* = 8.2 Hz, 2H), 2.31 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 145.6, 145.0, 140.9, 140.7, 140.5, 140.1, 139.9, 138.1, 135.2, 131.1, 129.7, 129.6, 129.2, 129.1, 129.0, 128.5, 127.9, 127.7, 127.3, 122.6, 120.5, 115.5, 21.6. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{27}H_{20}N_3O_2S$ 450.1276; Found 450.1260

General procedure for Detosylation of 5

To a mixture of sodium metal (0.023 g, 1 mmol, 2 equiv) in ethanol (2 mL) was added *N*-tosyl indolo[2,3-*b*]quinoxaline **5** (0.5 mmol) and refluxed for 3 hours. After the completion of reaction, the reaction mixture was evaporated. Water was added to the resultant and extracted with EtOAc (3 x 50 mL). The combined organic layers were dried over Na_2SO_4 and evaporated

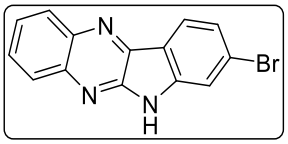
under reduced pressure. The crude product is purified in column chromatography using 70% hexane, 30% ethyl acetate and 0.5% triethylamine as eluent.

6*H*-Indolo[2,3-*b*]quinoxaline (9a)[3]



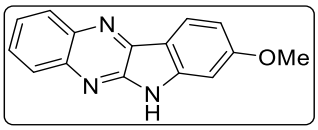
Reaction Time: 3 h; Yield: 84% (0.092 g); Nature of compound: yellow solid; Melting Point: 295-297 ºC; R_f: 0.35 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) =3439, 2951, 2088, 1645, 1227, 775. ^{1}H NMR (400 MHz, DMSO) δ 12.05 (s, 1H), 8.34 (d, *J* = 7.6 Hz, 1H), 8.24 (d, *J* = 8.2 Hz, 1H), 8.06 (d, *J* = 8.3 Hz, 1H), 7.79 (t, *J* = 7.4 Hz, 1H), 7.70 (dd, *J* = 10.7, 7.9 Hz, 2H), 7.58 (d, *J* = 8.0 Hz, 1H), 7.35 (t, *J* = 7.3 Hz, 1H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 145.9, 144.0, 140.2, 139.8, 138.6, 131.3, 129.1, 128.7, 127.5, 125.9, 122.3, 120.7, 118.9, 112.0. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{14}H_{10}N_3$ 220.0875; Found 220.0899

8-Bromo-6*H*-indolo[2,3-*b*]quinoxaline (9b)[4]



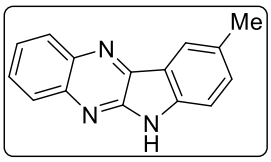
Reaction Time: 3 h; Yield: 72% (0.107 g); Nature of compound: yellow solid; Melting Point: 293 – 295 ºC; R_f: 0.38 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3468, 2970, 2094, 1623, 1239, 776. ^{1}H NMR (400 MHz, DMSO) δ 12.24 (s, 1H), 8.46 (d, *J* = 1.9 Hz, 1H), 8.30 – 8.19 (m, 1H), 8.08 (d, *J* = 8.4 Hz, 1H), 7.84 - 7.81 (m, 2H), 7.77 – 7.69 (m, 1H), 7.55 (d, *J* = 8.6 Hz, 1H). ^{13}C{^{1}H} NMR (100 MHz, DMSO) δ 146.5, 143.2, 140.88, 139.2, 139.0, 134.1, 129.7, 129.6, 128.1, 126.8, 124.9, 121.3, 114.6, 113.0. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{14}H_9BrN_3$ 297.9980 and 299.9980; Found 297.9983 and 299.9991

8-Methoxy-6*H*-indolo[2,3-*b*]quinoxaline (9f)[5]



Reaction Time: 3 h; Yield: 87% (0.108 g); Nature of compound: yellow solid; Melting Point: 290 – 292 ºC.; R_f: 0.32 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3472, 2979, 2012, 1669, 1229, 770. ^{1}H NMR (700 MHz, DMSO) δ 11.94 (s, 1H), 8.20 (d, *J* = 8.5 Hz, 1H), 8.18 (d, *J* = 8.9 Hz, 1H), 8.02 (d, *J* = 8.2 Hz, 1H), 7.74 (t, *J* = 7.5 Hz, 1H), 7.68 (t, *J* = 8.1 Hz, 1H), 7.04 (s, 1H), 6.93 (dd, *J* = 8.5, 2.0 Hz, 1H), 3.92 (s, 3H). ^{13}C{^{1}H} NMR (175 MHz, DMSO) δ 163.1, 146.7, 146.6, 140.3, 139.7, 139.1, 129.1, 128.4, 127.8, 126.3, 123.9, 112.5, 109.9, 96.3, 56.1. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{12}N_3O$ 250.0980; Found 250.0955

9-Methyl-6*H*-indolo[2,3-*b*]quinoxaline (9g)[6]

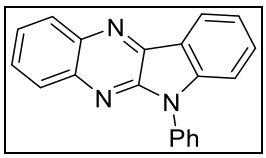


Reaction Time: 3 h; Yield: 67% (0.078 g); Nature of compound: yellow solid; Melting Point: 281 – 283 ºC.; R_f: 0.30 in 30% ethyl acetate in hexanes; IR (KBr): ν (cm^{-1}) = 3497, 2997, 2123, 1639, 1297, 781. ^{1}H NMR (700 MHz, DMSO) δ 11.89 (s, 1H), 8.22 (d, *J* = 8.3 Hz, 1H), 8.14 (s, 1H), 8.05 (d, *J* = 8.3 Hz, 1H), 7.78 (t, *J* = 7.5 Hz, 1H), 7.70 (t, *J* = 7.5 Hz, 1H), 7.52 (d, *J* = 8.1 Hz, 1H), 7.47 (d, *J* = 8.1 Hz, 1H), 2.50 (s, 3H). ^{13}C{^{1}H} NMR (175 MHz, DMSO) δ 146.0, 142.1, 140.1, 139.7, 138.5, 132.5, 129.7, 129.0, 128.6, 127.4, 125.8, 121.9, 119.0, 111.7, 20.8. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{15}H_{12}N_3$ 234.1031; Found 234.1050

Procedure for Chan-Lam coupling of 9a with phenyl boronic acid[7]

In a 10 mL Schlenk tube, 6H-indolo[2,3-*b*]quinoxaline **9a** (0.088g, 0.4 mmol, 1.0 equiv) and phenylboronic acid (0.055g, 0.45 mmol, 1.5 equiv) were dissolved in a mixed solvent of anhydrous DMF and anhydrous acetonitrile (1:1) (2.2 mL). Anhydrous copper acetate (0.108g, 0.6 mmol, 1.5 equiv), cesium carbonate (0.130g, 0.4 mmol, 1.0 equiv) and pyridine (0.095g, 1.2 mmol, 3.0 equiv) were added to the mixture. The mixture was stirred at 110 °C oil bath for 24 h under oxygen. The reaction mixture was cooled to room temperature and quenched with saturated NH_4Cl solution, an appropriate amount of water was added and extracted for three times with ethyl acetate. The combined organic layers were washed with saturated brine, dried over Na_2SO_4, filtered, concentrated under reduced pressure, and purified by column chromatography to afford the product.

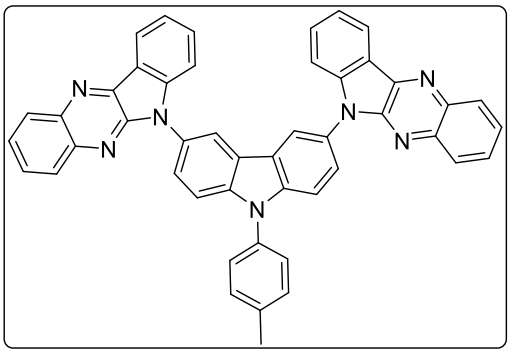
6-Phenyl-6H-indolo[2,3-*b*]quinoxaline 10a



Reaction Time: 24 h; Yield: 50% (0.060 g); Nature of compound: pale yellow solid; Melting Point: 231 - 233 °C; R_f: 0.2 in 3% ethyl acetate in hexanes. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.55 (d, *J* = 7.7 Hz, 1H), 8.40 – 8.25 (m, 1H), 8.16 – 8.03 (m, 1H), 7.83 – 7.60 (m, 7H), 7.53 (t, *J* = 8.1 Hz, 2H), 7.45 (t, *J* = 7.5 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.86, 144.74, 140.58, 140.19, 139.79, 135.39, 131.07, 129.81, 129.25, 128.86, 128.24, 128.02, 127.17, 126.54, 122.71, 121.88, 119.83, 110.63. HRMS (ESI) *m/z*: $[M+H]^+$ Calcd for $C_{20}H_{14}N_3$ 296.1188; Found 296.1196

Procedure for synthesis of target molecule 6,6'-(9-(*p*-tolyl)-9*H*-carbazole-3,6-diyl)bis(6*H*-indolo[2,3-*b*]quinoxaline) 12[8]

To a solution of 6*H*-indolo[2,3-*b*]quinoxaline **9a** (0.241 g, 1.1 mmol, 2.2 equiv) and 3,6-diiodo-9-(*p*-tolyl)-9*H*-carbazole **11** (0.254 g, 0.5 mmol) in dioxane in sealed tube, potassium phosphate (0.143 g, 1 mmol, 2.1 equiv), CuI (0.019 g, 10 mol%) and *trans*-1,2-DACH (0.023 g, 20 mol%) were added. The mixture was stirred at 110 ºC for 48 h. After the completion of the reaction, the reaction mixture was diluted with ethyl acetate, washed with water, brine, and dried over Na_2SO_4. The solvent was evaporated and the crude product was purified by flash chromatography on silica gel.



Reaction Time: 48 h; Yield: 64% (0.220 g); Nature of compound: yellow solid; Melting Point: 227 – 229 ºC; R_f: 0.23 in 20% ethyl acetate in hexanes. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.58 (d, *J* = 7.6 Hz, 2H), 8.47 (s, 1H), 8.35 (d, *J* = 7.4 Hz, 2H), 8.11 (d, *J* = 7.3 Hz, 2H), 7.78 – 7.62 (m, 12H), 7.54 - 7.52 (m, 4H), 7.46 (t, *J* = 7.4 Hz, 2H), 7.28 (s, 1H), 2.58 (s, 3H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ 146.6, 145.9, 141.4, 140.8, 140.4, 139.9, 138.5, 134.5, 131.2, 131.0, 129.4, 128.9, 128.4, 127.9, 127.3, 126.5, 126.2, 124.0, 122.8, 121.8, 120.2, 119.8, 111.6, 110.7, 21.5.

X-Ray crystal data for 5a

Identification code	VS_900
Empirical formula	$C_{21}H_{15}N_3O_2S$
Formula weight	373.42
Temperature/K	100.01(10)
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	7.9867(2)
b/Å	18.9604(5)
c/Å	11.5410(3)
α/°	90
β/°	98.527(2)
γ/°	90
Volume/Å^3	1728.35(8)
Z	4
ρ_{calc}g/cm^3	1.435
μ/mm^{-1}	0.210
F(000)	776.0
Crystal size/mm^3	0.19 × 0.15 × 0.1
Radiation	Mo Kα (λ = 0.71073)
2Θ range for data collection/°	7.032 to 63.844
Index ranges	$-11 \leq h \leq 11$, $-24 \leq k \leq 27$, $-16 \leq l \leq 14$
Reflections collected	19476
Independent reflections	4989 [R_{int} = 0.0272, R_{sigma} = 0.0207]
Data/restraints/parameters	4989/0/245
Goodness-of-fit on F^2	1.037
Final R indexes [I>=2σ (I)]	R_1 = 0.0375, wR_2 = 0.0970
Final R indexes [all data]	R_1 = 0.0438, wR_2 = 0.1010
Largest diff. peak/hole / e Å^{-3}	0.49/-0.37

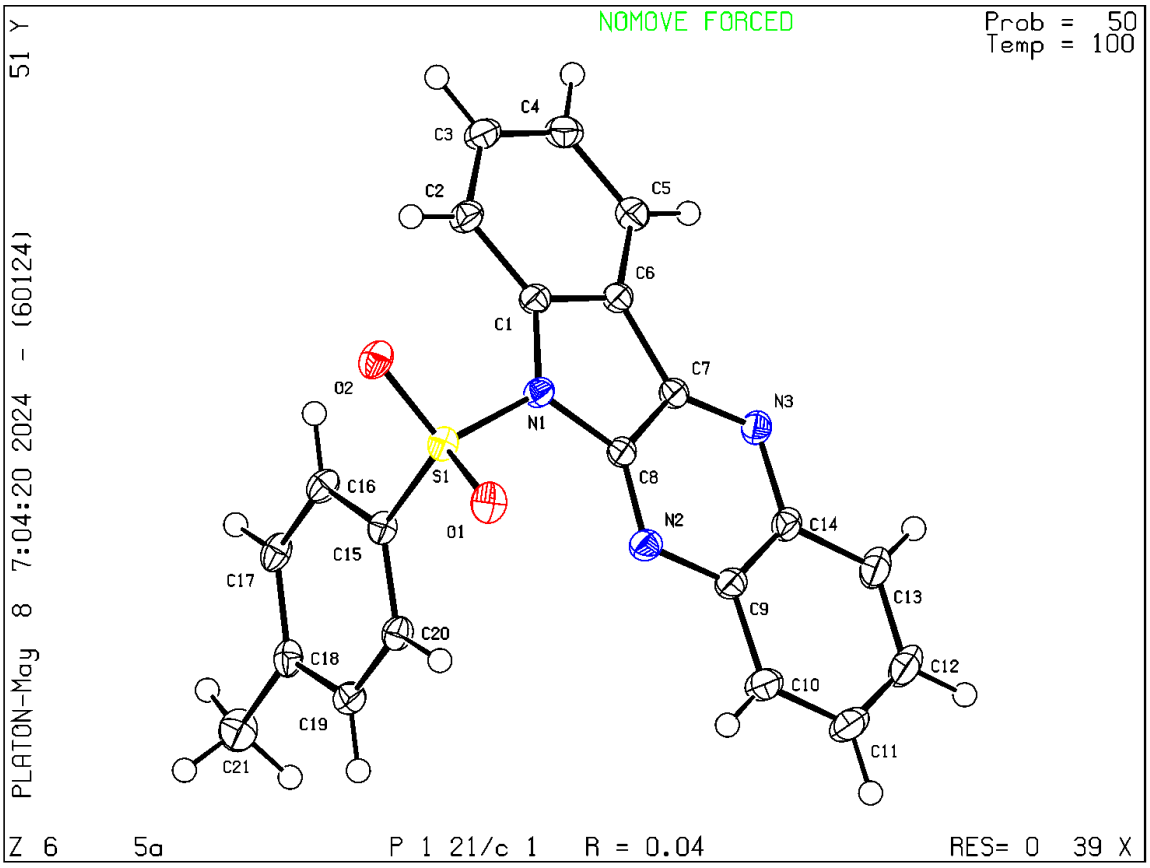


Figure S-1: Crystal structure of **5a**. ORTEP Views of the Molecular Structure with Thermal Ellipsoids Set at 50% Probability. X-Ray quality crystals were grown in CH_2Cl_2-Hexane solvent system

X-Ray crystal data for 6t

Identification code	SP_VS_968_auto
Empirical formula	$C_{25}H_{15}F_6N_3O_5S$
Formula weight	583.471
Temperature/K	298.0(7)
Crystal system	triclinic
Space group	P-1
a/Å	7.2215(2)
b/Å	10.8817(3)
c/Å	16.0374(6)
α/°	106.334(3)
β/°	92.084(3)
γ/°	95.137(2)
Volume/Å^3	1202.03(7)
Z	2
ρ_{calc}g/cm^3	1.612
μ/mm^{-1}	2.039
F(000)	595.3
Crystal size/mm^3	0.23 × 0.19 × 0.09
Radiation	Cu Kα (λ = 1.54184)
2Θ range for data collection/°	8.52 to 158.94
Index ranges	$-7 \leq h \leq 9$, $-13 \leq k \leq 13$, $-20 \leq l \leq 20$
Reflections collected	17841
Independent reflections	5026 [R_{int} = 0.0397, R_{sigma} = 0.0277]
Data/restraints/parameters	5026/0/362
Goodness-of-fit on F^2	1.009
Final R indexes [I>=2σ (I)]	R_1 = 0.0610, wR_2 = 0.1671
Final R indexes [all data]	R_1 = 0.0667, wR_2 = 0.1848
Largest diff. peak/hole / e Å^{-3}	0.96/-1.14

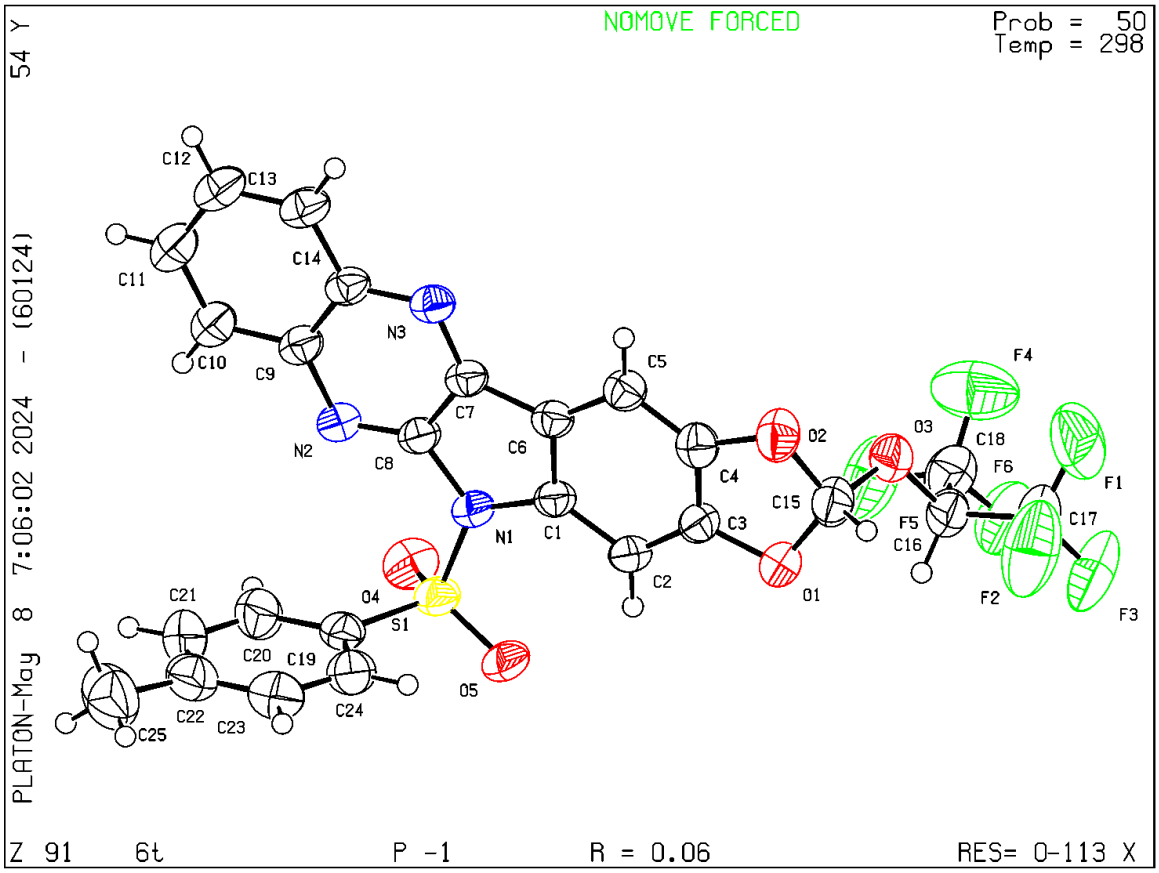


Figure S-2: Crystal structure of **6t**. ORTEP Views of the Molecular Structure with Thermal Ellipsoids Set at 50% Probability. X-Ray quality crystals were grown in CH_2Cl_2-Hexane solvent system

References:

1. Y. H. Cho, K. H. Kim and C. H. Cheon, *J. Org. Chem.*, 2014, **79**, 901-907.
2. S. K. Guchhait, G. Priyadarshani and N. M. Gulghane, *RSC Adv.*, 2016, **6**, 56056-56063.
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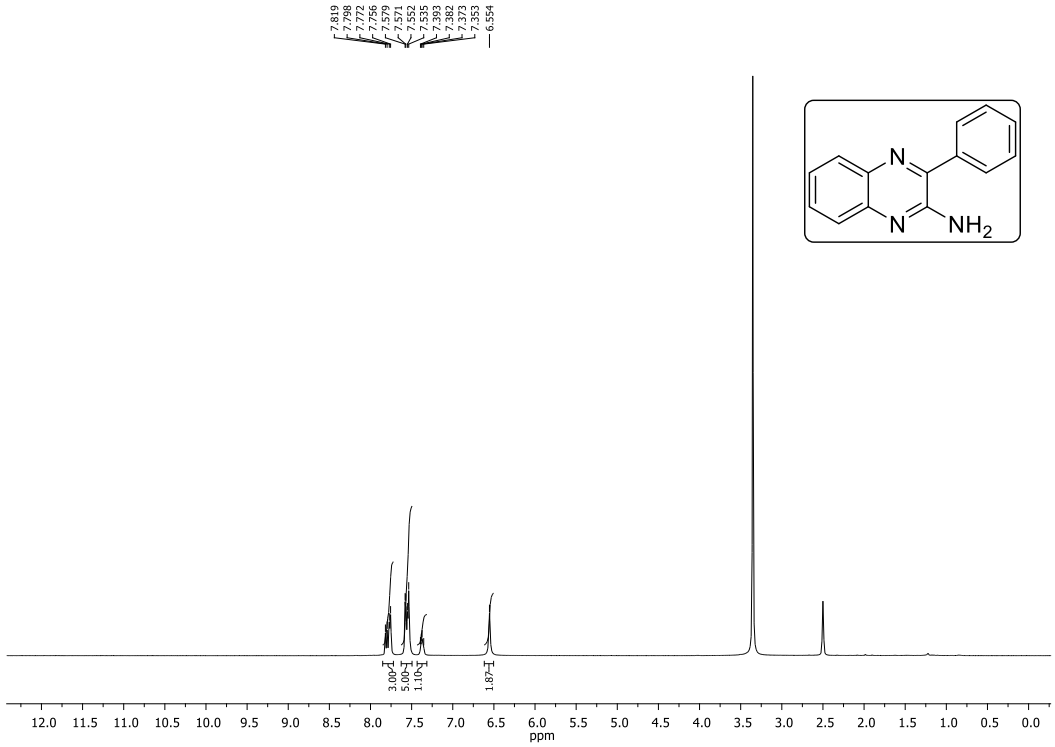
8. T. H. Su, Fan, C.H., Ou-Yang, Y.H., Hsu, L.C. and Cheng, C.H.,, *J. Mater. Chem. C.*, 2013, **1**, 5084-5092.

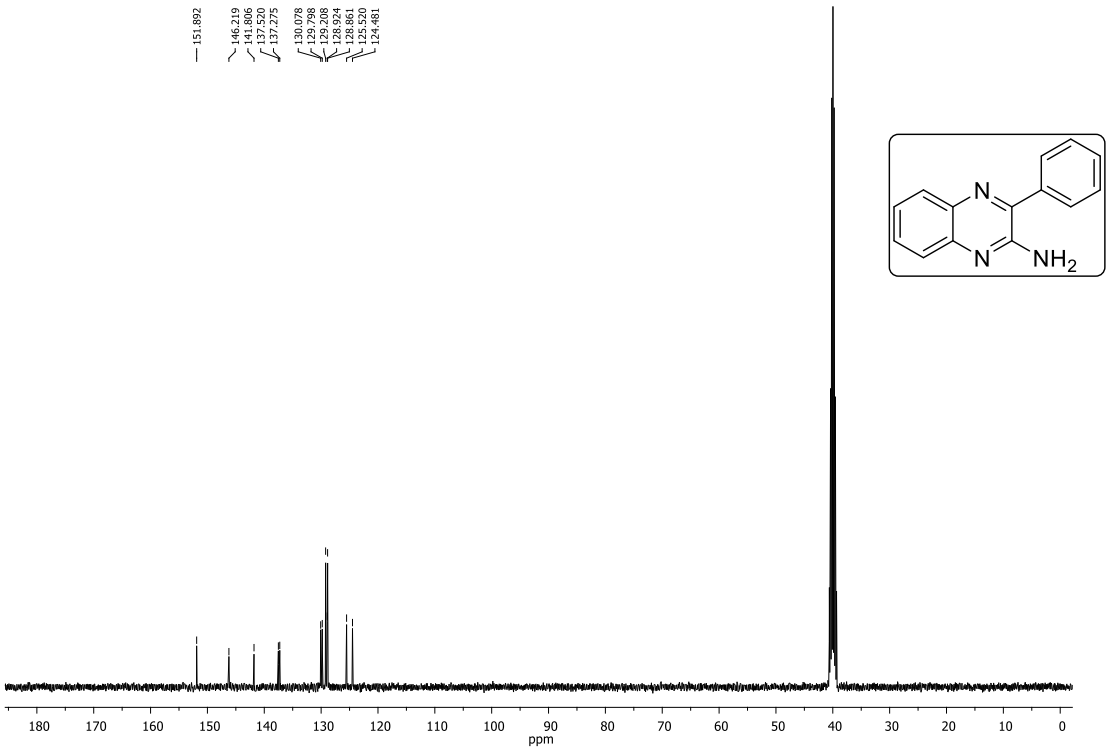
^{1}H and ^{13}C Spectra copies

3-Phenylquinoxalin-2-amine (3a)

^{1}H NMR (400 MHz, DMSO)

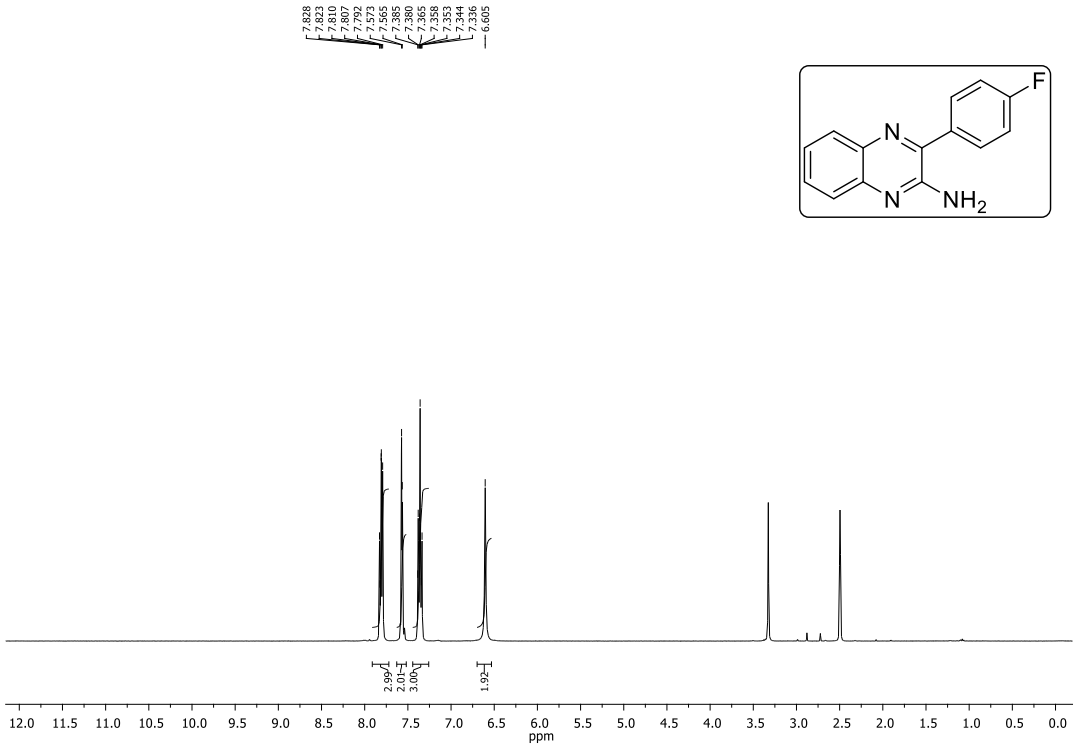


^{13}C{^{1}H} NMR (100 MHz, DMSO)

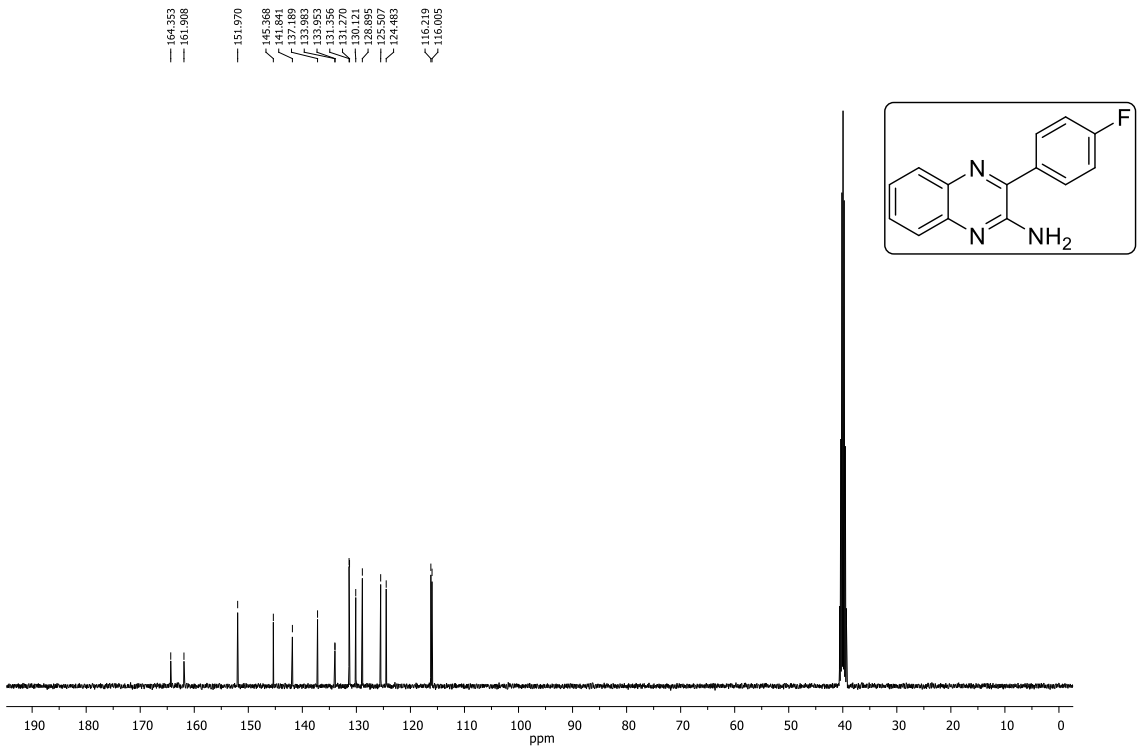


3-(4-Fluorophenyl)quinoxalin-2-amine (3b)

^{1}H NMR (400 MHz, DMSO)

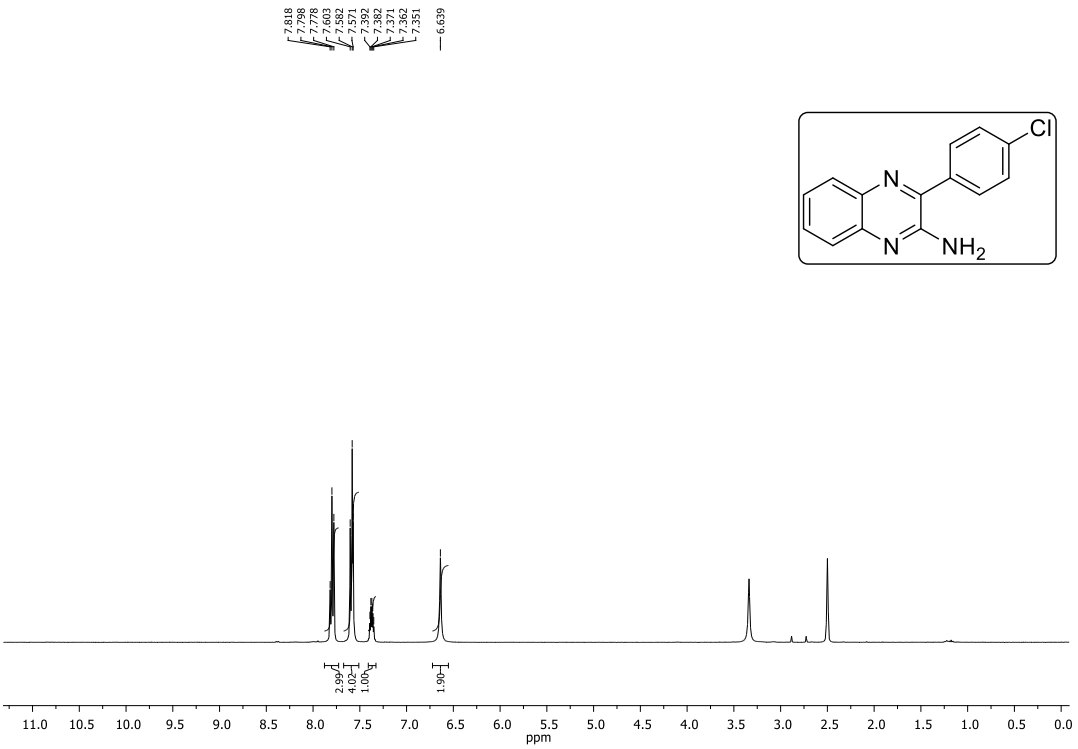


^{13}C{^{1}H} NMR (100 MHz, DMSO)

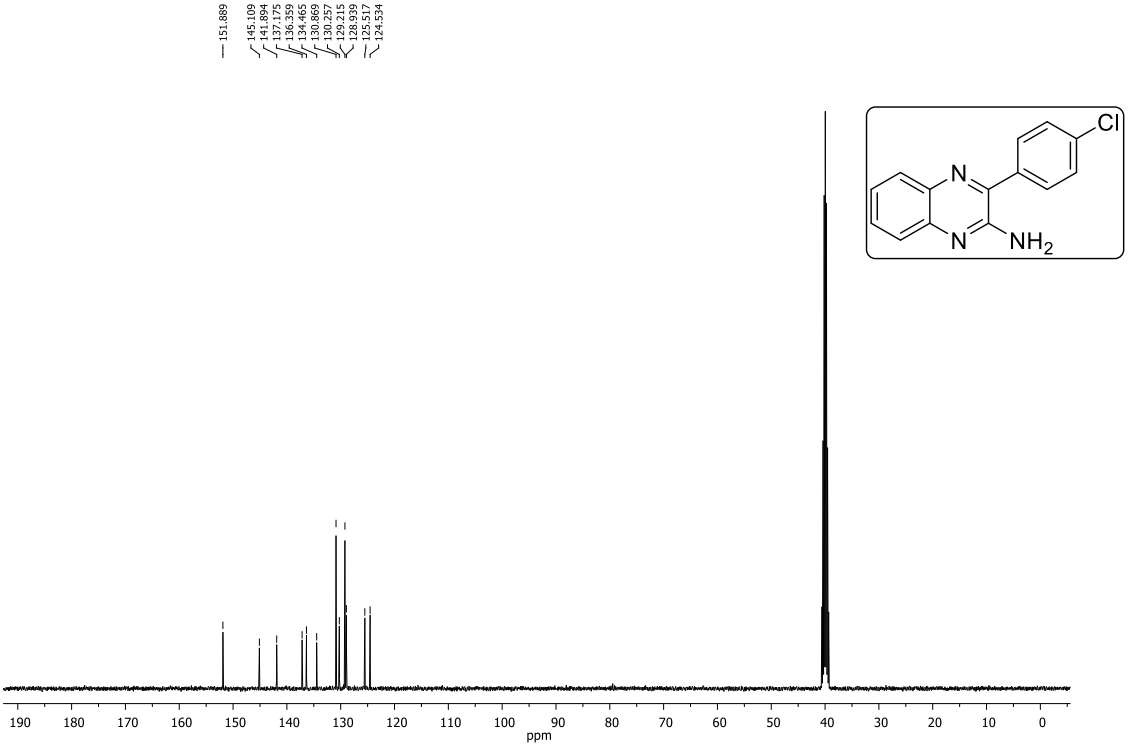


3-(4-Chlorophenyl)quinoxalin-2-amine (3c)

^{1}H NMR (400 MHz, DMSO)

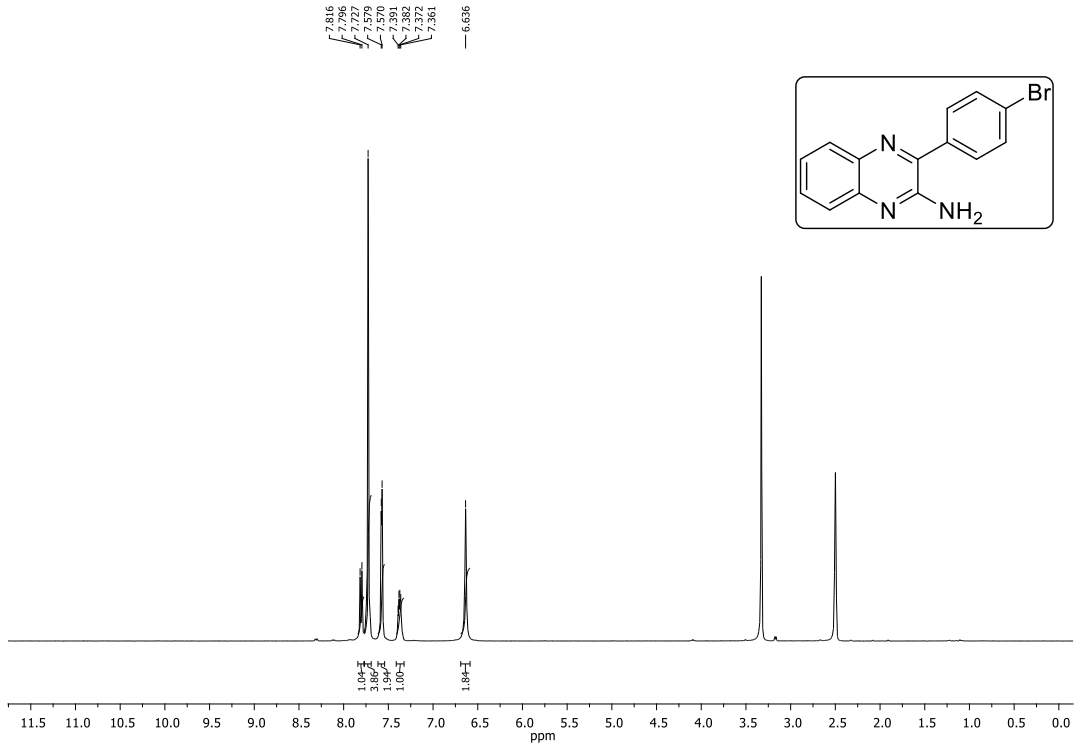


^{13}C{^{1}H} NMR (100 MHz, DMSO)

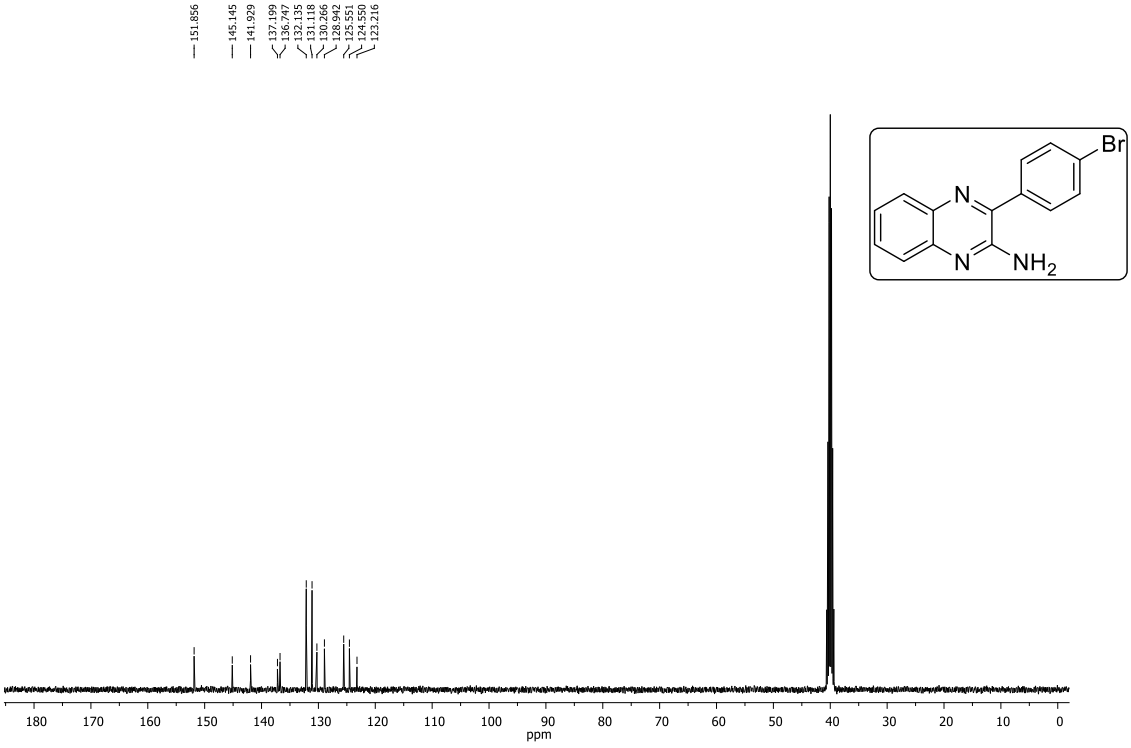


3-(4-Bromophenyl)quinoxalin-2-amine (3d)

^{1}H NMR (400 MHz, DMSO)

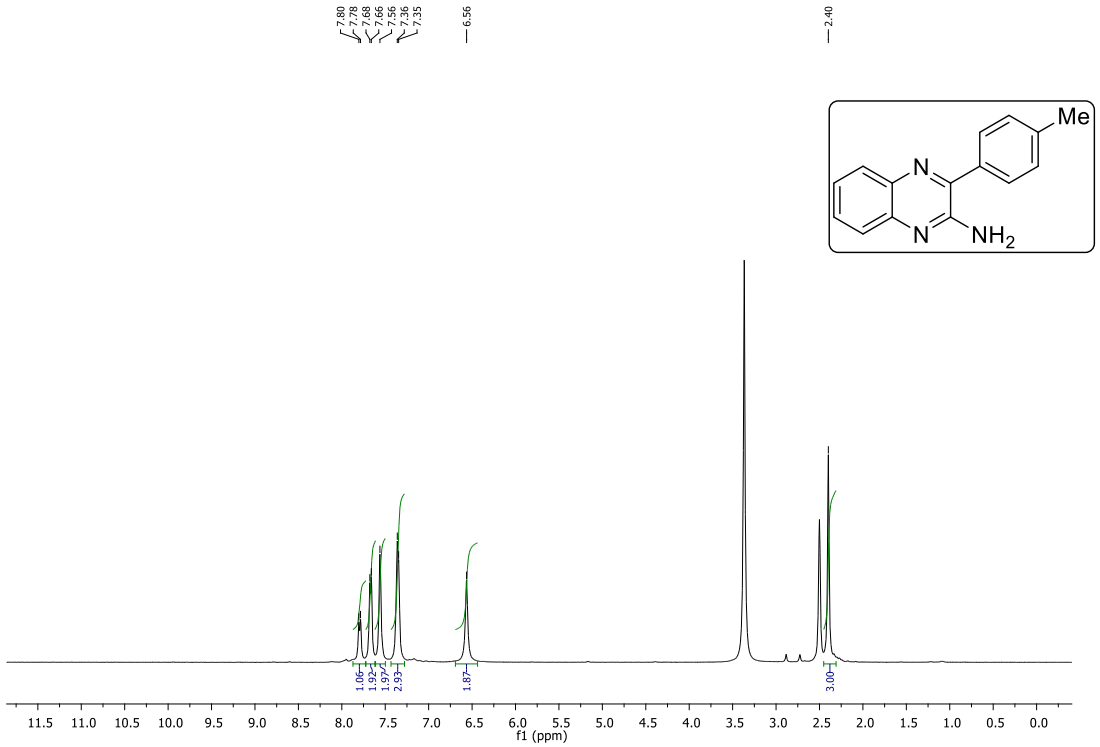


^{13}C{^{1}H} NMR (100 MHz, DMSO)

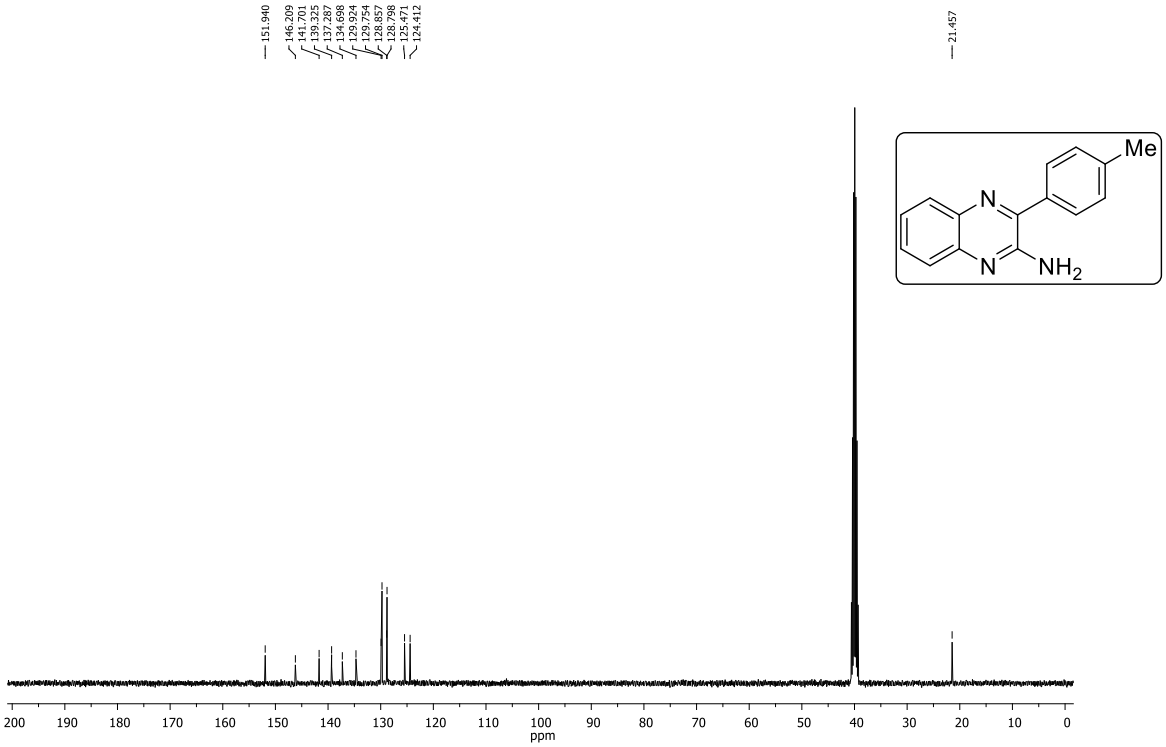


3-(*p*-Tolyl)quinoxalin-2-amine (3e)

^{1}H NMR (400 MHz, DMSO)

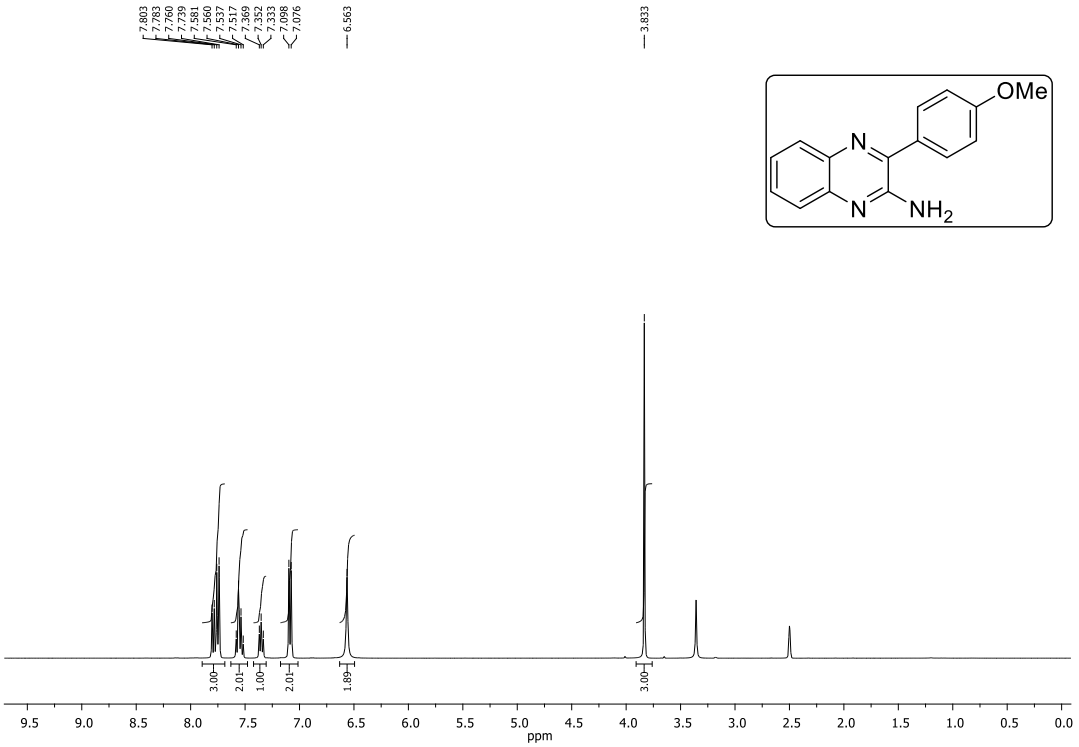


^{13}C{^{1}H} NMR (100 MHz, DMSO)

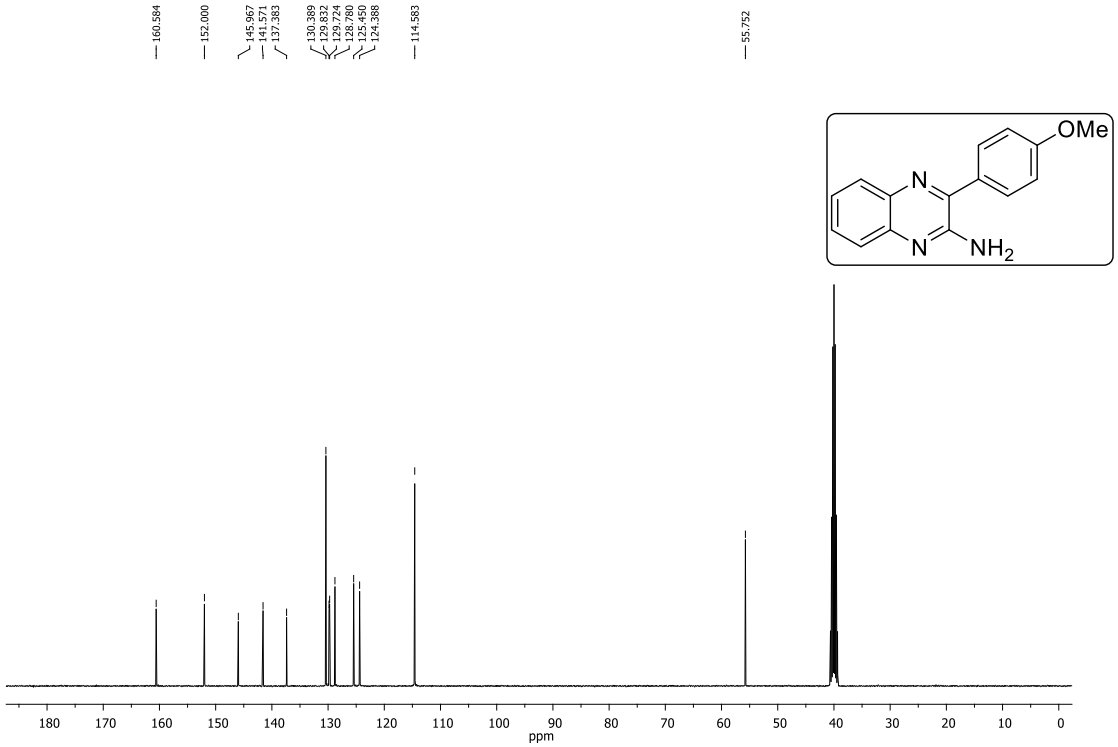


3-(4-Methoxyphenyl)quinoxalin-2-amine (3f)

^{1}H NMR (400 MHz, DMSO)

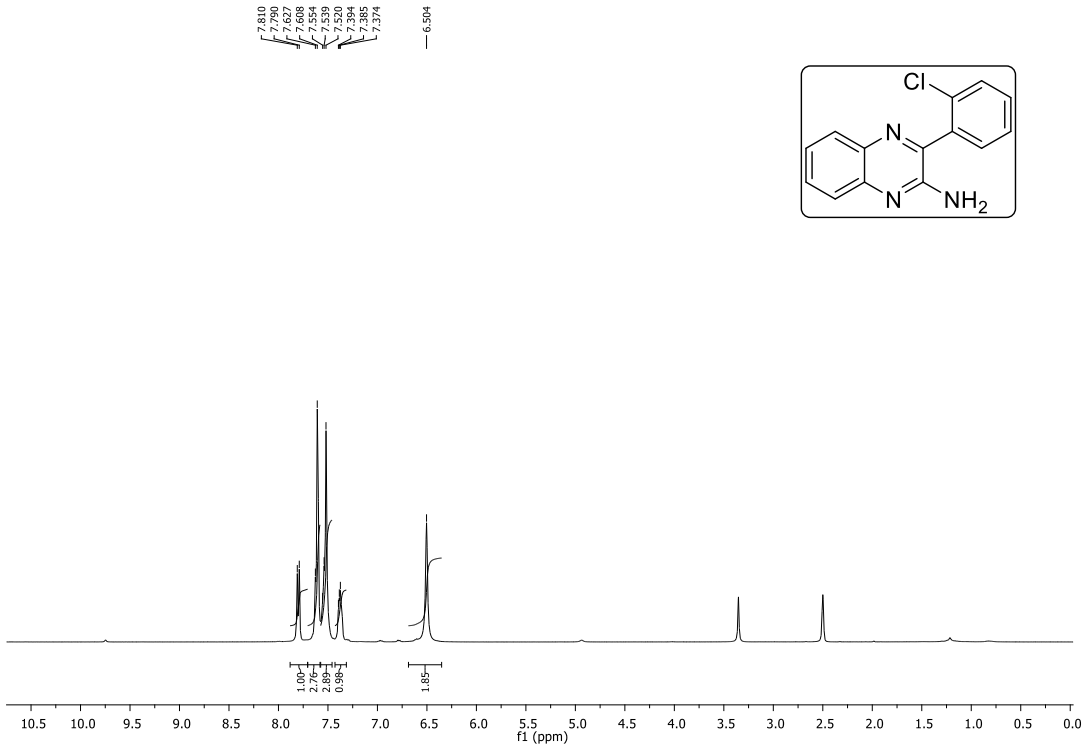


^{13}C{^{1}H} NMR (100 MHz, DMSO)

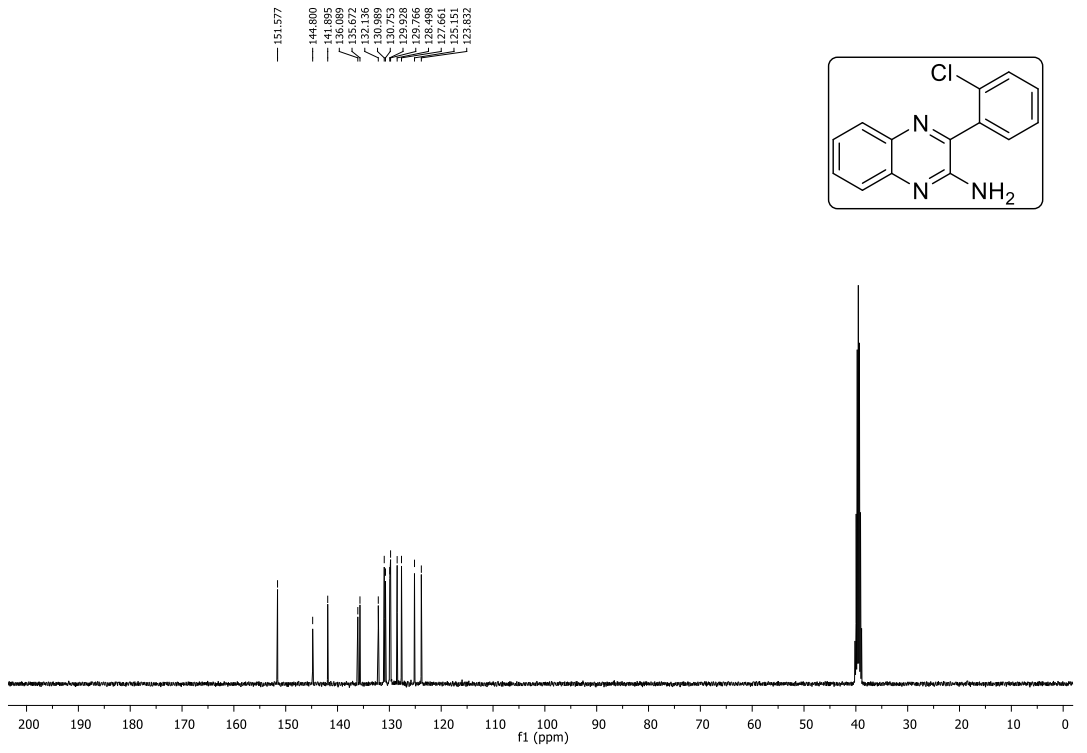


3-(2-Chlorophenyl)quinoxalin-2-amine (3g)

^{1}H NMR (400 MHz, DMSO)

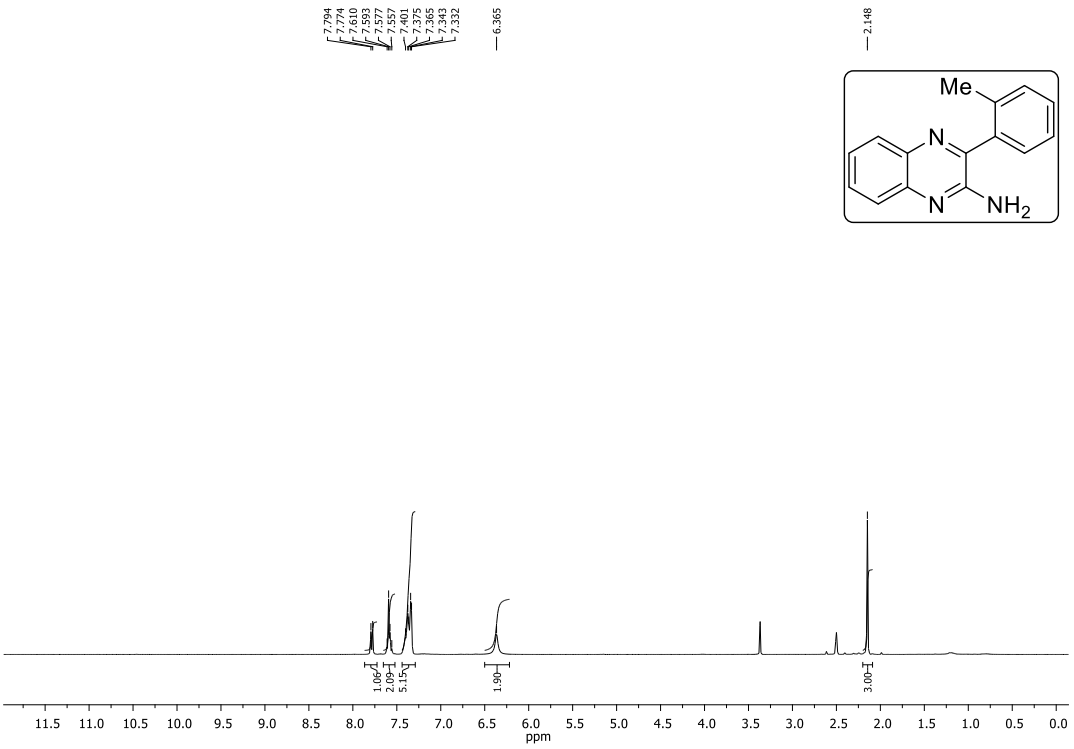


^{13}C{^{1}H} NMR (100 MHz, DMSO)

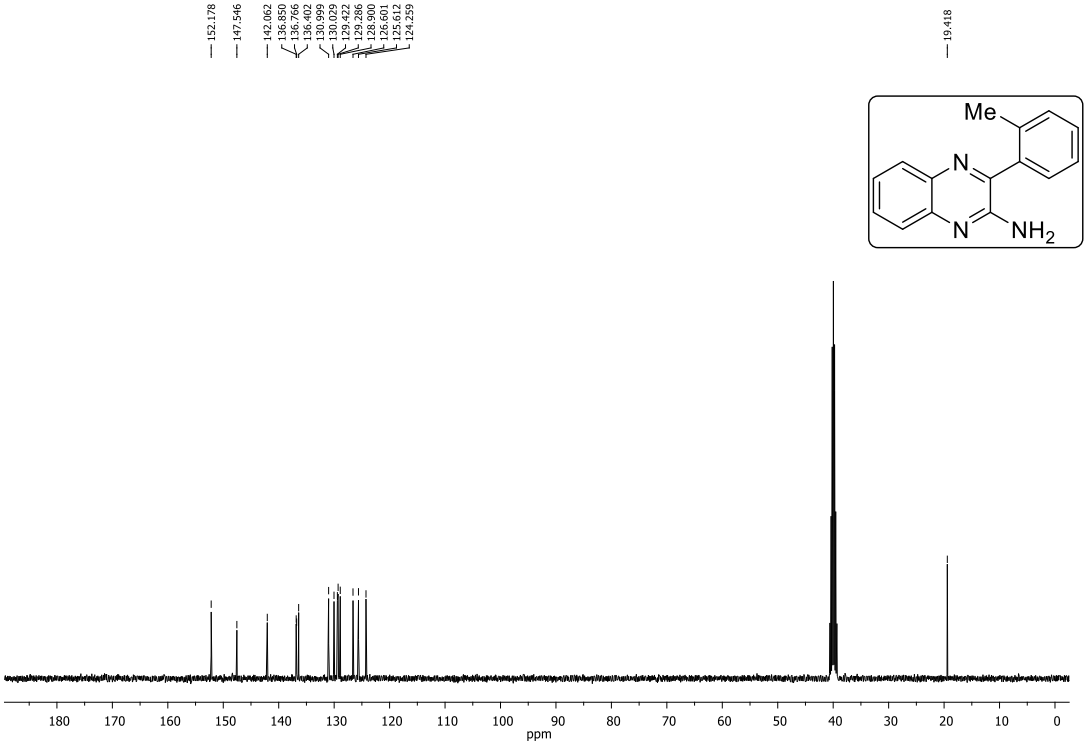


3-(*o*-Tolyl)quinoxalin-2-amine (3h)

^{1}H NMR (400 MHz, DMSO)

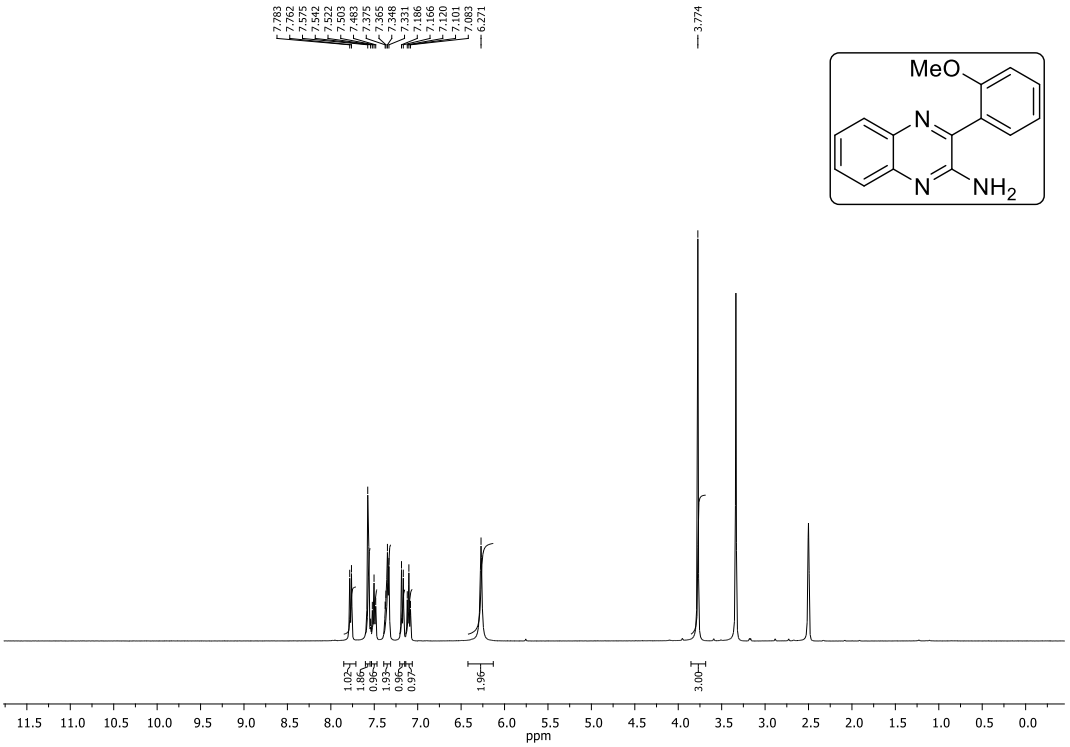


^{13}C{^{1}H} NMR (100 MHz, DMSO)

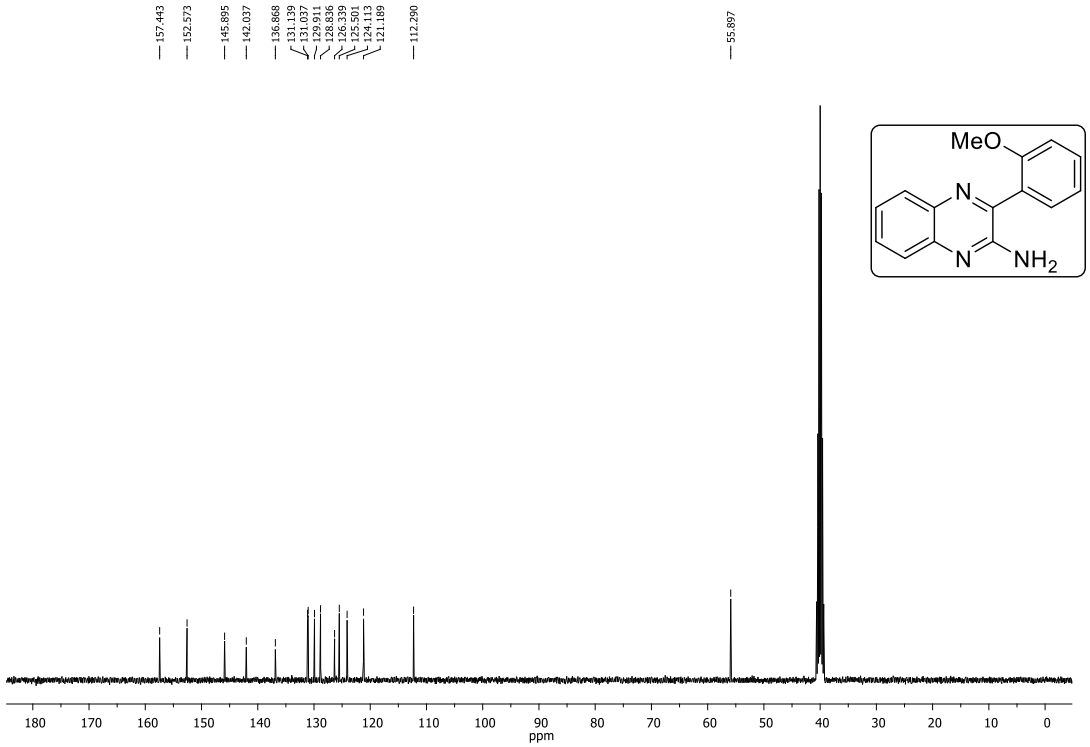


3-(2-Methoxyphenyl)quinoxalin-2-amine (3i)

^{1}H NMR (400 MHz, DMSO)

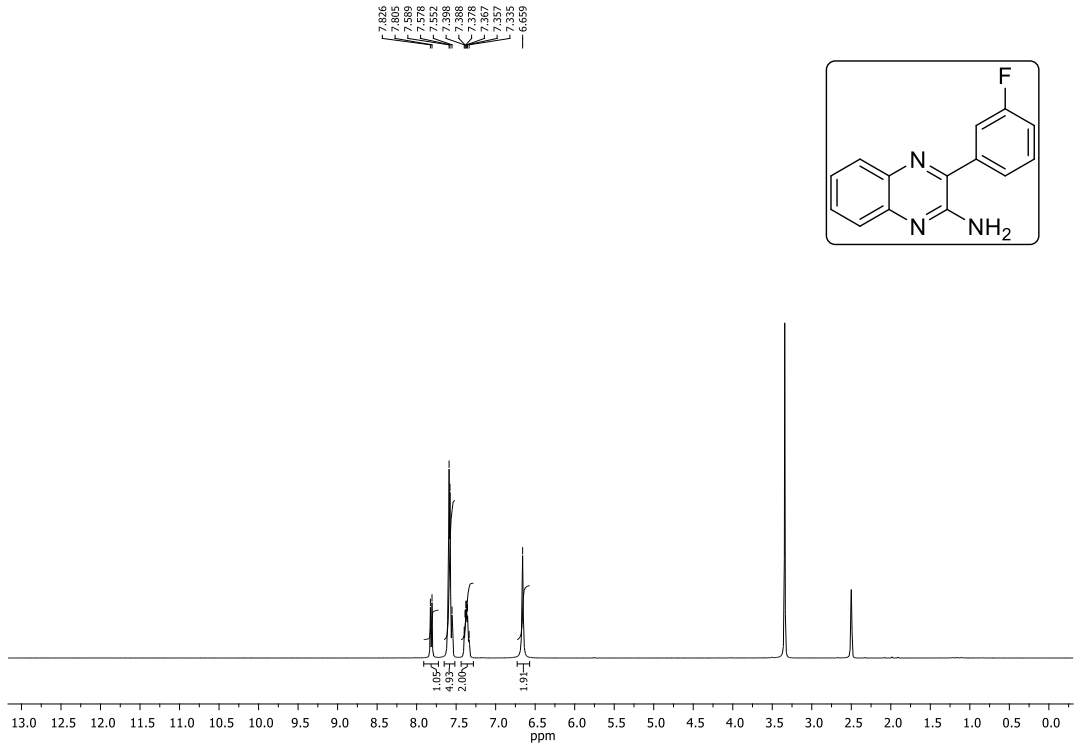


^{13}C{^{1}H} NMR (100 MHz, DMSO)

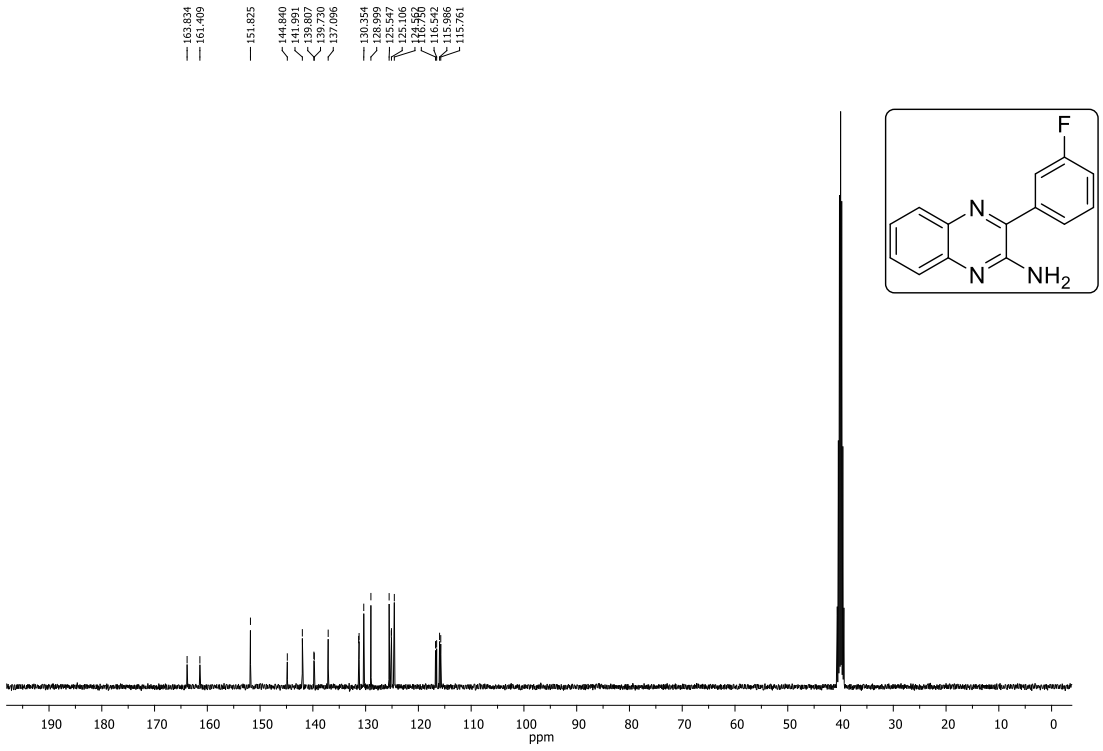


3-(3-Fluorophenyl)quinoxalin-2-amine (3j)

^{1}H NMR (400 MHz, DMSO)

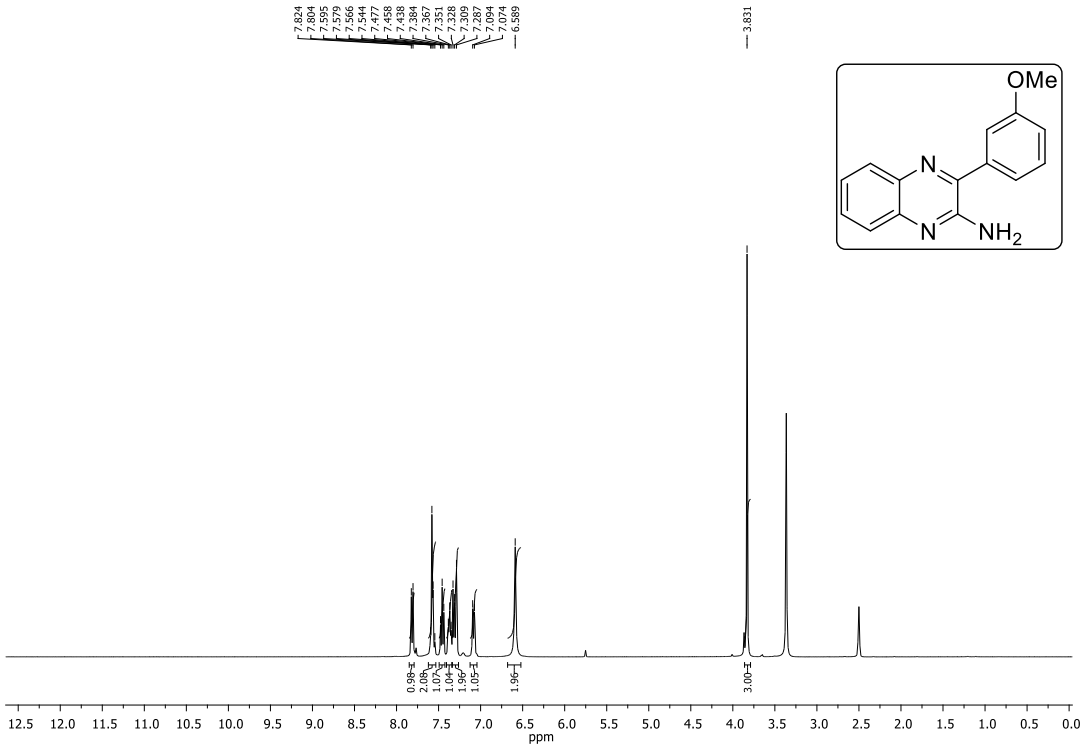


^{13}C{^{1}H} NMR (100 MHz, DMSO)

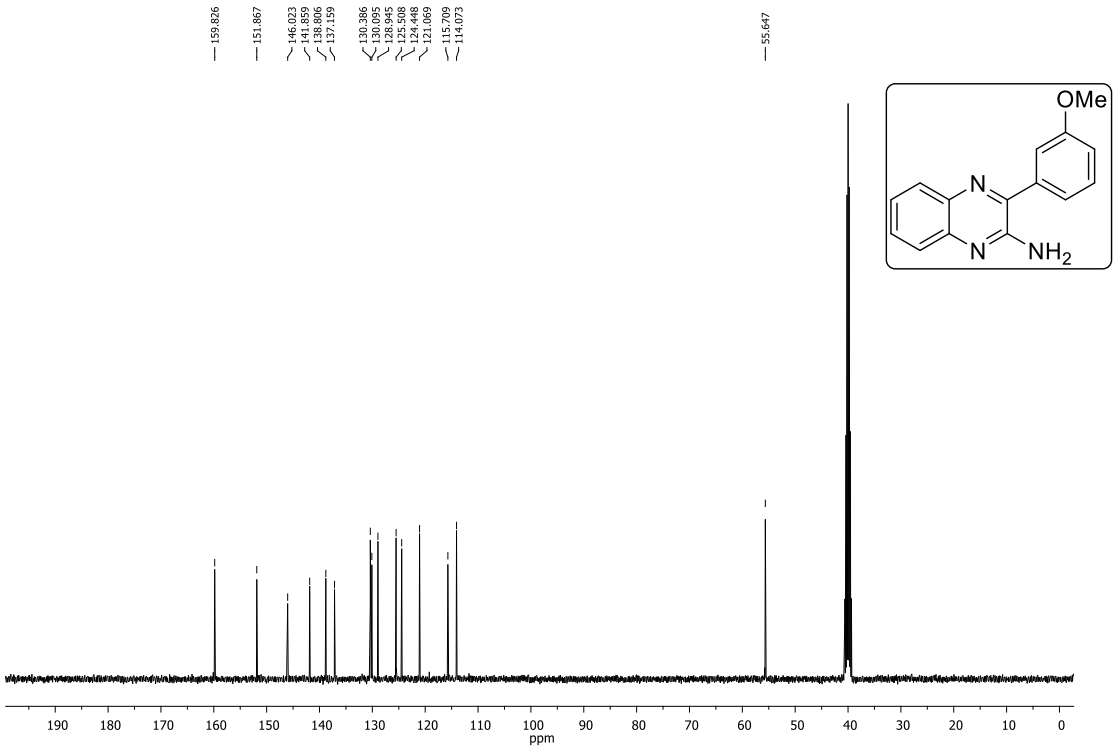


3-(3-Methoxyphenyl)quinoxalin-2-amine (3k)

^{1}H NMR (400 MHz, DMSO)

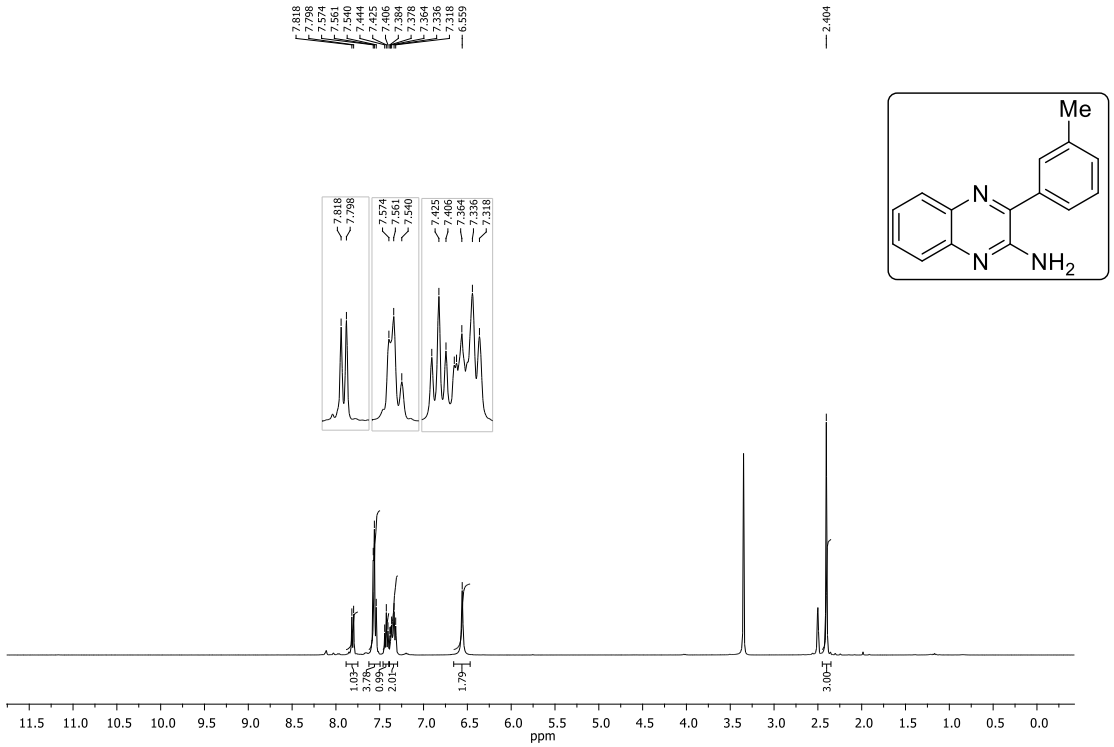


^{13}C{^{1}H} NMR (100 MHz, DMSO)

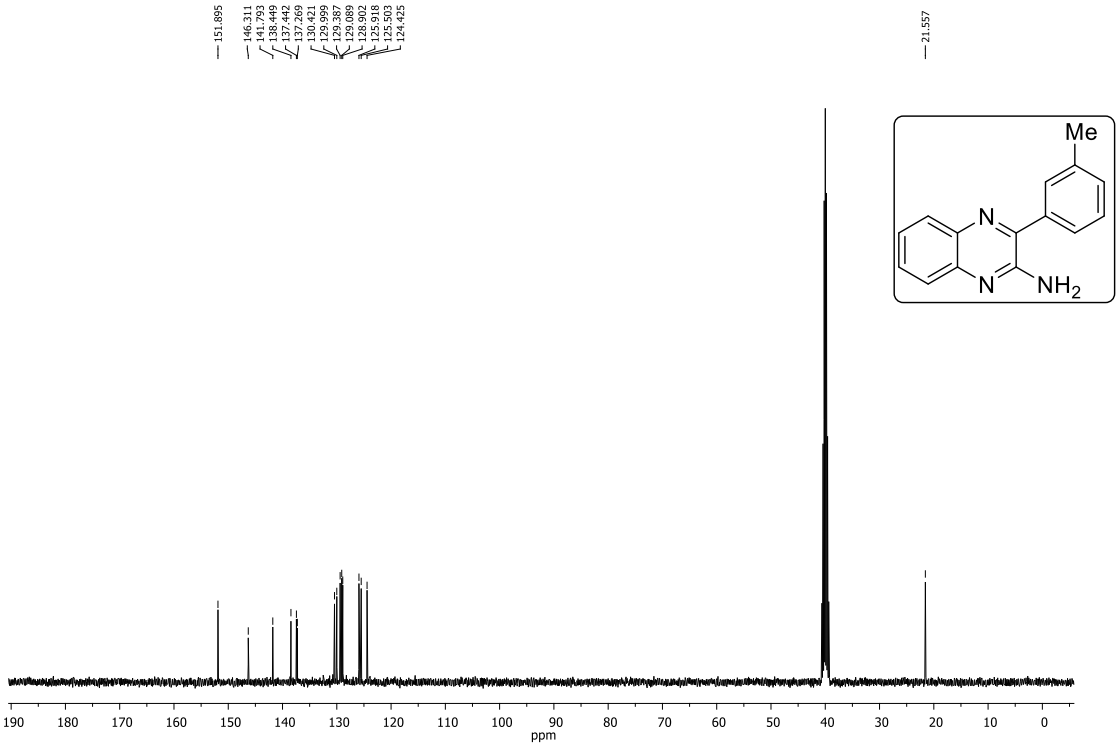


3-(*m*-Tolyl)quinoxalin-2-amine (3l)

^{1}H NMR (400 MHz, DMSO)

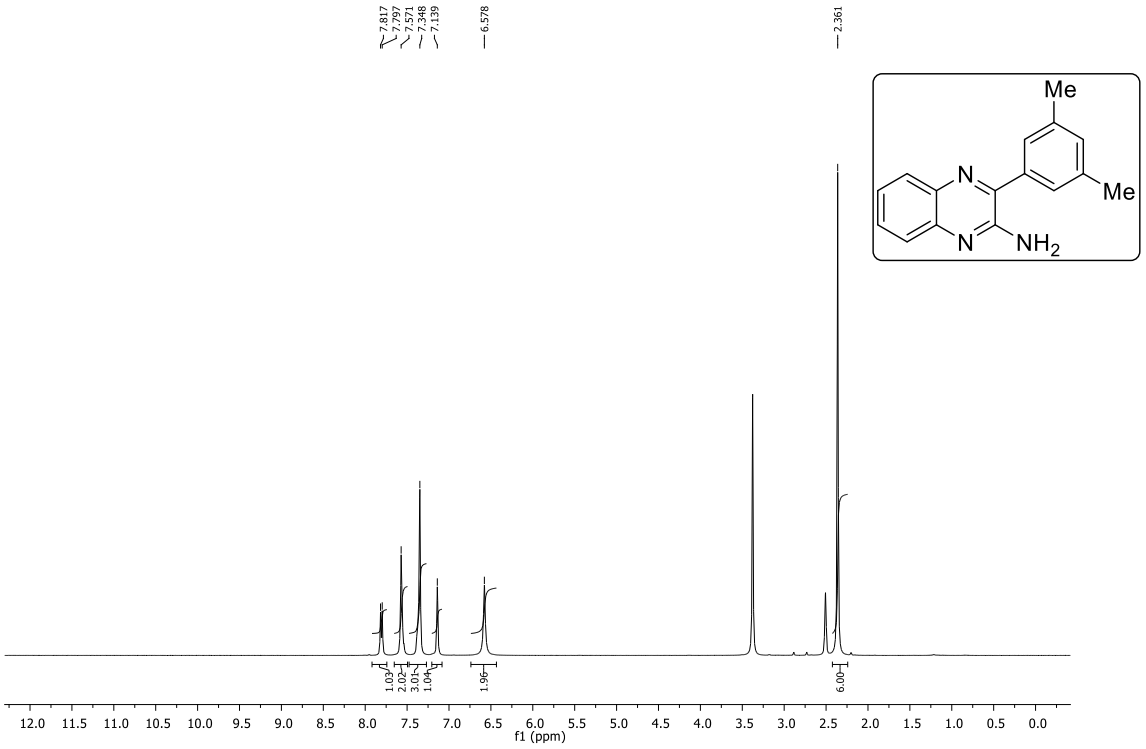


^{13}C{^{1}H} NMR (100 MHz, DMSO)

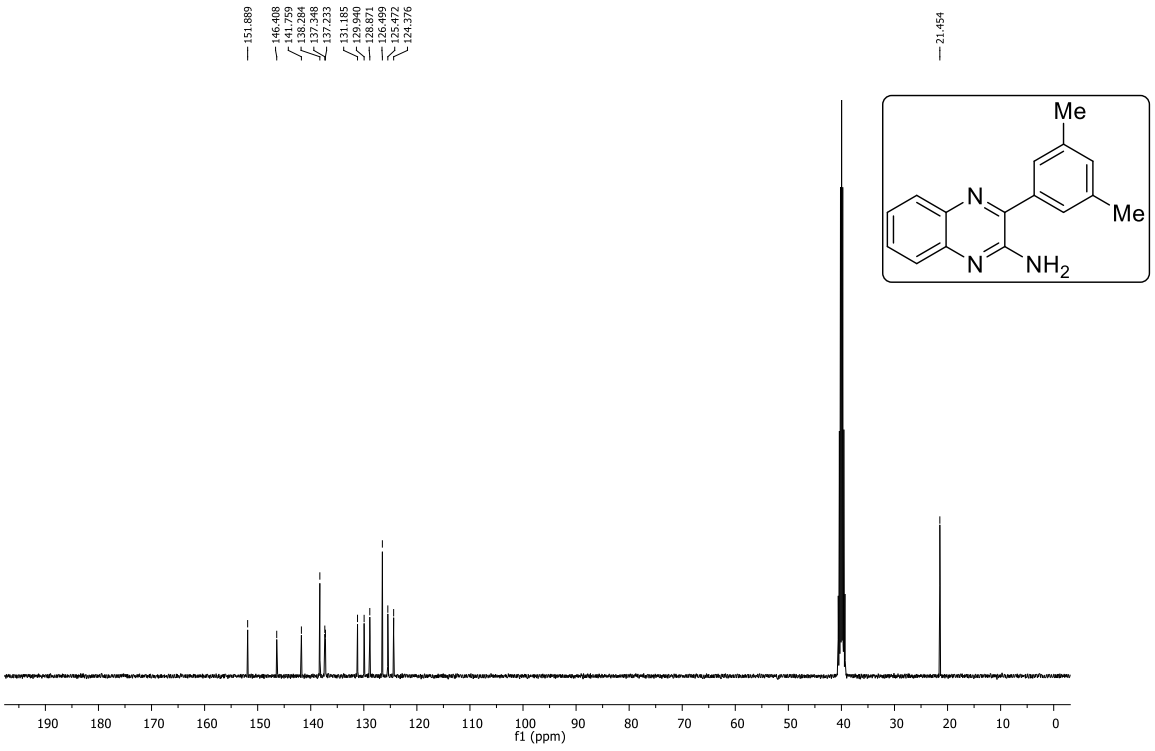


3-(3,5-Dimethylphenyl)quinoxalin-2-amine (3m)

^{1}H NMR (400 MHz, DMSO)

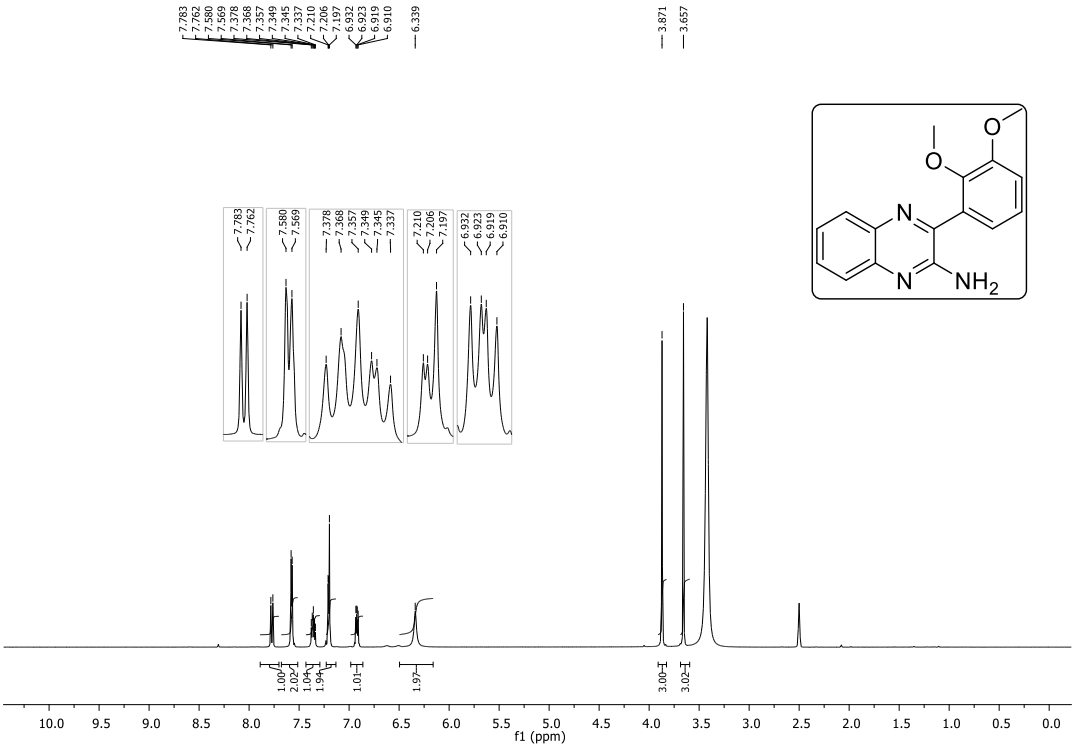


^{13}C{^{1}H} NMR (100 MHz, DMSO)

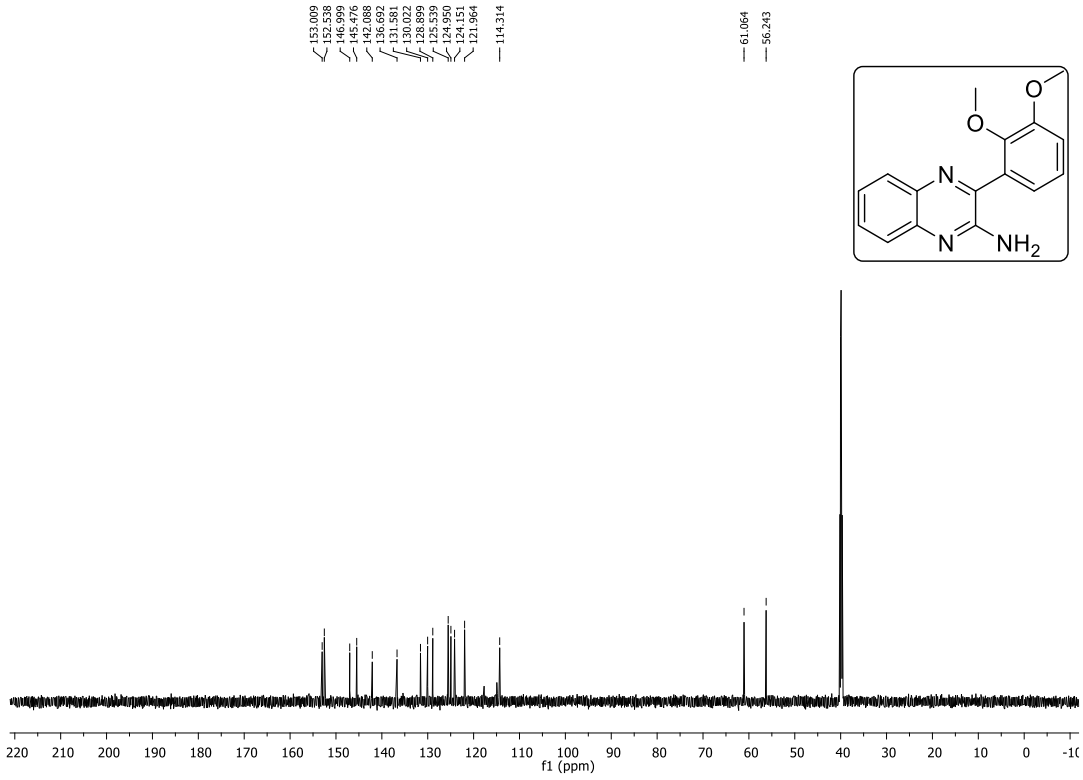


3-(2,3-Dimethoxyphenyl)quinoxalin-2-amine (3n)

^{1}H NMR (400 MHz, DMSO)

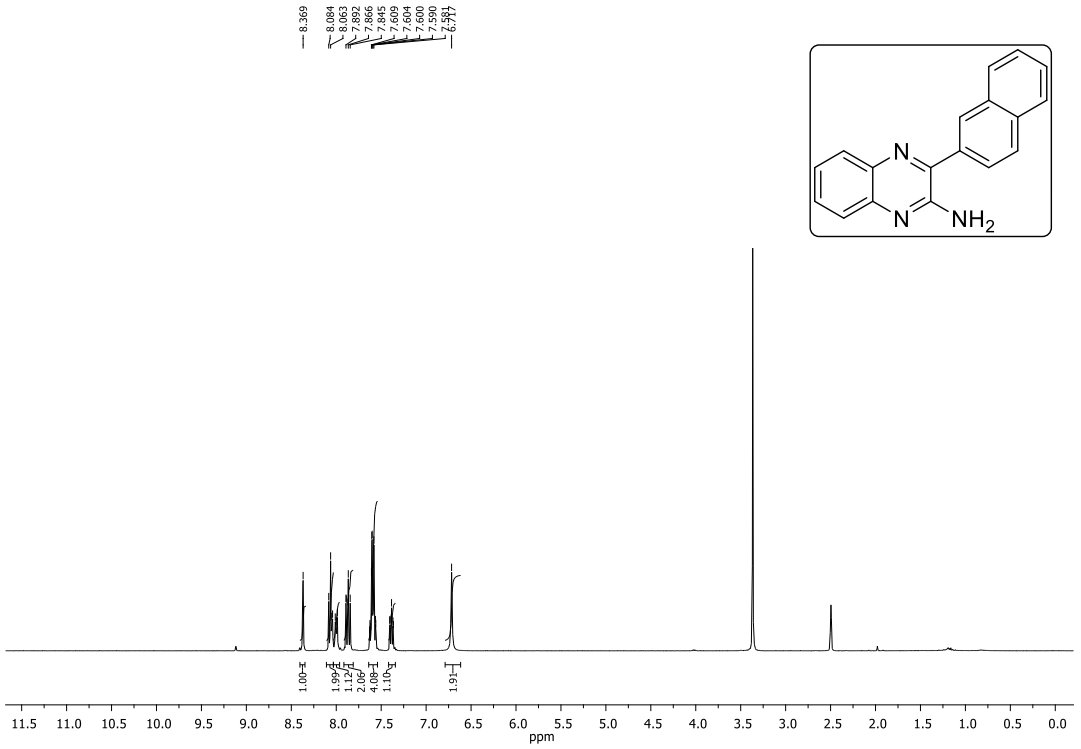


^{13}C{^{1}H} NMR (175 MHz, DMSO)

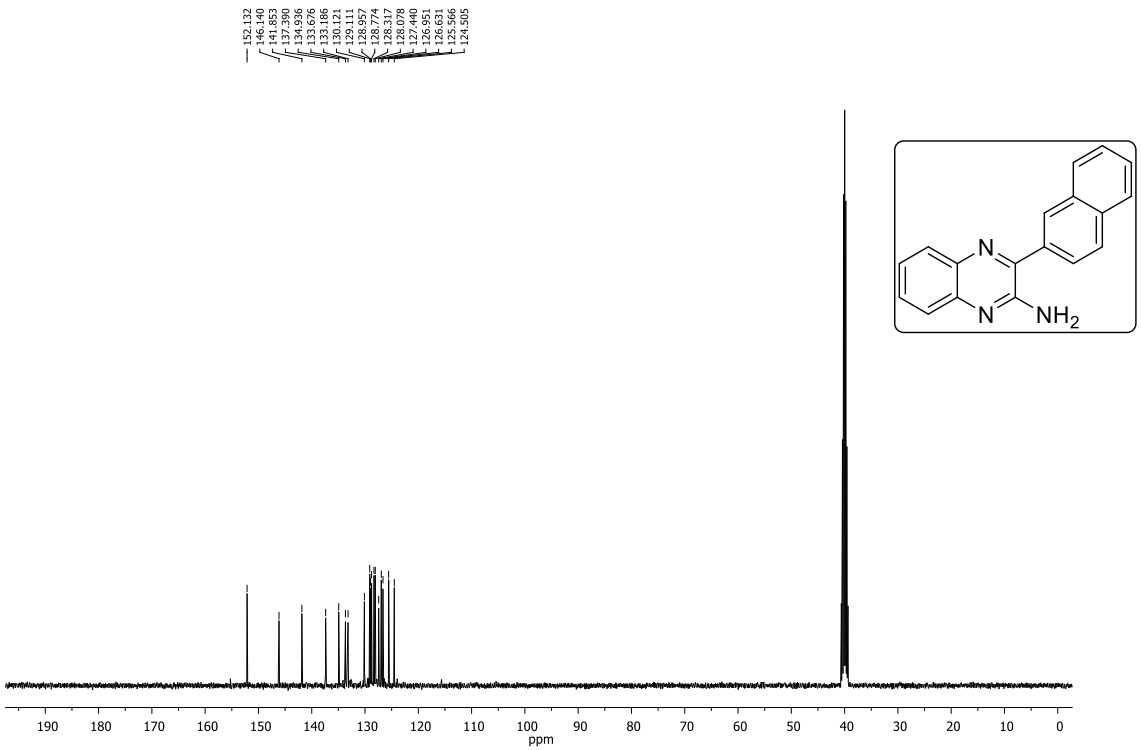


3-(Naphthalen-2-yl)quinoxalin-2-amine (3o)

^{1}H NMR (400 MHz, DMSO)

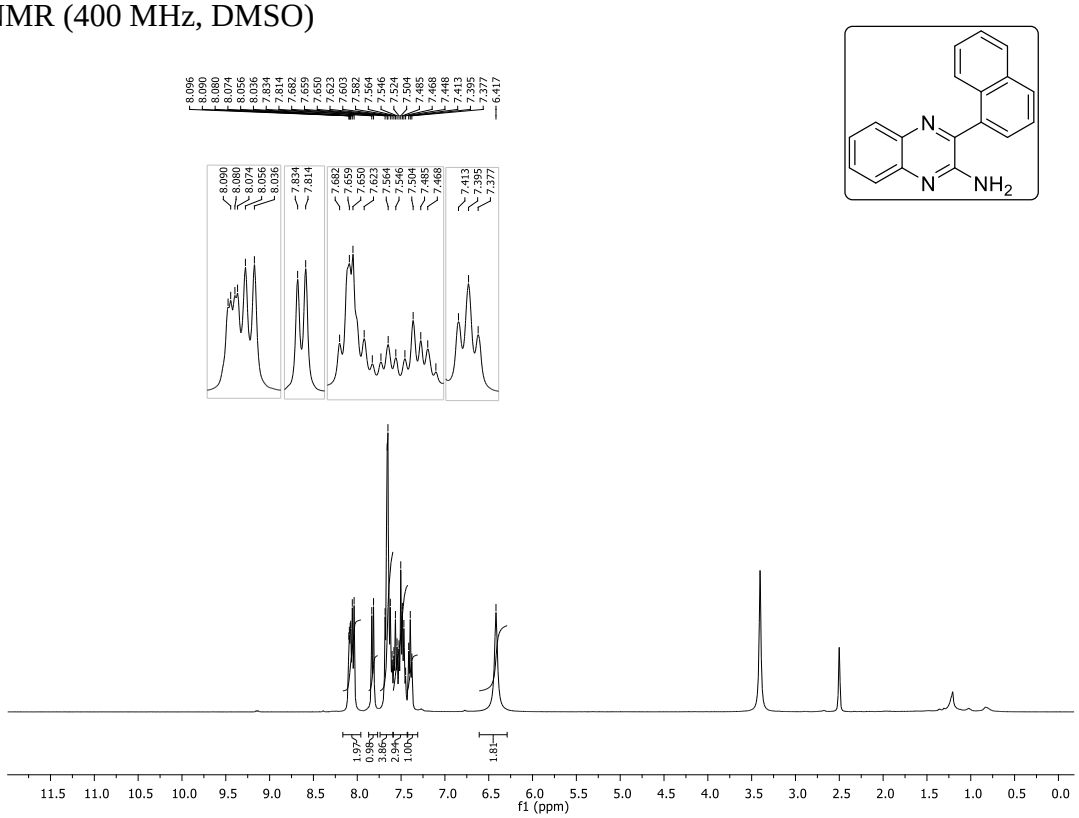


^{13}C{^{1}H} NMR (100 MHz, DMSO)

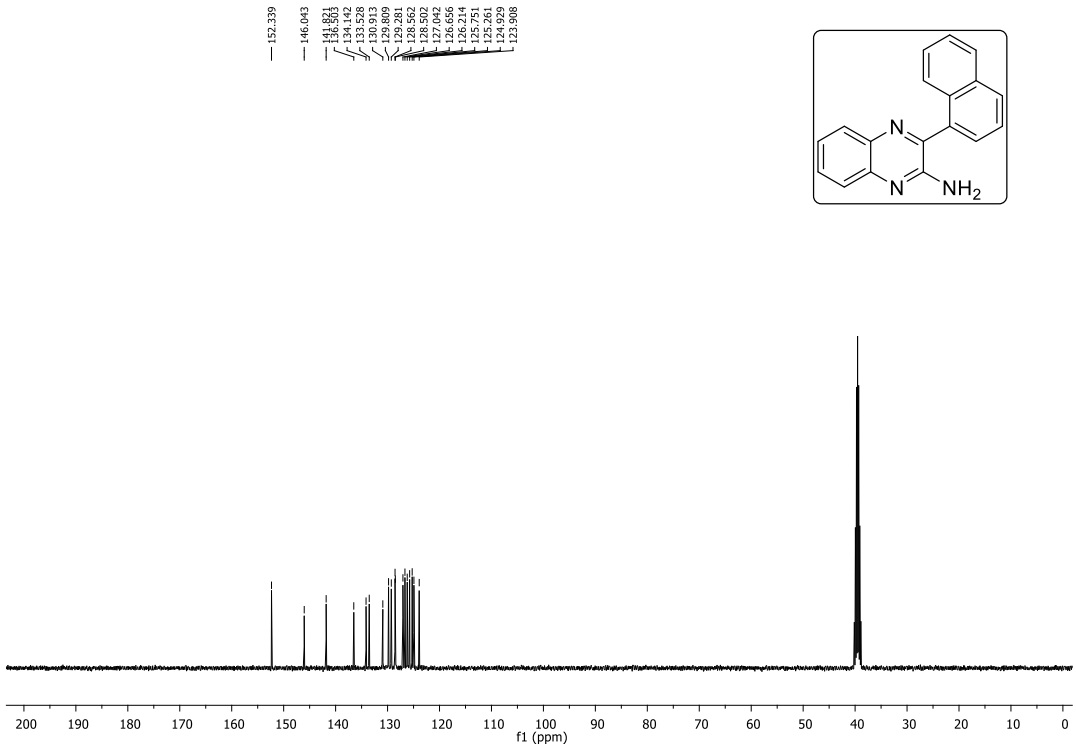


3-(Naphthalen-1-yl)quinoxalin-2-amine (3p)

^{1}H NMR (400 MHz, DMSO)

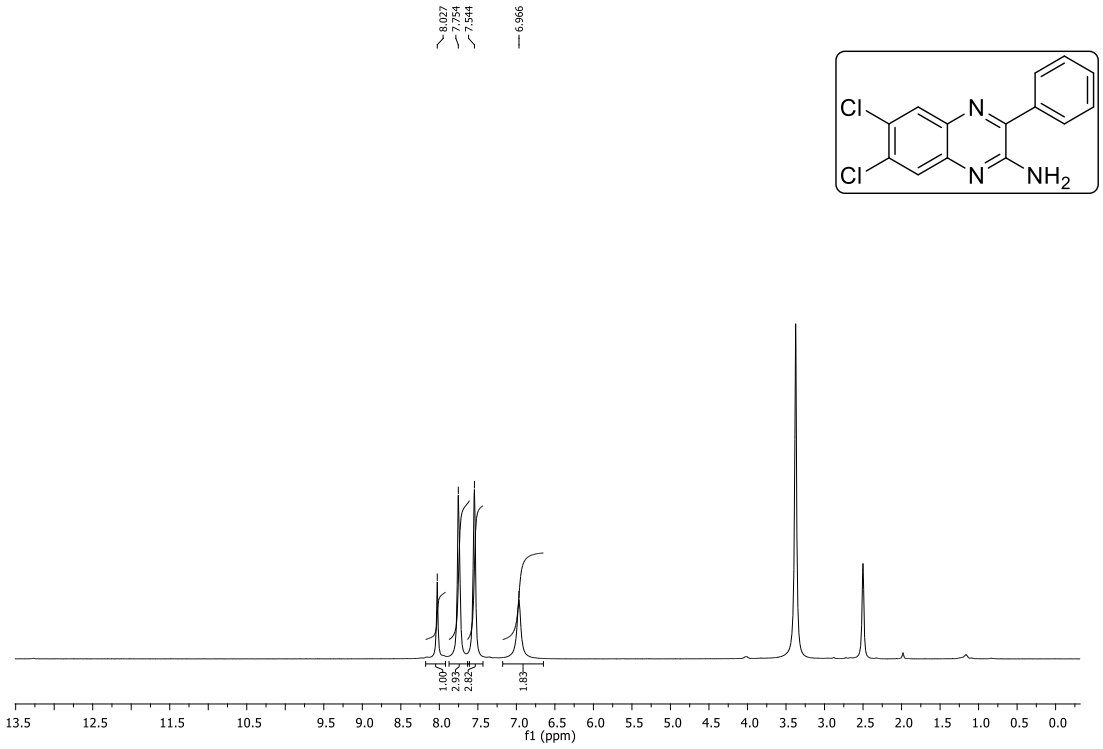


^{13}C{^{1}H} NMR (100 MHz, DMSO)

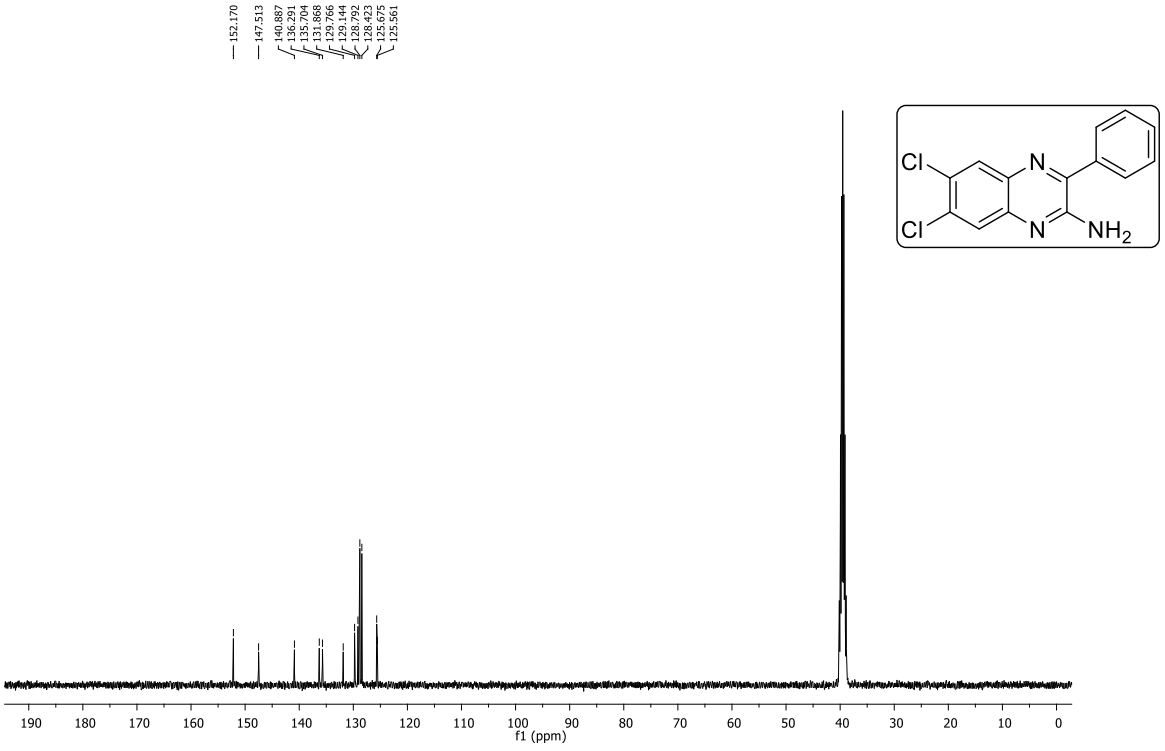


6,7-Dichloro-3-phenylquinoxalin-2-amine (3q)

^{1}H NMR (400 MHz, DMSO)

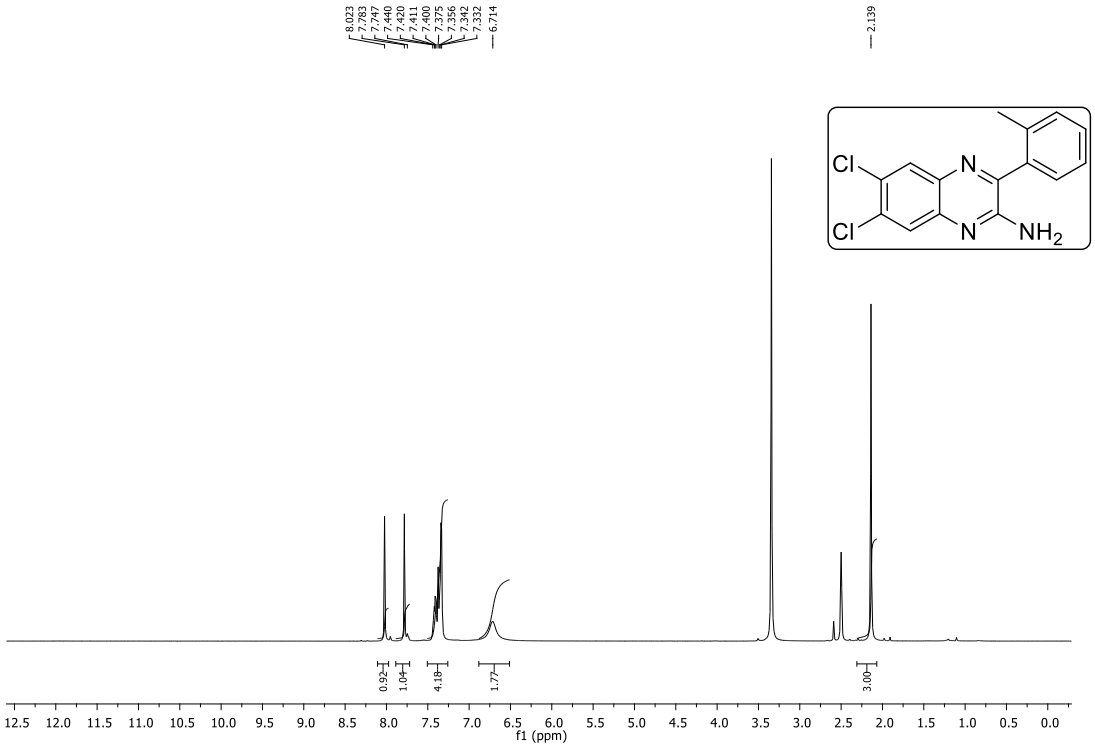


^{13}C{^{1}H} NMR (100 MHz, DMSO)

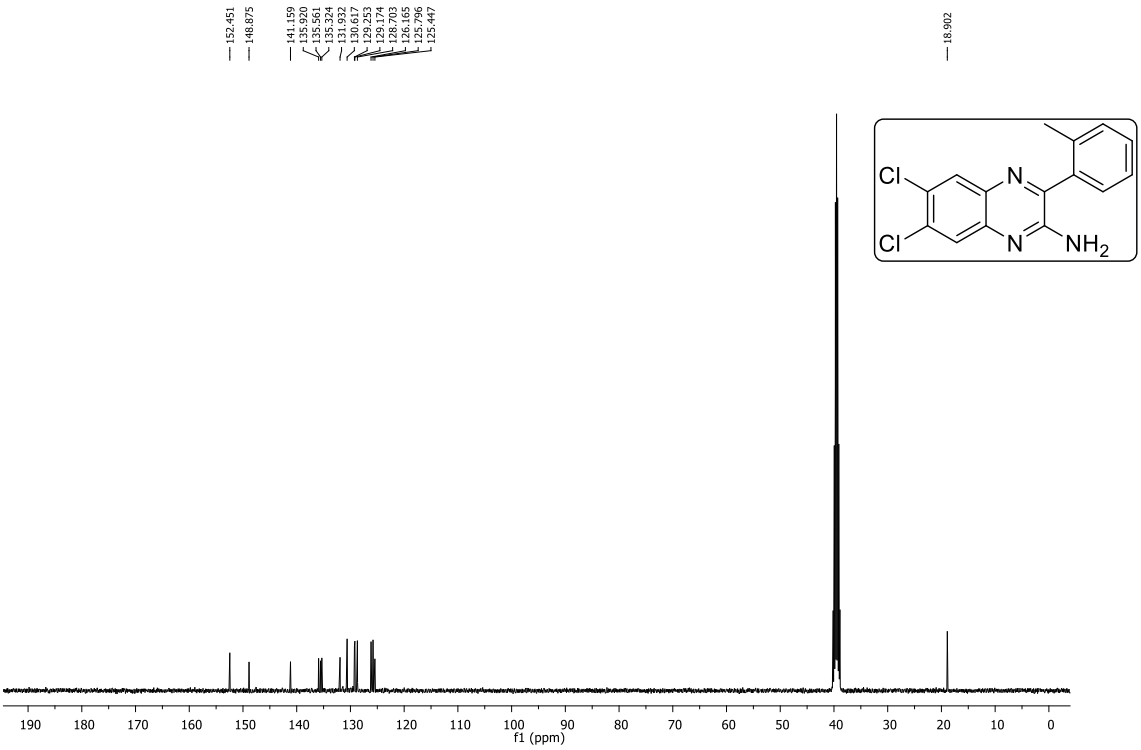


6,7-Dichloro-3-(*o*-tolyl)quinoxalin-2-amine (3r)

^{1}H NMR (400 MHz, DMSO)

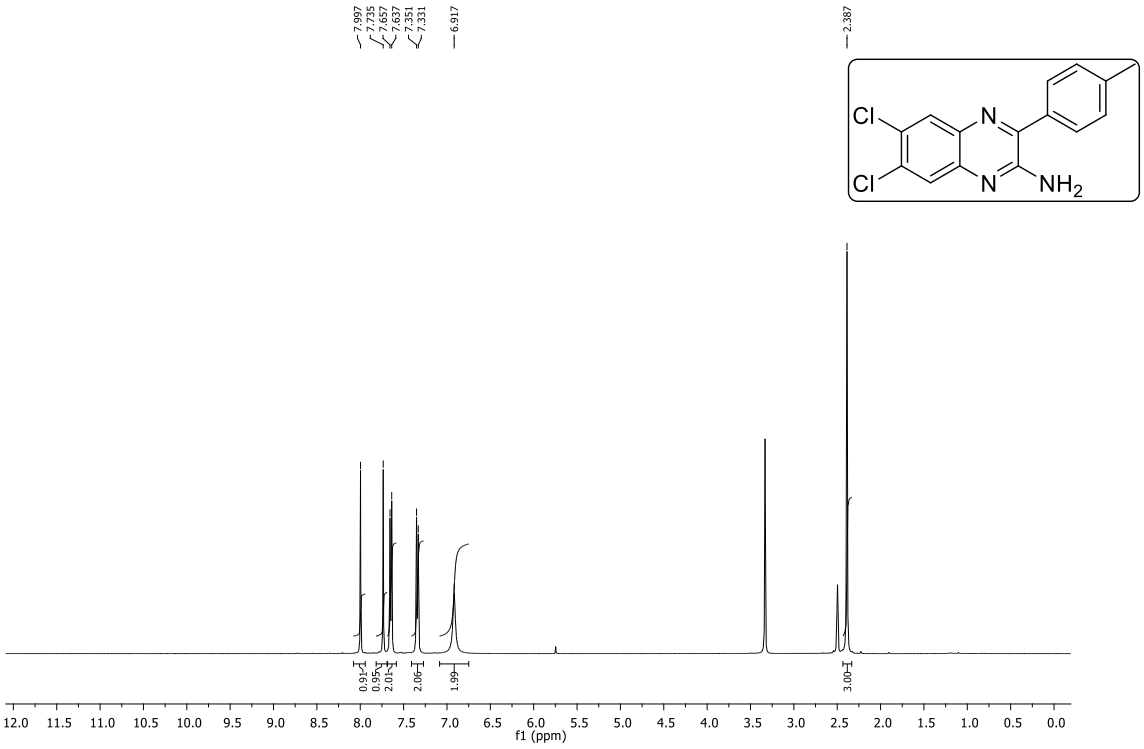


^{13}C{^{1}H} NMR (100 MHz, DMSO)

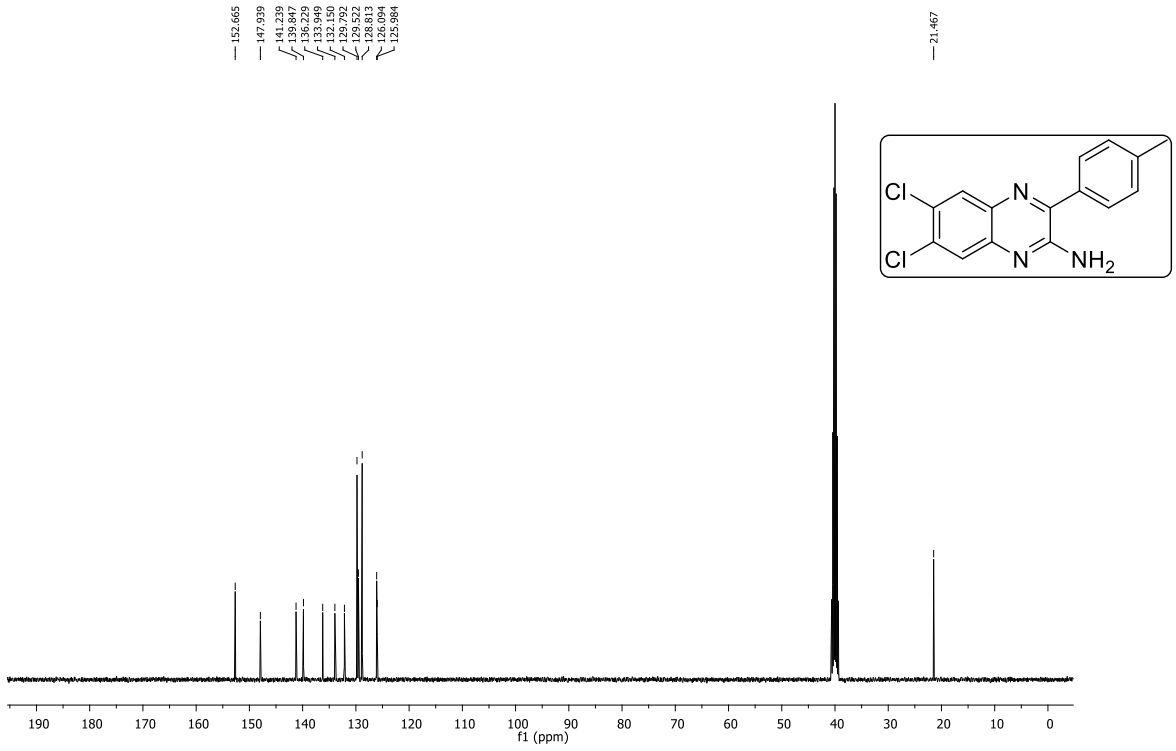


6,7-Dichloro-3-(*p*-tolyl)quinoxalin-2-amine (3s)

^{1}H NMR (400 MHz, DMSO)

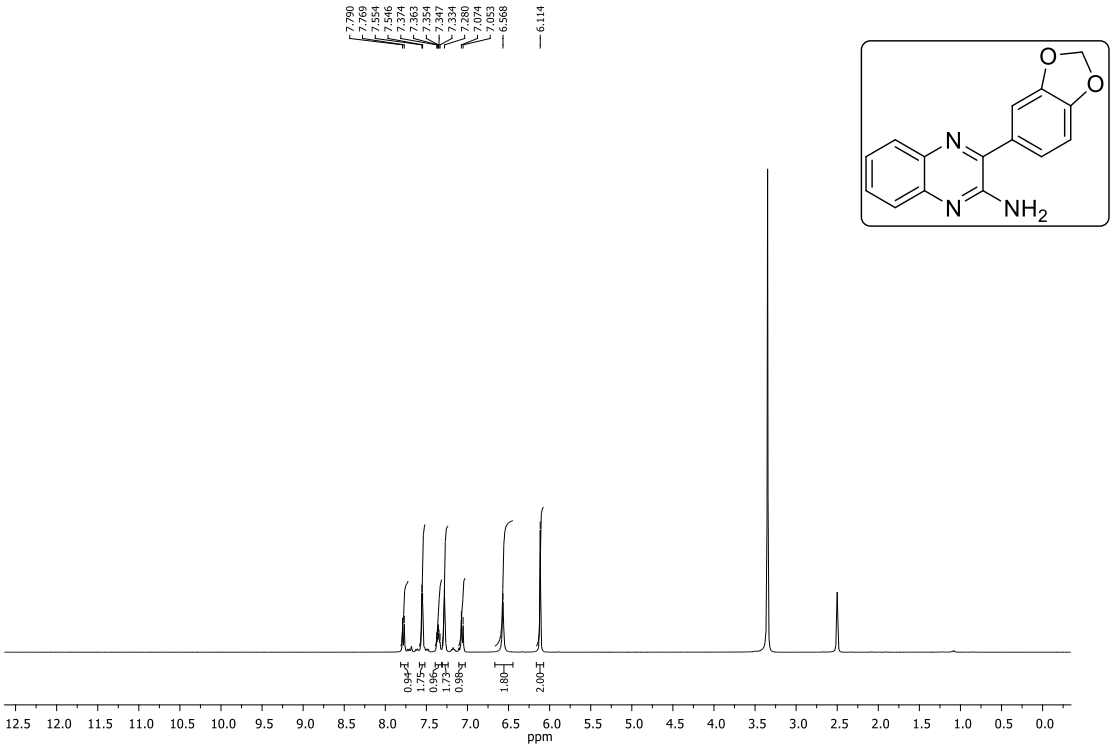


^{13}C{^{1}H} NMR (100 MHz, DMSO)

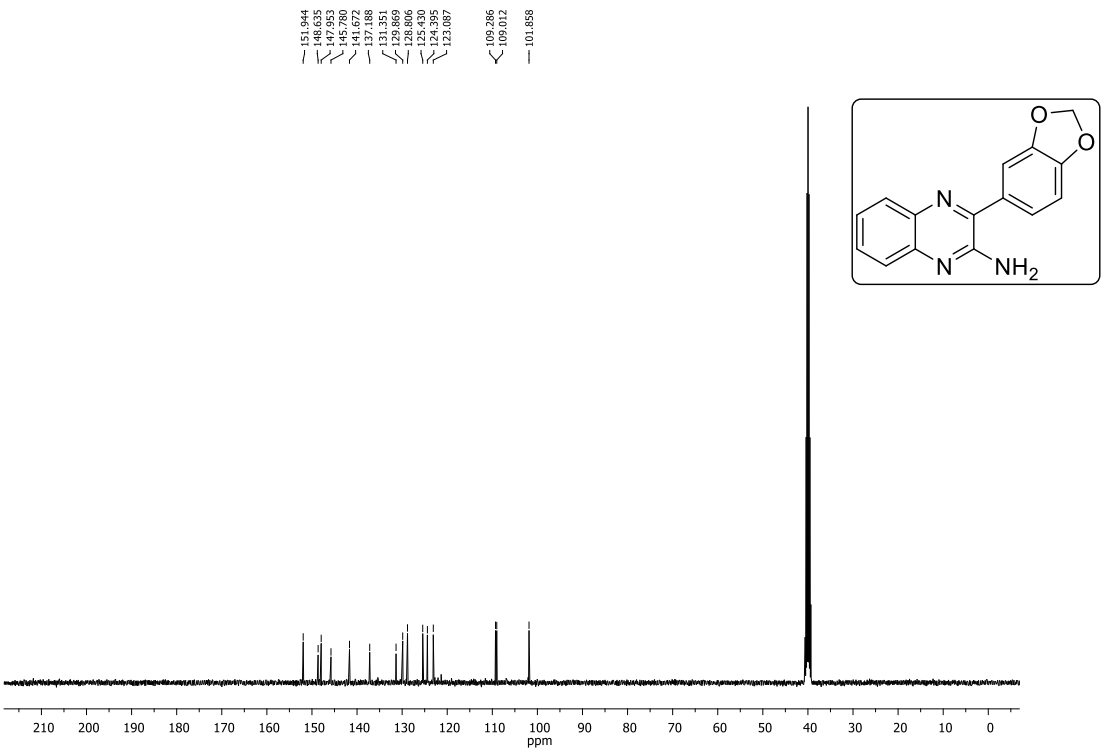


3-(Benzo[*d*][1,3]dioxol-5-yl)quinoxalin-2-amine (3t)

^{1}H NMR (400 MHz, DMSO)

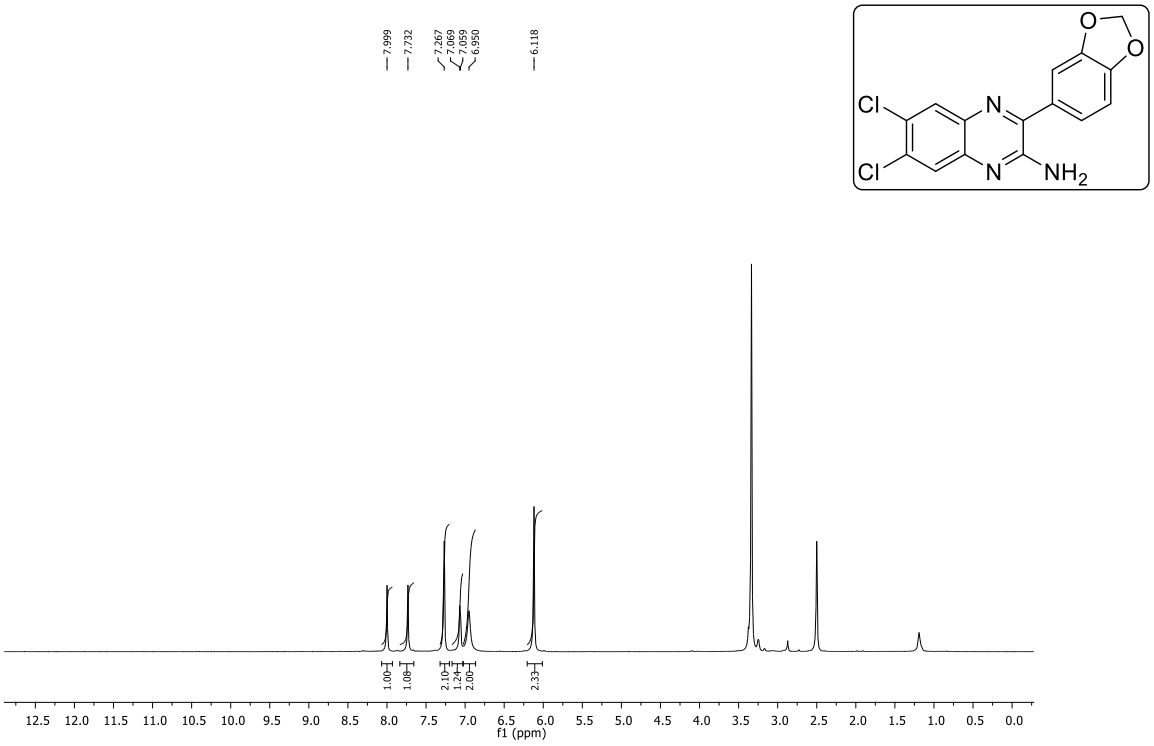


^{13}C{^{1}H} NMR (100 MHz, DMSO)

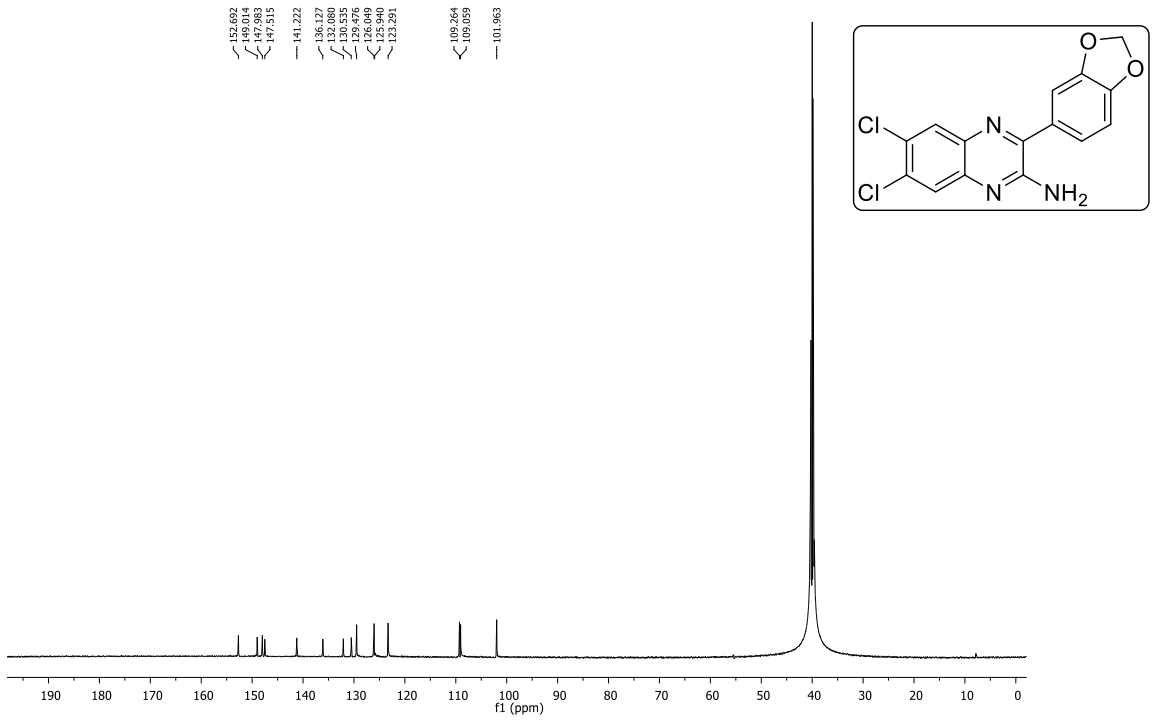


3-(Benzo[d][1,3]dioxol-5-yl)-6,7-dichloroquinoxalin-2-amine (3u)

^{1}H NMR (700 MHz, DMSO)

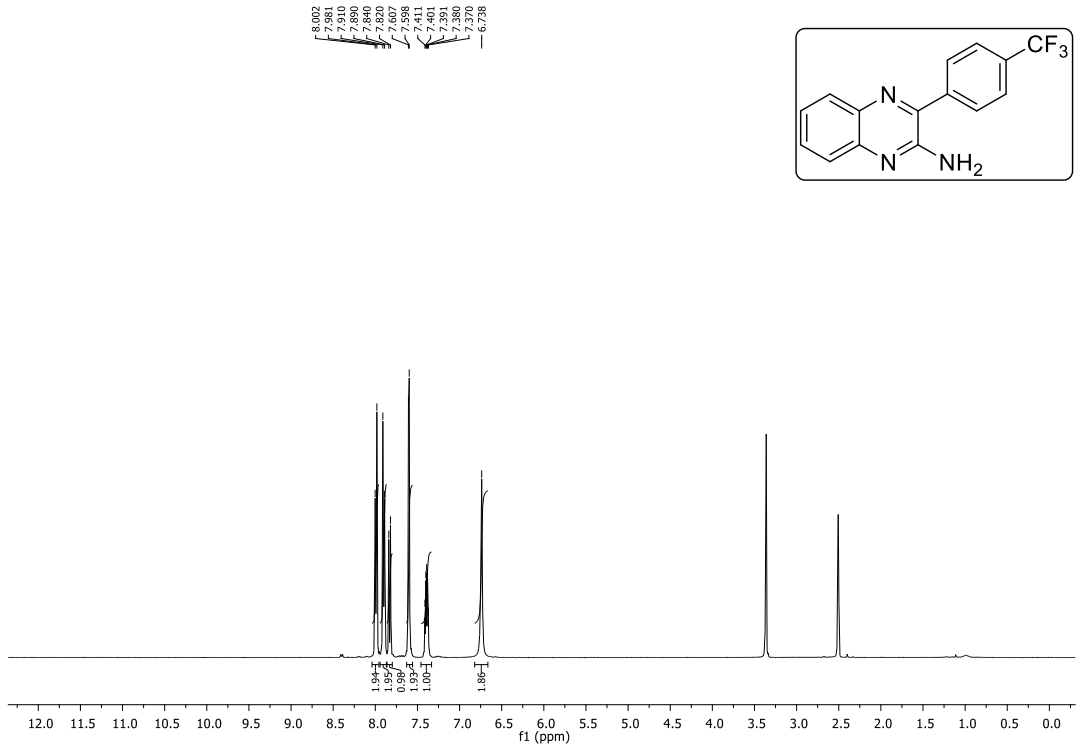


^{13}C NMR (175 MHz, DMSO)

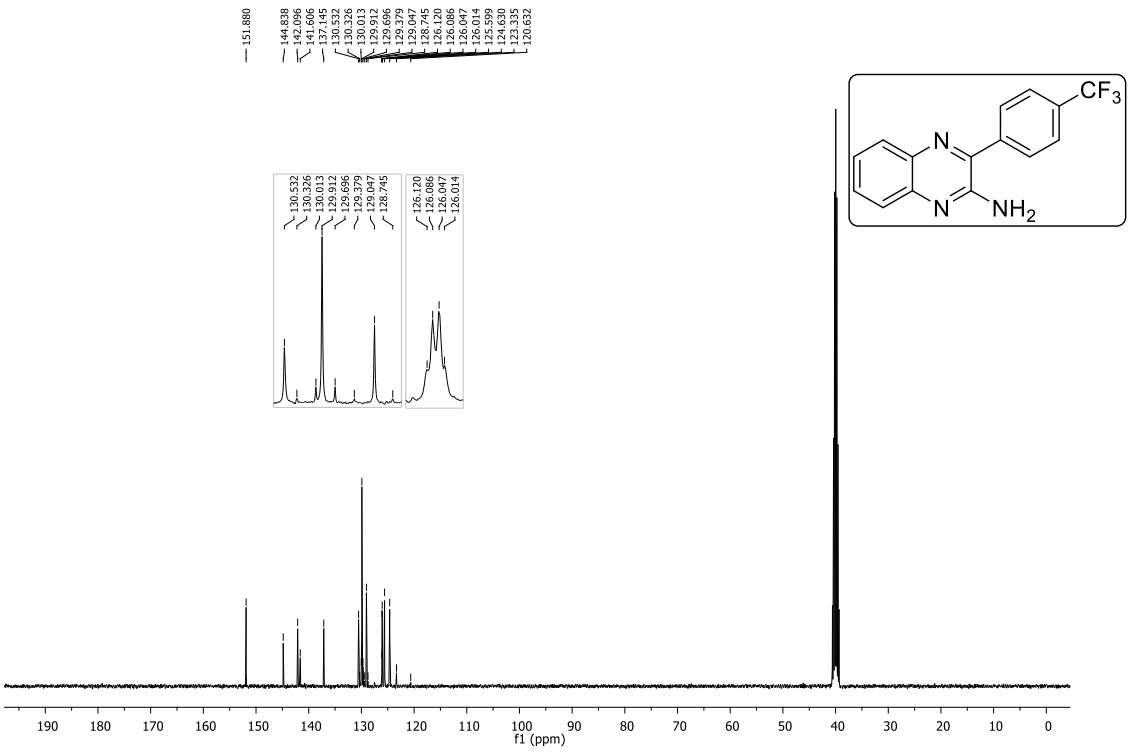


3-(4-(Trifluoromethyl)phenyl)quinoxalin-2-amine (3v)

^{1}H NMR (400 MHz, DMSO)

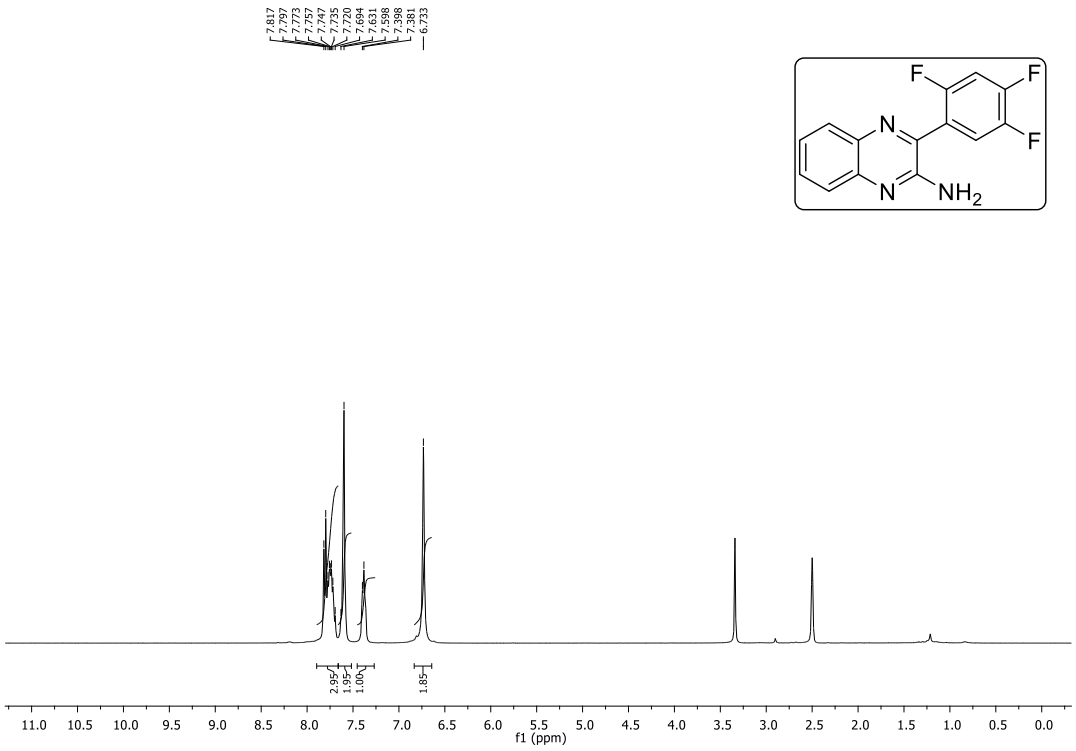


^{13}C{^{1}H} NMR (100 MHz, DMSO)

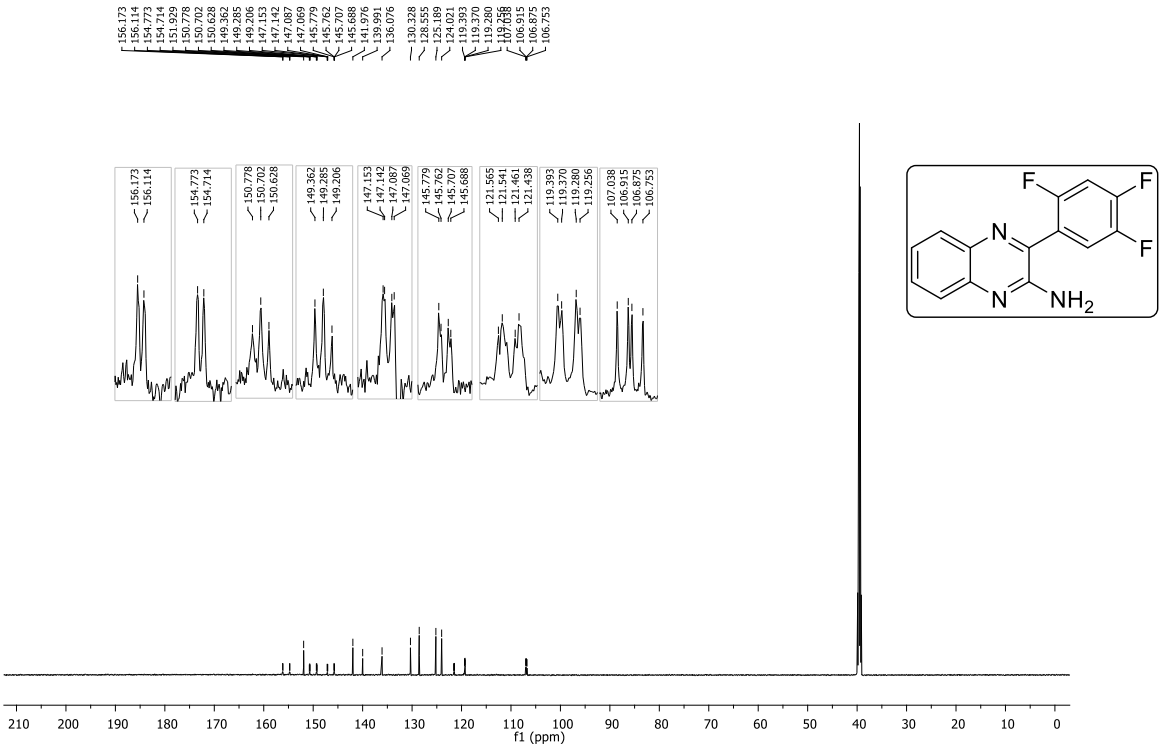


3-(2,4,5-Trifluorophenyl)quinoxalin-2-amine (3w)

^{1}H NMR (400 MHz, DMSO)

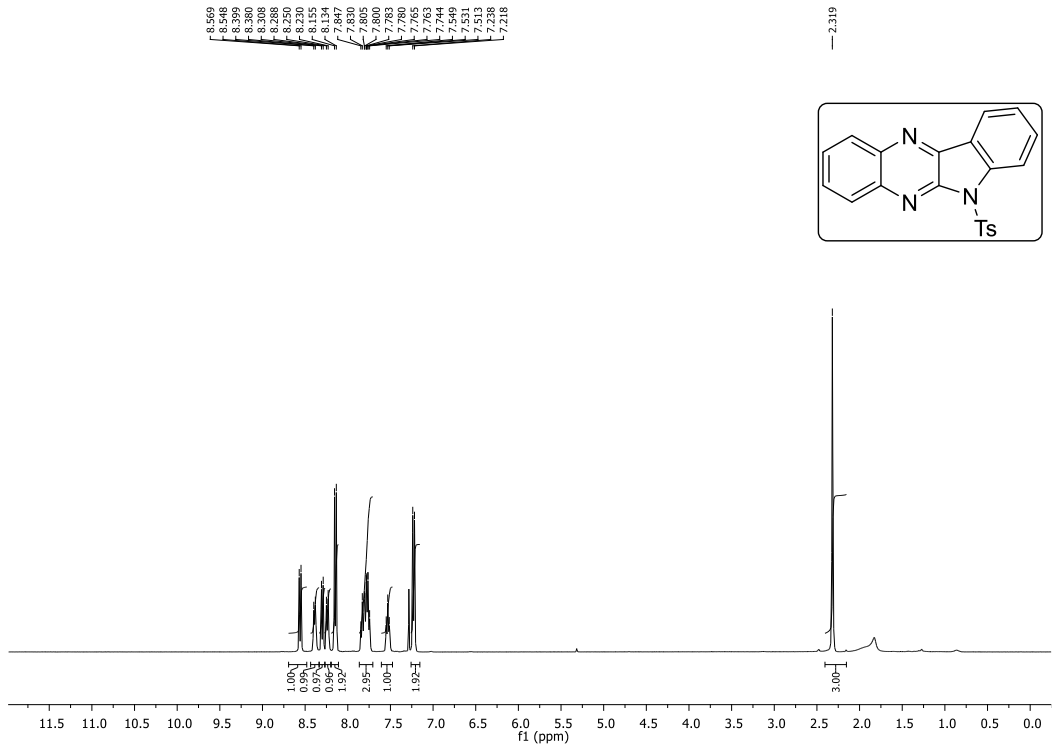


^{13}C{^{1}H} NMR (175 MHz, DMSO)

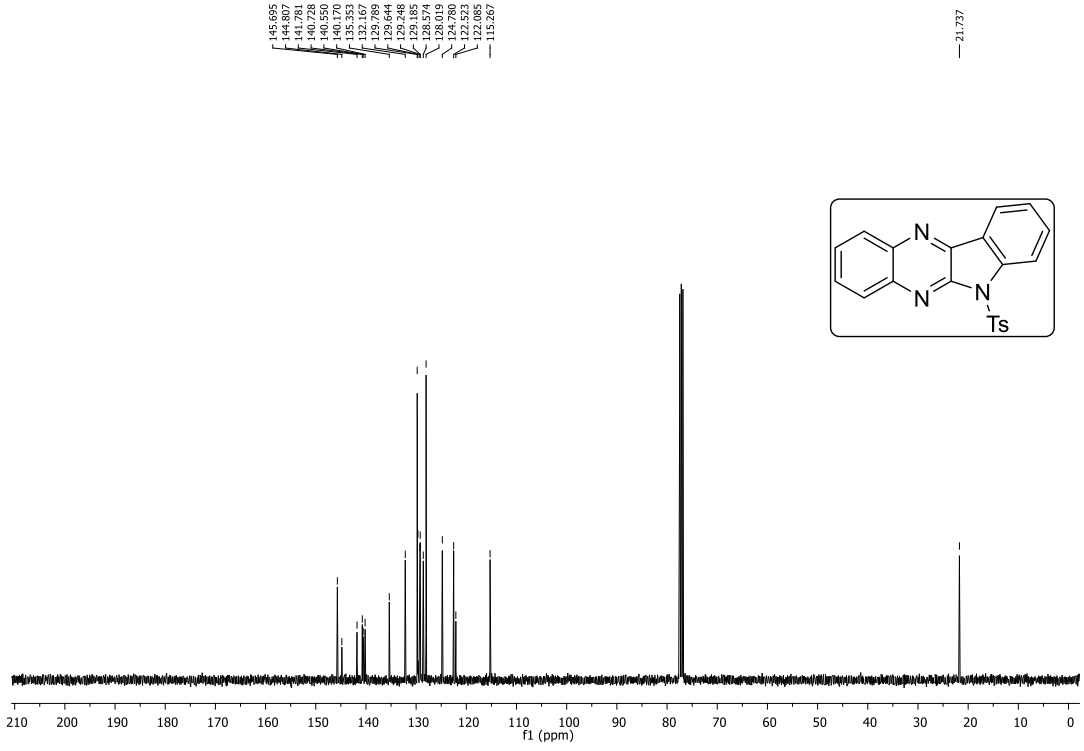


6-Tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5a)

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

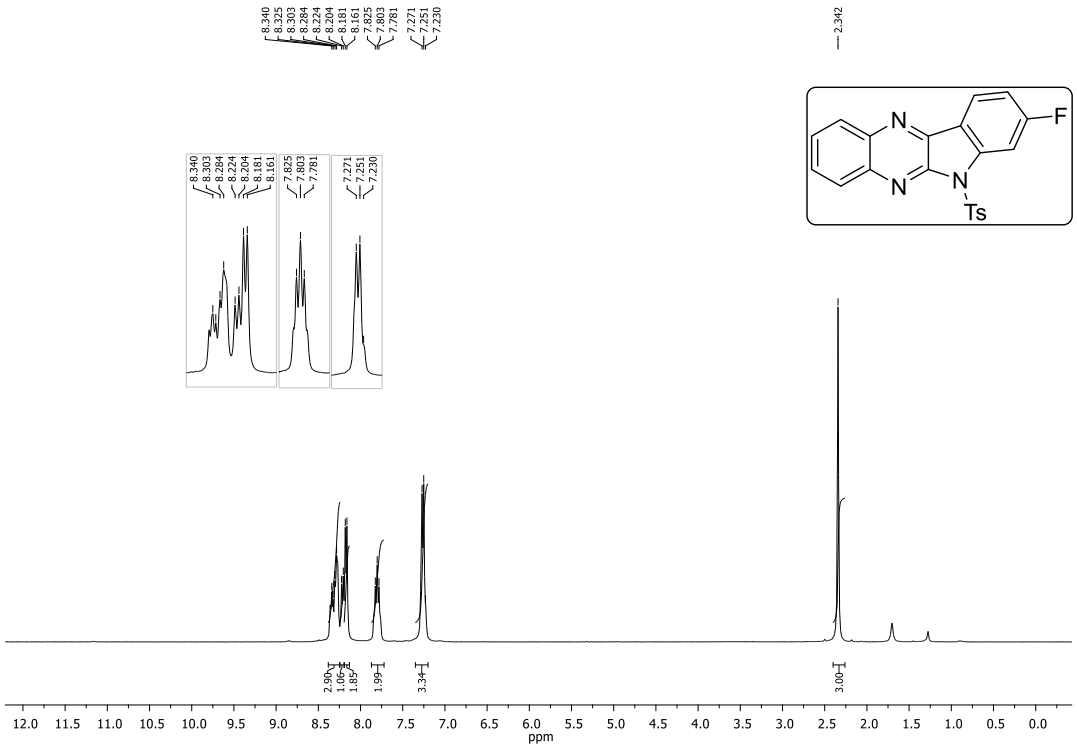


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

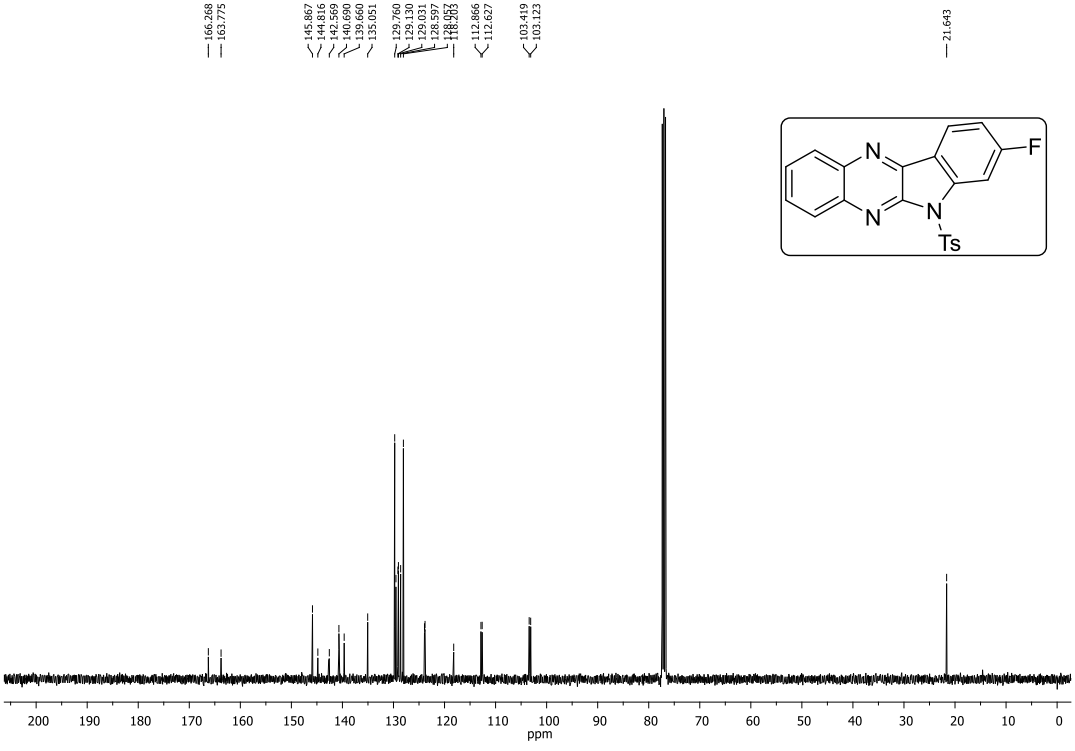


8-Fluoro-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5b)

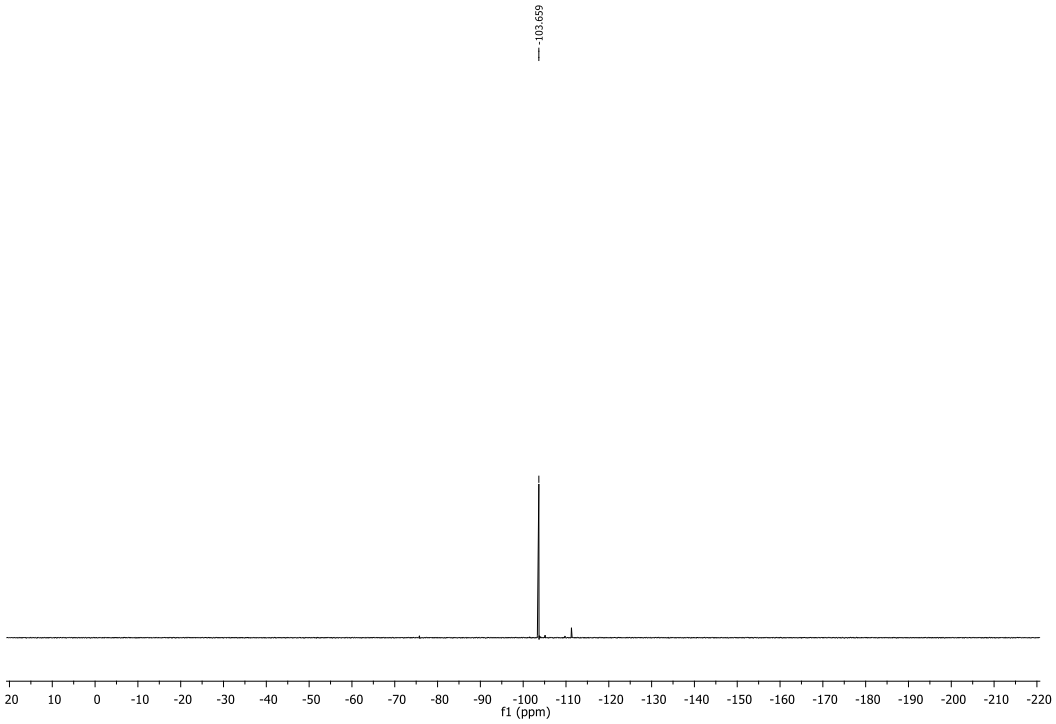
^{1}H NMR (400 MHz, $CDCl_3$



^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

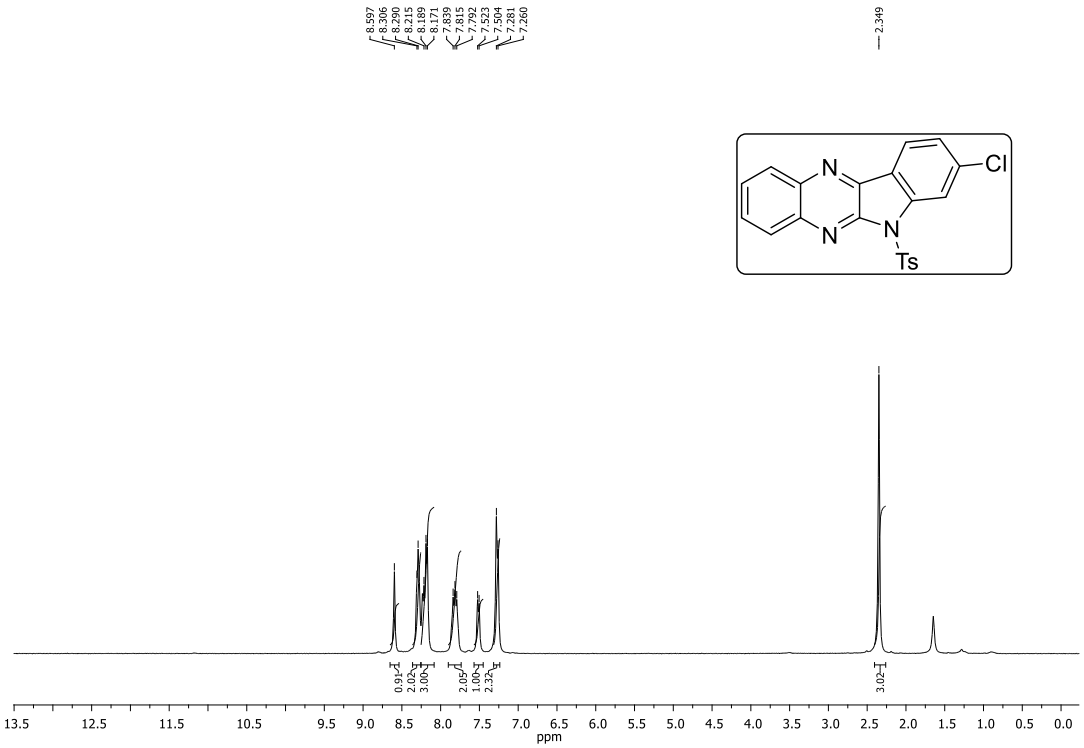


^{19}F NMR (377 MHz, $CDCl_3$)

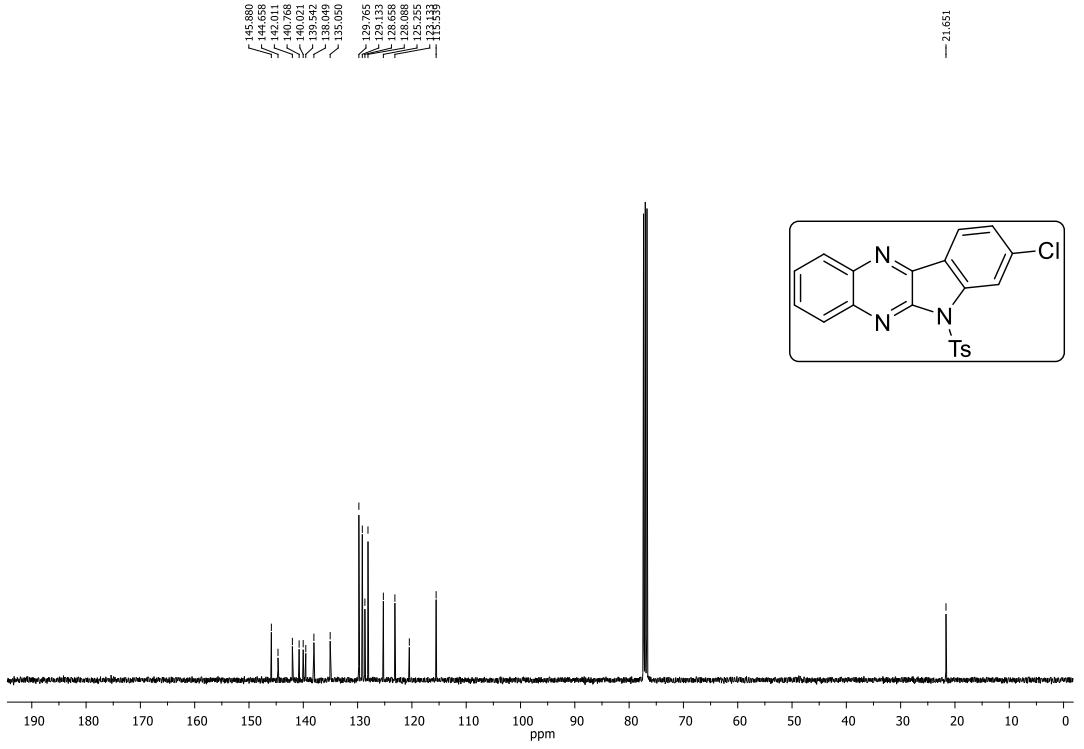


8-Chloro-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5c)

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

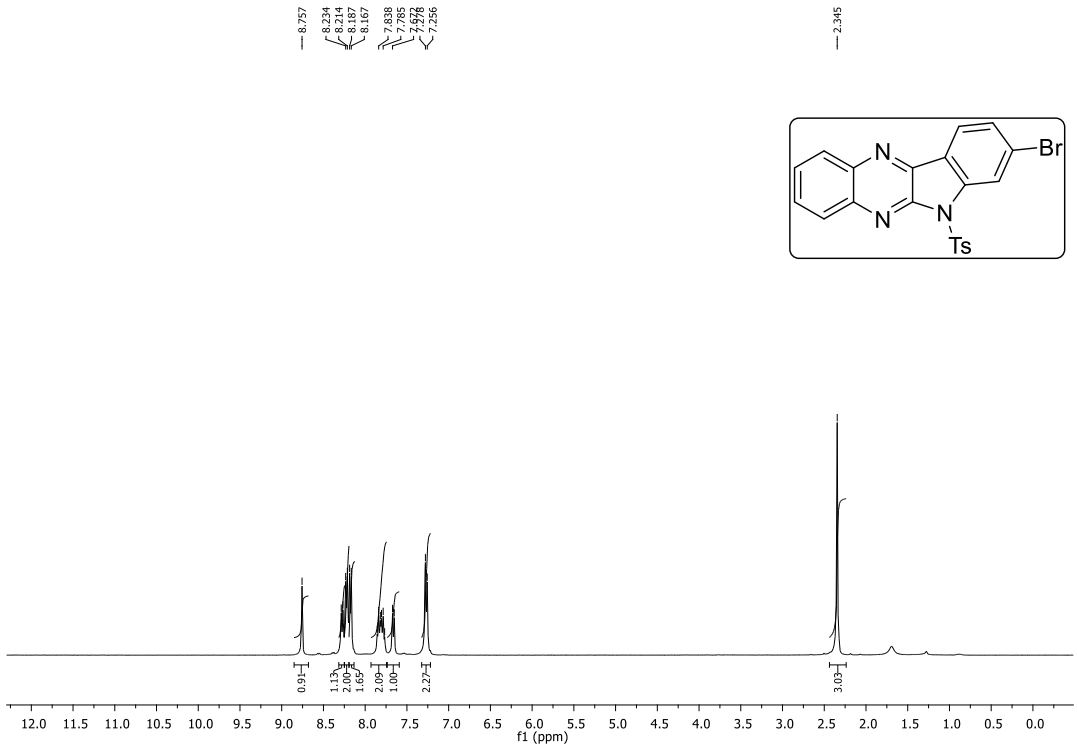


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

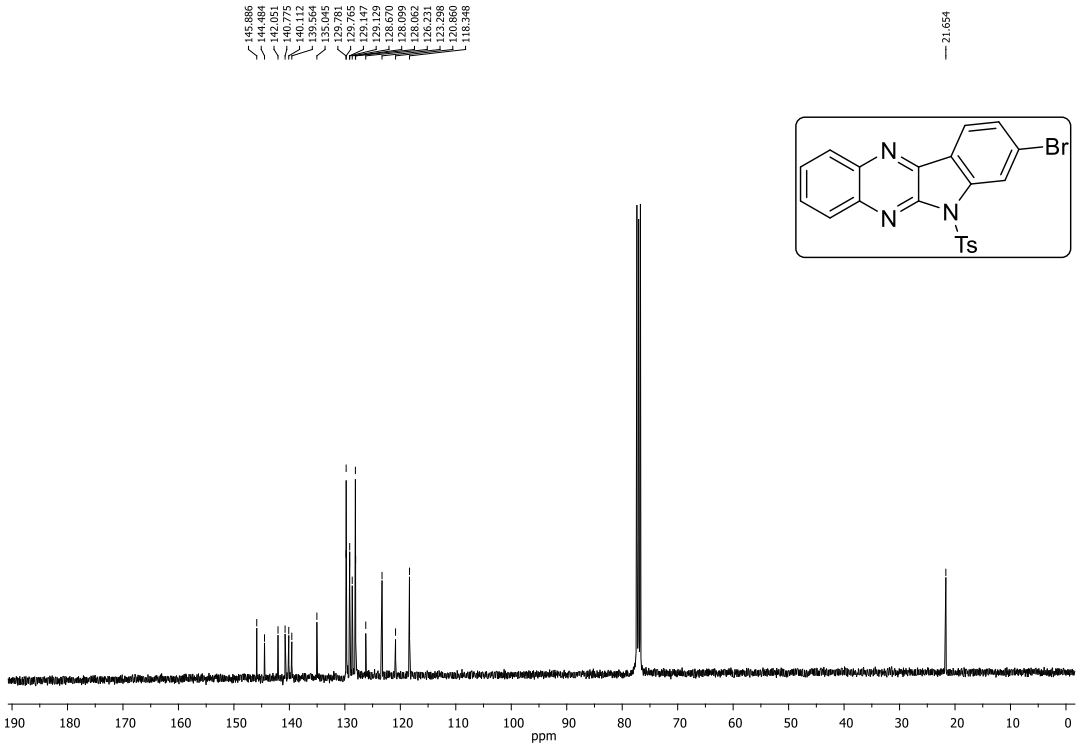


8-Bromo-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5d)

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

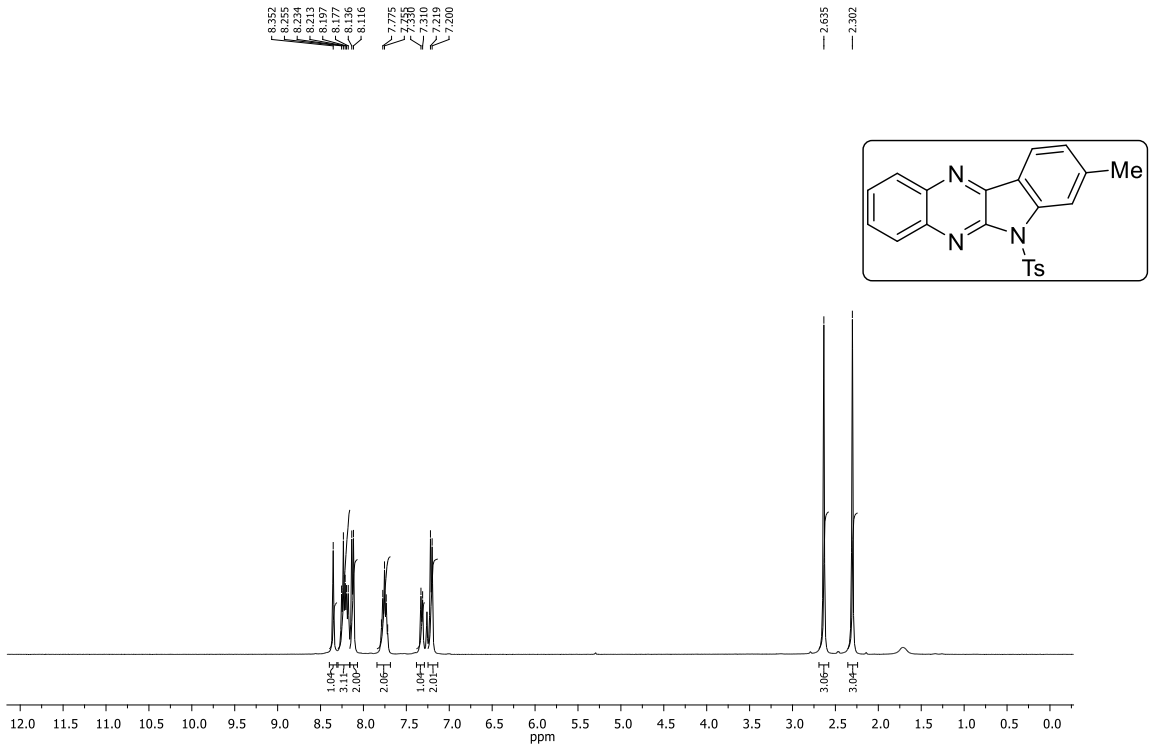


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

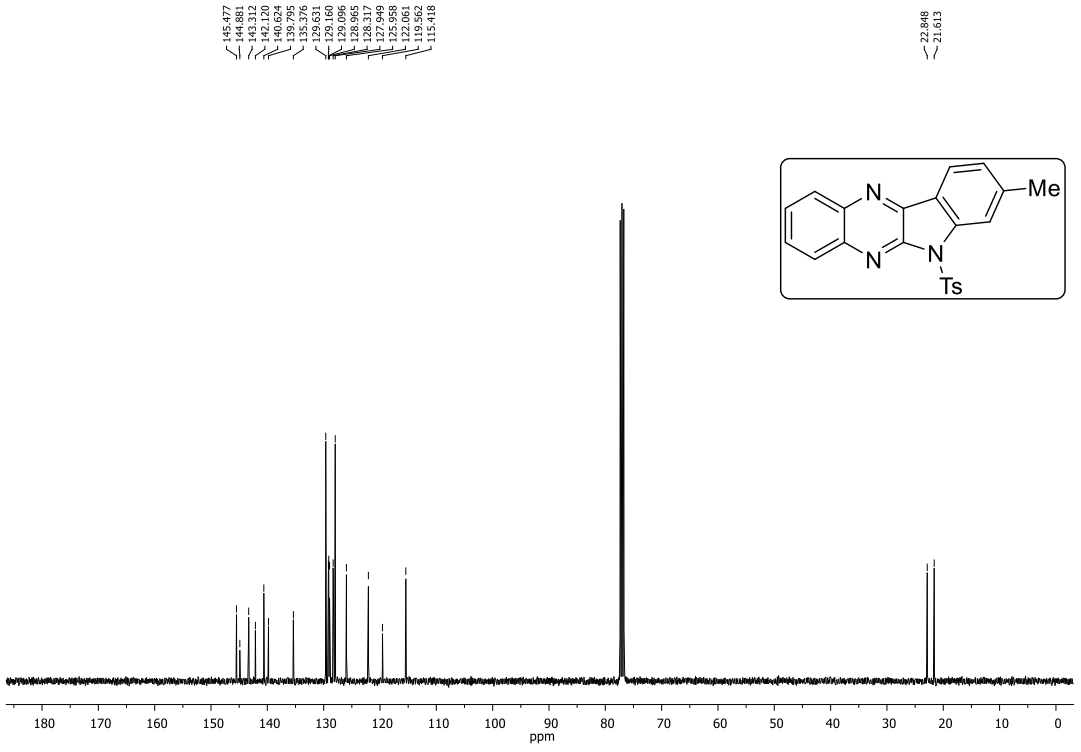


8-Methyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5e)

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

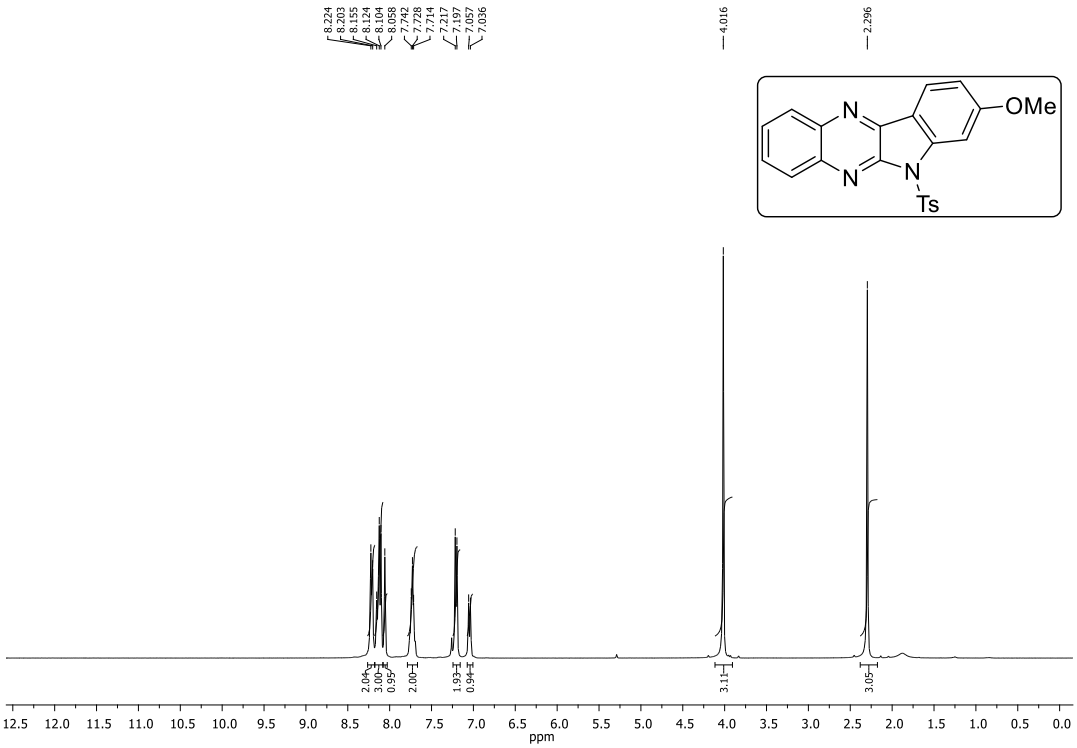


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

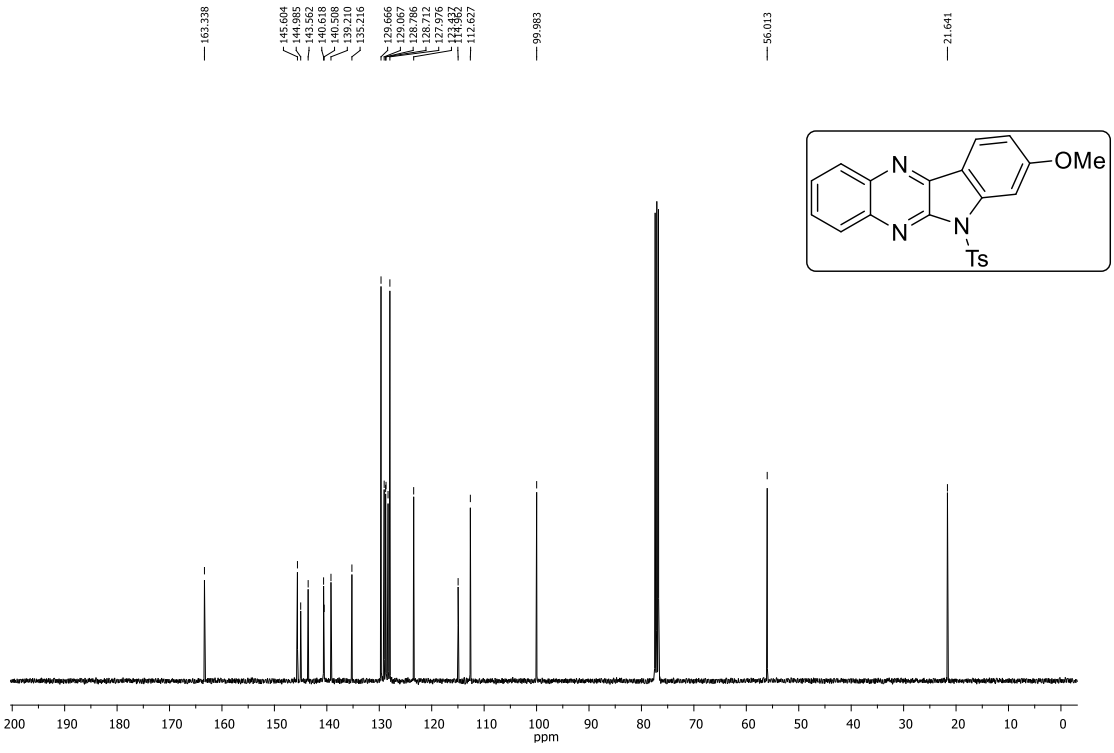


8-Methoxy-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5f)

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

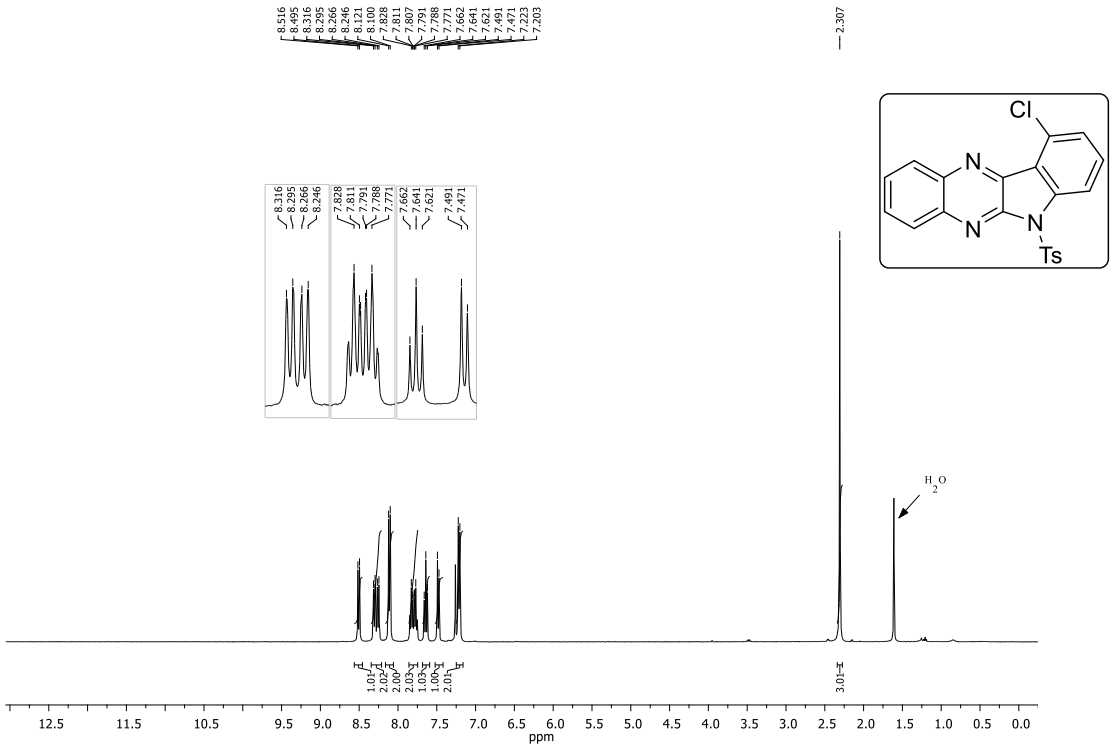


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

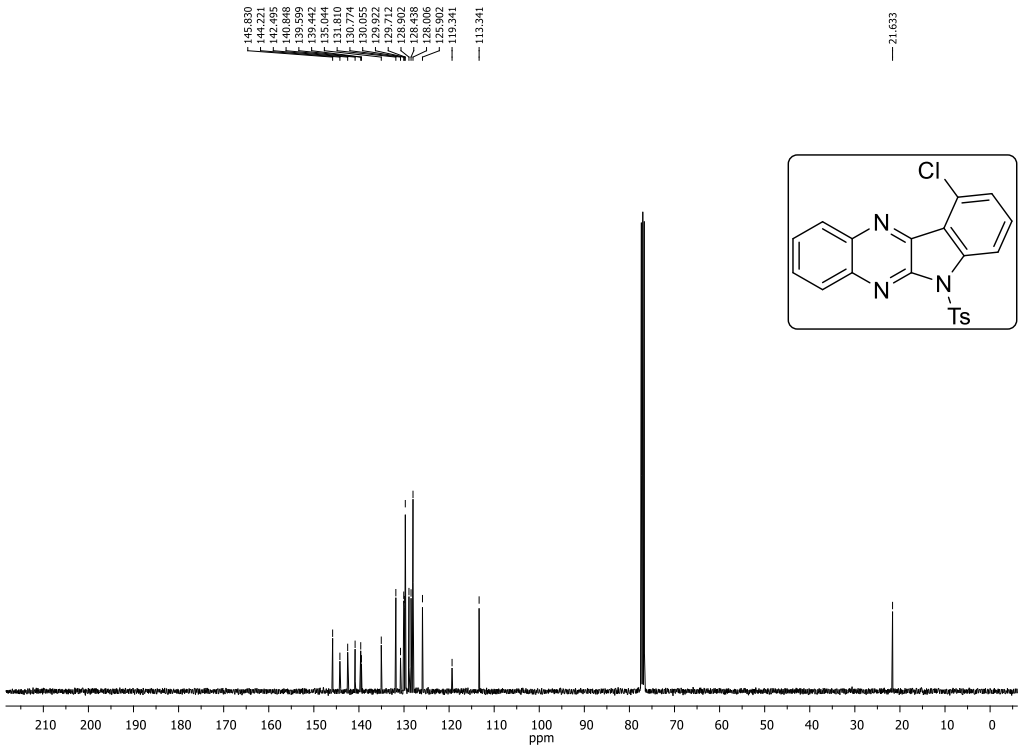


10-Chloro-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5g)

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

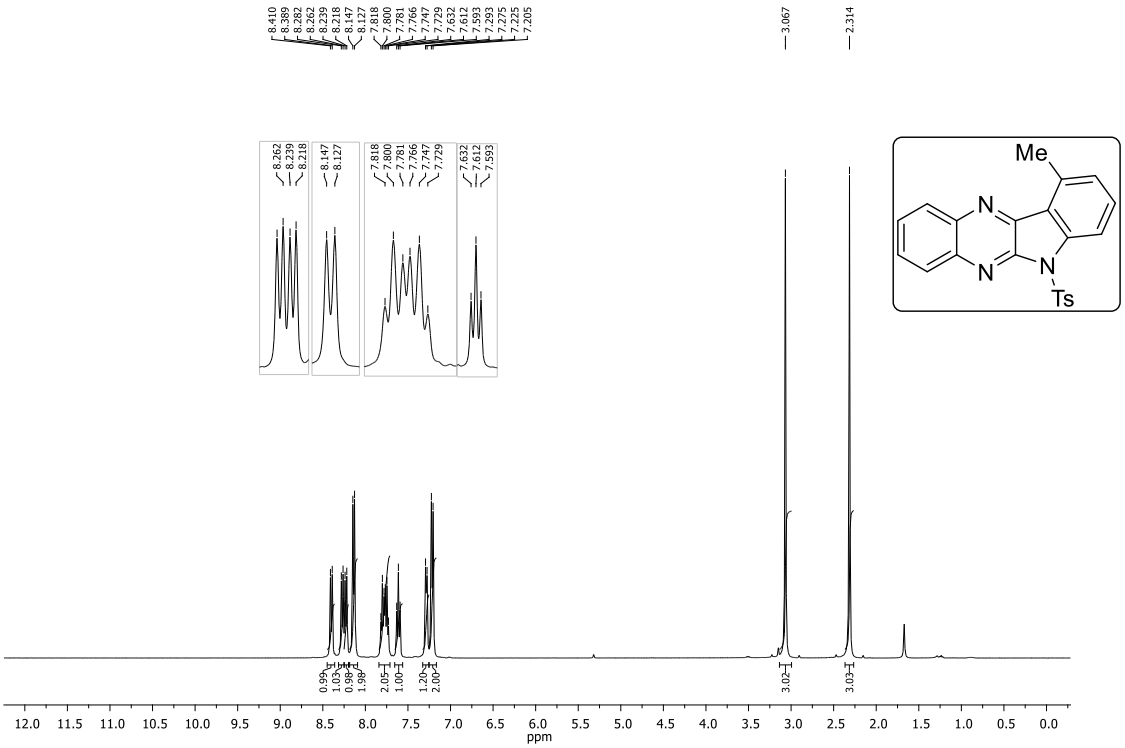


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

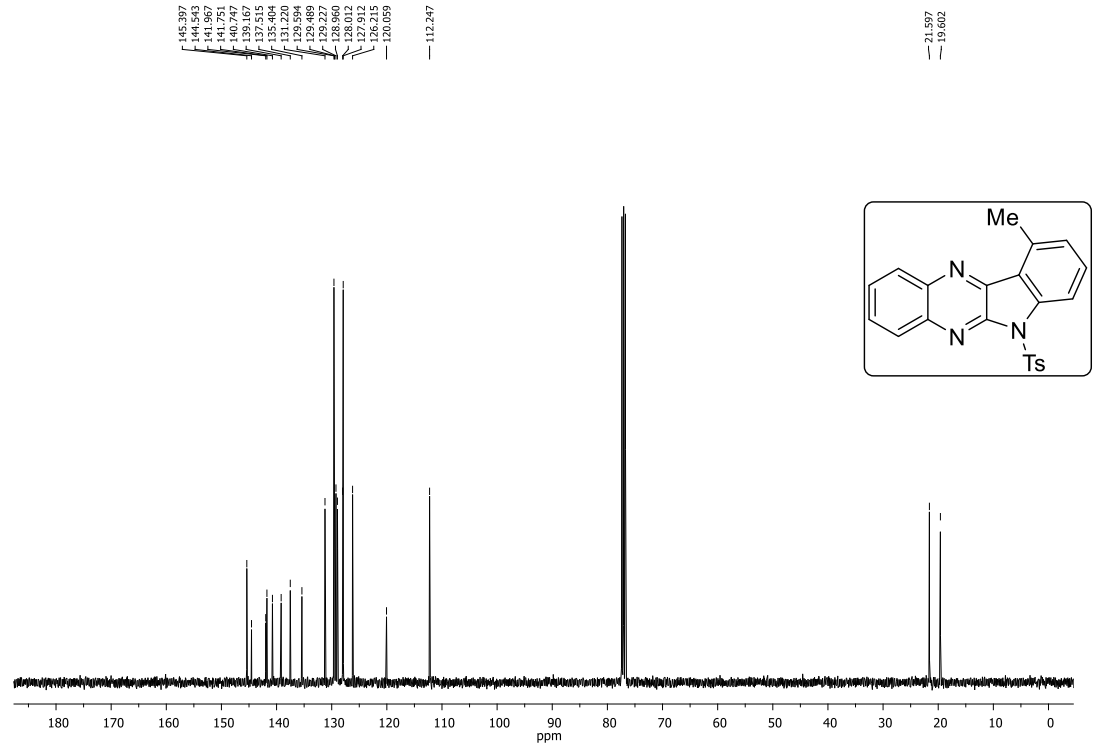


10-Methyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5h)

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

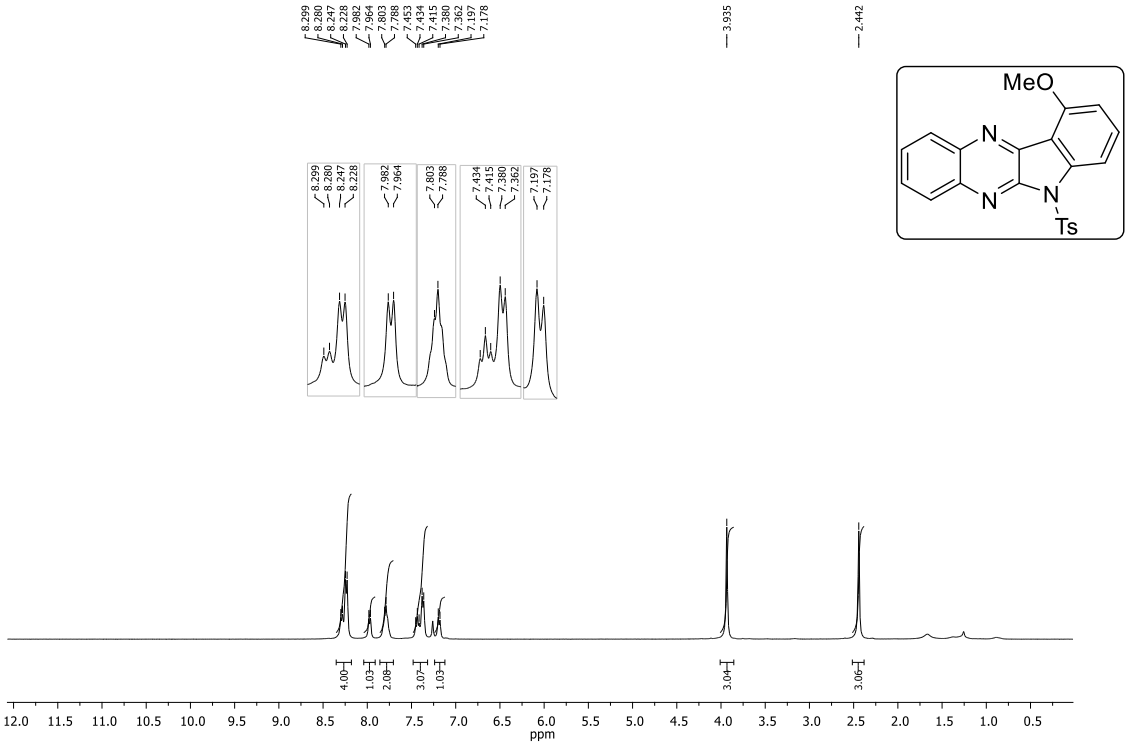


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

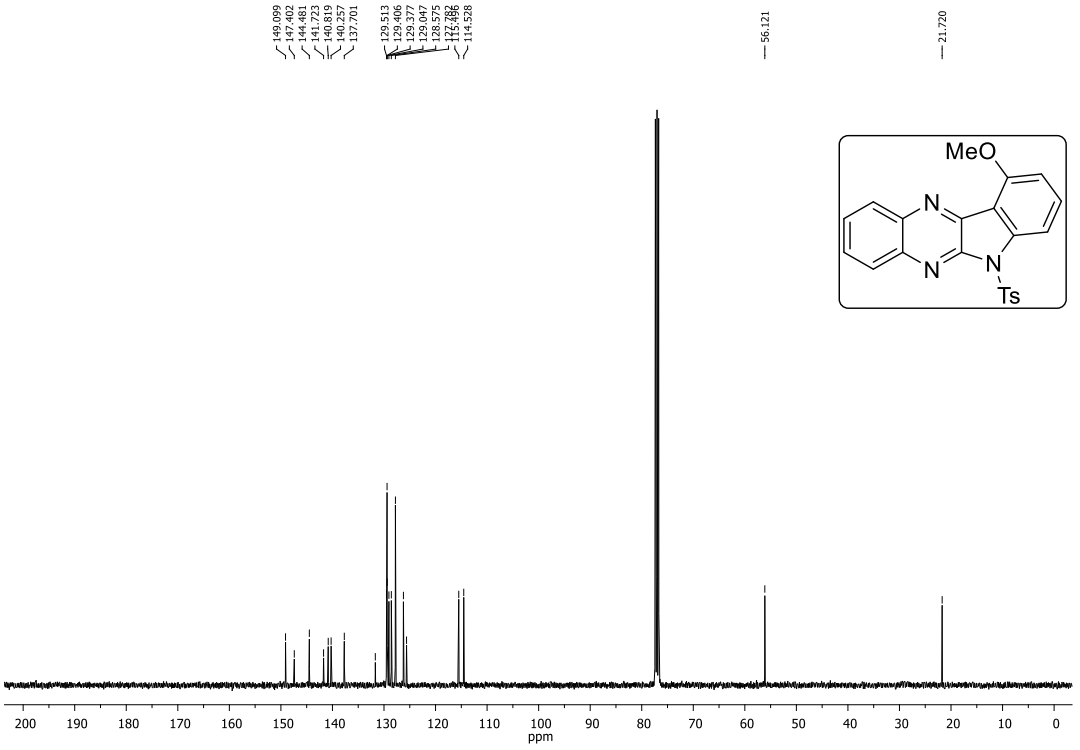


10-Methoxy-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5i)

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

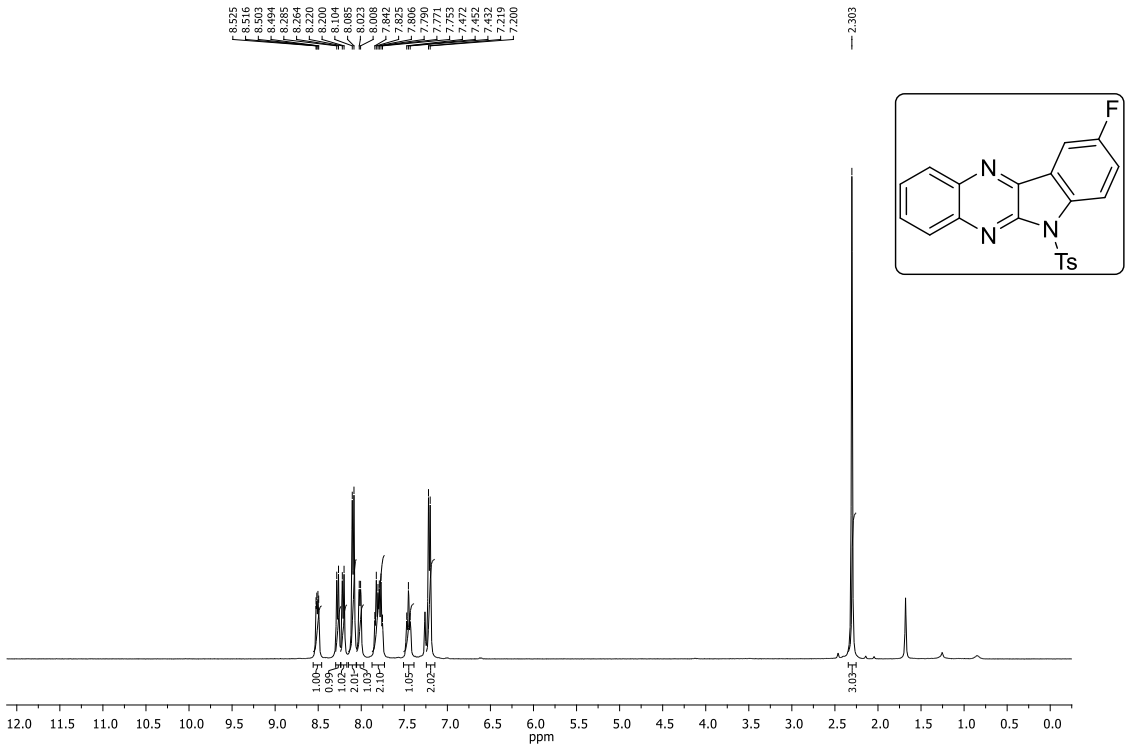


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

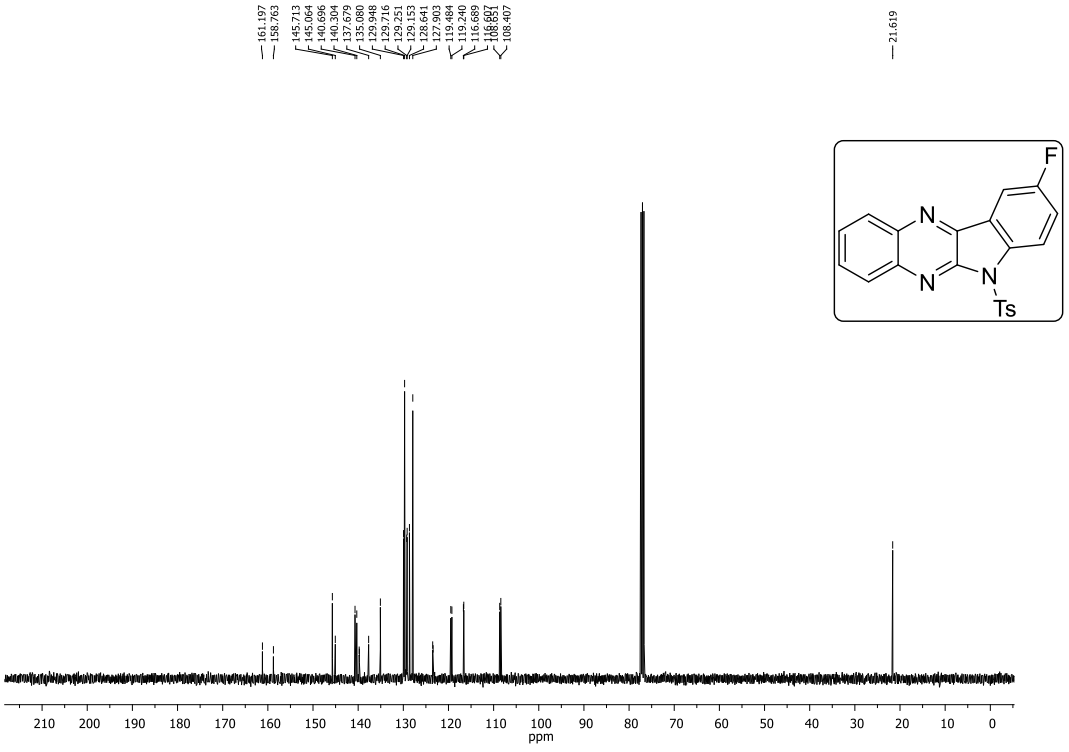


9-Fluoro-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5j)

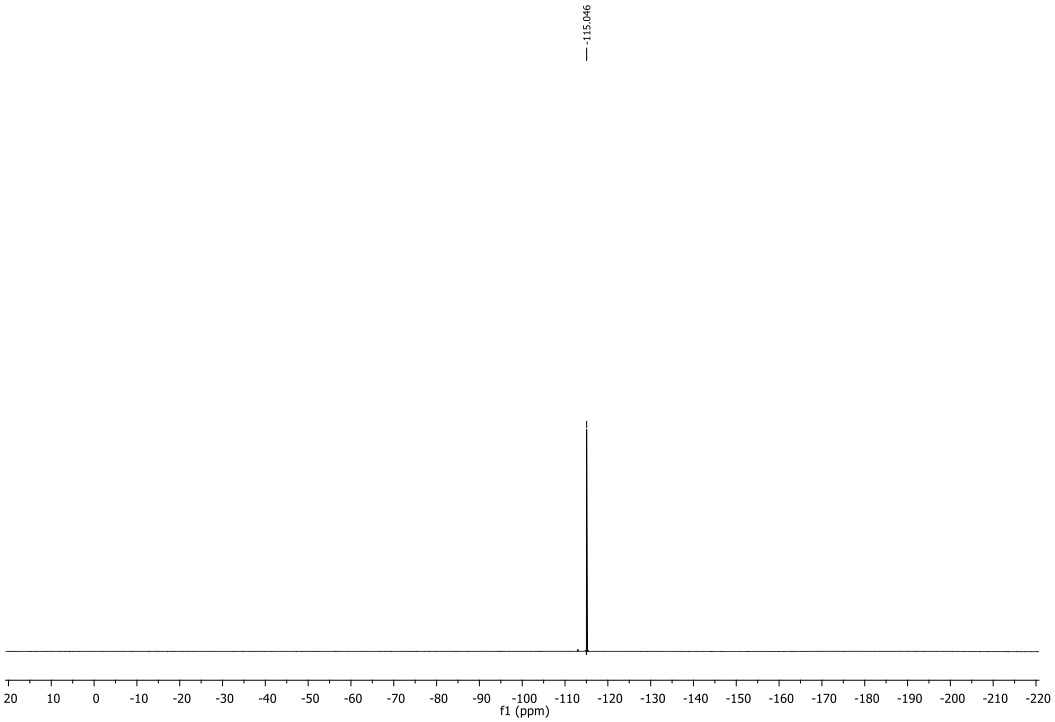
^{1}H NMR (400 MHz, $CDCl_3$)



^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

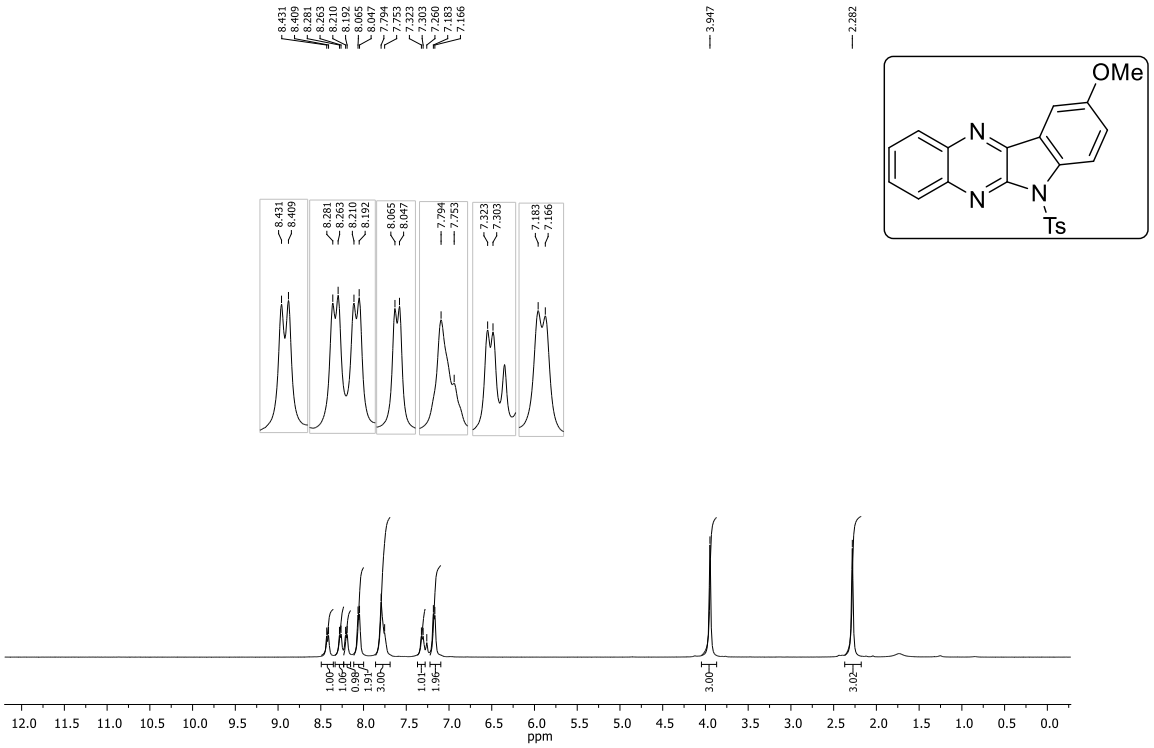


^{19}F NMR (377 MHz, $CDCl_3$)

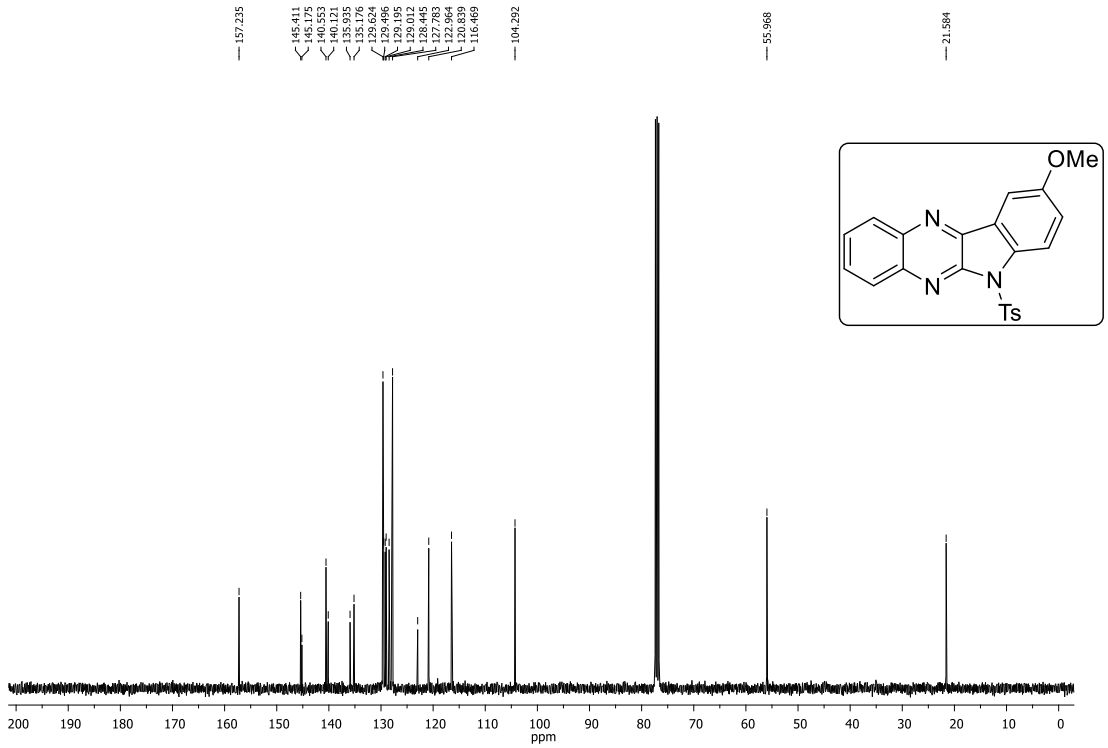


9-Methoxy-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5k)

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

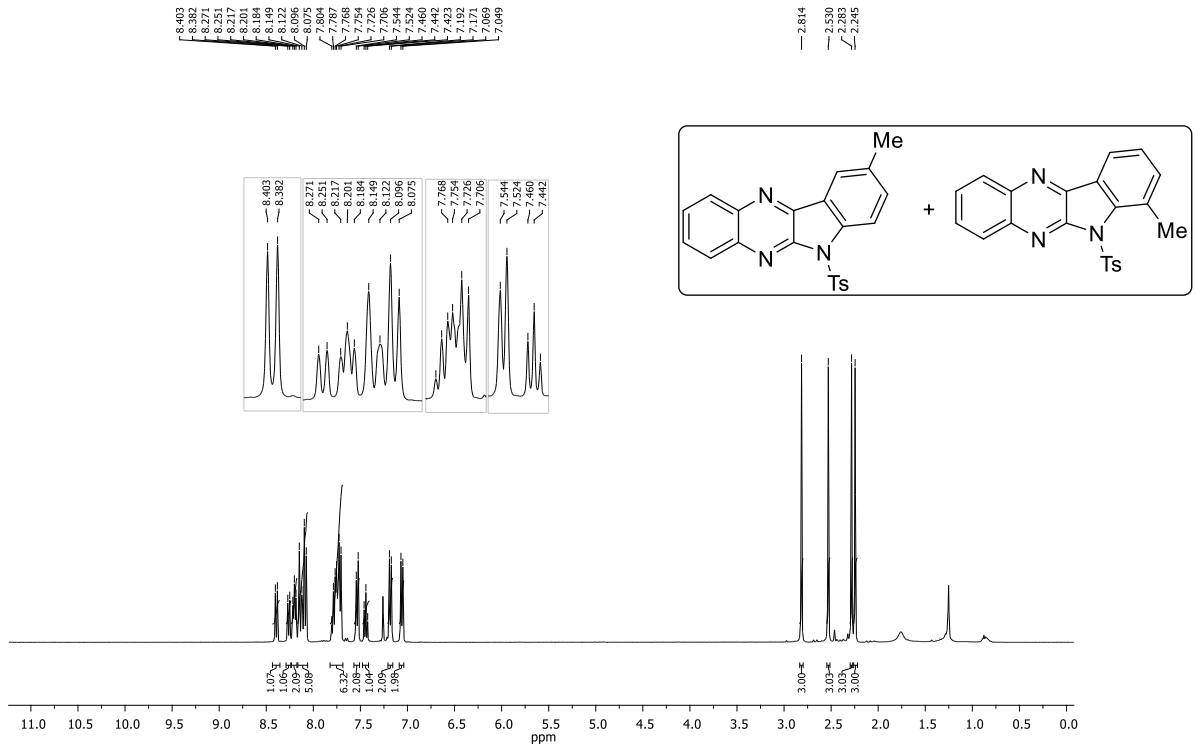


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

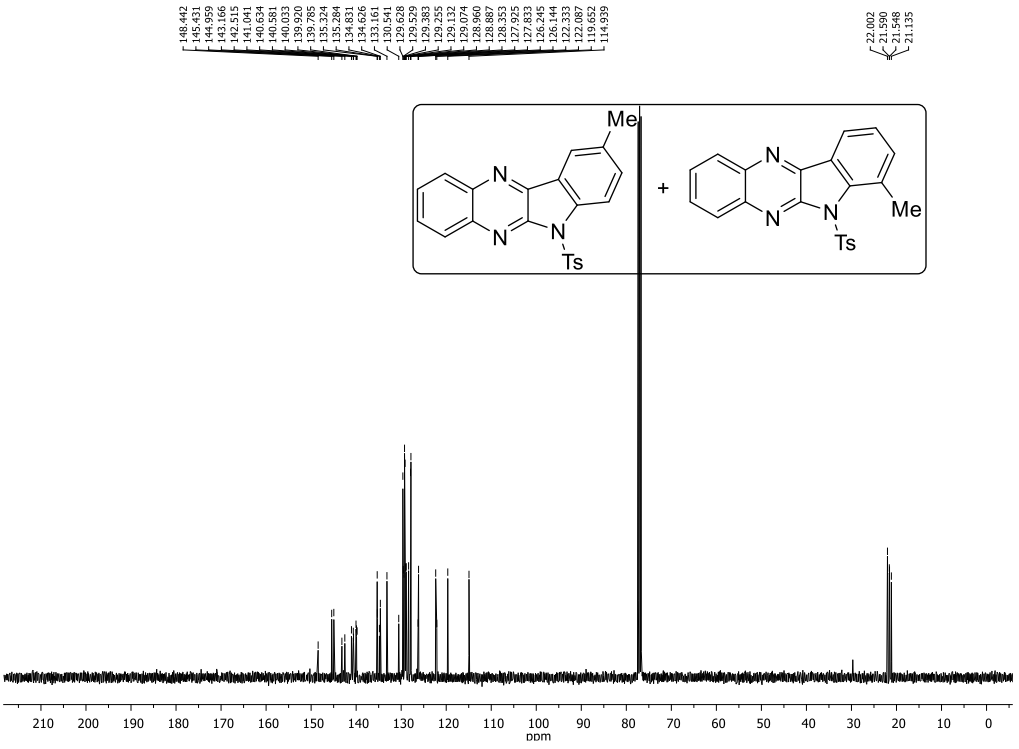


7-Methyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline/9-methyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (1:1) (5l)

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

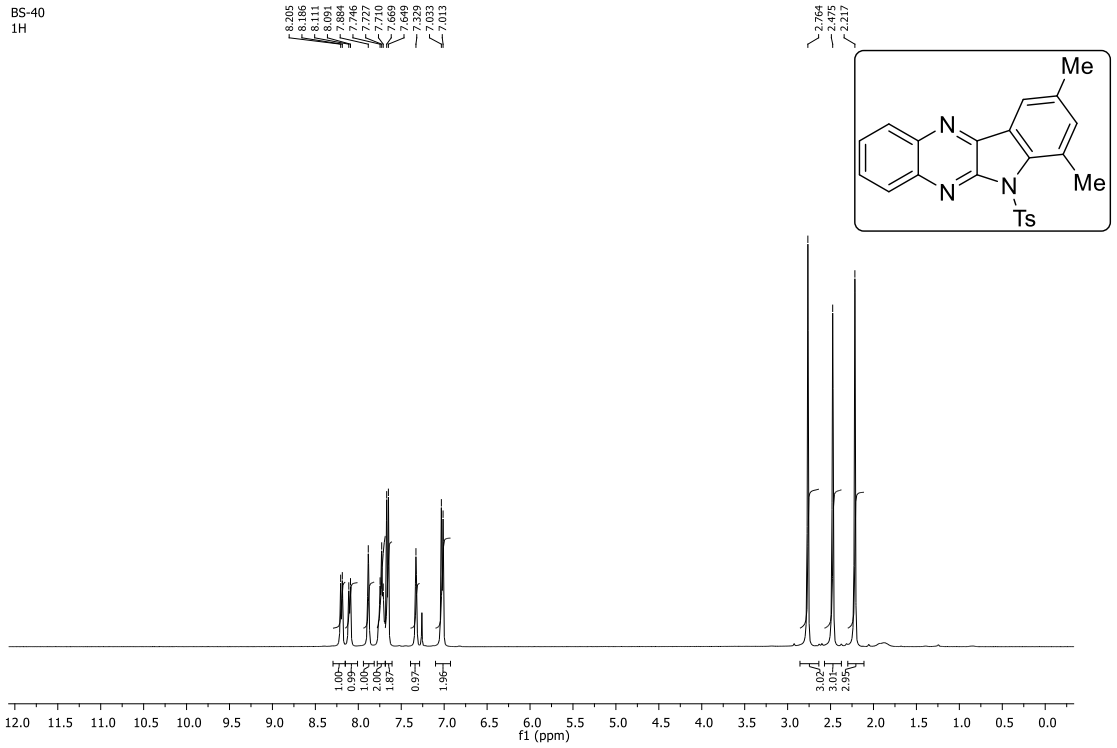


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

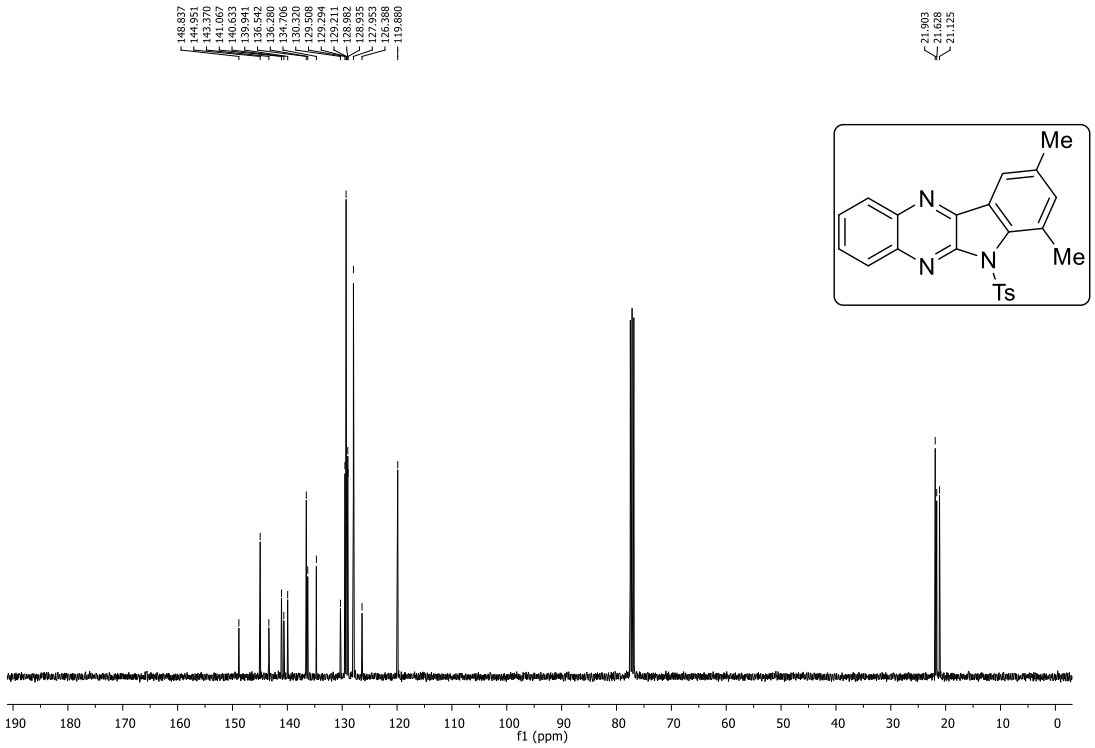


7,9-Dimethyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5m)

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

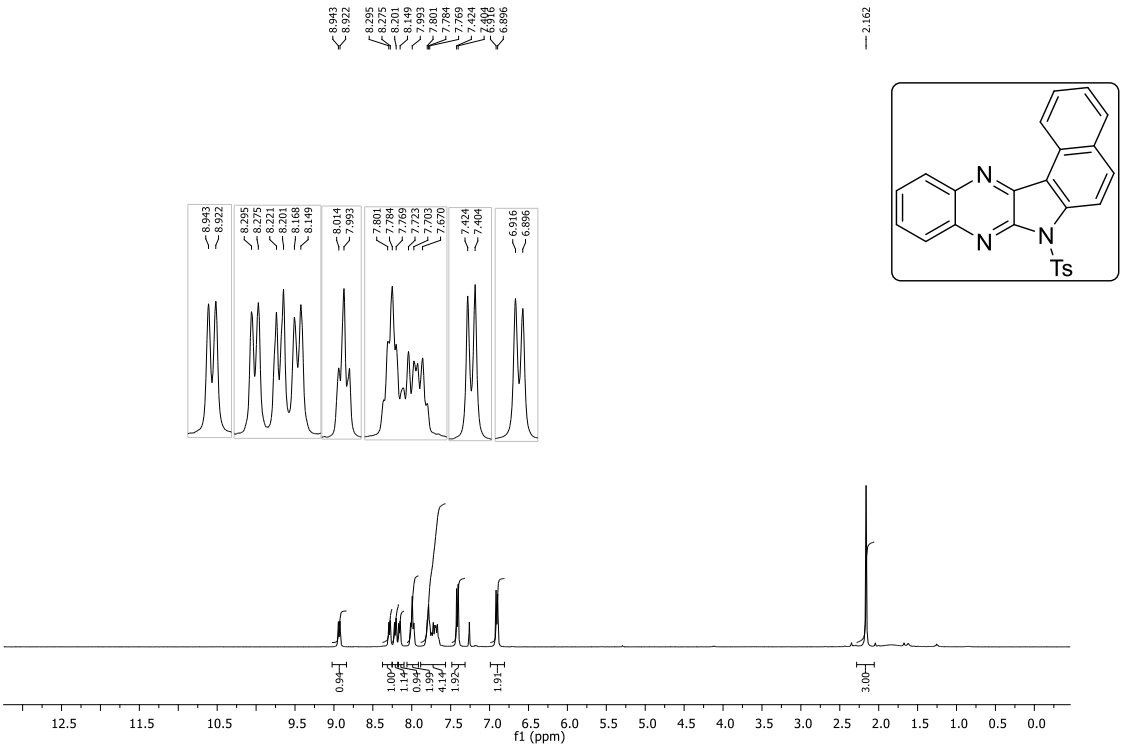


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

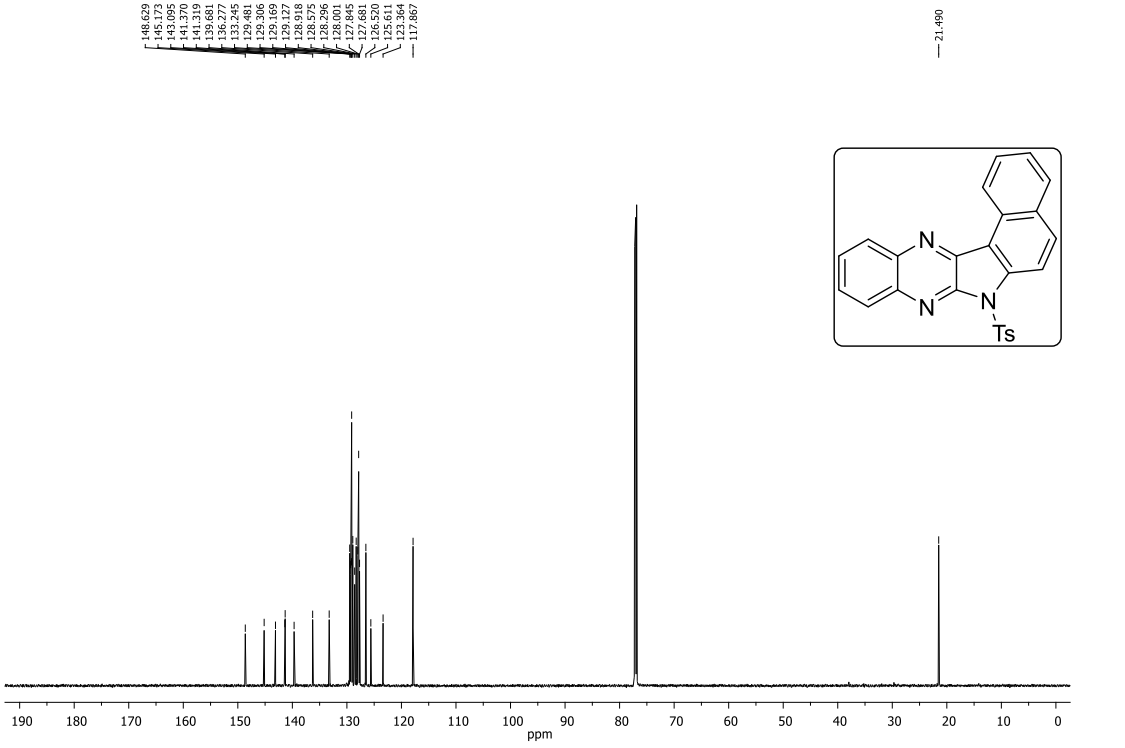


7-Tosyl-7*H*-benzo[4,5]indolo[2,3-*b*]quinoxaline (5o)

^{1}H NMR (700 MHz, $CDCl_3$)

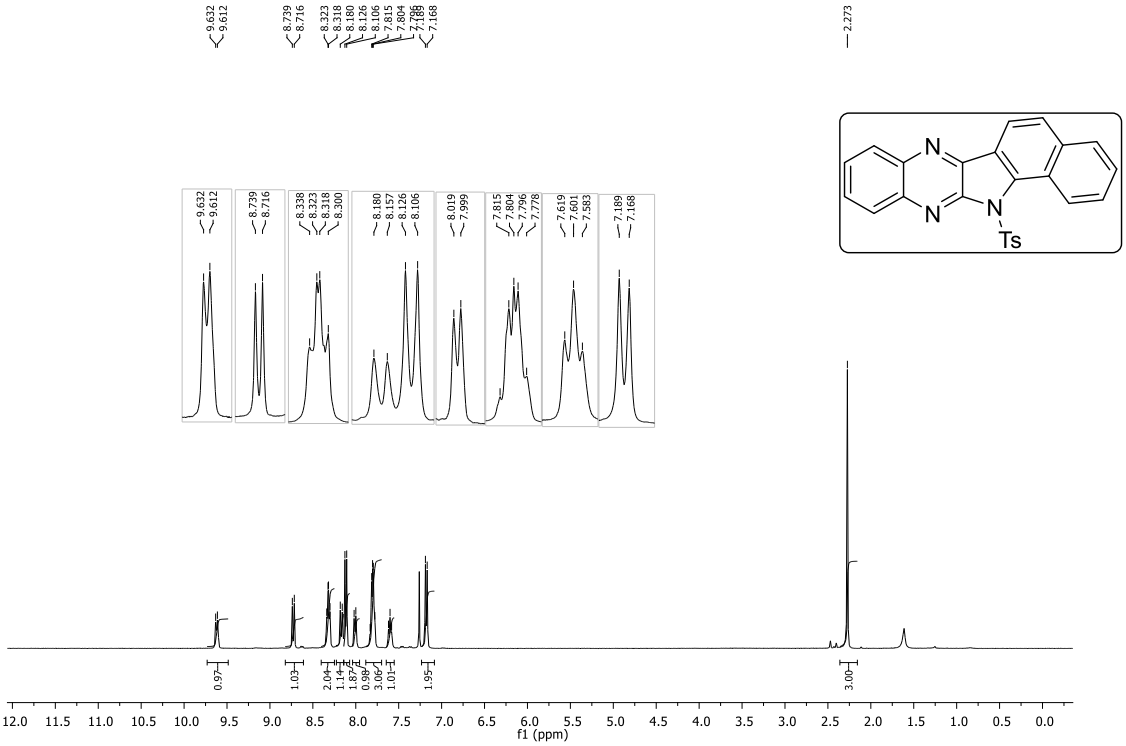


^{13}C{^{1}H} NMR (175 MHz, $CDCl_3$)

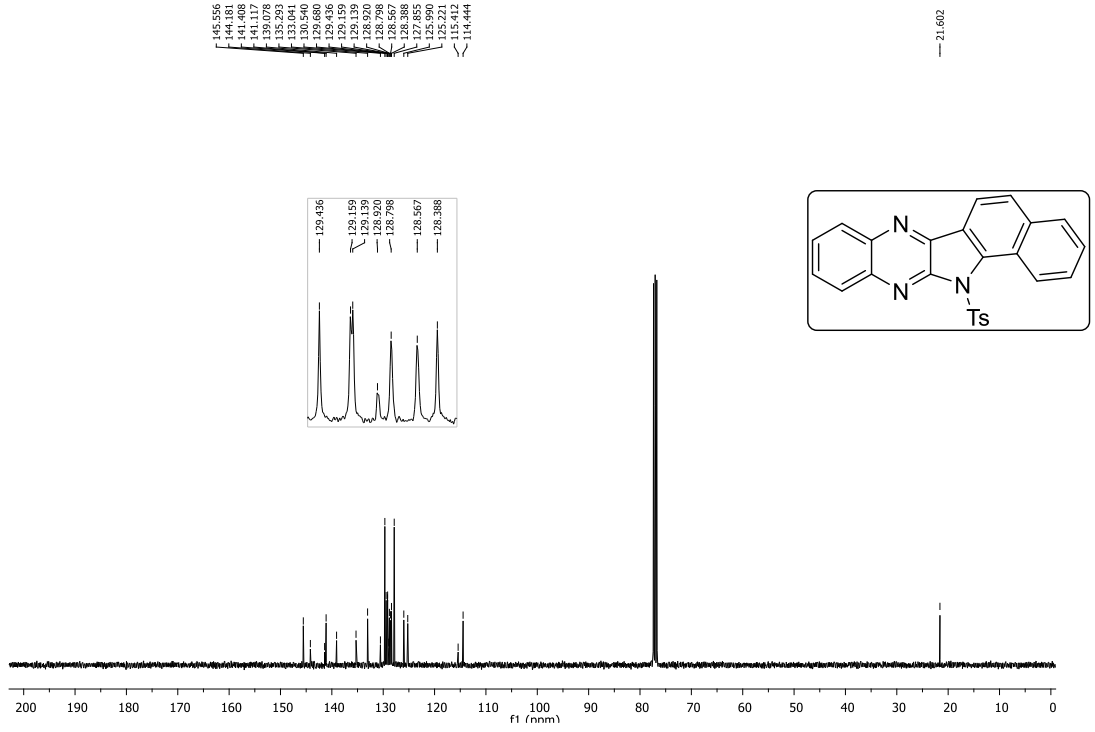


13-Tosyl-13*H*-benzo[6,7]indolo[2,3-b]quinoxaline (5p)

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

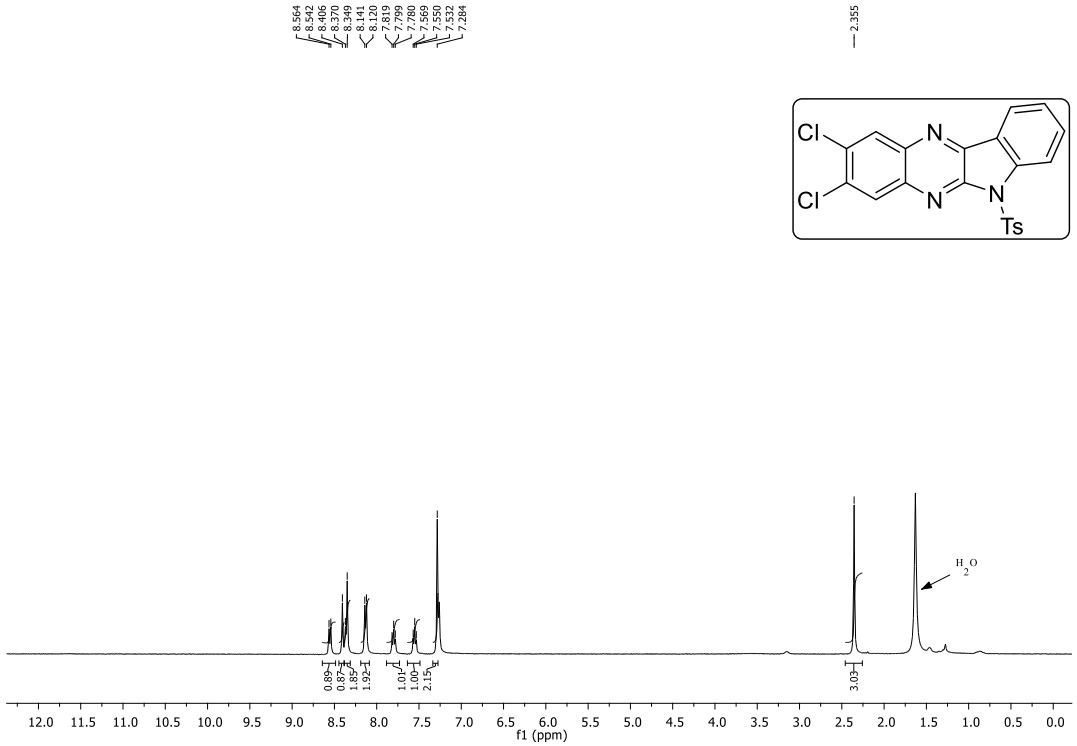


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

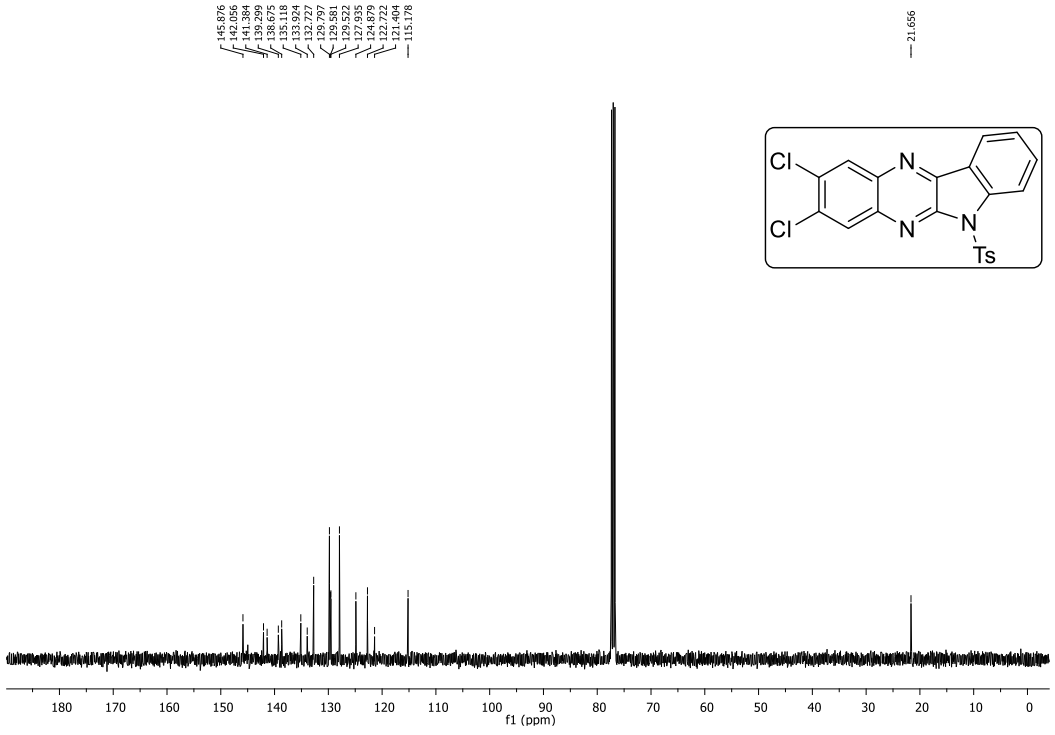


2,3-Dichloro-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5q)

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

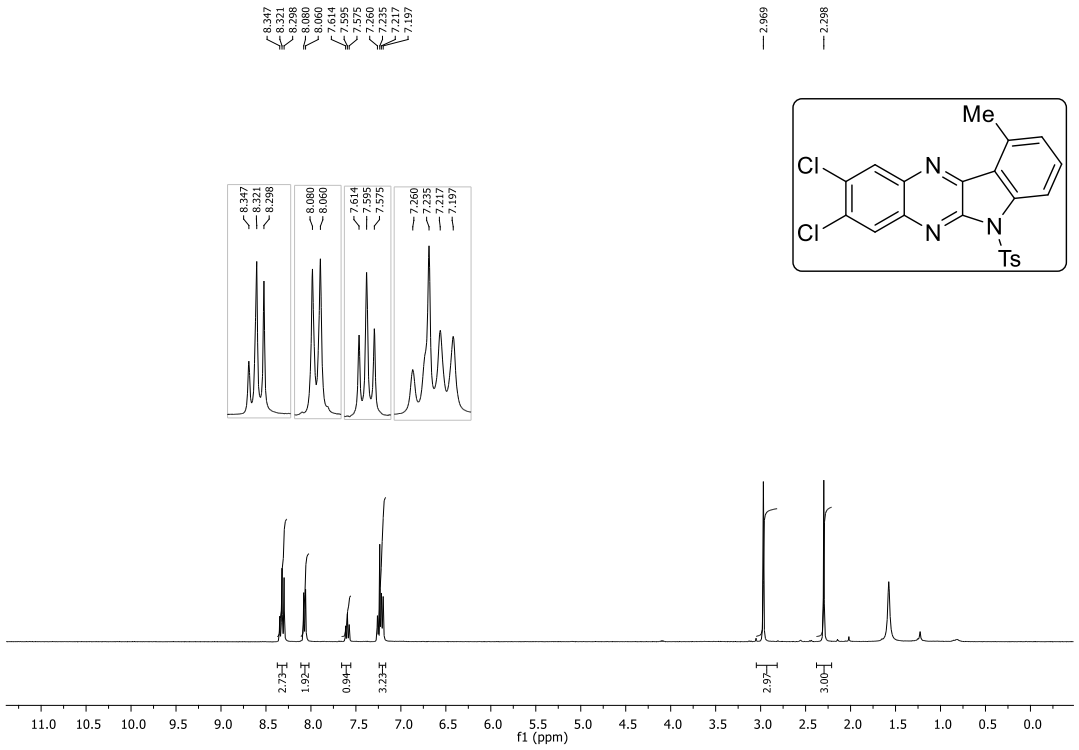


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

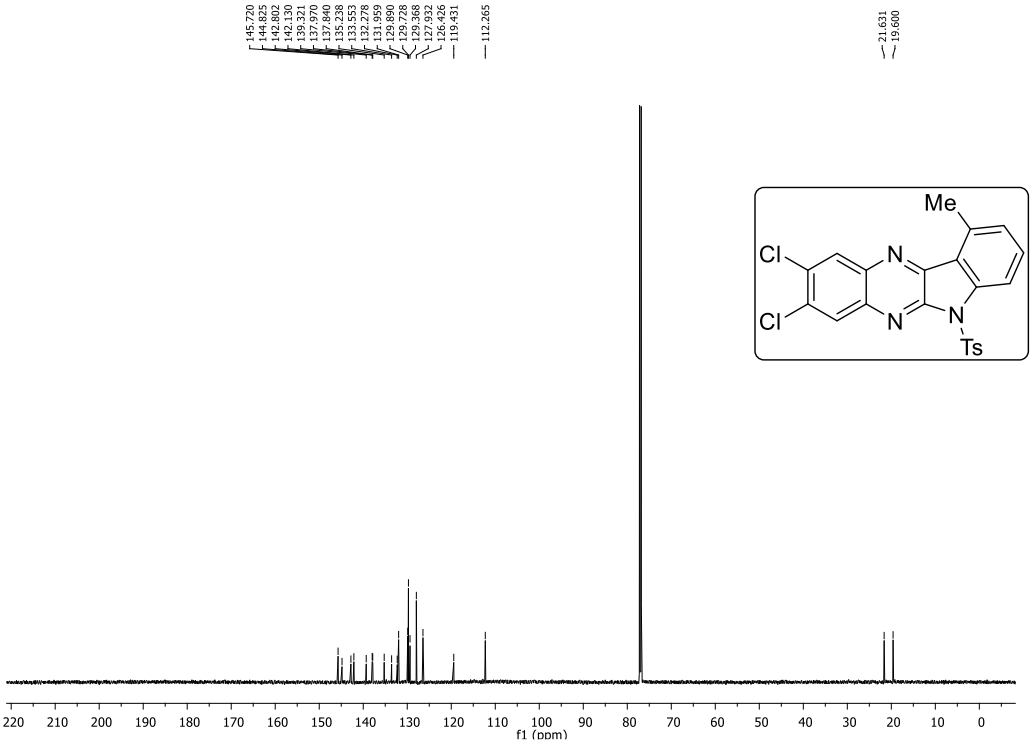


2,3-Dichloro-10-methyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5r)

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

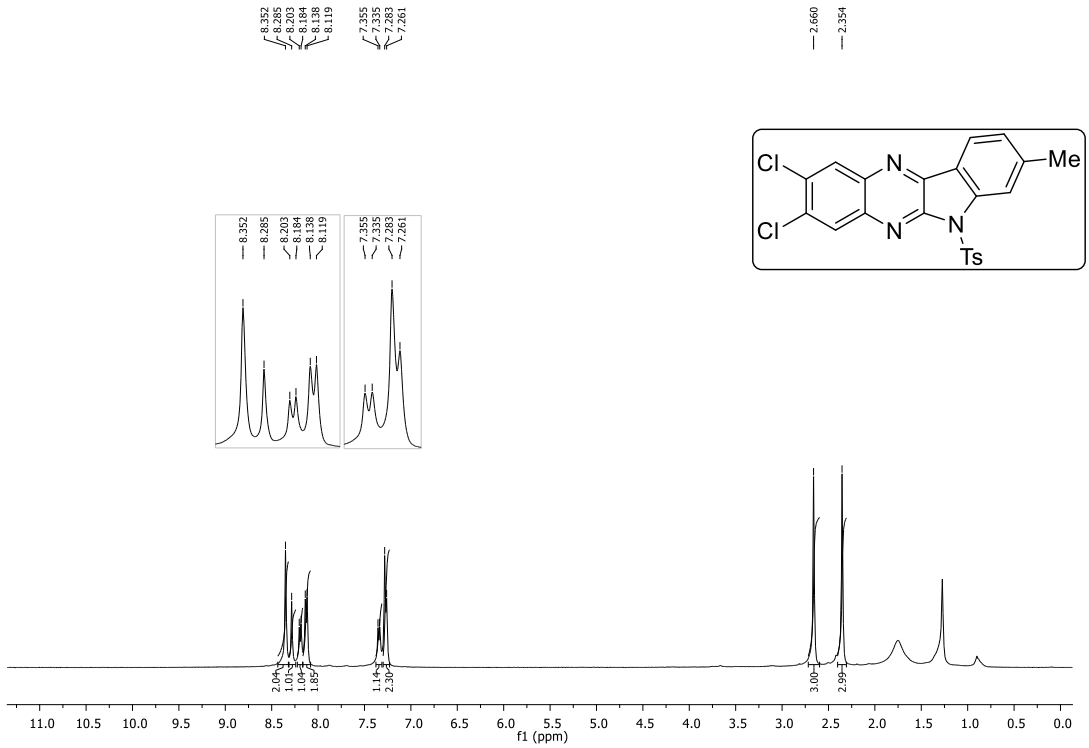


^{13}C{^{1}H} NMR (175 MHz, $CDCl_3$)

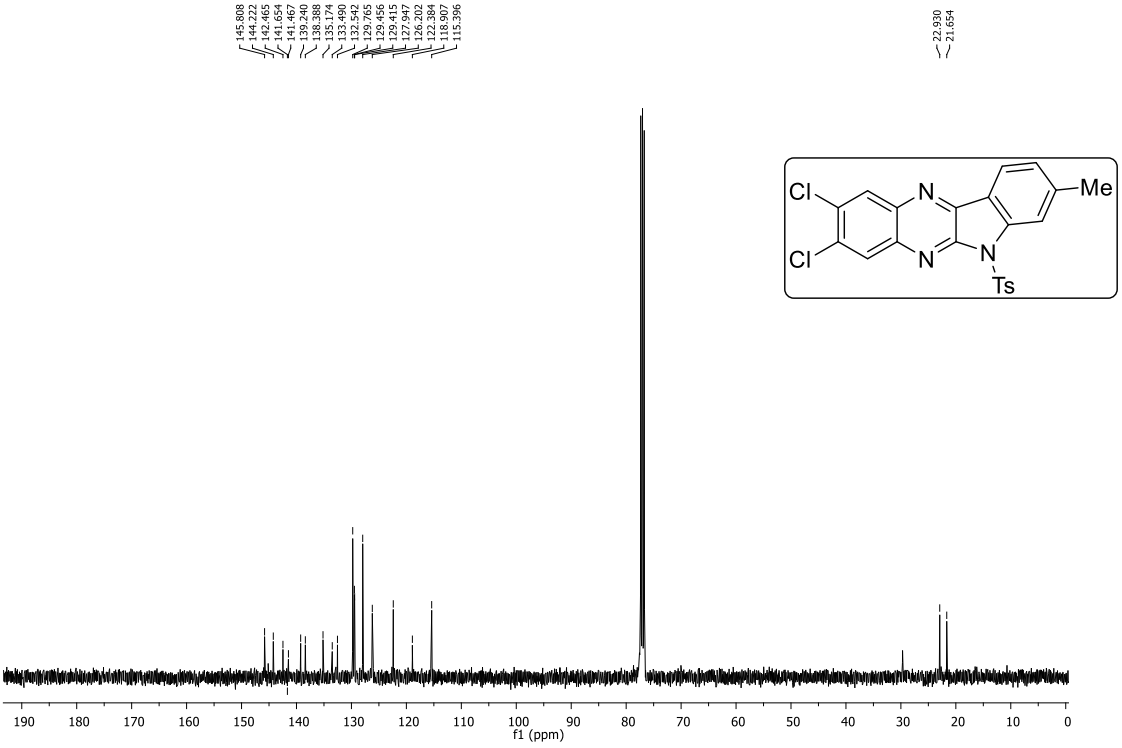


2,3-Dichloro-8-methyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (5s)

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

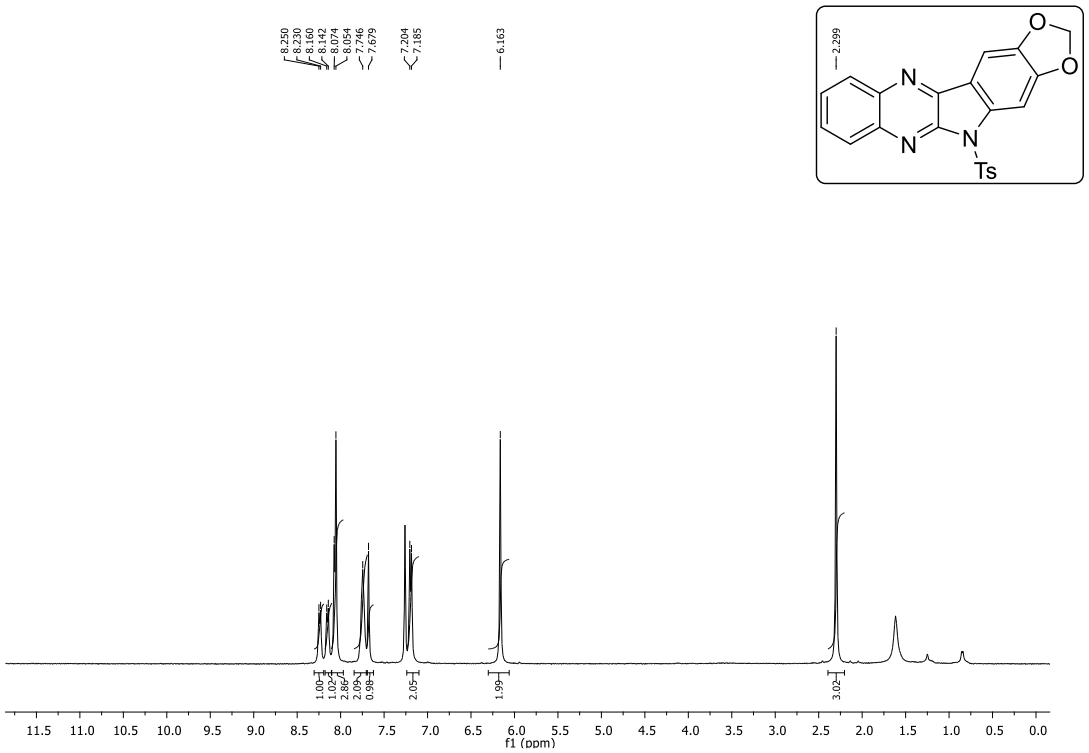


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

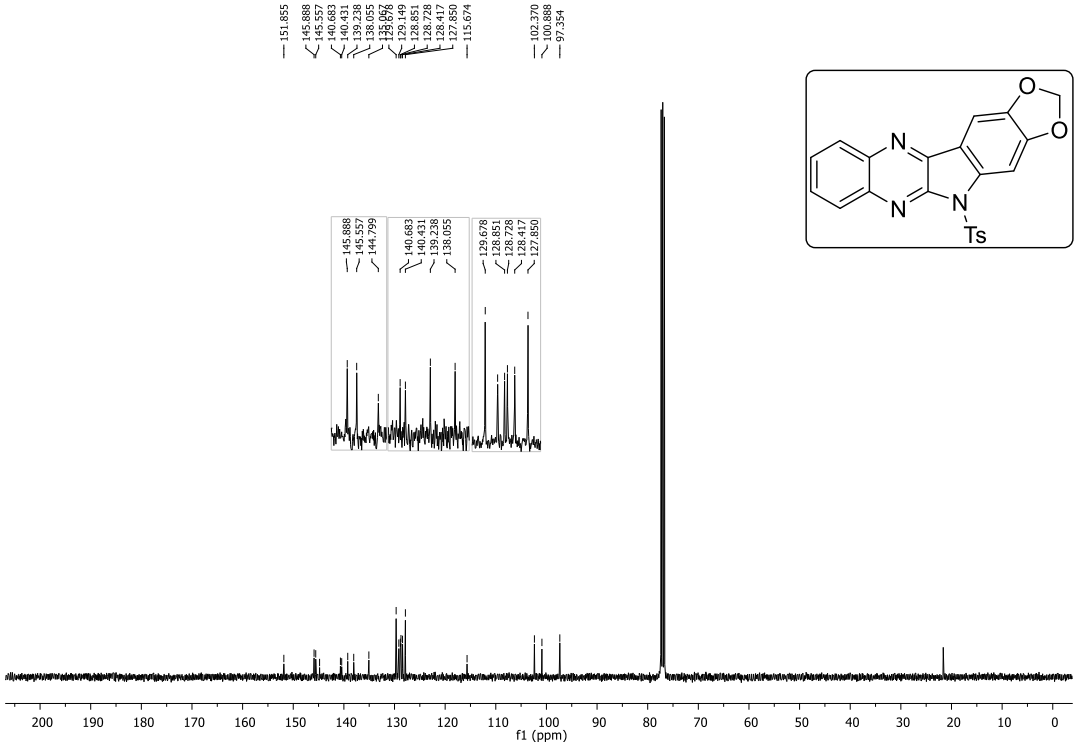


5-Tosyl-5*H*-[1,3]dioxolo[4',5':5,6]indolo[2,3-*b*]quinoxaline (5t)

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

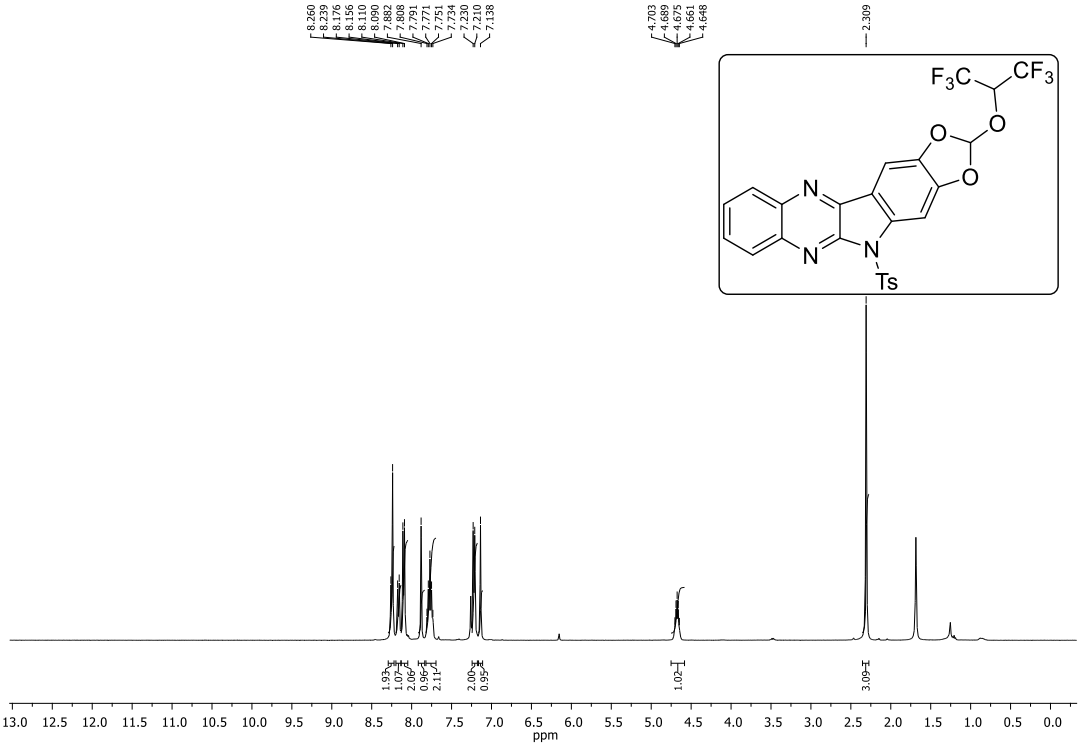


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

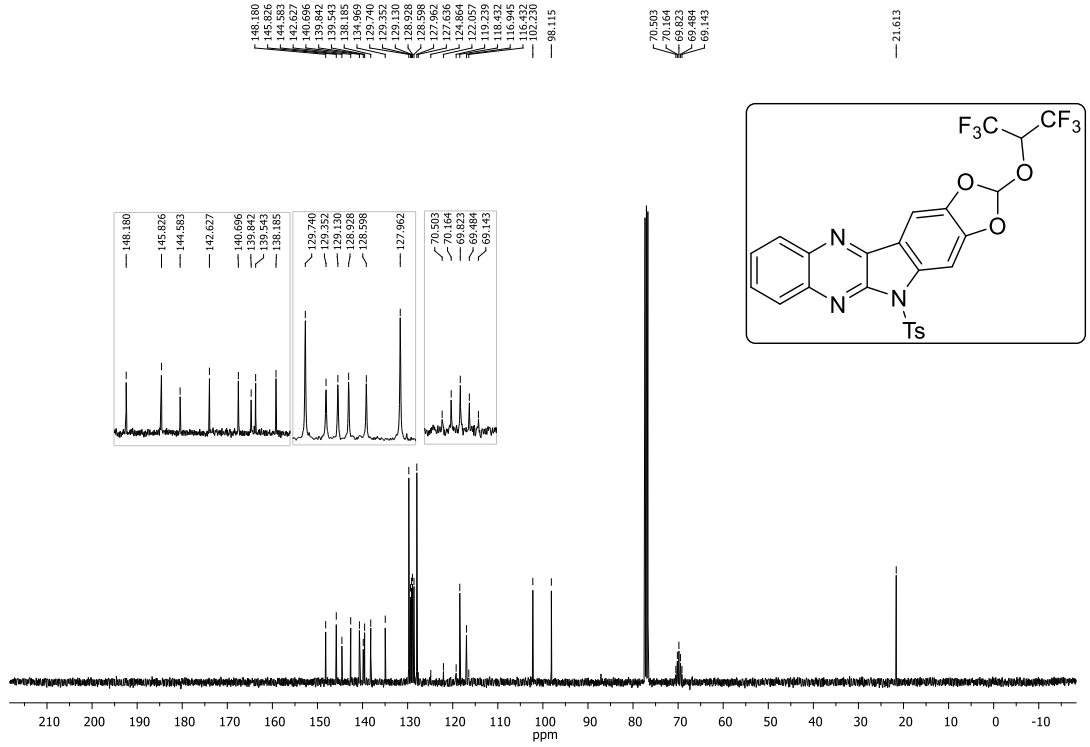


2-((1,1,1,3,3,3-Hexafluoropropan-2-yl)oxy)-5-tosyl-5*H*-[1,3]dioxolo[4',5':5,6]indolo[2,3-*b*]quinoxaline (6t)

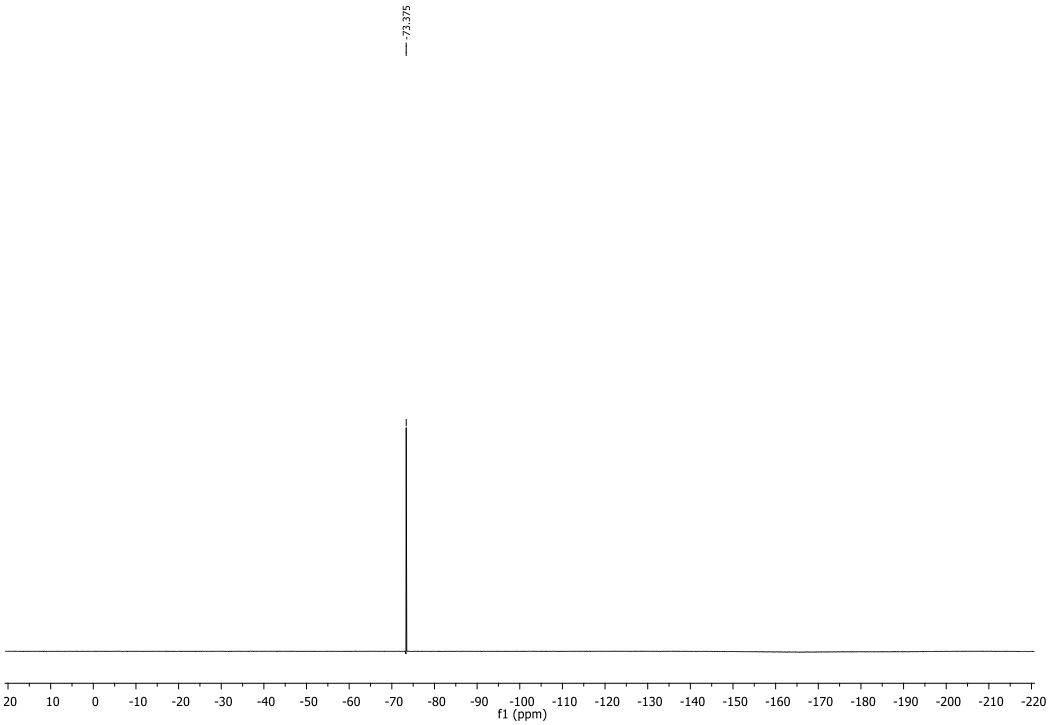
^{1}H NMR (400 MHz, $CDCl_3$)



^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

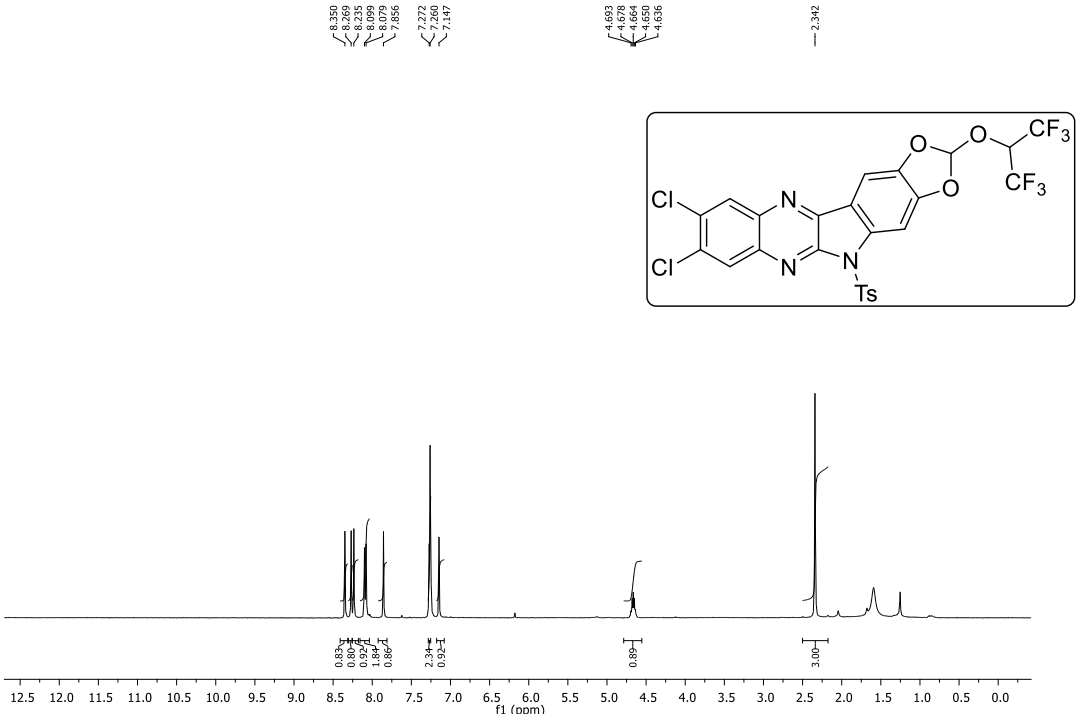


^{19}F NMR (377 MHz, $CDCl_3$)

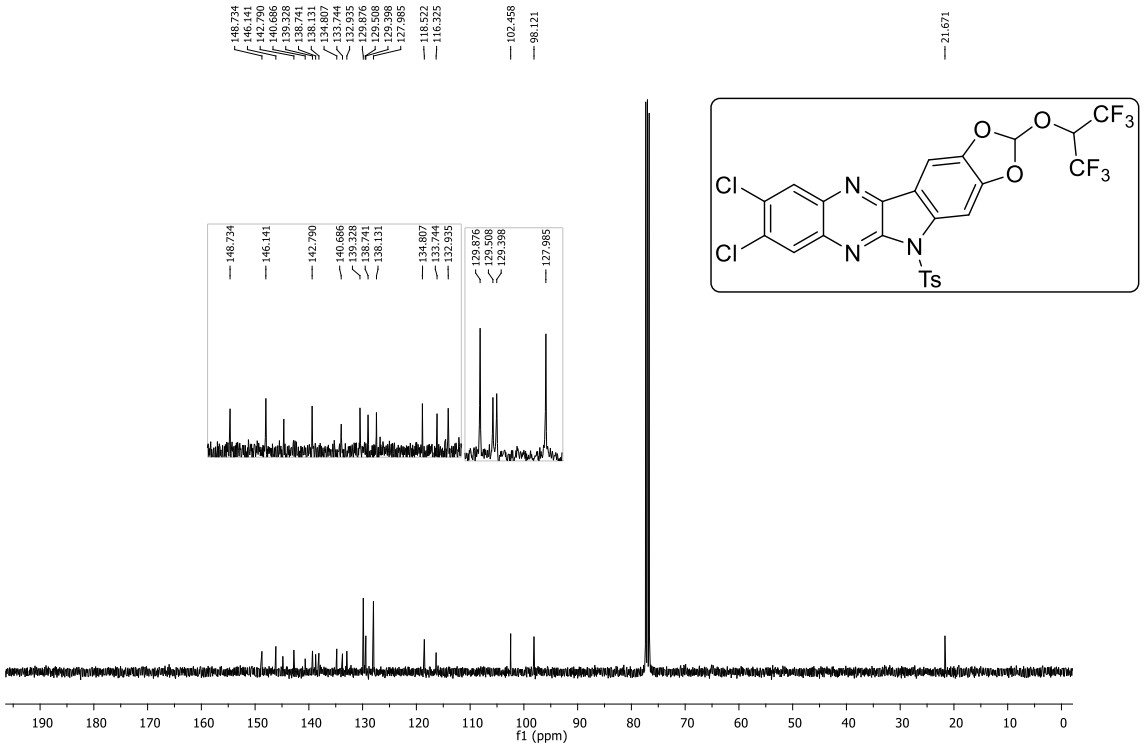


8,9-dichloro-2-((1,1,1,3,3,3-hexafluoropropan-2-yl)oxy)-5-tosyl-5H-[1,3]dioxolo[4',5':5,6]indolo[2,3-b]quinoxaline (6u)

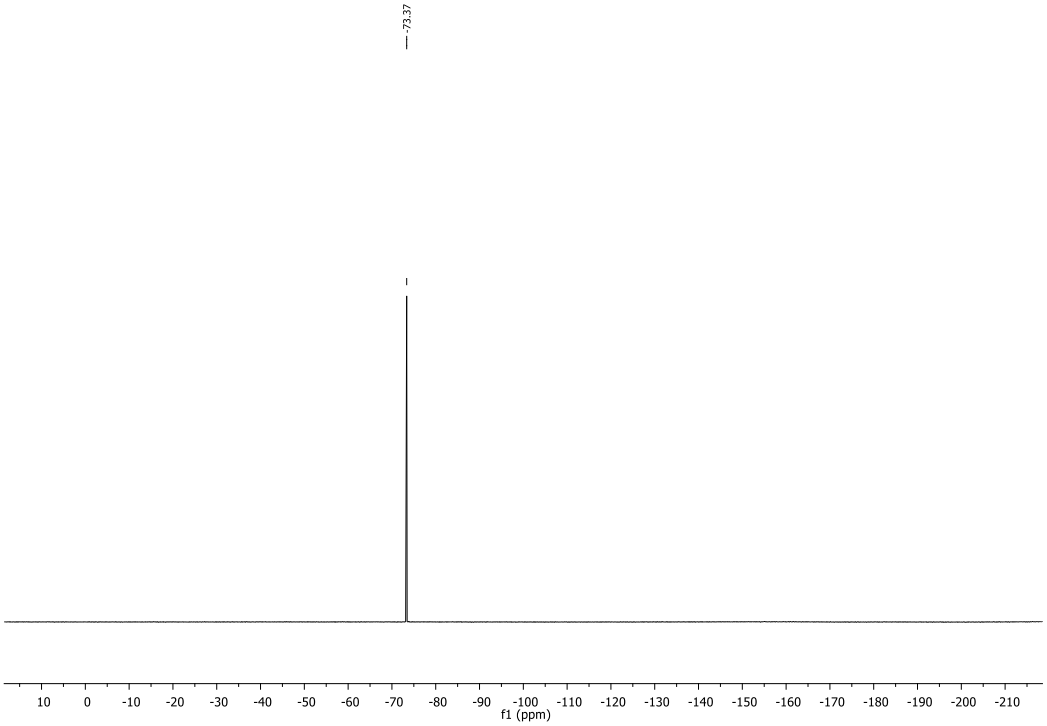
^{1}H NMR (400 MHz, $CDCl_3$)



^{13}C NMR (175 MHz, $CDCl_3$)

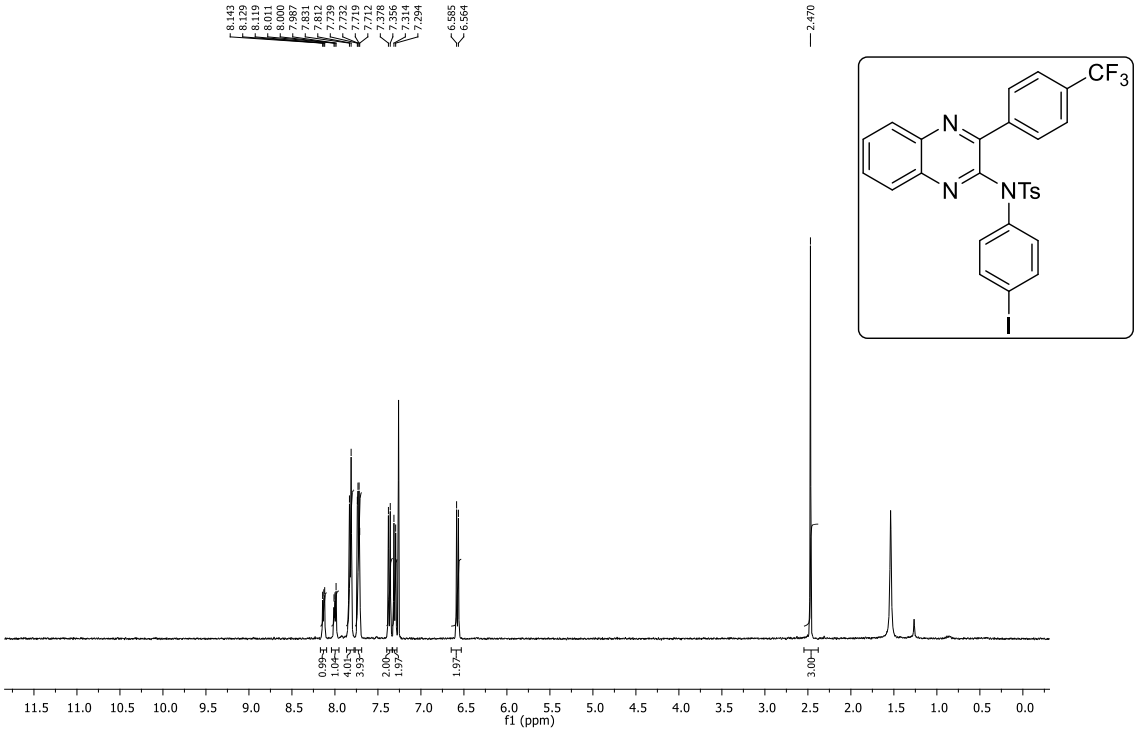


^{19}F NMR (377 MHz, $CDCl_3$)

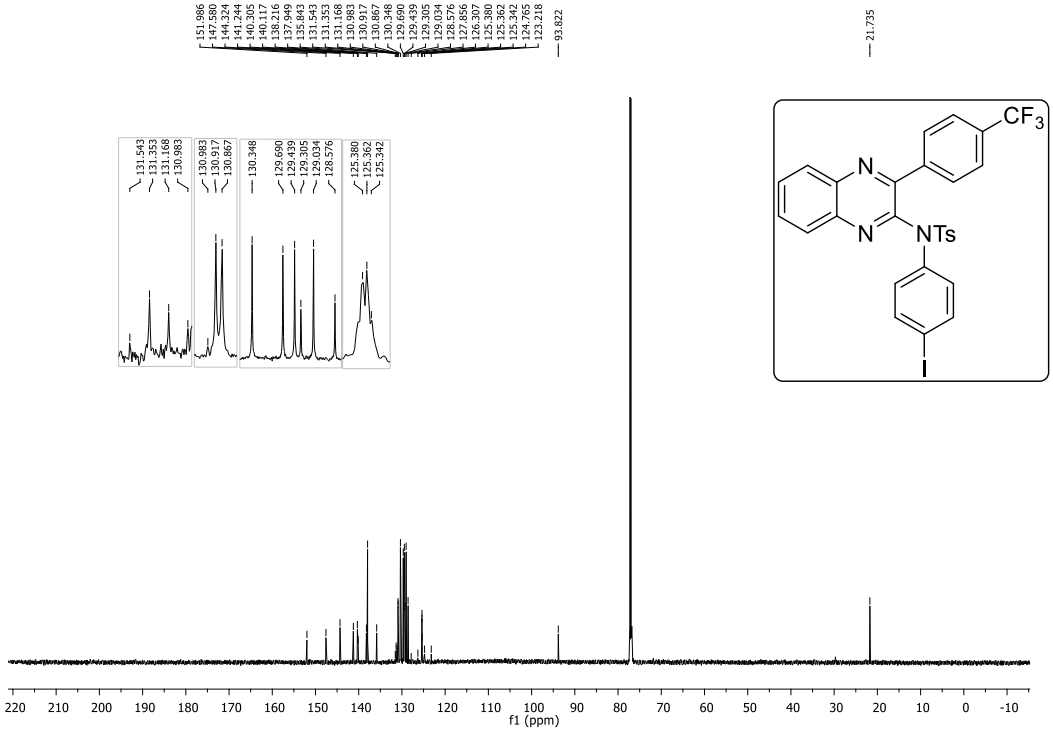


_N_-(4-Iodophenyl)-4-methyl-_N_-(3-(4-(trifluoromethyl)phenyl)quinoxalin-2-yl)benzenesulfonamide (7v)

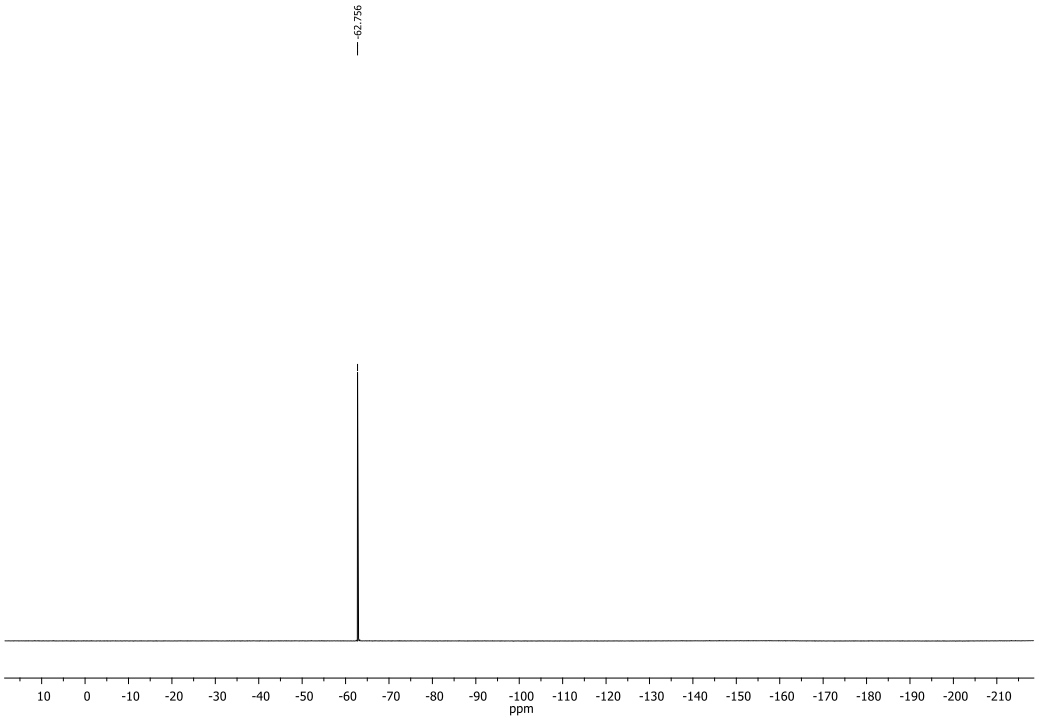
^{1}H NMR (400 MHz, $CDCl_3$)



^{13}C{^{1}H} NMR (175 MHz, $CDCl_3$)

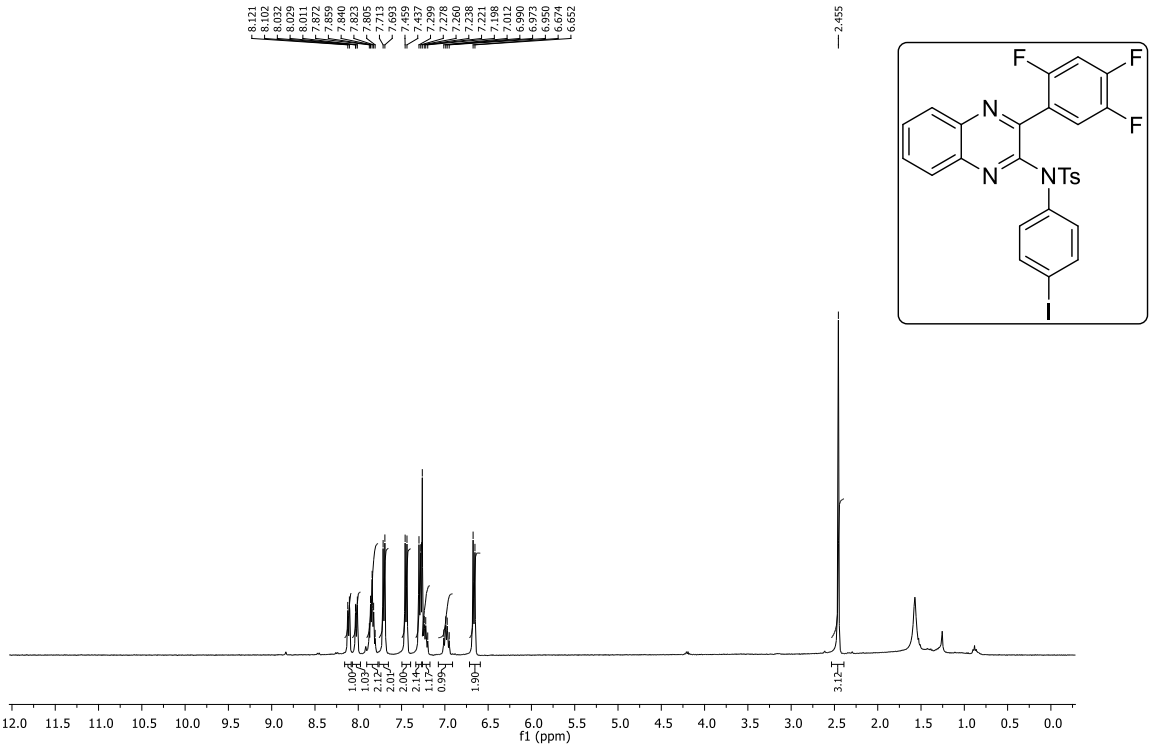


^{19}F NMR (377 MHz, $CDCl_3$)

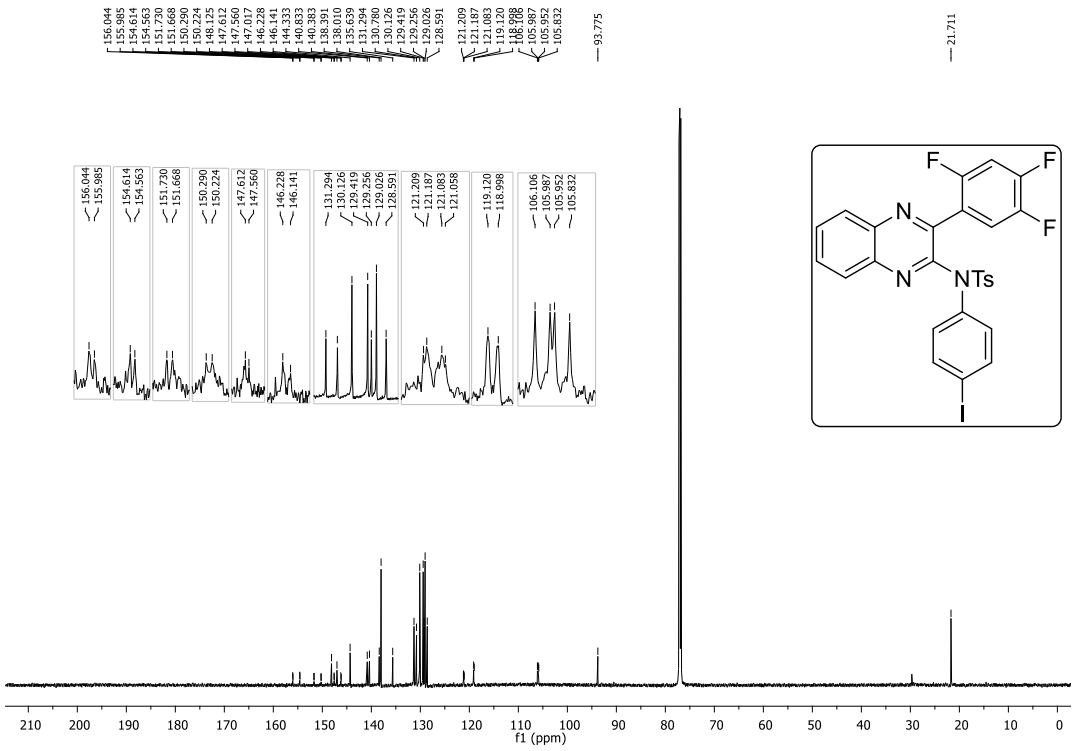


_N_-(4-Iodophenyl)-4-methyl-_N_-(3-(2,4,5-trifluorophenyl)quinoxalin-2-yl)benzenesulfonamide (7w)

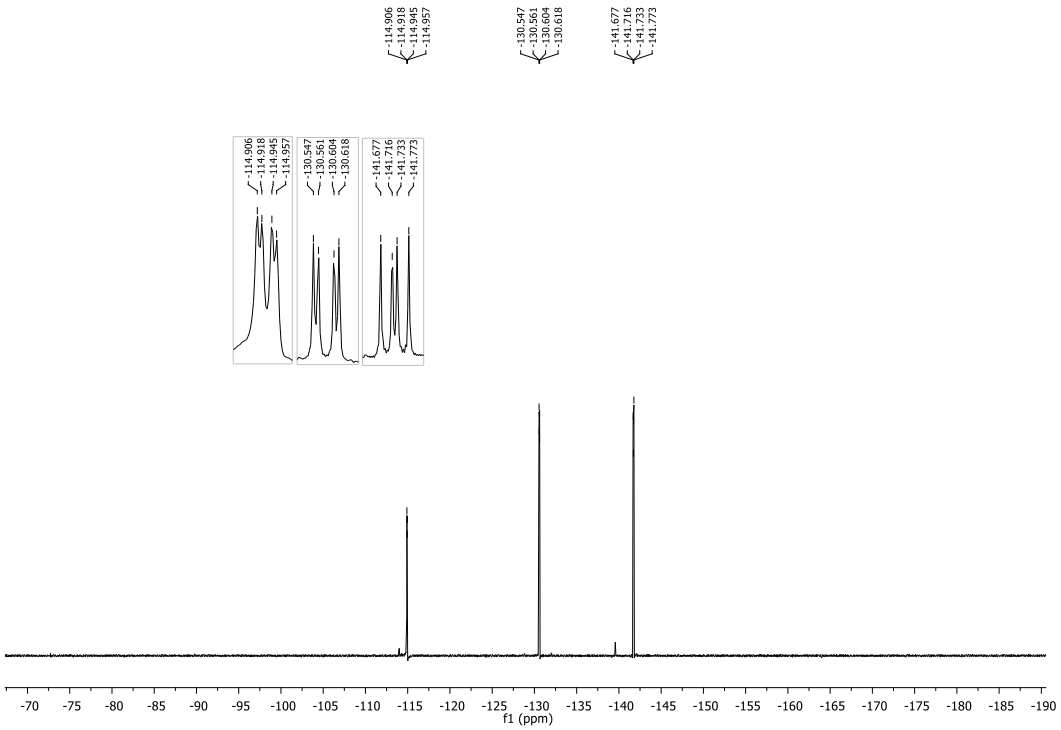
^{1}H NMR (400 MHz, $CDCl_3$)



^{13}C{^{1}H} NMR (175 MHz, $CDCl_3$)

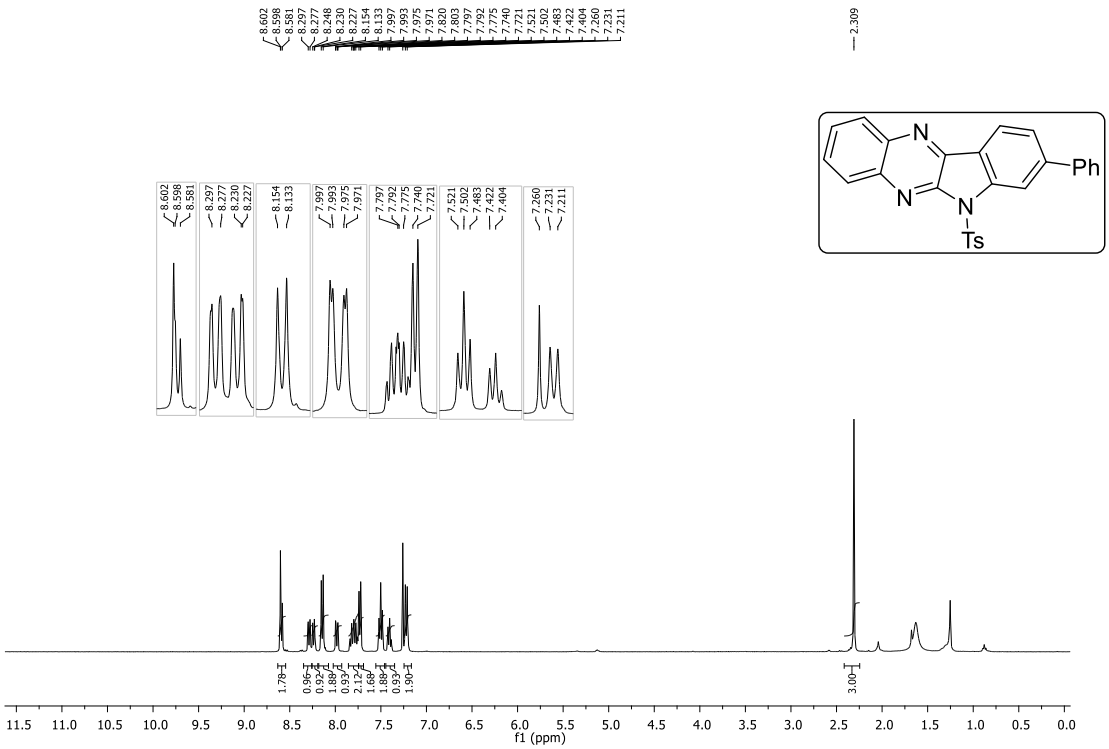


^{19}F NMR (377 MHz, $CDCl_3$)

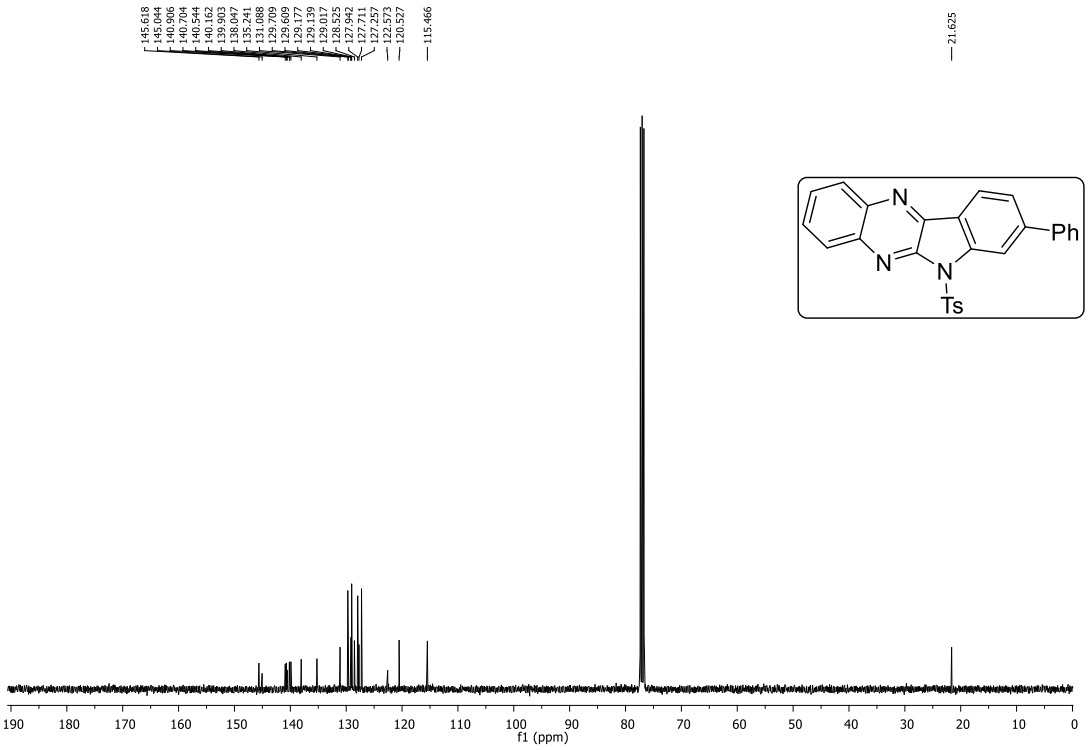


8-phenyl-6-tosyl-6*H*-indolo[2,3-*b*]quinoxaline (8)

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

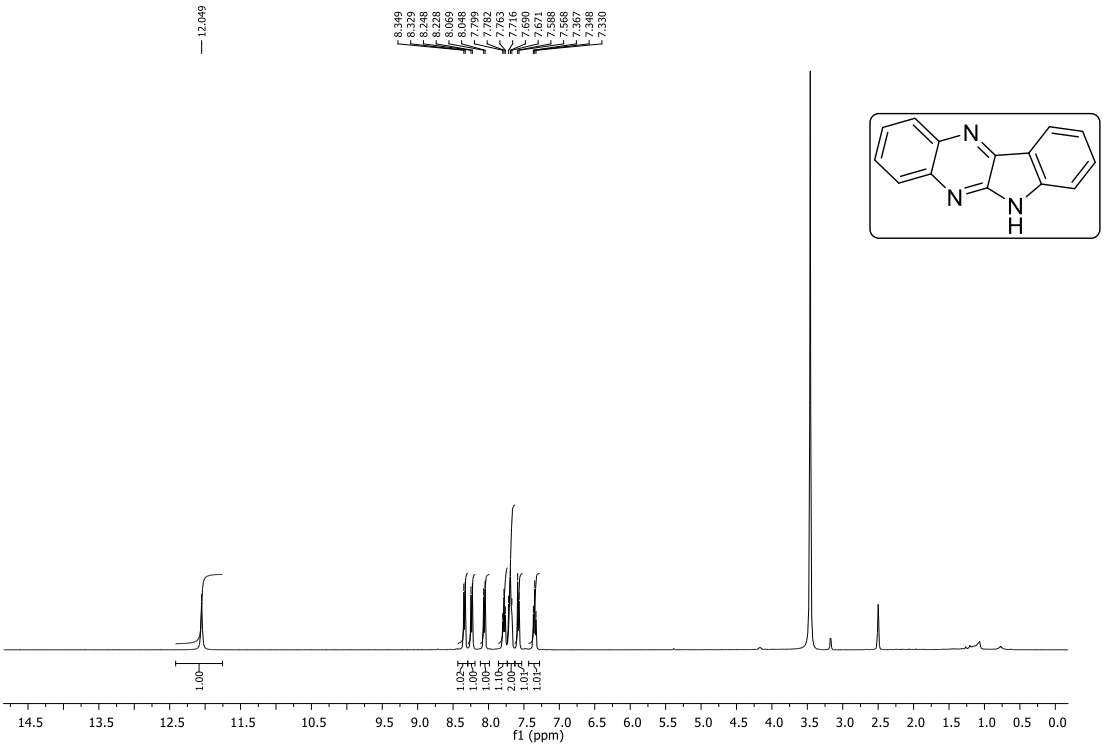


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

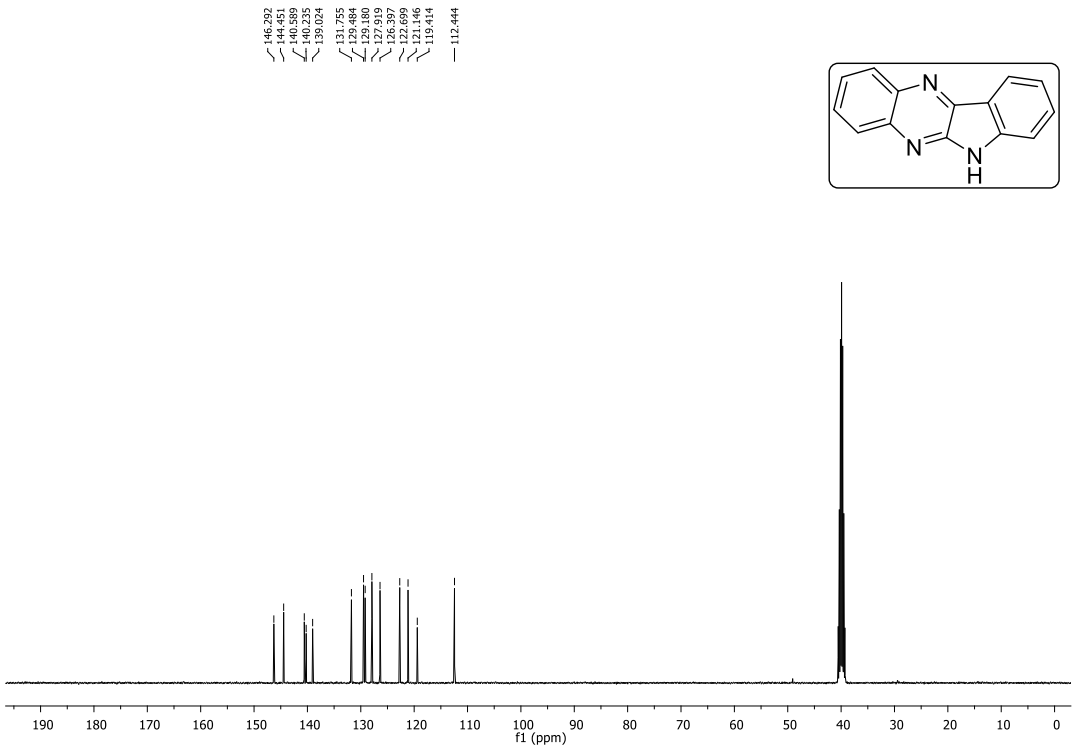


6*H*-Indolo[2,3-*b*]quinoxaline (9a)

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

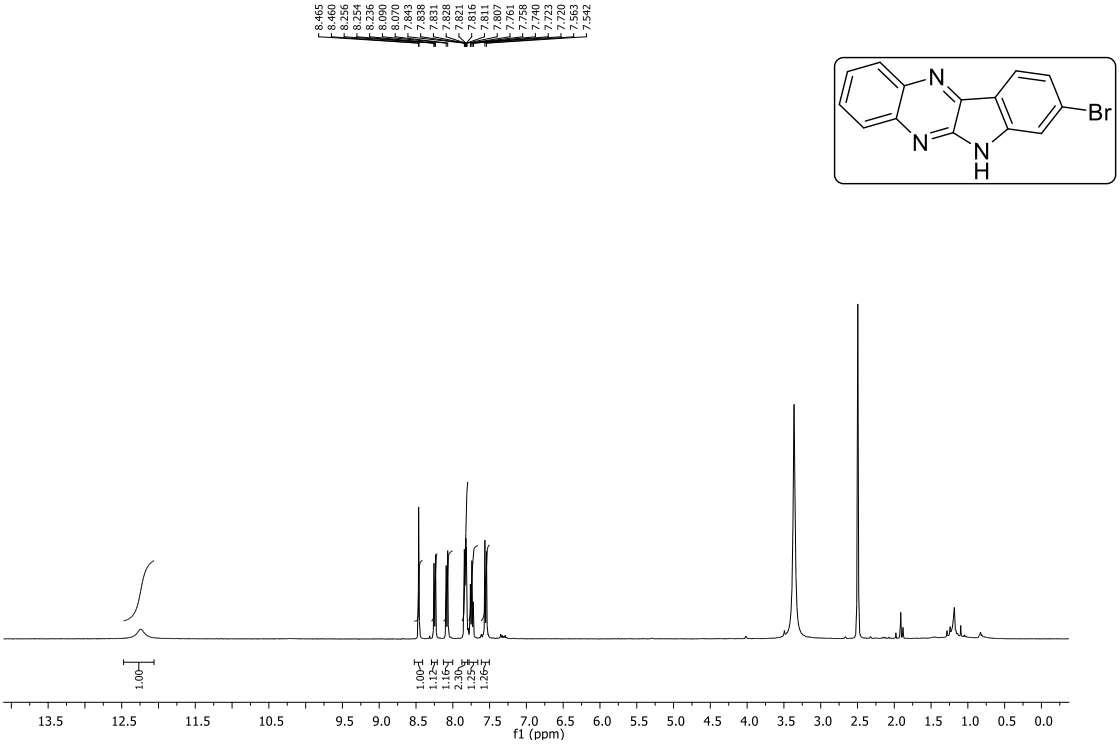


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

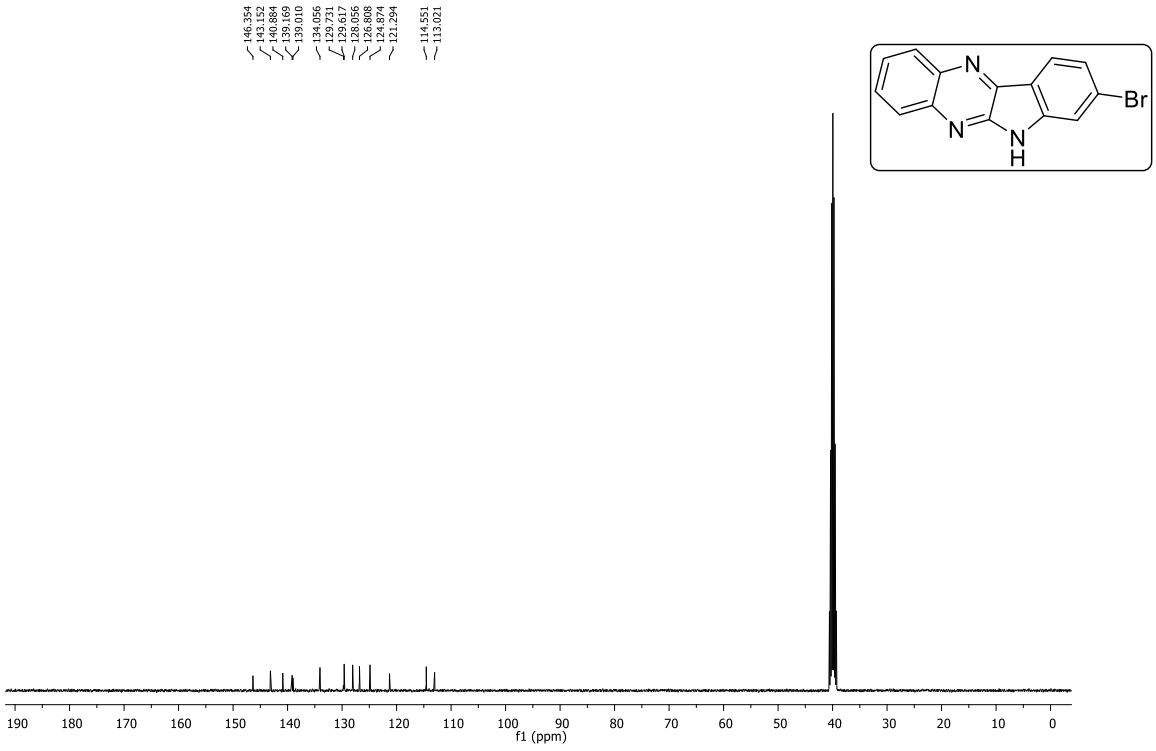


8-Bromo-6*H*-indolo[2,3-*b*]quinoxaline (9b)

^{1}H NMR (400 MHz, DMSO)

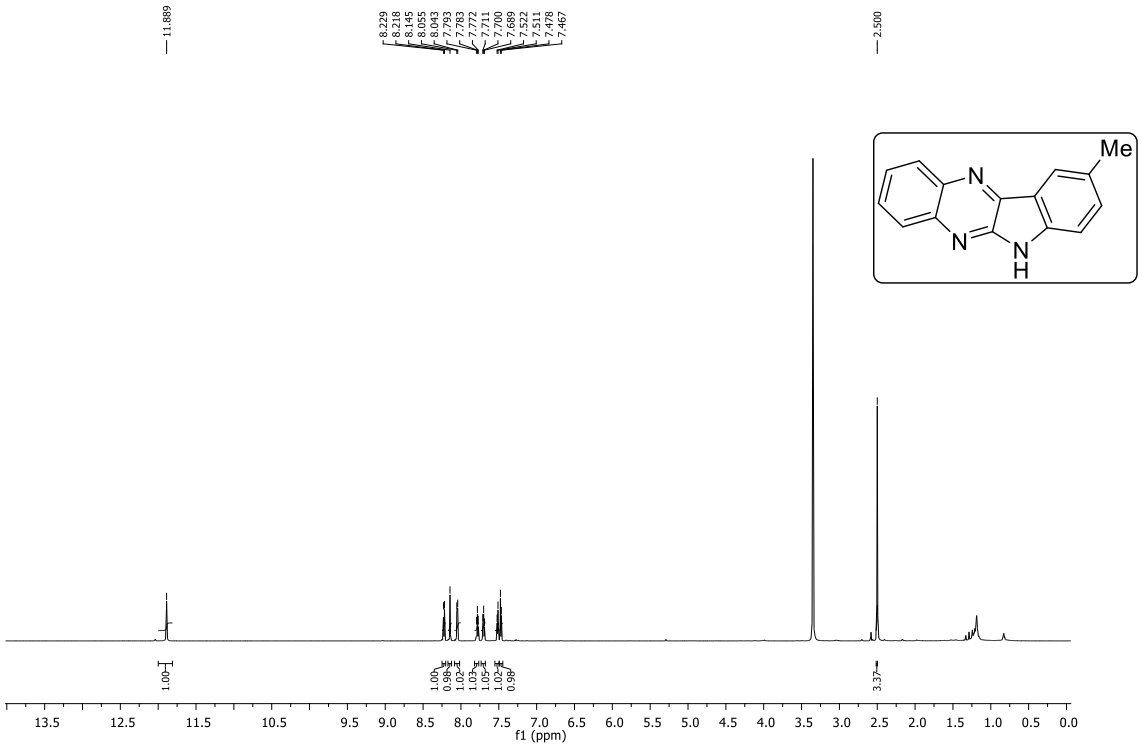


^{13}C{^{1}H} NMR (100 MHz, DMSO)

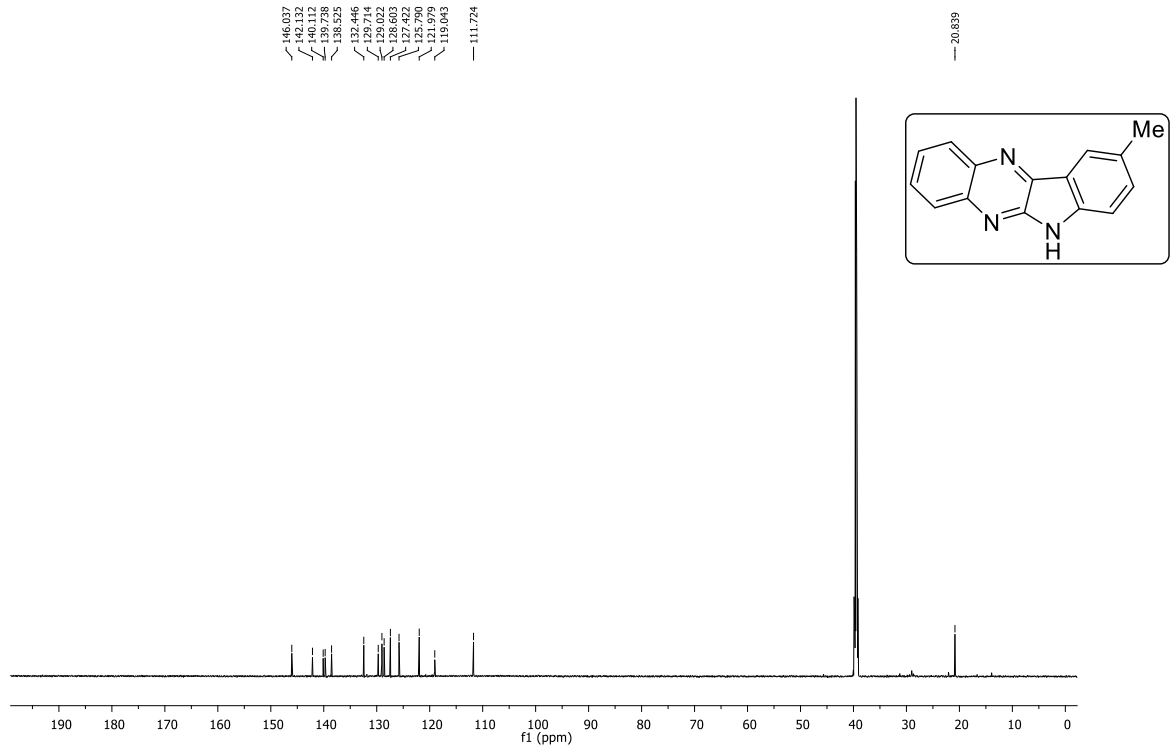


9-Methyl-6*H*-indolo[2,3-*b*]quinoxaline (9g)

^{1}H NMR (700 MHz, DMSO)

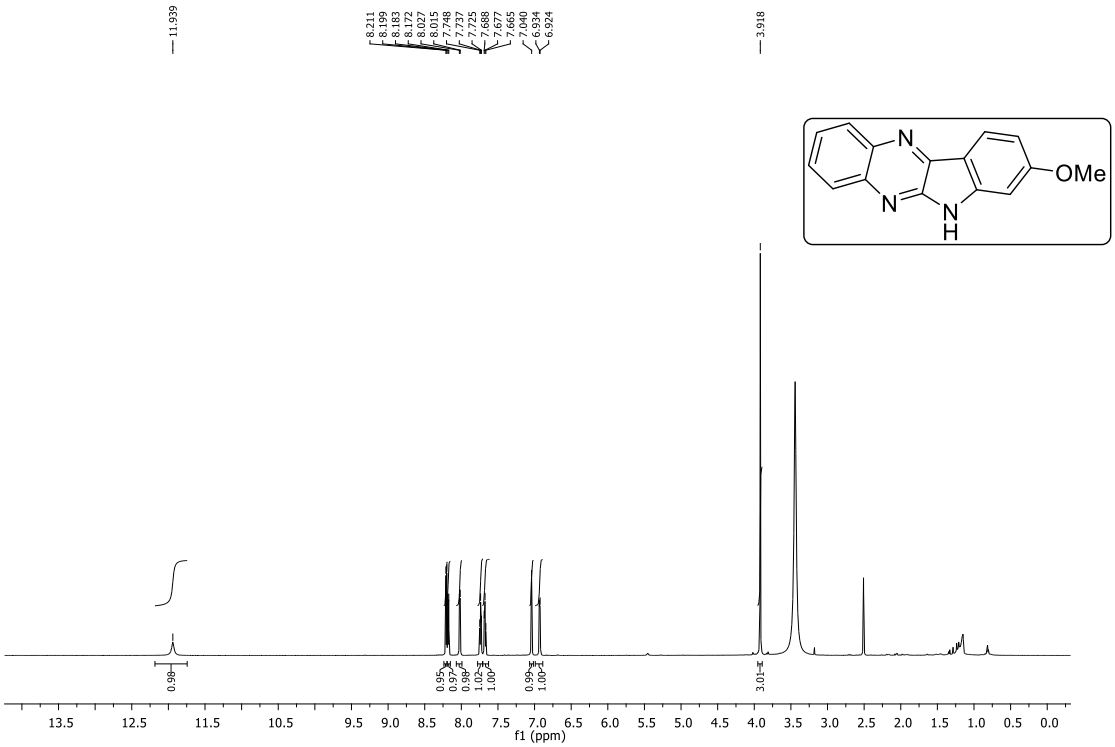


^{13}C{^{1}H} NMR (175 MHz, DMSO)

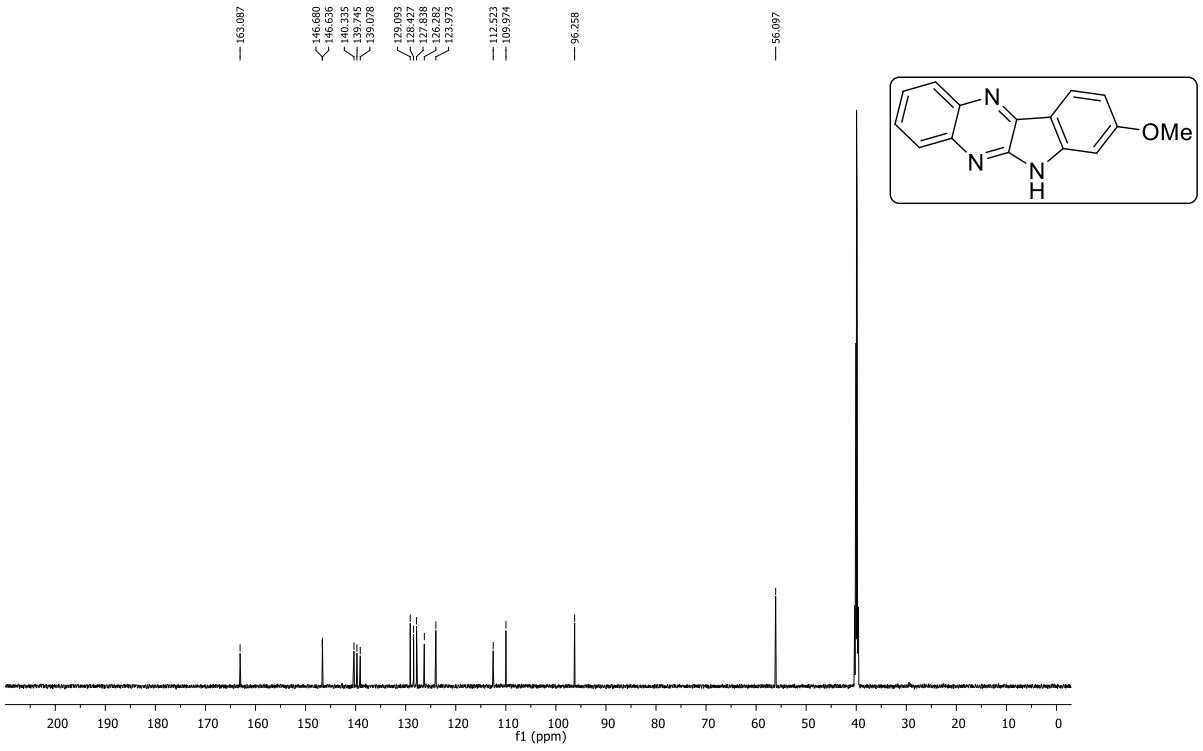


8-Methoxy-6*H*-indolo[2,3-*b*]quinoxaline (9f)

^{1}H NMR (700 MHz, DMSO)

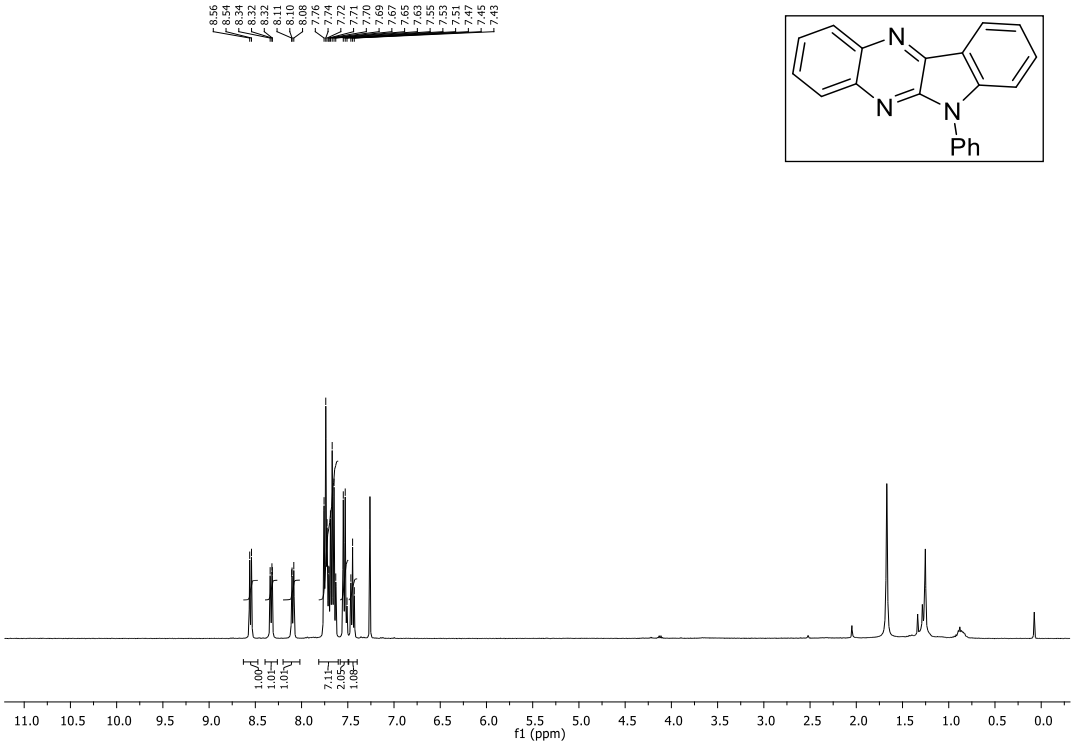


^{13}C{^{1}H} NMR (175 MHz, DMSO)

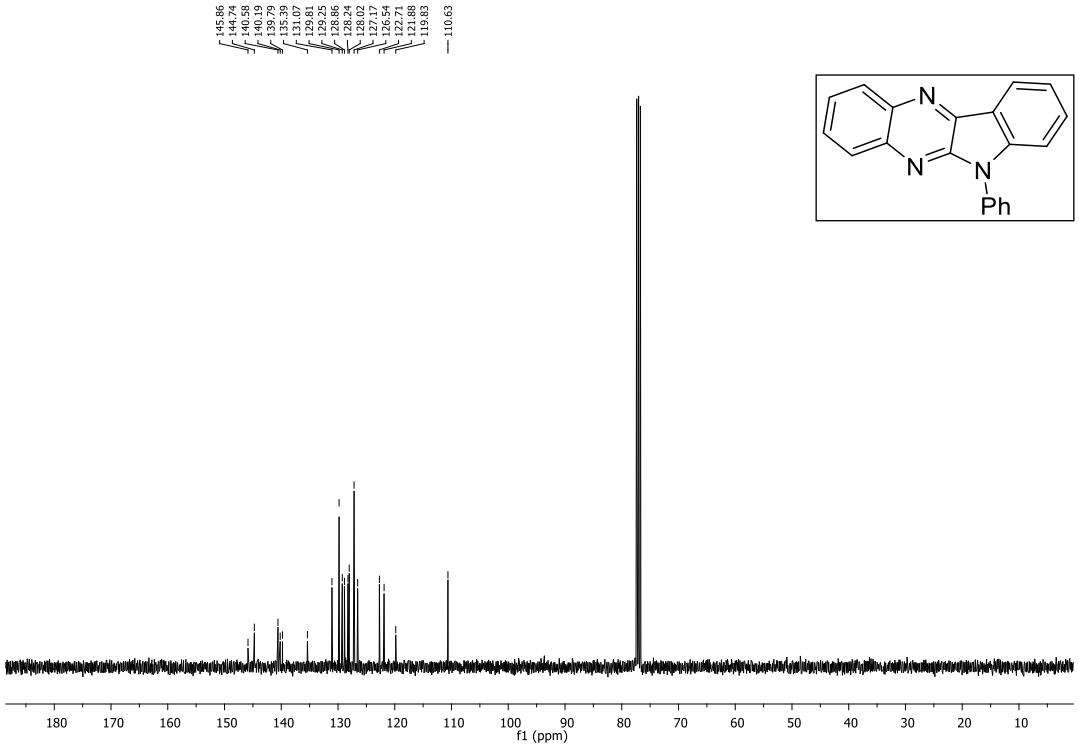


6-Phenyl-6*H*-indolo[2,3-*b*]quinoxaline (10a)

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

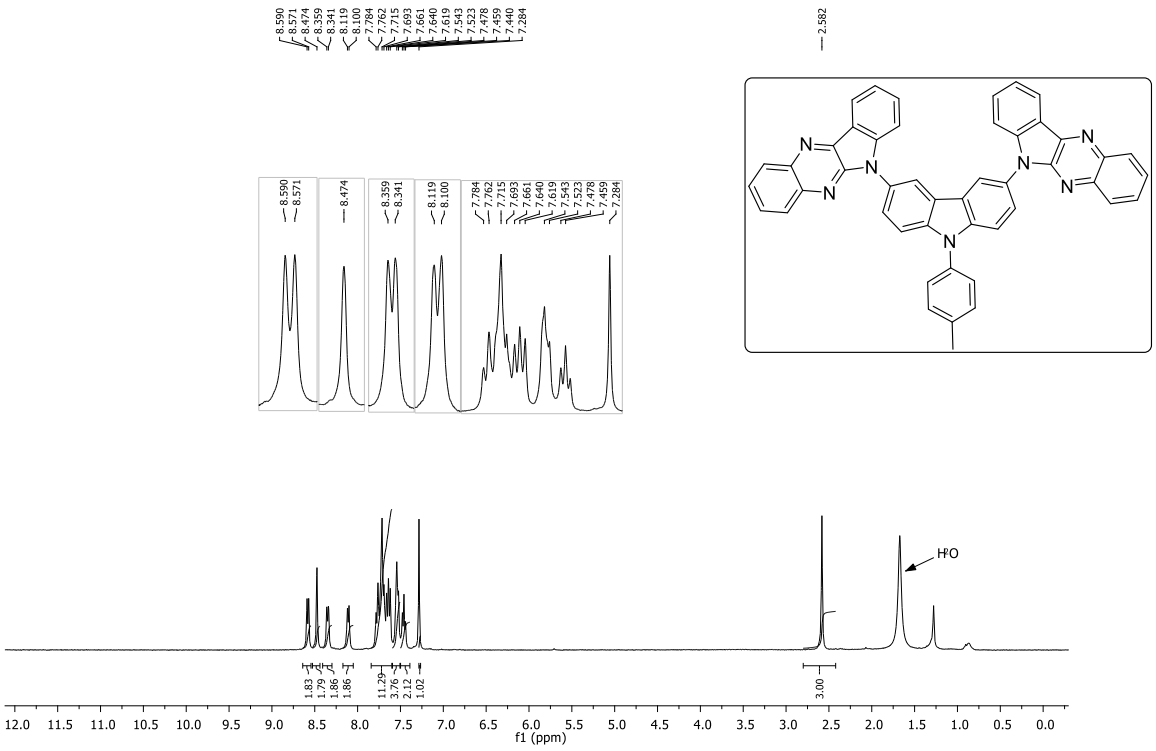


^{13}C NMR (100 MHz, $CDCl_3$)

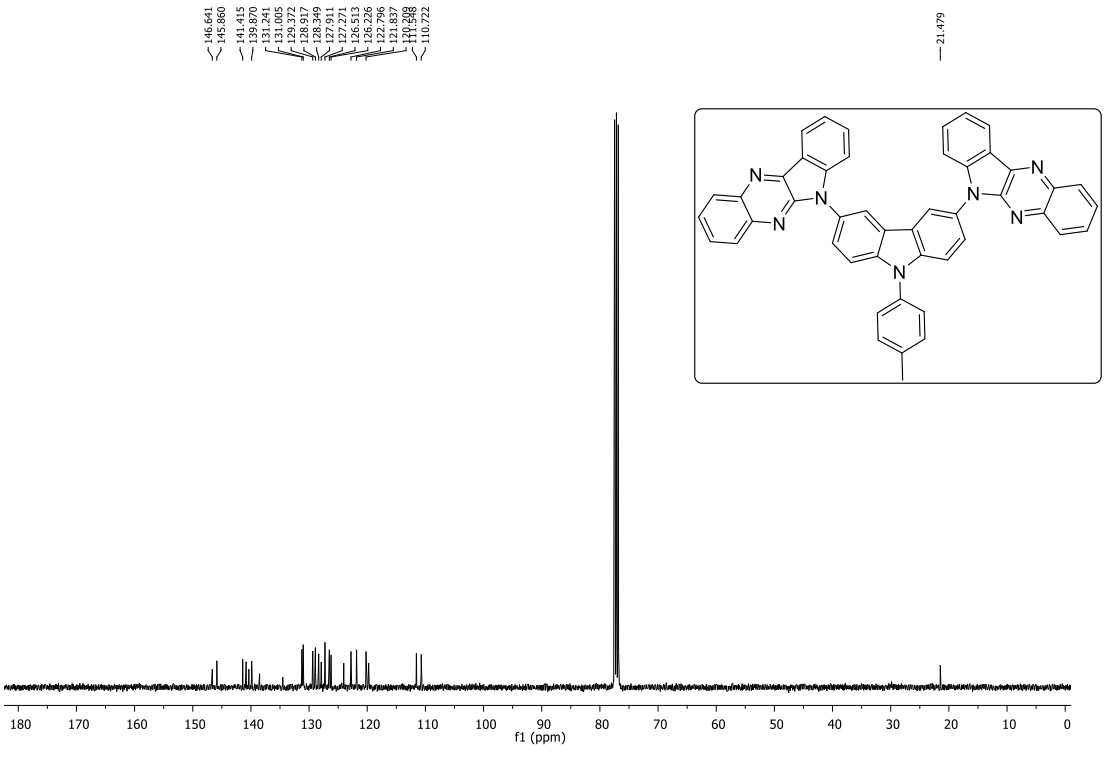


6,6'-(9-(*p*-Tolyl)-9*H*-carbazole-3,6-diyl)bis(6*H*-indolo[2,3-*b*]quinoxaline) (12)

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

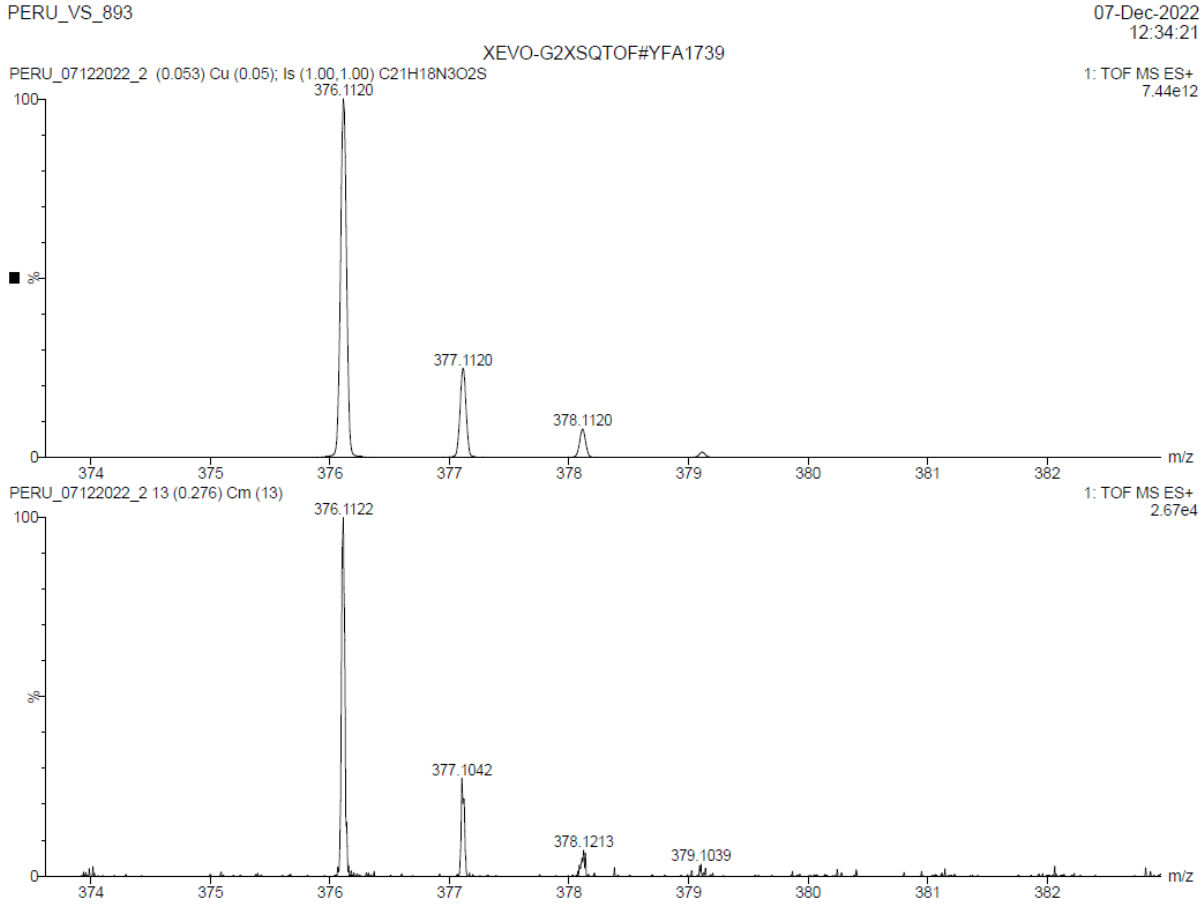


^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$)

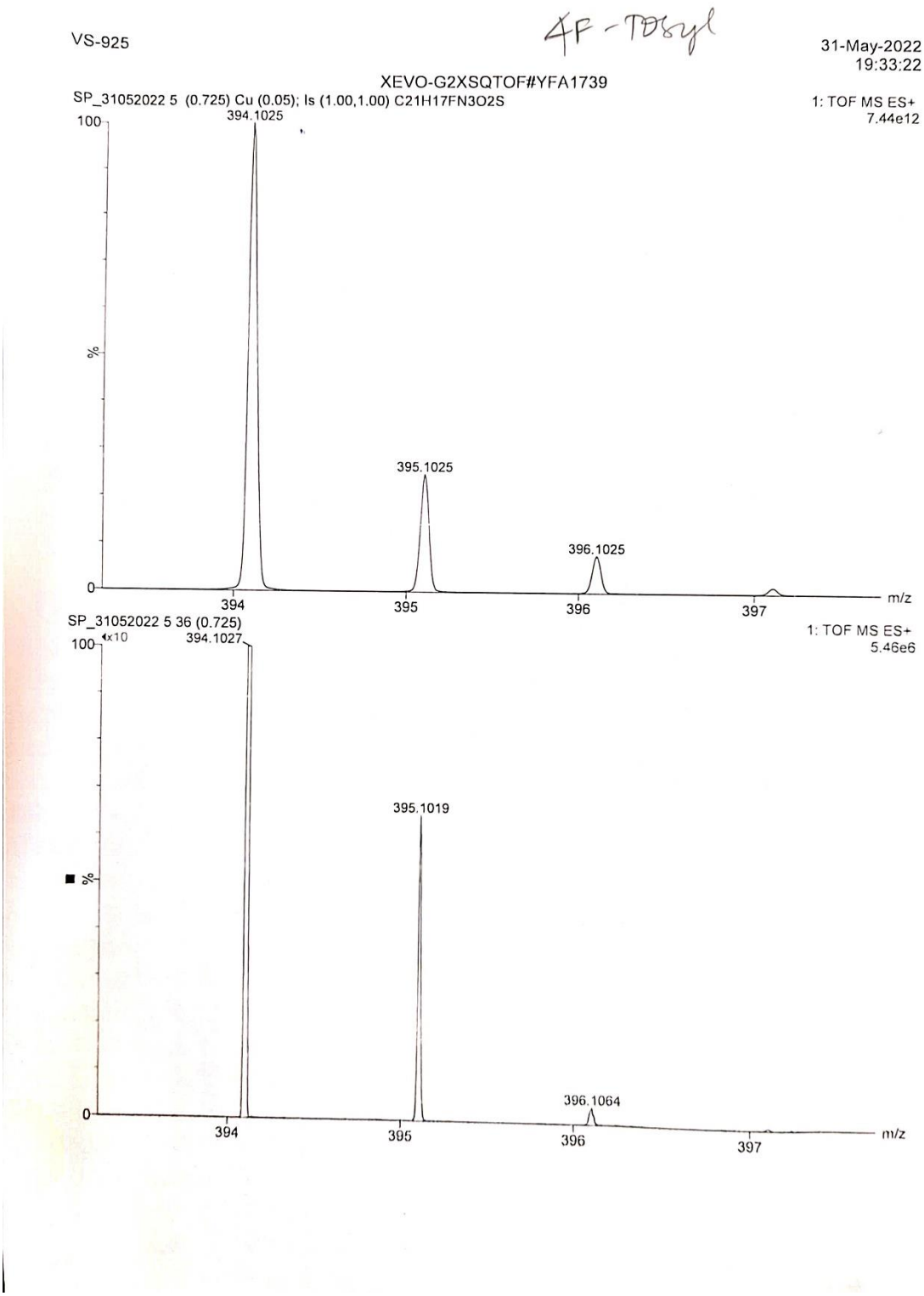


Mass spectra copies

4-Methyl-*N*-(3-phenylquinoxalin-2-yl)benzenesulfonamide (4a)



***N*-(3-(4-Fluorophenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4b)**



***N*-(3-(4-Chlorophenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4c)**

4-C-75

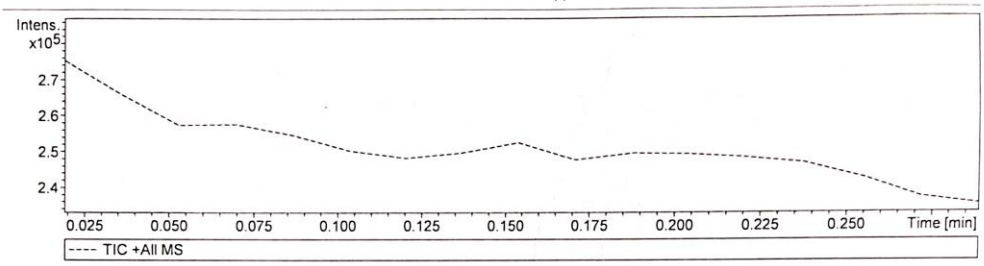
Display Report

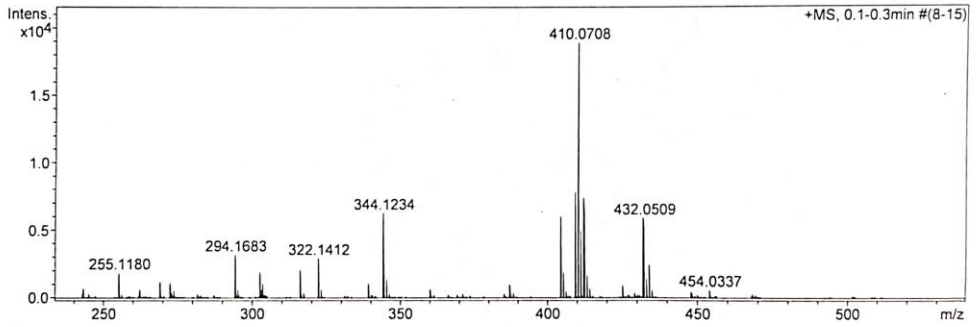
Analysis Info

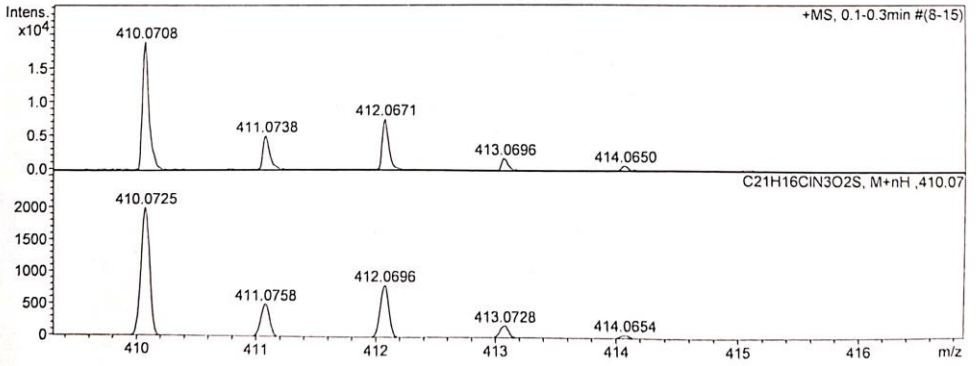
Analysis Name	D:\Data\APR-2022\PERU\01042022_PERU_VS_924_RE.d	Acquisition Date	4/1/2022 11:09:44 AM
Method	Pos_tune_low.m	Operator	Amit S.Sahu
Sample Name	Tmix-131118	Instrument	micrOTOF-Q II 10337
Comment			

Acquisition Parameter

Source Type	ESI	Ion Polarity	Positive	Set Nebulizer	0.4 Bar
Focus	Not active	Set Capillary	4500 V	Set Dry Heater	180 °C
Scan Begin	50 m/z	Set End Plate Offset	-500 V	Set Dry Gas	4.0 l/min
Scan End	3000 m/z	Set Collision Cell RF	130.0 Vpp	Set Divert Valve	Waste







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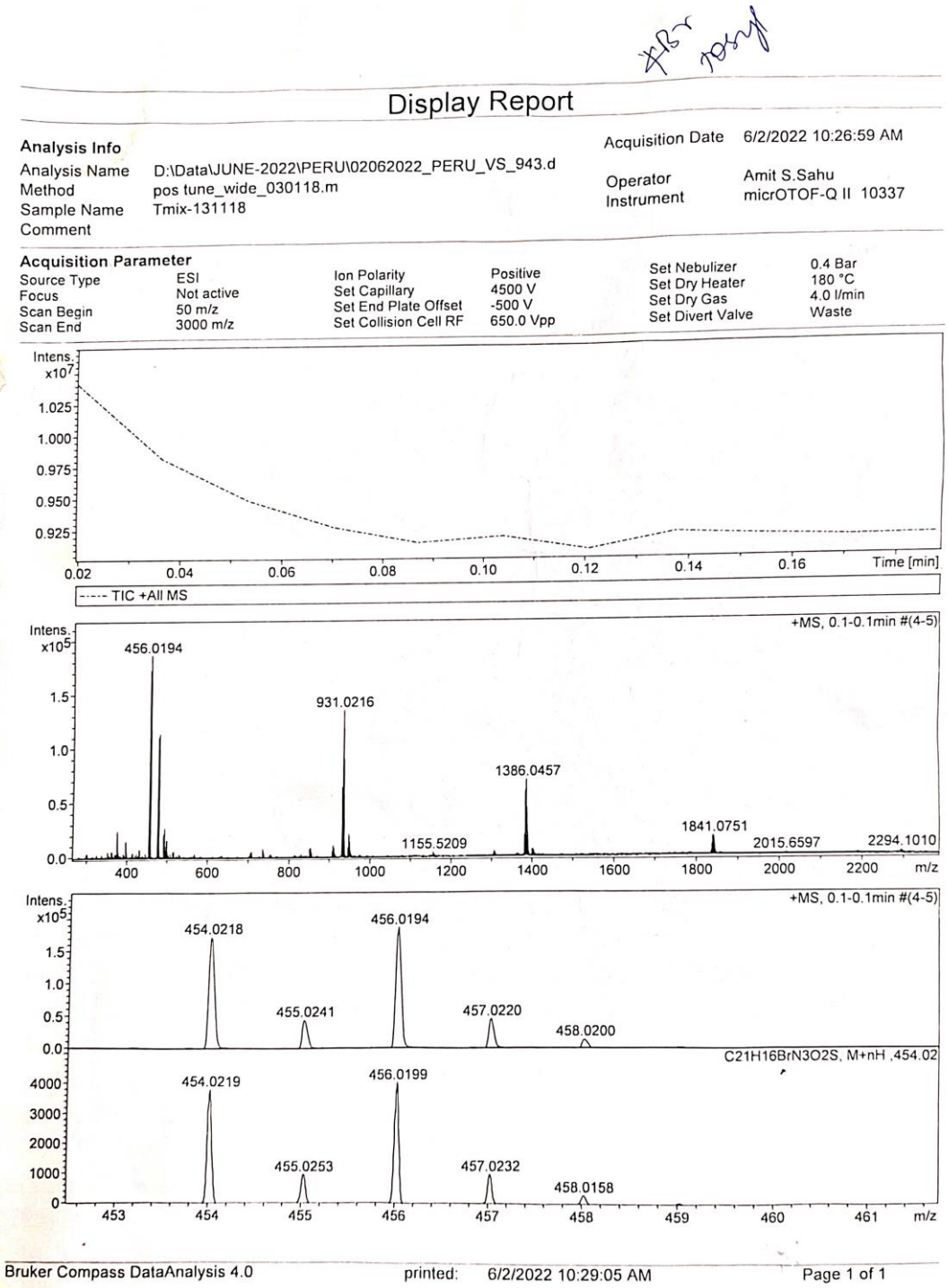
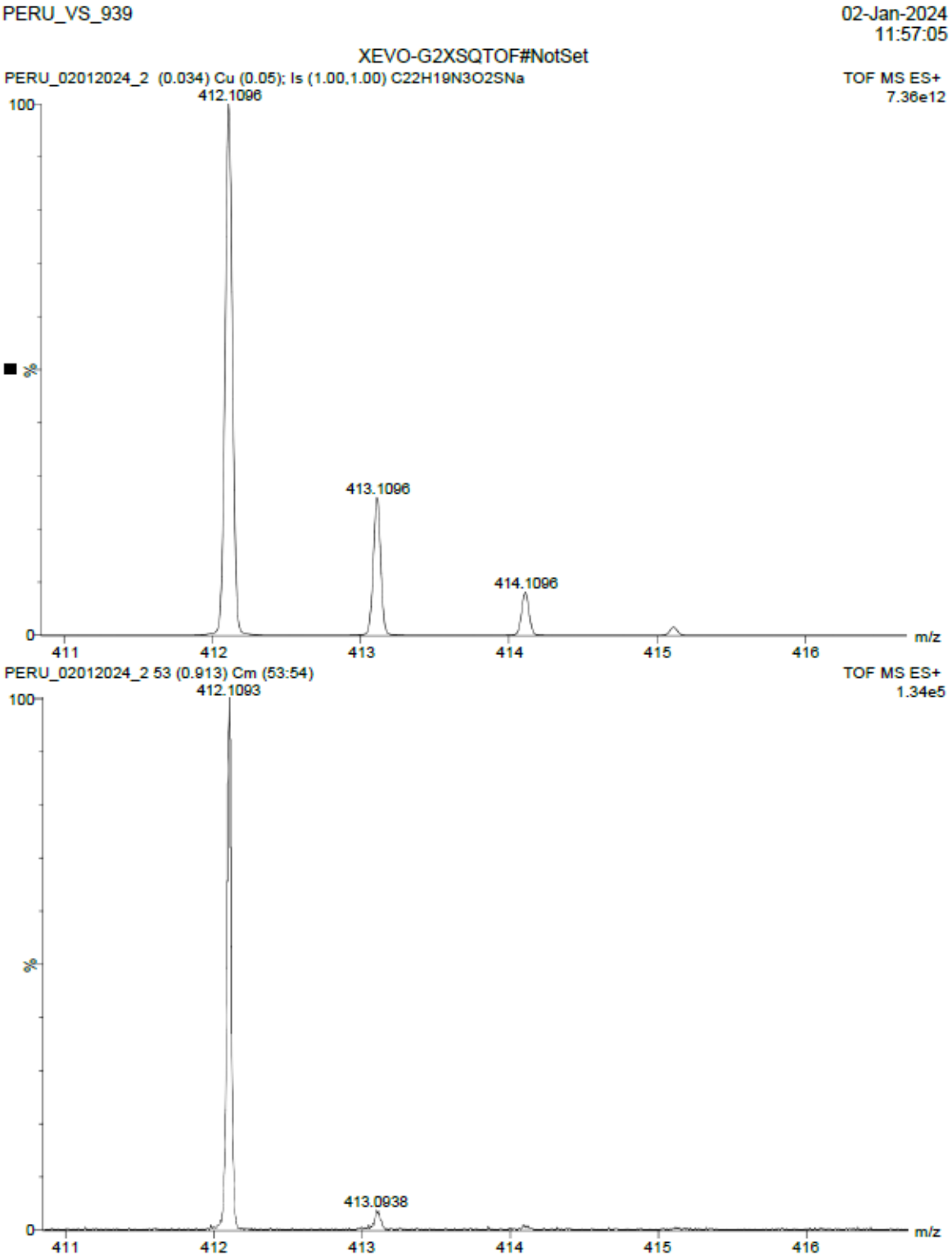
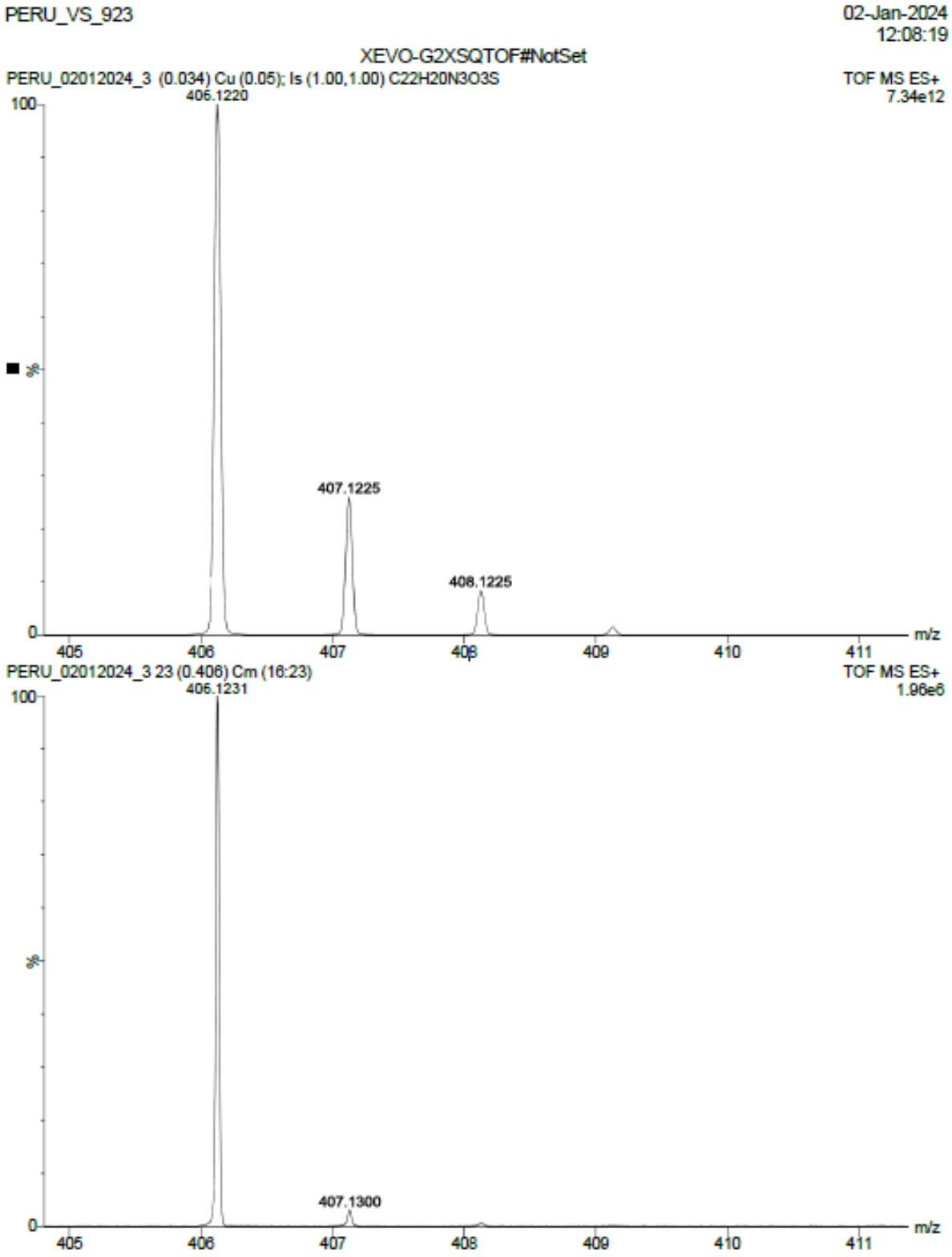
***N*-(3-(4-Bromophenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4d)**



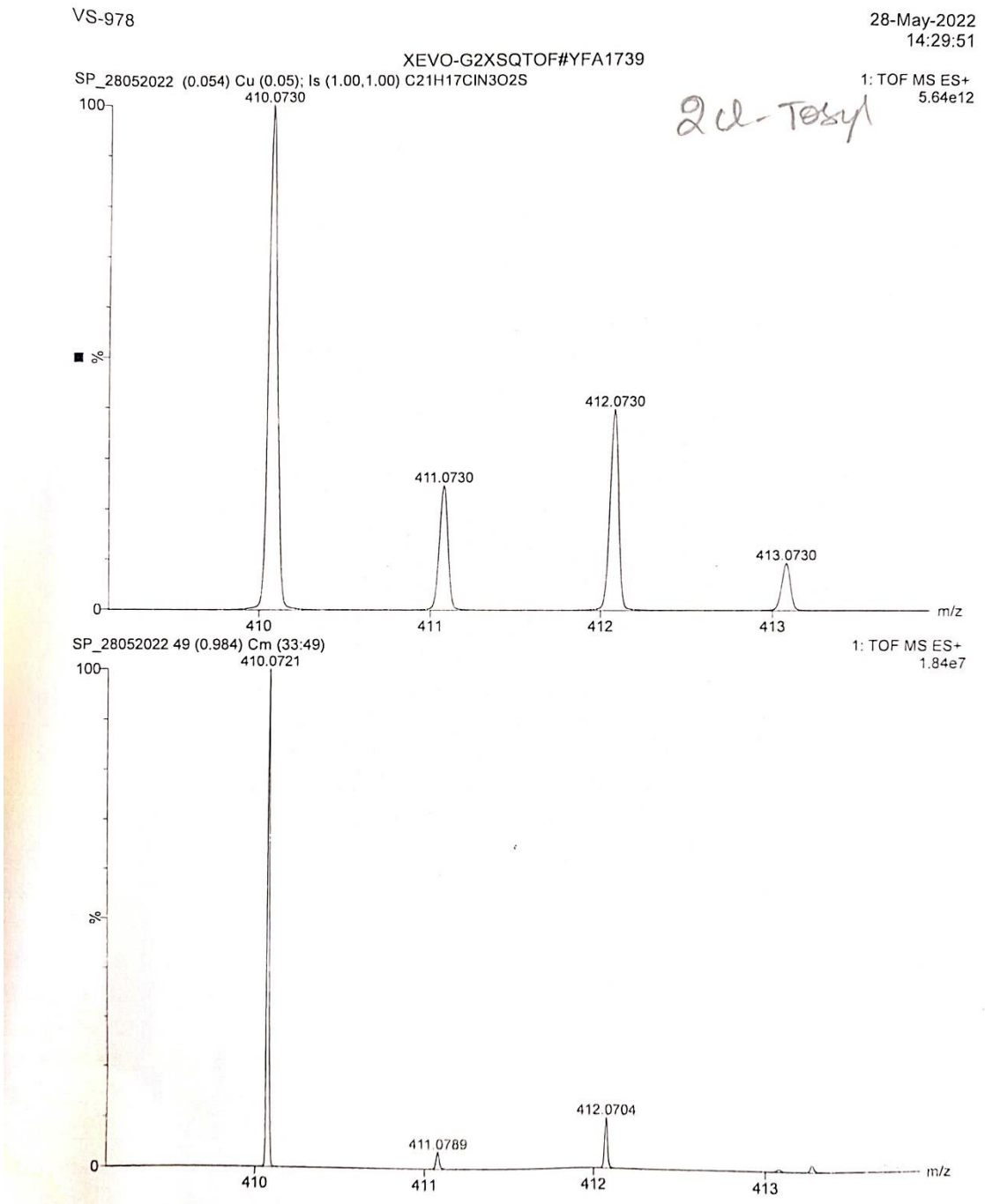
4-Methyl-*N*-(3-(*p*-tolyl)quinoxalin-2-yl)benzenesulfonamide (4e)



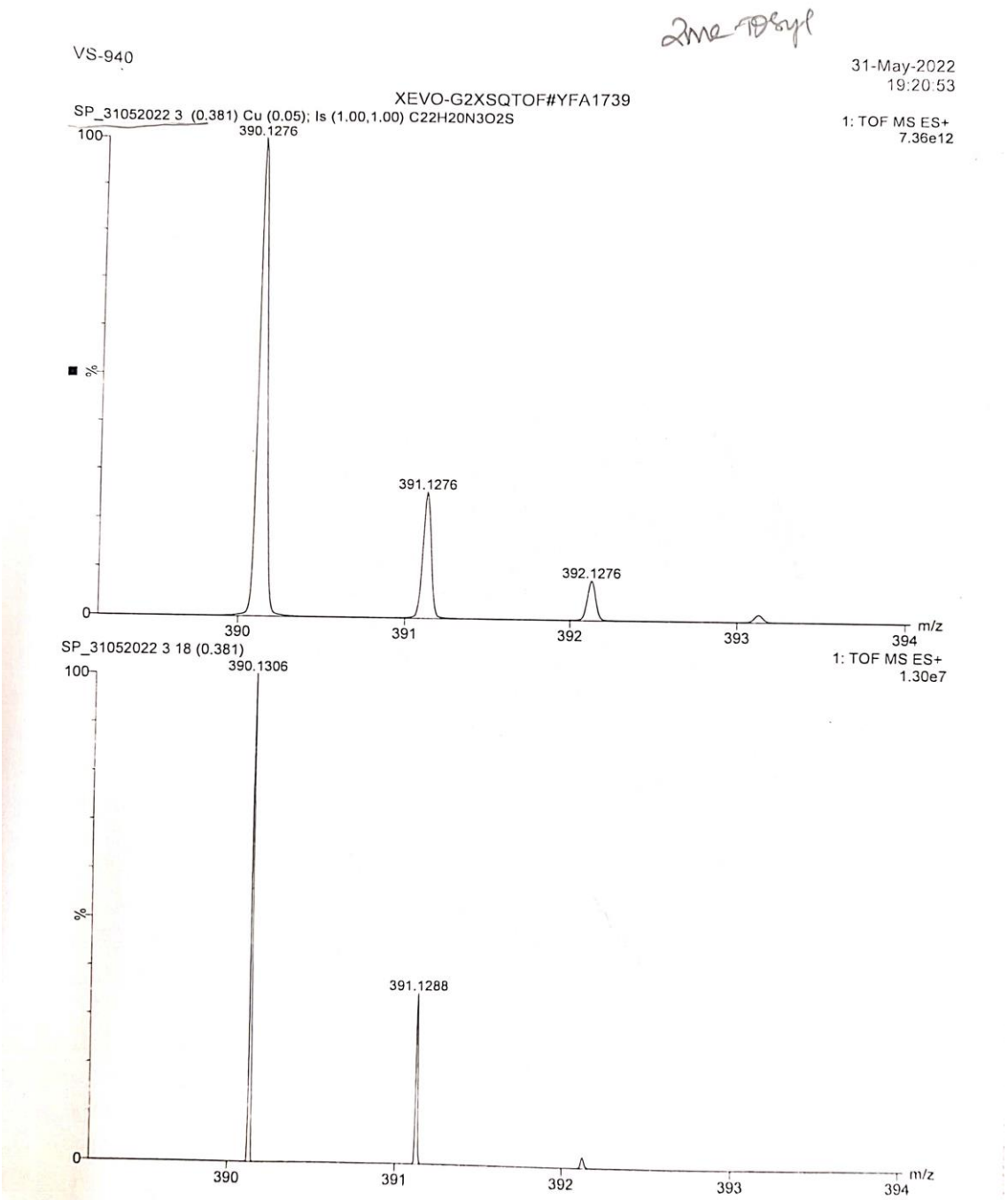
***N*-(3-(4-Methoxyphenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4f)**



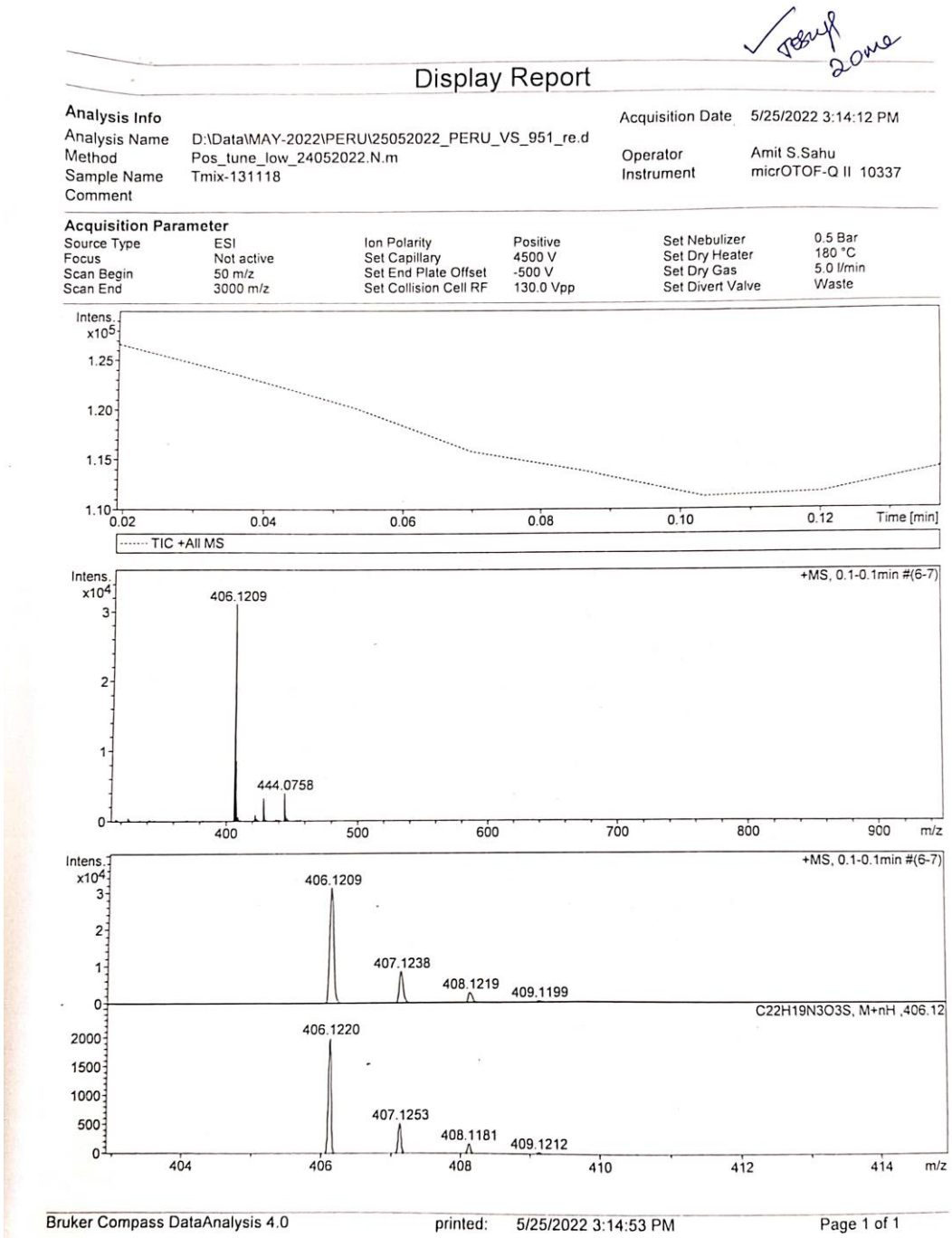
***N*-(3-(2-Chlorophenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4g)**



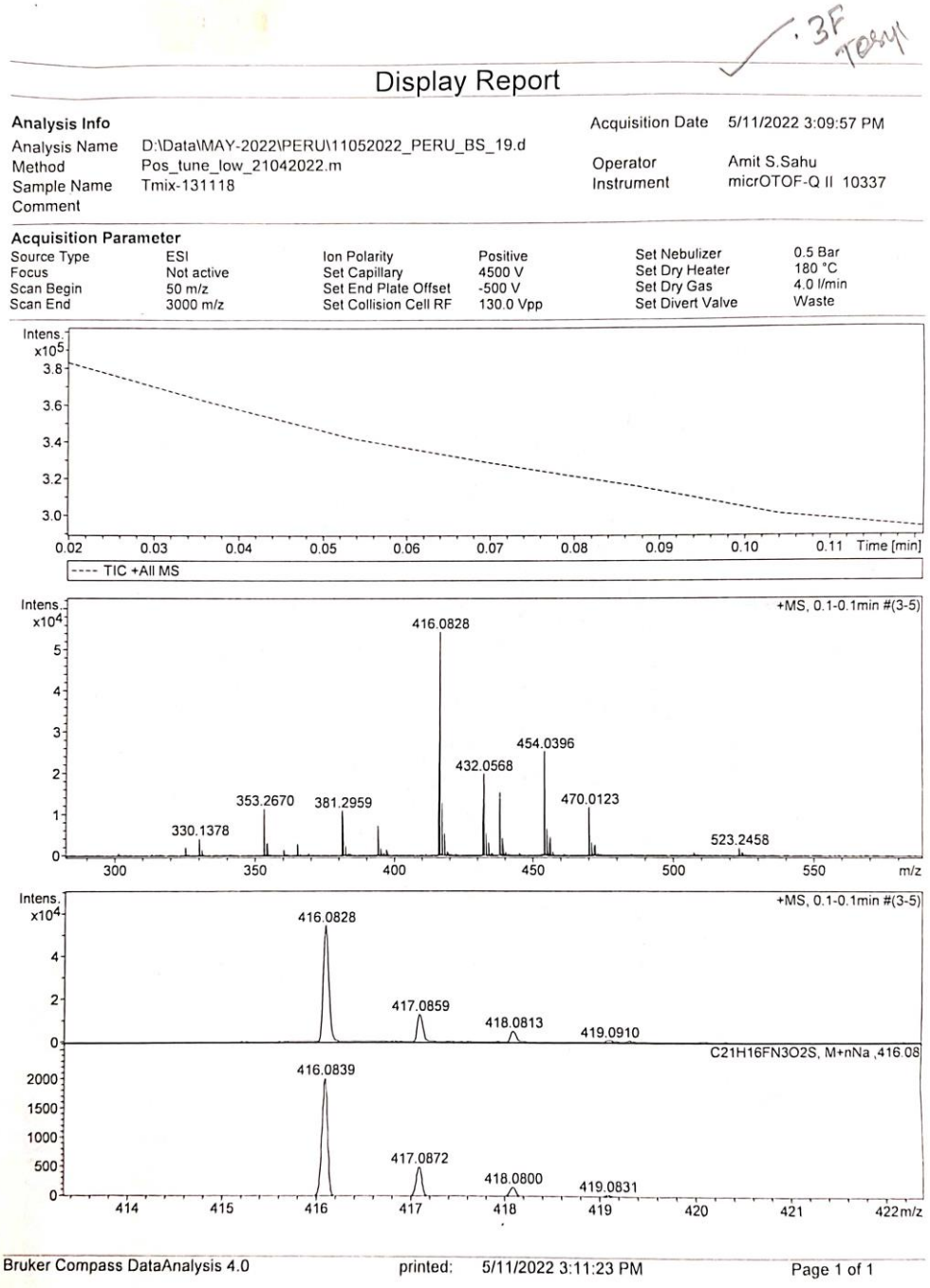
4-Methyl-*N*-(3-(*o*-tolyl)quinoxalin-2-yl)benzenesulfonamide (4h)



N-(3-(2-Methoxyphenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4i)



***N*-(3-(3-Fluorophenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4j)**



***N*-(3-(3-Methoxyphenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4k)**

Tosyl
3-OMe

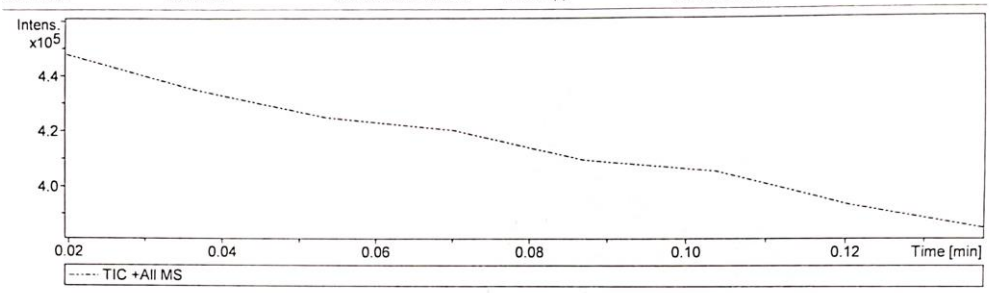
Display Report

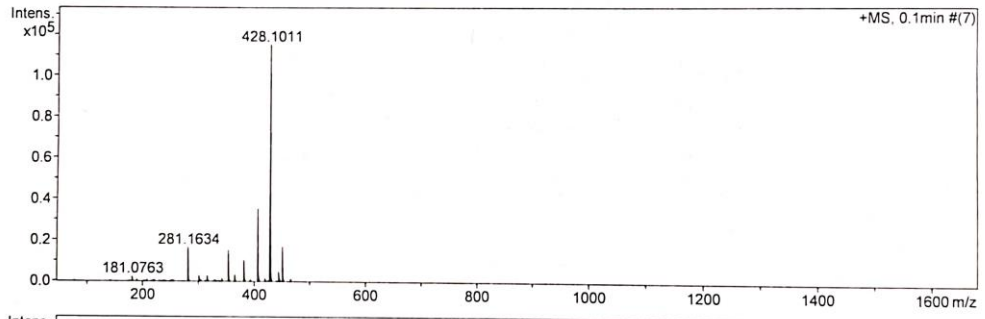
Analysis Info

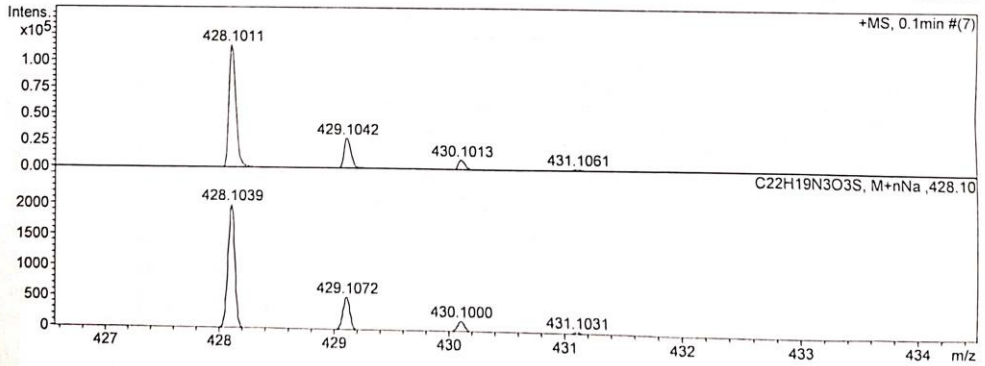
Analysis Name	D:\Data\MAY-2022\PERU\11052022_PERU_BS_17.d	Acquisition Date	5/11/2022 2:43:07 PM
Method	Pos_tune_low_21042022.m	Operator	Amit S.Sahu
Sample Name	Tmix-131118	Instrument	micrOTOF-Q II 10337
Comment			

Acquisition Parameter

Source Type	ESI	Ion Polarity	Positive	Set Nebulizer	0.5 Bar
Focus	Not active	Set Capillary	4500 V	Set Dry Heater	180 °C
Scan Begin	50 m/z	Set End Plate Offset	-500 V	Set Dry Gas	4.0 l/min
Scan End	3000 m/z	Set Collision Cell RF	130.0 Vpp	Set Divert Valve	Waste







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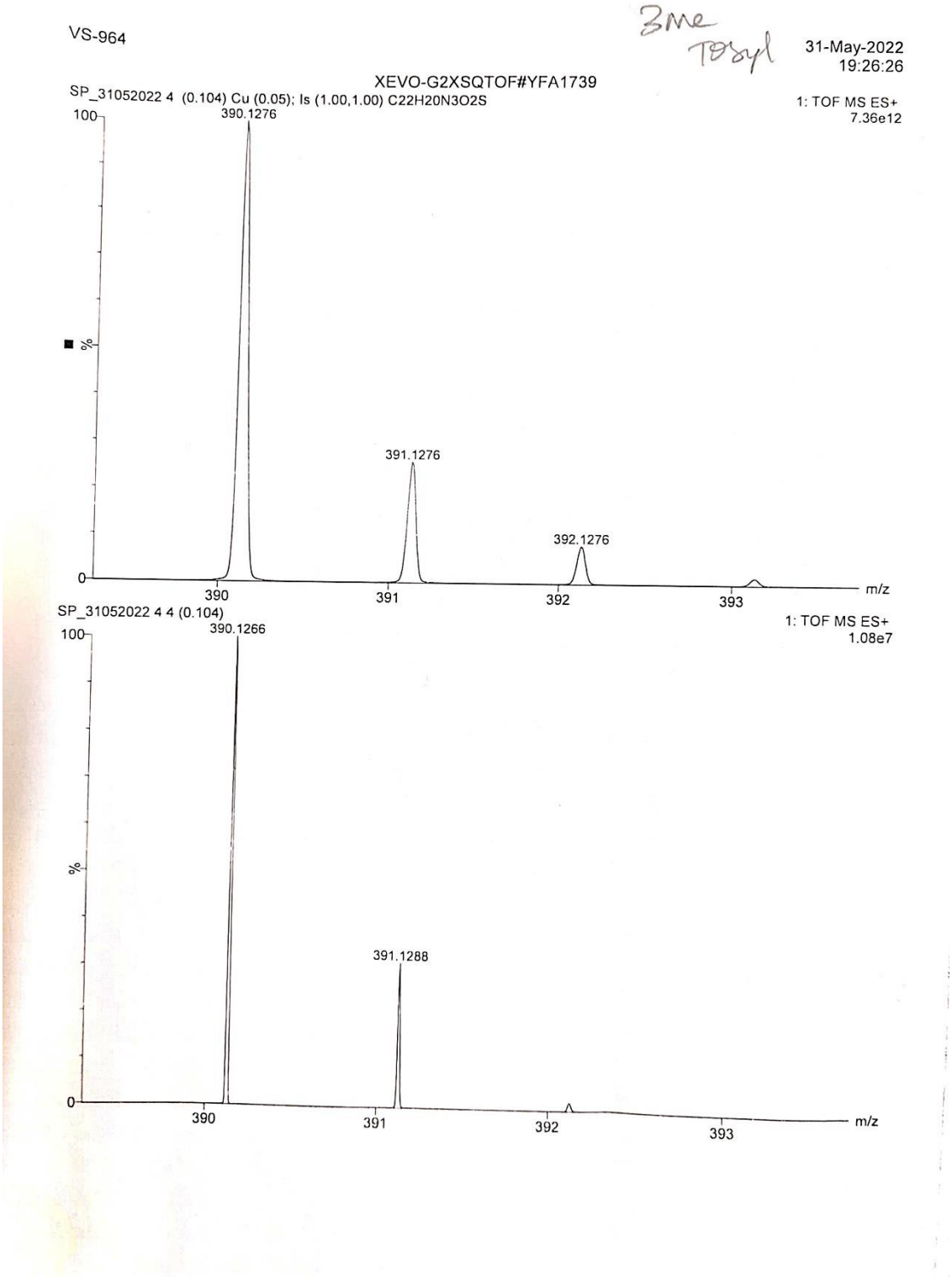
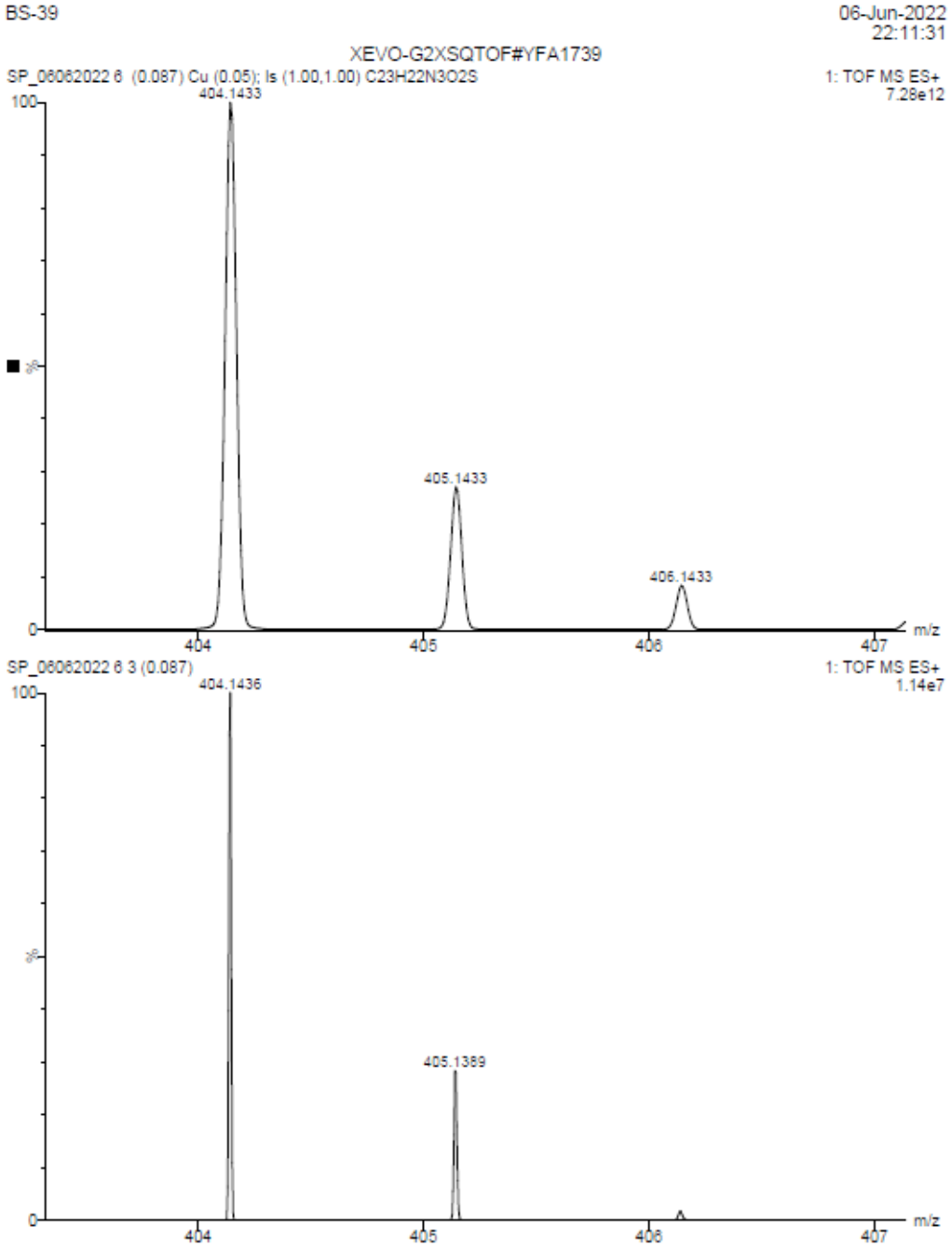
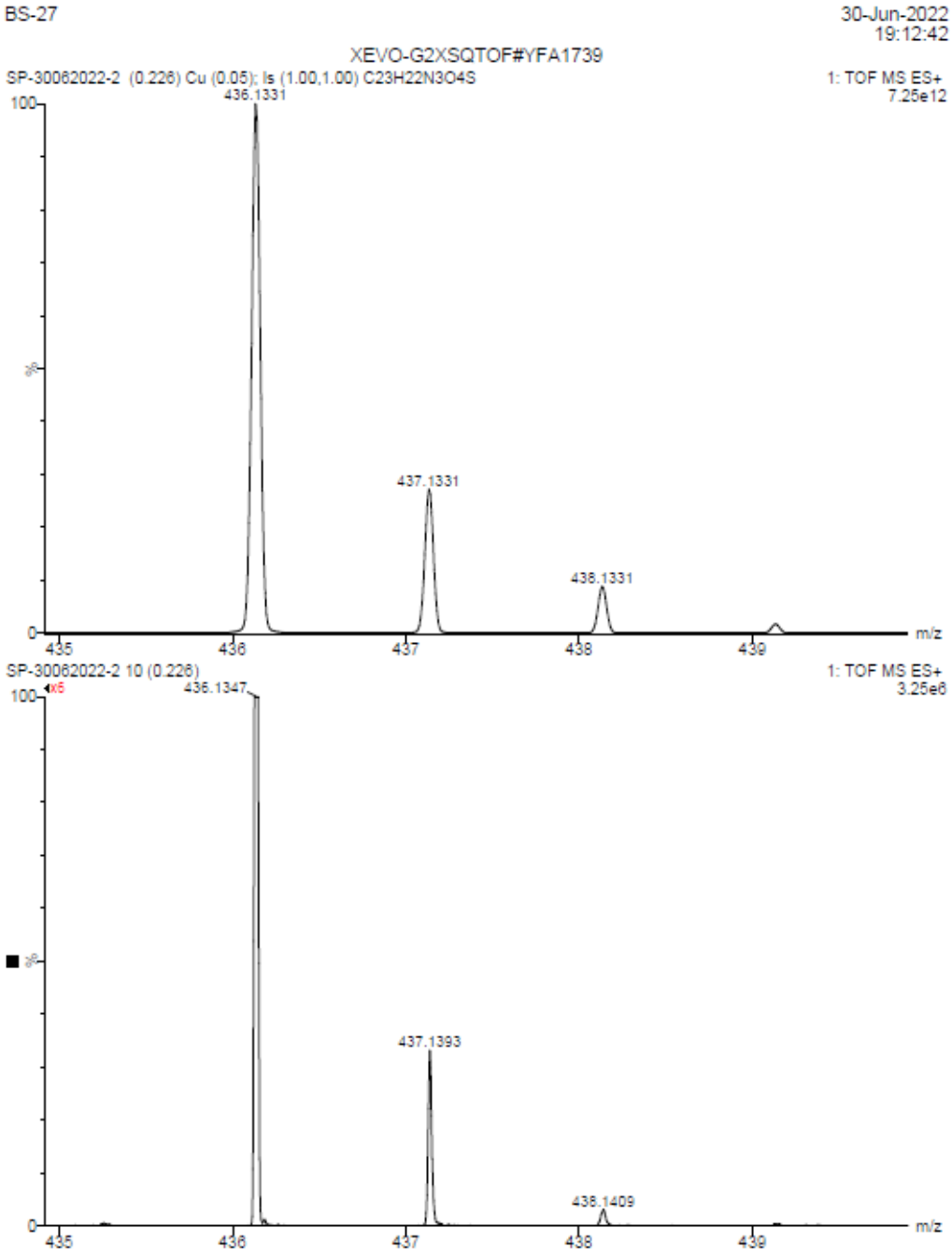
4-Methyl-*N*-(3-(*m*-tolyl)quinoxalin-2-yl)benzenesulfonamide (4l)



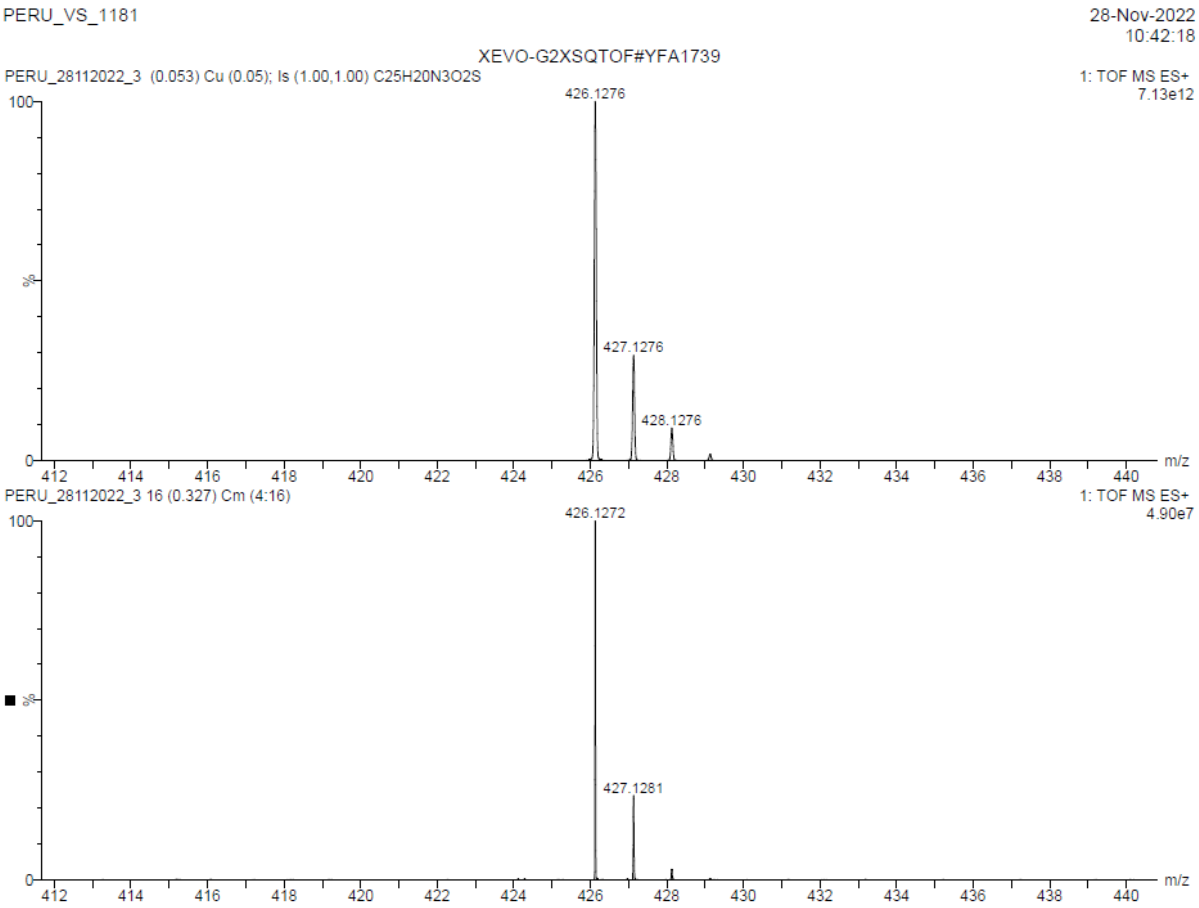
***N*-(3-(3,5-Dimethylphenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4m)**



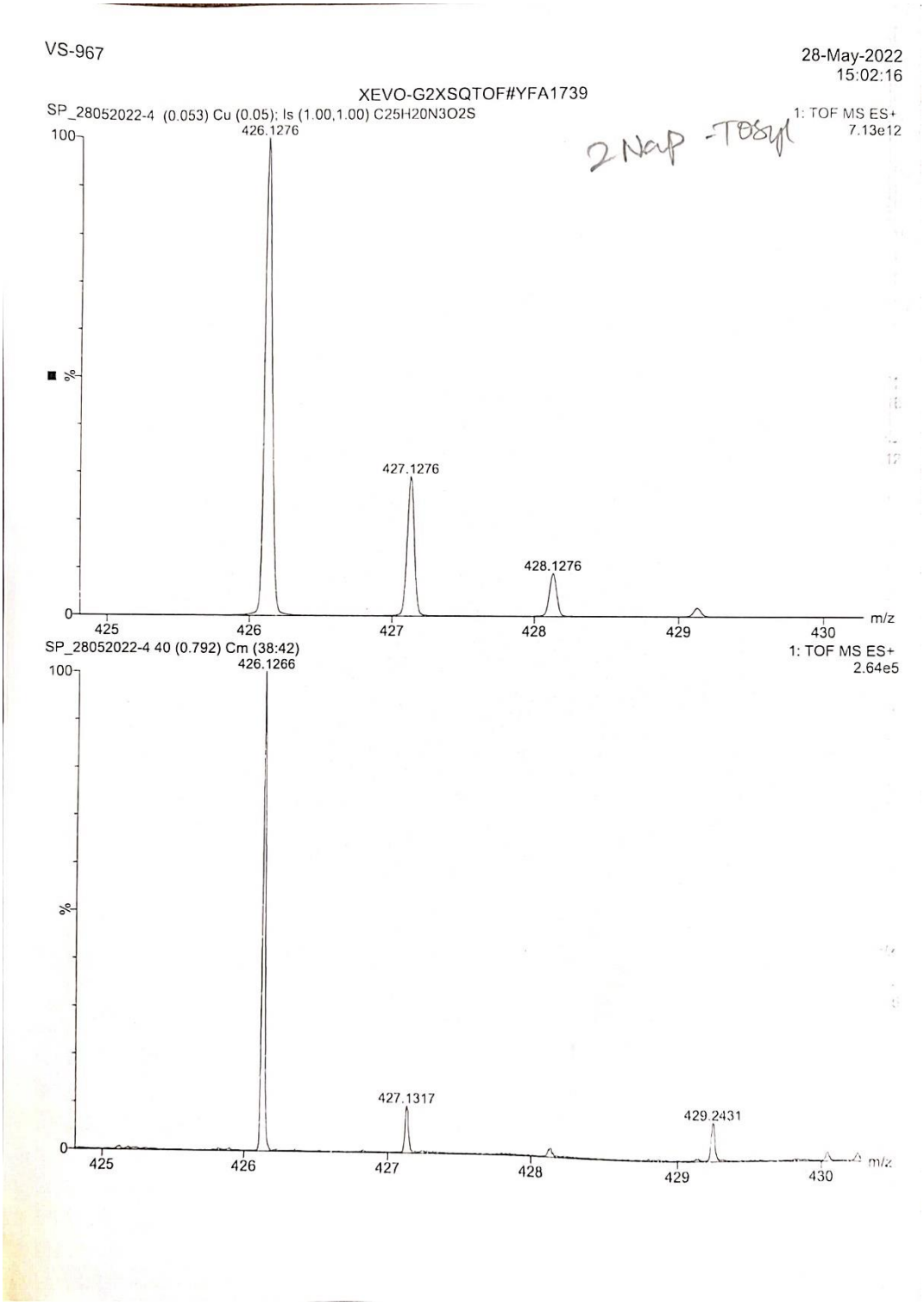
***N*-(3-(2,3-Dimethoxyphenyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4n)**



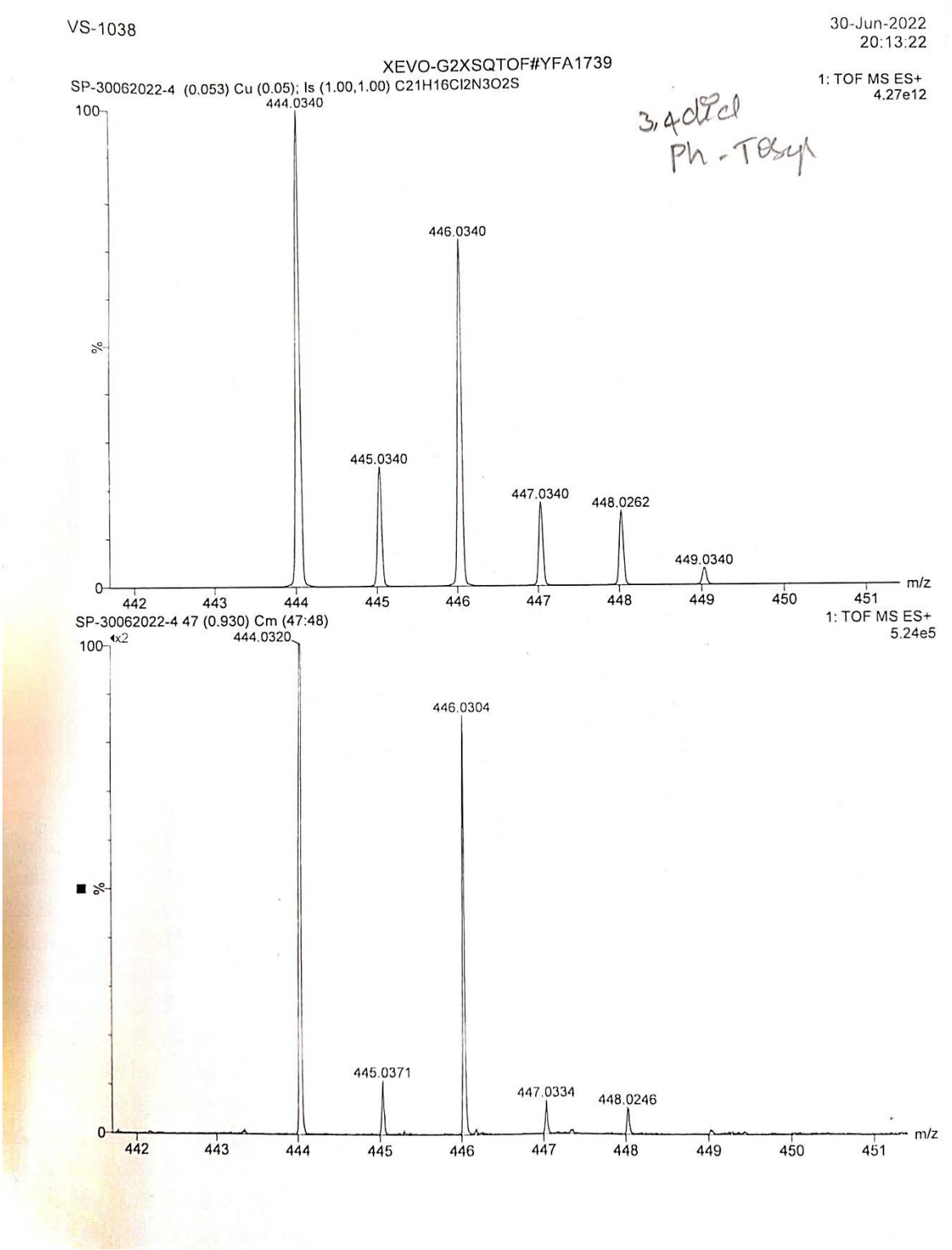
4-Methyl-*N*-(3-(naphthalen-2-yl)quinoxalin-2-yl)benzenesulfonamide (4o)



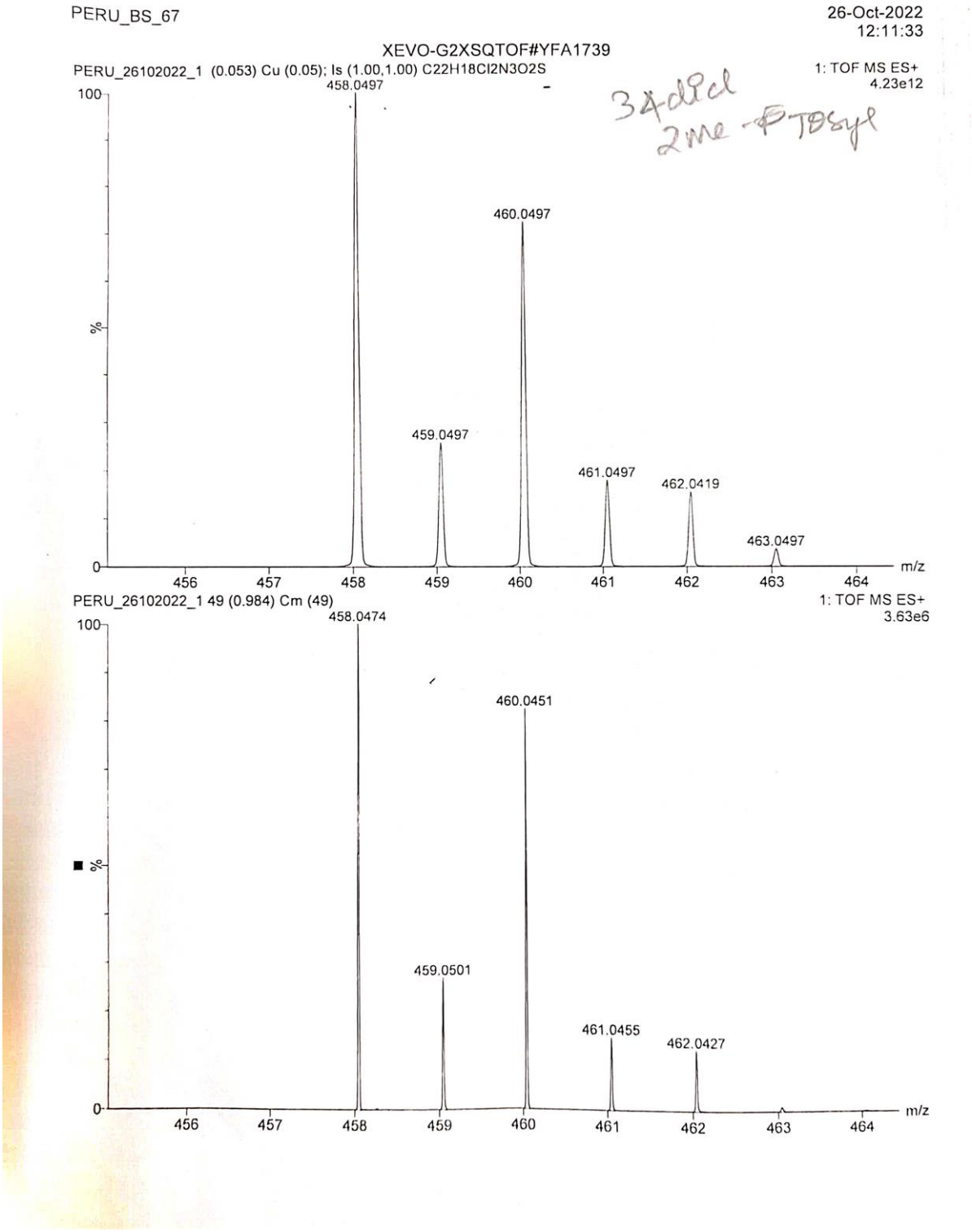
4-Methyl-*N*-(3-(naphthalen-1-yl)quinoxali*N*-2-yl)benzenesulfonamide (4p)



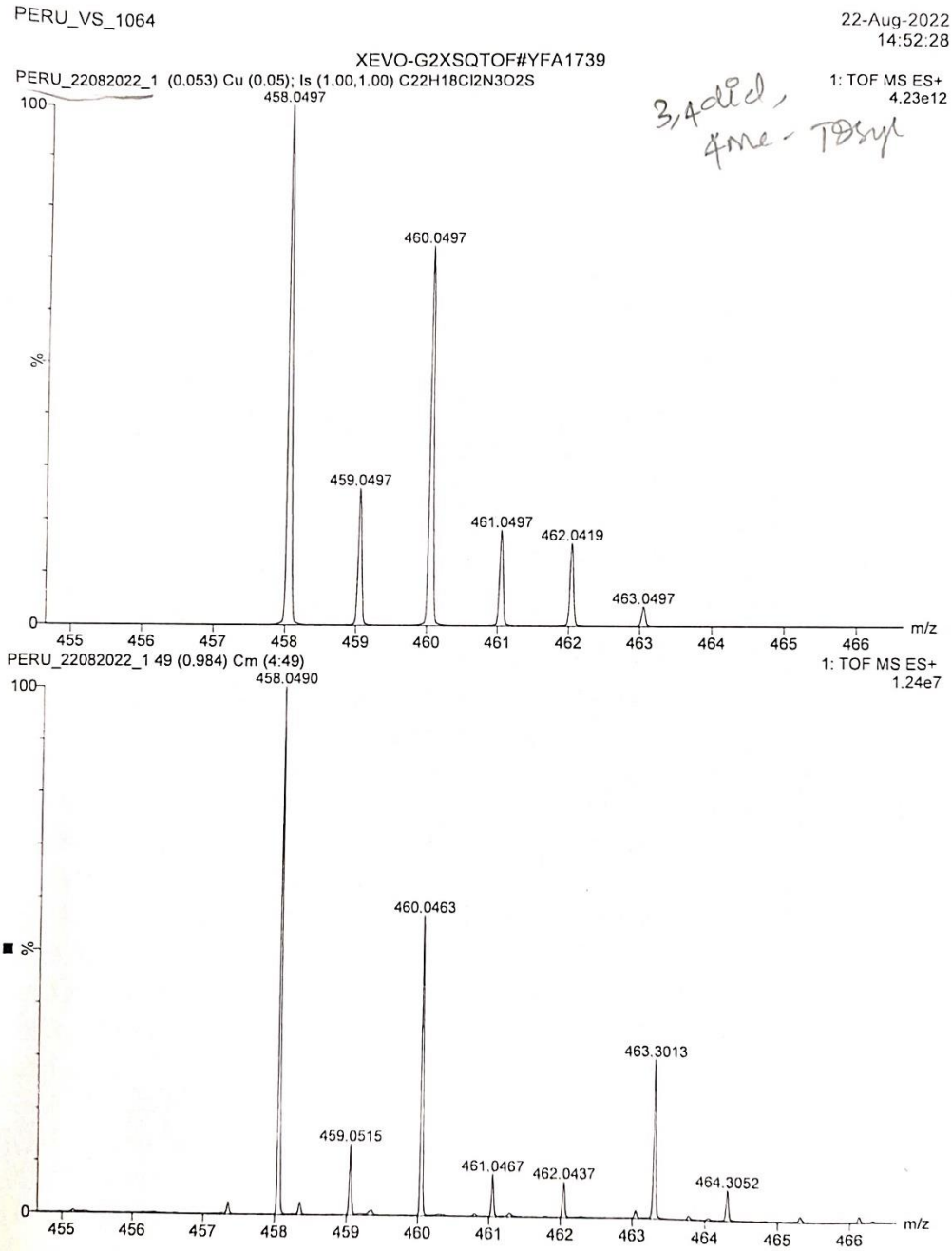
***N*-(6,7-Dichloro-3-phenylquinoxalin-2-yl)-4-methylbenzenesulfonamide (4q)**



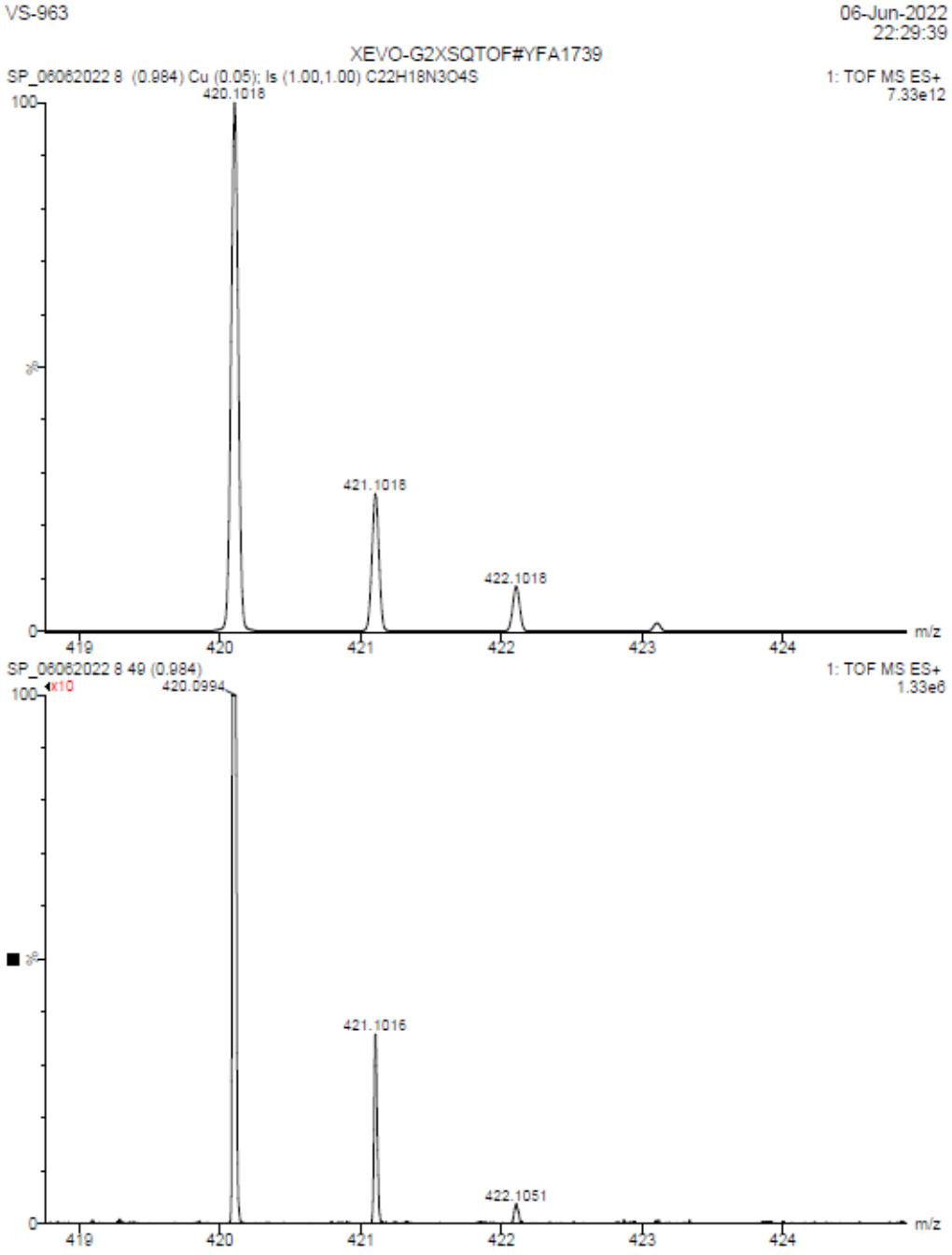
***N*-(6,7-Dichloro-3-(*o*-tolyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4r)**



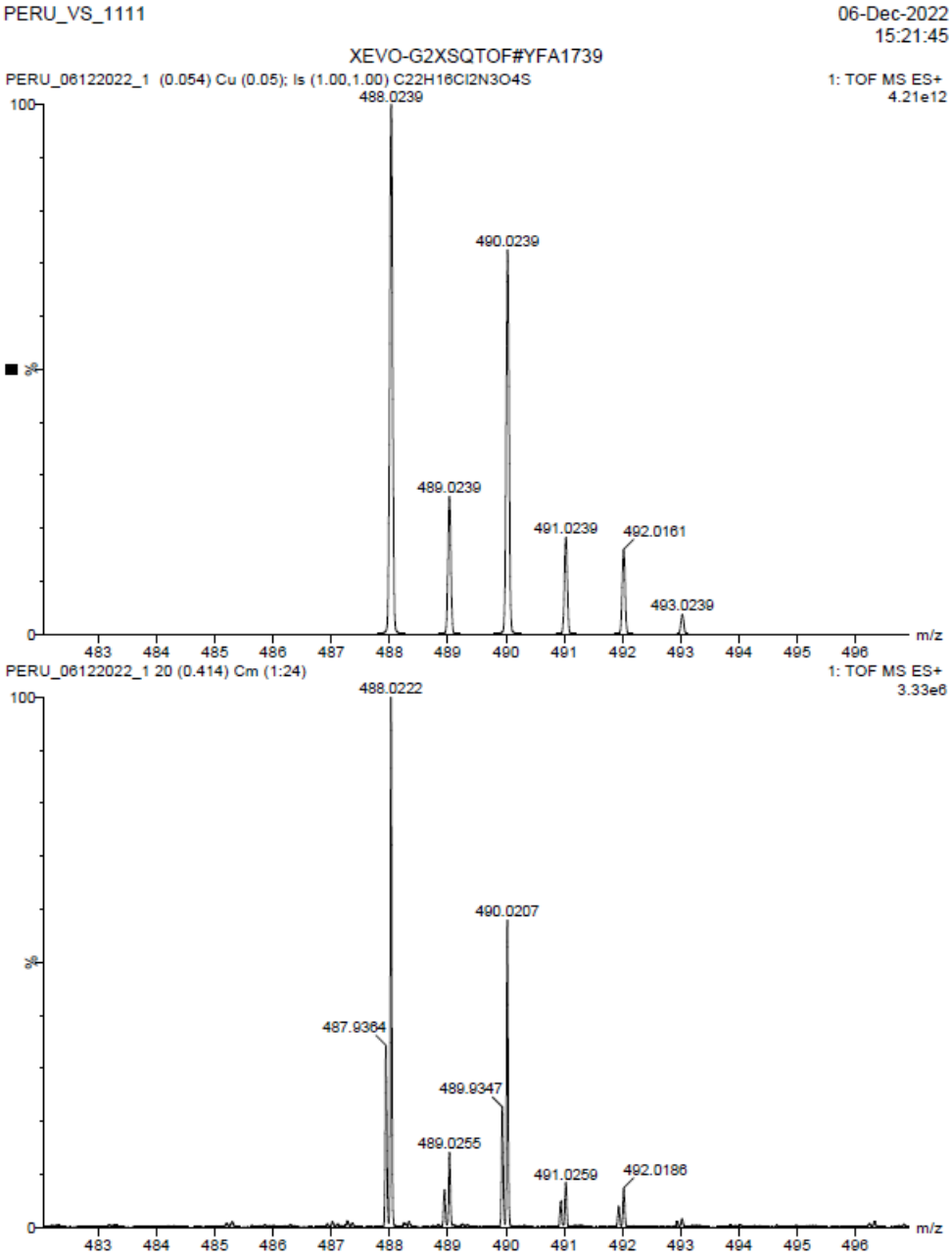
***N*-(6,7-Dichloro-3-(*p*-tolyl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4s)**



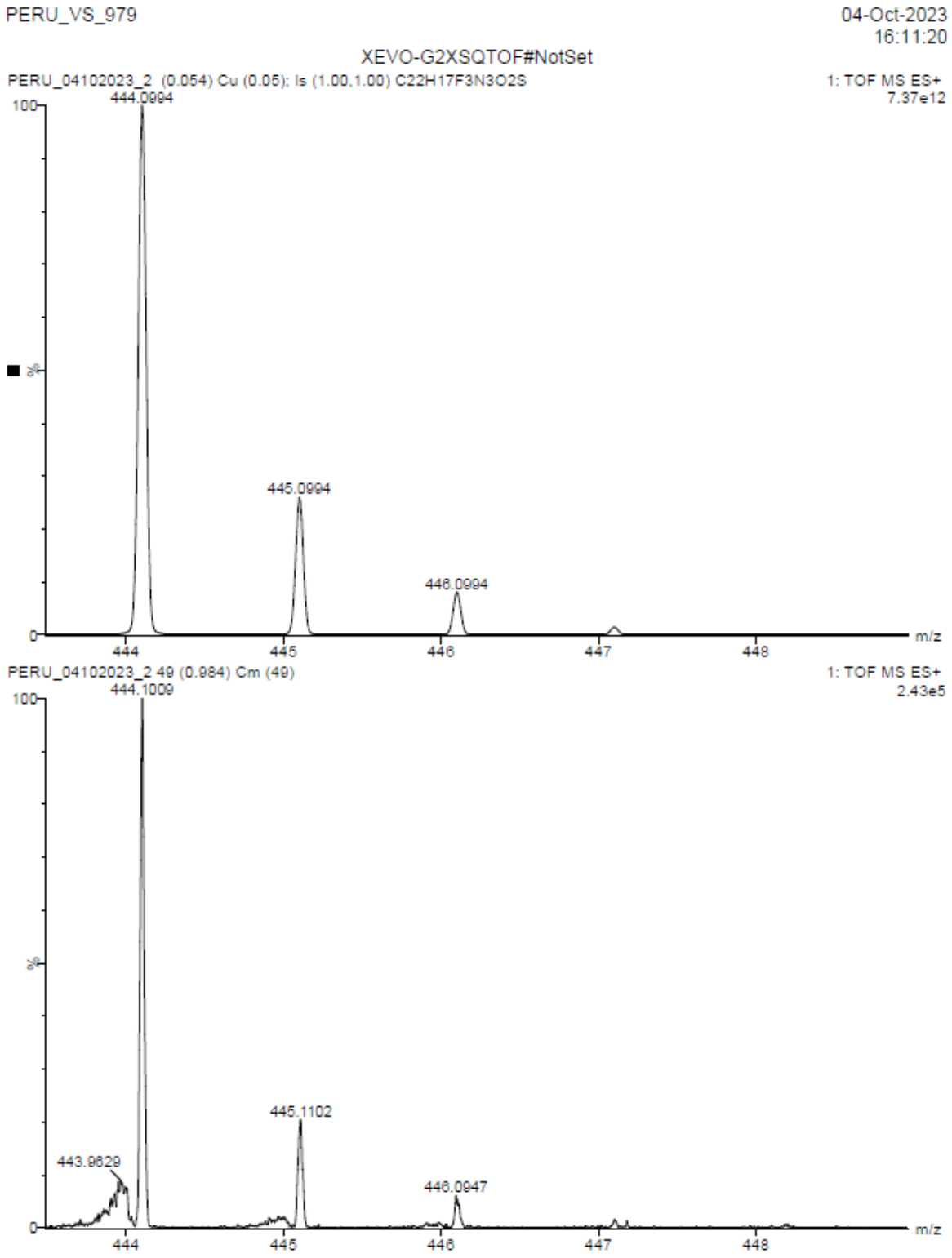
***N*-(3-(Benzo[*d*][1,3]dioxol-5-yl)quinoxalin-2-yl)-4-methylbenzenesulfonamide (4t)**



***N*-(3-(benzo[*d*][1,3]dioxol-5-yl)-6,7-dichloroquinoxalin-2-yl)-4-methylbenzenesulfonamide (4u)**



4-Methyl-*N*-(3-(4-(trifluoromethyl)phenyl)quinoxalin-2-yl)benzenesulfonamide (4v)



4-Methyl-*N*-(3-(2,4,5-trifluorophenyl)quinoxalin-2-yl)benzenesulfonamide (4w)