

Supplementary Material

Indole-3-carbinol and 1,3,4-oxadiazole hybrids: Synthesis and study of antiproliferative and antimicrobial activity

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Structural characterization data of intermediates **9a-u**:

2-(5-(4-fluorobenzylthio)-1,3,4-oxadiazol-2-yl)-1-methyl-1H-indole-3-carbaldehyde (9a): Yield: 0.21 g, 91%. Yellow solid, m.p. 156-157 °C. ¹H NMR (DMSO-d₆, 400 MHz, δ in ppm): 10.27 (s, 1H, -CHO), 8.31-7.17 (m, 8H, Ar-H), 4.64 (s, 2H, S-CH₂), 4.09 (s, 3H, N-CH₃). ¹³C NMR (DMSO-d₆, 100 MHz, δ in ppm): 186.75, 160.95, 158.90, 138.66, 133.18, 133.15, 131.73, 129.54, 126.25, 124.54, 122.36, 120.44, 120.33, 117.72, 116.02, 115.81, 112.10, 35.67, 33.12. MS: m/z= 368.4 (M+1). Anal. calculated for C₁₉H₁₄FN₃O₂S: C, 62.11; H, 3.84; N, 11.44; S, 8.73. Found: C, 62.09; H, 3.80; N, 11.42; S, 8.70.

2-(5-(4-methoxybenzylthio)-1,3,4-oxadiazol-2-yl)-1-methyl-1H-indole-3-carbaldehyde (9b): Yield: 0.20 g, 87%. Orange solid, m.p. 160-161 °C. ¹H NMR (DMSO-d₆, 400 MHz, δ in ppm): 10.26 (s, 1H, -CHO), 8.30-7.14 (m, 8H, Ar-H), 4.67 (s, 2H, S-CH₂), 4.09 (s, 3H, N-CH₃), 3.69 (s, 3H, O-CH₃). ¹³C NMR (DMSO-d₆, 100 MHz, δ in ppm): 186.61, 162.76, 161.55, 160.93, 133.09, 131.70, 130.62, 126.32, 124.96, 123.06, 122.80, 121.12, 118.53, 115.99, 115.78, 112.24, 106.70, 54.40, 35.59, 33.12. MS: m/z= 380.2 (M+1). Anal. calculated for C₂₀H₁₇N₃O₃S: C, 63.31; H, 4.52; N, 11.07; S, 8.45. Found: C, 63.29; H, 4.50; N, 11.05; S, 8.41.

4-((5-(3-formyl-1-methyl-1H-indol-2-yl)-1,3,4-oxadiazol-2-ylthio)methyl)benzotrile (9c): Yield: 0.20 g, 88%. Pale yellow solid, m.p. 165-166 °C. ¹H NMR (DMSO-d₆, 400 MHz, δ in ppm): 10.23 (s, 1H, -CHO), 8.31-7.14 (m, 8H, Ar-H), 4.71 (s, 2H, S-CH₂), 4.08 (s, 3H, N-CH₃). ¹³C NMR (DMSO-d₆, 100 MHz, δ in ppm): 186.71, 160.98, 158.95, 143.10, 136.65, 134.78, 134.73, 130.54, 129.98, 129.81, 127.69, 124.30, 122.80, 121.11, 118.53, 115.78, 111.21, 107.70, 35.43, 33.19. MS: m/z= 375.4

(M+1). Anal. calculated for C₂₀H₁₄N₄O₂S: C, 64.16; H, 3.77; N, 14.96; S, 8.56. Found: C, 64.14; H, 3.73; N, 14.93 S, 8.52.

2-(5-(2-fluorobenzylthio)-1,3,4-oxadiazol-2-yl)-1-methyl-1H-indole-3-carbaldehyde (9d): Yield: 0.212 g, 92%. White solid, m.p. 150-151 °C. ¹H NMR (DMSO-d₆, 400 MHz, δ in ppm): 10.27 (s, 1H, -CHO), 8.31-7.14 (m, 8H, Ar-H), 4.63 (s, 2H, S-CH₂), 4.08 (s, 3H, N-CH₃). ¹³C NMR (DMSO-d₆, 100 MHz, δ in ppm): 186.73, 163.14, 162.61, 159.87, 139.57, 131.19, 130.31, 129.47, 128.30, 126.77, 124.96, 124.10, 122.18, 121.12, 115.99, 111.24, 106.48, 33.18, 29.49. MS: m/z= 368.4 (M+1). Anal. calculated for C₁₉H₁₄FN₃O₂S: C, 62.11; H, 3.84; N, 11.44; S, 8.73. Found: C, 62.09; H, 3.81; N, 11.41; S, 8.71.

2-(5-(4-nitrobenzylthio)-1,3,4-oxadiazol-2-yl)-1-methyl-1H-indole-3-carbaldehyde (9e): Yield: 0.198 g, 86%. Yellow solid, m.p. 170-171 °C. ¹H NMR (DMSO-d₆, 400 MHz, δ in ppm): 10.29 (s, 1H, -CHO), 8.27-7.19 (m, 8H, Ar-H), 4.71 (s, 2H, S-CH₂), 4.09 (s, 3H, N-CH₃). ¹³C NMR (DMSO-d₆, 100 MHz, δ in ppm): 186.78, 160.91, 158.87, 147.33, 146.72, 138.64, 131.21, 129.63, 129.49, 127.51, 122.63, 122.48, 122.04, 120.79, 115.93, 111.18, 106.97, 35.36, 33.11. MS: m/z= 395.2 (M+1). Anal. calculated for C₁₉H₁₄N₄O₄S: C, 57.86; H, 3.58; N, 14.21; S, 8.13. Found: C, 57.83; H, 3.55; N, 14.18; S, 8.09.

2-(5-(isopropylthio)-1,3,4-oxadiazol-2-yl)-1-methyl-1H-indole-3-carbaldehyde (9f): Yield: 0.19 g, 83%. Off white solid, m.p. 147-148 °C. ¹H NMR (DMSO-d₆, 400 MHz, δ in ppm): 10.35 (s, 1H, -CHO), 8.32-7.16 (m, 4H, Ar-H), 4.12 (s, 3H, N-CH₃), 3.99 (sep, 1H, S-CH, *J* = 6.8 Hz), 1.51 (d, 6H, -(CH₃)₂, *J* = 6.8 Hz). ¹³C NMR (DMSO-d₆, 100 MHz, δ in ppm): 186.72, 165.06, 158.73, 138.63, 129.67, 126.21, 124.55, 124.38, 122.34, 117.67, 112.06, 33.12, 23.58, 20.48. MS: m/z= 302.1 (M+1). Anal. calculated for C₁₅H₁₅N₃O₂S: C, 59.78; H, 5.02; N, 13.94; S, 10.64. Found: C, 59.75; H, 4.99; N, 13.91; S, 10.60.

2-(5-(cyclopentylthio)-1,3,4-oxadiazol-2-yl)-1-methyl-1H-indole-3-carbaldehyde (9g): Yield: 0.184 g, 80%. Off white solid, m.p. 142-143 °C. ¹H NMR (DMSO-d₆, 400 MHz, δ in ppm): 10.32 (s, 1H, -CHO), 8.36-7.22 (m, 4H, Ar-H), 4.10 (s, 3H, N-CH₃), 4.09-4.02 (m, 1H, S-CH), 2.20-1.47 (m, 8H, aliphatic). ¹³C NMR (DMSO-d₆, 100 MHz, δ in ppm): 186.73, 162.77, 160.58, 139.71, 129.59, 127.75, 121.92, 121.24, 121.10, 111.23, 107.72, 44.19, 35.28, 35.34, 33.19, 26.35, 26.18. MS: m/z= 328.2 (M+1). Anal. calculated for C₁₇H₁₇N₃O₂S: C, 62.36; H, 5.23; N, 12.83; S, 9.79. Found: C, 62.32; H, 5.21; N, 12.81; S, 9.77.

2-(5-(4-(trifluoromethoxy)benzylthio)-1,3,4-oxadiazol-2-yl)-1-methyl-1H-indole-3-carbaldehyde (9h): Yield: 0.198 g, 86%. Off white solid, m.p. 136-137 °C. ¹H NMR (DMSO-d₆, 400 MHz, δ in ppm): 10.26 (s, 1H, -CHO), 8.30-7.17 (m, 8H, Ar-H), 4.72 (s, 2H, S-CH₂), 4.08 (s, 3H, N-CH₃). ¹³C NMR (DMSO-d₆, 100 MHz, δ in ppm): 186.77, 161.70, 160.58, 159.63, 139.62, 133.30, 129.97, 129.89,

128.47, 128.16, 126.98, 121.24, 121.10, 120.28, 115.68, 115.38, 111.23, 107.67, 35.58, 33.19. MS: $m/z = 434.2$ (M+1). Anal. calculated for $C_{20}H_{14}F_3N_3O_3S$: C, 55.43; H, 3.26; N, 9.70; S, 7.40. Found: C, 55.41; H, 3.24; N, 9.88; S, 7.37.

2-(5-(4-(trifluoromethyl)benzylthio)-1,3,4-oxadiazol-2-yl)-1-methyl-1H-indole-3-carbaldehyde (9i): Yield: 0.201 g, 87%. Pale yellow solid, m.p. 112-113 °C. 1H NMR (DMSO- d_6 , 400 MHz, δ in ppm): 10.26 (s, 1H, -CHO), 8.31-7.14 (m, 8H, Ar-H), 4.73 (s, 2H, S-CH₂), 4.09 (s, 3H, N-CH₃). ^{13}C NMR (DMSO- d_6 , 100 MHz, δ in ppm): 186.71, 160.57, 159.63, 146.19, 139.62, 129.89, 129.40, 128.47, 128.16, 126.73, 125.64, 125.37, 125.11, 122.18, 121.12, 115.91, 111.23, 107.72, 35.57, 33.18. MS: $m/z = 418.4$ (M+1). Anal. calculated for $C_{20}H_{14}F_3N_3O_2S$: C, 57.55; H, 3.38; N, 10.07; S, 7.68. Found: C, 57.51; H, 3.34; N, 10.06; S, 7.65.

2-(5-(benzylthio)-1,3,4-oxadiazol-2-yl)-1-methyl-1H-indole-3-carbaldehyde (9j): Yield: 0.21 g, 91%. Pale brown solid, m.p. 106-107 °C. 1H NMR (DMSO- d_6 , 400 MHz, δ in ppm): 10.28 (s, 1H, -CHO), 8.31-7.29 (m, 9H, Ar-H), 4.65 (s, 2H, S-CH₂), 4.08 (s, 3H, N-CH₃). ^{13}C NMR (DMSO- d_6 , 100 MHz, δ in ppm): 186.73, 165.47, 158.86, 138.65, 136.74, 129.34, 129.12, 128.99, 128.57, 128.34, 127.79, 126.24, 124.53, 124.39, 122.36, 117.71, 112.08, 36.50, 33.11. MS: $m/z = 350.2$ (M+1). Anal. calculated for $C_{19}H_{15}N_3O_2S$: C, 65.31; H, 4.33; N, 12.03; S, 9.18. Found: C, 65.28; H, 4.29; N, 11.99; S, 9.16.

2-(5-(ethylthio)-1,3,4-oxadiazol-2-yl)-1-methyl-1H-indole-3-carbaldehyde (9k): Yield: 0.188 g, 82%. White solid, m.p. 180-181 °C. 1H NMR (DMSO- d_6 , 400 MHz, δ in ppm): 10.26 (s, 1H, -CHO), 8.36-7.12 (m, 4H, Ar-H), 4.10 (s, 3H, N-CH₃), 2.83 (q, 2H, -CH₂, $J = 7.2$ Hz), 1.09 (t, 3H, -CH₃, $J = 7.2$ Hz). ^{13}C NMR (DMSO- d_6 , 100 MHz, δ in ppm): 186.75, 163.10, 160.17, 139.55, 131.28, 126.59, 122.18, 121.73, 121.19, 111.23, 107.72, 33.18, 30.05, 15.86. MS: $m/z = 288.2$ (M+1). Anal. calculated for $C_{14}H_{13}N_3O_2S$: C, 58.52; H, 4.56; N, 14.62; S, 11.16. Found: C, 58.48; H, 4.53; N, 14.60; S, 11.13.

2-(5-(4-fluorobenzylthio)-1,3,4-oxadiazol-2-yl)-5-fluoro-1-methyl-1H-indole-3-carbaldehyde (9l): Yield: 0.215 g, 93%. Off white solid, m.p. 140-141 °C. 1H NMR (DMSO- d_6 , 400 MHz, δ in ppm): 10.25 (s, 1H, -CHO), 7.76-7.36 (m, 7H, Ar-H), 4.68 (s, 2H, S-CH₂), 4.12 (s, 3H, N-CH₃). ^{13}C NMR (DMSO- d_6 , 100 MHz, δ in ppm): 186.92, 160.80, 160.29, 158.95, 156.63, 135.56, 133.32, 131.67, 131.59, 131.49, 129.41, 116.01, 115.91, 113.80, 113.53, 112.55, 106.33, 35.70, 33.46. MS: $m/z = 386.1$ (M+1). Anal. calculated for $C_{19}H_{13}F_2N_3O_2S$: C, 59.21; H, 3.40; N, 10.90; S, 8.32. Found: C, 59.18; H, 3.38; N, 10.87; S, 8.29.

4-((5-(5-fluoro-3-formyl-1-methyl-1H-indol-2-yl)-1,3,4-oxadiazol-2-ylthio)methyl)benzotrile (9m): Yield: 0.205 g, 89%. Pale yellow solid, m.p. 170-171 °C. 1H NMR (DMSO- d_6 , 400 MHz, δ in ppm): 10.28 (s, 1H, -CHO), 7.88-7.32 (m, 7H, Ar-H), 4.66 (s, 2H, S-CH₂), 4.10 (s, 3H, N-CH₃). ^{13}C NMR (DMSO- d_6 , 100 MHz, δ in ppm): 187.19, 162.42, 161.53, 159.87, 145.41, 132.26, 132.23, 131.91,

130.50, 129.61, 129.57, 128.82, 120.54, 115.63, 113.88, 112.84, 112.57, 107.53, 34.59, 33.46. MS: $m/z = 393.4$ (M+1). Anal. calculated for $C_{20}H_{13}FN_4O_2S$: C, 61.22; H, 3.34; N, 14.28; S, 8.17. Found: C, 61.18; H, 3.31; N, 14.26; S, 8.15.

2-(5-(2-fluorobenzylthio)-1,3,4-oxadiazol-2-yl)-5-fluoro-1-methyl-1H-indole-3-carbaldehyde (**9n**): Yield: 0.199 g, 86%. White solid, m.p. 162-163 °C. 1H NMR (DMSO- d_6 , 400 MHz, δ in ppm): 10.26 (s, 1H, -CHO), 7.98-7.35 (m, 7H, Ar-H), 4.67 (s, 2H, S-CH₂), 4.09 (s, 3H, N-CH₃). ^{13}C NMR (DMSO- d_6 , 100 MHz, δ in ppm): 186.85, 162.38, 160.92; 159.87, 158.53, 131.89, 130.31, 129.47, 128.30, 127.39, 126.77, 124.96, 121.12, 113.98, 112.99, 111.24, 106.56, 34.68, 33.51. MS: $m/z = 386.1$ (M+1). Anal. calculated for $C_{19}H_{13}F_2N_3O_2S$: C, 59.21; H, 3.40; N, 10.90; S, 8.32. Found: C, 59.18; H, 3.38; N, 10.87; S, 8.29.

2-(5-(4-nitrobenzylthio)-1,3,4-oxadiazol-2-yl)-5-fluoro-1-methyl-1H-indole-3-carbaldehyde (**9o**): Yield: 0.19 g, 82%. Brown solid, m.p. 177-178 °C. 1H NMR (DMSO- d_6 , 400 MHz, δ in ppm): 10.27 (s, 1H, -CHO), 7.96-7.34 (m, 7H, Ar-H), 4.70 (s, 2H, S-CH₂), 4.09 (s, 3H, N-CH₃). ^{13}C NMR (DMSO- d_6 , 100 MHz, δ in ppm): 186.91, 160.91, 158.87, 159.87, 147.66, 146.46, 132.20, 131.09, 129.66, 129.49, 128.15, 122.63, 122.48, 113.98, 112.64, 111.18, 106.71, 35.36, 33.41. MS: $m/z = 413.2$ (M+1). Anal. calculated for $C_{19}H_{13}FN_4O_4S$: C, 55.34; H, 3.18; N, 13.59; S, 7.78. Found: C, 55.32; H, 3.15; N, 13.57; S, 7.77.

5-fluoro-2-(5-(isopropylthio)-1,3,4-oxadiazol-2-yl)-1-methyl-1H-indole-3-carbaldehyde (**9p**): Yield: 0.194 g, 84%. Off white solid, m.p. 122-123 °C. 1H NMR (DMSO- d_6 , 400 MHz, δ in ppm): 10.32 (s, 1H, -CHO), 7.98-7.35 (m, 3H, Ar-H), 4.13 (s, 3H, N-CH₃), 3.99 (sep, 1H, -CH, $J = 6.8$ Hz), 1.51 (d, 6H, -(CH₃)₂, $J = 6.8$ Hz). ^{13}C NMR (DMSO- d_6 , 100 MHz, δ in ppm): 187.02, 162.78, 160.66, 159.86, 132.23, 131.91, 127.37, 113.98, 112.64, 111.23, 106.67, 35.89, 33.48, 23.55, 20.45. MS: $m/z = 320.2$ (M+1). Anal. calculated for $C_{15}H_{14}FN_3O_2S$: C, 56.41; H, 4.42; N, 13.16; S, 10.04. Found: C, 56.37; H, 4.40; N, 13.13; S, 10.01.

2-(5-(cyclopentylthio)-1,3,4-oxadiazol-2-yl)-5-fluoro-1-methyl-1H-indole-3-carbaldehyde (**9q**): Yield: 0.189 g, 82%. Pale yellow solid, m.p. 129-130 °C. 1H NMR (DMSO- d_6 , 400 MHz, δ in ppm): 10.31 (s, 1H, -CHO), 7.97-7.35 (m, 3H, Ar-H), 4.12 (s, 3H, N-CH₃), 4.10-4.02 (m, 1H, S-CH), 2.27-1.65 (m, 8H, aliphatic). ^{13}C NMR (DMSO- d_6 , 100 MHz, δ in ppm): 186.91, 162.77, 160.58, 159.78, 133.33, 129.59, 127.32, 113.70, 112.62, 111.20, 106.72, 44.23, 35.28, 35.31, 32.49, 26.35, 26.29. MS: $m/z = 346.3$ (M+1). Anal. calculated for $C_{17}H_{16}FN_3O_2S$: C, 59.12; H, 4.67; N, 12.17; S, 9.28. Found: C, 59.09; H, 4.65; N, 12.15; S, 9.25.

2-(5-(4-(trifluoromethoxy)benzylthio)-1,3,4-oxadiazol-2-yl)-5-fluoro-1-methyl-1H-indole-3-carbaldehyde (**9r**): Yield: 0.202 g, 88%. Off white solid, m.p. 143-144 °C. 1H NMR (DMSO- d_6 , 400 MHz, δ in ppm): 10.24 (s, 1H, -CHO), 7.76-7.31 (m, 7H, Ar-H), 4.72 (s, 2H, S-CH₂), 4.09 (s, 3H, N-

CH₃). ¹³C NMR (DMSO-d₆, 100 MHz, δ in ppm): 186.59, 161.24, 160.83, 158.87, 158.73, 131.54, 131.43, 130.55, 121.79, 121.59, 119.24, 117.47, 117.42, 114.95, 114.68, 114.02, 113.92, 106.98, 35.50, 32.72. MS: m/z= 452.2 (M+1). Anal. calculated for C₂₀H₁₃F₄N₃O₃S: C, 53.22; H, 2.90; N, 9.31; S, 7.10. Found: C, 53.19; H, 2.87; N, 9.29; S, 7.07.

2-(5-(4-(trifluoromethyl)benzylthio)-1,3,4-oxadiazol-2-yl)-5-fluoro-1-methyl-1H-indole-3-carbaldehyde (9s): Yield: 0.2 g, 87%. Pale yellow solid, m.p. 163-164 °C. ¹H NMR (DMSO-d₆, 400 MHz, δ in ppm): 10.24 (s, 1H, -CHO), 7.97-7.34 (m, 7H, Ar-H), 4.73 (s, 2H, S-CH₂), 4.09 (s, 3H, N-CH₃). ¹³C NMR (DMSO-d₆, 100 MHz, δ in ppm): 186.92, 160.57, 159.63, 159.17, 144.67, 133.32, 129.79, 129.71, 128.47, 128.16, 127.43, 125.64, 125.37, 125.21, 113.98, 112.71, 112.61, 106.70, 35.55, 32.69. MS: m/z= 436.2 (M+1). Anal. calculated for C₂₀H₁₃F₄N₃O₂S: C, 55.17; H, 3.01; N, 9.65; S, 7.36. Found: C, 55.14; H, 2.99; N, 9.63; S, 7.34.

2-(5-(benzylthio)-1,3,4-oxadiazol-2-yl)-5-fluoro-1-methyl-1H-indole-3-carbaldehyde (9t): Yield: 0.195 g, 85%. Off white solid, m.p. 122-123 °C. ¹H NMR (DMSO-d₆, 400 MHz, δ in ppm): 10.26 (s, 1H, -CHO), 7.97-7.28 (m, 8H, Ar-H), 4.65 (s, 2H, S-CH₂), 4.09 (s, 3H, N-CH₃). ¹³C NMR (DMSO-d₆, 100 MHz, δ in ppm): 186.89, 163.07, 160.76, 159.72, 140.06, 133.30, 129.62, 128.99, 128.87, 128.48, 128.69, 127.48, 127.17, 113.41, 112.12, 111.24, 106.76, 35.61, 32.48. MS: m/z= 368.2 (M+1). Anal. calculated for C₁₉H₁₄FN₃O₂S: C, 62.11; H, 3.84; N, 11.44; S, 8.73. Found: C, 62.08; H, 3.81; N, 11.41; S, 8.69.

2-(5-(ethylthio)-1,3,4-oxadiazol-2-yl)-5-fluoro-1-methyl-1H-indole-3-carbaldehyde (9u): Yield: 0.184 g, 80%. White solid, m.p. 83-84 °C. ¹H NMR (DMSO-d₆, 400 MHz, δ in ppm): 10.31 (s, 1H, -CHO), 7.97-7.35 (m, 3H, Ar-H), 4.12 (s, 3H, N-CH₃), 3.38 (q, 2H, -CH₂, J = 7.2 Hz), 1.47 (t, 3H, -CH₃, J = 7.2 Hz). ¹³C NMR (DMSO-d₆, 100 MHz, δ in ppm): 187.02, 163.10, 160.17, 159.71, 133.35, 130.43, 129.59, 113.34, 112.19, 112.23, 106.72, 32.48, 30.06, 15.86. MS: m/z= 306.2 (M+1). Anal. calculated for C₁₄H₁₂FN₃O₂S: C, 55.07; H, 3.96; N, 13.76; S, 10.50. Found: C, 55.05; H, 3.94; N, 13.73; S, 10.47.

Representative ^1H NMR and ^{13}C NMR spectra of intermediates and final compounds.

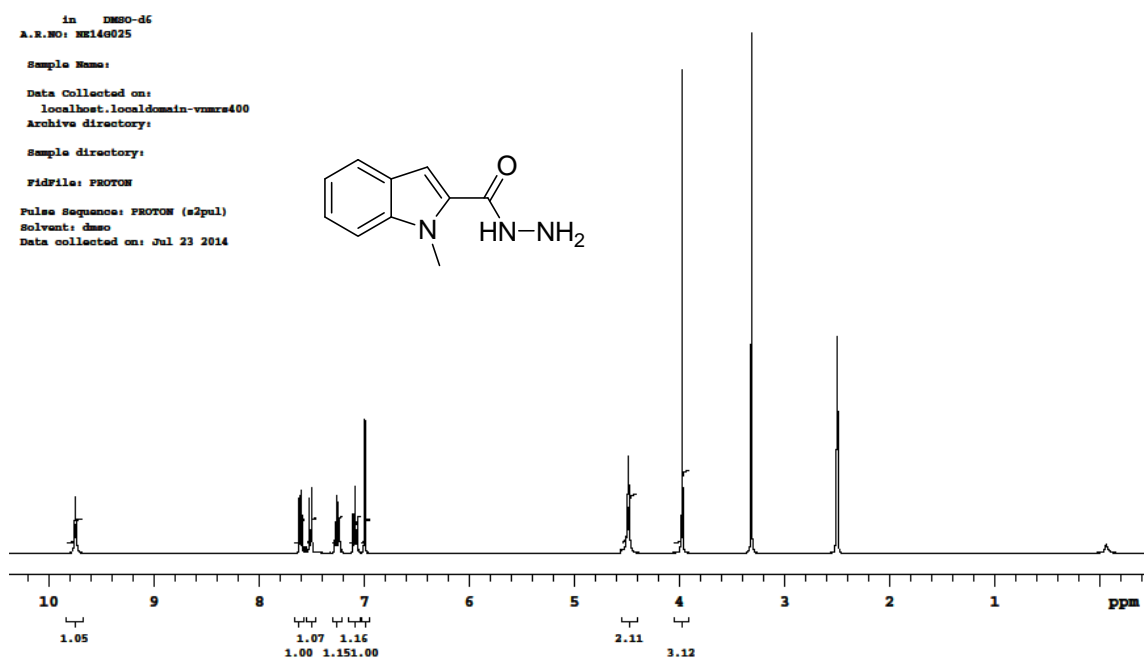


Figure S1 ^1H NMR spectrum of intermediate **6a** (400 MHz, DMSO-d₆)

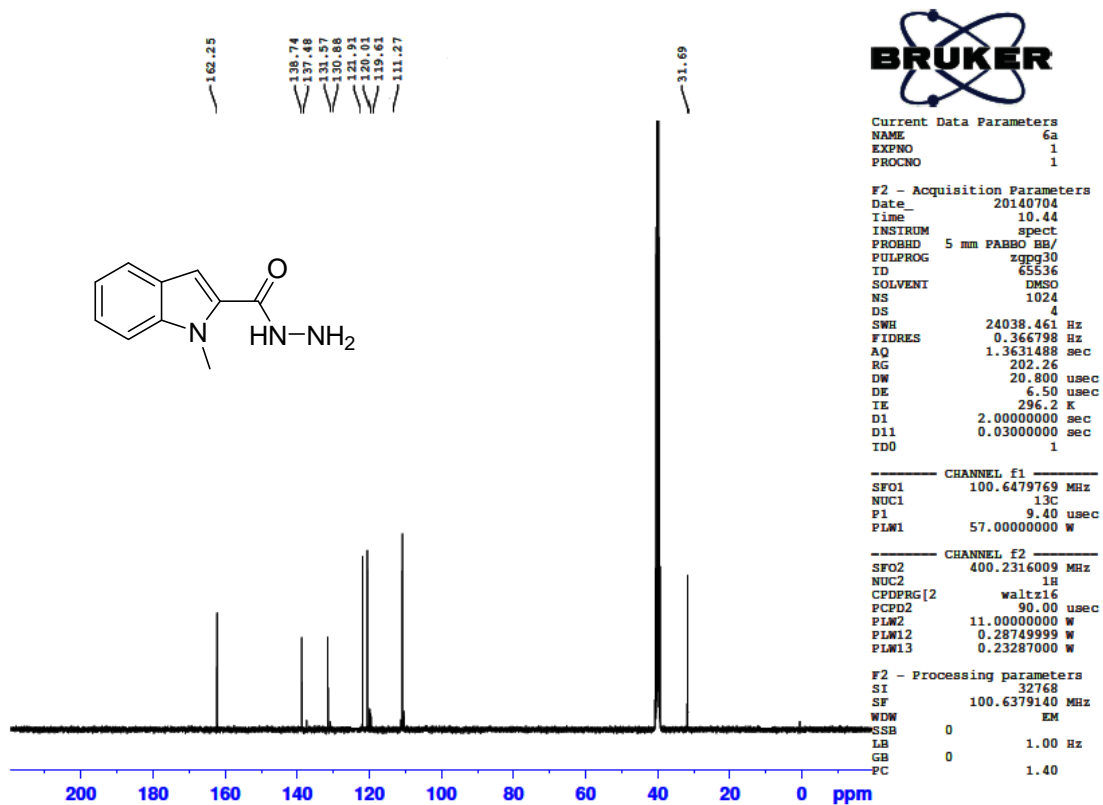


Figure S2 ^{13}C NMR spectrum of intermediate **6a** (100 MHz, DMSO-d_6)

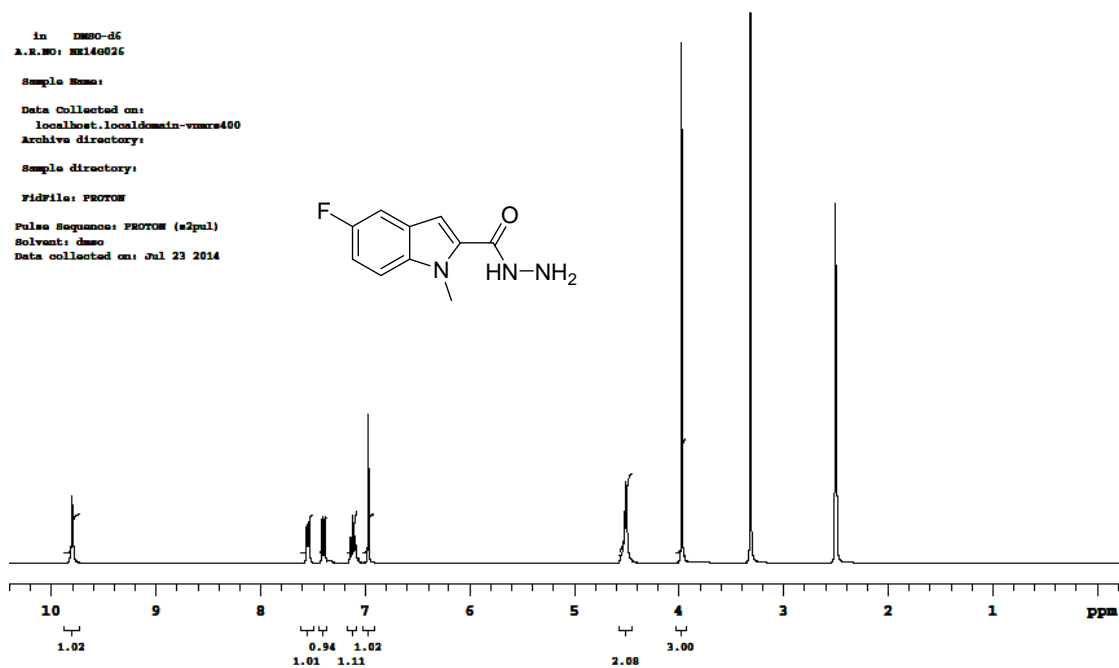


Figure S3 ^1H NMR spectrum of intermediate **6b** (400 MHz, DMSO-d_6)

in DMSO-d6
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Data Collected on:
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Sample directory:
Fidfile: PROTON
Pulse Sequence: PROTON (s2pul)
Solvent: dmsc
Data collected on: Jul 23 2014

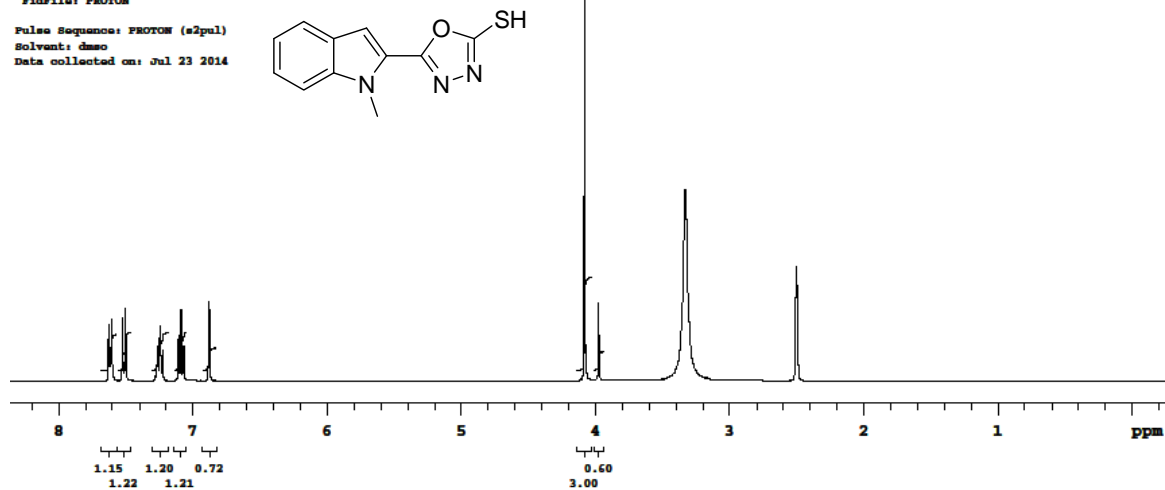


Figure S4 ¹H NMR spectrum of intermediate **7a** (400 MHz, DMSO-d₆)

in DMSO-d6
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Data collected on: Jul 23 2014

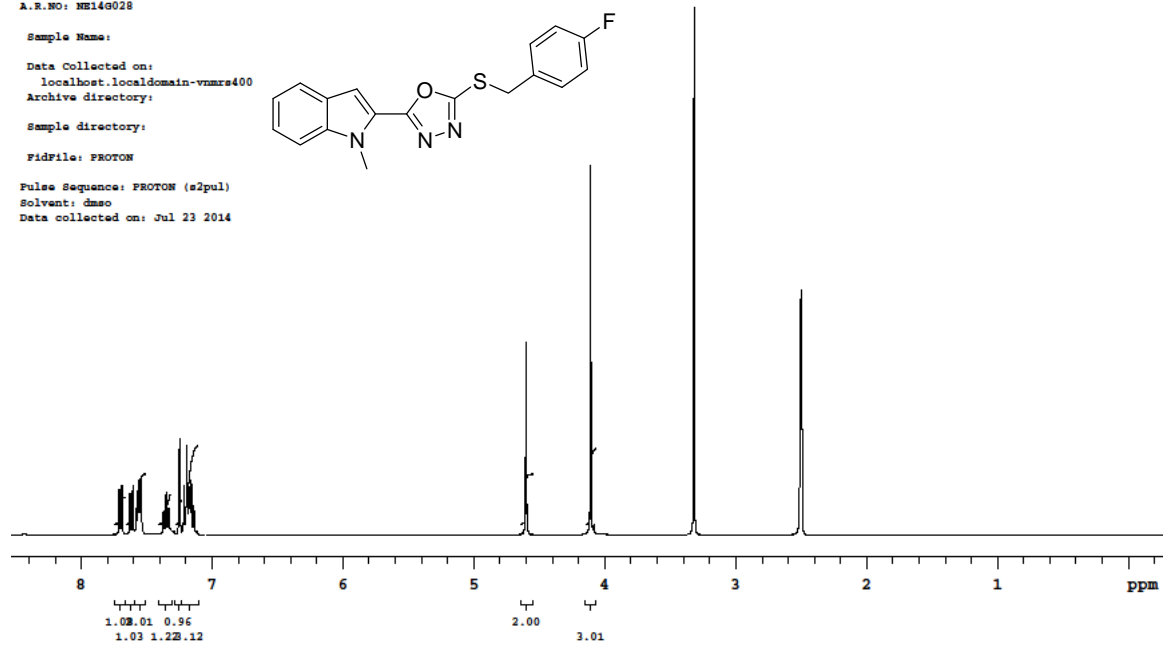


Figure S5 ¹H NMR spectrum of intermediate **8a** (400 MHz, DMSO-d₆)

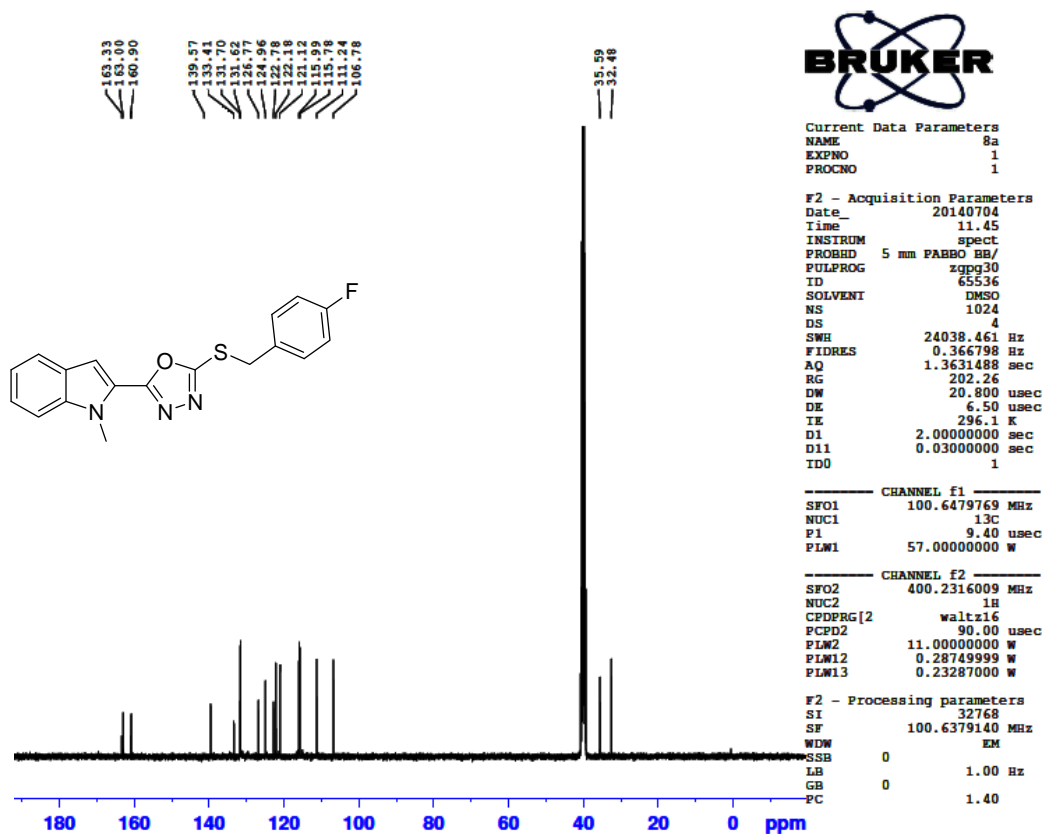


Figure S6 ^{13}C NMR spectrum of intermediate **8a** (100 MHz, DMSO- d_6)

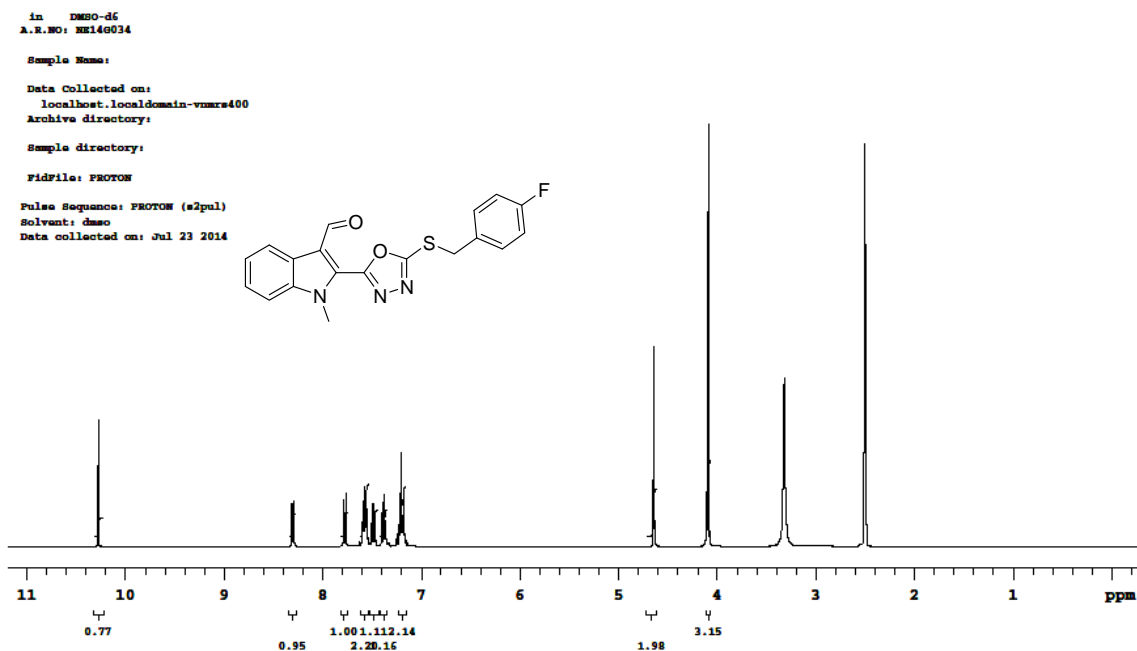


Figure S7 ^1H NMR spectrum of intermediate **9a** (400 MHz, DMSO- d_6)

DMSO-d₆
A.R.No : NR15A002

Sample Name:

Data Collected on:
DRILLS-vnmr400
Archive directory:

Sample directory:

Fidfile: PROTON

Pulse Sequence: PROTON (s2pul)
Solvent: dmsd
Data collected on: Jan 13 2015

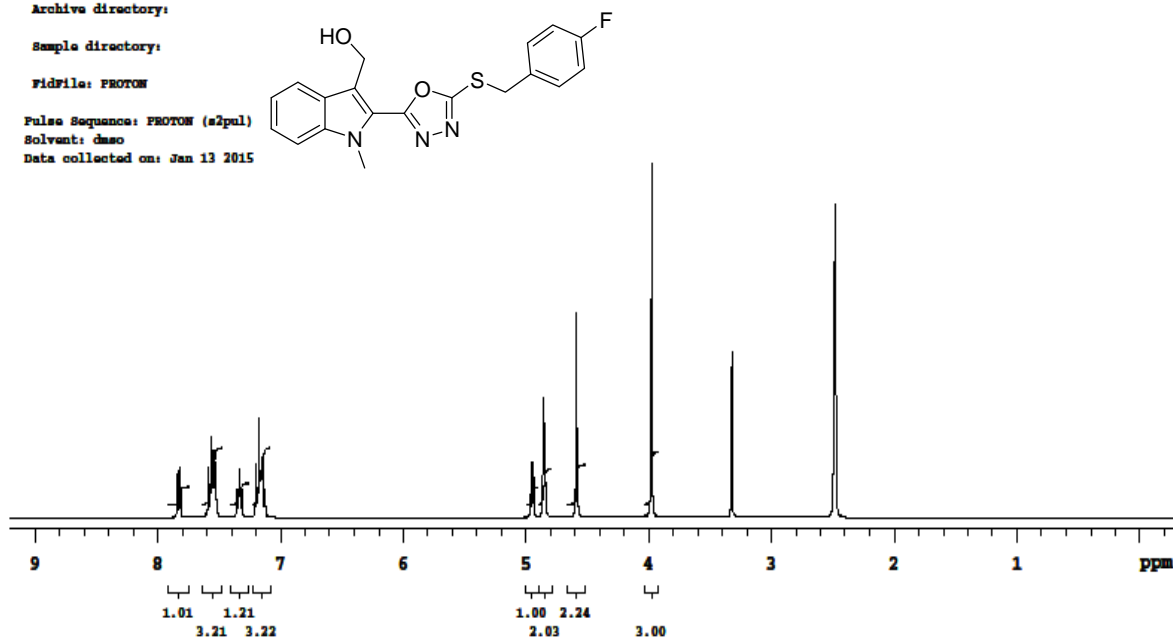


Figure S8 ¹H NMR spectrum of compound 10a (400 MHz, DMSO-d₆)

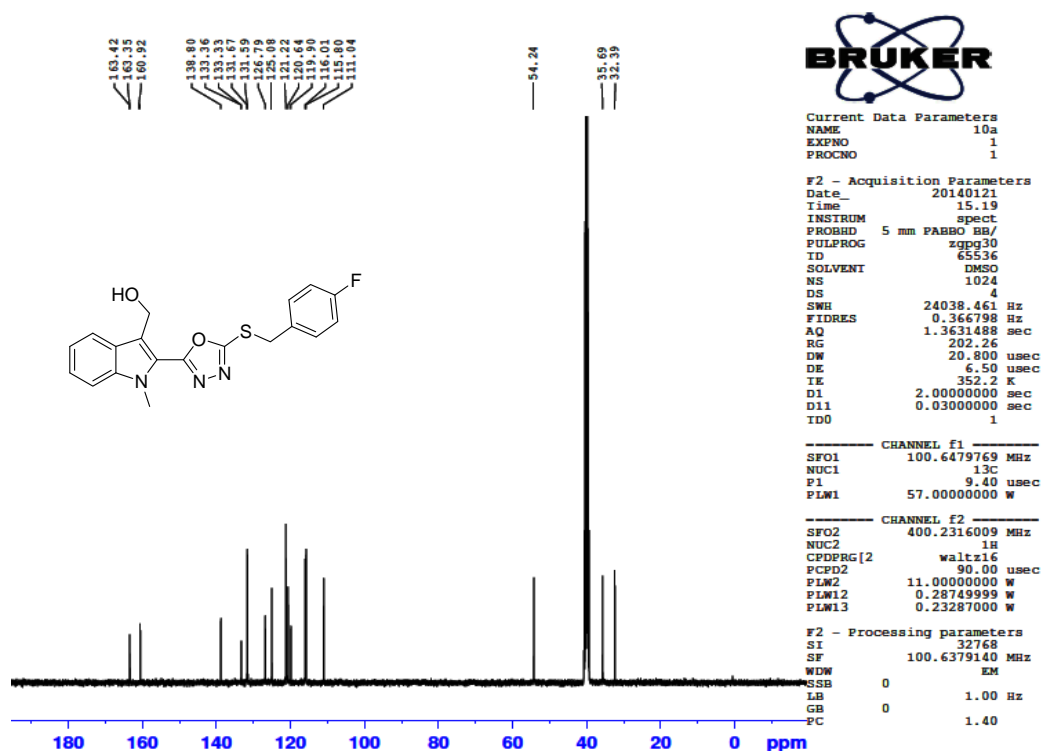


Figure S9 ¹³C NMR spectrum of compound 10a (100 MHz, DMSO-d₆)

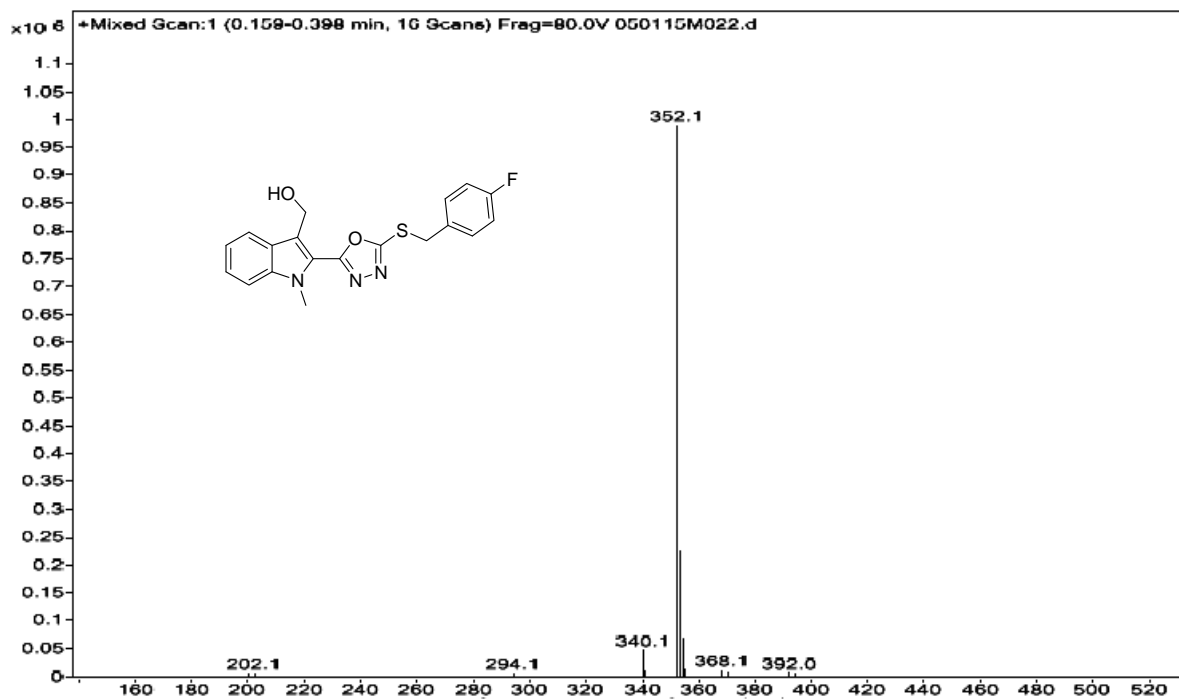


Figure S10 ESI-MS spectrum of compound **10a**

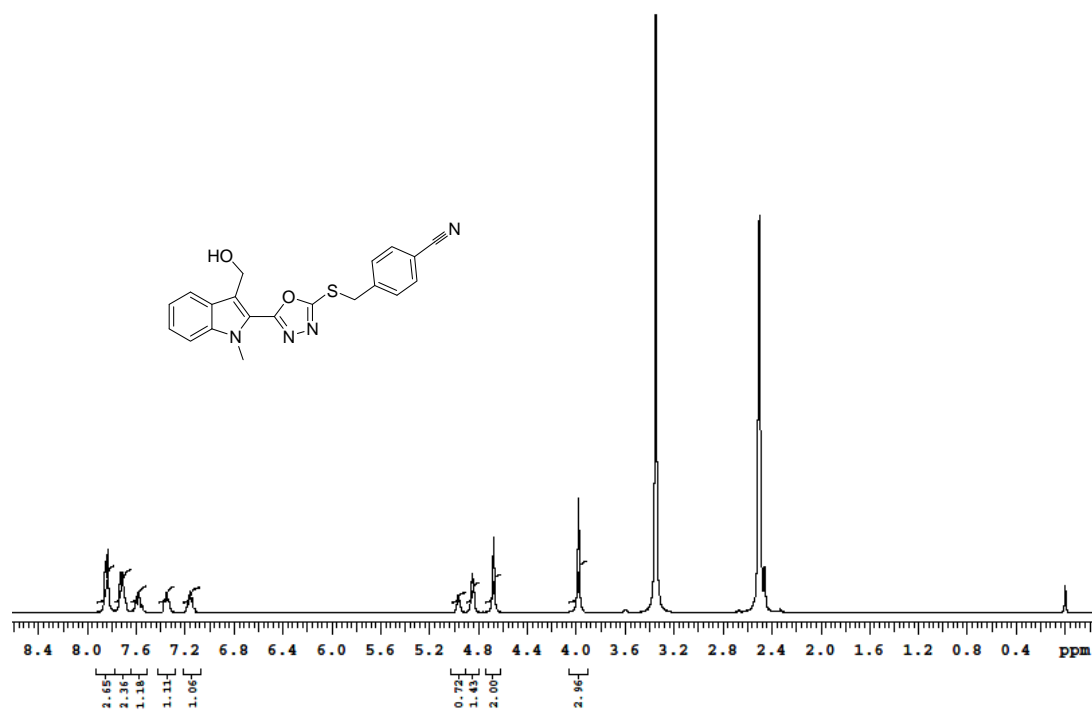


Figure S11 ¹H NMR spectrum of compound **10c** (400 MHz, DMSO-d₆)

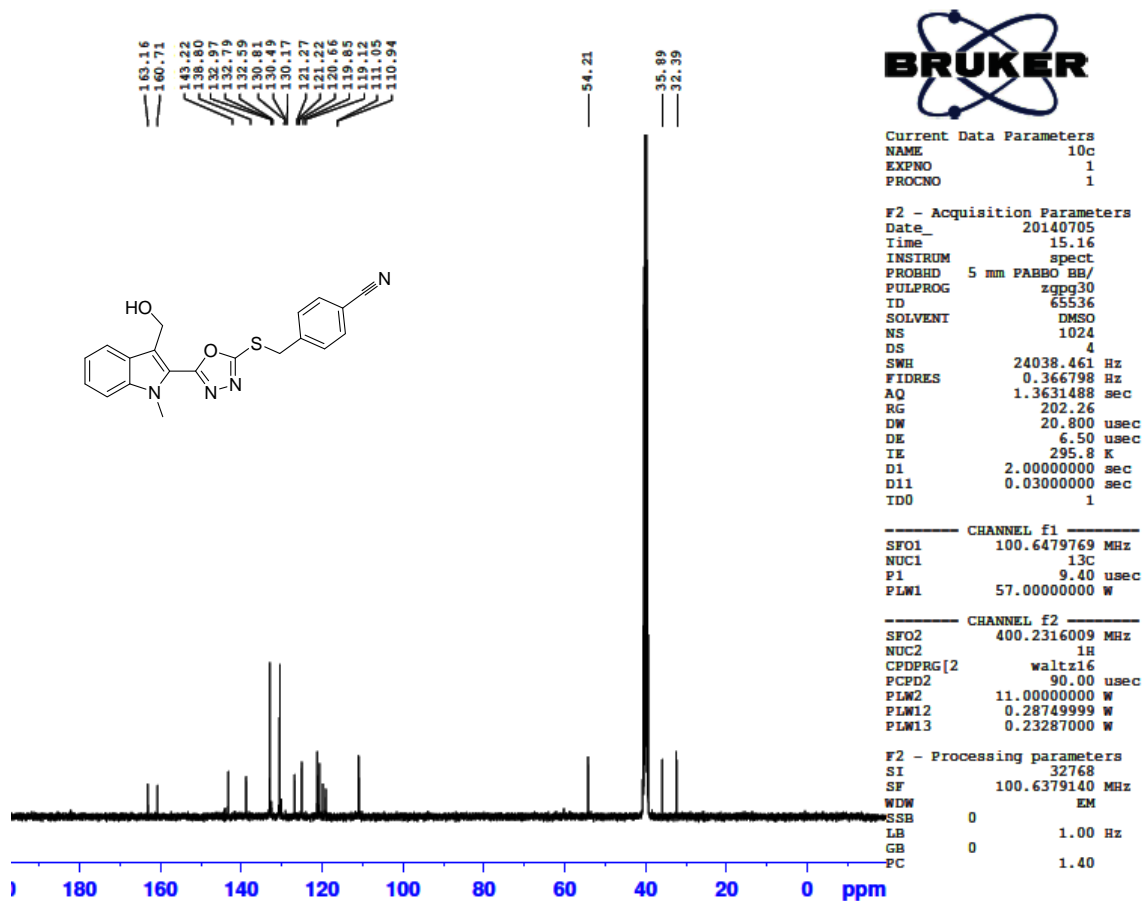


Figure S12 ^{13}C NMR spectrum of compound **10c** (100 MHz, DMSO- d_6)

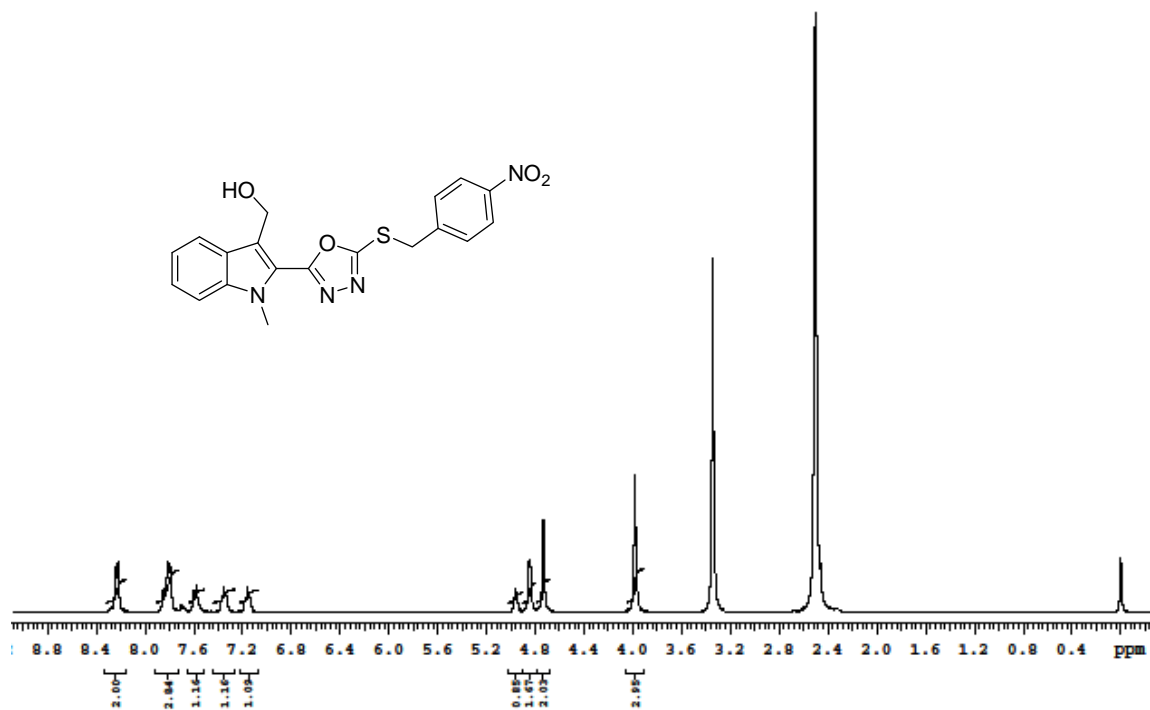


Figure S13 ^1H NMR spectrum of compound **10e** (400 MHz, DMSO- d_6)

8f in DMSO-d6
A.R.NO: HE14029

Sample Name:

Data Collected on:
localhost.localdomain-vmr400
Archive directory:

Sample directory:

Fidfile: PROTON

Pulse Sequence: PROTON (zgpg30)
Solvent: dms
Data collected on: Jul 23 2014

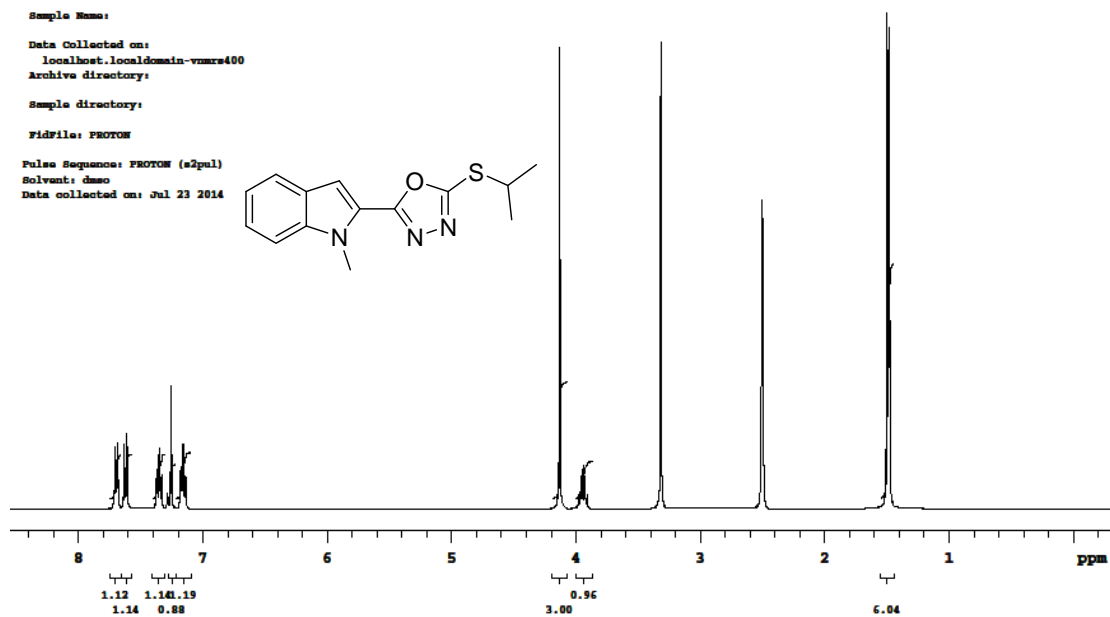
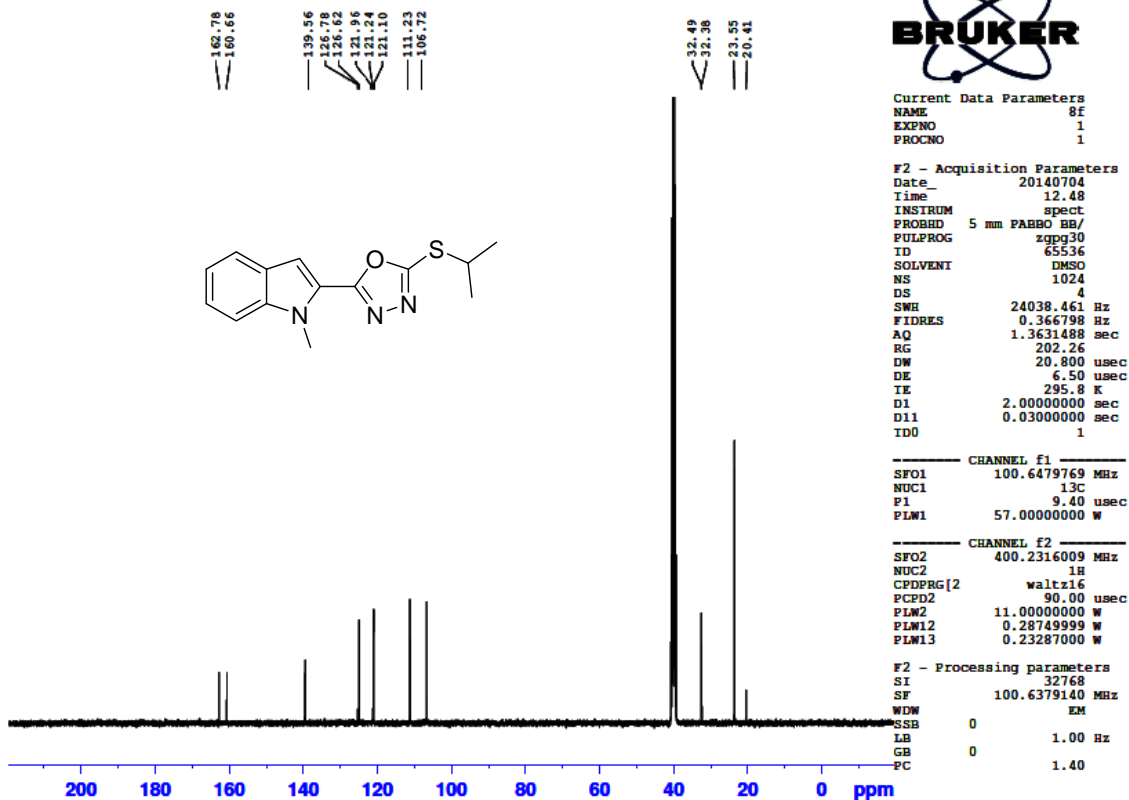


Figure S14 ^1H NMR spectrum of compound **8f** (400 MHz, DMSO- d_6)

8f



Current Data Parameters
NAME 8f
EXPNO 1
PROCNO 1

F2 - Acquisition Parameters
Date_ 20140704
Time 12.48
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
ID 65536
SOLVENT DMSO
NS 1024
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631488 sec
RG 202.26
DW 20.800 usec
DE 6.50 usec
TE 295.8 K
D1 2.0000000 sec
D11 0.0300000 sec
ID0 1

CHANNEL f1
SFO1 100.6479769 MHz
NUC1 13C
P1 9.40 usec
PLM1 57.0000000 W

CHANNEL f2
SFO2 400.2316009 MHz
NUC2 1H
CPDPRG[2] waltz16
PCPD2 90.00 usec
PLM2 11.0000000 W
PLM12 0.28749999 W
PLM13 0.23287000 W

F2 - Processing parameters
SI 32768
SF 100.6379140 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

Figure S15 ^{13}C NMR spectrum of compound **8f** (100 MHz, DMSO- d_6)

9f in DMSO-d6
A.R.NO: HE140035

Sample Name:

Data Collected on:
localhost.localdomain-vnmr400
Archive directory:

Sample directory:

Fidfile: PROTON

Pulse Sequence: PROTON (s2pul)
Solvent: dmsc
Data collected on: Jul 25 2014

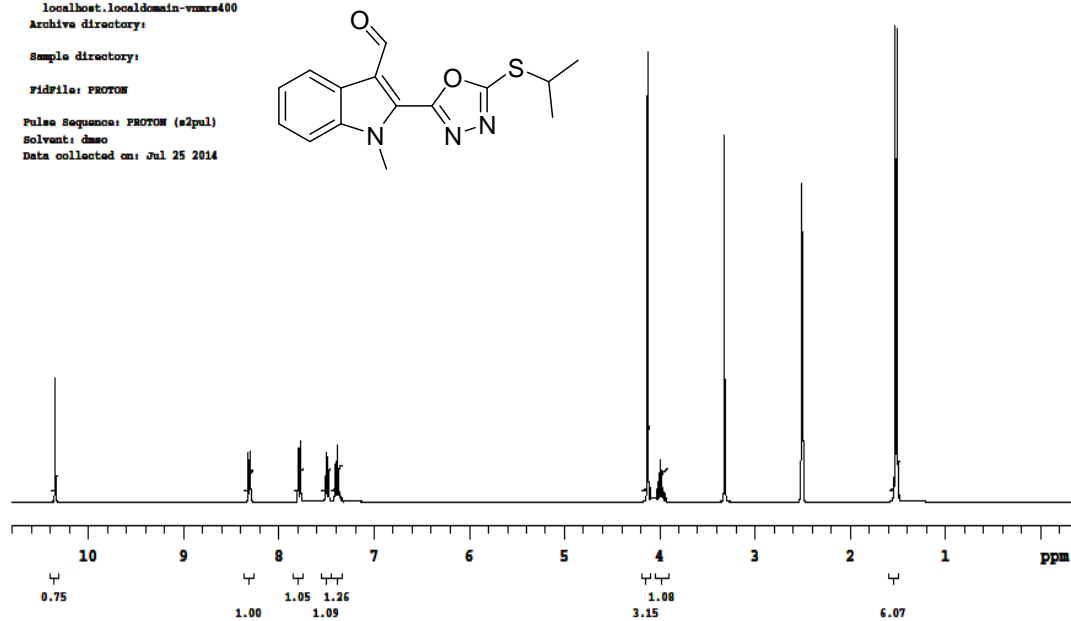


Figure S16 ^1H NMR spectrum of compound 9f (400 MHz, DMSO-d₆)

9f

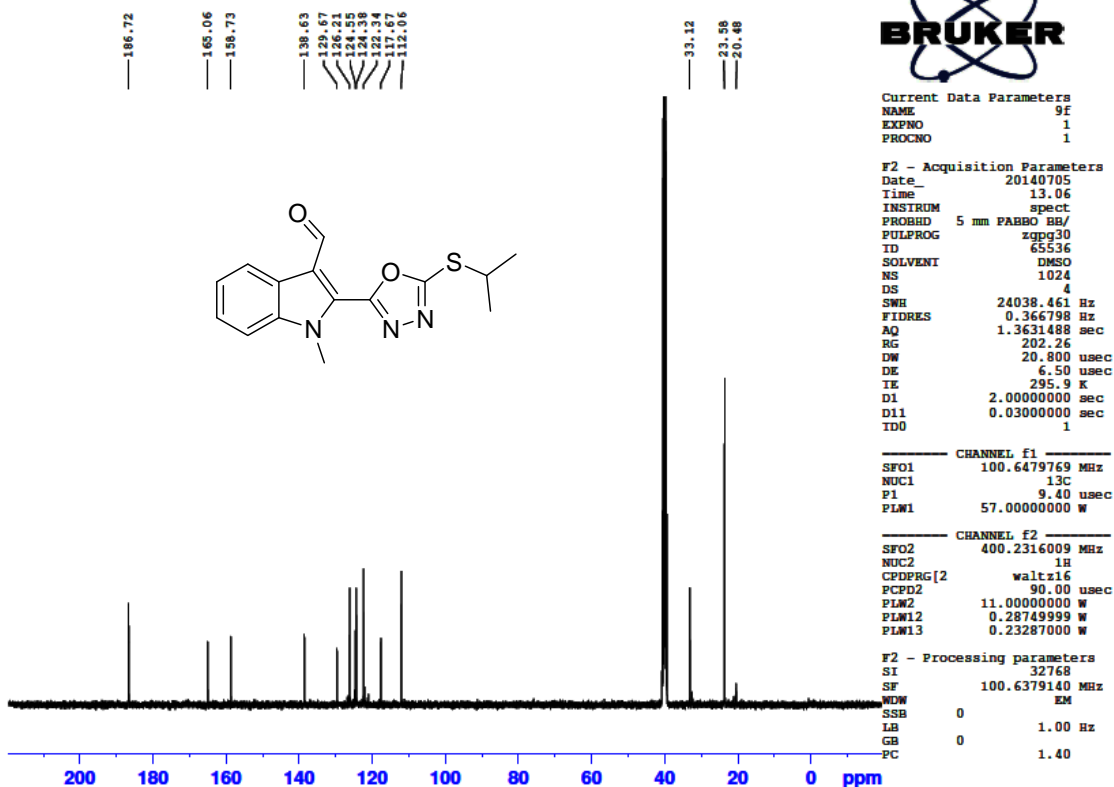


Figure S17 ^{13}C NMR spectrum of compound 9f (100 MHz, DMSO-d₆)

DMSO-d₆
 A.R.No : NE15A003
 Sample Name:
 Data Collected on:
 DRILS-vmr400
 Archive directory:
 Sample directory:
 Fidfile: PROTON
 Pulse Sequence: PROTON (s2pul)
 Solvent: dmsc
 Data collected on: Jan 13 2015

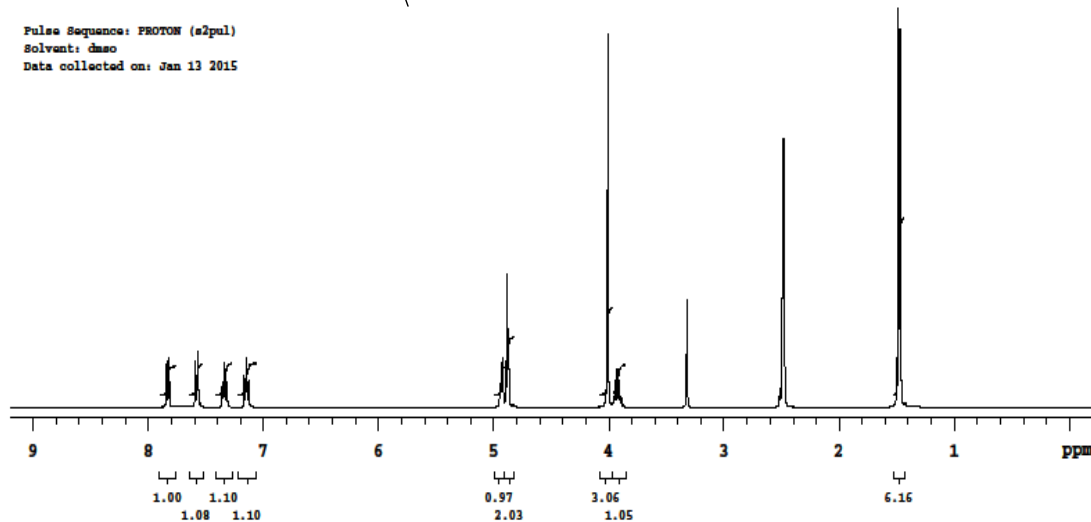
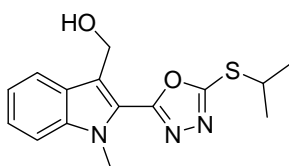


Figure S18 ¹H NMR spectrum of compound **10f** (400 MHz, DMSO-d₆)

10f

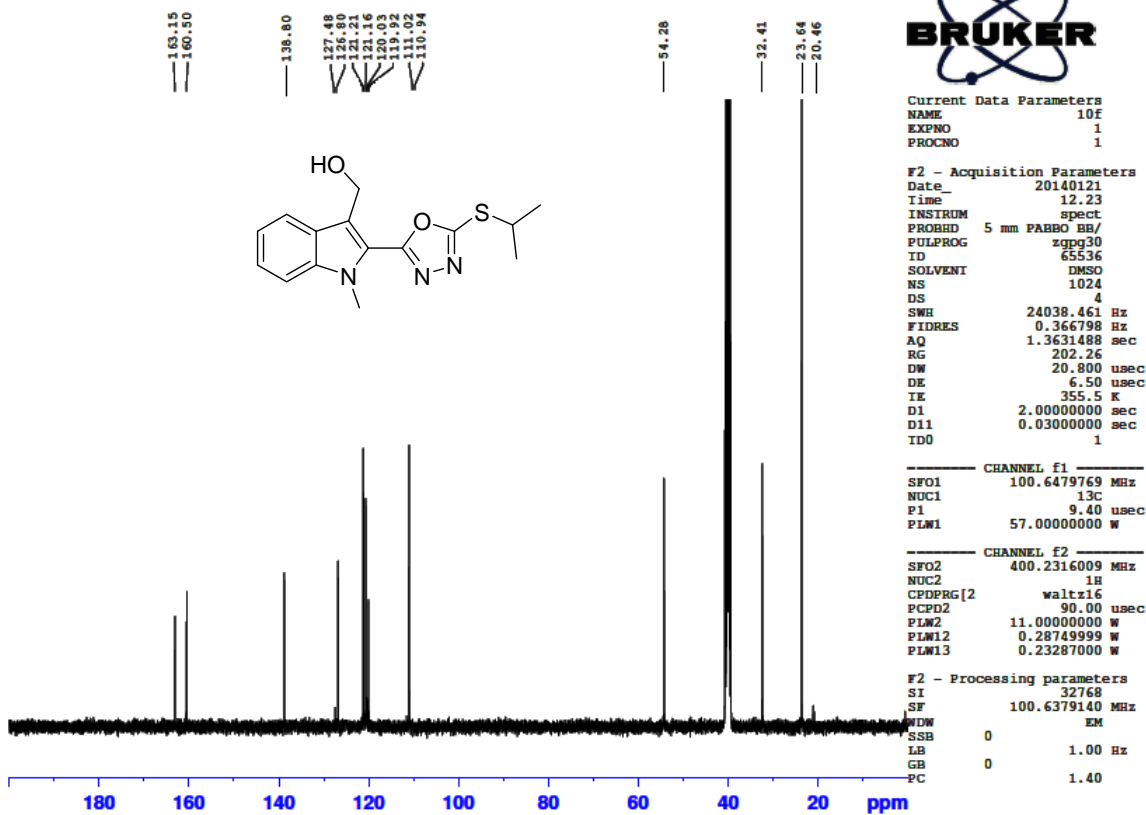


Figure S19 ¹³C NMR spectrum of compound **10f** (100 MHz, DMSO-d₆)

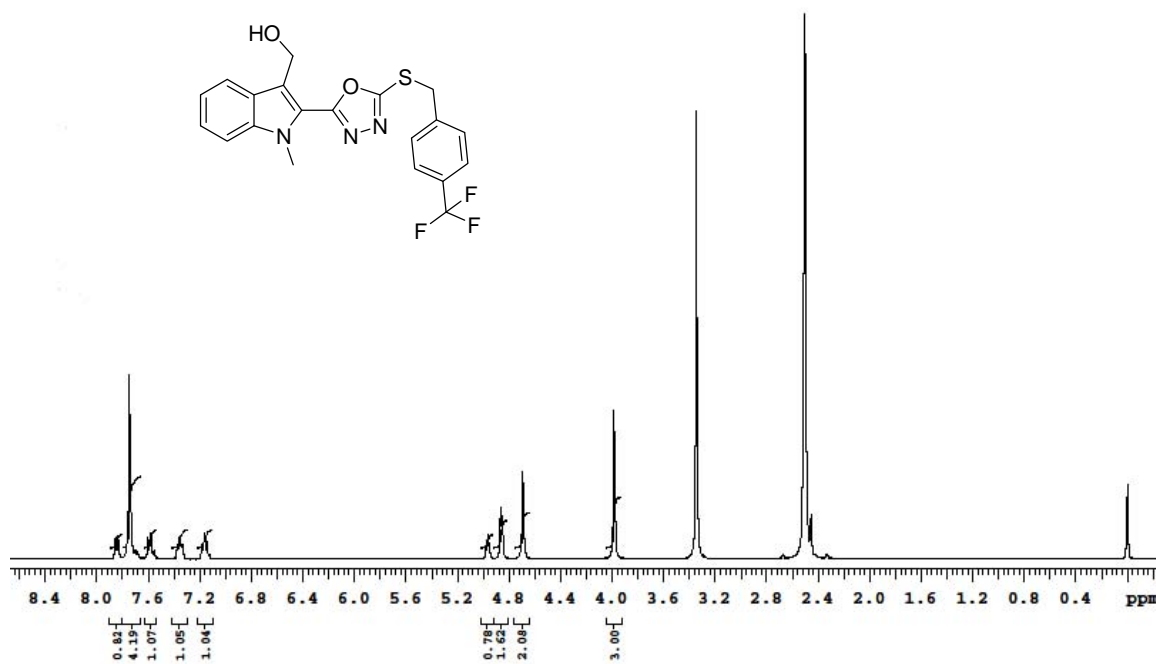


Figure S20 ¹H NMR spectrum of compound **10i** (400 MHz, DMSO-d₆)

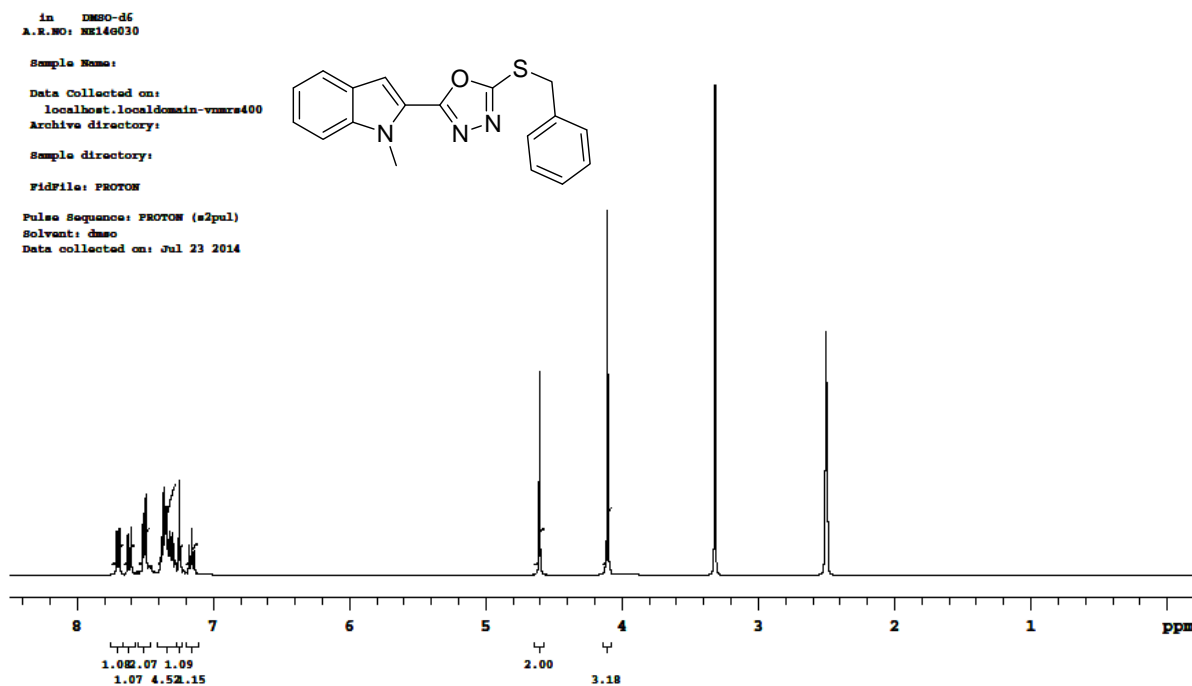


Figure S21 ¹H NMR spectrum of intermediate **8j** (400 MHz, DMSO-d₆)

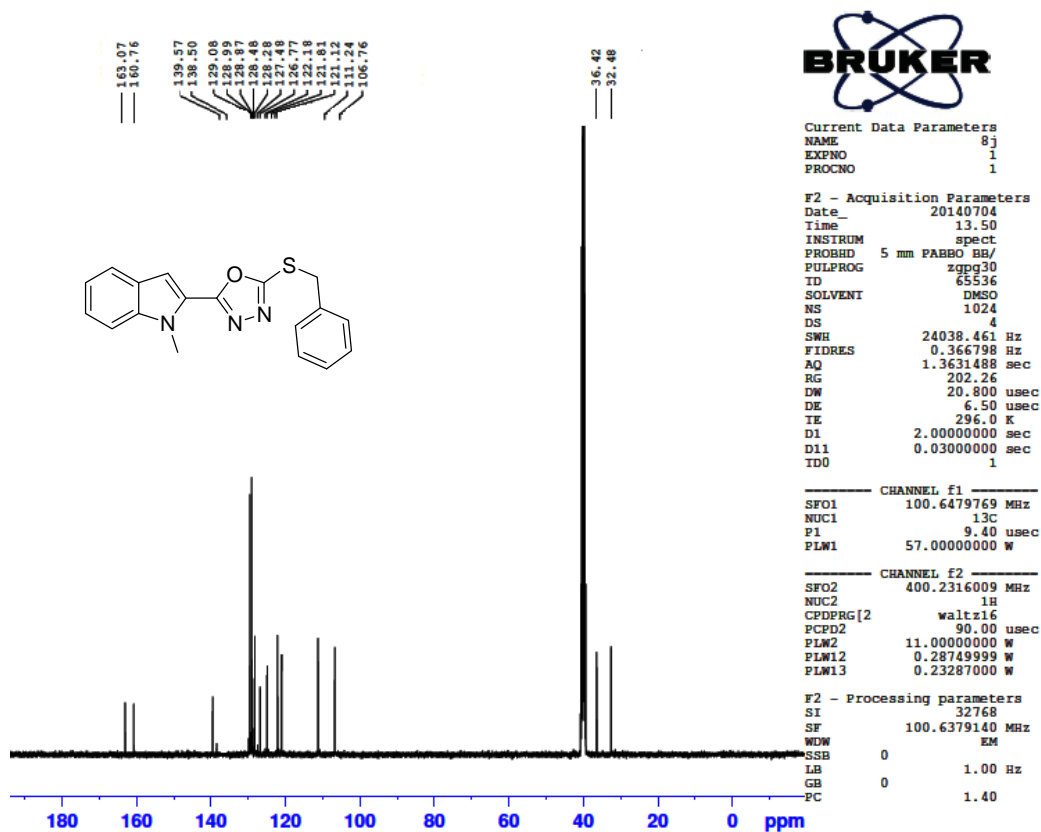


Figure S22 ^{13}C NMR spectrum of intermediate **8j** (100 MHz, DMSO- d_6)

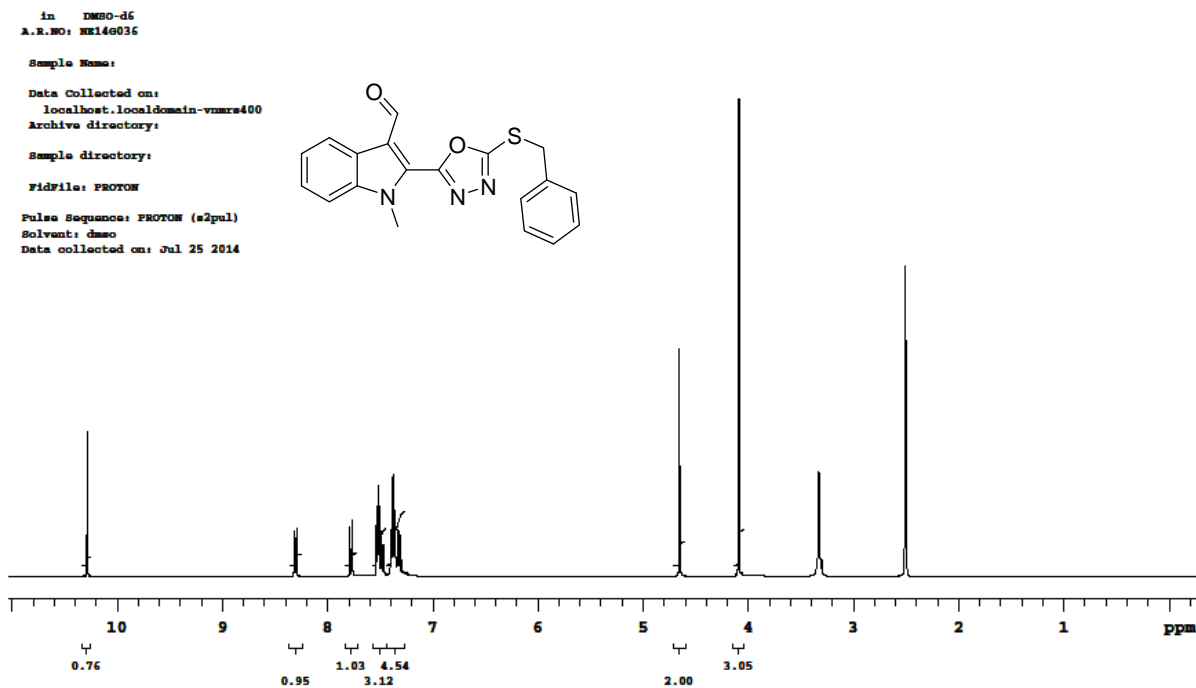


Figure S23 ^1H NMR spectrum of intermediate **9j** (400 MHz, DMSO- d_6)

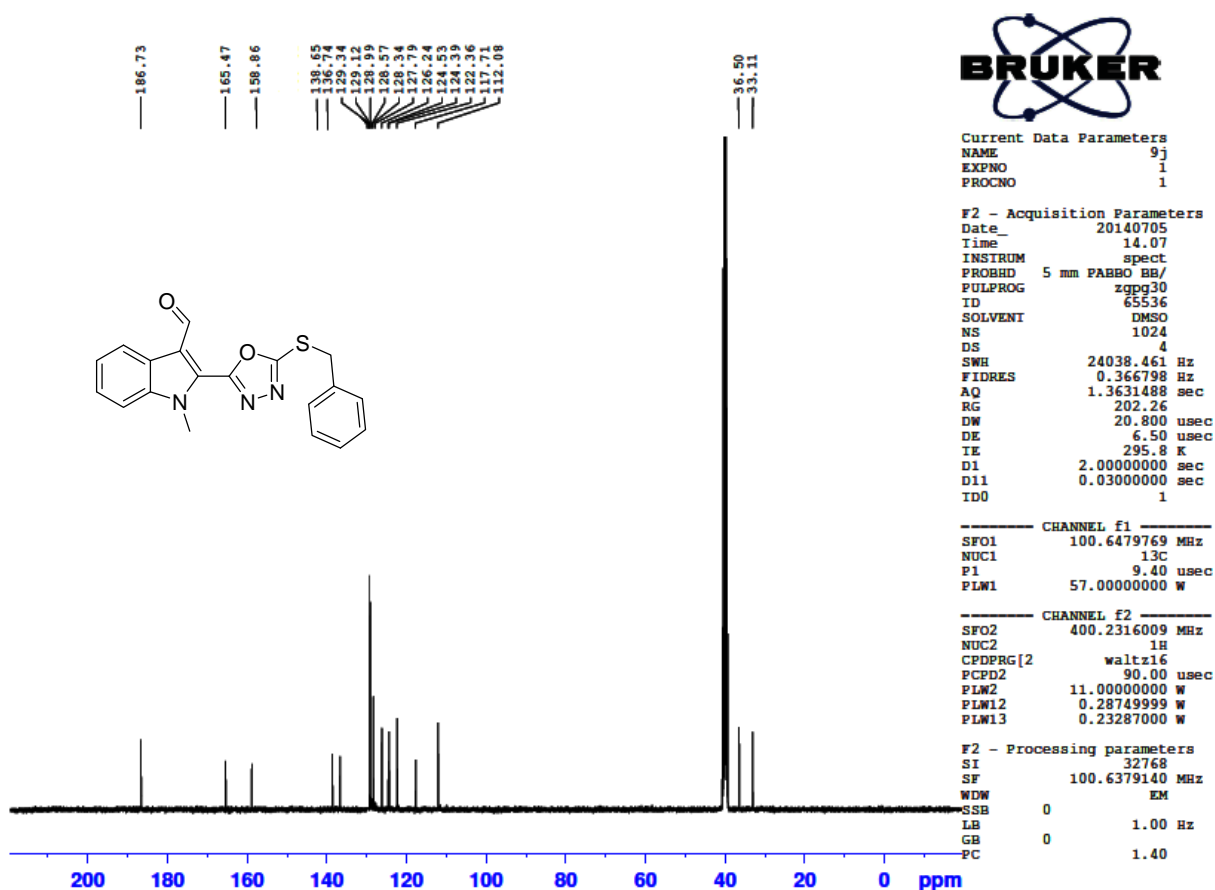


Figure S24 ^{13}C NMR spectrum of intermediate **9j** (100 MHz, DMSO- d_6)

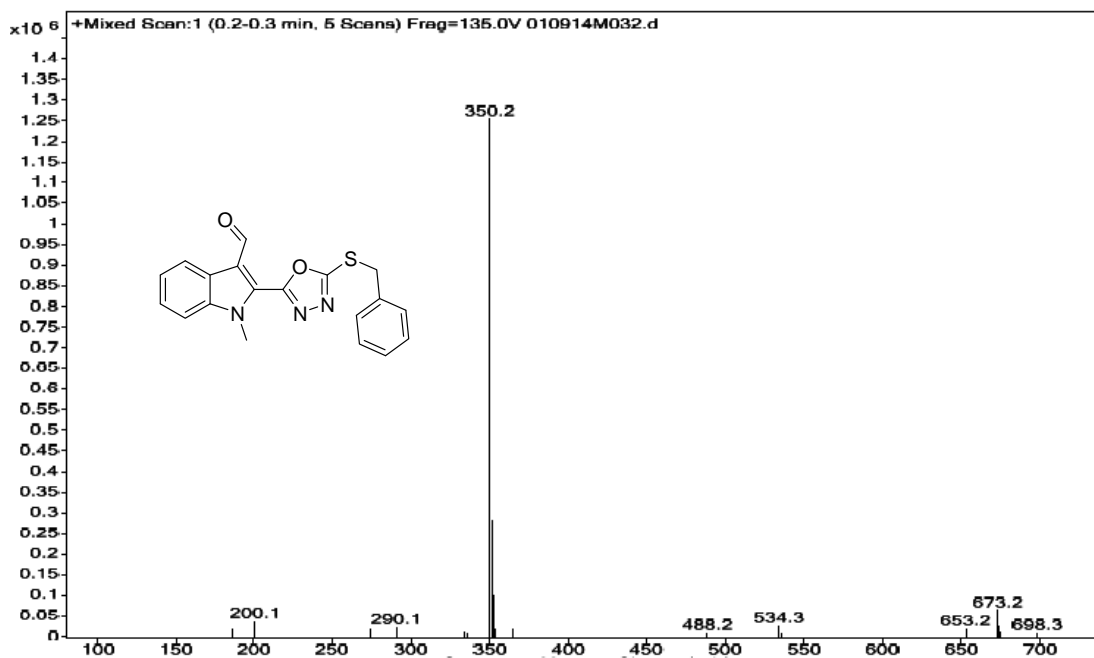


Figure S25 ESI-MS spectrum of compound **9j**

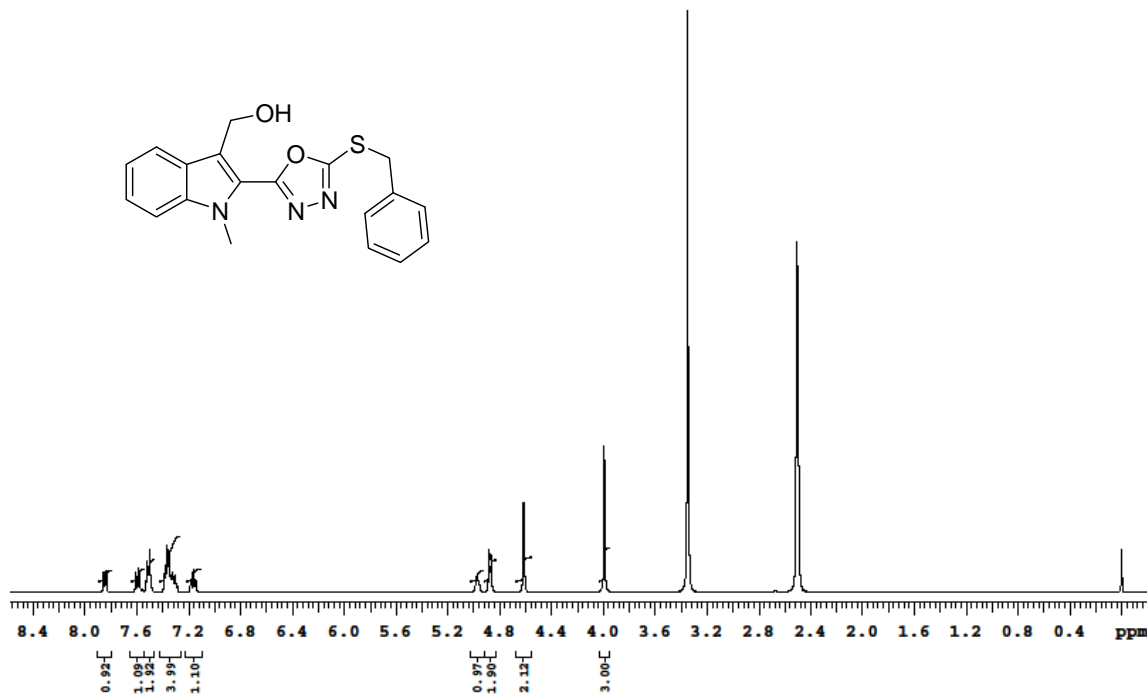


Figure S26 ¹H NMR spectrum of compound **10j** (400 MHz, DMSO-d₆)

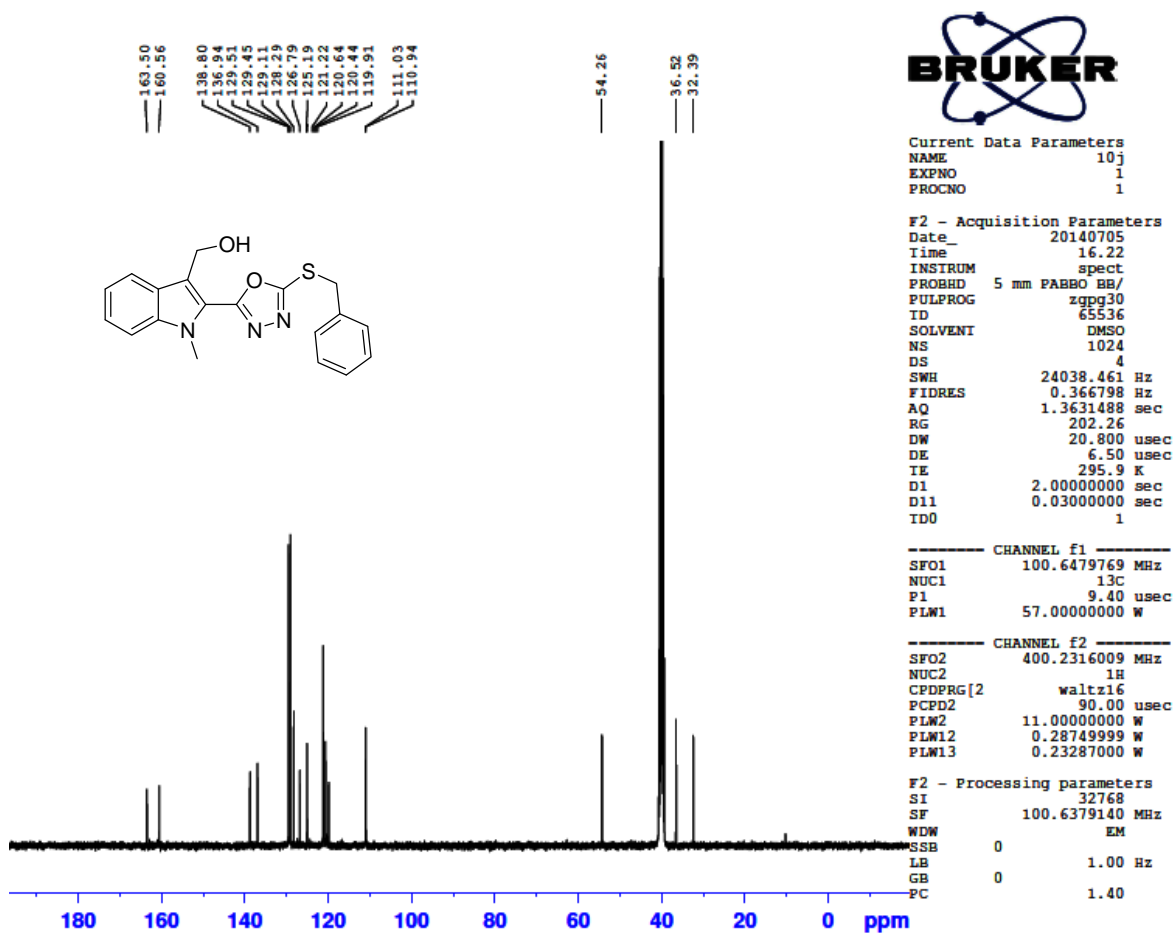


Figure S27 ¹³C NMR spectrum of compound **10j** (100 MHz, DMSO-d₆)

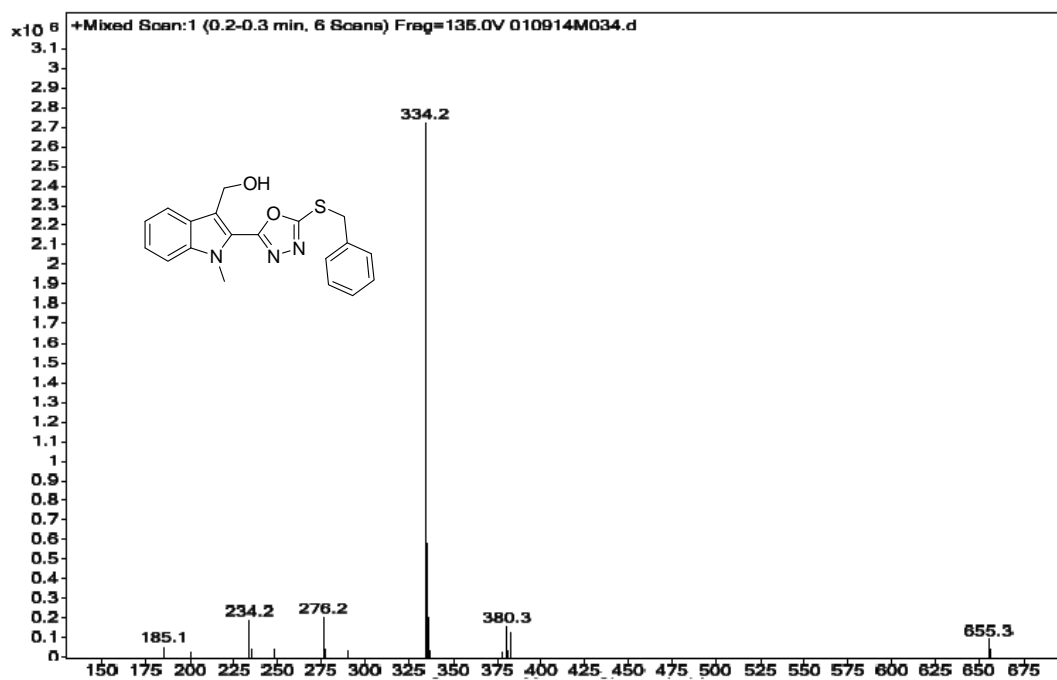


Figure S28 ESI-MS spectrum of compound 10j

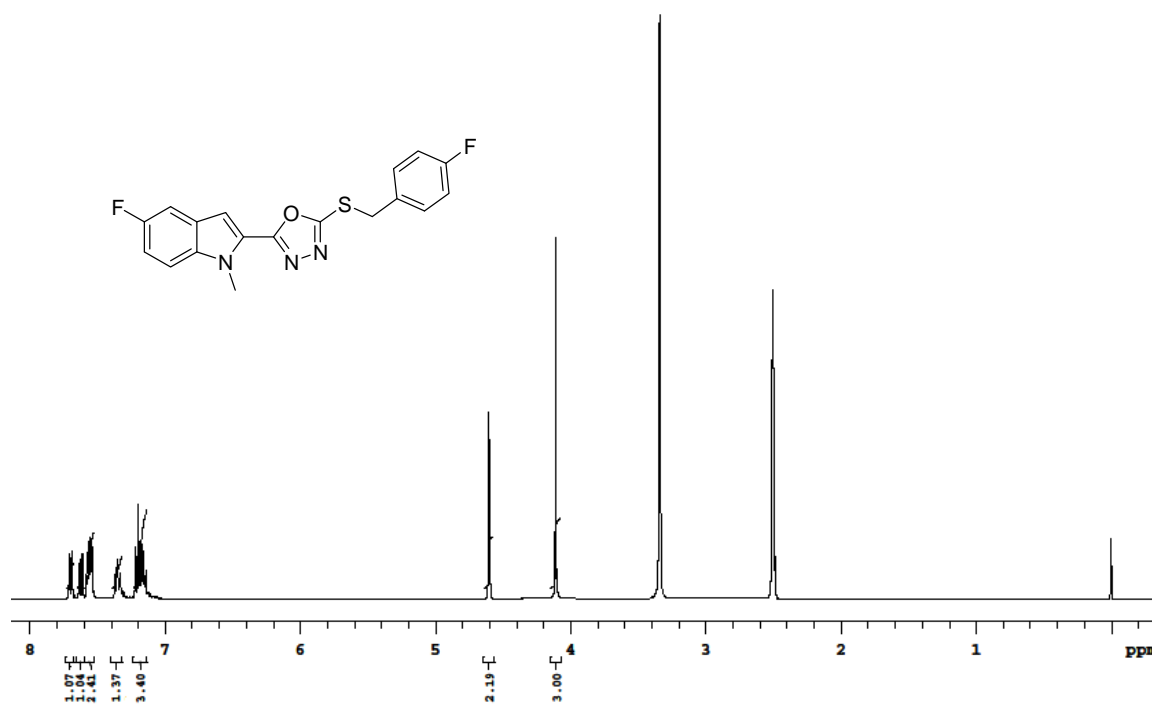


Figure S29 ¹H NMR spectrum of intermediate 81 (400 MHz, DMSO-d₆)

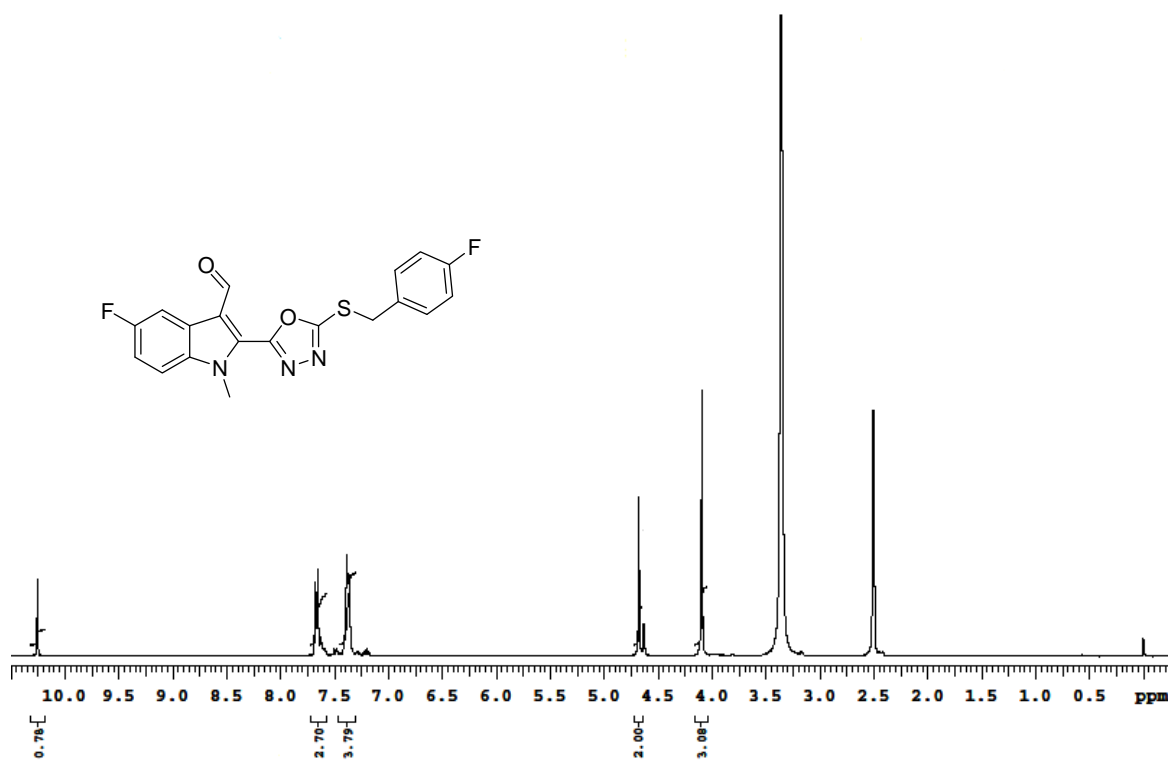


Figure S30 ¹H NMR spectrum of intermediate **91** (400 MHz, DMSO-d₆)

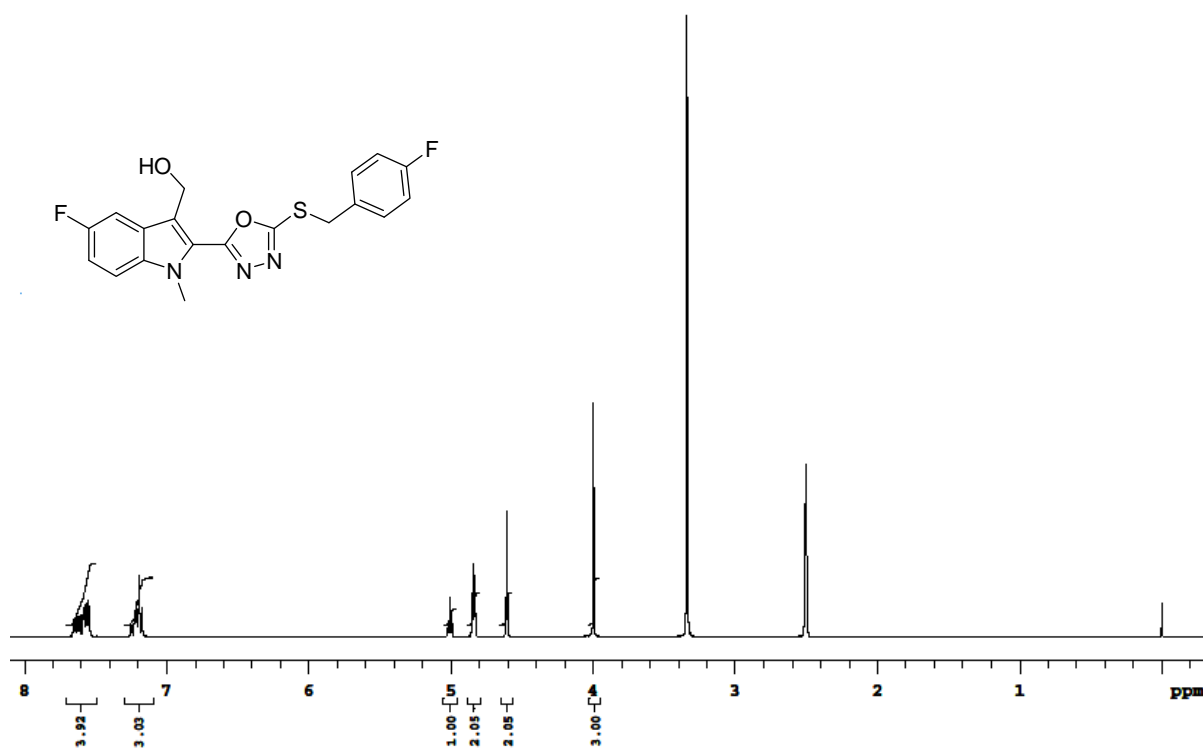


Figure S31 ¹H NMR spectrum of compound **101** (400 MHz, DMSO-d₆)

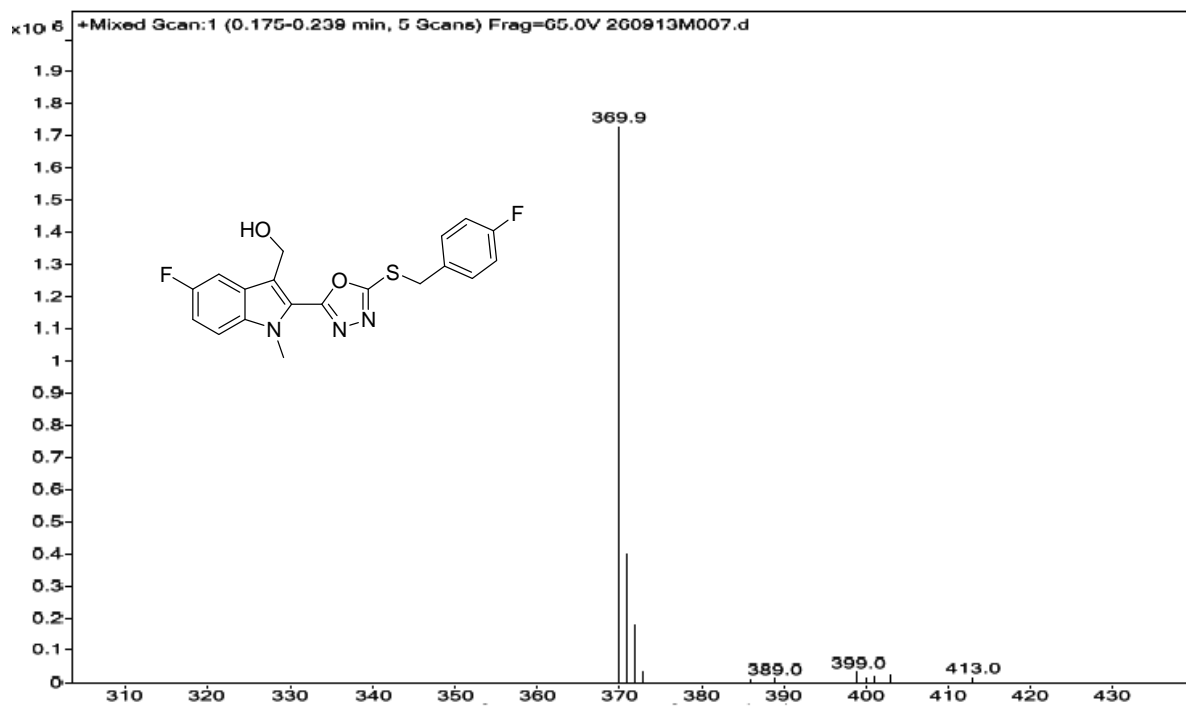


Figure S32 ESI-MS spectrum of compound 10l

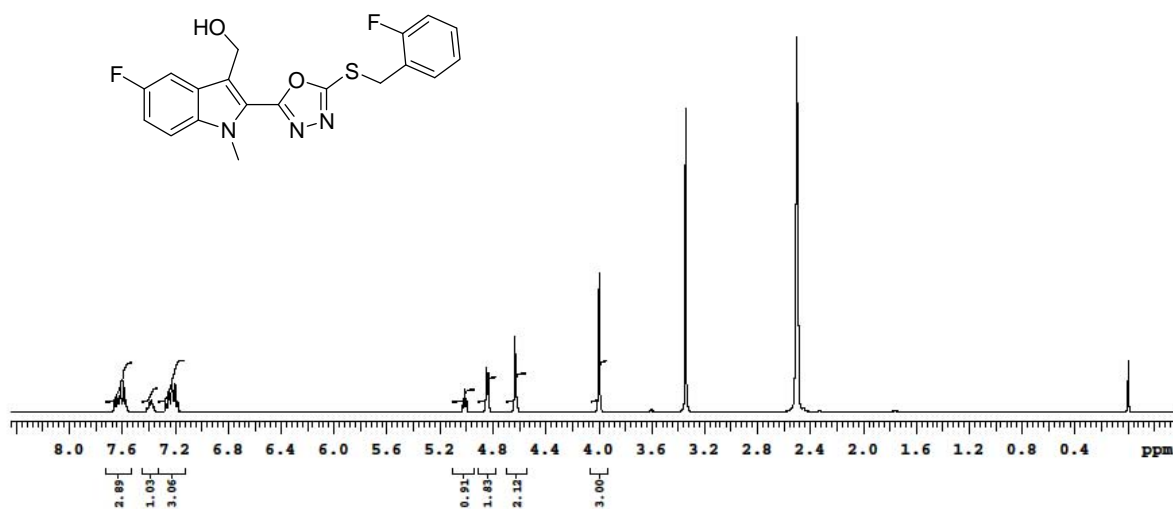


Figure S33 ¹H NMR spectrum of compound 10n (400 MHz, DMSO-d₆)

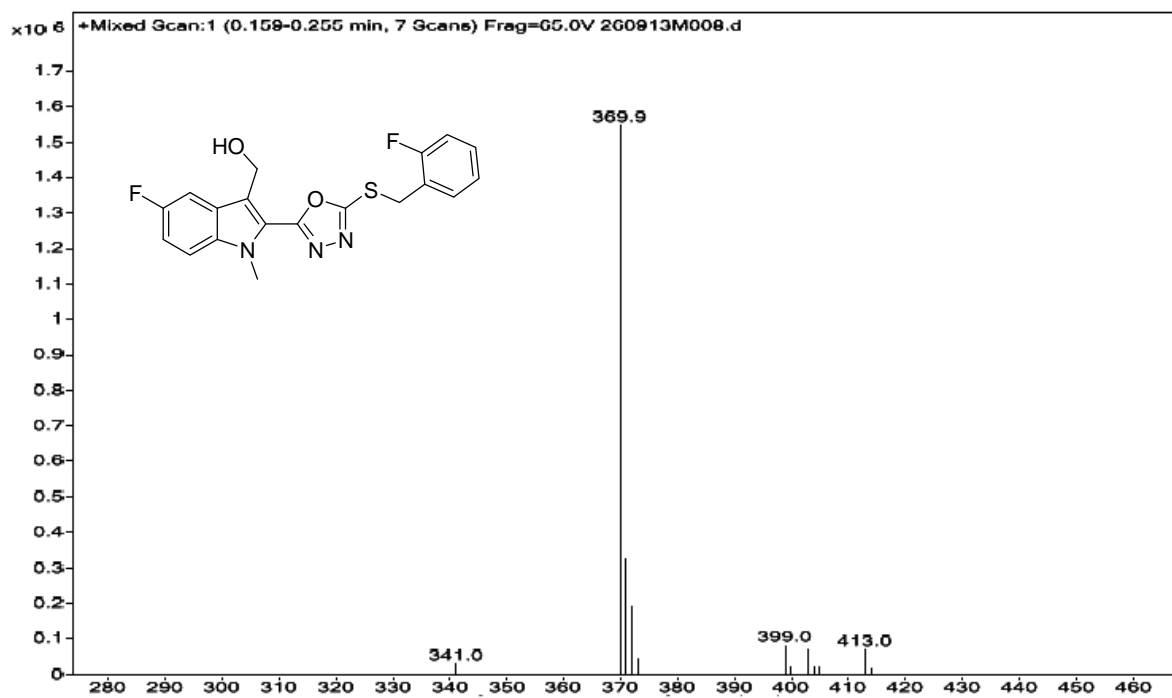


Figure S34 ESI-MS spectrum of compound 10n

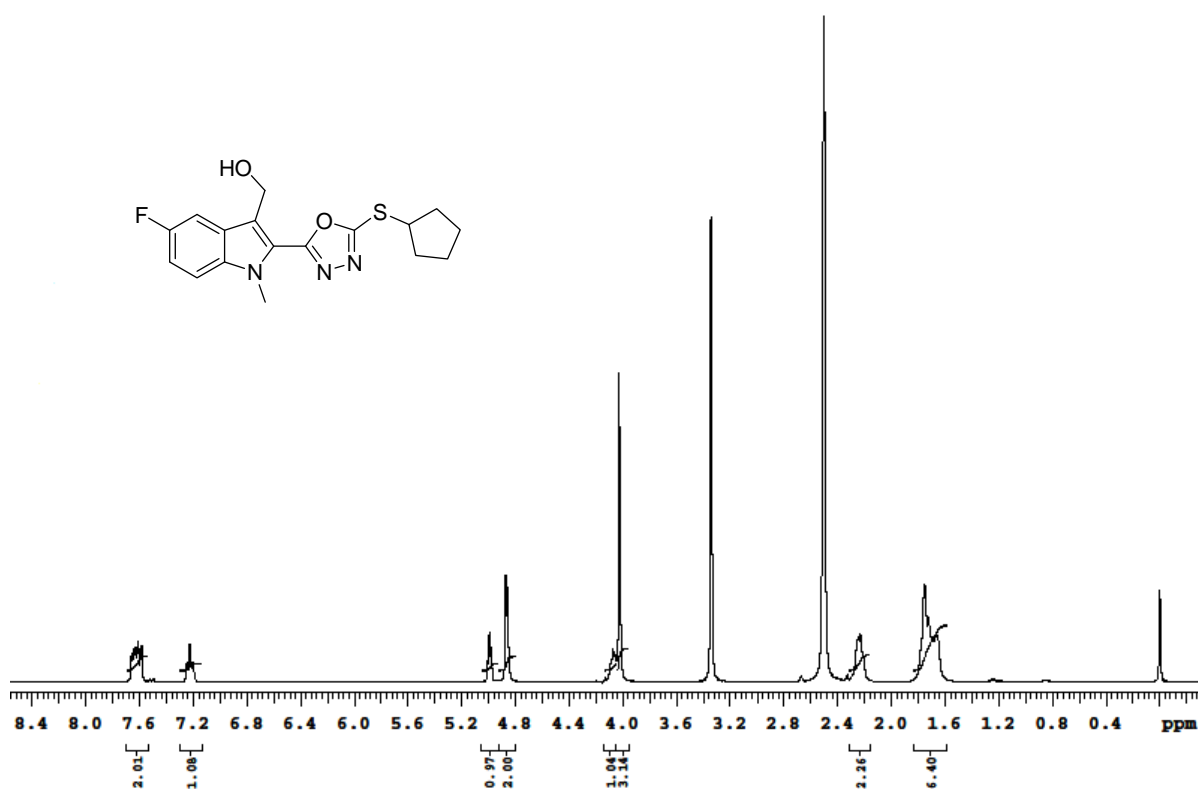


Figure S35 ¹H NMR spectrum of compound 10q (400 MHz, DMSO-d₆)

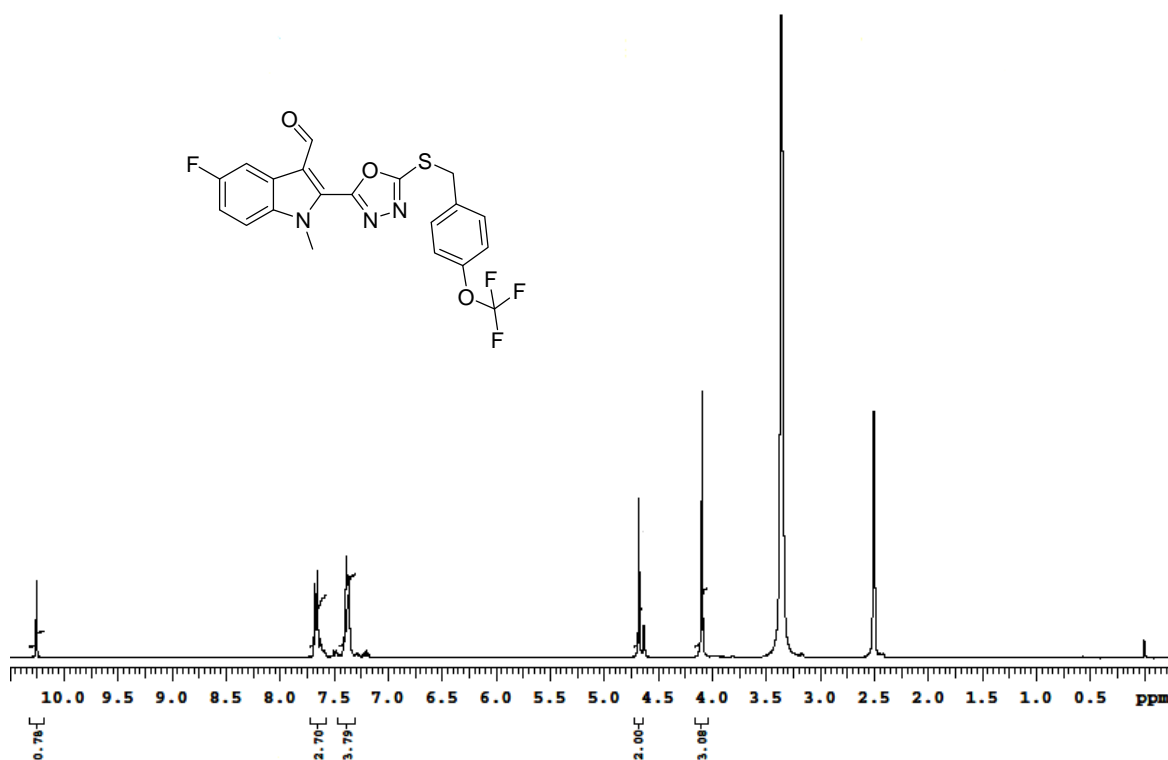


Figure S36 ¹H NMR spectrum of intermediate **9r** (400 MHz, DMSO-d₆)

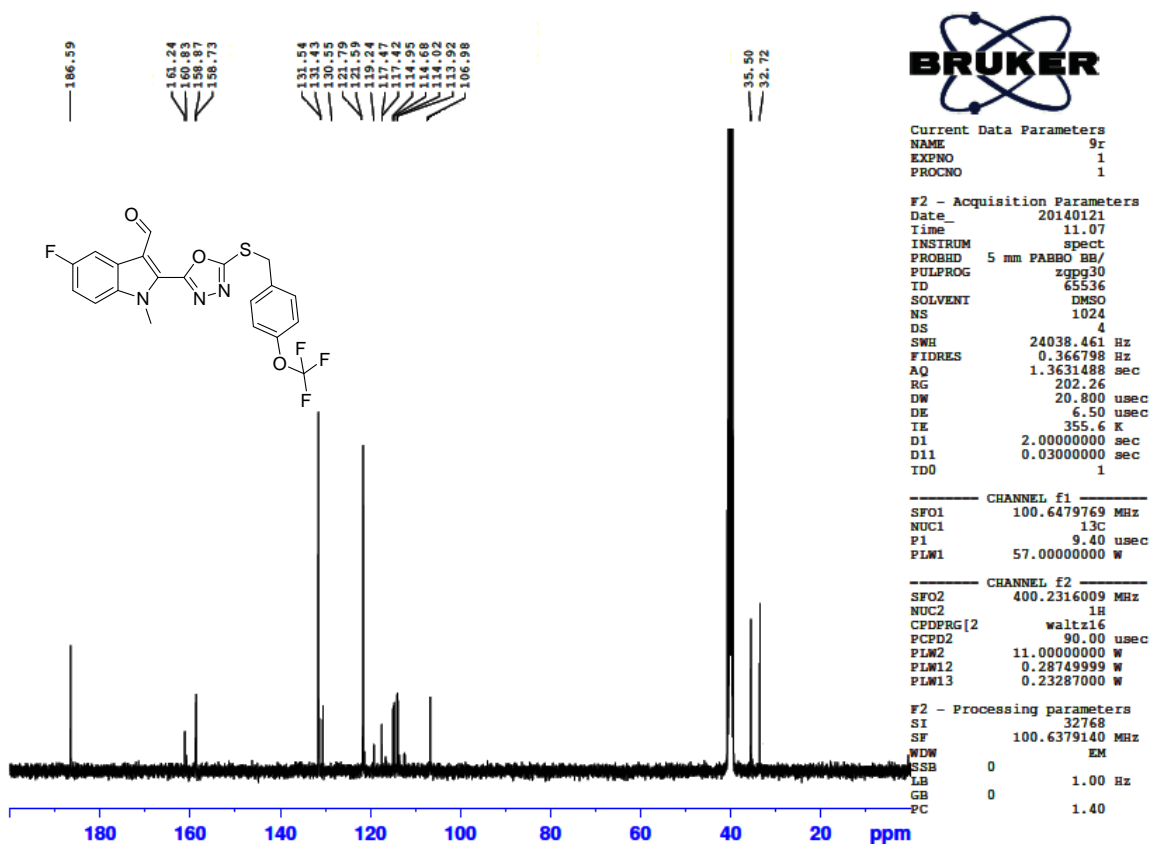


Figure S37 ¹³C NMR spectrum of intermediate **9r** (100 MHz, DMSO-d₆)

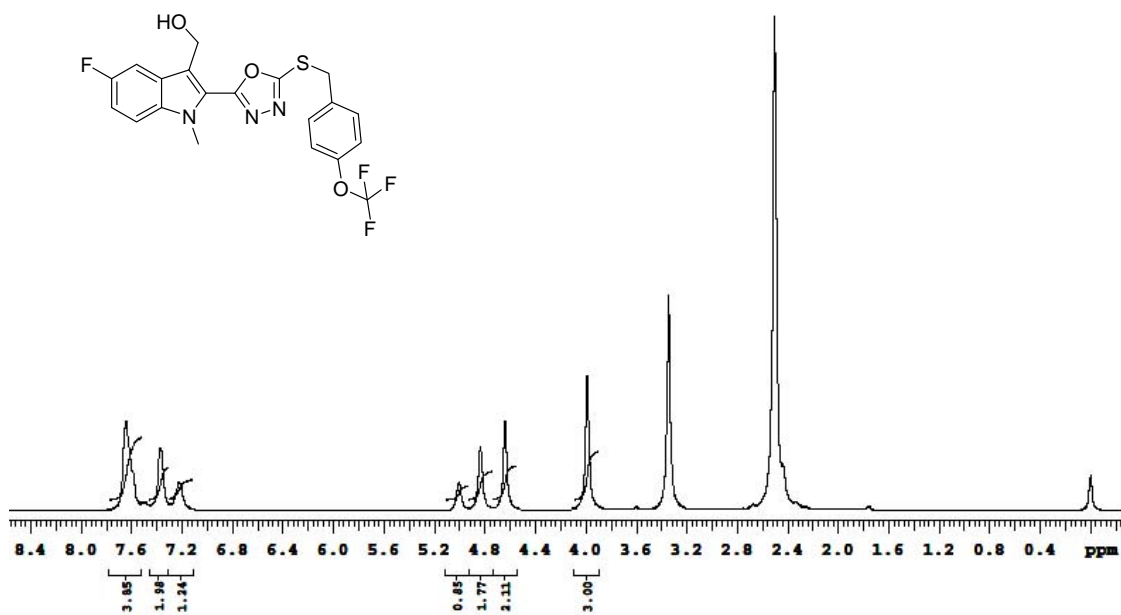


Figure S38 ^1H NMR spectrum of compound 10r (400 MHz, DMSO-d_6)

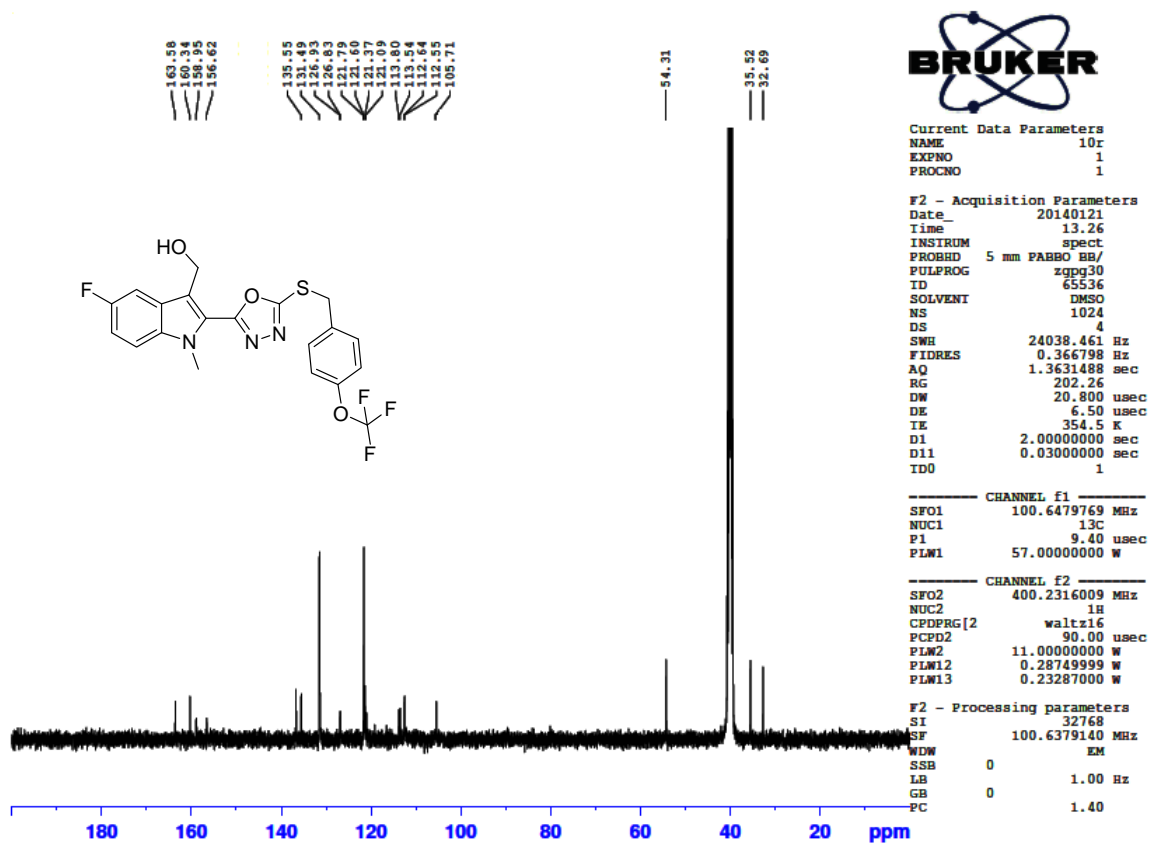


Figure S39 ^{13}C NMR spectrum of compound 10r (100 MHz, DMSO-d_6)

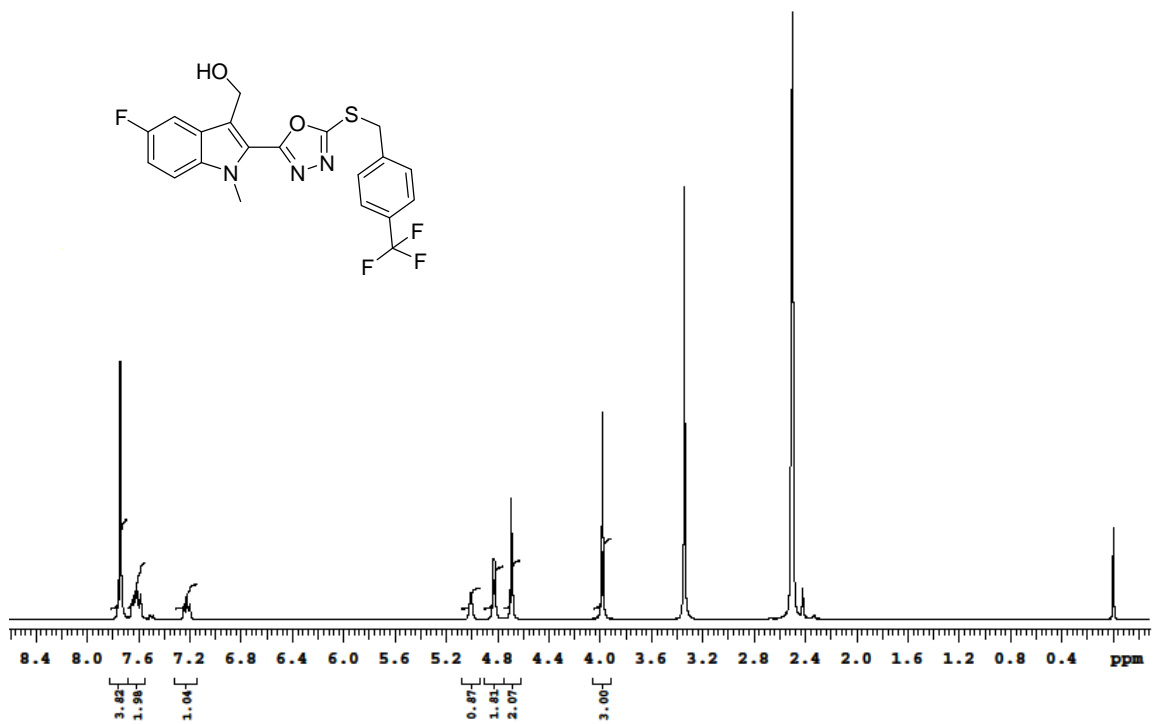


Figure S40 ¹H NMR spectrum of compound **10s** (400 MHz, DMSO-d₆)

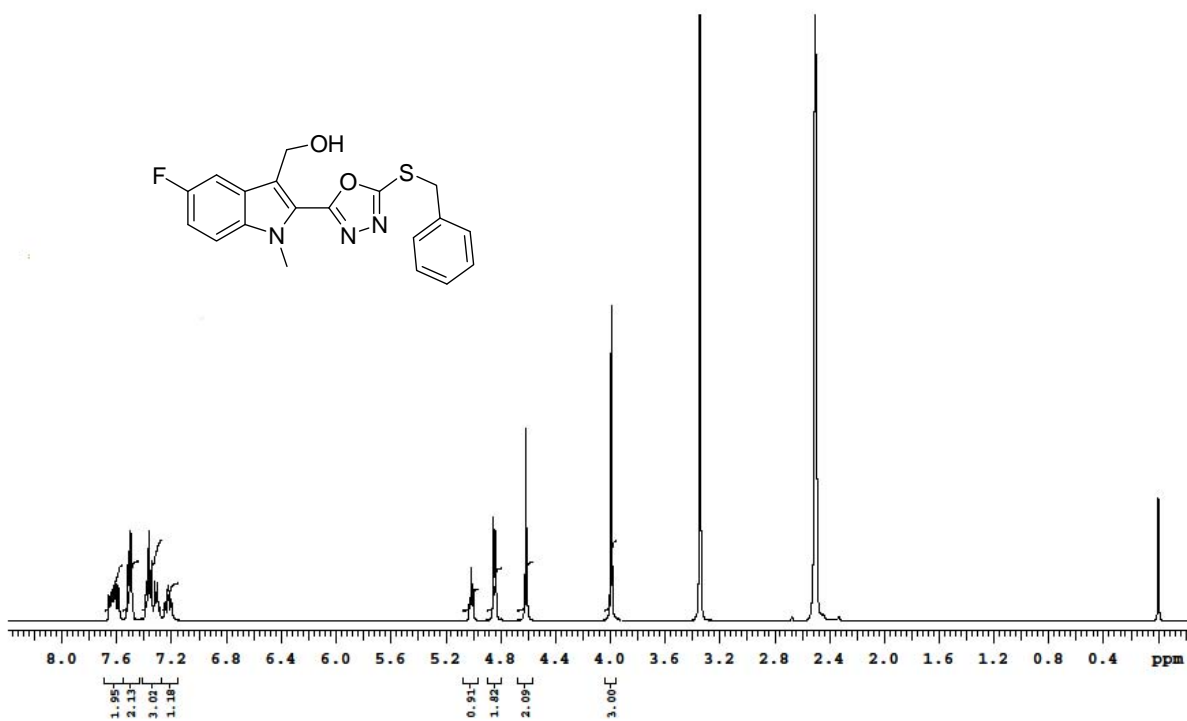


Figure S41 ¹H NMR spectrum of compound **10t** (400 MHz, DMSO-d₆)

in DMSO-d6
A.R.NO: NE146033
Sample Name:
Data Collected on:
localhost.localdomain-vmnr400
Archive directory:
Sample directory:
FidFile: PROTON
Pulse Sequence: PROTON (s2pul)
Solvent: dmsc
Data collected on: Jul 23 2014

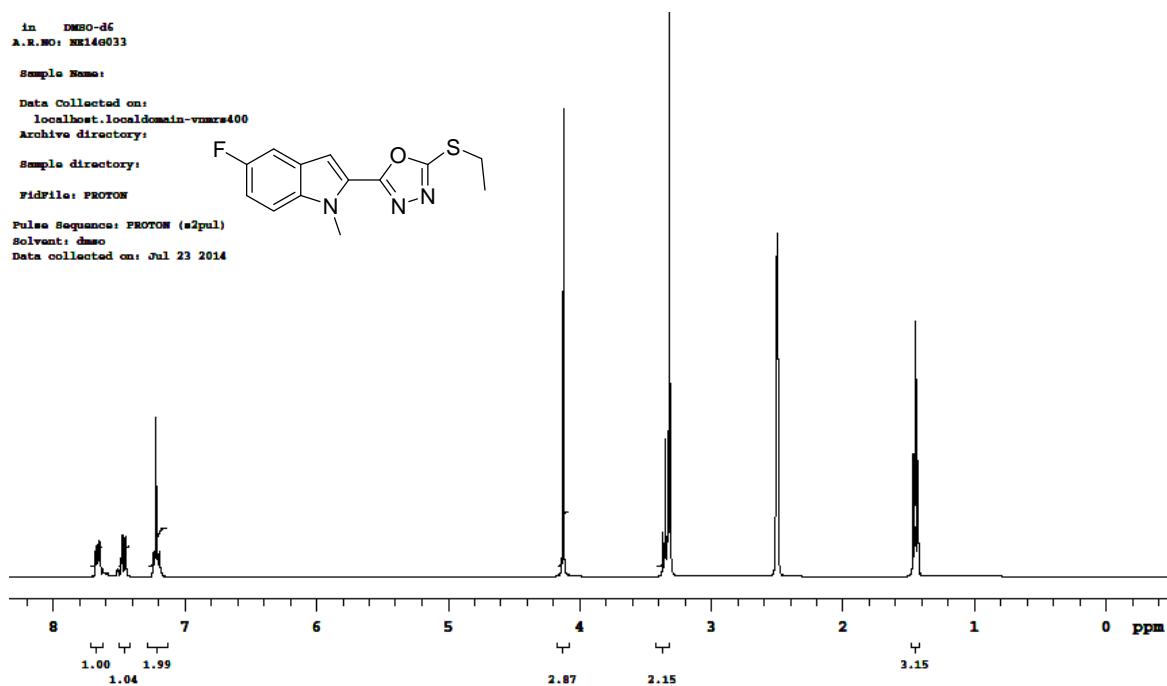


Figure S42 ^1H NMR spectrum of intermediate **8u** (400 MHz, DMSO- d_6)

in DMSO-d6
A.R.NO: NE146039
Sample Name:
Data Collected on:
localhost.localdomain-vmnr400
Archive directory:
Sample directory:
FidFile: PROTON
Pulse Sequence: PROTON (s2pul)
Solvent: dmsc
Data collected on: Jul 25 2014

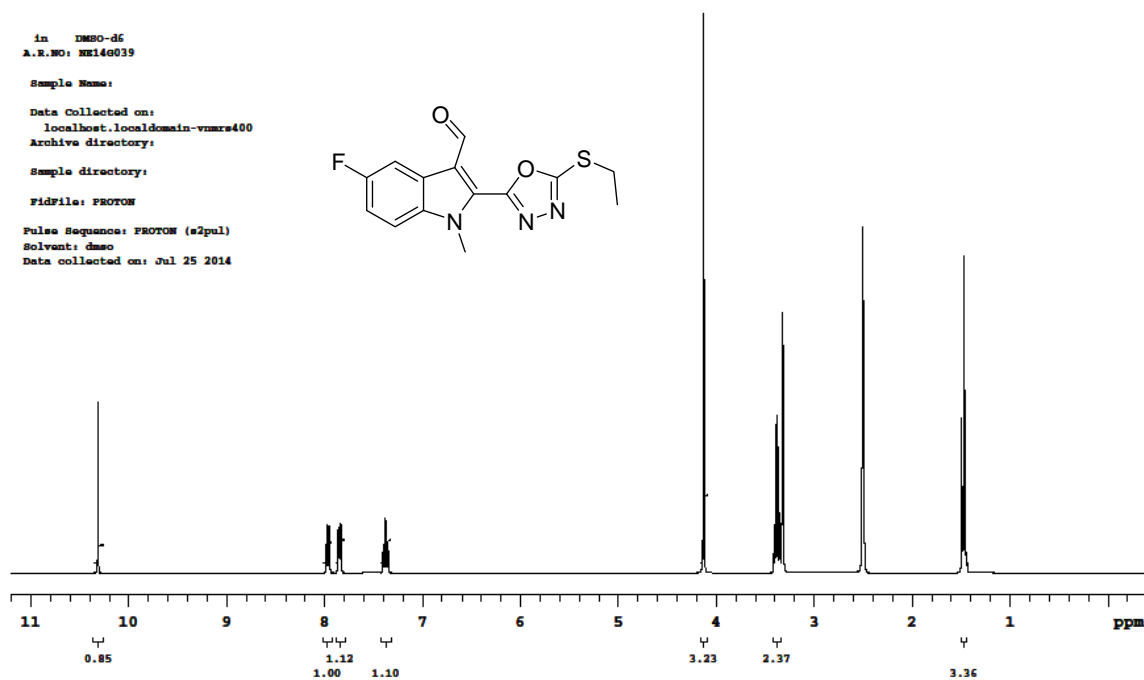


Figure S43 ^1H NMR spectrum of intermediate **9u** (400 MHz, DMSO- d_6)

in DMSO-d6
A.R.NO: ME14G040

Sample Name:

Data Collected on:
localhost.localdomain-vnmrs400
Archive directory:

Sample directory:

Fidfile: PROTON

Pulse Sequence: PROTON (a2pul)

Solvent: dmsc

Data collected on: Jul 25 2014

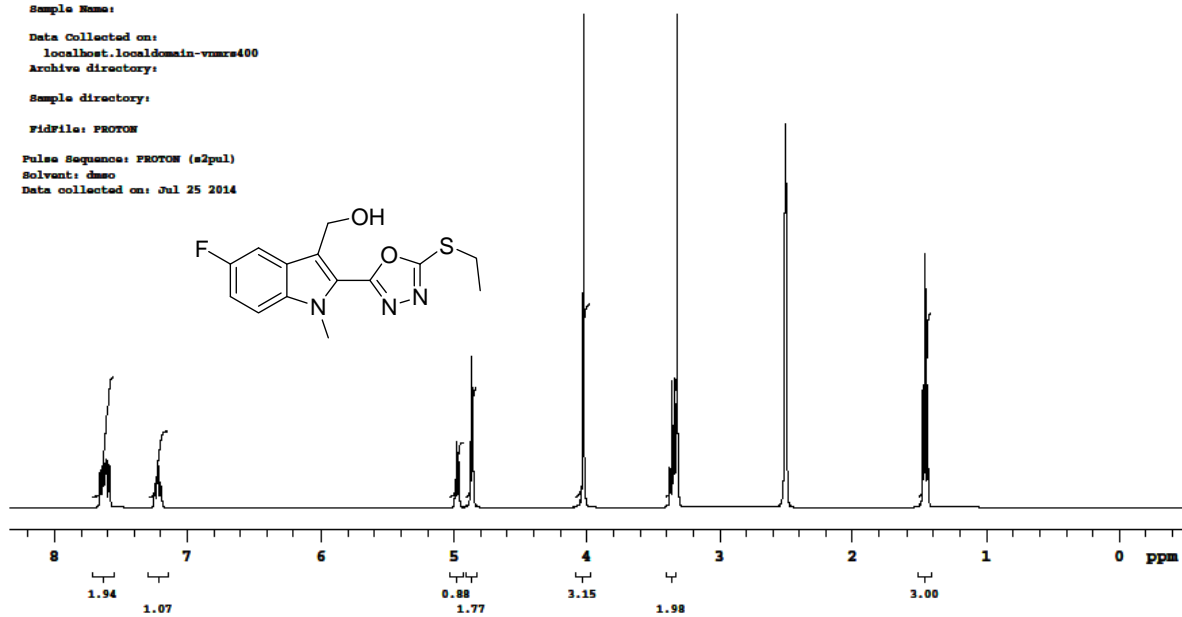


Figure S44 ^1H NMR spectrum of compound **10u** (400 MHz, DMSO- d_6)