Electronic Supplementary Material (ESI) for ChemComm.

Enantioselective synthesis of pyrazolone α-aminonitrile derivatives via an organocatalytic Strecker reaction

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Contents

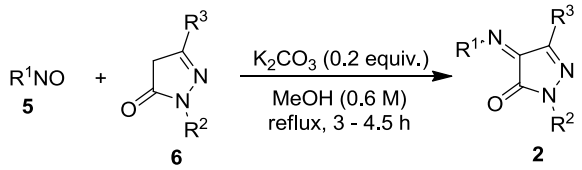
General Methods and Materials:

All reactions were performed in oven-dried glassware. Analytical TLC were carried out using SIL G-25 UV254 from Machery & Nagel and visualized with ultraviolet radiation at 254 nm. ^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$ at ambient temperature on Varian Innova 400 or Innova 600 instruments. Chemical shifts for ^{1}H NMR and ^{13}C NMR spectra were reported in parts per million (ppm), with coupling constants given in Hertz (Hz). The following abbreviations are used for spin multiplicity: s = singlet, d = doublet, dd = doublet of doublet, t = triplet, q = quartet, m = multiplet and br = broad signal. Mass spectra were recorded with the spectrometer SSQ 7000 from Finnigan at 70 eV, whereas HRMS data (ESI) were collected with a ThermoFisher Scientific LTQ-Orbitrap XL apparatus. IR spectra were taken on a PerkinElmer Spectrum 100 FT-IR spectrometer. Analytical HPLC was carried out either on a Hewlett-Packard 1050 series instrument or Agilent 1100 instrument using chiral stationary phases. Analytical SFC was carried out on a Thar SFC Waters Method Station II instrument using chiral stationary phases. The diasteromeric ratio was determined by the ^{1}H NMR and HPLC analysis of the isolated product. Optical rotation values were measured on a Perkin-Elmer 241 polarimeter. Melting points were measured on a LLG MPM-H2 melting point instrument.

Unless specified, the starting materials and reagents were purchased directly from the commercial suppliers and used without further purification. The catalysts **C1** to **C5**[1] and **C-7** to C-**8**[2] were synthesized using known literature procedures.

General Procedures:

General procedure for the synthesis of pyrazolone derived aryl ketimines 2a,g-p (Scheme 1): Nitrosoarene **5** (1.0 equiv.) and K_2CO_3 (0.2 equiv.) were added to a solution of pyrazolone derivative **6** (1.0 equiv.) in MeOH (0.6 M) at room temperature. The reaction mixture was then refluxed for 3 hours. The solvent was removed under reduced pressure and the residue was dissolved in ethyl acetate. The organic layer was washed three times with water, once with brine and then dried over anhydrous $MgSO_4$. After evaporation of ethyl acetate under reduced pressure, the crude product was purified by flash column chromatography (*n*-pentane/diethyl ether, 3:1) to afford the ketimine products **2a,g-p**.

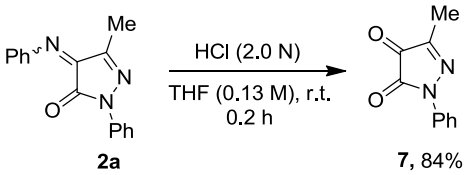


2a. R^1 = Ph, R^2 = Ph, R^3 = CH_3 (48%)
2g. R^1 = 2-MeC_6H_4, R^2 = Ph, R^3 = CH_3 (4
2h. R^1 = Ph, R^2 = 4-ClC_6H_4, R^3 = CH_3 (4
2i. R^1 = Ph, R^2 = 2-ClC_6H_4, R^3 = CH_3 (46
2j. R^1 = Ph, R^2 = 4-MeC_6H_4, R^3 = CH_3 (4
2k. R^1 = Ph, R^2 = Me, R^3 = CH_3 (62%)
2l. R^1 = Ph, R^2 = Ph, R^3 = Et (46%)
2m. R^1 = Ph, R^2 = Ph, R^3 = *n*-Pr (48%)
2n. R^1 = Ph, R^2 = Ph, R^3 = *i*-Pr (58%)
2o R^1 = Ph, R^2 = Ph, R^3 = *t*-Bu (49%)
2p. R^1 = R^1 = R^2 = Ph (56%)

Scheme 1

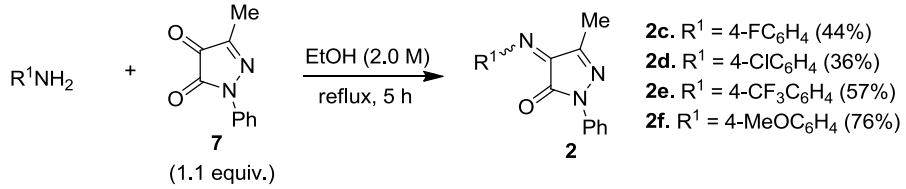
1. (*a*) J. P. Malerich, K. Hagihara and V. H. Rawal, *J. Am. Chem. Soc.*, **2008**, *130*, 14416; (*b*) Y. Zhu, J. P. Malerich and V. H. Rawal, *Angew. Chem., Int. Ed.*, **2010**, *49*, 153.
2. H. L. Yi, W. L. Tang and L. Deng, *J. Am. Chem. Soc.*, **2004,** *126*, 9906.

Procedure for the synthesis of pyrazolone-derived ketone 7 (Scheme 2): The ketimine **2a** (20 mmol) was dissolved in THF (0.13 M) and a 2.0 N HCl solution (20 mL) was added to the reaction mixure at room temperature. The progress of the reaction was monitored on TLC. After completion of the reaction, the mixture was diluted with water. The organic layer was extracted three times with dichloromethane and the combined organic layers were dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure and the crude product was directly purified by flash column chromatography (*n*-hexane/EtOAc, 1:1) to afford the desired product **7**.



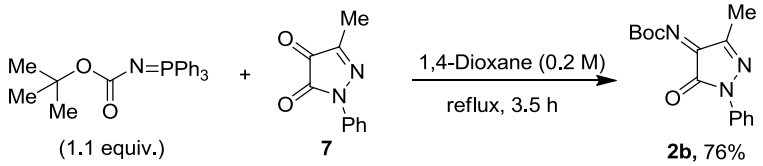
Scheme 2

General procedure for the synthesis of pyrazolone derived aryl ketimines 2c-f (Scheme 3): A mixture of pyrazolone-derived ketone **7** (1.0 equiv.) and aniline derivative (1.0 equiv.) in EtOH (2.0 M) was refluxed for 5 hours. In the case of **2e**, *p*-TSA (30 mol%) was added as catalyst. After completion of the reaction, the solvent was removed under reduced pressure and the crude product was directly purified by flash column chromatography (*n*-pentane/diethyl ether, 3:1) to afford the desired product **2c-f**.



Scheme 3

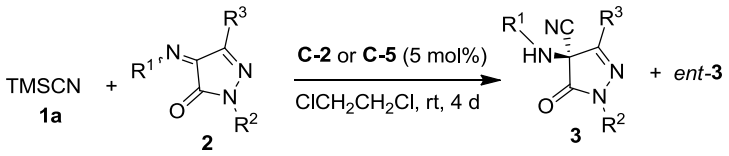
General procedure for the synthesis of pyrazolone derived *N*-Boc ketimine 2b (Scheme 4): The *tert*-butyl(triphenylphosphoranylidene)acetate (1.1 equiv.) was added to a solution of the pyrazolone-derived ketone **7** in 1,4-dioxane (0.2 M) at room temperature and the mixture was refluxed for 3-3.5 hours. After completion of the reaction, the solvent was removed under reduced pressure and the crude product was directly purified by flash column chromatography (*n*-pentane/diethyl ether, 1:1) to afford the desired product **2b**.



Scheme 4

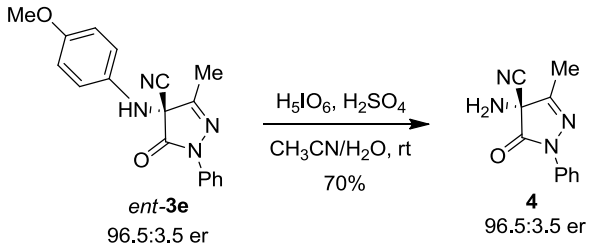
General procedure for the organocatalytic enantioselective Strecker synthesis of 3 and *ent*-3 (Scheme 5): In a 10 mL reaction tube equipped with a magnetic stirring bar, the imine **2** (1 equiv., 0.2 mmol), catalyst **C-2** or **C-5** (5 mol%) were stirred in dichloroethane (4.5 mL) at room temperature. After 10 minutes, trimethylsilyl cyanide **1a** (1.5 equiv. 0.45 mmol) was added and the stirring was continued for 4 days at room temperature. The crude product was

directly purified by flash column chromatography (*n*-hexane/EtOAc, 4:1) to afford the products **3** or *ent*-**3**.



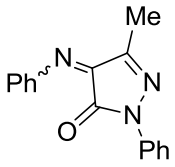
Scheme 5

Procedure for the deprotection of the 4-methoxyphenyl group (Scheme 6): The α-amino nitrile *ent*-**3e** (64 mg, 0.2 mmol) was dissolved in CH_3CN/H_2O (1:1, 4 mL). Periodic acid (182 mg, 0.8 mmol, 4 equiv.) and sulfuric acid (0.4 mL) were added and the mixture was stirred until completion of the reaction in 1 h. Diethyl ether was added to the solution, the phases were separated and the aqueous phase was extracted twice with diethyl ether. The combined organic phases were dried over sodium sulfate and concentrated under vacuum. The crude product was directly purified by flash column chromatography (*n*-hexane/EtOAc, 6:4) to afford the product **4**.

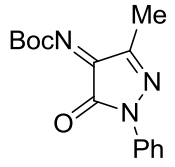


Scheme 6

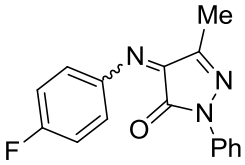
Analytical data:



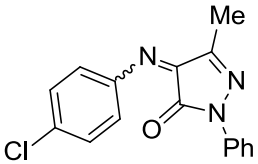
5-Methyl-2-phenyl-4-(phenylimino)-2,4-dihydro-3*H*-pyrazol-3-one (2a). Red solid; mp = 102-104 ˚C; IR (Capillary): 3060, 2287, 2084, 1937, 1664, 1587, 1488, 1412, 1360, 1297, 1132, 998, 911, 831, 744, 687 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$): δ 7.88– 7.86 (m, 2H, ArH), 7.45 – 7.23 (m, 7H, ArH), 7.22 – 7.19 (m, 1H, ArH), 2.35 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 152.7, 151.2, 150.8, 146.3, 137.7, 129.0 (2C), 128.7 (2C), 125.6, 121.8 (2C), 118.5 (2C), 118.4, 12.4; MS (EI): *m/z* 262.9 M^+; HRMS Calcd for $[C_{16}H_{13}N_3O + H]^+$: 264.1131, found: 264.1131.



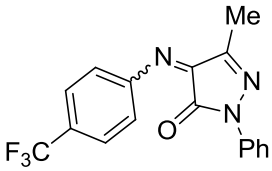
***tert*-Butyl (3-methyl-5-oxo-1-phenyl-1,5-dihydro-4*H*-pyrazol-4-ylidene)carbamate (2b).** Orange solid; mp = 173-175 °C; IR (Capillary): 2979, 2319, 2110, 1722, 1596, 1482, 1369, 1250, 1143, 843, 759 cm^{-1}; ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.84-7.82 (m, 2H, ArH), 7.42-7.40 (m, 2H, ArH), 7.24-7.21 (m, 1H, ArH), 2.28 (s, 3H, Me), 1.64 (s, 9H, *t*-Bu); ^{13}C NMR (151 MHz, $CDCl_3$): δ 158.9, 153.9, 150.2, 150.0, 137.0, 129.1 (2C), 126.0, 118.3 (2C), 85.4, 28.1 (3C), 12.1; MS (EI): *m/z* 286.9 M^+; HRMS Calcd for $[C_{15}H_{17}N_3O_3 + Na]^+$: 310.1162, found: 310.1161.



4-((4-Fluorophenyl)imino)-5-methyl-2-phenyl-2,4-dihydro-3*H*-pyrazol-3-one (2c). Red solid; mp = 98-100 ˚C; IR (Capillary): 3076, 2674, 2345, 2110, 1906, 1694, 1490, 1310, 1231, 1117, 1013, 840, 758, 688, 660 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.87 – 7.84 (m, 2H, ArH), 7.60 – 7.57 (m, 2H, ArH), 7.41 – 7.37 (m, 2H, ArH), 7.22 – 7.20 (m, 1H, ArH), 7.13 – 7.09 (m, 2H, ArH), 2.31 (s, 3H, CH_3); ^{13}C NMR (101 MHz, $CDCl_3$): δ 163.2, 152.0, 151.5, 151.1, 142.0, 137.7, 129.0 (2C), 126.1 (2C), 125.7, 118.6 (2C), 115.7 (2C), 12.4; MS (EI): *m/z* 280.9 M^+; Elemental Analysis (CHN): calculated for $[C_{16}H_{12}N_3OF]$: C = 68.32%, H = 4.30%, N = 14.94%, found C = 68.15%, H = 4.52%, N = 16.63%.

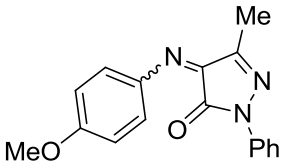


4-((4-Chlorophenyl)imino)-5-methyl-2-phenyl-2,4-dihydro-3*H*-pyrazol-3-one (2d). Red solid; mp = 118- 120 ˚C; IR (Capillary): 3470, 2972, 2287, 2089, 1887, 1732, 1587, 1484, 1368, 1214, 1084, 1018, 836, 757 cm^{-1}; ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.86 (d, *J* = 8.1 Hz, 2H, ArH), 7.42 – 7.37 (m, 6H, ArH), 7.22 (t, *J* = 7.4 Hz, 1H, ArH), 2.33 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 152.8, 151.2, 150.8, 144.5, 137.5, 134.7, 129.0 (2C), 128.9 (2C), 125.7, 123.9 (2C), 118.5 (2C), 12.4; MS (EI): *m/z* 296.8 M^+; Elemental Analysis (CHN): calculated for $[C_{16}H_{12}N_3OCl]$: C = 64.54%, H = 4.06%, N = 14.11%, found C = 64.73%, H = 4.25%, N = 14.05%.

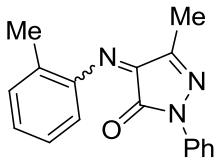


4-((4-Trifluoromethylphenyl)imino)-5-methyl-2-phenyl-2,4-dihydro-3*H*-pyrazol-3-one (2e). Red solid; mp = 155-157 ˚C; IR (Capillary): 3081, 2653, 2295, 2176, 2111, 2060, 2015, 1926, 1893, 1702, 1592, 1492, 1416, 1309, 1155. 1106, 1058, 840, 755, 692 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84 – 7.81 (m, 2H, ArH), 7.66 (d, *J* = 8.3 Hz, 2H, ArH), 7.40 – 7.36 (m, 2H, ArH), 7.24 – 7.18 (m, 3H, ArH), 2.34 (s, 3H, CH_3); ^{13}C NMR (101 MHz, $CDCl_3$): δ

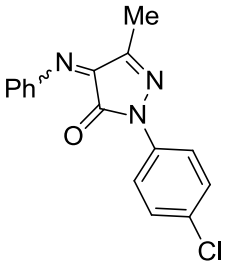
154.2, 150.7, 150.3, 149.6, 137.4, 129.2, 129.1 (2C), 126.1 (2C), 125.9, 120.0 (2C), 118.5, 118.4 (2C), 12.3; ^{19}F NMR (376 MHz, $CDCl_3$); δ –62.4; MS (EI): *m/z* 331.1 M^+; Elemental Analysis (CHN): calculated for [$C_{17}H_{12}N_3OF_3$]: C = 61.63%, H = 3.65%, N = 12.68%, found C = 61.63%, H = 3.64%, N = 12.69%.



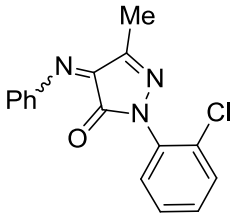
4-((4-Methoxyphenyl)imino)-5-methyl-2-phenyl-2,4-dihydro-3*H*-pyrazol-3-one (2f). Red solid; mp = 111-113 ˚C; IR (Capillary): 2929, 2661, 2340, 2092, 1906, 1686, 1499, 1253, 1113, 1012, 837, 755 cm^{-1}; ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.95 – 7.91 (m, 4H, ArH), 7.43 – 7.41 (m, 2H, ArH), 7.22 – 7.19 (m, 1H, ArH), 6.97 – 6.89 (m, 2H, ArH), 3.88 (s, 3H, OCH_3), 2.32 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 162.2, 152.4, 151.6, 148.9, 139.4, 138.0, 129.4 (2C), 129.0 (2C), 125.4, 118.7 (2C), 114.0 (2C), 55.6, 12.5; MS (EI): *m/z* 292.8 M^+; Elemental Analysis (CHN): calculated for [$C_{17}H_{15}N_3O_2$]: C = 69.61%, H = 5.15%, N = 14.33%, found C = 69.58%, H = 5.16%, N = 14.41%.



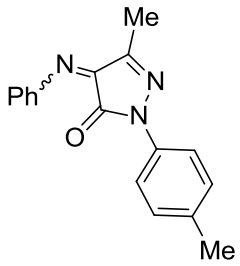
5-Methyl-2-phenyl-4-(*o*-tolylimino)-2,4-dihydro-3*H*-pyrazol-3-one (2g). Red solid; mp = 71-73 ˚C; IR (Capillary): 3389, 2920, 2648, 2325, 2093, 1906, 1712, 1594, 1481, 1307, 1151, 1036, 843, 758 cm^{-1}; ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.89 – 7.87 (m, 2H, ArH), 7.41 – 7.38 (m, 2H, ArH), 7.30 – 7.17 (m, 5H, ArH), 2.37 (s, 3H, CH_3), 2.30 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 152.2, 151.3, 150.6, 145.4, 137.7, 130.8, 129.2, 129.0 (2C), 128.6, 125.8, 125.6, 118.5, 118.4 (2C), 18.2 ,12.4.; MS (EI): *m/z* 276.9 M^+; HRMS Calcd for [$C_{17}H_{15}N_3O$ + Na]$^+$: 300.1107, found: 300.1107.



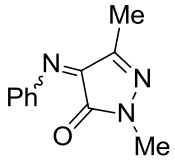
2-(4-Chlorophenyl)-5-methyl-4-(phenylimino)-2,4-dihydro-3*H*-pyrazol-3-one (2h). Red solid (83 mg, 95%); mp = 121-123 ˚C; IR (Capillary): 3461, 2993, 2678, 2338, 2093, 1902, 1716, 1577, 1479, 1305, 1105, 994, 820 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85 – 7.83 (m, 2H, ArH), 7.44 – 7.31 (m, 7H, ArH), 2.32 (s, 3H, CH_3); ^{13}C NMR (101 MHz, $CDCl_3$): δ 152.2, 151.2, 151.1, 146.2, 136.3, 129.1 (2C), 129.0, 128.7 (2C), 122.03, 122.01, 119.4 (2C), 118.8, 12.4; MS (EI): *m/z* 296.8 M^+; HRMS Calcd for [$C_{16}H_{12}N_3OCl$ + H]$^+$: 298.0742, found: 298.0742.



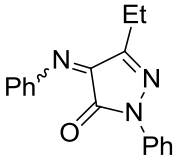
2-(2-Chlorophenyl)-5-methyl-4-(phenylimino)-2,4-dihydro-3*H*-pyrazol-3-one (2i). Red solid; mp = 119-120 ˚C; IR (Capillary): 3460, 2999, 2332, 2090, 1904, 1737, 1366, 1216, 1061, 885, 739 cm^{-1}; ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.51 – 7.47 (m, 3H, ArH), 7.44 – 7.39 (m, 3H, ArH), 7.35 – 7.31 (m, 3H, ArH), 2.33 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 151.9, 151.4, 150.9, 146.1, 130.7, 130.1, 129.3, 129.1, 128.7 (2C), 128.6, 127.7, 122.9 (2C), 118.9, 12.5; MS (EI): *m/z* 296.7 M^+; Elemental Analysis (CHN): calculated for [$C_{16}H_{12}N_3OCl$]: C = 64.54%, H = 4.06%, N = 14.11%, found C = 64.52%, H = 4.01%, N = 14.32%.



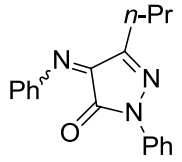
5-Methyl-4-(phenylimino)-2-(*p*-tolyl)-2,4-dihydro-3*H*-pyrazol-3-one (2j). Red solid; mp = 75-77 ˚C; IR (Capillary): 3354, 2934, 2702, 2339, 2092, 1907, 1690, 1497, 1306, 1129, 993, 774, 683 cm^{-1}; ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.75 (d, *J* = 8.5 Hz, 2H, ArH), 7.44 – 7.42 (m, 2H, ArH), 7.38 – 7.36 (m, 2H, ArH), 7.34 – 7.31 (m, 1H, ArH), 7.20 – 7.19 (m, 2H, ArH), 2.35 (s, 3H, CH_3), 2.33 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 152.8, 151.1, 150.6, 146.3, 135.3, 135.2, 129.5(2C), 129.1, 128.7(2C), 128.6, 121.8, 118.4 (2C), 21.1, 12.4.; MS (EI): *m/z* 276.9 M^+; HRMS Calcd for [$C_{17}H_{15}N_3O$ + Na]$^+$: 300.1107, found: 300.1107.



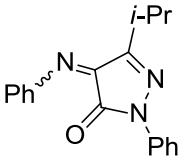
2,5-Dimethyl-4-(phenylimino)-2,4-dihydro-3*H*-pyrazol-3-one (2k). Red wax; IR ($CDCl_3$): 3339, 2932, 2666, 2340, 2094, 1906, 1705, 1440, 1307, 1218, 1056, 935, 735 cm^{-1}; ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.41 – 7.24 (m, 5H, ArH), 3.28 (s, 3H, CH_3), 2.20 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 153.0, 152.7, 149.1, 146.3, 128.7 (2C), 122.1 (2C), 115.3, 31.7, 12.2; MS (EI): *m/z* 201.1 M^+; HRMS Calcd for [$C_{11}H_{11}N_3O$ + Na]$^+$: 224.0794, found: 224.0794.



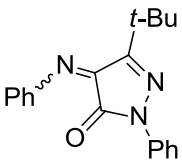
5-Ethyl-2-phenyl-4-(phenylimino)-2,4-dihydro-3*H*-pyrazol-3-one (2l). Red solid; mp = 94-96 ˚C; IR (Capillary): 3460, 2970, 2663, 2336, 2094, 1912, 1728, 1589, 1479, 1341, 1225, 1117, 1037, 919, 836, 755 cm^{-1}; ^{1}H NMR (600 MHz, $CDCl_3$): 7.92 – 7.90 (m, 2H, ArH), 7.45 – 7.32 (m, 6H, ArH), 7.22 – 7.20 (m, 2H, ArH), 2.76 (q, *J* = 7.5 Hz, 2H, CH_2CH_3), 1.40 (t, *J* = 7.5 Hz, 3H, CH_2CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 154.6, 152.3, 151.3, 146.4, 137.7, 129.0 (2C), 128.7 (2C), 128.5, 125.5, 121.7, 118.4 (2C), 118.3, 20.2, 10.6; MS (EI): *m/z* 276.8 M^+; HRMS Calcd for $[C_{17}H_{15}N_3O + Na]^+$: 300.1107, found: 300.1109.



2-Phenyl-4-(phenylimino)-5-propyl-2,4-dihydro-3*H*-pyrazol-3-one (2m). Red Solid; mp = 55-58 ˚C; IR (Capillary): 3351, 2944, 2338, 2092, 1905, 1703, 102, 1478, 1314, 1101, 894, 753 cm^{-1}; ^{1}H NMR (600 MHz, $CDCl_3$): 7.89 – 7.87 (m, 2H, ArH), 7.44 – 7.38 (m, 4H, ArH), 7.35 – 7.30 (m, 3H, ArH), 7.22 – 7.19 (m, 1H, ArH), 2.71 – 2.69 (m, 2H, $CH_2CH_2CH_3$), 1.89 – 1.83 (m, 2H, $CH_2CH_2CH_3$), 1.09 (t, *J* = 7.4 Hz, 3H, $CH_2CH_2CH_3$); ^{13}C NMR (151 MHz, $CDCl_3$): δ 153.7, 152.5, 151.26, 146.5, 137.7, 129.0 (2C), 128.7 (2C), 128.6, 125.6, 121.6 (2C), 118.5 (2C), 28.6, 20.1, 14.1; MS (EI): *m/z* 290.9 M^+; Elemental Analysis (CHN): calculated for $[C_{18}H_{17}N_3Ol]$: C = 74.20%, H = 5.88%, N = 14.42%, found C = 74.03%, H = 5.70%, N = 14.44%.

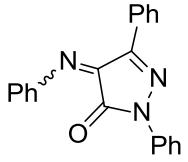


5-Isopropyl-2-phenyl-4-(phenylimino)-2,4-dihydro-3*H*-pyrazol-3-one (2n). Red solid; mp = 77-79 ˚C; IR (Capillary): 3398, 2959, 2707, 2340, 2093, 1709, 1593, 1467, 1334, 1256, 1102, 977, 835, 747, 685 cm^{-1}; ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.92 – 7.91 (m, 2H, ArH), 7.45 – 7.39 (m, 4H, ArH), 7.34 – 7.31 (m, 3H, ArH), 7.22 – 7.19 (m, 1H, ArH), 3.22 – 3.18 (m, 1H, $CH(CH_3)_2$), 1.42 (d, *J* = 7.0 Hz, 6H, $CH(CH_3)_2$); ^{13}C NMR (151 MHz, $CDCl_3$): δ 157.5, 152.0, 151.3, 146.5, 137.8, 129.0 (2C), 128.7 (2C), 128.4, 125.5, 121.4 (2C), 118.4 (2C), 27.1, 20.1 (2C); MS (EI): *m/z* 290.9 M^+; HRMS Calcd for $[C_{18}H_{17}N_3O + Na]^+$: 314.1264, found: 314.1264.

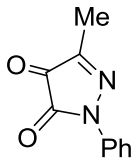


5-(*tert*-Butyl)-2-phenyl-4-(phenylimino)-2,4-dihydro-3*H*-pyrazol-3-one (2o). Red solid; mp = 95-97 ˚C; IR (Capillary): 2957, 2340, 2095, 1925, 1717, 1590, 1479, 1375, 1304, 1213, 1108, 963, 839, 689 cm^{-1}; ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.93 – 7.91 (m, 2H, ArH), 7.45 – 7.39 (m, 4H, ArH), 7.31 7.29 (m, 1H, ArH), 7.24 – 7.19 (m, 3H, ArH), 1.51 (s, 9H,

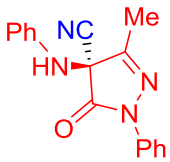
$C(CH_3)_3$); ^{13}C NMR (151 MHz, $CDCl_3$): δ 158.4, 152.0, 150.8, 146.7, 137.7, 128.9 (2C), 128.7 (2C), 127.8, 125.4, 120.3 (2C), 118.3 (2C), 35.1, 28.1(3C); MS (EI): *m/z* 304.9 M^+; HRMS Calcd for $[C_{19}H_{19}N_3O + H]^+$: 306.1601, found: 306.1602.



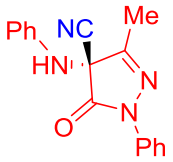
2,5-Diphenyl-4-(phenylimino)-2,4-dihydro-3*H*-pyrazol-3-one (2p). Red solid; mp = 176-178 ˚C; IR (Capillary): 3449, 3026, 2682, 2338, 2092, 1896, 1714, 1592, 1482, 1399, 1307, 1142, 925, 838, 687cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$): δ 8.32 – 8.30 (m, 2H, ArH), 7.99 – 7.97 (m, 2H, ArH), 7.51 – 7.42 (m, 7H, ArH), 7.35 – 7.21 (m, 3H, ArH), 7.26 – 7.23 (m, 1H, ArH); ^{13}C NMR (151 MHz, $CDCl_3$): δ 152.1, 150.7, 147.1, 146.9, 137.6, 130.8, 129.0 (2C), 128.8 (3C), 128.7 (2C), 128.2, 128.1 (2C), 125.9, 120.6 (2C), 118.7 (2C); MS (EI): *m/z* 324.8 M^+; Elemental Analysis (CHN): Calcd for $[C_{21}H_{15}N_3O]$: C = 77.52%, H = 4.65%, N = 12.91%, found C = 77.69%, H = 4.71%, N = 13.08%.



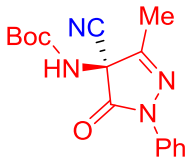
3-Methyl-1-phenyl-1*H*-pyrazole-4,5-dione (7). Red solid; mp = 119-121 ˚C; IR (Capillary): 3083, 2078, 1765, 1722, 1591, 1492, 1434, 1416, 1370, 1279, 1151, 1086, 1039, 972, 913, 849, 763, 689 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.84 – 7.82 (m, 2H, ArH), 7.44 – 7.40 (m, 2H, ArH), 7.26 – 7.22 (m, 1H, ArH), 2.18 (s, 3H, CH_3); ^{13}C NMR (101 MHz, $CDCl_3$): δ 184.6, 149.2, 144.5, 137.0, 129.3 (2C), 126.3, 117.8 (2C), 11.1; MS (EI): *m/z* 188.1 M^+; HRMS Calcd for $[C_{10}H_8N_2O_2]^+$: 188.0580, found: 188.0583.



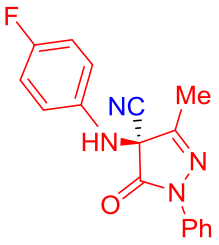
(*R*)-3-Methyl-5-oxo-1-phenyl-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3a). Reddish brown wax (83 mg, 95%); $[\alpha]_D^{24}$ = –11.5 (c = 0.6, CH_2Cl_2); 95.5:4.5 *er*; HPLC: tR 11.08 min (major), 12.44 min (minor), 230 nm, *n*-heptane/*i*-PrOH, 97:3, 0.7 mL/min, Chiralpak IC column; IR ($CHCl_3$): 3329, 2916, 2314, 2098, 1732, 1467, 1369, 1222, 747 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$): δ 7.85 – 7.83 (m, 2H, ArH), 7.46 – 7.44 (m, 2H, ArH), 7.30 – 7.26 (m, 1H, ArH), 7.22 – 7.20 (m, 2H, ArH), 6.96 (t, *J* = 7.4 Hz, 1H, ArH), 6.70 – 6.69 (m, 2H, ArH), 4.71 (s, 1H, NH), 2.35 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 164.7, 154.7, 141.9, 136.9, 129.9 (2C), 129.3 (2C), 126.6, 122.7, 119.2 (2C), 116.6 (2C), 112.4, 62.4, 14.5; MS (EI): *m/z* 289.9 M^+; HRMS Calcd for $[C_{17}H_{14}N_4O + Na]^+$: 313.1060, found: 313.1061.



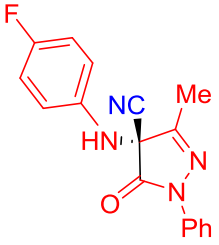
(*S*)-3-Methyl-5-oxo-1-phenyl-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3a). Reddish brown wax (75 mg, 86%); 93.9:6.1 *er*; HPLC: tR 11.21 min (minor), 12.51 min (major), 230 nm, *n*-heptane/*i*-PrOH, 97:3, 0.7 mL/min, Chiralpak IC column.



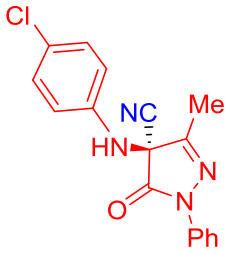
***tert*-Butyl (*R*)-(4-cyano-3-methyl-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazol-4-yl)carbamate (3b).** White Solid (93 mg, 83%); mp = 150 – 152 ˚C $[\alpha]_D^{24}$ = –10.0 (c = 0.5, $CHCl_3$); 62:38 *er*; HPLC: tR 7.73 min (minor), 8.23 min (major), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 0.5 mL/min, Chiralpak IA column; IR (Capillary): 3306, 2980, 2335, 2106, 1715, 1599, 1498, 1364, 1278, 1155, 880, 753 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$): δ 7.86 (d, *J* = 8.1 Hz, 2H, ArH), 7.44 – 7.41 (m, 2H, ArH), 7.26 – 7.24 (m, 1H), 5.98 (s, 1H, NH), 2.30 (s, 3H, CH_3), 1.39 (br s, 9H, *t*-Bu); ^{13}C NMR (151 MHz, $CDCl_3$): δ 164.1, 153.1, 137.2, 129.2 (2C), 126.3 (2C), 119.2 (2C), 111.1, 83.6, 58.9, 28.1 (3C), 13.7; MS (EI): *m/z* 314.2 M^+; HRMS Calcd for $[C_{16}H_{18}N_4O_3 + Na]^+$: 337.1271, found: 337.1269.



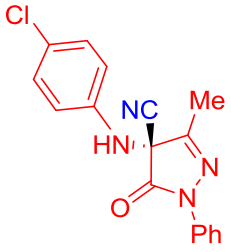
(*R*)-4-((4-Fluorophenyl)amino)-3-methyl-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3c). Yellowish brown wax (69 mg, 75%); $[\alpha]_D^{24}$ = –18.0 (c = 0.5, CH_2Cl_2); 97.0:3.0 *er*; HPLC: tR 8.27 min (minor), 15.32 min (major), 230 nm, *n*-heptane/*i*-PrOH, 8:2, 1.0 mL/min, Chiralpak AD column; IR ($CHCl_3$): 3343, 3052, 2257, 2090, 1724, 1600, 1501, 1363, 1227, 1115, 783 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.79 – 7.76 (m, 2H, ArH), 7.44 – 7.40 (m, 2H, ArH), 7.28 – 7.23 (m, 1H, ArH), 6.93 – 6.89 (m, 2H, ArH), 6.77 – 6.74 (m, 2H), 4.52 (s, 1H, NH), 2.33 (s, 3H, CH_3); ^{13}C NMR (101 MHz, $CDCl_3$): δ 164.8, 159.2, 154.3, 137.6, 136.8, 129.3 (2C), 126.6, 120.3 (2C), 119.2 (2C), 116.6 (2C), 112.4, 63.0, 14.5; MS (EI): *m/z* 308.0 M^+; HRMS Calcd for $[C_{17}H_{13}N_4OF + Na]^+$: 331.0966, found: 331.0966.



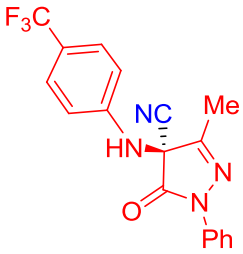
(*S*)-4-((4-Fluorophenyl)amino)-3-methyl-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3c). Yellowish brown wax (64 mg, 69%); 96.9:3.1 *er*; HPLC: tR 8.27 min (major), 15.33 min (minor), 230 nm, *n*-heptane/*i*-PrOH, 8:2, 1.0 mL/min, Chiralpak AD column.



(*R*)-4-((4-Chlorophenyl)amino)-3-methyl-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3d). Light brown wax (78 mg, 80%); $[\alpha]_D^{24}$ = –4.0 (c = 0.5, CH_2Cl_2); 94.4:5.6 *er*; HPLC: tR 6.35 min (minor), 13.32 min (major), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column; IR ($CHCl_3$): 3305, 2919, 2318, 2100, 1728, 1599, 1473, 1371, 1180, 1089, 812 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$): δ 7.84 – 7.72 (m, 2H, ArH), 7.47 – 7.44 (m, 2H, ArH), 7.31 – 7.28 (m, 1H, ArH), 7.15 – 7.14 (m, 2H, ArH), 6.62 – 6.60 (m, 2H, ArH), 4.87 (s, 1H, NH), 2.34 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 164.6, 154.5, 140.5, 136.8, 129.8 (2C), 129.3 (2C), 127.8, 126.7, 119.2 (2C), 117.8 (2C), 112.1, 62.3, 14.4; MS (EI): *m/z* 323.9 M^+, HRMS Calcd for $[C_{17}H_{13}N_4OCl + Na]^+$: 347.0670, found: 347.0671.

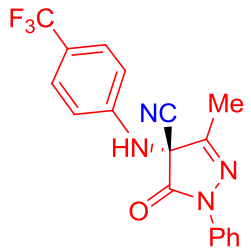


(*S*)-4-((4-Chlorophenyl)amino)-3-methyl-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3d). Light brown wax (77 mg, 79%); 94.4:5.6 *er*; HPLC: tR 6.35 min (major), 13.35 min (minor), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column.

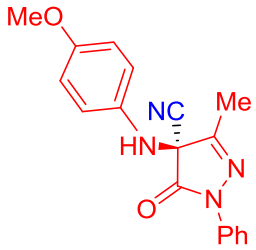


(*R*)-4-((4-Trifluoromethylphenyl)amino)-3-methyl-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3e). Light brown wax (88 mg, 82%); $[\alpha]_D^{24}$ = –15.0 (c = 0.4, CH_2Cl_2); 85.5:15.5 *er*; HPLC: tR 10.35 min (major), 13.81 min (minor), 254 nm, *n*-heptane/*i*-PrOH, 9:1, 1.0 mL/min, Chiralpak IA column; IR ($CHCl_3$): 3351, 2324, 2085, 1722, 1615,

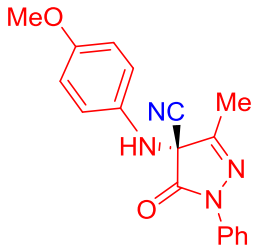
1530, 1495, 1362, 1321, 1262, 1160, 1100, 1065, 1011, 941, 908, 827, 755, 688 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.87 – 7.84 (m, 2H, ArH), 7.48 – 7.44 (m, 2H, ArH), 7.38 (d, *J* = 8.4 Hz, 2H, ArH), 7.32 – 7.28 (m, 1H, ArH), 6.59 (d, *J* = 8.4 Hz, 2H, ArH), 5.38 (s, 1H, NH), 2.33 (s, 3H, CH_3); ^{13}C NMR (101 MHz, $CDCl_3$): δ 164.4, 154.5, 144.9, 136.8, 129.4 (2C), 127.2 (2C), 126.9, 124.2, 123.7, 119.2 (2C), 114.7, 114.4, 111.7, 61.7, 14.2; MS (EI): *m/z* 358.4 M^+, HRMS Calcd for $[C_{18}H_{13}N_4OF_3 + K]^+$: 397.0673, found: 397.0607.



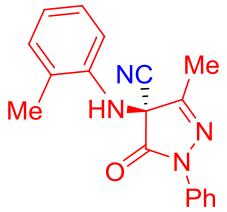
(*S*)-4-((4-Trifluoromethylphenyl)amino)-3-methyl-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3e). Light brown wax (86 mg, 80%); 89:11 *er*; HPLC: tR 10.31 min (minor), 13.75 min (major), 254 nm, *n*-heptane/*i*-PrOH, 9:1, 1.0 mL/min, Chiralpak IA column.



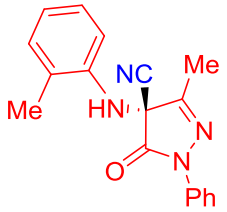
(*R*)-4-((4-Methoxyphenyl)amino)-3-methyl-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3f). Brown wax (58 mg, 60%); $[\alpha]_D^{24}$ = –16.7 (c = 0.6, CH_2Cl_2); 97.6:2.4 *er*; HPLC: tR 8.05 min (minor), 17.36 min (major), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column; IR ($CHCl_3$): 3276, 2910, 2343, 2088, 1731, 1475, 1205, 1056, 789 cm^{-1}; ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.79 – 7.77 (m, 2H, ArH), 7.43-7.41 (m, 2H, ArH), 7.26-7.24 (m, 1H, ArH), 6.85 (d, *J* = 9.0 Hz, 2H, ArH), 6.77 (d, *J* = 8.9 Hz, 2H, ArH), 4.35 (s, 1H, NH), 3.73 (s, 3H, OCH_3), 2.33 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 165.2, 156.7, 154.5, 136.8, 134.4, 129.2 (2C), 126.5, 122.2 (2C), 119.2 (2C), 114.9 (2C), 112.7, 63.6, 55.6, 14.7; MS (EI): *m/z* 319.9 M^+; HRMS Calcd for $[C_{18}H_{16}N_4O_2 + Na]^+$: 343.1165, found: 343.1166.



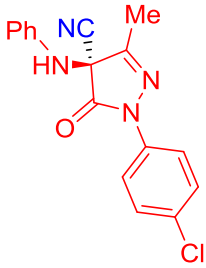
(*S*)-4-((4-Methoxyphenyl)amino)-3-methyl-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3f). Brown wax (57 mg, 59%); 96.4:3.6 *er*; HPLC: tR 8.07 min (major), 17.32 min (minor), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column.



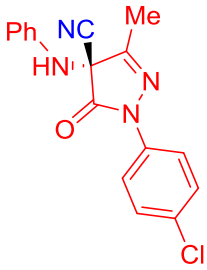
(*R*)-4-((2-Methylphenyl)amino)-3-methyl-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3g). Brown wax (35 mg, 38%); $[\alpha]_D^{24}$ = –26.7 (c = 0.6, CH_2Cl_2); 93.5:6.5 *er*; HPLC: tR 5.27 min (minor), 6.37 min (major), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column; IR ($CHCl_3$): 3325, 2969, 2334, 2098, 1737, 1600, 1365, 1216, 1053, 906, 750 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$): δ 7.97 – 7.85 (m, 2H, ArH), 7.47 – 7.44 (m, 2H, ArH), 7.30 – 7.27 (m, 1H, ArH), 7.15 (d, *J* = 7.2 Hz, 1H, ArH), 7.05 – 7.02 (m, 1H, ArH), 6.89 – 6.86 (m, 1H, ArH), 6.44 (dd, *J* = 8.0, 1.1 Hz, 1H, ArH), 4.41 (s, 1H, NH), 2.32 (s, 3H, CH_3), 2.29 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 164.8, 154.8, 140.2, 137.0, 131.4, 129.3 (2C), 127.6, 126.6, 125.9, 122.3, 119.2 (2C), 113.2, 112.6, 62.3, 17.7, 14.5; MS (EI): *m/z* 303.9 M^+; HRMS Calcd for $[C_{18}H_{16}N_4O + Na]^+$: 327.1216, found: 327.1219.



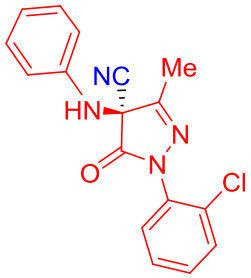
(*S*)-4-((2-Methylphenyl)amino)-3-methyl-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3g). Brown wax (34 mg, 37%); 92.0:8.0 *er*; HPLC: tR 5.27 min (major), 6.37 min (minor), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column.



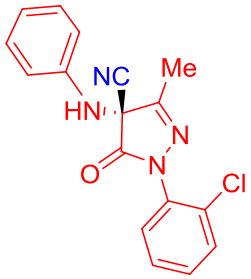
(*R*)-1-(4-Chlorophenyl)-3-methyl-5-oxo-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3h). Light brown solid (76 mg, 78%); mp = 131-134 ˚C; $[\alpha]_D^{24}$ = –8.2 (c = 0.6, CH_2Cl_2); 97.5:2.5 *er*; HPLC: 8.74 min (minor), tR 26.88 min (major), 214 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, ChiralCel AD column; IR ($CHCl_3$): 3322, 3040, 2320, 2061, 1717, 1605, 1491, 1356, 1254, 1157, 1089, 1011, 830, 751 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$): δ 7.82 – 7.79 (m, 2H, ArH), 7.41 – 7.39 (m, 2H, ArH), 7.22 – 7.20 (m, 2H, ArH), 6.98 – 6.96 (m, 1H, ArH), 6.69 – 6.67 (m, 2H, ArH), 4.64 (s, 1H, NH), 2.35 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 164.6, 155.1, 141.8, 135.5, 131.8, 130.0 (2C), 129.4 (2C), 122.9, 120.2 (2C), 116.7 (2C), 112.2, 62.4, 14.5; MS (EI): *m/z* 323.9 M^+, HRMS Calcd for $[C_{17}H_{13}N_4OCl + H]^+$: 325.0851, found: 325.0846.



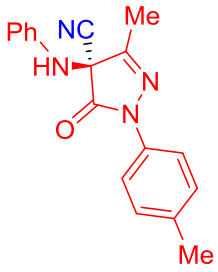
(*S*)-1-(4-Chlorophenyl)-3-methyl-5-oxo-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3h). Light brown solid (76 mg, 78%); 97.0:3.0 *er*; HPLC: tR 8.70 min (major), 26.63 min (minor), 214 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column.



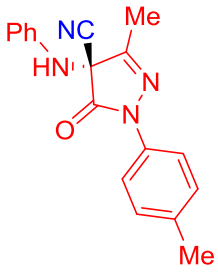
(*R*)-1-(2-Chlorophenyl)-3-methyl-5-oxo-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3i). White Solid (85 mg, 87%); mp = 128-130 ˚C; $[\alpha]_D^{24}$ = +15.0 (c = 1.0, CH_2Cl_2); 97:3 *er*; HPLC: tR 3.14 min (major), 3.70 min (minor), 230 nm, *n*-heptane/*i*-PrOH, 8:2, 1.0 mL/min, Chiralpak IC column; IR ($CHCl_3$): 3330, 3006, 2313, 2105, 1739, 1600, 1485, 1368, 1219, 1075, 864, 746 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.52 – 7.49 (m, 1H, ArH), 7.39 – 7.32 (m, 3H, ArH), 7.24 – 7.20 (m, 2H, ArH), 7.00 – 6.98 (m, 1H, ArH), 6.79 – 6.77 (m, 2H, ArH), 4.68 (s, 1H, NH), 2.32 (s, 3H, CH_3); ^{13}C NMR (101 MHz, $CDCl_3$): δ 165.5, 154.6, 141.9, 133.3, 132.0, 130.9, 130.8, 129.8 (2C), 128.6, 127.8, 122.9, 117.2 (2C), 112.3, 61.2, 14.4; MS (EI): *m/z* 323.9 M^+; Elemental Analysis (CHN): calculated for [$C_{17}H_{13}N_4OCl$]: C = 62.87%, H = 4.03%, N = 17.25%, found C = 62.87%, H = 3.96%, N = 17.29%.



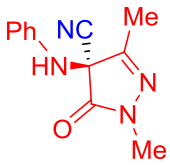
(*R*)-1-(2-Chlorophenyl)-3-methyl-5-oxo-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3i). White solid (85 mg, 87%); 96:4 *er*; HPLC: tR 3.14 min (minor), 3.70 min (major), 230 nm, *n*-heptane/*i*-PrOH, 8:2, 1.0 mL/min, Chiralpak IC column.



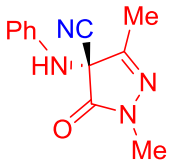
(*R*)-3-Methyl-5-oxo-4-(phenylamino)-1-(*p*-tolyl)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3j). Reddish brown wax (72 mg, 79%); $[\alpha]_D^{24}$ = –18.0 (c = 1.0, CH_2Cl_2); 97:3 *er*; HPLC: tR 11.86 min (minor), 43.87 min (major), 230 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, ChiralCel AD column; IR ($CHCl_3$): 3319, 2929, 2312, 2088, 1715, 1603, 1505, 1358, 1271, 1139, 815, 749, 690 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$): δ 7.72 – 7.70 (m, 2H, ArH), 7.26 – 7.24 (m, 2H, ArH), 7.21 – 7.18 (m, 2H, ArH), 6.95 (t, *J* = 7.5 Hz, 1H, ArH), 6.69 – 6.67 (m, 2H, ArH), 4.78 (s, 1H, NH), 2.38 (s, 3H, CH_3), 2.34 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 164.6, 154.6, 142.0, 136.5, 134.5, 129.8 (2C), 129.7 (2C), 122.5, 119.3 (2C), 116.5 (2C), 112.4, 62.3, 21.1, 14.4; MS (ESI): *m/z* 303.9 M^+; HRMS Calcd for $[C_{18}H_{16}N_4O + Na]^+$: 327.1216, found: 327.1218.



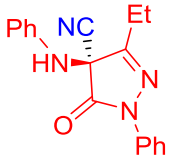
(*S*)-3-Methyl-5-oxo-4-(phenylamino)-1-(*p*-tolyl)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3j). Reddish brown wax (68 mg, 75%); 96:4 *er*; HPLC: tR 11.84 min (major), 43.18 min (minor), 230 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column.



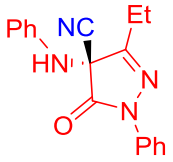
(*R*)-1,3-Dimethyl-5-oxo-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3k). Brown wax (63 mg, 92%); $[\alpha]_D^{24}$ = –34.9 (c = 0.6, CH_2Cl_2); 96.5:3.5 *er*; HPLC: tR 4.76 min (minor), 5.86 min (major), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column; IR ($CHCl_3$): 3369, 3013, 2277, 2088, 1725, 1601, 1493, 1375, 1221, 1034, 920, 746 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$): δ 7.22 – 7.20 (m, 2H, ArH), 6.99 – 6.92 (m, 1H, ArH), 6.65 – 6.63 (m, 2H), 4.59 (s, 1H, NH), 3.37 (s, 3H, N-CH_3), 2.22 (s, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 166.5, 153.8, 142.0, 129.7 (2C), 122.3, 116.3 (2C), 112.3, 60.6, 32.3, 14.2; MS (EI): *m/z* 228.0 M^+; Elemental Analysis (CHN): calculated for $[C_{12}H_{12}N_4O]$: C = 63.15%, H = 5.30%, N = 24.55%, found C = 63.09%, H = 5.16%, N = 24.47%.



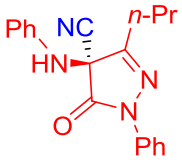
(*S*)-1,3-Dimethyl-5-oxo-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3k). Brown wax (63 mg, 92%); 97.5:2.5 *er*; HPLC: tR 4.77 min (major), 5.86 min (minor), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column.



(*R*)-3-Ethyl-5-oxo-1-phenyl-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3l). Brown wax (74 mg, 81%); $[\alpha]_D^{24}$ = –4.0 (c = 0.5, CH_2Cl_2); 96.5:3.5 *er*; HPLC: tR 8.03 min (minor), 21.64 min (major), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column; IR ($CHCl_3$): 3316, 2929, 2102, 1724, 1600, 1494, 1349, 1207, 1051, 909, 833, 747, 686 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.88 – 7.85 (m, 2H, ArH), 7.46 – 7.42 (m, 2H, ArH), 7.29 – 2.27 m, 1H, ArH), 7.19 – 7.15 (m, 2H, ArH), 6.94 – 6.91 (m, 1H, ArH), 6.64 – 6.62 (m, 2H, ArH), 4.82 (s, 1H, NH), 2.75 – 2.60 (m, 2H, C*H*$_2$CH$_3$), 1.36 (t, *J* = 7.3 Hz, 3H, CH$_2$C*H*$_3$); ^{13}C NMR (101 MHz, $CDCl_3$): δ 165.0, 158.8, 142.1, 137.1, 129.8 (2C), 129.2 (2C), 126.5, 122.4, 119.2 (2C), 116.2 (2C), 112.6, 62.2, 22.2, 9.4; MS (EI): *m/z* 303.9 M^+; Elemental Analysis (CHN): calculated for [$C_{18}H_{16}N_4O$]: C = 71.04%, H = 5.30%, N = 18.41%, found C = 70.93%, H = 5.29%, N = 18.53%.

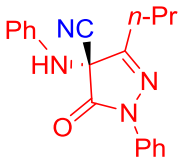


(*S*)-3-Ethyl-5-oxo-1-phenyl-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3l). Brown wax (72 mg, 79%); 95.5:5.5 *er*; HPLC: tR 8.02 min (major), 21.65 min (minor), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column.

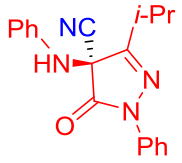


(*R*)-3-*n*-Propyl-5-oxo-1-phenyl-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3m). Brown wax (72 mg, 75%); $[\alpha]_D^{24}$ = –26.0 (c = 0.5, CH_2Cl_2); 98:2 *er*; HPLC: tR 9.04 min (minor), 21.19 min (major), 230 nm, *n*-heptane/*i*-PrOH, 8:2, 1.0 mL/min, Chiralpak AD column; IR ($CHCl_3$): 3351, 2955, 2329, 2100, 1730, 1598, 1493, 1355, 1219, 1111, 885, 748 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.85 (d, *J* = 8.1 Hz, 2H, ArH), 7.46 – 7.42 (m, 2H, ArH), 7.28 – 7.24 (m, 1H, ArH), 7.20 – 7.15 (m, 2H, ArH), 6.92 (t, *J* = 7.4 Hz, 1H, ArH), 6.63 – 6.61 (m, 2H, ArH), 4.78 (s, 1H, NH), 2.69 – 2.51 (m, 2H, C*H*$_2$CH$_2$CH$_3$), 1.80 – 1.82

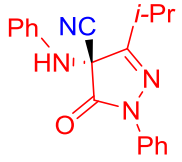
(m, 2H, $CH_2CH_2CH_2CH_3$), 1.05 (t, *J* = 7.3 Hz, 3H $CH_2CH_2CH_2CH_3$); ^{13}C NMR (101 MHz, $CDCl_3$): δ 164.9, 157.8, 142.1, 137.10, 129.8 (2C), 129.2 (2C), 126.5, 122.4, 119.2 (2C), 116.2 (2C), 112.6, 62.2, 30.5, 18.8, 13.8.; MS (EI): *m/z* 318.0 M^+; HRMS Calcd for $[C_{19}H_{18}N_4O + Na]^+$: 341.1373, found: 341.1372.



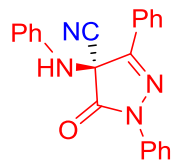
(*S*)-3-*n*-Propyl-5-oxo-1-phenyl-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3m). Brown wax (71 mg, 74%); 98.0:2.0 *er*; HPLC: tR 9.04 min (major), 21.15 min (minor), 234 nm, *n*-heptane/*i*-PrOH, 8:2, 1.0 mL/min, Diacel AD column.



(*R*)-3-*iso*-Propyl-5-oxo-1-phenyl-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3n). Light brown wax (54 mg, 56%); mp = 73 – 75 ˚C; $[\alpha]_D^{24}$ = –16.7 (c = 0.6, CH_2Cl_2); 98.5:1.5 *er*; HPLC: 8.16 min (minor), tR 20.83 min (major), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, ChiralCel AD column; IR ($CHCl_3$): 3309, 2925, 2326, 2016, 1717, 1599, 1494, 1349, 1080, 911, 749 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$): δ 7.88 (dd, *J* = 9.0, 1.2 Hz, 2H, ArH), 7.47 – 7.44 (m, 2H, ArH), 7.23 – 7.27 (m, 1H, ArH), 7.16 – 7.18 (m, 2H, ArH), 6.91 (t, *J* = 7.2 Hz, 1H), 6.56 – 6.54 (m, 2H, ArH), 4.85 (s, 1H, NH), 2.95 (hept, *J* = 6.9 Hz, 1H, CH), 1.48 (d, *J* = 6.9 Hz, 3H, CH_3), 1.32 (d, *J* = 6.9 Hz, 3H, CH_3); ^{13}C NMR (151 MHz, $CDCl_3$): δ 165.0, 162.0, 142.3, 137.2, 129.9 (2C), 129.3 (2C), 126.5, 122.1, 119.2 (2C), 115.6 (2C), 112.9, 61.7, 29.6, 21.3, 19.6; MS (EI): *m/z* 318.0 M^+; HRMS Calcd for $[C_{19}H_{18}N_4O + Na]^+$: 341.1373, found: 341.1388.

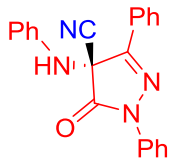


(*S*)-3-*iso*-Propyl-5-oxo-1-phenyl-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (*ent*-3n). Light brown wax (52 mg, 54%); 99:1.0 *er*; HPLC: tR 8.14 min (major), 21.01 min (minor), 254 nm, *n*-heptane/*i*-PrOH, 7:3, 1.0 mL/min, Chiralpak AD column.

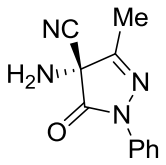


(*R*)-5-Oxo-1,3-diphenyl-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3p). Reddish brown wax (15 mg, 14%); $[\alpha]_D^{24}$ = –20.0 (c = 0.3, CH_2Cl_2); 92.8:7.2 *er*; HPLC: tR

28.49 min (minor), 32.03 min (major), 254 nm, *n*-heptane/*i*-PrOH, 97:3, 0.5 mL/min, Chiralpak OD column; IR ($CHCl_3$): 3347, 3050, 2918, 2638, 2453, 2299, 2078, 1988, 1718, 1598, 1493, 1376, 1296, 1114, 909, 751, 687 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$): δ 8.20 – 8.18 (m, 2H, ArH), 7.87 – 7.85 (m, 2H, ArH), 7.56 – 7.52 (m, 3H, ArH), 7.47 – 7.44 (m, 2H, ArH), 7.31 – 7.28 (m, 1H, ArH), 7.18 – 7.15 (m, 2H, ArH), 6.97 – 6.94 (m, 1H, ArH), 6.85 – 6.83 (m, 2H, ArH), 4.71 (s, 1H, NH); ^{13}C NMR (151 MHz, $CDCl_3$): δ 165.1, 151.3, 141.6, 136.9, 132.2, 129.7 (2C), 129.4 (2C), 129.3 (2C), 127.9, 127.0 (2C), 126.8, 123.5, 119.5 (2C), 118.7 (2C), 113.1, 61.5; MS (ESI): *m/z* 351.9 M^+; HRMS Calcd for $[C_{22}H_{16}N_4O + H]^+$: 353.1397, found: 353.1390.

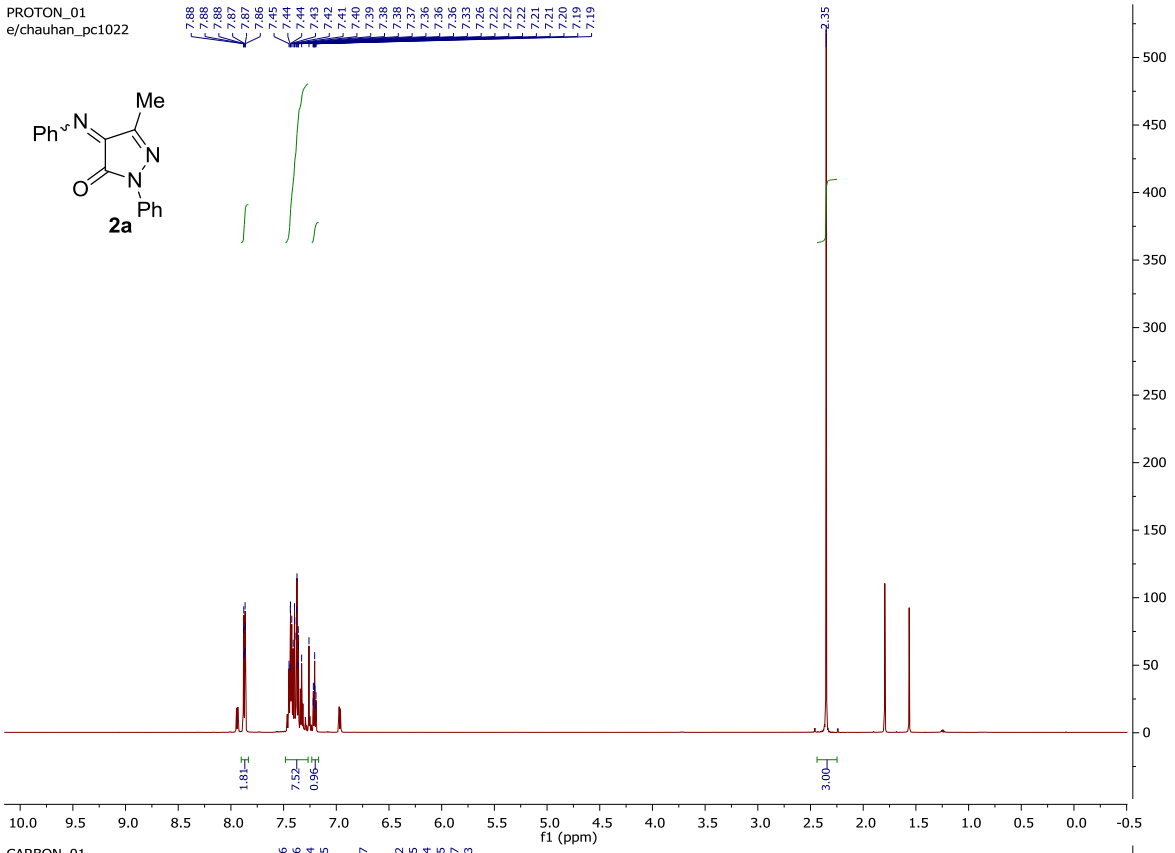


(*S*)-5-Oxo-1,3-diphenyl-4-(phenylamino)-4,5-dihydro-1*H*-pyrazole-4-carbonitrile (3p). Reddish brown wax (14 mg, 13%); 92.0:8.0 *er*; HPLC: tR 28.27 min (major), 31.91 min (minor), 254 nm, *n*-heptane/*i*-PrOH, 97:3, 0.5 mL/min, Chiralcel OD column.



(*S*)-4-Amino-3-methyl-5-oxo-phenyl-4-5-dihydro-1*H*-pyrazole-4-carbonitrile (4). Brown wax (30 mg, 70%); $[\alpha]_D^{24}$ = -11.5 (c = 0.5, $CHCl_3$); 96.3:3.4 *er*; HPLC: tR 6.31 min (major), 7.61 min (minor), 254 nm, *n*-heptane/*i*-PrOH, 8:2, 1.0 mL/min, Chiralpak AD column; IR ($CHCl_3$): 3842, 2679, 2344, 2092, 1752, 1140 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.81 – 7.79 (m, 2H, ArH), 7.43 – 7.39 (m, 2H, ArH), 7.26 – 7.22 (m, 1H, ArH), 2.32 (s, 3H, CH_3), 2.30 – 2.20 (m, 2H, NH_2); ^{13}C NMR (151 MHz, $CDCl_3$): δ 166.1, 154.9, 136.9, 129.2 (2C), 126.4, 119.1 (2C), 114.4, 58.8, 13.6; MS (EI): *m/z* 214.2; HRMS Calcd for $[C_{11}H_{10}N_4O + H]^+$: 215.0927, found: 215.0929.

NMR Spectra: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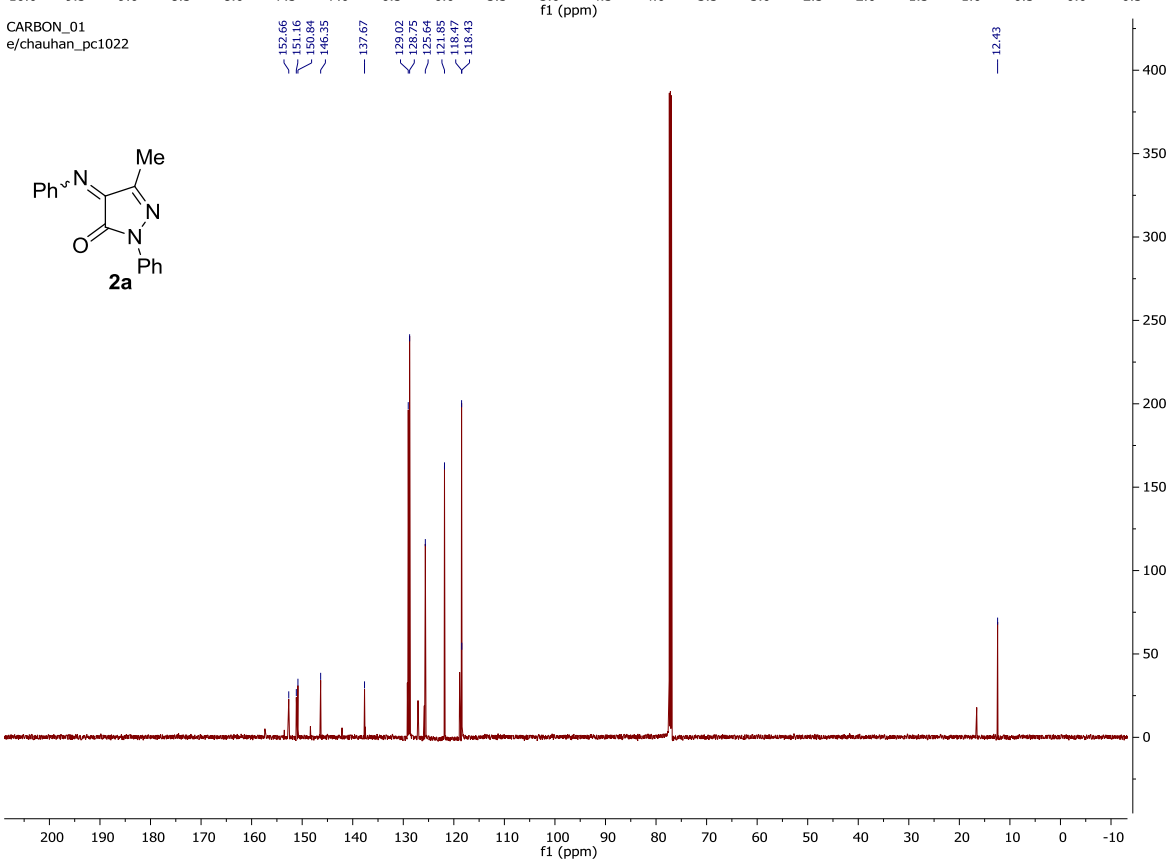
O
N
Ph
2a
f1 (ppm)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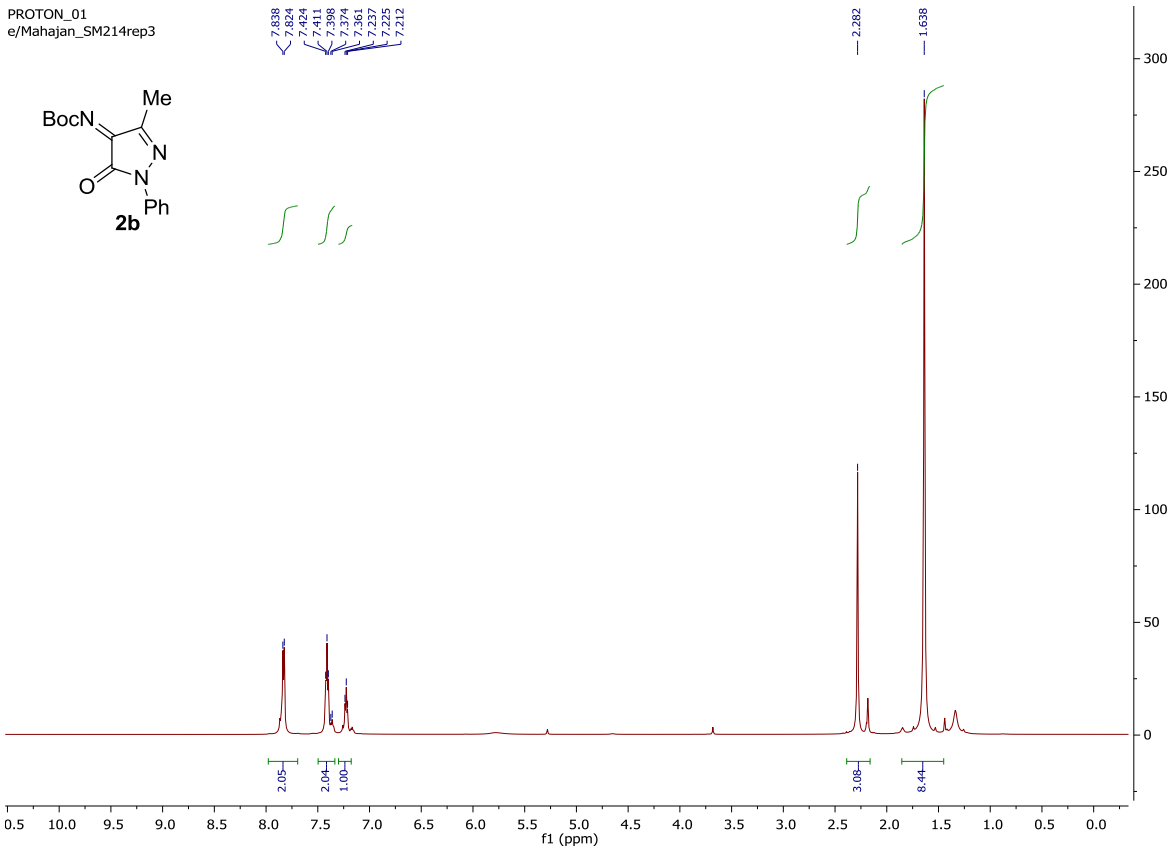
Ph
2a
f1 (ppm)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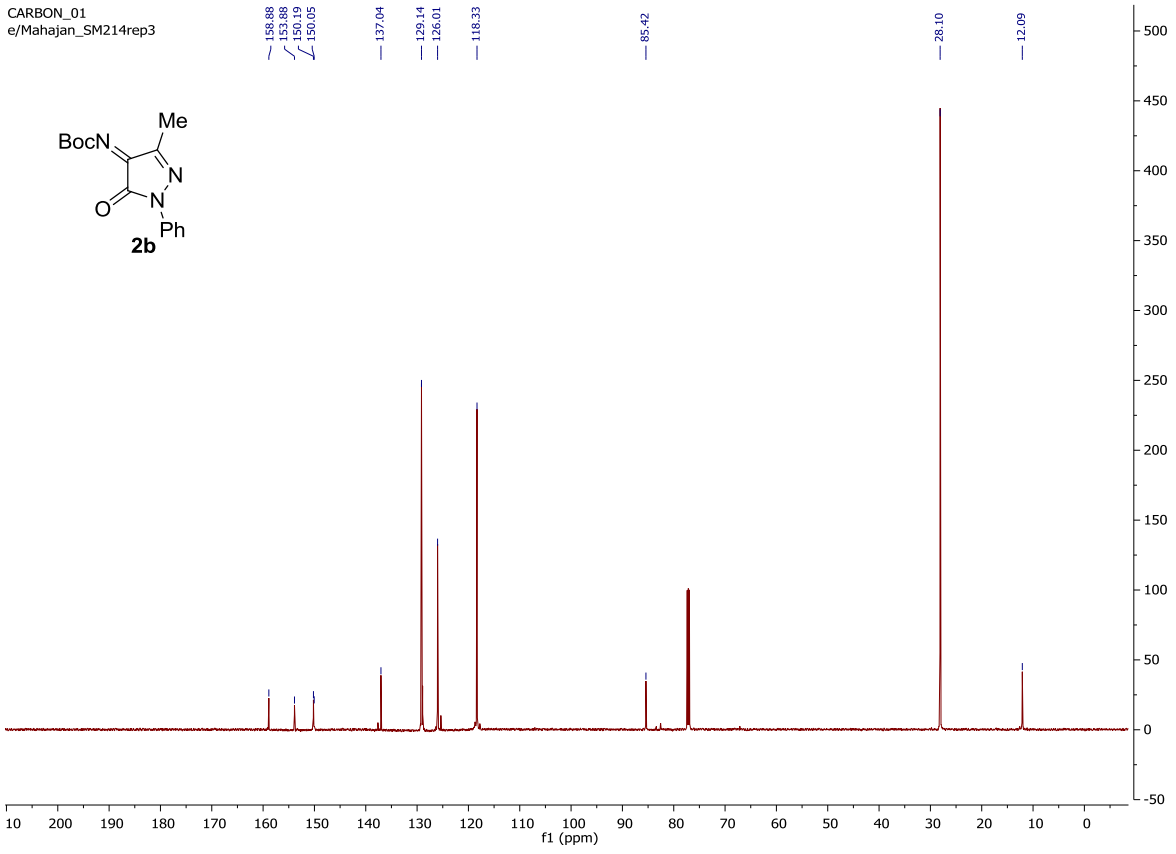
7.361
7.237
7.225
7.212
2.282
1.638
BocN
Me
N
O
N
Ph
2b
2.05
2.04
1.00
3.08
8.44
f1 (ppm)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150.05
137.04
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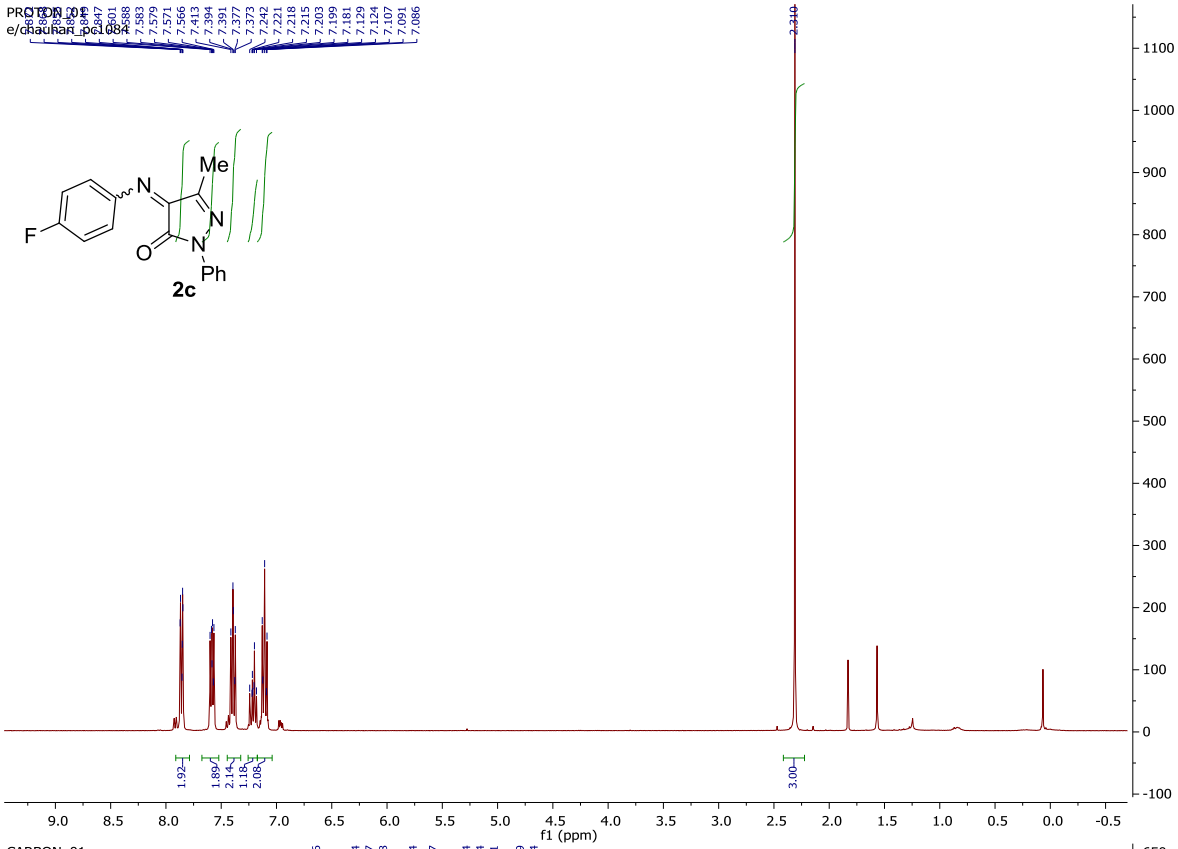
Me
N
O
N
Ph
2b
f1 (ppm)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7.394
7.391
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7.373
7.242
7.221
7.218
7.215
7.203
7.199
7.181
7.129
7.124
7.107
7.091
7.086
2.310
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N
Ph
F
2c
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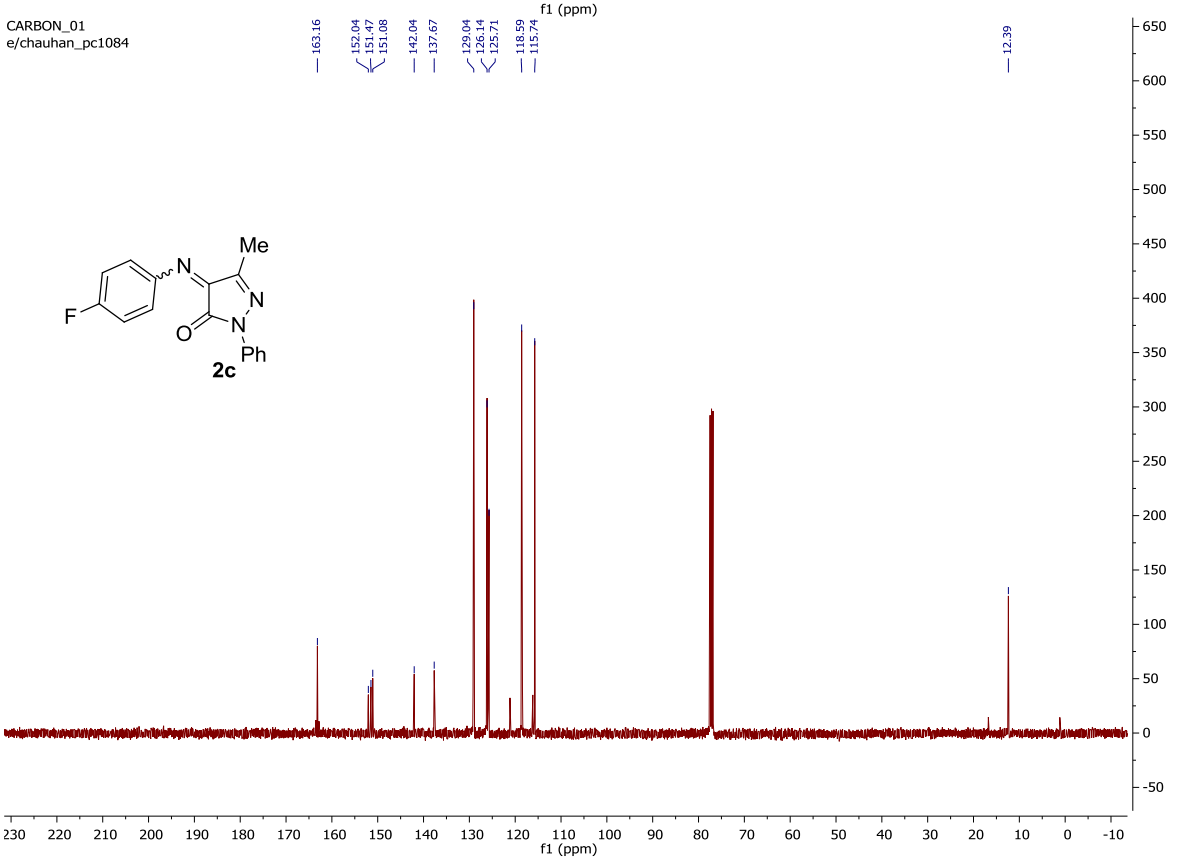
1.18
2.08
3.00
f1 (ppm)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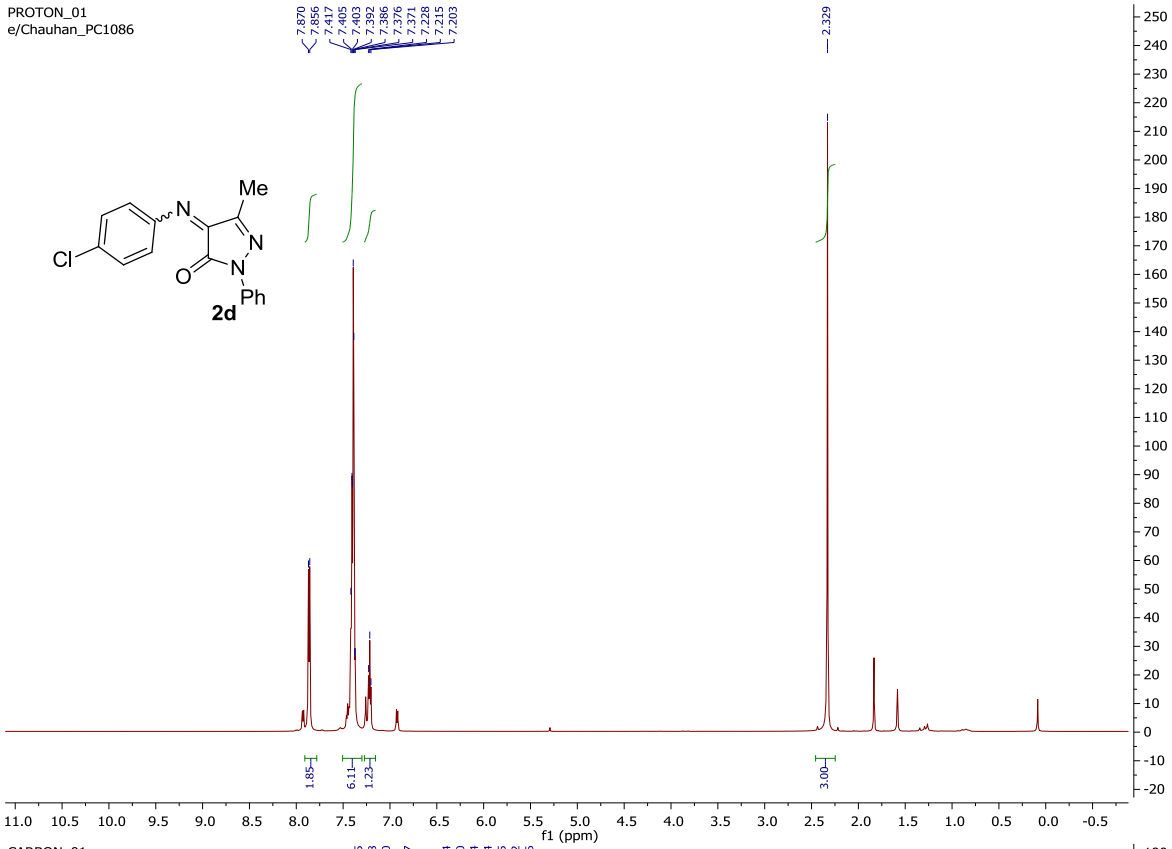
N
O
N
Ph
F
2c
f1 (ppm)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7.417
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7.403
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7.371
7.228
7.215
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2.329
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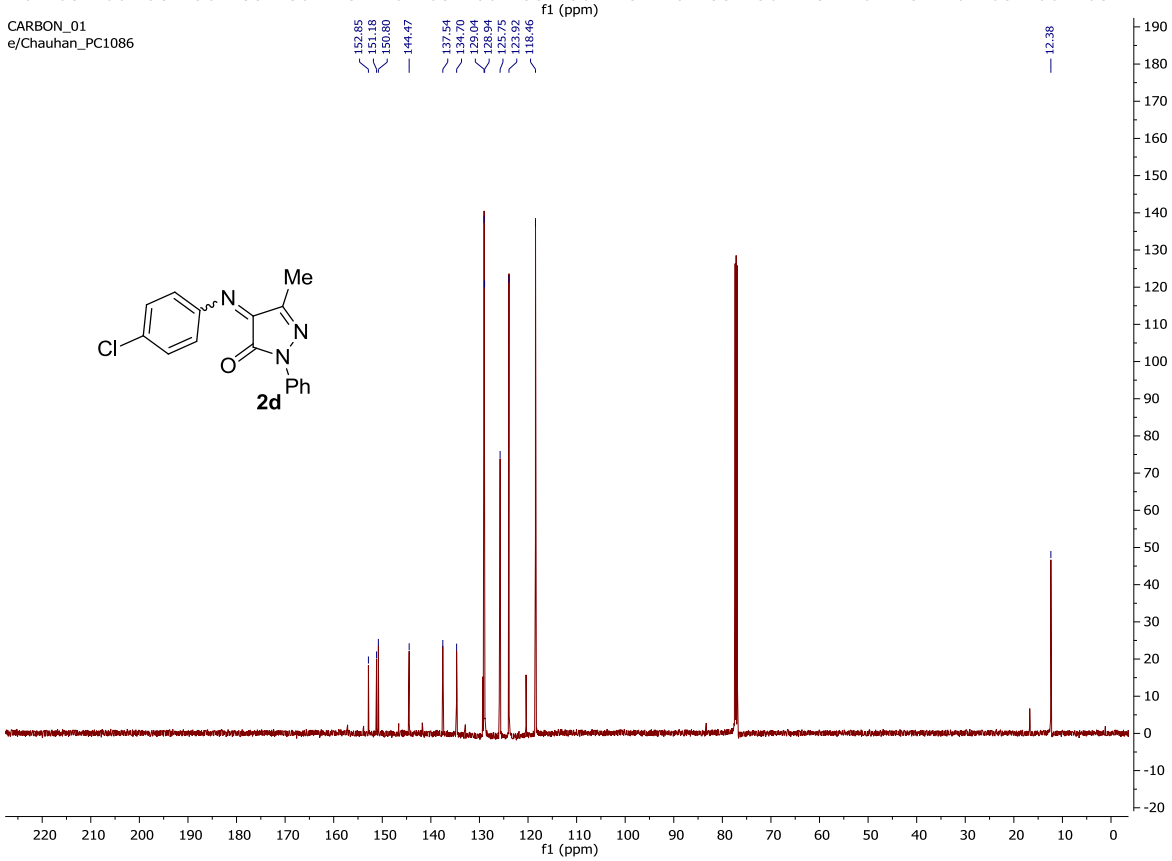
N
Cl
N
O
N
Ph
2d
1.85
6.11
1.23
3.00
f1 (ppm)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123.92
118.46
12.38
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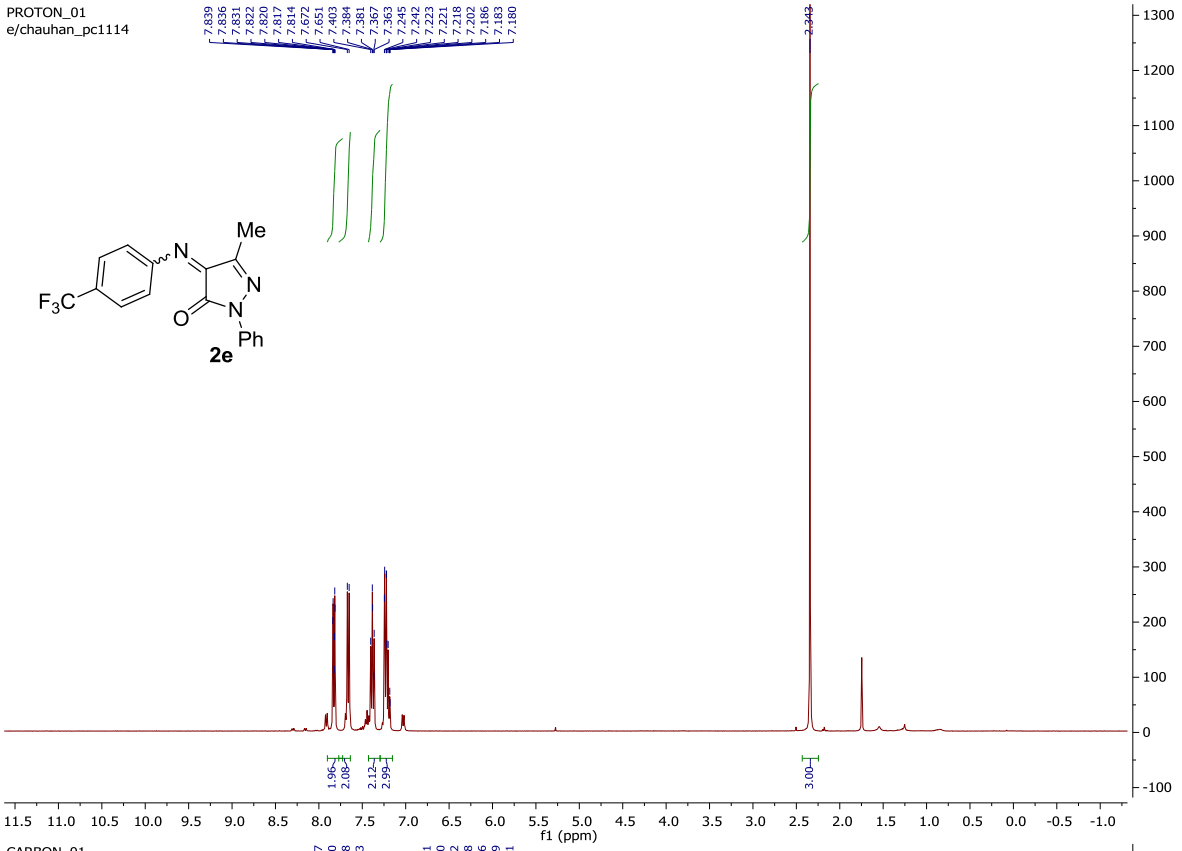
Cl
N
O
N
Ph
2d
f1 (ppm)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7.672
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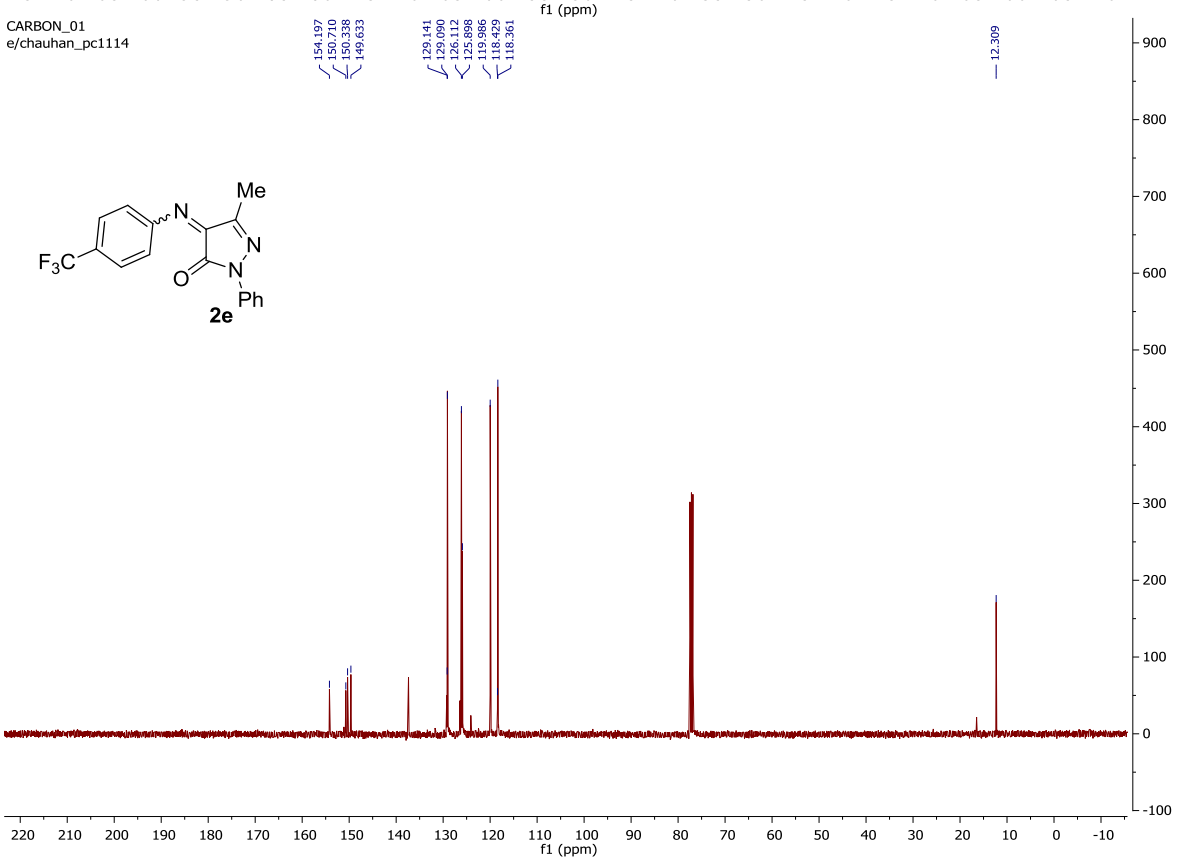
7.403
7.384
7.381
7.367
7.363
7.245
7.242
7.223
7.221
7.218
7.202
7.186
7.183
7.180
2.342
1.96
2.08
2.12
2.99
3.00
f1 (ppm)
Me
N
N
N
O
Ph
F3C
2e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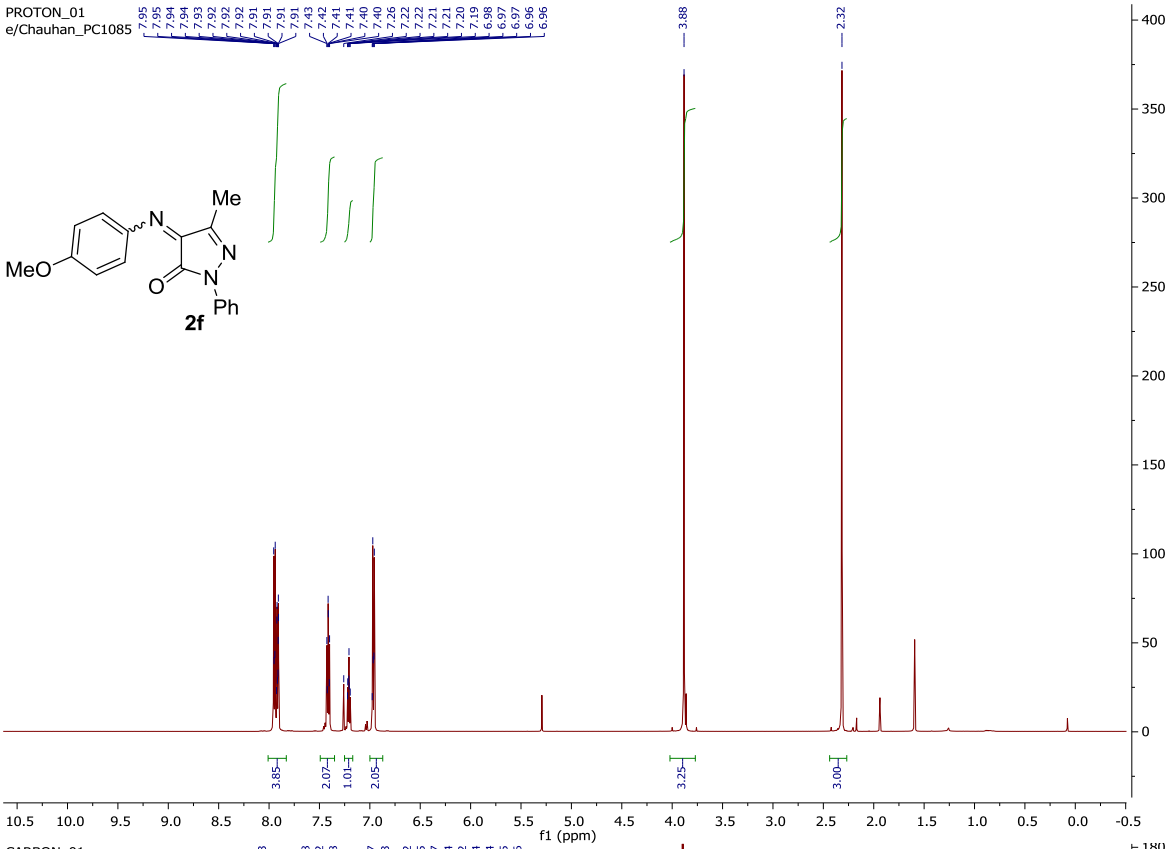
118.361
12.309
f1 (ppm)
Me
N
N
N
O
Ph
F3C
2e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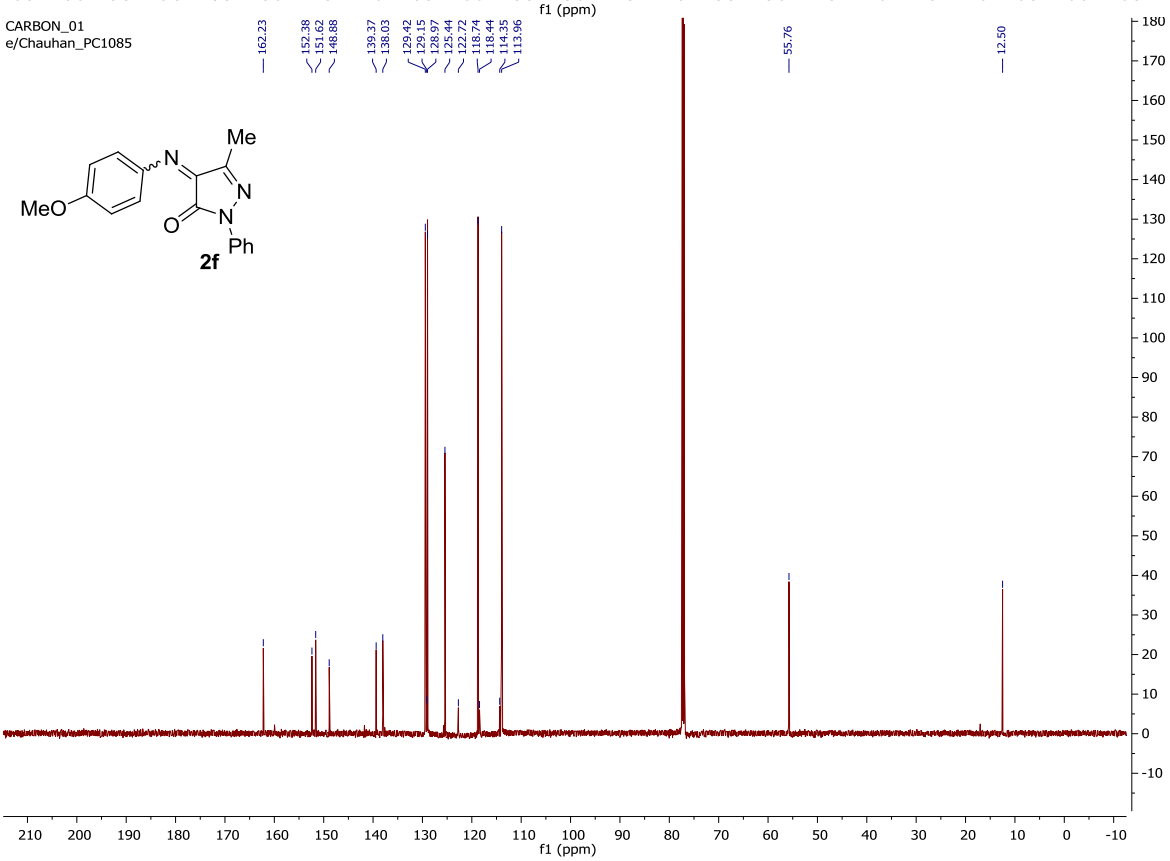
3.88
2.32
Me
N
N
MeO
O
N
Ph
2f
3.85
2.07
1.01
2.05
3.25
3.00
f1 (ppm)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125.44
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113.96
55.76
12.50
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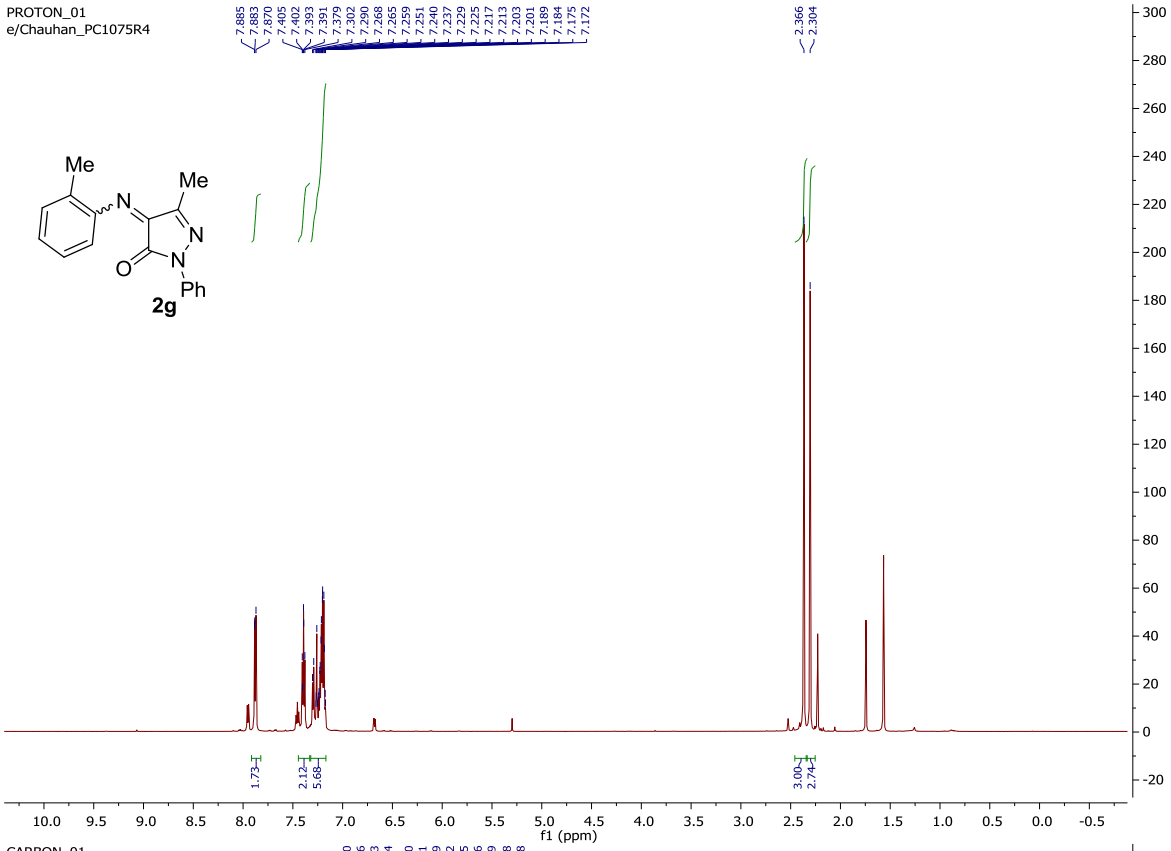
N
MeO
O
N
Ph
2f
f1 (ppm)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7.302
7.290
7.268
7.265
7.259
7.251
7.240
7.237
7.229
7.225
7.217
7.213
7.203
7.201
7.189
7.184
7.175
7.172
2.366
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Me
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N
O
N
Ph
2g
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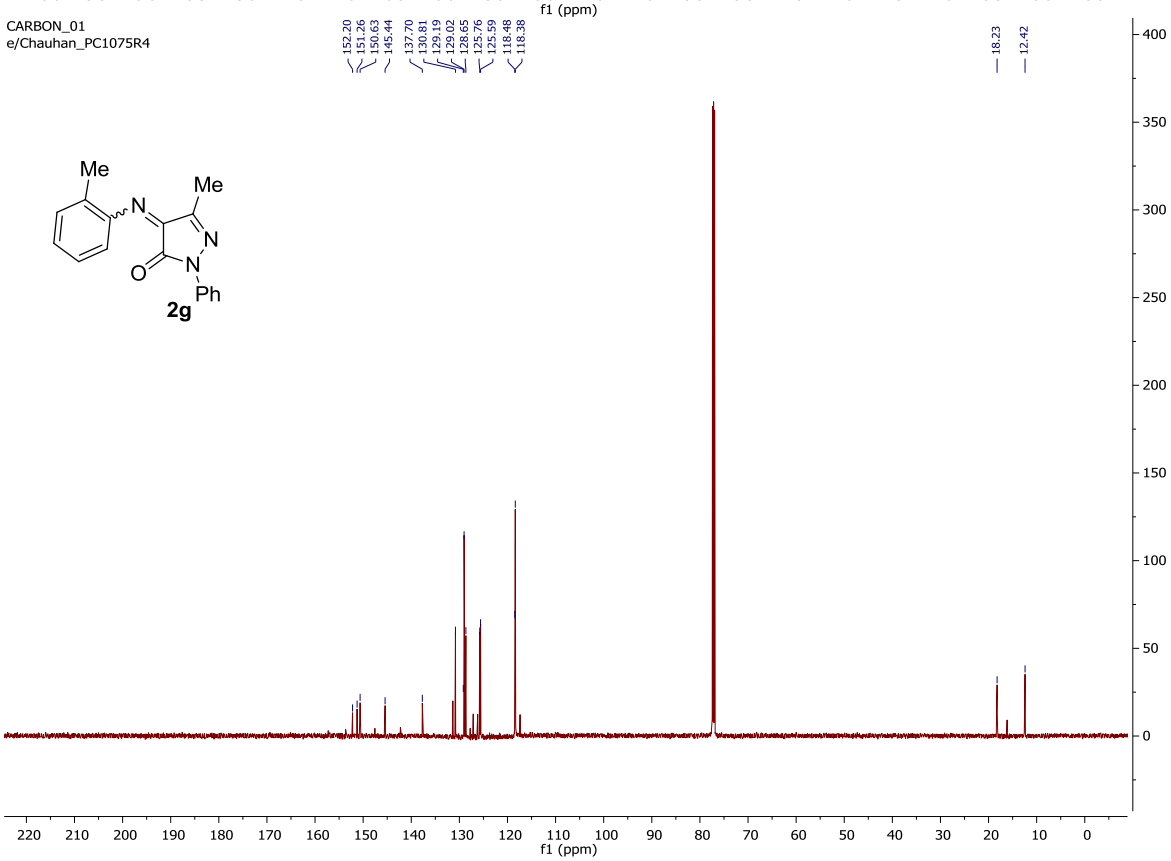
2.74
f1 (ppm)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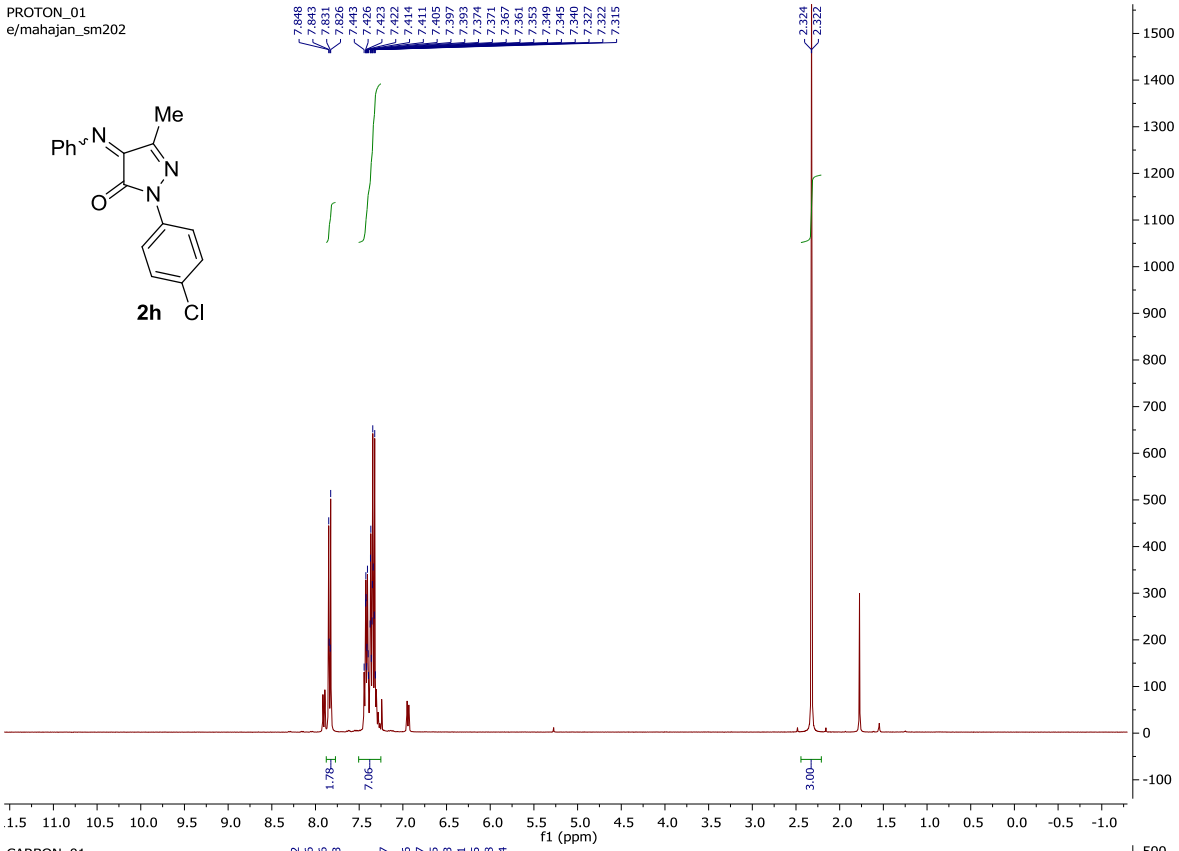
N
O
N
Ph
2g
f1 (ppm)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2h
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7.443
7.426
7.423
7.422
7.414
7.411
7.405
7.397
7.393
7.374
7.371
7.367
7.361
7.353
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7.322
7.315
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2.322
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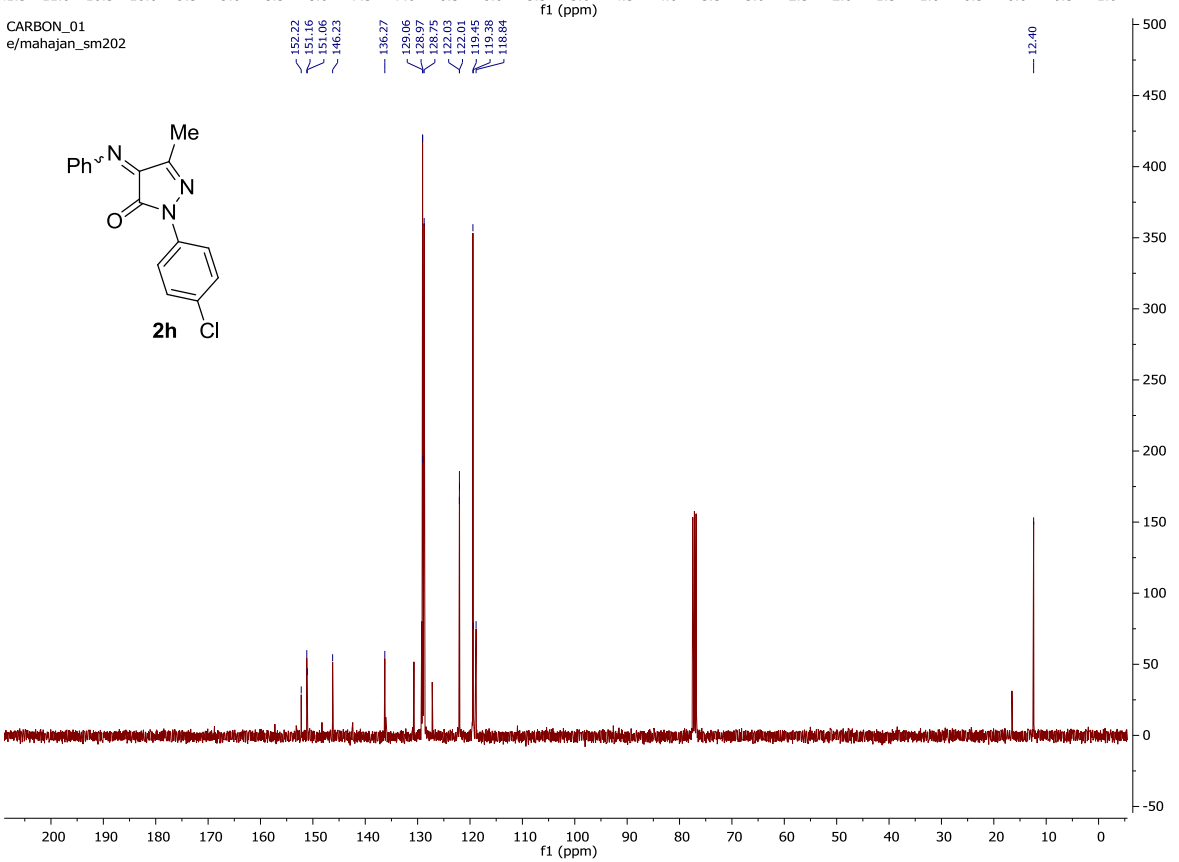
3.00
f1 (ppm)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Me
Ph
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N
O
N
2h
Cl
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122.03
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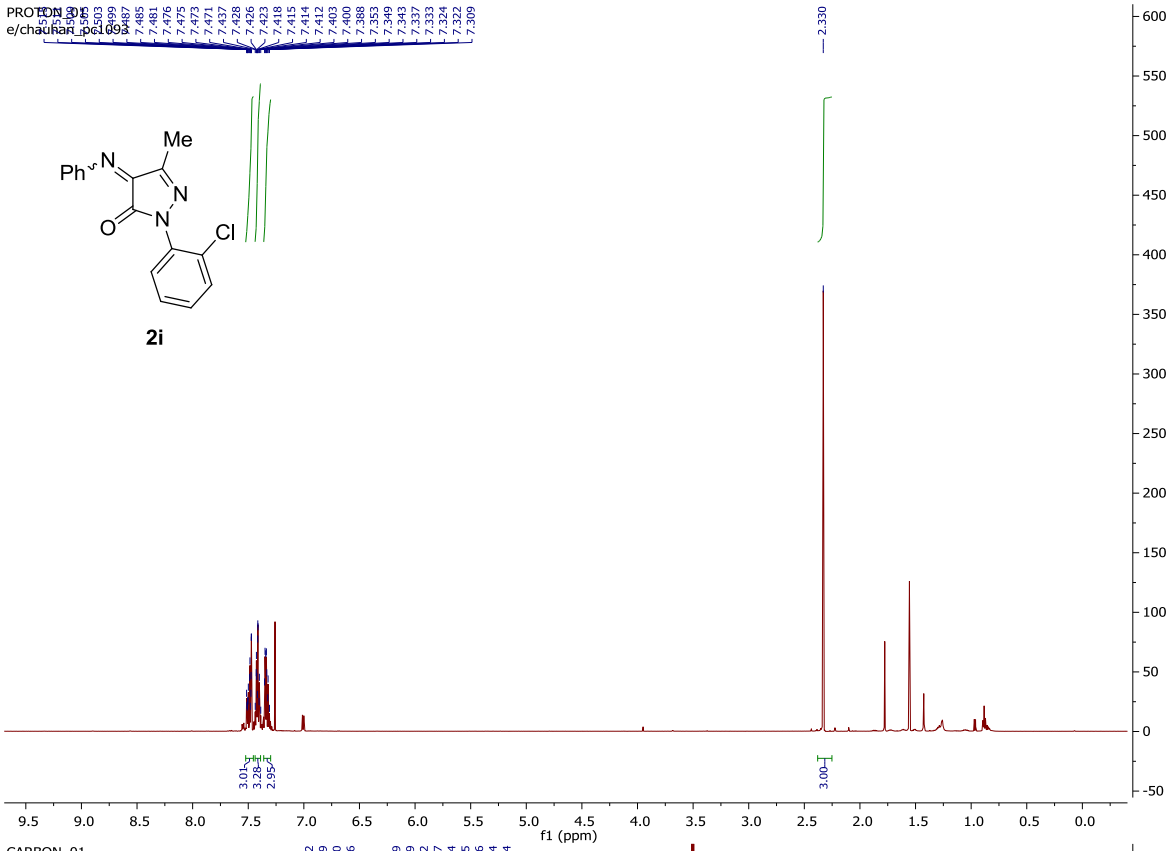
f1 (ppm)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Ph
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O
N
Cl
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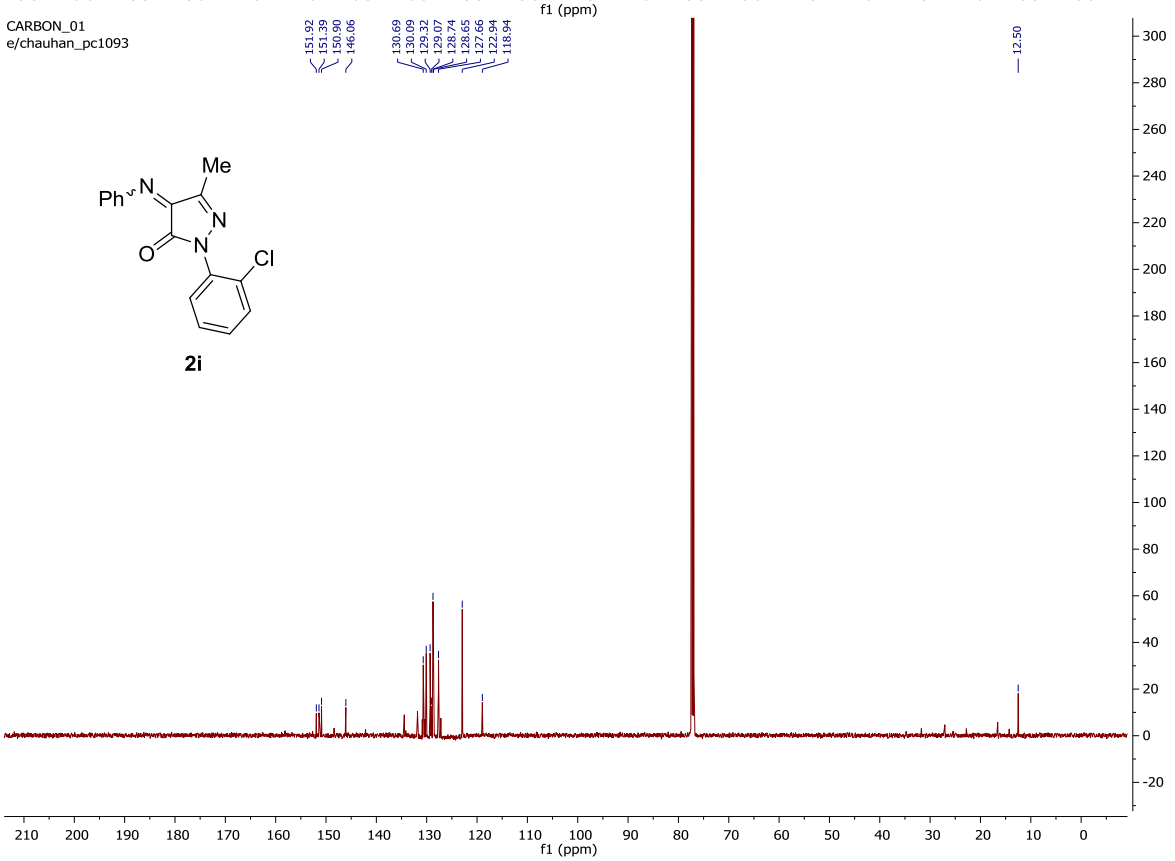
f1 (ppm)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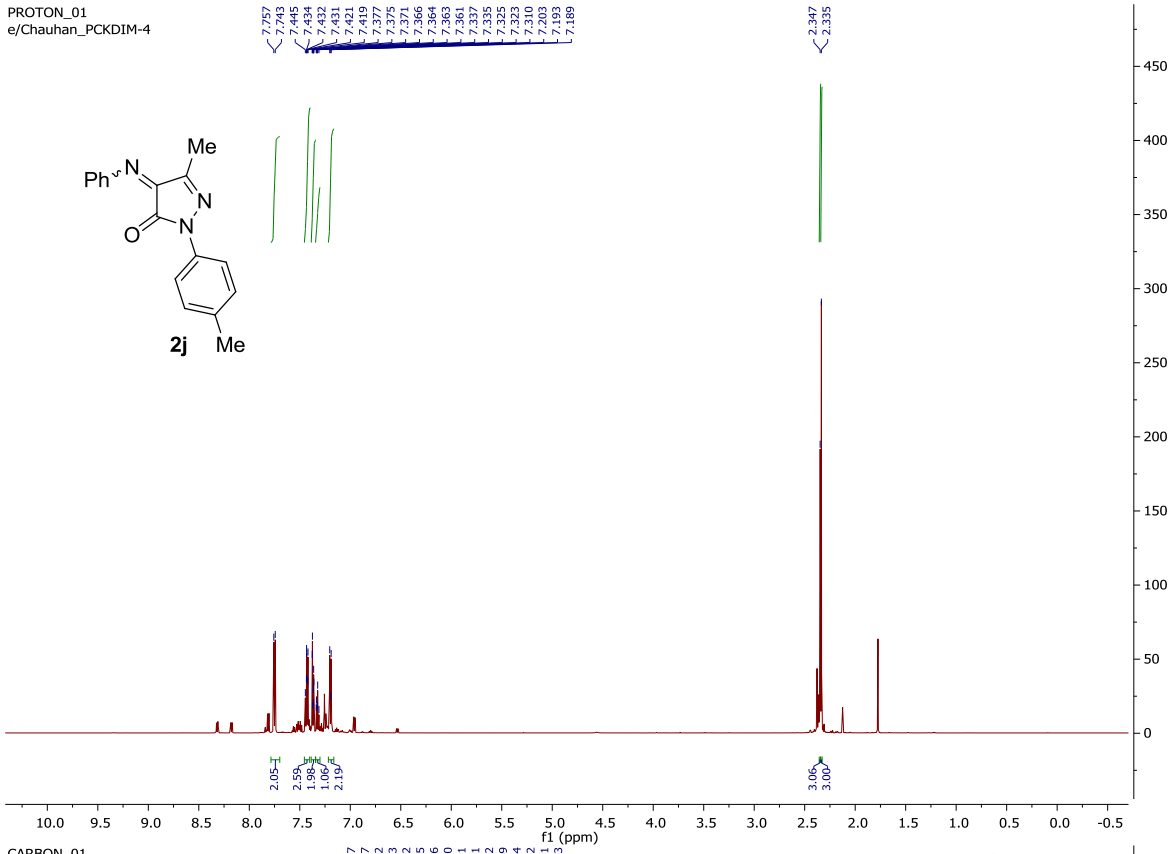
Cl
2i
f1 (ppm)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7.363
7.361
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7.189
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Ph
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Me
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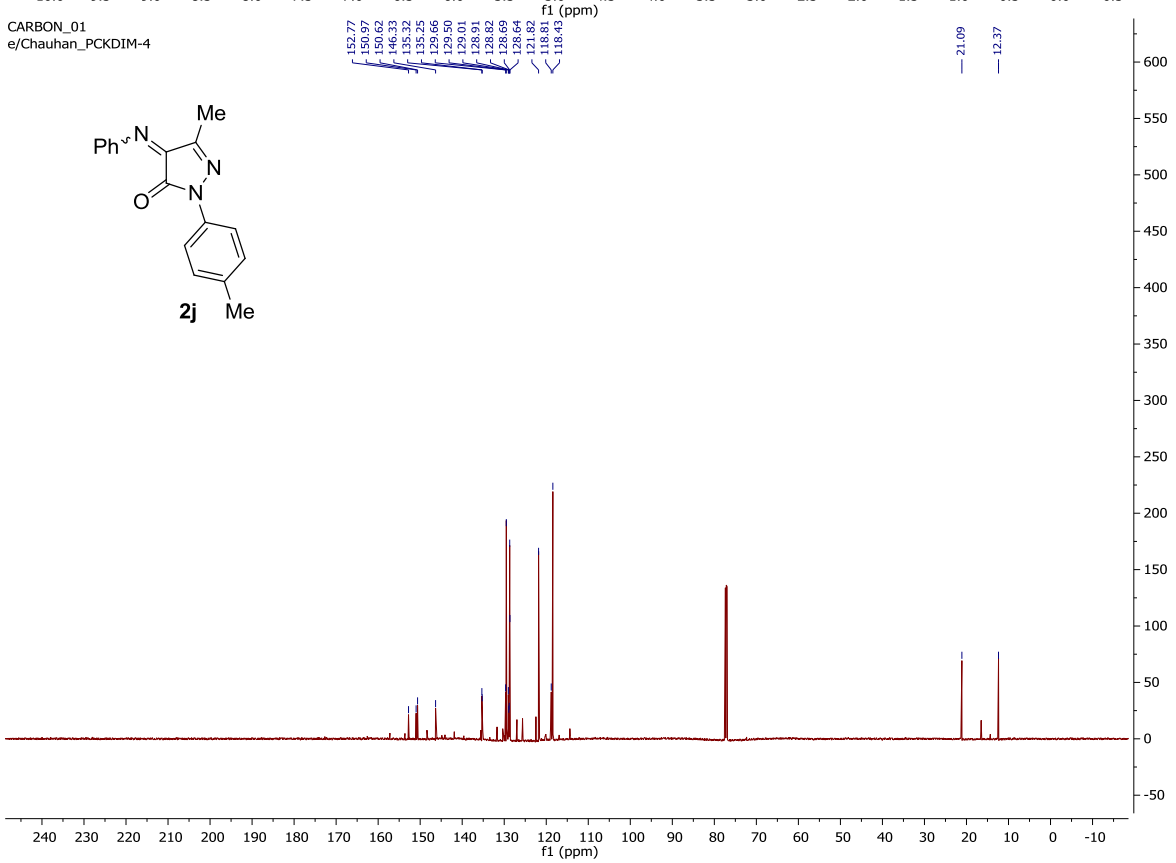
3.00
f1 (ppm)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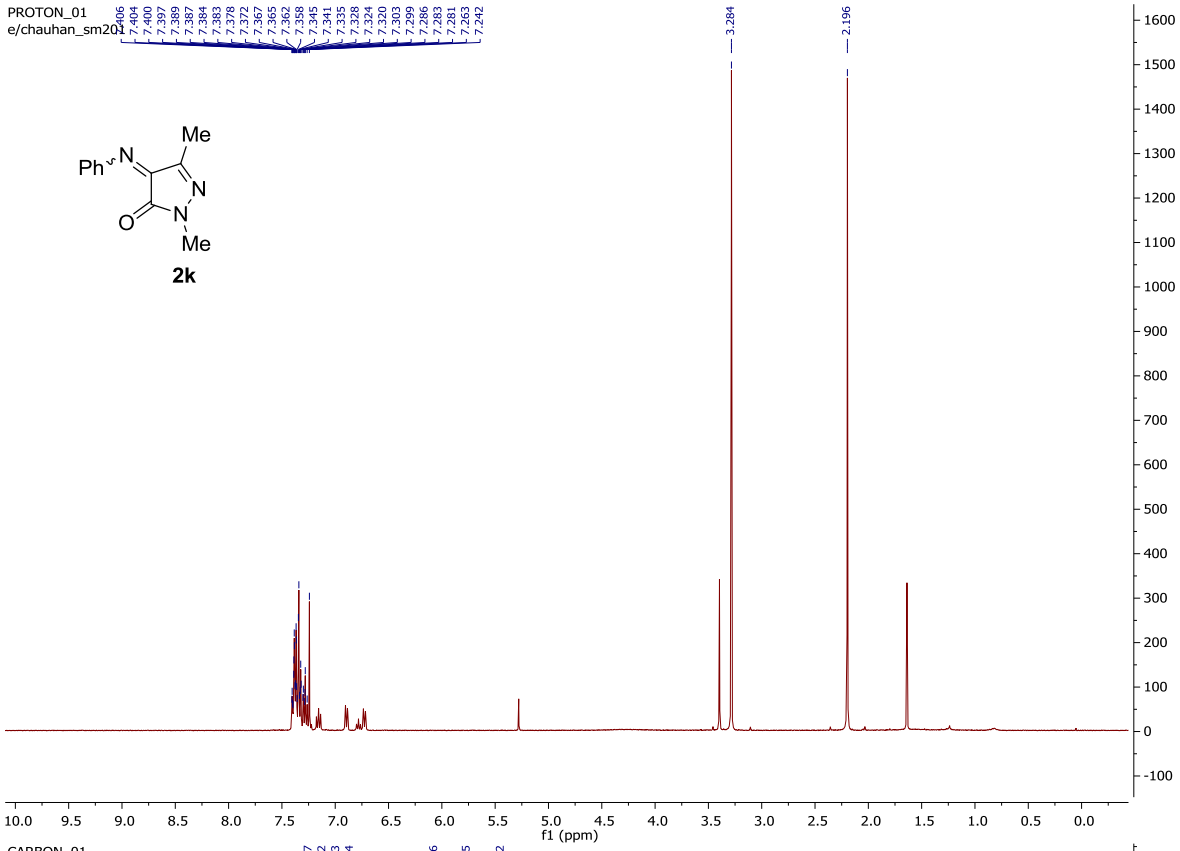
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7.372
7.367
7.365
7.362
7.358
7.345
7.341
7.335
7.328
7.324
7.320
7.303
7.299
7.286
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7.242
3.284
2.196
Me
Ph
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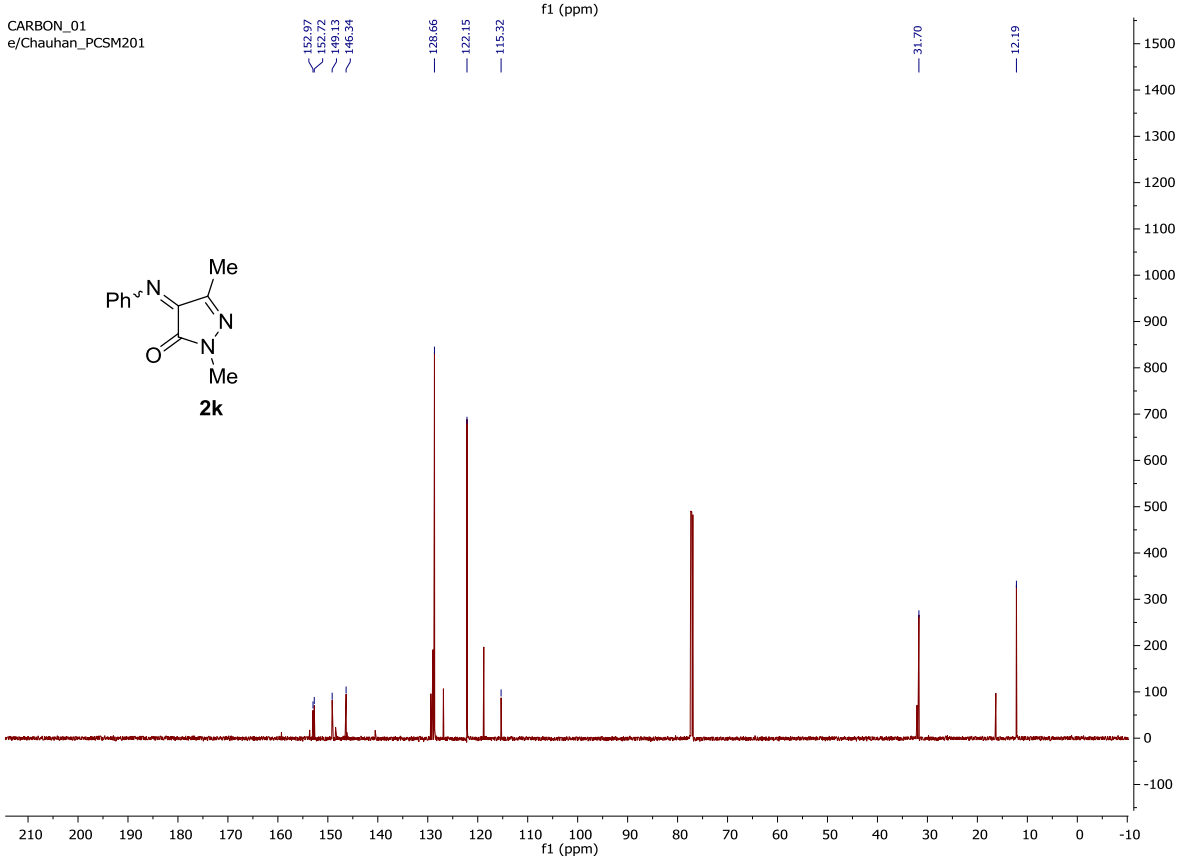
N
O
N
Me
2k
f1 (ppm)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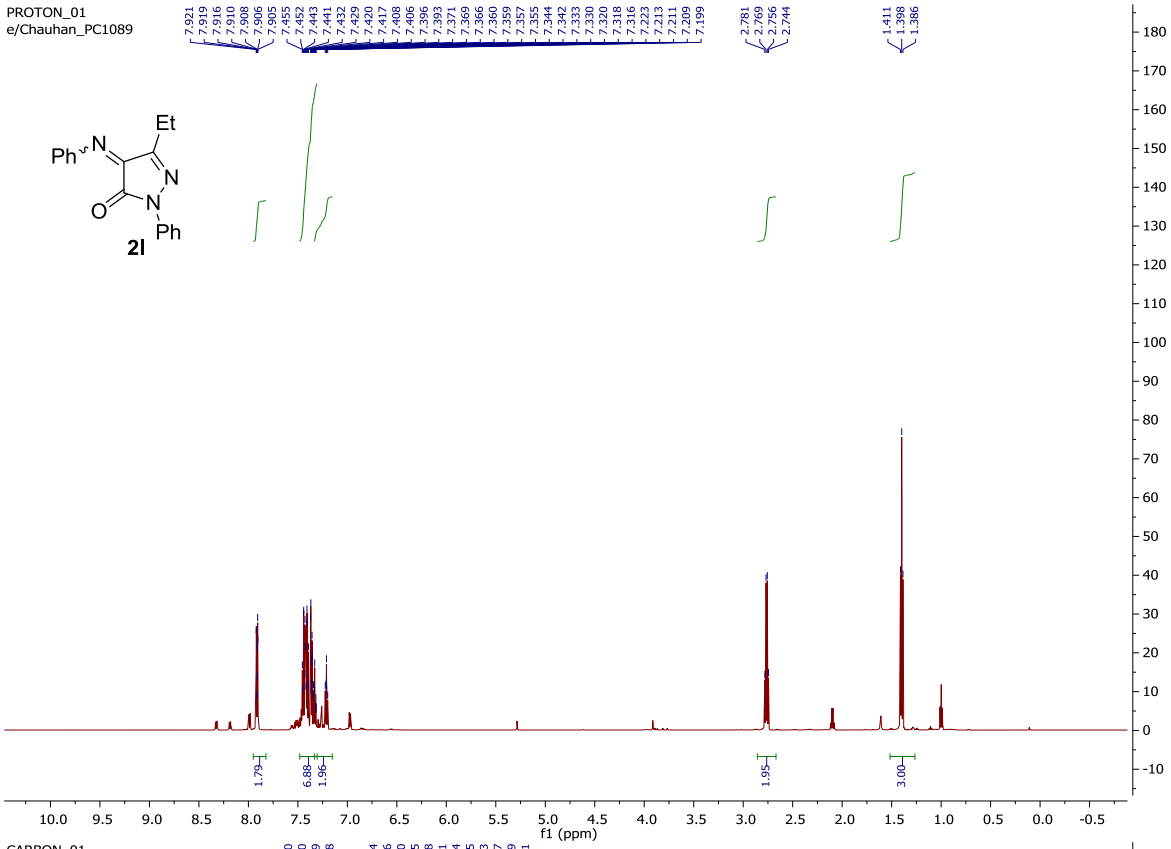
2k
f1 (ppm)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Ph
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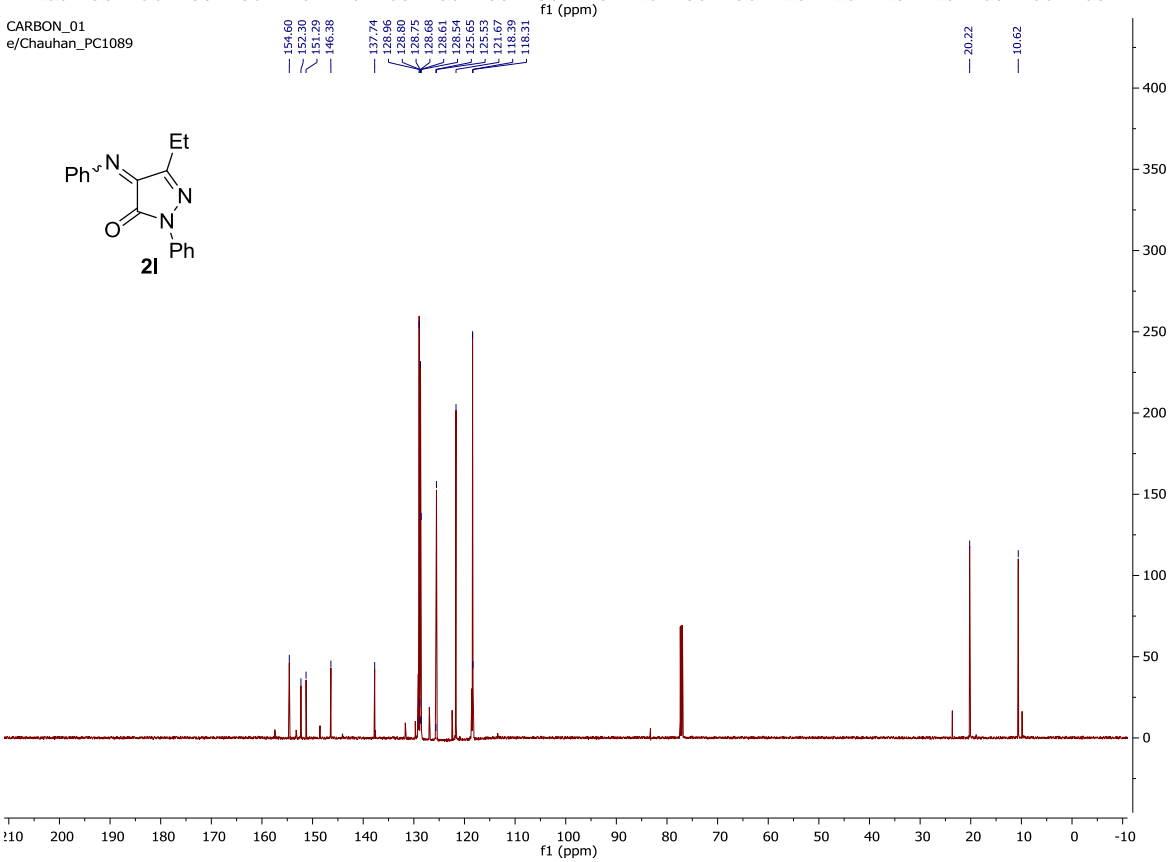
O
N
Ph
2l
f1 (ppm)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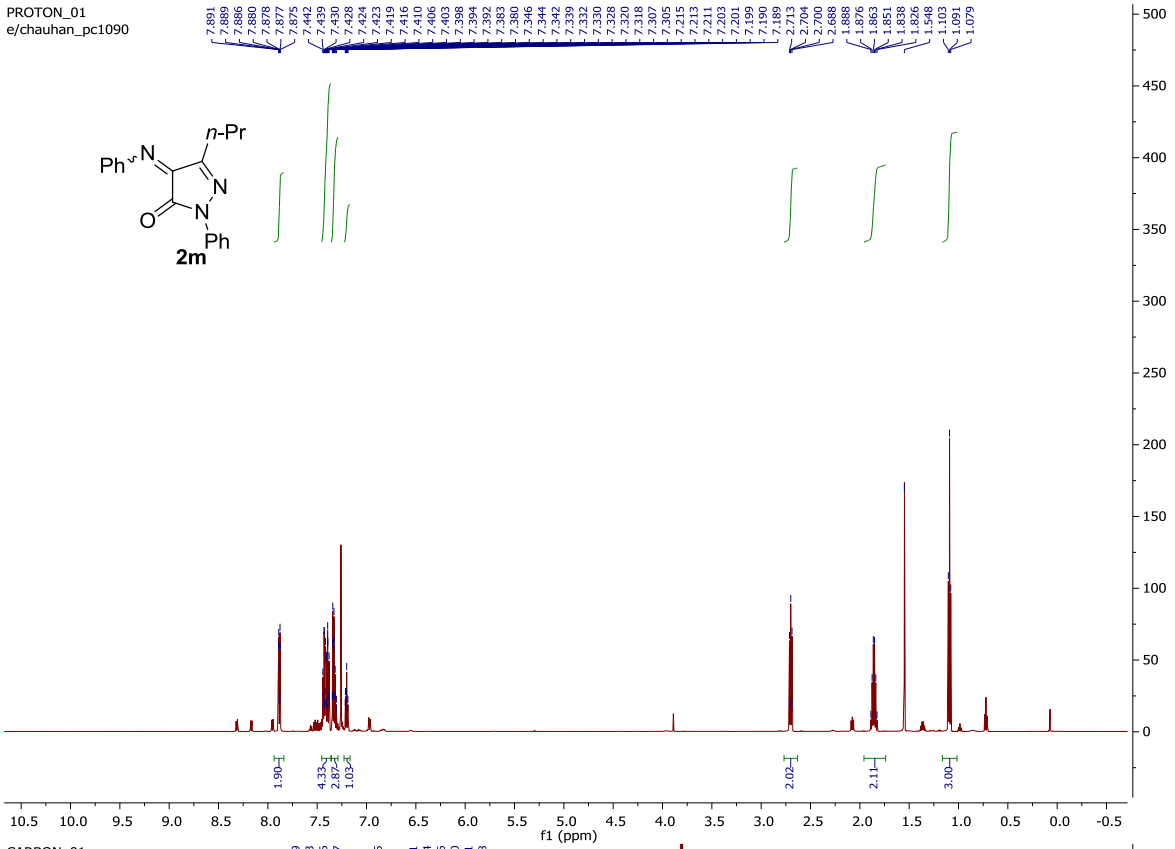
e/Chauhan_PC1089
Et
Ph
N
N
O
N
Ph
2l
f1 (ppm)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Ph
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N
O
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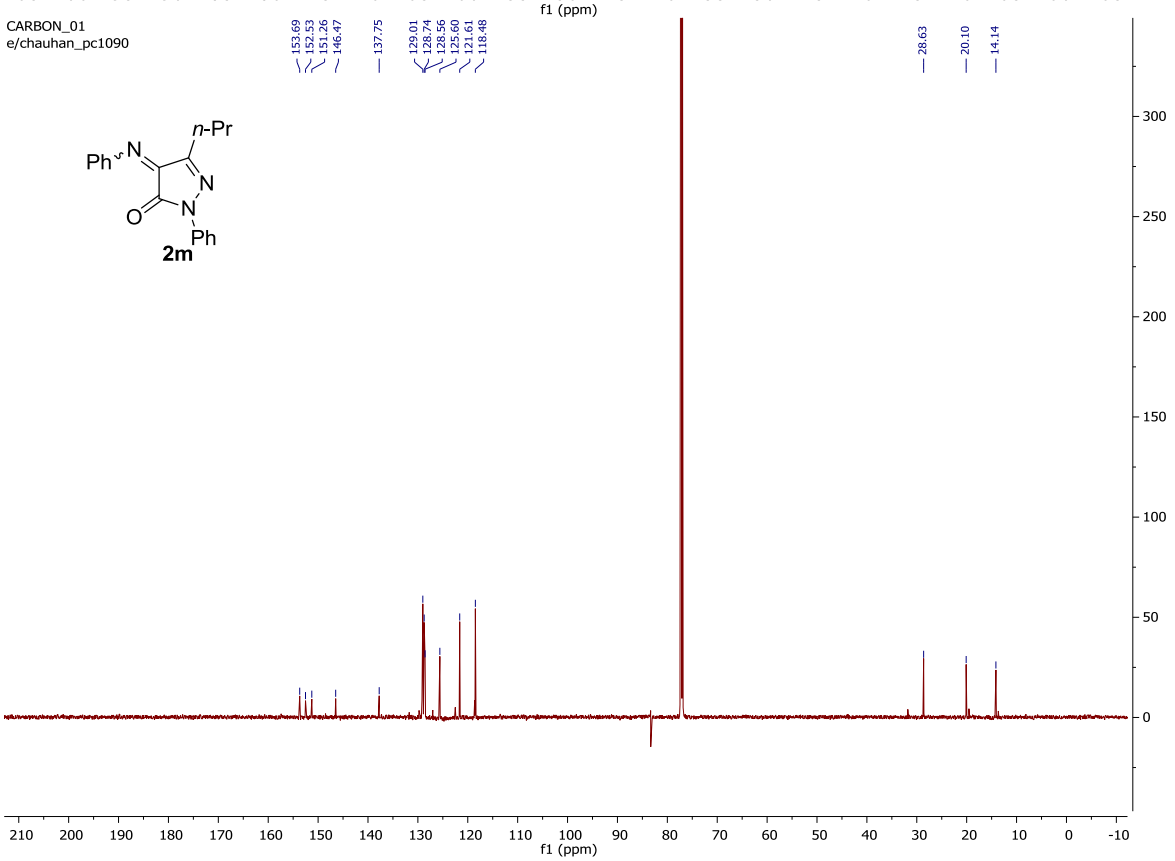
2m
f1 (ppm)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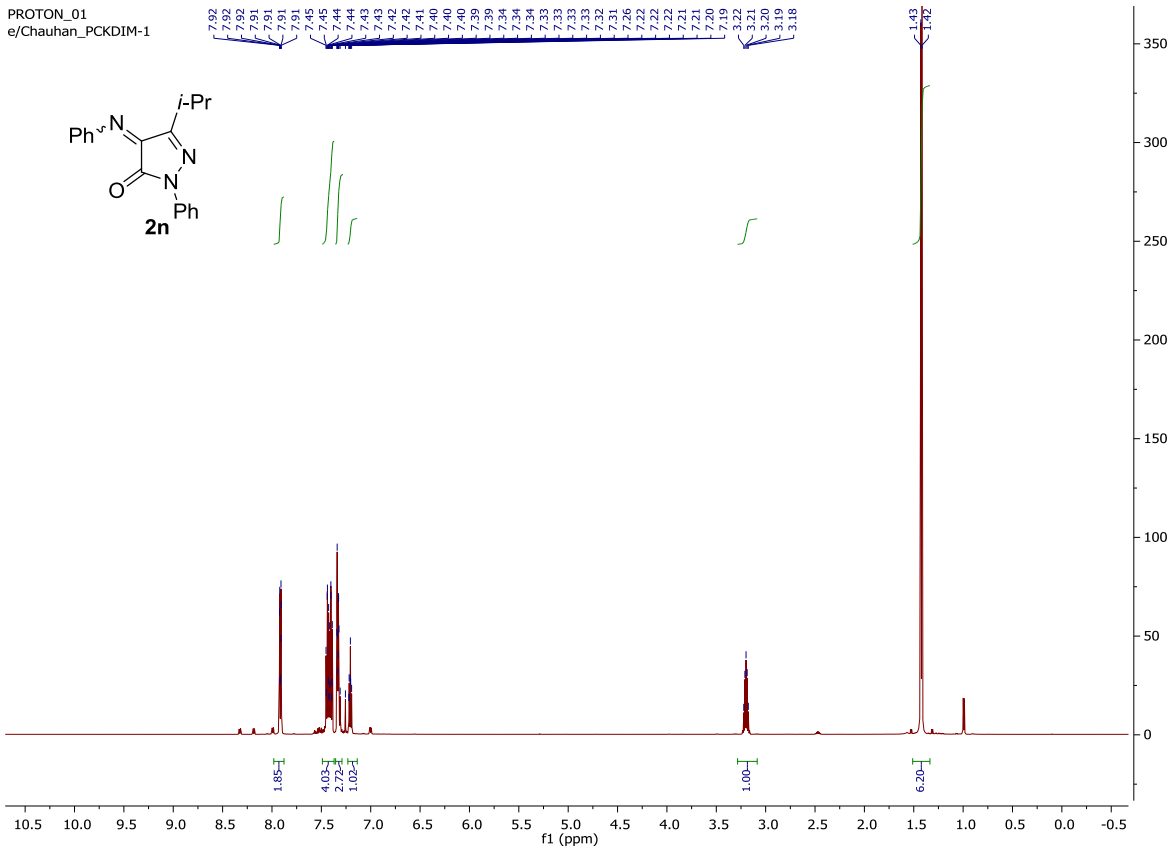
Ph
N
N
O
N
Ph
2m
f1 (ppm)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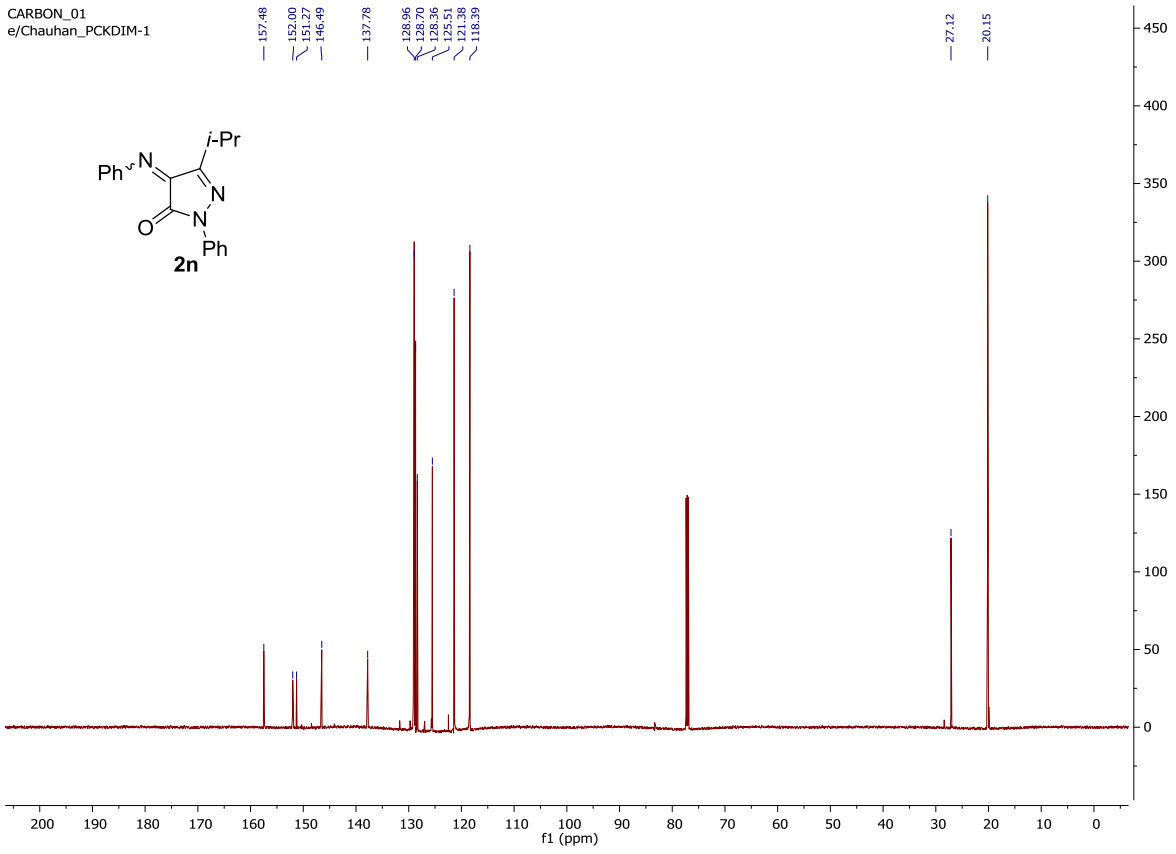
1.43 1.42
i-Pr
Ph
N
N
O
N
Ph
2n
1.85 4.03 2.72 1.02 1.00 6.20
f1 (ppm)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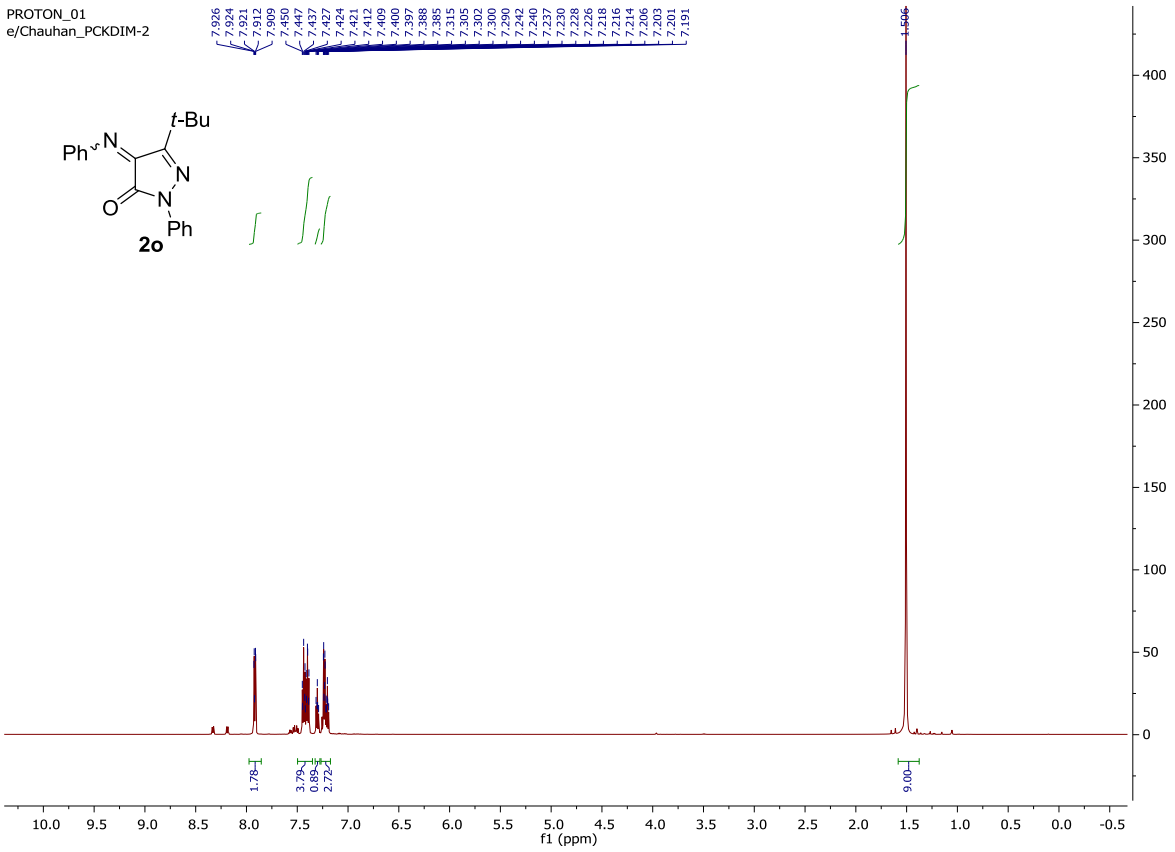
Ph
N
N
O
N
Ph
2n
f1 (ppm)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7.421
7.412
7.409
7.400
7.397
7.388
7.385
7.315
7.305
7.302
7.300
7.290
7.242
7.240
7.237
7.230
7.228
7.226
7.218
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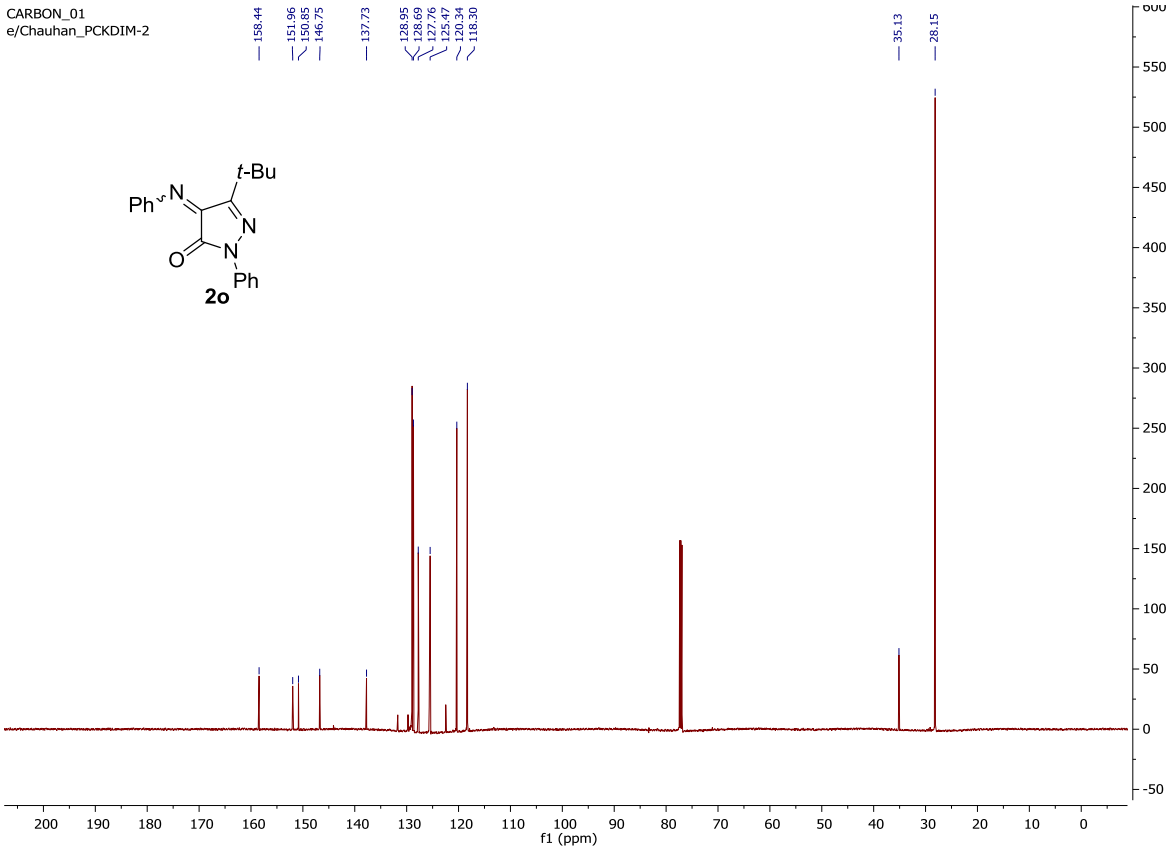
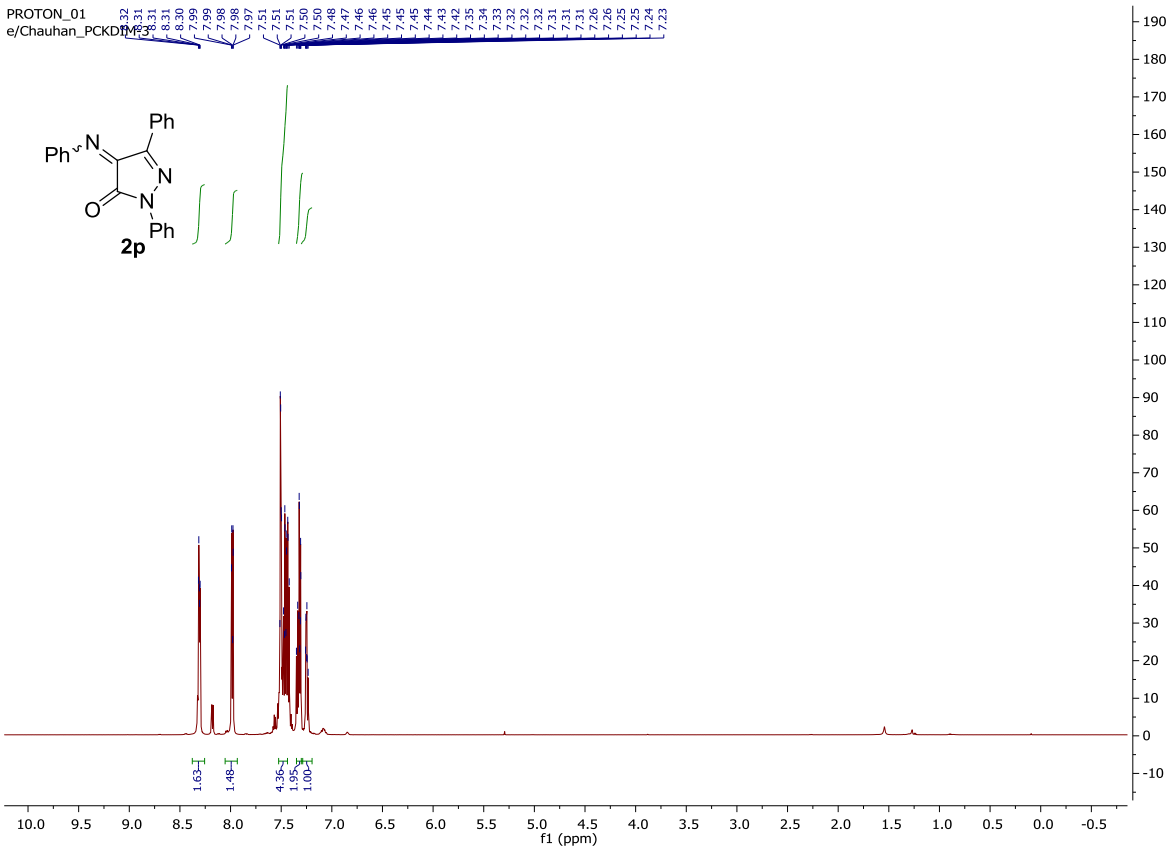
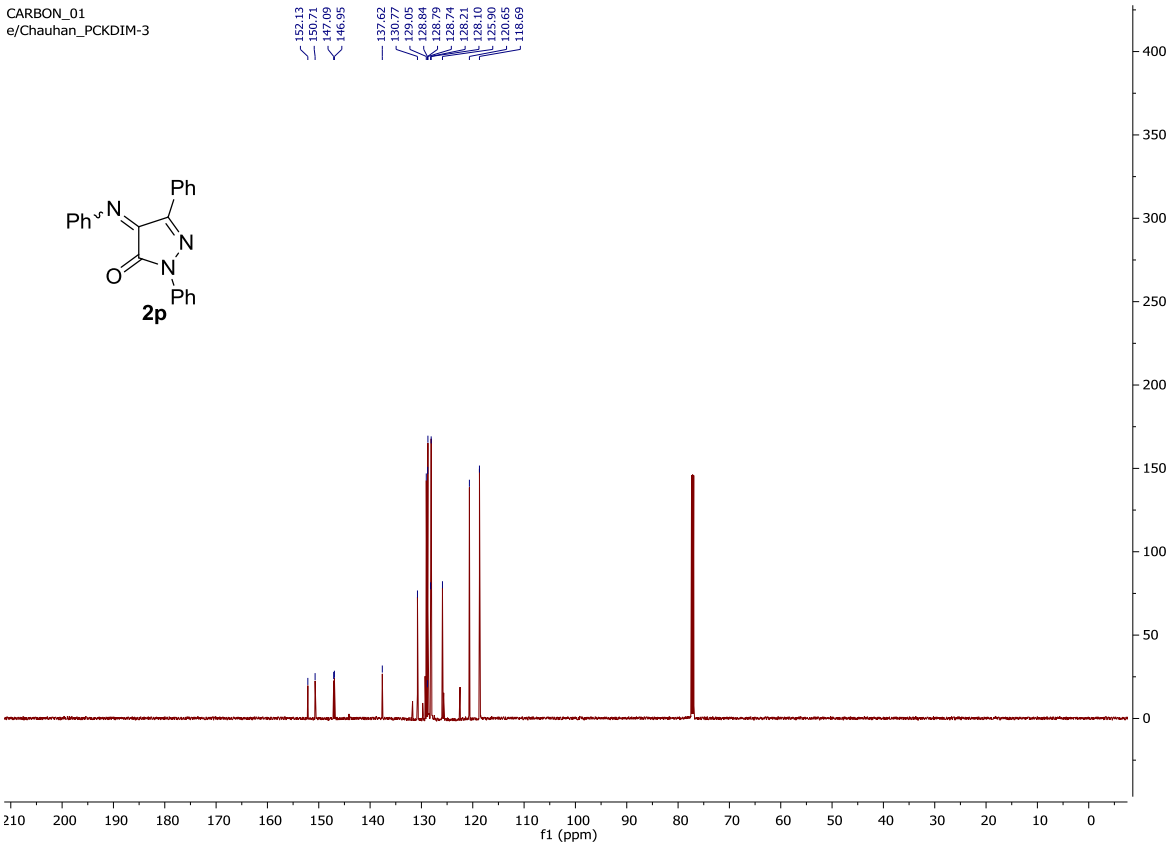
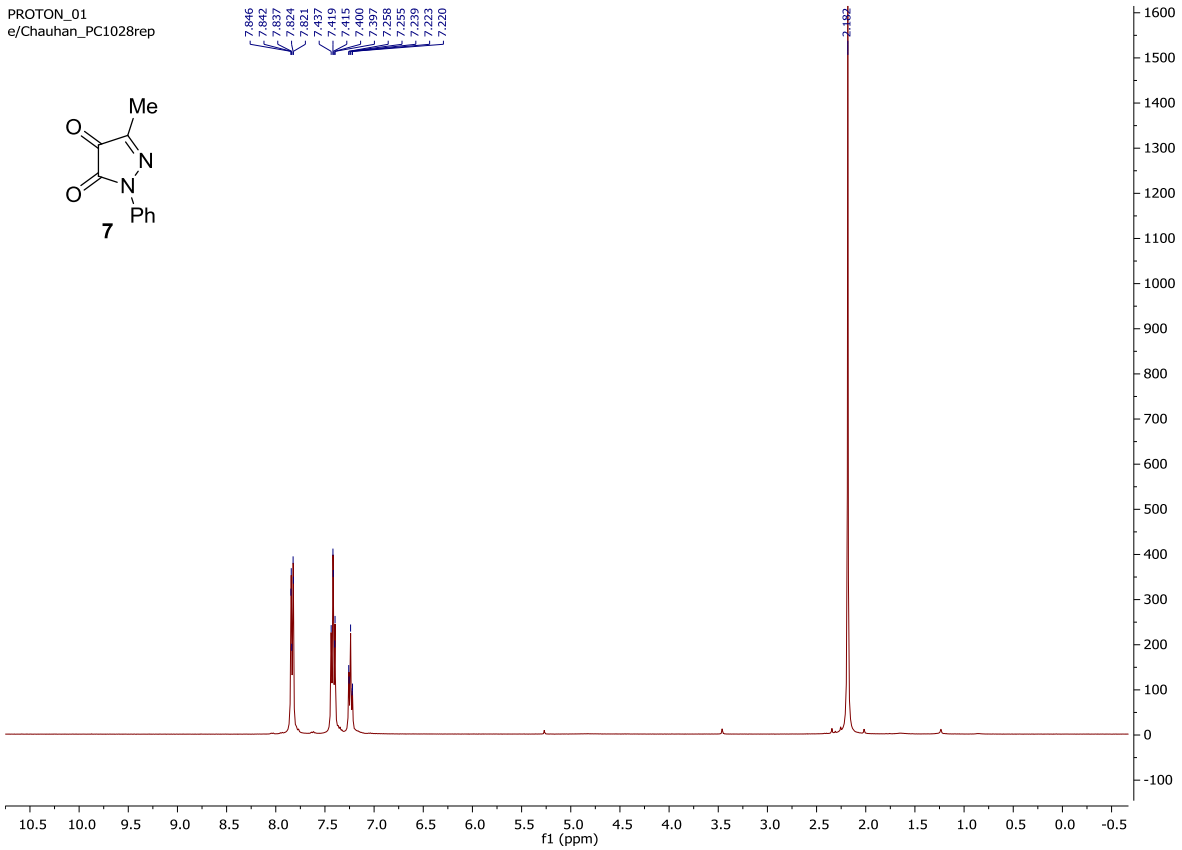
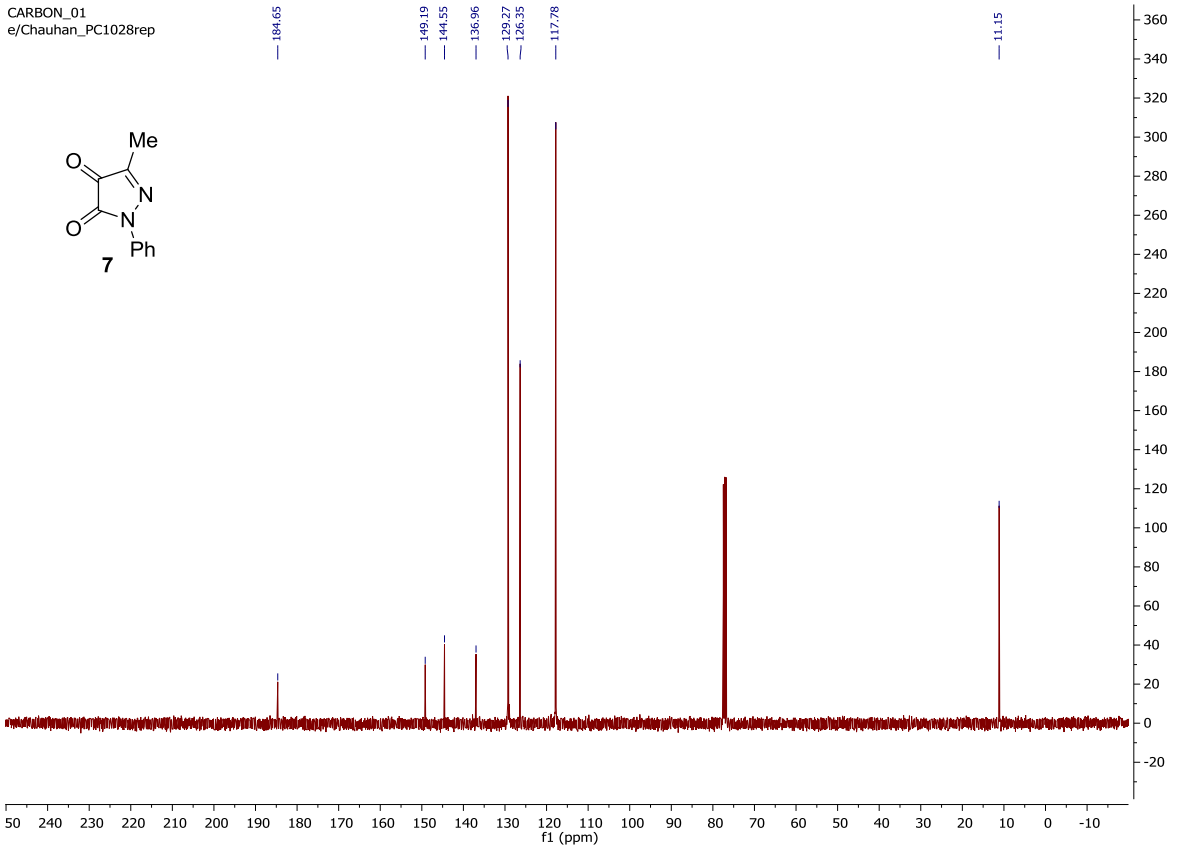
7.206
7.203
7.201
7.191
1.506
t-Bu
Ph
N
N
O
N
Ph
2o
1.78
3.79
0.89
2.72
9.00
f1 (ppm)

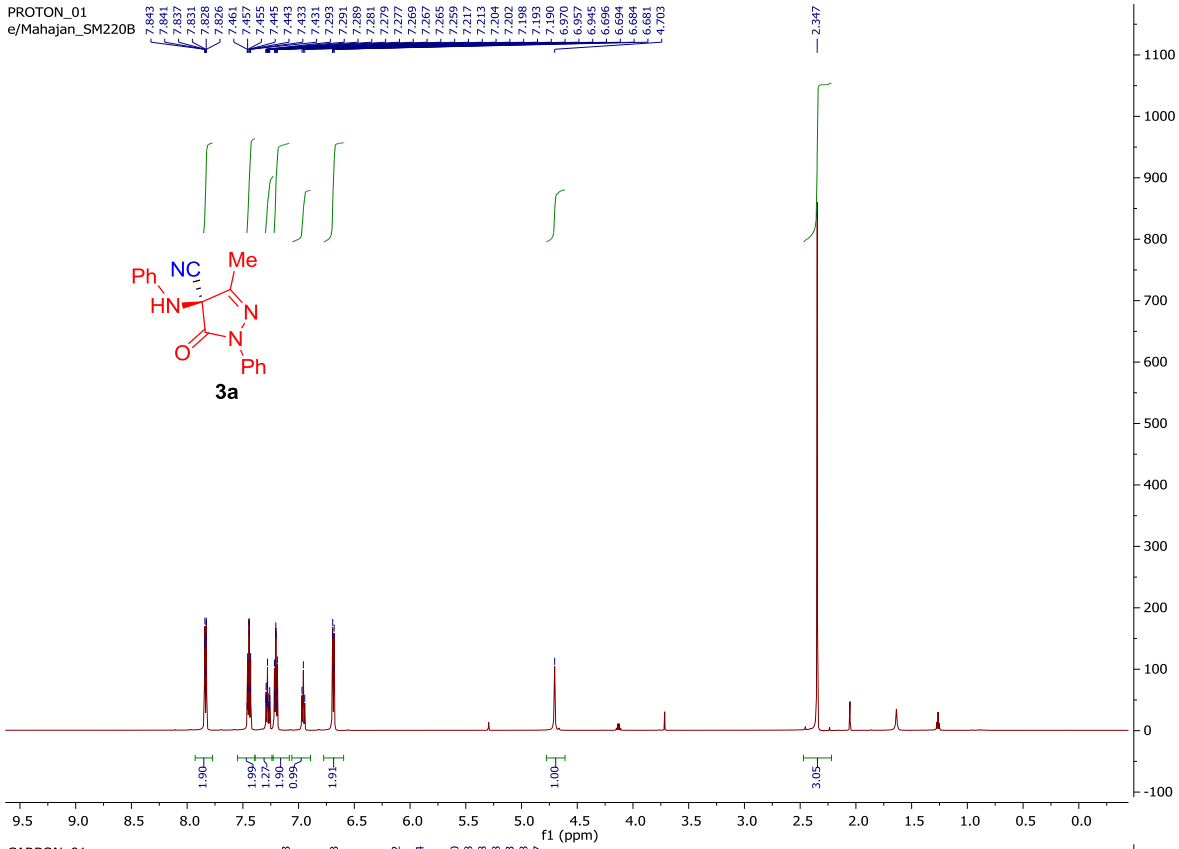

CARBON_01
e/Chauhan_PCKDIM-2
158.44
151.96
150.85
146.75
137.73
128.95
128.69
127.76
125.47
120.34
118.30
35.13
28.15
t-Bu
Ph
N
N
O
N
Ph
2o
f1 (ppm)

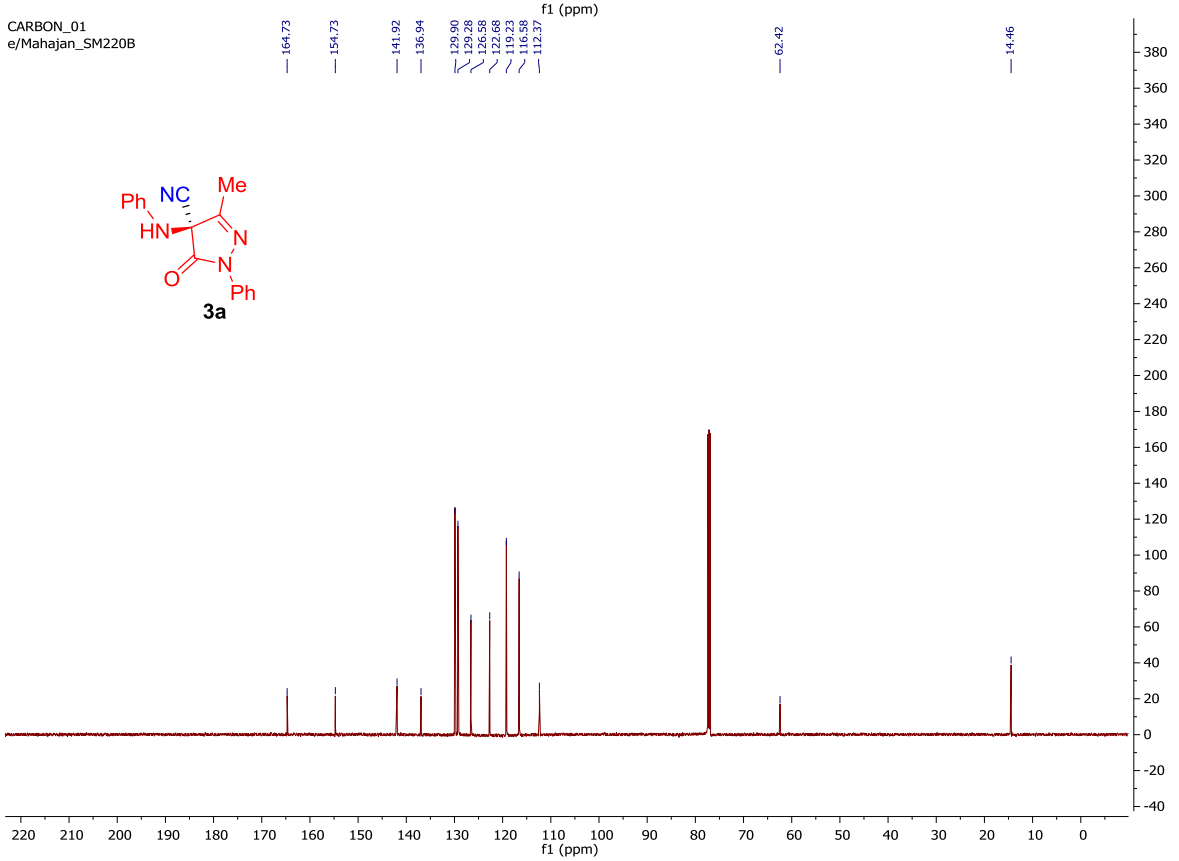

PROTON_01
e/Chauhan_PCKDIM3
8.32 8.31 8.31 8.31 8.30 7.99 7.99 7.98 7.98 7.97 7.51 7.51 7.51 7.50 7.50 7.48 7.47 7.46 7.46 7.45 7.45 7.45 7.44 7.43 7.42 7.35 7.34 7.33 7.32 7.32 7.32 7.31 7.31 7.26 7.26 7.25 7.25 7.24 7.23
Ph
Ph
N
N
O
N
Ph
2p
1.63 1.48 4.36 1.95 1.00
f1 (ppm)

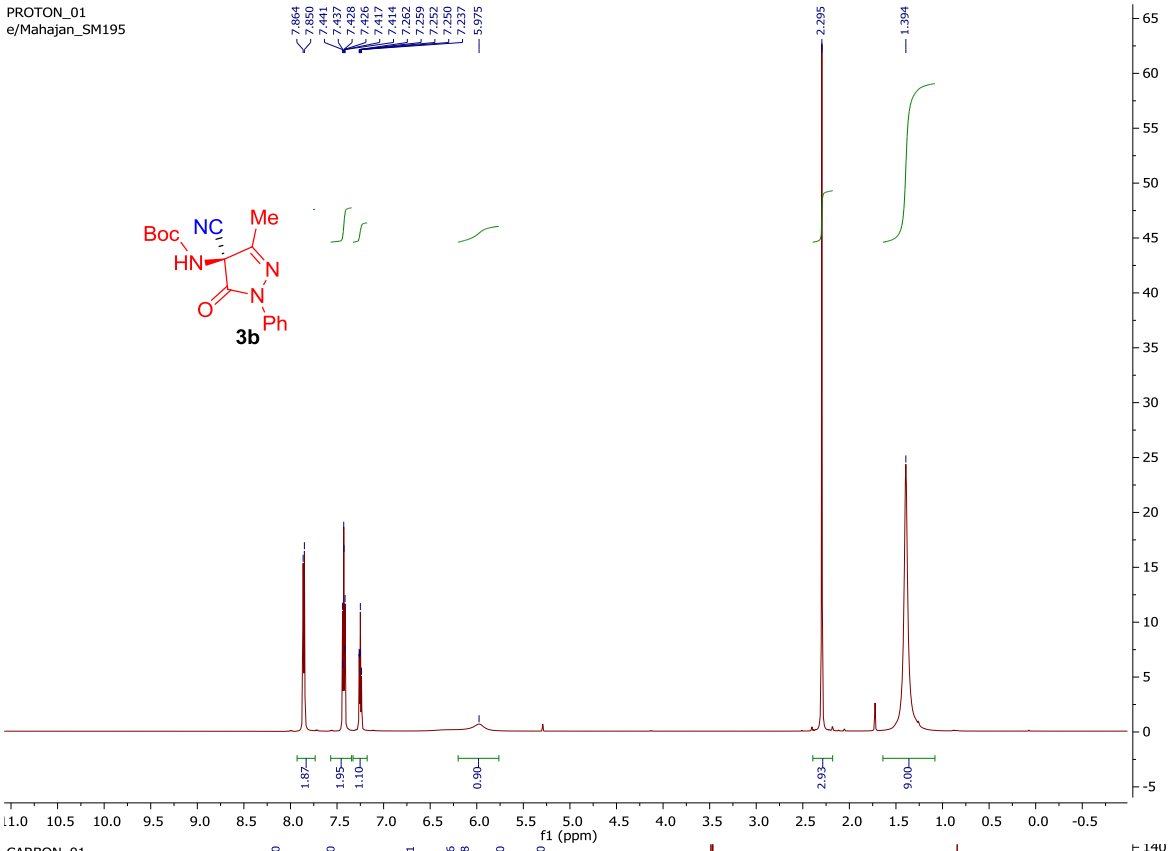

CARBON_01
e/Chauhan_PCKDIM-3
152.13 150.71 147.09 146.95 137.62 130.77 129.05 128.84 128.79 128.74 128.21 128.10 125.90 120.65 118.69
Ph
Ph
N
N
O
N
Ph
2p
f1 (ppm)

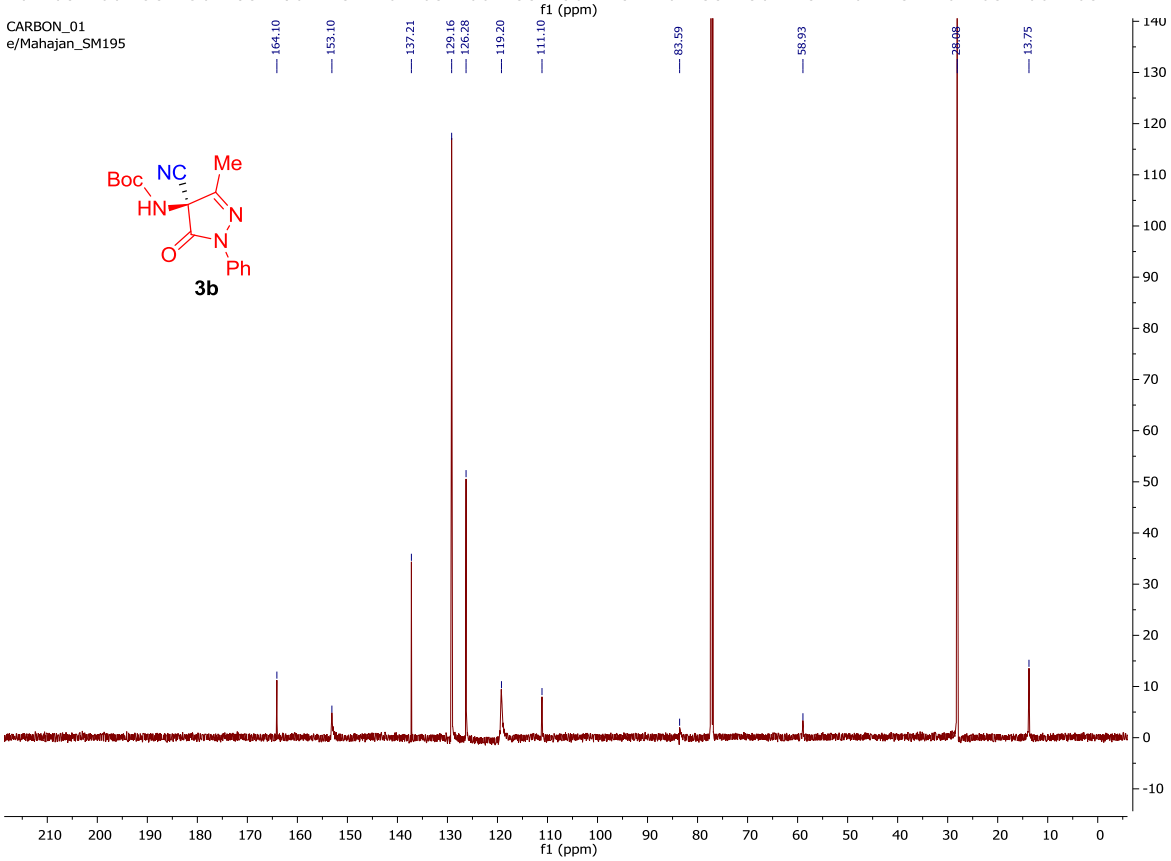

PROTON_01
e/Chauhan_PC1028rep
7.846
7.842
7.837
7.824
7.821
7.437
7.419
7.415
7.400
7.397
7.258
7.255
7.239
7.223
7.220
2.182
Me
O
N
O
N
Ph
7
f1 (ppm)

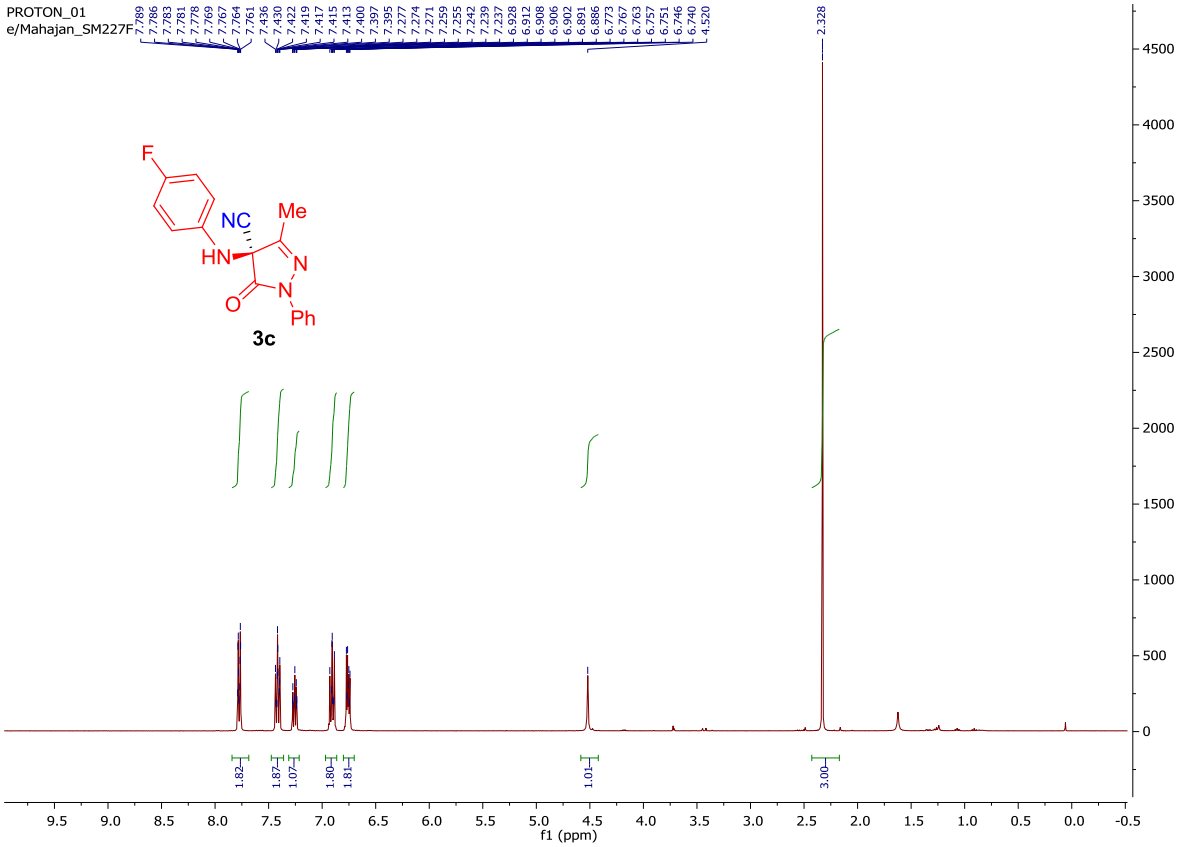

CARBON_01
e/Chauhan_PC1028rep
184.65
149.19
144.55
136.96
129.27
126.35
117.78
11.15
Me
O
N
O
N
Ph
7
f1 (ppm)

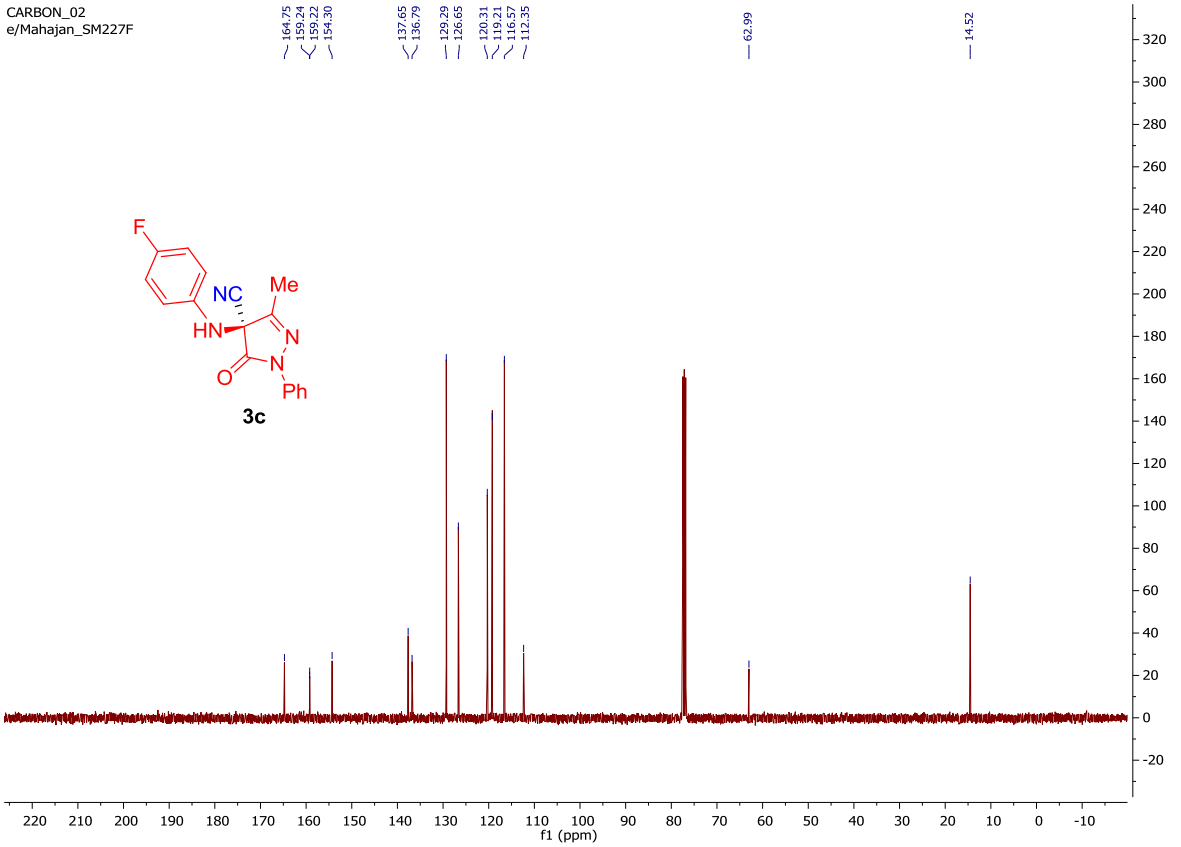

PROTON_01
e/Mahajan_SM220B
7.843
7.841
7.837
7.831
7.828
7.826
7.461
7.457
7.455
7.445
7.443
7.433
7.431
7.293
7.291
7.289
7.281
7.279
7.277
7.269
7.267
7.265
7.259
7.217
7.213
7.204
7.202
7.198
7.193
7.190
6.970
6.957
6.945
6.696
6.694
6.684
6.681
4.703
2.347
Ph
NC
Me
HN
N
O
N
Ph
3a
1.90
1.99
1.27
1.90
0.99
1.91
1.00
3.05
f1 (ppm)

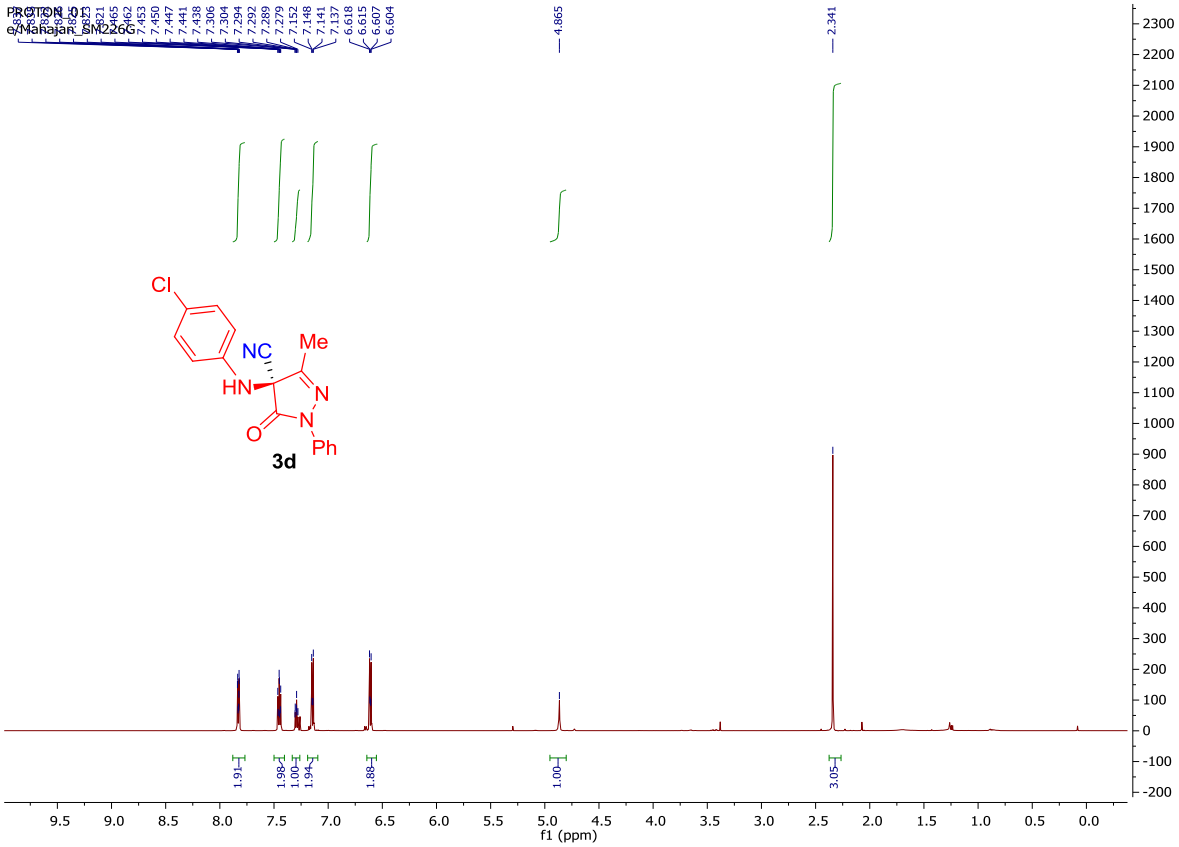

CARBON_01
e/Mahajan_SM220B
164.73
154.73
141.92
136.94
129.90
129.28
126.58
122.68
119.23
116.58
112.37
62.42
14.46
Ph
NC
Me
HN
N
O
N
Ph
3a
f1 (ppm)

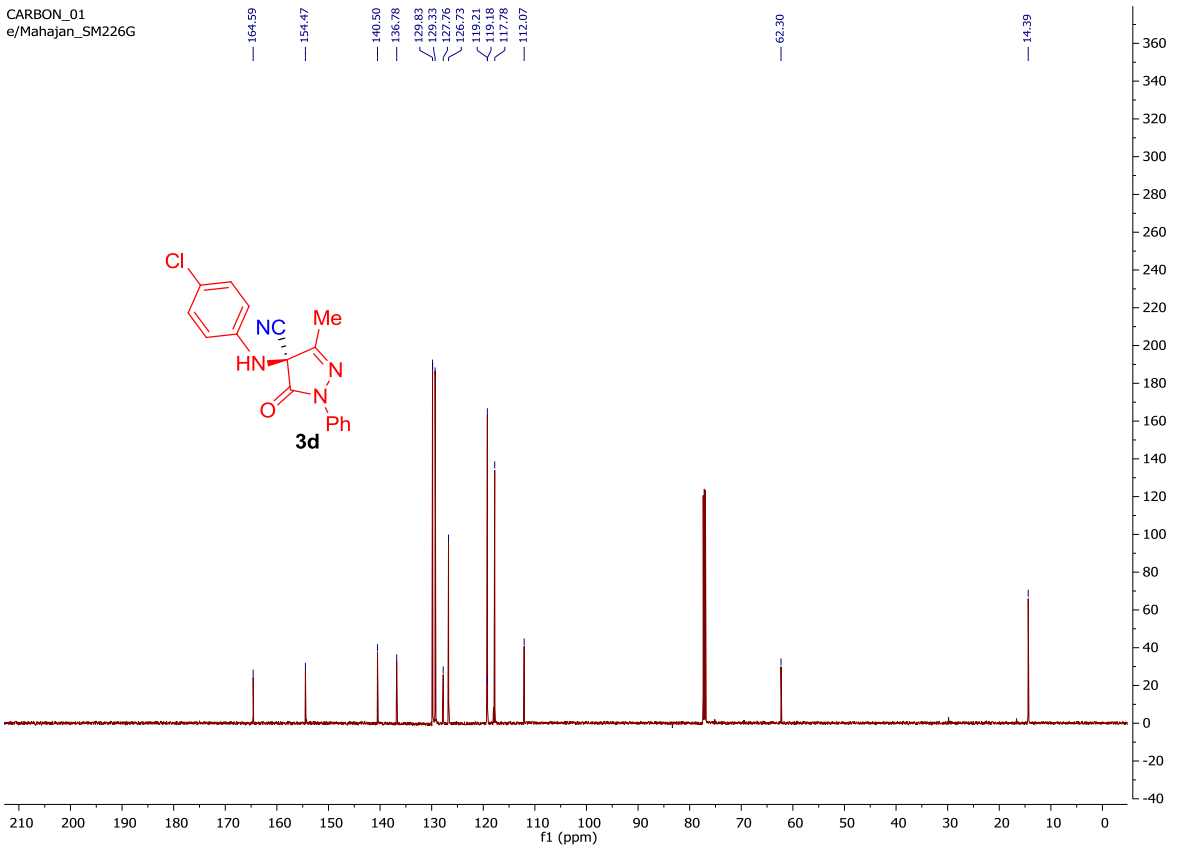

PROTON_01
e/Mahajan_SM195
7.864
7.850
7.441
7.437
7.428
7.426
7.417
7.414
7.262
7.259
7.252
7.250
7.237
5.975
2.295
1.394
Boc
NC
HN
Me
N
O
N
Ph
3b
1.87
1.95
1.10
0.90
2.93
9.00
f1 (ppm)

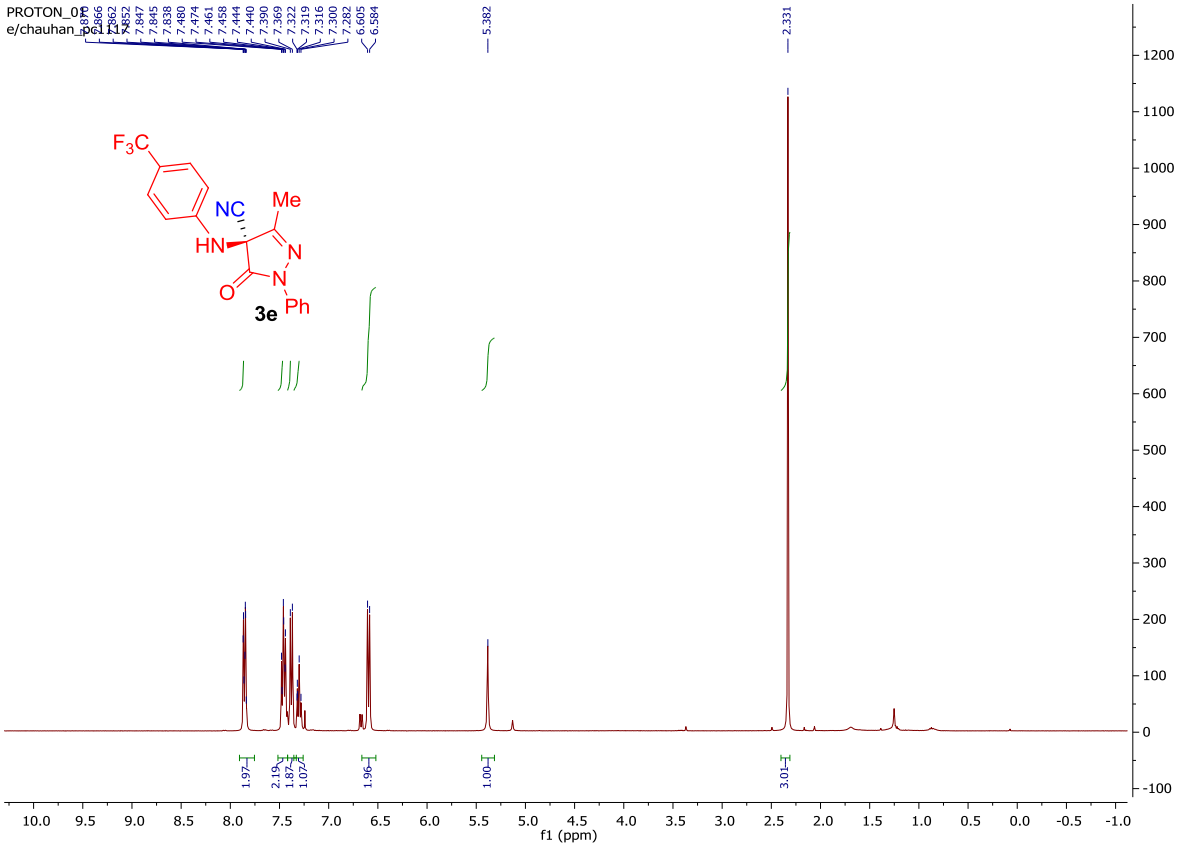

CARBON_01
e/Mahajan_SM195
164.10
153.10
137.21
129.16
126.28
119.20
111.10
83.59
58.93
28.08
13.75
Boc
NC
HN
Me
N
O
N
Ph
3b
f1 (ppm)

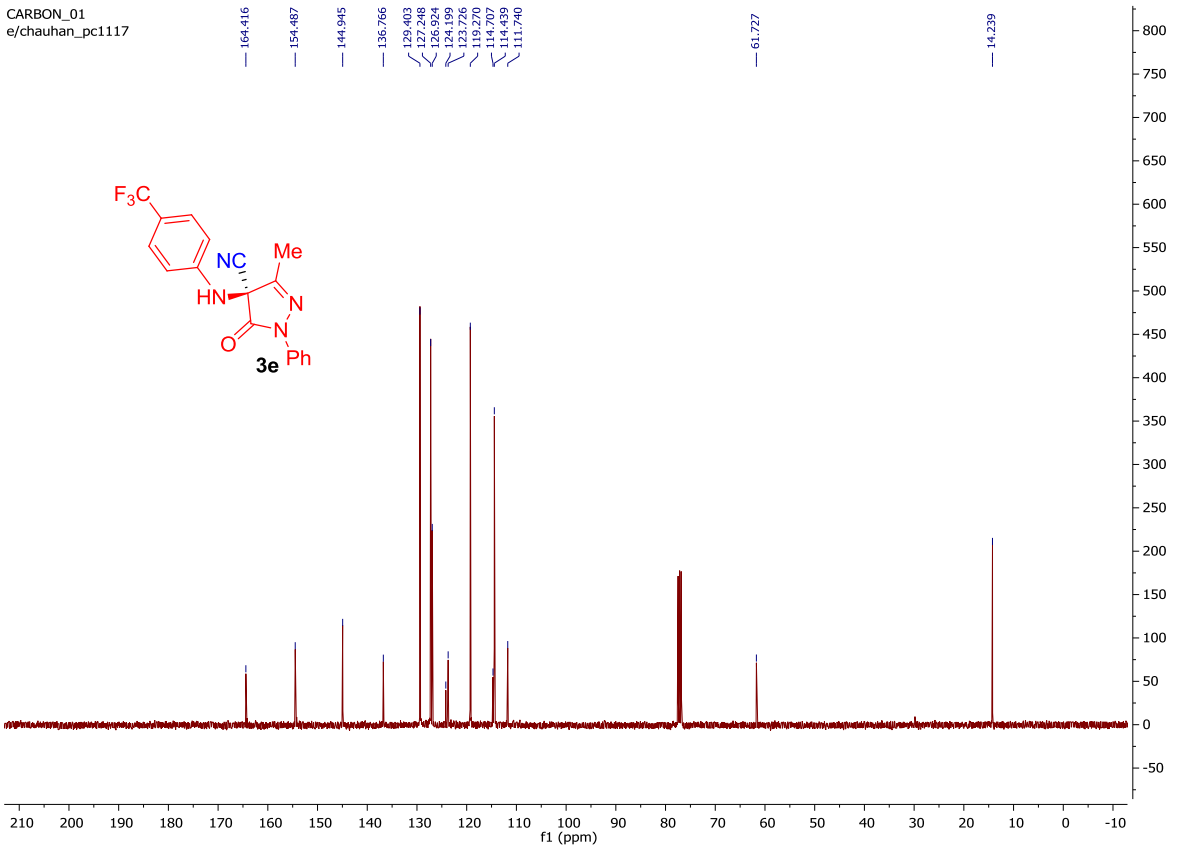

PROTON_01
e/Mahajan_SM227F
7.789
7.786
7.783
7.781
7.778
7.769
7.767
7.764
7.761
7.436
7.430
7.422
7.419
7.417
7.415
7.413
7.400
7.397
7.395
7.277
7.274
7.271
7.259
7.255
7.242
7.239
7.237
6.928
6.912
6.908
6.906
6.902
6.891
6.886
6.773
6.767
6.763
6.757
6.751
6.746
6.740
4.520
2.328
F
NC
Me
HN
N
O
N
Ph
3c
1.82
1.87
1.07
1.80
1.81
1.01
3.00
f1 (ppm)

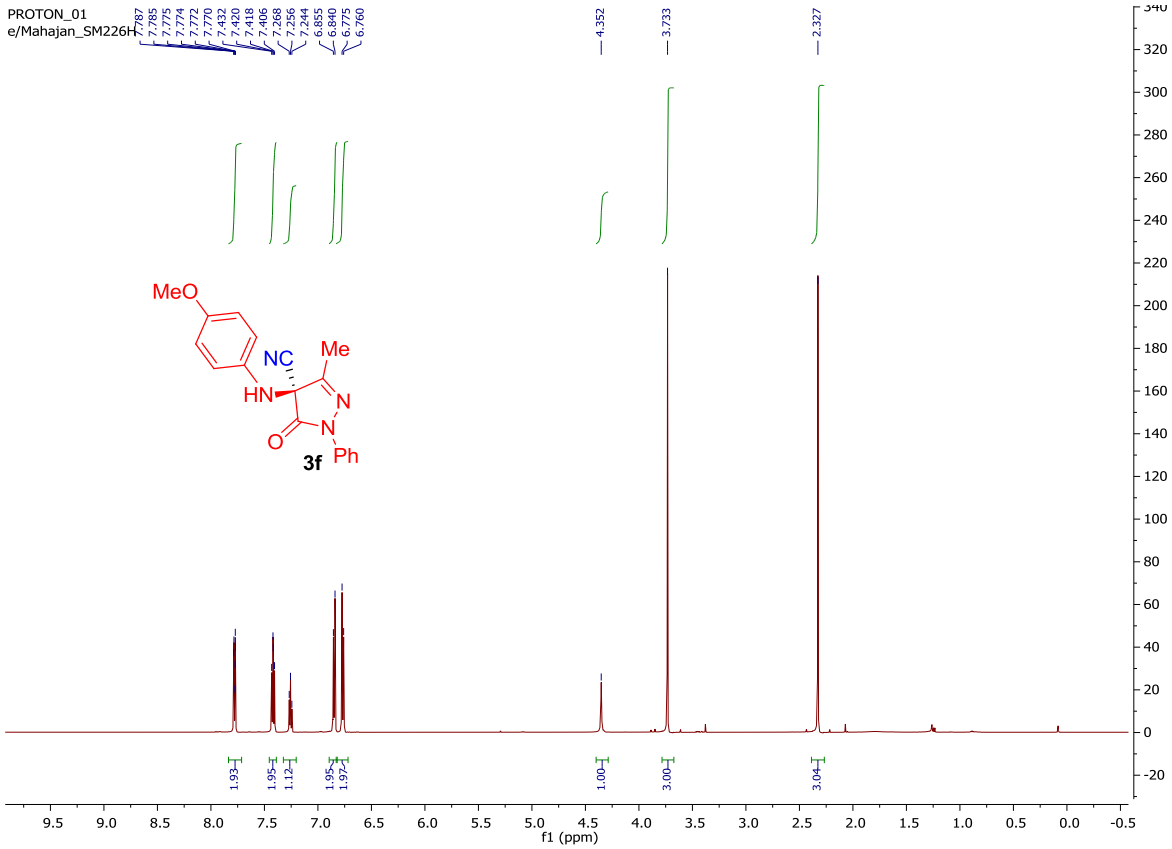

CARBON_02
e/Mahajan_SM227F
164.75
159.24
159.22
154.30
137.65
136.79
129.29
126.65
120.31
119.21
116.57
112.35
62.99
14.52
F
NC
Me
HN
N
O
N
Ph
3c
f1 (ppm)

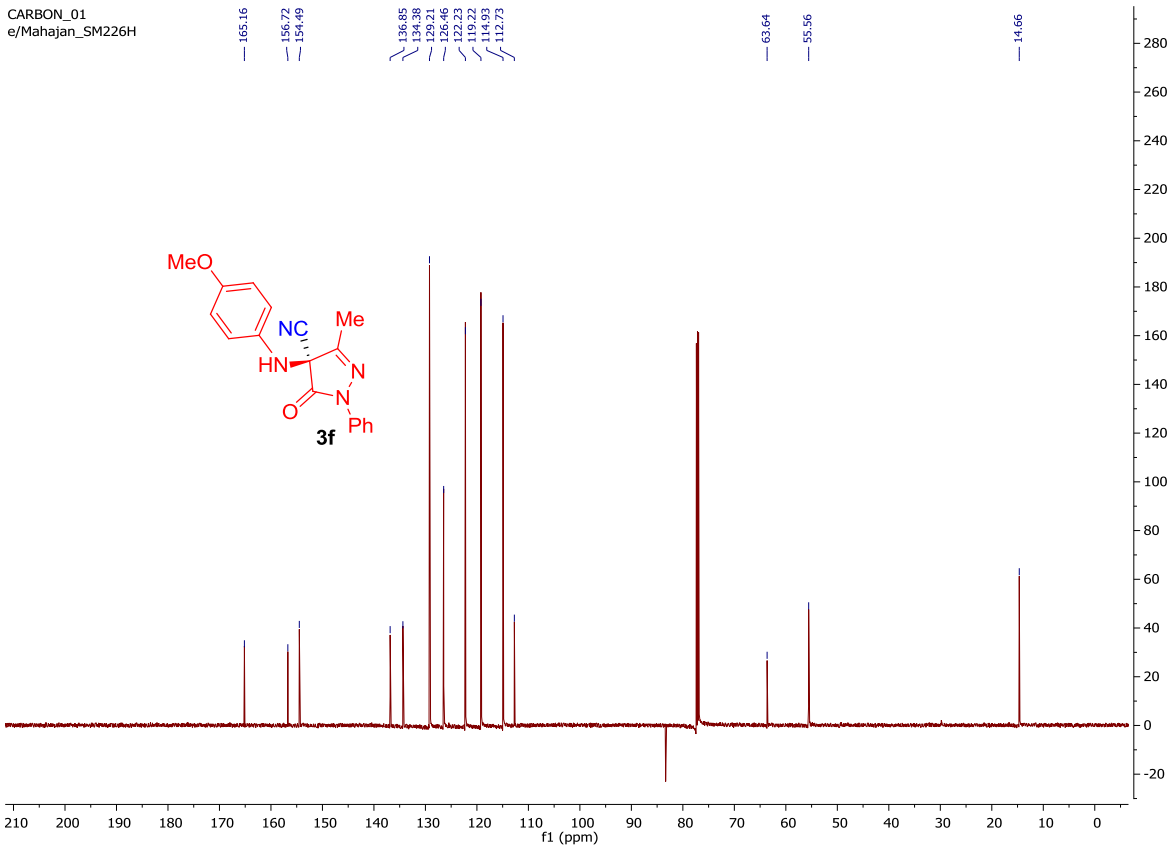

PROTON_01
e/Mahajan_SM226G
7.821
7.465
7.462
7.453
7.450
7.447
7.441
7.438
7.306
7.304
7.294
7.292
7.289
7.279
7.152
7.148
7.141
7.137
6.618
6.615
6.607
6.604
4.865
2.341
Cl
NC
Me
HN
N
N
O
Ph
3d
1.91
1.98
1.00
1.94
1.88
1.00
3.05
f1 (ppm)

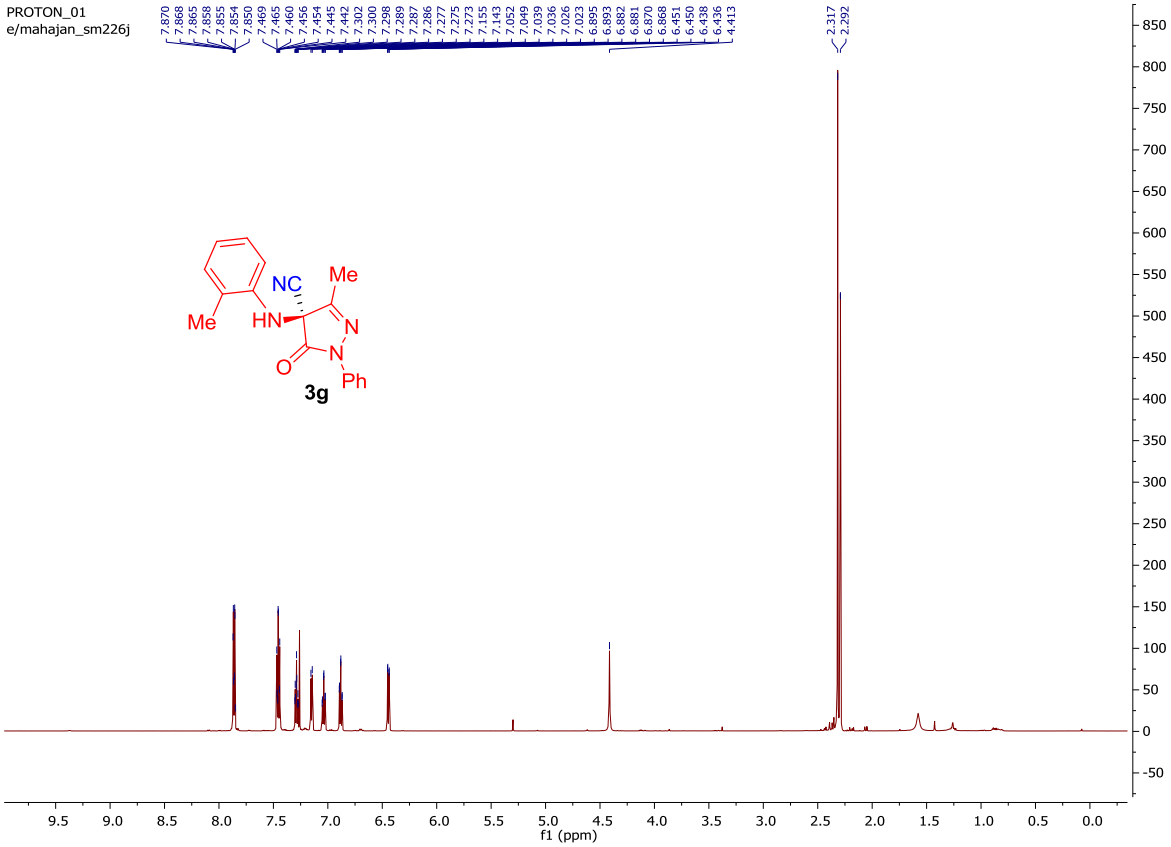

CARBON_01
e/Mahajan_SM226G
164.59
154.47
140.50
136.78
129.83
129.33
127.76
126.73
119.21
119.18
117.78
112.07
62.30
14.39
Cl
NC
Me
HN
N
N
O
Ph
3d
f1 (ppm)

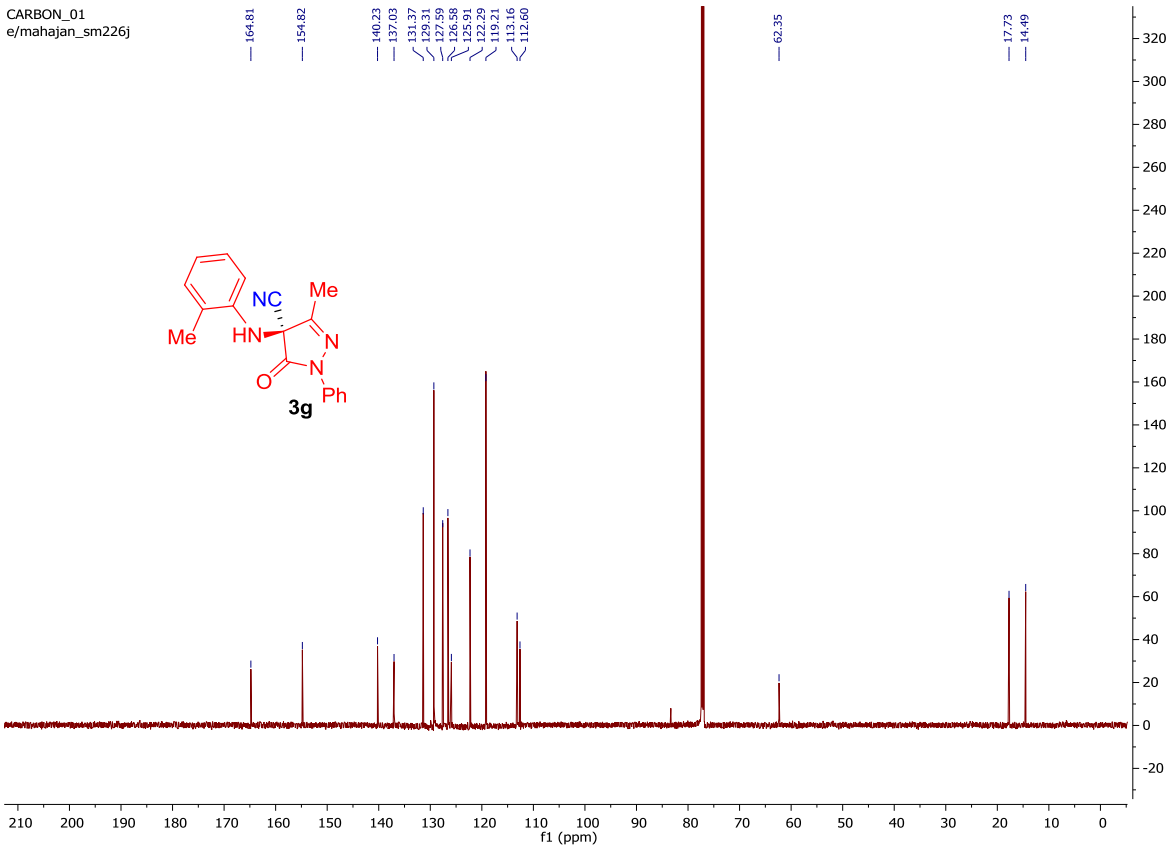

PROTON_01
e/chauhan_pc1117
7.867
7.866
7.862
7.852
7.847
7.845
7.838
7.480
7.474
7.461
7.458
7.444
7.440
7.390
7.369
7.322
7.319
7.316
7.300
7.282
6.605
6.584
5.382
2.331
F3C
NC
Me
HN
N
O
N
Ph
3e
1.97
2.19
1.87
1.07
1.96
1.00
3.01
f1 (ppm)

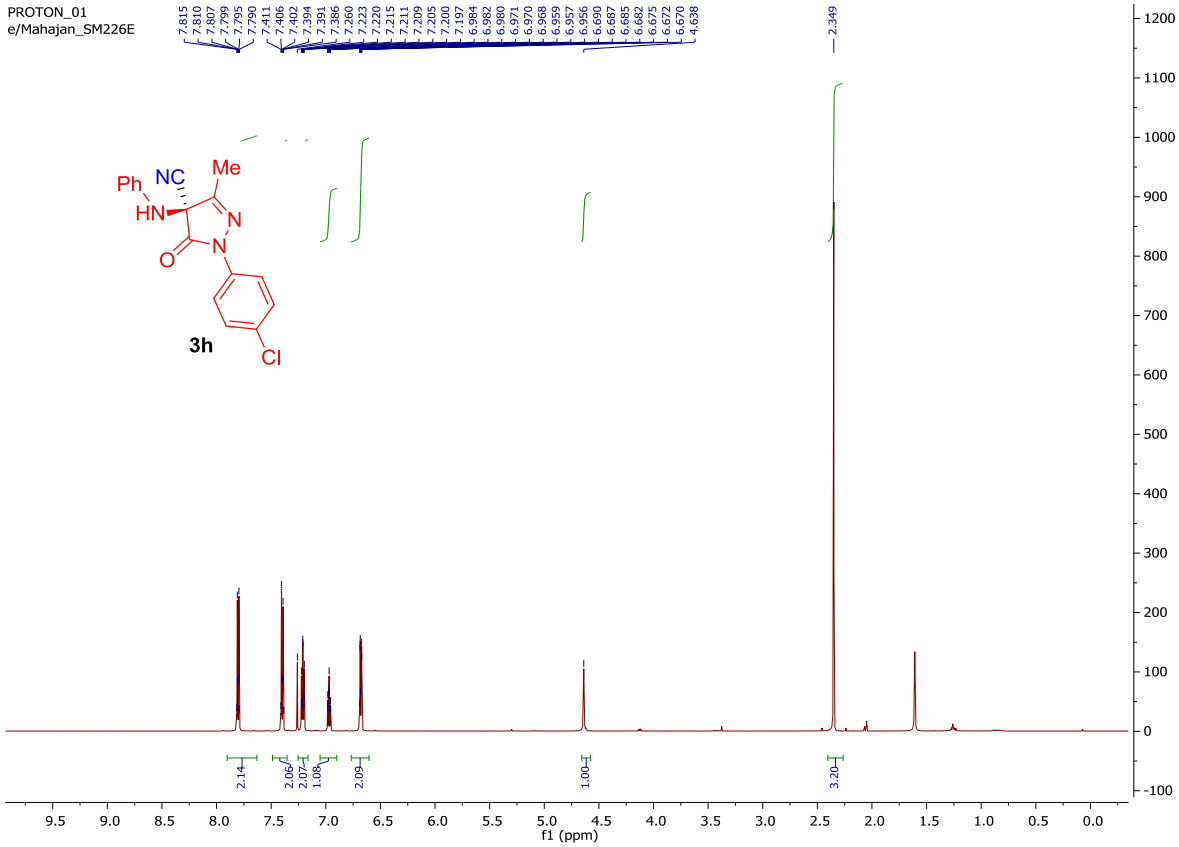

CARBON_01
e/chauhan_pc1117
164.416
154.487
144.945
136.766
129.403
127.248
126.924
124.199
123.726
119.270
114.707
114.439
111.740
61.727
14.239
F3C
NC
Me
HN
N
O
N
Ph
3e
f1 (ppm)

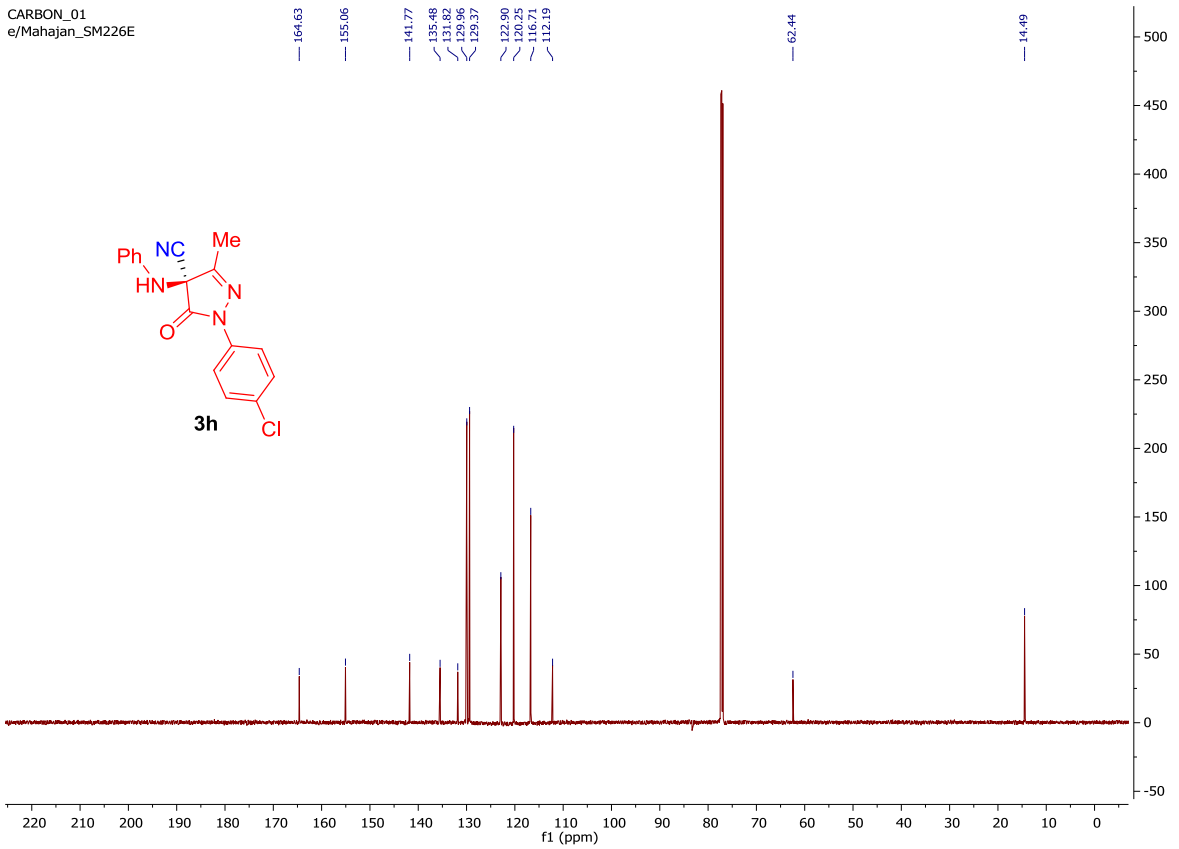

PROTON_01
e/Mahajan_SM226H
7.787
7.785
7.775
7.774
7.772
7.770
7.432
7.420
7.418
7.406
7.268
7.256
7.244
6.855
6.840
6.775
6.760
4.352
3.733
2.327
MeO
NC
Me
HN
N
N
O
Ph
3f
1.93
1.95
1.12
1.95
1.97
1.00
3.00
3.04
f1 (ppm)

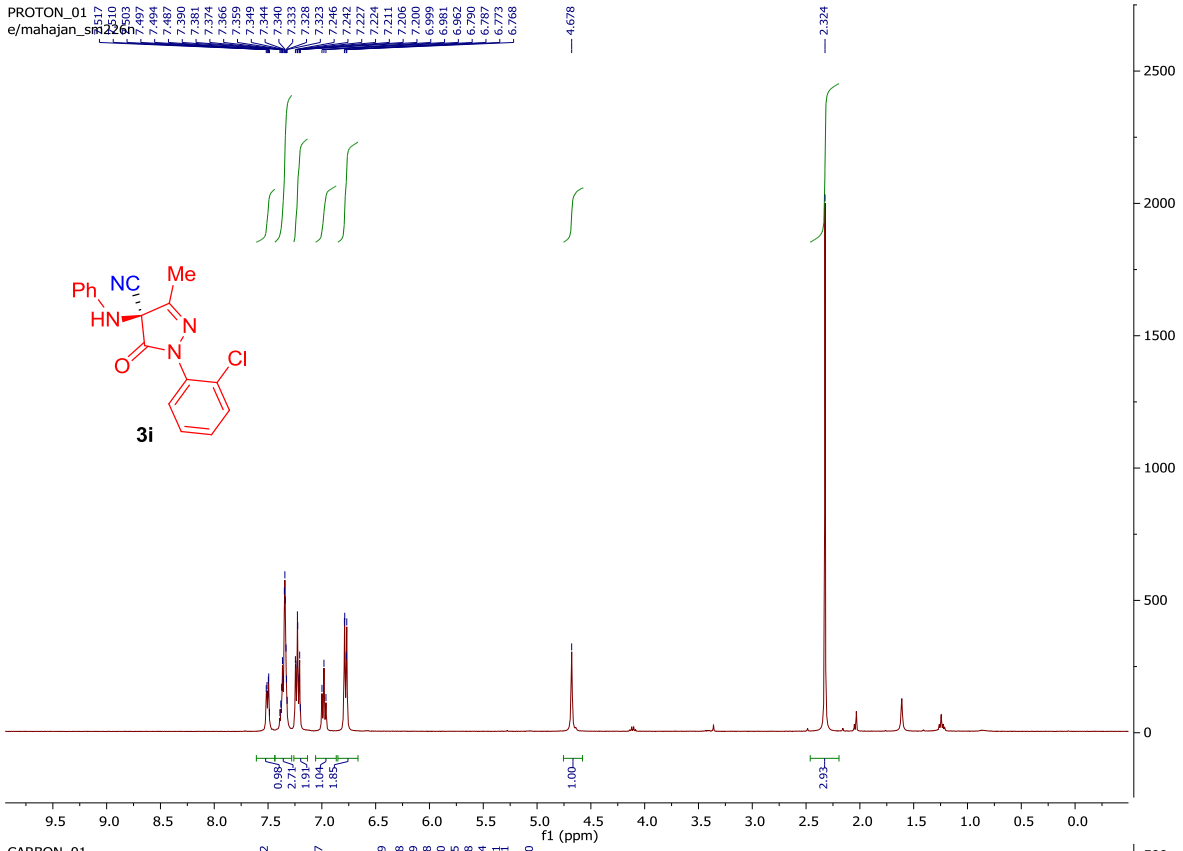

CARBON_01
e/Mahajan_SM226H
165.16
156.72
154.49
136.85
134.38
129.21
126.46
122.23
119.22
114.93
112.73
63.64
55.56
14.66
MeO
NC
Me
HN
N
N
O
Ph
3f
f1 (ppm)

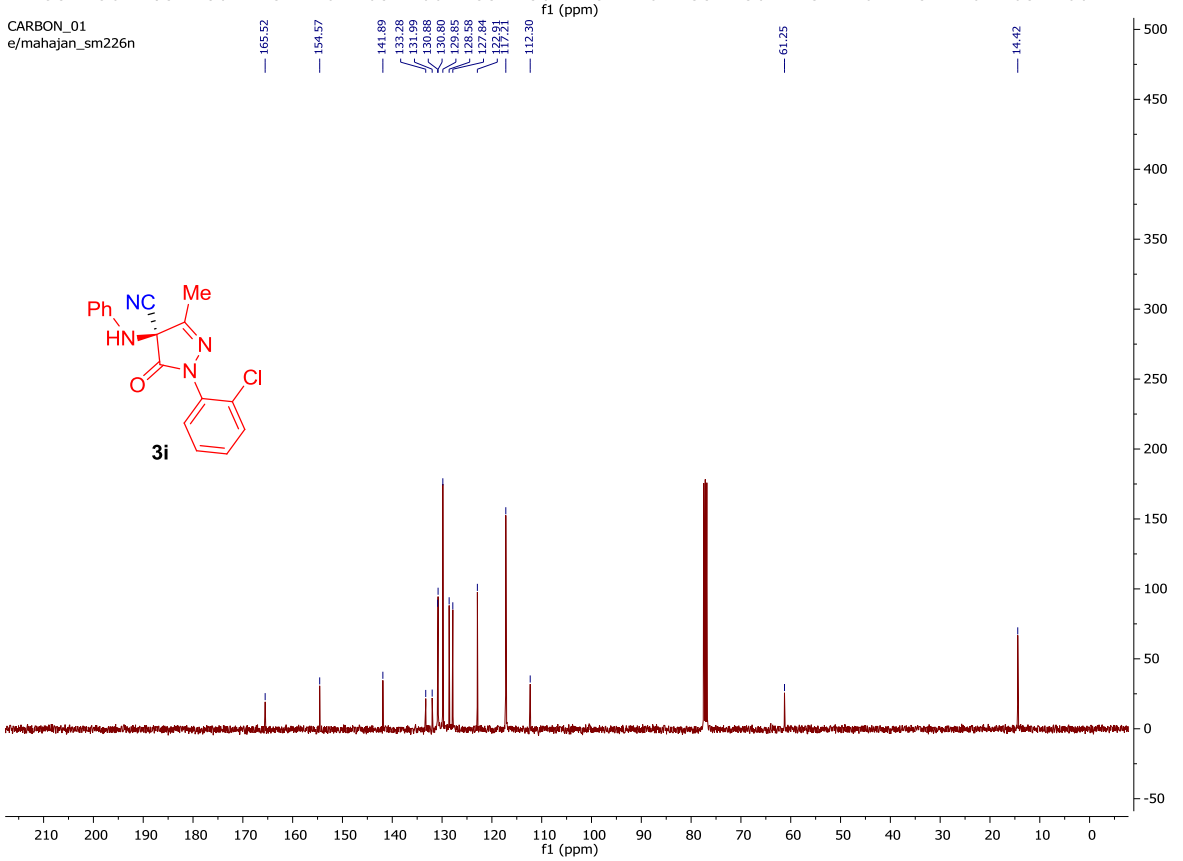

PROTON_01
e/mahajan_sm226j
7.870
7.868
7.865
7.858
7.855
7.854
7.850
7.469
7.465
7.460
7.456
7.454
7.445
7.442
7.302
7.300
7.298
7.289
7.287
7.286
7.277
7.275
7.273
7.155
7.143
7.052
7.049
7.039
7.036
7.026
7.023
6.895
6.893
6.882
6.881
6.870
6.868
6.451
6.450
6.438
6.436
4.413
2.317
2.292
NC
Me
HN
Me
N
O
N
Ph
3g
f1 (ppm)

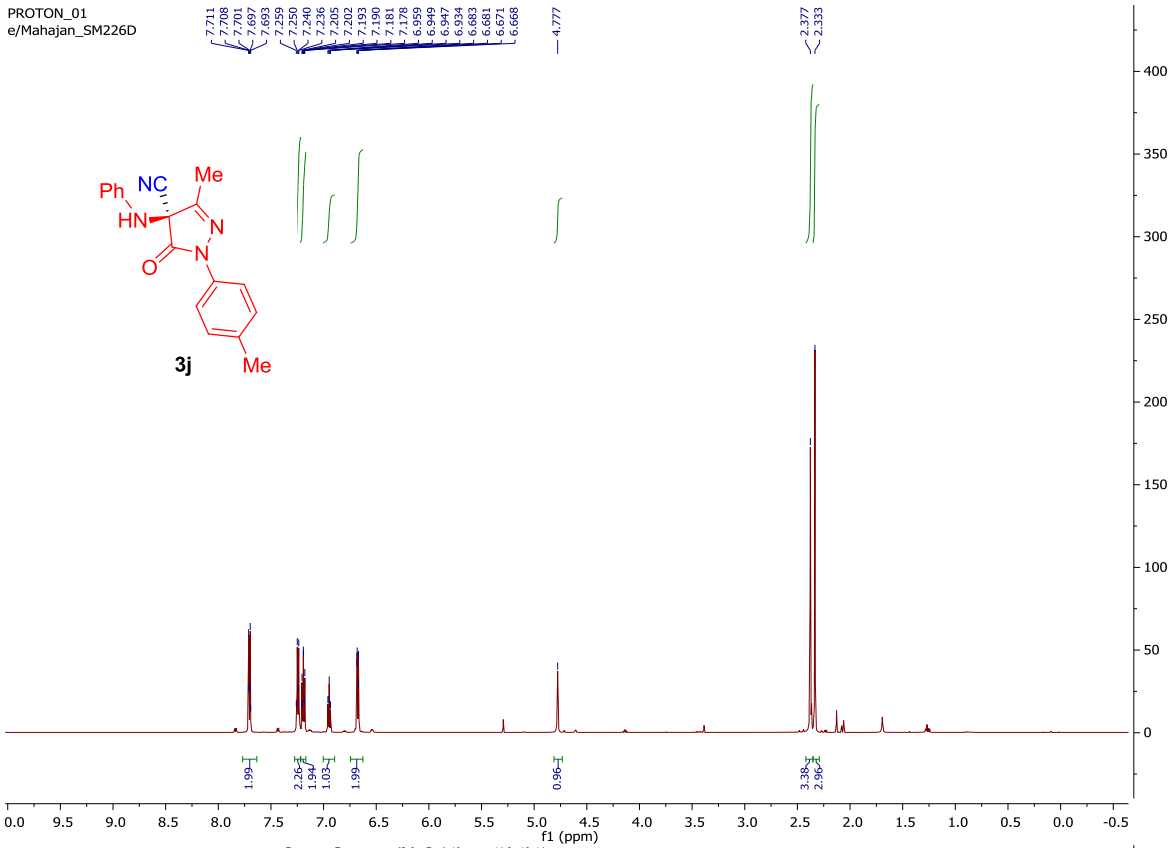

CARBON_01
e/mahajan_sm226j
164.81
154.82
140.23
137.03
131.37
129.31
127.59
126.58
125.91
122.29
119.21
113.16
112.60
62.35
17.73
14.49
NC
Me
HN
Me
N
O
N
Ph
3g
f1 (ppm)

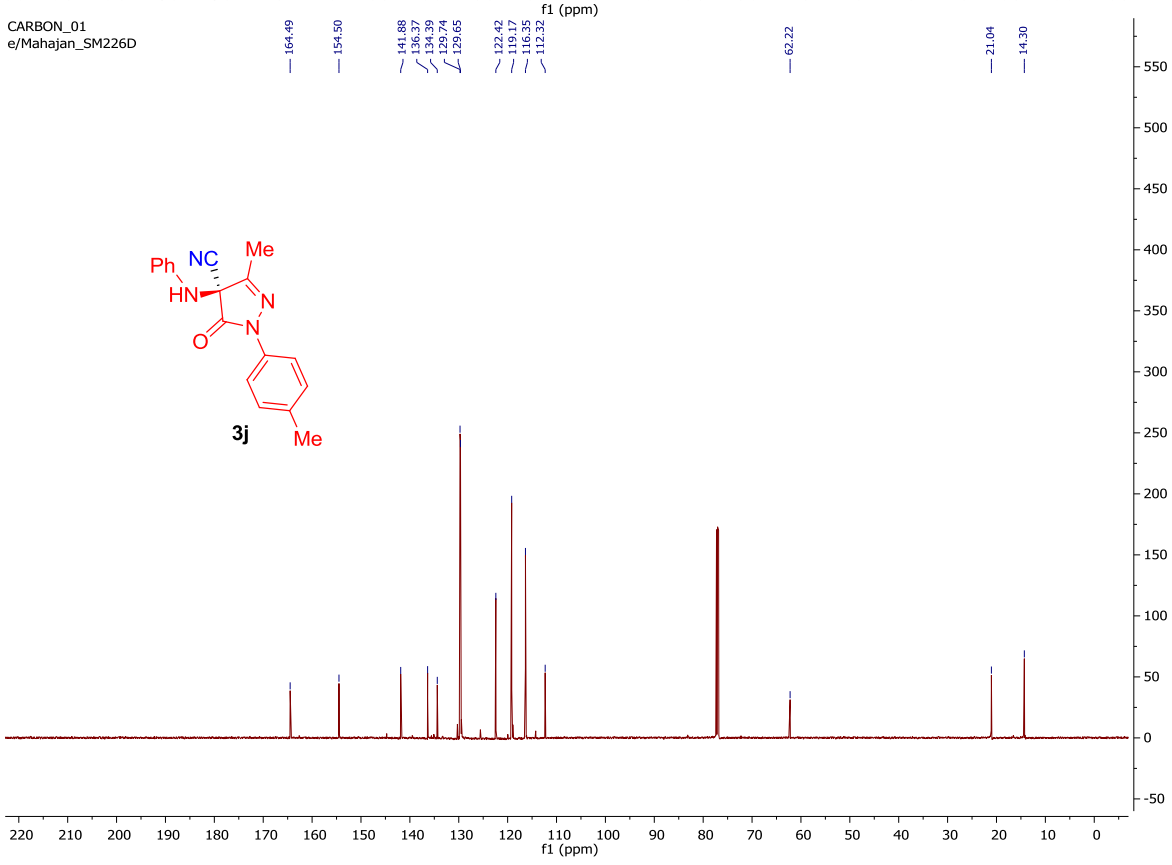

PROTON_01
e/Mahajan_SM226E
7.815
7.810
7.807
7.799
7.795
7.790
7.411
7.406
7.402
7.394
7.391
7.386
7.260
7.223
7.220
7.215
7.211
7.209
7.205
7.200
7.197
6.984
6.982
6.980
6.971
6.970
6.968
6.959
6.957
6.956
6.690
6.687
6.685
6.682
6.675
6.672
6.670
4.638
2.349
Ph
NC
Me
HN
N
N
O
Cl
3h
2.14
2.06
2.07
1.08
2.09
1.00
3.20
f1 (ppm)

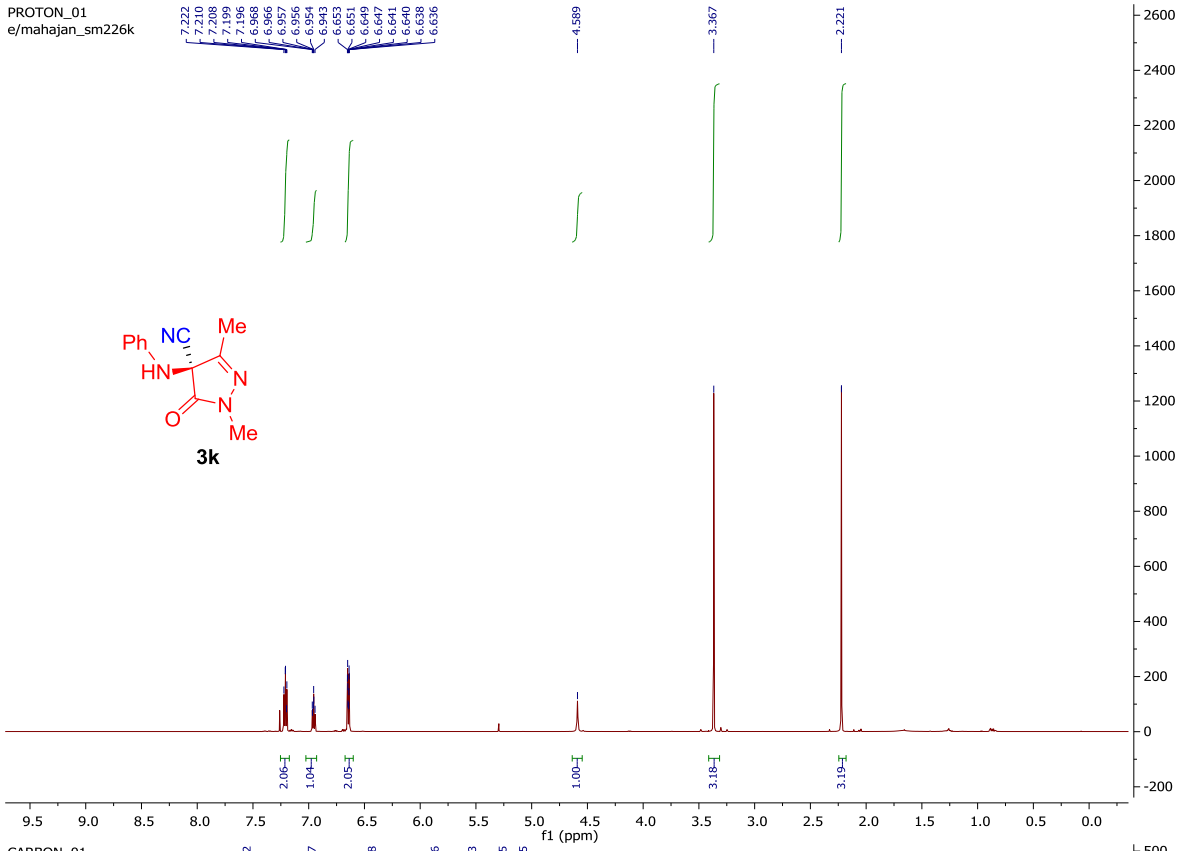

CARBON_01
e/Mahajan_SM226E
164.63
155.06
141.77
135.48
131.82
129.96
129.37
122.90
120.25
116.71
112.19
62.44
14.49
Ph
NC
Me
HN
N
N
O
Cl
3h
f1 (ppm)

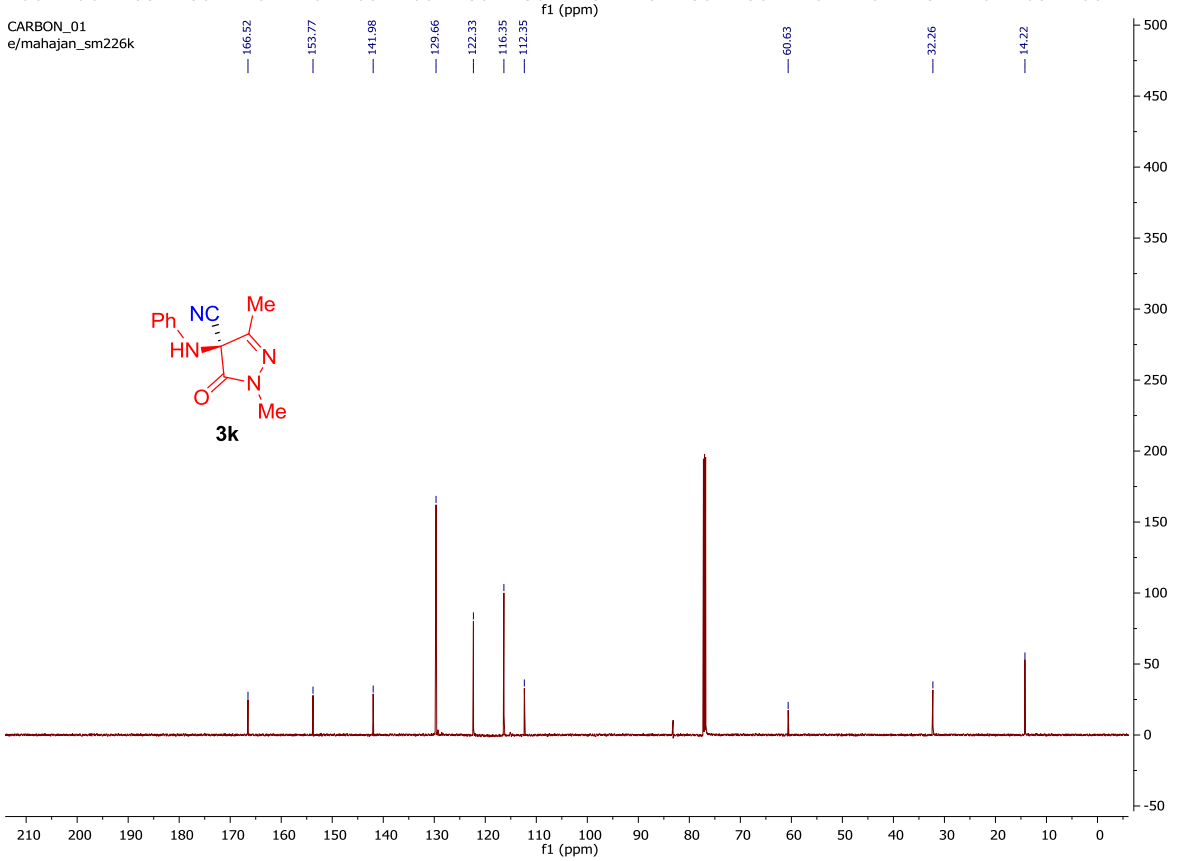

PROTON_01
e/mahajan_sm226n
7.517
7.510
7.503
7.497
7.494
7.487
7.390
7.381
7.374
7.366
7.359
7.349
7.344
7.340
7.333
7.328
7.323
7.246
7.242
7.227
7.224
7.211
7.206
7.200
6.999
6.981
6.962
6.790
6.787
6.773
6.768
4.678
2.324
Ph
NC
Me
HN
N
O
N
Cl
3i
0.98
2.71
1.91
1.04
1.85
1.00
2.93
f1 (ppm)

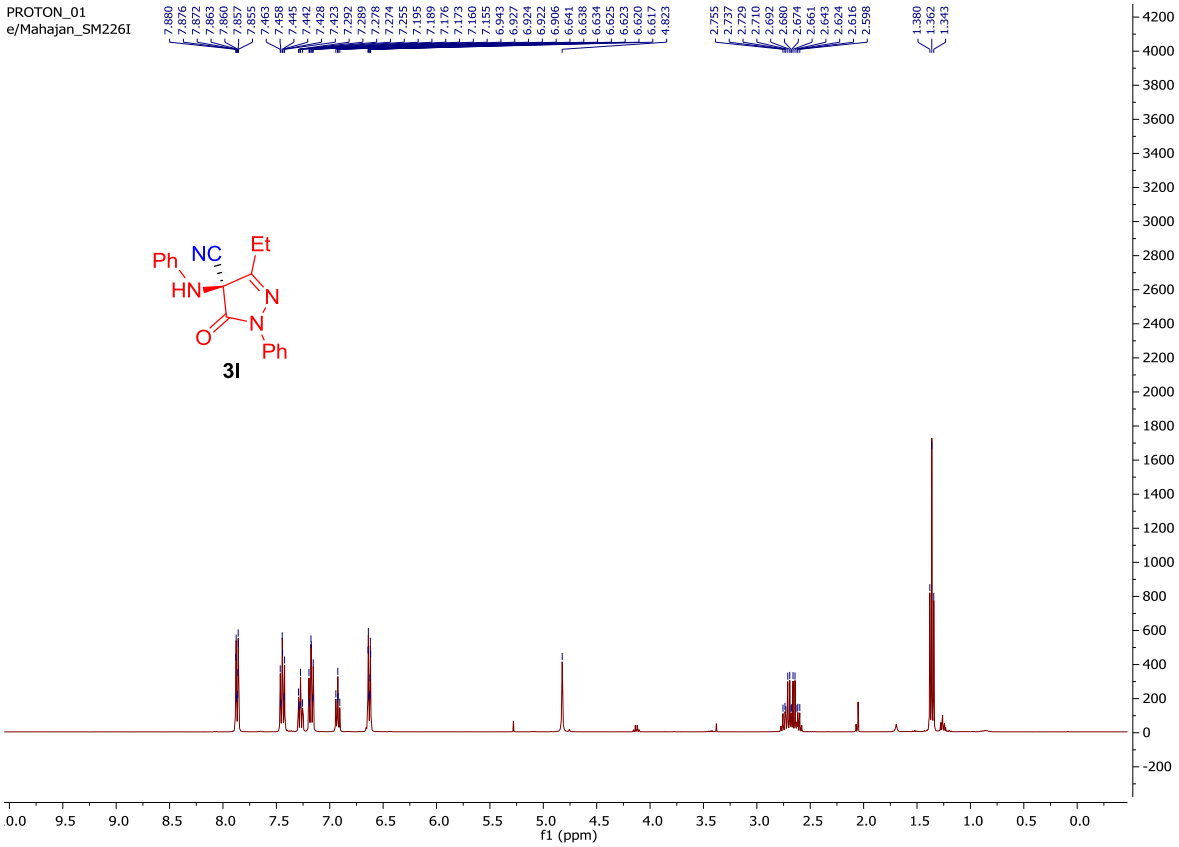

CARBON_01
e/mahajan_sm226n
165.52
154.57
141.89
133.28
131.99
130.88
130.80
129.85
128.58
127.84
122.91
117.21
112.30
61.25
14.42
Ph
NC
Me
HN
N
O
N
Cl
3i
f1 (ppm)

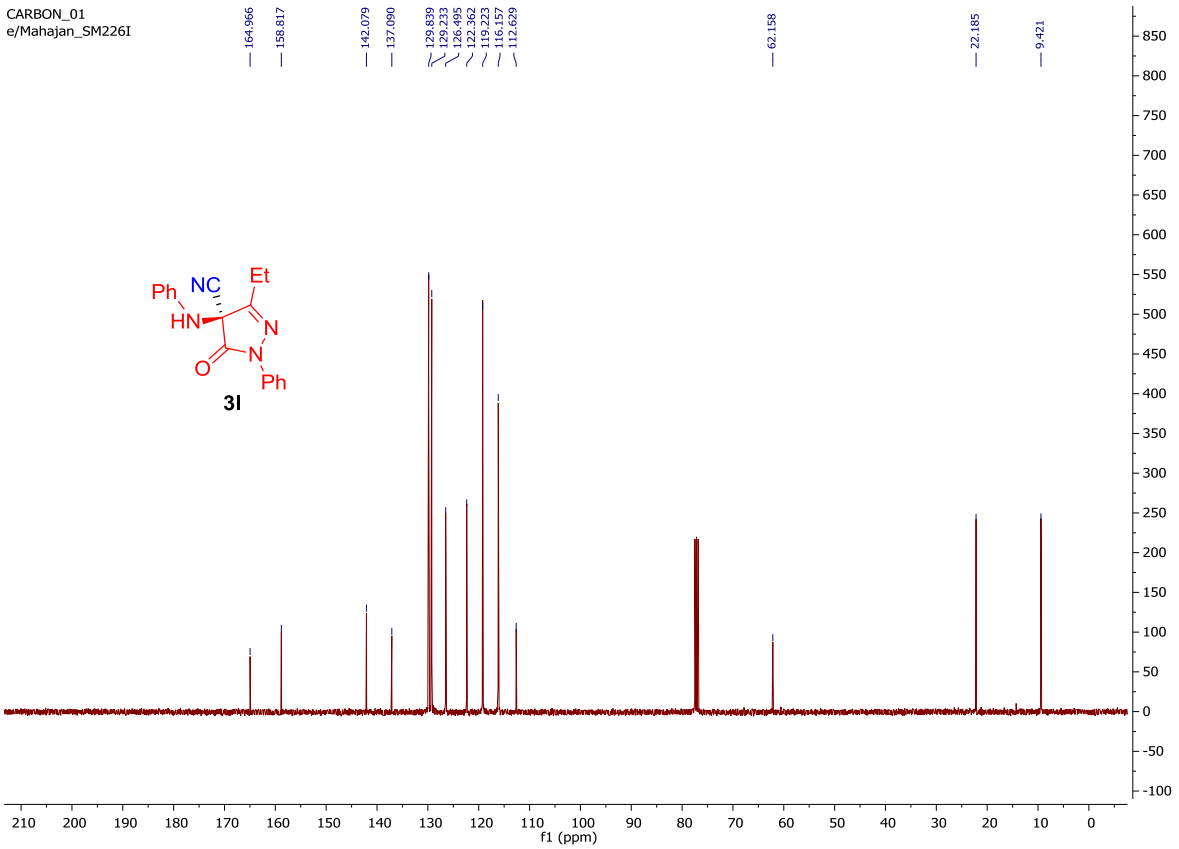

PROTON_01
e/Mahajan_SM226D
7.711
7.708
7.701
7.697
7.693
7.259
7.250
7.240
7.236
7.205
7.202
7.193
7.190
7.181
7.178
6.959
6.949
6.947
6.934
6.683
6.681
6.671
6.668
4.777
2.377
2.333
Ph
NC
Me
HN
N
N
O
Me
3j
1.99
2.26
1.94
1.03
1.99
0.96
3.38
2.96
f1 (ppm)

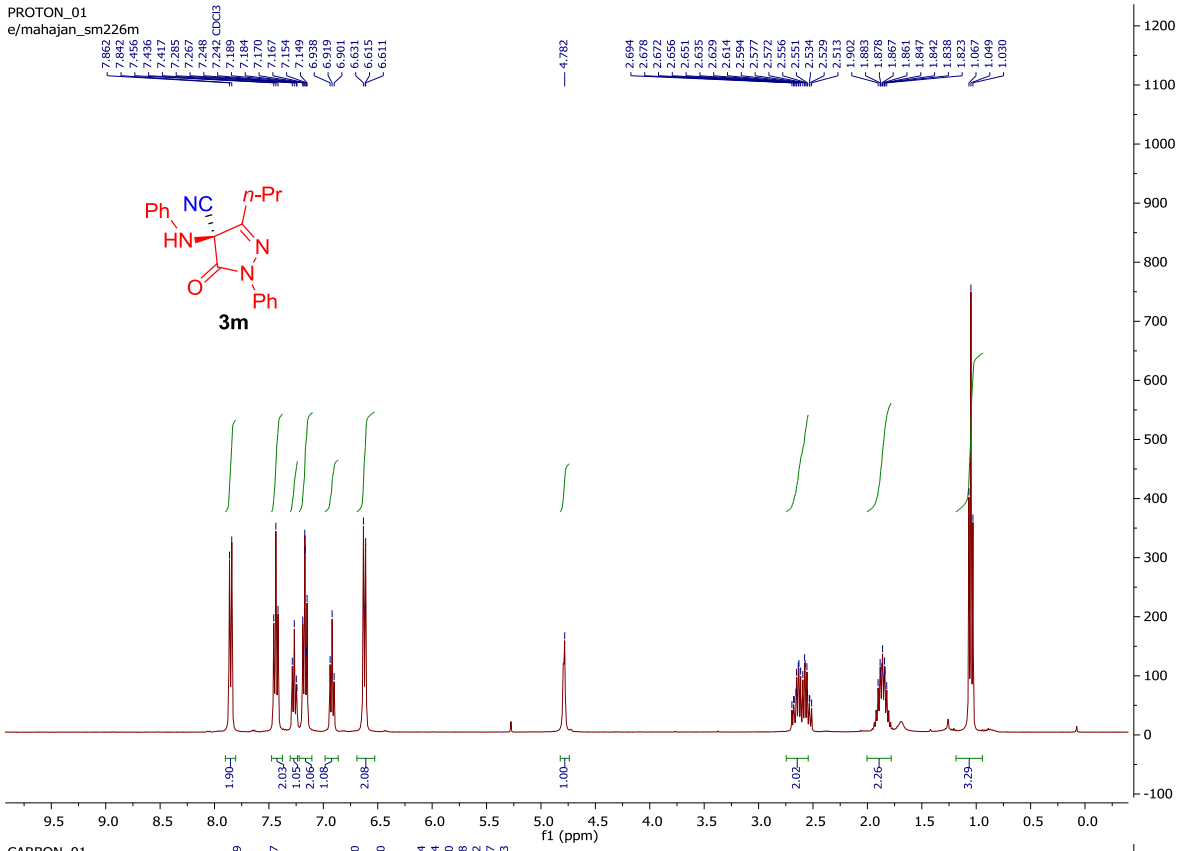

CARBON_01
e/Mahajan_SM226D
164.49
154.50
141.88
136.37
134.39
129.74
129.65
122.42
119.17
116.35
112.32
62.22
21.04
14.30
Ph
NC
Me
HN
N
N
O
Me
3j
f1 (ppm)

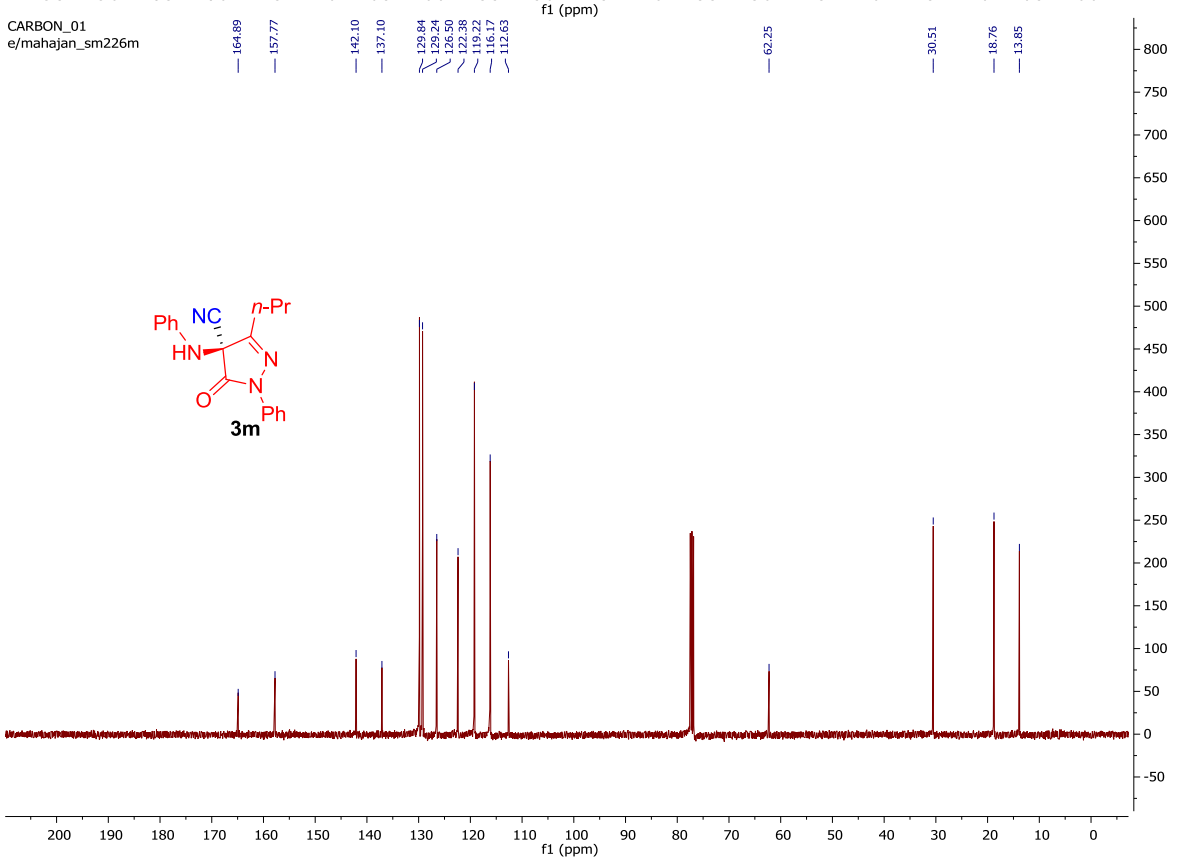

PROTON_01
e/mahajan_sm226k
7.222
7.210
7.208
7.199
7.196
6.968
6.966
6.957
6.956
6.954
6.943
6.653
6.651
6.649
6.647
6.641
6.640
6.638
6.636
4.589
3.367
2.221
Ph
NC
HN
Me
N
O
N
Me
3k
2.06
1.04
2.05
1.00
3.18
3.19
f1 (ppm)

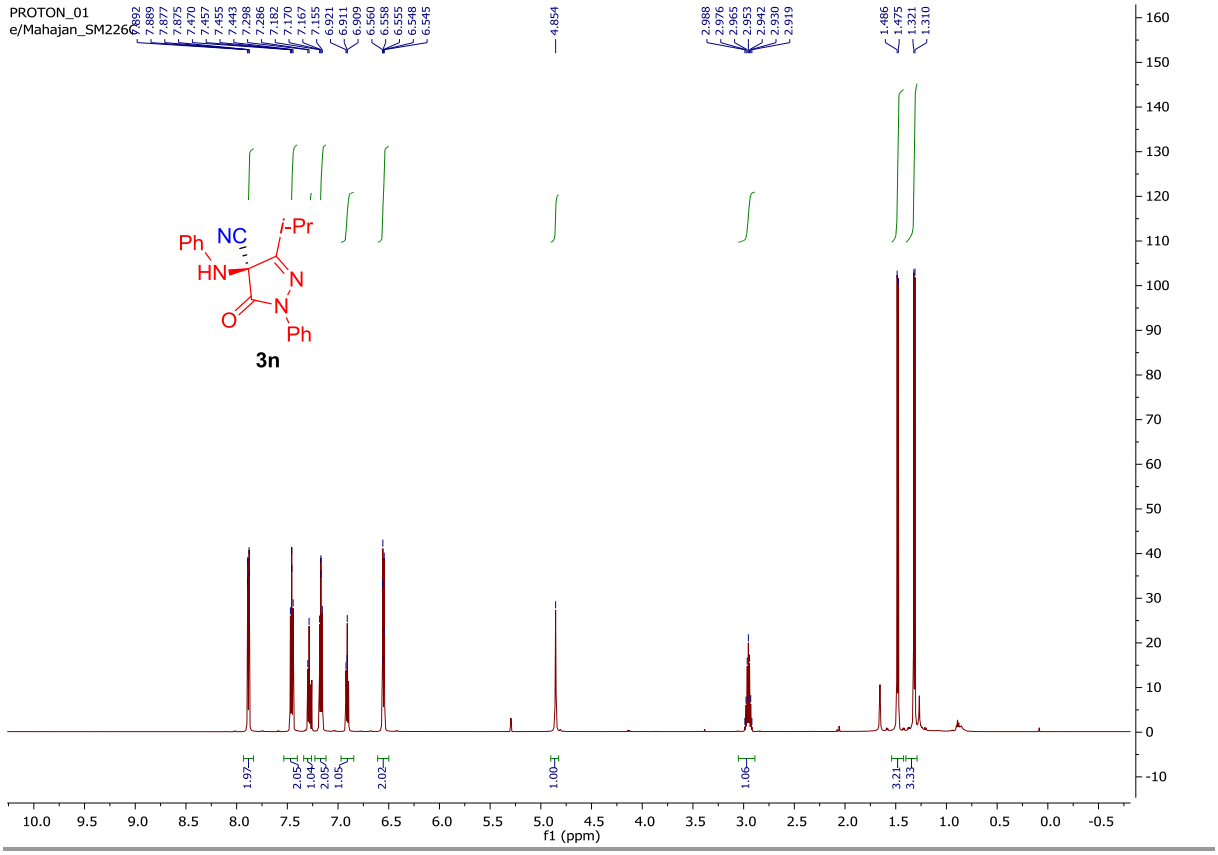

CARBON_01
e/mahajan_sm226k
166.52
153.77
141.98
129.66
122.33
116.35
112.35
60.63
32.26
14.22
Ph
NC
HN
Me
N
O
N
Me
3k
f1 (ppm)

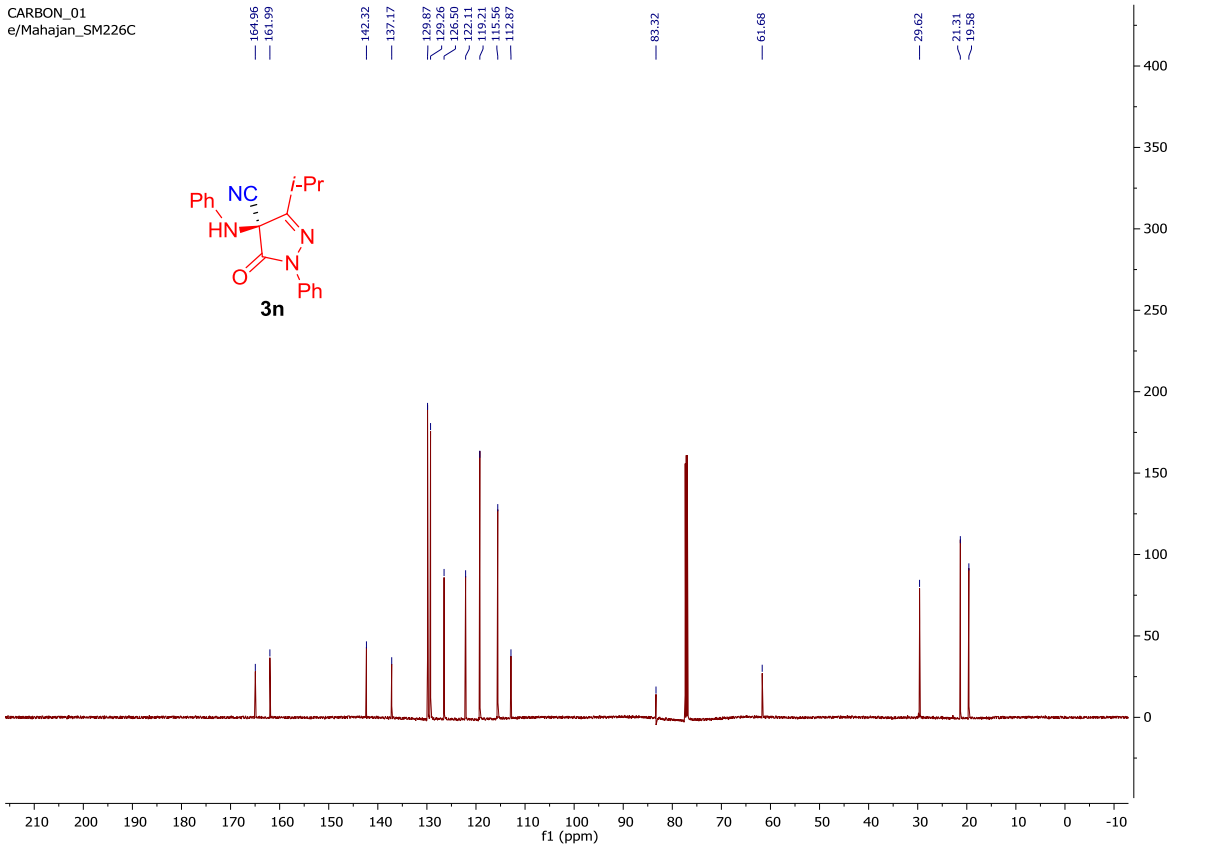

PROTON_01
e/Mahajan_SM226I
7.880
7.876
7.872
7.863
7.860
7.857
7.855
7.463
7.458
7.445
7.442
7.428
7.423
7.292
7.289
7.278
7.274
7.255
7.195
7.189
7.176
7.173
7.160
7.155
6.943
6.927
6.924
6.922
6.906
6.641
6.638
6.634
6.625
6.623
6.620
6.617
4.023
2.755
2.737
2.729
2.710
2.692
2.680
2.674
2.661
2.643
2.624
2.616
2.598
1.380
1.362
1.343
Ph
NC
Et
HN
N
O
N
Ph
3l
f1 (ppm)

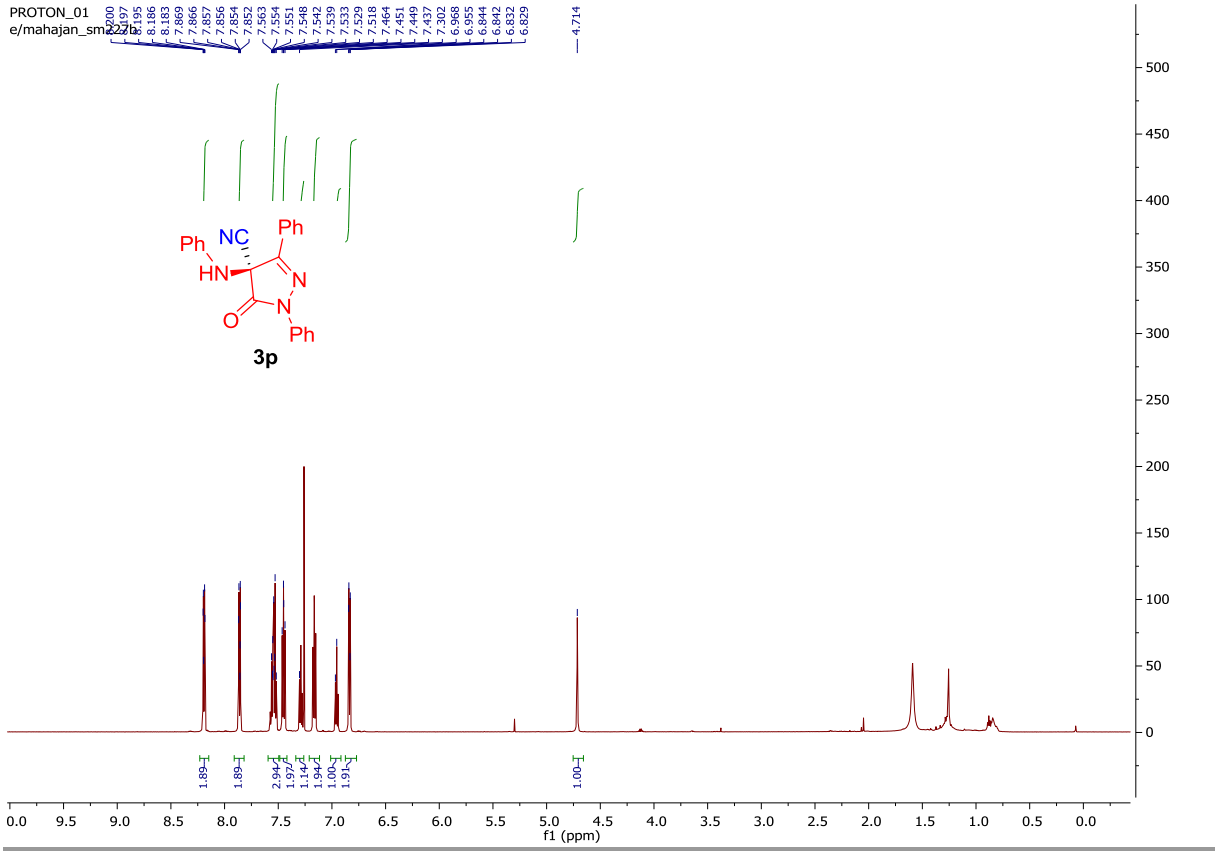

CARBON_01
e/Mahajan_SM226I
164.966
158.817
142.079
137.090
129.839
129.233
126.495
122.362
119.223
116.157
112.629
62.158
22.185
9.421
Ph
NC
Et
HN
N
O
N
Ph
3l
f1 (ppm)

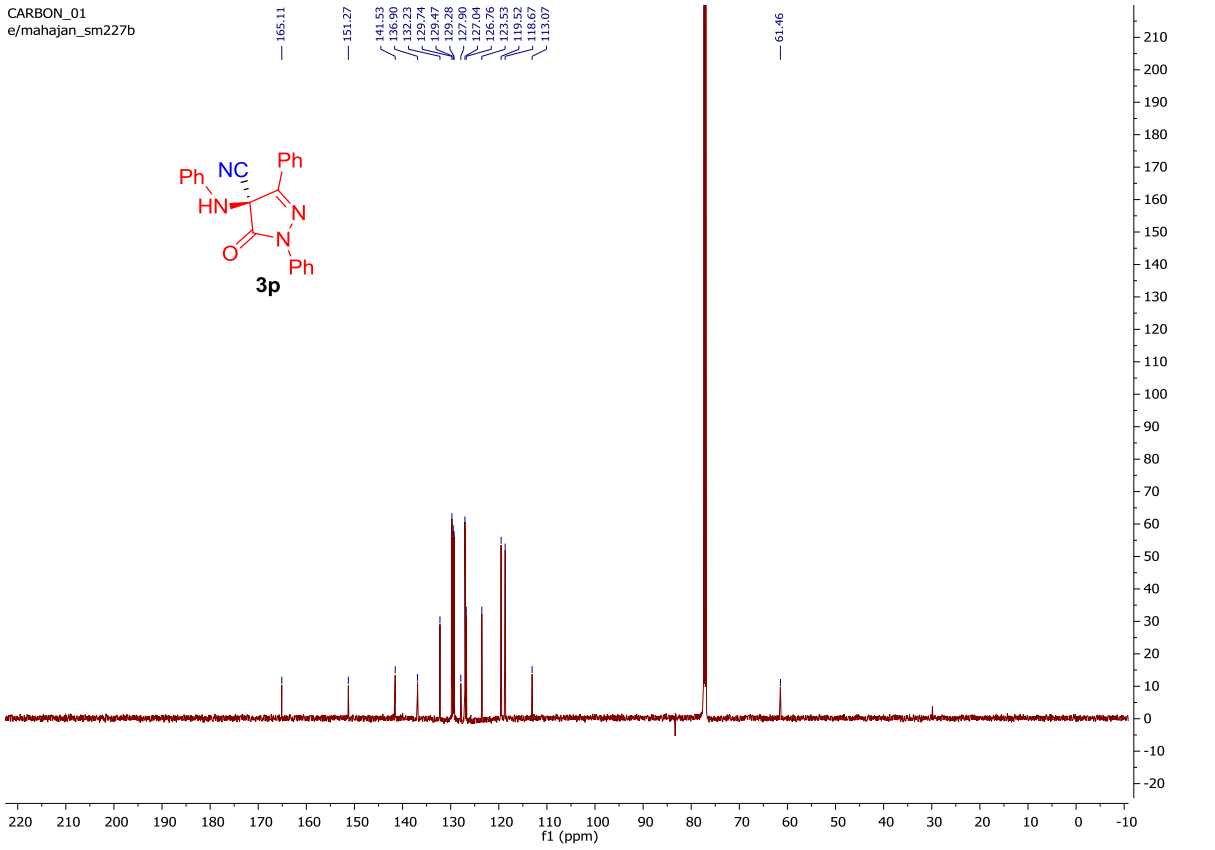

PROTON_01
e/mahajan_sm226m
CDCl3
7.862
7.842
7.456
7.436
7.417
7.285
7.267
7.248
7.242
7.189
7.184
7.170
7.167
7.154
7.149
6.938
6.919
6.901
6.631
6.615
6.611
4.782
2.694
2.678
2.672
2.656
2.651
2.635
2.629
2.614
2.594
2.577
2.572
2.556
2.551
2.534
2.529
2.513
1.902
1.883
1.878
1.867
1.861
1.847
1.842
1.838
1.823
1.067
1.049
1.030
Ph
NC
n-Pr
HN
N
O
N
Ph
3m
1.90
2.03
1.05
2.06
1.08
2.08
1.00
2.02
2.26
3.29
f1 (ppm)

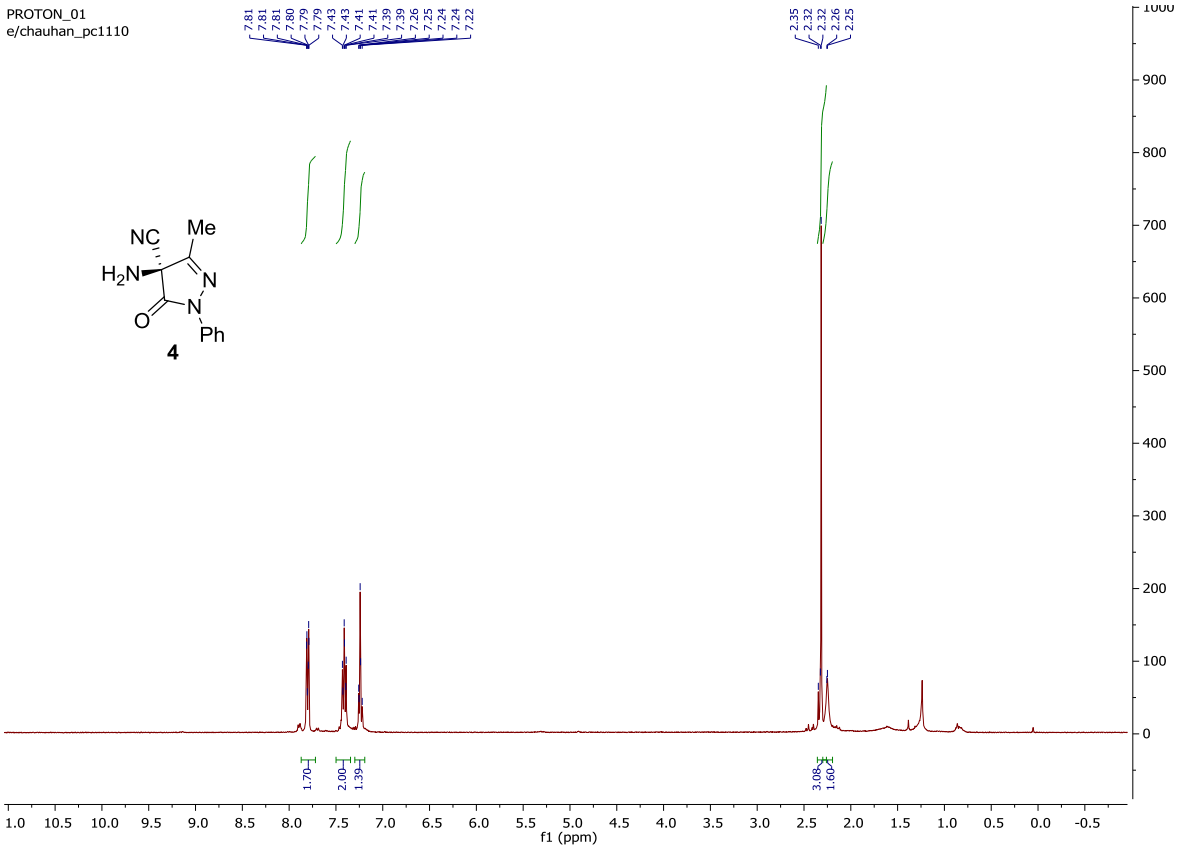

CARBON_01
e/mahajan_sm226m
164.89
157.77
142.10
137.10
129.84
129.24
126.50
122.38
119.22
116.17
112.63
62.25
30.51
18.76
13.85
Ph
NC
n-Pr
HN
N
O
N
Ph
3m
f1 (ppm)

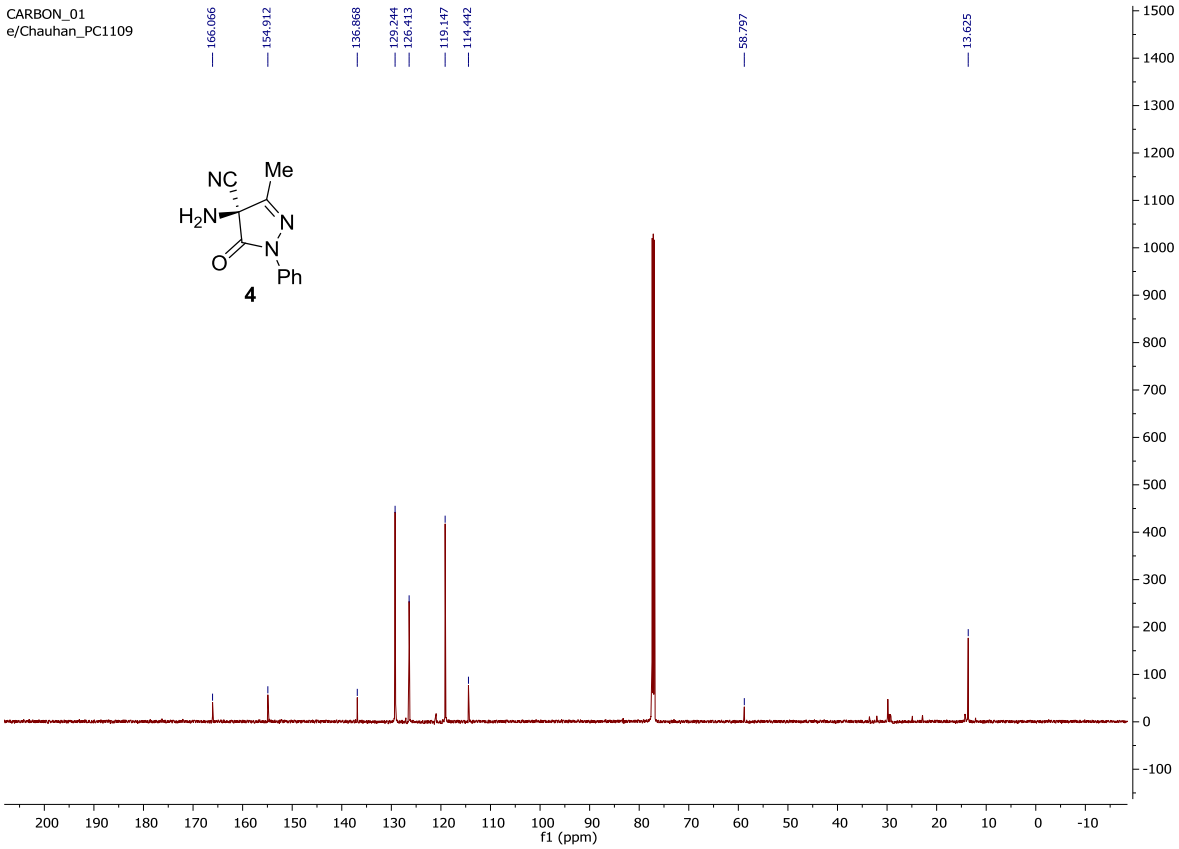

PROTON_01
e/Mahajan_SM226C
7.892
7.889
7.877
7.875
7.470
7.457
7.455
7.443
7.298
7.286
7.182
7.170
7.167
7.155
6.921
6.911
6.909
6.560
6.558
6.555
6.548
6.545
4.854
2.988
2.976
2.965
2.953
2.942
2.930
2.919
1.486
1.475
1.321
1.310
Ph
NC
i-Pr
HN
N
O
N
Ph
3n
1.97
2.05
1.04
2.05
1.05
2.02
1.00
1.06
3.21
3.33
f1 (ppm)


CARBON_01
e/Mahajan_SM226C
164.96
161.99
142.32
137.17
129.87
129.26
126.50
122.11
119.21
115.56
112.87
83.32
61.68
29.62
21.31
19.58
Ph
NC
i-Pr
HN
N
O
N
Ph
3n
f1 (ppm)


PROTON_01
e/mahajan_sm227b
8.200
8.197
8.195
8.186
8.183
7.869
7.866
7.857
7.856
7.854
7.852
7.563
7.554
7.551
7.548
7.542
7.539
7.533
7.529
7.518
7.464
7.451
7.449
7.437
7.302
6.968
6.955
6.844
6.842
6.832
6.829
4.714
Ph
NC
HN
Ph
N
N
O
Ph
3p
1.89
1.89
2.94
1.97
1.14
1.94
1.00
1.91
1.00
f1 (ppm)


CARBON_01
e/mahajan_sm227b
165.11
151.27
141.53
136.90
132.23
129.74
129.47
129.28
127.90
127.04
126.76
123.53
119.52
118.67
113.07
61.46
Ph
NC
HN
Ph
N
N
O
Ph
3p
f1 (ppm)


PROTON_01
e/chauhan_pc1110
7.81
7.81
7.81
7.80
7.79
7.79
7.43
7.43
7.41
7.41
7.39
7.39
7.26
7.25
7.24
7.24
7.22
2.35
2.32
2.32
2.26
2.25
NC
Me
H2N
N
O
N
Ph
4
1.70
2.00
1.39
3.08
1.60
f1 (ppm)


CARBON_01
e/Chauhan_PC1109
166.066
154.912
136.868
129.244
126.413
119.147
114.442
58.797
13.625
NC
Me
H2N
N
O
N
Ph
4
f1 (ppm)

HPLC Data:

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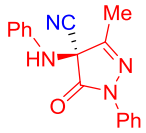
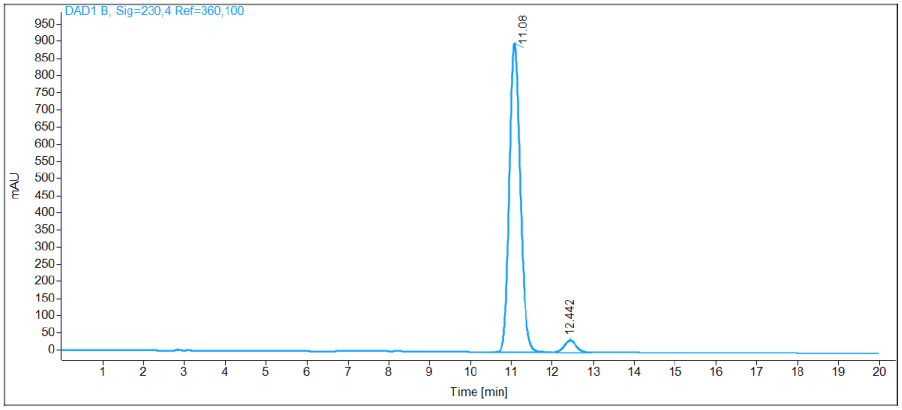


(*R*)-**3a**

Sample name: SM 226 L
Data file: C:\SNOOPY\SM\226LIC.D
Description: Mobile phase: n-Heptane/iPrOH 97:3 ; The sample is solved in DCM/MP
Injection date: 8/25/2016 3:36:41 PM
Acq. Analysis method: CHIRALPAKIC1-6LNP.M

Column: Chiralpak IC, (150 x 4,6) mm, 5µ, SN: IC00CD-QF015

Pressure at start: 23 bar **Start flow:** 0.700 ml/min **Column oven:** 29.98 °C



Name SM 226 L

RT [min]	Type	Area%	Area	Height	Width [min]
11.08	BV	95.49	16429.87	899.33	0.28
12.44	MM	4.51	775.52	35.74	0.36
	Sum	100.00	17205.39		

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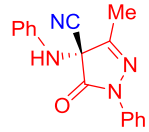
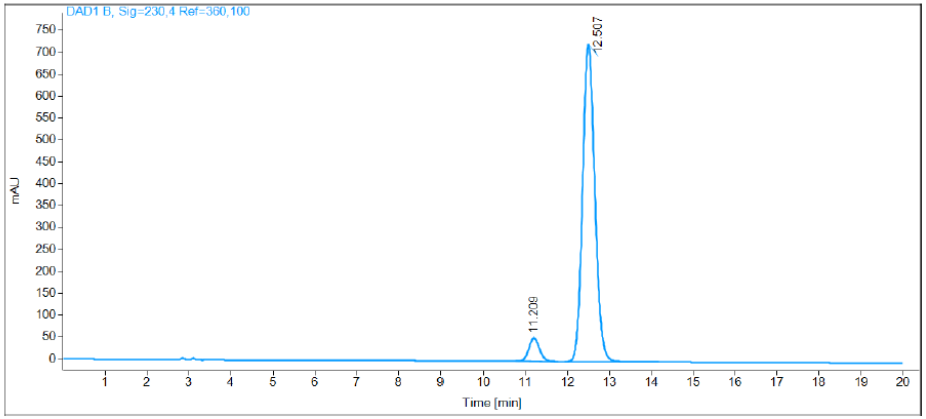


(*S*)-**3a**

Sample name: SM 227 L
Data file: C:\SNOOPY\SM\227LIC.D
Description: Mobile phase: n-Heptane/iPrOH 97:3 ; The sample is solved in DCM/MP
Injection date: 8/25/2016 3:57:49 PM
Acq. Analysis method: CHIRALPAKIC1-6LNP.M

Column: Chiralpak IC, (150 x 4,6) mm, 5µ, SN: IC00CD-QF015

Pressure at start: 23 bar **Start flow:** 0.700 ml/min **Column oven:** 29.98 °C



Name SM 227 L

RT [min]	Type	Area%	Area	Height	Width [min]
11.21	MM	6.12	953.52	52.93	0.30
12.51	BB	93.88	14637.44	723.92	0.31
	Sum	100.00	15590.96		

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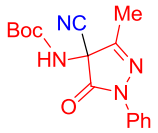
Sample name: **SM 200**
Data file: C:\SNOOPY\SM\SM 200 IA.D
Description: Mobile phase: n-Heptane/iPrOH 7:3;
The sample is solved in DCM/MP

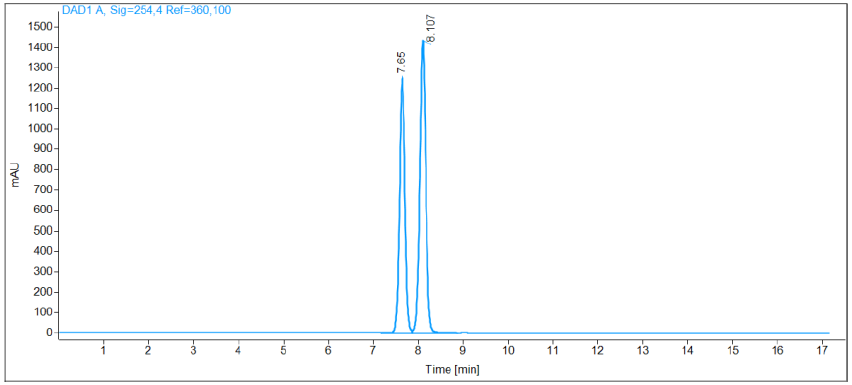
Injection date: 3/23/2016 8:50:39 AM
Acq. Analysis method: CHIRALPAKIARNP.M



(*rac*)-**3b**

Column: Chiralpak IA, (250 x 4,6) mm, 5µ, SN: IA00CE-RC036

Pressure at start: 30 bar **Start flow:** 0.500 ml/min **Column oven:** 29.99 °C



Name SM 200

RT [min]	Type	Area%	Area	Height	Width [min]
7.65	BV	44.81	10882.83	1249.23	0.14
8.11	VV	55.19	13402.97	1432.66	0.15
	Sum	100.00	24285.80		

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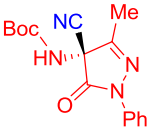
Sample name: **SM2270 chiral**
Data file: C:\SNOOPY\PC\2270IA.D
Description: Mobile phase: n-Heptane/iPrOH 7:3; 0.5 ml min-1 Chiralpack IA
The sample is solved in DCM/MP

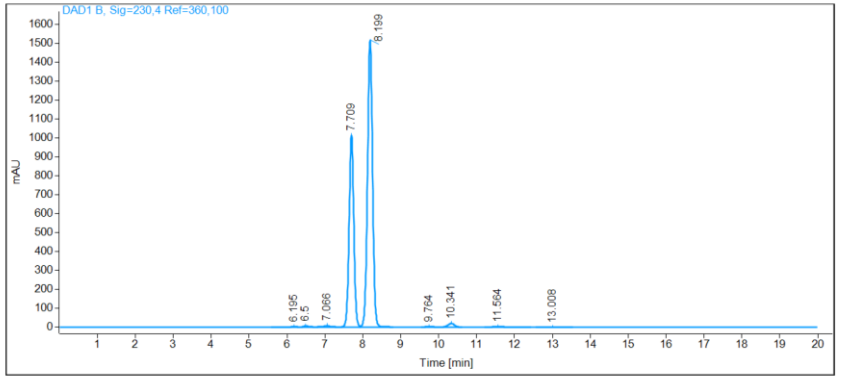
Injection date: 2/3/2017 10:30:43 AM
Acq. Analysis method: CHIRALPAK-IA.M



(*S*)-**3b**

Column: Chiralpak IA, (250 x 4,6) mm, 5µ, SN: IA00CE-RC036

Pressure at start: 30 bar **Start flow:** 0.500 ml/min **Column oven:** 30 °C



Name SM2270 chiral

RT [min]	Type	Area%	Area	Height	Width [min]
6.19	BV	0.18	41.48	3.58	0.17
6.50	VV	0.31	70.56	6.92	0.14
7.07	VB	0.45	103.95	8.20	0.18
7.71	BV	37.38	8630.44	1013.74	0.13
8.20	VB	60.24	13907.24	1514.70	0.14

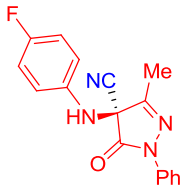
Sample Name: SM226F
Data file: D:\ERNIE\SM\226FAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 8:2
;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4)mm; 5µ non-chiral column

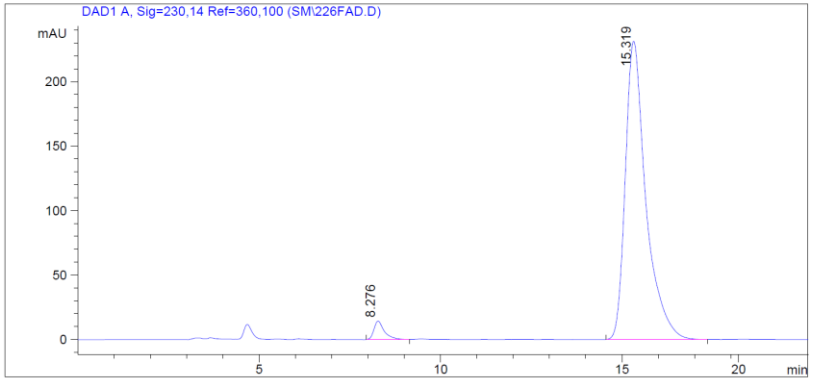
Operator: Analytical Lab AKEN

Injektion Time: 13:27:14
Injektion Date: 17.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	36.9	35.8
Flow in ml/min:	1.0	1.0



(*R*)-**3c**



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	8.28	0.30	14.33	284.71	3.03
2	15.32	0.58	231.55	9126.17	96.97
Total				9410.88	100.00

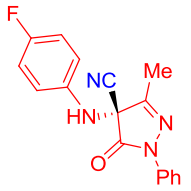
Sample Name: SM227F
Data file: D:\ERNIE\SM\227FAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 8:2
;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4)mm; 5µ non-chiral column

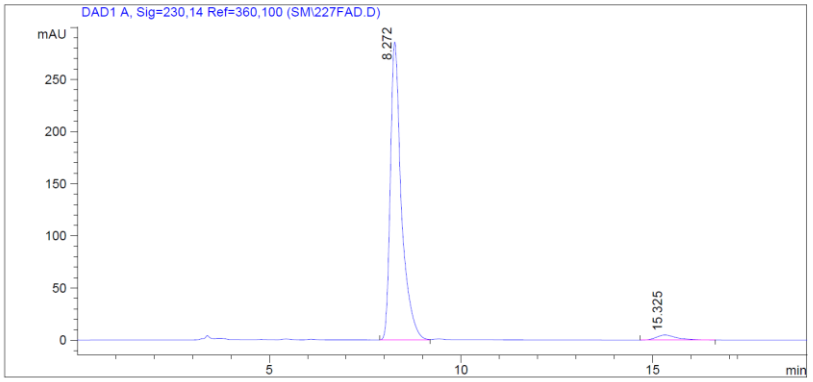
Operator: Analytical Lab AKEN

Injektion Time: 13:48:15
Injektion Date: 17.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	36.5	35.7
Flow in ml/min:	1.0	1.0



(*S*)-**3c**



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	8.27	0.29	286.02	5715.41	96.78
2	15.32	0.57	4.93	190.26	3.22
Total				5905.67	100.00

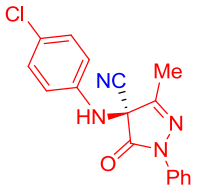
Sample Name: SM226G
Data file: D:\ERNIE\SM\226GAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3
;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4)mm; 5µ non-chiral column

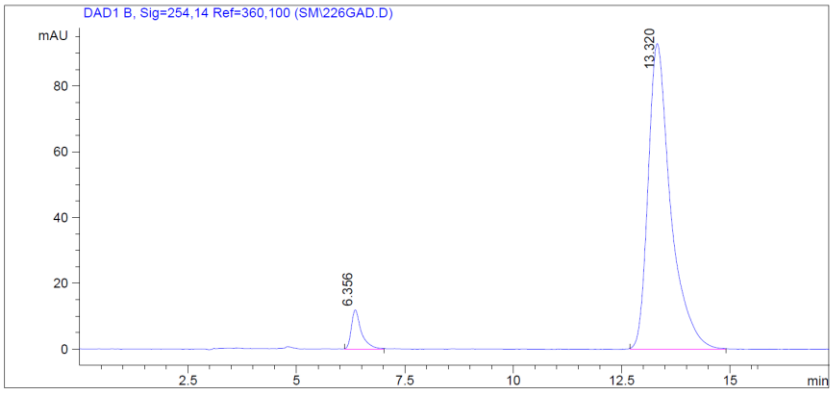
Operator: Analytical Lab AKEN

Injektion Time: 15:05:13
Injektion Date: 17.08.2016

Instrument Conditions:	At Start	At Sto
Temperature in°C:	30.0	30.0
Pressure in bar:	42.2	40.8
Flow in ml/min:	1.0	1.0



(*R*)-**3d**



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	6.36	0.23	11.91	189.69	5.36
2	13.32	0.54	92.98	3352.00	94.64
Total				3541.69	100.00

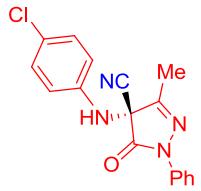
Sample Name: SM227G
Data file: D:\ERNIE\SM\227G2AD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3
;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4.6)mm 10µ

Operator: Analytical Lab AKEN

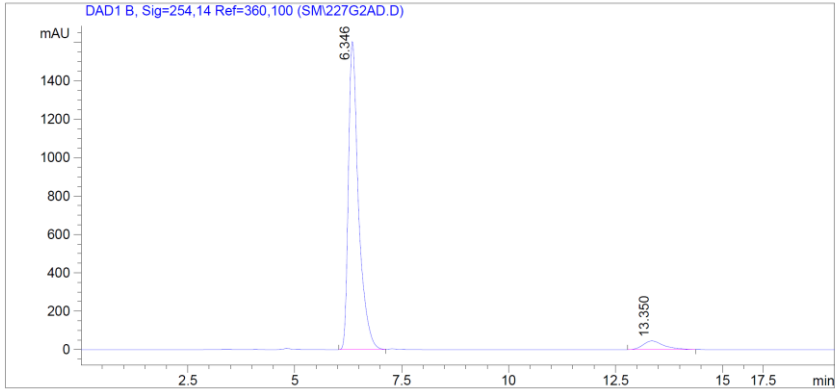
Injektion Time: 07:47:25
Injektion Date: 18.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	42.0	41.1
Flow in ml/min:	1.0	1.0



(*S*)-**3d**

->



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	6.35	0.24	1606.19	26431.27	94.42
2	13.35	0.51	45.35	1562.30	5.58
Total				27993.57	100.00

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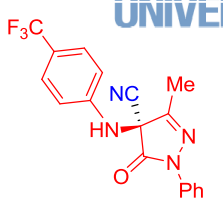
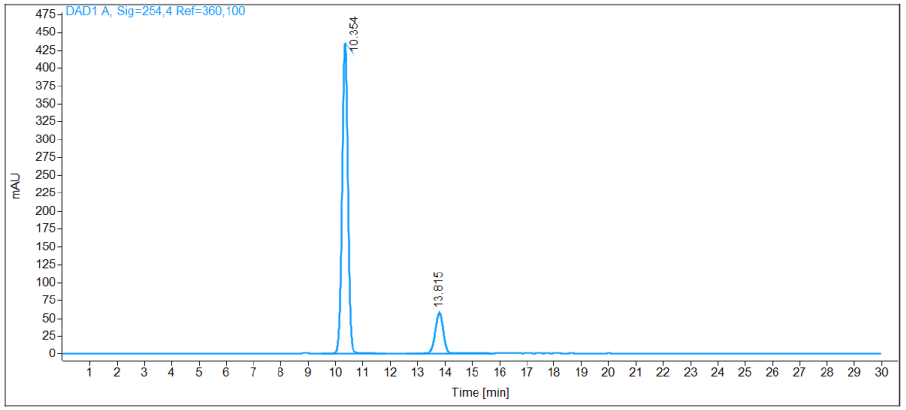


(*R*)-**3e**

Sample name: PC-1116
Data file: C:\SNOOPY\PC\PC1116.D
Description: Mobile phase: n-Heptane/iPrOH 9:1; flow rate 1.0 ml/min
The sample is solved in DCM/MP
Injection date: 5/22/2017 10:40:51 AM
Acq. Analysis method: CHIRALPAK-IA.M
Column: Chiralpak IA, (250 x 4,6) mm, 5µ, SN: IA00CE-RC036
Pressure at start: 44 bar **Start flow:** 1.000 ml/min **Column oven:** 30 °C



Name PC-1116

RT [min]	Type	Area%	Area	Height	Width [min]
10.35	BB	84.51	6282.66	434.16	0.22
13.81	BB	15.49	1151.75	56.98	0.31
	Sum	100.00	7434.41		

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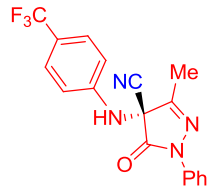
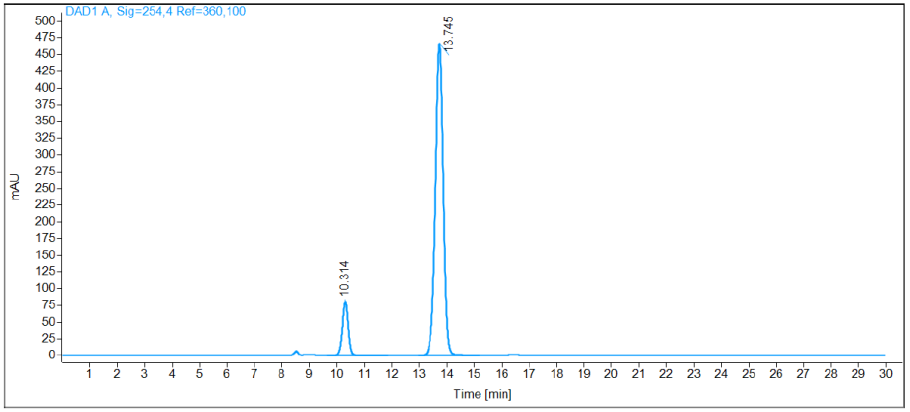


(*S*)-**3e**

Sample name: PC-1117
Data file: C:\SNOOPY\PC\PC1117.D
Description: Mobile phase: n-Heptane/iPrOH 9:1; flow rate 1.0 ml/min
The sample is solved in DCM/MP
Injection date: 5/22/2017 11:11:57 AM
Acq. Analysis method: CHIRALPAK-IA.M
Column: Chiralpak IA, (250 x 4,6) mm, 5µ, SN: IA00CE-RC036
Pressure at start: 44 bar **Start flow:** 1.000 ml/min **Colum**



Name PC-1117

RT [min]	Type	Area%	Area	Height	Width [min]
10.31	BB	11.15	1165.34	80.42	0.23
13.75	BB	88.85	9287.22	466.15	0.31
	Sum	100.00	10452.56		

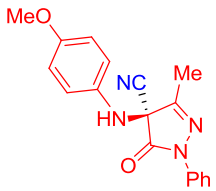
Sample Name: SM226H
Data file: D:\ERNIE\SM\226HAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3
;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4)mm; 5µ non-chiral column

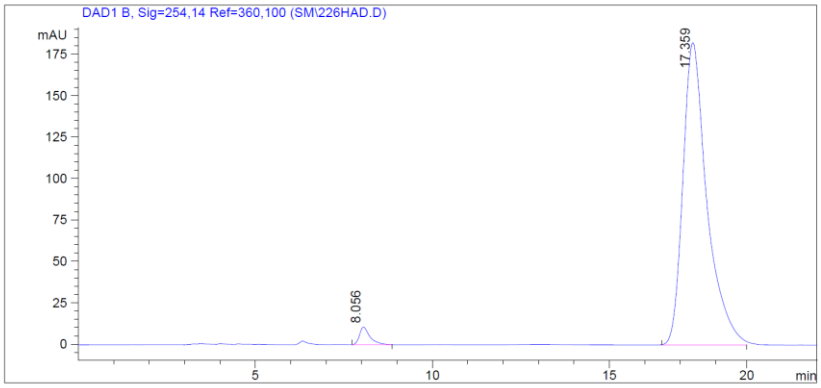
Operator: Analytical Lab AKEN

Injektion Time: 08:06:24
Injektion Date: 18.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	41.5	41.2
Flow in ml/min:	1.0	1.0



(*R*)-**3f**



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	8.06	0.30	10.64	217.26	2.46
2	17.36	0.70	182.33	8632.19	97.54
Total				8849.45	100.00

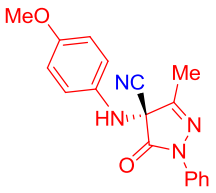
Sample Name: SM227H
Data file: D:\ERNIE\SM\227HAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3
;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4)mm; 5µ non-chiral column

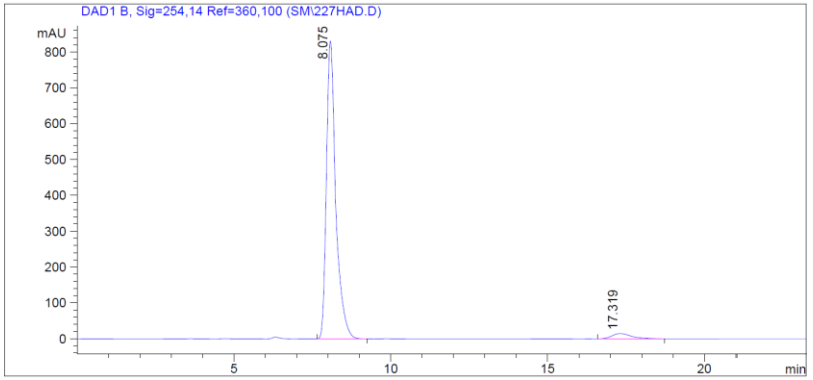
Operator: Analytical Lab AKEN

Injektion Time: 08:28:01
Injektion Date: 18.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	42.4	41.2
Flow in ml/min:	1.0	1.0



(*S*)-**3f**



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	8.07	0.31	831.68	17159.04	96.24
2	17.32	0.66	15.09	671.02	3.76
Total				17830.05	100.00

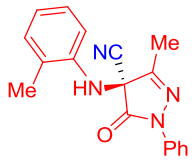
Sample Name: SM226J
Data file: D:\ERNIE\SM\226JAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3 ;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4)mm; 5µ non-chiral column

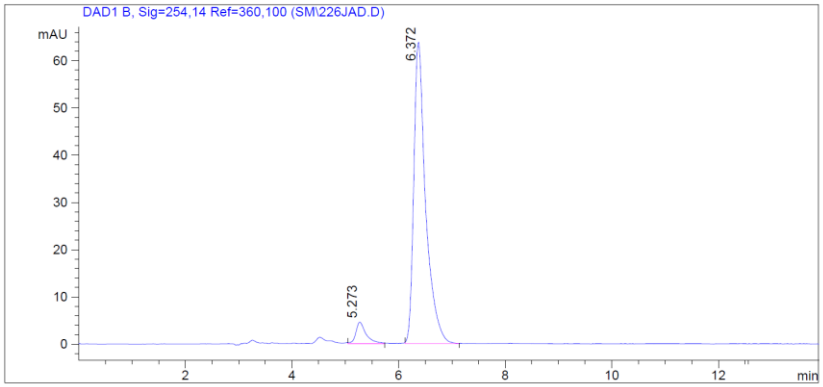
Operator: Analytical Lab AKEN

Injektion Time: 09:07:35
Injektion Date: 29.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	42.2	40.7
Flow in ml/min:	1.0	1.0



(*R*)-**3g**



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	5.27	0.20	4.57	61.16	5.84
2	6.37	0.23	63.81	985.33	94.16
Total				1046.49	100.00

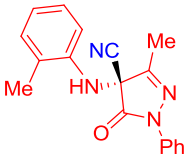
Sample Name: SM227J
Data file: D:\ERNIE\SM\227JAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3 ;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4)mm; 5µ non-chiral column

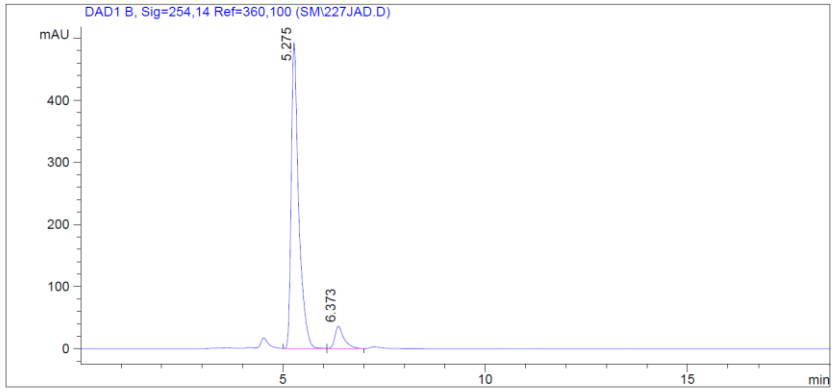
Operator: Analytical Lab AKEN

Injektion Time: 09:22:12
Injektion Date: 29.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	41.8	41.0
Flow in ml/min:	1.0	1.0



(*S*)-**3g**



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	5.28	0.19	493.48	6335.99	91.85
2	6.37	0.23	36.13	561.87	8.15
Total				6897.86	100.00

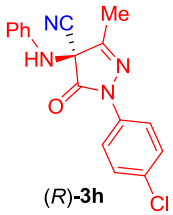
Sample Name: SM-226E
Data file: D:\ERNIE\SM\226EAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3
;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4.6)mm 10µ

Operator: Analytical Lab AKEN

Injektion Time: 10:31:22
Injektion Date: 16.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	41.7	41.2
Flow in ml/min:	1.0	1.0



(*R*)-3h

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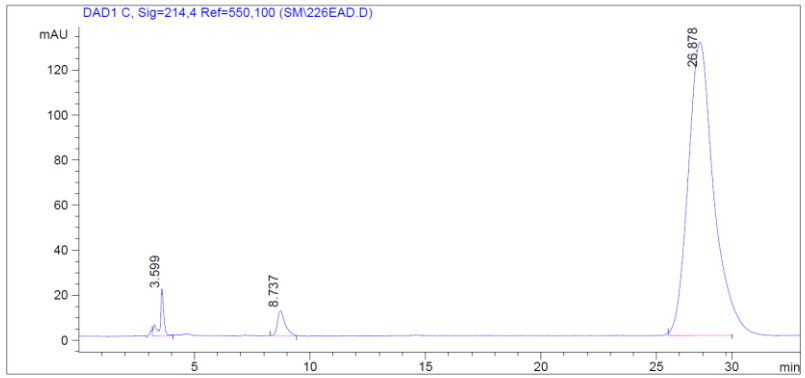


#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	3.60	0.21	19.67	240.35	2.27
2	8.74	0.37	11.06	257.24	2.43
3	26.88	1.16	130.16	10067.64	95.29
Total				10565.23	100.00

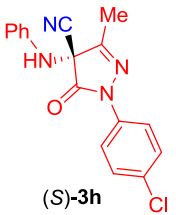
Sample Name: SM-227E
Data file: D:\ERNIE\SM\227EAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3
;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4.6)mm 10µ

Operator: Analytical Lab AKEN

Injektion Time: 11:03:35
Injektion Date: 16.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	42.4	41.3
Flow in ml/min:	1.0	1.0



(*S*)-3h

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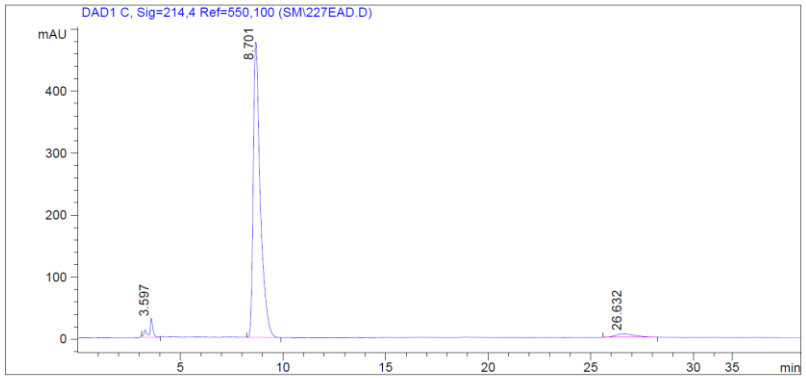
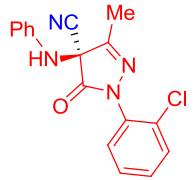


#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	3.60	0.24	27.59	410.22	3.39
2	8.70	0.39	454.51	11323.53	93.56
3	26.63	1.12	5.50	369.57	3.05
Total				12103.33	100.00

AK Prof. Enders - Analytiklabor 4.04



(*R*)-**3i**

Sample name: **SM-227N**

Data file: C:\SNOOPY\SM\227NIC.D

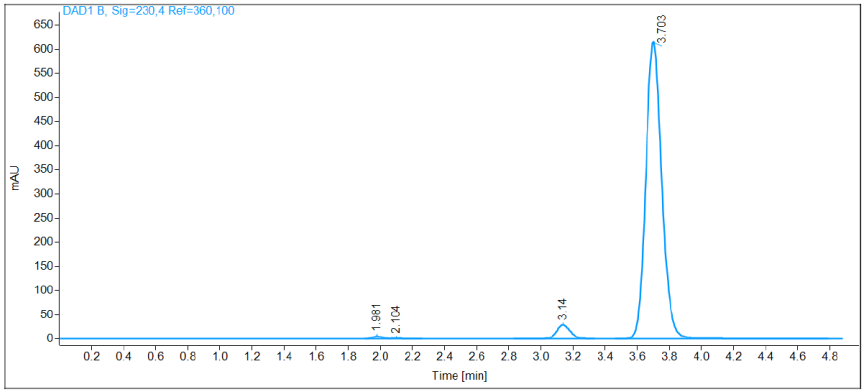
Description: Mobile phase: n-Heptane/i-PrOH 8:2 ;
The sample is solved in DCM/MP

Injection date: 11/16/2016 2:48:46 PM

Acq. Analysis method: CHIRALPAKIC1-6LNP.M

Column: Chiralpak IC, (150 x 4,6) mm, 5µ, SN: IC00CD-QF015

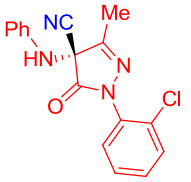
Pressure at start: 40 bar **Start flow:** 1.000 ml/min **Column oven:** 29.99 °C



Name SM-227N

RT [min]	Type	Area%	Area	Height	Width [min]
1.98	BV	0.49	21.75	5.15	0.07
2.10	VV	0.11	4.93	1.00	0.07
3.14	BB	3.74	166.05	29.03	0.09
3.70	BB	95.66	4243.14	614.64	0.11
	Sum	100.00	4435.87		

AK Prof. Enders - Analytiklabor 4.04



(*S*)-**3i**

Sample name: **SM-226N**

Data file: C:\SNOOPY\SM\226NIC.D

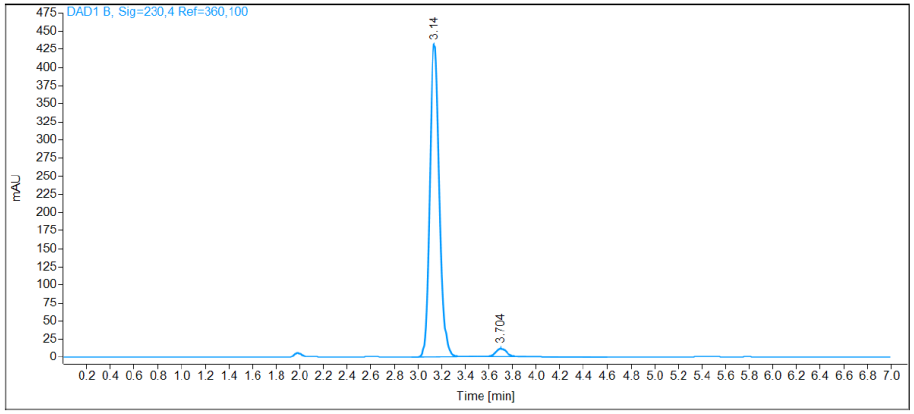
Description: Mobile phase: n-Heptane/i-PrOH 8:2 ;
The sample is solved in DCM/MP

Injection date: 11/16/2016 2:40:34 PM

Acq. Analysis method: CHIRALPAKIC1-6LNP.M

Column: Chiralpak IC, (150 x 4,6) mm, 5µ, SN: IC00CD-QF015

Pressure at start: 40 bar **Start flow:** 1.000 ml/min **Column oven:** 29.99 °C



Name SM-226N

RT [min]	Type	Area%	Area	Height	Width [min]
3.14	BB	96.77	2446.97	432.07	0.09
3.70	BB	3.23	81.56	11.27	0.11
	Sum	100.00	2528.53		

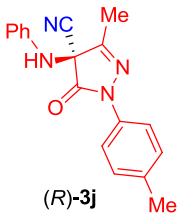
Sample Name: SM-226D
Data file: D:\ERNIE\SM\226DRAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3
;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4.6)mm 10µ

Operator: Analytical Lab AKEN

Injektion Time: 08:47:57
Injektion Date: 16.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	42.1	41.2
Flow in ml/min:	1.0	1.0



(*R*)-**3j**

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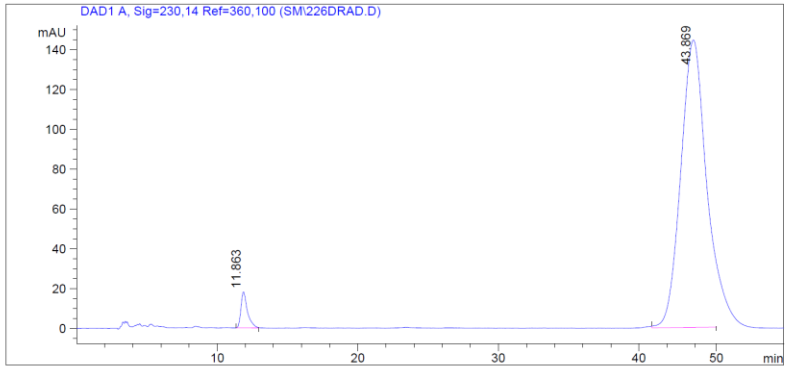


#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	11.86	0.46	18.06	579.71	3.00
2	43.87	1.66	144.35	18747.02	97.00
Total				19326.73	100.00

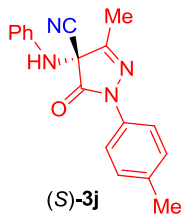
Sample Name: SM-227D
Data file: D:\ERNIE\SM\227DRAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3
;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4.6)mm 10µ

Operator: Analytical Lab AKEN

Injektion Time: 09:39:22
Injektion Date: 16.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	41.8	41.4
Flow in ml/min:	1.0	1.0



(*S*)-**3j**

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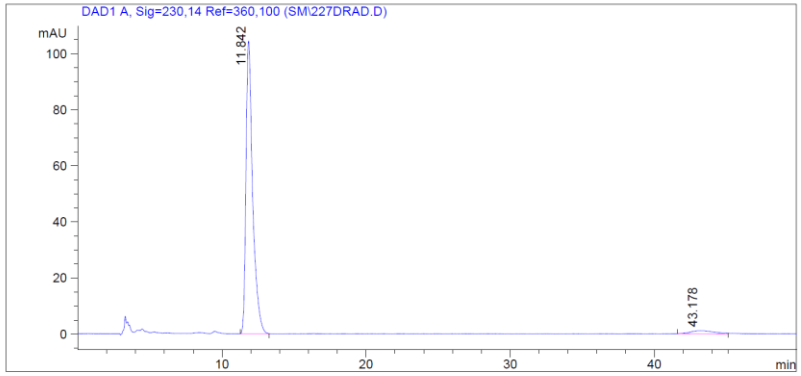


#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	11.84	0.48	104.49	3366.11	95.76
2	43.18	2.12	1.17	149.08	4.24
Total				3515.19	100.00

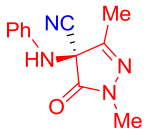
Sample Name: SM 226 K
Data file: D:\ERNIE\SM\226KAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3 ;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: Chiralpak AD (250 x 4.6)mm 10µ

Operator: Analytical Lab AKEN

Injektion Time: 13:15:39
Injektion Date: 23.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	41.4	41.3
Flow in ml/min:	1.0	1.0



(*R*)-**3k**

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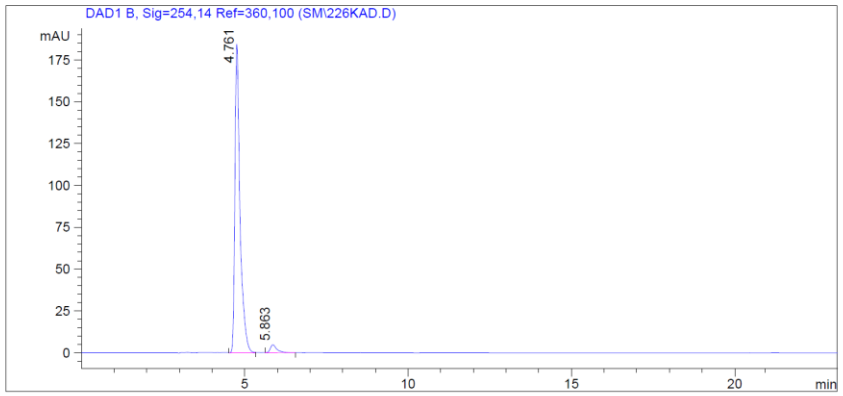


#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	4.76	0.16	184.84	2007.76	96.62
2	5.86	0.21	4.86	70.34	3.38
Total				2078.10	100.00

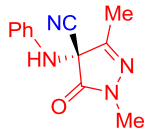
Sample Name: SM 227 K
Data file: D:\ERNIE\SM\227KAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3 ;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: Chiralpak AD (250 x 4.6)mm 10µ

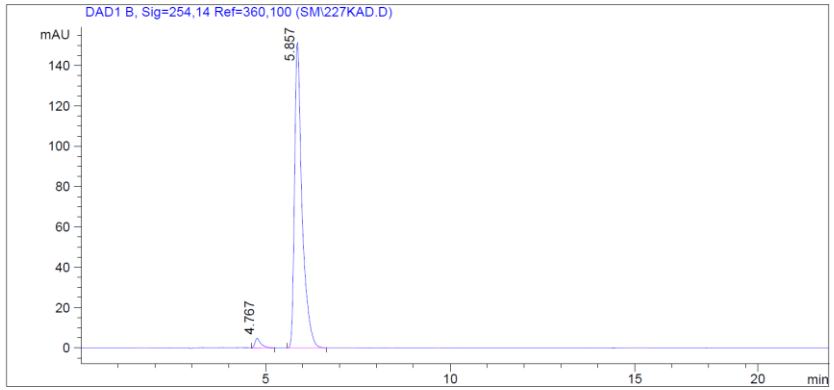
Operator: Analytical Lab AKEN

Injektion Time: 13:39:50
Injektion Date: 23.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	43.1	41.5
Flow in ml/min:	1.0	1.0



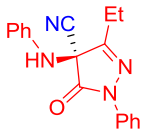
(*S*)-**3k**



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	4.77	0.18	4.94	59.42	2.69
2	5.86	0.21	151.68	2150.16	97.31
Total				2209.59	100.00

Sample Name: SM226I
Data file: D:\ERNIE\SM\226IAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3 ;
The sample is solved in DCM/LM

Agilent Technologies



(*R*)-**3l**

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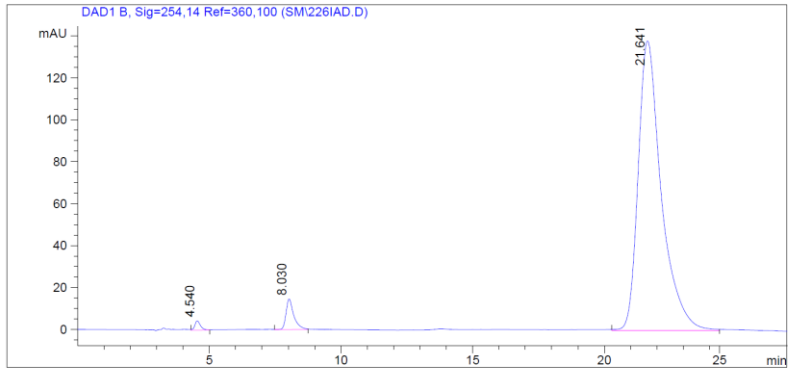
Column: DAICELAD.M
Column info: Chiralpak AD (250 x 4.6)mm 10µ

Operator: Analytical Lab AKEN

Injektion Time: 08:10:33
Injektion Date: 29.08.2016

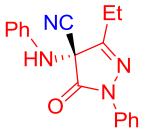
Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	41.6	40.8
Flow in ml/min:	1.0	1.0



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	4.54	0.22	4.49	67.90	0.77
2	8.03	0.30	14.65	303.77	3.44
3	20.72	0.00	1.92	0.00	0.00
4	21.64	1.02	138.27	8460.10	95.79
5	22.00	0.00	90.66	0.00	0.00
6	22.56	0.00	28.71	0.00	0.00
7	22.96	0.00	11.74	0.00	0.00
8	23.52	0.00	2.51	0.00	0.00
Total				8831.76	100.00

Sample Name: SM227I
Data file: D:\ERNIE\SM\227IAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3 ;
The sample is solved in DCM/LM

Agilent Technologies



(*S*)-**3l**

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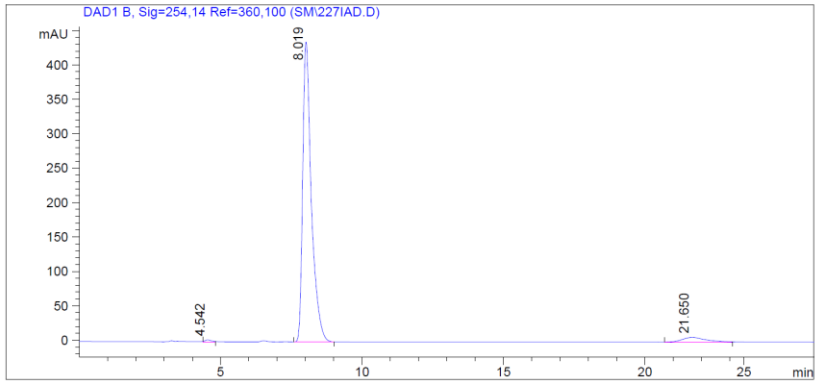
Column: DAICELAD.M
Column info: Chiralpak AD (250 x 4.6)mm 10µ

Operator: Analytical Lab AKEN

Injektion Time: 08:40:24
Injektion Date: 29.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	42.1	41.1
Flow in ml/min:	1.0	1.0



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	4.54	0.29	3.58	62.59	0.64
2	4.73	0.00	1.69	0.00	0.00
3	8.02	0.32	436.25	9272.51	94.81
4	21.61	0.00	7.01	0.00	0.00
5	21.65	1.04	7.12	445.50	4.55
6	22.90	0.00	0.96	0.00	0.00
Total				9780.60	100.00

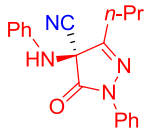
Sample Name: SM226m
Data file: D:\ERNIE\SM\226MAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 8:2 ;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: Chiralpak AD (250 x 4.6)mm 10µ

Operator: Analytical Lab AKEN

Injektion Time: 14:25:36
Injektion Date: 29.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	36.4	35.3
Flow in ml/min:	1.0	1.0



(*R*)-**3m**

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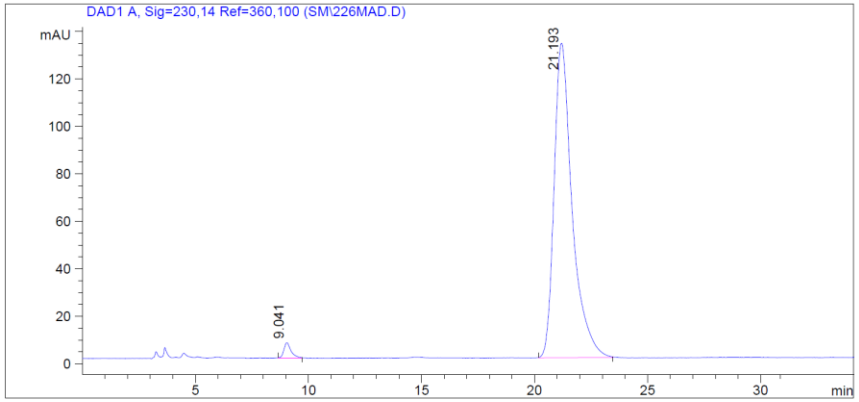


#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	9.04	0.32	6.46	142.21	1.89
2	21.19	0.81	132.58	7366.34	98.11
Total				7508.54	100.00

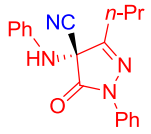
Sample Name: SM227m
Data file: D:\ERNIE\SM\227MAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 8:2 ;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: Chiralpak AD (250 x 4.6)mm 10µ

Operator: Analytical Lab AKEN

Injektion Time: 15:00:29
Injektion Date: 29.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	36.4	35.7
Flow in ml/min:	1.0	1.0



(*S*)-**3m**

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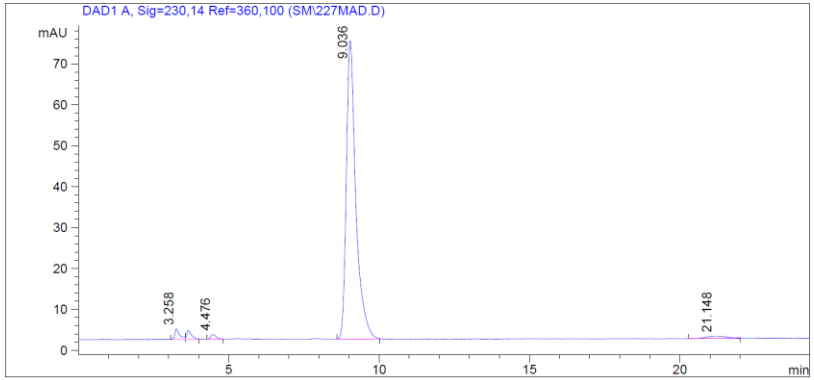


#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	3.26	0.15	2.58	28.12	1.66
2	3.65	0.15	2.16	22.59	1.33
3	4.48	0.18	1.11	13.78	0.81
4	9.04	0.32	73.00	1598.09	94.19
5	21.15	0.86	0.66	34.12	2.01
Total				1696.69	100.00

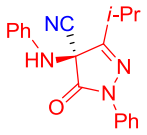
Sample Name: SM-226C
Data file: D:\ERNIE\SM\226CRAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3
;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4)mm; 5µ non-chiral column

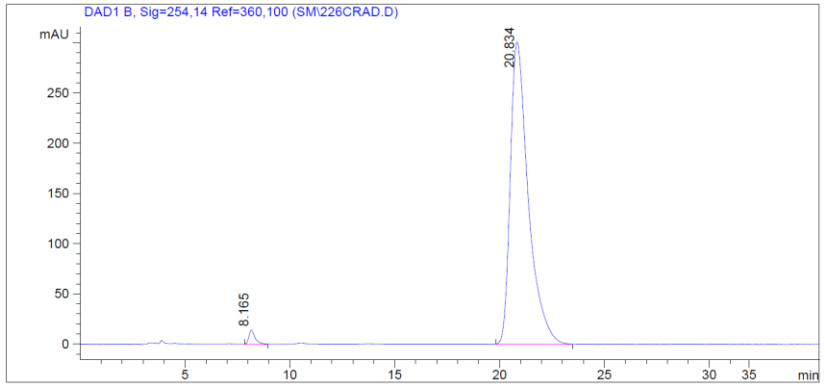
Operator: Analytical Lab AKEN

Injektion Time: 12:39:19
Injektion Date: 15.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	42.8	41.6
Flow in ml/min:	1.0	1.0



(*R*)-**3n**



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	8.16	0.31	14.01	287.26	1.57
2	20.83	0.89	301.06	17962.86	98.43
Total				18250.12	100.00

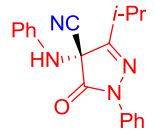
Sample Name: SM-227C
Data file: D:\ERNIE\SM\227CAD.D
Sample Info: Mobile phase: n-Heptane/iPrOH 7:3
;
The sample is solved in DCM/LM

Column: DAICELAD.M
Column info: (250 x 4)mm; 5µ non-chiral column

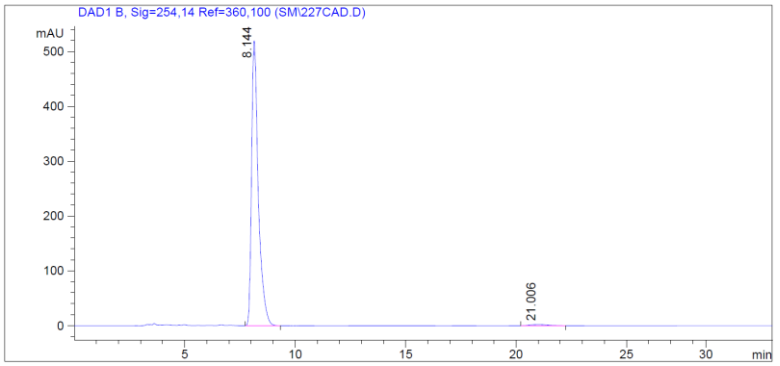
Operator: Analytical Lab AKEN

Injektion Time: 13:15:28
Injektion Date: 15.08.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0	30.0
Pressure in bar:	42.2	41.6
Flow in ml/min:	1.0	1.0



(*S*)-**3n**



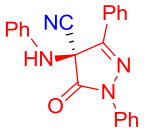
#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	8.14	0.32	520.11	11039.21	98.92
2	21.01	0.71	2.25	120.06	1.08
Total				11159.27	100.00

Sample Name: SM-226B
Data file: F:\2016#PNI.19D\SM\226BOD.D
Sample Info: Mobile phase: n-Heptane/EtOH 97:3;
The sample is solved in DCM/MP

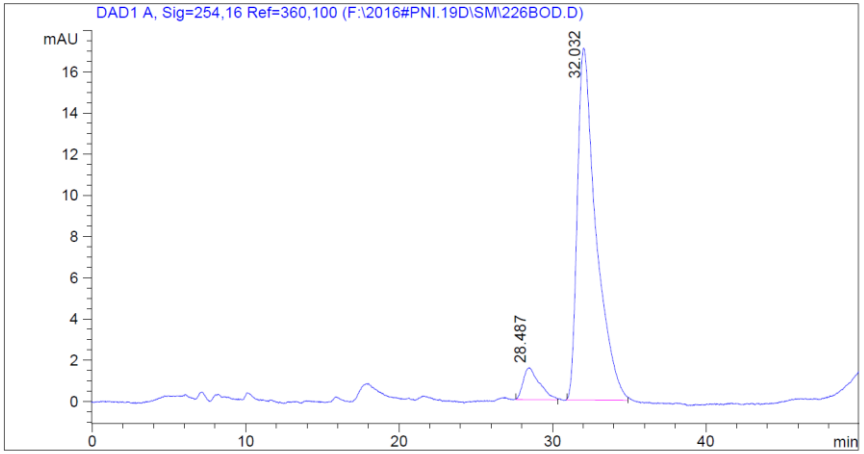
Säule: DAICELOD.M
Säuleninfo: Chiralpak AD (250x4,6)mm
Operator: Analytik Labor AKEN

Injektion Time: 13:11:45
Injektion Date: 25.11.2016

Instrument Conditions:	At Start	At Stop
Temperature in°C:	30.0°C	30.0°
Pressure in bar:	19.1	18.9
Flow in ml/min:	0.50	0.50



(*R*)-**3p**



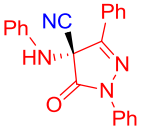
#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	28.49	0.87	1.56	114.20	7.30
2	32.03	1.16	17.09	1450.54	92.70
Total				1564.74	100.00

Sample Name: SM-227B
Data file: F:\2016#PNI.19D\SM\227BOD.D
Sample Info: Mobile phase: n-Heptane/EtOH 97:3;
The sample is solved in DCM/MP

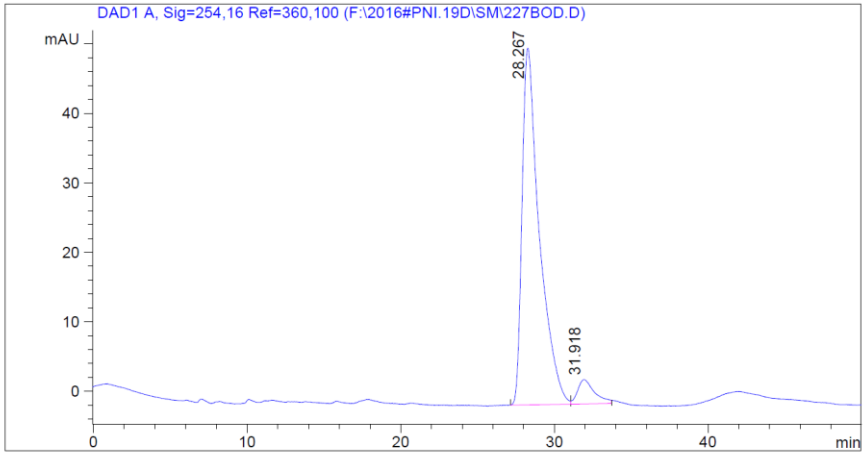
Säule: DAICELOD.M
Säuleninfo: Chiralpak AD (250x4,6)mm
Operator: Analytik Labor AKEN

Injektion Time: 14:02:58
Injektion Date: 25.11.2016

Instrument Conditions:	At Start	At Stc
Temperature in°C:	30.0°C	30.0
Pressure in bar:	19.2	19.3
Flow in ml/min:	0.50	0.50



(*S*)-**3p**



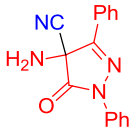
#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	28.27	1.12	51.32	4021.58	93.71
2	31.92	1.28	3.51	269.72	6.29
Total				4291.30	100.00

Sample Name: PC1110RAC
Data file: D:\GONZO\PC\PC1110RA.D
Sample Info: Chiralpack AD, 8:2 (Heptan:IPROH), 1 ml min-1
The sample is solved in DCM/MP

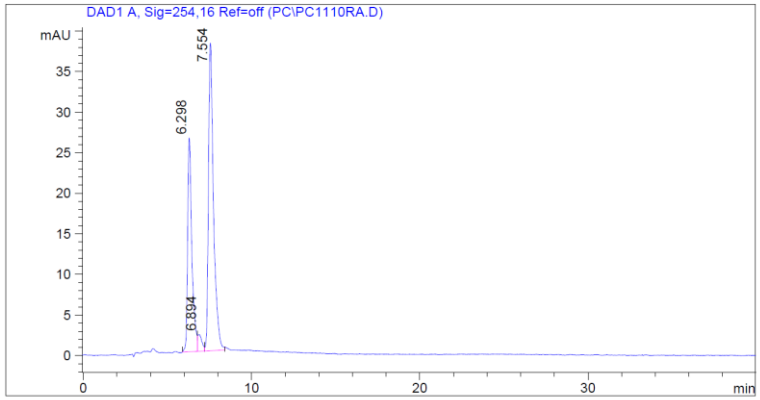
Säule: DAICELAD.M
Säuleninfo: Chiralpak AD (250x4,6)mm
Operator: Analytik Labor AKEN

Injektion Time: 15:49:55
Injektion Date: 09.03.2017

Instrument Conditions:	At Start	At Sto
Temperature in°C:	30.0°C	30.0
Pressure in bar:	35.6	35.8
Flow in ml/min:	1.00	1.00



(*rac*)-**4**



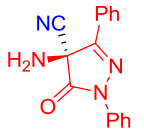
#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	6.30	0.26	26.35	465.24	36.03
2	6.89	0.22	2.07	36.19	2.80
3	7.55	0.31	37.92	789.87	61.17
Total				1291.31	100.00

Sample Name: PC1112
Data file: D:\GONZO\PC\PC1112.D
Sample Info: n-Heptane/iPrOH 8:2; Flow= 1.0 ml min-1, Chiralpack AD
The sample is solved in DCM/MP

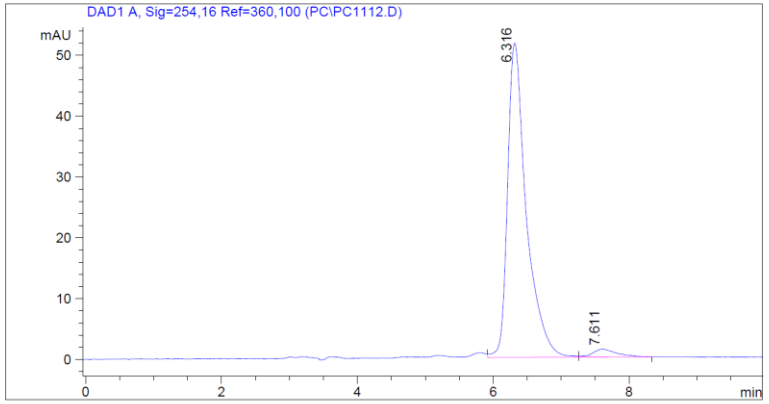
Säule: DAICELAD.M
Säuleninfo: Chiralpak AD (250x4,6)mm
Operator: Analytik Labor AKEN

Injektion Time: 10:17:46
Injektion Date: 03.04.2017

Instrument Conditions:	At Start	At St
Temperature in°C:	30.0°C	30.
Pressure in bar:	33.3	33.
Flow in ml/min:	1.00	1.(



4



#	Ret. Time (min)	Width	Height (mAU)	Area (mAU*s)	Area %
1	6.32	0.28	51.67	990.34	96.80
2	7.61	0.32	1.32	32.78	3.20
Total				1023.13	100.00