Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Diastereo and Enantioselective Construction of Cyclohexanone-fused Spirospyrazolones Containing Four Consecutive Stereocenters Through Asymmetric Sequential Reactions

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Supporting Information

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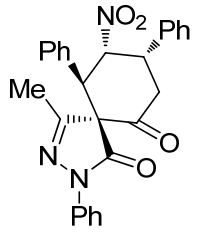
General information

Unless otherwise stated, commercially available compounds were used without further purification. Column chromatography was carried out with silica gel (200–300 mesh). Melting points were measured with a XT–4 melting-point apparatus without correction. ^{1}H NMR spectra were recorded with a Bruker Avance 400 MHz spectrometer. Chemical shifts were reported in δ (ppm) units relative to tetramethylsilane (TMS) as the internal standard. The data are reported as follows: chemical shift (ppm), and multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet or unresolved, br s = broad singlet), coupling constant(s) in Hz, integration assignment. ^{13}C NMR spectra were recorded at 100 MHz. Infrared spectra were obtained with a Perkin Elmer Spectrum One spectrometer. The ESI-HRMS spectra were obtained with a Bruker APEX IV FTMS or Agilent 6520 Accurate-Mass-Q-TOF MS spectrometer. Optical rotations were measured with a Krüss P8000 polarimeter at the indicated concentration with unit g per 100 mL. The enantiomeric excesses of the products were determined by chiral HPLC using an Agilent 1200 LC instrument with Daicel Chiralpak AD-H or IB columns.

General procedure for the cascade reactions to synthesize the cyclohexanone-fused spiropyrazolones

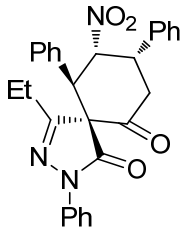
A mixture of pyrazolin-5-one **1** (0.2 mmol), nitroalkene **2** (0.24 mmol) and catalyst **I** (0.002 mmol) in THF (1.0 mL) was stirred at room temperature for 2 h. Then catalyst **IV** (0.04 mmol) and cinnamaldehyde **3** (0.3 mmol) were added and the reaction mixture was stirred for another 46 h. When the reaction was complete, the mixture was concentrated and purified by column chromatography on silica gel (with ethyl acetate–petroleum ether 1:3 as the eluent) to afford the intermediate product. Next, the intermediate product, PCC (0.4 mmol) and silica gel (86.2 mg) in CH_2Cl_2 (3 mL) was stirred at room temperature for 36 h, then the mixture was concentrated and purified by silica gel column chromatography (with ethyl acetate–petroleum ether 1:8 as the eluent) to afford the desired products **4**.



4a

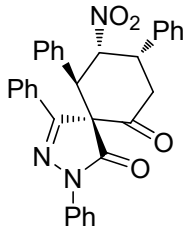
(5*R*,8*S*,9*R*,10*R*)-4-Methyl-9-nitro-2,8,10-triphenyl-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4a). The product **4a** was obtained according to the general procedure as white solid (53.6 mg, 59% yield). HPLC (Daicel Chiralpak AD-H column, *n*-hexane–2-propanol 80:20, flow rate

1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 21.8 min, >99% *ee*; minor diastereomer: t_{major} = 6.4 min, >99% *ee*; m.p. 59–63 °C. $[\alpha]_D^{20}$ = –324.2 (*c* 2.9, CH_2Cl_2); ^1H NMR (400 MHz, $CDCl_3$): δ 7.54–7.51 (m, 2H, ArH), 7.39–7.37 (m, 3H, ArH), 7.32 (t, J = 8.0 Hz, 2H, ArH), 7.22–7.19 (m, 2H, ArH), 7.17–7.15 (m, 4H, ArH), 7.13–7.10 (m, 2H, ArH), 6.60 (dd, J_1 = 5.8 Hz, J_2 = 11.6 Hz, 1H, CH), 4.47–4.43 (m, 1H, CH), 4.12 (d, J = 12.0 Hz, 1H, CH), 3.75 (dd, J_1 = 6.4 Hz, J_2 = 16.0 Hz, 1H, CH), 3.11 (dd, J_1 = 4.0 Hz, J_2 = 16.0 Hz, 1H, CH), 2.31 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 199.1, 167.7, 158.0, 136.7, 136.5, 132.7, 129.1, 129.01, 128.97, 128.8, 128.7, 127.9, 127.5, 126.1, 119.8, 85.2, 73.2, 44.8, 43.2, 41.8, 14.9 ppm; IR (KBr): $\tilde{\nu}$ 3034, 2923, 1715, 1691, 1595, 1557, 1499, 1455, 1396, 1366, 1298, 1258, 1202, 1152, 1115, 1032, 753, 742, 700, 656, 564, 507 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{27}H_{24}N_3O_4$ $[M + H]^+$ 454.17613, found 454.17705.



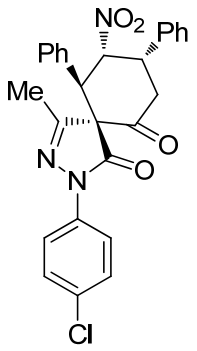
4b

(5*R*,8*S*,9*R*,10*R*)-4-Ethyl-9-nitro-2,8,10-triphenyl-2,3-diazaspiro[4.5]dec-3-ene-1,6-dion (4b). The product **4b** was obtained according to the general procedure as white solid (72.6 mg, 78% yield). HPLC (Daicel Chiralpak AD-H column, *n*-hexane–2-propanol 80:20, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 24.9 min, >99% *ee*; minor diastereomer: t_{major} = 5.4 min, >99% *ee*; m.p. 61–65 °C. $[\alpha]_D^{20}$ = –323.0 (*c* 1.6, CH_2Cl_2); ^1H NMR (400 MHz, $CDCl_3$): δ 7.55 (d, J = 8.0 Hz, 2H, ArH), 7.39–7.38 (m, 3H, ArH), 7.34 (t, J = 8.0 Hz, 2H, ArH), 7.23–7.16 (m, 6H, ArH), 7.13–7.11 (m, 2H, ArH), 6.59 (dd, J_1 = 5.6 Hz, J_2 = 12.0 Hz, 1H, CH), 4.45 (dd, J_1 = 6.0 Hz, J_2 = 10.0 Hz, 1H, CH), 4.14 (d, J = 12.0 Hz, 1H, CH), 3.75 (dd, J_1 = 6.4 Hz, J_2 = 16.0 Hz, 1H, CH), 3.12 (dd, J_1 = 4.0 Hz, J_2 = 15.6 Hz, 1H, CH), 2.77–2.67 (m, 1H, CH), 2.62–2.50 (m, 1H, CH), 1.29 (t, J = 7.4 Hz, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 199.3, 167.9, 161.8, 136.9, 136.5, 132.9, 129.1, 128.98, 128.96, 128.8, 128.7, 127.9, 127.6, 126.0, 119.8, 85.4, 73.4, 45.0, 43.2, 41.8, 22.2, 8.6 ppm; IR (KBr): $\tilde{\nu}$ 3032, 1716, 1690, 1597, 1555, 1499, 1456, 1352, 1261, 1022, 801, 754, 740, 701 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{28}H_{26}N_3O_4$ $[M + H]^+$ 468.19178, found 468.19303.



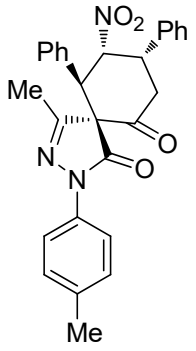
4c

(5*R*,8*S*,9*R*,10*R*)-9-Nitro-2,4,8,10-tetraphenyl-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4c). The product **4c** was obtained according to the general procedure as white solid (69.7 mg, 68% yield). HPLC (Daicel Chiralpak AD-H column, *n*-hexane–2-propanol 80:20, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 17.9 min, >99% *ee*; minor diastereomer: t_{major} = 6.4 min, >99% *ee*; m.p. 72–75 °C. $[\alpha]_D^{20}$ = –262.6 (*c* 0.9, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.67–7.64 (m, 4H, ArH), 7.54–7.37 (m, 8H, ArH), 7.31 (d, *J* = 7.6 Hz, 2H, ArH), 7.25–7.22 (m, 1H, ArH), 7.14–7.10 (m, 1H, ArH), 7.04 (t, *J* = 7.6 Hz, 2H, ArH), 6.84 (d, *J* = 7.6 Hz, 2H, ArH), 6.56 (dd, J_1 = 6.4 Hz, J_2 = 11.6 Hz, 1H, CH), 4.72 (dd, J_1 = 6.2 Hz, J_2 = 12.2 Hz, 1H, CH), 4.42 (d, *J* = 11.2 Hz, 1H, CH), 3.74 (dd, J_1 = 5.6 Hz, J_2 = 16.0 Hz, 1H, CH), 3.50 (dd, J_1 = 6.8 Hz, J_2 = 16.0 Hz, 1H, CH) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 199.3, 168.3, 156.5, 136.8, 136.3, 132.7, 130.9, 129.7, 128.99, 128.98, 128.92, 128.88, 128.8, 128.7, 128.0, 127.7, 127.2, 126.5, 120.1, 86.8, 72.9, 46.5, 41.7, 41.2 ppm; IR (KBr): $\tilde{\nu}$ 2921, 1718, 1695, 1596, 1556, 1497, 1456, 1385, 1319, 1275, 1262, 1198, 1087, 1029, 897, 764, 749, 700, 691, 605, 505 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{32}H_{26}N_3O_4$ $[M + H]^+$ 516.19178, found 516.19287.



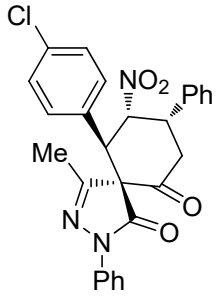
4d

(5*R*,8*S*,9*R*,10*R*)-2-(4-Chlorophenyl)-4-methyl-9-nitro-8,10-diphenyl-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4d). The product **4d** was obtained according to the general procedure as white solid (68.3 mg, 70% yield). HPLC (Daicel Chiralpak AD-H column, *n*-hexane–2-propanol 80:20, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 25.1 min, t_{minor} = 10.5 min, >99% *ee*; minor diastereomer: t_{major} = 6.5 min, >99% *ee*; m.p. 63–67 °C. $[\alpha]_D^{20}$ = –349.2 (*c* 2.9, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.53–7.49 (m, 2H, ArH), 7.39–7.37 (m, 3H, ArH), 7.31–7.27 (m, 2H, ArH), 7.20–7.15 (m, 5H, ArH), 7.12–7.10 (m, 2H, ArH), 6.57 (dd, J_1 = 5.6 Hz, J_2 = 12.0 Hz, 1H, CH), 4.47–4.43 (m, 1H, CH), 4.11 (d, *J* = 11.6 Hz, 1H, CH), 3.74 (dd, J_1 = 6.4 Hz, J_2 = 16.0 Hz, 1H, CH), 3.12 (dd, J_1 = 3.6 Hz, J_2 = 16.0 Hz, 1H, CH), 2.31 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 198.9, 167.7, 158.3, 136.4, 135.3, 132.6, 131.3, 129.2, 129.1, 128.9, 128.8, 127.9, 127.5, 120.7, 85.1, 73.3, 44.8, 43.2, 41.8, 14.9 ppm; IR (KBr): $\tilde{\nu}$ 2924, 1717, 1693, 1556, 1493, 1455, 1394, 1365, 1297, 1276, 1262, 1202, 1094, 1013, 829, 764, 747, 700, 655, 564, 510 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{27}H_{23}ClN_3O_4$ $[M + H]^+$ 488.13716, found 488.13863.



4e

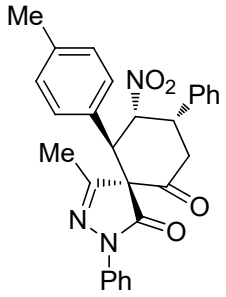
(5*R*,8*S*,9*R*,10*R*)-4-Methyl-9-nitro-8,10-diphenyl-2-(*p*-tolyl)-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4e). The product **4e** was obtained according to the general procedure as white solid (57.6 mg, 62% yield). HPLC (Daicel Chiralpak AD-H column, *n*-hexane–2-propanol 80:20, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 23.9 min, t_{minor} = 13.1 min, >99% *ee*; minor diastereomer: t_{major} = 6.0 min, >99% *ee*; m.p. 64–68 °C. $[\alpha]_D^{20}$ = –255.0 (*c* 0.9, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.39–7.36 (m, 5H, ArH), 7.23–7.16 (m, 5H, ArH), 7.14–7.11 (m, 4H, ArH), 6.60 (dd, J_1 = 5.6 Hz, J_2 = 12.0 Hz, 1H, CH), 4.45 (dd, J_1 = 6.4 Hz, J_2 = 10.0 Hz, 1H, CH), 4.11 (d, J = 12.0 Hz, 1H, CH), 3.76 (dd, J_1 = 6.4 Hz, J_2 = 15.6 Hz, 1H, CH), 3.11 (dd, J_1 = 3.6 Hz, J_2 = 15.6 Hz, 1H, CH), 2.32 (s, 3H, CH_3), 2.30 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 199.2, 167.6, 157.8, 136.6, 136.1, 134.2, 132.8, 129.3, 129.1, 129.02, 128.97, 128.7, 127.9, 127.6, 120.0, 85.3, 73.1, 44.8, 43.2, 41.8, 21.0, 14.9 ppm; IR (KBr): $\tilde{\nu}$ 2920, 2850, 1690, 1557, 1512, 1454, 1366, 1298, 1259, 1203, 1074, 1036, 818, 765, 746, 700, 656, 564, 507 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{28}H_{26}N_3O_4$ $[M + H]^+$ 468.19178, found 468.19310.



4f

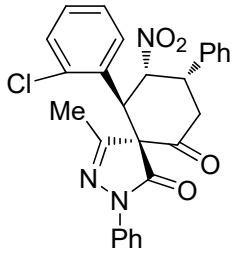
(5*R*,8*S*,9*R*,10*R*)-10-(4-Chlorophenyl)-4-methyl-9-nitro-2,8-diphenyl-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4f). The product **4f** was obtained according to the general procedure as white solid (64.6 mg, 66% yield). HPLC (Daicel Chiralpak IB column, *n*-hexane–2-propanol 90:10, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 7.6 min, >99% *ee*; m.p. 59–63 °C. $[\alpha]_D^{20}$ = –308.2 (*c* 0.9, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.55 (d, J = 8.4 Hz, 2H, ArH), 7.40–7.34 (m, 5H, ArH), 7.21 (t, J = 7.4 Hz, 1H, ArH), 7.16 (s, 4H, ArH), 7.11–7.09 (m, 2H, ArH), 6.56 (dd, J_1 = 5.6 Hz, J_2 = 12.0 Hz, 1H, CH), 4.43 (dd, J_1 = 6.0 Hz,

J_2 = 9.2 Hz, 1H, CH), 4.09 (d, J = 12.0 Hz, 1H, CH), 3.77 (dd, J_1 = 6.8 Hz, J_2 = 16.0 Hz, 1H, CH), 3.11 (dd, J_1 = 3.2 Hz, J_2 = 16.0 Hz, 1H, CH), 2.30 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 198.7, 167.5, 157.8, 136.6, 136.3, 135.1, 131.4, 129.3, 129.2, 129.0, 128.91, 128.87, 127.9, 126.3, 119.7, 85.0, 73.1, 44.2, 43.3, 41.8, 14.9 ppm; IR (KBr): $\tilde{\nu}$ 2922, 1716, 1692, 1596, 1555, 1496, 1454, 1366, 1297, 1259, 1200, 1092, 1015, 799, 759, 749, 700, 691 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{27}H_{23}ClN_3O_4$ $[M + H]^+$ 488.13716, found 488.13823.



4g

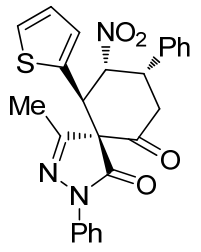
(5*R*,8*S*,9*R*,10*R*)-4-Methyl-9-nitro-2,8-diphenyl-10-(*p*-tolyl)-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4g). The product **4g** was obtained according to the general procedure as white solid (70.8 mg, 76% yield). HPLC (Daicel Chiralpak AD-H column, *n*-hexane–2-propanol 80:20, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 19.1 min, t_{minor} = 12.8 min, 99% *ee*; minor diastereomer: t_{major} = 6.1 min, t_{minor} = 8.5 min, 99% *ee*; m.p. 61–64 °C. $[\alpha]_D^{20}$ = –284.2 (*c* 0.5, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.56 (d, J = 7.6 Hz, 2H, ArH), 7.39–7.33 (m, 5H, ArH), 7.19 (t, J = 7.4 Hz, 1H ArH), 7.13–7.08 (m, 4H, ArH), 6.97 (d, J = 8.0 Hz, 2H, ArH), 6.56 (dd, J_1 = 6.0 Hz, J_2 = 12.0 Hz, 1H, CH), 4.45 (dd, J_1 = 6.0 Hz, J_2 = 10.0 Hz, 1H, CH), 4.09 (d, J = 12.0 Hz, 1H, CH), 3.74 (dd, J_1 = 6.4 Hz, J_2 = 15.6 Hz, 1H, CH), 3.11 (dd, J_1 = 4.0 Hz, J_2 = 16.0 Hz, 1H, CH), 2.30 (s, 3H, CH_3), 2.19 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 199.2, 167.8, 158.1, 138.9, 136.8, 136.6, 129.8, 129.7, 129.1, 128.8, 128.7, 127.9, 127.4, 126.1, 119.8, 85.5, 73.4, 44.6, 43.2, 41.7, 21.0, 14.9 ppm; IR (KBr): $\tilde{\nu}$ 2921, 2851, 1716, 1692, 1596, 1556, 1500, 1365, 1298, 1275, 1261, 1086, 1026, 799, 763, 751, 700 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{28}H_{26}N_3O_4$ $[M + H]^+$ 468.19178, found 468.19258.



4h

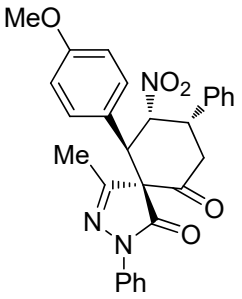
(5*R*,8*S*,9*R*,10*S*)-10-(2-Chlorophenyl)-4-methyl-9-nitro-2,8-diphenyl-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4h). The product **4h** was obtained according to the general procedure as

white solid (58.5 mg, 60% yield). HPLC (Daicel Chiralpak IB column, *n*-hexane–2-propanol 80:20, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 5.9 min, >99% *ee*; m.p. 71–75 °C. $[\alpha]_D^{20}$ = –164.7 (*c* 1.7, CH_2Cl_2); ^1H NMR (400 MHz, $CDCl_3$): δ 7.62 (d, *J* = 8.4 Hz, 2H, ArH), 7.52 (dd, J_1 = 1.2 Hz, J_2 = 7.6 Hz, 1H, ArH), 7.43–7.35 (m, 5H, ArH), 7.29 (d, *J* = 7.6 Hz, 1H, ArH), 7.22 (t, *J* = 7.4 Hz, 1H, ArH), 7.16–7.04 (m, 4H, ArH), 6.51 (dd, J_1 = 5.6 Hz, J_2 = 11.6 Hz, 1H, CH), 5.03 (d, *J* = 11.6 Hz, 1H, CH), 4.50 (dd, J_1 = 5.6 Hz, J_2 = 10.4 Hz, 1H, CH), 3.74 (dd, J_1 = 6.4 Hz, J_2 = 16.0 Hz, 1H, CH), 3.20 (dd, J_1 = 4.4 Hz, J_2 = 16.0 Hz, 1H, CH), 2.39 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 198.7, 168.0, 158.7, 136.8, 136.3, 134.7, 131.2, 130.6, 130.0, 129.1, 128.9, 128.8, 127.9, 127.60, 127.56, 126.2, 119.7, 86.1, 72.9, 43.1, 41.7, 39.5, 15.4 ppm; IR (KBr): $\tilde{\nu}$ 2918, 2850, 1718, 1689, 1594, 1557, 1499, 1366, 1297, 1259, 1197, 1024, 802, 797, 757, 700, 689, 649 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{27}H_{23}ClN_3O_4$ $[M + H]^+$ 488.13716, found 488.13834.



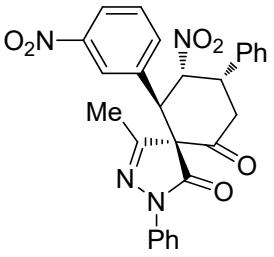
4i

(5*R*,8*S*,9*R*,10*R*)-4-Methyl-9-nitro-2,8-diphenyl-10-(thiophen-2-yl)-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4i). The product **4i** was obtained according to the general procedure as colorless oil (48.8 mg, 53% yield), HPLC (Daicel Chiralpak IB column, *n*-hexane–2-propanol 80:20, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 6.6 min, t_{minor} = 7.3 min, 99% *ee*; $[\alpha]_D^{20}$ = –156.4 (*c* 0.2, CH_2Cl_2); ^1H NMR (400 MHz, $CDCl_3$): δ 7.62 (d, *J* = 8.0 Hz, 2H, ArH), 7.39–7.34 (m, 5H, ArH), 7.20 (t, *J* = 7.4 Hz, 1H, ArH), 7.10–7.09 (m, 3H, ArH), 6.98 (d, *J* = 3.6 Hz, 1H, ArH), 6.80 (dd, J_1 = 4.8 Hz, J_2 = 4.0 Hz, 1H, ArH), 6.51 (dd, J_1 = 6.0 Hz, J_2 = 12.0 Hz, 1H, CH), 4.44–4.38 (m, 2H, CH_2), 3.74 (dd, J_1 = 6.4 Hz, J_2 = 16.0 Hz, 1H, CH), 3.09 (dd, J_1 = 4.0 Hz, J_2 = 16.0 Hz, 1H, CH), 2.33 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 198.5, 167.5, 158.0, 136.9, 136.3, 134.7, 129.2, 128.9, 127.8, 127.2, 126.5, 126.1, 125.8, 119.7, 86.4, 73.6, 43.1, 41.5, 40.2, 14.8 ppm; IR (KBr): $\tilde{\nu}$ 2917, 1715, 1692, 1595, 1557, 1499, 1455, 1395, 1365, 1299, 1260, 1200, 1115, 1084, 1021, 855, 800, 755, 738, 699, 658, 561, 506 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{25}H_{22}N_3O_4S$ $[M + H]^+$ 460.13255, found 460.13319.



4j

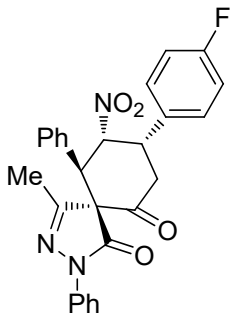
(5*R*,8*S*,9*R*,10*R*)-10-(4-Methoxyphenyl)-4-methyl-9-nitro-2,8-diphenyl-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4j). The product **4j** was obtained according to the general procedure as white solid (42.0 mg, 43% yield). HPLC (Daicel Chiralpak AD-H column, *n*-hexane–2-propanol 80:20, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 30.5 min, >99% *ee*; minor diastereomer: t_{major} = 7.4 min, >99% *ee*; m.p. 81–85 °C. $[\alpha]_D^{20}$ = –360.6 (*c* 1.1, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.57 (d, J = 8.4 Hz, 2H, ArH), 7.39–7.33 (m, 5H, ArH), 7.21–7.11 (m, 5H, ArH), 6.68 (d, J = 8.8 Hz, 2H, ArH), 6.54 (dd, J_1 = 5.6 Hz, J_2 = 12.0 Hz, 1H, CH), 4.43 (dd, J_1 = 6.0 Hz, J_2 = 10.0 Hz, 1H, CH), 4.08 (d, J = 12.0 Hz, 1H, CH), 3.74 (dd, J_1 = 6.6 Hz, J_2 = 15.8 Hz, 1H, CH), 3.66 (s, 3H, OCH_3), 3.11 (dd, J_1 = 3.8 Hz, J_2 = 15.8 Hz, 1H, CH), 2.30 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 199.2, 167.8, 159.8, 158.1, 136.8, 136.6, 129.1, 128.81, 128.76, 128.7, 127.9, 126.1, 124.6, 119.8, 114.4, 85.6, 73.5, 55.1, 44.3, 43.1, 41.7, 14.9 ppm; IR (KBr): $\tilde{\nu}$ 2962, 1715, 1690, 1611, 1595, 1553, 1514, 1499, 1455, 1395, 1364, 1298, 1258, 1182, 1115, 1085, 1030, 854, 800, 753, 699, 655, 563, 505 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{28}H_{26}N_3O_5$ $[M + H]^+$ 484.18670, found 484.18747.



4k

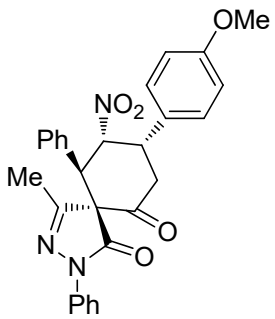
(5*R*,8*S*,9*R*,10*R*)-4-Methyl-9-nitro-10-(3-nitrophenyl)-2,8-diphenyl-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4k). The product **4k** was obtained according to the general procedure as white solid (29.8 mg, 30% yield). HPLC (Daicel Chiralpak AD-H column, *n*-hexane–2-propanol 80:20, flow rate 1.0 mL/min, detection at 254 nm): t_{major} = 28.1 min, t_{minor} = 21.6 min, 99% *ee*; m.p. 100–104 °C. $[\alpha]_D^{20}$ = –310.4 (*c* 1.0, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.12 (s, 1H, ArH), 8.06 (d, J = 8.0 Hz, 1H, ArH), 7.59 (d, J = 8.0 Hz, 1H, ArH), 7.54 (d, J = 8.4 Hz, 2H, ArH), 7.43–7.32 (m, 6H, ArH), 7.19 (t, J = 7.6 Hz, 1H, ArH), 7.12–7.10 (m, 2H, ArH), 6.68 (dd, J_1 = 5.6 Hz, J_2 = 12.0 Hz, 1H, CH), 4.48–4.45 (m, 1H,

CH), 4.22 (d, J = 12.0 Hz, 1H, CH), 3.83 (dd, J_1 = 6.8 Hz, J_2 = 16.0 Hz, 1H, CH), 3.13 (dd, J_1 = 2.8 Hz, J_2 = 16.0 Hz, 1H, CH), 2.36 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 198.2, 167.2, 157.6, 148.3, 136.4, 136.0, 135.2, 133.3, 130.2, 129.4, 129.1, 129.0, 127.9, 126.4, 124.0, 123.0, 119.5, 84.4, 72.8, 44.2, 43.5, 41.9, 14.9 ppm; IR (KBr): $\tilde{\nu}$ 2920, 2850, 1718, 1692, 1555, 1532, 1498, 1365, 1351, 1297, 1260, 1200, 1099, 1087, 1018, 801, 759, 751, 690 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{27}H_{23}N_4O_6$ [M + H]$^+$ 499.16121, found 499.16206.



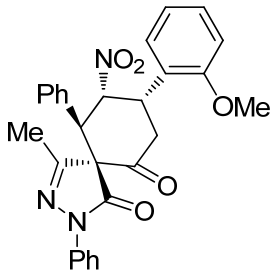
4l

(5*R*,8*S*,9*R*,10*R*)-8-(4-Fluorophenyl)-4-methyl-9-nitro-2,10-diphenyl-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4l). The product **4l** was obtained according to the general procedure as white solid (53.3 mg, 57% yield). HPLC (Daicel Chiralpak IB column, *n*-hexane–2-propanol 95:5, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 9.3 min, >99% *ee*; minor diastereomer: t_{major} = 12.8 min, t_{minor} = 8.4 min, 96% *ee*; m.p. 59–63 °C. $[\alpha]_D^{20}$ = –246.9 (*c* 0.4, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.53 (d, J = 8.0 Hz, 2H, ArH), 7.34 (t, J = 7.8 Hz, 2H, ArH), 7.23–7.18 (m, 6H, ArH), 7.13–7.06 (m, 4H, ArH), 6.56 (dd, J_1 = 6.0 Hz, J_2 = 12.0 Hz, 1H, CH), 4.48 (dd, J_1 = 6.0 Hz, J_2 = 10.4 Hz, 1H, CH), 4.08 (d, J = 11.6 Hz, 1H, CH), 3.74 (dd, J_1 = 6.4 Hz, J_2 = 16.0 Hz, 1H, CH), 3.11 (dd, J_1 = 4.4 Hz, J_2 = 16.0 Hz, 1H, CH), 2.29 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 199.0, 167.6, 157.8, 136.7, 132.6, 132.3, 129.64, 129.55, 129.1, 128.8, 127.5, 126.2, 119.8, 116.3, 116.1, 85.4, 73.1, 45.0, 42.3, 41.7, 15.0 ppm; IR (KBr): $\tilde{\nu}$ 2920, 1716, 1691, 1596, 1555, 1499, 1365, 1297, 1265, 1101, 740, 704 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{27}H_{23}FN_3O_4$ [M + H]$^+$ 472.16671, found 472.16753.



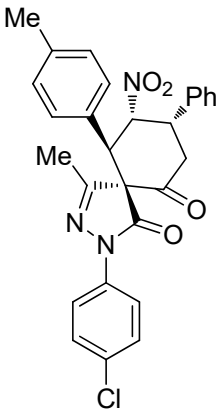
4m

(5*R*,8*S*,9*R*,10*R*)-8-(4-Methoxyphenyl)-4-methyl-9-nitro-2,10-diphenyl-2,3-diazaspiro[4.5] dec-3-ene-1,6-dione (4m). The product **4m** was obtained according to the general procedure as white solid (50.6 mg, 52% yield). HPLC (Daicel Chiralpak AD-H column, *n*-hexane–2-propanol 80:20, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 23.5 min, t_{minor} = 13.6 min, 99% *ee*; minor diastereomer: t_{major} = 7.5 min, >99% *ee*; m.p. 67–71 °C. $[\alpha]_D^{20}$ = –317.8 (*c* 0.7, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.51 (d, *J* = 7.6 Hz, 2H, ArH), 7.33 (t, *J* = 8.0 Hz, 2H, ArH), 7.23–7.16 (m, 6H, ArH), 7.03 (d, *J* = 8.4 Hz, 2H, ArH), 6.90 (d, *J* = 8.8 Hz, 2H, ArH), 6.57 (dd, J_1 = 5.6 Hz, J_2 = 12.0 Hz, 1H, CH), 4.40 (dd, J_1 = 6.0 Hz, J_2 = 9.2 Hz, 1H, CH), 4.09 (d, *J* = 12.0 Hz, 1H, CH), 3.81 (s, 3H, OCH_3), 3.76 (dd, J_1 = 6.4 Hz, J_2 = 15.6 Hz, 1H, CH), 3.08 (dd, J_1 = 3.6 Hz, J_2 = 15.6 Hz, 1H, CH), 2.31 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 199.3, 167.7, 159.8, 158.0, 136.7, 132.8, 129.03, 128.97, 128.8, 128.3, 127.6, 126.1, 119.8, 114.5, 85.3, 73.3, 55.3, 44.7, 42.7, 42.1, 15.0 ppm; IR (KBr): $\tilde{\nu}$ 2921, 1714, 1691, 1596, 1554, 1515, 1500, 1365, 1274, 1260, 1183, 1033, 800, 763, 749, 702 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{28}H_{26}N_3O_5$ $[M + H]^+$ 484.18670, found 484.18724.



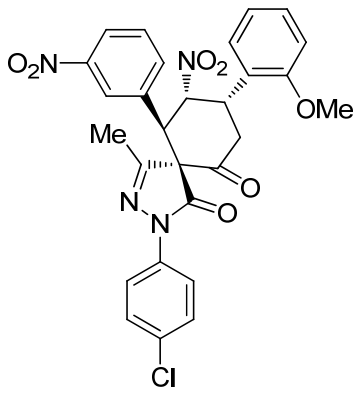
4n

(5*R*,8*S*,9*R*,10*R*)-8-(2-Methoxyphenyl)-4-methyl-9-nitro-2,10-diphenyl-2,3-diazaspiro[4.5] dec-3-ene-1,6-dione (4n). The product **4n** was obtained according to the general procedure as white solid (61.5 mg, 64% yield). HPLC (Daicel Chiralpak AD-H column, *n*-hexane–2-propanol 80:20, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 18.3 min, >99% *ee*; minor diastereomer: t_{major} = 8.1 min, t_{minor} = 7.2 min, >99% *ee*; m.p. 82–85 °C. $[\alpha]_D^{20}$ = –342.7 (*c* 1.5, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.55 (d, *J* = 8.4 Hz, 2H, ArH), 7.34 (t, *J* = 7.8 Hz, 3H, ArH), 7.21–7.17 (m, 6H, ArH), 7.04–6.94 (m, 3H, ArH), 6.62 (dd, J_1 = 6.0 Hz, J_2 = 11.6 Hz, 1H, CH), 4.82 (dd, J_1 = 5.6 Hz, J_2 = 11.2 Hz, 1H, CH), 4.24 (d, *J* = 11.6 Hz, 1H, CH), 3.78 (s, 3H, OCH_3), 3.54 (dd, J_1 = 6.8 Hz, J_2 = 16.4 Hz, 1H, CH), 3.09 (dd, J_1 = 4.8 Hz, J_2 = 16.4 Hz, 1H, CH), 2.25 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 198.2, 168.2, 158.1, 157.9, 136.8, 133.2, 129.8, 129.0, 128.9, 128.8, 127.6, 126.0, 125.2, 121.1, 119.8, 111.7, 85.5, 73.1, 55.5, 45.9, 41.1, 37.7, 14.9 ppm; IR (KBr): $\tilde{\nu}$ 3064, 2925, 2841, 1716, 1691, 1596, 1555, 1497, 1458, 1395, 1365, 1298, 1255, 1200, 1118, 1025, 799, 755, 737, 702, 690, 655, 564, 490 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{28}H_{26}N_3O_5$ $[M + H]^+$ 484.18670, found 484.18744.



4o

(5*R*,8*S*,9*R*,10*R*)-2-(4-Chlorophenyl)-4-methyl-9-nitro-8-phenyl-10-(p-tolyl)-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4o). The product **4o** was obtained according to the general procedure as white solid (51.0 mg, 51% yield), HPLC (Daicel Chiralpak AD-H column, *n*-hexane–2-propanol 80:20, flow rate 1.0 mL/min, detection at 254 nm): major diastereomer: t_{major} = 23.0 min, >99% *ee*; minor diastereomer: t_{major} = 6.3 min, >99% *ee*; m.p. 82–86 °C. $[\alpha]_D^{20}$ = –374.5 (*c* 1.0, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.55 (d, J = 8.8 Hz, 2H, ArH), 7.39–7.37 (m, 3H, ArH), 7.30 (d, J = 8.8 Hz, 2H, ArH), 7.12–7.05 (m, 4H, ArH), 6.96 (d, J = 8.0 Hz, 2H, ArH), 6.53 (dd, J_1 = 6.0 Hz, J_2 = 12.0 Hz, 1H, CH), 4.44 (dd, J_1 = 6.0 Hz, J_2 = 10.0 Hz, 1H, CH), 4.08 (d, J = 12.0 Hz, 1H, CH), 3.72 (dd, J_1 = 6.6 Hz, J_2 = 15.8 Hz, 1H, CH), 3.11 (dd, J_1 = 3.8 Hz, J_2 = 15.8 Hz, 1H, CH), 2.30 (s, 3H, CH_3), 2.18 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 199.1, 167.8, 158.4, 138.9, 136.5, 135.4, 131.2, 129.8, 129.6, 129.1, 128.9, 128.7, 127.9, 127.3, 120.7, 85.4, 73.4, 44.6, 43.1, 41.8, 21.0, 14.9 ppm; IR (KBr): $\tilde{\nu}$ 2921, 1716, 1693, 1556, 1492, 1454, 1364, 1297, 1276, 1261, 1215, 1093, 1012, 829, 748, 700, 655, 564, 509 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{28}H_{25}ClN_3O_4$ $[M + H]^+$ 502.15281, found 502.15377.

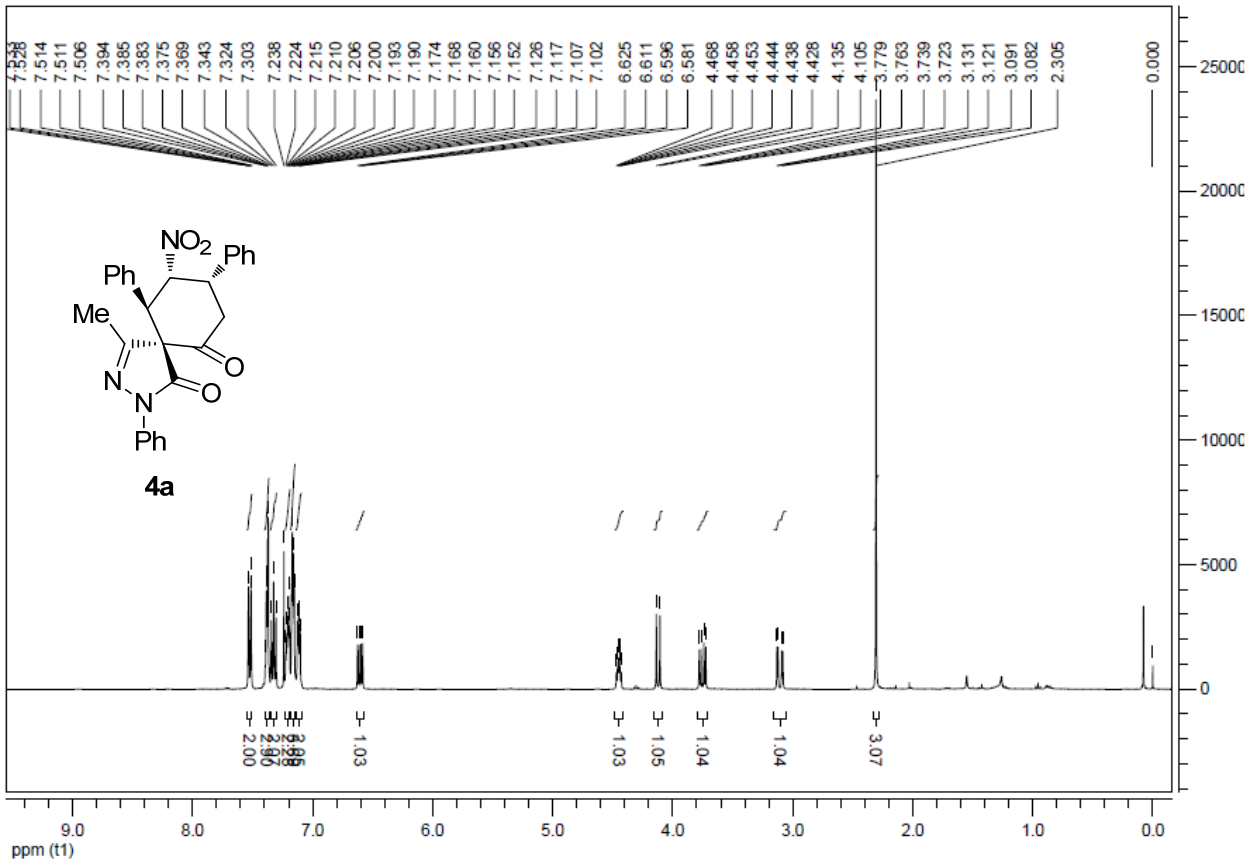


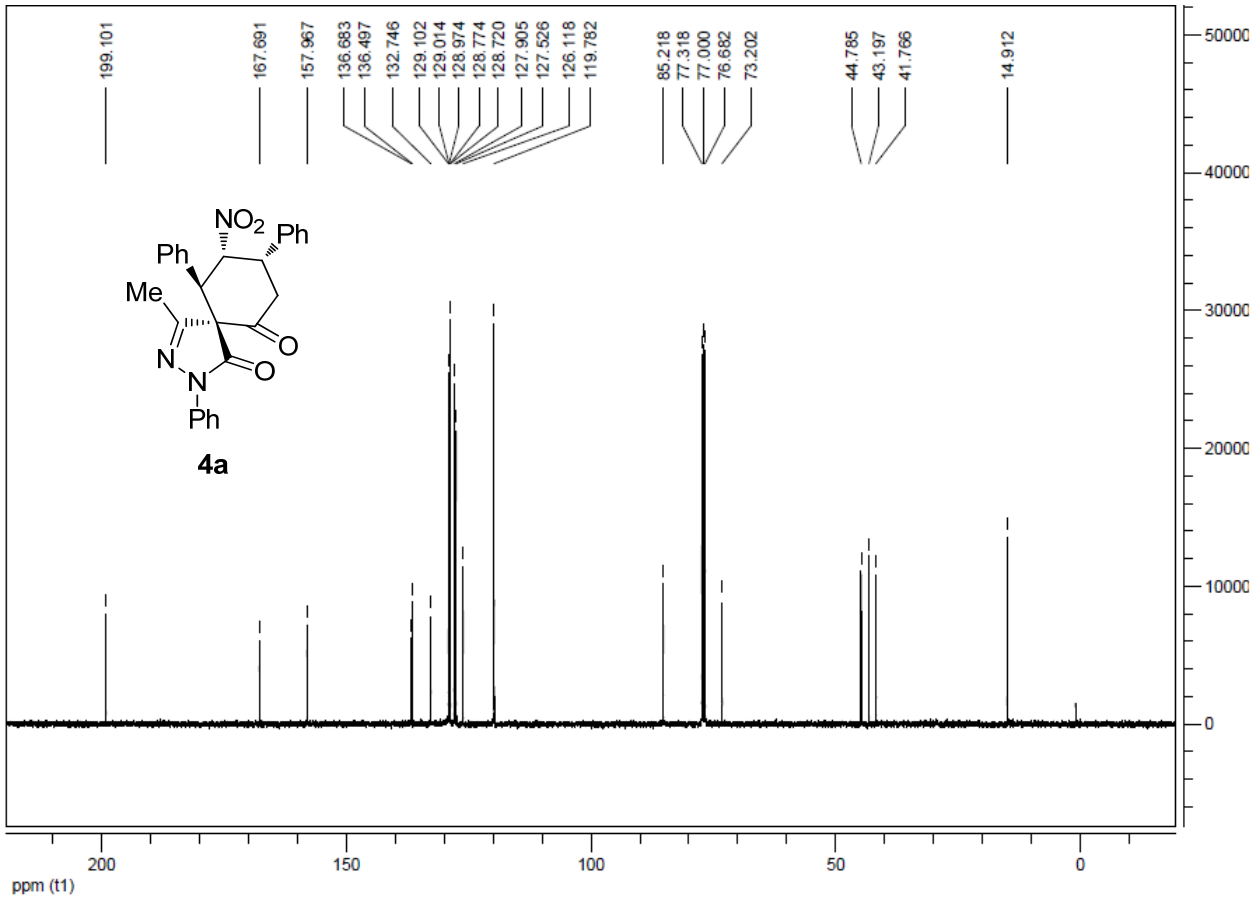
4p

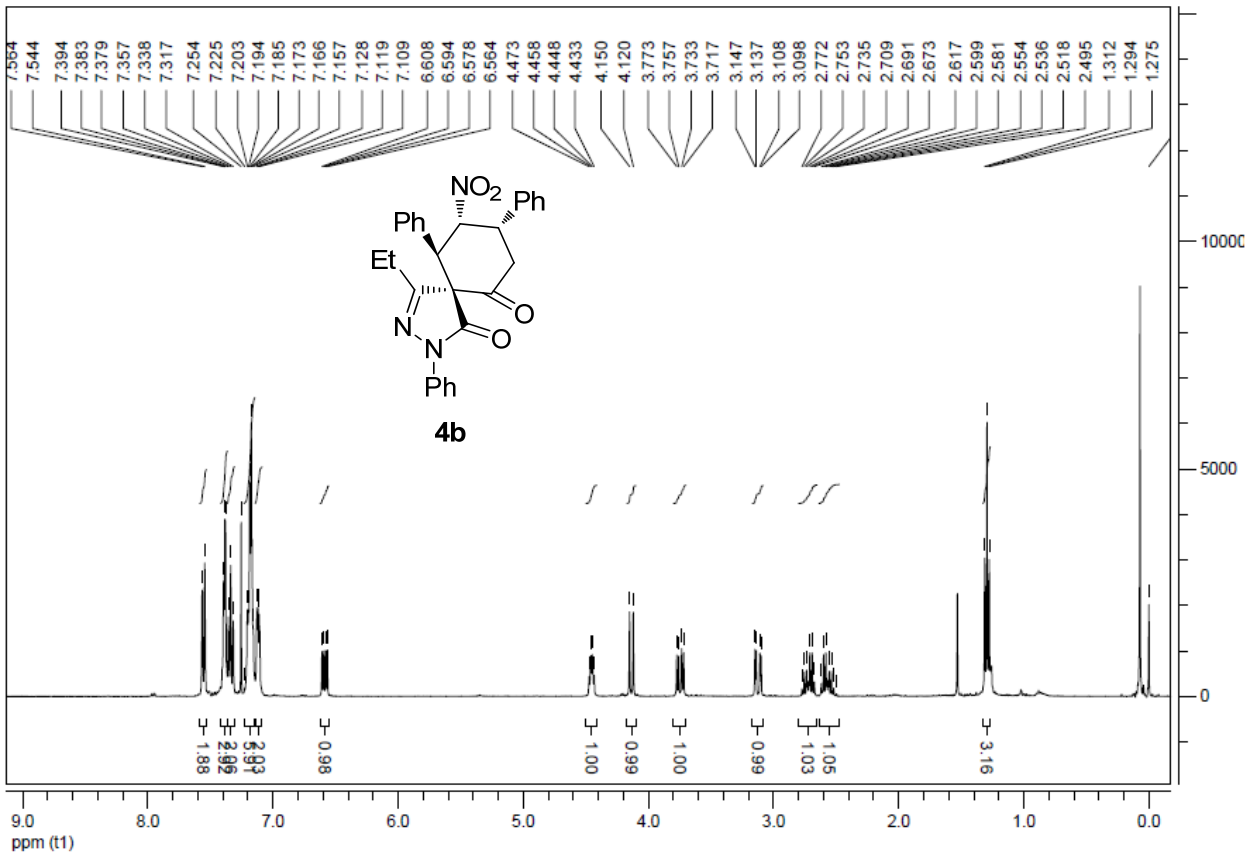
(5*R*,8*S*,9*R*,10*R*)-2-(4-Chlorophenyl)-8-(2-methoxyphenyl)-4-methyl-9-nitro-10-(3-nitrophenyl)-2,3-diazaspiro[4.5]dec-3-ene-1,6-dione (4p). The product **4p** was obtained according to the general procedure as white solid (68.7 mg, 61% yield). HPLC (Daicel Chiralpak AD-H column, *n*-hexane–2-propanol 70:30, flow rate 1.0 mL/min, detection at 254 nm): major

diastereomer: t_{major} = 20.2 min, t_{minor} = 18.1 min, >99% *ee*; minor diastereomer: t_{major} = 13.4 min, t_{minor} = 7.9 min, 99% *ee*; m.p. 205–208 °C. $[\alpha]_D^{20}$ = –360.8 (*c* 1.0, CH_2Cl_2); ^1H NMR (400 MHz, $CDCl_3$): δ 8.11 (s, 1H, ArH), 8.03 (dd, J_1 = 1.2 Hz, J_2 = 8.4 Hz, 1H, ArH), 7.56 (d, J = 8.8 Hz, 3H, ArH), 7.35 (t, J = 8.0 Hz, 2H, ArH), 7.29 (d, J = 8.8 Hz, 2H, ArH), 7.00–6.95 (m, 3H, ArH), 6.68 (dd, J_1 = 6.0 Hz, J_2 = 12.0 Hz, 1H, CH), 4.74 (d, J = 2.4 Hz, 1H, CH), 4.40 (d, J = 12.0 Hz, 1H, CH), 3.77 (s, 3H, OCH_3), 3.59 (dd, J_1 = 7.2 Hz, J_2 = 16.8 Hz, 1H, CH), 3.06 (dd, J_1 = 3.6 Hz, J_2 = 16.8 Hz, 1H, CH), 2.29 (s, 3H, CH_3) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 196.4, 167.7, 158.1, 157.8, 148.2, 135.5, 135.0, 133.1, 131.4, 130.2, 130.1, 129.5, 128.9, 124.4, 123.9, 122.9, 121.3, 120.4, 112.3, 84.8, 72.6, 55.5, 45.1, 41.0, 38.8, 14.9 ppm; IR (KBr): $\tilde{\nu}$ 3094, 2947, 2844, 1729, 1714, 1687, 1593, 1557, 1528, 1492, 1366, 1352, 1319, 1297, 1287, 1255, 1242, 1208, 1152, 1119, 1091, 1033, 1010, 909, 833, 813, 769, 756, 737, 689, 678, 653, 566, 505 cm^{-1}; HRMS (ESI): *m/z* calcd. for $C_{28}H_{24}ClN_4O_7$ $[M + H]^+$ 563.1328, found 563.1331.

Copies of ^{1}H and ^{13}C NMR spectra of new compounds



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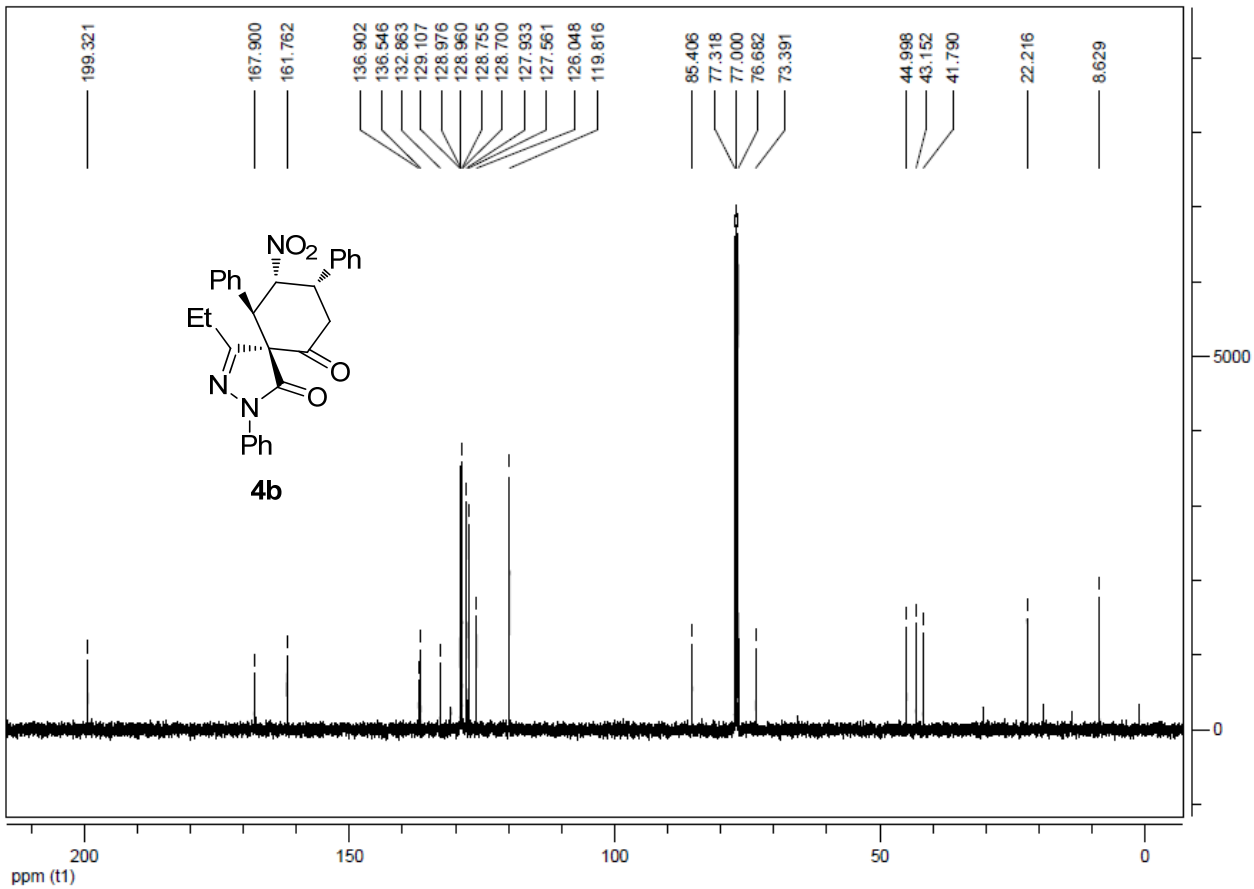
ppm (t1)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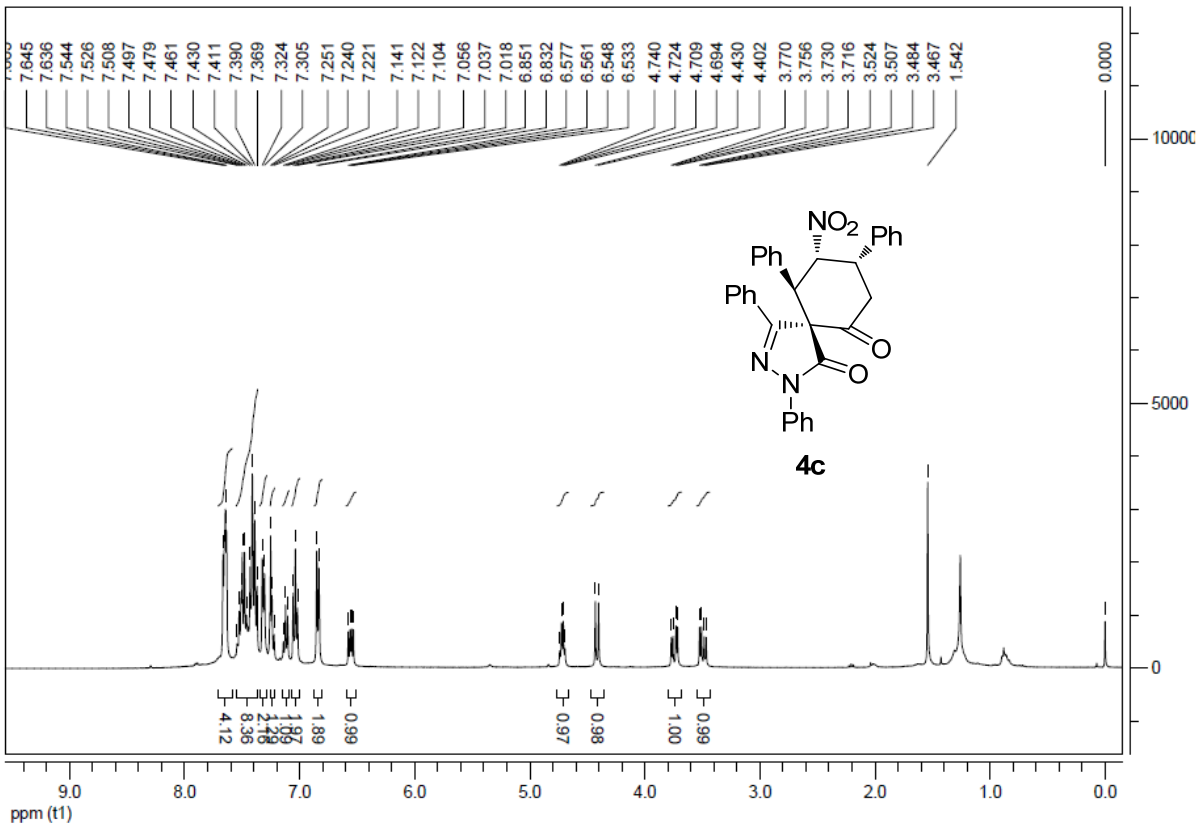
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3.730
3.716
3.524
3.507
3.484
3.467
1.542
0.000
NO2
Ph
Ph
Ph
N
N
O
O
Ph
4c
4.12
8.36
2.18
1.97
1.89
0.99
0.97
0.98
1.00
0.99
10000
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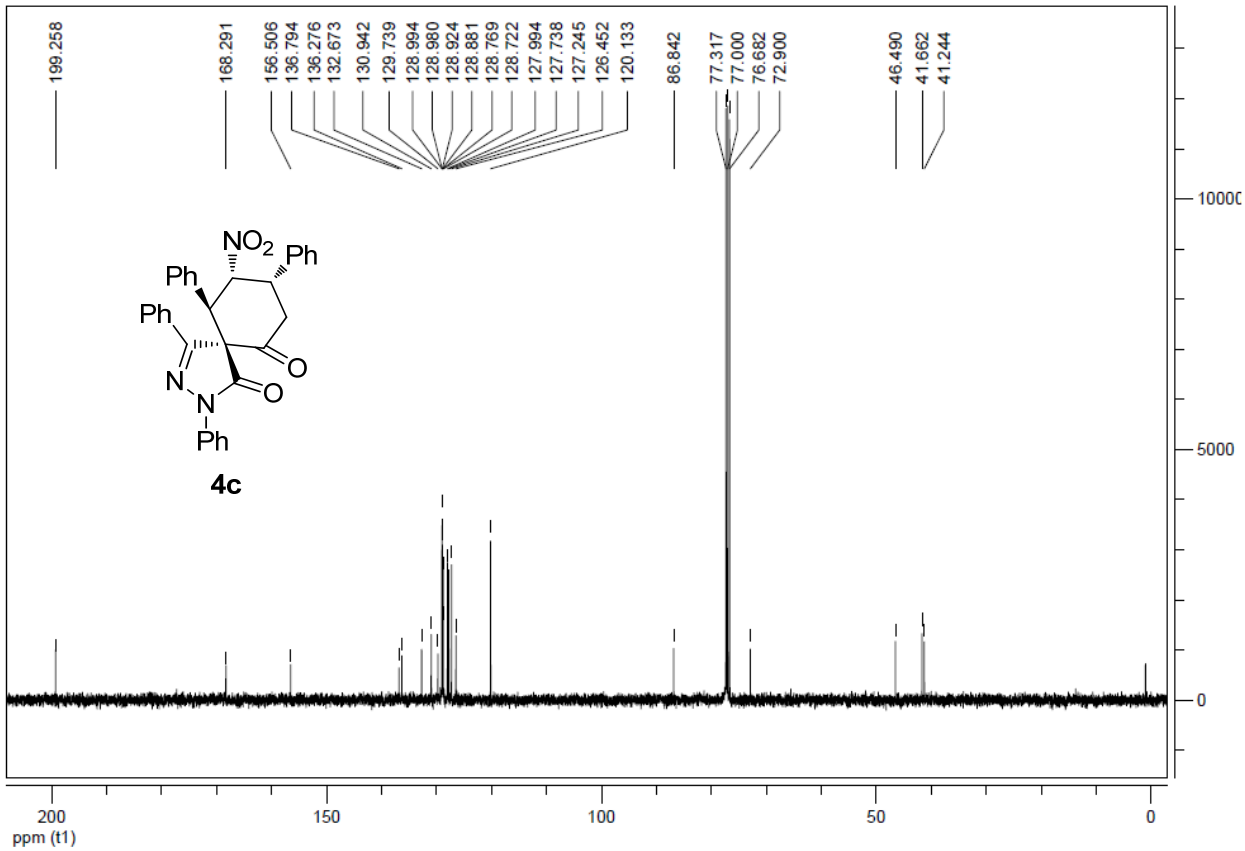
ppm (t1)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126.452
120.133
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77.317
77.000
76.682
72.900
46.490
41.662
41.244
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N
O
O
Ph
4c
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100
50
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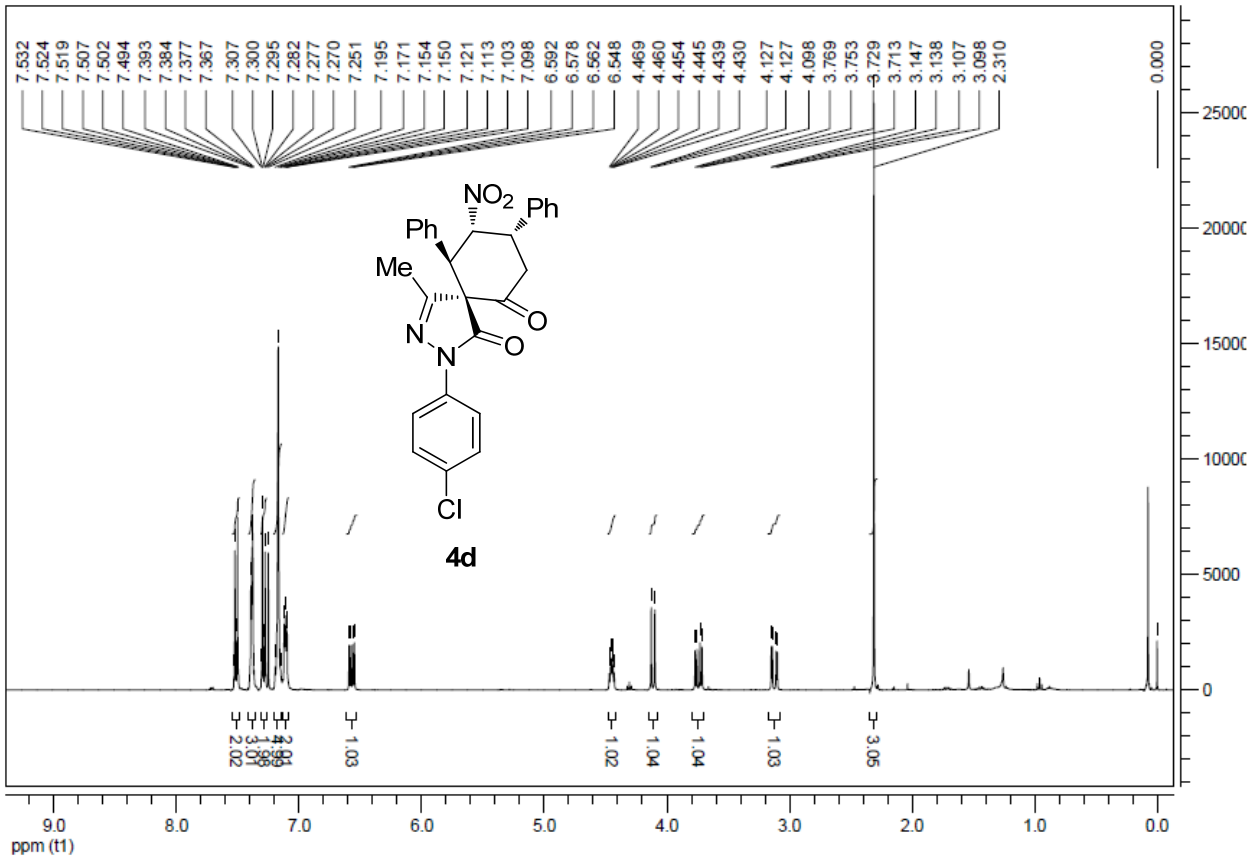
ppm (t1)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7.277
7.270
7.251
7.195
7.171
7.154
7.150
7.121
7.113
7.103
7.098
6.592
6.578
6.562
6.548
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4.454
4.445
4.439
4.430
4.127
4.127
4.098
3.769
3.753
3.729
3.713
3.147
3.138
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0.000
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Ph
Ph
Me
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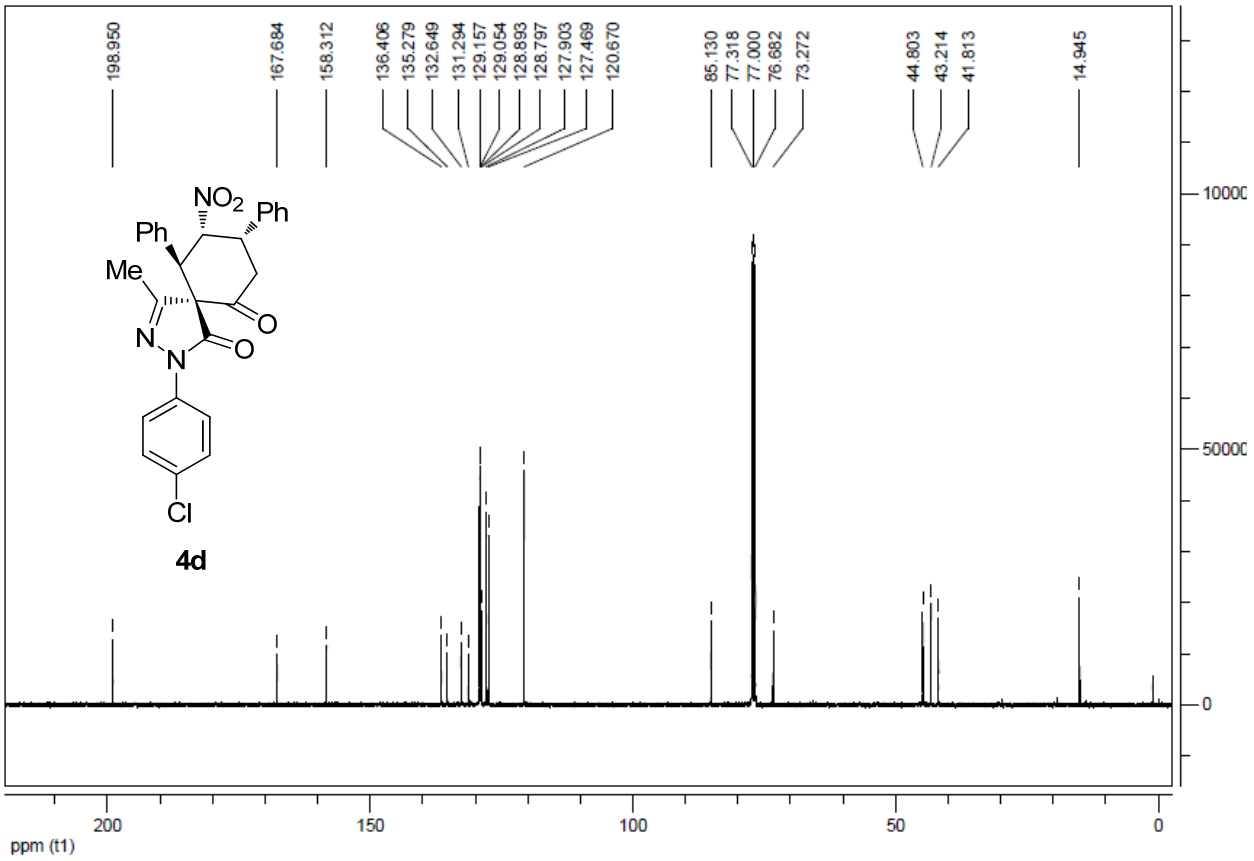
N
O
O
Cl
4d
ppm (t1)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77.000
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73.272
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Me
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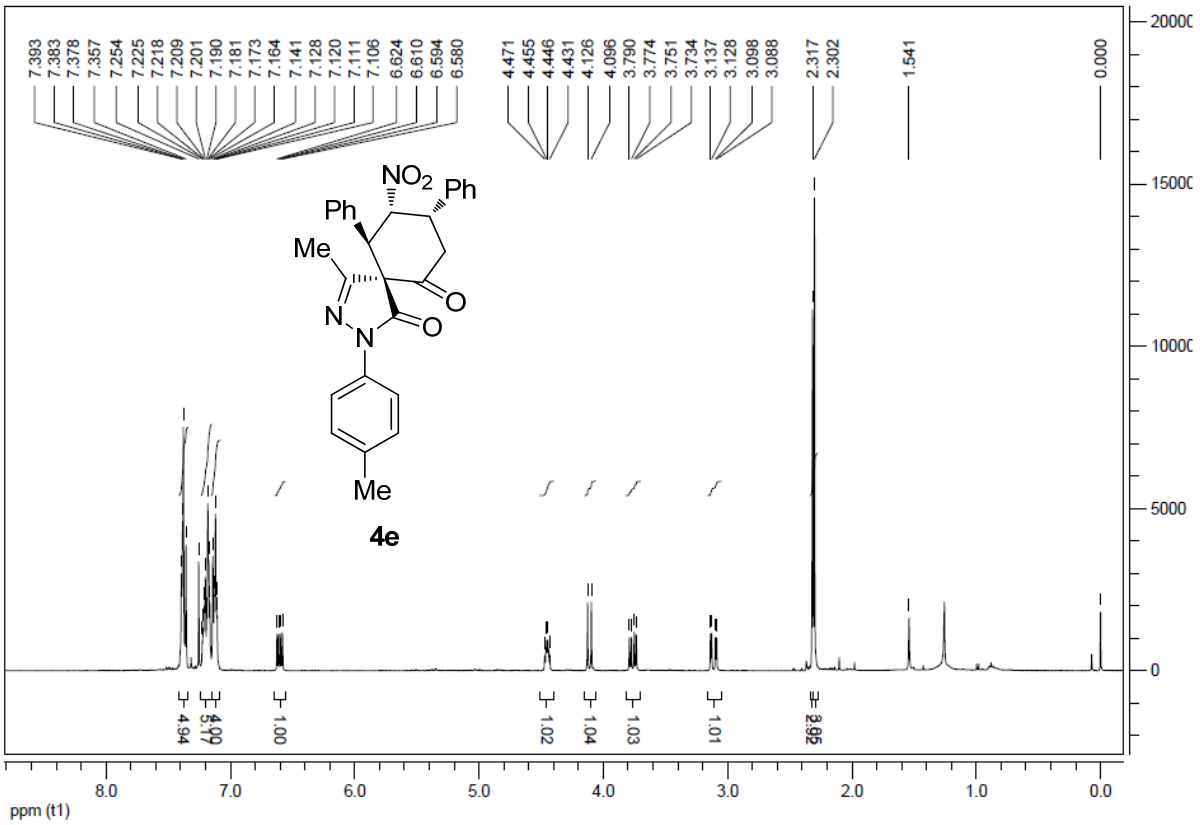
N
O
O
Cl
4d
ppm (t1)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7.164
7.141
7.128
7.120
7.111
7.106
6.624
6.610
6.594
6.580
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4.455
4.446
4.431
4.126
4.096
3.790
3.774
3.751
3.734
3.137
3.128
3.098
3.088
2.317
2.302
1.541
0.000
NO2
Ph
Ph
Me
O
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1.03
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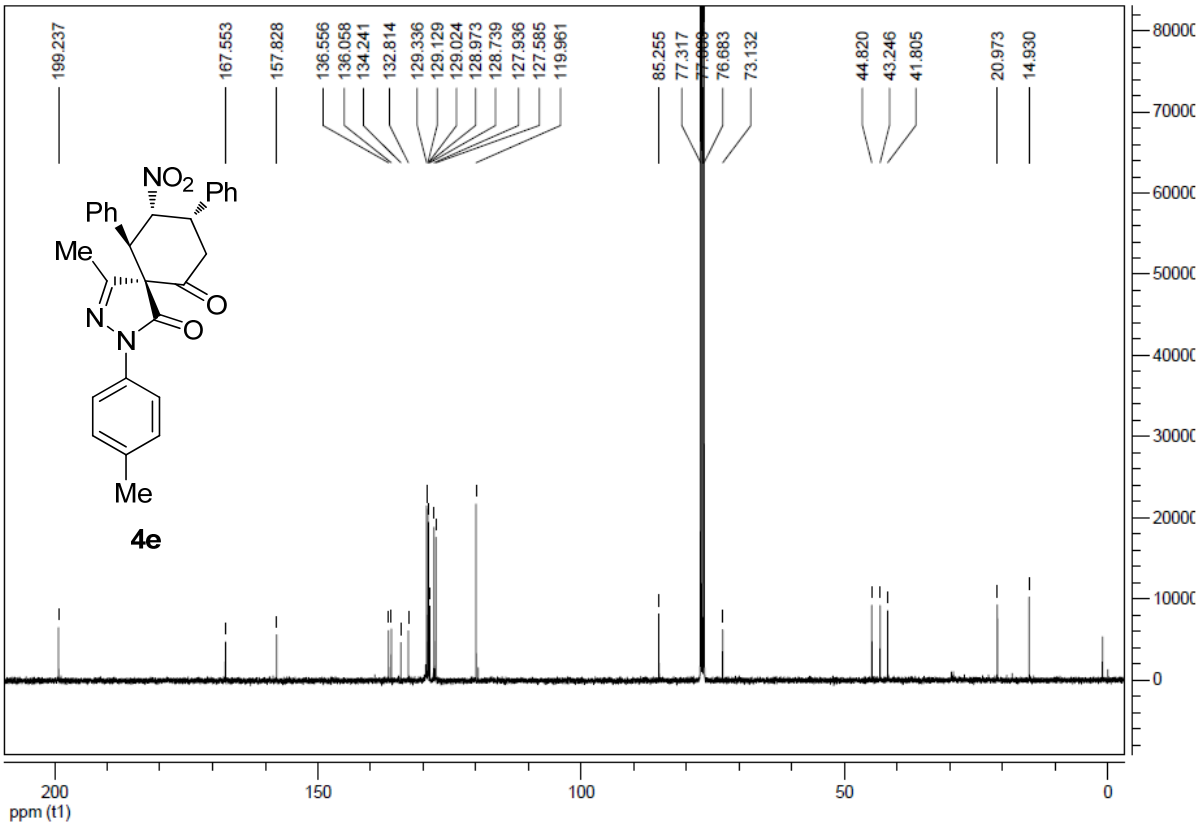
8.95
ppm (t1)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85.255
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76.683
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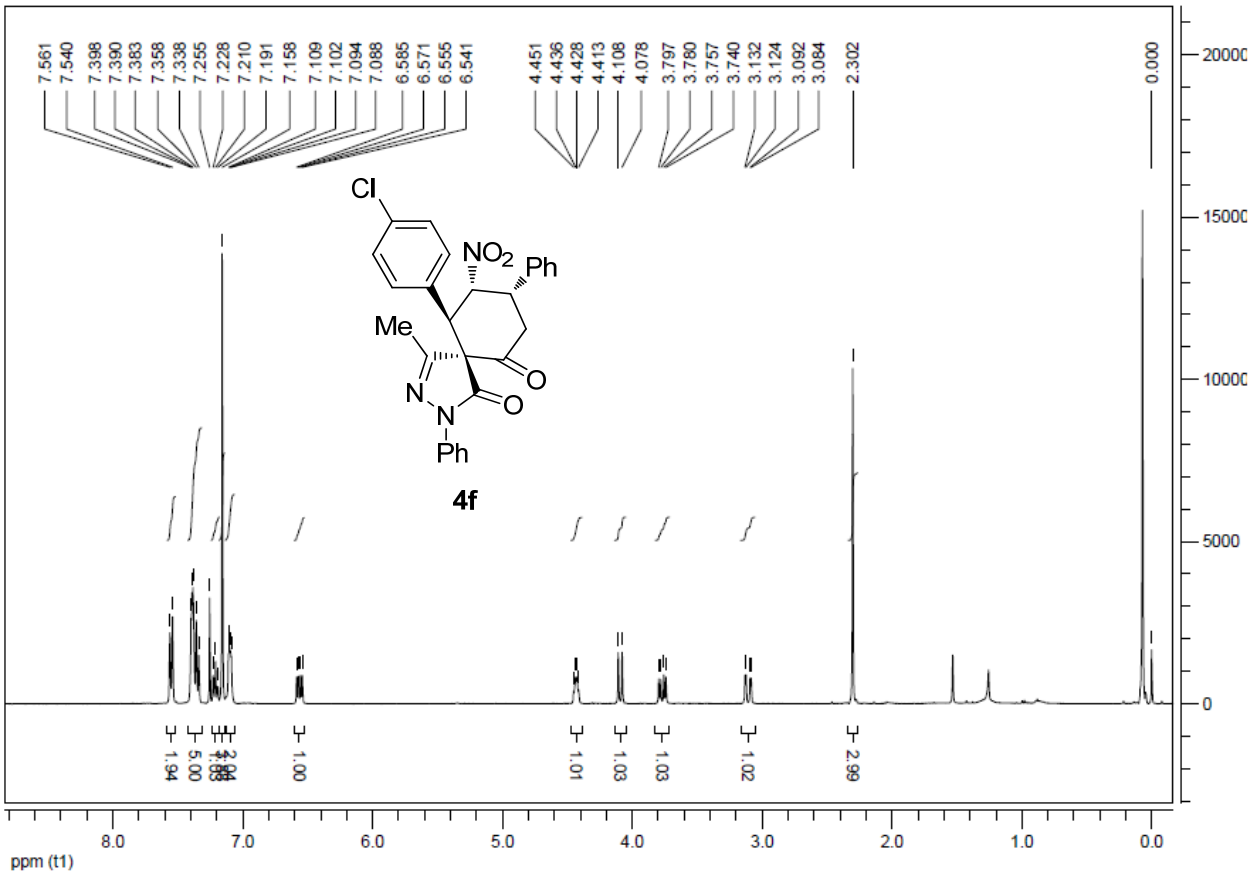
Ph
Me
O
O
N
N
Me
4e
ppm (t1)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7.158
7.109
7.102
7.094
7.088
6.585
6.571
6.555
6.541
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4.436
4.428
4.413
4.108
4.078
3.797
3.780
3.757
3.740
3.132
3.124
3.092
3.084
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0.000
Cl
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Ph
Me
N
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O
Ph
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1.00
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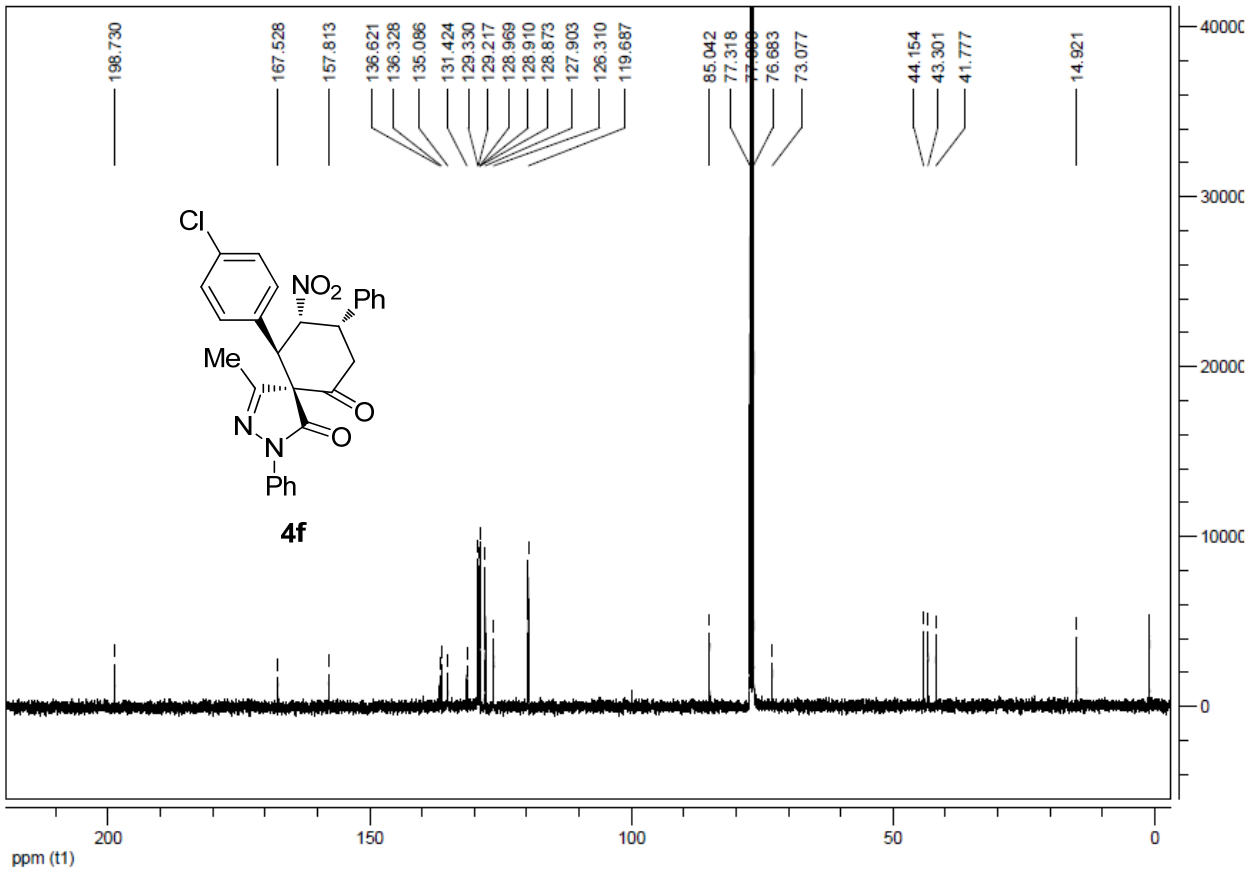
1.03
1.03
1.02
2.99
ppm (t1)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126.310
119.687
85.042
77.318
76.683
73.077
44.154
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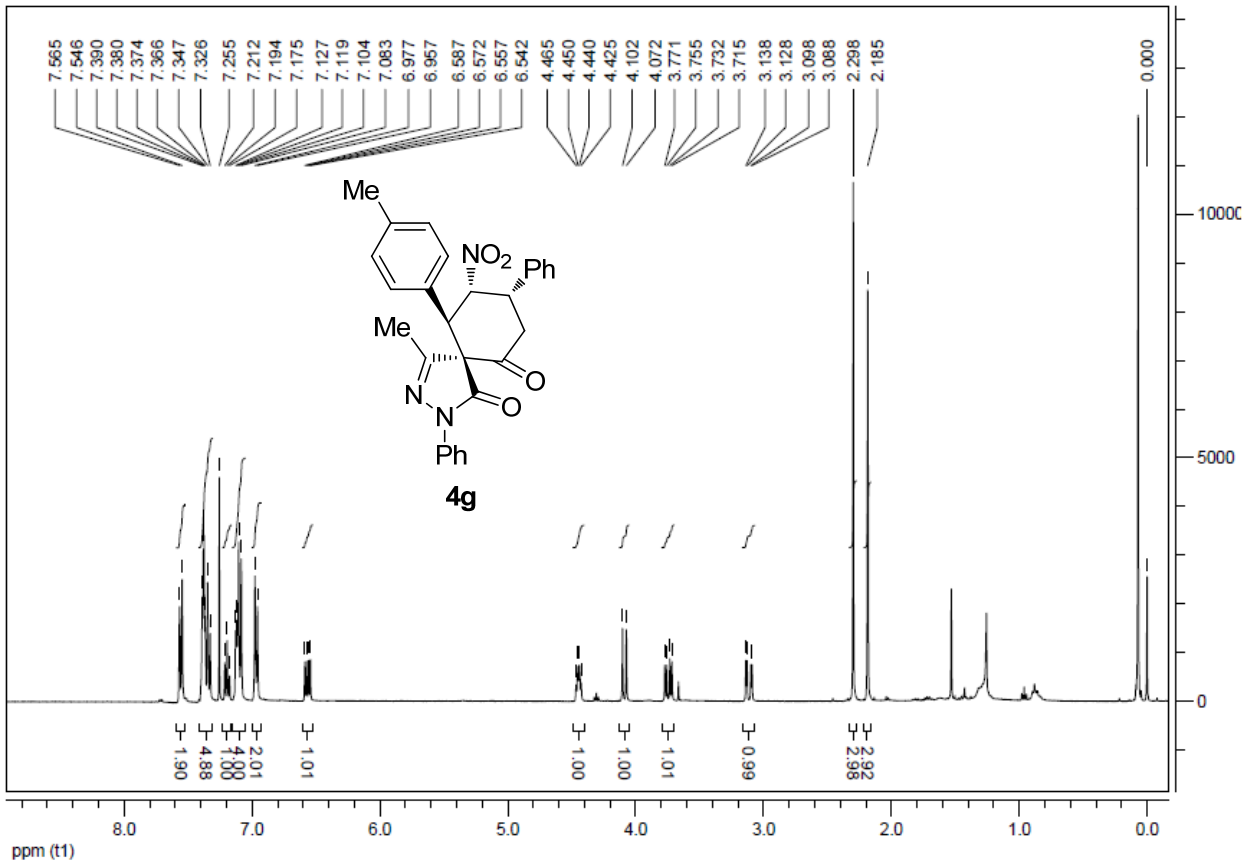
41.777
14.921
Cl
NO2
Ph
Me
N
N
O
O
Ph
4f
ppm (t1)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7.194
7.175
7.127
7.119
7.104
7.083
6.977
6.957
6.587
6.572
6.557
6.542
4.465
4.450
4.440
4.425
4.102
4.072
3.771
3.755
3.732
3.715
3.138
3.128
3.098
3.088
2.298
2.185
0.000
Me
NO2
Ph
Me
N
N
O
O
Ph
4g
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4.88
1.00
1.47
2.01
1.01
1.00
1.00
1.01
0.99
2.98
2.92
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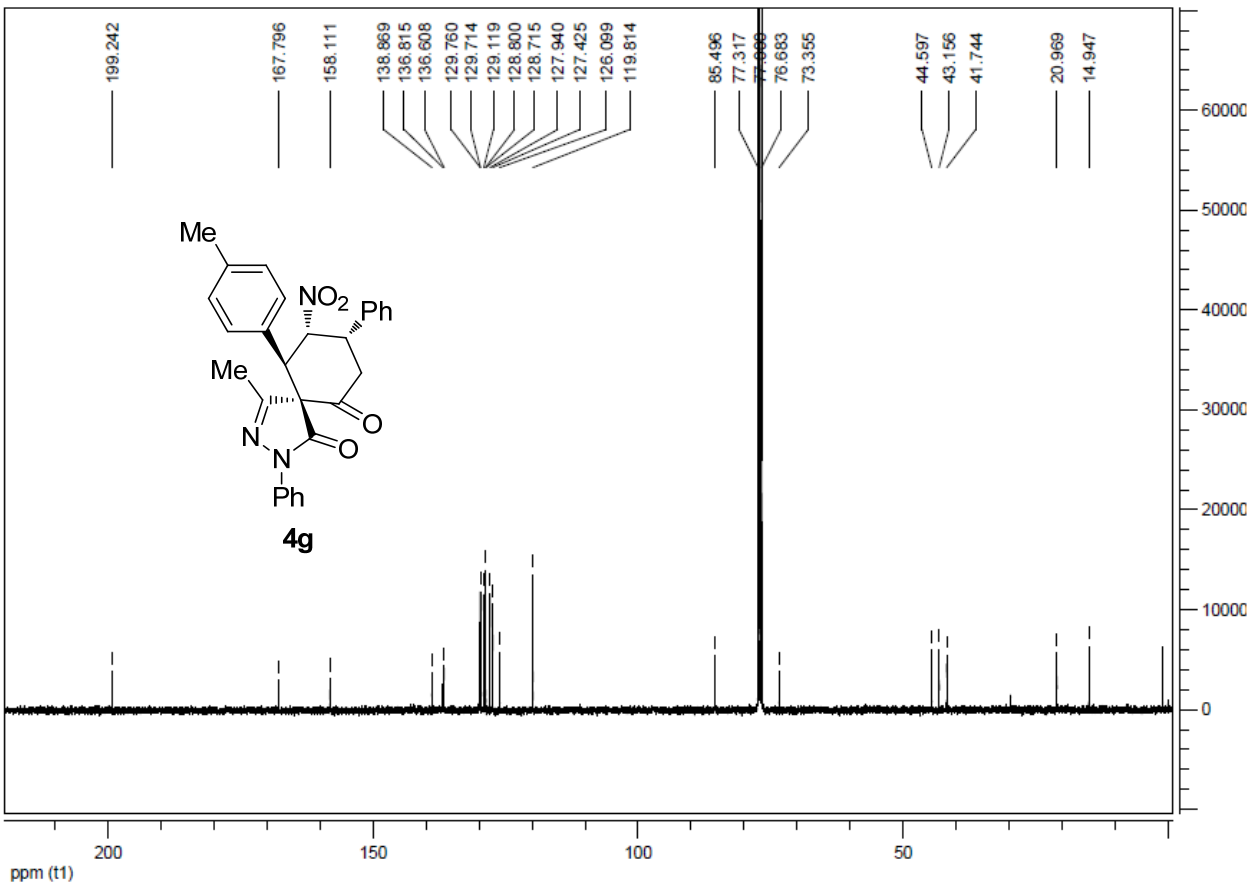
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)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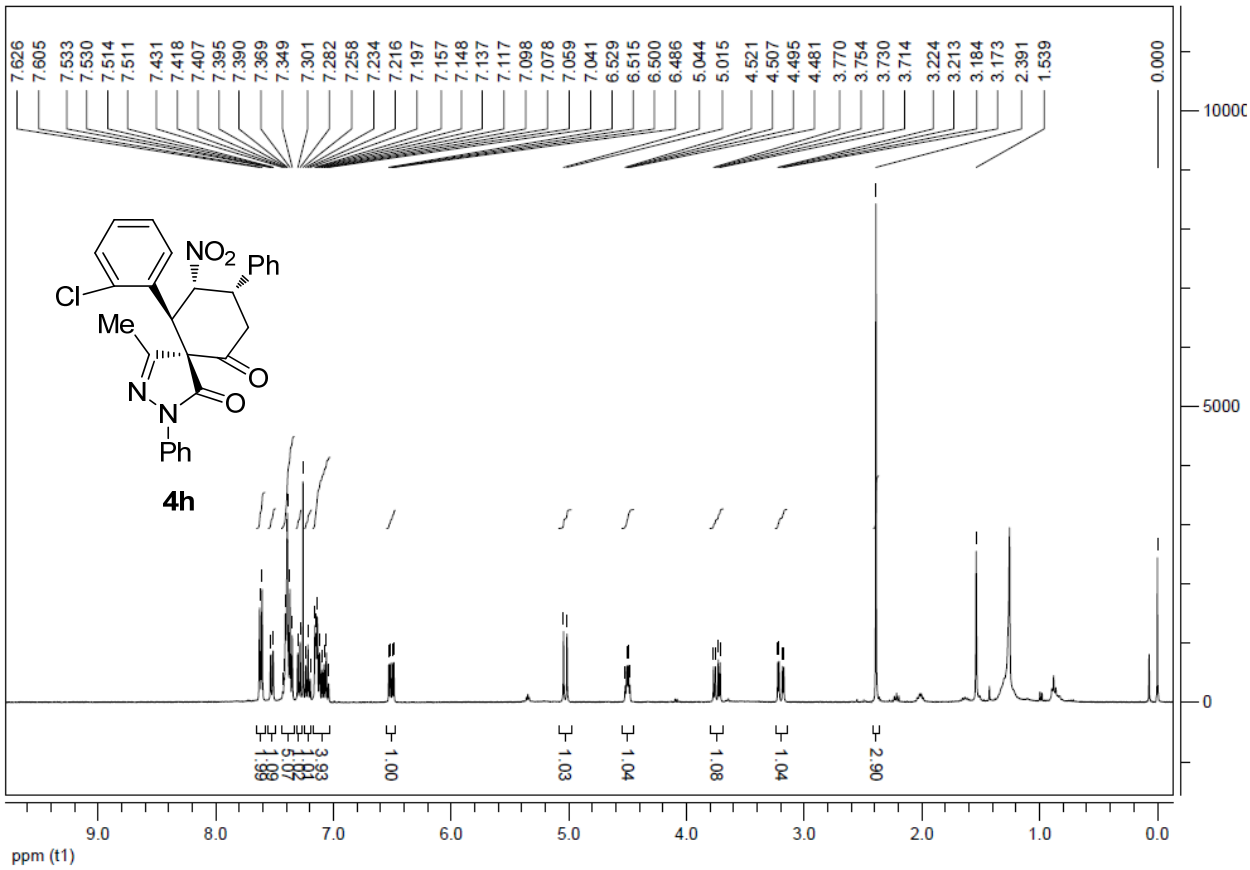
127.940
127.425
126.099
119.814
85.496
77.317
76.683
73.355
44.597
43.156
41.744
20.969
14.947
Me
NO2
Ph
Me
N
N
O
O
Ph
4g
60000
50000
40000
30000
20000
10000
0
200
150
100
50
ppm (t1)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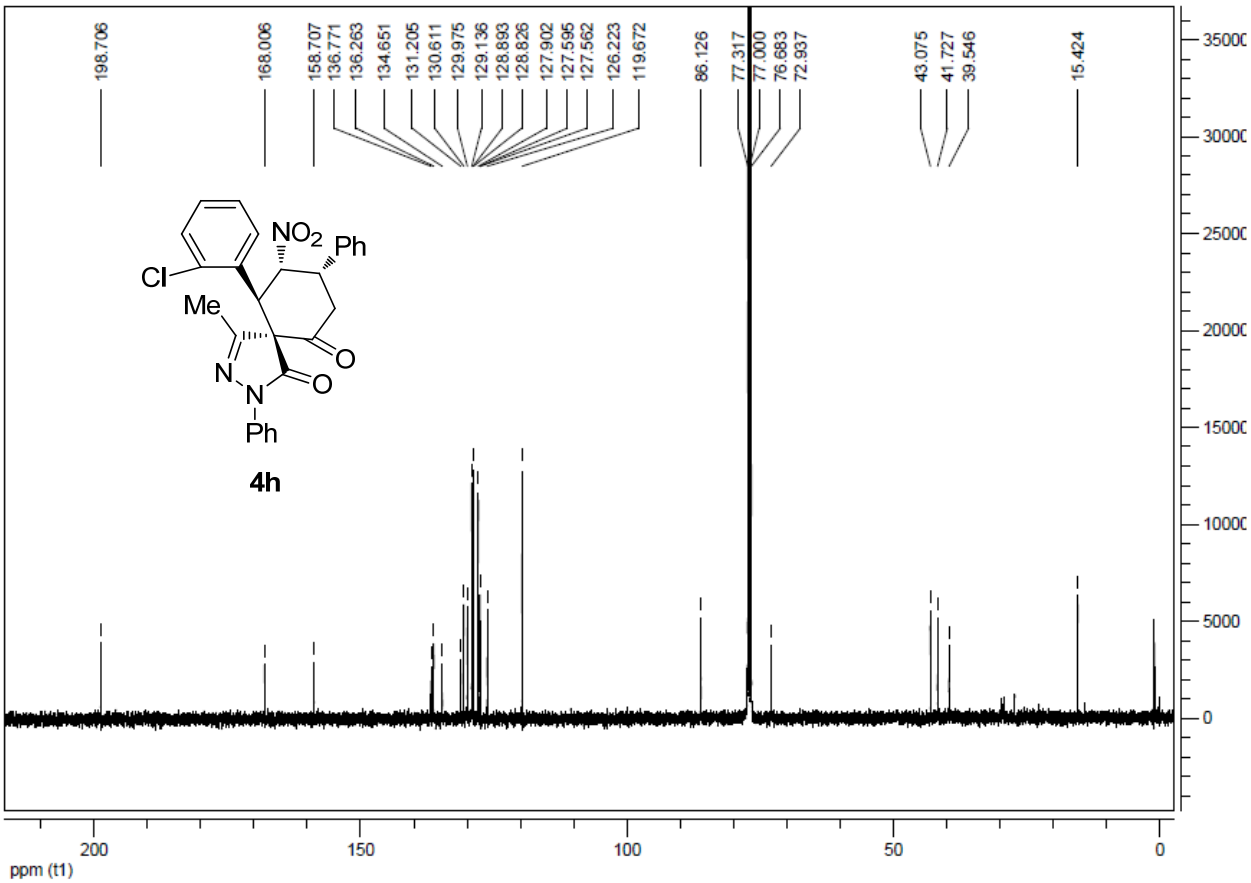
7.301
7.282
7.258
7.234
7.216
7.197
7.157
7.148
7.137
7.117
7.098
7.078
7.059
7.041
6.529
6.515
6.500
6.486
5.044
5.015
4.521
4.507
4.495
4.481
3.770
3.754
3.730
3.714
3.224
3.213
3.184
3.173
2.391
1.539
0.000
NO2
Ph
Cl
Me
N
N
Ph
O
O
4h
1.00
1.03
1.04
1.08
1.04
2.90
ppm (t1)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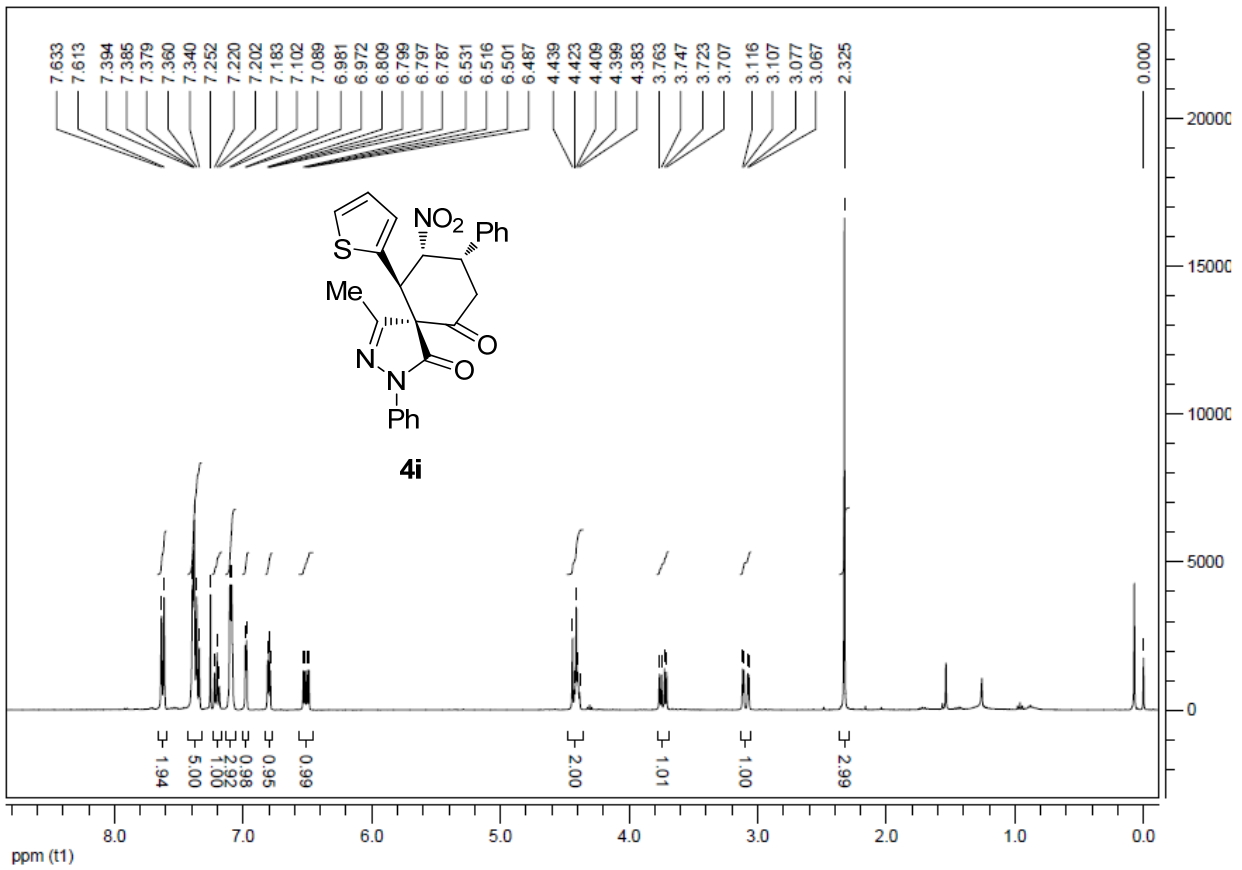
127.902
127.595
127.562
126.223
119.672
86.126
77.317
77.000
76.683
72.937
43.075
41.727
39.546
15.424
NO2
Ph
Cl
Me
N
N
Ph
O
O
4h
ppm (t1)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7.102
7.089
6.981
6.972
6.809
6.799
6.797
6.787
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6.516
6.501
6.487
4.439
4.423
4.409
4.399
4.383
3.763
3.747
3.723
3.707
3.116
3.107
3.077
3.067
2.325
0.000
NO2
Ph
S
Me
N
N
O
O
Ph
4i
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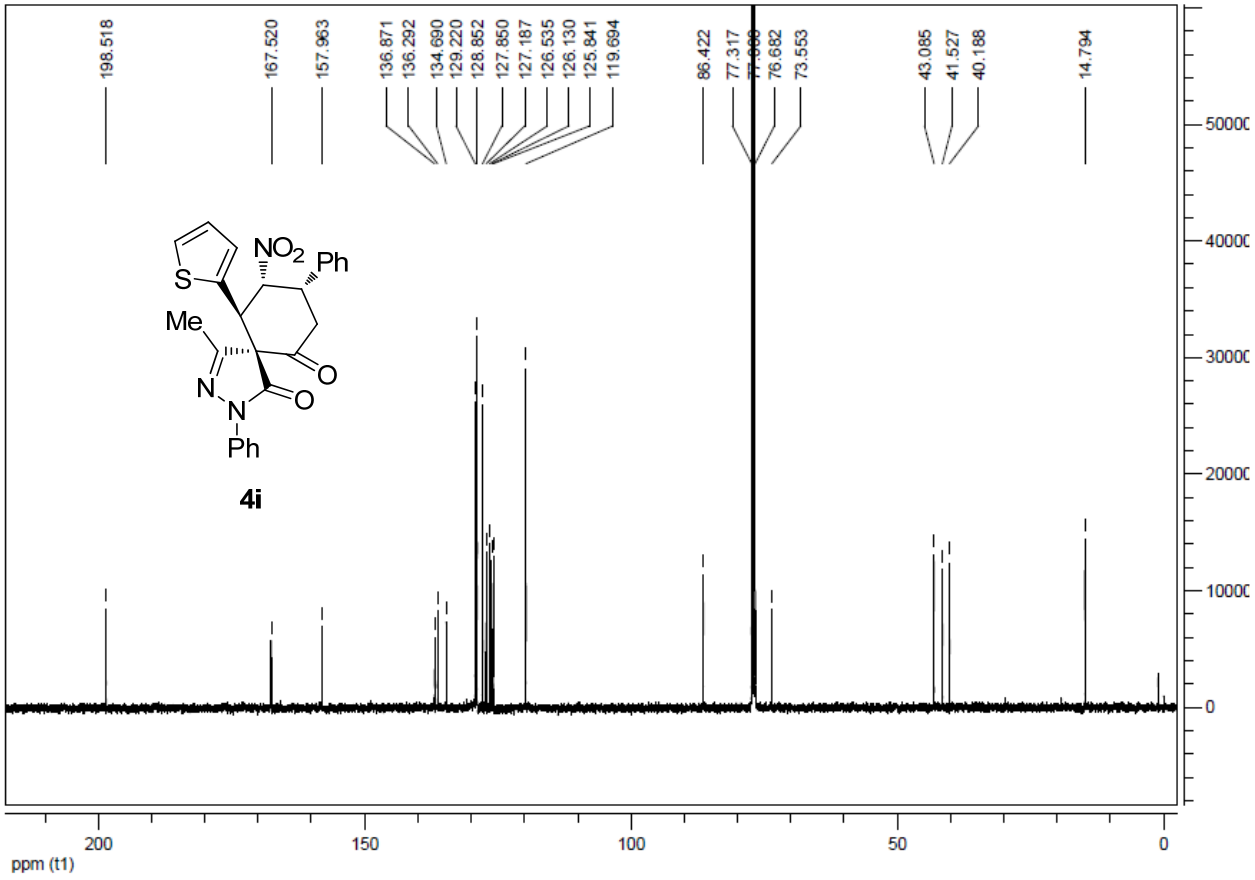
1.00
2.92
0.98
0.95
0.99
2.00
1.01
1.00
2.99
ppm (t1)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126.130
125.841
119.694
86.422
77.317
76.682
73.553
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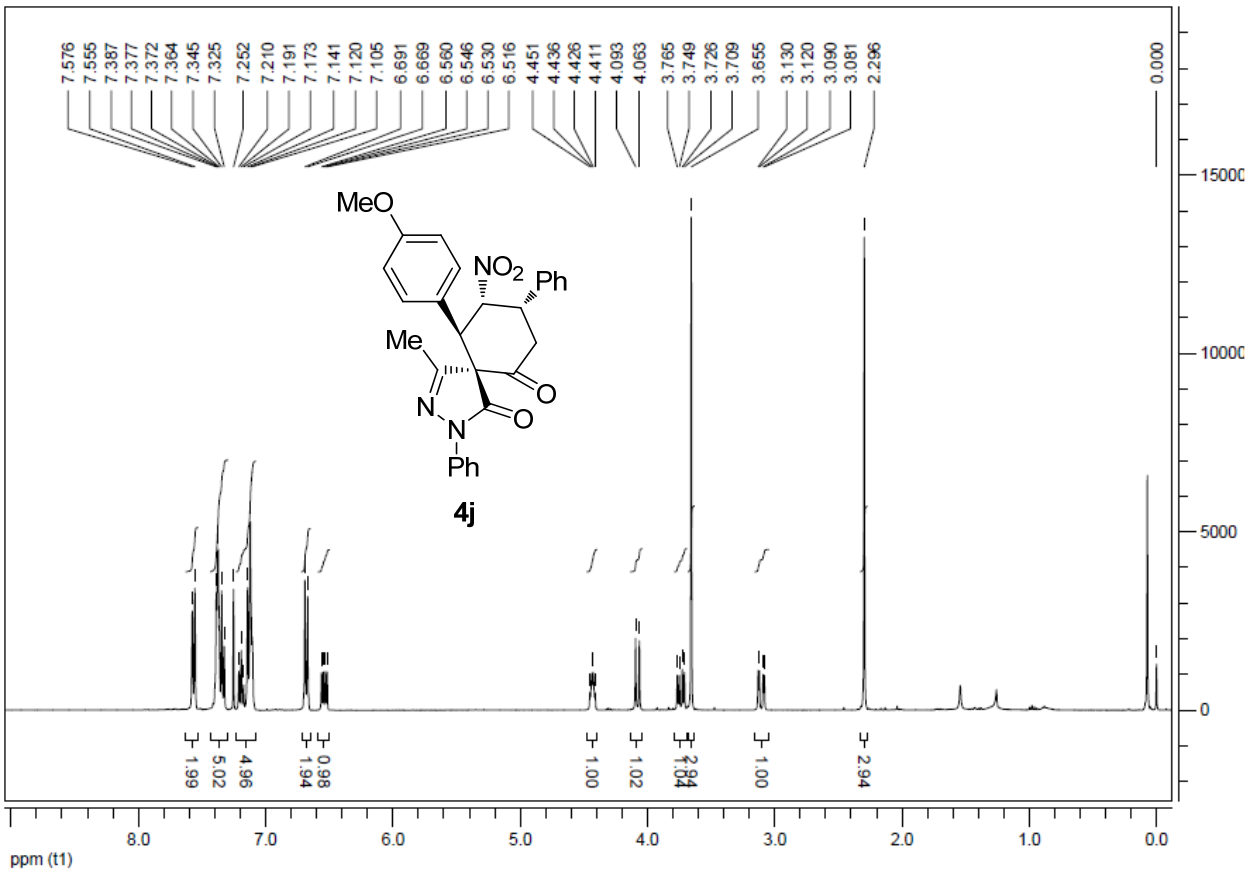
40.188
14.794
NO2
Ph
S
Me
N
N
O
O
Ph
4i
ppm (t1)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7.252
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7.173
7.141
7.120
7.105
6.691
6.669
6.560
6.546
6.530
6.516
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4.436
4.426
4.411
4.093
4.063
3.765
3.749
3.726
3.709
3.655
3.130
3.120
3.090
3.081
2.296
0.000
MeO
NO2
Ph
Me
N
N
O
O
Ph
4j
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4.96
1.94
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1.00
1.02
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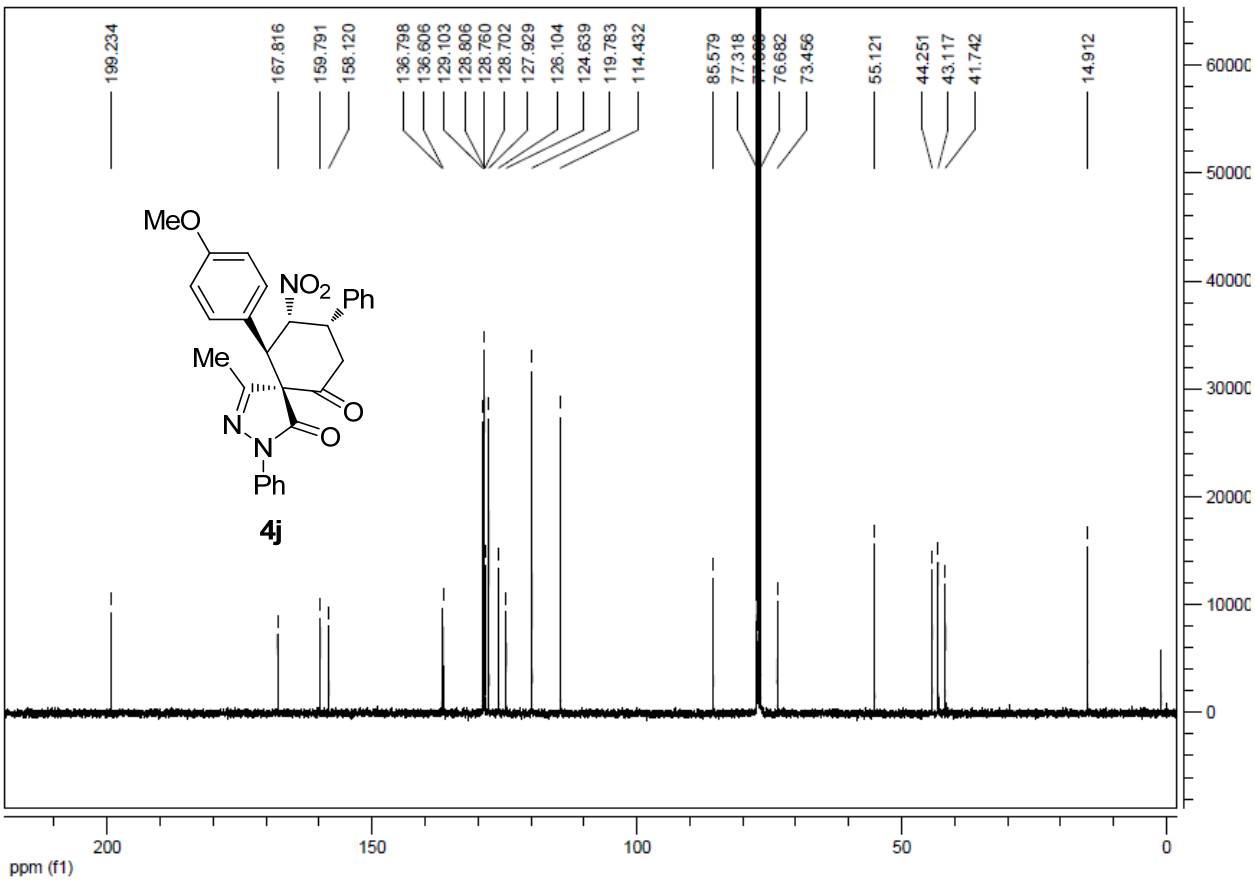
2.94
ppm (t1)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124.639
119.783
114.432
85.579
77.318
76.682
73.456
55.121
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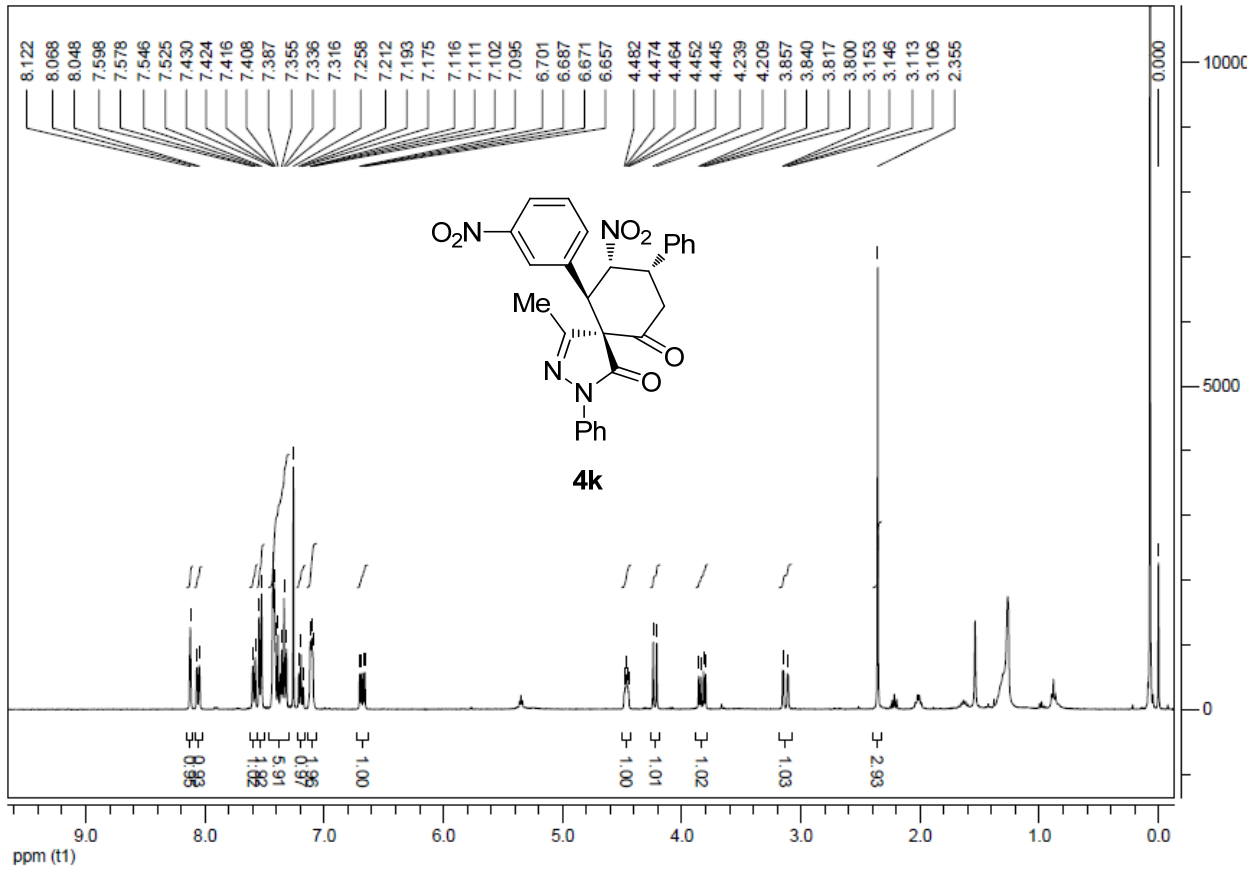
14.912
MeO
NO2
Ph
Me
N
N
O
O
Ph
4j
ppm (f1)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7.316
7.258
7.212
7.193
7.175
7.116
7.111
7.102
7.095
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6.687
6.671
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4.445
4.239
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3.840
3.817
3.800
3.153
3.146
3.113
3.106
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NO2
Ph
Me
N
N
O
O
Ph
4k
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1.01
1.02
1.03
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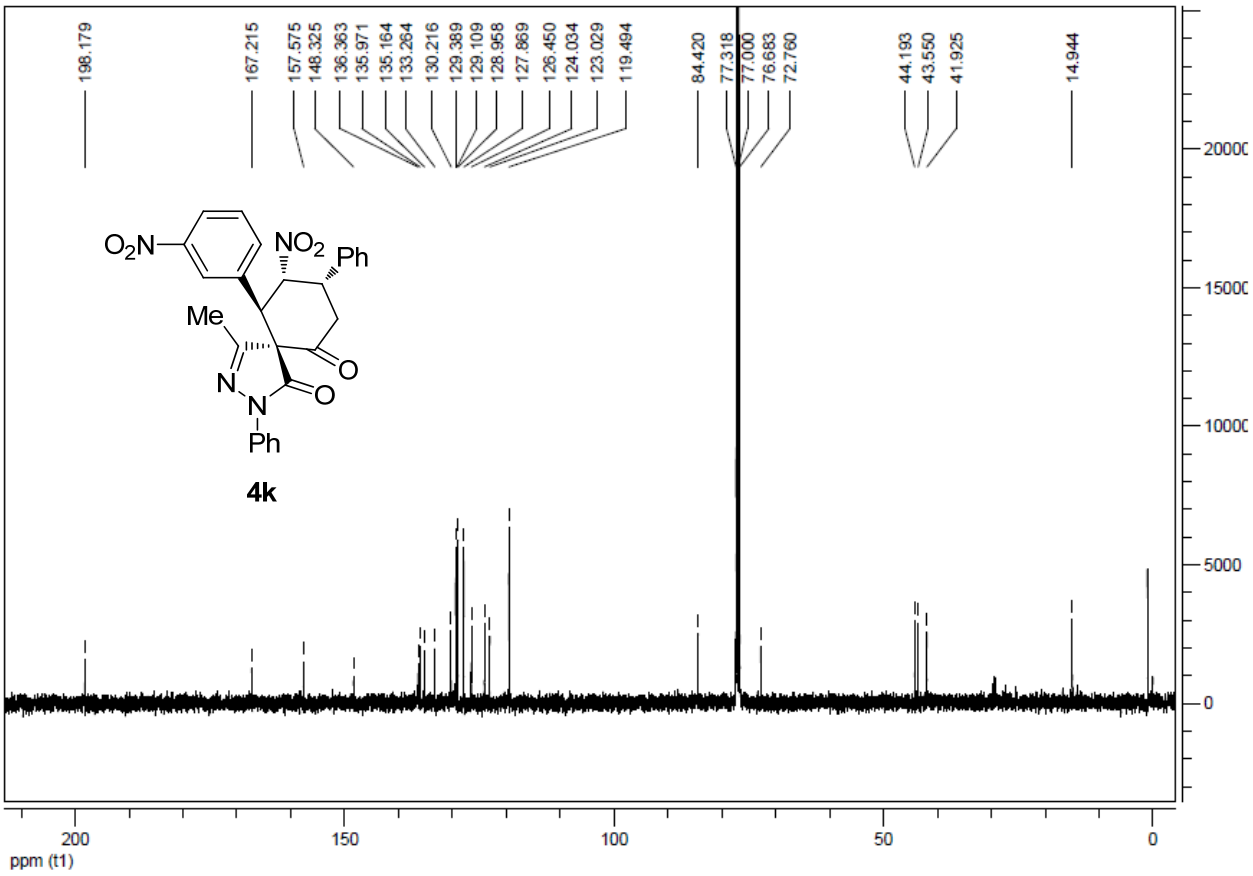
5000
0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124.034
123.029
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77.318
77.000
76.683
72.760
44.193
43.550
41.925
14.944
O2N
NO2
Ph
Me
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N
O
O
Ph
4k
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150
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50
0
ppm (t1)
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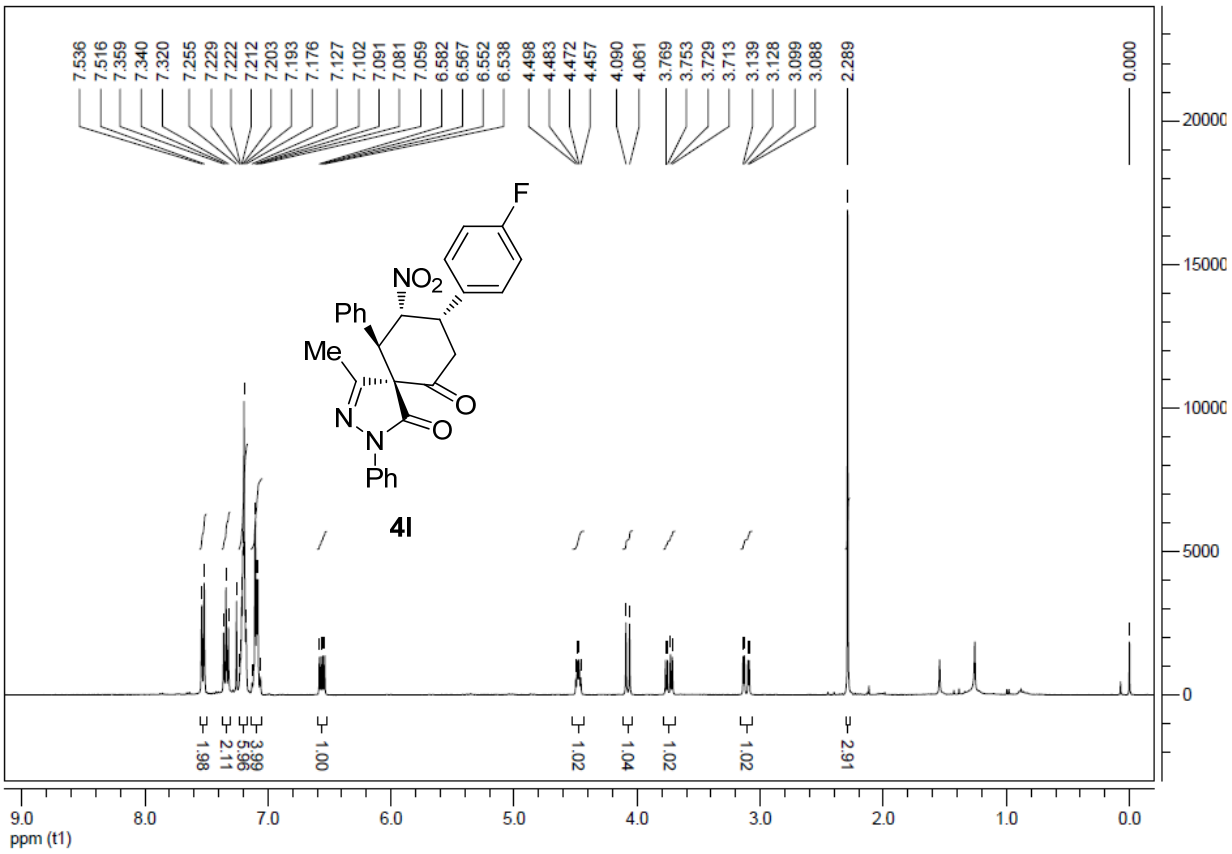
15000
10000
5000
0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7.127
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7.091
7.081
7.059
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6.552
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4.483
4.472
4.457
4.090
4.061
3.769
3.753
3.729
3.713
3.139
3.128
3.099
3.088
2.289
0.000
F
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Ph
Me
N
N
O
O
Ph
4l
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2.11
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3.99
1.00
1.02
1.04
1.02
1.02
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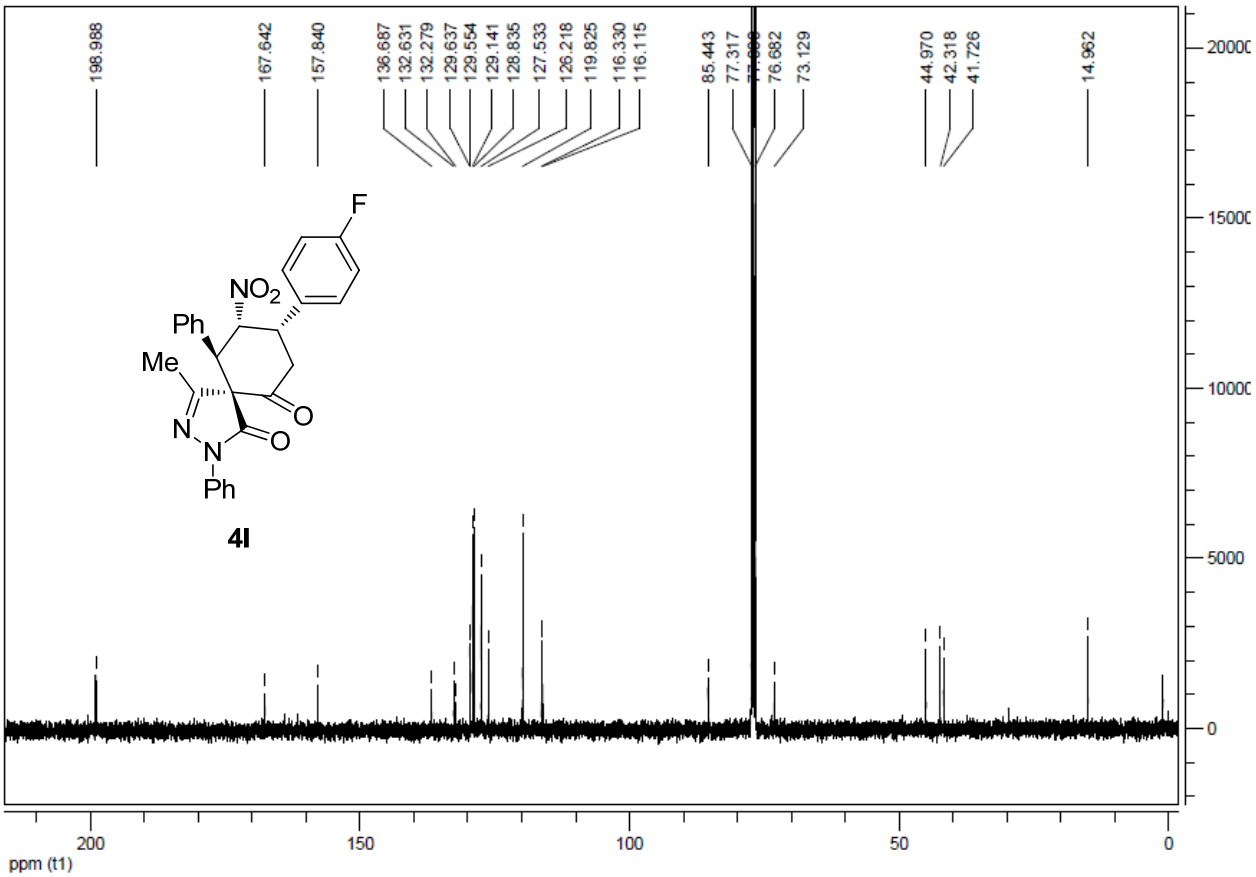
ppm (t1)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116.115
85.443
77.317
76.682
73.129
44.970
42.318
41.726
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O
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Ph
4l
200
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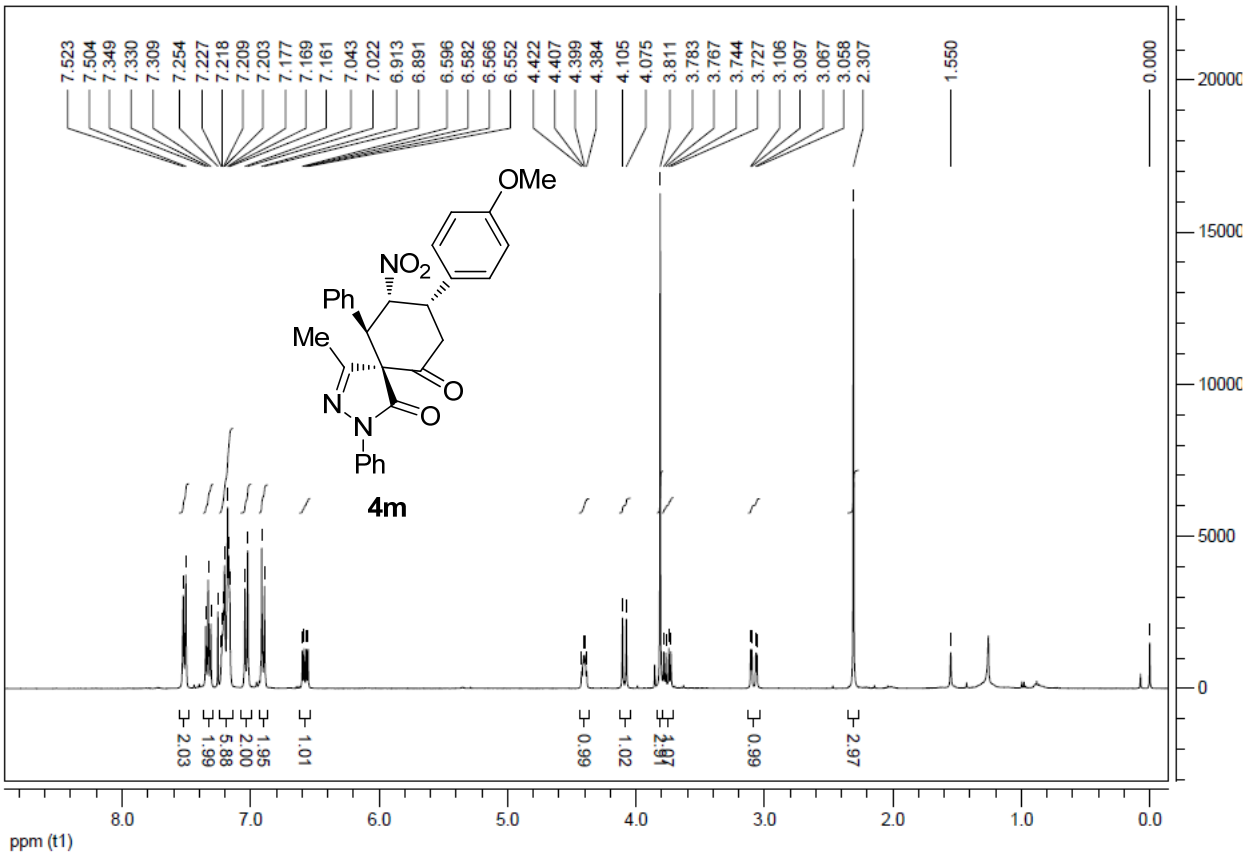
0
ppm (t1)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7.043
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4.407
4.399
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4.105
4.075
3.811
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3.767
3.744
3.727
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3.067
3.058
2.307
1.550
0.000
OMe
NO2
Ph
Me
N
N
O
O
Ph
4m
2.03
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5.88
2.00
1.96
1.01
0.99
1.02
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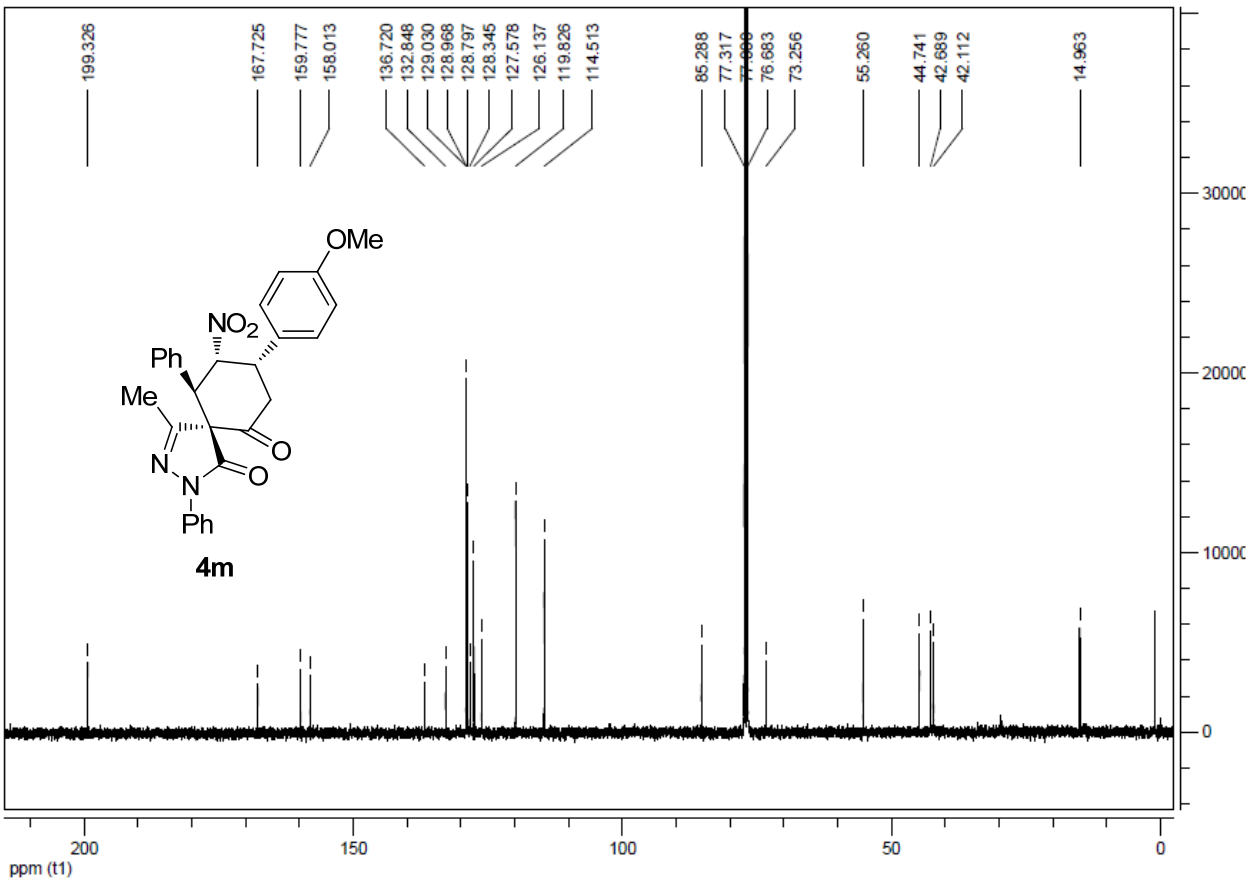
0.0
ppm (t1)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114.513
85.288
77.317
76.683
73.256
55.260
44.741
42.689
42.112
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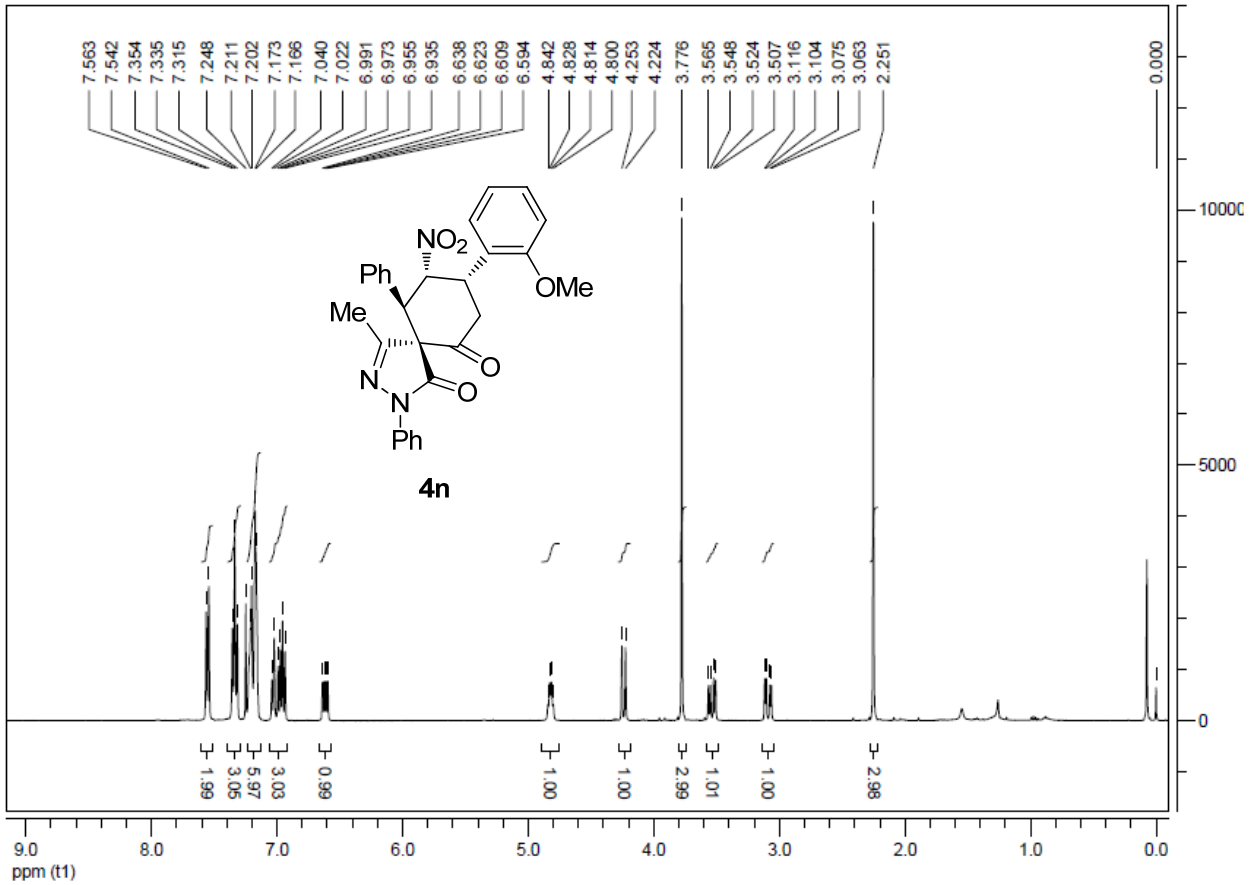
OMe
NO2
Ph
Me
N
N
O
O
Ph
4m
200
150
100
50
0
ppm (t1)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6.594
4.842
4.828
4.814
4.800
4.253
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3.776
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3.548
3.524
3.507
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3.104
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3.063
2.251
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NO2
Ph
OMe
Me
N
N
O
O
Ph
4n
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5.97
3.03
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1.00
1.00
2.99
1.01
1.00
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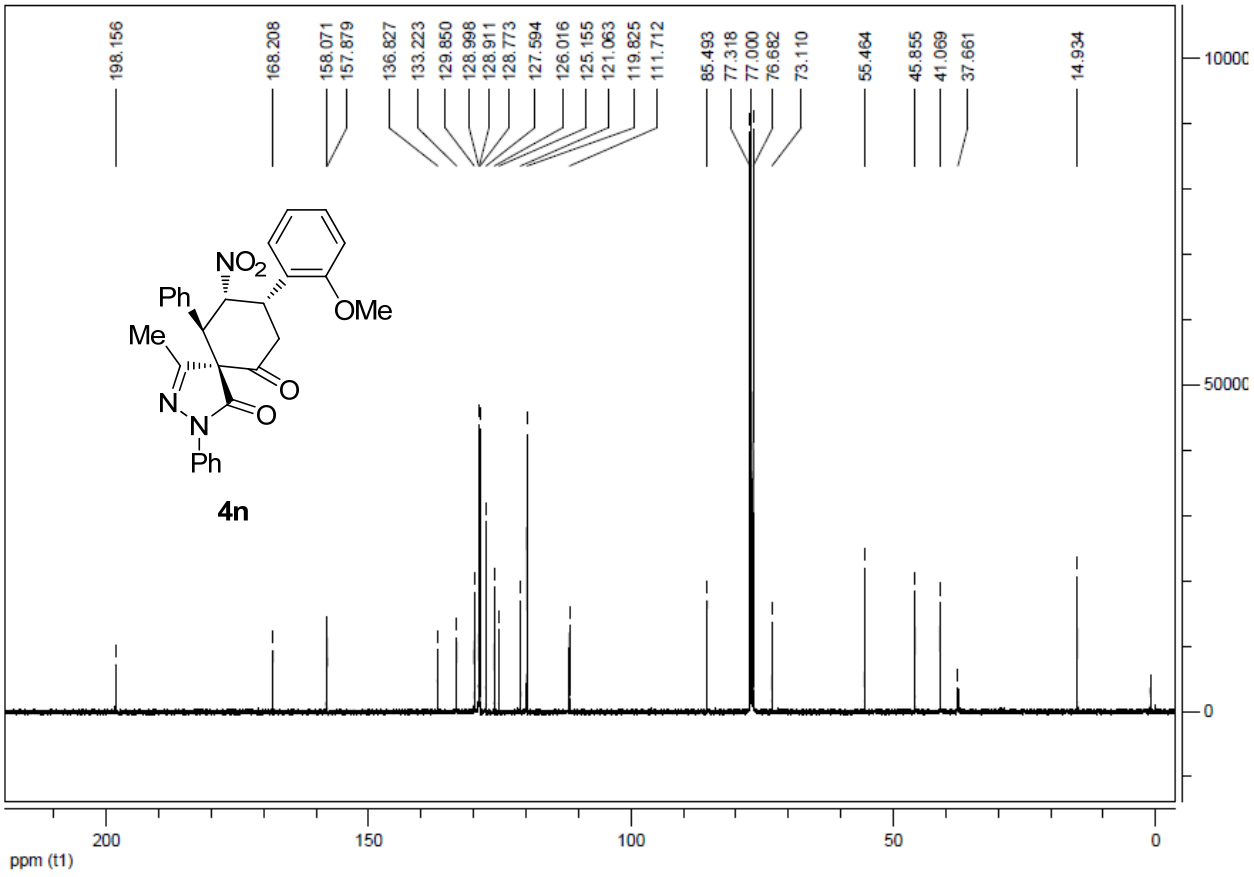
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NO2
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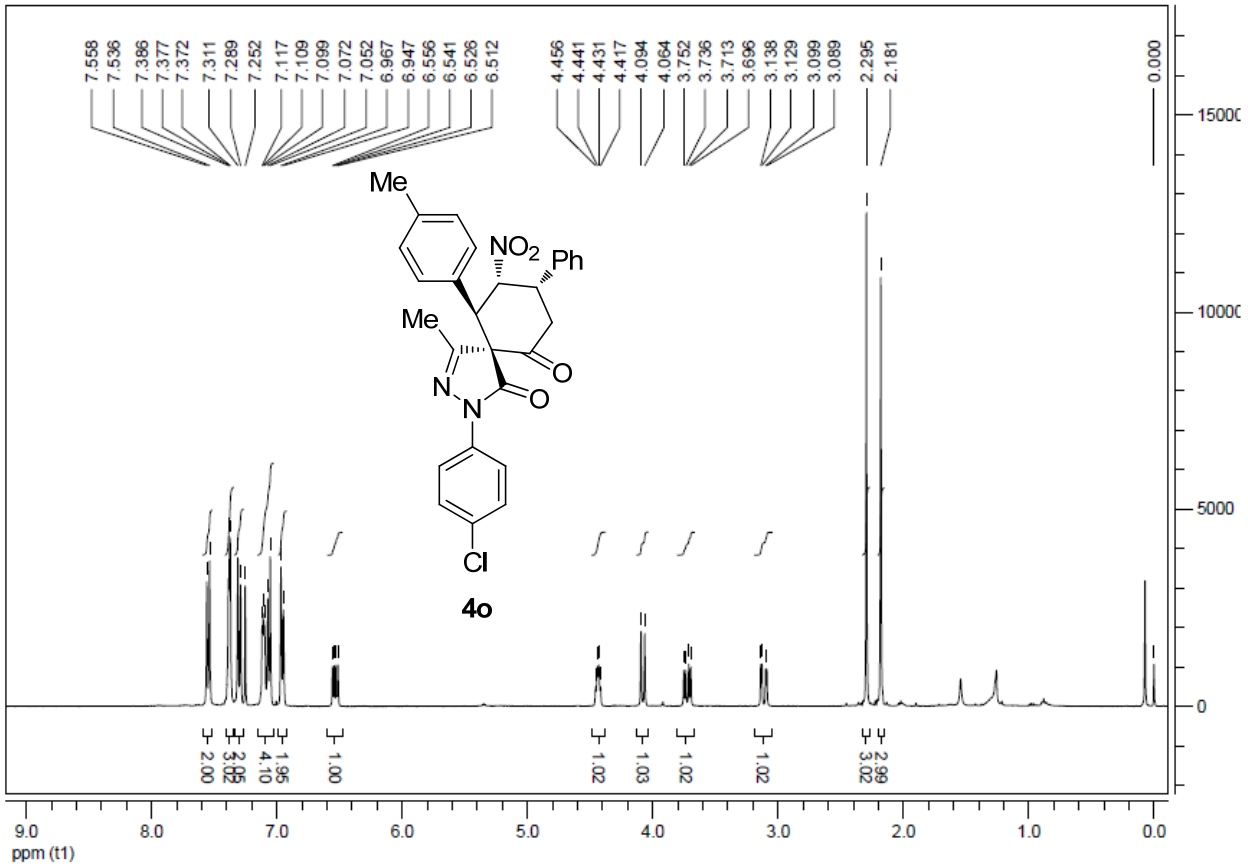
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6.967
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6.556
6.541
6.526
6.512
4.456
4.441
4.431
4.417
4.094
4.064
3.752
3.736
3.713
3.696
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3.129
3.099
3.089
2.295
2.181
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Me
NO2
Ph
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O
O
Cl
4o
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3.05
2.05
4.10
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1.02
1.03
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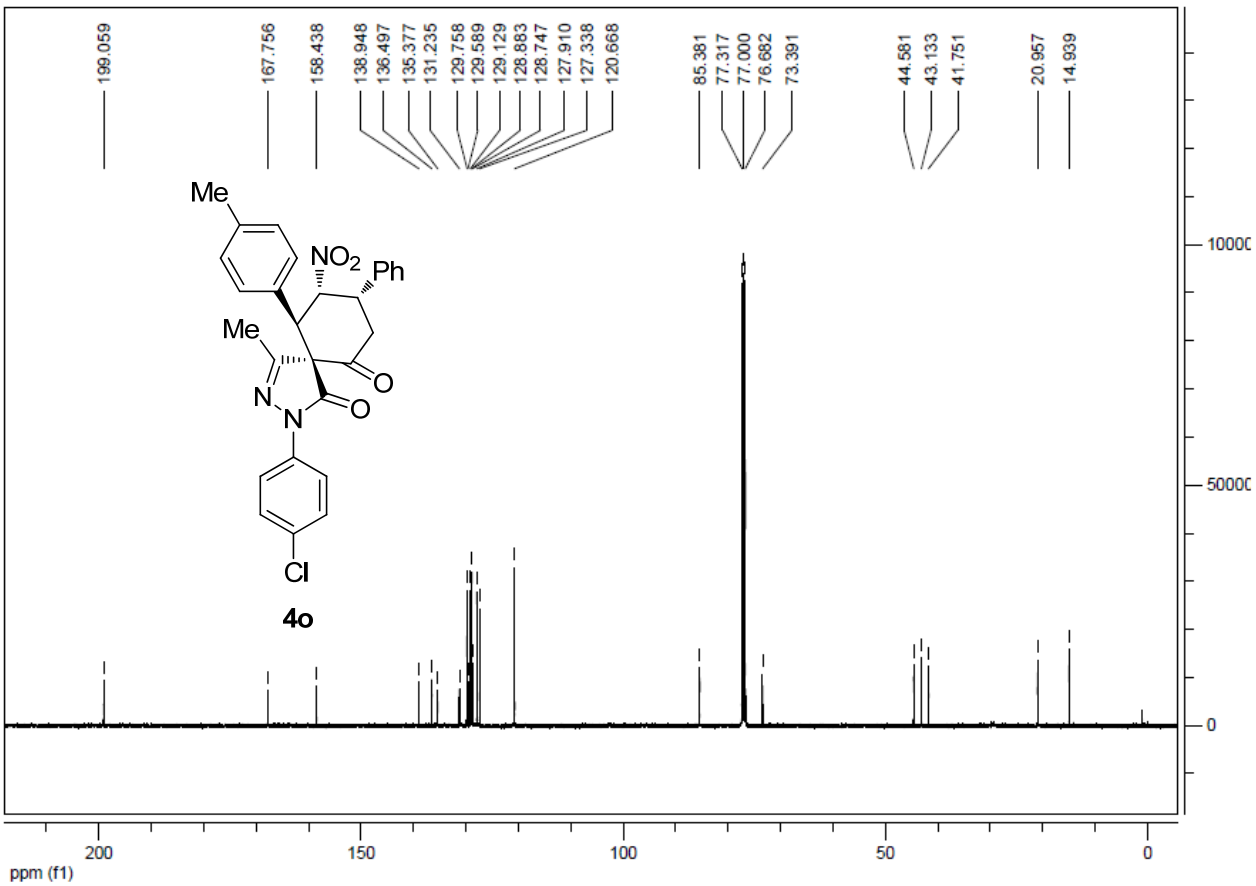
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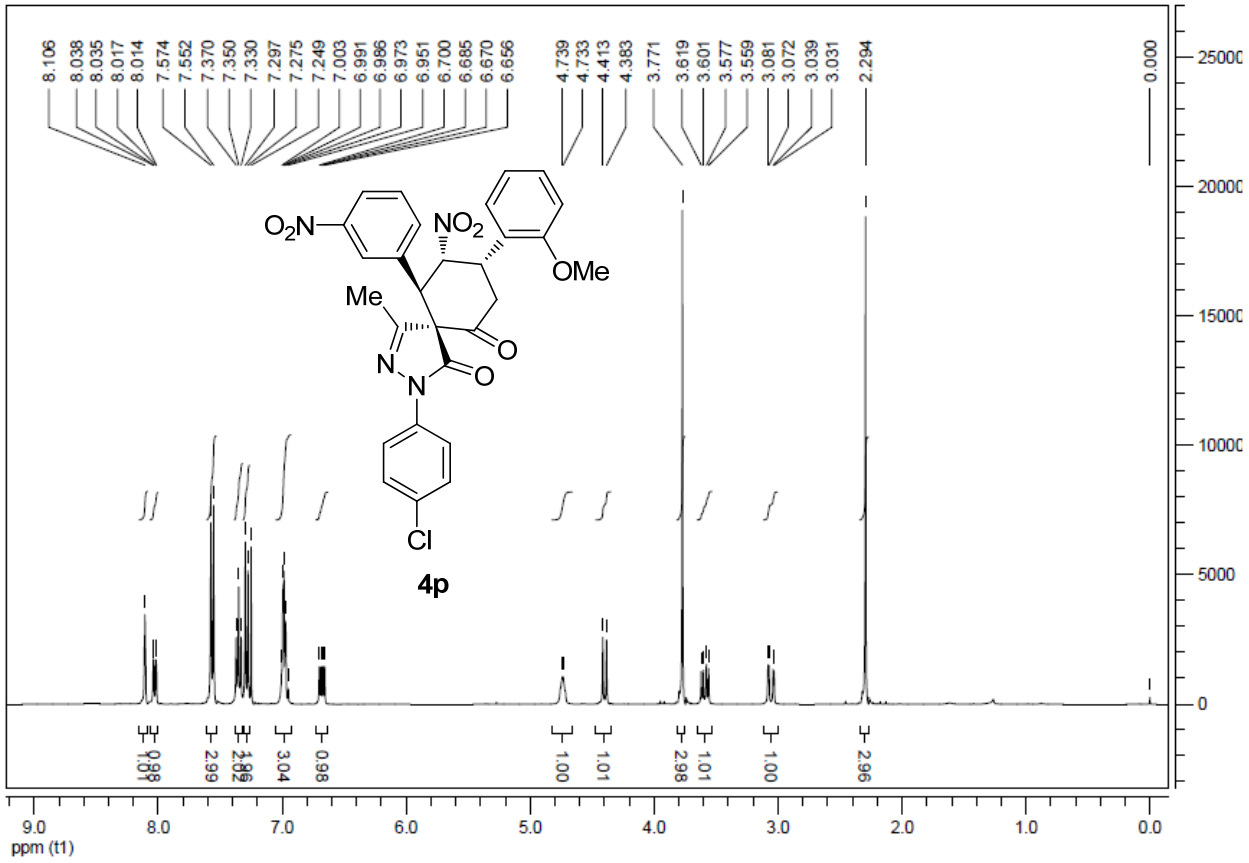
ppm (f1)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6.656
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3.577
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3.081
3.072
3.039
3.031
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OMe
Me
N
N
O
O
Cl
4p
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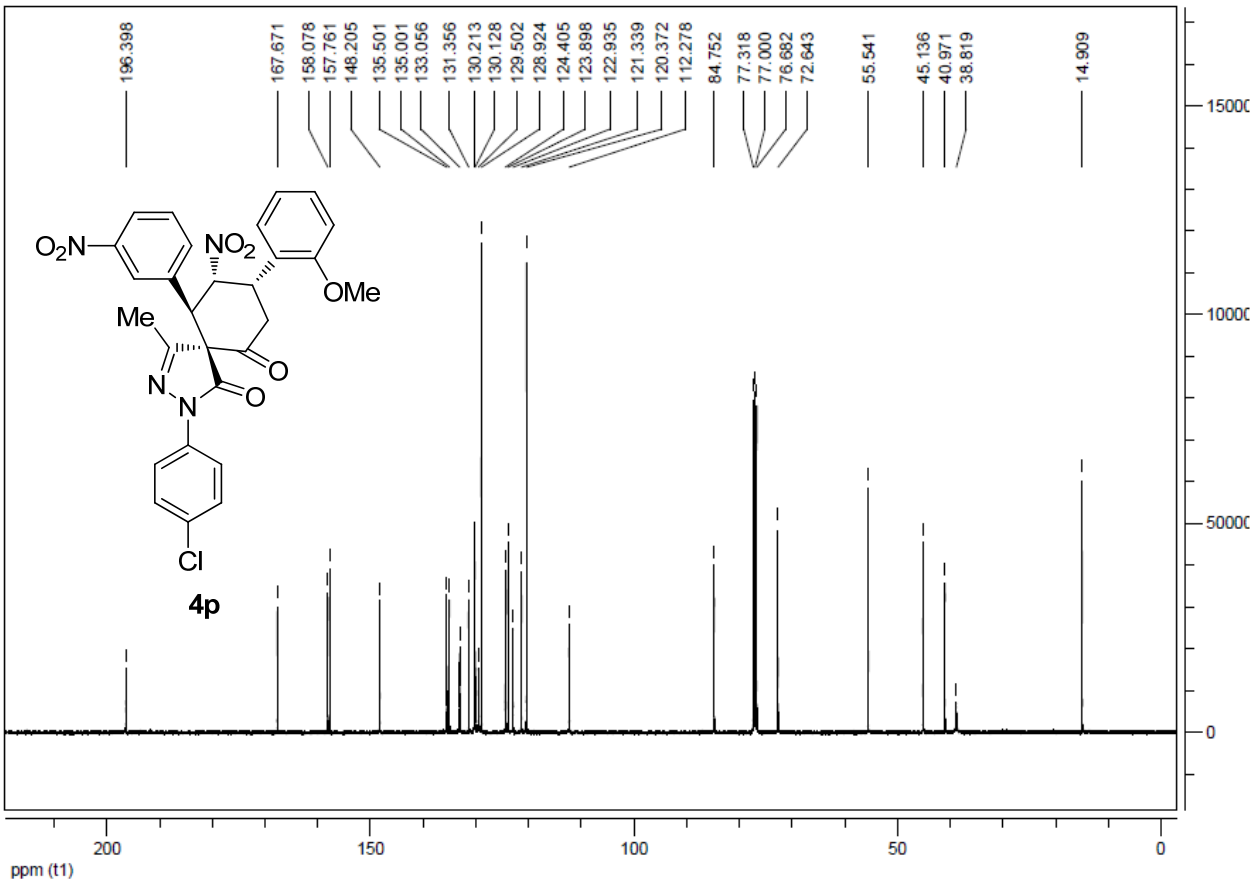
ppm (t1)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NO2
OMe
Me
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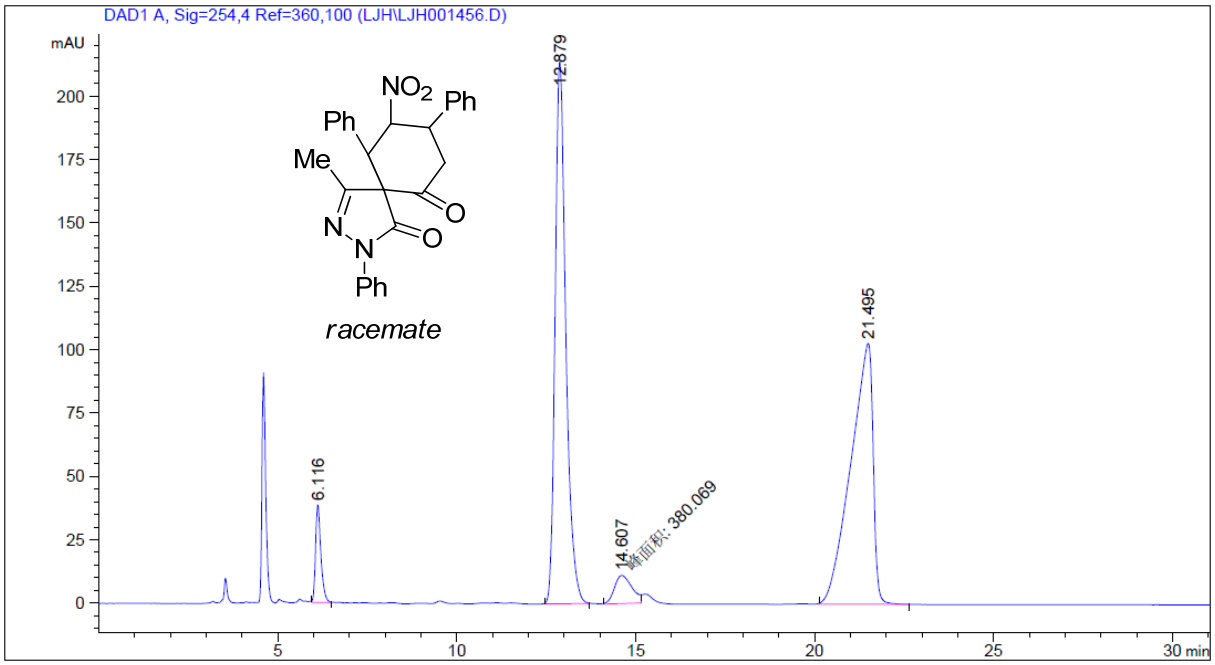
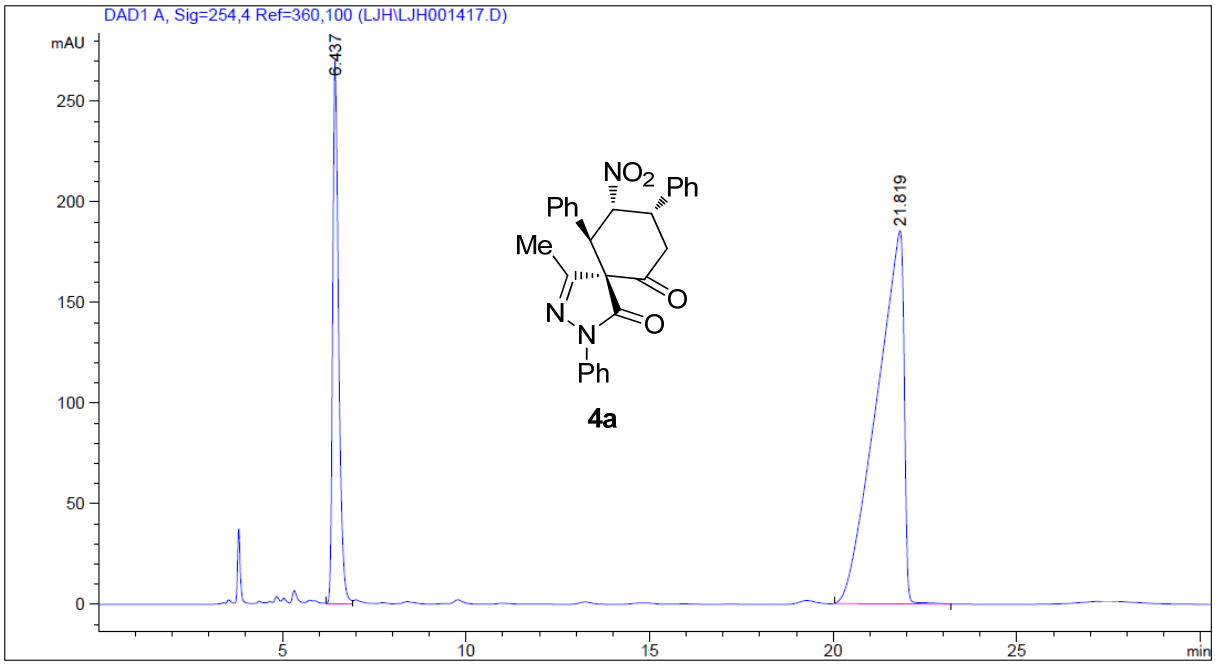
O
Cl
4p
ppm (t1)

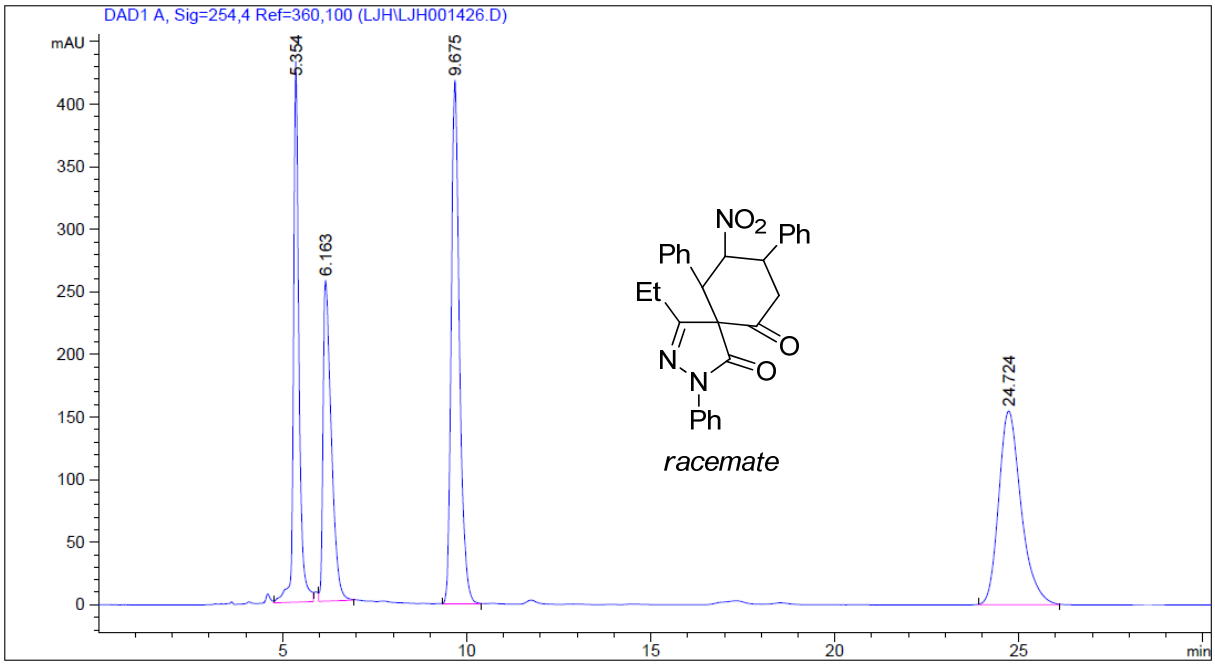
Copies of HPLC chromatograms



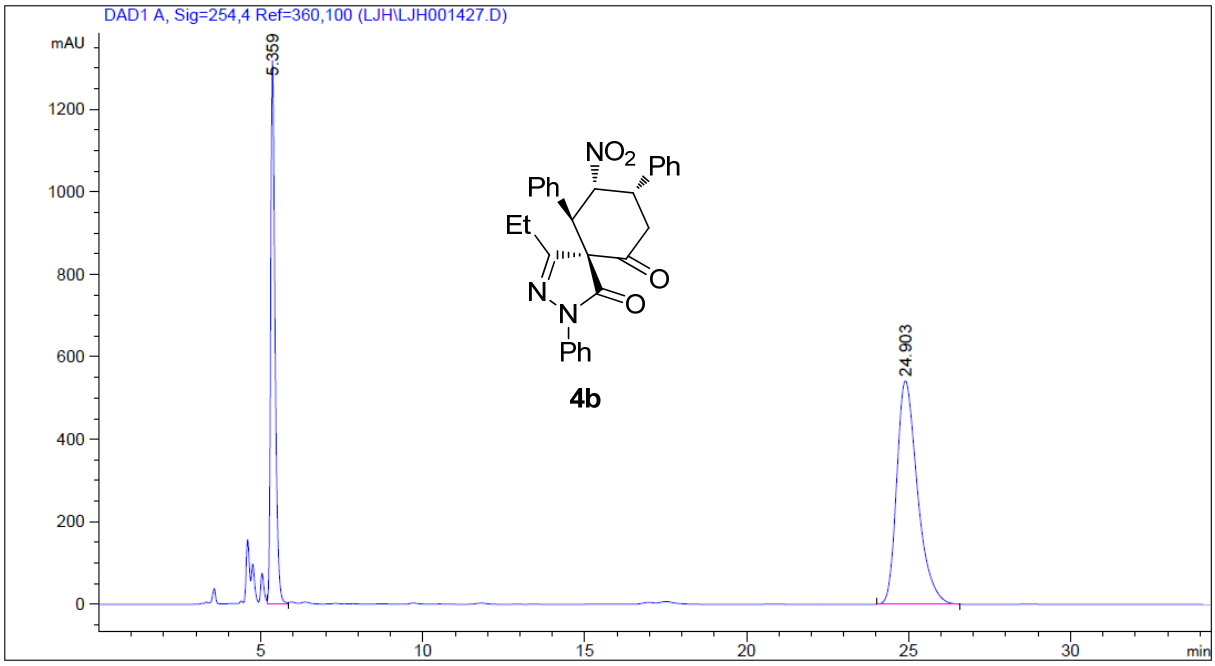
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.116	BB	0.1552	400.58069	38.56095	4.1378
2	12.879	BB	0.3141	4442.91504	214.13084	45.8932
3	14.607	MM T	0.5694	380.06900	11.12428	3.9259
4	21.495	BB	0.6173	4457.41455	102.91341	46.0430



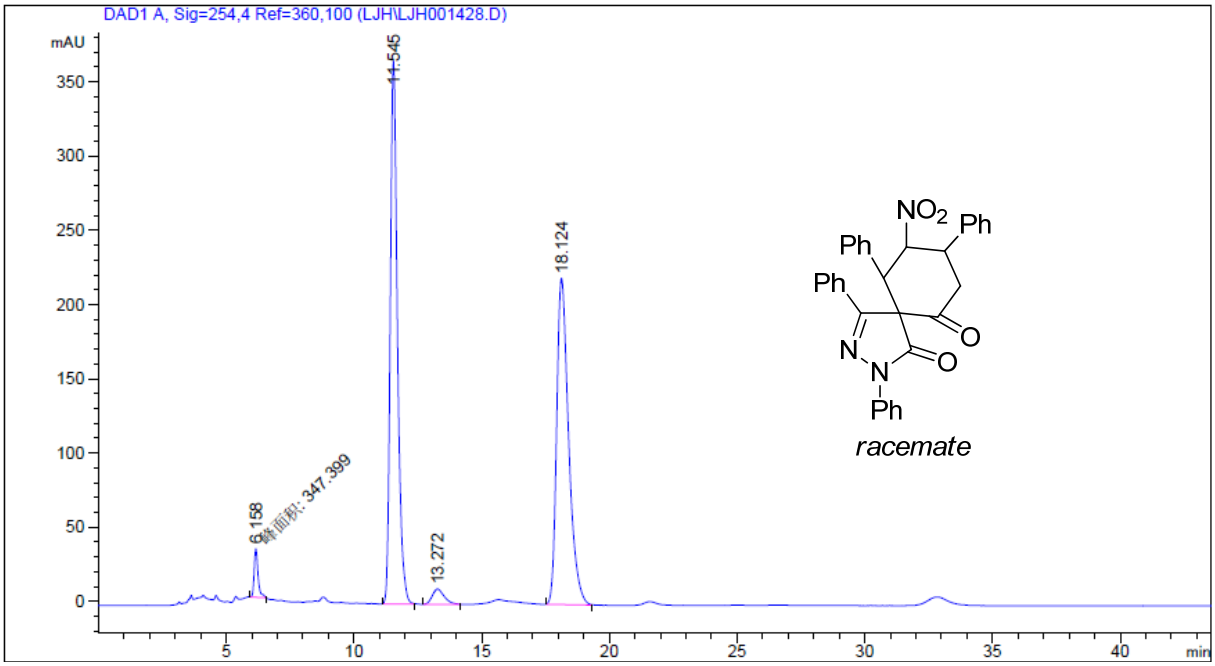
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.437	VB	0.1671	3032.18359	269.84119	23.9841
2	21.819	BB	0.6945	9610.30078	185.46701	76.0159



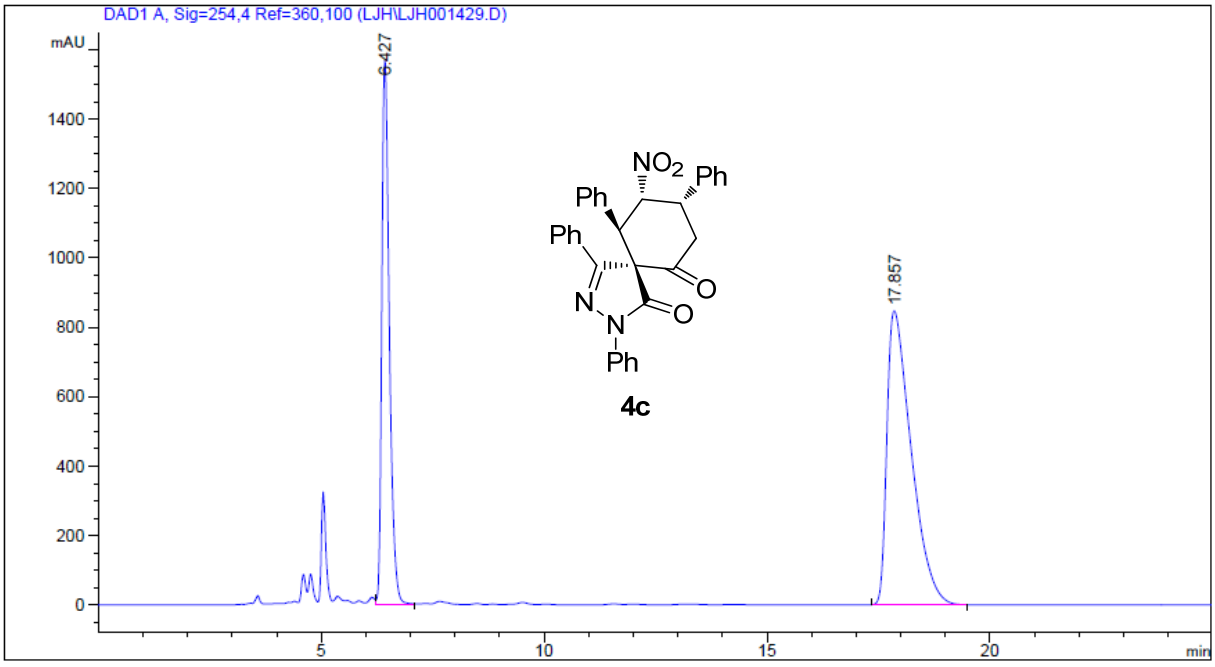
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.354	VV	0.1532	4490.80615	432.35919	20.8312
2	6.163	VB	0.2344	4008.67993	256.33978	18.5948
3	9.675	BB	0.2356	6510.31641	418.22272	30.1989
4	24.724	BB	0.6437	6548.30225	154.72932	30.3751



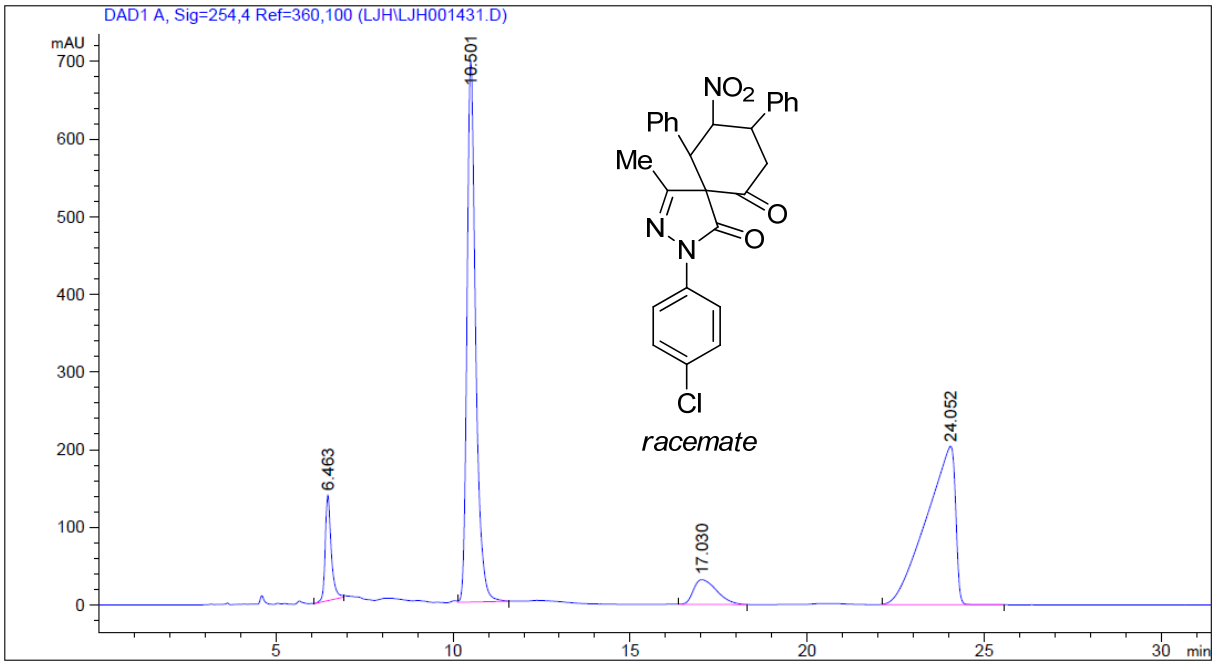
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.359	VV	0.1426	1.25055e4	1318.80603	34.1919
2	24.903	BB	0.6784	2.40690e4	541.65338	65.8081



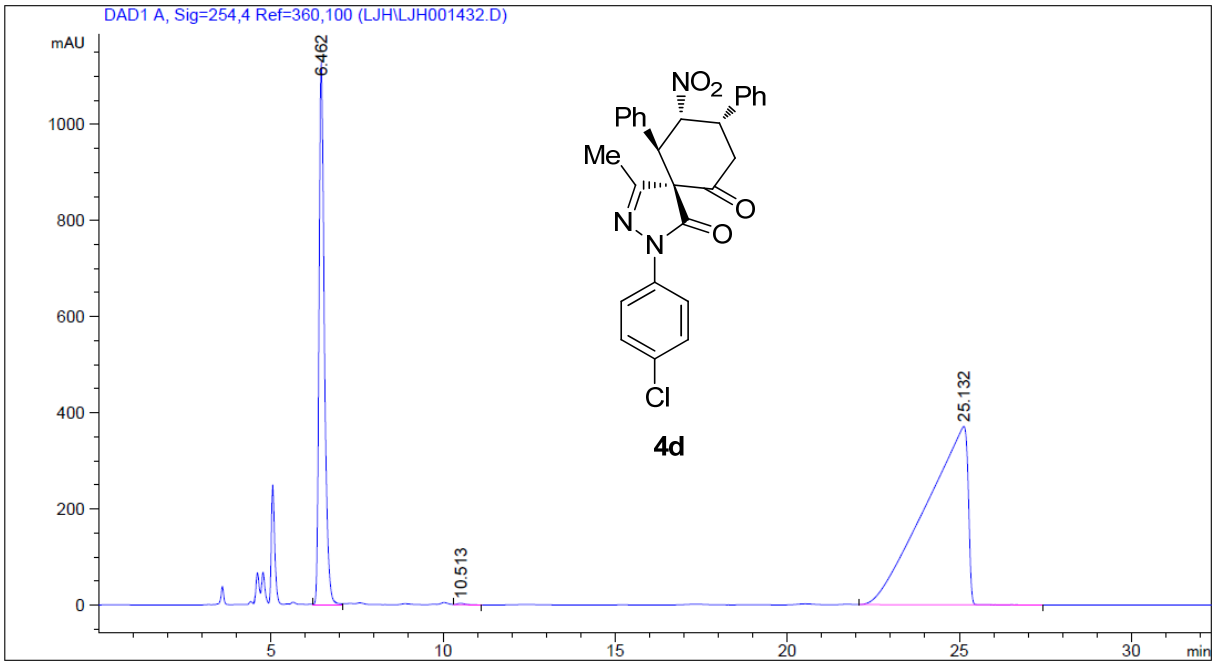
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.158	MM T	0.1768	347.39920	32.75555	2.3245
2	11.545	BB	0.2954	7129.72900	365.80530	47.7055
3	13.272	BB	0.4938	337.30011	10.36215	2.2569
4	18.124	BB	0.4925	7130.87939	219.78181	47.7132



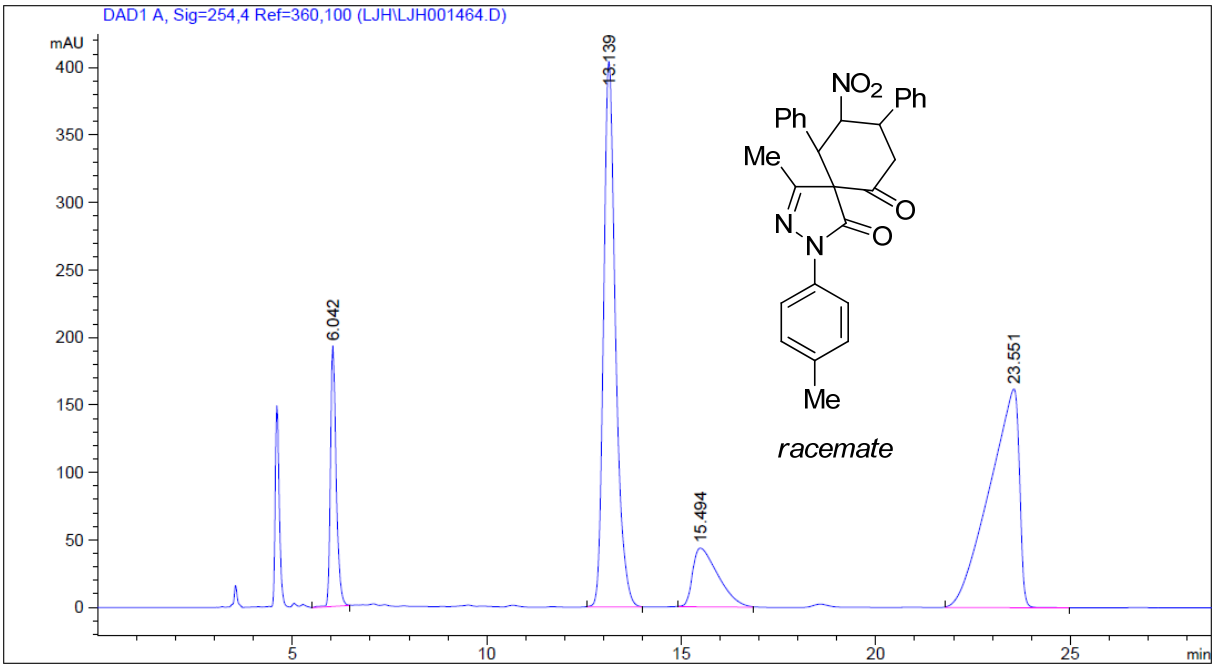
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.427	VB	0.1799	1.85489e4	1569.08618	36.6410
2	17.857	BB	0.5731	3.20744e4	848.36896	63.3590



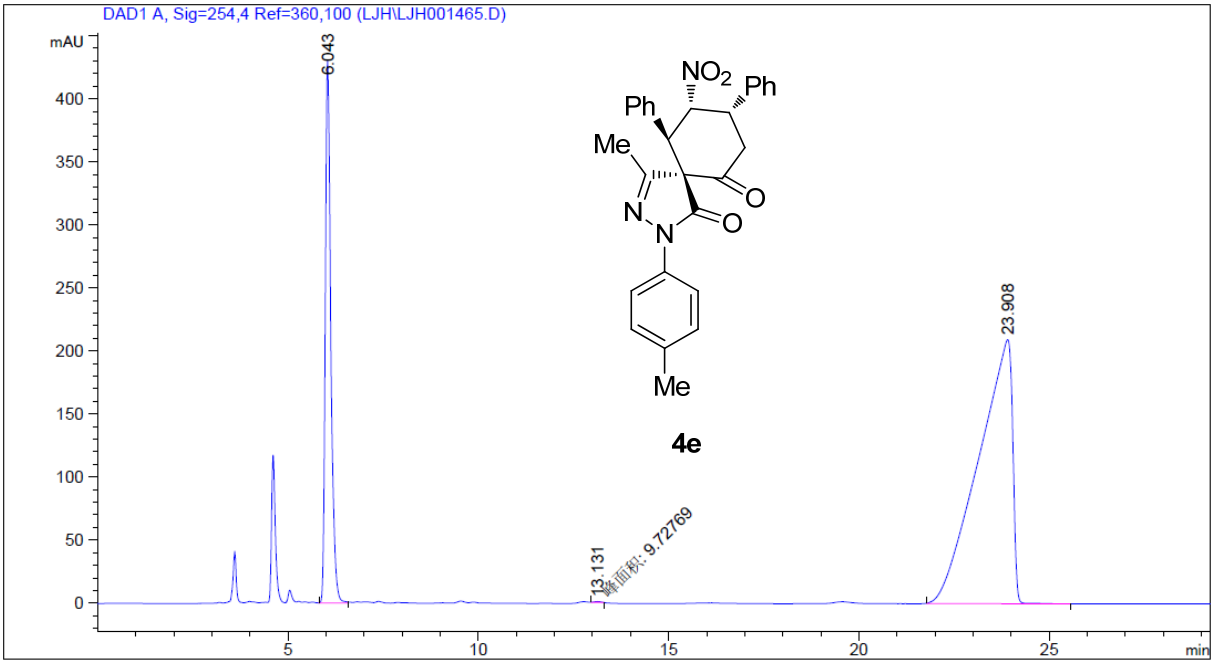
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.463	VB	0.1755	1607.31799	136.39209	6.0353
2	10.501	VB	0.2571	1.18925e4	696.83020	44.6548
3	17.030	BB	0.7223	1448.86243	31.75332	5.4403
4	24.052	BB	0.7698	1.16834e4	204.11763	43.8697



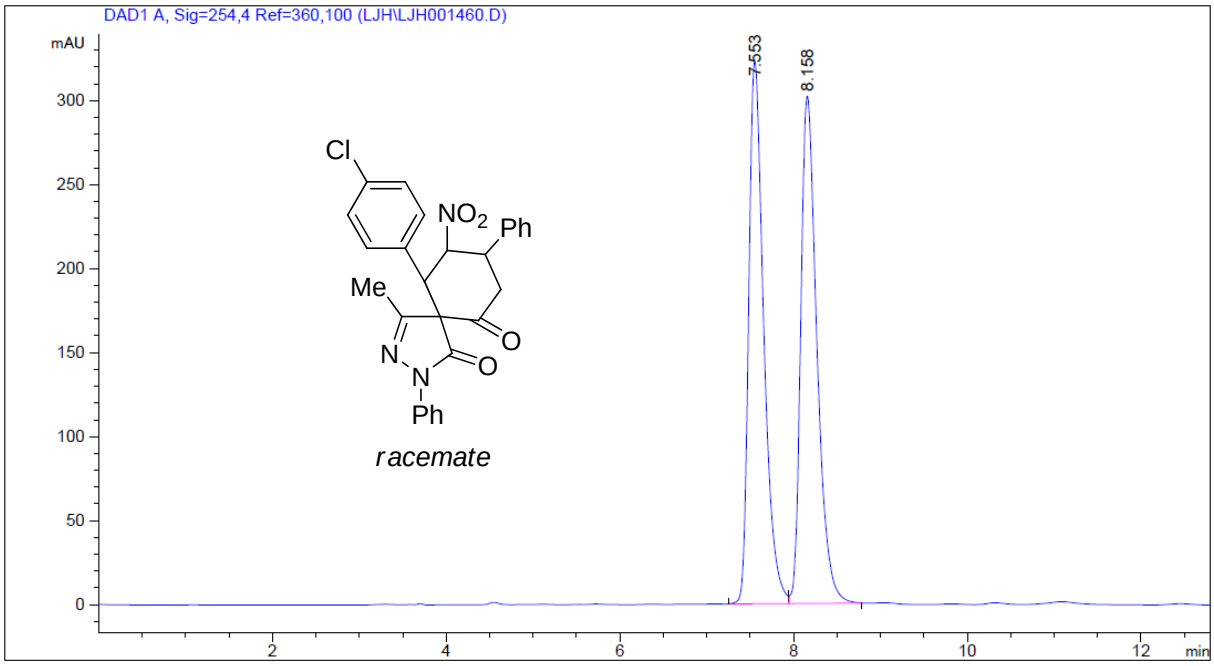
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.462	VB	0.1625	1.22651e4	1131.31433	27.7826
2	10.513	VB	0.2604	57.23522	3.26717	0.1296
3	25.132	BB	1.0883	3.18243e4	371.18823	72.0877



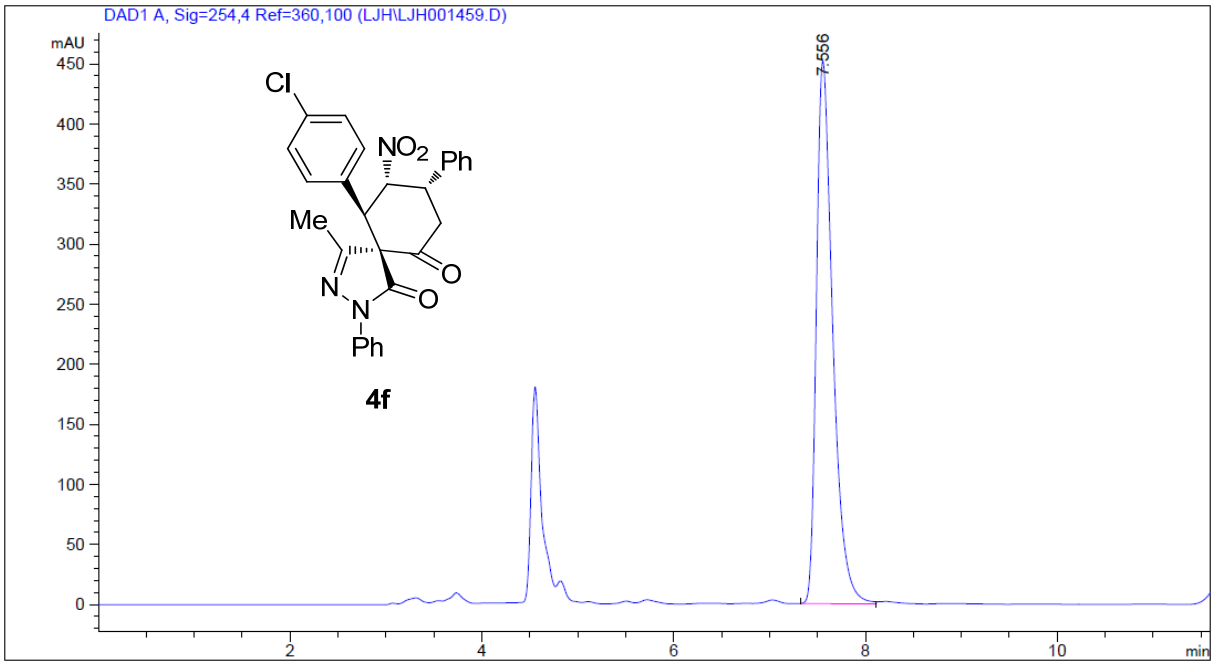
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.042	VB	0.1563	1991.41992	193.17516	9.3476
2	13.139	BB	0.3241	8670.84082	404.51437	40.7002
3	15.494	BB	0.6593	1967.90173	43.54037	9.2372
4	23.551	BB	0.7227	8674.01172	161.98935	40.7151



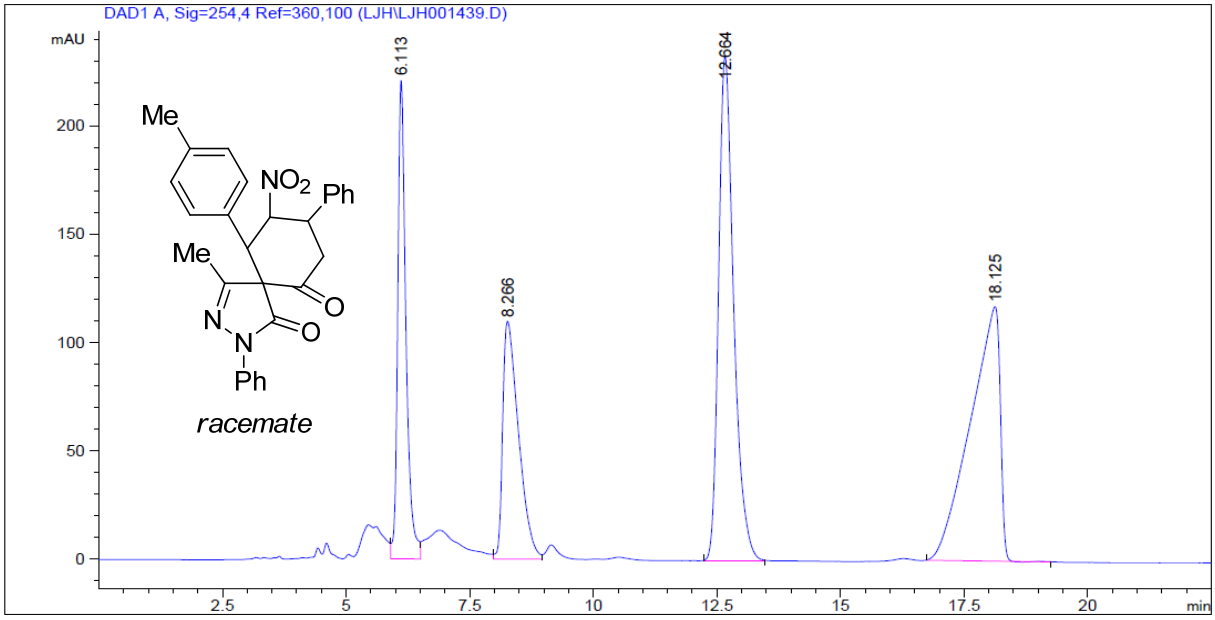
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.043	VB	0.1516	4344.66504	431.09793	24.9798
2	13.131	MM T	0.2142	9.72769	7.56866e-1	0.0559
3	23.908	BB	0.8122	1.30384e4	209.47574	74.9643



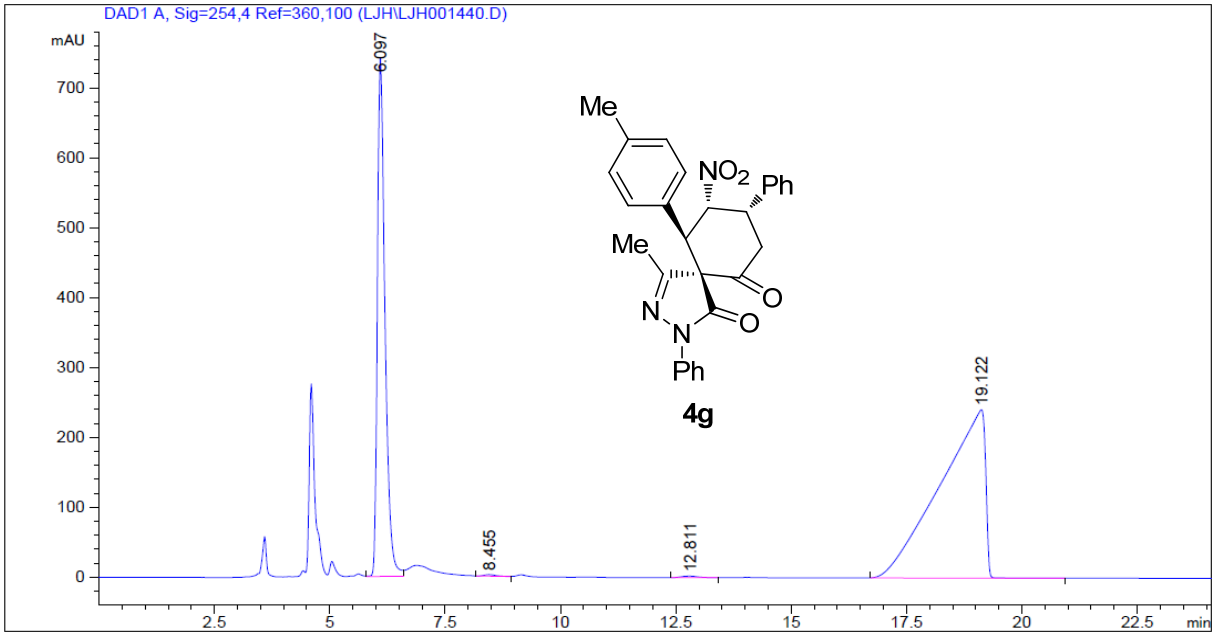
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.553	BV	0.1823	3883.35986	322.96677	49.8843
2	8.158	VB	0.1967	3901.36743	302.05917	50.1157



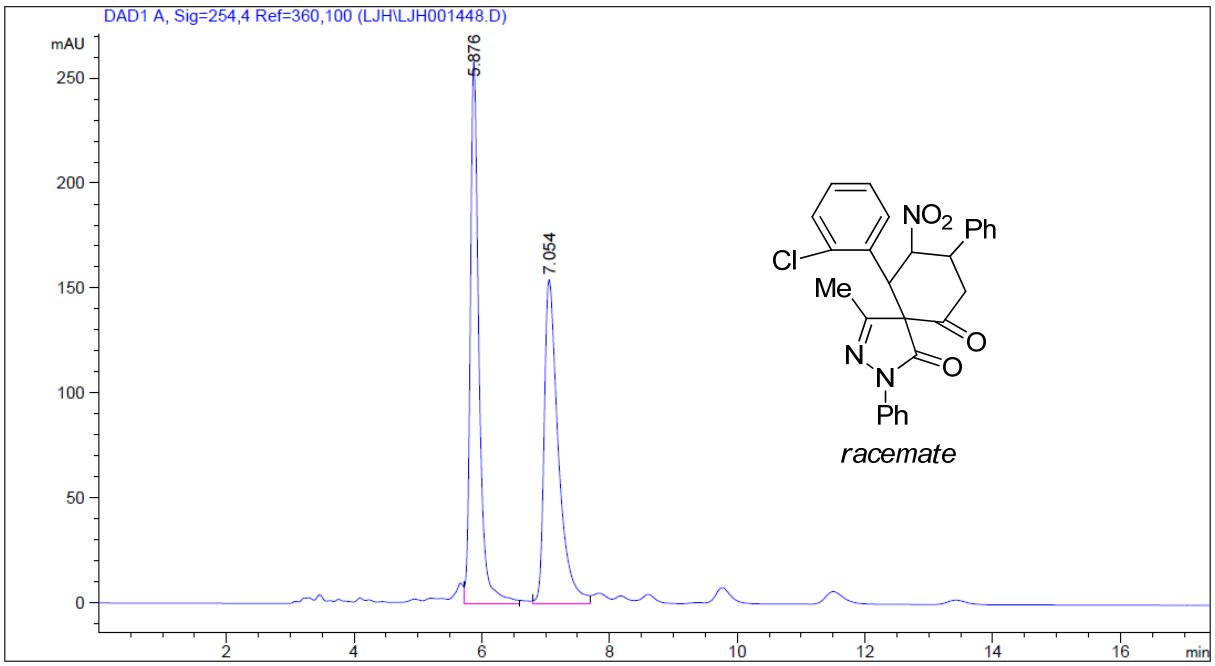
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.556	BV	0.1785	5364.25488	451.96509	100.0000



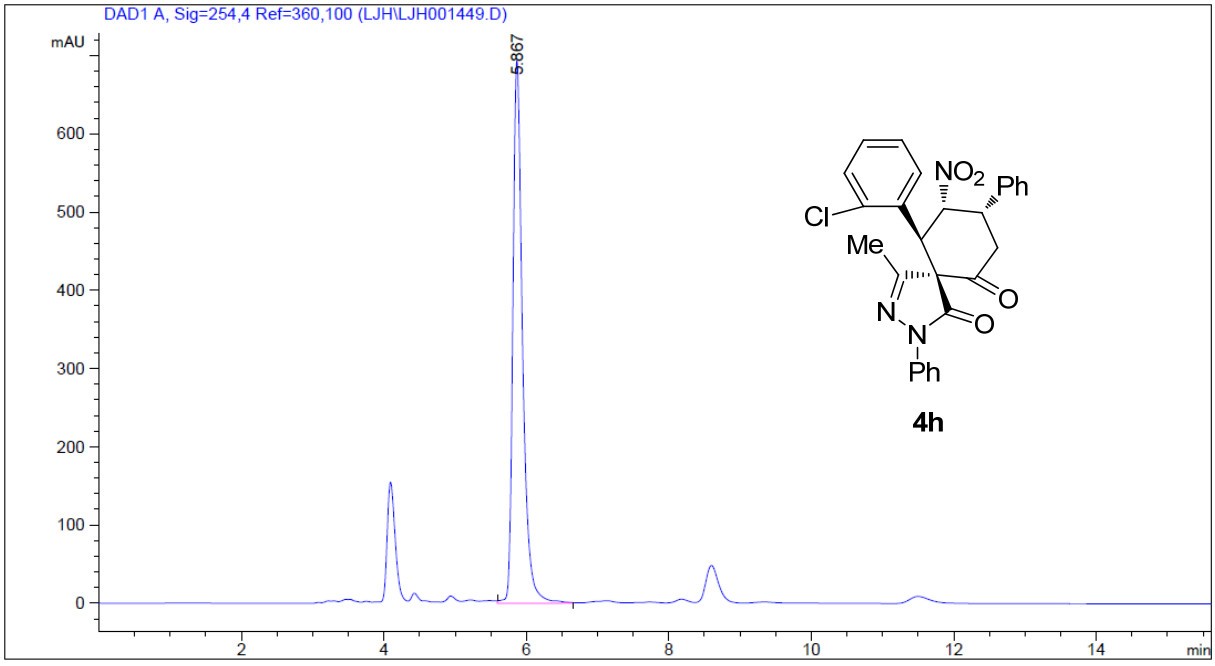
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.113	VV	0.1709	2557.03418	221.10815	17.1818
2	8.266	BV	0.3437	2444.62085	109.83149	16.4265
3	12.664	BB	0.3225	4960.68018	232.89888	33.3330
4	18.125	BB	0.5723	4919.87305	117.54940	33.0588



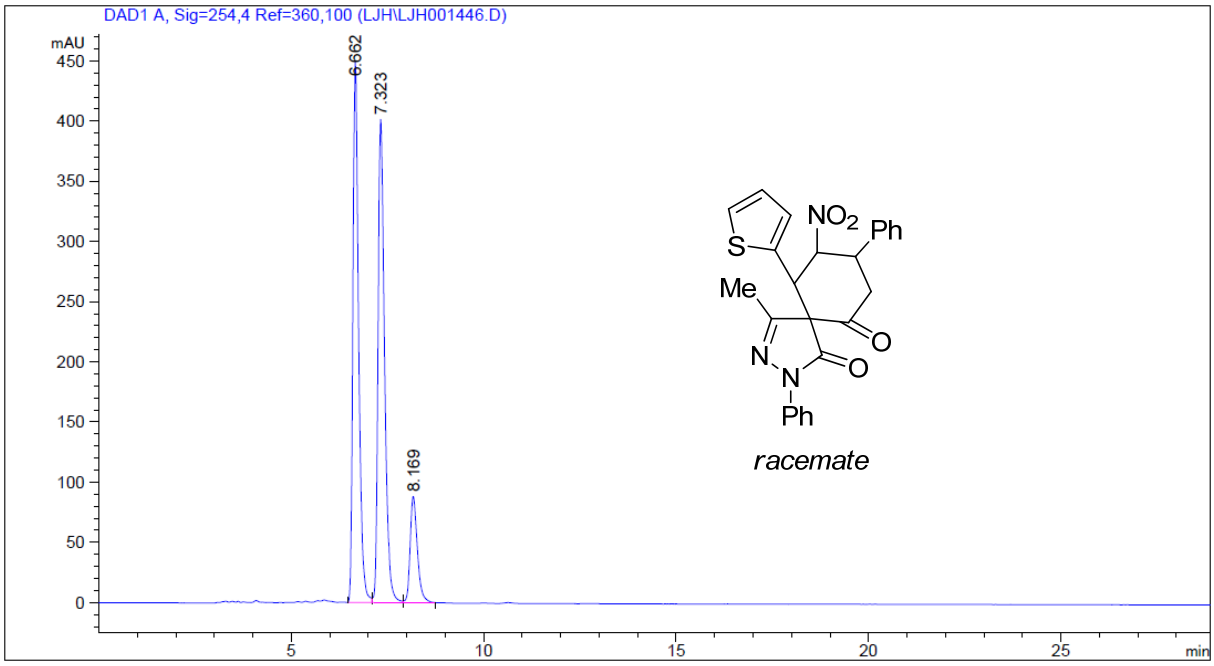
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.097	VV	0.1719	8524.42969	742.91357	33.9639
2	8.455	BV	0.2597	40.74870	2.33434	0.1624
3	12.811	BB	0.3181	57.56958	2.22322	0.2294
4	19.122	BB	0.8596	1.64757e4	240.97932	65.6444



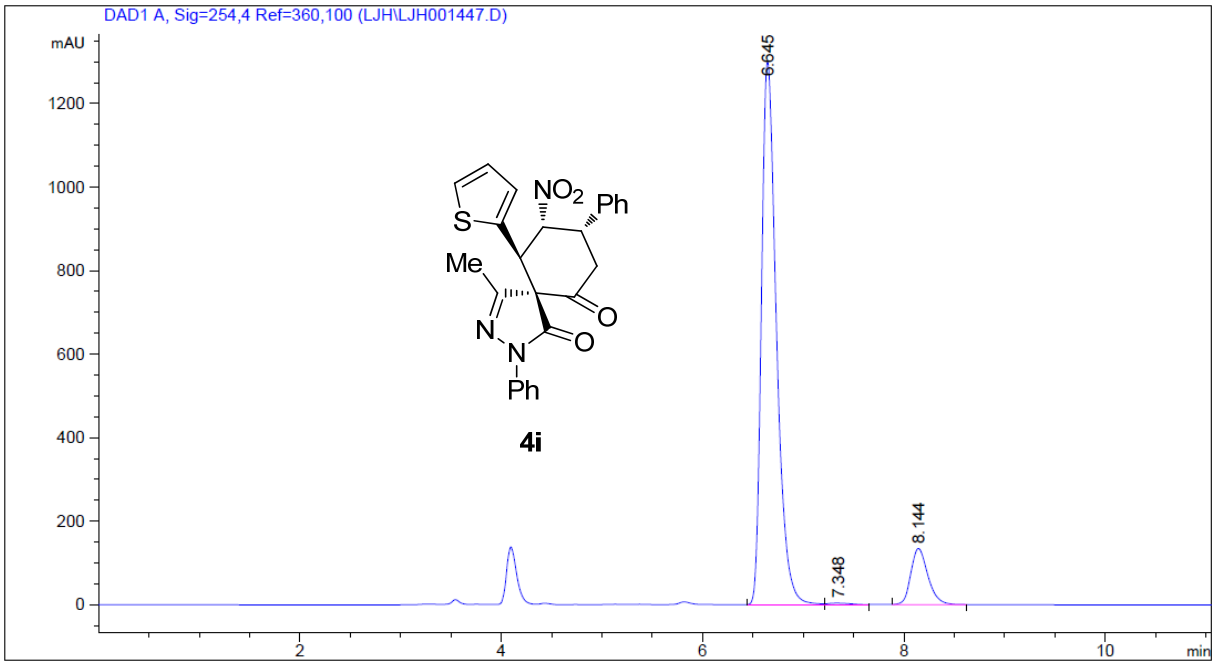
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.876	VB	0.1430	2458.11987	258.31342	50.8467
2	7.054	BV	0.2296	2376.25439	154.38126	49.1533



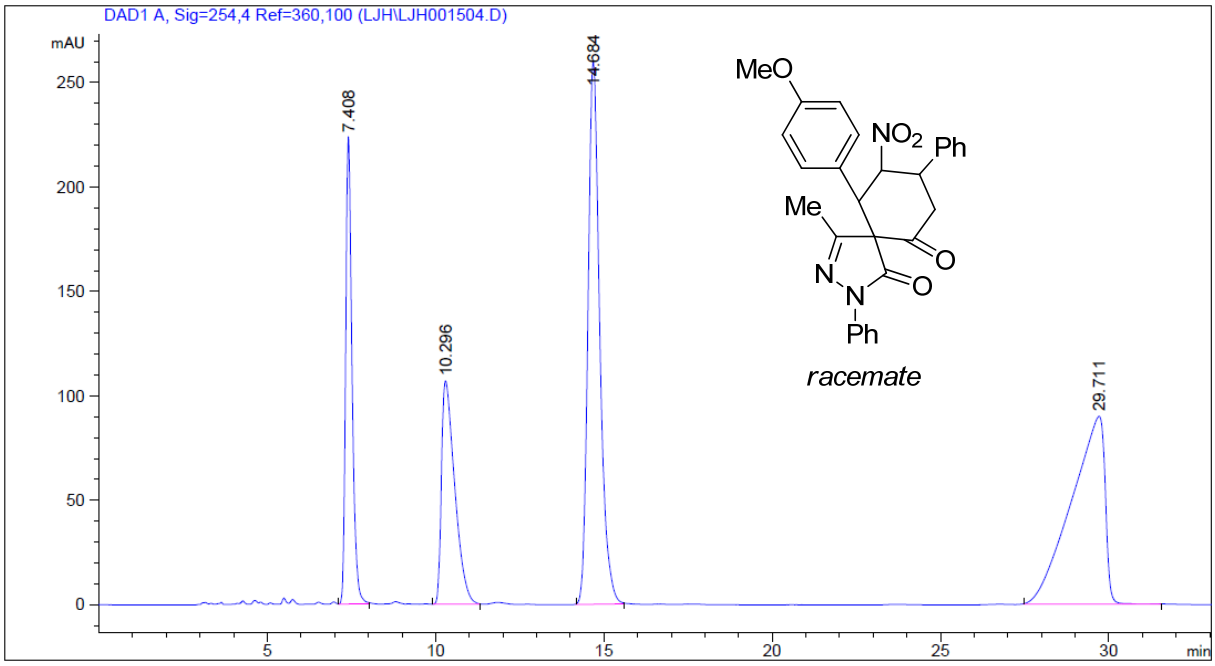
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.867	VB	0.1401	6553.36279	694.18958	100.0000



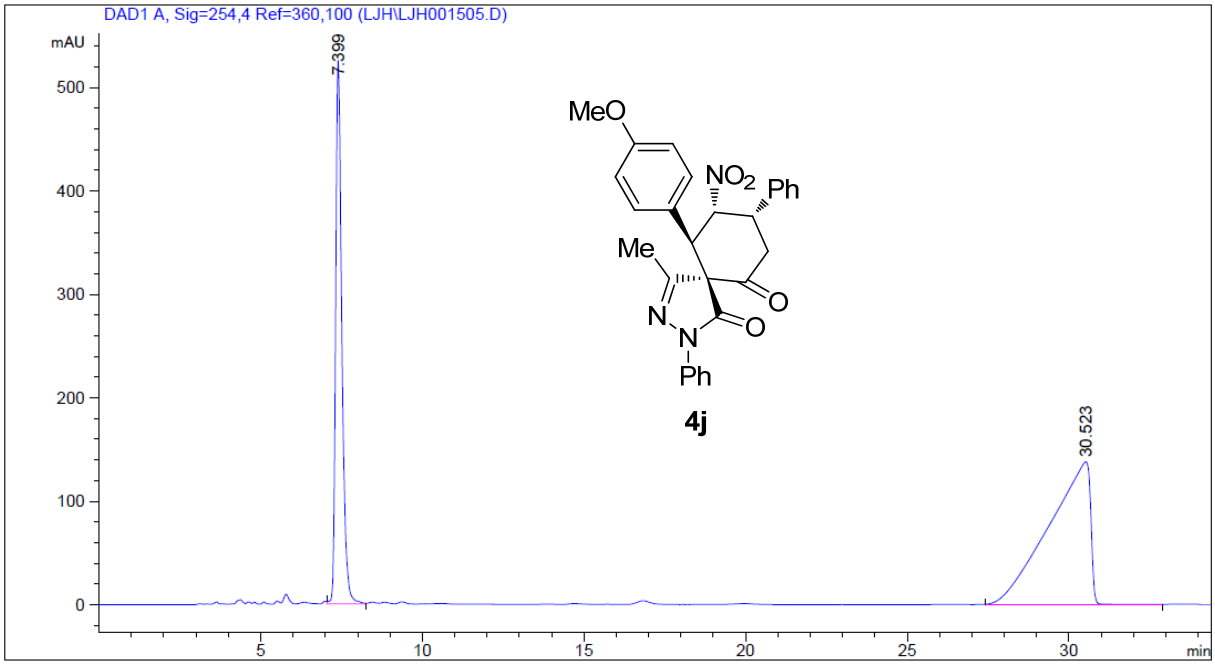
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.662	BV	0.1571	4669.75342	450.02954	44.2764
2	7.323	VV	0.1770	4717.40869	401.76086	44.7282
3	8.169	VB	0.1991	1159.67102	88.37058	10.9954



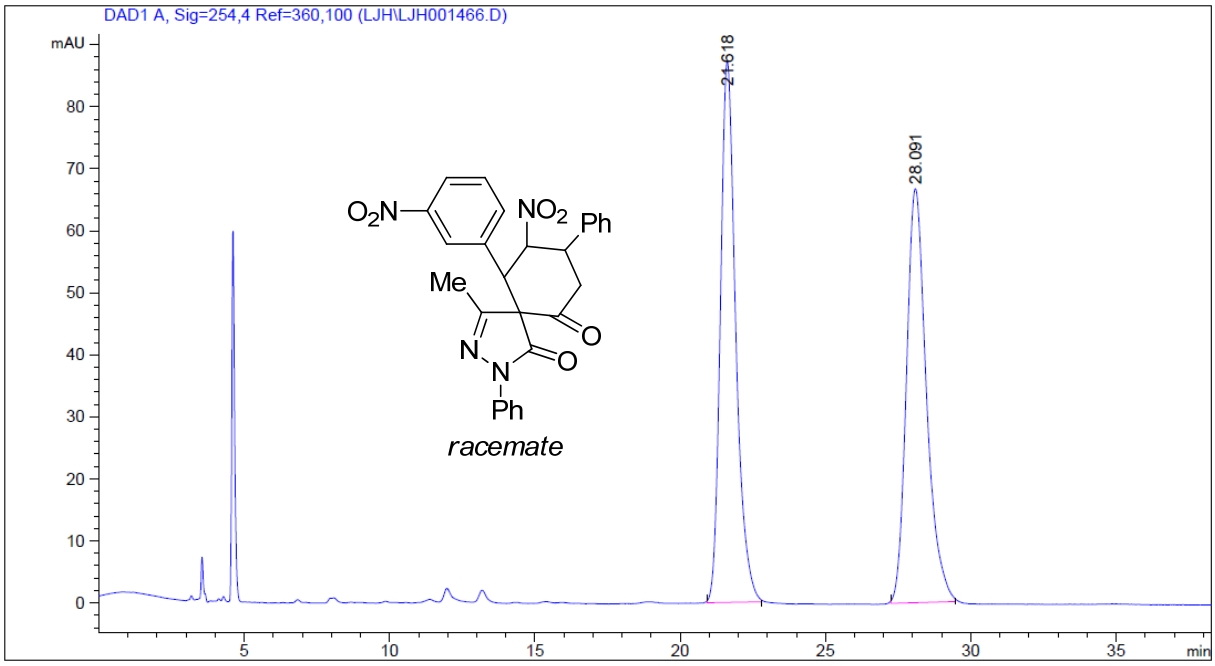
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.645	BV	0.1584	1.34276e4	1300.90625	89.0715
2	7.348	VB	0.2023	55.81441	4.01293	0.3702
3	8.144	BB	0.1800	1591.66956	134.53905	10.5583



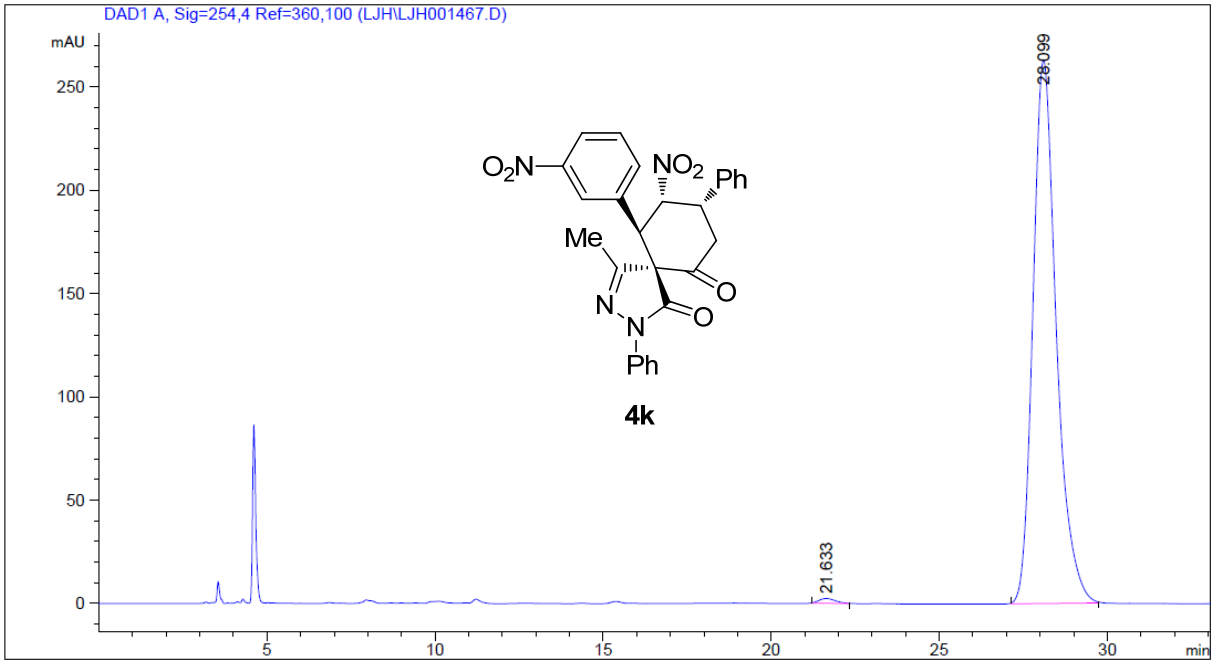
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.408	VB	0.1994	2941.88892	223.76357	15.9492
2	10.296	BB	0.4168	2921.96899	106.93636	15.8412
3	14.684	BB	0.3683	6291.90137	260.05075	34.1110
4	29.711	BB	0.9435	6289.62939	89.97787	34.0987



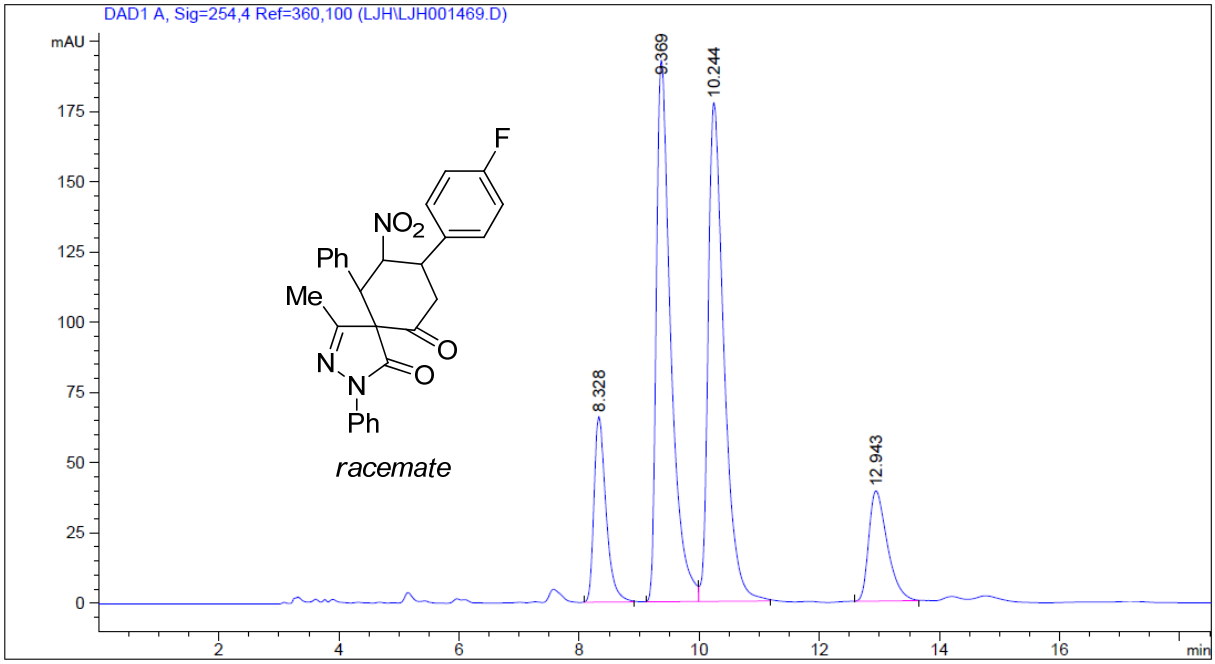
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.399	VB	0.2019	7026.03320	525.79614	36.2778
2	30.523	BB	1.1500	1.23412e4	137.91154	63.7222



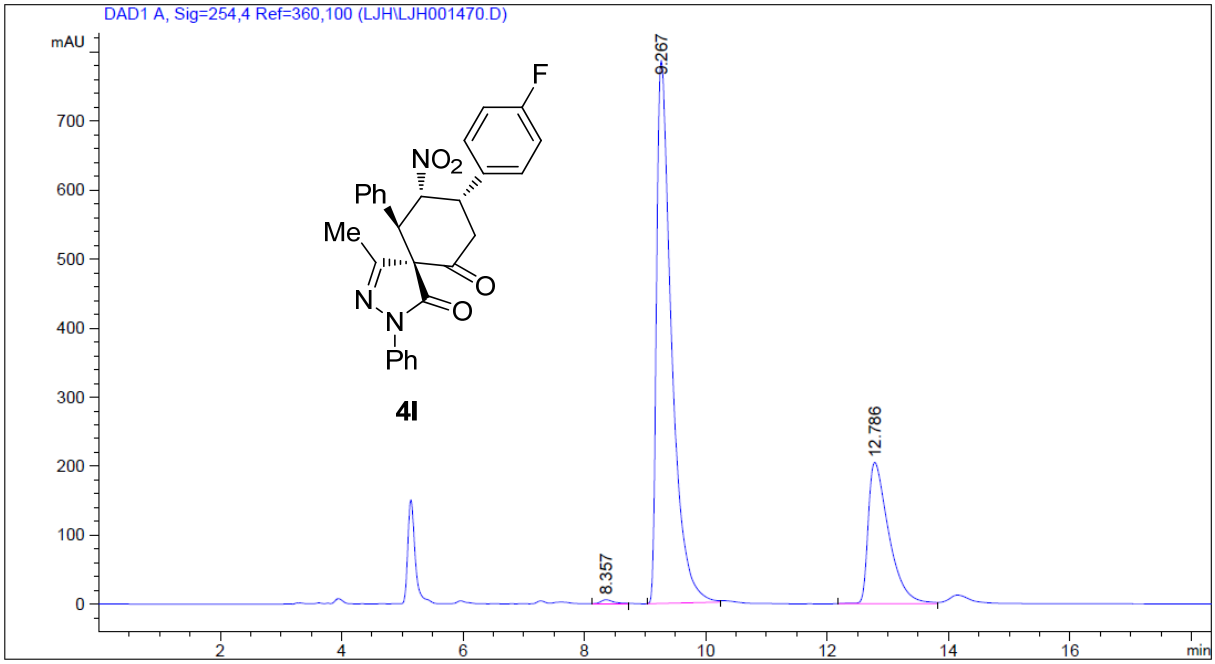
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.618	BB	0.5603	3203.94116	87.27444	50.1481
2	28.091	BB	0.7185	3185.01538	66.76805	49.8519



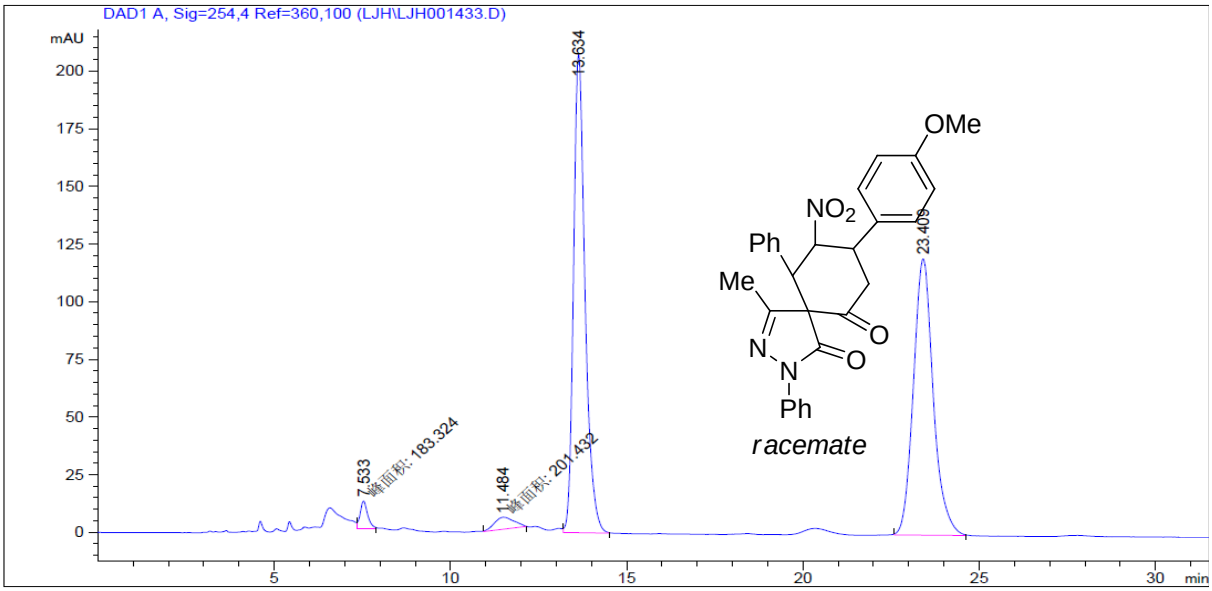
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.633	BB	0.4744	79.76756	2.35986	0.6235
2	28.099	BB	0.7358	1.27136e4	263.06351	99.3765



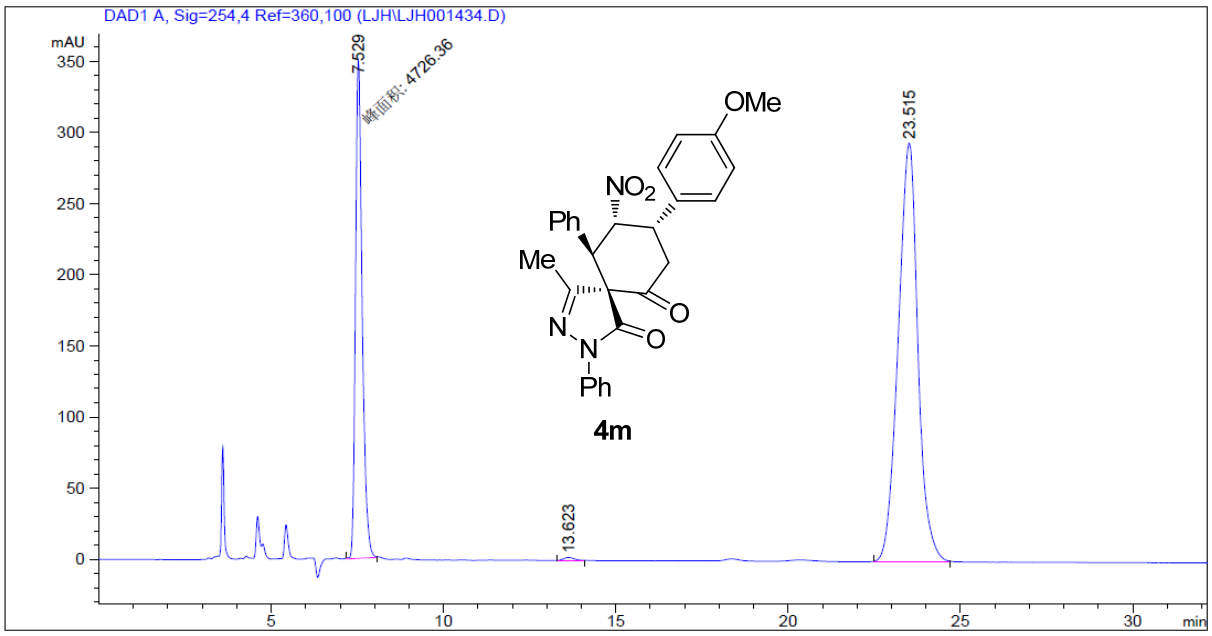
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.328	BB	0.2102	918.60809	66.06637	11.1275
2	9.369	BV	0.2499	3238.57422	192.83029	39.2301
3	10.244	VB	0.2758	3253.51831	177.53221	39.4112
4	12.943	BB	0.3271	844.62238	39.23791	10.2312



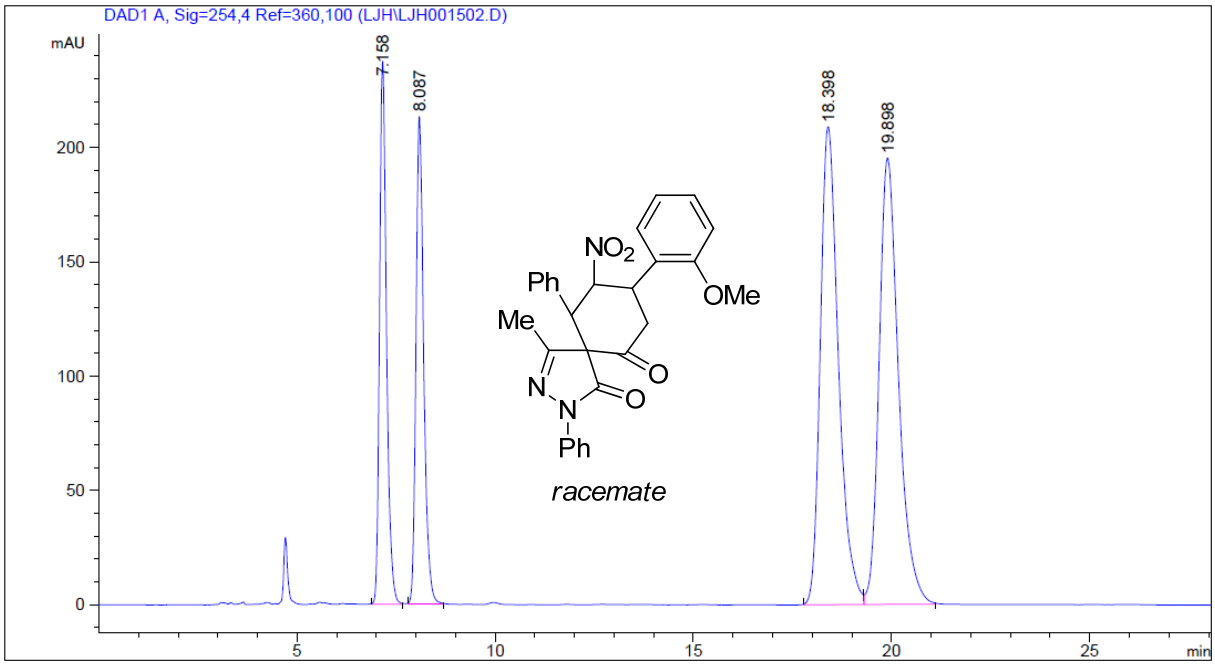
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.357	BB	0.2190	86.71334	5.84684	0.4698
2	9.267	BB	0.2550	1.35582e4	787.04828	73.4556
3	12.786	BB	0.3503	4812.76562	204.71701	26.0746



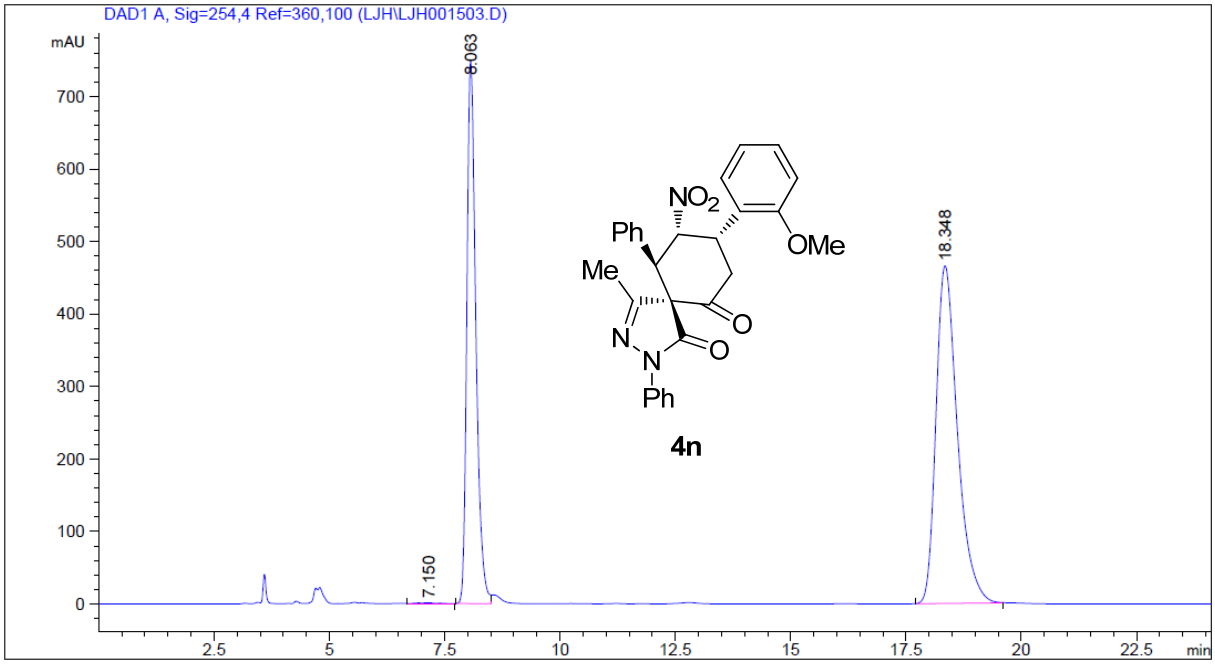
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.533	MM T	0.2501	183.32449	12.21765	1.8730
2	11.484	MM T	0.6404	201.43208	5.24243	2.0580
3	13.634	BB	0.3431	4713.47510	207.41252	48.1560
4	23.409	BB	0.5948	4689.68848	119.78683	47.9130



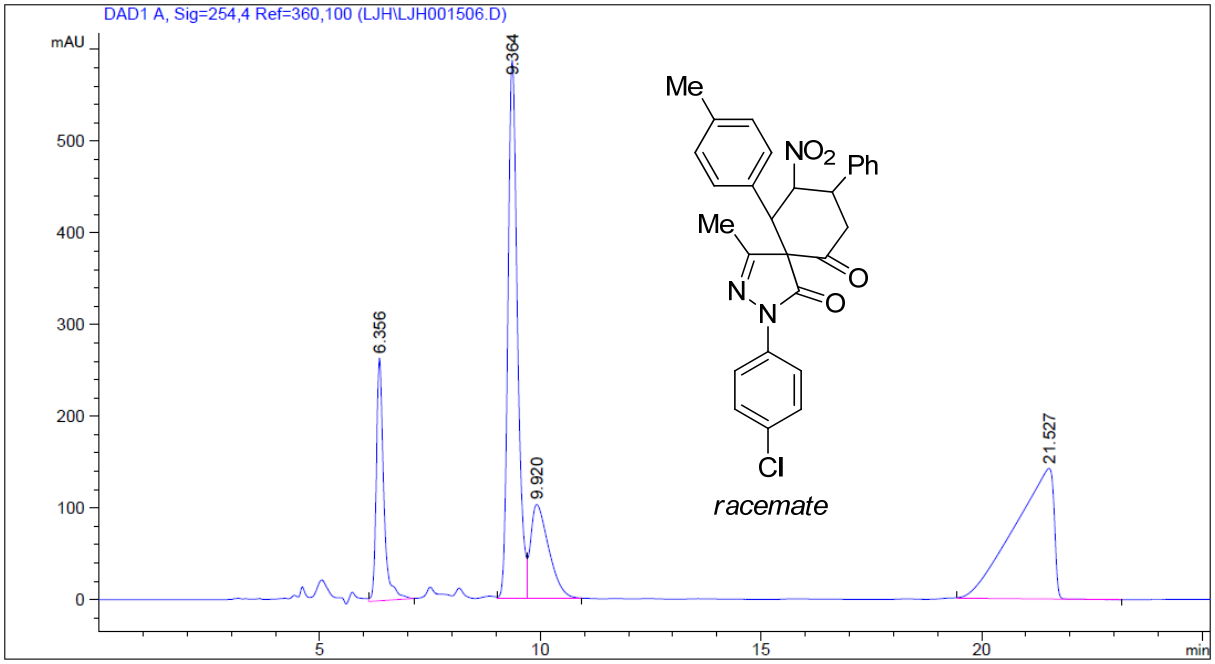
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.529	MM T	0.2247	4726.35645	350.57718	28.7506
2	13.623	BB	0.2674	42.39374	2.08367	0.2579
3	23.515	BB	0.6047	1.16704e4	294.25815	70.9915



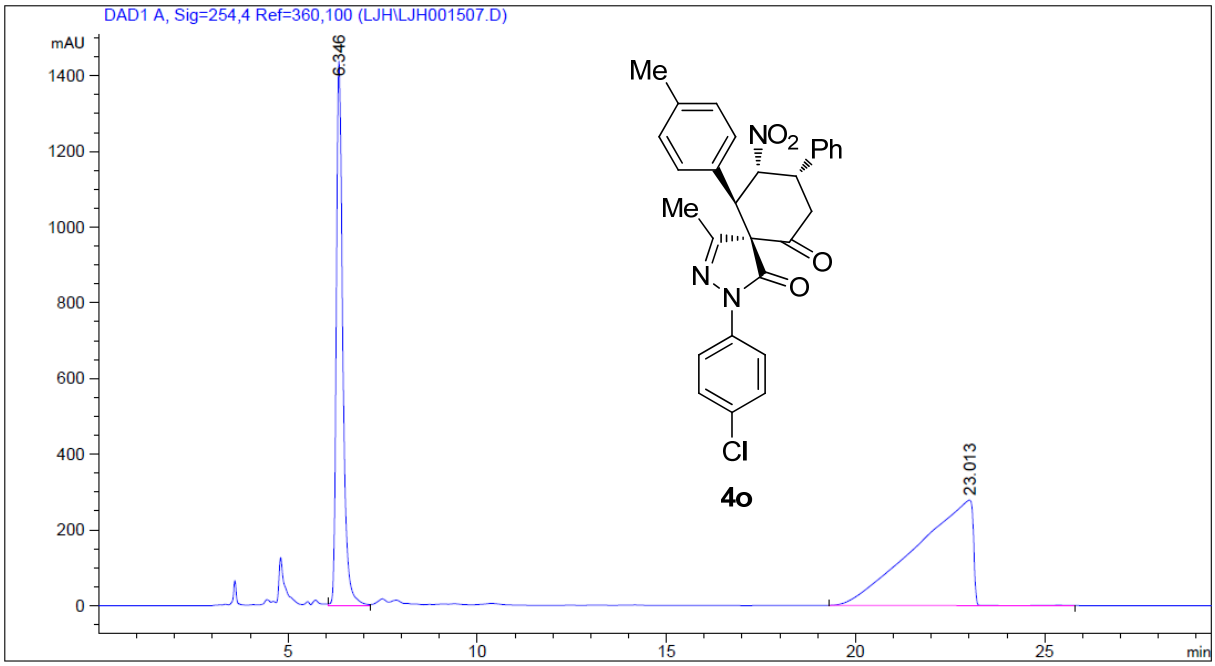
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.158	BB	0.1838	2887.19263	237.56528	15.1317
2	8.087	BB	0.2057	2885.20337	213.39725	15.1213
3	18.398	BV	0.4867	6643.86523	209.10982	34.8204
4	19.898	VB	0.5181	6664.10889	195.31577	34.9265



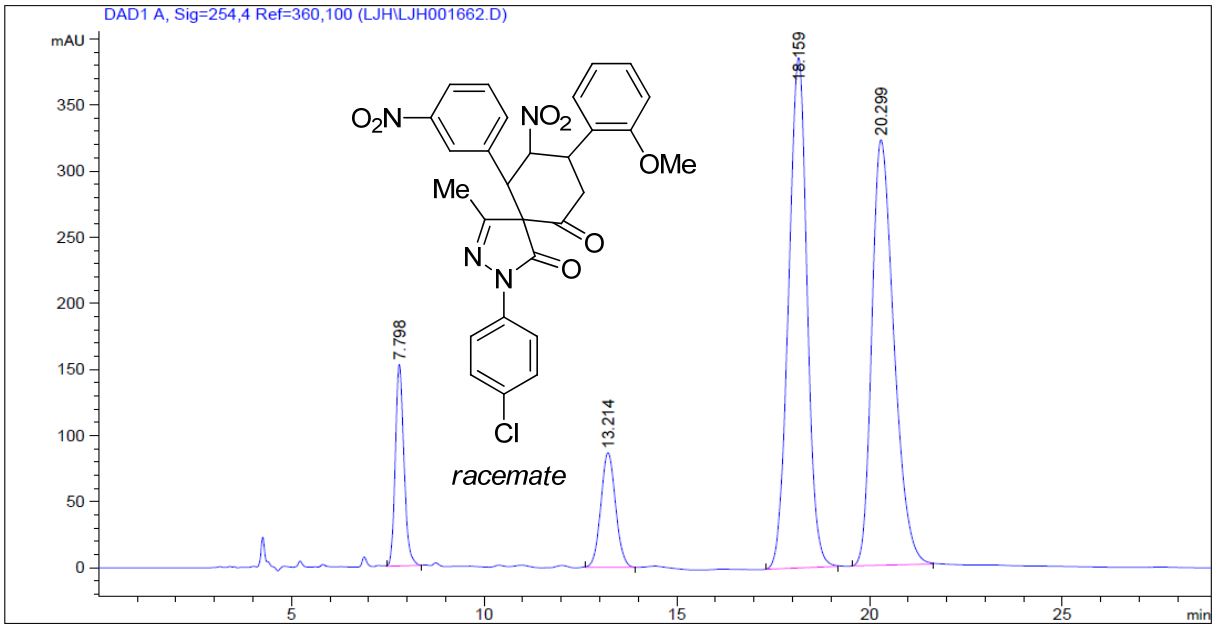
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.150	BB	0.2981	25.43869	1.15892	0.1007
2	8.063	BV	0.2067	1.01958e4	749.55261	40.3533
3	18.348	BB	0.4909	1.50451e4	465.76312	59.5460



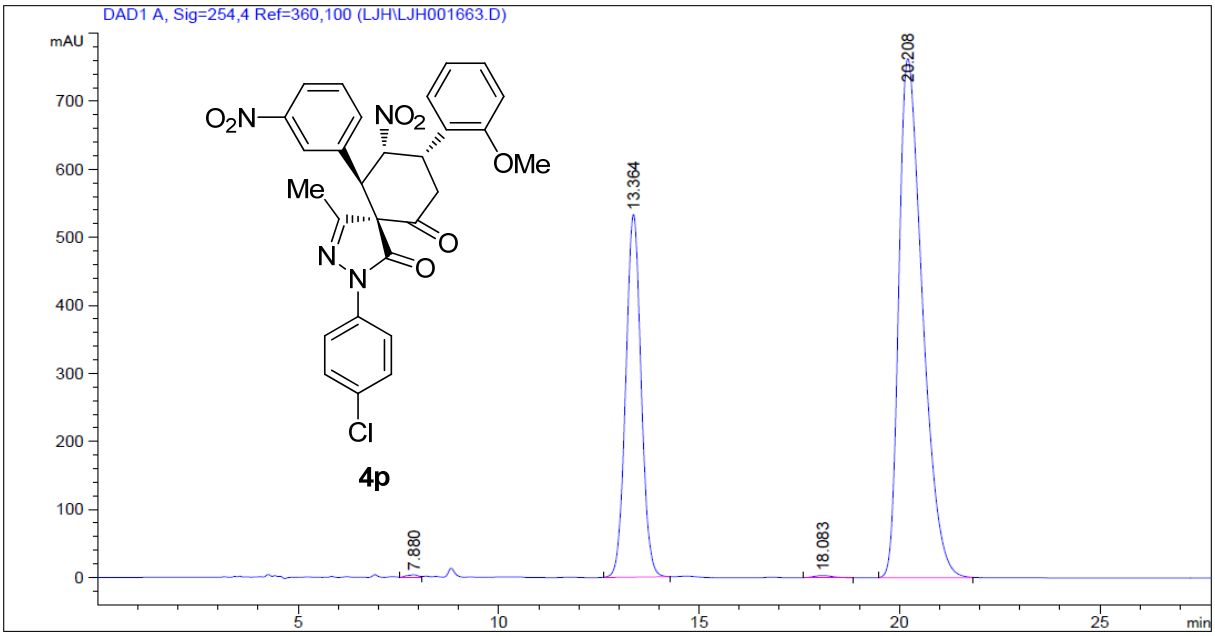
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.356	BB	0.1747	3101.29468	264.62479	13.0643
2	9.364	VV	0.2296	8841.17773	587.30432	37.2438
3	9.920	VB	0.4298	2940.69409	102.79271	12.3878
4	21.527	BB	0.8033	8855.46973	142.44621	37.3040



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.346	BB	0.1790	1.71401e4	1438.75452	37.0082
2	23.013	BB	1.2938	2.91743e4	279.03760	62.9918



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.798	BB	0.2406	2385.78882	152.42732	7.8440
2	13.214	BB	0.4124	2309.29980	86.81010	7.5925
3	18.159	BB	0.5157	1.28907e4	385.90414	42.3818
4	20.299	BB	0.6132	1.28298e4	321.72647	42.1817



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.880	VV	0.2755	71.93225	3.65706	0.1574
2	13.364	BB	0.4132	1.42225e4	533.11816	31.1231
3	18.083	BB	0.4631	108.53728	3.30502	0.2375
4	20.208	BB	0.6244	3.12947e4	763.16595	68.4820