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Supporting Information for

A Catalytic Multicomponent Coupling Reaction for the Enantioselective Synthesis of Spiroacetals

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Contents:

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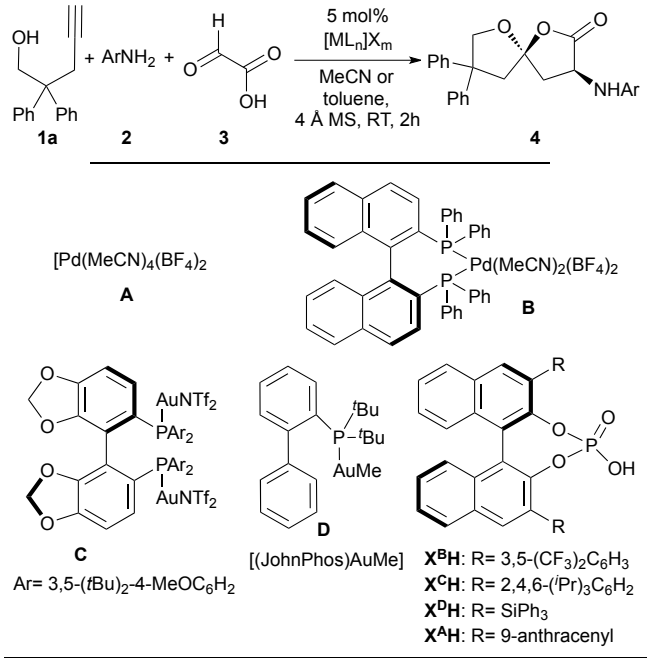
General. ^{1}H NMR spectra were recorded on a Bruker AMX-400 (400 MHz), Bruker AV-300 (300 MHz) or Bruker DPX-300 (300 MHz). Chemical shifts are reported in ppm from tetramethylsilane with the residual solvent resonance as the internal standard ($CDCl_3$: δ= 7.26 ppm; Acetone-d^6: δ= 1.96 ppm). Data are reported as follows: chemical shift, multiplicity (s: singlet, d: doublet, dd: double doublet, ddd: double doublet of doublets, dtd: double triplet of doublets, td: triplet of doublets, t: triplet, q: quartet, m: multiplet), coupling constants (J in Hz), integration and assignment. ^{13}C NMR spectra were recorded on a Bruker AMX-400 (100 MHz), Bruker AV-300 (75 MHz) or Bruker DPX-300 (75 MHz) with complete proton decoupling. Chemical shifts are reported in ppm from tetramethylsilane with the solvent resonance as internal standard ($CDCl_3$: δ = 7.26 ppm; Acetone-d_6: δ = 1.96 ppm; THF-d_8: δ = 1.73 ppm; CD_3CN: δ = 1.94 ppm). Bidimensional NMR experiments (COSY, HSQC and HMBC) were recorded on a Bruker AV-300 (300 MHz). High-resolution mass spectrometry was carried out on a Finnigan-Mat 95 spectrometer. All reactions were conducted in dried glassware under an inert atmosphere of argon when required. Solvents were dried with a PureSolv® column system before use. Technical grade starting materials were purified before use. Optical rotations were measured using a 2 mL cell with a 1 dm path length on an Autopol IV Rudolph Research Analytical polarimeter at 589 nm, and are reported as $[\alpha]^{T}_{D}$ (concentration in grams/mL solvent). Chiral HPLC analyses were performed using a Waters 2695 Alliance instrument.

Optimization of the Reaction Conditions. Effect of the aniline and catalyst.



Entry	**2**	Ar	$[ML_n]X_m$	**4**	Yield [%][a]	*d.r.*[b]	*e.r.*[c]
1	**2a**	Ph	**A**[d]	-	-[e]	-	-
2	**2b**	4-MeC_6H_4	**A**[d]	-	-[e]	-	-
3	**2c**	4-$MeOC_6H_4$	**A**[d]	-	-[e]	-	-
4	**2d**	3-$NO_2C_6H_4$	**A**[d]	**4a**	90	3:1	-
5	**2d**	3-$NO_2C_6H_4$	**B**[d]	**4a**	88	1:1.5	50:50[f]
6	**2d**	3-$NO_2C_6H_4$	**C**[g]	**4a**	90	1:1	50:50[f]
7	**2d**	3-$NO_2C_6H_4$	**D** / $\mathbf{X^BH}$[g]	**4a**	94	1:1	52:48[h]
8	**2d**	3-$NO_2C_6H_4$	**D** / $\mathbf{X^CH}$[g]	**4a**	85	1:1	57:43[h]
9	**2d**	3-$NO_2C_6H_4$	**D** / $\mathbf{X^DH}$[g]	**4a**	96	1:1	60:40[h]
10	**2d**	3-$NO_2C_6H_4$	**D** / $\mathbf{X^AH}$[g]	**4a**	92	3:1	98:2[i]
11[j]	**2d**	3-$NO_2C_6H_4$	**D** / $\mathbf{X^AH}$[g]	**4a**	94	3:1	97:3[i]
12[k]	**2d**	3-$NO_2C_6H_4$	**A** / $\mathbf{X^AH}$[g]	**4a**	93	4:1	64:36[h]
13	**2d**	3-$NO_2C_6H_4$	**D**[g]	**4a**	92	3:1	-
14	**2d**	3-$NO_2C_6H_4$	$\mathbf{X^AH}$[g]	-	-[l]	-	-

[a] Yield based on the starting alkynol **1a**. [b] Determined by ^{1}H-NMR on the crude of the reaction. [c] Determined by HPLC on a chiral stationary phase. [d] Reaction performed in MeCN as solvent. [e] Formation of a complex mixture of unidentified products. [f] Both diastereoisomers were racemic. [g] Reaction performed in toluene. [h] Similar enantiomeric ratio was observed in both diastereoisomers. [i] The minor diastereoisomer also showed very high enantiomeric ratio (*e.r.*= 97:3). [j] Reaction performed with 5 mol% of **D** and 10 mol% of $\mathbf{X^AH}$. When 5 mol% of **D** and 2 mol% of $\mathbf{X^AH}$ were used the enantiomeric ratio dropped (73:27). [k] Reaction performed with 5 mol% of **A** and 5 mol% of $\mathbf{X^AH}$. No changes were observed when 5 mol% of **A** and 10 mol% of $\mathbf{X^AH}$ were used. [l] Reaction performed in the absence of any metal catalyst. Product **4a** was not formed and unreacted alkynol **1a** was recovered.

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Experimental procedures

Starting materials

Starting materials 2,2-diphenylpent-4-yn-1-ol, [1-(prop-2-ynyl)cyclohexyl]methanol, 2-[1-(prop-2-ynyl)cyclopentyl] propan-2-ol, [1-(prop-2-ynyl)cyclopentyl]methanol and 2-(1-ethynylcyclohexyl)ethanol were synthesized according to the literature.[1] Methyl[(1,1′-biphenyl-2-yl)di-*tert*-butyl phosphine]gold(I), (*S*)-(-)-(1,1′-Binaphthalene-2,2′-diyl) bis(diphenylphosphine)tetrakis(acetonitrile)palladium(II) tetrafluoroborate and (*R*)-(-)-5,5′-Bis[di(3,5-di-tert-butyl-4-methoxyphenyl)phosphino]-4,4′-bi-1,3-benzodioxole bis[bis(trifluoromethylsulfonyl)imidate]gold(I) were prepared following known procedures.[2] All other commercially available starting materials were purchased.

Typical procedure for the synthesis of spiroacetals (4).

In a carousel tube with a magnetic stirring bar, activated molecular sieves (250 mg), (*R*)-3,3′-Bis(9-anthracenyl)-1,1′-binaphthyl-2,2′-diyl hydrogenphosphate (5 mol%, 0.0125 mmol, 8.7 mg), methyl[(1,1′-biphenyl-2-yl)di-tert-butyl phosphine]gold(I) (5 mol%, 0.0125 mmol, 6.1 mg) and dry toluene (2 mL) were placed under an atmosphere of argon and the mixture was stirred at room temperature for 30 minutes. Then, glyoxylic acid (**3**) (1.6 equiv., 0.4 mmol, 36.8 mg) and the corresponding aniline (**2**) (1.2 equiv., 0.3 mmol) were added. After 10 minutes at room temperature, the corresponding pent-4-yn-1-ol derivative (**1**) (0.25 mmol) was added. The reaction was allowed to react for 1.5–3h and then the mixture was filtered through a short pad of silica gel and celite with a 1:1 mixture of hexanes and ethyl acetate. The solvent was removed under reduced pressure and the residue was purified by flash column chromatography on silica gel to afford the corresponding pure compound **4**.

References

1 *(a)* K. Komeyama, K. Takahashi, K. Takaki, *Org. Lett.* **2008,** *10*, 5119-5122. *(b)* T. Imahori, H. Ojima, Y. Yoshimura, H. Takahata, *Chem. Eur. J.* **2008**, *14*, 10762-10771. *(c)* N. J. Kerrigan, P. C. Hutchison, T. D. Heightman, D. J. Procter, *Org. Biomol. Chem.* **2004**, *2*, 2476-2482. *(d)* E. Fillion, A. Wilsily, *J. Am. Chem. Soc.* **2006**, *128*, 2774-2775. *(e)* X. Huang, C. Chan, Q. Wu, *Tetrahedron Lett.* **1982**, *23,* 75-76. *(f)* E. Fillion, A. K. Zorzitto, *J. Am. Chem. Soc.* **2009**, *131*, 14608–14609. *(g)* J. Li, Y. Sha, *Molecules* **2008***, 13,* 1111-1119.

2 *(a)* C. Wang, Z. Han, H. Luo, L. Gong, *Org. Lett.* **2010**, *12*, 2266–2269. *(b)* C. A. Mullen, M. R. Gagné, *Org. Lett.* **2006**, *8*, 665–668. *(c)* C. Fehr, M. Vuagnoux, A. Buzas, J. Arpagaus, H. Sommer, *Chem. Eur. J.* **2011**, *17*, 6214–6220.

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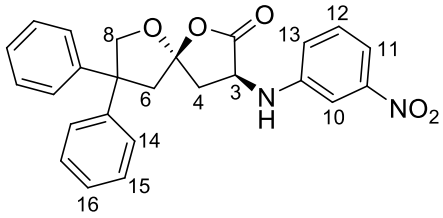
Physical and spectroscopical data for compounds 4

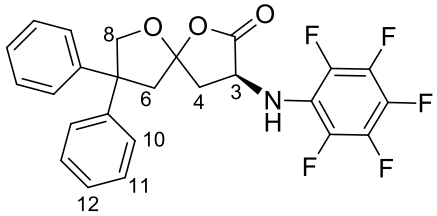
(3*S*,5*R*)-3-(3-Nitrophenylamino)-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (4a)



Yellow foam. R_f= 0.38 (silica gel, hexanes:EtOAc:MeOH 3:1:0.4); $[\alpha]_D^{30.3}$= –12º (c= 0.1, DCM); *er*= 98:2 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 80:20, 0.6 ml/min, 202.4 nm, t_R (major)= 41.9 min, t_R (minor)= 57.5 min]; ^{1}H NMR (401 MHz, Acetone-d_6) δ(ppm)= 7.61 (t, *J*= 2.2 Hz, 1H; H_{10}), 7.52 (dd, *J*= 8.1, 2.2 Hz, 1H; H_{11}), 7.43–7.17 (m, 12H; $H_{12\text{-}16}$), 5.94 (d, *J*= 6.5 Hz, 1H; NH), 4.86 (d, *J*= 9.2 Hz, 1H; H_{8a}), 4.80 (ddd, *J*= 11.0, 8.0, 6.5 Hz, 1H; H_3), 4.58 (d, *J*= 9.2 Hz, 1H; H_{8b}), 3.27 (d, *J*= 14.4 Hz, 1H; H_{6a}), 3.23 (d, *J*= 14.4 Hz, 1H; H_{6b}), 2.78 (dd, *J*= 12.9, 8.0 Hz, 1H; H_{4a}), 2.50 (dd, *J*= 12.9, 11.0 Hz, 1H; H_{4b}); ^{13}C NMR (75 MHz, Acetone-d_6) δ(ppm)= 174.0, 149.3, 148.7, 146.4, 144.9, 129.9, 128.4, 127.1, 126.7, 126.5, 126.4, 119.1, 113.1, 111.8, 106.9, 77.5, 55.4, 52.5, 52.5, 48.9, 40.7; HRMS (ESI): calcd for $C_{25}H_{22}N_2O_5$ [M^+] 430.1523 found 430.1521.

Enantiomeric ratio of the minor diastereoisomer ***diast*-4a** (98:2) could be determined by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 70:30, 0.7 ml/min, 202.4 nm, t_R (major)= 57.4 min, t_R (minor)= 71.3 min.

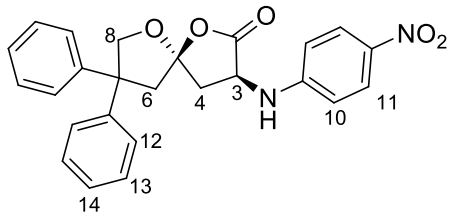
(3*S*,5*R*)-3-(Perfluorophenylamino)-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (4b) and (3*S*,5*S*)-3-(perfluorophenylamino)-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (*diast*-4b)



The 3:1 mixture of diastereoisomers **4b**/***diast*-4b** could not be separated by column chromatography. However, the enantiomeric ratio for both diastereoisomers could be determined from the mixture by chiral HPLC analysis.

White solid. R_f= 0.21 (silica gel, hexanes:EtOAc 7:1); *er* (**4b**)= 96:4 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 90:10, 0.5 ml/min, 201.3 nm, t_R (major)= 23.8 min, t_R (minor)= 43.9 min] and *er* (***diast*-4b**)= 89:11 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 90:10, 0.5 ml/min, 200.1 nm, t_R (major)= 48.4 min, t_R (minor)= 69.3 min]; ^{1}H NMR (401 MHz, Acetone-d_6) δ(ppm)= 7.45–7.19 (m, 10H; $H_{10\text{-}12}$ **4b** and ***diast*-4b**), 5.34 (d, *J*= 9.8 Hz, 1H; NH **4b**), 5.31 (d, *J*= 8.8 Hz, 1H; NH ***diast*-4b**), 4.95 (dd, *J*= 9.1, 1.3 Hz, 1H; H_{8a} ***diast*-4b**), 4.84 (dd, *J*= 9.2, 0.5 Hz, 1H; H_{8a} **4b**), 4.79 (ddd, *J*= 10.8, 9.8, 8.9 Hz, 1H; H_3 **4b***),* 4.72 (dt, 9.7, 8.8 Hz, 1H; H_3 ***diast*-4b**), 4.53 (d, *J*= 9.2 Hz, 1H; H_{8b} **4b**), 4.47 (d, *J*= 9.1 Hz, 1H; H_{8b} **4b**), 3.35 (dd, *J*= 14.0, 1.3 Hz, 1H; H_{6a} ***diast*-4b**), 3.25 (d, *J*= 14.3 Hz, 1H; H_{6a} **4b**), 3.21 (dd, *J*= 14.3, 0.5 Hz, 1H; H_{6b} **4b**), 3.19 (d, *J*= 14.0 Hz, 1H; H_{6b} ***diast*-4b**), 2.74-2.61 (m, 3H; H_4 **4b** and H_{4a} ***diast*-4b**), 2.44 (dd, *J*= 13.2, 9.7 Hz, 1H; H_{4b} ***diast*-4b**); ^{13}C NMR (75 MHz, Acetone-d_6) **4b**: δ(ppm)= 174.3, 146.3, 144.8, 139.8 (m), 136.6 (m), 128.4, 127.1, 126.7, 123.2 (m), 112.7, 77.4, 55.4, 54.5 (J_{CF}= 3.7 Hz), 48.9, 40.9; ***diast*-4b**: δ(ppm)= 172.6, 145.8, 144.7, 127.0, 126.8, 126.6, 113.6, 77.1, 56.0, 55.0 (J_{CF}= 3.8 Hz), 49.2, 40.7; ^{19}F NMR (282 MHz, Acetone-d_6) δ(ppm)= -158.5--158.8 (m; ***diast*-4b**), −159.2−−159.5 (m; **4b**), −166.6−−167.0 (m; **4b** and ***diast*-4b**), −173.2 (tt, *J*= 21.6, 5.9 Hz; ***diast*-4b**), −173.6 (tt, *J*= 21.6, 6.1 Hz; **4b**); HRMS (ESI): calcd for $C_{25}H_{18}F_5NO_3$ [M^+] 475.1201 found 430.1205.

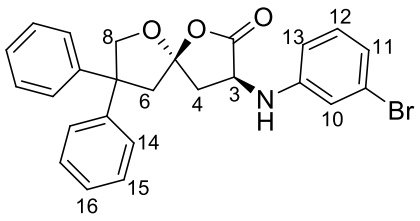
(3*S*,5*R*)-3-(4-Nitrophenylamino)-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (4c)



Yellow foam. R_f= 0.35 (silica gel, hexanes:EtOAc 3:1); $[\alpha]_D^{28.2}$= −21° (c= 0.02, DCM); *er*= 95:5 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 80:20, 0.7 ml/min, 201.3 nm, t_R (major)= 35.3 min, t_R (minor)= 98.5 min]; ^{1}H NMR (401 MHz, Acetone-d_6) δ(ppm)= 8.21-7.93 (m, 2H; H_{11}), 7.44-7.11 (m, 10H; H_{12}, H_{13} and H_{14}), 6.98-6.84 (m, 2H; H_{10}), 6.52 (d, *J*= 7.3 Hz, 1H; N*H*), 4.95-4.84 (m, 1H; H_3), 4.85 (d, *J*= 9.2 Hz, 1H; H_{8a}), 4.59 (d, *J*= 9.2 Hz, 1H; H_{8b}), 3.27 (d, *J*= 14.2 Hz, 1H; H_{6a}), 3.22 (d, *J*= 14.2 Hz, 1H; H_{6b}), 2.78 (dd, *J*= 12.9, 8.0 Hz, 1H; H_{4a}), 2.54 (dd, *J*= 12.9, 11.1 Hz, 1H; H_{4b}); ^{13}C NMR (75 MHz, Acetone-d_6) δ(ppm)= 173.4, 153.2, 146.3, 144.8, 138.3, 128.4, 127.1, 126.7, 126.5, 126.4, 125.7, 113.2, 112.0, 77.6, 55.4, 52.2, 48.9, 40.5; HRMS (ESI): calcd for $C_{25}H_{22}N_2O_5$ [M^+] 430.1523 found 430.1525.

Enantiomeric ratio of the minor diastereoisomer ***diast*-4c** (95:5) could be determined by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 80:20, 0.7 ml/min, 201.3 nm, t_R (major)= 53.6 min, t_R (minor)= 76.8 min.

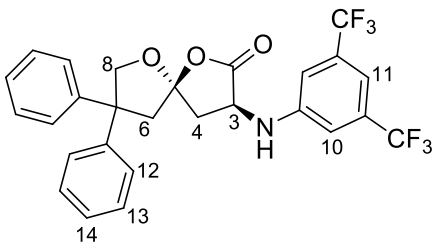
(3*S*,5*R*)-3-(3-Bromophenylamino)-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (4d)



White foam. R_f= 0.50 (silica gel, hexanes:Et_2O 1:1); $[\alpha]_D^{28.4}$= –8º (c= 0.7, DCM); *er*= 92:8 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 80:20, 0.6 ml/min, 207.1 nm, t_R (major)= 29.8 min, t_R (minor)= 40.5 min]; ^{1}H NMR (300 MHz, Acetone-d_6) δ(ppm)= 7.46-7.16 (m, 10H; H_{14},H_{15}, and H_{16}), 7.07 (t, *J*= 8.0 Hz, 1H; H_{12}), 6.97 (t, *J*= 2.0 Hz, 1H; H_{10}), 6.82 (ddd, *J*= 8.0, 2.0 Hz, 1H; H_{11}), 6.75 (ddd, *J*= 8.0, 2.0 Hz, 1H; H_{13}), 5.52 (d, *J*= 6.9 Hz, 1H; NH), 4.84 (d, *J*= 9.1 Hz, 1H; H_{8a}), 4.66 (ddd, *J*= 11.0, 7.9, 6.9 Hz, 1H; H_3), 4.57 (d, *J*= 9.1 Hz, 1H; H_{8b}), 3.26 (d, *J*= 14.2 Hz, 1H; H_{6a}), 3.20 (d, *J*= 14.2 Hz, 1H; H_{6b}), 2.75 (ddd, *J*= 12.9, 7.9, 1.4 Hz, 1H; H_{4a}), 2.43 (dd, *J*= 12.9, 11.1 Hz, 1H; H_{4b}); ^{13}C NMR (75 MHz, Acetone-d_6) δ(ppm)= 174.1, 149.1, 146.4, 144.9, 130.6, 128.4, 127.2, 126.7, 126.5, 126.4, 122.6, 120.1, 115.7, 113.0, 112.0, 77.5, 55.4, 52.6, 52.5, 48.9, 41.0; HRMS (ESI): calcd for $C_{25}H_{22}BrNO_3$ [M^+] 463.0778 found 463.0786.

Enantiomeric ratio of the minor diastereoisomer ***diast*-4d** (88:12) could be determined by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 80:20, 0.6 ml/min, 206.0 nm, t_R (major)= 67.1 min, t_R (minor)= 81.9 min.

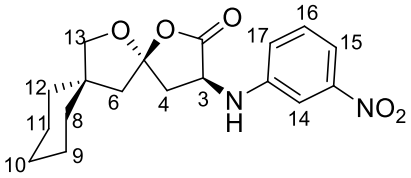
(3*S*,5*R*)-3-[3,5-Bis(trifluoromethyl)phenylamino]-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (4e)



Colourless oil. R_f= 0.46 (silica gel, hexanes:Et_2O:DCM 4:1:1); $[\alpha]_D^{30.4}$= –14º (c= 0.1, DCM); *er*= 96:4 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 90:10, 0.4 ml/min, 205.9 nm, t_R (major)= 22.9 min, t_R (minor)= 31.1 min]; ^{1}H NMR (401 MHz, Acetone-d_6) δ(ppm)= 7.43-7.19 (m, 13H; $H_{10\text{-}16}$), 6.17 (d, *J*= 7.5 Hz, 1H; N*H*), 4.93 (apparent dt, *J*= 11.1, 7.7 Hz; 1H, H_3), 4.85 (d, *J*= 9.2 Hz, 1H; H_{8a}), 4.58 (d, *J*= 9.2 Hz, 1H; H_{8b}), 3.27 (d, *J*= 14.4 Hz, 1H; H_{6a}), 3.23 (d, *J*= 14.4 Hz, 1H; H_{6b}), 2.79 (dd, *J*= 12.9, 8.0 Hz, 1H; H_{4a}), 2.51 (dd, *J*= 12.9, 11.1 Hz, 1H; H_{4b}); ^{13}C NMR (75 MHz, Acetone-d_6) δ(ppm)= 173.9, 149.1, 146.3, 144.8, 131.84 (q, J_{CF}= 32.2 Hz), 128.4, 127.1, 126.7, 126.5, 126.4, 123.76 (q, J_{CF}= 272.2 Hz), 113.1, 112.7, 109.7, 77.5, 55.4, 52.3, 48.9, 40.6; ^{19}F NMR (282 MHz, Acetone-d_6) δ(ppm)= –63; HRMS (ESI): calcd for $C_{27}H_{21}F_6NO_3$ [M^+] 521.1420 found 521.1428.

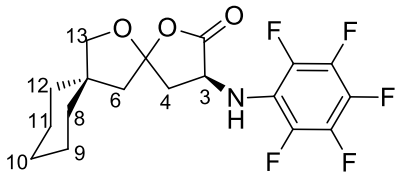
Enantiomeric ratio of minor the diastereoisomer ***diast*-4e** (96:4) could be determined by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 95:5, 0.4 ml/min, 201.2 nm, t_R (major)= 67.4 min, t_R (minor)= 148.1 min.

(3*S*,5*R*)-3-(3-Nitrophenylamino)-1,14-dioxadispiro[4.1.5.2]tetradecan-2-one (4f)



Yellow foam. R_f= 0.45 (silica gel, hexanes:Et_2O:DCM 3:2:1); $[\alpha]_D^{19.5}$= –26º (c= 0.15, DCM); *er*= 96:4 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:EtOH 80:20, 0.5 ml/min, 236.6 nm, t_R (major)= 40.9 min, t_R (minor)= 74.0 min]; ^{1}H NMR (401 MHz, Acetone-d_6) δ(ppm)= 7.61 (t, *J*= 2.3 Hz, 1H; H_{14}), 7.52 (dd, *J*= 8.1, 2.3 Hz, 1H; H_{15}), 7.41 (t, *J*= 8.1 Hz, 1H; H_{16}), 7.22 (dd, *J*= 8.1, 2.3 Hz, 1H; H_{17}), 5.94 (d, *J*= 7.1 Hz, 1H; N*H*), 4.75 (ddd, *J*= 11.0, 7.9, 7.1 Hz, 1H; H_3), 3.87 (d, *J*= 8.6 Hz, 1H; H_{13a}), 3.81 (d, *J*= 8.6 Hz, 1H; H_{13b}), 2.89 (dd, *J*= 12.9, 7.9 Hz, 1H; H_{4a}), 2.44 (dd, *J*= 12.9, 11.0 Hz, 1H; H_{4b}), 2.26 (d, *J*= 14.1 Hz, 1H; H_{6a}), 2.09 (d, *J*= 14.1 Hz, 1H; H_{6b}), 1.67–1.37 (m, 10H; $H_{8\text{-}12}$); ^{13}C NMR (75 MHz, Acetone) δ(ppm)= 174.3, 162.5, 149.3, 148.7, 129.9, 119.2, 113.6, 111.7, 106.9, 79.3, 52.6, 48.2, 42.4, 39.9, 36.9, 35.4, 25.4, 23.5, 23.4; HRMS (ESI): calcd for $C_{18}H_{22}N_2O_5$ [M^+] 346.1523 found 346.1523.

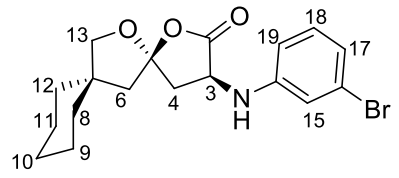
(3*S*,5*R*)-3-(Perfluorophenylamino)-1,14-dioxadispiro[4.1.5.2]tetradecan-2-one (4g) and (3*S*,5*S*)-3-(perfluorophenylamino)-1,14-dioxadispiro[4.1.5.2]tetradecan-2-one (*diast*-4g)



The 4:1 mixture of diastereoisomers **4g**/***diast*-4g** could not be separated by column chromatography. However, the enantiomeric ratio for both diastereoisomers could be determined from the mixture by chiral HPLC analysis.

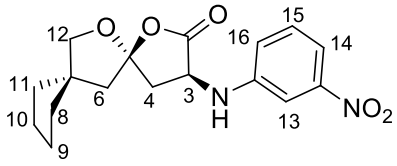
White solid. R_f= 0.38 (silica gel, hexanes:DCM:Et_2O 7:1:1); *er* (**4g**)= 95:5 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 95:5, 0.5 ml/min, 226.0 nm, t_R (major)= 23.0 min, t_R (minor)= 34.7 min]; *ee* (***diast*-4g**)= 95:5 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 95:5, 0.5 ml/min, 223.6 nm, t_R (major)= 43.4 min, t_R (minor)= 61.3 min]; ^{1}H NMR (401 MHz, Acetone-d_6) δ(ppm)= 5.31 (d, *J*= 9.6 Hz, 1H; NH **4g**), 5.25 (d, *J*= 10.0 Hz, 1H; NH ***diast*-4g**), 4.75 (ddd, *J*= 11.4, 9.6, 8.2 Hz, 1H; H_3 **4g**), 4.65 (apparent q, *J*= 8.8 Hz, 1H; H_3 ***diast*-4g**), 3.87 (d, *J*= 8.5 Hz, 1H; H_{13a} ***diast*-4g**), 3.84 (d, *J*= 8.6 Hz, 1H; H_{13a} **4g**), 3.82 (d, *J*= 8.5 Hz, 1H; H_{13b} ***diast*-4g**), 3.77 (d, *J*= 8.6 Hz, 1H; H_{13b} **4g**), 2.91 (dd, *J*= 13.2, 8.5 Hz, 1H; H_{4a} ***diast*-4g**), 2.76 (dd, *J*= 12.8, 8.2 Hz, 1H; H_{4a} **4g**), 2.64 (dd, *J*= 12.6, 11.4 Hz, 1H; H_{4b} **4g**), 2.53 (dd, *J*= 13.2, 9.0 Hz, 1H; H_{4b} ***diast*-4g**), 2.29 (d, *J*= 13.9 Hz, 1H; H_{6a} ***diast*-4g**), 2.22 (d, *J*= 14.1 Hz, 1H; H_{6a} **4g**), 2.15 (d, *J*= 13.9 Hz, 1H; H_{6b} ***diast*-4g**), 2.07 (d, *J*= 14.1 Hz, 2H; H_{6b} **4g**), 1.69-1.32 (m, 10H; $H_{8\text{-}12}$, **4g** and ***diast*-4g**); ^{13}C NMR (75 MHz, Acetone-d_6) **4g**: δ(ppm)= 174.6, 113.2, 79.2, 54.6, 48.1, 42.4, 40.0, 36.8, 35.3, 25.4, 23.5, 23.4; ^{19}F NMR (282 MHz, Acetone-d_6) δ(ppm)= −158.1--158.8 (m; ***diast*-4g**), −159.1--159.7 (m; **4g**), −166.3--167.4 (m; **4g** and ***diast*-4g**), −172.83--173.37 (m; ***diast*-4g**), −173.48--174.11 (m; **4g**); HRMS (ESI): calcd for $C_{18}H_{19}F_5NO_3$ $[M+1]^+$ 392.1280 found 392.1277.

(3*S*,5*R*)-3-(3-Bromophenylamino)-1,14-dioxadispiro[4.1.5.2]tetradecan-2-one (4h)



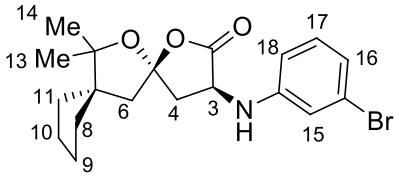
Light yellow solid; mp= 125-127 ºC; R_f= 0.37 (silica gel, hexanes:EtOAc 7:1); $[\alpha]_D^{19.5}$= –40º (c= 0.25, DCM); *er*= 97:3 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 90:10, 0.5 ml/min, 208.3 nm, t_R (major)= 33.5 min, t_R (minor)= 44.0 min]; ^{1}H NMR (300 MHz, Acetone-d_6) δ(ppm)= 7.08 (t, *J*= 8.0 Hz, 1H; H_{18}), 6.98 (t, *J*= 2.0 Hz, 1H; H_{15}), 6.83 (dd, *J*= 8.0, 2.0 Hz, 1H; H_{17}), 6.77 (dd, *J* =8.0, 2.0 Hz, 1H; H_{19}), 5.51 (d, *J*= 6.9 Hz, 1H; NH), 4.61 (ddd, *J*= 11.0, 7.9, 6.9 Hz, 1H; H_3), 3.86 (d, *J*= 8.6 Hz, 1H; H_{13a}), 3.79 (d, *J*= 8.6 Hz, 1H; H_{13b}), 2.84 (dd, *J*= 12.9, 7.9 Hz, 1H; H_{4a}), 2.37 (dd, *J*= 12.9, 11.0 Hz, 1H; H_{4b}), 2.25 (d, *J*= 14.1 Hz, 1H; H_{6a}), 2.07 (d, *J*= 14.0 Hz, 1H; H_{6b}), 1.66-1.44 (m, 10H; $H_{8\text{-}12}$); ^{13}C NMR (75 MHz, Acetone-d_6) δ(ppm)= 174.4, 149.2, 130.6, 122.6, 120.1, 115.6, 113.5, 112.1, 79.3, 52.6, 48.2, 42.4, 40.2, 36.9, 35.4, 25.4, 23.5, 23.4; HRMS (ESI): calcd for $C_{18}H_{22}BrNO_3$ [M^+] 379.0778 found 379.0789.

(3*S*,5*R*)-3-(3-Nitrophenylamino)-1,13-dioxadispiro[4.1.4.2]tetradecan-2-one (4i)



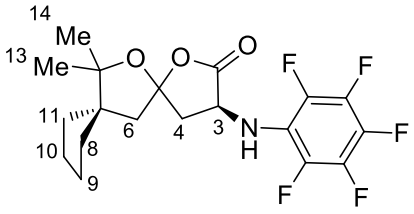
Yellow solid; mp= 114-117 ºC; R_f= 0.46 (silica gel, hexanes:Et_2O:DCM 2:1:1); $[\alpha]_D^{30.7}$= –7º (c= 0.1, DCM); *er*= 95:5 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:EtOH 80:20, 0.5 ml/min, 236.6 nm, t_R (major)= 50.1 min, t_R (minor)= 85.0 min]; ^{1}H NMR (300 MHz, Acetone-d_6) δ(ppm)= 7.62 (t, *J*= 2.3 Hz, 1H; H_{13}), 7.53 (dd, *J*= 8.1, 2.3 Hz, 1H; H_{14}), 7.41 (t, *J*= 8.1 Hz, 1H; H_{15}), 7.22 (dd, *J*= 8.1, 2.3 Hz, 1H; H_{16}), 5.95 (d, *J*= 6.8 Hz, 1H; NH), 4.77 (ddd, 11.1, 7.9, 6.8 Hz, 1H; H_3), 3.91 (d, *J*= 8.3 Hz, 1H; H_{12a}), 3.86 (d, *J*= 8.3 Hz, 1H; H_{12b}), 2.90 (dd, *J*= 12.8, 7.9 Hz, 1H; H_{4a}), 2.44 (dd, *J*= 12.8, 11.1 Hz, 1H; H_{4b}), 2.34 (d, *J*= 13.9 Hz, 1H; H_{6a}), 2.26 (d, *J*= 13.9 Hz, 1H; H_{6b}), 1.81-1.59 (m, 8H; $H_{8\text{-}11}$); ^{13}C NMR (75 MHz, Acetone-d_6) δ(ppm)= 174.3, 149.4, 148.7, 129.9, 119.2, 113.6, 111.7, 106.9, 79.9, 52.6, 49.5, 48.6, 39.9, 37.7, 36.8, 24.2, 24.0; HRMS (ESI): calcd for $C_{17}H_{20}N_2O_5$ [M^+] 332.1367 found 332.1378.

(3*S*,5*R*)-3-(3-Bromophenylamino)-12,12-dimethyl-1,13-dioxadispiro[4.1.4.2]tetradecan-2-one (4j)



White foam. R_f= 0.43 (silica gel, hexanes:AcOEt:MeOH 7:1:0.5); $[\alpha]_D^{29.1}$= –3º (c= 0.1, DCM); *er*= 93:7 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:EtOH 90:10, 0.4 ml/min), 208.3 nm, t_R (major)= 50.1 min, t_R (minor)= 92.5 min]; ^{1}H NMR (401 MHz, THF-d_8) δ(ppm)= 7.01 (t, *J*= 8.0 Hz, 1H; H_{18}), 6.88 (t, *J*= 2.3 Hz, 1H; H_{16}), 6.78 (dd, *J*= 8.0, 2.3 Hz, 1H; H_{17}), 6.65 (dd, *J*= 8.0, 2.3 Hz, 1H; H_{19}), 5.44 (d, *J*= 6.1 Hz, 1H; NH), 4.50 (ddd, *J*= 11.0, 7.6, 6.1 Hz, 1H; H_3), 2.78 (dd, *J*= 12.4, 7.6 Hz, 1H; H_{4a}), 2.42 (d, *J*= 14.0 Hz, 1H; H_{6a}), 2.26 (d, *J*= 14.0 Hz, 1H; H_{6b}), 2.17 (dd, *J*= 12.4, 11.0 Hz, 1H; H_{4b}), 1.84-1.40 (m, 10H; $H_{8\text{-}11}$), 1.29 (s, 3H; H_{14}), 1.23 (s, 3H; H_{15}); ^{13}C NMR (75 MHz, THF-d_8) δ(ppm)= 172.8, 148.3, 148.2, 129.1, 129.1, 121.7, 118.8, 114.6, 110.6, 109.8, 86.4, 54.2, 51.5, 47.5, 42.0, 33.1, 31.8, 22.1, 21.9; HRMS (ESI): calcd for $C_{19}H_{24}BrNO_3$ [M^+] 393.0934 found 393.0936.

(3*S*,5*R*)-12,12-Dimethyl-3-(perfluorophenylamino)-1,13-dioxadispiro[4.1.4.2] tetradecan-2-one (4k) and (3*S*,5*S*)-12,12-dimethyl-3-(perfluorophenylamino)-1,13-dioxadispiro[4.1.4.2] tetradecan-2-one (*diast*-4k)

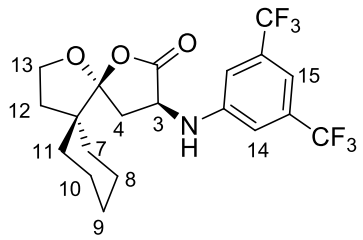


The 3:1 mixture of diastereoisomers **4k**/***diast*-4k** could not be separated by column chromatography. However, the enantiomeric ratio for both diastereoisomers could be determined from the mixture by chiral HPLC analysis.

White solid. R_f= 0.28 (silica gel, hexanes:Et_2O 4:1); *er* (**4k**)= 95:5 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 90:10, 0.2 ml/min, 226.0 nm, t_R (major)= 48.4 min, t_R (minor)= 52.9 min]; *er* (***diast*-4k**)= 95:5 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 90:10, 0.2 ml/min, 223.6 nm, t_R (major)= 42.4 min, t_R (minor)= 117.5 min]; ^{1}H NMR (401 MHz, Acetone-d_6) δ(ppm)= 5.27 (d, *J*= 9.5 Hz, 1H; NH, **4k** and ***diast*-4k**), 4.73 (ddd, *J*= 11.4, 9.5, 8.1 Hz, 1H; H_3 **4k**), 4.61 (apparent dt, *J*= 9.6, 8.5 Hz, 1H; H_3 ***diast*-4k**), 2.86

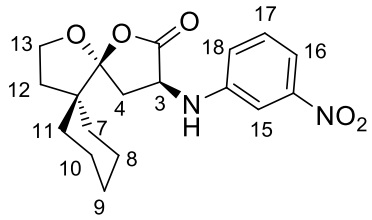
(dd, *J*= 13.0, 8.4 Hz, 1H; H_{4a} ***diast*-4k**), 2.71 (dd, *J*= 12.5, 8.1 Hz, 1H; H_{4a} **4k**), 2.61 (dd, *J*= 12.5, 11.4 Hz, 1H; H_{4b} **4k**), 2.48 (dd, *J*= 13.0, 9.6 Hz, 1H; H_{4b} ***diast*-4k**), 2.42 (apparent s, 2H; H_6 ***diast*-4k**), 2.42 (d, *J*= 14.1 Hz, 1H; H_{6a} **4k**), 2.34 (d, *J*= 14.1 Hz, 1H; H_{6b} **4k**), 1.78–1.43 (m, 10H; $H_{8\text{-}11}$), 1.29 (s, 3H; H_{13} ***diast*-4k**), 1.25 (s, 3H; H_{13} **4k**), 1.23 (s, 3H; H_{14} ***diast*-4k**), 1.21 (s, 3H; H_{14} **4k**); ^{13}C NMR (75 MHz, Acetone-d_6) **4k**: δ(ppm)= 174.6, 110.9, 87.7, 55.1, 54.6 (J_{CF}= 3.6 Hz), 48.2, 42.2, 33.9, 32.7, 24.3, 22.8; ***diast*-4k**: δ(ppm)= 172.9, 112.0, 87.5, 55.7, 55.2 (J_{CF}= 3.8 Hz), 48.4, 41.8, 33.8, 32.8, 24.4, 23.0; ^{19}F NMR (282 MHz, Acetone-d_6) δ(ppm)= –158.4--158.9 (m; ***diast*-4k**), –159.09--159.65 (m; **4k**), –166.51--167.50 (m; **4k** and ***diast*-4k**), –173.24 (tt, *J*= 21.5, 5.8 Hz; ***diast*-4k**), –173.80 (tt, *J*= 21.5, 6.1 Hz; **4k**); HRMS (ESI): calcd for $C_{19}H_{20}F_5NO_3$ [M^+] 405.1358 found 405.1362.

(3*S*,5*R*)-3-[3,5-bis(trifluoromethyl)phenylamino]-1,14-dioxadispiro[4.0.5.3]tetradecan-2-one (4l)



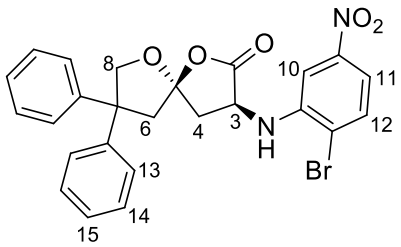
White solid; mp= 153-156 ºC; R_f= 0.43 (silica gel, hexanes:AcOEt 5:1); $[\alpha]_D^{28.5}$= –14º (c= 0.25, DCM); *er*= 98:2 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 90:10, 0.3 ml/min, 203.6 nm, t_R (major)= 40.4 min, t_R (minor)= 46.3 min]; ^{1}H NMR (401 MHz, Acetone-d_6) δ(ppm)= 7.25 (s, 2H; H_{14}), 7.11 (s, 1H; H_{15}), 6.14 (d, *J*= 7.8 Hz, 1H; NH), 4.80 (dt, *J*= 11.1, 7.8 Hz, 1H; H_3), 3.98-3.90 (m, 2H; H_{13}), 2.56 (dd, *J*= 12.9, 7.8 Hz, 1H; H_{4a}), 2.26 (dd, *J*= 12.9, 11.1 Hz, 1H; H_{4b}), 2.21 (ddd, *J*= 11.5, 6.3, 4.4 Hz, 1H; H_{12a}), 1.74 (dtd, *J*= 11.5, 9.6, 1.9 Hz, 1H; H_{12b}), 1.64-1.14 (m, 10H; $H_{7\text{-}11}$); ^{13}C NMR (75 MHz, Acetone-d_6) δ(ppm)= 173.9, 149.0, 131.9 (q, J_{CF}= 32.6 Hz), 123.8 (q, J_{CF}= 272.0 Hz), 116.5, 112.7, 109.5, 66.2, 52.3, 47.9, 34.0, 30.9, 30.6, 25.7, 23.1, 21.6; ^{19}F NMR (282 MHz, Acetone-d_6) δ(ppm)= –63.69; HRMS (ESI): calcd for $C_{20}H_{21}F_6NO_3$ [M^+] 437.1420 found 437.1404.

(3*S*,5*R*)-3-(3-Nitrophenylamino)-1,14-dioxadispiro[4.0.5.3] tetradecan-2-one (4m)



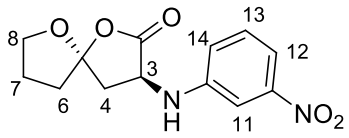
Yellow solid; mp= 150-152 ºC; R_f= 0.42 (silica gel, hexanes:AcOEt 3:1); $[\alpha]_D^{30.7}$= –3º (c= 0.1, DCM); *er*= 94:6 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 80:20, 0.6 ml/min, 236.6 nm, t_R (major)= 55.9 min, t_R (minor)= 71.2 min]; ^{1}H NMR (401 MHz, Acetone-d_6) δ(ppm)= 7.60 (t, *J*= 2.3 Hz, 1H; H_{15}), 7.53 (ddd, *J*= 8.2, 2.3 Hz, 1H; H_{16}), 7.41 (t, *J*= 8.1 Hz, 1H; H_{17}), 7.22 (ddd, *J*= 8.2, 2.3 Hz, 1H; H_{18}), 5.98 (d, *J*= 7.8 Hz, 1H; NH), 4.78 (dt, *J*= 11.2, 7.8 Hz, 1H; H_3), 4.14-3.96 (m, 2H; H_{13}), 2.67 (dd, *J*= 12.8, 7.8 Hz, 1H; H_{4a}), 2.35 (dd, *J*= 12.8, 11.2 Hz, 2H; H_{4b}), 2.33 (ddd, *J*= 11.5, 5.9, 4.1 Hz, 1H; H_{12a}), 1.85 (dtd, *J*= 11.5, 9.6, 1.9 Hz, 1H; H_{12b}), 1.76–1.14 (m, 10H; $H_{7\text{-}11}$); ^{13}C NMR (75 MHz, Acetone-d_6) δ(ppm)= 174.0, 149.4, 148.7, 130.0, 119.2, 116.5, 111.7, 106.8, 66.2, 52.6, 47.9, 34.3, 30.9, 30.6, 25.7, 23.1, 21.6; HRMS (ESI): calcd for $C_{18}H_{22}N_2O_5$ [M^+] 346.1523 found 346.1526.

(3*S*,5*R*)-3-(2-Bromo-5-nitrophenylamino)-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (4n)



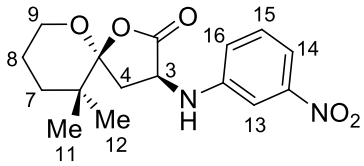
Yellow solid (^{i}PrOH); mp= 160-162 ºC; R_f= 0.43 (silica gel, hexanes:Et_2O 2:1); $[\alpha]_D^{30.8}$= –6º (c= 0.1, DCM); *er*= 85:15 (94:6 after crystallization) [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:^{i}PrOH 80:20, 0.5 ml/min, 202.4 nm, t_R (major)= 40.2 min, t_R (minor)= 56.6 min]; ^{1}H NMR (401 MHz, Acetone-d_6) δ(ppm)= 7.75 (d, *J*= 8.6 Hz, 1H; H_{12}), 7.72 (d, *J*= 2.6 Hz, 1H; H_{10}), 7.49 (dd, *J*= 8.6, 2.6 Hz, 1H; H_{11}), 7.44-7.18 (m, 10H; $H_{13\text{-}15}$), 5.68 (d, *J*= 7.6 Hz, 1H; NH), 5.00 (ddd, *J*= 11.1, 8.2, 7.6 Hz, 1H; H_3), 4.87 (d, *J*= 9.2 Hz, 1H; H_{8a}), 4.60 (d, *J*= 9.2 Hz, 1H; H_{8b}), 3.29 (d, *J*= 14.4 Hz, 1H; H_{6a}), 3.24 (d, *J*= 14.4 Hz, 1H; H_{6b}), 2.83 (dd, *J*= 12.7, 8.2 Hz, 3H; H_{4a}), 2.74 (dd, *J*= 12.7, 11.1 Hz, 1H; H_{4b}); ^{13}C NMR (75 MHz, Acetone-d_6) δ(ppm)= 173.8, 148.6, 146.3, 145.1, 144.9, 133.3, 128.4, 127.1, 126.8, 126.5, 126.4, 115.7, 113.3, 112.7, 106.2, 77.6, 55.4, 52.5, 49.0, 40.3; HRMS (ESI): calcd for $C_{25}H_{21}BrN_2O_5$ [M^+] 508.0628 found 508.0630.

(3*S*,5*R*)-3-(3-nitrophenylamino)-1,6-dioxaspiro[4.4]nonan-2-one (4o)



Yellow foam; R_f= 0.40 (silica gel, hexanes:DCM:Et_2O 1:1:1); $[\alpha]_D^{18.3}$= –15º (c= 0.1, DCM); *er*= 90:10 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:EtOH 80:20, 0.4 ml/min, 236.6 nm, t_R (major)= 80.6 min, t_R (minor)= 94.0 min]; ^{1}H NMR (401 MHz, THF) δ(ppm)= 7.55 (t, *J* = 2.2 Hz, 1H, H_{11}), 7.50 (ddd, *J* = 8.2, 2.2 Hz, 1H, H_{12}), 7.33 (t, *J* = 8.2 Hz, 1H, H_{13}), 7.10 (dd, *J* = 8.2, 2.2 Hz, 1H, H_{14}), 6.04 (d, *J* = 6.4 Hz, 1H, N*H*), 4.69 (ddd, *J* = 11.0, 7.9, 6.4 Hz, 1H, H_3), 4.13 – 3.97 (m, 2H, H_8), 2.85 (dd, *J* = 12.8, 7.9 Hz, 1H, H_{4a}), 2.34 – 2.25 (m, 1H, H_{7a}), 2.33 (dd, *J* = 12.8, 11.0 Hz, 1H, H_{4b}), 2.20 – 1.99 (m, 3H, H_6 y H_{7b}).; ^{13}C NMR (75 MHz, THF) δ(ppm)= 173.6, 149.4, 148.8, 129.5, 118.5, 112.7, 111.4, 106.9, 69.0, 52.7, 38.9, 35.7, 23.2.; HRMS (ESI): calcd for $C_{25}H_{21}BrN_2O_5$ [M^+] 278.0879 found 278.0890.

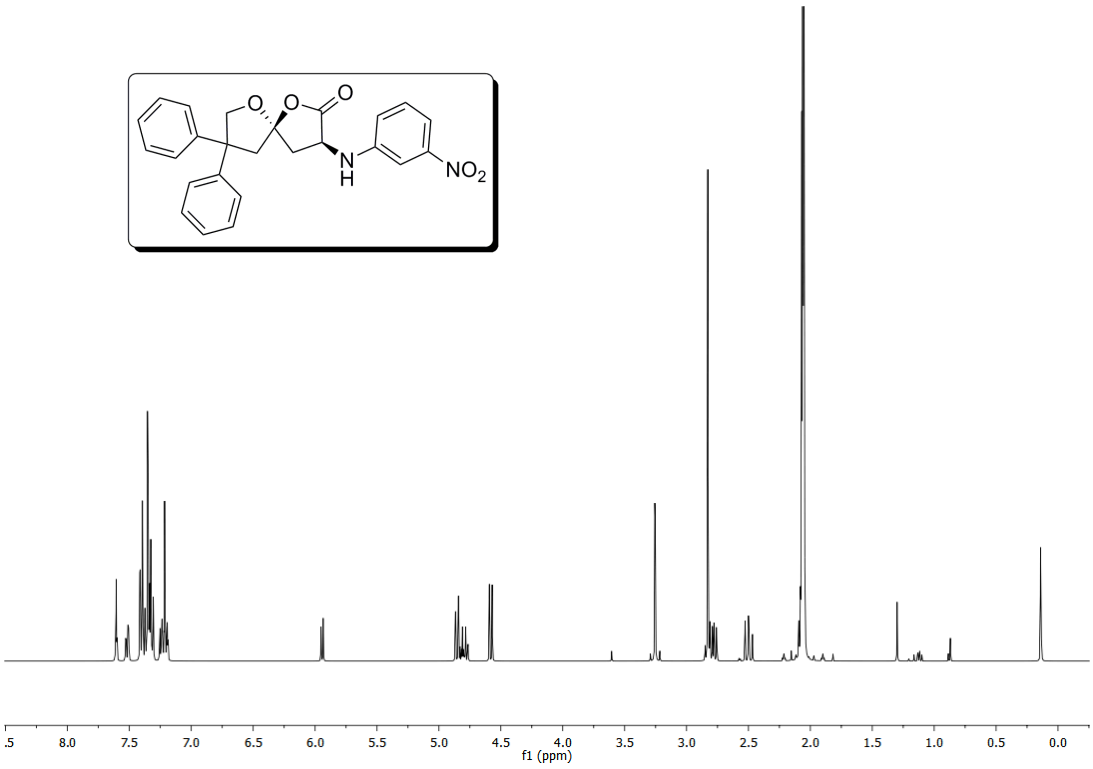
(3*S*,5*S*)-10,10-dimethyl-3-(3-nitrophenylamino)-1,6-dioxaspiro [4.5]decan-2-one (4p)

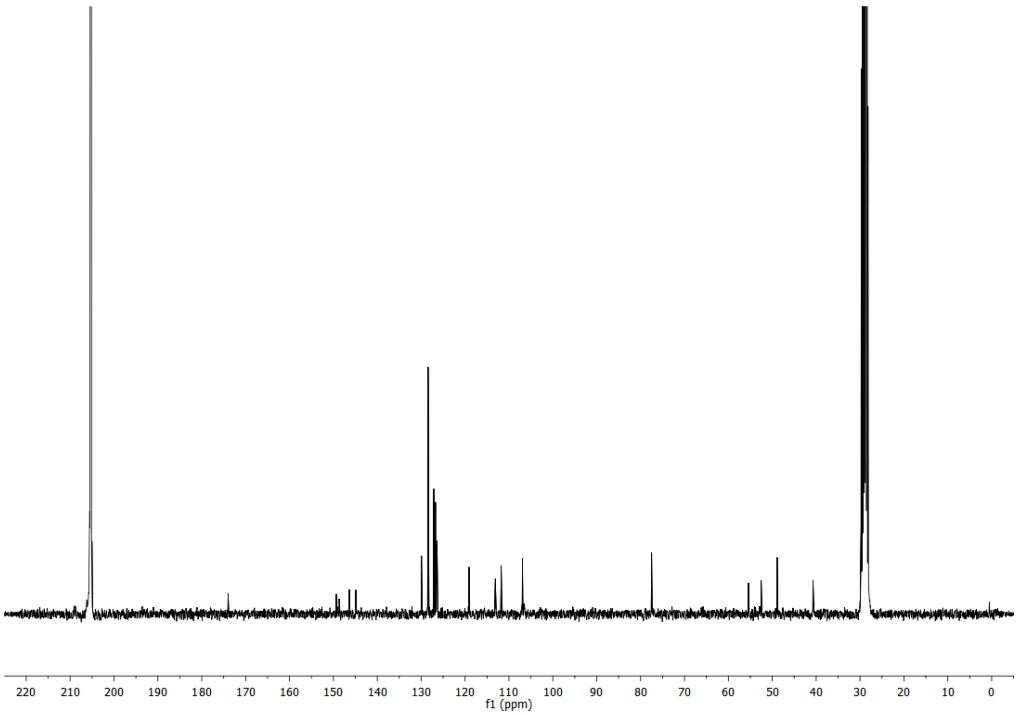


Yellow foam; R_f= 0.36 (silica gel, hexanes:AcOEt:MeOH 5:1:0.5); $[\alpha]_D^{18.5}$= –30º (c= 0.15, DCM); *er*= 80:20 [by HPLC in comparison with the racemate; Daicel CHIRALPAK AD-H, hexanes:EtOH 80:20, 0.4 ml/min, 237.5 nm, t_R (major)= 38.6 min, t_R (minor)= 56.8 min]; ^{1}H NMR (600 MHz, Acetone) δ(ppm)= 7.58 (t, *J* = 2.2 Hz, 1H, H_{13}), 7.53 (dd, *J* = 8.1, 2.2 Hz, 1H, H_{14}), 7.42 (t, *J* = 8.1 Hz, 1H, H_{15}), 7.20 (dd, *J* = 8.2, 2.2 Hz, 1H, H_{16}), 6.03 (d, *J* = 7.4 Hz, 1H, N*H*), 4.75 (ddd, *J* = 10.8, 8.2, 7.4 Hz, 1H, H_3), 3.82 (td, *J* = 11.3, 2.5 Hz, 1H, H_{9a}), 3.79 (ddt, *J* = 11.3, 5.5, 1.5 Hz, 1H, H_{9b}), 2.59 (dd, *J* = 12.8, 8.2 Hz, 1H, H_{4a}), 2.33 (dd, *J* = 12.8, 10.8 Hz, 1H, H_{4b}), 2.02 – 1.93 (m, 1H, H_{8a}), 1.85 (td, *J* = 13.1, 3.9 Hz, 1H, H_{7a}), 1.54 – 1.44 (m, 2H, H_{7b} y H_{8b}), 1.12 (s, 3H, H_{11}), 1.01 (s, 3H, H_{12}).; ^{13}C NMR (101 MHz,) δ(ppm)= 174.5, 149.4, 148.7, 129.9, 119.3, 111.7, 109.2, 106.7, 62.4, 52.2, 36.0, 34.8, 33.1, 24.7, 21.2, 21.1.; HRMS (ESI): calcd for $C_{25}H_{21}BrN_2O_5$ [M^+] 320.1367 found 320.1370.

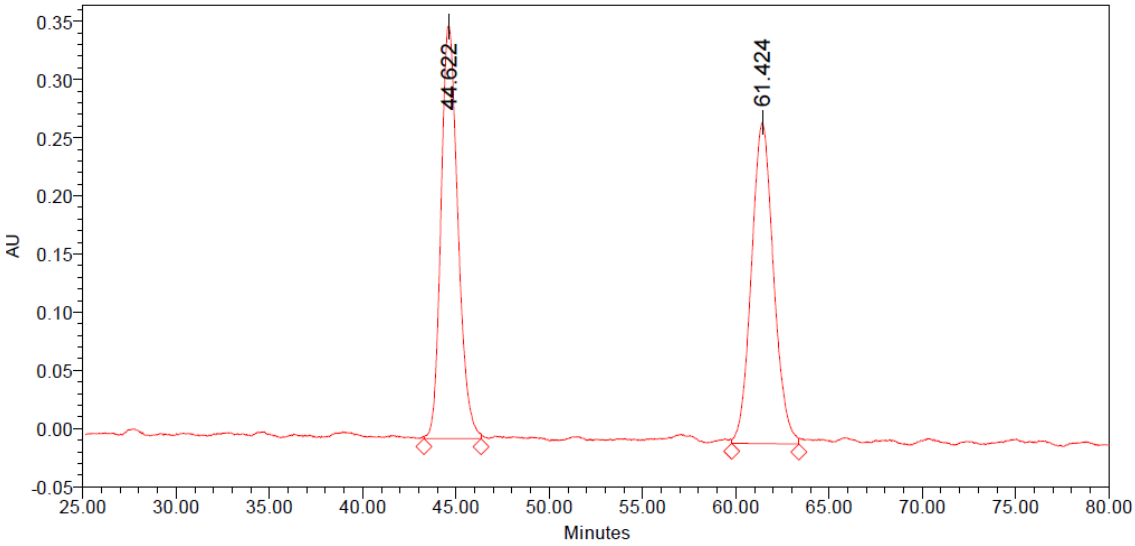
^{1}H, ^{13}C and ^{19}F spectra, HPLC data and X-ray:

(3*S*,5*R*)-3-(3-Nitrophenylamino)-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (4a)





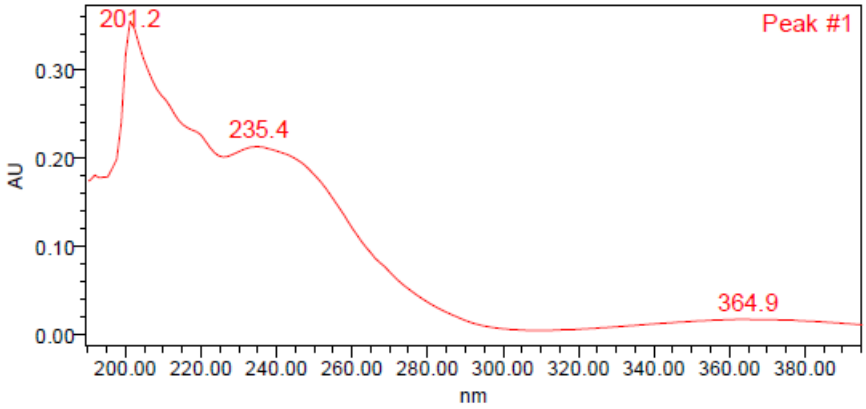
***rac*–4a**



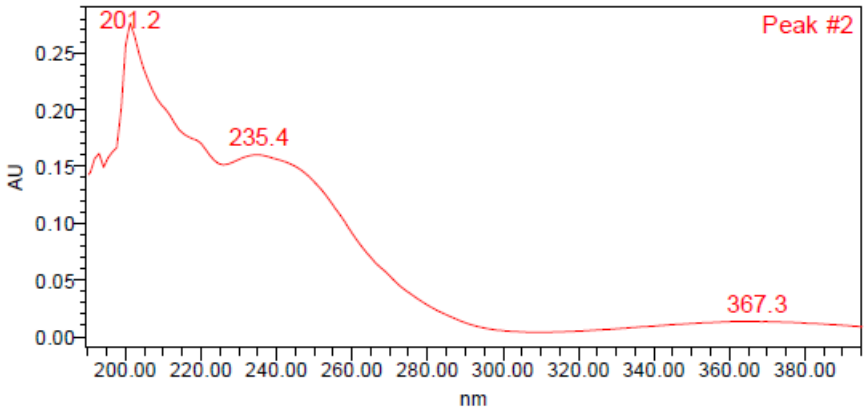
Peak Results

	RT	Area	% Area	Height
1	44.622	22346955	49.52	354708
2	61.424	22780029	50.48	276053

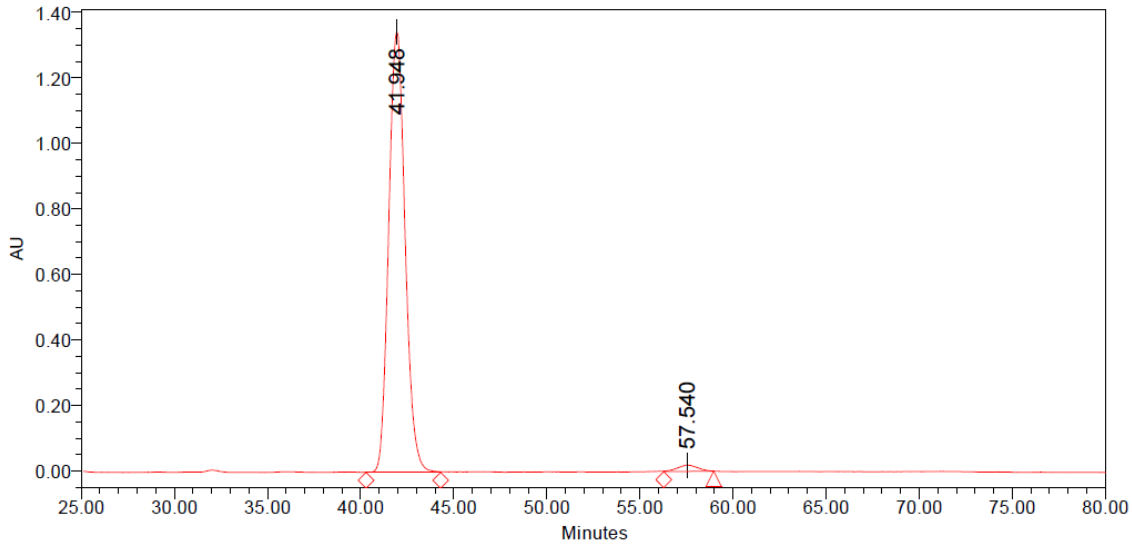
Match Plot



Match Plot



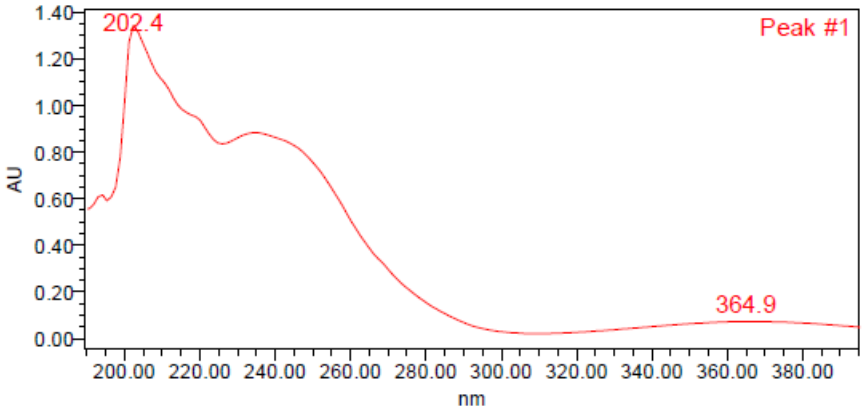
4a



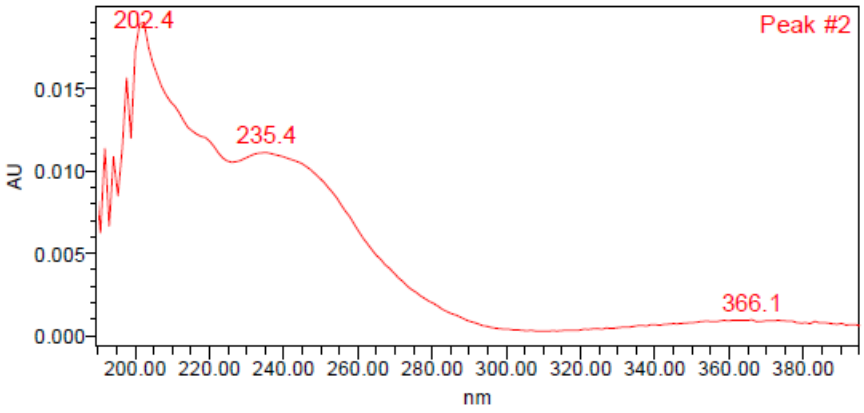
Peak Results

	RT	Area	% Area	Height
1	41.948	82263600	98.26	1344792
2	57.540	1455936	1.74	18994

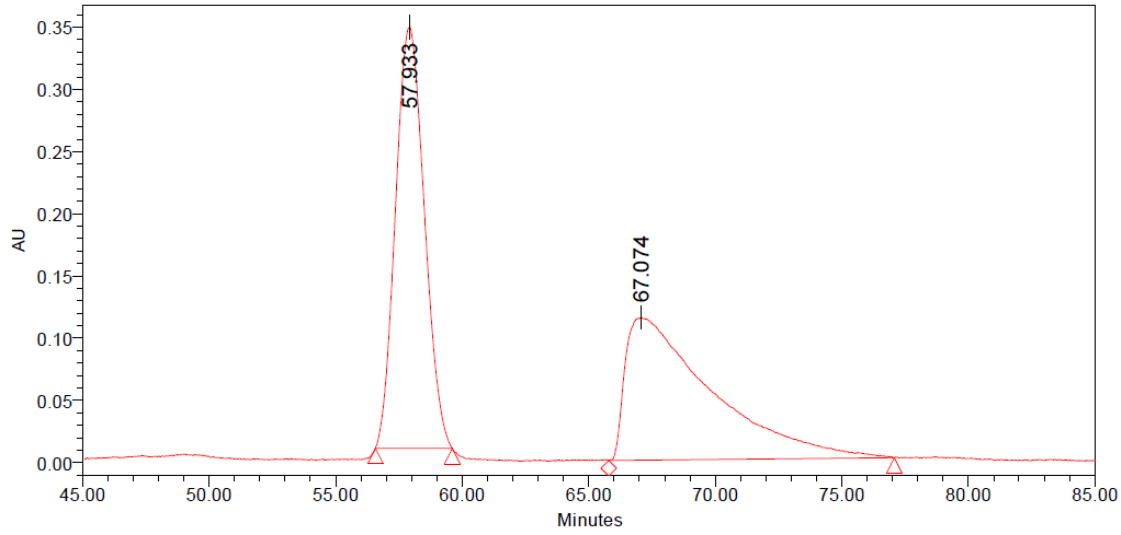
Match Plot



Match Plot



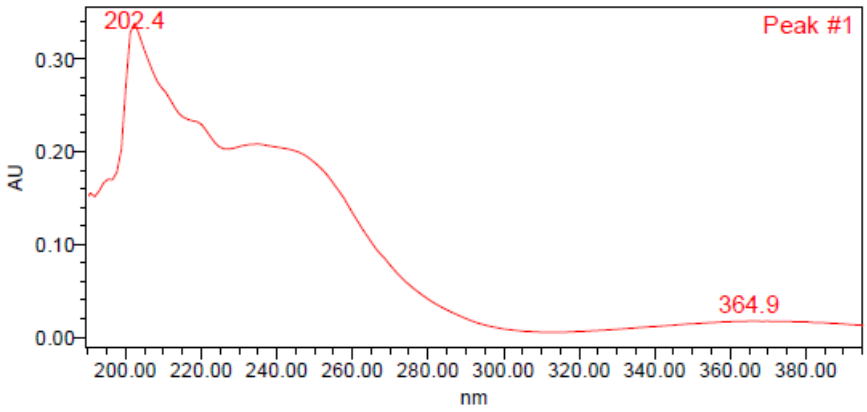
***rac-diast*-4a**



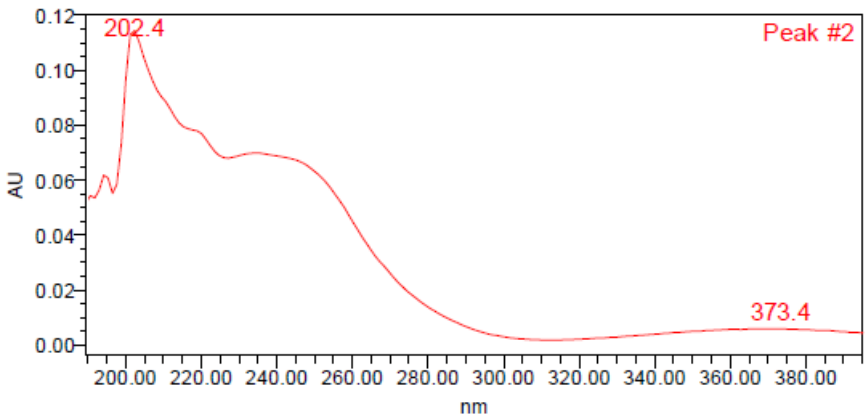
Peak Results

	RT	Area	% Area	Height
1	57.933	26822546	49.74	338931
2	67.074	27104852	50.26	114429

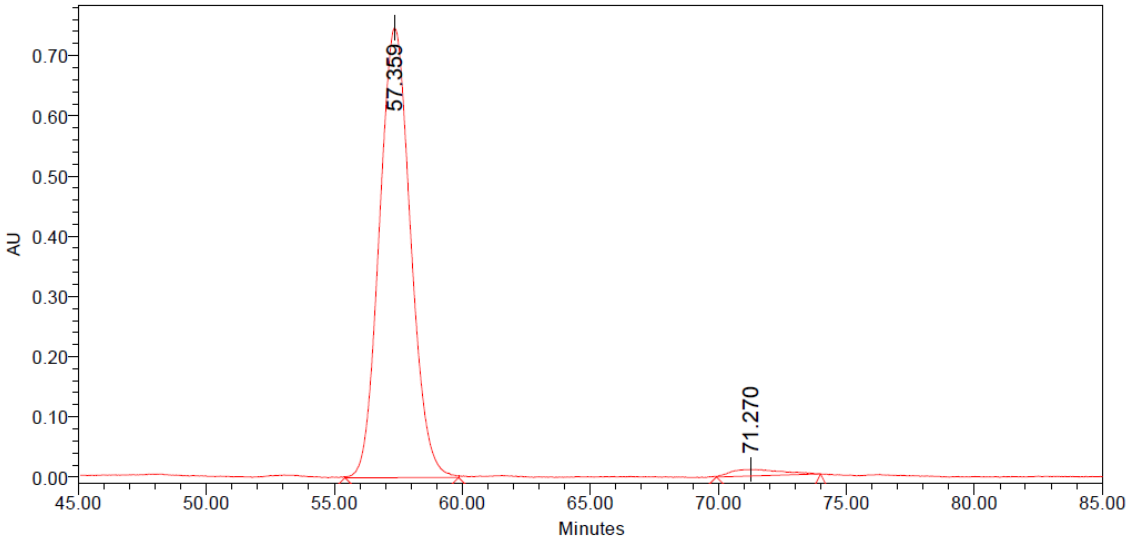
Match Plot



Match Plot



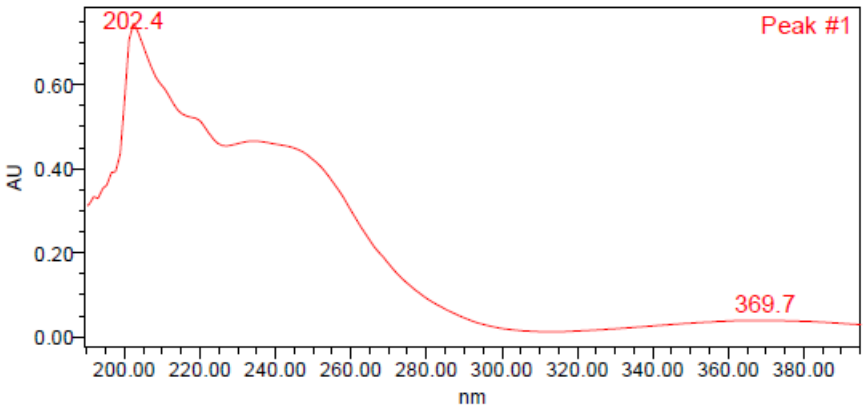
***diast*-4a**



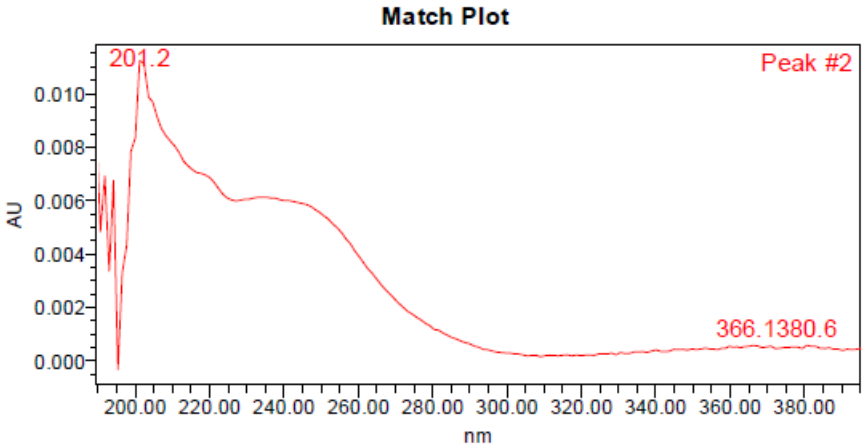
Peak Results

	RT	Area	% Area	Height
1	57.359	63269252	97.68	747074
2	71.270	1501658	2.32	11125

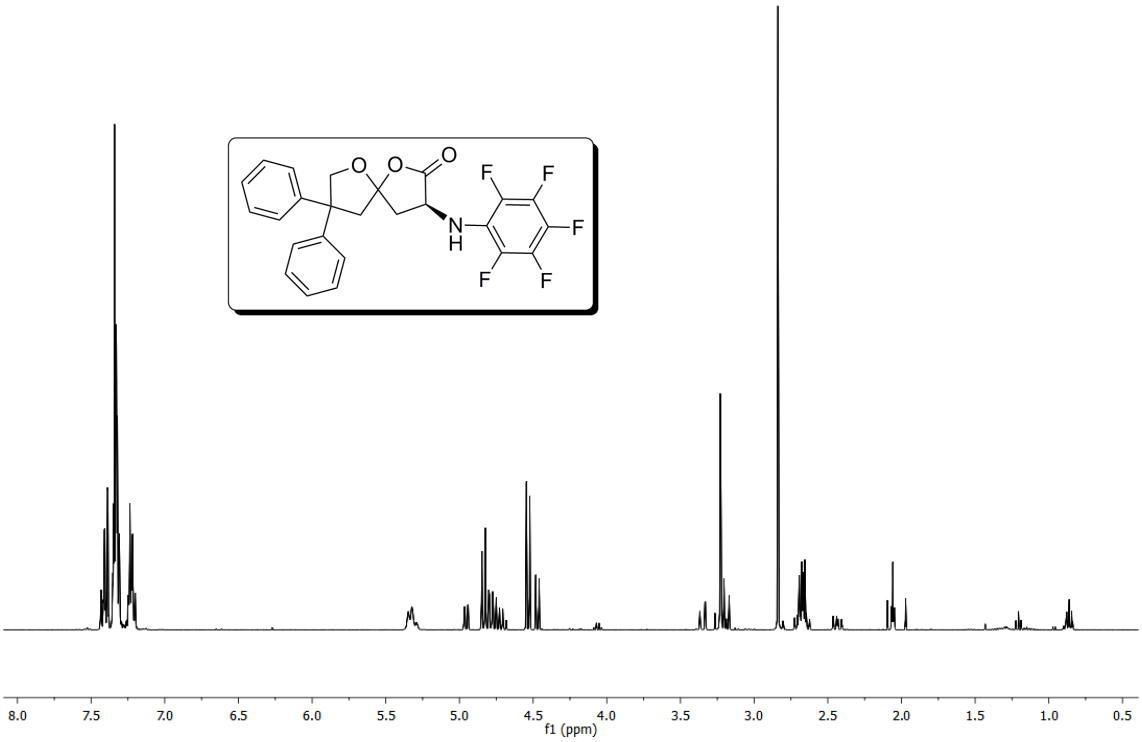
Match Plot

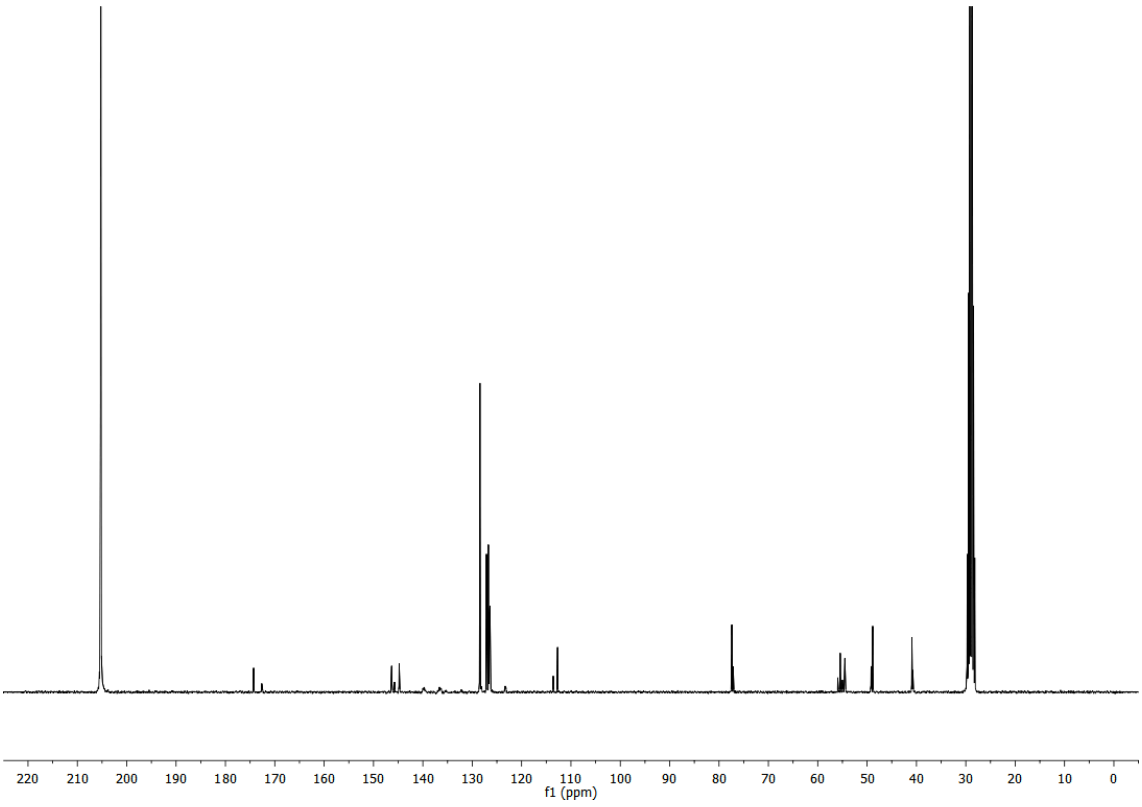


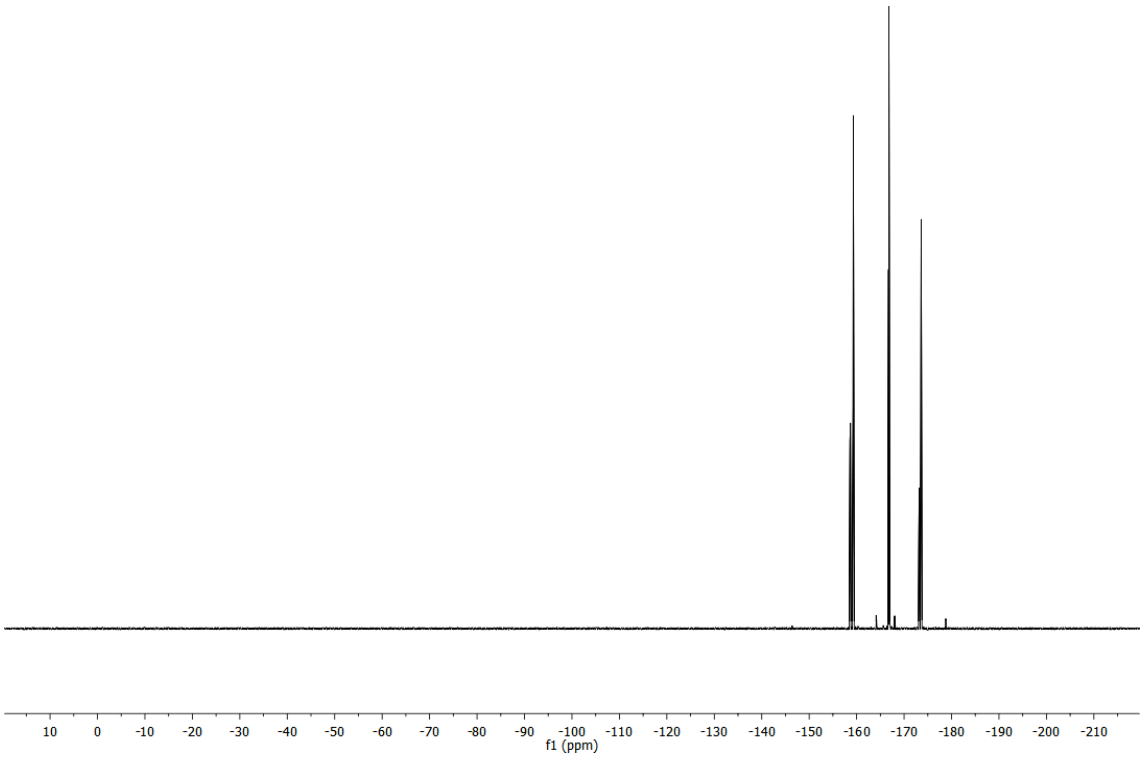
Match Plot



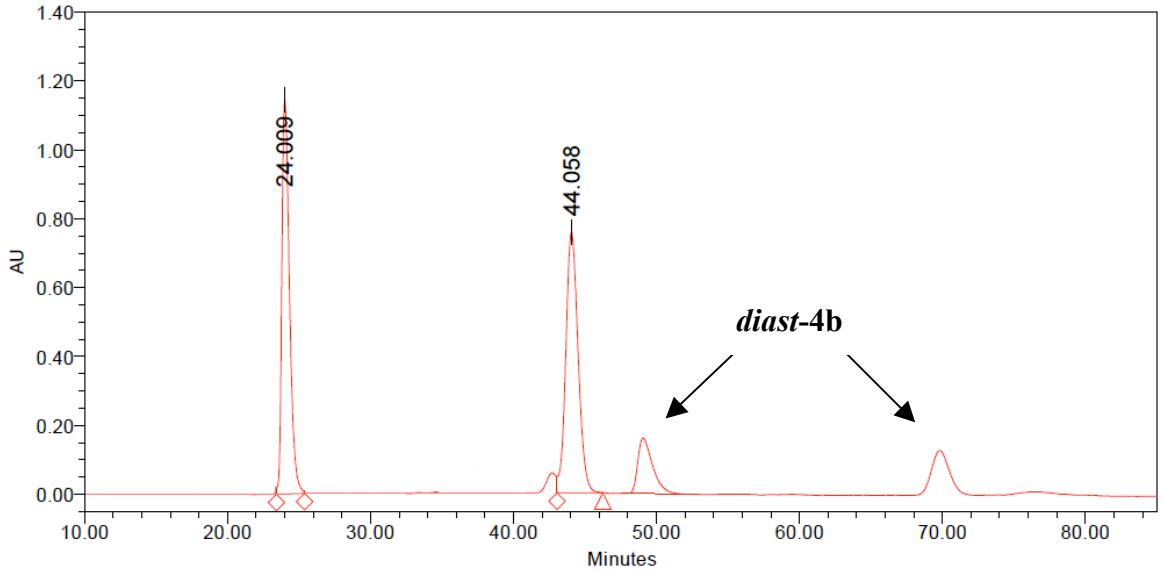
(3*S*,5*R*)-3-(Perfluorophenylamino)-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (4b) and (3*S*,5*S*)-3-(perfluorophenylamino)-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (*diast*-4b)






10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

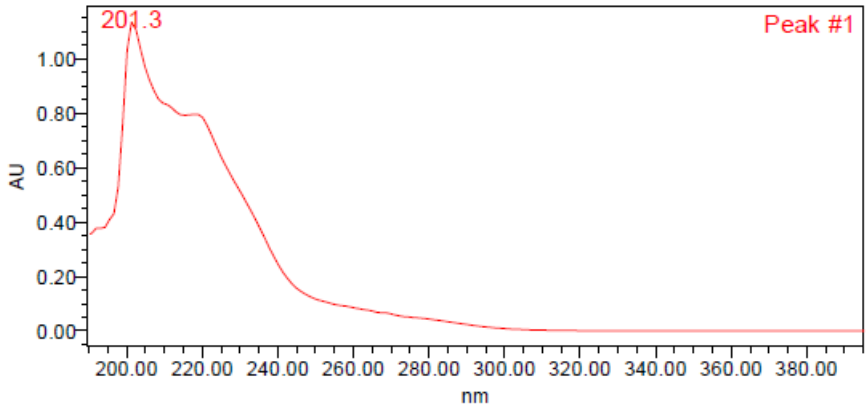
***rac*–4b**



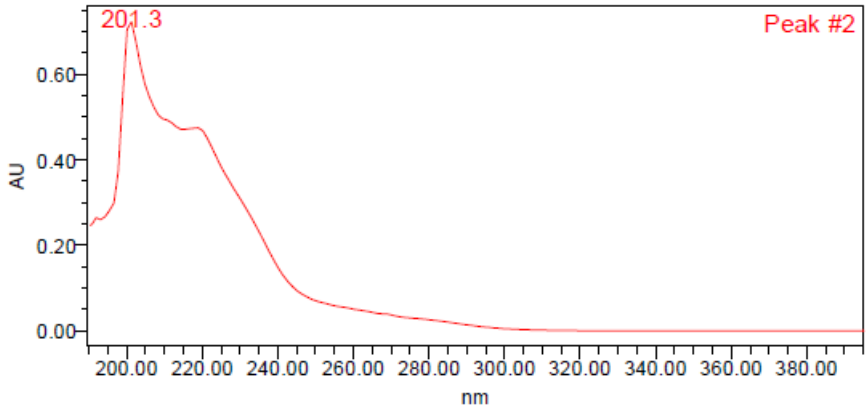
Peak Results

	RT	Area	% Area	Height
1	24.009	40976055	50.14	1134006
2	44.058	40750220	49.86	722669

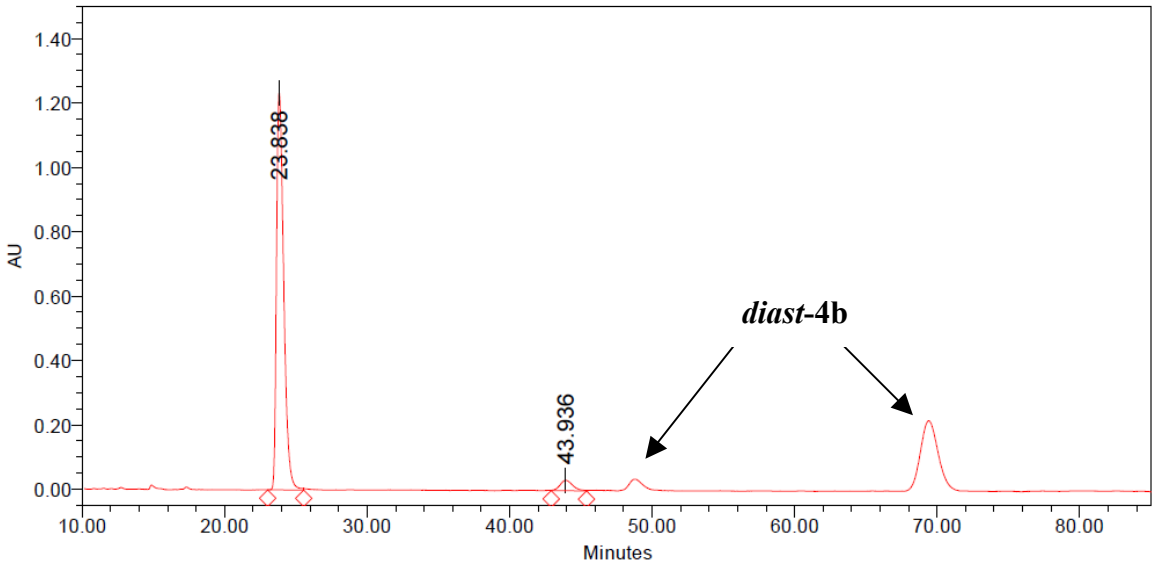
Match Plot



Match Plot



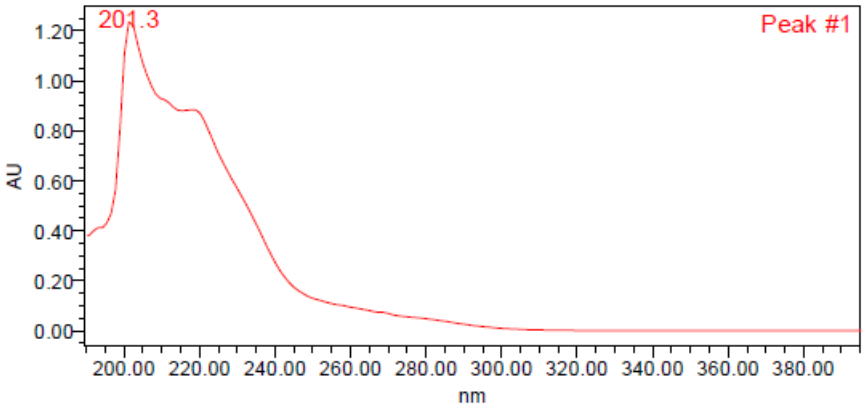
4b



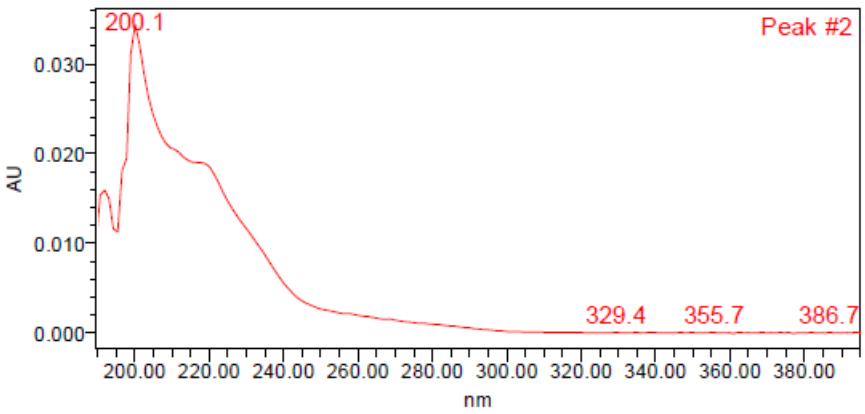
Peak Results

	RT	Area	% Area	Height
1	23.838	43462106	95.63	1235086
2	43.936	1988202	4.37	32256

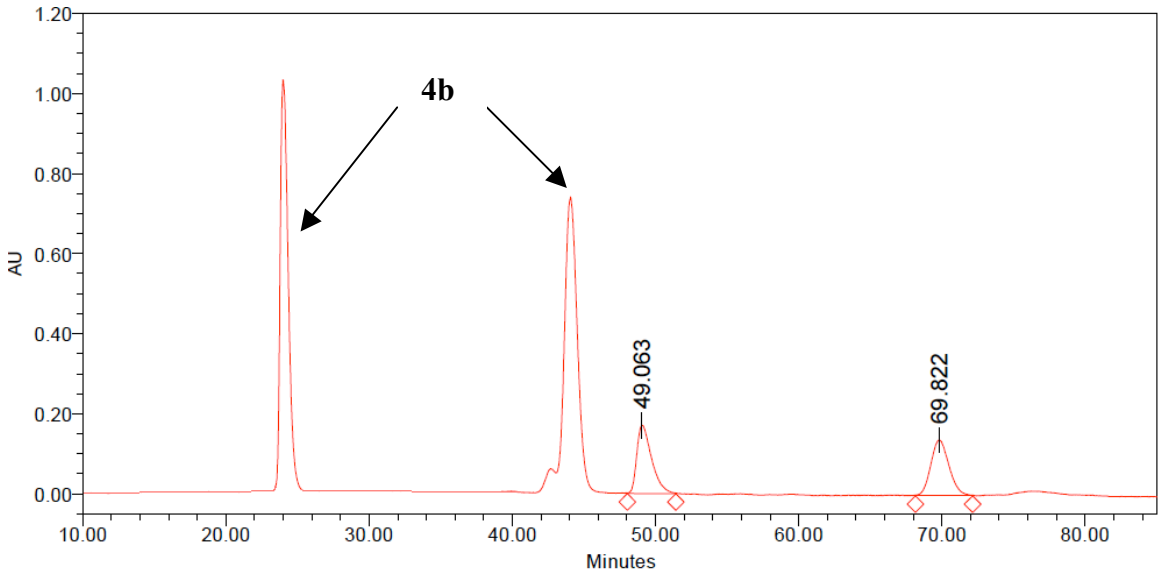
Match Plot



Match Plot



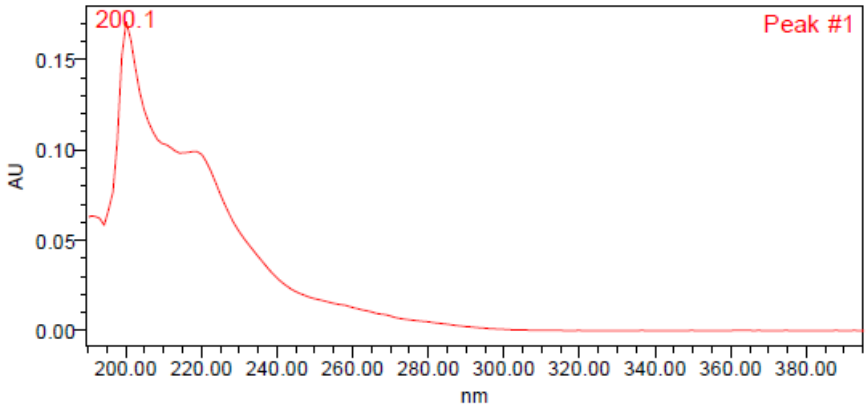
***rac-diast*-4b**



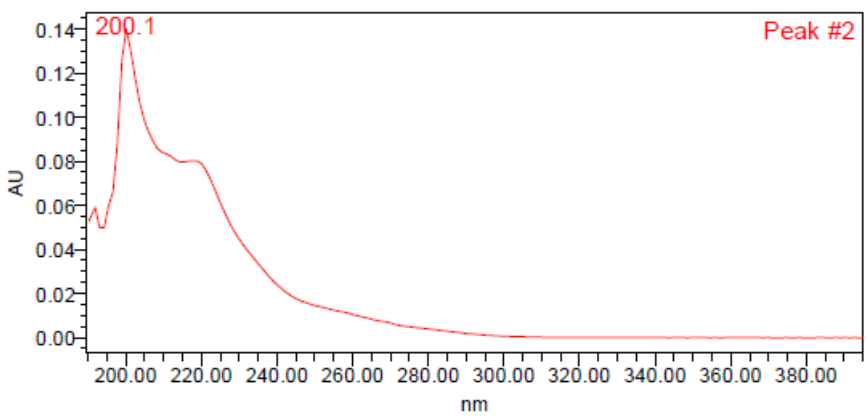
Peak Results

	RT	Area	% Area	Height
1	49.063	12276899	49.85	170409
2	69.822	12350243	50.15	139663

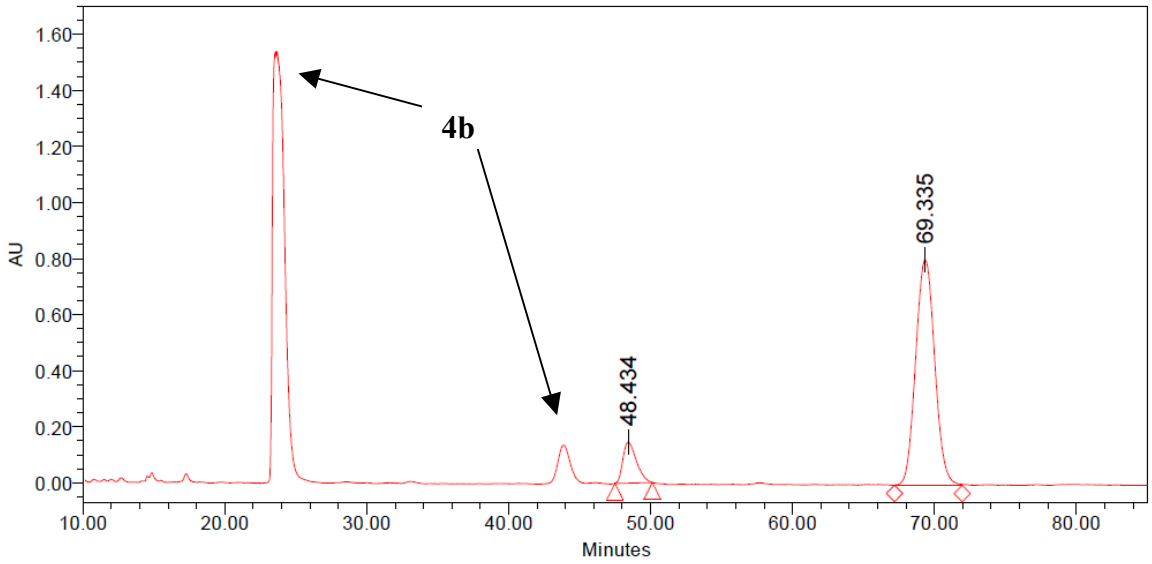
Match Plot



Match Plot



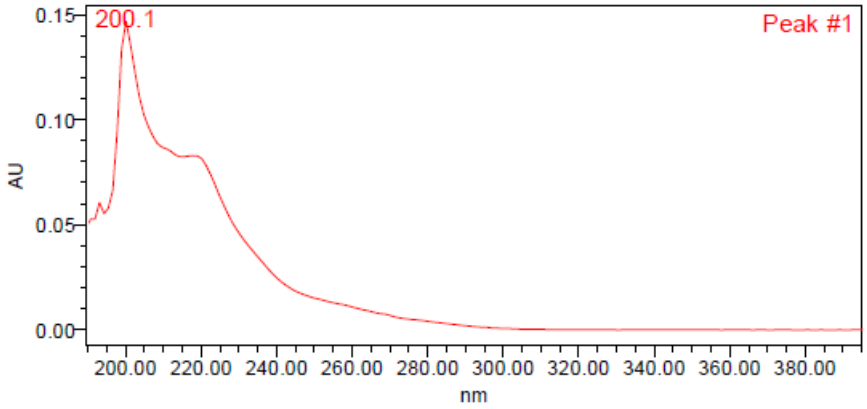
***diast*-4b**



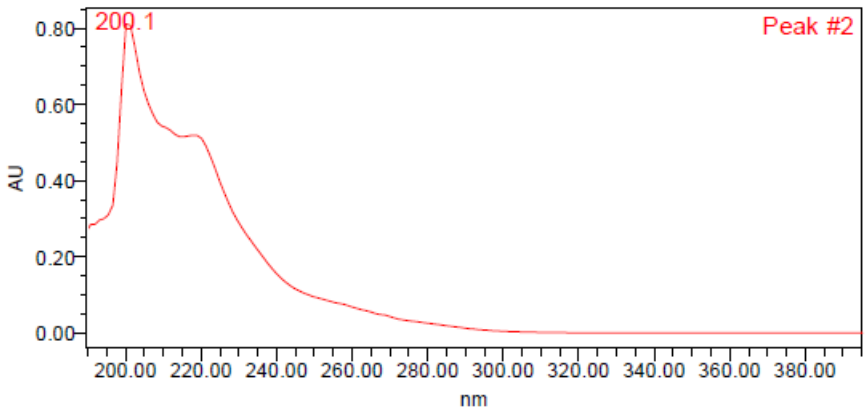
Peak Results

	RT	Area	% Area	Height
1	48.434	9695653	11.44	146481
2	69.335	75079934	88.56	805240

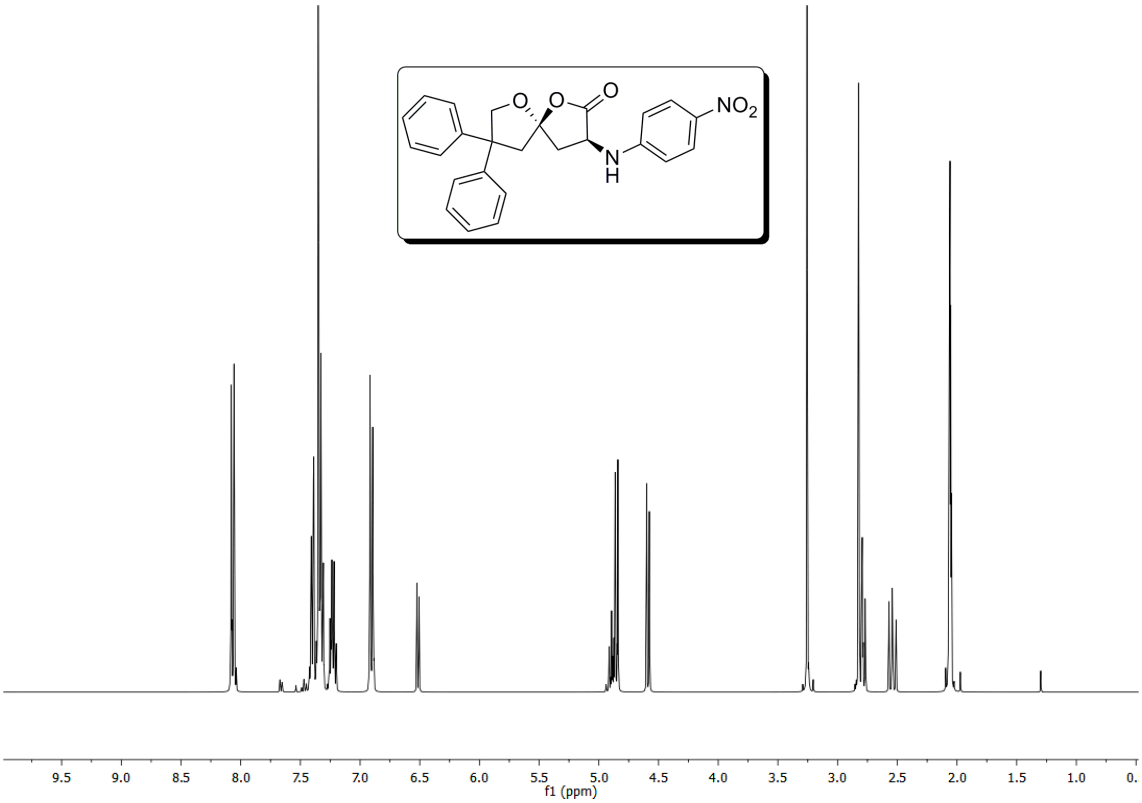
Match Plot

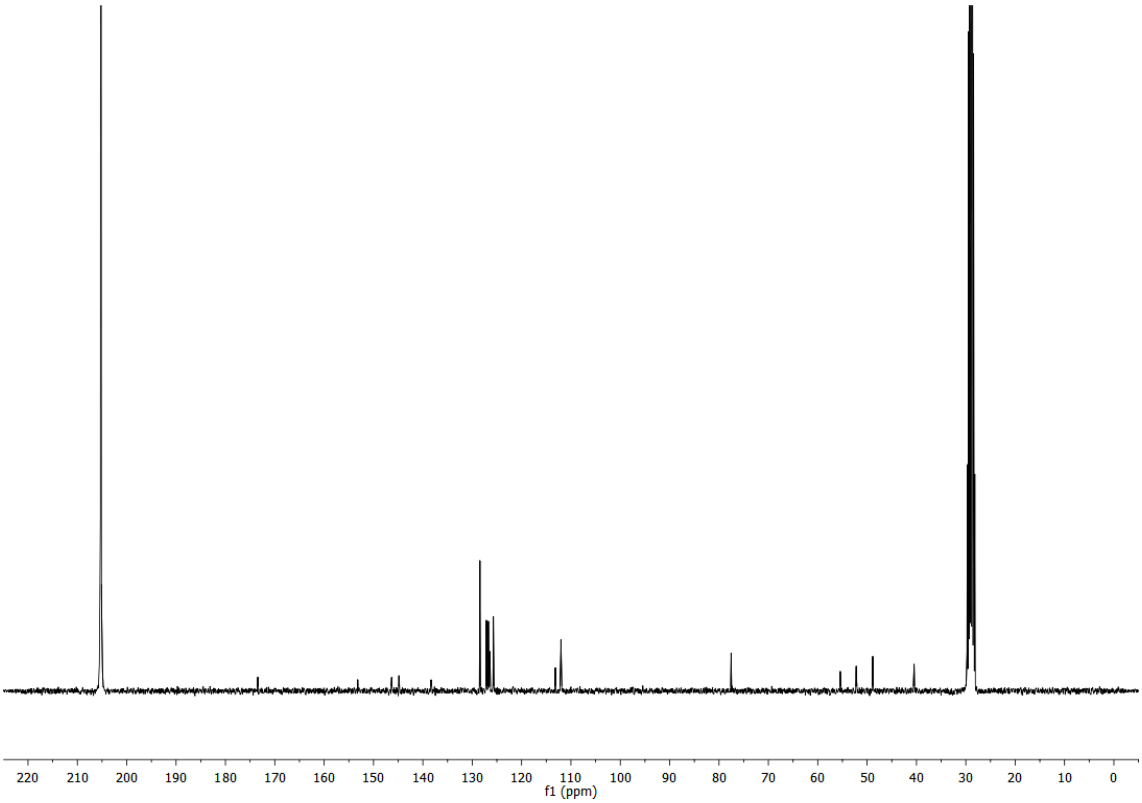


Match Plot

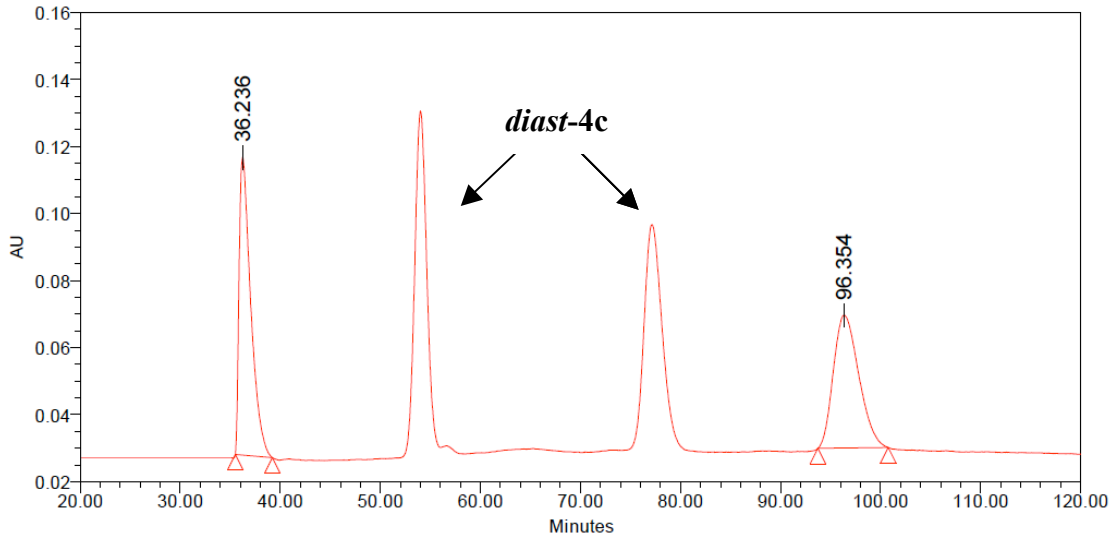


(3*S*,5*R*)-3-(4-Nitrophenylamino)-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (4c)





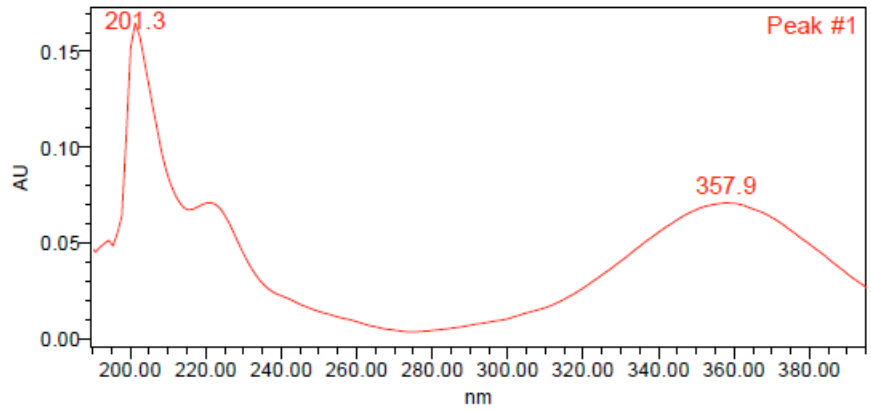
***rac*-4c**



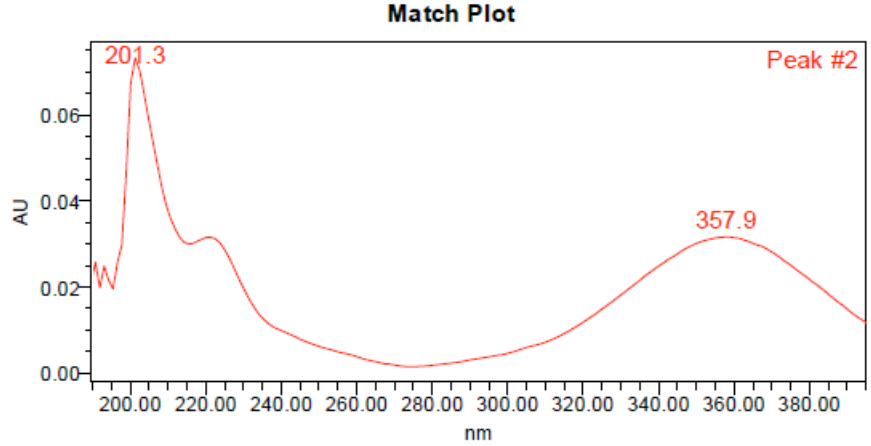
Peak Results

	RT	Area	% Area	Height
1	36.236	7191647	50.68	88828
2	96.354	6997495	49.32	39601

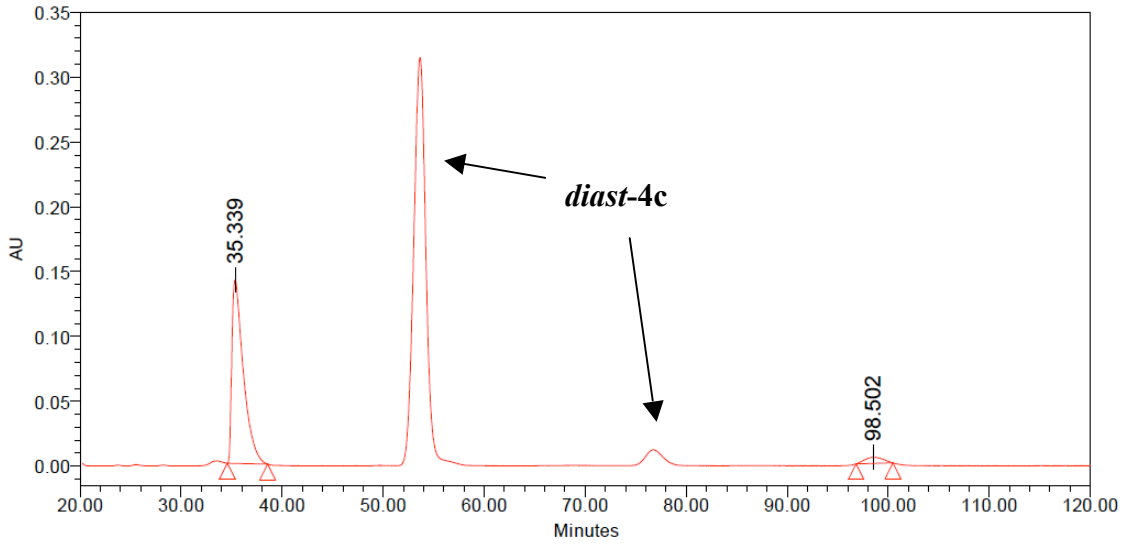
Match Plot



Match Plot



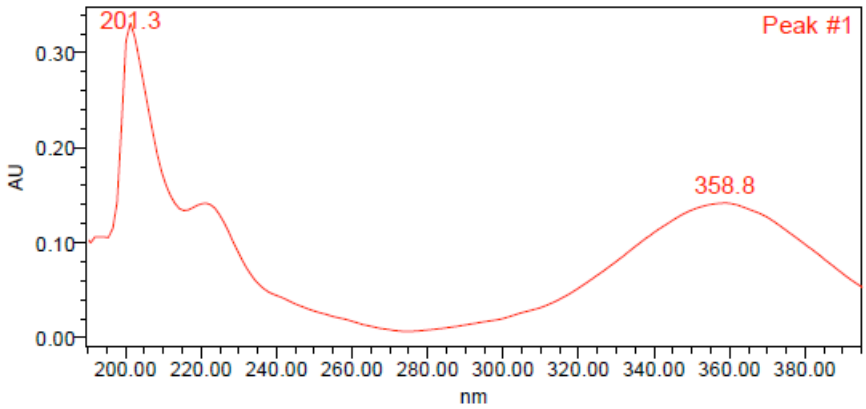
4c



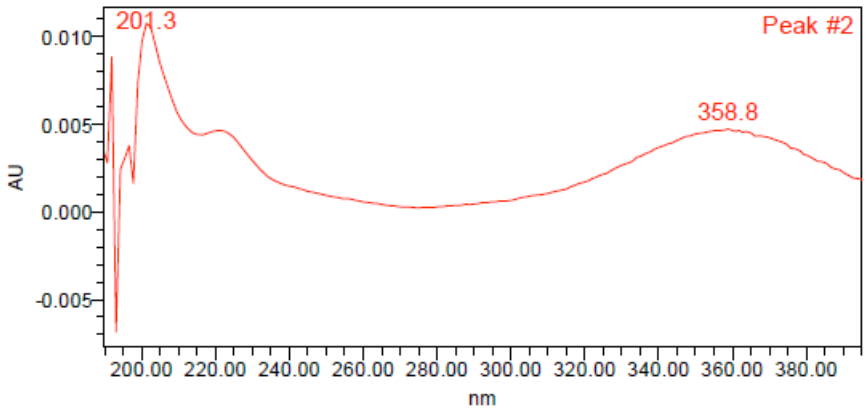
Peak Results

	RT	Area	% Area	Height
1	35.339	11204848	94.93	141718
2	98.502	598483	5.07	4730

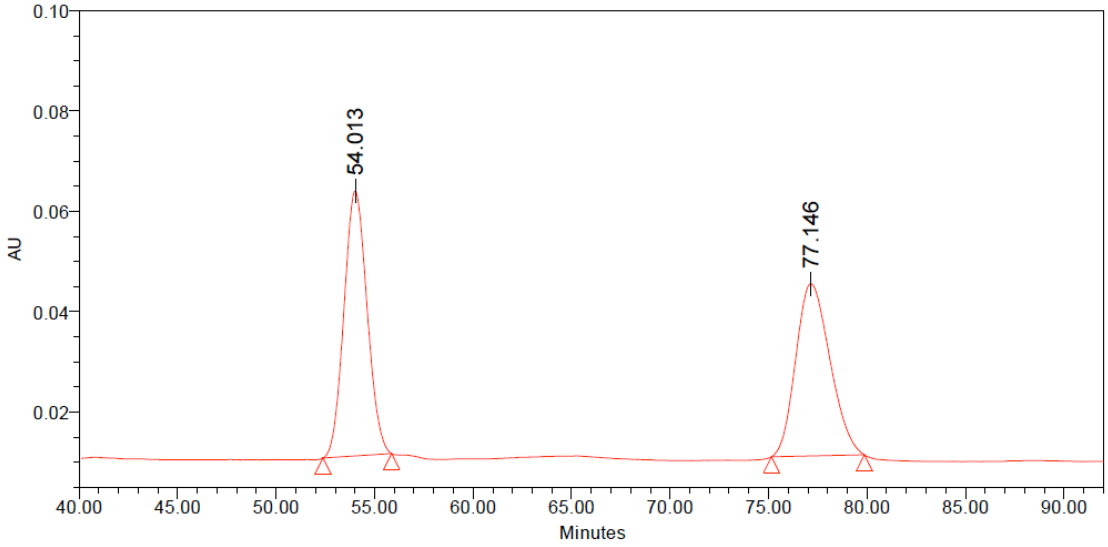
Match Plot



Match Plot



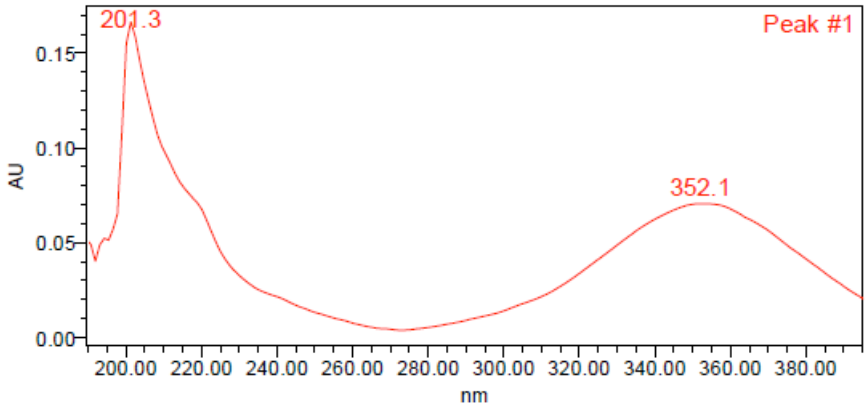
***rac-diast*-4c**



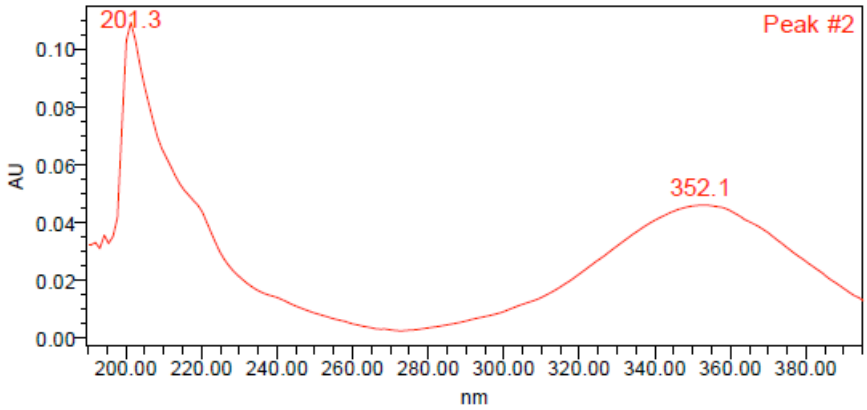
Peak Results

	RT	Area	% Area	Height
1	54.013	4310706	50.95	52791
2	77.146	4149601	49.05	34325

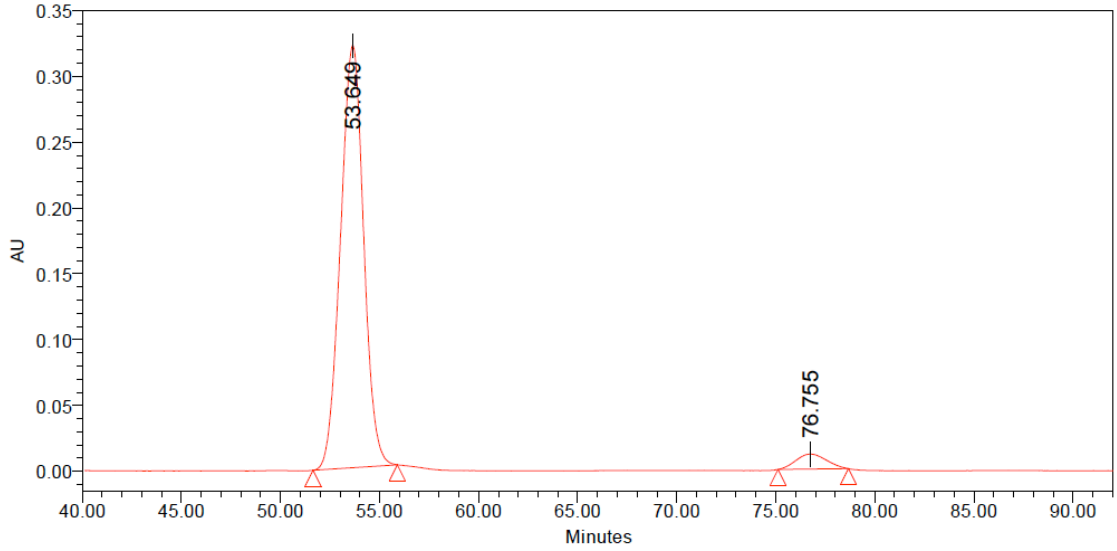
Match Plot



Match Plot



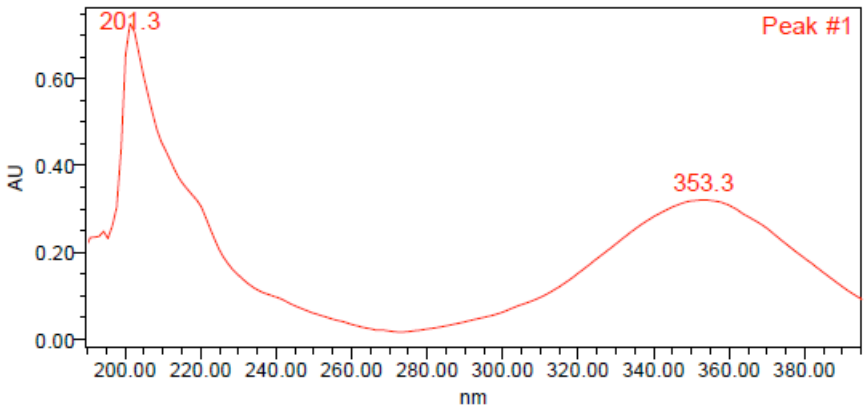
***diast*-4c**



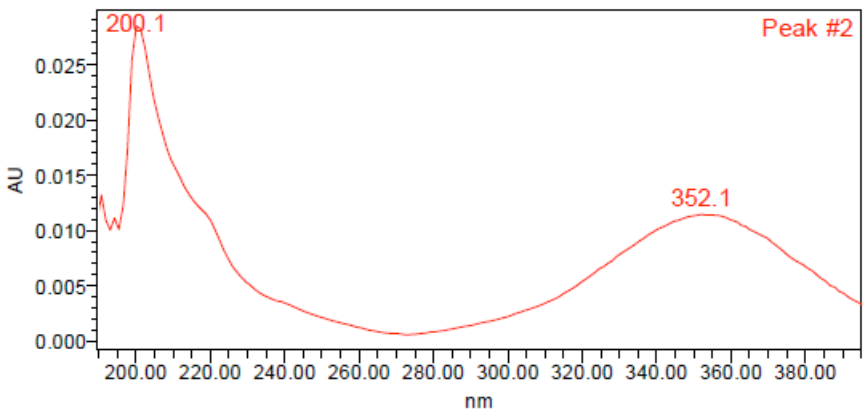
Peak Results

	RT	Area	% Area	Height
1	53.649	26015258	95.54	320717
2	76.755	1215272	4.46	11378

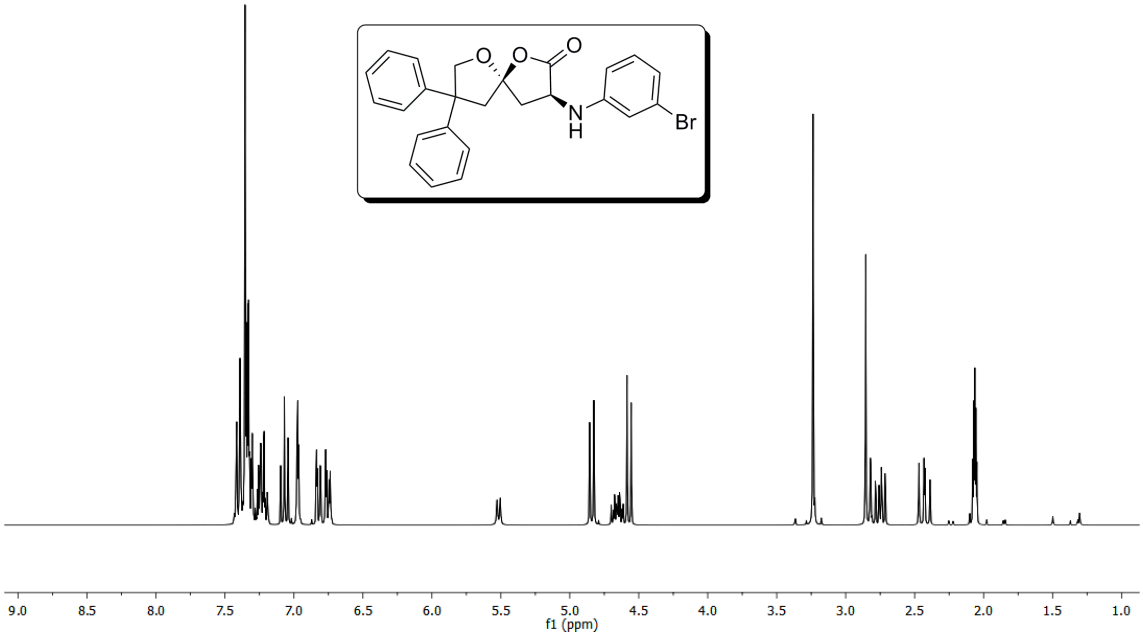
Match Plot

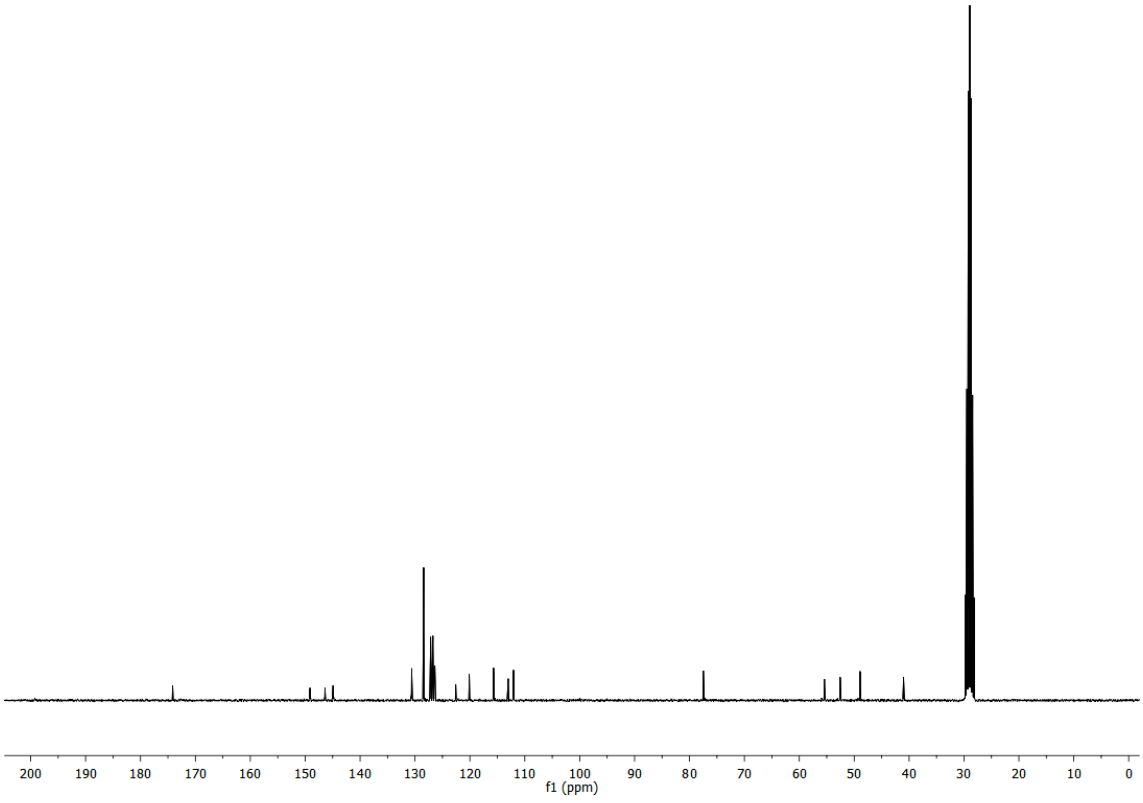


Match Plot

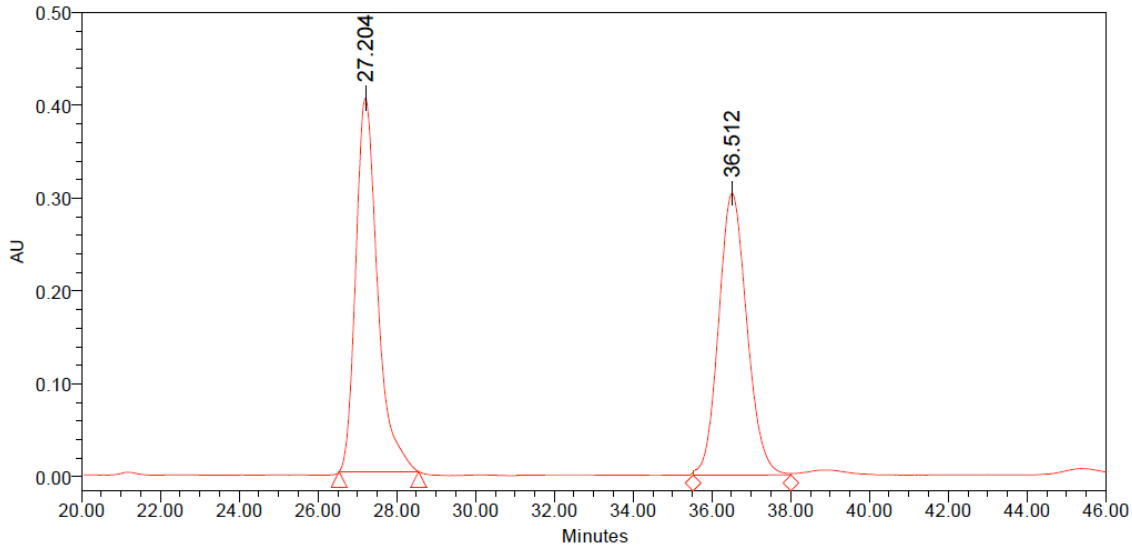


(3*S*,5*R*)-3-(3-Bromophenylamino)-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (4d)





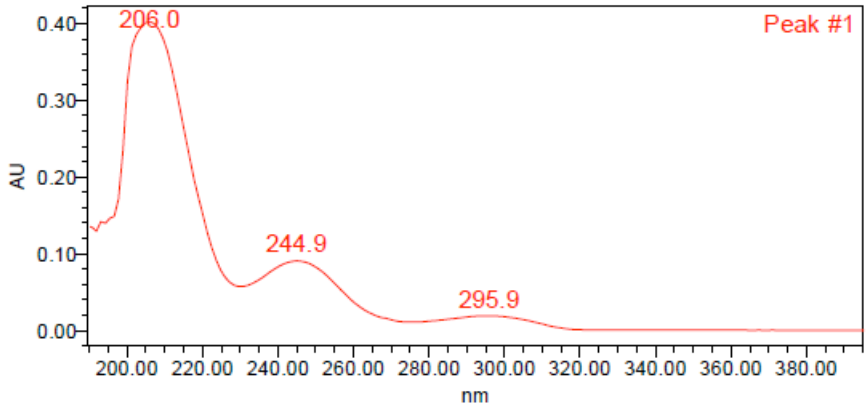
***rac*-4d**



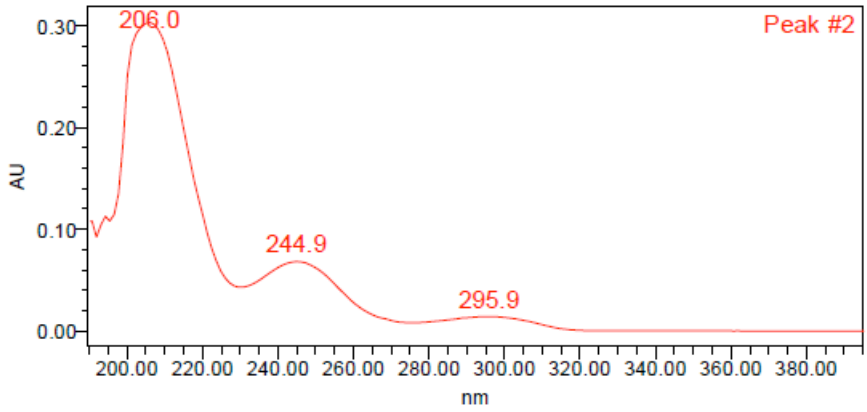
Peak Results

	RT	Area	% Area	Height
1	27.204	15456841	50.55	402604
2	36.512	15119353	49.45	303480

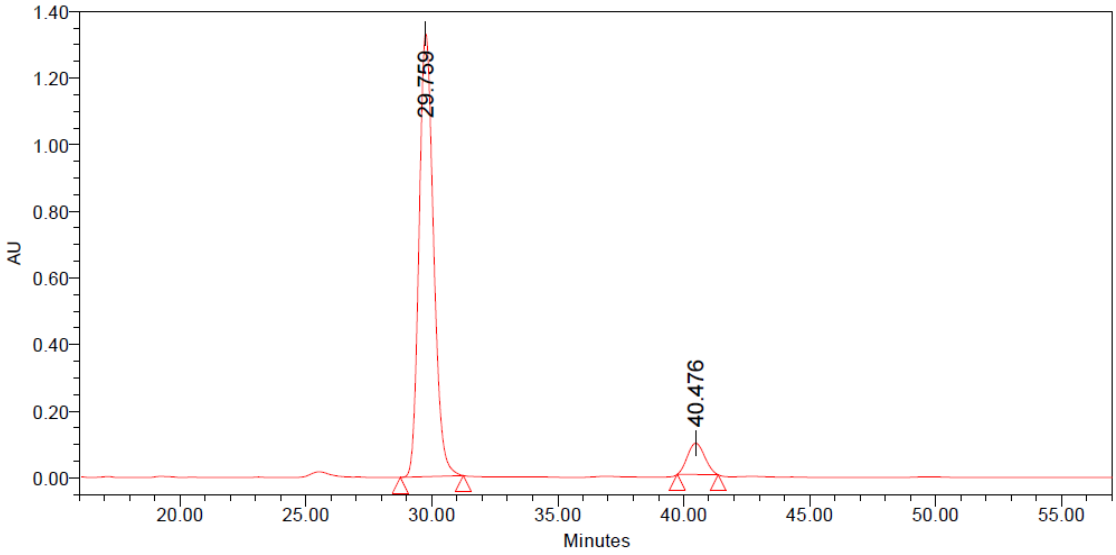
Match Plot



Match Plot



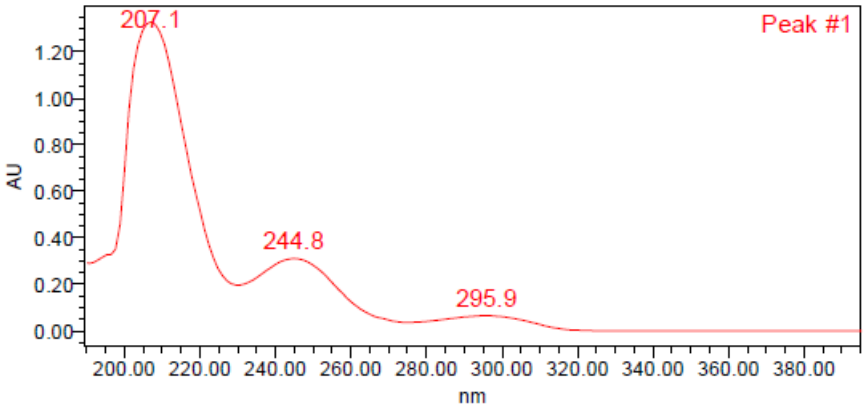
4d



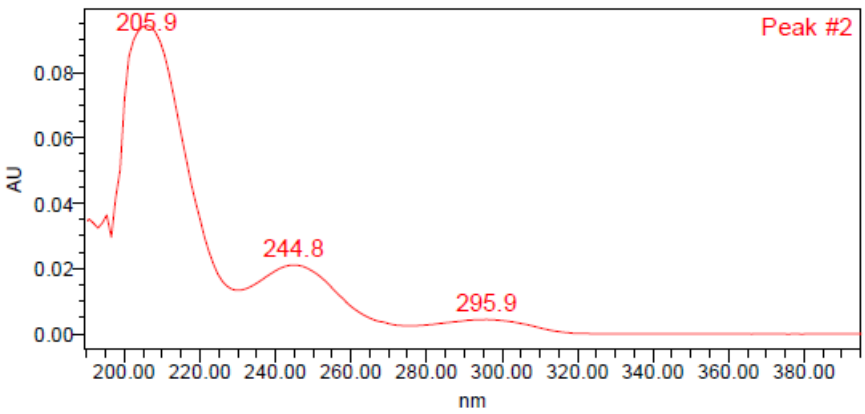
Peak Results

	RT	Area	% Area	Height
1	29.759	53130874	92.28	1329650
2	40.476	4447749	7.72	93979

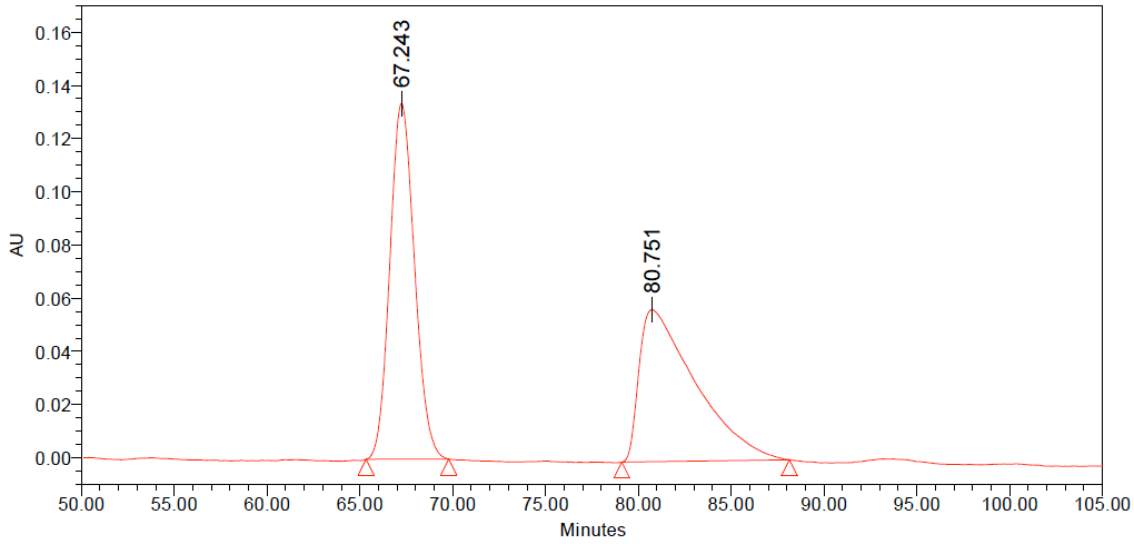
Match Plot



Match Plot



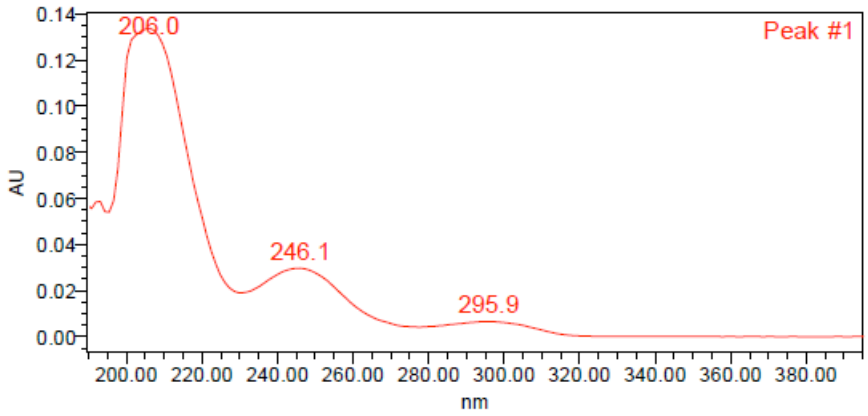
***rac-diast*-4d**



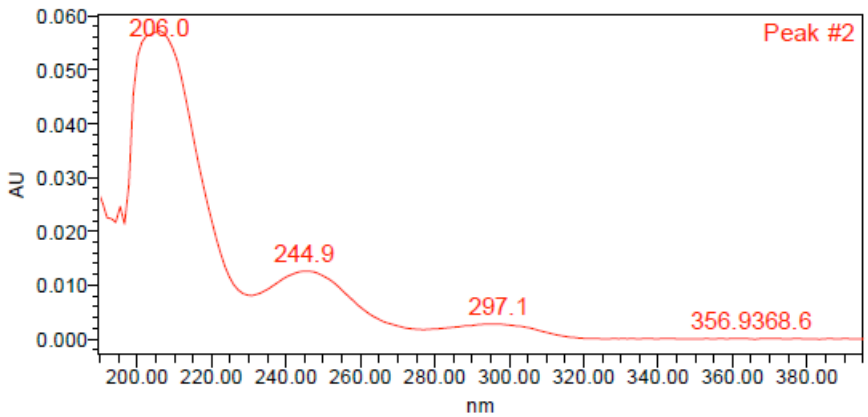
Peak Results

	RT	Area	% Area	Height
1	67.243	12371540	50.70	133763
2	80.751	12032057	49.30	57246

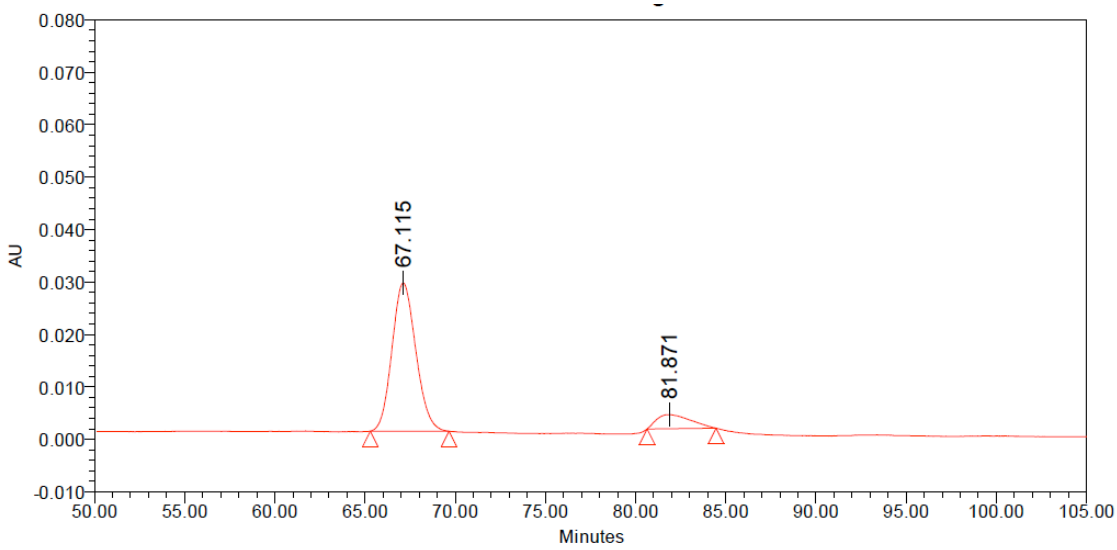
Match Plot



Match Plot



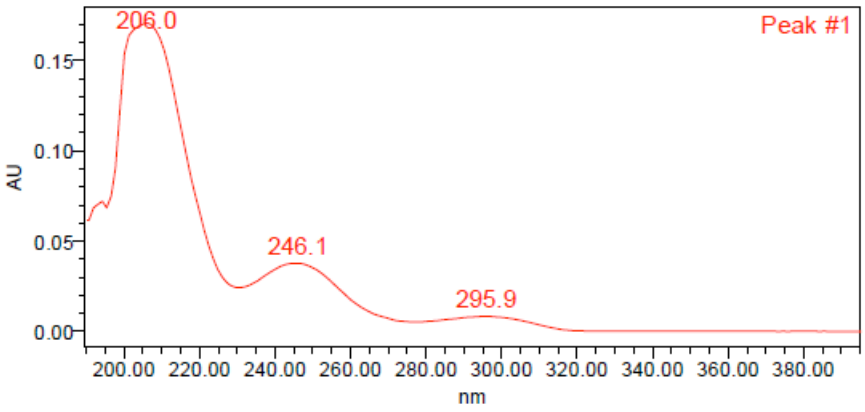
***diast*-4d**



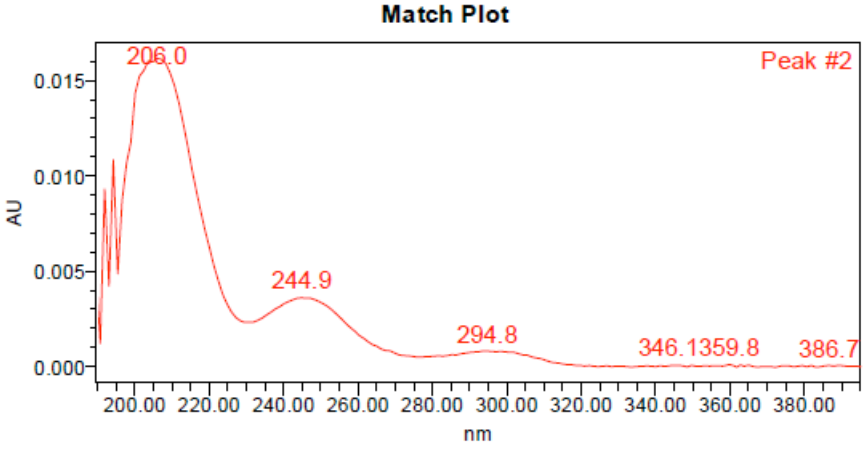
Peak Results

	RT	Area	% Area	Height
1	67.115	2594397	88.09	28244
2	81.871	350804	11.91	2703

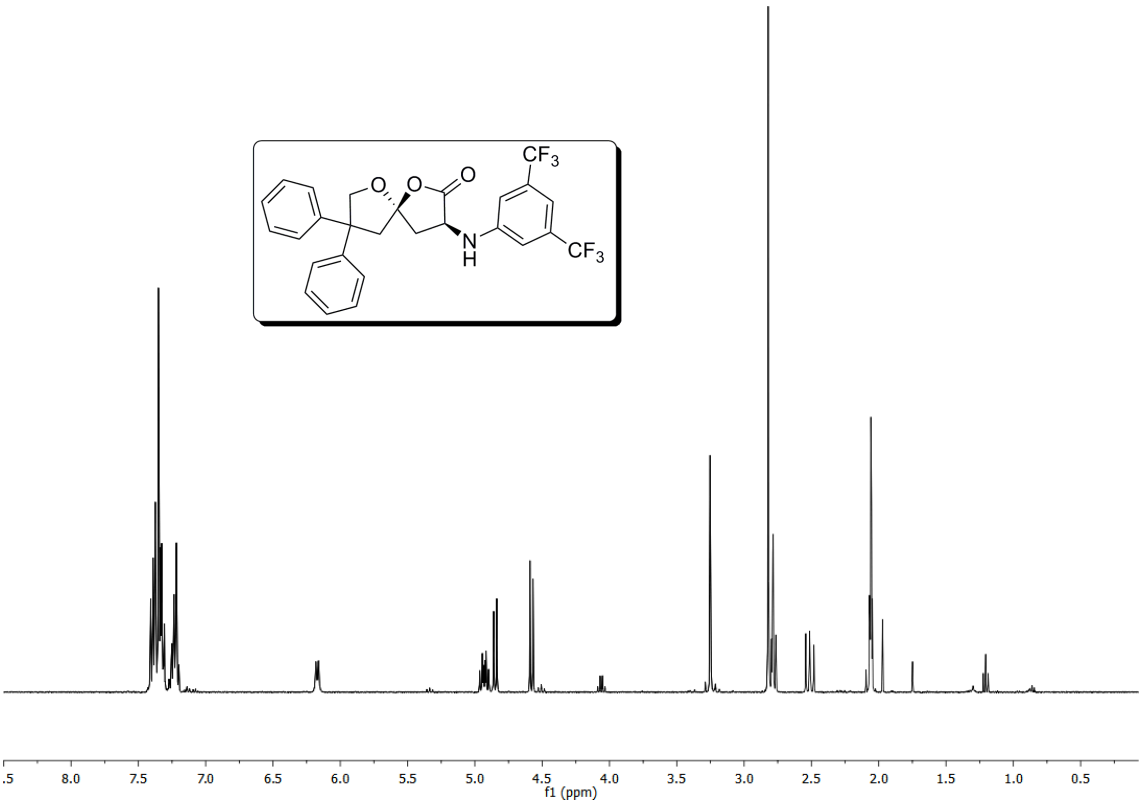
Match Plot

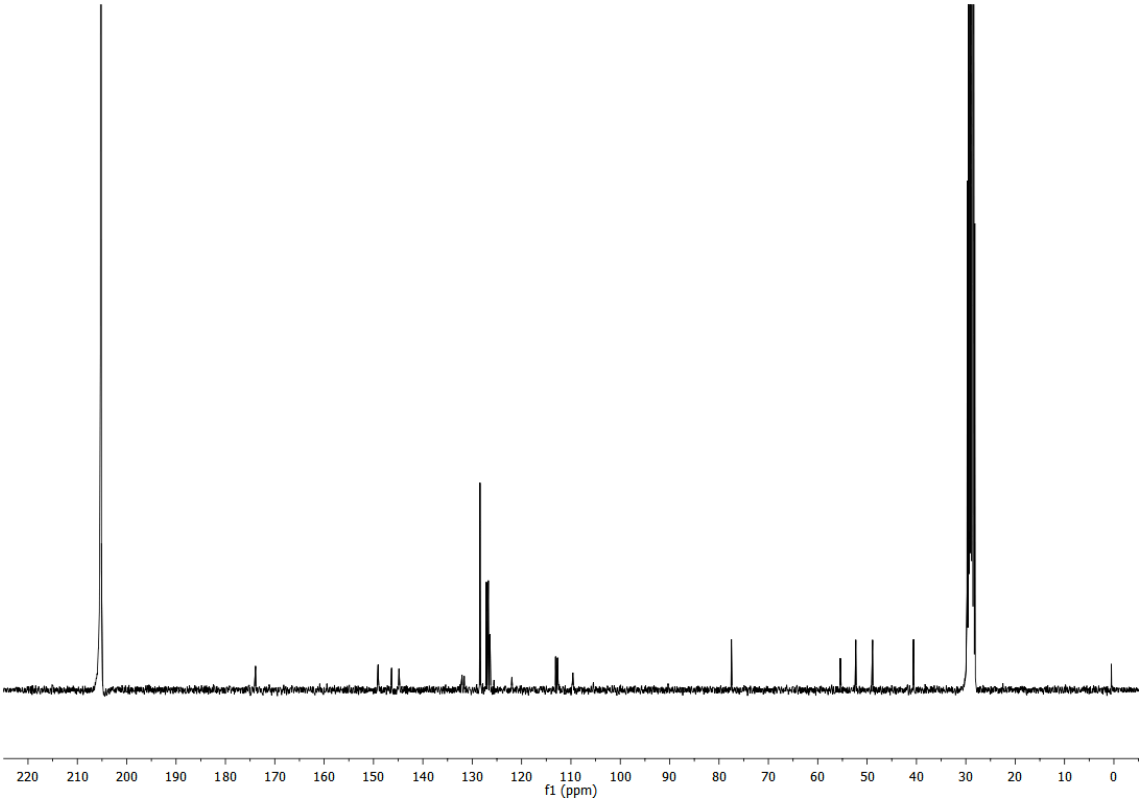


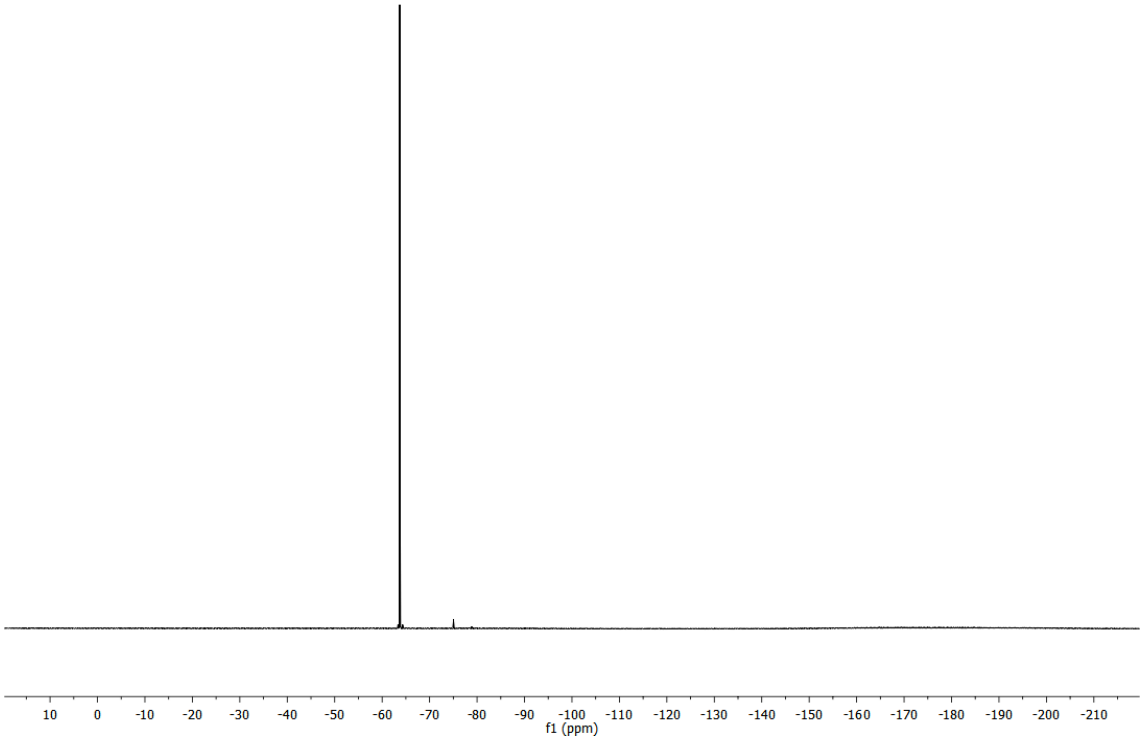
Match Plot



(3*S*,5*R*)-3-[3,5-Bis(trifluoromethyl)phenylamino]-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (4e)



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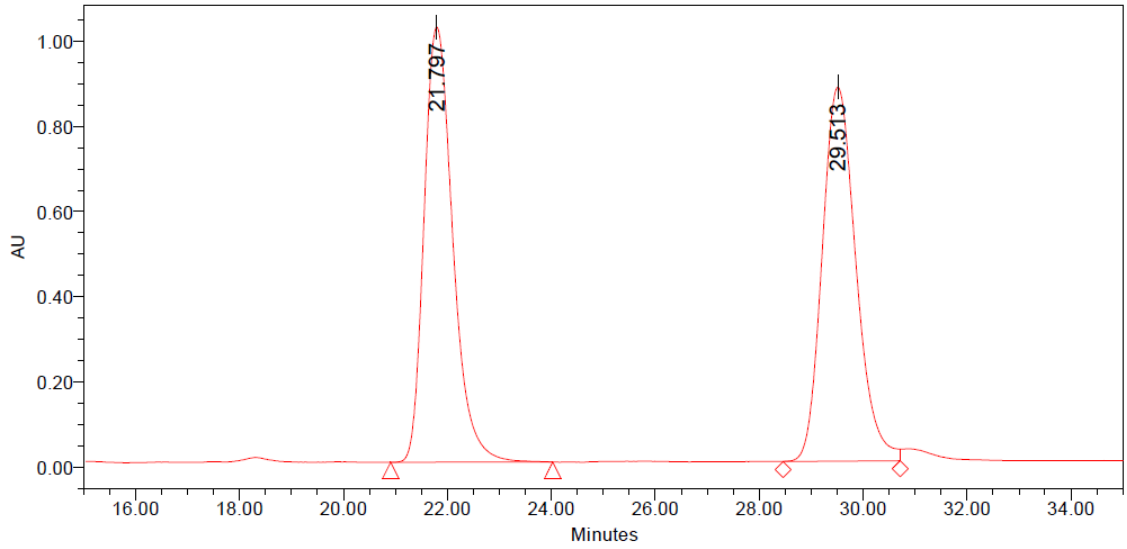
-210
f1 (ppm)

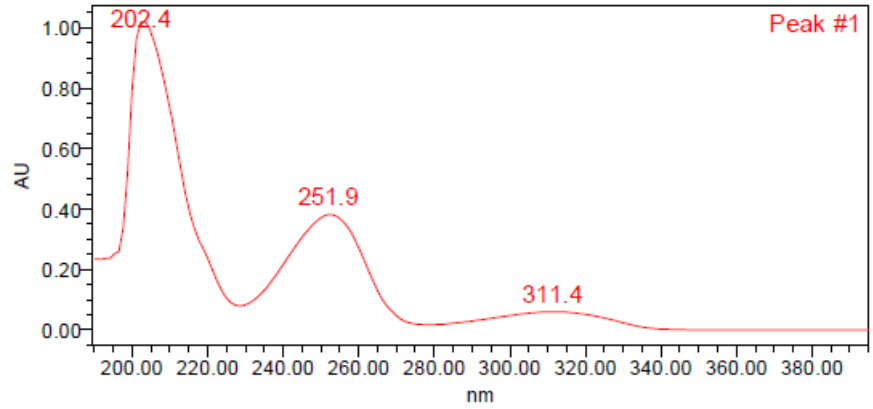
***rac*–4e**



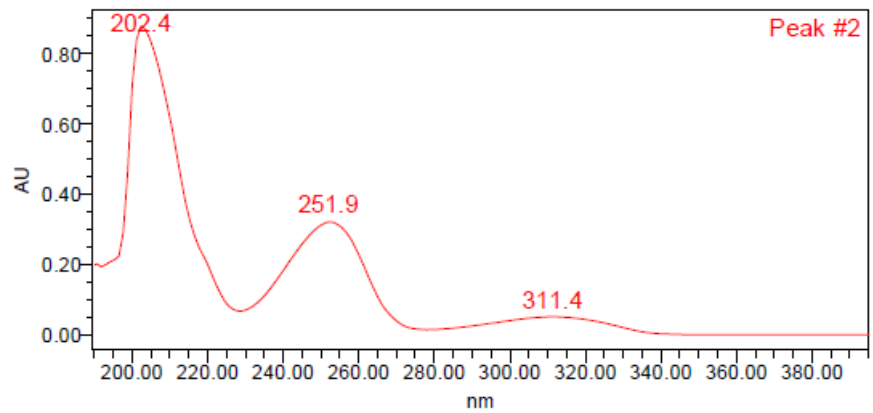
Peak Results

	RT	Area	% Area	Height
1	21.797	39221650	49.72	1021600
2	29.513	39660573	50.28	878071

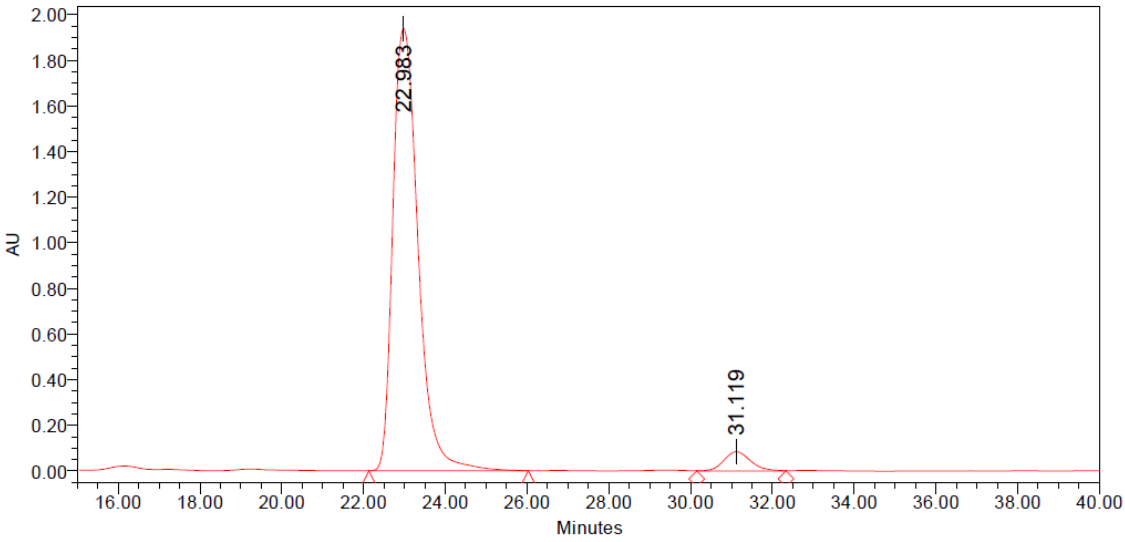
Match Plot



Match Plot



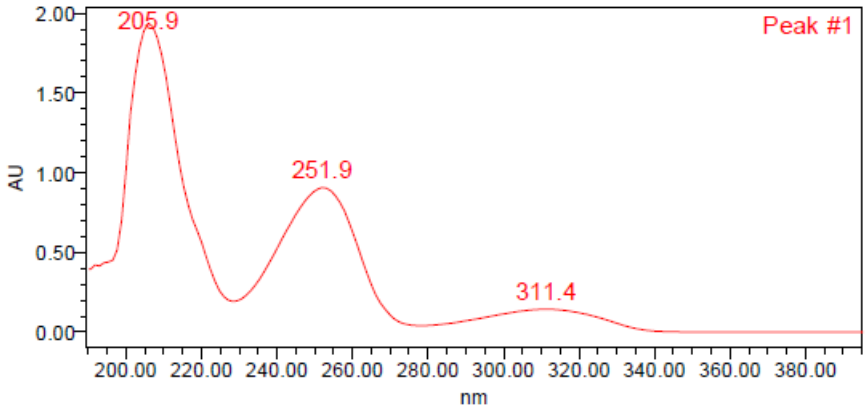
4e



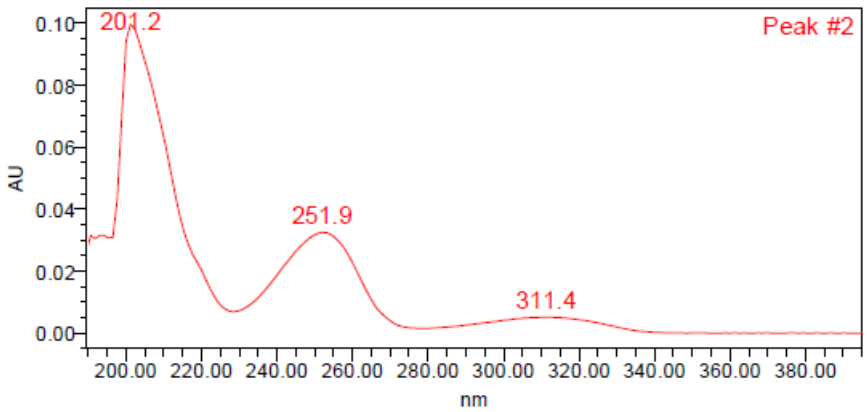
Peak Results

	RT	Area	% Area	Height
1	22.983	82975814	95.57	1937649
2	31.119	3845006	4.43	84217

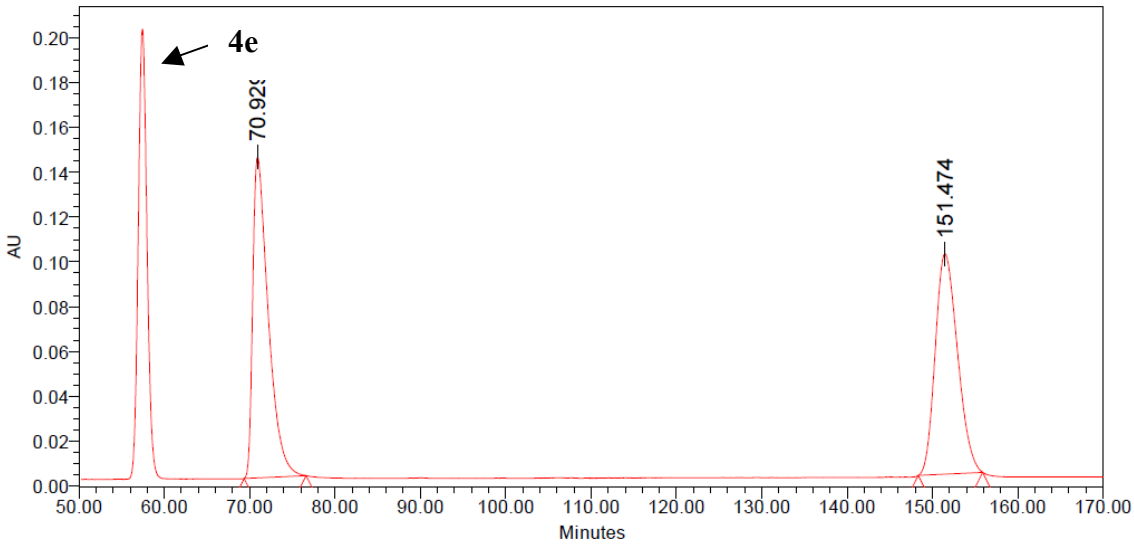
Match Plot



Match Plot



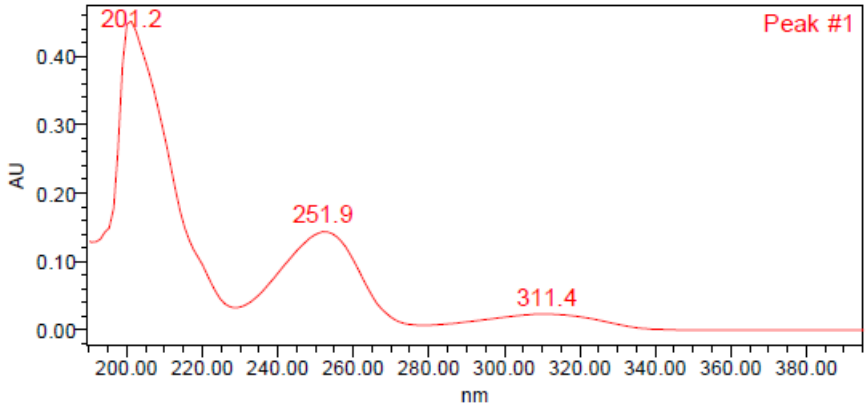
***rac–diast*-4e**



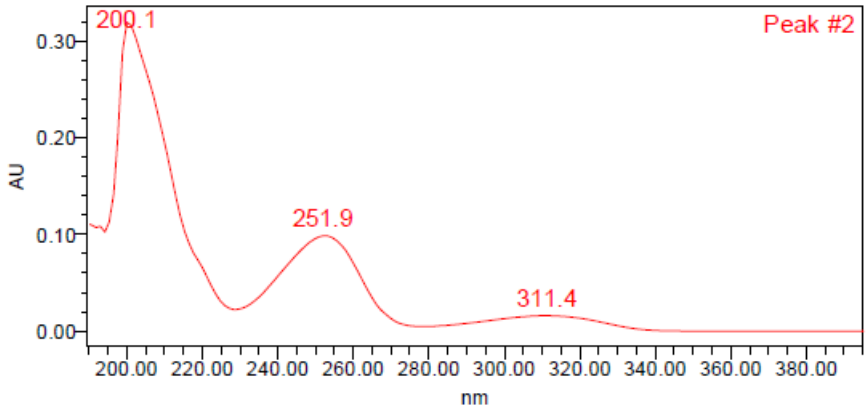
Peak Results

	RT	Area	% Area	Height
1	70.929	18080375	50.27	143424
2	151.474	17884584	49.73	98542

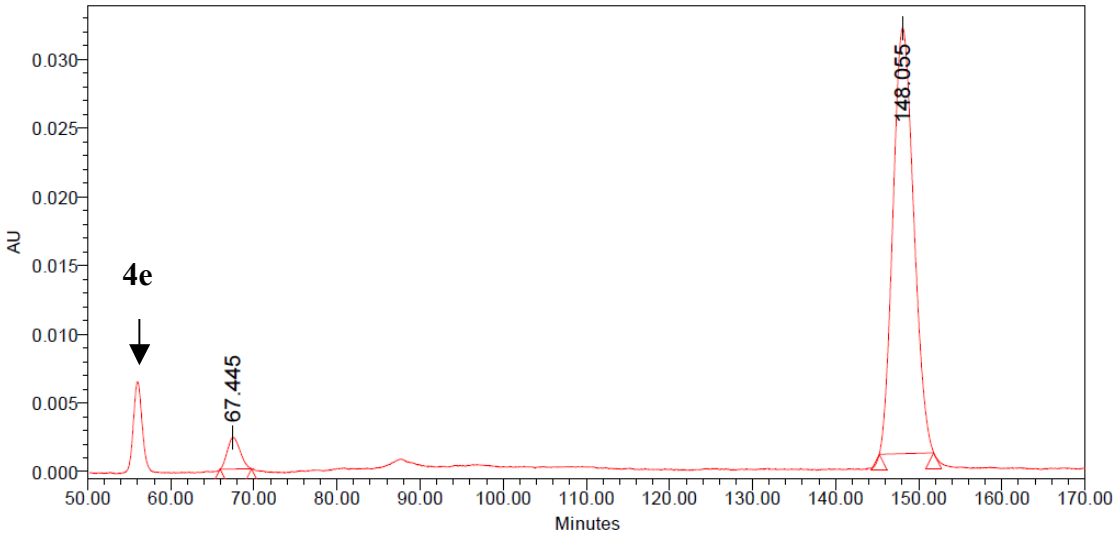
Match Plot



Match Plot



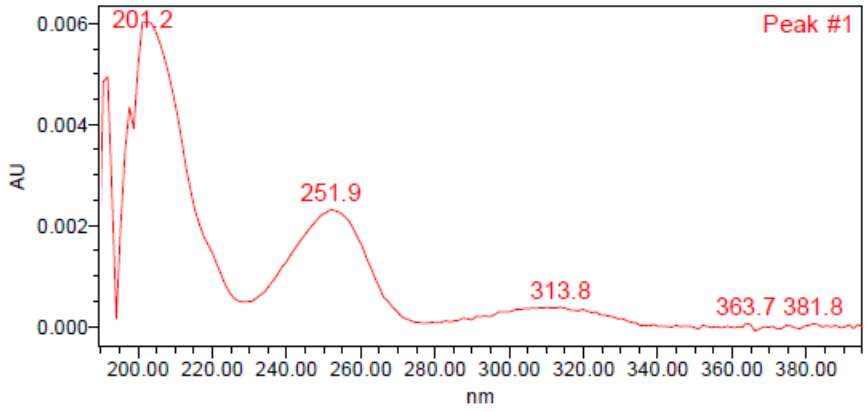
***diast*-4e**



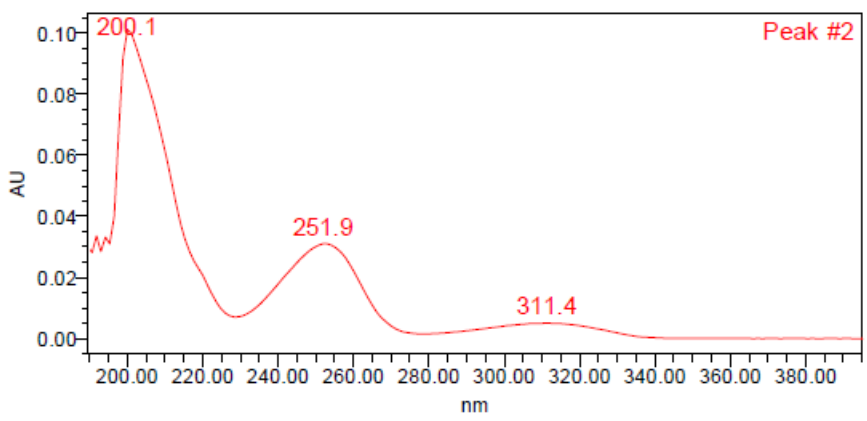
Peak Results

	RT	Area	% Area	Height
1	67.445	244701	4.37	2316
2	148.055	5358098	95.63	30989

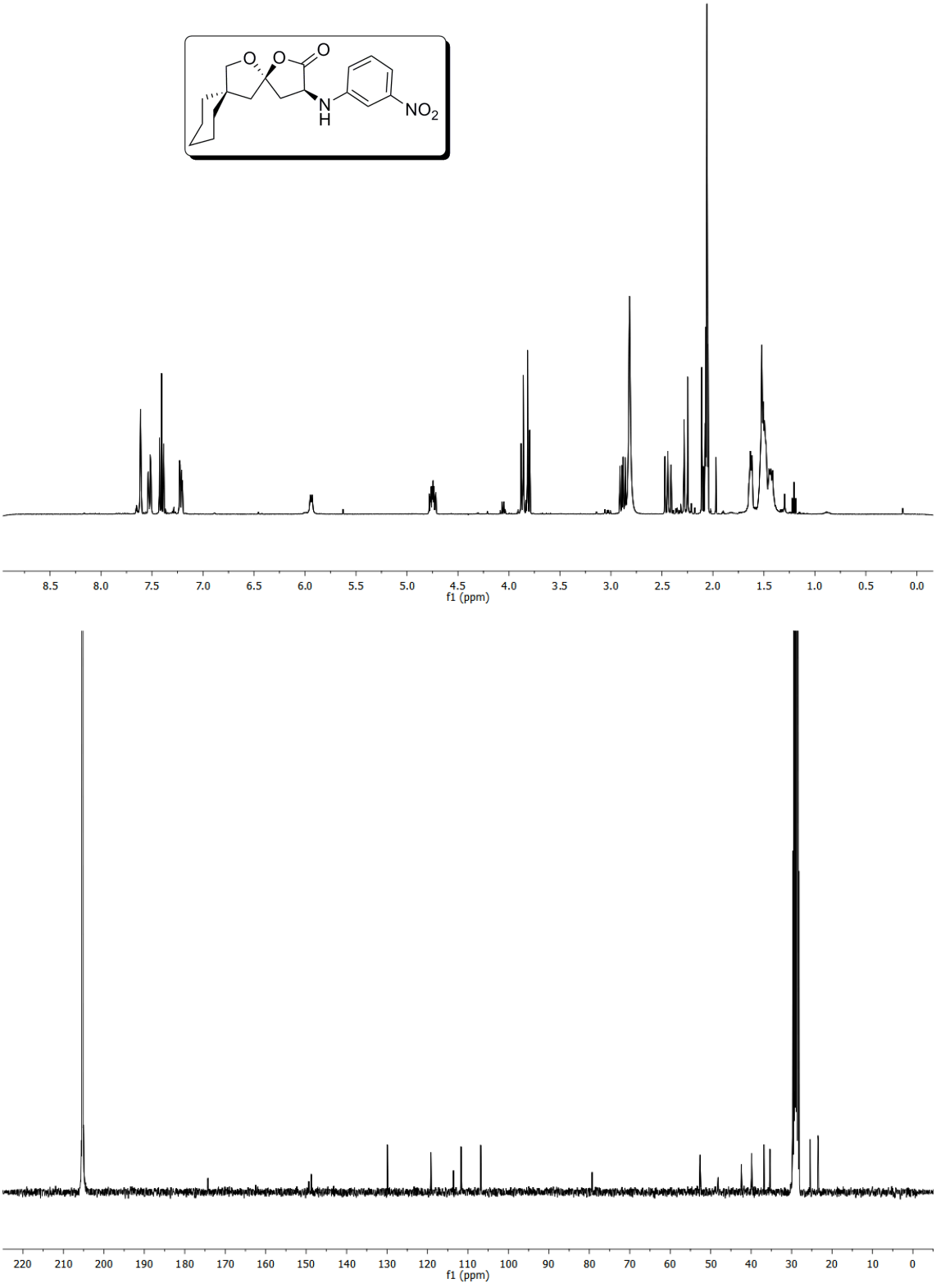
Match Plot



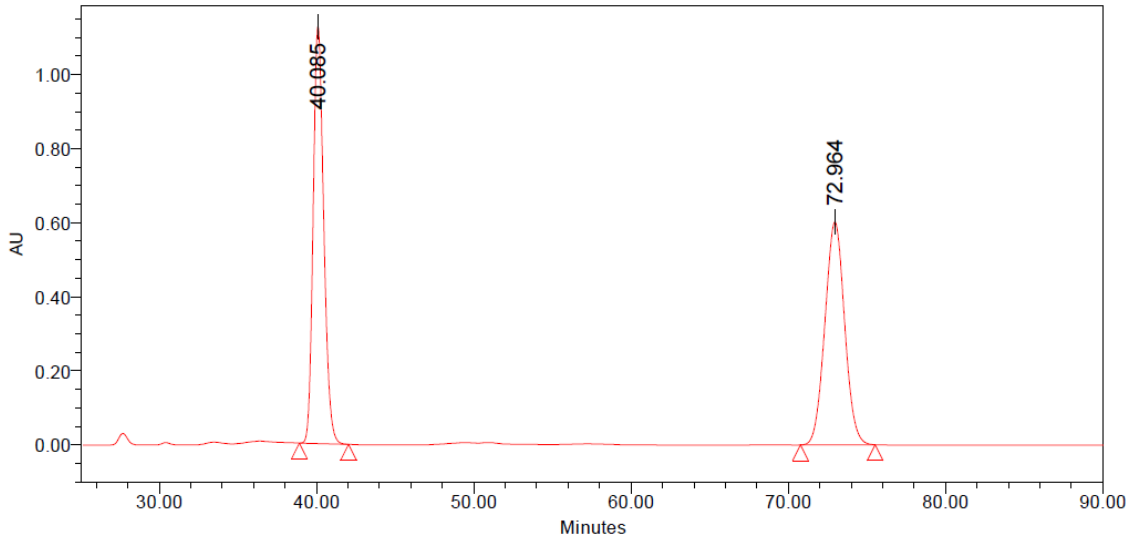
Match Plot



(3*S*,5*R*)-3-(3-Nitrophenylamino)-1,14-dioxadispiro[4.1.5.2]tetradecan-2-one (4f)



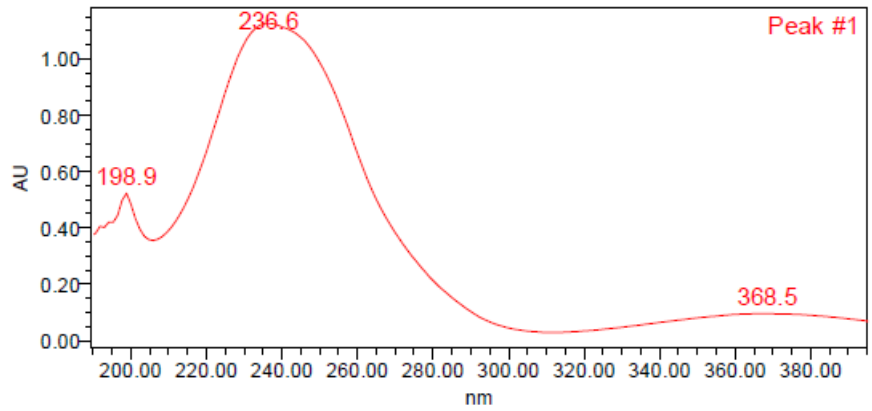
***rac*–4f**



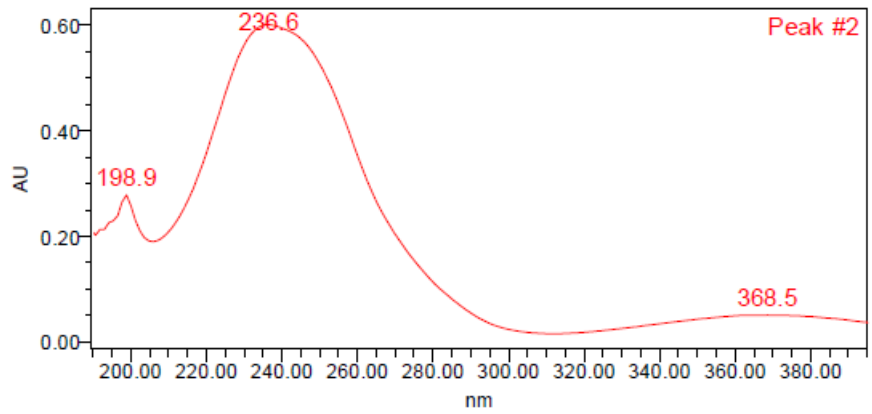
Peak Results

	RT	Area	% Area	Height
1	40.085	52449470	50.02	1126358
2	72.964	52417623	49.98	601568

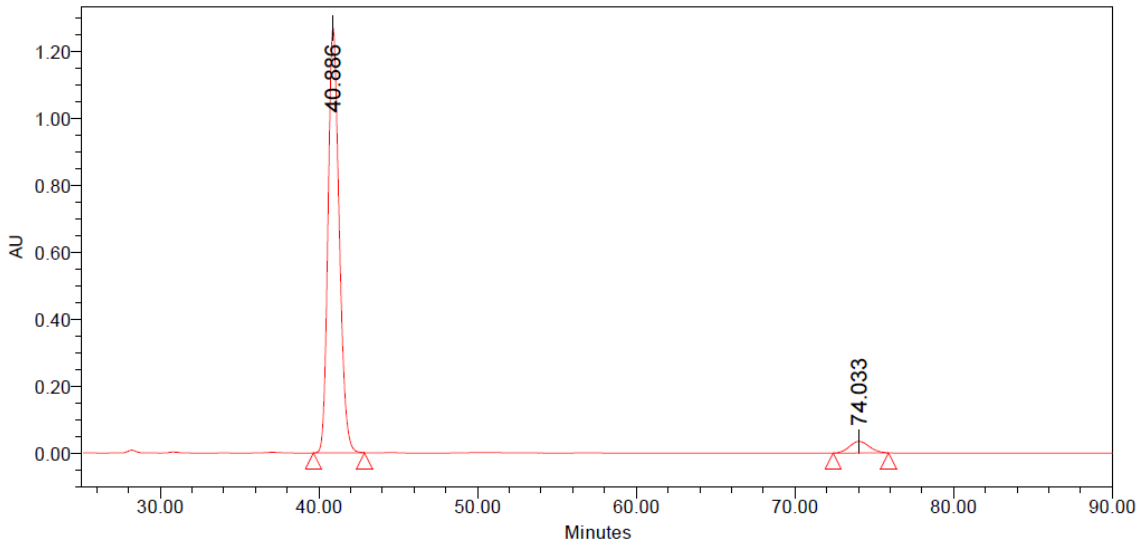
Match Plot



Match Plot



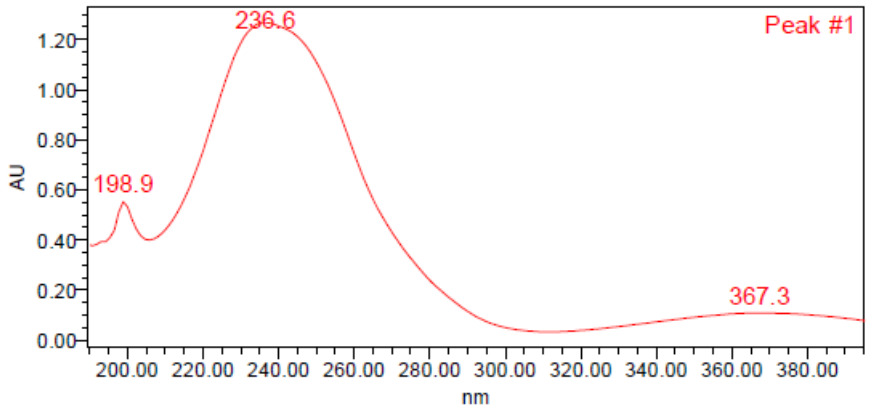
4f



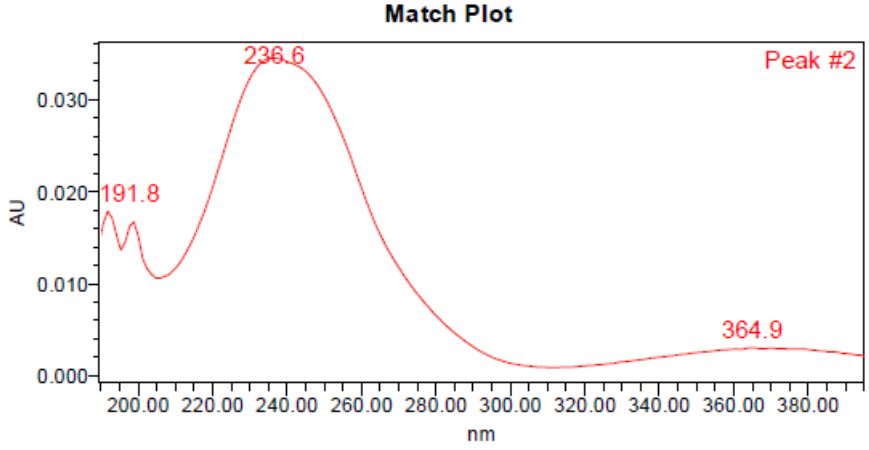
Peak Results

	RT	Area	% Area	Height
1	40.886	61994332	95.44	1268093
2	74.033	2963451	4.56	34510

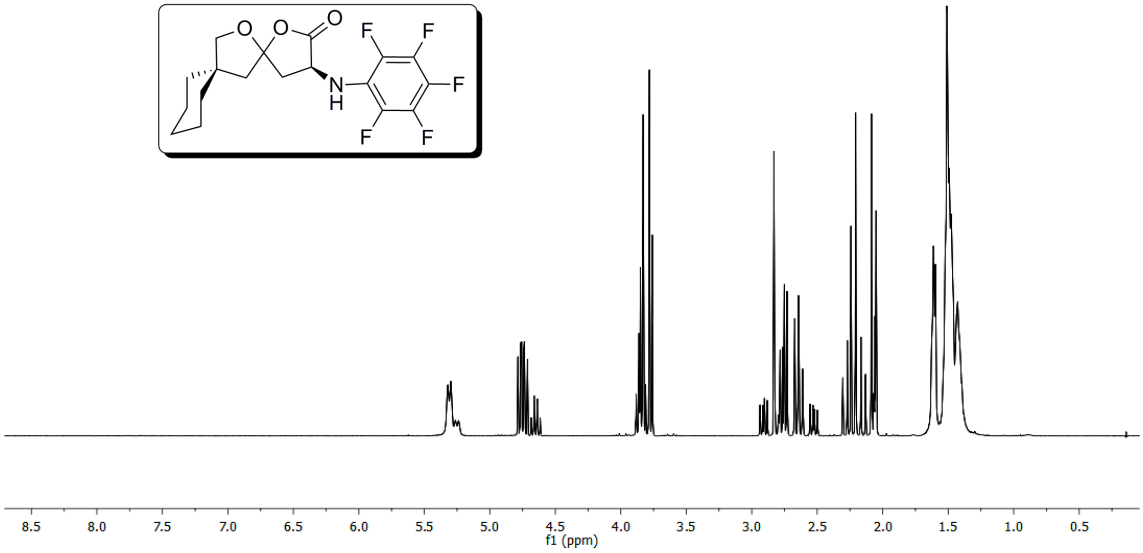
Match Plot

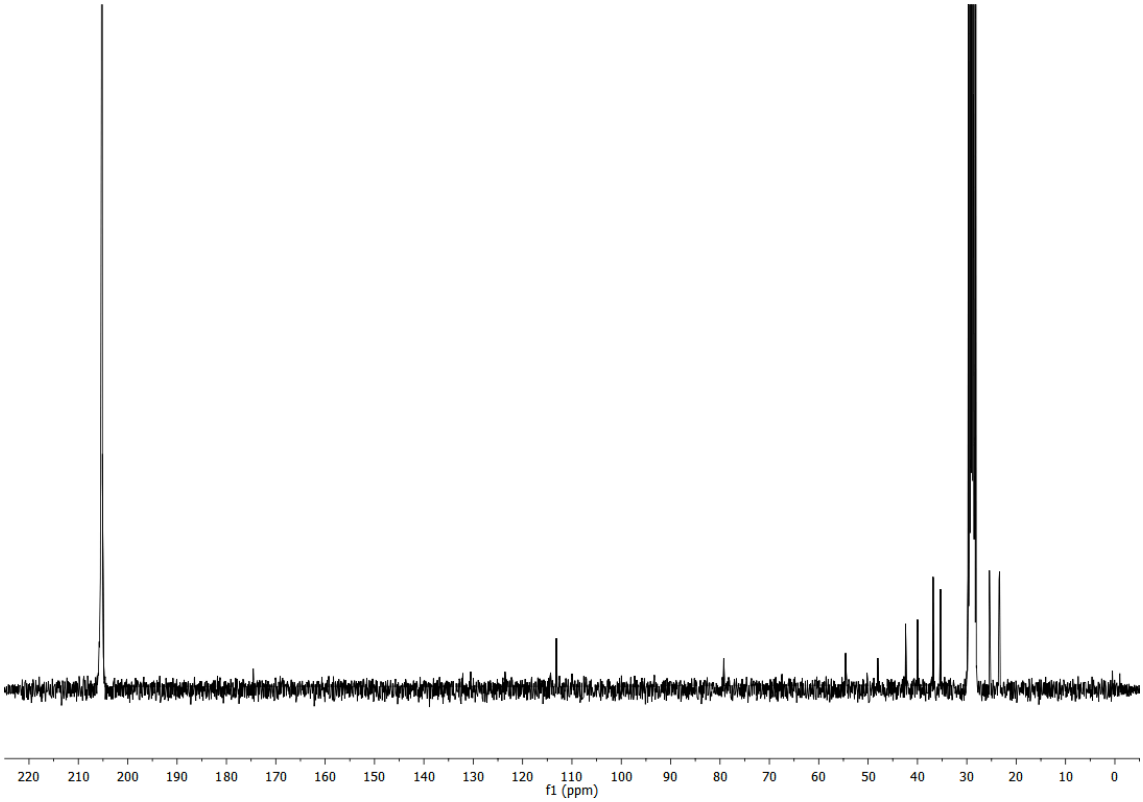


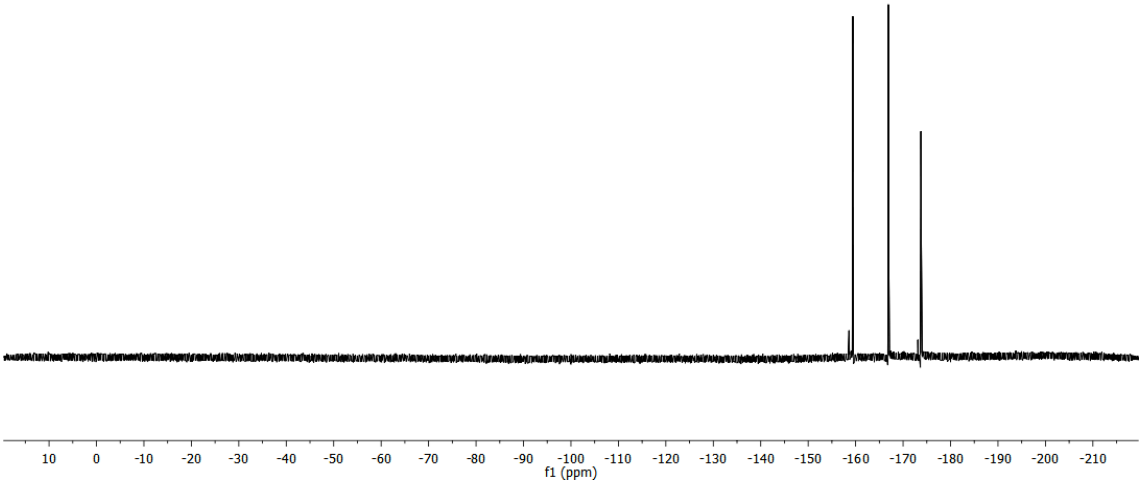
Match Plot



(3*S*,5*R*)-3-(Perfluorophenylamino)-1,14-dioxadispiro[4.1.5.2]tetradecan-2-one (4g) and (3*S*,5*S*)-3-(perfluorophenylamino)-1,14-dioxadispiro[4.1.5.2]tetradecan-2-one (*diast*-4g)



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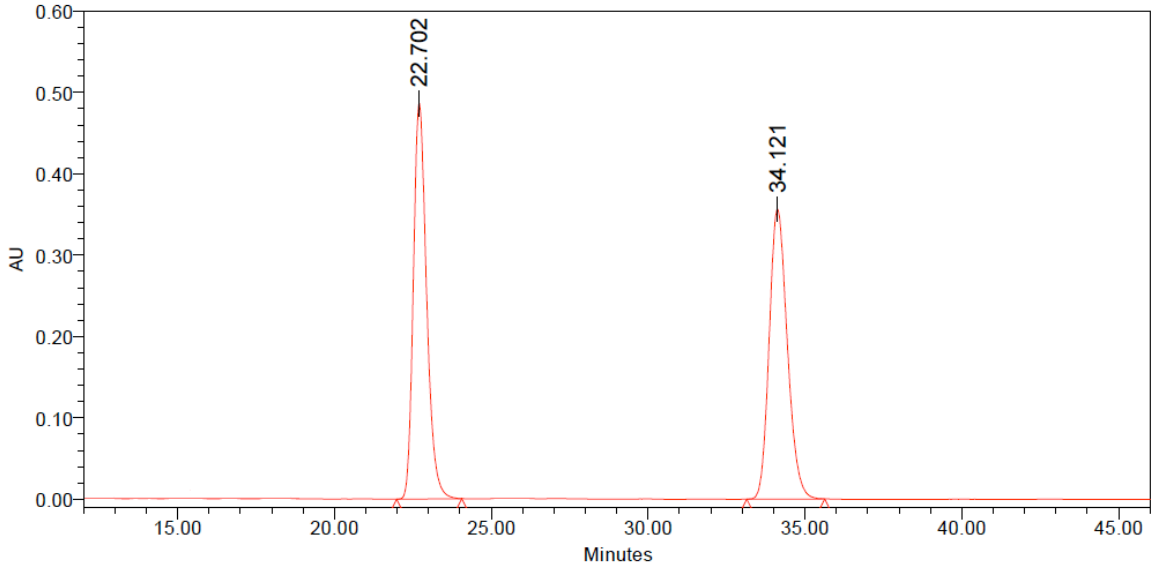
-210
f1 (ppm)

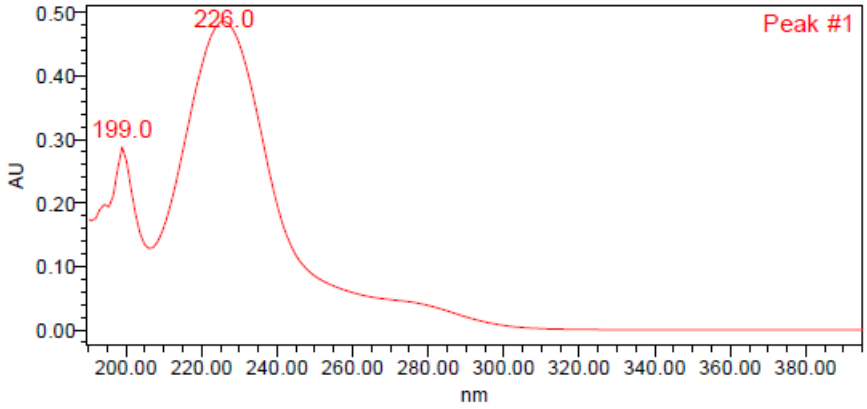
***rac*–4g**



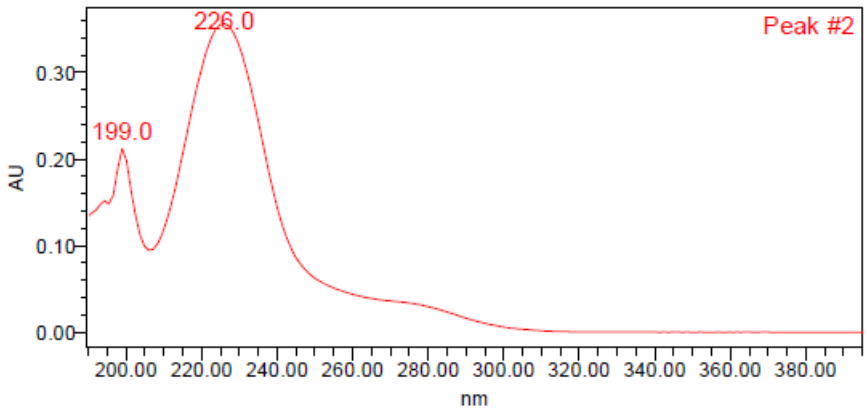
Peak Results

	RT	Area	% Area	Height
1	22.702	14282622	49.92	486764
2	34.121	14326952	50.08	356513

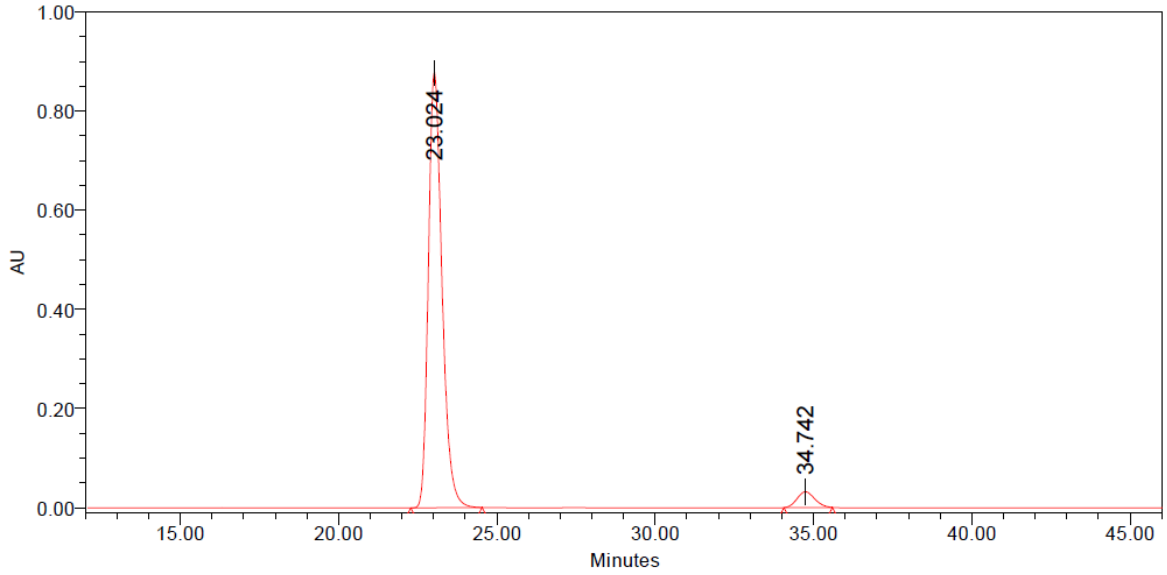
Match Plot



Match Plot



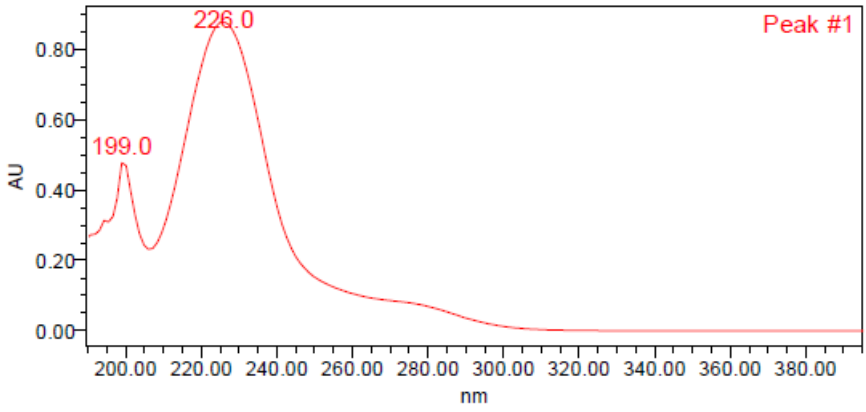
4g



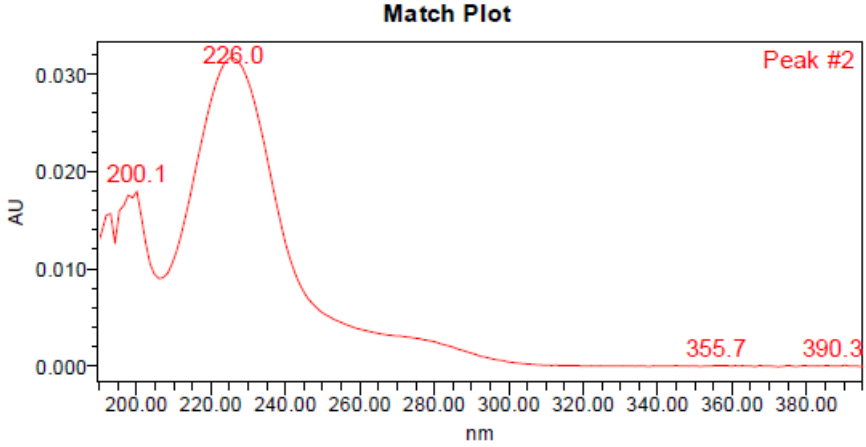
Peak Results

	RT	Area	% Area	Height
1	23.024	26258304	95.55	877505
2	34.742	1222911	4.45	31641

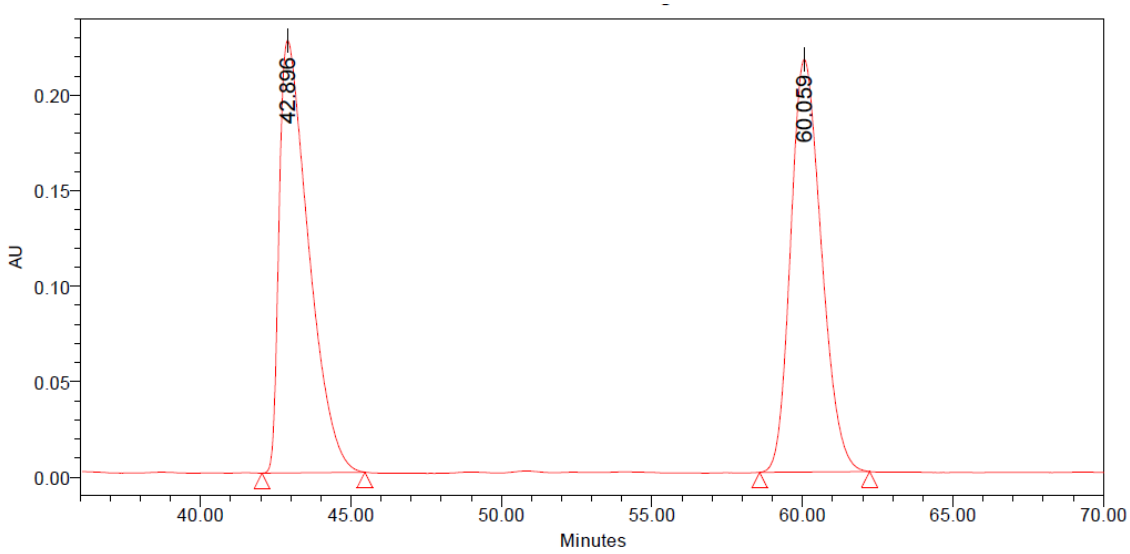
Match Plot



Match Plot

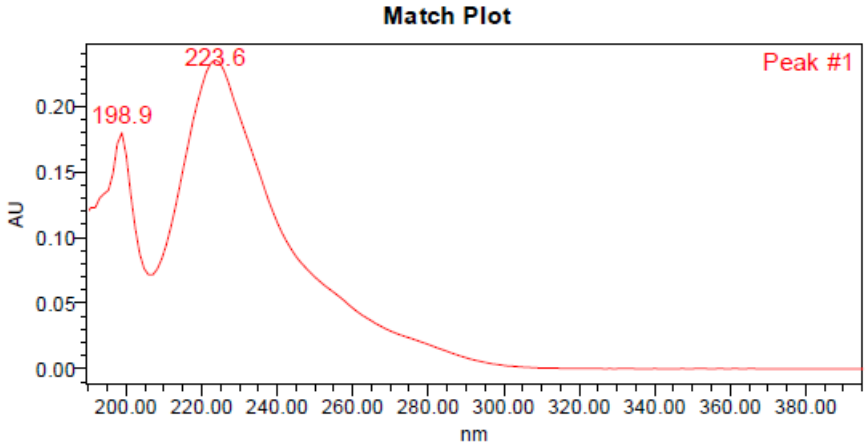


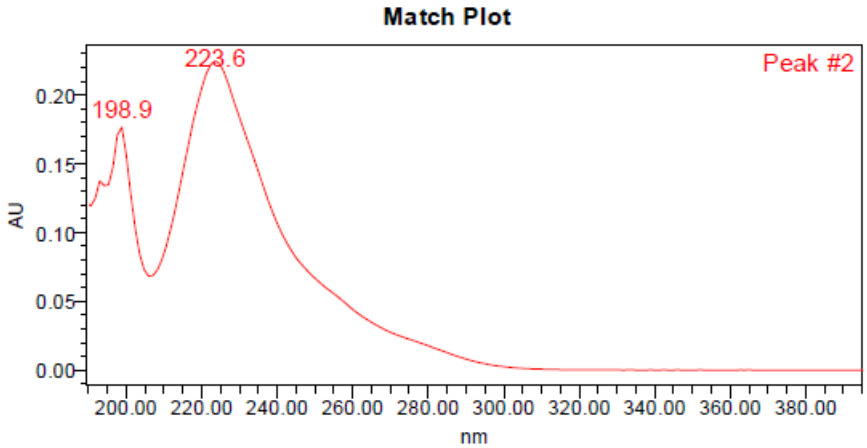
***rac–diast*-4g**



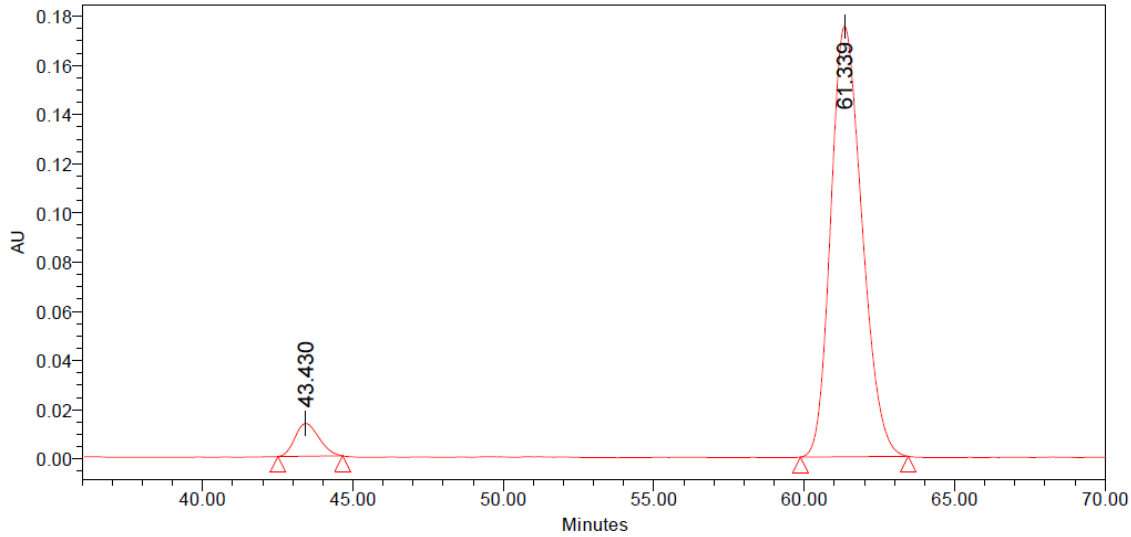
Peak Results

	RT	Area	% Area	Height
1	42.896	15362067	50.01	226563
2	60.059	15355853	49.99	216138





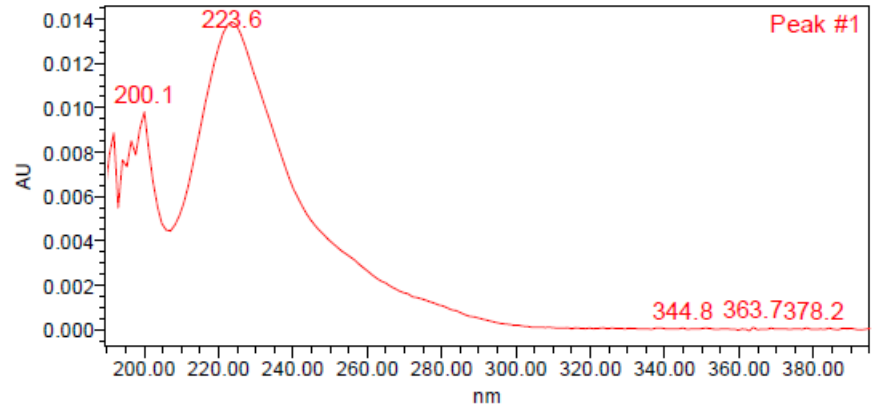
***diast*-4g**



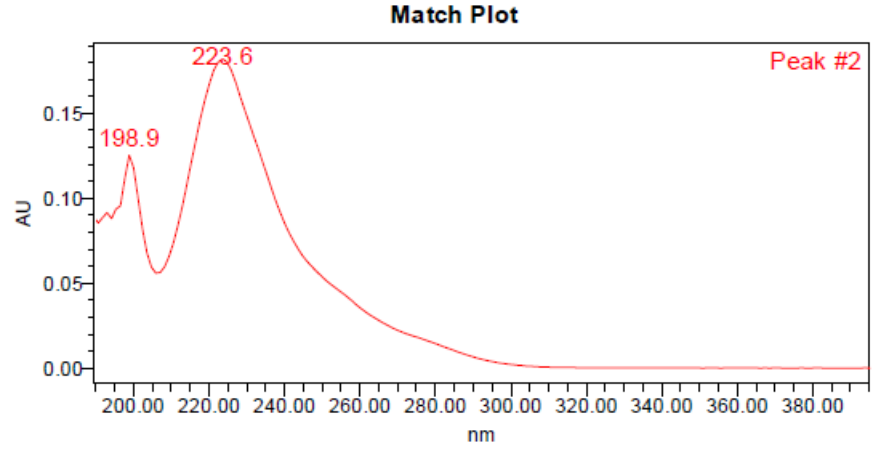
Peak Results

	RT	Area	% Area	Height
1	43.430	738786	5.53	13326
2	61.339	12631425	94.47	174891

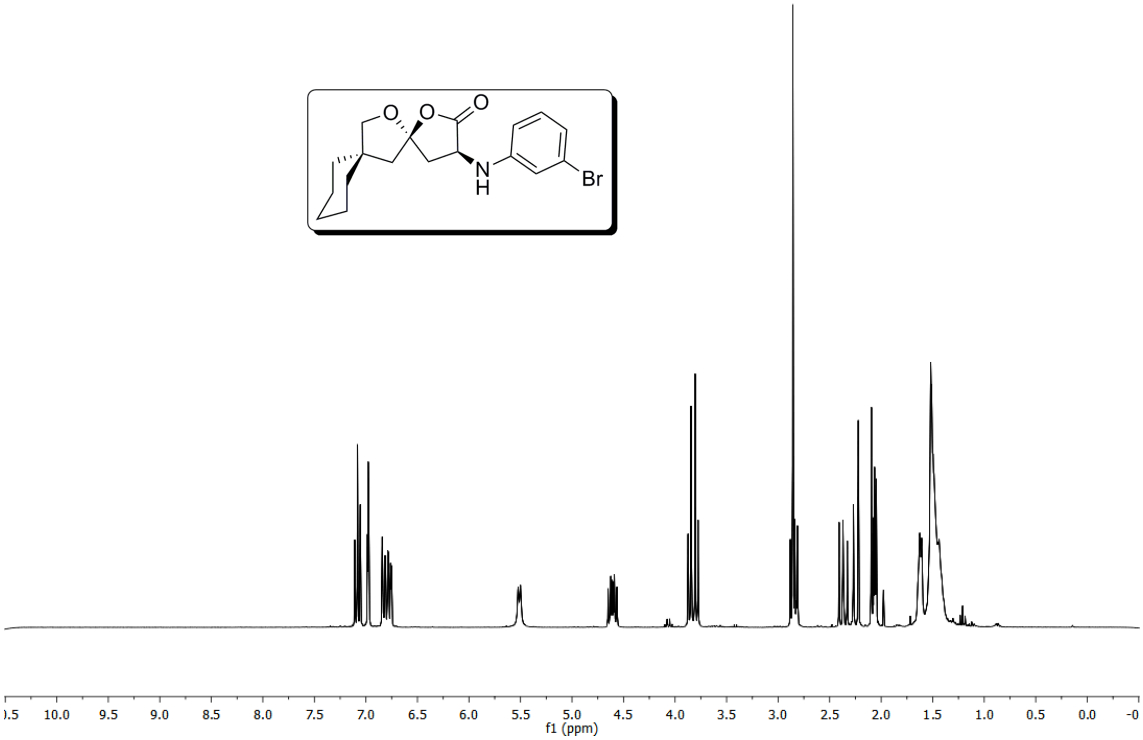
Match Plot

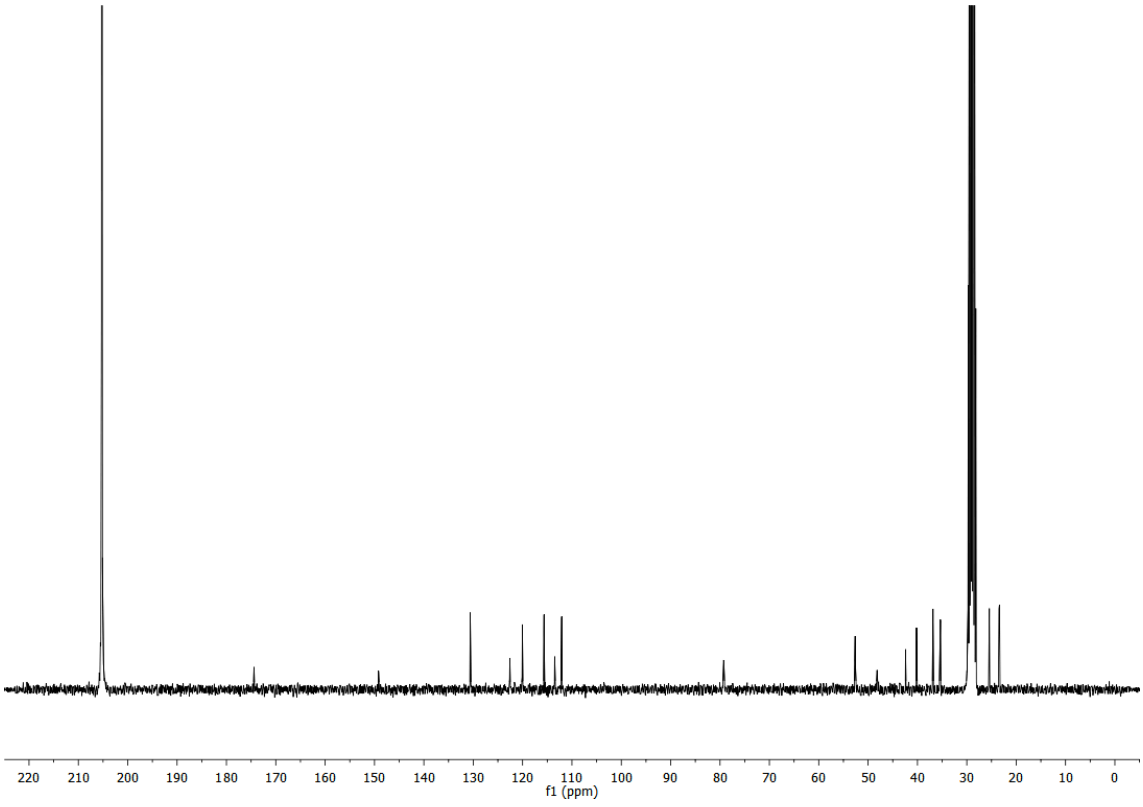


Match Plot

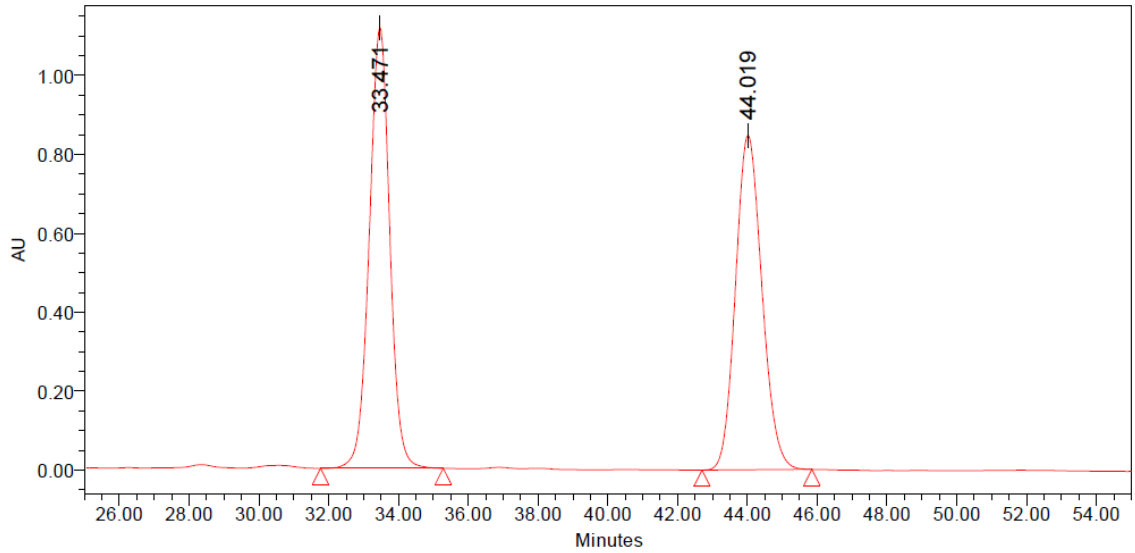


(3*S*,5*R*)-3-(3-Bromophenylamino)-1,14-dioxadispiro[4.1.5.2]tetradecan-2-one (4h)





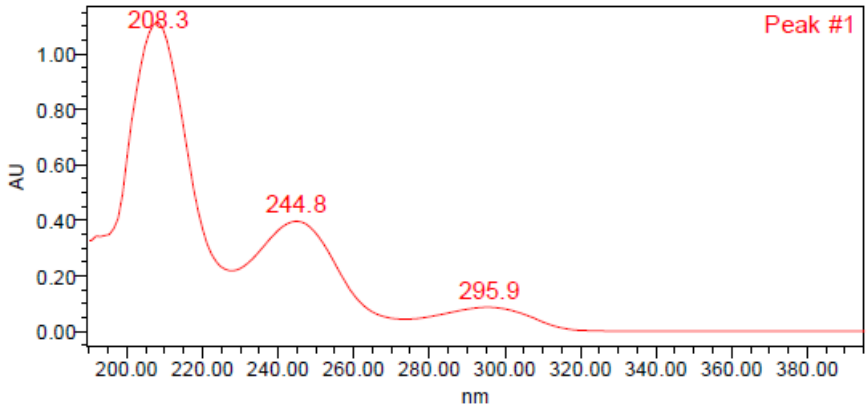
***rac*–4h**



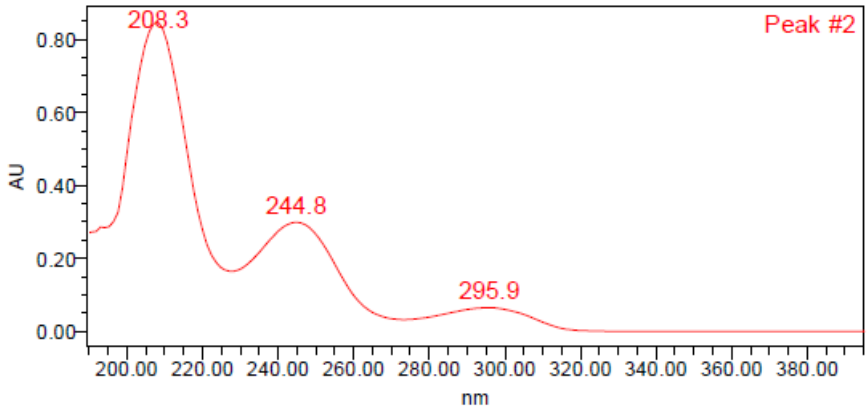
Peak Results

	RT	Area	% Area	Height
1	33.471	45557434	50.53	1116413
2	44.019	44596469	49.47	847103

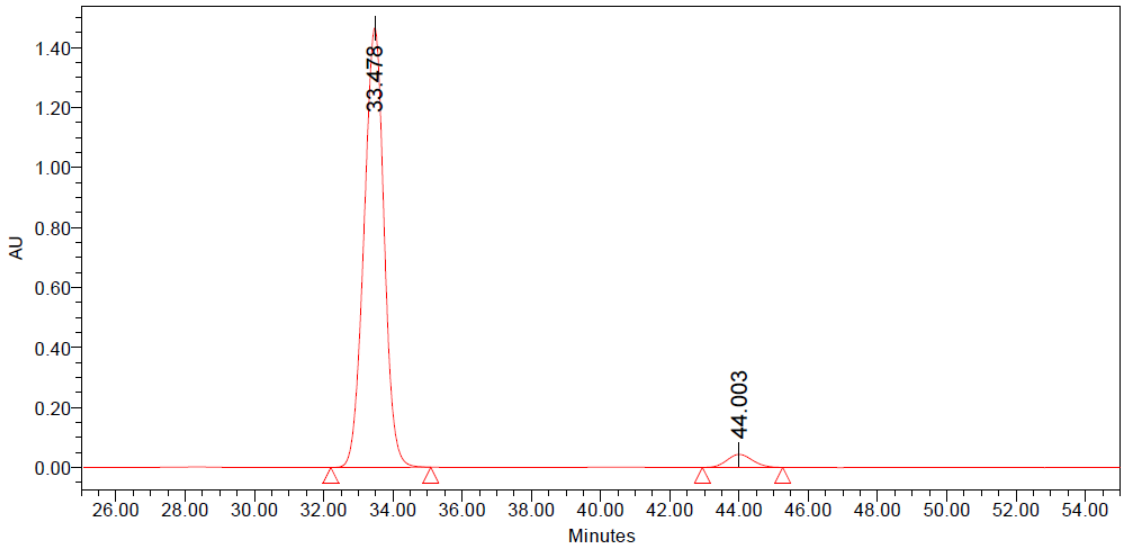
Match Plot



Match Plot



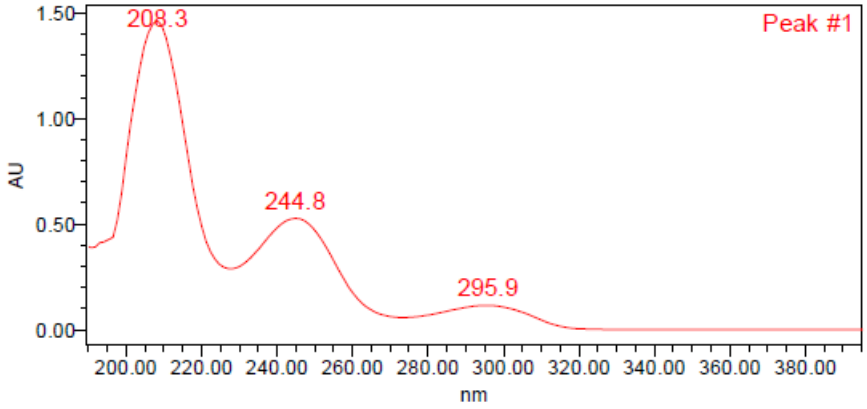
4h



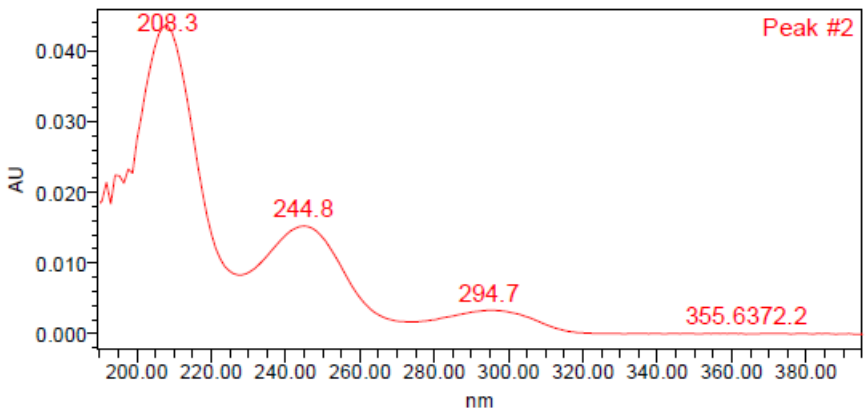
Peak Results

	RT	Area	% Area	Height
1	33.478	59044935	96.36	1462978
2	44.003	2227254	3.64	43565

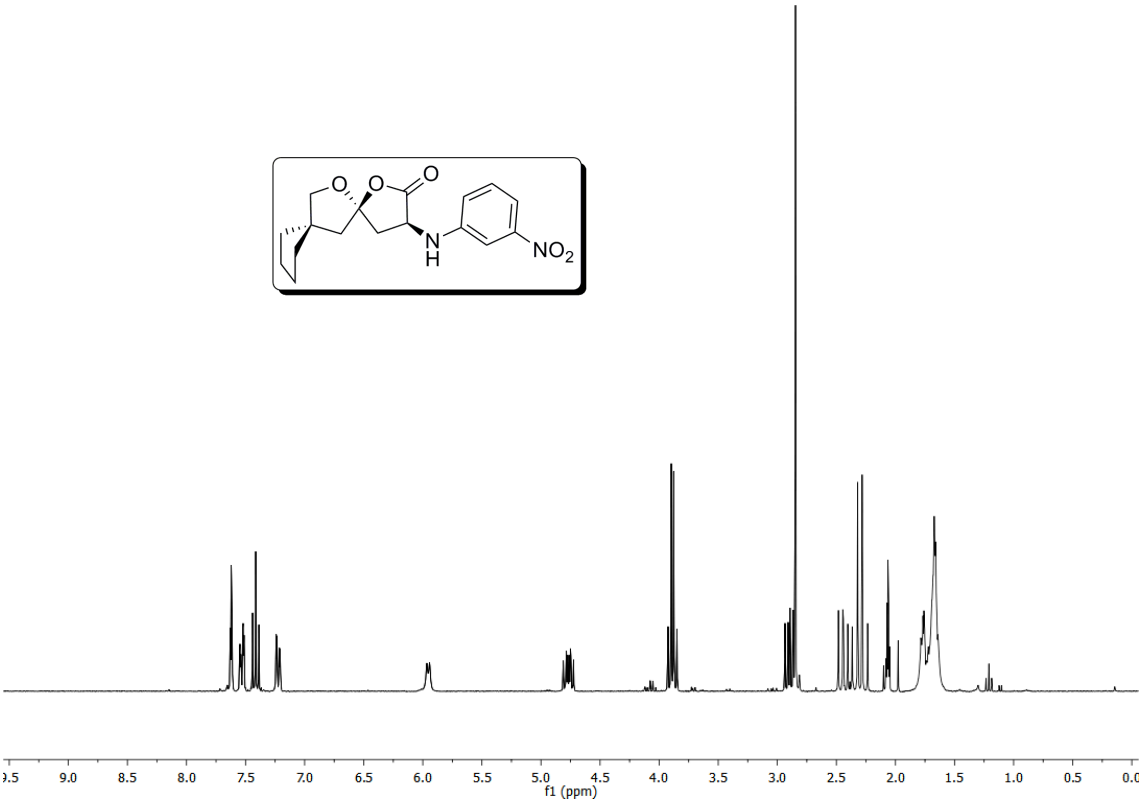
Match Plot

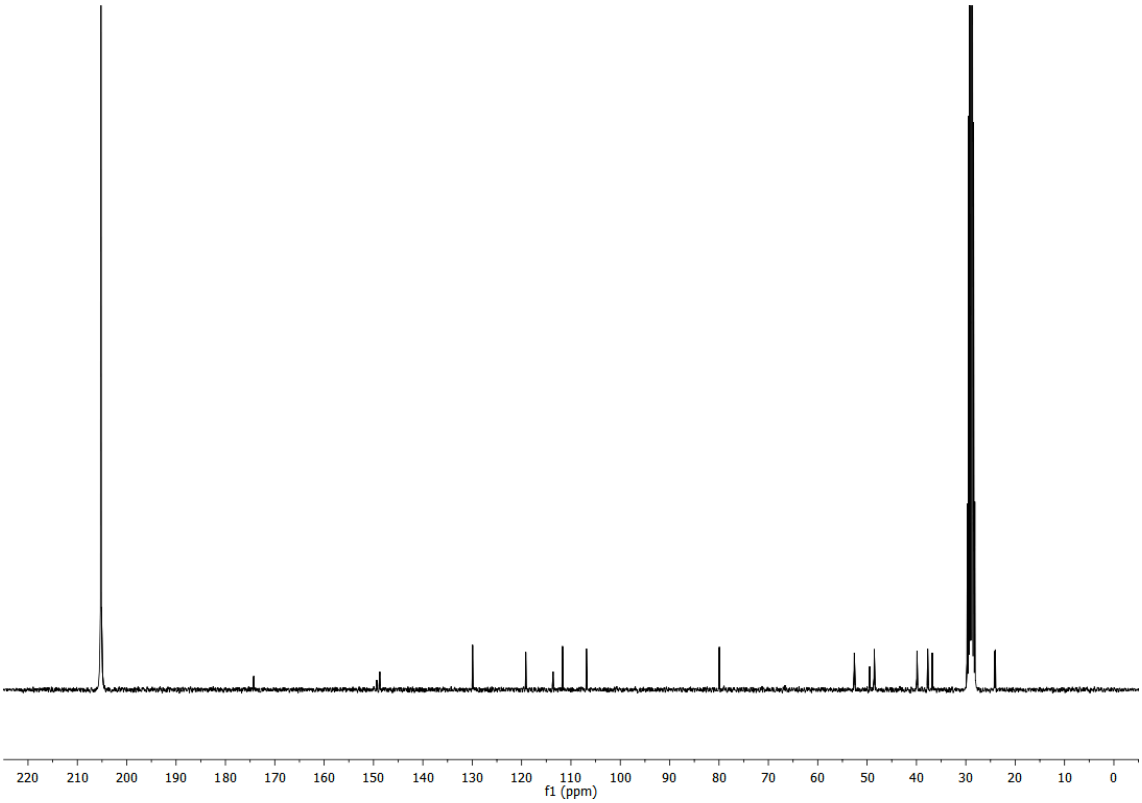


Match Plot

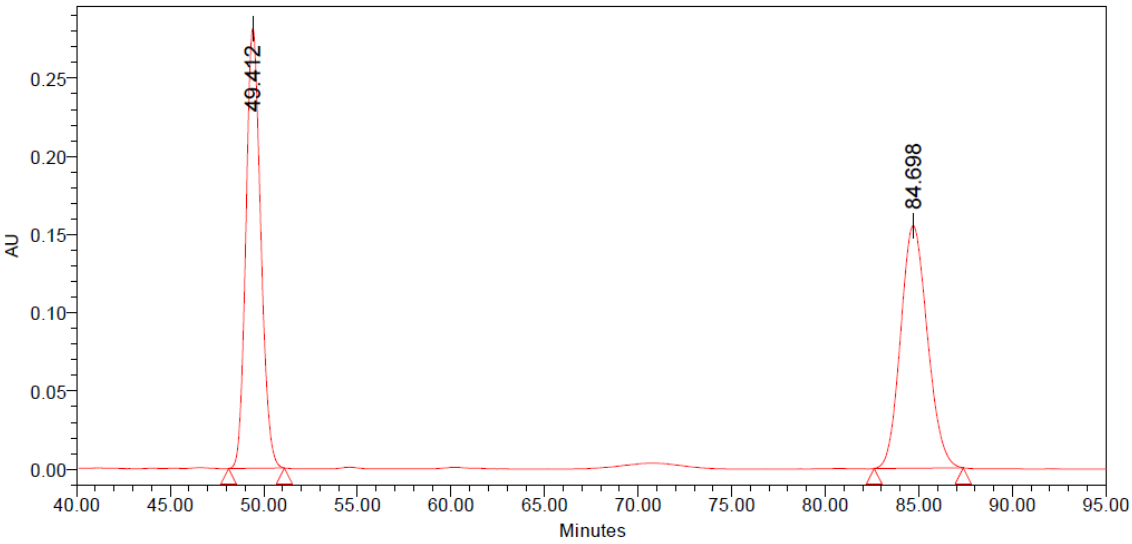


(3*S*,5*R*)-3-(3-Nitrophenylamino)-1,13-dioxadispiro[4.1.4.2]tetradecan-2-one (4i)



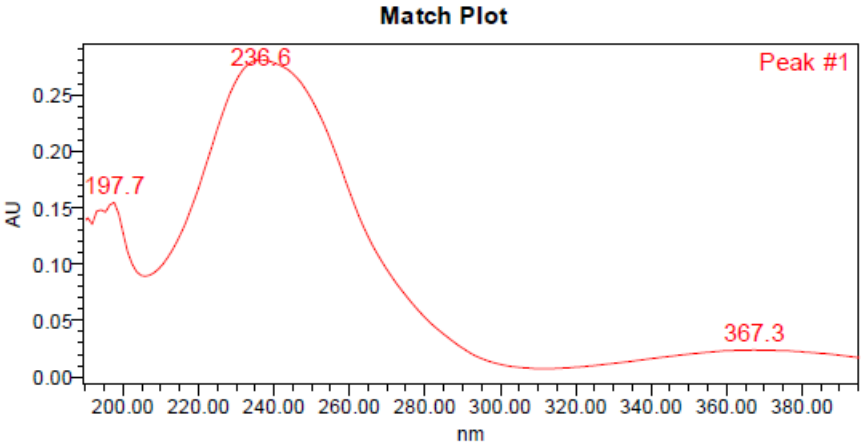


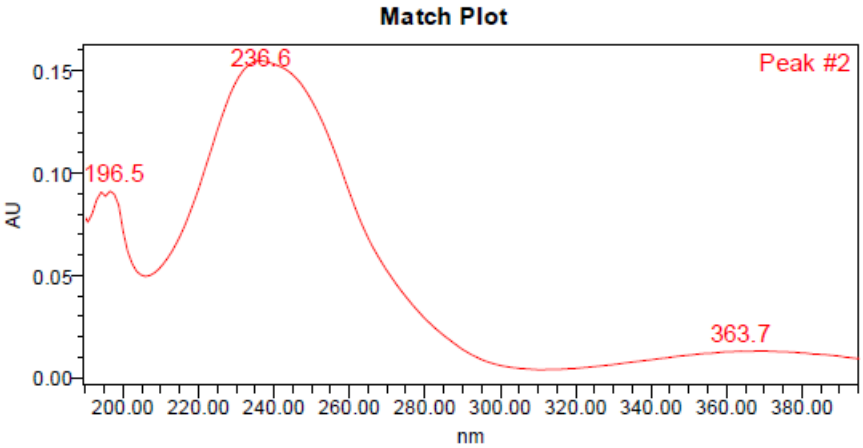
***rac*–4i**



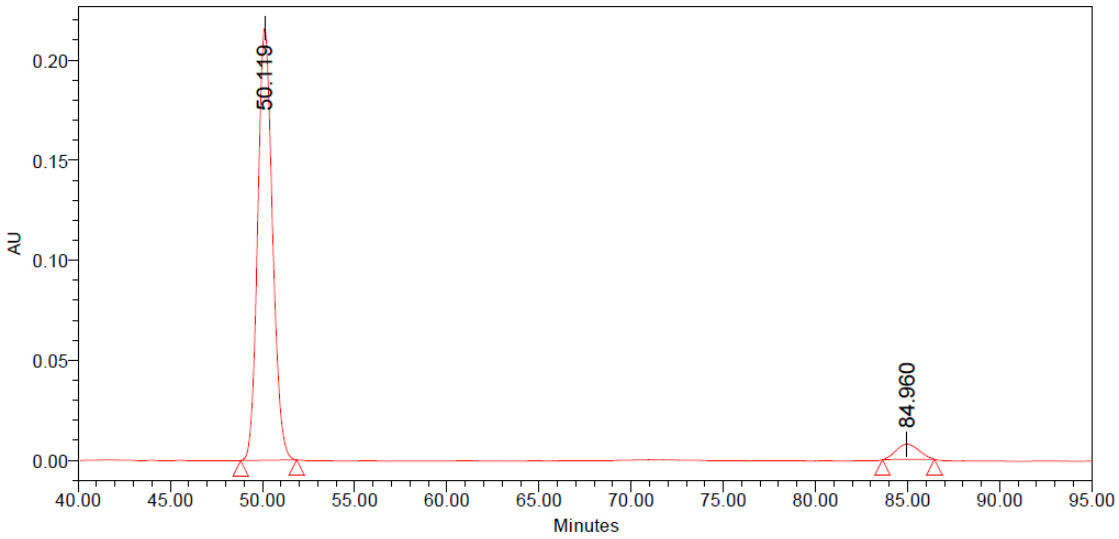
Peak Results

	RT	Area	% Area	Height
1	49.412	15461494	50.05	281176
2	84.698	15430581	49.95	154984



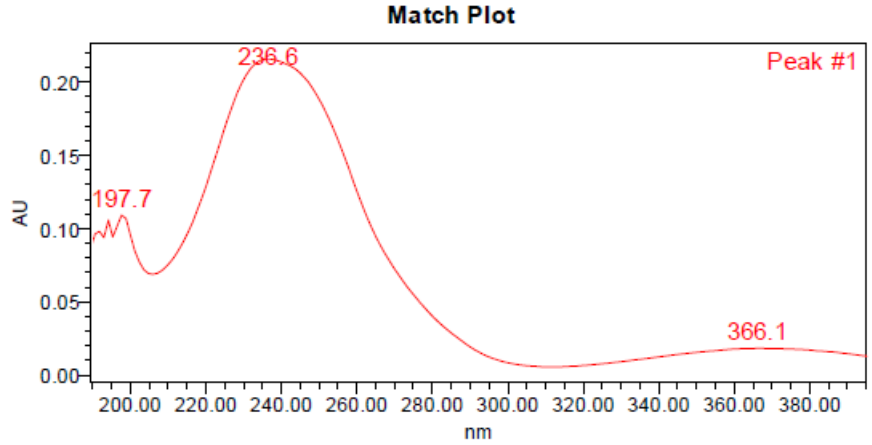


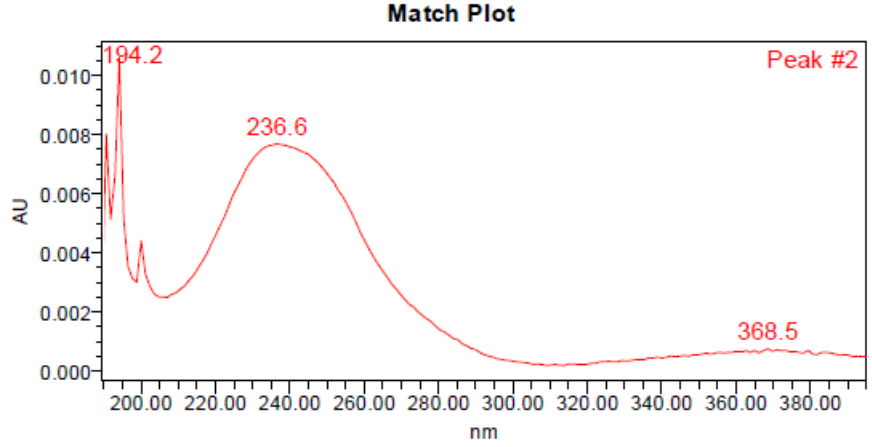
4i



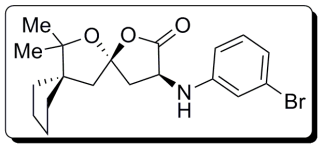
Peak Results

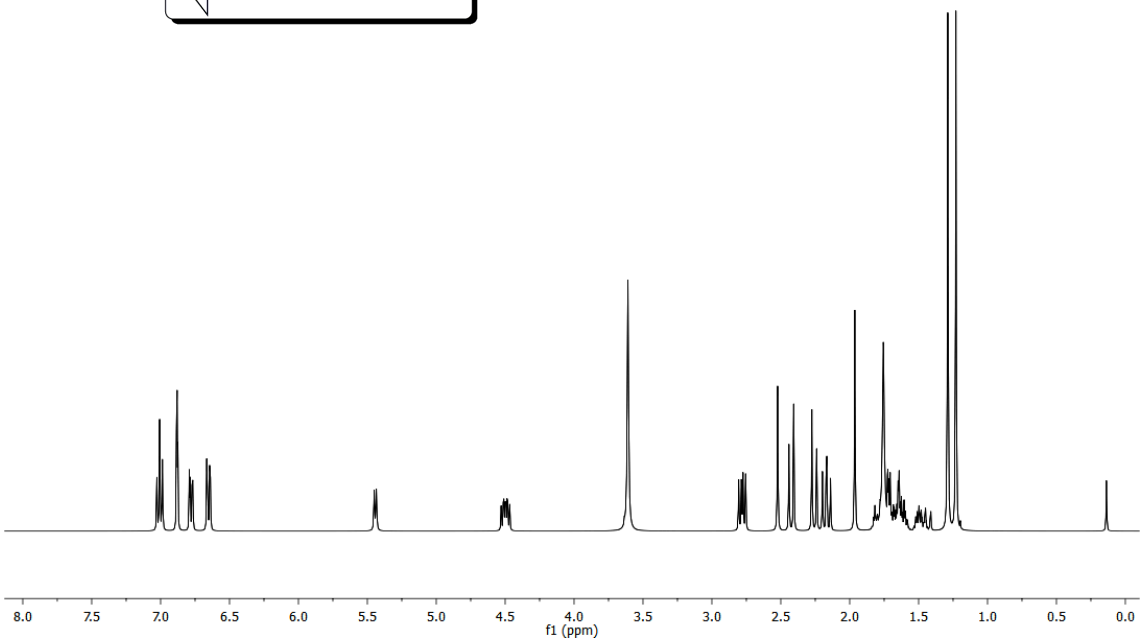
	RT	Area	% Area	Height
1	50.119	12040759	94.82	216016
2	84.960	657325	5.18	7680

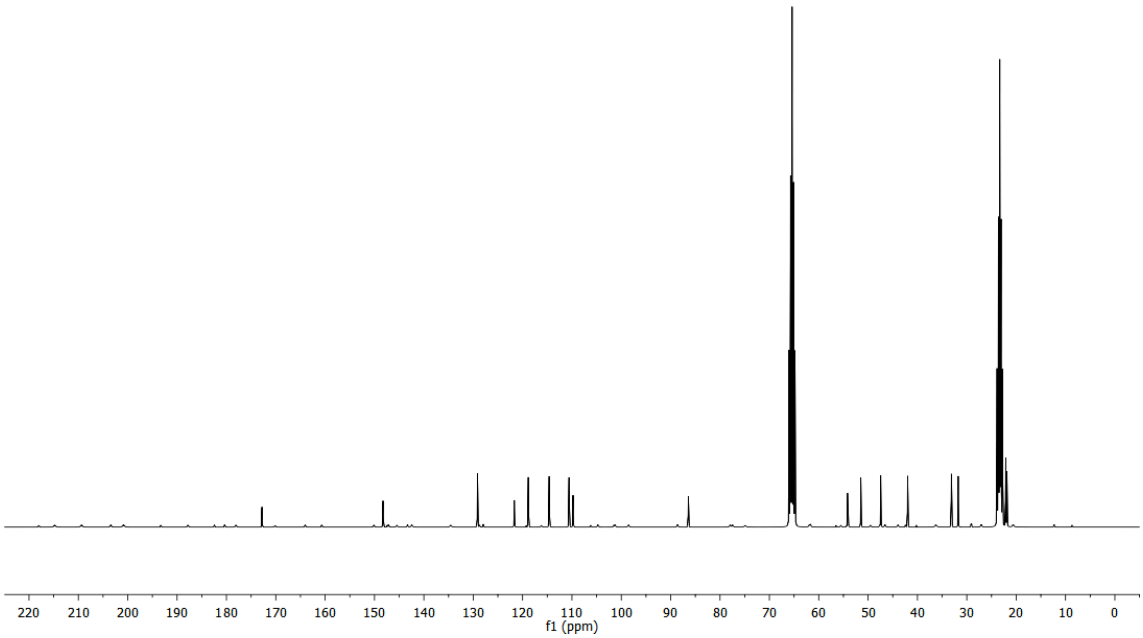




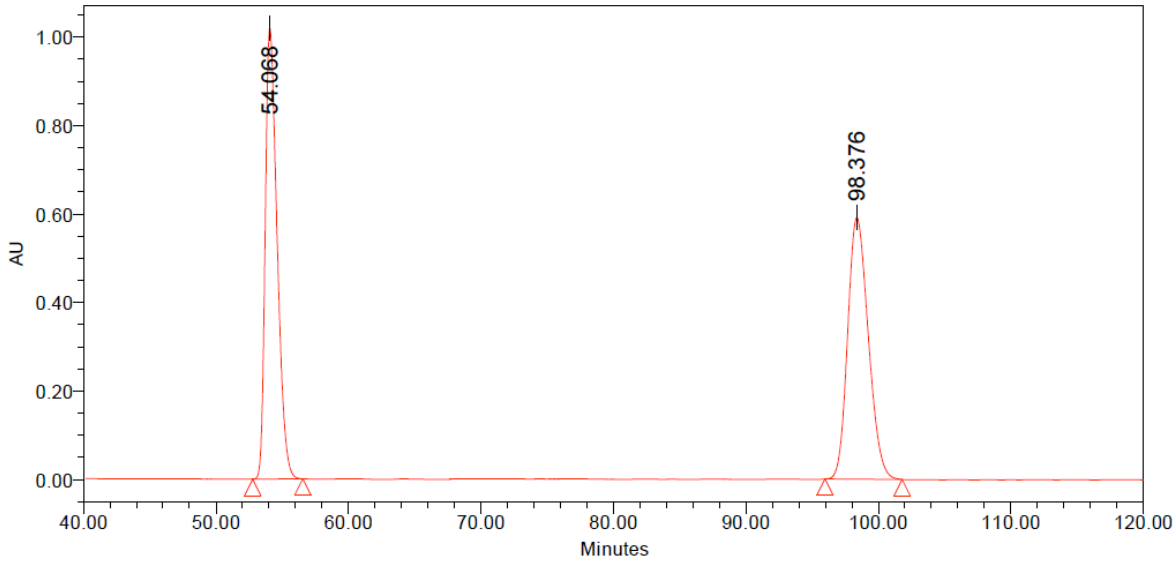
(3*S*,5*R*)-3-(3-Bromophenylamino)-12,12-dimethyl-1,13-dioxadispiro [4.1.4.2]tetradecan-2-one (4j)







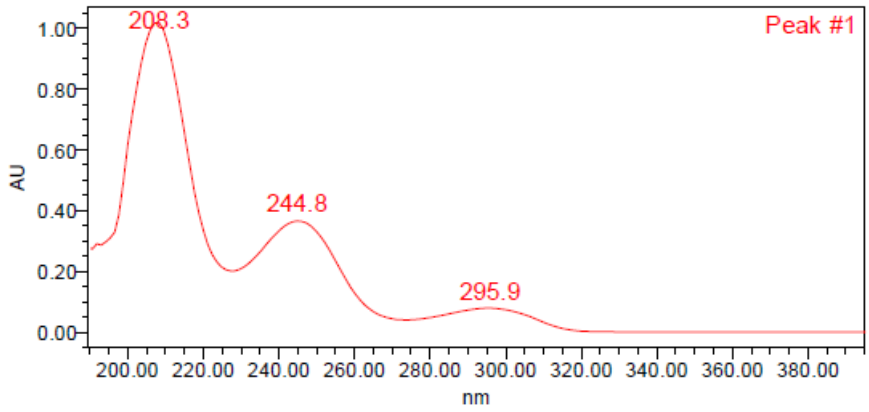
***rac*–4j**



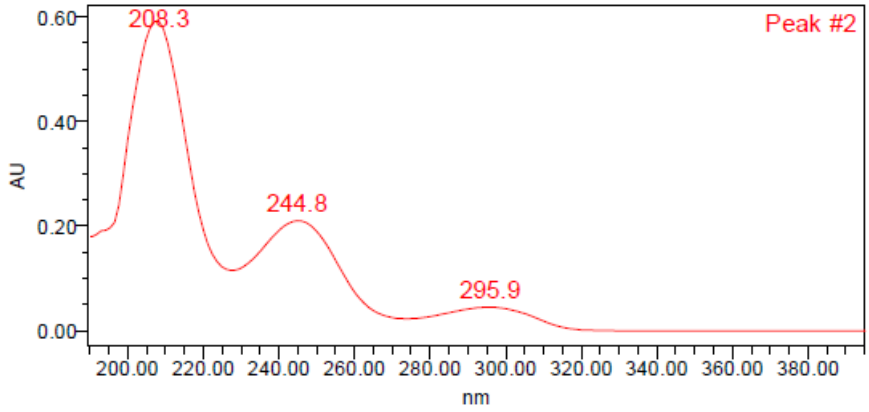
Peak Results

	RT	Area	% Area	Height
1	54.068	63365146	49.72	1019499
2	98.376	64067332	50.28	591069

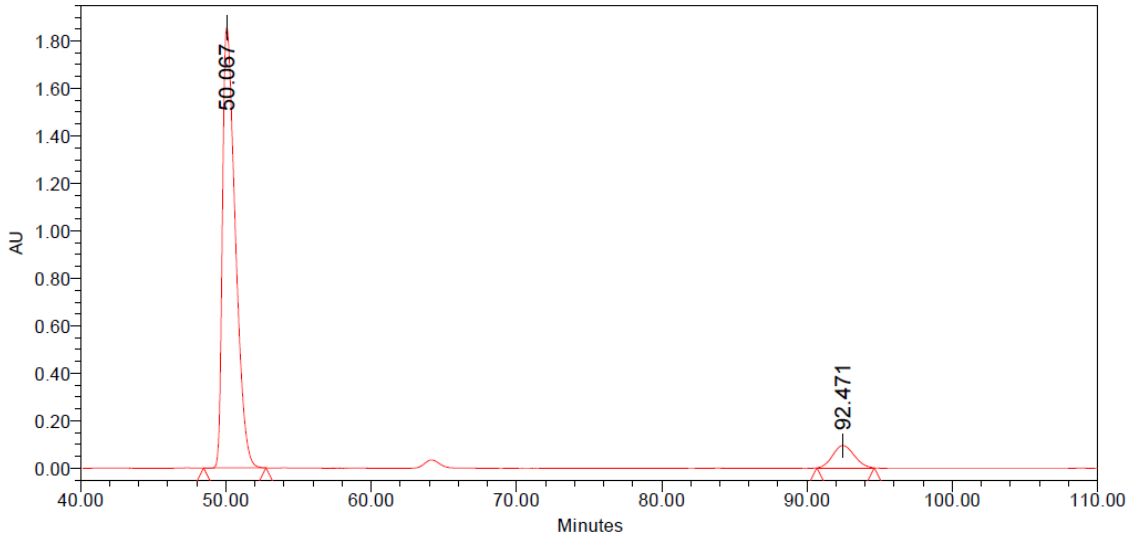
Match Plot



Match Plot



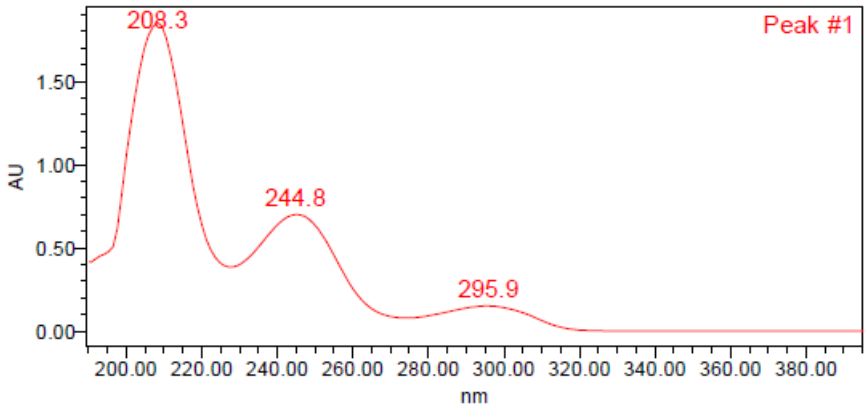
4j



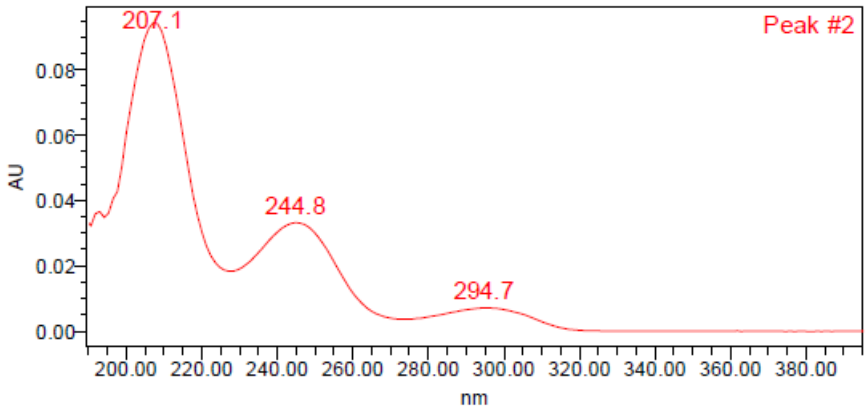
Peak Results

	RT	Area	% Area	Height
1	50.067	114161792	92.25	1854920
2	92.471	9591033	7.75	94061

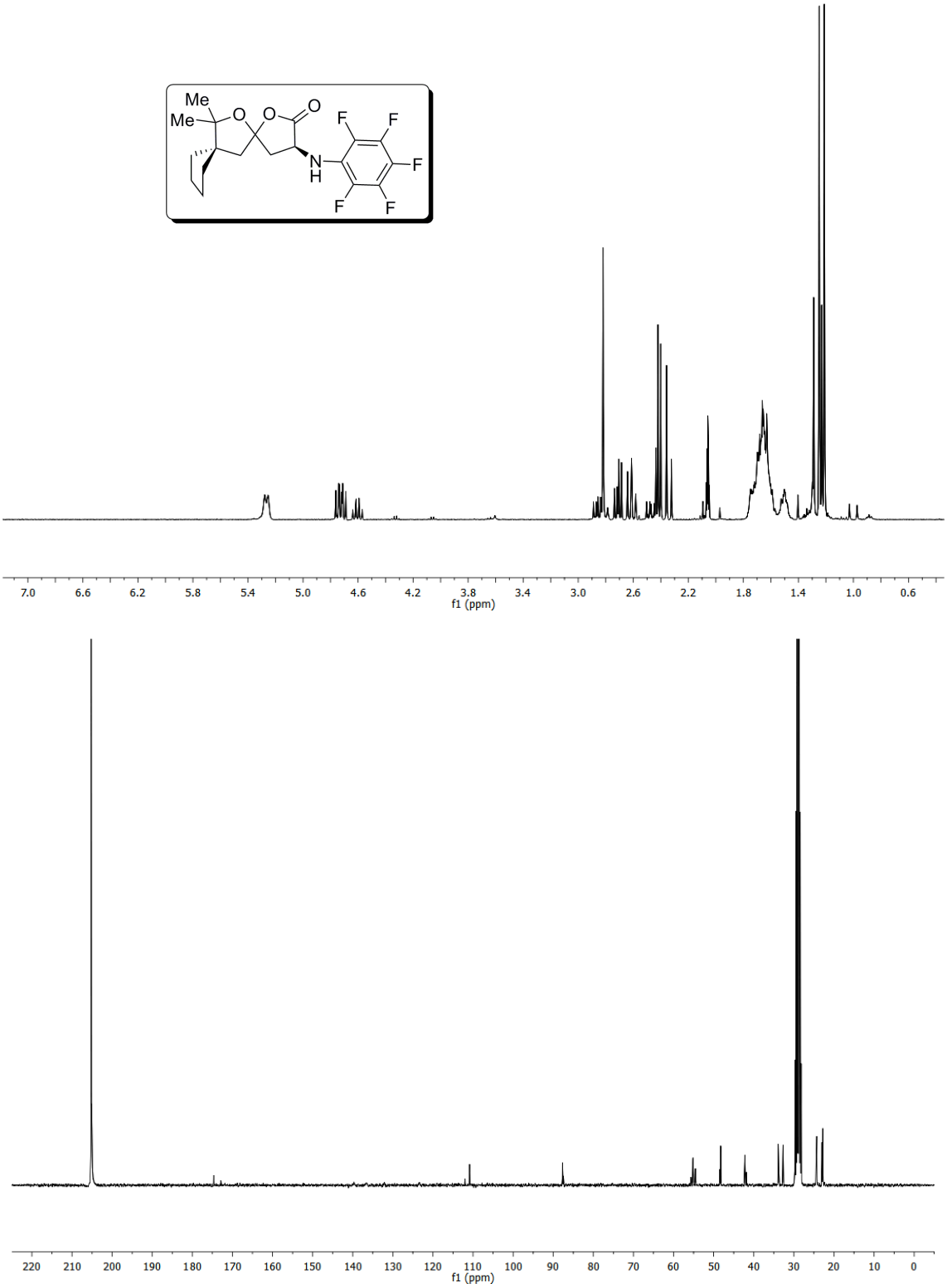
Match Plot

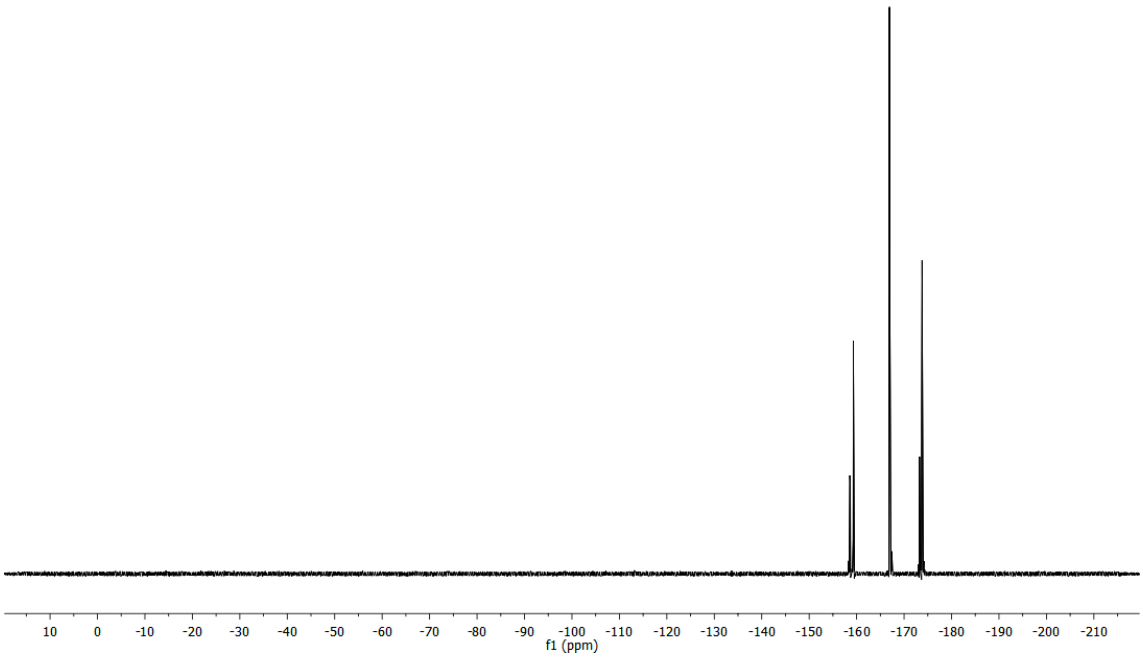


Match Plot



(3*S*,5*R*)-12,12-Dimethyl-3-(perfluorophenylamino)-1,13-dioxadispiro [4.1.4.2]tetradecan-2-one (4k) and (3*S*,5*S*)-12,12-dimethyl-3-(perfluorophenylamino)-1,13-dioxadispiro [4.1.4.2]tetradecan-2-one (*diast*-4k)

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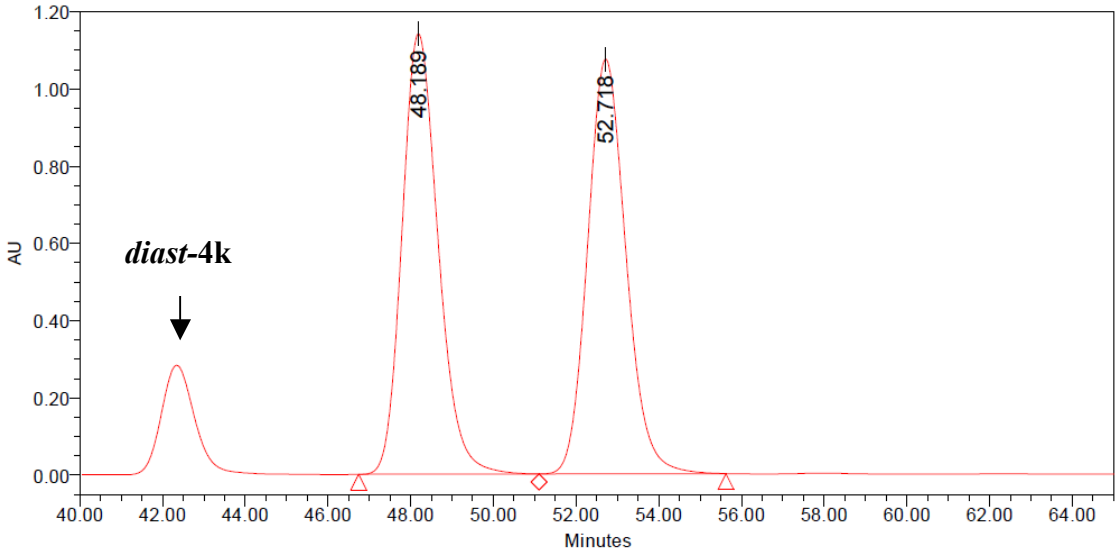
-200
-210
f1 (ppm)

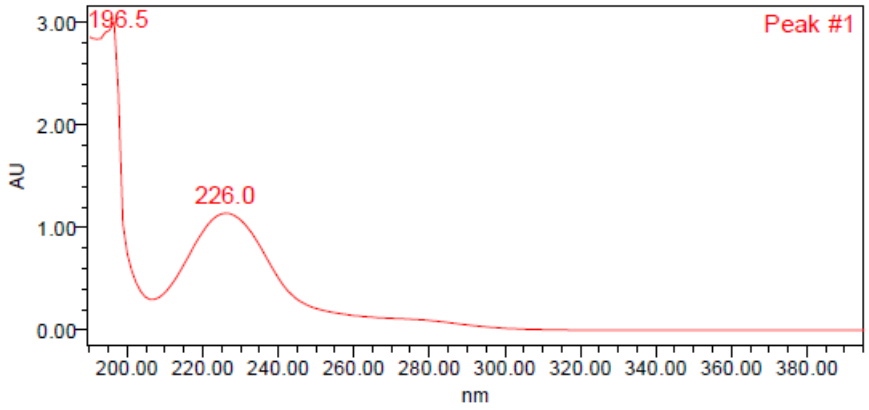
***rac*–4k**



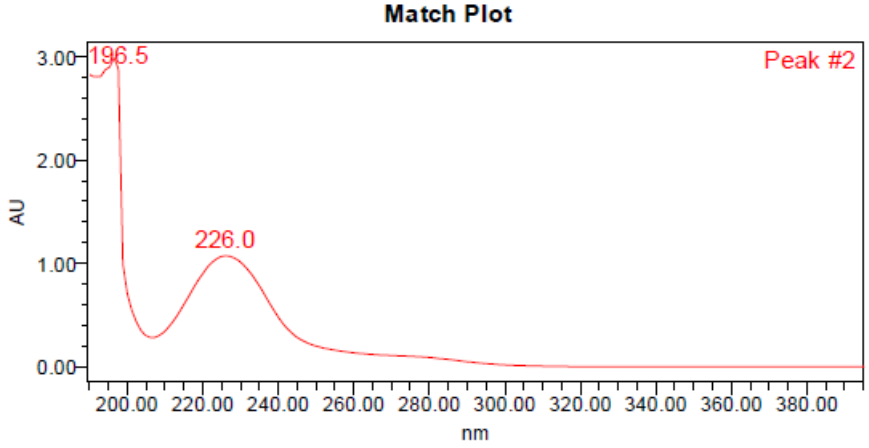
Peak Results

	RT	Area	% Area	Height
1	48.189	69149270	49.97	1140416
2	52.718	69223599	50.03	1073441

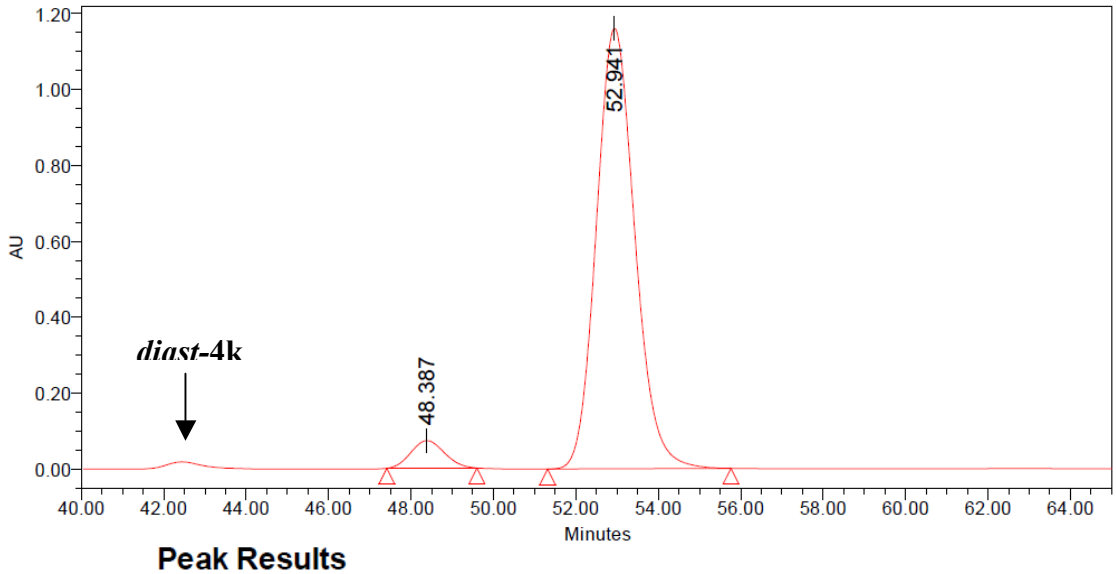
Match Plot



Match Plot



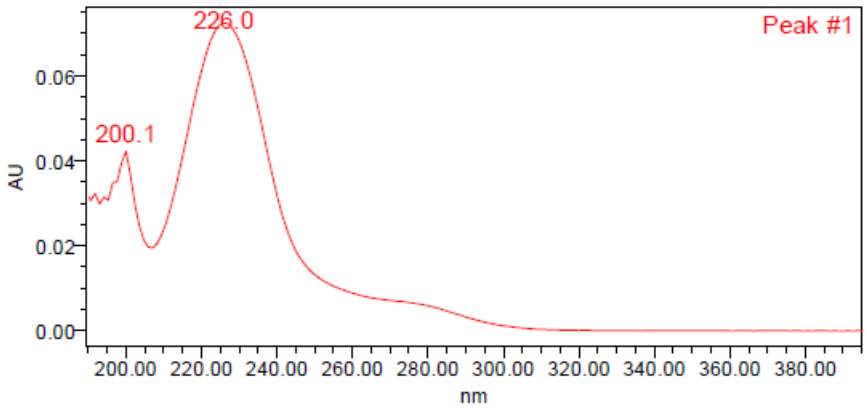
4k



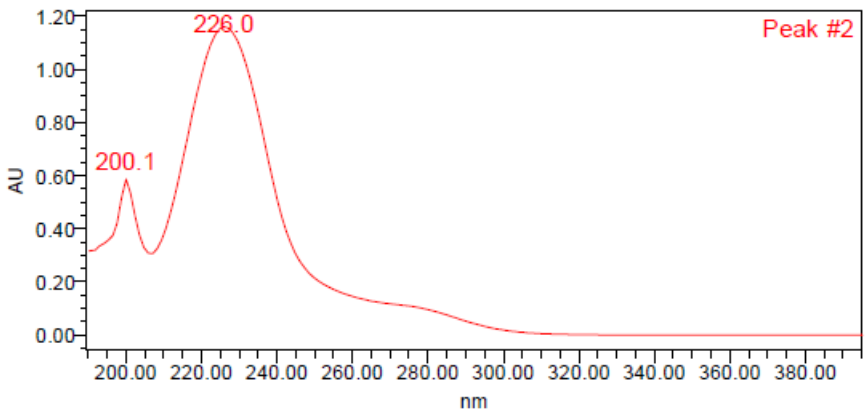
Peak Results

	RT	Area	% Area	Height
1	48.387	4092219	5.15	72533
2	52.941	75321742	94.85	1160369

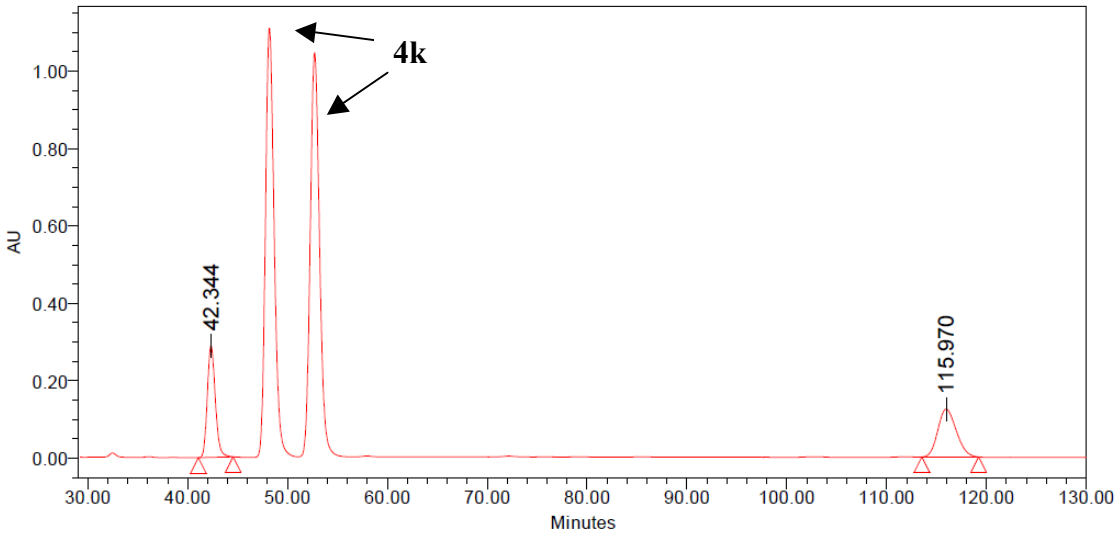
Match Plot



Match Plot



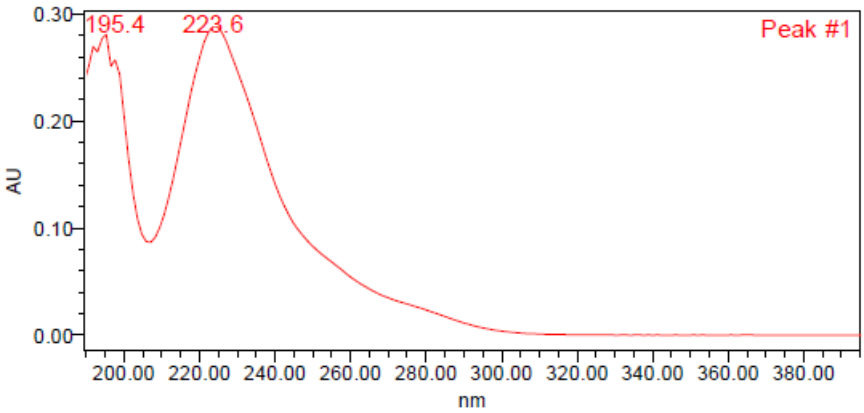
***rac–diast*-4k**



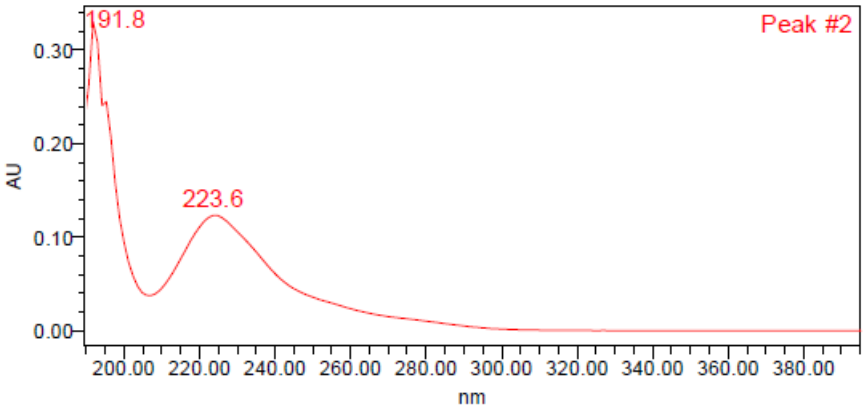
Peak Results

	RT	Area	% Area	Height
1	42.344	16014809	50.33	288412
2	115.970	15804300	49.67	123262

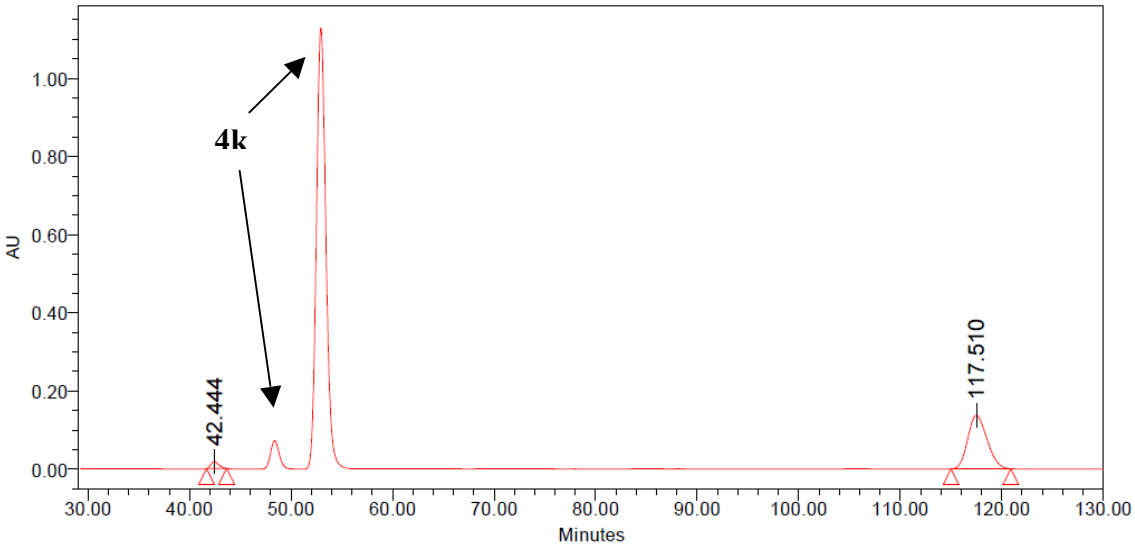
Match Plot



Match Plot



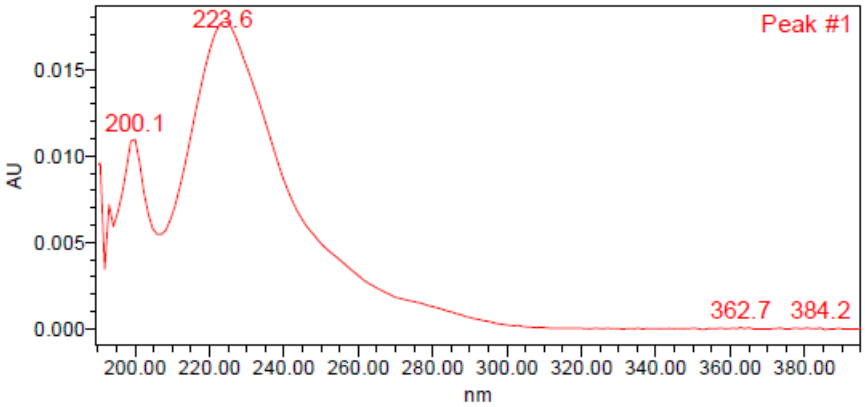
***diast*-4k**



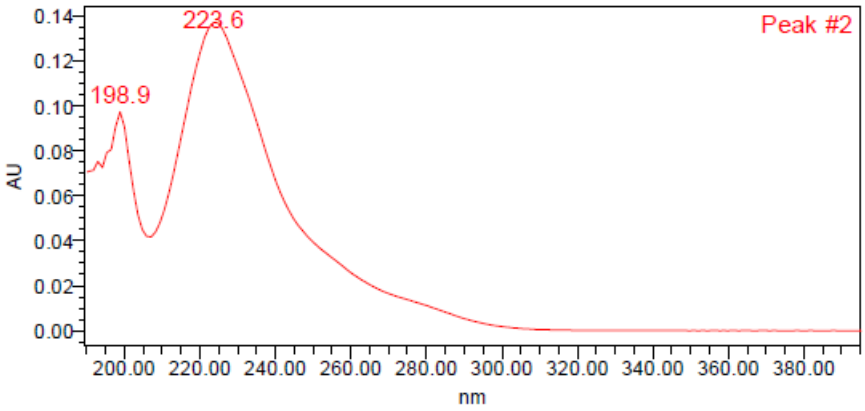
Peak Results

	RT	Area	% Area	Height
1	42.444	955460	5.02	17776
2	117.510	18063034	94.98	136957

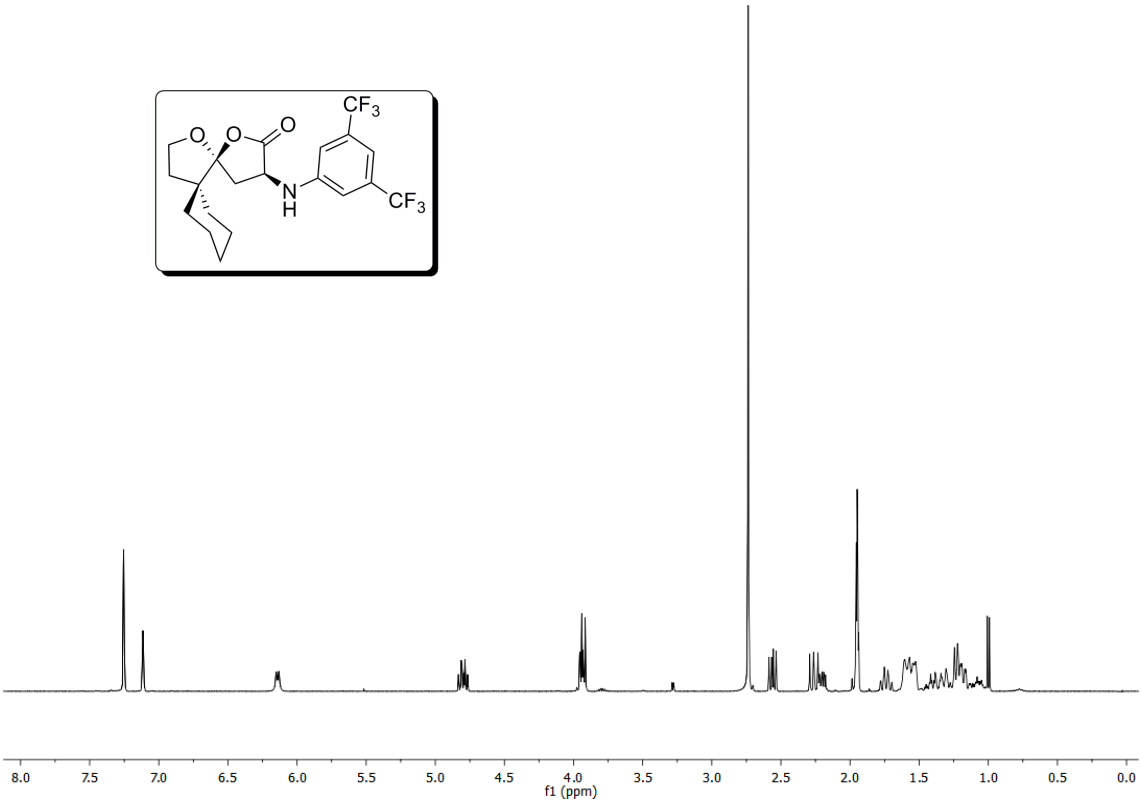
Match Plot

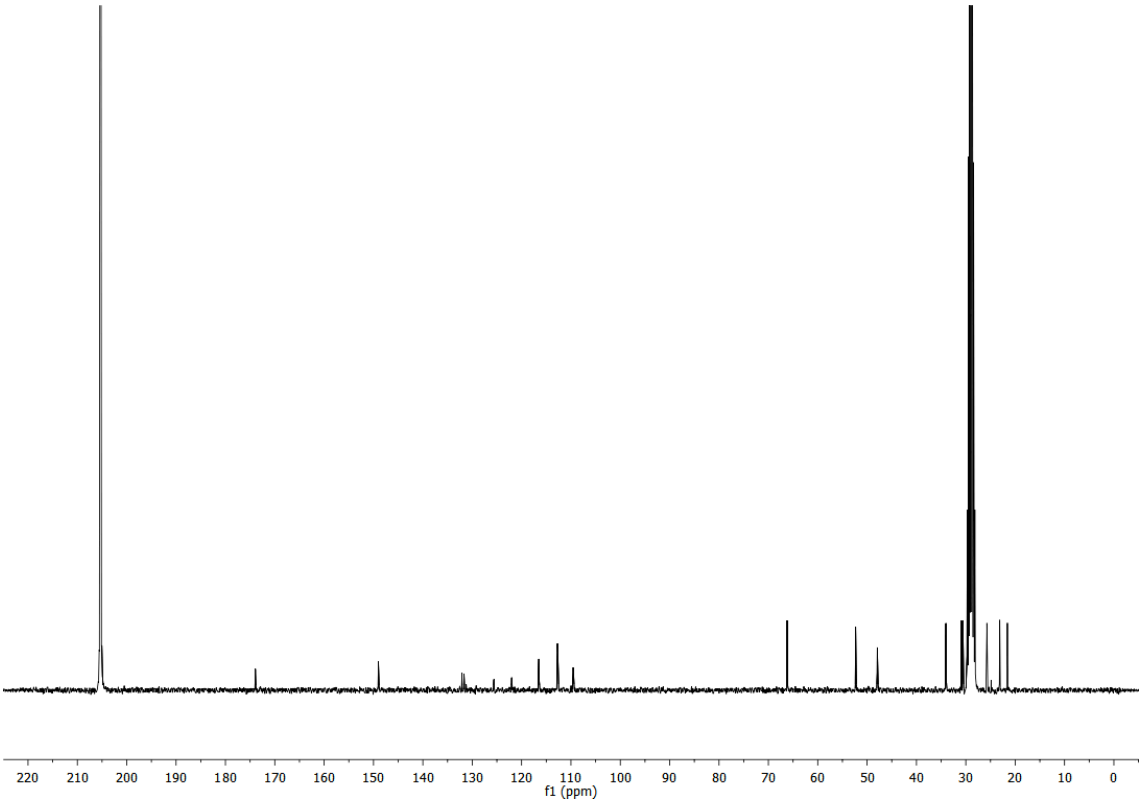


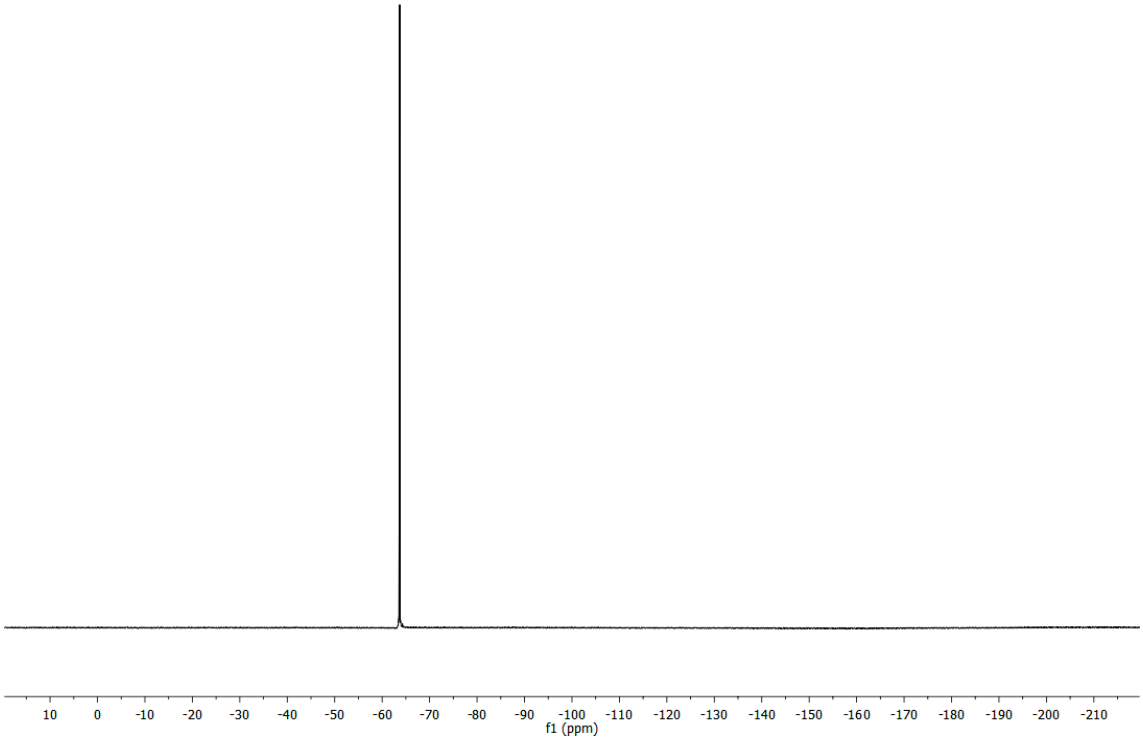
Match Plot



(3*S*,5*R*)-3-[3,5-Bis(trifluoromethyl)phenylamino]-1,14-dioxadispiro[4.0.5.3]tetradecan-2-one (4l)



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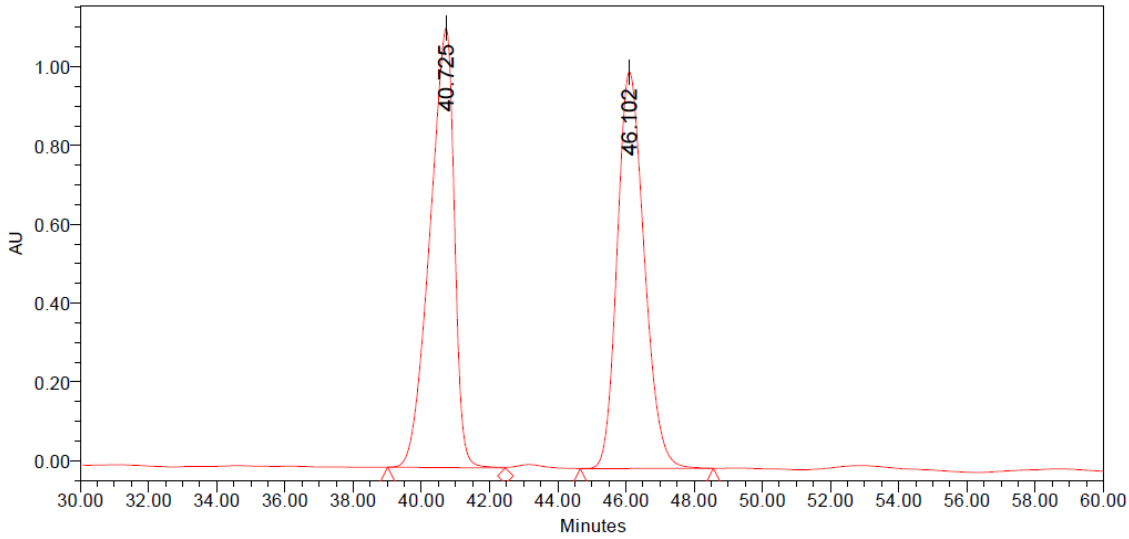
-210
f1 (ppm)

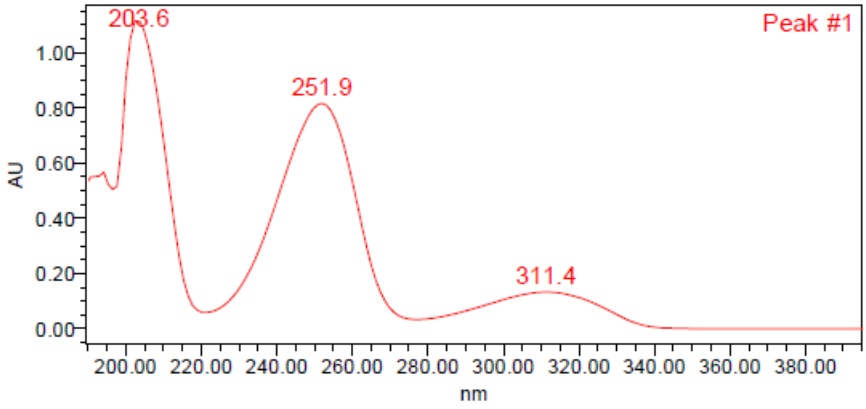
***rac*–4l**



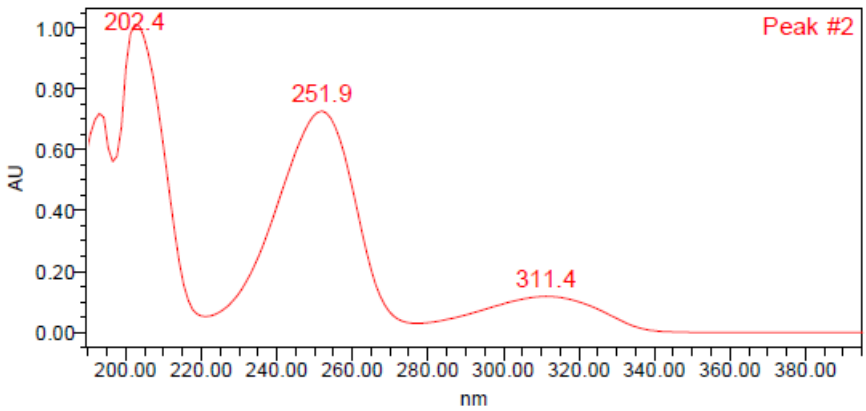
Peak Results

	RT	Area	% Area	Height
1	40.725	55477846	49.99	1115374
2	46.102	55491567	50.01	1006076

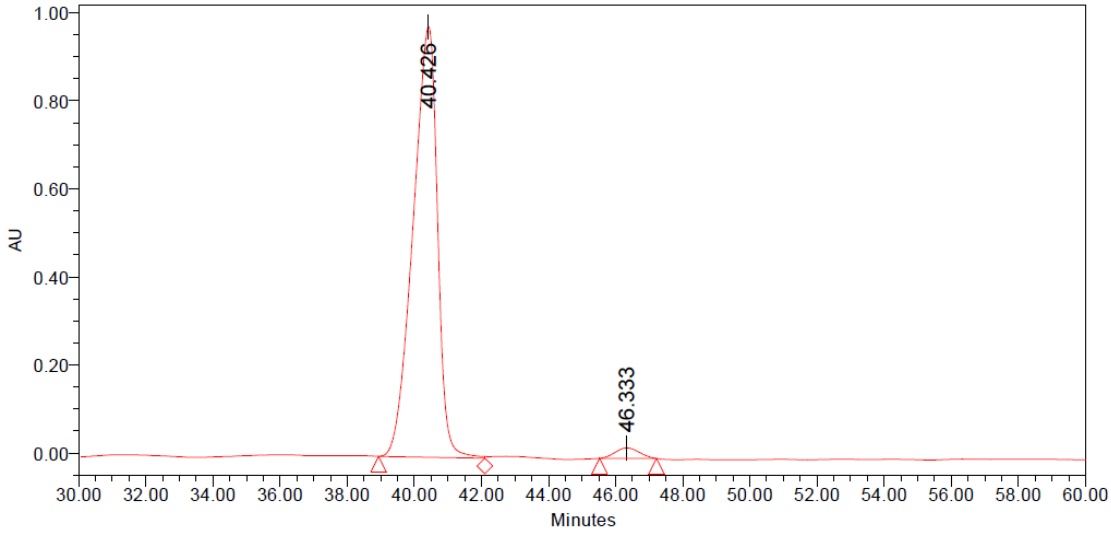
Match Plot



Match Plot



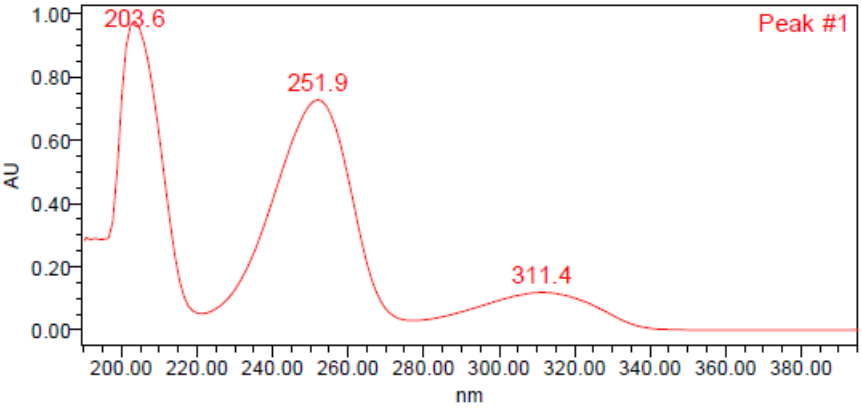
4l



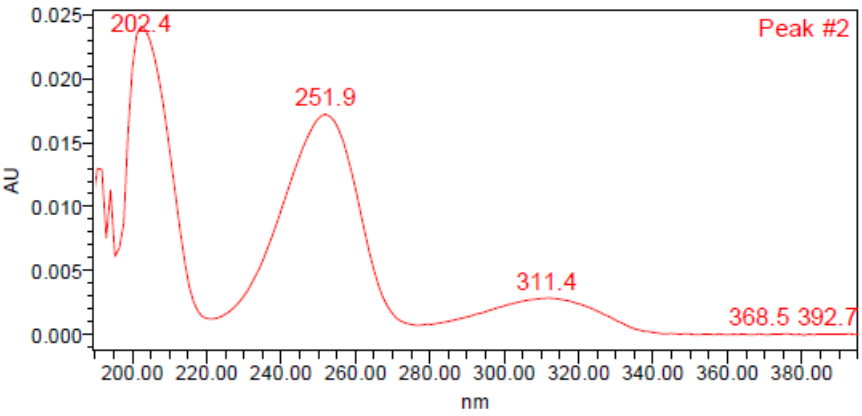
Peak Results

	RT	Area	% Area	Height
1	40.426	49333396	97.65	977963
2	46.333	1184739	2.35	23802

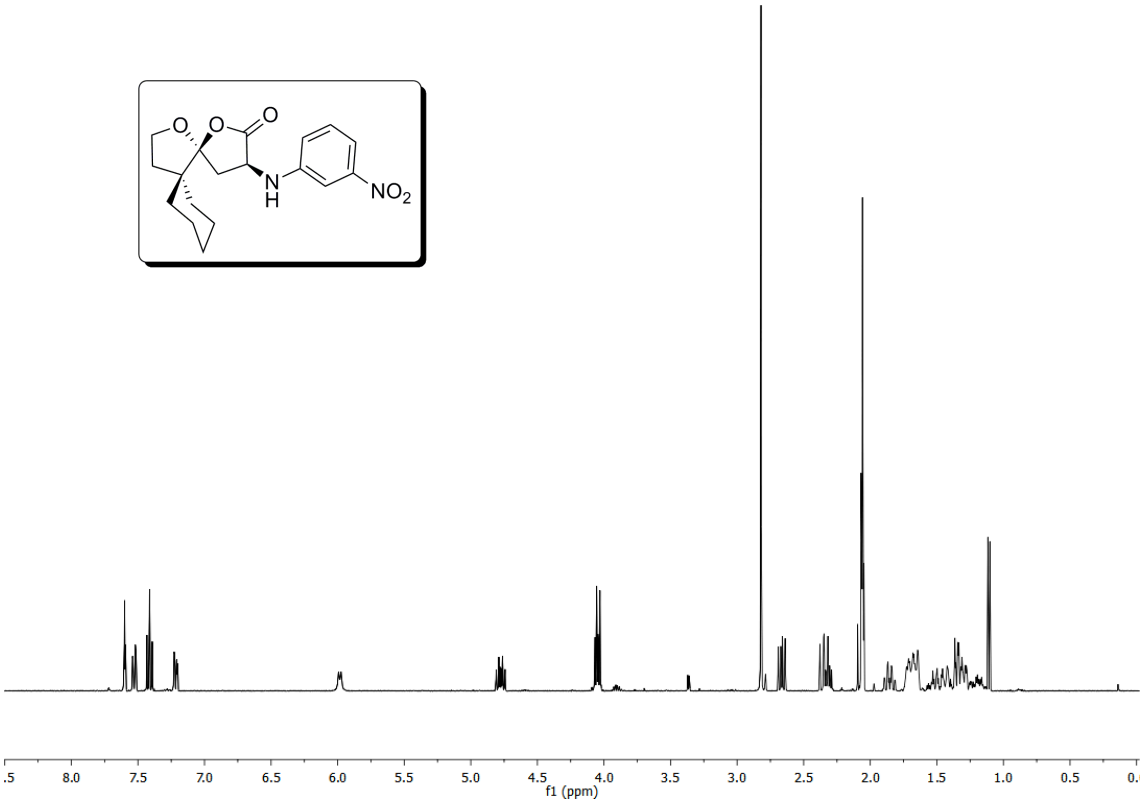
Match Plot

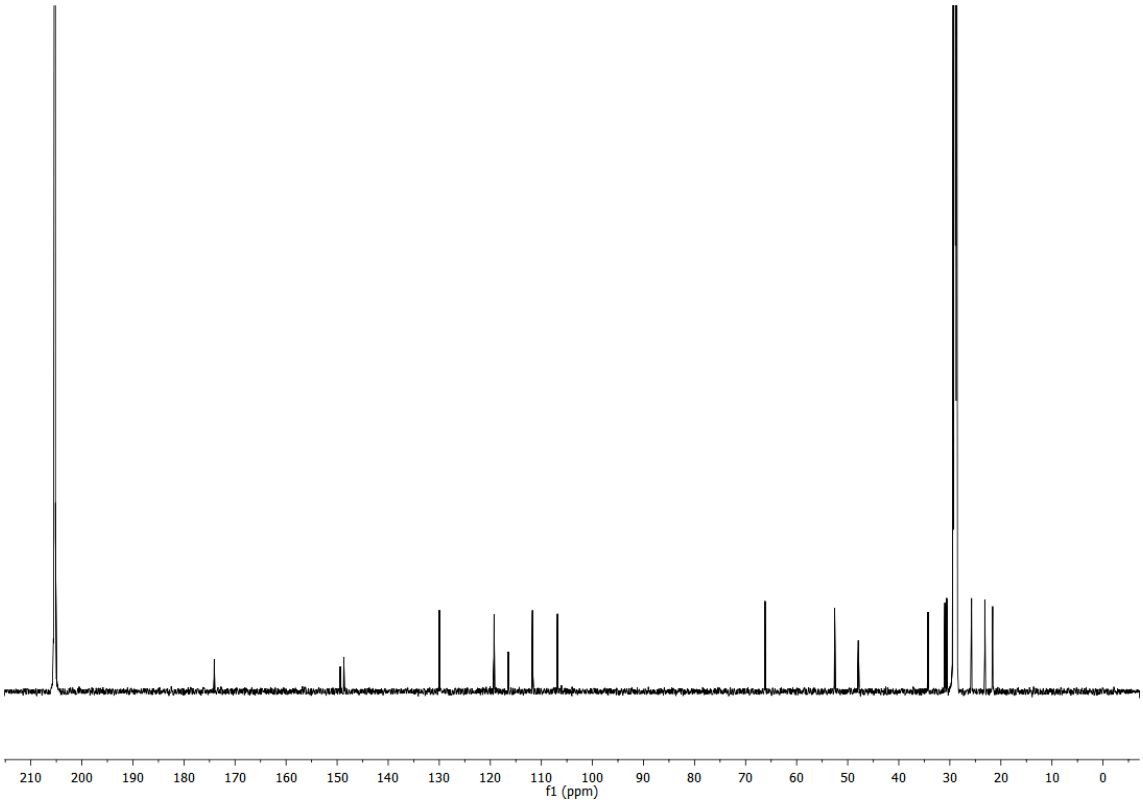


Match Plot

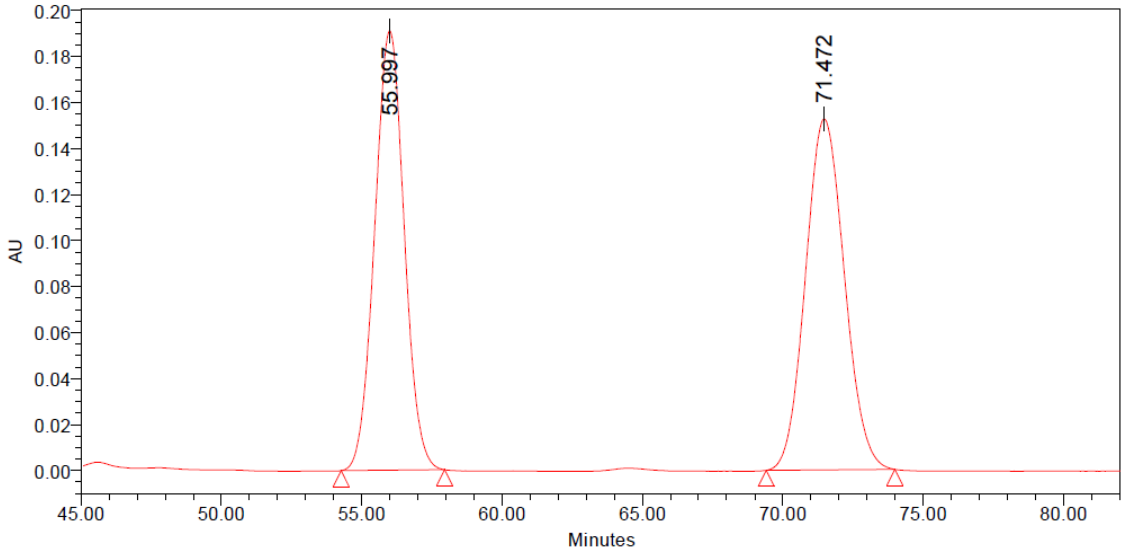


(3*S*,5*R*)-3-(3-Nitrophenylamino)-1,14-dioxadispiro[4.0.5.3]tetradecan-2-one (4m)





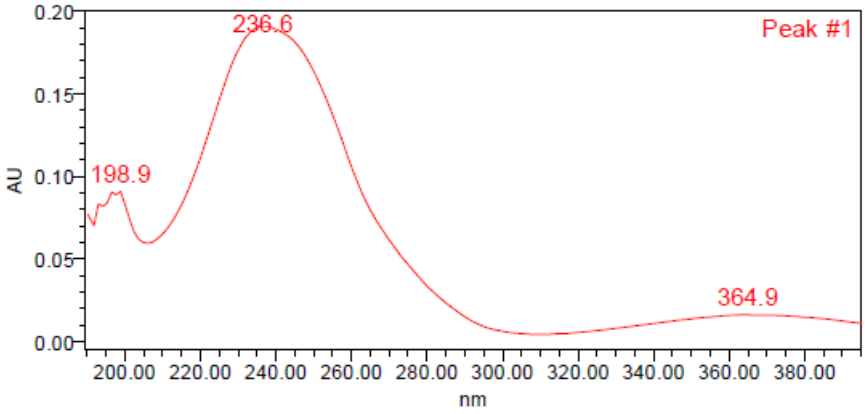
***rac*–4m**



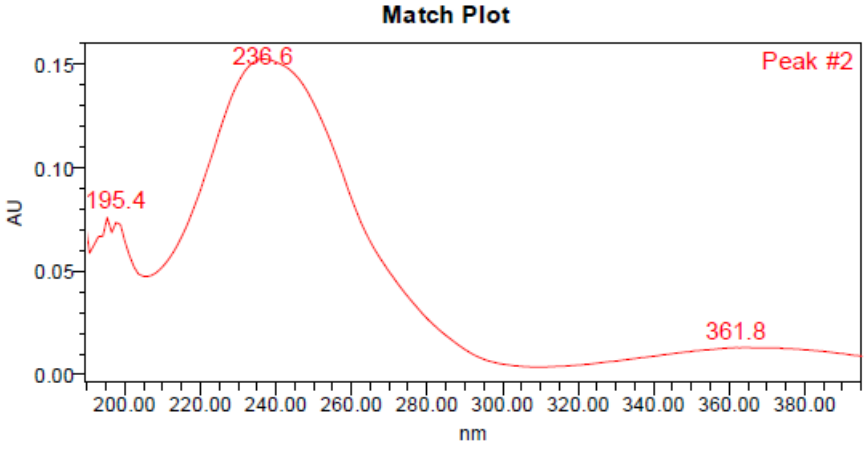
Peak Results

	RT	Area	% Area	Height
1	55.997	13962570	48.67	191005
2	71.472	14724971	51.33	152542

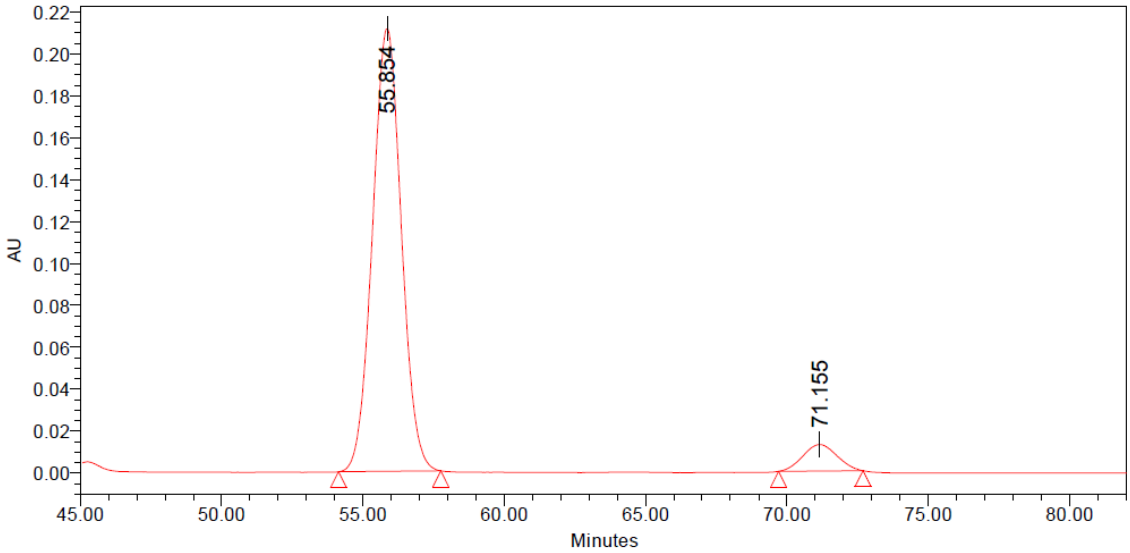
Match Plot



Match Plot



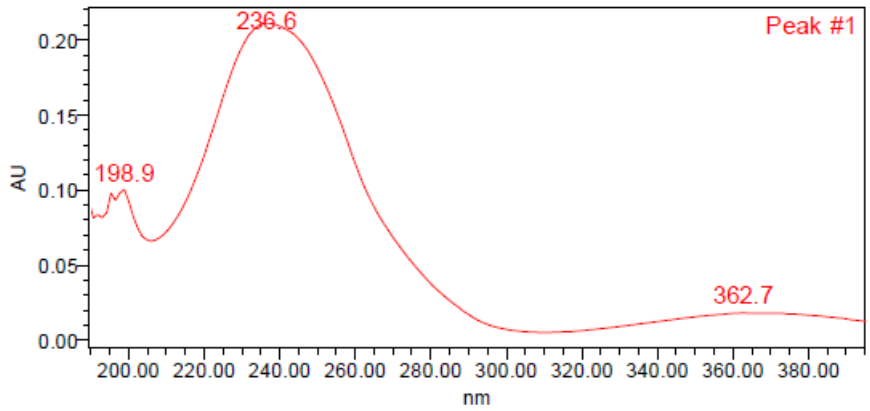
4m



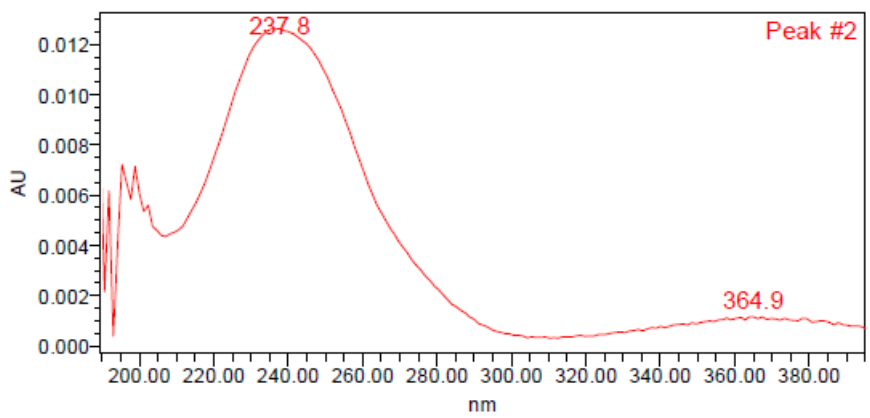
Peak Results

	RT	Area	% Area	Height
1	55.854	14966311	93.40	211260
2	71.155	1058177	6.60	12617

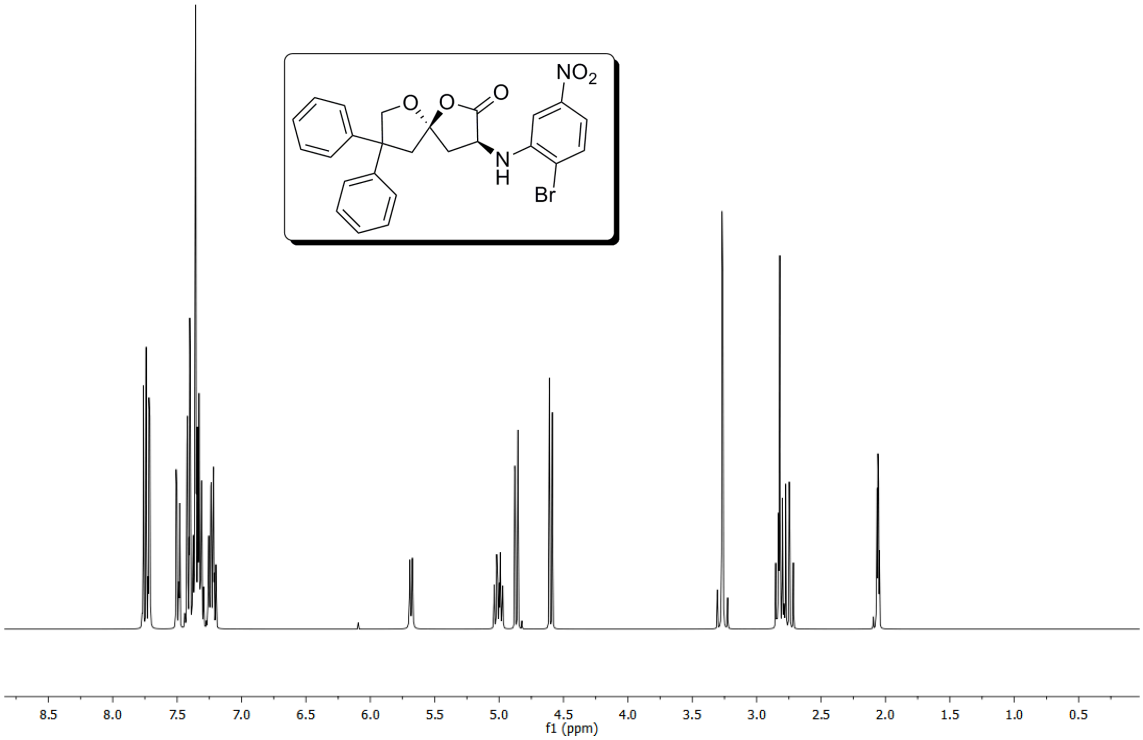
Match Plot

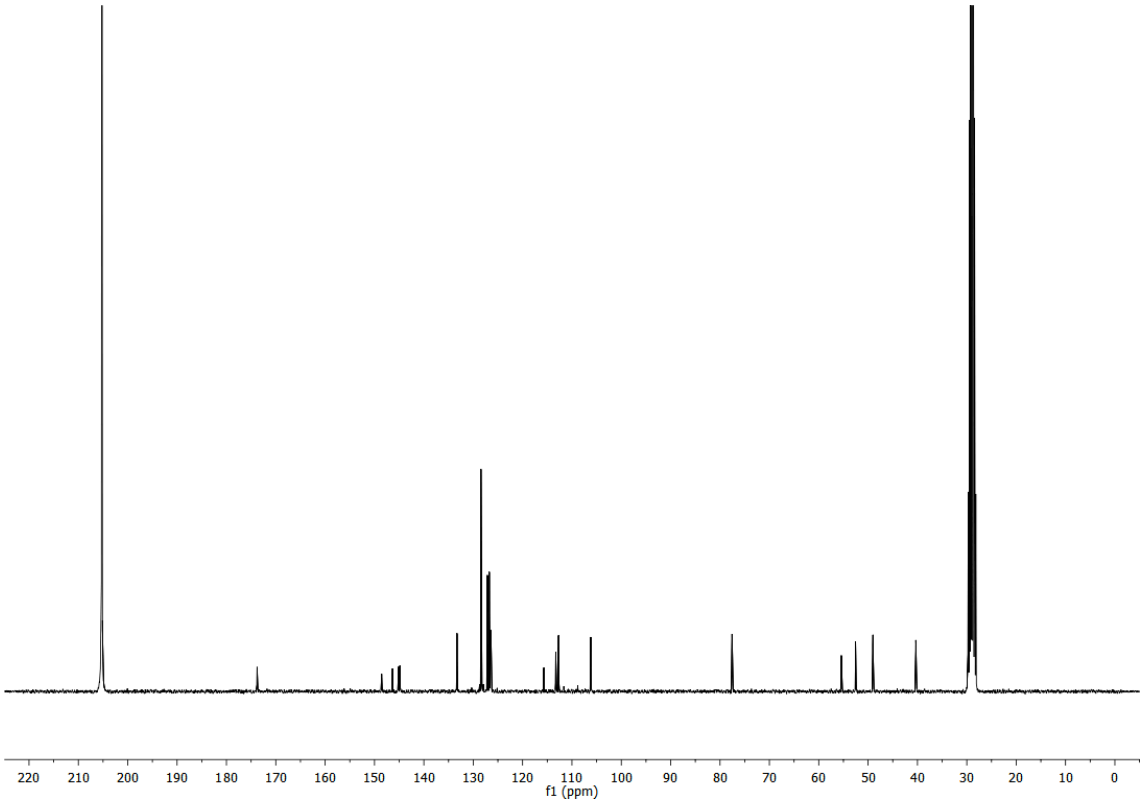


Match Plot

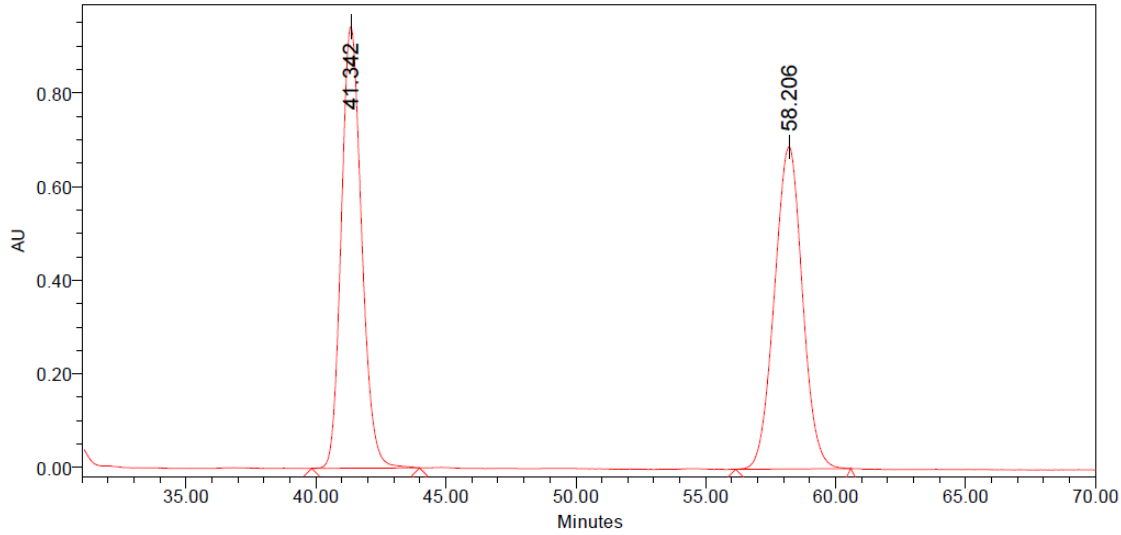


(3*S*,5*R*)-3-(2-Bromo-5-nitrophenylamino)-8,8-diphenyl-1,6-dioxaspiro [4.4]nonan-2-one (4n)





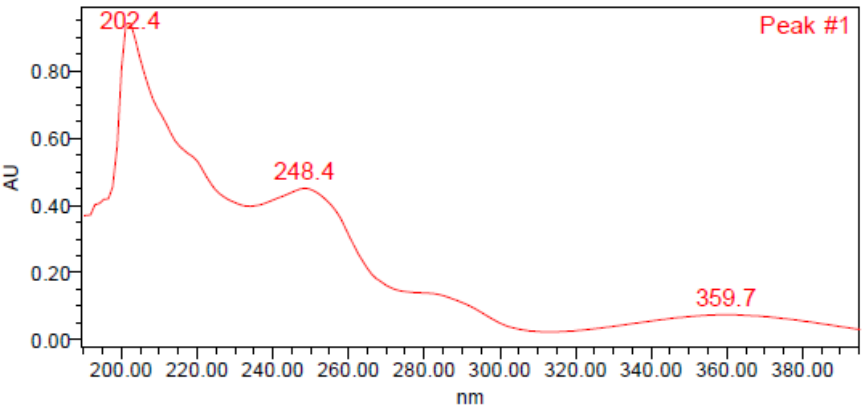
***rac*–4n**



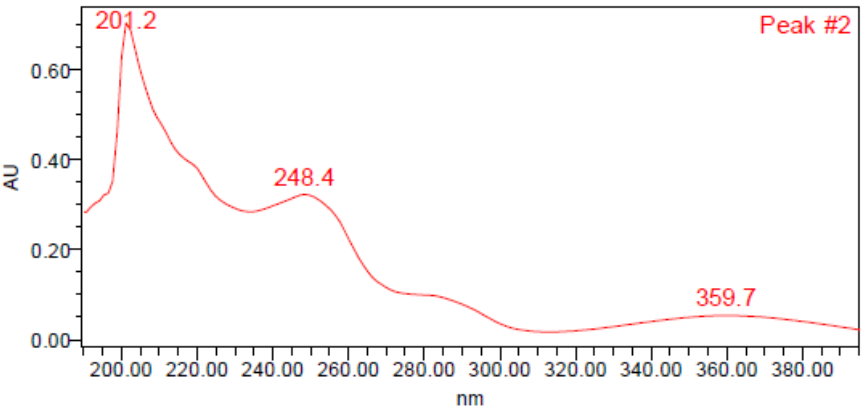
Peak Results

	RT	Area	% Area	Height
1	41.342	51267108	49.81	943190
2	58.206	51663865	50.19	688514

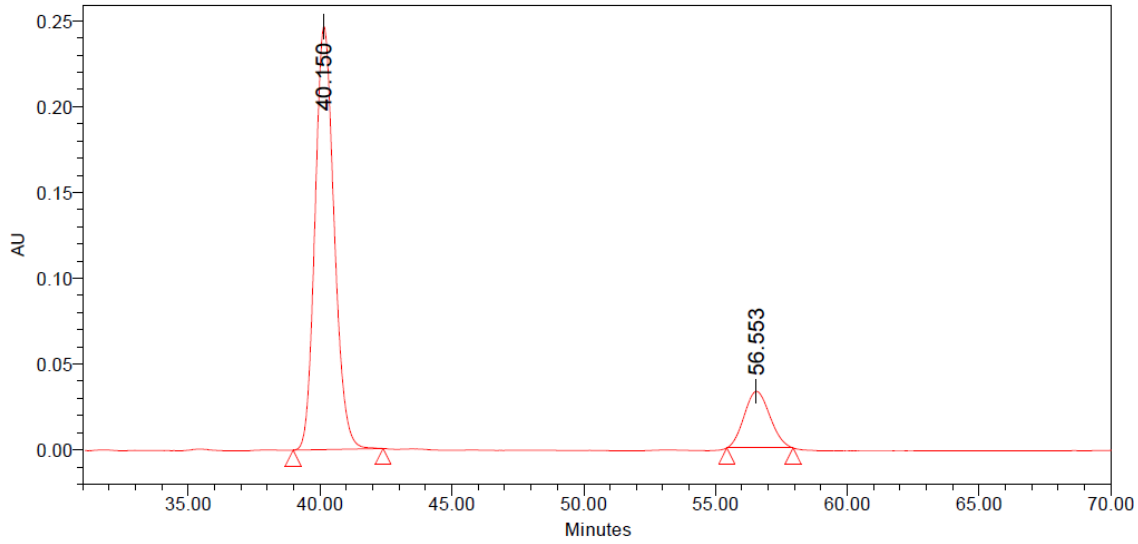
Match Plot



Match Plot



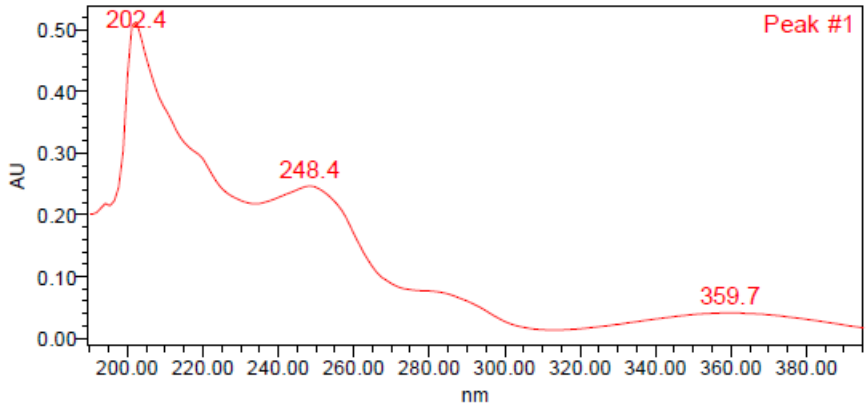
4n



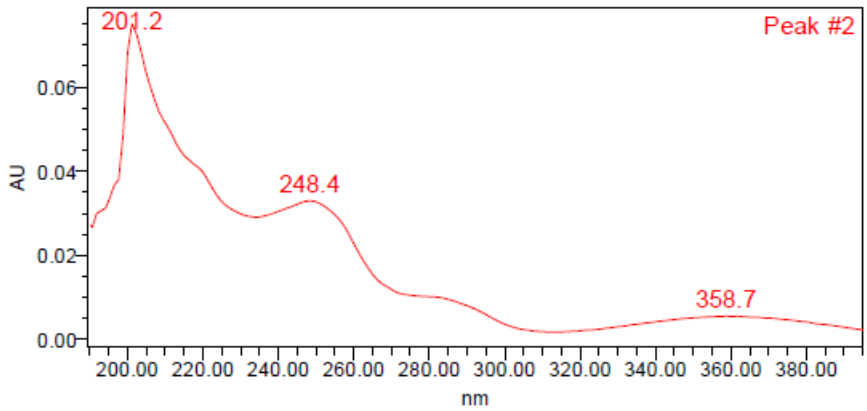
Peak Results

	RT	Area	% Area	Height
1	40.150	12406465	84.75	246554
2	56.553	2233053	15.25	32953

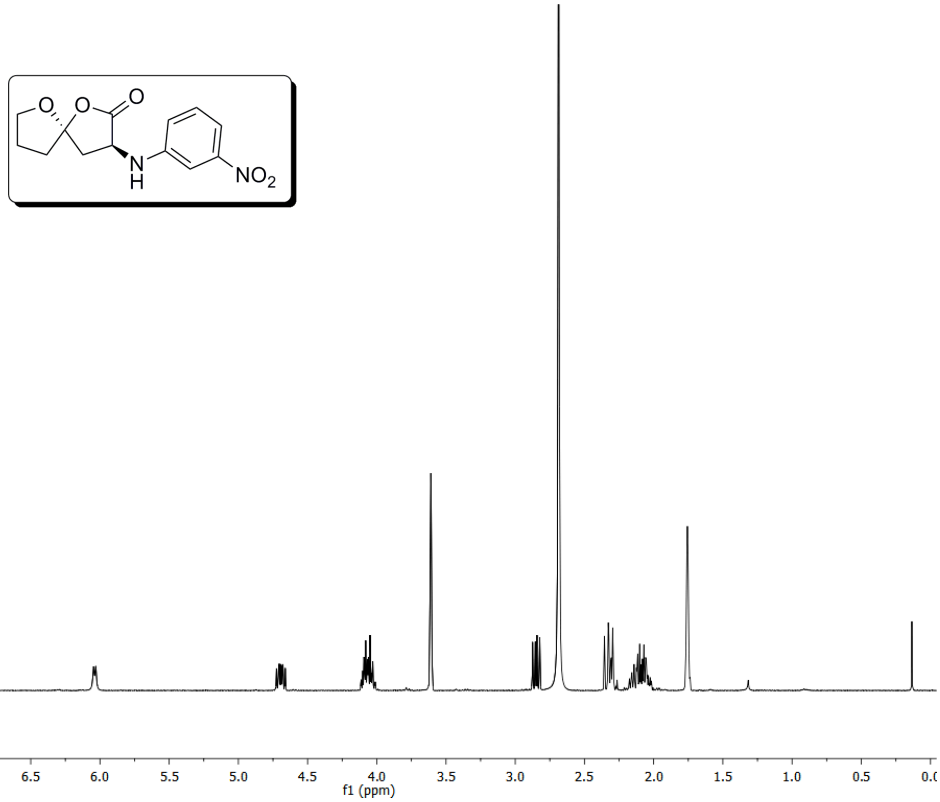
Match Plot

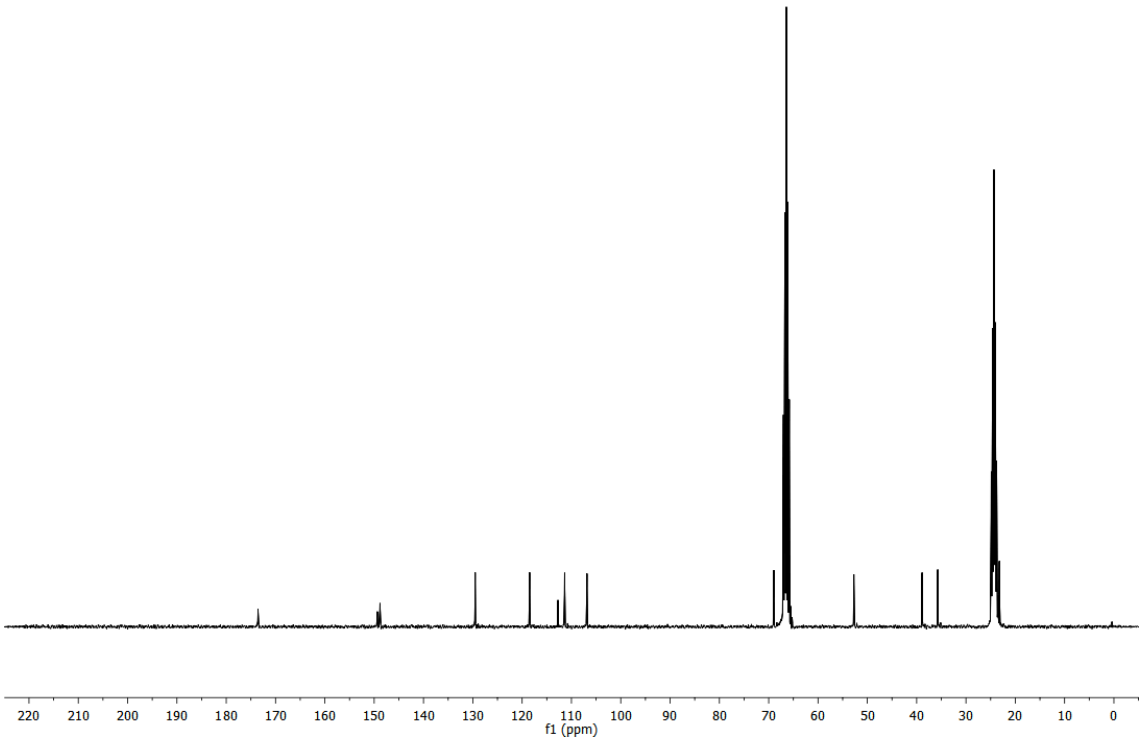


Match Plot

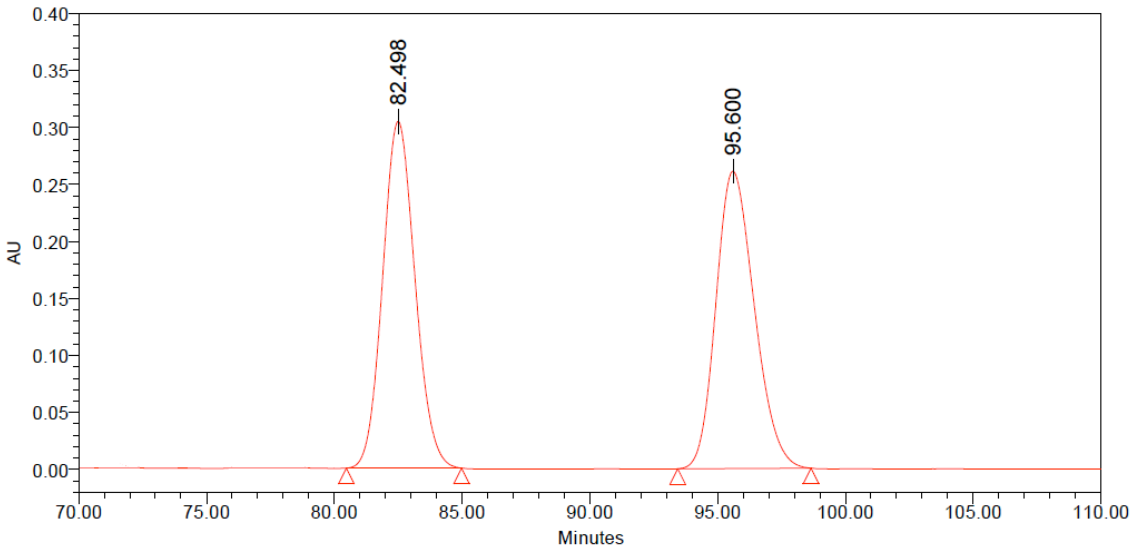


(3*S*,5*R*)-3-(3-nitrophenylamino)-1,6-dioxaspiro[4.4]nonan-2-one (4o)





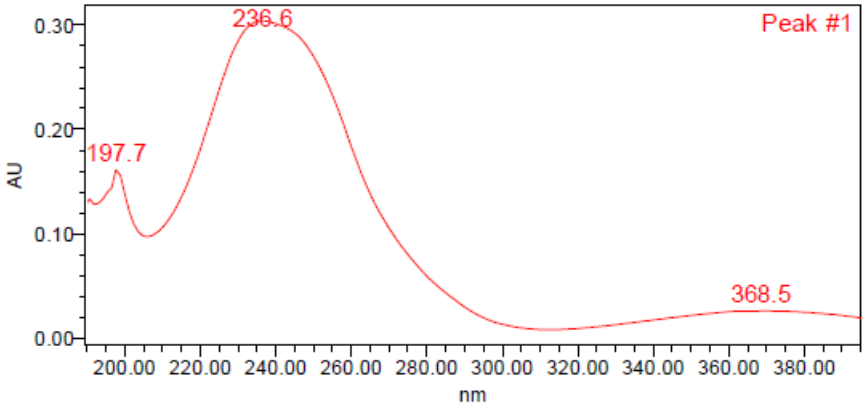
***rac*–4o**



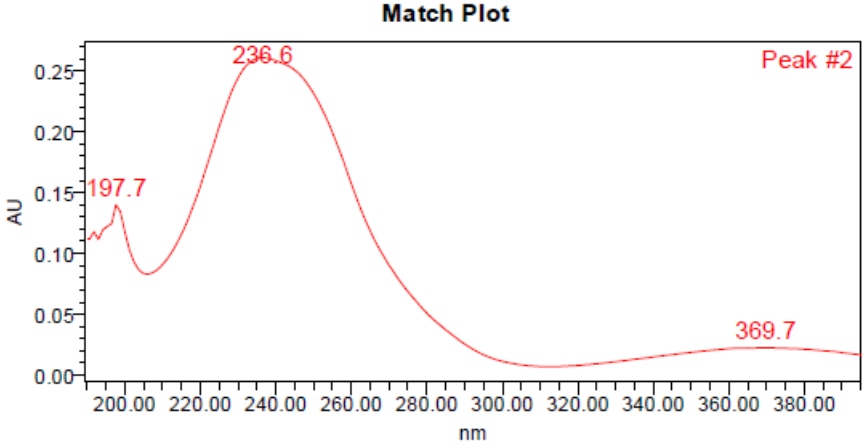
Peak Results

	RT	Area	% Area	Height
1	82.498	26786769	49.56	304235
2	95.600	27259890	50.44	260822

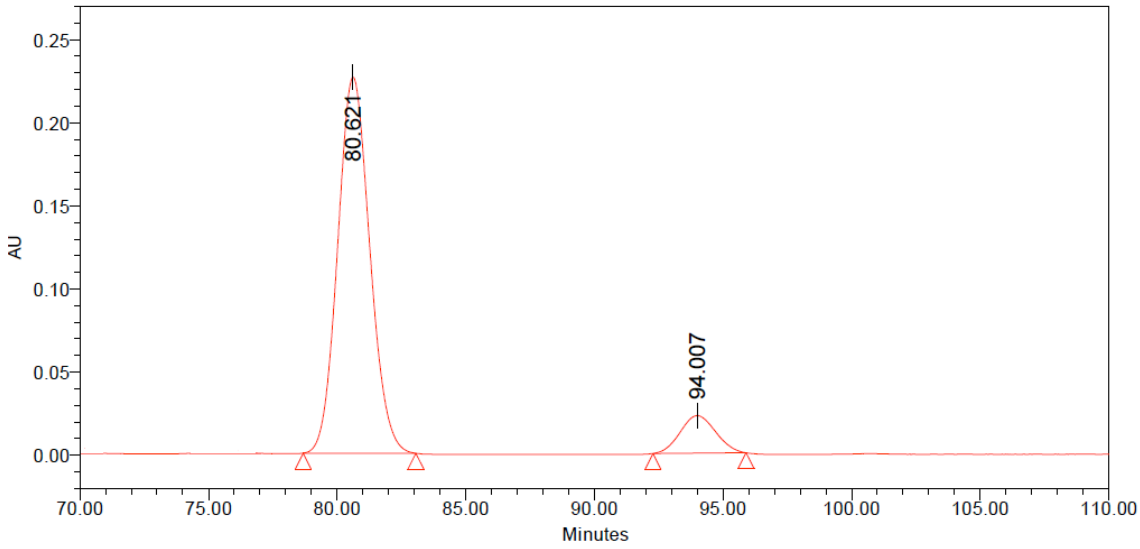
Match Plot



Match Plot



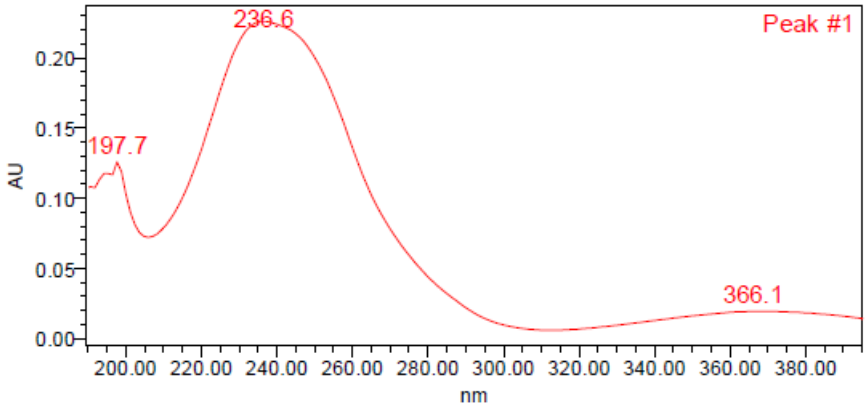
4o



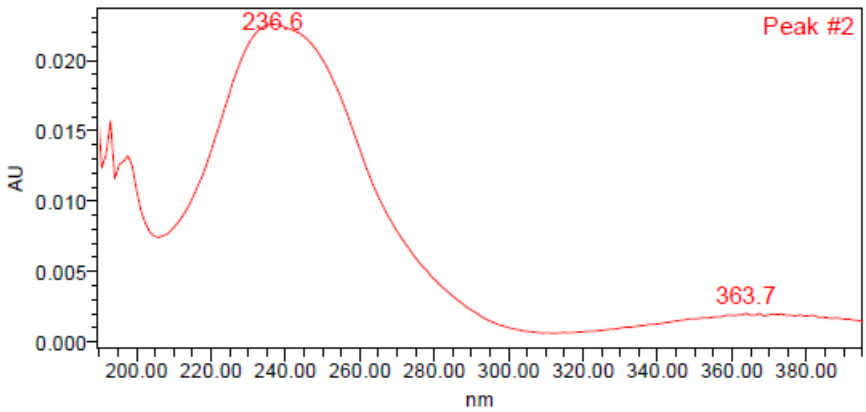
Peak Results

	RT	Area	% Area	Height
1	80.621	19628046	90.10	226165
2	94.007	2156246	9.90	22582

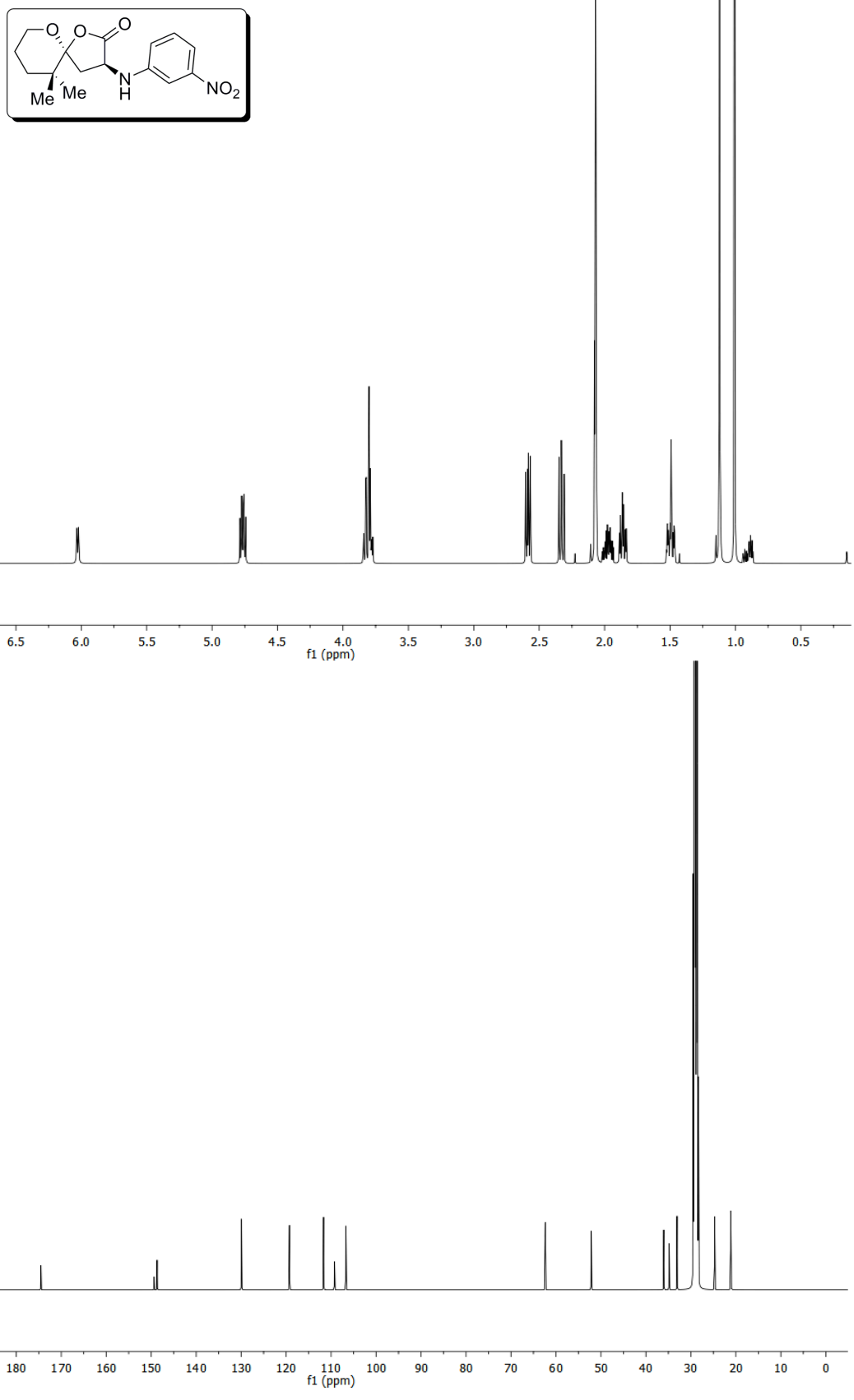
Match Plot



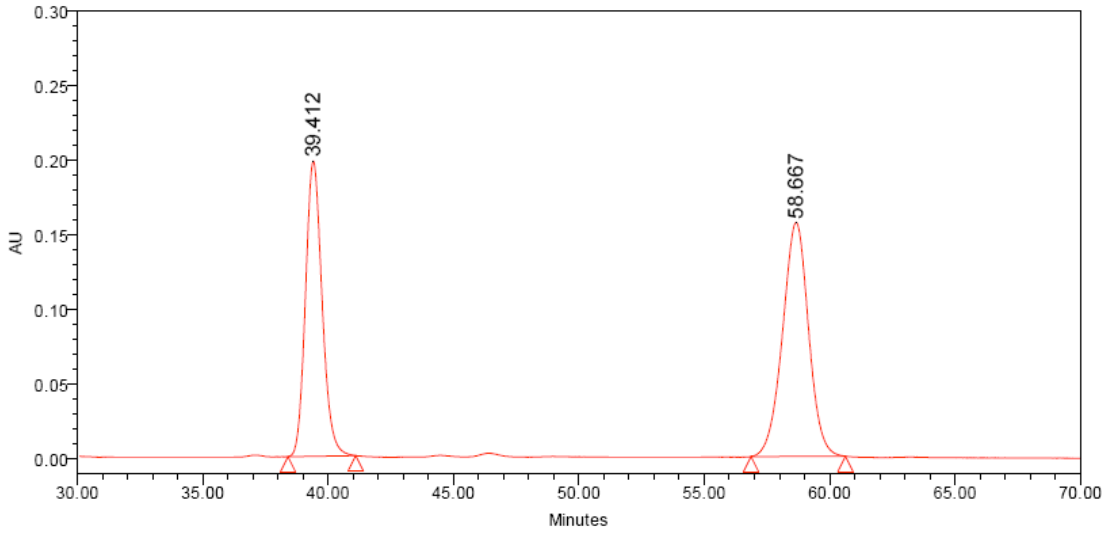
Match Plot



(3S,5S)-10,10-dimethyl-3-(3-nitrophenylamino)-1,6-dioxaspiro[4.5]decan-2-one (4p)



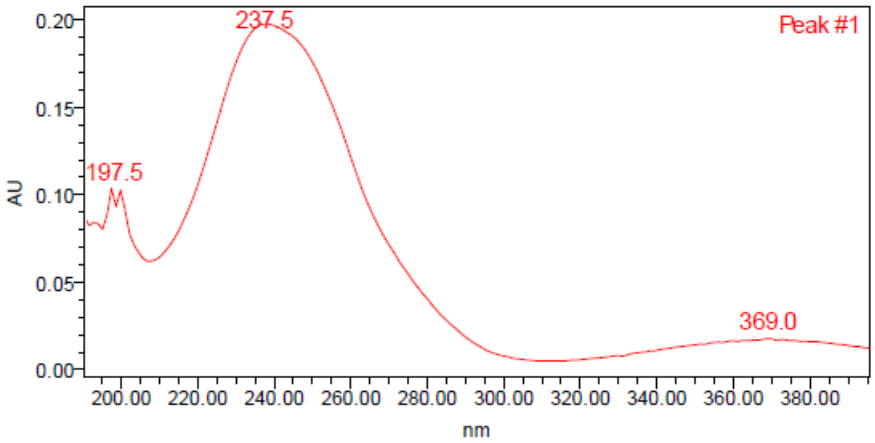
***rac*-4p**



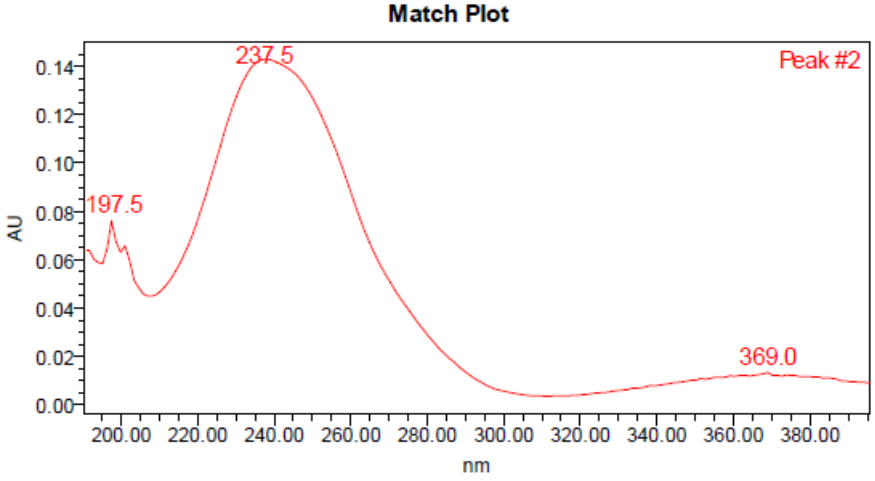
Peak Results

	RT	Area	% Area	Height
1	39.412	9100329	49.98	197915
2	58.667	9105814	50.02	142910

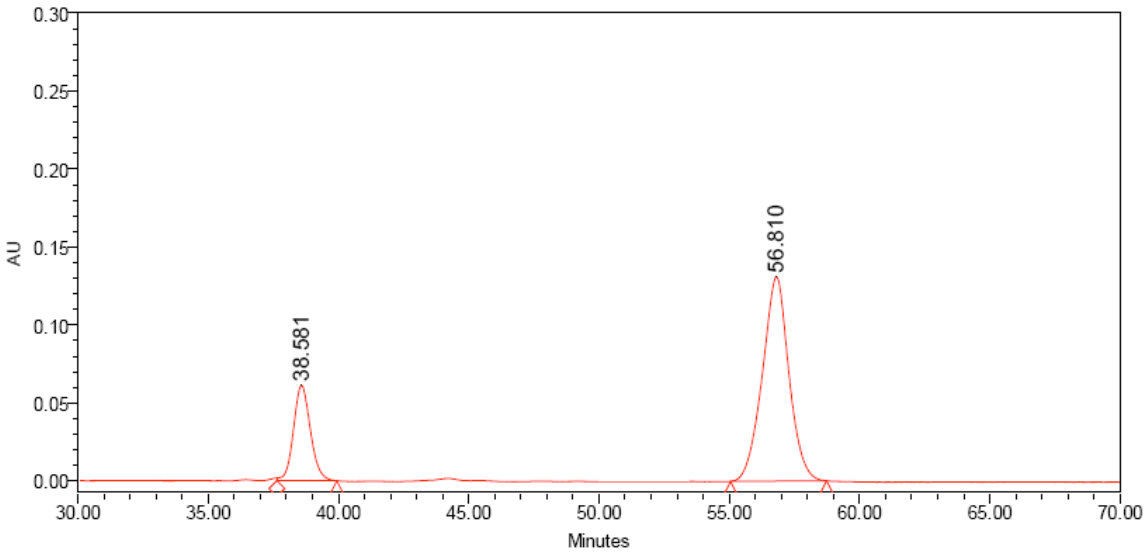
Match Plot



Match Plot



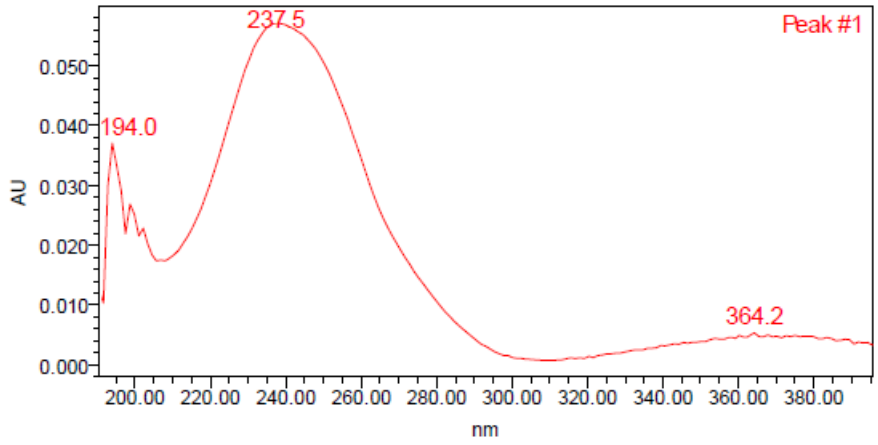
4p



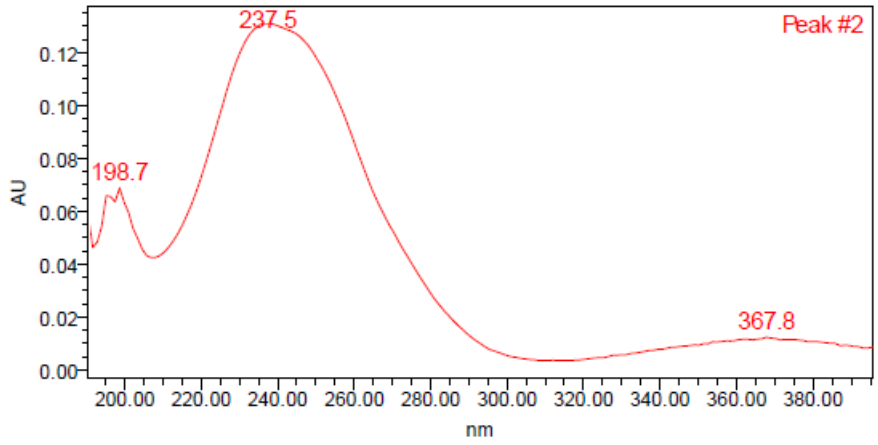
Peak Results

	RT	Area	% Area	Height
1	38.581	2361202	20.29	57124
2	56.810	9275155	79.71	131095

Match Plot



Match Plot



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***Ortep* representation of (3*S*,5*R*)-3-(2-bromo-5-nitrophenylamino)-8,8-diphenyl-1,6-dioxaspiro[4.4]nonan-2-one (4n)**