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The first organocatalytic, *ortho*-regioselective inverse-electron-demand hetero-Diels-Alder reaction

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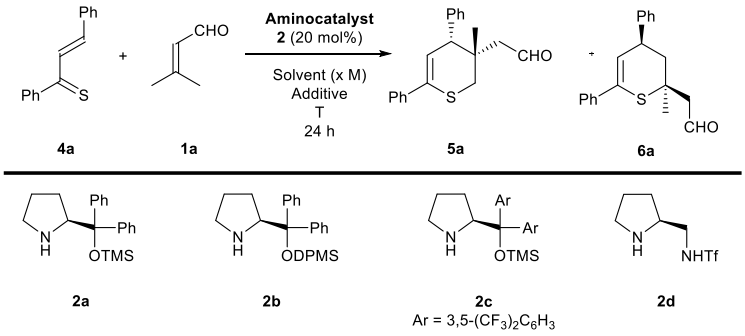
1. General methods

NMR spectra were acquired on a Bruker Ultra Shield 700 instrument, running at 700 MHz for ^{1}H and 176 MHz for ^{13}C, respectively. Chemical shifts (δ) are reported in ppm relative to residual solvent signals ($CDCl_3$: 7.26 ppm for ^{1}H NMR, 77.16 ppm for ^{13}C NMR). Mass spectra were recorded on a Bruker Maxis Impact spectrometer using electrospray (ES+) ionization (referenced to the mass of the charged species). Optical rotations were measured on a Perkin-Elmer 241 polarimeter and $[\alpha]_D$ values are given in deg•cm•g^{-1}•dm^{-1}; concentration *c* is listed in g•(100 mL)$^{-1}$. Analytical thin layer chromatography (TLC) was performed using pre-coated aluminum-backed plates (Merck Kieselgel 60 F254) and visualized by ultraviolet irradiation or I_2 stain. The enantiomeric ratio (er) of the products was determined by chiral stationary phase HPLC (Daicel Chiralpak IA and IC column). Unless otherwise noted, analytical grade solvents and commercially available reagents were used without further purification. For flash chromatography (FC) silica gel (Silica gel 60, 230-400 mesh, Fluka). Thiochalcones **4**[1] and α,β-unsaturated aldehydes **1**[2] were prepared according to literature procedures. Aminocatalysts **2** were synthesized following the literature procedures.[3]

[1] a) N. M. Rabet and H. F. Zohdi, *Synth. Commun.,* 2009, **39**, 2787; b) J. Montess-Avila, S.P. Diaz-Camacho, J. Sicairos-Félix, F. Delgado-Vargas and I. A. Rivero, *Bioorg. Med. Chem.,* 2009, **17**, 6780; c) S. Attar, Z. O'Brien, H. Alhaddad, M. L. Golden and A. Calderón-Urrea, *Bioorg. Med. Chem.,* 2011, **19**, 2055.
[2] H. Jiang, K. S. Halskov, T. K. Johansen and K. A. Jørgensen, *Chem. Eur. J.* 2011, **17**, 3842.
[3] U. Grošelj, D. Seebach, D. M. Badine, W. B. Schweizer, A. K. Beck, I. Krossing, P. Klose, Y. Hayashi and T. Uchimaru, *Helv. Chim. Acta* 2009, **92**, 1225.

2. o*rtho*-Regioselective inverse-electron-demand hetero-Diels-Alder (IEDHDA) reaction – optimization studies

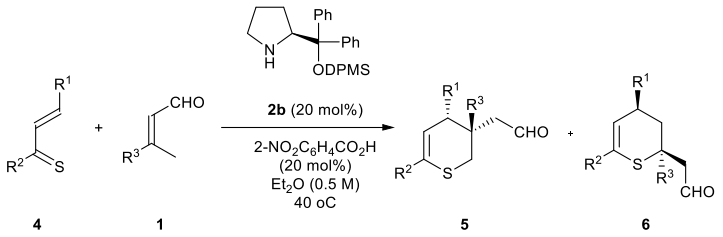


Entry	Cat.	Solvent	Additive (20 mol%)	Conv.[b]	rr[c]	dr (**5a**)[d]	er (**5a**)[e]
1	**2a**	$CHCl_3$	-	>95	1:2.5	> 95:5	n.d.
2	**2a**	CH_2Cl_2	-	81	1:1.7	>95:5	n.d.
3	**2a**	DCE	-	81	1:1.7	>95:5	n.d.
4	**2a**	THF	-	39	1:2.5	>95:5	n.d.
5	**2a**	Toluene	-	93	1.4:1	>95:5	n.d.
6	**2a**	1,4-Dioxane	-	88	1.4:1	>95:5	n.d.
7	**2a**	Et_2O	-	>95	1.7:1	>95:5	99:1
8	**2a**	MTBE	-	>95	1.4:1	>95:5	n.d.
9	**2a**	CH_3CN	-	70	1:1.7	>95:5	n.d.
10	**2b**	Et_2O	-	>95 (62)	3.5:1	>95:5	97:3
11	**2c**	Et_2O	-	>95 (42)	4:1	>95:5	98:2
12	**2d**	Et_2O	-	decomposition	-	-	-
13	**2a**	Et_2O	2-$(NO_2)C_6H_4CO_2H$	>95	3.3:1	>95:5	n.d.
14	**2a**	Et_2O	NaOAc	>95	1.4:1	>95:5	n.d.
15	**2a**	Et_2O	$PhCO_2H$	92	1.8:1	>95:5	n.d.
16	**2a**	Et_2O	NEt_3	85	1.4:1	>95:5	n.d.
17	**2c**	Et_2O	NaOAc	71	2.5:1	>95:5	n.d.
18	**2c**	Et_2O	$PhCO_2H$	79	2.5:1	>95:5	n.d.
19	**2c**	Et_2O	2-$(NO_2)C_6H_4CO_2H$	60	4:1	>95:5	n.d.
20	**2c**	Et_2O	TEA	75	2.8:1	>95:5	n.d.
21	**2b**	Et_2O	2-$(NO_2)C_6H_4CO_2H$	>95 (40)	5:1	>95:5	n.d.
22	**2b**	Et_2O	2-$FC_6H_4CO_2H$	86 (31)	4.2:1	>95:5	n.d.

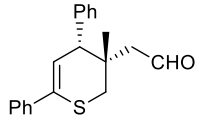
23	**2b**	Et_2O	4-$((CH_3)_2N)C_6H_4CO_2H$	88 (34)	3.3:1	>95:5	n.d.
24[f]	**2b**	Et_2O	2-$(NO_2)C_6H_4CO_2H$	>95 (26)	5:1	>95:5	n.d.
25[g]	**2b**	Et_2O	2-$(NO_2)C_6H_4CO_2H$	>95 (51)	5:1	>95:5	n.d.
26[h]	**2b**	Et_2O	2-$(NO_2)C_6H_4CO_2H$	>95 (70)	5:1	>95:5	99:1
27[i]	**2b**	Et_2O	2-$(NO_2)C_6H_4CO_2H$	>95 (26)	3.3:1	>95:5	n.d.

[a] Reactions performed on a 0.1 mmol scale using **4a** (1.0 equiv) and **1a** (1.0 equiv) in 0.4 mL of the solvent. [b] Conversion as determined by ^{1}H NMR of a crude reaction mixture. In parentheses isolated yields are given. [c] Regioisomeric ratio (rr) **5a**:**6a** as determined by ^{1}H NMR of a crude reaction mixture. [d] Diastereomeric ratio for **5a** as determined by ^{1}H NMR of a crude reaction mixture. [e] Determined by a chiral stationary phase HPLC. [f] Reaction performed using **1a** (2 equiv). [g] Reaction performed using **4a** (2 equiv). [h] Reaction performed using **4a** (2 equiv) in 0.2 mL of Et_2O. [i] Reaction performed using **4a** (2 equiv) in 0.8 mL of Et_2O.

3. *ortho*-Regioselective inverse-electron-demand hetero-Diels-Alder (IEDHDA) reaction – general procedure

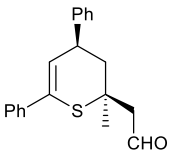


An ordinary screw-cap vial was charged with a magnetic stirring bar, the corresponding α,β -unsaturated aldehyde **1** (0.1 mmol, 1 equiv), the thiochalcone **4** (0.2 mmol, 2 equiv), the catalyst **2b** (0.02 mmol, 0.4 equiv) and Et_2O (0.2 mL). The reaction mixture was stirred at 40 °C and monitored by ^1H NMR spectroscopy. After 24-48 h the mixture was directly purified by FC on silica gel to afford a target product.



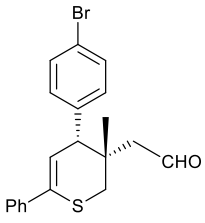
5a 2-((3*S*,4*R*)-3-Methyl-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

Following the general procedure (reaction time 24 h, 5:1 rr), **5a** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 70% yield as an yellow oil (>95:5 dr). ^1H NMR (700 MHz, $CDCl_3$) δ 9.74 (t, *J* = 2.1 Hz, 1H), 7.55 – 7.52 (m, 2H), 7.36 – 7.27 (m, 6H), 7.25 – 7.22 (m, 2H), 6.06 (d, *J* = 4.2 Hz, 1H), 3.54 (d, *J* = 4.2 Hz, 1H), 3.20 (d, *J* = 13.0 Hz, 1H), 2.97 (d, *J* = 13.0 Hz, 1H), 2.58 (dd, *J* = 16.5, 1.8 Hz, 1H), 2.12 (dd, *J* = 16.5, 2.3 Hz, 1H), 1.34 (s, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 202.0, 141.3, 139.6, 133.6, 130.1 (2C), 128.6 (2C), 128.4 (2C), 128.3, 127.4, 126.3 (2C),121.5, 52.3, 49.4, 35.7, 33.1, 25.3. HRMS calculated for $[C_{20}H_{20}OS+H]^+$: 309.1308; found: 309.1300. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 8.4 min, τ_{minor} = 9.7 min (99:1 er). $[\alpha]^{20}_D$ = +24.1 (c = 0.8, $CHCl_3$).



6a 2-((2*S*,4*S*)-2-Methyl-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-2-yl)acetaldehyde

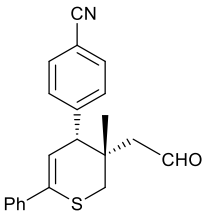
Following the general procedure (reaction time 24 h, 5:1 rr), **6a** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) as an yellow oil (>95:5 dr). ^1H NMR (700 MHz, $CDCl_3$) δ 10.01 (dd, *J* = 3.1, 2.0 Hz, 1H), 7.55 – 7.49 (m, 3H), 7.39 – 7.23 (m, 7H), 6.10 (d, *J* = 2.6 Hz, 1H), 3.69 (ddd, *J* = 12.3, 6.1, 2.7 Hz, 1H), 3.03 (dd, *J* = 15.7, 2.00 Hz, 1H), 2.73 (dd, *J* = 15.6, 3.1 Hz, 1H), 2.27 (dd, *J* = 13.9, 6.1 Hz, 1H), 1.96 (dd, *J* = 13.9, 12.3 Hz, 1H), 1.57 (s, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.7, 144.5, 139.7, 134.1, 128.9 (2C), 128.6 (2C), 128.5, 127.9 (2C), 127.0, 126.7 (2C), 121.9, 51.9, 45.8, 43.7, 41.0, 28.0. HRMS calculated for $[C_{20}H_{20}OS+H]^+$: 309.1308; found: 309.1299. $[\alpha]^{20}_D$ = +35.6 (c = 0.2, $CHCl_3$).



5b 2-((3*S*,4*R*)-4-(4-Bromophenyl)-3-methyl-6-phenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

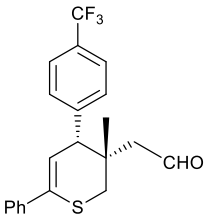
Following the general procedure (reaction time 24 h, 3.5:1 rr), **5b** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 52% yield as an yellow oil (>95:5 dr). ^1H NMR (700 MHz, $CDCl_3$) δ 9.76 (t, *J* = 1.9 Hz, 1H), 7.52 – 7.50 (m, 2H), 7.47 – 7.44 (m, 2H), 7.37 – 7.29 (m, 3H), 7.12 – 7.09 (m, 2H), 5.98 (d, *J* = 4.2 Hz, 1H), 3.52 (d, *J* = 4.2 Hz, 1H), 3.16 (d, *J* = 13.1 Hz, 1H), 2.95 (d, *J* = 13.1 Hz, 1H), 2.57 (dd, *J* = 16.6, 1.7

Hz, 1H), 2.07 (dd, *J* = 16.7, 2.1 Hz, 1H), 1.33 (s, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.6, 140.3, 139.4, 134.2, 131.6 (2C), 131.5 (2C), 128.6 (2C), 128.5, 126.3 (2C), 121.4, 120.7, 51.7, 49.3, 35.5, 32.9, 25.2. HRMS calculated for $[C_{20}H_{19}BrOS+H]^+$: 387.0413; found: 387.0420. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 10.9 min, τ_{minor} = 13.5 min (97:3 er). $[\alpha]^{20}_D$ = +34.3 (c = 0.6, $CHCl_3$).



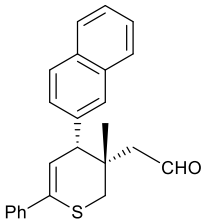
5c 4-((3*S*,4*R*)-3-Methyl-3-(2-oxoethyl)-6-phenyl-3,4-dihydro-2*H*-thiopyran-4-yl)benzonitrile

Following the general procedure (reaction time 24 h, >95:5 rr), **5c** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 8:2) in 64% yield as an white solid (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.77 (t, *J* = 1.8 Hz, 1H), 7.65 – 7.61 (m, 2H), 7.53 – 7.48 (m, 2H), 7.40 – 7.29 (m, 5H), 5.96 (d, *J* = 4.3 Hz, 1H), 3.64 (d, *J* = 4.3 Hz, 1H), 3.17 (d, *J* = 13.1 Hz, 1H), 2.96 (d, *J* = 13.1 Hz, 1H), 2.59 (dd, *J* = 16.6, 1.6 Hz, 1H), 2.01 (dd, *J* = 16.6, 2.0 Hz, 1H), 1.34 (s, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.1, 146.9, 139.1, 135.0, 132.1 (2C), 130.7 (2C), 128.7, 128.6 (2C), 126.2 (2C), 119.6, 118.7, 111.4, 52.1, 49.2, 35.4, 33.0, 25.1. HRMS calculated for $[C_{21}H_{19}NOS+H]^+$: 334.1261; found: 334.1264. The er was determined by HPLC using a Chiralpak IC column [hexane/*i*-PrOH (80:20)]; flow rate 1.0 mL/min; τ_{major} = 30.4 min, τ_{minor} = 24.0 min (98:2 er). $[\alpha]^{20}_D$ = +100.6 (c = 0.2, $CHCl_3$).



5d 2-((3*S*,4*R*)-3-Methyl-6-phenyl-4-(4-(trifluoromethyl)phenyl)-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

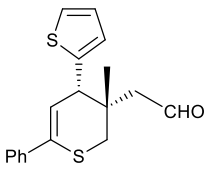
Following the general procedure (reaction time 24 h, >95:5 rr), **5d** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 70% yield as an yellow oil (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.78 (t, *J* = 1.8 Hz, 1H), 7.60 (d, *J* = 8.0 Hz, 2H), 7.54 – 7.51 (m, 2H), 7.38 – 7.34 (m, 4H), 7.34 – 7.31 (m, 1H), 6.00 (d, *J* = 4.2 Hz, 1H), 3.64 (d, *J* = 4.2 Hz, 1H), 3.19 (d, *J* = 13.1 Hz, 1H), 2.98 (d, *J* = 13.1 Hz, 1H), 2.63 – 2.59 (m, 1H), 2.06 (dd, *J* = 16.6, 2.1 Hz, 1H), 1.35 (s, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.4, 145.5, 139.3, 134.6, 130.4 (2C), 129.7, 128.7 (2C), 128.6, 126.3 (2C), 125.3 (q, *J* = 3.7 Hz, 2C), 124.2 (q, *J* = 272.2 Hz), 120.3, 52.1, 49.2, 35.6, 33.0, 25.2. HRMS calculated for $[C_{21}H_{19}F_3OS+H]^+$: 377.1182; found: 377.1184. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 8.9 min, τ_{minor} = 9.7 min (99:1 er). $[\alpha]^{20}_D$ = +45.0 (c = 0.8, $CHCl_3$).



5e 2-((3*S*,4*R*)-3-Methyl-4-(naphthalen-2-yl)-6-phenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

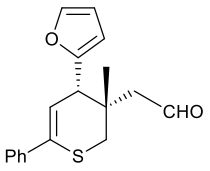
Following the general procedure (reaction time 24 h, 4.5:1 rr), **5f** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 79% yield as an yellow oil (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.75 (t, *J* = 2.0 Hz, 1H), 7.86 – 7.79 (m, 3H), 7.69 – 7.66 (m, 1H), 7.59 – 7.55 (m, 2H), 7.53 – 7.46 (m, 2H), 7.39 – 7.34 (m, 3H), 7.34 – 7.30 (m, 1H), 6.14 (d, *J* = 4.3 Hz, 1H), 3.72 (d, *J* = 4.2 Hz, 1H), 3.27 (d, *J* = 13.0 Hz, 1H), 3.01 (d, *J* = 12.9 Hz, 1H), 2.63 (dd, *J* = 16.7, 1.8 Hz, 1H), 2.17 (dd, *J* = 16.5, 2.1 Hz, 1H), 1.40 (s, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.9, 139.6, 138.8, 133.7, 133.3, 132.8, 128.9 (2C), 128.6 (2C), 128.4, 128.0, 127.9, 127.7, 126.4, 126.3 (2C), 126.1, 121.4, 52.4, 49.5, 35.7, 33.4, 25.4. HRMS calculated for $[C_{24}H_{22}OS+H]^+$:

359.1464; found: 359.1469. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 13.0 min, τ_{minor} = 14.2 min (94:6 er). $[\alpha]^{20}_D$ = +29.2 (c = 0.7, $CHCl_3$).



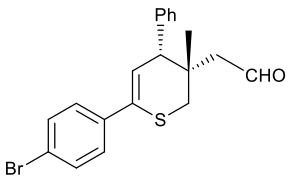
5f 2-((3*S*,4*S*)-3-Methyl-6-phenyl-4-(thiophen-2-yl)-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

Following the general procedure (reaction time 24 h, 17:1 rr), **5g** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 81% yield as an yellow oil (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.75 (t, *J* = 1.8 Hz, 1H), 7.64 – 7.58 (m, 2H), 7.57 – 7.51 (m, 2H), 7.40 – 7.33 (m, 4H), 6.01 (d, *J* = 4.2 Hz, 1H), 3.64 (d, *J* = 4.2 Hz, 1H), 3.20 (d, *J* = 13.2 Hz, 1H), 2.98 (d, *J* = 13.2 Hz, 1H), 2.62 (d, *J* = 16.7 Hz, 1H), 2.05 (dd, *J* = 16.7, 2.1 Hz, 1H), 1.35 (s, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.9, 144.8, 139.7, 133.7, 128.9 (2C), 128.7, 127.4, 127.2, 126.8 (2C), 125.2, 121.3, 50.5, 47.3, 35.7, 33.6, 25.0. HRMS calculated for $[C_{18}H_{18}OS_2+H]^+$: 315.0872; found: 315.0863. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 9.3 min, τ_{minor} = 12.0 min (96.5:3.5 er). $[\alpha]^{20}_D$ = +90.8 (c = 0.5, $CHCl_3$).



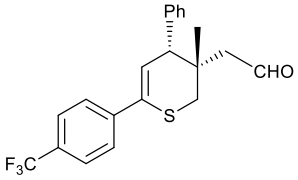
5g 2-((3*S*,4*S*)-4-(Furan-2-yl)-3-methyl-6-phenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

Following the general procedure (reaction time 24 h, >95:5 rr), **5h** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 77% yield as an yellow oil (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.75 (t, *J* = 1.9 Hz, 1H), 7.53 – 7.49 (m, 2H), 7.37 – 7.29 (m, 3H), 7.24 (dd, *J* = 5.2, 1.1 Hz, 1H), 7.00 (dd, *J* = 5.1, 3.5 Hz, 1H), 6.91 (dd, *J* = 3.4, 1.1 Hz, 1H), 6.10 (d, *J* = 4.5 Hz, 1H), 3.85 (d, *J* = 4.5 Hz, 1H), 3.26 (d, *J* = 13.0 Hz, 1H), 2.87 (dd, *J* = 13.0, 1.1 Hz, 1H), 2.56 (dd, *J* = 16.8, 1.8 Hz, 1H), 2.28 (dd, *J* = 16.7, 2.0 Hz, 1H), 1.39 (s, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.6, 144.6, 139.4, 133.5, 128.6 (2C), 128.5, 127.1, 126.9, 126.4 (2C), 124.9, 121.0, 50.3, 47.0, 35.4, 33.4, 24.7. HRMS calculated for $[C_{18}H_{18}O_2S+H]^+$: 299.1101; found: 299.1105. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 9.3 min, τ_{minor} = 12.0 min (95.5:4.5 er). $[\alpha]^{20}_D$ = +20.0 (c = 1.0, $CHCl_3$).



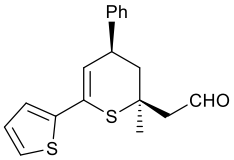
5h 2-((3*S*,4*R*)-6-(4-Bromophenyl)-3-methyl-4-phenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

Following the general procedure (reaction time 24 h, 8:1 rr), **5i** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 76% yield as an yellow oil (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.72 (t, *J* = 2.0 Hz, 1H), 7.48 – 7.44 (m, 2H), 7.41 – 7.37 (m, 2H), 7.36 – 7.32 (m, 2H), 7.30 – 7.27 (m, 1H), 7.23 – 7.19 (m, 2H), 6.04 (d, *J* = 4.3 Hz, 1H), 3.52 (d, *J* = 4.3 Hz, 1H), 3.20 (d, *J* = 13.0 Hz, 1H), 2.95 (d, *J* = 13.0 Hz, 1H), 2.55 (dd, *J* = 16.6, 1.8 Hz, 1H), 2.12 (dd, *J* = 16.5, 2.2 Hz, 1H), 1.33 (s, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.8, 141.0, 138.5, 132.6, 131.7 (2C), 130.0, 128.5 (2C), 127.9, 127.8 (2C), 127.5, 122.3, 122.0, 52.2, 49.4, 35.6, 33.0, 25.3. HRMS calculated for $[C_{20}H_{19}BrOS+H]^+$: 387.0413; found: 387.0414. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 10.9 min, τ_{minor} = 13.1 min (98:2 er). $[\alpha]^{20}_D$ = +70.1 (c = 0.6, $CHCl_3$).



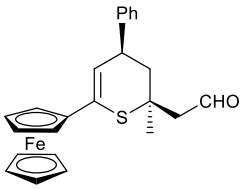
5i 2-((3*S*,4*R*)-3-Methyl-4-phenyl-6-(4-(trifluoromethyl)phenyl)-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

Following the general procedure (reaction time 24 h, >95:5 rr), **5j** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 60% yield as an yellow oil (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.73 (t, *J* = 1.9 Hz, 1H), 7.63 (d, *J* = 8.3 Hz, 2H), 7.60 (d, *J* = 8.3 Hz, 2H), 7.36 – 7.33 (m, 2H), 7.31 – 7.28 (m, 1H), 7.23 – 7.21 (m, 2H), 6.13 (d, *J* = 4.4 Hz, 1H), 3.55 (d, *J* = 4.4 Hz, 1H), 3.23 (d, *J* = 13.0 Hz, 1H), 2.97 (d, *J* = 13.1 Hz, 1H), 2.54 (dd, *J* = 16.6, 1.8 Hz, 1H), 2.15 (dd, *J* = 16.5, 2.1 Hz, 1H), 1.35 (s, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.7, 143.0, 140.8, 132.6, 130.3 (q, *J* = 32.3Hz), 130.0 (2C), 128.5 (2C), 127.6, 126.6 (2C), 125.6 (q, *J* = 3.9 Hz, 2C), 124.2 (q, *J* = 272.0 Hz), 123.2, 52.2, 49.5, 35.5, 33.1, 25.2. HRMS calculated for $[C_{21}H_{19}F_3OS+H]^+$: 377.1182; found: 377.1189. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 9.1 min, τ_{minor} = 10.7 min (98.5:1.5 er). $[\alpha]^{20}_D$ = +36.9 (c = 0.8, $CHCl_3$).



6j 2-((2*S*,4*S*)-2-Methyl-4-phenyl-6-(thiophen-2-yl)-3,4-dihydro-2*H*-thiopyran-2-yl)acetaldehyde

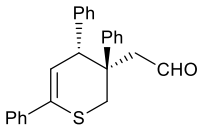
Following the general procedure (reaction time 48 h, 3:1 rr), **5l** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 65% yield as an orange oil (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.98 (dd, *J* = 3.1, 1.8 Hz, 1H), 7.37 – 7.33 (m, 2H), 7.29 – 7.25 (m, 3H), 7.20 (ddd, *J* = 5.4, 4.5, 1.2 Hz, 2H), 7.00 (dd, *J* = 5.1, 3.7 Hz, 1H), 6.22 (d, *J* = 2.9 Hz, 1H), 3.68 (ddd, *J* = 12.3, 6.2, 2.9 Hz, 1H), 3.02 (dd, *J* = 15.7, 1.8 Hz, 1H), 2.74 (dd, *J* = 15.7, 3.1 Hz, 1H), 2.29 (dd, *J* = 14.0, 6.1 Hz, 1H), 1.95 (dd, *J* = 14.0, 12.3 Hz, 1H), 1.54 (s, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.5, 144.2, 142.9, 129.0 (2C), 127.9 (2C), 127.5, 127.4, 127.1, 124.8, 124.0, 120.8, 51.8, 45.8, 44.1, 40.9, 27.8. HRMS calculated for $[C_{18}H_{18}OS_2+H]^+$: 315.0872; found: 315.0870. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 9.3 min, τ_{minor} = 10.1 min (97:3 er). $[\alpha]^{20}_D$ = +14.3 (c = 0.3, $CHCl_3$).



6k 2-((2*S*,4*S*)-6-Ferrocenyl-2-methyl-4-phenyl-3,4-dihydro-2*H*-thiopyran-2-yl)acetaldehyde

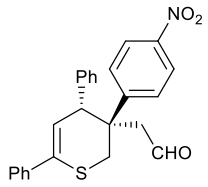
Following the general procedure (reaction time 48 h, >95:5 rr), **6k** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:2) in 62% yield as an orange oil (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.99 (dd, *J* = 3.1, 2.0 Hz, 1H), 7.37 – 7.34 (m, 2H), 7.28 – 7.24 (m, 3H), 5.97 (d, *J* = 2.7 Hz, 1H), 4.48 (ddt, *J* = 5.4, 2.6, 1.3 Hz, 2H), 4.25 – 4.18 (m, 7H), 3.53 (ddd, *J* = 12.3, 6.3, 2.8 Hz, 1H), 2.98 (dd, *J* = 15.6, 2.0 Hz, 1H), 2.69 (dd, *J* = 15.6, 3.1 Hz, 1H), 2.25 (dd, *J* = 13.8, 6.2 Hz, 1H), 1.94 (dd, *J* = 13.8, 12.2 Hz, 1H), 1.53 (s, 3H).^{13}C NMR (176 MHz, $CDCl_3$) δ 201.9, 144.8, 131.7, 128.9 (2C), 127.9 (2C), 126.9, 117.8, 85.2, 69.8 (4C), 68.8, 68.7, 66.7, 65.5, 51.8, 46.6, 43.5, 41.0, 28.0. HRMS calculated for $[C_{24}H_{24}FeOS+H]^+$: 417.0970; found: 417.0974. The er was determined by HPLC using a Chiralpak IG column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 20.7 min, τ_{minor} = 18.8 min (92:8 er). $[\alpha]^{20}_D$ = +53.7 (c = 0.4, $CHCl_3$).

5l 2-((3*S*,4*R*)-3,4,6-Triphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde



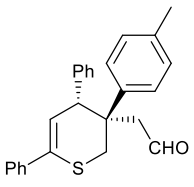
Following the general procedure (reaction time 24 h, >95:5 rr), **5n** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 70% yield as an yellow oil (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.67 (t, *J* = 1.9 Hz, 1H), 7.54 – 7.50 (m, 2H), 7.36 – 7.33 (m, 2H), 7.33 – 7.29 (m, 3H), 7.28 – 7.24 (m, 1H), 7.23 – 7.17 (m, 5H), 6.87– 6.85 (m, 2H), 6.22 (d, *J* = 3.7 Hz, 1H), 4.14 (d, *J* = 3.7 Hz, 1H), 3.80 (d, *J* = 13.2 Hz, 1H), 3.45 (d, *J* = 13.2 Hz, 1H), 3.08 (dd, *J* = 17.9, 1.5 Hz, 1H), 2.65 (ddd, *J* = 17.8, 2.4, 1.1 Hz, 1H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.4, 143.4, 140.0, 139.3, 134.5, 130.0 (2C), 128.5 (2C), 128.4 (2C), 128.4, 127.9 (2C), 127.2, 127.1, 126.8 (2C), 126.2 (2C), 122.8, 52.4, 46.0, 39.9, 35.2. HRMS calculated for $[C_{25}H_{22}OS+H]^+$: 371.1464; found: 371.1461. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 12.6 min, τ_{minor} = 13.3 min (99.5:0.5 er). $[\alpha]^{20}_D$ = +25.8 (c = 0.6, $CHCl_3$).

5m 2-((3*S*,4*R*)-3-(4-Nitrophenyl)-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

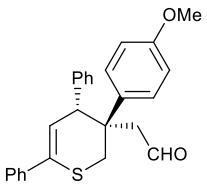


Following the general procedure (reaction time 48 h, 14:1 rr), **5o** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 9:1) in 63% yield as a white solid (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.67 (t, *J* = 1.2 Hz, 1H), 8.18 – 8.14 (m, 2H), 7.49 – 7.47 (m, 2H), 7.42 – 7.39 (m, 2H), 7.37 – 7.31 (m, 3H), 7.28 – 7.23 (m, 3H), 6.95 – 6.91 (m, 2H), 6.21 (d, *J* = 4.1 Hz, 1H), 4.20 (d, *J* = 4.0 Hz, 1H), 3.67 (d, *J* = 13.1 Hz, 1H), 3.51 (d, *J* = 13.1 Hz, 1H), 3.21 (d, *J* = 18.5 Hz, 1H), 2.72 (d, *J* = 18.5 Hz, 1H). ^{13}C NMR (176 MHz, $CDCl_3$) 199.8, 151.3, 146.8, 139.5, 139.0, 134.9, 130.0 (2C), 128.8, 128.7 (2C), 128.4 (2C), 127.8, 127.9 (2C), 126.3 (2C), 123.5 (2C), 121.9, 51.5, 47.5, 40.8, 34.7. HRMS calculated for $[C_{25}H_{21}NO_3S+H]^+$: 416.1315; found: 416.1310. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (70:30)]; flow rate 1.0 mL/min; τ_{major} = 9.3 min, τ_{minor} = 12.0 min (91:9 er). $[\alpha]^{20}_D$ = +44.9 (c = 1.0, $CHCl_3$).

5n 2-((3*S*,4*R*)-4,6-Diphenyl-3-*p*-tolyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

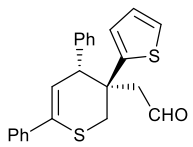


Following the general procedure (reaction time 24 h, 4:1 rr), **5p** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 72% yield as an yellow oil (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.65 (t, *J* = 1.9 Hz, 1H), 7.53 – 7.51 (m, 2H), 7.35 – 7.33 (m, 2H), 7.32 – 7.30 (m, 1H), 7.23 – 7.17 (m, 3H), 7.13 – 7.07 (m, 4H), 6.91 – 6.87 (m, 2H), 6.21 (d, *J* = 3.7 Hz, 1H), 4.12 (d, *J* = 3.6 Hz, 1H), 3.76 (d, *J* = 13.2 Hz, 1H), 3.41 (d, *J* = 13.2 Hz, 1H), 3.03 (dd, *J* = 17.7, 1.6 Hz, 1H), 2.61 (ddd, *J* = 17.5, 2.4, 1.1 Hz, 1H), 2.34 (s, 3H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.7, 140.4, 140.3, 139.4, 136.7, 134.4, 130.2 (2C), 129.3 (2C), 128.6 (2C), 128.4, 128.0 (2C), 127.3, 126.7 (2C), 126.3 (2C), 122.89, 52.4, 39.6, 35.4, 31.1, 21.1. HRMS calculated for $[C_{26}H_{24}OS+H]^+$: 385.1621; found: 385.1616. The er was determined by HPLC using a Chiralpak IG column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 16.1 min, τ_{minor} = 20.3 min (95:5 er). $[\alpha]^{20}_D$ = +23.3 (c = 0.5, $CHCl_3$).



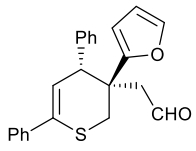
5o 2-((3*S*,4*R*)-3-(4-Methoxyphenyl)-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

Following the general procedure (reaction time 24 h, >5:1 rr), **5q** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 81% yield as an yellow oil (>95:5 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.66 (t, *J* = 1.8 Hz, 1H), 7.54 – 7.50 (m, 1H), 7.37 – 7.30 (m, 5H), 7.23 – 7.19 (m, 3H), 7.11 (d, *J* = 8.8 Hz, 2H), 6.89 (dd, *J* = 7.8, 1.7 Hz, 2H), 6.84 (d, *J* = 8.9 Hz, 1H), 6.21 (d, *J* = 3.7 Hz, 1H), 4.09 (d, *J* = 3.7 Hz, 1H), 3.81 (s, 3H), 3.76 (d, *J* = 13.2 Hz, 1H), 3.41 (d, *J* = 13.2 Hz, 1H), 3.05 (dd, *J* = 17.6, 1.6 Hz, 1H), 2.60 (ddd, *J* = 17.8, 2.4, 1.0 Hz, 1H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.7, 158.5, 140.2, 139.4, 135.4, 134.4, 130.2 (2C), 128.6 (2C), 128.5, 128.0 (2C), 127.9 (2C), 127.3, 126.3 (2C), 122.9, 113.8 (2C), 55.4, 52.6, 46.3, 39.3, 35.4. HRMS calculated for $[C_{26}H_{24}O_2S+H]^+$: 401.1570; found: 401.1563. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 19.2 min, τ_{minor} = 20.8 min (94:6 er). $[\alpha]^{20}_D$ = +43.2 (c = 0.6, $CHCl_3$).



5p 2-((3*R*,4*R*)-4,6-Diphenyl-3-(thiophen-2-yl)-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

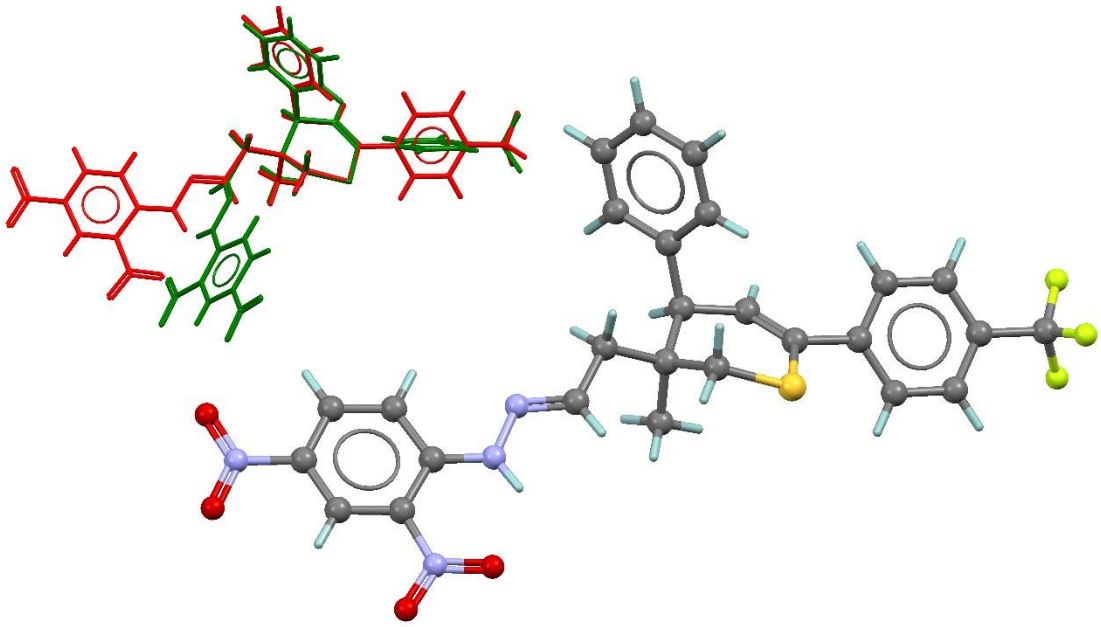
Following the general procedure (reaction time 24 h, 3:1 rr), **5r** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 50% yield as an yellow oil (8:1 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.73 (t, *J* = 2.0 Hz, 1H), 7.59 – 7.53 (m, 2H), 7.41 – 7.33 (m, 3H), 7.27 – 7.24 (m, 4H), 6.95 – 6.92 (m, 2H), 6.91 (dd, *J* = 5.1, 3.6 Hz, 1H), 6.65 (dd, *J* = 3.6, 1.1 Hz, 1H), 6.19 (d, *J* = 3.5 Hz, 1H), 4.10 (d, *J* = 3.5 Hz, 1H), 3.77 (dt, *J* = 13.2, 0.9 Hz, 1H), 3.56 (d, *J* = 13.1 Hz, 1H), 3.10 (dd, *J* = 17.4, 1.7 Hz, 1H), 2.60 (ddd, *J* = 17.4, 2.4, 1.1 Hz, 1H).^{13}C NMR (176 MHz, $CDCl_3$) δ 201.0, 149.0, 140.0, 139.2, 134.5, 129.9 (2C), 128.7, 128.6 (2C), 128.1 (2C), 127.6, 126.6, 126.3 (2C), 125.3, 124.2, 122.4, 54.6, 47.0, 39.4, 36.8. HRMS calculated for $[C_{23}H_{20}OS_2+H]^+$: 377.1029; found: 377.1033. The er was determined by HPLC using a Chiralpak IA column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 17.8 min, τ_{minor} = 16.4 min (95.5:4.5 er). $[\alpha]^{20}_D$ = +16.4 (c = 0.5, $CHCl_3$).



5q 2-((3*S*,4*R*)-3-(Furan-2-yl)-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde

Following the general procedure (reaction time 24 h, 7:1 rr), **5s** was isolated by FC on silica gel (gradient hexane/AcOEt from 100:0 to 100:3) in 52% yield as an yellow oil (6:1 dr). ^{1}H NMR (700 MHz, $CDCl_3$) δ 9.69 (t, *J* = 2.0 Hz, 1H), 7.55 – 7.52 (m, 2H), 7.38 (dd, *J* = 1.9, 0.8 Hz, 1H), 7.37 – 7.34 (m, 2H), 7.33 – 7.30 (m, 1H), 7.25 – 7.23 (m, 3H), 7.00 – 6.78 (m, 2H), 6.31 (dd, *J* = 3.3, 1.8 Hz, 1H), 6.16 (d, *J* = 3.5 Hz, 1H), 6.03 (dd, *J* = 3.3, 0.8 Hz, 1H), 4.22 (d, *J* = 3.5 Hz, 1H), 3.75 (dd, *J* = 13.2, 0.9 Hz, 1H), 3.38 (d, *J* = 13.2 Hz, 1H), 2.95 (dd, *J* = 17.2, 1.7 Hz, 1H), 2.44 (ddd, *J* = 17.2, 2.4, 1.0 Hz, 1H). ^{13}C NMR (176 MHz, $CDCl_3$) δ 201.0, 156.6, 141.6, 140.1, 139.3, 134.4, 129.7 (2C), 128.6 (2C), 128.5, 128.2 (2C), 127.5, 126.3 (2C), 121.9, 110.6, 107.5, 50.6, 45.1, 38.3, 33.8. HRMS calculated for $[C_{23}H_{20}O_2S+H]^+$: 361.1257; found: 361.1250. The er was determined by HPLC using a Chiralpak IC column [hexane/*i*-PrOH (98:2)]; flow rate 1.0 mL/min; τ_{major} = 21.9 min, τ_{minor} = 13.5 min (97:3 er). $[\alpha]^{20}_D$ = +24.6 (c = 0.3, $CHCl_3$).

4. Crystal and X-ray data for (*E*)-1-(2,4-dinitrophenyl)-2-(2-((3*S*,4*R*)-3-methyl-4-phenyl-6-(4-(trifluoromethyl)phenyl)-3,4-dihydro-2*H*-thiopyran-3-yl)ethylidene)hydrazine 11



Formula $C_{27}H_{23}F_3N_4O_4S$, orthorhombic, space group *P* $2_12_12_1$, *Z* = 8, Z'=2, unit cell constants a = 6.72742(6) Å, b = 18.3659(2) Å, c = 51.8482(5) Å, V = 6406.12(11) Å^3. The data was collected on a XtaLAB Synergy, Dualflex, Pilatus 300K diffractometer at 100 K using PhotonJet micro-focus X-ray Source Cu-Kα (*λ* =1.54184 Å) as a source of radiation. The integration of the data yielded a total of 208346 reflections to a θ angle of 78.95°, of which 13828 unique (R_{int} = 6.55%,) and 13203 were greater than 2σ(F^2). The final anisotropic full-matrix least-squares refinement on F^2 with 713 variables converged at R_1 = 3.66%, for the observed data and wR_2 = 9.86% for all data. The hydrogen atoms were placed in calculated positions and refined isotropically by using a riding model, except hydrogen atom in hydrazine moieties, with was left to refine freely . The goodness-of-fit was 1.023.

The structure was solved with the ShelXT[4] structure solution program using Intrinsic Phasing and refined with the ShelXL[5] refinement package using Least Squares minimisation. The Olex2[6] software was used to calculate solvent maps,[7] for four identical channels each of 437.7 Å^3 volume (cumulatively 27,2 % of unit cell volume). In every one 148.7 electrons from disorder solvents were mask to improve refinement of large solvent accessible voids found in crystal.

The absolute configuration of 11 was determined from anomalous scattering, by calculating the by calculating the Flack parameter: 0.012(4) from 5497 selected quotients (Parsons' method)[8].

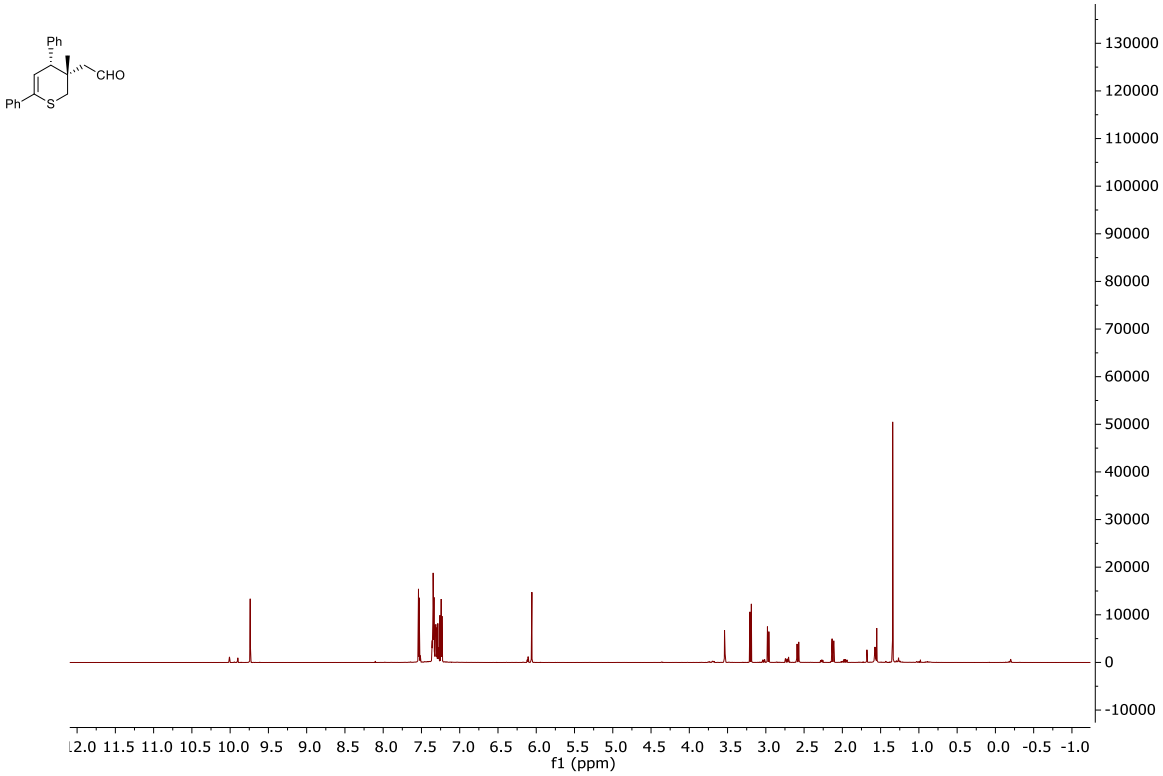
CCD8C 1561874 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via https://www.ccdc.cam.ac.uk/structures/

[4] G. M. Sheldrick, *Acta Cryst. A* 2015, **71**, 3.
[5] G. M. Sheldrick, *Acta Cryst. A* 2008, **64**, 112.
[6] O. V. Dolomanov, L.J. Bourhis, R. J. Gildea, J. A. K. Howard and H. Puschmann, *J. Appl. Cryst.* 2009, **42**, 339.
[7] B. Rees, L. Jenner and M. Yusupov, *Acta Cryst. D* 2005, **61**, 1299.
[8] S. Parsons, H. D. Flack and T. Wagner, Acta Cryst. *B* 2013, **69**, 249.

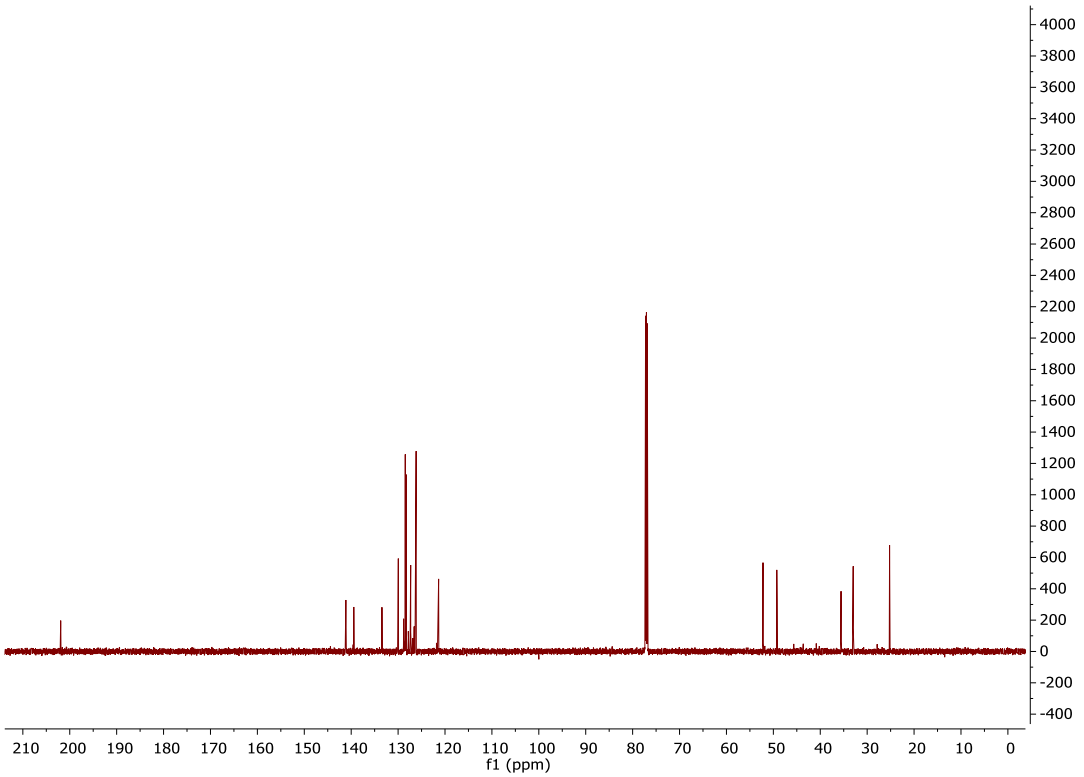
5. NMR data

2-((3*S*,4*R*)-3-Methyl-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5a)

^{1}H NMR (**5a**:**6a** 5:1 rr, dr = 2:1 for **6a**)

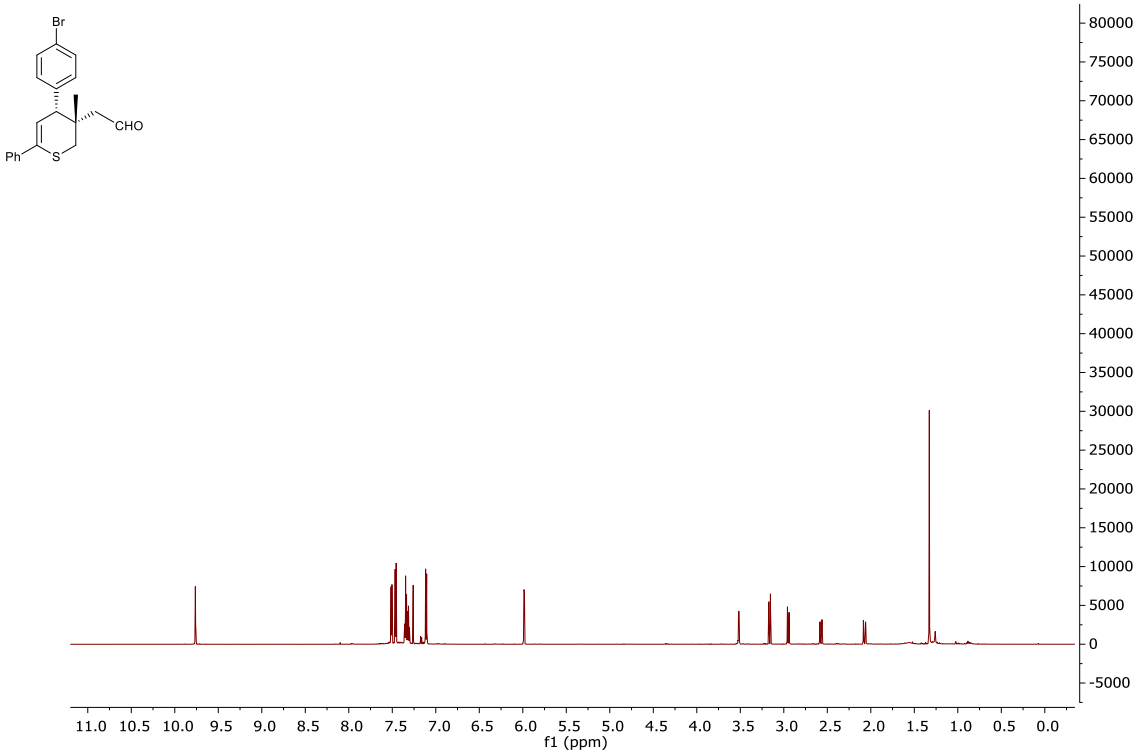


^{13}C NMR

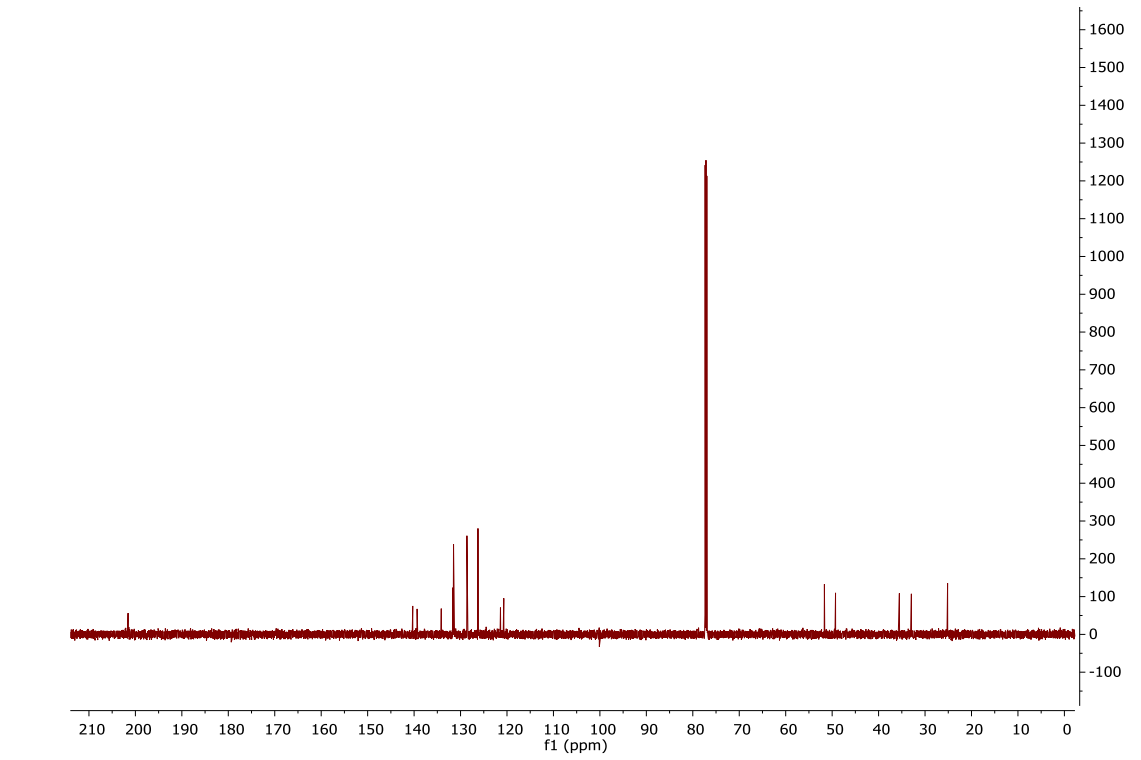


2-((3*S*,4*R*)-4-(4-Bromophenyl)-3-methyl-6-phenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5b)

^{1}H NMR

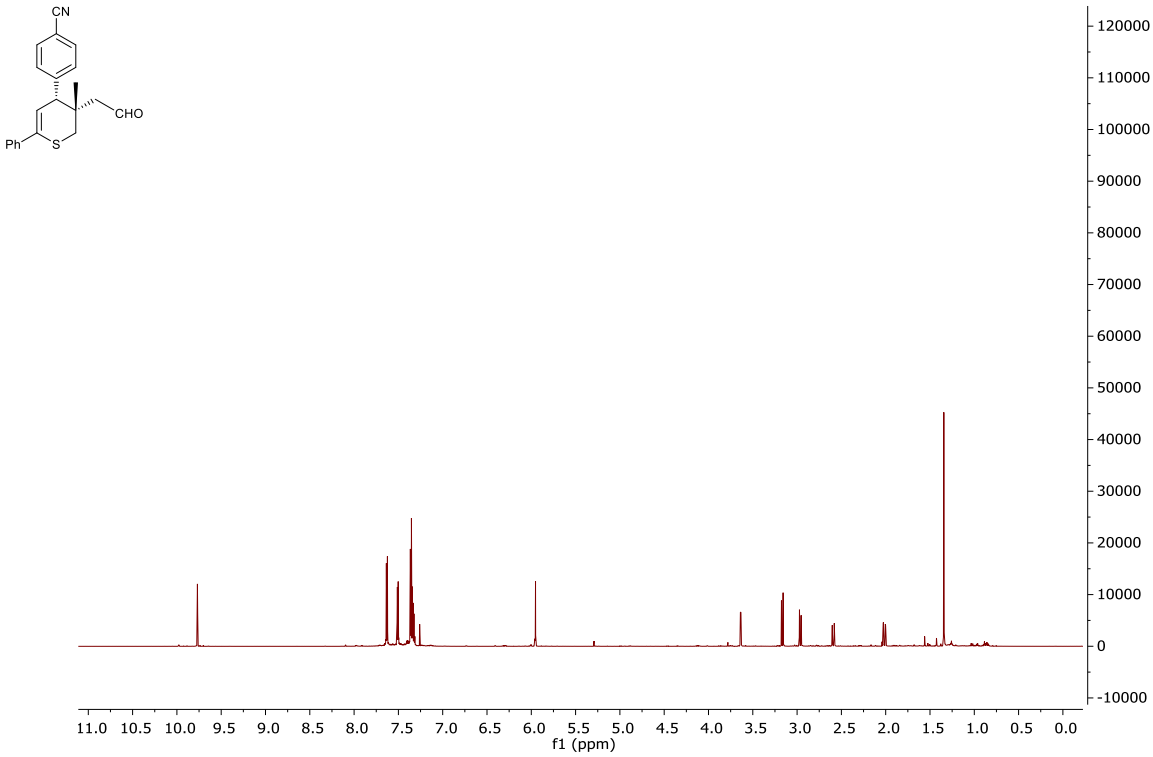


^{13}C NMR

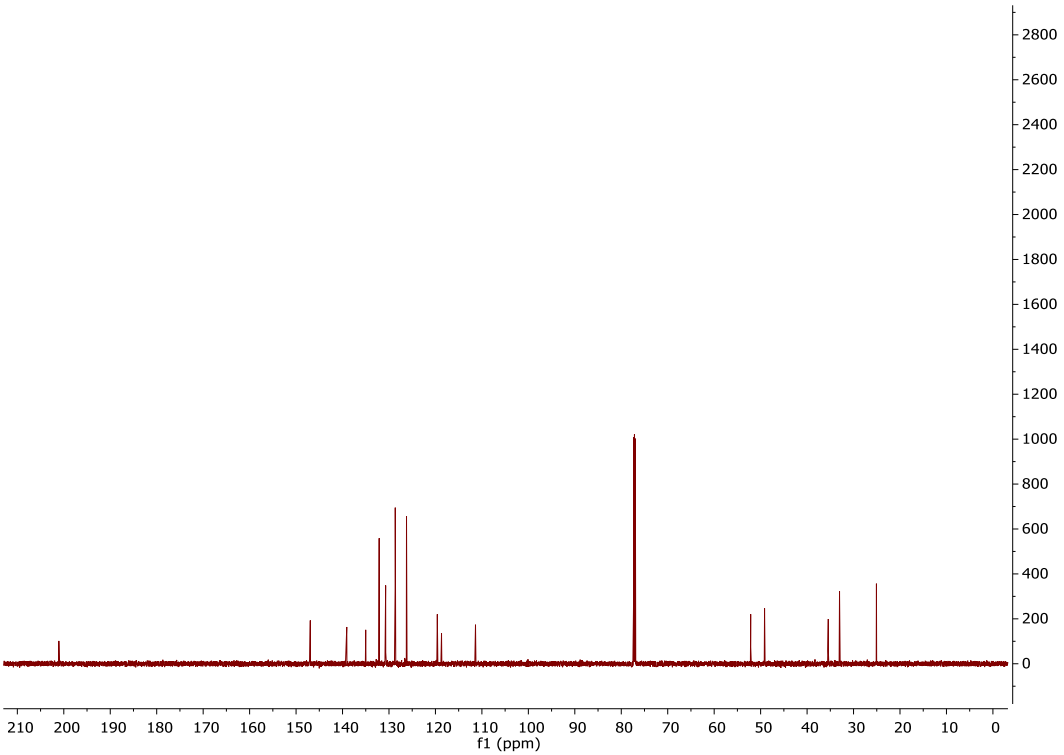


4-((3*S*,4*R*)-3-Methyl-3-(2-oxoethyl)-6-phenyl-3,4-dihydro-2*H*-thiopyran-4-yl)benzonitrile (5c)

^{1}H NMR

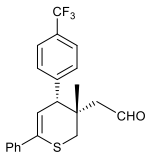


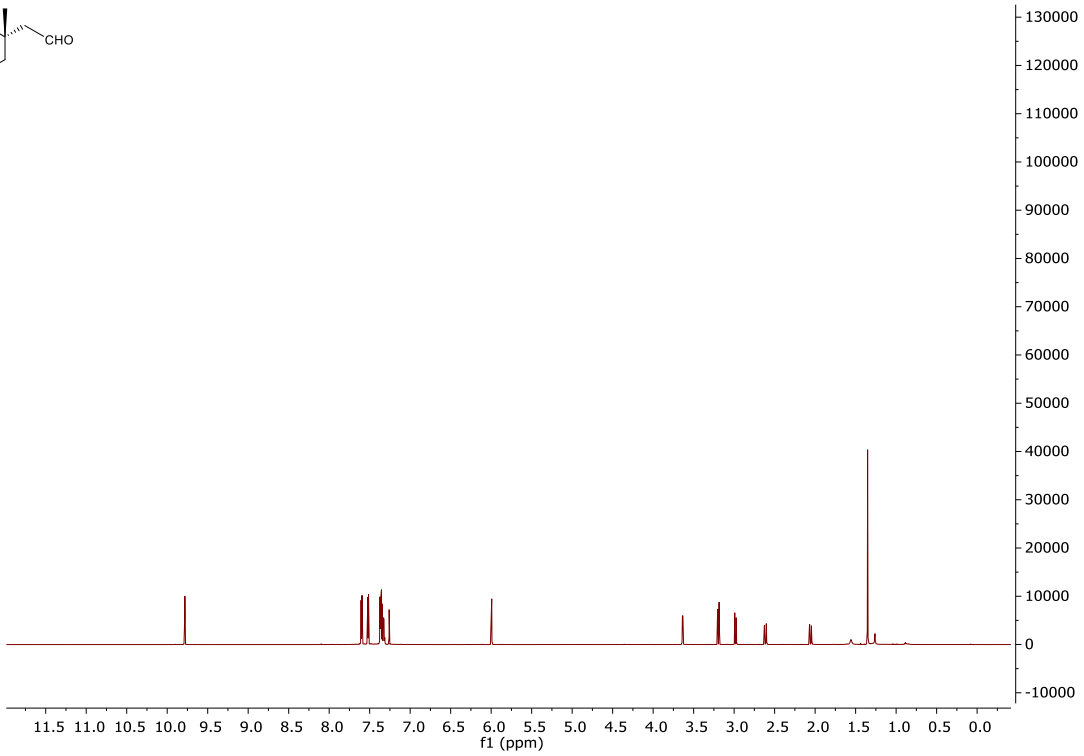
^{13}C NMR



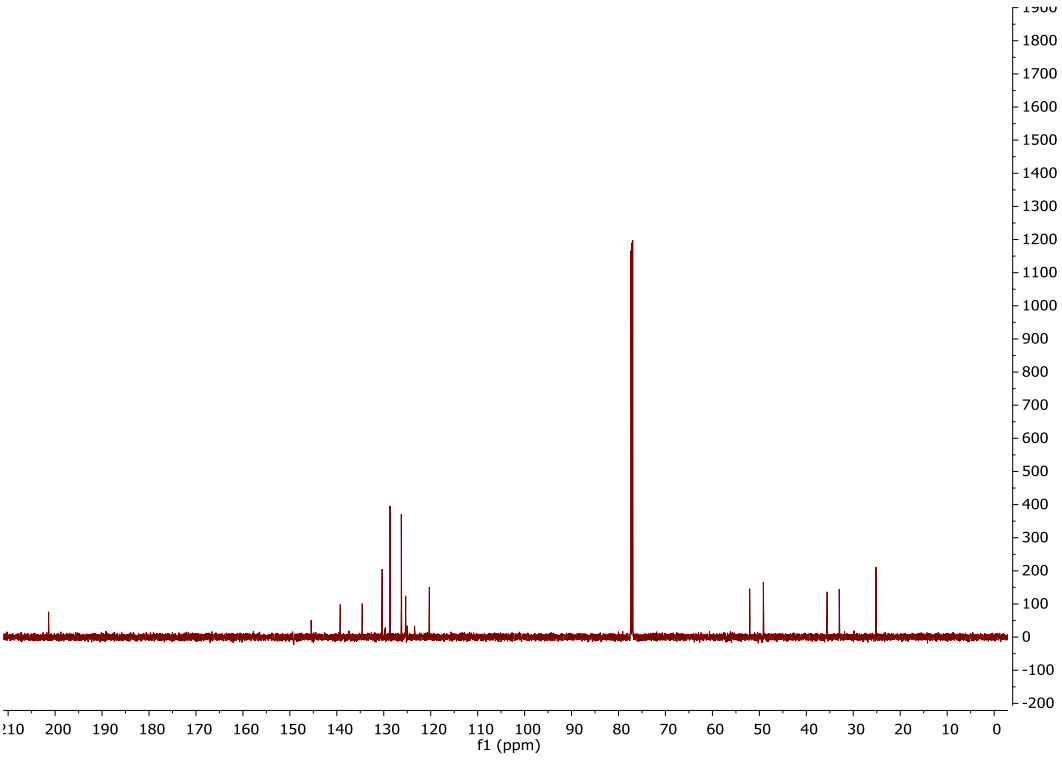
2-((3*S*,4*R*)-3-Methyl-6-phenyl-4-(4-(trifluoromethyl)phenyl)-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5d)

^{1}H NMR



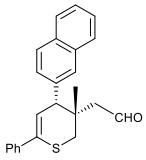


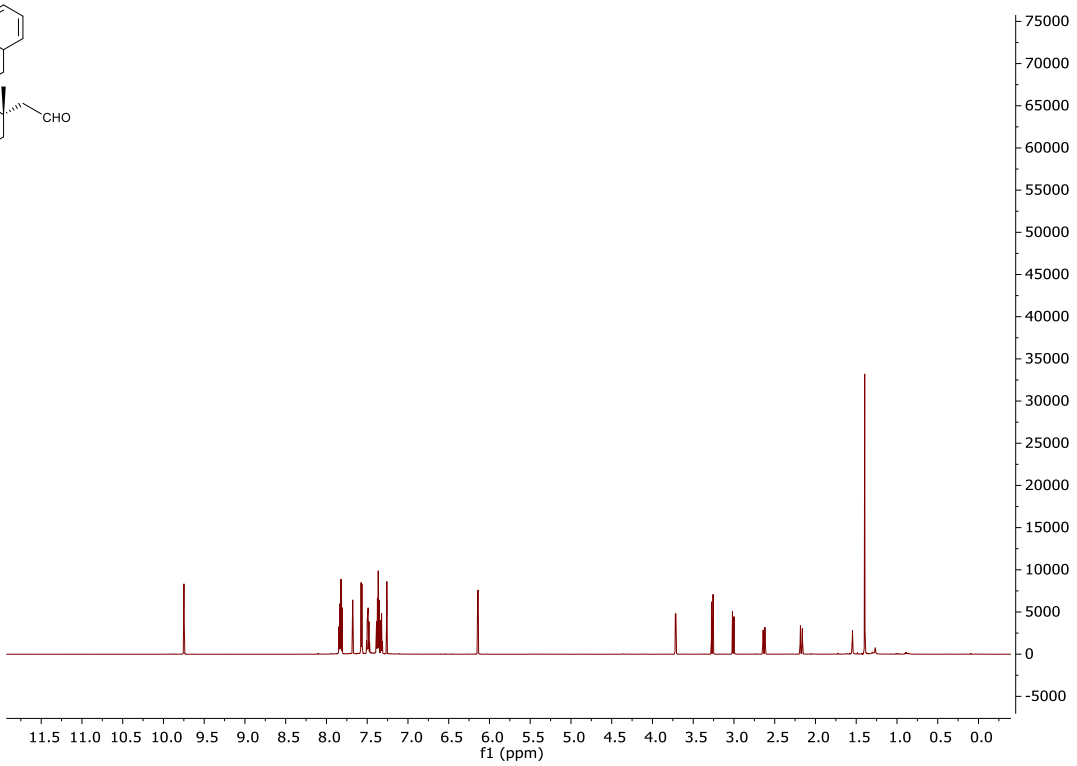
^{13}C NMR



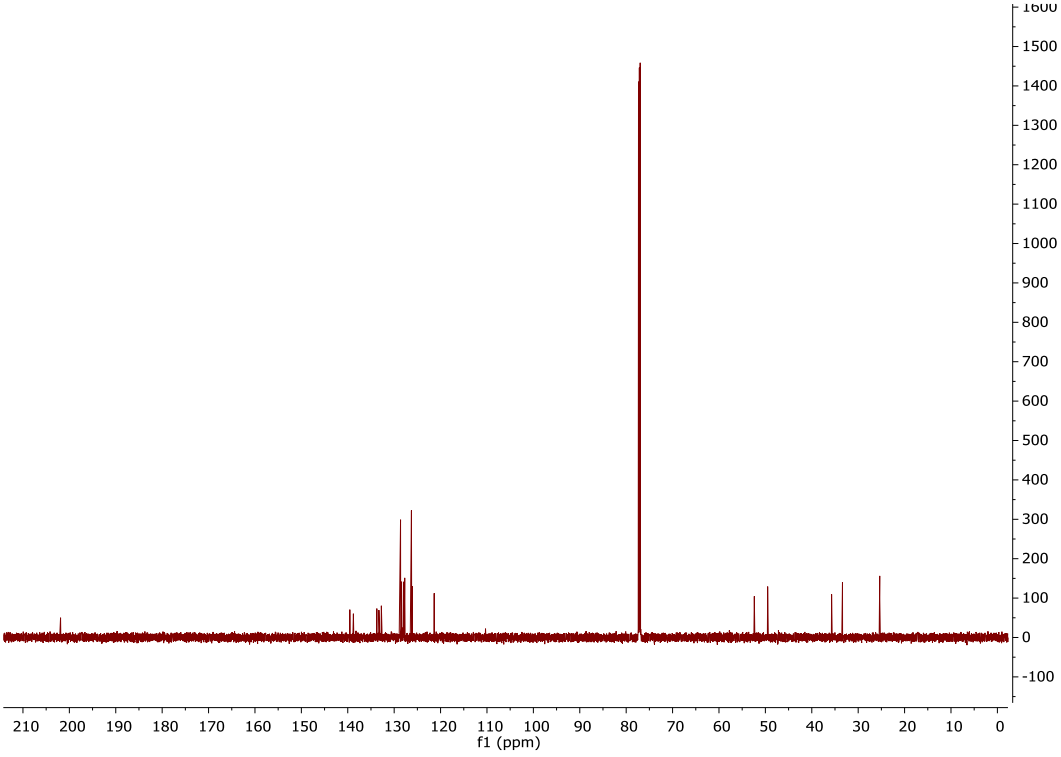
2-((3*S*,4*R*)-3-Methyl-4-(naphthalen-2-yl)-6-phenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5e)

^{1}H NMR



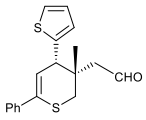


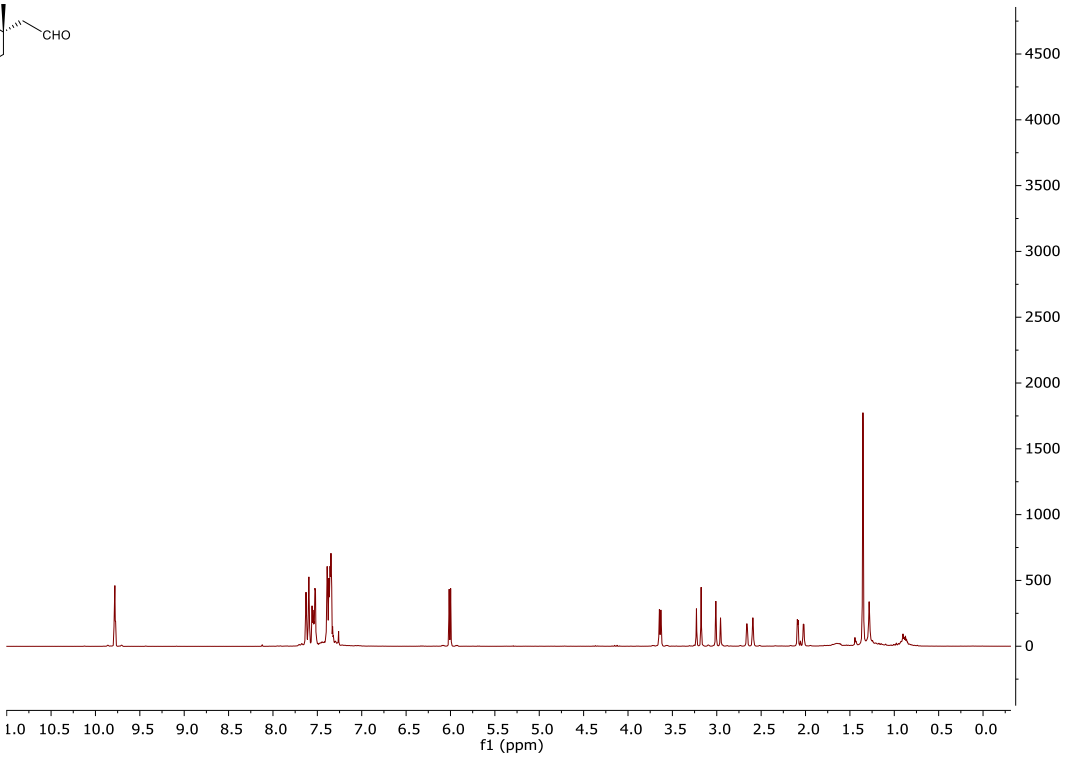
^{13}C NMR



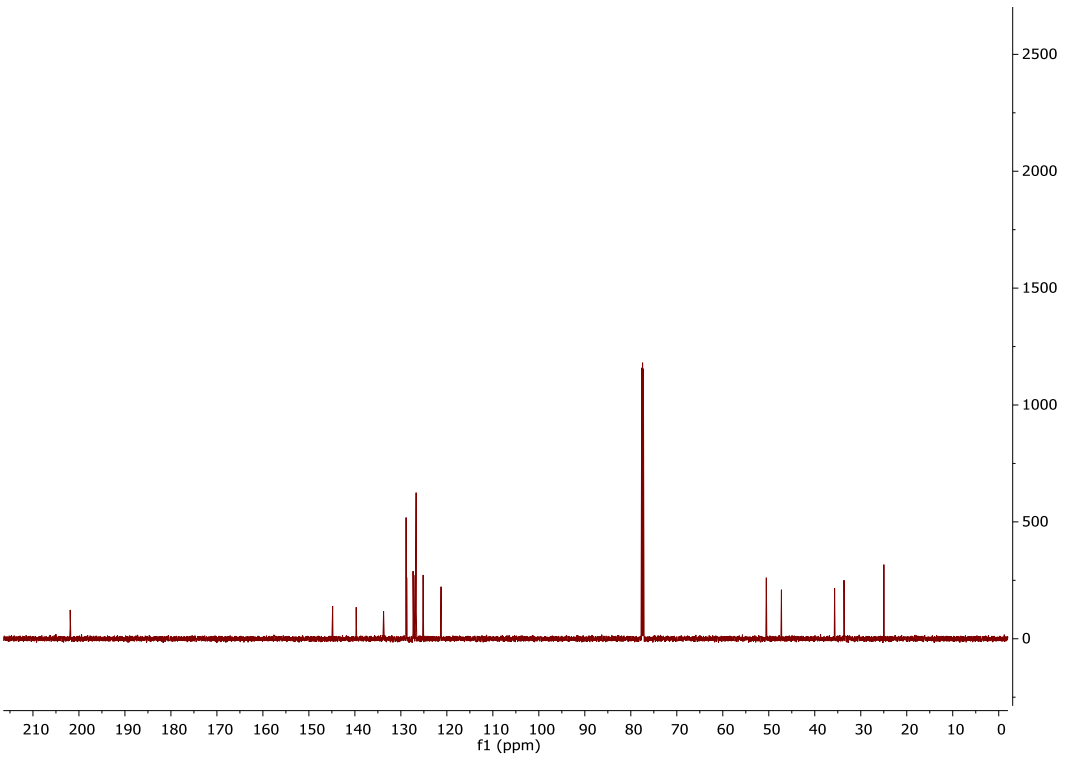
2-((3*S*,4*S*)-3-Methyl-6-phenyl-4-(thiophen-2-yl)-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5f)

^{1}H NMR



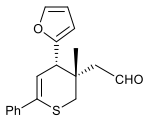


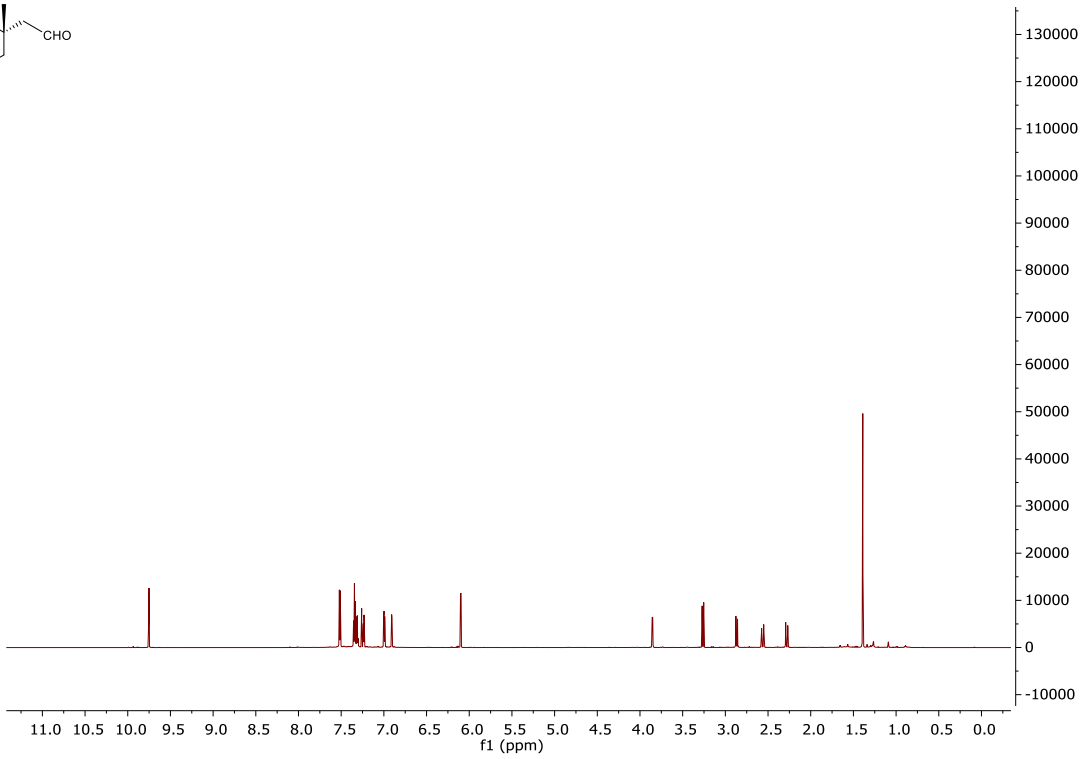
^{13}C NMR



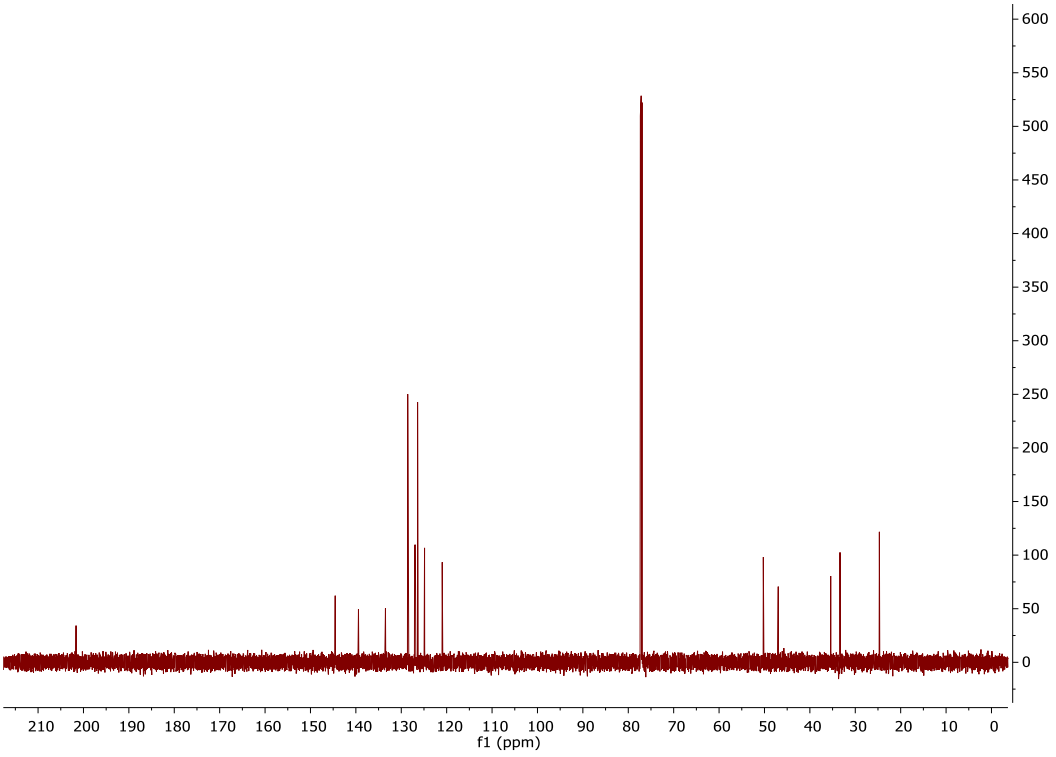
2-((3*S*,4*S*)-4-(Furan-2-yl)-3-methyl-6-phenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5g)

^{1}H NMR



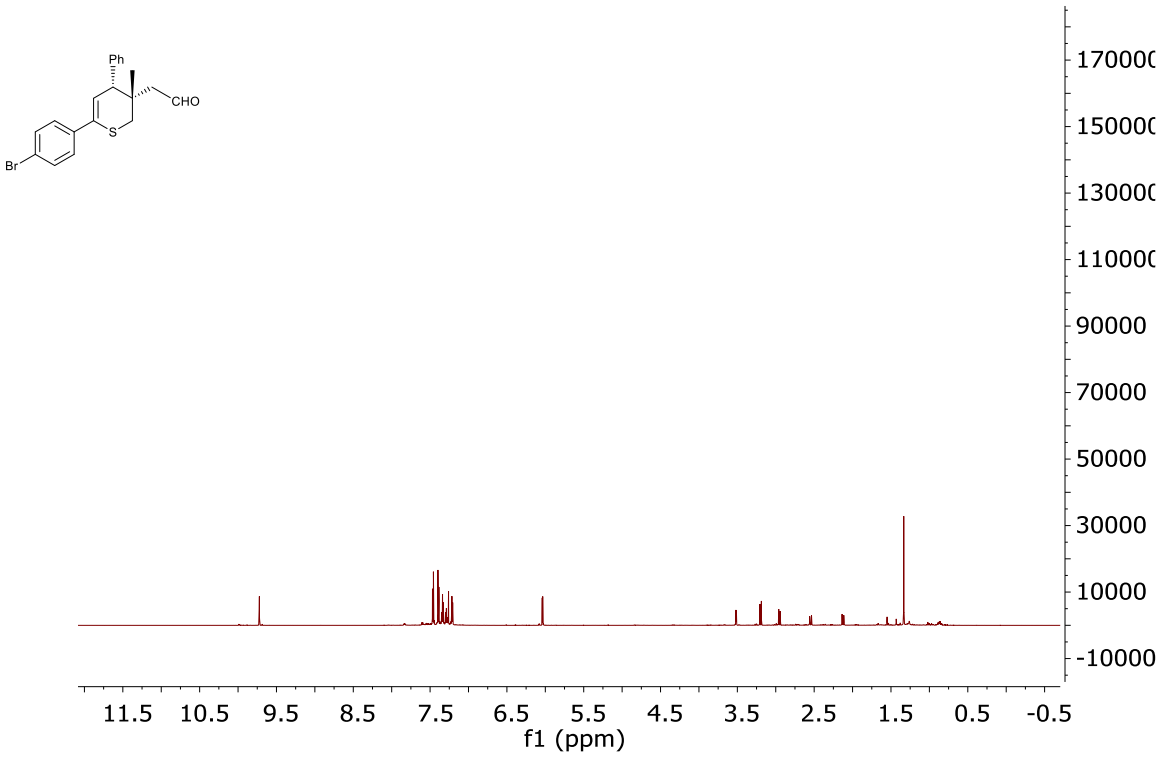


^{13}C NMR

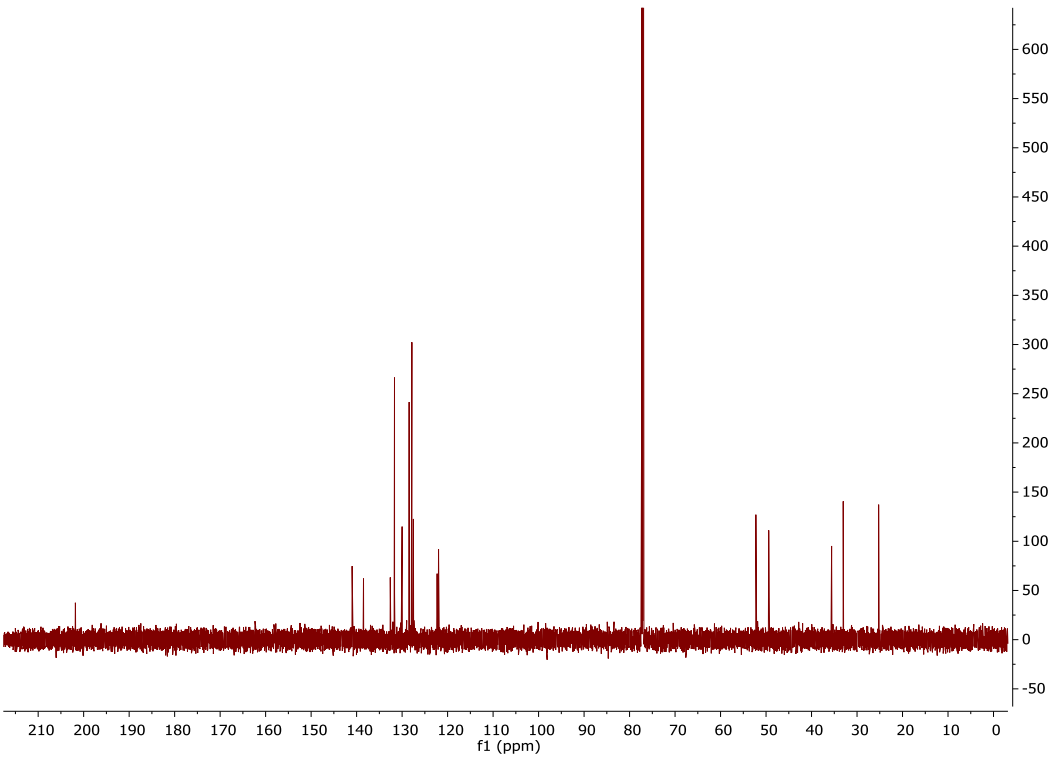


2-((3*S*,4*R*)-6-(4-Bromophenyl)-3-methyl-4-phenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5h)

^{1}H NMR

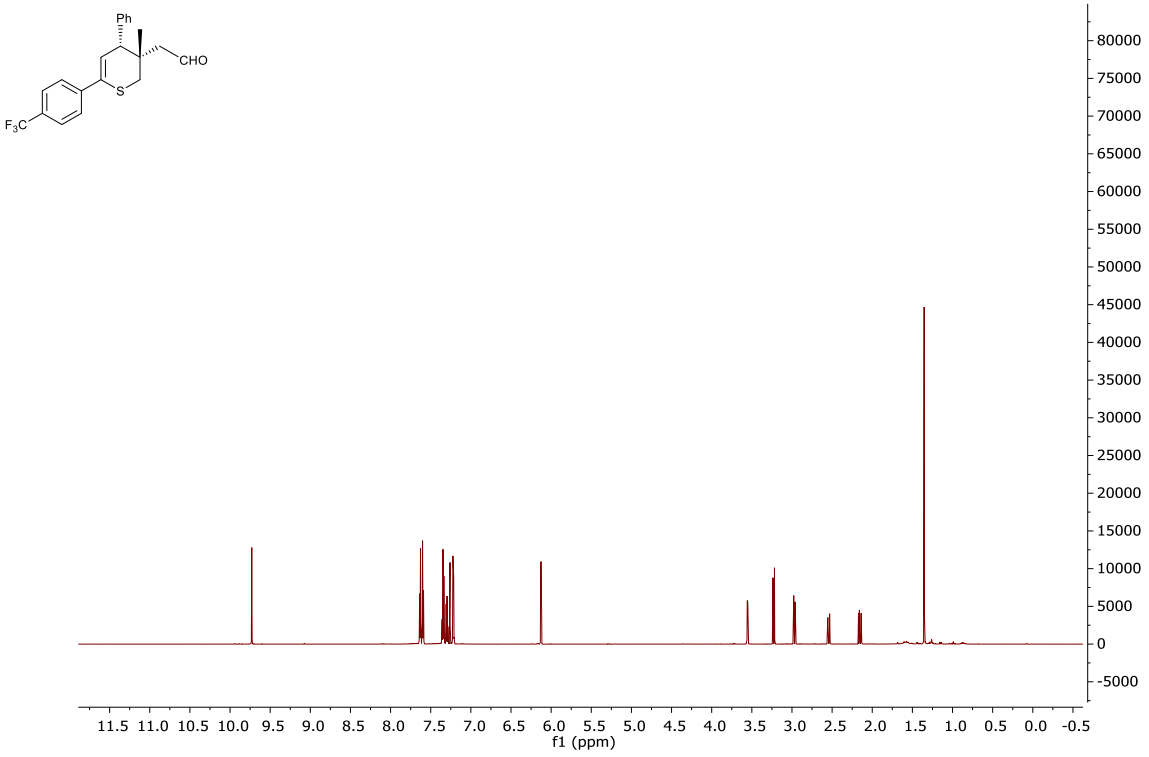


^{13}C NMR

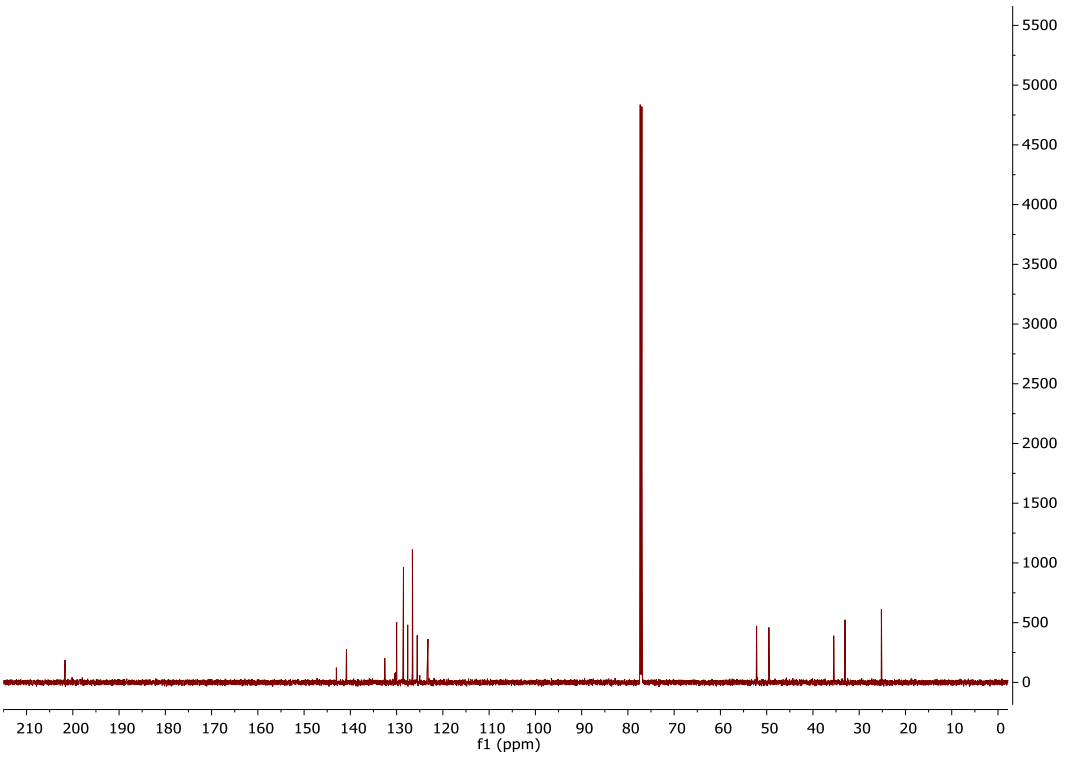


2-((3*S*,4*R*)-3-Methyl-4-phenyl-6-(4-(trifluoromethyl)phenyl)-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5i)

^{1}H NMR

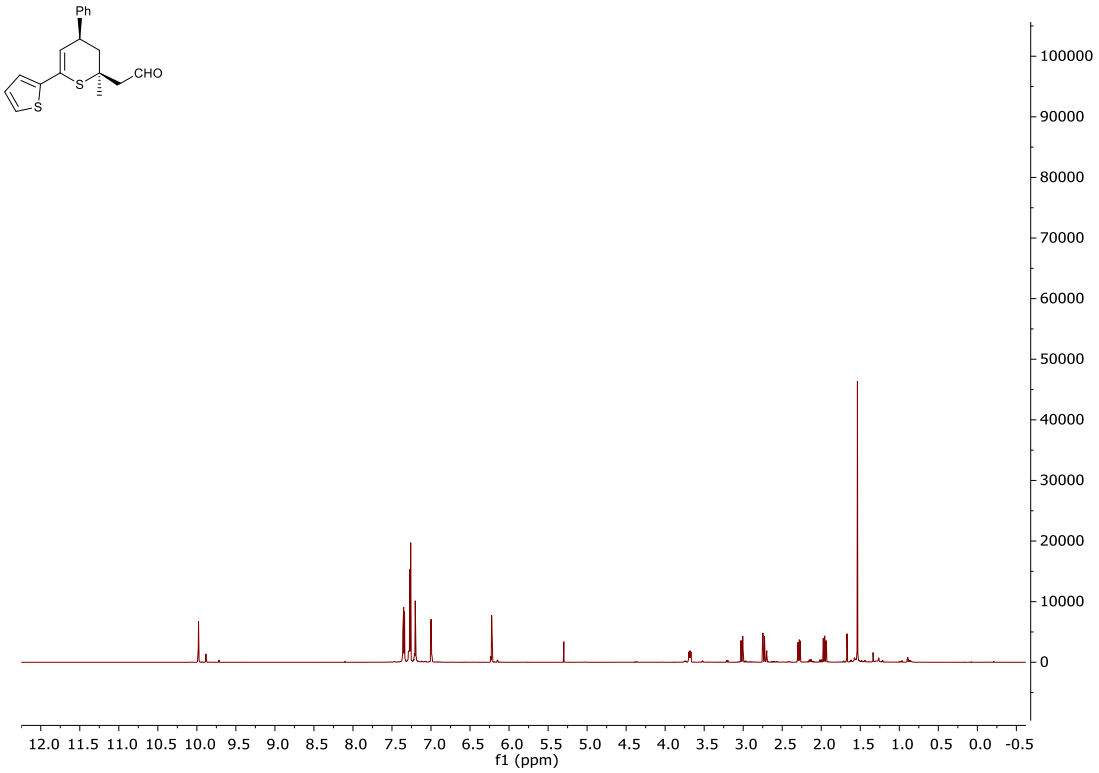


^{13}C NMR

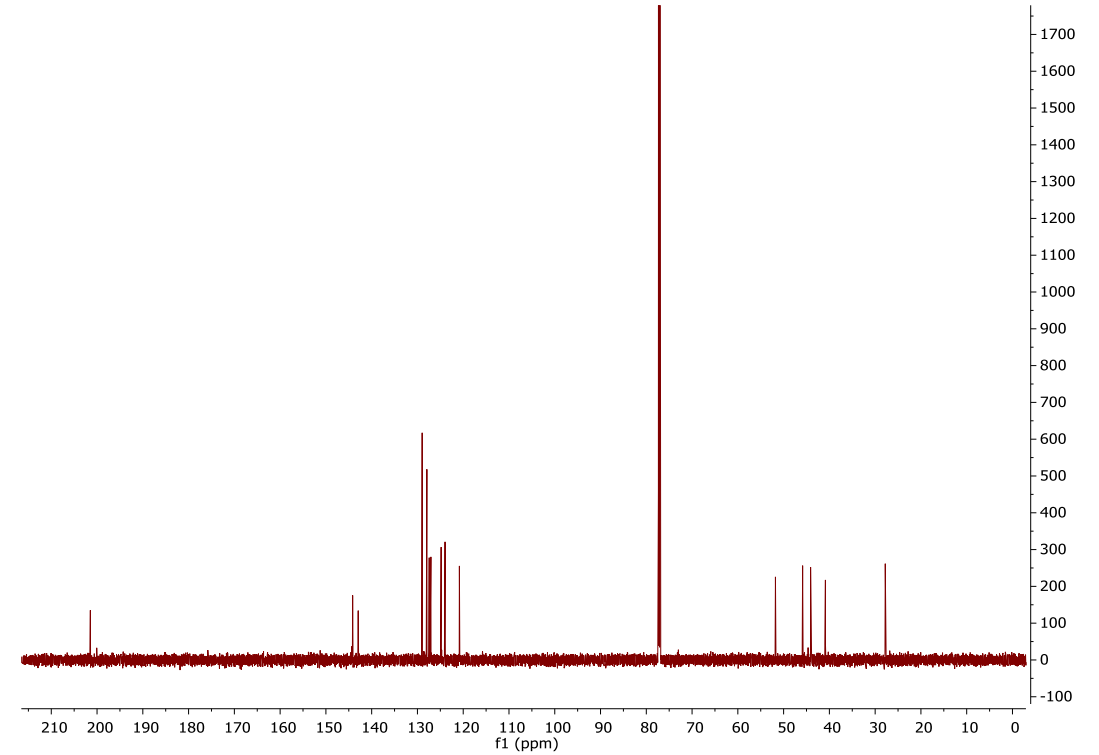


2-((2*S*,4*S*)-2-Methyl-4-phenyl-6-(thiophen-2-yl)-3,4-dihydro-2*H*-thiopyran-2-yl)acetaldehyde (6j)

^{1}H NMR (**6j**:**5j** 8.5:1 rr)

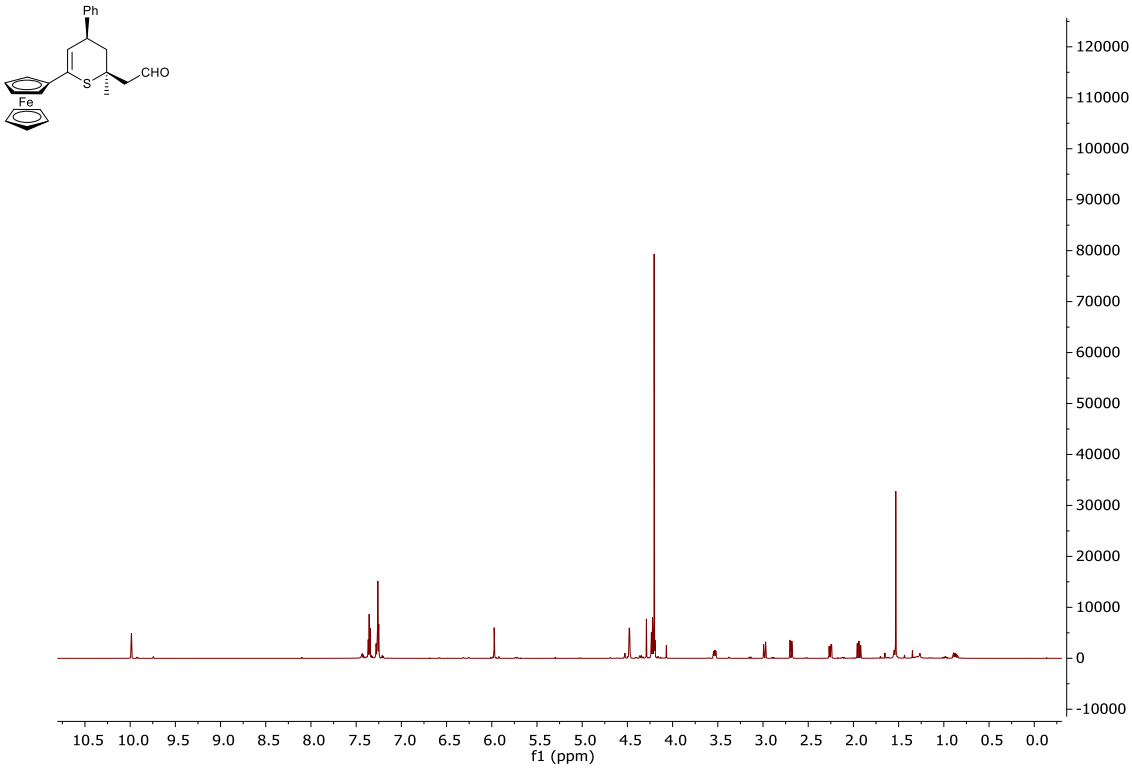


^{13}C NMR

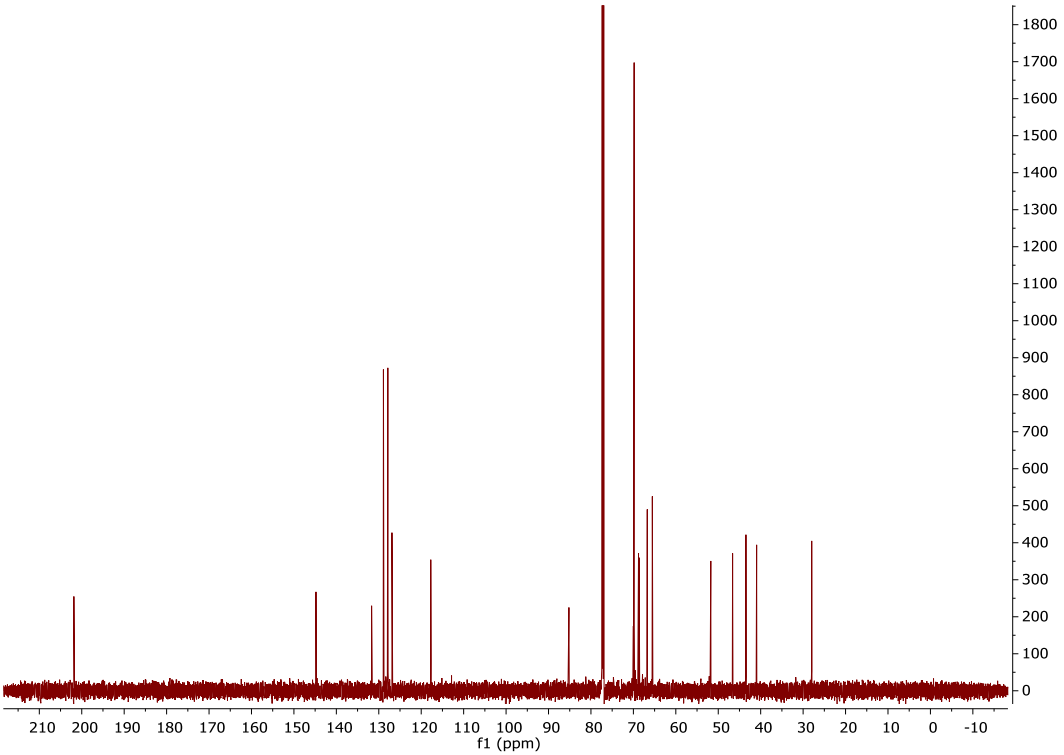


2-((2*S*,4*S*)-6-Ferrocenyl-2-methyl-4-phenyl-3,4-dihydro-2*H*-thiopyran-2-yl)acetaldehyde (6k)

^{1}H NMR

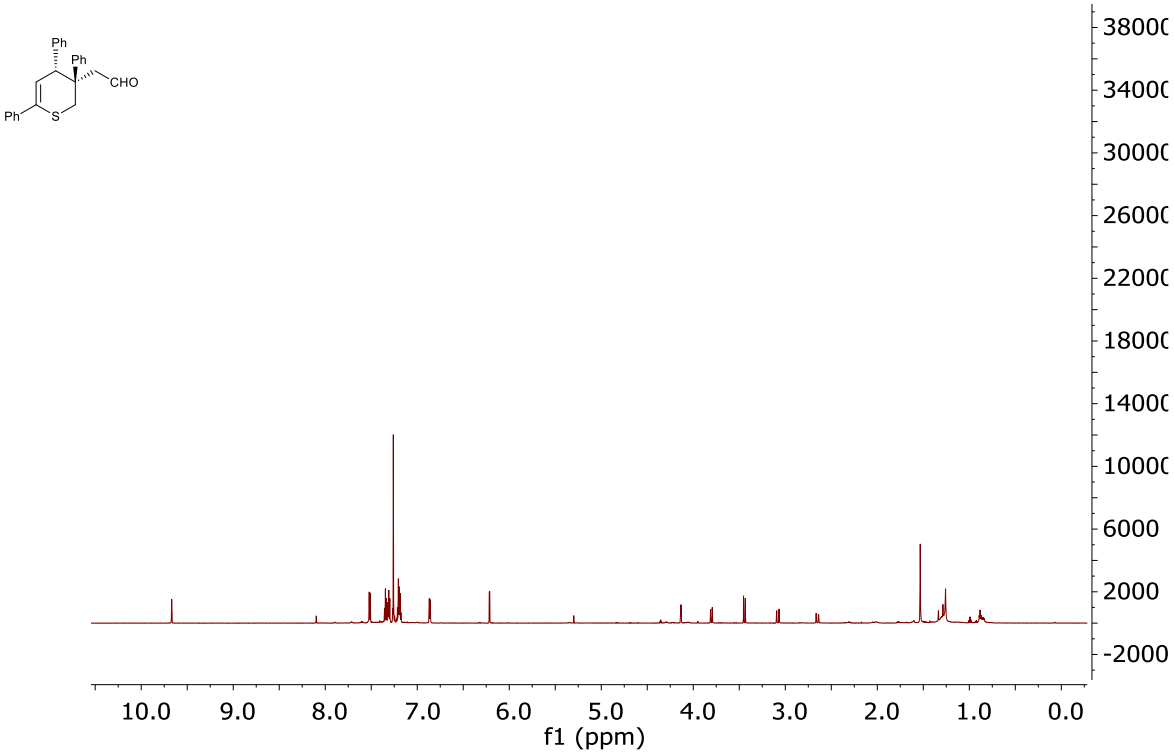


^{13}C NMR

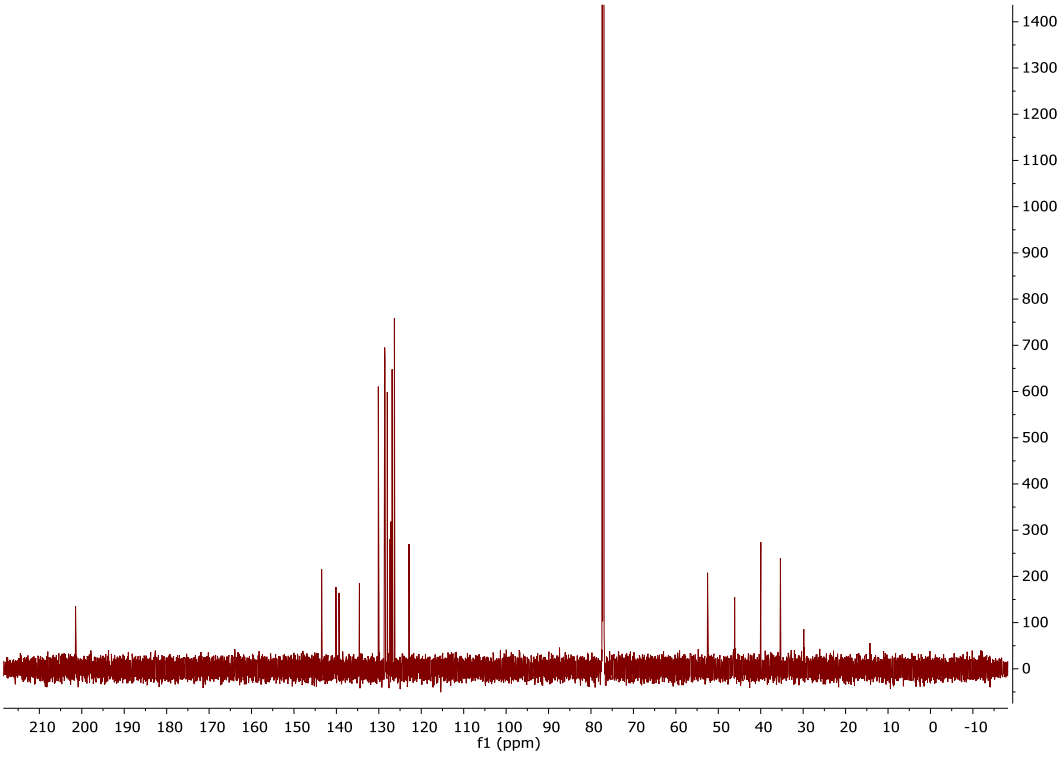


2-((3*S*,4*R*)-3,4,6-Triphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5l)

^{1}H NMR

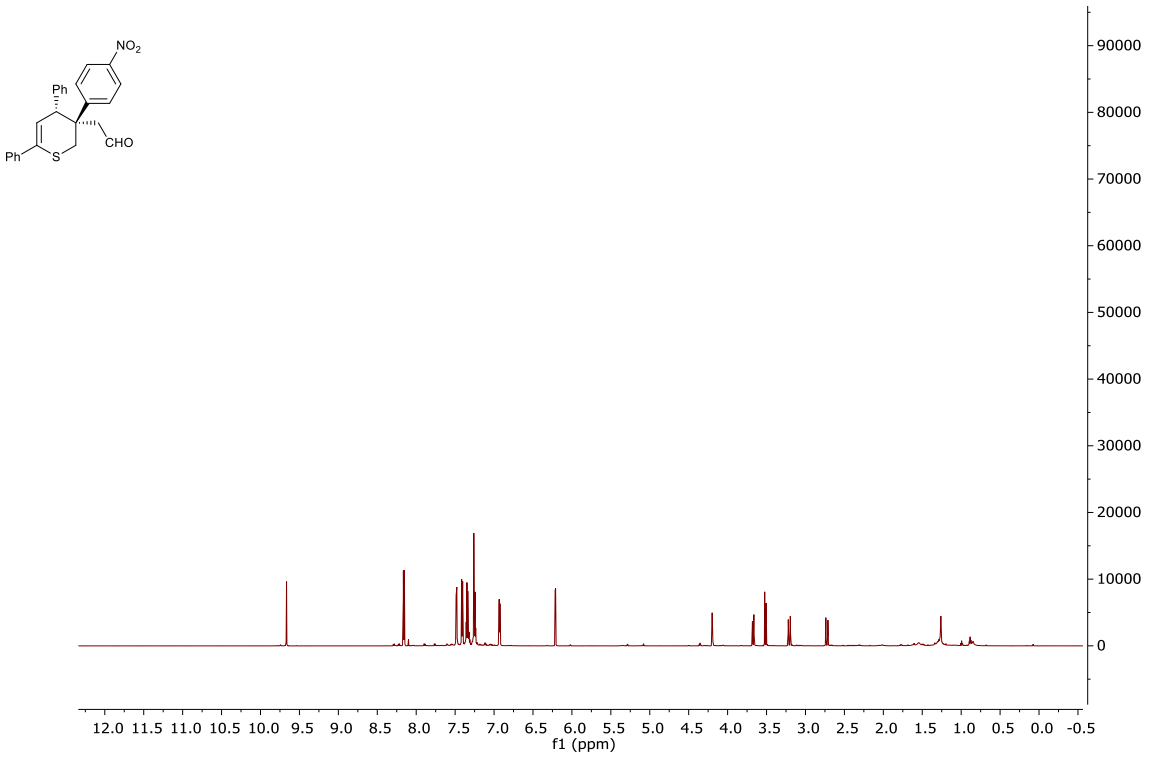


^{13}C NMR

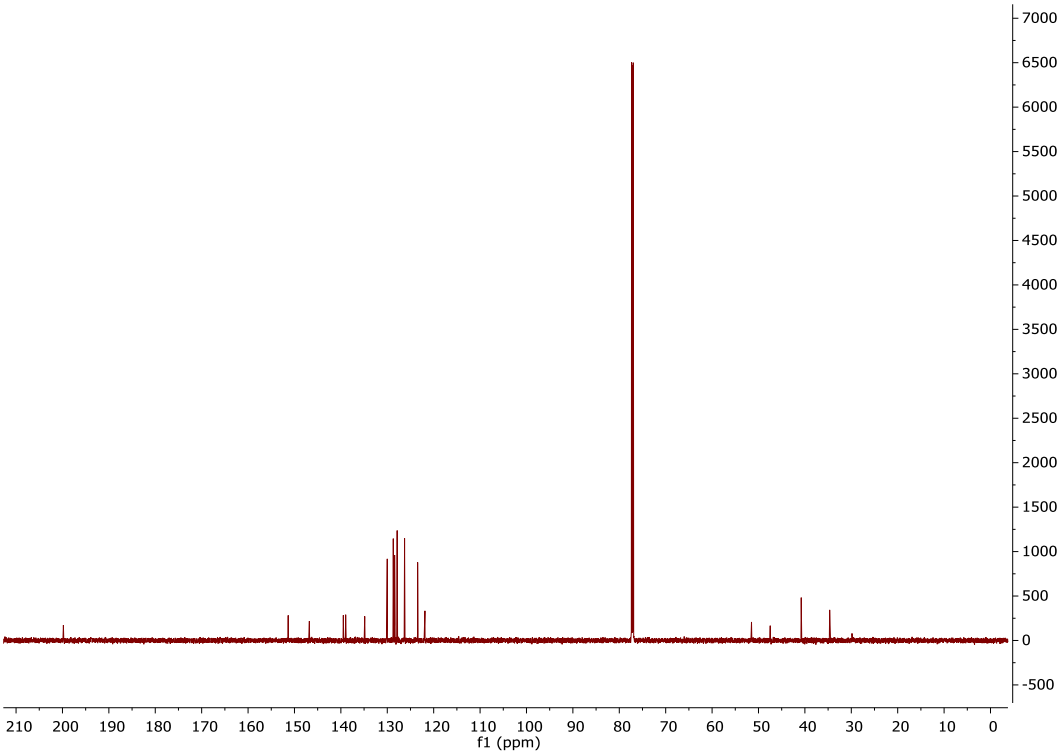


2-((3*S*,4*R*)-3-(4-Nitrophenyl)-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5m)

^{1}H NMR

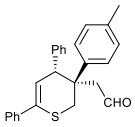


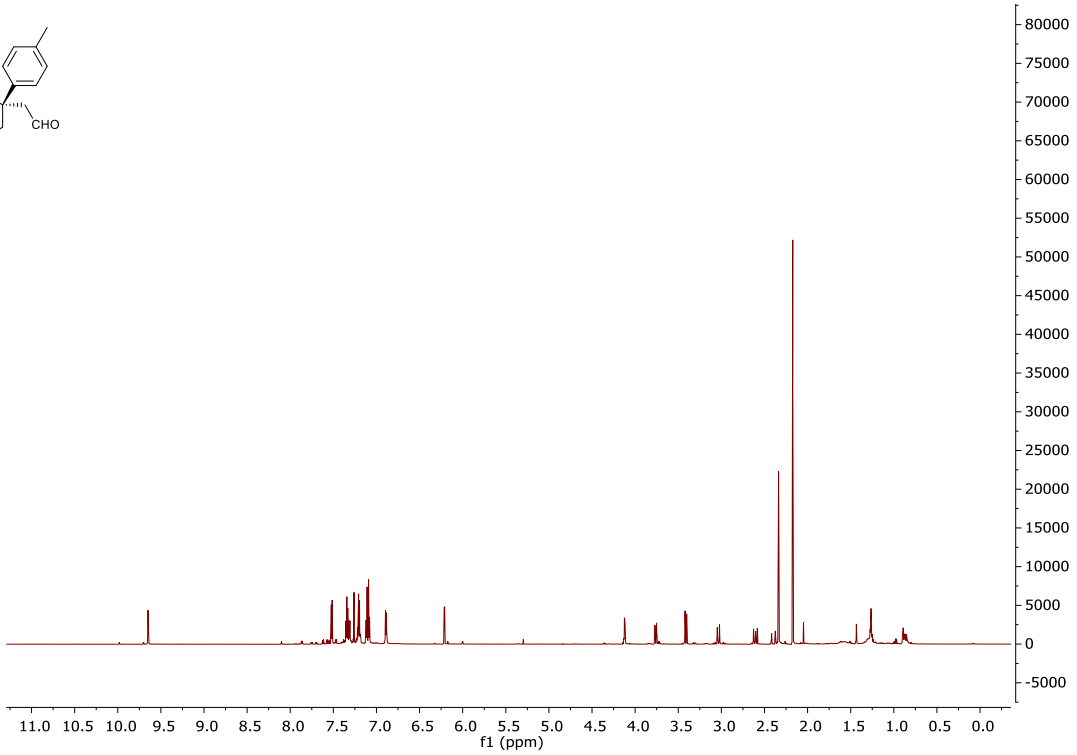
^{13}C NMR



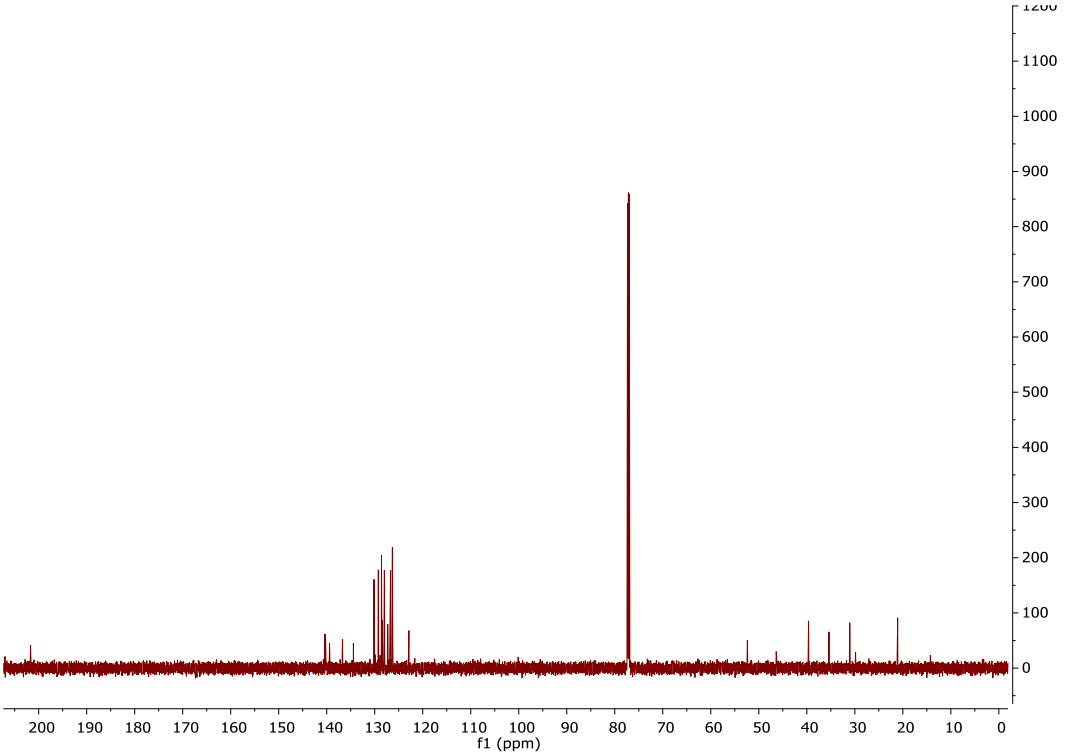
2-((3*S*,4*R*)-4,6-Diphenyl-3-*p*-tolyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5n)

^{1}H NMR (**5n**:**6n** 11:1 rr)



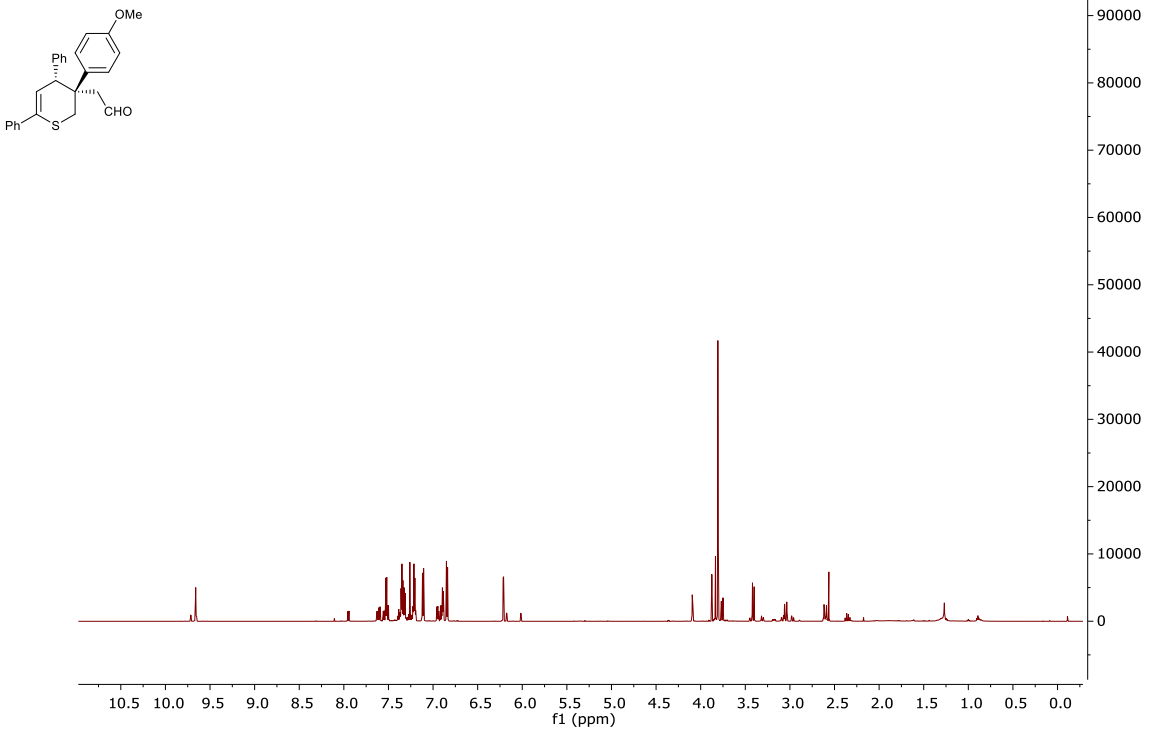


^{13}C NMR

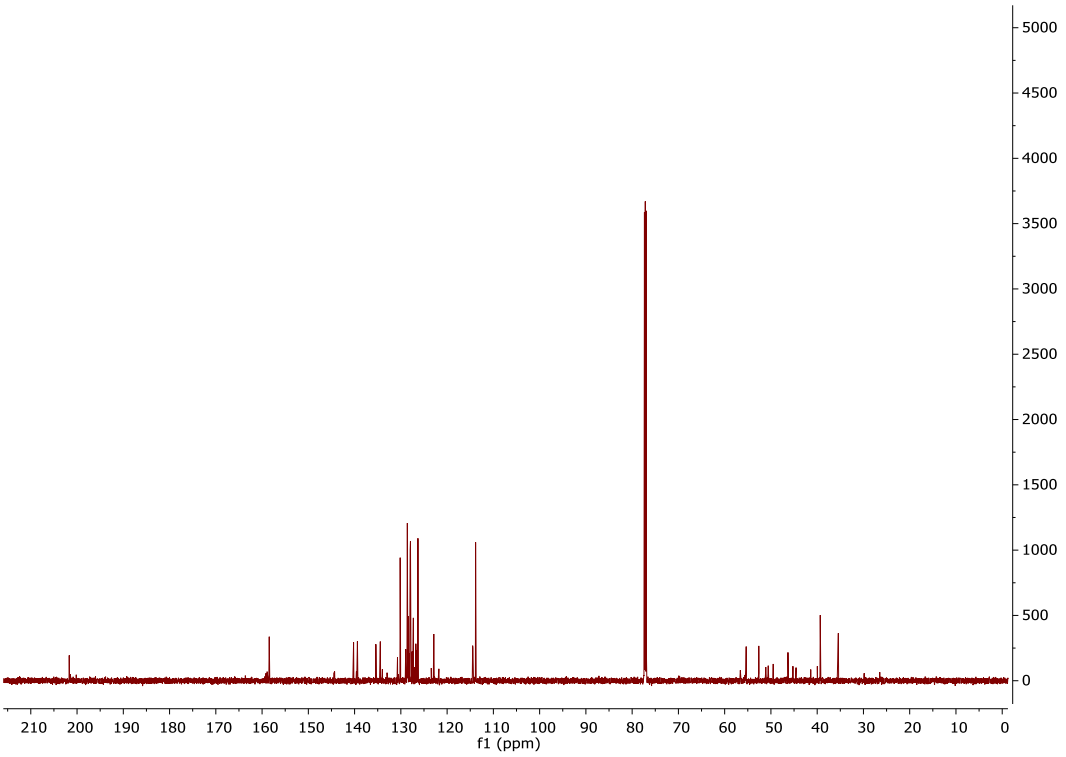


2-((3*S*,4*R*)-3-(4-Methoxyphenyl)-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5o)

^{1}H NMR (**5o**:**6o** 5:1 rr)

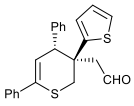


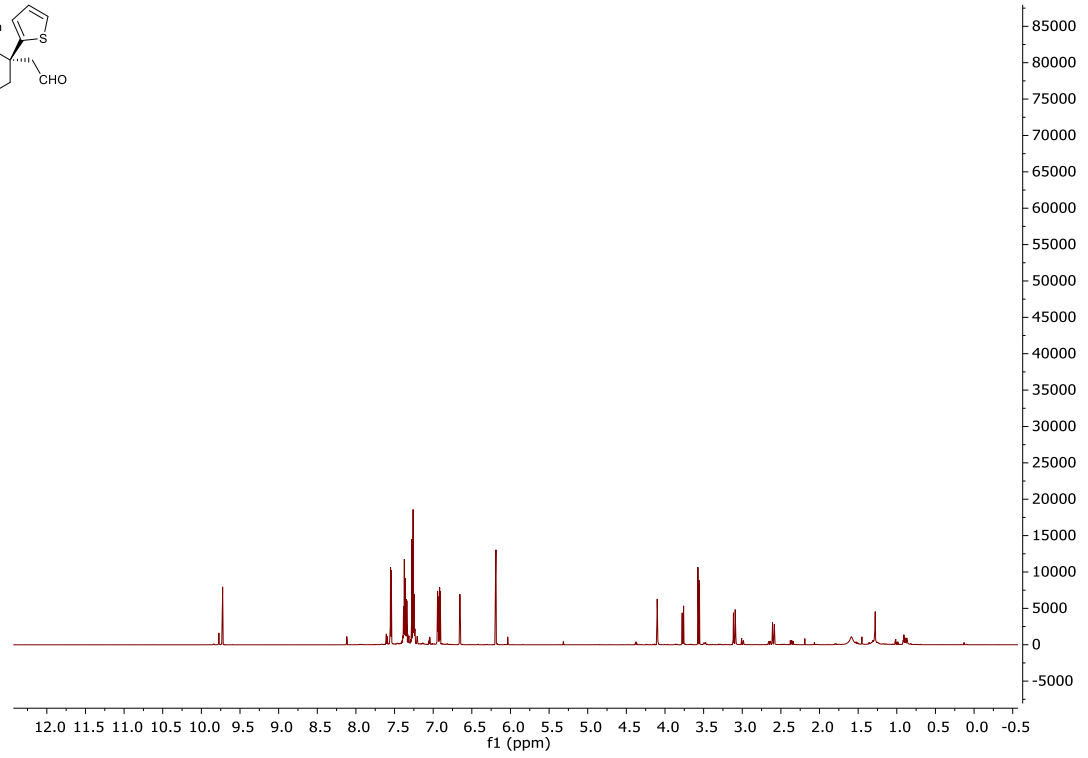
^{13}C NMR



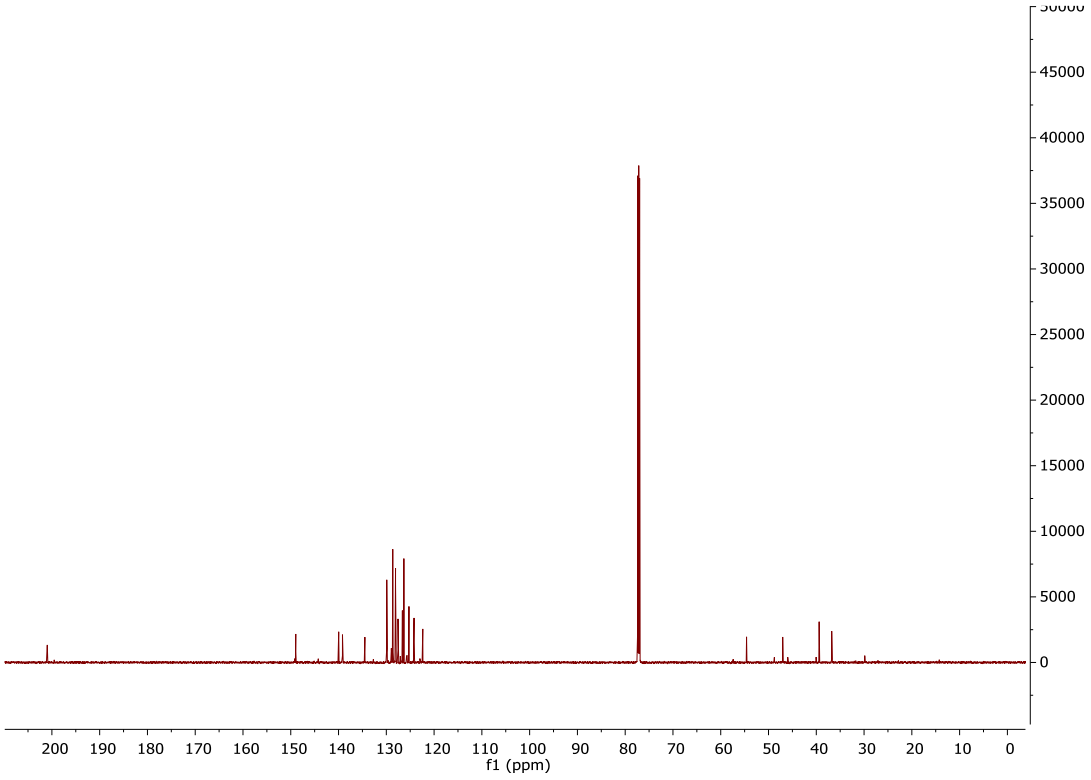
2-((3*R*,4*R*)-4,6-Diphenyl-3-(thiophen-2-yl)-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehydeacetaldehyde (5p)

^{1}H NMR (8:1 dr)



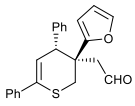


^{13}C NMR

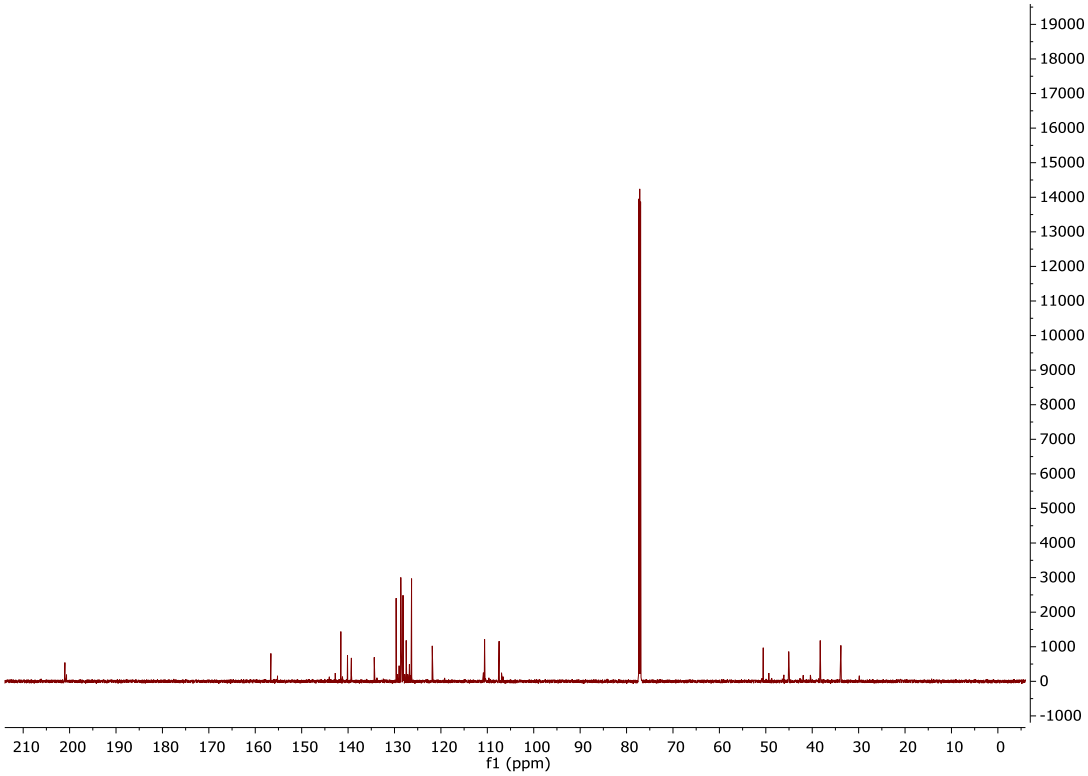


2-((3*S*,4*R*)-3-(Furan-2-yl)-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5q)

^{1}H NMR (95:5 dr)



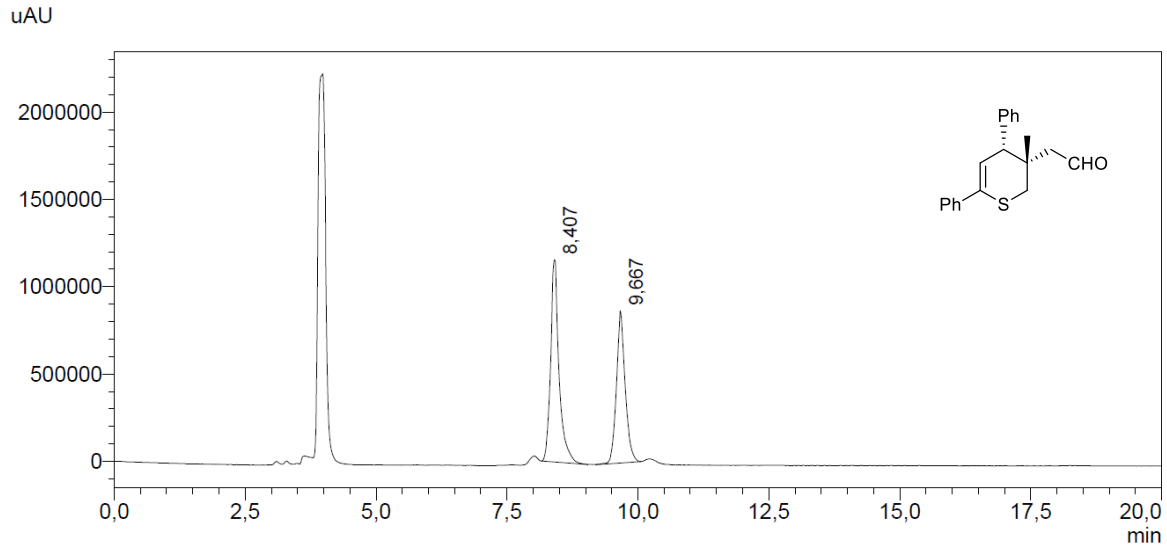
^{13}C NMR



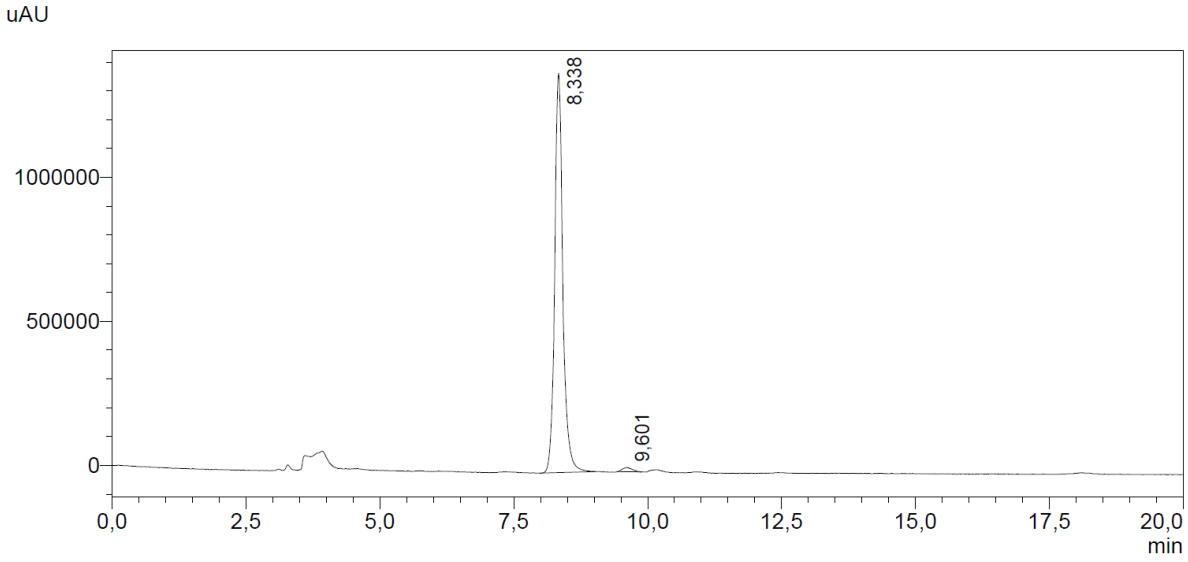
6. HPLC traces

2-((3*S*,4*R*)-3-Methyl-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5a)

Racemic sample



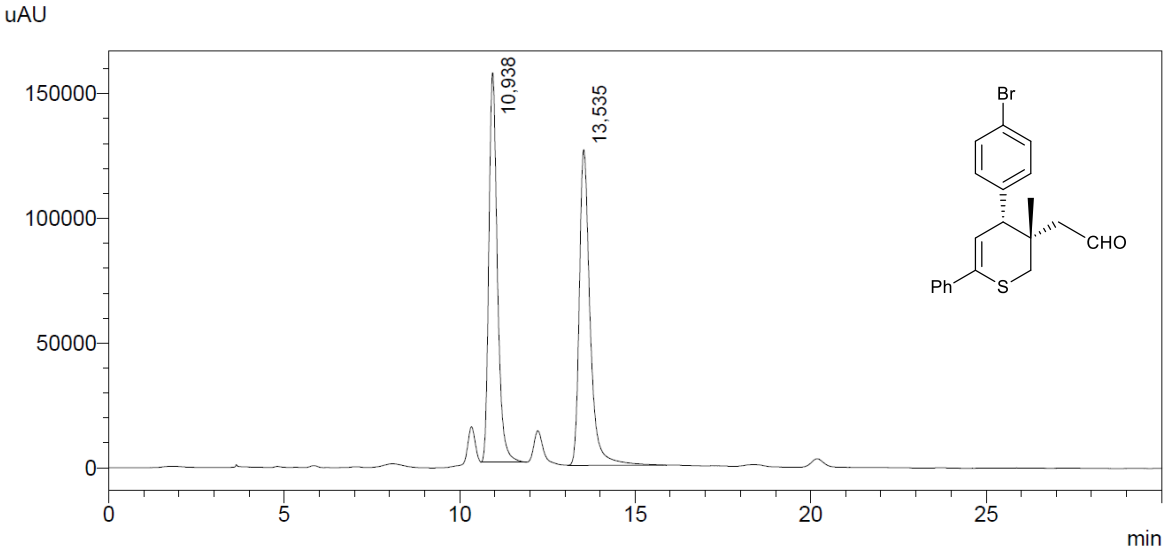
Enantiomerically enriched sample



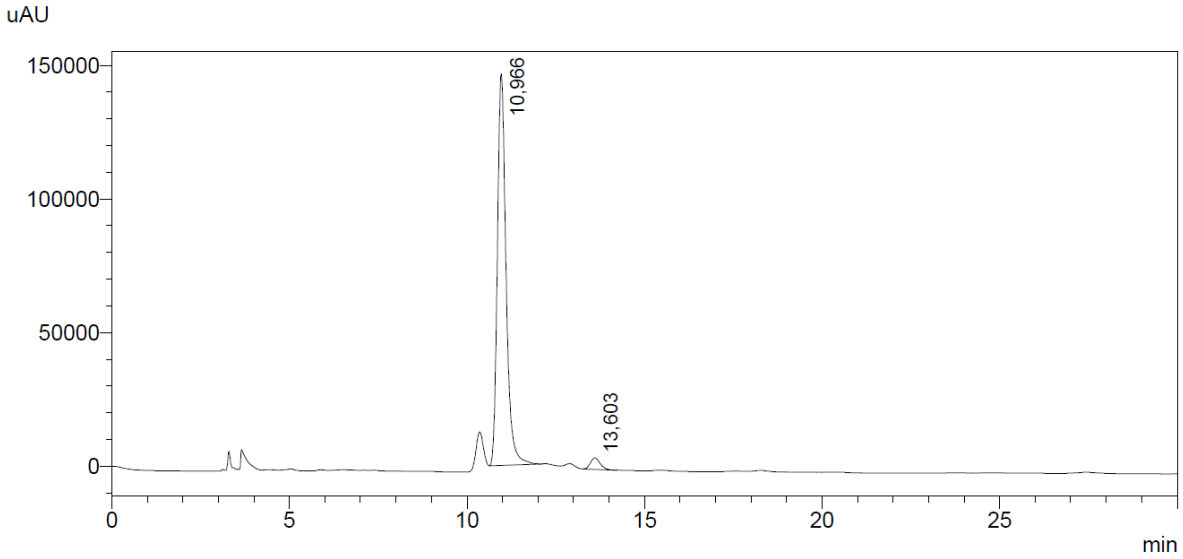
Peak#	Ret. Time	Area%
1	8,338	98,713
2	9,601	1,287
Total		100,000

2-((3*S*,4*R*)-4-(4-Bromophenyl)-3-methyl-6-phenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5b)

Racemic sample



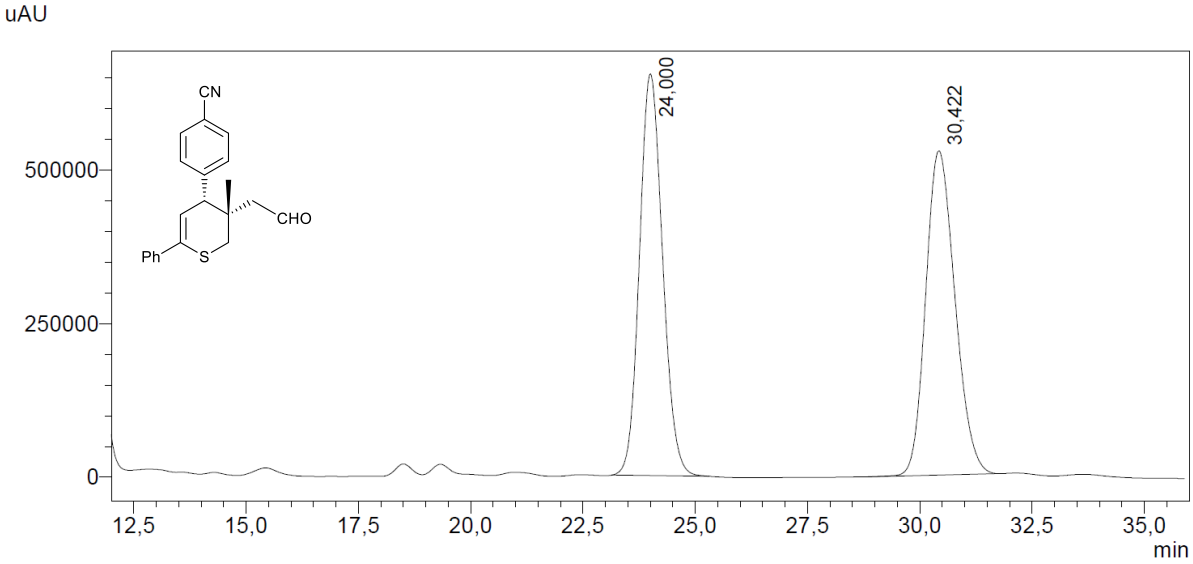
Enantiomerically enriched sample



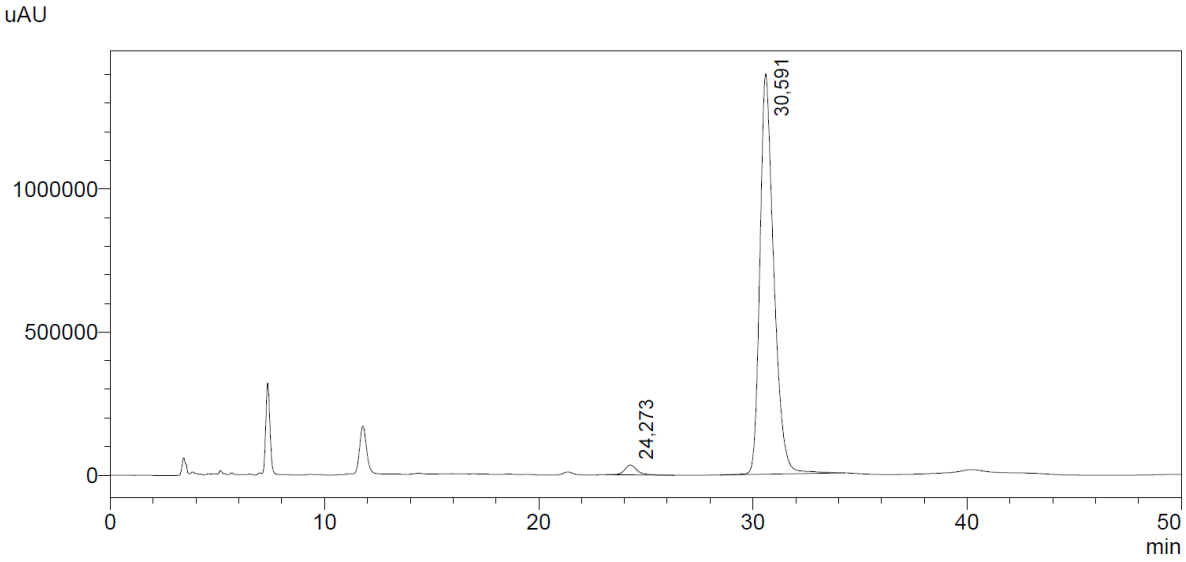
Peak#	Ret. Time	Area%
1	10,966	96,816
2	13,603	3,184
Total		100,000

4-((3*S*,4*R*)-3-Methyl-3-(2-oxoethyl)-6-phenyl-3,4-dihydro-2*H*-thiopyran-4-yl)benzonitrile (5c)

Racemic sample



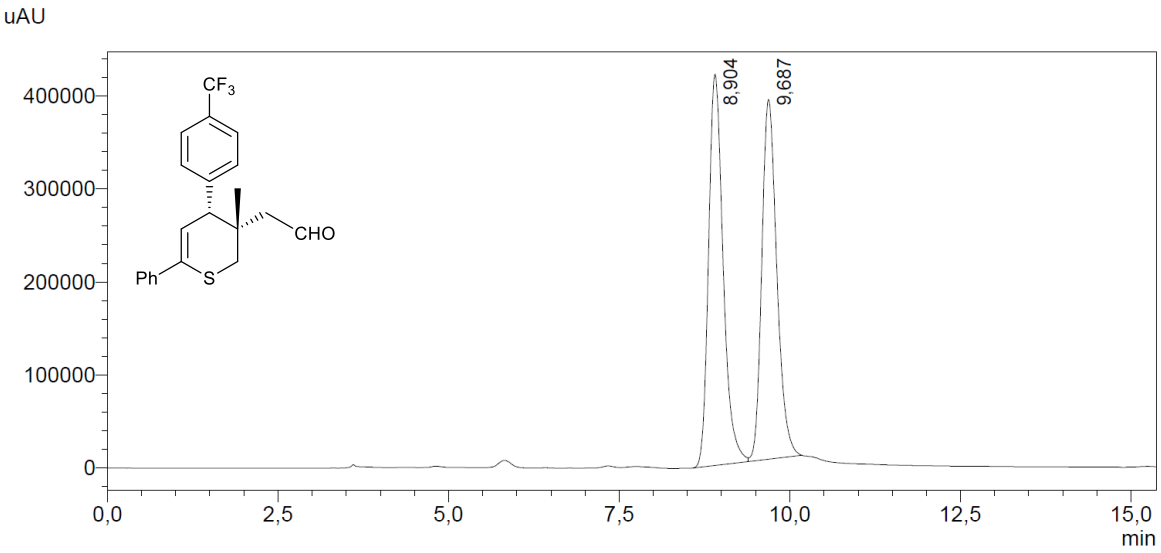
Enantiomerically enriched sample



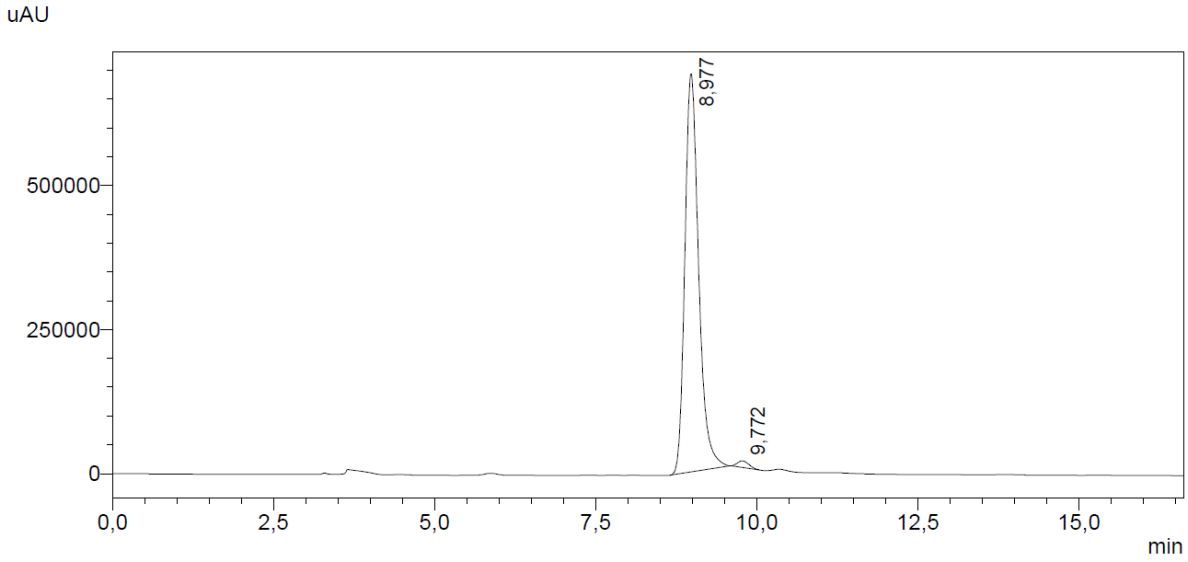
Peak#	Ret. Time	Area%
1	24,273	2,189
2	30,591	97,811
Total		100,000

2-((3*S*,4*R*)-3-Methyl-6-phenyl-4-(4-(trifluoromethyl)phenyl)-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5d)

Racemic sample



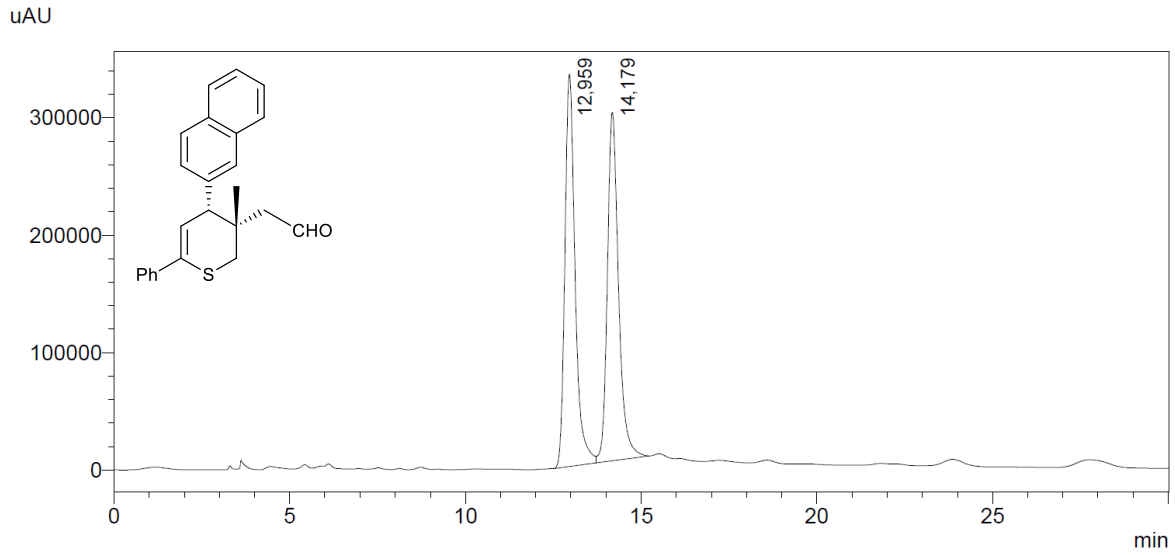
Enantiomerically enriched sample



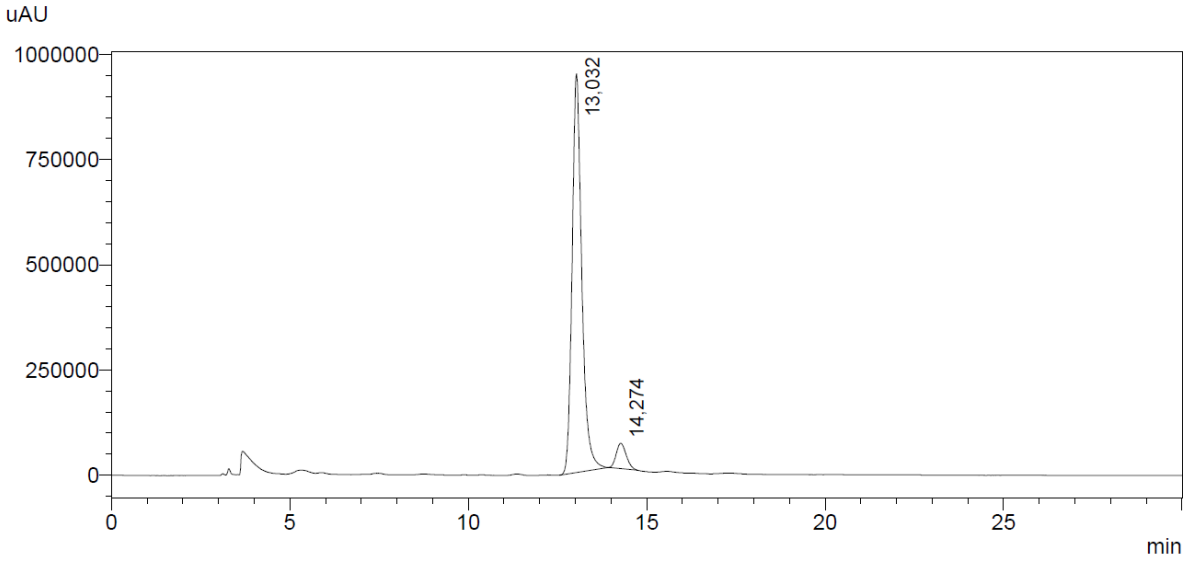
Peak#	Ret. Time	Area%
1	8,977	98,633
2	9,772	1,367
Total		100,000

2-((3*S*,4*R*)-3-Methyl-4-(naphthalen-2-yl)-6-phenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5e)

Racemic sample



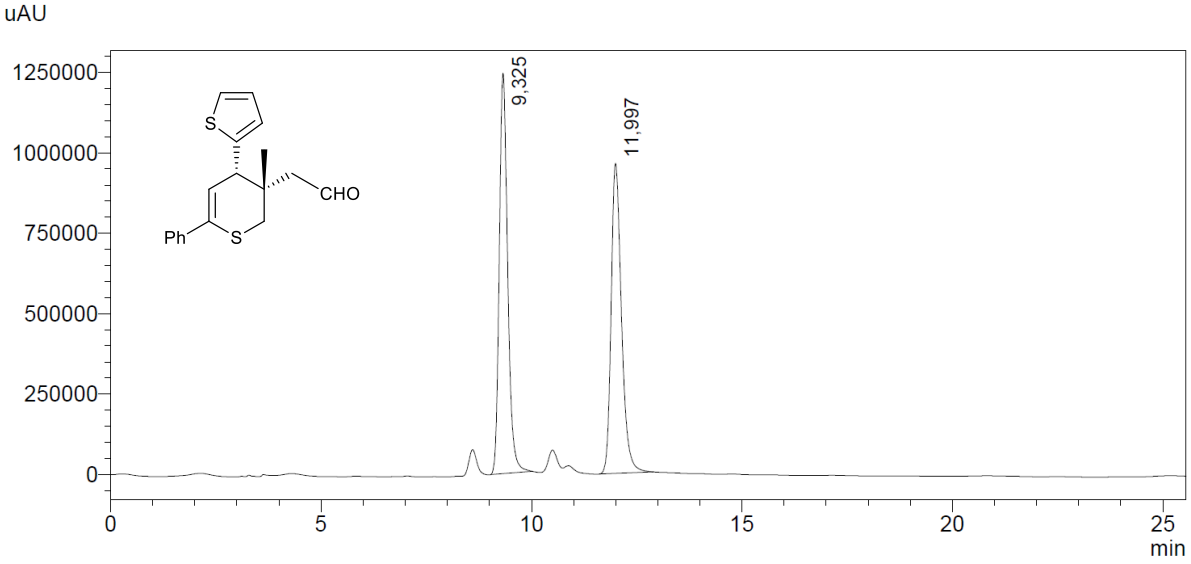
Enantiomerically enriched sample



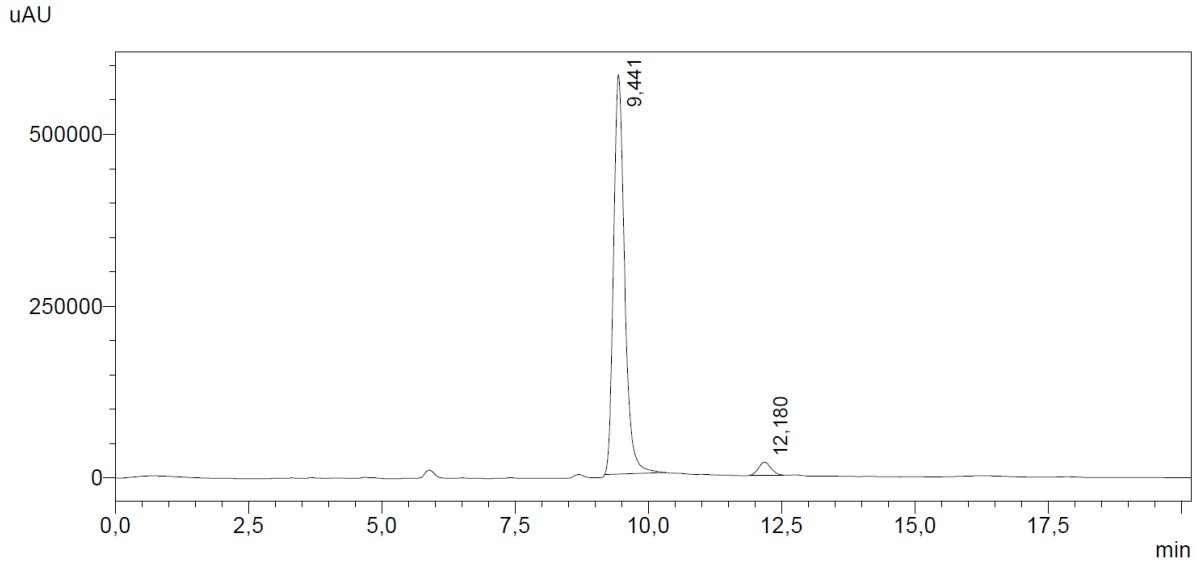
Peak#	Ret. Time	Area%
1	13,032	93,859
2	14,274	6,141
Total		100,000

2-((3*S*,4*S*)-3-Methyl-6-phenyl-4-(thiophen-2-yl)-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5f)

Racemic sample



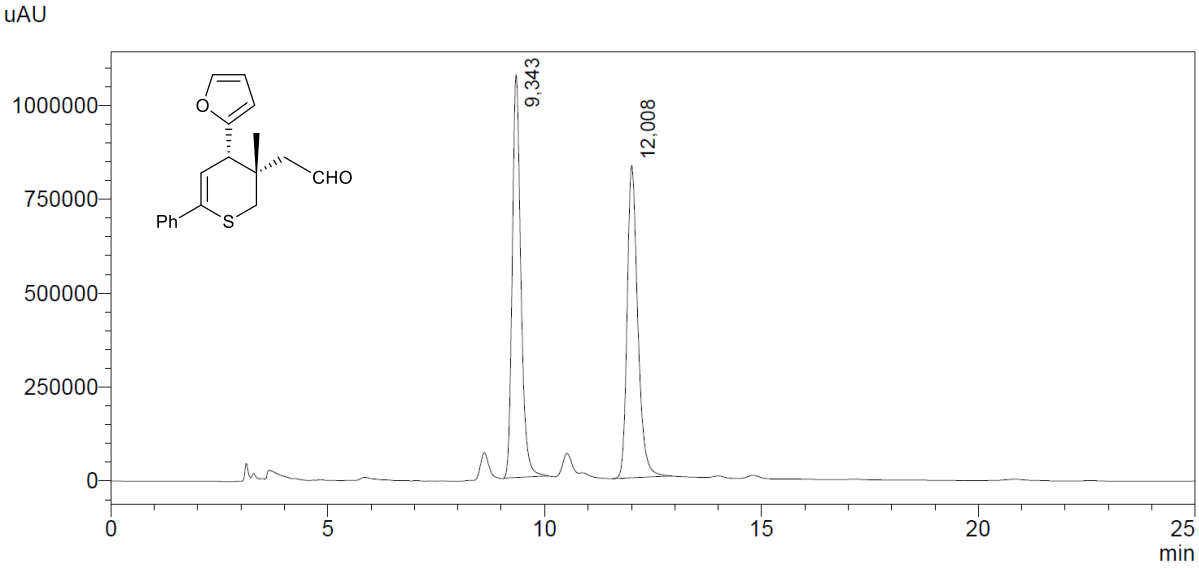
Enantiomerically enriched sample



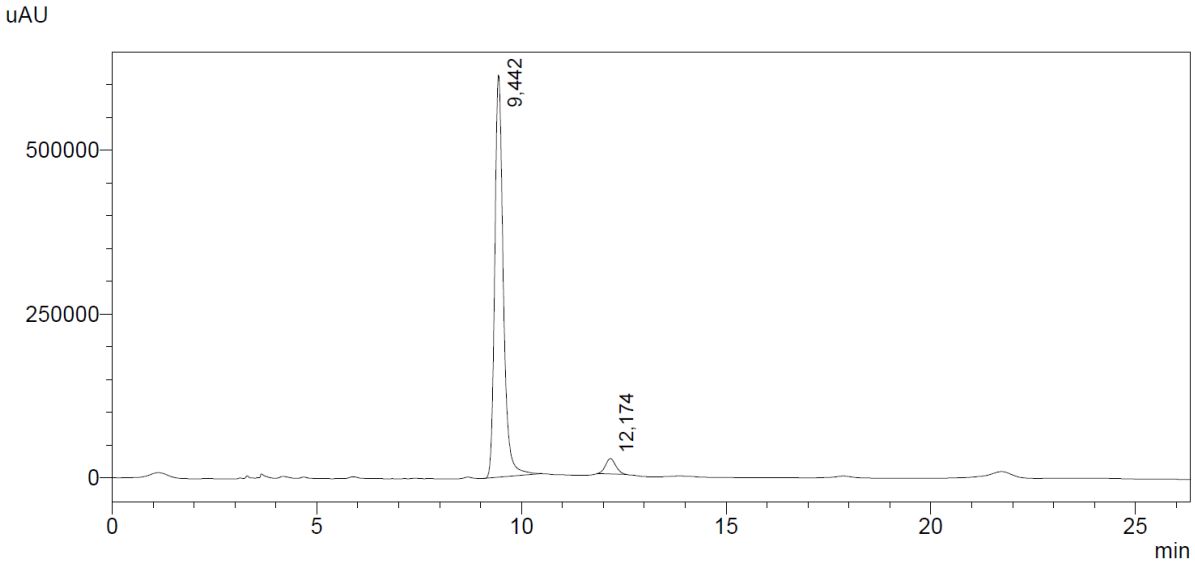
Peak#	Ret. Time	Area%
1	9,441	96,532
2	12,180	3,468
Total		100,000

2-((3*S*,4*S*)-4-(Furan-2-yl)-3-methyl-6-phenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5g)

Racemic sample



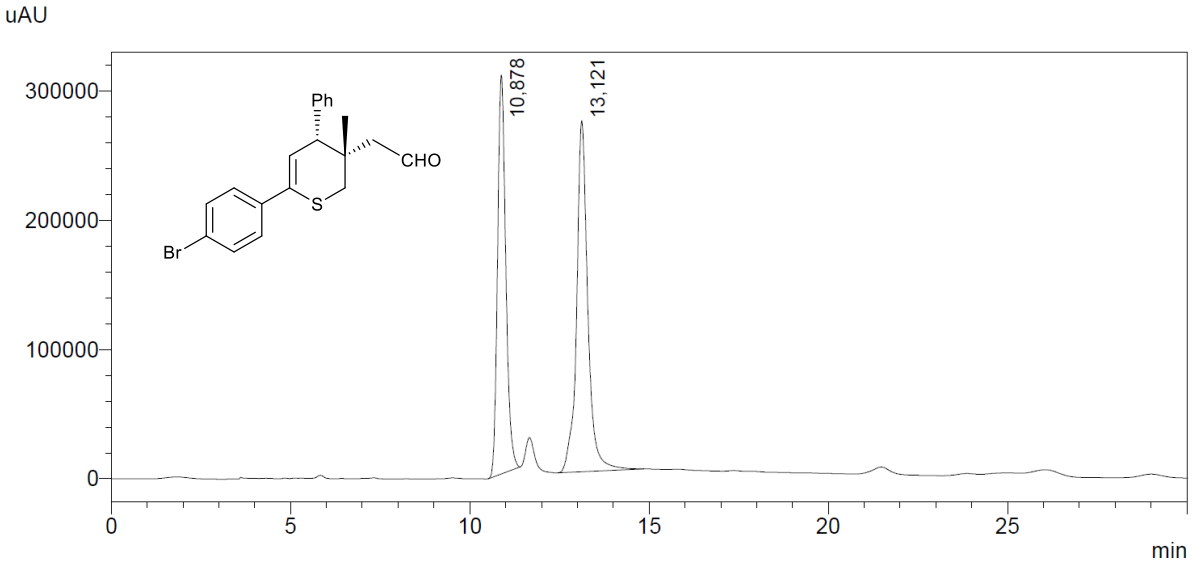
Enantiomerically enriched sample



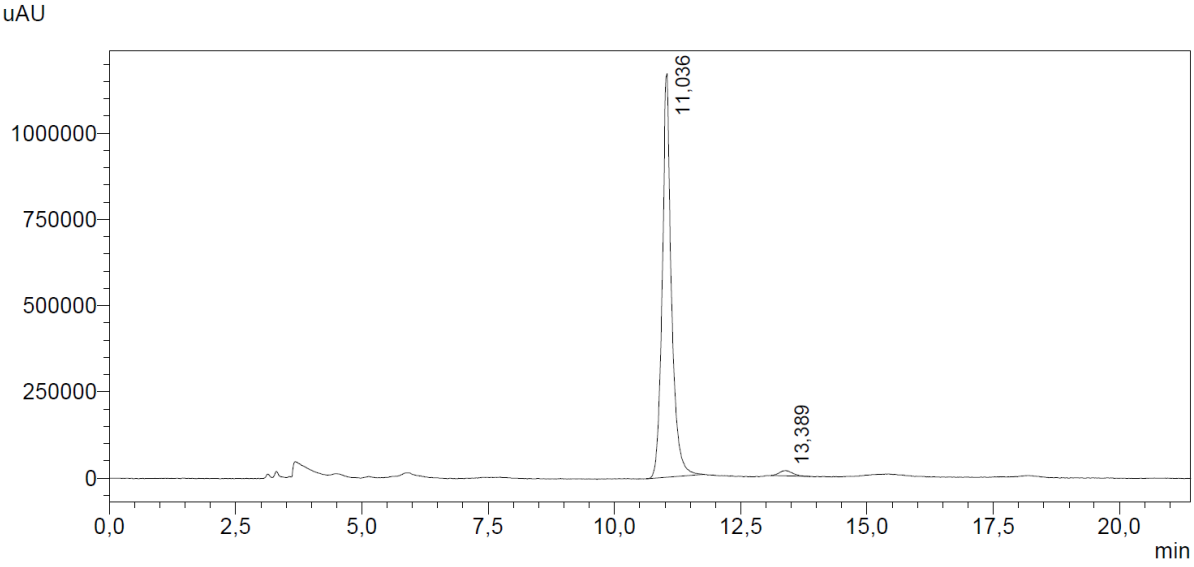
Peak#	Ret. Time	Area%
1	9,442	95,537
2	12,174	4,463
Total		100,000

2-((3*S*,4*R*)-6-(4-Bromophenyl)-3-methyl-4-phenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5h)

Racemic sample



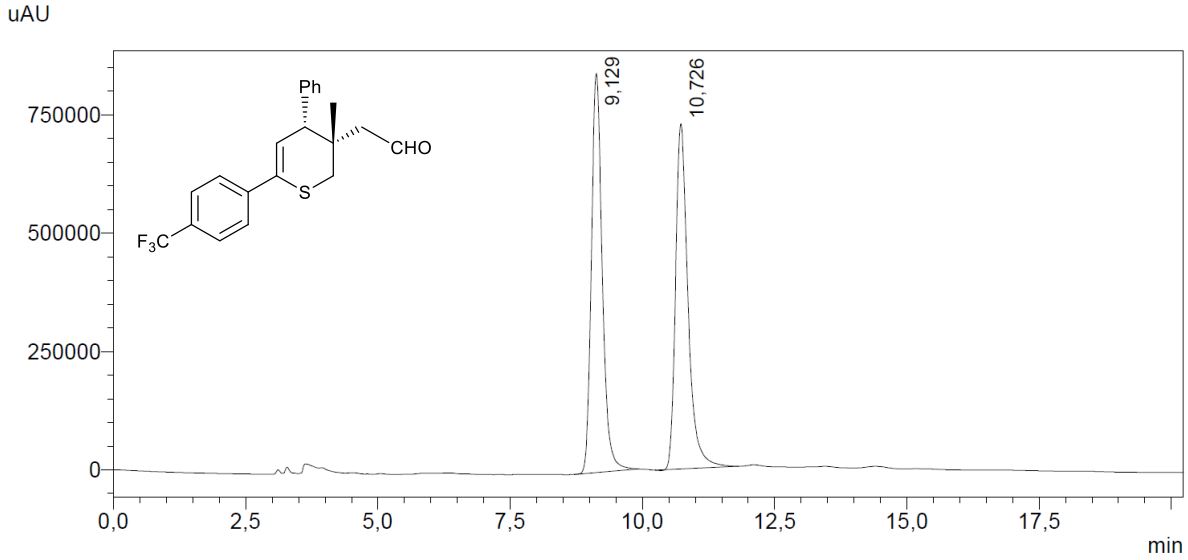
Enantiomerically enriched sample



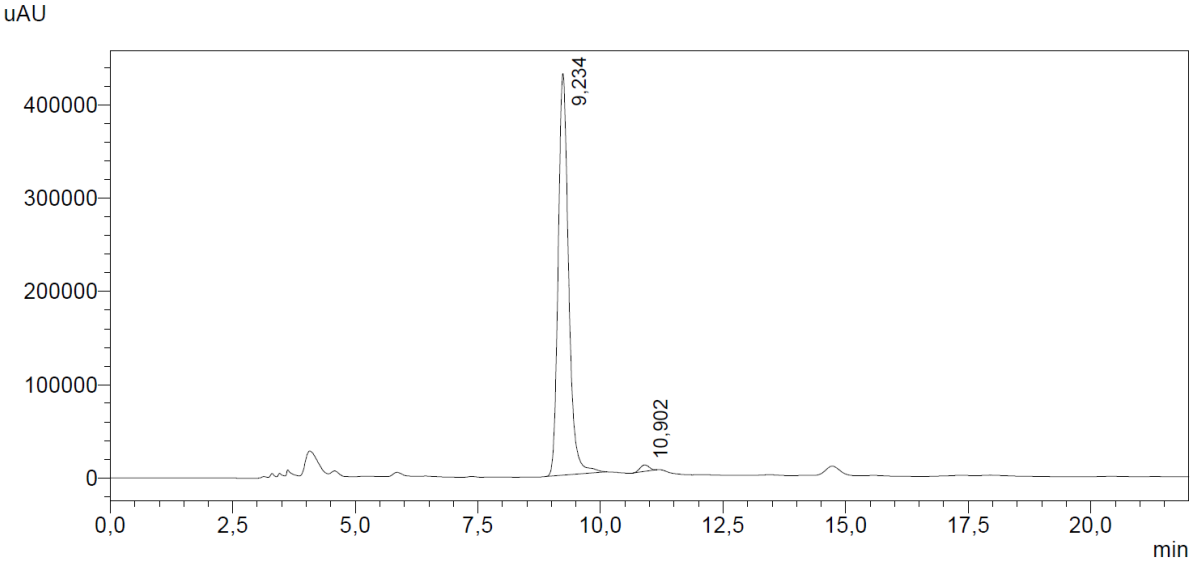
Peak#	Ret. Time	Area%
1	11,036	98,151
2	13,389	1,849
Total		100,000

2-((3*S*,4*R*)-3-Methyl-4-phenyl-6-(4-(trifluoromethyl)phenyl)-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5i)

Racemic sample



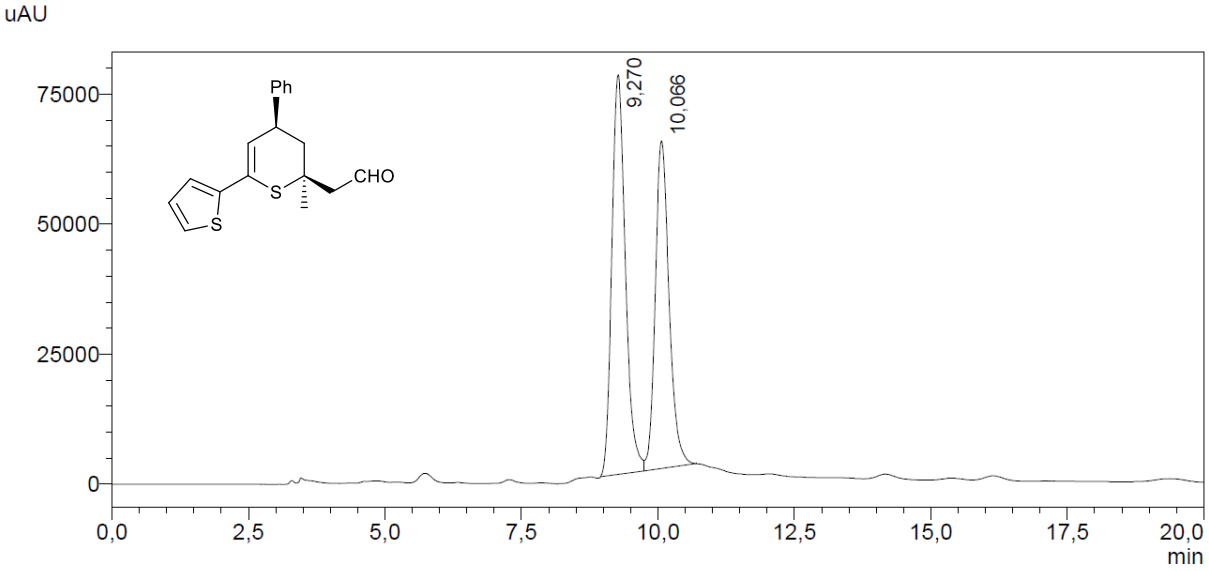
Enantiomerically enriched sample



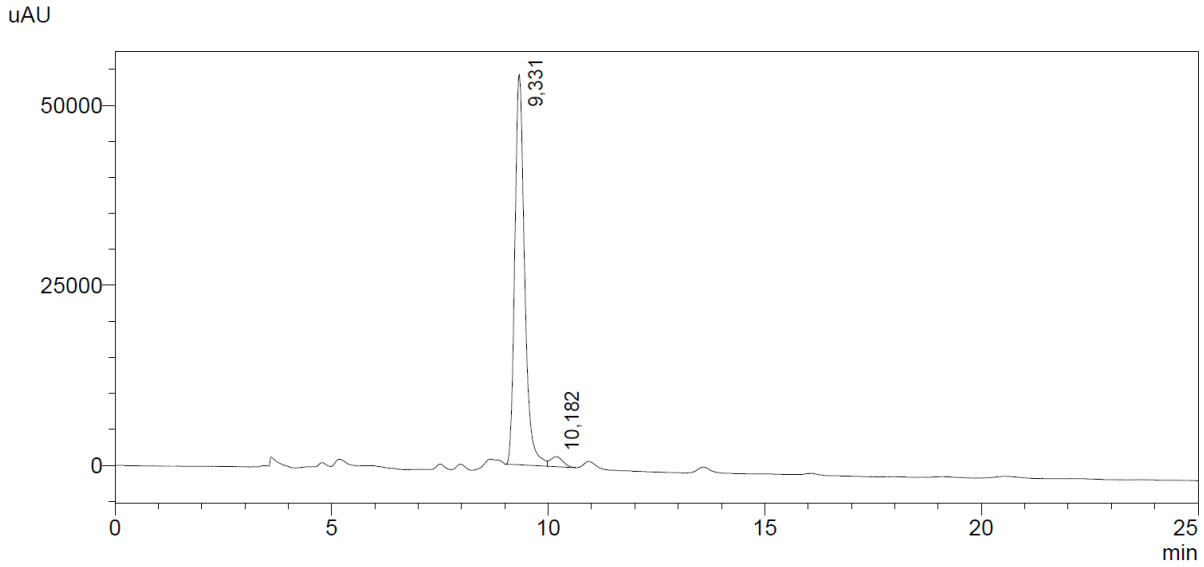
Peak#	Ret. Time	Area%
1	9,234	98,560
2	10,902	1,440
Total		100,000

2-((2*S*,4*S*)-2-Methyl-4-phenyl-6-(thiophen-2-yl)-3,4-dihydro-2*H*-thiopyran-2-yl)acetaldehyde (6j)

Racemic sample



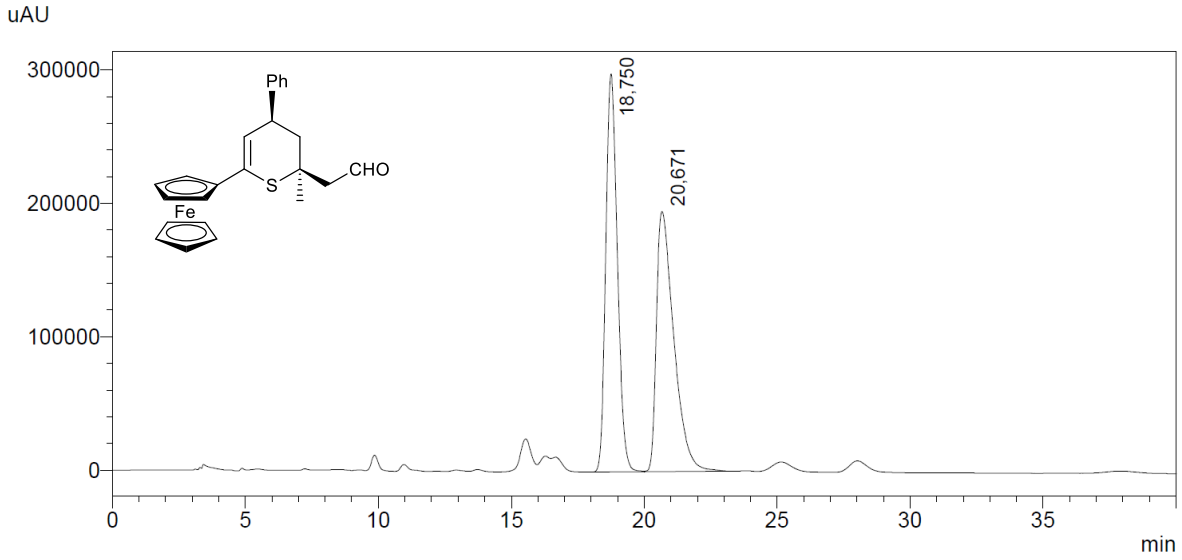
Enantiomerically enriched sample



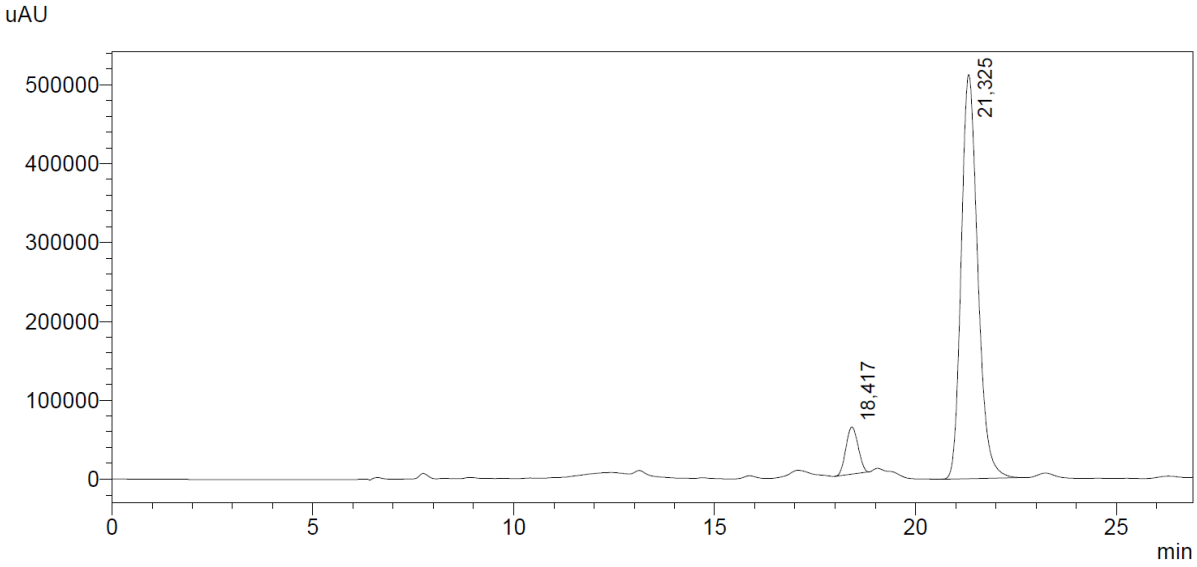
Peak#	Ret. Time	Area%
1	9,331	96,814
2	10,182	3,186
Total		100,000

2-((2*S*,4*S*)-6-Ferrocenyl-2-methyl-4-phenyl-3,4-dihydro-2*H*-thiopyran-2-yl)acetaldehyde (6k)

Racemic sample



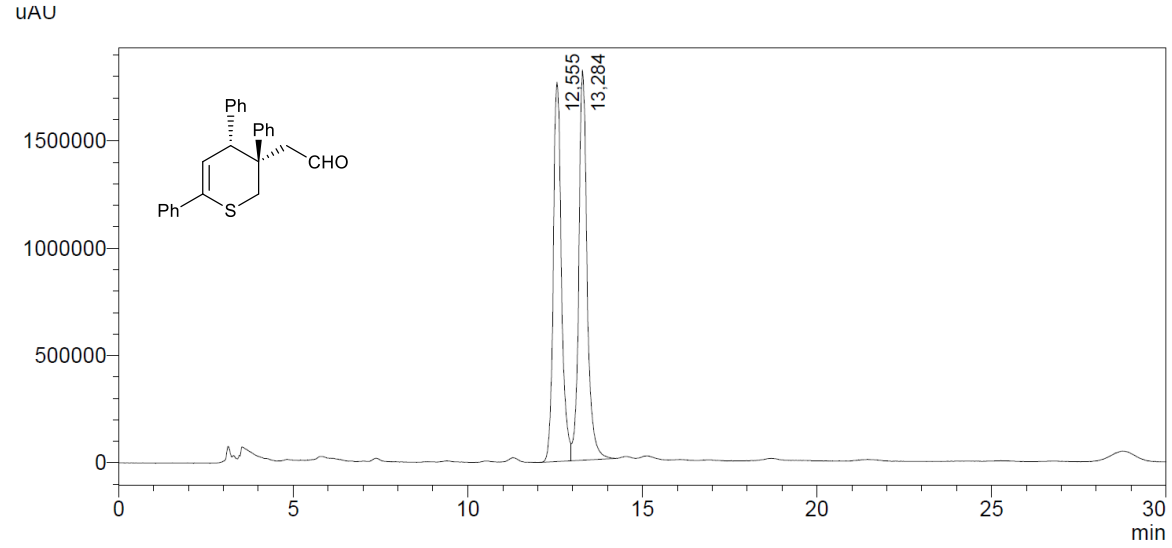
Enantiomerically enriched sample



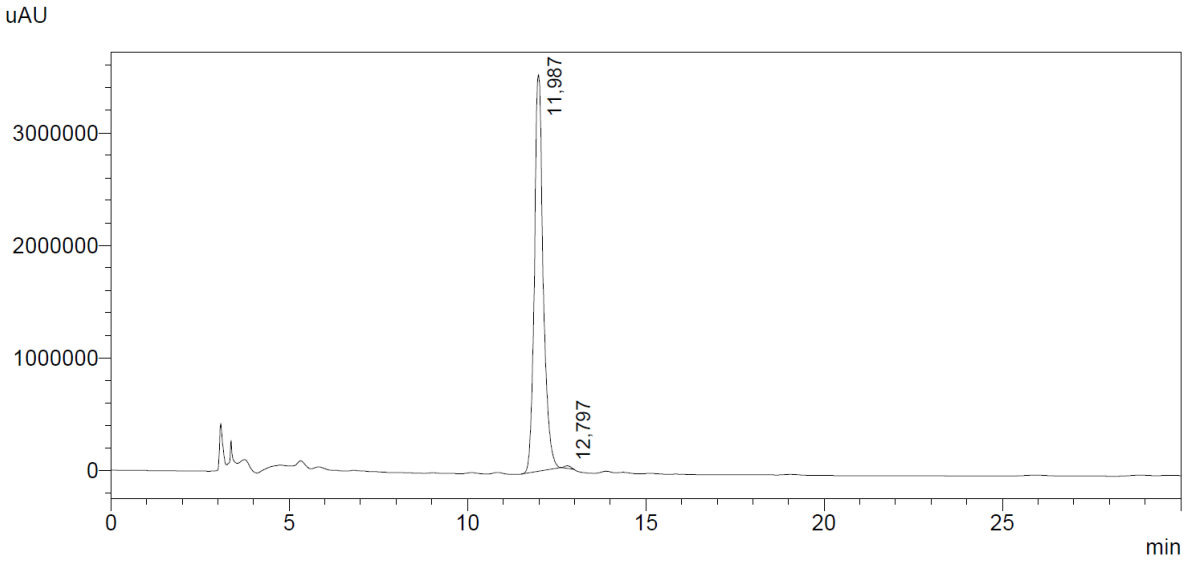
Peak#	Ret. Time	Area%
1	18,417	7,944
2	21,325	92,056
Total		100,000

2-((3*S*,4*R*)-3,4,6-Triphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5l)

Racemic sample



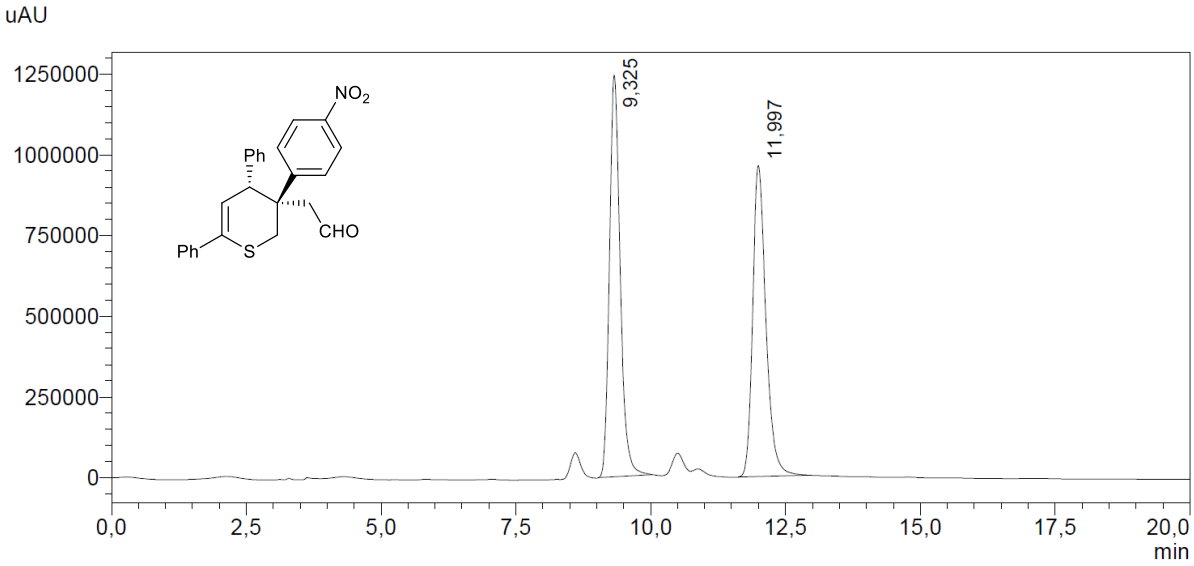
Enantiomerically enriched sample



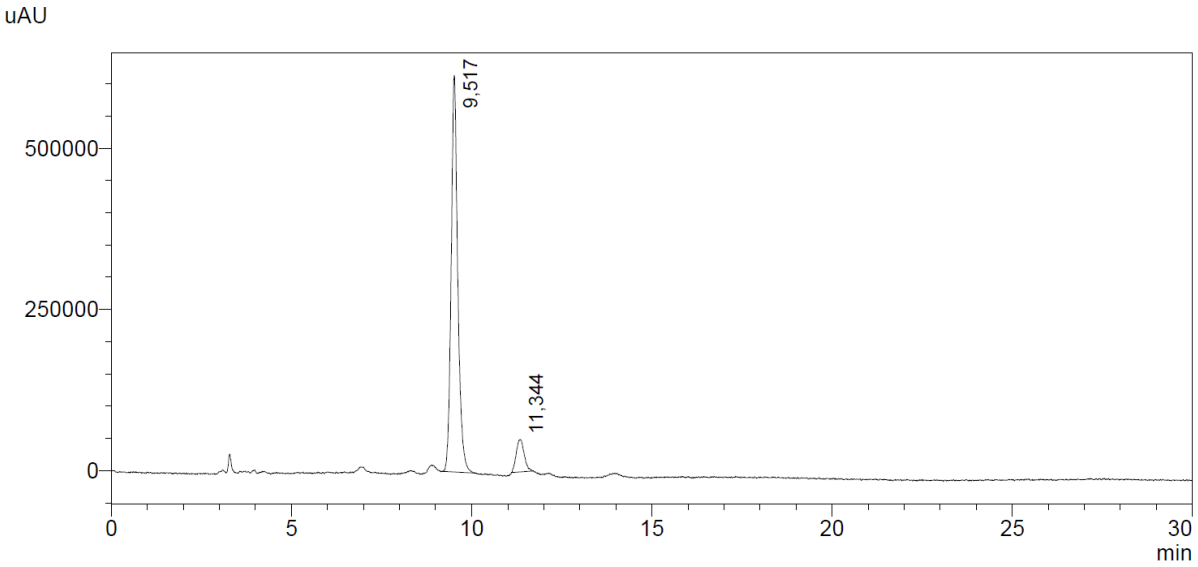
Peak#	Ret. Time	Area%
1	11,987	99,557
2	12,797	0,443
Total		100,000

2-((3*S*,4*R*)-3-(4-Nitrophenyl)-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5m)

Racemic sample



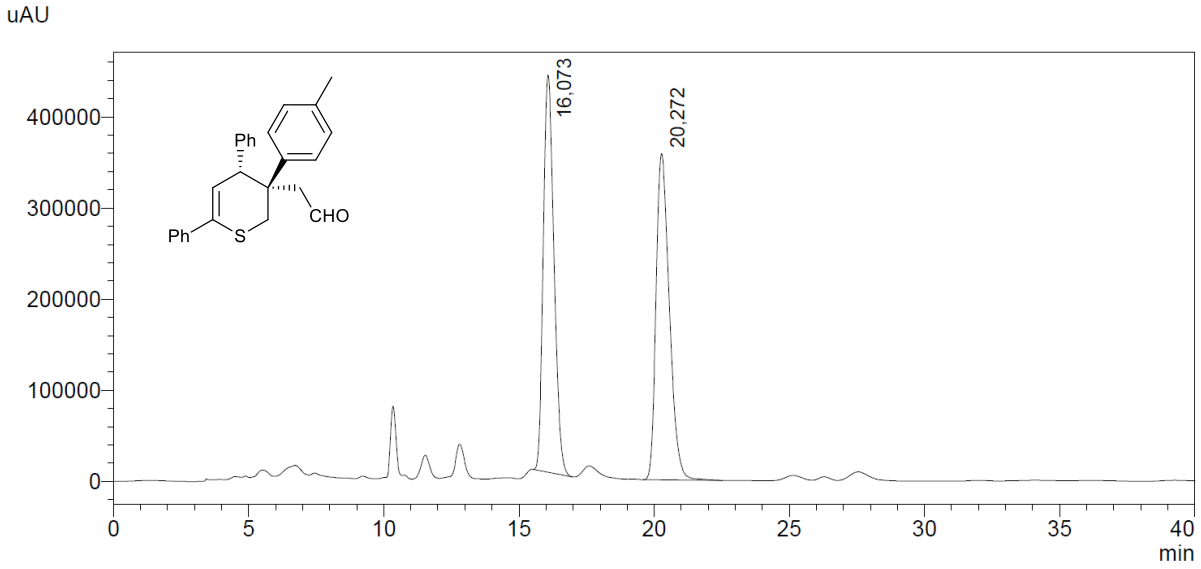
Enantiomerically enriched sample



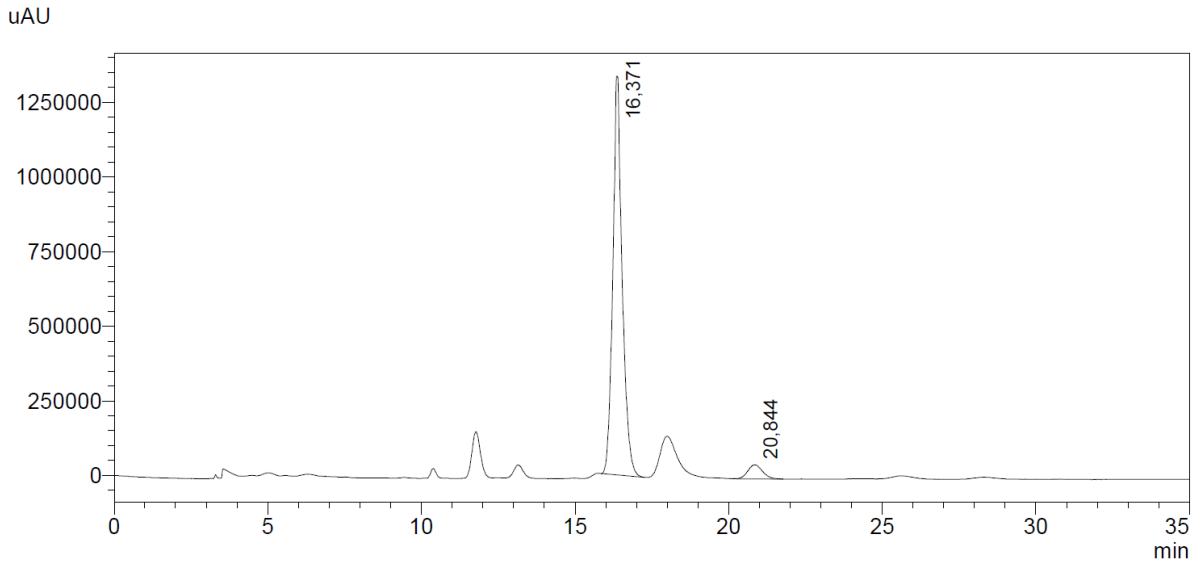
Peak#	Ret. Time	Area%
1	9,517	91,048
2	11,344	8,952
Total		100,000

2-((3*S*,4*R*)-4,6-Diphenyl-3-*p*-tolyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5n)

Racemic sample



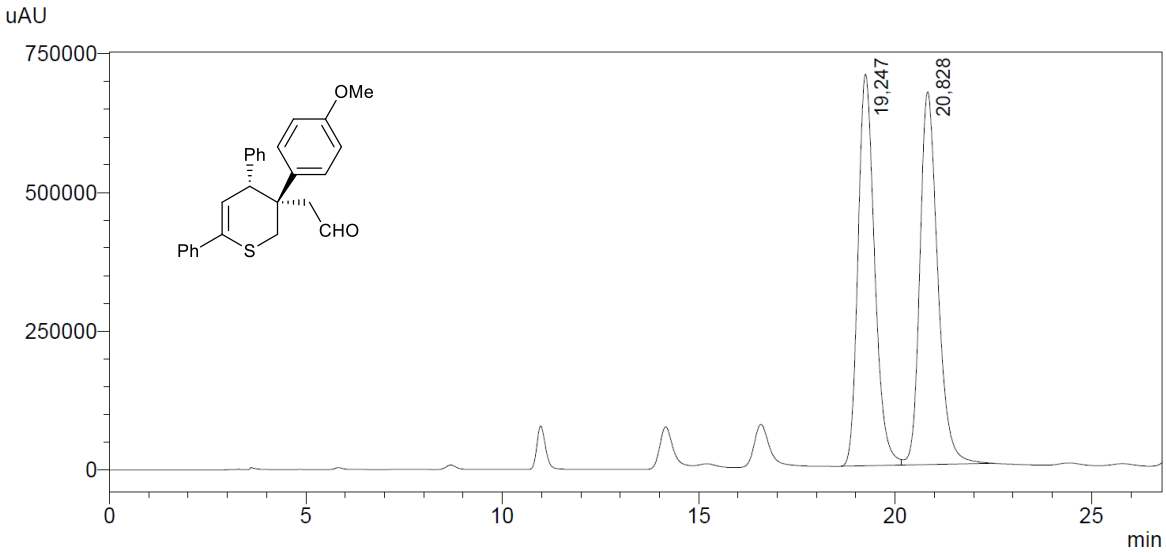
Enantiomerically enriched sample



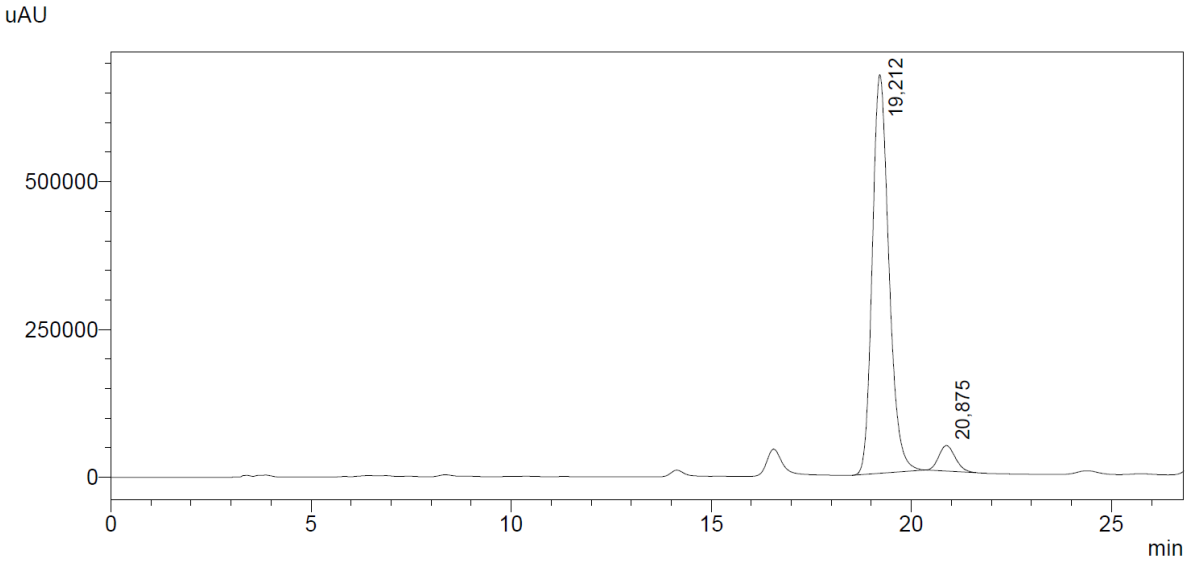
Peak#	Ret. Time	Area%
1	16,371	94,749
2	20,844	5,251
Total		100,000

2-((3*S*,4*R*)-3-(4-Methoxyphenyl)-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5o)

Racemic sample



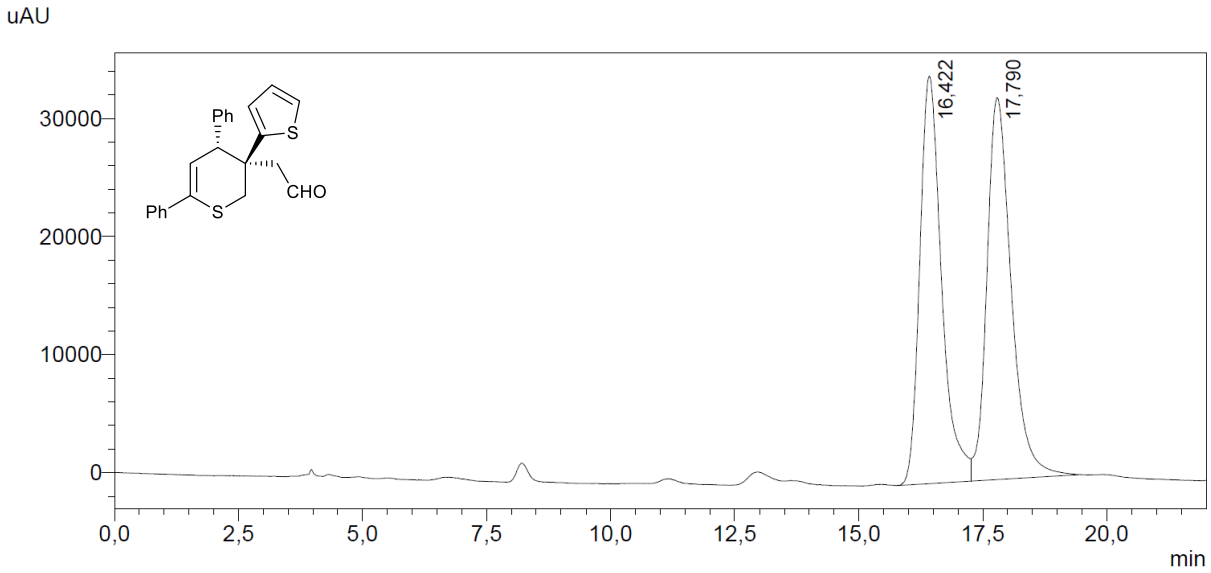
Enantiomerically enriched sample



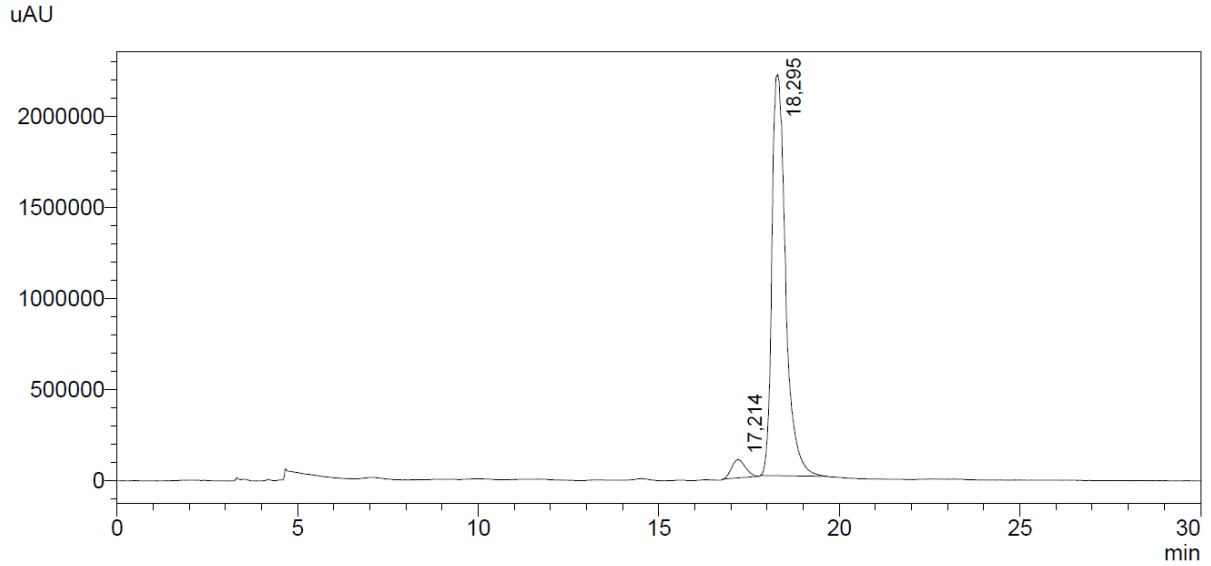
Peak#	Ret. Time	Area%
1	19,212	94,013
2	20,875	5,987
Total		100,000

2-((3*R*,4*R*)-4,6-Diphenyl-3-(thiophen-2-yl)-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5p)

Racemic sample



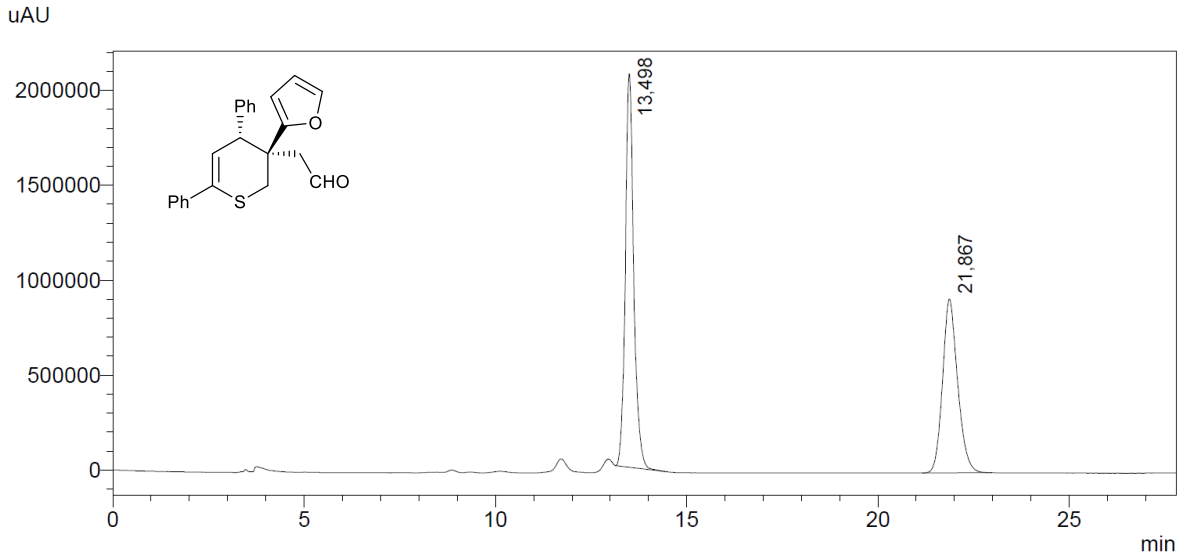
Enantiomerically enriched sample



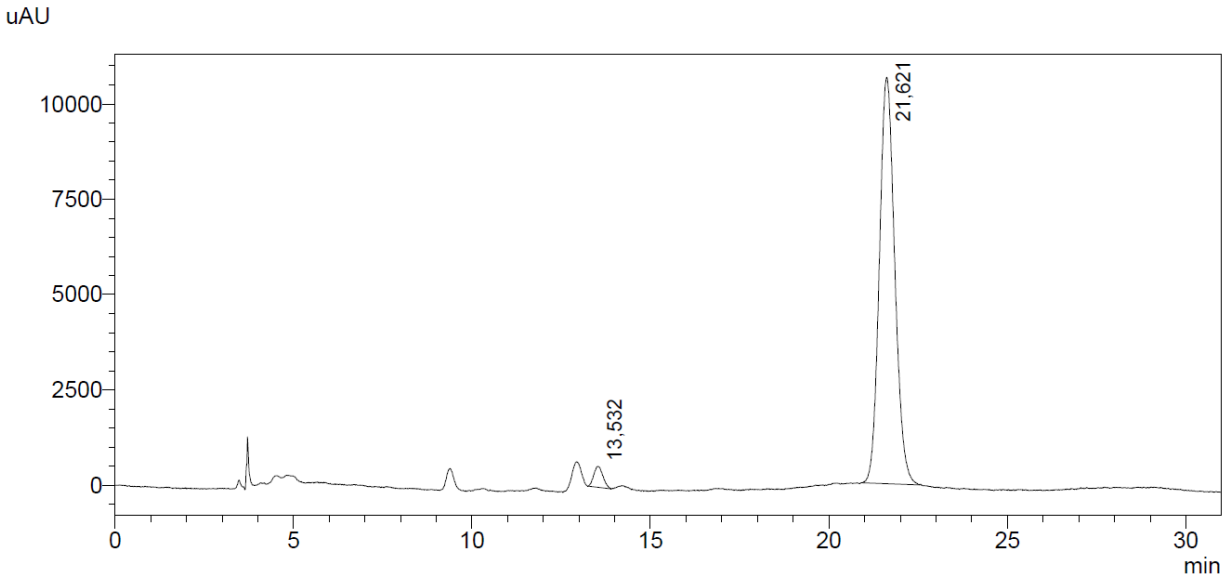
Peak#	Ret. Time	Area%
1	17,214	4,430
2	18,295	95,570
Total		100,000

2-((3*S*,4*R*)-3-(Furan-2-yl)-4,6-diphenyl-3,4-dihydro-2*H*-thiopyran-3-yl)acetaldehyde (5q)

Racemic sample



Enantiomerically enriched sample



Peak#	Ret. Time	Area%
1	13,526	2,885
2	21,620	97,115
Total		100,000