Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.

Visible-light driven enantioselective intermolecular photocyclization via bathochromic excitation by chiral phosphoric acid

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Contents

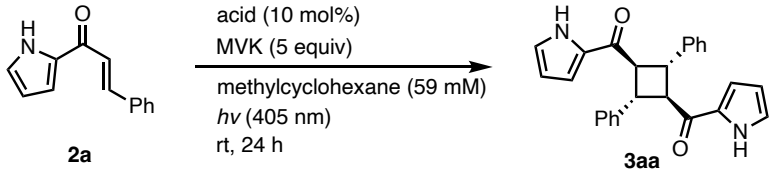
1. General methods

All operations were performed under nitrogen unless otherwise noted. NMR spectra for products data (^{1}H and ^{13}C) were recorded on a Bruker AVANCE-III (400 MHz for ^{1}H, 100 MHz for ^{13}C, 376 MHz for ^{19}F) and JEOL ECZ-400 (400 MHz for ^{1}H, 100 MHz for ^{13}C, 376 MHz for ^{19}F) spectrometer using $CDCl_3$ [tetramethylsilane (0 ppm) served as an internal standard in ^{1}H NMR and $CDCl_3$ (77.0 ppm) in ^{13}C NMR, hexafluorobenzene (−163.9 ppm) or benzotrifluoride (−63.7 ppm) served as an internal or external standard in ^{19}F NMR]. Chemical shifts are expressed in parts per million (ppm). ESI mass analyses were performed on Bruker micrOTOF mass spectrometer. IR spectra were recorded on a FT/IR-4200 (JASCO Co., Ltd.). UV-Vis spectra were recorded on a V-670 UV–VIS–NIR spectrometer (JASCO Co., Ltd.). Emission spectra were recorded on a FP-6500 (JASCO Co., Ltd.). Visible light irradiation was performed with LED405-100STND (Optcode Co., Ltd.) for 405 nm LED and Twin LED Light (Relyon Co., Ltd.) for 365 nm LED. High performance liquid chromatography (HPLC) was performed on a Chromaster (Hitachi High-Tech Co., Ltd.) with CHIRALPak® IF (Daicel Co., Ltd.).

Solvents were distilled according to the usual procedures and stored over molecular sieves unless otherwise noted. All of the substrates were purified by distillation (for liquid) or recrystallization (for solid). Other chemicals were purchased and used as received.

2. Additional data of conditions screening

Table S1. Screening of conditions of [2+2] photocycloaddition



entry	acid	solvent	yield
1	–	toluene	2.1%
2	**1a**	toluene	21%
3	**1c**	toluene	3.6%
4	**1d**	toluene	1.5%
5	**1e**	toluene	7.5%
6	**1f**	toluene	8.4%
7	–	CyMe	<1%
8	**1a**	CyMe	57%
9	**1b**	CyMe	23%
10	**1g**	CyMe	0%
11	diphenylphosphoric acid	CyMe	23%
12	benzoic acid	CyMe	1.5%
13	$TsOH•H_2O$	CyMe	1.5%
14	TFA	CyMe	33%
15	**1a**	benzene	3.0%
16	**1a**	cyclohexane	20%
17	**1a**	$PhCF_3$	1.9%
18	**1a**	CH_2Cl_2	1.1%
19	**1a**	*m*-xylene	1.4%
20[a)]	**1a**	CyMe	22%

a) 29 mM.

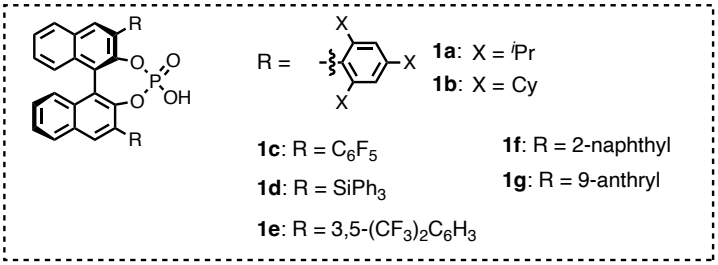
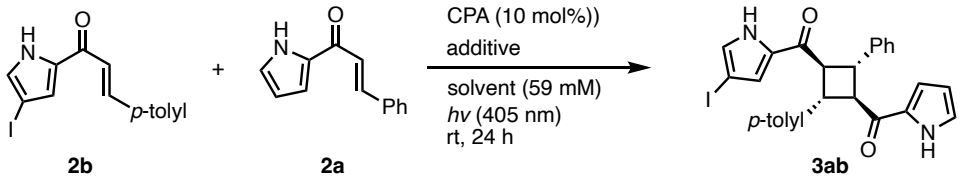


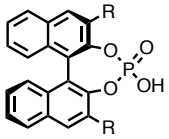
Table S2. Screening of conditions of enantioselective [2+2] photocycloaddition

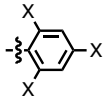


2b + **2a** (X equiv) → **3ab**

					3ab		
entry	CPA	solvent	additive	X	yield	ee	**3bb**
1	**1a**	toluene	MVK (5 equiv)	1	17%	68%	11%
2	**1b**	toluene	MVK (5 equiv)	1	40%	90%	30%
3	**1c**	toluene	MVK (5 equiv)	1	< 1.0%	0%	6%
4	**1d**	toluene	MVK (5 equiv)	1	3.8%	–[a]	6%
5	**1b**	CyMe	MVK (5 equiv)	1	37%	83%	5.0%
6	**1b**	DCM	MVK (5 equiv)	1	28%	76%	42%
7	**1b**	$PhCF_3$	MVK (5 equiv)	1	18%	87%	4.0%
8	**1b**	toluene	none	1	25%	84%	22%
9	**1b**	toluene	MVK (3 equiv)	1	36%	88%	37%
10	**1b**	toluene	MVK (10 equiv)	1	44%	87%	38%
11	**1b**	toluene	MVK (50 equiv)	1	34%	72%	42%
12	**1b**	toluene	2-butanone (5 equiv)	1	34%	86%	25%
13	**1b**	toluene	MVK (10 equiv)	1	44%	87%	38%
14	**1b**	toluene	acetophenone	1	17%	72%	–[e]
15	**1b**	toluene	MS4A (100 wt%)	1	0%	–	0%
16	**1b**	toluene	MVK (5 equiv)	3	85%	98%	11%
17[a]	–	toluene	MVK (5 equiv)	3	0%	–	0%
18[b]	**1b**	toluene	MVK (5 equiv)	3	0%	–	0%
19[c]	**1b**	toluene	MVK (5 equiv)	3	80%	98%	–[e]
20[d]	**1b**	toluene	MVK (5 equiv)	3	78%	98%	–[e]
21	**1h**	toluene	MVK (5 equiv)	3	23%	89%	–[e]

a) Without CPA.
b) Under dark conditions.
c) Under air
d) Under oxygen
e) Not isolated.



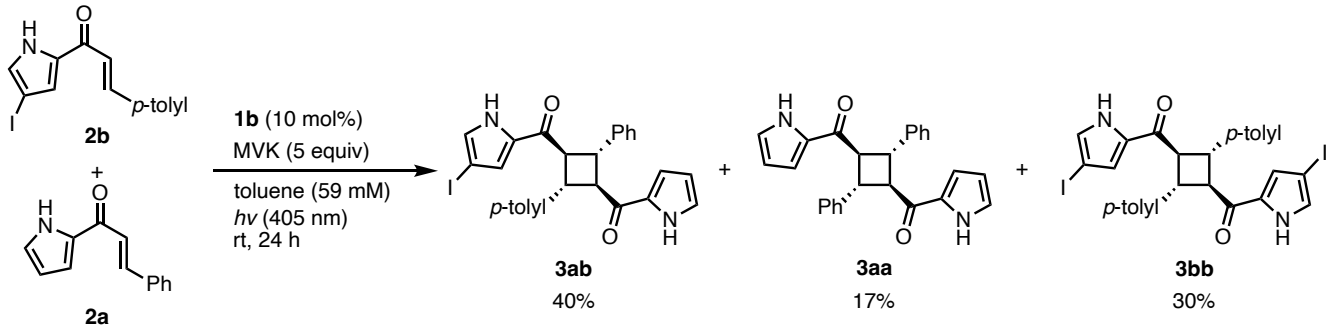
R = 

1a: X = ^{i}Pr
1b: X = Cy
1h: X = Me

1c: R = C_6F_5

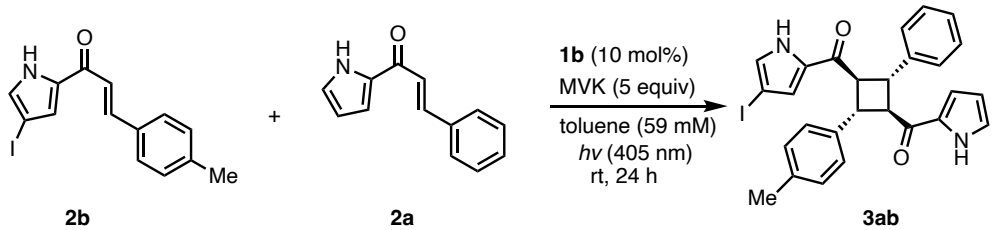
1d: R = $SiPh_3$

Scheme S1. Selectivity of *homo*- or *hetero*- coupling products



3. Synthetic procedures and characterization of new compounds

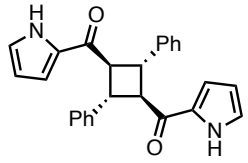
3-1. General procedure of [2+2] cycloaddition (Procedure I)

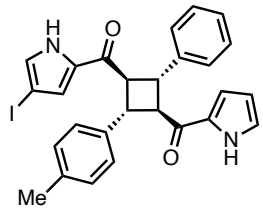


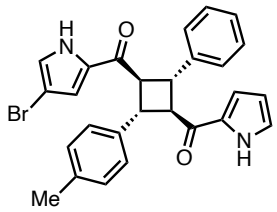
In a dried test tube, **2a** (17.3 mg, 0.088 mmol), **2b** (9.9 mg, 0.029 mmol), **1b** (1.0 mg, 0.0029 mmol), methyl vinyl ketone (12.3 µL, 0.145 mmol) and were mixed in toluene (0.5 mL), and degassed three times by the freeze-pump-thaw. The mixture was irradiated with 405 nm violet LED for 24 h. After the irradiation, the solvent was removed. The crude mixture was purified by preparative TLC on SiO_2 (toluene: ethyl acetate = 7 : 3) to give **3ab** (13.3 mg, 24.9 µmol) in 85%.

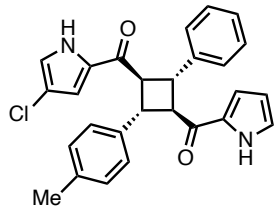
The reactions of other substrates in Figure 2 were performed based on this Procedure I.

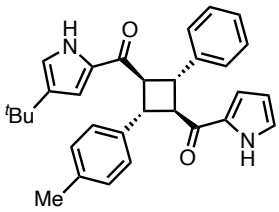
Data of products

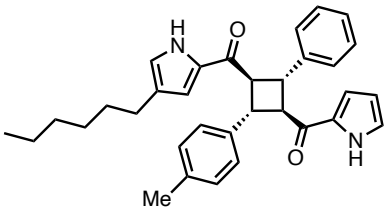
3aa	White powder
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.58 (brs, 2H), 7.32 (d, *J* = 4.0 Hz, 8H), 7.28 – 7.21 (m, 2H), 7.00 (ddd, *J* = 2.7, 2.7, 1.3 Hz, 2H), 6.37 – 6.31 (m, 2H), 6.11 – 6.04 (m, 2H), 4.24 – 4.14 (m, 2H), 4.04 – 3.97 (m, 2H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 188.0, 141.6, 131.4, 128.7, 127.3, 127.1, 125.2, 117.0, 110.7, 52.4, 42.6.
	LRMS (ESI): *m/z* = 417 [M+Na].
	HRMS (ESI): Calcd for $C_{26}H_{22}N_2NaO_2$: 417.1579. Found 417.1573.
	IR (neat, cm^{-1}): 3274, 1624, 1403.

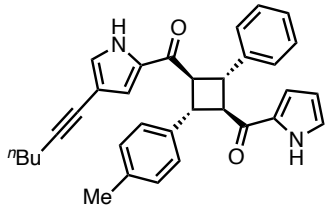
3ab	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.51 (brs, 1H), 9.44 (brs, 1H), 7.38 – 7.28 (m, 5H), 7.20 (d, *J* = 8.1 Hz, 2H), 7.15 (d, *J* = 8.0 Hz, 2H), 7.02 (dd, *J* = 2.9, 1.3 Hz, 1H), 7.00 (ddd, *J* = 2.7, 2.7, 1.2 Hz, 1H), 6.39 – 6.34 (m, 1H), 6.30 (dd, *J* = 2.5, 1.4 Hz, 1H), 6.09 (dt, *J* = 3.9, 2.5 Hz, 1H), 4.16 (t, *J* = 9.3 Hz, 1H), 4.07 (t, *J* = 9.3 Hz, 1H), 3.99 (t, *J* = 9.3 Hz, 1H), 3.87 (t, *J* = 9.3 Hz, 1H), 2.35 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 187.9, 187.5, 141.3, 138.1, 136.9, 132.8, 131.4, 129.8, 129.4, 128.8, 127.2, 127.1, 125.3, 123.5, 117.1, 110.8, 62.0, 52.9, 52.2, 42.7, 42.3, 21.1.
	LRMS (ESI): *m/z* = 557 [M+Na].
	HRMS (ESI): Calcd for $C_{27}H_{23}IN_2NaO_2$, 557.0702: Found 557.0696.
	IR (neat, cm^{-1}): 3293, 1625, 1395.
	$[\alpha]_D^{24}$ -14.5 (c 0.3, $CHCl_3$).

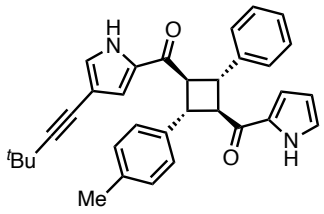
3ac	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.57 (brs, 1H), 9.49 (brs, 1H), 7.38 – 7.27 (m, 5H), 7.20 (d, *J* = 8.1 Hz, 2H), 7.15 (d, *J* = 8.1 Hz, 2H), 7.00 (ddd, *J* = 2.7, 2.7, 1.3 Hz, 1H), 6.97 (dd, *J* = 3.0, 1.4 Hz, 1H), 6.38 – 6.33 (m, 1H), 6.25 (dd, *J* = 2.7, 1.4 Hz, 1H), 6.09 (dt, *J* = 3.9, 2.5 Hz, 1H), 4.17 (t, *J* = 9.4 Hz, 1H), 4.09 (t, *J* = 9.3 Hz, 1H), 3.99 (t, *J* = 9.4 Hz, 1H), 3.87 (t, *J* = 9.3 Hz, 1H), 2.34 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 187.9, 187.8, 141.3, 138.2, 136.9, 131.4, 131.3, 129.4, 128.8, 127.20, 127.17, 127.1, 125.2, 124.8, 118.3, 117.0, 110.8, 98.0, 52.8, 52.4, 42.6, 42.2, 21.1.
	LRMS (ESI): *m/z* = 507, 509 [M+Na].
	HRMS (ESI): Calcd for $C_{27}H_{23}BrN_2NaO_2$, 509.0840: Found 509.0814.
	IR (neat, cm^{-1}): 3279, 1631, 1395.
	$[\alpha]_D^{24}$ +13.0 (c 0.2, $CHCl_3$).

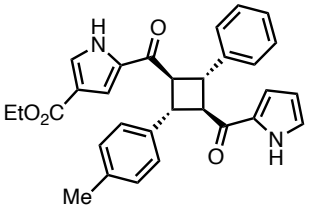
3ad	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.69 (brs, 1H), 9.63 (brs, 1H), 7.37 – 7.27 (m, 5H), 7.20 (d, *J* = 8.1 Hz, 2H), 7.15 (d, *J* = 8.0 Hz, 2H), 7.01 (ddd, *J* = 2.7, 2.7, 1.3 Hz, 1H), 6.94 (dd, *J* = 3.1, 1.5 Hz, 1H), 6.39 – 6.33 (m, 1H), 6.19 (dd, *J* = 2.7, 1.5 Hz, 1H), 6.09 (dt, *J* = 3.9, 2.5 Hz, 1H), 4.18 (t, *J* = 9.4 Hz, 1H), 4.09 (t, *J* = 9.3 Hz, 1H), 3.99 (t, *J* = 9.3 Hz, 1H), 3.88 (t, *J* = 9.3 Hz, 1H), 2.34 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 188.0, 187.9, 141.3, 138.2, 136.9, 131.4, 130.3, 129.4, 128.8, 127.19, 127.16, 127.1, 125.3, 122.6, 117.1, 115.8, 114.2, 110.8, 52.7, 52.4, 42.6, 42.2, 21.1.
	LRMS (ESI): *m/z* = 463, 465 [M+Na].
	HRMS (ESI): Calcd for $C_{27}H_{23}ClN_2NaO_2$, 465.1346: Found 465.1346.
	IR (neat, cm^{-1}): 3272, 1628, 1396.
	$[\alpha]_D^{24}$ -29.1 (c 0.2, $CHCl_3$).

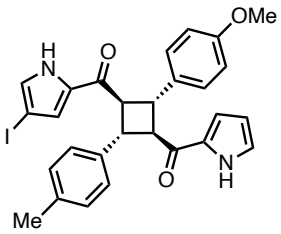
3ae	Colorless oil.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.47 (brs, 1H), 9.19 (brs, 1H), 7.37 – 7.30 (m, 5H), 7.25 – 7.21 (m, 2H), 7.17 – 7.11 (m, 2H), 6.99 (ddd, *J* = 2.7, 2.7, 1.3 Hz, 1H), 6.78 (dd, *J* = 2.8, 1.6 Hz, 1H), 6.41 – 6.36 (m, 1H), 6.08 (dt, *J* = 3.8, 2.5 Hz, 1H), 5.99 (dd, *J* = 2.6, 1.6 Hz, 1H), 4.21 – 4.12 (m, 1H), 4.09 – 4.00 (m, 2H), 3.93 – 3.84 (m, 1H), 2.33 (s, 3H), 1.02 (s, 9H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 188.1, 187.5, 141.8, 138.6, 137.5, 136.7, 131.5, 130.7, 129.3, 128.6, 127.4 (2C), 127.0, 124.9, 120.6, 116.8, 114.7, 110.7, 53.5, 52.1, 42.7, 42.0, 31.3, 30.2, 21.1.
	LRMS (ESI): *m/z* = 487 [M+Na].
	HRMS (ESI): Calcd for $C_{31}H_{32}N_2NaO_2$, 487.2361: Found 487.2356.
	IR (neat, cm^{-1}): 3277, 2957, 1625, 1400.
	$[\alpha]_D^{24}$ -1.0 (c 0.2, $CHCl_3$).

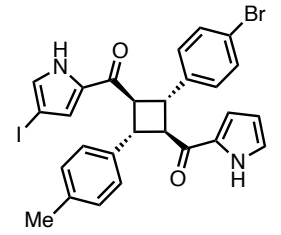
3af	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$): δ 9.68 (brs, 1H), 9.41 (brs, 1H), 7.35 – 7.28 (m, 4H), 7.25 – 7.18 (m, 3H), 7.13 (d, *J* = 7.9 Hz, 2H), 7.03 – 6.99 (m, 1H), 6.80 – 6.75 (m, 1H), 6.41 – 6.35 (m, 1H), 6.12 – 6.06 (m, 2H), 4.19 (t, *J* = 9.4 Hz, 1H), 4.10 (t, *J* = 9.4 Hz, 1H), 3.99 (t, *J* = 9.4 Hz, 1H), 3.92 (t, *J* = 9.4 Hz, 1H), 2.33 (s, 3H), 2.26 (t, *J* = 7.6 Hz, 2H), 1.39 – 1.13 (m, 8H), 0.88 (t, *J* = 6.9 Hz, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 188.2, 187.7, 141.8, 138.6, 136.6, 131.5, 131.0, 129.3, 128.6, 127.3, 127.2, 126.9, 126.9, 125.2, 123.2, 117.0, 116.9, 110.6, 52.8, 52.4, 42.6, 42.2, 31.6, 30.6, 28.8, 26.4, 22.6, 21.1, 14.1.
	LRMS (ESI): *m/z* = 515 [M+Na].
	HRMS (ESI): Calcd for $C_{33}H_{36}N_2NaO_2$, 515.2674: Found 515.2659.
	IR (neat, cm^{-1}): 3274, 2924,1624, 1402.
	$[\alpha]_D^{24}$ +30.3 (c 0.2, $CHCl_3$).

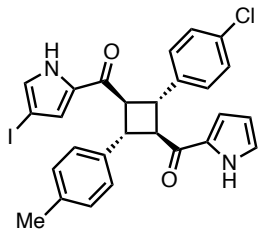
3ag	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.47 (brs, 1H), 9.41 (brs, 1H), 7.35 – 7.22 (m, 5H), 7.19 (d, *J* = 8.1 Hz, 2H), 7.13 (d, *J* = 7.8 Hz, 2H), 7.08 (dd, *J* = 3.0, 1.4 Hz, 1H), 7.00 (ddd, *J* = 2.7, 2.7, 1.3 Hz, 1H), 6.40 (dd, *J* = 2.6, 1.4 Hz, 1H), 6.37 – 6.34 (m, 1H), 6.09 (dt, *J* = 3.9, 2.5 Hz, 1H), 4.18 (t, *J* = 9.4 Hz, 1H), 4.10 (t, *J* = 9.3 Hz, 1H), 3.95 (t, *J* = 9.4 Hz, 1H), 3.92 (t, *J* = 9.4 Hz, 1H), 2.35 – 2.29 (m, 5H), 1.56 – 1.47 (m, 2H), 1.47 – 1.37 (m, 2H), 0.93 (t, *J* = 7.3 Hz, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 188.3, 188.0, 141.5, 138.3, 136.8, 131.5, 131.0, 129.4, 128.7, 128.0, 127.12, 127.07, 125.1, 119.4, 117.0, 110.7, 107.7, 89.2, 73.5, 52.5, 52.3, 42.7, 42.3, 30.8, 21.9, 21.1, 19.0, 13.6.
	LRMS (ESI): *m/z* = 511 [M+Na].
	HRMS (ESI): Calcd for $C_{33}H_{32}N_2NaO_2$, 511.2361: Found 511.2356
	IR (neat, cm^{-1}): 3272, 2927, 1627, 1401.
	$[\alpha]_D^{24}$ +2.9 (c 0.2, $CHCl_3$).

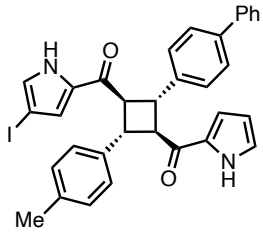
3ah	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.55 (brs, 1H), 9.52 (brs, 1H), 7.35 – 7.21 (m, 5H), 7.18 (d, *J* = 8.1 Hz, 2H), 7.16 – 7.12 (m, 2H), 7.08 (dd, *J* = 3.0, 1.4 Hz, 1H), 7.01 (ddd, *J* = 2.7, 2.7, 1.3 Hz, 1H), 6.40 (dd, *J* = 2.6, 1.4 Hz, 1H), 6.39 – 6.35 (m, 1H), 6.09 (dt, *J* = 3.9, 2.5 Hz, 1H), 4.20 (t, *J* = 9.4 Hz, 1H), 4.09 (t, *J* = 9.4 Hz, 1H), 3.97 (t, *J* = 9.4 Hz, 1H), 3.92 (t, *J* = 9.4 Hz, 2H), 2.33 (s, 3H), 1.25 (s, 9H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 188.3, 188.0, 141.5, 138.3, 136.7, 131.5, 131.0, 129.4, 128.7, 128.0, 127.11, 127.10, 127.0, 125.1, 119.7, 117.0, 110.7, 107.6, 97.4, 71.9, 52.4, 52.4, 42.9, 42.3, 31.0, 27.9, 21.1.
	LRMS (ESI): *m/z* = 511 [M+Na].
	HRMS (ESI): Calcd for $C_{33}H_{32}N_2NaO_2$, 511.2361: Found 511.2356.
	IR (neat, cm^{-1}): 3275, 2317, 1627, 1401.
	$[\alpha]_D^{24}$ +2.9 (c 0.5, $CHCl_3$).

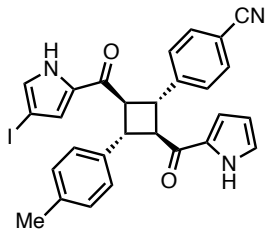
3ai	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.59 (brs, 1H), 9.36 (brs, 1H), 7.55 (dd, *J* = 3.2, 1.4 Hz, 1H), 7.38 – 7.23 (m, 5H), 7.23 – 7.19 (m, 2H), 7.15 (d, *J* = 7.8 Hz, 2H), 6.99 (ddd, *J* = 2.7, 2.7, 1.3 Hz, 1H), 6.70 (dd, *J* = 2.6, 1.4 Hz, 1H), 6.37 – 6.31 (m, 1H), 6.09 (dt, *J* = 3.8, 2.5 Hz, 1H), 4.21 (q, *J* = 7.2 Hz, 2H), 4.17 (t, *J* = 9.3 Hz, 1H), 4.12 – 4.06 (m, 1H), 3.99 (t, *J* = 9.4 Hz, 1H), 3.98 (t, *J* = 9.4 Hz, 1H), 2.34 (s, 3H), 1.28 (t, *J* = 7.1 Hz, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 189.0, 188.0, 163.7, 141.3, 138.1, 136.9, 131.7, 131.4, 129.4, 128.9, 128.8, 127.2, 127.1, 125.4, 118.4, 117.5, 117.3, 110.7, 60.0, 52.5, 42.6, 42.4, 21.1, 14.3.
	LRMS (ESI): *m/z* = 503 [M+Na].
	HRMS (ESI): Calcd for $C_{30}H_{28}N_2NaO_4$, 503.1946: Found 503.1936.
	IR (neat, cm^{-1}): 3285, 1705, 1633, 1209.
	$[\alpha]_D^{24}$ -22.3 (c 0.1, $CHCl_3$)..

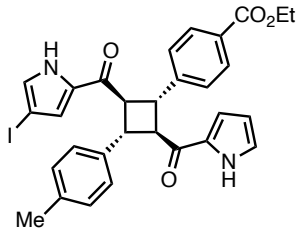
3bj	Colorless oil.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.72 (brs, 1H), 9.59 (brs, 1H), 7.23 (d, *J* = 8.6 Hz, 2H), 7.19 (d, *J* = 8.1 Hz, 2H), 7.14 (d, *J* = 8.1 Hz, 2H), 7.03 (dd, *J* = 3.0, 1.4 Hz, 1H), 7.00 (ddd, *J* = 2.7, 2.7, 1.3 Hz, 1H), 6.88 (d, *J* = 8.7 Hz, 2H), 6.40 – 6.35 (m, 1H), 6.31 (dd, *J* = 2.5, 1.4 Hz, 1H), 6.09 (dt, *J* = 3.9, 2.5 Hz, 1H), 4.11 (t, *J* = 9.3 Hz, 1H), 4.03 (t, *J* = 9.3 Hz, 1H), 3.95 (t, *J* = 9.3 Hz, 1H), 3.82 (t, *J* = 9.3 Hz, 1H), 3.81 (s, 3H), 2.34 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 188.0, 187.6, 158.7, 138.3, 136.8, 133.4, 132.8, 131.4, 129.7, 129.4, 128.3, 127.1, 125.2, 123.5, 117.1, 114.1, 110.7, 62.0, 55.3, 53.3, 52.6, 42.4, 41.9, 21.1.
	LRMS (ESI): *m/z* = 587 [M+Na].
	HRMS (ESI): Calcd for $C_{28}H_{25}IN_2NaO_3$, 587.0808: Found 587.0802.
	IR (neat, cm^{-1}): 3273, 1629, 1247.
	$[\alpha]_D^{24}$ +4.5 (c 0.2, $CHCl_3$).

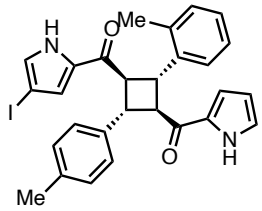
3bk	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.47 (brs, 1H), 9.41 (brs, 1H), 7.45 (d, *J* = 8.4 Hz, 1H), 7.20 – 7.13 (m, 6H), 7.04 (dd, *J* = 2.9, 1.3 Hz, 1H), 7.01 (ddd, *J* = 2.7, 2.7, 1.3 Hz, 1H), 6.38 – 6.34 (m, 1H), 6.31 (dd, *J* = 2.5, 1.4 Hz, 1H), 6.11 (dt, *J* = 3.9, 2.5 Hz, 1H), 4.18 (t, *J* = 9.3 Hz, 1H), 4.00 (t, *J* = 9.2 Hz, 1H), 3.93 (t, *J* = 9.3 Hz, 1H), 3.81 (t, *J* = 9.3 Hz, 1H), 2.35 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 187.5, 187.1, 140.4, 137.8, 137.2, 132.7, 131.8, 131.3, 129.7, 129.5, 128.8, 127.1, 125.3, 123.4, 120.9, 117.0, 110.9, 62.1, 52.8, 52.2, 43.3, 41.0, 21.1.
	LRMS (ESI): *m/z* = 635 [M+Na].
	HRMS (ESI): Calcd for $C_{27}H_{22}BrIN_2NaO_2$, 634.9807: Found 634.9802.
	IR (neat, cm^{-1}): 3280, 1630, 1392.
	$[\alpha]_D^{24}$ +34.4 (c 0.4, $CHCl_3$).

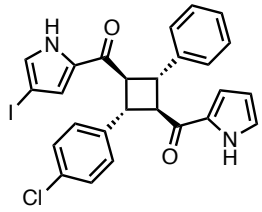
3bl	Colorless oil.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.70 (brs, 1H), 9.58 (brs, 1H), 7.30 (d, *J* = 8.4 Hz, 2H), 7.22 (d, *J* = 8.4 Hz, 2H), 7.19 – 7.13 (m, 4H), 7.05 (dd, *J* = 2.9, 1.3 Hz, 1H), 7.02 (ddd, *J* = 2.7, 2.7, 1.2 Hz, 1H), 6.40 – 6.34 (m, 1H), 6.32 (dd, *J* = 2.5, 1.3 Hz, 1H), 6.11 (dt, *J* = 4.0, 2.5 Hz, 1H), 4.19 (t, *J* = 9.4 Hz, 1H), 4.01 (t, *J* = 9.2 Hz, 1H), 3.94 (t, *J* = 9.3 Hz, 1H), 3.82 (t, *J* = 9.3 Hz, 2H), 2.35 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 187.6, 187.2, 139.9, 137.8, 137.1, 132.9, 132.7, 131.3, 129.9, 129.5, 128.9, 128.5, 127.1, 125.4, 123.5, 117.1, 110.9, 62.1, 52.9, 52.2, 43.2, 41.1, 21.1.
	LRMS (ESI): *m/z* = 589, 591 [M+Na].
	HRMS (ESI): Calcd for $C_{27}H_{22}ClIN_2NaO_2$, 591.0312: Found 591.0307.
	IR (neat, cm^{-1}): 3274, 2924, 1634, 1394.
	$[\alpha]_D^{24}$ -31.3 (c 0.2, $CHCl_3$).

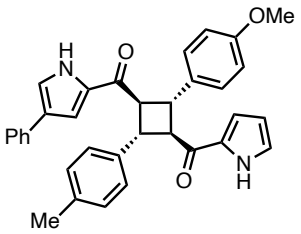
3bm	Colorless oil.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.70 (brs, 1H), 9.59 (brs, 1H), 7.63 – 7.53 (m, 4H), 7.44 (t, *J* = 7.6 Hz, 2H), 7.40 – 7.31 (m, 3H), 7.21 (d, *J* = 8.0 Hz, 2H), 7.16 (d, *J* = 7.9 Hz, 2H), 7.07 – 6.96 (m, 2H), 6.45 – 6.39 (m, 1H), 6.38 – 6.31 (m, 1H), 6.14 – 6.06 (m, 1H), 4.22 (t, *J* = 9.2 Hz, 1H), 4.12 – 4.00 (m, 2H), 3.90 (t, *J* = 9.1 Hz, 1H), 2.35 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 187.9, 187.5, 140.7, 140.4, 140.1, 138.1, 137.0, 132.8, 131.4, 129.8, 129.5, 128.8, 127.6, 127.5, 127.3, 127.2, 127.1, 125.3, 123.6, 117.2, 110.8, 62.0, 53.0, 52.2, 42.8, 41.9, 21.1.
	LRMS (ESI): *m/z* = 633 [M+Na].
	HRMS (ESI): Calcd for $C_{33}H_{27}IN_2NaO_2$, 633.1015: Found 633.1009.
	IR (neat, cm^{-1}): 3273, 2924, 1628, 1395.
	$[\alpha]_D^{24}$ +7.8 (c 0.5, $CHCl_3$).

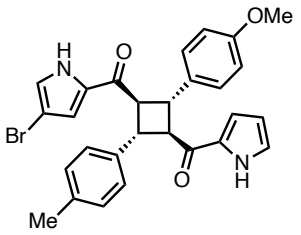
3bn	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.56 (brs, 1H), 9.48 (brs, 1H), 7.62 (d, *J* = 8.4 Hz, 2H), 7.41 – 7.35 (m, 2H), 7.18 (s, 4H), 7.06 (dd, *J* = 2.9, 1.4 Hz, 1H), 7.03 (dd, *J* = 2.7, 2.7, 1.2 Hz, 1H), 6.36 – 6.32 (m, 1H), 6.27 (dd, *J* = 2.5, 1.3 Hz, 1H), 6.11 (dt, *J* = 3.9, 2.6 Hz, 1H), 4.41 (t, *J* = 9.3 Hz, 1H), 3.97 (t, *J* = 9.1 Hz, 1H), 3.90 (t, *J* = 8.9 Hz, 1H), 3.84 (t, *J* = 9.1 Hz, 1H), 2.37 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 187.1, 186.7, 147.0, 137.5, 137.3, 132.6, 132.5, 131.1, 130.0, 129.6, 127.8, 127.2, 125.6, 123.6, 118.7, 117.1, 111.0, 110.8, 62.2, 52.6, 51.9, 44.6, 40.2, 21.1.
	LRMS (ESI): *m/z* = 246 [M+Na].
	HRMS (ESI): Calcd for $C_{28}H_{22}IN_3NaO_2$, 582.0654: Found 582.0649.
	IR (neat, cm^{-1}): 3275, 2227, 1633, 1395, 1371.
	$[\alpha]_D^{24}$ -29.3 (c 0.4, $CHCl_3$).

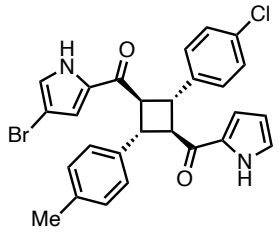
3bo	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.57 (brs, 1H), 9.49 (brs, 1H), 8.01 (d, *J* = 8.3 Hz, 2H), 7.38 – 7.32 (m, 2H), 7.21 – 7.14 (m, 4H), 7.07 – 7.03 (m, 1H), 7.03 – 7.00 (m, 1H), 6.37 – 6.34 (m, 1H), 6.33 (dd, *J* = 2.6, 1.3 Hz, 1H), 6.10 (ddd, *J* = 3.8, 2.5, 2.5 Hz, 1H), 4.37 (q, *J* = 7.1 Hz, 2H), 4.30 (t, *J* = 9.0 Hz, 1H), 4.06 – 3.94 (m, 2H), 3.88 (t, *J* = 9.3 Hz, 1H), 2.36 (s, 3H), 1.39 (t, *J* = 7.1 Hz, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 187.4, 187.1, 166.3, 146.5, 137.8, 137.2, 132.6, 131.2, 130.0, 129.8, 129.5, 129.3, 127.2, 127.1, 125.3, 123.4, 117.1, 110.9, 62.1, 61.0, 52.6, 52.1, 43.5, 41.3, 21.1, 14.3.
	LRMS (ESI): *m/z* = 629 [M+Na].
	HRMS (ESI): Calcd for $C_{30}H_{27}IN_2NaO_4$, 629.0913: Found 629.0908.
	IR (neat, cm^{-1}): 3278, 1632, 1278, 1108.
	$[\alpha]_D^{24}$ +7.7 (c 0.5, $CHCl_3$).

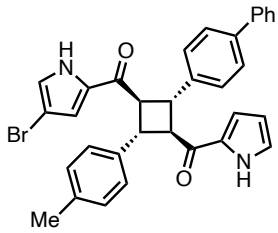
3bp	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.40 (brs, 1H), 9.36 (brs, 1H), 7.66 – 7.58 (m, 1H), 7.37 – 7.30 (m, 1H), 7.22 (d, *J* = 8.1 Hz, 2H), 7.20 – 7.13 (m, 3H), 7.09 (d, *J* = 7.5 Hz, 1H), 7.00 (dd, *J* = 2.9, 1.4 Hz, 1H), 6.98 (ddd, *J* = 2.7, 2.7, 1.3 Hz, 1H), 6.35 – 6.30 (m, 1H), 6.28 (dd, *J* = 2.5, 1.4 Hz, 1H), 6.07 (dt, *J* = 3.9, 2.5 Hz, 1H), 4.33 (t, *J* = 9.4 Hz, 1H), 4.12 (t, *J* = 9.4 Hz, 1H), 4.01 (t, *J* = 9.4 Hz, 1H), 3.89 (t, *J* = 9.4 Hz, 1H), 2.35 (s, 3H), 2.11 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 188.0, 187.5, 139.3, 138.4, 137.0, 136.8, 132.7, 131.4, 130.5, 129.42, 129.41, 127.12 (2C), 127.07, 126.6, 126.0, 124.9, 123.1, 116.7, 110.8, 62.0, 53.3, 52.7, 41.8, 38.8, 21.1, 19.9.
	LRMS (ESI): *m/z* = 571 [M+Na].
	HRMS (ESI): Calcd for $C_{28}H_{25}N_2NaO_2$, 571.0858: Found 571.0853.
	IR (neat, cm^{-1}): 3274, 2922, 2852, 1626, 1394.
	$[\alpha]_D^{24}$ -25.2 (c 0.2, $CHCl_3$).

3aq	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$). δ 9.90 (s, 1H), 9.72 (s, 1H), 7.45 – 7.16 (m, 9H), 7.12 – 6.97 (m, 2H), 6.40 – 6.35 (m, 1H), 6.35 – 6.30 (m, 1H), 6.13 – 6.07 (m, 1H), 4.18 (t, *J* = 9.4 Hz, 1H), 4.09 (t, *J* = 8.6 Hz, 1H), 3.97 (t, *J* = 9.4 Hz, 1H), 3.86 (t, *J* = 9.4 Hz, 1H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 187.6, 187.2, 140.9, 139.8, 133.0, 132.7, 131.3, 130.3, 129.0, 128.9, 128.5, 127.5, 127.2, 125.7, 123.7, 117.3, 110.9, 62.1, 52.7, 52.2, 43.2, 41.5.
	LRMS (ESI): *m/z* = 575, 577 [M+Na].
	HRMS (ESI): Calcd for $C_{26}H_{20}ClIN_2NaO_2$, 577.0156: Found 577.0123.
	IR (neat, cm^{-1}): 3279, 2918, 1633, 1135.
	$[\alpha]_D^{24}$ -25.2 (c 0.2, $CHCl_3$).

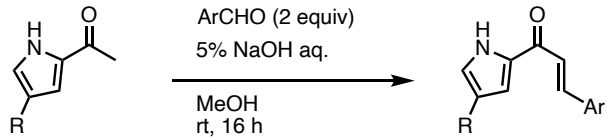
3jr	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.21 (m, 6H), 7.22 – 7.13 (m, 5H), 7.01 – 6.95 (m, 2H), 6.90 (d, *J* = 8.6 Hz, 2H), 6.43 – 6.38 (m, 1H), 6.38 – 6.32 (m, 1H), 6.13 – 6.05 (m, 1H), 4.13 (t, *J* = 9.3 Hz, 1H), 4.08 (t, *J* = 9.3 Hz, 1H), 4.01 (t, *J* = 9.2 Hz, 1H), 3.91 (t, *J* = 9.3 Hz, 1H), 3.80 (s, 3H), 2.36 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 188.13, 188.08, 158.7, 138.7, 136.8, 134.1, 133.8, 131.8, 131.5, 129.4, 128.64, 128.55, 127.3, 126.7, 126.2, 125.0(2C), 121.5, 117.0, 114.2, 114.1, 110.7, 55.3, 53.9, 52.5, 42.2, 42.0, 21.1.
	LRMS (ESI): *m/z* = 537 [M+Na].
	HRMS (ESI): Calcd for $C_{34}H_{30}N_2NaO_3$, 537.2154: Found 537.2125.
	IR (neat, cm^{-1}): 3274, 1625, 1513, 1399.
	$[\alpha]_D^{24}$ +4.5 (c 0.1, $CHCl_3$).

3cj	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.60 (brs, 1H), 9.51 (brs, 1H), 7.25 – 7.21 (m, 2H), 7.19 (d, *J* = 8.1 Hz, 2H), 7.14 (d, *J* = 7.9 Hz, 2H), 7.01 – 6.98 (m, 1H), 6.98 – 6.95 (m, 1H), 6.91 – 6.85 (m, 2H), 6.38 – 6.33 (m, 1H), 6.28 – 6.24 (m, 1H), 6.12 – 6.05 (m, 1H), 4.12 (t, *J* = 9.3, 9.3 Hz, 1H), 4.03 (t, *J* = 9.3, 9.3 Hz, 1H), 3.94 (t, *J* = 9.3, 9.3 Hz, 1H), 3.87 – 3.77 (m, 4H), 2.34 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 188.0, 187.9, 158.7, 138.3, 136.8, 133.4, 131.4, 131.3, 129.4, 128.3, 127.1, 125.2, 124.8, 118.3, 117.1, 114.2, 110.8, 98.0, 55.3, 53.1, 52.7, 42.4, 41.9, 21.1.
	LRMS (ESI): *m/z* = 537, 539 [M+Na].
	HRMS (ESI): Calcd for $C_{28}H_{25}BrN_2NaO_3$, 539.0946: Found 539.0941.
	IR (neat, cm^{-1}): 3274, 1632, 1514, 1396.
	$[\alpha]_D^{24}$ +24.9(c 0.2, $CHCl_3$).

3cl	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$). δ 9.63 (s, 1H), 9.54 (s, 1H), 7.30 (d, *J* = 8.5 Hz, 2H), 7.22 (d, *J* = 8.5 Hz, 2H), 7.20 – 7.13 (m, 4H), 7.03 – 7.00 (m, 1H), 7.00 – 6.97 (m, 1H), 6.38 – 6.33 (m, 1H), 6.28 – 6.24 (m, 1H), 6.13 – 6.07 (m, 1H), 4.19 (t, *J* = 9.4 Hz, 1H), 4.02 (t, *J* = 9.3 Hz, 1H), 3.93 (t, *J* = 9.3 Hz, 1H), 3.82 (t, *J* = 9.4 Hz, 1H), 2.35 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$) δ 187.53, 187.48, 139.9, 137.8, 137.2, 132.9, 131.3, 131.2, 129.5, 128.9, 128.5, 127.1, 125.4, 125.0, 118.3, 117.1, 110.9, 98.1, 52.7, 52.4, 43.2, 41.1, 21.1.
	LRMS (ESI): *m/z* = 539, 541, 543 [M+Na].
	HRMS (ESI): Calcd for $C_{27}H_{22}BrClN_2NaO_2$, 543.0451: Found 543.0445.
	IR (neat, cm^{-1}): 3271, 1629, 1385.
	$[\alpha]_D^{24}$ -10.3 (c 0.5, $CHCl_3$).

3cm	White powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.37 (brs, 2H), 7.63 – 7.54 (m, 4H), 7.48 – 7.41 (m, 2H), 7.41 – 7.31 (m, 3H), 7.22 (d, *J* = 8.1 Hz, 2H), 7.16 (d, *J* = 7.9 Hz, 2H), 7.00 (ddd, *J* = 2.8, 2.8, 1.2 Hz, 1H), 6.97 (dd, *J* = 3.0, 1.4 Hz, 1H), 6.42 – 6.37 (m, 1H), 6.28 (dd, *J* = 2.6, 1.4 Hz, 1H), 6.10 (dt, *J* = 3.9, 2.5 Hz, 1H), 4.23 (t, *J* = 9.3 Hz, 1H), 4.09 (t, *J* = 9.3 Hz, 1H), 4.02 (t, *J* = 9.3 Hz, 1H), 3.90 (t, *J* = 9.3 Hz, 1H), 2.35 (s, 3H).
	^{13}C NMR (100 MHz, $CDCl_3$): δ 187.93, 187.85, 140.7, 140.4, 140.1, 138.1, 137.0, 131.4, 131.3, 129.5, 128.8, 127.6, 127.5, 127.3, 127.1, 127.0, 125.4, 125.1, 118.5, 117.2, 110.8, 98.1, 52.8, 52.3, 42.9, 41.9, 21.1.
	LRMS (ESI): *m/z* = 583, 585 [M+Na].
	HRMS (ESI): Calcd for $C_{33}H_{27}BrN_2NaO_2$, 585.1154: Found 585.1148.
	IR (neat, cm^{-1}): 3275, 1627, 1395.
	$[\alpha]_D^{24}$ -1.3 (c 0.2, $CHCl_3$).

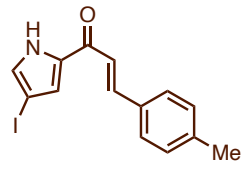
3-2. Synthesis of 2

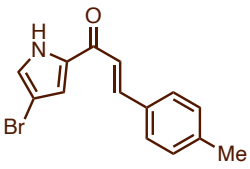


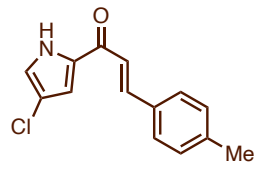
2

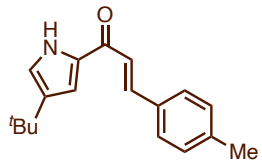
In round bottom flask, 2-acetylpyrrole (500 mg, 4.58 mmol) and aldehyde (9.16 mmol) were mixed in methanol (20 mL). 5% NaOH aq. was added to the solution and the mixture was stirred overnight at room temperature. Then, the precipitate was filtered and washed with water. The solid was recrystallized from ethanol to give **2**.

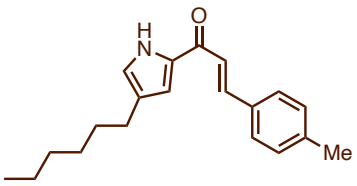
Data of new products.

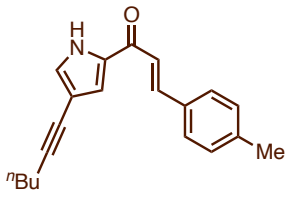
2b	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.45 (brs, 1H), 7.81 (d, *J* = 15.6 Hz, 1H), 7.53 (d, *J* = 8.3 Hz, 2H), 7.25 – 7.18 (m, 3H), 7.15 – 7.13 (m, 1H), 7.13 – 7.11 (m, 1H), 2.40 (s, 3H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 178.2, 143.4, 141.1, 134.5, 131.9, 129.7, 129.5, 128.5, 122.2, 120.1, 62.3, 21.5.
	LRMS (ESI): *m/z* = 360 [M+Na].
	HRMS (ESI): Calcd for $C_{14}H_{12}INNaO$, 359.9861; Found 359.9856.
	IR (neat, cm^{-1}): 3216, 1649, 1579.

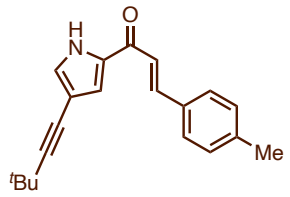
2c	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.43 (brs, 1H), 7.82 (d, *J* = 15.7 Hz, 1H), 7.53 (d, *J* = 8.1 Hz, 2H), 7.25 – 7.18 (m, 4H), 7.08 – 7.06 (m, 1H), 7.05 – 7.03 (m, 1H), 2.40 (s, 3H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 178.5, 143.5, 141.2, 133.0, 131.9, 129.7, 128.5, 124.6, 120.1, 117.3, 98.3, 21.5.
	LRMS (ESI): *m/z* = 312, 314 [M+Na].
	HRMS (ESI): Calcd for $C_{14}H_{12}BrNNaO$, 312.0000; Found 311.9994.
	IR (neat, cm^{-1}): 3224, 1649, 1579.

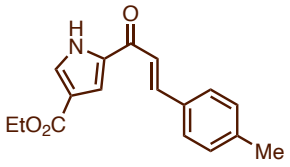
2d	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.59 (brs, 1H), 7.82 (d, *J* = 15.7 Hz, 1H), 7.53 (d, *J* = 8.2 Hz, 2H), 7.25 – 7.17 (m, 3H), 7.06 – 7.01 (m, 1H), 6.99 – 6.95 (m, 1H), 2.40 (s, 3H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 178.6, 143.5, 141.1, 132.1, 131.9, 129.7, 128.5, 122.1, 120.0, 114.7, 114.5, 21.5.
	LRMS (ESI): *m/z* = 268, 270 [M+Na].
	HRMS (ESI): Calcd for $C_{14}H_{12}ClNNaO$, 268.0505; Found 268.0500.
	IR (neat, cm^{-1}): 3244, 1649, 1574.

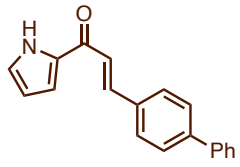
2e	Colorless oil.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.23 (brs, 1H), 7.78 (d, *J* = 15.7 Hz, 1H), 7.55 (d, *J* = 8.1 Hz, 2H), 7.31 (d, *J* = 15.7 Hz, 1H), 7.22 (d, *J* = 7.9 Hz, 2H), 6.99 – 6.95 (m, 1H), 6.95 – 6.91 (m, 1H), 2.39 (s, 3H), 1.30 (s, 9H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 178.7, 142.0, 140.5, 138.1, 132.8, 132.4, 129.6, 128.3, 121.04, 120.97, 113.4, 31.7, 30.6, 21.5.
	LRMS (ESI): *m/z* = 290 [M+Na].
	HRMS (ESI): Calcd for $C_{18}H_{21}NO$, 290.1521; Found 290.1515.
	IR (neat, cm^{-1}): 3441, 1645, 1579.

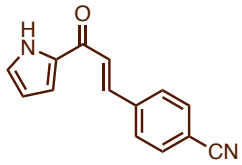
2f	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.34 (brs, 1H), 7.78 (d, *J* = 15.7 Hz, 1H), 7.54 (d, *J* = 8.2 Hz, 2H), 7.29 (d, *J* = 15.7 Hz, 1H), 7.22 (d, *J* = 7.9 Hz, 2H), 6.93 – 6.85 (m, 2H), 2.50 (t, *J* = 7.7 Hz, 2H), 2.39 (s, 3H), 1.67 – 1.53 (m, 2H), 1.42 – 1.22 (m, 6H), 0.95 – 0.85 (m, 3H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 178.6, 141.9, 140.5, 132.9, 132.4, 129.6, 128.3, 127.4, 123.1, 121.0, 115.8, 31.7, 31.0, 29.0, 26.7, 22.6, 21.5, 14.1.
	LRMS (ESI): *m/z* = 318 [M+Na].
	HRMS (ESI): Calcd for $C_{20}H_{25}NNaO$, 318.1834; Found 318.1828.
	IR (neat, cm^{-1}): 3242, 1649, 1580.

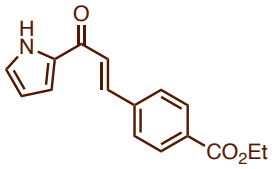
2g	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.47 (brs, 1H), 7.80 (d, *J* = 15.7 Hz, 1H), 7.52 (d, *J* = 8.2 Hz, 2H), 7.27 – 7.20 (m, 3H), 7.19 – 7.14 (m, 1H), 7.10 – 7.04 (m, 1H), 2.44 – 2.35 (m, 5H), 1.64 – 1.53 (m, 2H), 1.53 – 1.41 (m, 2H), 0.95 (t, *J* = 7.2 Hz, 3H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 178.8, 142.9, 140.9, 132.5, 132.1, 129.7, 128.4, 127.6, 120.5, 118.3, 108.0, 89.5, 73.6, 30.9, 22.0, 21.5, 19.1, 13.7.
	LRMS (ESI): *m/z* = 314 [M+Na].
	HRMS (ESI): Calcd for $C_{20}H_{21}NNaO$, 314.1521; Found 314.1515.
	IR (neat, cm^{-1}): 3250, 2344, 1647, 1577.

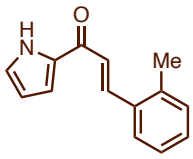
2h	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.45 (brs, 1H), 7.79 (d, *J* = 15.7 Hz, 1H), 7.52 (d, *J* = 8.3 Hz, 2H), 7.28 – 7.19 (m, 3H), 7.19 – 7.13 (m, 1H), 7.12 – 7.06 (m, 1H), 2.39 (s, 3H), 1.31 (s, 9H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 178.8, 142.8, 140.9, 132.5, 132.1, 129.7, 128.4, 127.5, 120.5, 118.5, 107.9, 97.6, 72.1, 31.1, 28.0, 21.5.
	LRMS (ESI): *m/z* = 314 [M+Na].
	HRMS (ESI): Calcd for $C_{20}H_{21}NNaO$, 314.1521; Found 314.1515.
	IR (neat, cm^{-1}): 3249, 2358, 1645, 1575.

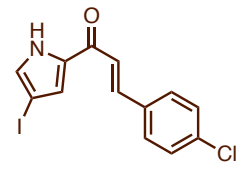
2i	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.88 (s, 1H), 7.84 (d, *J* = 15.6 Hz, 1H), 7.69 – 7.63 (m, 1H), 7.55 (d, *J* = 8.2 Hz, 1H), 7.49 – 7.44 (m, 1H), 7.32 (d, *J* = 15.7 Hz, 1H), 7.24 (d, *J* = 7.9 Hz, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 2.40 (s, 3H), 1.38 (t, *J* = 7.1 Hz, 3H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 179.4, 163.9, 143.6, 141.2, 133.5, 131.9, 129.7, 128.5, 128.4, 120.0, 118.7, 116.1, 60.3, 21.6, 14.4.
	LRMS (ESI): *m/z* = 306 [M+Na].
	HRMS (ESI): Calcd for $C_{17}H_{17}NNaO_3$, 306.1106; Found 306.1101.
	IR (neat, cm^{-1}): 3237, 1709, 1648, 1207.

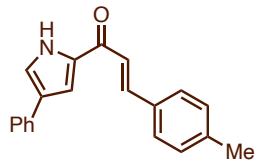
2m	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.72 (brs, 1H), 7.87 (d, *J* = 15.7 Hz, 1H), 7.75 – 7.68 (m, 2H), 7.68 – 7.60 (m, 4H), 7.50 – 7.43 (m, 2H), 7.43 – 7.35 (m, 2H), 7.16 – 7.07 (m, 2H), 6.37 (dt, *J* = 3.8, 2.5 Hz, 1H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 178.8, 143.0, 141.8, 140.2, 134.0, 133.2, 128.9, 128.8, 127.8, 127.5, 127.0, 125.2, 121.7, 116.2, 111.0.
	LRMS (ESI): *m/z* = 296 [M+Na].
	HRMS (ESI): Calcd for $C_{19}H_{15}NNaO$, 296.1051; Found 296.1046.
	IR (neat, cm^{-1}): 3260, 1649, 1585.

2n	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.81 (brs, 1H), 7.79 (d, *J* = 15.7 Hz, 1H), 7.75 – 7.67 (m, 4H), 7.41 (d, *J* = 15.7 Hz, 1H), 7.17 (td, *J* = 2.7, 1.3 Hz, 1H), 7.14 – 7.07 (m, 1H), 6.39 (dt, *J* = 4.0, 2.5 Hz, 1H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 177.8, 139.7, 139.3, 132.9, 132.6, 128.6, 126.1, 125.1, 118.5, 116.9, 113.1, 111.3.
	LRMS (ESI): *m/z* = 245 [M+Na].
	HRMS (ESI): Calcd for $C_{14}H_{10}N_2NaO$, 245.0691; Found 245.0685.
	IR (neat, cm^{-1}): 3244, 2223, 1645, 1590.

2o	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.86 (brs, 1H), 8.08 (d, *J* = 8.4 Hz, 2H), 7.84 (d, *J* = 15.7 Hz, 1H), 7.69 (d, *J* = 8.4 Hz, 2H), 7.42 (d, *J* = 15.7 Hz, 1H), 7.15 (td, *J* = 2.7, 1.3 Hz, 1H), 7.14 – 7.08 (m, 1H), 6.38 (dt, *J* = 3.9, 2.5 Hz, 1H), 4.40 (q, *J* = 7.1 Hz, 2H), 1.42 (t, *J* = 7.1 Hz, 3H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 178.3, 166.0, 140.8, 139.1, 133.0, 131.6, 130.0, 128.1, 125.8, 124.0, 116.7, 111.2, 61.2, 14.3.
	LRMS (ESI): *m/z* = 292 [M+Na].
	HRMS (ESI): Calcd for $C_{16}H_{15}NNaO$, 292.0950; Found 292.0944.
	IR (neat, cm^{-1}): 3253, 1707, 1645, 1587, 1284.

2p	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.56 (brs, 1H), 8.11 (d, *J* = 15.6 Hz, 1H), 7.73 – 7.66 (m, 1H), 7.33 – 7.20 (m, 4H), 7.13 – 7.09 (m, 1H), 7.09 – 7.04 (m, 1H), 6.39 – 6.32 (m, 1H), 2.49 (s, 3H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 178.9, 139.9, 138.2, 134.0, 133.2, 130.8, 130.0, 126.3, 126.3, 125.0, 123.0, 116.1, 111.0, 19.9.
	LRMS (ESI): *m/z* = 234 [M+Na].
	HRMS (ESI): Calcd for $C_{14}H_{13}NNaO$, 234.0895; Found 234.0889.
	IR (neat, cm^{-1}): 3410, 1643, 1586, 1403.

2q	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.53 (s, 1H), 7.77 (d, *J* = 15.7 Hz, 1H), 7.56 (d, *J* = 8.5 Hz, 2H), 7.40 (d, *J* = 8.5 Hz, 2H), 7.23 (d, *J* = 15.7 Hz, 1H), 7.17 – 7.11 (m, 2H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 177.7, 141.9, 136.5, 134.4, 133.2, 129.6, 129.6, 129.3, 122.4, 121.6, 62.4.
	LRMS (ESI): *m/z* = 354, 356 [M+Na].
	HRMS (ESI): Calcd for $C_{13}H_9ClINNaO$, 379.9315; Found 379.9310.
	IR (neat, cm^{-1}): 3224, 1649, 1581.

2r	Pale yellow powder.
	^{1}H NMR (400 MHz, $CDCl_3$) δ 9.60 (brs, 1H), 7.84 (d, *J* = 15.6 Hz, 1H), 7.57 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.44 – 7.31 (m, 4H), 7.28 – 7.21 (m, 2H), 2.40 (s, 3H).
	^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 142.7, 140.9, 134.3, 133.8, 132.2, 129.7, 128.8, 128.4, 127.4, 126.5, 125.3, 121.7, 120.6, 112.8, 21.5.
	LRMS (ESI): *m/z* = 310 [M+Na].
	HRMS (ESI): Calcd for $C_{20}H_{17}NNaO$, 310.1208; Found 310.1202.
	IR (neat, cm^{-1}): 3224, 1647, 1583.

4. Mechanistic study

4-1. UV–Vis spectra

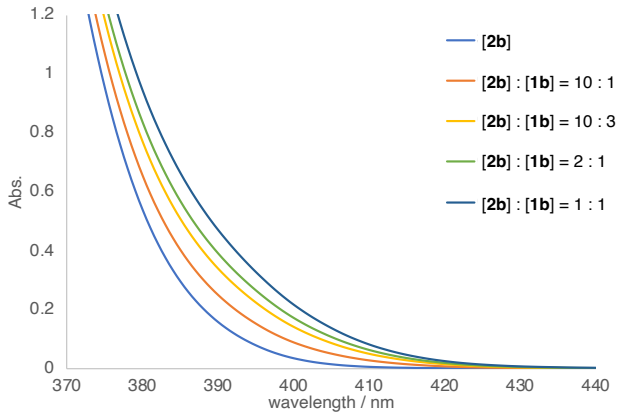


Figure S1. UV–Vis spectra

Solution (A) was prepared by dissolving **2b** (1.0 mg, 2.9 µmol) in toluene (12 mL).

Solution (B) was prepared by dissolving **1b** (2.9 mg, 2.9 µmol) in 4 mL of solution (A).

In quartz cell (*l* = 1 cm), 2.0 mL of solution (A) and various volume (0, 0.1, 0.3, 0.5, 1.0 mL) of solution (B) were mixed. Then UV–Vis spectra were measured by V-670 UV–VIS–NIR spectrometer (JASCO Co., Ltd.).

Addition of MVK

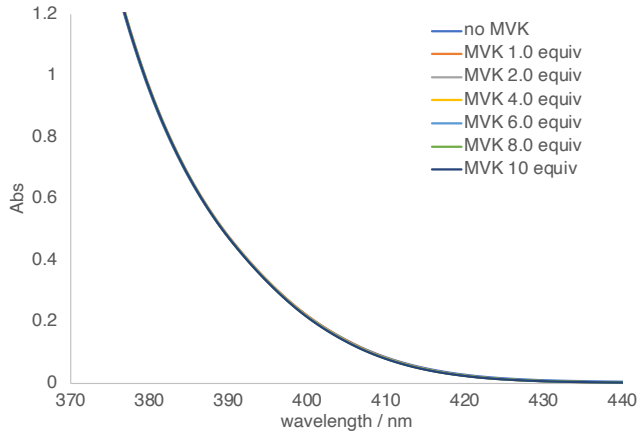


Figure S2. UV–Vis spectra of addition of MVK.

To a toluene solution of 1:1 ratio **2b** and **1b**, various amount of MVK was added and UV–Vis spectra were measured. However, no change was observed.

4-2. ^{1}H NMR study

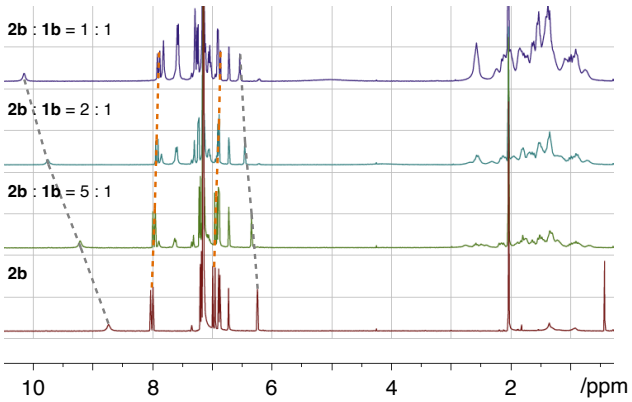


Figure S3. ^{1}H NMR spectra of 2b and 1b in benzene-d_6.

In a NMR tube, several ratio of **2b** and **1b** was mixed in benzene-d_6. Interaction of **2b** and **1b** was observed in ^{1}H NMR.

Addition of MVK

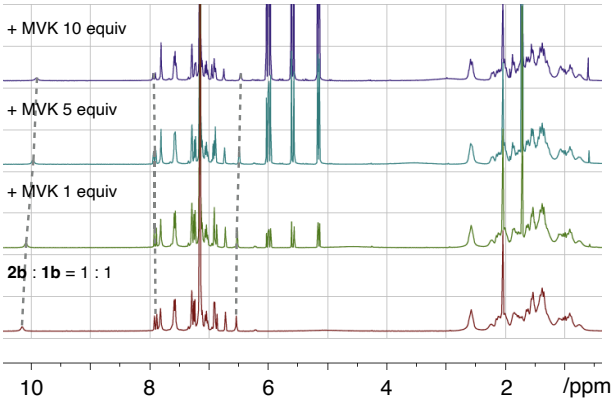


Figure S4. ^{1}H NMR spectra of 2b and 1b with MVK in benzene-d_6.

To the benzene-d_6 solution of 1:1 ratio **2b** and **1b**, various amount of MVK was added and ^{1}H NMR were measured. However, remarkable change was not observed.

4-3. Correlation between ee of 1b and ee of 3ab in photocycloaddition

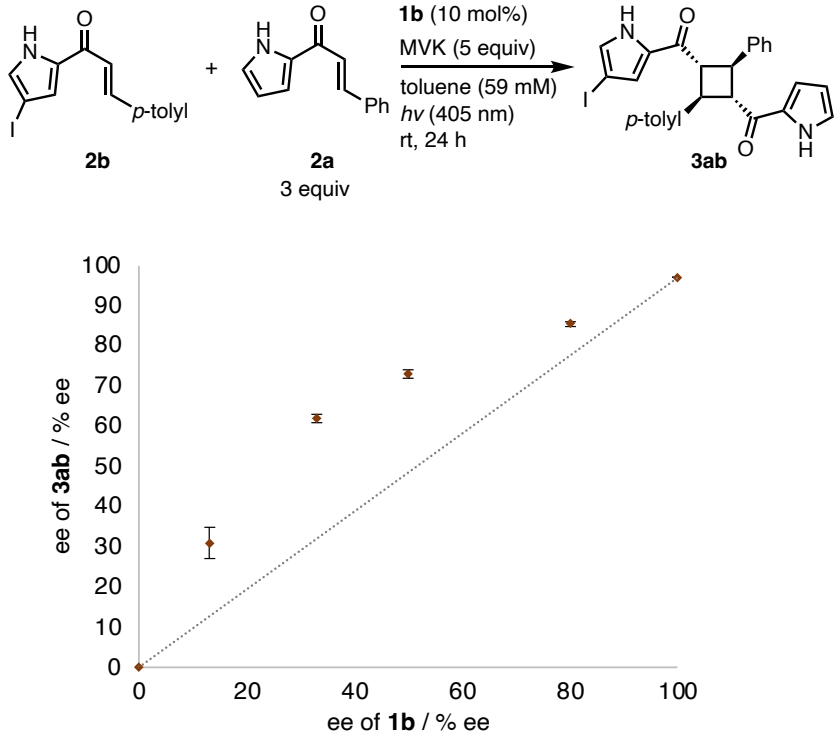


Figure S5. Correlation of ee of 1b and 3ab in photocycloaddition.

In a dried test tube, **2a** (17.3 mg, 0.088 mmol), **2b** (9.9 mg, 0.029 mmol), methyl vinyl ketone (12.3 μL, 0.145 mmol) and various ratio (shown in Table S3) of (*R*)-**1b** and (*S*)-**1b** were mixed in toluene (0.5 mL), and degassed three times by the freeze-pump-thaw. The mixture was irradiated with 405 nm violet LED for 24 h. After the irradiation, the solvent was removed. The crude mixture was purified by preparative TLC on SiO_2 (toluene: ethyl acetate = 7 : 3 / v:v) to give **3ab**.

Table S3. Results of the correlation of ee

ee of **1b**	ee of **3ab**
13% ee	27% ee
13% ee	35% ee
33% ee	61% ee
33% ee	63% ee
50% ee	72% ee
50% ee	74% ee
80% ee	86% ee
80% ee	86% ee
100% ee	97% ee

4-4. Correlation between ee of 1b and ee of 3ag in photocycloaddition

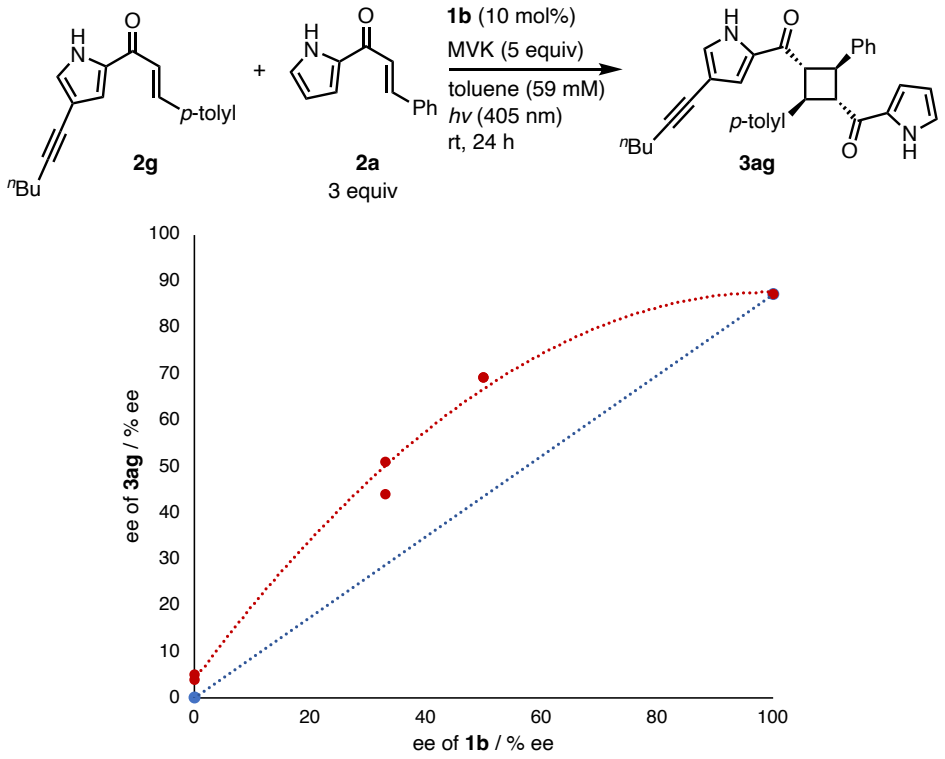


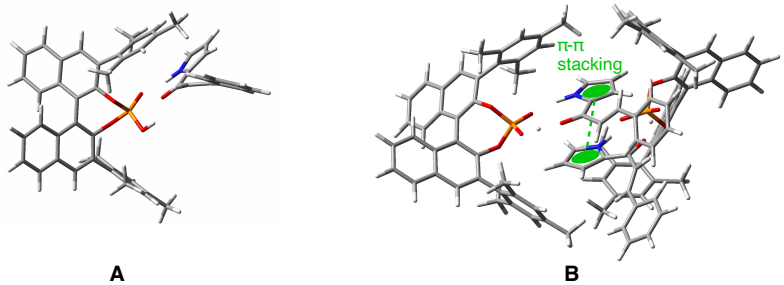
Figure S6. Correlation of ee of 1b and 3ag in photocycloaddition.

Table S4. Results of the correlation of ee

ee of **1b**	ee of **3ab**
33% ee	44% ee
33% ee	51% ee
50% ee	69% ee
50% ee	69% ee
100% ee	87% ee

4-5. DFT calculation

All calculations were performed with Gaussian 16 program by using M06-2X method with basis set of 6-31G (d,p) for other atoms.[S1] In order to elucidate the origin of the non-linear effect, we calculated and compared the monomer complex and dimer complex of **1f** as CPA and **2a** as substrate.



A (–17.4 kcal/mol) **B** (–22.8 kcal/mol)

Table S4. Sum of thermal free energies

	G(hartree)	G(kcal/mol)
1f	-2109.068224	-1323461.401
2a	-631.540993	-396298.289
A	-2740.623118	-1719768.413
B	-5481.254729	-3439542.155

Cartesian Coordinates

1f

Charge = 0 Multiplicity = 1

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	2.256462	4.548883	-2.593184
2	6	0	3.069304	3.526038	-2.182882
3	6	0	2.548433	2.441583	-1.427763
4	6	0	1.170885	2.434717	-1.070696
5	6	0	0.349676	3.501040	-1.528227
6	6	0	0.878916	4.525677	-2.270235
7	1	0	4.433743	1.389470	-1.281863
8	1	0	2.660569	5.370160	-3.175654
9	1	0	4.125558	3.518695	-2.437031
10	6	0	3.374279	1.359151	-1.038360
11	6	0	0.662746	1.343747	-0.290149
12	1	0	-0.709546	3.490520	-1.296558
13	1	0	0.232834	5.324510	-2.619315
14	6	0	1.496880	0.271391	-0.049923
15	6	0	2.872854	0.259714	-0.387964
16	6	0	-0.722868	1.353547	0.250094
17	6	0	-1.204740	2.441624	1.054152
18	6	0	-1.581483	0.307504	-0.005240
19	6	0	-0.357616	3.480992	1.526263
20	6	0	-2.578185	2.468884	1.422758
21	6	0	-2.958603	0.313389	0.342816
22	6	0	-0.860027	4.503950	2.289311
23	1	0	0.700232	3.449449	1.289430
24	6	0	-3.070893	3.550252	2.199345
25	6	0	-3.430001	1.404643	1.027991
26	6	0	-2.234530	4.550087	2.620240
27	1	0	-0.195271	5.282680	2.648475
28	1	0	-4.124747	3.559344	2.463062
29	1	0	-4.483576	1.448664	1.291935
30	1	0	-2.618452	5.369577	3.218715
31	8	0	1.006727	-0.821839	0.644321
32	15	0	-0.105331	-1.787786	-0.007156

33	8	0	0.520200	-2.487115	-1.262469
34	1	0	0.988355	-3.311190	-0.968656
35	8	0	-0.650220	-2.652630	1.058385
36	8	0	-1.115744	-0.778807	-0.738757
37	6	0	-3.849777	-0.823968	-0.044243
38	6	0	-4.040095	-1.882784	0.869401
39	6	0	-4.497685	-0.833937	-1.292462
40	6	0	-4.880662	-2.935708	0.513237
41	6	0	-5.324714	-1.919394	-1.599181
42	6	0	-5.529282	-2.976016	-0.719963
43	1	0	-5.028867	-3.751055	1.216184
44	1	0	-5.827622	-1.933556	-2.564605
45	6	0	3.770984	-0.862968	0.019626
46	6	0	4.272899	-1.792814	-0.913108
47	6	0	4.206084	-0.896622	1.373841
48	6	0	5.238521	-2.715601	-0.465607
49	6	0	5.116210	-1.875822	1.753547
50	6	0	5.670994	-2.781390	0.847345
51	1	0	5.680766	-3.386154	-1.195462
52	1	0	5.442095	-1.913017	2.791545
53	6	0	-4.454446	0.290798	-2.325357
54	1	0	-4.813299	-0.169218	-3.254018
55	6	0	-3.411008	-1.859977	2.256095
56	1	0	-2.476507	-1.293918	2.194051
57	6	0	-6.427184	-4.140354	-1.091650
58	1	0	-6.823681	-3.939286	-2.094924
59	6	0	3.970845	-1.904185	-2.424507
60	1	0	4.940849	-1.731931	-2.913298
61	6	0	3.867482	0.139031	2.457639
62	1	0	4.500194	-0.166907	3.298232
63	6	0	6.764623	-3.722591	1.322100
64	1	0	6.394704	-4.205943	2.237281
65	1	0	-7.256077	-4.224458	-0.420261
66	1	0	-5.876225	-5.056744	-1.131339
67	1	0	-5.155474	1.056815	-2.067138
68	1	0	-3.502074	0.721412	-2.554395
69	1	0	-4.061182	-1.364552	2.946549
70	1	0	-3.165229	-2.833328	2.626338
71	1	0	4.168272	1.138235	2.220957
72	1	0	2.869195	0.138067	2.842765
73	1	0	7.640339	-3.166128	1.583580
74	1	0	7.015388	-4.489228	0.619047
75	1	0	3.272145	-1.237421	-2.885098
76	1	0	3.673167	-2.898735	-2.683655

2a

Charge = 0 Multiplicity = 1

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	4.506204	-0.899751	0.092387
2	6	0	3.631896	-1.826785	-0.458085
3	6	0	2.367380	-1.203577	-0.556383
4	6	0	2.496115	0.092612	-0.056115
5	7	0	3.811647	0.245104	0.323956
6	1	0	4.151095	1.128755	0.677137
7	1	0	5.557152	-0.980004	0.328569
8	1	0	3.885068	-2.833417	-0.758815
9	1	0	1.470992	-1.632281	-0.978476
10	6	0	1.626229	1.265943	0.074897
11	6	0	0.161213	1.162163	-0.100499
12	1	0	-0.301378	2.111116	-0.358579
13	6	0	-0.580981	0.068386	0.161248
14	1	0	-0.067409	-0.827926	0.501106
15	6	0	-2.039851	-0.052778	0.079100
16	6	0	-2.641060	-1.253607	0.497496
17	6	0	-2.873823	0.973575	-0.404806
18	6	0	-4.022542	-1.425478	0.442379
19	1	0	-2.011804	-2.056875	0.872125
20	6	0	-4.252665	0.802265	-0.460365
21	1	0	-2.439712	1.908761	-0.743552
22	6	0	-4.834131	-0.396988	-0.036691
23	1	0	-4.464248	-2.360983	0.772590
24	1	0	-4.878993	1.605423	-0.837363
25	1	0	-5.911291	-0.526605	-0.082395
26	8	0	2.133136	2.364054	0.336573

A

Charge = 0 Multiplicity = 1

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	5.414174	-1.069157	4.292416
2	6	0	5.425690	0.075650	3.541515
3	6	0	4.639289	0.181202	2.363376
4	6	0	3.853907	-0.928762	1.944127
5	6	0	3.841783	-2.092923	2.760929
6	6	0	4.600991	-2.159093	3.900737
7	1	0	5.199969	2.229422	1.952510
8	1	0	6.013968	-1.139554	5.193753
9	1	0	6.027774	0.929597	3.838976
10	6	0	4.599123	1.386359	1.620037
11	6	0	3.082133	-0.815770	0.741712
12	1	0	3.214595	-2.930852	2.478852
13	1	0	4.573252	-3.054576	4.512916
14	6	0	3.054803	0.401871	0.092755
15	6	0	3.802613	1.531920	0.510000
16	6	0	2.262873	-1.944147	0.221092
17	6	0	2.823491	-3.224322	-0.097416
18	6	0	0.915329	-1.753564	0.003144
19	6	0	4.219701	-3.485400	-0.040834
20	6	0	1.955311	-4.268882	-0.522628
21	6	0	0.029947	-2.773032	-0.431924
22	6	0	4.715169	-4.725305	-0.353095
23	1	0	4.894888	-2.686215	0.244134
24	6	0	2.498907	-5.545578	-0.825222
25	6	0	0.566789	-4.015828	-0.660816
26	6	0	3.846511	-5.773618	-0.738655
27	1	0	5.784660	-4.903366	-0.309590
28	1	0	1.820931	-6.334935	-1.137369
29	1	0	-0.087448	-4.824869	-0.976355
30	1	0	4.252855	-6.751098	-0.976568
31	8	0	2.281463	0.538094	-1.051115
32	15	0	0.673622	0.600705	-0.898349

33	8	0	0.313394	1.902690	-0.090610
34	1	0	-0.706021	2.378774	-0.314697
35	8	0	0.057117	0.368019	-2.218184
36	8	0	0.373054	-0.492674	0.241352
37	6	0	-1.424044	-2.495886	-0.615034
38	6	0	-1.970374	-2.441884	-1.906999
39	6	0	-2.239750	-2.310936	0.513000
40	6	0	-3.338706	-2.209847	-2.045468
41	6	0	-3.602370	-2.085623	0.329854
42	6	0	-4.169611	-2.028399	-0.942211
43	1	0	-3.764513	-2.163477	-3.045330
44	1	0	-4.236565	-1.951350	1.203582
45	6	0	3.740236	2.843273	-0.201273
46	6	0	3.148443	3.942832	0.442843
47	6	0	4.349149	3.001112	-1.458563
48	6	0	3.221586	5.199084	-0.162343
49	6	0	4.419592	4.276834	-2.015712
50	6	0	3.880915	5.392152	-1.373670
51	1	0	2.767027	6.050959	0.339427
52	1	0	4.906637	4.400188	-2.981081
53	6	0	-1.656595	-2.357458	1.902487
54	1	0	-2.447763	-2.351092	2.655066
55	6	0	-1.103790	-2.603688	-3.130896
56	1	0	-0.296216	-1.866277	-3.119623
57	6	0	-5.639274	-1.744627	-1.119087
58	1	0	-6.223390	-2.146857	-0.287578
59	6	0	2.444805	3.791940	1.770512
60	1	0	3.156706	3.665113	2.592214
61	6	0	4.914517	1.822263	-2.205917
62	1	0	5.513158	2.152899	-3.057120
63	6	0	4.022074	6.766336	-1.976740
64	1	0	3.808952	6.754781	-3.050300
65	6	0	-3.276827	0.000935	-3.754127
66	6	0	-4.640936	-0.079002	-3.515079
67	6	0	-4.872882	0.522410	-2.263616
68	6	0	-3.641255	0.957623	-1.779901
69	7	0	-2.692070	0.634693	-2.714272
70	1	0	-1.691142	0.826743	-2.606294
71	1	0	-2.689840	-0.352605	-4.588575
72	1	0	-5.375324	-0.517789	-4.173531
73	1	0	-5.826225	0.672106	-1.777275
74	6	0	-3.259388	1.729359	-0.602847
75	6	0	-4.117310	1.737753	0.599208
76	1	0	-3.561678	1.867810	1.524097
77	6	0	-5.436543	1.495603	0.582759
78	1	0	-5.913785	1.311712	-0.377691
79	6	0	-6.326133	1.432885	1.749614
80	6	0	-7.683864	1.159859	1.542726
81	6	0	-5.878028	1.641904	3.062268
82	6	0	-8.572217	1.097928	2.610761
83	1	0	-8.040890	0.994593	0.529799
84	6	0	-6.763811	1.580471	4.128854
85	1	0	-4.829642	1.851344	3.249213
86	6	0	-8.114095	1.308997	3.907534
87	1	0	-9.620594	0.884432	2.430215
88	1	0	-6.401754	1.743556	5.138712
89	1	0	-8.803434	1.261380	4.744149
90	8	0	-2.207352	2.371187	-0.594109
91	1	0	-6.018223	-2.180121	-2.046797
92	1	0	-5.824214	-0.666159	-1.160765
93	1	0	-1.048299	-3.255034	2.049385
94	1	0	-1.011345	-1.491140	2.080877
95	1	0	-0.651900	-3.598707	-3.181934
96	1	0	-1.693962	-2.452796	-4.037234
97	1	0	5.537980	1.198456	-1.558076
98	1	0	4.103092	1.195505	-2.592117
99	1	0	5.040923	7.145444	-1.846549
100	1	0	3.342678	7.479551	-1.501372
101	1	0	1.786719	2.919004	1.772503
102	1	0	1.843894	4.678584	1.984780

B

Charge = 0 Multiplicity = 1

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	-7.081342	-6.024785	-3.799154
2	6	0	-6.229423	-5.106527	-4.352904
3	6	0	-5.906644	-3.904836	-3.669389
4	6	0	-6.504715	-3.641555	-2.404088
5	6	0	-7.360146	-4.627980	-1.842071
6	6	0	-7.640672	-5.785419	-2.522106
7	1	0	-4.485901	-3.233623	-5.157947
8	1	0	-7.316815	-6.942010	-4.328629
9	1	0	-5.773317	-5.287132	-5.322187
10	6	0	-4.958530	-2.996325	-4.208096
11	6	0	-6.189459	-2.414187	-1.734273
12	1	0	-7.785984	-4.459125	-0.859329
13	1	0	-8.292868	-6.527939	-2.073948
14	6	0	-5.251149	-1.587223	-2.312050
15	6	0	-4.587883	-1.857728	-3.538269
16	6	0	-6.773100	-2.027514	-0.419594
17	6	0	-8.187354	-1.924955	-0.205452
18	6	0	-5.935580	-1.692261	0.625181
19	6	0	-9.133416	-2.104228	-1.251271
20	6	0	-8.669894	-1.590836	1.091203
21	6	0	-6.393418	-1.329681	1.920307
22	6	0	-10.478835	-2.002544	-1.007882
23	1	0	-8.778152	-2.313794	-2.253867
24	6	0	-10.069884	-1.506970	1.313890
25	6	0	-7.748613	-1.312015	2.133054
26	6	0	-10.957695	-1.714033	0.291807
27	1	0	-11.183477	-2.137933	-1.821837
28	1	0	-10.420100	-1.262611	2.312855
29	1	0	-8.128920	-1.051991	3.117811
30	1	0	-12.025469	-1.642987	0.470555
31	8	0	-4.916954	-0.415212	-1.649761
32	15	0	-3.850794	-0.590283	-0.449089
33	8	0	-4.557377	-1.734339	0.443679
34	6	0	-5.412757	-0.966574	2.986061
35	6	0	-5.233674	0.383072	3.333917
36	6	0	-4.666991	-1.970739	3.624153
37	6	0	-4.280414	0.703588	4.300234
38	6	0	-3.736416	-1.607973	4.598820
39	6	0	-3.513840	-0.273442	4.933385
40	1	0	-4.123705	1.750520	4.555551
41	1	0	-3.151714	-2.385050	5.087147

42	6	0	-3.475934	-0.964981	-3.978126
43	6	0	-2.153864	-1.433695	-3.876249
44	6	0	-3.731341	0.355571	-4.378324
45	6	0	-1.110665	-0.559218	-4.157581
46	6	0	-2.652250	1.203508	-4.646064
47	6	0	-1.335405	0.767328	-4.524231
48	1	0	-0.085773	-0.911270	-4.057522
49	1	0	-2.850843	2.231072	-4.942747
50	6	0	-4.846026	-3.417265	3.240846
51	1	0	-4.292420	-4.070800	3.918160
52	6	0	-6.045998	1.473671	2.681736
53	1	0	-6.034868	1.374065	1.594096
54	6	0	-2.422036	0.118279	5.893130
55	1	0	-2.156908	-0.706959	6.559081
56	6	0	-1.848504	-2.830948	-3.398800
57	1	0	-2.219785	-3.592977	-4.090049
58	6	0	-5.143839	0.870246	-4.496946
59	1	0	-5.168094	1.808921	-5.054773
60	6	0	-0.156483	1.676891	-4.768018
61	1	0	-0.473465	2.718543	-4.867634
62	6	0	0.756547	0.297032	-1.357241
63	6	0	1.742355	1.281759	-1.417706
64	6	0	1.104858	2.502463	-1.166478
65	6	0	-0.259064	2.235742	-0.963743
66	7	0	-0.424726	0.876068	-1.089034
67	1	0	-1.295826	0.349257	-0.975939
68	1	0	0.838440	-0.775717	-1.456665
69	1	0	2.796002	1.122803	-1.602200
70	1	0	1.589282	3.464050	-1.073822
71	6	0	-1.344315	3.079754	-0.529507
72	6	0	-1.181588	4.550417	-0.495095
73	1	0	-1.772528	5.034777	0.279366
74	6	0	-0.471608	5.249001	-1.388239
75	1	0	0.061142	4.704227	-2.165492
76	6	0	-0.324850	6.711797	-1.432481
77	6	0	0.667557	7.262205	-2.253366
78	6	0	-1.131655	7.578898	-0.681426
79	6	0	0.865848	8.637586	-2.311076
80	1	0	1.291053	6.596797	-2.845577
81	6	0	-0.936033	8.952942	-0.742695
82	1	0	-1.924006	7.178024	-0.056593
83	6	0	0.064830	9.487301	-1.553908
84	1	0	1.642952	9.045449	-2.949020
85	1	0	-1.575560	9.611976	-0.163460
86	1	0	0.212121	10.561284	-1.600790
87	8	0	-2.434198	2.634134	-0.131493
88	1	0	-2.715133	0.975883	6.504929
89	1	0	-1.520232	0.396808	5.333370
90	1	0	-5.900448	-3.707915	3.263685
91	1	0	-4.481072	-3.592329	2.223150
92	1	0	-7.090022	1.440617	3.009661
93	1	0	-5.642866	2.455552	2.939518
94	1	0	-5.787878	0.149136	-5.008119
95	1	0	-5.574193	1.052154	-3.506914
96	1	0	0.377494	1.399806	-5.684310
97	1	0	0.559041	1.613826	-3.934720
98	1	0	-2.310982	-3.005942	-2.423497
99	1	0	-0.769907	-2.968001	-3.293542
100	8	0	-2.496967	-1.007974	-0.866562
101	8	0	-4.011218	0.742879	0.333904
102	1	0	-3.295340	1.445323	0.147534
103	6	0	7.925299	-6.610230	-0.363631
104	6	0	7.011349	-6.362730	0.626105
105	6	0	6.535874	-5.046352	0.867136
106	6	0	7.042976	-3.968196	0.086927
107	6	0	7.966792	-4.262302	-0.952404
108	6	0	8.395678	-5.546612	-1.169140
109	1	0	5.127940	-5.644524	2.398674
110	1	0	8.278606	-7.620269	-0.542906
111	1	0	6.622791	-7.172258	1.237688
112	6	0	5.527630	-4.804410	1.836003
113	6	0	6.575010	-2.640159	0.356948
114	1	0	8.326628	-3.456545	-1.582311
115	1	0	9.098059	-5.750449	-1.970740
116	6	0	5.583872	-2.483571	1.301514
117	6	0	5.011167	-3.549955	2.044259
118	6	0	7.061351	-1.440444	-0.380118
119	6	0	8.448501	-1.079534	-0.432184
120	6	0	6.150500	-0.603573	-0.992991
121	6	0	9.451586	-1.786878	0.285583
122	6	0	8.840583	0.055112	-1.197041
123	6	0	6.515541	0.546001	-1.741062
124	6	0	10.768332	-1.412444	0.207813
125	1	0	9.162646	-2.625291	0.909085
126	6	0	10.214504	0.408134	-1.268831
127	6	0	7.853283	0.835488	-1.849452
128	6	0	11.160616	-0.310604	-0.588425
129	1	0	11.516935	-1.962591	0.768407
130	1	0	10.495721	1.270149	-1.867247
131	1	0	8.164297	1.699730	-2.431398
132	1	0	12.207284	-0.030552	-0.644826
133	8	0	5.109169	-1.202539	1.548200
134	15	0	4.033037	-0.634677	0.486738
135	8	0	4.793396	-0.893037	-0.914980
136	6	0	5.475770	1.402972	-2.381461
137	6	0	5.208192	2.682410	-1.862443
138	6	0	4.790381	0.936239	-3.514133
139	6	0	4.254287	3.474976	-2.499081
140	6	0	3.848339	1.764060	-4.123815
141	6	0	3.566631	3.033872	-3.628887
142	1	0	4.041986	4.465472	-2.099162
143	1	0	3.316457	1.403424	-5.001800
144	6	0	3.841257	-3.288326	2.932571
145	6	0	2.569454	-3.738296	2.532231
146	6	0	3.990981	-2.542584	4.110314
147	6	0	1.469430	-3.424858	3.325682
148	6	0	2.856867	-2.229194	4.862932
149	6	0	1.586306	-2.650437	4.480343
150	1	0	0.485005	-3.776732	3.023581
151	1	0	2.972728	-1.633739	5.765858
152	6	0	5.060720	-0.440628	-4.063250
153	1	0	4.562301	-0.579647	-5.024632
154	6	0	5.925987	3.199805	-0.641089
155	1	0	5.906500	2.460750	0.163368
156	6	0	2.514580	3.894528	-4.265510
157	1	0	2.262706	3.543349	-5.268278
158	6	0	2.367954	-4.478803	1.233610
159	1	0	2.899630	-5.433751	1.211555
160	6	0	5.349997	-2.063110	4.552978
161	1	0	5.319892	-1.714190	5.587344

162	6	0	0.355496	-2.276487	5.265296
163	1	0	0.590206	-1.558437	6.054684
164	6	0	-0.542672	-1.091659	1.830324
165	6	0	-1.709942	-0.392775	2.123775
166	6	0	-1.349933	0.951713	2.268296
167	6	0	0.038545	1.038860	2.090924
168	7	0	0.492111	-0.234267	1.831273
169	1	0	1.436411	-0.497630	1.540687
170	1	0	-0.390924	-2.133415	1.590711
171	1	0	-2.706345	-0.805065	2.194393
172	1	0	-2.031163	1.773798	2.429122
173	6	0	0.933056	2.165464	2.039228
174	6	0	0.424640	3.539034	2.259603
175	1	0	0.966468	4.284933	1.683049
176	6	0	-0.517173	3.892742	3.144813
177	1	0	-0.962399	3.122783	3.771917
178	6	0	-0.998531	5.260262	3.384286
179	6	0	-1.855632	5.492910	4.466873
180	6	0	-0.646918	6.343156	2.563948
181	6	0	-2.337345	6.769355	4.736824
182	1	0	-2.140640	4.659037	5.103333
183	6	0	-1.128031	7.617773	2.832953
184	1	0	-0.002203	6.190192	1.702328
185	6	0	-1.972591	7.836598	3.921301
186	1	0	-2.997848	6.930055	5.582579
187	1	0	-0.842489	8.441227	2.185270
188	1	0	-2.346659	8.833892	4.128709
189	8	0	2.139930	2.060930	1.768325
190	1	0	2.839201	4.938018	-4.338077
191	1	0	1.592329	3.867289	-3.672152
192	1	0	6.132775	-0.608926	-4.201598
193	1	0	4.694959	-1.208593	-3.373843
194	1	0	6.973893	3.428259	-0.859190
195	1	0	5.450734	4.114142	-0.279464
196	1	0	6.094365	-2.861238	4.480050
197	1	0	5.692489	-1.235514	3.923976
198	1	0	-0.099688	-3.156276	5.732757
199	1	0	-0.397062	-1.827155	4.606170
200	1	0	2.731609	-3.871734	0.398797
201	1	0	1.306355	-4.679586	1.071434
202	8	0	2.716884	-1.307313	0.495936
203	8	0	4.083851	0.894027	0.750615
204	1	0	3.231633	1.308617	1.141821

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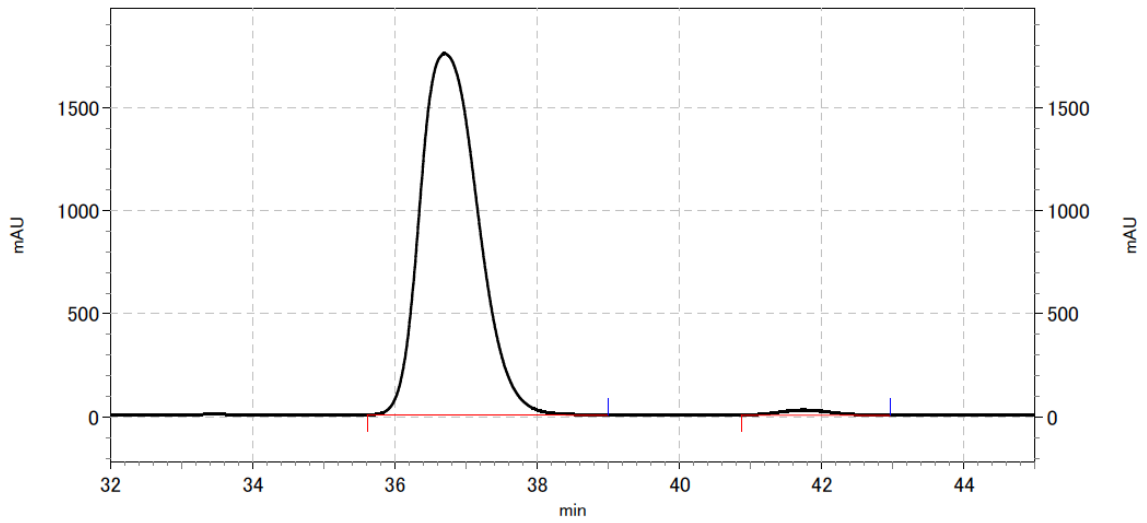
5. HPLC data

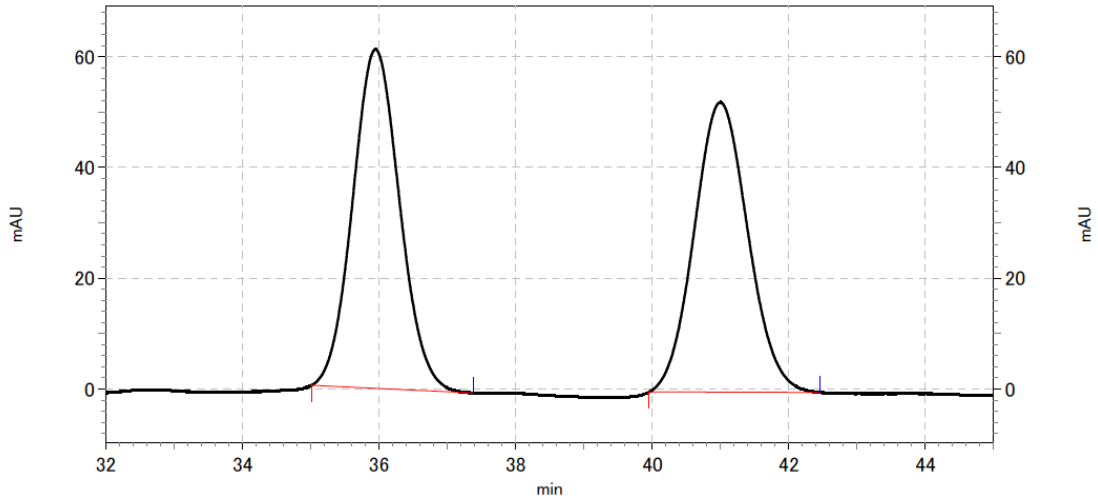
3ab

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 36.70 min, t_{minor} = 41.70 min.



Peak #	Retention time	Area	Area %
1	36.700	394544953	98.670
2	41.740	5318253	1.330

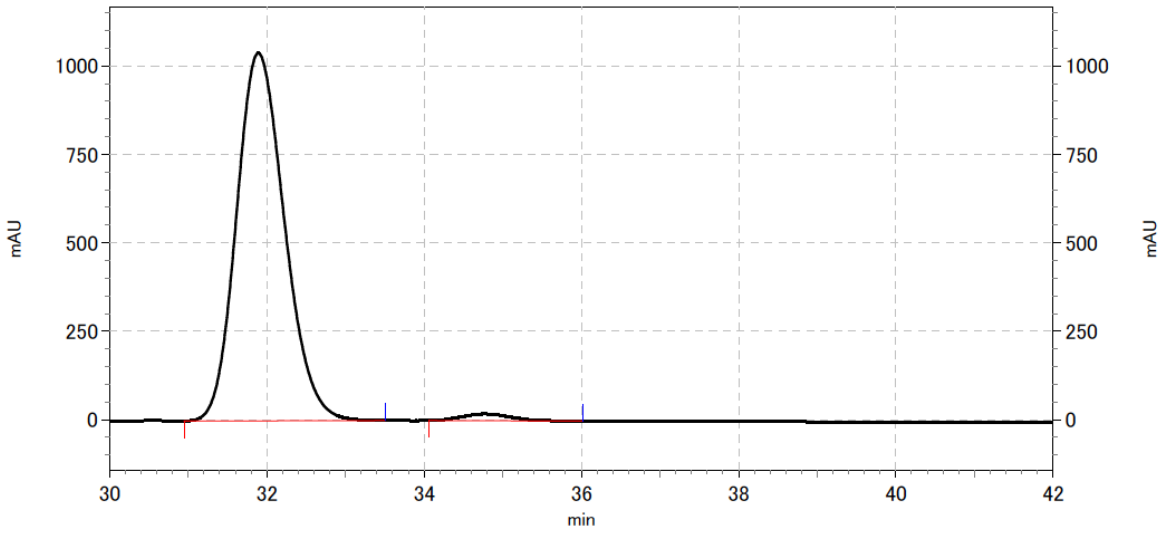
Racemate



Peak #	Retention time	Area	Area %
1	35.953	11712105	50.590
2	41.000	11438835	49.410

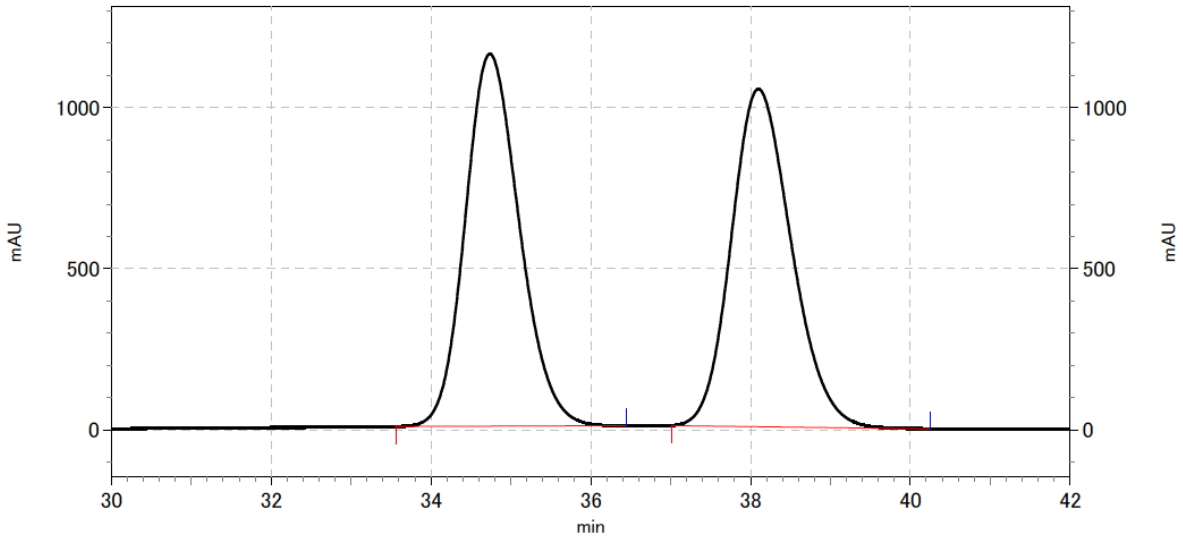
3ac

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 31.89 min, t_{minor} = 34.76 min.



Peak #	Retention time	Area	Area %
1	31.893	176162551	98.156
2	34.767	3310208	1.844

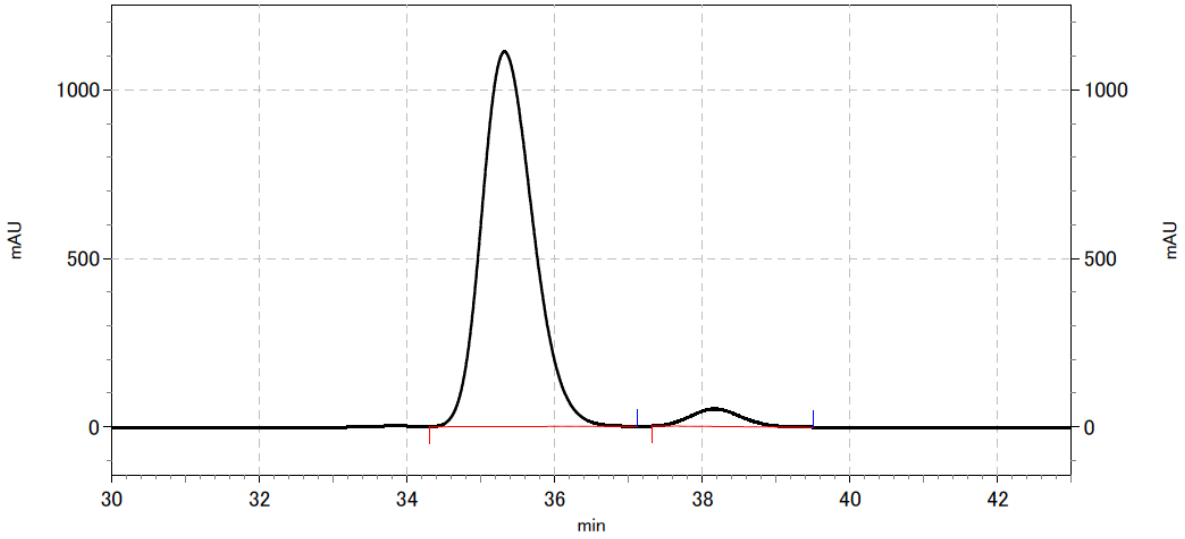
Racemate



Peak #	Retention time	Area	Area %
1	34.740	218428161	49.911
2	38.100	219208512	50.089

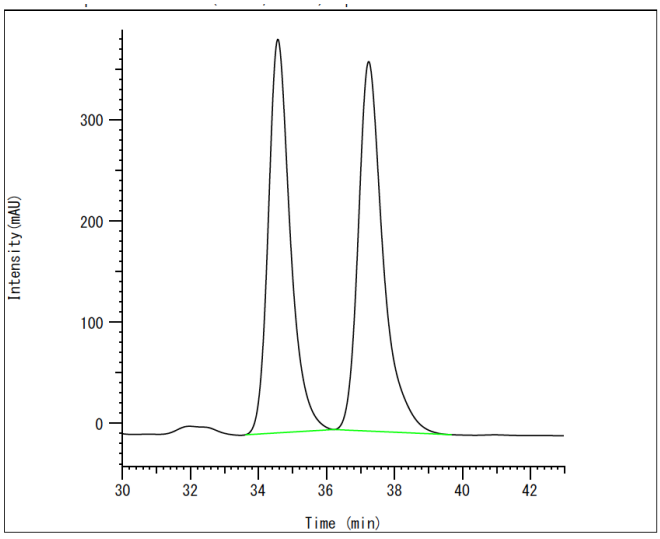
3ad

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 35.32 min, t_{minor} = 38.16 min.



Peak #	Retention time	Area	Area %
1	35.327	214433451	95.472
2	38.167	10169716	4.528

Racemate

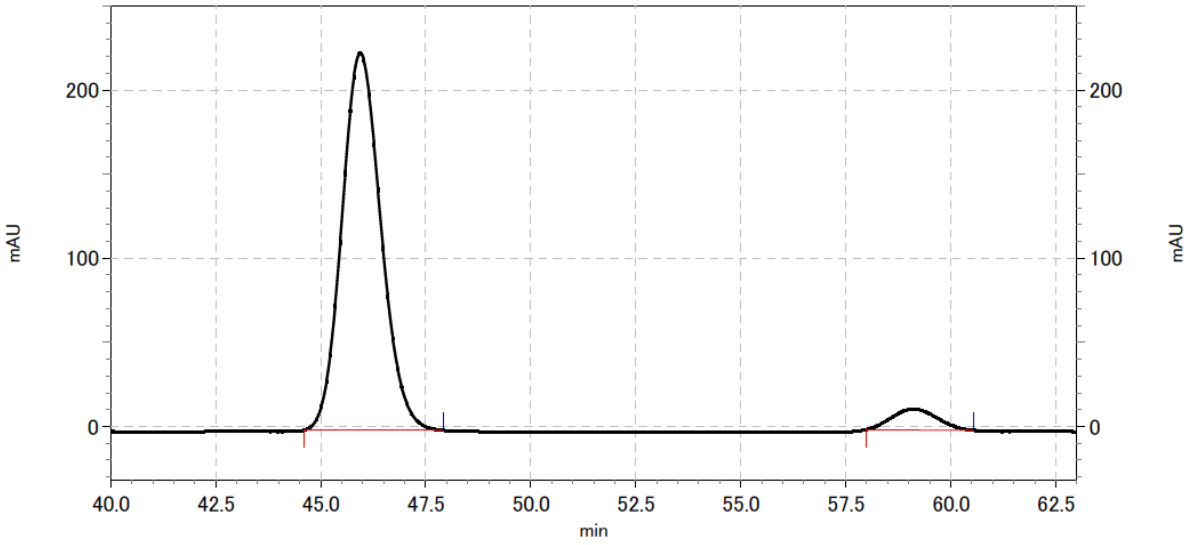


5430 Diode Array Detector SampleID:1 kt-349-rac (Extract, 300nm) Repeat:1

No.	Compounds	RT	Area	Area%
1	Peak 1	34.487	17478901	48.478
2	Peak 2	37.240	18576281	51.522
			36055182	100.000

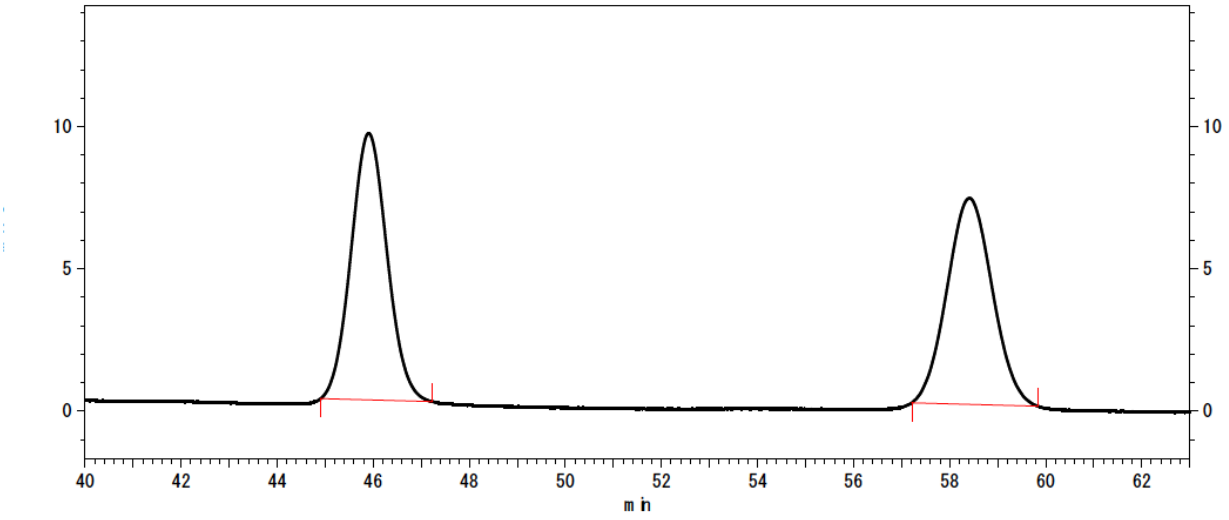
3ae

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 45.94 min, t_{minor} = 59.10 min.



Peak #	Retention time	**Area**	**Area %**
1	45.940	58170513	93.977
2	59.107	3728442	6.023

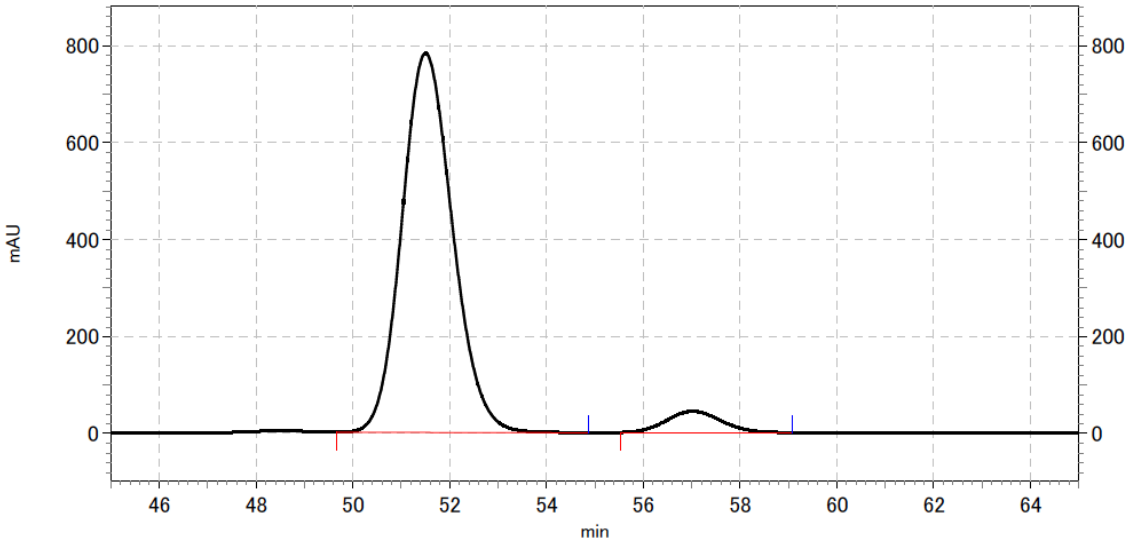
Racemate



Peak #	Retention time	Area	Area %
1	45.900	1959874	50.754
2	58.413	1901657	49.246

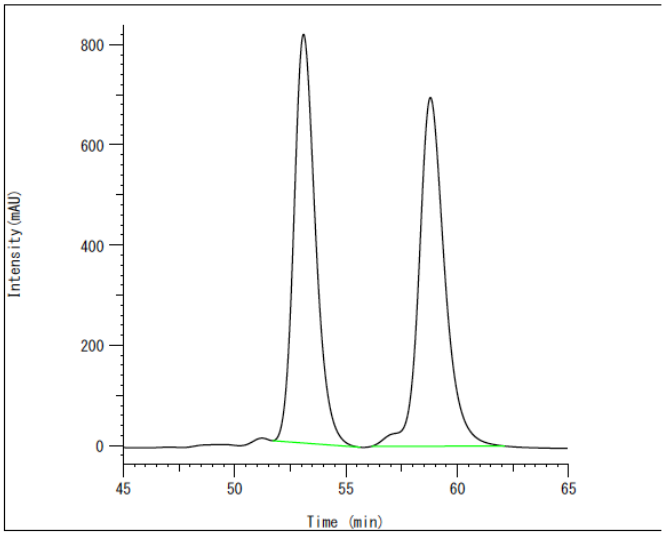
3af

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 51.50 min, t_{minor} = 57.02 min.



Peak #	Retention time	**Area**	**Area %**
1	51.500	228338153	94.233
2	57.020	13973153	5.767

Racemate

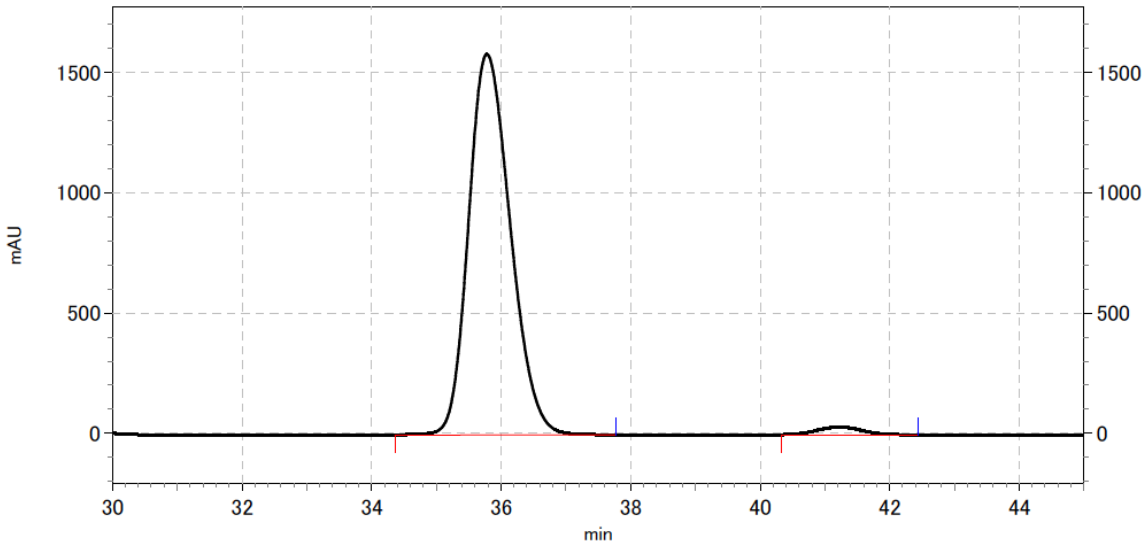


5430 Diode Array Detector SampleID:1 kt-385-rac (Extract, 300nm) Repeat:1

No.	Compounds	RT	Area	Area%
1	Peak 1	53.093	54981235	49.457
2	Peak 2	58.793	56188199	50.543
			111169434	100.000

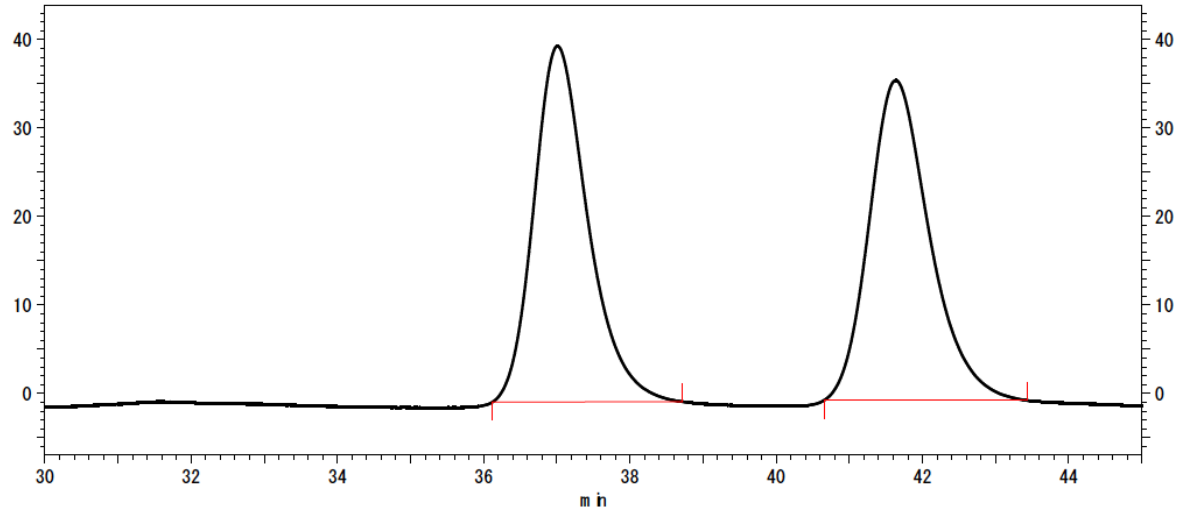
3ag

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 35.78 min, t_{minor} = 41.22 min.



Peak #	Retention time	**Area**	**Area %**
1	35.780	284280000	97.797
2	41.227	6403619	2.203

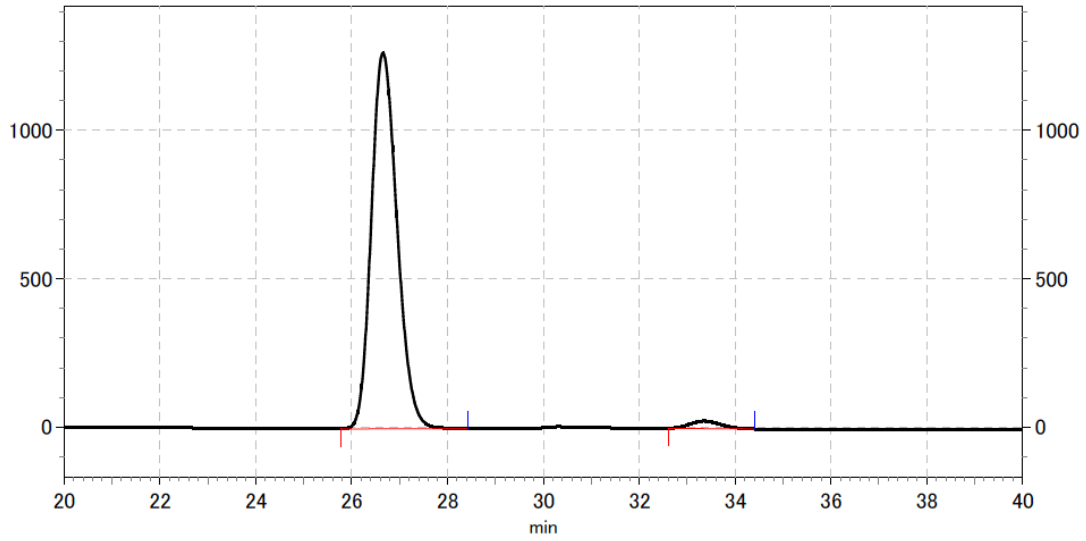
Racemate



Peak #	Retention time	Area	Area %
1	37.007	8273810	49.894
2	41.640	8308941	50.106

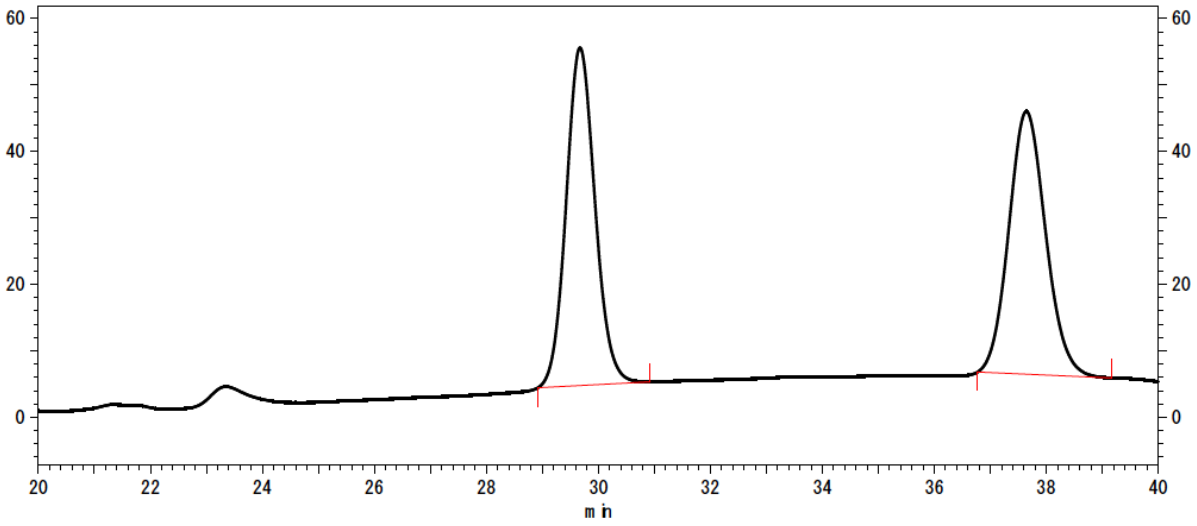
3ah

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 26.65 min, t_{minor} = 33.35 min.



Peak #	Retention time	**Area**	**Area %**
1	26.653	188900469	97.548
2	33.353	4747361	2.452

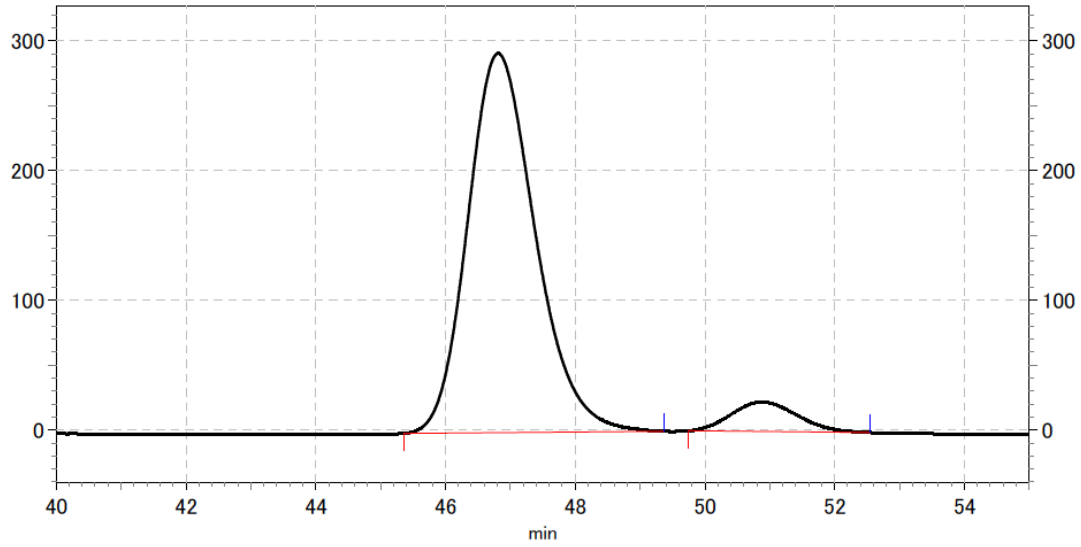
Racemate



Peak #	Retention time	Area	Area %
1	29.673	7285650	50.151
2	37.640	7241802	49.849

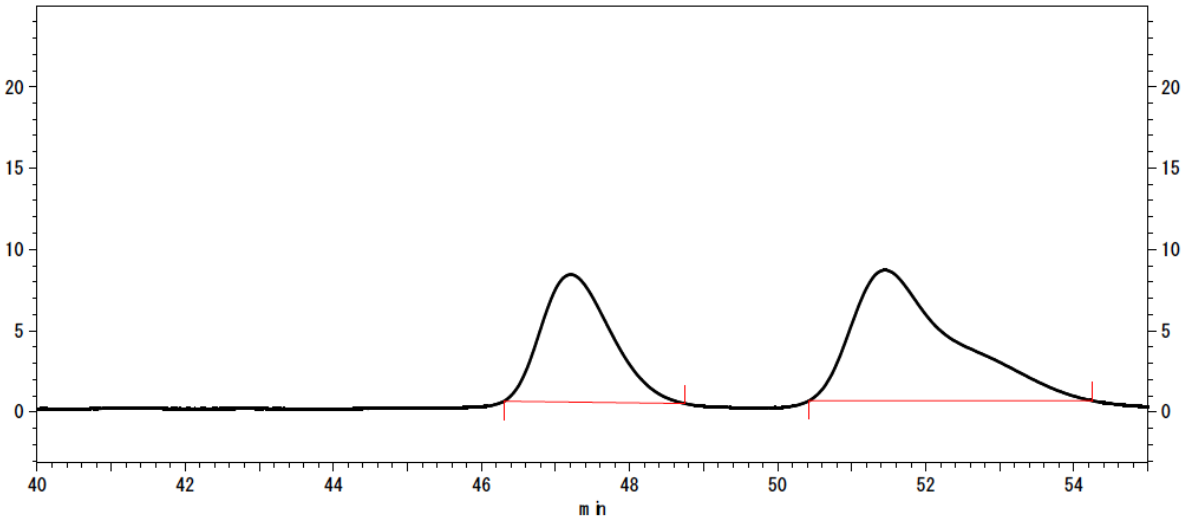
3ai

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 46.81 min, t_{minor} = 50.88 min.



Peak #	Retention time	**Area**	**Area %**
1	46.813	84596180	92.926
2	50.887	6439471	7.074

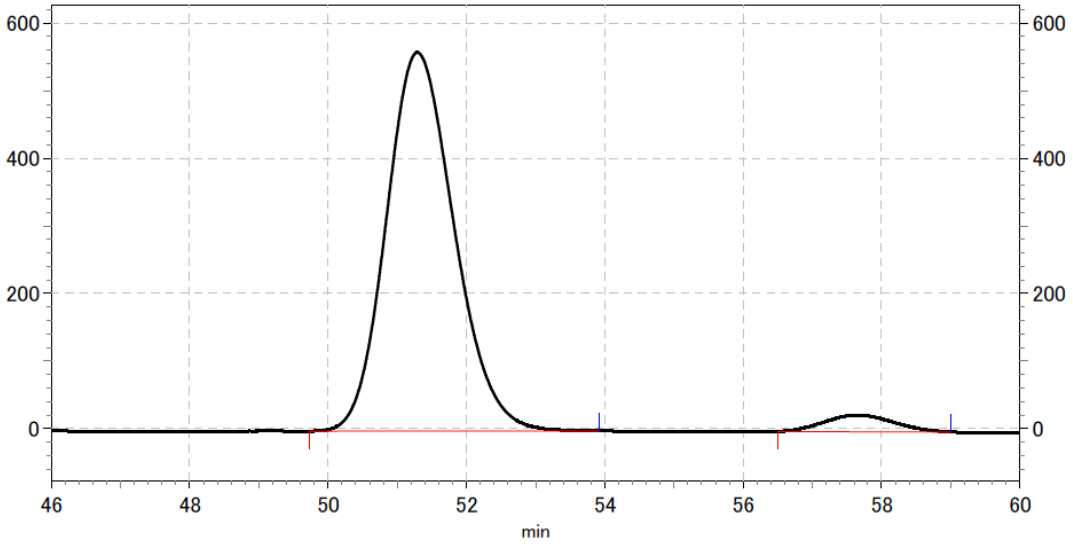
Racemate



Peak #	Retention time	Area	Area %
1	47.207	2037797	40.009
2	51.447	3055582	59.991

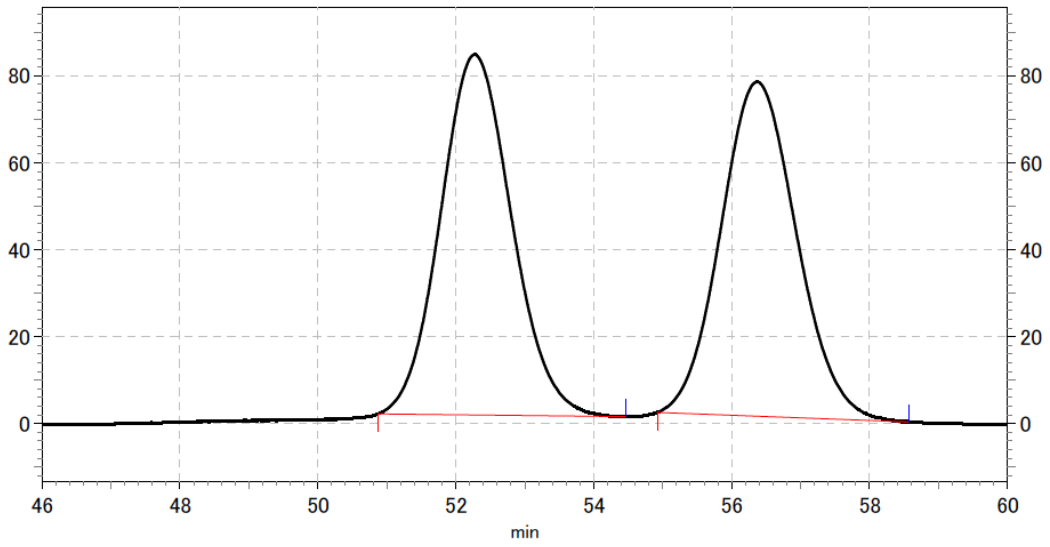
3bj

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 51.28 min, t_{minor} = 57.66 min.



Peak #	Retention time	**Area**	**Area %**
1	51.287	152842046	95.678
2	57.660	6904746	4.322

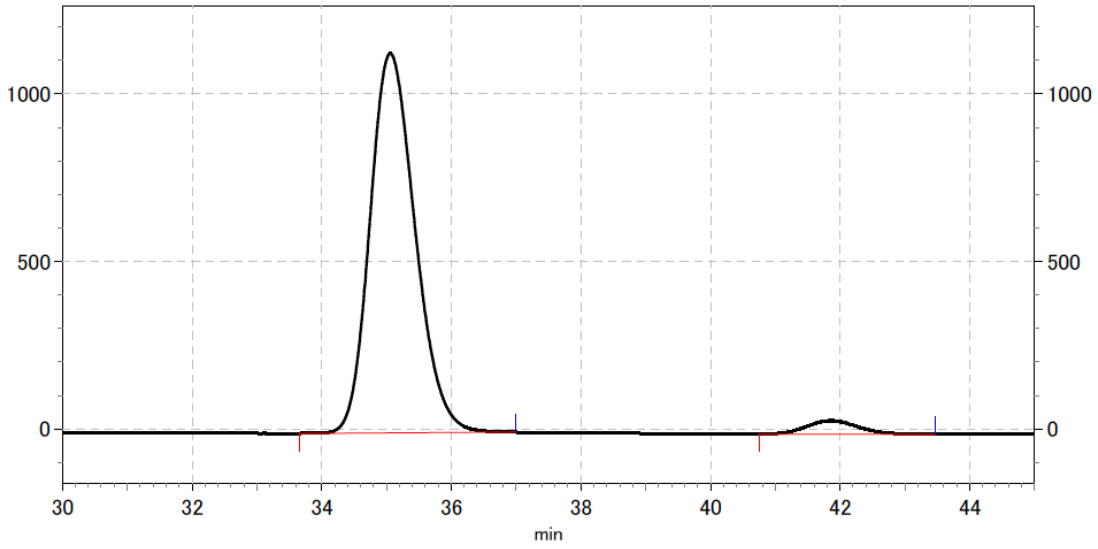
Racemate



Peak #	Retention time	**Area**	**Area %**
1	52.273	23852462	50.383
2	56.373	23489518	49.617

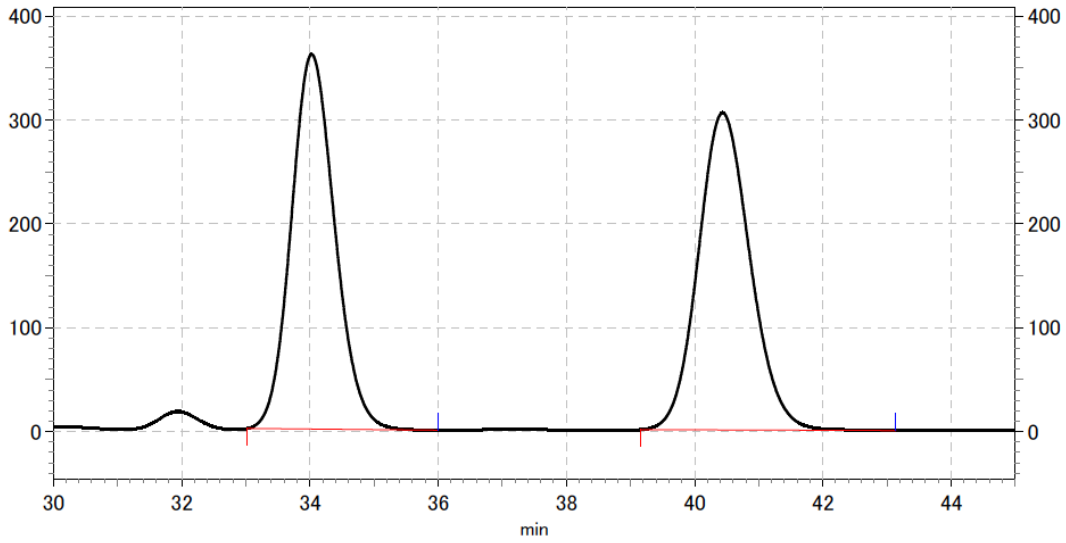
3bk

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 35.06 min, t_{minor} = 41.86 min.



Peak #	Retention time	**Area**	**Area %**
1	35.060	219025585	96.067
2	41.860	8967755	3.933

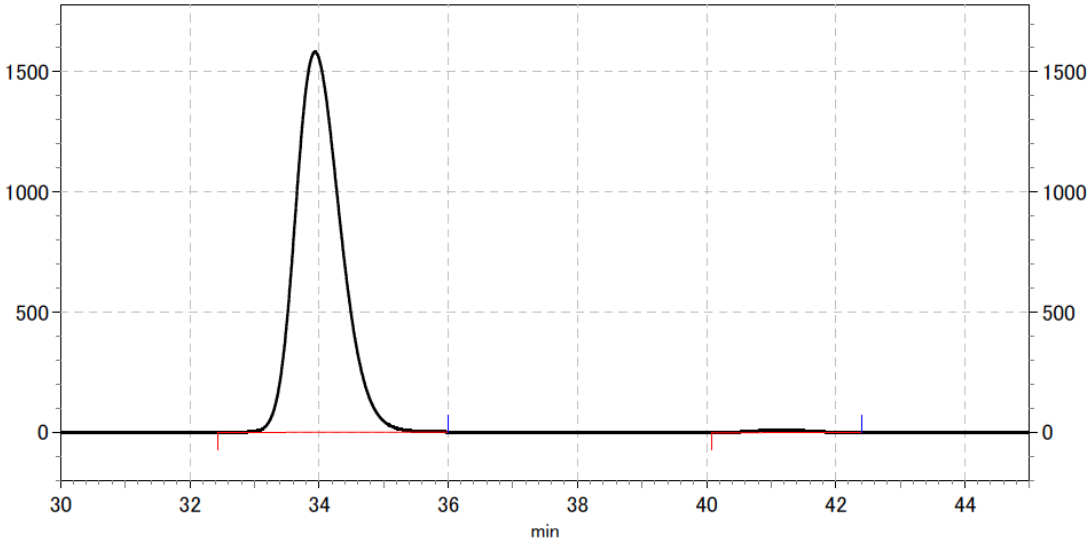
Racemate



Peak #	Retention time	**Area**	**Area %**
1	34.027	68324317	49.820
2	40.440	68817597	50.180

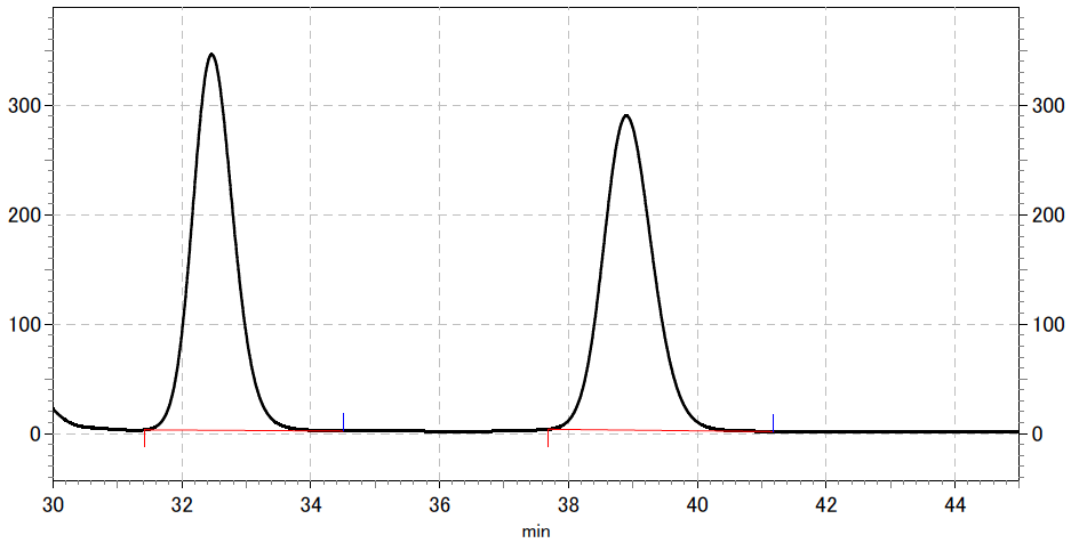
3bl

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 33.94 min, t_{minor} = 41.16 min.



Peak #	Retention time	**Area**	**Area %**
1	33.940	309416343	99.171
2	41.160	2585252	0.829

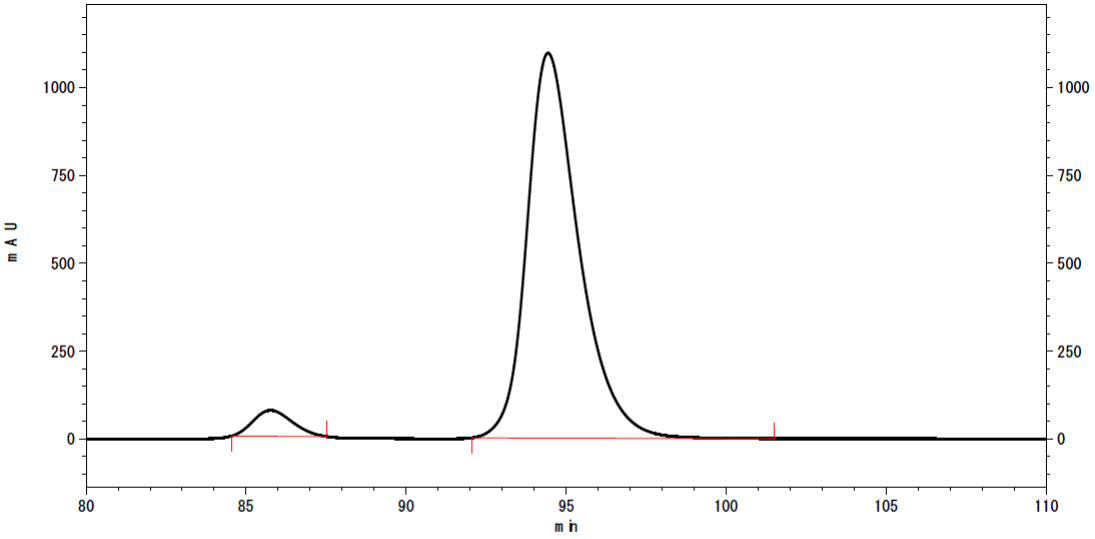
Racemate



Peak #	Retention time	**Area**	**Area %**
1	32.467	62900764	50.138
2	38.900	62555295	49.862

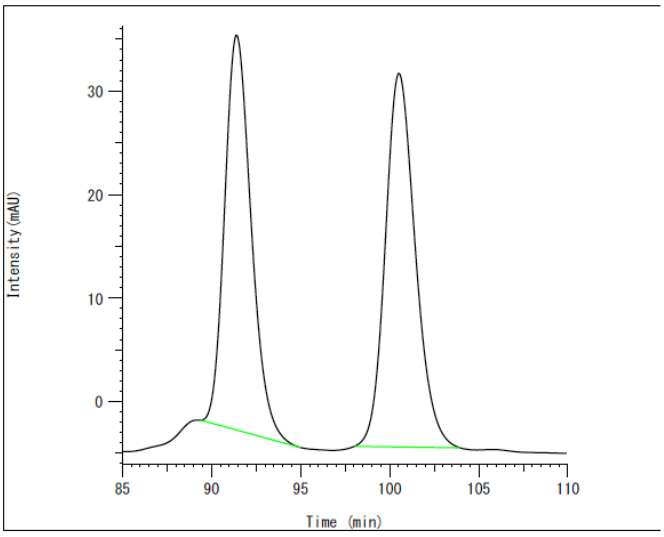
3bm

CHIRALPAK® IA-3 column, *n*-hexane/*i*-PrOH = 85/15, flow rate = 0.5 mL/min, t_{major} = 96.10 min, t_{minor} = 88.00 min.



Peak #	Retention time	Area	Area%
1	85.760	24891460	4.810
2	94.433	492613603	95.190

Racemate

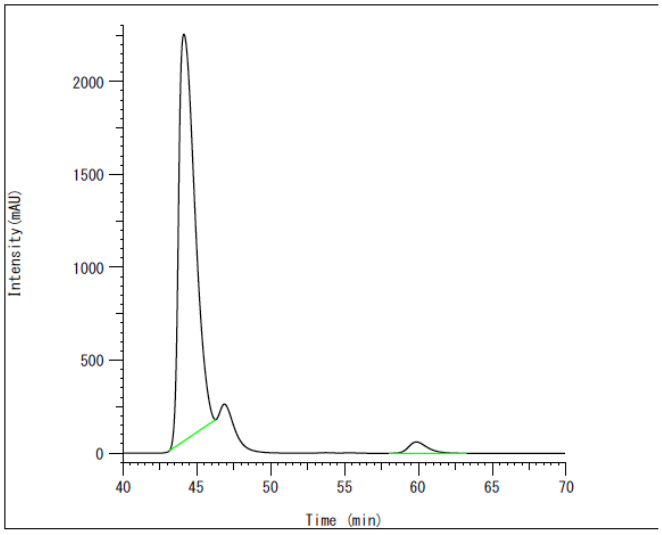


5430 Diode Array Detector SampleID:1 kt-268-rac (Extract, 300nm) Repeat:1

No.	Compounds	RT	Area	Area%
1	Peak 1	91.407	3954316	48.343
2	Peak 2	100.520	4225466	51.657
			8179783	100.000

3bn

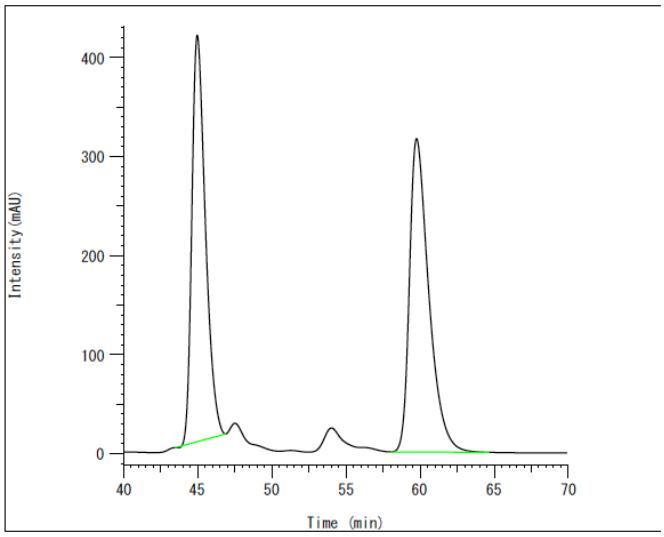
CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 44.12 min, t_{minor} = 59.86 min.



5430 Diode Array Detector SampleID:1 UNK001 (Extract, 300nm) Repeat:1

No.	Compounds	RT	Area	Area%
1	Peak 1	44.120	167025788	96.796
2	Peak 2	59.860	5528738	3.204
			172554526	100.000

Racemate

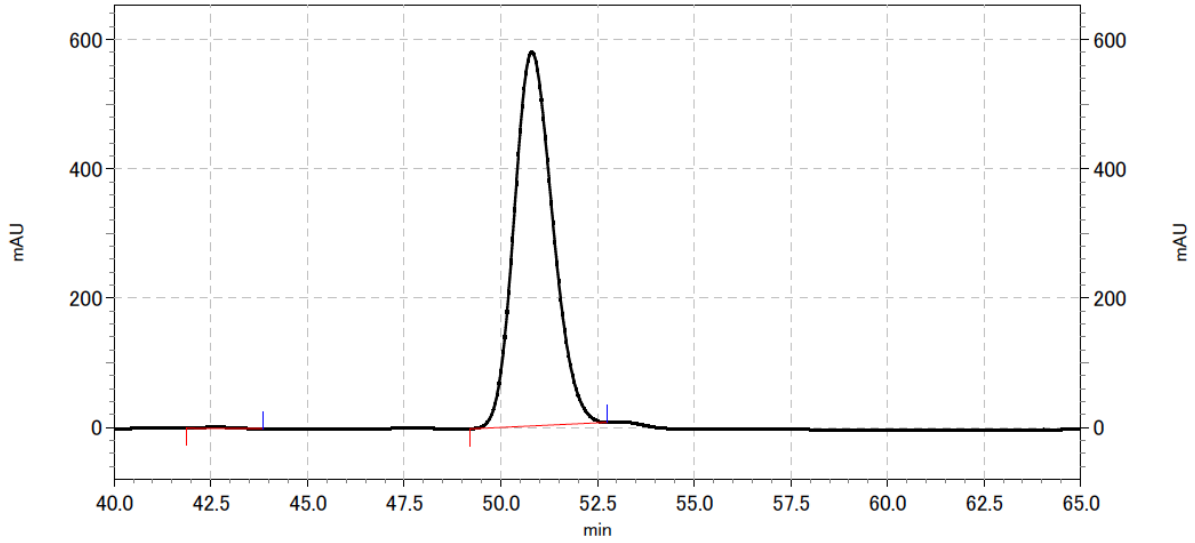


5430 Diode Array Detector SampleID:1 kt-435-rac-2 (Extract, 300nm) Repeat:1

No.	Compounds	RT	Area	Area%
1	Peak 1	44.960	26106229	47.597
2	Peak 2	59.760	28742303	52.403
			54848532	100.000

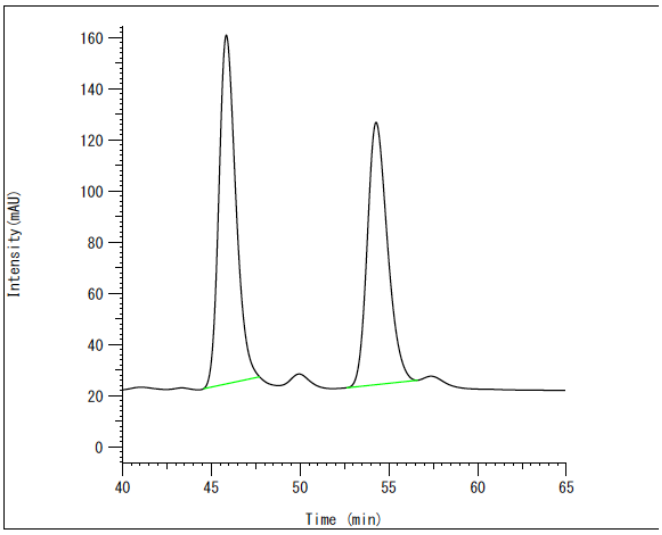
3bo

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 44.12 min, t_{minor} = 59.86 min.



Peak #	Retention time	Area	Area %
1	42.567	507304	0.315
2	50.807	160630543	99.685

Racemate

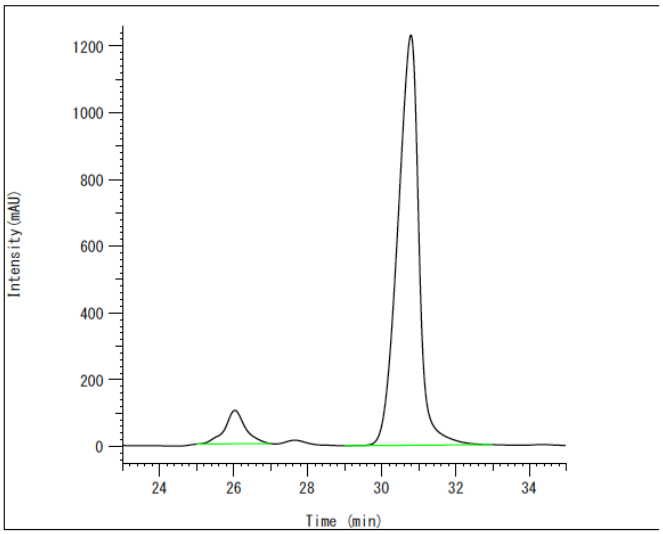


5430 Diode Array Detector SampleID:1 kt-604 rac (Extract, 300nm) Repeat:1

No.	Compounds	RT	Area	Area%
1	Peak 1	45.847	9022375	52.688
2	Peak 2	54.287	8101921	47.312
			17124295	100.000

3bp

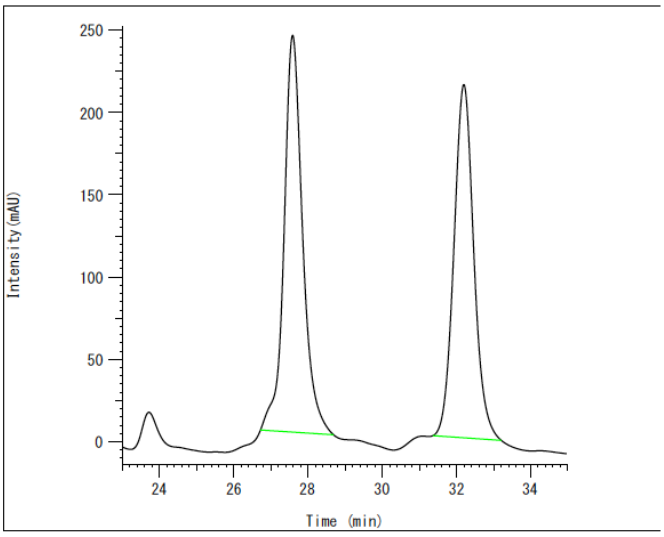
CHIRALPAK® IA-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 30.78 min, t_{minor} = 26.03 min.



5430 Diode Array Detector SampleID:1 kt-tu-l-o-Me (Extract, 300nm) Repeat:1

No.	Compounds	RT	Area	Area%
1	Peak 1	26.033	3902409	7.416
2	Peak 2	30.787	48722086	92.584
			52624495	100.000

Racemate

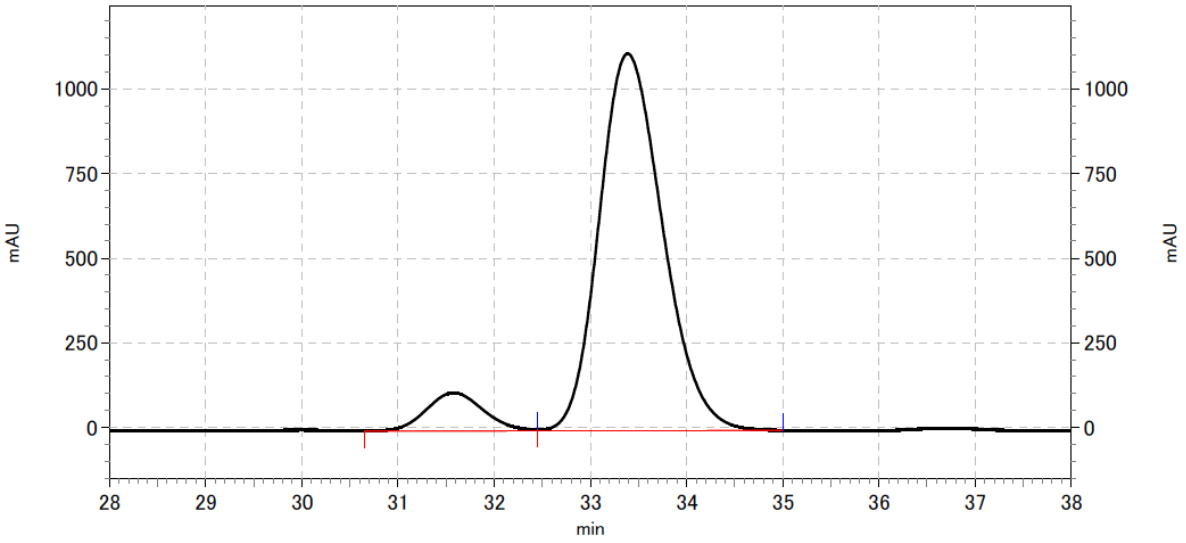


5430 Diode Array Detector SampleID:1 kt-603 rac (Extract, 300nm) Repeat:1

No.	Compounds	RT	Area	Area%
1	Peak 1	27.587	8394856	51.298
2	Peak 2	32.200	7969869	48.702
			16364725	100.000

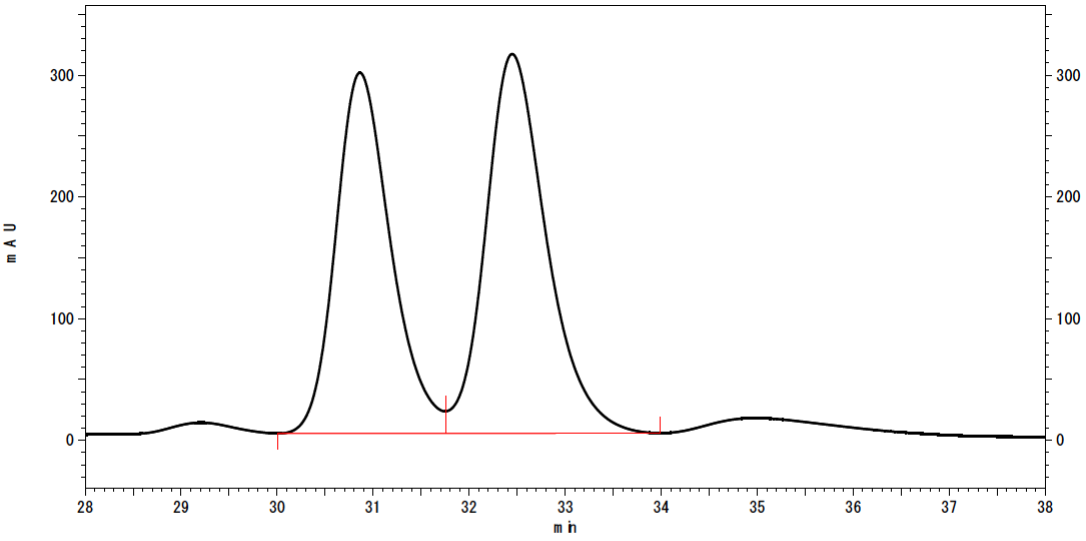
3aq

CHIRALPAK® IA-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 34.50 min, t_{minor} = 39.20 min.



Peak #	Retention time	Area	Area %
1	31.573	18532309	8.320
2	33.387	204204871	91.680

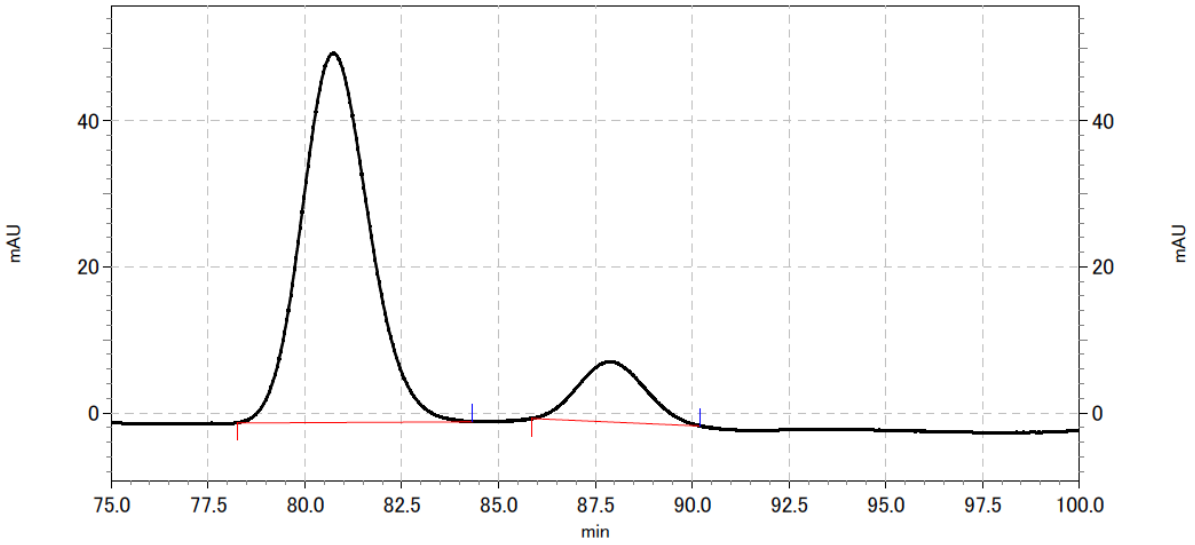
Racemate



Peak #	Retention time	Area	Area%
1	30.860	47246484	46.294
2	32.447	54811228	53.706

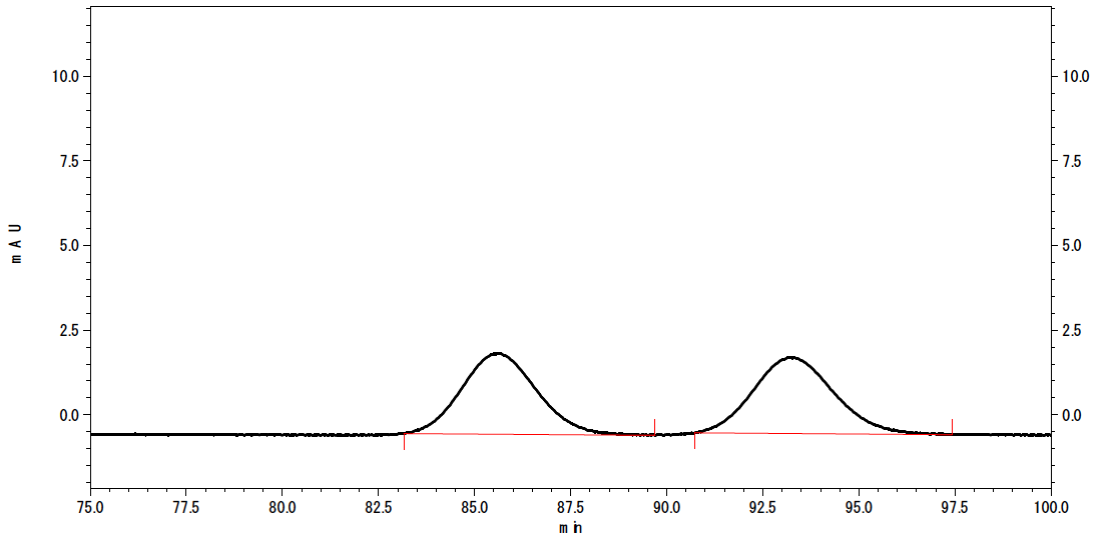
3jr

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 80.74 min, t_{minor} = 87.88 min.



Peak #	Retention time	Area	Area %
1	80.740	24509992	86.012
2	87.887	3986024	13.988

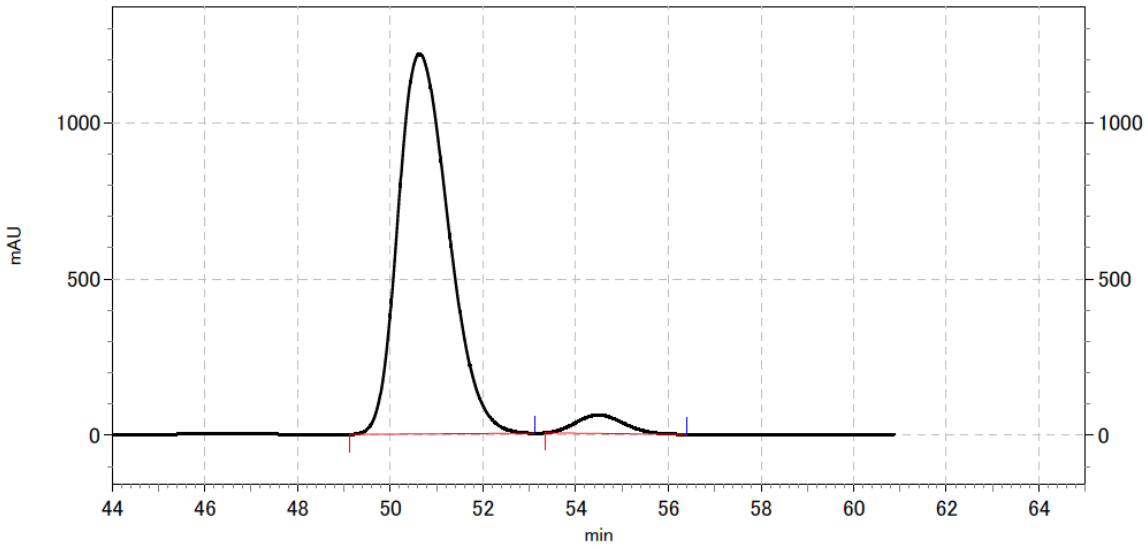
Racemate



Peak #	Retention time	Area	Area%
1	85.600	1298412	49.727
2	93.207	1312654	50.273

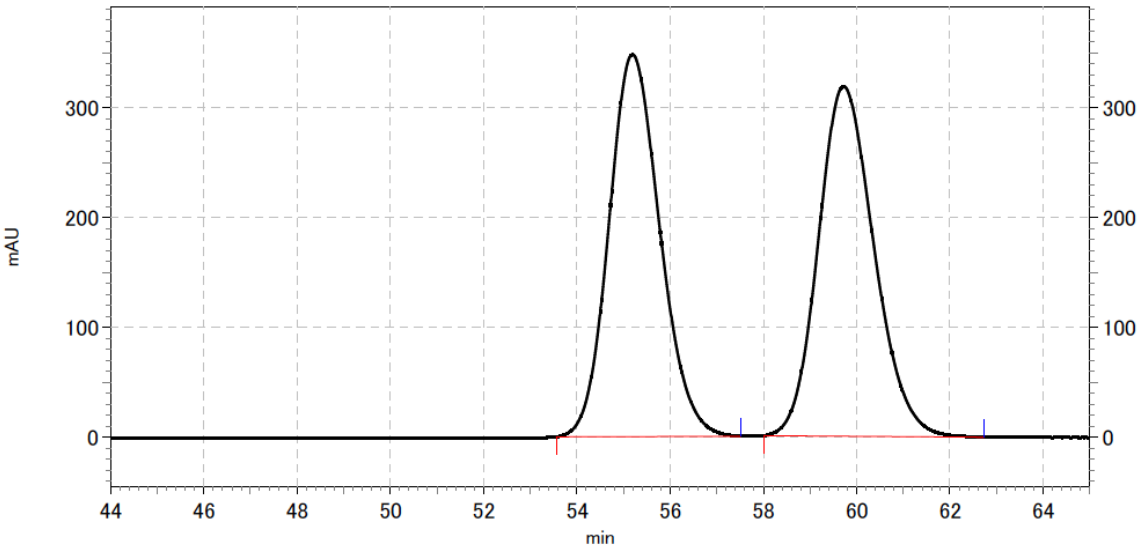
3cj

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 50.62 min, t_{minor} = 54.48 min.



Peak #	Retention time	**Area**	**Area %**
1	50.620	367245405	95.542
2	54.487	17135685	4.458

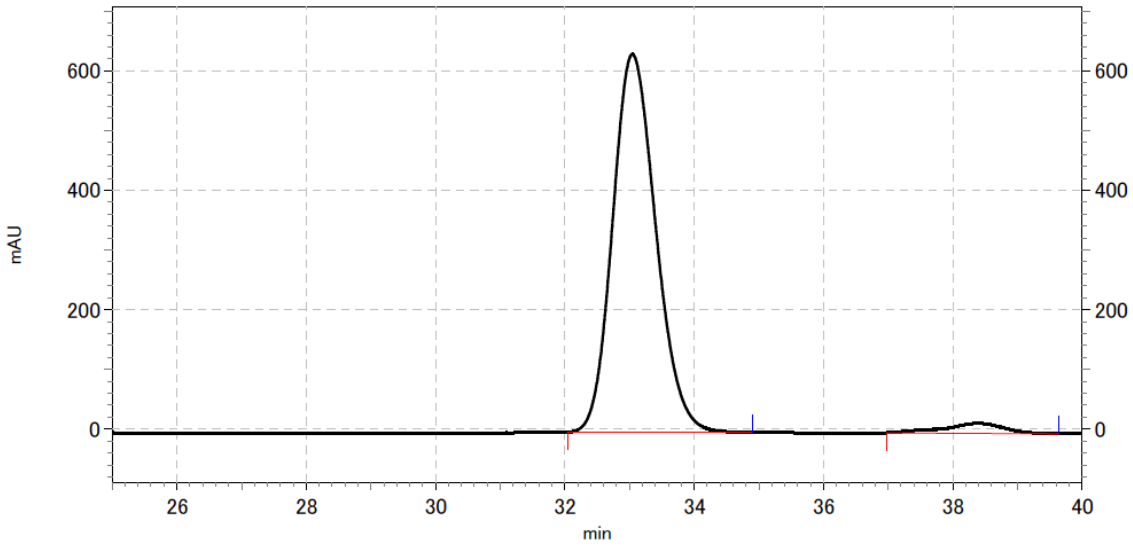
Racemate



Peak #	Retention time	**Area**	**Area %**
1	55.193	105806865	49.988
2	59.720	105856990	50.012

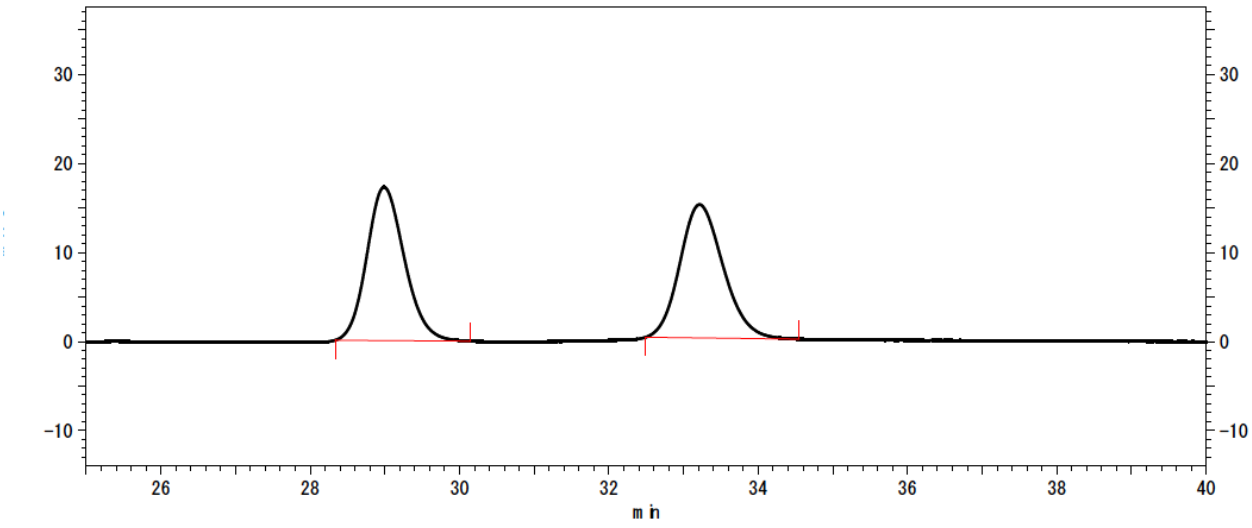
3cl

CHIRALPAK® IF-3 column, *n*-hexane/*i*-PrOH = 7/3, flow rate = 0.5 mL/min, t_{major} = 33.04 min, t_{minor} = 38.38 min.



Peak #	Retention time	**Area**	**Area %**
1	33.040	117479643	96.439
2	38.387	4337967	3.561

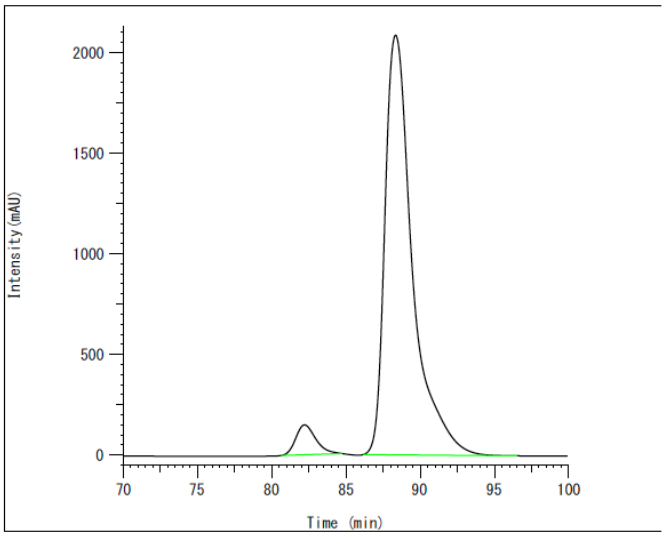
Racemate



Peak #	Retention time	Area	Area %
1	28.987	2414092	49.912
2	33.213	2422645	50.088

3cm

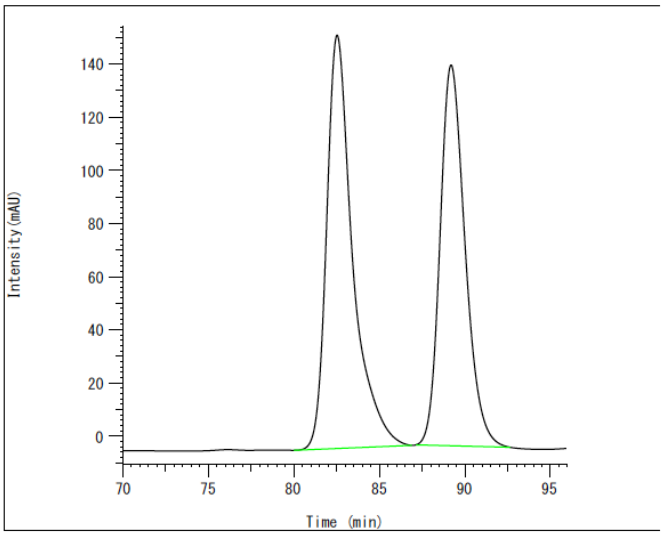
CHIRALPAK® IA-3 column, *n*-hexane/*i*-PrOH = 85/15, flow rate = 0.5 mL/min, t_{major} = 88.33 min, t_{minor} = 82.20 min.



5430 Diode Array Detector SampleID:1 kt-479-Br-Ph pro (Extract, 300nm) Repeat:1

No.	Compounds	RT	Area	Area%
1	Peak 1	82.207	13896385	4.929
2	Peak 2	88.333	268011906	95.071
			281908290	100.000

Racemate



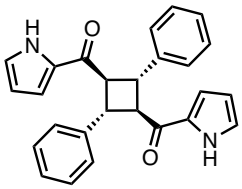
5430 Diode Array Detector SampleID:1 kt-366-rac-2 (Extract, 300nm) Repeat:1

No.	Compounds	RT	Area	Area%
1	Peak 1	82.527	16434737	53.006
2	Peak 2	89.193	14570542	46.994
			31005280	100.000

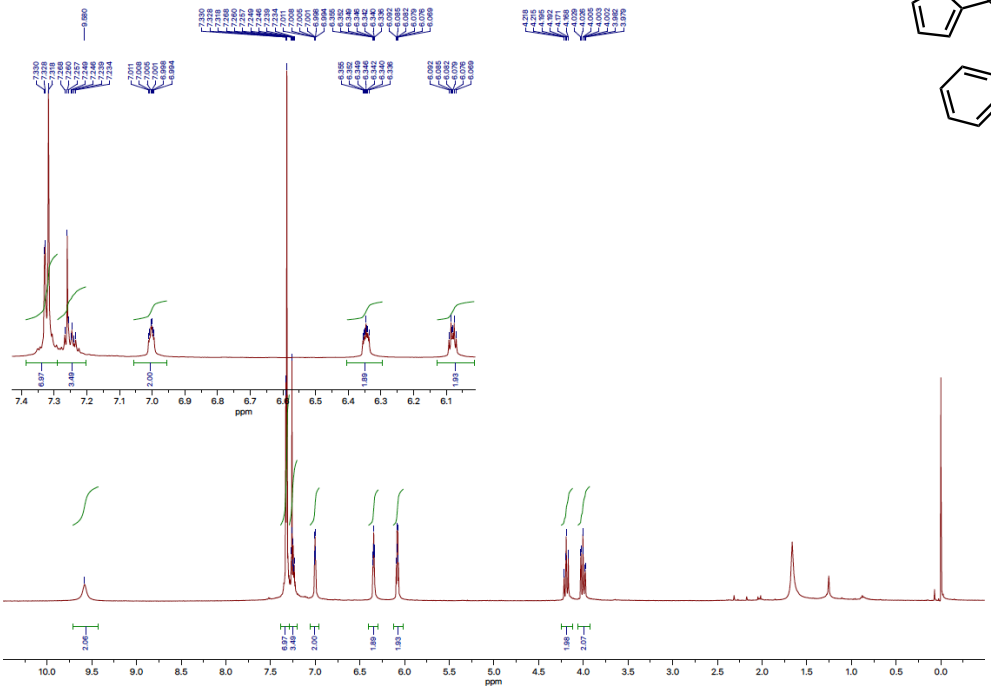
6. NMR spectra

3aa

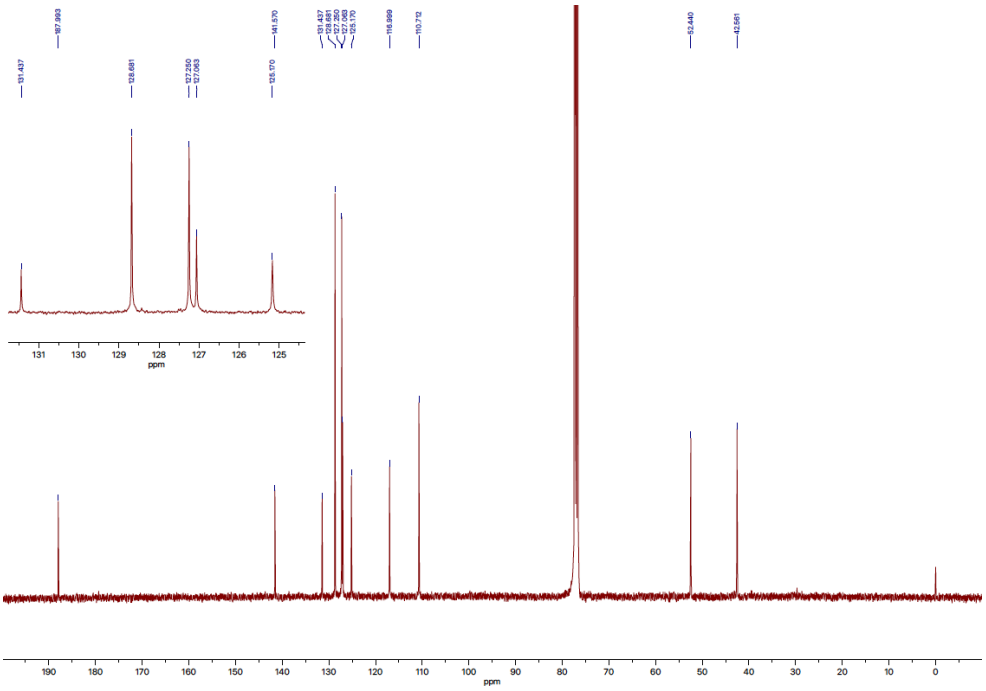
^{1}H NMR (400 MHz, $CDCl_3$)



3aa

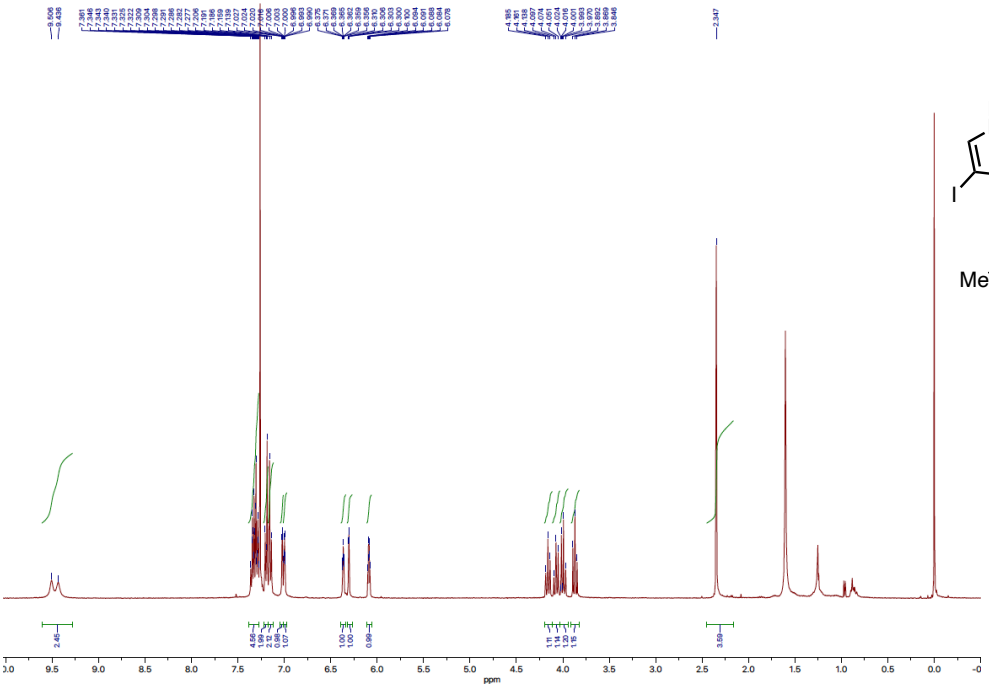


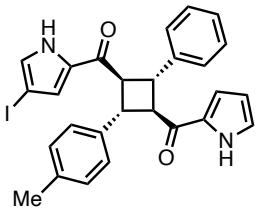
^{13}C NMR (101 MHz, $CDCl_3$)



3ab

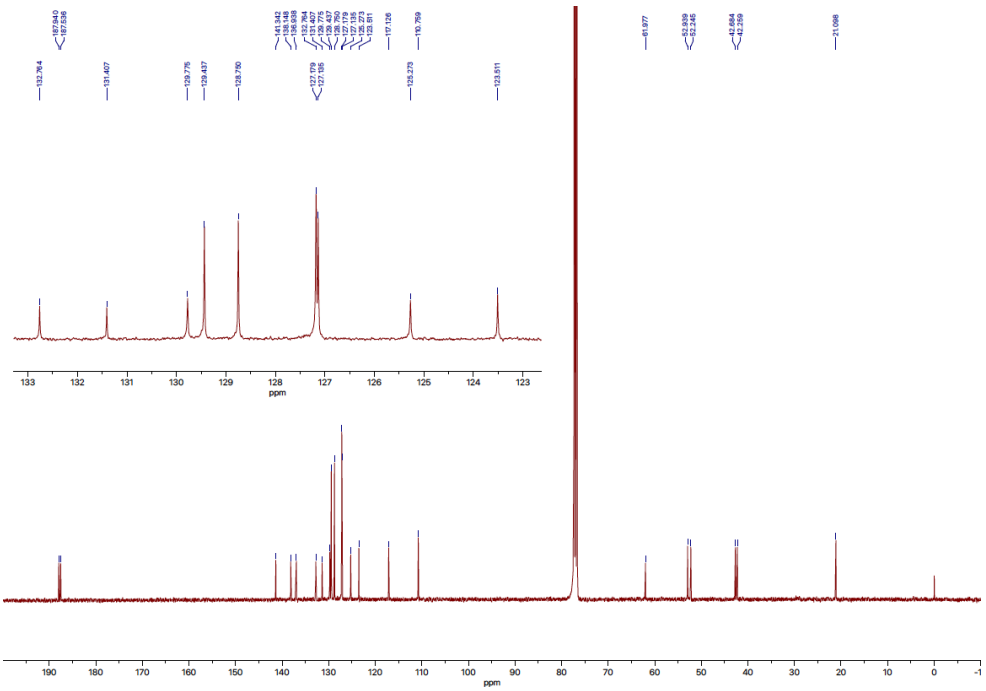
^{1}H NMR (400 MHz, $CDCl_3$)





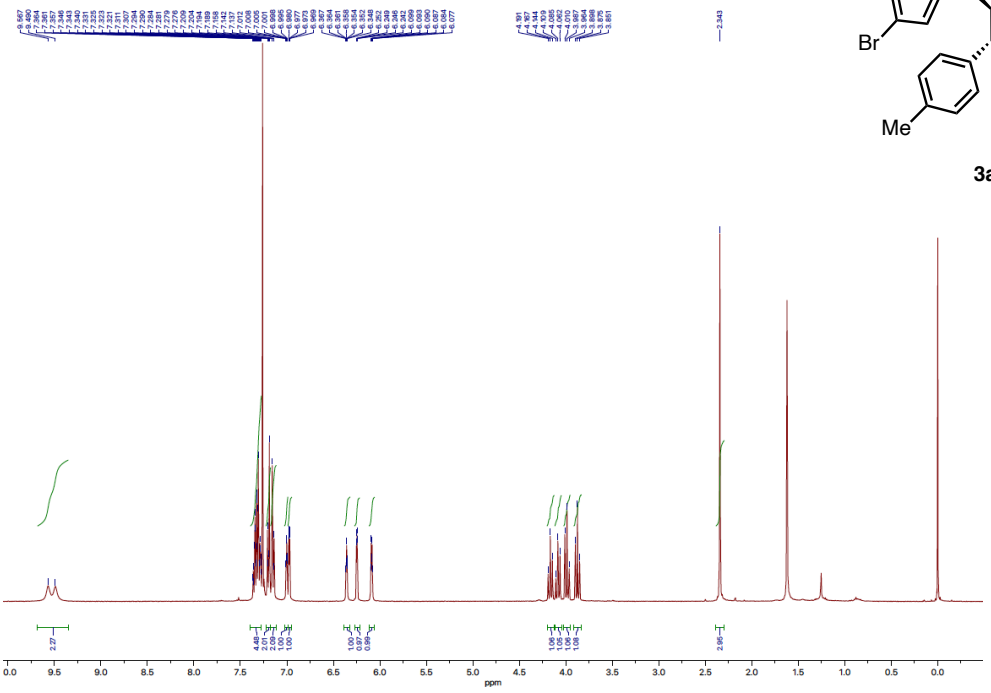
3ab

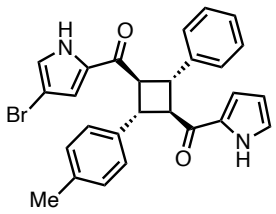
^{13}C NMR (101 MHz, $CDCl_3$)



3ac

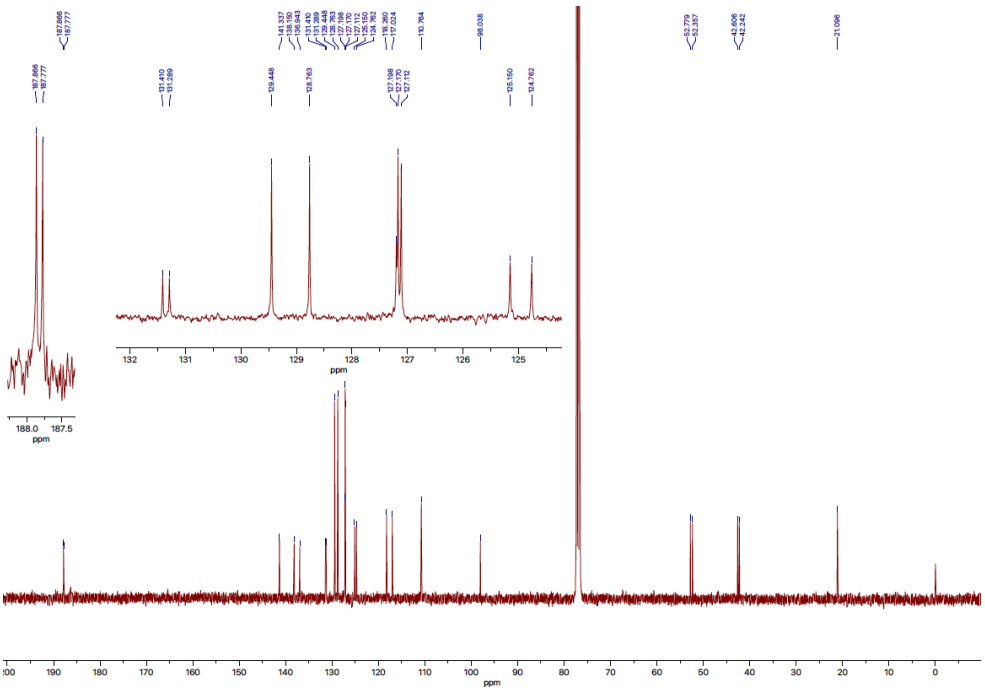
^{1}H NMR (400 MHz, $CDCl_3$)





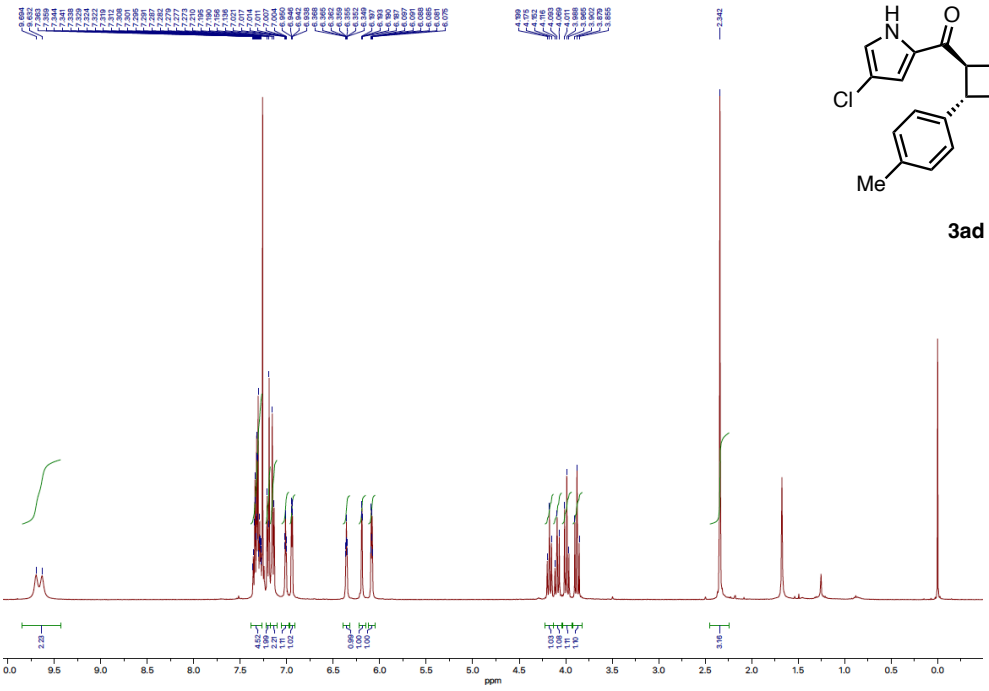
3ac

^{13}C NMR (101 MHz, $CDCl_3$)



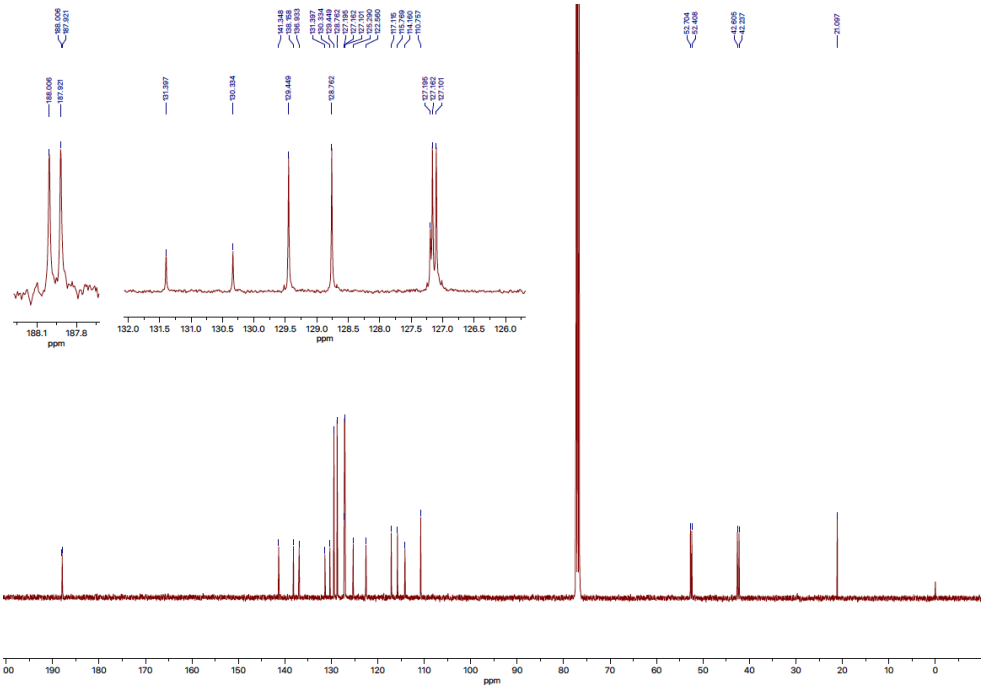
3ad

^{1}H NMR (400 MHz, $CDCl_3$)



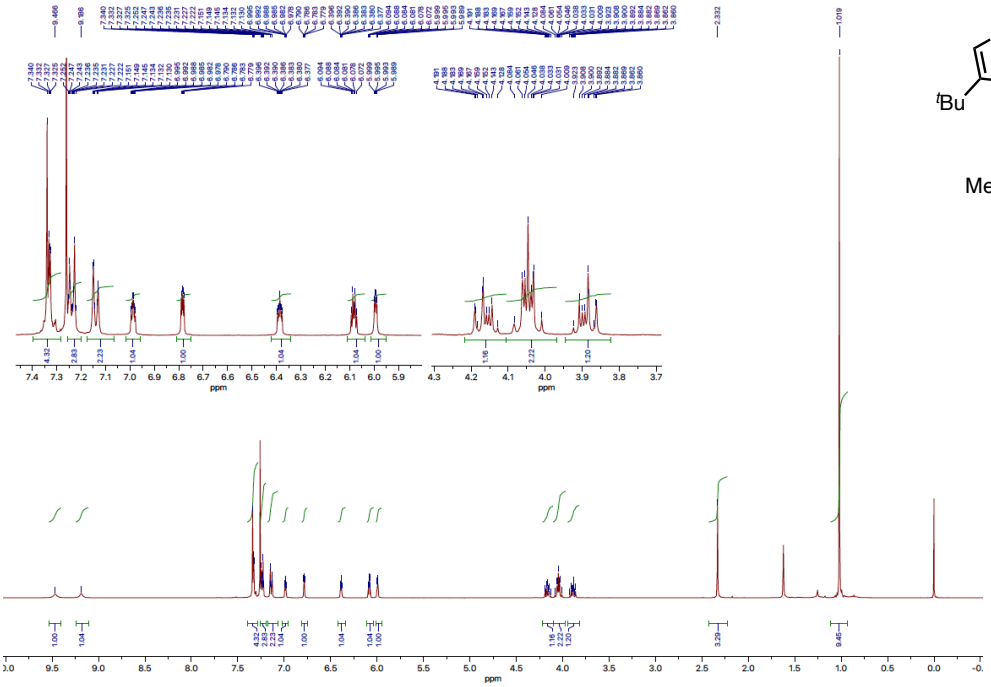
3ad

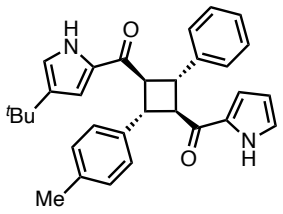
^{13}C NMR (101 MHz, $CDCl_3$)



3ae

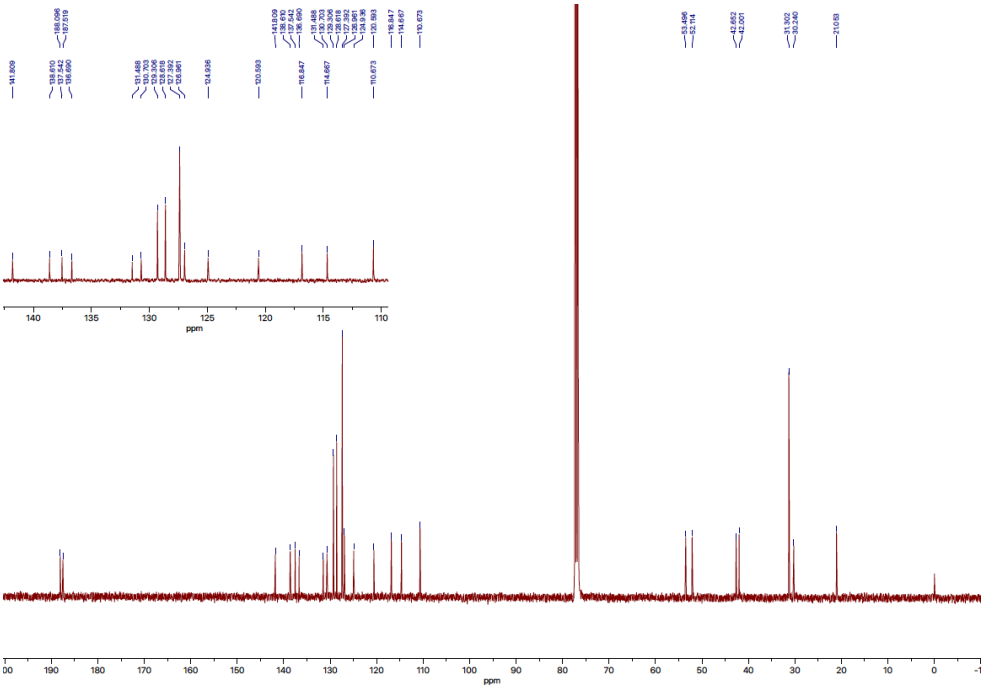
^{1}H NMR (400 MHz, $CDCl_3$)





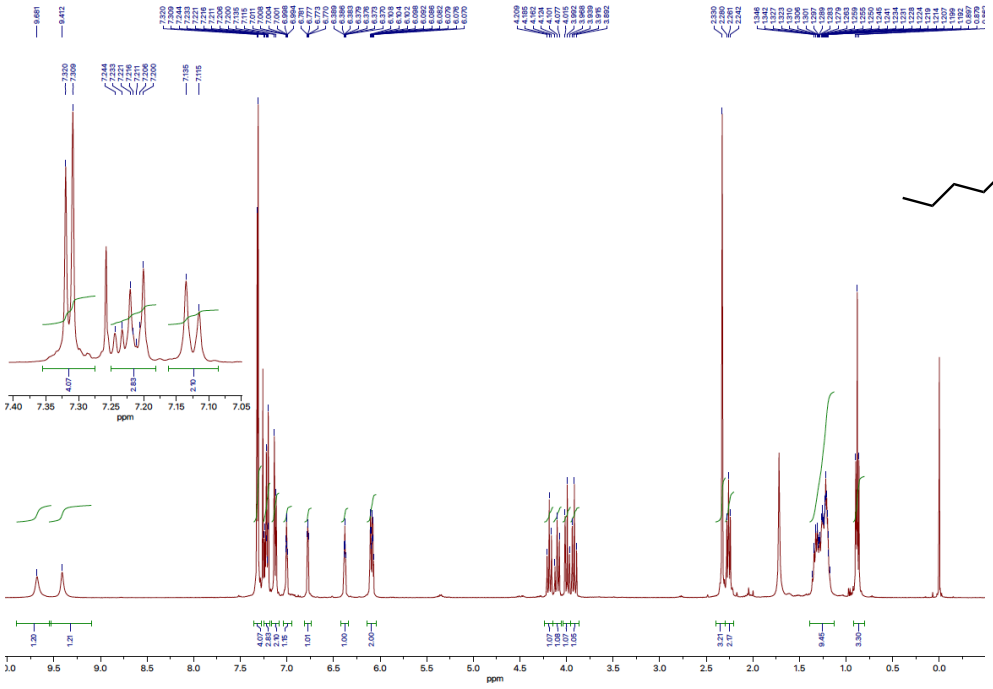
3ae

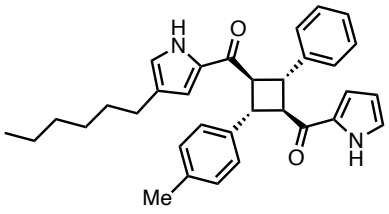
^{13}C NMR (101 MHz, $CDCl_3$)



3af

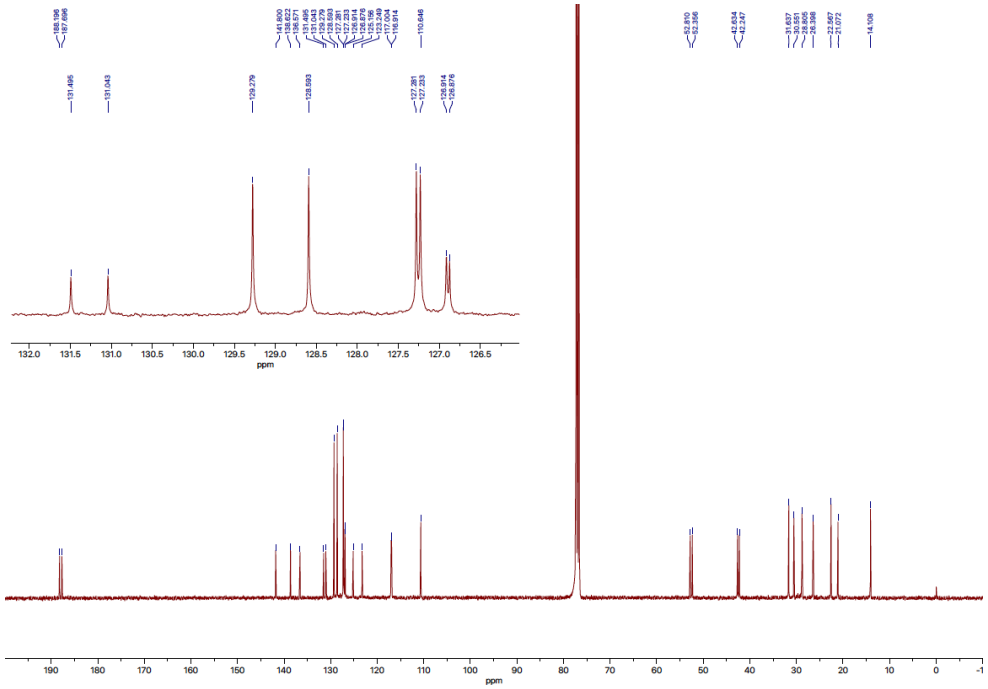
^{1}H NMR (400 MHz, $CDCl_3$)





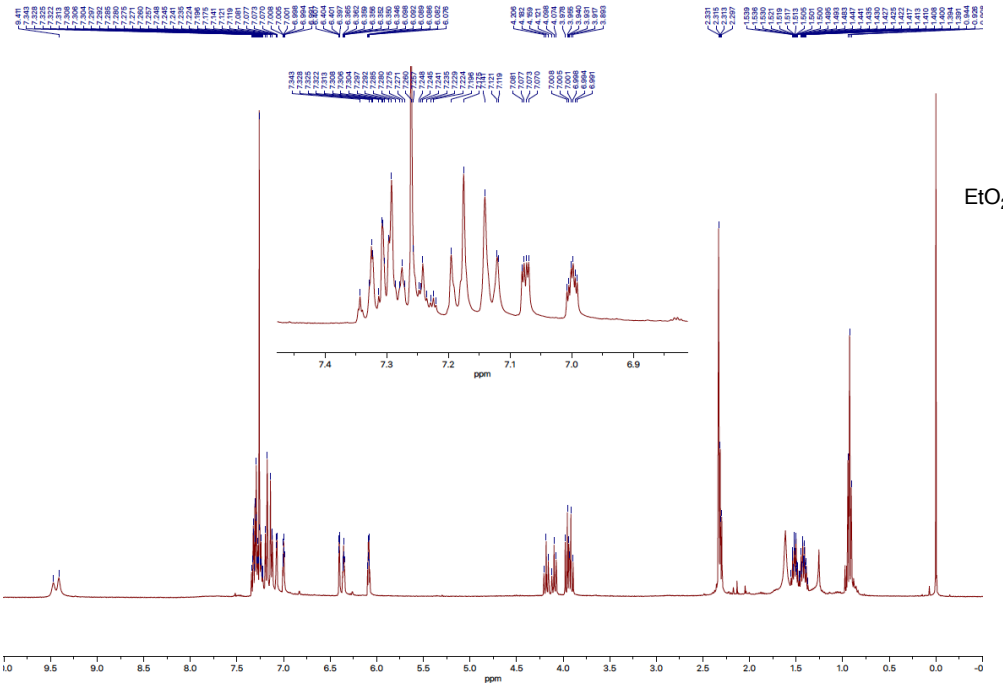
3af

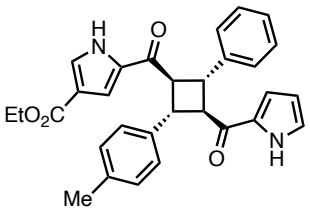
^{13}C NMR (101 MHz, $CDCl_3$)



3ag

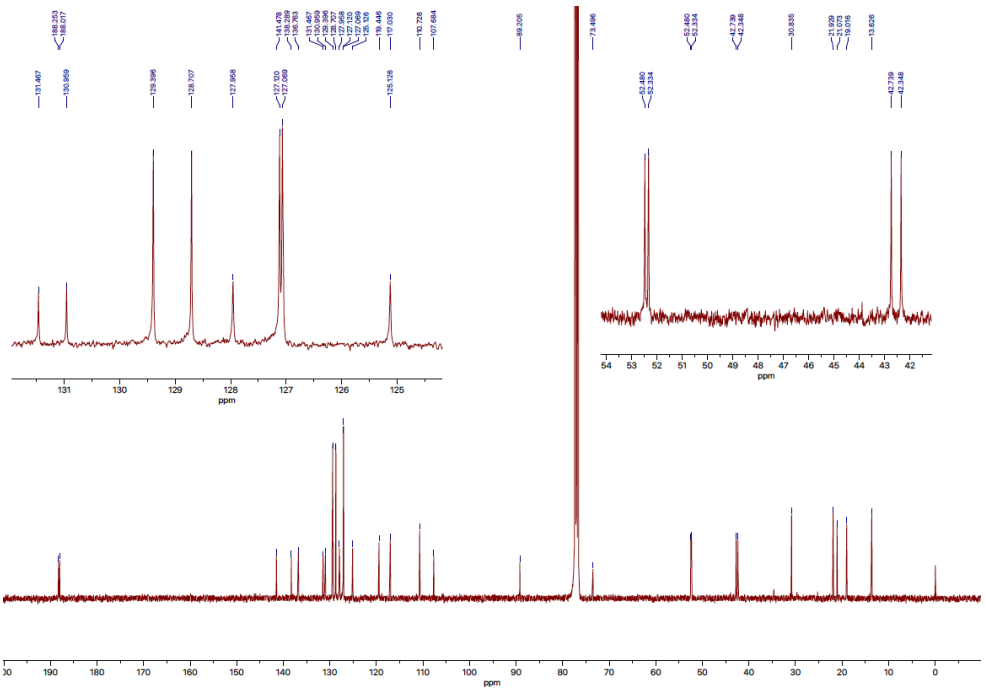
^{1}H NMR (400 MHz, $CDCl_3$)





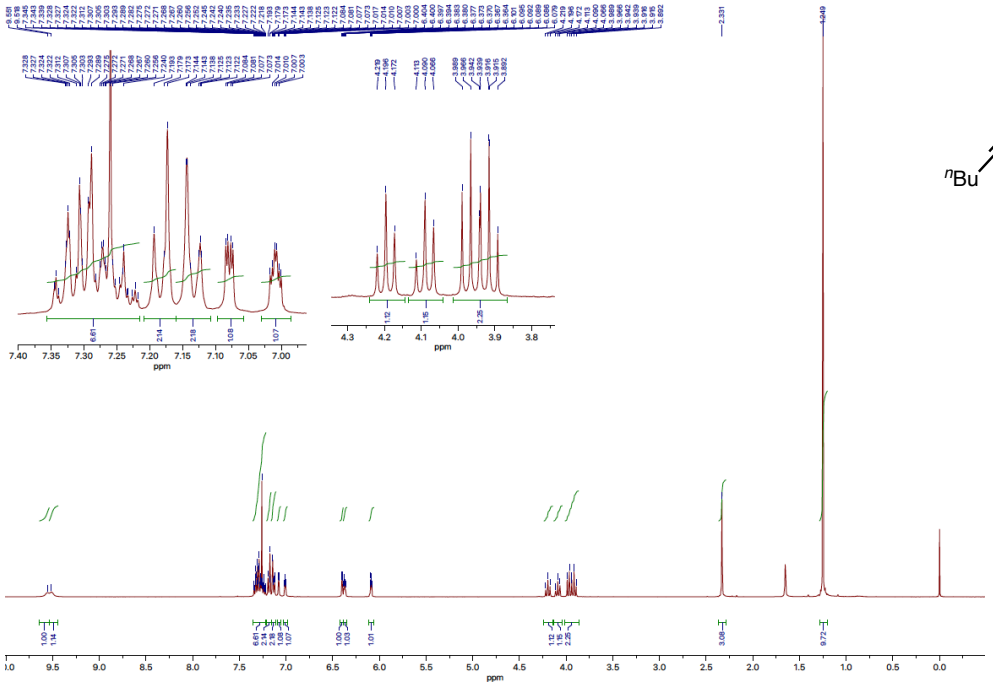
3ag

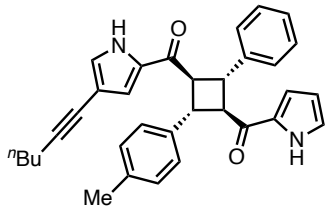
^{13}C NMR (101 MHz, $CDCl_3$)



3ah

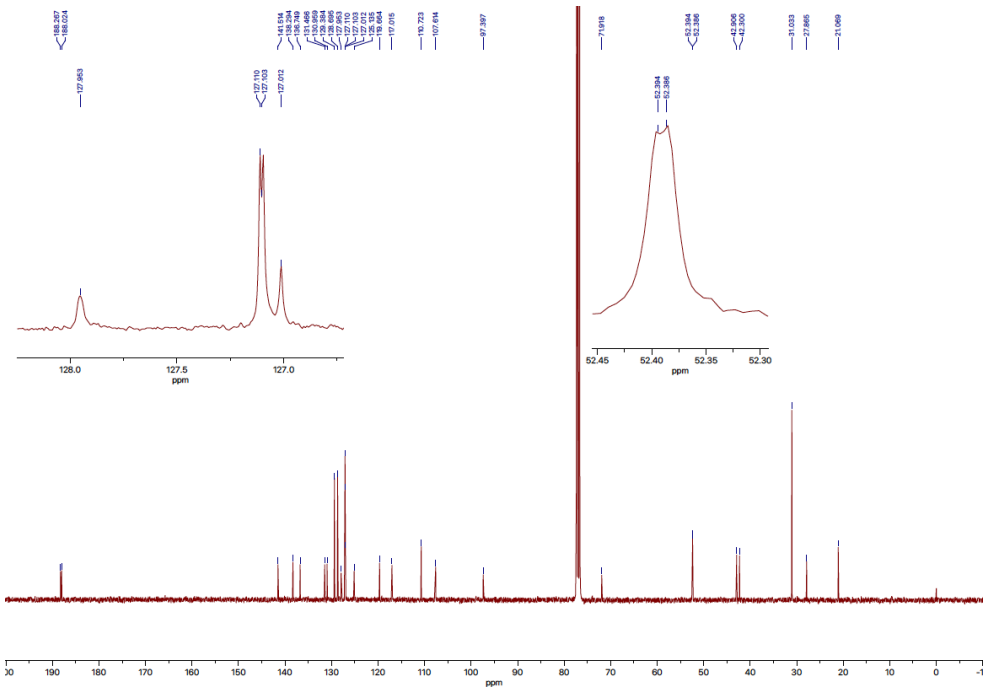
^{1}H NMR (400 MHz, $CDCl_3$)





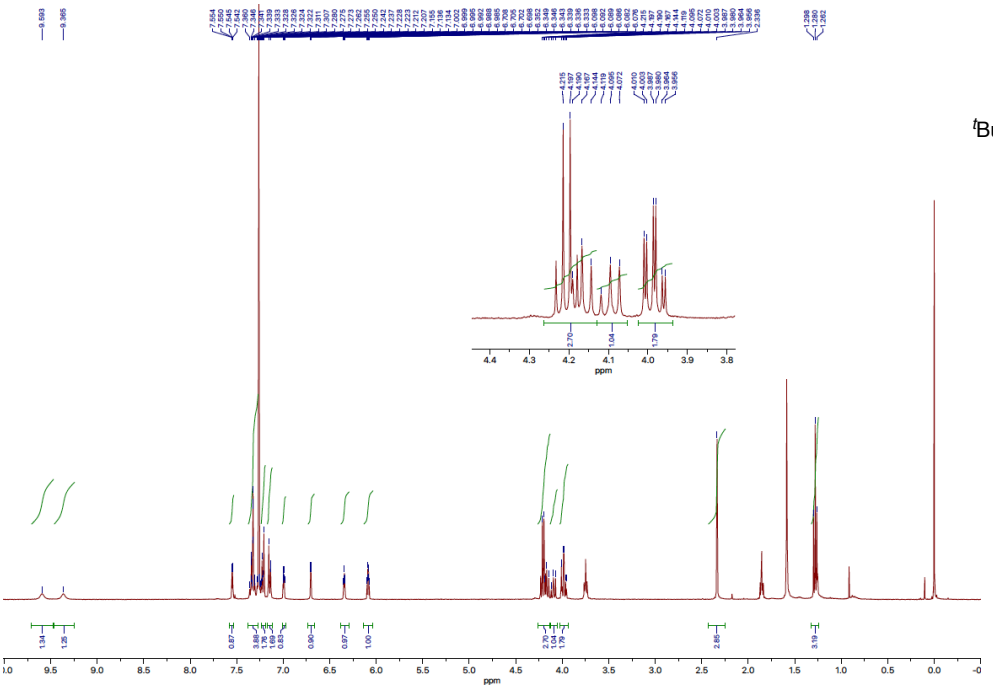
3ah

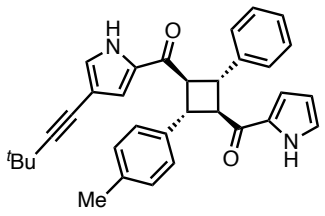
^{13}C NMR (101 MHz, $CDCl_3$)



3ai

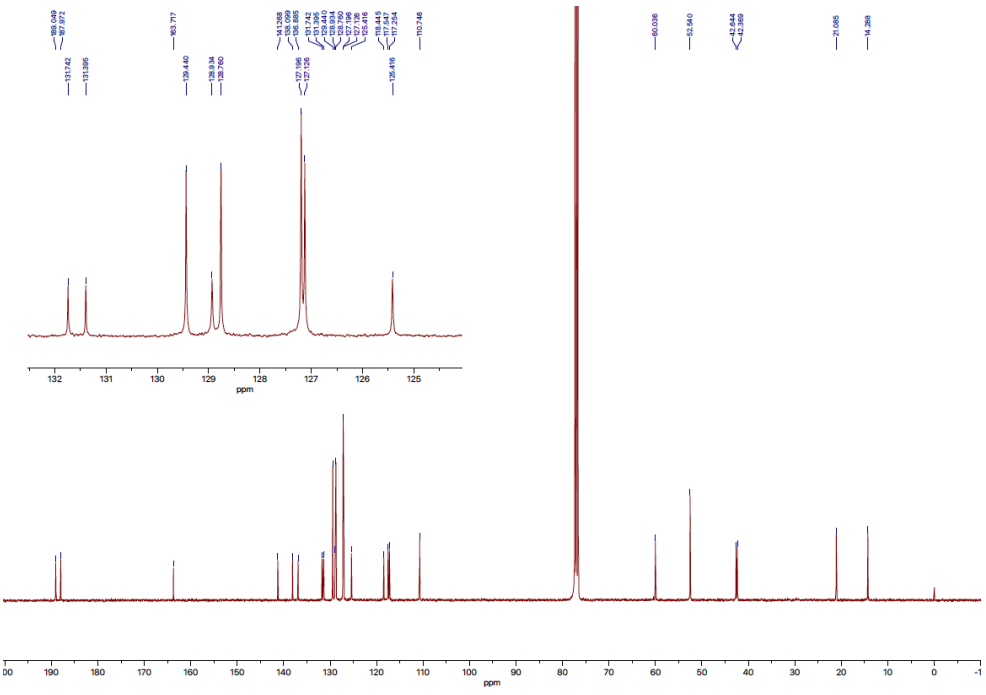
^{1}H NMR (400 MHz, $CDCl_3$)





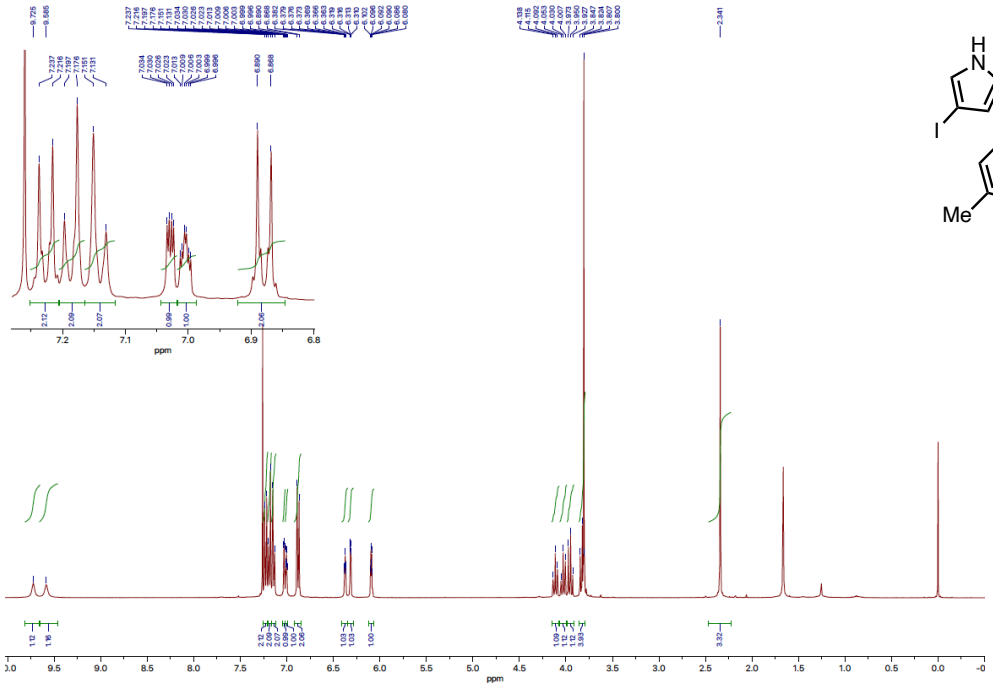
3ai

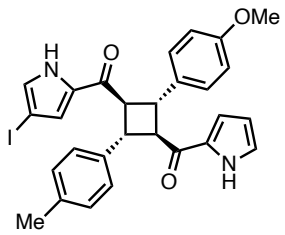
^{13}C NMR (101 MHz, $CDCl_3$)



3bj

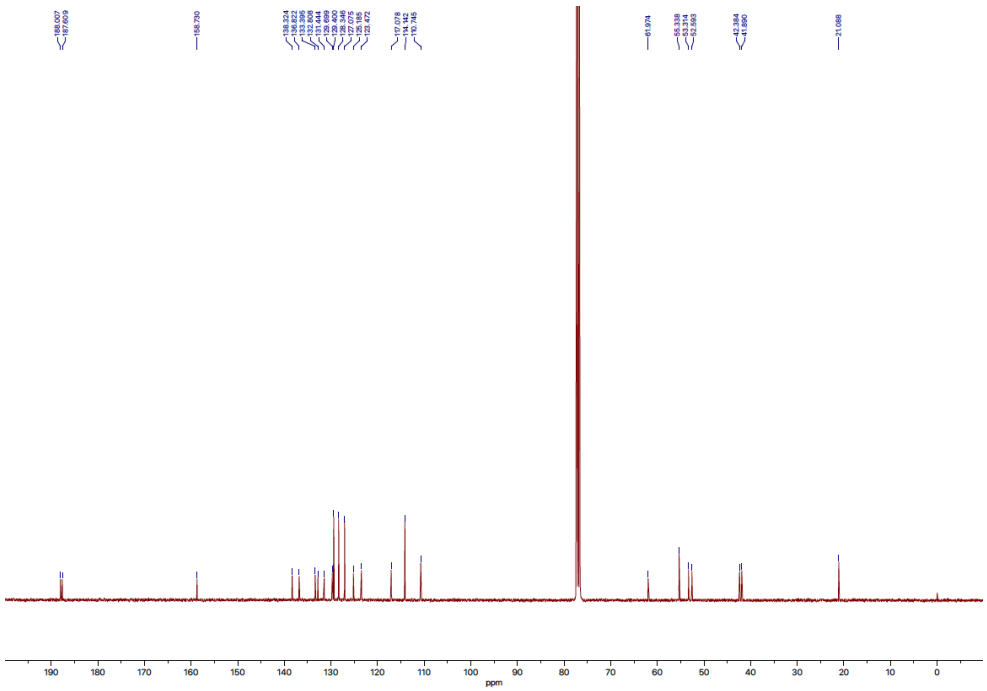
^{1}H NMR (400 MHz, $CDCl_3$)





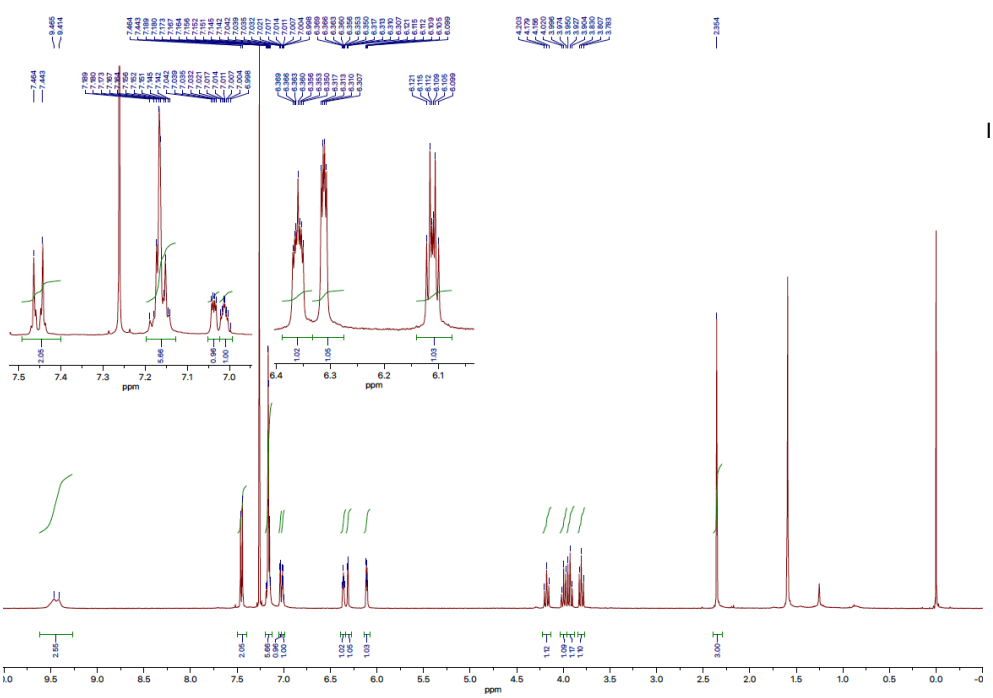
3bj

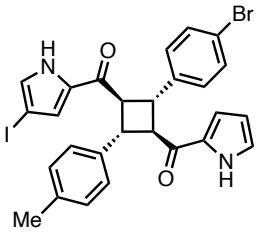
^{13}C NMR (101 MHz, $CDCl_3$)



3bk

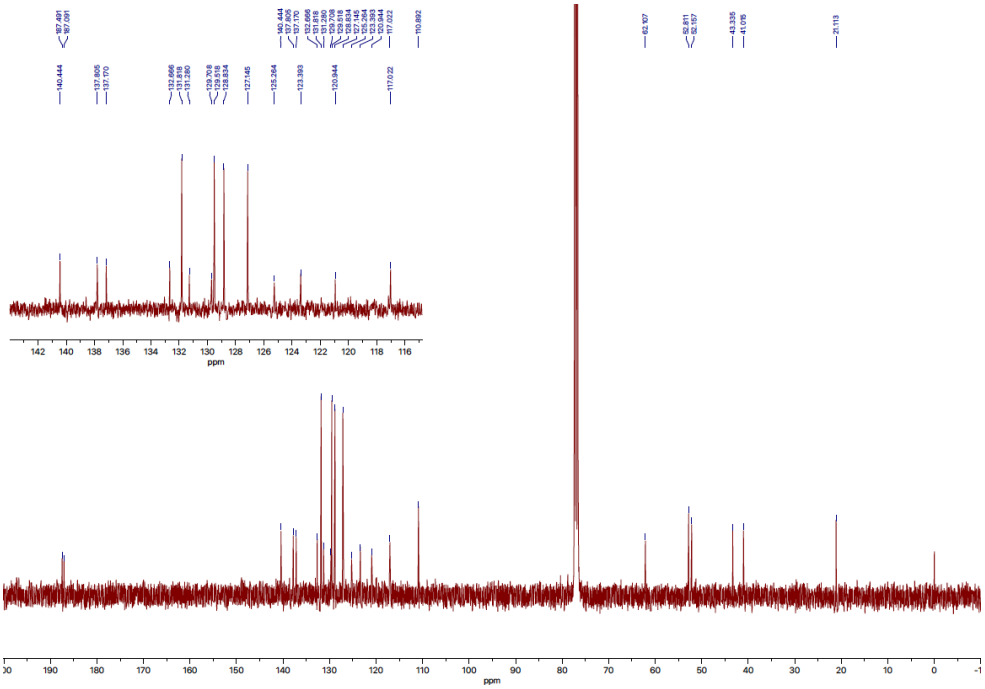
^{1}H NMR (400 MHz, $CDCl_3$)





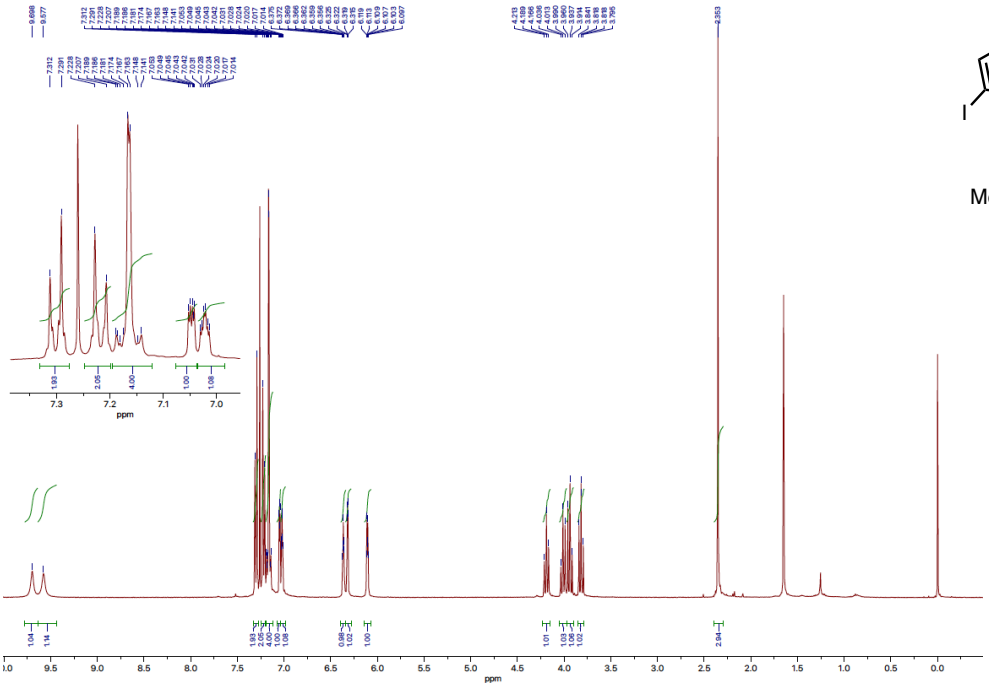
3bk

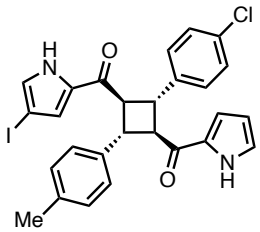
^{13}C NMR (101 MHz, $CDCl_3$)



3bl

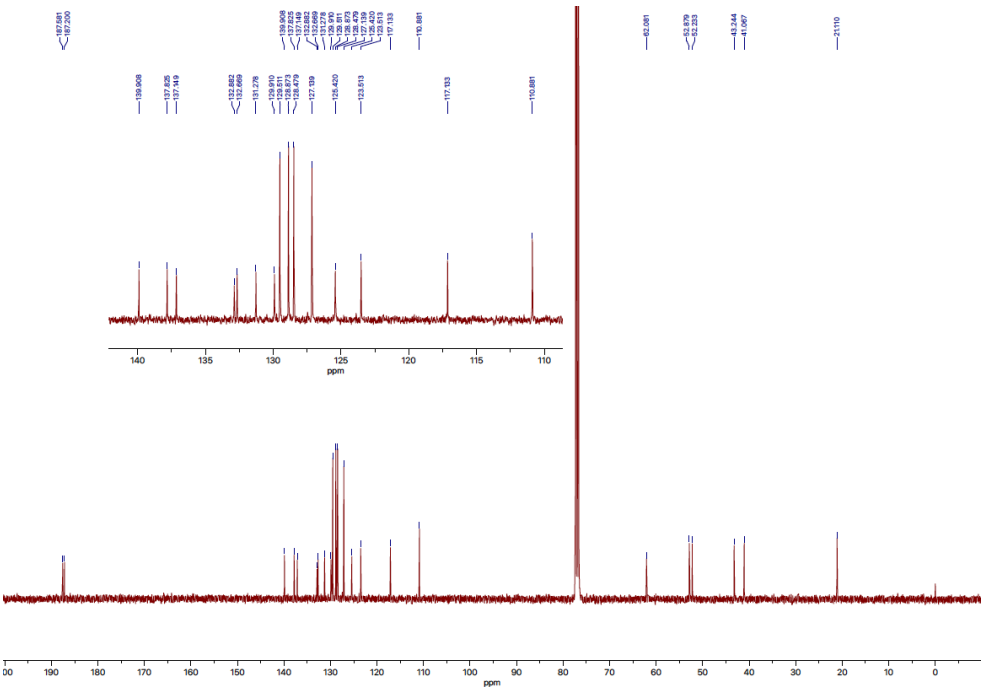
^{1}H NMR (400 MHz, $CDCl_3$)





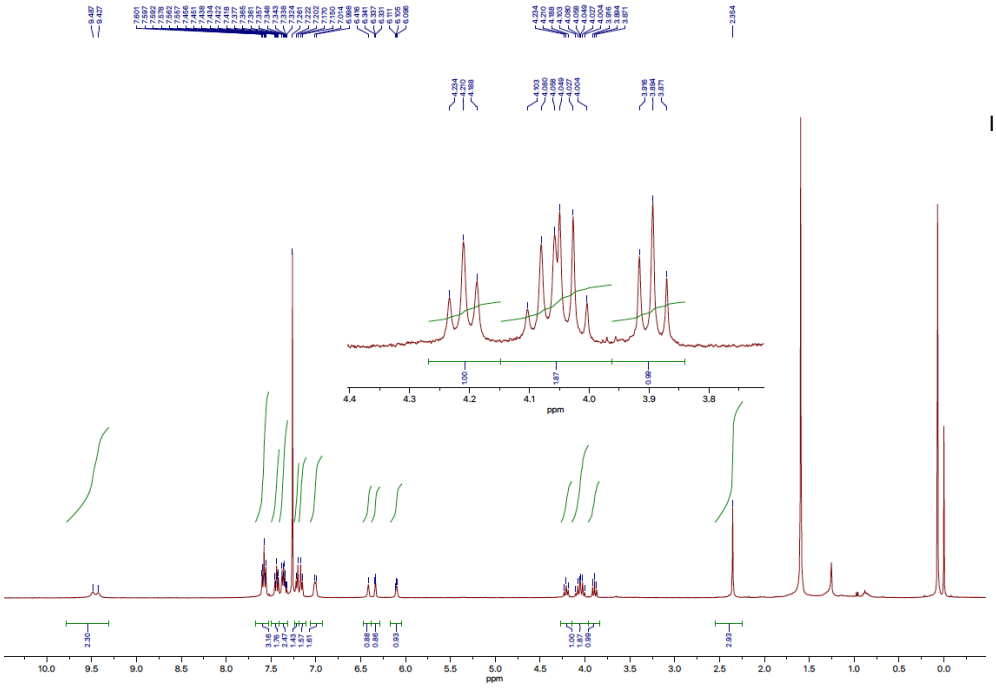
3bl

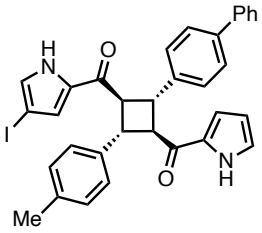
^{13}C NMR (101 MHz, $CDCl_3$)



3bm

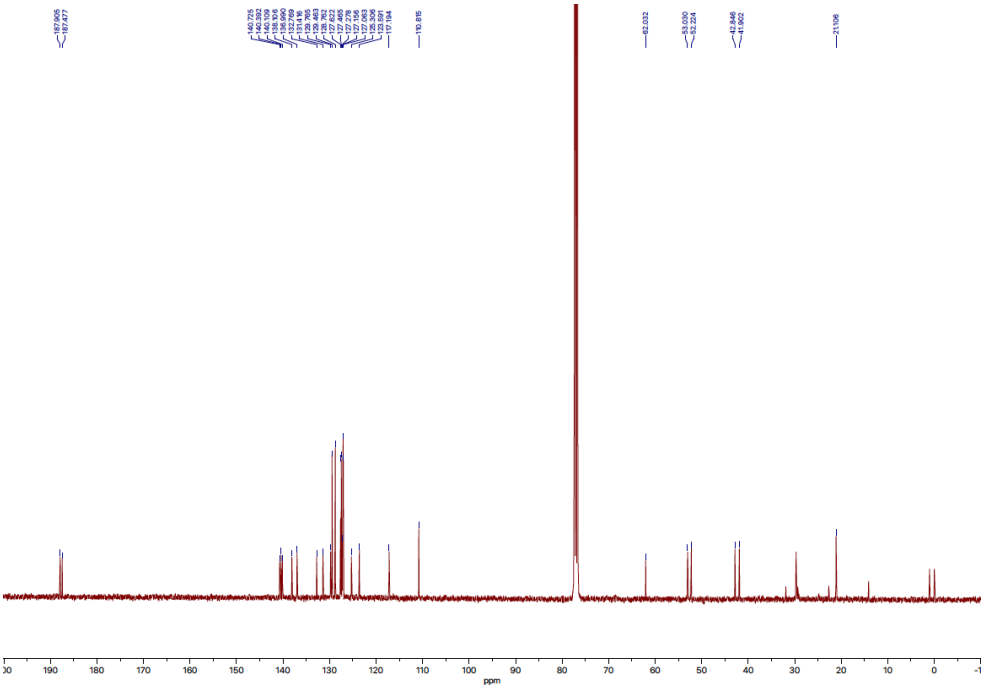
^{1}H NMR (400 MHz, $CDCl_3$)





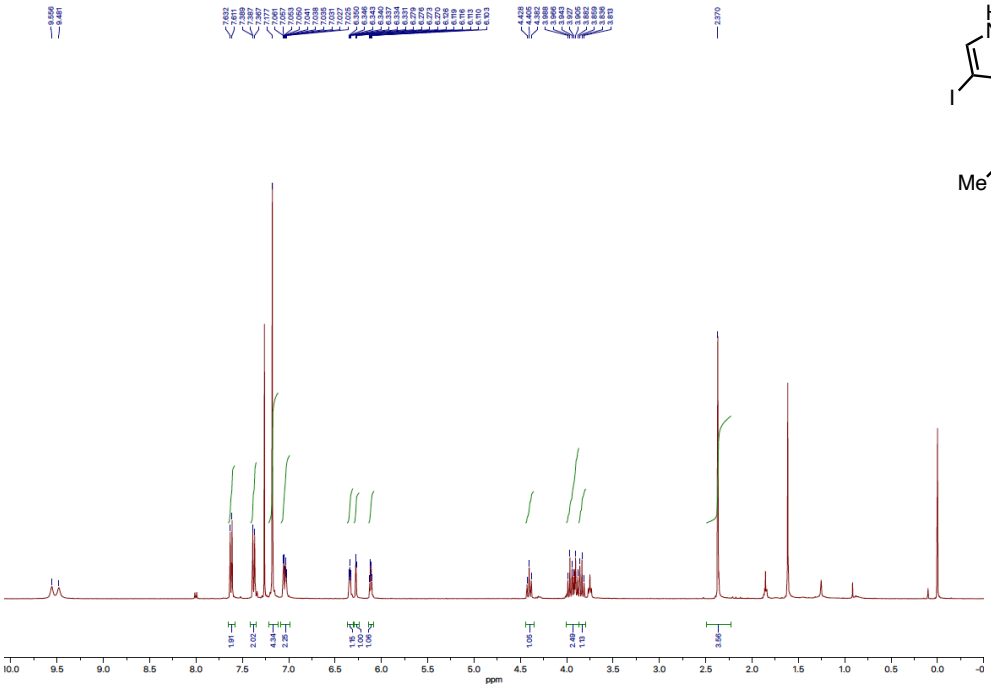
3bm

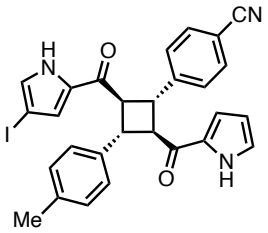
^{13}C NMR (101 MHz, $CDCl_3$)



3bn

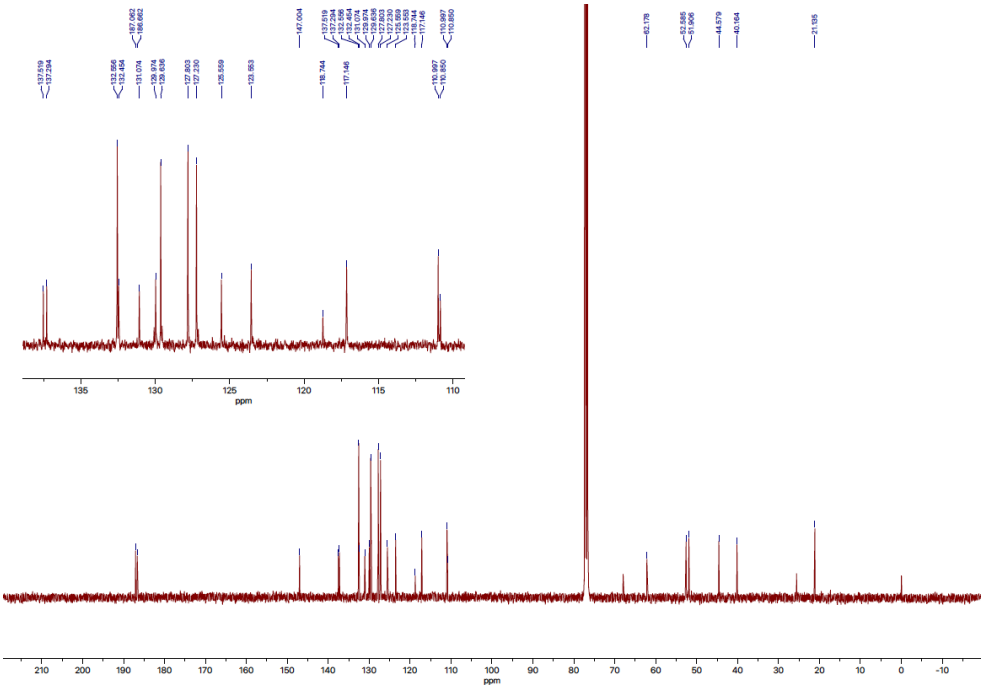
^{1}H NMR (400 MHz, $CDCl_3$)





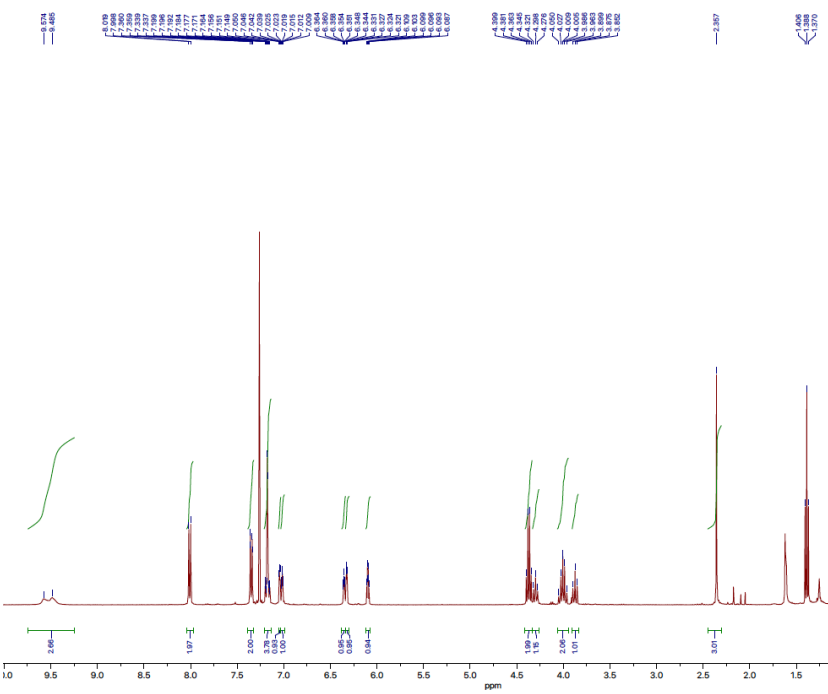
3bn

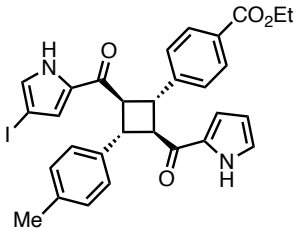
^{13}C NMR (101 MHz, $CDCl_3$)



3bo

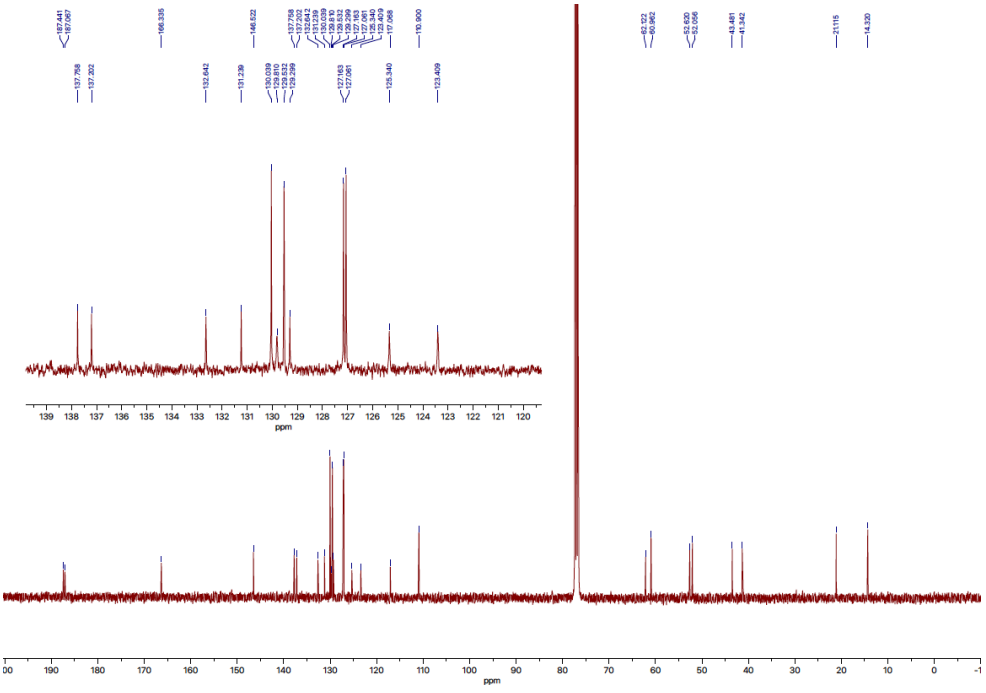
^{1}H NMR (400 MHz, $CDCl_3$)





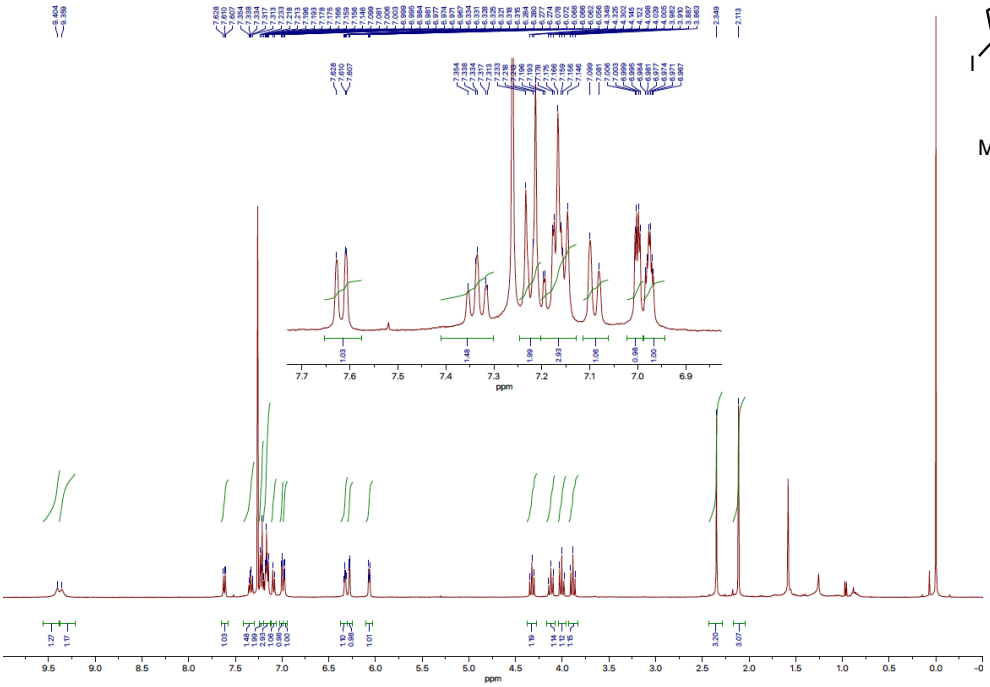
3bo

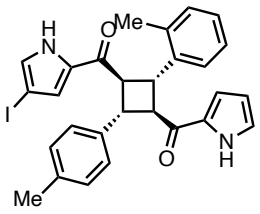
^{13}C NMR (101 MHz, $CDCl_3$)



3bp

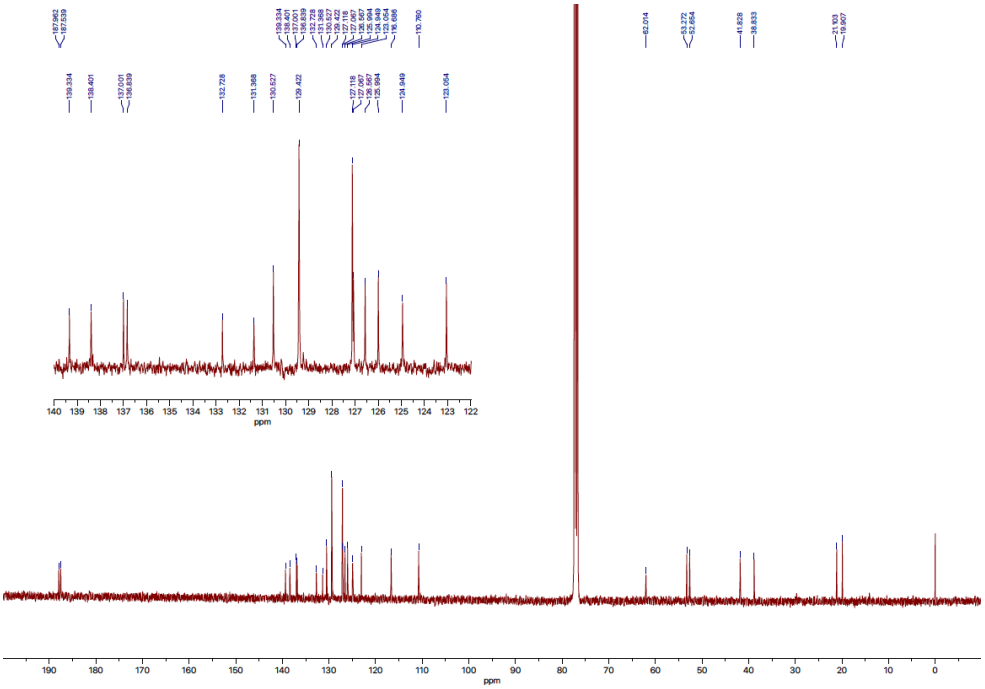
^{1}H NMR (400 MHz, $CDCl_3$)





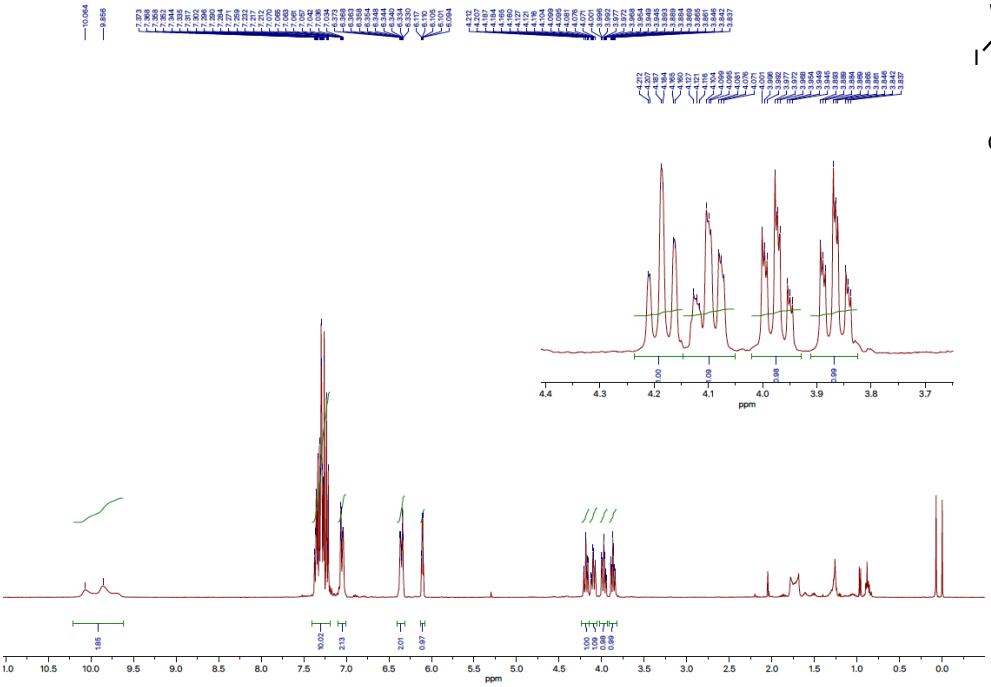
3bp

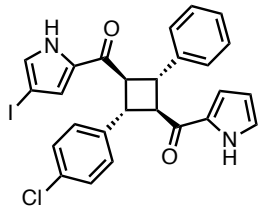
^{13}C NMR (101 MHz, $CDCl_3$)



3aq

^{1}H NMR (400 MHz, $CDCl_3$)





3aq

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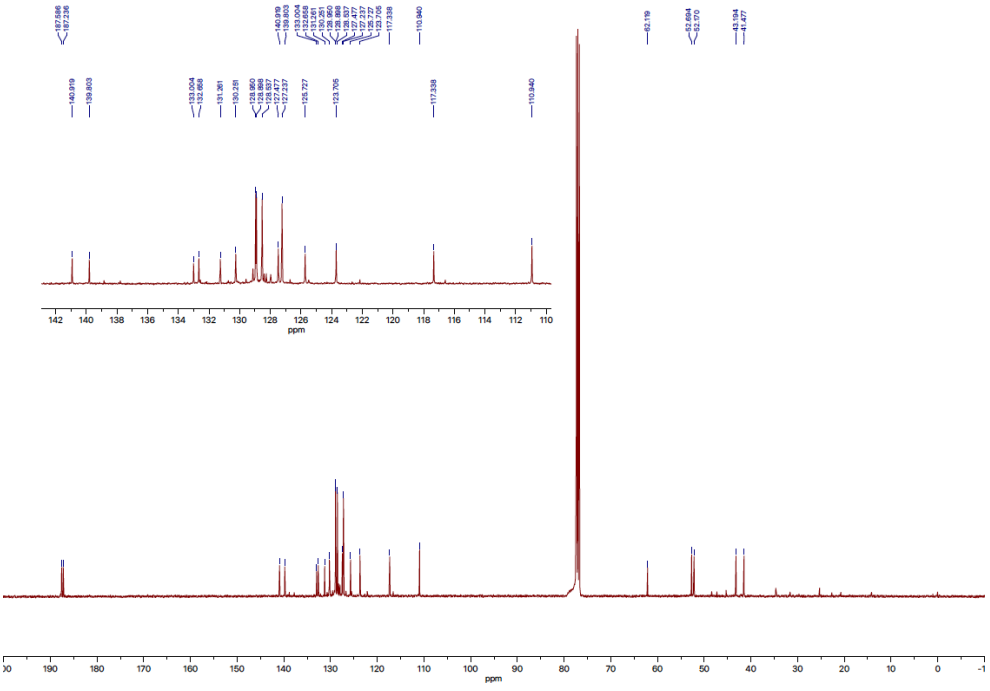
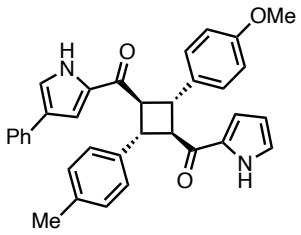


3jr

^{1}H NMR (400 MHz, $CDCl_3$)



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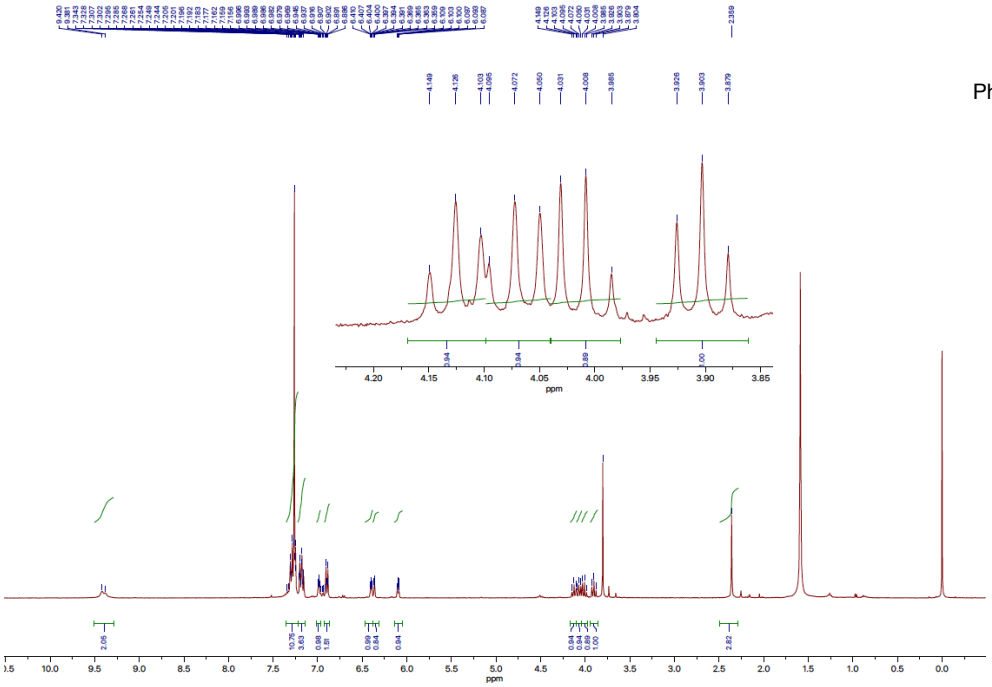
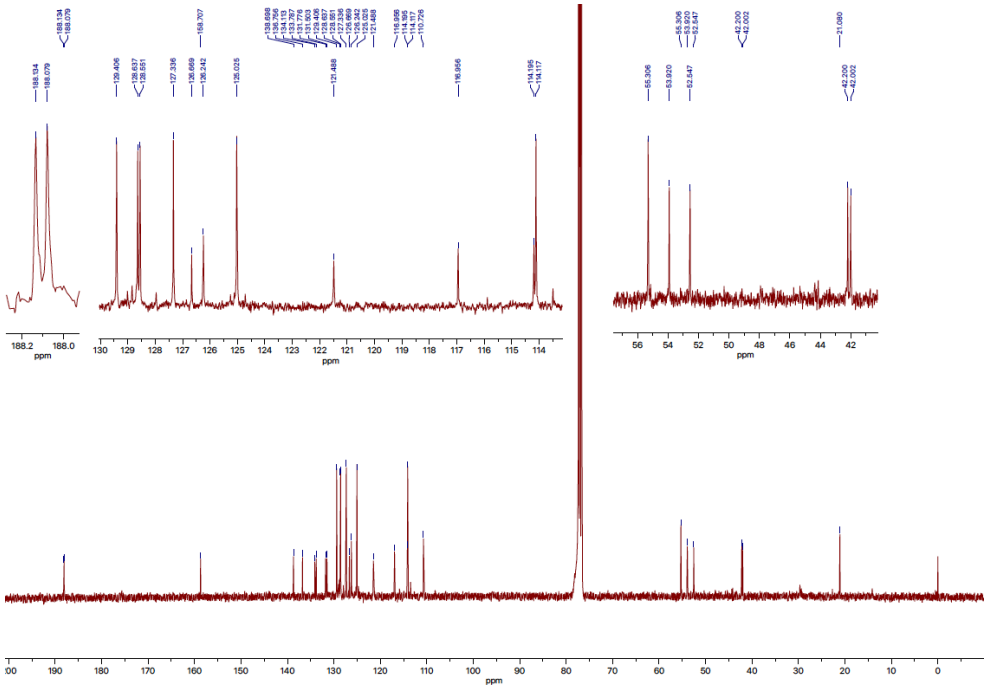


^{13}C NMR (101 MHz, $CDCl_3$)



3cj

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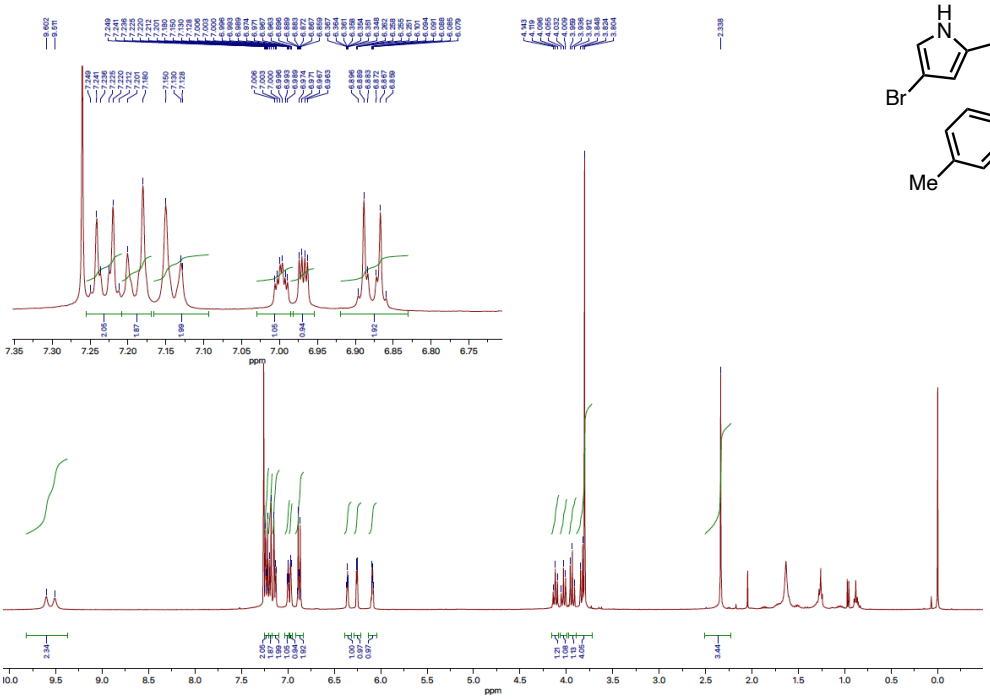
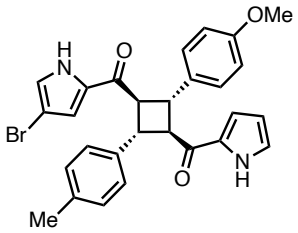
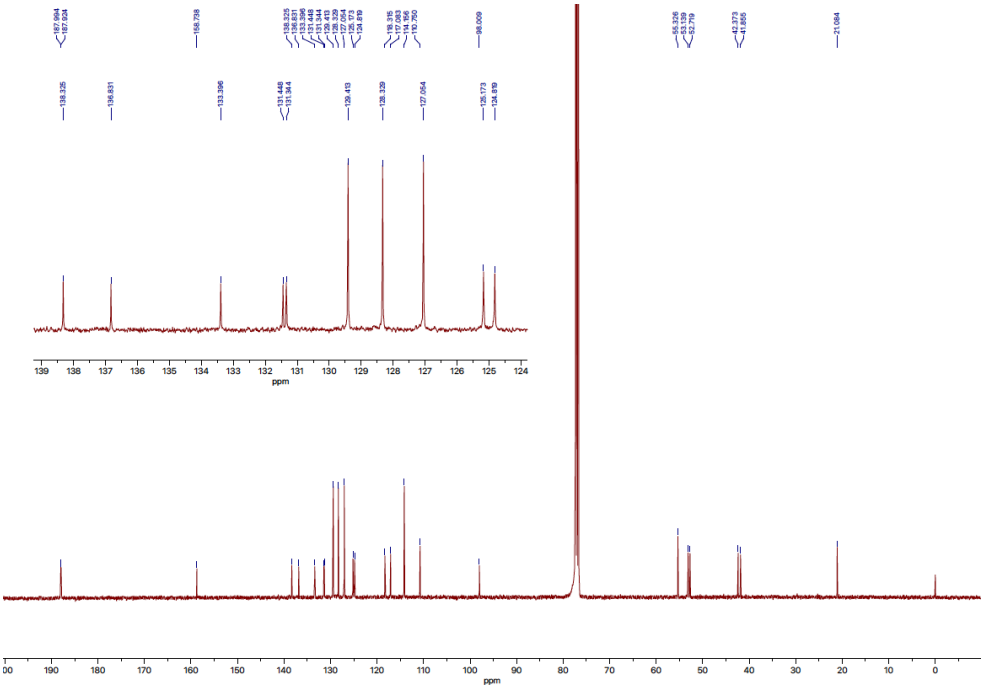




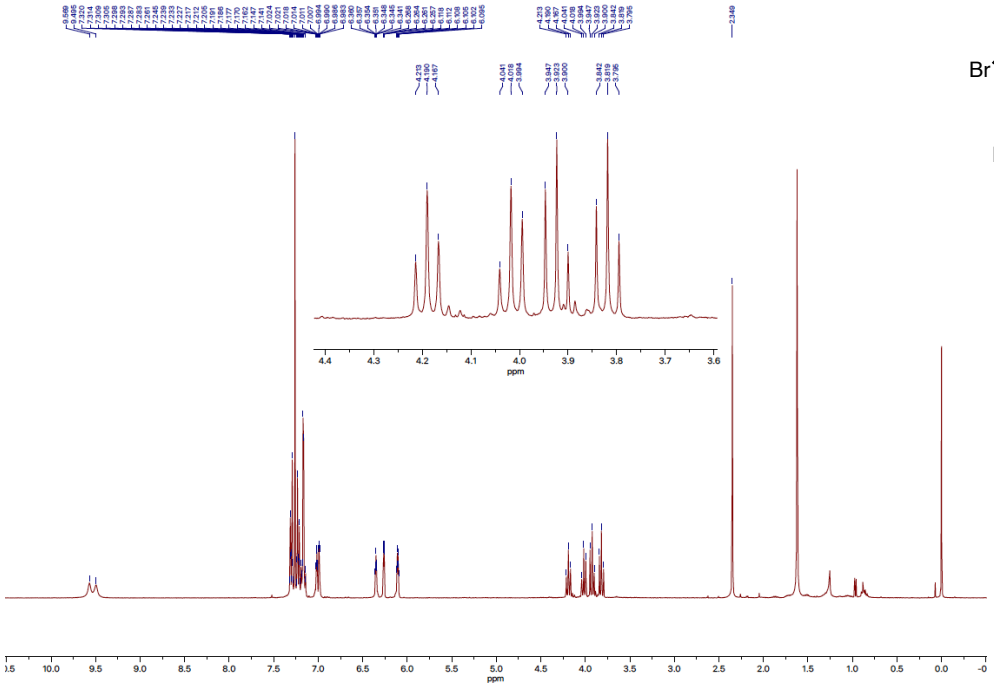
3cj

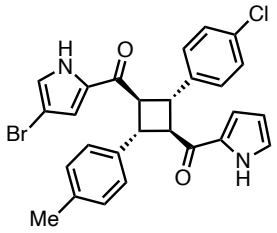
^{13}C NMR (101 MHz, $CDCl_3$)



3cl

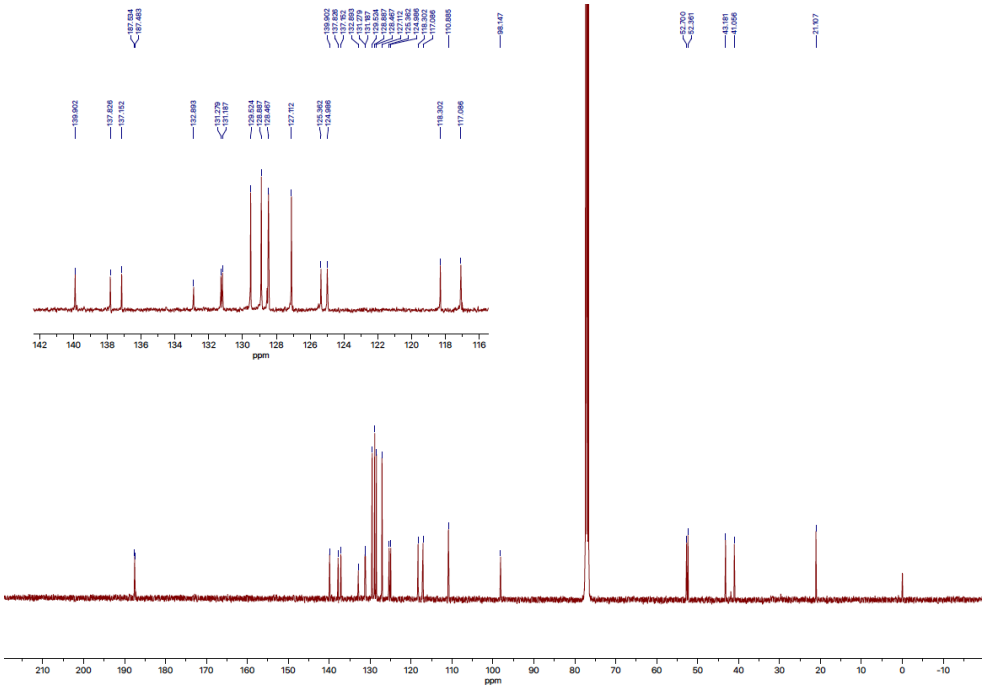
^{1}H NMR (400 MHz, $CDCl_3$)





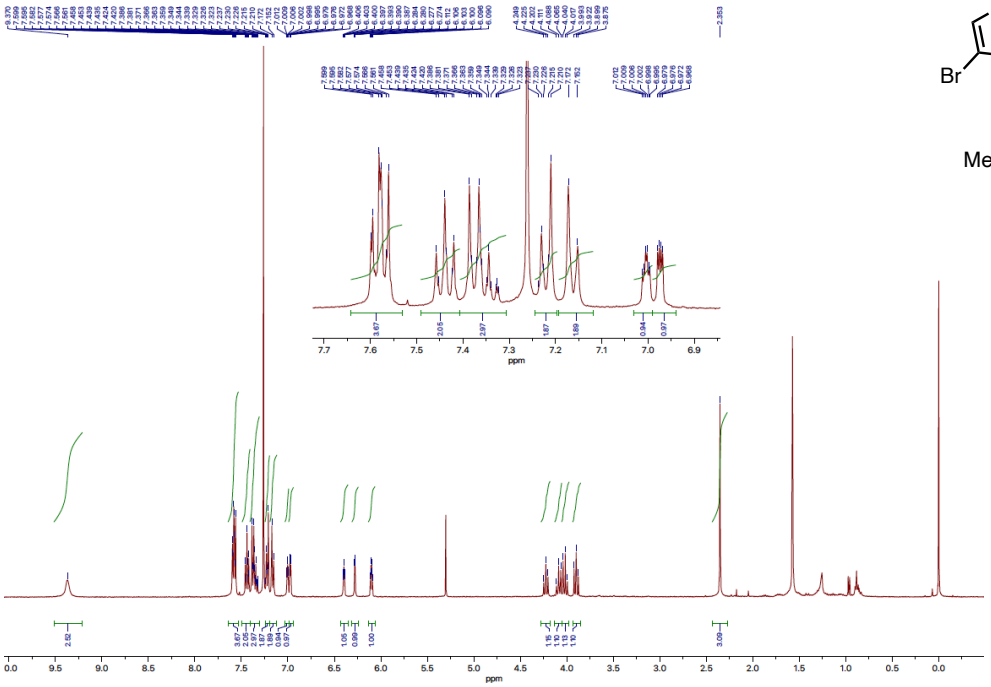
3cl

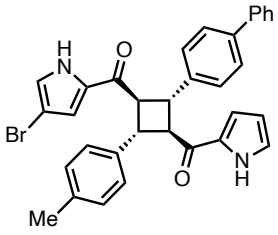
^{13}C NMR (101 MHz, $CDCl_3$)



3cm

^{1}H NMR (400 MHz, $CDCl_3$)





3cm

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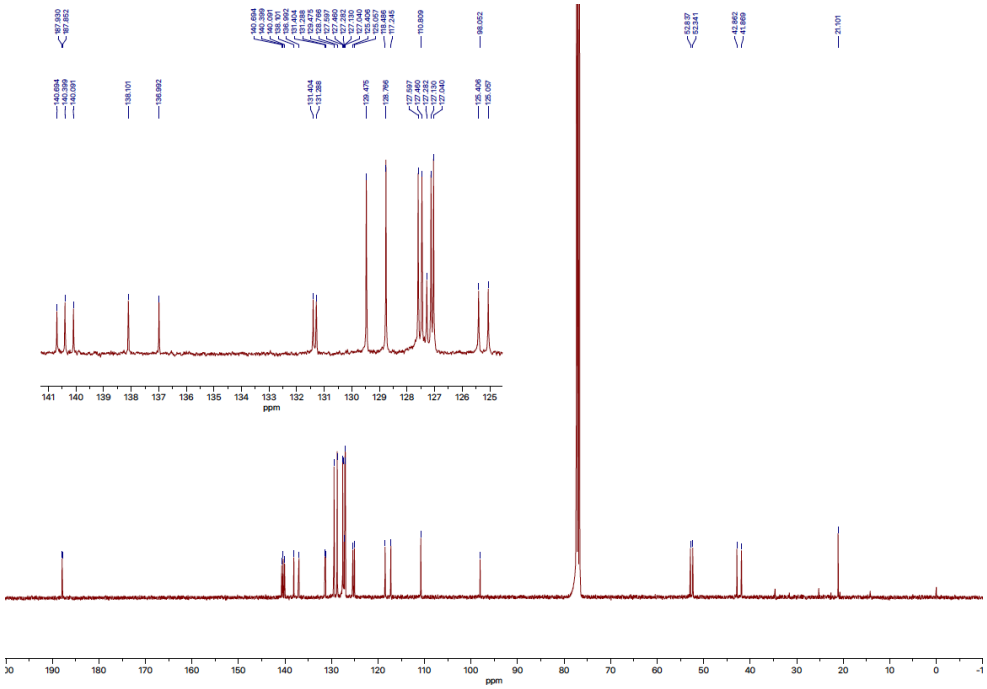
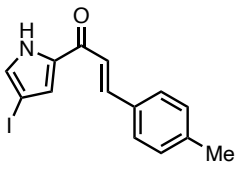
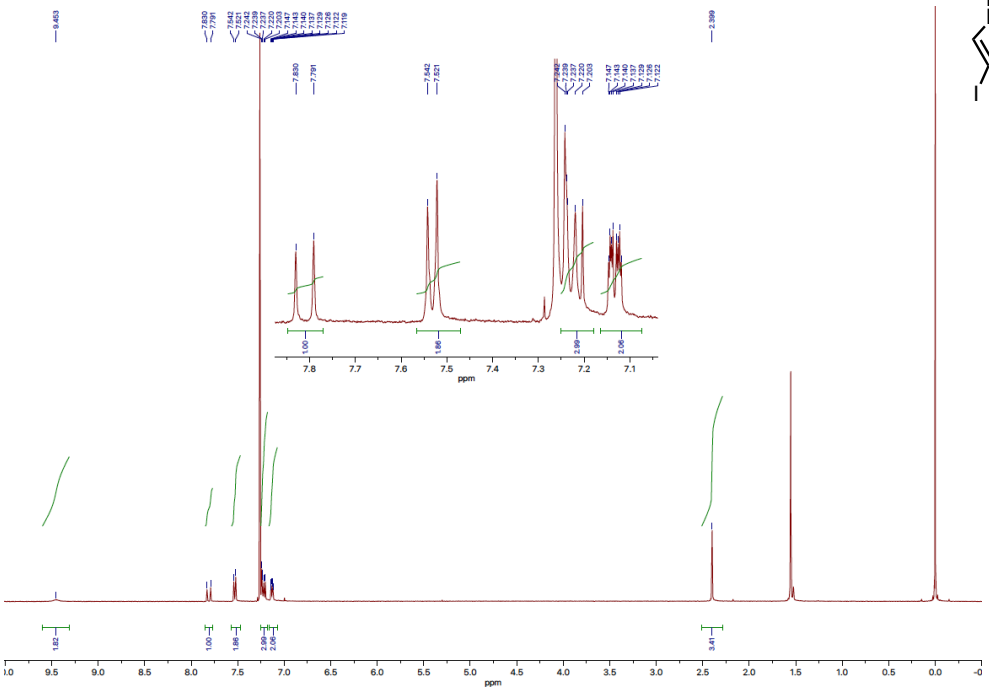


2b

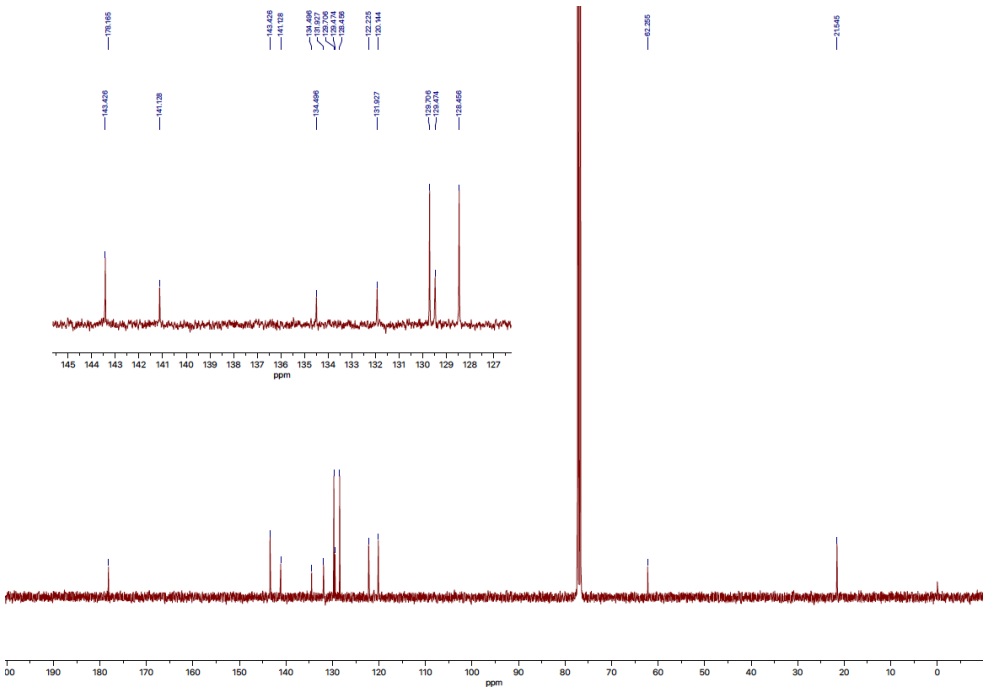
^{1}H NMR (400 MHz, $CDCl_3$)



2b

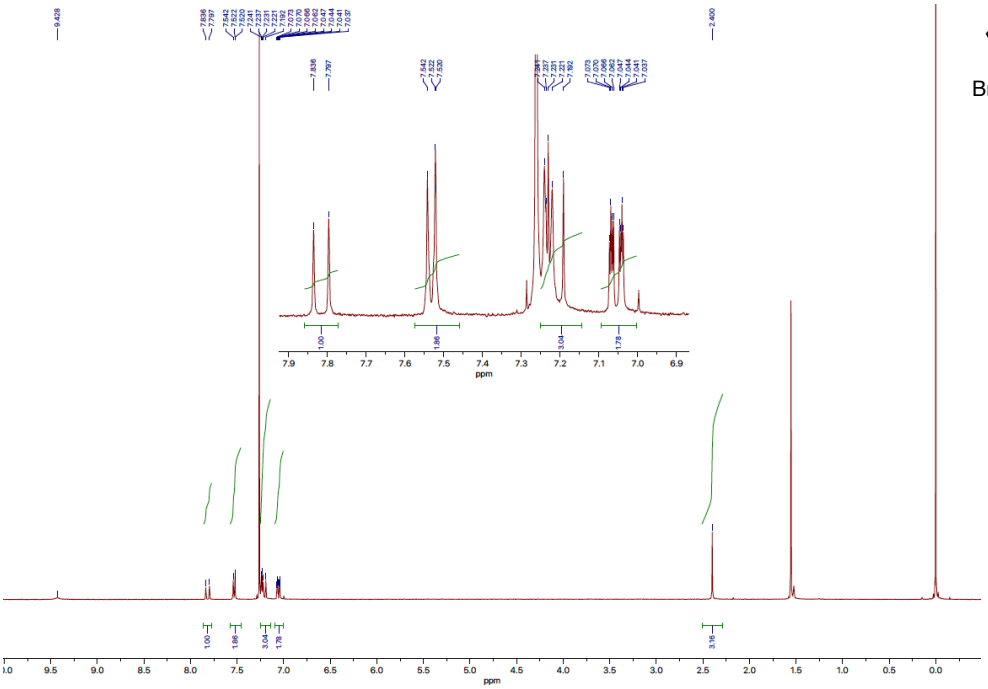


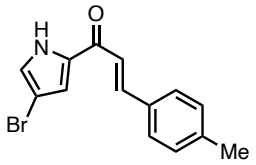
^{13}C NMR (101 MHz, $CDCl_3$)



2c

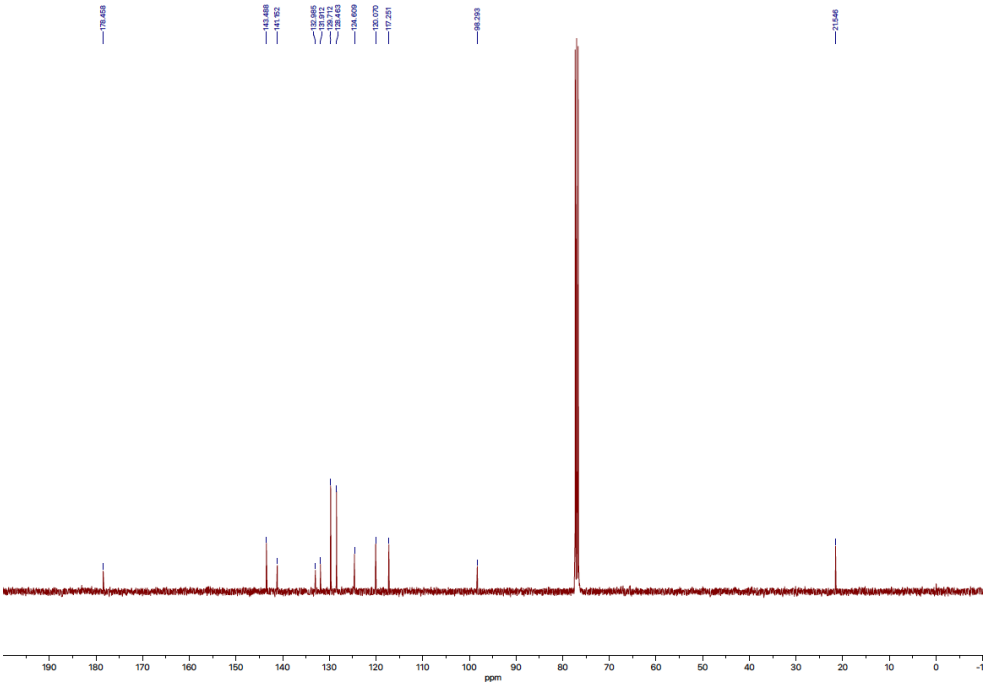
^{1}H NMR (400 MHz, $CDCl_3$)





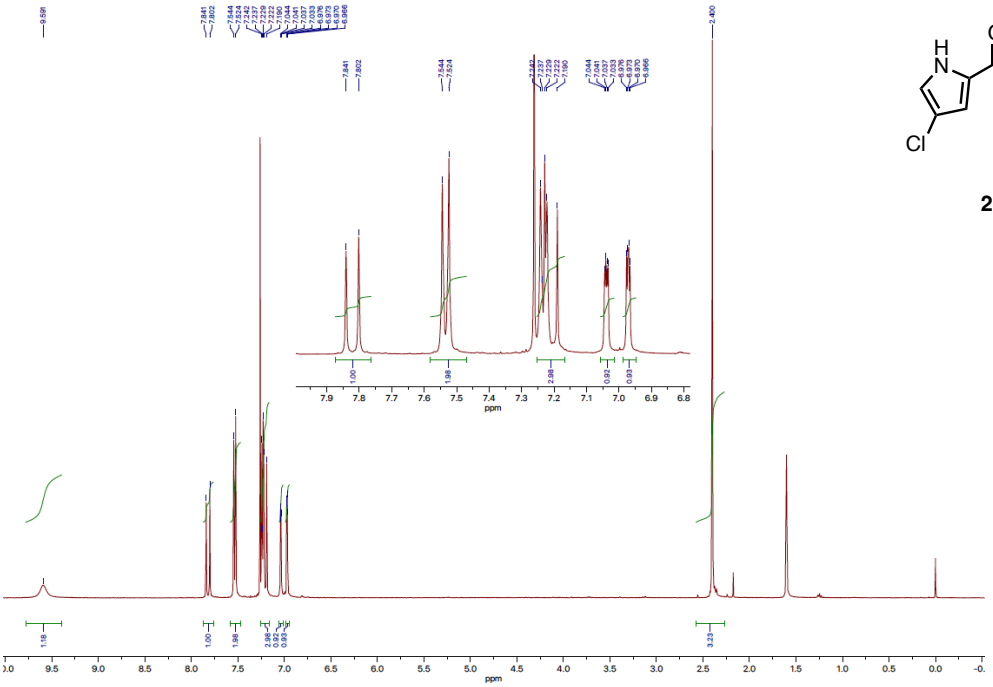
2c

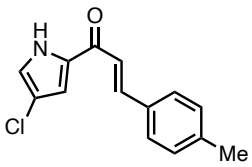
^{13}C NMR (101 MHz, $CDCl_3$)



2d

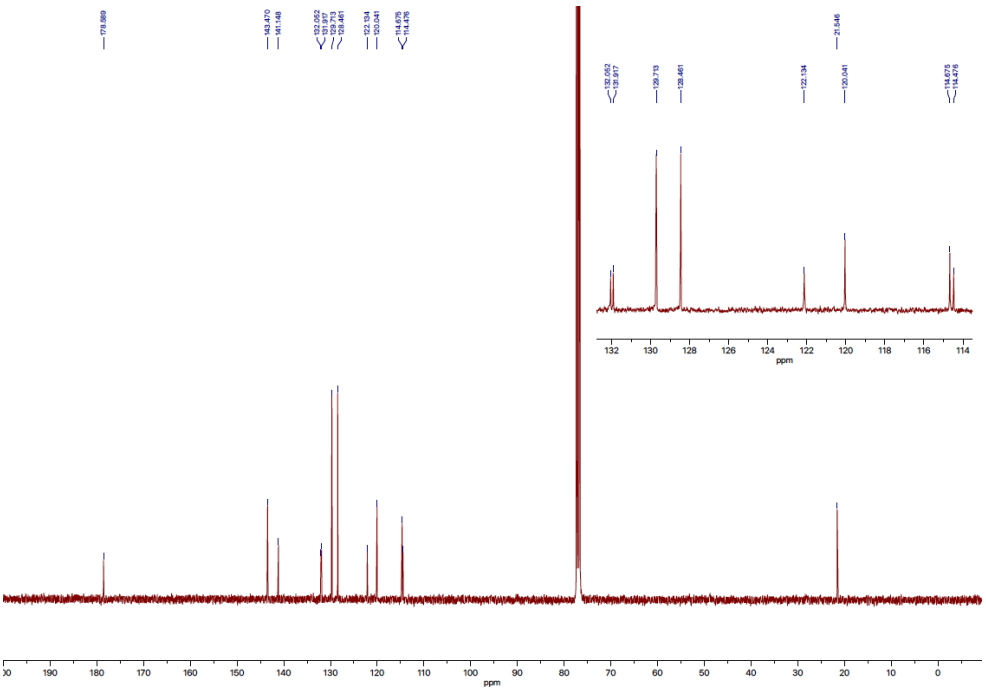
^{1}H NMR (400 MHz, $CDCl_3$)





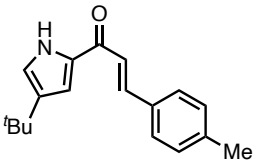
2d

^{13}C NMR (101 MHz, $CDCl_3$)

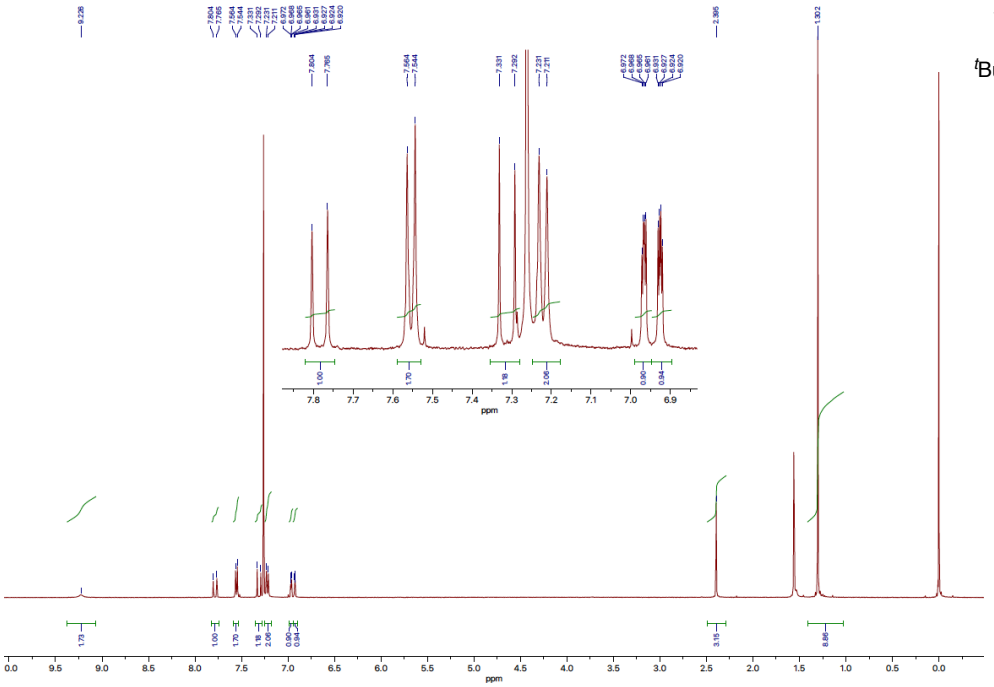


2e

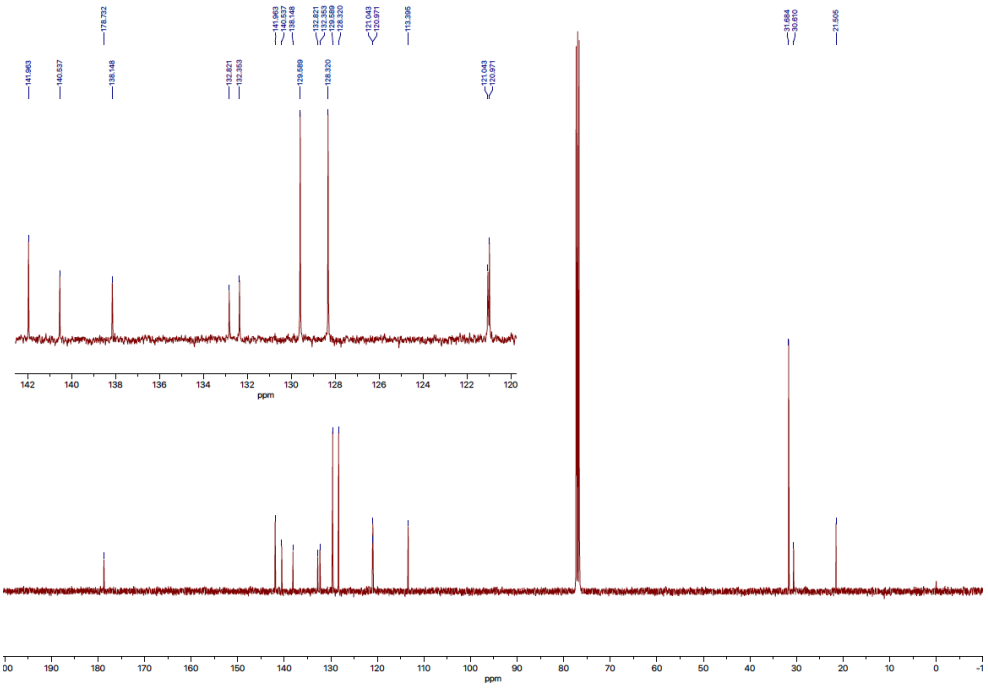
^{1}H NMR (400 MHz, $CDCl_3$)



2e

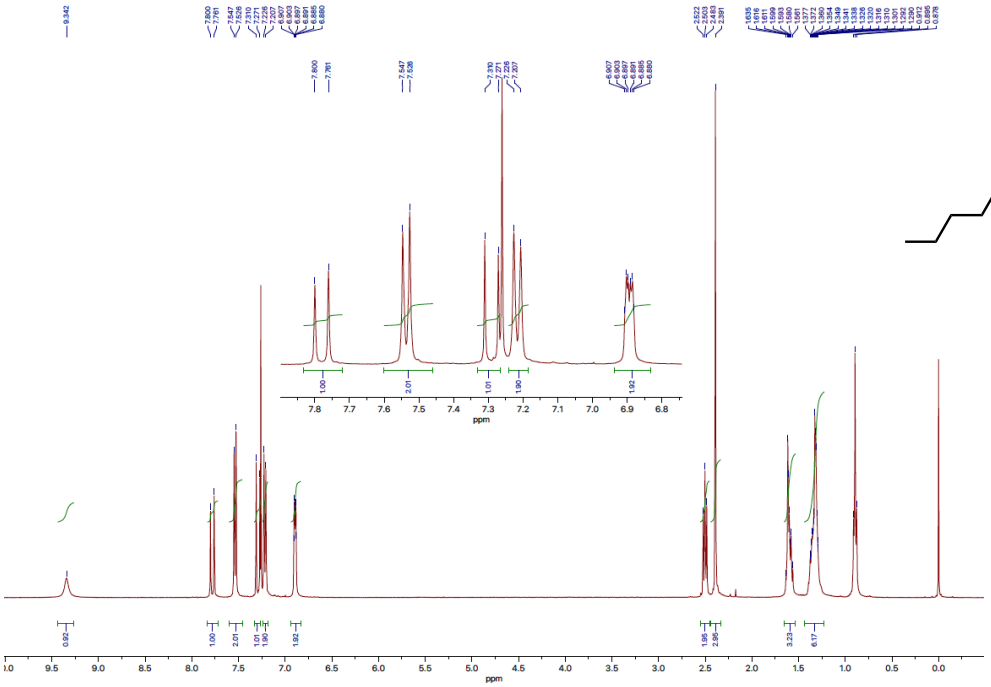


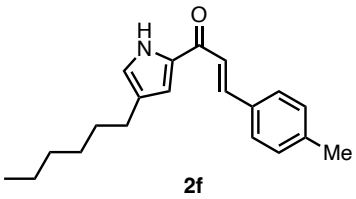
^{13}C NMR (101 MHz, $CDCl_3$)



2f

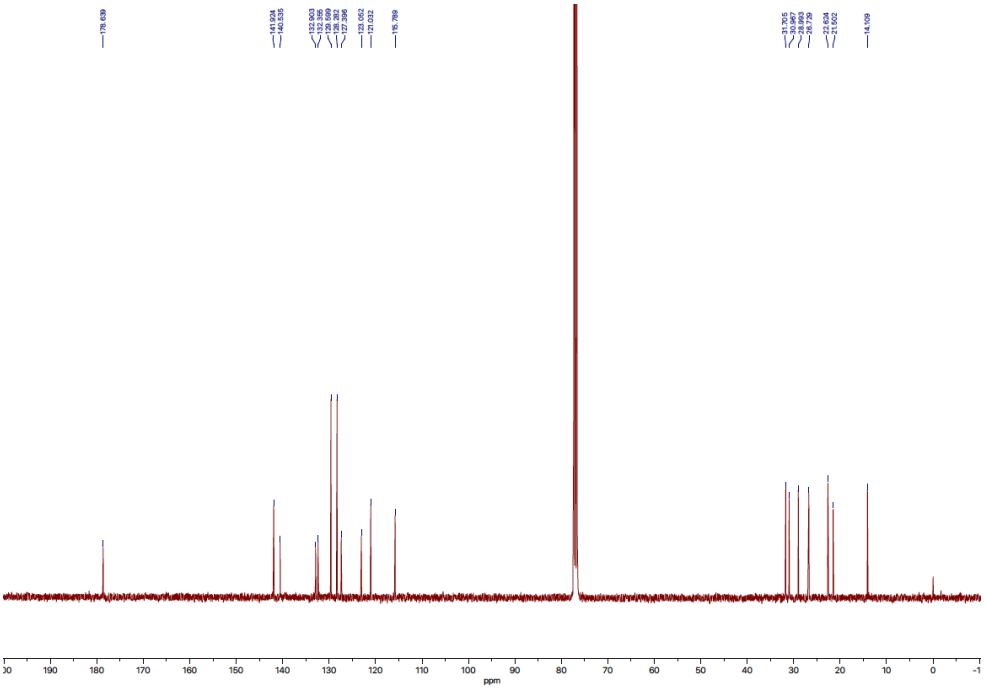
^{1}H NMR (400 MHz, $CDCl_3$)





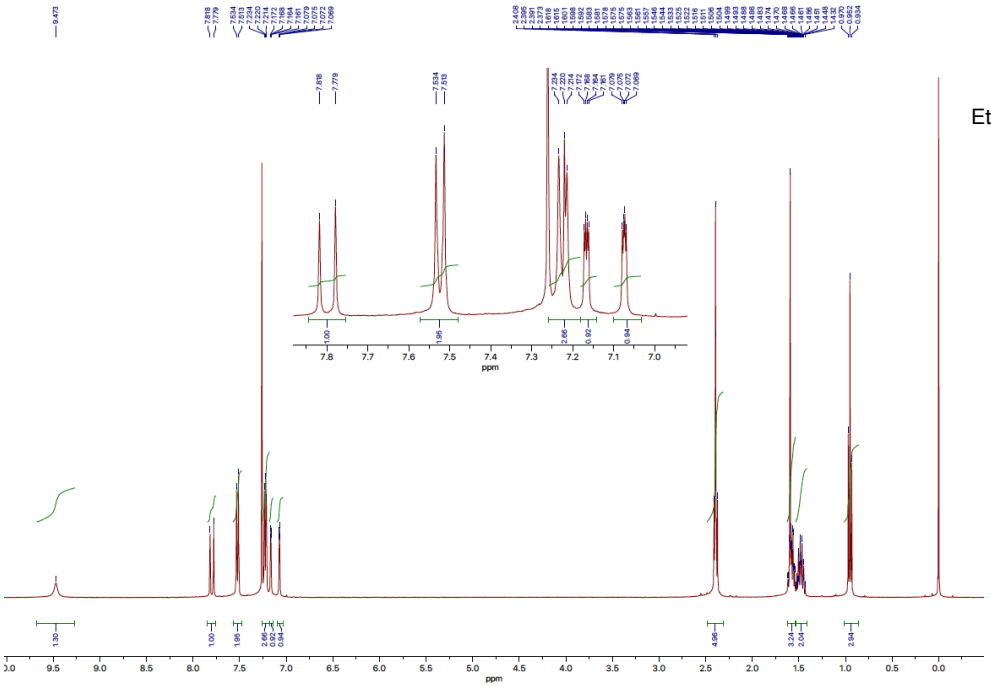
2f

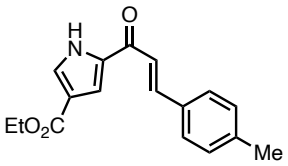
^{13}C NMR (101 MHz, $CDCl_3$)



2g

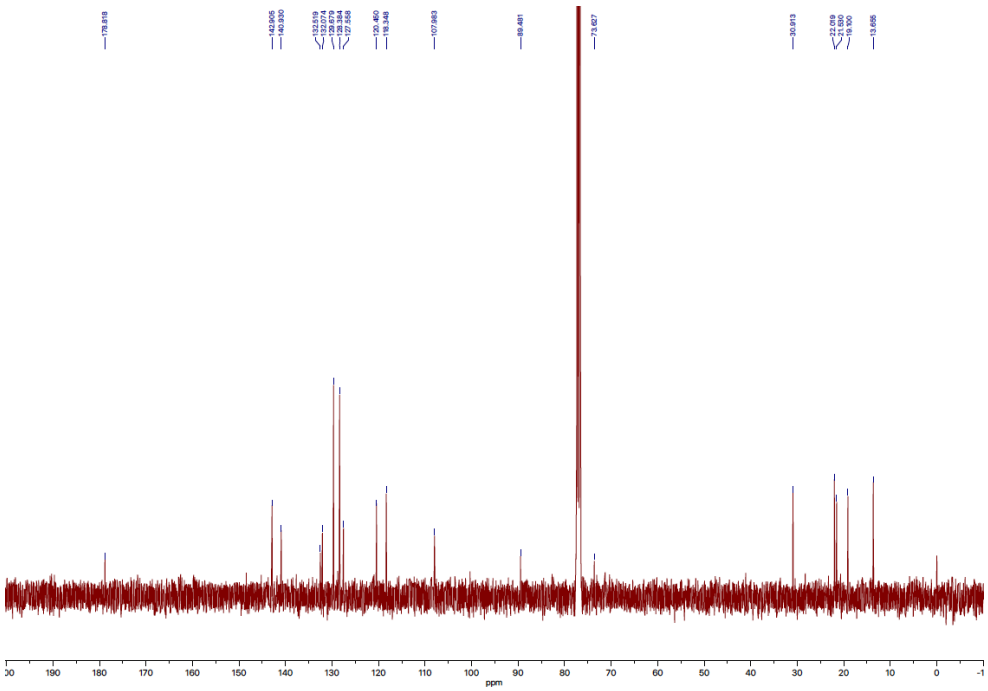
^{1}H NMR (400 MHz, $CDCl_3$)





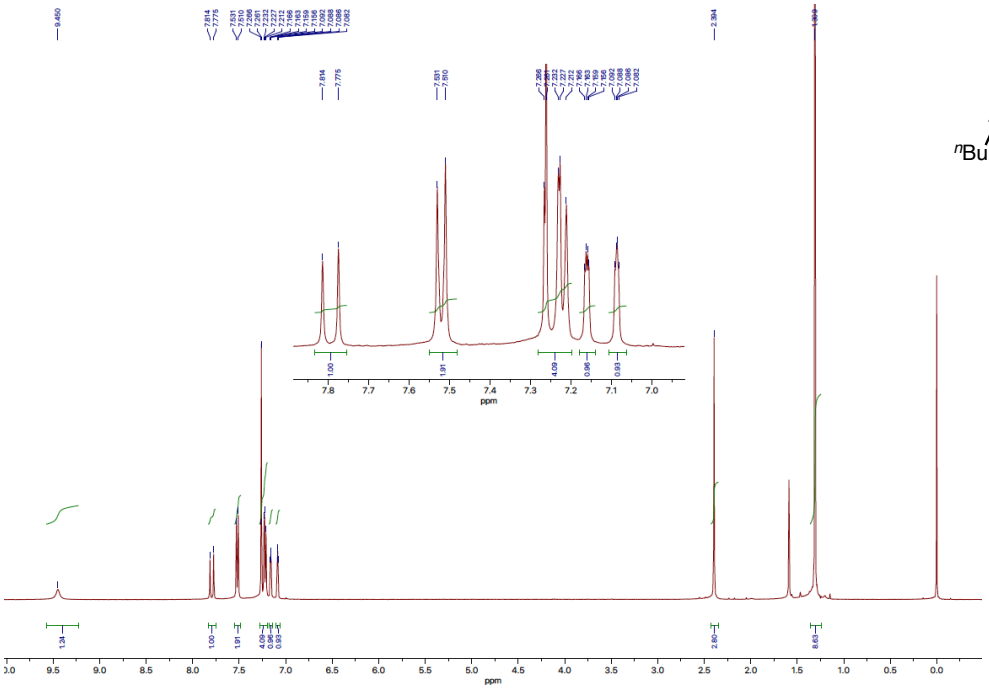
2g

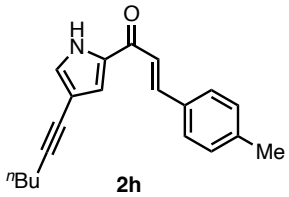
^{13}C NMR (101 MHz, $CDCl_3$)



2h

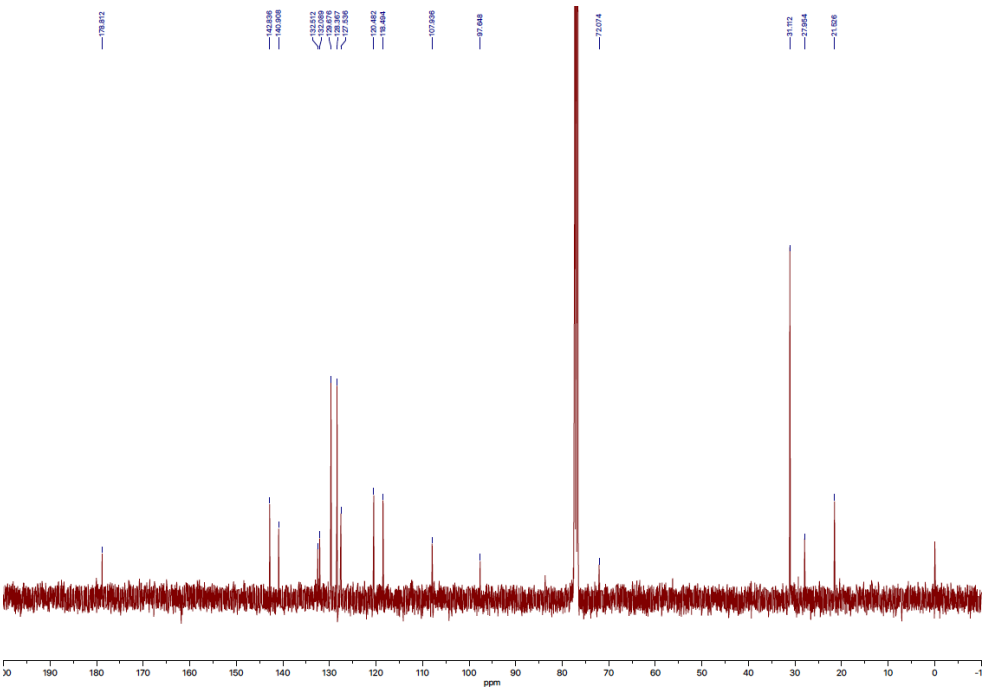
^{1}H NMR (400 MHz, $CDCl_3$)





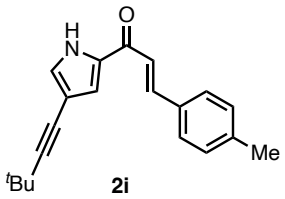
2h

^{13}C NMR (101 MHz, $CDCl_3$)

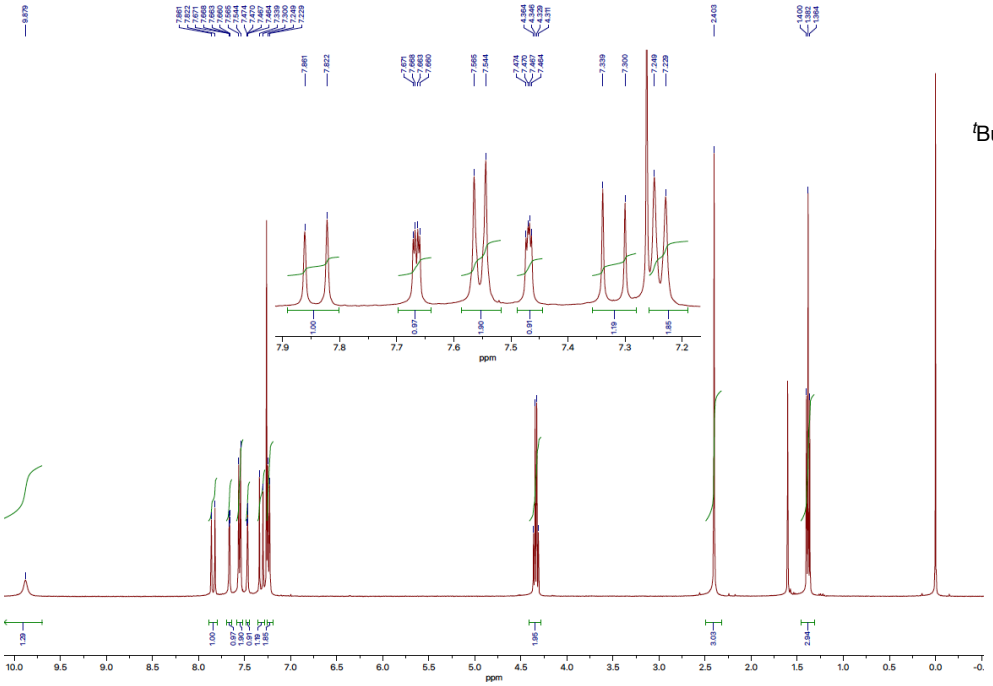


2i

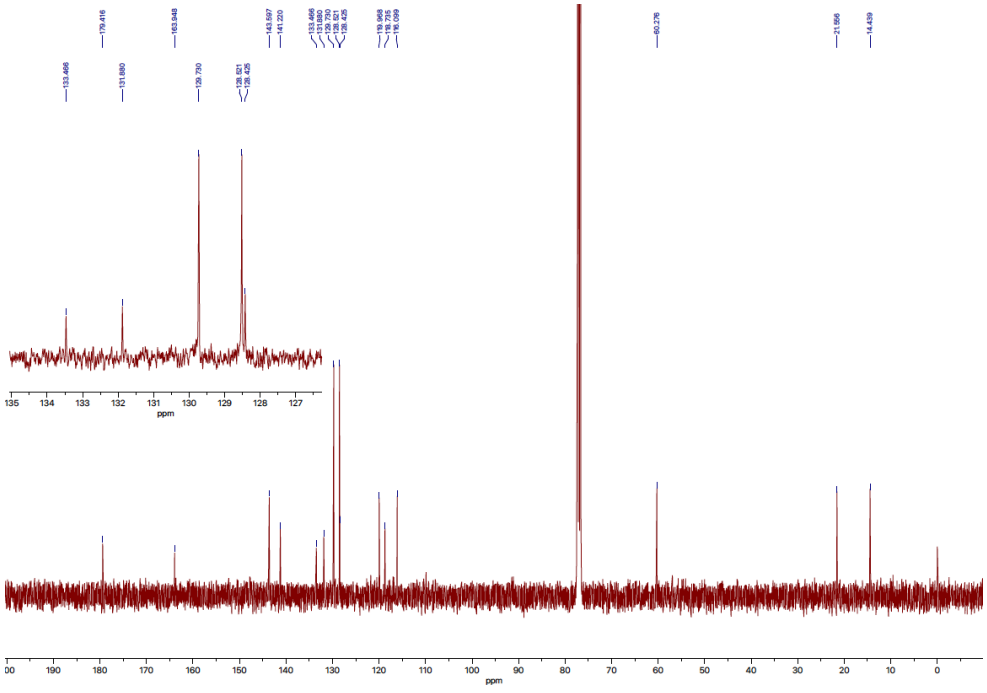
^{1}H NMR (400 MHz, $CDCl_3$)



2i

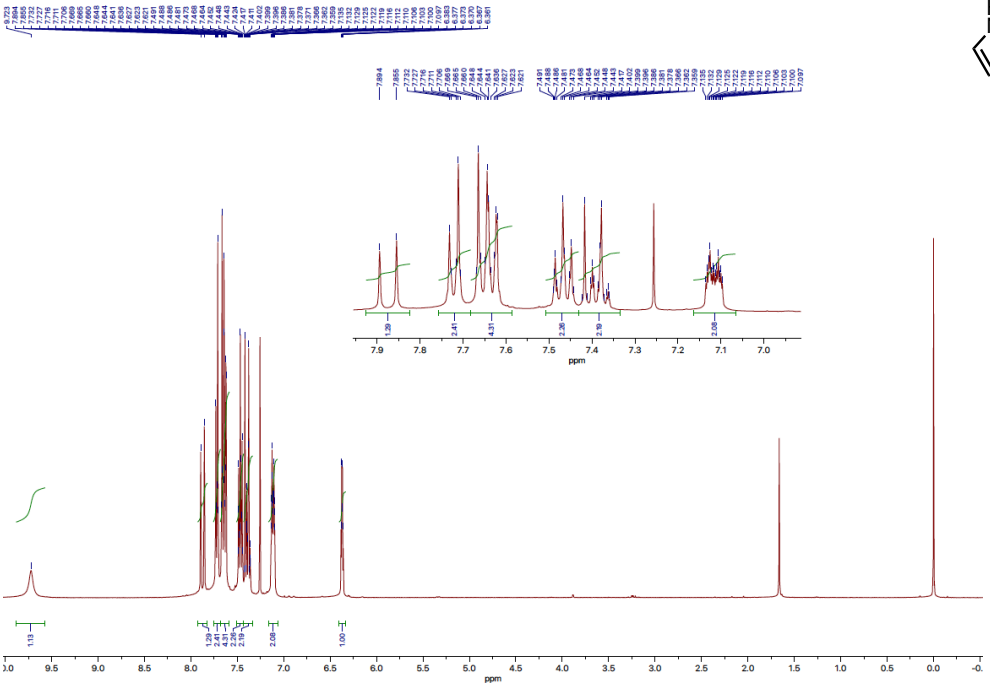


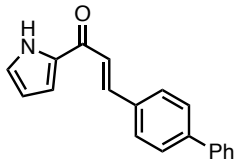
^{13}C NMR (101 MHz, $CDCl_3$)



2m

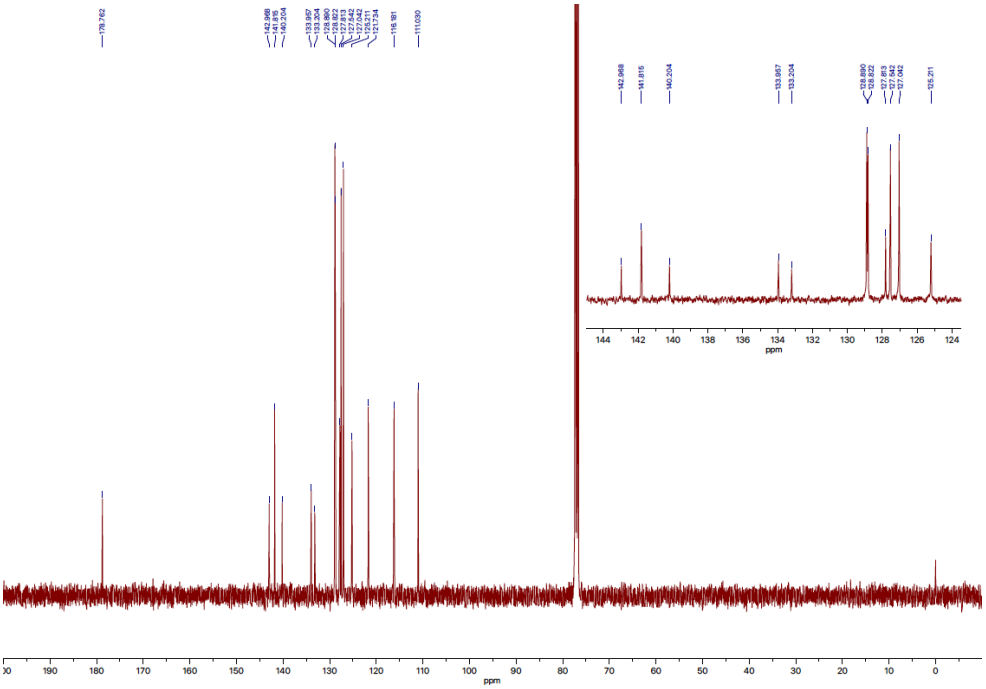
^{1}H NMR (400 MHz, $CDCl_3$)





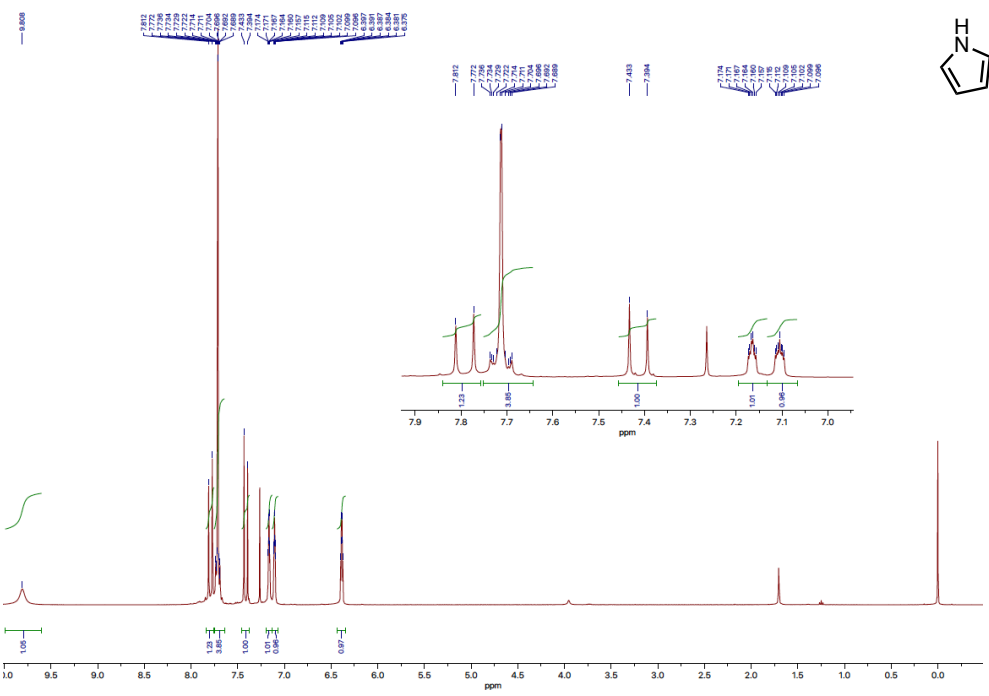
2m

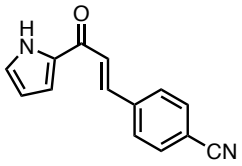
^{13}C NMR (101 MHz, $CDCl_3$)



2n

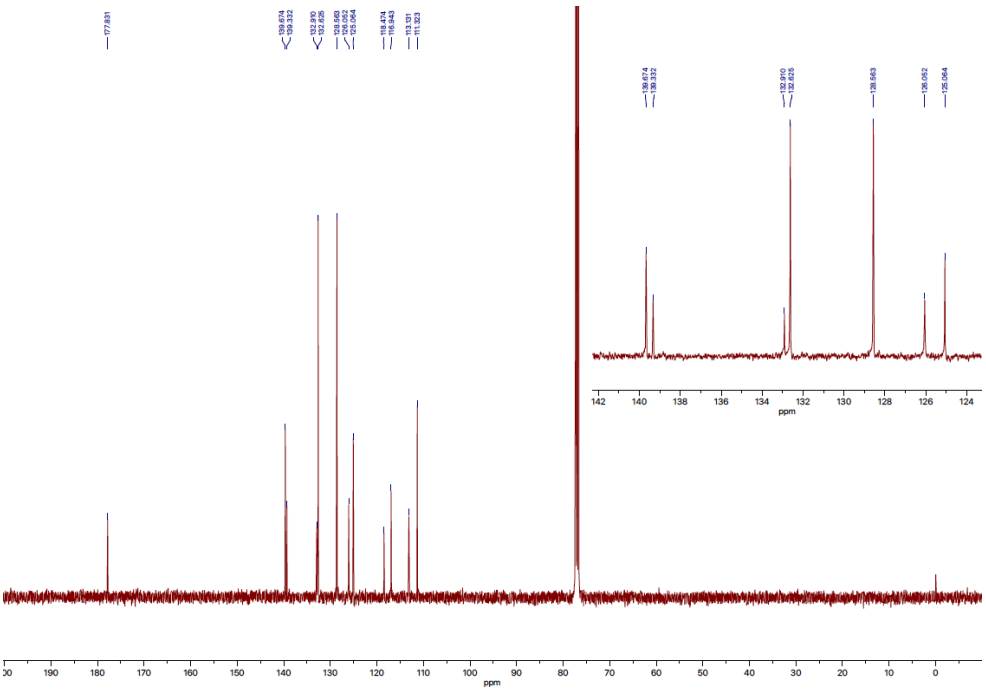
^{1}H NMR (400 MHz, $CDCl_3$)





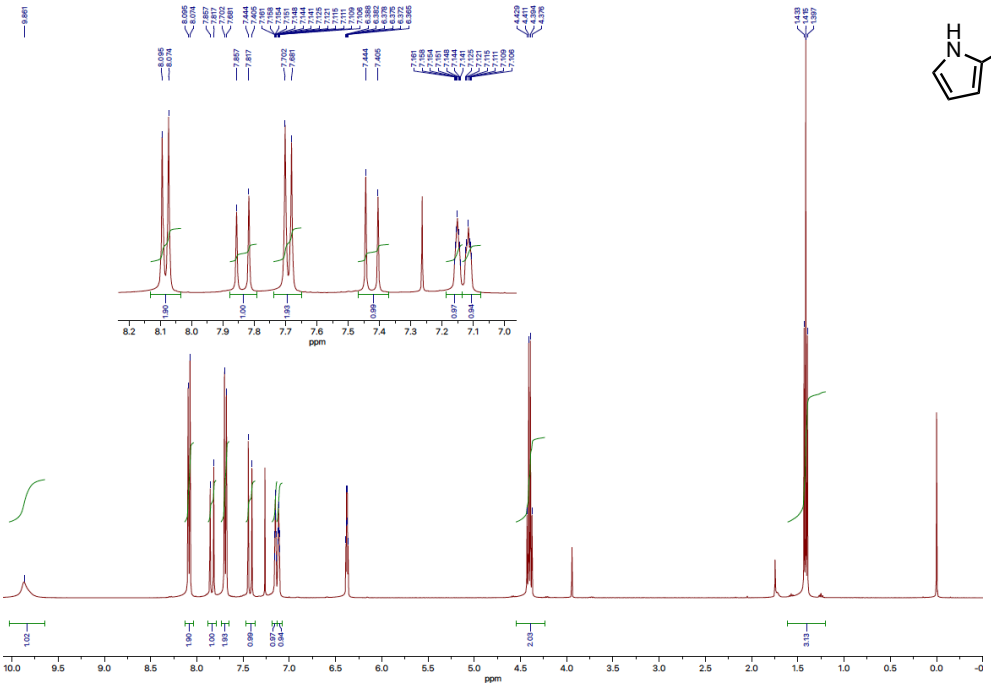
2n

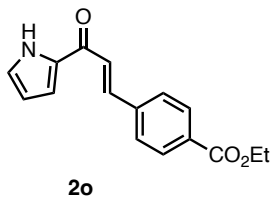
^{13}C NMR (101 MHz, $CDCl_3$)



2o

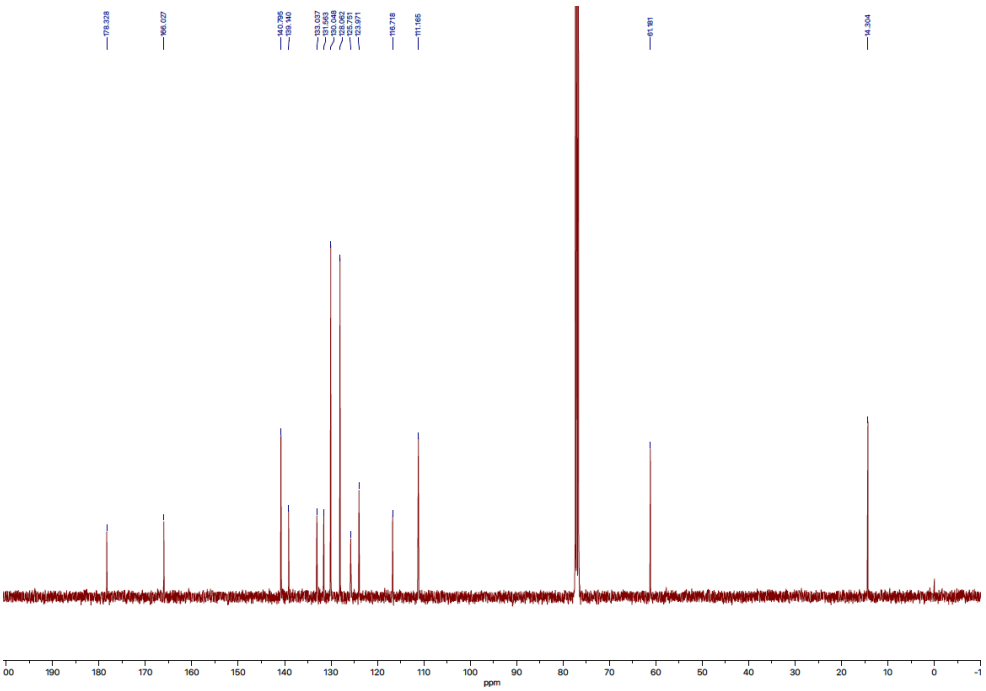
^{1}H NMR (400 MHz, $CDCl_3$)





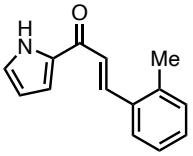
2o

^{13}C NMR (101 MHz, $CDCl_3$)

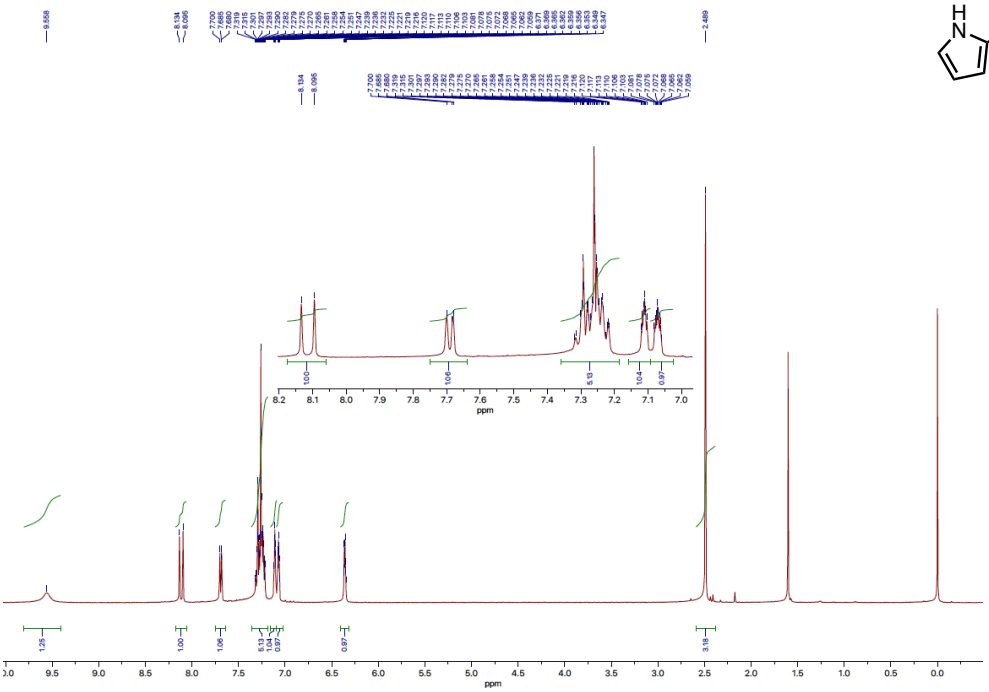


2p

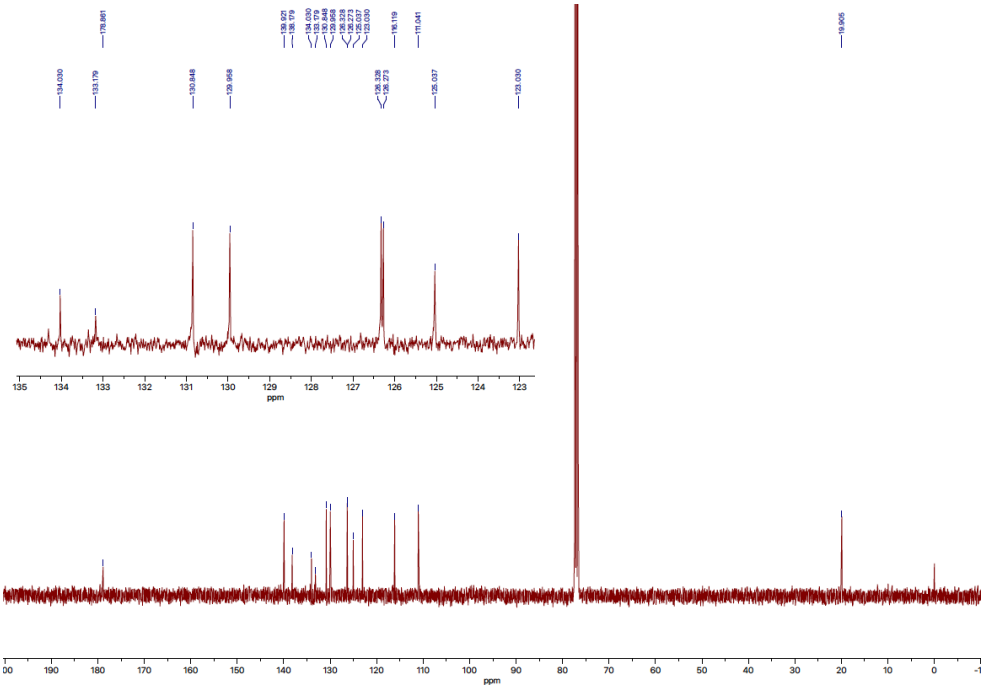
^{1}H NMR (400 MHz, $CDCl_3$)



2p

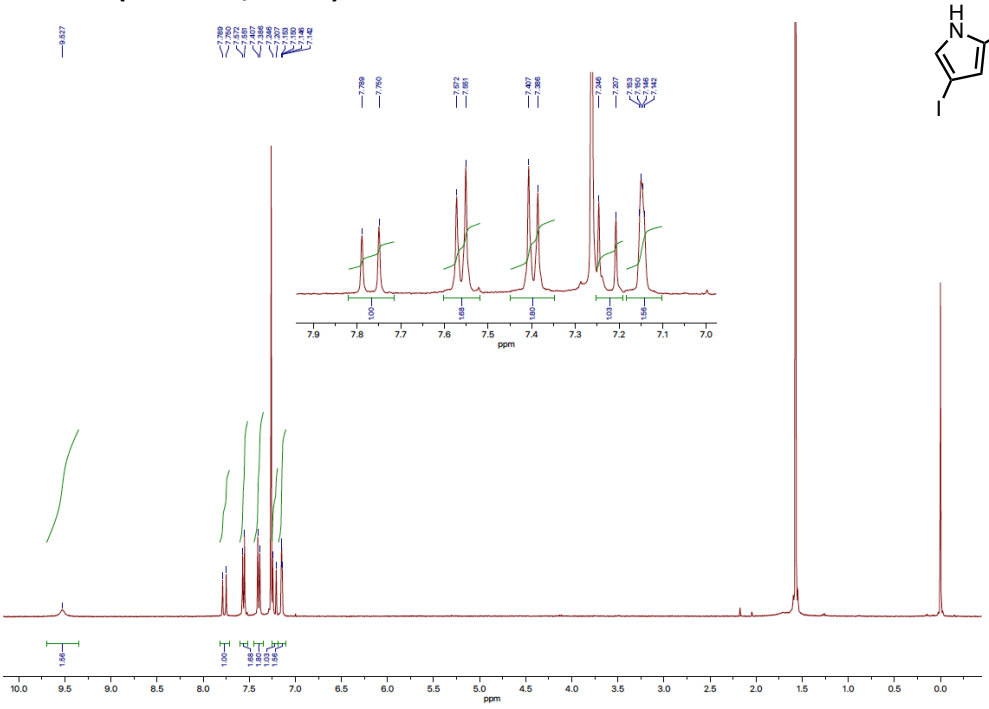


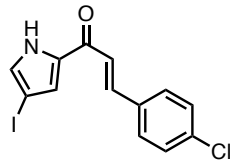
^{13}C NMR (101 MHz, $CDCl_3$)



2q

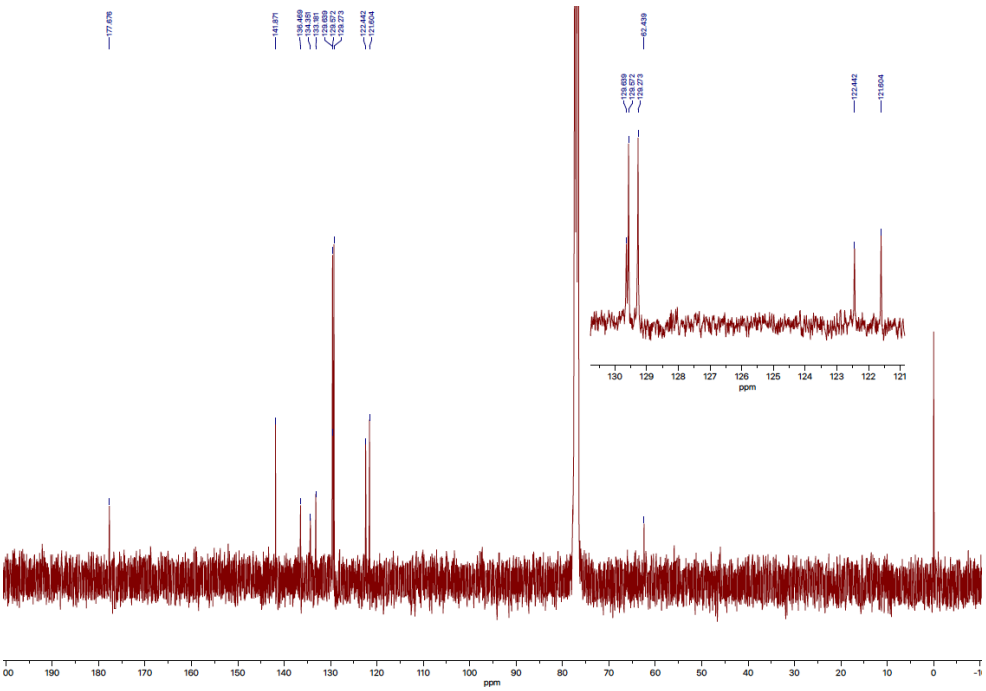
^{1}H NMR (400 MHz, $CDCl_3$)





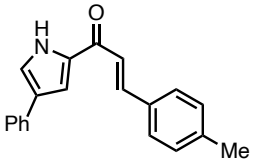
2q

^{13}C NMR (101 MHz, $CDCl_3$)

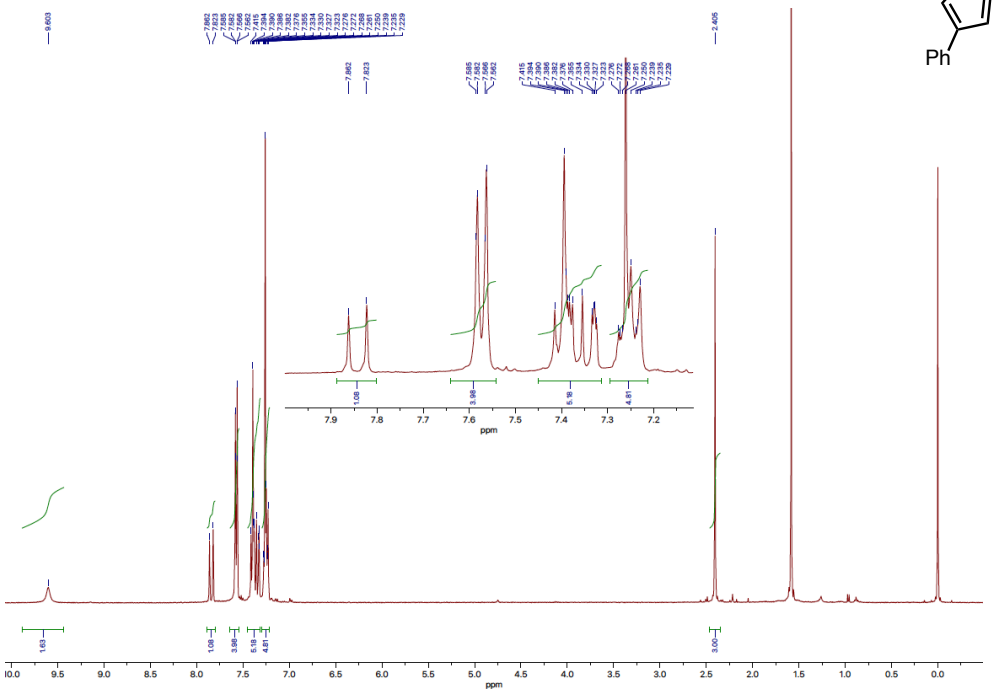


2r

^{1}H NMR (400 MHz, $CDCl_3$)



2r



^{13}C NMR (101 MHz, $CDCl_3$)