Supporting Information

Enantioselective and site-specific copper-satalyzed reductive allyl-allyl cross-coupling of allenes

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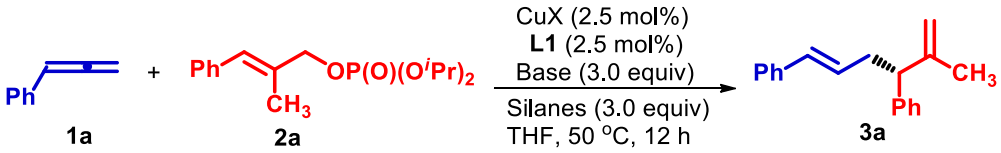
1. General Considerations

All reactions were performed under nitrogen atmosphere in flame dried flasks. All reactions were monitored by thin layer chromatography (TLC) using Macherey-Nagel 0.20 mm silica gel 60 plates. Flash column chromatography was performed on silica gel 60 (particle size 300-400 mesh ASTM, purchased from Taizhou, China). ^{1}H, ^{13}C, ^{19}F nuclear magnetic resonance (NMR) spectra were recorded on Varian (400/500 MHz) or Bruker 600 MHz NMR spectrometers. ^{1}H and ^{13}C NMR spectra are reported in parts per million (ppm) downfield from an internal standard, tetramethylsilane (0 ppm for ^{1}H) and $CHCl_3$ (77.0 ppm for ^{13}C), respectively. High resolution mass spectra were recorded on Bruck microtof. High-pressure liquid chromatography (HPLC) was performed on Agilent 1260 Series chromatographs using a chiral column (25 cm) as noted for each compound. HPLC analysis carried on Chiralpak OZ-H, OD-H, AD-H, IA column (Daicel Chemical Industries, LTD). Optical rotations were measured on a Perkin–Elmer 341 polarmeter.

Unless otherwise stated, all commercially available compounds were purchased from Aldrich or Energy–Chemical Limited and used as supplied without further purification. THF was purified by distillation from sodium benzophenone ketyl immediately prior to use. 1,4–Dioxane was distilled over sodium, degassed, and stored over activated molecular sieves. $(Me_2SiH)_2O$ (TMDS) was purchased from Energy–Chemical Limited and vacuum transferred over calcium hydride before use. **L1** and **L2** have been reported by Amir H. Hoveyda.[1] To obtain racemic samples of the hydroallylation products, rac-**L1** was used as the ligand. Allenes were prepared according to the procedure reported by Gérard Buono.[2] Primary allylic phosphates and (*Z*)-allylic phosphate were prepared according to the reported procedures.[3]

2. Optimization Studies for Asymmetric Hydroallylation of Allenes[a].

Table S1. Screening of the catalysts, bases and hydrosilanes[a,b]



entry	cat.	base	silanes	yield (%)	ee[c]
1	**CuCl**	**NaO^{t}Bu**	**TMDS**	**50**	**33**
2	CuBr	NaO^{t}Bu	TMDS	14	33
3	CuOAc	NaO^{t}Bu	TMDS	30	33
4	CuI	NaO^{t}Bu	TMDS	24	32
5	Cu(CH$_3$CN)$_4$PF$_6$	NaO^{t}Bu	TMDS	30	nd
6	CuCl$_2$	NaO^{t}Bu	TMDS	42	nd
7	CuCl	LiO^{t}Bu	TMDS	50	26
8	CuCl	KO^{t}Bu	TMDS	nr	---
9	CuCl	NaOMe	TMDS	nr	---
10	CuCl	NaO^{t}Bu	DEMS	nr	---
11	CuCl	NaO^{t}Bu	PMHS	58	27
12	CuCl	NaO^{t}Bu	PhSiH$_3$	nr	---

[a]Reaction conditions: **1a** (0.2 mmol), allyl phosphate (1.5 equiv), catalyst (2.5 mol%), **L1** (2,5 mol%), base (3.0 equiv) and silane (3.0 equiv) in 2.0 mL THF at 50 °C. [b]Isolated yields. [c]ee determined by HPLC. TMDS = $(Me_2HSi)_2O$, DEMS = $(EtO)_2MeSiH$.

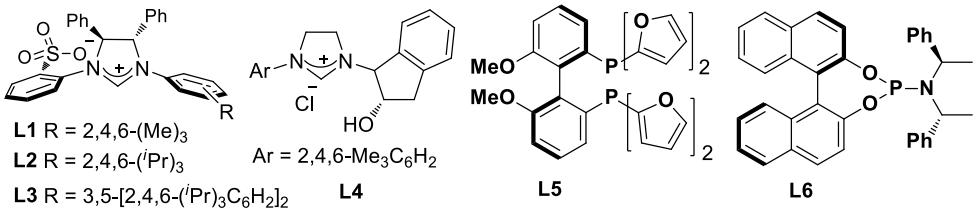
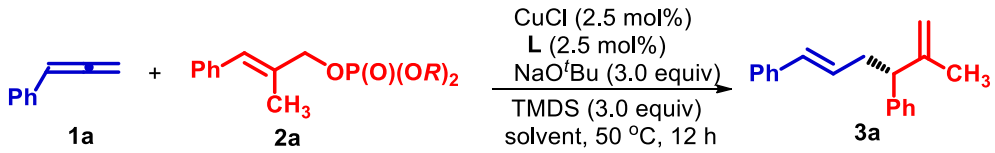


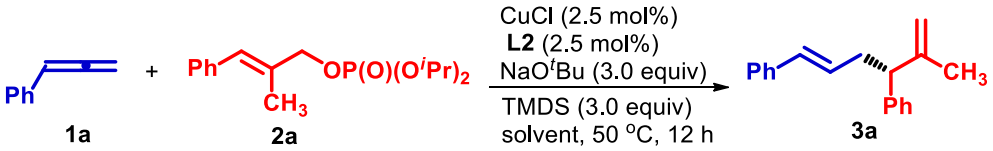
Table S2. Screening of the ligands, leaving groups and solvents[a,b]



entry	solvent	R	L	yield (%)	ee[d]
1	THF	Me	**L1**	50	33
2	THF	Me	**L2**	50	85
3	THF	Me	**L3**	0	---
4	THF	Me	**L4**	0	---
5	THF	Me	**L5**	0	---
6	THF	Me	**L6**	0	---
7	THF	Me	**L2**	50	85
8	THF	^{i}Bu	**L2**	50	78
9	THF	Et	**L2**	50	87
10	**THF**	**^{i}Pr**	**L2**	**50**	**89**
11	CyH	^{i}Pr	**L2**	66	77
12	MTBE	^{i}Pr	**L2**	trace	nd
13	Toluene	^{i}Pr	**L2**	70	76
14	Et_2O	^{i}Pr	**L2**	tace	nd
15	Dioxane	^{i}Pr	**L2**	60	93
16[c]	**Dioxane**	**^{i}Pr**	**L2**	**73**	**93**

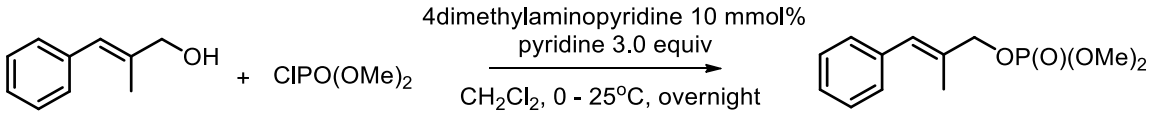
[a]Reaction conditions: **1a** (0.2 mmol), allyl phosphate (1.5 equiv), catalyst (2.5 mol%), **L2** (2.5 mol%), base (3.0 equiv) and silane (3.0 equiv) in 2.0 mL solvent at 50 °C. MTBE = methyl tert-butyl ether. [b]Isolated yields. [c]**1a** (1.5 equiv), allyl phosphate (0.2 mmol). [d]ee determined by HPLC.

3. General Procedure for Enantioselective Hydroallylation of Allene



In a nitrogen-filled glove box, a screw-cap test tube was charged with **L2** (9 mg, 0.010 mmol) and NaO^{t}Bu (60 mg, 0.6 mmol). Anhydrous dioxane (2.0 mL) was added and the mixture was stirred for 30 minutes at 50 °C after the addition of CuCl (1 mg, 0.010 mmol). TMDS (80 mg, 0.6 mmol) was added, after 5 minutes, **1a** (34.8 mg, 0.3 mmol) and **2c** (62.4 mg, 0.2 mmol) was added to the mixture. The reaction tube was sealed with a Teflon screw cap, removed from the glove box and stirred at 50 °C for 12 h. Then, the mixture was quenched by 1M NaOH (10.0 mL), extracted with CH_2Cl_2 (3 × 5.0 mL), combined the organic phases, and dried over anhydrous $MgSO_4$. The solvents were evaporated under vacuum and the crude product was purified on silica gel column chromatography to give the corresponding product **3a** (36.2 mg, 73% yield, 93% ee) as a colorless oil.

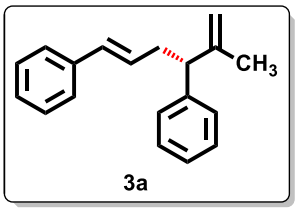
4. Preparation of Primary Allyl Phosphates



In a 50 ml dry two-neck flask equipped with a magnetic bar was added 4-dimethylaminopyridine (DMAP, 0.042 mmol, 51 mg). The flask was then evacuated and back-filled with argon three times. Dry dichloromethane (10 mL), pyridine (24.9 mmol, 2.0 mL) and (*E*)-2-methyl-3-phenylprop-2-en-1-ol (8.3 mmol, 1.2 g) were added in turn to the flask. The reaction mixture was cooled to 0 °C and then diisopropyl phosphorochloridate (12.5 mmol, 2.5 g) was added dropwise. After the reaction was slowly

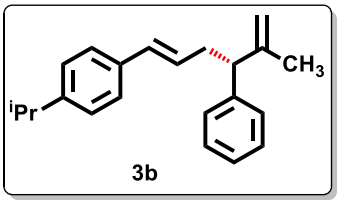
warmed to room temperature through overnight with stirring, it was quenched with water (10.0 mL) at 0 °C. The organic layer was separated and the water layer was extracted with CH_2Cl_2(3×15 mL). The solution was concentrated in vacuo, which afforded an oil that was purified by flash chromatography (ethyl acetate : petroleum ether = 10:90) to give (*E*)-diisopropyl (2-methyl-3-phenylallyl) phosphate (1.55 g, 60%) as a colorless oil.

5. Compounds Characterization



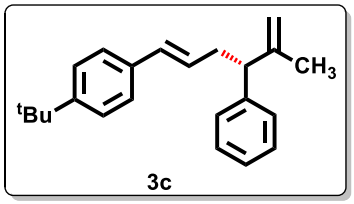
(*R*,*E*)-(5-methylhexa-1,5-diene-1,4-diyl)dibenzene (3a)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (36.2 mg, 73%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.31 - 7.27 (m, 5H), 7.24 – 7.22 (m, 3H), 7.20 – 7.15 (m, 2H), 6.38 (d, J = 16.2 Hz, 1H), 6.14 – 6.09 (m, 1H), 4.97 (s, 1H), 4.89 (s, 1H), 3.36 (t, J = 7.2 Hz, 1H), 2.78 – 2.73 (m, 1H), 2.67 – 2.60 (m, 1H), 1.61 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 147.3, 143.1, 137.7, 131.0, 129.1, 128.4, 128.3, 127.8, 126.9, 126.3, 126.0, 110.8, 53.0, 36.8, 21.2. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{19}H_{20}Na$ ([M + Na]$^+$): 271.1457; found: 271.1462. **$[\alpha]_D^{14}$** = 21.3, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 31.0 min, t_R (major) = 37.9 min); ee = 93%.



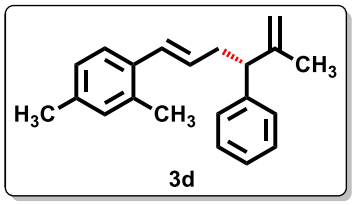
(*R*,*E*)-1-isopropyl-4-(5-methyl-4-phenylhexa-1,5-dien-1-yl)be nzene (3b)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (41.8 mg, 72%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.28 (t, J = 7.2 Hz, 2H), 7.23 – 7.18 (m, 5H), 7.12 (d, J = 7.8 Hz, 2H), 6.35 (d, J = 15.6 Hz, 1H), 6.09 – 6,04 (m, 1H), 4.96 (s, 1H), 4.87 (s, 1H), 3.35 (t, J = 7.8 Hz, 1H), 2.88 – 2.83 (m, 1H), 2.76 – 2.71 (m, 1H), 2.65 – 2.60 (m, 1H), 1.60 (s, 3H), 1.22 (d, J = 6.6 Hz, 6H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 147.7, 147.4, 143.1, 135.4, 130.8, 128.3, 128.1, 127.8, 126.5, 126.3, 126.0, 110.8, 53.1, 36.8, 33.8, 23.9, 21.1. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{22}H_{26}Na$ ([M + Na]$^+$): 313.1928; found: 313.1927. **$[\alpha]_D^{14}$** = 2.8, (c = 0.5, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 23.6 min, t_R (major) = 26.8 min); ee = 90%.



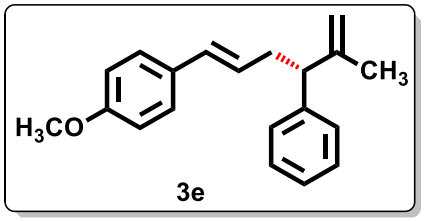
(*R*,*E*)-1-(tert-butyl)-4-(5-methyl-4-phenylhexa-1,5-dien-1-yl) benzene (3c)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (56.0 mg, 92%); **^{1}H NMR** (600 MHz, $CDCl_3$) *δ:* 7.29 – 7.26 (m, 4H), 7.22 (t, *J* = 8.4 Hz, 4H), 7.20 – 7.17 (m, 1H), 6.35 (d, *J* = 16.2 Hz, 1H), 6.09 – 6.04 (m, 1H), 4.96 (s, 1H), 4.87 (s, 1H), 3.34 (t, *J* = 7.2 Hz, 1H), 2.76 – 2.71 (m, 1H), 2.65 – 2.60 (m, 1H), 1.60 (s, 3H), 1.29 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) *δ:* 149.9 147.4, 143.1, 135.0, 130.7, 128.3, 128.2, 127.8, 126.3, 125.7, 125.3, 110.8, 53.1, 36.8, 34.4, 31.3, 21.2. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{23}H_{28}K$ ([M + K]$^+$): 343.1828; found: 343.1823. **$[\alpha]_D^{14}$** = 30.7, (c = 2.5, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 20.8 min, t_R (major) = 23.5 min); ee = 92%.



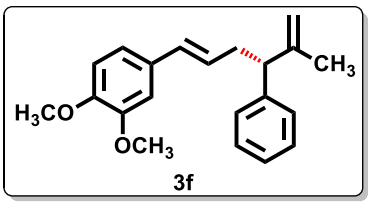
(*R*,*E*)-2,4-dimethyl-1-(5-methyl-4-phenylhexa-1,5-dien-1-yl) benzene (3d)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (36.4 mg, 66%); **^{1}H NMR** (600 MHz, $CDCl_3$) *δ*: 7.28 (t, *J* = 7.2Hz, 2H), 7.24 (s, 2H), 7.19 (t, *J* = 7.8 Hz, 2H), 6.91 (d, *J* = 6.6 Hz, 2H), 6.49 (d, *J* = 15.6 Hz, 1H), 5.94 – 5.89 (m, 1H), 4.97 (s, 1H), 4.88 (s, 1H), 3.36 (t, *J* = 7.8 Hz, 1H), 2.78 – 2.73 (m, 1H), 2.67 – 2.62 (m, 1H), 2.27 (s, 3H), 2.20 (s, 3H), 1.61 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) *δ*: 147.5, 143.1, 136.5, 134.8, 134.1, 130.8, 129.4, 128.9, 128.2, 127.9, 126.6, 126.2, 125.5, 110.7, 53.1, 37.1, 21.2, 21.0, 19.6. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{21}H_{24}K$ ([M + K]$^+$): 315.1503; found: 315.1509. **$[\alpha]_D^{14}$** = 57.7, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 34.2 min, t_R (major) = 39.8 min); ee = 94%.



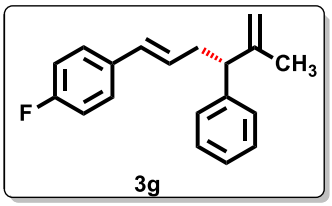
(*R*,*E*)-1-methoxy-4-(5-methyl-4-phenylhexa-1,5-dien-1-yl)benzene (3e)

Purified by flash column chromatography (eluent: Petroleum ether / dichloromethane = 20:1). Colorless oil (30.0 mg, 54%); **^{1}H NMR** (500 MHz, $CDCl_3$) δ: 7.29 (t, J = 7.5 Hz, 2H), 7.24 – 7.22 (m, 3H), 7.20 – 7.19 (m, 2H), 6.80 (d, J = 8.5 Hz, 2H), 6.32 (d, J = 15.5 Hz, 1H), 6.00 – 6.94 (m, 1H), 4.96 (s, 1H), 4.88 (s, 1H), 3.78 (s, 3H), 3.34 (t, J = 7.5 Hz, 1H), 2.76 – 2.70 (m, 1H), 2.64 – 2.59 (m, 1H), 1.61 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 158.7, 147.4, 143.2, 130.6, 130.3, 128.2, 127.8, 127.1, 126.9, 126.3, 113.8, 110.7, 55.3, 53.1, 36.8, 21.16. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{20}H_{22}ONa$ ($[M + Na]^+$): 301.1549; found: 301.1562. **$[\alpha]_D^{14}$** = 94.0, (c = 1.5, $CHCl_3$). **HPLC** analysis (Chiralpak IA column, hexanes/i-PrOH = 100/0, 1.0 mL/min, 250 nm, t_R (minor) = 19.0 min, t_R (major) = 20.6 min); ee = 94%.



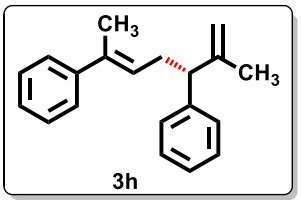
(*R*,*E*)-1,2-dimethoxy-4-(5-methyl-4-phenylhexa-1,5-dien-1-yl)benzene (3f)

Purified by flash column chromatography (eluent: Petroleum ether / dichloromethane = 20:1). Colorless oil (38.2 mg, 62%); **^{1}H NMR** (500 MHz, $CDCl_3$) δ: 7.30 (t, J = 7.0 Hz, 2H), 7.25 – 7.19 (m, 3H), 6.83 – 6.76 (m, 3H), 6.32 (d, J = 16.0 Hz, 1H), 6.01 - 5.95 (m, 1H), 4.97 (s, 1H), 4.89 (s, 1H), 3.87 (s, 3H), 3.85 (s, 3H), 3.36 (t, J = 7.5 Hz, 1H), 2.77 – 2.71 (m, 1H), 2.65 – 2.59 (m, 1H), 1.61 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 148.9, 148.3, 147.3, 143.1, 130.9, 130.6, 128.2, 127.8, 127.2, 126.3, 118.8, 111.1, 110.8, 108.7, 55.9, 55.8, 53.1, 36.8, 21.2. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{21}H_{25}$ ($[M + H]^+$): 309.1846; found: 309.1849. **$[\alpha]_D^{14}$** = 26.2, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak AD-H column, hexanes/i-PrOH = 99/1, 0.5 mL/min, 250 nm, t_R (minor) = 21.6 min, t_R (major) = 25.1 min); ee = 92%.



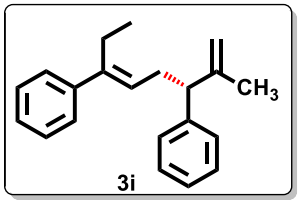
(*R*,*E*)-1-fluoro-4-(5-methyl-4-phenylhexa-1,5-dien-1-yl)benzene (3g)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (22.9 mg, 43%); **^{1}H NMR** (600 MHz, $CDCl_3$) *δ:* 7.31 – 7.28 (m, 2H), 7.25 – 7.20 (m, 5H), 6.94 (t, *J* = 8.4 Hz, 2H), 6.33 (d, *J* = 15.6 Hz, 1H), 6.04 – 5.99 (m, 1H), 4.96 (s, 1H), 4.89 (3) – 4.88 (8) (m, 1H), 3.35 (t, *J* = 7.2 Hz, 1H), 2.76 – 2.71 (m, 1H), 2.65 – 2.60 (m, 1H), 1.61 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) *δ*: 161.9 (*J* = 244.2 Hz), 147.3, 143.0, 129.8, 128.8 (*J* = 2.1 Hz), 128.3, 127.8, 127.4 (*J* = 117.0 Hz) 126.35, 115.2 (*J* = 20.9 Hz,), 110.80, 53.0, 36.8, 21.2. **^{19}F NMR** (564 MHz; $CDCl_3$) *δ:* -115.63 – -115.68 (m). **HRMS** (ESI-TOF) (m/z): Calcd for $C_{19}H_{20}F$ ($[M + H]^+$): 267.1543; found: 267.1544. **$[\alpha]_D^{15}$** = 58.3, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 1.0 mL/min, 250 nm, t_R (minor) = 10.6 min, t_R (major) = 12.4 min); ee = 93%.



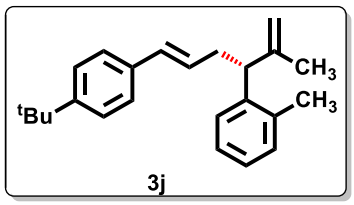
(*R*,*E*)-(6-methylhepta-2,6-diene-2,5-diyl)dibenzene (3h)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (45.6 mg, 63%); **^{1}H NMR** (600 MHz, $CDCl_3$) *δ:* 7.30 – 7.26 (m, 6H), 7.25 – 7.23 (m, 2H), 7.21 – 7.17 (m, 2H), 5.70 – 5.68 (m, 1H), 4.97 (s, 1H), 4.91 (s, 1H), 3.35 (t, *J* = 7.8 Hz, 1H), 2.75 – 2.70 (m, 1H), 2.64 – 2.59(m, 1H), 1.96 (s, 3H), 1.62 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) *δ*: 147.5, 143.9, 143.3, 135.4, 128.2, 128.1, 127.9, 126.7, 126.5, 126.3, 125.7, 110.8, 52.7, 32.7, 21.3, 16.0. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{20}H_{22}Na$ ($[M + Na]^+$): 285.1619; found: 285.1614. **$[\alpha]_D^{14}$** = 41.3, (c = 1.5, $CHCl_3$). **HPLC** analysis (Chiralpak IA column, hexanes/i-PrOH = 100/0, 1.0 mL/min, 250 nm, t_R (minor) = 5.4 min, t_R (major) = 5.6 min); ee = 90%.



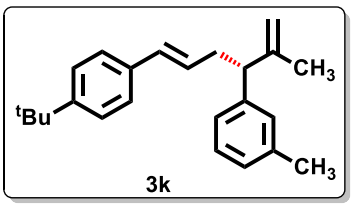
(*R*,*E*)-(2-methylocta-1,5-diene-3,6-diyl)dibenzene (3i)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (42.0 mg, 76%); **^{1}H NMR** (400 MHz, $CDCl_3$) δ: 7.31 – 7.26 (2) (m, 4H), 7.25 (5) – 7.24 (m, 4H), 7.21 – 7.18 (m, 2H), 5.55 (t, J = 6.4 Hz, 1H), 5.01 (s, 1H),4.91 (d, J = 6.4 Hz, 1H), 3.34 (t, J = 6.4 Hz, 1H), 3.76 – 2.70 (m, 1H), 2.65 – 2.59 (m, 1H), 2.45 (q, J = 6.0 Hz, 2H), 1.62 (s, 3H), 0.89 (t, J = 6.0 Hz, 2H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ: 147.5, 143.3, 143.0, 142.2, 128.2, 128.1, 127. 9, 126.5, 126.3, 126.3, 110.8, 53.1, 32.3, 23.0, 21.4, 13.3. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{21}H_{24}Na$ ($[M + Na]^+$): 299.1767; found: 299.1770. **$[\alpha]_D^{14}$** = 43.1, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak IA column, hexanes/i-PrOH = 100/0, 0.4 mL/min, 250 nm, t_R (minor) = 11.8 min, t_R (major) = 12.1min); ee = 92%.



(*R*,*E*)-1-(6-(4-(tert-butyl)phenyl)-2-methylhexa-1,5-dien-3-yl)-2-methylbenzene (3j)

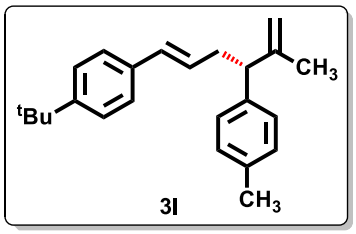
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (51.5 mg, 81%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.31 – 7.27 (m, 2H), 7.23 – 7.20 (m, 3H), 7.18 – 7.15 (m, 1H), 7.13 – 7.08 (m, 2H), 6.36 (d, J = 15.6 Hz, 1H), 6.10 – 6.05 (m, 1H), 4.91 (s, 2H), 3.59 (t, J = 7.8 Hz, 1H), 2.77 – 2.72 (m, 1H), 2.61 – 2.56 (m, 1H), 2.32 (s, 3H), 1.60 (s, 3H), 1.29 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 149.9, 146.8, 141.2, 136.4, 135.0, 130.7, 130.3, 128.3, 126.5, 126.0, 125.7, 125.3, 111.1, 48.3, 37.2, 34.5, 31.3, 21.6, 19.8. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{24}H_{30}Na$ ($[M + Na]^+$): 341.2245; found: 341.2242. **$[\alpha]_D^{14}$** = 23.1, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 1.0 mL/min, 250 nm, t_R (minor) = 11.0 min, t_R (major) = 12.3 min); ee = 94%.



(*R*,*E*)-1-(6-(4-(tert-butyl)phenyl)-2-methylhexa-1,5-dien-3-yl)-3-methylbenzene (3k)

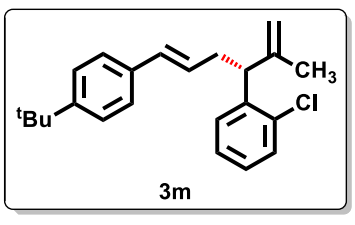
Purified by flash column chromatography (eluent: Petroleum

ether). Colorless oil (36.3 mg, 57%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.29 (d, J = 8.4 Hz, 2H), 7.22 (d, J = 8.4 Hz, 2H), 7.19 – 7.15 (m, 1H), 7.04 – 7.00 (m, 3H), 6.36 (d, J = 16.2 Hz, 1H), 6.10 – 6.05 (m, 1H), 4.95 (s, 1H), 4.89 – 4.86 (m, 1H), 3.31 (t, J = 7.8 Hz, 1H), 2.75 – 2.70 (m, 1H), 2.64 – 2.59 (m, 1H), 2.33 (s, 3H), 1.60 (s, 3H), 1.29 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 149.9, 147.4, 143.1, 137.7, 135.0, 130.6, 128.6, 128.4, 128.1, 127.0, 125.7, 125.3, 124.8, 110.7, 53.1, 36.8, 34.5, 31.3, 21.5, 21.2. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{24}H_{30}Na$ ([M + Na]$^+$): 341.2245; found: 341.2241. **$[\alpha]_D^{14}$** = 8.1, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 1.0 ml/min, 250 nm, t_R (minor) = 9.5 min, t_R (major) = 10.7 min); ee = 93%.



(*R*,*E*)-1-(tert-butyl)-4-(5-methyl-4-(p-tolyl)hexa-1,5-dien-1-yl)benzene (3l)

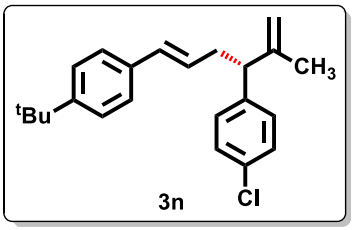
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (36.3 mg, 57%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.29 (d, J = 8.4 Hz, 2H), 7.22 (d, J = 8.4 Hz, 2H), 7.11 – 7.09 (m, 4H), 6.36 (d, J = 15.6 Hz, 1H), 6.10 – 6.05 (m, 1H), 4.94 (s, 1H), 4.86 – 4.85 (m, 1H), 3.31 (t, J = 7.2 Hz, 1H), 2.74 – 2.69 (m, 1H), 2.63 – 2.58 (m, 1H), 2.32 (s, 3H), 1.60 (s, 3H), 1.29 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 149.9, 147.6, 140.1, 135.7, 135.0, 130.6, 128.9, 128.4, 127.7, 125.7, 125.3, 110.6, 52.7, 36.9, 34.5, 31.3, 21.1, 21.0. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{24}H_{30}Na$ ([M + Na]$^+$): 341.2245; found: 341.2242. **$[\alpha]_D^{14}$** = 18.4, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak IA column, hexanes/i-PrOH = 99.9/0.1, 1.0 mL/min, 250 nm, t_R (minor) = 7.7 min, t_R (major) = 9.7 min); ee = 90%.



(*R*,*E*)-1-(6-(4-(tert-butyl)phenyl)-2-methylhexa-1,5-dien-3-yl)-2-chlorobenzene (3m)

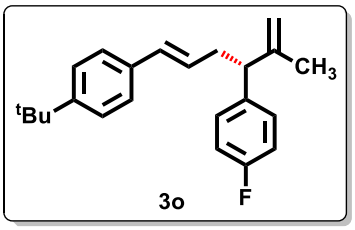
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (58.8 mg, 87%); **^{1}H NMR** (600 MHz,

$CDCl_3$) δ: 7.34 – 7.33 (m, 1H), 7.29 – 7.27 (m, 3H), 7.22 – 7.20 (m, 3H), 7.13 – 7.10 (m, 1H), 6.33 (d, J = 15.6 Hz, 1H), 6.11 – 6.06 (m, 1H), 4.96 (s, 2H), 3.97 (t, J = 7.2 Hz, 1H), 2.77 – 2.72 (m, 1H), 2.61 – 2.56 (m, 1H), 1.64 (s, 3H), 1.29 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 149.9, 146.2, 140.6, 134.9, 134.7, 130.9, 129.5, 128.3, 127.7, 127.4, 126.8, 125.7, 125.3, 111.6, 47.9, 37.0, 34.5, 31.3, 22.1. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{23}H_{28}Cl$ ($[M + H]^+$): 339.1876; found: 339.1874. **$[\alpha]_D^{14}$** = 48.5, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak IA column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 12.3 min, t_R (major) = 13.0 min); ee = 92%.



(*R*,*E*)-1-(tert-butyl)-4-(4-(4-chlorophenyl)-5-methylhexa-1,5-dien-1-yl)benzene (3n)

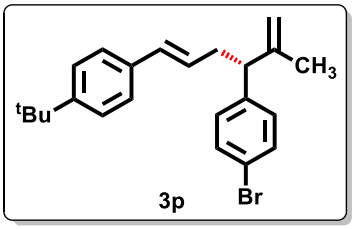
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (52.1 mg, 77%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.29 (d, J = 8.4 Hz, 2H), 7.25 (d, J = 8.4 Hz, 2H), 7.21 (d, J = 8.4 Hz, 2H), 7.15 (d, J = 8.4 Hz, 2H), 6.34 (d, J = 15.6 Hz, 1H), 6.05 – 6.00 (m, 1H), 4.94 (s, 1H), 4.89 – 4.88 (m, 1H), 3.31 (t, J = 7.8 Hz, 1H), 2.74 – 2.67 (m, 1H), 2.60 – 2.55 (m, 1H), 1.58 (s, 3H), 1.29 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 150.0, 146.9, 141.6, 134.8, 131.9, 131.1, 129.2, 128.4, 127.7, 125.7, 125.3, 111.1, 52.5, 36.8, 34.5, 31.3, 21.1. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{23}H_{28}Cl$ ($[M + H]^+$): 339.1877; found: 339.1874. **$[\alpha]_D^{14}$** = 78.3, (c = 2.0, $CHCl_3$). **HPLC** analysis (Chiralpak IA column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 21.7 min, t_R (major) = 24.6 min); ee = 91%.



(*R*,*E*)-1-(tert-butyl)-4-(4-(4-fluorophenyl)-5-methylhexa-1,5-dien-1-yl)benzene (3o)

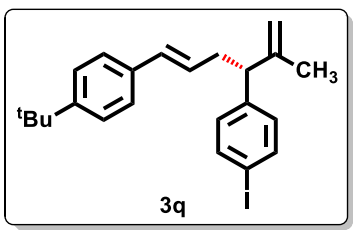
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (39.9 mg, 62%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.30 – 7.28 (m, 2H), 7.22 – 7.20 (m, 2H), 7.18 – 7.16 (m, 2H), 6.98 – 6.95 (m, 2H), 6.34 (d, J = 16.2 Hz, 1H), 6.06 – 6.01(m, 1H), 4.94 (s, 1H), 4.88 –

4.87 (m, 1H), 3.32 (t, *J* = 7.8 Hz, 1H), 2.72 – 2.69 (m, 1H), 2.61 – 2.56 (m, 1H), 1.59 (s, 3H), 1.29 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) *δ*: 161.5 (d, *J* = 242.6 Hz), 150.0, 147.3, 138.7 (d, *J* = 3.0 Hz), 134.9, 130.9, 129.2 (d, *J* = 7.65 Hz), 127.9, 125.7, 125.4, 115.0 (d, *J* = 20.85 Hz), 110.9, 52.31, 36.97, 34.47, 31.28, 21.12. **^{19}F NMR** (564 MHz; $CDCl_3$) *δ* -117.02 – (-117.07) (m). **HRMS** (ESI-TOF) (m/z): Calcd for $C_{23}H_{27}FK$ ($[M + K]^+$): 361.1723; found: 361.1728. **$[\alpha]_D^{14}$** = 90.5, (c = 2.0, $CHCl_3$). **HPLC** analysis (Chiralpak OZ-H column, hexanes/i-PrOH = 100/0, 1.0 mL/min, 250 nm, t_R (minor) = 7.2 min, t_R (major) = 7.8 min); ee = 92%.



(*R*,*E*)-1-bromo-4-(6-(4-(tert-butyl)phenyl)-2-methylhexa-1,5-dien-3-yl)benzene (3p)

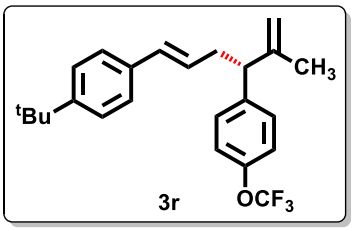
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (55.0 mg, 72%); **^{1}H NMR** (600 MHz, $CDCl_3$) *δ*: 7.40 (d, *J* = 7.8 Hz, 2H), 7.29 (d, *J* = 7.8 Hz, 2H), 7.21 (d, *J* = 8.4 Hz, 2H), 7.09 (d, *J* = 8.4 Hz, 2H), 6.34 (d, *J* = 15.6 Hz, 1H), 6.05 – 6.00 (m, 1H), 4.94 (s, 1H), 4.88 (s, 1H), 3.30 (t, *J* = 7.2 Hz, 1H), 2.73 – 2.69 (m, 1H), 2.60 – 2.55 (m, 1H), 1.58 (s, 3H), 1.29 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) *δ*: 150.0, 146.9, 142.1, 134.8, 131.3, 131.1, 129.7, 127.6, 125.7, 125.4, 120.1, 111.2, 52.5, 36.7, 34.5, 31.3, 21.2. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{23}H_{27}BrK$ ($[M + K]^+$): 421.0924; found: 421.0910. **$[\alpha]_D^{14}$** = 21.8, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak IA column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 22.9 min, t_R (major) = 33.1 min); ee = 94%.



(*R*,*E*)-1-(tert-butyl)-4-(4-(4-iodophenyl)-5-methylhexa-1,5-dien-1-yl)benzene (3q)

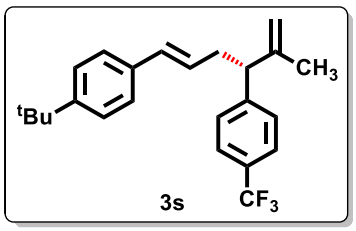
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (26.7 mg, 31%); **^{1}H NMR** (600 MHz, $CDCl_3$) *δ*: 7.32 – 7.26 (m, 4H), 7.23 – 7.21 (m, 4H), 6.35 (d, *J* = 13.8 Hz, 1H), 6.01 – 6.0 (m, 1H), 4.96 (s, 1H), 4.88 – 4.87 (m, 1H), 3.35 (t, *J* = 7.8 Hz, 1H), 2.76

– 2.71 (m, 1H), 2.66 – 2.60 (m, 1H), 1.60 (s, 3H), 1.29 (s, 11H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 149.9, 147.4, 143.1, 135.0, 130.7, 128.3, 128.3, 127.9, 126.3, 125.7, 125.3, 110.8, 53.1, 36.8, 34.5, 31.3, 21.2. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{23}H_{27}IK$ ($[M + K]^+$): 469.0786; found: 469.0789. **$[\alpha]_D^{15}$** = 2.5, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 1.0 mL/min, 250 nm, t_R (minor) = 9.6 min, t_R (major) = 10.6 min); ee = 84%.



(*R*,*E*)-1-(tert-butyl)-4-(5-methyl-4-(4-(trifluoromethoxy)phenyl)hexa-1,5-dien-1-yl)benzene (3r)

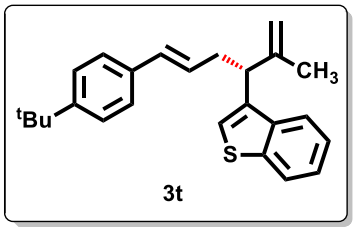
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (38.0 mg, 49%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.30 (d, J = 8.4 Hz, 2H), 7.24 (d, J = 8.4 Hz, 2H), 7.21 (d, J = 8.4 Hz, 2H), 7.13 (d, J = 7.8 Hz, 2H), 6.34 (d, J = 16.2 Hz, 1H), 6.06 – 6.01 (m, 1H), 4.96 (s, 1H), 4.90 (s, 1H), 3.36 (t, J = 7.8 Hz, 1H), 2.75 – 2.70 (m, 1H), 2.62 – 2.57 (m, 1H), 1.59 (s, 3H), 1.29 (s, 10H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 150.1, 147.7, 146.9, 141.8, 134.8, 131.1, 129.1, 127.6, 125.7, 125.4, 120.7, 120.5 (q, J = 255.0 Hz), 111.3, 52.5, 36.8, 34.5, 31.3, 21.1. **^{19}F NMR** (564 MHz; $CDCl_3$) δ: -57.82. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{24}H_{27}F_3ONa$ ($[M + Na]^+$): 411.1904; found: 411.1904. **$[\alpha]_D^{20}$** = 23.5, (c = 2.0, $CHCl_3$). **HPLC** analysis (Chiralpak IA column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 12.3 min, t_R (major) = 13.3 min); ee = 93%.



(*R*,*E*)-1-(tert-butyl)-4-(5-methyl-4-(4-(trifluoromethyl)phenyl)hexa-1,5-dien-1-yl)benzene (3s)

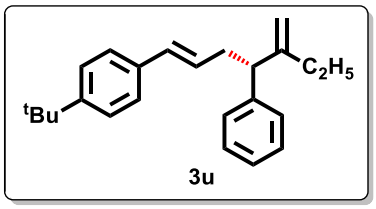
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (27.5 mg, 37%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.54 (d, J = 8.4 Hz, 2H), 7.34 (d, J = 8.4 Hz, 2H), 7.30 (d, J = 8.4 Hz, 2H), 7.21 (d, J = 8.4 Hz, 2H), 6.35 (d, J = 15.6 Hz, 1H), 6.01 – 6.0 (m, 1H), 4.98 (s, 1H), 4.93 – 4.92 (m, 1H), 3.41 (t, J = 7.8 Hz, 1H), 2.79 – 2.74 (m, 1H), 2.65 – 2.60 (m,

1H), 1.60 (s, 3H), 1.29 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 150.1, 147.2, 146.5, 134.7, 131.3, 128.2, 127.4, 125.7, 125.4, 125.2, 125.2, 111.6, 52.9, 36.7, 34.5, 31.3, 21.2. **^{19}F NMR** (564 MHz; $CDCl_3$) δ: -62.29. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{24}H_{27}F_3Na$ ([M + Na]$^+$): 395.1952; found: 395.1957. **$[\alpha]_D^{14}$** = 13.4, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak IA column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 15.3 min, t_R (major) = 19.4 min); ee = 98%.



(*R*,*E*)-3-(6-(4-(tert-butyl)phenyl)-2-methylhexa-1,5-dien-3-yl)benzo[b]thiophene (3t)

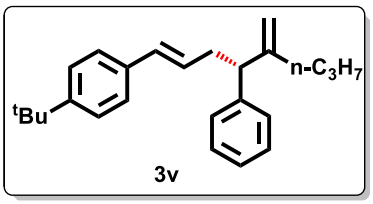
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (25.2 mg, 35%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.85 – 7.82 (m, 2H), 7.37 – 7.20 (m, 4H), 7.24 – 7.23 (m, 2H), 7.20 (s, 1H), 6.43 (d, *J* = 15.6 Hz, 1H), 6.20 – 6.15 (m, 1H), 5.03 (s, 1H), 4.94 (d, *J* = 1.8 Hz, 1H), 3.84 (t, *J* = 7.2 Hz, 1H), 2.82 (t, *J* = 7.2 Hz, 2H), 1.63 (s, 3H), 1.29 (d, *J* = 1.8 Hz, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 150.0, 145.7, 140.5, 138.9, 137.6, 134.8, 131.0, 127.9, 125.8, 125.4, 124.2, 123.7, 122.8, 122.3, 121.6, 112.4, 47.2, 36.2, 34.5, 31.3, 20.2. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{25}H_{28}SNa$ ([M + Na]$^+$): 383.1806; found: 383.1806. **$[\alpha]_D^{14}$** = 2.4, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak IA column, hexanes/i-PrOH = 100/0, 1.0 mL/min, 250 nm, t_R (minor) = 12.3 min, t_R (major) = 16.4 min); ee = 85%.



(*R*,*E*)-1-(tert-butyl)-4-(5-methylene-4-phenylhept-1-en-1-yl)benzene (3u)

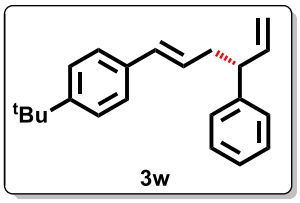
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (33.7 mg, 53%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.28 (t, *J* = 8.4 Hz, 4H), 7.23 – 7.17 (m, 5H), 6.33 (d, *J* = 16.2 Hz, 1H), 6.08 – 6.03 (m, 1H), 5.01 (s, 1H), 4.93 (d, *J* = 1.2 Hz, 1H), 3.36 (t, *J* = 7.6 Hz, 1H), 2.77 – 2.72 (m, 1H), 2.64 – 2.59 (m, 1H), 1.98 – 1.92 (m, 1H), 1.89 – 1.84 (m, 1H), 1.29 (s, 9H), 0.96 (t, *J* = 7.2 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 153.0, 149.9, 143.5, 135.0, 130.7, 128.4, 128.2, 128.0, 126.2, 125.7,

125.3, 108.2, 52.2, 37.7, 34.5, 31.3, 27.7, 12.2. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{24}H_{30}K$ ([M + K]$^+$): 357,1977; found: 357.1979. **[α]$_D^{14}$** = 16.8, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 1.0 mL/min, 250 nm, t_R (minor) = 8.0 min, t_R (major) = 8.7 min); ee = 84%.



(*R*,*E*)-1-(tert-butyl)-4-(5-methylene-4-phenyloct-1-en-1-yl)benzene (3v)

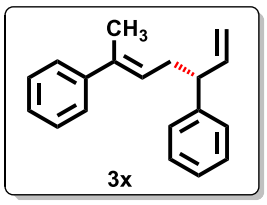
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (41.2 mg, 62%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.27 (t, J = 7.8 Hz, 4H), 7.22 – 7.17 (m, 5H), 6.33 (d, J = 16.2 Hz, 1H), 6.08 – 6.03 (m, 1H), 5.02 (s, 1H), 4.93 (s, 1H), 3.33 (t, J = 7.8 Hz, 1H), 2.76 – 2.72 (m, 1H), 2.63 – 2.58 (m, 1H), 1.91 – 1.81 (m, 2H), 1.45 – 1.34 (m, 2H), 1.29 (s, 9H), 0.83 (t, J = 7.2 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 151.3, 149.8, 143.5, 135.0, 130.7, 128.4, 128.2, 128.0, 126.2, 125.7, 125.3, 109.3, 51.9, 37.8, 37.3, 34.5, 31.3, 20.8, 13.8. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{25}H_{32}K$ ([M + K]$^+$): 371.2131; found: 371.2136. **[α]$_D^{14}$** = 31.7, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 1.0 mL/min, 250 nm, t_R (minor) = 7.6 min, t_R (major) = 8.2 min); ee = 88%.



(*R*,*E*)-1-(tert-butyl)-4-(4-phenylhexa-1,5-dien-1-yl)benzene (3w)

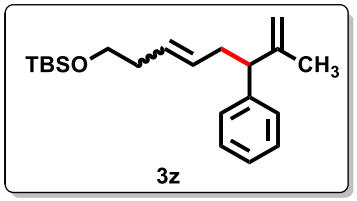
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (40.6 mg, 70%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.32 – 7.29 (m, 5H), 7.24 – 7.20 (m, 5H), 6.36 (d, J = 15.6 Hz, 1H), 6.11 – 5.99 (m, 2H), 5.08 – 5.04 (m, 2H), 3.42 (q, J = 7.8 Hz, 1H), 2.67 – 2.60 (m, 2H), 1.29 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 150.0, 143.8, 141.5, 134.9, 131.1, 128.5, 127.7, 126.3, 125.7, 125.3, 114.6, 50.2, 39.1, 34.5, 31.3. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{22}H_{26}Na$ ([M + Na]$^+$): 313.1932; found: 313.1931. **[α]$_D^{14}$** = 3.0, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 99.9/0.1, 0.5 mL/min, 250 nm, t_R (minor) = 23.9 min, t_R (major) = 25.7 min); ee

= 71%.



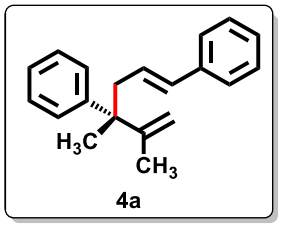
(*R*,*E*)-hepta-2,6-diene-2,5-diyldibenzene (3x)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (35.2 mg, 71%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.32 – 7.28 (m, 5H), 7.26 – 7.22 (m, 3H), 7.20 – 7.18 (m, 2H), 6.08 – 6.02 (m, 1H), 5.72 (t, J = 7.2 Hz, 1H), 5.10 (d, J = 4.2 Hz, 1H), 5.07 (s, 1H), 3.43 (q, J = 7.2 Hz, 1H), 2.67 – 2.57 (m, 2H), 1.96 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 143.9, 141.6, 135.8, 128.4, 128.1, 127.7, 126.5, 126.3, 126.1, 125.7, 114.5, 49.8, 34.7, 16.0. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{19}H_{20}Na$ ($[M + Na]^+$): 271.1463; found: 271.1462. **$[\alpha]_D^{20}$** = 22.9, (c = 1.0, $CHCl_3$). Enantiomeric purity was determined by chiral HPLC analysis in comparison with authentic racemic material obtained from the derived alcohol **7**, which was synthesized by hydroboration of the terminal olefin with 9-BBN, followed by oxidation with H_2O_2. **HPLC** analysis (chiralpak IB column, hexanes/i-PrOH = 97/3, 1.0 mL/min, 250 nm, t_R (minor) = 10.0 min, t_R (major) = 11.6 min); ee = 93%.



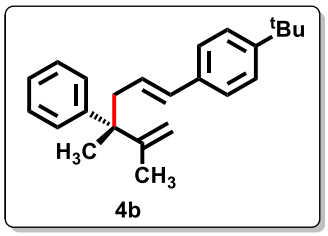
tert-butyldimethyl((7-methyl-6-phenylocta-3,7-dien-1-yl)oxy)silane (3z)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (52.8 mg, 80%, *Z*:*E* = 2:1); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.29 – 7.25 (m, 3.56H), 7.21 – 7.18 (m, 4.72H), 5.40 – 5.34 (m, 3.19H), 4.92 (s, 1H), 4.91 (s, 0.6H), 4.87 (s, 1H), 4.84 (s, 0.59H), 3.55 – 3.52 (m, 3.25H), 3.23 (t, J = 7.2 Hz, 1H), 2.61 – 2.40 (m, 3.38H), 2.26 – 2.13 (m, 3.46H), 1.58 (s, 3H), 1.57 (s, 1.69H), 0.04 (s, 6H), 0.03 (s, 3.22H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 147.6, 147.5, 143.3, 143.2, 130.5, 129.7, 128.2, 128.1, 128.0, 127.8 (8), 127.8 (7), 126.6, 126.2, 126.1, 110.5, 63.3, 62.8, 53.1, 52.8, 36.5, 36.3, 31.3, 31.2, 25.9 (6), 25.9 (5), 21.3, 21.1, 18.4, 18.3, -5.3. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{21}H_{34}NaOSi$ ($[M + Na]^+$): 353.2277; found: 353.2275.



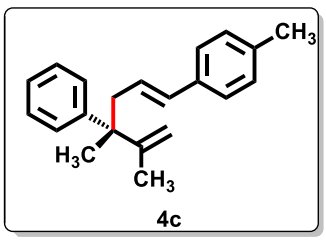
(*R*,*E*)-(4,5-dimethylhexa-1,5-diene-1,4-diyl)dibenzene (4a)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (39.8 mg, 55%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.31 – 7.30 (m, 3H), 7.28 – 7.23 (m, 5H), 7.20 – 7.17 (m, 2H), 6.39 (d, J = 15.6 Hz, 1H), 6.01 – 5.96 (m, 1H), 5.02 (s, 1H), 4.99 (s, 1H), 2.79 – 2.70 (m, 2H), 1.54 (s, 3H), 1.39 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 150.8, 147.0, 137.8, 132.2, 128.4, 128.1, 127.5, 126.9, 126.4, 126.0, 125.9, 111.0, 47.2, 42.5, 25.4, 20.3. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{20}H_{22}Na$ ([M + Na]$^+$): 285.1619; found: 285.1617. **$[\alpha]_D^{20}$** = 20.9, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H then OD-H column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 46.3 min, t_R (major) = 47.5 min); ee = 87%.



(*R*,*E*)-1-(tert-butyl)-4-(4,5-dimethyl-4-phenylhexa-1,5-dien-1-yl)benzene (4b)

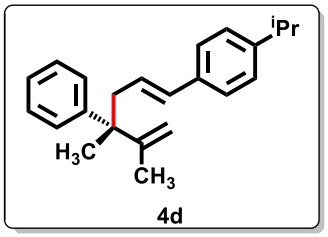
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (38.8 mg, 61%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.31 – 7.29 (m, 5H), 7.24 – 7.19 (m, 4H), 6.37 (d, J = 16.2 Hz, 1H), 5.97 – 5.92 (m, 1H), 5.00 (d, J = 18.0 Hz, 2H), 2.78 – 2.69 (m, 2H), 1.53 (s, 3H), 1.38 (s, 3H), 1.30 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 150.8, 149.9, 147.1, 135.0, 131.9, 128.1, 126.6, 126.5, 125.8, 125.7, 125.3, 111.0, 47.2, 42.5, 34.5, 31.3, 25.3, 20.3. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{24}H_{30}Na$ ([M + Na]$^+$): 341.2245; found: 341.2242. **$[\alpha]_D^{14}$** = 22.7, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 15.0 min, t_R (major) = 15.2 min); ee = 91%.



(*R*,*E*)-1-(4,5-dimethyl-4-phenylhexa-1,5-dien-1-yl)-4-methylbenzene (4c)

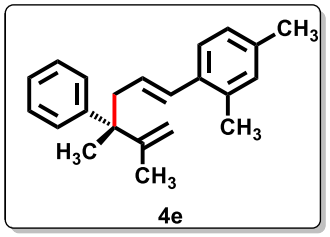
Purified by flash column chromatography (eluent: Petroleum

ether). Colorless oil (27.0 mg, 49%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.32 – 7.29 (m, 5H), 7.24 – 7.20 (m, 5H), 6.36 (d, J = 15.6 Hz, 1H), 6.11 – 5.99 (m, 2H), 5.08 – 5.04 (m, 2H), 3.42 (q, J = 7.8 Hz, 1H), 2.67 – 2.60 (m, 2H), 1.29 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 150.0, 143.8, 141.5, 134.9, 131.1, 128.5, 127.7, 126.3, 125.7, 125.3, 114.6, 50.2, 39.1, 34.5, 31.3. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{21}H_{24}Na$ ([M + Na]$^+$): 299.1773; found: 299.1770. **$[\alpha]_D^{15}$** = 66.1, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak IA column, hexanes/i-PrOH = 100/0, 1.0 mL/min, 250 nm, t_R (minor) = 5.2 min, t_R (major) = 5.8 min); ee = 88%.



(*R*,*E*)-1-(4,5-dimethyl-4-phenylhexa-1,5-dien-1-yl)-4-isopropyl benzene (4d)

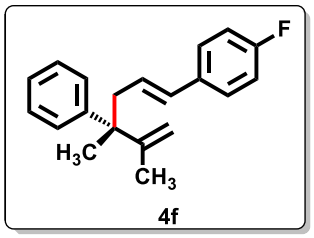
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (37.1 mg, 61%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.39 – 7.29 (m, 4H), 7.21 (d, J = 8.4 Hz, 2H), 7.13 (d, J = 8.4 Hz, 2H), 6.37 (d, J = 15.6 Hz, 1H), 5.96 – 5.91 (m, 1H), 5.01 (s, 1H), 4.98 (s, 1H), 2.90 – 2.94 (m, 1H), 2.78 – 2.69 (ddd, J = 31.3, 13.7, 7.3 Hz, 2H), 1.53 (s, 3H), 1.38 (s, 3H), 1.22 (d, J = 6.6 Hz, 6H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 150.8, 147.7, 147.1, 135.4, 132.0, 128.1, 126.5, 126.5, 126.0, 125.8, 111.0, 47.2, 42.5, 33.8, 25.3, 23.9, 20.3. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{23}H_{28}Na$ ([M + Na]$^+$): 327.2083; found: 327.2083. **$[\alpha]_D^{14}$** = 1.4, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 16.9 min, t_R (major) = 17.5 min); ee = 91%.



(*R*,*E*)-1-(4,5-dimethyl-4-phenylhexa-1,5-dien-1-yl)-2,4-dimethy lbenzene (4e)

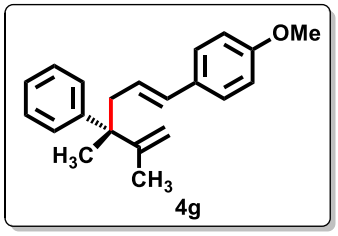
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (31.9 mg, 55%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.30 – 7.29 (m, 4H), 7.20 – 7.18 (m, 2H), 6.92 (d, J = 7.8 Hz, 2H), 6.52 (d, J = 15.6 Hz, 1H), 5.93 – 5.79 (m, 1H), 5.02 (s, 1H), 4.98 (s, 1H), 2.80 – 2.71 (m, 2H),

2.27 (s, 3H), 2.24 (s, 3H), 1.54 (s, 3H), 1.40 (s, 3H).**^{13}C NMR** (150 MHz, $CDCl_3$) δ: 150.9, 147.1, 136.5, 134.8, 134.2, 130.8, 130.1, 128.1, 127.9, 126.7, 126.5, 125.8, 125.7, 111.0, 47.2, 42.8, 25.3, 21.0, 20.3, 19.7.**HRMS** (ESI-TOF) (m/z): Calcd for $C_{22}H_{26}Na$ ($[M + Na]^+$): 313.1932; found: 313.1934. **$[\alpha]_D^{14}$** = 17.9, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak IA column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 9.2 min, t_R (major) = 9.4 min); ee = 91%.



(*R*,*E*)-1-(4,5-dimethyl-4-phenylhexa-1,5-dien-1-yl)-4-fluorobenzene (4f)

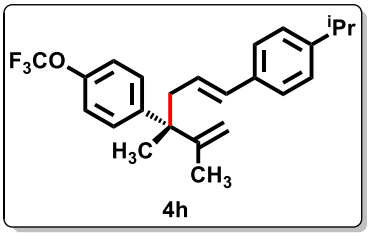
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (34.2 mg, 61%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.31 – 7.30 (m, 4H), 7.24 – 7.19 (m, 3H), 6.95 (t, *J* = 9.0 Hz, 2H), 6.35 (d, *J* = 15.6 Hz, 1H), 5.91 – 5.86 (m, 1H), 5.02 (s, 1H), 5.00 (s, 1H), 2.78 – 2.69 (m, 2H), 1.53 (s, 3H), 1.38 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 161.9 (*J* = 244.4 Hz), 150.8, 146.9, 133.9, 131.0, 128.1, 127.4 (*J* = 7.8 Hz), 127.2 (*J* = 2.1 Hz), 126.4, 125.9, 115.3 (*J* = 21.5 Hz), 111.0, 47.2, 42.5, 25.3, 20.3. **^{19}F NMR** (564 MHz; $CDCl_3$) *δ:* -115.59 – -115.64. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{20}H_{21}F$ ($[M + Na]^+$): 303.1525; found: 303.1523. **$[\alpha]_D^{14}$** = 8.5, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 1.0 mL/min, 250 nm, t_R (minor) = 9.5 min, t_R (major) = 10.2 min); ee = 90%.



(*R*,*E*)-1-(4,5-dimethyl-4-phenylhexa-1,5-dien-1-yl)-4-methoxybenzene (4g)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (28.0 mg, 48%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.31 – 7.30 (m, 4H), 7.21 (d, *J* = 8.4 Hz, 2H), 7.18 – 7.15 (m, 1H), 6.81 (d, *J* = 9.0 Hz, 2H), 6.33 (d, *J* = 16.2 Hz, 1H), 5.86 – 5.81 (m, 1H), 5.02 – 4.98 (m, 2H), 3.78 (s, 3H), 2.79 – 2.58 (m, 2H), 1.53 (d, *J* = 0.6 Hz, 3H), 1.38 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 158.7, 150.9, 147.1, 131.5, 130.7, 128.1, 127.1, 126.5, 125.8, 125.2, 113.9, 111.0, 55.3, 47.2, 42.5, 25.3, 20.3. **HRMS** (ESI-TOF) (m/z):

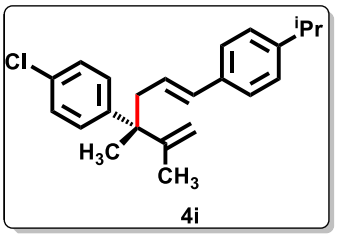
Calcd for $C_{21}H_{25}O$ ([M + H]$^+$): 293.1505; found: 293.1508. **[α]$_D^{15}$** = 40.1, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak IB column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 32.7 min, t_R (major) = 34.6 min); ee = 91%.



4h

(*R*,*E*)-1-(4,5-dimethyl-4-(4-(trifluoromethoxy)phenyl)hexa-1,5-dien-1-yl)-4-isopropylbenzene (4h)

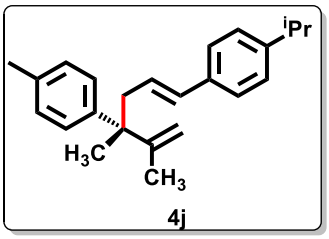
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (37.2 mg, 55%); **^{1}H NMR** (400 MHz, $CDCl_3$) δ: 7.32 (d, *J* = 7.2 Hz, 2H), 7.21 (d, *J* = 6.4 Hz, 2H), 7.14 (d, *J* = 7.2 Hz, 4H), 6.36 (d, *J* = 12.8 Hz, 1H), 5.93 – 5.87 (m, 1H), 5.02 – 5.00 (m, 2H), 2.77 – 2.73 (m, 1H), 2.70 – 2.65 (m, 2H), 1.53 (s, 3H), 1.38 (s, 3H), 1.23 (d, *J* = 6.4 Hz, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ: 149.8, 147.4, 146.9, 145.4, 134.8, 132.0, 127.4, 126.0, 125.5, 125.3, 120.0, 111.0, 46.5, 42.1, 33.3, 24.9, 23.5, 19.8. **^{19}F NMR** (470 MHz; $CDCl_3$) δ: -71.11. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{24}H_{27}F_3NaO$ ([M + Na]$^+$): 411.1912; found: 411.1913. **[α]$_D^{14}$** = 38.5, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H then OD-H column in series, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 45.8 min, t_R (major) = 46.9 min); ee = 90%.



4i

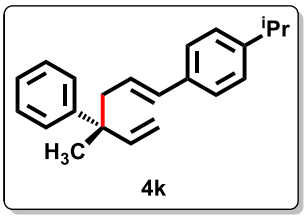
(*R*,*E*)-1-(4-(4-chlorophenyl)-4,5-dimethylhexa-1,5-dien-1-yl)-4-isopropyl-2-methylbenzene (4i)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (37.2 mg, 55%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.26 (d, *J* = 8.4 Hz, 2H), 7.23 – 7.20 (m, 4H), 7.14 (d, *J* = 8.4 Hz, 2H), 6.36 (d, *J* = 15.6 Hz, 1H), 5.92 – 5.87 (m, 1H), 5.01 (s, 1H), 4.99 (s, 1H), 2.90 – 2.84 (m, 1H), 2.74 – 2.65 (m, 2H), 1.52 (s, 3H), 1.36 (s, 3H), 1.23 (d, *J* = 6.6 Hz, 6H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 150.4, 147.8, 145.7, 135.3, 132.4, 131.6, 128.2, 128.0, 126.5, 126.0, 125.9, 111.3, 46.9, 42.6, 33.8, 25.2, 23.9, 20.2. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{23}H_{28}Cl$ ([M + H]$^+$): 339.1874; found: 339.1874. **[α]$_D^{14}$** = 60.5, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 21.6 min, t_R (major) = 22.7 min); ee = 91%.



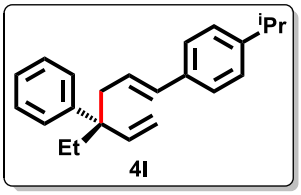
(*R*,*E*)-1-(4,5-dimethyl-4-(p-tolyl)hexa-1,5-dien-1-yl)-4-isopropyl benzene (4j)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (46.4 mg, 73%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.22 (d, J = 7.8 Hz, 2H), 7.19 (d, J = 7.8 Hz, 2H), 7.13 (d, J = 8.4 Hz, 2H), 7.10 (d, J = 7.8 Hz, 2H), 6.37 (d, J = 15.6 Hz, 1H), 5.97 – 5.92 (m, 1H), 4.99 – 4.96 (m, 2H), 2.89 – 2.84 (m, 1H), 2.78 – 2.67 (m, 2H), 2.32 (s, 3H), 1.53 (d, J = 0.6 Hz, 3H), 1.36 (s, 3H), 1.22 (d, J = 7.8 Hz, 6H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 150.9, 147.6, 144.2, 135.5, 135.2, 131.9, 128.8, 126.7, 126.5, 126.3, 126.0, 110.9, 46.8, 42.5, 33.8, 25.5, 23.9, 20.9, 20.3. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{24}H_{31}$ ([M + H]$^+$): 319.2426; found: 319.2424. **$[\alpha]_D^{14}$** = 20.4, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 0.5 mL/min, 250 nm, t_R (minor) = 14.5 min, t_R (major) = 15.3 min); ee = 92%.



(*R*,*E*)-1-isopropyl-4-(4-methyl-4-phenylhexa-1,5-dien-1-yl)benzene (4k)

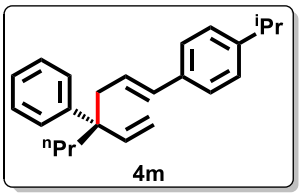
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (38.9 mg, 67%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.36 (d, J = 7.2 Hz, 2H), 7.33 – 7.30 (m, 3H), 7.19 (d, J = 7.8 Hz, 2H), 7.12 (d, J = 7.8 Hz, 2H), 6.35 (d, J = 16.2 Hz, 1H), 6.02 – 6.07 (m, 1H), 6.00 – 5.94 (m, 1H), 5.14 – 5.06 (m, 2H), 2.89 – 2.84 (m, 1H), 2.70 – 2.61 (m, 2H), 1.40 (s, 3H), 1.22 (d, J = 7.2 Hz, 6H).**^{13}C NMR** (150 MHz, $CDCl_3$) δ: 147.7, 147.1, 146.6, 135.3, 132.3, 128.1, 126.7, 126.5, 126.1, 126.0, 125.9, 112.1, 44.7, 44.6, 33.8, 25.0, 23.9. **$[\alpha]_D^{14}$** = 19.7, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 1.0 mL/min, 250 nm, t_R (minor) = 11.4 min, t_R (major) = 12.1 min); ee = 91%.



(*R*,*E*)-1-(4-ethyl-4-phenylhexa-1,5-dien-1-yl)-4-isopropylbenzene

(4l)

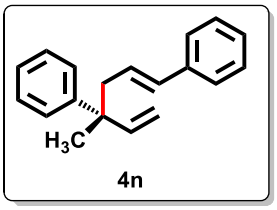
Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (37.1 mg, 61%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ:7.32 – 7.31 (m, 4H), 7.19 (d, J = 8.4 Hz, 3H), 7.12 (d, J = 9.0 Hz, 2H), 6.34 (d, J = 16.2 Hz, 1H), 6.00 – 5.92 (m, 2H), 5.23 (d, J = 11.4 Hz, 1H), 5.12 (d, J = 17.4 Hz, 1H), 2.88 – 2.83 (m, 1H), 2.67 (d, J = 7.2 Hz, 2H), 1.87 – 1.78 (m, 2H), 1.22 (d, J = 6.6 Hz, 6H), 0.76 (t, J = 7.2 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 147.7, 145.5, 145.3, 135.4, 131.9, 128.0, 127.4, 126.5, 126.7, 126.0, 125.9, 113.1, 48.1, 40.5, 33.8, 29.5, 23.9, 8.4. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{23}H_{28}Na$ ($[M + Na]^+$): 327.2089; found: 327.2088. **$[\alpha]_D^{14}$** = 6.7, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak OD-H column, hexanes/i-PrOH = 100/0, 1.0 ml/min, 250 nm, t_R (minor) = 9.7 min, t_R (major) = 10.1 min); ee = 90%.



4m

(*R*,*E*)-1-isopropyl-4-(4-phenyl-4-vinylhept-1-en-1-yl)benzene (4m)

Purified by flash column chromatography (eluent: Petroleum ether). Colorless oil (36.9 mg, 58%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.32 – 7.31 (m, 4H), 7.19 (d, J = 8.4 Hz, 3H), 7.12 (d, J = 7.8 Hz, 2H), 6.33 (d, J = 16.2 Hz, 1H), 6.01 – 5.92 (m, 2H), 5.61 (t, J = 7.2 Hz, 0.23H), 5.21 (dd, J = 10.8, 1.2 Hz, 1H), 5.11 (dd, J = 17.4, 1.2Hz, 1H), 2.89 – 2.84 (m, 1H), 2.67 (dd, J = 7.2, 1.2 Hz, 2H), 1.79 – 1.70 (m, 2H), 1.22 (d, J = 6.6 Hz, 6H), 1.19 – 1.01 (m, 2H), 0.84 (t, J = 7.2 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 147.7, 145.8, 145.5, 135.4, 131.9, 128.0, 127.3, 126.5, 126.1, 126.0, 125.8, 112.9, 48.0, 41.2, 39.6, 33.8, 23.9, 17.2, 14.7. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{24}H_{30}Na$ ($[M + Na]^+$): 341.2245; found: 341.2243. **$[\alpha]_D^{14}$** = 27.7, (c = 1.0, $CHCl_3$). **HPLC** analysis (Chiralpak IB column, hexanes/i-PrOH = 100/0, 1.0 ml/min, 250 nm, t_R (minor) = 9.1 min, t_R (major) = 9.7 min); ee = 85%. A structure undetermined compound and compound **4m** were obtained and can not isolated by flash column chromatography.



4n

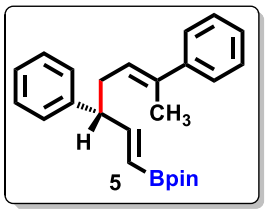
(*R*,*E*)-(4-methylhexa-1,5-diene-1,4-diyl)dibenzene (4n)

Purified by flash column chromatography (eluent: Petroleum ether).

Colorless oil (46.4 mg, 73%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.36 (d, J = 7.8 Hz, 2H), 7.32 (t, J = 7.2 Hz, 3H), 7.26 – 7.24 (m, 2H), 7.22 – 7.16 (m, 3H), 6.37 (d, J = 15.6 Hz, 1H), 6.10 (dd, J = 17.4, 10.8 Hz, 1H), 6.04 – 5.99 (m, 1H), 5.15 (d, J = 10.8 Hz, 1H), 5.09 (d, J = 17.4 Hz, 1H), 2.72 – 2.64 (m, 2H), 1.41 (s, 3H).. **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 147.0, 146.5, 137.7, 132.4, 128.4, 128.1, 127.1, 126.9, 126.6, 126.0 (3), 125.9 (6), 112.2, 44.7, 44.6, 25.0. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{19}H_{20}Na$ ($[M + Na]^+$): 271.1463; found: 271.1462. **$[\alpha]_D^{20}$** = 7.8, (c = 0.5, $CHCl_3$). **HPLC** analysis (Chiralpak IB column, hexanes/i-PrOH = 100/0, 0.3 ml/min, 250 nm, t_R (minor) = 25.7 min, t_R (major) = 26.9 min); ee = 90%.

Proof of Stereochemistry:

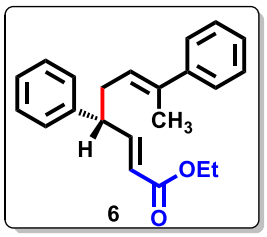
Spectra datas are in accordance with literature.[4] Based on the optical rotation of **6** in ref 4 (which was assigned to possess *S* absolute stereochemistry, **$[\alpha]_D^{20}$** = -45.342, (c = 2.1, $CHCl_3$), the absolute stereochemistry of product **4n** was determined as *R*.



2-((*R*,1*E*,5*E*)-3,6-diphenylhepta-1,5-dien-1-yl)-4,4,5,5-tetramethyl-1, 3,2-dioxaborolane (5)

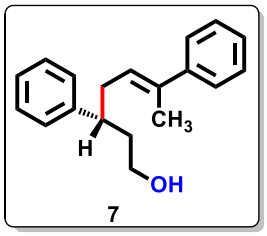
Hoveyda-Grubbs Catalyst 2nd (6.26 mg, 0.01 mmol), pinacol vinylboronate (61.6 mg, 0.4 mmol) were weighed out into a flamedried 50 mL round-bottom flask under a N_2 atmosphere in a glove box. The flask was fitted with a reflux condenser and removed from the glove box. A solution of **3y** (49.6 mg, 0.2 mmol) dissolved in DCM (5.0 mL) was added through a plastic syringe and the resulting mixture was allowed to stir at reflux (50 °C) for 24 h. The mixture was allowed to cool to 22 °C and the volatiles were removed in vacuo and the crude product was purified by flash column chromatography (using 1% diethyl ether / *n*-hexane) to give the corresponding product **5** colorless oil (56.1 mg, 75%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.31 – 7.25 (m, 6H), 7.22 – 7.18 (m, 4H), 6.81 (dd, J = 18.0, 7.2 Hz, 1H), 5.67 (t, J = 7.7 Hz, 1H), 5.48 (d, J = 17.4 Hz, 1H), 3.49 (d, J = 7.2 Hz, 1H), 2.72 – 2.67 (m, 1H), 2.65 – 2.59 (m, 1H), 1.95 (s, 3H), 1.25 (s, 12H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 156.2, 143.9, 143.0, 136.0, 128.4, 128.1, 128.0, 126.5, 126.4, 125.9, 125.7, 83.1, 51.7, 34.3, 24.8, 24.8, 16.1. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{19}H_{20}BNaO_2$ ($[M + Na]^+$):

397.2135; found: 397.2131.



(*R*,2*E*,6*E*)-ethyl 4,7-diphenylocta-2,6-dienoate (6)

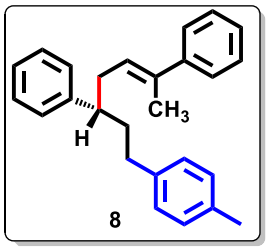
Hoveyda-Grubbs Catalyst 2nd (6.26 mg, 0.01 mmol), ethyl acrylate (40.0 mg, 0.4 mmol) were weighed out into a flamedried 50 mL round-bottom flask under a N_2 atmosphere in a glove box. The flask was fitted with a reflux condenser and removed from the glove box. A solution of **3y** (49.6 mg, 0.2 mmol) dissolved in DCM (5.0 mL) was added through a plastic syringe and the resulting mixture was allowed to stir at reflux (50 °C) for 24 h. The mixture was allowed to cool to 22 °C and the volatiles were removed in vacuo and the crude product was purified by flash column chromatography (using 1% diethyl ether / *n*-hexane) to give the corresponding product **6** colorless oil (49.5 mg, 77%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.32 (t, J = 7.2 Hz, 2H), 7.28 (d, J = 4.2 Hz, 4H), 7.24 – 7.22 (m, 3H), 7.11 – 7.14 (m, 1H), 5.83 (d, J = 15.6 Hz, 1H), 5.66 (t, J = 6.6 Hz, 1H), 4.17 (q, J = 7.2 Hz, 2H), 3.57 (q, J = 7.2 Hz, 1H), 2.74 – 2.64 (m, 2H), 1.97 (s, 3H), 1.27 (t, J = 7.2 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 166.6, 151.0, 143.7, 141.8, 137.0, 128.7, 128.1, 127.9, 126.9, 126.7, 125.7, 124.9, 121.2, 60.3, 48.5, 34.3, 16.1, 14.2. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{19}H_{24}O_2Na$ ($[M + Na]^+$): 343.1674; found: 343.1670.



(*R*,*E*)-3,6-diphenylhept-5-en-1-ol (7)

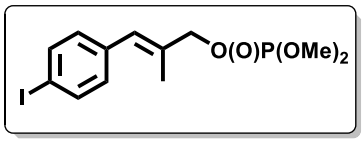
A dry 25 mL flask equipped with a magnetic stirring bar was flushed with nitrogen. To the flask were added **3y** (49.6 mg, 0.2 mmol) and dry THF (2.0 mL) and then a solution of 9-BBN (0.5 M solution in THF, 0.4 mL) at 0 ^{o}C. Then the reaction flask was stirred for 6 h at rt. NaOH (80 mg) and H_2O_2 (30%, 1.2 mL) were added to the reaction. After 3 h, the mixture was extracted with DCM (3 × 5.0 mL). The residue was purified by chromatography on silica gel (using 5% EtOAc/*n*-hexane) to afford **7** (colorless oil, 39.4 mg, 74 %); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.30 (t, J = 7.2 Hz, 2H), 7.27 – 7.25 (m, 4H), 7.22 – 7.19 (m, 4H), 5.68 (t, J = 7.8 Hz, 1H), 3.59 – 3.56 (m, 1H),

3.52 – 3.48 (m, 1H), 2.90 – 2.85 (m, 1H), 2.58 – 2.53 (m, 1H), 2.50 – 2.46 (m, 1H), 2.08 – 2.02 (m, 1H), 1.95 – 1.85 (m, 4H), 1.16 (s, 1H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 144.6, 143.9, 135.9, 128.5, 128.1, 127.6, 126.9, 126.5, 126.3, 126.2, 126.1, 125.6, 61.2, 42.8, 38.6, 36.3, 15.9. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{19}H_{20}Na$ ($[M + Na]^+$): 289.1563; found: 289.1580.



(*S*,*E*)-(7-(p-tolyl)hept-2-ene-2,5-diyl)dibenzene (8)

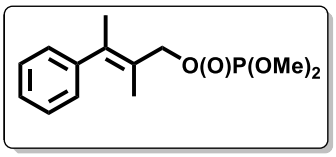
To the dry 25 mL flask with a magnetic stirring bar was added **3y** (49.6 mg, 0.2 mmol) and dry THF (2.0 mL) and then added the solution of 9-BBN (0.5 M solution in THF, 0.4 mL) at 0 ^oC under N_2 atmosphere. After 12 h at rt, $Pd(dppf)Cl_2$ (14.5 mg, 10 mol%), 4-bromotoluene (51.3 mg, 1.5 equiv.) and aqueous NaOH (3.0 mL of 3 M) were added successively to the above mixture at rt and then reacted 16 h under reflux. The reaction mixture was diluted with hexane (10.0 mL), and the residual borane was oxidized by addition of H_2O_2 (30%, 4.0 mL) at rt. The mixture was extracted with DCM (3 × 5.0 mL). The residue was purified by chromatography on silica gel (using 1% diethyl ether / *n*-hexane) to afford **8** (colorless oil, 39.4 mg, 59%); **^{1}H NMR** (600 MHz, $CDCl_3$) δ: ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.31 (t, *J* = 7.8 Hz, 2H), 7.26 – 7.21 (m, 7H), 7.19 – 7.17 (m, 1H), 7.06 (d, *J* = 7.8 Hz, 2H), 7.00 (d, *J* = 7.8 Hz, 2H), 5.65 (t, *J* = 6.6 Hz, 1H), 2.74 – 2.69 (m, 1H), 2.57 – 2.40 (m, 4H), 2.30 (s, 3H), 2.07 – 1.93 (m, 2H), 1.90 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 145.1, 144.0, 139.3, 135.7, 135.1, 129.0, 128.3, 128.2, 128.1, 127.8, 126.5, 126.1, 125.6, 45.8, 37.6, 36.4, 33.3, 21.0, 15.9. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{26}H_{28}Na$ ($[M + Na]^+$): 363.2089; found: 363.2086.



(E)-3-(4-iodophenyl)-2-methylallyl dimethyl phosphoroperoxoite

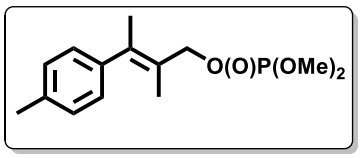
Following the general procedure **4.** **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.67 (d, *J* = 8.4 Hz, 2H), 7.02 (d, *J* = 8.4 Hz, 2H), 6.49 (s, 1H), 4.57 (d, *J* = 7.8 Hz, 2H), 3.80 (d, *J* = 9.6 Hz, 6H), 1.90 (d, *J* = 1.2 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 137.3, 136.2, 133.7(d, *J* = 6.75

Hz), 130.7, 127.2, 92.3, 72.9(d, *J* = 5.55 Hz), 54.3(d, *J* = 6.0 Hz), 15.1. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{12}H_{16}NaIO_4P$ ($[M + Na]^+$): 404.9723; found: 404.9722.



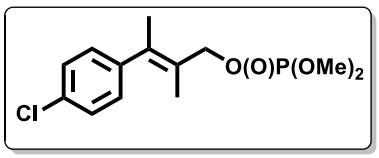
***(E)*-dimethyl (2-methyl-3-phenylbut-2-en-1-yl) phosphoroperoxoite**

Following the general procedure **4.** **^{1}H NMR** (600 MHz, $CDCl_3$) *δ*: 7.33 (t, *J* = 7.8 Hz, 2H), 7.24 (t, *J* = 7.8 Hz, 1H), 7.13 (d, *J* = 6.6 Hz, 2H), 4.73 (d, *J* = 7.2 Hz, 2H), 3.81 (d, *J* = 10.8 Hz, 6H), 2.07 (s, 3H), 1.67 (d, *J* = 1.2 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) *δ*: 143.8, 137.2, 128.2, 127.7, 126.6, 126.1 (d, *J* = 6.6 Hz), 68.4 (d, *J* = 5.55 Hz), 54.2 (d, *J* = 6.0 Hz), 20.6, 17.8. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{13}H_{19}NaO_4P$ ($[M + Na]^+$): 293.0913; found: 293.0914.



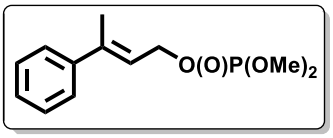
***(E)*-dimethyl (2-methyl-3-(*p*-tolyl)but-2-en-1-yl) phosphoroperoxoite**

Following the general procedure **4.** **^{1}H NMR** (600 MHz, $CDCl_3$) *δ*: 7.14 (d, *J* = 7.8 Hz, 2H), 7.02 (d, *J* = 7.8 Hz, 2H), 4.72 (d, *J* = 7.2 Hz, 2H), 3.80 (d, *J* = 11.4 Hz, 6H), 2.35 (s, 4H), 2.05 (d, *J* = 1.8 Hz, 3H), 1.68 (d, *J* = 1.8 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) *δ*: 140.8, 137.1, 136.1, 128.8, 127.7, 125.9 (d, *J* = 6.6 Hz), 68.5 (d, *J* = 5.7 Hz), 54.2 (d, *J* = 6.0 Hz), 21.1, 20.6, 17.9. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{14}H_{21}NaO_4P$ ($[M + Na]^+$): 307.1075; found: 307.1074.



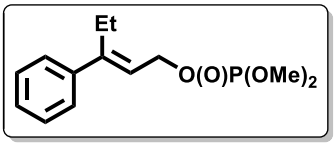
(*E*)-3-(4-chlorophenyl)-2-methylbut-2-en-1-yl dimethyl phosphoroperoxoite

Following the general procedure **4.** **^{1}H NMR** (500 MHz, $CDCl_3$) *δ*: 7.30 (d, *J* = 8.5 Hz, 2H), 7.07 (d, *J* = 8.5 Hz, 2H), 4.72 (d, *J* = 7.5 Hz, 2H), 3.81 (d, *J* = 11.0 Hz, 6H), 2.04 (s, 3H), 1.67 (d, *J* = 1.0 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) *δ*: 141.9, 135.7, 132.1, 129.0, 128.1, 126.6 (d, *J* = 6.45 Hz), 67.9 (d, *J* = 5.55 Hz), 54.0 (d, *J* = 6.0 Hz), 20.2, 17.5. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{13}H_{18}ClNaO_4P$ ($[M + Na]^+$): 327.0529; found: 327.0524.



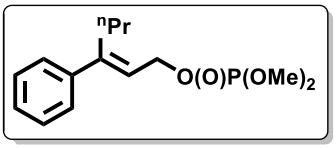
(*E*)-dimethyl (3-phenylbut-2-en-1-yl) phosphoroperoxoite

Following the general procedure **4.** **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.40 (d, J = 7.2 Hz, 2H), 7.33 (t, J = 7.8 Hz, 2H), 7.27 (t, J = 7.2 Hz, 1H), 5.96 – 5.93 (m, 1H), 4.77 (t, J = 7.2 Hz, 2H), 3.77 (d, J = 10.8 Hz, 6H), 2.12 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 142.1, 140.7, 128.1, 127.5, 125. 7, 121.3(d, J = 6.45 Hz), 64.4 (d, J = 5.4 Hz), 54.1 (d, J = 6.0 Hz), 16.0. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{12}H_{17}NaO_4P$ ($[M + Na]^+$): 279.0757; found: 279.0765.



***(E)*-dimethyl (3-phenylpent-2-en-1-yl) phosphoroperoxoite**

Following the general procedure **4.** **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.37 (d, J = 7.2 Hz, 2H), 7.33 (t, J = 7.2 Hz, 2H), 7.28 (t, J = 7.2 Hz, 1H), 5.81 (t, J = 7.2 Hz, 1H), 4.77 (t, J = 7.2 Hz, 2H), 3.78 (d, J = 11.4 Hz, 6H), 2.59 – 2.86 (m, 2H), 1.00 (t, J = 7.8 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 147.6, 141.4, 128.3, 127.6, 126.4, 121.2 (d, J = 6.6 Hz), 64.3 (d, J = 5.4 Hz), 54.2 (d, J = 5.85 Hz), 23.3, 13.7. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{13}H_{19}NaO_4P$ ($[M + Na]^+$): 293.0913; found: 293.0909.



***(E)*-dimethyl (3-phenylhex-2-en-1-yl) phosphoroperoxoite**

Following the general procedure **4.** **^{1}H NMR** (600 MHz, $CDCl_3$) δ: 7.36 – 7.31 (m, 4H), 7.29 – 7.26 (m, 1H), 5.84 (t, J = 6.6 Hz, 1H), 4.77 (t, J = 7.2 Hz, 2H), 3.78 (d, J = 10.8 Hz, 6H), 2.53 (t, J = 7.8 Hz, 2H), 1.41 – 1.35 (m, 2H), 0.88 (t, J = 7.2 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ: 145.9, 141.7, 128.3, 127.5, 126.4, 122.1(d, J = 6.75 Hz), 64.4 (d, J = 5.4 Hz, 6H), 54.2 (d, J = 6.0 Hz, 6H), 32.0, 21.8, 13.7. **HRMS** (ESI-TOF) (m/z): Calcd for $C_{14}H_{21}NaO_4P$ ($[M + Na]^+$): 3071070; found: 3071056.

6. References

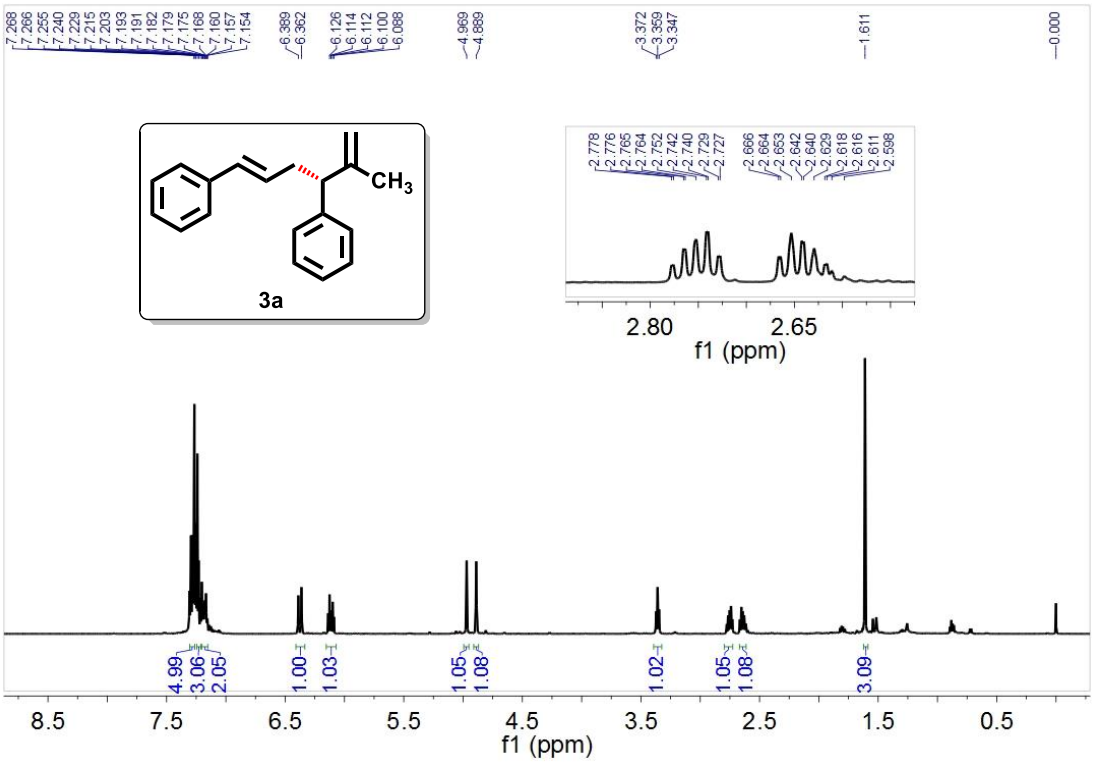
1. B. Jung and A. H. Hoveyda, *J. Am. Chem. Soc.* 2012, **134**, 1490.

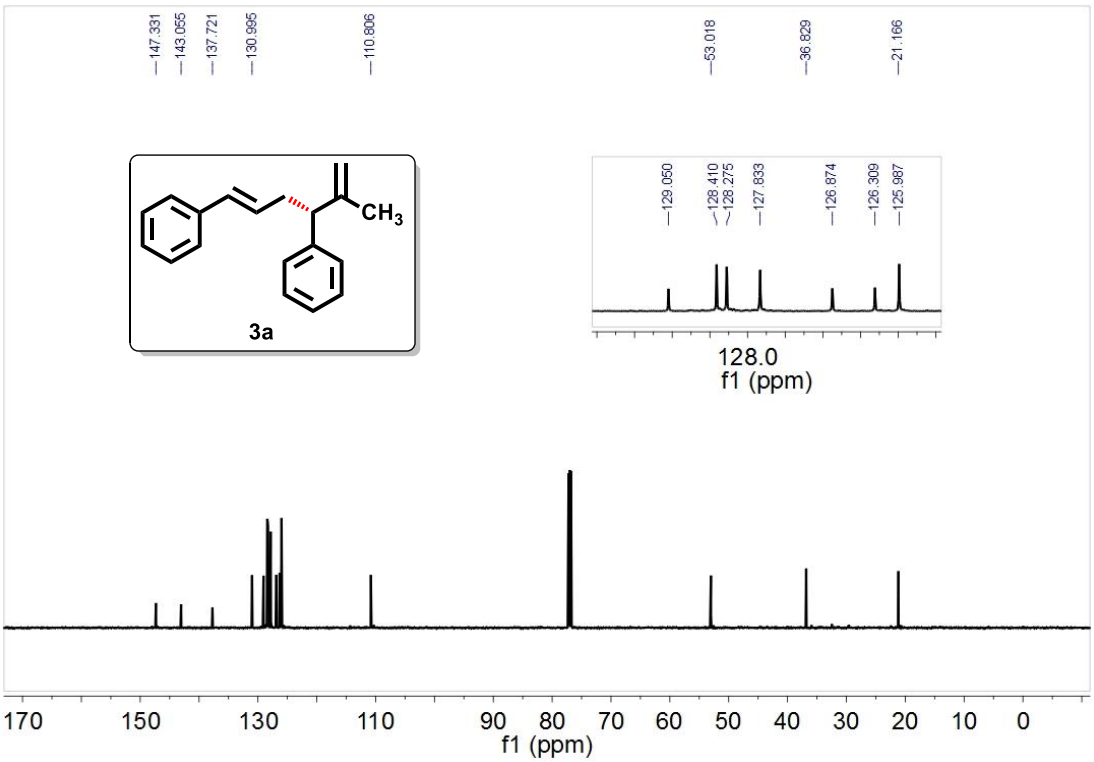
2. M. S. Baird, A. V. Nizovtsev and I. G. Bolesov, *Tetrahedron* 2002, **58**, 1581.

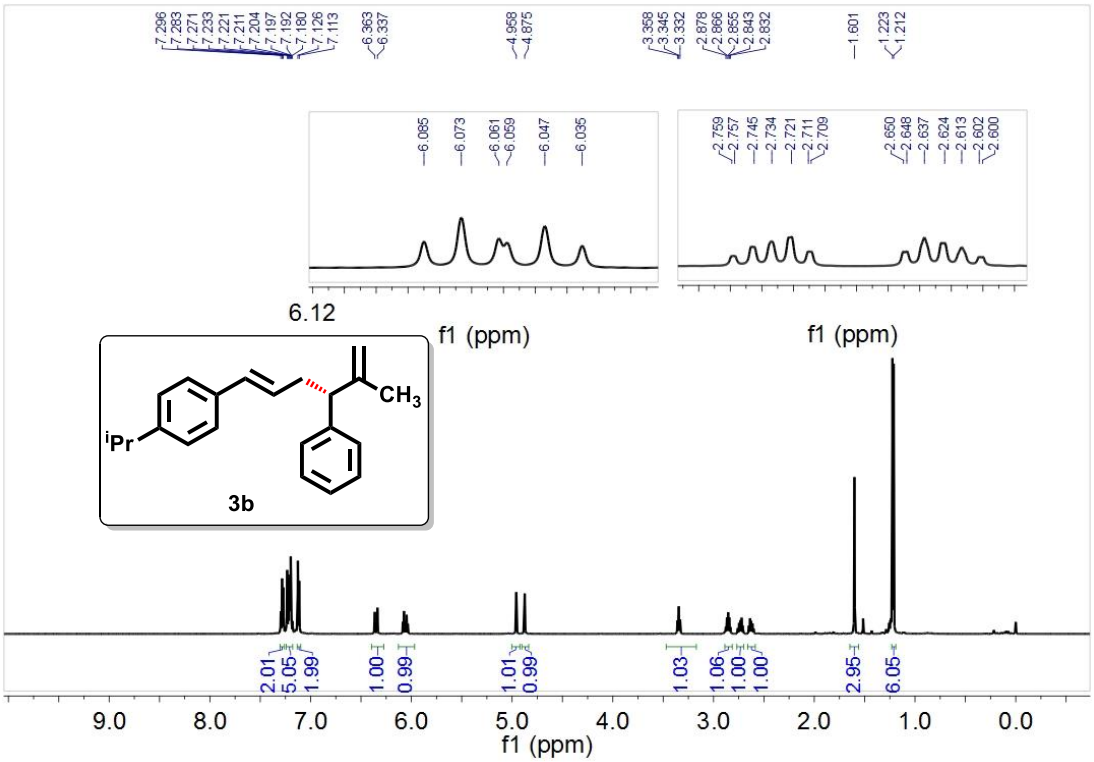
3. C.-M. Zhong, S. Kunii, Y. Kosaka, M. Sawamura and H. Ito, *J. Am. Chem. Soc*. 2010, **132**, 11440.

4. P. Zhang, H. Le, R. E. Kyne and J. P. Morken, *J. Am. Chem. Soc*. 2011, **133**, 9716.

7. ^{1}H, ^{13}C and ^{19}F Spectra of New Compounds



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6.337
4.958
4.875
3.358
3.345
3.332
2.878
2.866
2.855
2.843
2.832
1.601
1.223
1.212
6.085
6.073
6.061
6.059
6.047
6.035
2.759
2.757
2.745
2.734
2.721
2.711
2.709
2.650
2.648
2.637
2.624
2.613
2.602
2.600
6.12
f1 (ppm)
f1 (ppm)
iPr
CH3
3b
2.01
5.05
1.99
1.00
0.99
1.01
0.99
1.03
1.06
1.00
1.00
2.95
6.05
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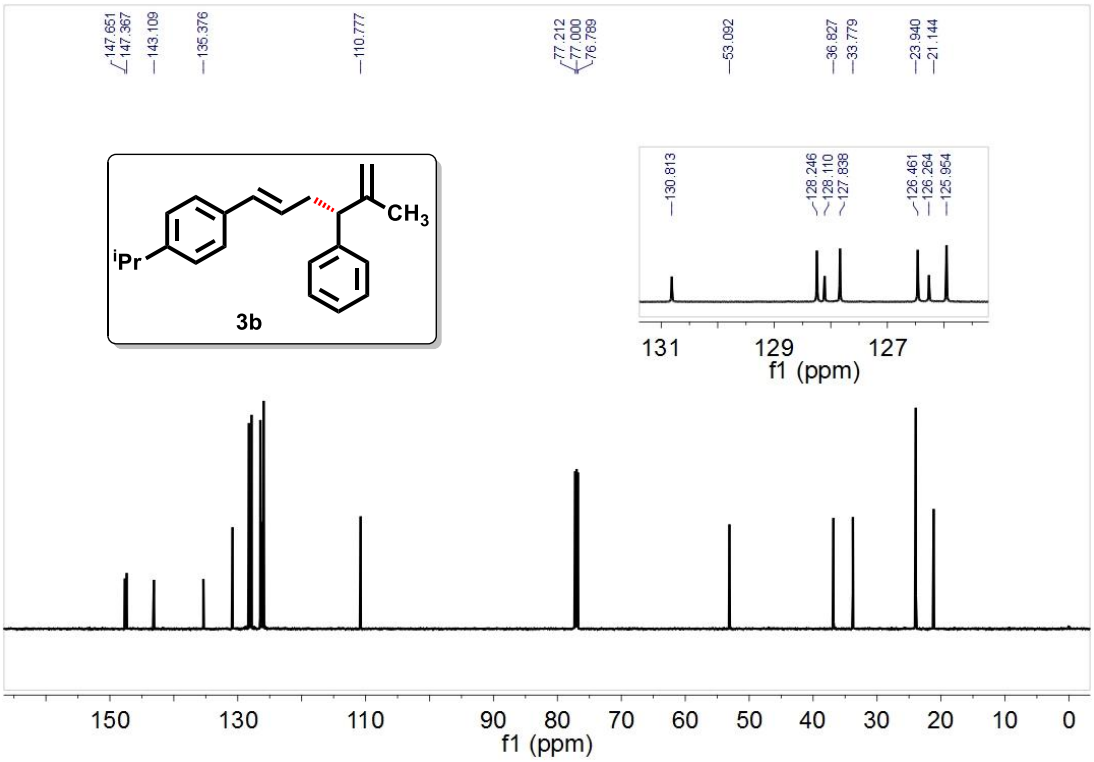
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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21.144
130.813
128.246
128.110
127.838
126.461
126.264
125.954
iPr
CH3
3b
131
129
127
f1 (ppm)
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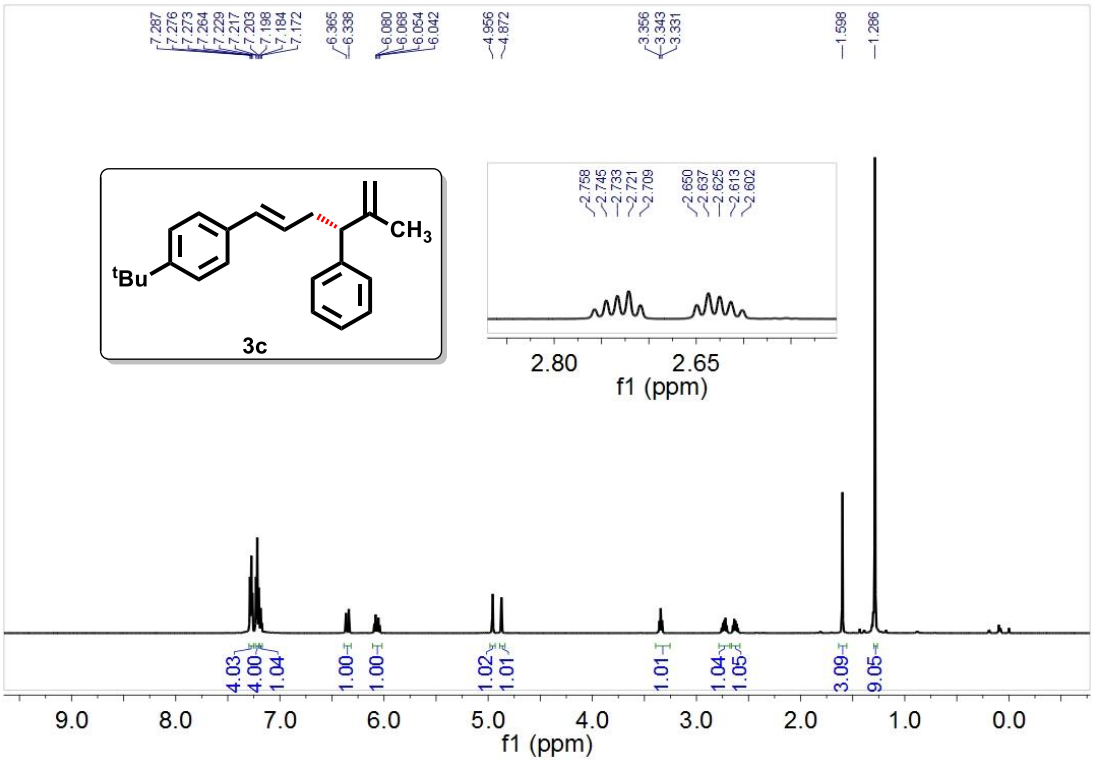
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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6.068
6.054
6.042
4.956
4.872
3.356
3.343
3.331
1.598
1.286
2.758
2.745
2.733
2.721
2.709
2.650
2.637
2.625
2.613
2.602
CH3
tBu
3c
2.80
2.65
f1 (ppm)
4.03
4.00
1.04
1.00
1.00
1.02
1.01
1.01
1.04
1.05
3.09
9.05
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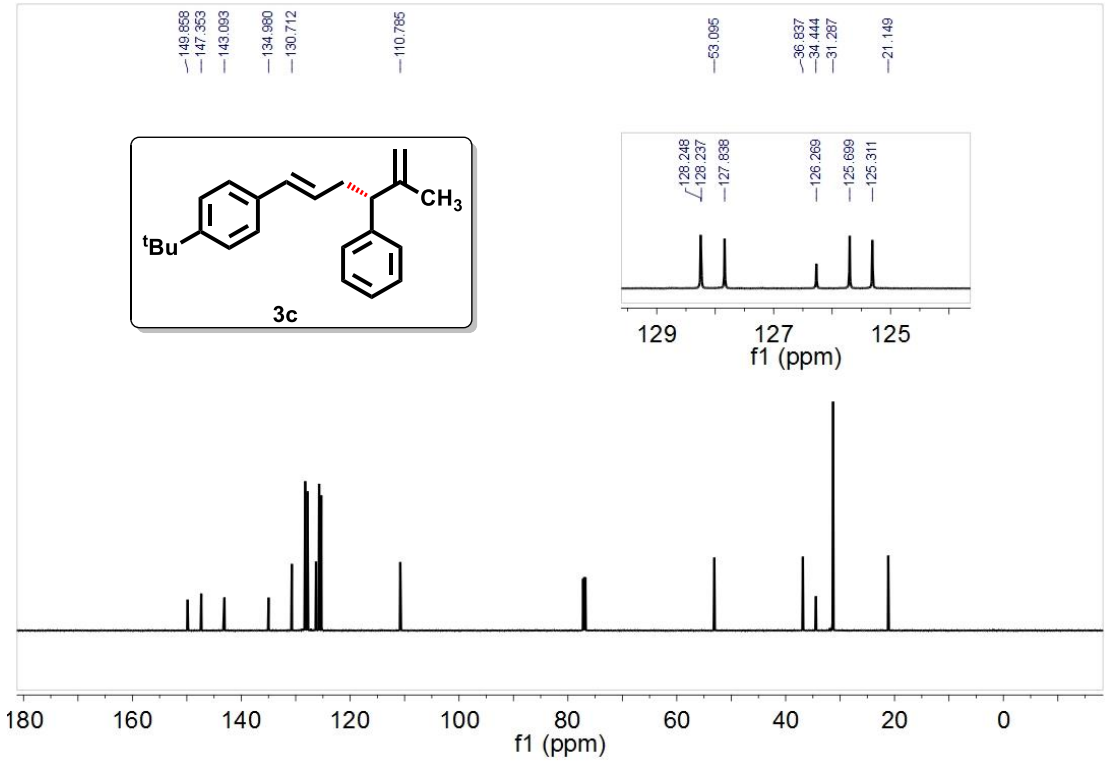
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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128.237
127.838
126.269
125.699
125.311
CH3
tBu
3c
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127
125
f1 (ppm)
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140
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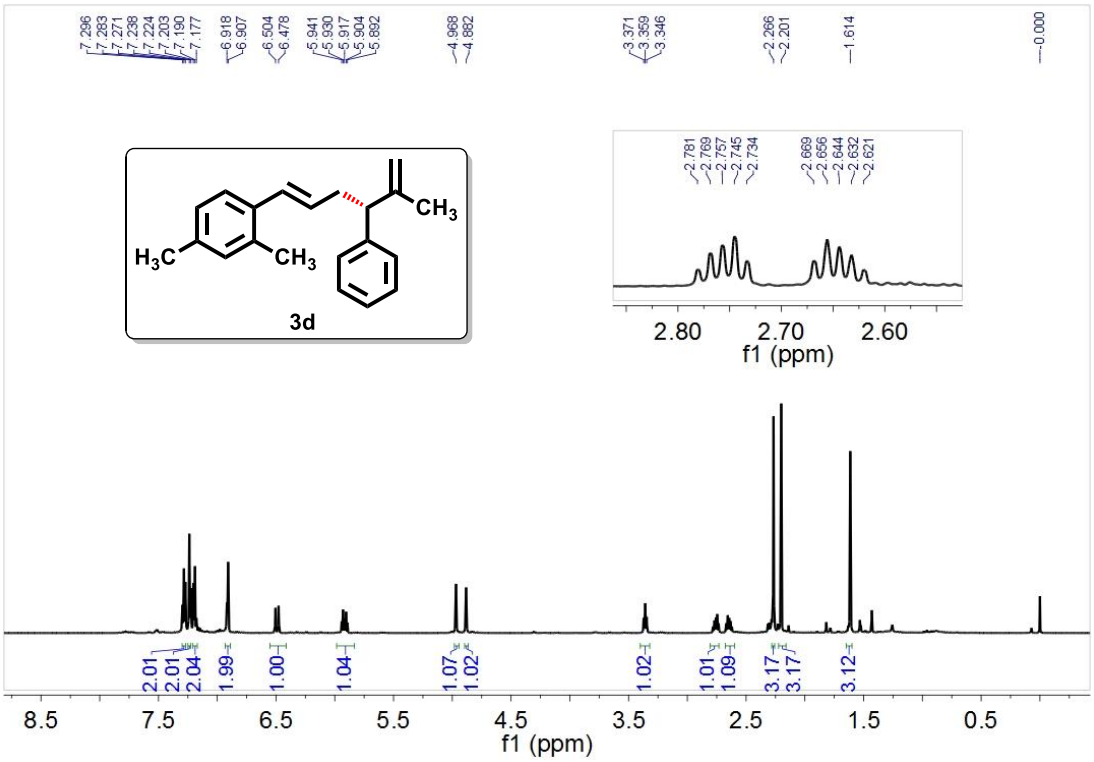
100
80
60
40
20
0
f1 (ppm)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5.941
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5.917
5.904
5.892
4.968
4.882
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3.359
3.346
2.266
2.201
1.614
0.000
2.781
2.769
2.757
2.745
2.734
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2.656
2.644
2.632
2.621
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H3C
CH3
3d
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2.70
2.60
f1 (ppm)
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2.01
2.04
1.99
1.00
1.04
1.07
1.02
1.02
1.01
1.09
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7.5
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2.5
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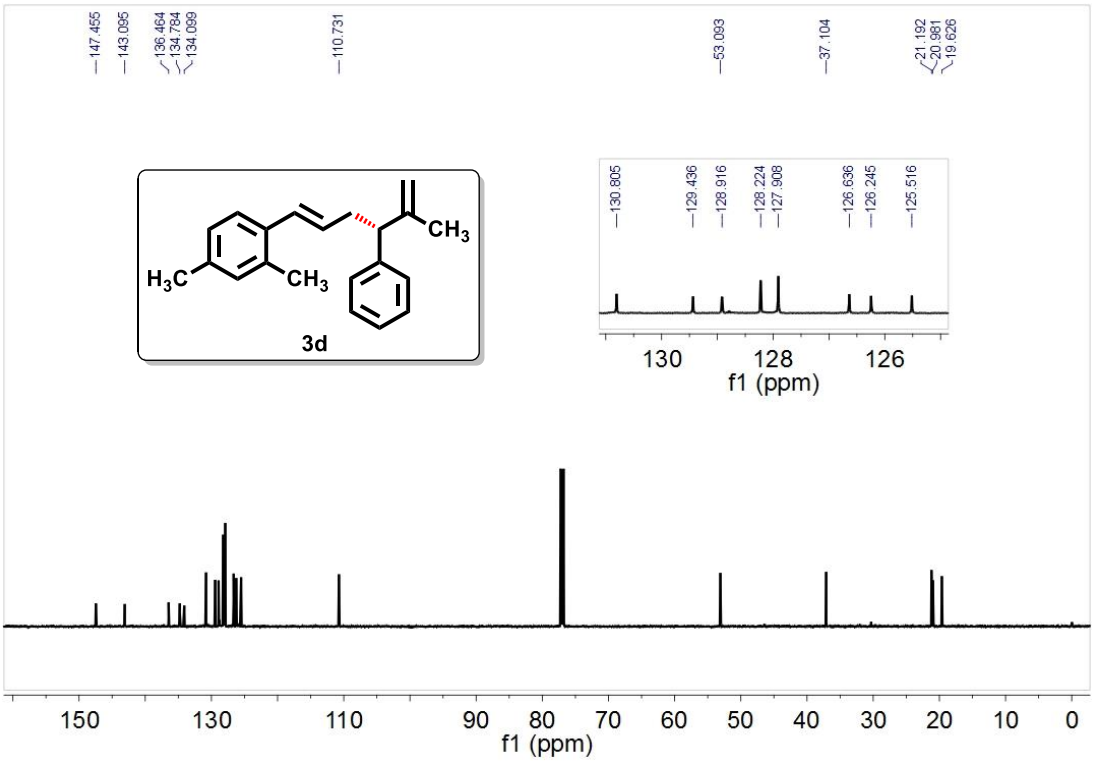
0.5
f1 (ppm)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127.908
126.636
126.245
125.516
CH3
H3C
CH3
3d
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128
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130
110
90
80
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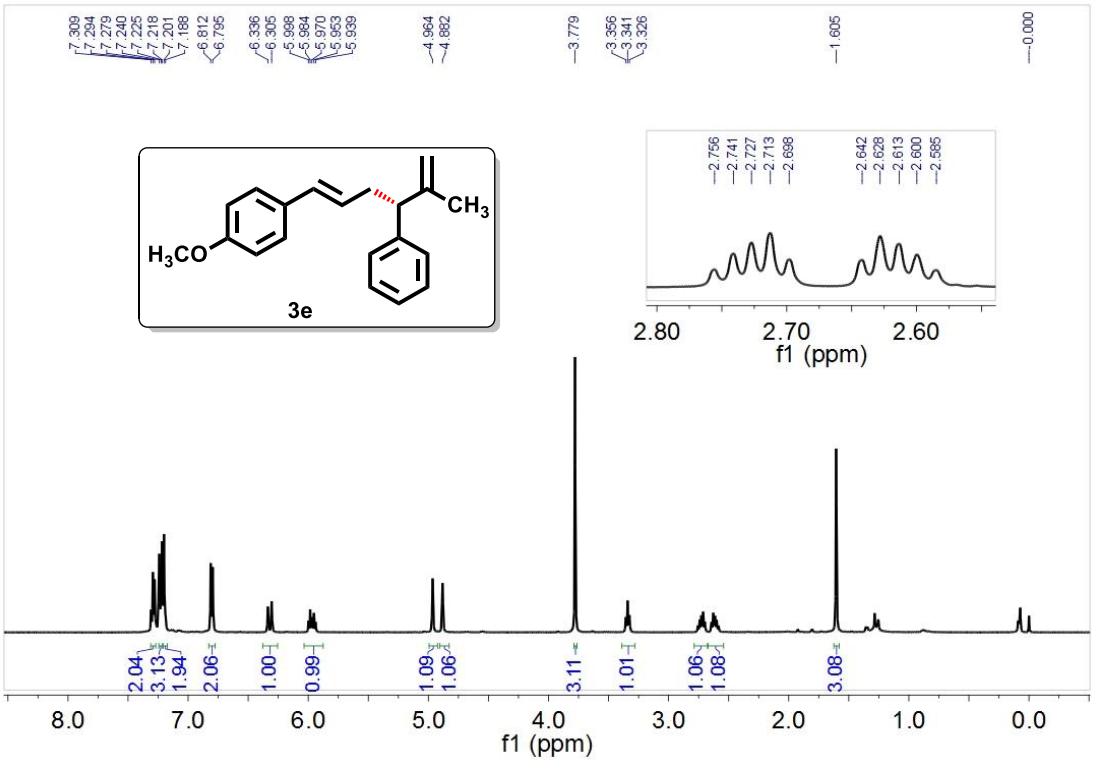
60
50
40
30
20
10
0
f1 (ppm)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5.984
5.970
5.953
5.939
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3.356
3.341
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2.642
2.628
2.613
2.600
2.585
H_3CO
CH_3
3e
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2.70
2.60
f1 (ppm)
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3.13
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0.99
1.09
1.06
3.11
1.01
1.06
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7.0
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5.0
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2.0
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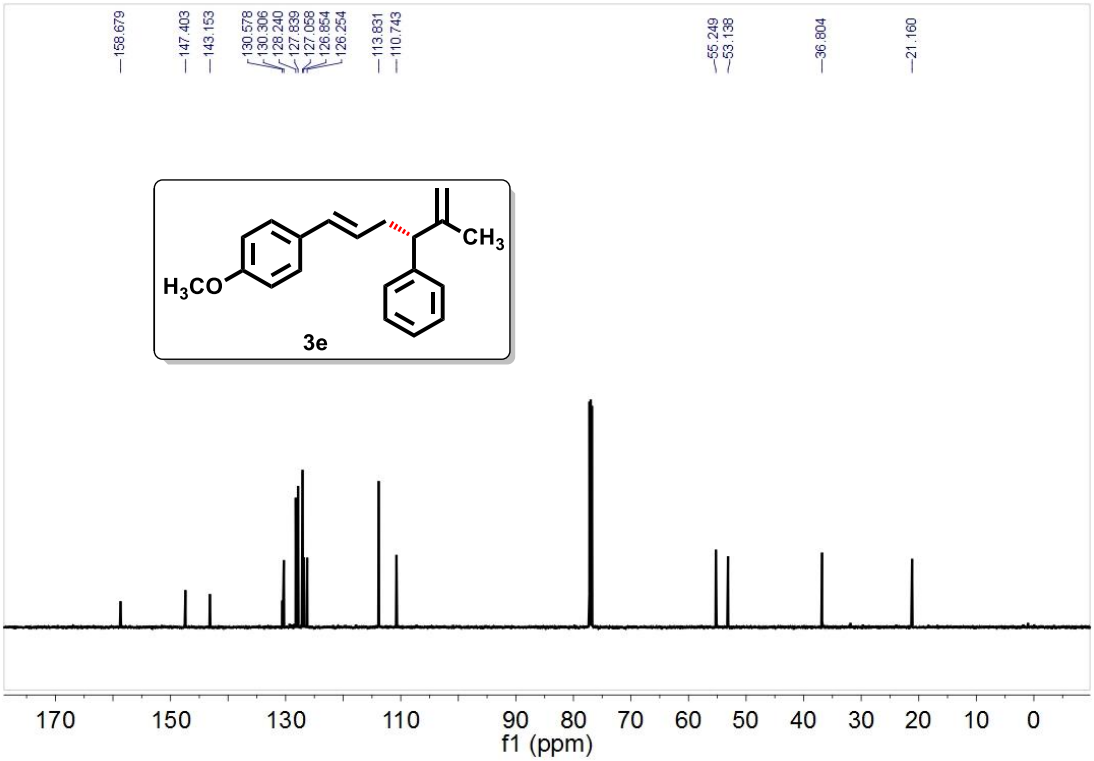
f1 (ppm)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55.249
53.138
36.804
21.160
H_3CO
CH_3
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50
40
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20
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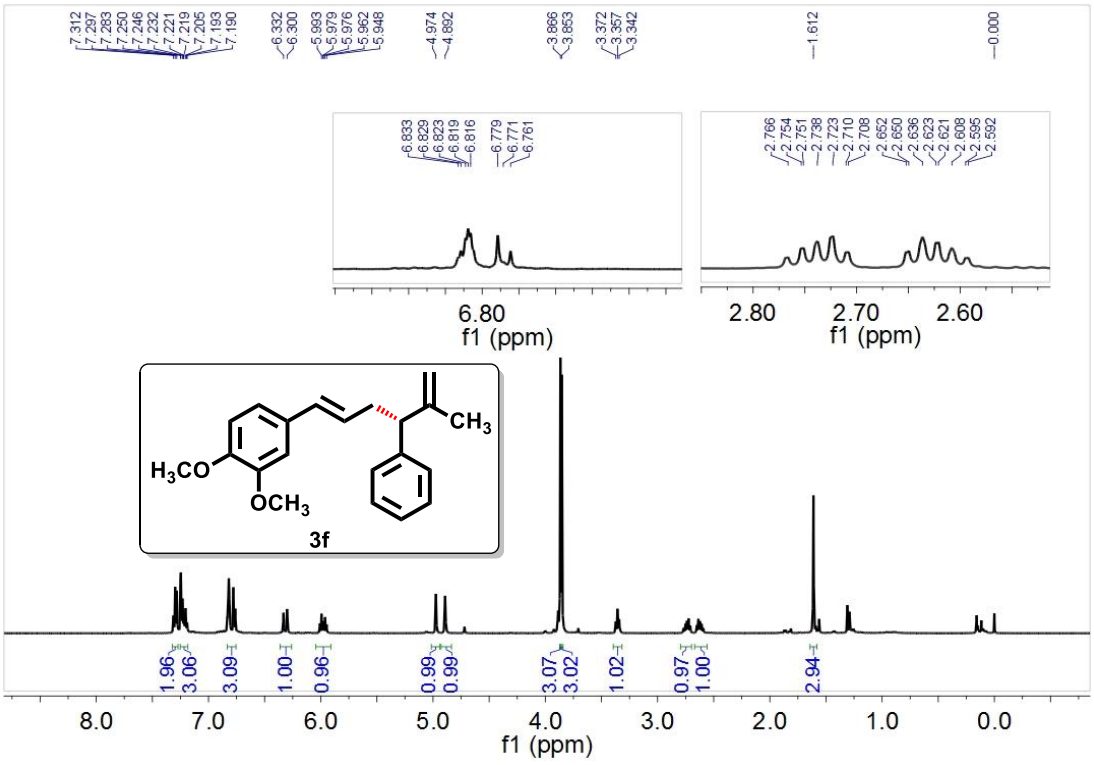
f1 (ppm)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5.976
5.962
5.948
4.974
4.892
3.866
3.853
3.372
3.357
3.342
1.612
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6.829
6.823
6.819
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2.751
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2.723
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2.650
2.636
2.623
2.621
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2.592
6.80
f1 (ppm)
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2.70
2.60
f1 (ppm)
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OCH3
CH3
3f
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3.09
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0.96
0.99
0.99
3.07
3.02
1.02
0.97
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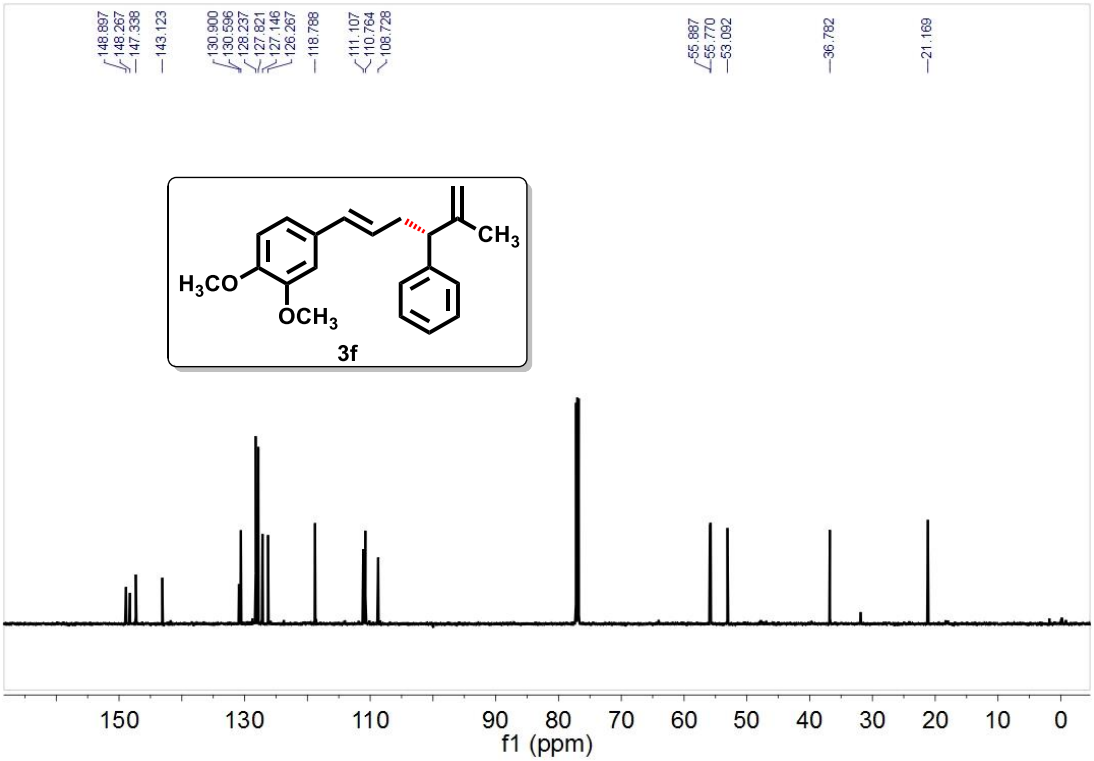
f1 (ppm)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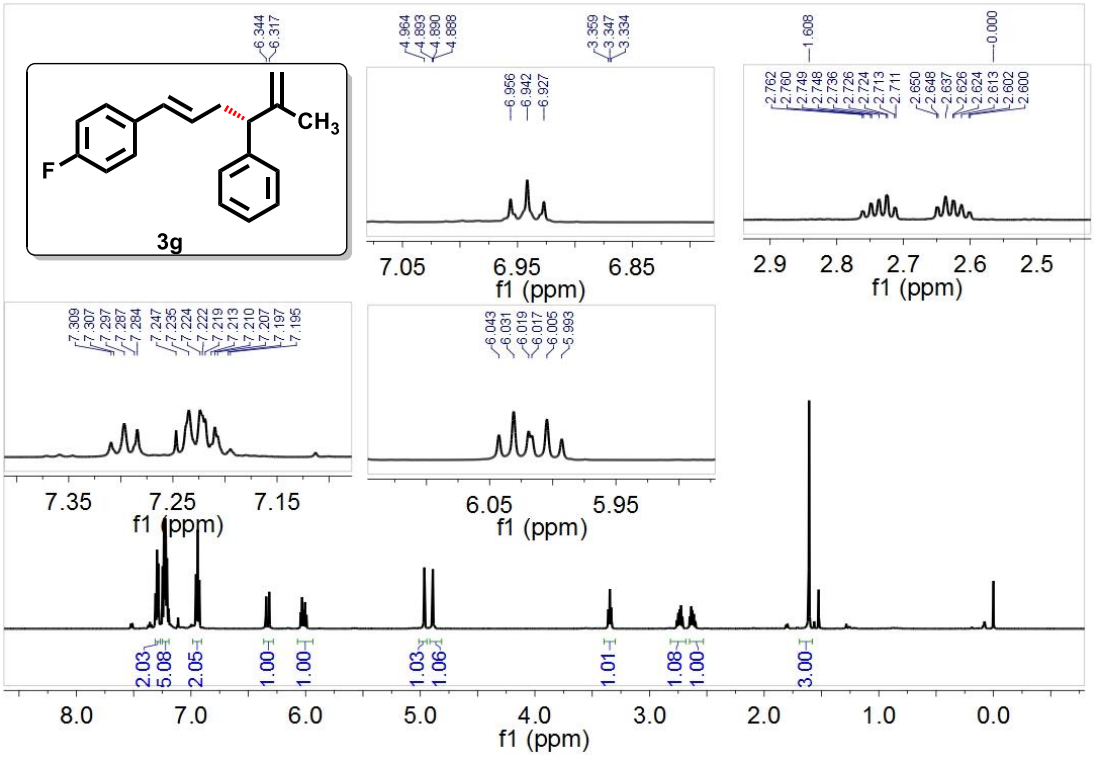
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f1 (ppm)
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2.7
2.6
2.5
f1 (ppm)
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f1 (ppm)
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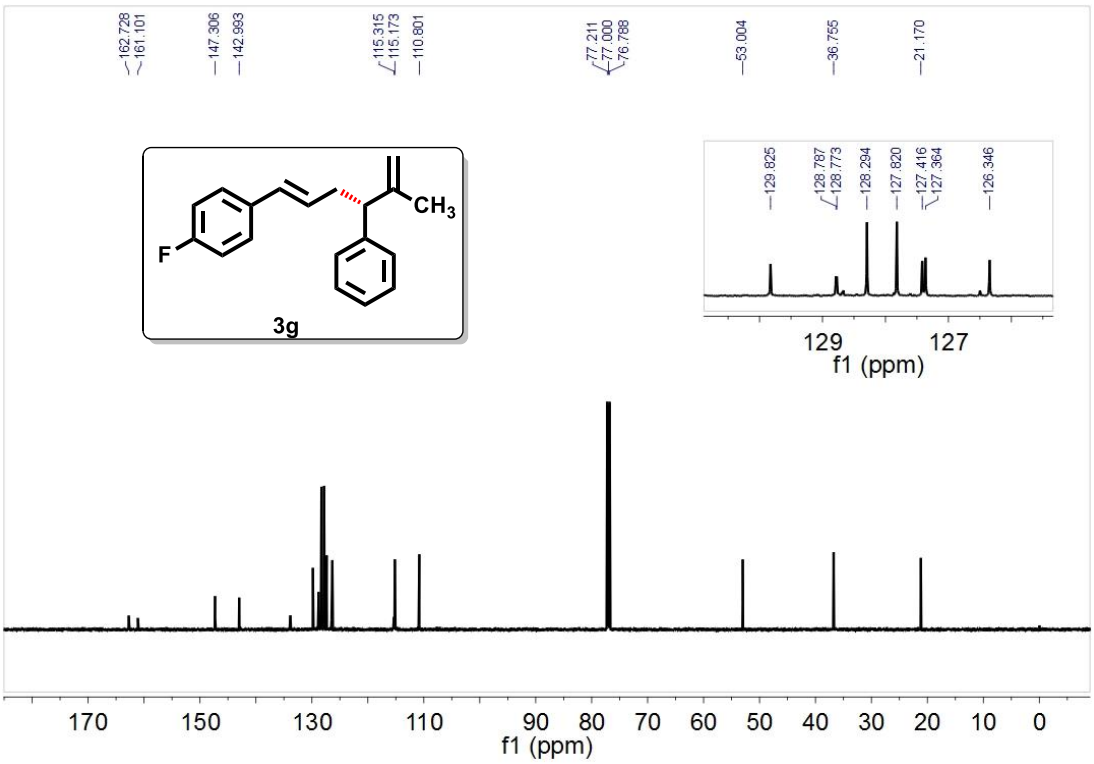
f1 (ppm)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21.170
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128.787
128.773
128.294
127.820
127.416
127.364
126.346
F
CH3
3g
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50
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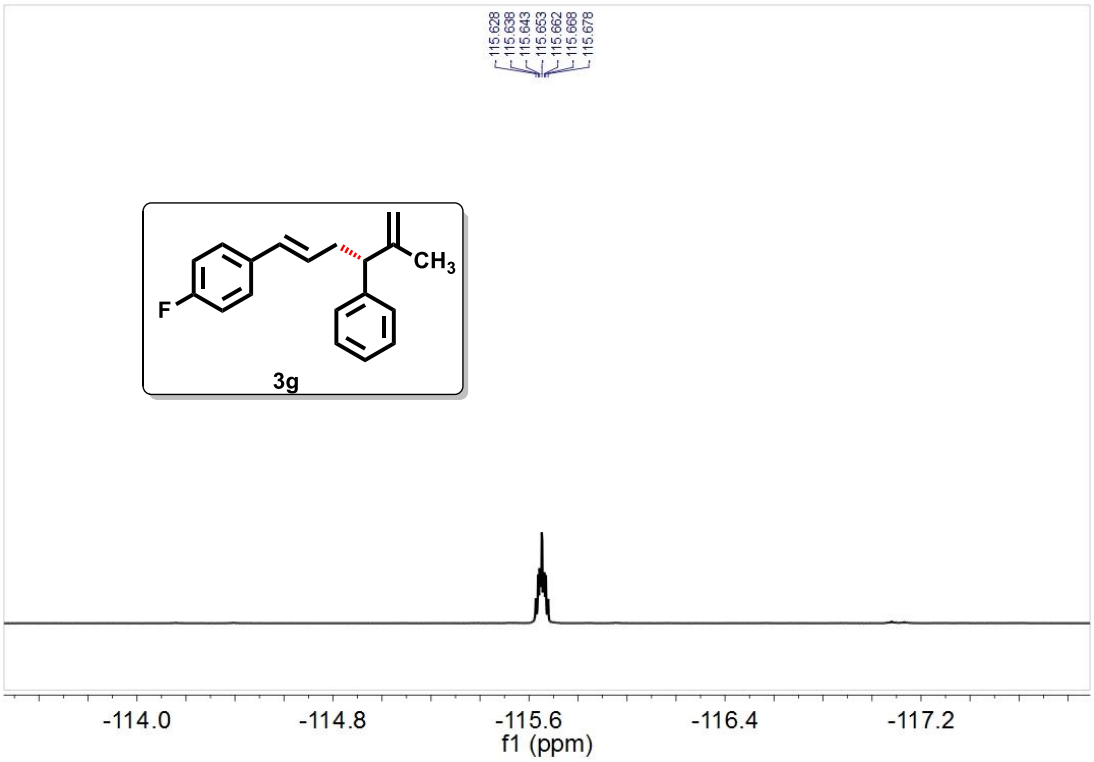
f1 (ppm)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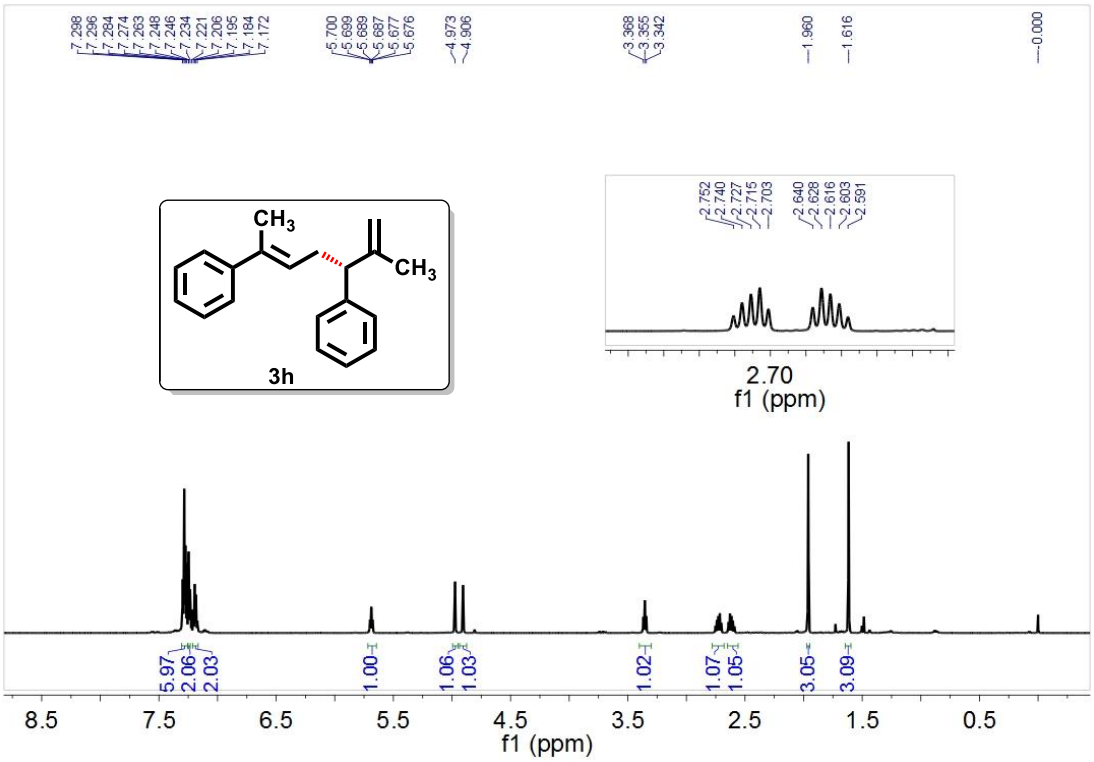
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f1 (ppm)
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1.06
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1.07
1.05
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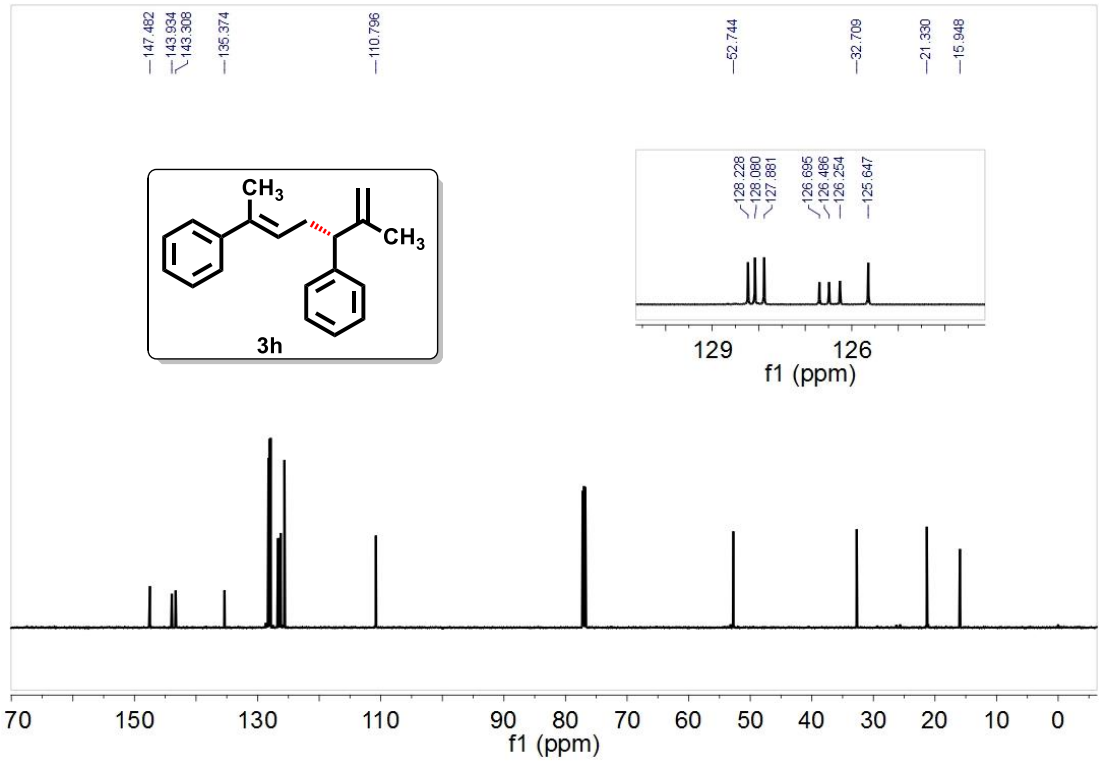
f1 (ppm)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125.647
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126
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10
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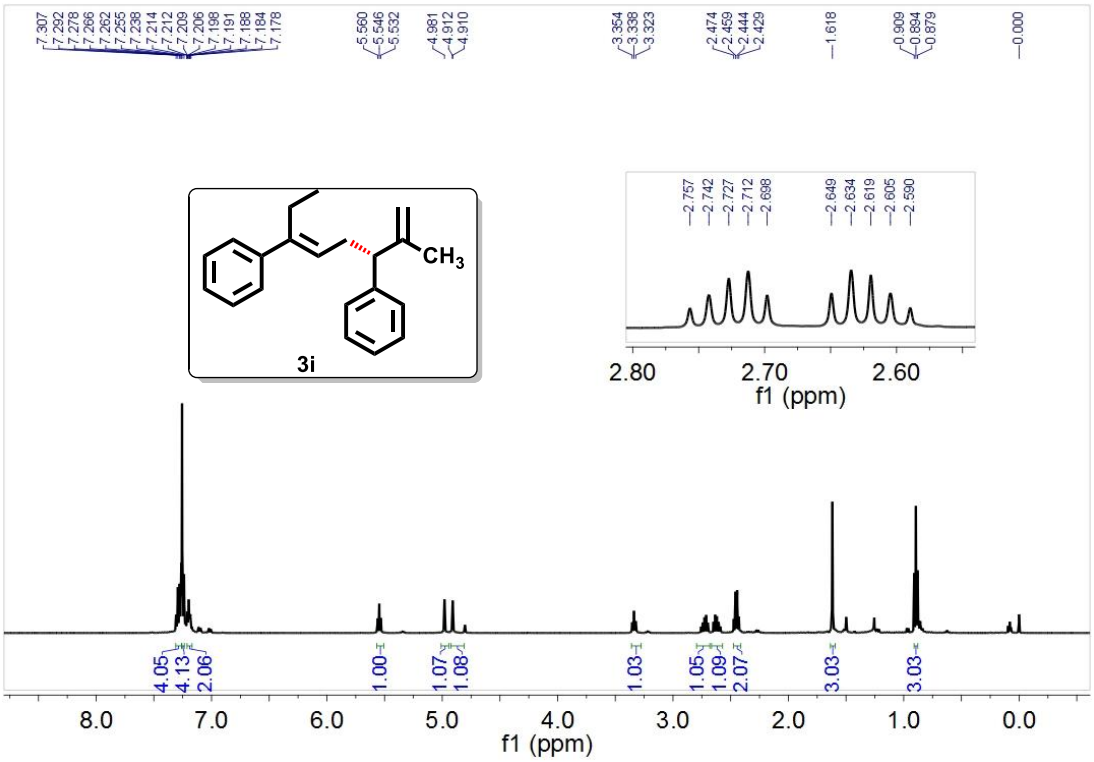
f1 (ppm)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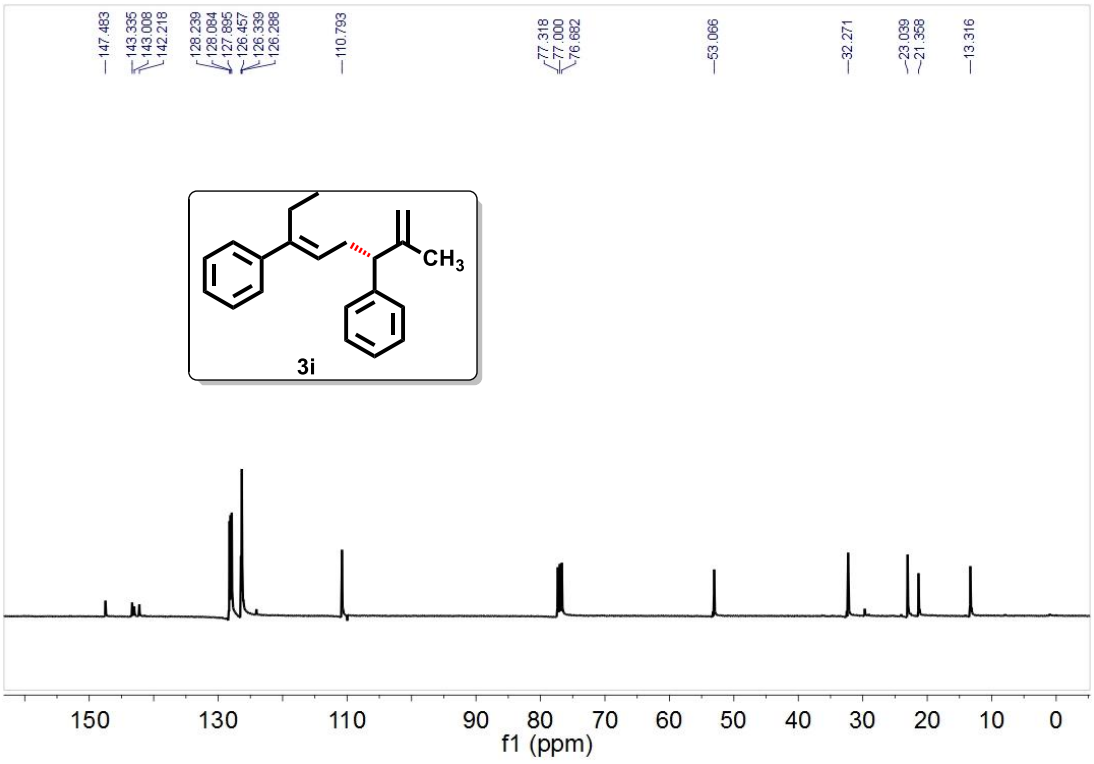
7.198
7.191
7.188
7.184
7.178
5.560
5.546
5.532
4.981
4.912
4.910
3.354
3.338
3.323
2.474
2.459
2.444
2.429
1.618
0.909
0.894
0.879
0.000
CH3
3i
2.757
2.742
2.727
2.712
2.698
2.649
2.634
2.619
2.605
2.590
2.80
2.70
2.60
f1 (ppm)
4.05
4.13
2.06
1.00
1.07
1.08
1.03
1.05
1.09
2.07
3.03
3.03
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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143.335
143.008
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128.084
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126.457
126.339
126.288
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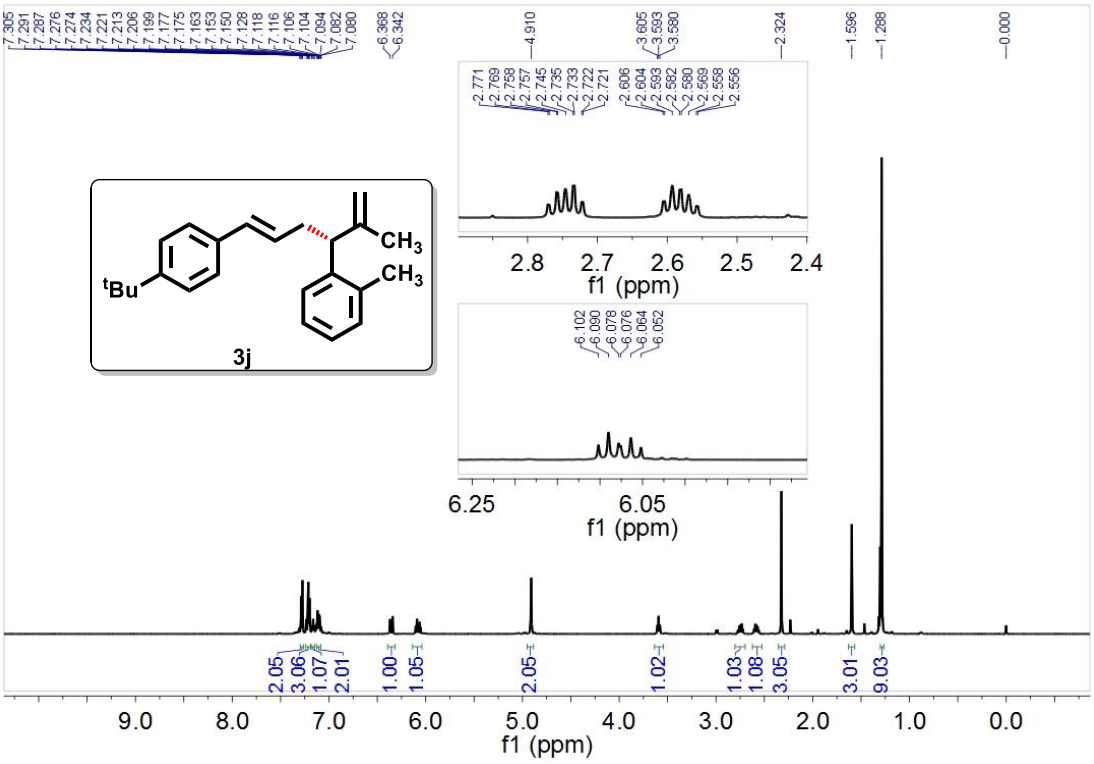
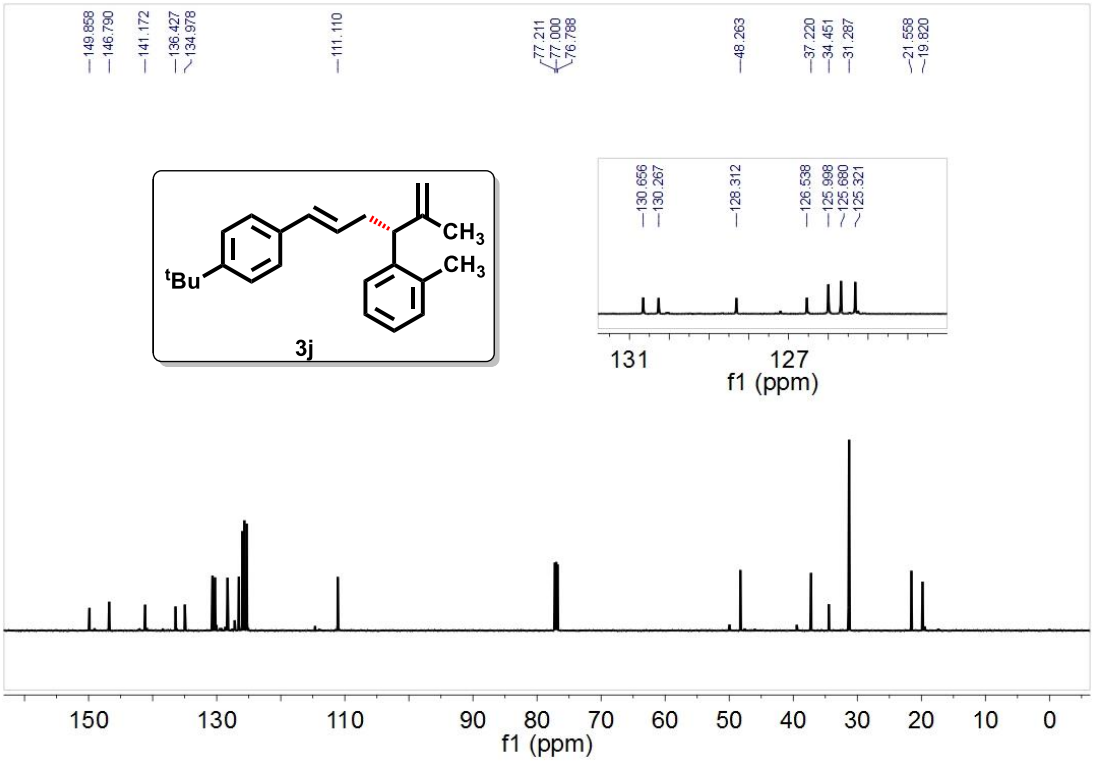
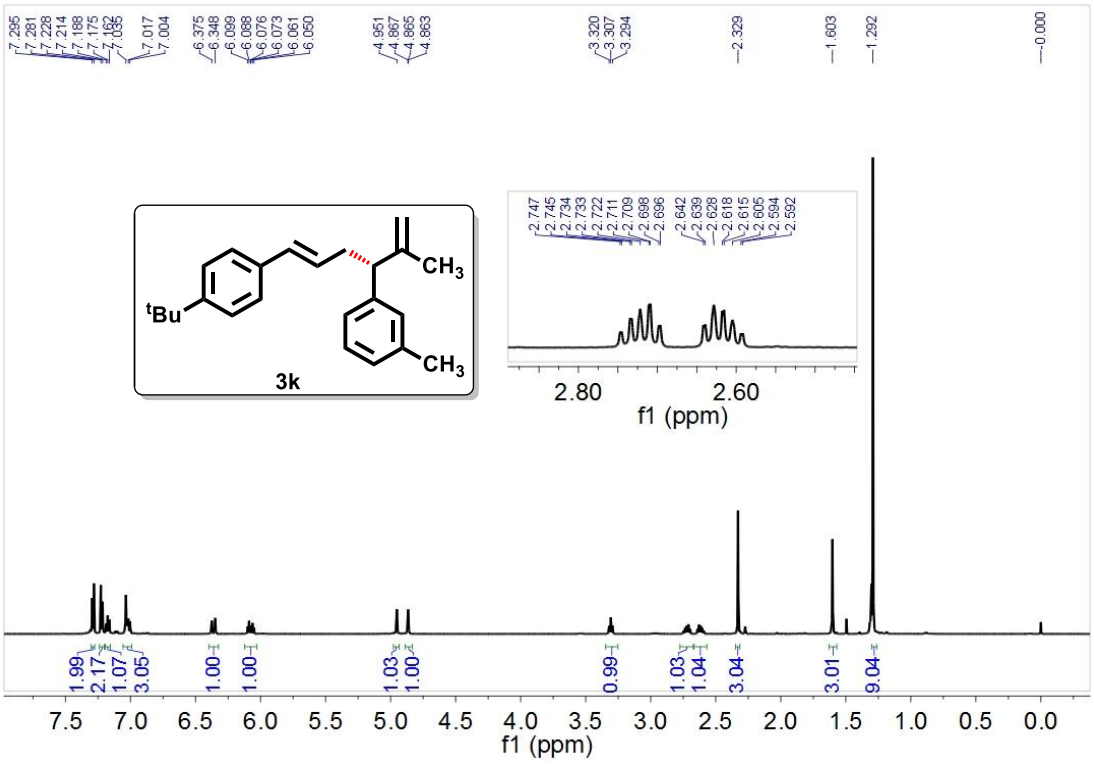
77.000
76.682
53.066
32.271
23.039
21.358
13.316
CH3
3i
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


3j
f1 (ppm)


3j
f1 (ppm)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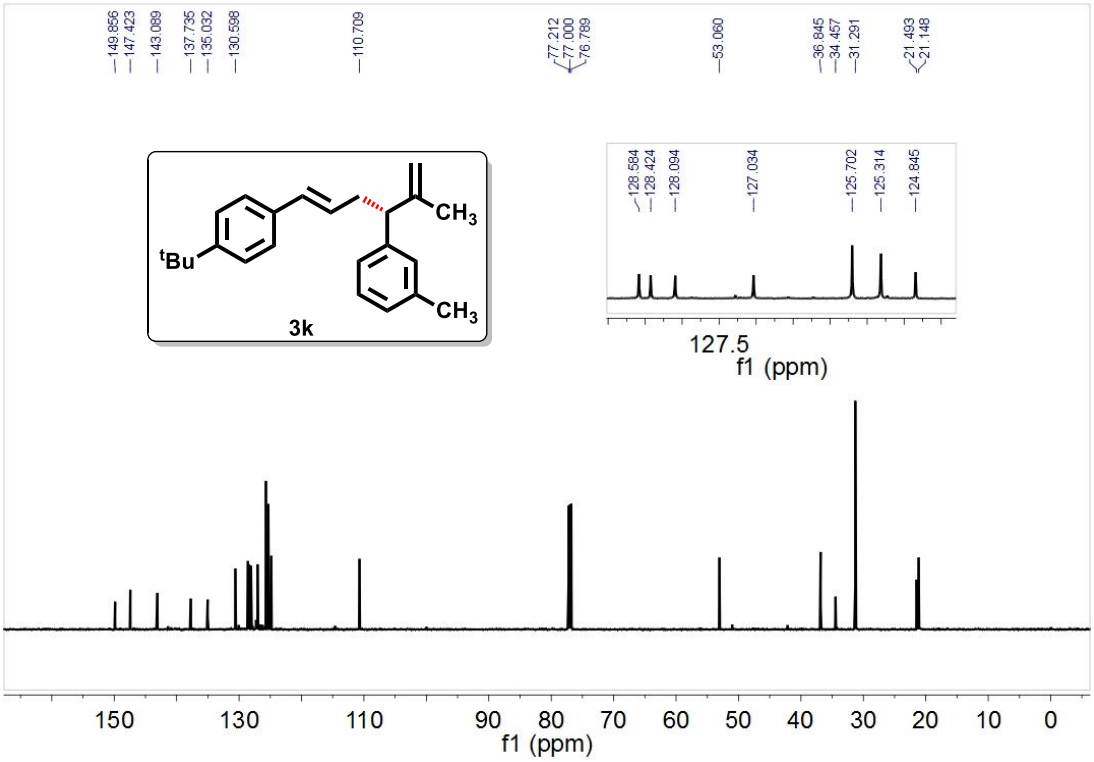
7.281
7.228
7.214
7.168
7.175
7.162
7.035
7.017
7.004
6.375
6.348
6.089
6.068
6.076
6.073
6.061
6.050
4.951
4.867
4.865
4.863
3.320
3.307
3.294
2.329
1.603
1.292
0.000
2.747
2.745
2.734
2.733
2.722
2.711
2.709
2.698
2.696
2.642
2.639
2.628
2.618
2.615
2.605
2.594
2.592
tBu
CH3
CH3
3k
2.80
2.60
f1 (ppm)
1.99
2.17
1.07
3.05
1.00
1.00
1.03
1.00
0.99
1.03
1.04
3.04
3.01
9.04
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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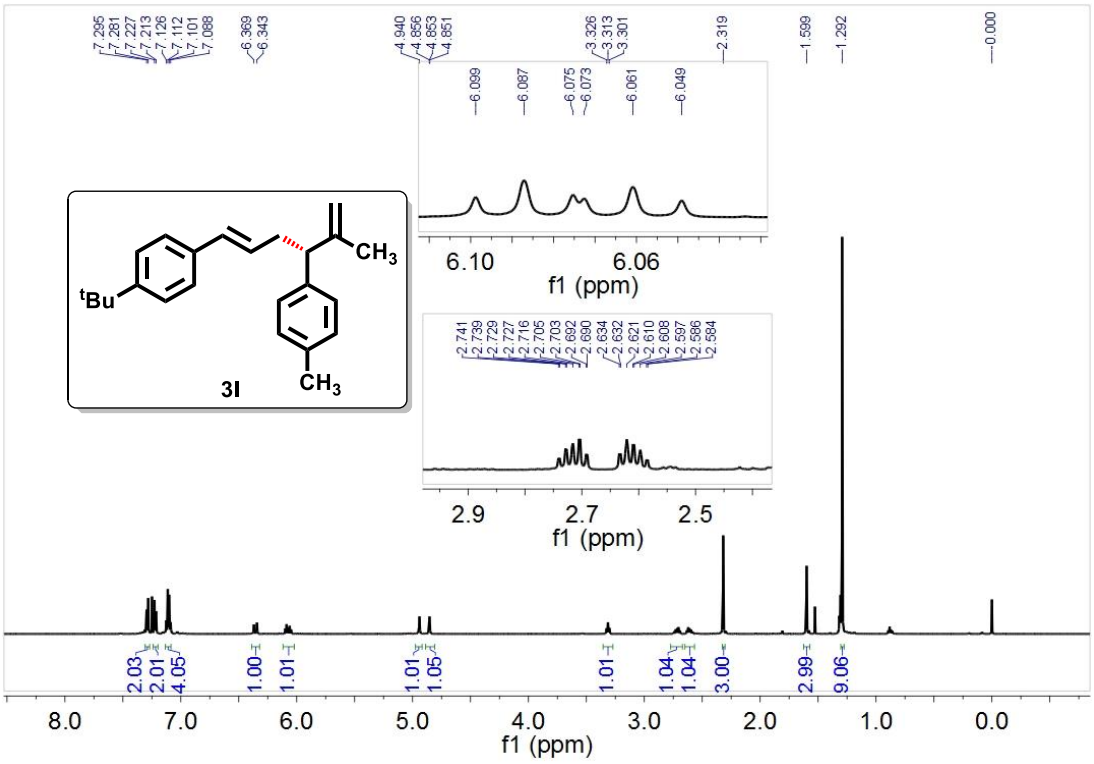
143.089
137.735
135.032
130.598
110.709
77.212
77.000
76.789
53.060
36.845
34.457
31.291
21.493
21.148
128.584
128.424
128.094
127.034
125.702
125.314
124.845
tBu
CH3
CH3
3k
127.5
f1 (ppm)
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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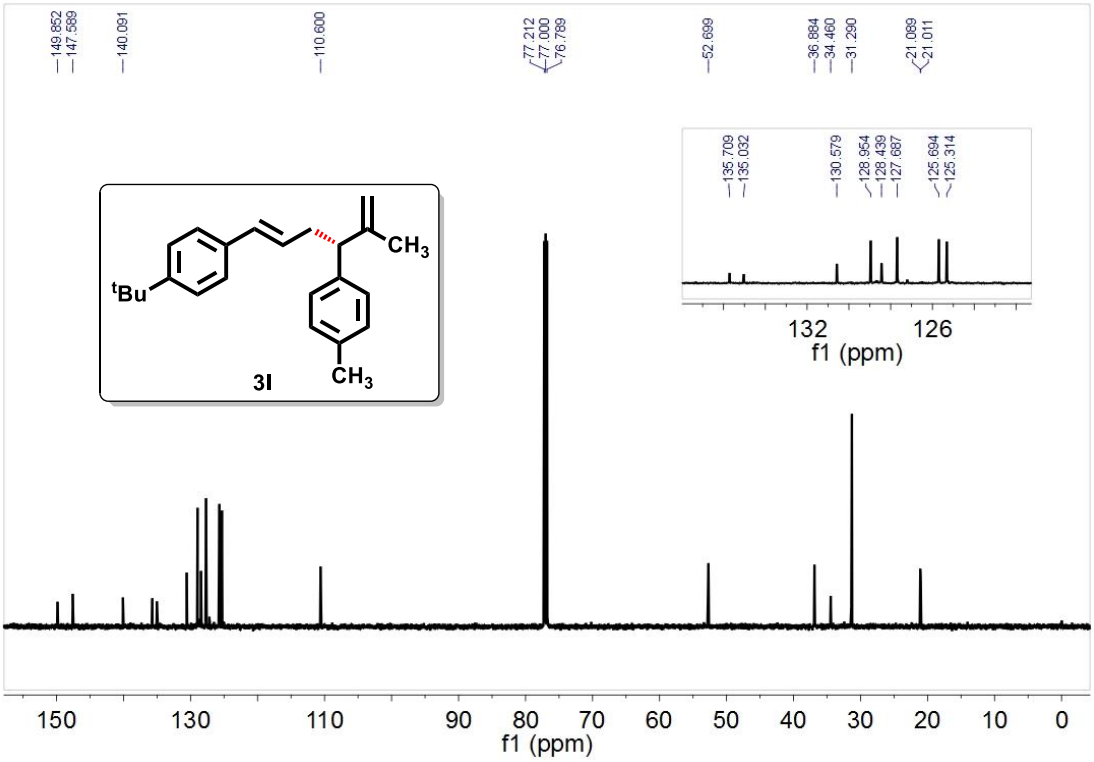
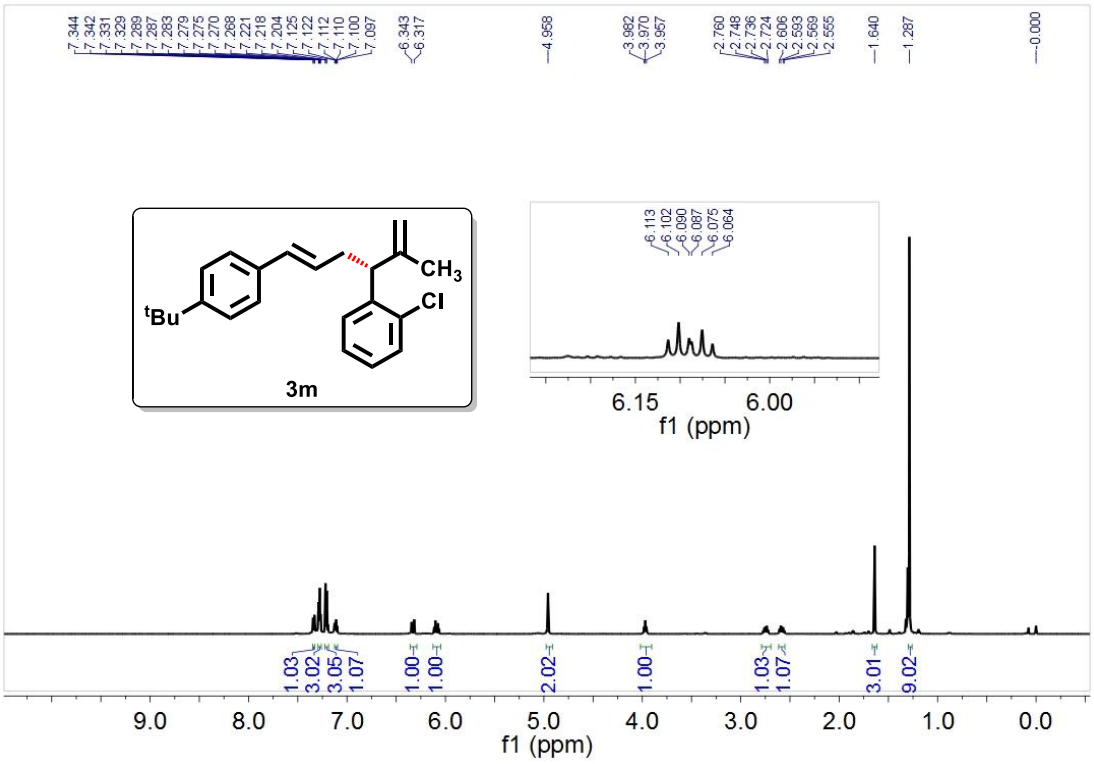
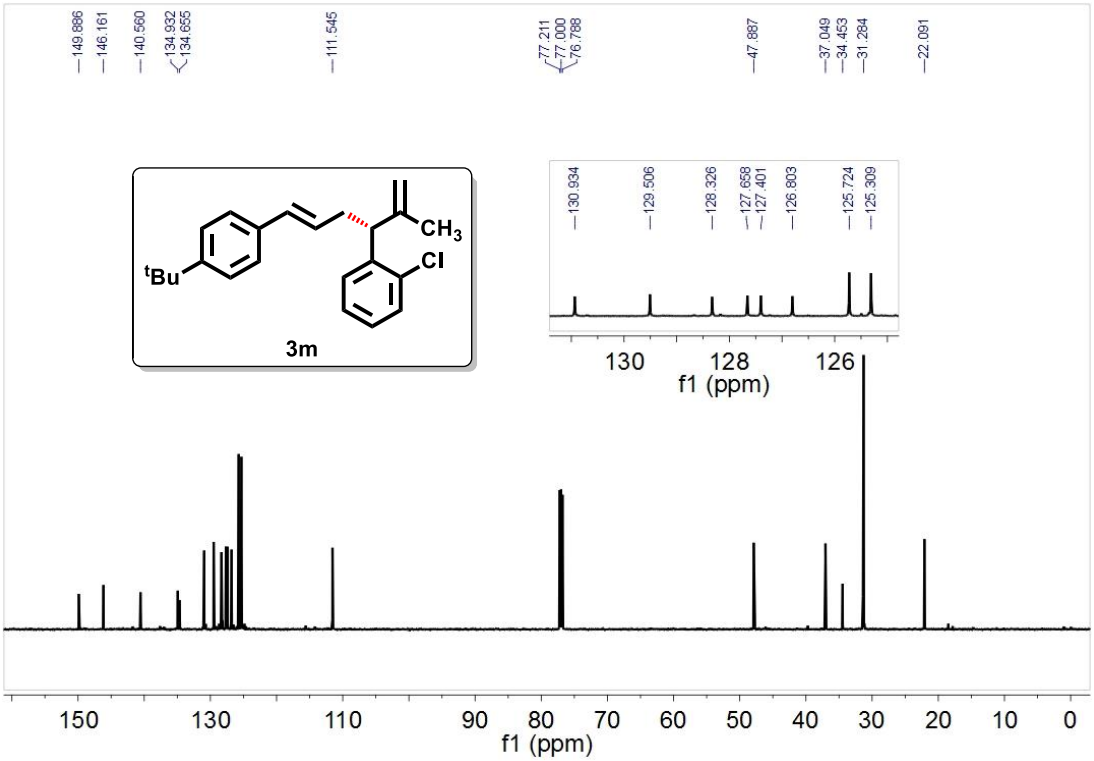
7.281
7.227
7.213
7.126
7.112
7.101
7.088
6.369
6.343
4.940
4.856
4.853
4.851
3.326
3.313
3.301
2.319
1.599
1.292
0.000
6.099
6.087
6.075
6.073
6.061
6.049
6.10
6.06
f1 (ppm)
2.741
2.739
2.729
2.727
2.716
2.705
2.703
2.692
2.690
2.634
2.632
2.621
2.610
2.608
2.597
2.586
2.584
2.9
2.7
2.5
f1 (ppm)
tBu
CH3
CH3
3l
2.03
2.01
4.05
1.00
1.01
1.01
1.05
1.01
1.04
1.04
3.00
2.99
9.06
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


149.852
147.589
140.091
110.600
77.212
77.000
76.789
52.699
36.884
34.460
31.290
21.089
21.011
135.709
135.032
130.579
128.954
128.439
127.687
125.694
125.314
132
126
f1 (ppm)
tBu
CH3
CH3
3l
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.344
7.342
7.331
7.329
7.289
7.287
7.283
7.279
7.275
7.270
7.268
7.221
7.218
7.204
7.125
7.122
7.112
7.110
7.100
7.097
6.343
6.317
4.958
3.982
3.970
3.957
2.760
2.748
2.736
2.724
2.606
2.593
2.569
2.555
1.640
1.287
0.000
tBu
CH3
Cl
3m
6.113
6.102
6.090
6.087
6.075
6.064
6.15
6.00
f1 (ppm)
1.03
3.02
3.05
1.07
1.00
1.00
2.02
1.00
1.03
1.07
3.01
9.02
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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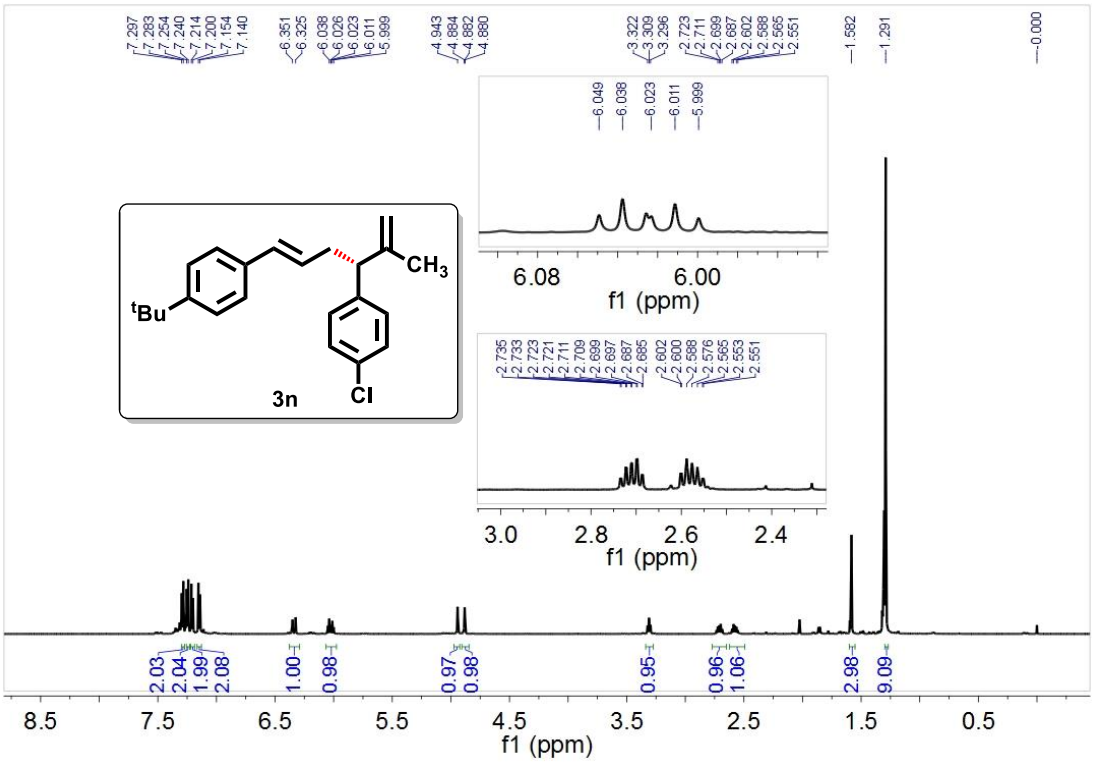
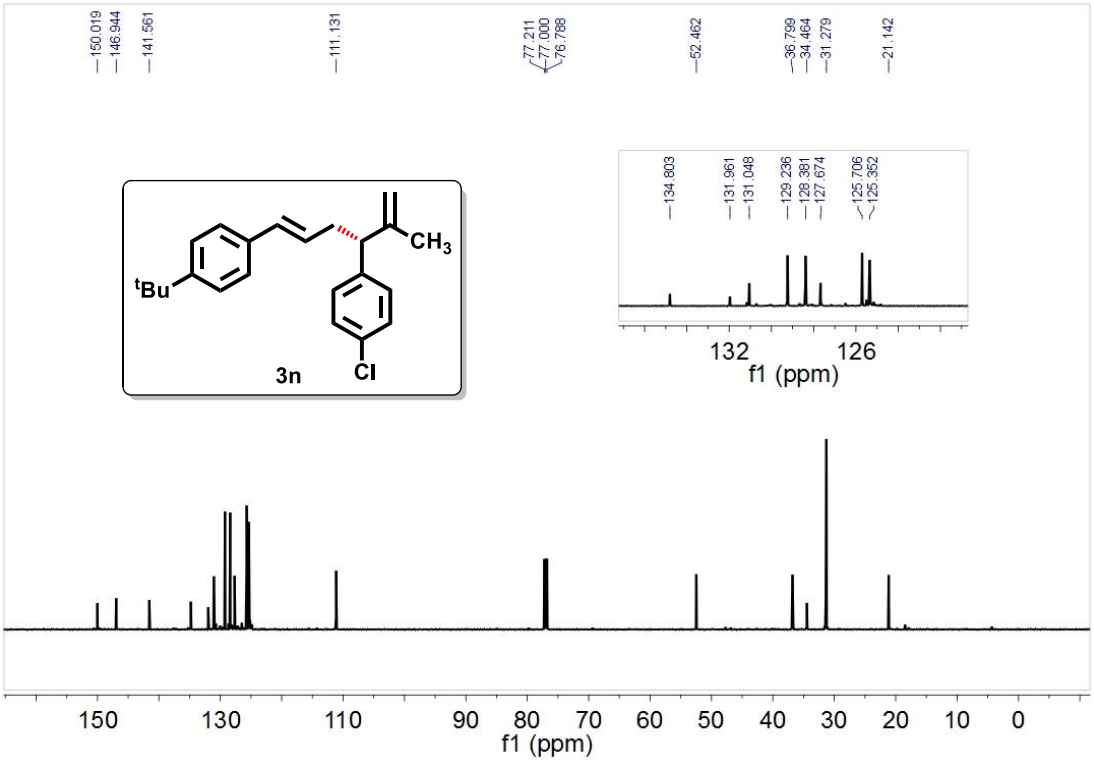
140.560
134.932
134.655
111.545
77.211
77.000
76.788
47.887
37.049
34.453
31.284
22.091
tBu
CH3
Cl
3m
130.934
129.506
128.326
127.658
127.401
126.803
125.724
125.309
130
128
126
f1 (ppm)
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.297
7.283
7.254
7.240
7.214
7.200
7.154
7.140
6.351
6.325
6.038
6.026
6.023
6.011
5.999
4.943
4.884
4.862
4.850
3.322
3.306
3.296
2.723
2.711
2.699
2.687
2.602
2.588
2.565
2.551
1.582
1.291
0.000
6.049
6.038
6.023
6.011
5.999
6.08
6.00
f1 (ppm)
2.735
2.733
2.723
2.721
2.711
2.709
2.699
2.697
2.687
2.685
2.602
2.600
2.588
2.576
2.565
2.553
2.551
3.0
2.8
2.6
2.4
f1 (ppm)
tBu
CH3
Cl
3n
2.03
2.04
1.99
2.08
1.00
0.98
0.97
0.98
0.95
0.96
1.06
2.98
9.09
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)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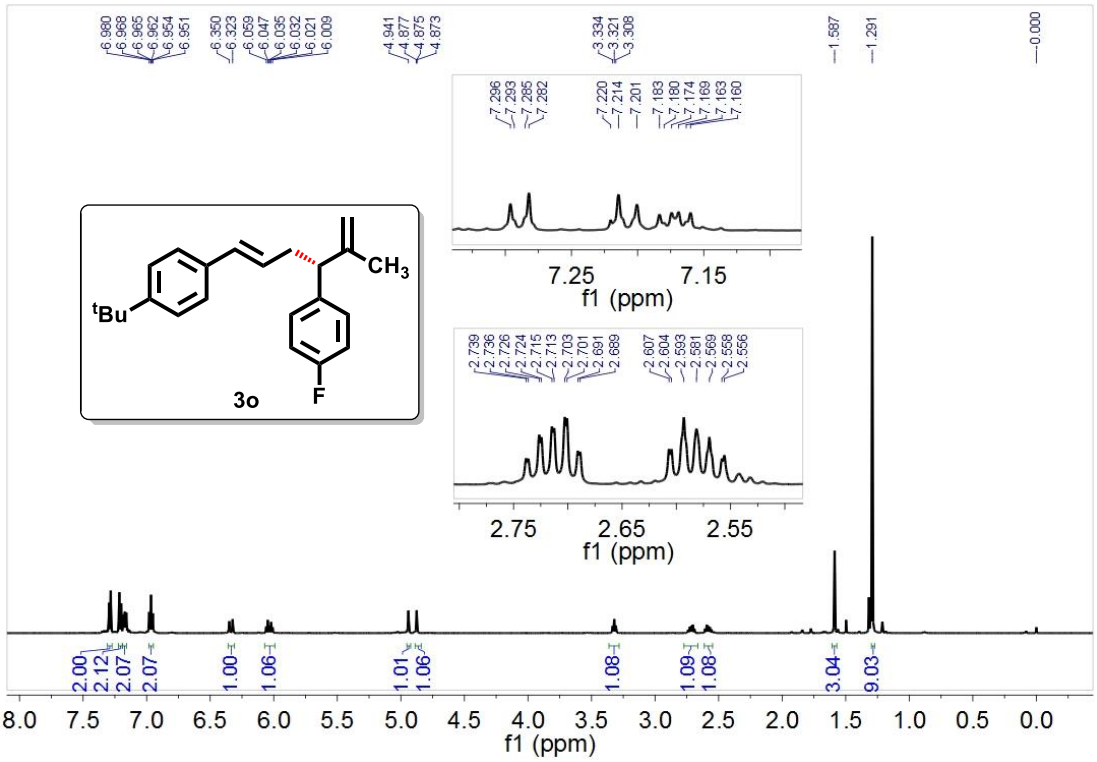
77.000
76.788
52.462
36.799
34.464
31.279
21.142
134.803
131.961
131.048
129.236
128.381
127.674
125.706
125.352
132
126
f1 (ppm)
tBu
CH3
Cl
3n
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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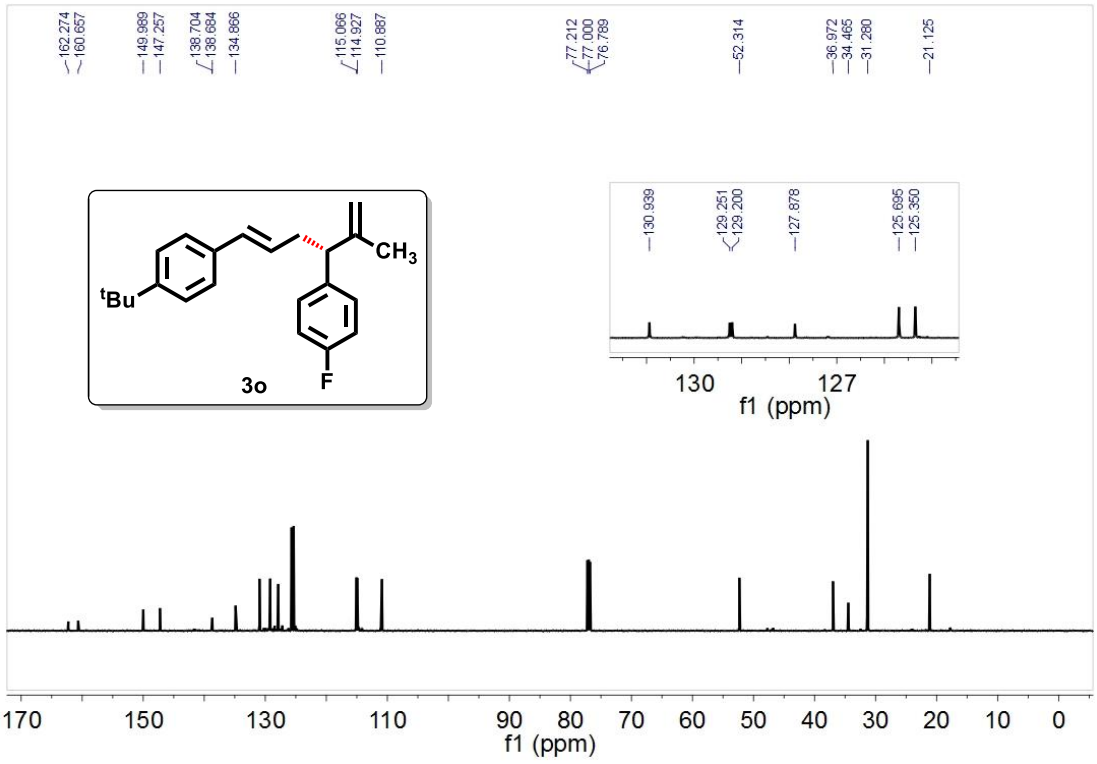
6.968
6.965
6.962
6.954
6.951
6.350
6.323
6.059
6.047
6.035
6.032
6.021
6.009
4.941
4.877
4.875
4.873
3.334
3.321
3.308
1.587
1.291
0.000
7.296
7.293
7.285
7.282
7.220
7.214
7.201
7.183
7.180
7.174
7.169
7.163
7.160
7.25
7.15
f1 (ppm)
2.739
2.736
2.726
2.724
2.715
2.713
2.703
2.701
2.691
2.689
2.607
2.604
2.593
2.581
2.569
2.558
2.556
2.75
2.65
2.55
f1 (ppm)
tBu
CH3
F
3o
2.00
2.12
2.07
2.07
1.00
1.06
1.01
1.06
1.08
1.09
1.08
3.04
9.03
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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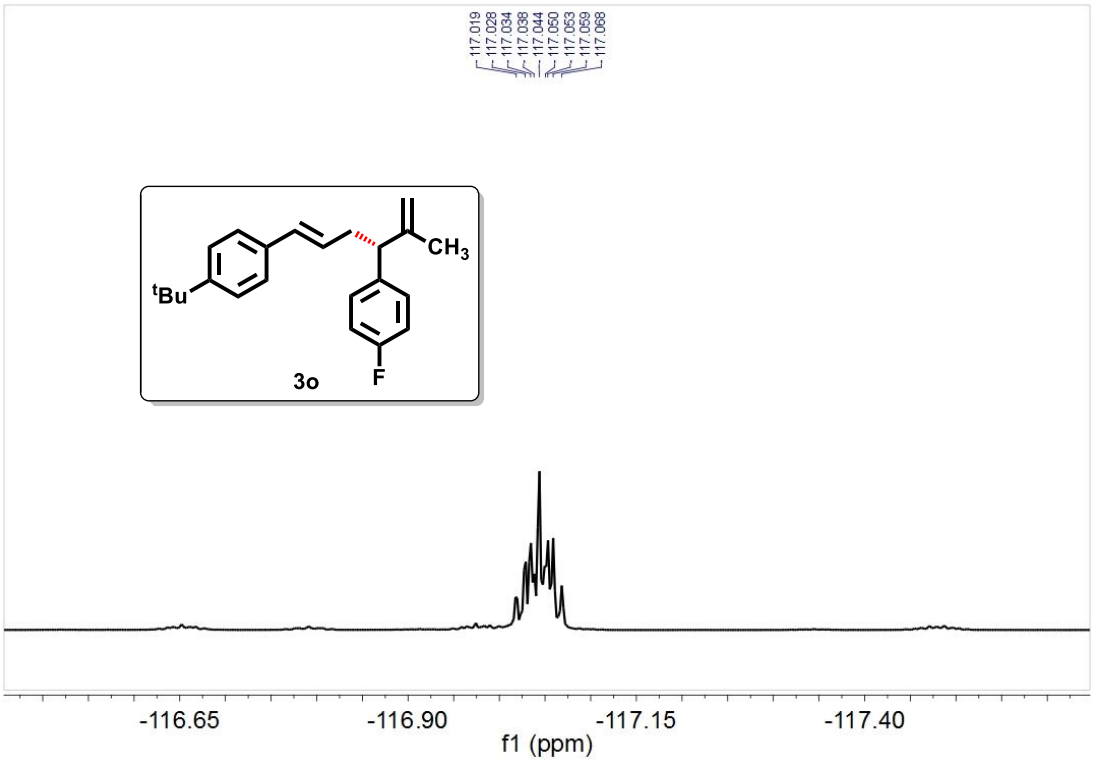
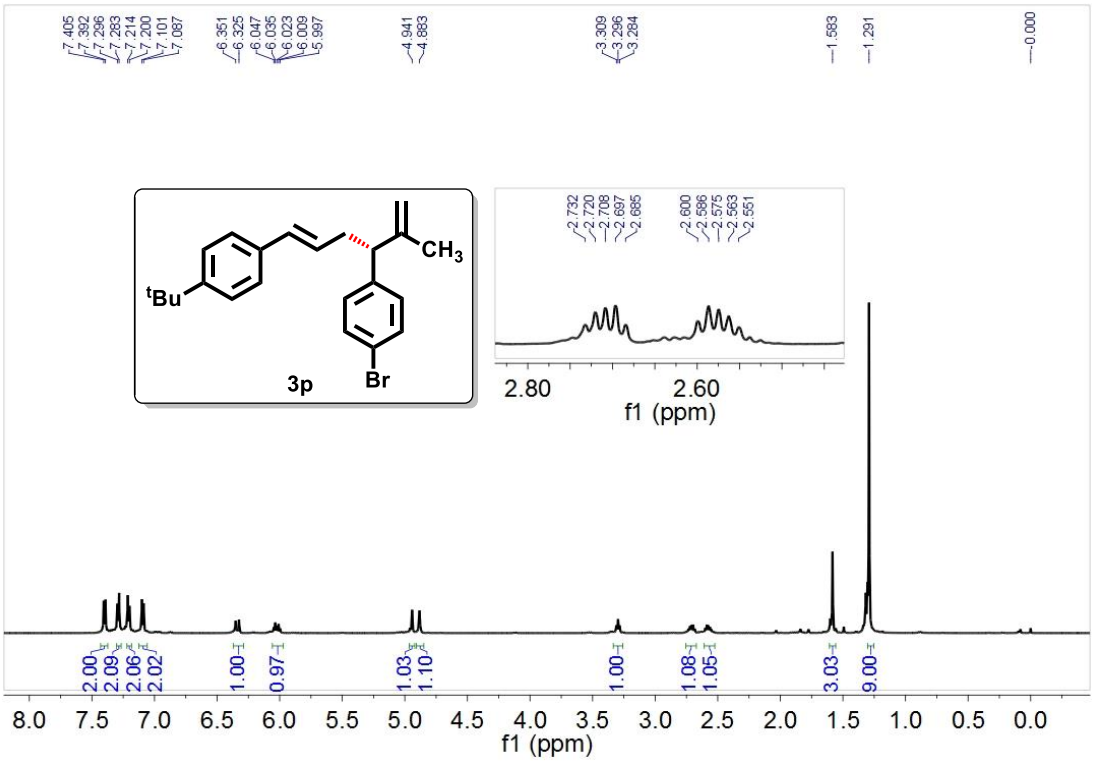
147.257
138.704
138.684
134.866
115.066
114.927
110.887
77.212
77.000
76.789
52.314
36.972
34.465
31.280
21.125
130.939
129.251
129.200
127.878
125.695
125.350
130
127
f1 (ppm)
tBu
CH3
F
3o
170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


117.019
117.028
117.034
117.038
117.044
117.050
117.053
117.059
117.068
CH3
tBu
F
3o
-116.65
-116.90
-117.15
-117.40
f1 (ppm)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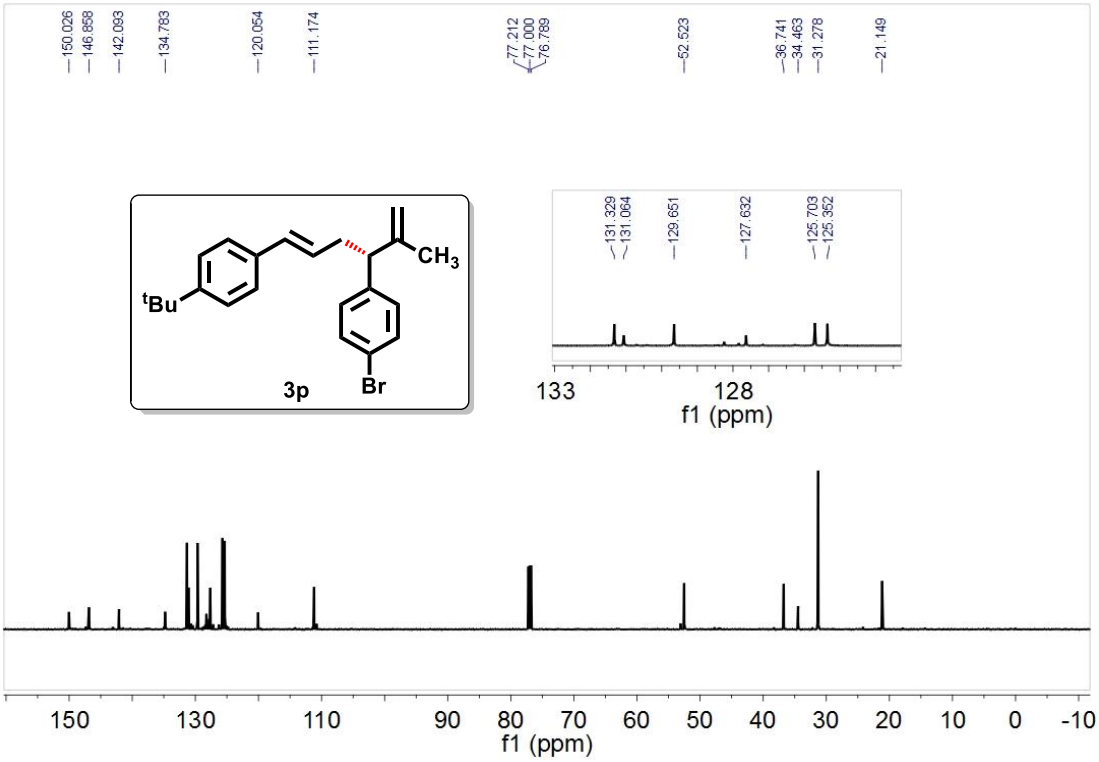
7.283
7.214
7.200
7.101
7.087
6.351
6.325
6.047
6.035
6.023
6.009
5.997
4.941
4.883
3.309
3.296
3.284
1.583
1.291
0.000
2.732
2.720
2.708
2.697
2.685
2.600
2.586
2.575
2.563
2.551
tBu
CH3
Br
3p
2.80
2.60
f1 (ppm)
2.00
2.09
2.06
2.02
1.00
0.97
1.03
1.10
1.00
1.08
1.05
3.03
9.00
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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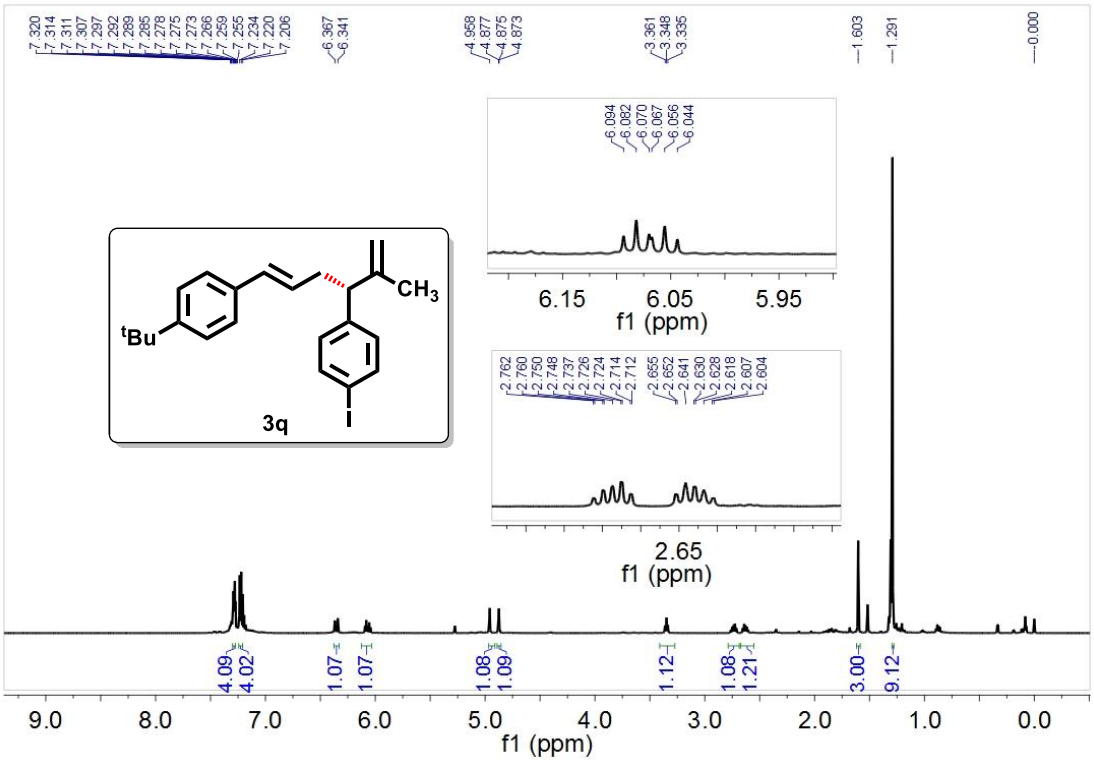
142.093
134.783
120.054
111.174
77.212
77.000
76.789
52.523
36.741
34.463
31.278
21.149
131.329
131.064
129.651
127.632
125.703
125.352
tBu
CH3
Br
3p
133
128
f1 (ppm)
150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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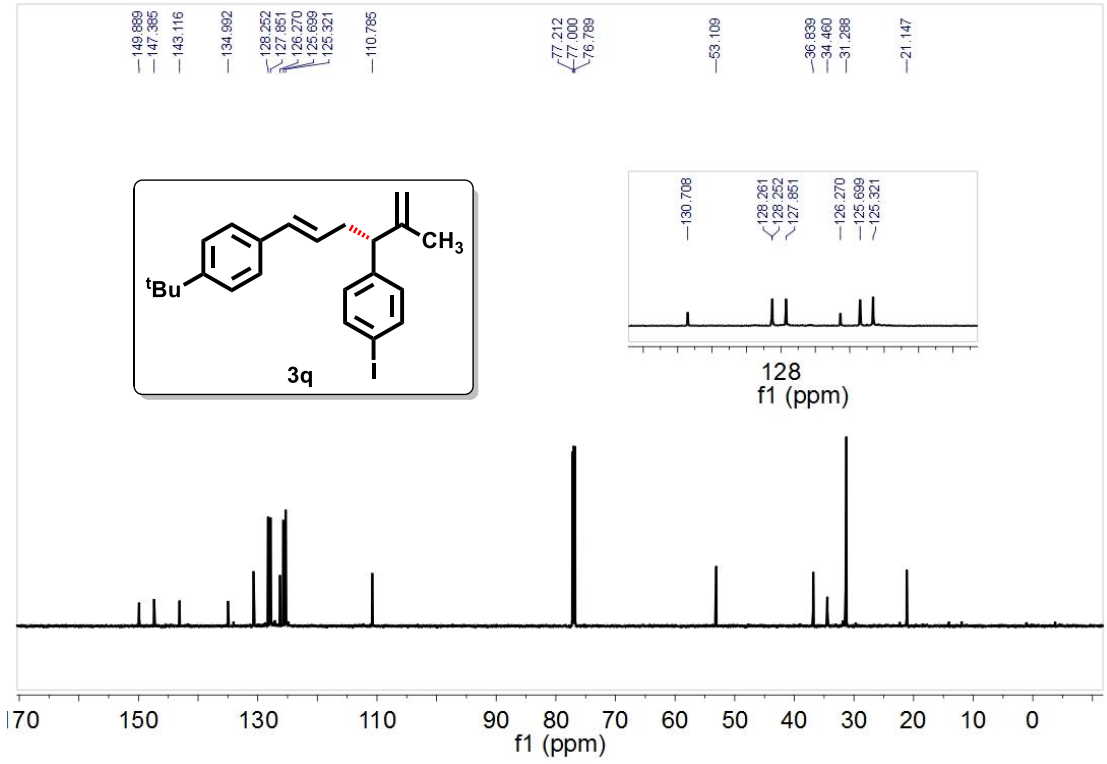
7.314
7.311
7.307
7.297
7.292
7.288
7.285
7.278
7.275
7.273
7.266
7.259
7.255
7.234
7.220
7.206
6.367
6.341
4.958
4.877
4.875
4.873
3.361
3.348
3.335
1.603
1.291
0.000
6.094
6.082
6.070
6.067
6.056
6.044
6.15
6.05
5.95
f1 (ppm)
2.762
2.760
2.750
2.748
2.737
2.726
2.724
2.714
2.712
2.655
2.652
2.641
2.630
2.628
2.618
2.607
2.604
2.65
f1 (ppm)
tBu
CH3
3q
4.09
4.02
1.07
1.07
1.08
1.09
1.12
1.08
1.21
3.00
9.12
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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143.116
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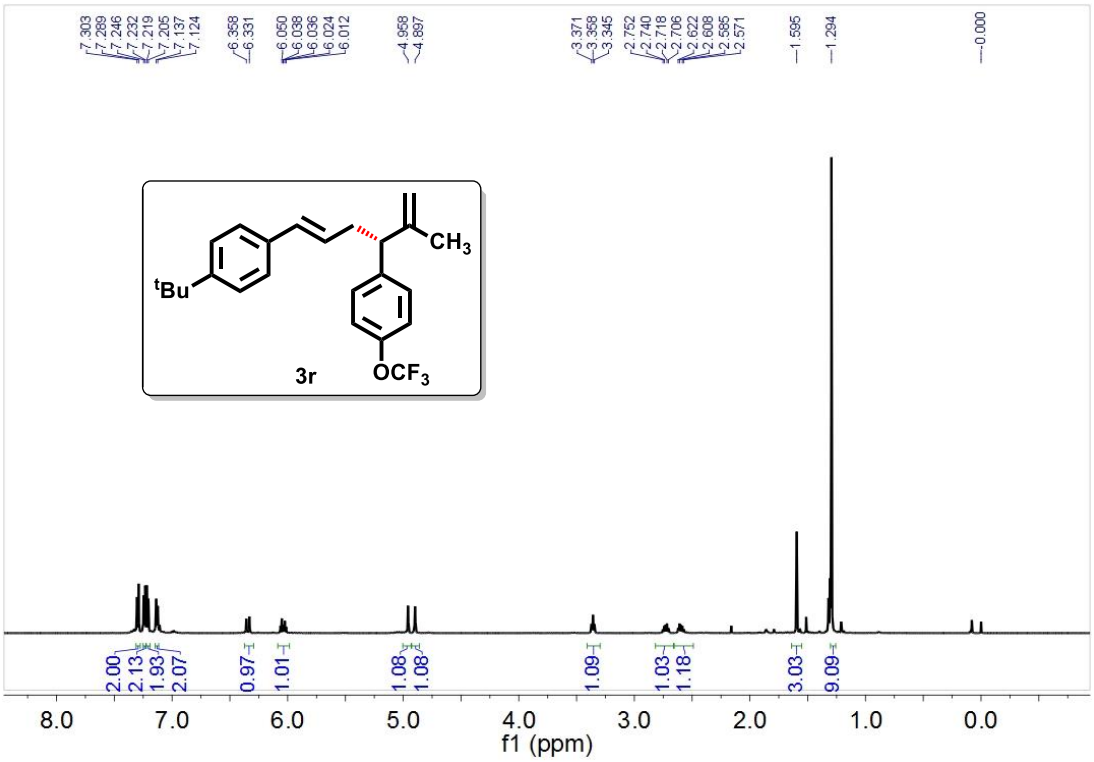
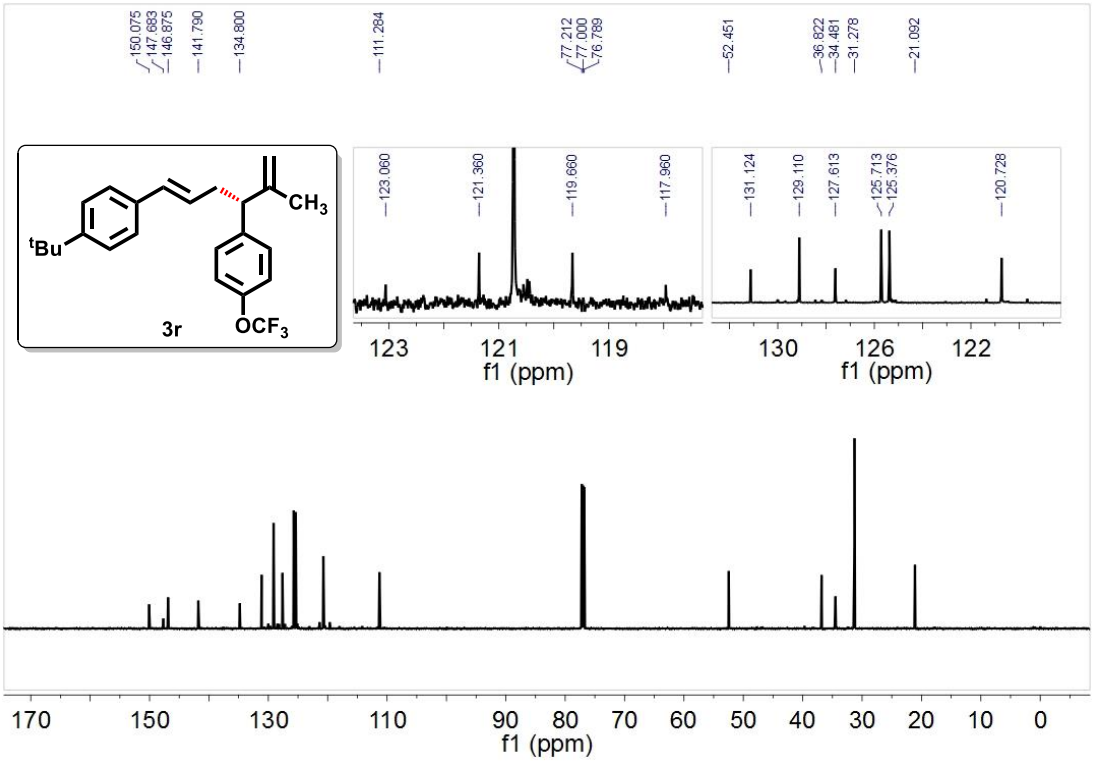
127.851
126.270
125.699
125.321
110.785
77.212
77.000
76.789
53.109
36.839
34.460
31.288
21.147
130.708
128.261
128.252
127.851
126.270
125.699
125.321
128
f1 (ppm)
tBu
CH3
3q
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.303
7.289
7.246
7.232
7.219
7.205
7.137
7.124
6.358
6.331
6.050
6.038
6.036
6.024
6.012
4.958
4.897
3.371
3.358
3.345
2.752
2.740
2.718
2.706
2.622
2.608
2.585
2.571
1.595
1.294
0.000
tBu
CH3
OCF3
3r
2.00
2.13
1.93
2.07
0.97
1.01
1.08
1.08
1.09
1.03
1.18
3.03
9.09
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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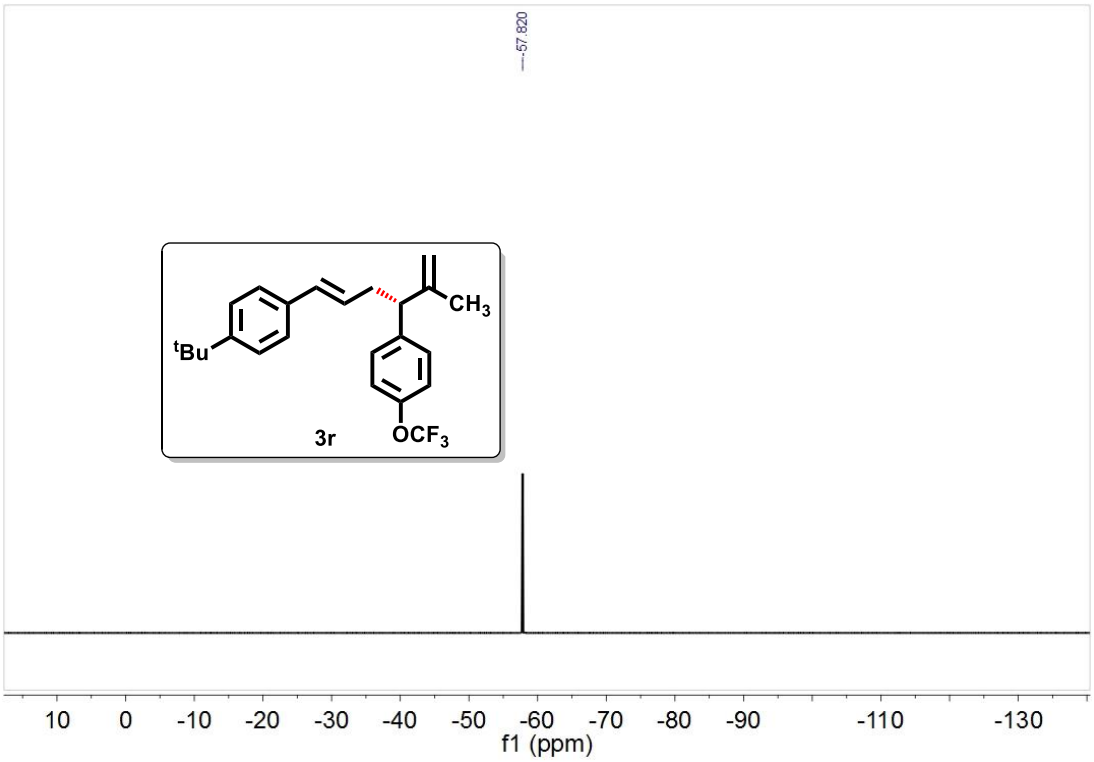
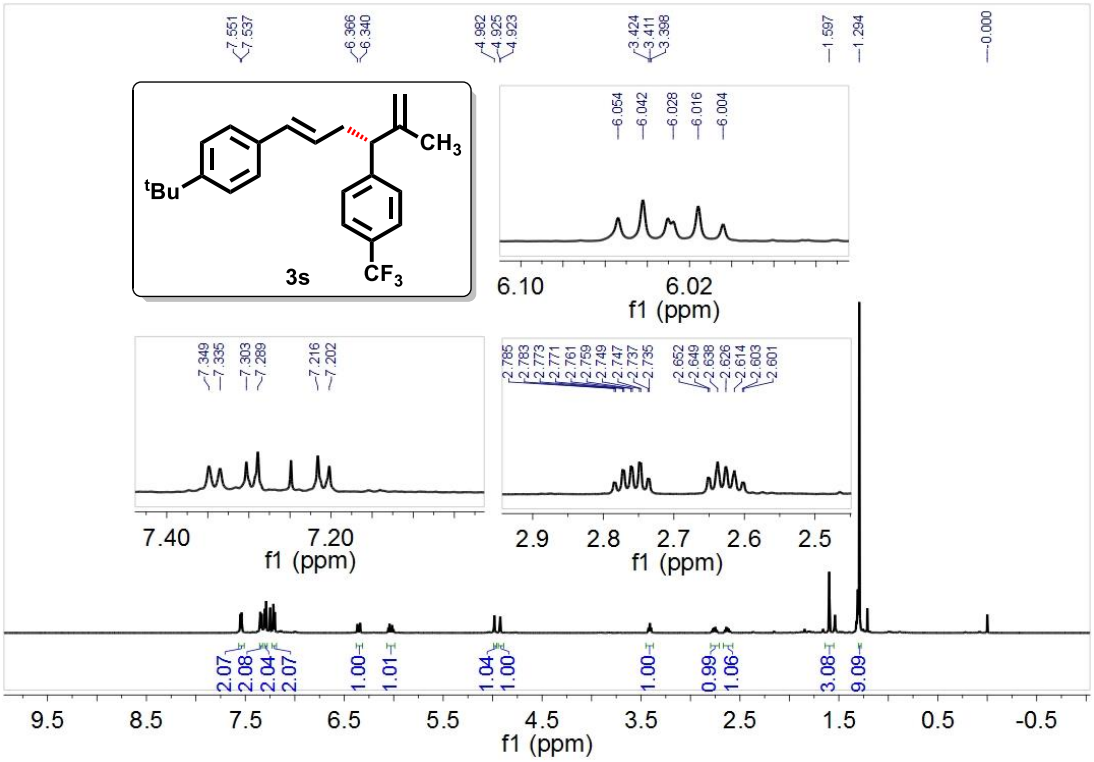
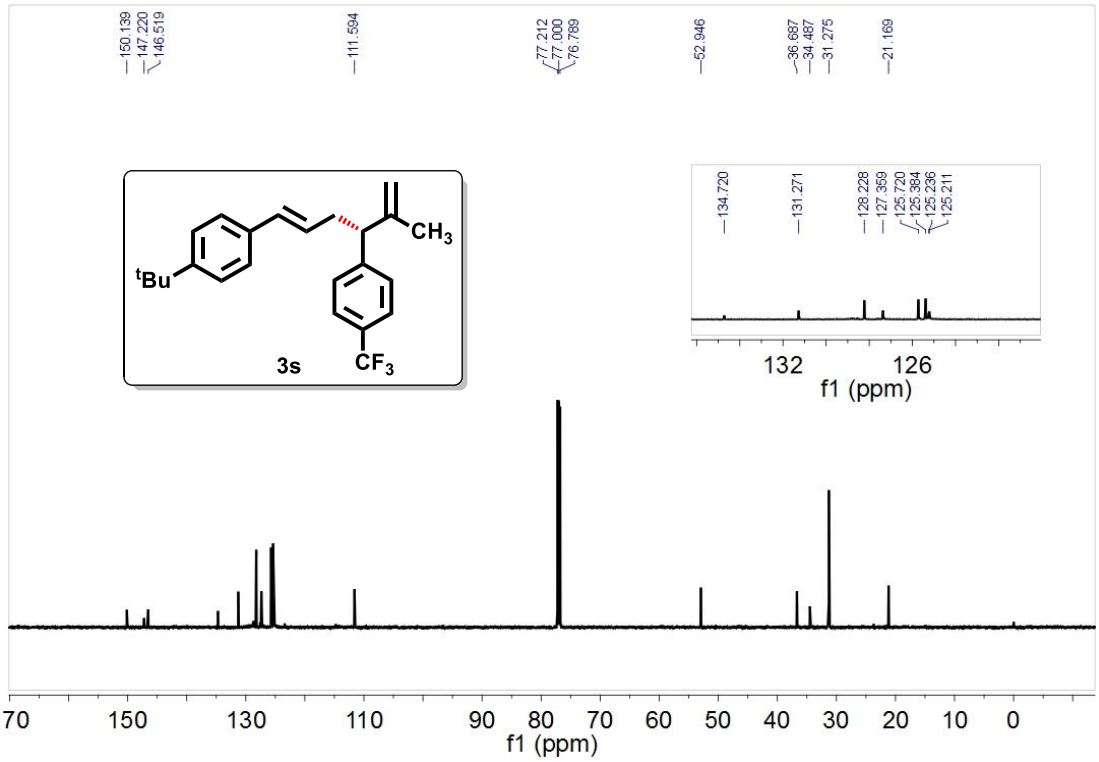
146.875
141.790
134.800
111.284
77.212
77.000
76.789
52.451
36.822
34.481
31.278
21.092
123.060
121.360
119.660
117.960
131.124
129.110
127.613
125.713
125.376
120.728
tBu
CH3
OCF3
3r
123
121
119
f1 (ppm)
130
126
122
f1 (ppm)
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


-57.820
tBu
CH3
3r
OCF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
f1 (ppm)


7.551
7.537
6.366
6.340
4.982
4.925
4.923
3.424
3.411
3.398
1.597
1.294
0.000
tBu
CH3
3s
CF3
6.054
6.042
6.028
6.016
6.004
6.10
6.02
f1 (ppm)
7.349
7.335
7.303
7.289
7.216
7.202
7.40
7.20
f1 (ppm)
2.785
2.783
2.773
2.771
2.761
2.759
2.749
2.747
2.737
2.735
2.652
2.649
2.638
2.626
2.614
2.603
2.601
2.9
2.8
2.7
2.6
2.5
f1 (ppm)
2.07
2.08
2.04
2.07
1.00
1.01
1.04
1.00
1.00
0.99
1.06
3.08
9.09
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)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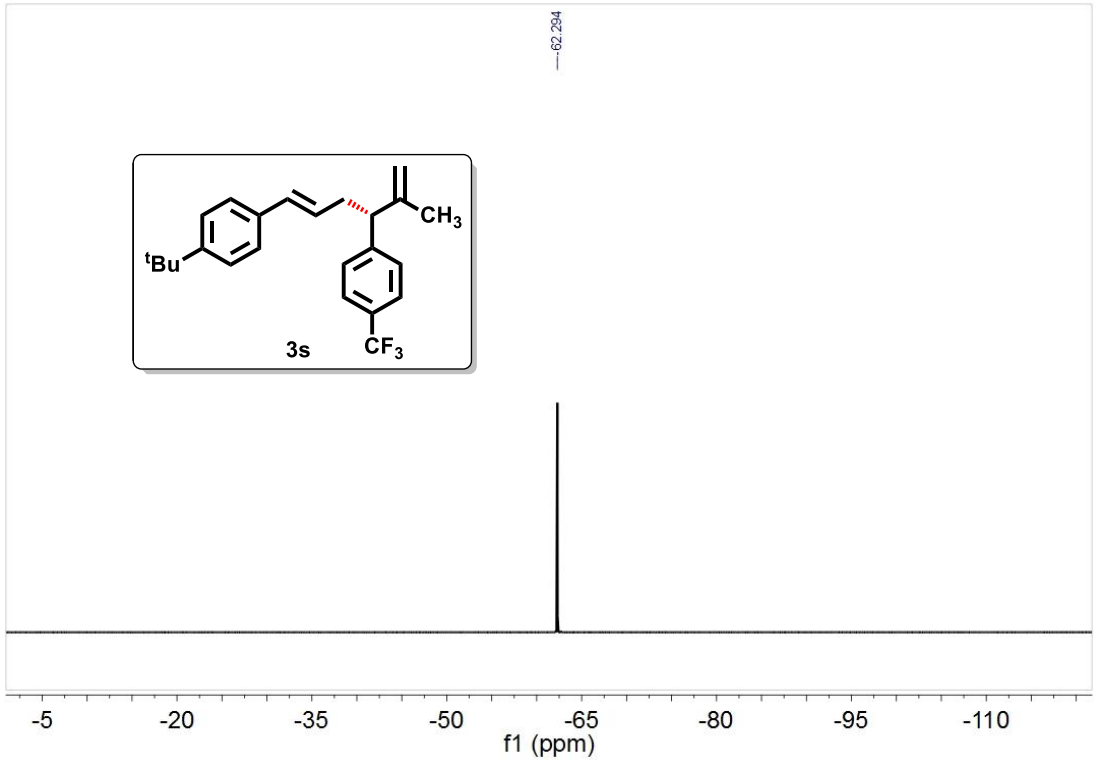
147.220
146.519
111.594
77.212
77.000
76.789
52.946
36.687
34.487
31.275
21.169
134.720
131.271
128.228
127.359
125.720
125.384
125.236
125.211
tBu
CH3
CF3
3s
132
126
f1 (ppm)
70
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


62.294
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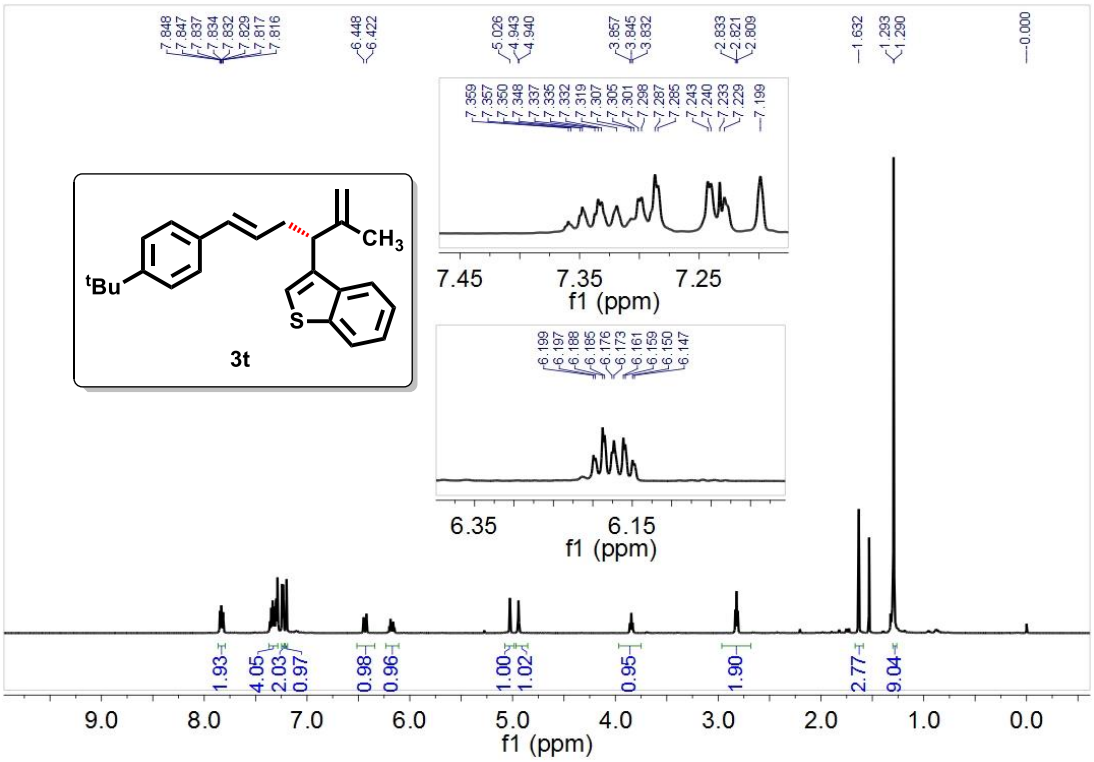
CF3
3s
-5
-20
-35
-50
-65
-80
-95
-110
f1 (ppm)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7.837
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7.832
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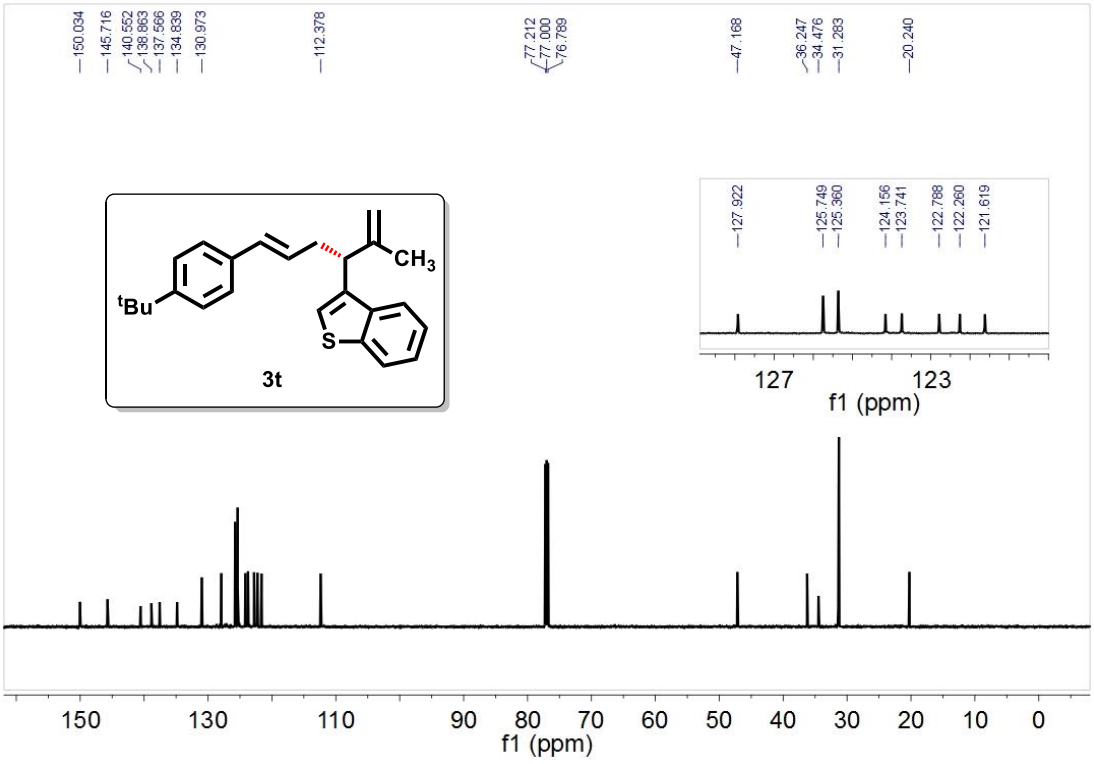
7.817
7.816
6.448
6.422
5.026
4.943
4.940
3.857
3.845
3.832
2.833
2.821
2.809
1.632
1.293
1.290
0.000
7.359
7.357
7.350
7.348
7.337
7.335
7.332
7.319
7.307
7.305
7.301
7.298
7.287
7.285
7.243
7.240
7.233
7.229
7.199
7.45
7.35
7.25
f1 (ppm)
6.199
6.197
6.188
6.185
6.176
6.173
6.161
6.159
6.150
6.147
6.35
6.15
f1 (ppm)
tBu
CH3
S
3t
1.93
4.05
2.03
0.97
0.98
0.96
1.00
1.02
0.95
1.90
2.77
9.04
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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140.552
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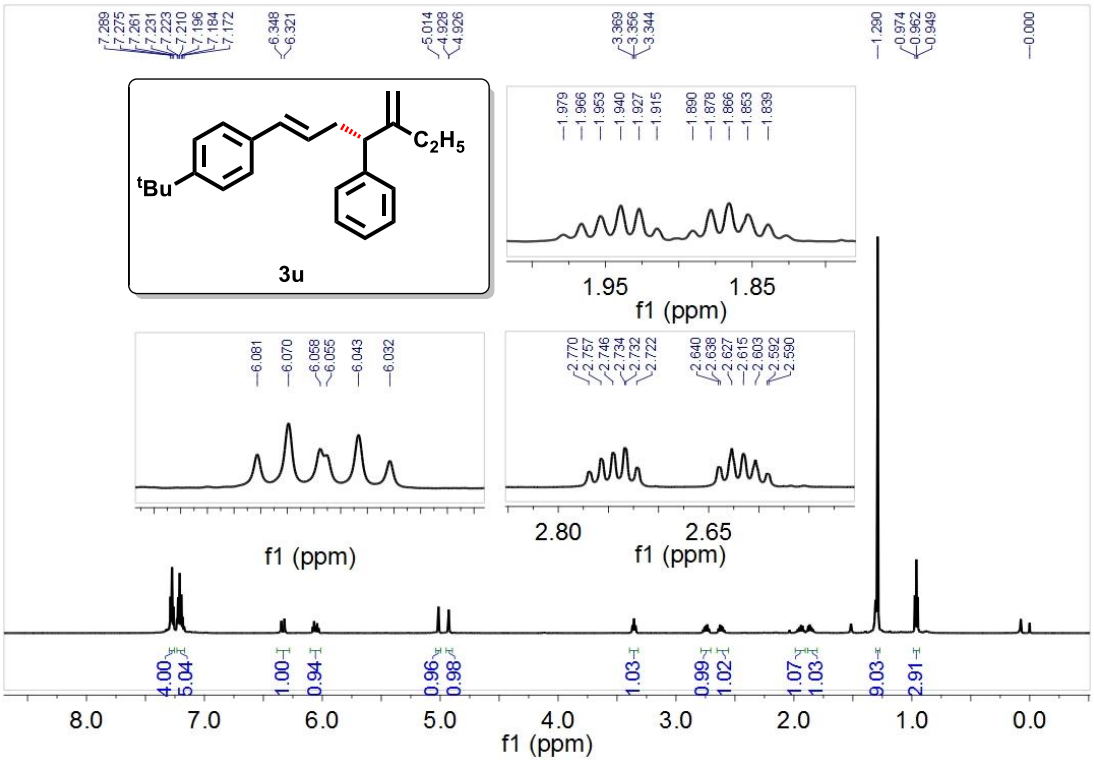
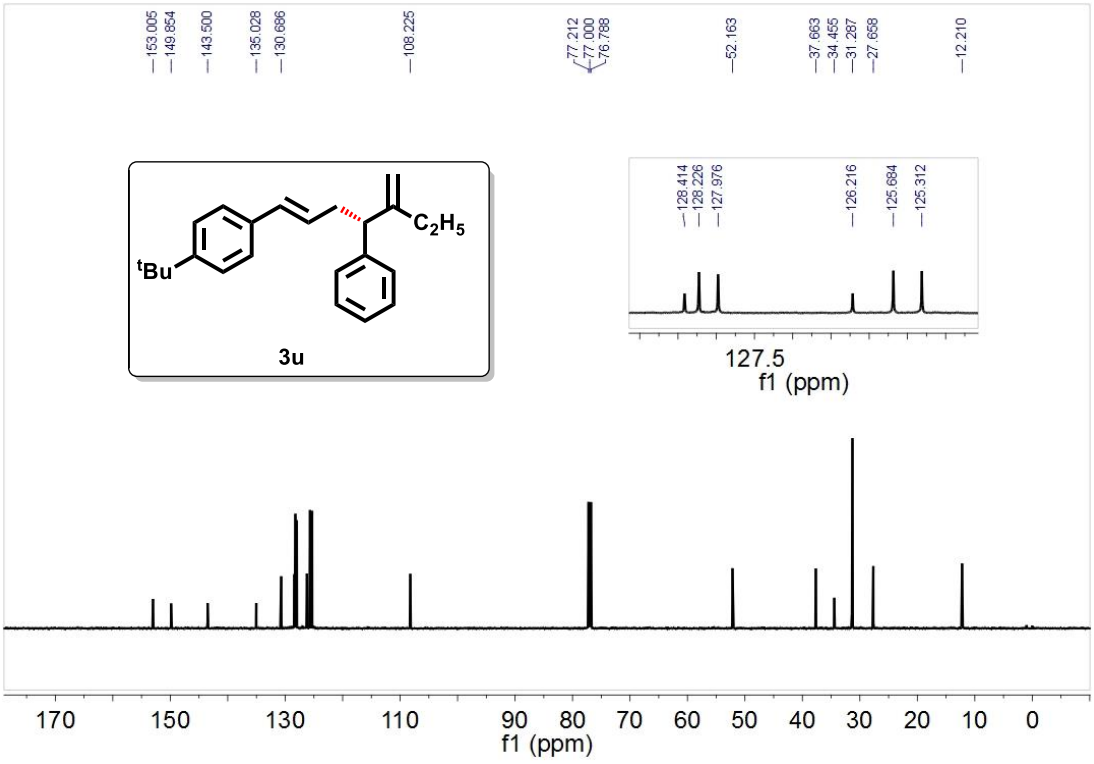
134.839
130.973
112.378
77.212
77.000
76.789
47.168
36.247
34.476
31.283
20.240
127.922
125.749
125.360
124.156
123.741
122.788
122.260
121.619
127
123
f1 (ppm)
tBu
CH3
S
3t
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.289
7.275
7.261
7.231
7.223
7.210
7.196
7.184
7.172
6.348
6.321
5.014
4.928
4.926
3.369
3.356
3.344
1.290
0.974
0.962
0.949
0.000
^{t}Bu
C_2H_5
3u
1.979
1.966
1.953
1.940
1.927
1.915
1.890
1.878
1.866
1.853
1.839
1.95
1.85
f1 (ppm)
6.081
6.070
6.058
6.055
6.043
6.032
f1 (ppm)
2.770
2.757
2.746
2.734
2.732
2.722
2.640
2.638
2.627
2.615
2.603
2.592
2.590
2.80
2.65
f1 (ppm)
4.00
5.04
1.00
0.94
0.96
0.98
1.03
0.99
1.02
1.07
1.03
9.03
2.91
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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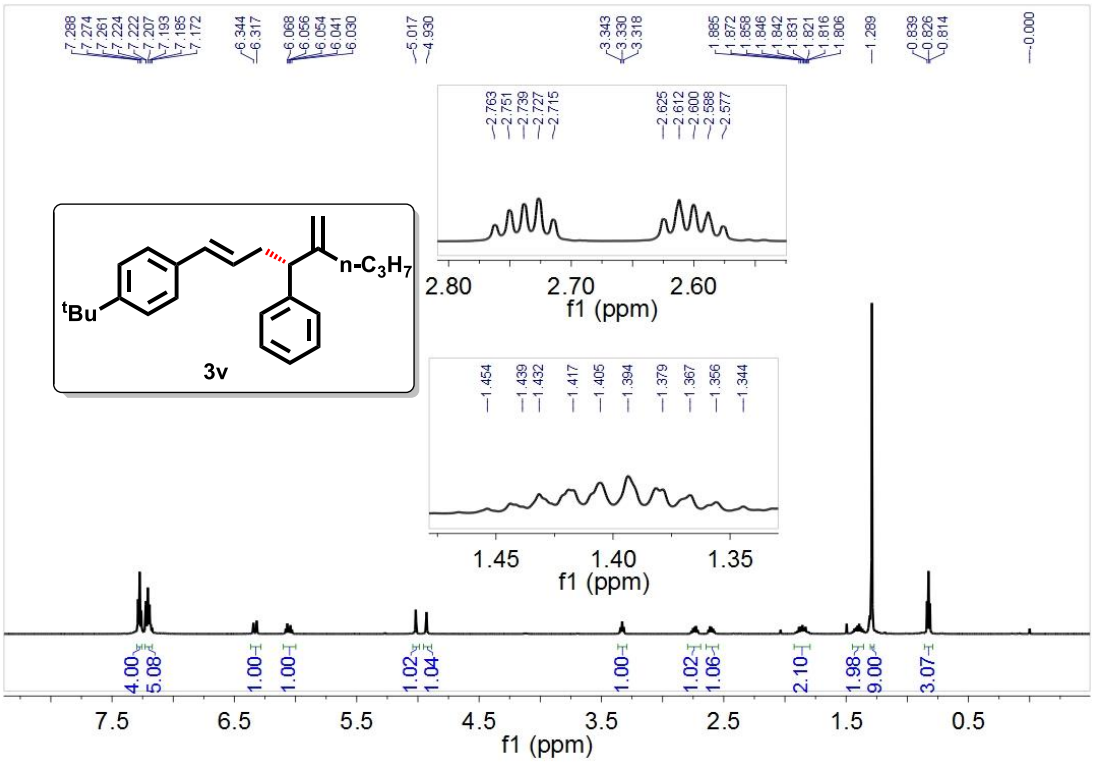
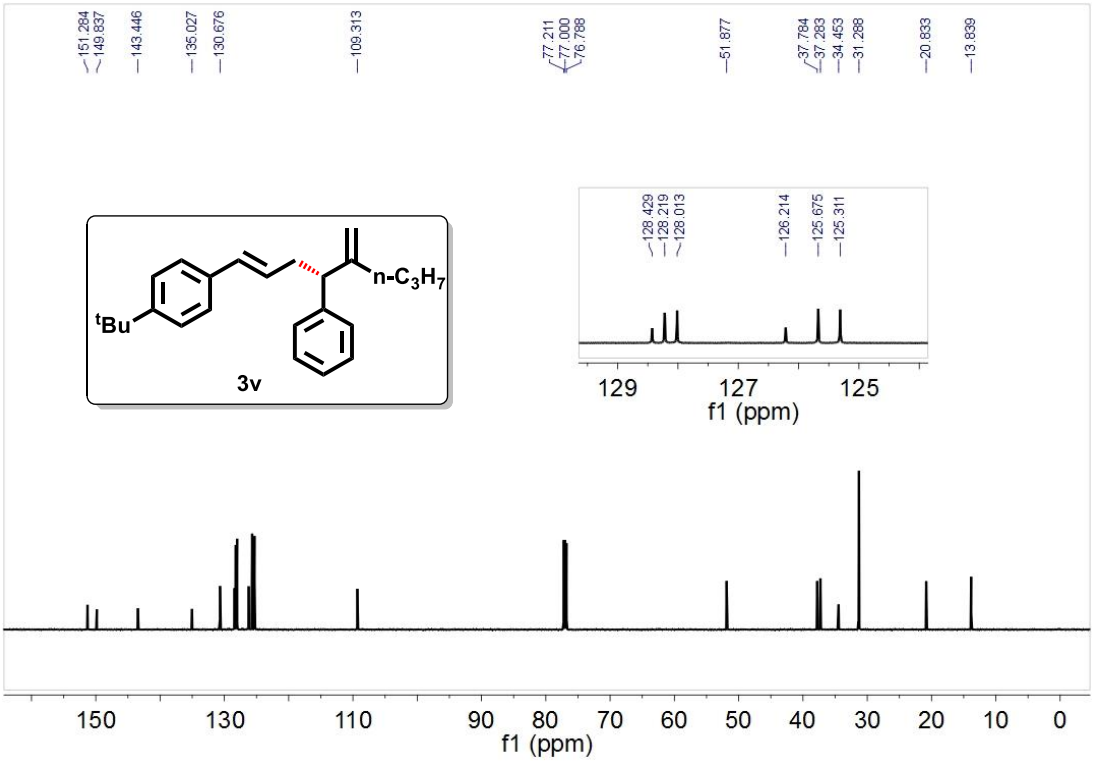
149.854
143.500
135.028
130.686
108.225
77.212
77.000
76.788
52.163
37.663
34.455
31.287
27.658
12.210
^{t}Bu
C_2H_5
3u
128.414
128.226
127.976
126.216
125.684
125.312
127.5
f1 (ppm)
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.288
7.274
7.261
7.224
7.222
7.207
7.193
7.185
7.172
6.344
6.317
6.068
6.056
6.054
6.041
6.030
5.017
4.930
3.343
3.330
3.318
1.885
1.872
1.858
1.846
1.842
1.831
1.821
1.816
1.806
1.289
0.839
0.826
0.814
0.000
2.763
2.751
2.739
2.727
2.715
2.625
2.612
2.600
2.588
2.577
2.80
2.70
2.60
f1 (ppm)
n-C3H7
tBu
3v
1.454
1.439
1.432
1.417
1.405
1.394
1.379
1.367
1.356
1.344
1.45
1.40
1.35
f1 (ppm)
4.00
5.08
1.00
1.00
1.02
1.04
1.00
1.02
1.06
2.10
1.98
9.00
3.07
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)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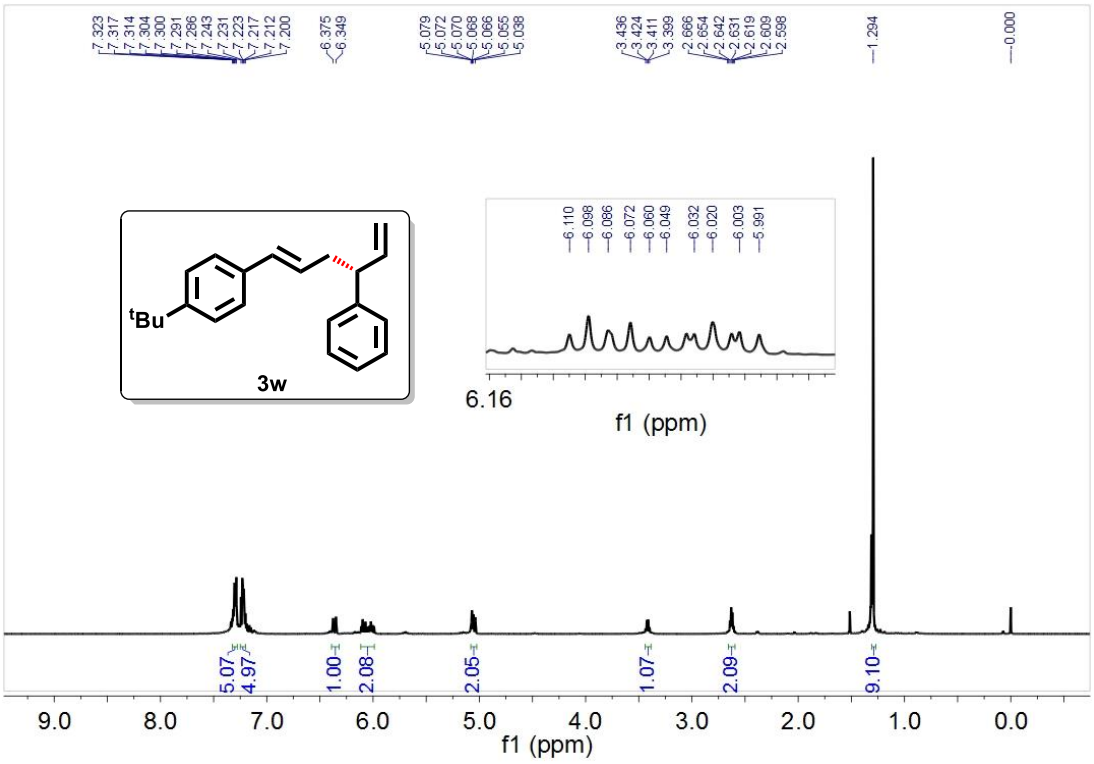
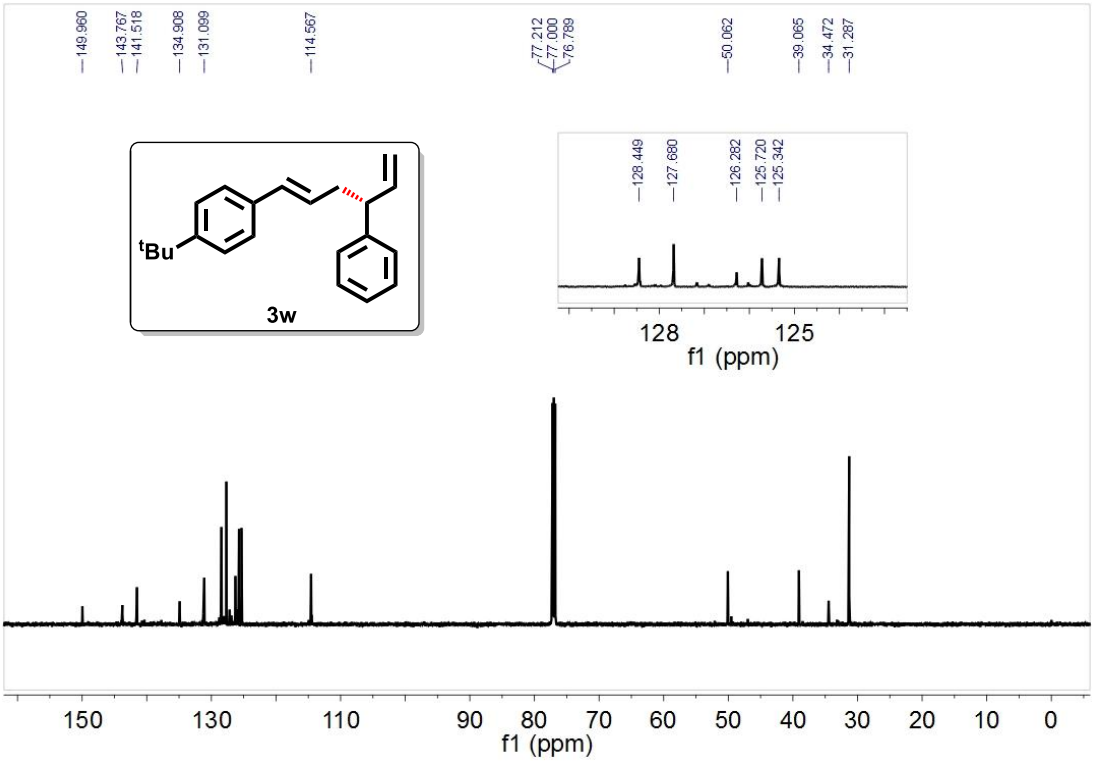
149.837
143.446
135.027
130.676
109.313
77.211
77.000
76.788
51.877
37.784
37.283
34.453
31.288
20.833
13.839
128.429
128.219
128.013
126.214
125.675
125.311
129
127
125
f1 (ppm)
n-C3H7
tBu
3v
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.323
7.317
7.314
7.304
7.300
7.291
7.286
7.243
7.231
7.223
7.217
7.212
7.200
6.375
6.349
5.079
5.072
5.070
5.068
5.066
5.055
5.038
3.436
3.424
3.411
3.399
2.666
2.654
2.642
2.631
2.619
2.609
2.598
1.294
0.000
tBu
3w
6.110
6.098
6.086
6.072
6.060
6.049
6.032
6.020
6.003
5.991
6.16
f1 (ppm)
5.07
4.97
1.00
2.08
2.05
1.07
2.09
9.10
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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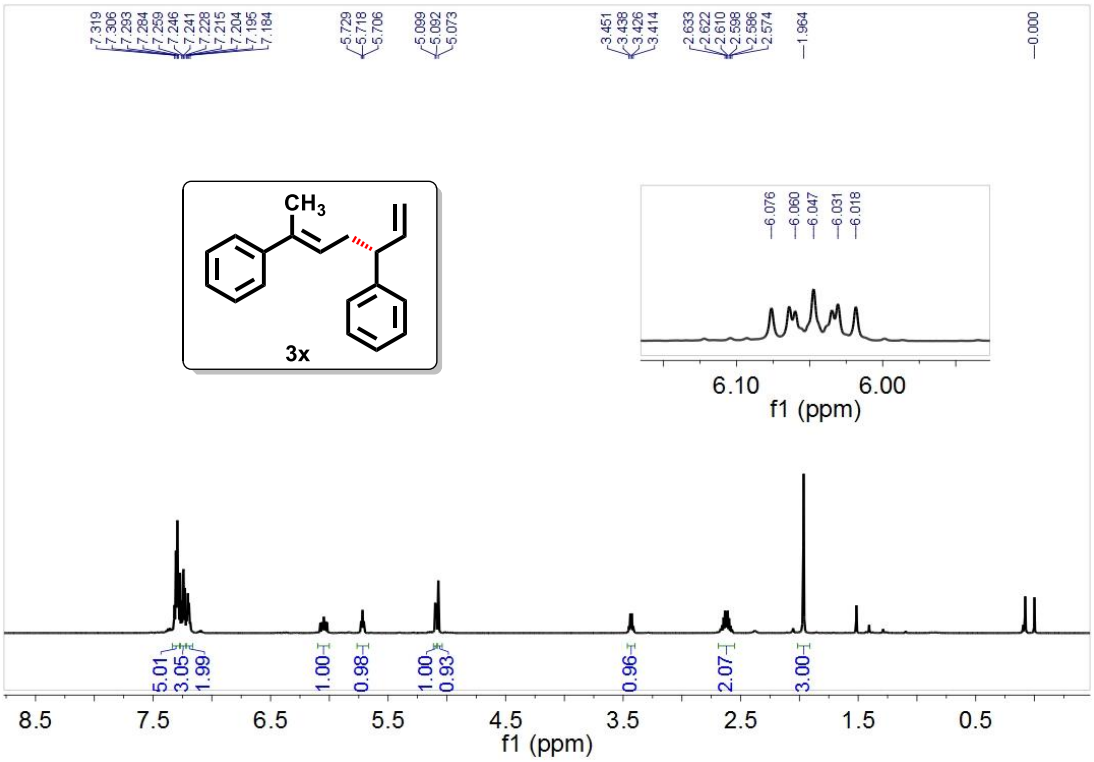
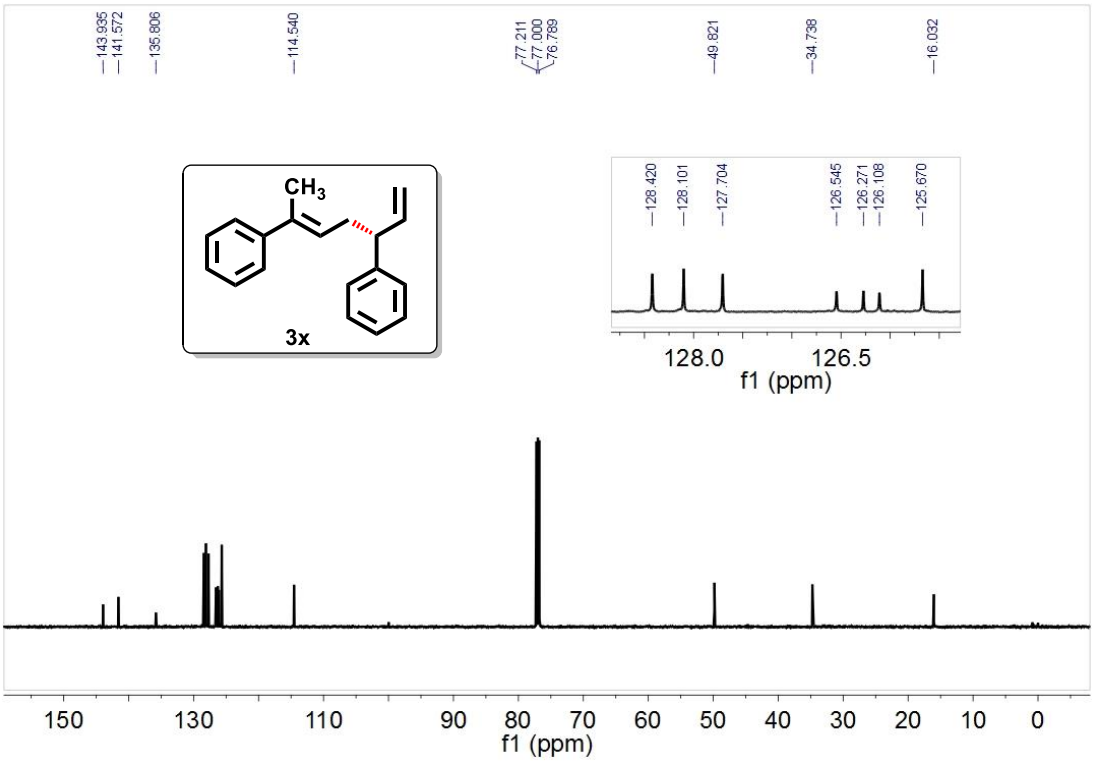
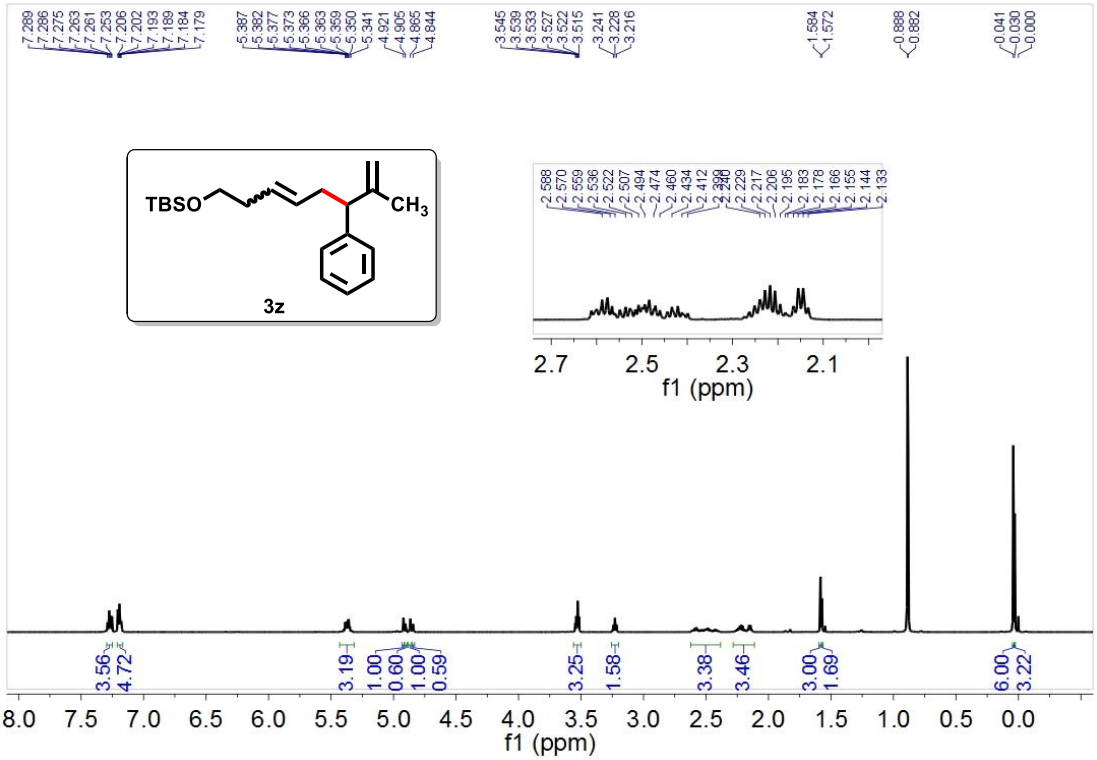
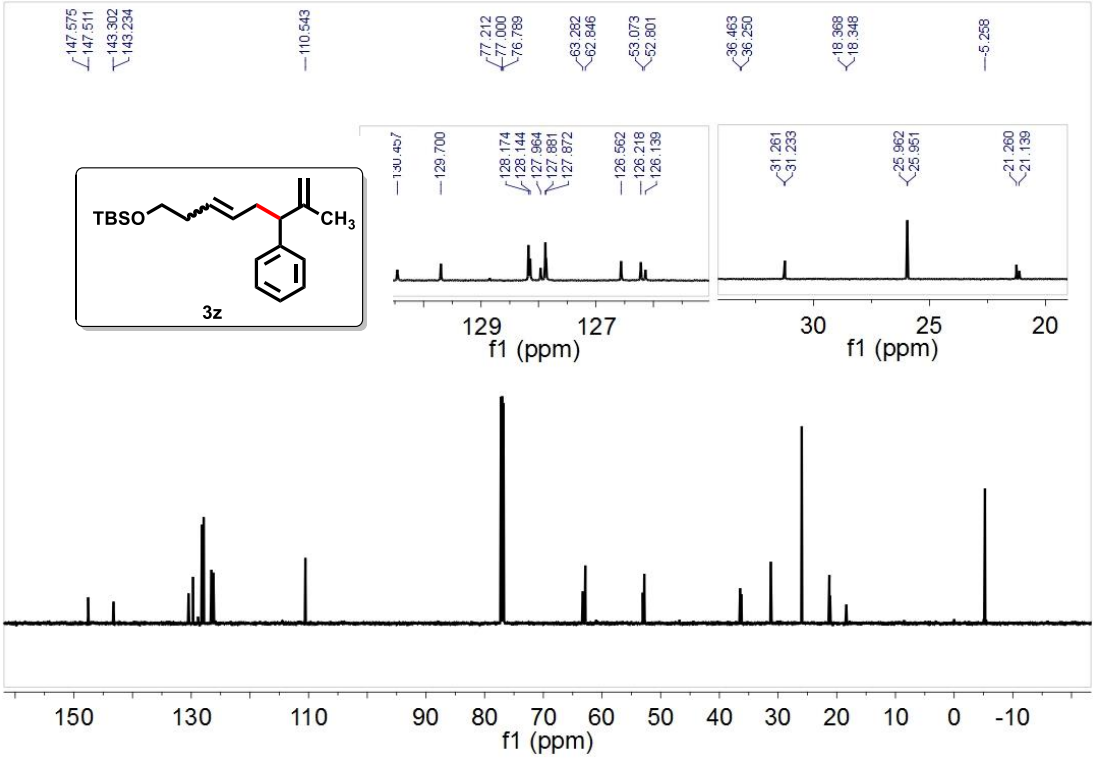
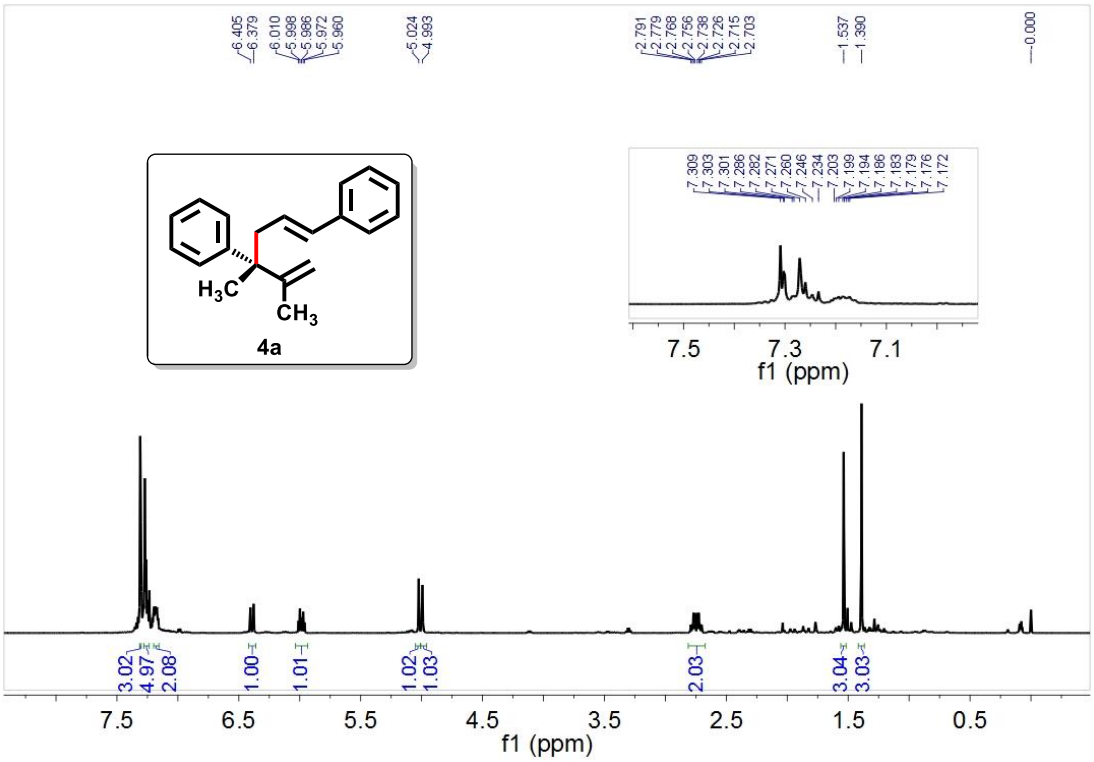
143.767
141.518
134.908
131.099
114.567
77.212
77.000
76.789
50.062
39.065
34.472
31.287
tBu
3w
128.449
127.680
126.282
125.720
125.342
128
125
f1 (ppm)
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.319
7.306
7.293
7.284
7.259
7.246
7.241
7.228
7.215
7.204
7.195
7.184
5.729
5.718
5.706
5.099
5.092
5.073
3.451
3.438
3.426
3.414
2.633
2.622
2.610
2.598
2.586
2.574
1.964
0.000
CH3
3x
6.076
6.060
6.047
6.031
6.018
6.10
6.00
f1 (ppm)
5.01
3.05
1.99
1.00
0.98
1.00
0.93
0.96
2.07
3.00
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)


143.935
141.572
135.806
114.540
77.211
77.000
76.789
49.821
34.738
16.032
CH3
3x
128.420
128.101
127.704
126.545
126.271
126.108
125.670
128.0
126.5
f1 (ppm)
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


TBSO
CH3
3z
f1 (ppm)


TBSO
CH3
3z
f1 (ppm)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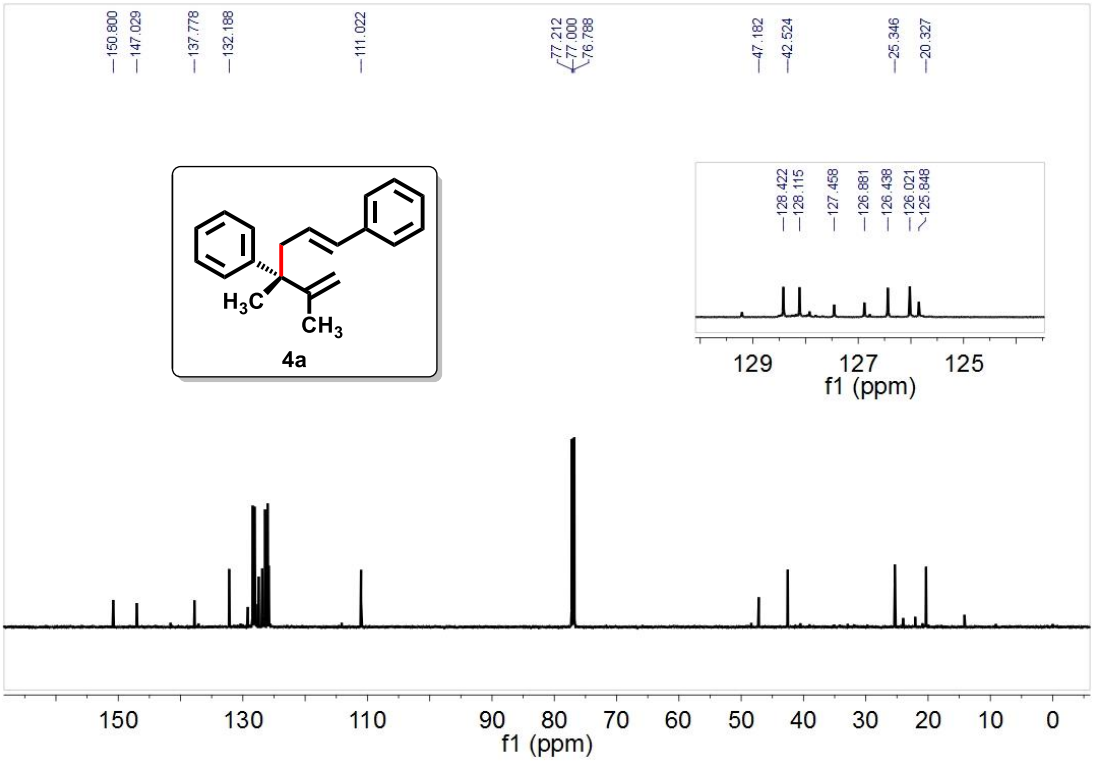
5.024
4.993
2.791
2.779
2.768
2.756
2.738
2.726
2.715
2.703
1.537
1.390
0.000
7.309
7.303
7.301
7.286
7.282
7.271
7.260
7.246
7.234
7.203
7.199
7.194
7.186
7.183
7.179
7.176
7.172
H3C
CH3
4a
7.5
7.3
7.1
f1 (ppm)
3.02
4.97
2.08
1.00
1.01
1.02
1.03
2.03
3.04
3.03
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)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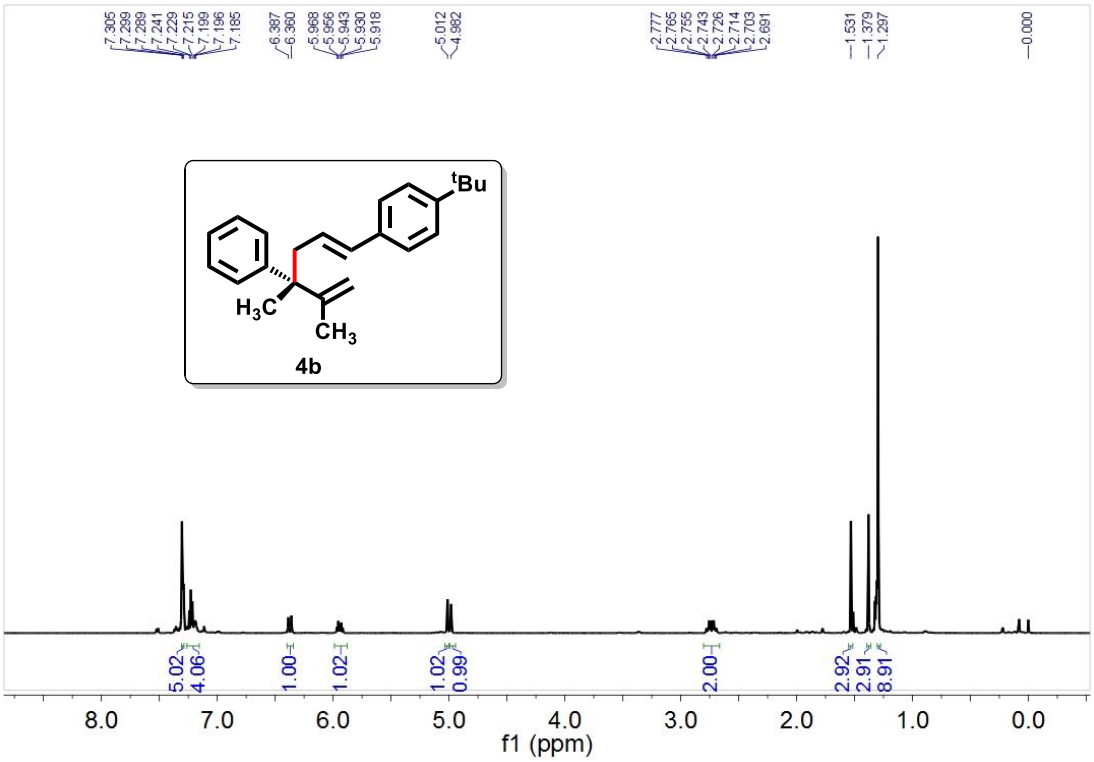
137.778
132.188
111.022
77.212
77.000
76.788
47.182
42.524
25.346
20.327
128.422
128.115
127.458
126.881
126.438
126.021
125.848
H3C
CH3
4a
129
127
125
f1 (ppm)
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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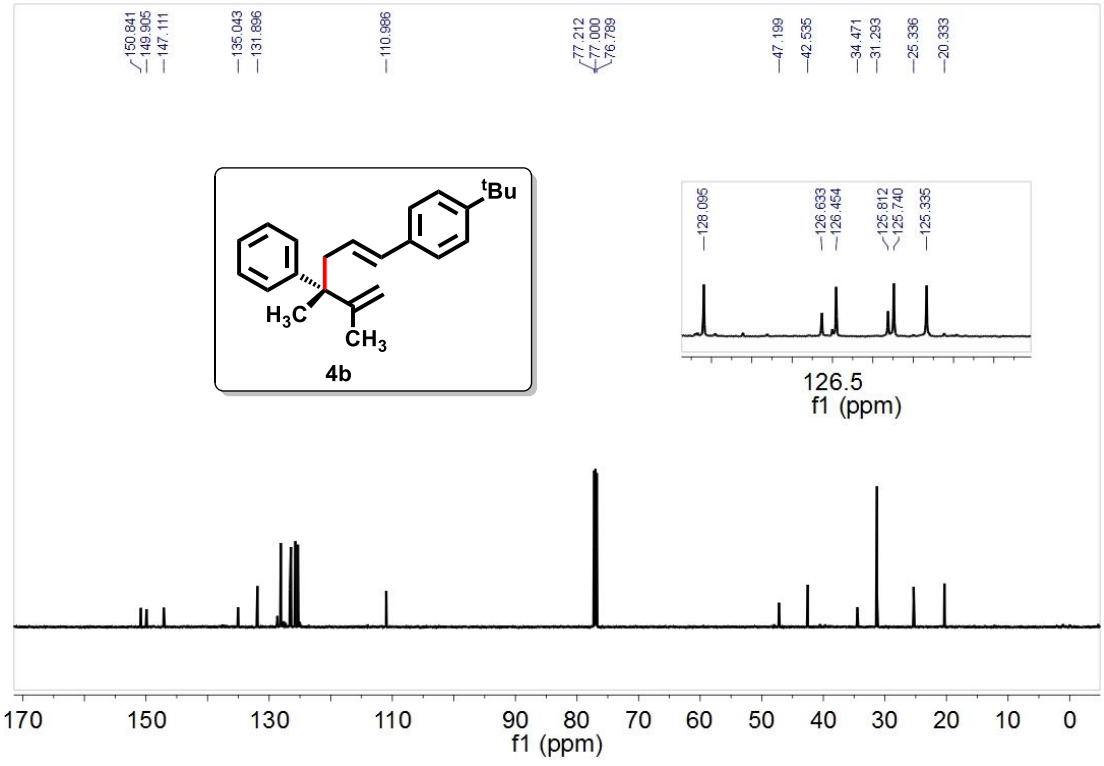
7.241
7.229
7.215
7.199
7.196
7.185
6.387
6.360
5.968
5.956
5.943
5.930
5.918
5.012
4.982
2.777
2.765
2.755
2.743
2.726
2.714
2.703
2.691
1.531
1.379
1.297
0.000
tBu
H3C
CH3
4b
5.02
4.06
1.00
1.02
1.02
0.99
2.00
2.92
2.91
8.91
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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135.043
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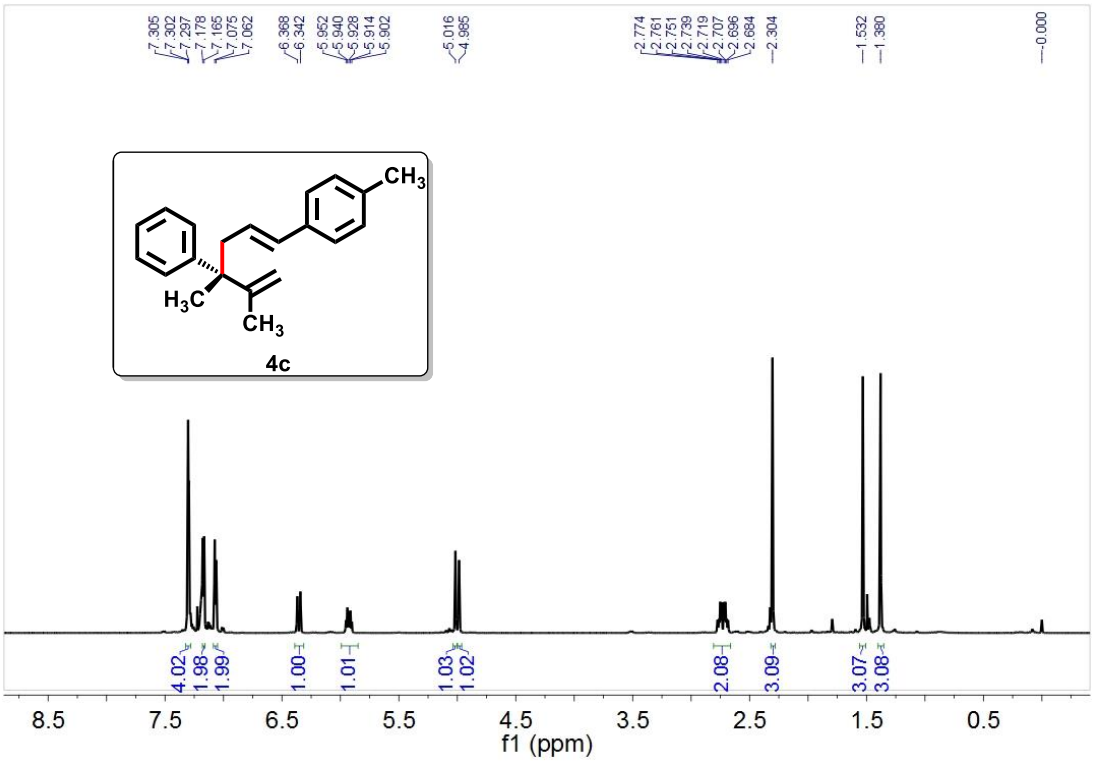
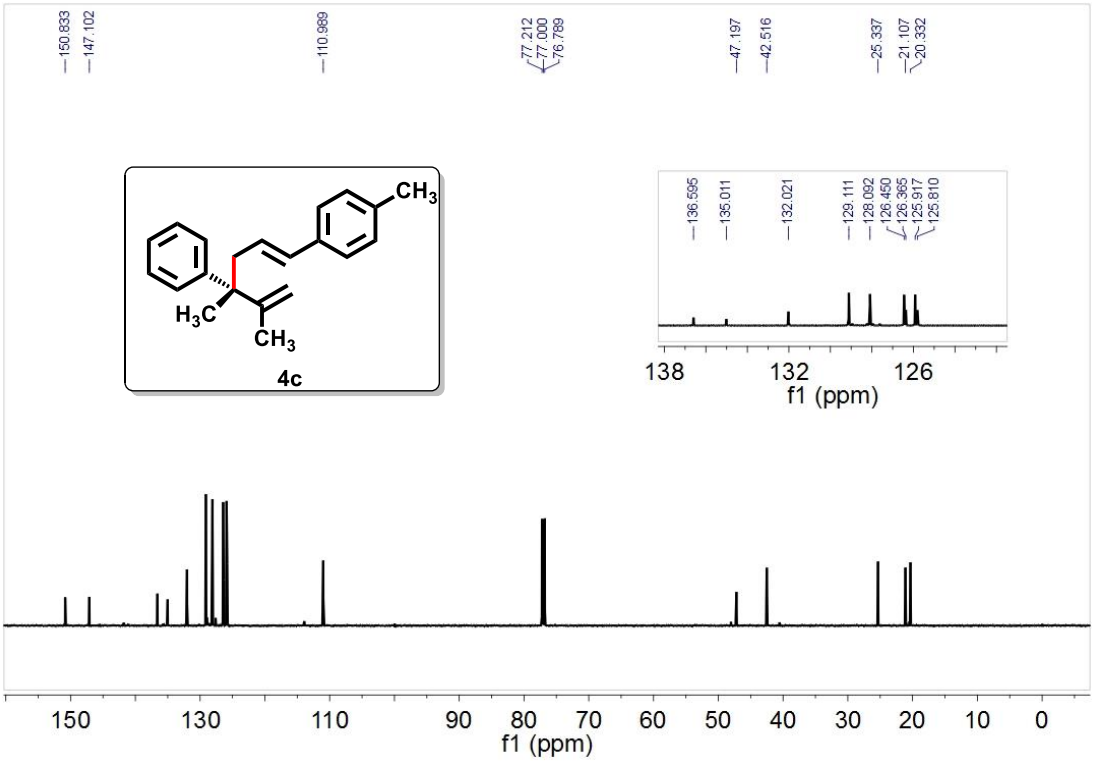
110.986
77.212
77.000
76.789
47.199
42.535
34.471
31.293
25.336
20.333
tBu
H3C
CH3
4b
128.095
126.633
126.454
125.812
125.740
125.335
126.5
f1 (ppm)
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.305
7.302
7.297
7.178
7.165
7.075
7.062
6.368
6.342
5.952
5.940
5.928
5.914
5.902
5.016
4.985
2.774
2.761
2.751
2.739
2.719
2.707
2.696
2.684
2.304
1.532
1.380
0.000
CH3
H3C
CH3
4c
4.02
1.98
1.99
1.00
1.01
1.03
1.02
2.08
3.09
3.07
3.08
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)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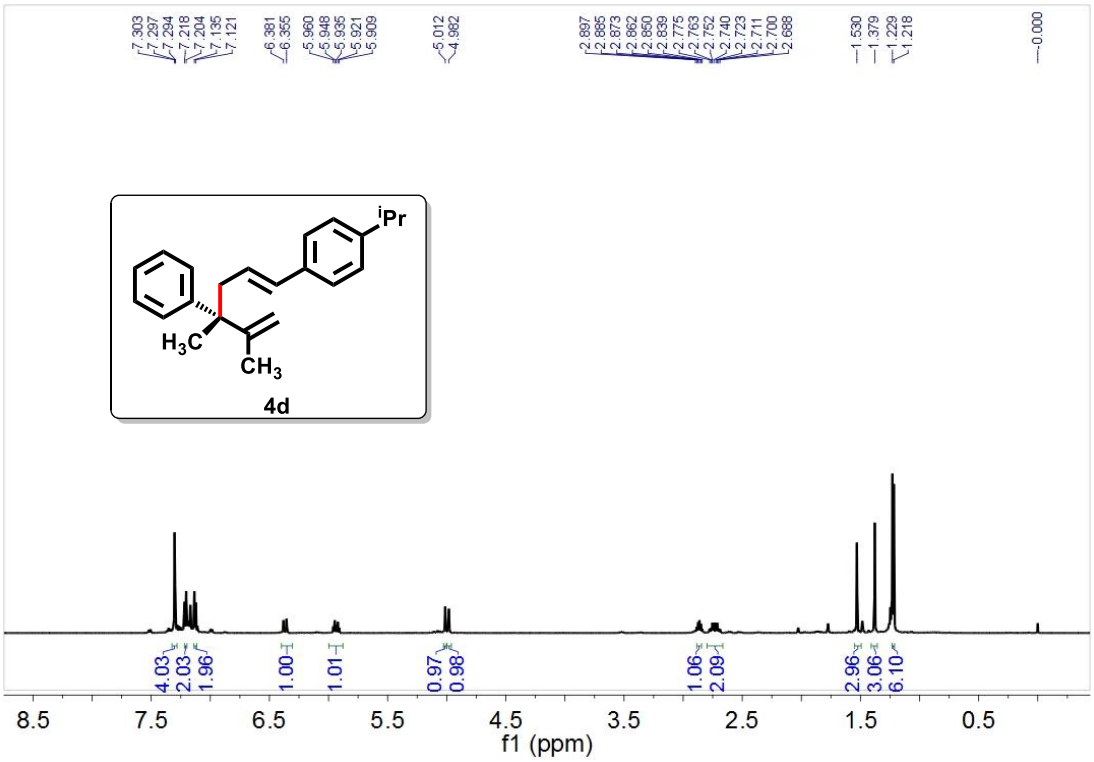
110.989
77.212
77.000
76.789
47.197
42.516
25.337
21.107
20.332
CH3
H3C
CH3
4c
136.595
135.011
132.021
129.111
128.092
126.450
126.365
125.917
125.810
138
132
126
f1 (ppm)
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.303
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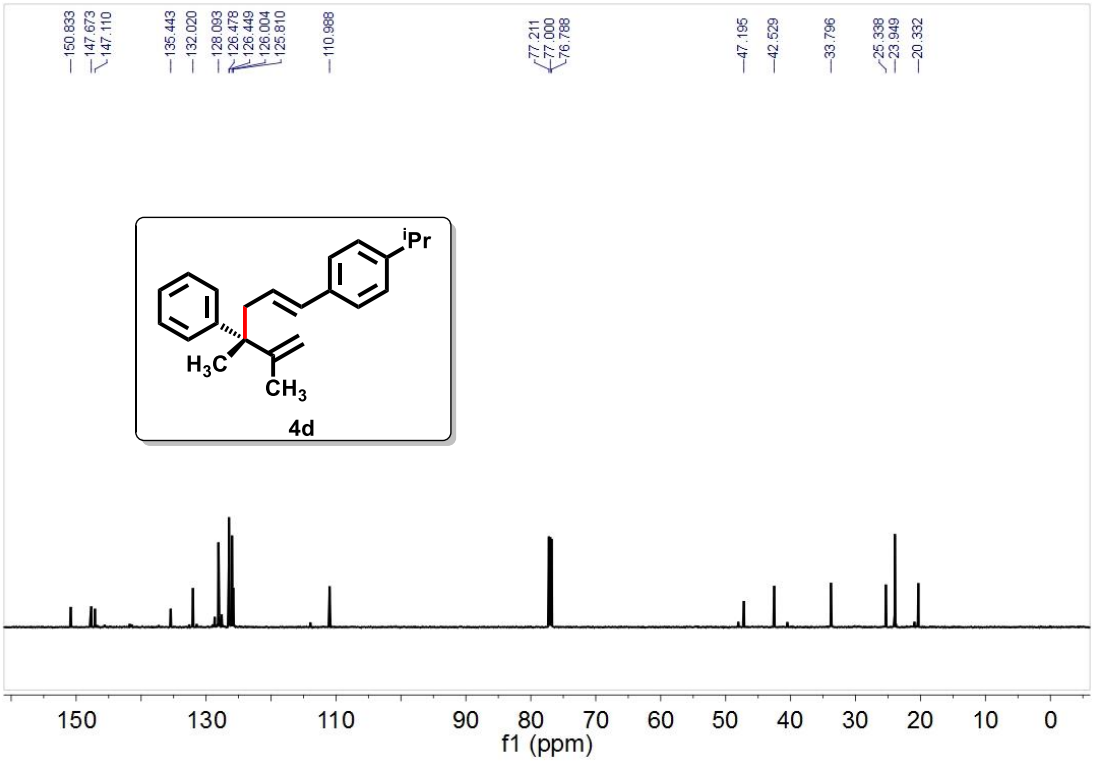
7.294
7.218
7.204
7.135
7.121
6.381
6.355
5.960
5.948
5.935
5.921
5.909
5.012
4.982
2.897
2.885
2.873
2.862
2.850
2.839
2.775
2.763
2.752
2.740
2.723
2.711
2.700
2.688
1.530
1.379
1.229
1.218
0.000
iPr
H3C
CH3
4d
4.03
2.03
1.96
1.00
1.01
0.97
0.98
1.06
2.09
2.96
3.06
6.10
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)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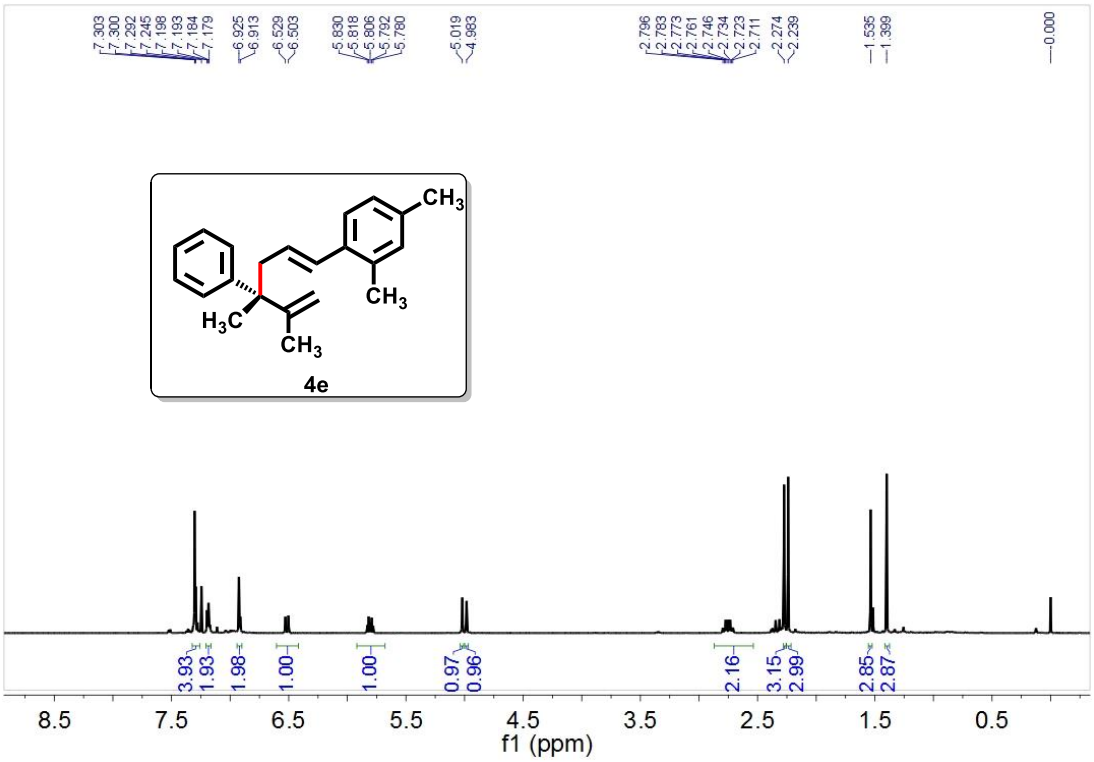
147.673
147.110
135.443
132.020
128.093
126.478
126.449
126.004
125.810
110.988
77.211
77.000
76.788
47.195
42.529
33.796
25.338
23.949
20.332
iPr
H3C
CH3
4d
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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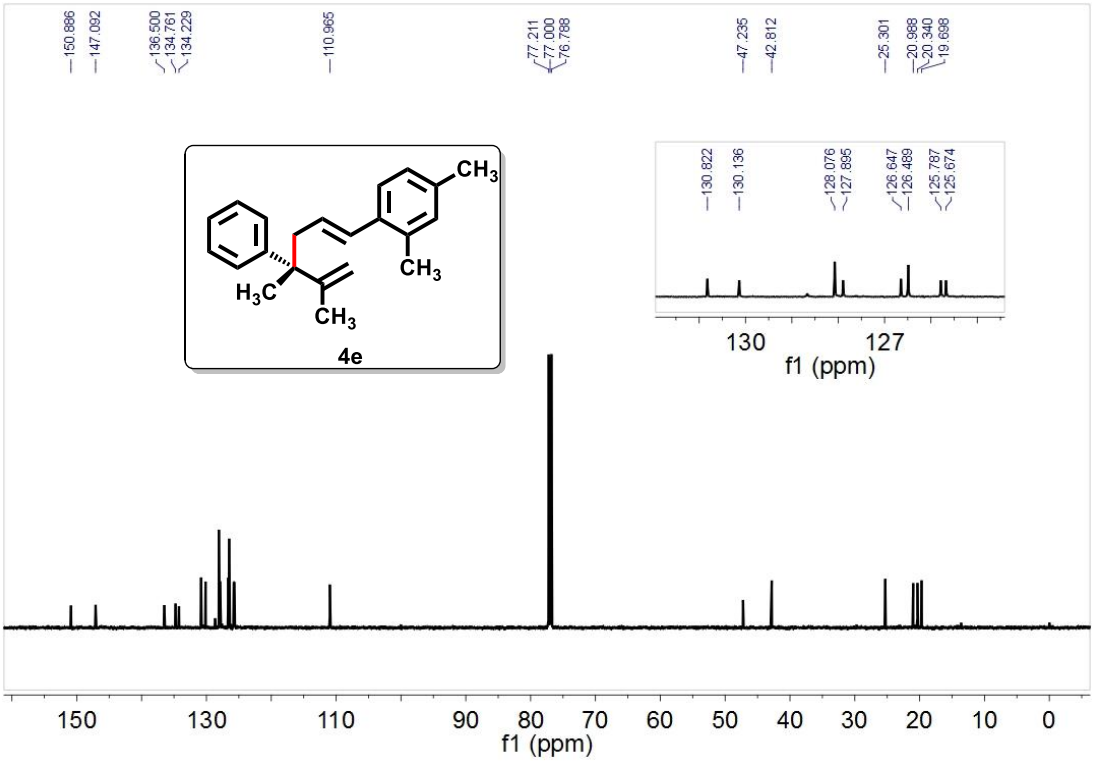
7.245
7.198
7.193
7.184
7.179
6.925
6.913
6.529
6.503
5.830
5.818
5.806
5.792
5.780
5.019
4.983
2.796
2.783
2.773
2.761
2.746
2.734
2.723
2.711
2.274
2.239
1.535
1.399
0.000
CH3
CH3
H3C
CH3
4e
3.93
1.93
1.98
1.00
1.00
0.97
0.96
2.16
3.15
2.99
2.85
2.87
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)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134.761
134.229
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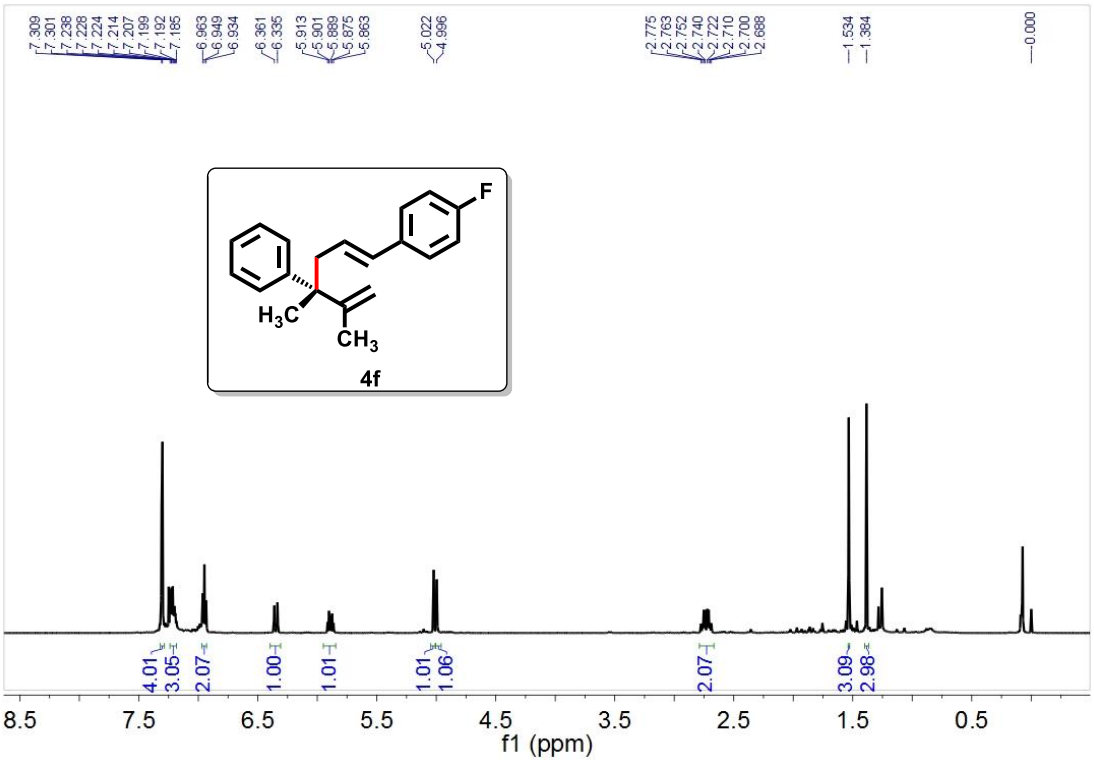
77.211
77.000
76.788
47.235
42.812
25.301
20.988
20.340
19.698
CH3
CH3
H3C
CH3
4e
130.822
130.136
128.076
127.895
126.647
126.489
125.787
125.674
130
127
f1 (ppm)
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.301
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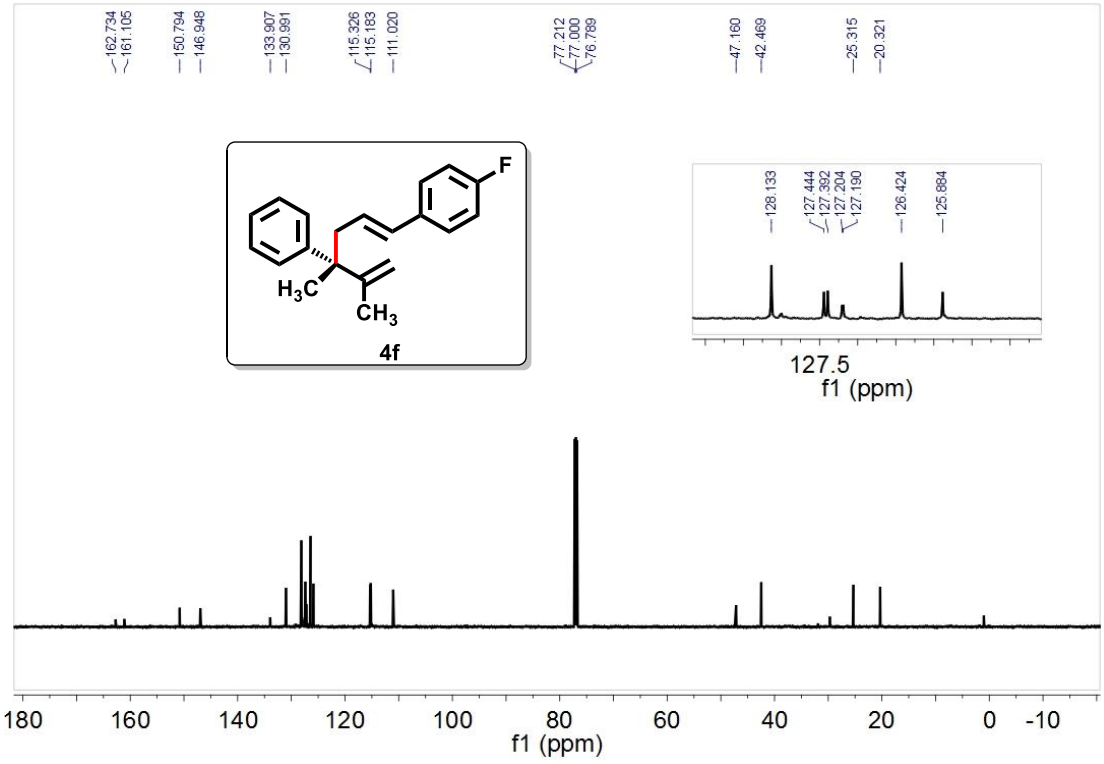
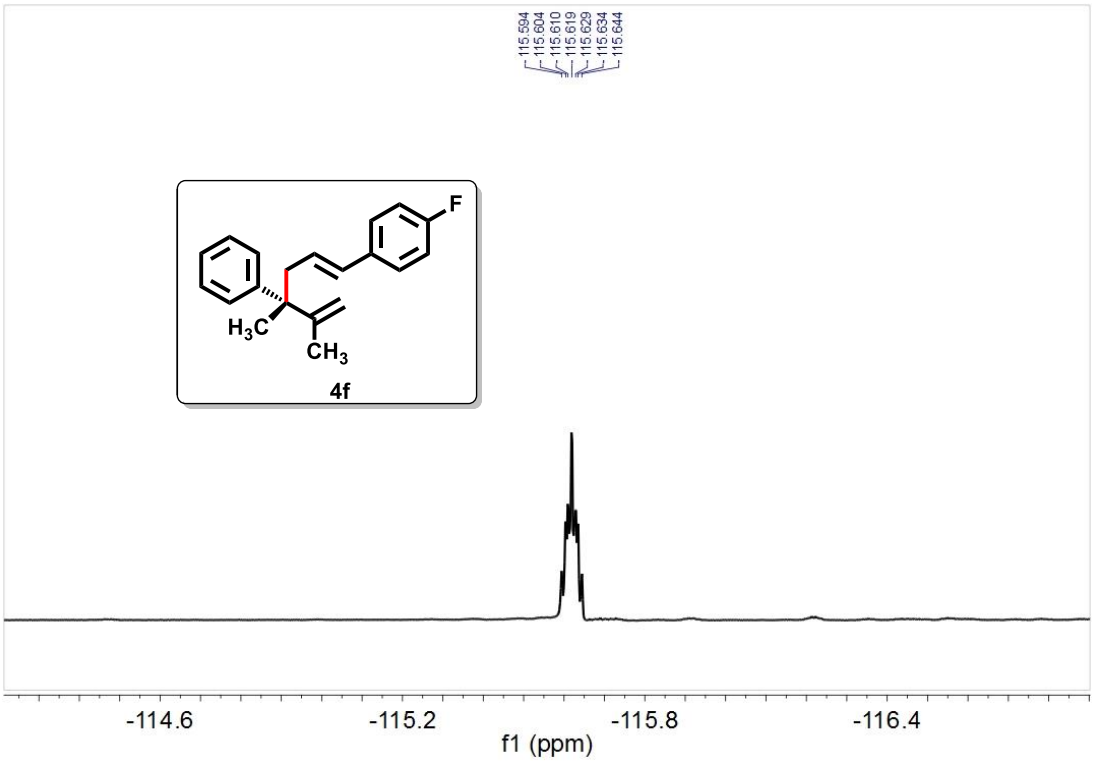
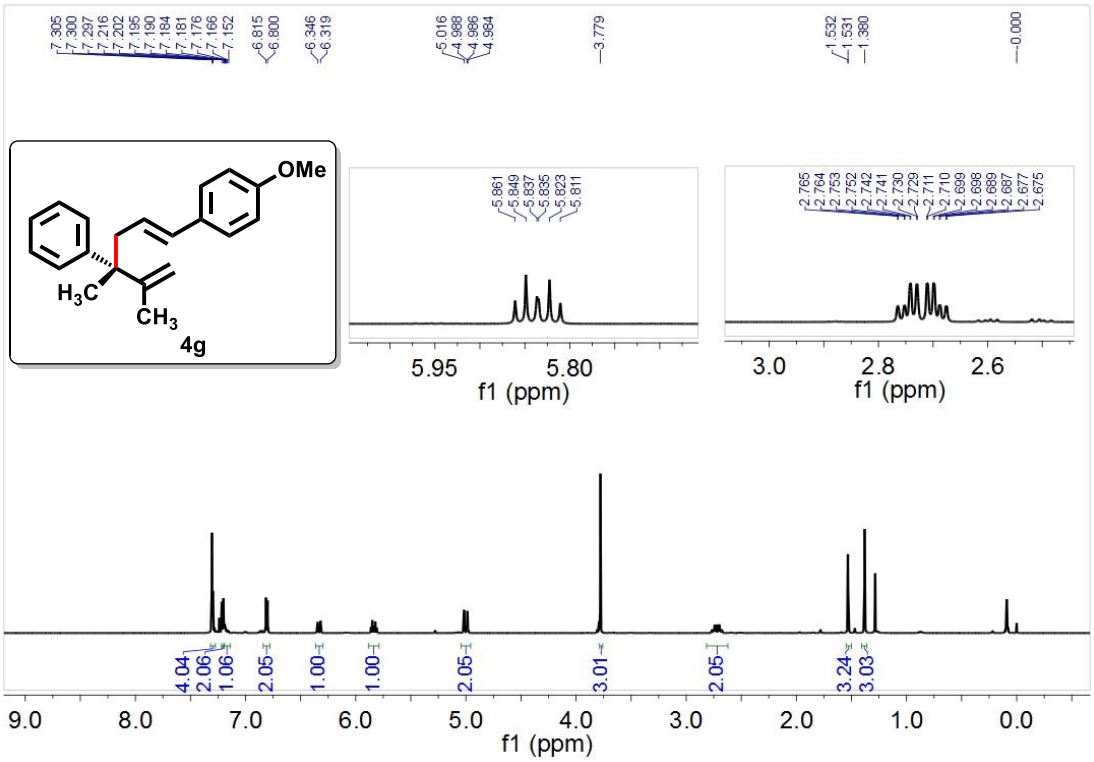
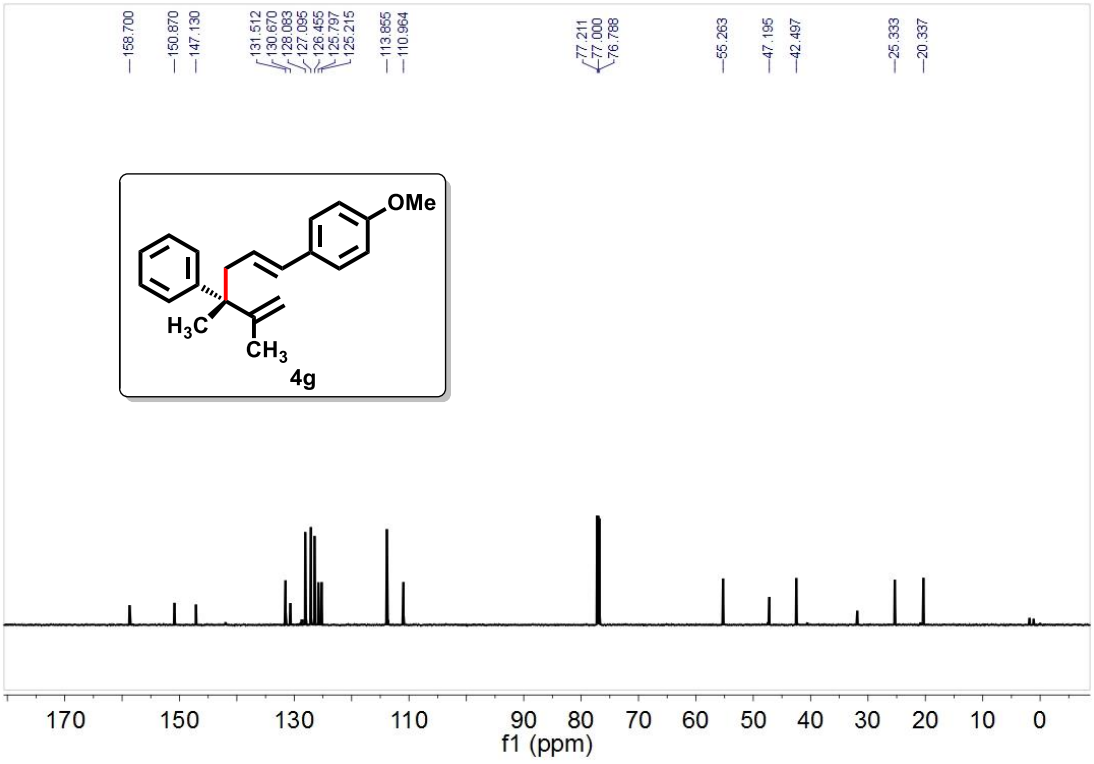
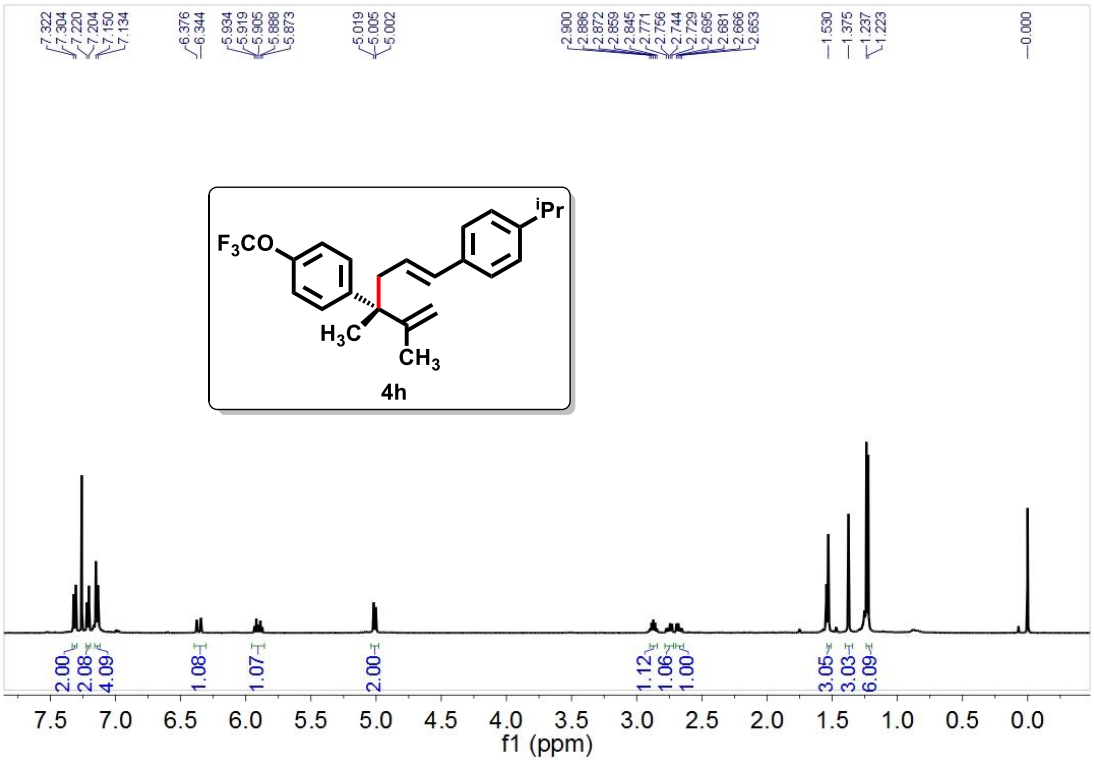
7.228
7.224
7.214
7.207
7.199
7.192
7.185
6.963
6.949
6.934
6.361
6.335
5.913
5.901
5.889
5.875
5.863
5.022
4.996
2.775
2.763
2.752
2.740
2.722
2.710
2.700
2.688
1.534
1.384
0.000
F
H3C
CH3
4f
4.01
3.05
2.07
1.00
1.01
1.01
1.06
2.07
3.09
2.98
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)


162.734
161.105
150.794
146.948
133.907
130.991
115.326
115.183
111.020
77.212
77.000
76.789
47.160
42.469
25.315
20.321
F
H3C
CH3
4f
128.133
127.444
127.392
127.204
127.190
126.424
125.884
127.5
f1 (ppm)
180
160
140
120
100
80
60
40
20
0
-10
f1 (ppm)


115.594
115.604
115.610
115.619
115.629
115.634
115.644
F
H3C
CH3
4f
-114.6
-115.2
-115.8
-116.4
f1 (ppm)


OMe
H3C
CH3
4g
f1 (ppm)
f1 (ppm)
f1 (ppm)


OMe
H3C
CH3
4g
f1 (ppm)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7.220
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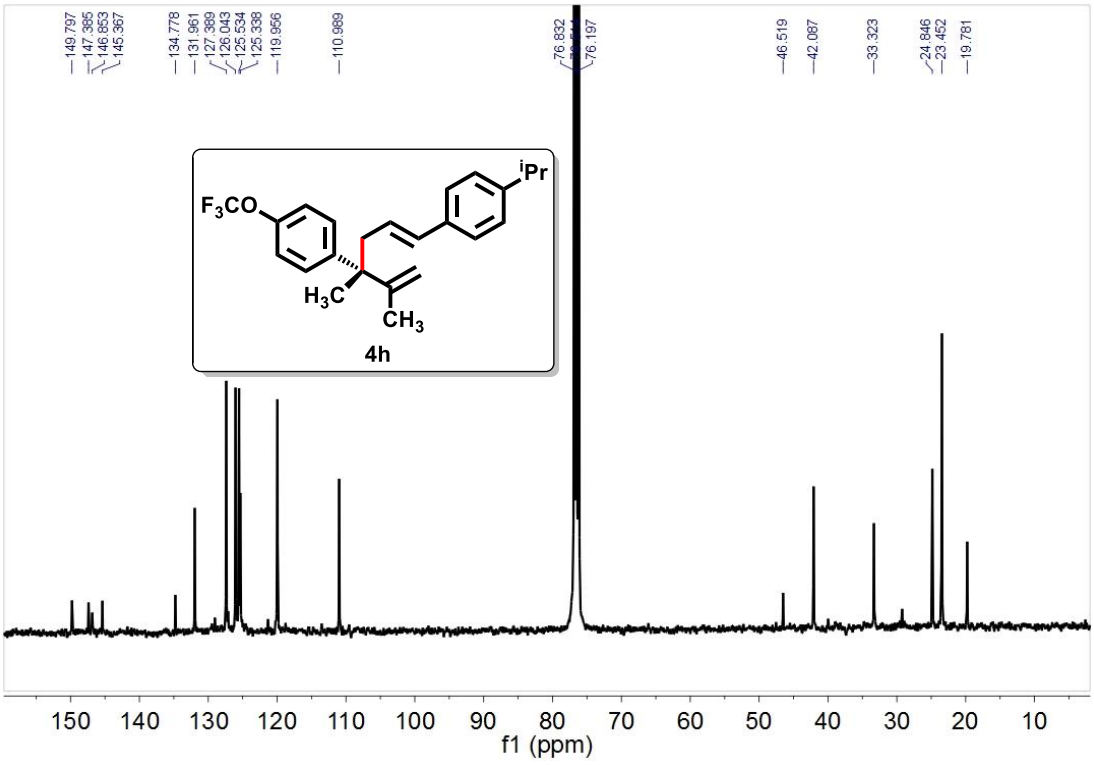
7.150
7.134
6.376
6.344
5.934
5.919
5.905
5.888
5.873
5.019
5.005
5.002
2.900
2.886
2.872
2.859
2.845
2.771
2.756
2.744
2.729
2.695
2.681
2.666
2.653
1.530
1.375
1.237
1.223
0.000
F3CO
iPr
H3C
CH3
4h
2.00
2.08
4.09
1.08
1.07
2.00
1.12
1.06
1.00
3.05
3.03
6.09
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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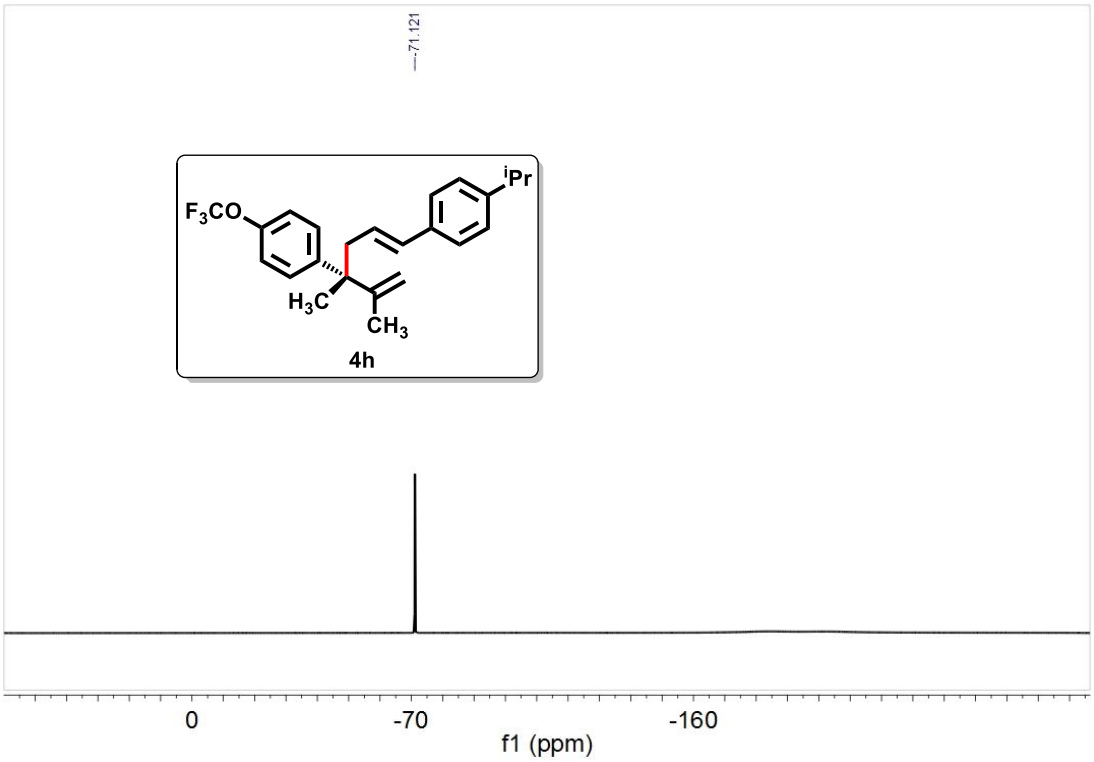
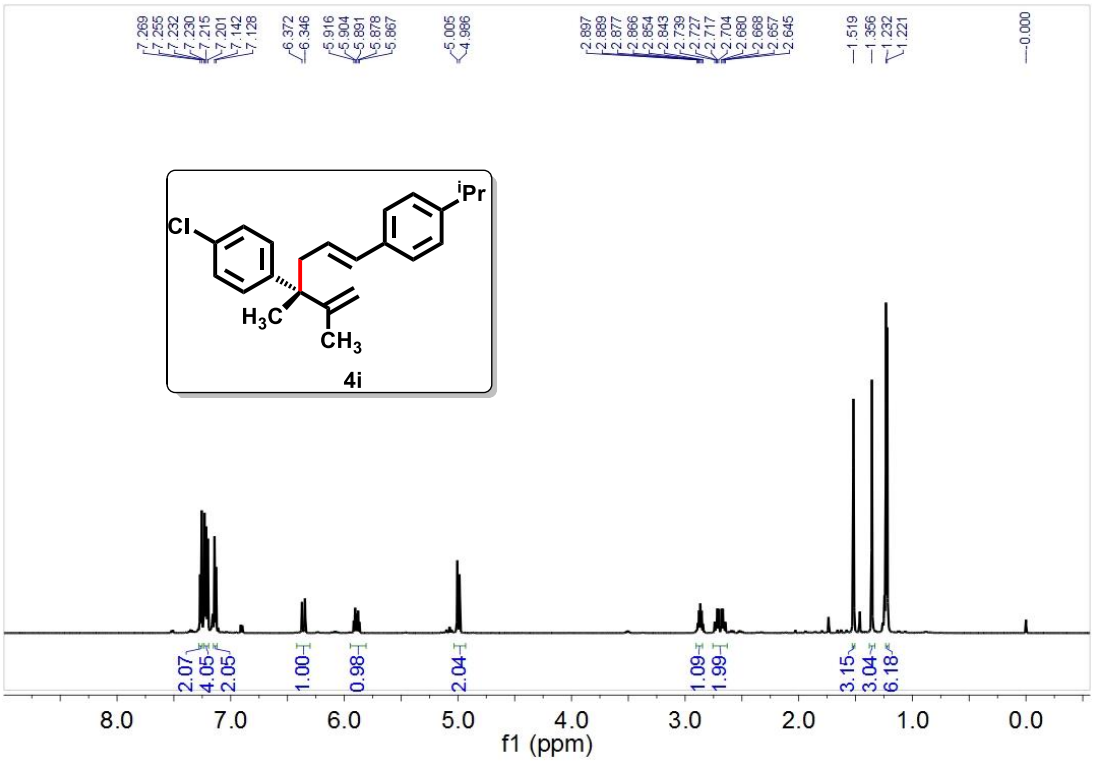
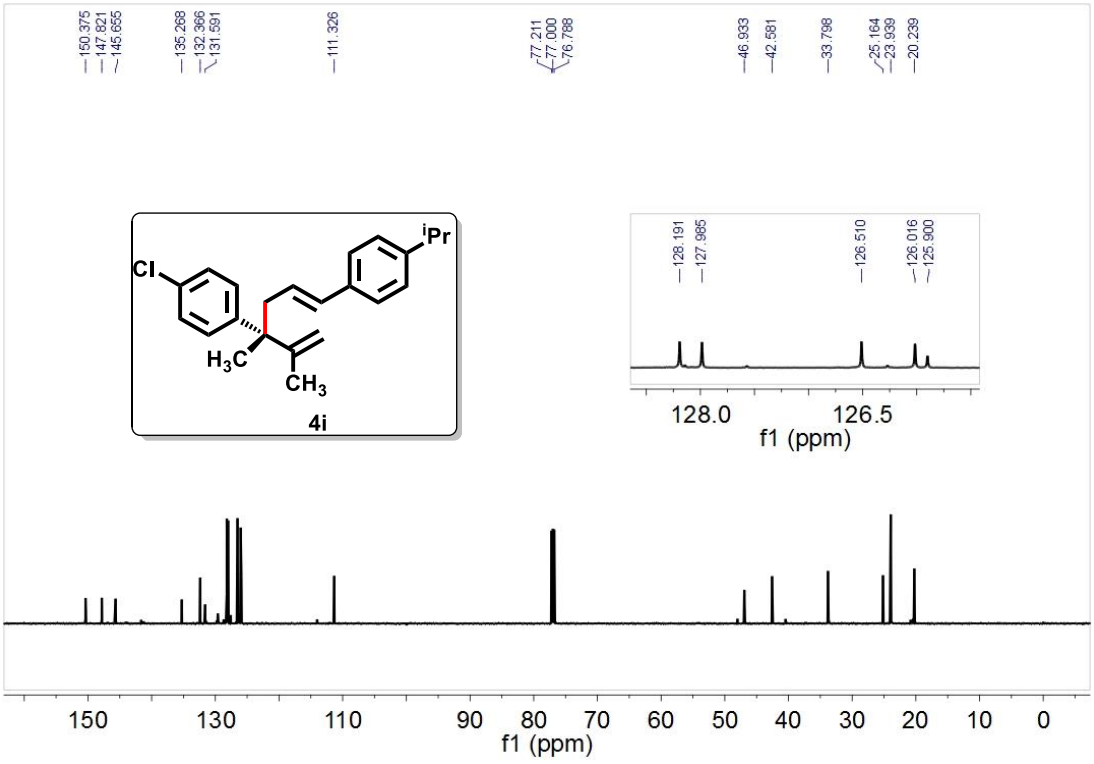
147.385
146.853
145.367
134.778
131.961
127.389
126.043
125.534
125.338
119.956
110.989
76.832
76.197
46.519
42.087
33.323
24.846
23.452
19.781
F3CO
iPr
H3C
CH3
4h
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


-71.121
F3CO
iPr
H3C
CH3
4h
0
-70
-160
f1 (ppm)


7.269
7.255
7.232
7.230
7.215
7.201
7.142
7.128
6.372
6.346
5.916
5.904
5.891
5.878
5.867
5.005
4.986
2.897
2.889
2.877
2.866
2.854
2.843
2.739
2.727
2.717
2.704
2.680
2.668
2.657
2.645
1.519
1.356
1.232
1.221
0.000
Cl
iPr
H3C
CH3
4i
2.07
4.05
2.05
1.00
0.98
2.04
1.09
1.99
3.15
3.04
6.18
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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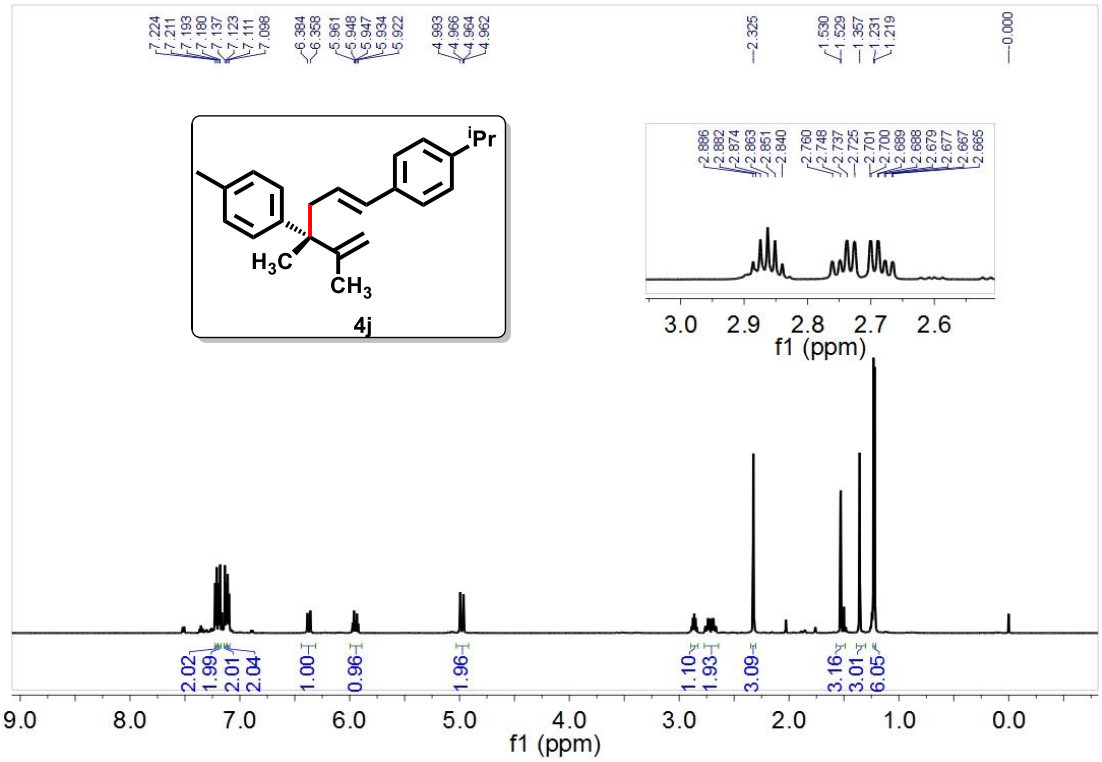
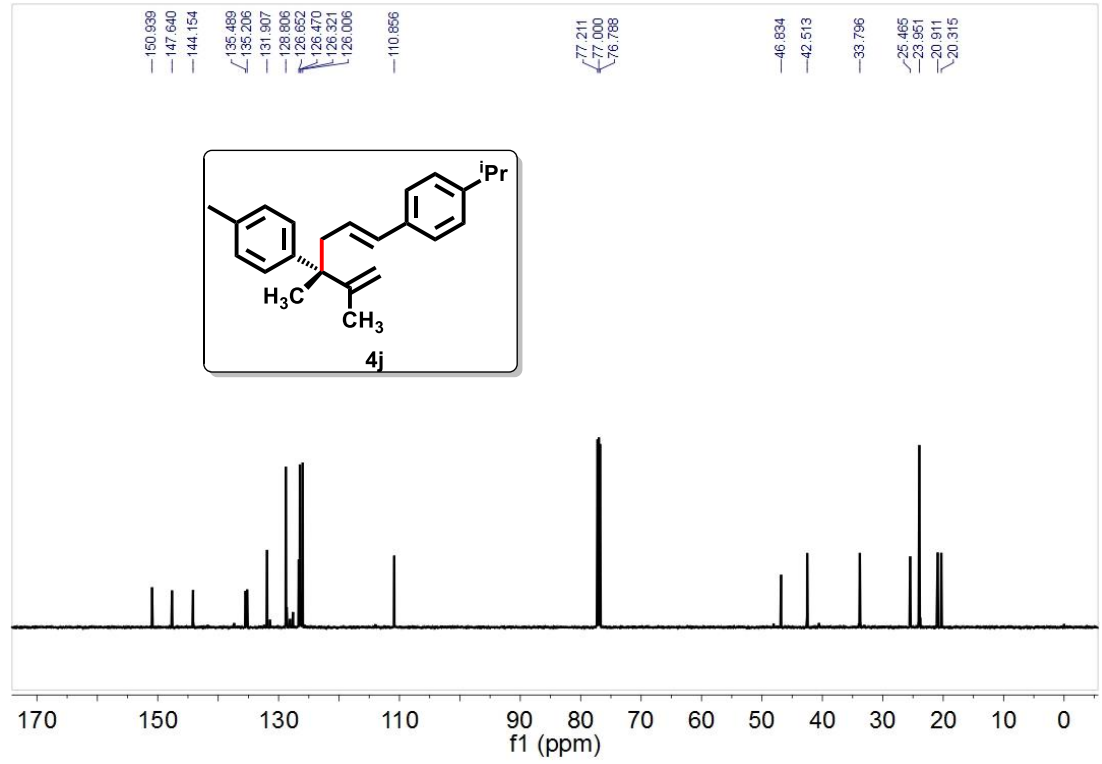
147.821
145.655
135.268
132.366
131.591
111.326
77.211
77.000
76.788
46.933
42.581
33.798
25.164
23.939
20.239
Cl
iPr
H3C
CH3
4i
128.191
127.985
126.510
126.016
125.900
128.0
126.5
f1 (ppm)
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.224
7.211
7.193
7.180
7.137
7.123
7.111
7.098
6.384
6.368
5.961
5.948
5.947
5.934
5.922
4.993
4.966
4.964
4.962
2.325
1.530
1.529
1.357
1.231
1.219
0.000
2.886
2.882
2.874
2.863
2.851
2.840
2.760
2.748
2.737
2.725
2.701
2.700
2.689
2.688
2.679
2.677
2.667
2.665
iPr
H3C
CH3
4j
3.0
2.9
2.8
2.7
2.6
f1 (ppm)
2.02
1.99
2.01
2.04
1.00
0.96
1.96
1.10
1.93
3.09
3.16
3.01
6.05
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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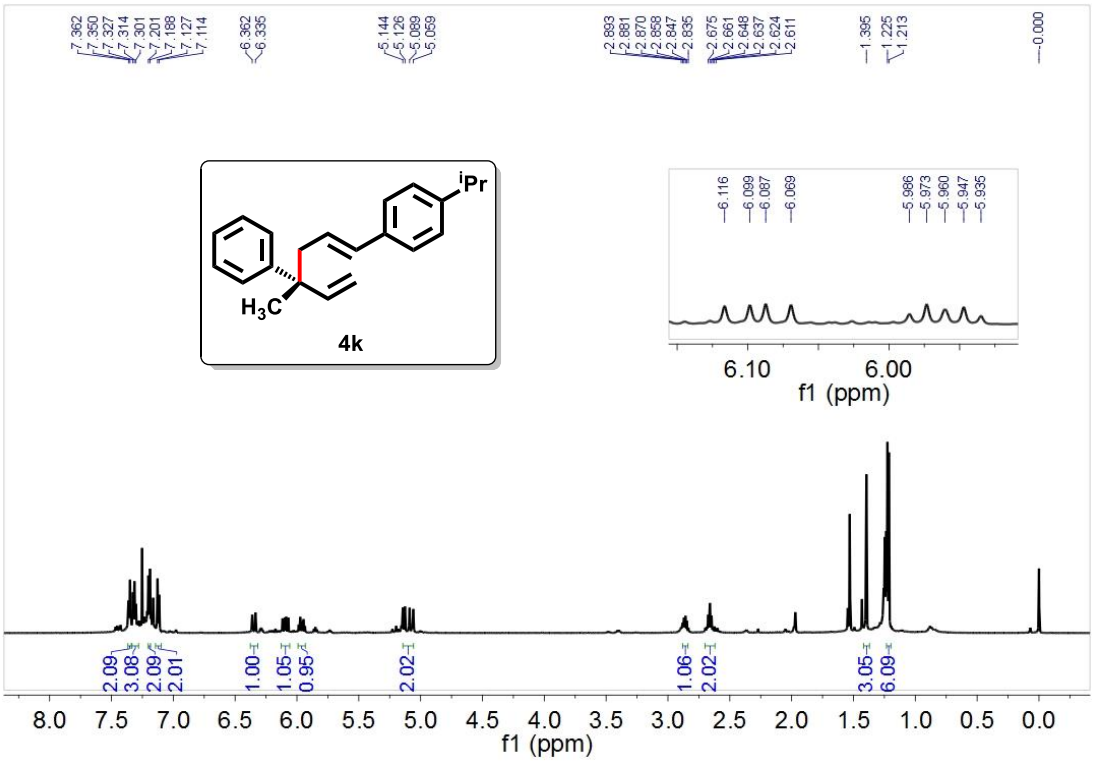
126.006
110.856
77.211
77.000
76.788
46.834
42.513
33.796
25.465
23.951
20.911
20.315
iPr
H3C
CH3
4j
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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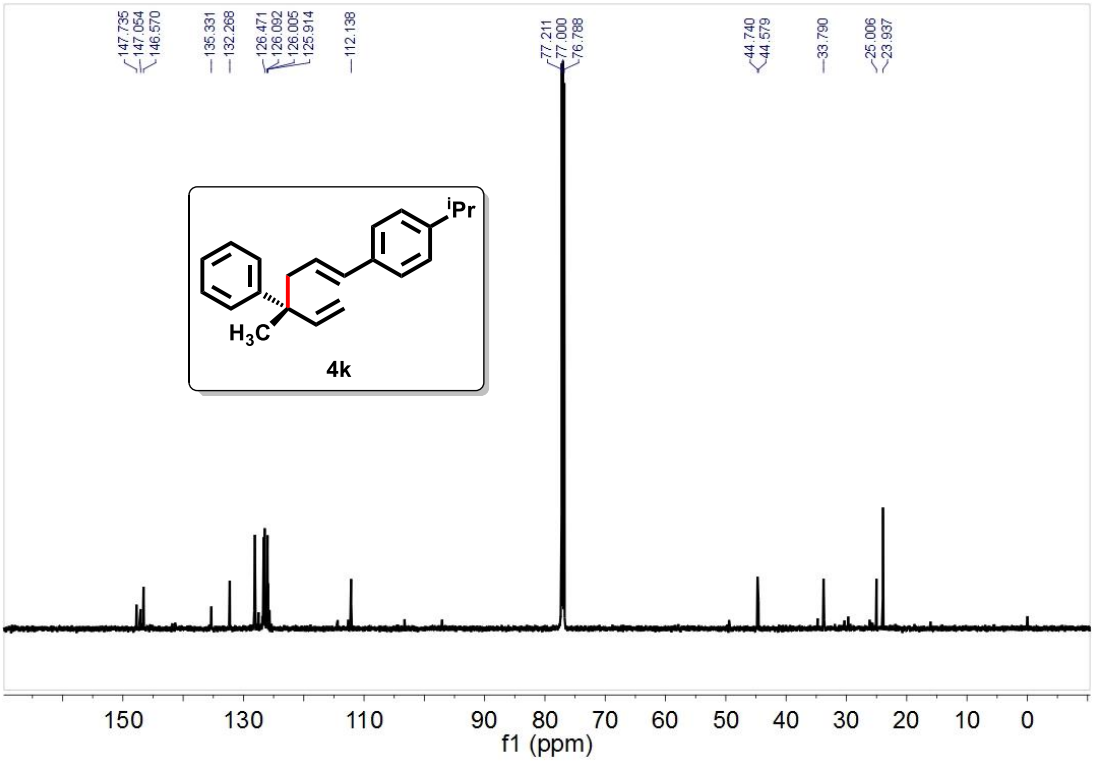
7.360
7.327
7.314
7.301
7.201
7.188
7.127
7.114
6.362
6.335
5.144
5.126
5.089
5.069
2.893
2.881
2.870
2.868
2.847
2.835
2.675
2.661
2.648
2.637
2.624
2.611
1.395
1.225
1.213
0.000
iPr
H3C
4k
6.116
6.099
6.087
6.069
5.986
5.973
5.960
5.947
5.935
6.10
6.00
f1 (ppm)
2.09
3.08
2.09
2.01
1.00
1.05
0.95
2.02
1.06
2.02
3.05
6.09
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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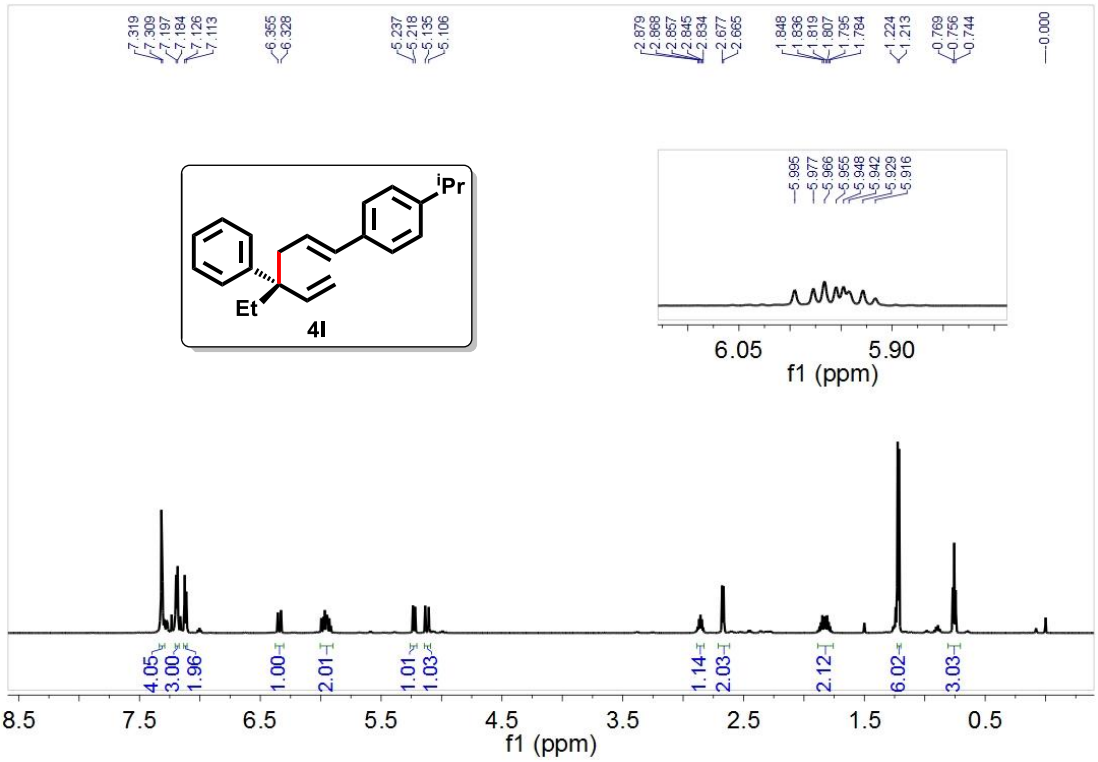
126.005
125.914
112.138
77.211
77.000
76.788
44.740
44.579
33.790
25.006
23.937
iPr
H3C
4k
150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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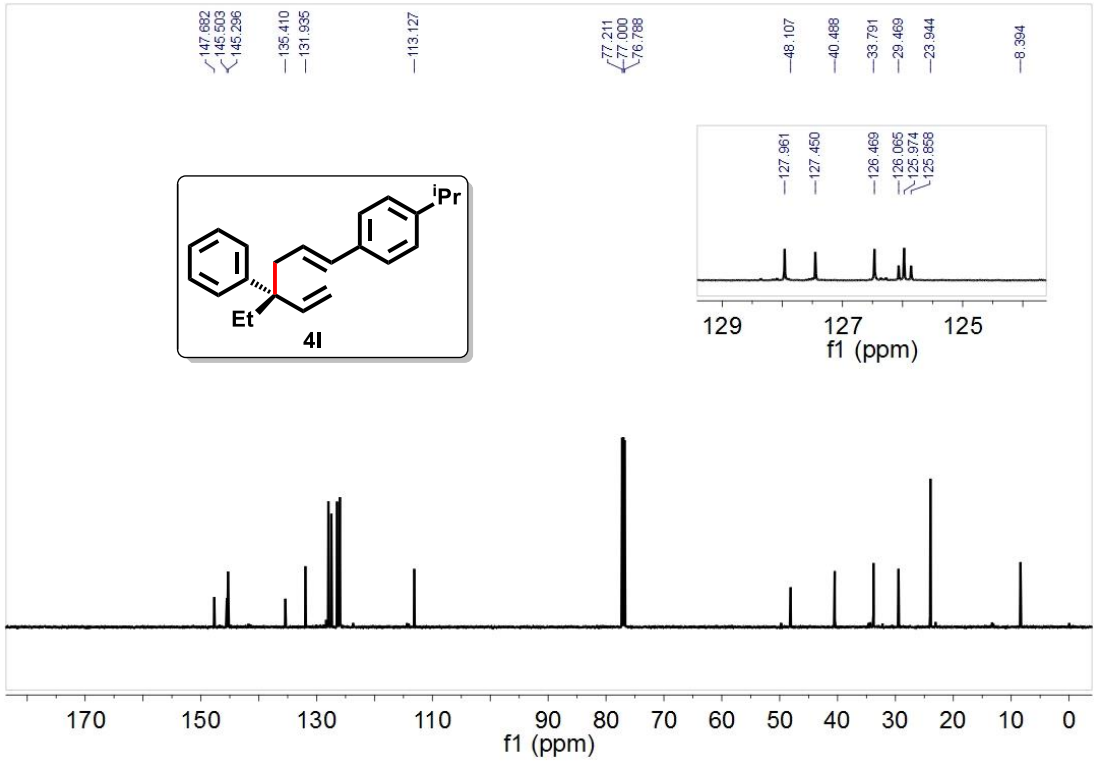
7.184
7.126
7.113
6.355
6.328
5.237
5.218
5.135
5.106
2.879
2.868
2.857
2.845
2.834
2.677
2.665
1.848
1.836
1.819
1.807
1.795
1.784
1.224
1.213
0.769
0.756
0.744
0.000
iPr
Et
4l
5.995
5.977
5.966
5.955
5.948
5.942
5.929
5.916
6.05
5.90
f1 (ppm)
4.05
3.00
1.96
1.00
2.01
1.01
1.03
1.14
2.03
2.12
6.02
3.03
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)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77.000
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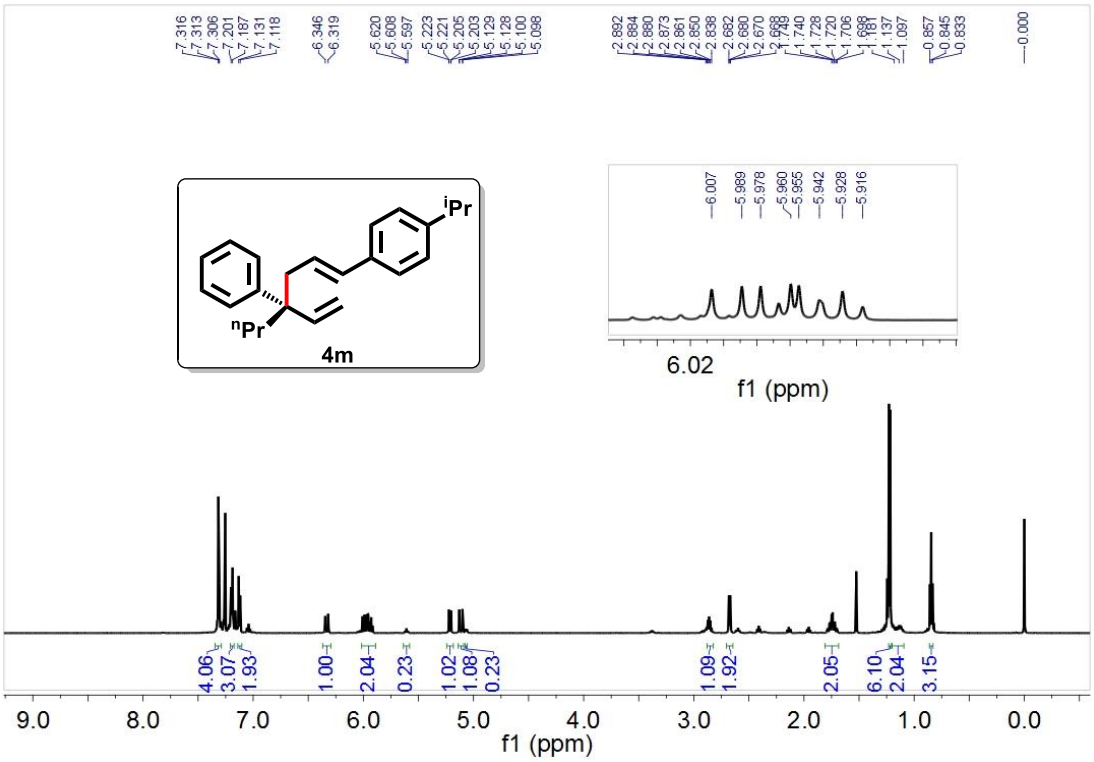
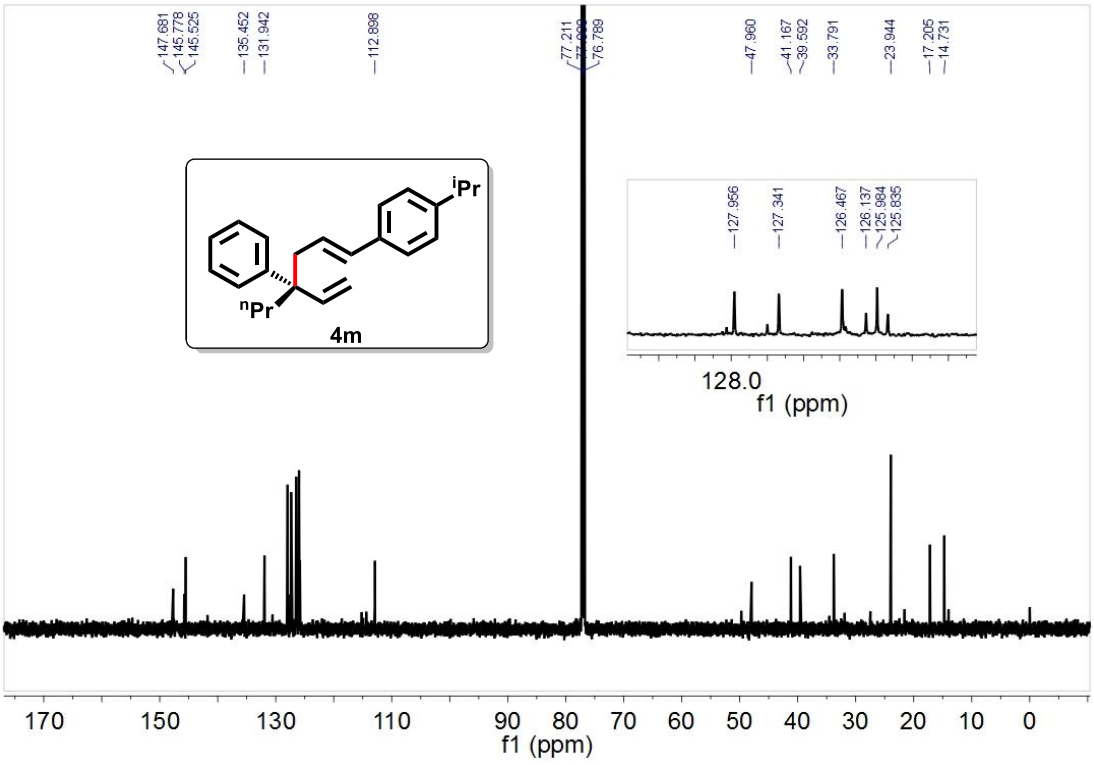
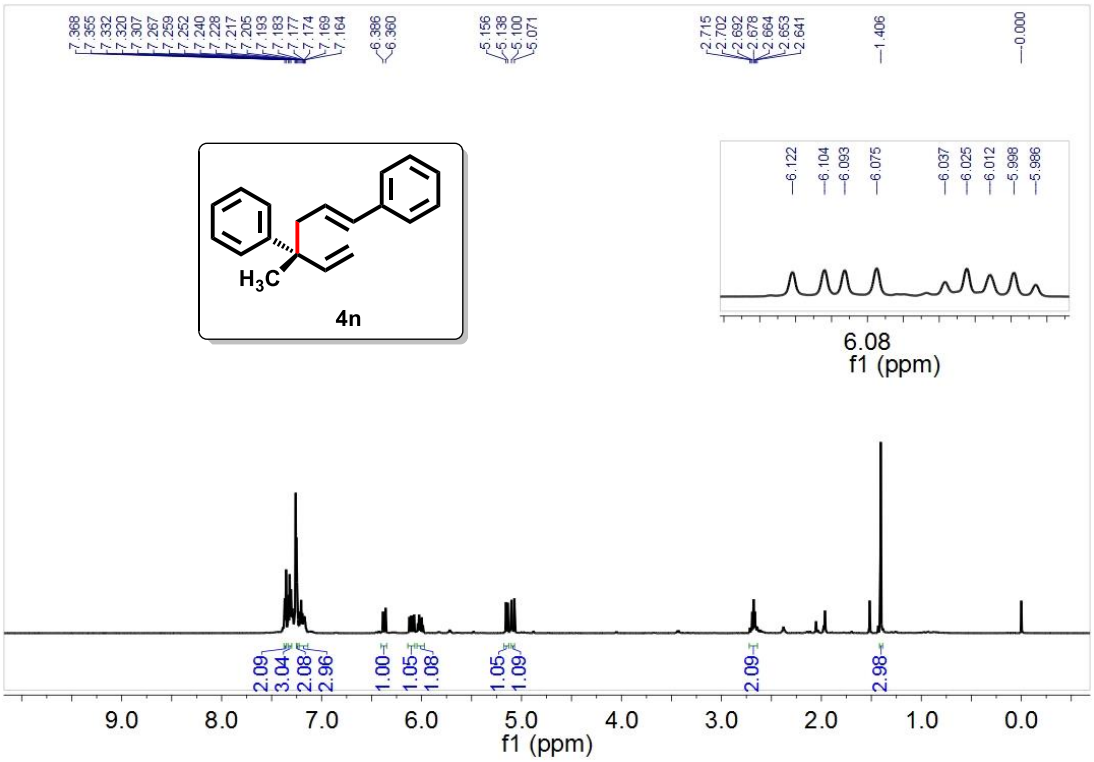
33.791
29.469
23.944
8.394
iPr
Et
4l
127.961
127.450
126.469
126.065
125.974
125.858
129
127
125
f1 (ppm)
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


4m
6.02
f1 (ppm)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


4m
128.0
f1 (ppm)
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.252
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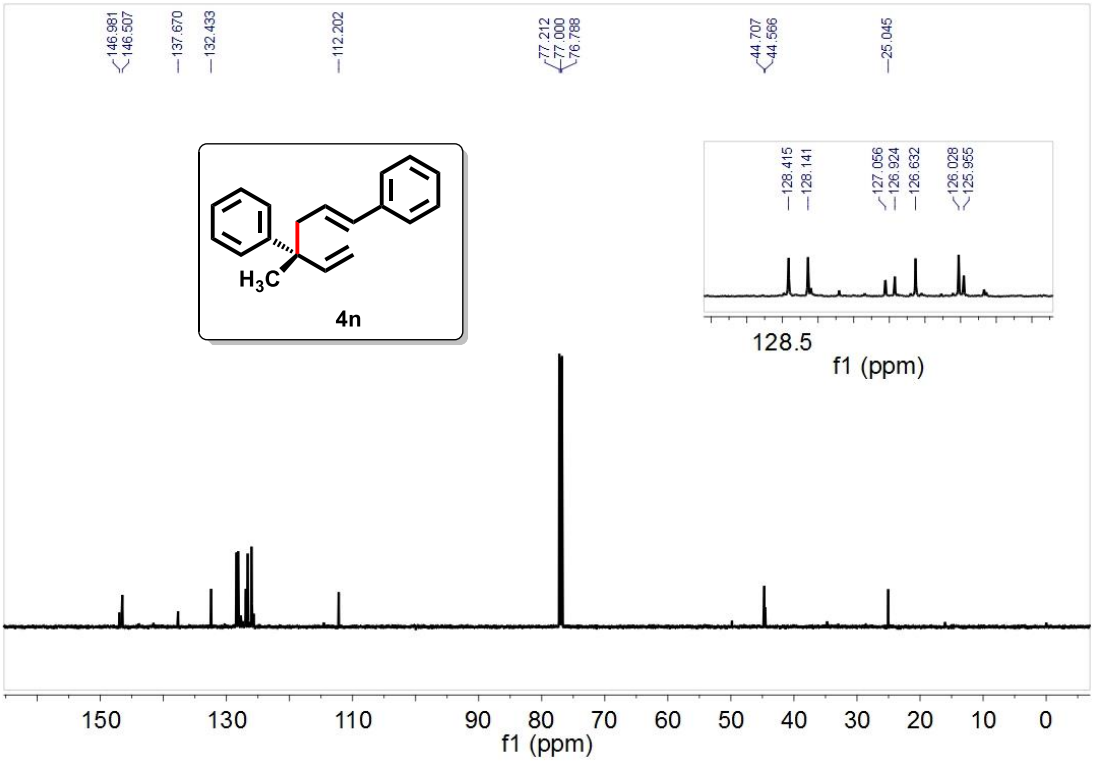
7.228
7.217
7.205
7.193
7.183
7.177
7.174
7.169
7.164
6.386
6.360
5.156
5.138
5.100
5.071
2.715
2.702
2.692
2.678
2.664
2.653
2.641
1.406
0.000
6.122
6.104
6.093
6.075
6.037
6.025
6.012
5.998
5.986
6.08
f1 (ppm)
H3C
4n
2.09
3.04
2.08
2.96
1.00
1.05
1.08
1.05
1.09
2.09
2.98
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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137.670
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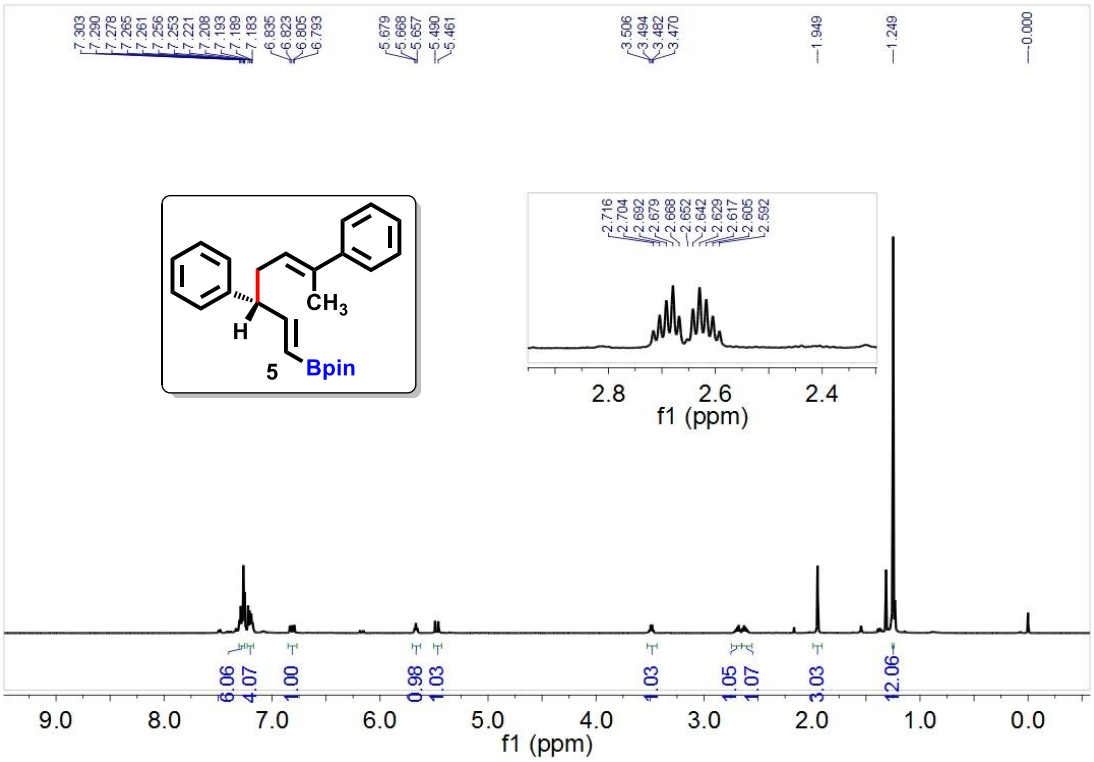
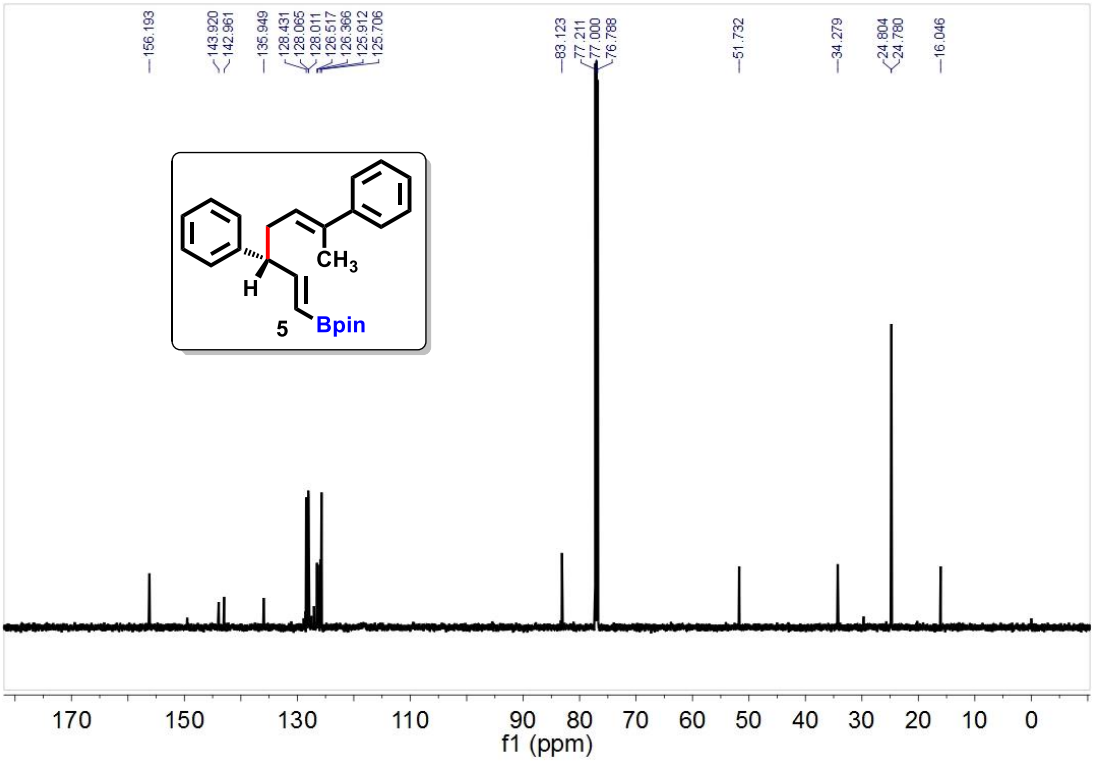
112.202
77.212
77.000
76.788
44.707
44.566
25.045
128.415
128.141
127.056
126.924
126.632
126.028
125.955
128.5
f1 (ppm)
H3C
4n
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.303
7.290
7.278
7.265
7.261
7.256
7.253
7.221
7.208
7.193
7.189
7.183
6.835
6.823
6.805
6.793
5.679
5.668
5.657
5.490
5.461
3.506
3.494
3.482
3.470
1.949
1.249
0.000
CH3
H
5
Bpin
2.716
2.704
2.692
2.679
2.668
2.652
2.642
2.629
2.617
2.605
2.592
2.8
2.6
2.4
f1 (ppm)
6.06
4.07
1.00
0.98
1.03
1.03
1.05
1.07
3.03
12.06
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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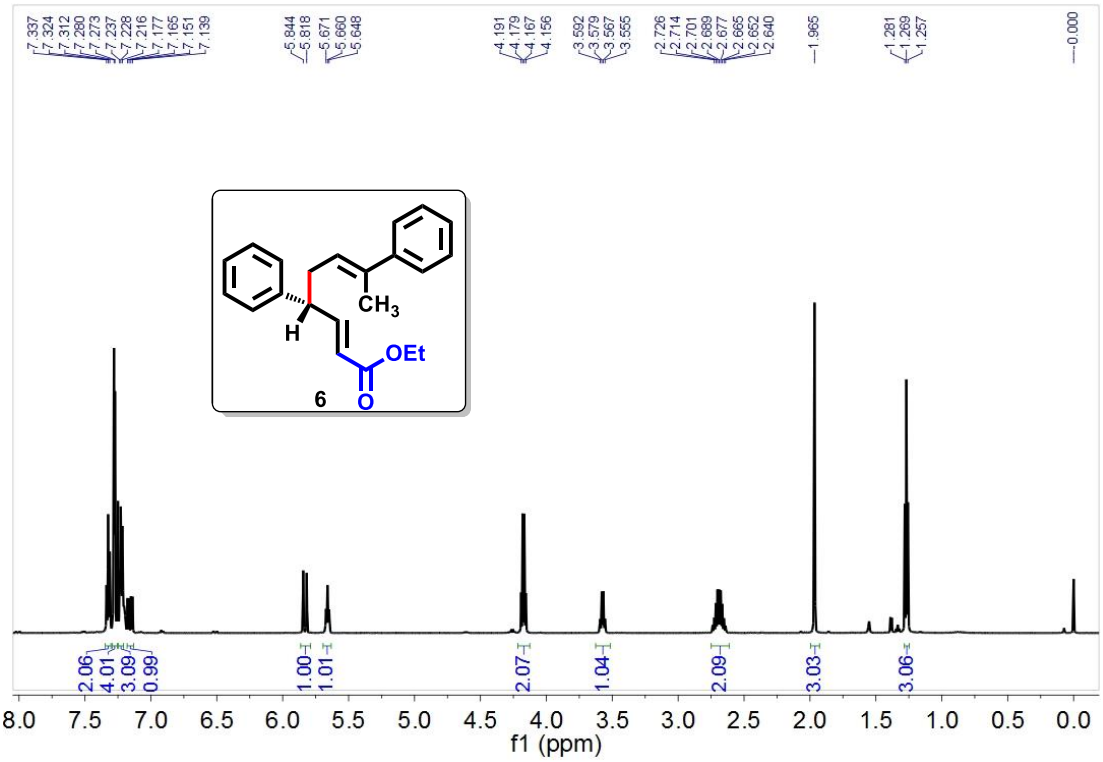
142.961
135.949
128.431
128.065
128.011
126.517
126.366
125.912
125.706
83.123
77.211
77.000
76.788
51.732
34.279
24.804
24.780
16.046
CH3
H
5
Bpin
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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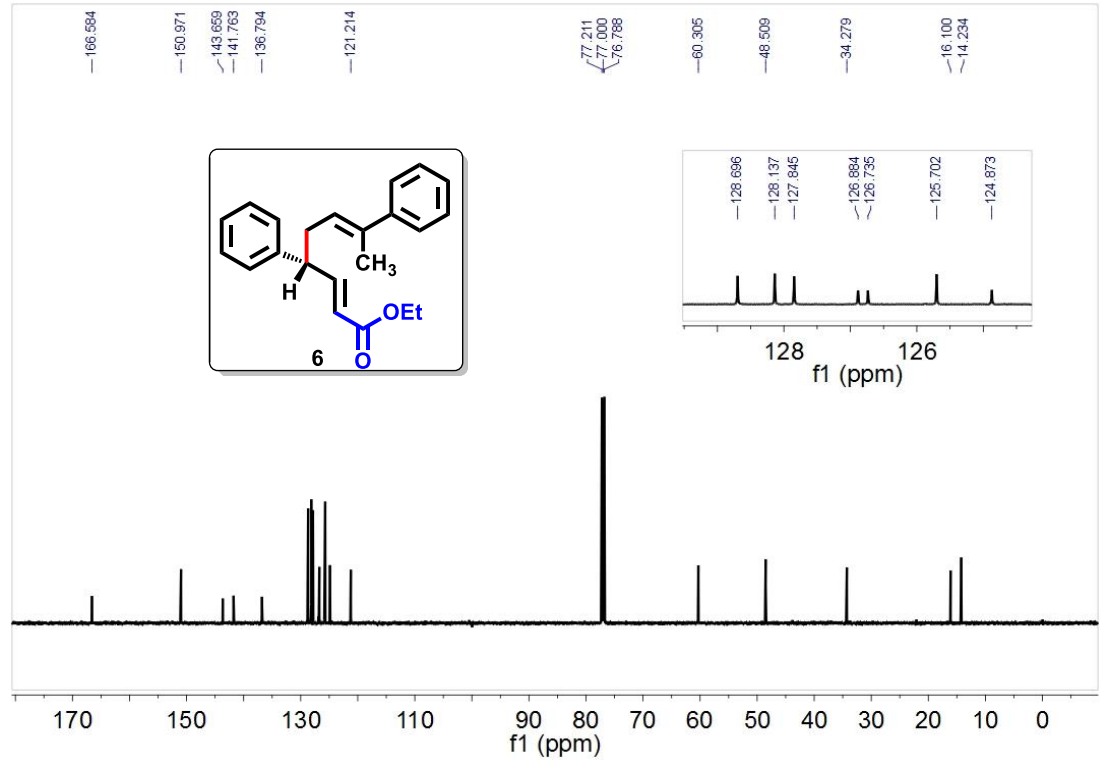
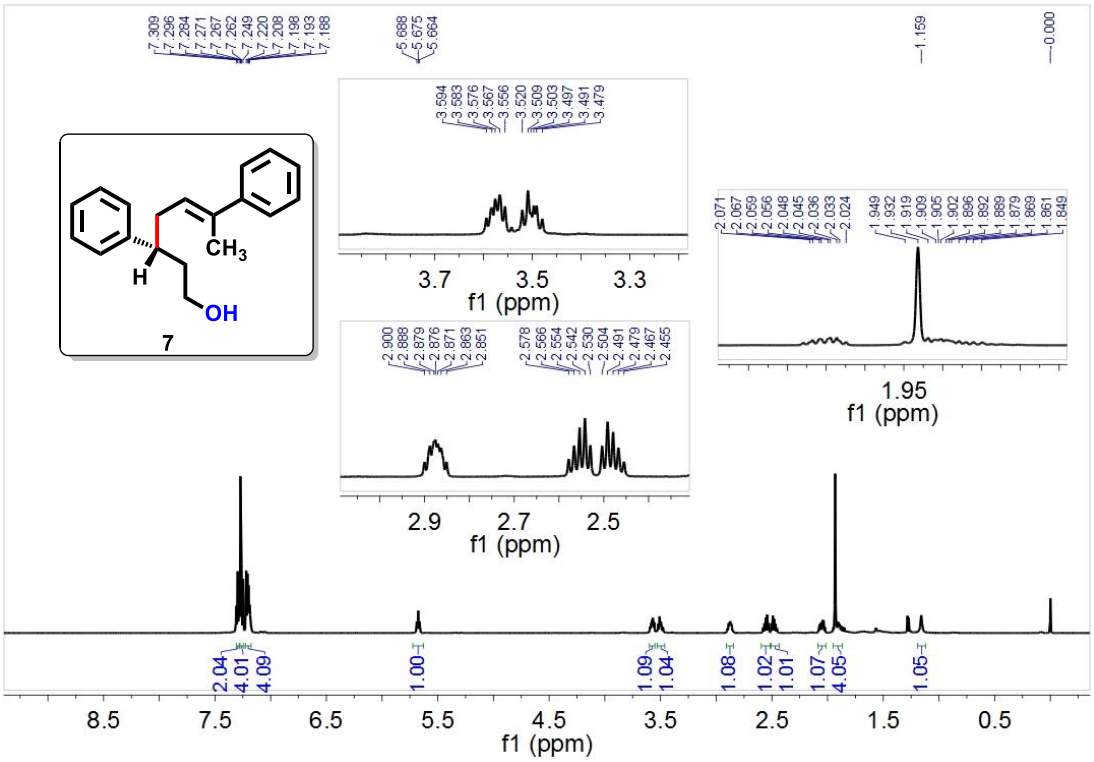
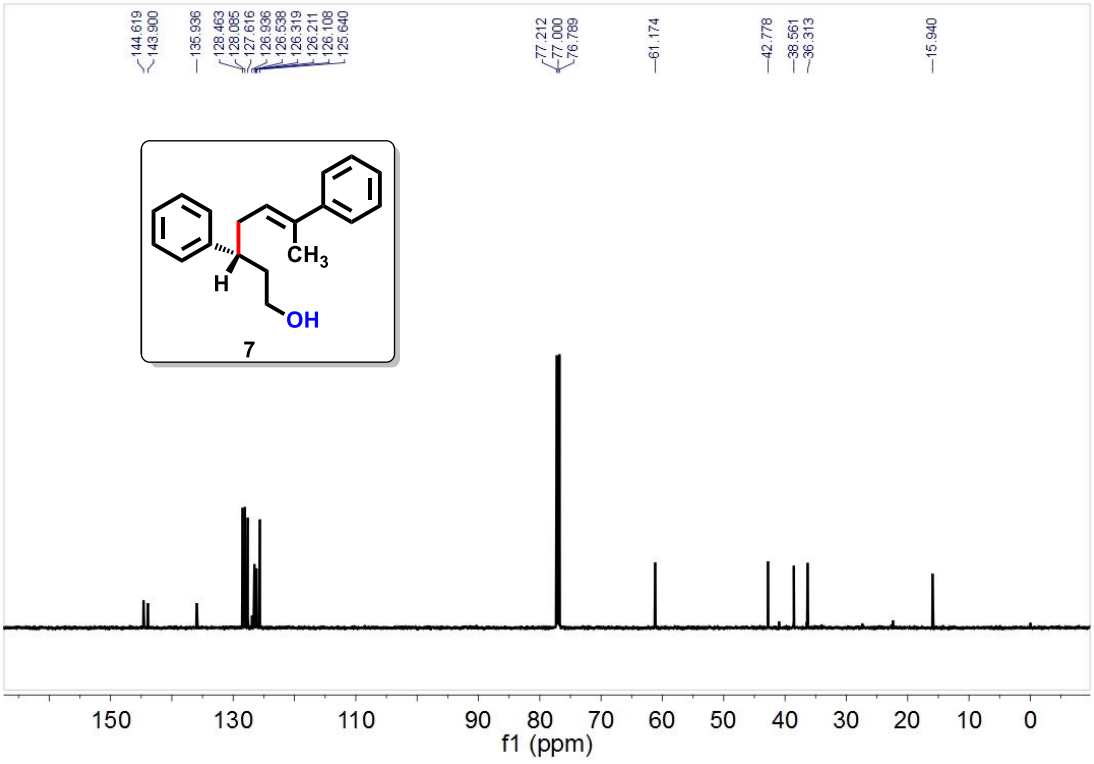
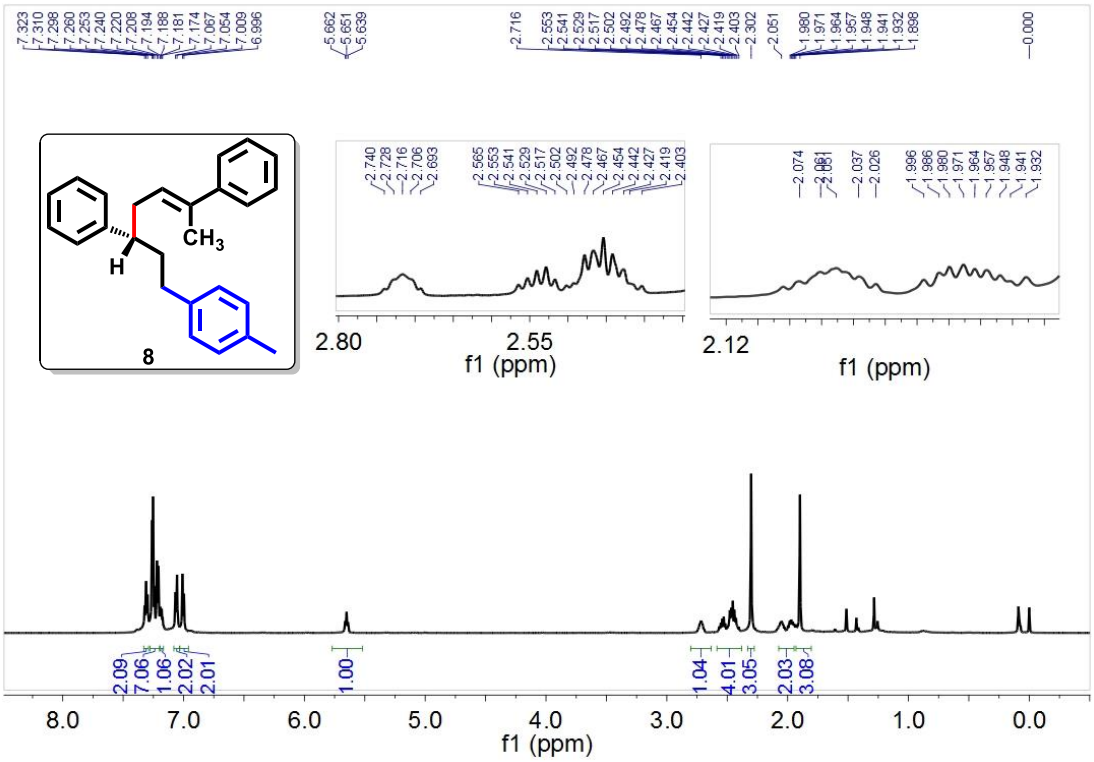
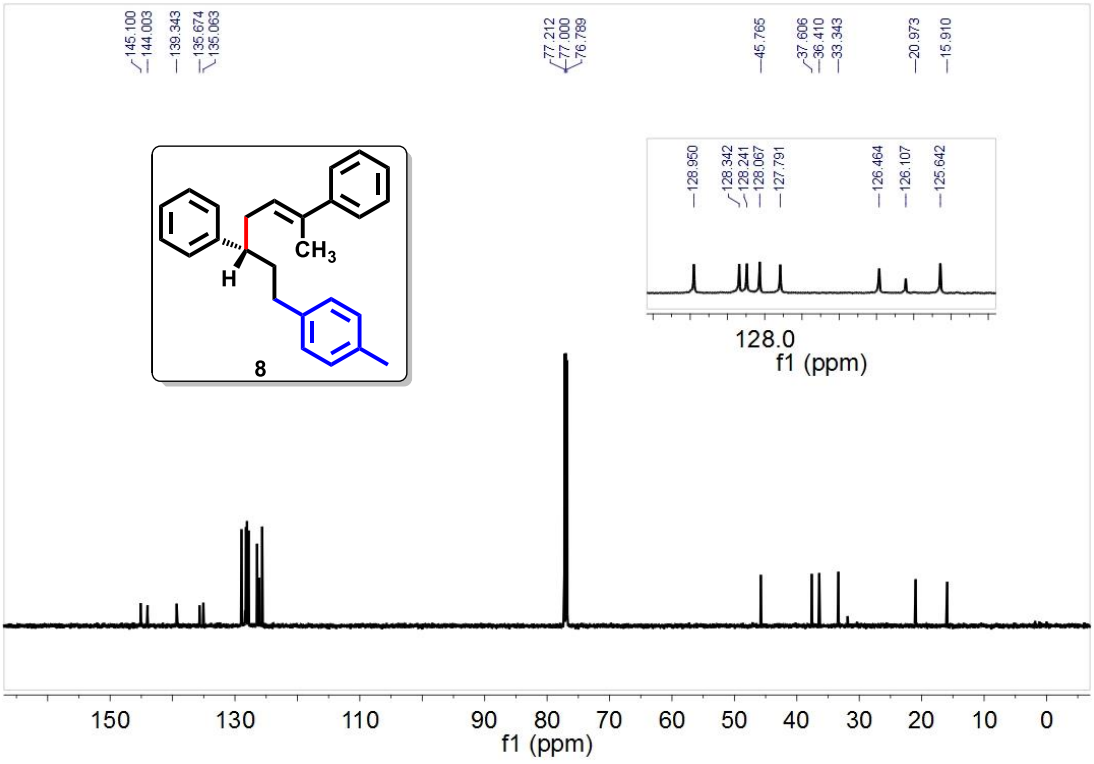
7.312
7.280
7.273
7.237
7.228
7.216
7.177
7.165
7.151
7.139
5.844
5.818
5.671
5.660
5.648
4.191
4.179
4.167
4.156
3.592
3.579
3.567
3.555
2.726
2.714
2.701
2.689
2.677
2.665
2.652
2.640
1.965
1.281
1.269
1.257
0.000
CH3
H
OEt
O
6
2.06
4.01
3.09
0.99
1.00
1.01
2.07
1.04
2.09
3.03
3.06
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

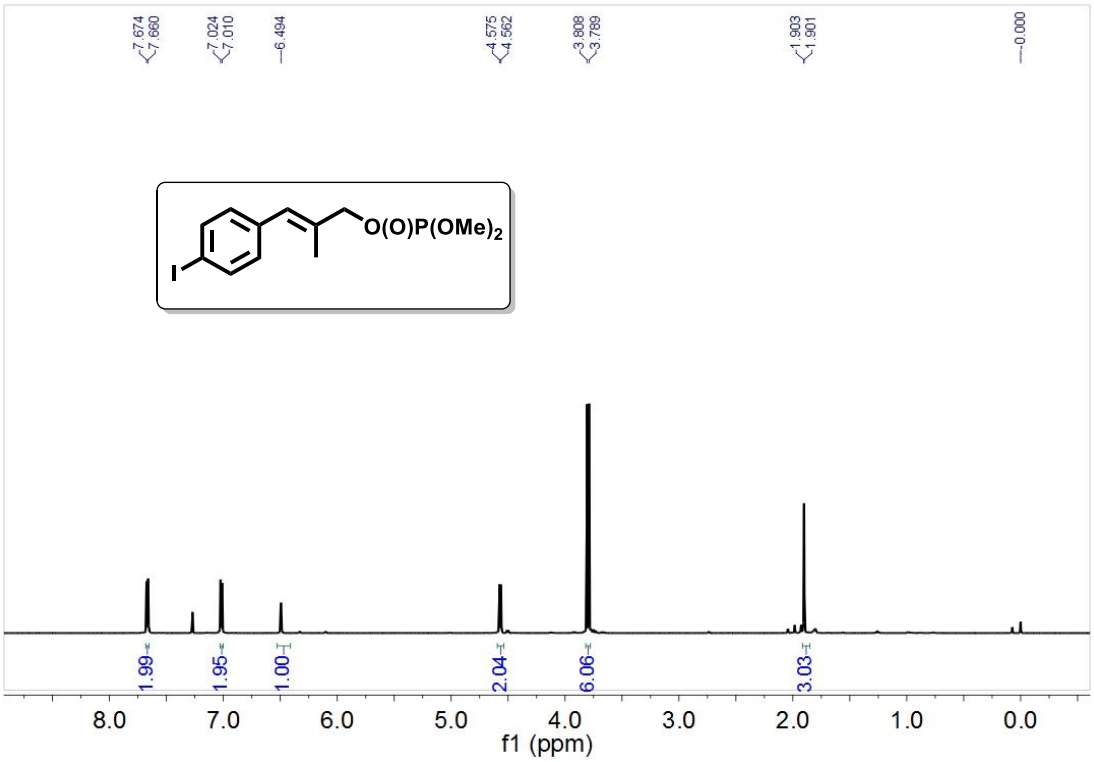

166.584
150.971
143.659
141.763
136.794
121.214
77.211
77.000
76.788
60.305
48.509
34.279
16.100
14.234
CH3
H
OEt
O
6
128.696
128.137
127.845
126.884
126.735
125.702
124.873
128
126
f1 (ppm)
170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

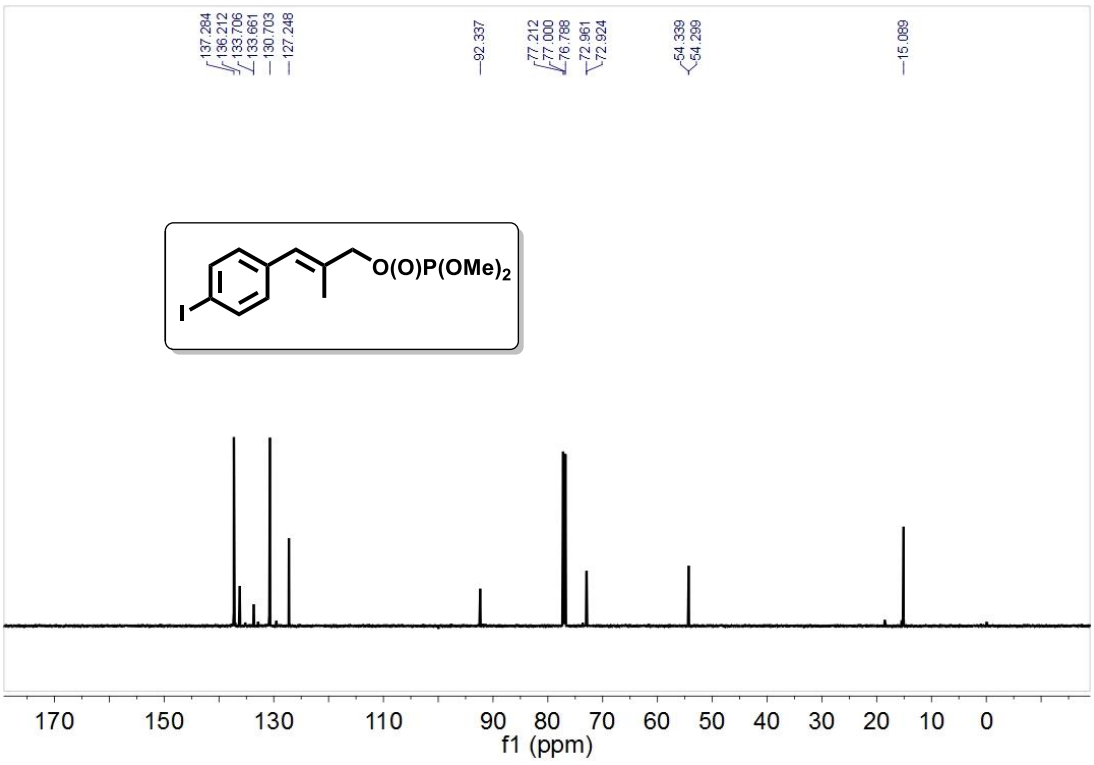

7.309
7.296
7.284
7.271
7.267
7.262
7.249
7.220
7.208
7.198
7.193
7.188
5.688
5.675
5.664
1.159
0.000
3.594
3.583
3.576
3.567
3.556
3.520
3.509
3.503
3.497
3.491
3.479
3.7
3.5
3.3
f1 (ppm)
2.071
2.067
2.059
2.056
2.048
2.045
2.036
2.033
2.024
1.949
1.932
1.919
1.909
1.905
1.902
1.896
1.892
1.889
1.879
1.869
1.861
1.849
1.95
f1 (ppm)
2.900
2.888
2.879
2.876
2.871
2.863
2.851
2.578
2.566
2.554
2.542
2.530
2.504
2.491
2.479
2.467
2.455
2.9
2.7
2.5
f1 (ppm)
CH3
H
OH
7
2.04
4.01
4.09
1.00
1.09
1.04
1.08
1.02
1.01
1.07
4.05
1.05
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)

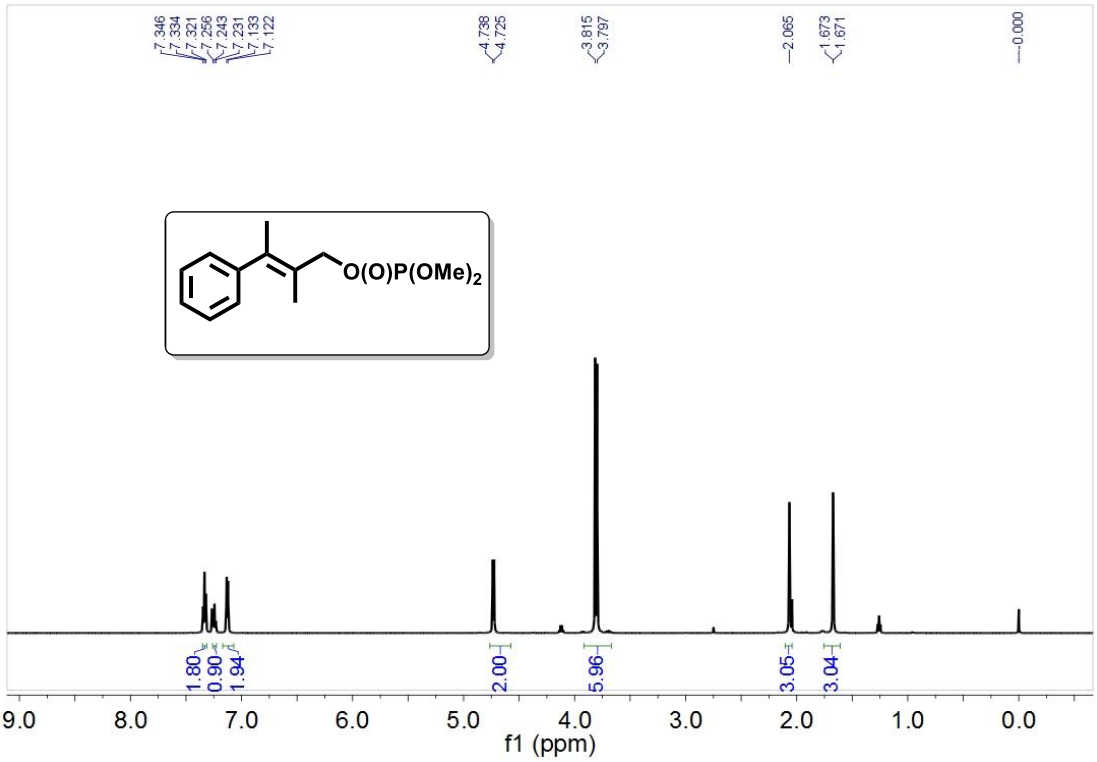

144.619
143.900
135.936
128.463
128.085
127.616
126.936
126.538
126.319
126.211
126.108
125.640
77.212
77.000
76.789
61.174
42.778
38.561
36.313
15.940
CH3
H
OH
7
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

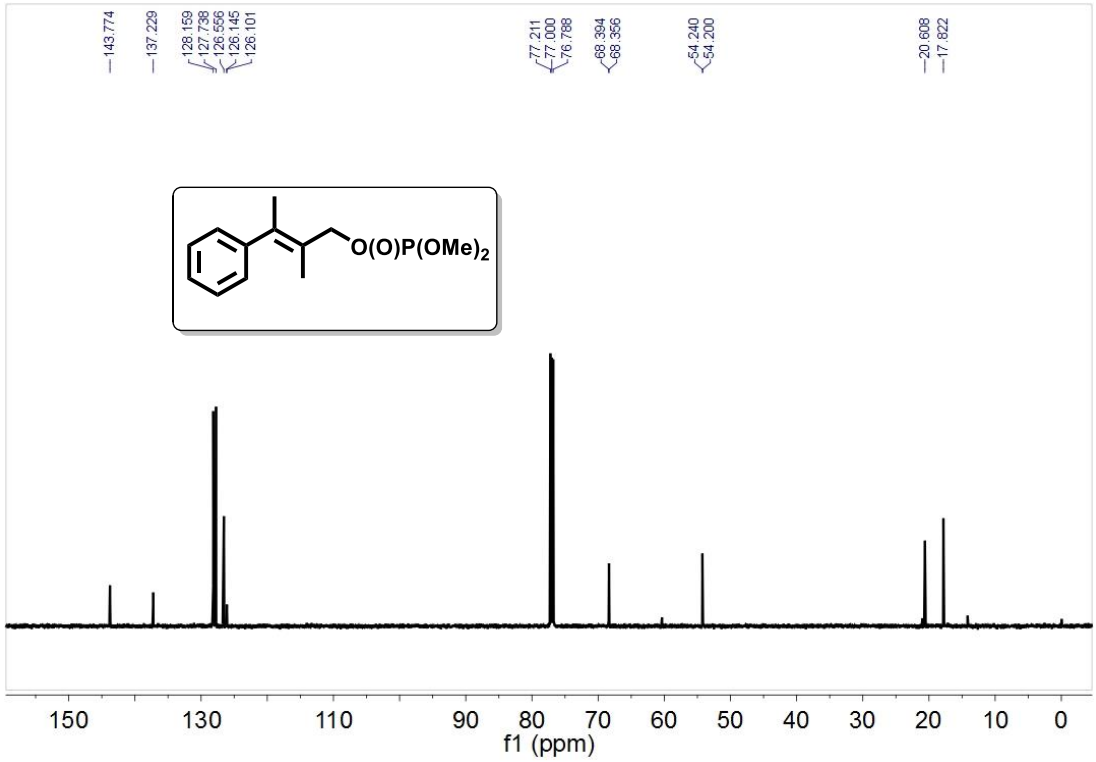

8
2.80
2.55
f1 (ppm)
2.12
f1 (ppm)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

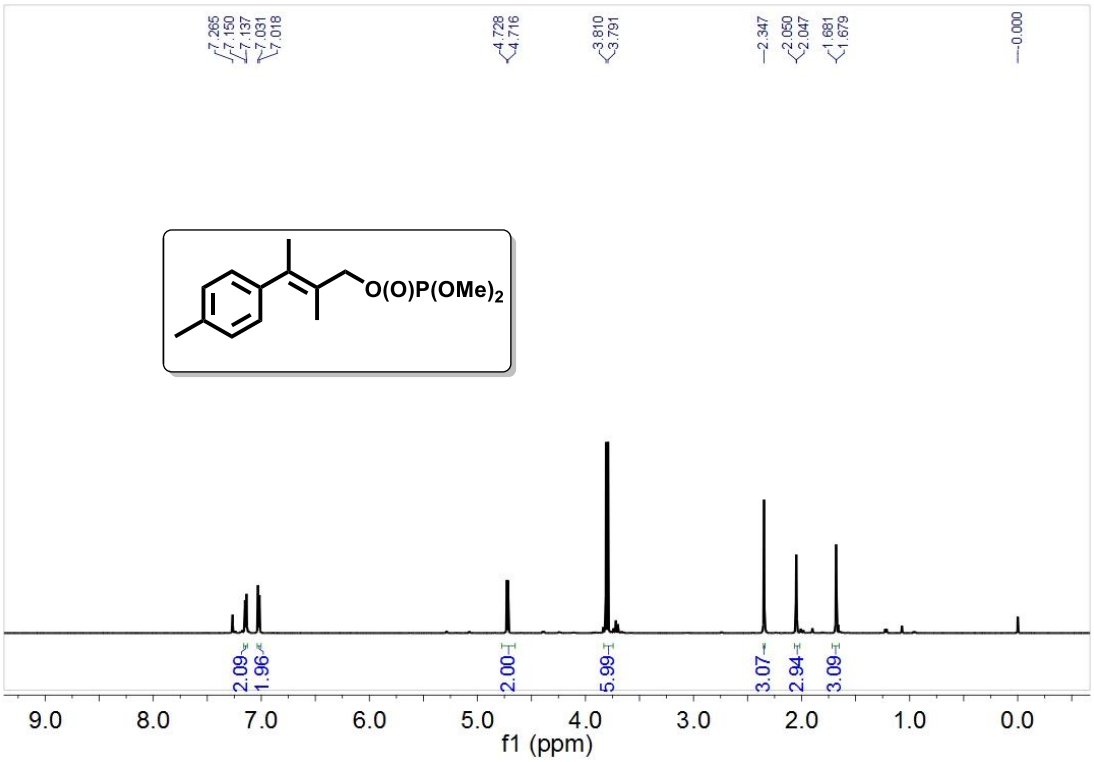

8
128.0
f1 (ppm)
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

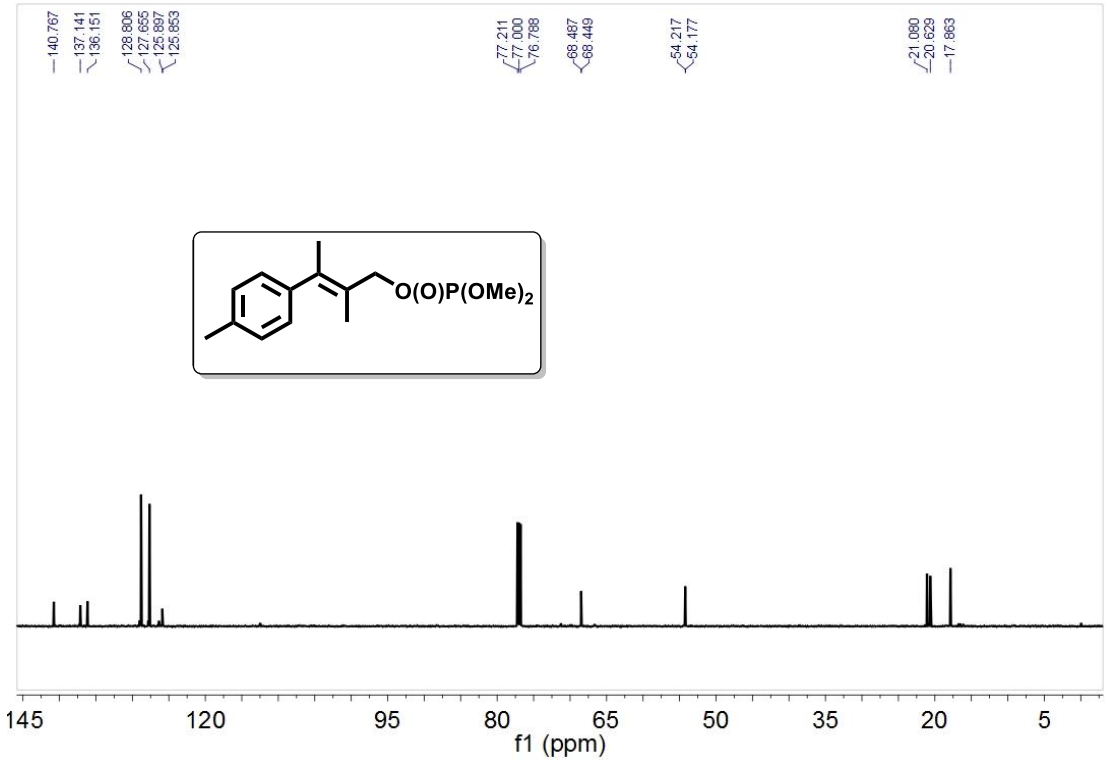

7.674
7.660
7.024
7.010
6.494
4.575
4.562
3.808
3.789
1.903
1.901
0.000
O(O)P(OMe)2
I
1.99
1.95
1.00
2.04
6.06
3.03
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

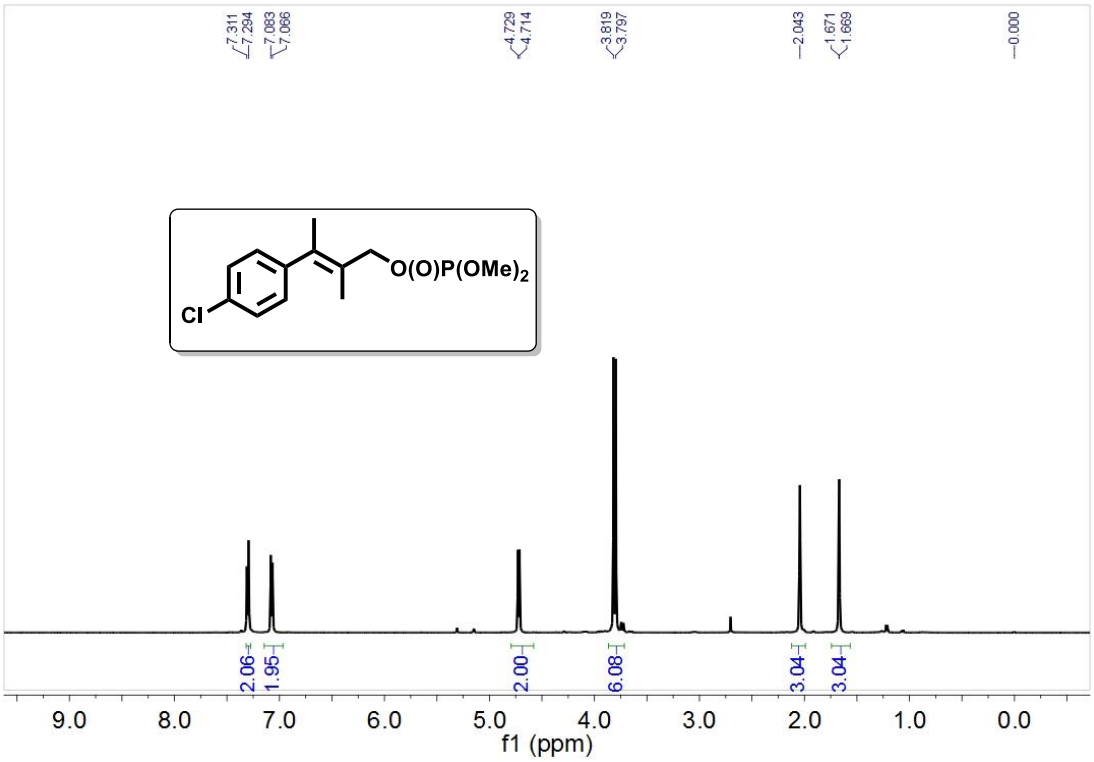

137.284
136.212
133.706
133.661
130.703
127.248
92.337
77.212
77.000
76.788
72.961
72.924
54.339
54.299
15.089
O(O)P(OMe)2
I
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

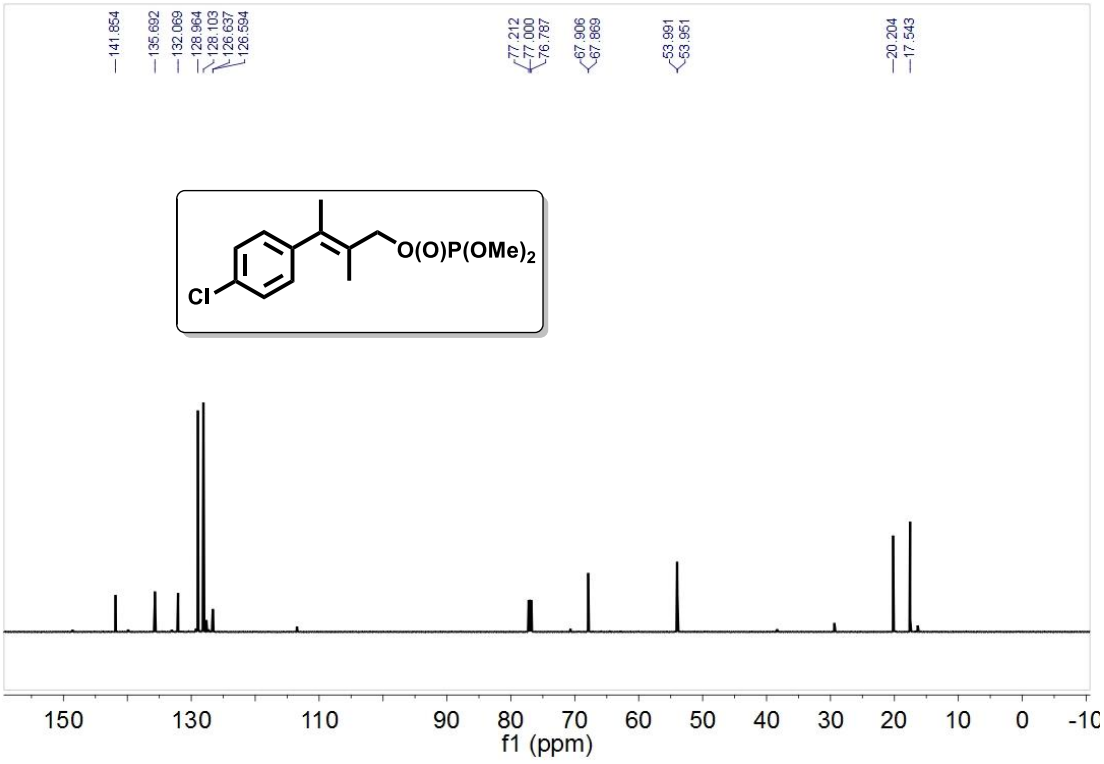

7.346
7.334
7.321
7.256
7.243
7.231
7.133
7.122
4.738
4.725
3.815
3.797
2.065
1.673
1.671
0.000
O(O)P(OMe)2
1.80
0.90
1.94
2.00
5.96
3.05
3.04
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

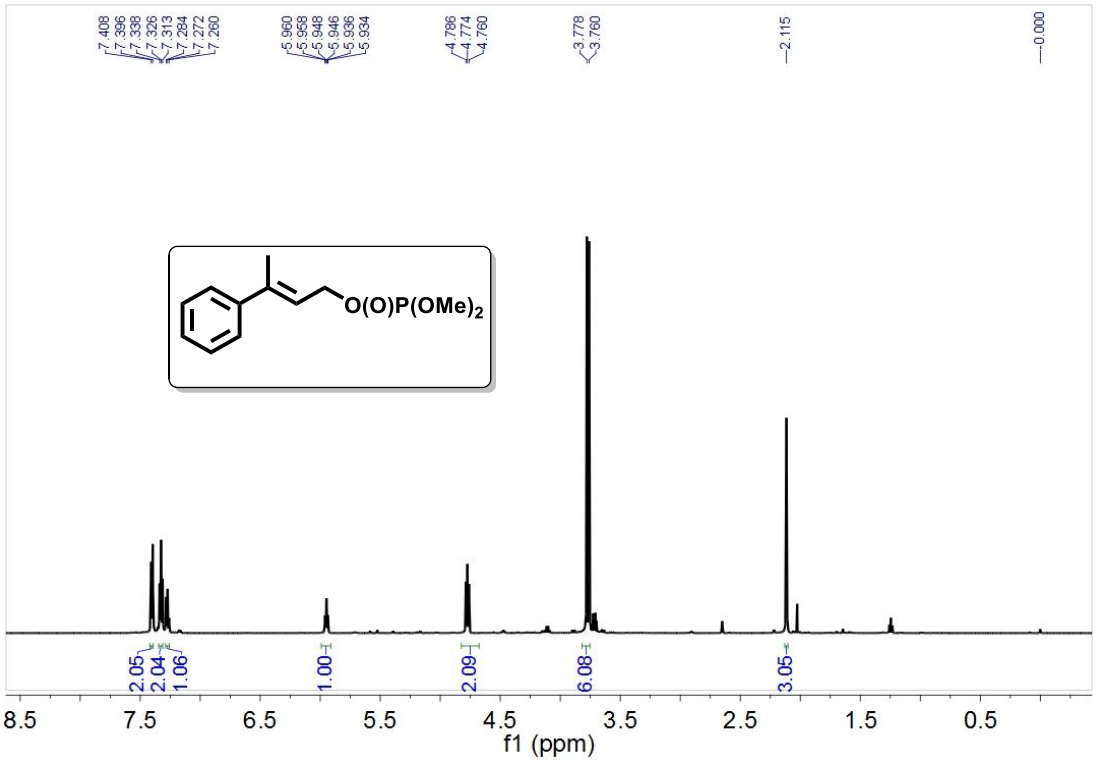

143.774
137.229
128.159
127.738
126.556
126.145
126.101
77.211
77.000
76.788
68.394
68.356
54.240
54.200
20.608
17.822
O(O)P(OMe)2
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

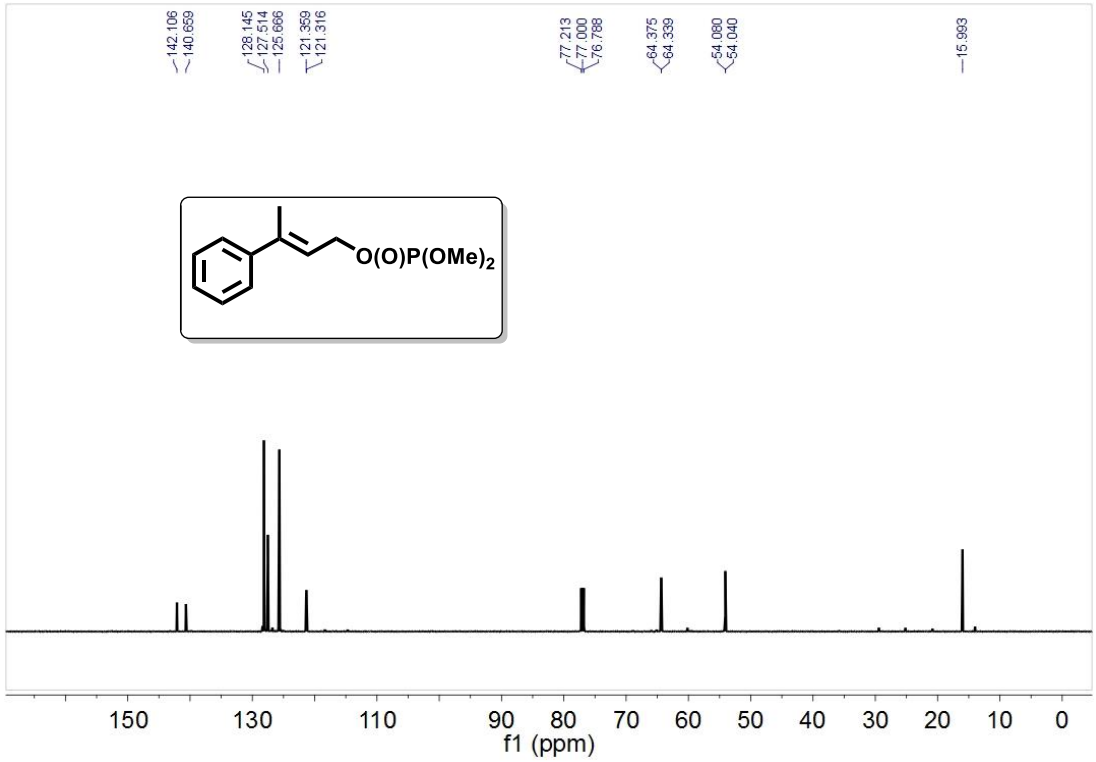

7.265
7.150
7.137
7.031
7.018
4.728
4.716
3.810
3.791
2.347
2.050
2.047
1.681
1.679
0.000
O(O)P(OMe)2
2.09
1.96
2.00
5.99
3.07
2.94
3.09
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

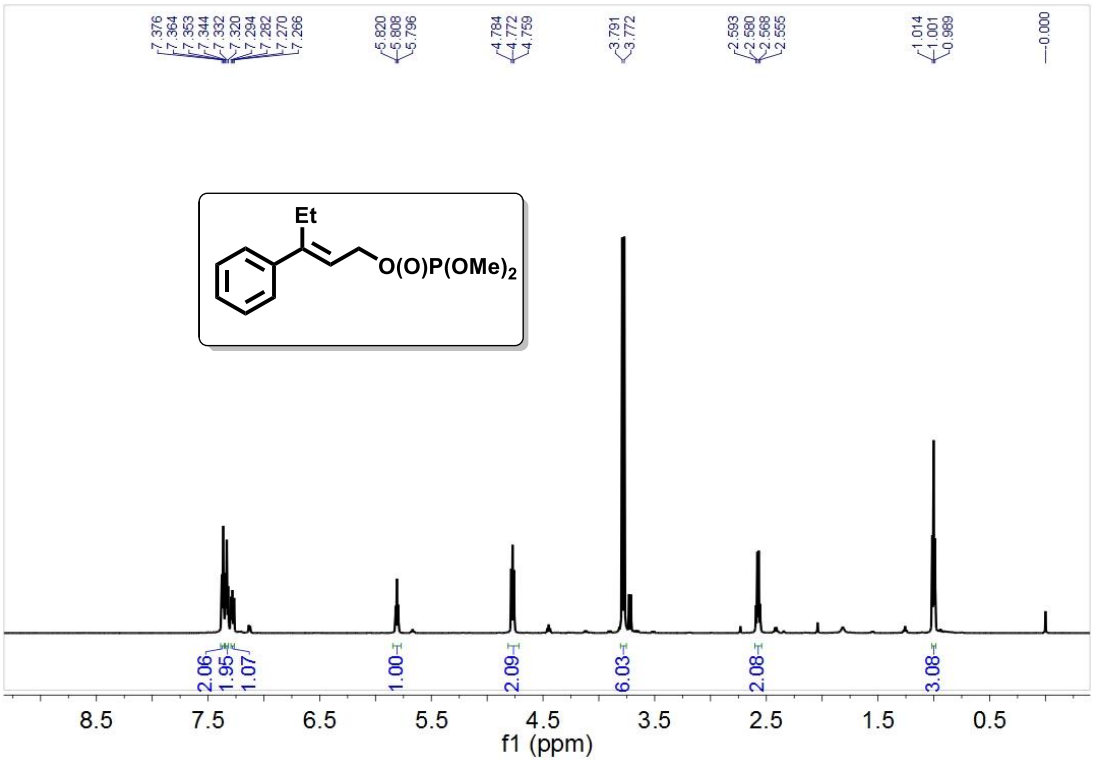

140.767
137.141
136.151
128.806
127.655
125.897
125.853
77.211
77.000
76.788
68.487
68.449
54.217
54.177
21.080
20.629
17.863
O(O)P(OMe)2
145
120
95
80
65
50
35
20
5
f1 (ppm)

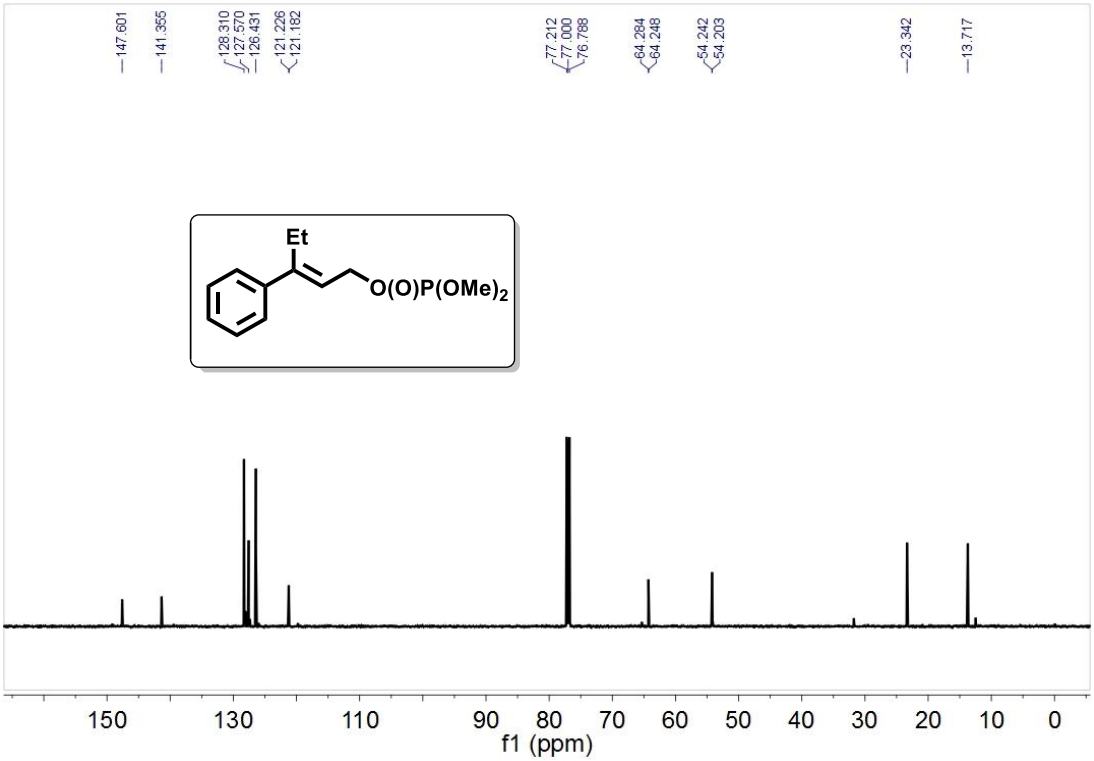

7.311
7.294
7.083
7.066
4.729
4.714
3.819
3.797
2.043
1.671
1.669
0.000
O(O)P(OMe)2
Cl
2.06
1.95
2.00
6.08
3.04
3.04
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

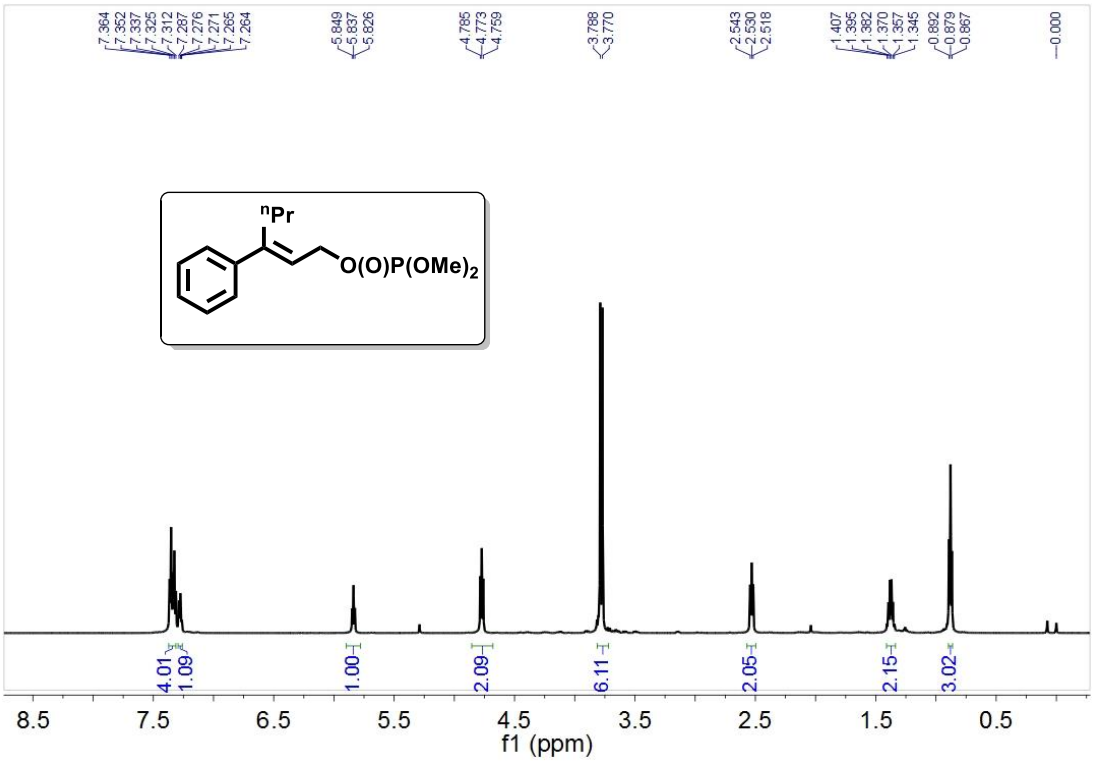

141.854
135.692
132.069
128.964
128.103
126.637
126.594
77.212
77.000
76.787
67.906
67.869
53.991
53.951
20.204
17.543
O(O)P(OMe)2
Cl
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

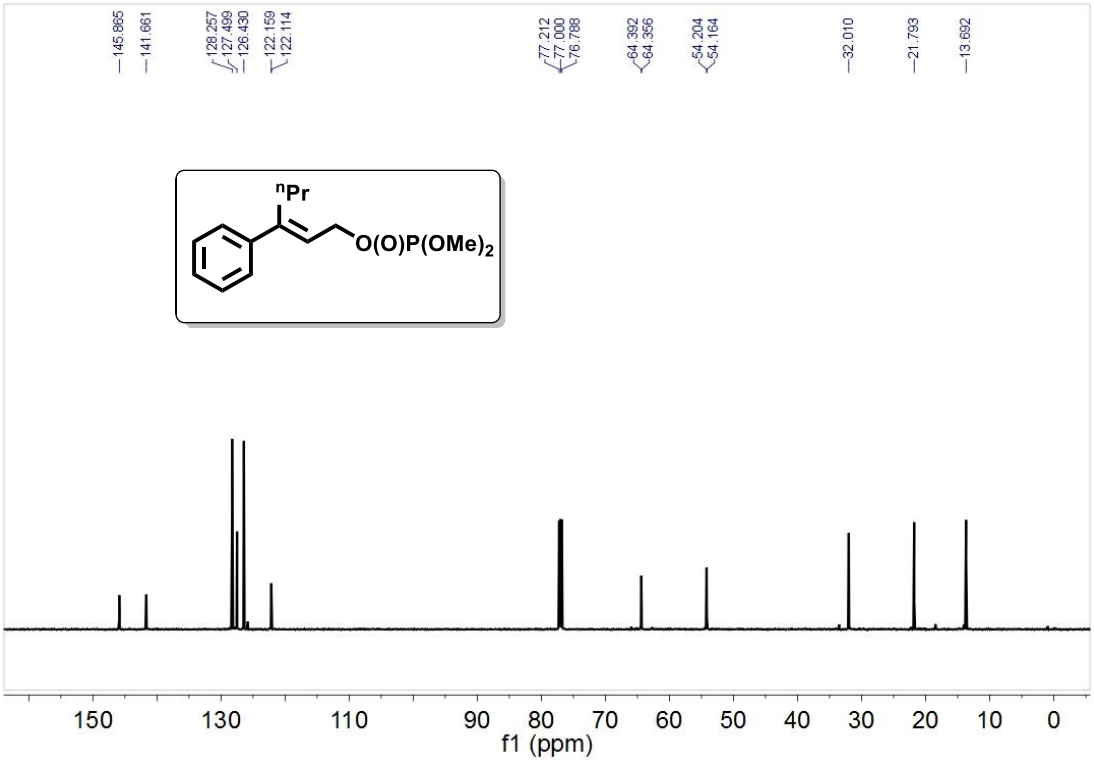

7.408
7.396
7.388
7.326
7.313
7.284
7.272
7.260
5.960
5.948
5.946
5.936
5.934
4.786
4.774
4.760
3.778
3.760
2.115
0.000
O(O)P(OMe)2
2.05
2.04
1.06
1.00
2.09
6.08
3.05
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)


142.106
140.659
128.145
127.514
125.666
121.359
121.316
77.213
77.000
76.788
64.375
64.339
54.080
54.040
15.993
O(O)P(OMe)2
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

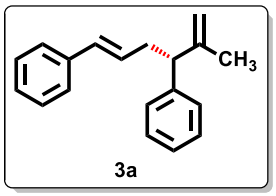

7.376
7.364
7.353
7.344
7.332
7.320
7.294
7.282
7.270
7.266
5.820
5.808
5.796
4.784
4.772
4.759
3.791
3.772
2.593
2.580
2.568
2.555
1.014
1.001
0.989
0.000
Et
O(O)P(OMe)2
2.06
1.95
1.07
1.00
2.09
6.03
2.08
3.08
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)


147.601
141.355
128.310
127.570
126.431
121.226
121.182
77.212
77.000
76.788
64.284
64.248
54.242
54.203
23.342
13.717
Et
O(O)P(OMe)2
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

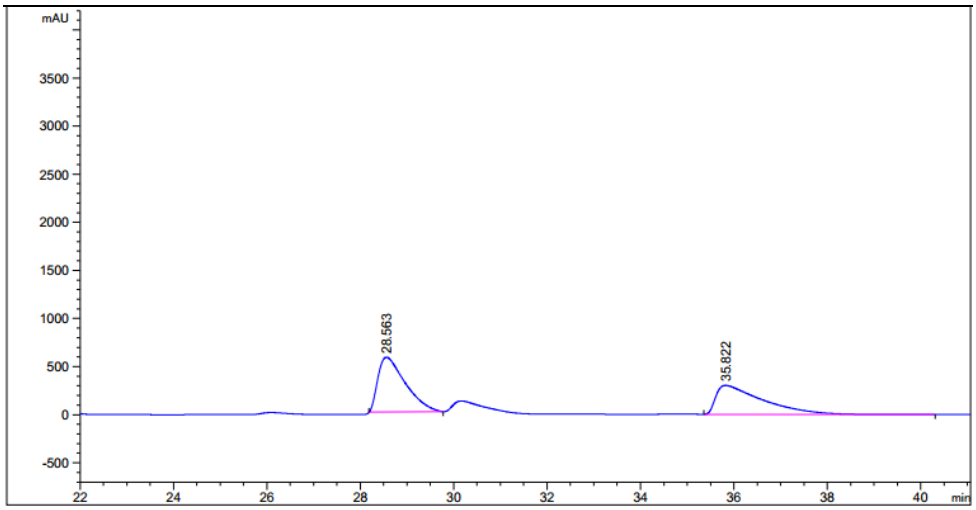

7.364
7.352
7.337
7.325
7.312
7.287
7.276
7.271
7.265
7.264
5.849
5.837
5.826
4.785
4.773
4.759
3.788
3.770
2.543
2.530
2.518
1.407
1.395
1.382
1.370
1.357
1.345
0.892
0.879
0.867
0.000
nPr
O(O)P(OMe)2
4.01
1.09
1.00
2.09
6.11
2.05
2.15
3.02
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)


145.865
141.661
128.257
127.499
126.430
122.159
122.114
77.212
77.000
76.788
64.392
64.356
54.204
54.164
32.010
21.793
13.692
nPr
O(O)P(OMe)2
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

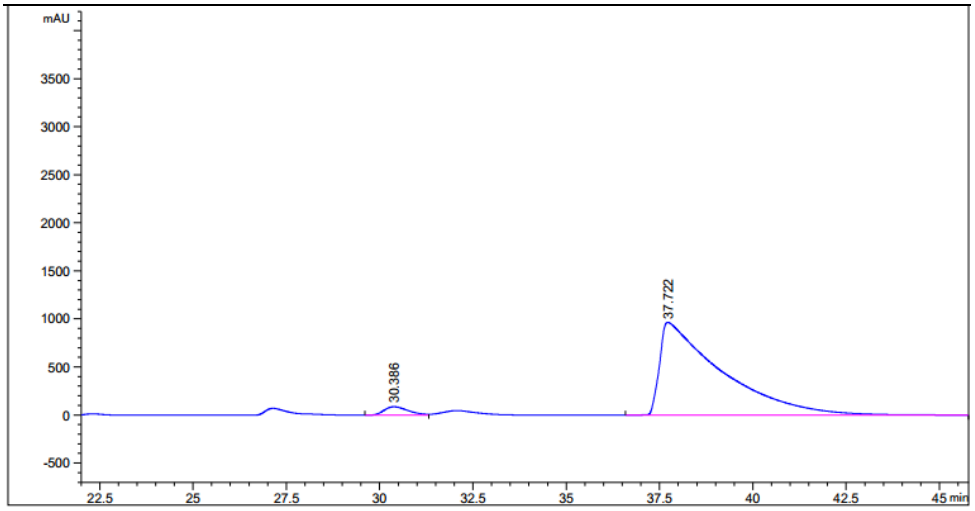
8. Copies of HPLC Traces for Chiral Products



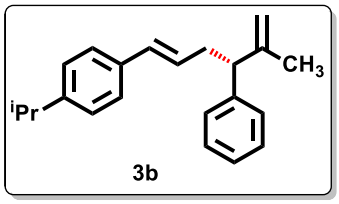
3a



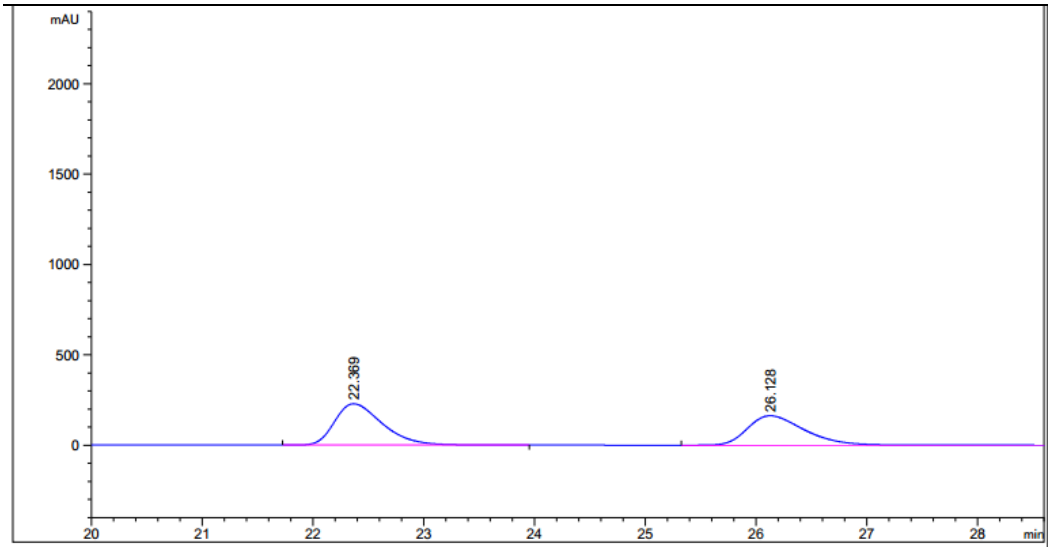
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	28.563	0.6777	$2.32029e^4$	570.64282	52.2796
2	35.822	1.1649	$2.11794e^4$	302.61514	47.7204



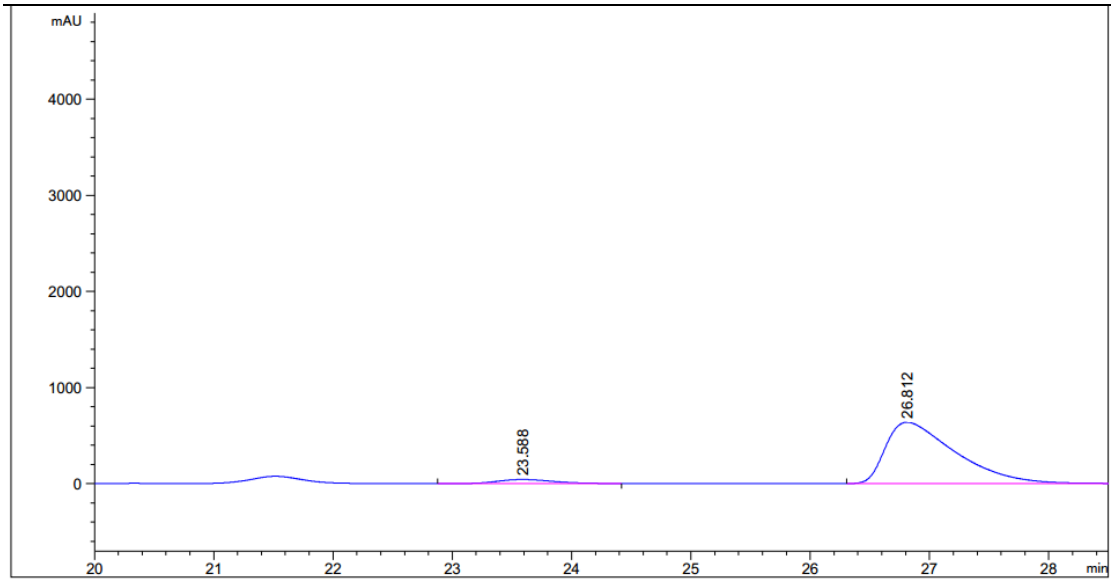
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	30.386	0.6945	3916.02148	87.27412	3.4094
2	37.722	1.4854	$1.10945e^5$	965.63922	96.5906



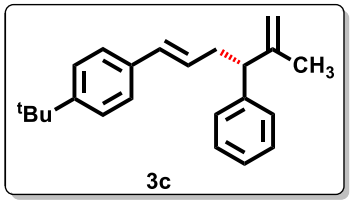
3b



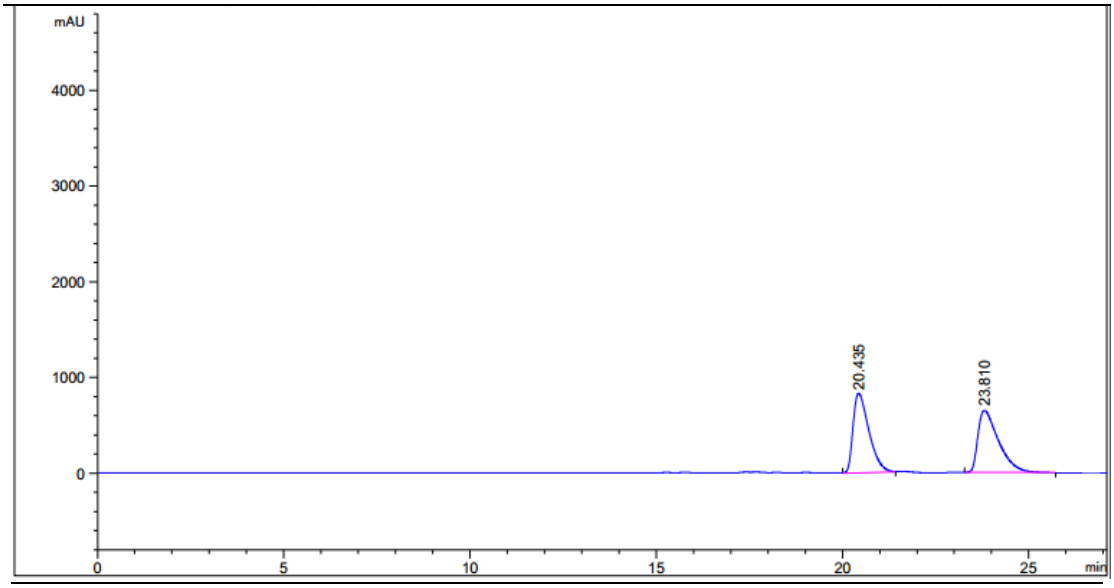
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.369	0.4584	6850.30371	228.74400	54.1361
2	26.128	0.5494	5803.55469	162.60884	45.8639



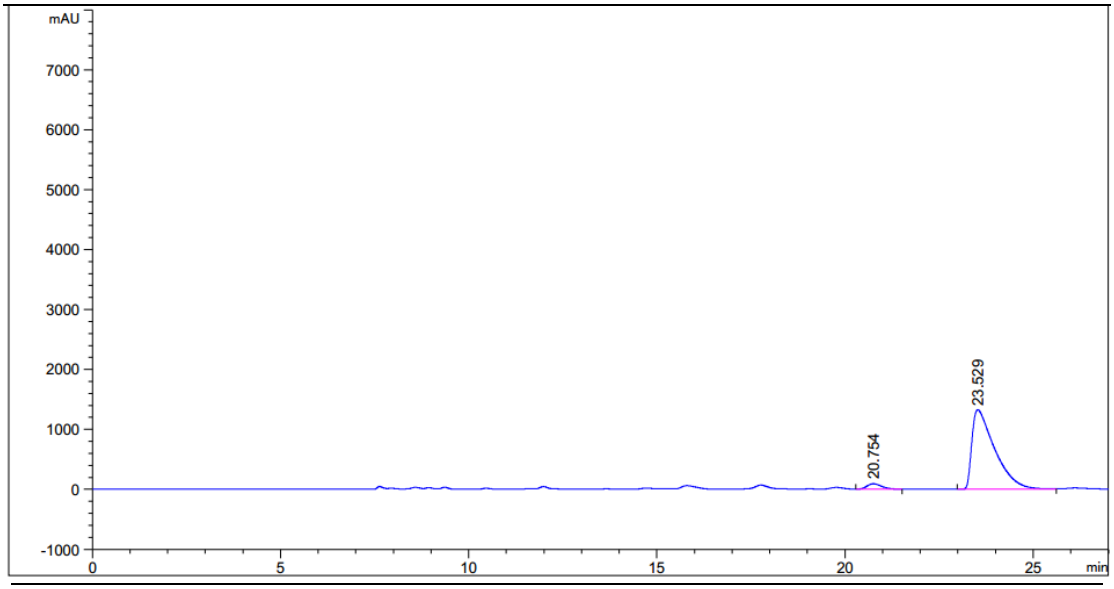
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	23.588	0.5523	1434.95471	42.93385	5.2225
2	26.812	0.6791	$2.60413e^4$	638.83112	94.7775



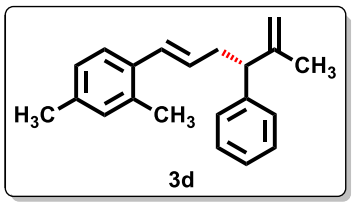
3c



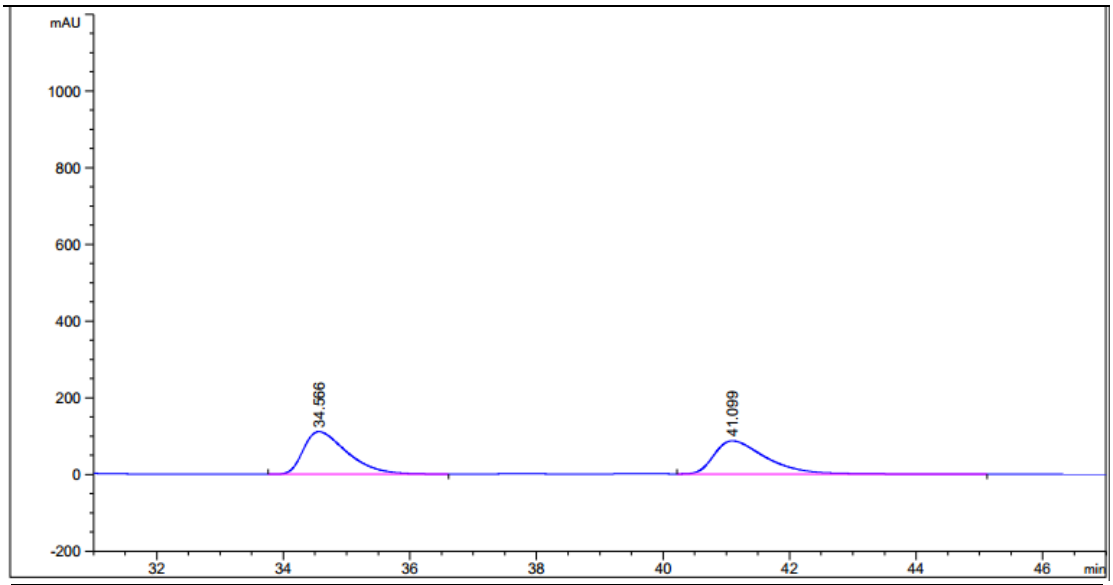
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.435	0.4919	$2.45441e^4$	830.17517	49.7105
2	23.810	0.6372	$2.48300e^4$	648.14868	50.2895



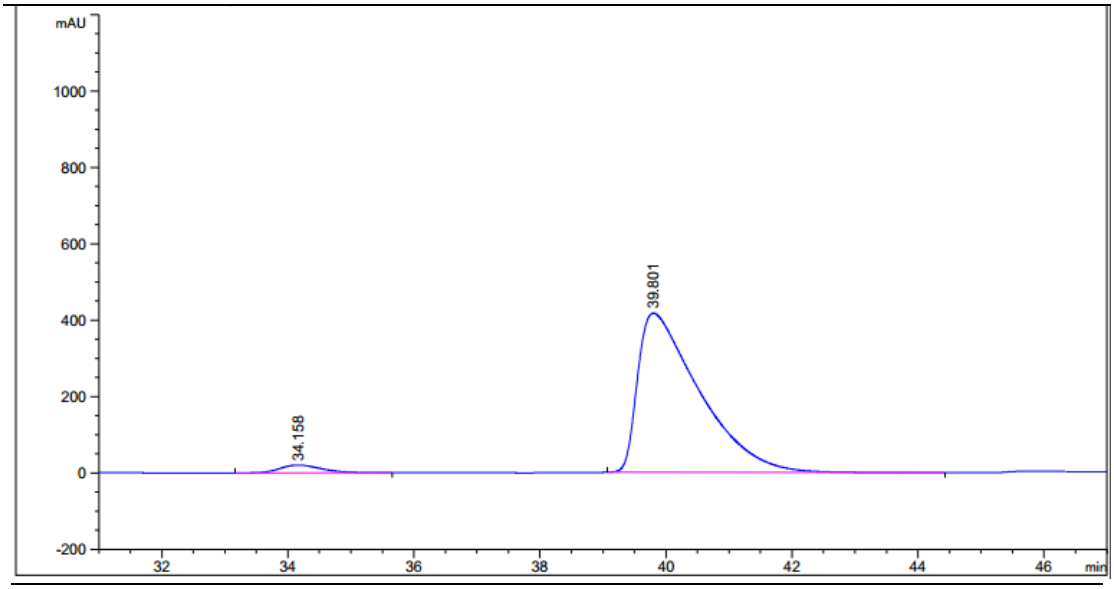
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.754	0.4480	2431.55615	90.07298	4.1595
2	23.529	0.7006	$5.60265e^4$	1329.33398	95.8405



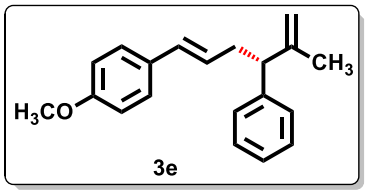
3d



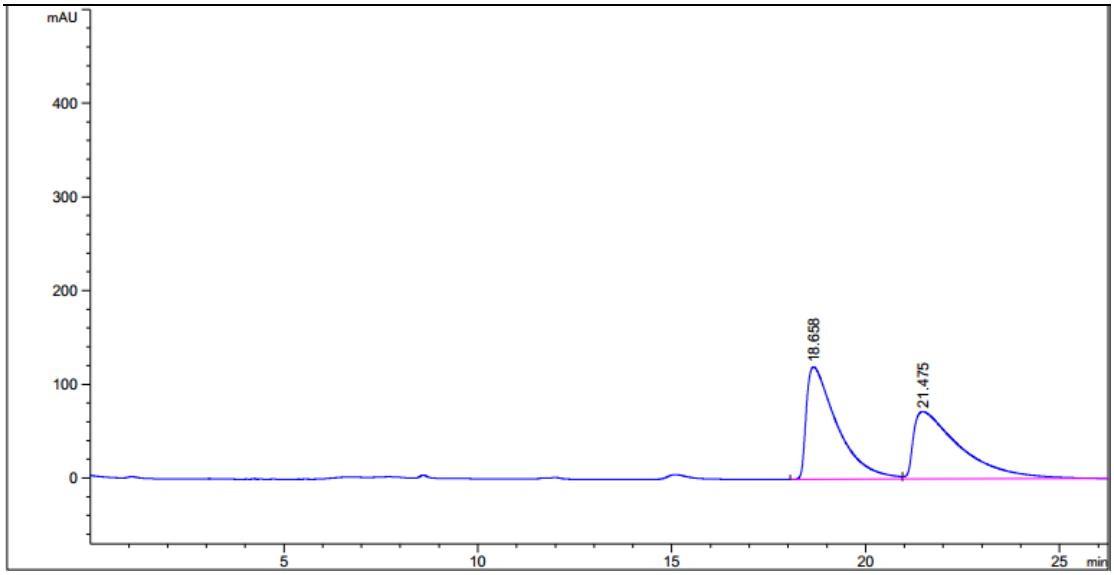
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	34.566	0.7235	5318.93652	111.10107	51.8534
2	41.099	0.8603	4938.71533	86.46931	48.1466



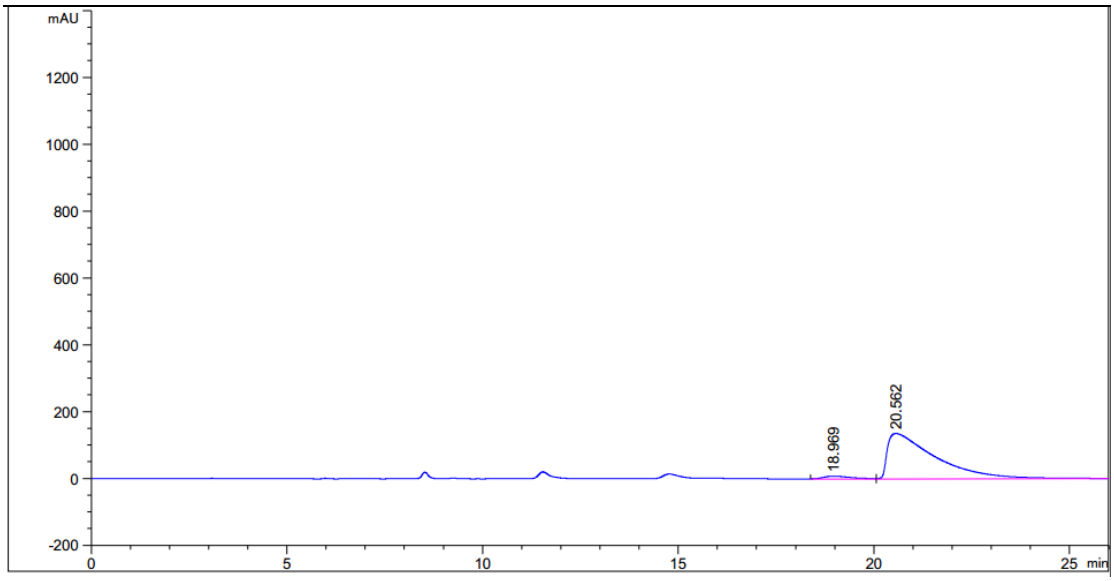
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	34.158	0.7031	934.13037	20.44251	3.1962
2	39.801	0.9401	$2.82921e^4$	416.72687	96.8038



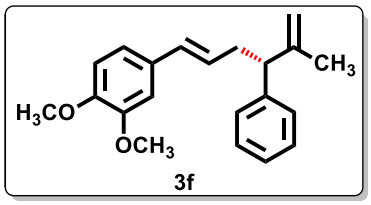
3e



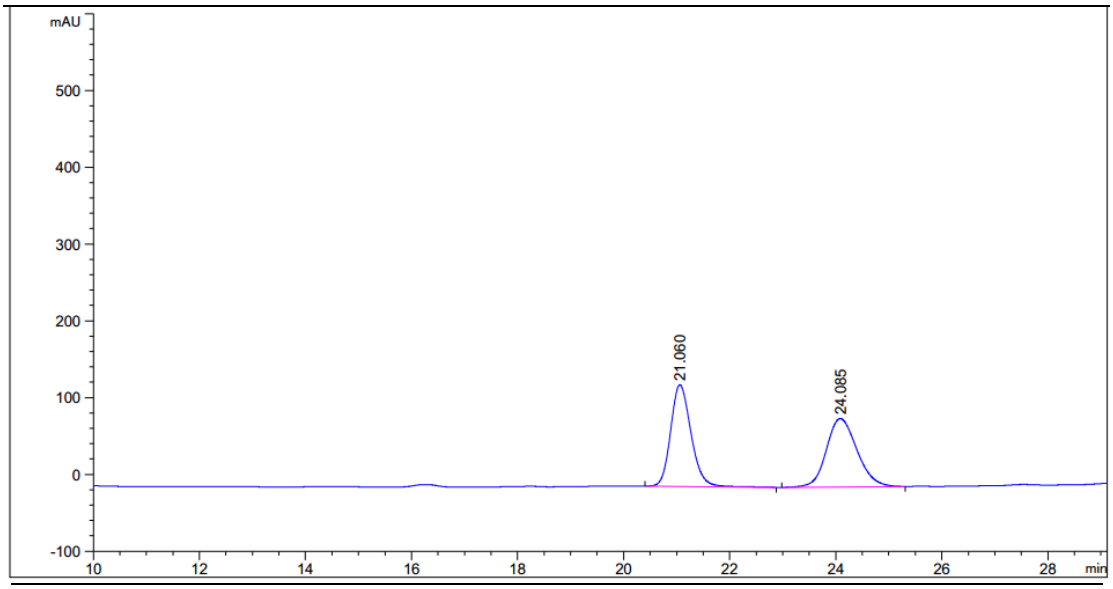
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.658	0.8041	6629.76172	120.08854	52.3172
2	21.475	1.1932	6042.47314	71.91923	47.6828



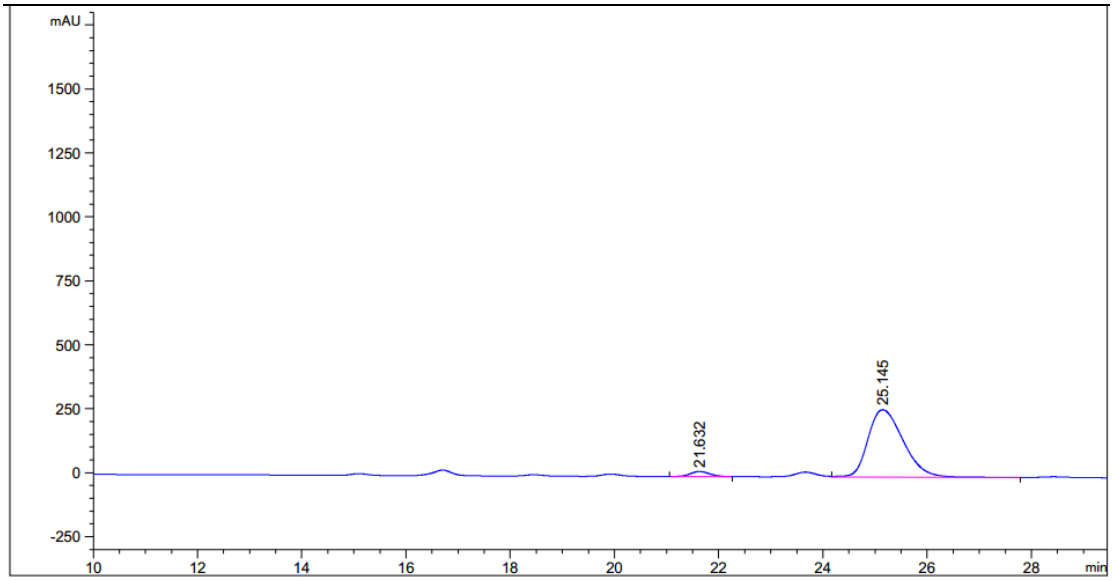
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.969	0.7625	389.39426	8.38979	3.2410
2	20.562	1.4194	$1.16251e^4$	135.62494	96.7590



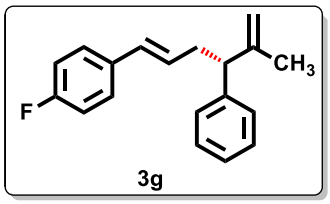
3f



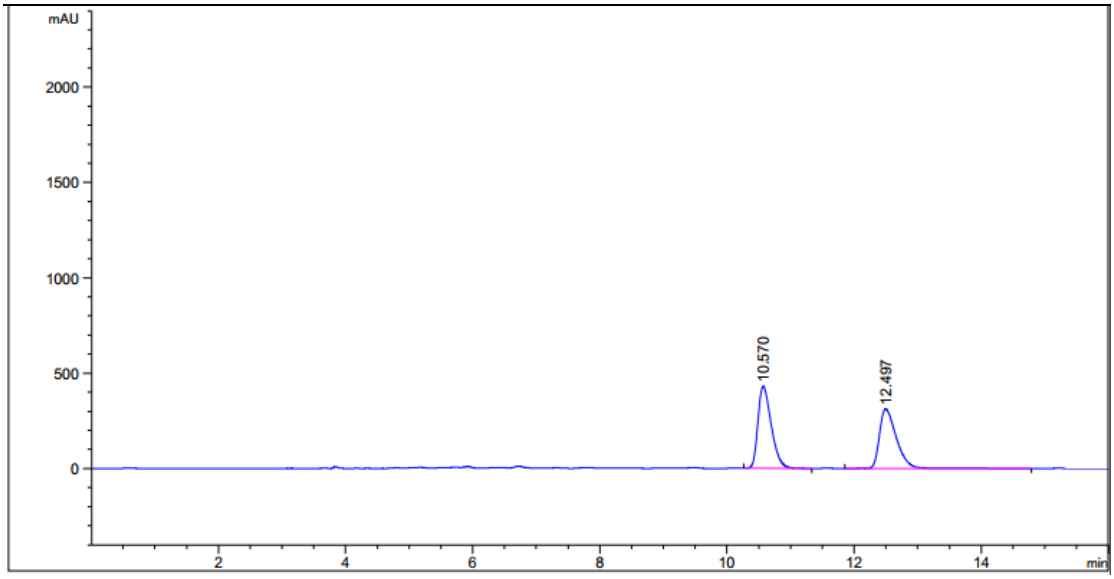
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.060	0.4126	3530.24976	132.19418	49.7755
2	24.085	0.6219	3562.08813	89.01189	50.2245



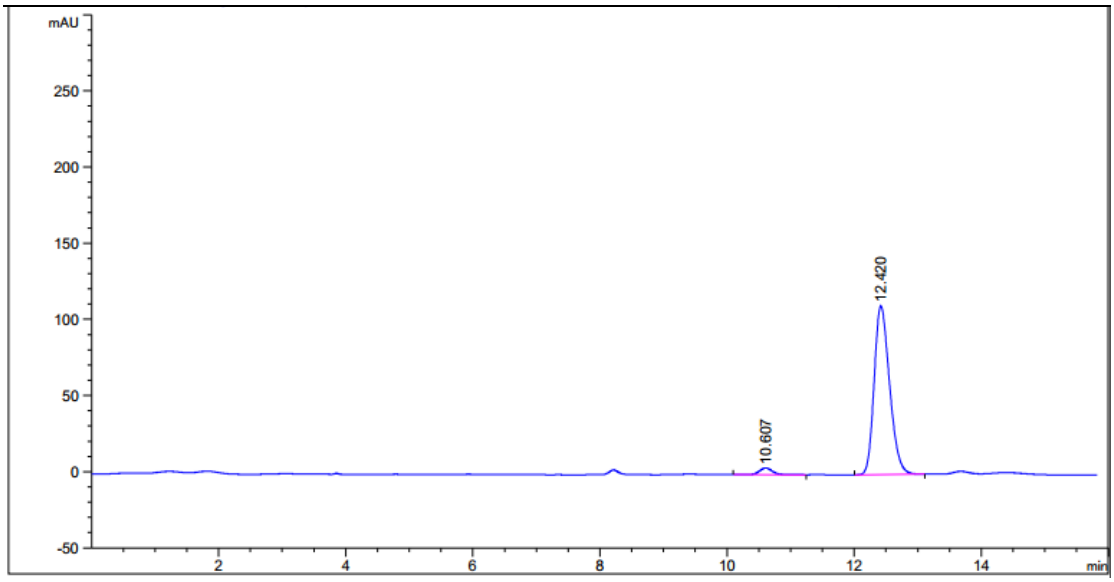
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.632	0.4272	506.44952	19.66724	3.9299
2	25.145	0.7827	$1.23807e^4$	263.52487	96.0701



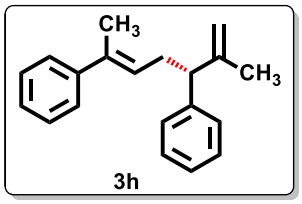
3g

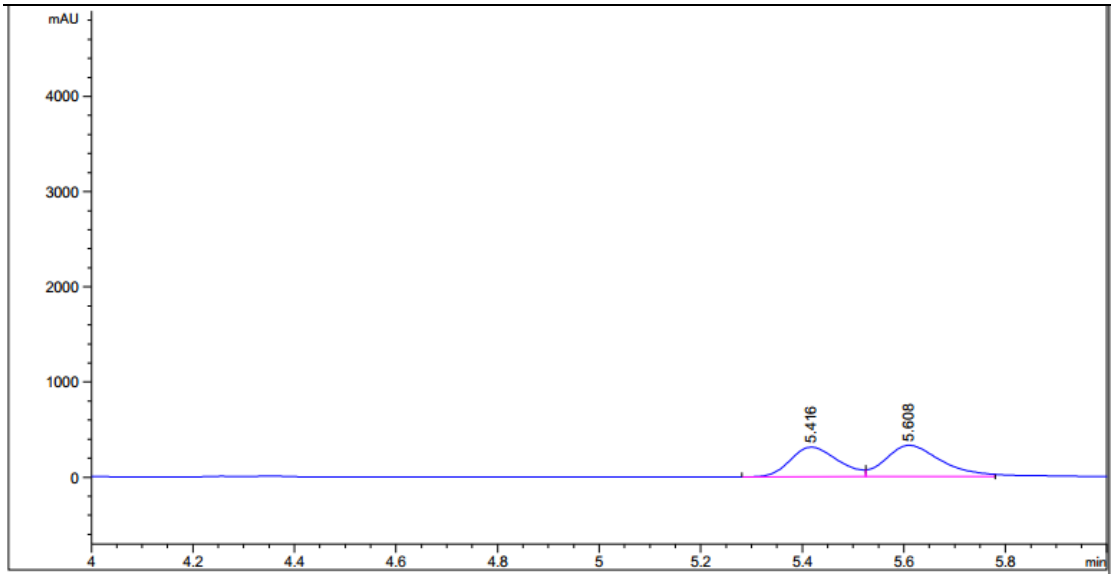


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.570	0.2427	6269.53564	430.27206	51.3084
2	12.497	0.2823	5949.77246	313.57324	48.6916

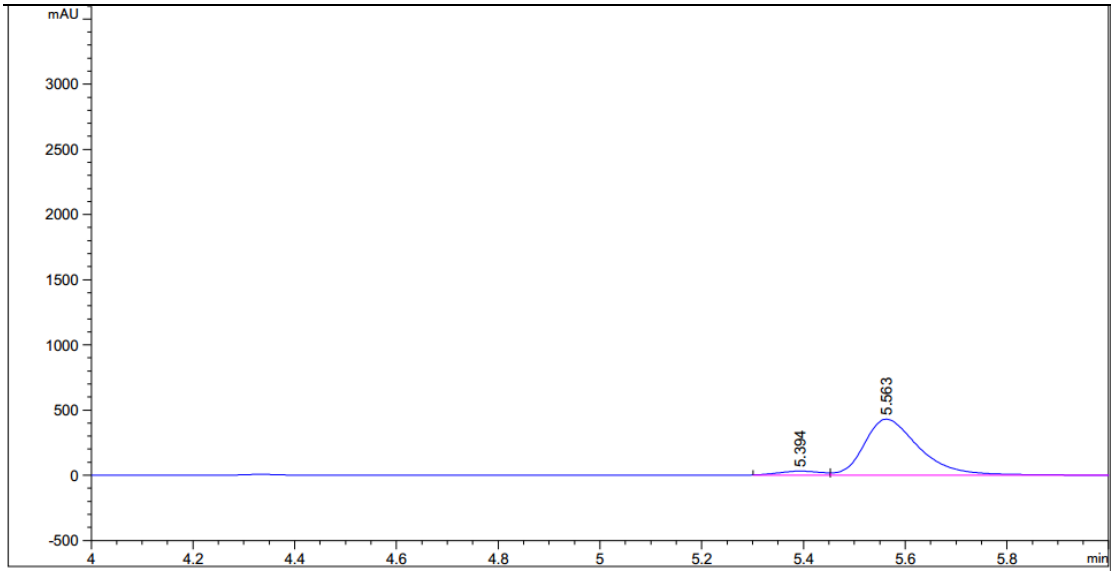


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.607	0.2230	64.14311	4.40324	3.3199
2	12.420	0.2598	1867.94470	110.71239	96.6801

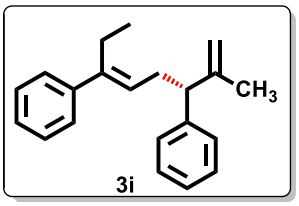


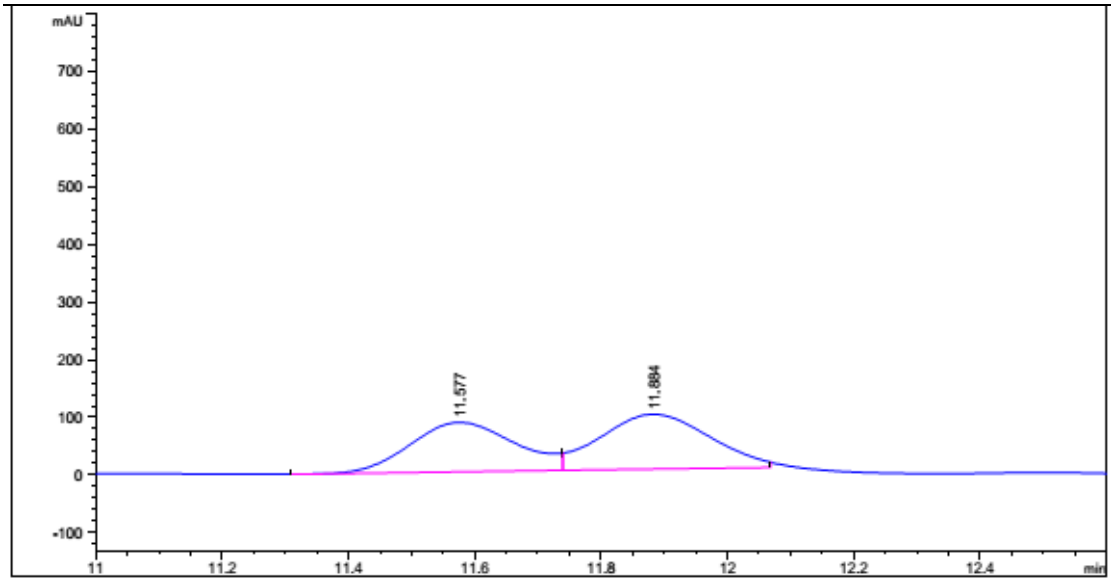


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.416	0.1089	2067.66772	312.21786	45.5663
2	5.608	0.1225	2470.04077	329.90192	54.4337

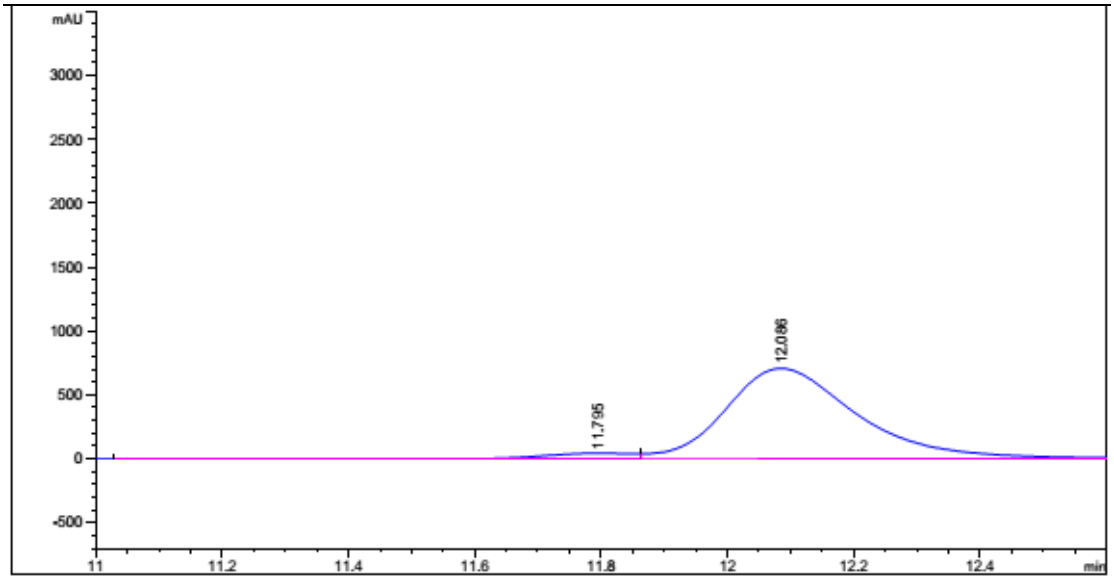


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.394	0.0961	173.87526	30.15701	5.1460
2	5.563	0.1232	3204.98340	429.35303	94.8540

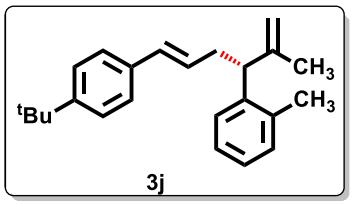




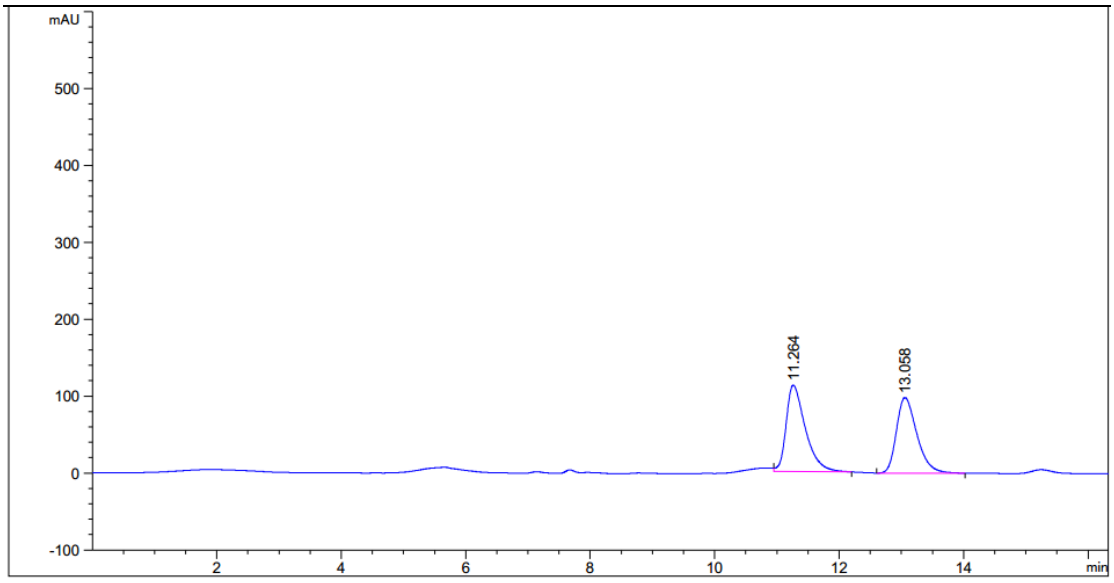
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.577	0.1927	995.23657	85.84478	46.5720
2	11.884	0.2002	1141.74878	95.05934	53.4280



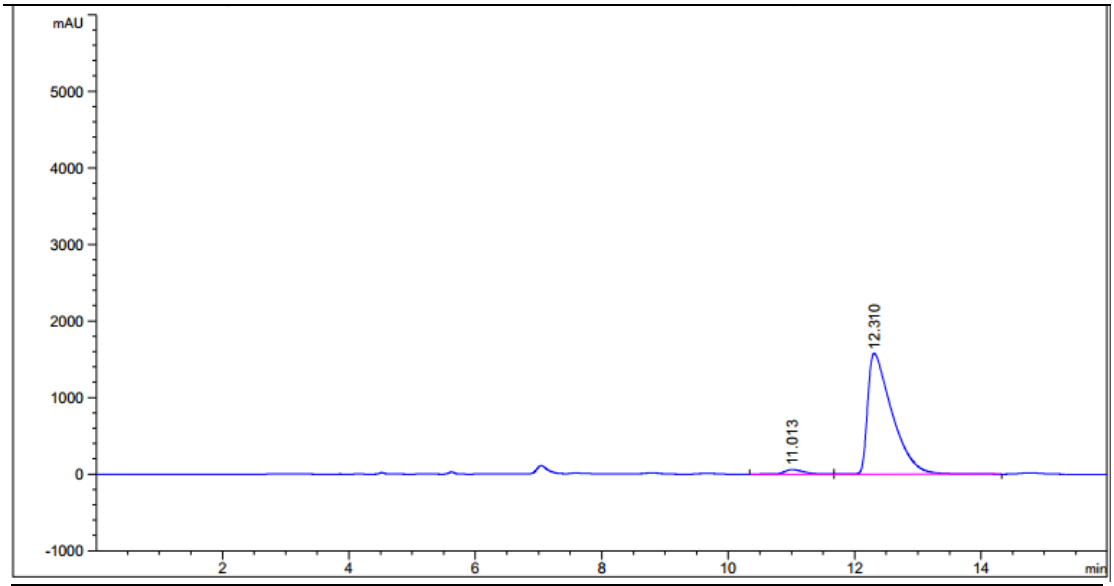
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.795	0.1710	435.83896	42.47535	4.0607
2	12.086	0.2419	1.02972e4	708.24408	95.9393



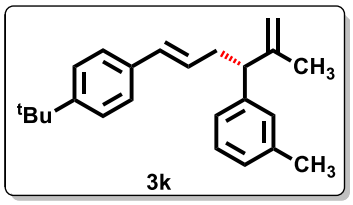
3j



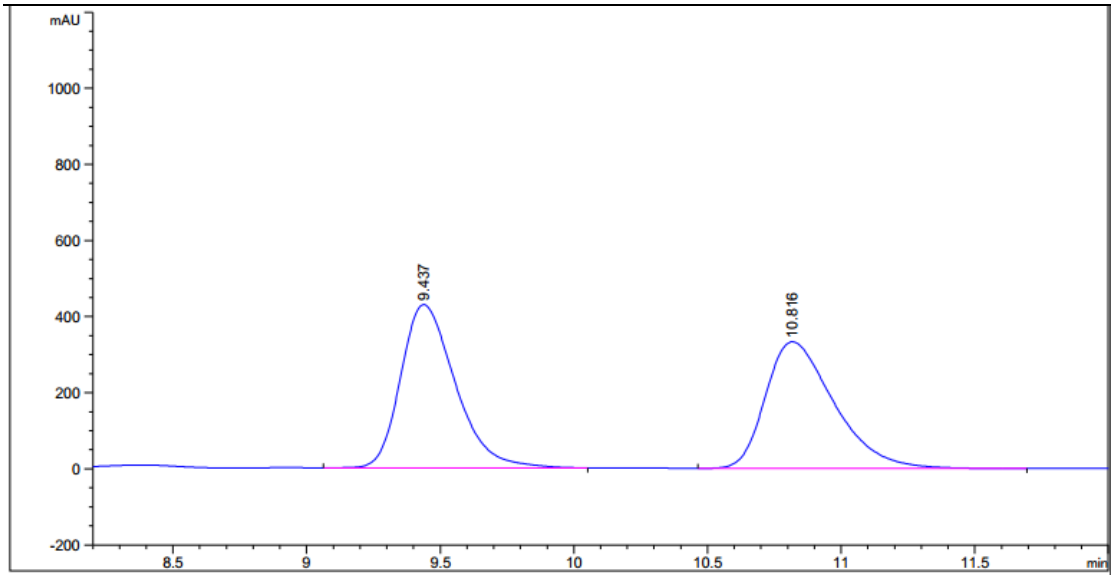
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.264	0.3541	2418.16724	112.32983	51.7921
2	13.058	0.3798	2250.81689	98.32371	48.2079



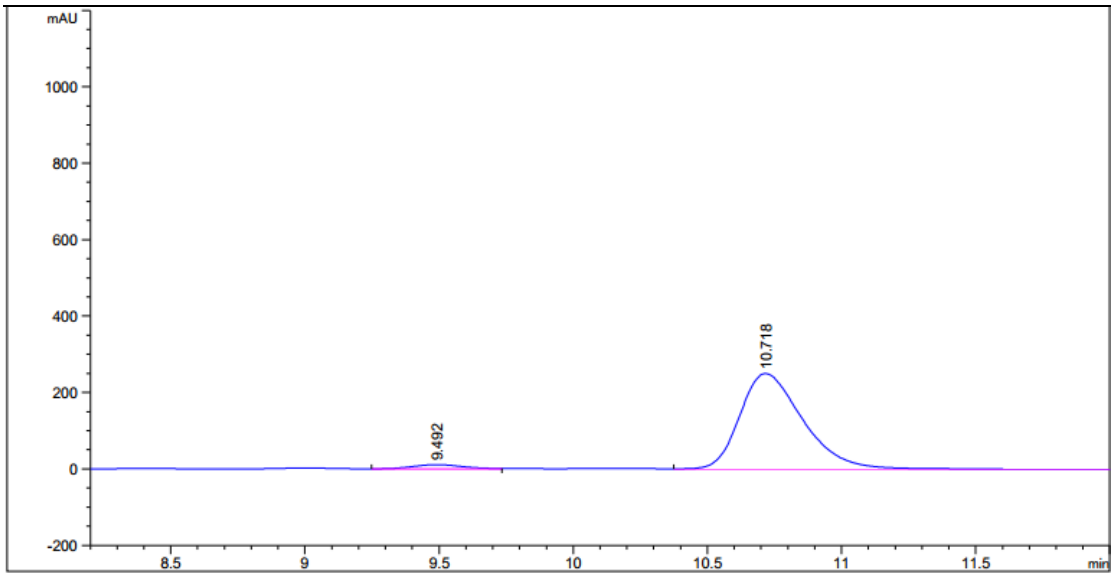
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.013	0.3162	1257.21277	60.07287	2.8993
2	12.310	0.3903	$4.21051e^4$	1577.94177	97.1007



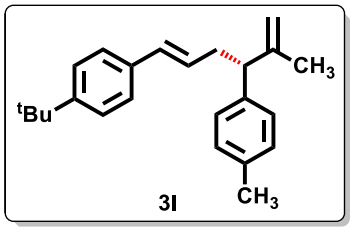
3k



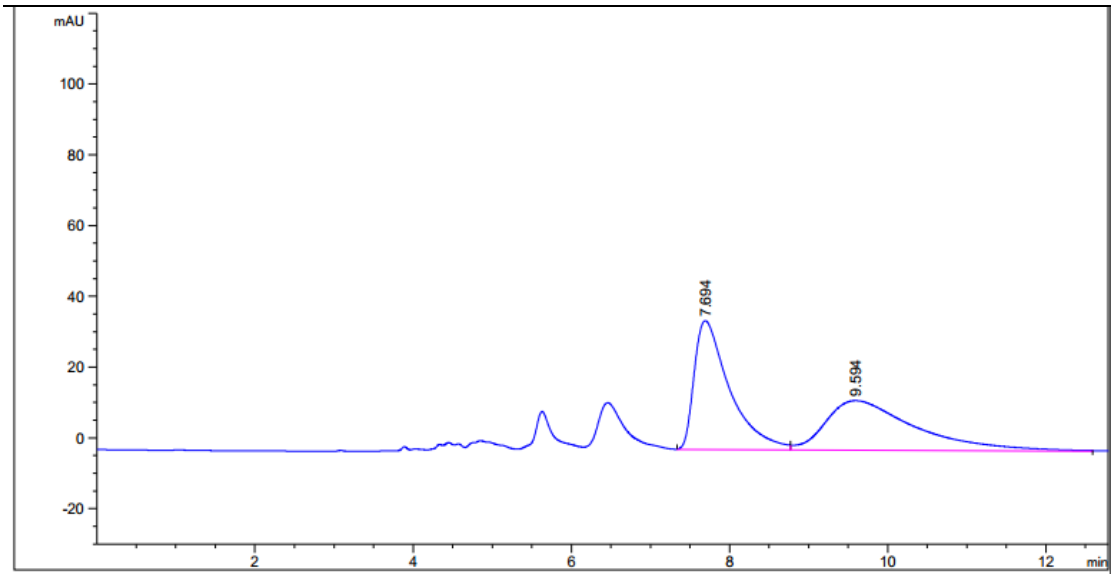
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.437	0.2366	6099.33398	429.36243	50.7244
2	10.816	0.2727	5925.12305	332.74637	49.2756



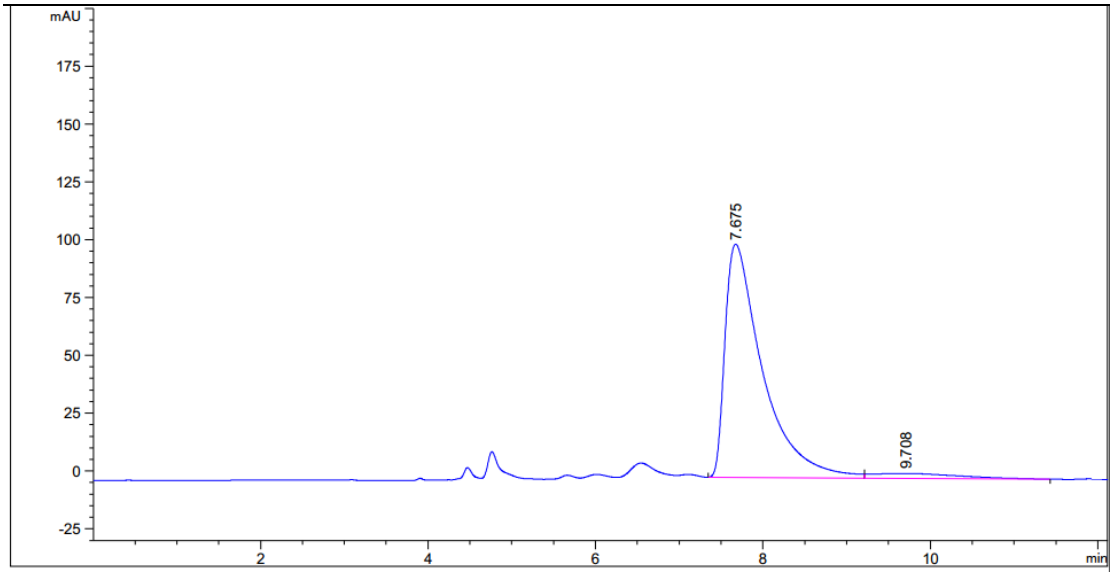
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.492	0.2152	142.09402	11.00443	3.3876
2	10.718	0.2705	4052.43335	249.37569	96.6124



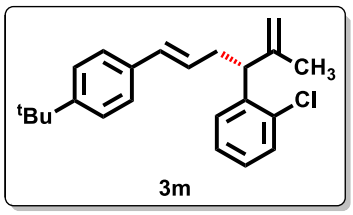
3l



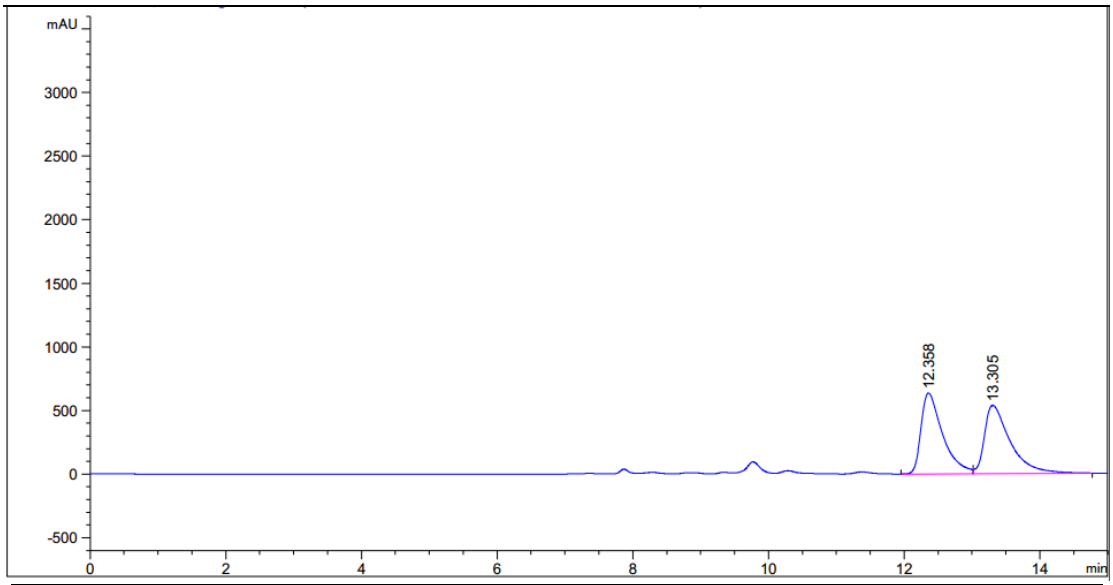
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.694	0.5207	1138.80261	36.45444	50.5467
2	9.594	1.3114	1114.16956	14.04941	49.4533



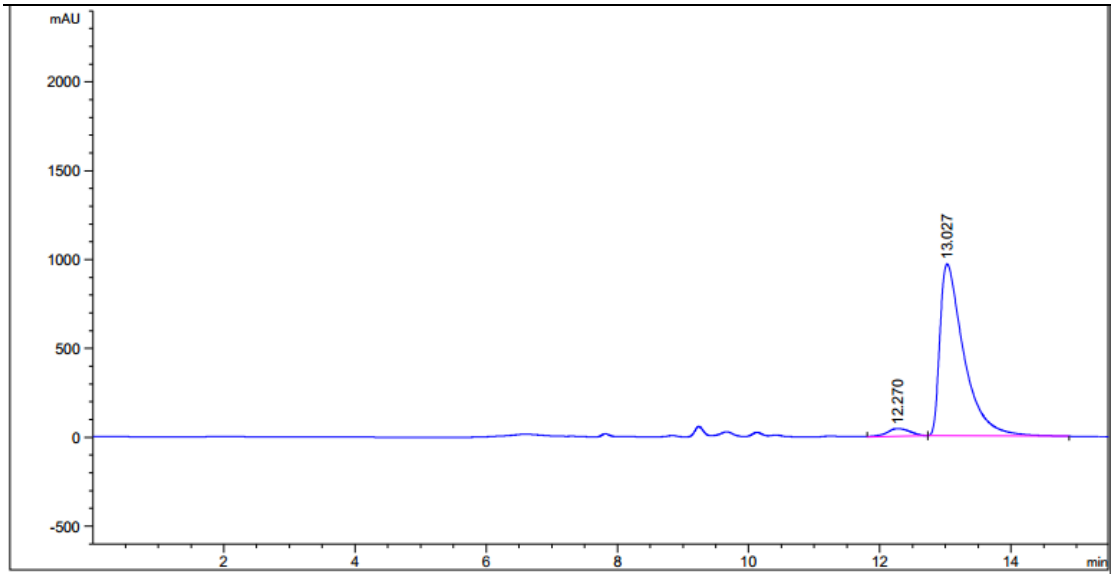
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.675	0.5149	3149.39136	100.89886	95.1456
2	9.708	1.2185	160.68565	2.19779	4.8544



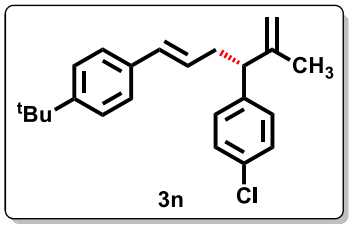
3m



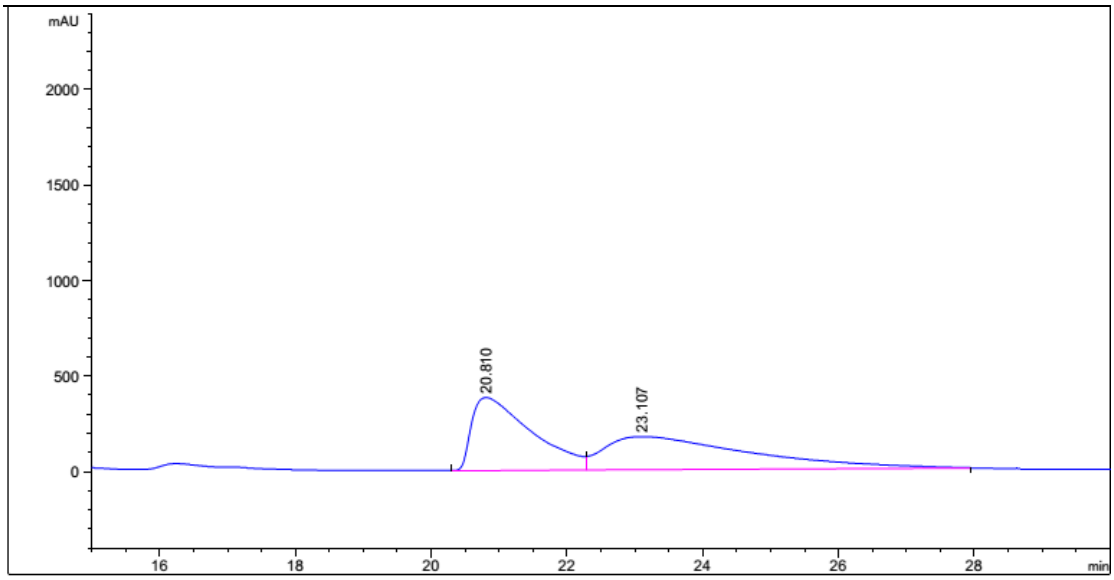
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.358	0.3688	1.40713e4	635.88507	49.9516
2	13.305	0.4380	1.40986e4	536.50537	50.0484



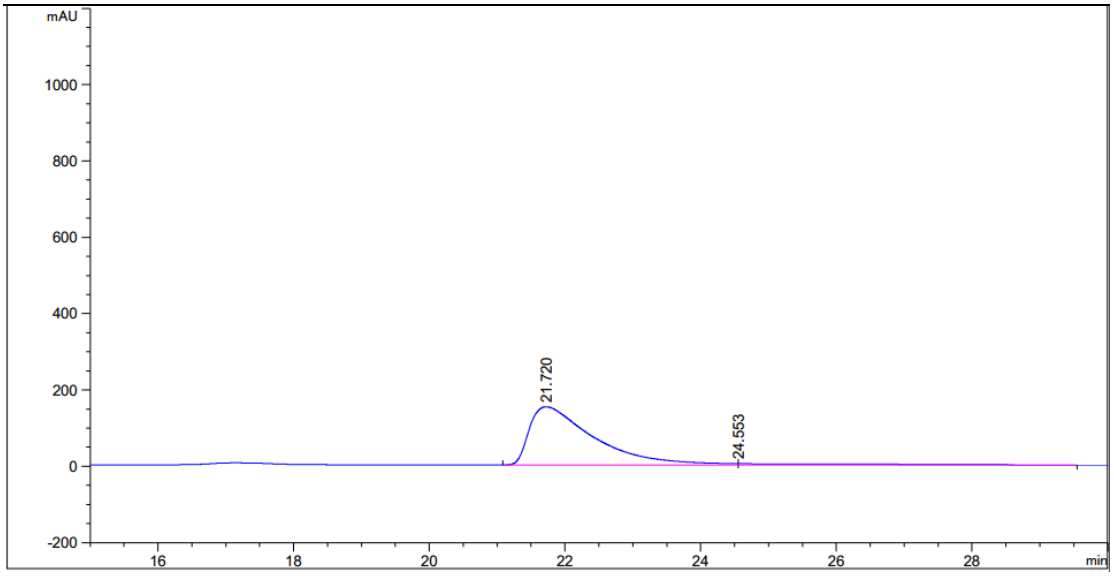
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.270	0.3978	1030.33337	43.17025	4.0329
2	13.027	0.4065	2.45179e4	966.39618	95.9671



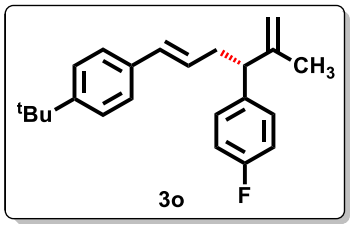
3n

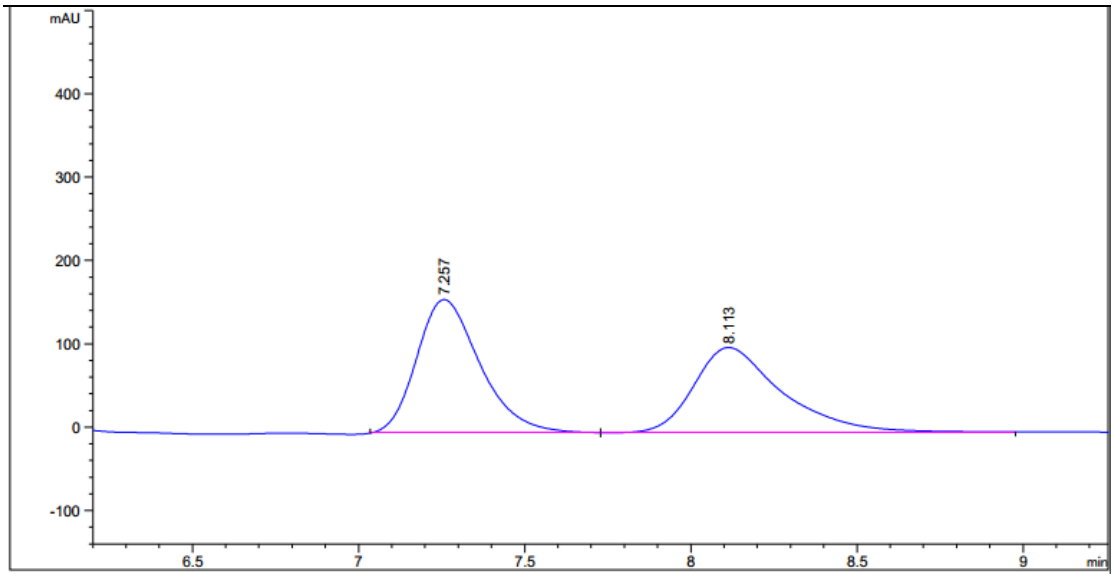


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.810	1.0234	2.34716e4	381.78271	47.8665
2	23.107	2.4518	2.55639e4	173.71227	52.1335

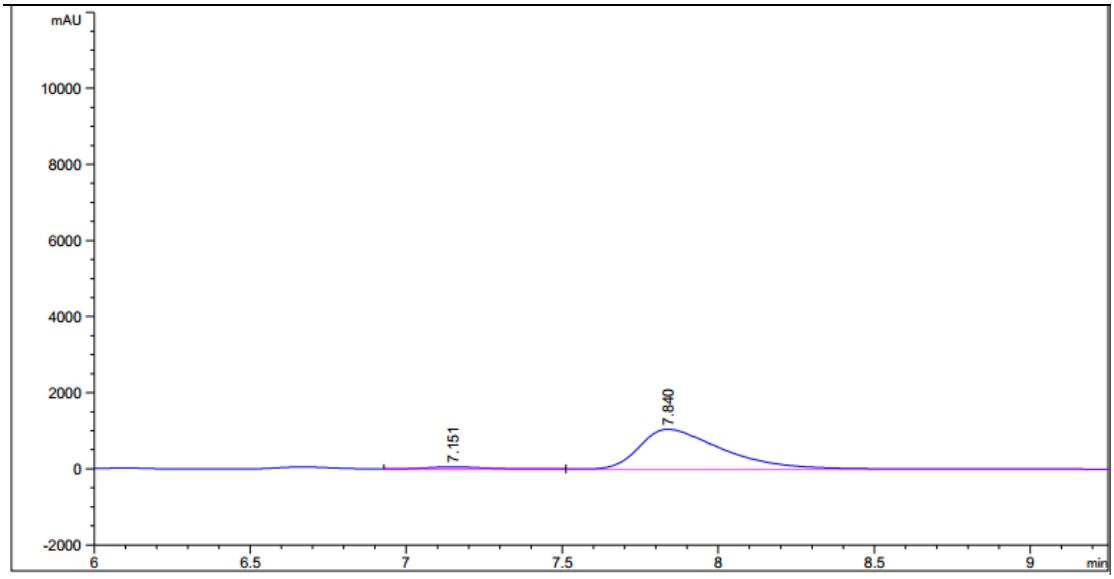


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.720	1.0965	1.00623e4	152.55455	95.3245
2	24.553	2.4180	493.53549	3.40177	4.6755

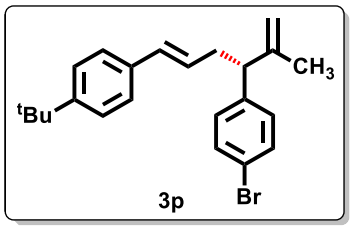


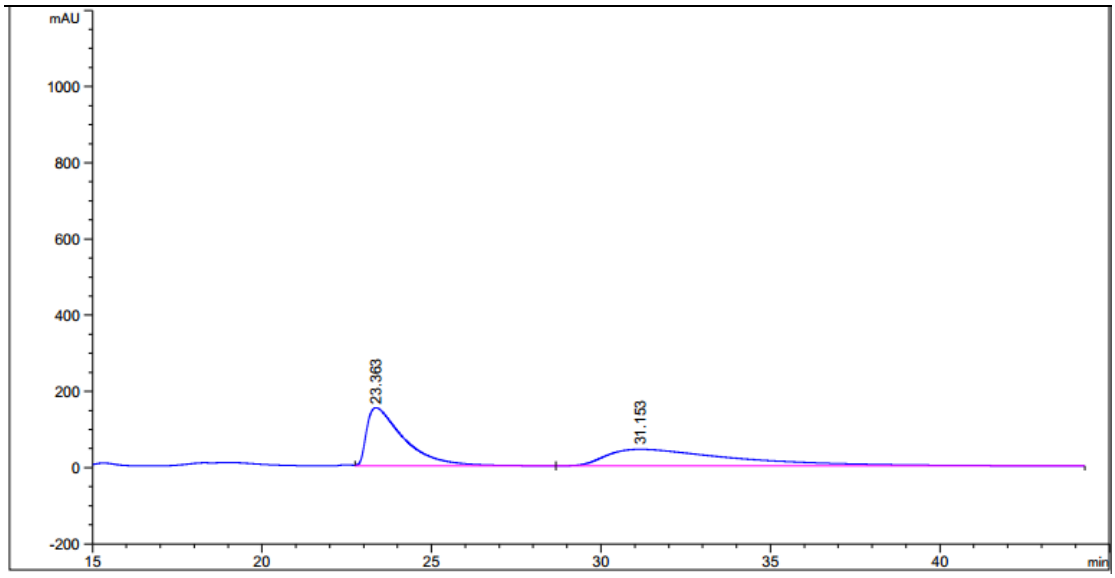


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.257	0.2183	2088.07104	159.07199	52.8867
2	8.113	0.3046	1860.12622	101.56214	47.1133

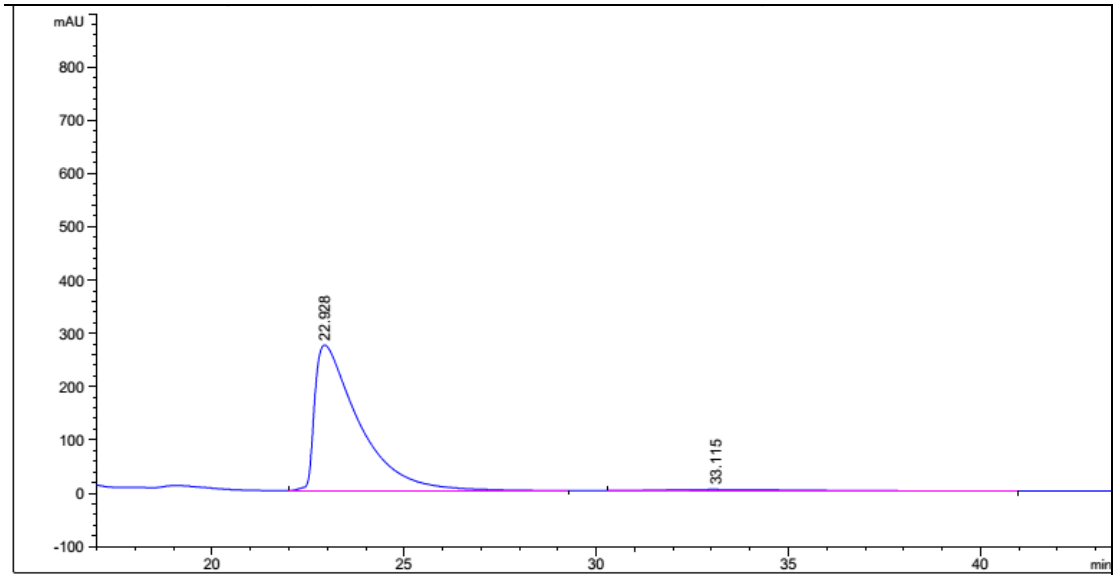


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.151	0.2033	778.33716	58.47493	3.8840
2	7.840	0.2748	$1.92611e^4$	1046.29395	96.1160

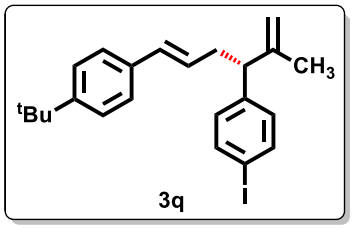


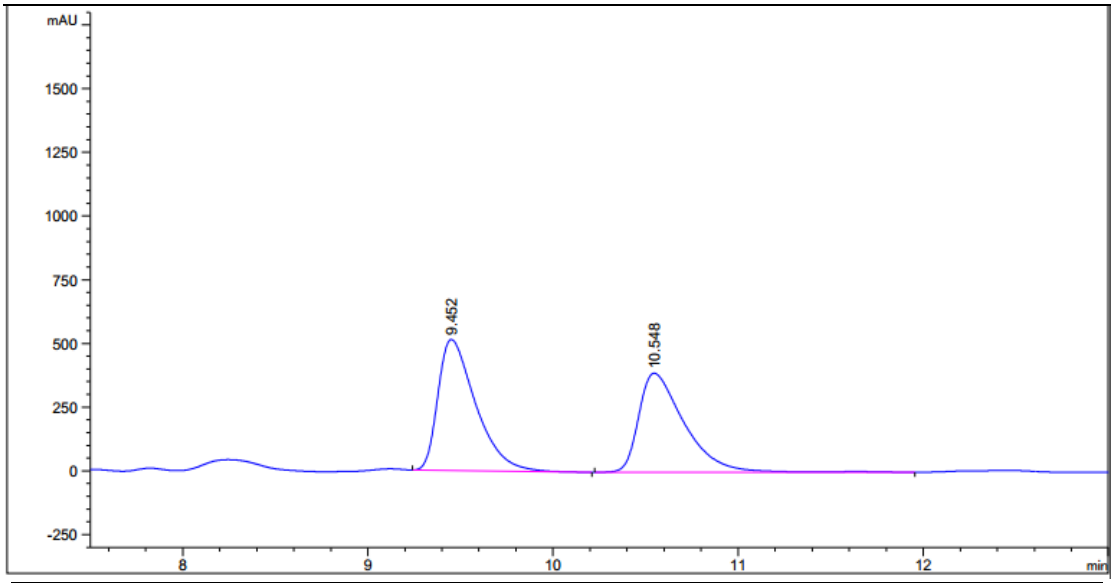


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	23.363	1.2586	1.16557e4	152.84065	50.6791
2	31.153	3.3407	1.13433e4	43.18190	49.3209

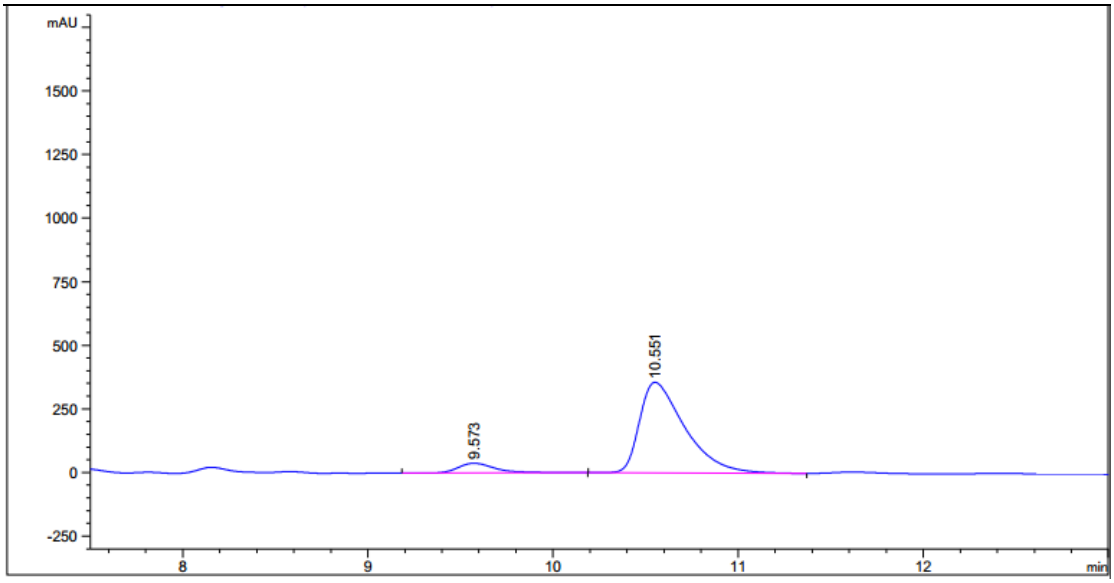


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.928	1.3278	2.18193e^4	273.37143	96.9034
2	33.115	4.4716	697.25415	2.59884	3.0966

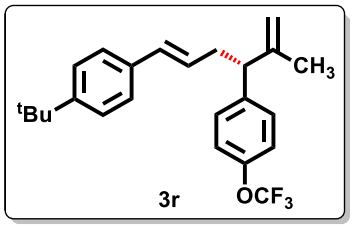


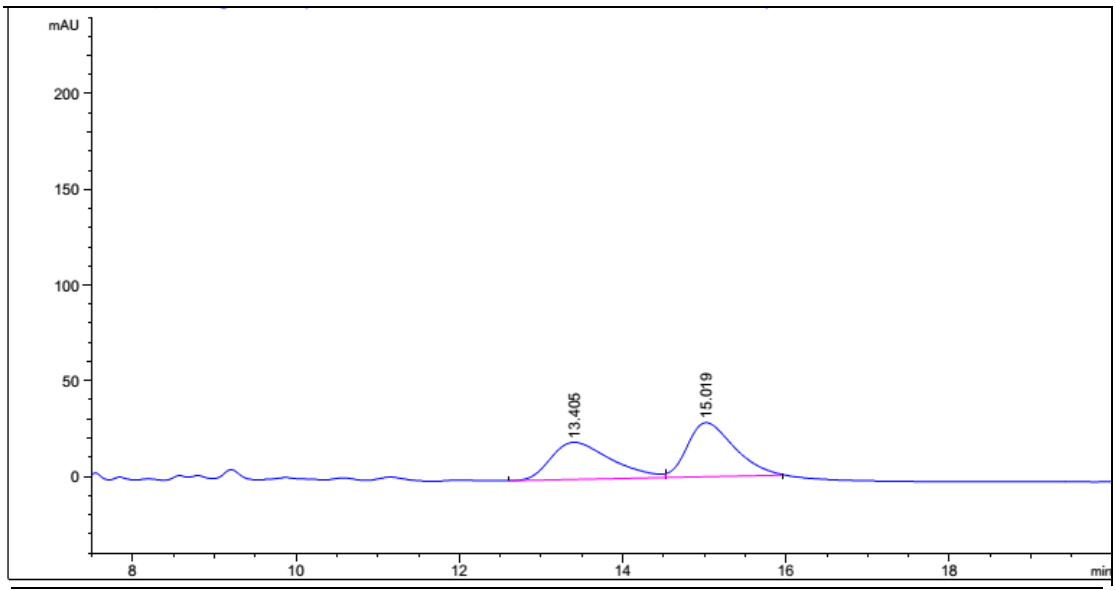


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.452	0.2358	7279.04834	514.03363	52.2215
2	10.548	0.2544	6659.73926	388.60910	47.7785

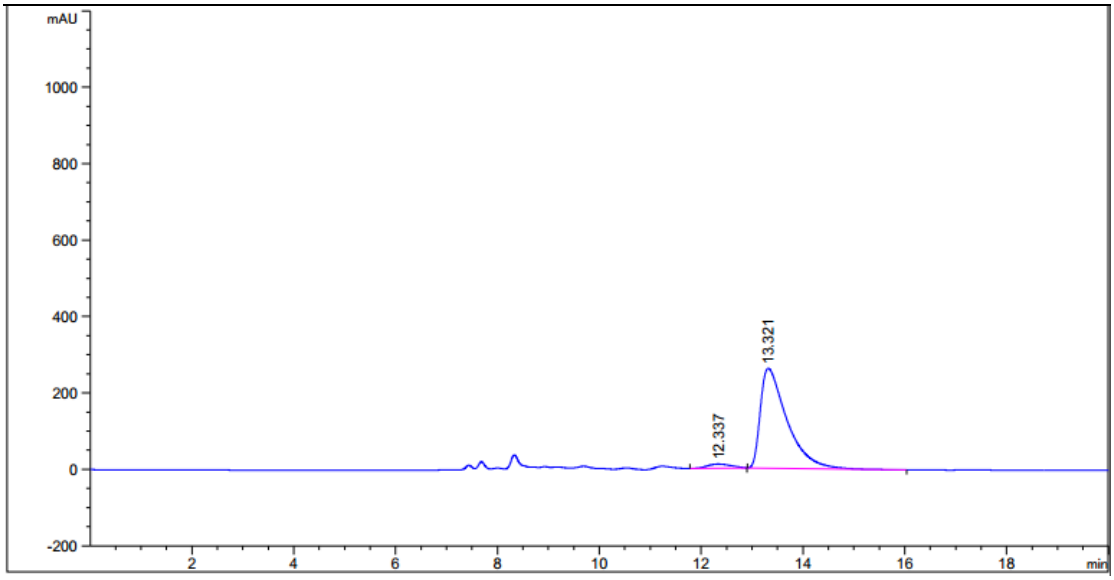


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.573	0.2139	533.79907	38.22643	8.1154
2	10.551	0.2541	6043.78174	355.98837	91.8846

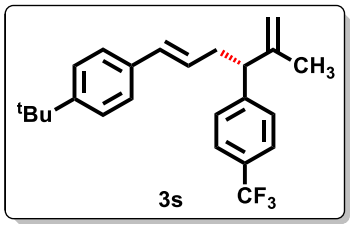


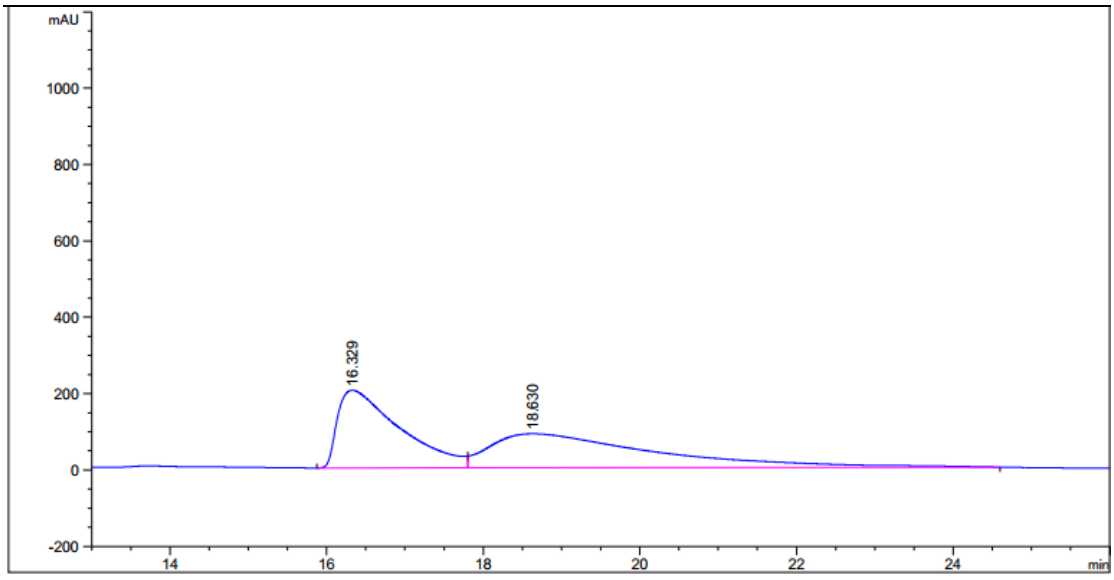


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.405	0.8506	987.11475	19.34062	46.6464
2	15.019	0.6670	1129.05164	28.21390	53.3536

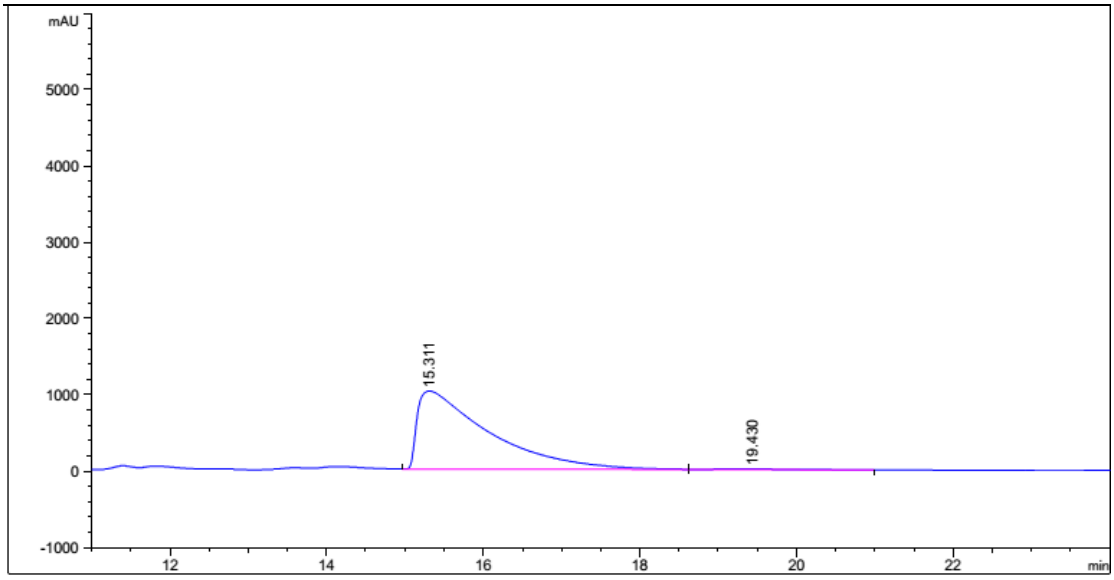


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.337	0.5349	352.91824	10.85855	3.5911
2	13.321	0.6041	9474.75879	261.34335	96.4089

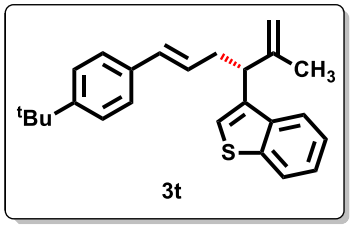




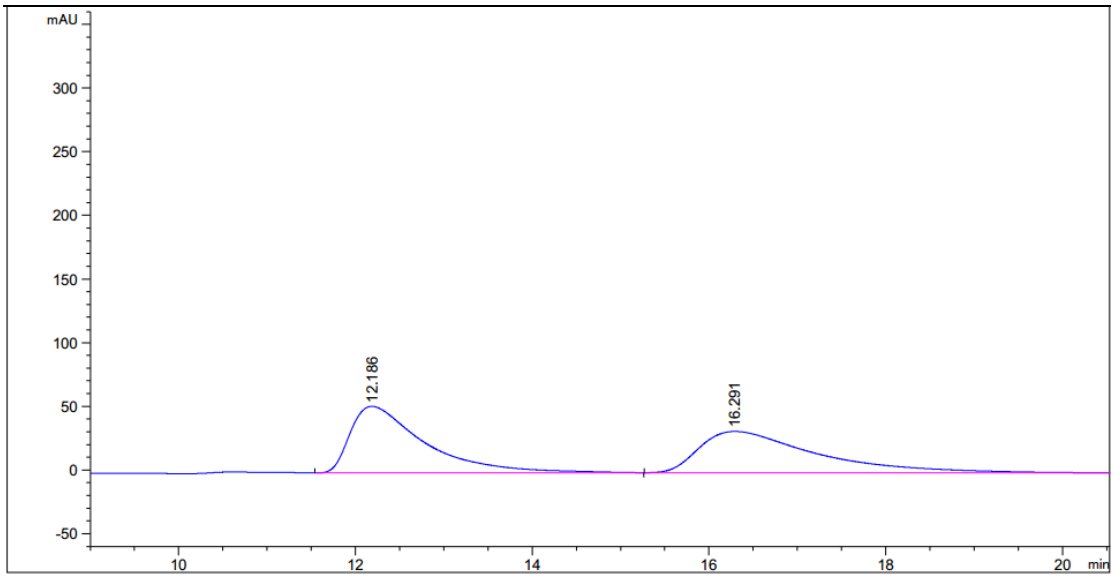
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.329	0.9192	$1.12779e^4$	203.62604	46.7377
2	18.630	2.4029	$1.28523e^4$	89.03124	53.2623



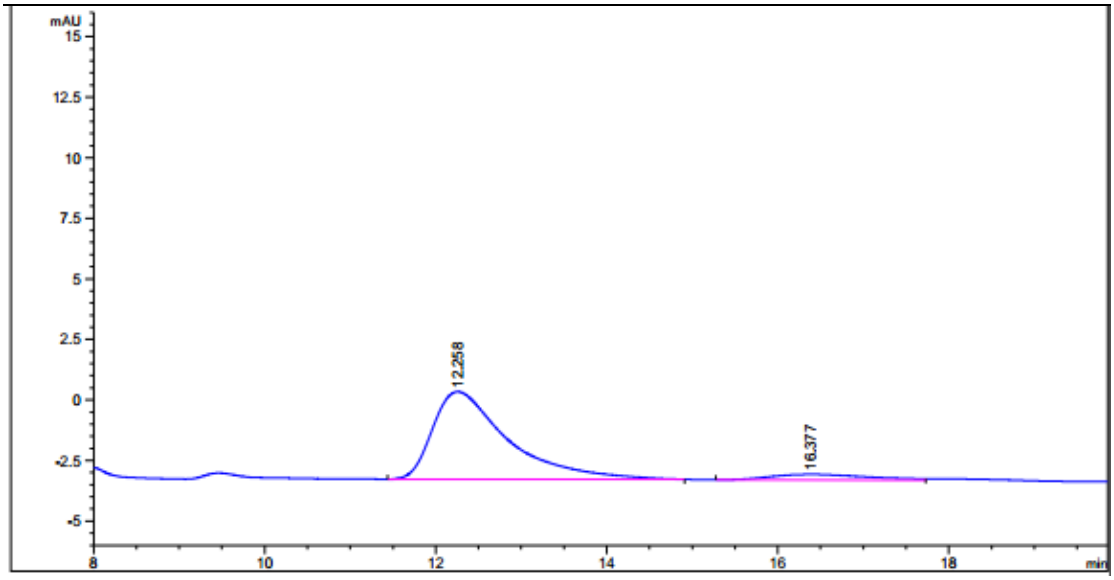
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.311	1.0576	6.49471e4	1023.46857	98.8110
2	19.430	1.5609	781.48462	8.32029	1.1890



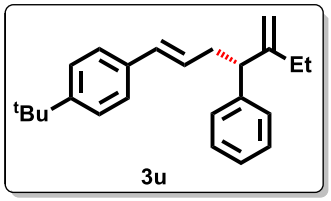
3t



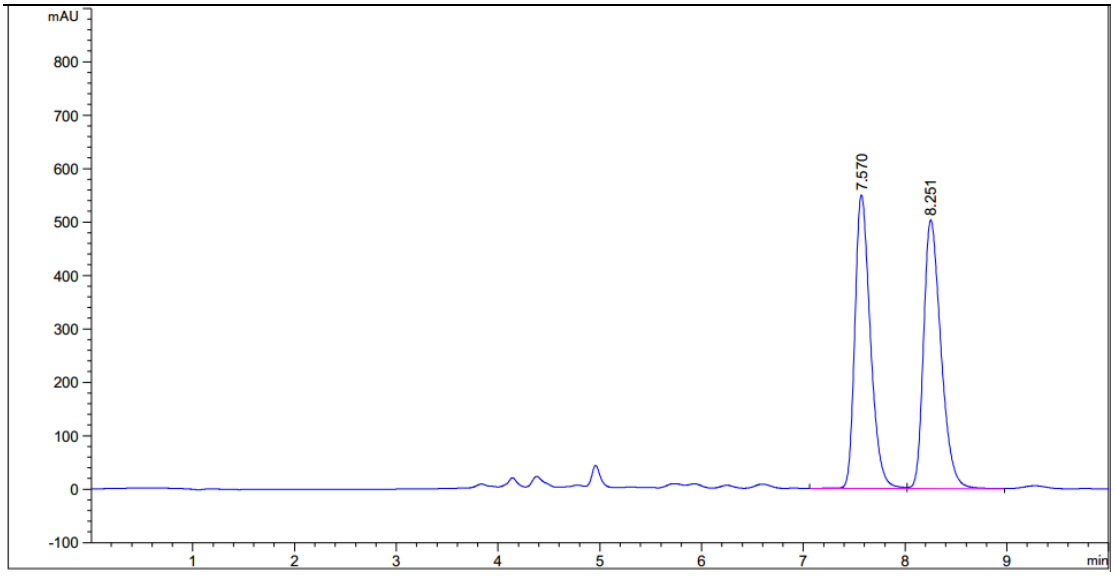
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.186	0.8456	3044.01489	52.33733	50.5982
2	16.291	1.3233	2972.04419	32.42663	49.4018



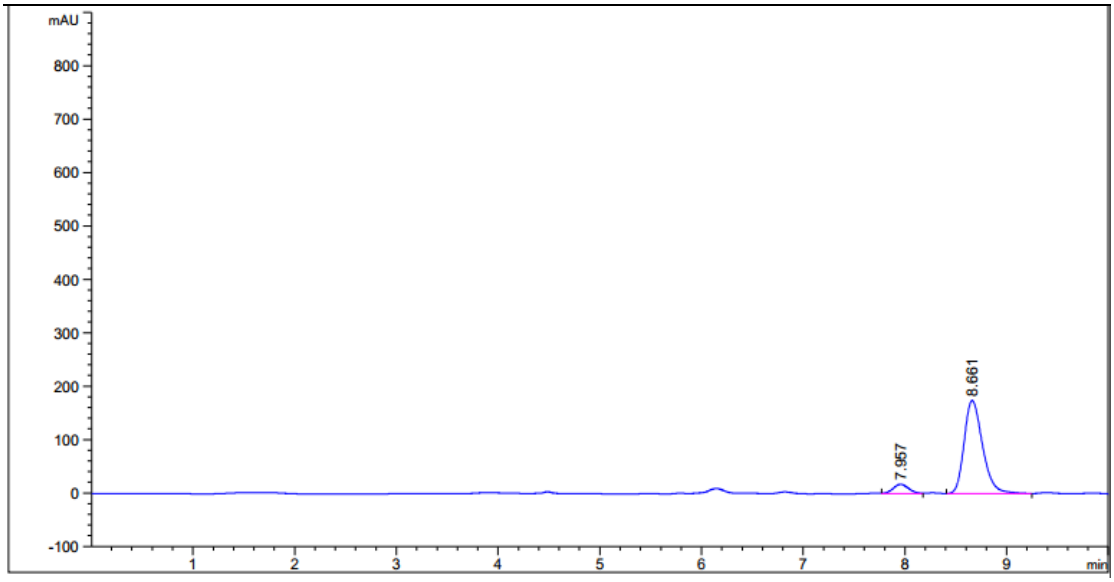
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.258	0.8702	220.61562	3.61885	92.3454
2	16.377	1.3100	18.28707	2.32665e-1	7.6546



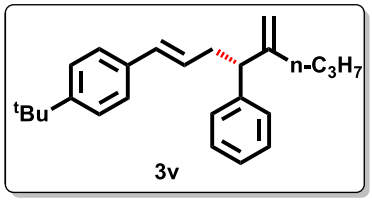
3u



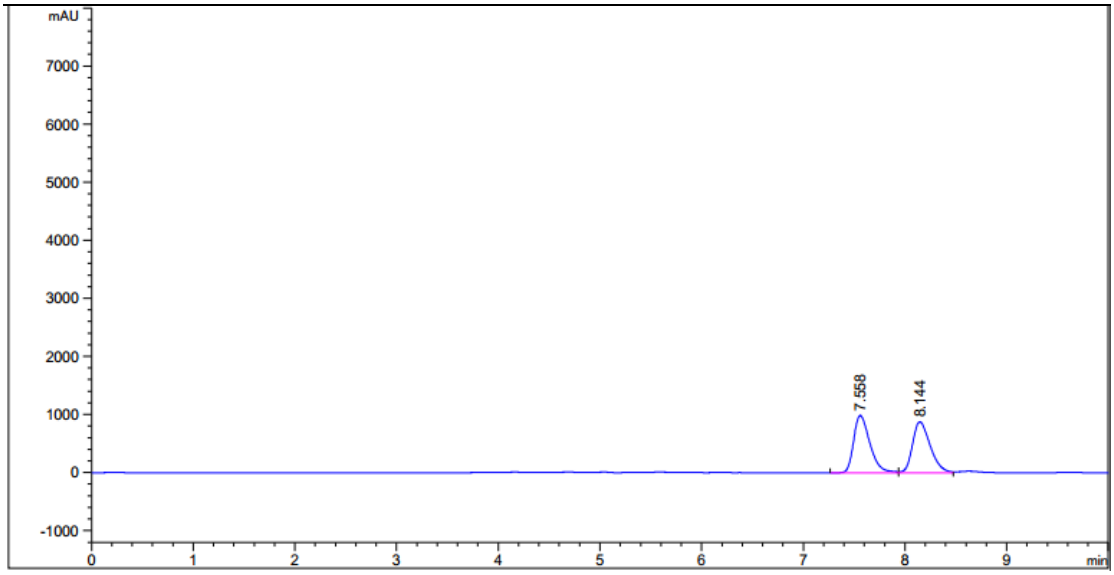
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.570	0.1625	5819.43262	549.81604	49.3688
2	8.251	0.1825	5968.23389	502.61896	50.6312



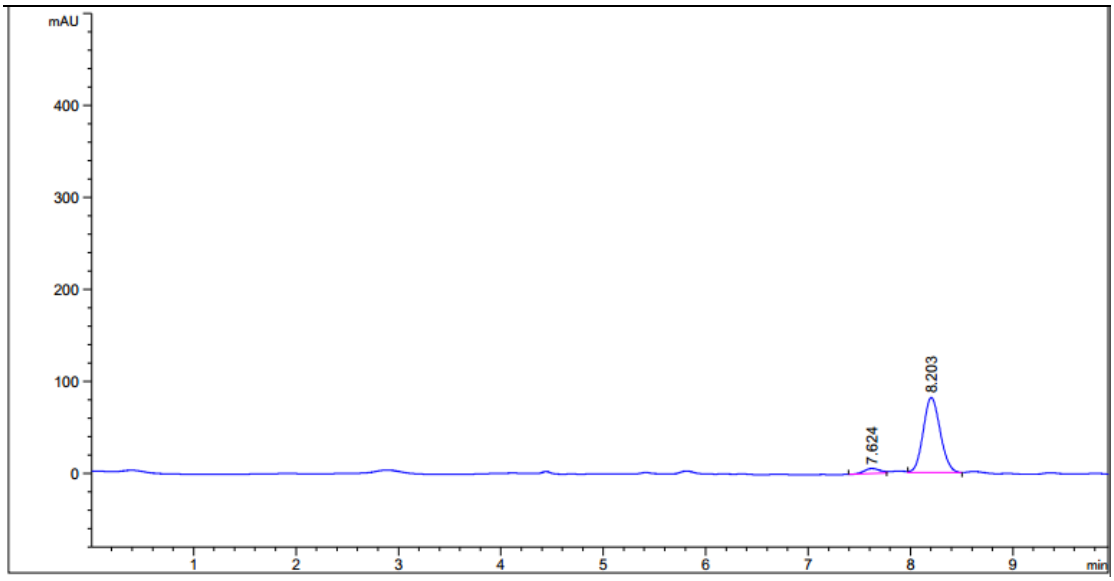
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.957	0.1810	192.38066	17.71098	8.0309
2	8.661	0.2100	2203.12329	174.72110	91.9691



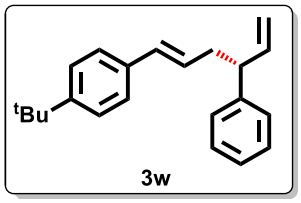
3v

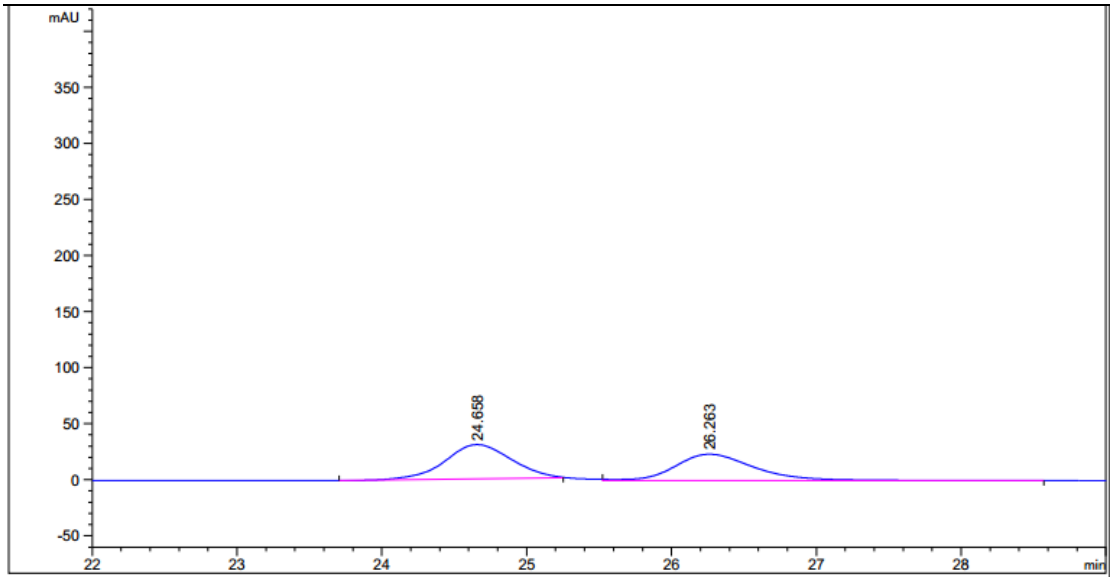


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.558	0.1706	$1.09612e^4$	986.73853	50.8010
2	8.144	0.2017	$1.06155e^4$	876.72778	49.1990

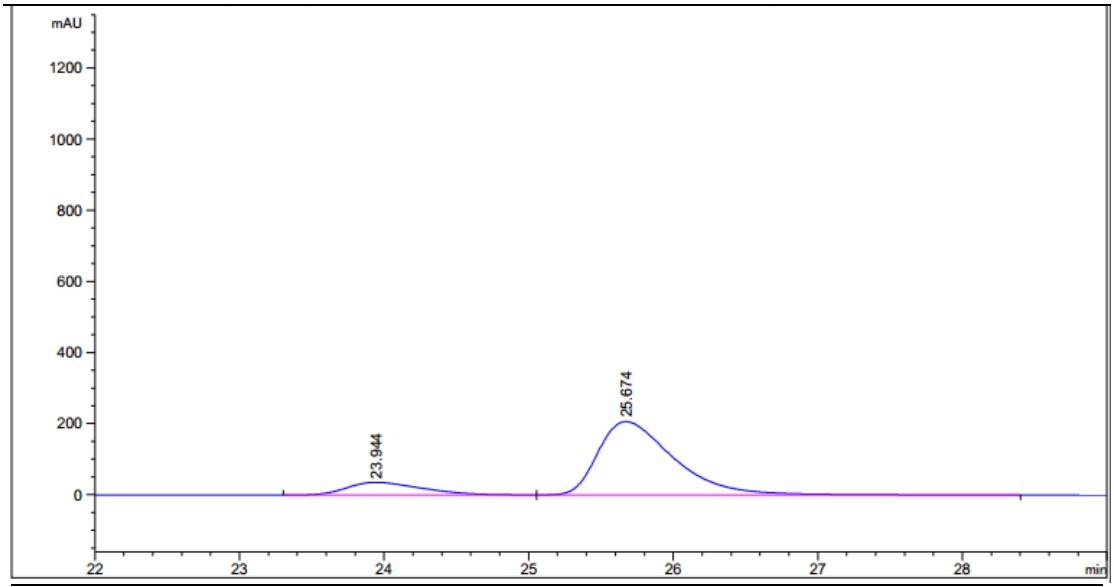


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.624	0.1771	58.58163	5.51326	5.8571
2	8.203	0.1925	941.60486	81.53452	94.1429

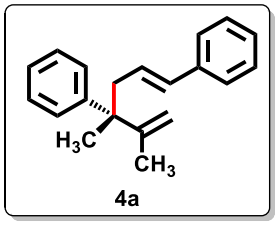




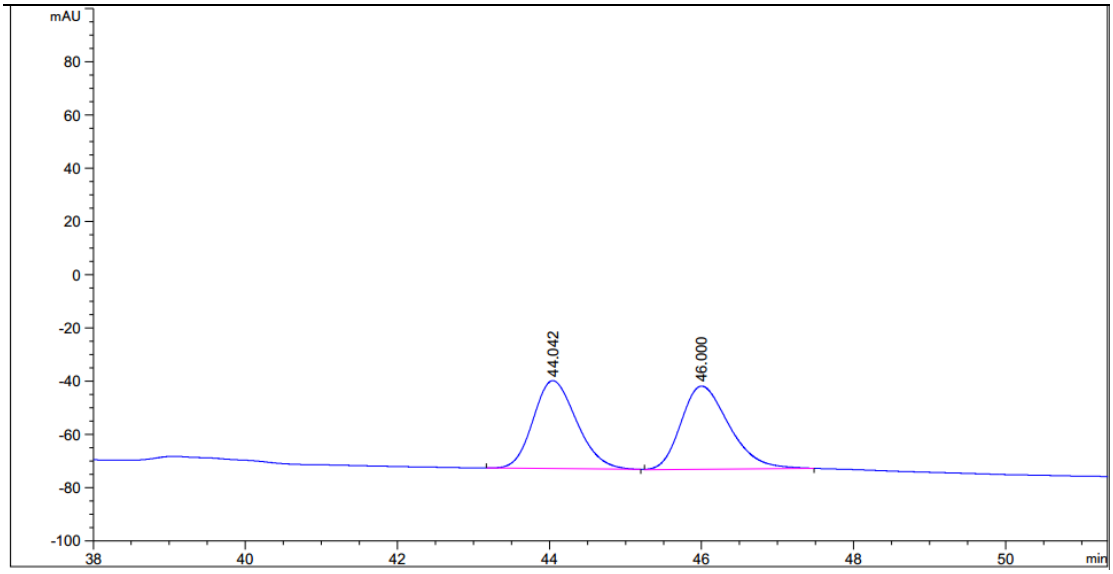
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	24.658	0.5275	971.43060	30.50536	51.4262
2	26.263	0.6476	917.54871	23.61549	48.5738



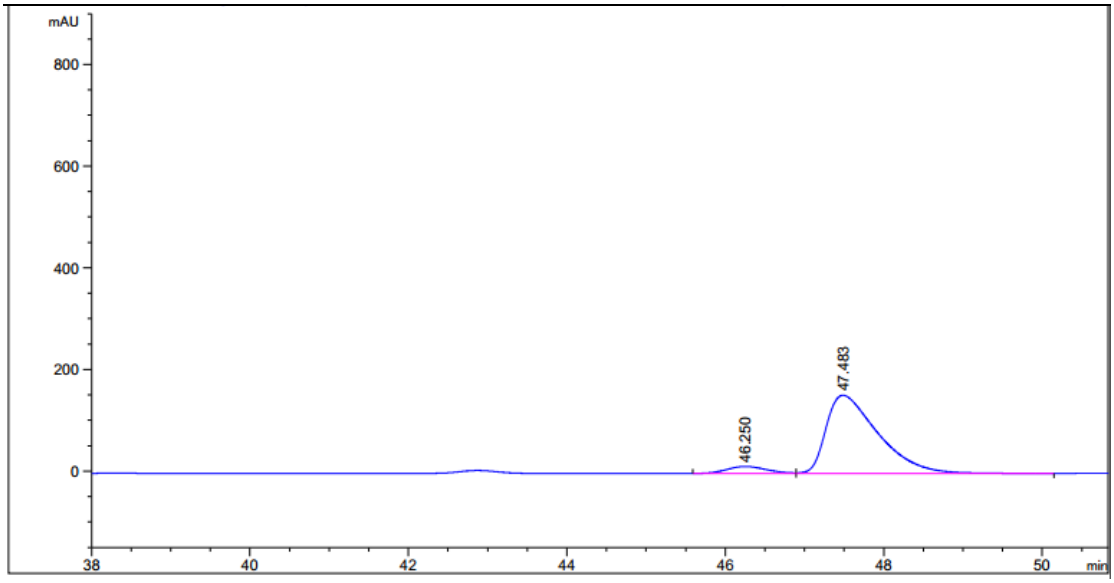
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	23.944	0.5521	1294.80981	35.78869	14.6473
2	25.674	0.5607	7545.11523	206.27385	85.3527



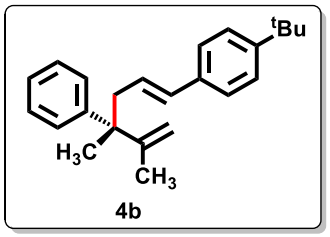
4a



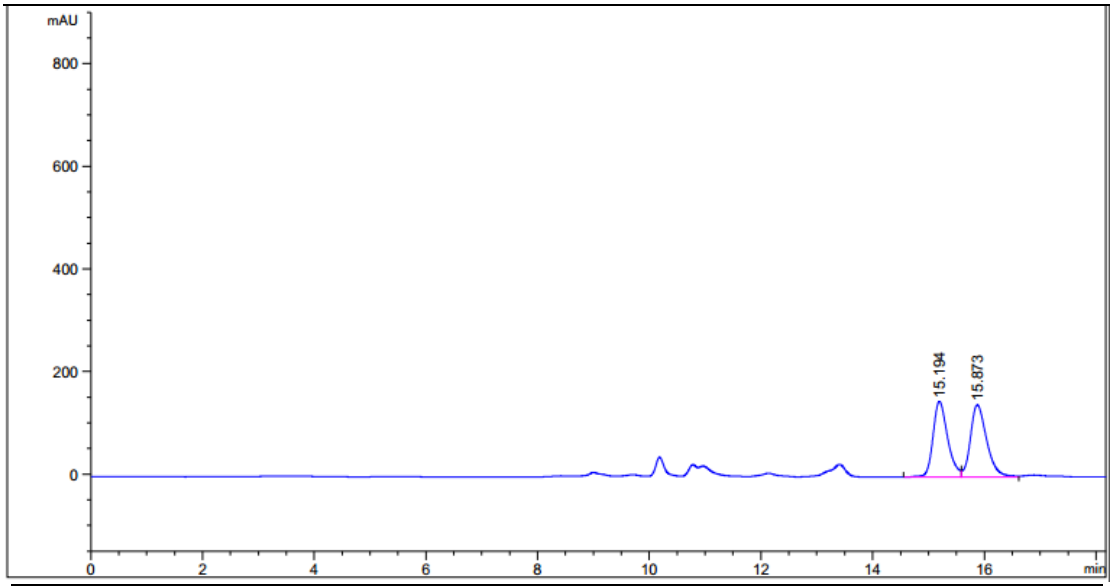
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	44.042	0.6160	1311.97595	33.05962	48.9612
2	46.000	0.7301	1367.65051	31.21997	51.0388



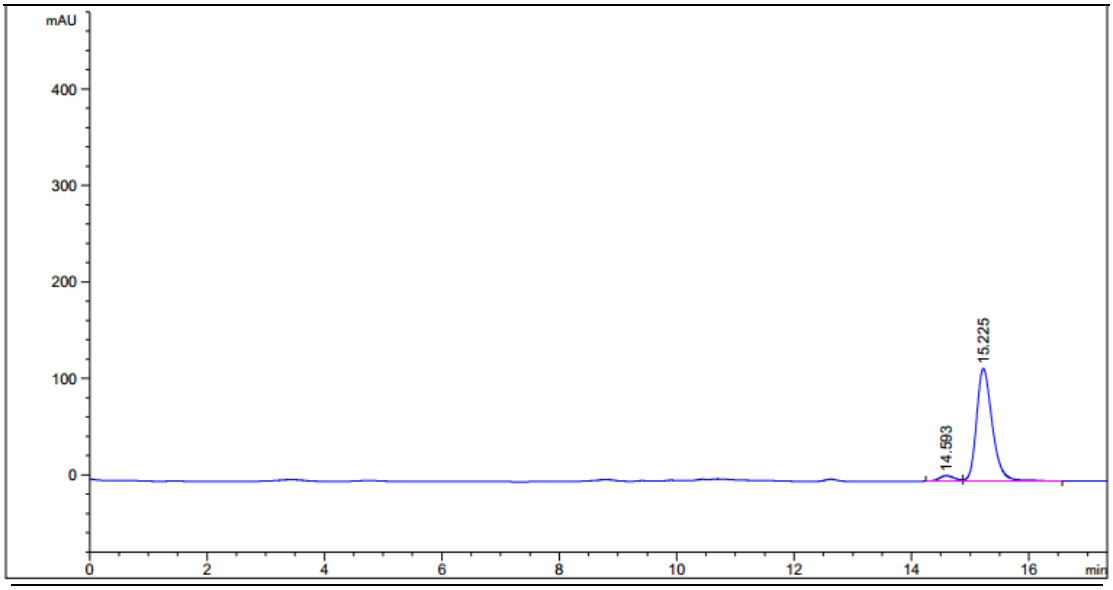
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	46.250	0.5834	488.85046	13.89795	6.5168
2	47.483	0.7593	7012.57080	153.84323	93.4832



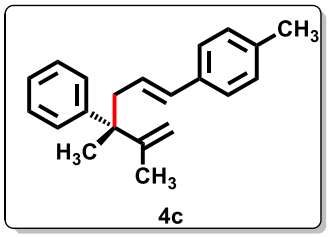
4b



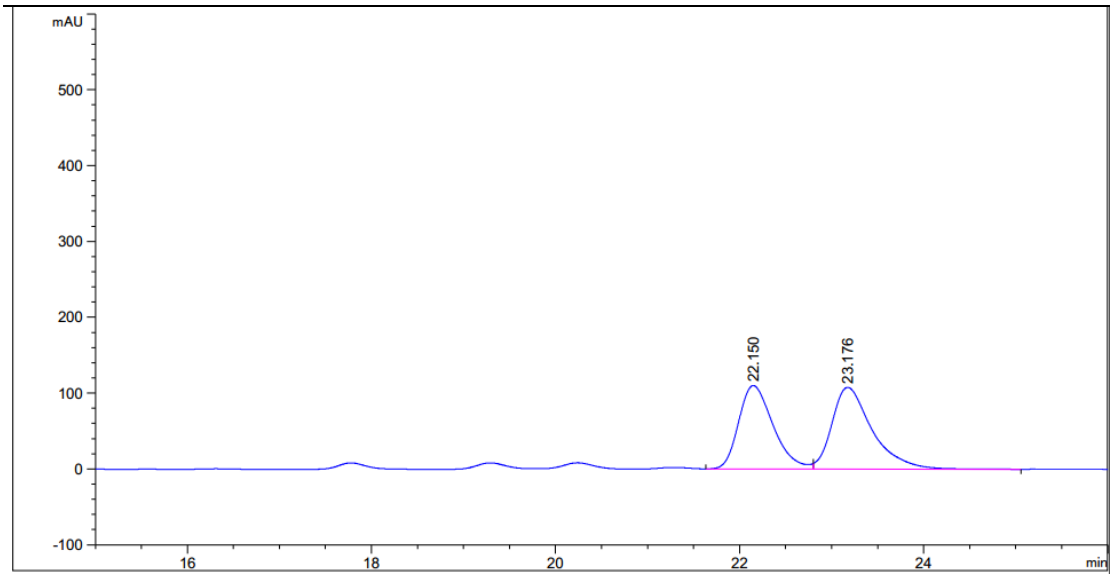
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.194	0.2803	2716.46216	147.91949	48.5731
2	15.873	0.3395	2876.06567	141.01596	51.4269



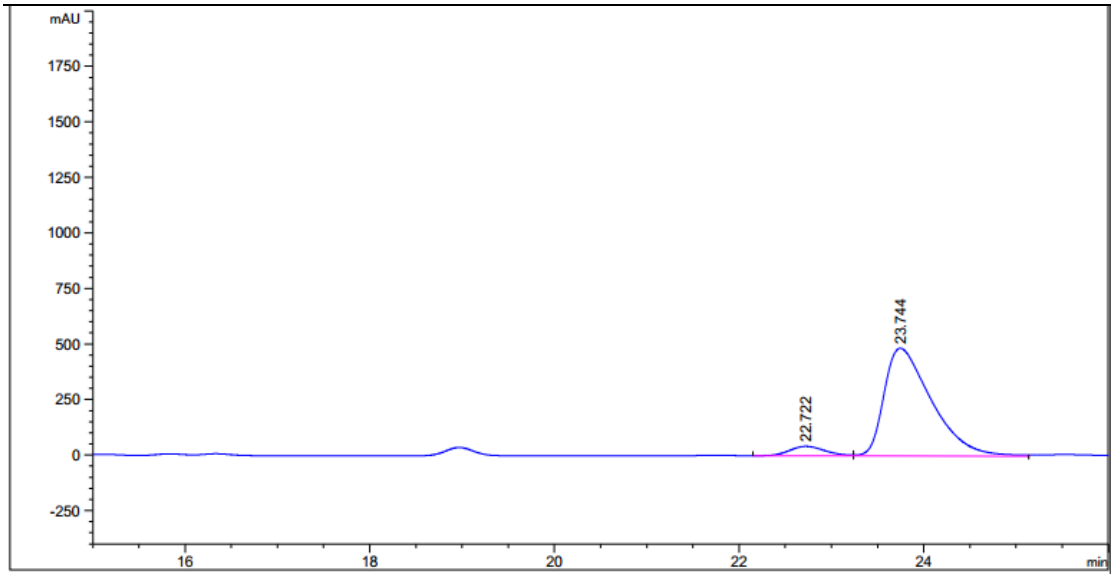
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.593	0.2984	102.99178	5.75167	4.5115
2	15.225	0.3111	2179.85962	116.77763	95.4885



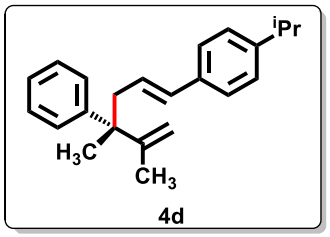
4c



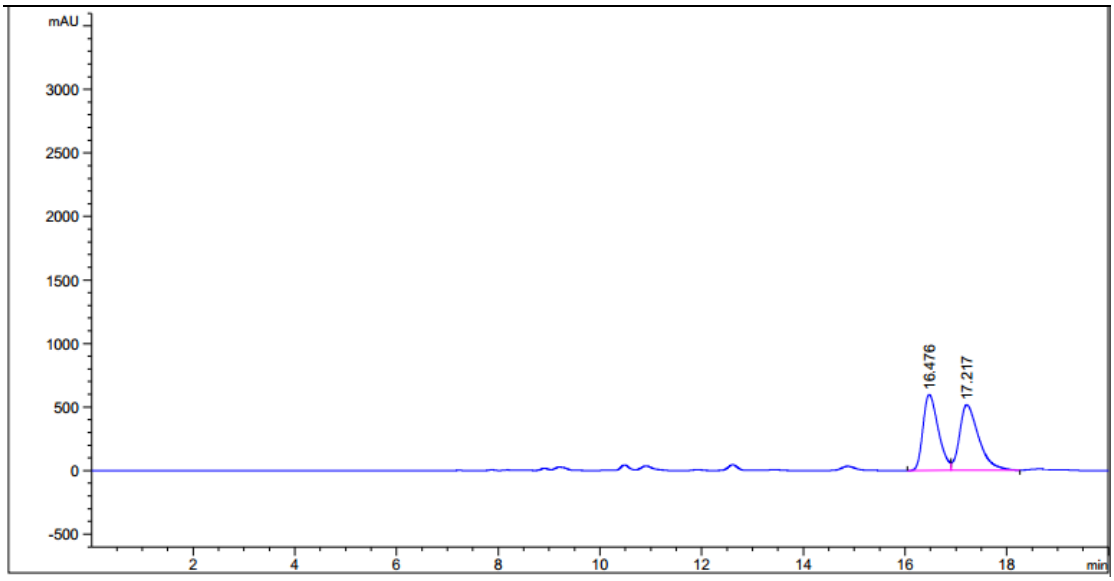
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.150	0.4355	2884.14697	110.32850	46.8122
2	23.176	0.5051	3276.95410	107.97476	53.1878



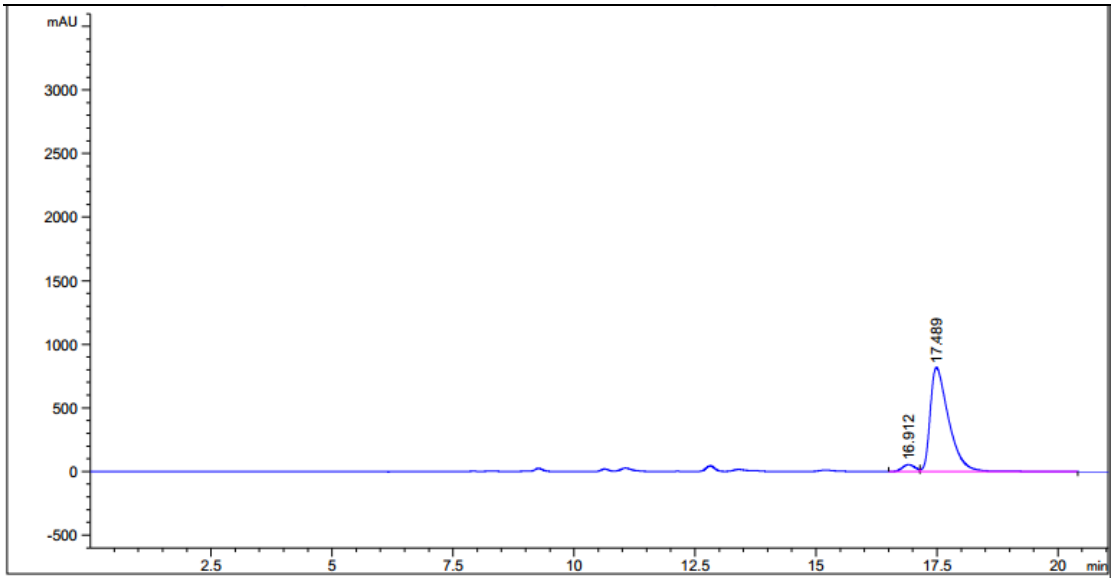
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.722	0.4449	1150.42603	42.73675	6.2408
2	23.744	0.5930	$1.72836e^4$	484.93158	93.7592



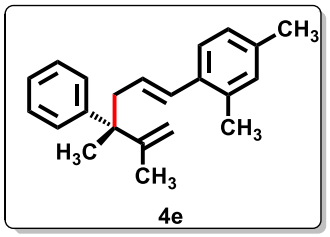
4d



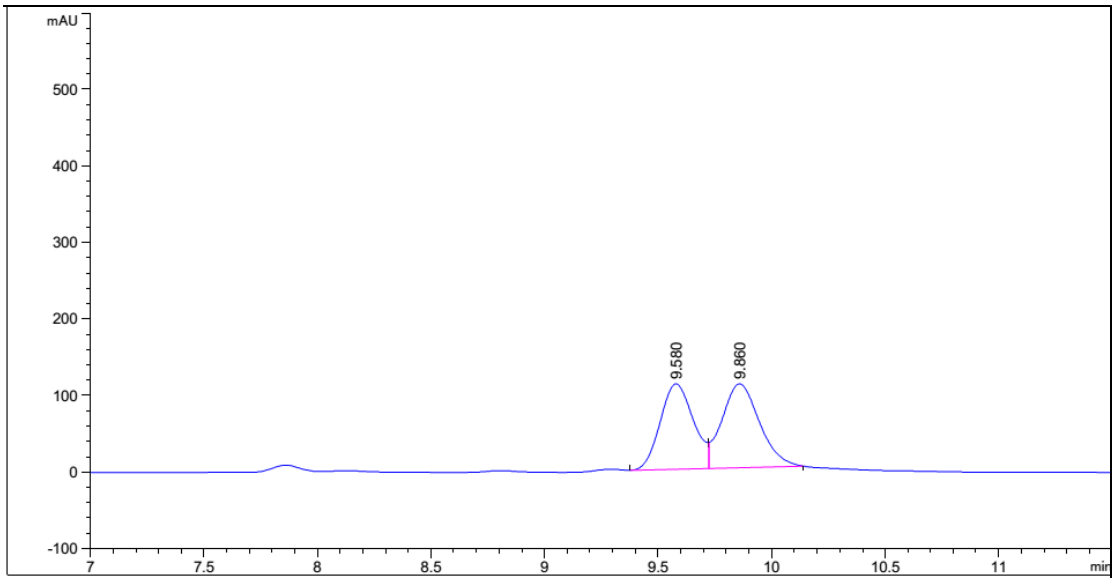
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.476	0.3226	1.25425e4	598.13715	48.2445
2	17.217	0.3929	1.34553e4	516.50696	51.7555



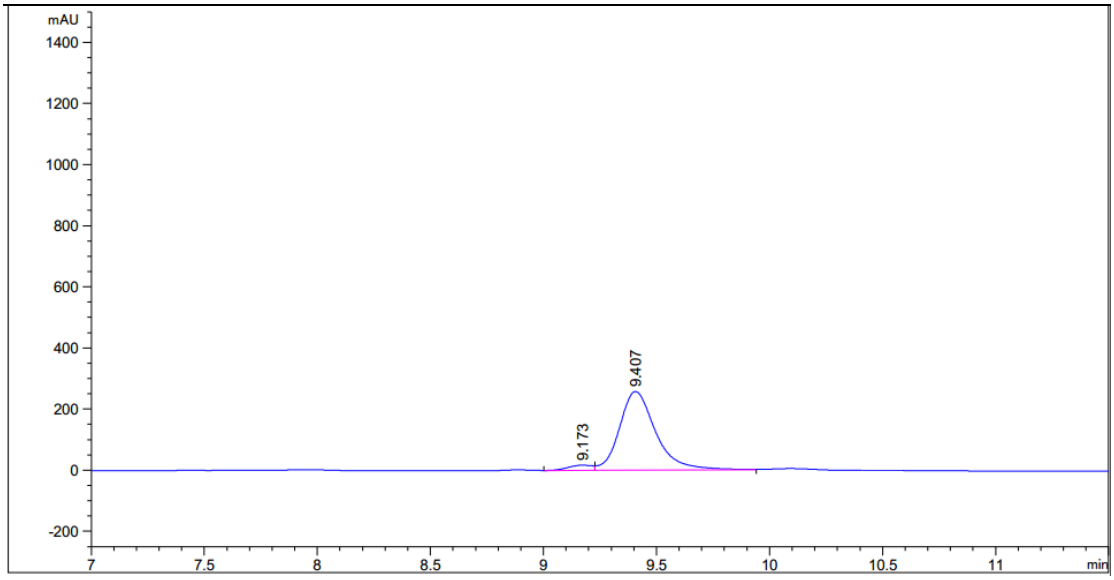
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.912	0.3047	1007.54034	54.71403	4.4175
2	17.489	0.4433	$2.18006e^{4}$	818.92853	95.5825



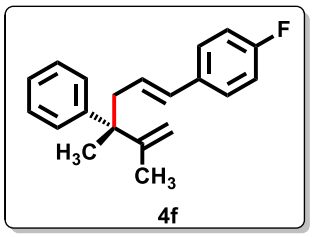
4e



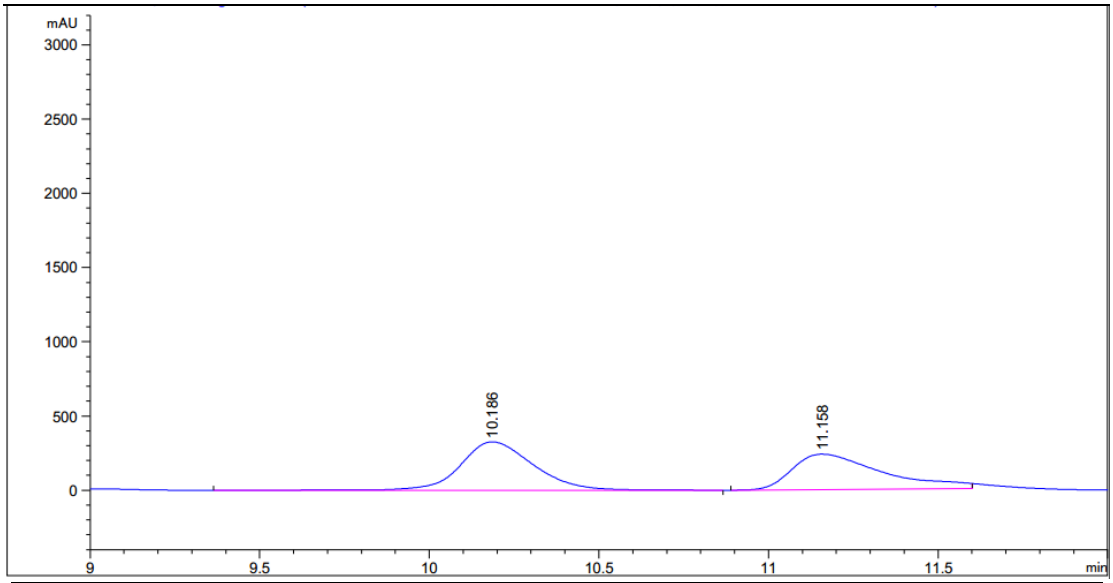
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.580	0.1701	1136.38354	111.37443	47.4153
2	9.860	0.1915	1260.27478	109.67850	52.5847



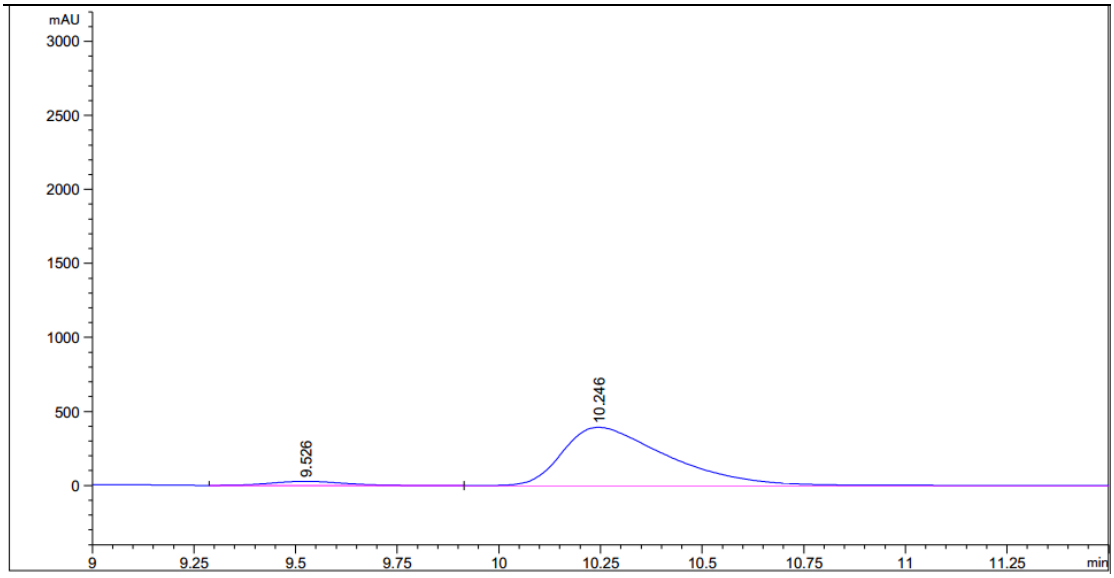
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.173	0.1270	130.43488	17.11140	4.3584
2	9.407	0.1852	2862.29956	257.17929	95.6416



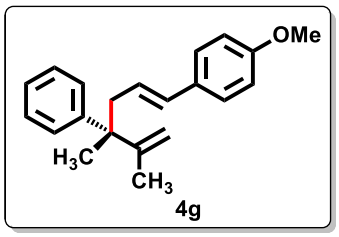
4f



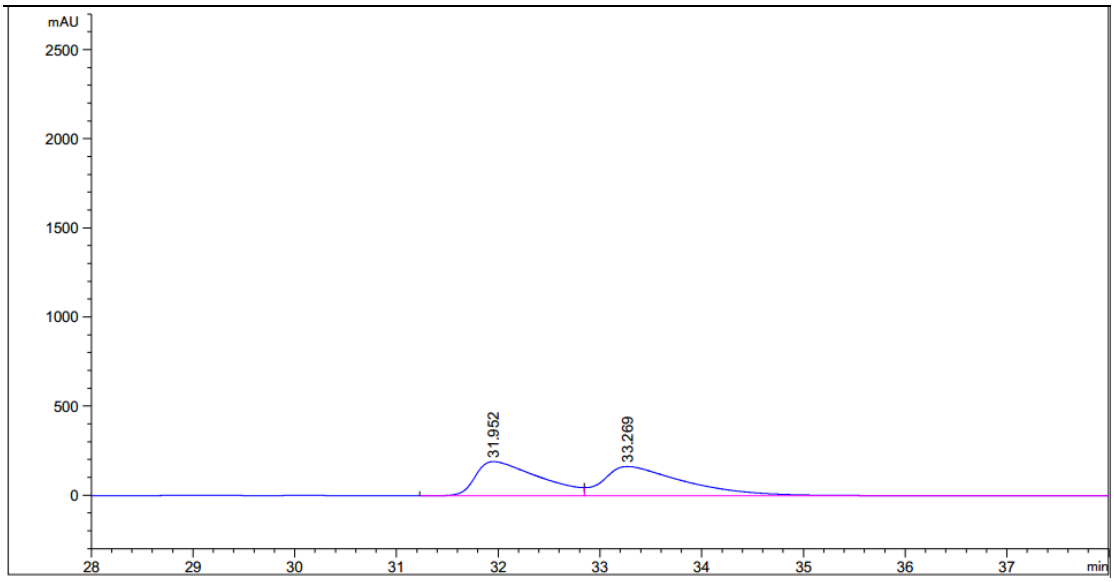
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.186	0.2288	4913.85205	326.18320	52.9267
2	11.158	0.3061	4370.41113	237.98885	47.0733



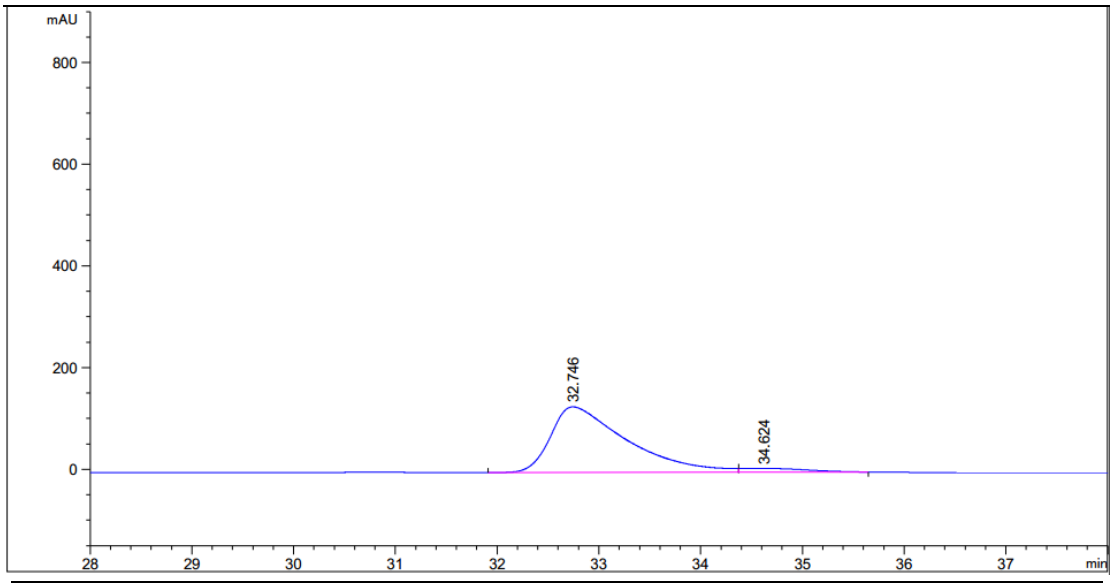
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.526	0.2009	369.67935	28.57846	4.9678
2	10.246	0.2688	7071.86377	393.28238	95.0322



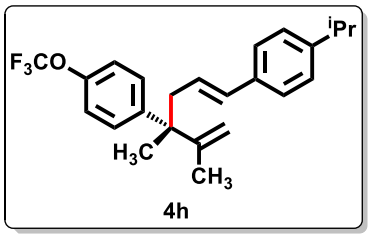
4g



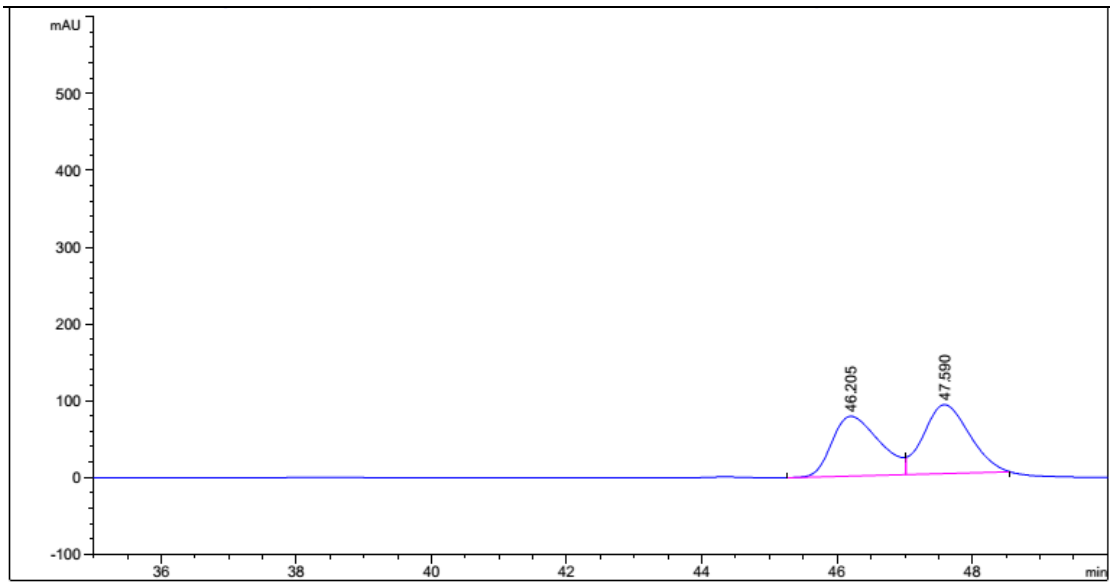
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	**31.952**	**0.6353**	**8297.36523**	**191.58676**	**47.6756**
2	**33.269**	**0.7970**	**9106.44922**	**164.45020**	**52.3244**



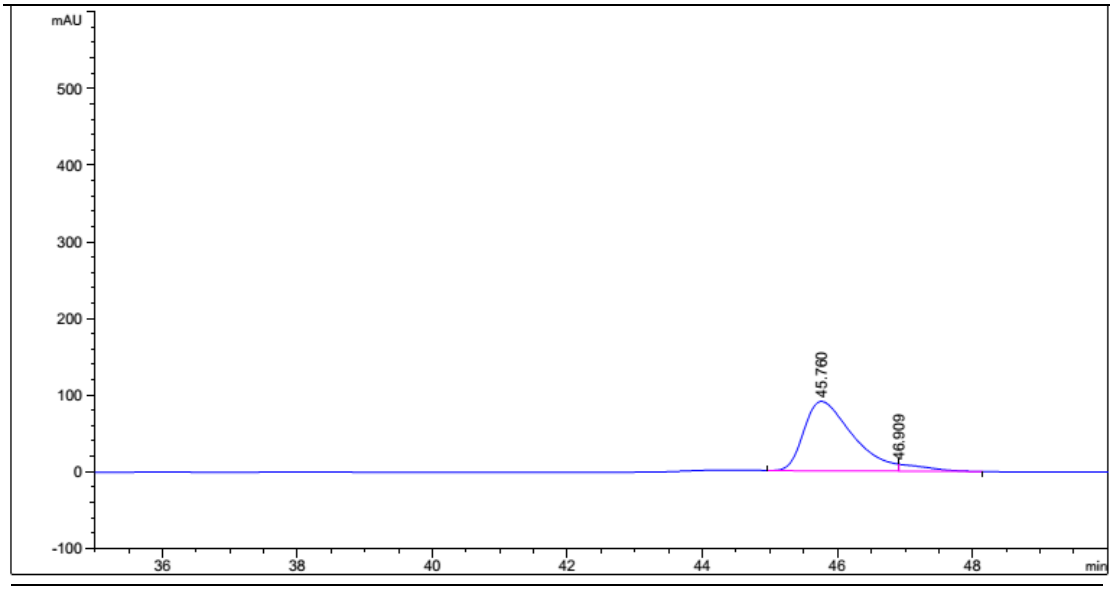
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	**32.746**	0.8638	6686.59570	129.01019	95.3188
2	**34.624**	0.7397	328.38428	7.39879	4.6812



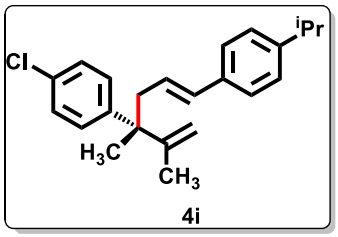
4h



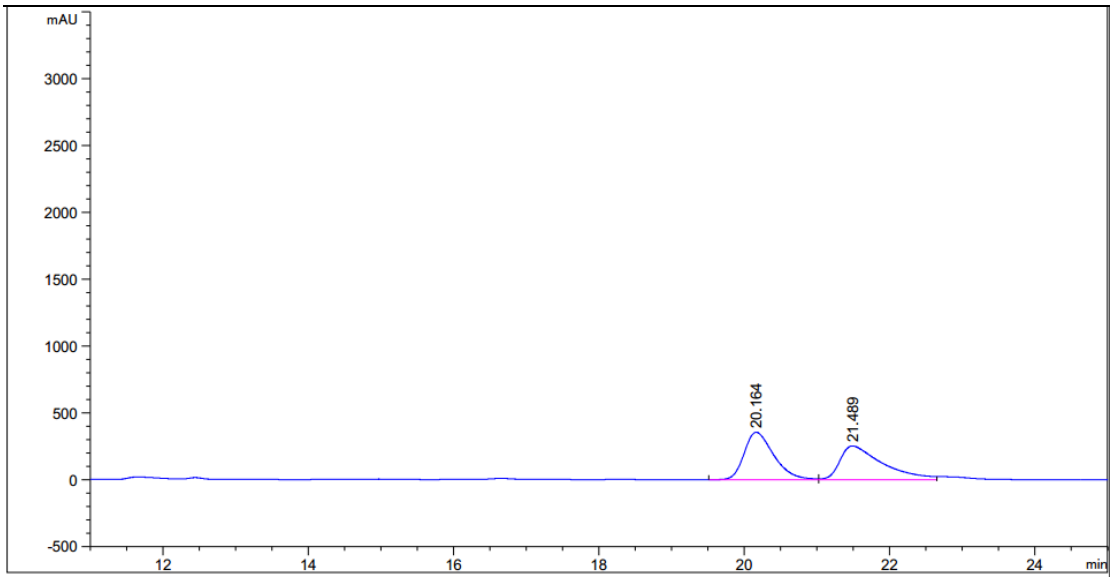
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	46.205	0.8161	3815.18262	77.83292	47.1953
2	47.590	0.7906	4268.63574	89.79787	52.8047



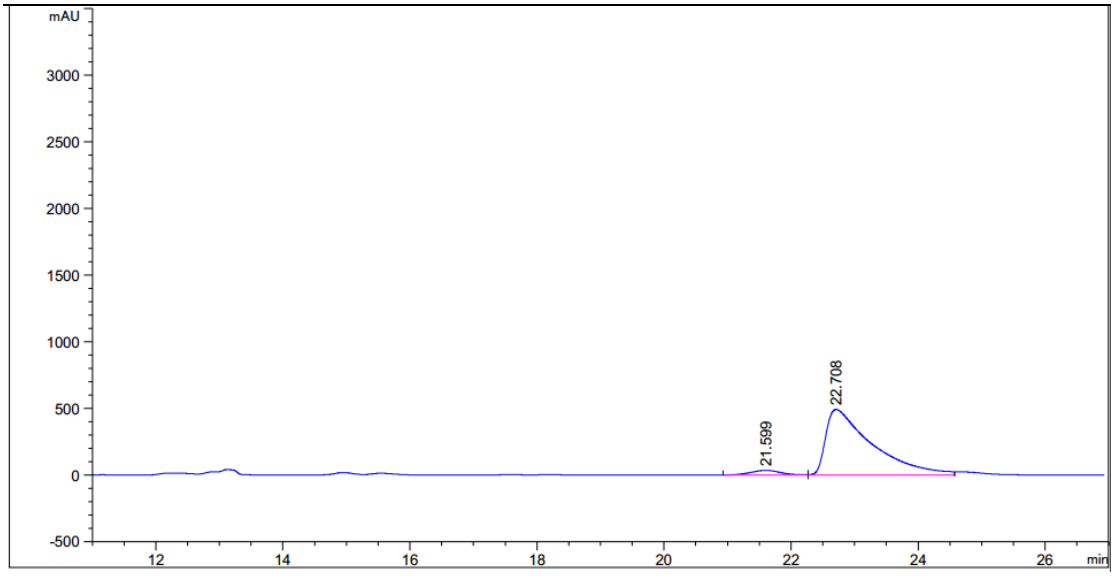
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	45.760	0.8318	4524.51367	90.58230	94.8985
2	46.909	0.4474	243.22765	9.06024	5.1015



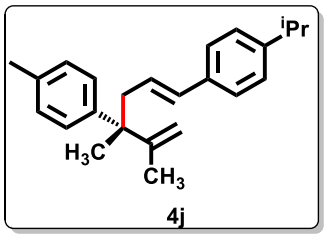
4i



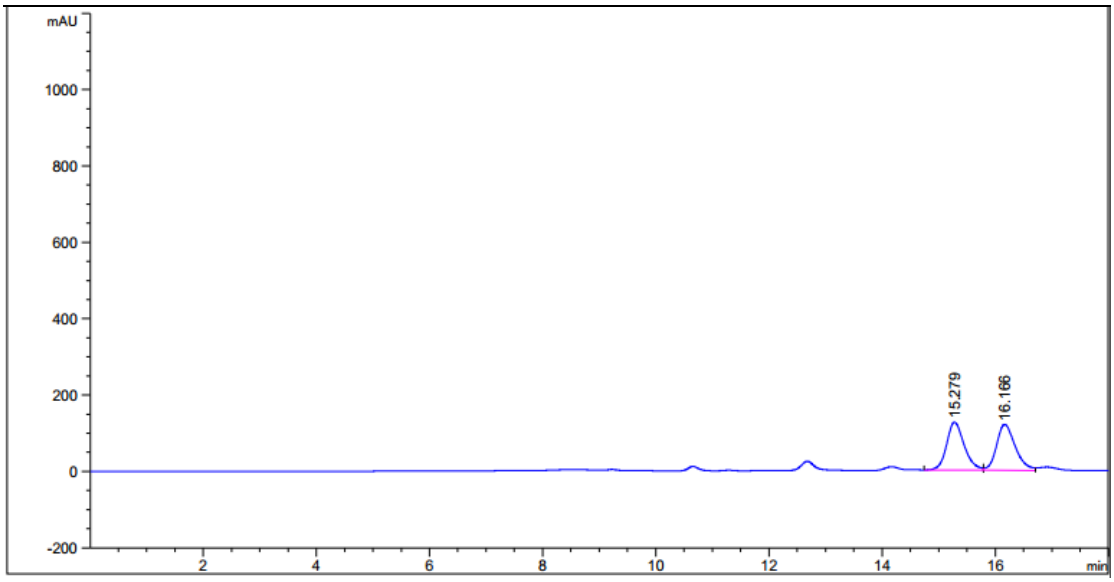
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.164	0.4295	9996.97949	353.93567	49.3547
2	21.489	0.6784	$1.02584e^4$	251.77444	50.6453



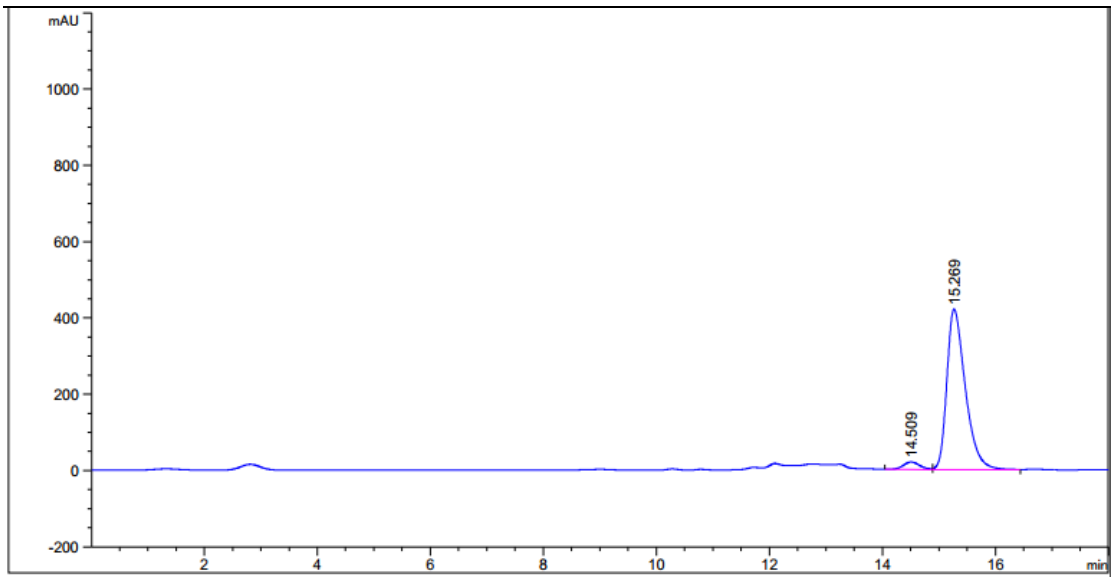
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.599	0.5378	1130.94580	35.04936	4.3566
2	22.708	0.8403	$2.48287e^4$	492.13495	95.6434



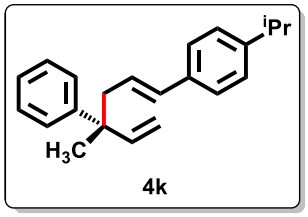
4j



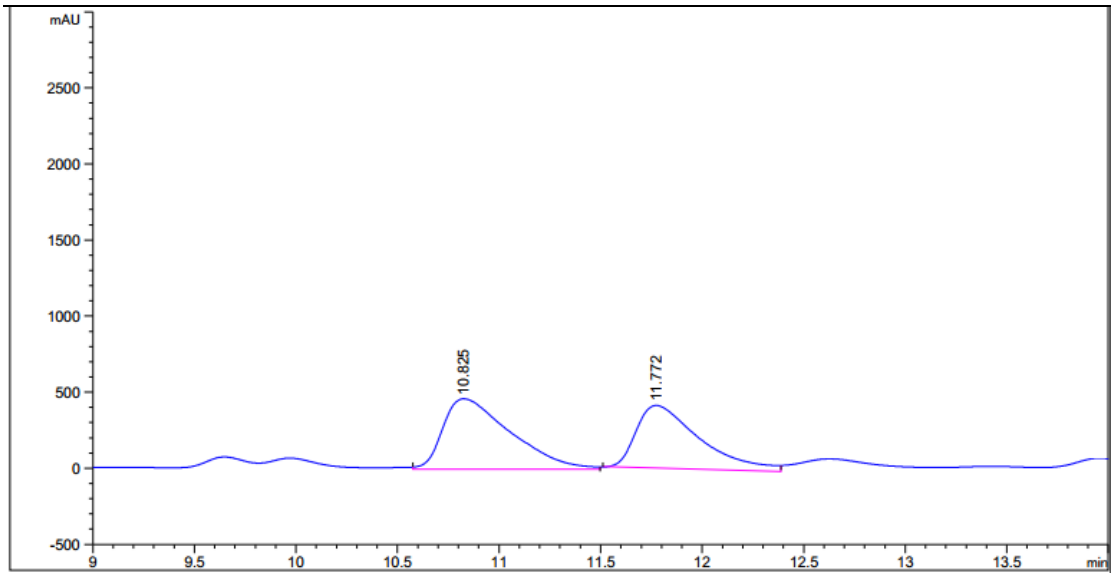
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.279	0.3267	2705.96973	125.40205	49.5810
2	16.166	0.3811	2751.70728	120.09173	50.4190



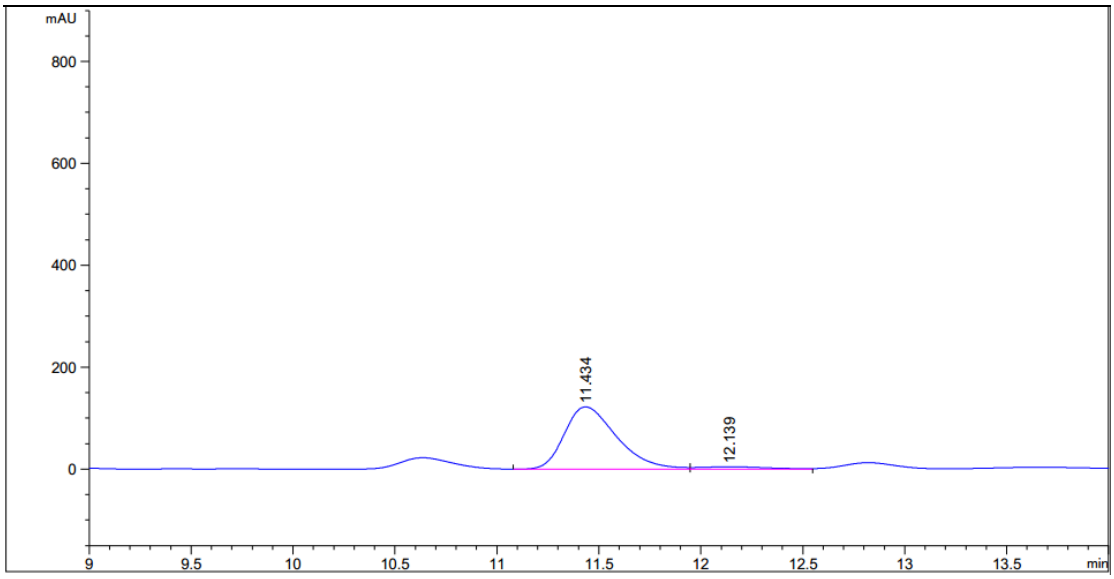
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.509	0.3305	393.37875	19.55937	3.9673
2	15.269	0.3772	9522.09766	420.32910	96.0327



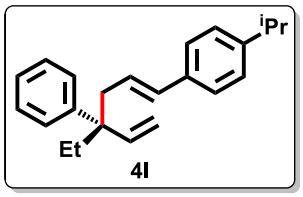
4k

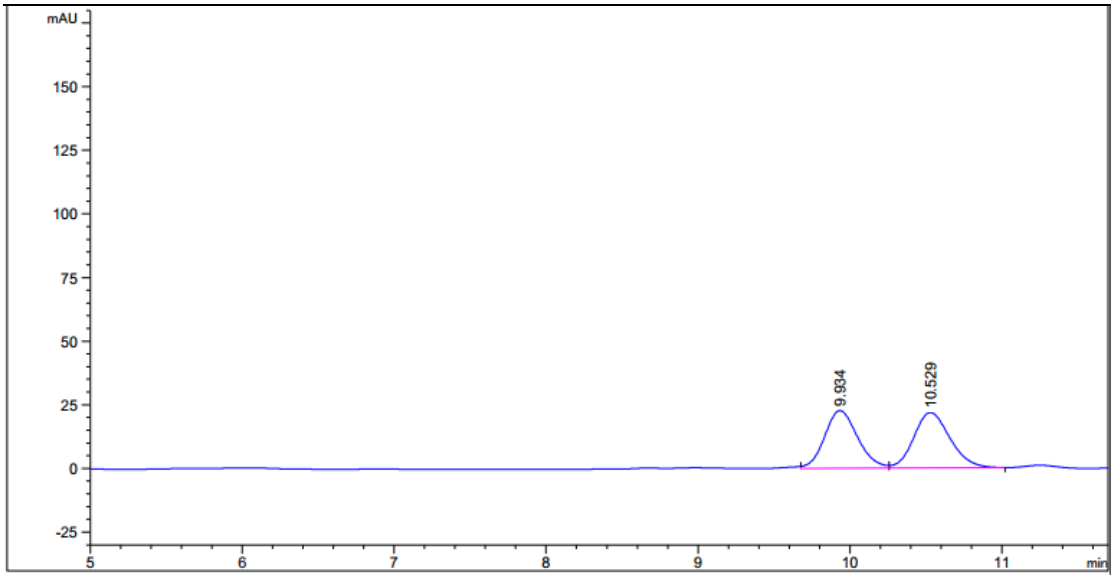


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.825	0.3813	$1.06420e^4$	462.30759	54.3857
2	11.772	0.3560	8925.61719	411.85898	45.6143

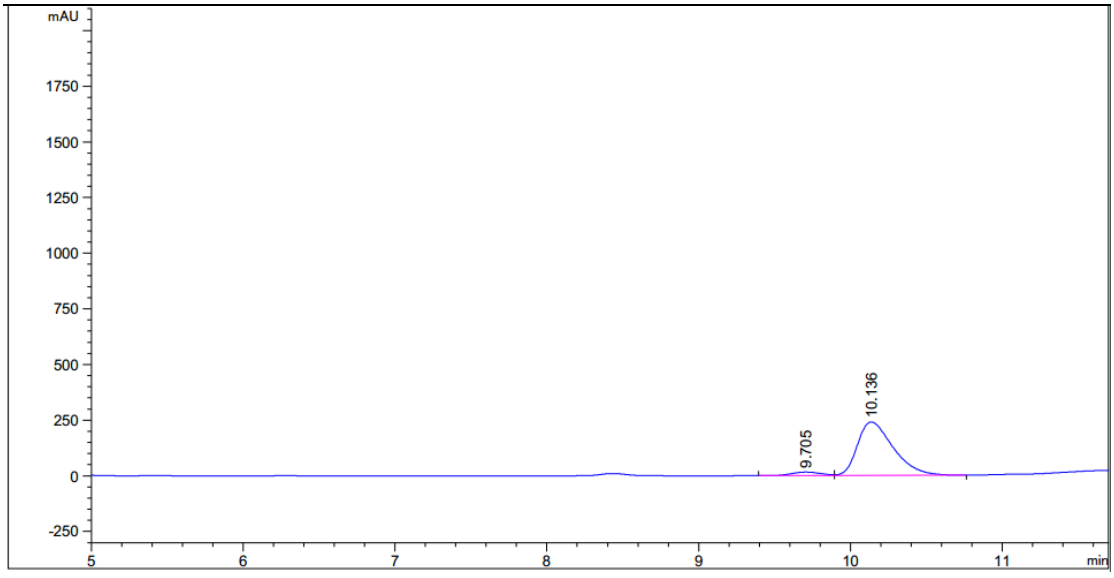


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.434	0.2972	2180.66138	122.28105	95.4757
2	12.139	0.3697	103.33508	4.65877	4.5243

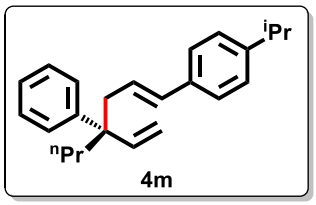




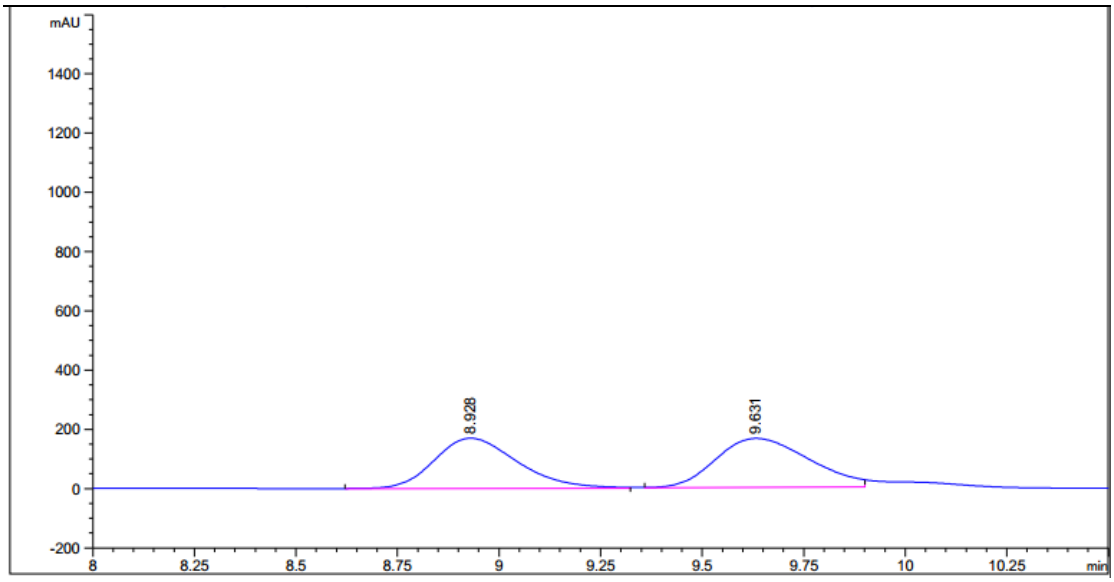
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.934	0.2512	342.01526	22.69213	48.6985
2	10.529	0.2550	360.29626	21.78042	51.3015



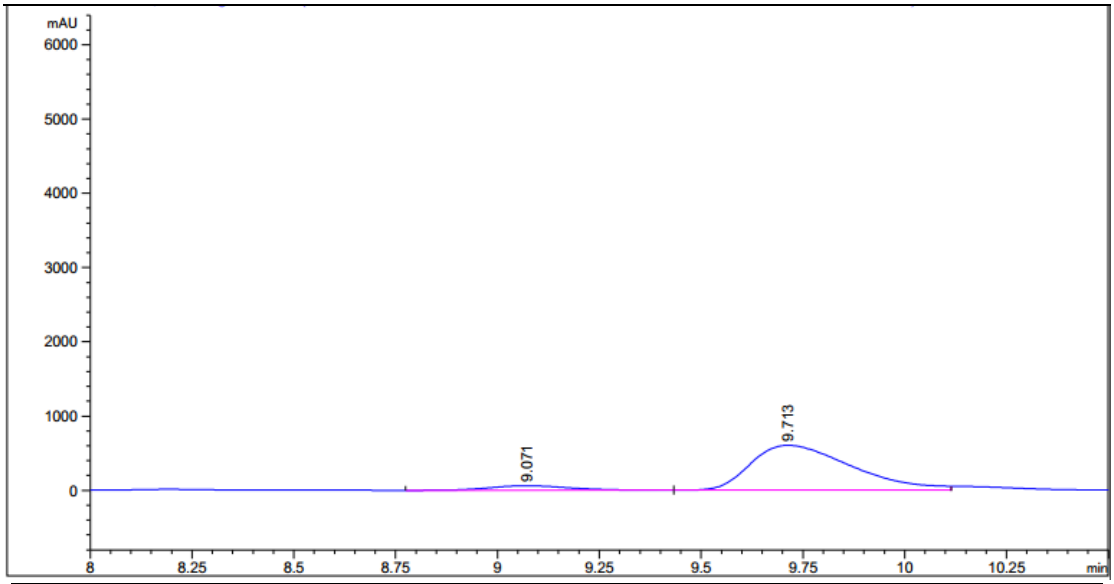
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.705	0.2237	216.42914	16.12771	5.2019
2	10.136	0.2730	3944.17310	240.76036	94.7981



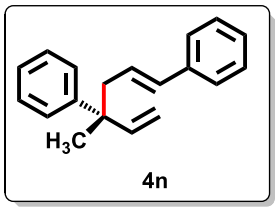
4m



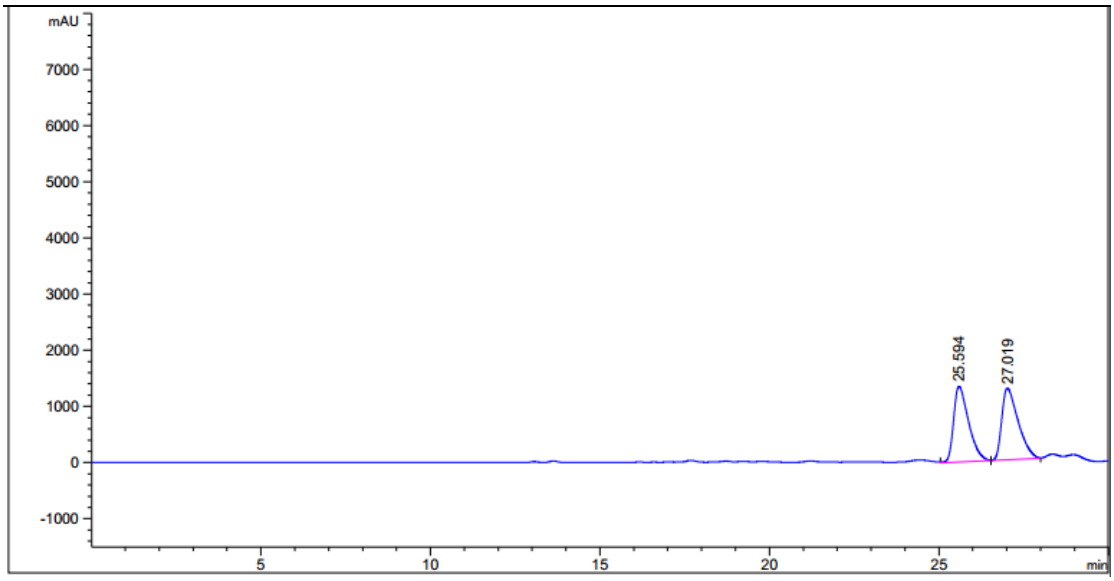
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.928	0.2395	2447.28467	170.28084	48.1105
2	9.631	0.2659	2639.51538	165.24644	51.8895



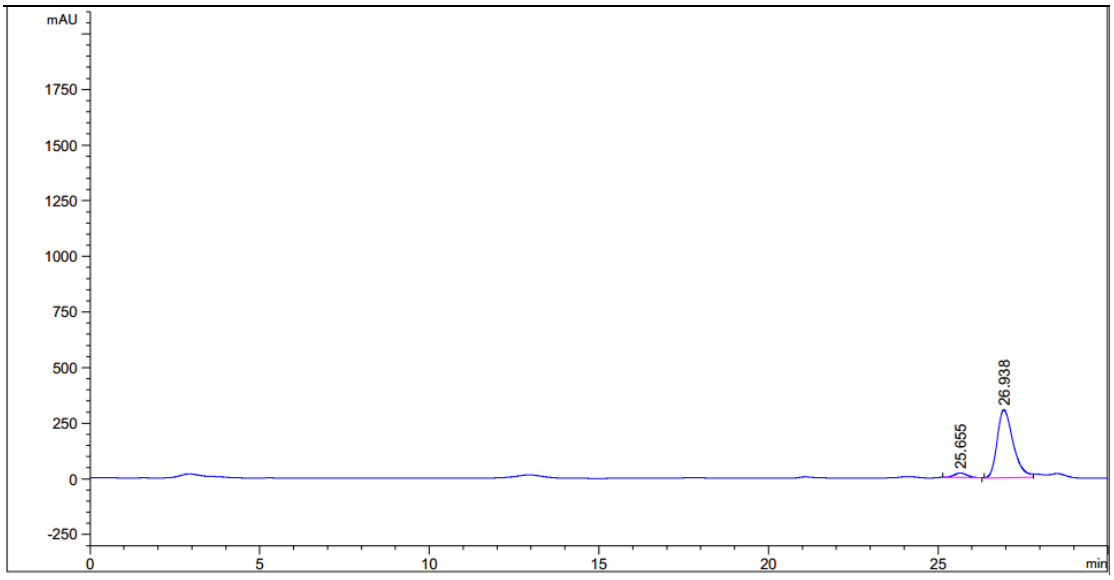
Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.071	0.2132	841.97571	60.92037	7.4570
2	9.713	0.2878	1.04492e4	604.87158	92.5430



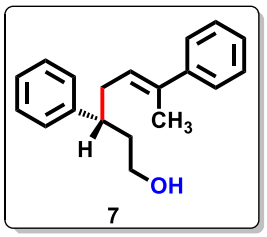
4n



Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	25.594	0.5082	$4.10507e^4$	1344.86572	49.1222
2	27.019	0.5570	$4.25178e^4$	1272.07520	50.8778



Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	25.655	0.4462	534.47650	19.96199	5.0862
2	26.938	0.5438	9973.89648	305.55920	94.9138



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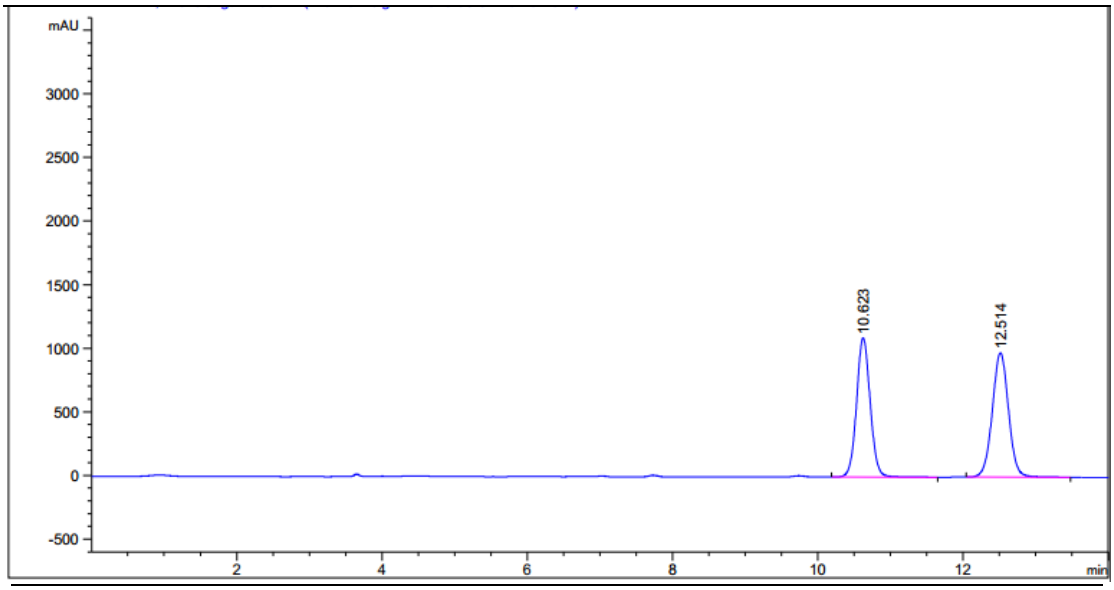
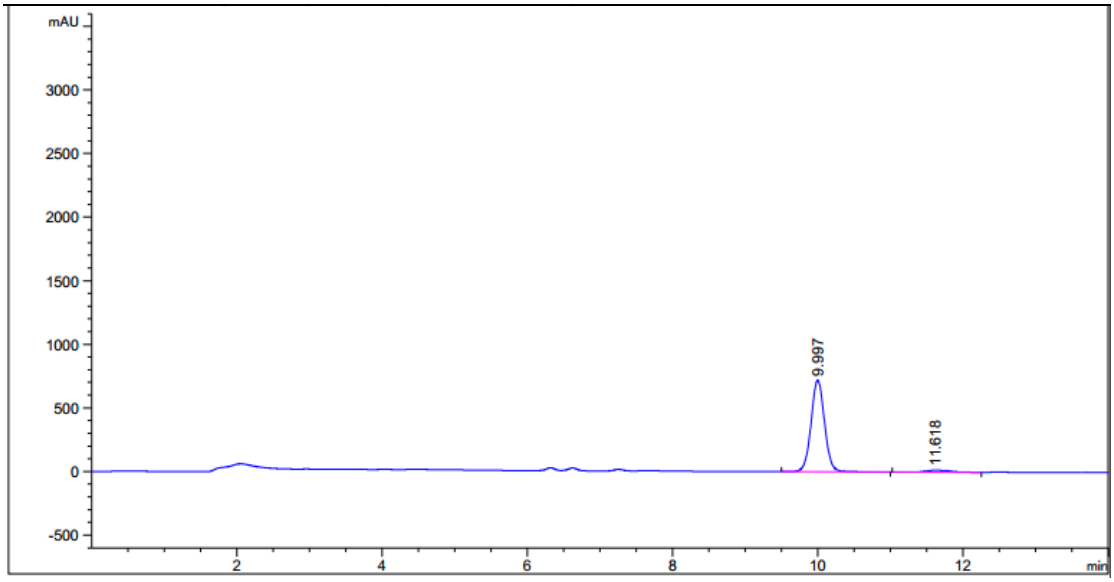


Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.623	0.2172	1.43608e4	1096.68591	48.6896
2	12.514	0.2581	1.51338e4	977.01282	51.3104



Peak #	Ret. Time [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.997	0.1989	9329.68457	721.53705	96.3689
2	11.618	0.3786	351.53030	14.98834	3.6311