**Electronic Supplementary Information**

**Csp\(^3\)–H bond functionalization of amines via tunable iminium ions: divergent synthesis of trifluoromethylated arylamines**

Lou Shi, Mingshan Wang, Ling Pan,* Yifei Li and Qun Liu*

Department of Chemistry, Jilin Province Key Laboratory of Organic Functional Molecular Design & Synthesis, Northeast Normal University, Changchun 130024, China.

E-mail: panl948@nenu.edu.cn; liuqun@nenu.edu.cn

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I. General Information
All reagents were purchased from commercial sources and used without further purification. All products were monitored by TLC and purified by flash column chromatography on silica gel (300–400 mesh). Melting points were uncorrected. NMR spectra were obtained on a Bruker AVANCE 600 MHz spectrometer (600 MHz for $^1$H NMR; 150 MHz for $^{13}$C NMR; 565 MHz for $^{19}$F NMR). $^1$H NMR and $^{13}$C NMR were determined with TMS as the internal standard. $^{19}$F NMR was determined with C$_6$H$_5$F as external reference. All chemical shifts are given in ppm. High-resolution mass spectra (HRMS) were obtained using a Bruker microTOF II focus spectrometer (ESI).

II. Experimental procedure and characterization data

4a: 2-(phenylethynyl)-1-(4-(trifluoromethyl)phenyl)pyrrolidine
To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (125 mg, 0.50 mmol), phenylacetylene (138 µL, 1.25 mmol), copper(II) bromide (16.8 mg, 0.075 mmol), 4-methoxyphenol (74.4 mg, 0.6 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (42 µL, 0.5 mmol) and reacted at 180 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOAc = 60 : 1) to afford 4a (97 mg, 61%).
Brown liquid. $^1$H NMR (600 MHz, CDCl$_3$): δ 7.47 (d, $J$ = 8.4 Hz, 2H), 7.37 – 7.32 (m, 2H), 7.29 – 7.23 (m, 3H), 6.76 (d, $J$ = 8.4 Hz, 2H), 4.63 – 4.54 (m, 1H), 3.53 – 3.44 (m, 1H), 3.37 – 3.26 (m, 1H), 2.34 – 2.21 (m, 3H), 2.14 – 2.06 (m, 1H). $^{13}$C NMR (150 MHz, CDCl$_3$): δ 148.7, 131.7, 128.2(2), 126.3 (q, $J$ = 3.9 Hz), 125.5 (q, $J$ = 268.5 Hz), 122.8, 117.8 (q, $J$ = 32.4 Hz), 116.0, 88.7, 83.1, 50.1, 47.7, 33.8, 24.2. $^{19}$F NMR (565 MHz, CDCl$_3$) δ -60.7. IR (KBr, cm$^{-1}$): 3057, 2951, 2872, 2647, 2227, 1885, 1706, 1615, 1531, 1489, 1325, 1108. HRMS (ESI-TOF) Calcd for C$_{19}$H$_{17}$F$_3$N (M+H)$^+$: 316.1314. Found 316.1308.

4b: 2-(p-tolylethynyl)-1-(4-(trifluoromethyl)phenyl)pyrrolidine
To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (125 mg, 0.50 mmol), 4-ethynyltoluene (145.2 mg, 1.25 mmol), copper(II) bromide (16.8 mg, 0.075 mmol), 4-methoxyphenol (74.4 mg, 0.6 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (42 µL, 0.5 mmol) and reacted at 180 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOAc = 60 : 1) to afford 4b (105 mg, 64%).

Brown liquid. 

1H NMR (600 MHz, CDCl3): δ 7.46 (d, J = 8.4 Hz, 2H), 7.24 (d, J = 7.8 Hz, 2H), 7.05 (d, J = 7.8 Hz, 2H), 6.75 (d, J = 8.4 Hz, 2H), 4.57 – 4.53 (m, 1H), 3.53 – 3.44 (m, 1H), 3.36 – 3.23 (m, 1H), 2.30 (s, 3H), 2.30 – 2.22 (m, 3H), 2.17 – 2.03 (m, 1H). 13C NMR (150 MHz, CDCl3): δ 148.7, 138.3, 131.6, 128.9, 126.3 (q, J = 3.8 Hz), 125.2 (q, J = 268.2 Hz), 119.7, 117.7 (q, J = 32.4 Hz), 111.9, 87.9, 83.2, 50.2, 47.7, 33.9, 24.2, 21.4. 19F NMR (565 MHz, CDCl3) δ -60.7. IR (KBr, cm⁻¹): 3028, 2975, 2870, 2646, 2225, 1887, 1614, 1531, 1383. HRMS (ESI-TOF) Caled for C20H16F3N (M+H)⁺ 330.1464. Found 330.1466.

4c: 2-((4-chlorophenyl)ethyl)-1-(4-(trifluoromethyl)phenyl)pyrrolidine

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (125 mg, 0.50 mmol), 4-chlorophenylacetylene (145.2 mg, 1.25 mmol), copper(II) bromide (16.8 mg, 0.075 mmol), 4-methoxyphenol (74.4 mg, 0.6 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (42 µL, 0.5 mmol) and reacted at 180 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOAc = 60 : 1) to afford 4c (93 mg, 53%).

Brown liquid. 

1H NMR (600 MHz, CDCl3): δ 7.47 (d, J = 8.4 Hz, 2H), 7.27 (d, J = 8.4 Hz, 2H), 7.23 (d, J = 8.4 Hz, 2H), 6.74 (d, J = 8.4 Hz, 2H), 4.62 – 4.53 (m, 1H), 3.54 – 3.45 (m, 1H), 3.40 – 3.27 (m, 1H), 2.28 (t, J = 3.6 Hz, 3H), 2.17 – 2.08 (m, 1H). 13C NMR (150 MHz, CDCl3): δ 148.6, 134.2, 132.9, 128.5, 126.3 (q, J = 3.6 Hz), 125.2 (q, J = 268.5 Hz), 121.3, 118.0 (q, J = 32.3 Hz), 111.9, 89.7, 82.0, 50.1, 47.7, 33.8, 24.2. 19F NMR (565 MHz, CDCl3) δ -60.8. IR (KBr, cm⁻¹): 3056, 2976, 2854, 2647, 2227, 1889, 1704, 1615, 1530, 1488. HRMS (ESI-TOF) Caled for C19H16ClF3N (M+H)⁺ 350.0918. Found 350.0909.
4d: 1-(4-(trifluoromethyl)phenyl)-2-((4-(trifluoromethyl)phenyl)ethynyl)pyrrolidine

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (125 mg, 0.50 mmol), 4-(trifluoromethyl)phenylacetylene (213 mg, 1.25 mmol), copper(II) bromide (16.8 mg, 0.075 mmol), 4-methoxyphenol (74.4 mg, 0.6 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (42 µL, 0.5 mmol) and reacted at 180 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOAc = 60 : 1) to afford 4d (105 mg, 55%).

Colorless liquid. $^1$H NMR (600 MHz, CDCl$_3$) $\delta$ 7.51 (d, $J$ = 8.4 Hz, 2H), 7.48 (d, $J$ = 8.4 Hz, 2H), 7.44 (d, $J$ = 8.4 Hz, 2H), 6.75 (d, $J$ = 8.4 Hz, 2H), 4.59 (d, $J$ = 6.0 Hz, 1H), 3.50 (m, 1H), 3.34 (m, 1H), 2.40 – 2.22 (m, 3H), 2.22 – 2.04 (m, 1H). $^{13}$C NMR (151 MHz, CDCl$_3$) $\delta$ 148.6, 132.0, 130.0 (q, $J$ = 32.6 Hz), 126.6, 126.4 (q, $J$ = 3.6 Hz), 125.2 (q, $J$ = 270.2 Hz), 125.1 (q, $J$ = 3.8 Hz), 123.9 (q, $J$ = 272.1 Hz), 118.1 (q, $J$ = 32.6 Hz), 111.9, 91.4, 81.8, 50.1, 47.7, 33.7, 24.2. $^{19}$F NMR (565 MHz, CDCl$_3$) $\delta$ -60.8(2). IR (KBr, cm$^{-1}$): 3057, 2980, 2875, 1706, 1615, 1506, 1489, 1287, 1203. HRMS (ESI-TOF) Calcd for C$_{20}$H$_{16}$F$_6$N (M+H)$^+$ 384.1181. Found 384.1190.

4e: 2-((4-fluorophenyl)ethynyl)-1-(4-(trifluoromethyl)phenyl)pyrrolidine

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (125 mg, 0.50 mmol), 4-fluorophenacetylene (150 mg, 1.25 mmol), copper(II) bromide (16.8 mg, 0.075 mmol), 4-methoxyphenol (74.4 mg, 0.6 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (42 µL, 0.5 mmol) and reacted at 180 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOAc = 60 : 1) to afford 4e (83 mg, 50%).

Colorless liquid. $^1$H NMR (600 MHz, CDCl$_3$) $\delta$ 7.48 (d, $J$ = 8.4 Hz, 2H), 7.39 – 7.29 (m, 2H), 6.96 (t, $J$ = 8.4 Hz, 2H), 6.76 (d, $J$ = 8.4 Hz, 2H), 4.57 (d, $J$ = 6.0 Hz, 1H), 2.56 – 2.45 (m, 1H), 3.40 – 3.28 (m, 1H), 2.36 – 2.23 (m, 3H), 2.18 – 2.06 (m, 1H). $^{13}$C NMR (151 MHz, CDCl$_3$) $\delta$ 163.2 (d, $J$ = 249.5 Hz), 148.6, 133.6 (d, $J$ = 8.3 Hz), 126.3 (d, $J$ = 3.8 Hz), 125.2 (d, $J$ = 270.0 Hz), 118.8 (d, $J$ = 3.5 Hz), 118.0 (q, $J$ = 32.6 Hz), 115.5, 115.4, 111.9, 88.4, 82.0, 50.1, 47.7, 33.8, 24.2. $^{19}$F NMR (565 MHz, CDCl$_3$) $\delta$ -60.8, -111.1. IR (KBr, cm$^{-1}$): 2927, 1709, 1615, 1530, 1506, 1325, 1109. HRMS (ESI-TOF) Calcd for C$_{18}$H$_{16}$F$_6$N (M+H)$^+$ 334.1213. Found 334.1223.
4f: 2-((4-bromophenyl)ethynyl)-1-(4-(trifluoromethyl)phenyl)pyrrolidine

To the solution of 4-(trifluoromethyl)-4-(((trimethylsilyl)oxy)cyclohexa-2,5-dieneone (125 mg, 0.50 mmol), 4-bromophenylacetylene (226 mg, 1.25 mmol), copper(II) bromide (16.8 mg, 0.075 mmol), 4-methoxyphenol (74.4 mg, 0.6 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (42 µL, 0.5 mmol) and reacted at 180 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOAc = 50 : 1) to afford 4f (106 mg, 54%).

Colorless liquid. ¹H NMR (600 MHz, CDCl₃) δ 7.48 (d, J = 8.4 Hz, 2H), 7.39 (d, J = 8.4 Hz, 2H), 7.21 (d, J = 8.4 Hz, 2H), 6.74 (d, J = 8.4 Hz, 2H), 4.57 (d, J = 6.0 Hz, 1H), 3.50 (t, J = 8.4 Hz, 1H), 3.34 (dd, J = 15.4, 8.0 Hz, 1H), 2.33 – 2.24 (m, 3H), 2.19 – 2.05 (m, 1H). ¹³C NMR (151 MHz, CDCl₃) δ 148.6, 133.1, 131.5, 126.3 (q, J = 3.6 Hz), 125.2 (q, J = 270.3 Hz), 122.4, 121.7, 118.0 (q, J = 32.6 Hz), 111.9, 89.9, 82.1, 50.1, 47.7, 33.8, 24.2. ¹⁹F NMR (565 MHz, CDCl₃) δ -60.8. IR (KBr, cm⁻¹): 3055, 2950, 2872, 1889, 1707, 1614, 1530, 1486, 1325, 1110. HRMS (ESI-TOF) Calcd for C₁₉H₁₆BrF₃N (M+H)⁺ 394.0413. Found 394.0422.

4g: 2-([1,1′-biphenyl]-4-ylethynyl)-1-(4-(trifluoromethyl)phenyl)pyrrolidine

To the solution of 4-(trifluoromethyl)-4-(((trimethylsilyl)oxy)cyclohexa-2,5-dieneone (125 mg, 0.50 mmol), 4-ethynyl-1,1′-biphenyl (222 mg, 1.25 mmol), copper(II) bromide (16.8 mg, 0.075 mmol), 4-methoxyphenol (74.4 mg, 0.6 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (42 µL, 0.5 mmol) and reacted at 180 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOAc = 50 : 1) to afford 4f (84 mg, 43%).

Light yellow solid; mp: 128-129 °C; ¹H NMR (600 MHz, CDCl₃) δ 7.56 (d, J = 7.8 Hz, 2H), 7.53 – 7.46 (m, 4H), 7.46 – 7.40 (m, 4H), 7.34 (t, J = 7.2 Hz, 1H), 6.78 (d, J = 8.4 Hz, 2H), 4.62 (d, J = 6.0 Hz, 1H), 3.53 (t, J = 6.0 Hz, 1H), 3.43 – 3.30 (m, 1H), 2.39 – 2.25 (m, 3H), 2.21 – 2.08 (m, 1H). ¹³C NMR (151 MHz, CDCl₃) δ 148.7, 140.9, 140.3, 152.1, 128.8, 127.6, 127.0, 126.9, 126.3 (q, J = 3.8 Hz), 121.7, 111.9, 89.4, 83.0, 50.2, 47.7, 33.9, 24.2. ¹⁹F NMR (565 MHz, CDCl₃) δ -60.8. IR (KBr, cm⁻¹): 2921, 2852, 1614, 1532, 1322, 1098. HRMS (ESI-TOF) Calcd for
C_{25}H_{32}F_{3}N (M+H)^+ 392.1621. Found 392.1618.

4h: 2-(thiophen-3-ylethynyl)-1-(4-(trifluoromethyl)phenyl)pyrrolidine

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dieneone (125 mg, 0.50 mmol), 3-ethynylthiophene (135 mg, 1.25 mmol), copper(II) bromide (16.8 mg, 0.075 mmol), 4-methoxyphenol (74.4 mg, 0.6 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (42 µL, 0.5 mmol) and reacted at 180 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel use pure petroleum ether to afford 4i (87 mg, 54%).

Colorless liquid. ^1H NMR (600 MHz, CDCl₃) δ 7.47 (d, J = 8.4 Hz, 2H), 7.34 (d, J = 2.4 Hz, 1H), 7.19 (dd, J = 4.8, 3.0 Hz, 1H), 7.02 (d, J = 4.8 Hz, 1H), 6.74 (d, J = 8.4 Hz, 2H), 4.55 (d, J = 7.2 Hz, 1H), 3.55 – 3.40 (m, 1H), 3.38 – 3.23 (m, 1H), 2.39 – 2.19 (m, 3H), 2.16 – 2.01 (m, 1H). ^13C NMR (151 MHz, CDCl₃) δ 148.6, 129.9, 128.6, 126.3 (q, J = 3.6 Hz), 125.3 (q, J = 270.3 Hz), 125.2, 121.8, 117.8 (q, J = 32.6 Hz), 111.9, 88.3, 78.2, 50.1, 47.6, 33.8, 24.2. ^19F NMR (565 MHz, CDCl₃) δ -60.7. IR (KBr, cm⁻¹): 3108, 2977, 2872, 2644, 2221, 1887, 1708, 1615, 1531, 1328. HRMS (ESI-TOF) Calcd for C_{17}H_{15}F_{3}NS (M+H)^+ 322.0872. Found 322.0874.

4i: 1-(3-methyl-4-(trifluoromethyl)phenyl)-2-(phenylethynyl)pyrrolidine

To the solution of 3-methyl-4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dieneone (132 mg, 0.50 mmol), phenylacetylene (138 µL, 1.25 mmol), copper(II) bromide (16.8 mg, 0.075 mmol), 4-methoxyphenol (74.4 mg, 0.6 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (42 µL, 0.5 mmol) and reacted at 180 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel use pure petroleum ether to afford 4i (89 mg, 54%).

Colorless liquid. ^1H NMR (600 MHz, CDCl₃) δ 7.45 (d, J = 8.4 Hz, 1H), 7.43 – 7.30 (m, 2H), 7.30 – 7.20 (m, 3H), 6.70 – 6.50 (m, 2H), 4.56 (d, J = 6.6 Hz, 1H), 3.59 – 3.42 (m, 1H), 3.40 – 3.25 (m, 1H), 2.44 (s, 3H), 2.37 – 2.17 (m, 3H), 2.15 – 2.00 (m, 1H). ^13C NMR (151 MHz, CDCl₃) δ 148.6, 137.6, 131.8, 128.3, 128.2, 127.1 (q, J = 5.4 Hz), 125.7 (q, J = 271.5 Hz), 122.9, 116.7 (q, J = 30.1 Hz), 115.2, 109.1, 89.0, 83.1, 50.1, 47.7, 33.9, 24.2, 19.8. ^19F NMR (565 MHz, CDCl₃) δ -59.3. IR (KBr, cm⁻¹): 3061, 2977, 2873, 2623, 1706, 1613, 1376, 1314, 1117. HRMS
4j: 1-(4-(trifluoromethyl)phenyl)-2-(undec-1-yn-1-yl)pyrrolidine

To the solution of 4-(trifluoromethyl)-4-(((trimethylsilyl)oxy)cyclohexa-2,5-diene (125 mg, 0.50 mmol), 1-tridecyne (225 mg, 1.25 mmol), copper(II) bromide (16.8 mg, 0.075 mmol), 4-methoxyphenol (74.4 mg, 0.6 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (42 µL, 0.5 mmol) and reacted at 180 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel use pure petroleum ether to afford 4j (82 mg, 42%).

Colorless liquid. $^1$H NMR (600 MHz, CDCl$_3$) $\delta$ 7.45 (d, $J = 8.4$ Hz, 2H), 6.70 (d, $J = 8.4$ Hz, 2H), 4.34 (s, 1H), 3.50 – 3.40 (m, 1H), 3.28 (dd, $J = 15.6$, 7.8 Hz, 1H), 2.24 – 2.11 (m, 5H), 2.08 – 2.00 (m, 1H), 1.46 – 1.41 (m, 2H), 1.32 – 1.20 (m, 16H), 0.88 (t, $J = 7.2$ Hz, 3H). $^{13}$C NMR (151 MHz, CDCl$_3$) $\delta$ 148.7, 126.2 (q, $J = 3.8$ Hz), 125.0 (q, $J = 270.5$ Hz), 117.7 (q, $J = 32.5$ Hz), 111.9, 83.6, 79.5, 49.8, 47.6, 34.1, 31.9, 29.7, 29.6, 29.5, 29.3, 29.1, 28.8, 28.7, 24.1, 22.7, 18.6, 14.1. $^{19}$F NMR (565 MHz, CDCl$_3$) $\delta$ -61.7. IR (KBr, cm$^{-1}$): 2925, 2854, 1711, 1615, 1529, 1376, 1325, 1112. HRMS (ESI-TOF) Calcd for C$_{29}$H$_{38}$F$_3$N (M+H)$^+$ 394.2716. Found 374.2712.

4k: 1-(phenylethynyl)-2-(4-(trifluoromethyl)phenyl)-1,2,3,4-tetrahydroisoquinoline

To the solution of 4-(trifluoromethyl)-4-(((trimethylsilyl)oxy)cyclohexa-2,5-diene (125 mg, 0.50 mmol), phenylacetylene (138 µL, 1.25 mmol), copper(II) bromide (16.8 mg, 0.075 mmol), 4-methoxyphenol (74.4 mg, 0.6 mmol) in toluene (1 mL) in a sealed tube was added 1,2,3,4-tetrahydroisoquinoline (67 mg, 0.5 mmol) and reacted at 180 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOAc = 60 : 1) to afford 4k (138 mg, 73%).

Colorless liquid. $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 7.54 (d, $J = 8.4$ Hz, 2H), 7.38 (t, $J = 4.8$ Hz, 1H), 7.31 (d, $J = 8.4$ Hz, 2H), 7.28 – 7.18 (m, 6H), 7.09 (d, $J = 8.4$ Hz, 2H), 5.67 (s, 1H), 3.85 – 3.77 (m, 1H), 3.74 – 3.36 (m, 1H), 3.16 – 3.02 (m, 2H). $^{13}$C NMR (150 MHz, CDCl$_3$): $\delta$ 151.3, 134.9, 134.4, 131.7, 128.7, 128.3, 128.1, 127.5, 127.3, 126.6, 126.5 (q, $J = 3.6$ Hz), 124.8 (q, $J = 269.0$ Hz).
Hz), 122.6, 120.0 (q, $J = 32.6$ Hz), 114.2, 87.9, 84.4, 50.9, 43.2, 28.7. $^{19}$F NMR (565 MHz, CDCl$_3$) δ -61.1. IR (KBr, cm$^{-1}$): 3027, 2924, 2849, 1616, 1525, 1380, 1328, 1112. HRMS (ESI-TOF) Calcd for C$_{24}$H$_{19}$F$_3$N (M+H)$^+$ 378.1464. Found 378.1459.

![Diagram](image1.png)

4l: 2-(phenylethynyl)-1-(4-(trifluoromethyl)phenyl)piperidine

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (125 mg, 0.50 mmol), phenylacetylene (138 µL, 1.25 mmol), copper(II) bromide (16.8 mg, 0.075 mmol), 4-methoxyphenol (74.4 mg, 0.6 mmol) in toluene (1 mL) in a sealed tube was added piperidine (42 µL, 0.5 mmol) and reacted at 180 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/Et$_3$N = 40 : 1) to afford 4l (32 mg, 20%).

Colorless liquid. $^1$H NMR (600 MHz, CDCl$_3$) δ 7.50 (d, $J = 9.0$ Hz, 2H), 7.37 – 7.33 (m, 2H), 7.28 – 7.25 (m, 3H), 7.05 (d, $J = 9.0$ Hz, 2H), 4.82 (s, 1H), 3.56 (d, $J = 12.6$ Hz, 1H), 3.21 (td, $J = 12.6, 3.0$ Hz, 1H), 2.03 (d, $J = 13.2$ Hz, 1H), 1.98 – 1.83 (m, 3H), 1.76 – 1.67 (m, 2H). $^{13}$C NMR (150 MHz, CDCl$_3$) δ 153.4, 131.8, 128.2, 128.1, 126.2 (q, $J = 3.8$ Hz), 122.9, 116.2, 100.0, 86.7, 85.7, 49.3, 45.2, 31.2, 25.7, 20.0. $^{19}$F NMR (565 MHz, CDCl$_3$) δ -61.4. IR (KBr, cm$^{-1}$): 2924, 2852, 1613, 1521, 1489, 1442, 1328, 1114. HRMS (ESI-TOF) Calcd for C$_{26}$H$_{19}$F$_3$N (M+H)$^+$ 330.1416. Found 330.1407.

![Diagram](image2.png)

5a: N-(6-phenyl-4-(pyrrolidin-1-yl)hex-5-yn-1-yl)-4-(trifluoromethyl)aniline

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (125 mg, 0.50 mmol), phenylacetylene (99 µL, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 µL, 1.5 mmol) and reacted at 150 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NET$_3$ = 120: 6: 1) to afford 5a (162 mg, 84%).

Brown liquid. $^1$H NMR (600 MHz, CDCl$_3$): δ 7.41–7.38 (m, 2H), 7.37 (d, $J = 8.4$ Hz, 2H), 7.33 – 7.25 (m, 3H), 6.56 (d, $J = 8.4$ Hz, 2H), 4.38 (s, 1H), 3.74 (t, $J = 7.2$ Hz, 1H), 3.27 – 3.13 (m, 2H), 2.84 – 2.64 (m, 4H), 1.97 – 1.76 (m, 8H). $^{13}$C NMR (150 MHz, CDCl$_3$): δ 150.7, 131.7, 128.2, 128.0, 126.5 (q, $J = 3.6$ Hz), 125.0 (q, $J = 268.1$ Hz), 118.2 (q, $J = 31.5$ Hz), 123.1, 111.6, 87.5,
85.7, 54.5, 49.6, 43.1, 32.7, 26.2, 23.5. $^{19}$F NMR (565 MHz, CDCl$_3$) $\delta$ -60.8. IR (KBr, cm$^{-1}$): 3430, 3257, 2957, 2185, 1891, 1614, 1531, 1485, 1326, 1107. HRMS (ESI-TOF) Calcd for C$_{23}$H$_{28}$F$_3$N$_2$ (M+H)$^+$ 387.2052. Found 387.2043.

5b: $N$-(4-(pyrrolidin-1-yl)-6-(p-tolyl)hex-5-yn-1-yl)-4-(trifluoromethyl)aniline

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-diene (125 mg, 0.50 mmol), 4-ethynyltoluene (104.5 mg, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 $\mu$L, 1.5 mmol) and reacted at 150 $^\circ$C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NEt$_3 = 120: 6: 1$) to afford 5b (134 mg, 67%). Brown liquid. $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 7.36 (d, $J = 8.4$ Hz, 2H), 7.29 (d, $J = 8.4$ Hz, 2H), 7.09 (d, $J = 8.4$ Hz, 2H), 6.55 (d, $J = 8.4$ Hz, 2H), 4.30 (s, 1H), 3.72 (t, $J = 7.0$ Hz, 1H), 3.18 (q, $J = 6.6$ Hz, 2H), 2.78 – 2.66 (m, 4H), 2.33 (s, 3H). $^{13}$C NMR (150 MHz, CDCl$_3$): $\delta$ 150.8, 138.1, 131.6, 129.0, 126.6 (q, $J = 3.8$ Hz), 125.1 (q, $J = 268.1$ Hz), 120.0, 118.3 (q, $J = 32.1$ Hz), 111.6, 86.8, 85.9, 54.6, 49.7, 43.2, 32.8, 26.3, 23.6, 21.4. $^{19}$F NMR (565 MHz, CDCl$_3$) $\delta$ -60.8. IR (KBr, cm$^{-1}$): 3415, 3255, 2958, 2200, 1892, 1620, 1488, 1325, 1123, 1010. HRMS (ESI-TOF) Calcd for C$_{24}$H$_{29}$F$_3$N$_2$ (M+H)$^+$ 401.2199. Found 401.2206.

5c: $N$-((6-(4-methoxyphenyl)-4-(pyrrolidin-1-yl)hex-5-yn-1-yl)-4-(trifluoromethyl)aniline

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-diene (125 mg, 0.50 mmol), 1-ethynyl-4-methoxybenzene (0.119 g, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 $\mu$L, 1.5 mmol) and reacted at 150 $^\circ$C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NEt$_3 = 120: 7: 1$) to afford 5c (171 mg, 82%). Brown liquid. $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 7.37 (d, $J = 8.4$ Hz, 2H), 7.33 (d, $J = 9.0$ Hz, 2H), 6.82 (d, $J = 9.0$ Hz, 2H), 6.57 (d, $J = 8.4$ Hz, 2H), 4.39 (s, 1H), 3.80 (s, 3H), 3.77 – 3.70 (m, 1H), 3.20 (q, $J = 6.0$ Hz, 2H), 2.78 – 2.67 (m, 4H), 2.01 – 1.75 (m, 8H). $^{13}$C NMR (150 MHz, CDCl$_3$): $\delta$ 159.4, 150.8, 133.1, 126.5 (q, $J = 3.5$ Hz), 125.3 (q, $J = 268.7$ Hz), 118.3 (q, $J = 32.4$ Hz), 115.2,
113.9, 111.6, 85.9, 85.5, 55.3, 54.6, 49.7, 43.2, 32.8, 26.2, 23.5. 19F NMR (565 MHz, CDCl3): δ -60.9. IR (KBr, cm⁻¹): 3414, 2955, 2642, 2539, 2218, 2053, 1889, 1615, 1508, 1415, 1326. HRMS (ESI-TOF) Calcd for C25H30F3N2O (M+H)⁺ 417.2148. Found 417.2157.

5d: N-(6-[(1,1'-biphenyl)-4-yl]-4-(pyrrolidin-1-yl)hex-5-yn-1-yl)-4-(trifluoromethyl)aniline

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-diene (125 mg, 0.50 mmol), 4-ethylbiphenyl (160 mg, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 µL, 1.5 mmol) and reacted at 150 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NEt3 = 120: 6: 1) to afford 5d (162 mg, 70%).

Brown liquid. 1H NMR (600 MHz, CDCl3): δ 7.56 (d, J = 7.2 Hz, 2H), 7.54 – 7.51 (m, 2H), 7.48 – 7.42 (m, 4H), 7.40 – 7.33 (m, 3H), 6.56 (d, J = 8.4 Hz, 2H), 4.37 (s, 1H), 3.76 (t, J = 7.2 Hz, 1H), 3.25 – 3.10 (m, 2H), 2.85 – 2.65 (m, 4H), 1.99 – 1.75 (m, 8H). 13C NMR (150 MHz, CDCl3): δ 150.7, 140.8, 140.3, 132.1, 128.8, 127.6, 126.9, 127.0, 126.5 (q, J = 3.5 Hz), 125.1 (q, J = 268.4 Hz), 122.0, 118.3 (q, J = 32.3 Hz), 111.6, 88.3, 85.6, 54.6, 49.6, 43.1, 32.7, 26.2, 23.5. 19F NMR (565 MHz, CDCl3): δ -60.8. IR (KBr, cm⁻¹): 3423, 3232, 3031, 2955, 2249, 1889, 1726, 1616, 1534, 1485, 1326, 1108. HRMS (ESI-TOF) Calcd for C25H30F3N2 (M+H)⁺ 463.2356. Found 463.2362.

5e: N-(6-[(4-fluorophenyl)-4-(pyrrolidin-1-yl)hex-5-yn-1-yl]-4-(trifluoromethyl)aniline

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-diene (125 mg, 0.50 mmol), 4-fluorophenylacetylene (108 mg, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 µL, 1.5 mmol) and reacted at 150 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NEt3 = 120: 6: 1) to afford 5e (156 mg, 77%).

Brown liquid. 1H NMR (600 MHz, CDCl3): δ 7.40 – 7.33 (m, 4H), 6.97 (t, J = 8.4 Hz, 2H), 6.55 (d, J = 8.4 Hz, 2H), 4.39 (s, 1H), 3.78 – 3.66 (m, 1H), 3.18 (q, J = 6.0 Hz, 2H), 2.84 – 2.62 (m,
column chromatography directly on silica gel (PE/EtOH/NEt3 = 120: 6: 1) to afford **5f** (155 mg, 74%).

Brown liquid. \(^1\text{H NMR\)} (600 MHz, CDCl\(_3\)): \(\delta\) 7.37 (d, \(J = 8.4\) Hz, 2H), 7.31 (d, \(J = 8.4\) Hz, 2H), 7.25 (d, \(J = 8.4\) Hz, 2H), 6.55 (d, \(J = 8.4\) Hz, 2H), 4.38 (s, 1H), 3.79 – 3.69 (m, 1H), 3.18 (q, \(J = 6.0\) Hz, 2H), 2.77 – 2.65 (m, 4H), 1.98 – 1.73 (m, 8H). \(^{13}\text{C NMR\)} (150 MHz, CDCl\(_3\)): \(\delta\) 150.7, 133.9, 132.9, 128.5, 126.5 (q, \(J = 3.8\) Hz), 125.6 (q, \(J = 268.7\) Hz), 121.6, 118.2 (q, \(J = 32.3\) Hz), 111.5, 88.7, 84.5, 54.4, 49.6, 43.1, 32.6, 26.1, 23.5. \(^{19}\text{F NMR\)} (565 MHz, CDCl\(_3\)) \(\delta\) -60.8. \(^{19}\text{F NMR\)} (KBr, cm\(^{-1}\)): 3425, 2959, 2644, 2281, 1895, 1618, 1535, 1488, 1326, 1111. **HRMS\**(ESI-TOF) Calcd for C\(_{23}\)H\(_{25}\)F\(_3\)N\(_2\) (M+H\(^+\))\(^{+}\) 421.1653. Found 421.1658.

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**5g: \(N\)-(6-(4-bromophenyl)-4-(pyrrolidin-1-yl)hex-5-yn-1-yl)-4-(trifluoromethyl)aniline**

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-diene (125 mg, 0.50 mmol), 1-bromo-4-ethynylbenzene (0.163 g, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 \(\mu\)L, 1.5 mmol) and reacted at 150 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NEt\(_3\) = 120: 6: 1) to afford **5g** (179 mg, 40% yield).
Brown liquid. \(^1^H\) NMR (600 MHz, CDCl\(_3\)): \(\delta\) 7.42 – 7.38 (m, 2H), 7.36 (d, \(J = 8.4\) Hz, 2H), 7.26 – 7.22 (m, 2H), 6.54 (d, \(J = 8.4\) Hz, 2H), 4.54 (s, 1H), 3.78 – 3.70 (m, 1H), 3.20 – 3.12 (m, 2H), 2.82 – 2.64 (m, 4H), 1.92 – 1.76 (m, 8H). \(^{13}\)C NMR (150 MHz, CDCl\(_3\)): \(\delta\) 150.7, 133.1, 131.4, 126.4 (q, \(J = 3.6\) Hz), 125.9 (q, \(J = 268.4\) Hz), 122.1, 121.9, 118.1 (q, \(J = 32.3\) Hz), 111.5, 88.7, 84.7, 54.4, 49.6, 43.0, 32.4, 26.0, 23.5. \(^{19}\)F NMR (565 MHz, CDCl\(_3\)) \(\delta\) -60.9. IR (KBr, cm\(^{-1}\)): 3426, 3255, 2956, 2874, 2181, 1896, 1617, 1485, 1326, 1109. HRMS (ESI-TOF) Calcd for C\(_{24}\)H\(_{24}\)BrF\(_3\)N\(_2\) (M+H)\(^+\) 465.1148. Found 465.1148.

5h: 4-(3-(pyrrolidin-1-yl)-6-((4-(trifluoromethyl)phenyl)amino)hex-1-yn-1-yl)benzonitrile

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-diene (125 mg, 0.50 mmol), 4-ethynlbenzonitrile (0.114 g, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 \(\mu\)L, 1.5 mmol) and reacted at 150 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NEt\(_3\) = 120: 6: 1) to afford Sh (138 mg, 67%). Brown liquid. \(^1^H\) NMR (600 MHz, CDCl\(_3\)): \(\delta\) 7.56 (d, \(J = 8.4\) Hz, 2H), 7.45 (d, \(J = 8.4\) Hz, 2H), 7.37 (d, \(J = 8.4\) Hz, 2H), 6.57 (d, \(J = 8.4\) Hz, 2H), 4.55 – 4.32 (m, 1H), 3.77 (t, \(J = 6.6\) Hz, 1H), 3.20 (q, \(J = 5.4\) Hz, 2H), 2.81 – 2.65 (m, 4H), 1.95 – 1.76 (m, 8H). \(^{13}\)C NMR (150 MHz, CDCl\(_3\)): \(\delta\) 150.7, 132.2, 131.9, 128.0, 126.4 (q, \(J = 3.9\) Hz), 125.0 (q, \(J = 268.5\) Hz), 118.4, 118.2 (q, \(J = 32.1\) Hz), 111.5, 111.2, 92.7, 84.2, 54.4, 49.6, 43.0, 32.4, 26.0, 23.4. \(^{19}\)F NMR (565 MHz, CDCl\(_3\)) \(\delta\) -60.8. IR (KBr, cm\(^{-1}\)): 3399, 2958, 2874, 2227, 1919, 1617, 1536, 1326, 1108. HRMS (ESI-TOF) Calcd for C\(_{24}\)H\(_{24}\)F\(_3\)N\(_2\) (M+H)\(^+\) 412.1999. Found 412.1999.

5i: N-(6-(pyridin-3-yl)-4-(pyrrolidin-1-yl)hex-5-yn-1-yl)-4-(trifluoromethyl)aniline

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-diene (125 mg, 0.50 mmol), 3-ethynlypyridine (0.093 g, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 \(\mu\)L, 1.5 mmol) and reacted at 150 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NEt\(_3\) = 120: 6: 1) to afford Si (110 mg, 57%).
Brown liquid. $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 8.65 (s, 1H), 8.50 (dd, $J$ = 4.8, 1.8 Hz, 1H), 7.66 (dt, $J$ = 7.8, 1.8 Hz, 1H), 7.37 (d, $J$ = 8.4 Hz, 2H), 7.22 (dd, $J$ = 7.8, 4.8 Hz, 1H), 6.57 (d, $J$ = 8.4 Hz, 2H), 4.31 (s, 1H), 3.83 – 3.74 (m, 1H), 3.26 – 3.17 (m, 2H), 2.83 – 2.67 (m, 4H), 1.97 – 1.78 (m, 8H). $^{13}$C NMR (150 MHz, CDCl$_3$): $\delta$ 152.2, 150.7, 148.3, 138.5, 126.4 (q, $J$ = 3.9 Hz), 124.8 (q, $J$ = 268.4 Hz), 122.9, 120.1, 118.1 (q, $J$ = 32.3 Hz), 111.5, 91.1, 82.4, 54.4, 49.6, 43.0, 32.4, 26.0, 23.4. $^{19}$F NMR (565 MHz, CDCl$_3$) $\delta$ –62.8. IR (KBr, cm$^{-1}$): 3299, 2956, 2874, 2223, 1891, 1616, 1536, 1330, 1107. HRMS (ESI-TOF) Caled for C$_{22}$H$_{25}$F$_3$N$_2$ (M+H)$^+$ 388.1995. Found 388.2002.

5j: N-(4-(pyrrolidin-1-yl)-6-(thiophen-3-yl)hex-5-yn-1-yl)-4-(trifluoromethyl)anilin

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (125 mg, 0.50 mmol), 3-ethynylthiophene (0.097 g, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 $\mu$L, 1.5 mmol) and reacted at 100 °C for 20 minutes. The reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NET$_3$ = 120: 6: 1) to afford 5j (177 mg, 78%). Brown liquid. $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 7.41 – 7.34 (m, 3H), 7.23 (dd, $J$ = 4.8, 3.0 Hz, 1H), 7.06 (d, $J$ = 4.8 Hz, 1H), 6.55 (d, $J$ = 8.4 Hz, 2H), 4.38 (s, 1H), 3.78 – 3.68 (m, 1H), 3.24 – 3.11 (m, 2H), 2.83 – 2.61 (m, 4H), 1.94 – 1.76 (m, 8H). $^{13}$C NMR (150 MHz, CDCl$_3$): $\delta$ 150.7, 130.0, 128.3, 126.5 (q, $J$ = 3.5 Hz), 125.9 (q, $J$ = 268.7 Hz), 125.2, 122.0, 118.3 (q, $J$ = 3.5 Hz), 111.5, 87.1, 80.6, 54.5, 49.6, 43.1, 32.7, 26.2, 23.5. $^{19}$F NMR (565 MHz, CDCl$_3$) $\delta$ –60.8. IR (KBr, cm$^{-1}$): 3422, 3259, 3108, 2955, 2874, 2221, 1889, 1616, 1535, 1327, 1110. HRMS (ESI-TOF) Caled for C$_{21}$H$_{23}$F$_3$N$_2$S (M+H)$^+$ 393.1607. Found 393.1612.

5k: N-(7-cyclohexyl-4-(pyrrolidin-1-yl)hept-5-yn-1-yl)-4-(trifluoromethyl)aniline

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (125 mg, 0.50 mmol), 3-cyclohexyl-propyne (0.110 g, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 $\mu$L, 1.5 mmol) and reacted at 100 °C for 20 minutes. The reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NET$_3$ = 120: 3: 1) to afford 5k (128 mg, 63%). Brown liquid. $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 7.37 (d, $J$ = 8.4 Hz, 2H), 6.55 (d, $J$ = 8.4 Hz, 2H), 4.41 (s, 1H), 3.55 – 3.42 (m, 1H), 3.15 (d, $J$ = 7.2 Hz, 2H), 2.76 – 2.52 (m, 4H), 2.09 (d, $J$ = 6.6
Hz, 2H), 1.90 – 1.83 (m, 1H), 1.82 – 1.68 (m, 1H), 1.68 – 1.61 (m, 1H), 1.48 – 1.37 (m, 1H), 1.32 – 1.18 (m, 2H), 1.18 – 1.06 (m, 1H), 1.05 – 0.92 (m, 2H). $^{13}$C NMR (150 MHz, CDCl$_3$): $\delta$ 150.8, 126.5 (q, $J$ = 3.9 Hz), 125.0 (q, $J$ = 268.5 Hz), 118.1 (q, $J$ = 32.4 Hz), 111.5, 84.4, 78.6, 54.2, 49.5, 43.2, 37.5, 33.1, 32.7, 26.5, 26.3, 26.2, 26.1, 23.5. $^{19}$F NMR (565 MHz, CDCl$_3$) $\delta$ -60.9. IR (KBr, cm$^{-1}$): 3256, 2925, 2222, 1887, 1725, 1617, 1536, 1326, 1111. HRMS (ESI-TOF) Calcd for C$_{24}$H$_{32}$F$_3$N$_2$ (M+H)$^+$ 407.2669. Found 407.2686.

SI: N-(4-(pyrrolidin-1-yl)heptadec-5-yn-1-yl)-4-(trifluoromethyl)aniline

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (125 mg, 0.50 mmol), 1-tridecyne (0.162 g, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 µL, 1.5 mmol) and reacted at 150 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NE$_3$ = 120: 3: 1) to afford SI (148 mg, 64%). Brown liquid. $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 7.37 (d, $J$ = 8.4 Hz, 2H), 6.55 (d, $J$ = 8.4 Hz, 2H), 4.41 (s, 1H), 3.54 – 3.44 (m, 1H), 3.19 – 3.10 (m, 2H), 2.73 – 2.56 (m, 4H), 2.23 – 2.16 (m, 2H), 1.92 – 1.83 (m, 1H), 1.82 – 1.68 (m, 7H), 1.54 – 1.45 (m, 2H), 1.43 – 1.33 (m, 2H), 1.33 – 1.20 (m, 14H), 0.88 (t, $J$ = 7.2 Hz, 3H). $^{13}$C NMR (150 MHz, CDCl$_3$): $\delta$ 150.8, 126.4 (q, $J$ = 3.9 Hz), 125.0 (q, $J$ = 268.2 Hz), 118.2 (q, $J$ = 32.3 Hz), 111.5, 85.7, 76.8, 54.1, 49.4, 43.2, 33.0, 31.9, 29.6(2), 29.5, 29.3, 29.1, 29.0, 28.8, 26.2, 23.5, 22.6, 18.6, 14.0. $^{19}$F NMR (565 MHz, CDCl$_3$) $\delta$ -60.9. IR (KBr, cm$^{-1}$): 3428, 2926, 2855, 1618, 1535, 1327, 1111. HRMS (ESI-TOF) Calcd for C$_{28}$H$_{44}$F$_3$N$_2$ (M+H)$^+$ 465.3451 Found 465.3463.

5m: 3-methyl-N-(6-phenyl-4-(pyrrolidin-1-yl)hex-5-yn-1-yl)-4-(trifluoromethyl)aniline

To the solution of 3-methyl-4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (132 mg, 0.50 mmol), phenylacetylene (99 µL, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 µL, 1.5 mmol) and reacted at 150 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NE$_3$ = 120: 6: 1) to afford 5m (136 mg, 68%). Brown liquid. $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 7.42 – 7.38 (m, 2H), 7.35 (d, $J$ = 8.4 Hz, 1H), 7.29
- 7.25 (m, 3H), 6.38 (s, 1H), 6.36 (d, J = 8.4 Hz, 1H), 4.47 – 4.04 (m, 1H), 3.73 (t, J = 6.6 Hz, 1H),
3.17 (t, J = 7.8 Hz, 2H), 2.80 – 2.66 (m, 4H), 2.36 (s, 3H), 1.93 – 1.78 (m, 8H). 13C NMR (150 MHz,
CDCl3): δ 150.5, 137.8, 131.6, 128.2, 128.0, 127.2 (q, J = 5.6 Hz), 125.4 (q, J = 270.0 Hz),
123.1, 116.8 (q, J = 30.0 Hz), 114.9, 108.4, 87.5, 85.7, 54.5, 49.6, 43.1, 32.6, 26.2, 23.5, 19.5 (d, J =
2.25 Hz). 19F NMR (565 MHz, CDCl3) δ -59.4. IR (KBr, cm⁻¹): 3421, 3261, 2957, 2874, 2225,
1882, 1614, 1313, 1114. HRMS (ESI-TOF) Calcd for C24H28F3N2 (M+H)⁺ 401.2199. Found
401.2198.

5n: N-(6-phenyl-4-(pyrrolidin-1-yl)hex-5-yn-1-yl)-6-(trifluoromethyl)-[1,1'-biphenyl]-3-amine

To the solution of 6-(trifluoromethyl)-6-((trimethylsilyl)oxy)-[1,1'-biphenyl]-3(6H)-one (163
mg, 0.50 mmol), phenylacetylene (99 μL, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol)
in toluene (1 mL) in a sealed tube was added pyrrolidine (126 μL, 1.5 mmol) and reacted at 150
°C. After 20 minutes, the reaction was cooled down to room temperature and purified by column
chromatography directly on silica gel (PE/EtOH/NET3 = 120: 6: 1) to afford 5n (120 mg, 52%).
Brown liquid. 1H NMR (600 MHz, CDCl3): δ 7.47 (d, J = 9.0 Hz, 1H), 7.39 – 7.26 (m, 10H), 6.53
(d, J = 9.0 Hz, 1H), 6.41 (s, 1H), 4.38 (s, 1H), 3.71 (t, J = 6.6 Hz, 1H), 3.18 (q, J = 5.4 Hz, 2H),
2.82 – 2.60 (m, 4H), 1.96 – 1.75 (m, 8H). 13C NMR (150 MHz, CDCl3): δ 150.0, 142.7, 140.6,
131.6, 128.7, 128.2, 128.0, 127.6 (q, J = 3.6 Hz), 127.2, 125.0 (q, J = 270.3 Hz), 123.0, 116.6 (q, J =
30.3 Hz), 115.0, 110.1, 87.5, 85.7, 54.5, 49.6, 43.1, 32.6, 26.2, 23.5. 19F NMR (565 MHz,
CDCl3) δ -54.8. IR (KBr, cm⁻¹): 3423, 3254, 3056, 2955, 2874, 2248, 1886, 1611, 1488, 1308,
1122. HRMS (ESI-TOF) Calcd for C29H30F3N2 (M+H)⁺ 463.2356. Found 463.2350.

5o: 3, 5-dimethyl-N-(6-phenyl-4-(pyrrolidin-1-yl)hex-5-yn-1-yl)-4-(trifluoromethyl)aniline

To the solution of 3,5-dimethyl-4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone
(139 mg, 0.50 mmol), phenylacetylene (99 μL, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075
mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 μL, 1.5 mmol) and reacted at
150 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column
chromatography directly on silica gel (PE/EtOH/NET3 = 120: 6: 1) to afford 5o (139 mg,
67%).
Brown liquid. \(^1\)H NMR (600 MHz, CDCl\(_3\)): \(\delta\) 7.43 – 7.37 (m, 2H), 7.30 – 7.24 (m, 3H), 6.21 (s, 2H), 4.12 (s, 1H), 3.78 – 3.69 (m, 1H), 3.16 (t, \(J = 6.6\) Hz, 2H), 2.84 – 2.65 (m, 4H), 2.36 (q, \(J = 3.6\) Hz, 2H), 1.92 – 1.77 (m, 8H). \(^{13}\)C NMR (150 MHz, CDCl\(_3\)): \(\delta\) 149.5, 138.7 (q, \(J = 2.3\) Hz), 131.6, 128.2, 128.0, 126.7 (q, \(J = 272.4\) Hz), 123.1, 115.6 (q, \(J = 28.5\) Hz), 113.1, 87.6, 85.7, 54.5, 49.6, 42.9, 32.6, 26.3, 23.5, 21.6 (q, \(J = 4.1\) Hz). \(^{19}\)F NMR (565 MHz, CDCl\(_3\)) \(\delta\) -51.9. IR (KBr, cm\(^{-1}\)): 3417, 2935, 2874, 1608, 1295, 1140, 1094, 1030. HRMS (ESI-TOF) Calcd for C\(_{25}\)H\(_{30}\)F\(_3\)N\(_2\) (M+H)\(^+\) 415.2356. Found 415.2363.

5p: 4-(perfluoroethyl)-N-(6-phenyl-4-(pyrrolidin-1-yl)hex-5-yn-1-yl)aniline
To the solution of 4-(perfluoroethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (150 mg, 0.50 mmol), phenylacetylene (99 µL, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 µL, 1.5 mmol) and reacted at 150 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NET\(_3\) = 120: 7: 1) to afford 5p (73 mg, 40%). Brown liquid. \(^1\)H NMR (600 MHz, CDCl\(_3\)) \(\delta\) 7.43 – 7.38 (m, 2H), 7.33 (d, \(J = 8.4\) Hz, 2H), 7.30 – 7.27 (m, 3H), 6.58 (d, \(J = 8.4\) Hz, 2H), 4.42 (s, 1H), 3.75 (t, \(J = 7.2\) Hz, 1H), 3.20 (s, 2H), 2.74 (dd, \(J = 37.8, 7.8\) Hz, 4H), 1.98 – 1.77 (m, 8H). \(^{13}\)C NMR (151 MHz, CDCl\(_3\)) \(\delta\) 150.9, 131.7, 128.2, 128.0, 127.6 (t, \(J = 6.0\) Hz), 123.1, 119.4 (tq, \(J_1 = 286.0\) Hz, \(J_2 = 36.9\) Hz), 114.8 (tq, \(J_1 = 250.3\) Hz, \(J_2 = 36.6\) Hz), 111.7, 87.6, 85.7, 54.5, 49.6, 43.1, 32.7, 26.2, 23.5. \(^{19}\)F NMR (565 MHz, CDCl\(_3\)) \(\delta\) -85.0, -113.2. IR (KBr, cm\(^{-1}\)): 3421, 3033, 2955, 2874, 1615, 1530, 1287, 1203, 1087. HRMS (ESI-TOF) Calcd for C\(_{24}\)H\(_{29}\)F\(_3\)N\(_2\) (M+H)\(^+\) 436.1938. Found 436.1930.

5q: N-(7-phenyl-5-(piperidin-1-yl)hept-6-yn-1-yl)-4-(trifluoromethyl)aniline
To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (125 mg, 0.50 mmol), phenylacetylene (99 µL, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added piperidine (127 µL, 1.5 mmol) and reacted at 150 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOH/NET\(_3\) = 120: 5: 1) to afford 5p (60 mg, 29%). Brown liquid. \(^1\)H NMR (600 MHz, CDCl\(_3\)) \(\delta\) 7.42 (d, \(J = 8.4\) Hz, 2H), 7.37 (d, \(J = 8.4\) Hz, 2H),
7.32 – 7.27 (m, 3H), 6.56 (d, J = 8.4 Hz, 2H), 3.98 (s, 1H), 3.50 (dd, J = 12.6, 6.6 Hz, 1H), 3.16 (dd, J = 12.4, 6.6 Hz, 2H), 2.75 – 2.60 (m, 2H), 2.55 – 2.42 (m, 2H), 1.82 – 1.73 (m, 2H), 1.70 – 1.55 (m, 8H), 1.50 – 1.41 (m, 2H). \[^{13}\text{C NMR}\] (151 MHz, CDCl\(_3\)) \(\delta\) 150.7, 131.7, 128.2, 127.9, 126.5 (q, J = 3.6 Hz), 125.0 (q, J = 270.1 Hz), 123.3, 118.4 (q, J = 32.6 Hz), 111.6, 87.7, 85.9, 58.4, 43.3, 33.0, 28.9, 26.2, 24.5, 24.3. \[^{19}\text{F NMR}\] (565 MHz, CDCl\(_3\)) \(\delta\) -60.4.

IR (KBr, cm\(^{-1}\)):
3423, 3057, 2934, 2858, 2805, 2750, 1888, 1725, 1617, 1327, 1109.

HRMS (ESI-TOF) Calcd for C\(_{25}\)H\(_{30}\)F\(_3\)N\(_2\) (M+H)\(^+\) 415.2356. Found 415.2349.

5r: \(\text{N-}[6\text{-phenyl-4-\text{pyrrolidin-1-yl}hexit-5-yn-1-yl}]-[1,1'\text{-biphenyl}]-4\text{-amine}\)

To the solution of 1-((trimethylsilyl)oxy)-[1,1'-biphenyl]-4(1H)one (129 mg, 0.50 mmol), phenylacetylene (99 \(\mu\)L, 0.9 mmol), copper(II) bromide (16.8 mg, 0.075 mmol) in toluene (1 mL) in a sealed tube was added pyrrolidine (126 \(\mu\)L, 1.5 mmol) and reacted at 150 °C. After 20 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOAc/NEt\(_3\) = 120: 20:1) to afford \(5r\) (43 mg, 22%).

Brown liquid. \(^1\text{H NMR}\) (600 MHz, CDCl\(_3\)) \(\delta\) 7.52 (d, J = 7.8 Hz, 2H), 7.45 – 7.40 (m, 4H), 7.37 (t, J = 7.8 Hz, 1H), 7.31 – 7.26 (m, 3H), 7.23 (t, J = 7.8 Hz, 1H), 6.66 (d, J = 8.4 Hz, 2H), 3.98 (s, 1H), 3.75 (t, J = 7.8 Hz, 1H), 3.22 (d, J = 7.8 Hz, 2H), 2.82 – 2.66 (m, 4H), 1.95 – 1.78 (m, 8H). \(^{13}\text{C NMR}\) (150 MHz, CDCl\(_3\)) \(\delta\) 147.8, 141.3, 131.7, 129.9, 128.6, 128.2, 127.9, 127.9, 126.2, 125.9, 123.2, 112.9, 87.8, 85.6, 54.6, 49.7, 43.7, 32.8, 26.6, 23.5. IR (KBr, cm\(^{-1}\)):

6:10-(trifluoromethyl)-1-(4-(trifluoromethyl)phenyl)-2,3,3a,3b,4,5,6,11b-octahydro-1H-dipyrido[1,2-az:3',2'-c]quinoline

To the solution of 4-(trifluoromethyl)-4-((trimethylsilyl)oxy)cyclohexa-2,5-dienone (125 mg, 0.50 mmol), 4-methoxyphenol (124 mg, 1 mmol) in toluene (1 mL) in a 25 mL round-bottomed flask was added pyrrolidine (42 \(\mu\)L, 0.50 mmol) and reacted at 80 °C. After 40 minutes, the reaction was cooled down to room temperature and purified by column chromatography directly on silica gel (PE/EtOAc/NEt\(_3\) = 120: 7: 1) to afford crude product of \(6\) (91 mg, 85%), the dr value is about 2.5: 1.
6a:
10-(trifluoromethyl)-1-(4-(trifluoromethyl)phenyl)-2,3,3a,3b,4,5,6,11b-octahydro-1H-dipyrrrolo[1,2-α:3′,2′-c]quinoline

The crude product of 6 was purified by column chromatography on silica gel (PE/EtOAc/NEt₃ = 120: 4: 1) to afford 6a (60 mg, 56%).

White solid: m.p. 174–175 °C. 
1H NMR (600 MHz, CDCl₃): δ 7.48 (d, J = 8.4 Hz, 2H), 7.38 (s, 1H), 7.31 (d, J = 8.4 Hz, 1H), 6.78 (d, J = 8.4 Hz, 2H), 6.40 (d, J = 8.4 Hz, 1H), 5.08 (d, J = 6.6 Hz, 1H), 3.87 – 3.78 (m, 1H), 3.45 (t, J = 9.0 Hz, 1H), 3.41 (t, J = 9.6 Hz, 1H), 3.36 – 3.28 (m, 2H), 2.58 – 2.50 (m, 1H), 2.20 – 2.12 (m, 1H), 2.12 – 2.06 (m, 1H), 2.06 – 1.93 (m, 2H), 1.80 – 1.65 (m, 2H). 
13C NMR (150 MHz, CDCl₃): δ 150.6, 145.2, 126.7 (q, J = 3.6 Hz), 125.6 (q, J = 4.1 Hz), 125.2 (q, J = 268.4 Hz), 125.4 (q, J = 3.6 Hz), 125.0 (q, J = 268.7 Hz), 121.2, 117.5 (q, J = 32.1 Hz), 117.1 (q, J = 3.3 Hz), 110.5, 109.8, 57.5, 56.0, 47.4, 46.7, 39.5, 30.3, 23.4, 23.2. 
19F NMR (565 MHz, CDCl₃): δ -60.7. 
IR (KBr, cm⁻¹): 2974, 2907, 2867, 2644, 1880, 1615, 1525, 1452, 126.7, 125.6, 125.4, 125.0, 121.2, 117.5, 117.1, 110.5, 109.8, 57.5, 56.0, 47.4, 46.7, 39.5, 30.3, 23.4, 23.2. 
HRMS (ESI-TOF) Calcd for C₂₀H₂₀F₆N₂Na (M+Na)⁺ 425.1423 Found 425.1436.

6a’:
10-(trifluoromethyl)-1-(4-(trifluoromethyl)phenyl)-2,3,3a,3b,4,5,6,11b-octahydro-1H-dipyrrrolo[1,2-α:3′,2′-c]quinoline

The crude product of 6 was purified by column chromatography on silica gel (PE/ EtOAc/NEt₃ = 120: 4: 1) to afford 6a’ (31 mg, about 29%).

Yellow viscous liquid; 
1H NMR (600 MHz, CDCl₃): δ 7.49 – 7.41 (m, 3H), 7.23 (s, 1H), 6.72 (d, J = 8.4 Hz, 1H), 6.65 (d, J = 8.4 Hz, 2H), 4.43 (d, J = 8.4 Hz, 1H), 3.69 (t, J = 8.4 Hz, 1H), 3.47 (td, J = 9.0, 3.6 Hz, 1H), 3.37 (tt, J = 9.6, 6.6 Hz, 1H), 3.03 – 2.94 (m, 1H), 2.88 – 2.76 (m, 1H), 2.65 – 2.56 (m, 1H), 2.35 – 2.21 (m, 2H), 2.21 – 2.11 (m, 1H), 2.06 – 1.95 (m, 1H), 1.89 – 1.72 (m, 2H). 
13C NMR (150 MHz, CDCl₃): δ 151.0, 149.5, 127.0, 126.4 (q, J = 3.9 Hz), 125.1 (q, J = 279.2 Hz), 125.0 (q, J = 3.9 Hz), 124.8 (q, J = 269.3 Hz), 123.7 (q, J = 3.5 Hz), 120.3 (q, J = 3.2 Hz), 118.6 (q, J = 3.6 Hz), 112.1, 111.9, 63.4, 59.5, 49.0, 47.8, 46.9, 32.2, 30.3, 22.3. 
19F NMR (565 MHz, CDCl₃): δ -60.9, -61.1. 
IR (KBr, cm⁻¹): 2924, 2852, 1614, 1530, 1327, 1104, 1067. 
HRMS (ESI-TOF) Calcd for C₂₀H₂₀F₆N₂Na (M+Na)⁺ 425.1423 Found 425.1436.
## IV. Crystal Data and OPTEP Drawing

![Crystal Structure Diagram](image)

### Crystal data:

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<tr>
<td>c (Å)</td>
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<td>α (deg)</td>
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</tr>
<tr>
<td>β (deg)</td>
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</tr>
<tr>
<td>γ (deg)</td>
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</tr>
<tr>
<td>Volume (Å³)</td>
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<tr>
<td>Goodness-of-fit on F²</td>
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<tr>
<td>Final R indices [I &gt; 2σ(I)]</td>
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<tr>
<td>R indices (all data)</td>
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</table>
V. NOE Spectra of $6a'$

$H_b$ and $H_c$ have no interaction.
VI. Copies of $^1$H NMR, $^{13}$C NMR and $^{19}$F NMR Spectra.

$^1$H spectrum (600 MHz, CDCl$_3$) of compound 4a

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 4a
$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 4a

$^1$H spectrum (600 MHz, CDCl$_3$) of compound 4b
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 4b

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 4b
$^{1}H$ spectrum (600 MHz, CDCl$_3$) of compound 4c

$^{13}C$ spectrum (150 MHz, CDCl$_3$) of compound 4c
$^{19}F$ spectrum (565 MHz, CDCl$_3$) of compound 4c

$^1$H spectrum (600 MHz, CDCl$_3$) of compound 4d
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 4d

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 4d
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 4e

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 4e
$^{19}\text{F}$ spectrum (565 MHz, CDCl$_3$) of compound 4e

$^{1}\text{H}$ spectrum (600 MHz, CDCl$_3$) of compound 4f
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 4f

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 4f
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 4g

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 4g
$^{19}\text{F}$ spectrum (565 MHz, CDCl$_3$) of compound 4g

$^1\text{H}$ spectrum (600 MHz, CDCl$_3$) of compound 4h
$^{13}\text{C}$ spectrum (150 MHz, CDCl$_3$) of compound 4h

$^{19}\text{F}$ spectrum (565 MHz, CDCl$_3$) of compound 4h
$^1$H spectrum(600 MHz, CDCl$_3$) of compound 4i

$^{13}$C spectrum(150 MHz, CDCl$_3$) of compound 4i
$^{19}F$ spectrum (565 MHz, CDCl$_3$) of compound 4i

$^1$H spectrum (600 MHz, CDCl$_3$) of compound 4j
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 4j

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 4j
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 4k

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 4k
$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 4k

$^1$H spectrum (600 MHz, CDCl$_3$) of compound 4l
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 4l

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 4l
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5a

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5a
$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5a

$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5b
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5b

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5b
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5c

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5c
$^{19}\text{F}$ spectrum (565 MHz, CDCl$_3$) of compound 5c

$^{1}\text{H}$ spectrum (600 MHz, CDCl$_3$) of compound 5d
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5d

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5d
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5e

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5e
$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5e

$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5f
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5f

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5f
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5g

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5g
$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5g

$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5h
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5h

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5h
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5i

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5i
$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5i

$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5j
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5j

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5j
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5k

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5k
$^{19}F$ spectrum (565 MHz, CDCl$_3$) of compound 5k

$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5l
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5l

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5l
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5m

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5m
$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5m

$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5n
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5n

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5n
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5o

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5o
$^{19}\text{F}$ spectrum (565 MHz, CDCl$_3$) of compound 5o

$^{1}\text{H}$ spectrum (600 MHz, CDCl$_3$) of compound 5p
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5p

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 5p
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 5q

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 5q
$^{19}\text{F} \text{ spectrum(565 MHz, CDCl}_3\text{)} \text{ of compound } 5q$

$^{1}\text{H} \text{ spectrum(600 MHz, CDCl}_3\text{)} \text{ of compound } 5r$
\(^{13}\)C spectrum (150 MHz, CDCl\(_3\)) of compound 5r

\(^1\)H spectrum (600 MHz, CDCl\(_3\)) of crude compound 6

Crude product of 6
\(\delta r = 2.5 : 1\)
$^1$H spectrum (600 MHz, CDCl$_3$) of compound 6a

$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 6a
$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 6a

$^1$H spectrum (600 MHz, CDCl$_3$) of compound 6a'
$^{13}$C spectrum (150 MHz, CDCl$_3$) of compound 6a'

$^{19}$F spectrum (565 MHz, CDCl$_3$) of compound 6a'