Supporting Information

Nickel-Catalyzed C–H Activation of Purine Bases with Alkyl Halides

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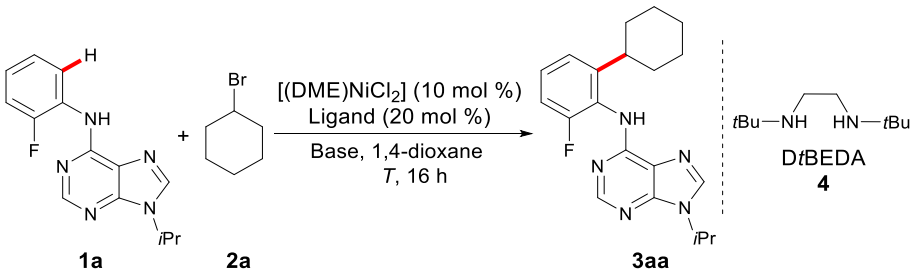
General Remarks

Catalytic reactions were performed under N_2 atmosphere using pre-dried glassware and standard Schlenk techniques. 1,4-Dioxane was dried with sodium and freshly distilled under N_2. The 6-anilinopurine substrates **1a-1m**[1] and **1n**[2] were synthesized according to previously described methods. Other chemicals were obtained from commercial sources and were used without further purification. Yields refer to isolated compounds, estimated to be >95% pure as determined by ^{1}H-NMR and GC. TLC: Macherey-Nagel, TLC plates Alugram®Sil G/UV254. Detection under UV light at 254 nm. Chromatography: Separations were carried out on Merck Silica 60 (0.040–0.063 mm, 70–230 mesh ASTM). All IR spectra were recorded on a BRUKER ALPHA-P spectrometer. MS: EI-MS: Finnigan MAT 95, 70eV; ESI-MS: Finnigan LCQ. High resolution mass spectrometry (HRMS): APEX IV 7T FTICR, Bruker Daltonic. M. p. Stuart® Melting Point Apparatus SMP3 melting point apparatus, values are uncorrected. ^{1}H, ^{13}C, ^{19}F NMR-spectra were recorded at 300 (^{1}H), 400 (^{1}H), 500 (^{1}H), 600 (^{1}H), 75, 100, 125 {^{13}C, APT (Attached Proton Test)} and 283 MHz (^{19}F), respectively, on Varian Unity-300 (600) and AMX 300 instruments in $CDCl_3$ solutions. If not otherwise specified, chemical shifts (δ) are given in ppm.

Table 1. Optimization of nickel-catalyzed C–H alkylation[a]



1a **2a** **3aa**

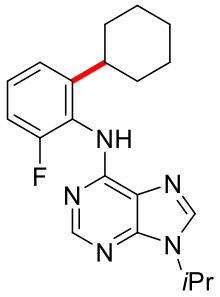
Entry	Ligand	Base	*T* [°C]	**3aa** [%]
1	PPh_3	LiO*t*Bu	120	47
2	IPr·HCl	LiO*t*Bu	120	70
3	IMes·HCl	LiO*t*Bu	120	trace
4	D*t*BBPY	LiO*t*Bu	120	0
5	D*t*BEDA (**4**)	LiO*t*Bu	120	98
6	D*t*BEDA (**4**)	Na_2CO_3	120	0
7	D*t*BEDA (**4**)	K_2CO_3	120	0
8	-	LiO*t*Bu	120	68
9	D*t*BEDA (**4**)	LiO*t*Bu	100	85
10	D*t*BEDA (**4**)	LiO*t*Bu	120	0[b]

[a] Reaction conditions: **1a** (0.30 mmol), **2a** (2.0 equiv), [(DME)$NiCl_2$] (10 mol %), ligand (20 mol %), base (2.0 equiv), 1,4-dioxane (1.5 mL), under N_2, 16 h. [b] Without [Ni]. D*t*BBPY = 4,4'-Di-*tert*-butyl-2,2'-dipyridyl.

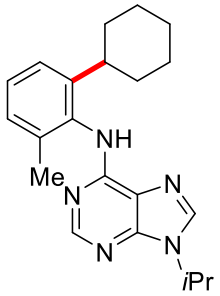
General Procedures for C–H Alkylation of Purine Bases

General Procedure A: 6-Anilinopurines **1** (0.30 mmol), [(DME)$NiCl_2$] (6.6 mg, 10 mol %) and Li*O*tBu (48 mg, 0.60 mmol) were placed in a Schlenk tube. The tube was degassed and purged with N_2 three times. D*t*BEDA (**4**) (13 µL, 20 mol %), alkyl bromides **2** (0.60 mmol) and 1,4-dioxane (1.5 mL) were then added, and the mixture was stirred at 120 °C for 16 h. At ambient temperature, CH_2Cl_2 (2.0 mL) was added, and the reaction mixture was transferred into a round flask with CH_2Cl_2 and concentrated under reduced pressure, purified by flash column chromatography on silica gel to afford the desired products **3**.

General Procedure B: 6-Anilinopurines **1** (0.50 mmol), [(DME)$NiCl_2$] (3.3 mg, 5.0 mol %) and Li*O*tBu (48 mg, 0.60 mmol) were placed in a Schlenk tube. The tube was degassed and purged with N_2 three times. D*t*BEDA (**4**) (6.5 µL, 10 mol %), alkyl bromides **2** (0.60 mmol) and 1,4-dioxane (1.5 mL) were then added, and the mixture was stirred at 120 °C for 16 h. At ambient temperature, CH_2Cl_2 (2.0 mL) was added, and the reaction mixture was transferred into a round flask with CH_2Cl_2 and concentrated under reduced pressure, purified by flash column chromatography on silica gel to afford the desired products **3**.

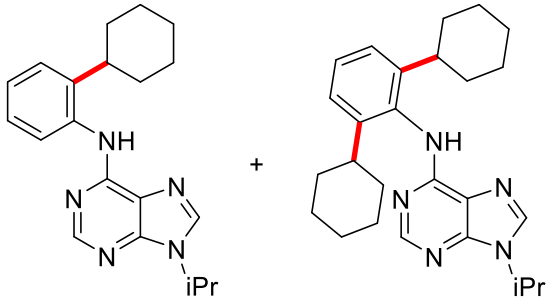


***N*-(2-Cyclohexyl-6-fluorophenyl)-9-*iso*-propyl-9*H*-purin-6-amine (3aa)**: The general procedure **A** was followed using substrate **1a** (81 mg, 0.30 mmol) and bromide **2a** (74 µL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3aa** (104 mg, 98%) as a white solid. M.p. = 90 °C. ^{1}H NMR (600 MHz, $CDCl_3$) δ = 8.37 (s, 1H), 7.78 (s, 1H), 7.63 (s, 1H), 7.26 (ddd, J = 8.2, 7.9, 5.5 Hz, 1H), 7.13 (d, J = 7.9 Hz, 1H), 6.99 (ddd, J = 9.5, 8.2, 1.4 Hz, 1H), 4.83 (hept, J = 6.8 Hz, 1H), 2.82 (tt, J = 12.0, 3.2 Hz, 1H), 1.81–1.74 (m, 2H), 1.73–1.70 (m, 2H), 1.67–1.61 (m, 1H), 1.58 (d, J = 6.8 Hz, 6H), 1.41–1.34 (m, 2H), 1.24–1.16 (m, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ = 158.6 (C_q, $^{1}J_{C\text{-}F}$ = 247.6 Hz), 154.1 (C_q), 152.8 (CH), 149.4 (C_q), 147.9 (C_q), 137.9 (CH), 128.3 (CH, $^{3}J_{C\text{-}F}$ = 8.5 Hz), 122.8 (C_q, $^{2}J_{C\text{-}F}$ = 12.7 Hz), 122.0 (CH, $^{4}J_{C\text{-}F}$ = 3.3 Hz), 120.2 (C_q), 113.2 (CH, $^{2}J_{C\text{-}F}$ = 20.8 Hz), 47.1 (CH), 39.0 (CH, $^{4}J_{C\text{-}F}$ = 2.2 Hz), 33.8 (CH_2), 26.8 (CH_2), 26.1 (CH_2), 22.7 (CH_3). ^{19}F NMR (282 MHz, $CDCl_3$) δ = -118.68 (dd, J = 9.6, 5.5 Hz). IR (neat): 3181, 2925, 2850, 1607, 1468, 1223, 648 cm^{-1}. MS (ESI) *m/z* (relative intensity) 354 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{20}H_{25}FN_5$ [M+H$^+$] 354.2089, found 354.2089.



***N*-(2-Cyclohexyl-6-methylphenyl)-9-*iso*-propyl-9*H*-purin-6-amine (3ba)**: The general procedure **B** was followed using substrate **1b** (80 mg, 0.30 mmol) and bromide **2a** (74 µL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc:

2/1→1/1) yielded **3ba** (81 mg, 77%) as a white solid. M.p. = 156–157 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.38 (s, 1H), 8.36 (s, 1H), 7.51 (s, 1H), 7.36–7.20 (m, 2H), 7.16 (dd, J = 6.5, 2.2 Hz, 1H), 4.82 (hept, J = 6.8 Hz, 1H), 2.83 (tt, J = 12.1, 3.2 Hz, 1H), 2.20 (s, 3H), 1.89–1.60 (m, 5H), 1.57 (d, J = 6.8 Hz, 6H), 1.48–1.31 (m, 2H), 1.21–1.17 (m, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ = 154.4 (C_q), 153.3 (CH), 149.1 (C_q), 146.2 (C_q), 137.5 (CH), 136.9 (C_q), 133.4 (C_q), 128.1 (CH), 127.9 (CH), 124.5 (CH), 119.8 (C_q), 47.0 (CH), 39.2 (CH), 34.0 (CH_2), 26.9 (CH_2), 26.2 (CH_2), 22.7 (CH_3), 18.9 (CH_3). IR (neat): 3228, 2925, 2850, 1606, 1468, 1217, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 350 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{21}H_{28}N_5$ [M+H$^+$] 350.2339, found 350.2339.

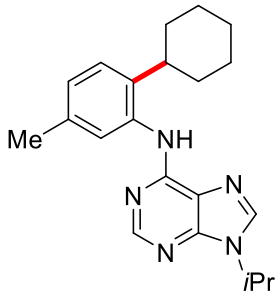


3ca **3ca'**

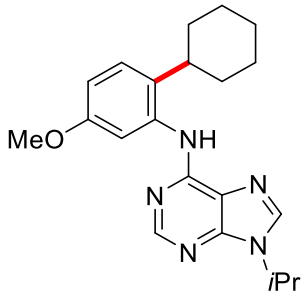
The general procedure **A** was followed using substrate **1c** (76 mg, 0.30 mmol) and bromide **2a** (41 µL, 0.33 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ca** (80 mg, 80%) as a colorless oil and **3ca'** (7 mg, 5%) as a white solid.

***N*-(2-Cyclohexylphenyl)-9-*iso*-propyl-9*H*-purin-6-amine (3ca)**: ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.41 (s, 1H), 7.81 (s, 1H), 7.77–7.69 (m, 2H), 7.32 (dd, J = 7.3, 2.1 Hz, 1H), 7.27–7.17 (m, 2H), 4.84 (hept, J = 6.8 Hz, 1H), 2.80 (tt, J = 11.7, 3.2 Hz, 1H), 1.88–1.74 (m, 4H), 1.73–1.63 (m, 1H), 1.60 (d, J = 6.8 Hz, 6H), 1.50–1.15 (m, 5H). ^{13}C NMR (125 MHz, $CDCl_3$) δ = 153.5 (C_q), 152.8 (CH), 149.2 (C_q), 141.5 (C_q), 137.9 (CH), 134.7 (C_q), 126.6 (CH), 126.2 (CH), 126.1 (CH), 125.7 (CH), 120.5 (C_q), 47.0 (CH), 38.7 (CH), 33.6 (CH_2), 26.8 (CH_2), 26.1 (CH_2), 22.7 (CH_3). IR (neat): 3235, 2925, 2851, 1606, 1467, 1220, 648 cm^{-1}. MS (ESI) *m/z* (relative intensity) 336 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{20}H_{26}N_5$ [M+H$^+$] 336.2183, found 336.2183.

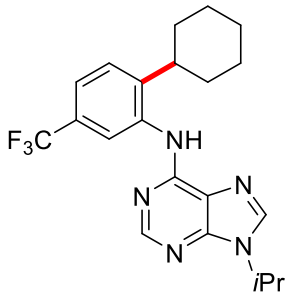
***N*-(2,6-Dicyclohexylphenyl)-9-*iso*-propyl-9*H*-purin-6-amine (3ca')**: M.p. = 220 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.31 (s, 1H), 7.73 (s, 1H), 7.41 (br s, 1H), 7.32 (dd, *J* = 7.7, 7.7 Hz, 1H), 7.21 (d, *J* = 7.7 Hz, 2H), 4.85 (hept, *J* = 6.8 Hz, 1H), 2.71 (tt, *J* = 11.9, 3.2 Hz, 2H), 1.85–1.58 (m, 16H), 1.40–1.31 (m, 4H), 1.24–1.16 (m, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 154.9 (C_q), 153.2 (CH), 149.1 (C_q), 146.1 (C_q), 137.6 (CH), 131.9 (C_q), 128.3 (CH), 124.4 (CH), 119.7 (C_q), 47.0 (CH), 39.5 (CH), 34.6 (CH_2), 33.4 (CH_2), 26.9 (CH_2), 26.1 (CH_2), 22.8 (CH_3). IR (neat): 3180, 2921, 2849, 1612, 1470, 1226, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 418 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{26}H_{36}N_5$ [M+H$^+$] 418.2965, found 418.2962.



***N*-(2-Cyclohexyl-5-methylphenyl)-9-*iso*-propyl-9*H*-purin-6-amine (3da)**: The general procedure **A** was followed using substrate **1d** (80 mg, 0.30 mmol) and bromide **2a** (74 µL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3da** (86 mg, 82%) as a white solid. M.p. = 126 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.42 (s, 1H), 7.78 (s, 1H), 7.68 (br s, 1H), 7.51 (d, *J* = 1.8 Hz, 1H), 7.21 (d, *J* = 8.0 Hz, 1H), 7.02 (dd, *J* = 8.0, 1.8 Hz, 1H), 4.83 (hept, *J* = 6.8 Hz, 1H), 2.74 (tt, *J* = 11.8, 3.2 Hz, 1H), 2.32 (s, 3H), 1.86–1.64 (m, 5H), 1.59 (d, *J* = 6.8 Hz, 6H), 1.47–1.15 (m, 5H). ^{13}C NMR (75 MHz, $CDCl_3$) δ = 153.6 (C_q), 152.9 (CH), 149.2 (C_q), 138.8 (C_q), 137.8 (CH), 135.8 (C_q), 134.5 (C_q), 127.1 (CH), 126.5 (CH), 126.4 (CH), 120.5 (C_q), 47.0 (CH), 38.4 (CH), 33.7 (CH_2), 26.9 (CH_2), 26.1 (CH_2), 22.7 (CH_3), 21.0 (CH_3). IR (neat): 3211, 2924, 2851, 1604, 1468, 1223, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 350 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{21}H_{28}N_5$ [M+H$^+$] 350.2339, found 350.2339.

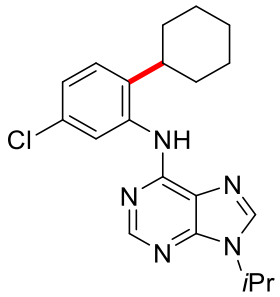


***N*-(2-Cyclohexyl-5-methoxyphenyl)-9-*iso*-propyl-9*H*-purin-6-amine (3ea)**: The general procedure **A** was followed using substrate **1e** (85 mg, 0.30 mmol) and bromide **2a** (74 µL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ea** (89 mg, 81%) as a white solid. M.p. = 130 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.44 (s, 1H), 7.83 (s, 1H), 7.61 (br s, 1H), 7.50 (d, J = 2.7 Hz, 1H), 7.20 (d, J = 8.6 Hz, 1H), 6.75 (dd, J = 8.6, 2.7 Hz, 1H), 4.84 (hept, J = 6.8 Hz, 1H), 3.78 (s, 3H), 2.70 (tt, J = 11.1, 3.0 Hz, 1H), 1.95–1.64 (m, 5H), 1.60 (d, J = 6.8 Hz, 6H), 1.51–1.12 (m, 5H). ^{13}C NMR (75 MHz, $CDCl_3$) δ = 157.7 (C_q), 153.2 (C_q), 152.7 (CH), 149.3 (C_q), 138.0 (CH), 135.6 (C_q), 132.8 (C_q), 127.1 (CH), 120.7 (C_q), 111.4 (CH), 110.3 (CH), 55.2 (CH_3), 47.1 (CH), 38.2 (CH), 33.8 (CH_2), 26.9 (CH_2), 26.2 (CH_2), 22.7 (CH_3). IR (neat): 3241, 2925, 2850, 1602, 1467, 1224, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 366 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{21}H_{27}N_5O$ [M+H$^+$] 366.2288, found 366.2288.

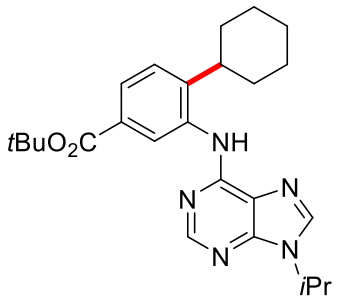


***N*-[2-Cyclohexyl-5-(trifluoromethyl)phenyl]-9-*iso*-propyl-9*H*-purin-6-amine (3fa)**: The general procedure **A** was followed using substrate **1f** (96 mg, 0.30 mmol) and bromide **2a** (74 µL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3fa** (120 mg, 99%) as a white solid. M.p. = 68 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.43 (s, 1H), 8.14 (s, 1H), 8.09 (br s, 1H), 7.76 (s, 1H),

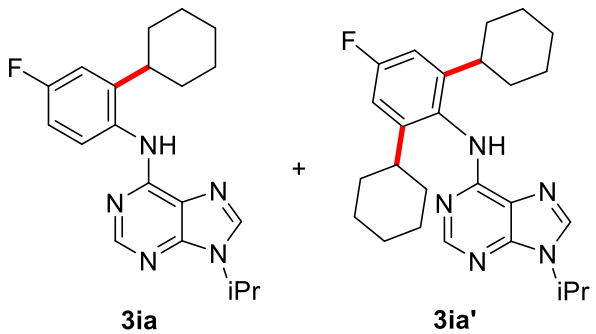
7.42–7.41 (m, 2H), 4.83 (hept, J = 6.8 Hz, 1H), 2.93–2.68 (m, 1H), 1.92–1.67 (m, 5H), 1.57 (d, J = 6.8 Hz, 6H), 1.50–1.15 (m, 5H). ^{13}C NMR (125 MHz, $CDCl_3$) δ = 152.9 (C_q), 152.5 (CH), 149.4 (C_q), 144.3 (C_q), 138.2 (CH), 135.5 (C_q), 128.4 (q, $^2J_{C\text{-}F}$ = 32.6 Hz, C_q), 127.0 (CH), 124.0 (q, $^1J_{C\text{-}F}$ = 271.7 Hz, C_q), 122.0 (q, $^3J_{C\text{-}F}$ = 4.1 Hz, CH), 121.9 (q, $^3J_{C\text{-}F}$ = 4.1 Hz, CH), 120.7 (C_q), 47.2 (CH), 38.9 (CH), 33.4 (CH_2), 26.8 (CH_2), 26.1 (CH_2), 22.7 (CH_3). ^{19}F NMR (282 MHz, $CDCl_3$) δ = -62.32 (s). IR (neat): 2928, 2853, 1607, 1328, 1118, 1010, 648 cm^{-1}. MS (ESI) *m/z* (relative intensity) 404 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{21}H_{25}F_3N_5$ [M+H$^+$] 404.2057, found 404.2066.



***N*-(5-Chloro-2-cyclohexylphenyl)-9-*iso*-propyl-9*H*-purin-6-amine (3ga)**: The general procedure **B** was followed using substrate **1g** (86 mg, 0.30 mmol) and bromide **2a** (74 µL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ga** (90 mg, 81%) as a colorless oil. ^{1}H NMR (600 MHz, $CDCl_3$) δ = 8.46 (s, 1H), 7.95 (d, J = 2.2 Hz, 1H), 7.82 (s, 1H), 7.75 (br s, 1H), 7.22 (d, J = 8.4 Hz, 1H), 7.13 (dd, J = 8.4, 2.2 Hz, 1H), 4.84 (hept, J = 6.8 Hz, 1H), 2.74 (tt, J = 11.7, 3.2 Hz, 1H), 1.83–1.77 (m, 4H), 1.73–1.67 (m, 1H), 1.57 (d, J = 6.8 Hz, 6H), 1.43–1.28 (m, 4H), 1.26–1.18 (m, 1H). ^{13}C NMR (125 MHz, $CDCl_3$) δ = 152.8 (C_q), 152.5 (CH), 149.4 (C_q), 138.7 (C_q), 138.2 (CH), 136.0 (C_q), 131.4 (C_q), 127.5 (CH), 125.4 (CH), 124.5 (CH), 120.6 (C_q), 47.2 (CH), 38.8 (CH), 33.5 (CH_2), 26.8 (CH_2), 26.1 (CH_2), 22.7 (CH_3). IR (neat): 2925, 2851, 1612, 1464, 1220, 1009, 646 cm^{-1}. MS (ESI) *m/z* (relative intensity) 370 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{20}H_{25}ClN_5$ [M+H$^+$] 370.1793, found 370.1806.



***tert*-Butyl 4-cyclohexyl-3-[(9-*iso*-propyl-9*H*-purin-6-yl)amino]benzoate (3ha)**: The general procedure **A** was followed using substrate **1h** (106 mg, 0.30 mmol) and bromide **2a** (74 µL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ha** (84 mg, 64%) as a white solid. M.p. = 88 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.41 (s, 1H), 8.29 (d, J = 1.8 Hz, 1H), 8.05 (br s, 1H), 7.82 (dd, J = 8.2, 1.8 Hz, 1H), 7.74 (s, 1H), 7.36 (d, J = 8.2 Hz, 1H), 4.81 (hept, J = 6.8 Hz, 1H), 2.91–2.73 (m, 1H), 1.86–1.62 (m, 5H), 1.56 (d, J = 6.8 Hz, 6H), 1.53 (s, 9H), 1.36–1.13 (m, 5H). ^{13}C NMR (125 MHz, $CDCl_3$) δ = 165.2 (C_q), 153.4 (C_q), 152.6 (CH), 149.3 (C_q), 146.7 (C_q), 138.0 (CH), 134.8 (C_q), 130.2 (C_q), 127.0 (CH), 127.0 (CH), 126.5 (C_q), 120.4 (CH), 80.7 (C_q), 47.1 (CH), 39.0 (CH), 33.4 (CH_2), 28.2 (CH_3), 26.7 (CH_2), 26.1 (CH_2), 22.7 (CH_3). IR (neat): 2977, 2927, 2852, 1710, 1604, 1298, 648 cm^{-1}. MS (ESI) *m/z* (relative intensity) 436 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{25}H_{33}N_5O_2Na$ [M+Na$^+$] 458.2526, found 458.2533.

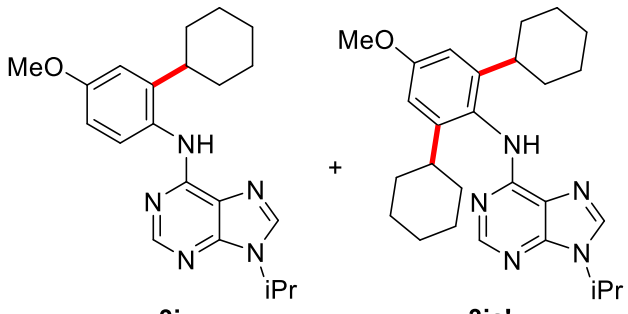


3ia **3ia'**

The general procedure **A** was followed using substrate **1i** (81 mg, 0.30 mmol) and bromide **2a** (41 µL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ia** (76 mg, 72%) and **3ia'** (23 mg, 17%) as white solids.

***N*-(2-Cyclohexyl-4-fluorophenyl)-9-*iso*-propyl-9*H*-purin-6-amine (3ia)**: M.p. = 137 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.38 (s, 1H), 7.83 (br s, 1H), 7.74 (s, 1H), 7.54 (dd, J = 8.8, 5.6 Hz, 1H), 7.01 (dd, J = 10.2, 3.0 Hz, 1H), 6.91 (ddd, J = 8.8, 7.8, 3.0 Hz, 1H), 4.82 (hept, J = 6.8 Hz, 1H), 2.86–2.71 (m, 1H), 1.87–1.62 (m, 5H), 1.58 (d, J = 6.8 Hz, 6H), 1.47–1.10 (m, 5H). ^{13}C NMR (125 MHz, $CDCl_3$) δ = 161.0 (C_q, $^{1}J_{C\text{-}F}$ = 244.1 Hz), 153.7 (C_q), 152.7 (CH), 149.2 (C_q), 145.1 (C_q, $^{3}J_{C\text{-}F}$ = 7.2 Hz), 137.9 (CH), 130.6 (C_q), 128.1 (CH, $^{3}J_{C\text{-}F}$ = 8.4 Hz), 120.3 (C_q), 113.4 (CH, $^{2}J_{C\text{-}F}$ = 22.7 Hz), 113.0 (CH, $^{2}J_{C\text{-}F}$ = 22.6 Hz), 47.1 (CH), 39.0 (CH), 33.5 (CH_2), 26.7 (CH_2), 26.1 (CH_2), 22.7 (CH_3). ^{19}F NMR (283 MHz, $CDCl_3$) δ = -115.47 (dd, J = 7.9, 2.2 Hz). IR (neat): 3235, 2927, 2852, 1606, 1468, 1221, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 354 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{20}H_{24}FN_5$ [M+H$^+$] 354.2089, found 354.2104.

***N*-(2,6-Dicyclohexyl-4-fluorophenyl)-9-*iso*-propyl-9*H*-purin-6-amine (3ia')**: M.p. = 250 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.31 (s, 1H), 7.72 (s, 1H), 7.38 (br s, 1H), 6.89 (d, J = 9.8 Hz, 2H), 4.85 (hept, J = 6.8 Hz, 1H), 2.73–2.65 (m, 2H), 1.87–1.50 (m, 16H), 1.39–0.91 (m, 10H). ^{13}C NMR (75 MHz, $CDCl_3$) δ = 162.6 (C_q, $^{1}J_{C\text{-}F}$ = 244.8 Hz), 154.9 (C_q), 153.2 (CH), 149.1 (C_q), 148.8 (C_q, $^{3}J_{C\text{-}F}$ = 7.5 Hz), 137.8 (CH), 127.6 (C_q), 119.8 (C_q), 111.4 (CH, $^{2}J_{C\text{-}F}$ = 22.6 Hz), 47.0 (CH), 39.6 (CH, $^{4}J_{C\text{-}F}$ = 1.6 Hz), 34.5 (CH_2), 33.2 (CH_2), 26.7 (CH_2), 26.0 (CH_2), 22.7 (CH_3). ^{19}F NMR (283 MHz, $CDCl_3$) δ = -113.57 (t, J = 9.7 Hz). IR (neat): 3178, 2926, 2850, 1609, 1470, 1224, 650 cm^{-1}. MS (ESI) *m/z* (relative intensity) 436 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{26}H_{34}FN_5Na$ [M+Na$^+$] 458.2690, found 458.2695.



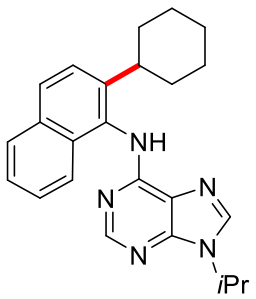
3ja **3ja'**

The general procedure **A** was followed using substrate **1j** (85 mg, 0.30 mmol) and

bromide **2a** (41 μL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ja** (64 mg, 58%) and **3ja'** (20 mg, 15%) as white solids.

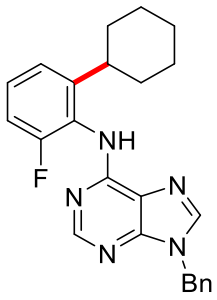
***N*-(2-Cyclohexyl-4-methoxyphenyl)-9-*iso*-propyl-9*H*-purin-6-amine (3ja)**: M.p. = 150 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.36 (s, 1H), 7.76 (s, 1H), 7.73 (s, 1H), 7.41 (d, J = 8.7 Hz, 1H), 6.86 (d, J = 2.9 Hz, 1H), 6.76 (dd, J = 8.7, 2.9 Hz, 1H), 4.81 (hept, J = 6.8 Hz, 1H), 3.79 (s, 3H), 2.80–2.70 (m, 1H), 1.83–1.61 (m, 5H), 1.57 (d, J = 6.8 Hz, 6H), 1.45–1.11 (m, 5H). ^{13}C NMR (75 MHz, $CDCl_3$) δ = 158.2 (C_q), 154.3 (C_q), 153.0 (CH), 149.1 (C_q), 144.9 (C_q), 137.7 (CH), 128.2 (CH), 127.6 (C_q), 120.2 (C_q), 112.7 (CH), 111.0 (CH), 55.3 (CH_3), 47.0 (CH), 38.9 (CH), 33.6 (CH_2), 26.8 (CH_2), 26.1 (CH_2), 22.7 (CH_3). IR (neat): 3242, 2926, 2851, 1612, 1469, 1223, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 366 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{21}H_{27}N_5O$ [M+H$^+$] 366.2288, found 366.2299.

***N*-(2,6-Dicyclohexyl-4-methoxyphenyl)-9-*iso*-propyl-9*H*-purin-6-amine (3ja')**: M.p. = 210 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.31 (s, 1H), 7.77 (s, 1H), 7.21 (s, 1H), 6.73 (s, 2H), 4.85 (hept, J = 6.8 Hz, 1H), 3.81 (s, 3H), 2.78–2.59 (m, 2H), 1.76–1.56 (m, 16H), 1.36–1.04 (m, 10H). ^{13}C NMR (75 MHz, $CDCl_3$) δ = 159.1 (C_q), 155.2 (C_q), 153.3 (CH), 149.0 (C_q), 147.5 (C_q), 137.6 (CH), 124.6 (C_q), 119.8 (C_q), 109.9 (CH), 55.1 (CH_3), 47.0 (CH), 39.6 (CH), 34.6 (CH_2), 33.3 (CH_2), 26.8 (CH_2), 26.1 (CH_2), 22.8 (CH_3). IR (neat): 3225, 2925, 2850, 1611, 1468, 1227, 650 cm^{-1}. MS (ESI) *m/z* (relative intensity) 448 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{27}H_{37}N_5O$ [M+H$^+$] 448.3071, found 448.3084.



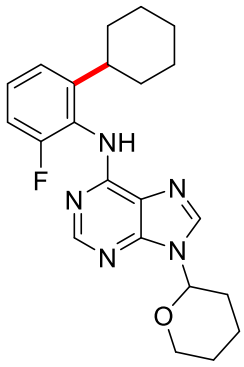
***N*-(2-Cyclohexylnaphthalen-1-yl)-9-*iso*-propyl-9*H*-purin-6-amine (3ka)**: The

general procedure **A** was followed using substrate **1k** (91 mg, 0.30 mmol) and bromide **2a** (74 μL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ka** (85 mg, 74%) as a white solid. M.p. = 120 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.56 (br s, 1H), 8.29 (s, 1H), 7.94–7.78 (m, 3H), 7.56 (d, J = 8.7 Hz, 1H), 7.51 (s, 1H), 7.40 (ddd, J = 8.0, 6.8, 1.3 Hz, 1H), 7.32 (ddd, J = 8.2, 6.8, 1.4 Hz, 1H), 4.74 (hept, J = 6.8 Hz, 1H), 3.04 (tt, J = 12.4, 2.8 Hz, 1H), 1.85–1.52 (m, 7H), 1.47 (d, J = 6.8 Hz, 6H), 1.31–1.07 (m, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ = 155.0 (C_q), 153.2 (CH), 149.1 (C_q), 143.3 (C_q), 137.6 (CH), 132.8 (C_q), 131.4 (C_q), 129.3 (C_q), 128.0 (CH), 127.9 (CH), 126.2 (CH), 125.2 (CH), 124.8 (CH), 123.3 (CH), 119.8 (C_q), 46.9 (CH), 39.6 (CH), 33.5 (CH_2), 26.8 (CH_2), 26.2 (CH_2), 22.6 (CH_3). IR (neat): 3179, 2926, 2851, 1711, 1605, 1220, 648 cm^{-1}. MS (ESI) *m/z* (relative intensity) 386 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{24}H_{28}N_5$ [M+H$^+$] 386.2339, found 386.2348.

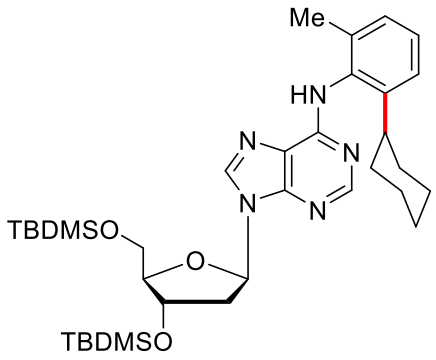


9-Benzyl-*N*-(2-cyclohexyl-6-fluorophenyl)-9*H*-purin-6-amine (3la): The general procedure **A** was followed using substrate **1l** (96 mg, 0.30 mmol) and bromide **2a** (74 μL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3la** (106 mg, 88%) as a white solid. M.p. = 95 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.41 (s, 1H), 7.72 (br s, 1H), 7.65 (s, 1H), 7.42–7.21 (m, 6H), 7.12 (d, J = 7.9 Hz, 1H), 6.98 (ddd, J = 9.5, 8.1, 1.4 Hz, 1H), 5.34 (s, 2H), 2.81 (tt, J = 12.0, 3.2 Hz, 1H), 1.84–1.52 (m, 5H), 1.50–0.96 (m, 5H). ^{13}C NMR (75 MHz, $CDCl_3$) δ = 158.7 (C_q, $^{1}J_{C\text{-}F}$ = 248.0 Hz), 154.3 (C_q), 153.4 (CH), 150.0 (C_q), 148.0 (C_q), 140.3 (CH), 135.4 (C_q), 129.0 (CH), 128.4 (CH, $^{3}J_{C\text{-}F}$ = 8.9 Hz), 128.3 (CH), 127.9 (CH), 122.8 (C_q, $^{2}J_{C\text{-}F}$ = 12.7 Hz), 122.1 (CH, $^{4}J_{C\text{-}F}$ = 3.3 Hz), 119.8 (C_q), 113.2 (CH, $^{2}J_{C\text{-}F}$ = 20.7 Hz), 47.2 (CH_2), 38.9 (CH, $^{4}J_{C\text{-}F}$ = 2.3 Hz), 33.7 (CH_2), 26.7 (CH_2), 26.0 (CH_2). ^{19}F NMR (283 MHz,

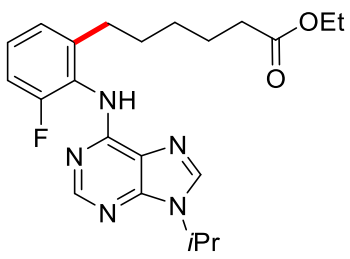
$CDCl_3$) δ = -118.69 (dd, J = 9.6, 5.6 Hz). IR (neat): 3180, 2925, 2851, 1605, 1469, 1295, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 402 [M+H^+] (100). HR-MS (ESI) *m/z* calcd for $C_{24}H_{25}FN_5$ [M+H^+] 402.2089, found 402.2103.



***N*-(2-Cyclohexyl-6-fluorophenyl)-9-(tetrahydro-2*H*-pyran-2-yl)-9*H*-purin-6-amine (3ma)**: The general procedure **A** was followed using substrate **1m** (94 mg, 0.30 mmol) and bromide **2a** (74 µL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ma** (117 mg, 99%) as a white solid. M.p. = 97 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.36 (s, 1H), 7.93 (s, 1H), 7.77 (br s, 1H), 7.26 (ddd, J = 8.1, 7.9, 6.0 Hz, 1H), 7.12 (dd, J = 7.9, 1.4 Hz, 1H), 6.98 (ddd, J = 9.5, 8.1, 1.4 Hz, 1H), 5.69 (dd, J = 9.8, 2.8 Hz, 1H), 4.13 (ddd, J = 12.9, 2.9, 2.9 Hz, 1H), 3.74 (ddd, J = 11.5, 2.9, 2.9 Hz, 1H), 2.80 (tt, J = 12.0, 3.2 Hz, 1H), 2.20–1.94 (m, 3H), 1.84–1.54 (m, 8H), 1.50–1.30 (m, 2H), 1.26–1.13 (m, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ = 158.6 (C_q, $^1J_{C\text{-}F}$ = 247.8 Hz), 154.1 (C_q), 153.1 (CH), 149.1 (C_q), 147.9 (C_q), 138.2 (CH), 128.3 (CH, $^3J_{C\text{-}F}$ = 8.5 Hz), 122.7 (C_q, $^2J_{C\text{-}F}$ = 12.7 Hz), 122.0 (CH, $^4J_{C\text{-}F}$ = 3.3 Hz), 119.8 (C_q), 113.1 (CH, $^2J_{C\text{-}F}$ = 20.7 Hz), 81.8 (CH), 68.7 (CH_2), 39.0 (CH, $^4J_{C\text{-}F}$ = 2.1 Hz), 33.7 (CH_2), 31.8 (CH_2), 26.7, (CH_2), 26.1 (CH_2), 24.9 (CH_2), 22.8 (CH_2). ^{19}F NMR (282 MHz, $CDCl_3$) δ = -118.77 (dd, J = 9.5, 5.6 Hz). IR (neat): 3183, 2926, 2852, 1711, 1449, 1221, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 396 [M+H^+] (100). HR-MS (ESI) *m/z* calcd for $C_{22}H_{27}FN_5O$ [M+H^+] 396.2194, found 396.2205.

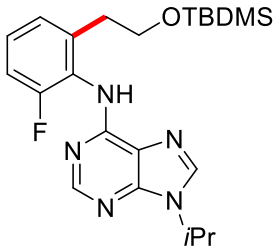


9-{(2*R*,4*S*,5*R*)-4-[(*tert*-Butyldimethylsilyl)oxy]-5-{[(*tert*-butyldimethylsilyl)oxy] methyl}tetrahydrofuran-2-yl}-*N*-(2-cyclohexyl-6-methylphenyl)-9*H*-purin-6 amine (3na): The general procedure **A** was followed using substrate **1n** (171 mg, 0.30 mmol) and bromide **2a** (74 µL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3na** (160 mg, 82%) as a colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.33 (s, 1H), 8.06 (br s, 1H), 7.23–7.18 (m, 2H), 7.13 (dd, *J* = 7.0, 2.0 Hz, 1H), 6.45 (dd, *J* = 6.5, 6.5 Hz, 1H), 4.62 (m, 1H), 4.01 (m, 1H), 3.85 (dd, *J* = 11.3, 4.4 Hz, 1H), 3.76 (dd, *J* = 11.2, 3.4 Hz, 1H), 2.89–2.62 (m, 2H), 2.42 (ddd, *J* = 13.1, 6.1, 3.6 Hz, 1H), 2.19 (s, 3H), 1.82–1.56 (m, 5H), 1.40–1.33 (m, 2H), 1.25–1.19 (m, 3H), 0.90 (s, 19H), 0.10 (s, 6H), 0.07 (d, *J* = 2.6 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 154.2 (CH), 153.5 (C_q), 149.1 (C_q), 145.9 (CH), 138.7 (C_q), 136.8 (C_q), 133.1 (C_q), 128.2 (CH), 128.0 (CH), 124.5 (CH), 120.0 (C_q), 87.9 (CH), 84.3 (CH), 72.1 (CH), 62.9 (CH_2), 41.0 (CH_2), 39.2 (CH), 33.9 (CH_2), 26.8 (CH_2), 26.1 (CH_2), 25.9 (CH_3), 25.8 (CH_3), 18.8 (CH_3), 18.4 (C_q), 18.0 (C_q), -4.7 (CH_3), -4.8 (CH_3), -5.4 (CH_3), -5.5 (CH_3). IR (neat): 2954, 2925, 2856, 1712, 1612, 1360, 1219, 835 cm^{-1}. MS (ESI) *m/z* (relative intensity) 652 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{35}H_{58}N_5O_3Si_2$ [M+H$^+$] 652.4073, found 652.4068.



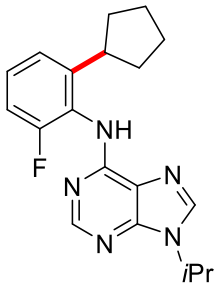
Ethyl-6-{3-fluoro-2-[(9-*iso*-propyl-9*H*-purin-6-yl)amino]phenyl}hexanoate (3ab):

The general procedure **A** was followed using substrate **1a** (81 mg, 0.30 mmol) and bromide **2b** (134 mg, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ab** (67 mg, 54%) as a colorless oil. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.34 (s, 1H), 8.15 (s, 1H), 7.69 (s, 1H), 7.21 (ddd, J = 8.0, 7.7, 4.8 Hz, 1H), 7.05 (d, J = 7.7 Hz, 1H), 6.99 (ddd, J = 9.6, 8.0, 1.5 Hz, 1H), 4.79 (hept, J = 6.6 Hz, 1H), 4.02 (q, J = 7.1 Hz, 2H), 2.62 (t, J = 7.7 Hz, 2H), 2.12 (t, J = 7.5 Hz, 2H), 1.54 (d, J = 6.6 Hz, 6H), 1.50–1.42 (m, 4H), 1.26–1.21 (m, 2H), 1.17 (t, J = 7.1 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ = 173.5 (C_q), 158.8 (C_q, $^{1}J_{C\text{-}F}$ = 248.0 Hz), 154.0 (C_q), 152.8 (CH), 149.4 (C_q), 142.9 (C_q), 138.0 (CH), 128.1 (CH, $^{3}J_{C\text{-}F}$ = 8.6 Hz), 124.7 (CH, $^{4}J_{C\text{-}F}$ = 3.3 Hz), 123.8 (C_q, $^{2}J_{C\text{-}F}$ = 13.1 Hz), 120.2 (C_q), 113.5 (CH, $^{2}J_{C\text{-}F}$ = 20.7 Hz), 60.0 (CH_2), 47.0 (CH), 34.0 (CH_2), 31.2 (CH_2, $^{4}J_{C\text{-}F}$ = 2.4 Hz), 29.6 (CH_2), 28.7 (CH_2), 24.6 (CH_2), 22.5 (CH_3), 14.1 (CH_3). ^{19}F NMR (283 MHz, $CDCl_3$) δ = -119.45 (dd, J = 9.5, 5.6 Hz). IR (neat): 3179, 2933, 2861, 1606, 1467, 1223, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 414 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{22}H_{29}FN_5O_2$ [M+H$^+$] 414.2300, found 414.2303.

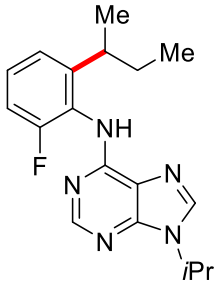


***N*-{2-[2-(*tert*-Butyldimethylsilyl)oxyethyl]-6-fluorophenyl}-9-*iso*-propyl-9*H*-purin-6-amine (3ac)**: The general procedure **A** was followed using substrate **1a** (81 mg, 0.30 mmol) and bromide **2c** (143 mg, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ac** (80 mg, 62%) as a colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.38 (s, 1H), 8.17 (br s, 1H), 7.81 (s, 1H), 7.19 (ddd, J = 8.2, 8.0, 5.3 Hz, 1H), 7.07–7.01 (m, 2H), 4.82 (hept, J = 6.8 Hz, 1H), 3.83 (t, J = 6.1 Hz, 2H), 2.89 (t, J = 6.1 Hz, 2H), 1.57 (d, J = 6.8 Hz, 6H), 0.79 (s, 9H), -0.05 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 158.4 (C_q, $^{1}J_{C\text{-}F}$ = 249.1 Hz), 153.3 (C_q), 152.6 (CH), 149.5 (C_q), 138.7 (C_q), 138.0 (CH), 127.4 (CH, $^{3}J_{C\text{-}F}$ = 8.5 Hz), 125.4 (CH, $^{4}J_{C\text{-}F}$

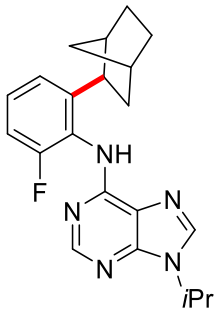
= 3.2 Hz), 125.0 (C_q, $^2J_{C\text{-}F}$ = 12.8 Hz), 120.6 (C_q), 114.2 (CH, $^2J_{C\text{-}F}$ = 20.7 Hz), 64.8 (CH_2), 46.9 (CH), 34.9 (CH_2, $^4J_{C\text{-}F}$ = 2.3 Hz), 25.9 (CH_3), 22.6 (CH_3), 18.4 (C_q), -5.6 (CH_3). ^{19}F NMR (376 MHz, $CDCl_3$) δ = -117.39 (dd, J = 9.6, 5.3 Hz). IR (neat): 3172, 2926, 2854, 1611, 1470, 1228, 833, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 430 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{22}H_{33}FN_5OSi$ [M+H$^+$] 430.2433, found 430.2437.



***N*-(2-Cyclopentyl-6-fluorophenyl)-9-*iso*-propyl-9*H*-purin-6-amine (3ad)**: The general procedure **A** was followed using substrate **1a** (81 mg, 0.30 mmol) and bromide **2d** (89 mg, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ad** (100 mg, 98%) as a white solid. M.p. = 145 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.38 (s, 1H), 7.79 (s, 1H), 7.55 (br s, 1H), 7.26 (ddd, J = 8.1, 8.0, 5.6 Hz, 1H), 7.16 (dd, J = 8.0, 1.5 Hz, 1H), 7.00 (ddd, J = 9.5, 8.1, 1.5 Hz, 1H), 4.83 (hept, J = 6.8 Hz, 1H), 3.25 (p, J = 8.4 Hz, 1H), 2.04–1.87 (m, 2H), 1.86–1.68 (m, 2H), 1.59 (d, J = 6.8 Hz, 6H), 1.57–1.47 (m, 4H). ^{13}C NMR (125 MHz, $CDCl_3$) δ = 158.7 (C_q, $^1J_{C\text{-}F}$ = 247.7 Hz), 154.0 (C_q), 152.8 (CH), 149.4 (C_q), 147.0 (C_q), 138.0 (CH), 128.3 (CH, $^3J_{C\text{-}F}$ = 8.7 Hz), 123.4 (C_q, $^2J_{C\text{-}F}$ = 12.9 Hz), 121.9 (CH, $^4J_{C\text{-}F}$ = 3.3 Hz), 120.3 (C_q), 113.2 (CH, $^2J_{C\text{-}F}$ = 20.7 Hz), 47.1 (CH), 40.4 (CH, $^4J_{C\text{-}F}$ = 2.2 Hz), 34.2 (CH_2), 25.7 (CH_2), 22.8 (CH_3). ^{19}F NMR (282 MHz, $CDCl_3$) δ = -119.19 (dd, J = 9.4, 5.5 Hz). IR (neat): 3189, 2945, 1605, 1470, 1222, 1006, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 340 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{19}H_{23}FN_5$ [M+H$^+$] 340.1932, found 340.1932.

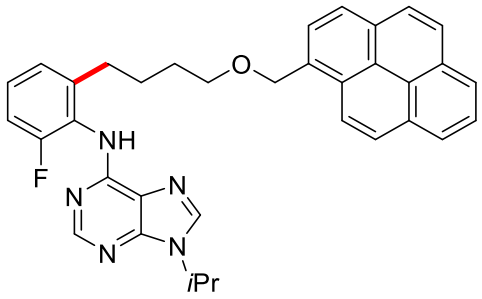


***N*-[2-(*sec*-Butyl)-6-fluorophenyl]-9-*iso*-propyl-9*H*-purin-6-amine (3ae)**: The general procedure **A** was followed using substrate **1a** (81 mg, 0.30 mmol) and bromide **2e** (82 mg, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ae** (84 mg, 86%) as a white solid. M.p. = 180 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.36 (s, 1H), 7.79 (br s, 1H), 7.75 (s, 1H), 7.28 (ddd, J = 8.1, 8.0, 5.5 Hz, 1H), 7.09 (dd, J = 8.0, 1.4 Hz, 1H), 7.00 (ddd, J = 9.5, 8.1, 1.4 Hz, 1H), 4.81 (hept, J = 6.8 Hz, 1H), 2.96 (m, 1H), 1.65–1.40 (m, 8H), 1.13 (d, J = 6.9 Hz, 3H), 0.69 (t, J = 7.4 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ = 158.7 (d, J = 247.4 Hz), 154.2 (C_q), 152.7 (CH), 149.3 (C_q), 148.2 (C_q), 137.8 (CH), 128.4 (CH, $^{3}J_{C\text{-}F}$ = 8.5 Hz), 123.4 (C_q, $^{2}J_{C\text{-}F}$ = 12.8 Hz), 121.7 (CH, $^{4}J_{C\text{-}F}$ = 3.3 Hz), 120.2 (C_q), 113.2 (CH, $^{2}J_{C\text{-}F}$ = 20.7 Hz), 47.0 (CH), 35.4 (CH, $^{4}J_{C\text{-}F}$ = 2.0 Hz), 30.5 (CH_2), 22.7 (CH_3), 21.1 (CH_3), 12.1 (CH_3). ^{19}F NMR (283 MHz, $CDCl_3$) δ = -119.09 (dd, J = 9.5, 5.6 Hz). IR (neat): 3180, 2962, 2931, 1610, 1470, 1224, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 328 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{18}H_{23}FN_5$ [M+H$^+$] 328.1932, found 328.1934.



***N*-{2-[(2*S*)-Bicyclo[2.2.1]heptan-2-yl]-6-fluorophenyl}-9-*iso*-propyl-9*H*-purin-6-amine (3af)**: The general procedure **A** was followed using substrate **1a** (81 mg, 0.30 mmol) and bromide **2f** (105 mg, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3af** (100 mg, 91%) as a white solid. M.p. = 92 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.39 (s, 1H), 7.76 (s, 1H), 7.73 (s, 1H), 7.26 (ddd, J =

8.1, 8.0, 5.5 Hz, 1H), 7.16 (dd, J = 8.0, 1.4 Hz, 1H), 7.01 (ddd, J = 9.5, 8.1, 1.5 Hz, 1H), 4.83 (hept, J = 6.8 Hz, 1H), 2.92 (dd, J = 8.9, 5.7 Hz, 1H), 2.41 (d, J = 2.6 Hz, 1H), 2.25 (d, J = 4.3 Hz, 1H), 1.70 (ddd, J = 12.0, 9.1, 2.3 Hz, 1H), 1.59 (d, J = 6.8 Hz, 6H), 1.53–1.43 (m, 4H), 1.26–1.09 (m, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ = 159.1 (C_q, $^1J_{C\text{-}F}$ = 248.9 Hz), 153.9 (C_q), 152.8 (CH), 149.6 (C_q), 147.5 (C_q), 138.1 (CH), 128.0 (CH, $^3J_{C\text{-}F}$ = 8.5 Hz), 123.5 (C_q, $^2J_{C\text{-}F}$ = 12.6 Hz), 121.2 (CH, $^4J_{C\text{-}F}$ = 3.1 Hz), 120.3 (C_q), 113.3 (CH, $^2J_{C\text{-}F}$ = 20.6 Hz), 47.1 (CH), 42.6 (CH, $^4J_{C\text{-}F}$ = 2.1 Hz), 41.3 (CH), 39.3 (CH_2), 36.9 (CH), 36.4 (CH_2), 30.2 (CH_2), 28.7 (CH_2), 22.7 (CH_3). ^{19}F NMR (283 MHz, $CDCl_3$) δ = -118.24 (dd, J = 9.4, 5.5 Hz). IR (neat): 3226, 2950, 2870, 1711, 1468, 1220, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 366 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{21}H_{25}FN_5$ [M+H$^+$] 366.2089, found 366.2090.

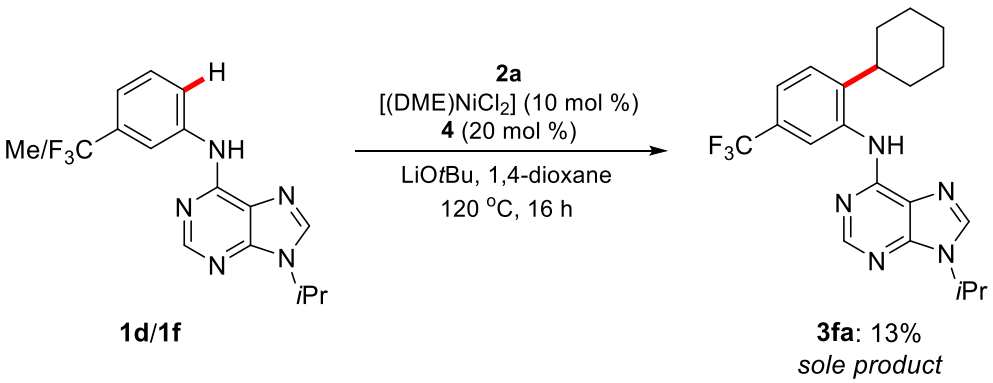


***N*-{2-Fluoro-6-[4-(pyren-1-ylmethoxy)butyl]phenyl}-9-*iso*-propyl-9*H*-purin-6-amine (3ag)**: The general procedure **A** was followed using substrate **1a** (81 mg, 0.30 mmol) and bromide **2g** (74 µL, 0.60 mmol). Isolation by column chromatography (*n*-hexane/EtOAc: 2/1→1/1) yielded **3ag** (90 mg, 54%) as a white solid. M.p. = 110 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.41 (s, 1H), 8.27 (d, J = 9.2 Hz, 1H), 8.16–8.13 (m, 2H), 8.09–8.04 (m, 3H), 8.00 (d, J = 0.7 Hz, 2H), 7.97 (dd, J = 7.5, 7.5 Hz, 1H), 7.92 (d, J = 7.8 Hz, 1H), 7.70 (br s, 1H), 7.15 (ddd, J = 8.1, 8.0, 5.5 Hz, 1H), 7.04–6.95 (m, 2H), 5.07 (s, 2H), 4.74 (hept, J = 6.7 Hz, 1H), 3.47 (t, J = 6.1 Hz, 2H), 2.65 (t, J = 7.5 Hz, 2H), 1.71–1.53 (m, 4H), 1.49 (d, J = 6.8 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 158.8 (C_q, $^1J_{C\text{-}F}$ = 247.9 Hz), 153.9 (C_q), 152.7 (CH), 149.5 (C_q), 142.8 (C_q), 138.0 (CH), 131.6 (C_q), 131.1 (C_q), 131.0 (C_q), 130.7 (C_q), 129.1 (C_q), 128.1 (CH, $^3J_{C\text{-}F}$ = 8.5 Hz), 127.5 (CH), 127.3 (CH), 127.2 (CH), 126.7 (CH), 125.8 (CH), 125.1 (CH), 125.0

(CH), 124.8 (CH, $^{4}J_{C\text{-}F}$ = 3.2 Hz), 124.8 (C_q), 124.6 (C_q), 124.4 (CH), 123.7 (C_q, $^{2}J_{C\text{-}F}$ = 13.1 Hz), 123.4 (CH), 120.2 (C_q), 113.5 (CH, $^{2}J_{C\text{-}F}$ = 20.7 Hz), 71.3 (CH_2), 70.0 (CH_2), 47.0 (CH), 31.1 (CH_2, $^{4}J_{C\text{-}F}$ = 2.3 Hz), 29.4 (CH_2), 26.6 (CH_2), 22.5 (CH_3). ^{19}F NMR (376 MHz, $CDCl_3$) δ = -119.34 (dd, J = 9.3, 5.5 Hz). IR (neat): 3039, 2929, 2858, 1606, 1467, 845, 648 cm^{-1}. MS (ESI) *m/z* (relative intensity) 558 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{35}H_{32}FN_5O$ [M+H$^+$] 558.2664, found 558.2668.

Mechanistic Studies

Intermolecular Competition Experiment between 1d and 1f

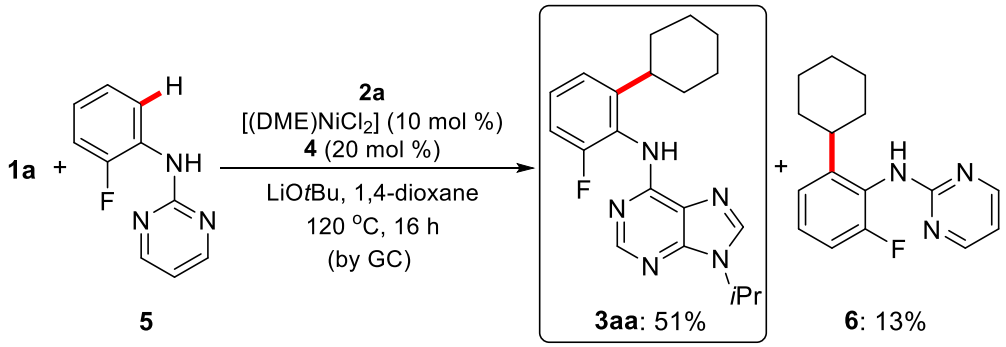


1d/1f

3fa: 13%
sole product

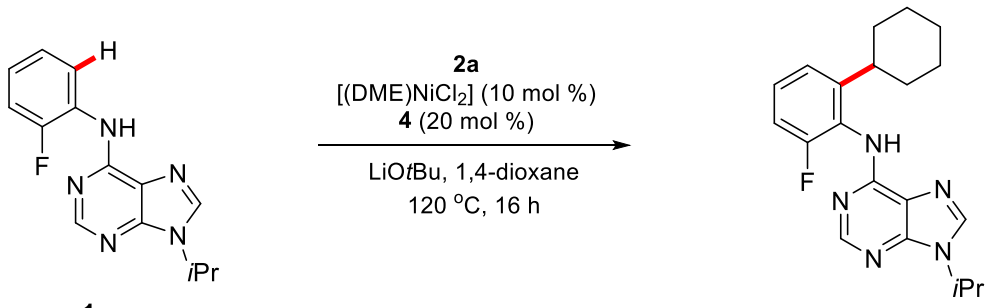
9-*iso*Propyl-*N*-(*m*-tolyl)-9*H*-purin-6-amine **(1d)** (80 mg, 0.30 mmol), 9-*iso*propyl-*N*-[3-(trifluoromethyl)phenyl]-9*H*-purin-6-amine (**1f**) (96 mg, 0.30 mmol), [(DME)$NiCl_2$] (6.6 mg, 10 mol %) and LiO*t*Bu (48 mg, 0.60 mmol) were placed in a Schlenk tube. The tube was degassed and purged with N_2 for three times. D*t*BEDA (**4**) (13 µL, 20 mol %), alkyl bromide **2a** (49 mg, 0.30 mmol) and 1,4-dioxane (1.5 mL) were then added, and the mixture was stirred at 120 °C for 16 h. At ambient temperature, CH_2Cl_2 (2.0 mL) was added, and the reaction mixture was transferred into a round flask with CH_2Cl_2 and concentrated under reduced pressure. Purification by flash column chromatography on silica gel (*n*-hexane/EtOAc: 2/1→1/1) to afford **3fa** (16 mg, 13%) as the sole product, and the starting materials **1d** (77 mg, 96%) and **1f** (76 mg, 79%) were reisolated.

Intermolecular Competition Experiment between Different Directing Groups



N-(2-Fluorophenyl)-9-*iso*-propyl-9*H*-purin-6-amine **(1a)** (81 mg, 0.30 mmol), *N*-(2-fluorophenyl)pyrimidin-2-amine (**5**) (57 mg, 0.30 mmol), [(DME)$NiCl_2$] (6.6 mg, 10 mol %) and LiO*t*Bu (48 mg, 0.60 mmol) were placed in a Schlenk tube. The tube was degassed and purged with N_2 for three times. D*t*BEDA (**4**) (13 μL, 20 mol %), alkyl bromide **2a** (49 mg, 0.30 mmol) and 1,4-dioxane (1.5 mL) were then added, and the mixture was stirred at 120 °C for 16 h. After cooling to ambient temperature, the GC conversions were determined by using *n*-dodecane (51 mg, 0.30 mmol) as internal standard.

Reactions in the Presence of Radical Scavengers



1a **3aa**

additive (1.0 equiv)	yield
---	98%
TEMPO	0%
BHT	52%
Galvinoxyl	trace

(a)

N-(2-Fluorophenyl)-9-*iso*-propyl-9*H*-purin-6-amine **(1a)** (81 mg, 0.30 mmol), [(DME)$NiCl_2$] (6.6 mg, 10 mol %), TEMPO (47 mg, 0.30 mmol) and LiO*t*Bu (48 mg, 0.6 mmol) were placed in a 25 mL Schlenk tube. The tube was degassed and purged with N_2 three times. D*t*BEDA (**4**) (13 µL, 20 mol %), bromocyclohexane (**2a**) (74 µL, 0.6 mmol) and 1,4-dioxane (1.5 mL) were then added, and the mixture was stirred at 120 °C for 16 h. After cooling to ambient temperature, CH_2Cl_2 (2 mL) was added. No conversion was observed by GCMS and ^{1}H NMR analysis of the crude reaction mixture. Starting material **1a** (80 mg, 98%) and TEMPO (45 mg, 96%) were reisolated by flash column chromatography on silica gel (*n*-hexane/EtOAc: 200/1→1/1).

(b)

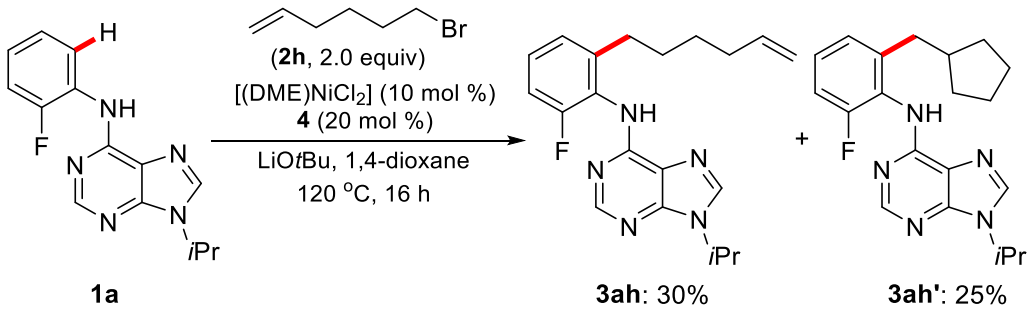
N-(2-Fluorophenyl)-9-*iso*-propyl-9*H*-purin-6-amine **(1a)** (81 mg, 0.30 mmol), [(DME)$NiCl_2$] (6.6 mg, 10 mol %), BHT (66 mg, 0.30 mmol) and LiO*t*Bu (48 mg, 0.6 mmol) were placed in a Schlenk tube. The tube was degassed and purged with N_2 three times. D*t*BEDA (**4**) (13 µL, 20 mol %), bromocyclohexane (**2a**) (74 µL, 0.6 mmol) and 1,4-dioxane (1.5 mL) were then added, and the mixture was stirred at 120 °C for 16 h. At ambient temperature, CH_2Cl_2 (2 mL) was added, and the reaction mixture was

transferred into a round flask with CH_2Cl_2 and concentrated under reduced pressure. Purification by flash column chromatography on silica gel (*n*-hexane/EtOAc: 2/1→1/1) to afford **3aa** (55 mg, 52%).

(c)

N-(2-Fluorophenyl)-9-*iso*-propyl-9*H*-purin-6-amine **(1a)** (81 mg, 0.30 mmol), [(DME)$NiCl_2$] (6.6 mg, 10 mol %), Galvinoxyl (127 mg, 0.30 mmol) and LiO*t*Bu (48 mg, 0.6 mmol) were placed in a Schlenk tube. The tube was degassed and purged with N_2 three times. D*t*BEDA (**4**) (13 µL, 20 mol %), bromocyclohexane (**2a**) (74 µL, 0.6 mmol) and 1,4-dioxane (1.5 mL) were then added, and the mixture was stirred at 120 °C for 16 h. After cooling to ambient temperature, CH_2Cl_2 (2.0 mL) was added. Trace conversion was observed by GCMS analysis of the crude reaction mixture.

Reaction with 6-Bromohexene (2h)

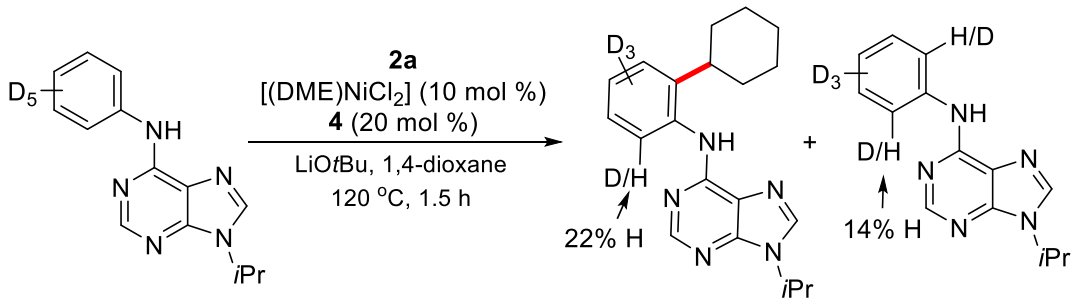


N-(2-Fluorophenyl)-9-*iso*-propyl-9*H*-purin-6-amine **(1a)** (81 mg, 0.30 mmol), [(DME)$NiCl_2$] (6.6 mg, 10 mol %) and LiO*t*Bu (48 mg, 0.6 mmol) were placed in a 25 mL Schlenk tube. The tube was degassed and purged with N_2 three times. D*t*BEDA (**4**) (13 µL, 20 mol %), 6-bromohexene (**2h**) (98 mg, 0.6 mmol) and 1,4-dioxane (1.5 mL) were then added, and the mixture was stirred at 120 °C for 16 h. At ambient temperature, CH_2Cl_2 (2 mL) was added, and the reaction mixture was transferred into a round flask with CH_2Cl_2 and concentrated under reduced pressure. Isolation by GPC yielded **3ah** (32 mg, 30%) and **3ah'** (26 mg, 25%) as colorless oils.

***N*-[2-Fluoro-6-(hex-5-en-1-yl)phenyl]-9-*iso*-propyl-9*H*-purin-6-amine (3ah)**: ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.33 (s, 1H), 7.78 (s, 1H), 7.71 (br s, 1H), 7.18 (ddd, *J* = 8.1, 7.2, 5.5 Hz, 1H), 7.03 (d, *J* = 7.2 Hz, 1H), 6.97 (ddd, *J* = 9.6, 8.1, 1.5 Hz, 1H), 5.59 (ddt, *J* = 16.9, 10.2, 6.6 Hz, 1H), 4.83 (dd, *J* = 17.1, 1.7 Hz, 1H), 4.78 (dd, *J* = 10.1, 1.7 Hz, 1H), 4.75 (hept, *J* = 6.9 Hz, 1H), 2.60 (t, *J* = 7.8 Hz, 2H), 1.88 (q, *J* = 7.1 Hz, 2H), 1.54 (d, *J* = 6.8 Hz, 6H), 1.52–1.42 (m, 2H), 1.26 (p, *J* = 7.5 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$) δ = 158.7 (C_q, $^{1}J_{C\text{-}F}$ = 247.6 Hz), 153.9 (C_q), 152.7 (CH), 149.4 (C_q), 142.9 (C_q), 138.4 (CH), 138.1(CH), 128.1 (CH, $^{3}J_{C\text{-}F}$ = 8.5 Hz), 124.8 (CH, $^{4}J_{C\text{-}F}$ = 3.2 Hz), 123.6 (C_q, $^{2}J_{C\text{-}F}$ = 12.9 Hz), 120.3 (C_q), 114.3 (CH_2), 113.5 (CH, $^{2}J_{C\text{-}F}$ = 20.6 Hz), 47.2 (CH), 33.5 (CH_2), 31.5 (CH_2), 29.6 (CH_2), 28.6 (CH_2), 22.7 (CH_3). ^{19}F NMR (282 MHz, $CDCl_3$) δ = -119.43 (dd, *J* = 9.5, 5.5 Hz). IR (neat): 3198, 2977, 2930, 1612, 1470, 1227, 668 cm^{-1}. MS (ESI) *m/z* (relative intensity) 354 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{20}H_{25}FN_5$ [M+H$^+$] 354.2089, found 354.2089.

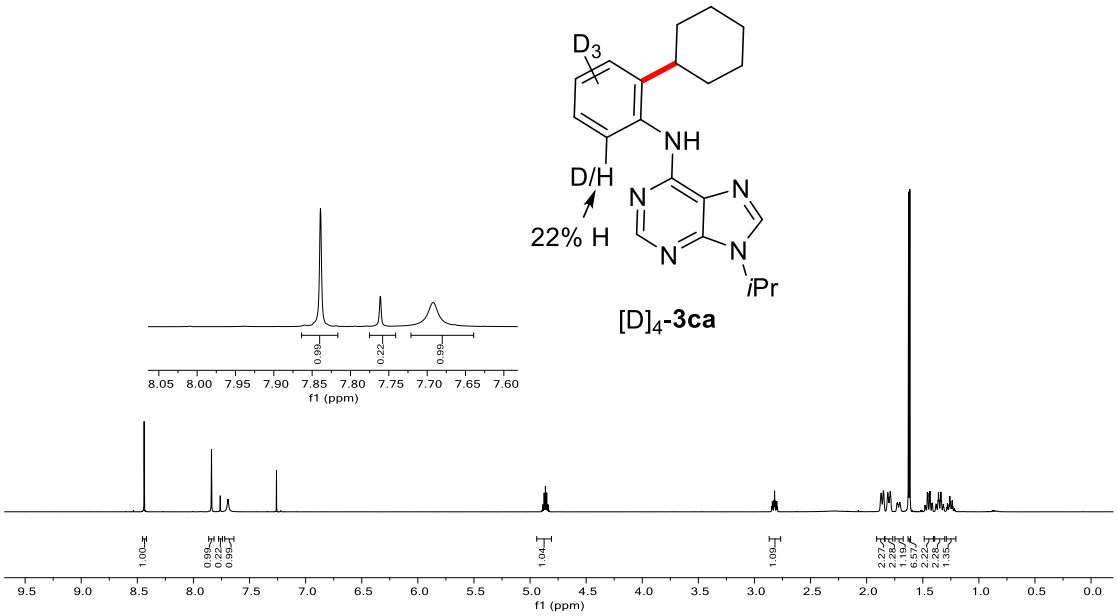
***N*-[2-(Cyclopentylmethyl)-6-fluorophenyl]-9-*iso*-propyl-9*H*-purin-6-amine (3ah')**: ^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.34 (s, 1H), 7.75 (s, 1H), 7.58 (s, 1H), 7.17 (ddd, *J* = 8.1, 7.1, 5.3 Hz, 1H), 7.04 (d, *J* = 7.1 Hz, 1H), 6.97 (ddd, *J* = 9.6, 8.1, 1.5 Hz, 1H), 4.79 (hept, *J* = 6.9 Hz, 1H), 2.61 (d, *J* = 7.4 Hz, 2H), 2.12–1.87 (m, 1H), 1.68–1.40 (m, 10H), 1.39–1.32 (m, 2H), 1.11–0.93 (m, 2H). ^{13}C NMR (125 MHz, $CDCl_3$) δ = 158.7 (C_q, $^{1}J_{C\text{-}F}$ = 247.7 Hz), 153.8 (C_q), 152.7 (CH), 149.5 (C_q), 142.5 (C_q), 138.1(CH), 127.9 (CH, $^{3}J_{C\text{-}F}$ = 8.4 Hz), 125.3 (CH, $^{4}J_{C\text{-}F}$ = 3.0 Hz), 123.68 (C_q, $^{2}J_{C\text{-}F}$ = 13.0 Hz), 120.3 (C_q), 113.4 (CH, $^{2}J_{C\text{-}F}$ = 20.6 Hz), 47.2 (CH), 40.8 (CH), 37.5 (CH_2), 32.6 (CH_2), 24.8 (CH_2), 22.8 (CH_3). ^{19}F NMR (282 MHz, $CDCl_3$) δ = -119.17 (dd, *J* = 9.5, 5.5 Hz). IR (neat): 3181, 2948, 2867, 1608, 1468, 1225, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 354 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{20}H_{25}FN_5$ [M+H$^+$] 354.2089, found 354.2090.

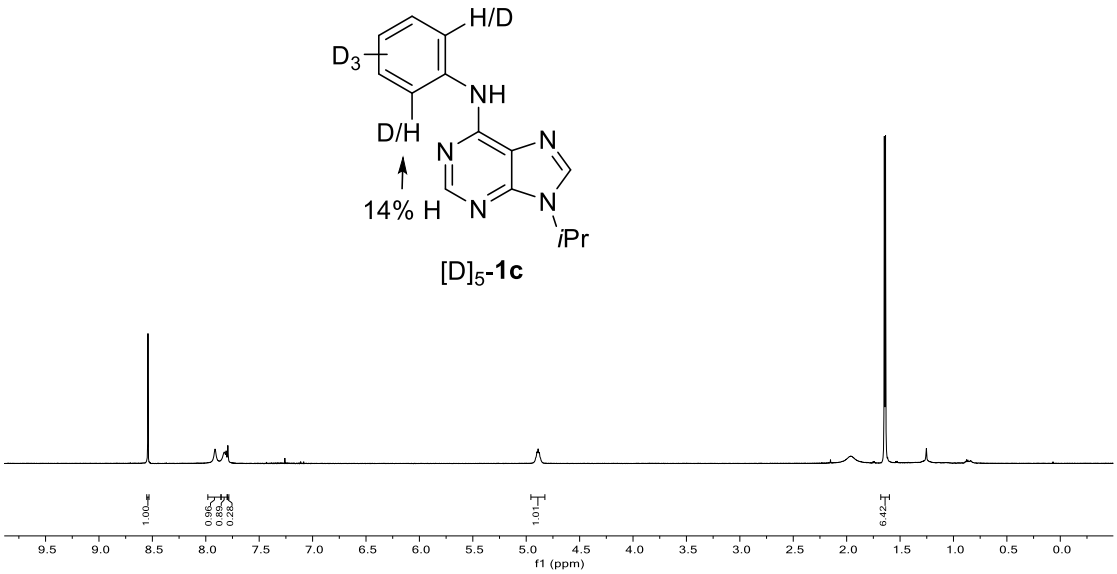
H/D Exchange Experiments with [D]$_5$-1c as the Substrate:



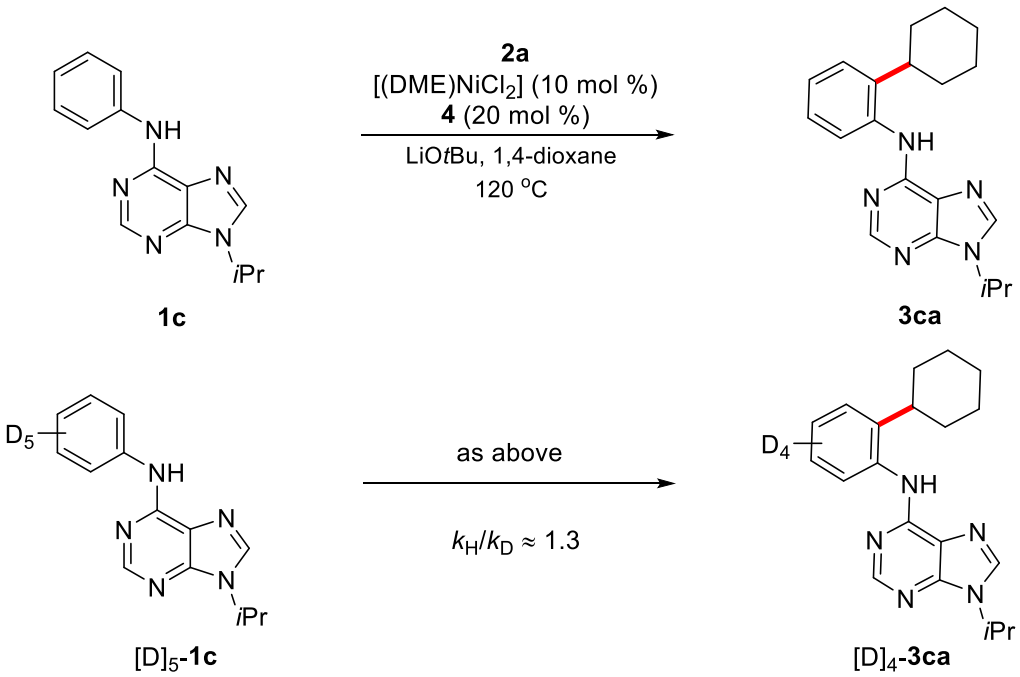
[D]$_5$-**1c** [D]$_4$-**3ca**: 64% [D]$_5$-**1c**: 13%

Substrate [D]$_5$-**1c** (77 mg, 0.3 mmol), [(DME)NiCl$_2$] (6.6 mg, 10 mol %) and LiO*t*Bu (48 mg, 0.60 mmol) were placed in a Schlenk tube. The tube was degassed and purged with N_2 three times. D*t*BEDA (**4**) (13 µL, 20 mol %), bromocyclohexane (**2a**) (41 µL, 0.33 mmol) and 1,4-dioxane (1.5 mL) were then added, and the mixture was stirred at 120 °C for 1.5 h. At ambient temperature, CH_2Cl_2 (2.0 mL) was added, and the reaction mixture was transferred into a round flask with CH_2Cl_2 and concentrated under reduced pressure. Purification by flash column chromatography on silica gel (*n*-hexane/EtOAc: 2/1→1/1) to afford [D]$_4$-**3ca** (65 mg, 64%) and [D]$_5$-**1c** (10 mg, 13%).





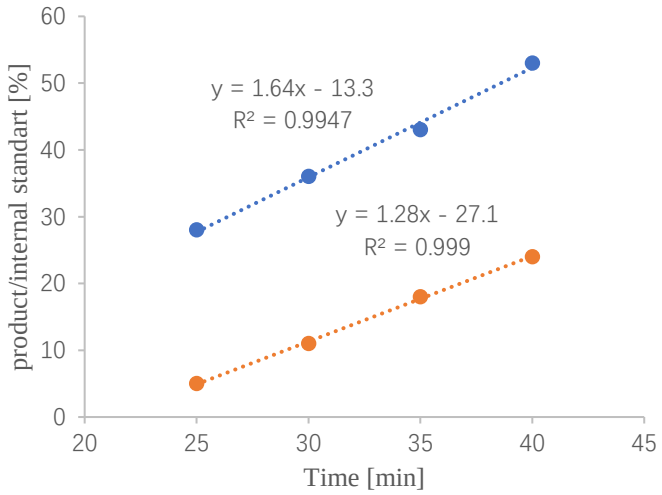
KIE Experiments with 1c and [D]$_5$-1c as the Substrates



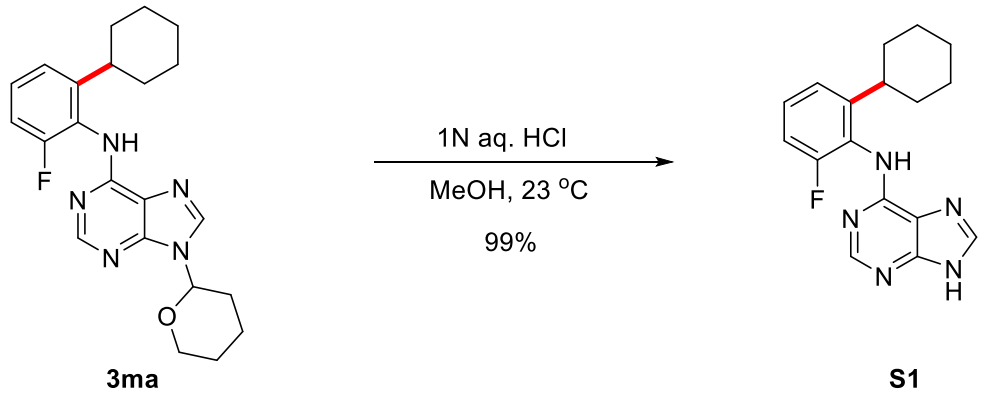
Independent reactions of **1c** or [D]$_5$-**1c** with **2a** were performed to determine the corresponding KIE value. Following general procedure **A**, **1c** (76 mg, 0.3 mmol) or [D]$_5$-**1c** (77 mg, 0.3 mmol) were reacted with **2a** (41μL, 0.33 mmol). After cooling to ambient temperature, the GC conversions were determined using *n*-dodecane (51 mg,

0.30 mmol) as internal standard:

T [min]	25	30	35	40
5ca/%	28	36	43	53
$[D]_n$-**5ca**/%	5	11	18	24



Removal of the THP Group



3ma **S1**

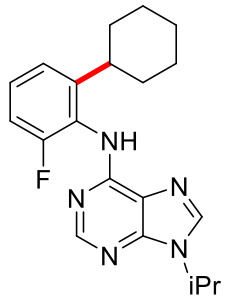
***N*-(2-Cyclohexyl-6-fluorophenyl)-9*H*-purin-6-amine (S1)**: To a solution of **3ma** (79mg, 0.20 mmol) in MeOH (1.0 mL), aqueous HCl (1N, 1.0 mL) was added and stirred for 3 h at 23 °C. The reaction mixture was poured into EtOAc (10 mL), and then

saturated aqueous Na_2CO_3 solution was added until the pH was adjusted to 8. The aqueous layer was extracted with EtOAc (3 × 10 mL), the combined organic layers were dried with Na_2SO_4 and concentrated *in vacuo* to afford **7** (62 mg, 99%) as a white solid. M.p. = 270 °C. ^{1}H NMR (500 MHz, DMSO-d_6) δ = 9.14 (br s, 1H), 8.16 (s, 1H), 8.10 (s, 1H), 7.28 (ddd, J = 8.0, 7.8, 5.6 Hz, 1H), 7.15 (dd, J = 7.8, 1.4 Hz, 1H), 7.05 (ddd, J = 9.7, 8.1, 1.4 Hz, 1H), 3.34 (br s, 1H), 2.84 (tt, J = 12.1, 3.1 Hz, 1H), 1.79–1.56 (m, 5H), 1.43–1.24 (m, 2H), 1.23–1.10 (tt, J = 11.6, 5.9 Hz, 3H). ^{13}C NMR (125 MHz, DMSO-d_6) δ = 158.6 (C_q, $^1J_{C\text{-}F}$ = 245.5 Hz), 153.6 (C_q), 151.9 (CH), 151.5 (C_q), 147.9 (C_q), 140.1 (CH), 127.6 (CH, $^3J_{C\text{-}F}$ = 8.8 Hz), 124.2 (C_q, $^2J_{C\text{-}F}$ = 13.0 Hz), 121.7 (CH, $^4J_{C\text{-}F}$ = 3.1 Hz), 118.2 (C_q), 112.7 (CH, $^2J_{C\text{-}F}$ = 21.0 Hz), 38.1 (CH, $^4J_{C\text{-}F}$ = 2.1 Hz), 32.9 (CH_2), 26.4 (CH_2), 25.5 (CH_2). ^{19}F NMR (471 MHz, DMSO-d_6) δ = -118.88 (dd, J = 9.8, 5.6 Hz). IR (neat): 3197, 2929, 2850, 1611, 1591, 1246, 649 cm^{-1}. MS (ESI) *m/z* (relative intensity) 312 [M+H$^+$] (100). HR-MS (ESI) *m/z* calcd for $C_{17}H_{19}FN_5$ [M+H$^+$] 312.1619, found 312.1630.

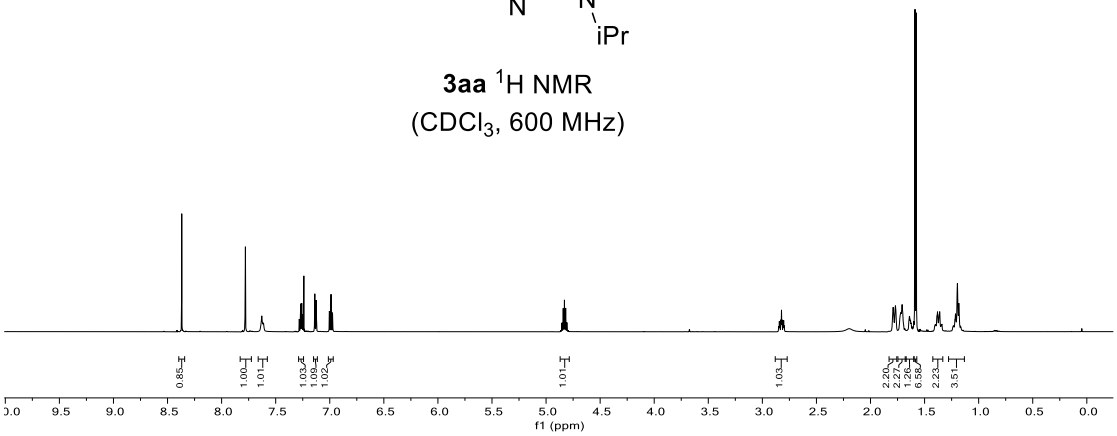
References

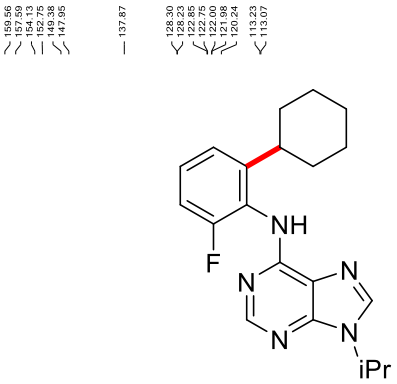
[1] Z. Ruan, S. Lackner and L. Ackermann, *ACS Catal.*, 2016, **6**, 4690–4693.

[2] S. Satishkumar and M. K. Lakshman, *Chem. Commun.*, 2017, **53**, 2226–2229.

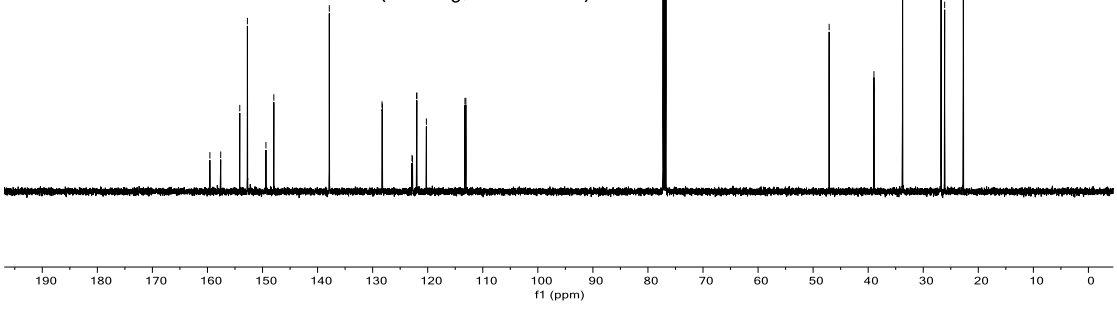


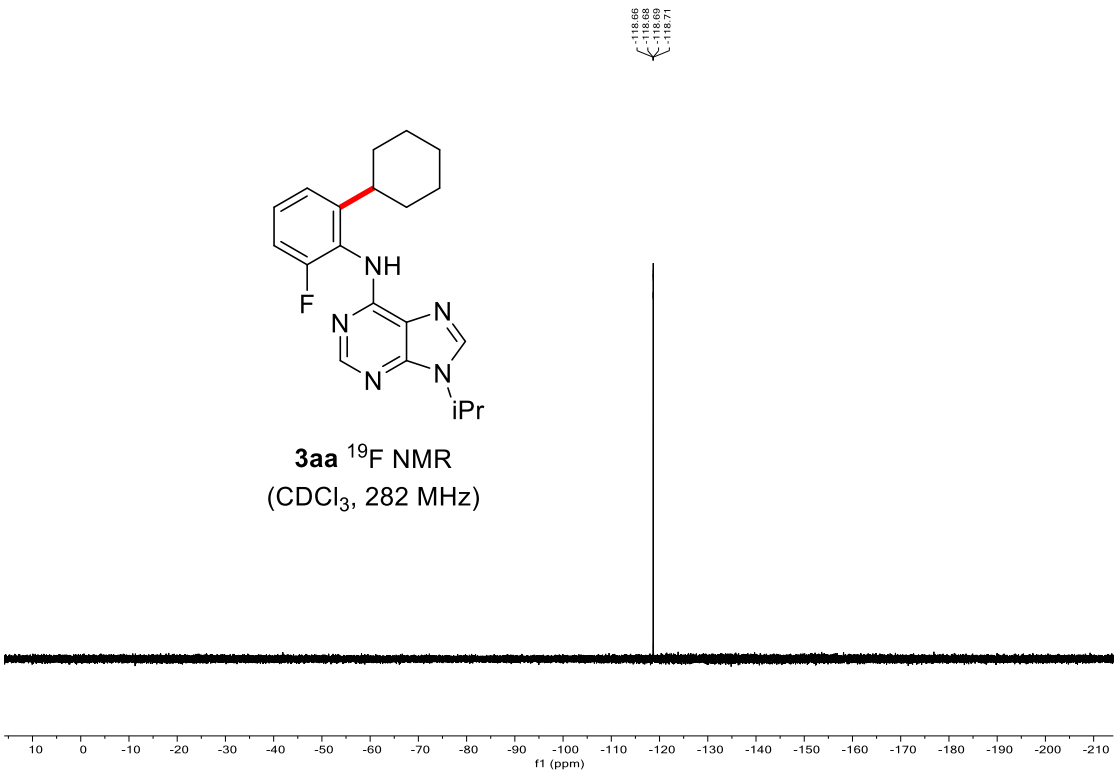
3aa ^{1}H NMR
($CDCl_3$, 600 MHz)



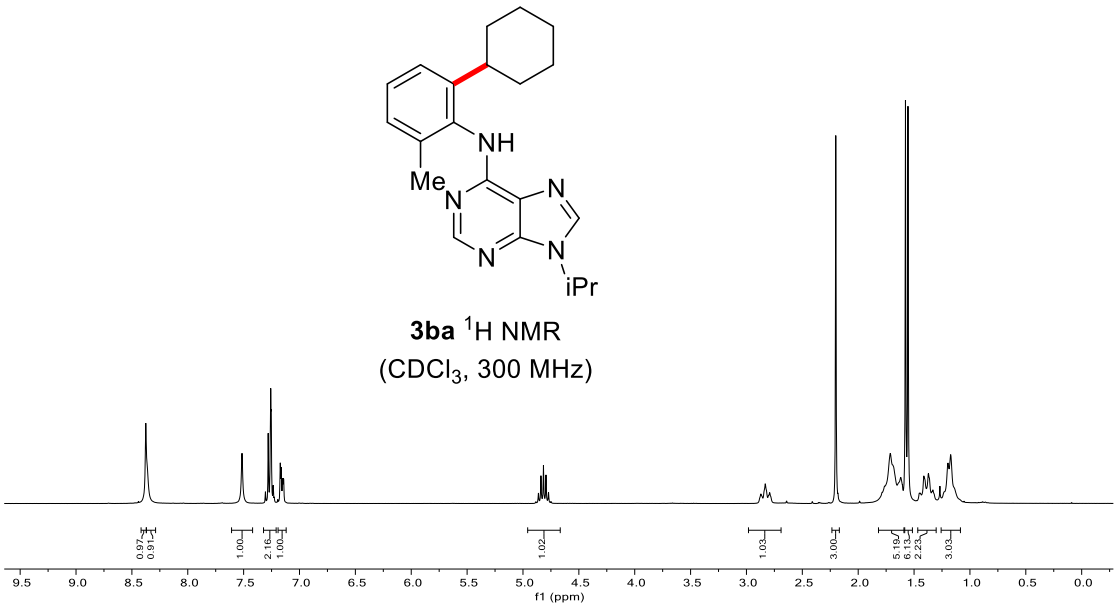


3aa ^{13}C NMR
($CDCl_3$, 125 MHz)

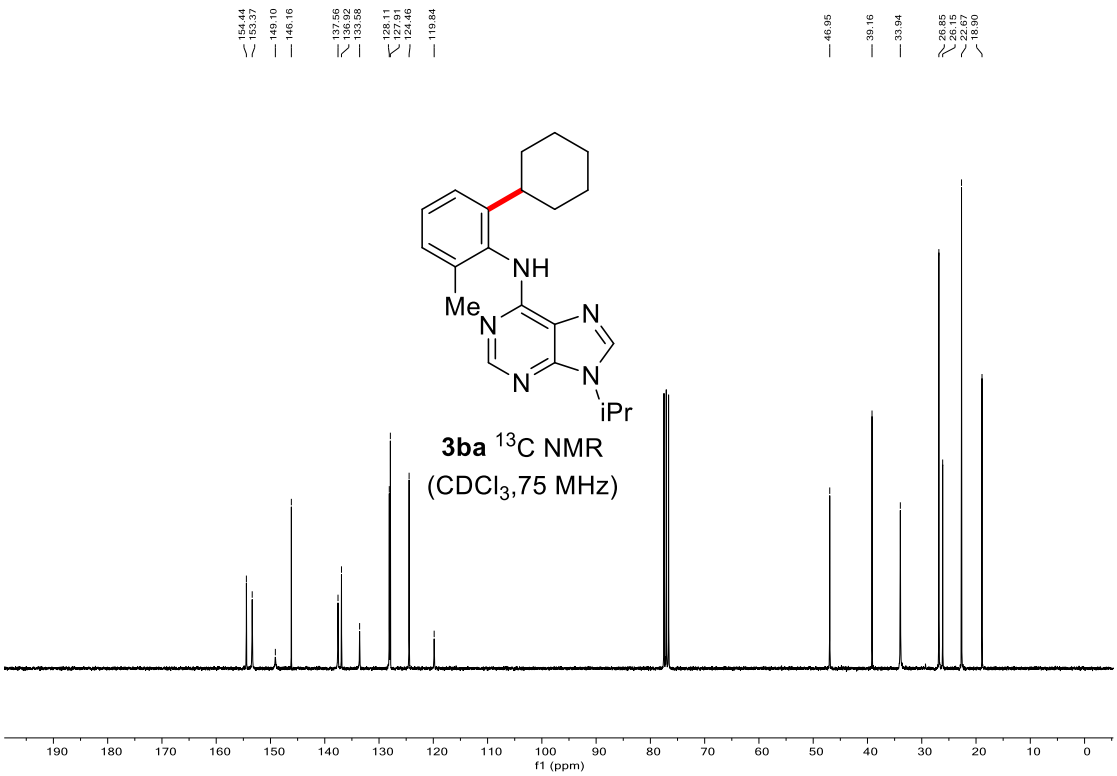


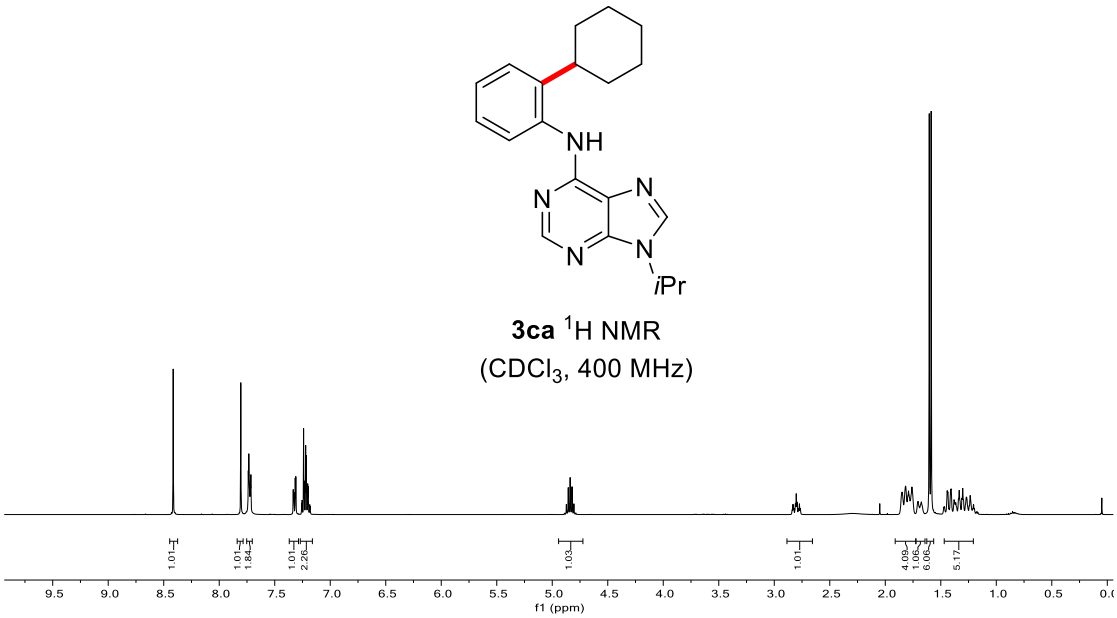


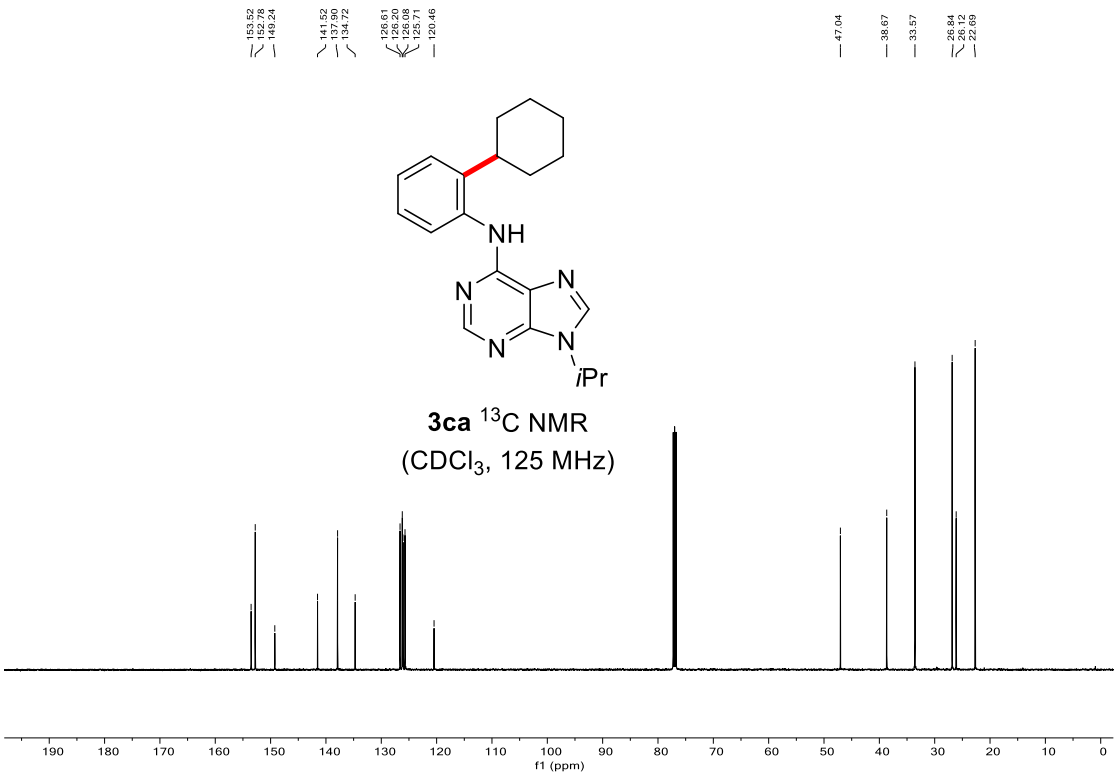
3aa ^{19}F NMR
($CDCl_3$, 282 MHz)



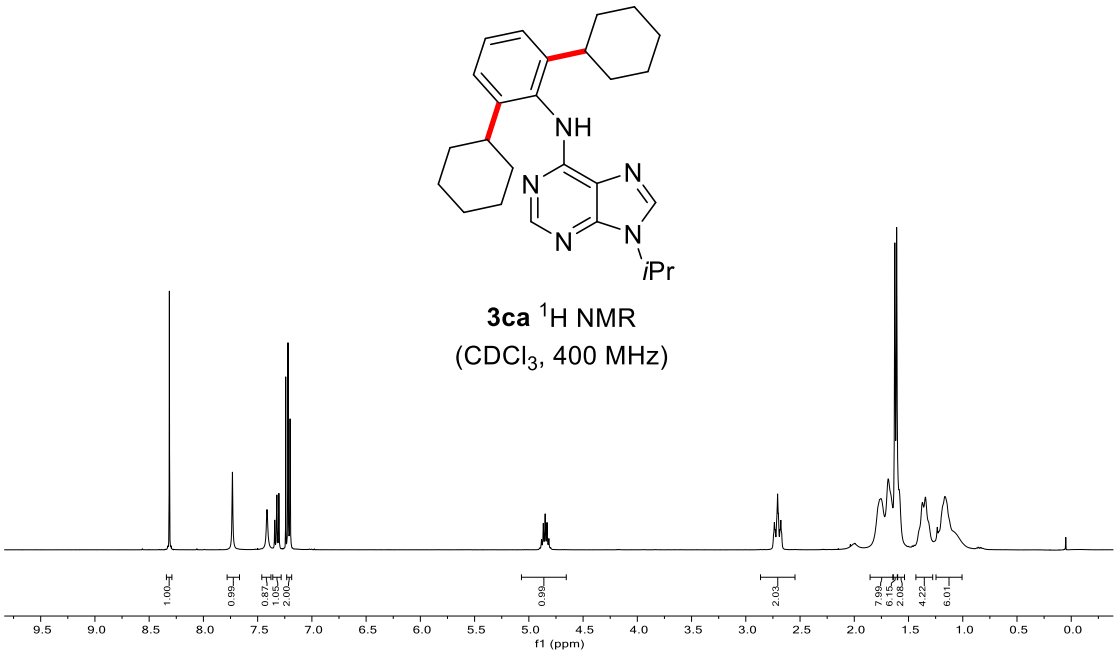
3ba ^{1}H NMR
($CDCl_3$, 300 MHz)


154.44
153.37
149.10
146.16
137.56
136.92
133.58
128.11
127.91
124.46
119.84
46.95
39.16
33.94
26.85
26.15
22.67
18.90
NH
Me
N
N
N
N
iPr
3ba 13C NMR
(CDCl3,75 MHz)
f1 (ppm)

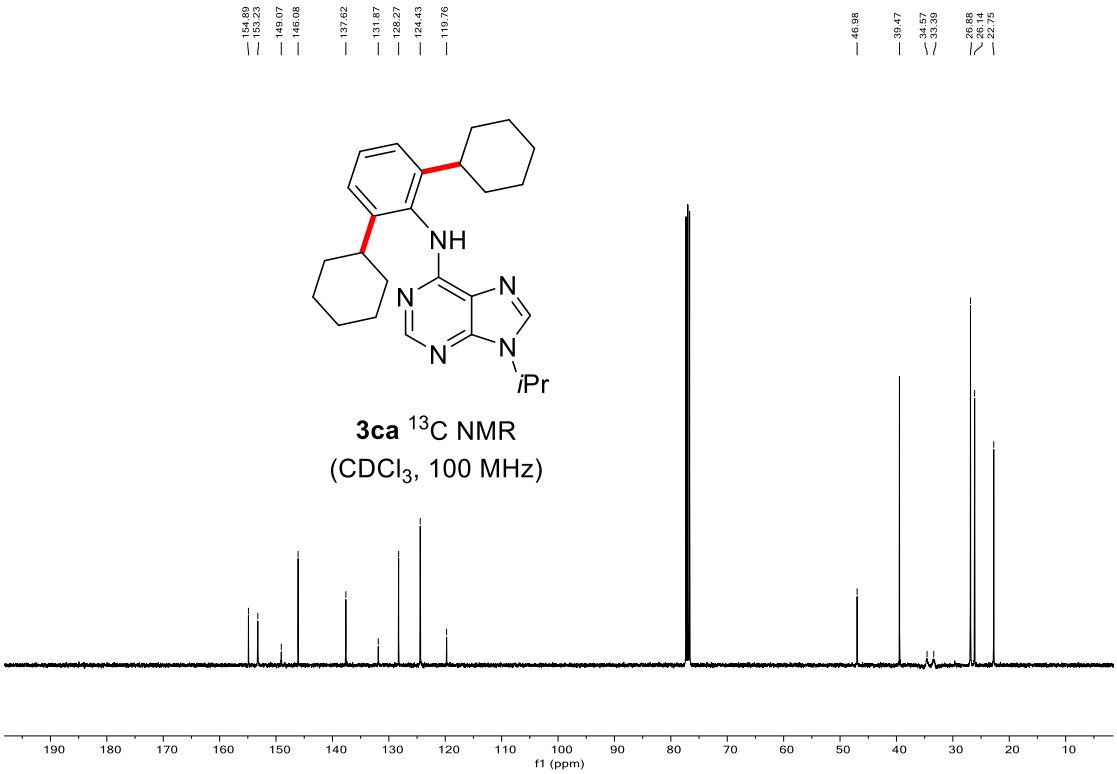

NH
N
N
N
N
iPr
3ca 1H NMR
(CDCl3, 400 MHz)
1.01
1.01
1.84
1.01
2.26
1.03
1.01
4.08
1.06
6.08
5.17
f1 (ppm)



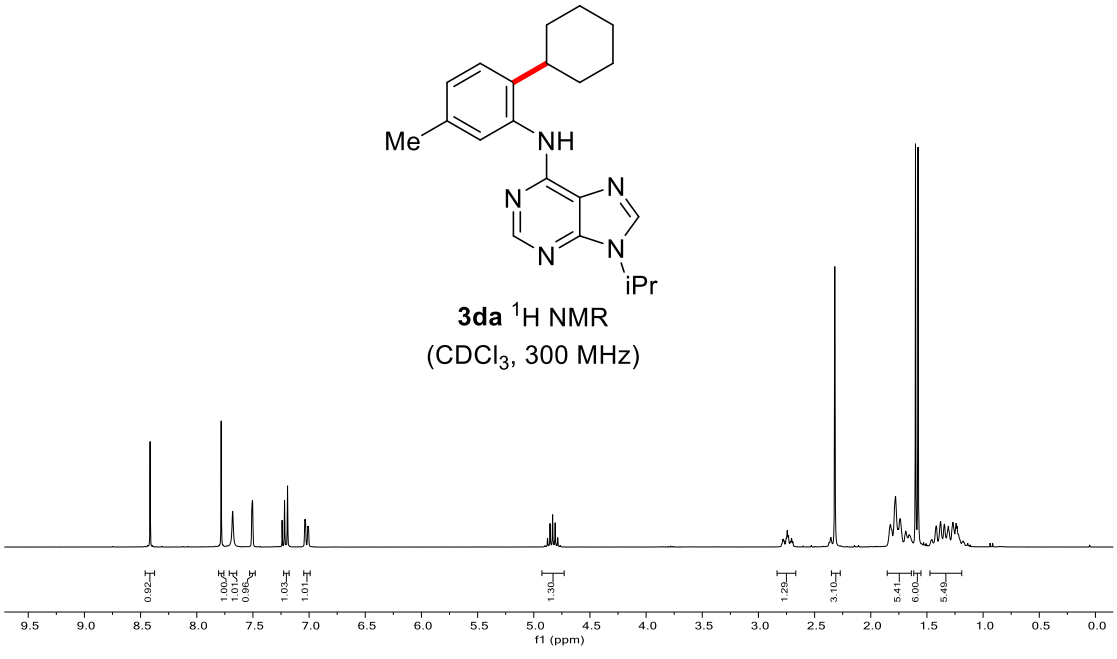
3ca ^{13}C NMR
($CDCl_3$, 125 MHz)



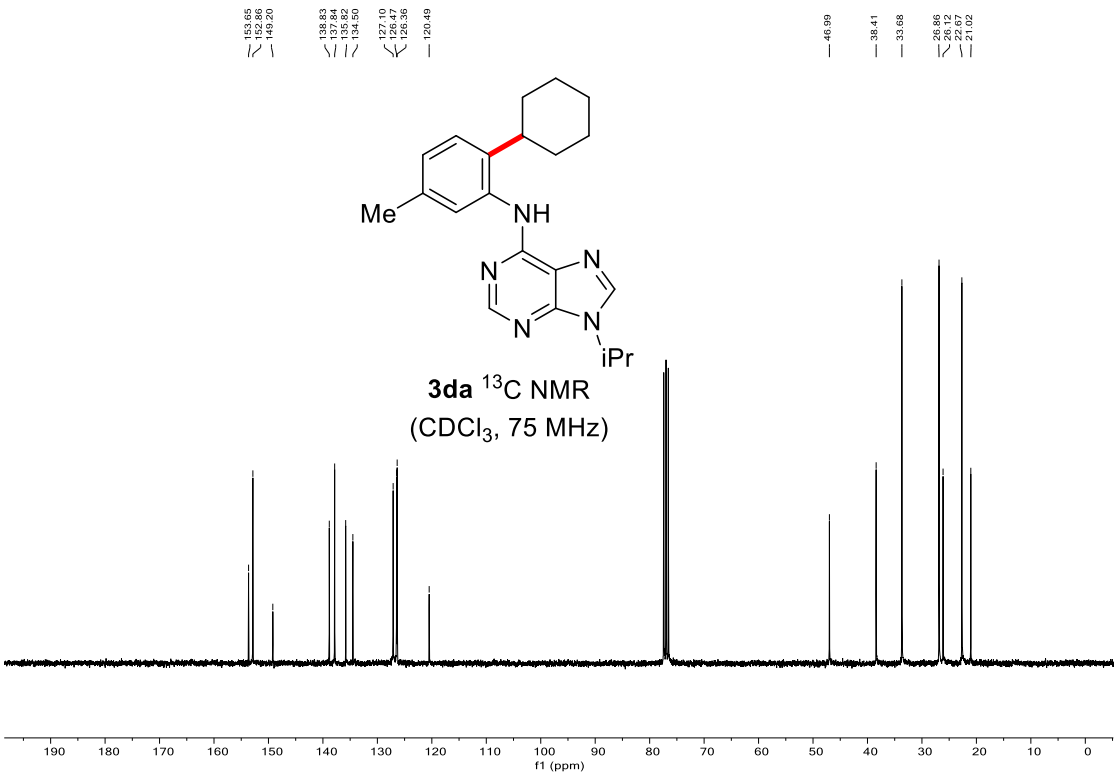
3ca ^{1}H NMR
($CDCl_3$, 400 MHz)



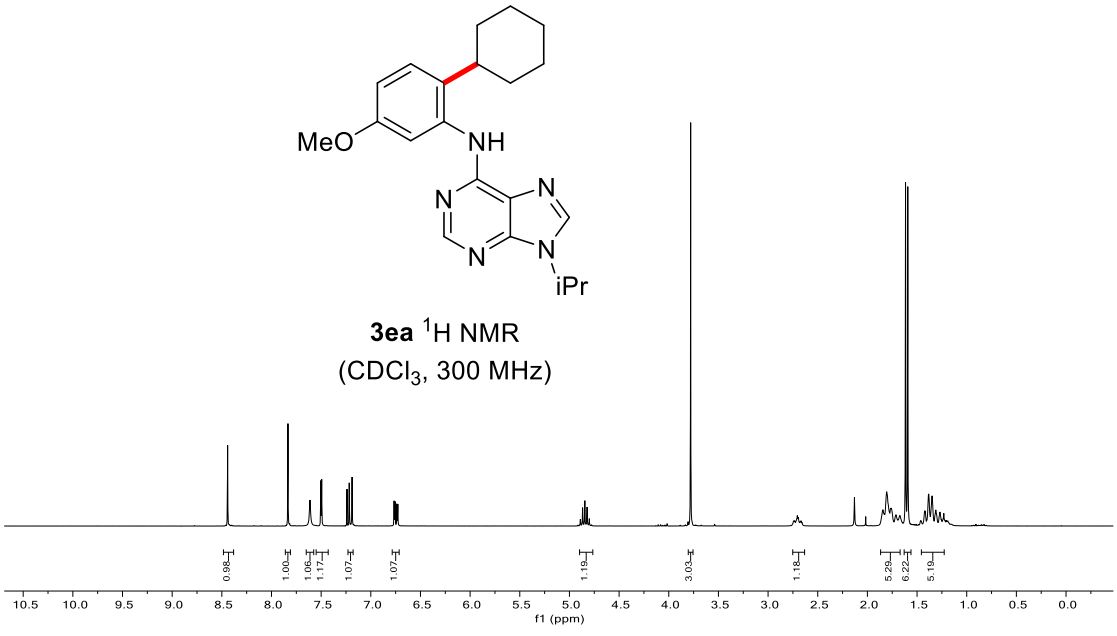
3ca ^{13}C NMR
($CDCl_3$, 100 MHz)



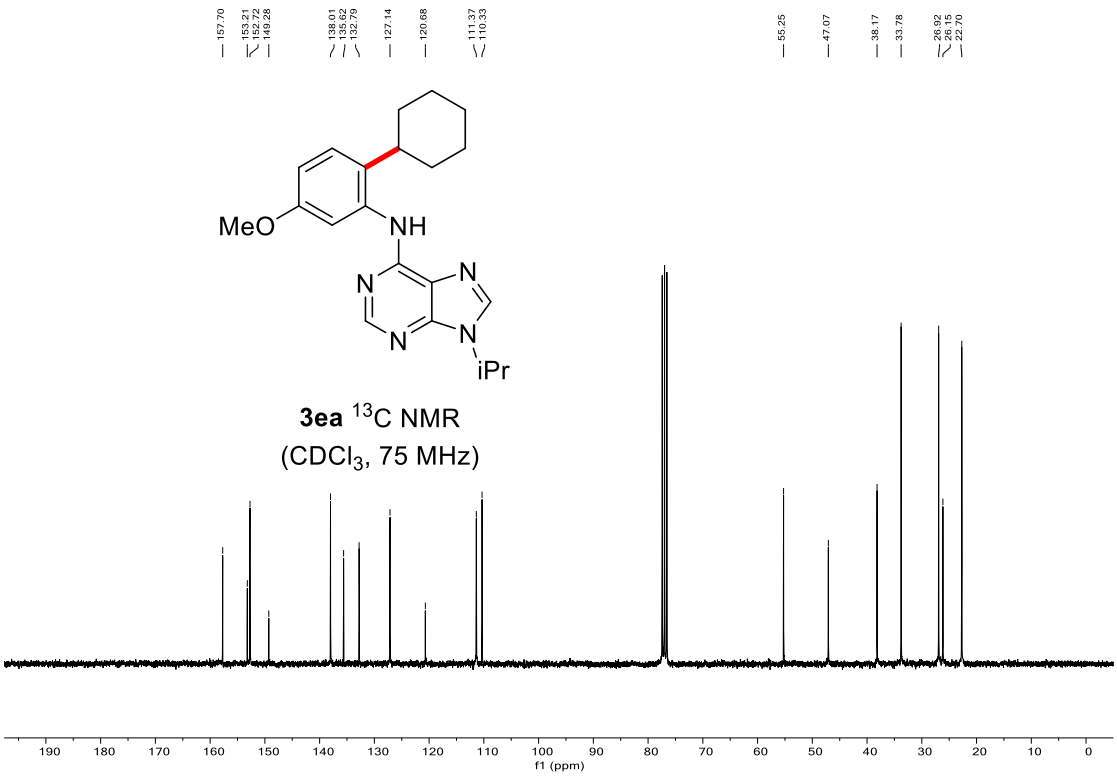
3da ^{1}H NMR
($CDCl_3$, 300 MHz)



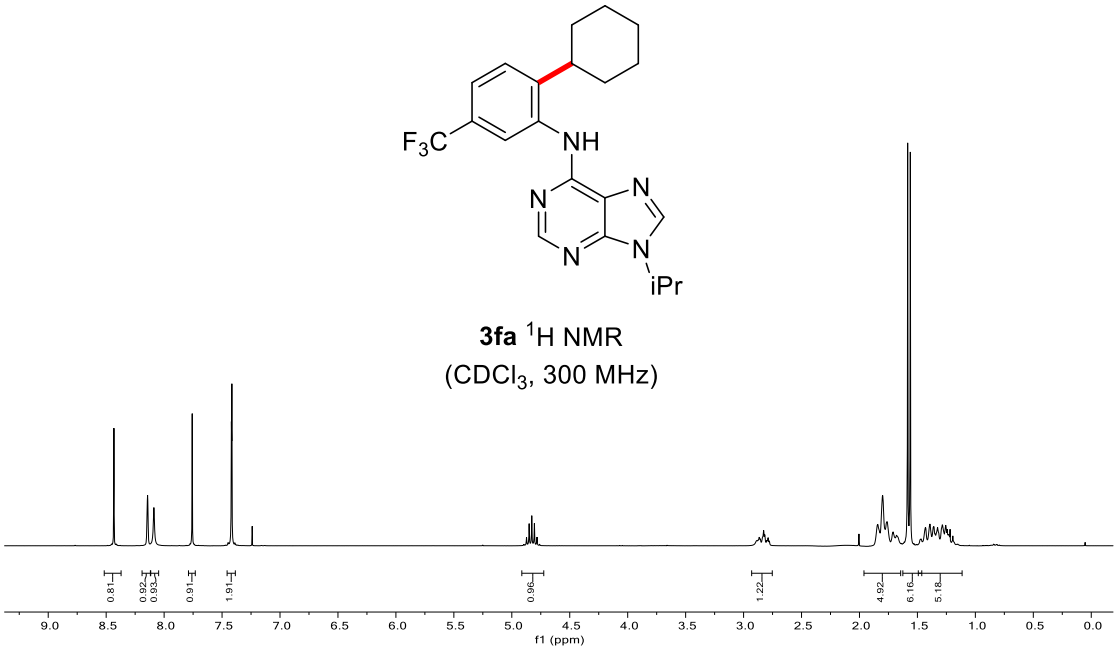
3da ^{13}C NMR
($CDCl_3$, 75 MHz)



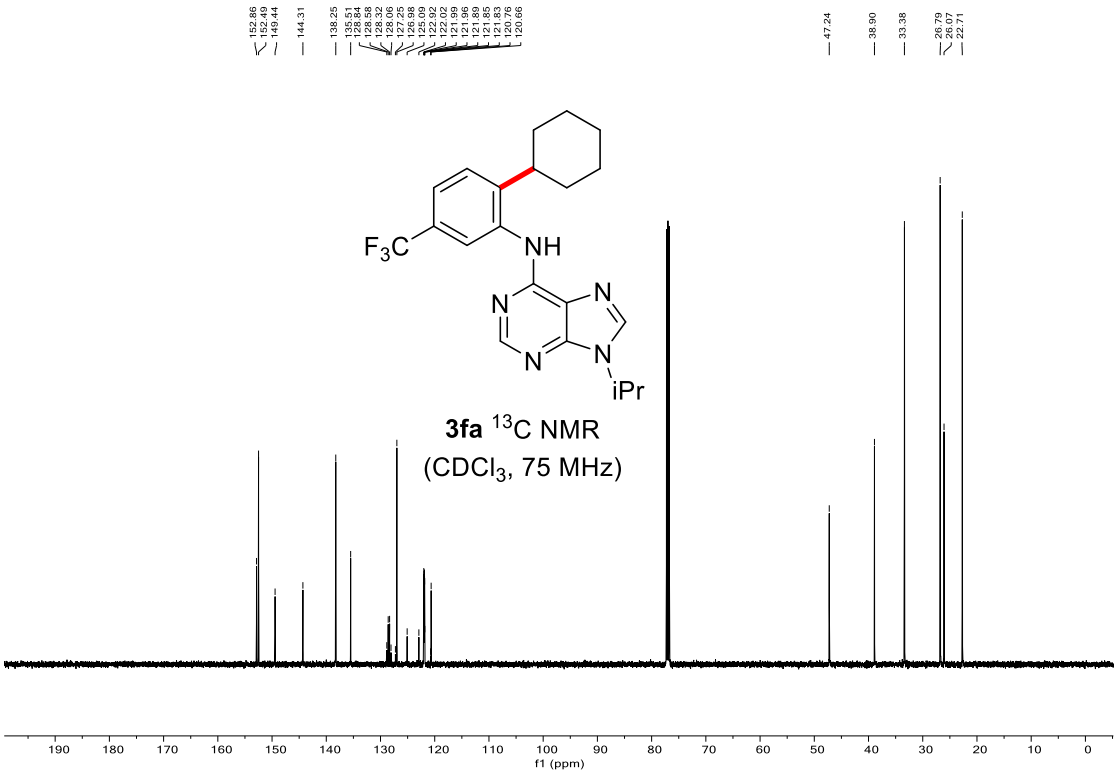
3ea ^{1}H NMR
($CDCl_3$, 300 MHz)



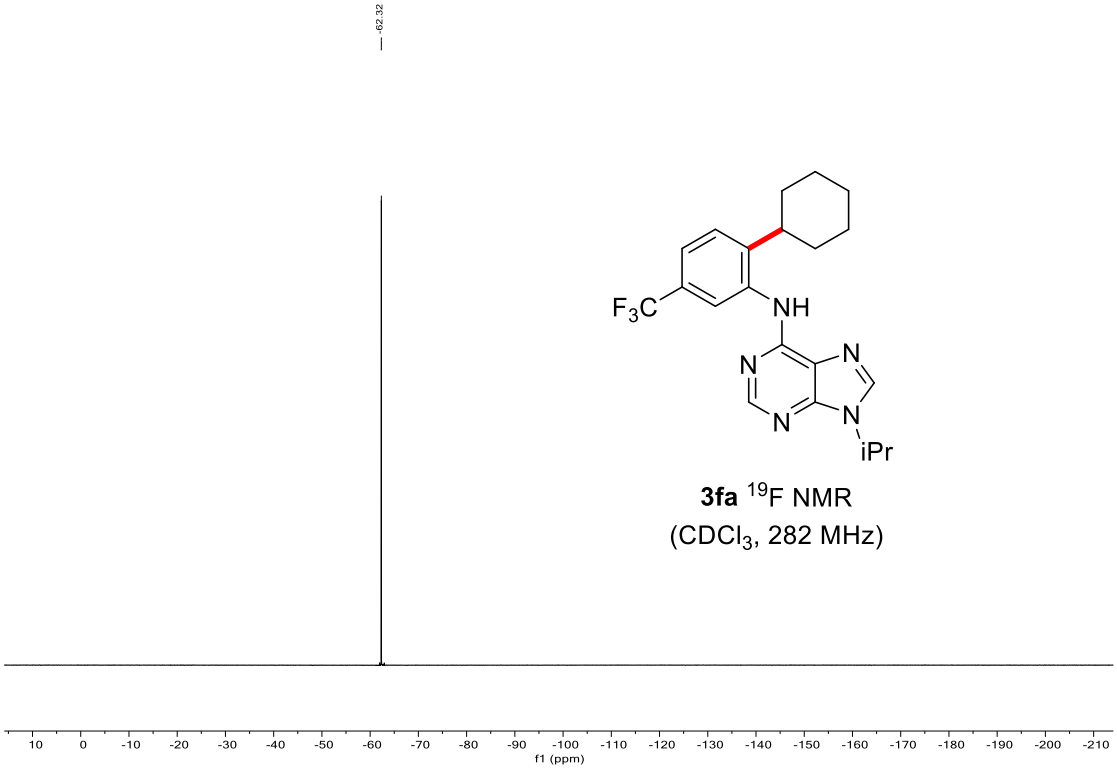
3ea ^{13}C NMR
($CDCl_3$, 75 MHz)



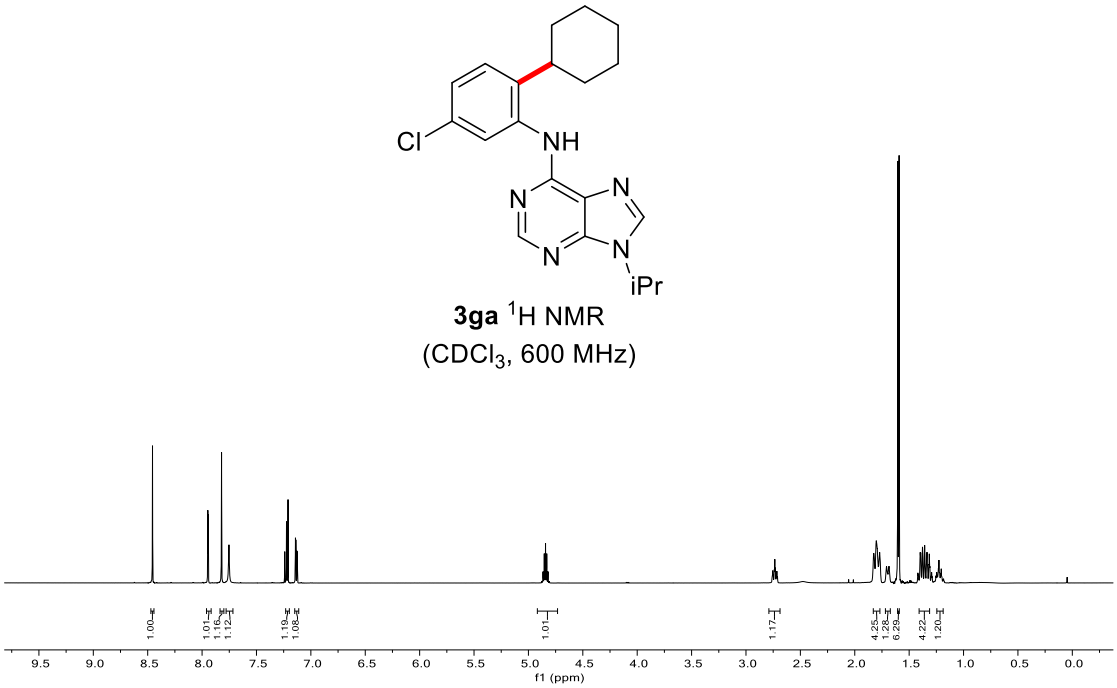
3fa ^{1}H NMR
($CDCl_3$, 300 MHz)



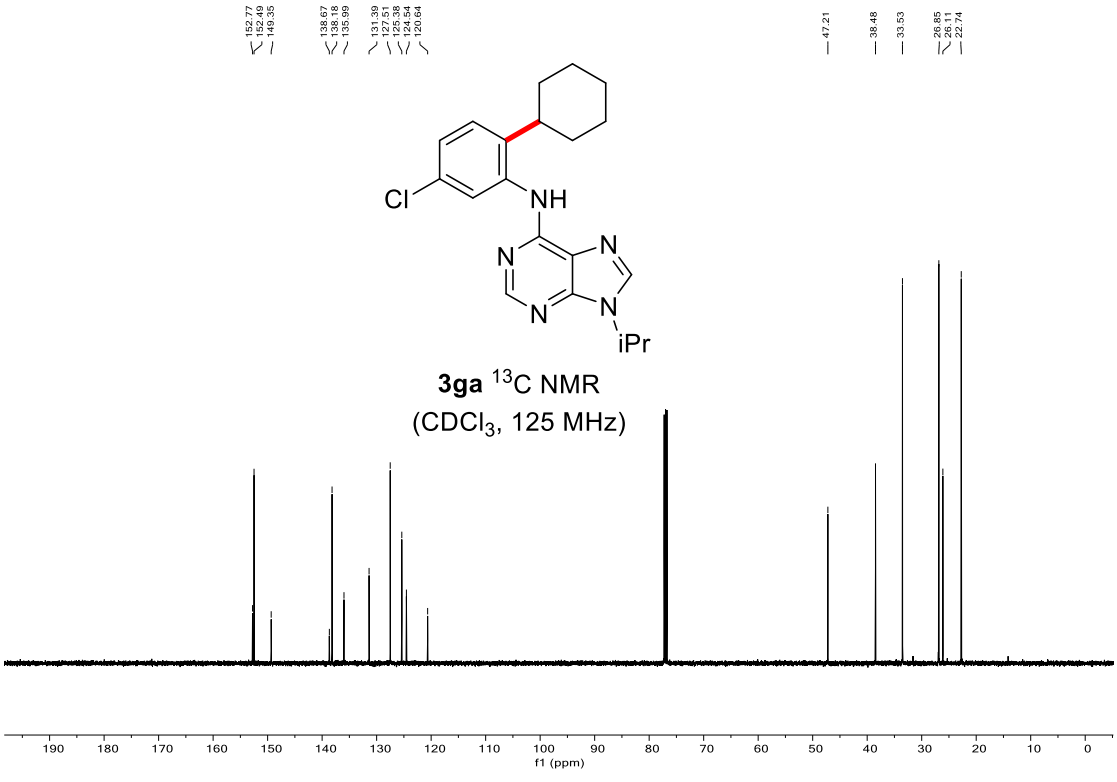
3fa ^{13}C NMR
($CDCl_3$, 75 MHz)



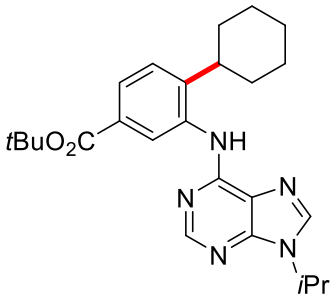
3fa ^{19}F NMR
($CDCl_3$, 282 MHz)



3ga ^{1}H NMR
($CDCl_3$, 600 MHz)

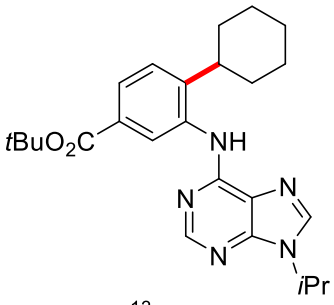


3ga ^{13}C NMR
($CDCl_3$, 125 MHz)



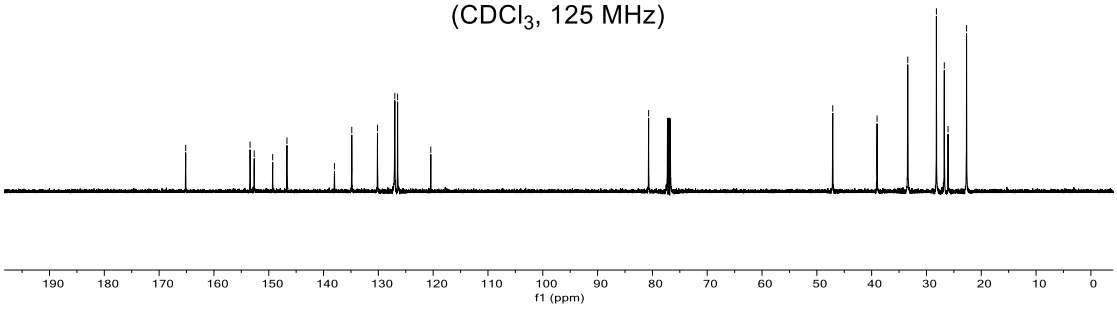
3ha ^{1}H NMR

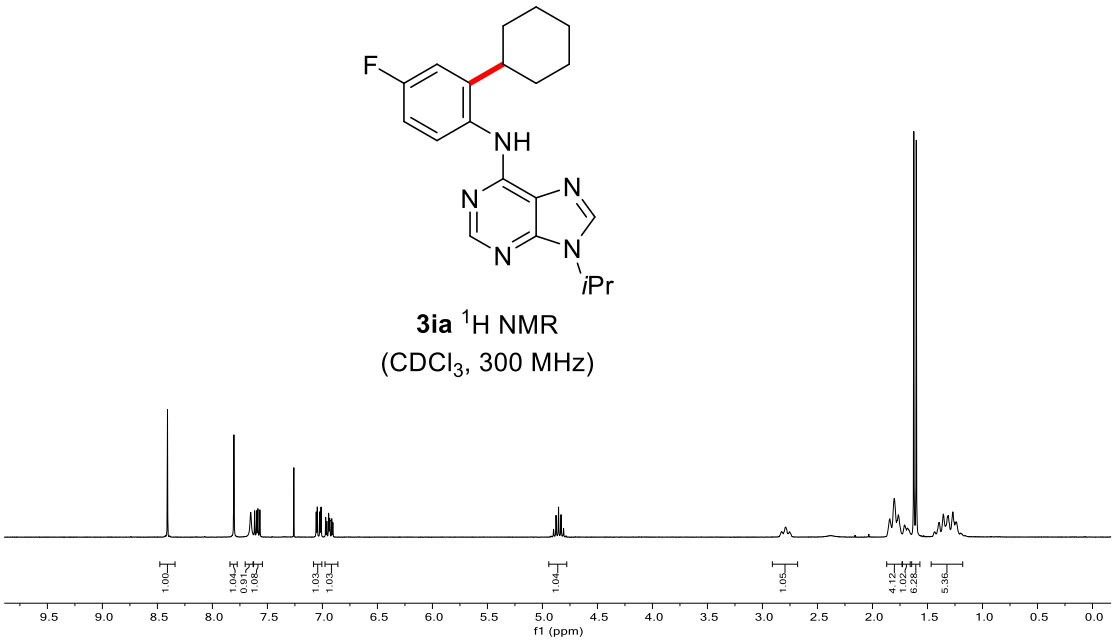
($CDCl_3$, 300 MHz)



3ha ^{13}C NMR

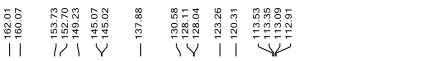
($CDCl_3$, 125 MHz)

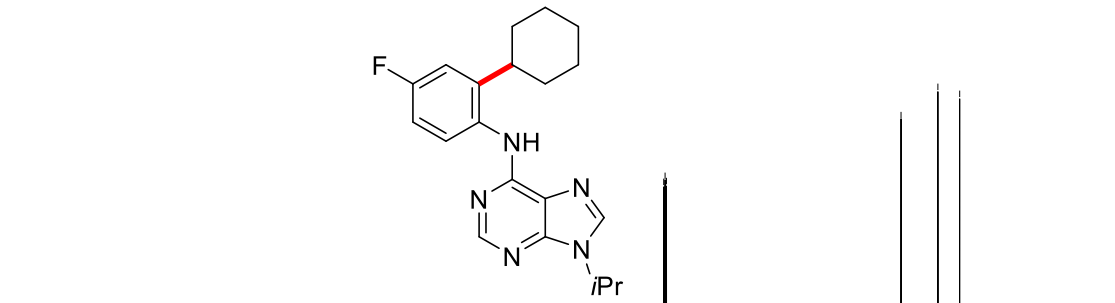




3ia ^{1}H NMR

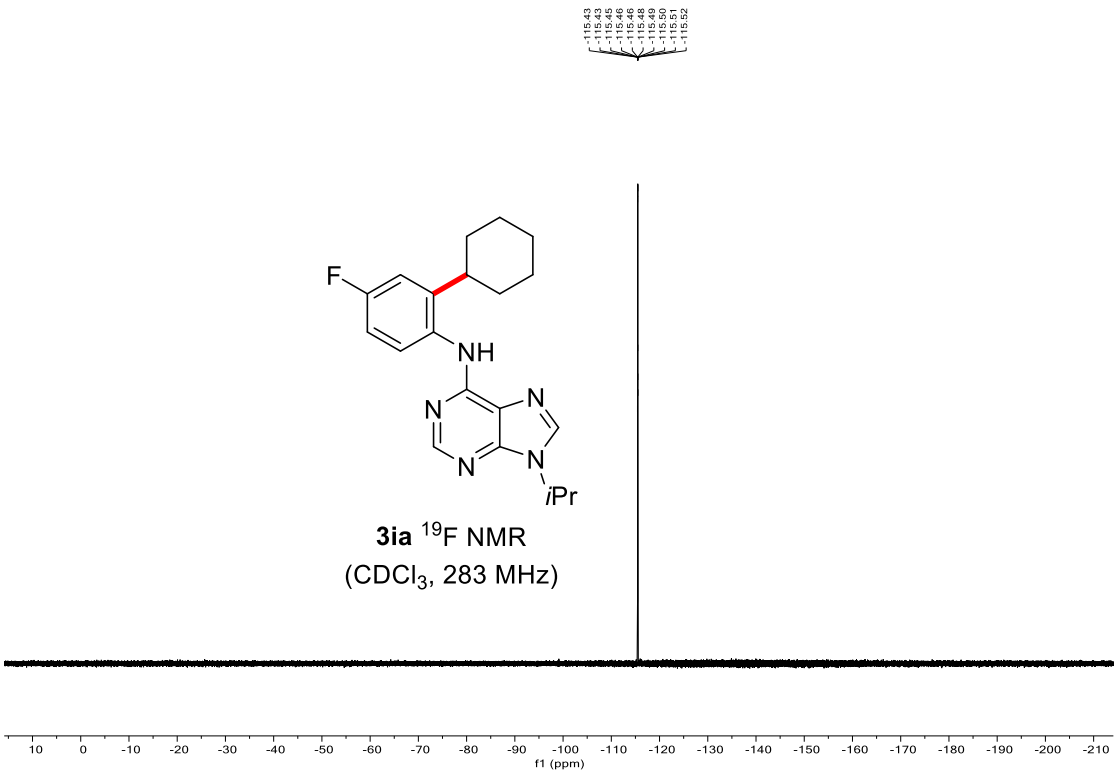
($CDCl_3$, 300 MHz)



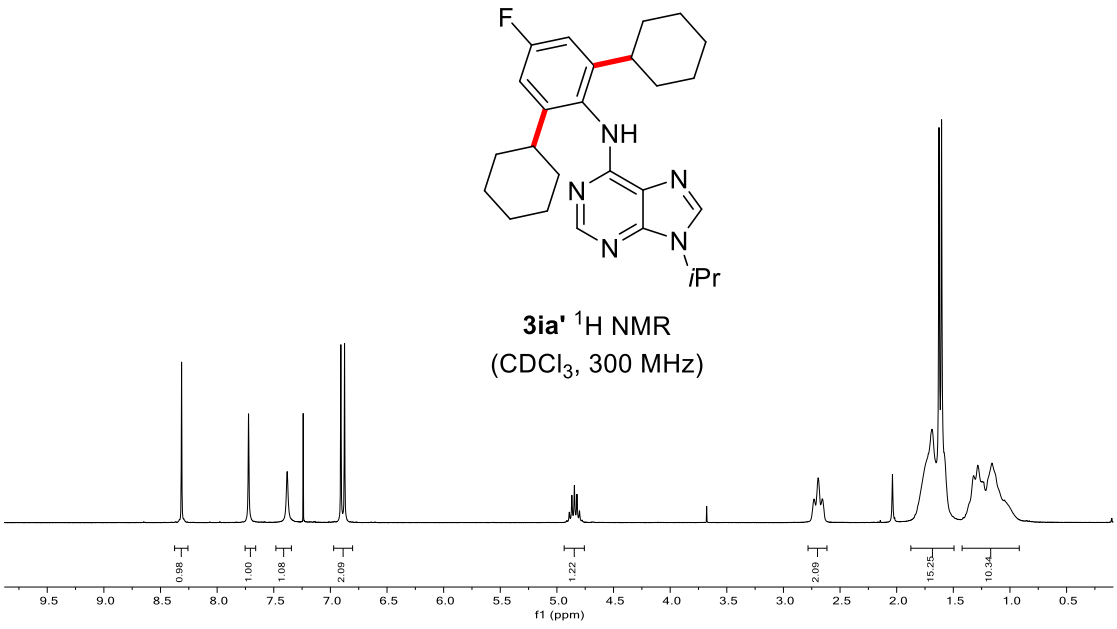


3ia ^{13}C NMR

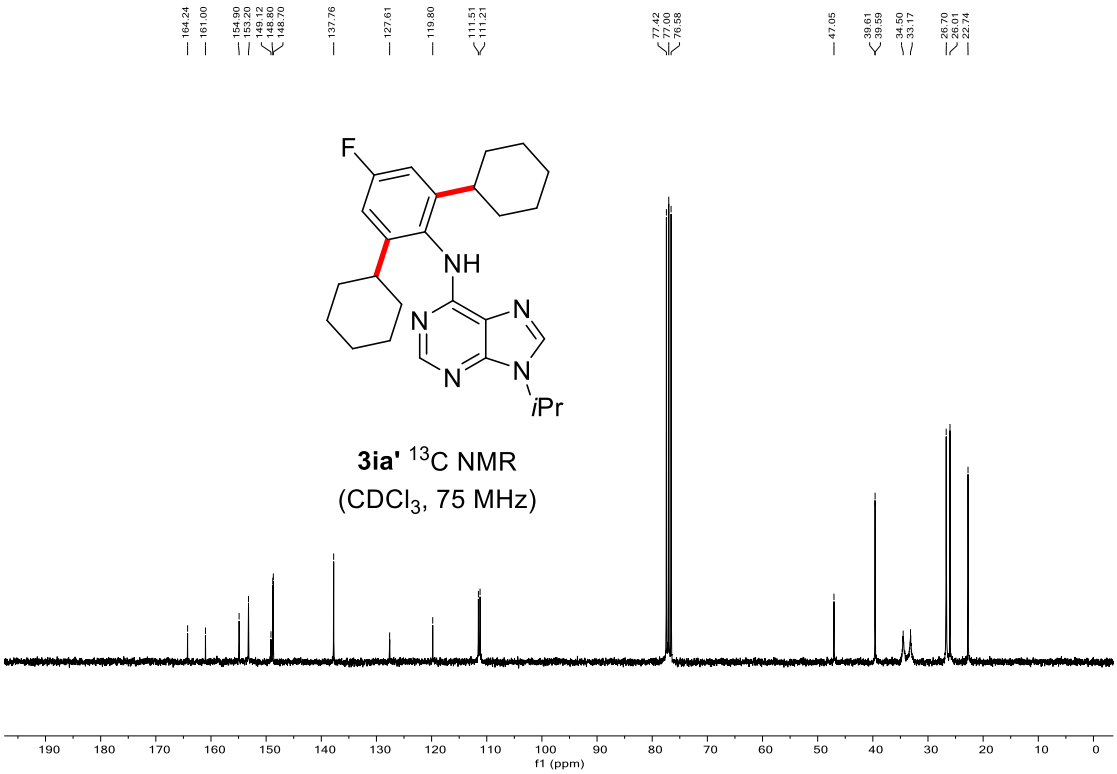
($CDCl_3$, 125 MHz)



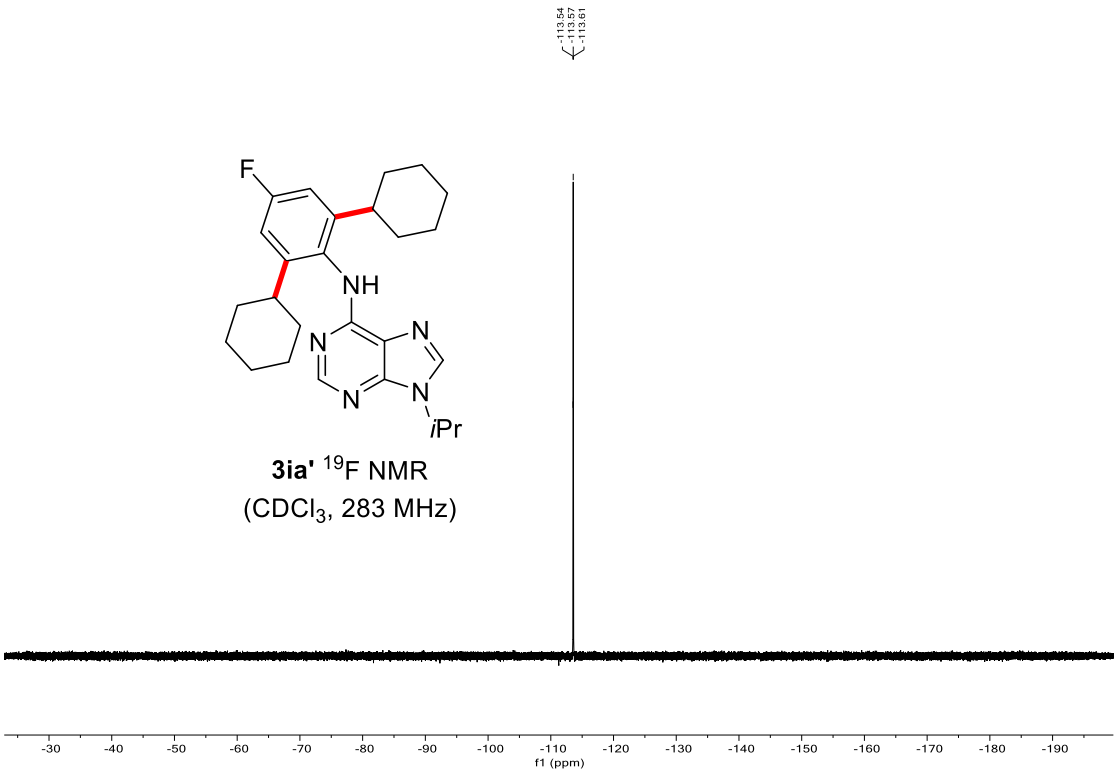
3ia ^{19}F NMR
($CDCl_3$, 283 MHz)



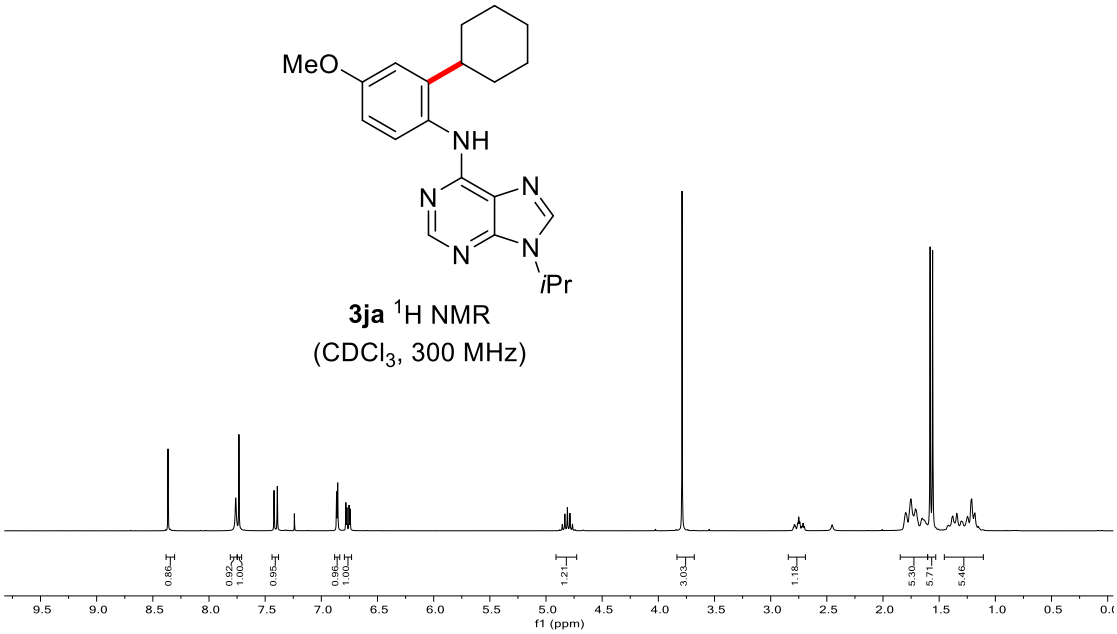
3ia' ^{1}H NMR
($CDCl_3$, 300 MHz)



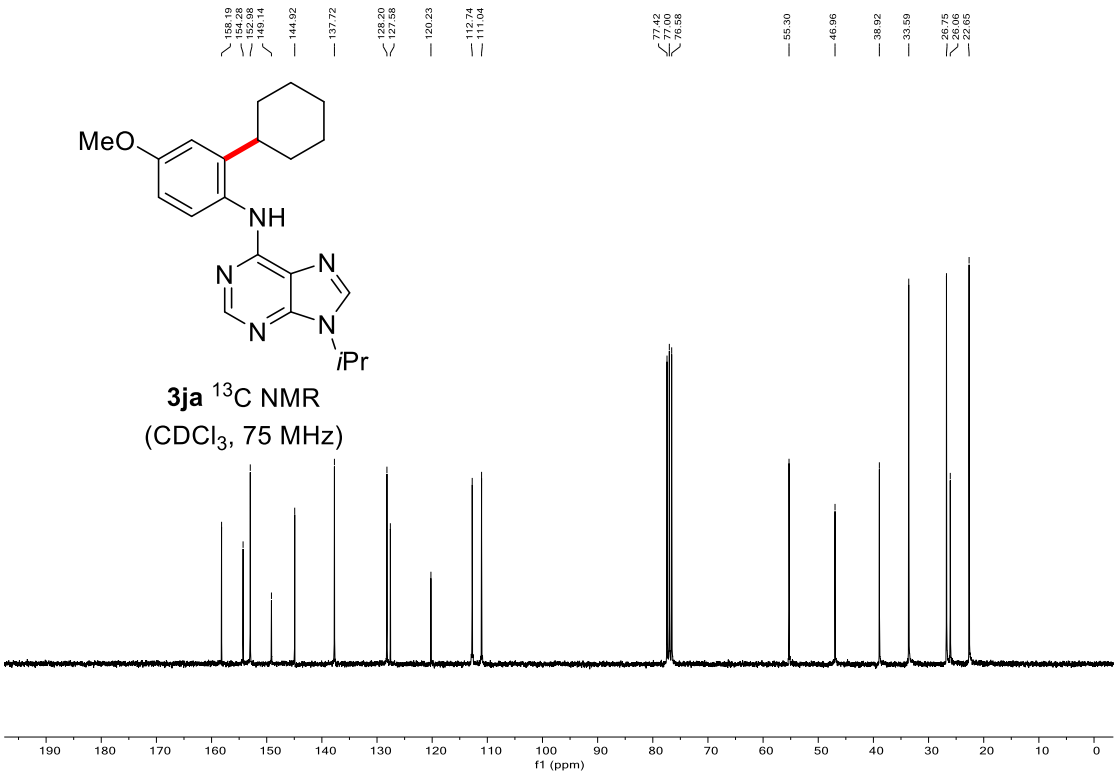
3ia' ^{13}C NMR
($CDCl_3$, 75 MHz)



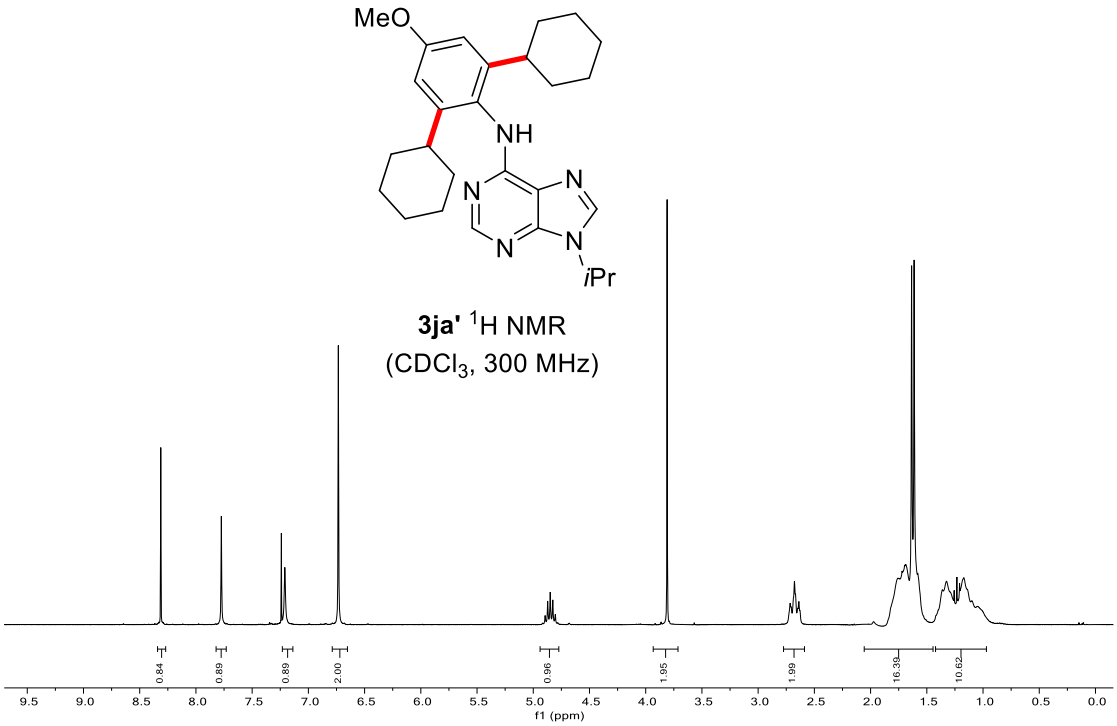
3ia' ^{19}F NMR
($CDCl_3$, 283 MHz)

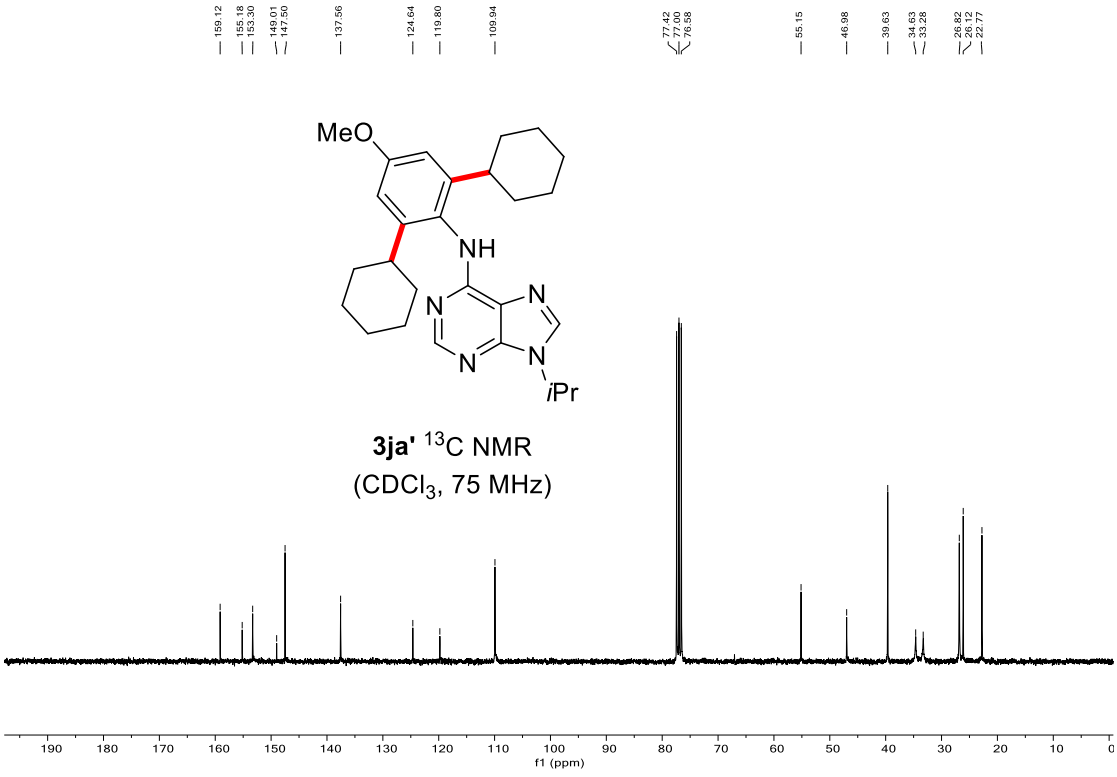


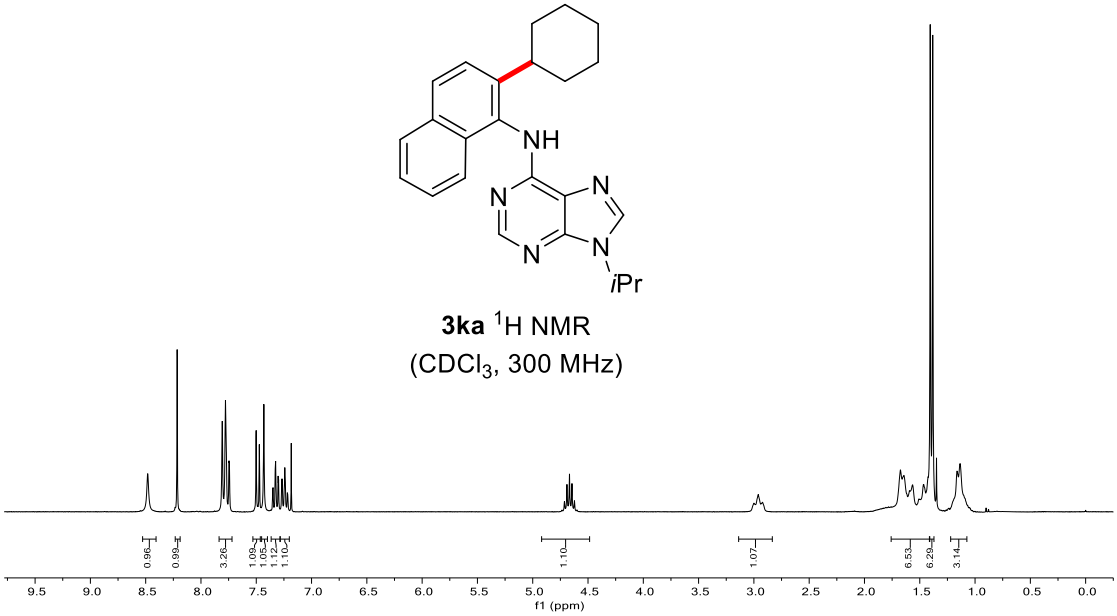
3ja ^{1}H NMR
($CDCl_3$, 300 MHz)



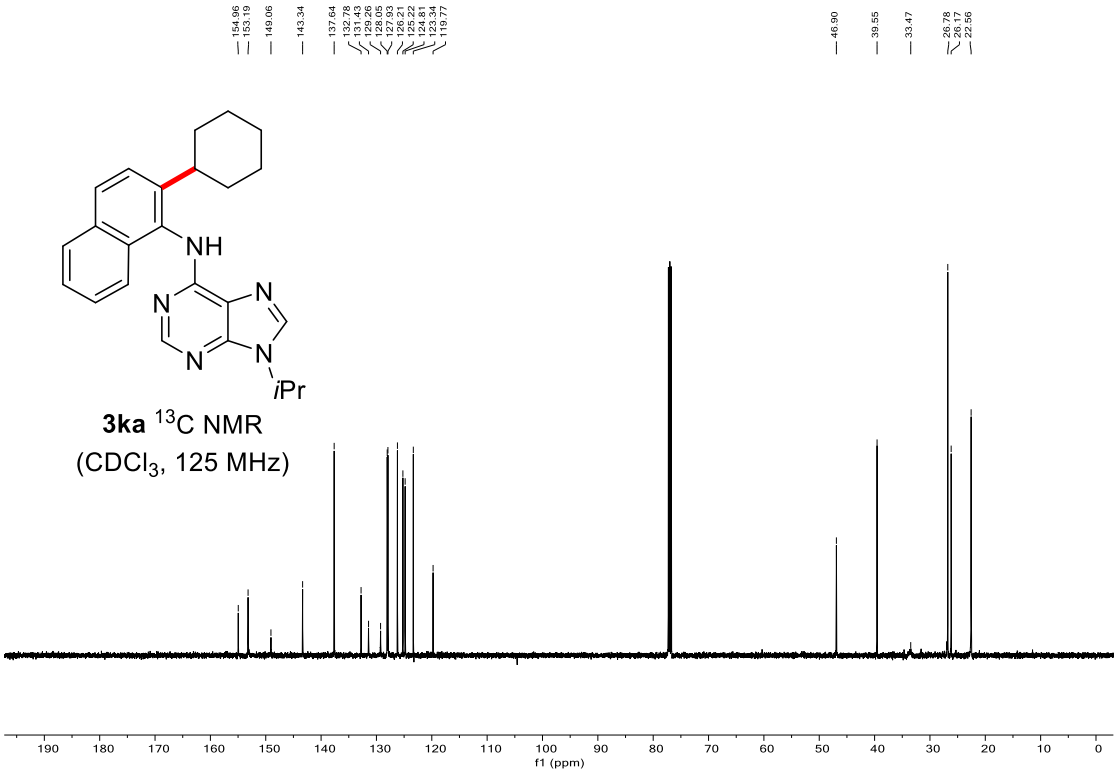
3ja ^{13}C NMR
($CDCl_3$, 75 MHz)


MeO
NH
N
N
N
N
iPr
3ja' 1H NMR
(CDCl3, 300 MHz)
0.84
0.89
0.89
2.00
0.96
1.95
1.99
16.39
10.62
f1 (ppm)

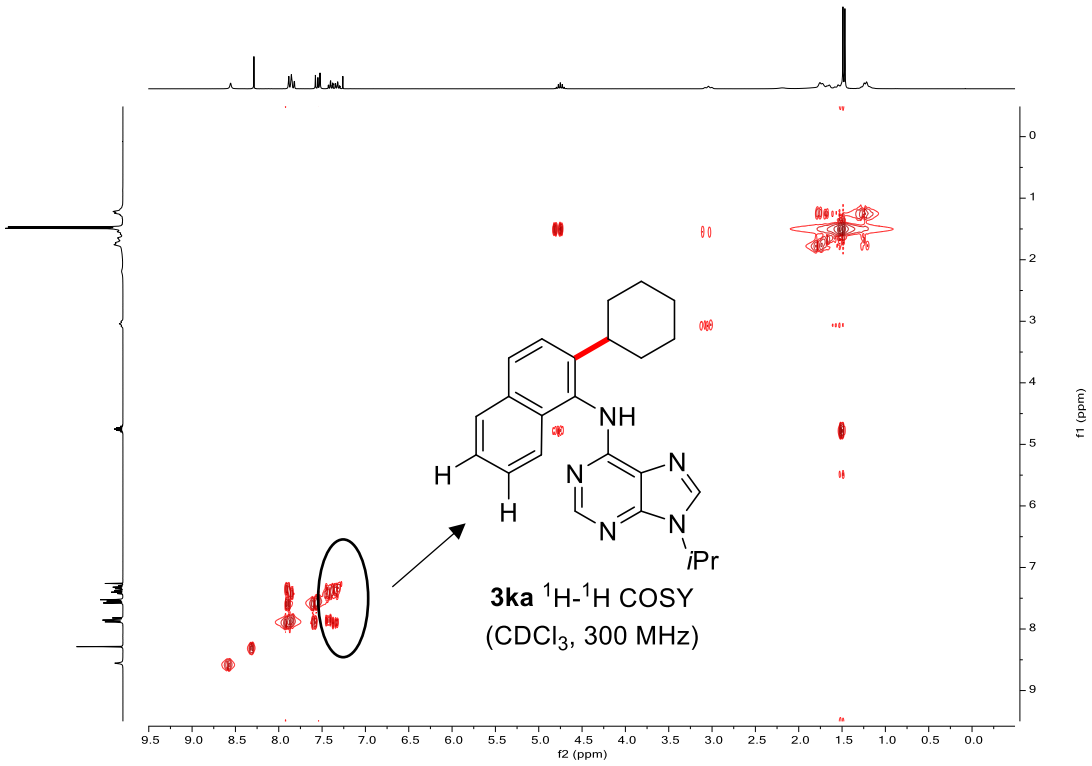

159.12
155.18
153.30
149.01
147.50
137.56
124.64
119.80
109.94
77.42
77.00
76.58
55.15
46.98
39.63
34.63
33.28
26.82
26.12
22.77
MeO
NH
N
N
N
N
iPr
3ja' 13C NMR
(CDCl3, 75 MHz)
f1 (ppm)



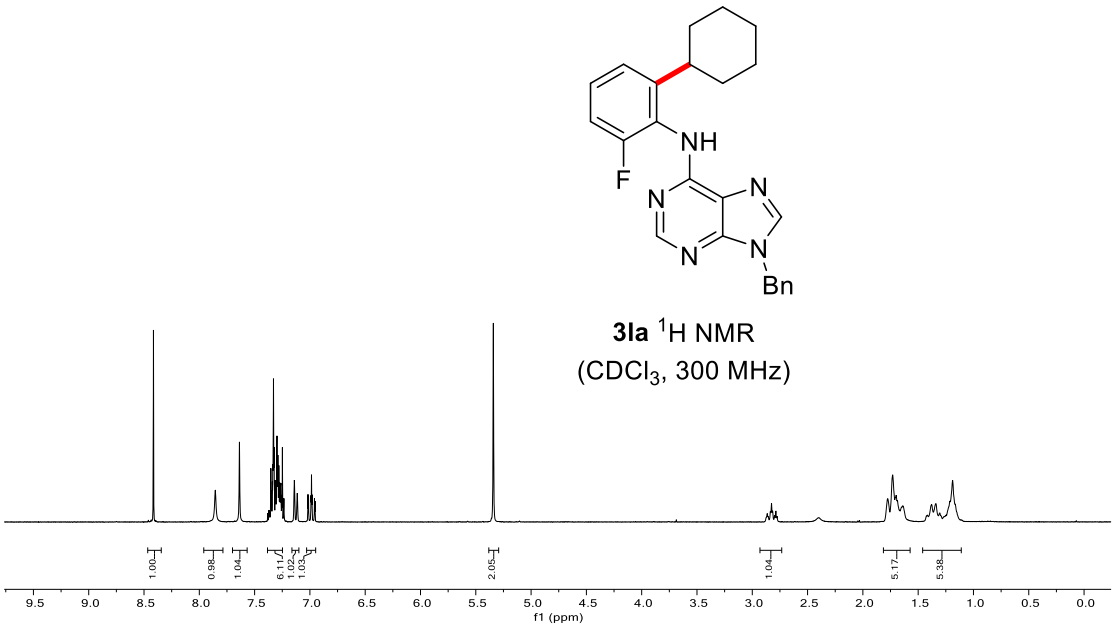
3ka ^{1}H NMR
($CDCl_3$, 300 MHz)



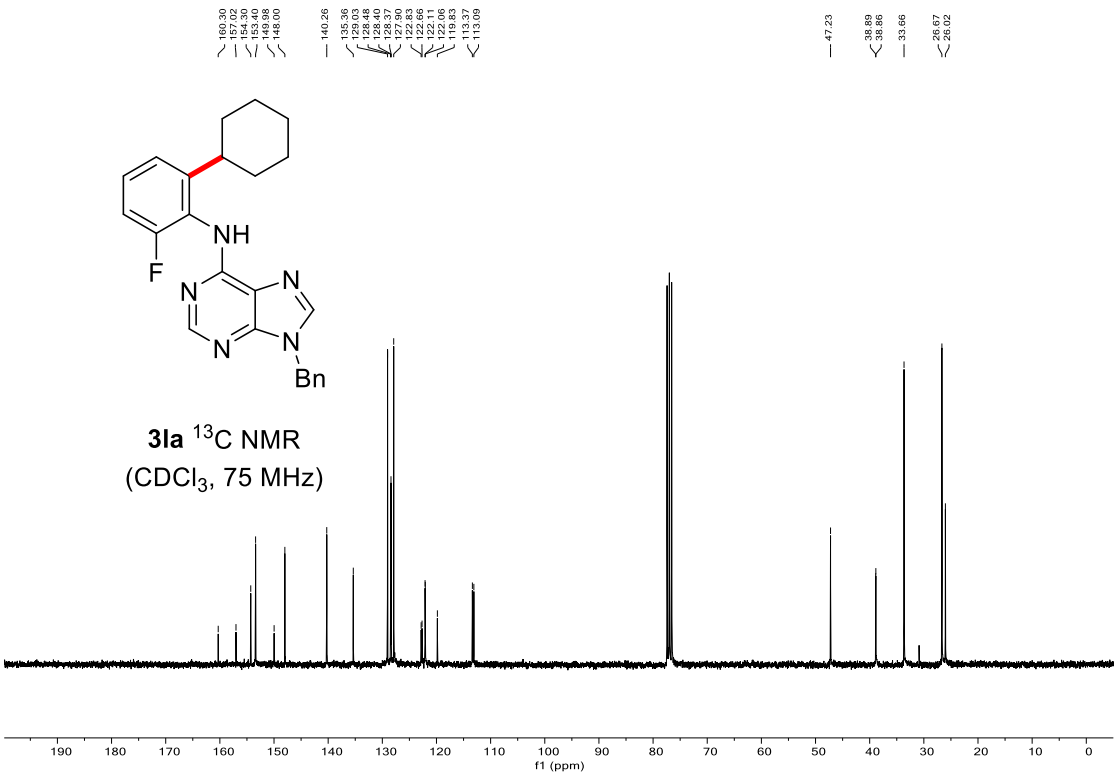
3ka ^{13}C NMR
($CDCl_3$, 125 MHz)



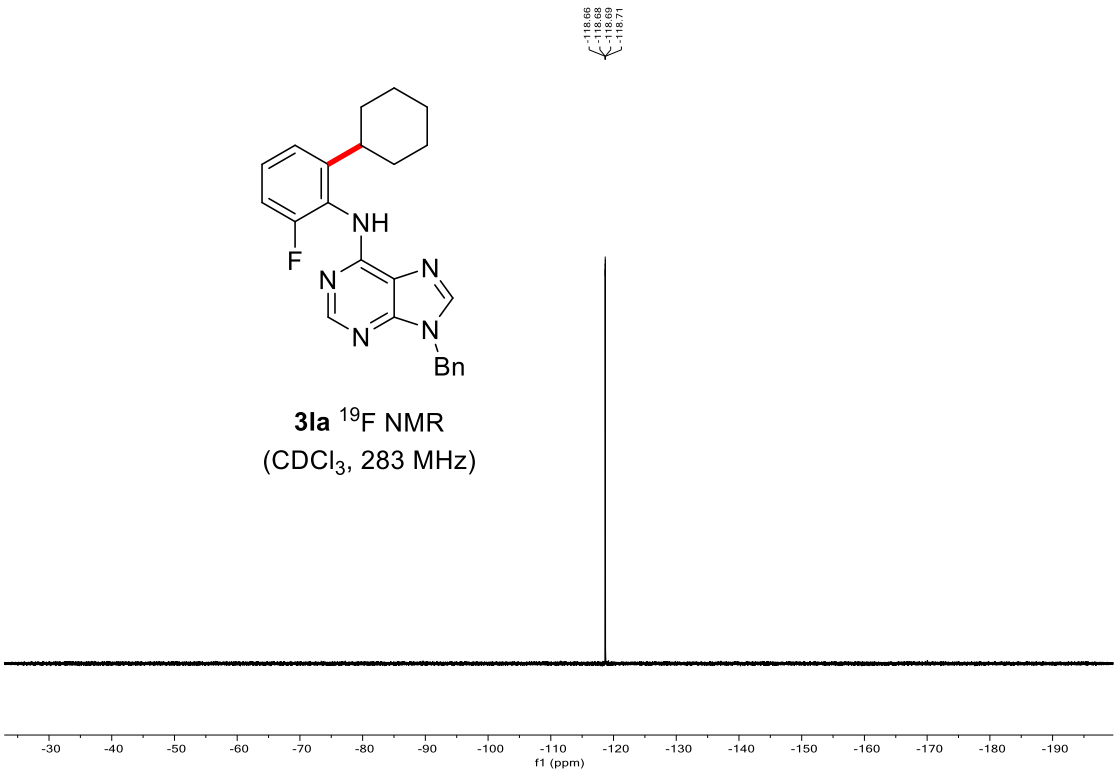
3ka ^{1}H-^{1}H COSY
($CDCl_3$, 300 MHz)



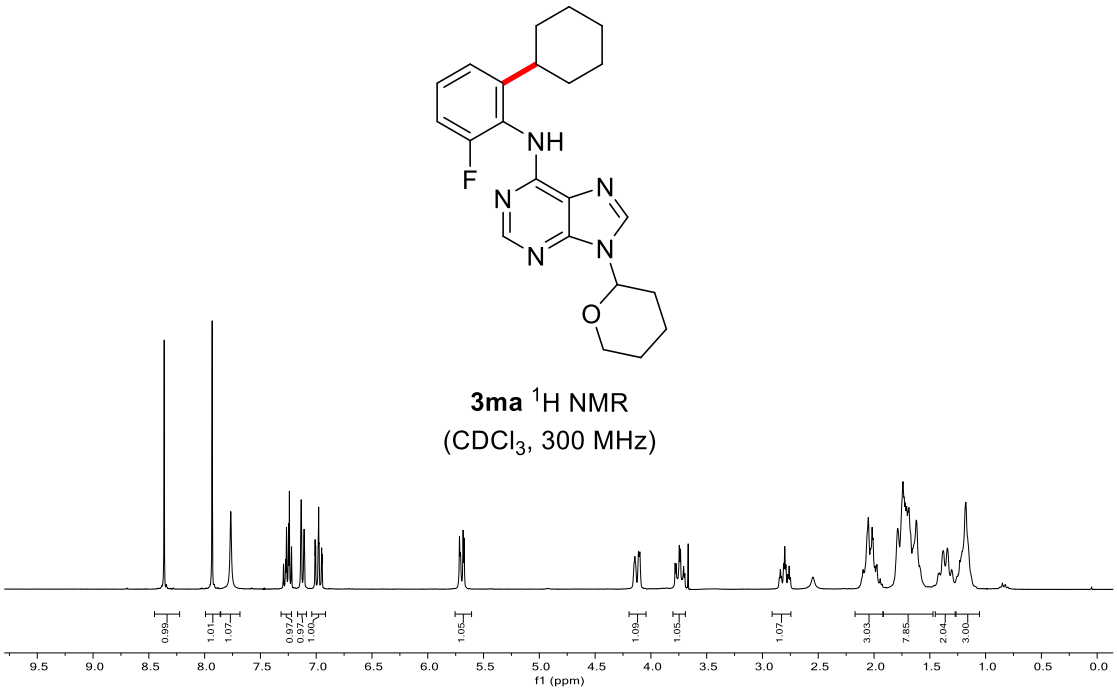
3la ^{1}H NMR
($CDCl_3$, 300 MHz)



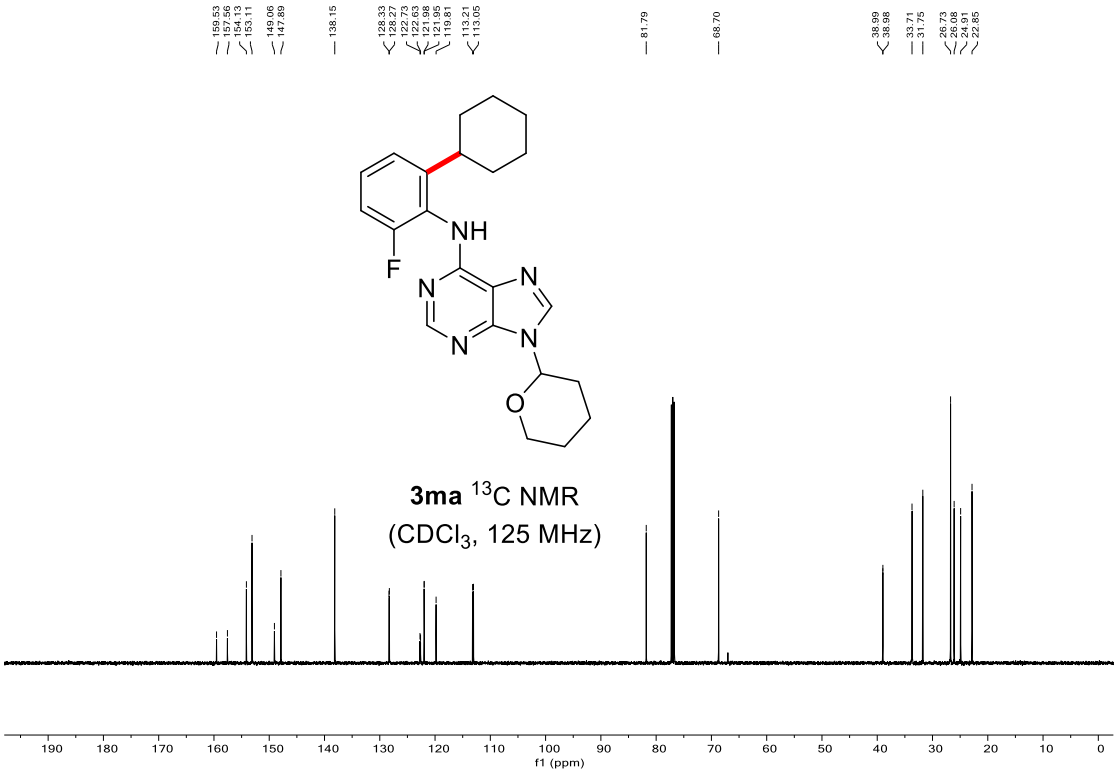
3la ^{13}C NMR
($CDCl_3$, 75 MHz)



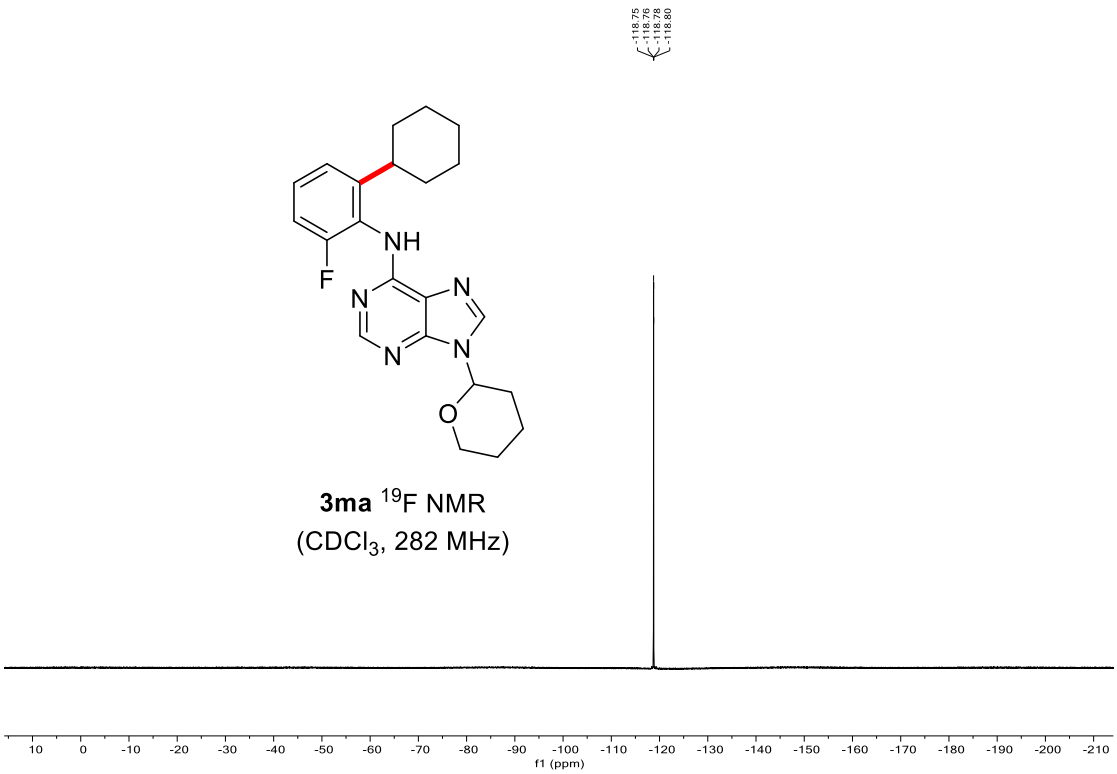
3la ^{19}F NMR
($CDCl_3$, 283 MHz)



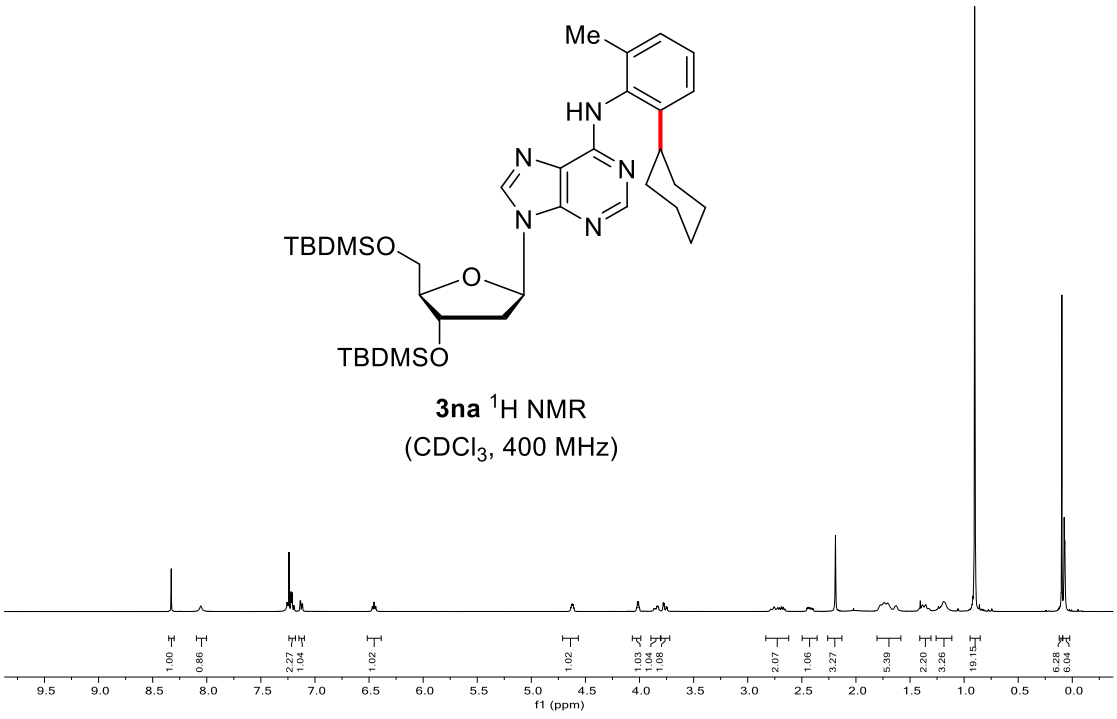
3ma ^{1}H NMR
($CDCl_3$, 300 MHz)



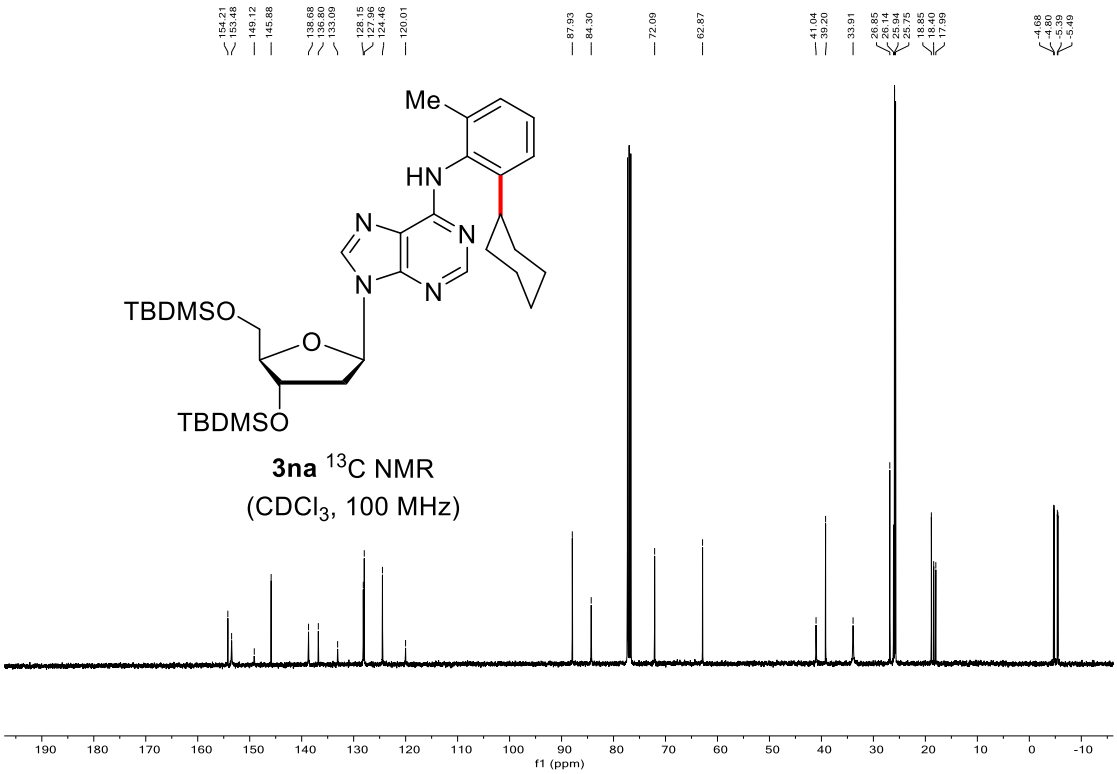
3ma ^{13}C NMR
($CDCl_3$, 125 MHz)



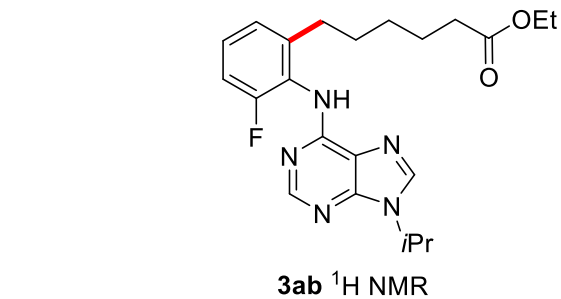
3ma ^{19}F NMR
($CDCl_3$, 282 MHz)



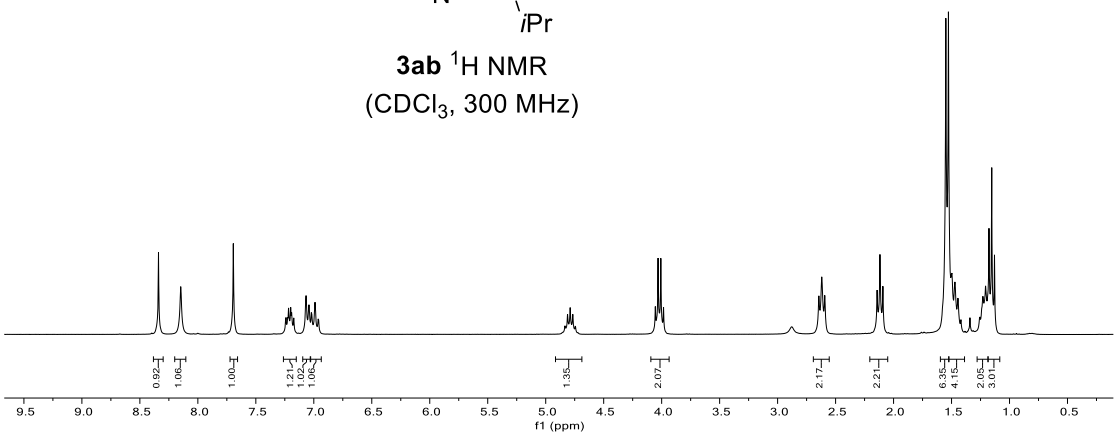
3na ^{1}H NMR
($CDCl_3$, 400 MHz)

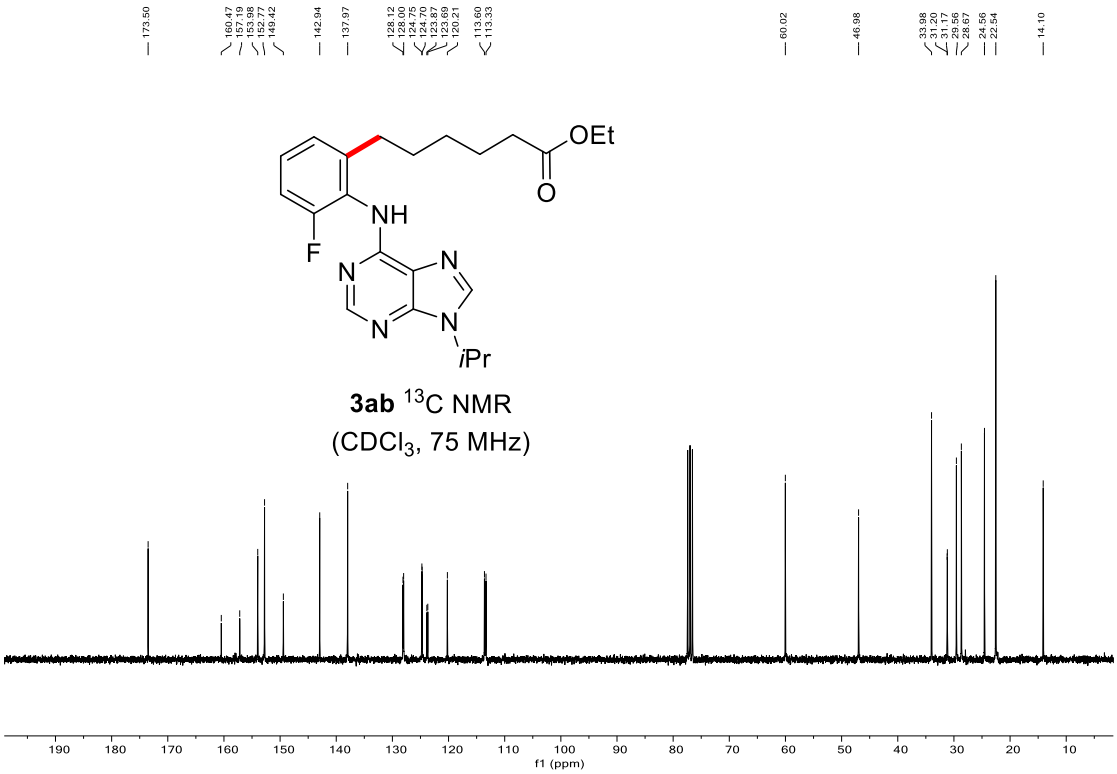


3na ^{13}C NMR
($CDCl_3$, 100 MHz)

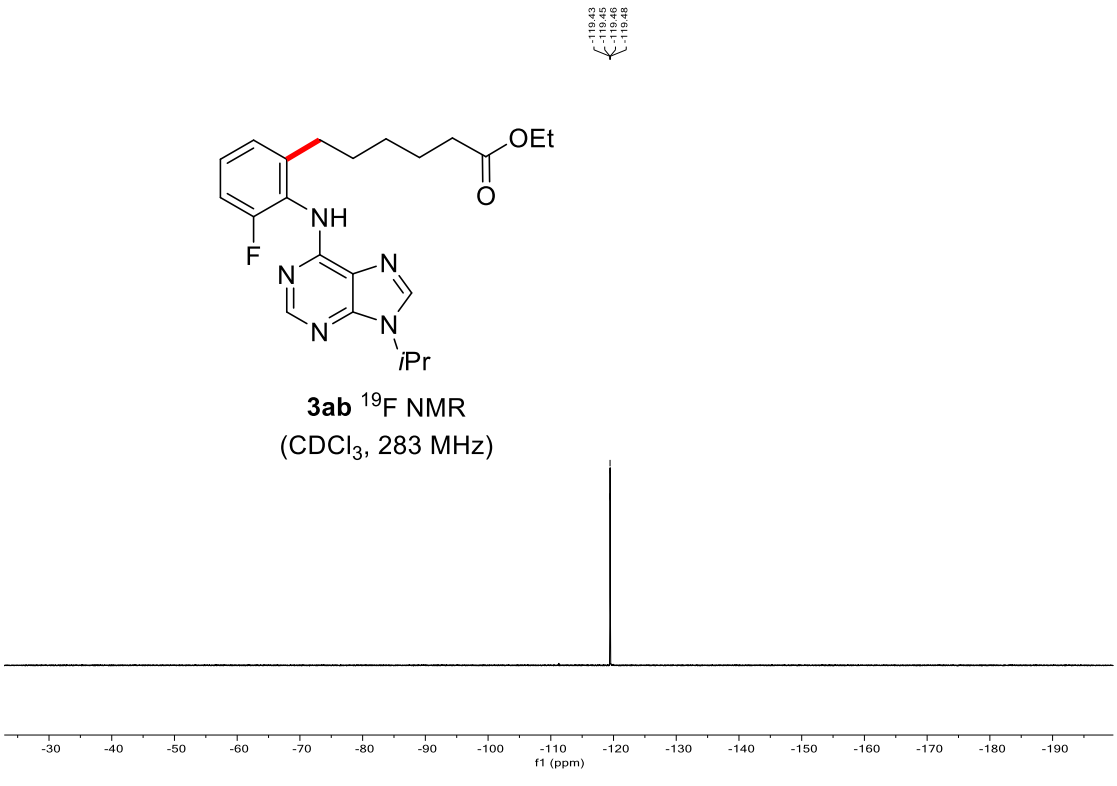


3ab ^{1}H NMR
($CDCl_3$, 300 MHz)

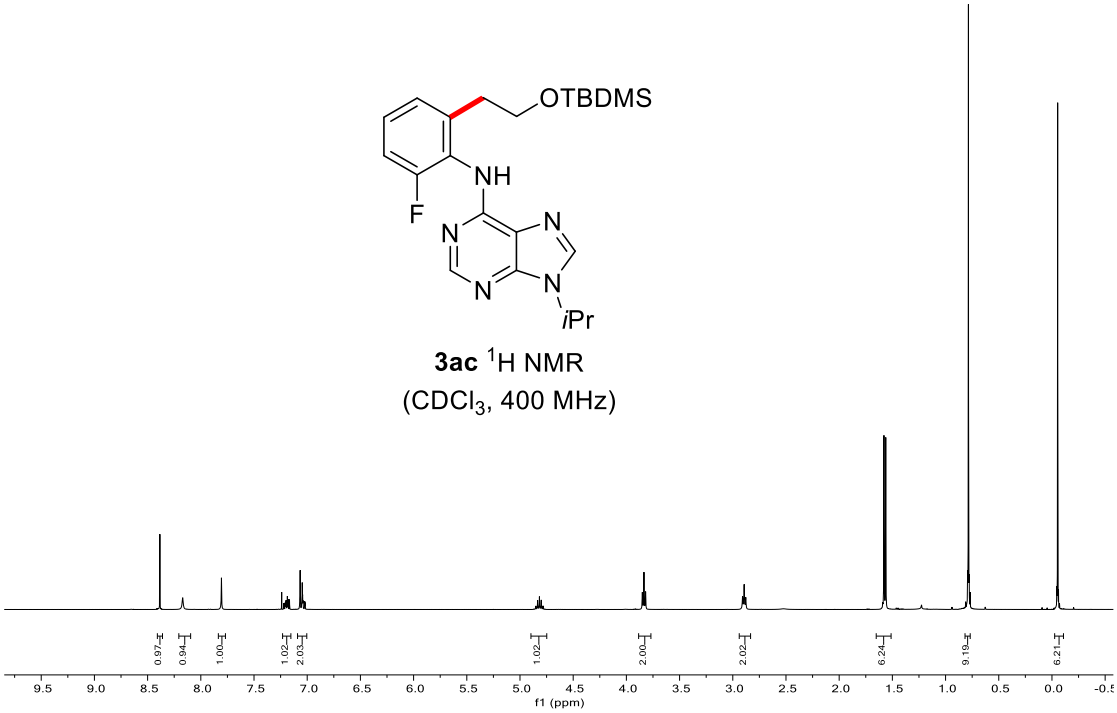




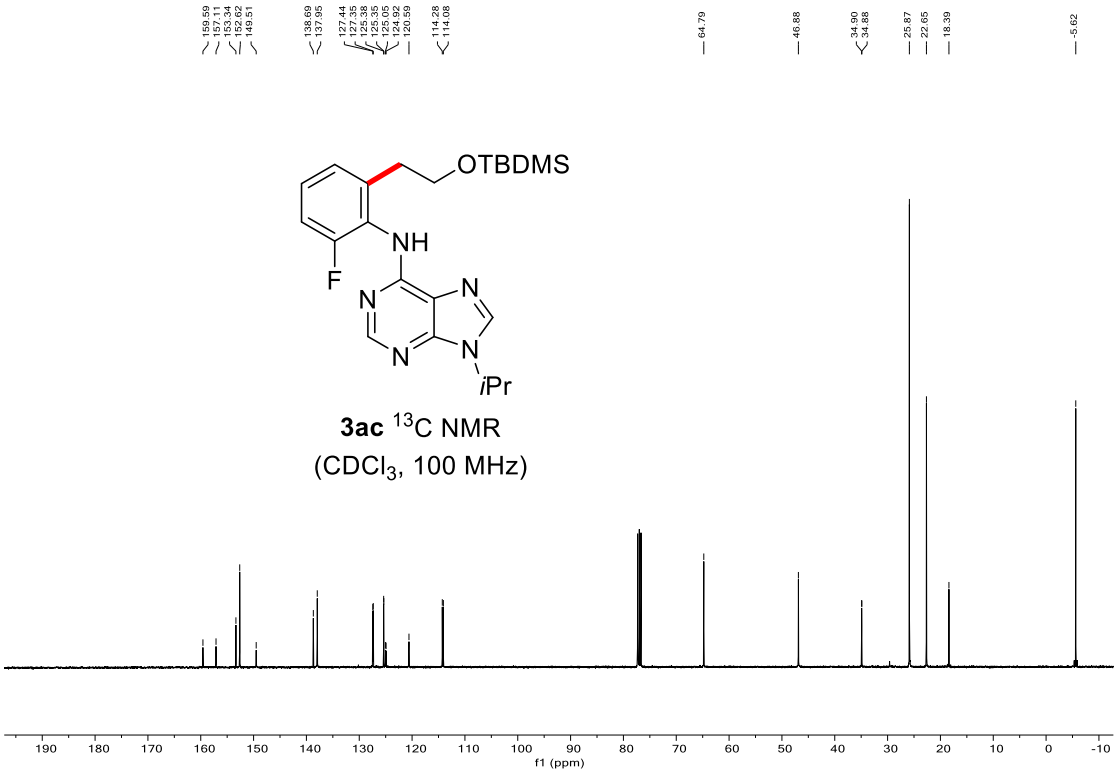
3ab ^{13}C NMR
($CDCl_3$, 75 MHz)



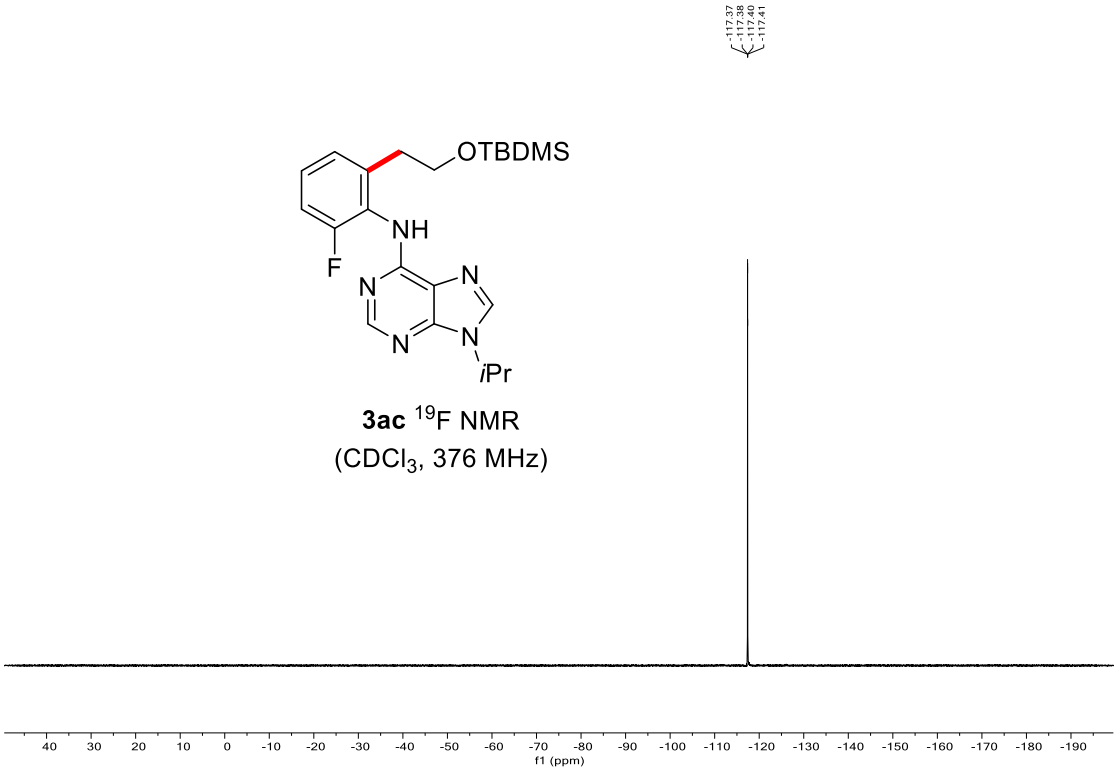
3ab ^{19}F NMR
($CDCl_3$, 283 MHz)



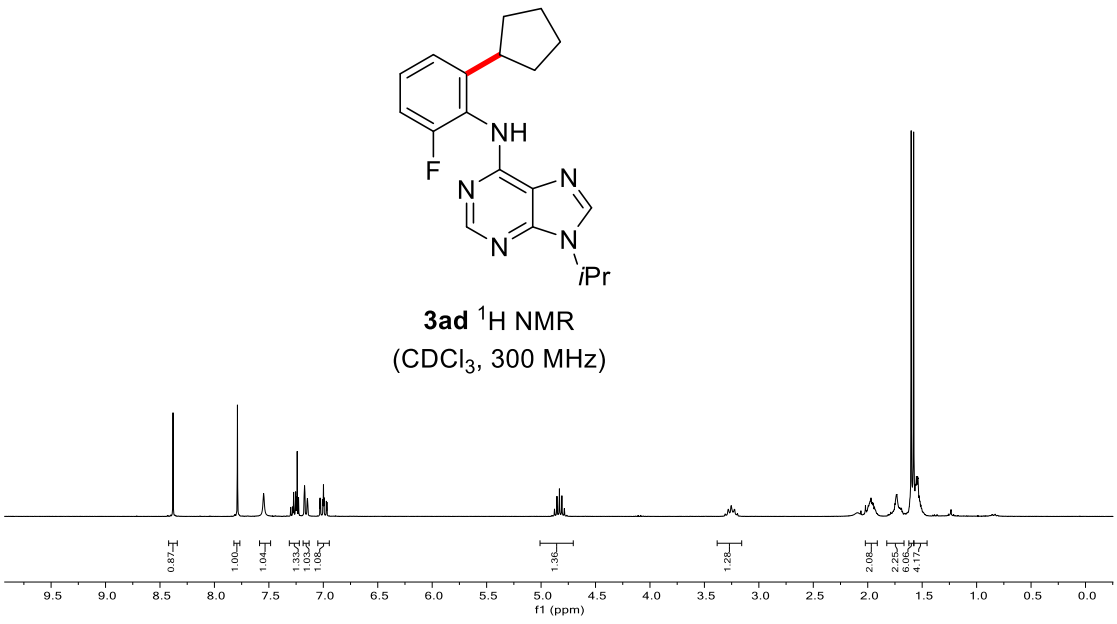
3ac ^{1}H NMR
($CDCl_3$, 400 MHz)



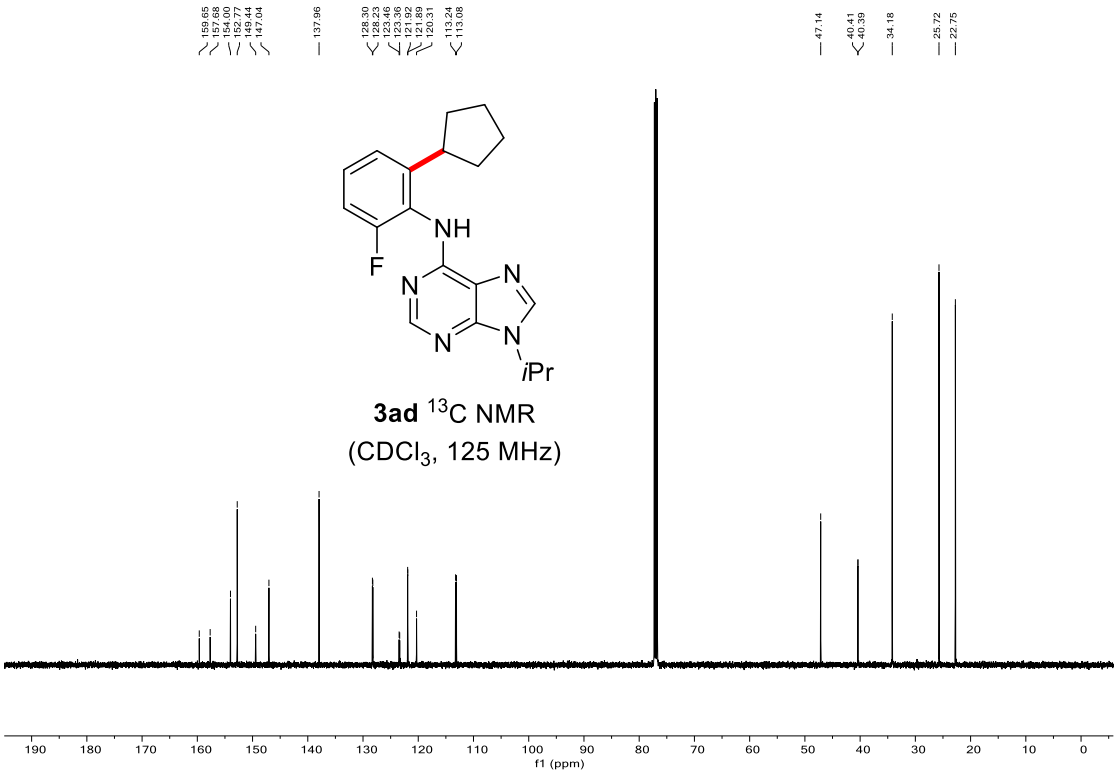
3ac ^{13}C NMR
($CDCl_3$, 100 MHz)



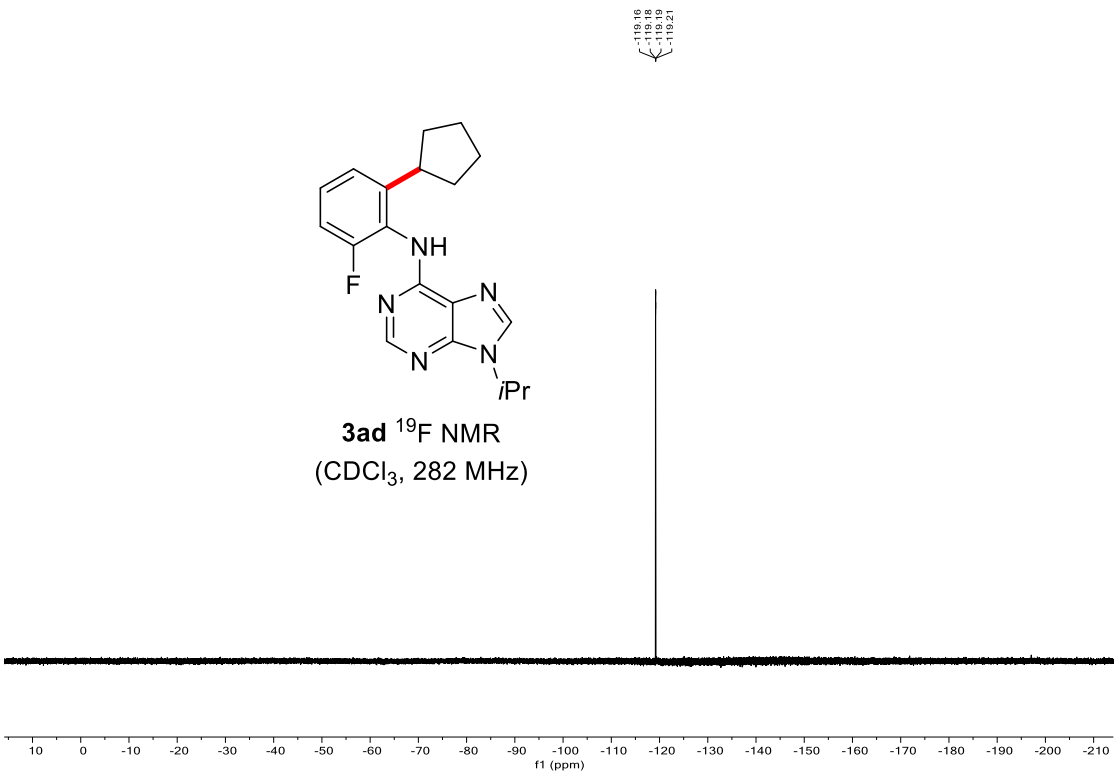
3ac ^{19}F NMR
($CDCl_3$, 376 MHz)



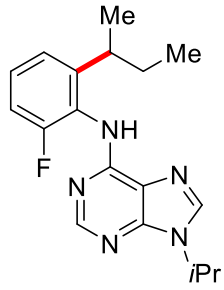
3ad ^{1}H NMR
($CDCl_3$, 300 MHz)



3ad ^{13}C NMR
($CDCl_3$, 125 MHz)

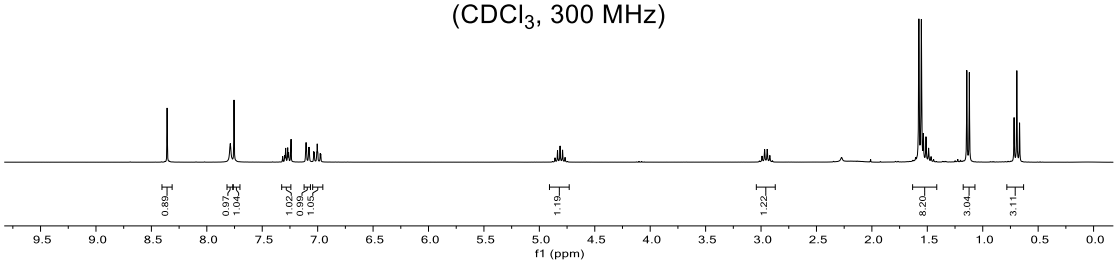


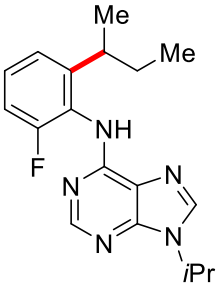
3ad ^{19}F NMR
($CDCl_3$, 282 MHz)



3ae ^{1}H NMR

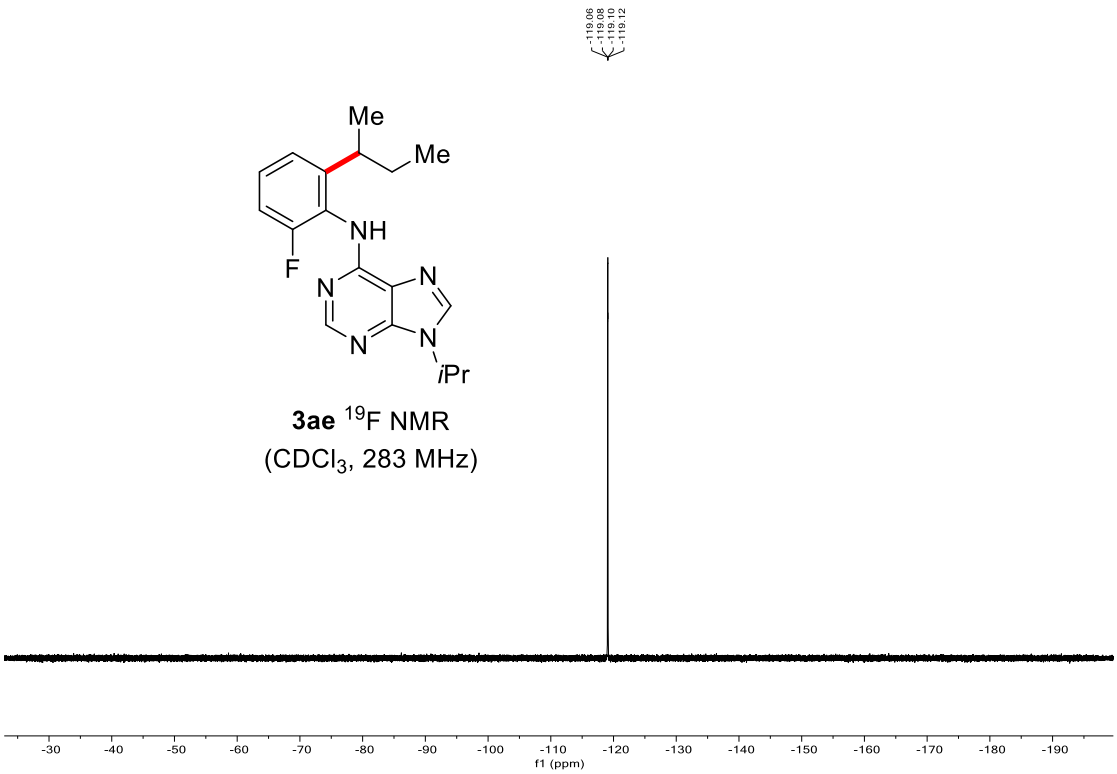
($CDCl_3$, 300 MHz)



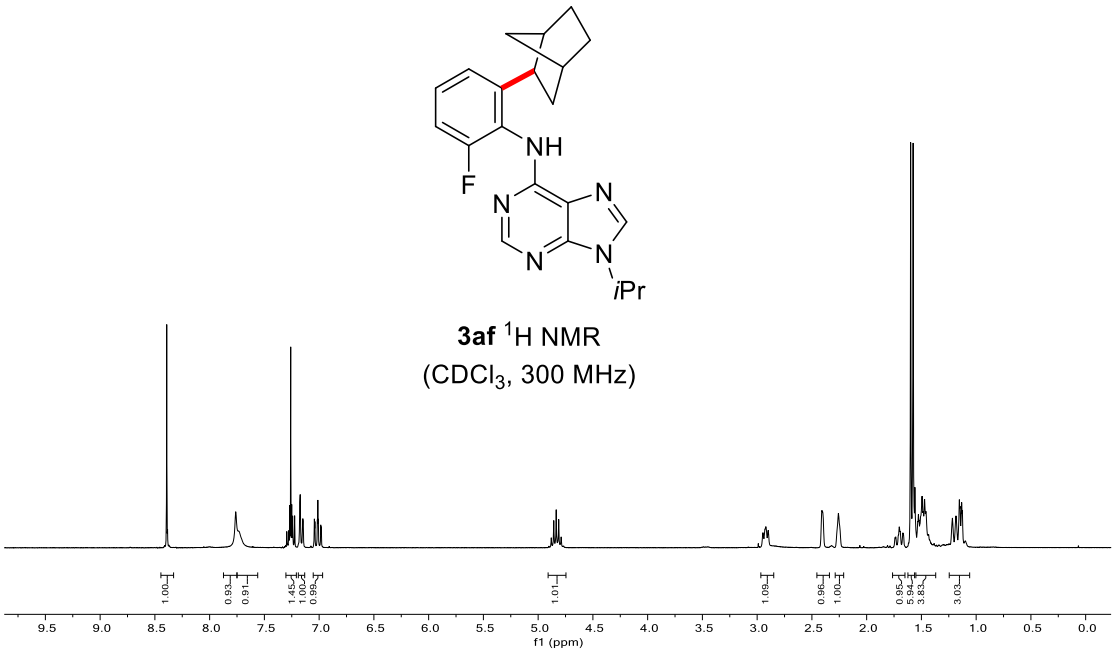


3ae ^{13}C NMR

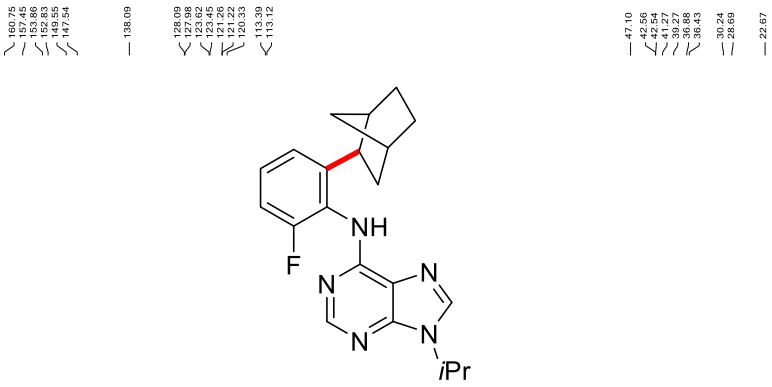
($CDCl_3$, 125 MHz)



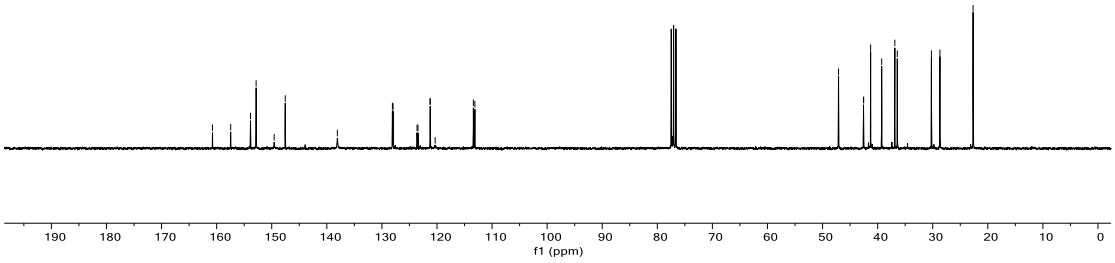
3ae ^{19}F NMR
($CDCl_3$, 283 MHz)

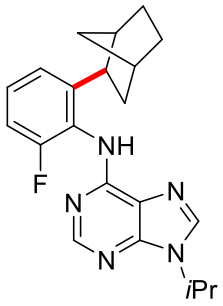


3af ^{1}H NMR
($CDCl_3$, 300 MHz)

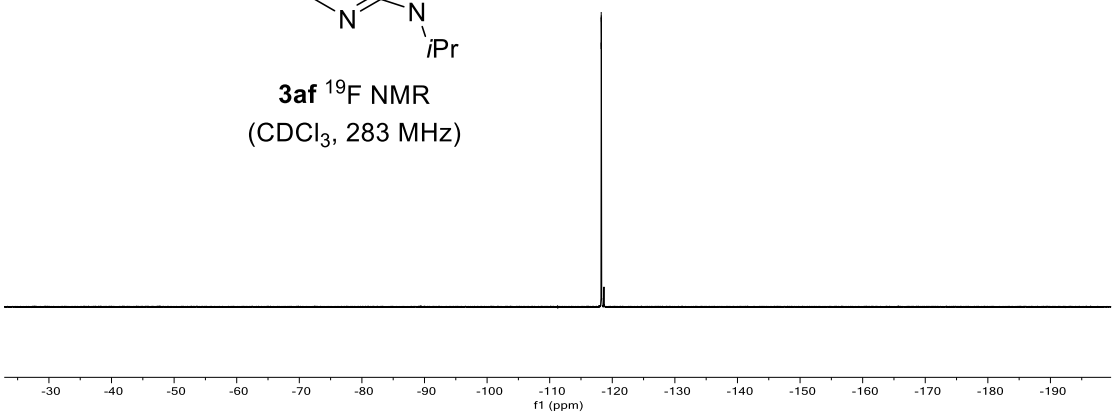


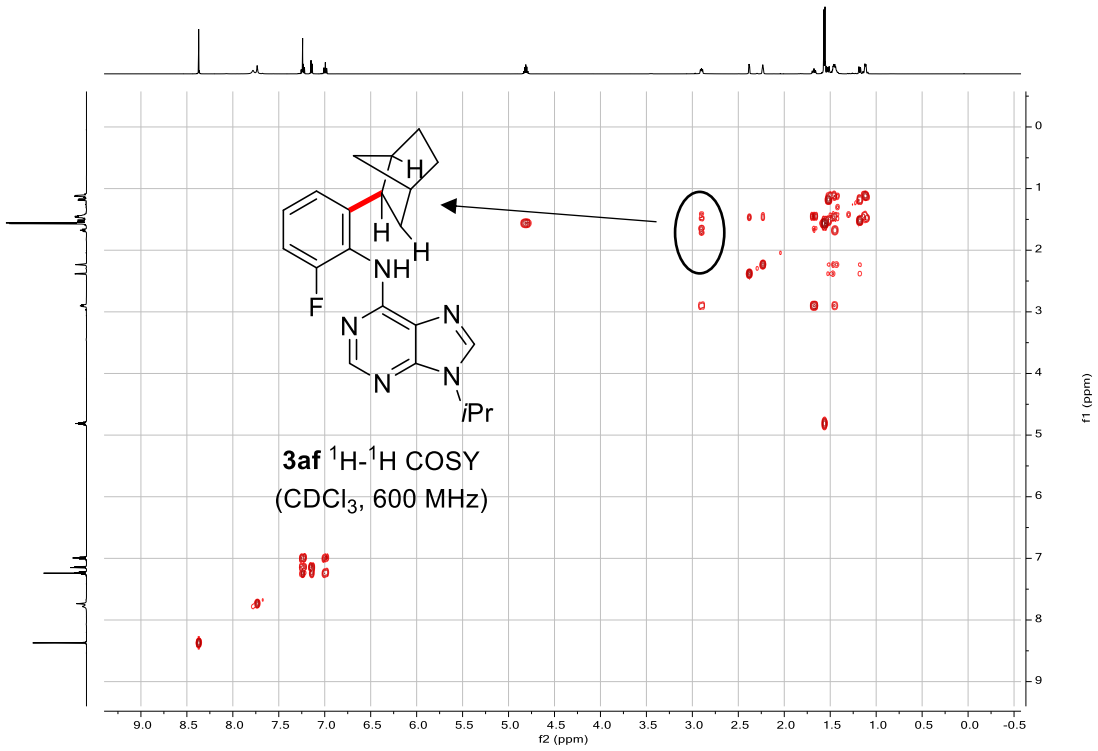
3af ^{13}C NMR
($CDCl_3$, 75 MHz)



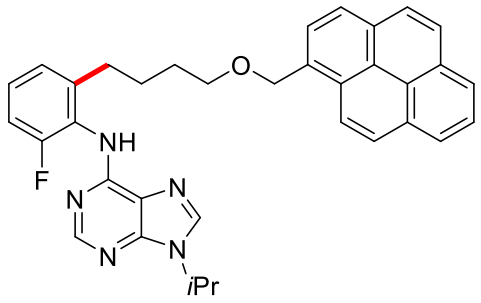


3af ^{19}F NMR
($CDCl_3$, 283 MHz)

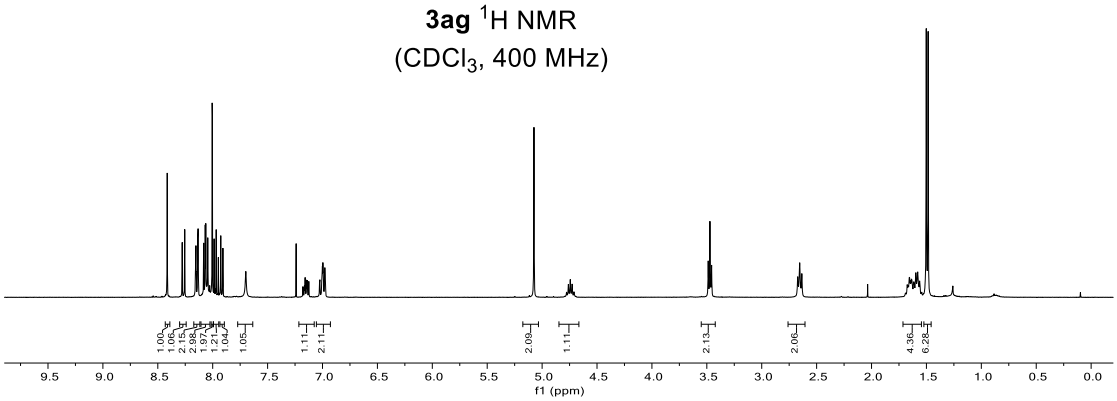


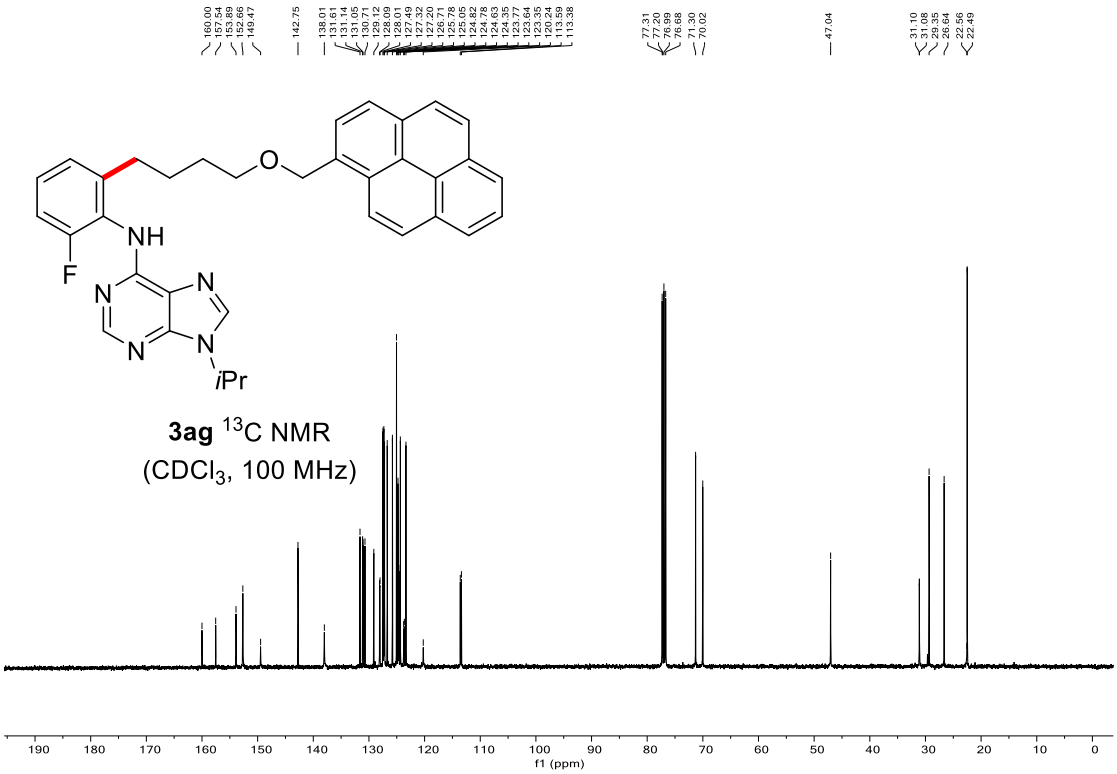


3af ^{1}H-^{1}H COSY
($CDCl_3$, 600 MHz)

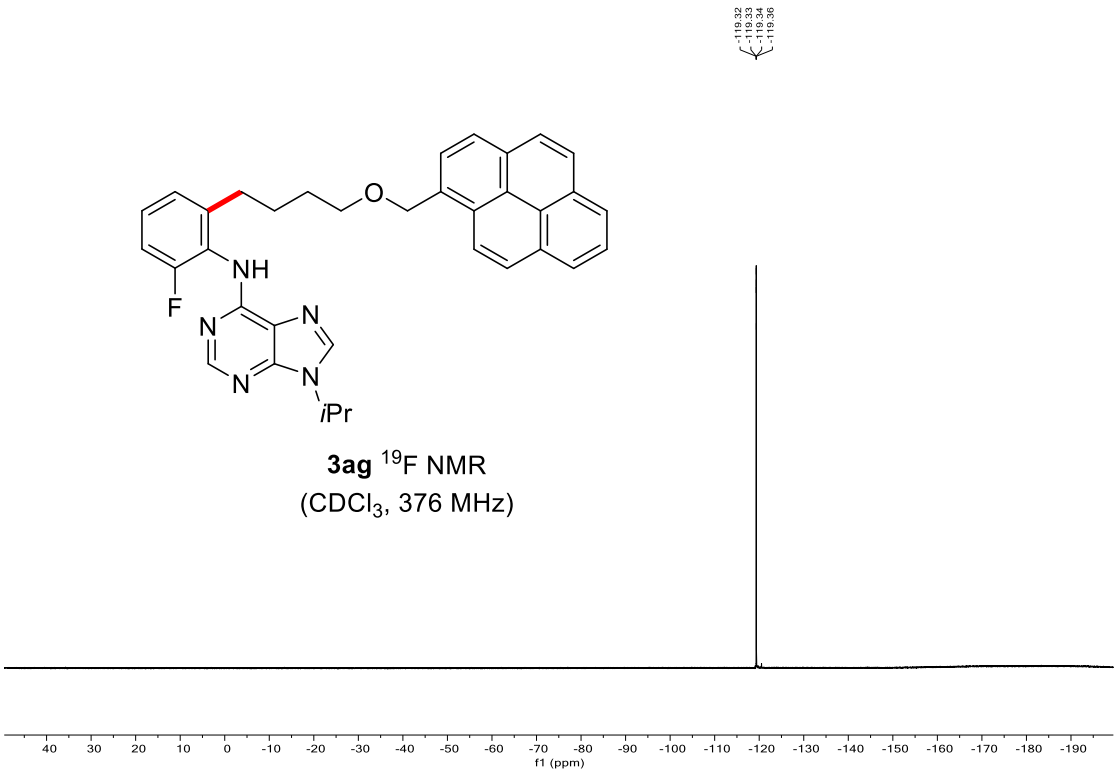


3ag ^{1}H NMR
($CDCl_3$, 400 MHz)

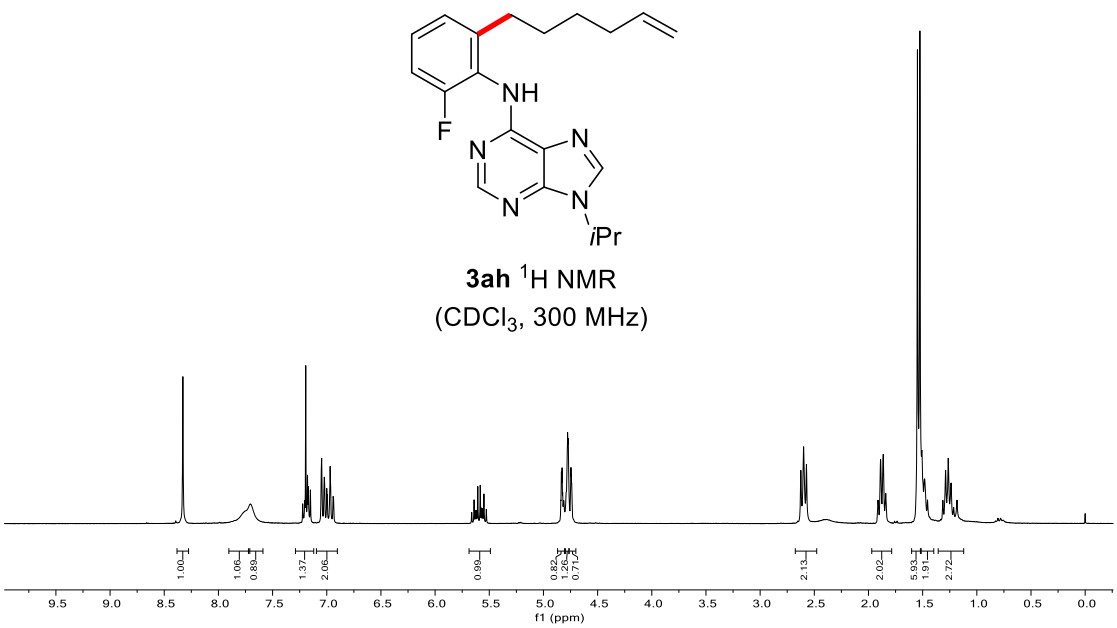




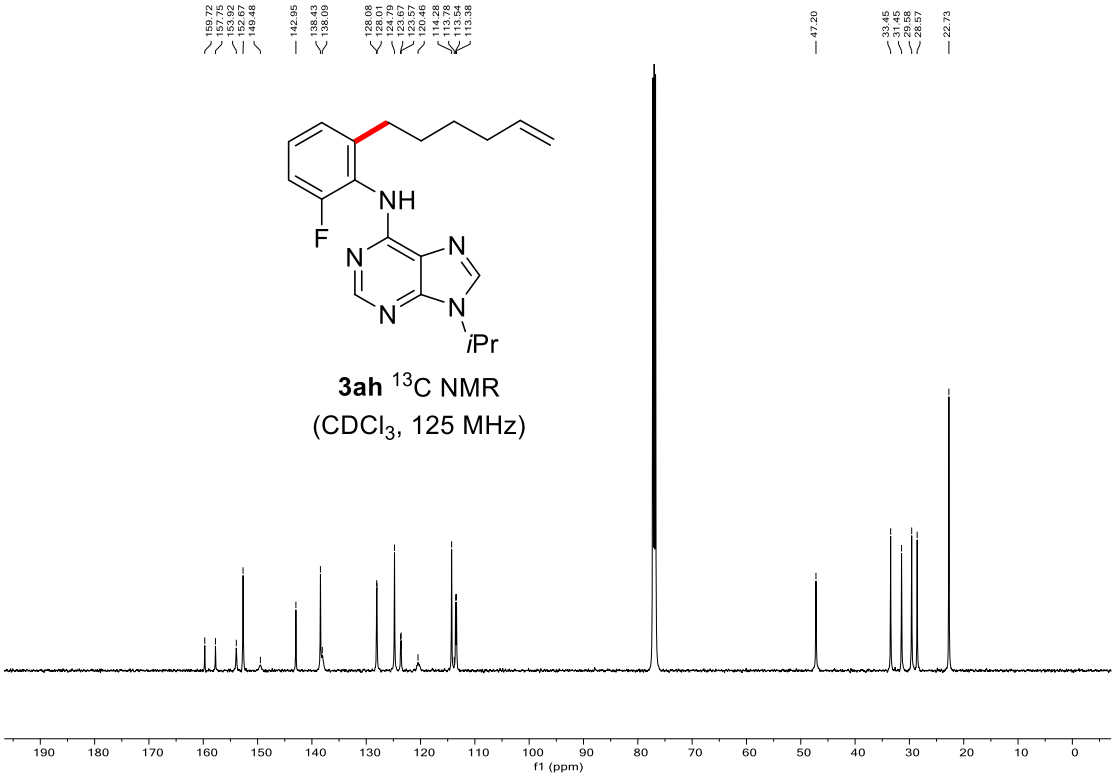
3ag ^{13}C NMR
($CDCl_3$, 100 MHz)



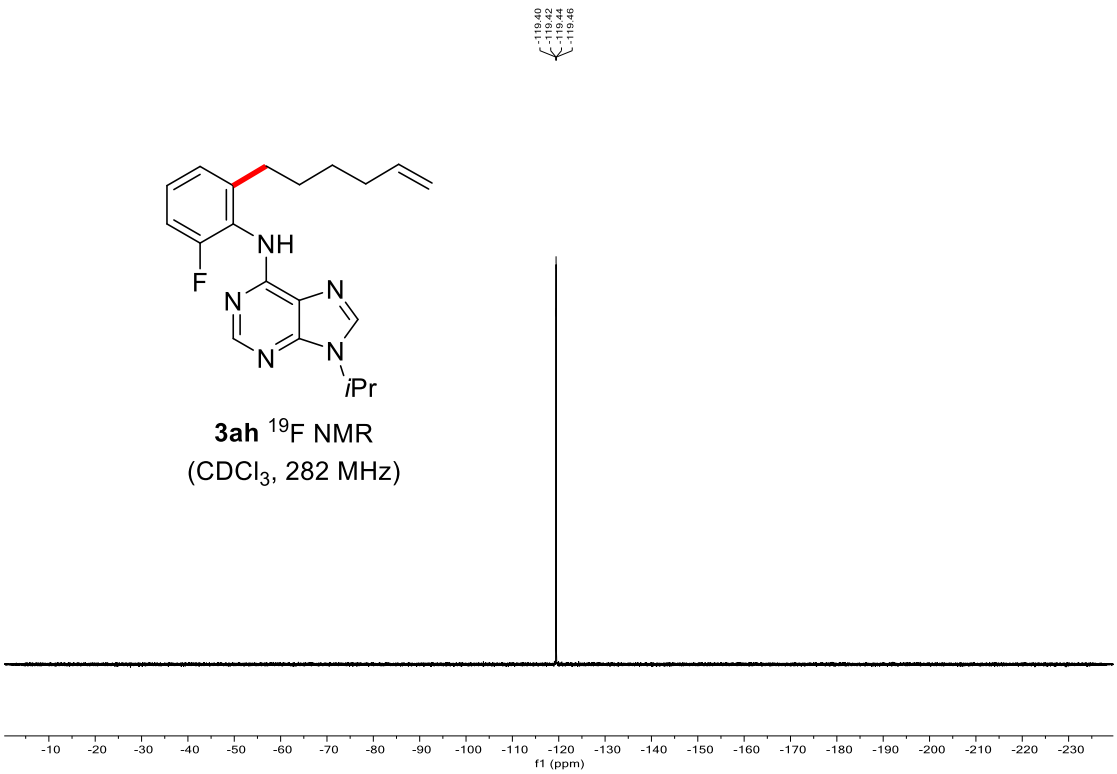
3ag ^{19}F NMR
($CDCl_3$, 376 MHz)



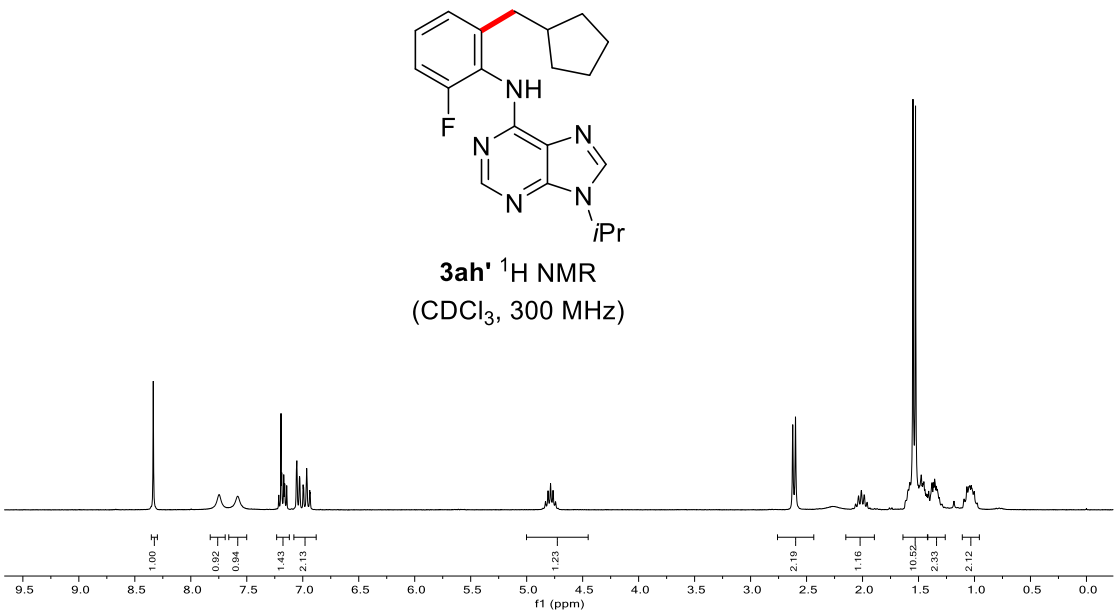
3ah ^{1}H NMR
($CDCl_3$, 300 MHz)



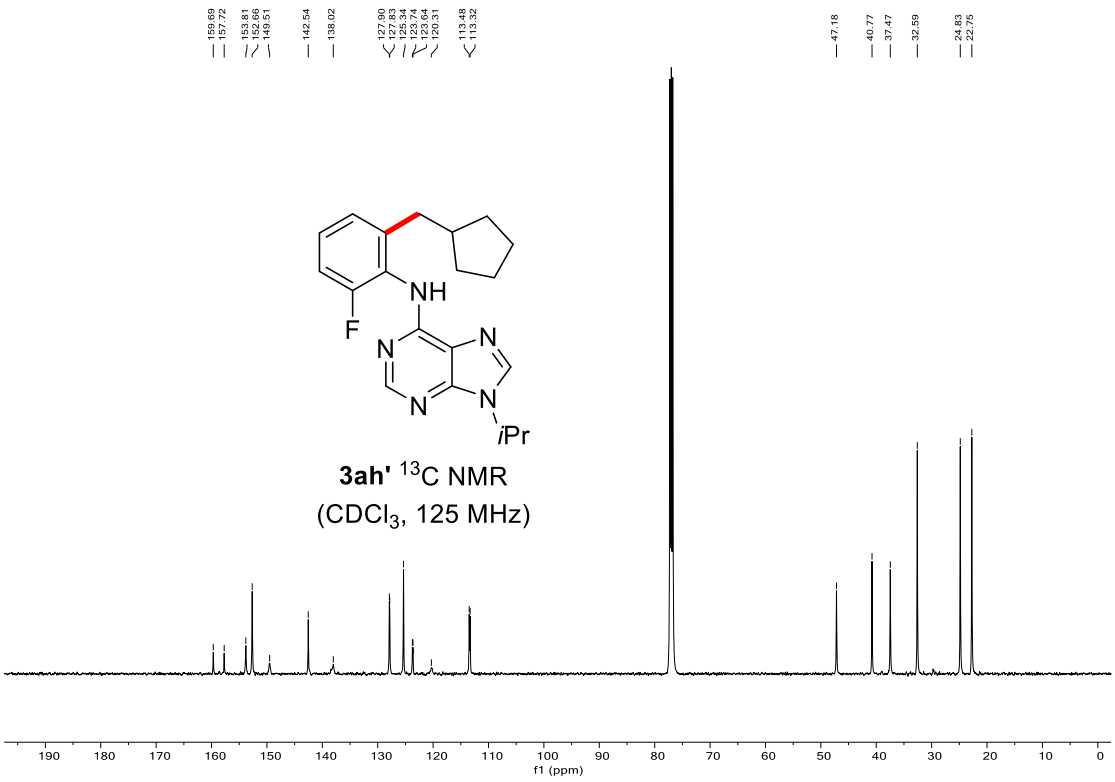
3ah ^{13}C NMR
($CDCl_3$, 125 MHz)



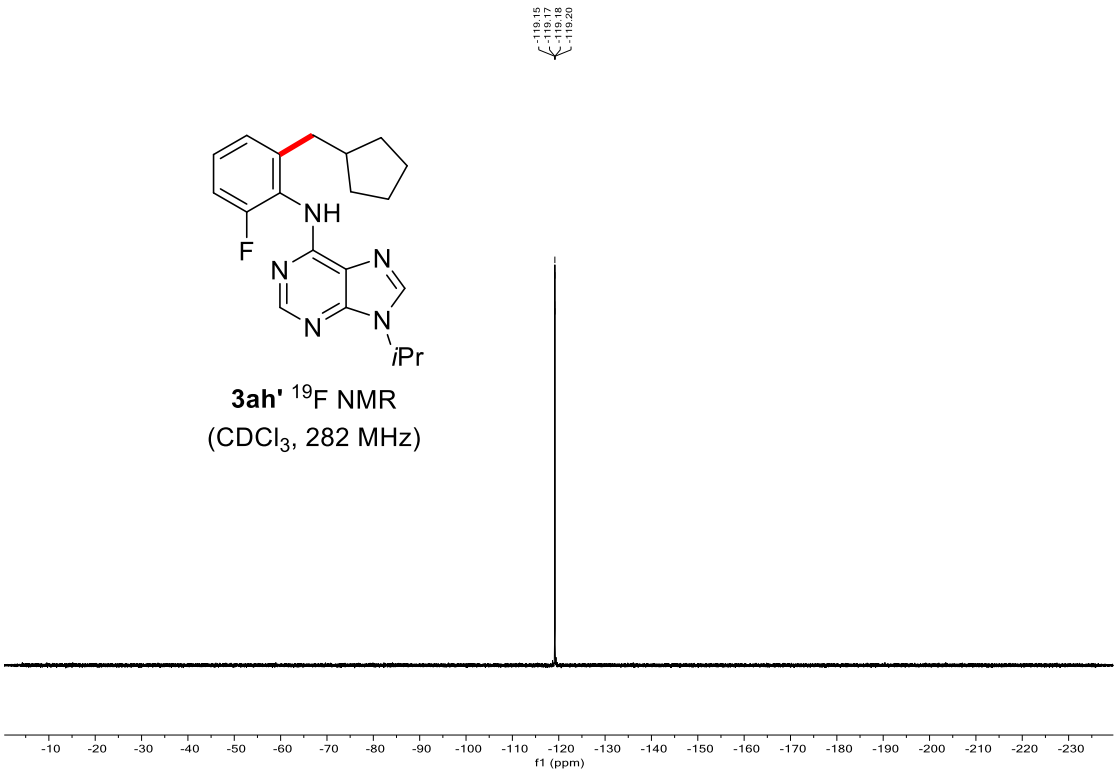
3ah ^{19}F NMR
($CDCl_3$, 282 MHz)



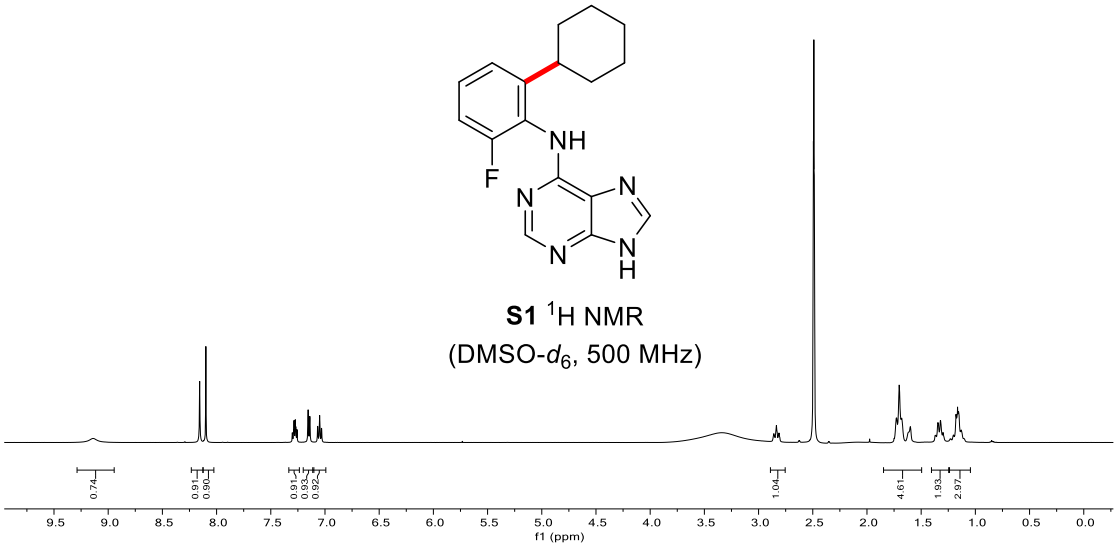
3ah' ^{1}H NMR
($CDCl_3$, 300 MHz)



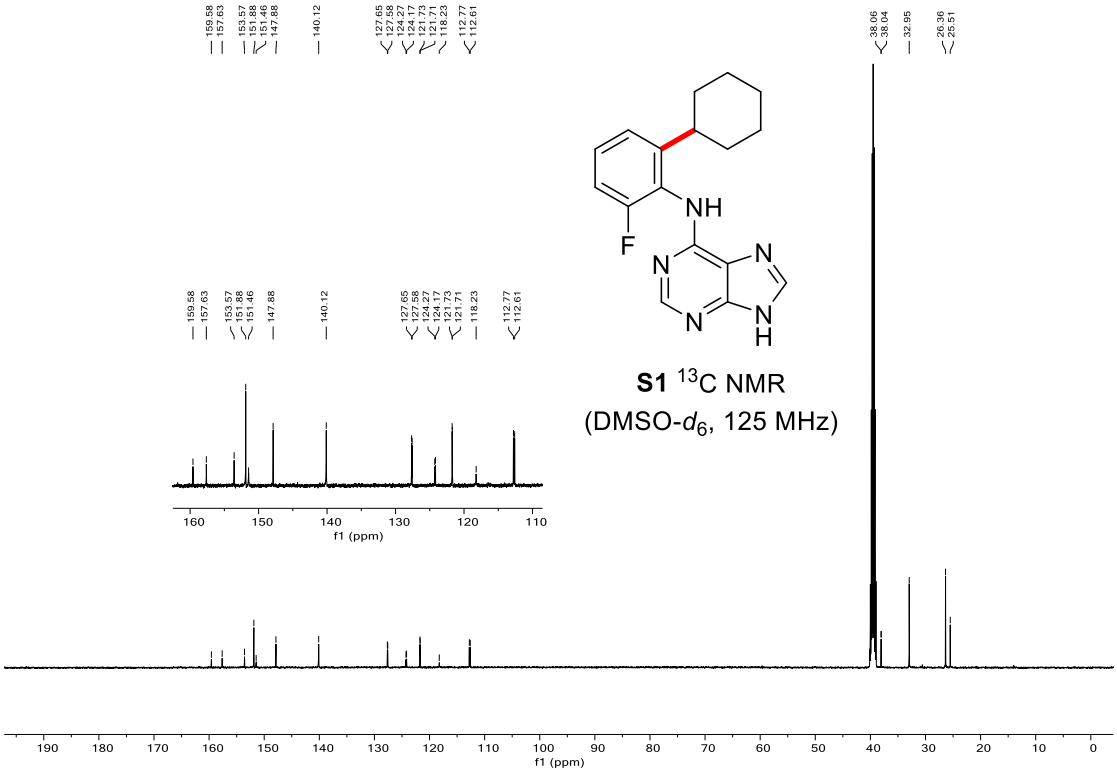
3ah' ^{13}C NMR
($CDCl_3$, 125 MHz)



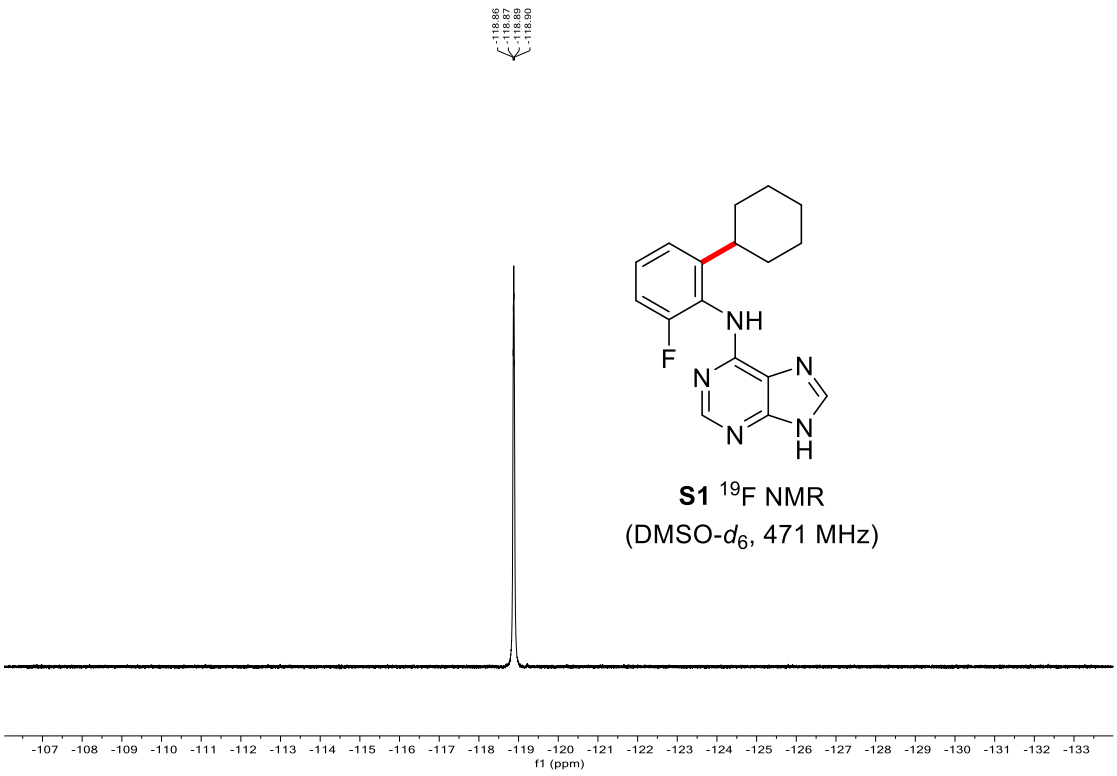
3ah' ^{19}F NMR
($CDCl_3$, 282 MHz)



S1 ^{1}H NMR
(DMSO-d_6, 500 MHz)



S1 ^{13}C NMR
(DMSO-d_6, 125 MHz)



S1 ^{19}F NMR
(DMSO-d_6, 471 MHz)