Supporting Information

Solvent dependent reductive defluorination of aliphatic C-F bonds employing $Sm(HMDS)_2$

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General methods

All reactions were performed using dry conditions under nitrogen atmosphere using glove-box, if not otherwise stated. THF and *n*-hexane were distilled from benzophenone/Na and stored over Na in a glove-box. All reagents were used as purchased without further purifications. Sealed tubes approved for microwave heating were used for all defluorination reactions. Silica column chromatography was performed with chromatographic silica media for separation and purification applications (35-70 micron). ^{1}H-NMR, ^{13}C-NMR, and ^{19}F-NMR were recorded with Varian 400. The chemical shifts are reported in ppm relative to the residual peak from the solvent $CDCl_3$ (^{1}H-NMR δ 7.26, ^{13}C-NMR δ 77.16). For ^{19}F-NMR, the peaks are reported in ppm relative to $CDCl_3$, using ethyl trifluoroactetate as internal reference (^{19}F-NMR δ −75.8).[1] The yields of the reductive defluorination reactions were measured by GC-FID with *n*-dodecane as internal standard. GC-FID was performed on a GC Varian 3900 with an auto sampler equipped with a EQUITYTM-5 column (30 m * 0.25 mm * 0.25 µm), and with hydrogen as carrier gas. HRMS was recorded with Bruker MicroTOF ESI. Compound **1a** was purchased from Apollo scientific, while **1i**, and **1k** were purchased from Sigma Aldrich. Compounds **1b**,[2] **1c**,[3] **1e**,[4] **1f**,[5] **1g**3 and **1h**[6] were synthesized following literature procedures.

Synthesis of 3-methyl-undecan-3-ol

The reaction was performed in a fume hood, under dry conditions. Ethylmagnesiumbromide (22 mL, 21 mmol, 1 M in THF) was diluted in 80 mL dry THF and cooled to 0 °C. To this was 2-decanone (2.0 mL, 11 mmol) dissolved in 20 mL dry THF, added dropwise. When the reaction had reached completion it was quenched with 100 mL sat. NH_4Cl (aq). The crude was extracted with 3x100 mL Et_2O. The organic phases were combined, dried over $MgSO_4$, filtered and concentrated giving a colorless oil (1.8 g, 9.7 mmol, 92% yield) that was used without further purification. ^{1}H NMR (400 MHz, $CDCl_3$): δ 1.48 ($C\underline{H}_2CH_3$, q, *J* = 7.6 Hz, 2H), 1.44-1.41 ($C\underline{H}_2$, m, 2H), 1.33-1.25 (m, 12H), 1.14 ($C\underline{H}_3$, s, 3H), 0.89 ($CH_2C\underline{H}_3$, t, *J* = 7.5 Hz, 3H), 0.88 ($CH_2C\underline{H}_3$, t, *J* = 6.9 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$): δ 73.1, 41.5, 34.3, 32.1, 30.4, 29.8, 29.5, 26.5, 24.0, 22.8, 14.3, 8.4.

Synthesis of 3-fluoro-3-methyl-undecane (1d)

The reaction was performed in a fume hood, under N_2(g) in dry Teflon-flask. 3-Methyl-undecan-3-ol was dissolved in dry CH_2Cl_2 and stirred over MS (4Å) over night before use. Deoxo-fluor (5 mL, 10.6 mmol, 50% solution in THF) was added to a Teflon round-bottom flask and cooled to −78 °C. To this was added drop wise 3-methyl-undecan-3-ol (1.8 g, 9.7 mmol) dissolved in 3.3 mL dry CH_2Cl_2. The reaction was followed by GC-FID. When it had reached completion it was quenched by dropwise addition to 75 mL sat. $NaHCO_3$ (aq) at 0 °C. Caution, gas evolution! When gas evolution ceased the crude was extracted with 3x75 mL Et_2O. The combined organic phases were washed with 150 mL sat. $NaHCO_3$ (aq). The organic phase was dried over $MgSO_4$, filtered and concentrated. Purified by column chromatography (silica gel, pentane) yielding a colorless oil (0.75 g, 4 mmol, 41% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 1.69-1.53 (m, 4H), 1.36-1.24 (m, 15H), 0.91 ($CH_2C\underline{H}_3$, t, *J* = 7.5 Hz, 3H), 0.88 ($CH_2C\underline{H}_3$, t, *J* = 6.9 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$): δ 98.0 (d, $^{1}J_{C\text{-}F}$ = 166.6 Hz), 39.3 (d, $^{2}J_{C\text{-}F}$ = 22.6 Hz), 32.3 (d, $^{2}J_{C\text{-}F}$ = 23.7 Hz), 32.0, 30.2, 29.7, 29.4, 23.9 (d, $^{2}J_{C\text{-}F}$ = 25.1 Hz), 23.8 (d, $^{3}J_{C\text{-}F}$ = 5.7 Hz), 22.8, 14.3, 8.1 (d, $^{3}J_{C\text{-}F}$ = 6.8 Hz).^{19}F NMR (376 MHz, $CDCl_3$): δ −145.8 - –146.2 (m, 1F). HR-MS (ESI): calc. for $C_{12}H_{26}F^{+}$: 189.2019; Found $[M+H]^{+}$ 189.2029.

Synthesis of (3,3,3-trifluoropropyl)benzene (1j)[7]

The reaction was run dry under N_2(g) atmosphere. To CuI (26 mg, 0.14 mmol) was added 1,1,1-trifluoro-3-iodopropane (1.0 g, 4.5 mmol) diluted in 5 mL dry THF. To this was added phenylmagnesium chloride (2.5 mL, 4.9 mmol, 2 M in THF). The reaction was stirred over night at room temperature. It was quenched by adding 20 mL HCl (1.0 M), and extracted with 3x20 mL Et_2O. The organic phase was dried over $MgSO_4$, filtered and concentrated. The crude was purified by column chromatography (silica gel, pentane) yielding a colorless oil (0.177 g, 1 mmol, 22% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35-7.19 (Ar, m, 5H), 2.90-2.86 (PhC$\underline{H}_2$, m, 2H), 2.41-2.36 (C$\underline{H}_2$CF$_3$, m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 139.1, 128.9, 128.4, 126.8 (CH$_2\underline{C}$F$_3$, q, $^1J_{C\text{-}F}$ = 278.1 Hz), 126.7, 35.8 ($\underline{C}$H$_2$CF$_3$, q, $^2J_{C\text{-}F}$ = 28.4 Hz), 28.3 (Ph$\underline{C}$H$_2$, q, $^3J_{C\text{-}F}$ = 3.2 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ −67.3 (t, $^2J_{H\text{-}F}$ = 10.6 Hz, 3F). HR-MS (ESI): calc. for $C_9H_{10}F_3^+$: 175.0735; Found $[M+H]^+$: 175.0730.

Preparation of SmI_2 in THF

To samarium metal (2.7 g, 16 mmol) and diiodoethane (3.4 g, 10 mmol) was added dry THF (100 mL). The mixture was allowed to stir for 3 h at room temperature. This yielded a 0.10 M deep-blue SmI_2 solution.

Preparation of Sm(HMDS)$_2$ in THF

To a 0.10 M SmI_2 solution in THF (100 mL, 10 mmol) was added potassium bis(trimethylsilyl)amide (4.78 g, 20 mmol). This was stirred for 3 h at room temperature. The potassium iodide formed during the reaction was filtered of through a fritted glass-funnel. This yielded a 0.10 M deep-purple Sm(HMDS)$_2$ solution in THF.

Preparation of KI free Sm(HMDS)$_2$ (in *n*-hexane and THF)[8]

THF was removed under reduced pressure from a 0.10 M solution of Sm(HMDS)$_2$ (100 mL, 10 mmol). The solid was dissolved in 100 mL *n*-hexane and allowed to stand for 2 h, in which additional potassium iodide precipitated and was filtered of. This yielded a 0.10 M deep-purple KI-free Sm(HMDS)$_2$ solution in *n*-hexane. Further, to afford KI-free Sm(HMDS)$_2$ in THF, the *n*-hexane was removed under reduced pressure and the purple solid was dissolved in appropriate amount of THF.

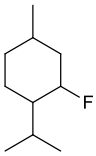
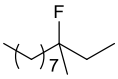
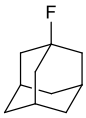
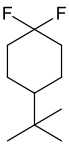
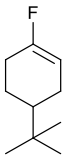
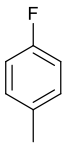
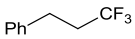
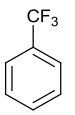
Preparation of NaSm^{II}(HMDS)$_3$ (in *n*-hexane and THF)[9]

To Sm(HMDS)$_3$ (0.19 g, 0.3 mmol) and Na (6.9 mg, 0.3 mmol) was added THF or *n*-hexane (3.0 mL). The mixture was allowed to stir at room temperature for 2 h. This yielded a deep-purple 0.10 M NaSm^{II}(HMDS)$_3$ solution.

General procedure for reductive defluorination

To KI-free Sm(HMDS)$_2$ in *n*-hexane (1.0 mL, 0.1 M in *n*-hexane, 0.1 mmol) was added substrate (0.04 mmol). *N*-Dodecane (9.1 µL, 0.04 mmol) was added as internal standard. The reaction was heated in microwave cavity (for respective reactions conditions see Table S1). The reaction was quenched by adding 2 mL HCl (0.5 M) and extracted with 2 mL Et_2O. The outcome of the reaction was analyzed by GC-FID.

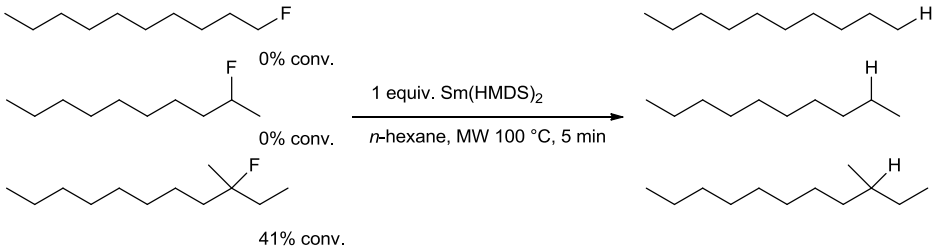
Table S1: Reaction conditions for reductive defluorination.

Entry	Substrate	Substrate (mmol)	Sm(II) (mmol)	*T* (°C)	*t* (min)
1	 **1a**	0.04	0.1	100	60
2	 **1b**	0.04	0.1[a]	100	20
3	 **1c**	0.04	0.1[a]	100	40
4	 **1d**	0.04	0.1[a]	100	10
5	 **1e**	0.04	0.1	100	30
6	 **1f**	0.02	0.1	100	60
7	 **1g**	0.02	0.1	100	60
8	 **1h**	0.04	0.1	100	60
9	 **1i**	0.01	0.1	100	60
10	 **1j**	0.013	0.1	100	60
11	 **1k**	0.013	0.1	r.t.	30

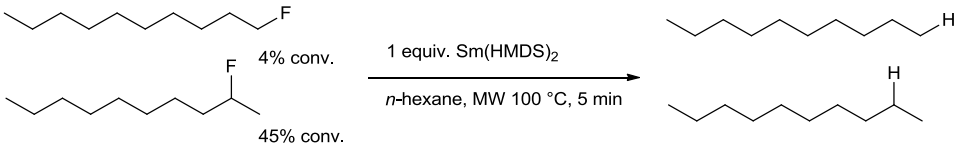
[a] Sm(III) can cause elimination and therefore it is important to add a small excess of Sm(II).

Examining the selectivity between 1°, 2°, and 3° alkyl fluorides

To KI-free $Sm(HMDS)_2$ in n-hexane (1.0 mL, 0.1 M in *n*-hexane, 0.1 mmol) was added 1-fluorodecane **1a** (20 µL, 0.1 mmol), **1b** (100 µL, 1.0 M in *n*-hexane, 0.1 mmol), and **1d** (100 µL, 1.0 M in *n*-hexane, 0.1 mmol). *n*-Dodecane (23 µL, 0.1 mmol) was added as an internal standard. The reaction was heated in the microwave cavity at 100 °C for 5 min. The reaction was quenched by adding 2 mL HCl (0.5 M), and extracted with 2 mL Et_2O. The reaction was analyzed by GC-FID.



Scheme S1: Selectivity between 1˚, 2˚ and 3˚ alkyl fluorides.

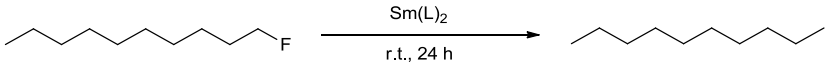


Scheme S2: Selectivity between 1˚ and 2˚ alkyl fluorides.

Examination of different Sm(II)-reductants in C-F cleavage

To respective $Sm(L)_2$ (1.0 mL, 0.1 M in solvent, 0.1 mmol) was added 1-fluorodecane (7.9 µL, 0.04 mmol). *n*-Dodecane (9.1 µL, 0.04 mmol) was added as internal standard. The reaction was stirred for 24 h after which a sample was quenched in 0.5 M HCl and extracted with Et_2O. The crude was analyzed by GC-FID.

Table S2: Different Sm(II) reductants used in C-F cleavage.



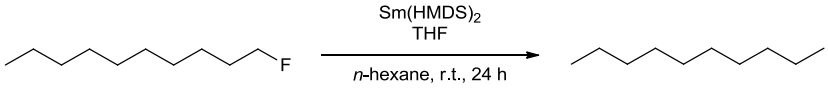
Entry	$Sm(L)_2$	Solvent	Yield (%)
1	$SmI_2/Et_3N/H_2O$[a]	THF	n/r
2	SmI_2/TPPA[b]	THF	n/r
3	SmI_2/DMPU[c]	THF	n/r
4	$Sm(HMDS)_2$	THF	26
5	$Sm(HMDS)_2$	THF	2
6	$Sm(HMDS)_2$	*n*-hexane	55
7	$NaSm^{II}(HMDS)_3$	THF	n/r
8	$NaSm^{II}(HMDS)_3$	*n*-hexane	30

a) Et_3N (28 µL, 0.2 mmol) and H_2O (5.4 µL, 0.3 mmol) was added. b) TPPA (92 µL, 0.4 mmol) was added. c) DMPU (48 µL, 0.4 mmol) was added.

Investigation of the THF effect

To KI-free $Sm(HMDS)_2$ in *n*-hexane (1.0 mL, 0.1 M in *n*-hexane, 0.1 mmol) was added THF (see Table S3) and 1-fluorodecane (7.9 µL, 0.04 mmol). *n*-Dodecane (9.1 µL, 0.04 mmol) was added as internal standard. The reaction was stirred for 24 h at room temperature after which a sample was quenched in 0.5 M HCl and extracted with Et_2O. The crude was analyzed by GC-FID.

Table S3: The THF effect.

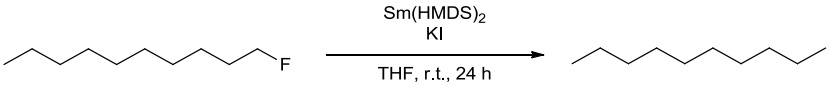


Entry	THF (µL / (equiv.))	Yield (%)
1	0	54
2	10 / (1.2)	40
3	50 / (6.2)	19
4	100 / (12.3)	12
5	200 / (24.6)	7

Investigation of the potassium iodide effect

To KI-free $Sm(HMDS)_2$ in THF (1.0 mL, 0.1 M in THF, 0.1 mmol) was added KI in different mol% (see Table S4). This was allowed to stir for 1 h at room temperature. 1-fluorodecane (7.9 µL, 0.04 mmol) was then added. *n*-Dodecane (9.1 µL, 0.04 mmol) was added as internal standard. The reaction was allowed to stir for 24 h at room temperature after which a sample was quenched in 0.5 M HCl and extracted with Et_2O. The crude was analyzed by GC-FID.

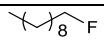
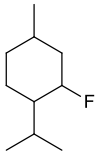
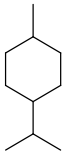
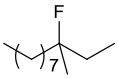
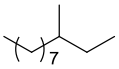
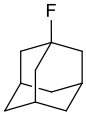
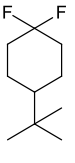
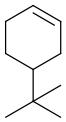
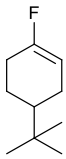
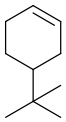
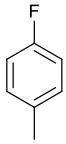
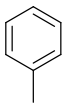
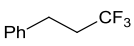
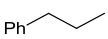
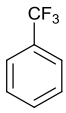
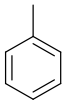
Table S4: The KI effect.



Entry	KI (mol%)	Yield (%)
1	0	2
2	25	13
3	50	32
4	100	50
5	150	50

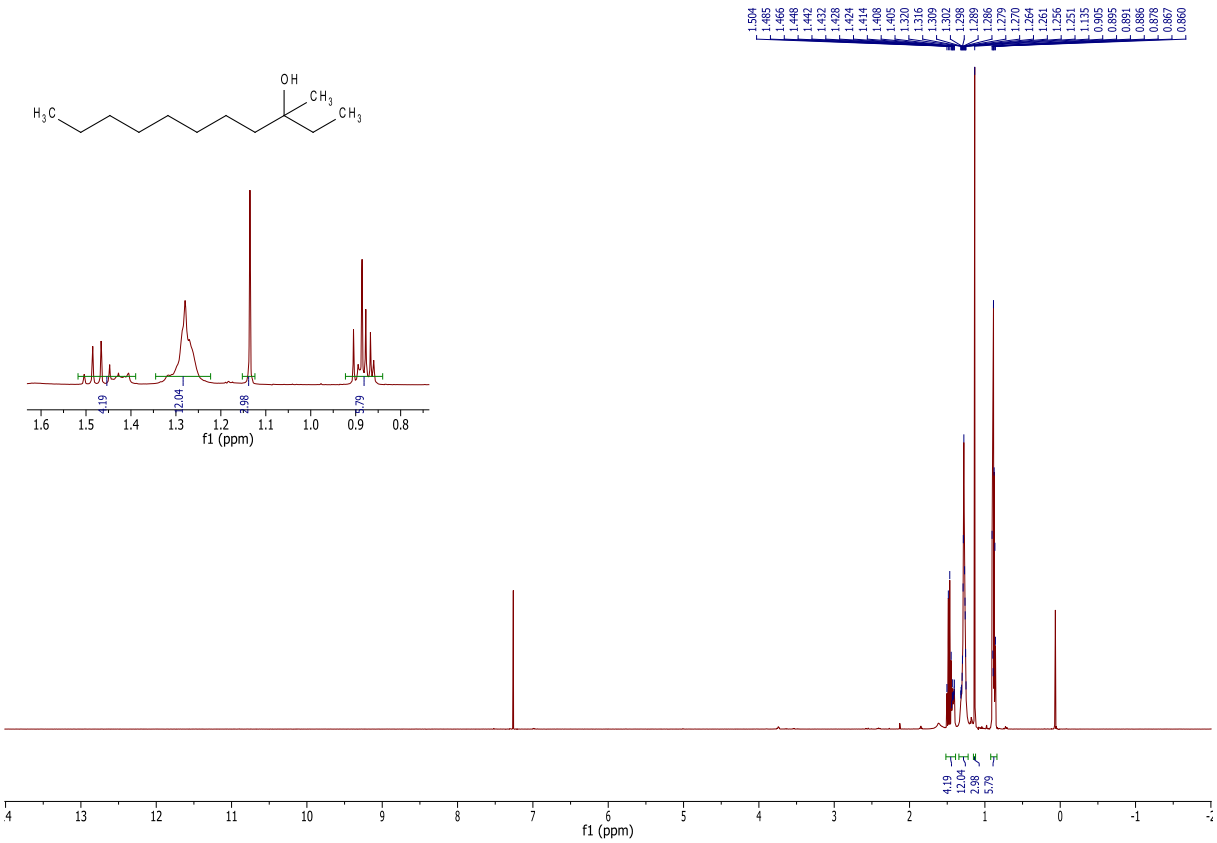
GC-FID conditions

Table S5: GC-FID conditions.

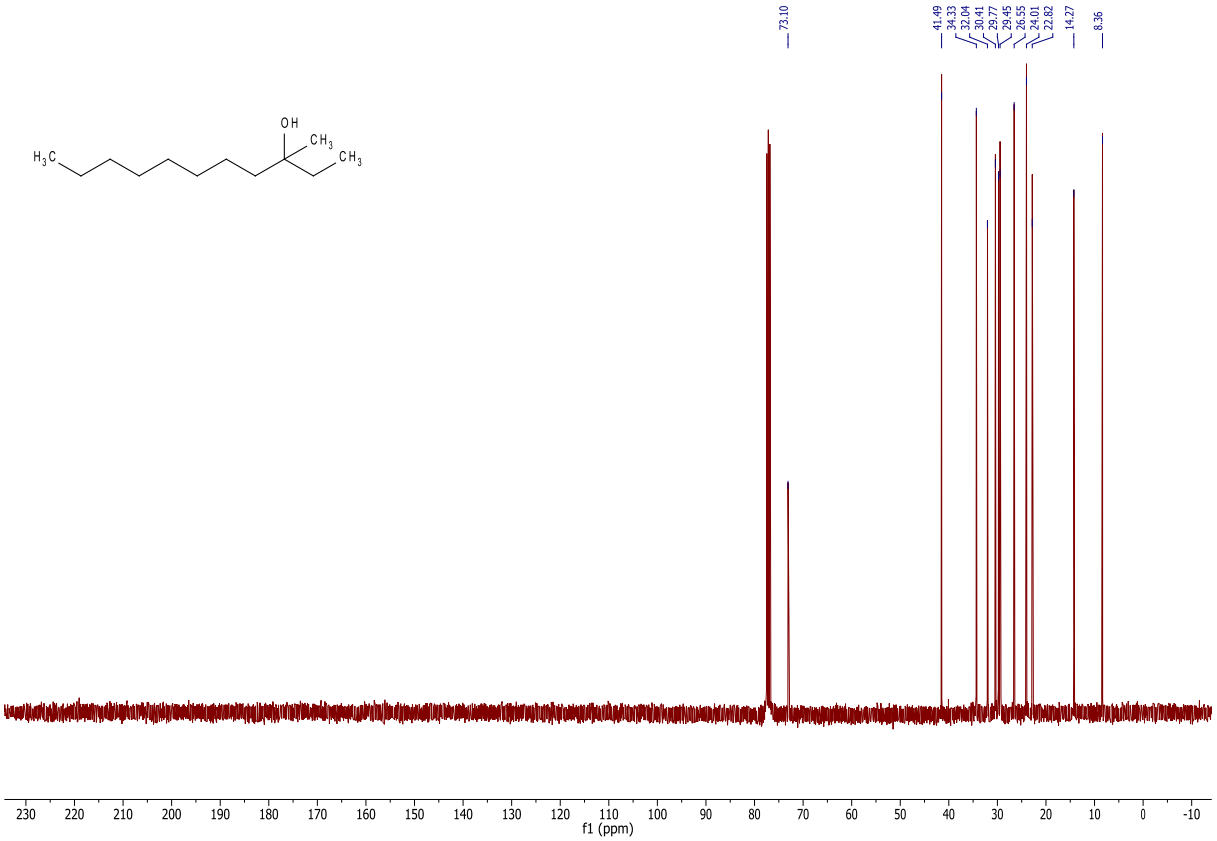
Conditions[a]	Substrate	Rt	Rf	Product	Rt	Rf
A		10.0	0.83		8.4	0.81
A		9.5	0.71		8.4	0.81
A		9.3	0.73		8.2	0.67
A		11.8	0.57		11.0	0.80
A		10.9	0.62		10.1	0.82
A		9.0	0.68		8.3; 8.5; 8.7	-
A		9.1	0.7		8.6	-
A		9.4	0.73		8.6	-
B		6.3	0.60		6.05	0.61
B		8.3	0.68		-	-
B		5.1	0.70		6.05	0.61

a) A: 70 °C, 4 min; 12 °C·min^{-1} to 300 °C, 2 min; injector temperature 300 °C. Rt (*n*-dodecane) = 11.4 min. B: 40 °C, 2 min; 12 °C·min^{-1} to 300 °C, 2 min; injector temperature 300 °C. Rt (*n*-dodecane) = 12.0 min.

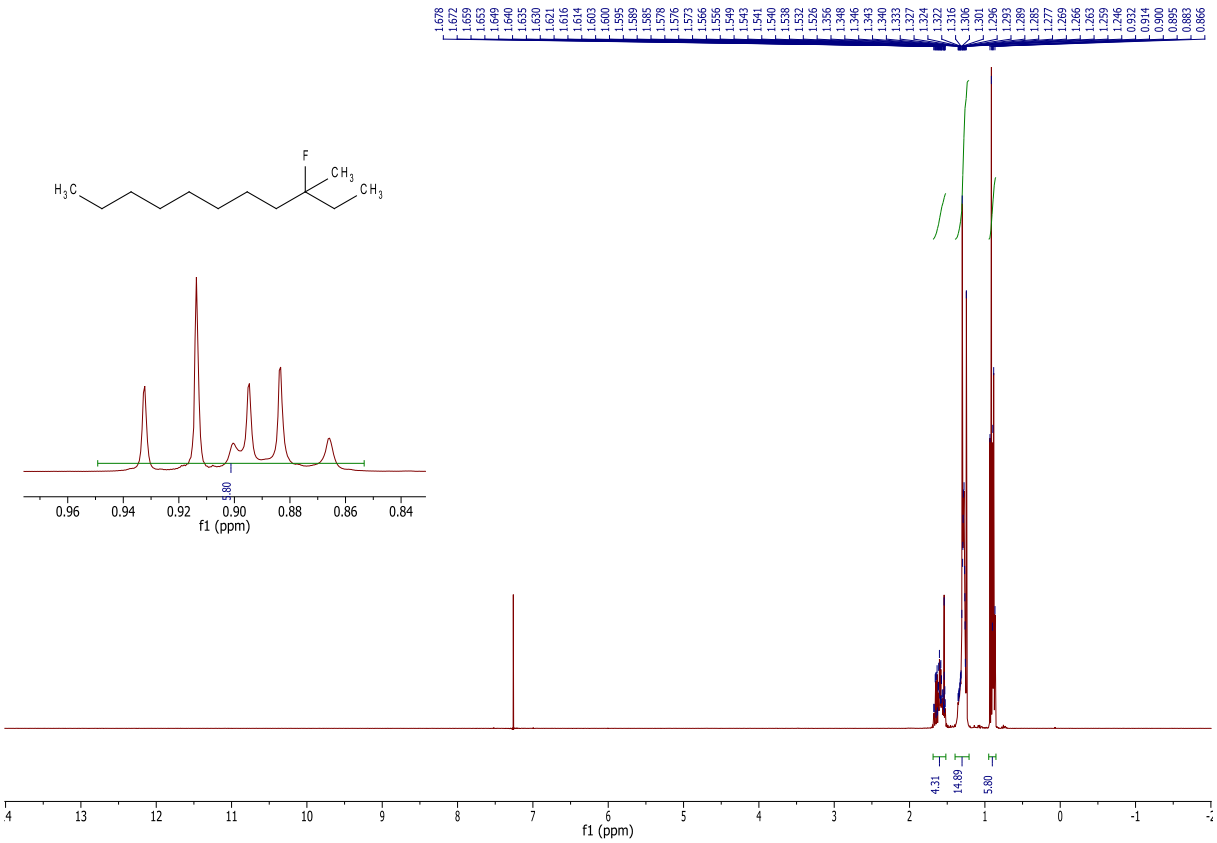
^{1}H-NMR of 3-methyl-undecan-3-ol



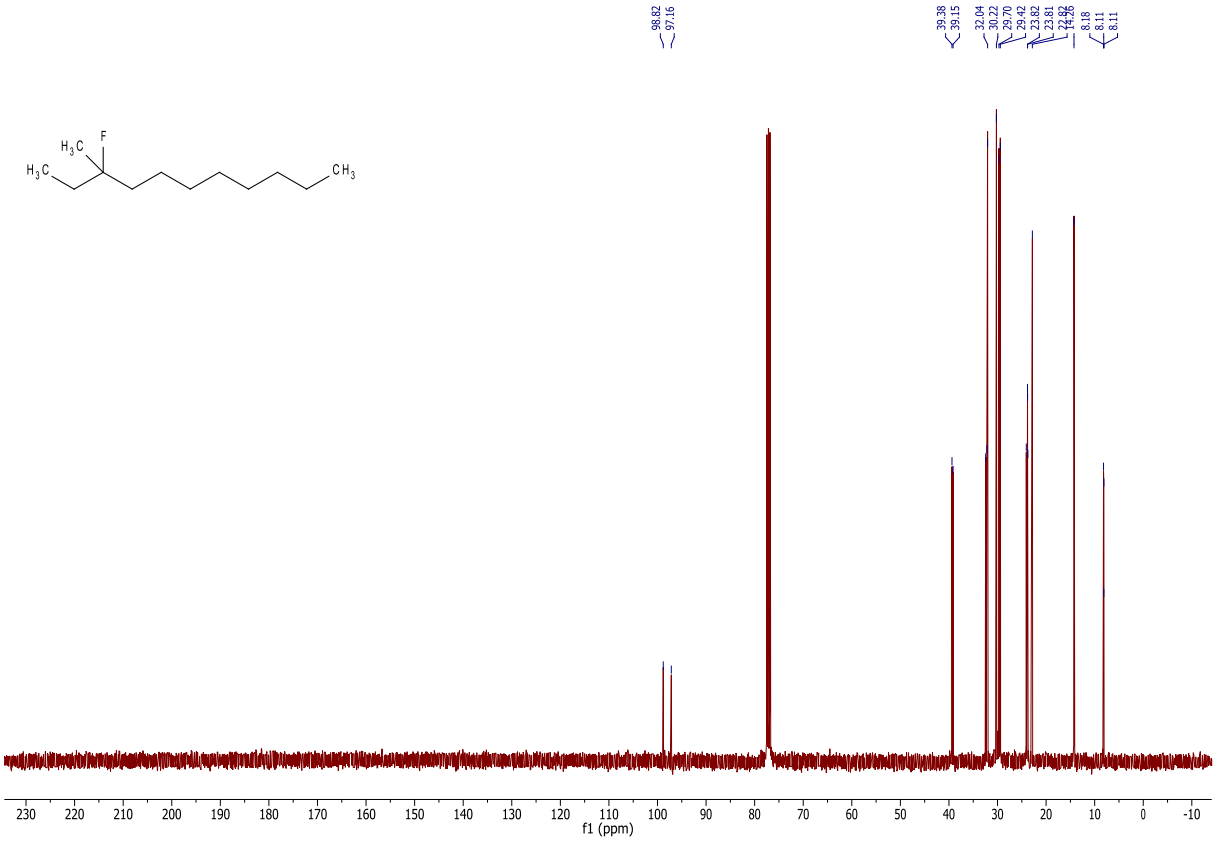
^{13}C-NMR of 3-methyl-undecan-3-ol



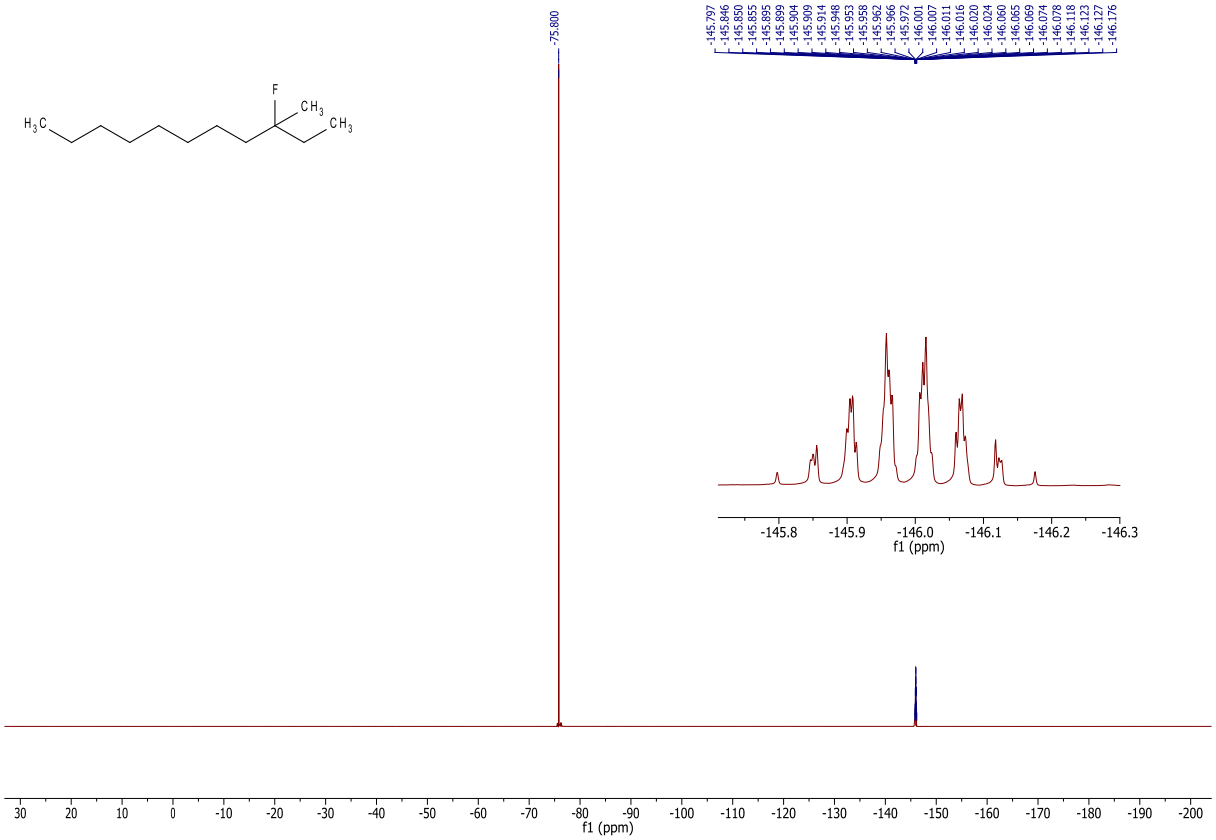
^{1}H-NMR of 3-fluoro-3-methyl-undecane (1d)



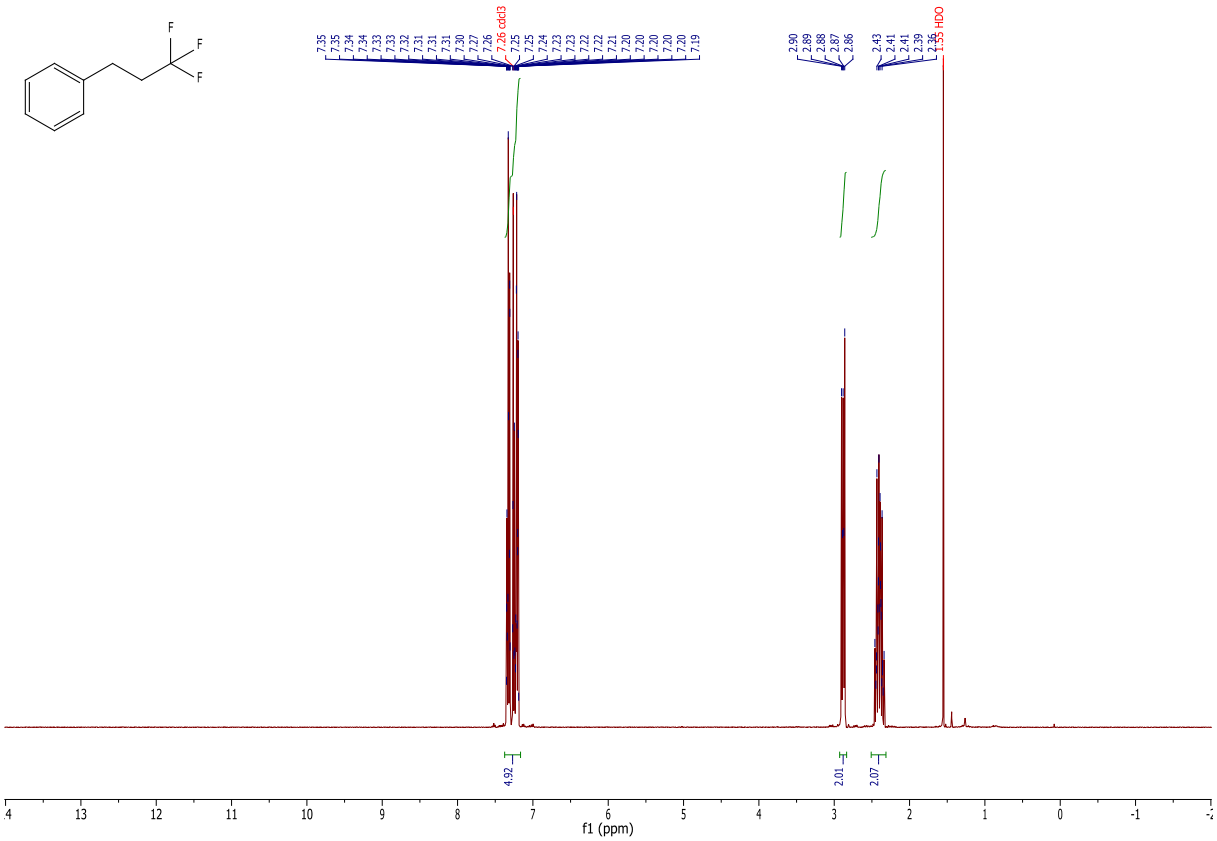
^{13}C-NMR of 3-fluoro-3-methyl-undecane (1d)



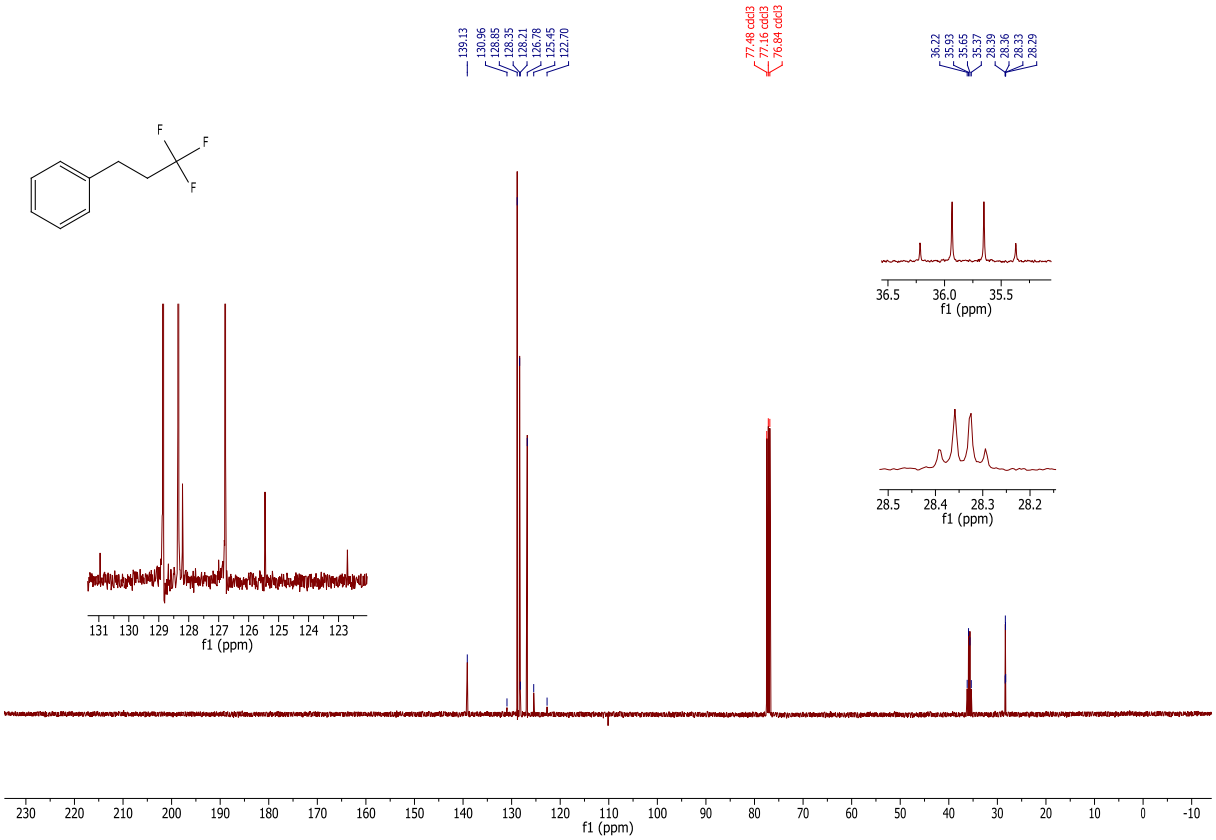
^{19}F-NMR of 3-fluoro-3-methyl-undecane (1d)



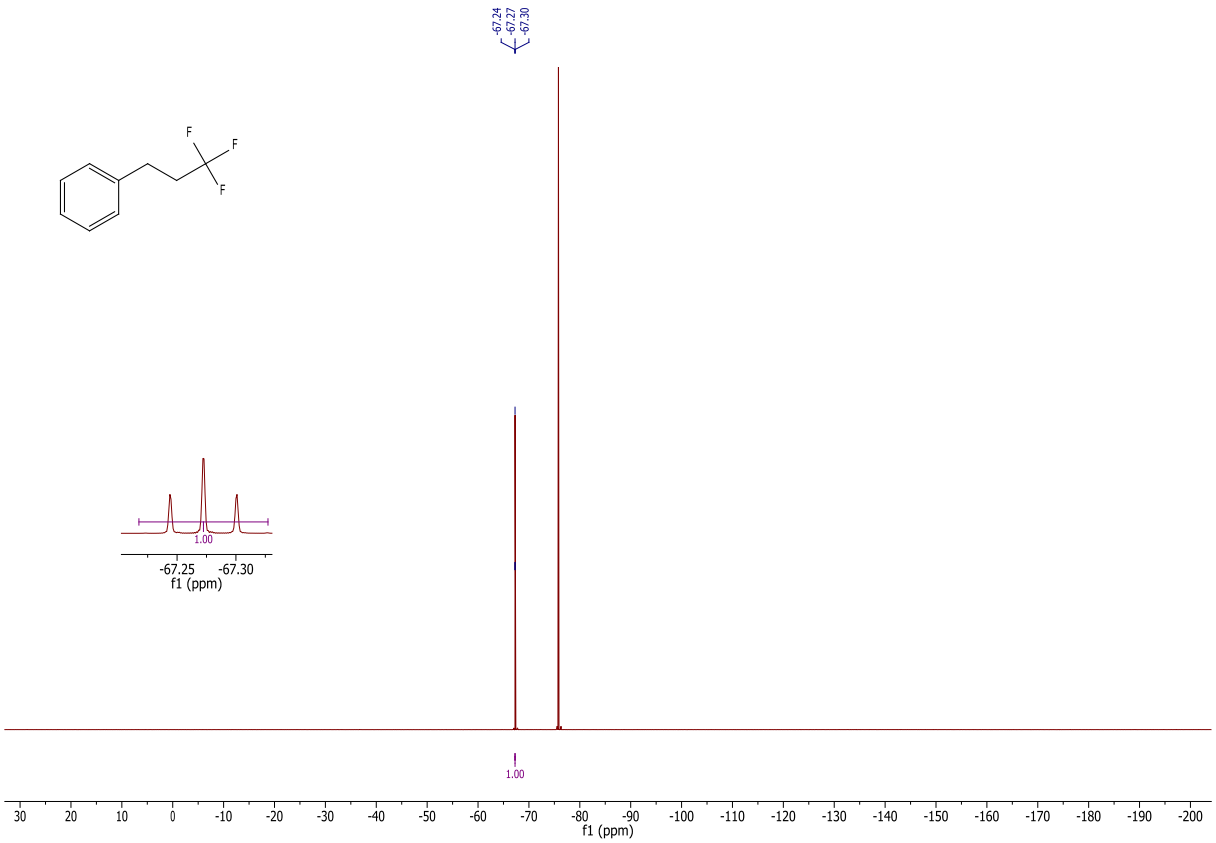
^{1}H-NMR of (3,3,3-trifluoropropyl)benzene (1j)



^{13}C-NMR of (3,3,3-trifluoropropyl)benzene (1j)



^{19}F-NMR of (3,3,3-trifluoropropyl)benzene (1j)



[1] W. R. Dolbier, in *Guide to fluorine NMR for organic chemists*, John Wiley & Sons, Inc., Hoboken, New Jersy, USA, 2009, p 5.
[2] **1b** was synthesized following the general procedure for fluorination of ketones reported in: G. S. Lal, G. P. Pez, R. J. Pesaresi, F. M. Prozonic, H. Cheng, *J. Org. Chem.*, 1999, **64**, 7048. NMR was in agreement with previously published data: R. D. Chambers, A. M. Kenwright, M. Parsons, G. Sandford, J. S. Moilliet, *J. Chem. Soc., Perkin Trans. 1*, 2002, 2190.
[3] G. S. Lal, G. P. Pez, R. J. Pesaresi, F. M. Prozonic, H. Cheng, *J. Org. Chem.*, 1999, **64**, 7048.
[4] R. D. Chambers, A. M. Kenwright, M. Parsons, G. Sandford, J. S. Moilliet, *J. Chem. Soc., Perkin Trans. 1*, 2002, 2190.
[5] **1f** was synthesized following the general procedure for fluorination of ketones reported in: G. S. Lal, G. P. Pez, R. J. Pesaresi, F. M. Prozonic, H. Cheng, *J. Org. Chem.*, 1999, **64**, 7048. NMR was in agreement with previously published data: S. Rozen, D. Zamir, *J. Org. Chem.*, 1991, **56**, 4695.
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