Supporting Information

Site-Selective Deuteration at α-Position of Enals by an Amine and Bis(phenylsulfonyl)methane Co-catalyzed H/D Exchange Reaction

Pengfei Qian, Shilei Zhang,* Fan Luo, Jiarui Wang, Xinyu Zhang, Xuejun Liu, Xiaodong Chen, Wei Wang* and Xiaobei Chen*

Table of Contents

1. General Information

Commercial reagents and solvents were used as received, unless otherwise stated. Organic solution was concentrated under reduced pressure on a Büchi rotary evaporator. Analytical thin layer chromatography (TLC) was performed on 0.25 mm silica gel plates (Qingdao Haiyang Chemical China), and the compounds were visualized with a UV light at 254 nm. Further visualization was achieved by staining with iodine. Column chromatography was performed on silica gel 200–300 mesh (purchased from Qingdao Haiyang Chemical China) with commercial solvents (purchased from Adamas-beta®). The ^{1}H NMR, ^{2}H NMR, ^{13}C NMR and ^{19}F NMR spectra were recorded on a Bruker AM 400 Spectrometer (400, 77, 151 and 565 MHz for ^{1}H NMR, ^{2}H NMR, ^{13}C NMR and ^{19}F NMR, respectively) and are internally referenced to residual solvent signals (note: $CDCl_3$ referenced at 7.26 ppm in ^{1}H NMR, C_6F_6 referenced at -161.64 ppm in ^{19}F NMR[1]). Multiplicities were given as s (singlet), d (doublet), t (triplet), dd (double of doublet), and m (multiplets). Coupling constants were reported in Hertz (Hz). Data for ^{13}C NMR are reported in terms of chemical shift. Mass spectra were obtained using a TOF MS instrument EI or ESI source.

The level of deuterium incorporation in the product was determined by ^{1}H NMR (**Supplementary Equation 1**) or ^{2}H NMR (**Supplementary Equation 2**) spectroscopy. The integrals were calibrated against a peak corresponding to a position not expected to be labelled.

Supplementary Equation 1 was based on ^{1}H NMR and used to calculate the extent of labelling for most of the deuterated products:

$$\%\ \text{Deuteration} = 100 - \left[\left(\frac{\text{residual integral}}{\text{number of labelling sites}} \right) \times 100 \right]$$

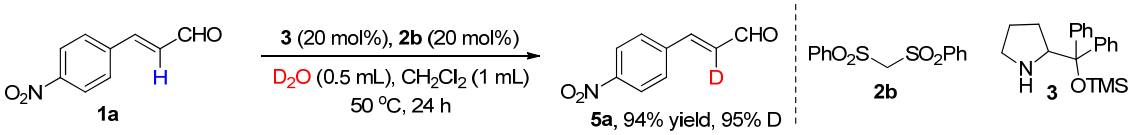
Supplementary Equation 1

Supplementary Equation 2 was based on ^{2}H NMR and used to calculate the extent of labelling for the deuterated products containing some special sites where only slight deuterium incorporation occurred (**5ae, 5ah, 5ai, 5aj):**

$$\%\ \text{Deuteration} = \text{integral of the needed peak}$$

Supplementary Equation 2

2. Sensitivity assessment of the reaction



Standard conditions: **1a** (0.2 mmol), **2b** (0.04 mmol) and cat. **3** (0.04 mmol) in DCM (1 mL) and D_2O (0.5 mL) was vigorously stirred at 50 °C for 24 h.

Table S1. Preparation of sensitivity assessment of the reaction[2]

Number	Experiment	Description	Preparation
1	High c	n/(*V*-10%*V*)	0.9 mL DCM
2	Low c	n/(*V*+10%*V*)	1.1 mL DCM
3	High O_2	+ air, V_{air} = 10 *V*	1.0 mL DCM + 10 mL air
4	Low O_2	degassed	1.0 mL DCM + degassed
5	High *T*	T + 10 ºC	1.0 mL DCM, T = 60 ºC
6	Low *T*	T - 10 ºC	1.0 mL DCM, T = 40 ºC
7	Control	Standard conditions	1.0 mL DCM
8	Big scale	n · 30	6.0 mmol of **1a**

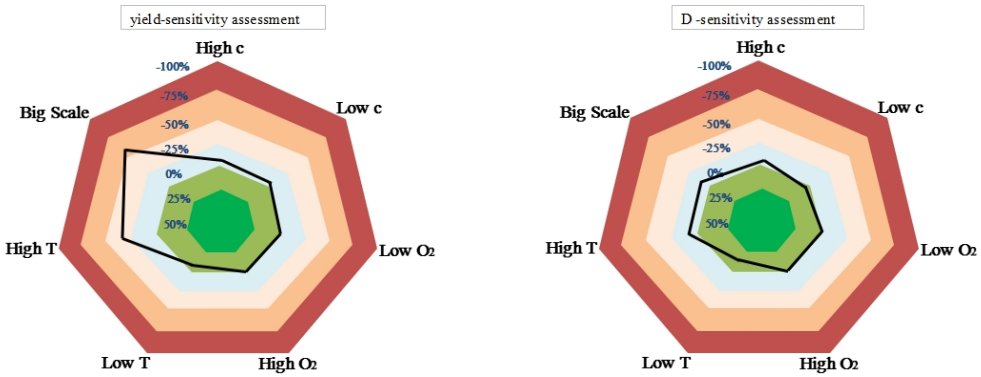
Table S2. Results (yield) of sensitivity assessment of the reaction

Number	Experiment	Yield 1 / %	Yield 2 / %	Average Y. / %	Deviation / %
1	High c	89	93	91	-3
2	Low c	92	94	93	-1
3	High O_2	94	94	94	0
4	Low O_2	93	95	94	0
5	High *T*	78	80	79	-15
6	Low *T*	97	95	96	2
7	Control	95	93	94	0
8	Big scale	69	65	67	-27

Table S3. Results (D value) of sensitivity assessment of reaction

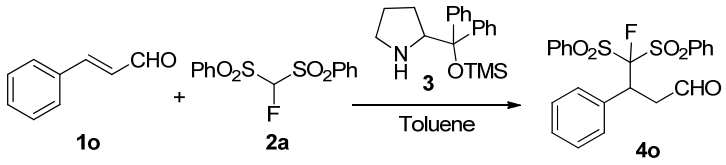
Number	Experiment	D. 1 / %	D. 2 / %	Average D. / %	Deviation / %
1	High c	95	96	96	1
2	Low c	94	93	94	-1
3	High O_2	95	95	95	0
4	Low O_2	95	95	95	0
5	High *T*	99	99	99	4
6	Low *T*	89	91	90	-5
7	Control	95	95	95	0
8	Big scale	99	99	99	4

Radar diagram:



3. Mechanism study

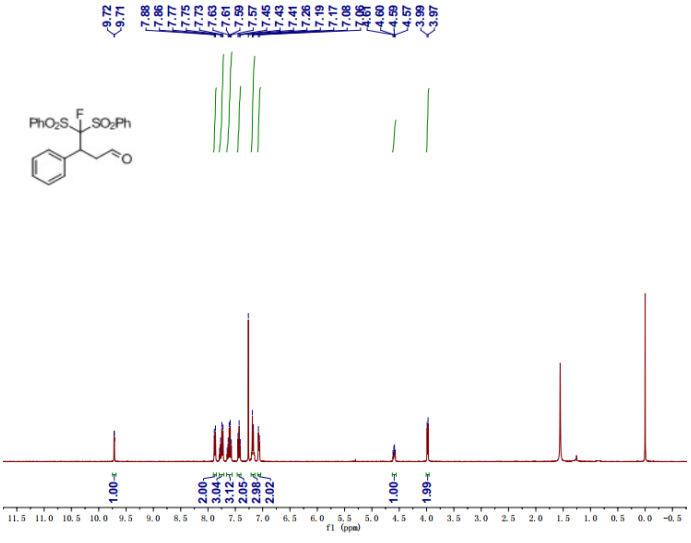
Preparation of compound **4o**



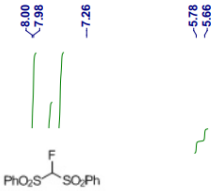
Supplementary Scheme 1

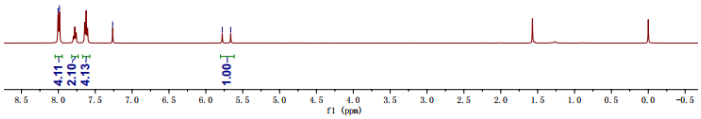
According to our previously developed procedure (*Chem. Commun.,* 2009, 4886), a solution of **1o** (495 mg, 3.75 mmol), **2a** (235.5 mg, 0.75 mmol) and **3** (48.7 mg, 0.15 mmol) in toluene (6 mL) was stirred at 0 °C for 72 h, then it was purified by column chromatography to give the disired product **4o**.

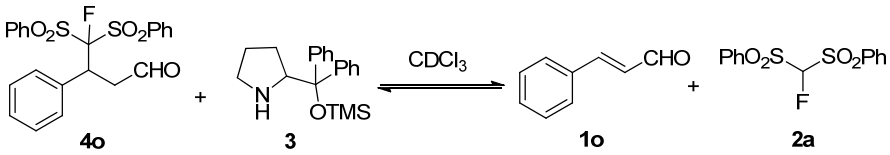
^{1}H NMR of **4o**:



^{1}H NMR of **2a**:

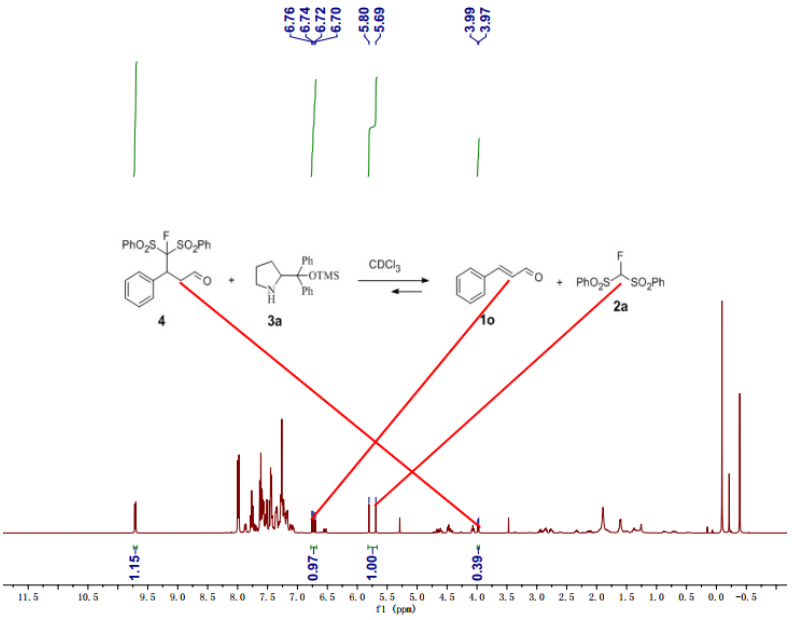






Supplementary Scheme 2

A solution of **4o** (22.4 mg, 0.05 mmol) and **3** (3.3 mg, 0.01 mmol) in $CDCl_3$ (0.5 mL) was stirred at rt for 12 h. The reaction mixture was directly detected by ^{1}HNMR as follow:

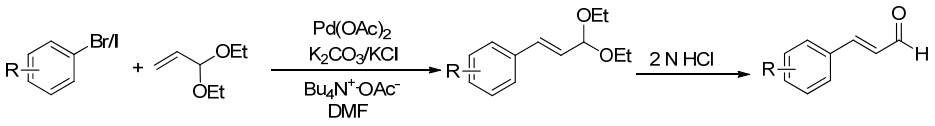


From the ^{1}HNMR we could find the typical peaks of cinnamaldehyde **1o** and fluorobis(phenylsulfonyl)methane **2a**. So this experiment can prove that the Michael addition reaction is reversible.

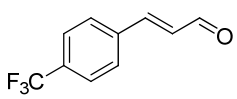
4. Preparation of the starting materials

Cinnamaldehydes (**1a, 1c, 1d, 1g, 1i, 1j, 1k, 1o, 1r, 1s, 1t, 1u, 1w, 1z, 1ae**), **9, 13, 17, 19** and nucleophiles **2b, 2c, 2d, 2e, 2f, 2g, 2h** are commercially available. **2a**[3], **3**[4] and **12**[13] were prepared according to literature procedures.

Procedure A: Synthesis of cinnamaldehydes via Heck reaction/deprotection[5,6]



A mixture of aryl halide (1 mmol), acrolein diethyl acetal (3 mmol), K_2CO_3 (1.5 mmol), $Bu_4N^{+}\cdot OAc$ (2 mmol), KCl (1 mmol) and $Pd(OAc)_2$ (3 mol%) in DMF (4 mL) was stirred at 90°C under N_2, and the reaction was monitored by TLC. After the reaction was completed, it was cooled to room temperature and 2 N HCl (10 mL) was slowly added, and the mixture was stirred at room temperature for 30 min. Then the reaction was diluted with EtOAc and washed with H_2O. The organic layer was isolated and dried over Na_2SO_4. The solvent was concentrated under reduced pressure, and the crude product was purified by column chromatography to give the cinnamaldehyde products.



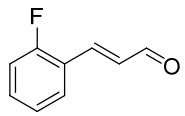
(*E*)-3-(4-(trifluoromethyl)phenyl)acrylaldehyde (1e)

Following the general procedure A, the title compound was prepared from 4-iodobenzotrifluoride (5 mmol) as a light yellow solid (610 mg, 61% yield). The spectra data was consistent with the literature report.[5]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.66 (d, *J* = 7.5 Hz, 1H), 7.63 – 7.56 (m, 4H), 7.42 (d, *J* = 16.0 Hz, 1H), 6.68 (dd, *J* = 16.0, 7.5 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.3, 150.4, 137.4, 132.7 (q, *J* = 33.2 Hz), 130.7, 128.7, 126.2 (q, *J* = 4.5 Hz), 123.8 (q, *J* = 271.8 Hz).

^{19}F NMR (565 MHz, $CDCl_3$): δ -62.84 (s, 3F).



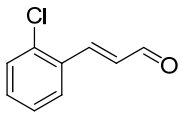
(*E*)-3-(2-fluorophenyl)acrylaldehyde (1f)

Following the general procedure A, the title compound was prepared from 1-fluoro-2-iodobenzene (5 mmol) as a light yellow liquid (530 mg, 71% yield). The spectra data was consistent with the literature report.[6]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.72 (d, *J* = 7.6 Hz, 1H), 7.66 (d, *J* = 16.1 Hz, 1H), 7.59 (t, *J* = 7.3 Hz, 1H), 7.48 – 7.38 (m, 1H), 7.21 (t, *J* = 7.4 Hz, 1H), 7.14 (t, *J* = 9.4 Hz, 1H), 6.79 (dd, *J* = 16.1, 7.6 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.9, 161.2 (d, *J* = 254.8 Hz), 144.9 (d, *J* = 3.6 Hz), 132.9 (d, *J* = 8.9 Hz), 130.5 (d, *J* = 5.3 Hz), 128.8, 124.7 (d, *J* = 3.7 Hz), 122.1 (d, *J* = 11.4 Hz), 116.3 (d, *J* = 21.8 Hz),

^{19}F NMR (565 MHz, $CDCl_3$): δ -114.14 (s, 1F).

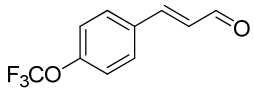


(*E*)-3-(2-chlorophenyl)acrylaldehyde (1h)

Following the general procedure A, the title compound was prepared from 1-chloro-2-iodobenzene (5 mmol) as a white solid (635 mg, 77% yield). The spectra data was consistent with the literature report.[5]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.76 (d, *J* = 7.7 Hz, 1H), 7.94 (d, *J* = 16.0 Hz, 1H), 7.67 (d, *J* = 7.3 Hz, 1H), 7.46 (d, *J* = 7.5 Hz, 1H), 7.39 – 7.38 (m, 2H), 6.71 (dd, *J* = 16.0, 7.7 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.6, 148.0, 135.2, 132.1, 132.0, 130.5, 130.4, 127.9, 127.3.



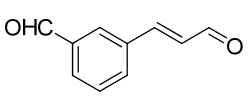
(*E*)-3-(4-(trifluoromethoxy)phenyl)acrylaldehyde (1l)

Following the general procedure A, the title compound was prepared from 1-iodo-4-(trifluoromethoxy)benzene (4 mmol) as a light yellow liquid (695 mg, 80% yield). The spectra data was consistent with the literature report.[7]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.72 (d, *J* = 7.6 Hz, 1H), 7.61 (d, *J* = 8.6 Hz, 2H), 7.47 (d, *J* = 16.0 Hz, 1H), 7.28 (d, *J* = 8.6 Hz, 2H), 6.70 (dd, *J* = 16.0, 7.6 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.5, 151.2, 150.8, 132.7, 130.1, 129.4, 121.4, 120.5 (q, *J* = 258.2 Hz).

^{19}F NMR (565 MHz, $CDCl_3$): δ -57.56 (s, 3F).

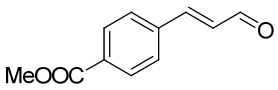


(*E*)-3-(3-oxoprop-1-en-1-yl)benzaldehyde (1m)

Following the general procedure A, the title compound was prepared from 3-bromobenzaldehyde (6 mmol) as a white solid (762 mg, 79% yield). The spectra data was consistent with the literature report.[6]

^{1}H NMR (400 MHz, $CDCl_3$): δ 10.08 (s, 1H), 9.76 (d, *J* = 7.6 Hz, 1H), 8.08 (s, 1H), 7.96 (d, *J* = 7.6 Hz, 1H), 7.85 (d, *J* = 7.7 Hz, 1H), 7.64 (t, *J* = 7.7 Hz, 1H), 7.56 (d, *J* = 16.0 Hz, 1H), 6.81 (dd, *J* = 16.0, 7.6 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.2 (d, *J* = 3.4 Hz), 191.4 (d, *J* = 1.9 Hz), 150.6 (d, *J* = 2.4 Hz), 137.1, 135.0, 133.7, 132.0, 130.0, 129.9, 129.3.

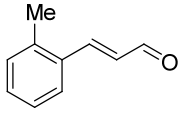


(*E*)-methyl 4-(3-oxoprop-1-en-1-yl)benzoate (1n)

Following the general procedure A, the title compound was prepared from methyl 4-iodobenzoate (5 mmol) as a white solid (520 mg, 58% yield). The spectra data was consistent with the literature report.[9]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.74 (d, *J* = 7.6 Hz, 1H), 8.09 (d, *J* = 8.1 Hz, 2H), 7.63 (d, *J* = 8.1 Hz, 2H), 7.50 (d, *J* = 16.0 Hz, 1H), 6.78 (dd, *J* = 16.0, 7.6 Hz, 1H), 3.94 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.4, 166.3, 150.9, 138.1, 132.2, 130.4, 130.3, 128.3, 52.4.

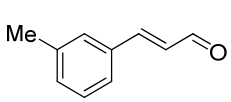


(*E*)-3-(o-tolyl)acrylaldehyde (1p)

Following the general procedure A, the title compound was prepared from 1-iodo-2-methylbenzene (5 mmol) as a light yellow liquid (580 mg, 79% yield). The spectra data was consistent with the literature report.[6]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.72 (d, *J* = 7.5 Hz, 1H), 7.77 (d, *J* = 15.8 Hz, 1H), 7.59 (d, *J* = 7.1 Hz, 1H), 7.32 (d, *J* = 6.9 Hz, 1H), 7.24 (d, *J* = 6.1 Hz, 2H), 6.66 (dd, *J* = 15.8, 7.5 Hz, 1H), 2.48 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.9, 150.3, 137.9, 132.8, 131.1, 131.0, 129.6, 126.8, 126.6, 19.7.

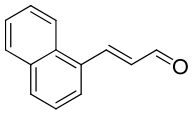


(*E*)-3-(m-tolyl)acrylaldehyde (1q)

Following the general procedure A, the title compound was prepared from 1-iodo-3-methylbenzene (5 mmol) as a light yellow liquid (585 mg, 80% yield). The spectra data was consistent with the literature report.[6]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.60 (d, *J* = 7.7 Hz, 1H), 7.35 (d, *J* = 15.9 Hz, 1H), 7.28 (s, 2H), 7.23 – 7.15 (m, 2H), 6.61 (dd, *J* = 15.9, 7.7 Hz, 1H), 2.30 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.8, 153.1, 138.9, 134.0, 132.2, 129.2, 129.0, 128.4, 125.8, 21.1.



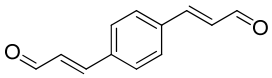
(*E*)-3-(naphthalen-1-yl)acrylaldehyde (1x)

Following the general procedure A, the title compound was prepared from 1-iodonaphthalene (6 mmol) as a yellow solid (665 mg, 61% yield). The spectra data was consistent with the

literature report.[17]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.86 (d, *J* = 7.7 Hz, 1H), 8.34 (d, *J* = 15.7 Hz, 1H), 8.19 (d, *J* = 8.4 Hz, 1H), 7.94 (dd, *J* = 18.0, 8.1 Hz, 2H), 7.83 (d, *J* = 7.2 Hz, 1H), 7.66 – 7.49 (m, 3H), 6.85 (dd, *J* = 15.7, 7.7 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.7, 149.3, 133.8, 131.6, 131.2, 131.0, 130.9, 129.0, 127.3, 126.4, 125.7, 125.5, 122.8.



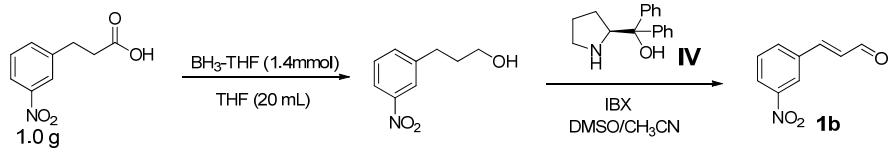
(2*E*,2'*E*)-3,3'-(1,4-phenylene)diacrylaldehyde (1ag)

Following the general procedure A, the title compound was prepared from 1,4-diiodobenzene (5 mmol) as a yellow solid (390 mg, 42% yield). The spectra data was consistent with the literature report.[10]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.74 (d, *J* = 7.6 Hz, 2H), 7.64 (s, 4H), 7.49 (d, *J* = 16.0 Hz, 2H), 6.77 (dd, *J* = 16.0, 7.6 Hz, 2H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.4, 150.9, 136.6, 129.8, 129.1.

(*E*)-3-(3-nitrophenyl)acrylaldehyde (1b)



To a solution of 3-(3-Nitrophenyl)propionic acid (1.0 g, 5.13 mmol) in THF (20 mL) was added tetrahydrofuran-borane/tetrahydrofuran solution (1 mol/L, 7.25 mL) dropwise at 0°C. The mixture was stirred at 0°C for 30 min, then warmed to room temperature for 3 h. H_2O (5 mL) was added to the reaction mixture, followed by the addition of 1 N HCl (5 mL). The mixture was extracted with EtOAc (15 mL × 3). The combined organic layer was washed with H_2O (10 mL), saturated aqueous $NaHCO_3$ solution (10 mL) and saturated brine (10 mL), and dried over Na_2SO_4. The solvent was concentrated under reduced pressure. The desired product (3-(3-nitrophenyl)-1-propanol) was obtained as a yellow oil and used in the next step without purification.

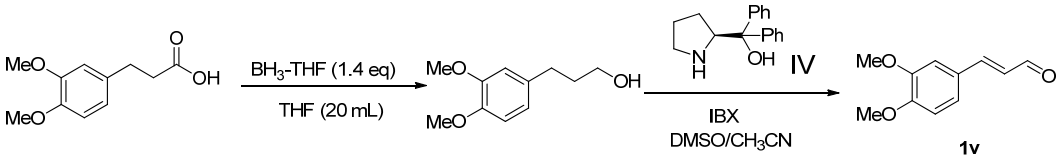
To a solution of 3-(3-nitrophenyl)-1-propanol (5.13 mmol) in DMSO (10 mL) and CH_3CN (15 mL) was added IBX (3.59 g, 12.83 mmol) and catalyst **IV** (259.6 mg, 1.03 mmol). The mixture was then stirred at room temperature until the reaction was completed monitored with TLC. H_2O (20 mL) was added to the

reaction mixture, the reaction mixture was diluted with EtOAc (80 mL) and washed with H_2O (20 mL × 4), saturated brine (20 mL). The organic solution was dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography to give aldehyde **1b** as a white solid (569 mg, 63% yield for two steps). The spectra data was consistent with the literature report.[8]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.77 (d, *J* = 7.4 Hz, 1H), 8.42 (s, 1H), 8.29 (d, *J* = 8.0 Hz, 1H), 7.89 (d, *J* = 7.6 Hz, 1H), 7.65 (t, *J* = 7.6 Hz, 1H), 7.54 (d, *J* = 16.0 Hz, 1H), 6.82 (dd, *J* = 16.0, 7.4 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 192.8, 149.1, 148.8, 135.7, 133.6, 130.9, 130.3, 125.4, 123.1.

(*E*)-3-(3,4-dimethoxyphenyl)acrylaldehyde (1v)

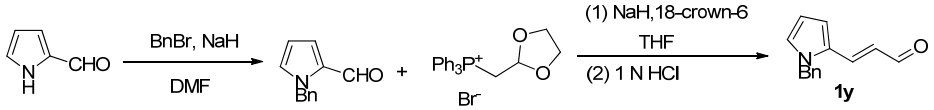


Following the same procedure for the synthesis of **1b** as described above, the title compound **1v** was obtained from 3-(3,4-dimethoxyphenyl)propanoic acid (1.05 g, 5 mmol) as a black solid (750 mg, 78% yield for two steps). The spectra data was consistent with the literature report.[10]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.64 (d, *J* = 7.7 Hz, 1H), 7.40 (d, *J* = 15.8 Hz, 1H), 7.15 (dd, *J* = 8.3, 1.8 Hz, 1H), 7.07 (d, *J* = 1.8 Hz, 1H), 6.89 (d, *J* = 8.3 Hz, 1H), 6.60 (dd, *J* = 15.8, 8.3 Hz, 1H), 3.92 (s, 3H), 3.91 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.6, 152.9, 152.0, 149.4, 127.1, 126.7, 123.5, 111.1, 109.9, 56.1, 55.9.

(*E*)-3-(1-benzyl-1*H*-pyrrol-2-yl)acrylaldehyde (1y)



To a stirred solution of NaH (800 mg, 20 mmol) in DMF (20 ml) was added pyrrole-2-carboxyaldehyde (950 mg, 10 mmol) under N_2 at 0 ºC. After 20 min, BnBr (2.38 mL, 20 mmol) was added. The reaction was slowly warmed up to room temperature and stirred for 3 h. H_2O (10 mL) was slowly added to the reaction mixture at 0 ºC, the reaction mixture was diluted with DCM (80 mL) and washed with H_2O (20 mL × 4), and saturated brine (20 mL). The organic solution was dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography to give 1-benzyl-1H-pyrrole-2-carbaldehyde (1.73 g,

94% yield) as a dark red oil.

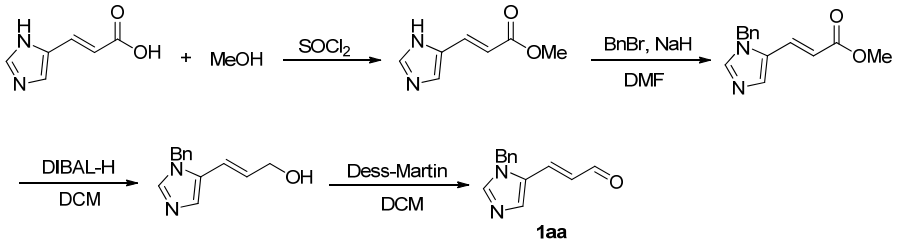
To a stirred solution of 1-benzyl-1H-pyrrole-2-carbaldehyde (1.73 g, 9.35 mmol) in THF (30 mL) under N_2 at 0 ºC was added (1,3-dioxolan-2-ylmethyl)triphenylphosphonium bromide (6.02 g, 14 mmol), NaH (1.87 g, 46.75 mmol), and 18-crown-6 (200 mg). The reaction was slowly warmed to room temperature and stirred overnight. Then 1N HCl (80 mL) was added slowly to quench the reaction, the mixture was stirred for 30 min and neutralized with ammonia water then extracted with DCM (40 mL × 3). The combined organic solution was washed with saturated brine (30 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography to give aldehyde **1y** as a black lilquid (723 mg, 34% yield).

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.42 (d, *J* = 7.9 Hz, 1H), 7.37 – 7.28 (m, 3H), 7.22 (d, *J* = 15.5 Hz, 1H), 7.03 (d, *J* = 7.3 Hz, 2H), 6.96 (s, 1H), 6.84 (d, *J* = 3.8 Hz, 1H), 6.41 (dd, *J* = 15.5, 7.9 Hz, 1H), 6.35 – 6.31 (m, 1H), 5.26 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.1, 139.7, 136.9, 129.1, 129.0, 128.5, 128.0, 126.1, 124.1, 114.6, 110.7, 50.9.

HRMS (ESI-TOF): m/z caled for $C_{14}H_{14}NO$ $[(M + H)]^+$: 212.1075, found: 212.1076

(*E*)-3-(1-Benzyl-1H-imidazol-5-yl)acrylaldehyde (1aa)



To a stirred solution of (*E*)-3-(1*H*-imidazol-4-yl) acrylic acid (2.5 g, 18.1 mmol) in MeOH (25 mL) was added $SOCl_2$ (7.5 mL) dropwise at 0 °C. The reaction mixture was stirred at 80 °C for 6 h. The solvent was removed under reduced pressure. The residue was added saturated $NaHCO_3$ solution until pH = 7 and extracted with EtOAc (50 mL × 3). The combined organic solution was washed with saturated brine (30 mL), dried over Na_2SO_4 and concentrated under reduced pressure to give the product methyl (*E*)-3-(1*H*-imidazol-4-yl)acrylate as a white solid that was used directly in the next step without purification.

To a stirred solution of methyl (*E*)-3-(1*H*-imidazol-4-yl)acrylate (18.12 mmol) in DMF (20 mL) was slowly added NaH (1.09 g, 27.18 mmol) slowly at 0 °C, followed by the addition of BnBr (3.41 g, 19.93 mmol).

The mixture was warmed to room temperature and stirred for 1 h. The reaction was quenched with H_2O (20 mL) at 0 °C and diluted with EtOAc (80 mL). The organic layer was seperated and washed with H_2O (20 mL × 4) and saturated brine (20 mL). The combined organic solution was dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography to give the product ((*E*)-methyl 3-(1-benzyl-1*H*-imidazol-5-yl)acrylate) as a white solid (1.9 g, 44% yield for two steps).

To a stirred solution of (*E*)-methyl 3-(1-benzyl-1H-imidazol-5-yl)acrylate (1.9 g, 7.8 mmol) in dry DCM (55 mL) was added DIBAL-H (23.5 mL, 23.5 mmol, 1.0 M in hexanes) slowly under N_2 at -78 °C. After completion of reaction monitored by TLC, the mixture was quenched by slowly adding H_2O (8 mL). The mixture was allowed to warm to room temperature before it was poured into a suspension of $NaHCO_3$ (30 g) and $MgSO_4$ (30 g) in EtOAc (300 mL). After filtration, the filtrate was concentrated under reduced pressure. H_2O (20 mL) was added to the mixture, and the mixture was extracted with DCM (30 mL × 3), The combined organic solution was washed with saturated brine (20 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography to give (*E*)-3-(1-benzyl-1H-imidazol-5-yl)prop-2-en-1-ol as colorless oil (1.6 g, 96% yield).

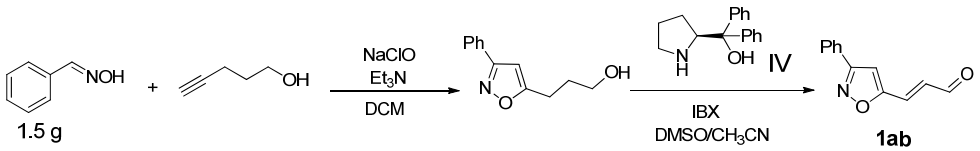
To a stirred solution of (*E*)-3-(1-benzyl-1H-imidazol-5-yl)prop-2-en-1-ol (1.6 g, 7.5 mmol) in dry DCM (50 mL) was added Dess-Martin reagent (3.82 g, 9 mmol) slowly at 0 °C. The mixture was slowly warmed to room temperature and stirred overnight. The mixture was quenched by slowly adding saturated aqueous $Na_2S_2O_3$ (30 mL) and the aqueous phase was extracted with DCM (50 mL × 3). The combined organic solution was washed with saturated brine (30 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography to give aldehyde **1aa** as light yellow solid (1.3 g, 82% yield).

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.60 (d, *J* = 8.0 Hz, 1H), 7.61 (s, 1H), 7.41 – 7.30 (m, 4H), 7.22 (s, 1H), 7.20 – 7.15 (m, 2H), 6.76 (dd, *J* = 15.6, 8.0 Hz, 1H), 5.13 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 194.2, 146.2, 140.4, 137.9, 137.6, 129.3, 128.4, 128.1, 125.7, 125.2, 50.3.

HRMS (ESI-TOF): m/z caled for $C_{13}H_{13}N_2O$ $[(M + H)]^+$: 213.1028. found: 213.1029.

(*E*)-3-(3-Phenylisoxazol-5-yl)acrylaldehyde (1ab)



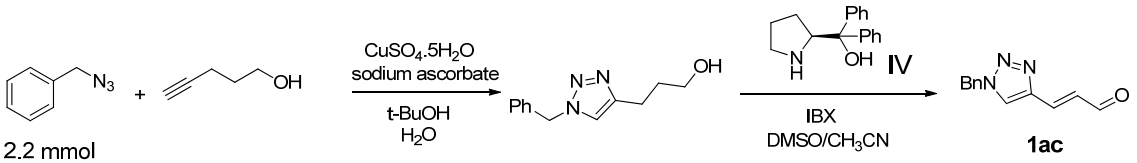
To a stirred solution of benzaldehydeoxime (1.5 g, 7.9 mmol), pent-4-yn-1-ol (529 mg, 6.3 mmol) and Et_3N (1.27 g, 12.6 mmol) in DCM (60 mL) was added aqueous NaClO (11-14% available chlorine, 66 mL). The mixture was stirred at room temperature for 10 h. H_2O (20 mL) was added and extracted with DCM (50 mL × 3). The combined organic solution was washed with saturated brine (50 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography to give 3-(3-phenylisoxazol-5-yl)propan-1-ol as light yellow solid (400 mg, 31% yield).

The second step followed the same procedure for the synthesis of **1b** as described above. The title compound **1ab** was obtained as a white solid (514 mg, 60% yield). The spectra data was consistent with the literature report.[10]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.76 (d, *J* = 7.2 Hz, 1H), 7.83 (s, 2H), 7.49 (s, 3H), 7.37 (d, *J* = 16.1 Hz, 1H), 6.88 (dd, *J* = 16.1, 7.2 Hz, 2H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 192.1, 165.8, 163.2, 133.3, 132.2, 130.5, 129.1, 128.1, 126.8, 105.0.

(*E*)-3-(1-Benzyl-1H-1,2,3-triazol-4-yl)acrylaldehyde (1ac)



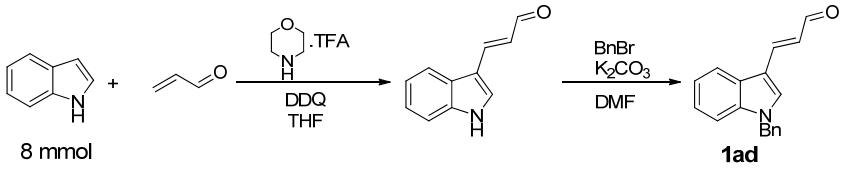
To a stirred solution of BnN_3 (262 mg, 2.2 mmol) and pent-4-yn-1-ol (168 mg, 2.0 mmol) in *t*-BuOH (8 mL) and H_2O (8 mL) was added $CuSO_4 \cdot 5H_2O$ (50 mg, 0.2 mmol) and sodium ascorbate (198 mg, 1 mmol) in H_2O (1 mL). The reaction was stirred at room temperature for 2 h. H_2O (10 mL) was added and extracted with EtOAc (30 mL × 3). The combined organic solution were washed with saturated brine (20 mL), dried over Na_2SO_4 and concentrated under reduced pressure to give the product 3-(1-benzyl-1H-1,2,3-triazol-4-yl)propan-1-ol that was used directly in the next step without purification.

The second step followed the same procedure for the synthesis of **1b** as described above. The title compound **1ac** was obtained as a white solid (307 mg, 75% yield for two steps). The spectra data was consistent with the literature report.[10]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.66 (d, *J* = 7.7 Hz, 1H), 7.69 (s, 1H), 7.48 (d, *J* = 16.1 Hz, 1H), 7.40 (s, 3H), 7.31 (s, 2H), 6.78 (dd, *J* = 16.1, 7.7 Hz, 1H), 5.57 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.1, 143.8, 140.0, 133.9, 129.9, 129.4, 129.2, 128.2, 123.5, 54.5.

(*E*)-3-(1-Benzyl-1H-indol-3-yl)acrylaldehyde (1ad)



To a stirred solution of morpholine·trifluoroacetic acid (322 mg, 1.6 mmol), indole (936 mg, 8 mmol) in THF (60 mL) was added acrolein (1.34 g, 24 mmol). The reaction was stirred at room temperature for 24 h. Then DDQ (2.36 g, 10.4 mmol) was added and the reaction was continued to stir for 2 h. The reaction mixture was directly concentrated under reduced pressure and purified by column chromatography to give (*E*)-3-(1H-indol-3-yl)acrylaldehyde as a yellow solid (1.19 g, 88% yield).

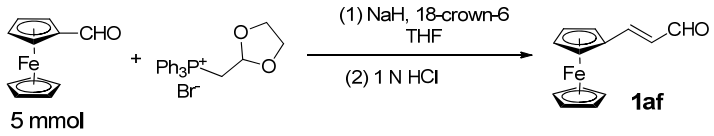
A mixture of (*E*)-3-(1H-indol-3-yl)acrylaldehyde (1.19 g, 7 mmol), BnBr (1.44 g, 8.4 mmol) and K_2CO_3 (1.93 g, 14 mmol) in DMF (15 mL) was stirred at 80°C overnight. H_2O (20 mL) was added and extracted with EtOAc (80 mL), The organic layer was washed with H_2O (20 mL × 4) and saturated brine (20 mL). The organic solution was dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography to give the aldehyde **1ad** as a yellow solid (327 mg, 18% yield).

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.61 (d, *J* = 7.9 Hz, 1H), 7.95 – 7.89 (m, 1H), 7.65 (d, *J* = 15.8 Hz, 1H), 7.49 (s, 1H), 7.36 – 7.28 (m, 6H), 7.18 – 7.16 (m, 2H) ,6.76 (dd, *J* = 15.8, 7.9 Hz, 1H), 5.35 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 194.1, 146.3, 137.9, 135.7, 133.3, 129.1, 128.3, 127.1, 126.1, 124.6, 123.6, 122.1, 120.6, 113.0, 110.7, 50.6.

HRMS (ESI-TOF): m/z caled for $C_{18}H_{15}NNaO$ $[(M + Na)]^+$: 284.1051. found: 284.1050.

(*E*)-3-(Ferrocenyl)acrylaldehyde (1af)



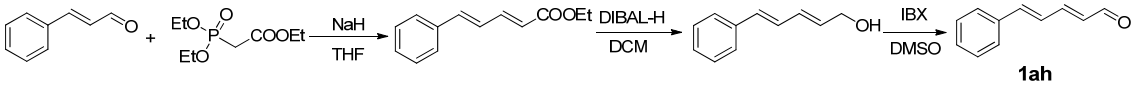
To a stirred solution of ferrocenecarboxaldehyde (1.07 g, 5 mmol) in THF (20 mL) was added (1,3-dioxolan-2-ylmethyl)triphenylphosphonium bromide (3.22 g, 7.5 mmol), NaH (1.0 g, 25 mmol), and 18-crown-6 (100 mg) under N_2 at 0 ºC, The reaction was slowly warmed up to room temperature and stirred overnight. Then 1N HCl (40 mL) was added slowly to quench the reaction, the mixture was stirred for 30 min and neutralized with ammonia water, then extracted with DCM (50 mL × 3). The combined organic solution was washed with saturated brine (30 mL), dried over Na_2SO_4 and concentrated under reduced

pressure. The crude product was purified by column chromatography to give the aldehyde **1af** as a black solid (850mg, 70% yield). The spectra data was consistent with the literature report.[11]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.56 (d, *J* = 8.0 Hz, 1H), 7.43 (d, *J* = 15.6 Hz, 1H), 6.35 (dd, *J* = 15.6, 8.0 Hz, 1H), 4.54 (d, *J* = 14.0 Hz, 4H), 4.18 (s, 5H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.2, 155.2, 126.4, 77.8, 71.9, 70.0, 69.2.

(2*E*,4*E*)-5-phenylpenta-2,4-dienal (1ah)



1ah

To a stirred solution of NaH (1.2 g, 30 mmol) in dry THF (120 mL) was added triethylphosphonoacetate (5.38 g, 24 mmol) dropwise under N_2 at 0 °C. The mixture was stirred for 1 h before a solution of (*E*)-cinnamaldehyde (2.64 g, 20 mmol) in THF (20 mL) was added dropwise. The reaction was slowly warmed up to room temperature and stirred for 3 h. The reaction was quenched with saturated NH_4Cl (40 mL) and extracted with EtOAc (60 mL × 3). The combined organic solution was washed with brine (40 mL), dried over Na_2SO_4 and concentrated under reduced pressure to give the product (2*E*,4*E*)-ethyl 5-phenylpenta-2,4-dienoate that was used directly in the next step without purification.

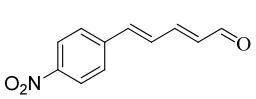
To a stirred solution of (2*E*,4*E*)-ethyl 5-phenylpenta-2,4-dienoate (20 mmol) in dry DCM (60 mL) was added DIBAL-H (50 mL, 50 mmol, 1.0 M in hexanes) slowly under N_2 at -78 °C. After completion of reaction monitored by TLC, the mixture was quenched by slowly adding H_2O (20 mL). The mixture was allowed to warm to room temperature before it was poured into a suspension of $NaHCO_3$ (75 g) and $MgSO_4$ (75 g) in EtOAc (750 mL). After filtration, the filtrate was concentrated under reduced pressure. H_2O (25 mL) was added to the mixture, and the mixture was extracted with DCM (60 mL × 3), The combined organic solution was washed with saturated brine (40 mL), dried over Na_2SO_4 and concentrated under reduced pressure to give the product (2*E*,4*E*)-5-phenylpenta-2,4-dien-1-ol that was used directly in the next step without purification.

To a solution of (2*E*,4*E*)-5-phenylpenta-2,4-dien-1-ol (20 mmol) in stirred dry DMSO (30 mL) was added IBX (7.0 g, 25 mmol) slowly at 0 °C, and the mixture was slowly warmed to room temperature and stirred overnight. Water (60 mL) was added and the mixture was filtered. The filtrate was extracted with EtOAc (80 mL). The organic layer was seperated and washed with H_2O (20 mL × 4), and saturated brine (20 mL). The combined organic solution was dried over Na_2SO_4 and concentrated under reduced pressure. The crude

product was purified by column chromatography to give aldehyde **1ah** as a light yellow liquid (1.85 g, 59% yield for three steps). The spectra data was consistent with the literature report.[16]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.62 (d, *J* = 8.0 Hz, 1H), 7.51 (d, *J* = 7.0 Hz, 2H), 7.43 – 7.34 (m, 3H), 7.31 – 7.25 (m, 1H), 7.05 – 6.99 (m, 2H), 6.28 (dd, *J* = 15.2, 8.0 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.6, 152.1, 142.4, 135.6, 131.6, 129.7, 128.9, 127.5, 126.2.

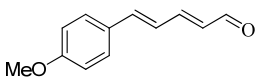


(2*E*,4*E*)-5-(4-nitrophenyl)penta-2,4-dienal (1ai)

Following the same procedure for the synthesis of **1ah** as described above, the title compound **1ai** was obtained from (*E*)-3-(4-nitrophenyl)acrylaldehyde (2.66 g, 15.0 mmol) as a yellow solid (1.67 g, 55% yield for three steps). The spectra data was consistent with the literature report.[12]

^{1}H NMR (400 MHz, DMSO-d_6): δ 9.64 (d, *J* = 8.0 Hz, 1H), 8.25 (d, *J* = 8.4 Hz, 2H), 7.88 (d, *J* = 8.4 Hz, 2H), 7.60 – 7.40 (m, 2H), 7.31 (d, *J* = 14.7 Hz, 1H), 6.38 (dd, *J* = 14.7, 8.0 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.2, 150.0, 147.9, 141.7, 139.0, 133.7, 130.2, 128.0, 124.3.



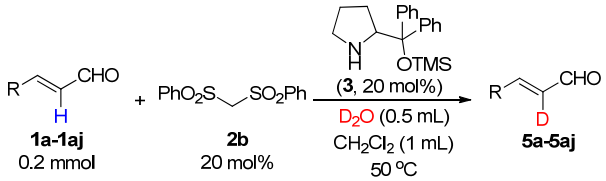
(2*E*,4*E*)-5-(4-methoxyphenyl)penta-2,4-dienal (1aj)

Following the same procedure for the synthesis of **1ah** as described above, the title compound **1aj** was obtained from (*E*)-3-(4-methoxyphenyl)acrylaldehyde (1 g, 6.17 mmol) as a yellow solid (724 mg, 64% yield for three steps). The spectra data was consistent with the literature report.[17]

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.60 (d, *J* = 8.0 Hz, 1H), 7.46 (d, *J* = 8.6 Hz, 2H), 7.26 (dd, *J* = 15.1, 8.6 Hz, 1H), 7.01 – 6.84 (m, 4H), 6.23 (dd, *J* = 15.1, 8.0 Hz, 1H), 3.85 (s, 3H).

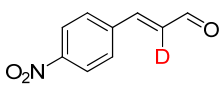
^{13}C NMR (151 MHz, $CDCl_3$): δ 193.6, 161.0, 152.7, 142.3, 130.6, 129.2, 128.4, 124.1, 114.4. 55.4.

5. Deuteration of enals



General procedure: a mixture of enal **1** (0.2 mmol), catalyst **3** (0.04 mmol) and **2b** (0.04 mmol) in D_2O (0.5 mL) and DCM (1 mL) was vigorously stirred at 50 °C for specified time. After cooling to room temperature, the reaction mixture was extracted with DCM (5 mL × 3). The combined organic solution were dried over Na_2SO_4, concentrated under reduced pressure. The residue was purified by column

chromatography to give the deuterated product **5**. The level of deuterium incorporation for the product was determined by ^{1}H NMR spectroscopy.



(*E*)-3-(4-nitrophenyl)acrylaldehyde-*α*-*d*$_1$ (5a)

Following the general procedure, **1a** (35.4 mg, 0.2 mmol) was used in the deuteration reaction, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a light yellow solid (33.5 mg, 94% yield) with 95% D-incorporation.

^{1}H NMR (400 MHz, CDCl$_3$): δ 9.78 (s, 1H), 8.31 – 8.29 (m, 2H), 7.75 – 7.73 (m, 2H), 7.53 (s, 1H), 6.81 (dd, *J* = 16.1, 7.4 Hz, 0.05H).

^{13}C NMR (151 MHz, CDCl$_3$): δ 192.9, 149.0, 148.8, 139.9, 131.5 (t, *J* = 24.9 Hz), 129.1, 124.4.

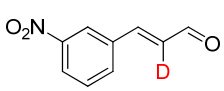
^{2}H NMR (77 MHz, CHCl$_3$): δ 6.87 (s, 1D).

HRMS (EI-TOF): m/z caled for $C_9H_6DNO_3$ [$(M)^+$]: 178.0489, found: 178.0492.

Scale-up:

A mixture of **1a** (1.06 g, 6 mmol), catalyst **3** (390 mg, 1.2 mmol) and **2b** (355.2 mg, 1.2 mmol) in D_2O (15 mL) and DCM (20 mL) in sealed tube was vigorously stirred at 70 °C for 48 h. After cooling to room temperature, the reaction mixture was extracted with DCM (30 mL × 3). The combined organic solution was washed with saturated brine (20 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography to give **5a** as a yellow solid (705 mg, 66% yield) with 99% D-incorporation.

^{1}H NMR (400 MHz, CDCl$_3$): δ 9.78 (s, 1H), 8.31 – 8.29 (m, 2H), 7.74 – 7.72 (m, 2H), 7.55 – 7.49 (m, 1H), 6.81 (dd, *J* = 16.1, 7.4 Hz, 0.01H).



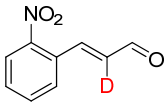
(*E*)--3-(3-nitrophenyl)acrylaldehyde-*α*-*d*$_1$ (5b)

Following the general procedure, **1b** (35.4 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a light yellow solid (32.7 mg, 92% yield) with 99% D-incorporation.

^{1}H NMR (400 MHz, CDCl$_3$): δ 9.77 (s, 1H), 8.41 (s, 1H), 8.30 (d, *J* = 8.2 Hz, 1H), 7.90 (d, *J* = 8.2 Hz, 1H), 7.65 (t, *J* = 8.0 Hz, 1H), 7.53 (s, 1H), 6.82 (dd, *J* = 16.0, 7.6 Hz, 0.01H).

^{13}C NMR (151 MHz, CDCl$_3$): δ 192.8, 148.9, 148.8 135.7, 133.6, 130.83 – 130.58 (m), 130.3, 125.2, 123.1.

HRMS (EI-TOF): m/z caled for $C_9H_6DNO_3$ [$(M)^+$]: 178.0489, found: 178.0492.



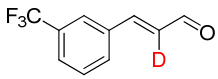
(*E*)-3-(2-nitrophenyl)acrylaldehyde-*α*-*d*$_1$ (5c)

Following the general procedure, **1c** (35.4 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a light yellow solid (33.5 mg, 94% yield) with 99% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.78 (s, 1H), 8.11 (dd, *J* = 8.1, 0.9 Hz, 1H), 8.04 – 8.03 (m, 1H), 7.74 – 7.66 (m, 2H), 7.63 – 7.59 (m, 1H), 6.64 (dd, *J* = 15.8, 7.7 Hz, 0.01H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.3, 148.2, 147.4, 134.0, 132.5 (t, *J* = 24.8 Hz), 131.3, 130.2, 129.2, 125.4.

HRMS (EI-TOF): m/z caled for $C_9H_6DNO_3$ [$(M)^+$]: 178.0489, found: 178.0487.



(*E*)-3-(3-(trifluoromethyl)phenyl)acrylaldehyde-*α*-*d*$_1$ (5d)

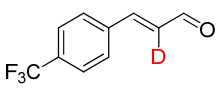
Following the general procedure, **1d** (40.0 mg, 0.2 mmol) was used in the deuteration reaction, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a white solid (28.5 mg, 71% yield) with 99% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.74 (s, 1H), 7.80 (s, 1H), 7.75 (d, *J* = 7.8 Hz, 1H), 7.69 (d, *J* = 7.8 Hz, 1H), 7.57 (t, *J* = 7.8 Hz, 1H), 7.52 – 7.47 (m, 1H), 6.77 (dd, *J* = 16.0, 7.5 Hz, 0.01H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.3, 150.4, 134.9, 131.9 (q, *J* = 32.8 Hz), 131.2, 129.7, 129.6 (t, *J* = 24.9 Hz) , 127.8 (q, *J* =3.4 Hz), 125.4 (q, *J* = 3.7 Hz), 122.1 (q, *J* = 272.5 Hz).

^{19}F NMR (565 MHz, $CDCl_3$): δ -62.77 (s, 3F).

HRMS (EI-TOF): m/z caled for $C_{10}H_6DF_3O$ [$(M)^+$]: 201.0512, found: 201.0510.



(*E*)-3-(4-(trifluoromethyl)phenyl)acrylaldehyde-*α*-*d*$_1$ (5e)

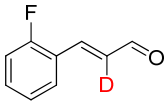
Following the general procedure, **1e** (40 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 96 h. The title compound was obtained as a light yellow liquid (31.4 mg, 78% yield) with 97% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.76 (s, 1H), 7.72 – 7.66 (m, 4H), 7.52 – 7.49 (m, 1H), 6.78 (dd, *J* = 16.0, 7.6 Hz, 0.03H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.3, 150.3, 137.4, 132.8 (q, *J* = 33.2 Hz), 130.4 (t, *J* = 24.2 Hz), 128.7, 126.2 (q, *J* = 4.5 Hz), 123.8 (q, *J* = 271.8 Hz).

^{19}F NMR (565 MHz, $CDCl_3$): δ -62.88 (s, 3F).

HRMS (EI-TOF): m/z caled for $C_{10}H_6DF_3O$ [$(M)^+$]: 201.0512, found: 201.0509.



(*E*)-3-(2-fluorophenyl)acrylaldehyde-*α*-*d*$_1$ (5f)

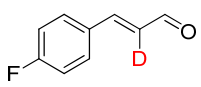
Following the general procedure, **1f** (30 mg, 0.2 mmol) was used in the deuteration reaction, **2a** (12.6 mg, 0.04 mmol) instead of **2b** was used, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 72 h. The title compound was obtained as a light yellow liquid (26.9 mg, 89% yield) with 99% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.70 (s, 1H), 7.64 (s, 1H), 7.58 (t, *J* = 7.5 Hz, 1H), 7.42 (dd, *J* = 14.1, 6.8 Hz, 1H), 7.20 (t, *J* = 7.5 Hz, 1H), 7.16 – 7.09 (m, 1H), 6.78 (dd, *J* = 16.1, 7.7 Hz, 0.01H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.9, 161.3 (d, *J* = 254.8 Hz), 144.8 (d, *J* = 3.6 Hz), 133.0 (d, *J* = 8.9 Hz), 130.51 – 130.15 (m), 128.9, 124.8 (d, *J* = 3.6 Hz), 122.2 (d, *J* = 11.4 Hz), 116.5 (d, *J* = 22.0 Hz).

^{19}F NMR (565 MHz, $CDCl_3$): δ -114.15 (s, 1F).

HRMS (EI-TOF): m/z caled for C_9H_6DFO [$(M)^+$]: 151.0544, found: 151.0547.



(*E*)-3-(4-fluorophenyl)acrylaldehyde-*α*-*d*$_1$ (5g)

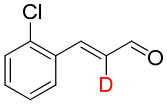
Following the general procedure, **1g** (30.0 mg, 0.2 mmol) was used in the deuteration reaction, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a light yellow solid (22.3 mg, 74% yield) with 98% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.69 (s, 1H), 7.59 – 7.54 (m, 2H), 7.44 (d, *J* = 1.9 Hz, 1H), 7.13 (t, *J* = 8.6 Hz, 2H), 6.65 (dd, *J* = 16.0, 7.7 Hz, 0.02H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 193.4, 165.5 (d, *J* = 254.2 Hz), 151.2, 130.4 (dd, *J* = 21.0, 6.0 Hz), 128.2 (t, *J* = 25.6 Hz), 116.3, 116.1.

^{19}F NMR (565 MHz, $CDCl_3$): δ -107.61(s, 1F).

HRMS (EI-TOF): caled for C_9H_6DFO [$(M)^+$]: 151.0544, found: 151.0546.



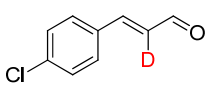
(*E*)-3-(2-chlorophenyl)acrylaldehyde-*α*-*d*$_1$ (5h)

Following the general procedure, **1h** (33.2 mg, 0.2 mmol) was used in the deuteration reaction, **2a** (12.6 mg, 0.04 mmol) instead of **2b** was used, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 108 h. The title compound was obtained as a white solid (26.3 mg, 79% yield) with 99% D-incorporation.

^{1}H NMR (400 MHz, CDCl$_3$): δ 9.77 (s, 1H), 7.94 (s, 1H), 7.67 (d, *J* = 7.5 Hz, 1H), 7.47 (d, *J* = 7.5Hz, 1H), 7.40 – 7.31 (m, 2H), 6.71 (dd, *J* = 16.0, 7.7 Hz, 0.01H).

^{13}C NMR (151 MHz, CDCl$_3$): δ 193.7, 148.0, 135.3, 132.2, 132.1, 130.56 – 130.18 (m), 130.4, 128.0, 127.4.

HRMS (EI-TOF): m/z caled for C_9H_6DClO [$(M)^+$]: 167.0248, found: 167.0246.



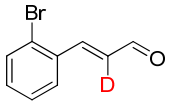
(*E*)-3-(4-chlorophenyl)acrylaldehyde-*α*-*d*$_1$ (5i)

Following the general procedure, **1i** (33.2 mg, 0.2 mmol) was used in the deuteration reaction, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a white solid (28.7 mg, 86% yield) with 96% D-incorporation.

^{1}H NMR (400 MHz, CDCl$_3$): δ 9.71 (s, 1H), 7.51 (d, *J* = 8.5 Hz, 2H), 7.41 (d, *J* = 8.5 Hz, 3H), 6.69 (dd, *J* = 16.0, 7.8 Hz, 0.04H).

^{13}C NMR (151 MHz, CDCl$_3$): δ 193.4, 151.0, 137.2, 132.5, 129.7, 129.4, 128.7 (t, *J* = 24.5 Hz)

HRMS (EI-TOF): m/z caled for C_9H_6DClO [$(M)^+$]: 167.0248, found: 167.0251.



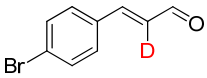
(*E*)-3-(2-bromophenyl)acrylaldehyde-*α*-*d*$_1$ (5j)

Following the general procedure, **1j** (41.8 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 48 h. The title compound was obtained as a yellow solid (33.8 mg, 80% yield) with 88% D-incorporation. Following the general procedure, (*E*)-3-(2-bromophenyl)acrylaldehyde-*α*-*d*$_1$ (33.8 mg, 0.16 mmol, deuteration 80%) was used in the deuteration reaction, PhCOOH (3.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 72 h. The title compound was obtained as a yellow solid (23.2 mg, 55% yield for two steps) with 97% D-incorporation.

^{1}H NMR (400 MHz, CDCl$_3$): δ 9.78 (s, 1H), 7.93 – 7.88 (m, 1H), 7.66 (dd, *J* = 7.8, 1.9 Hz, 2H), 7.38 (t, *J* = 7.3 Hz, 1H), 7.31 – 7.27 (m, 1H), 6.68 (dd, *J* = 15.8, 7.7 Hz, 0.03H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.7, 150.7, 134.0, 133.8, 132.3, 130.6 (t, *J* = 24.0 Hz), 128.1 (d, *J* = 13.4 Hz), 125.9.

HRMS (EI-TOF): m/z caled for C_9H_6DBrO [$(M)^+$]: 210.9743, found: 210.9748.



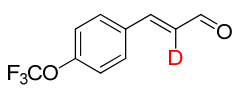
(*E*)-3-(4-bromophenyl)acrylaldehyde-*α*-*d*$_1$ (5k)

Following the general procedure, **1k** (41.8 mg, 0.2 mmol) was used in the deuteration reaction, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a yellow solid (37.6 mg, 89% yield) with 97% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.71 (s, 1H), 7.57 (d, *J* = 8.4 Hz, 2H), 7.43 (d, *J* = 8.6 Hz, 2H), 7.41 (s, 1H), 6.70 (dd, *J* = 15.9, 7.6 Hz, 0.03H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 193.4, 151.0, 132.9, 132.4, 129.8, 128.8 (t, *J* = 24.4 Hz), 125.7.

HRMS (EI-TOF): m/z caled for C_9H_6DBrO [$(M)^+$]: 210.9743, found: 210.9746.



(*E*)-3-(4-(trifluoromethoxy)phenyl)acrylaldehyde-*α*-*d*$_1$ (5l)

Following the general procedure, **1l** (43.2 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 96 h. The title compound was obtained as a light yellow liquid (39.9 mg, 92% yield) with 98% D-incorporation.

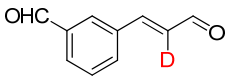
^{1}H NMR (400 MHz, $CDCl_3$): δ 9.74 (s, 1H), 7.63 (d, *J* = 8.7 Hz, 2H), 7.48 (s, 1H), 7.30 (d, *J* = 8.4 Hz, 2H), 6.72 (dd, *J* = 16.0, 7.6 Hz, 0.02H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.5, 151.2, 150.7, 132.6, 130.1, 129.1 (t, *J* = 24.2 Hz), 121.4, 120.5 (q, *J* = 258.2 Hz).

^{2}H NMR (77 MHz, CH_2Cl_2): δ 6.76 (s, 1D).

^{19}F NMR (565 MHz, $CDCl_3$): δ -57.54 (s, 3F).

HRMS (EI-TOF): m/z caled for $C_{10}H_6DF_3O_2$ [$(M)^+$]: 217.0461, found: 217.0458.



(*E*)-3-(3-oxoprop-1-en-1-yl)benzaldehyde-*α*-*d*$_1$ (5m)

Following the general procedure, **1m** (32.0 mg, 0.2 mmol) was used in the deuteration reaction, and the reaction mixture was vigorously stirred at 50 °C for 48 h. The title compound was obtained as a white solid (28.7 mg, 89% yield) with 58% D-incorporation.

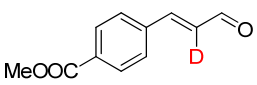
Following the general procedure, (*E*)-3-(3-oxoprop-1-en-1-yl)benzaldehyde-*α*-*d*$_1$ (28.7 mg, 0.18 mmol, deuteration 58%) was used in the deuteration reaction, and the reaction mixture was vigorously stirred at 50 °C for 72 h. The title compound was obtained as white solid (22.5 mg, 70% yield for two steps) with 95% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 10.08 (s, 1H), 9.76 (s, 1H), 8.07 (s, 1H), 7.98 – 7.94 (m, 1H), 7.84 (d, *J* = 7.8 Hz, 1H), 7.65 (d, *J* = 7.7 Hz, 1H), 7.56 – 7.52 (m, 1H), 6.81 (dd, *J* = 16.0, 7.5 Hz, 0.05H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.3, 191.5, 150.6, 137.1, 135.0, 133.7, 132.0, 129.9, 130.20 – 129.47 (m), 129.3.

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.86 (s, 1D).

HRMS (EI-TOF): m/z caled for $C_{10}H_7DO_2$ [$(M)^+$]: 161.0587, found: 161.0590.



(*E*)-methyl 4-(3-oxoprop-1-en-1-yl)benzoate-*α*-*d*$_1$ (5n)

Following the general procedure, **1n** (38.0 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 48 h. The title compound was obtained as a white solid (30.6 mg, 80% yield) with 84% D-incorporation.

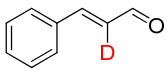
Following the general procedure, (*E*)-methyl 4-(3-oxoprop-1-en-1-yl)benzoate-*α*-d_1 (30.6 mg, 0.16 mmol, deuteration 84%) was used in the deuteration reaction, PhCOOH (3.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 72 h. The title compound was obtained as a white solid (21 mg, 55% yield for two steps) with 96% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.74 (s, 1H), 8.09 (d, *J* = 8.3 Hz, 2H), 7.63 (d, *J* = 8.3 Hz, 2H), 7.50 (s, 1H), 6.78 (dd, *J* = 16.0, 7.7 Hz, 0.04H), 3.94 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.5, 166.4, 150.9, 138.2, 132.3, 130.4, 130.1 (t, *J* = 24.2 Hz), 128.5, 52.5.

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.83 (s, 1D).

HRMS (EI-TOF): m/z caled for $C_{11}H_9DO_3$ [$(M)^+$]: 191.0693, found: 191.0695.



(*E*)-cinnamaldehyde-*α*-d_1 (5o)

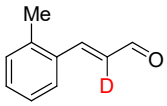
Following the general procedure, **1o** (26.4 mg, 0.2 mmol) was used in the deuteration reaction, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a light yellow liquid (21.3 mg, 80% yield) with 98% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.71 (s, 1H), 7.57 (dd, *J* = 6.7, 2.9 Hz, 2H), 7.49 – 7.46 (m, 1H), 7.46 – 7.40 (m, 3H), 6.72 (dd, *J* = 16.0, 7.7 Hz, 0.02H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 193.8, 152.8, 134.1, 131.4, 129.2, 128.6, 128.4 (t, *J* = 24.6 Hz).

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.79 (s, 1D).

HRMS (EI-TOF): m/z caled for C_9H_7DO [$(M)^+$]: 133.0638, found: 133.0640.



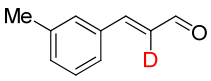
(*E*)-3-(o-tolyl)acrylaldehyde-*α*-d_1 (5p)

Following the general procedure, **1p** (29.2 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a light yellow liquid (23.2 mg, 79% yield) with 94% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.71 (s, 1H), 7.76 (s, 1H), 7.58 (d, *J* = 7.5 Hz, 1H), 7.35 – 7.29 (m, 1H), 7.23 (d, *J* = 7.4 Hz, 2H), 6.66 (dd, *J* = 15.8, 7.7 Hz, 0.06H), 2.47 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 194.0, 150.3, 138.0, 132.9, 131.2 (d, *J* = 2.9 Hz), 129.68 –129.23 (m), 127.0, 126.7, 19.9.

HRMS (EI-TOF): m/z caled for $C_{10}H_9DO$ [$(M)^+$]: 147.0794, found: 147.0796.



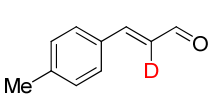
(*E*)-3-(m-tolyl)acrylaldehyde-*α*-*d*$_1$ (5q)

Following the general procedure, **1q** (29.2 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a light yellow liquid (24.1 mg, 82% yield) with 96% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.69 (s, 1H), 7.45 (s, 1H), 7.37 (d, *J* = 4.5 Hz, 2H), 7.33 (t, *J* = 5.7 Hz, 1H), 7.26 (d, *J* = 7.5 Hz, 1H), 6.71 (dd, *J* = 16.0, 7.7 Hz, 0.04H), 2.39 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 194.0, 153.1, 138.9, 134.1, 132.2, 129.2, 129.1, 128.3 (t, *J* = 24.2 Hz), 125.8, 21.4.

HRMS (EI-TOF): m/z caled for $C_{10}H_9DO$ [$(M)^+$]: 147.0794, found: 147.0796.



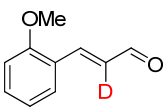
(*E*)-3-(p-tolyl)acrylaldehyde-*α*-*d*$_1$ (5r)

Following the general procedure, **1r** (29.2 mg, 0.2 mmol) was used in the deuteration reaction, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a light yellow solid (20.9 mg, 71% yield) with 98% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.68 (s, 1H), 7.46 (d, *J* = 8.1 Hz, 2H), 7.45 (d, *J* = 2.6 Hz, 1H), 7.24 (d, *J* = 8.1 Hz, 2H), 6.68 (dd, *J* = 15.9, 7.7 Hz, 0.02H), 2.40 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 193.9, 153.0, 142.1, 131.4, 130.0, 128.7, 127.6 (t, *J* = 24.3 Hz), 21.7.

HRMS (EI-TOF): m/z caled for $C_{10}H_9DO$ [$(M)^+$]: 147.0794, found: 147.0792.



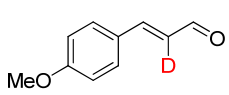
(*E*)-3-(2-methoxyphenyl)acrylaldehyde-*α*-*d*$_1$ (5s)

Following the general procedure, **1s** (32.4 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 72 h. The title compound was obtained as a light yellow solid (25.1 mg, 77% yield) with 94% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.68 (s, 1H), 7.83 (s, 1H), 7.54 (d, *J* = 7.6 Hz, 1H), 7.41 (t, *J* = 7.6 Hz, 1H), 7.00 (t, *J* = 7.6 Hz, 1H), 6.95 (d, *J* = 7.6 Hz, 1H), 6.79 (dd, *J* = 16.0, 7.9 Hz, 0.06H), 3.91 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 194.7, 158.4, 148.3, 132.8, 129.18 – 128.75 (m), 129.0, 123.0, 121.0, 111.4, 55.7.

HRMS (EI-TOF): m/z caled for $C_{10}H_9DO_2$ [$(M)^+$]: 163.0744, found: 163.0746.



(*E*)-3-(4-methoxyphenyl)acrylaldehyde-*α*-d_1 (5t)

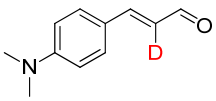
Following the general procedure, **1t** (32.4 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a yellow solid (30.6 mg, 94% yield) with 98% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.66 (s, 1H), 7.53 (d, *J* = 8.7 Hz, 2H), 7.42 (s, 1H), 6.95 (d, *J* = 8.7 Hz, 2H), 6.61 (dd, *J* = 15.9, 7.8 Hz, 0.02H), 3.86 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.9, 162.3, 152.8, 130.5, 126.9, 126.3 (t, *J* = 24.5 Hz), 114.7, 55.6.

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.67 (s, 1D).

HRMS (EI-TOF): m/z caled for $C_{10}H_9DO_2$ [$(M)^+$]: 163.0744, found: 163.0742.



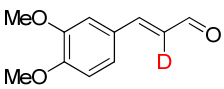
(*E*)-3-(4-(dimethylamino)phenyl)acrylaldehyde-*α*-d_1 (5u)

Following the general procedure, **1u** (35 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, toluene (1 mL) instead of DCM, and the reaction mixture was vigorously stirred at 80 °C for 48 h. The title compound was obtained as a yellow solid (23.2 mg, 66% yield) with 98% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.59 (s, 1H), 7.49 – 7.43 (m, 2H), 7.37 (s, 1H), 6.71 – 6.67 (m, 2H), 6.54 (dd, *J* = 15.6, 7.9 Hz, 0.02H), 3.05 (s, 6H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.8, 154.0, 152.5, 130.6, 123.6 (t, *J* = 24.2 Hz), 121.8, 111.8, 40.2.

HRMS (EI-TOF): m/z caled for $C_{11}H_{12}DNO$ [$(M)^+$]: 176.1060, found: 176.1063.



(*E*)-3-(3,4-dimethoxyphenyl)acrylaldehyde-*α*-d_1 (5v)

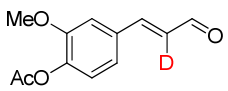
Following the general procedure, **1v** (38.4 mg, 0.2 mmol) was used in the deuteration reaction, **2a** (12.6 mg, 0.04 mmol) instead of **2b** was used, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 72 h. The title compound was obtained as a black solid

(34.3 mg, 89% yield) with 97% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.67 (s, 1H), 7.42 (s, 1H), 7.17 (d, *J* = 8.3 Hz, 1H), 7.08 (s, 1H), 6.91 (d, *J* = 8.3 Hz, 1H), 6.62 (dd, *J* = 15.8, 7.7 Hz, 0.03H), 3.94 (d, *J* = 3.7 Hz, 6H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 193.7, 152.9, 152.1, 149.5, 127.1, 126.67 – 126.35 (m), 123.6, 111.2, 109.9, 56.1, 56.0.

HRMS (EI-TOF): m/z caled for $C_{11}H_{11}DO_3$ [$(M)^+$]: 193.0849, found: 193.0847.



(*E*)-2-methoxy-4-(3-oxoprop-1-en-1-yl)phenyl acetate-*α*-*d*$_1$ (5w)

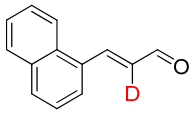
Following the general procedure, **1w** (44 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 72 h. The title compound was obtained as a light yellow solid (30.1 mg, 68% yield) with 91% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.70 (s, 1H), 7.43 (s, 1H), 7.17 (dd, *J* = 8.1, 1.8 Hz, 1H), 7.14 (d, *J* = 1.8 Hz, 1H), 7.10 (d, *J* = 8.1 Hz, 1H), 6.67 (dd, *J* = 15.9, 7.6 Hz, 0.09H), 3.88 (s, 3H), 2.33 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.6, 168.8, 151.9, 151.7, 142.3, 133.0, 128.84 – 128.40 (m), 123.6, 122.0, 111.5, 56.0, 20.8.

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.72 (s, 1D).

HRMS (EI-TOF): m/z caled for $C_{12}H_{11}DO_4$ [$(M)^+$]: 221.0798, found: 221.0800.



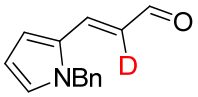
(*E*)-3-(naphthalen-1-yl)acrylaldehyde-*α*-*d*$_1$ (5x)

Following the general procedure, **1x** (36.4 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 72 h. The title compound was obtained as a yellow solid (22.7 mg, 62% yield) with 98% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.84 (s, 1H), 8.31 (s, 1H), 8.18 (d, *J* = 8.4 Hz, 1H), 7.96-7.89 (m, 2H), 7.80 (d, *J* = 8.4 Hz, 1H), 7.64-7.50 (m, 3H), 6.83 (dd, *J* = 15.6, 7.7 Hz, 0.02H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.8, 149.3, 133.9, 131.7, 131.3, 131.0, 130.7 (t, *J* = 24.6 Hz), 129.1, 127.4, 126.5, 125.9, 125.6, 122.9.

HRMS (EI-TOF): m/z caled for $C_{13}H_9DO$ [$(M)^+$]: 183.0794, found: 183.0791.



(*E*)-3-(1-benzyl-1*H*-pyrrol-2-yl)acrylaldehyde-*α*-*d*$_1$ (5y)

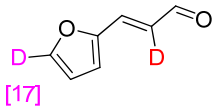
Following the general procedure, **1y** (42.2 mg, 0.2 mmol) was used in the deuteration reaction, **2a** (12.6 mg, 0.04 mmol) instead of **2b** was used, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 96 h. The title compound was obtained as a black solid (39 mg, 92% yield) with 85% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.41 (s, 1H), 7.35-7.28 (m, 3H), 7.21 (s, 1H), 7.03 (d, *J* = 7.3 Hz, 2H), 6.95 (s, 1H), 6.83 (d, *J* = 3.8 Hz, 1H), 6.40 (dd, *J* = 15.5, 7.9 Hz, 0.15H), 6.34 – 6.29 (m, 1H), 5.25 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.1, 139.7, 137.0, 129.1, 129.0, 128.6, 128.1, 126.2, 124.15 – 123.71 (m), 114.6, 110.8, 51.0.

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.46 (s, 1D).

HRMS (EI-TOF): m/z caled for $C_{14}H_{12}DNO$ [$(M)^+$]: 212.1060, found: 212.1057.



(*E*)-3-(Furan-2-yl)acrylaldehyde-*α*-*d*$_1$ (5z)

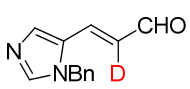
Following the general procedure, **1z** (24.4 mg, 0.2 mmol) was used in the deuteration reaction, **2a** (12.6 mg, 0.04 mmol) instead of **2b** was used, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 96 h. The title compound was obtained as a white solid (17.3 mg, 70% yield) with 96% D-incorporation at *α*-position and 17% D-incorporation at C-5 position of furan.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.62 (s, 1H), 7.57 (s, 1H), 7.24 – 7.19 (m, 1H), 6.77 (d, *J* = 3.3 Hz, 1H), 6.59 (dd, *J* = 14.2, 6.3 Hz, 0.04H), 6.54 (dd, *J* = 3.4, 1.8 Hz, 0.83H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 192.9, 150.5, 145.9, 137.7, 125.83 – 125.34 (m), 116.8, 116.7, 112.9.

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.63 (s, 1.17D), two deuterium peaks are overlapped.

HRMS (EI-TOF): m/z caled for $C_7H_4D_2O_2$ [$(M)^+$]: 124.0493, found: 124.0490.



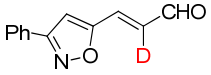
(*E*)-3-(1-Benzyl-1H-imidazol-5-yl)acrylaldehyde-*α*-*d*$_1$ (5aa)

Following the general procedure, **1aa** (42.2 mg, 0.2 mmol) was used in the deuteration reaction, **2a** (12.6 mg, 0.04 mmol) instead of **2b** was used, and the reaction mixture was vigorously stirred at 50 °C for 72 h. The title compound was obtained as a yellow solid (36.6 mg, 86% yield) with 92% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.60 (s, 1H), 7.62 (s, 1H), 7.41-7.36 (m, 3H), 7.33 (s, 1H), 7.23 (s, 1H), 7.22 – 7.16 (m, 2H), 6.77 (dd, *J* = 15.6, 8.0 Hz, 0.08H), 5.14 (s, 2H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 193.6, 144.3, 139.2, 138.4, 135.2, 129.2, 128.6, 127.5, 126.8 (t, *J* = 27.9 Hz), 122.9, 51.2.

HRMS (EI-TOF): m/z caled for $C_{13}H_{11}DN_2O$ [$(M)^+$]: 213.1012, found: 213.1015.



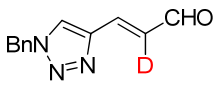
(*E*)-3-(3-Phenylisoxazol-5-yl)acrylaldehyde-*α*-*d*$_1$ (5ab)

Following the general procedure, **1ab** (39.8 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 48 h. The title compound was obtained as a white solid (30 mg, 75% yield) with 72% D-incorporation. Following the general procedure, (*E*)-3-(3-Phenylisoxazol-5-yl)acrylaldehyde-*α*-*d*$_1$ (30 mg, 0.15 mmol, deuteration 72%) was used in the deuteration reaction, PhCOOH (3.7 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 72 h. The title compound was obtained as a white solid (19.6 mg, 49% yield for two steps) with 95% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.76 (s, 1H), 7.84 – 7.81 (m, 2H), 7.50 – 7.45 (m, 3H), 7.36 (s, 1H), 6.90 (s, 1H), 6.86 (s, 0.05H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 192.1, 165.8, 163.2, 133.2, 131.69 – 132.25 (m), 130.5, 129.1, 128.2, 126.8, 105.1.

HRMS (EI-TOF): m/z caled for $C_{12}H_8DNO_2$ [$(M)^+$]: 200.0696, found: 200.0694.



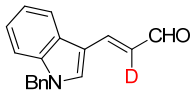
(*E*)-3-(1-Benzyl-1H-1,2,3-triazol-4-yl)acrylaldehyde-*α*-*d*$_1$ (5ac)

Following the general procedure, **1ac** (42.6 mg, 0.2 mmol) was used in the deuteration reaction, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a white solid (39.3 mg, 92% yield) with 98% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.64 (s, 1H), 7.78 (s, 1H), 7.46 (s, 1H), 7.40 – 7.37 (m, 3H), 7.31 – 7.29 (m, 2H), 6.77 (dd, *J* = 15.9, 7.7 Hz, 0.02H), 5.57 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.2, 143.7, 140.1, 134.1, 129.77 – 129.33 (m), 129.2, 129.1, 128.3, 123.9, 54.4.

HRMS (EI-TOF): m/z caled for $C_{12}H_{10}DN_3O$ [$(M)^+$]: 214.0965, found: 214.0963.



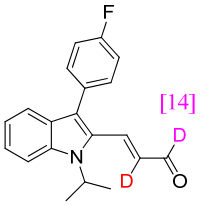
(*E*)-3-(1-Benzyl-1H-indol-3-yl)acrylaldehyde-*α*-*d*$_1$ (5ad)

Following the general procedure, **1ad** (52.2 mg, 0.2 mmol) was used in the deuteration reaction, **2a** (12.6 mg, 0.04 mmol) instead of **2b** was used, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 60 h. The title compound was obtained as a yellow solid (50.3 mg, 96% yield) with 99% D-incorporation.

^{1}H NMR (400 MHz, CDCl$_3$): δ 9.60 (s, 1H), 7.94 – 7.88 (m, 1H), 7.64 (s, 1H), 7.49 (s, 1H), 7.36 – 7.19 (m, 6H), 7.19 – 7.14 (m, 2H), 6.76 (dd, *J* = 15.6, 7.9 Hz, 0.01H), 5.35 (s, 2H).

^{13}C NMR (151 MHz, CDCl$_3$): δ 194.2, 146.3, 138.0, 135.9, 133.5, 129.2, 128.4, 127.2, 126.3, 124.4 (t, *J* = 23.9 Hz), 123.7, 122.2, 120.8, 113.0, 110.8, 50.8.

HRMS (EI-TOF): m/z caled for $C_{18}H_{14}DNO$ [$(M)^+$]: 262.1216, found: 262.1220.



(*E*)-3-(3-(4-fluorophenyl)-1-isopropyl-1*H*-indol-2-yl)acrylaldehyde-*α*-*d*$_1$ (5ae)

Following the general procedure, **1ae** (61.4 mg, 0.2 mmol) was used in the deuteration reaction, PhCOOH (4.9 mg, 20 mol%) was added, toluene (1 mL) instead of DCM, and the reaction mixture was vigorously stirred at 80 °C for 48 h. The title compound was obtained as a yellow solid (46.1 mg, 75% yield) with 82% D-incorporation.

Following the general procedure, (*E*)-3-(3-(4-fluorophenyl)-1-isopropyl-1*H*-indol-2-yl)-acrylaldehyde-*α*-*d*$_1$ (46.1 mg, 0.15 mmol, deuteration 82%) was used in the deuteration reaction, PhCOOH (3.7 mg, 20 mol%) was added, toluene (1 mL) instead of DCM, and the reaction mixture was vigorously stirred at 80 °C for 72 h. The title compound was obtained as yellow solid (24.6 mg, 40% yield for two steps) with 96% D-incorporation at α-position of enal and 14% D-incorporation at C1-position of aldehyde.

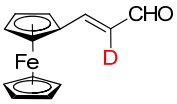
^{1}H NMR (400 MHz, CDCl$_3$): δ 9.57 (s, 0.82H), 7.61 (d, *J* = 8.5 Hz, 1H), 7.59 – 7.52 (m, 2H), 7.41 – 7.38 (m, 2H), 7.32 (t, *J* = 7.7 Hz, 1H), 7.19 (t, *J* = 8.5 Hz, 2H), 7.13 (t, *J* = 7.5 Hz, 1H), 6.32 (dd, *J* = 16.1, 7.3 Hz, 0.04H), 5.01 – 4.94 (m, 1H), 1.75 (s, 3H), 1.73 (s, 3H).

^{13}C NMR (151 MHz, CDCl$_3$): δ 193.4, 162.3 (d, *J* = 247.1 Hz), 141.1, 137.6, 132.0 (d, *J* = 8.0 Hz), 130.5, 129.95, 129.92, 129.7, 129.2 (t, *J* = 24.6 Hz), 128.5, 124.8, 122.9, 121.1, 120.8, 116.1, 116.0, 112.6, 48.4, 21.9.

^{2}H NMR (77 MHz, CHCl$_3$): δ 6.37 (s, 1D), 9.62 (s, 0.14D).

^{19}F NMR (565 MHz, CDCl$_3$): δ -114.51 (s, 1F).

HRMS (EI-TOF): m/z caled for $C_{20}H_{17}DFNO$ [$(M)^+$]: 308.1435, found: 308.1438.



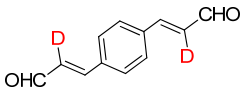
(*E*)-3-(Ferrocenyl)acrylaldehyde-*α*-*d*$_1$ (5af)

Following the general procedure, **1af** (48.0 mg, 0.2 mmol) was used in the deuteration reaction, **2a** (12.6 mg, 0.04 mmol) instead of **2b** was used, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 96 h. The title compound was obtained as a black solid (44 mg, 91% yield) with 98% D-incorporation.

^{1}H NMR (400 MHz, CDCl$_3$): δ 9.55 (s, 1H), 7.41 (s, 1H), 6.34 (dd, *J* = 15.6, 8.0 Hz, 0.02H), 4.53 (dd, *J* = 12.1, 1.6 Hz, 4H), 4.16 (s, 5H).

^{13}C NMR (151 MHz, CDCl$_3$): δ 193.3, 155.2, 126.2 (t, *J* = 24.2 Hz), 77.9, 72.0, 70.1, 69.3.

HRMS (EI-TOF): m/z caled for $C_{13}H_{11}DFeO$ [$(M)^+$]: 241.0301, found: 241.0303



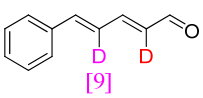
(2*E*,2'*E*)-3,3'-(1,4-phenylene)diacrylaldehyde-*α*-*d*$_1$ (5ag)

Following the general procedure, **1ag** (37.2 mg, 0.2 mmol) was used in the deuteration reaction, **3** (26.0 mg, 40 mol%), **2b** (23.7 mg, 40 mol%), PhCOOH (9.8 mg, 40 mol%) and D_2O (1 mL) was added, the reaction mixture was vigorously stirred at 50 °C for 96 h. The title compound was obtained as a white solid (30.1 mg, 80% yield) with 99% D-incorporation.

^{1}H NMR (400 MHz, CDCl$_3$): δ 9.72 (s, 2H), 7.62 (s, 4H), 7.47 (s, 2H), 6.78 – 6.72 (m, 0,02H).

^{13}C NMR (151 MHz, CDCl$_3$): δ 193.4, 150.8, 136.5, 129.74 – 129.21 (m), 129.1.

HRMS (EI-TOF): m/z caled for $C_{12}H_8D_2O_2$ [$(M)^+$]: 188.0806, found: 188.0804.



(2*E*,4*E*)-5-phenylpenta-2,4-dienal-*α*-*d*$_1$ (5ah)

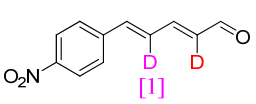
Following the general procedure, **1ah** (31.6 mg, 0.2 mmol) was used in the deuteration reaction, **2a** (12.6 mg, 0.04 mmol) instead of **2b** was used, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 96 h. The title compound was obtained as a yellow liquid (26.7 mg, 84% yield) with 99% D-incorporation at α-position and 9% D-incorporation at γ-position.

^{1}H NMR (400 MHz, CDCl$_3$): δ 9.62 (s, 1H), 7.54 – 7.48 (m, 2H), 7.41-7.32 (m, 3H), 7.28 – 7.23 (m, 1H), 7.05 – 6.96 (m, 2H), 6.27 (dd, *J* = 15.2, 8.0 Hz, 0.01H).

^{13}C NMR (151 MHz, CDCl$_3$): δ 193.7, 152.0, 142.5, 135.7, 131.4 (t, *J* = 24.6 Hz), 129.8, 129.0, 127.6, 126.3.

^{2}H NMR (77 MHz, CHCl$_3$): δ 6.33 (s, 1D), 7.07 (s, 0.09D).

HRMS (EI-TOF): m/z caled for $C_{11}H_9DO$ [$(M)^+$]: 159.0794, found: 159.0791.



(2*E*,4*E*)-5-(4-nitrophenyl)penta-2,4-dienal-*α*-*d*$_1$ (5ai)

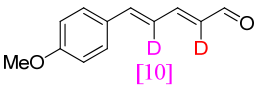
Following the general procedure, **1ai** (40.6 mg, 0.2 mmol) was used in the deuteration reaction, and the reaction mixture was vigorously stirred at 50 °C for 24 h. The title compound was obtained as a yellow solid (27.7 mg, 68% yield) with 96% D-incorporation at α-position and 1% D-incorporation at γ-position.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.68 (s, 1H), 8.25 (d, *J* = 8.6 Hz, 2H), 7.65 (d, *J* = 8.6 Hz, 2H), 7.28 (d, *J* = 11.1 Hz, 1H), 7.18-7.04 (m, 2H), 6.37 (dd, *J* = 14.9, 7.4 Hz, 0.04H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.2, 149.9, 147.9, 141.7, 139.0, 133.3 (t, *J* = 24.8 Hz), 130.2, 128.0, 124.3.

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.42 (s, 1D), 7.20 (s, 0.01D).

HRMS (EI-TOF): m/z caled for $C_{11}H_8DNO_3$ [$(M)^+$]: 204.0645, found: 204.0648.



(2*E*,4*E*)-5-(4-methoxyphenyl)penta-2,4-dienal-*α*-*d*$_1$ (5aj)

Following the general procedure, **1aj** (37.6 mg, 0.2 mmol) was used in the deuteration reaction, **2a** (12.6 mg, 0.04 mmol) instead of **2b** was used, PhCOOH (4.9 mg, 20 mol%) was added, and the reaction mixture was vigorously stirred at 50 °C for 96 h. The title compound was obtained as a yellow solid (28.0 mg, 74% yield) with 99% D-incorporation at α-position and 10% D-incorporation at γ-position.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.59 (s, 1H), 7.45 (d, *J* = 8.7 Hz, 2H), 7.24 (d, *J* = 10.5 Hz, 1H), 6.99 – 6.84 (m, 4H), 6.22 (dd, *J* = 15.1, 8.0 Hz, 0.01H), 3.84 (s, 3H).

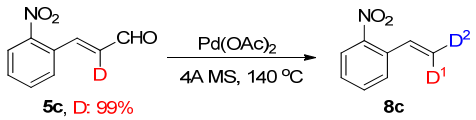
^{13}C NMR (151 MHz, $CDCl_3$): δ 193.7, 161.1, 152.7, 142.4, 130.4 (t, *J* = 24.8 Hz), 129.3, 128.5, 124.2, 114.5, 55.5.

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.28 (s, 1D),6.93 (s, 0.1D).

HRMS (EI-TOF): m/z caled for $C_{12}H_{11}DO_2$ [$(M)^+$]: 189.0900, found: 189.0903.

6. Applications of α-Deuterated Enals

1-nitro-2-vinylbenzene-1,1-*d*$_2$ (8c)



A clean, oven–dried screw cap reaction tube with previously placed magnetic stir–bar was charged with molecular sieves (4Å, 150 mg), **5c** (89 mg, 0.5 mmol, 99% D-incorporation), $Pd(OAc)_2$ (9 mg, 8 mol%). Cyclohexane (2 mL) was added to this mixture by syringe. The tube was closed by screw cap and placed in a preheated oil bath at 140 °C . The reaction mixture was vigorously stirred for 6 h. The reaction mixture was cooled to room temperature and filtered through celite. Reaction tube and the residue was washed with EtOAc (20 mL). The filtrate was concentrated and purified by column chromatography to give the title compound **8c** as a yellow oil (37 mg, 49% yield) with 94% D-incorporation at D_1-position, and 4% D-incorporation at D_2-position.

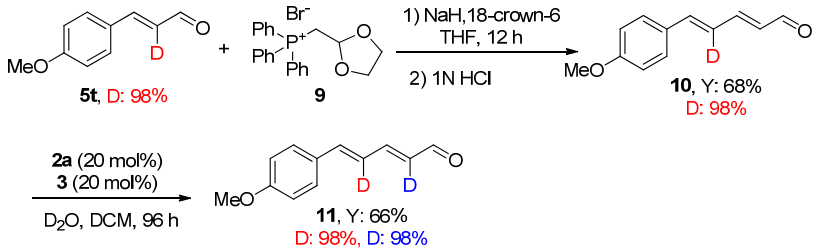
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.93 (d, *J* = 8.2 Hz, 1H), 7.66 – 7.54 (m, 2H), 7.45 – 7.38 (m, 1H), 7.22 – 7.13 (m, 1H), 5.74 (dd, *J* = 17.3, 6.2 Hz, 0.06H), 5.48 (dd, *J* = 10.9, 5.9 Hz, 0.96H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 148.0, 133.5, 133.3, 132.6, 128.7, 128.5, 124.6, 118.7 (t, *J* = 24.0 Hz).

^{2}H NMR (77 MHz, $CHCl_3$): δ 5.80 (d, *J* = 2.6 Hz, 1D), 5.54 (d, *J* = 1.2 Hz, 0.04D).

HRMS (EI-TOF): m/z caled for $C_8H_6D_1NO_2$ [$(M)^+$]: 150.0540, found: 150.0536.

(2*E*,4*E*)-5-(4-methoxyphenyl)penta-2,4-dienal-*α*-*γ*-d_2 (11)



To a stirred solution of **5t** (603 mg, 3.7 mmol, 98% D-incorporation) in THF (30 mL) was added **9** (2.38 g, 5.55 mmol), NaH (747 mg, 18.69 mmol), and 18-crown-6 (88 mg) under N_2 at 0 ºC. The reaction was slowly warmed to room temperature and stirred overnight. 1N HCl (15 mL) was added slowly to quench the reaction, and the mixture was stirred for 30 min and neutralized with ammonia water, then extracted with DCM (30 mL × 3). The combined organic solution was washed with saturated brine (20 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography to give the title compound **10** as a yellow solid (476 mg, 68% yield) with 98% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.59 (d, *J* = 8.0 Hz, 1H), 7.46 (d, *J* = 8.8 Hz, 2H), 7.29 – 7.21 (m, 1H), 6.97 (s, 1H), 6.91 (d, *J* = 8.8 Hz, 2.02H), 6.23 (dd, *J* = 15.2, 8.0 Hz, 1H), 3.84 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.8, 161.1, 152.8, 142.4, 130.7, 129.3, 128.5, 123.9 (t, *J* = 23.6 Hz), 114.6, 55.5.

HRMS (ESI-TOF): calculated for $C_{12}H_{12}DO_2$ $[(M + H)]^+$: 190.0978, found: 190.0979.

Following the general procedure, **10** (37.8 mg, 0.2 mmol, deuteration 98%) was used in the deuteration reaction, **2a** (12.6 mg, 0.04 mmol) instead of **2b** was used, and the reaction mixture was vigorously stirred at 50 °C for 96 h. The title compound **11** was obtained as a yellow solid (25 mg, 66% yield) with 98% D-incorporation at α- and γ-position.

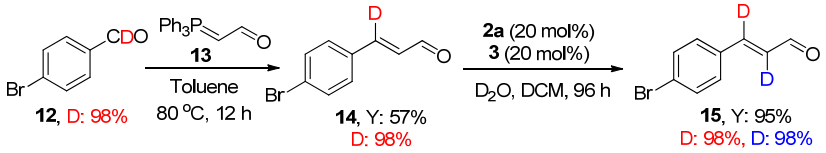
^{1}H NMR (400 MHz, $CDCl_3$): δ 9.59 (s, 1H), 7.45 (d, *J* = 8.8 Hz, 2H), 7.24 (s, 1H), 6.96 (s, 1H), 6.91 (d, *J* = 8.8 Hz, 2.02H), 6.23 (dd, *J* = 15.2, 8.0 Hz, 0.02H), 3.84 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.7, 161.0, 152.7, 142.3, 130.67 – 130.20 (m), 129.3, 128.5, 124.17 – 123.74 (m), 114.5, 55.5.

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.94 (s, 1D), 6.28 (s, 1D).

HRMS (ESI-TOF): m/z caled for $C_{12}H_{11}D_2O_2$ $[(M + H)]^+$: 191.1041, found: 191.1040.

(*E*)-3-(4-bromophenyl)acrylaldehyde-*α*-*β*-d_2 (15)



A mixture of **12** (930 mg, 5 mmol, 98% D-incorporation) and **13** (2.13 g, 7 mmol) in toluene (40 mL) was vigorously stirred at 80 °C for 17 h under N_2. Then the reaction was concentrated under reduced pressure and purified by column chromatography to give the title compound **14** as a brown solid (606 mg, 57% yield) with 98% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.71 (d, *J* = 7.6 Hz, 1H), 7.58 (d, *J* = 8.5 Hz, 2H), 7.44 (d, *J* = 8.5 Hz, 2.02H), 6.72 – 6.68 (m, 1H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.5, 150.9 (t, *J* = 23.6 Hz), 133.0, 132.6, 129.9, 129.0, 125.9.

HRMS (ESI-TOF): calculated for C_9H_7DBrO $[(M + H)]^+$: 211.9821, found: 211.9824.

Following the general procedure, **14** (42.4 mg, 0.2 mmol, 98% D-incorporation) was used in the deuteration reaction, **2a** (12.6 mg, 0.04 mmol) instead of **2b** was used, and the reaction mixture was vigorously stirred at 50 °C for 96 h. The title compound **15** was obtained as a yellow solid (40.5 mg, 95% yield) with 98% D-incorporation at *α*- and *β*-position.

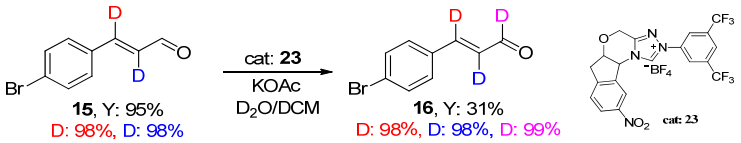
^{1}H NMR (400 MHz, $CDCl_3$): δ 9.71 (s, 1H), 7.58 (d, *J* = 8.3 Hz, 2H), 7.44 (d, *J* = 8.3 Hz, 2.02H), 6.70 (dd, *J* = 8.4, 2.8 Hz, 0.02H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 193.5, 150.8 (t, *J* = 23.4 Hz), 133.0, 132.6, 129.9, 129.09 – 128.64 (m), 125.9.

^{2}H NMR (77 MHz, $CHCl_3$): δ 7.46 (s, 1D), 6.75 (s, 1D).

HRMS (ESI-TOF): m/z caled for $C_9H_6D_2BrO$ $[(M + H)]^+$: 212.9884, found: 212.9883.

(*E*)-3-(4-bromophenyl)acrylaldehyde-*1-2-3-d*$_3$ (16)



Following the reported procedure,[13] **15** (106 mg, 0.5 mmol), **23** (10 mol%) and KOAc (49.07 mg, 0.5 mmol) was dissolved in a mixture of D_2O (2 mL) and DCM (0.5 mL) in a reaction vessel (5 mL). Then the reaction mixture was vigorously stirred at 60 °C for 12 h. The title compound **16** was obtained as a yellow solid (33 mg, 31% yield) with 98% D-incorporation at *α*- and *β*-position and 99% D-incorporation at aldehyde C1-

position.

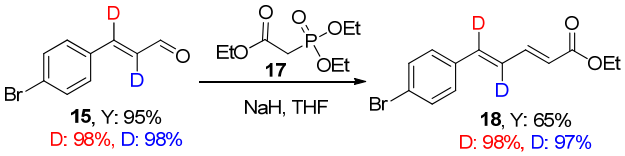
^{1}H NMR (400 MHz, $CDCl_3$): δ 9.7 (s, 0.00H), 7.58 (d, *J* = 8.4 Hz, 2H), 7.44 (d, *J* = 8.4 Hz, 2.02H), 6.70 (s, 0.02H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 193.3 (t, *J* = 26.6 Hz), 150.8 (t, *J* = 23.5 Hz), 132.9, 132.5, 129.9, 128.97 – 128.48 (m), 125.8.

^{2}H NMR (77 MHz, $CHCl_3$): δ 9.75 (s, 1.03D), 7.46 (s, 1D), 6.74 (s, 1D).

HRMS (ESI-TOF): m/z caled for $C_9H_5D_3BrO$ $[(M + H)]^+$: 213.9947, found: 213.9944.

Ethyl (2*E*,4*E*)-5-(4-bromophenyl)penta-2,4-dienoate-*4-5-d*$_2$ (18)



Following the reported procedure,[12] to a stirred solution of NaH (13.2 mg, 0.33 mmol) in dry THF (3 mL) was added **17** (74 mg, 0.33 mmol) dropwise under N_2 at 0 °C. The mixture was stirred for 1 h before a solution of **15** (63.6 mg, 0.3 mmol) in THF (2 mL) was added dropwise. The reaction was slowly warmed to room temperature and stirred until completion monitored by TLC. The reaction was quenched with saturated NH_4Cl (5 mL) and the aqueous phase was extracted with EtOAc (5 mL × 3). The combined organic solution was washed with saturated brine (5 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography to give the title compound **18** as light a yellow solid (55.5 mg, 65% yield) with 97% D-incorporation at γ-position and 98% D-incorporation at δ-position.

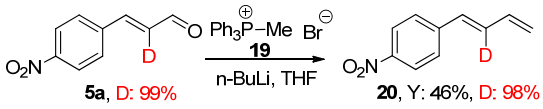
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.47 (d, *J* = 8.8 Hz, 2H), 7.41 (d, *J* = 15.6 Hz, 1H), 7.31 (d, *J* = 8.8 Hz, 2H), 6.85 (s, 0.02H), 6.82 (d, *J* = 6.8 Hz, 0.03H), 6.00 (d, *J* = 15.2 Hz, 1H), 4.23 (q, *J* = 7.2 Hz, 2H), 1.31 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 167.0, 144.1, 138.85 – 138.34 (m), 135.0, 132.1, 128.7, 126.88 – 126.44 (m), 123.1, 122.0, 60.5, 14.4.

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.87 (s, 2D), two deuterium peaks are overlapped.

HRMS (ESI-TOF): m/z caled for $C_{13}H_{12}D_2BrO_2$ $[(M + H)]^+$: 283.0303, found: 283.0301.

(*E*)-1-(buta-1,3-dien-yl)-4-nitrobenzene-*3-d*$_1$ (20)



Following the reported procedure,[14] to a stirred solution of **19** (129 mg, 0.36 mmol) in THF (2 mL) was added n-BuLi (0.16 mL, 0.39 mmol, 2.5 M in hexane) dropwise at 0 °C under N_2. The reaction was slowly warmed to room temperature and stirred for 30 min, giving a dark red solution. **5a** (53.4 mg, 0.3 mmo) in THF (1.0 mL) was then added dropwise at room temperature and stirred overnight. Then petroleum ether (5 mL) was added to the reaction mixture and stirred for 1 h. The reaction was filtered through celite and concentrated under reduced pressure. The crude product was purified by column chromatography to give the title compound **20** as a light yellow oil (24.2 mg, 46% yield) with 98% D-incorporation.

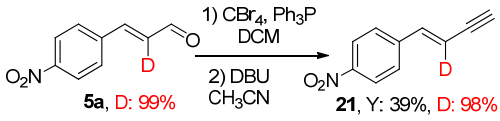
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.18 (d, *J* = 8.8 Hz, 2H), 7.52 (d, *J* = 8.8 Hz, 2H), 6.93 (dd, *J* = 15.6, 10.8 Hz, 0.02H), 6.64 – 6.45 (m, 2H), 5.48 (d, *J* = 17.2 Hz, 1H), 5.35 (d, *J* = 10.0 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 146.8, 143.7, 136.4, 134.06 – 133.59 (m), 130.3, 126.9, 124.1, 120.9.

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.90 (s, 1D).

HRMS (EI-TOF): m/z caled for $C_{10}H_8DNO_2$ [$(M)^+$]: 176.0696, found: 176.0697.

(*E*)-1-(but-1-en-3-yn-1-yl)-4-nitrobenzene-2-*d*$_1$ (21)



Following the reported procedure,[15] to a stirred solution of **5a** (178 mg, 1 mmol) and CBr_4 (664 mg, 2 mmol) in anhydrous DCM (10 mL) was added Ph_3P (3.05 g, 4 mmol) in portions over a period of 20 min under N_2 at 0 °C. The reaction mixture was turned brown and allowed to stir at 0 °C for 2 h. H_2O (5 mL) was added to the reaction mixture, and the reaction mixture was extracted with DCM (10 mL × 3), the combined organic solution was washed with saturated brine (10 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography to give the compound (*E*)-1-(4,4-dibromobuta-1,3-dien-1-yl)-4-nitrobenzene as a light yellow solid (315 mg, 95% yield) .

To a stirred solution of (*E*)-1-(4,4-dibromobuta-1,3-dien-1-yl)-4-nitrobenzene (315 mg, 0.95 mmol) in anhydrous CH_3CN (4 mL) was added DBU (578 mg, 3.8 mmol)) dropwise at room temperature. The reaction mixture was stirred for 16 h at rt, then the solvent was removed under reduced pressure. The crude product was purified by column chromatography to give the title compound **21** as a light yellow oil (64.4 mg, 39%

yield) with 98% D-incorporation.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.21 (d, *J* = 8.8 Hz, 2H), 7.53 (d, *J* = 8.8 Hz, 2H), 7.07 (s, 1H), 6.30 (dd, *J* = 16.0, 2.4 Hz, 0.02H), 3.21 (s, 1H).

^{13}C NMR (151 MHz, $CDCl_3$): δ 147.8, 142.1, 140.6, 127.0, 124.3, 112.05 – 111.60 (m), 82.1, 82.0.

^{2}H NMR (77 MHz, $CHCl_3$): δ 6.34 (s, 1D).

HRMS (EI-TOF): m/z caled for $C_{10}H_6DNO_2$ [$(M)^+$]: 174.0540, found: 174.0542.

7. References

(1) Rosenau, C. P.; Jelier, B. J.; Gossert, A. D.; Togni, A. *Angew. Chem., Int. Ed.* **2018**, *57*, 9528-9533.

(2) Pitzer, L.; Schäfers, F.; Glorius, F. *Angew. Chem., Int. Ed.* **2019**, *58*, 8572−8576.

(3) Ni, C.; Zhang, L.; Hu, J. *J. Org. Chem.* **2008**, *73*, 5699−5713.

(4) Murar, C. E.; Thuaud, F.; Bode, J. W. *J. Am. Chem. Soc.* **2014**, *136*, 18140−18148.

(5) Silvi, M.; Verrier, C.; Rey, Y. P.; Buzzetti, L.; Melchiorre, P. *Nat. Chem.* **2017**, *9*, 868−873.

(6) Battistuzzi, G.; Cacchi, S.; Fabrizi, G. *Org. Lett.* **2003**, *5*, 777-780.

(7) Kim, P.; Kang, S.; Boshoff, H. I.; Jiricek, J.; Collins, M.; Singh, R.; Manjunatha, U. H.; Niyomrattanakit, P.; Zhang, L.; Goodwind, M.; Dick, T.; Keller, T. H.; Dowd, C. S.; Barry, C. E. *J. Med. Chem*. **2009**, *52*, 1329–1344.

(8) Zhang, S.; Xie, H.; Song, A.; Wu, D.; Zhu, J.; Zhao, S.; Li, J.; Yu, X.; Wang, W. *Sci. China: Chem.* **2011**, *54*, 1932−1936.

(9) Ni, S.; Wei, H.; Li, B.; Chen, F.; Liu, Y.; Chen, W.; Xu, Y.; Qiu, X.; Li, X.; Lu, Y.; Liu, W.; Hu, L.; Lin, D.; Wang, M.; Zheng, X.; Mao, F.; Zhu, J.; Lan, L.; Li, J. *J. Med. Chem.* **2017**, *60*, 8145− 8159.

(10) Chen, X.; Zhang,Y.; Wan, H.; Wang. W.; Zhang, S. *Chem. Commun*. **2016**, *52*, 3532-3535.

(11) Li, Y.; Josowicz, M.; Tolber, L. M. *J. Am. Chem. Soc.* **2010**, *132*, 10374-10382.

(12) Poulsen, P. H.; Feu, K. S.; Paz, B. M.; Jensen, F.; Jørgensen, K. A. *Angew. Chem., Int. Ed.* **2015**, *54*, 8203-8207.

(13) Geng, H.; Chen, X.; Gui, J.; Zhang, Y.; Shen, Z.; Qia, P.; Chen, J.; Zhang, S.; Wang, W. *Nat. Catal.* **2019**, *2*, 1071-1077.

(14) Trost, B. M.; Huang, Z. *Angew. Chem., Int. Ed.* **2019**, *58*, 6396-6399.

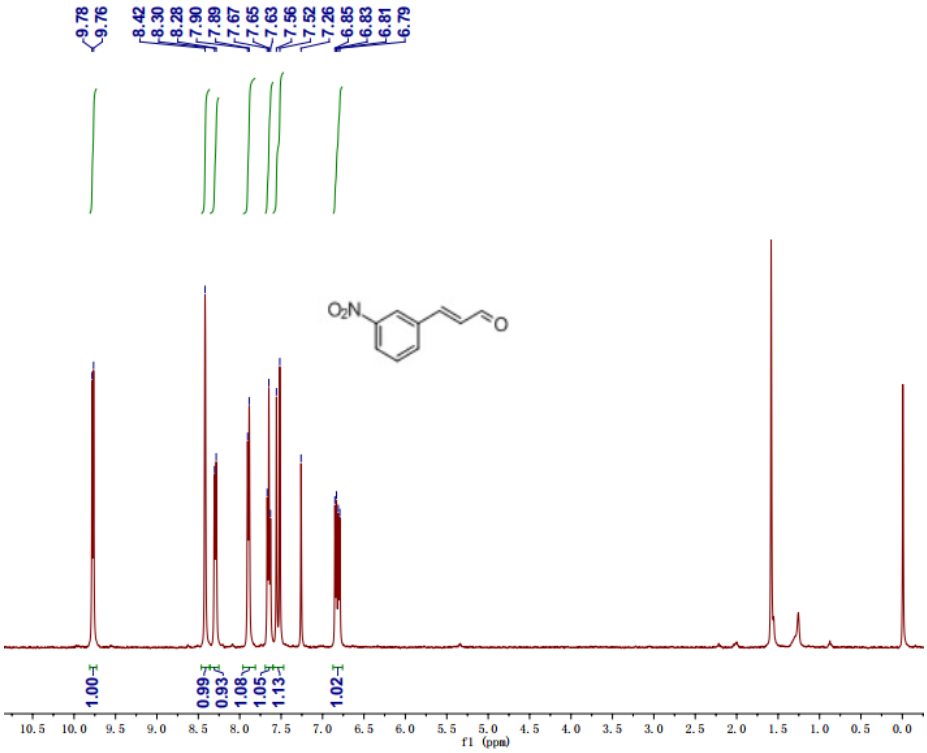
(15) Morri, A. K.; Thummala, Y.; Doddi, V. R. *Org. Lett.* **2015**, *17*, 4640−4643.

(16) Motika, S. E.; Wang, Q.; Ye, X.; Shi, X. *Org. Lett.* **2015**, *17*, 290-293.

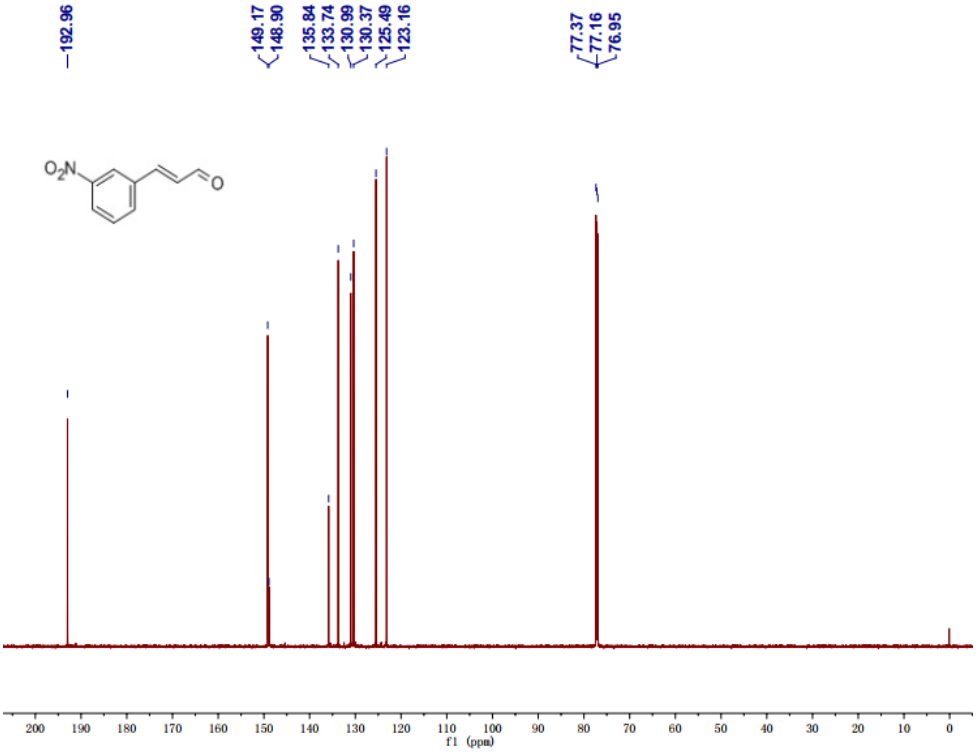
(17) Zhao, J.; Zheng, X.; Tao, S.; Zhu, Y.; Yi, J.; Tang, S.; Li, R.; Chen, H.; Fu, H.; Yuan, M. *Org. Lett.* **2021**, *23*, 6067−6072.

8. NMR Spectra

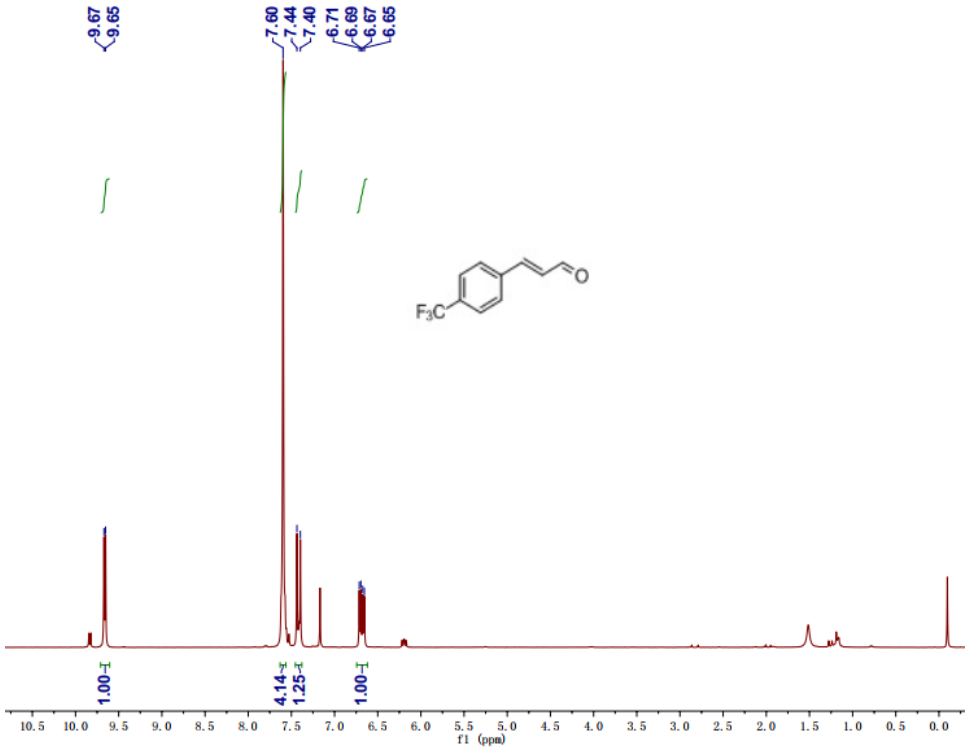
^{1}H NMR of **1b**



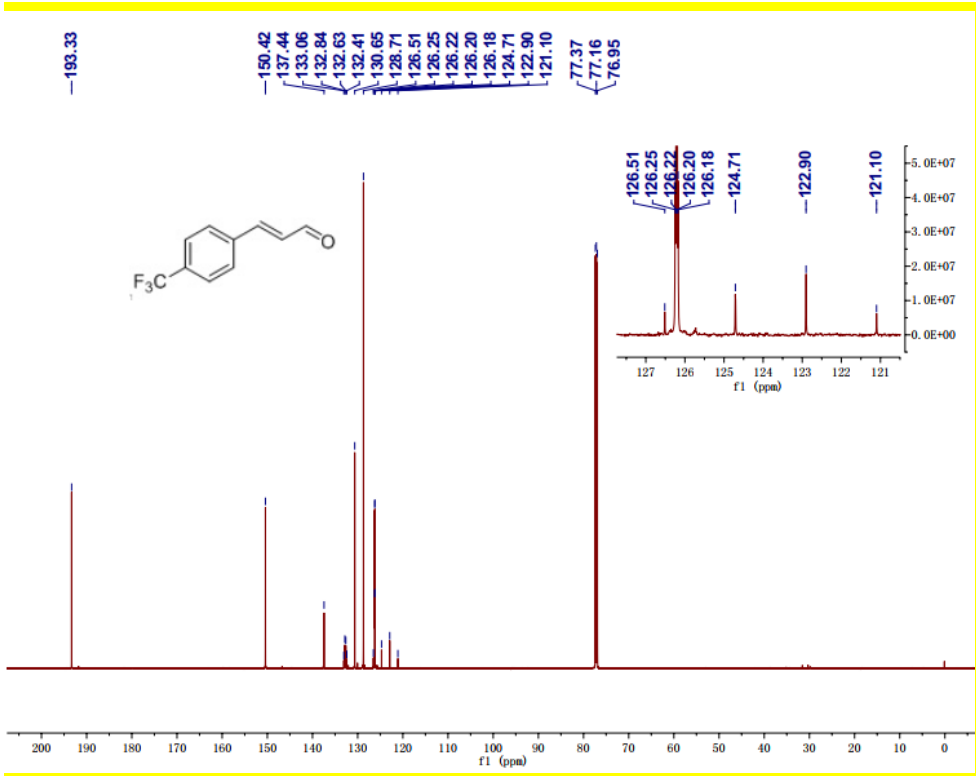
^{13}C NMR of **1b**



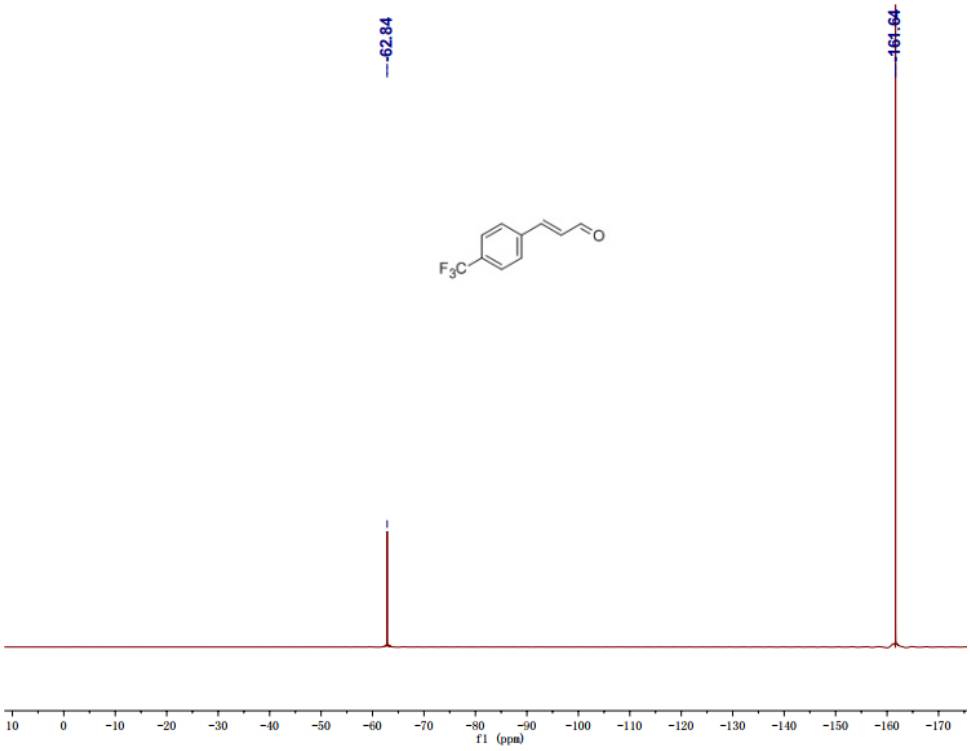
^{1}H NMR of **1e**



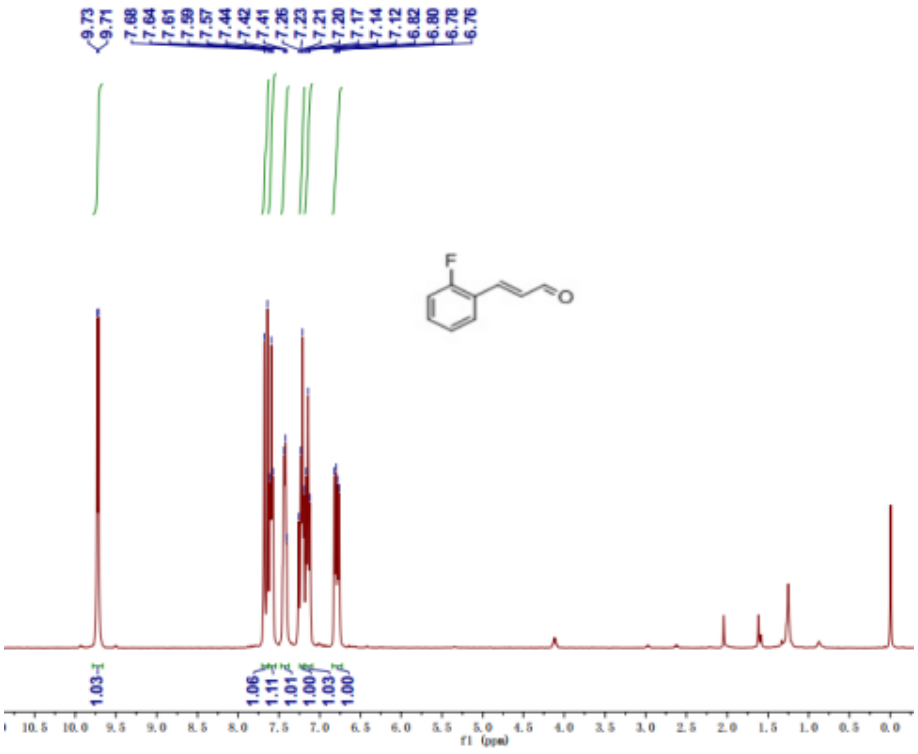
^{13}C NMR of **1e**



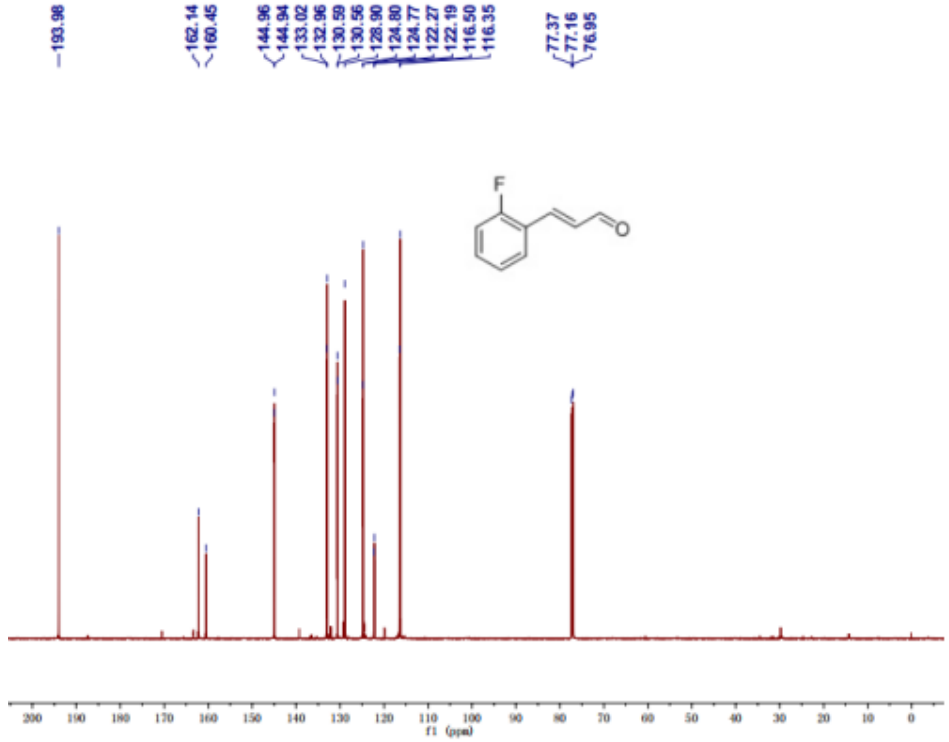
^{19}F NMR of **1e**



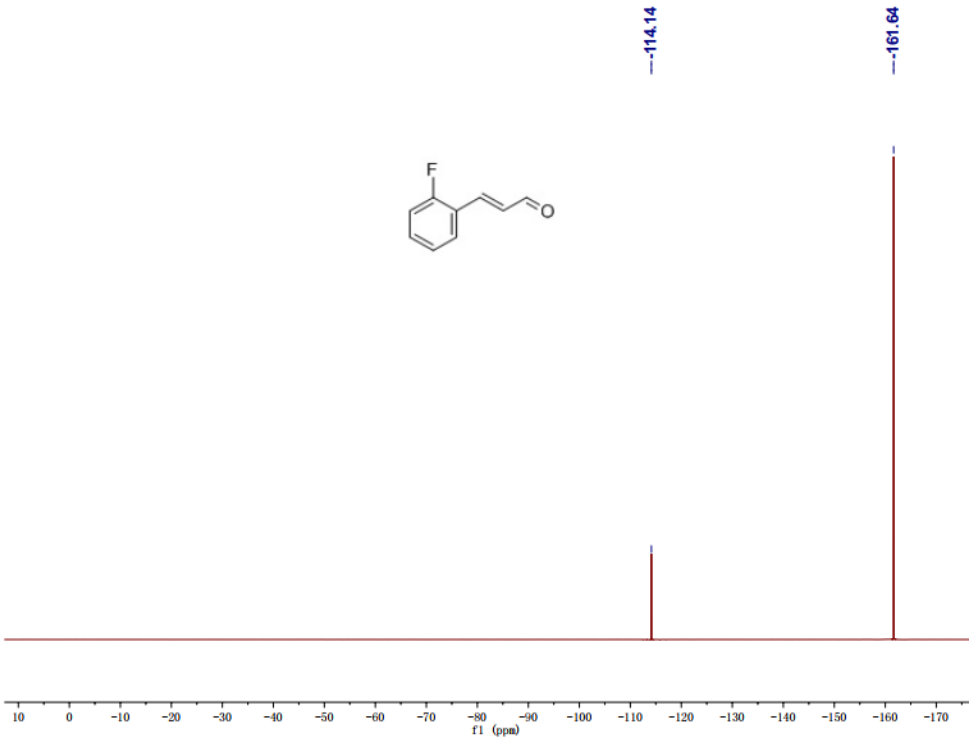
^{1}H NMR of **1f**



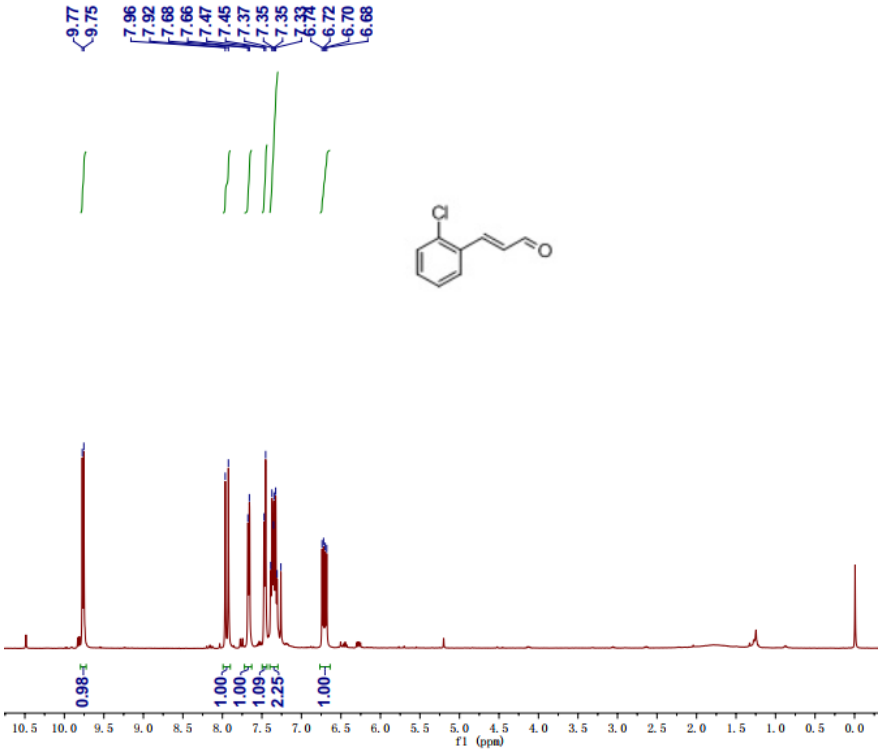
^{13}C NMR of **1f**



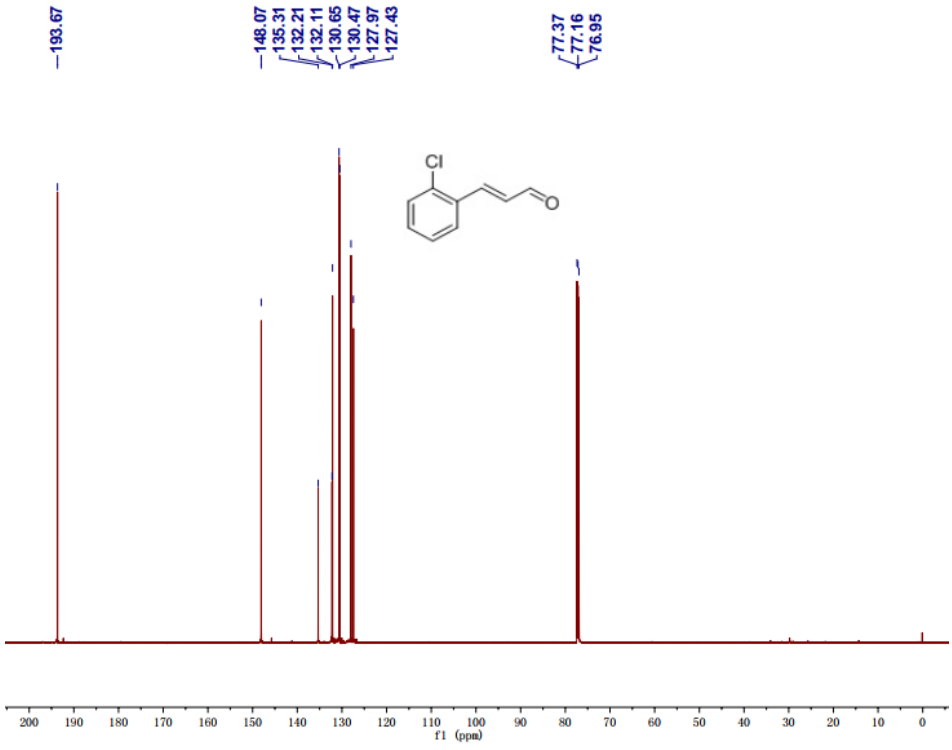
^{19}F NMR of **1f**



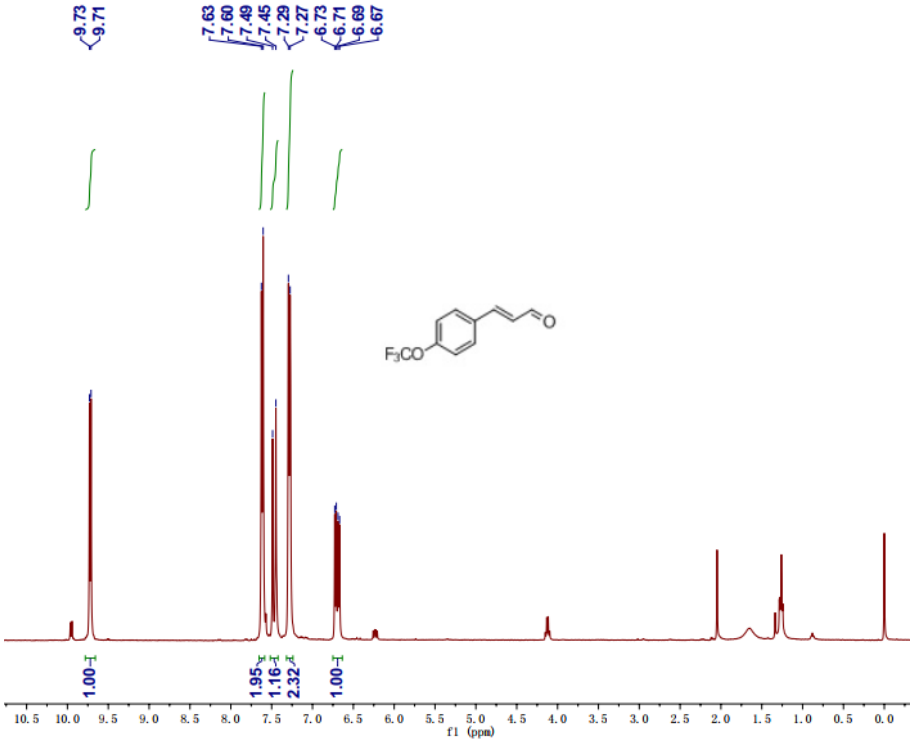
^{1}H NMR of **1h**



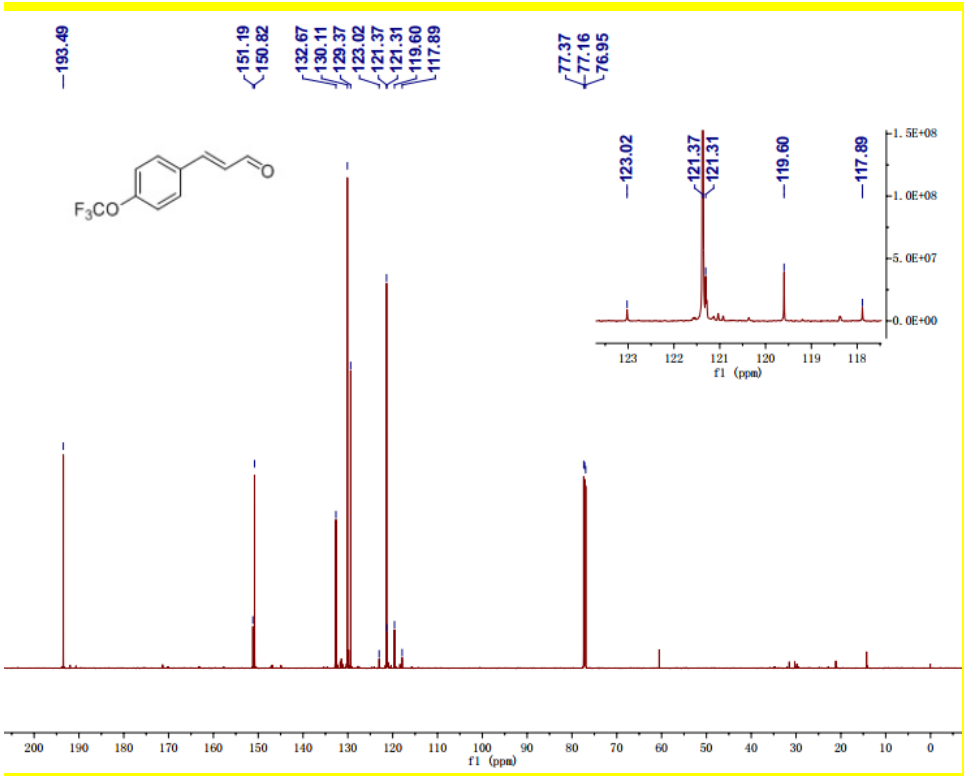
^{13}C NMR of **1h**



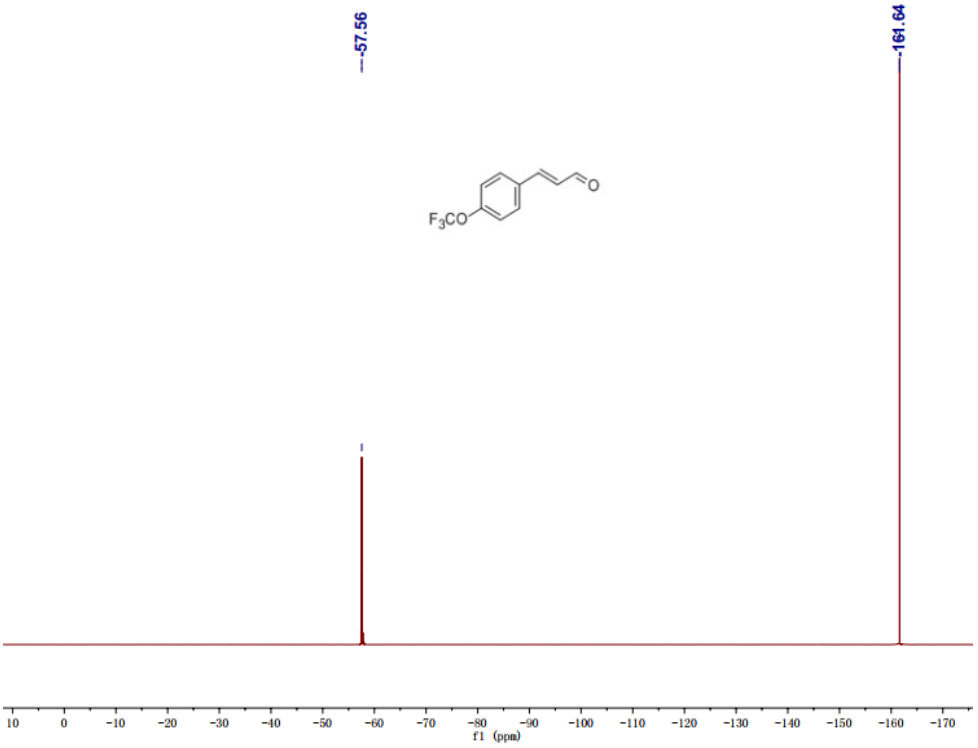
^{1}H NMR of **1l**



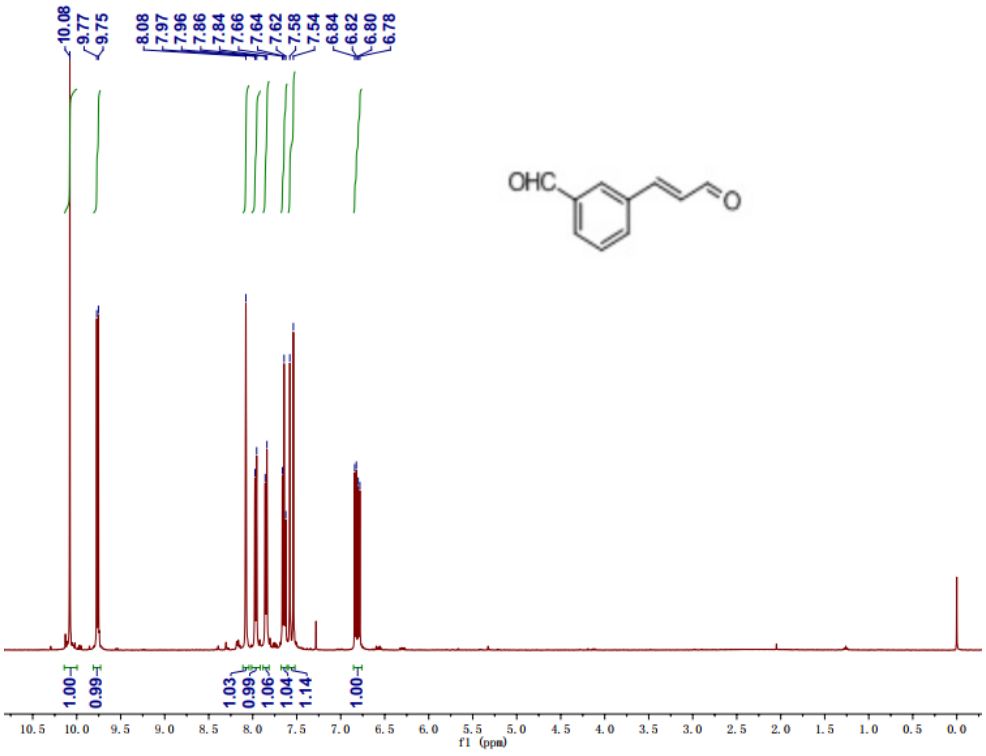
^{13}C NMR of **1l**



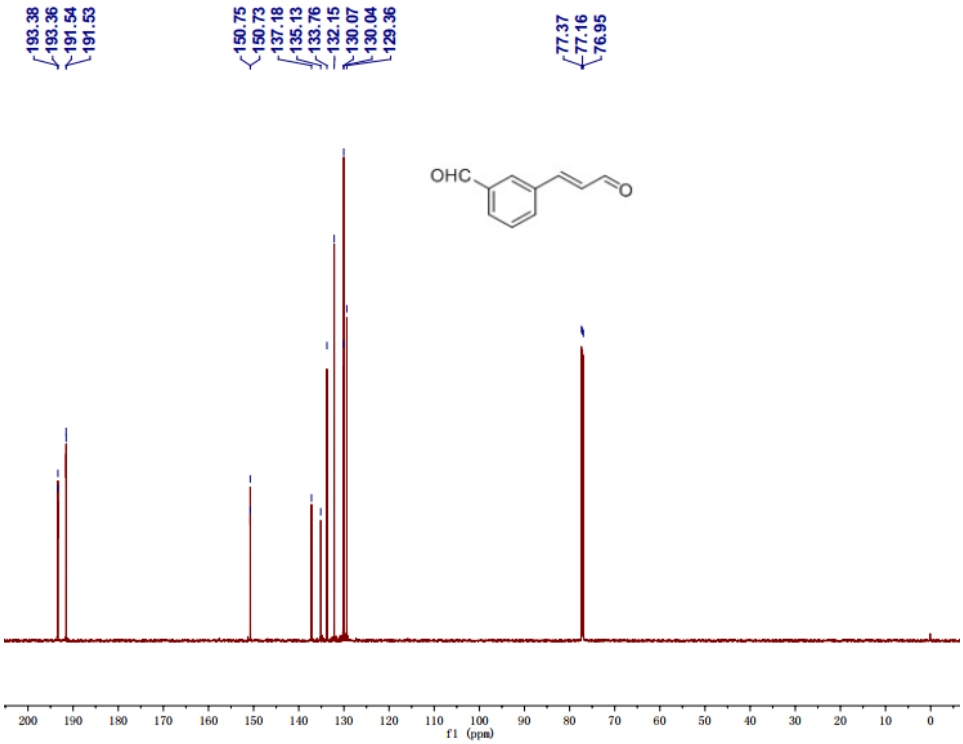
^{19}F NMR of **1l**



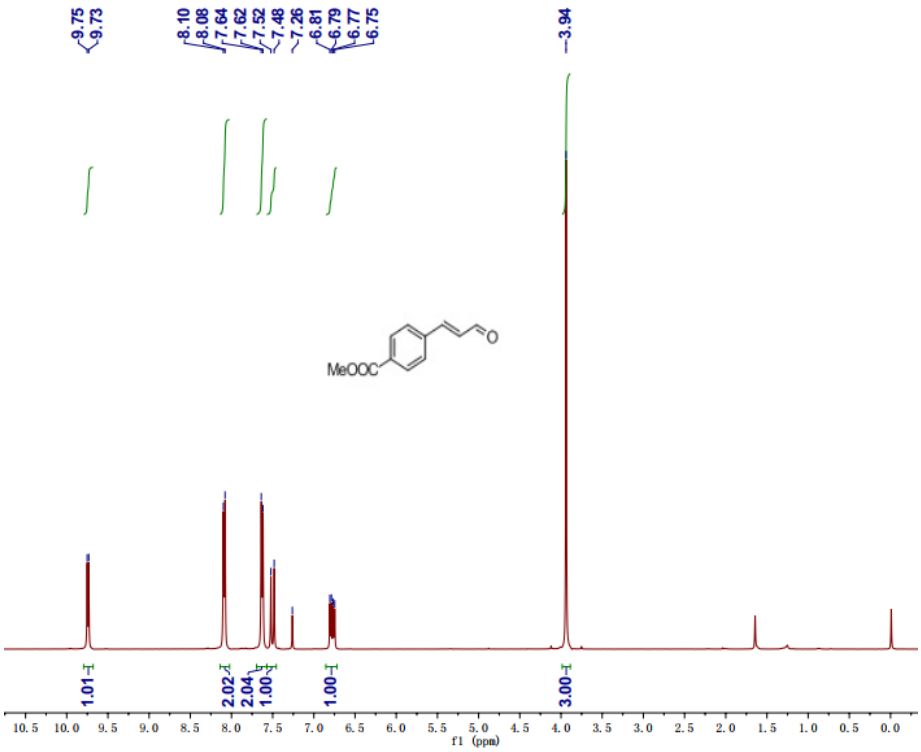
^{1}H NMR of **1m**



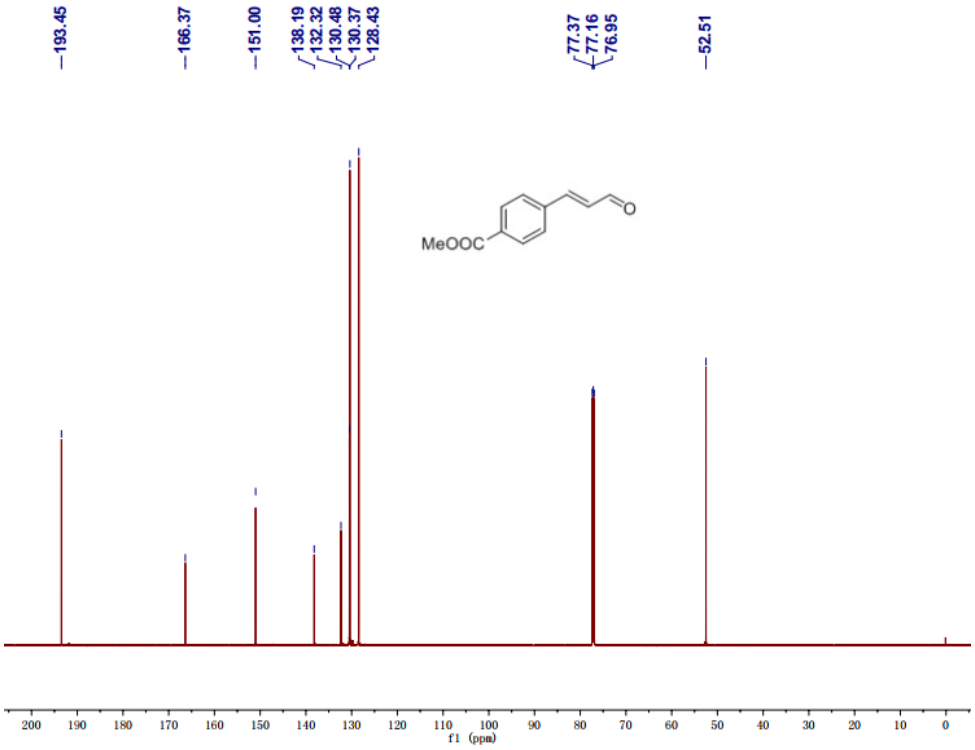
^{13}CNMR of **1m**



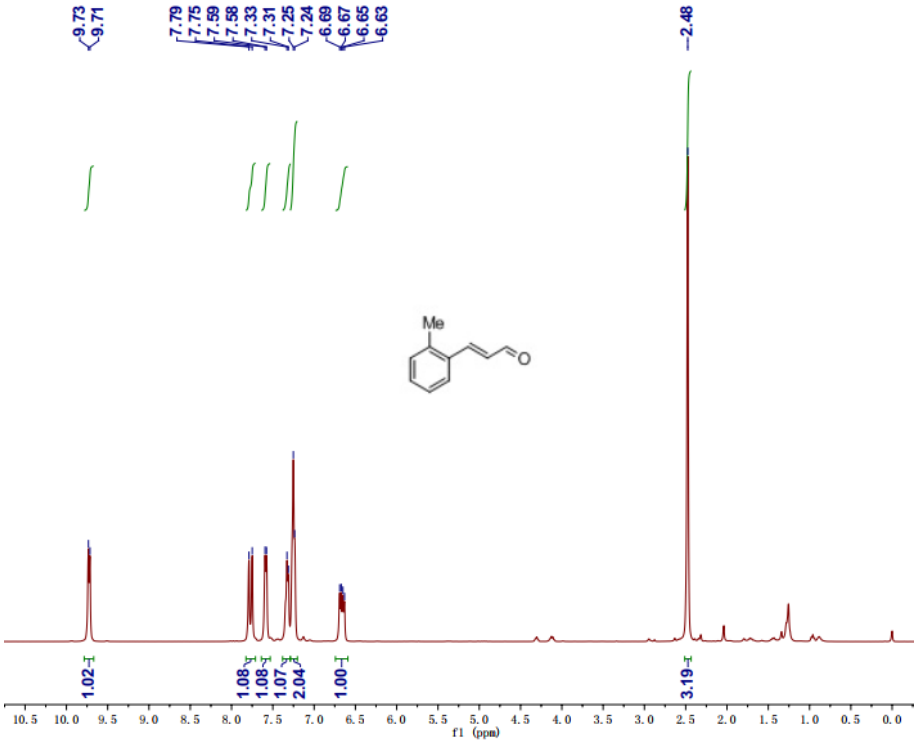
^{1}H NMR of **1n**



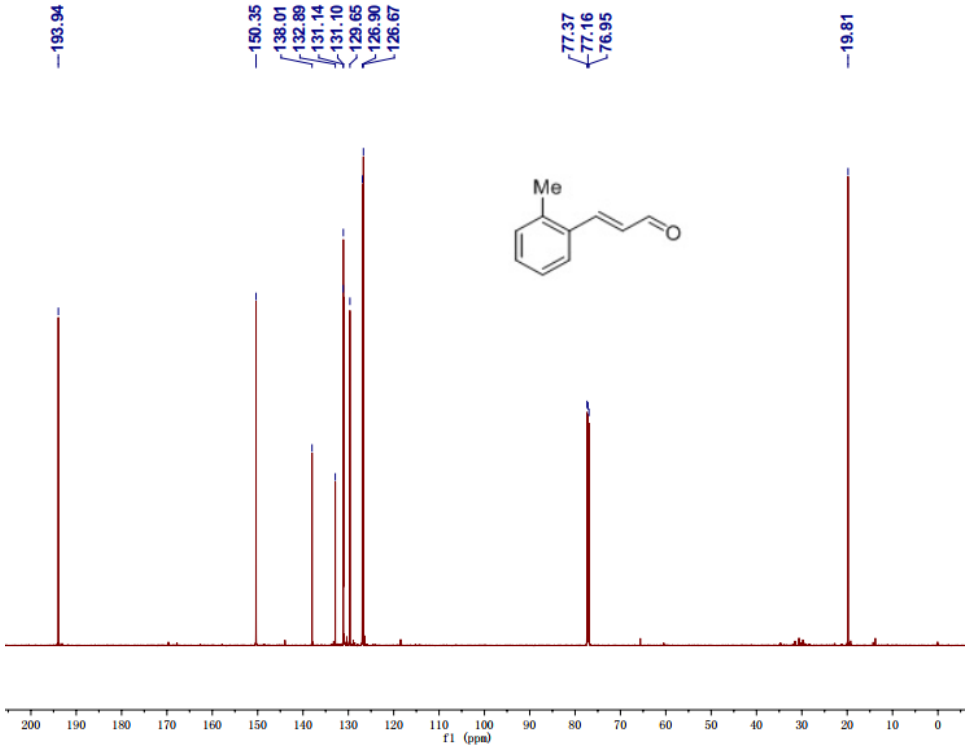
^{13}C NMR of **1n**



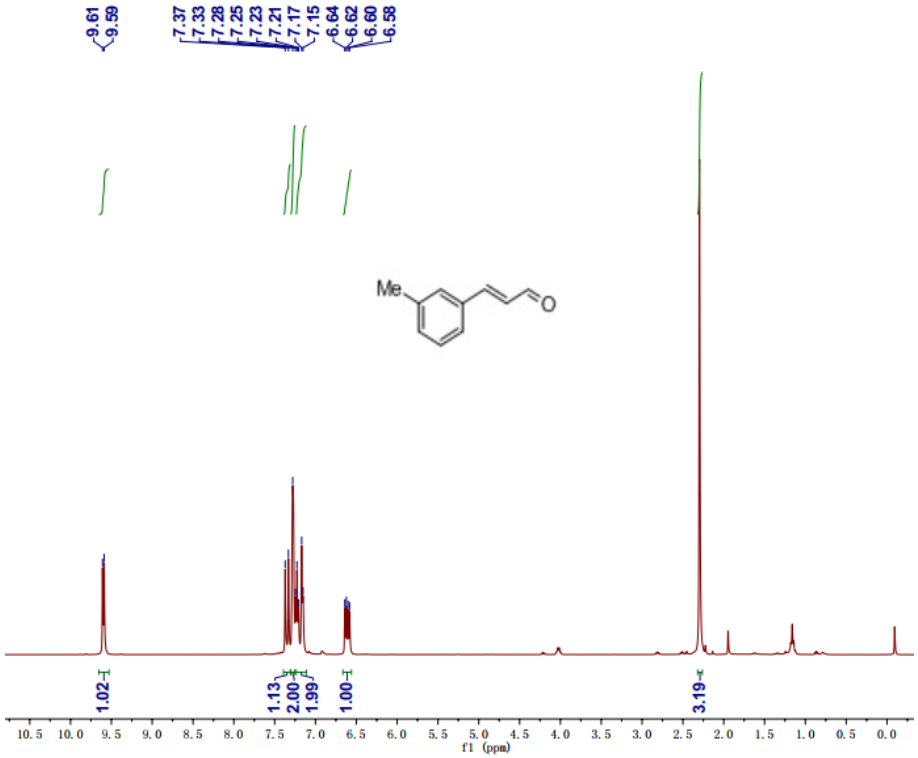
^{1}H NMR of **1p**



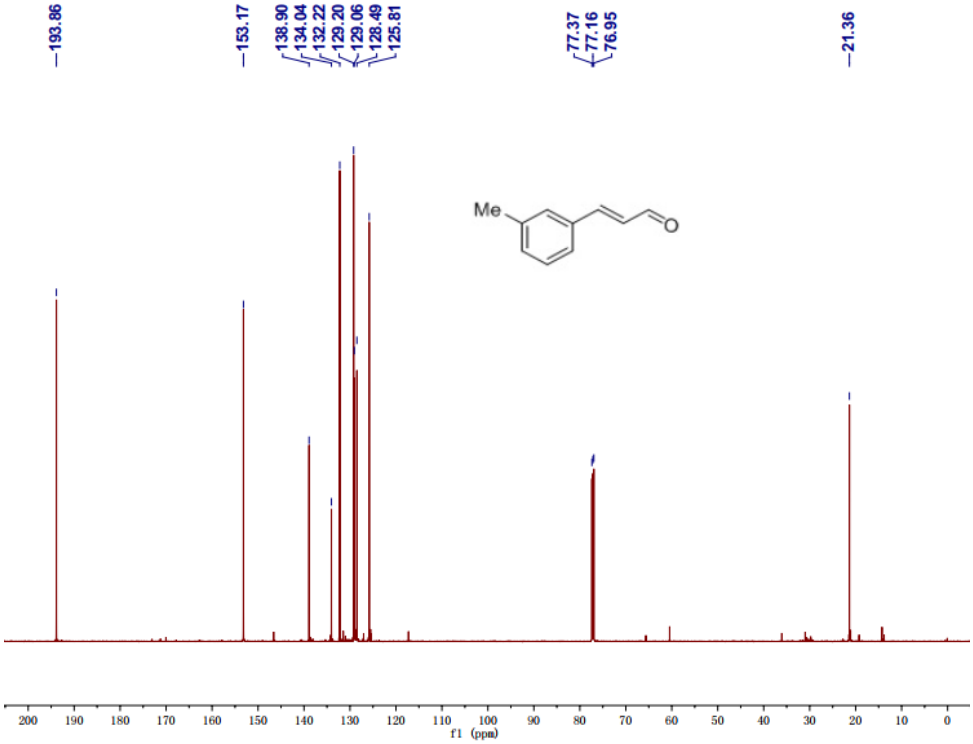
^{13}C NMR of **1p**



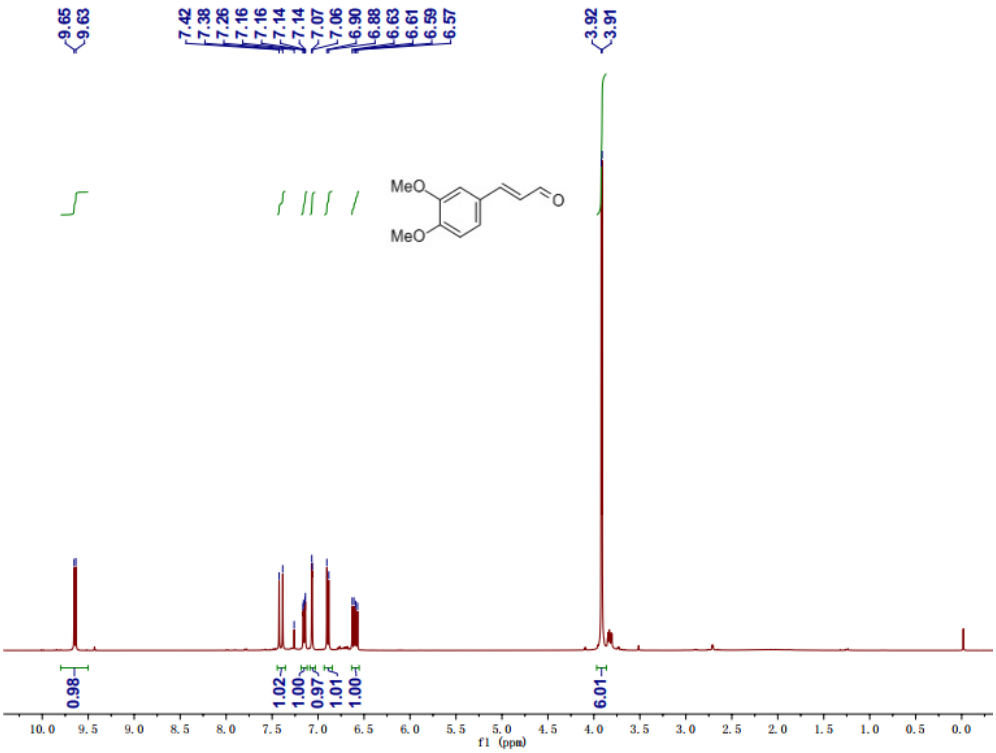
^{1}H NMR of **1q**



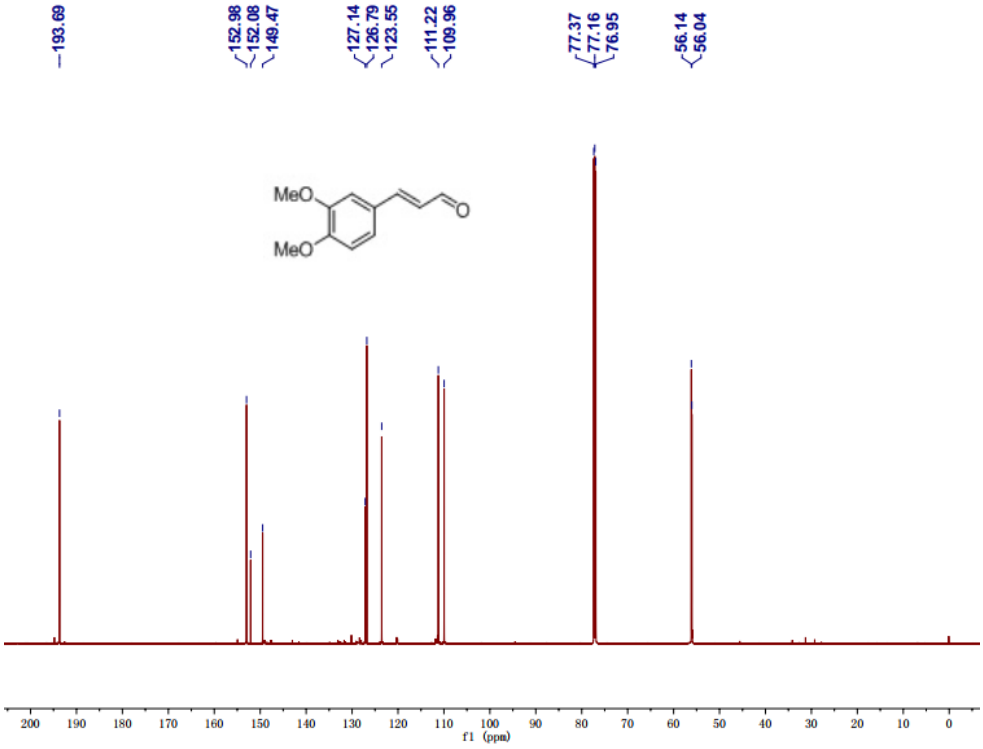
^{13}C NMR of **1q**



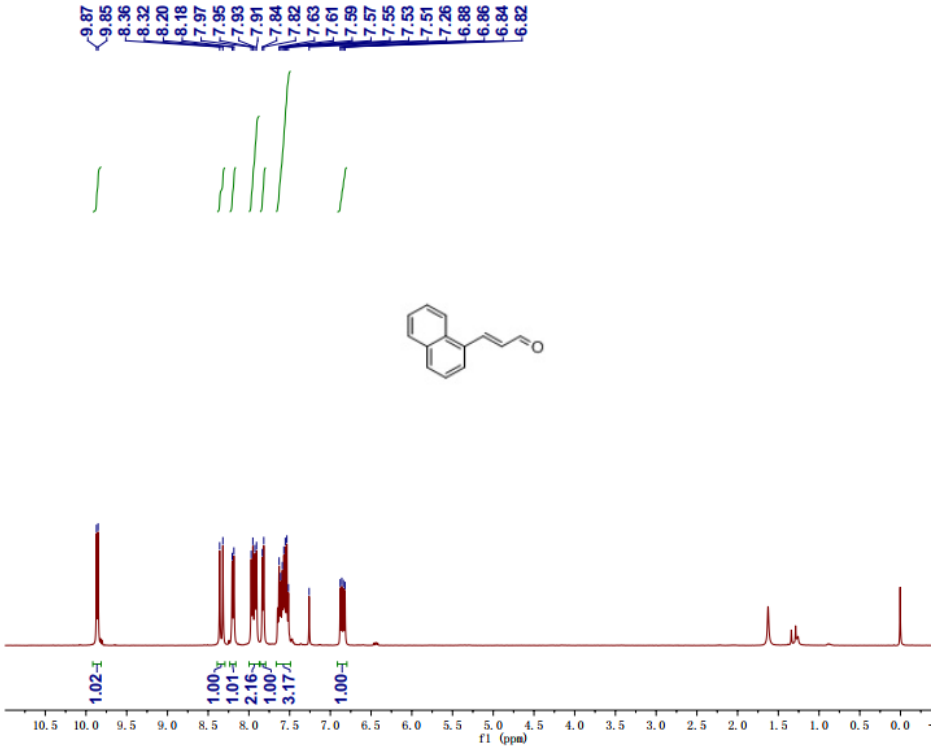
^{1}H NMR of **1v**



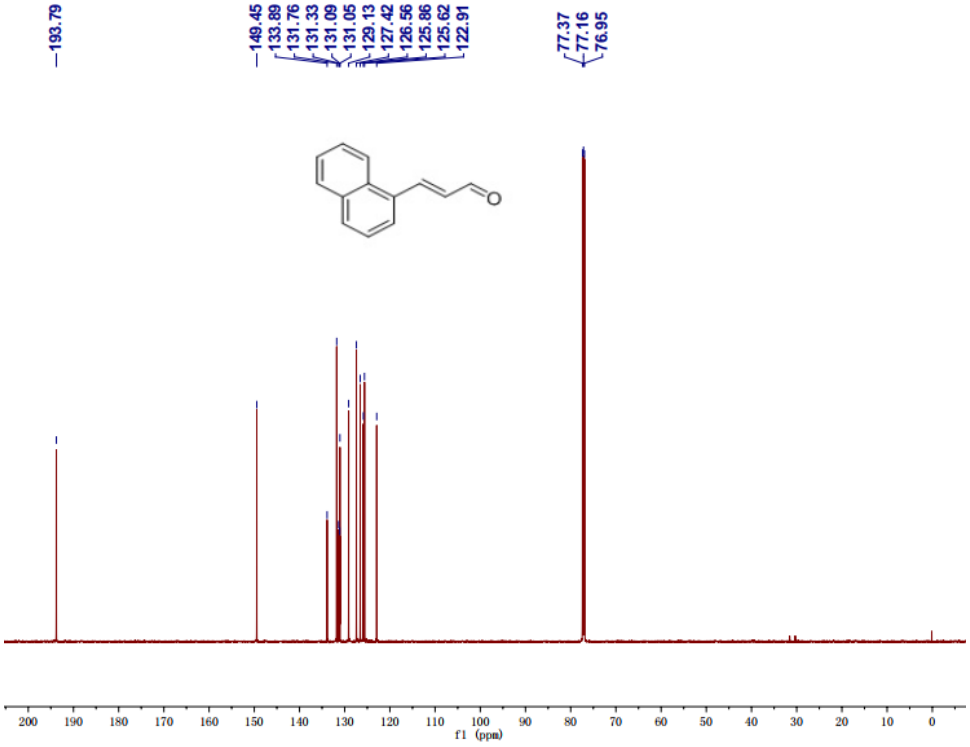
^{13}C NMR of **1v**



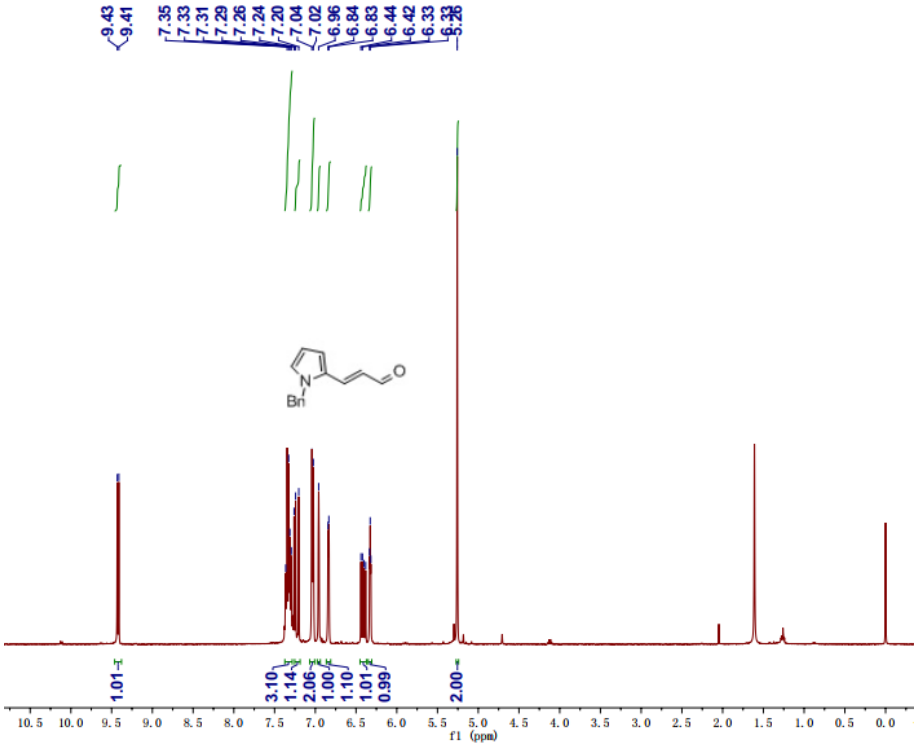
^{1}H NMR of **1x**



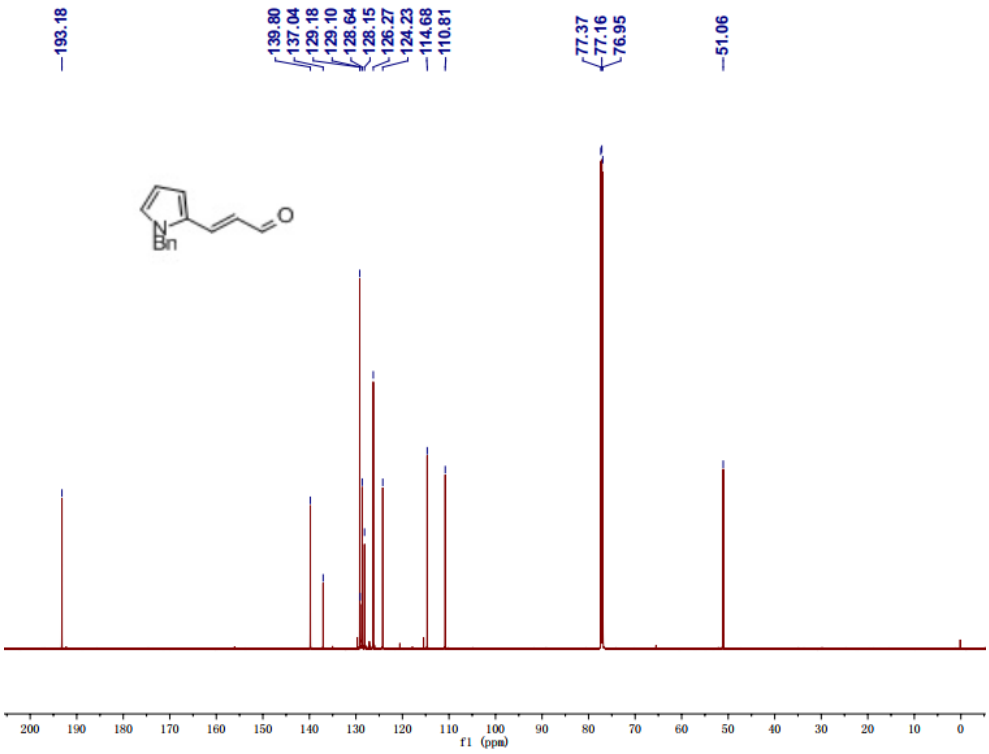
^{13}C NMR of **1x**



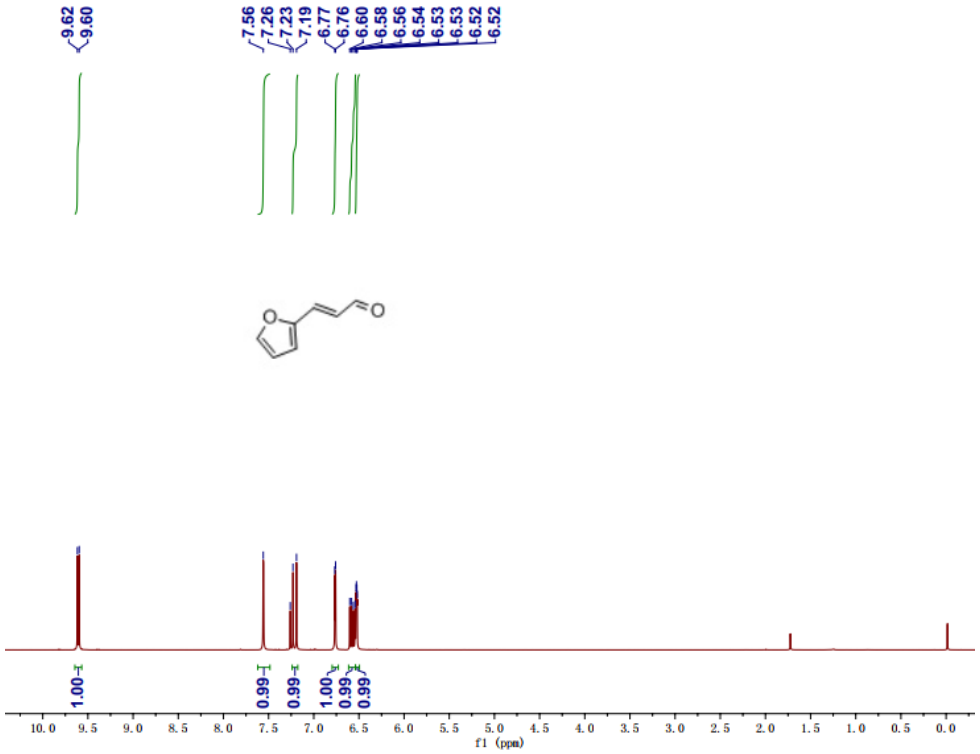
^{1}H NMR of **1y**



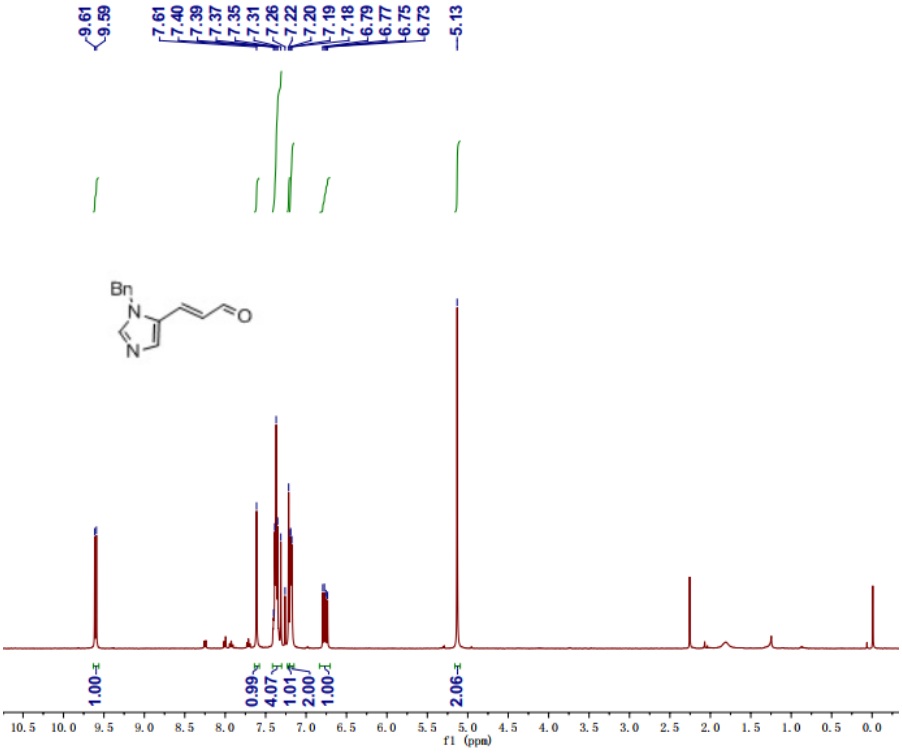
^{13}C NMR of **1y**



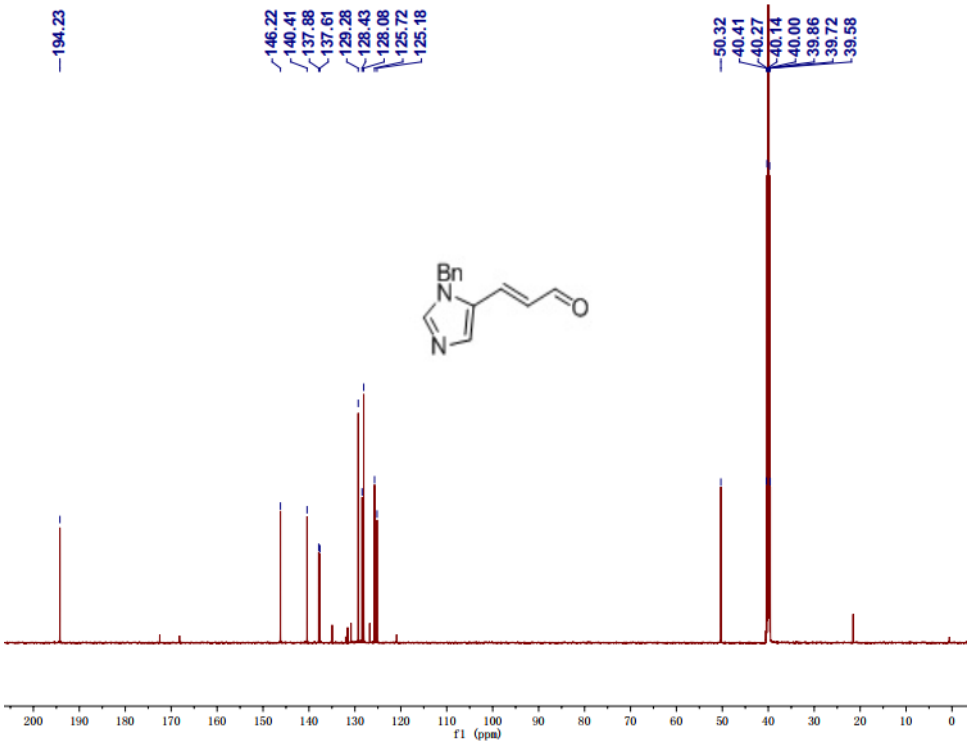
^{1}H NMR of **1z**



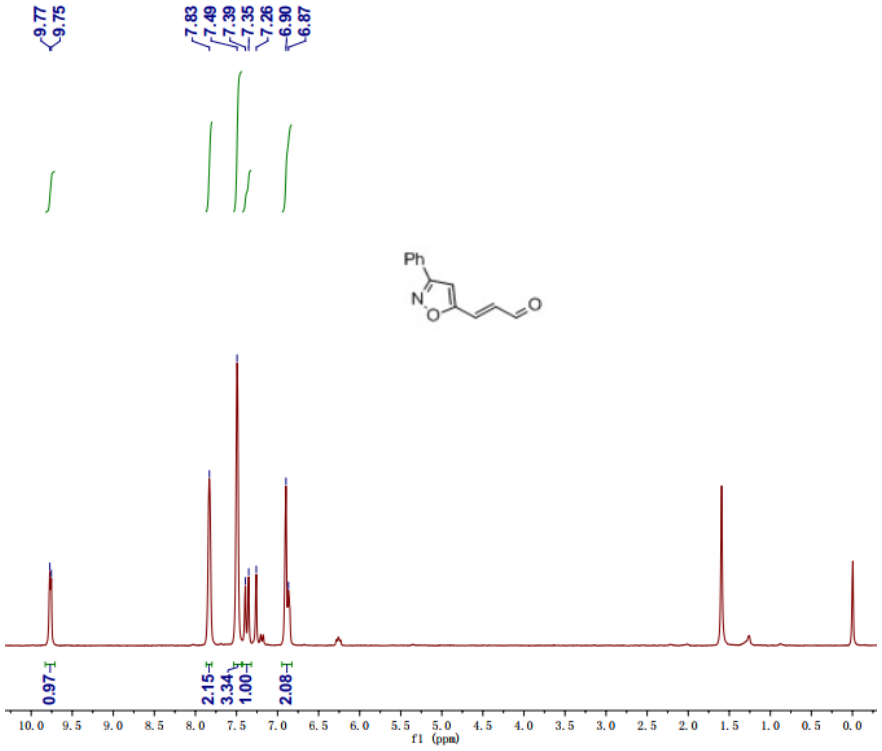
^{1}H NMR of **1aa**



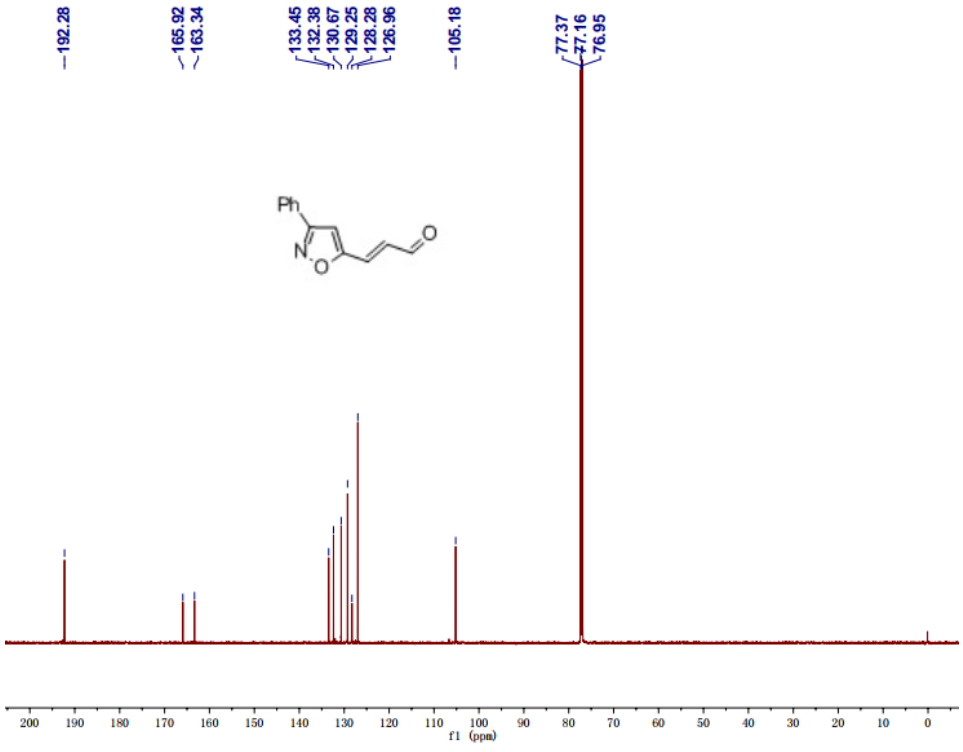
^{13}C NMR of **1aa**



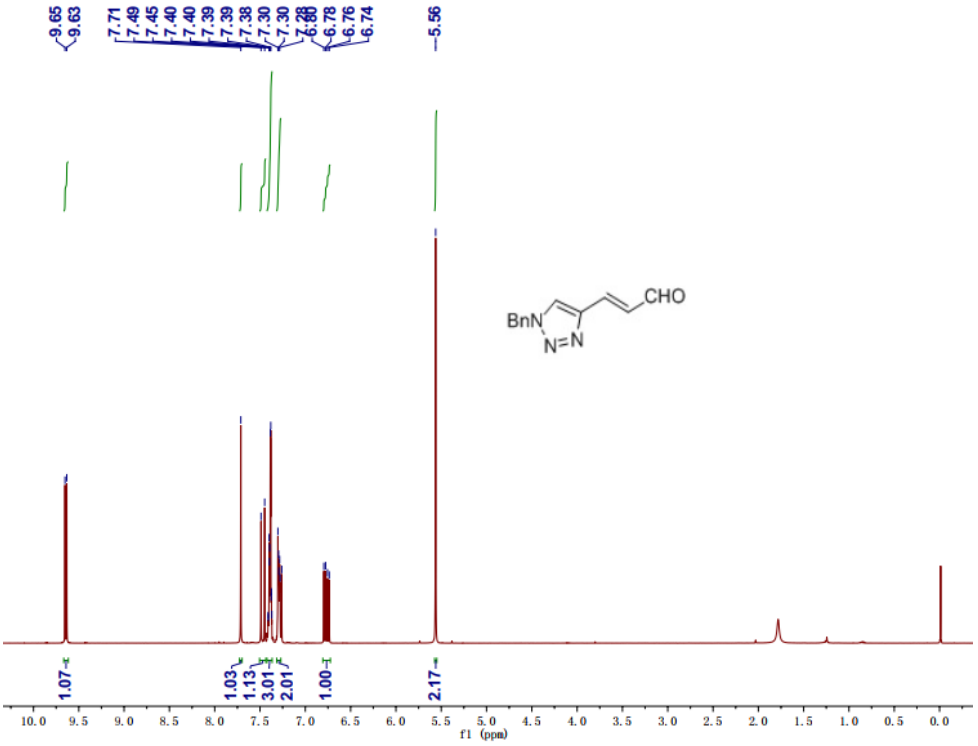
^{1}H NMR of **1ab**



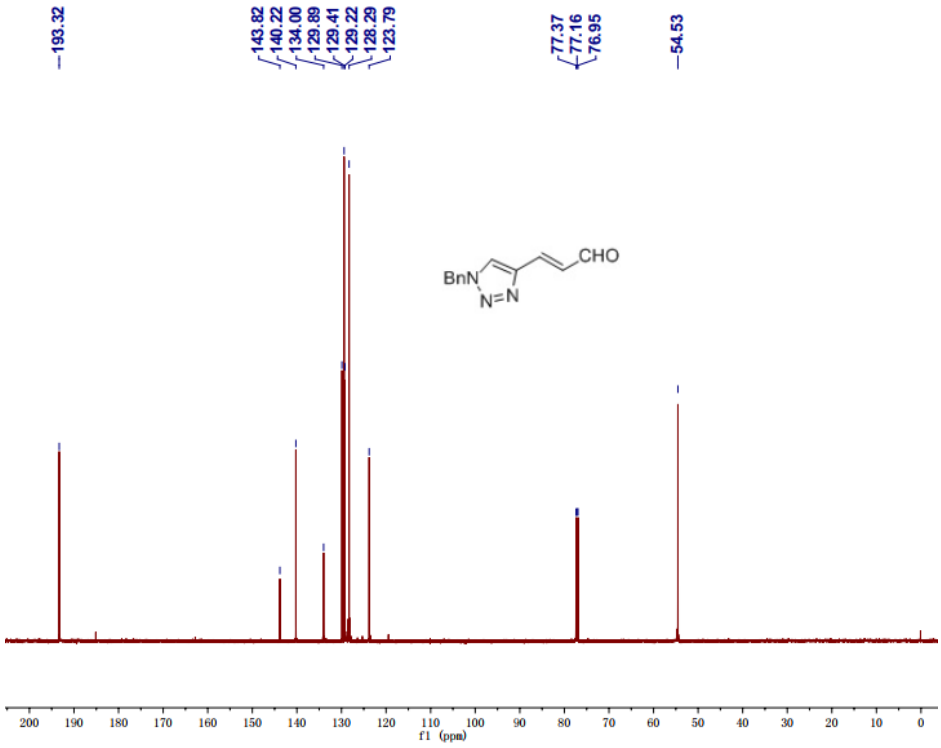
^{13}C NMR of **1ab**



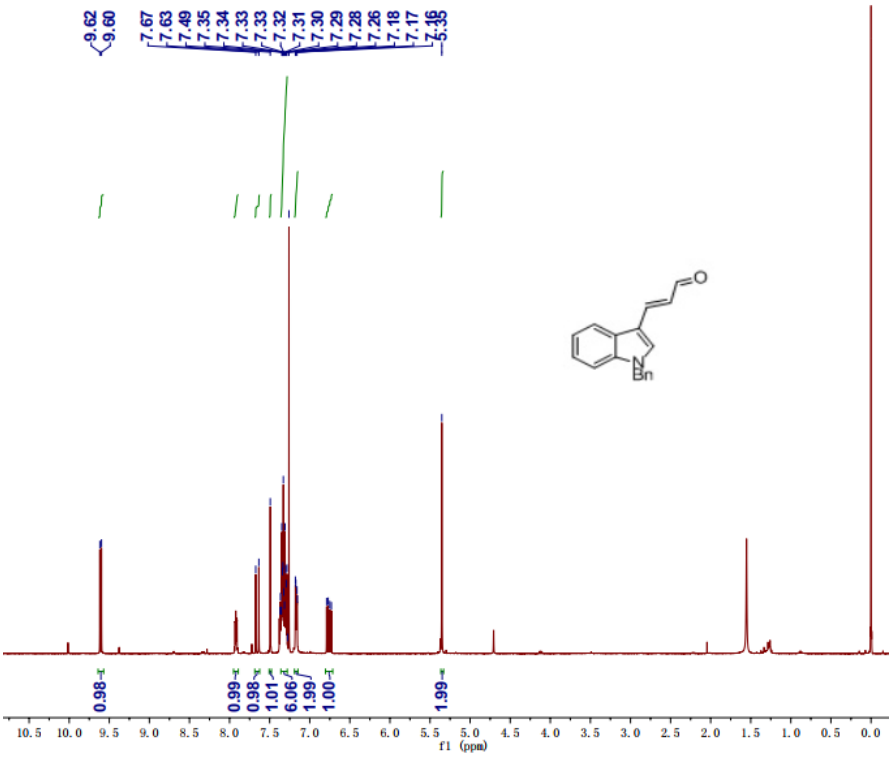
^{1}H NMR of **1ac**



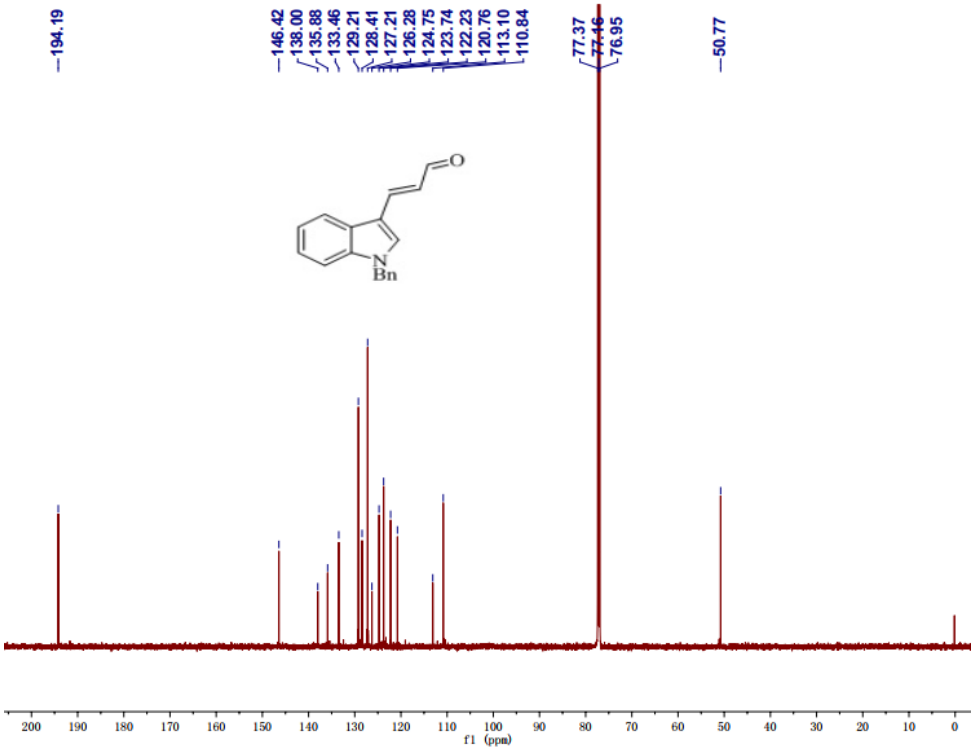
^{13}C NMR of **1ac**



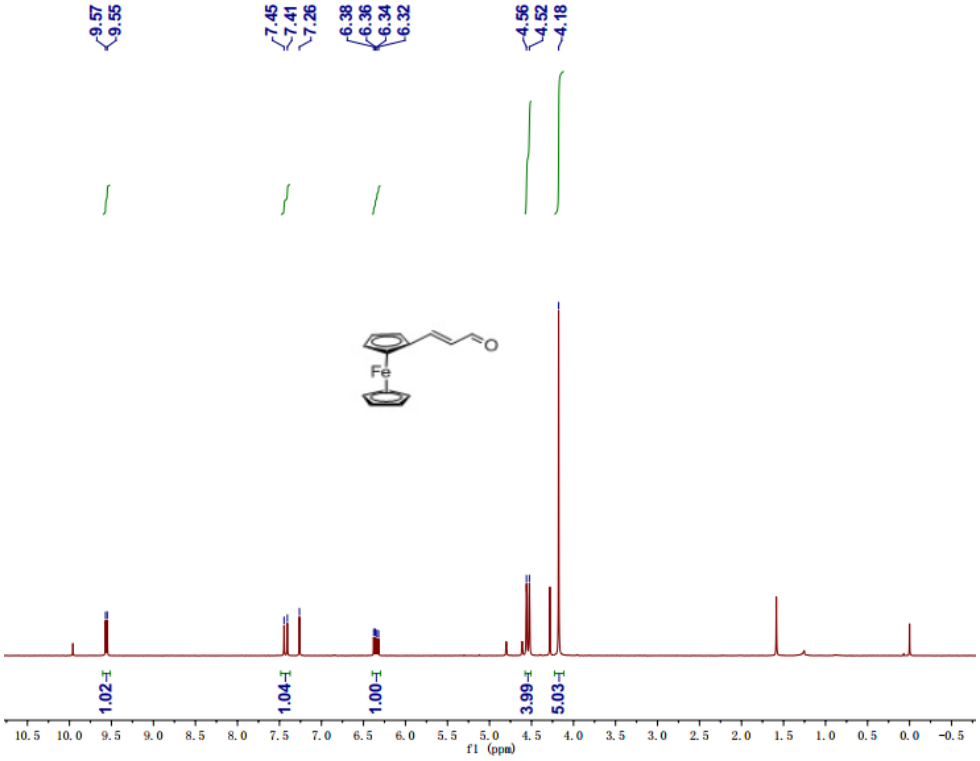
^{1}H NMR of **1ad**



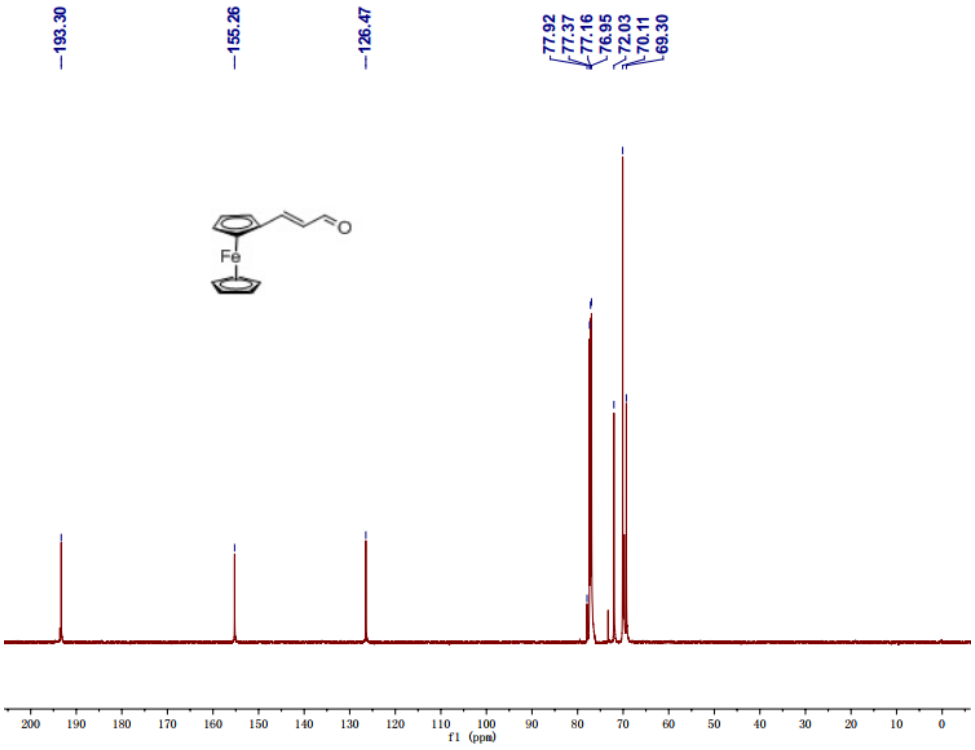
^{13}C NMR of **1ad**



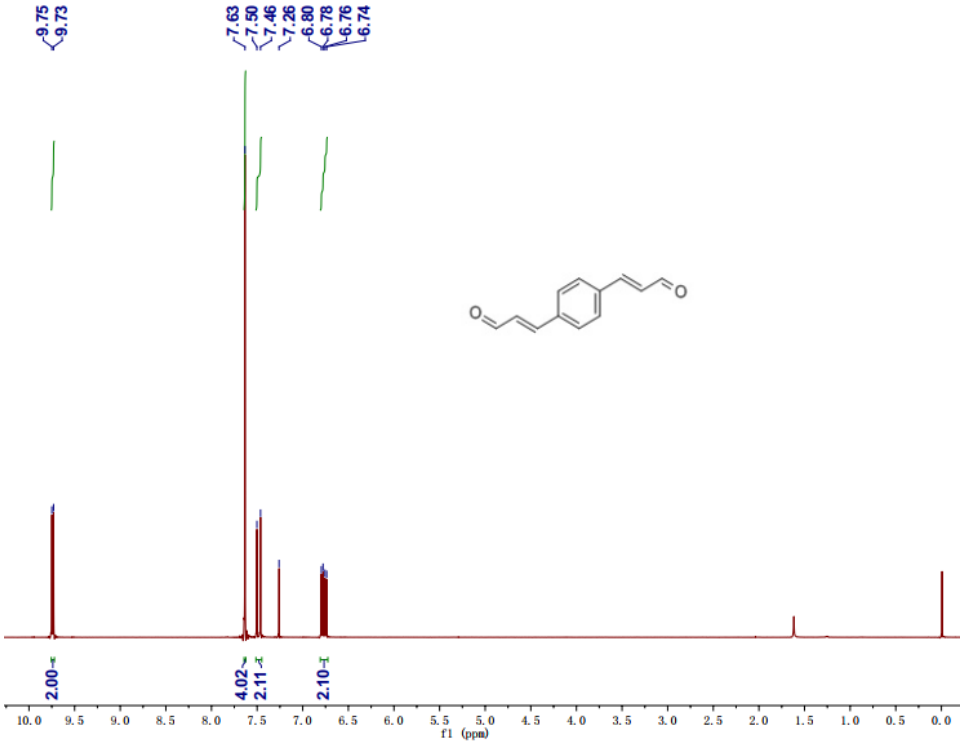
^{1}H NMR of **1af**



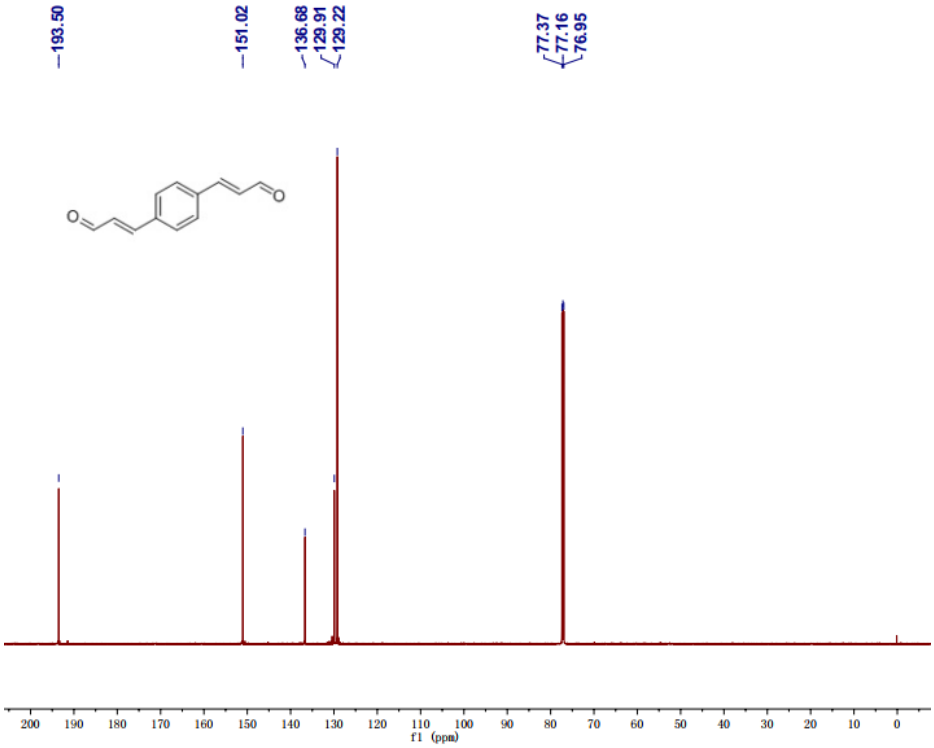
^{13}C NMR of **1af**



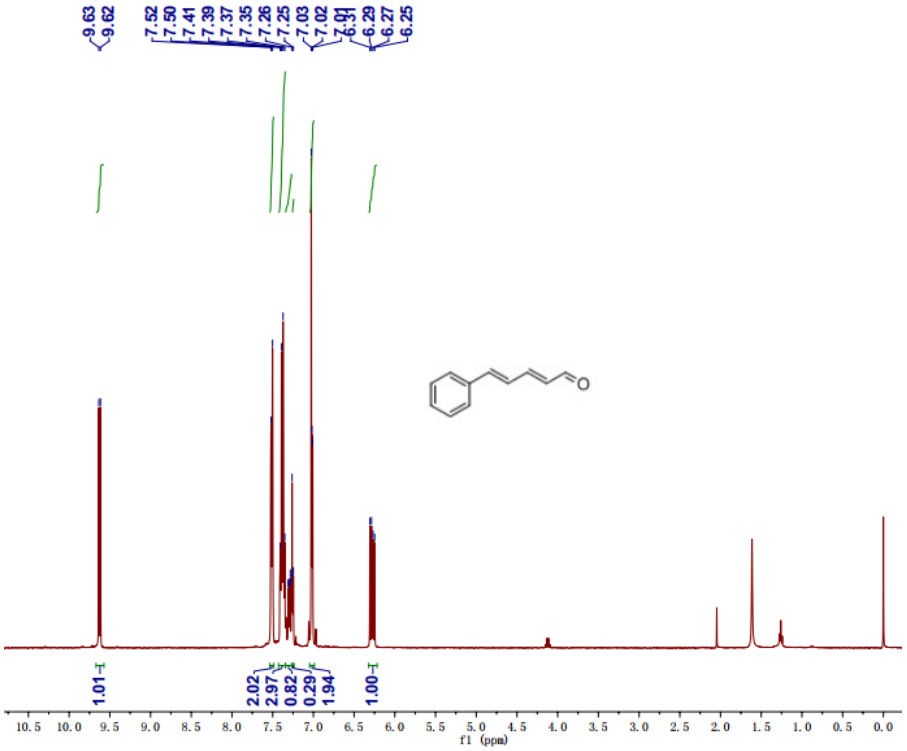
^{1}H NMR of **1ag**



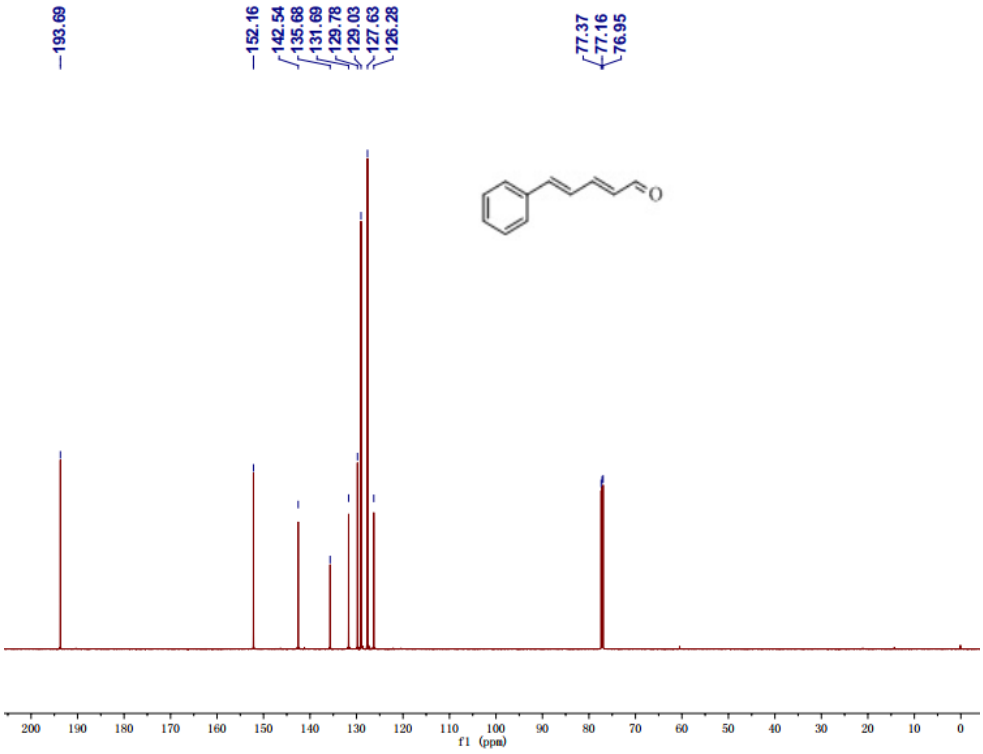
^{13}C NMR of **1ag**



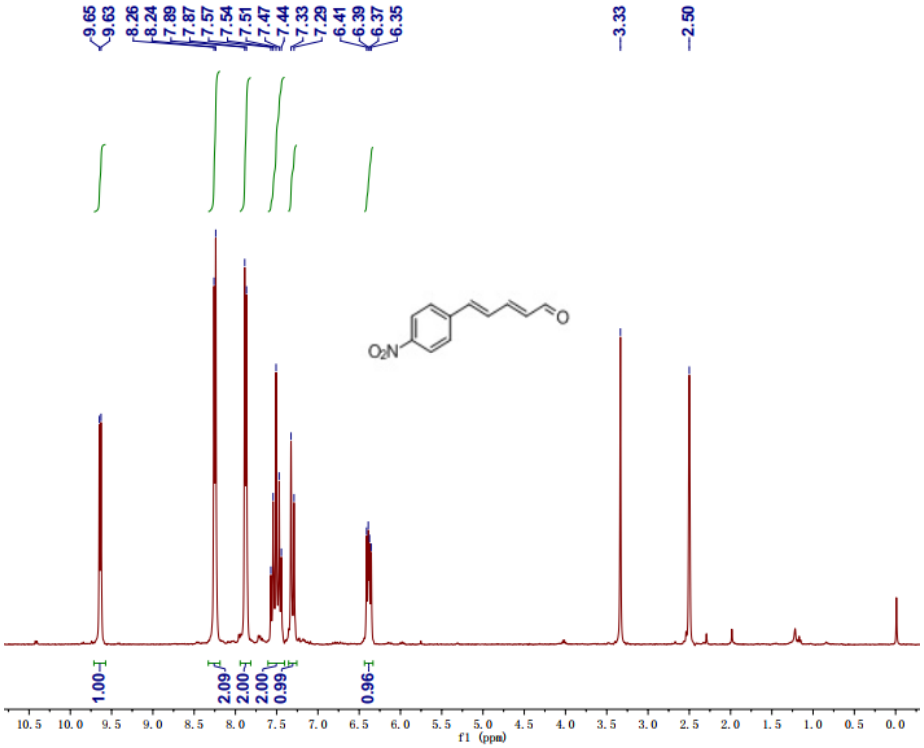
^{1}H NMR of **1ah**



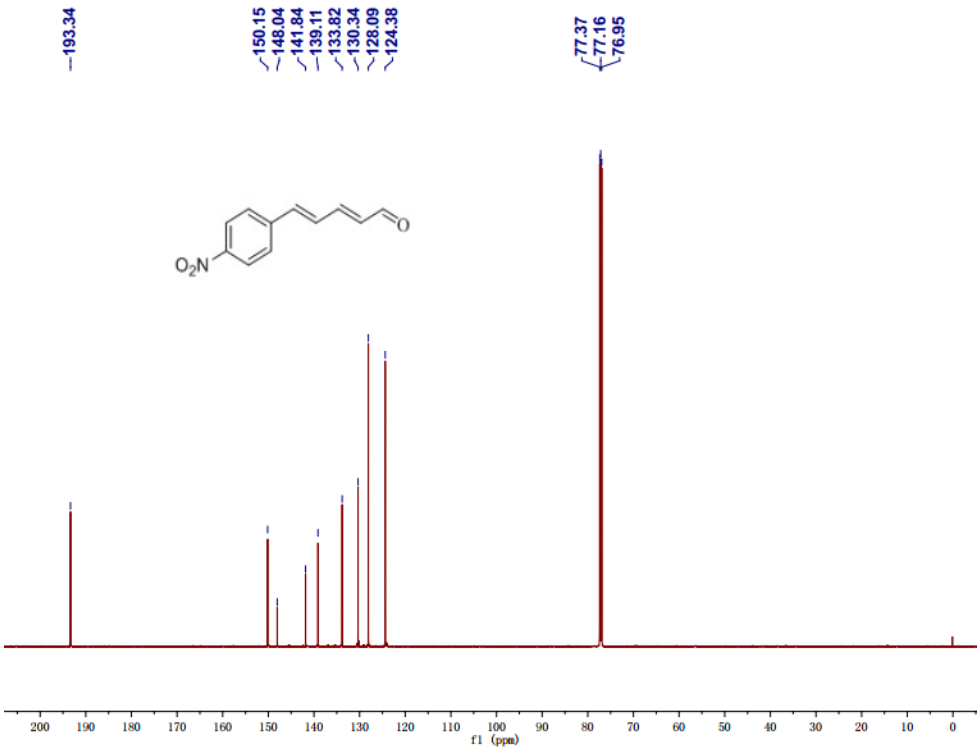
^{13}C NMR of **1ah**



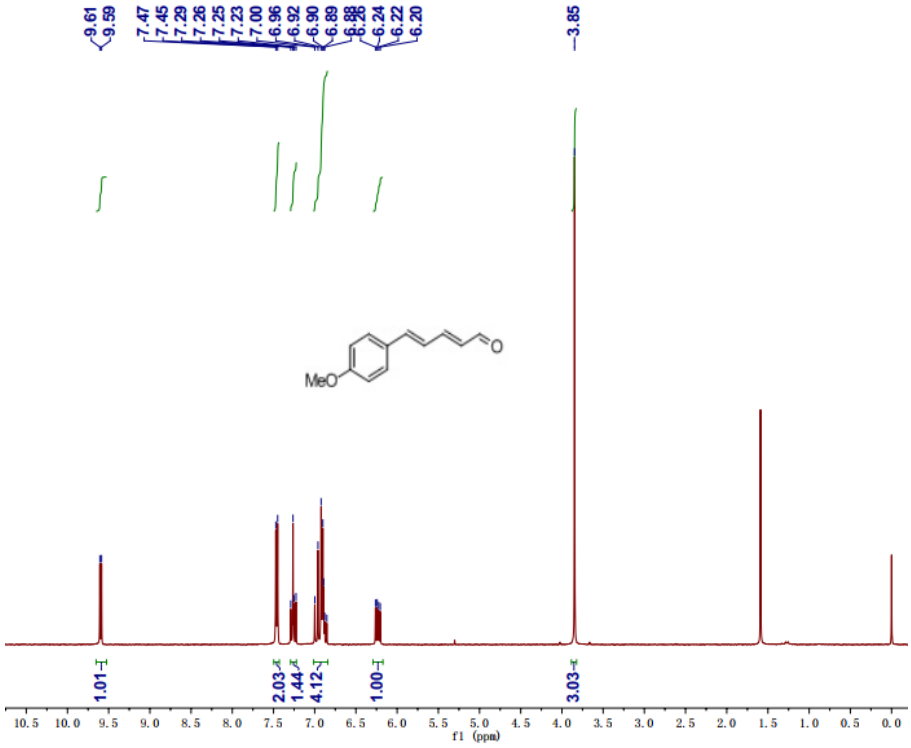
^{1}H NMR of **1ai**



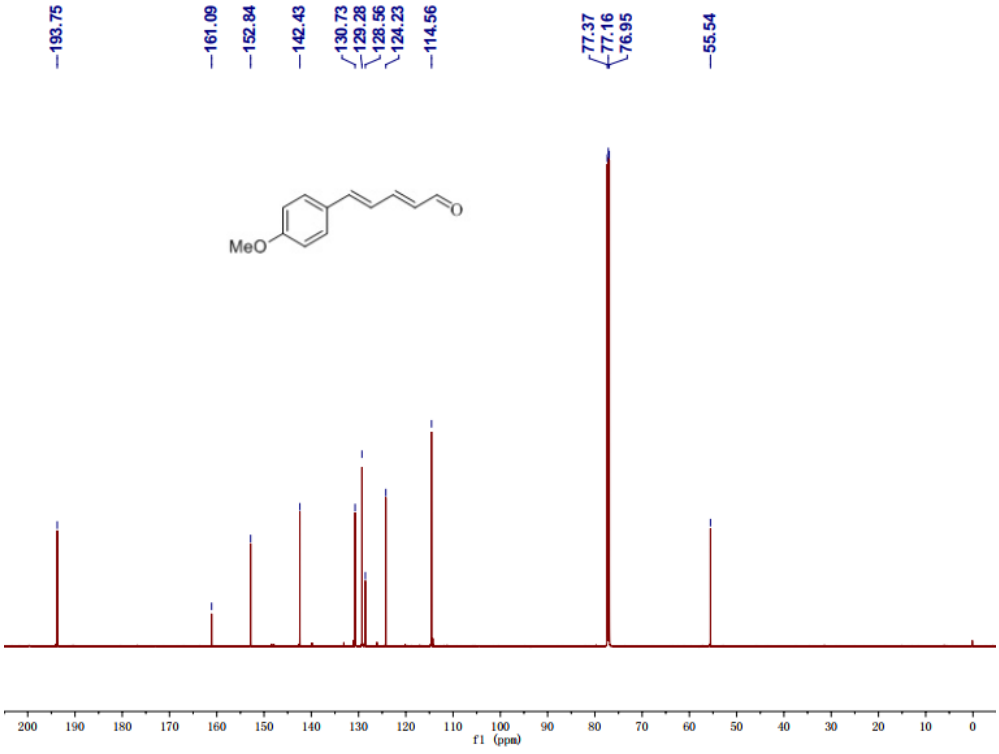
^{13}C NMR of **1ai**



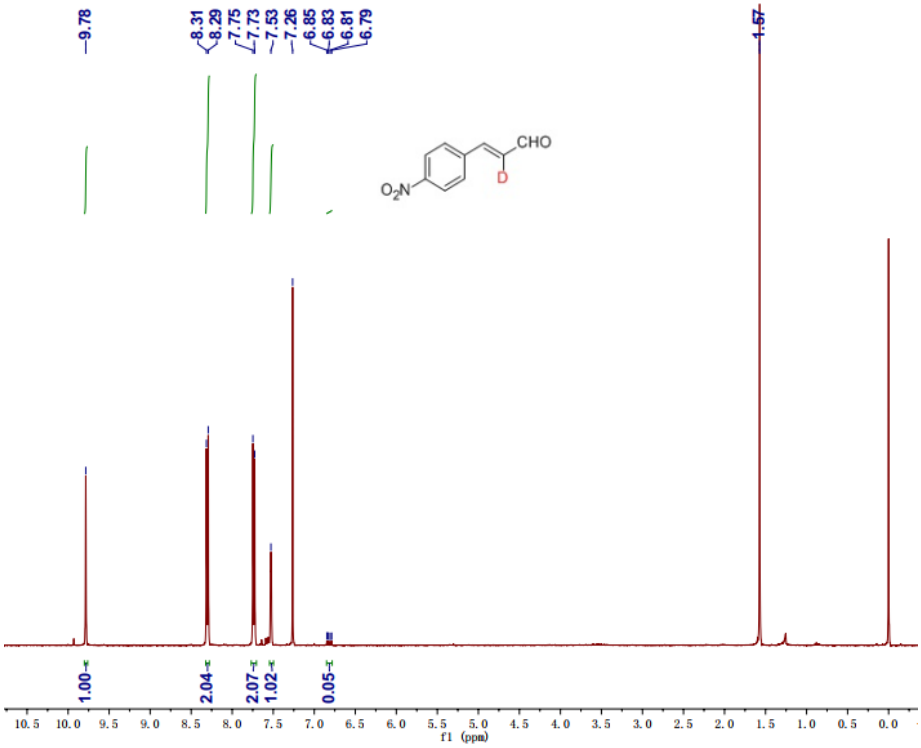
^{1}H NMR of **1aj**



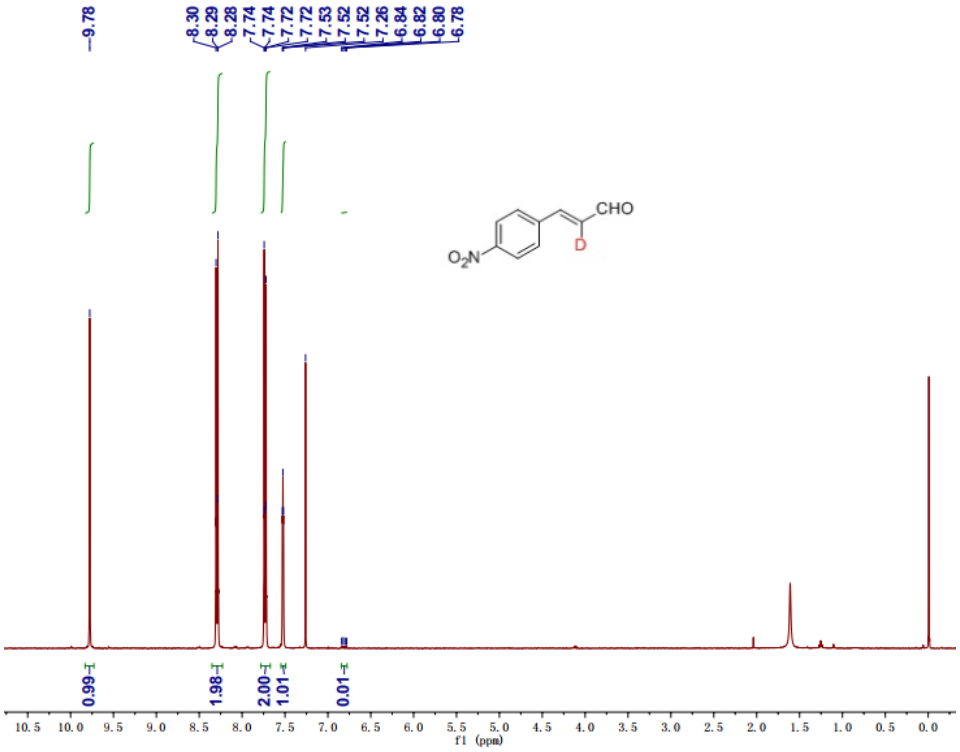
^{13}C NMR of **1aj**



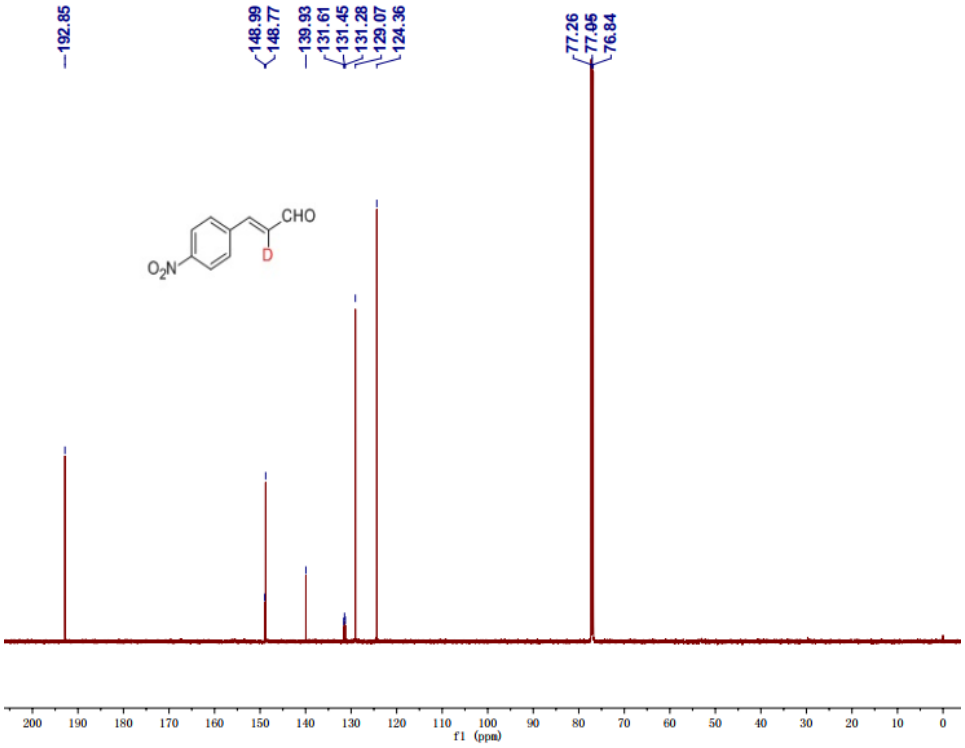
^{1}H NMR of **5a**



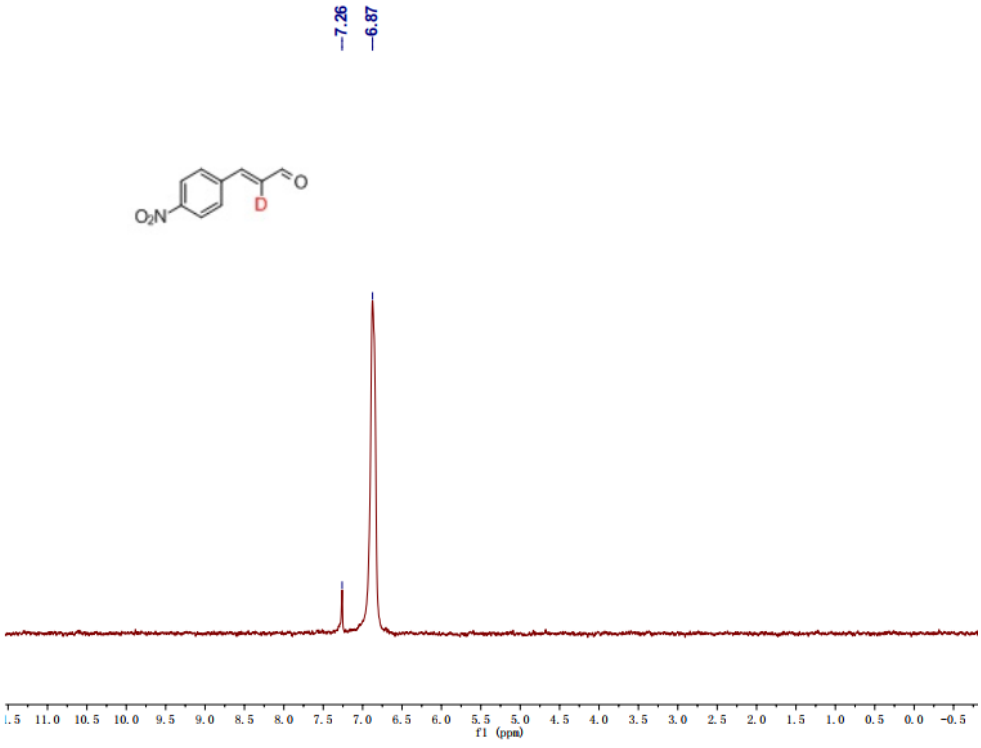
^{1}H NMR of scale up **5a**



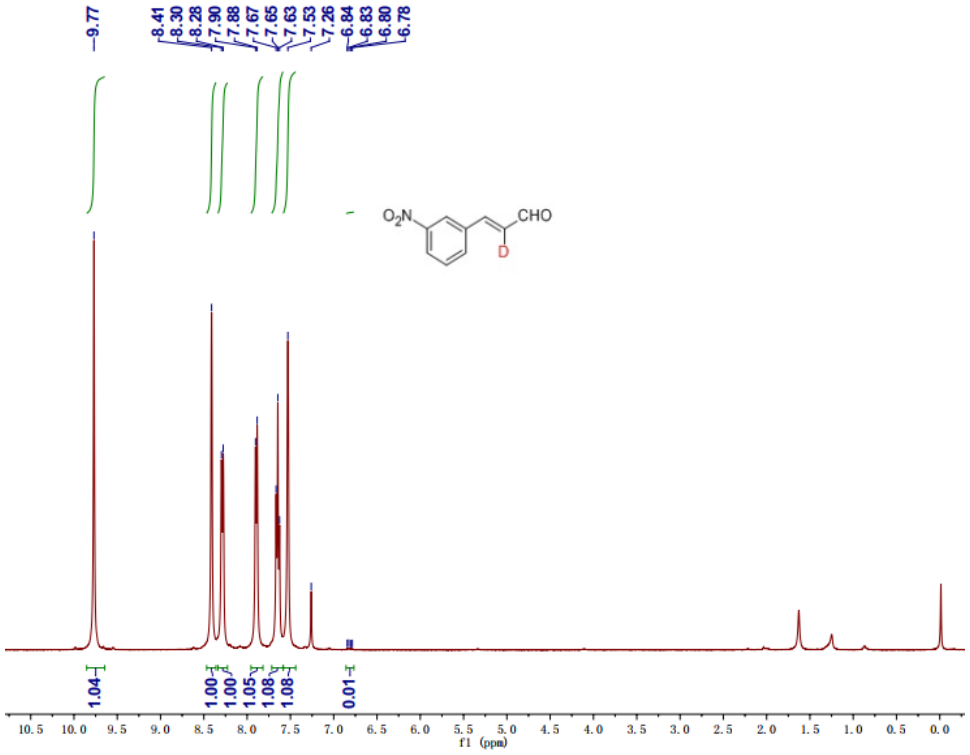
^{13}C NMR of **5a**



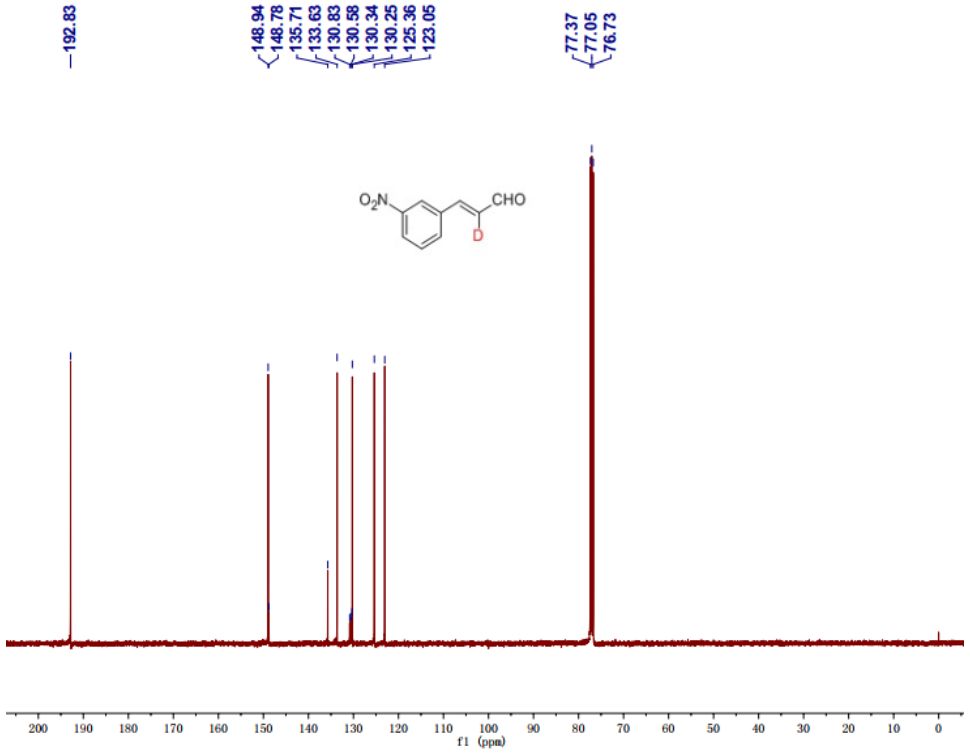
^{2}H NMR of **5a**



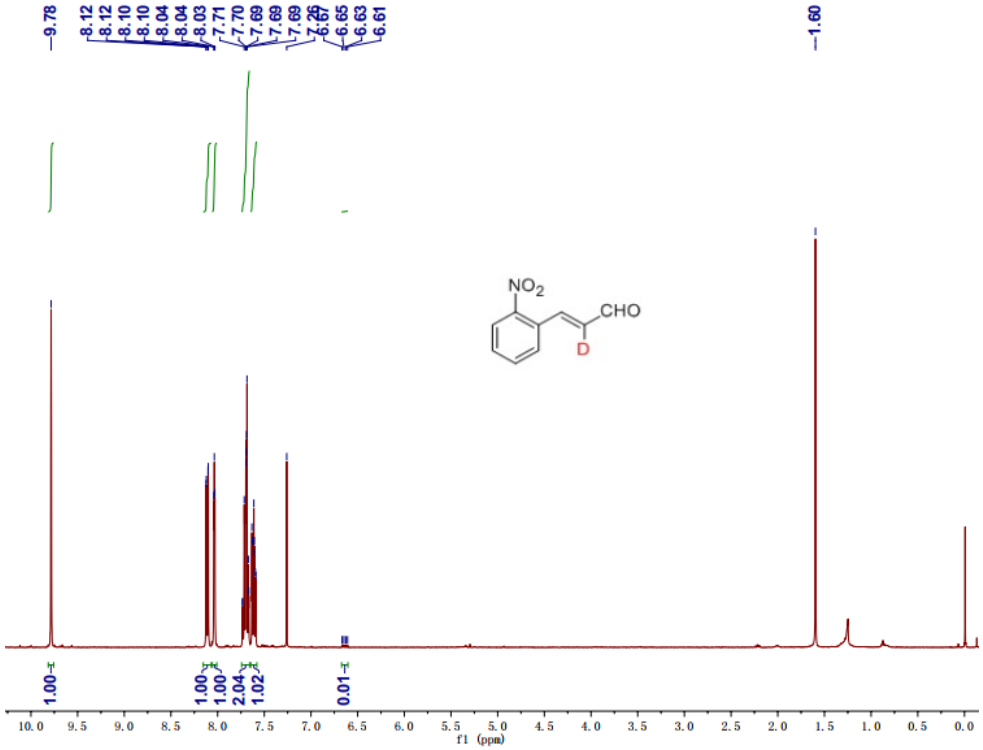
^{1}H NMR of **5b**



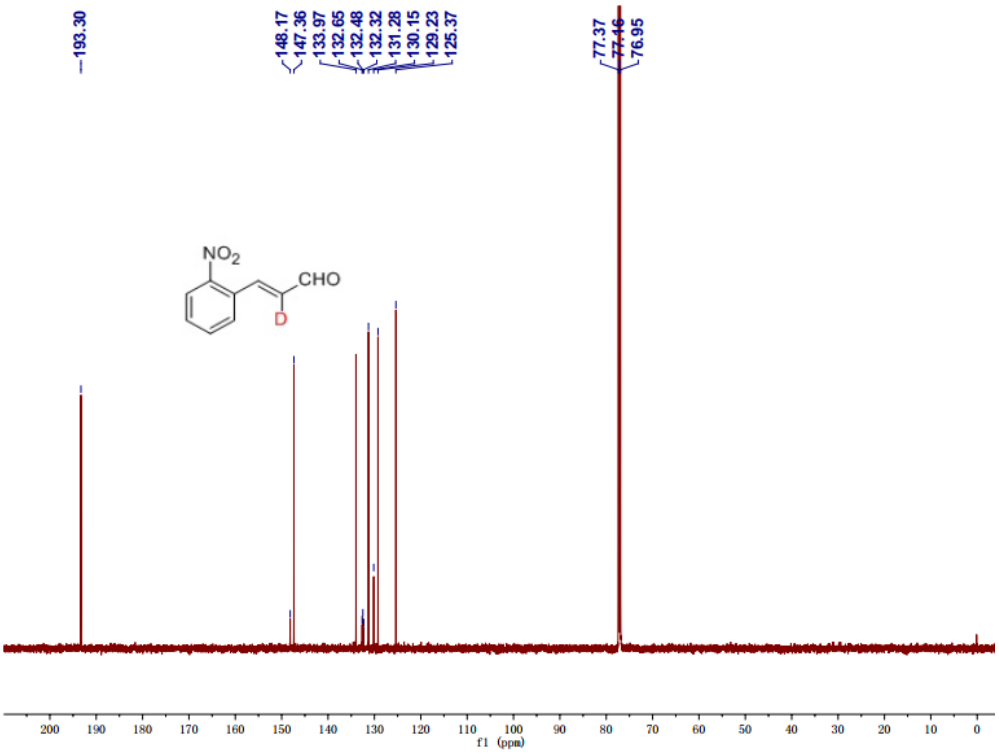
^{13}C NMR of **5b**



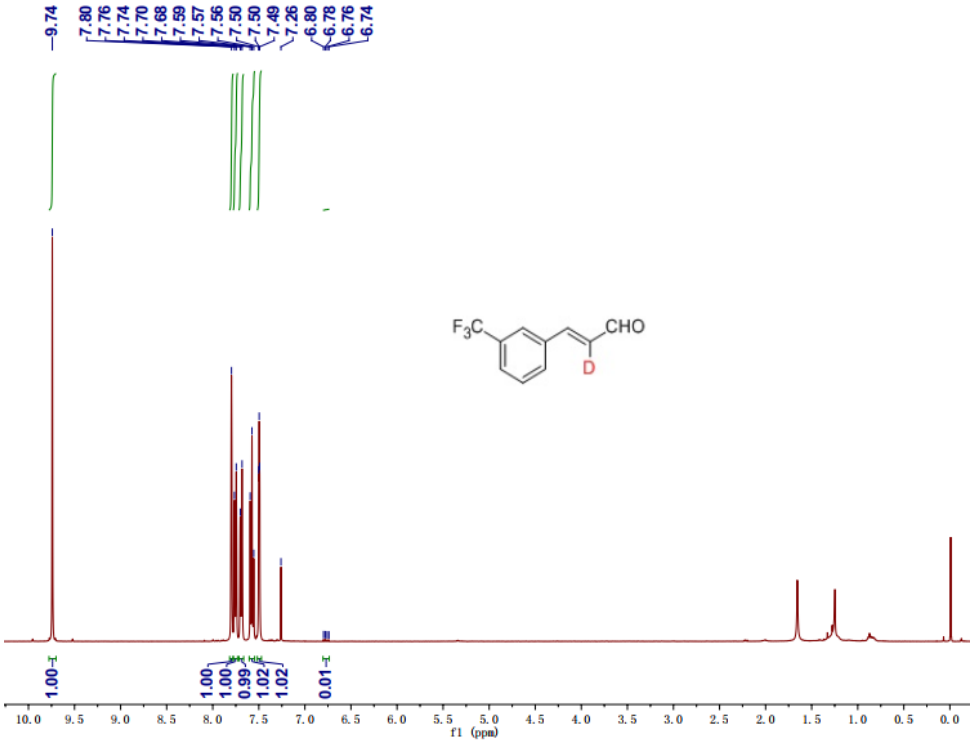
^{1}H NMR of **5c**



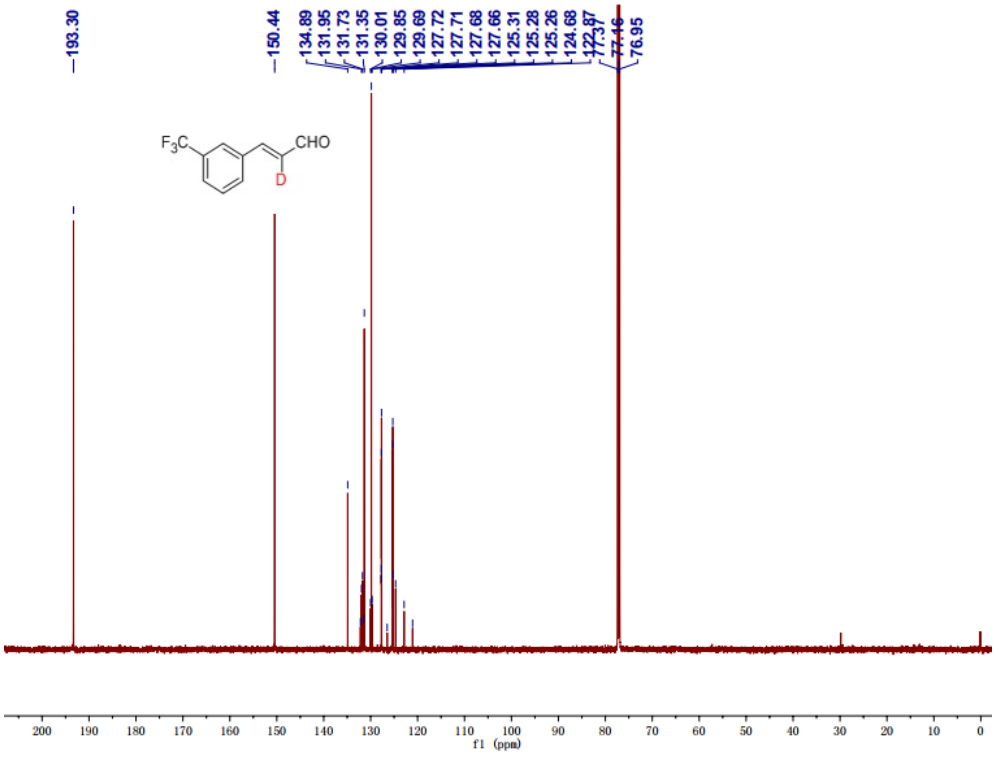
^{13}C NMR of **5c**



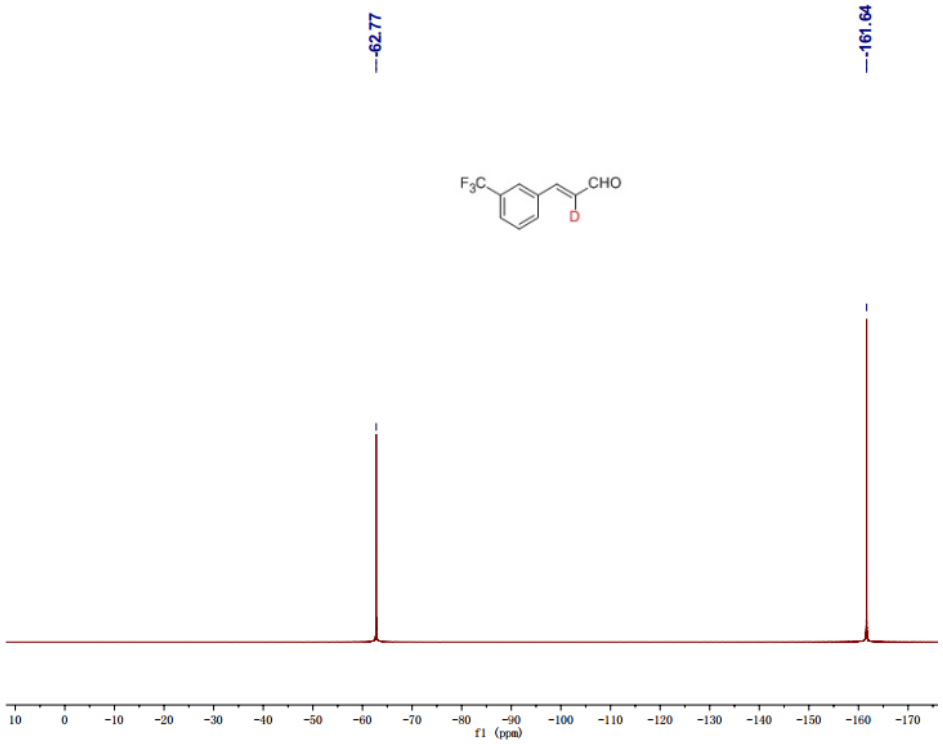
^{1}H NMR of **5d**



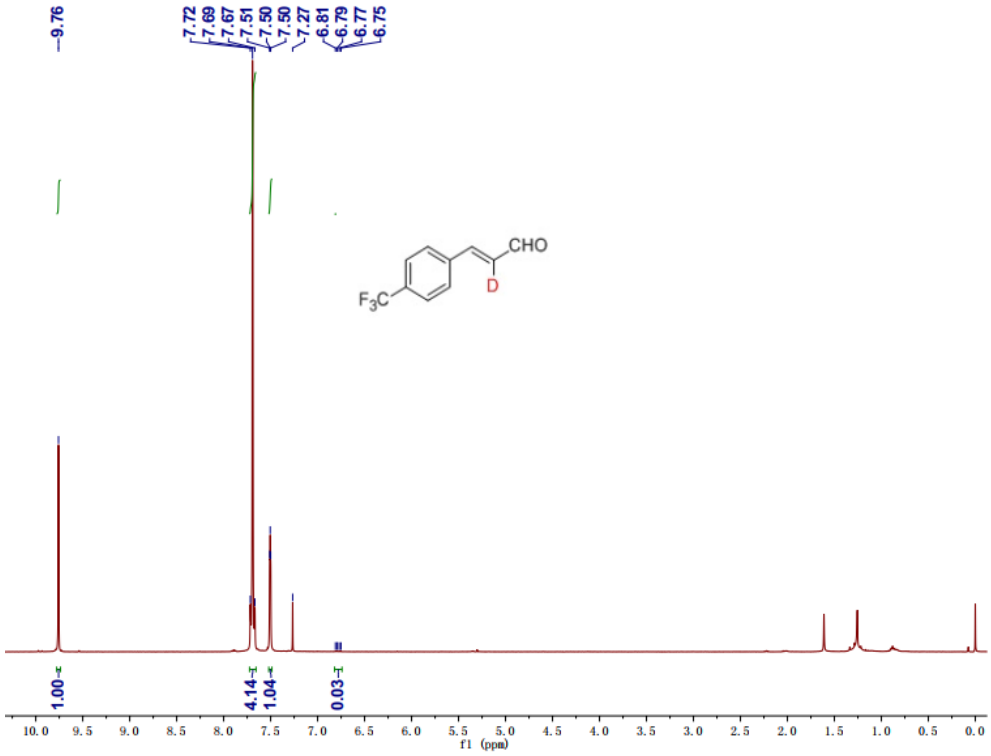
^{13}C NMR of **5d**



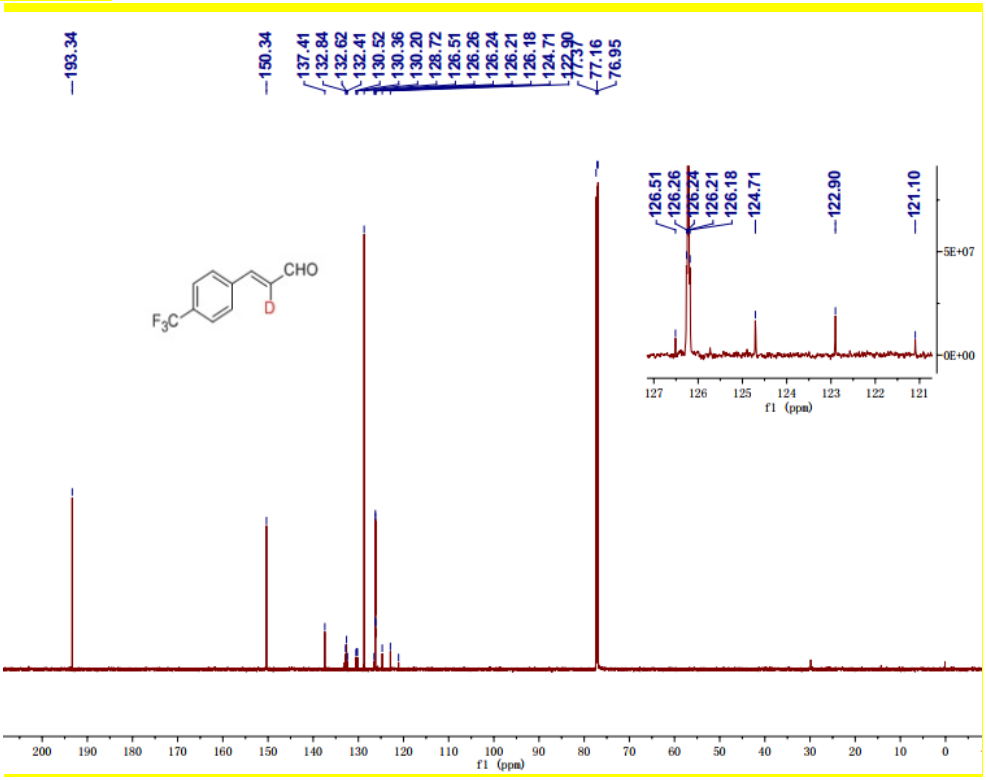
^{19}F NMR of **5d**



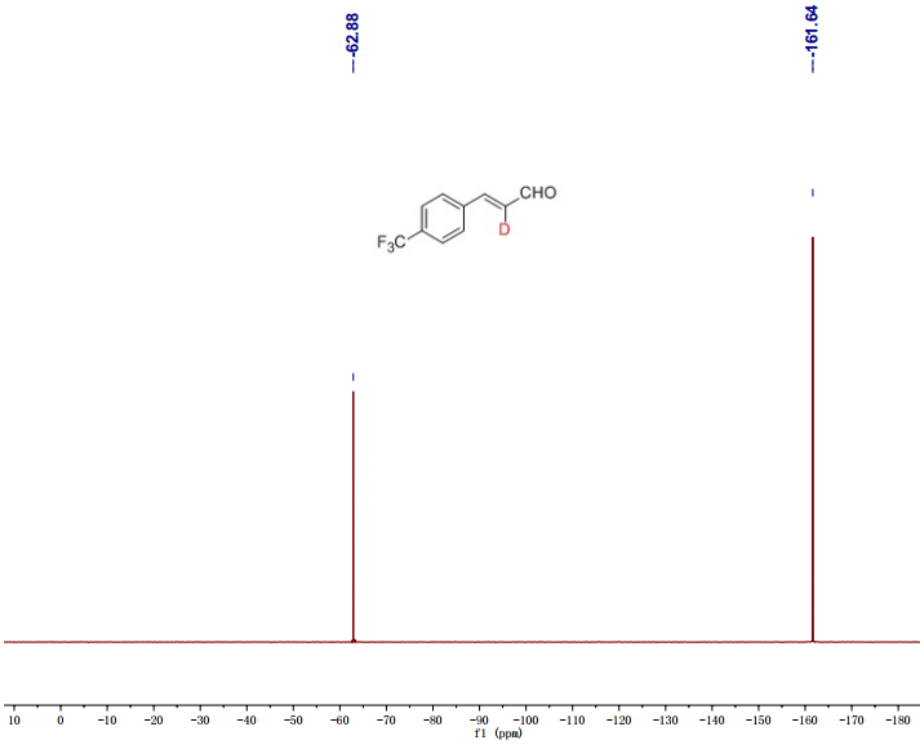
^{1}H NMR of **5e**



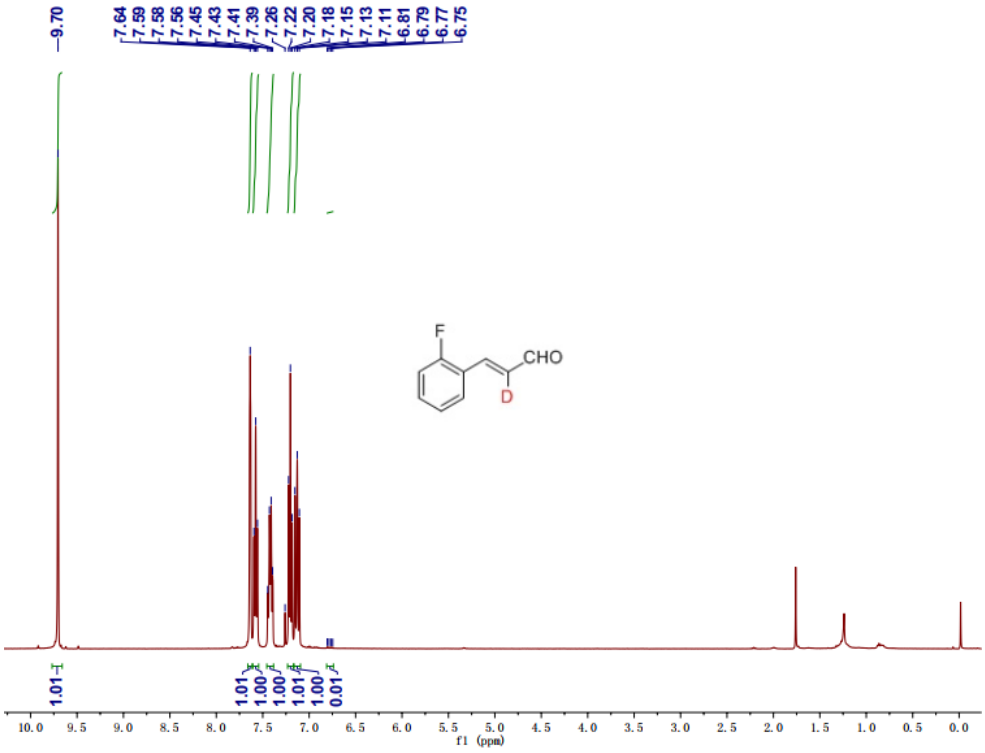
^{13}C NMR of **5e**



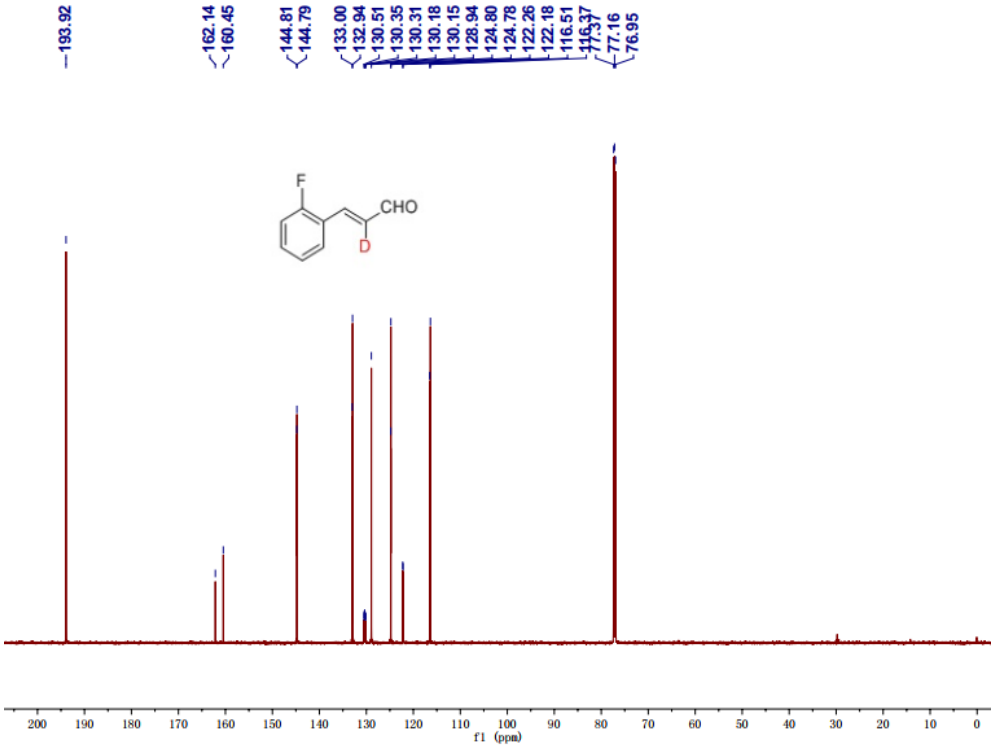
^{19}F NMR of **5e**



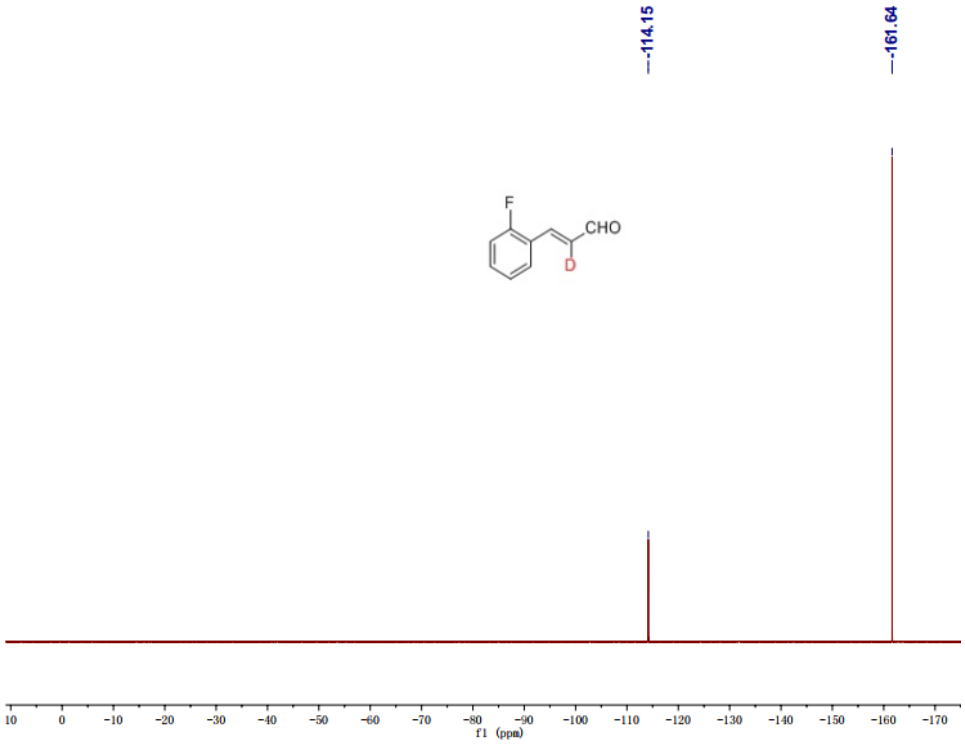
^{1}H NMR of **5f**



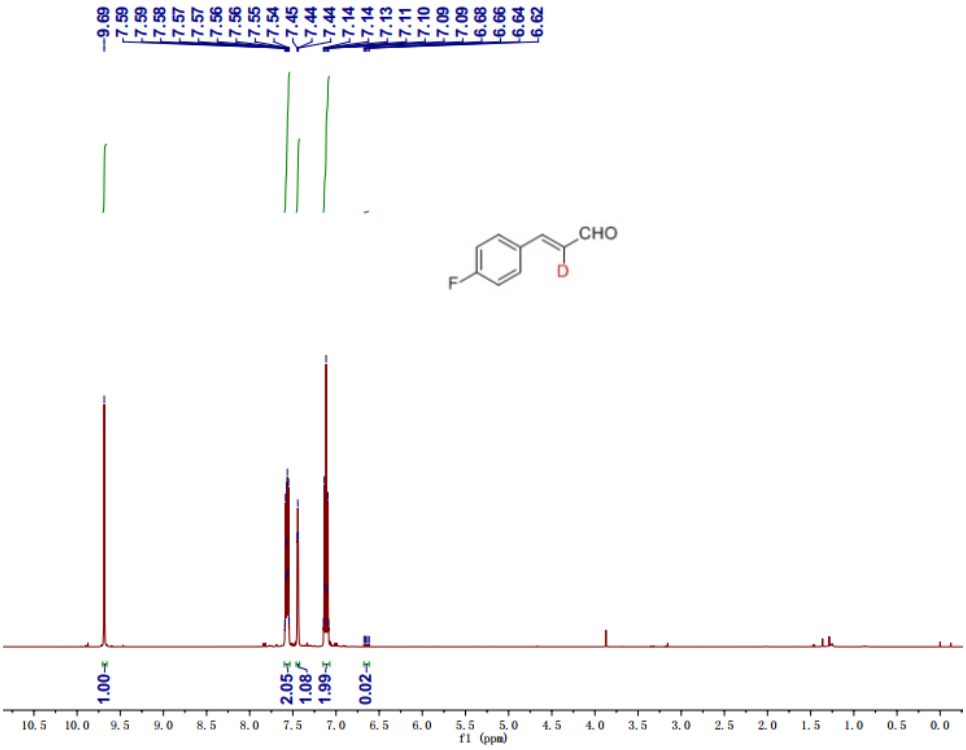
^{13}C NMR of **5f**



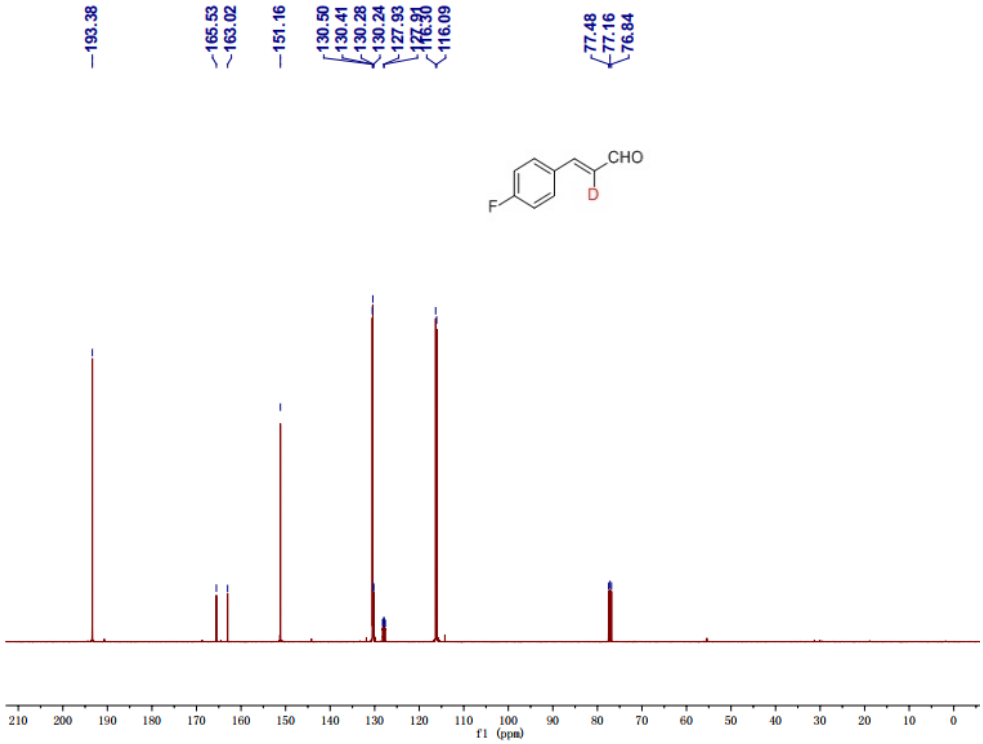
^{19}F NMR of **5f**



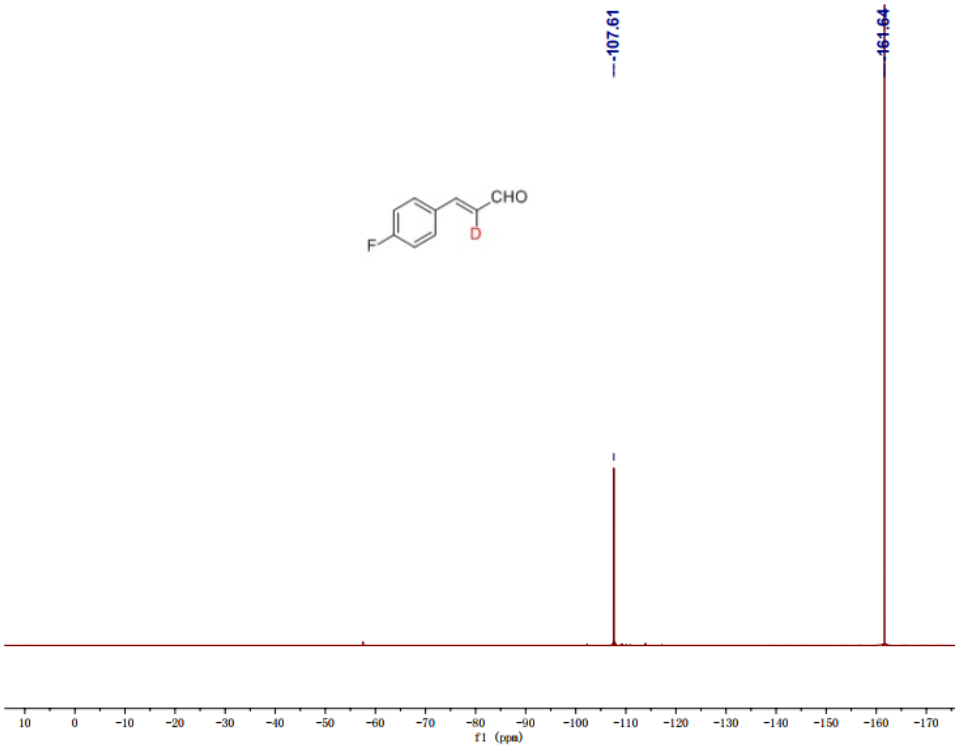
^{1}H NMR of **5g**



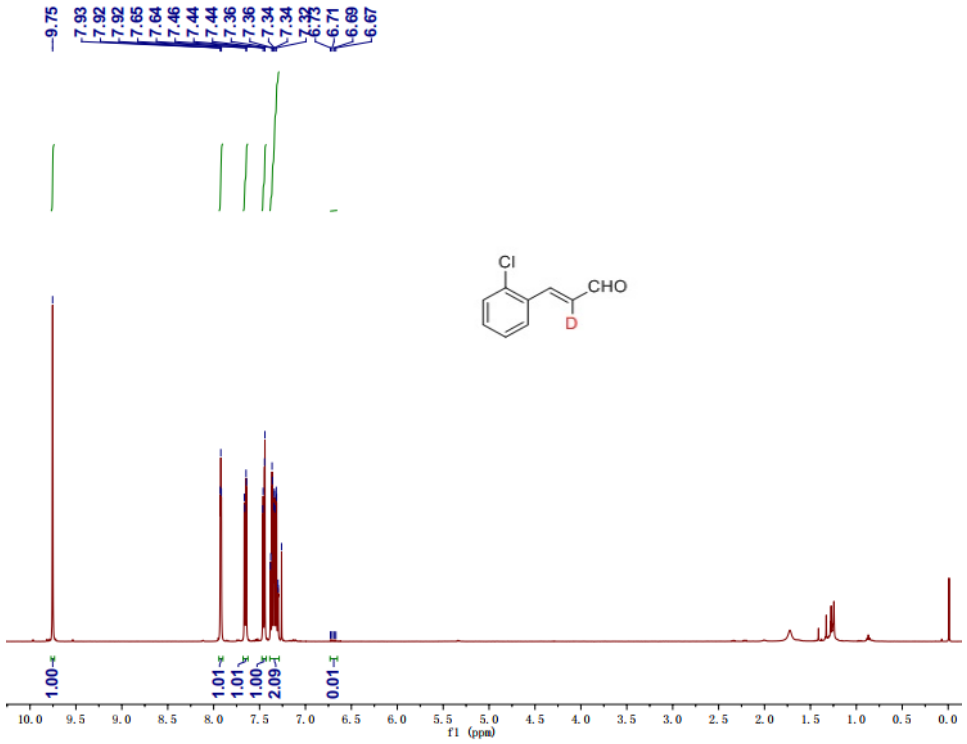
^{13}C NMR of **5g**



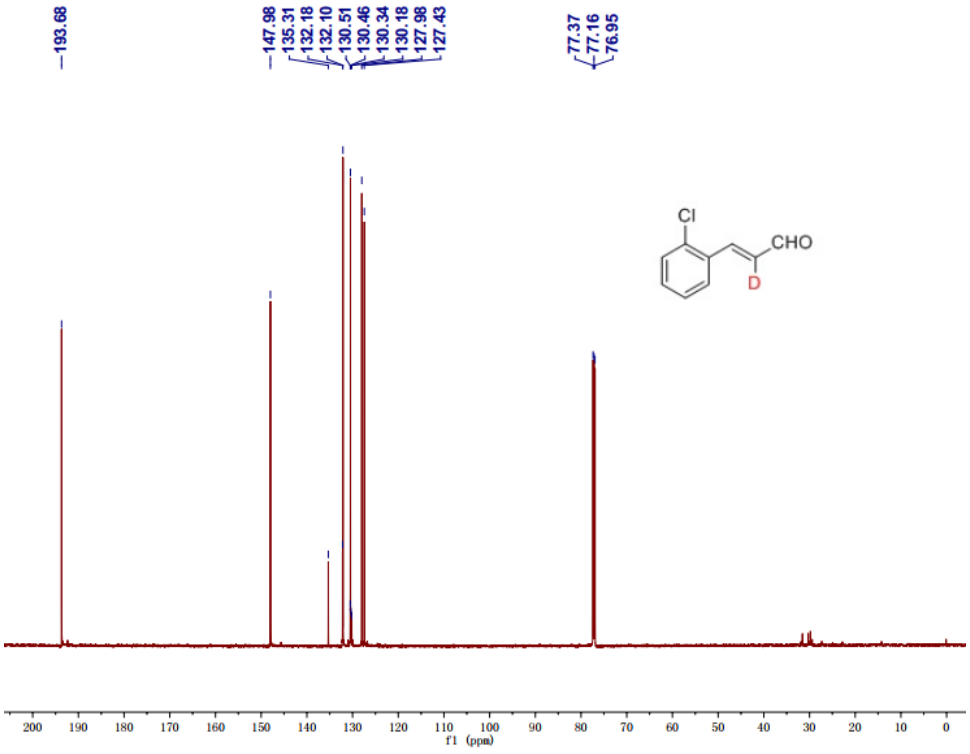
^{19}F NMR of **5g**



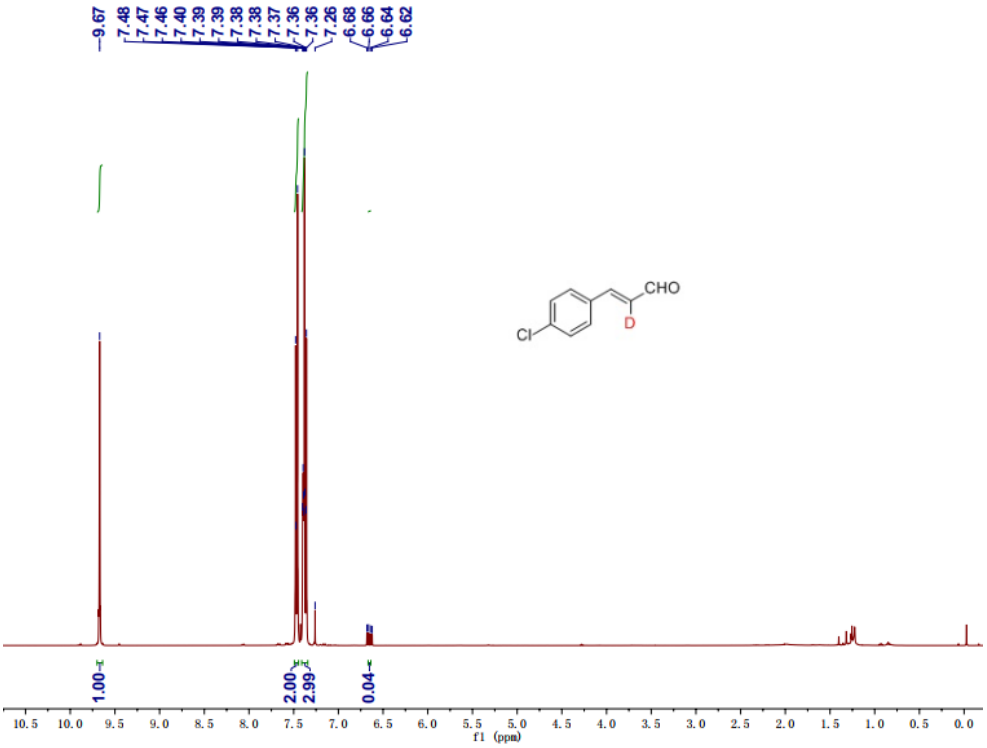
^{1}H NMR of **5h**



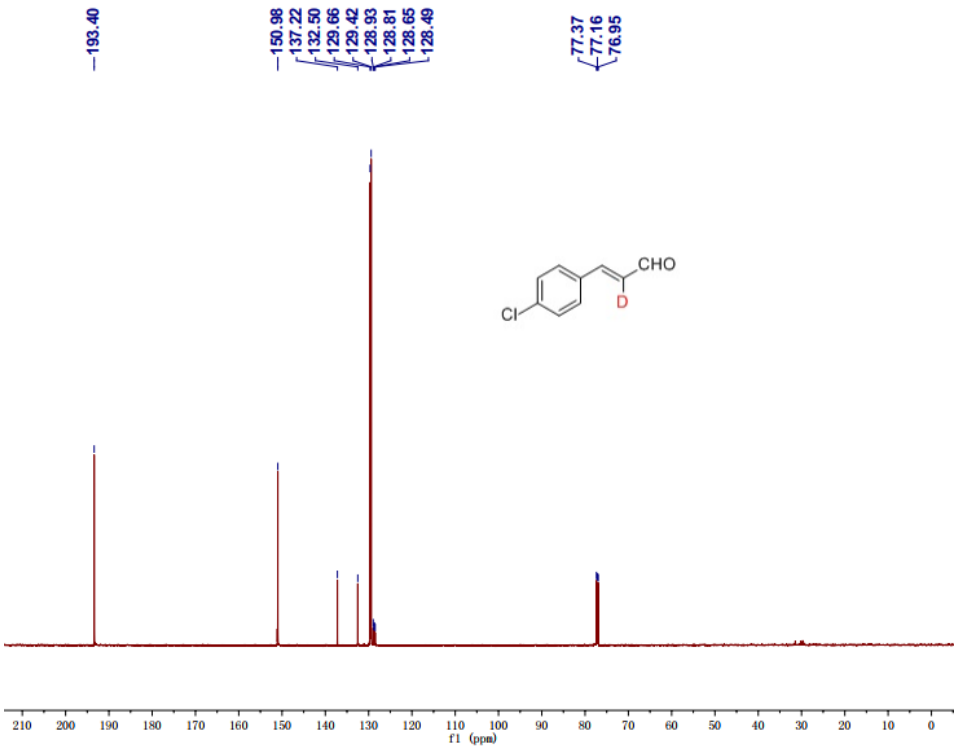
^{13}C NMR of **5h**



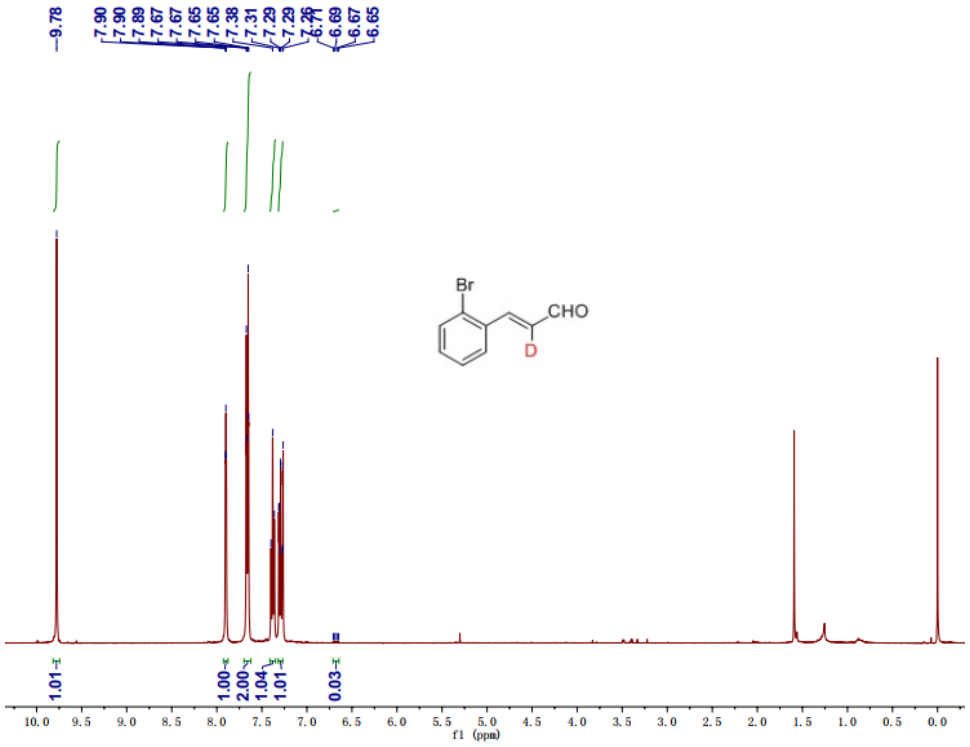
^{1}H NMR of **5i**



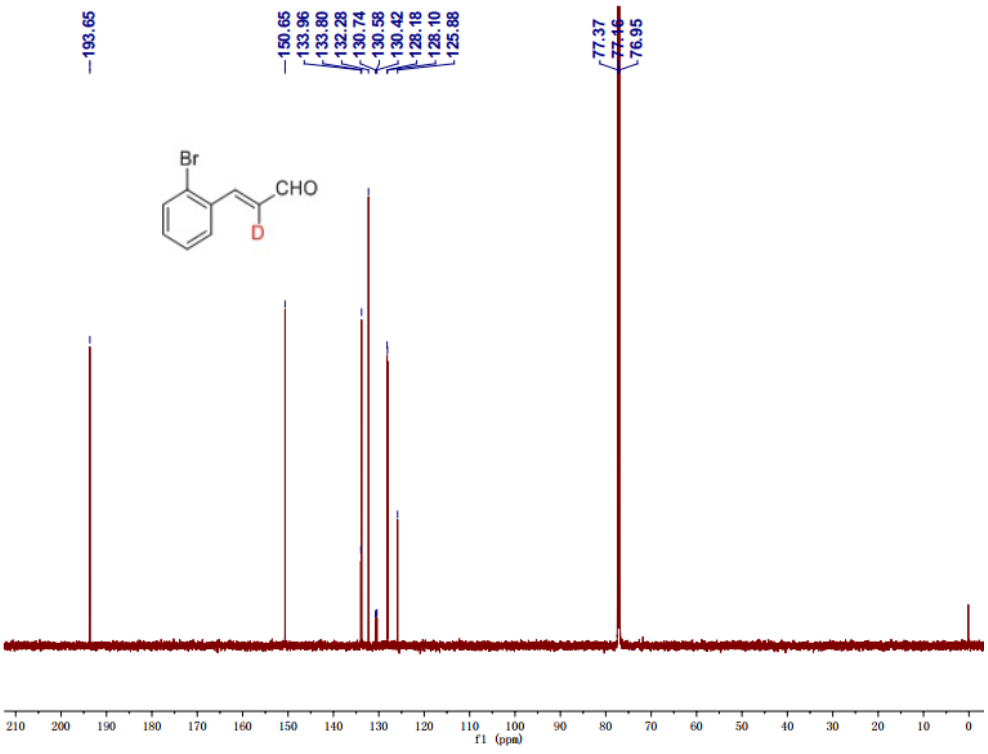
^{13}C NMR of **5i**



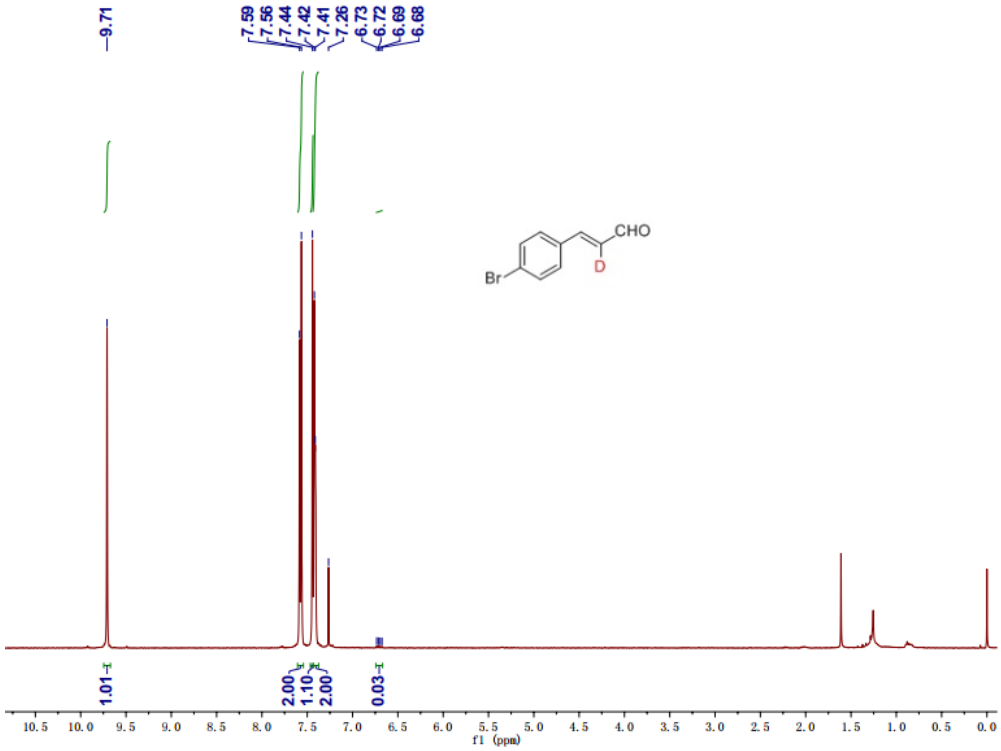
^{1}H NMR of **5j**



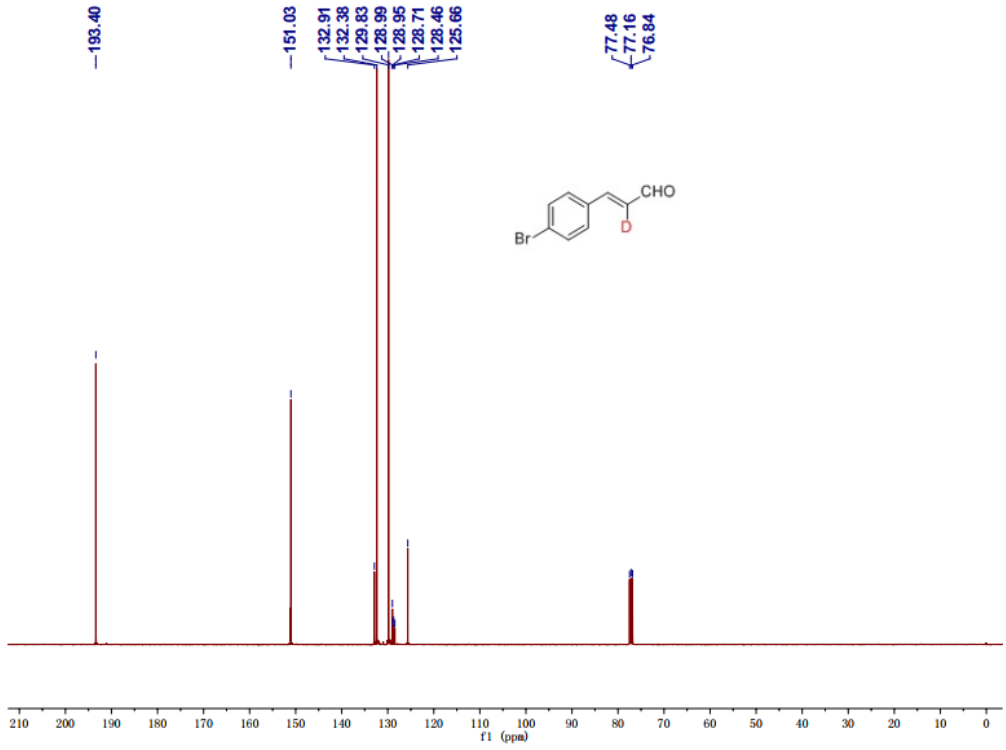
^{13}C NMR of **5j**



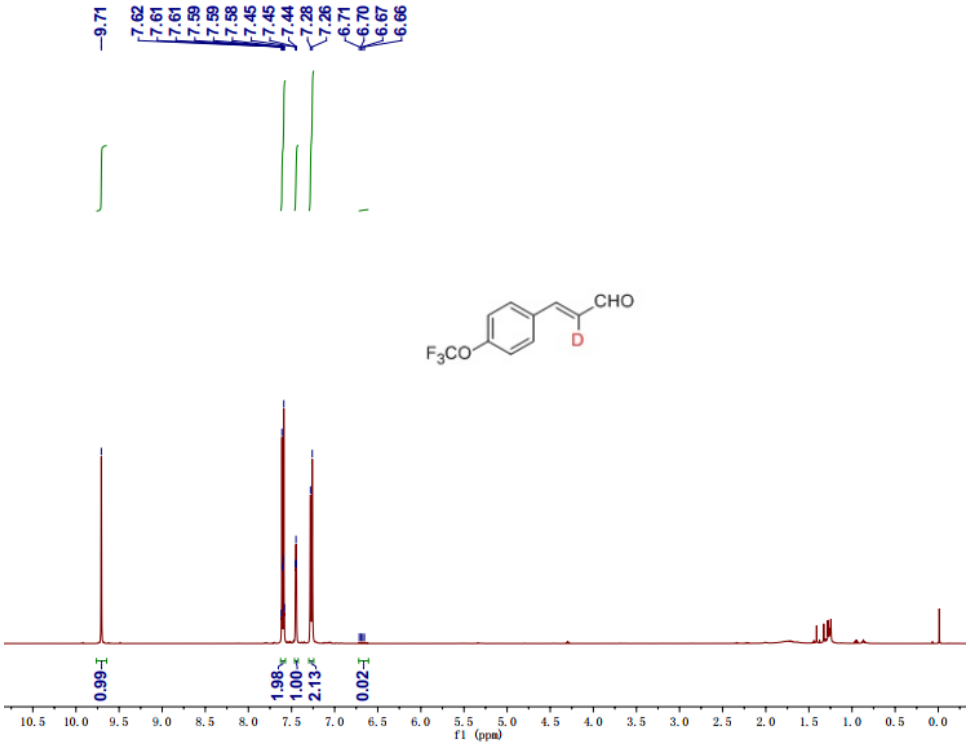
^{1}H NMR of **5k**



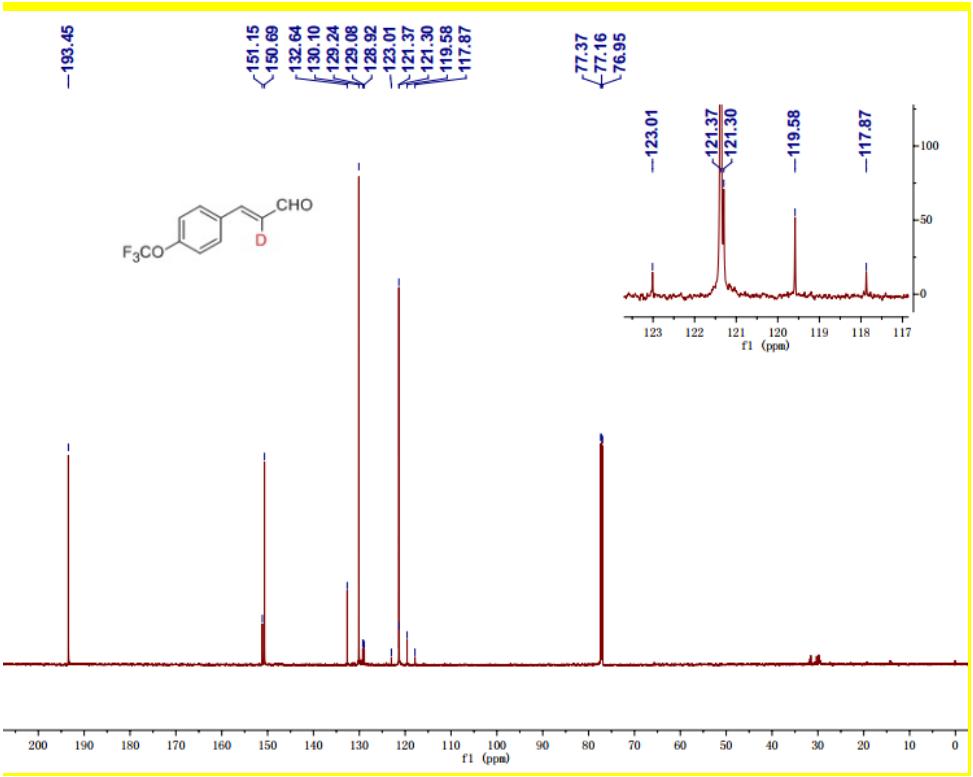
^{13}C NMR of **5k**



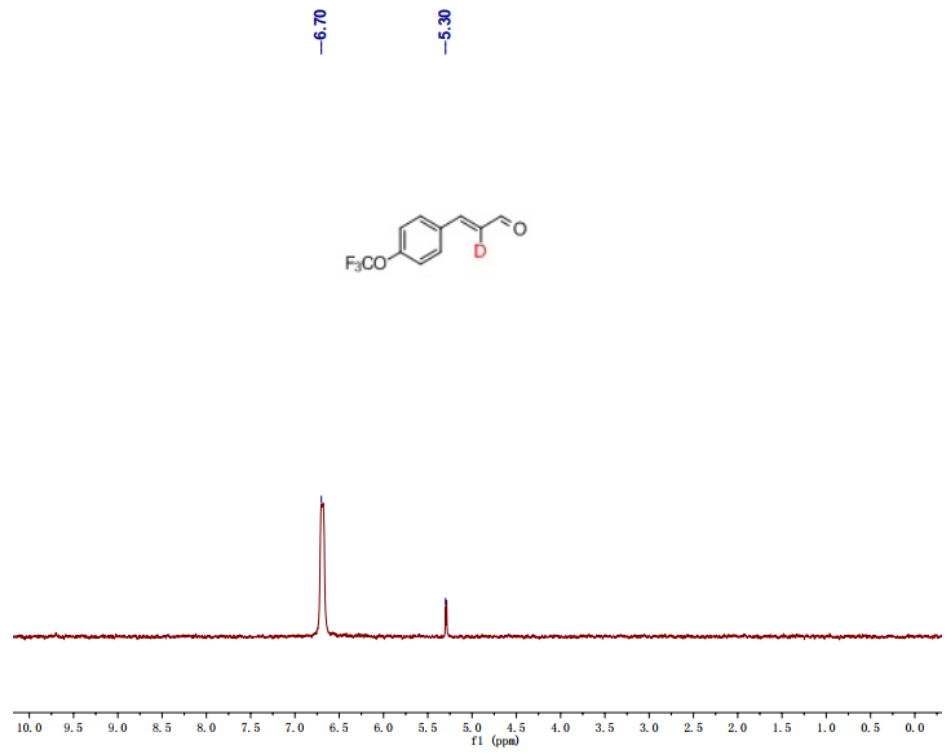
^{1}H NMR of **5l**



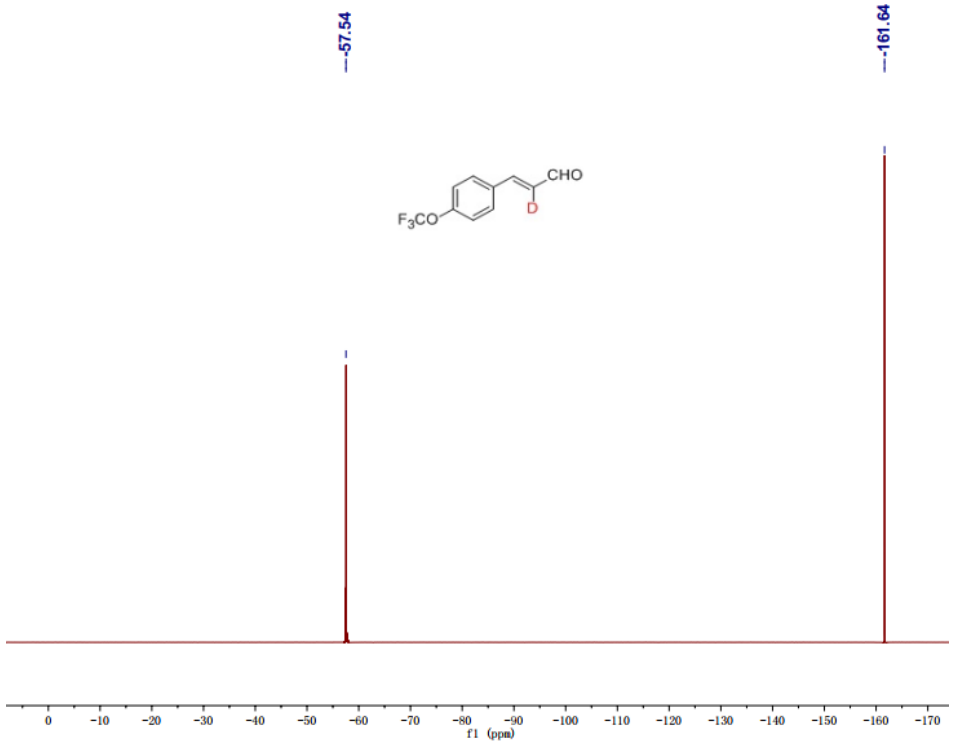
^{13}C NMR of **5l**



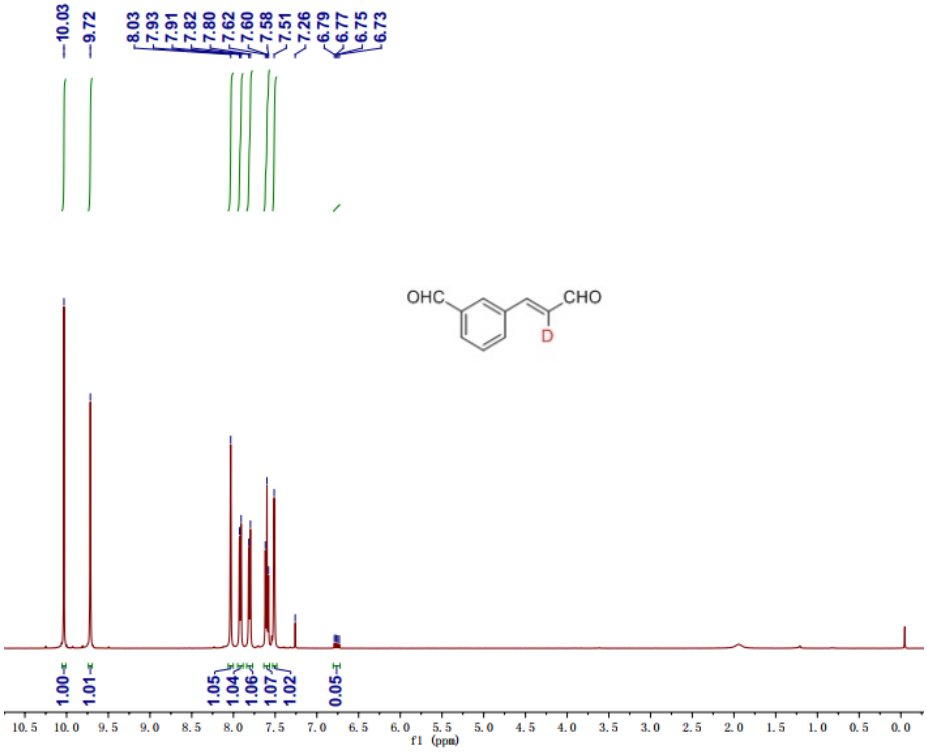
^{2}H NMR of **5l**



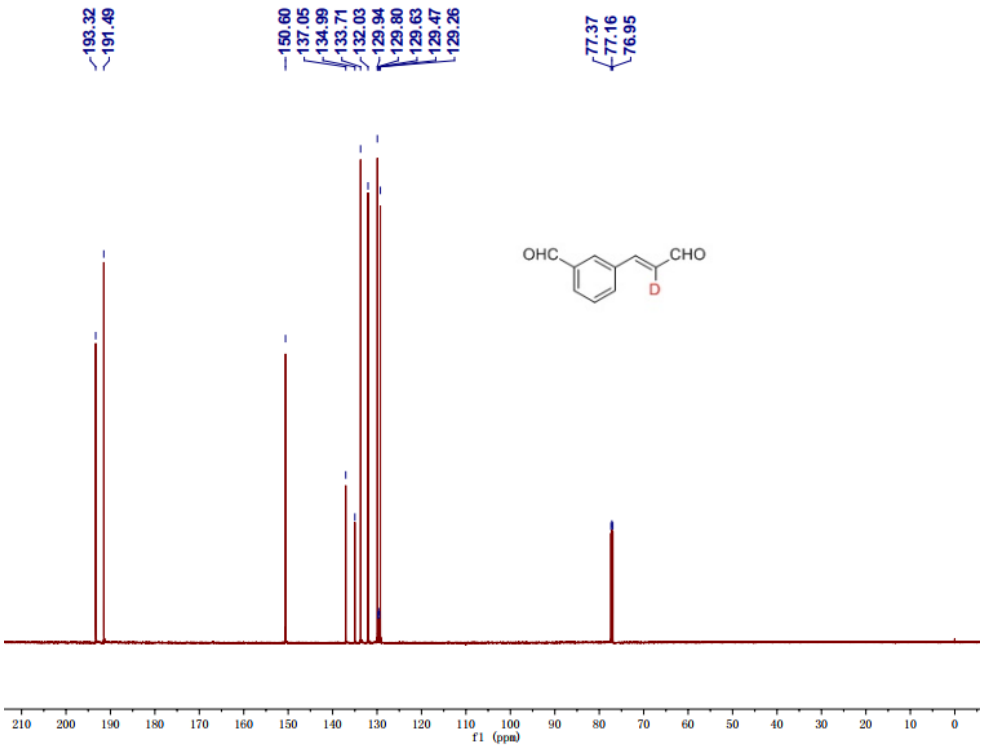
^{19}F NMR of **5l**



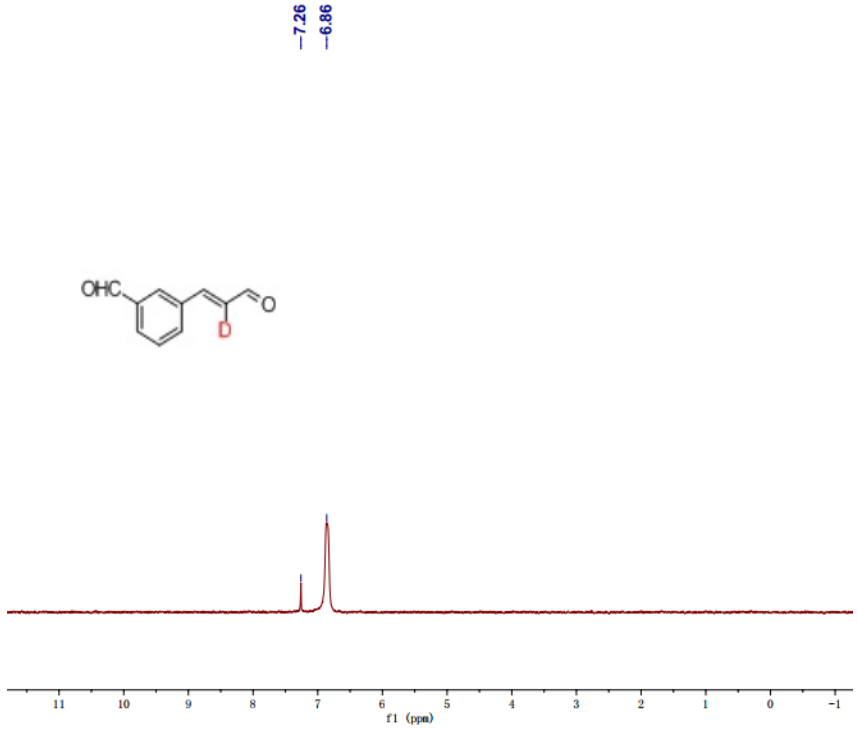
^{1}H NMR of **5m**



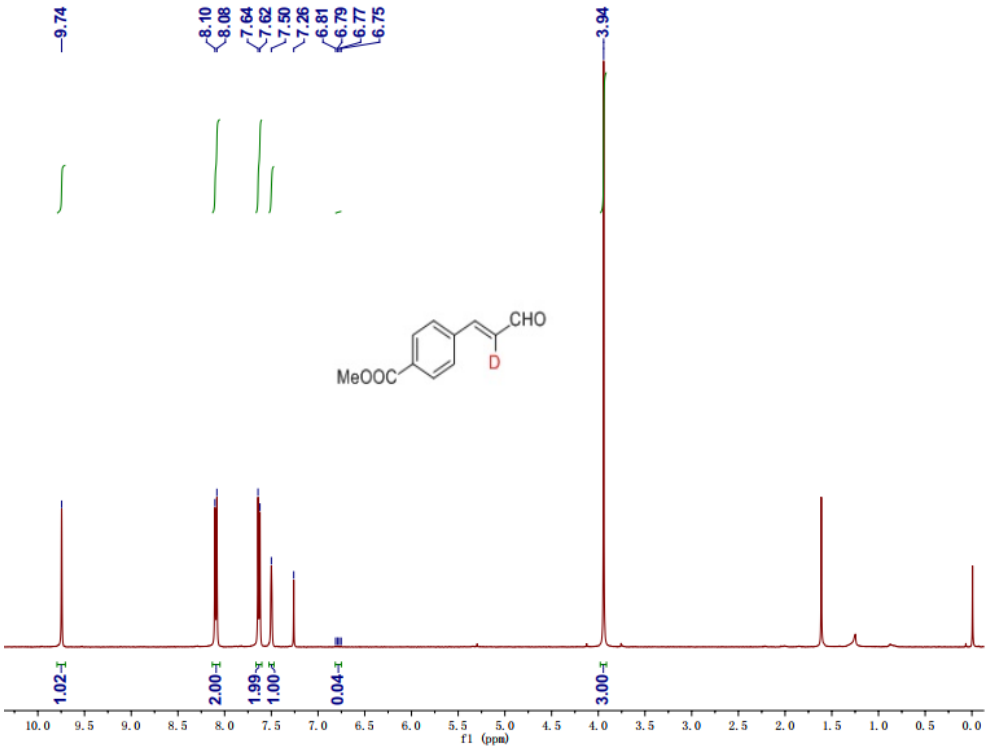
^{13}C NMR of **5m**



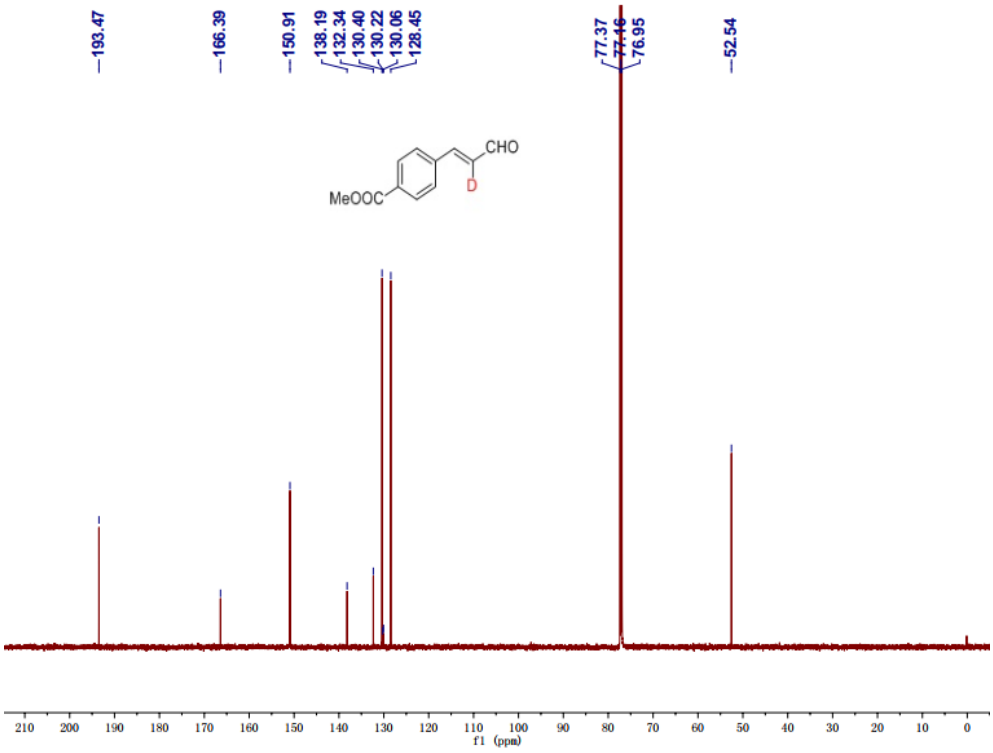
^{2}H NMR of **5m**



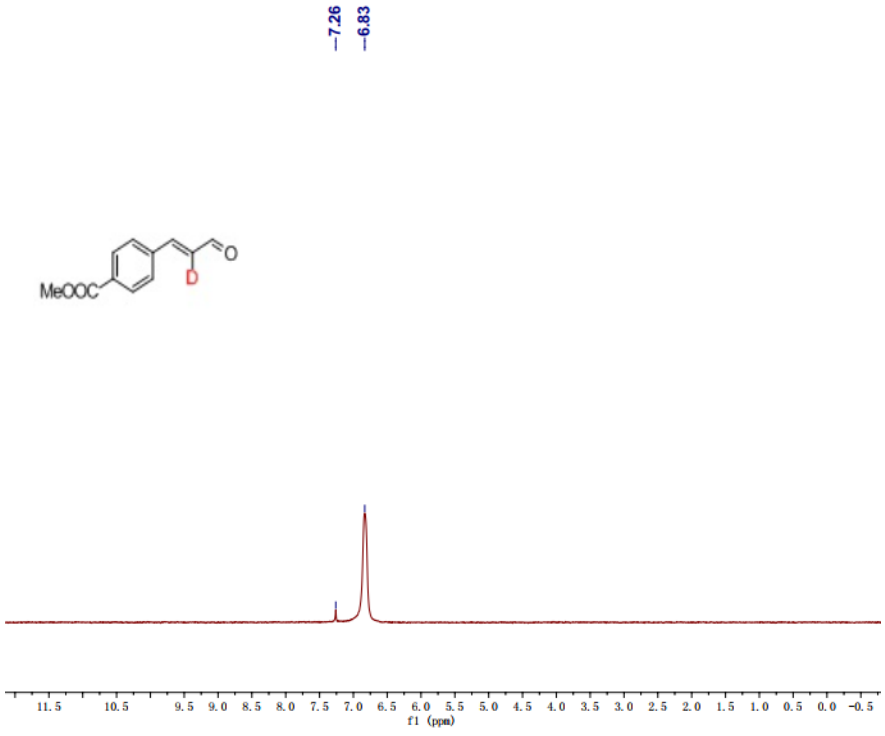
^{1}H NMR of **5n**



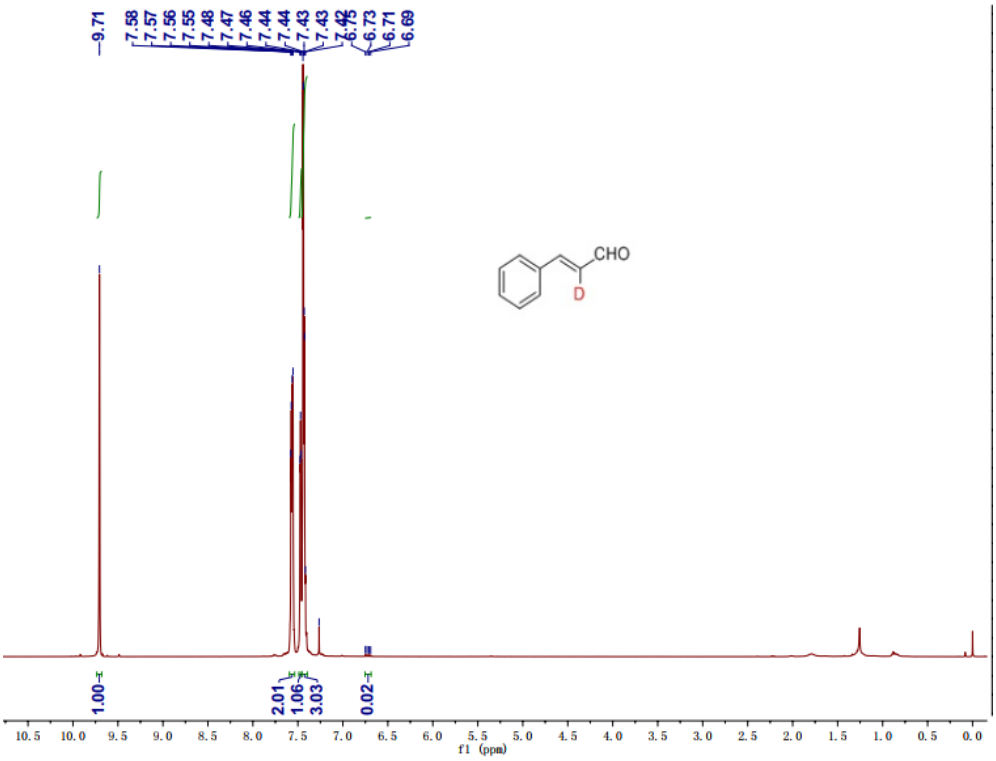
^{13}C NMR of **5n**



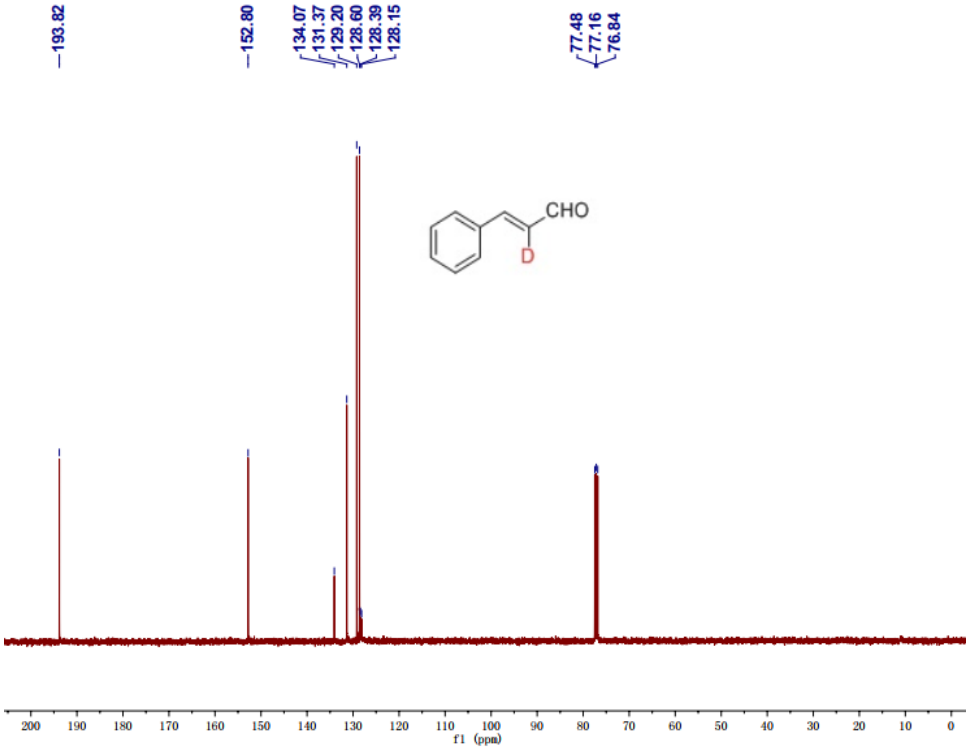
^{2}H NMR of **5n**



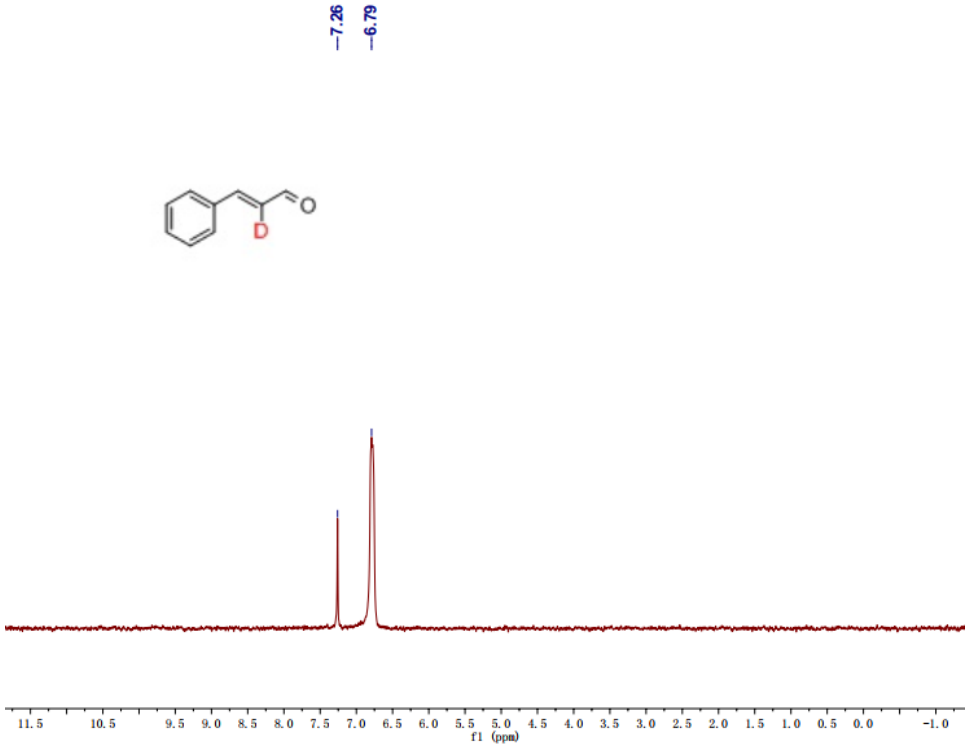
^{1}H NMR of **5o**



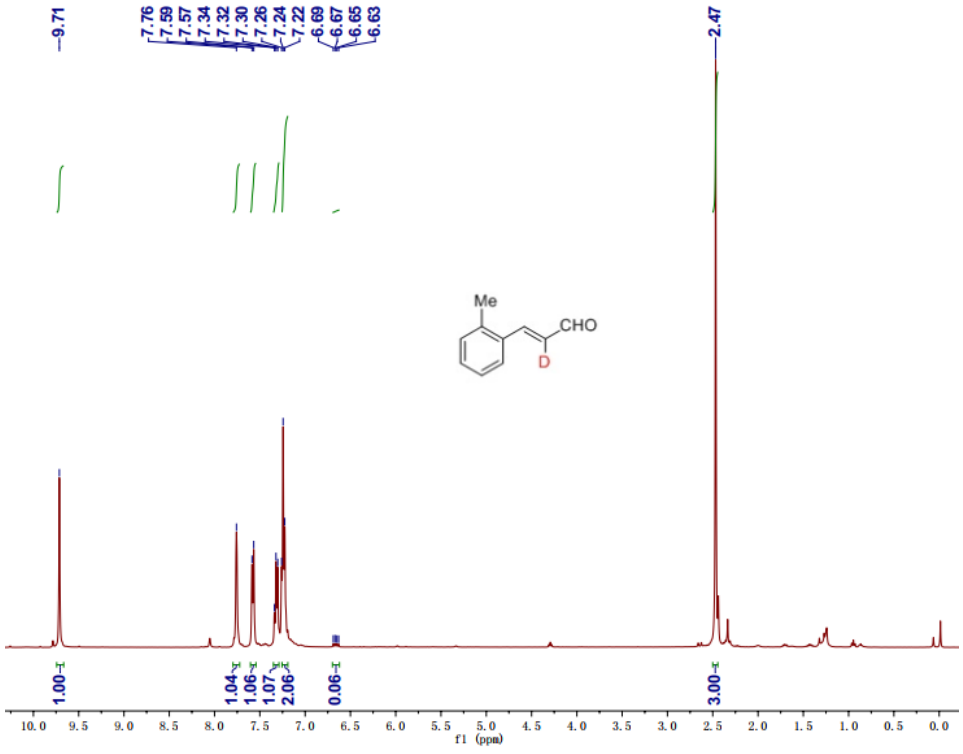
^{13}C NMR of **5o**



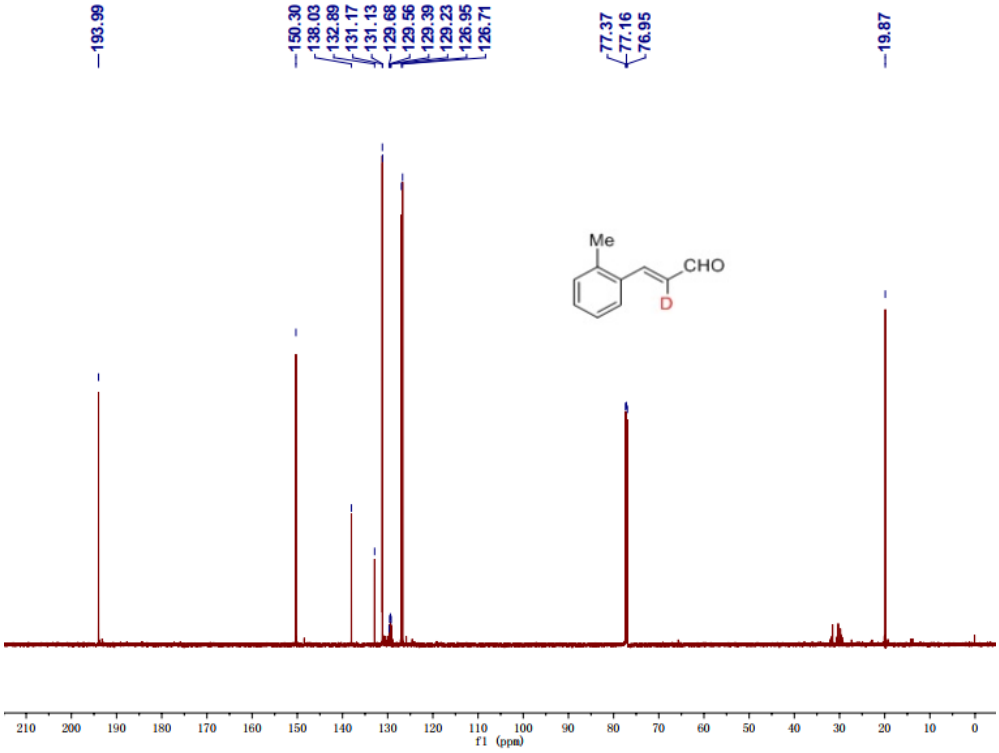
^{2}H NMR of **5o**



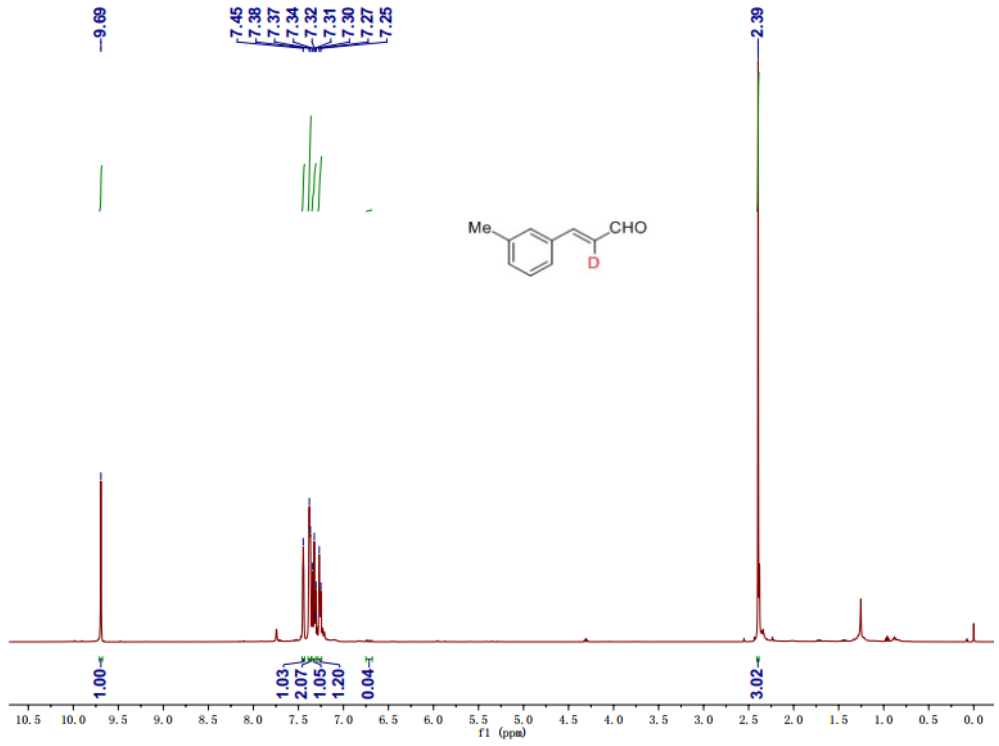
^{1}H NMR of **5p**



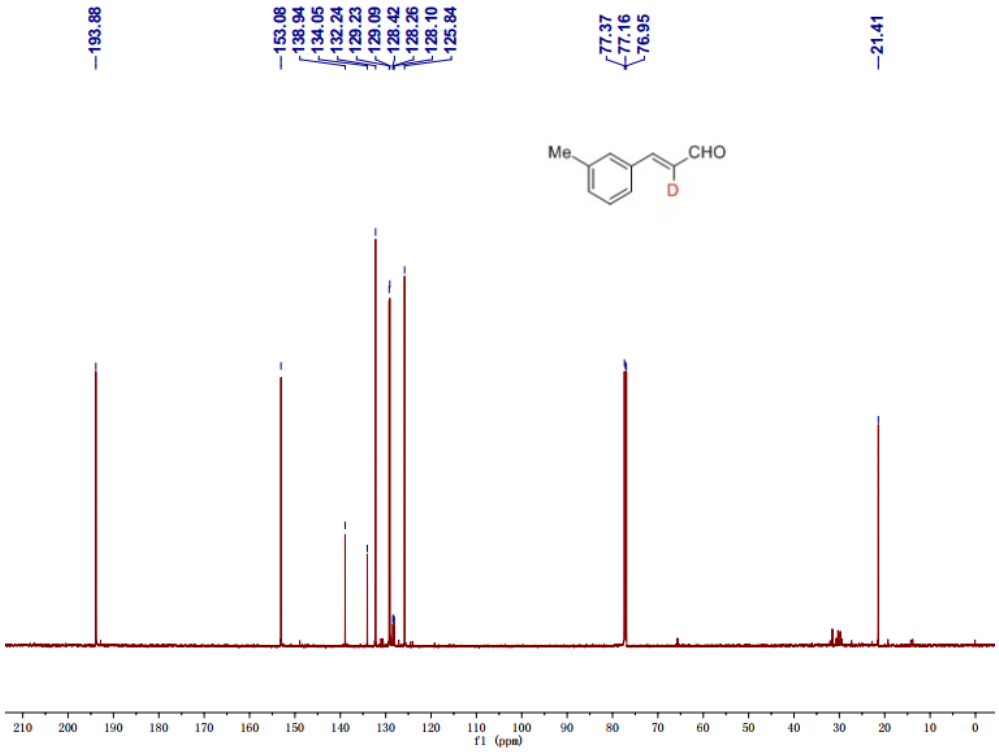
^{13}C NMR of **5p**



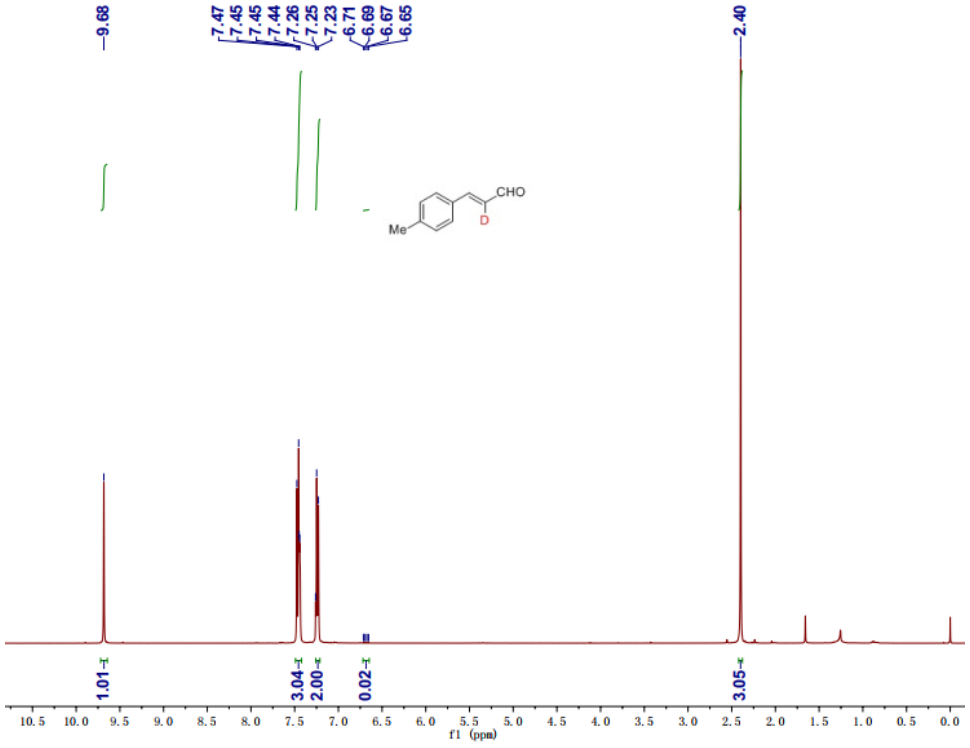
^{1}H NMR of **5q**



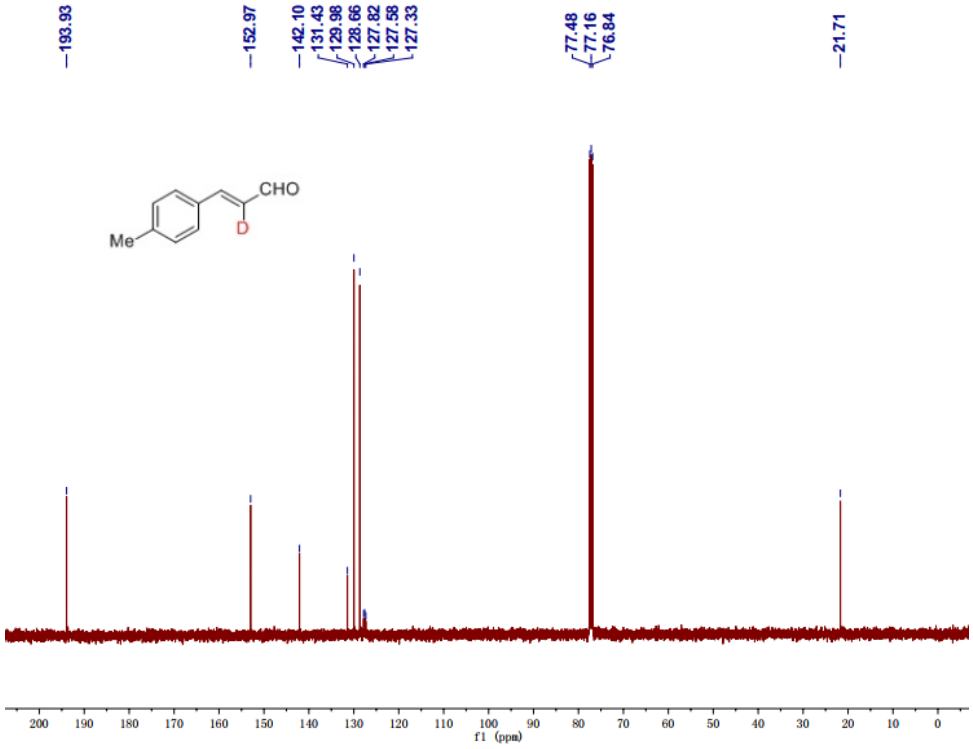
^{13}C NMR of **5q**



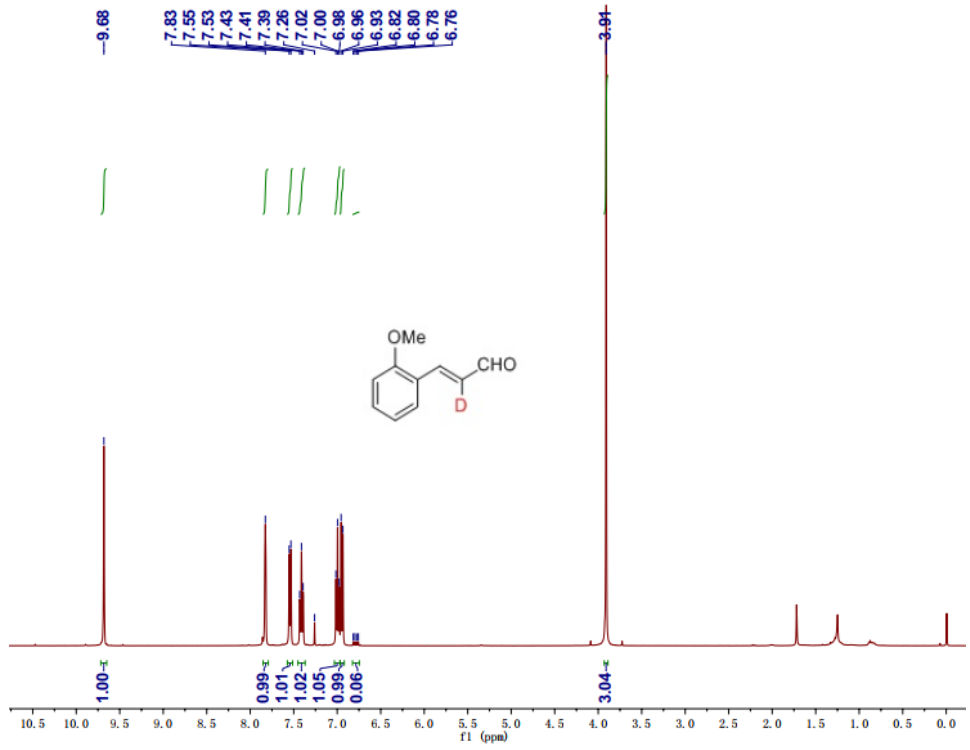
^{1}H NMR of **5r**



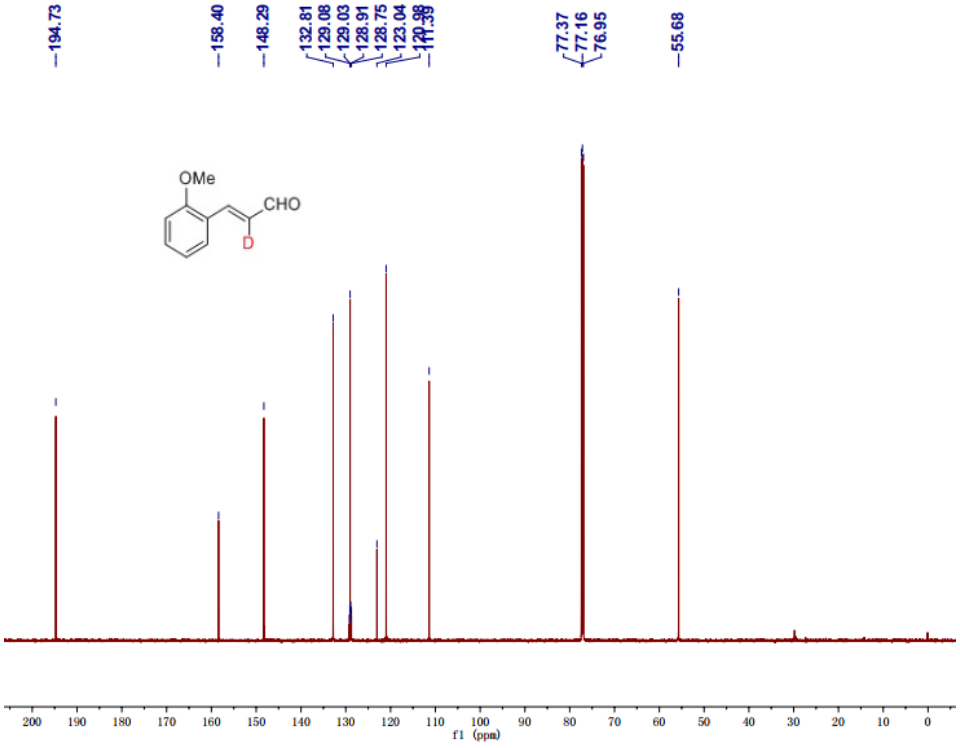
^{13}C NMR of **5r**



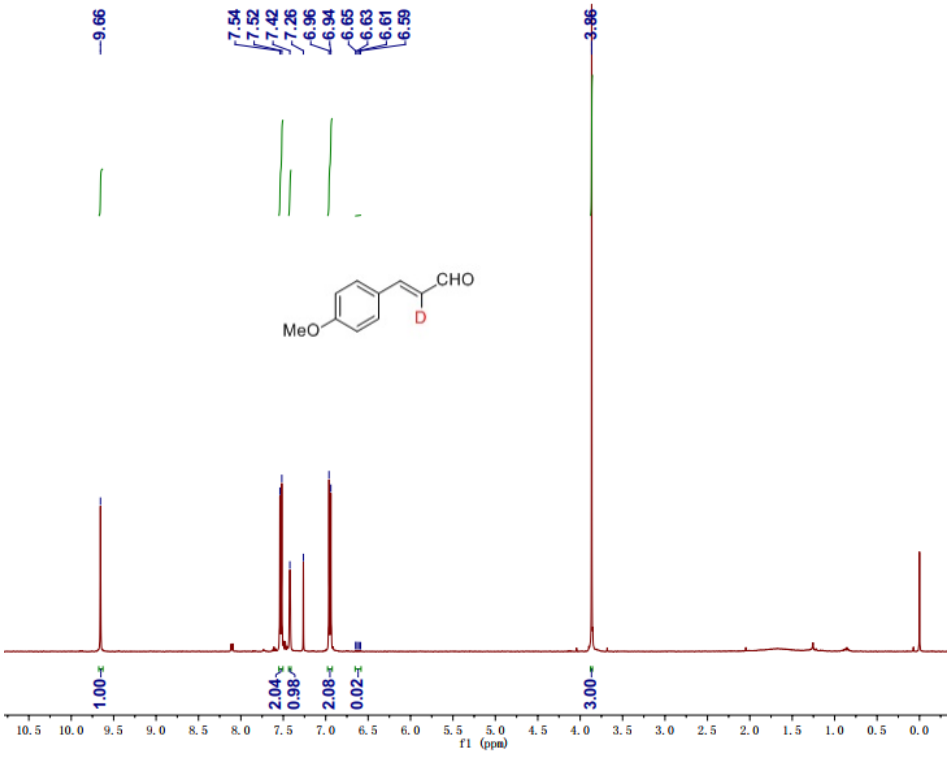
^{1}H NMR of **5s**



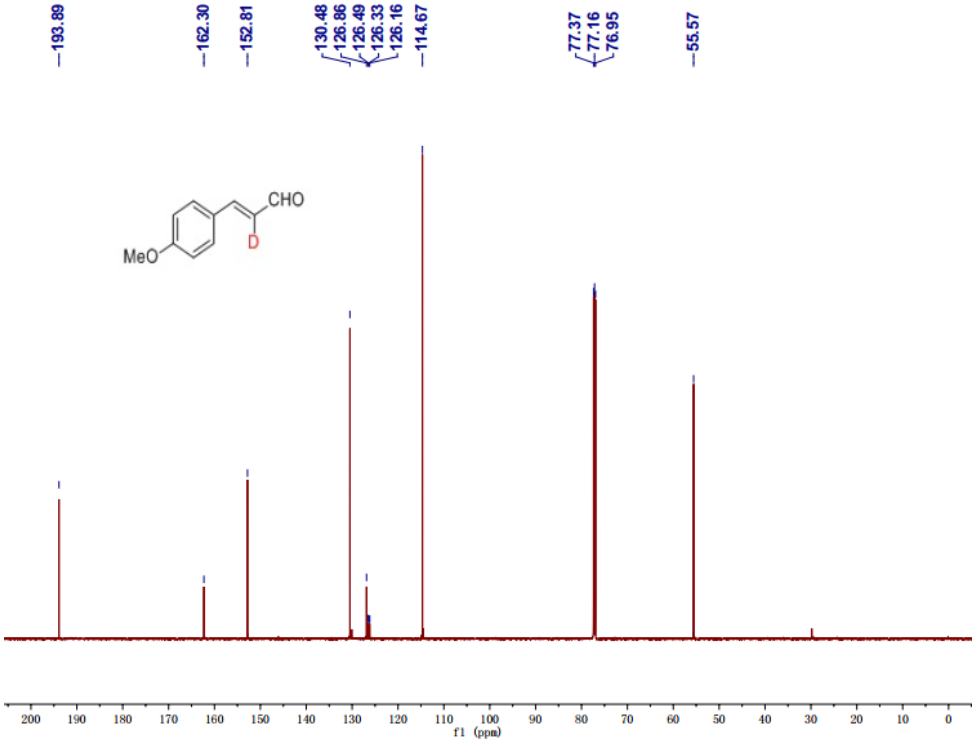
^{13}C NMR of **5s**



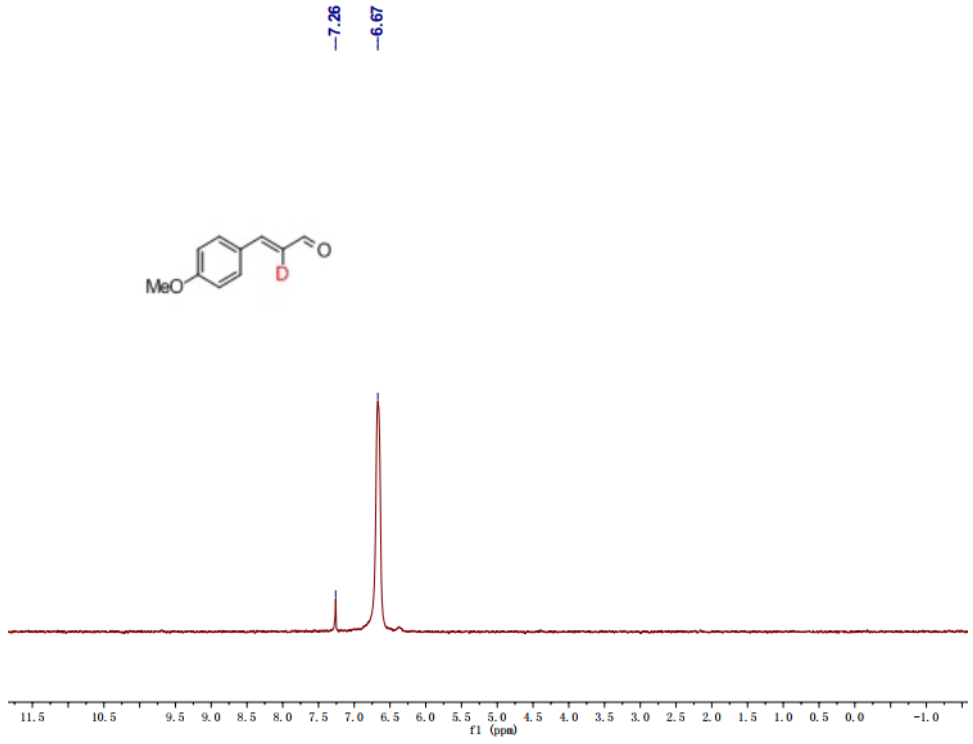
^{1}H NMR of **5t**



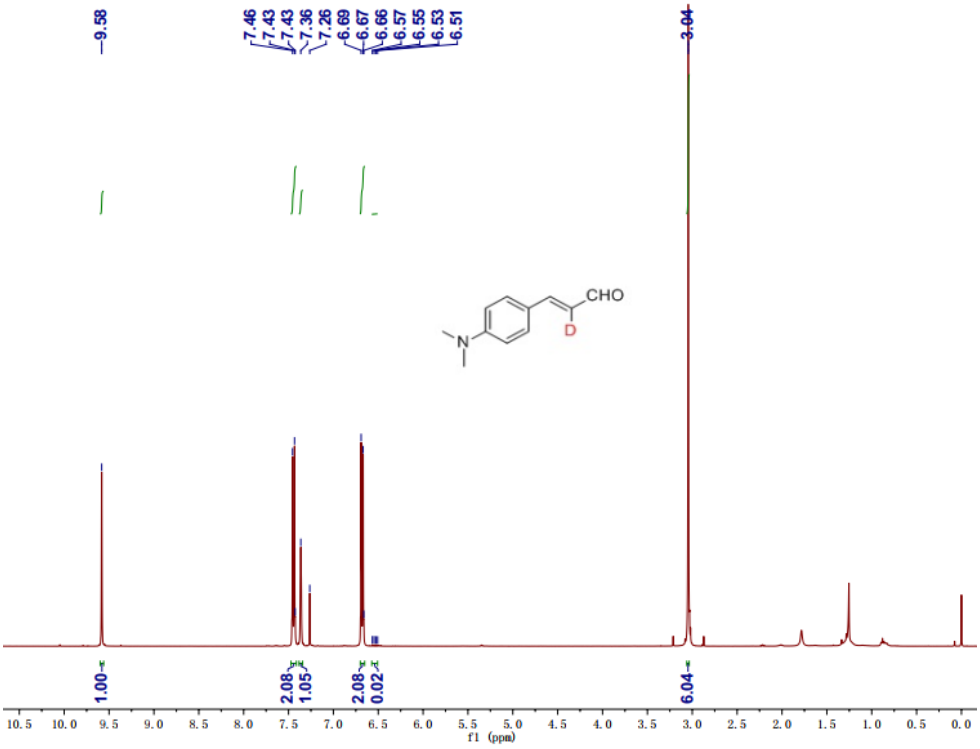
^{13}C NMR of **5t**



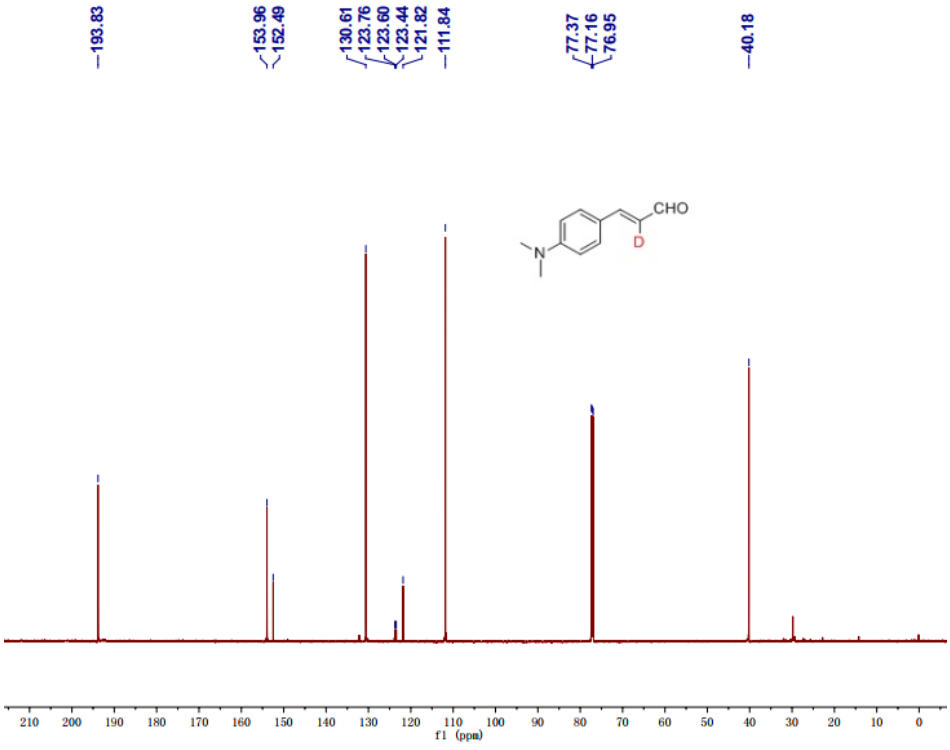
^{2}H NMR of **5t**



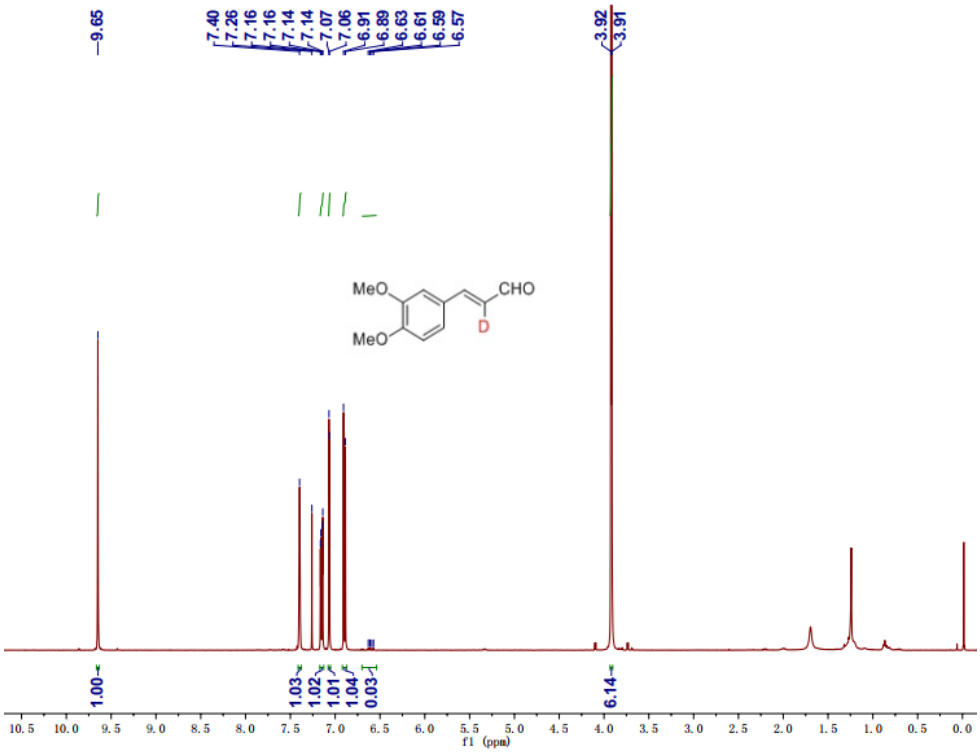
^{1}H NMR of **5u**



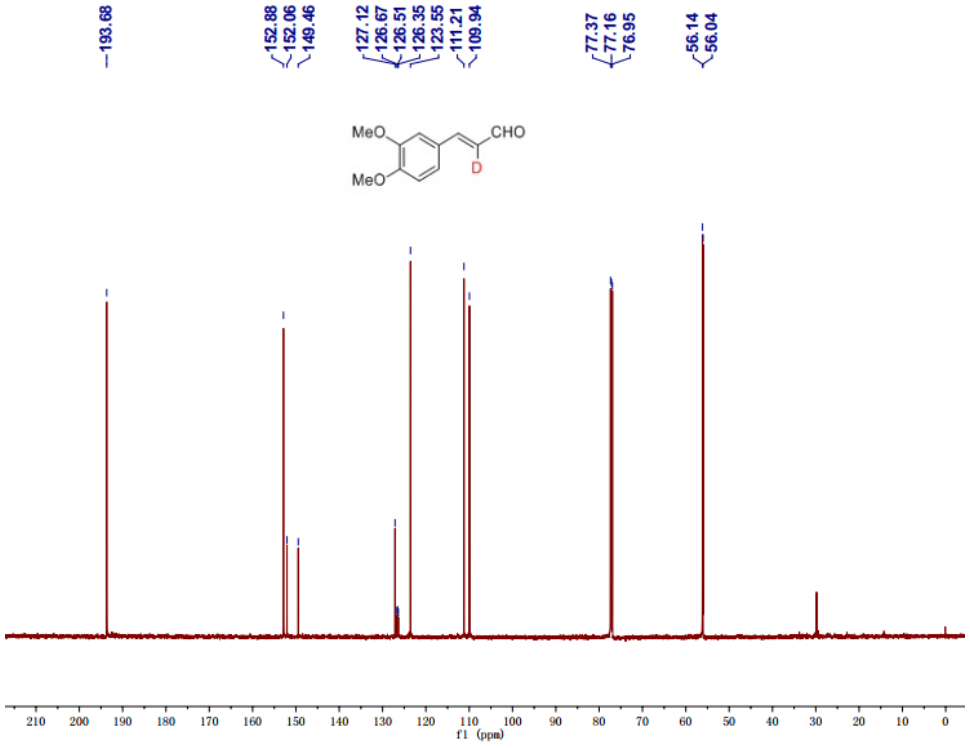
^{13}C NMR of **5u**



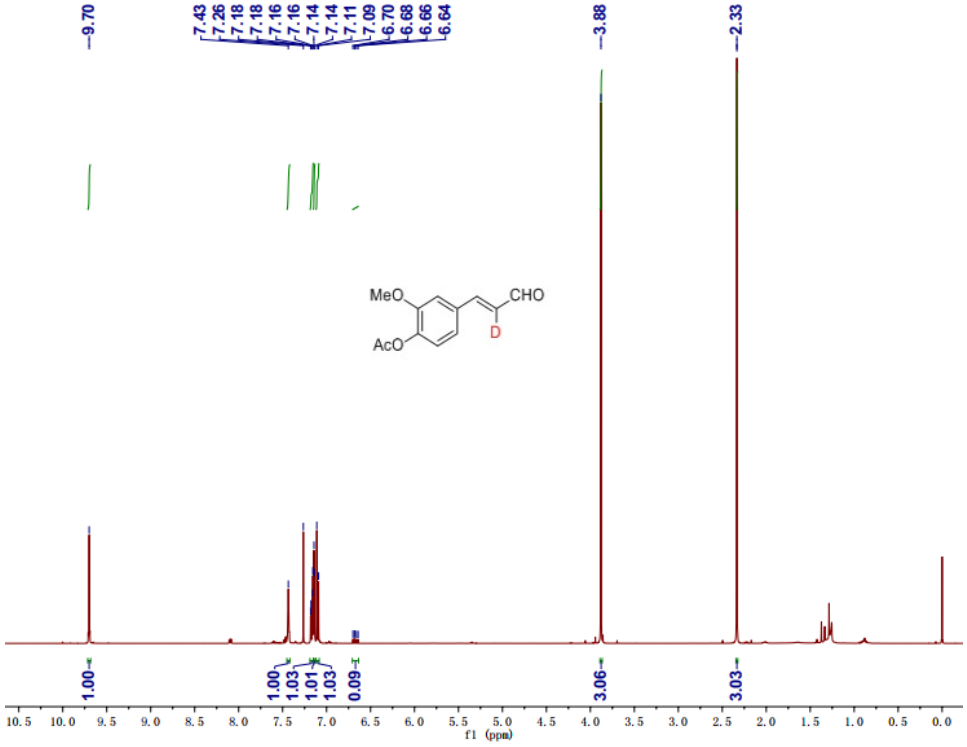
^{1}H NMR of **5v**



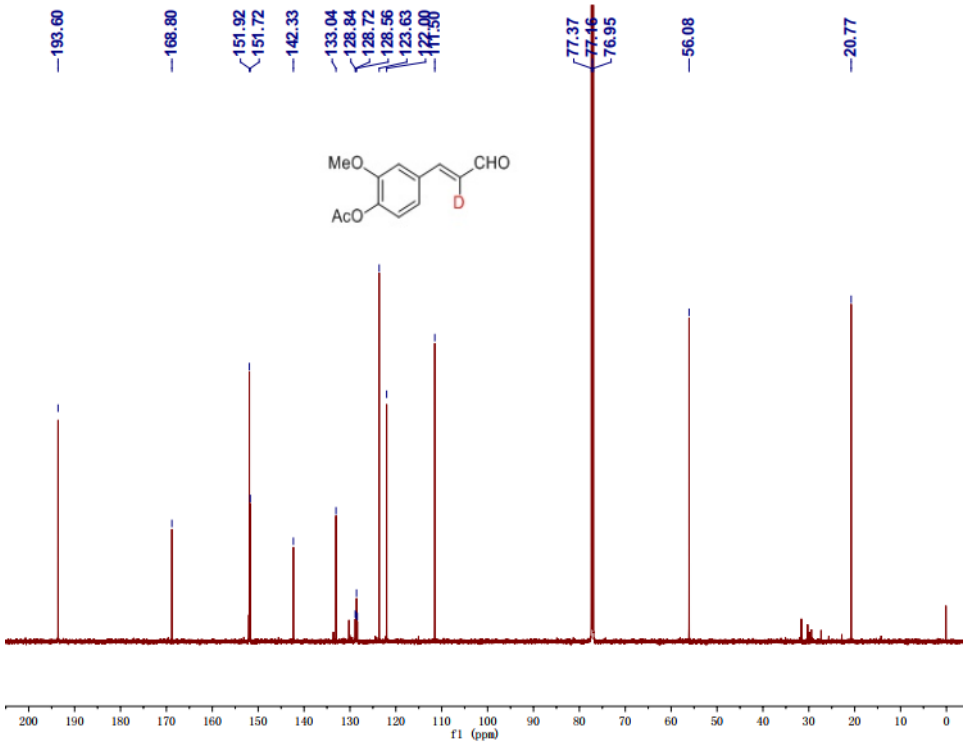
^{13}C NMR of **5v**



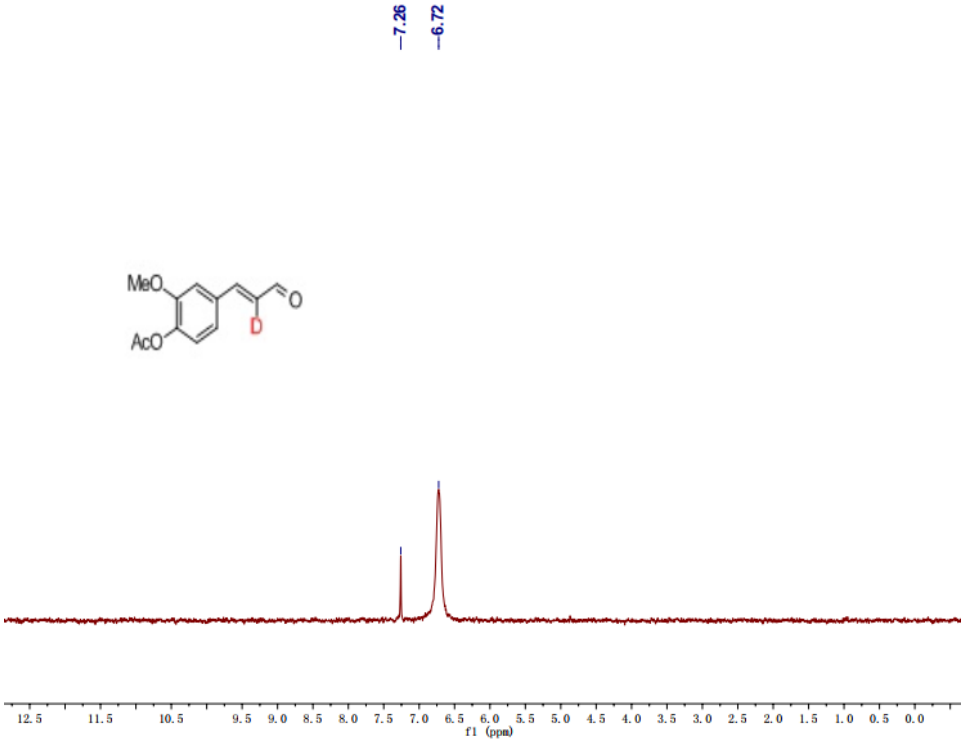
^{1}H NMR of **5w**



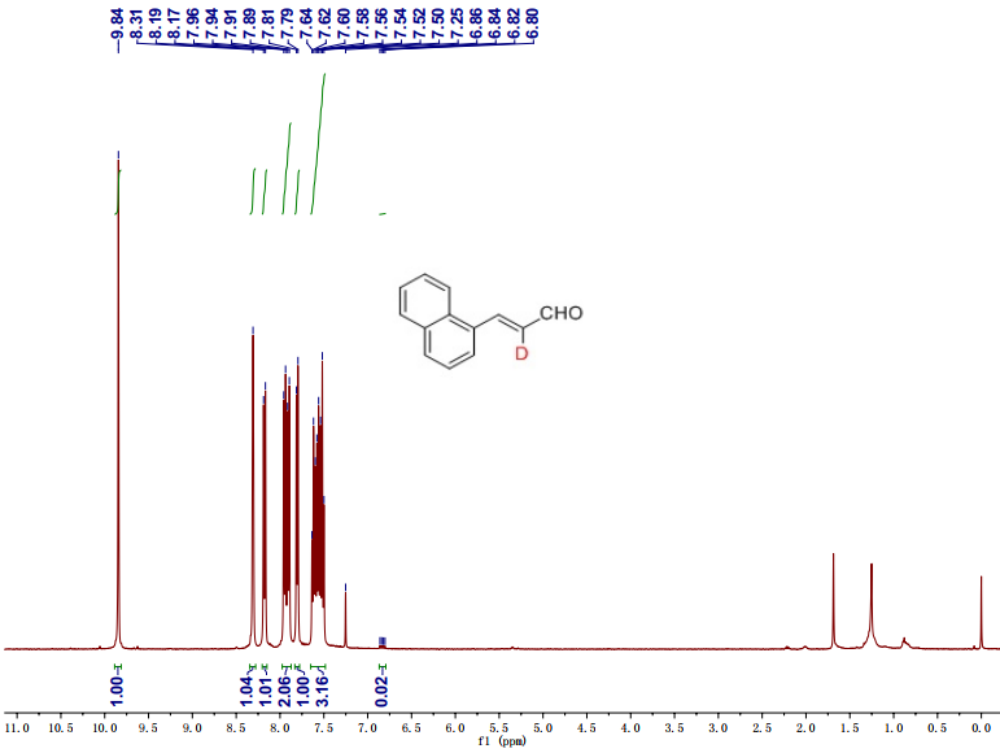
^{13}C NMR of **5w**



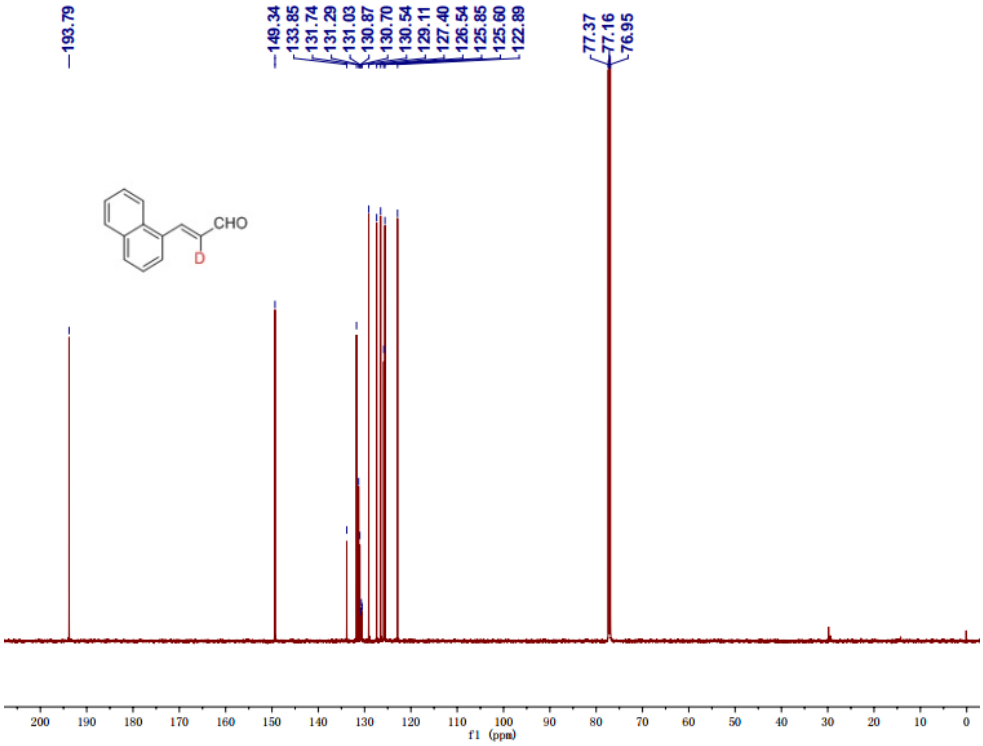
^{2}H NMR of **5w**



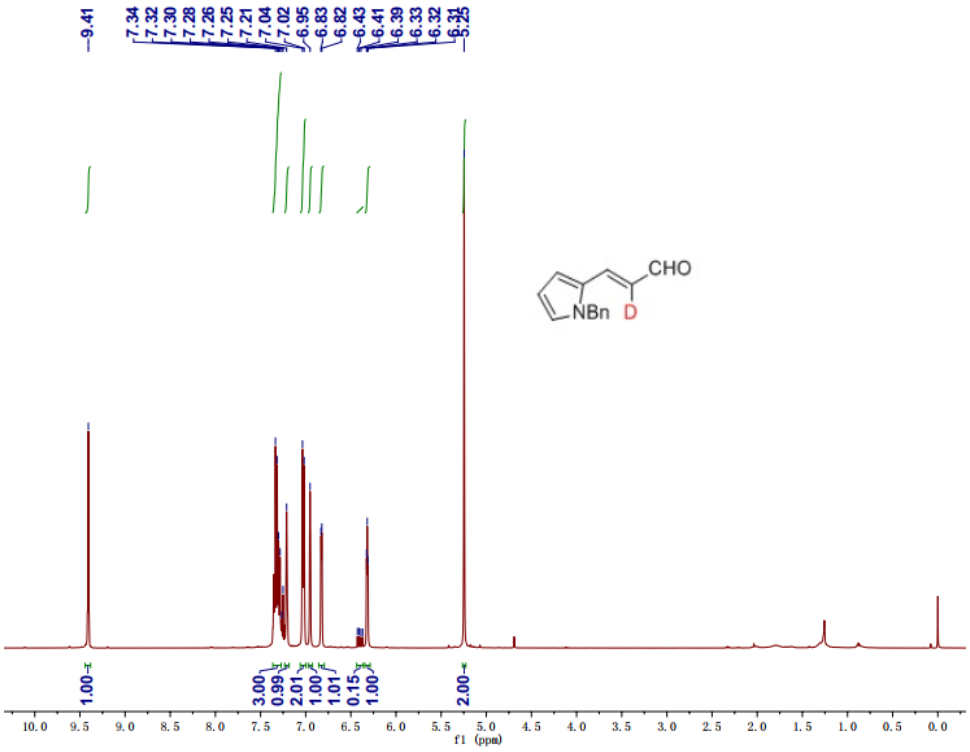
^{1}H NMR of **5x**



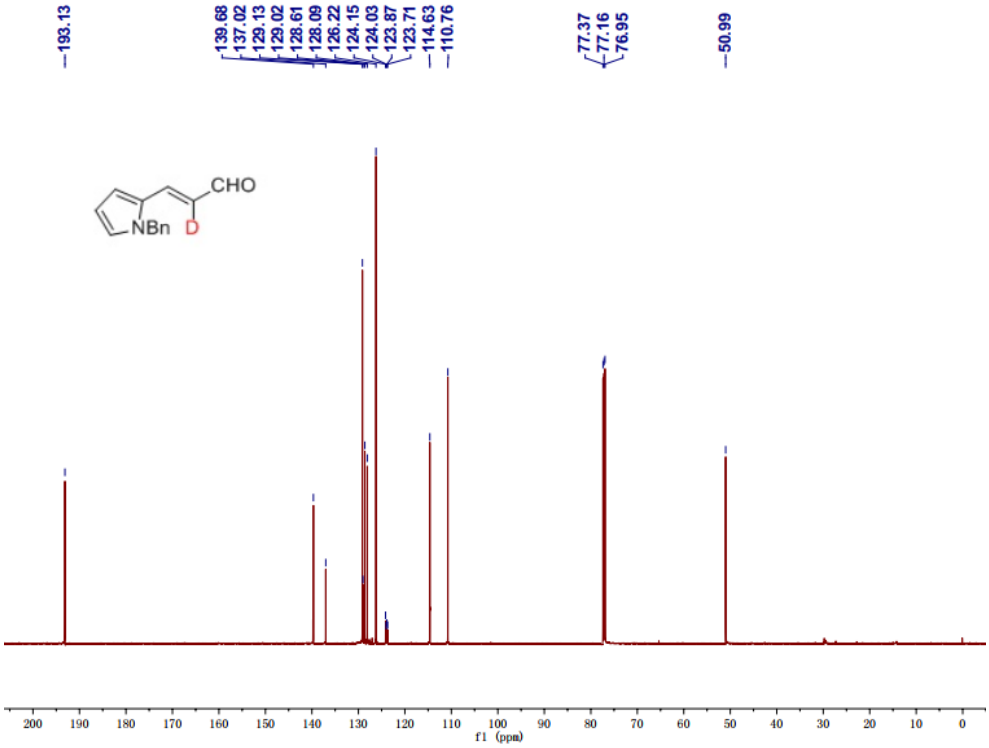
^{13}C NMR of **5x**



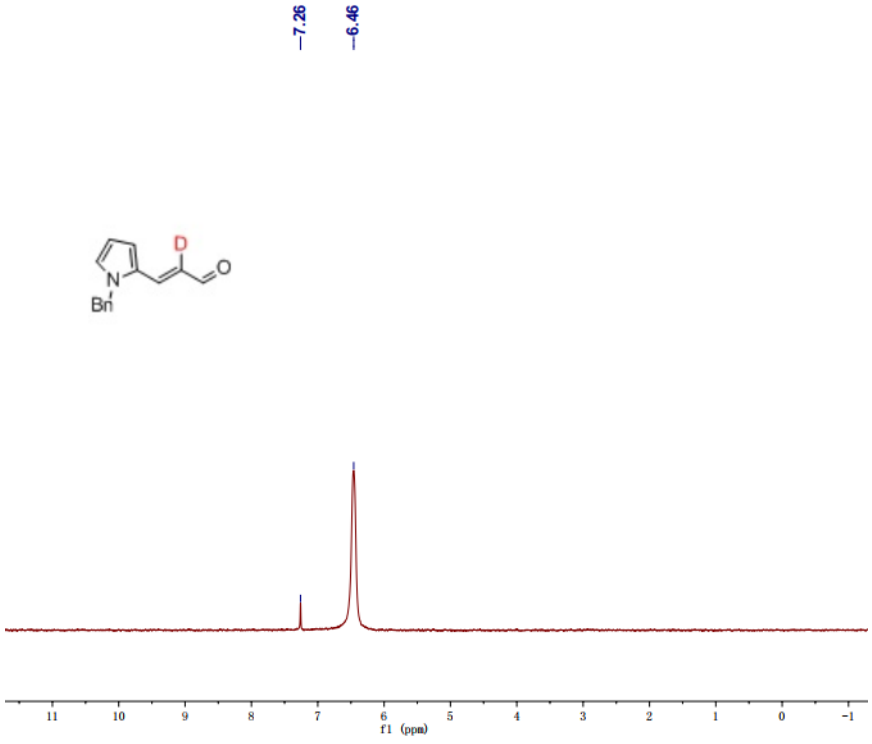
^{1}H NMR of **5y**



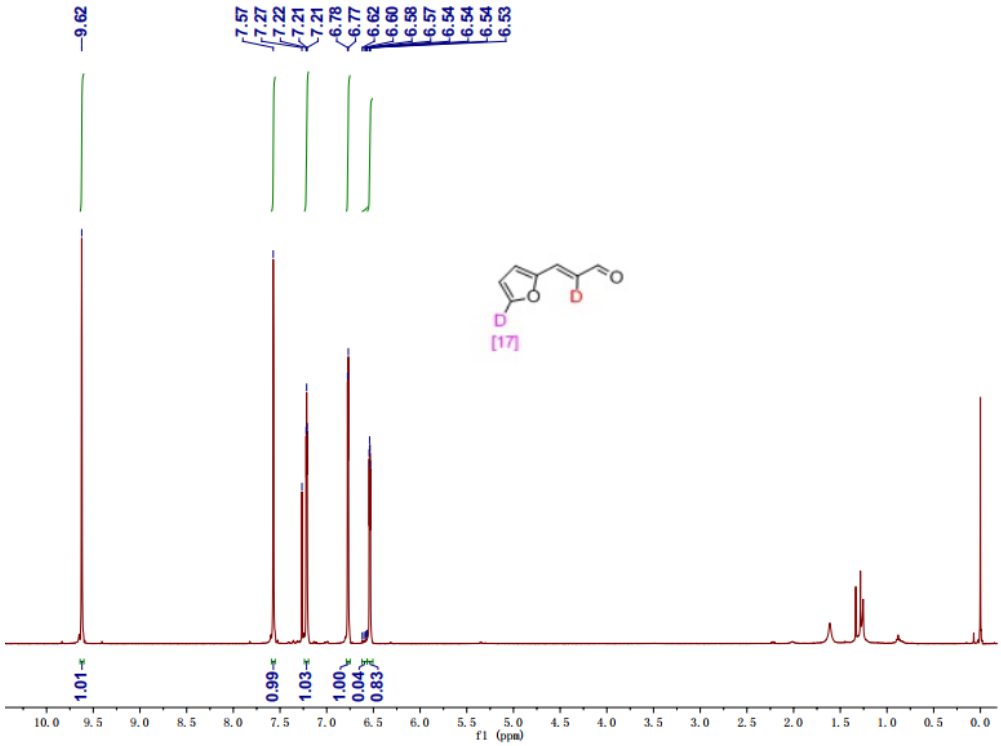
^{13}C NMR of **5y**



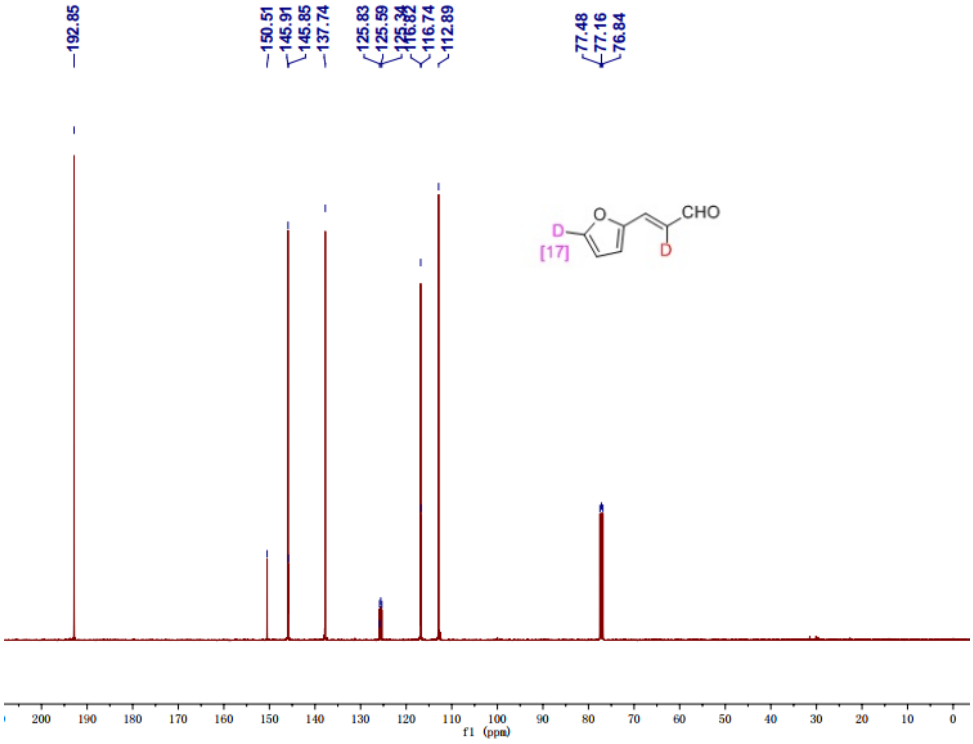
^{2}H NMR of **5y**



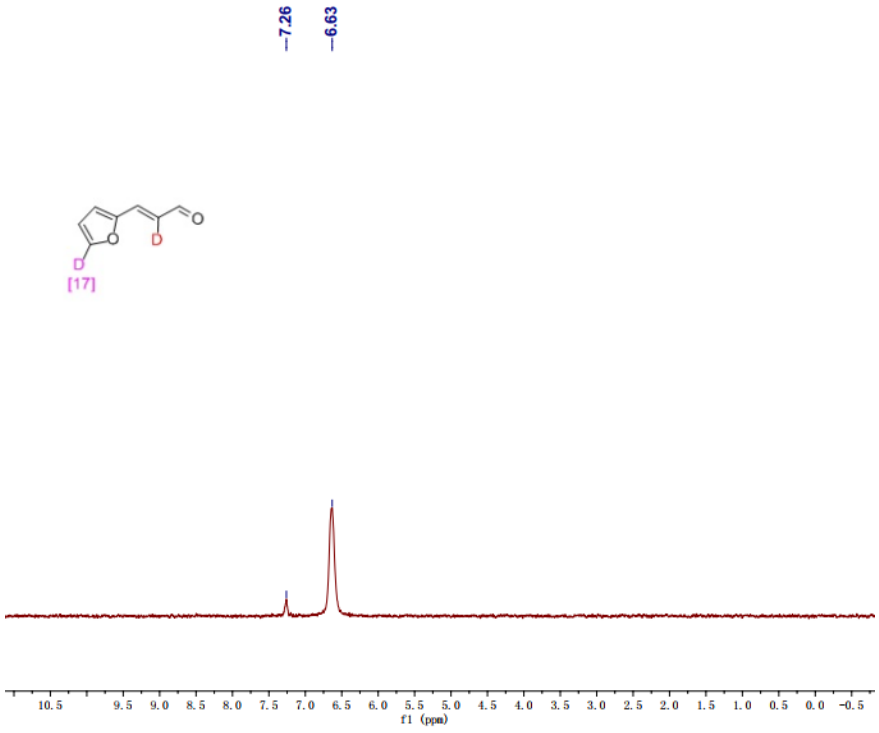
^{1}H NMR of **5z**



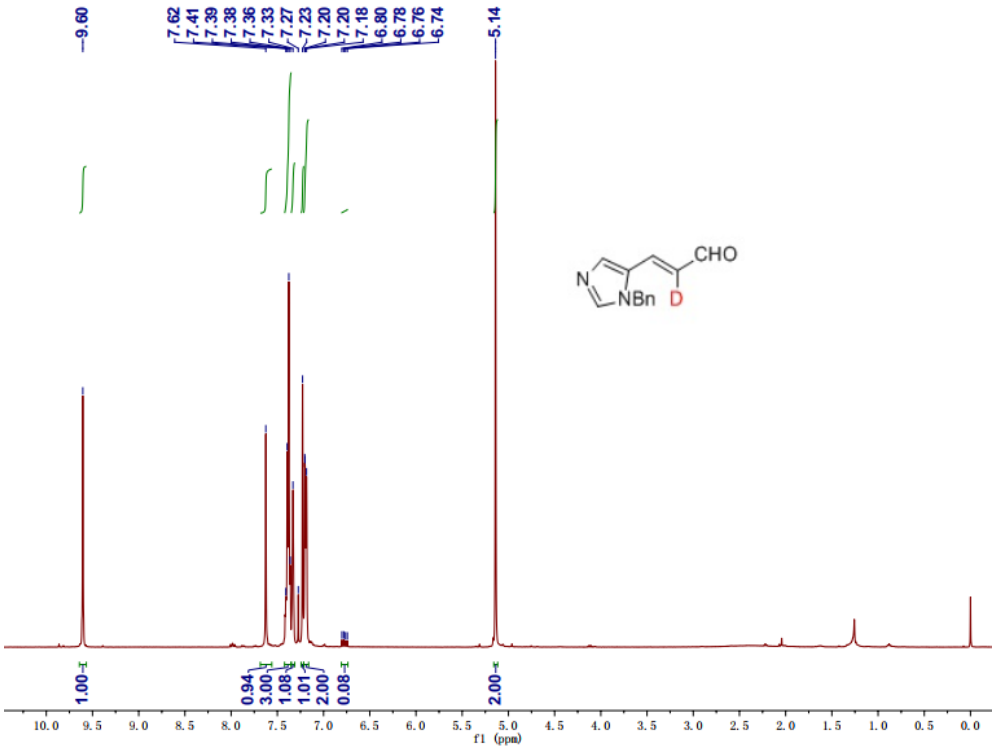
^{13}C NMR of **5z**



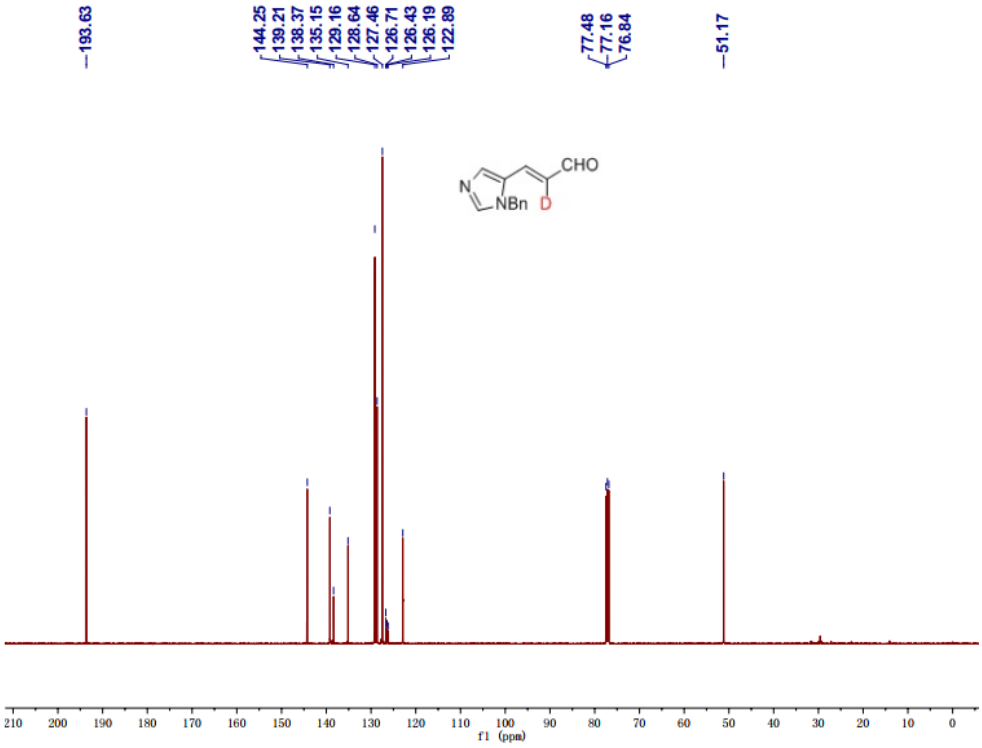
^{2}H NMR of **5z**



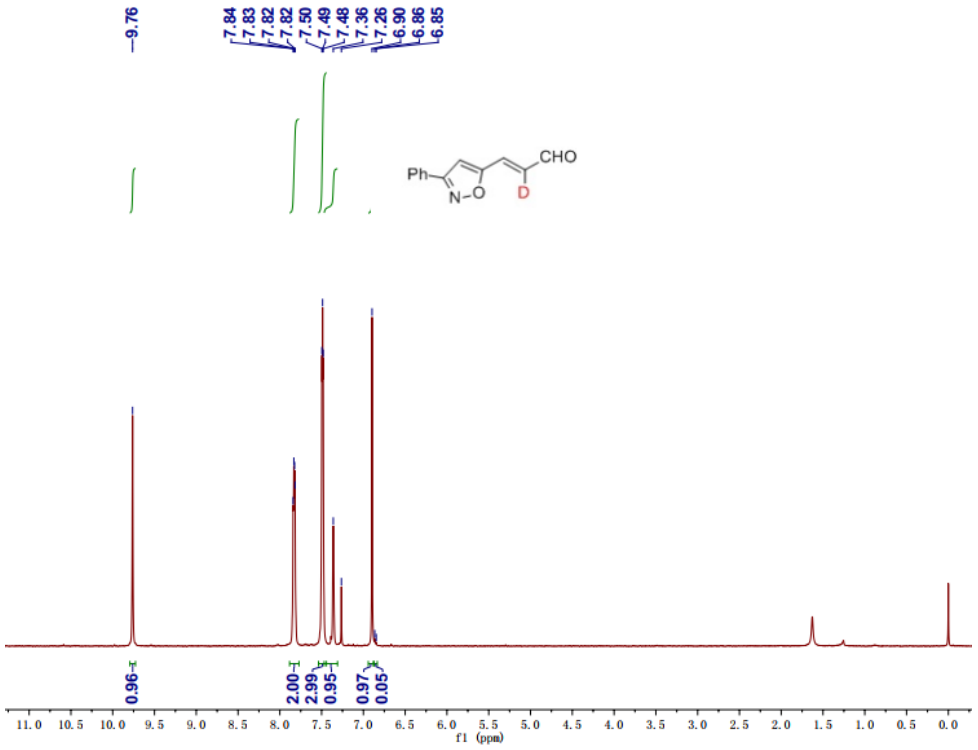
^{1}H NMR of **5aa**



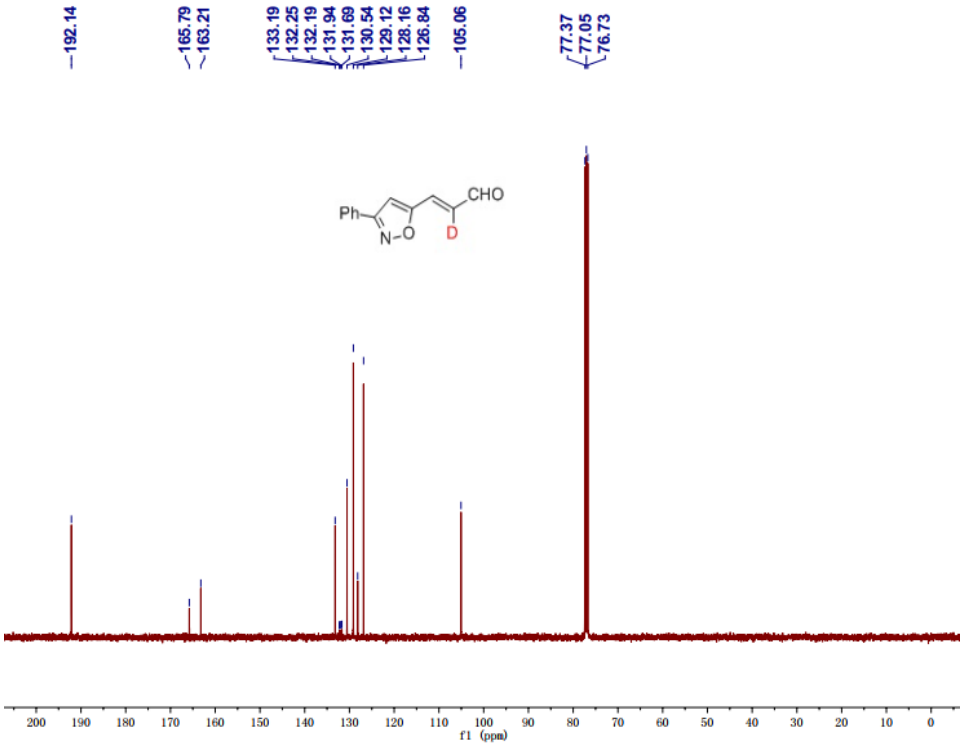
^{13}C NMR of **5aa**



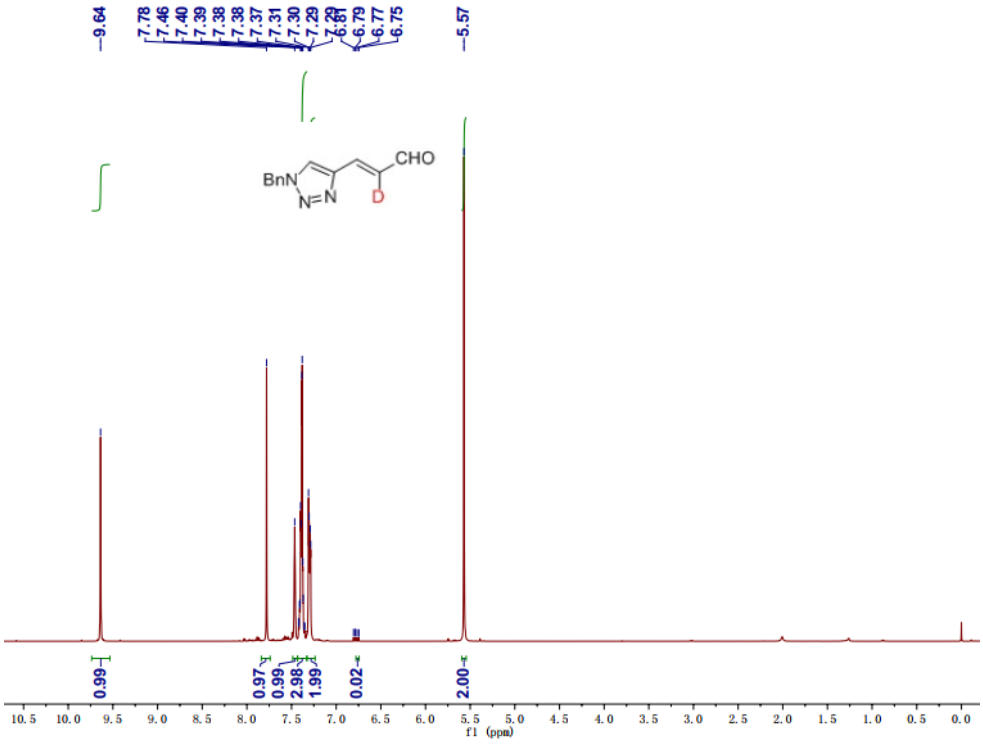
^{1}H NMR of **5ab**



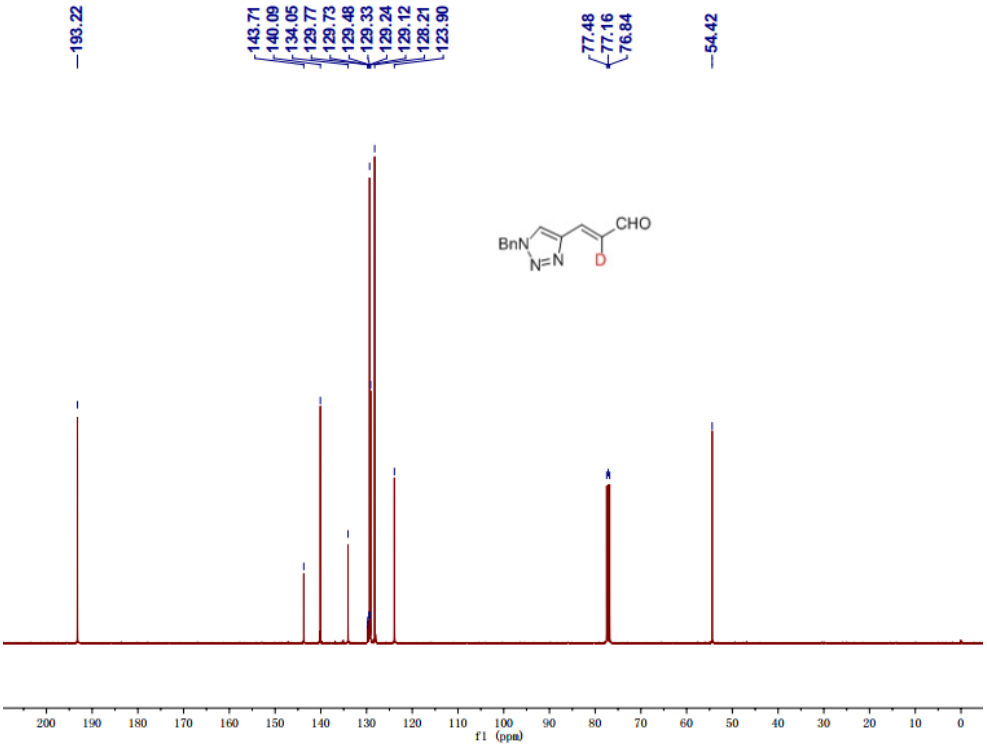
^{13}C NMR of **5ab**



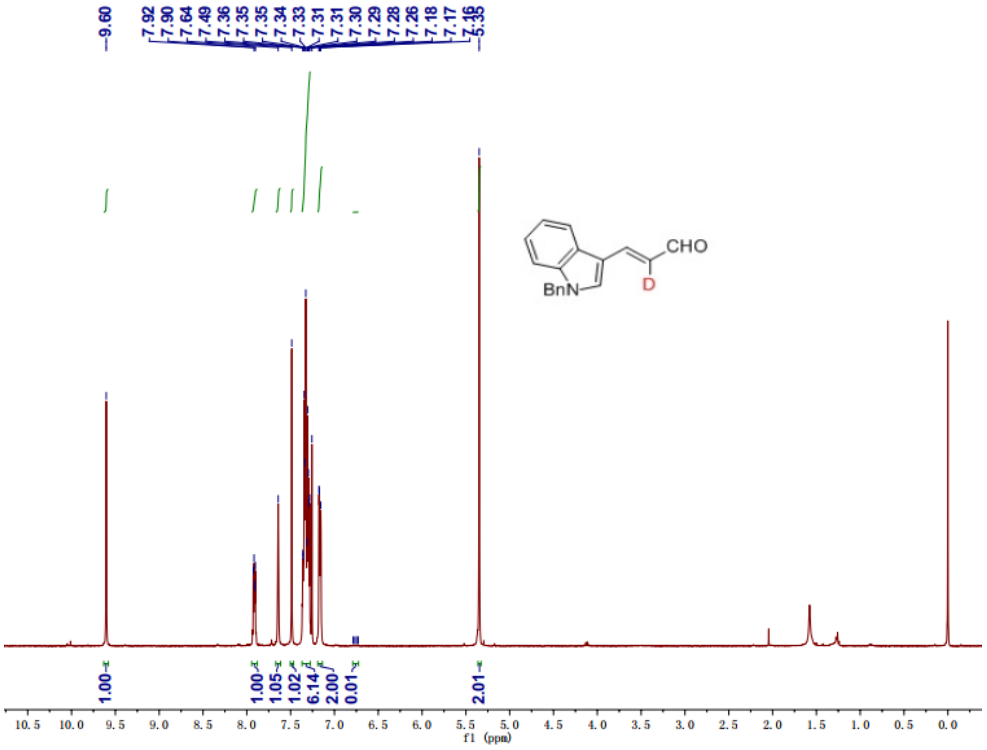
^{1}H NMR of **5ac**



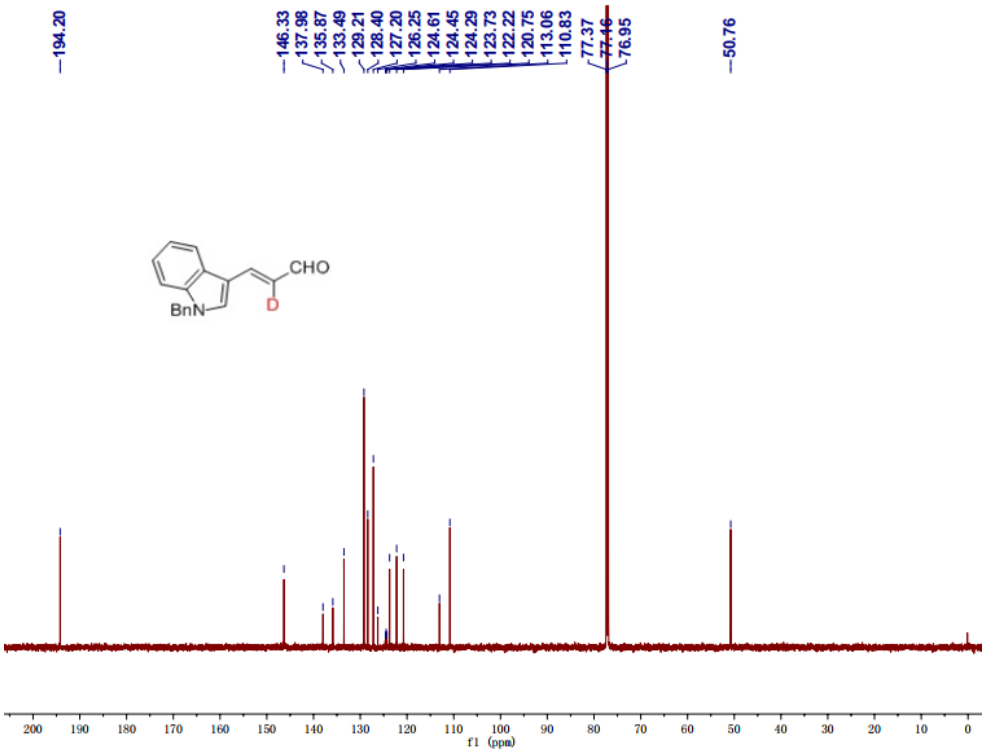
^{13}C NMR of **5ac**



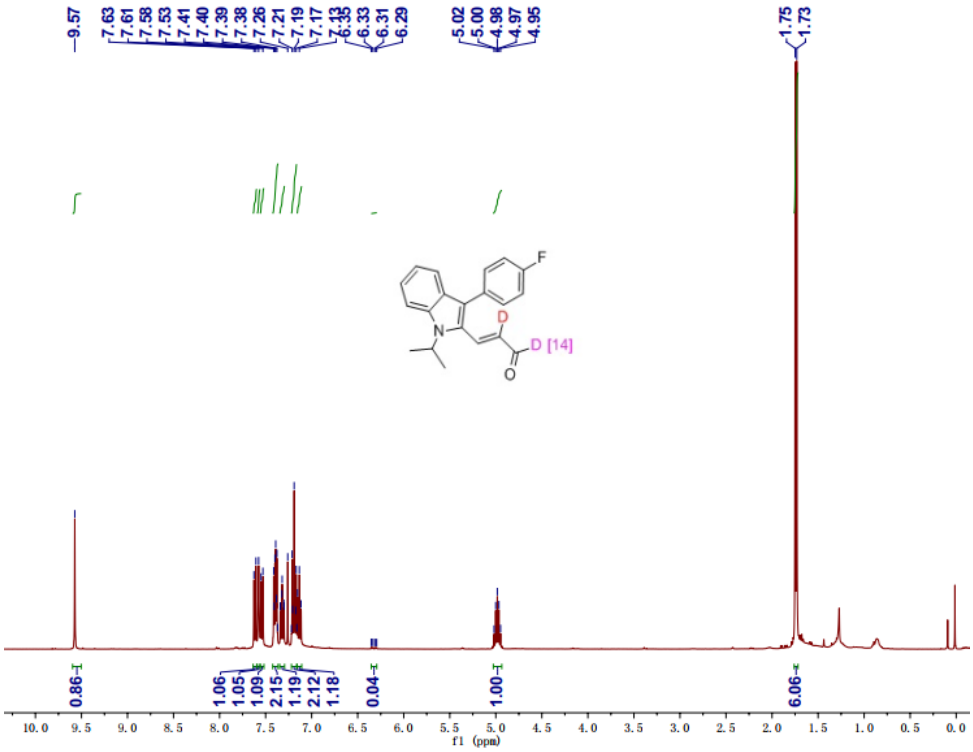
^{1}H NMR of **5ad**



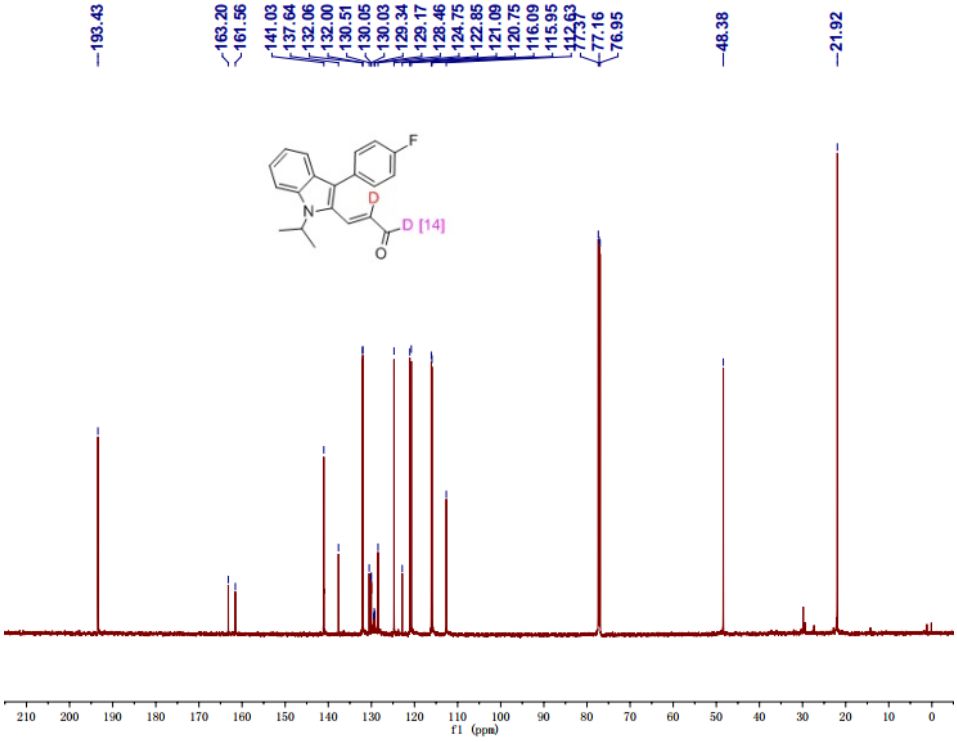
^{13}C NMR of **5ad**



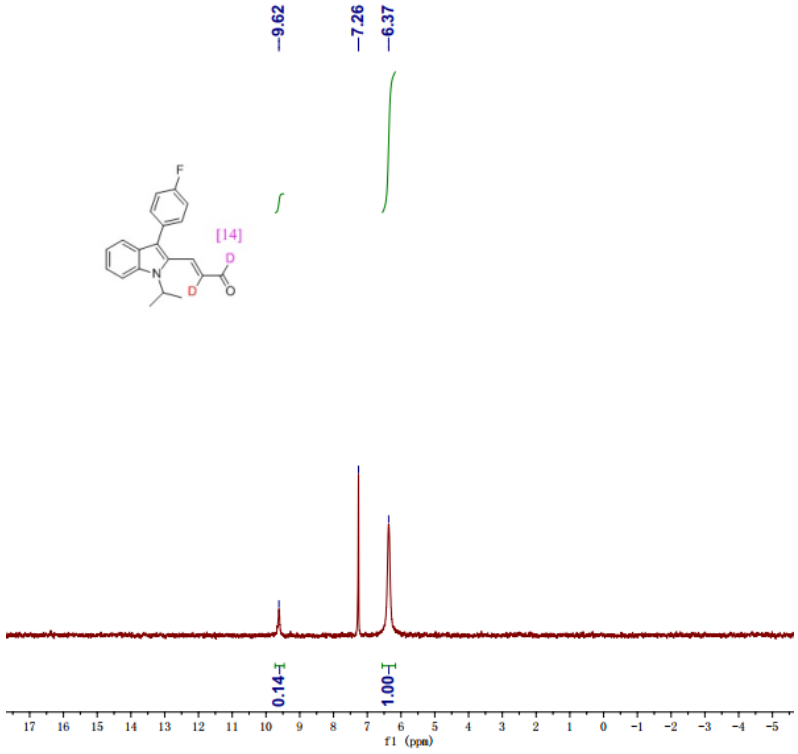
^{1}H NMR of **5ae**



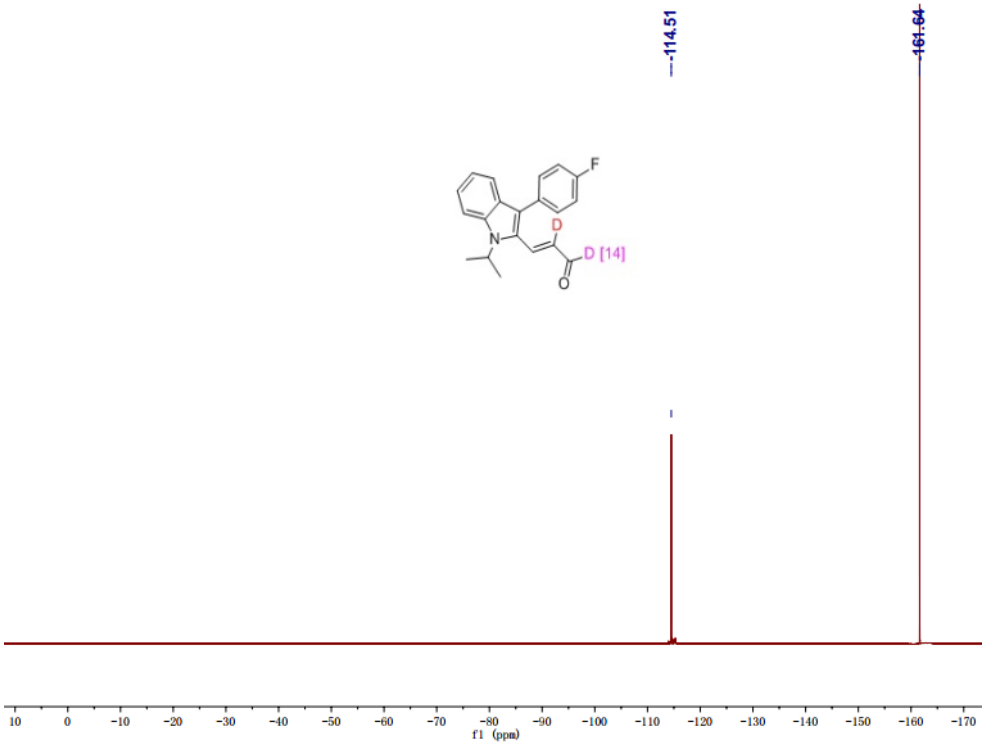
^{13}C NMR of **5ae**



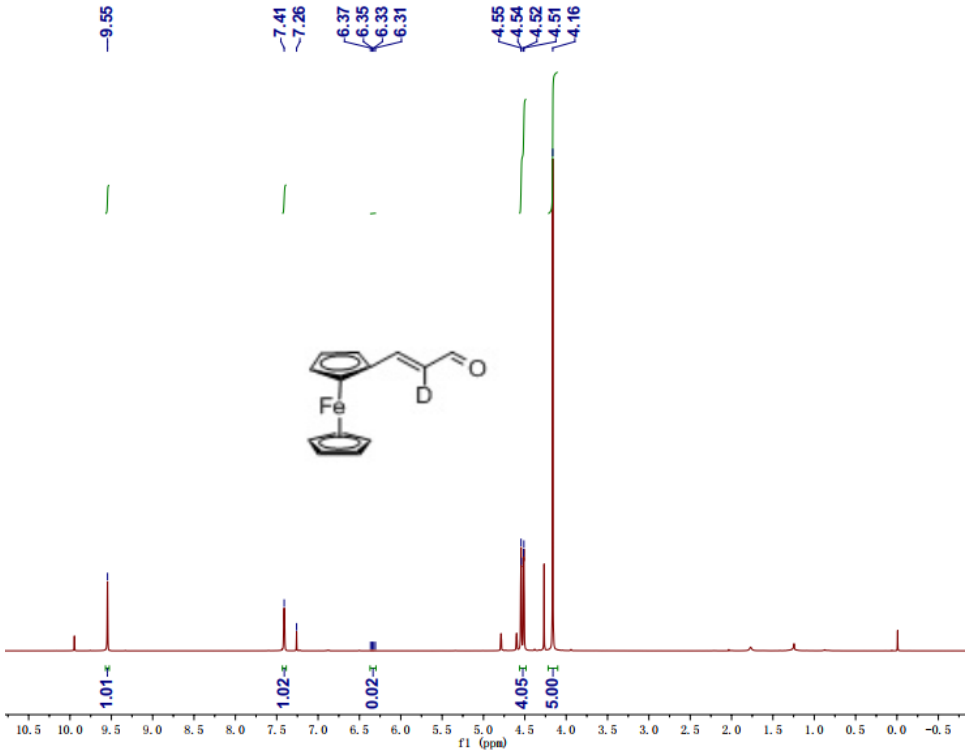
^{2}H NMR of **5ae**



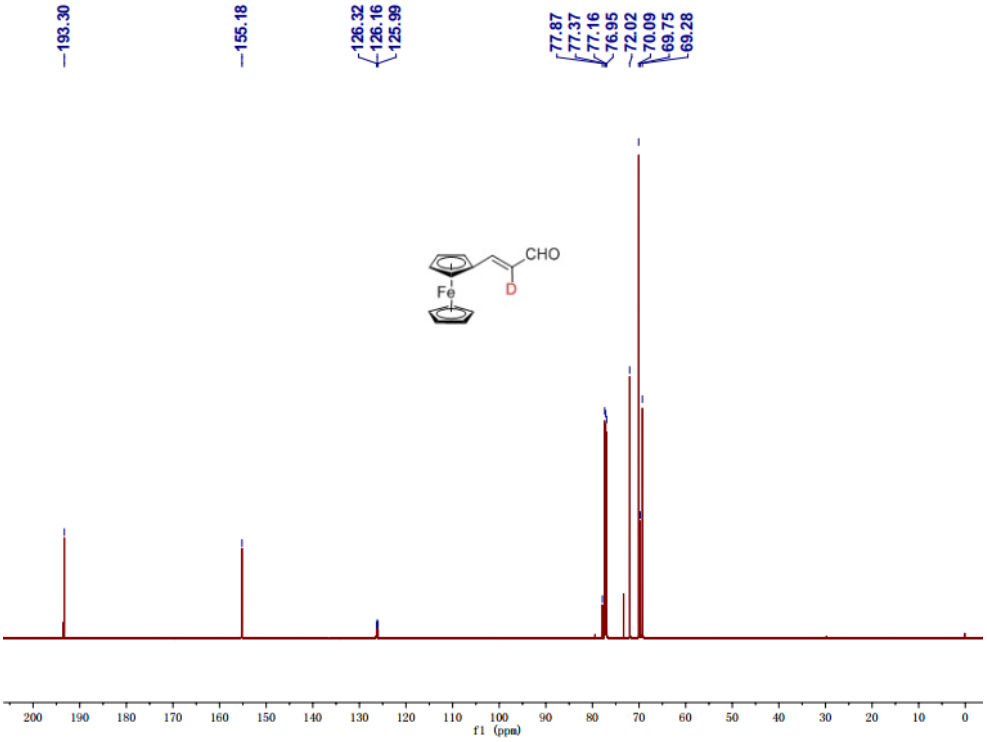
^{19}F NMR of **5ae**



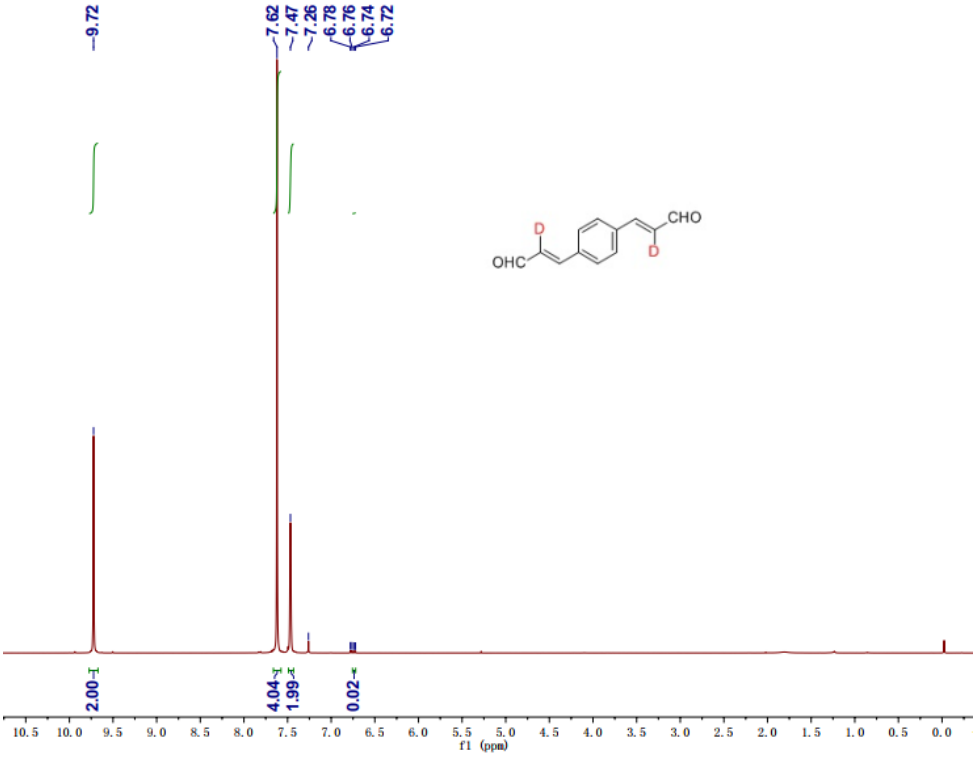
^{1}H NMR of **5af**



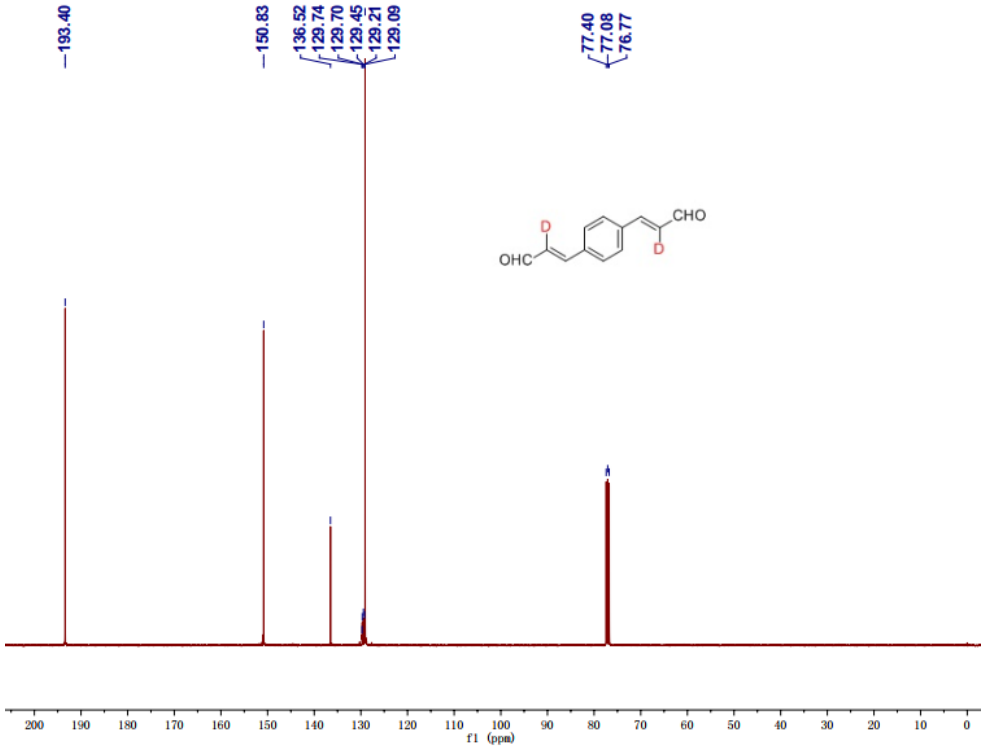
^{13}C NMR of **5af**



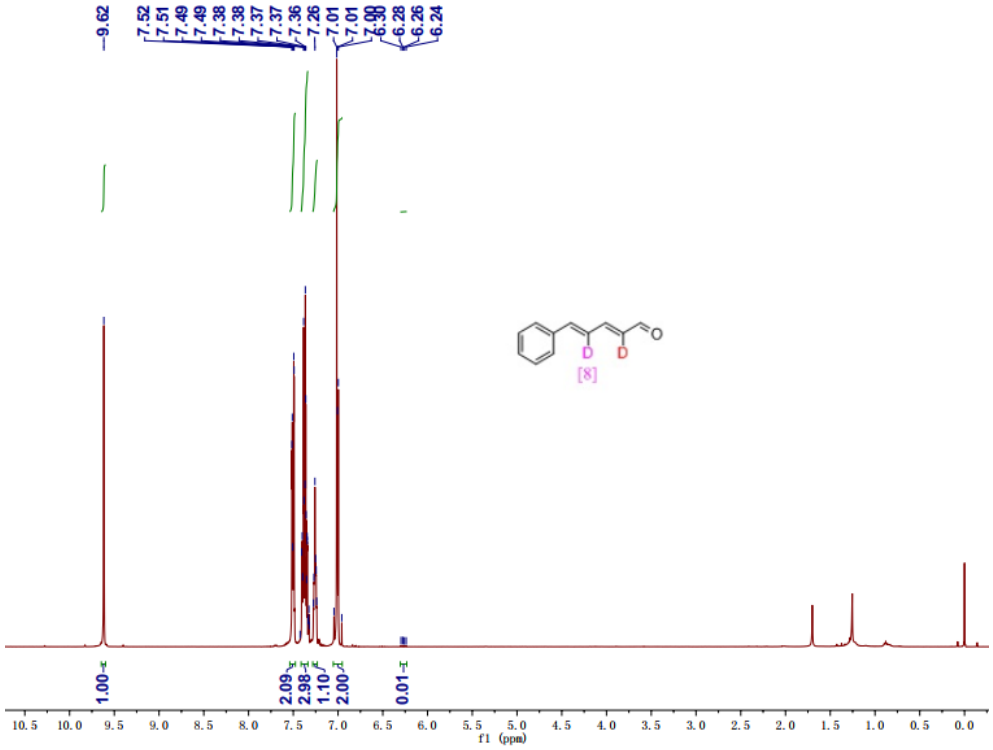
^{1}H NMR of **5ag**



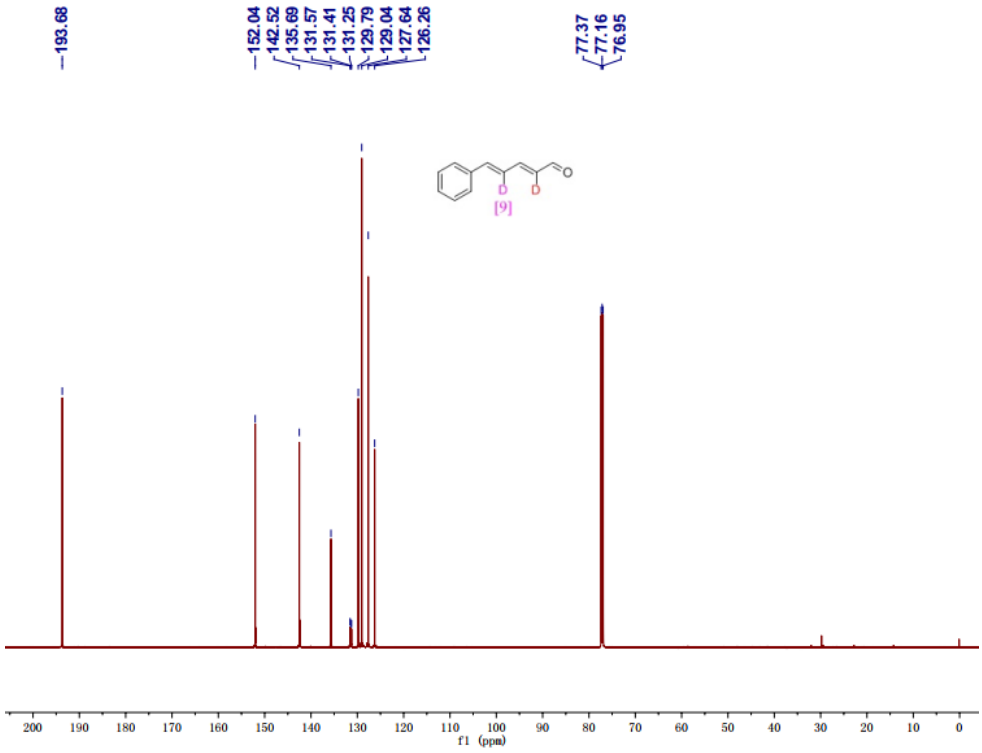
^{13}C NMR of **5ag**



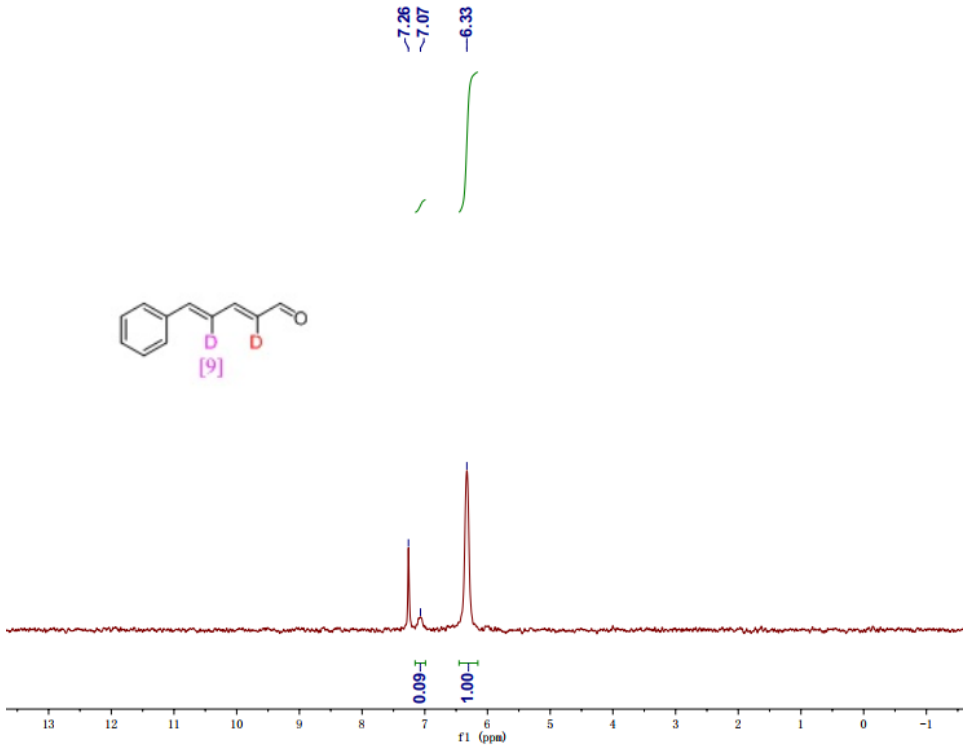
^{1}H NMR of **5ah**



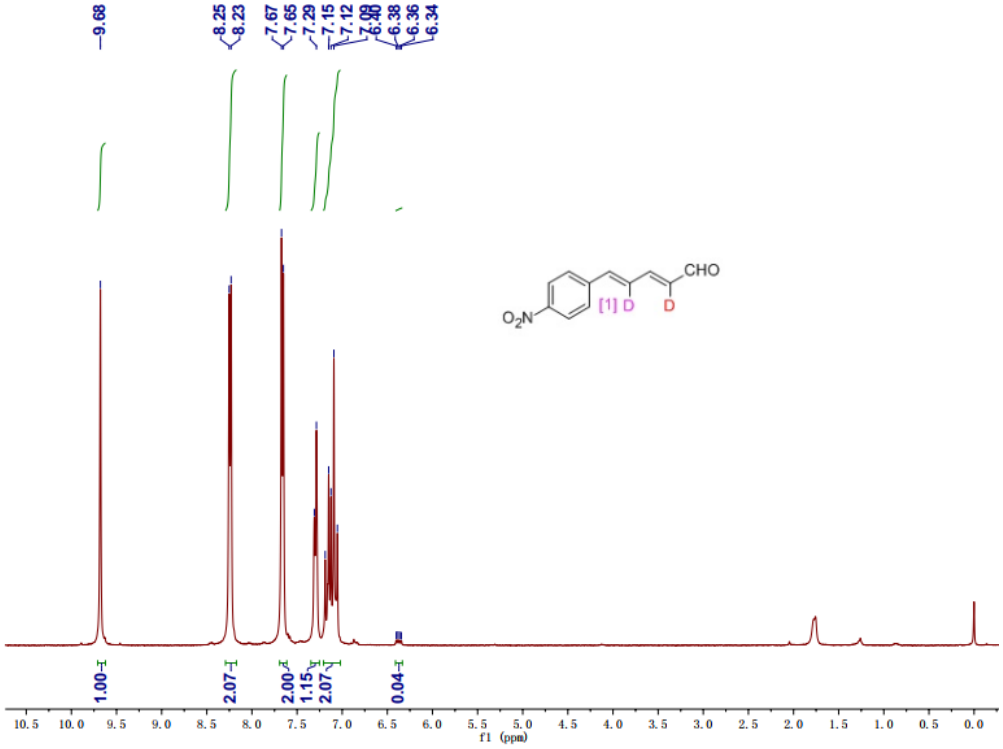
^{13}C NMR of **5ah**



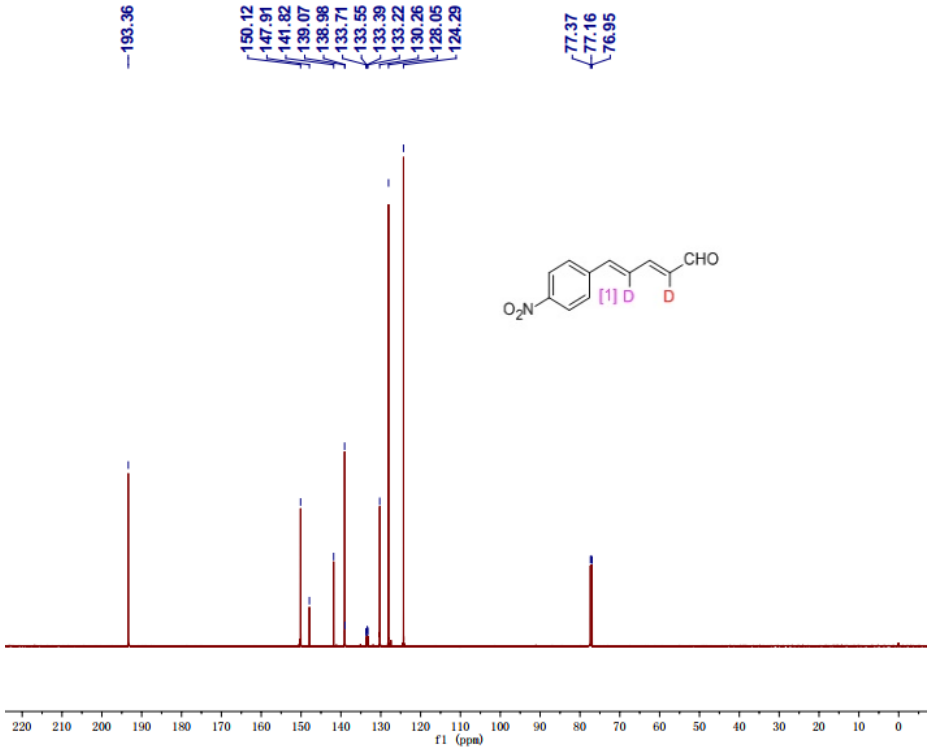
^{2}H NMR of **5ah**



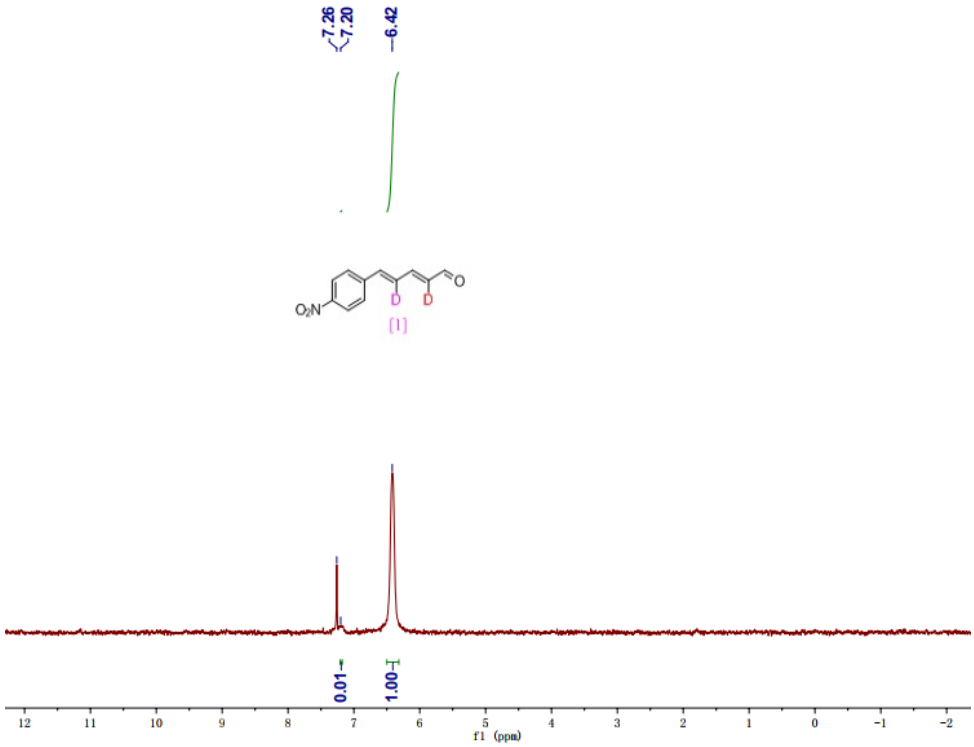
^{1}H NMR of **5ai**



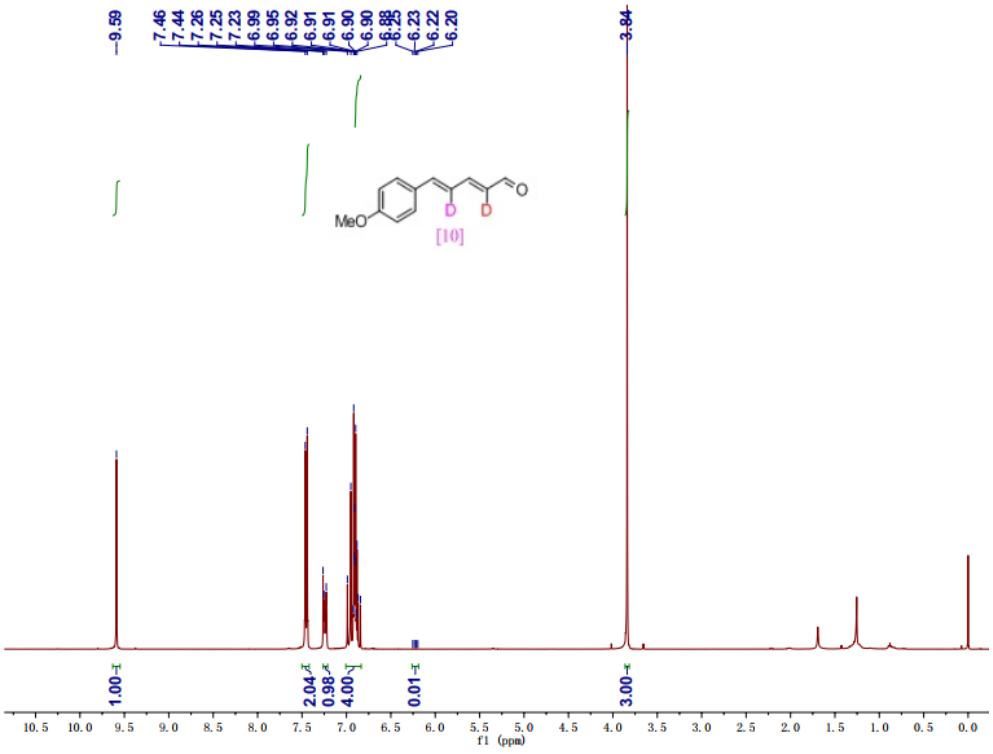
^{13}C NMR of **5ai**



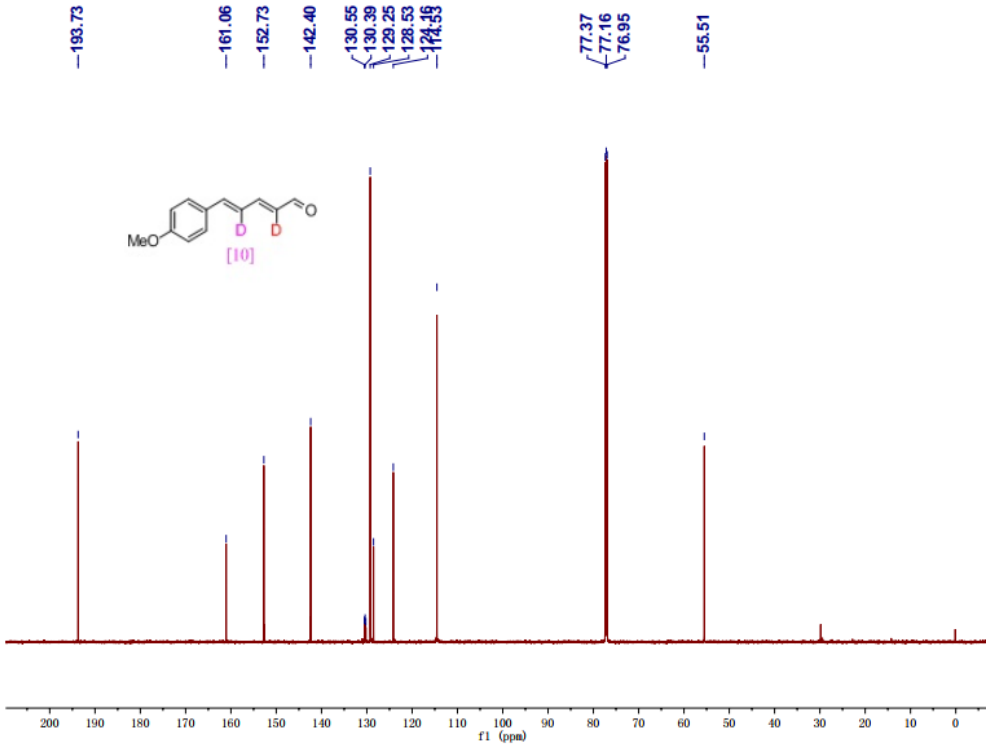
^{2}H NMR of **5ai**



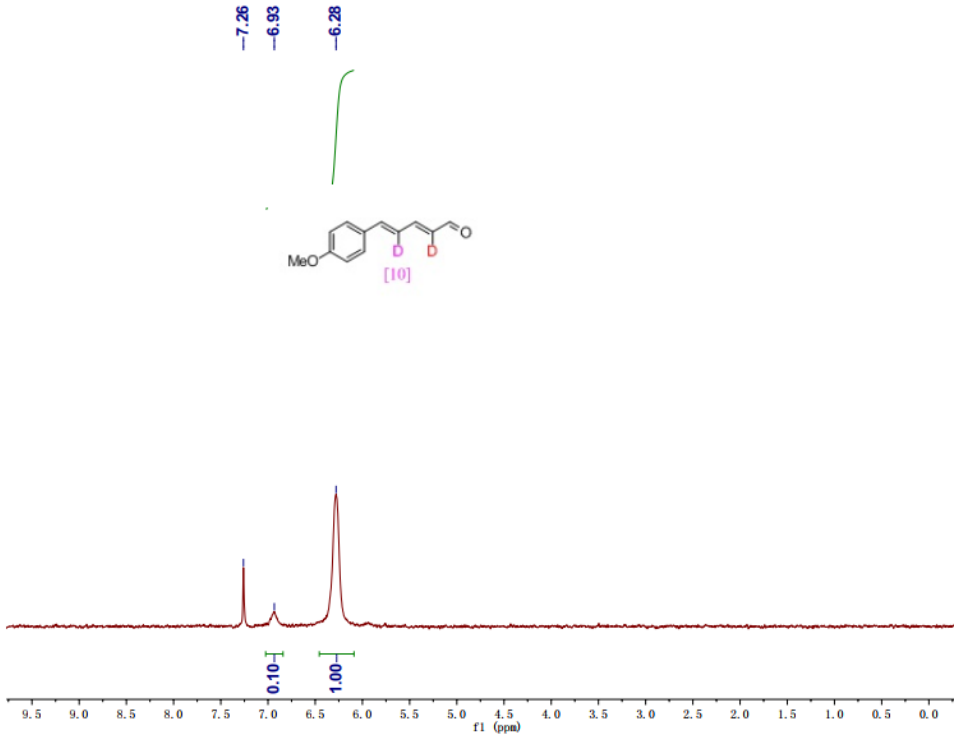
^{1}H NMR of **5aj**



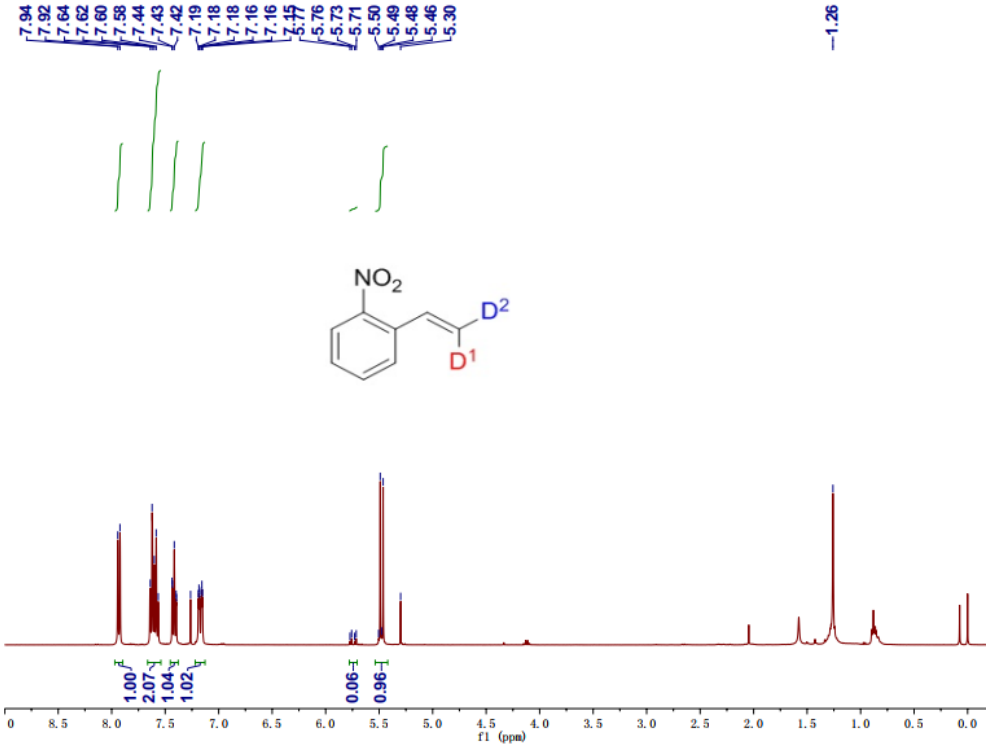
^{13}C NMR of **5aj**



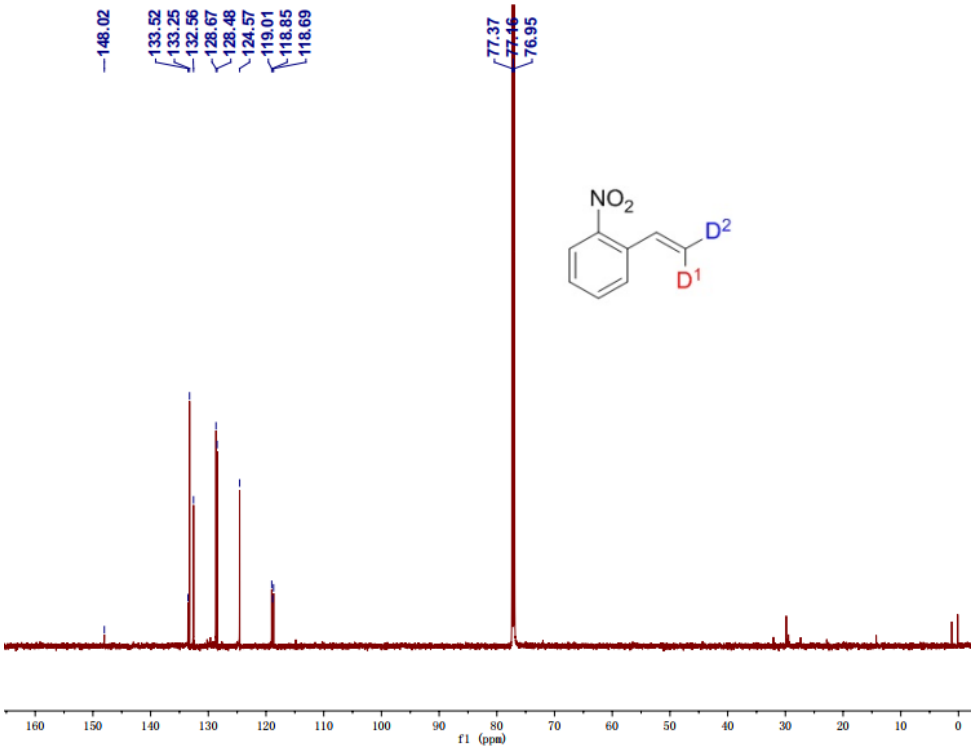
^{2}H NMR of **5aj**



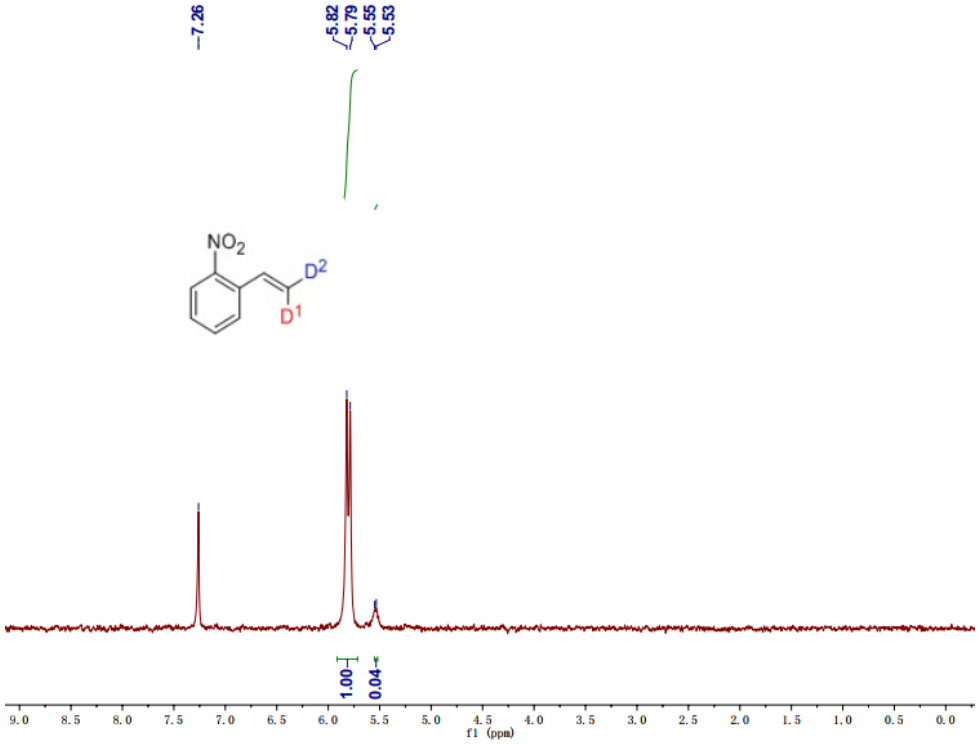
^{1}H NMR of **8c**



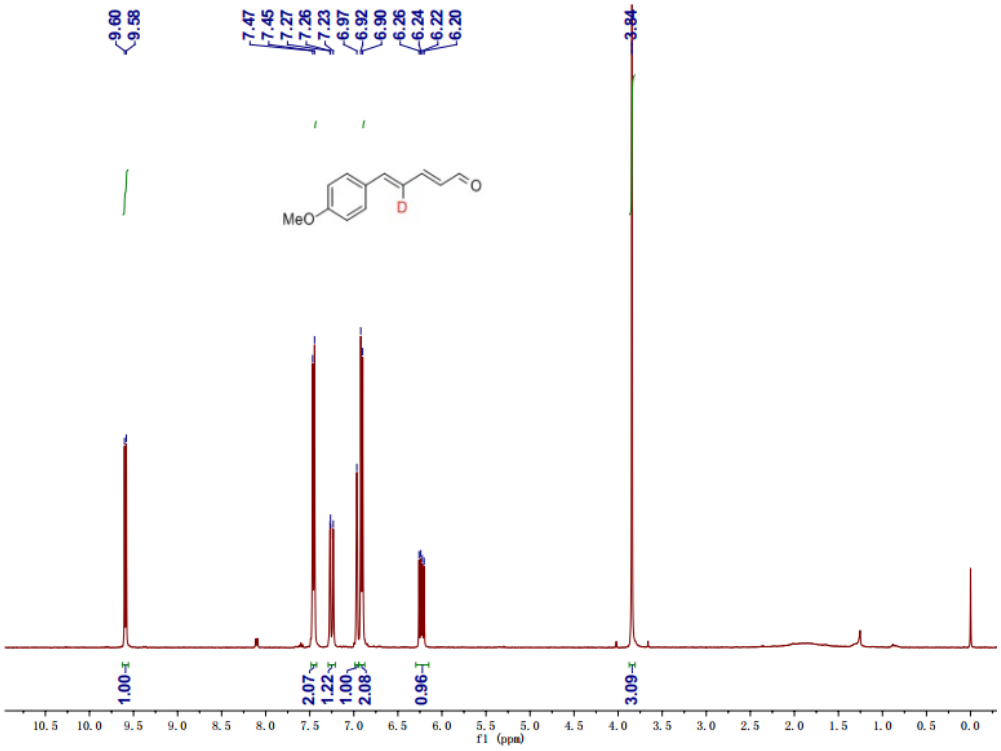
^{13}C NMR of **8c**



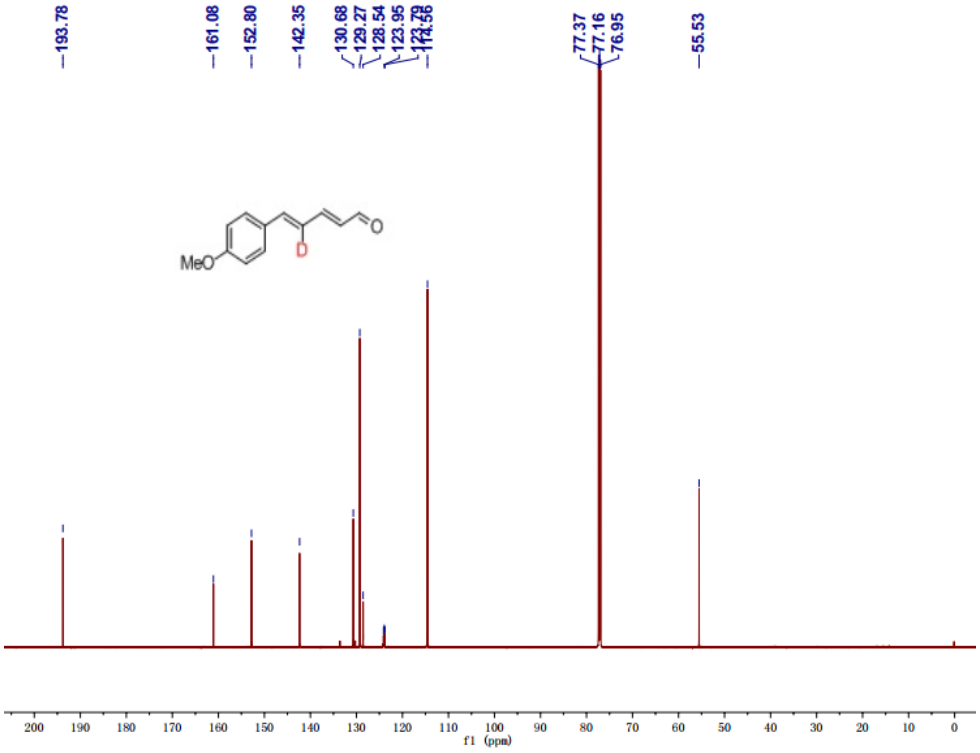
^{2}H NMR of **8c**



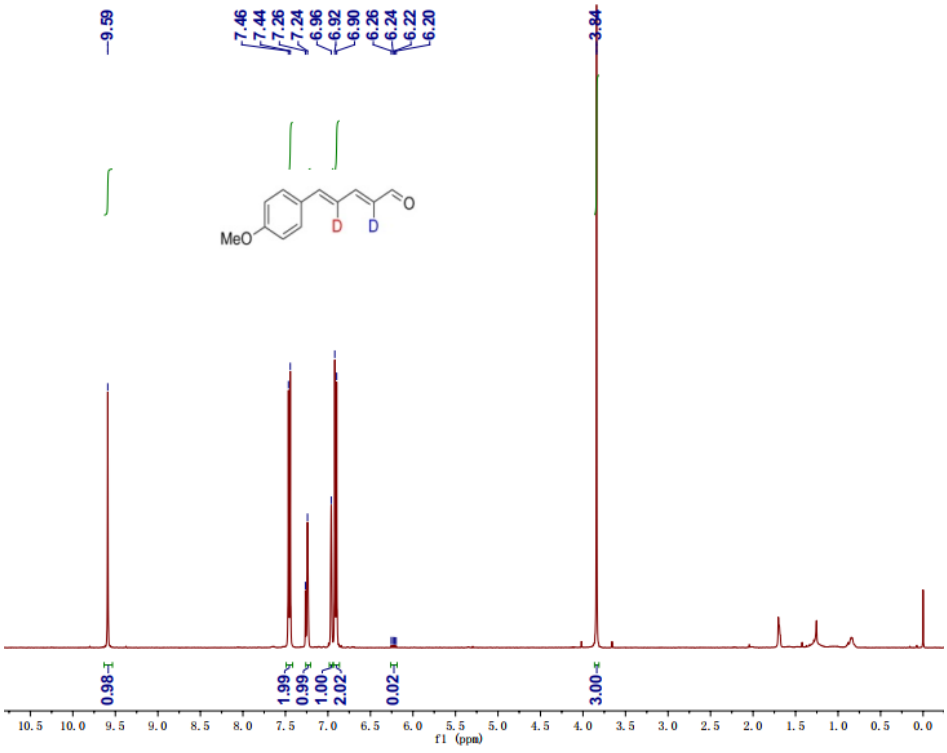
^{1}H NMR of **10**



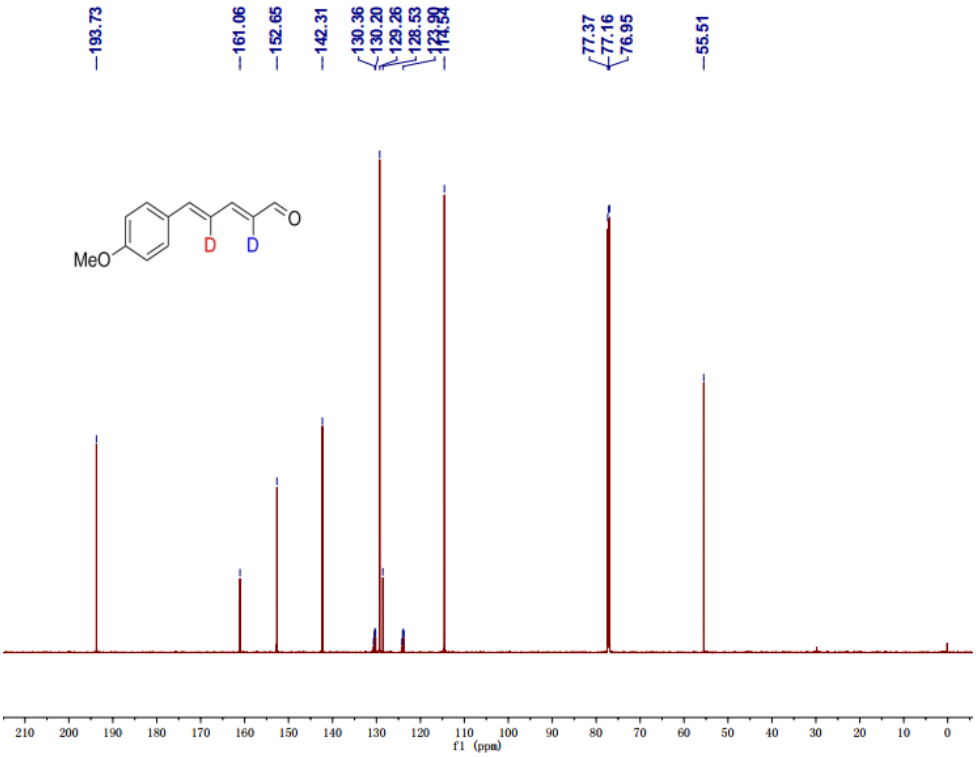
^{13}C NMR of **10**



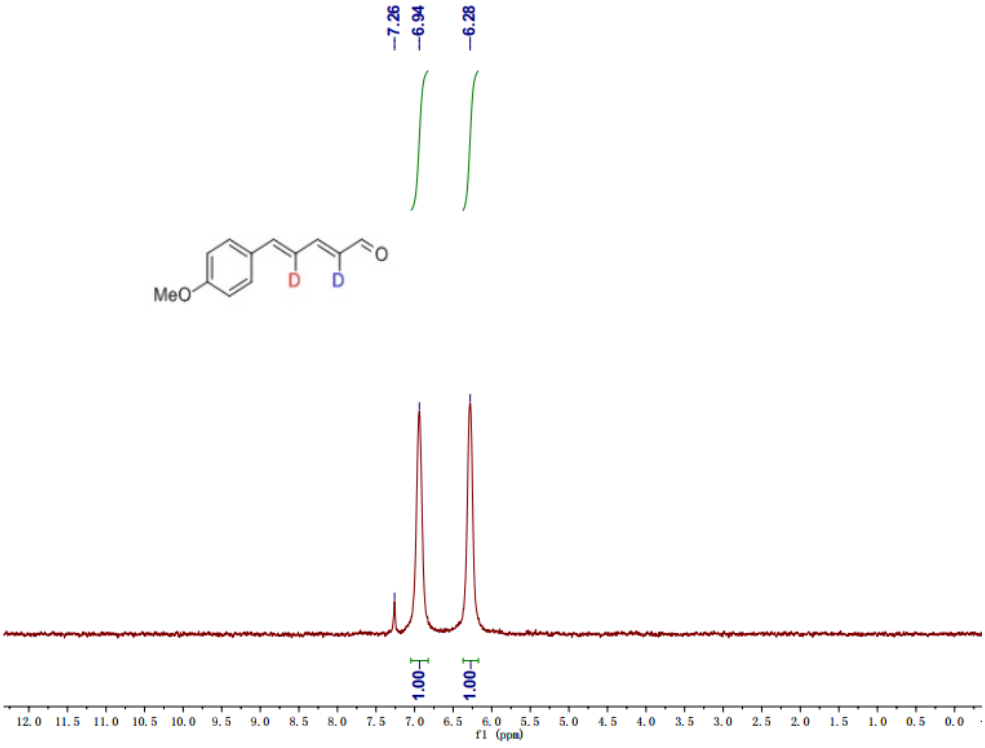
^{1}H NMR of **11**



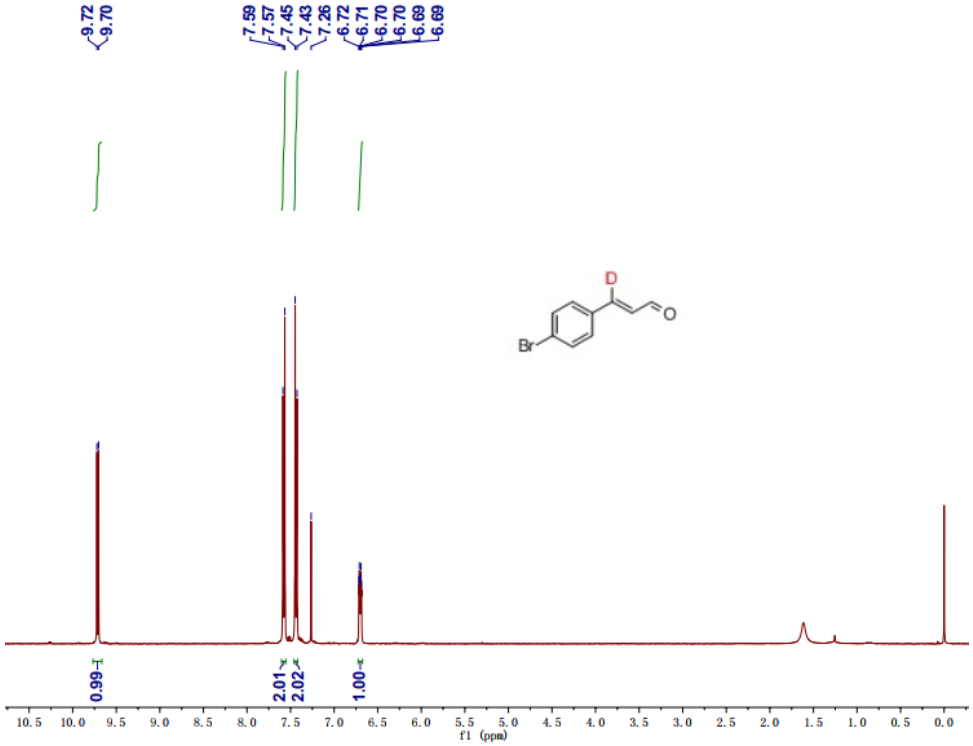
^{13}C NMR of **11**



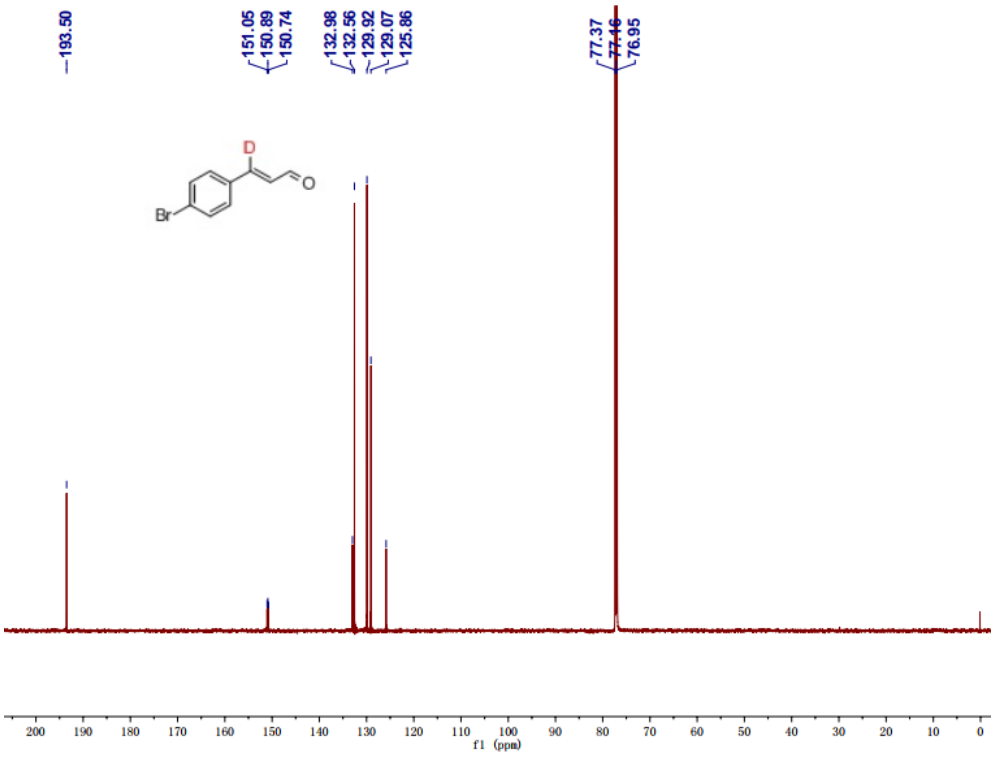
^{2}H NMR of **11**



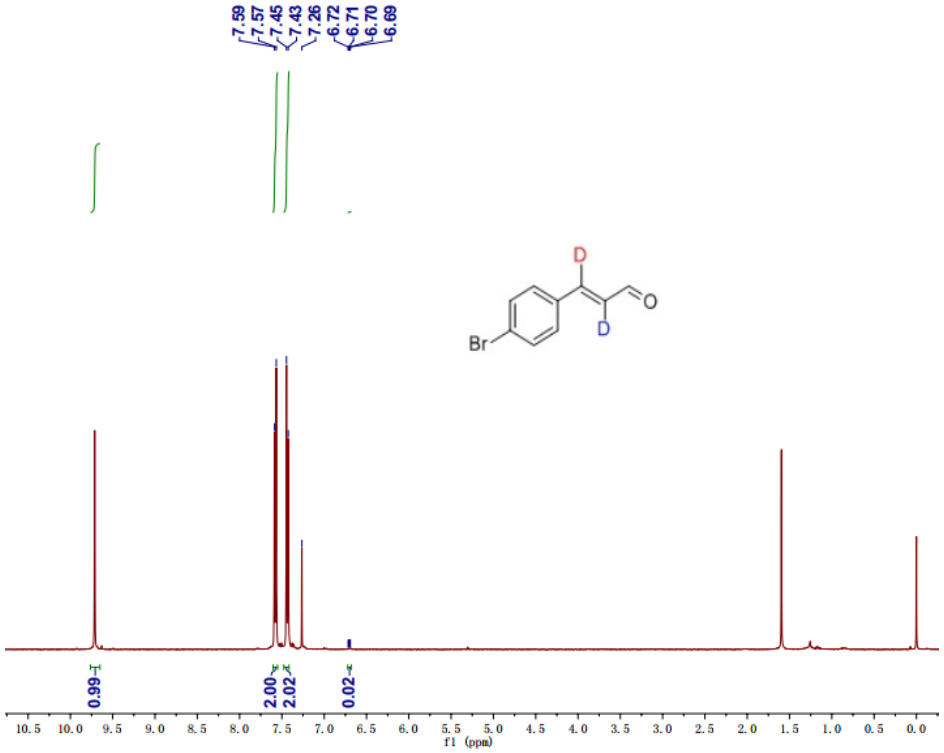
^{1}H NMR of **14**



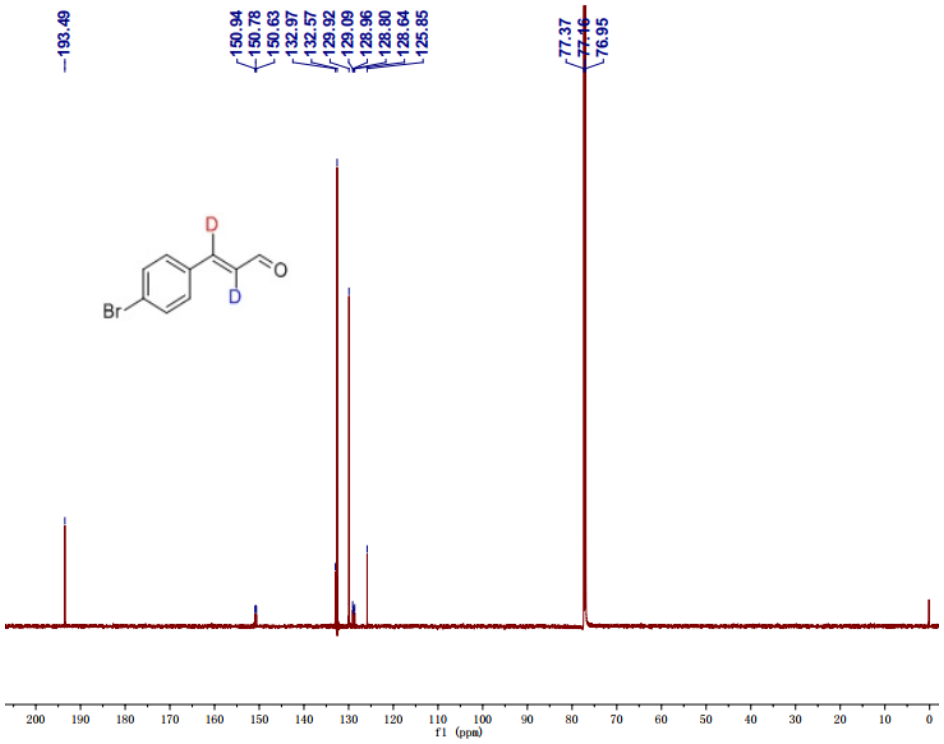
^{13}C NMR of **14**



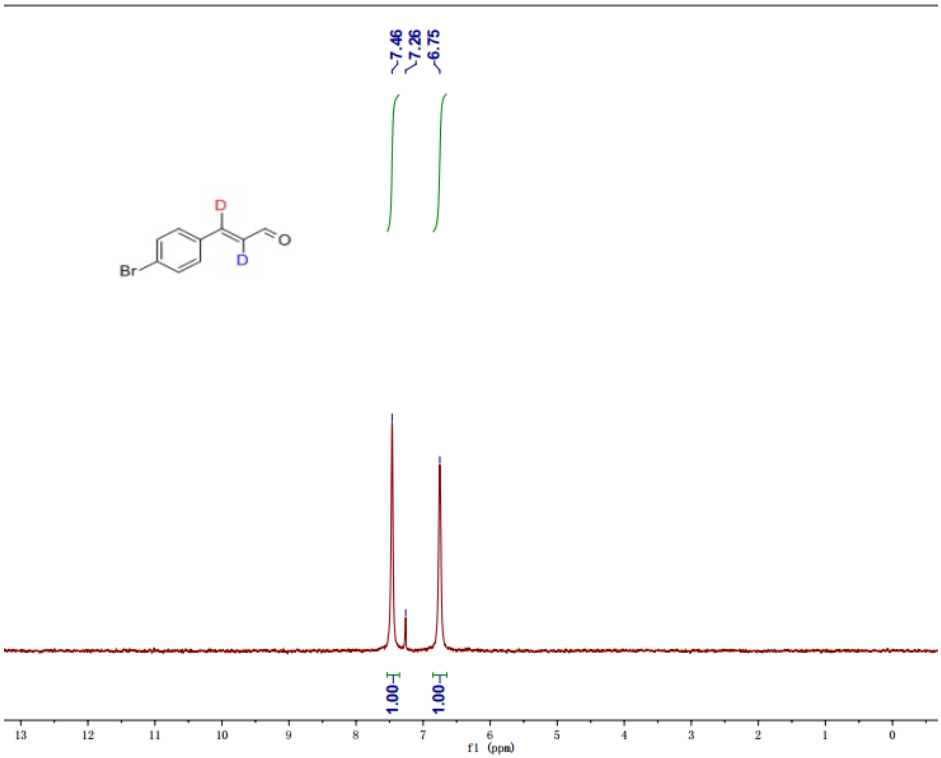
^{1}H NMR of **15**



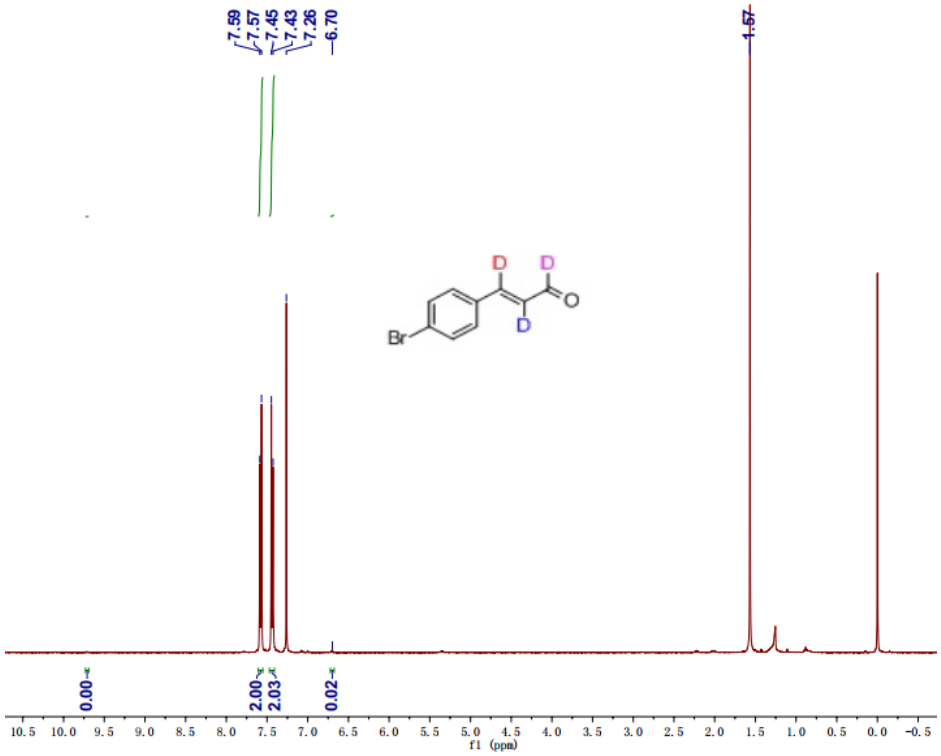
^{13}C NMR of **15**



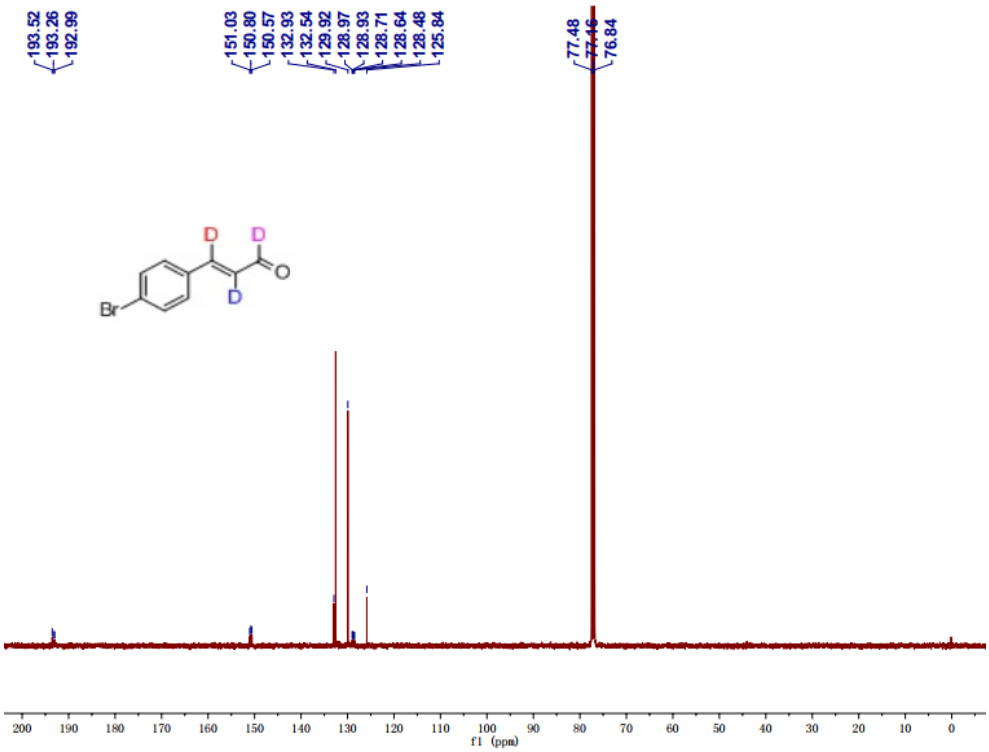
^{2}H NMR of **15**



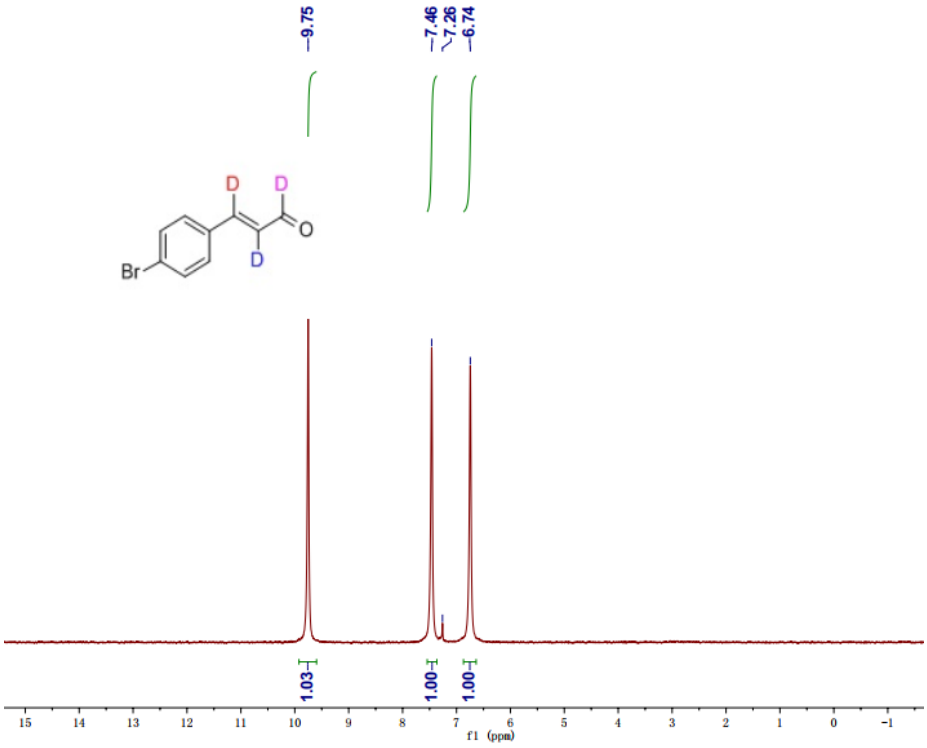
^{1}H NMR of **16**



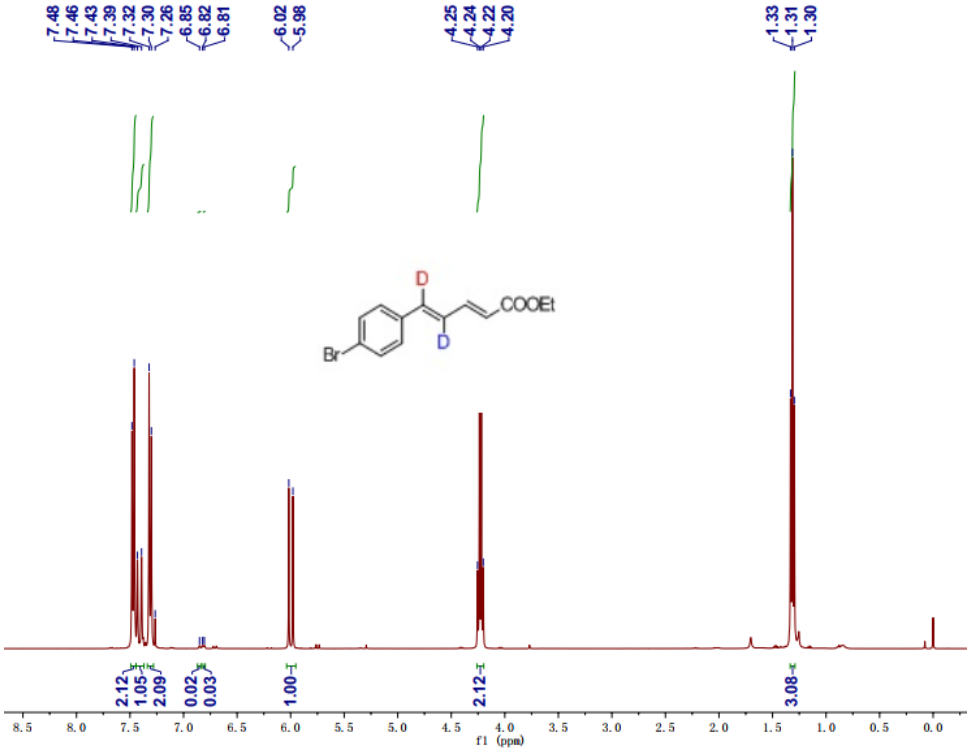
^{13}C NMR of **16**



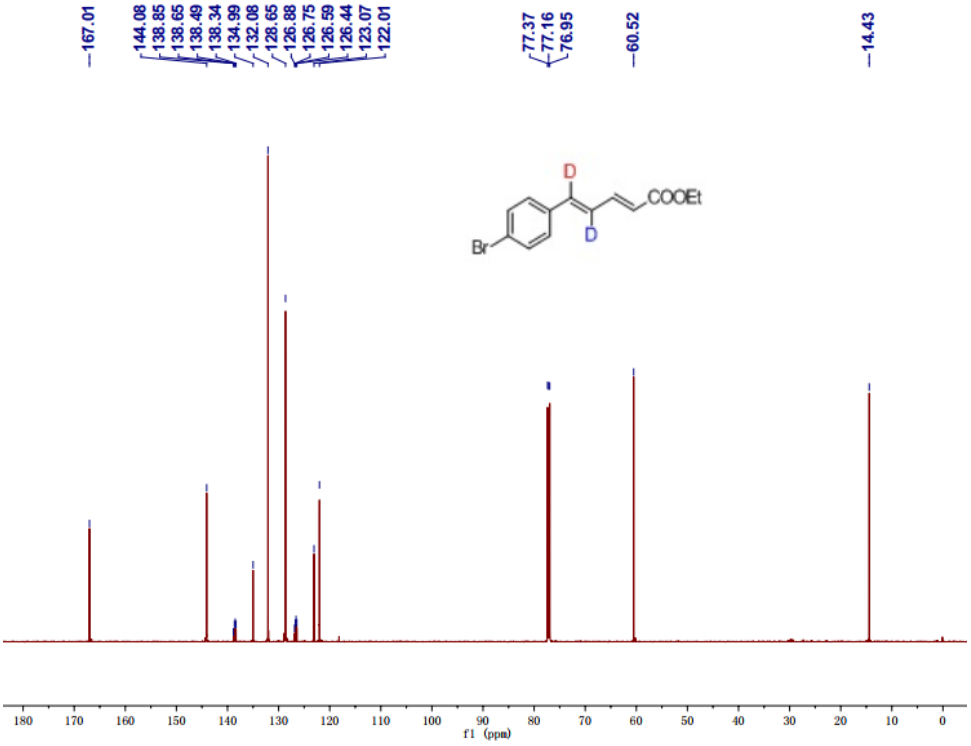
^{2}H NMR of **16**



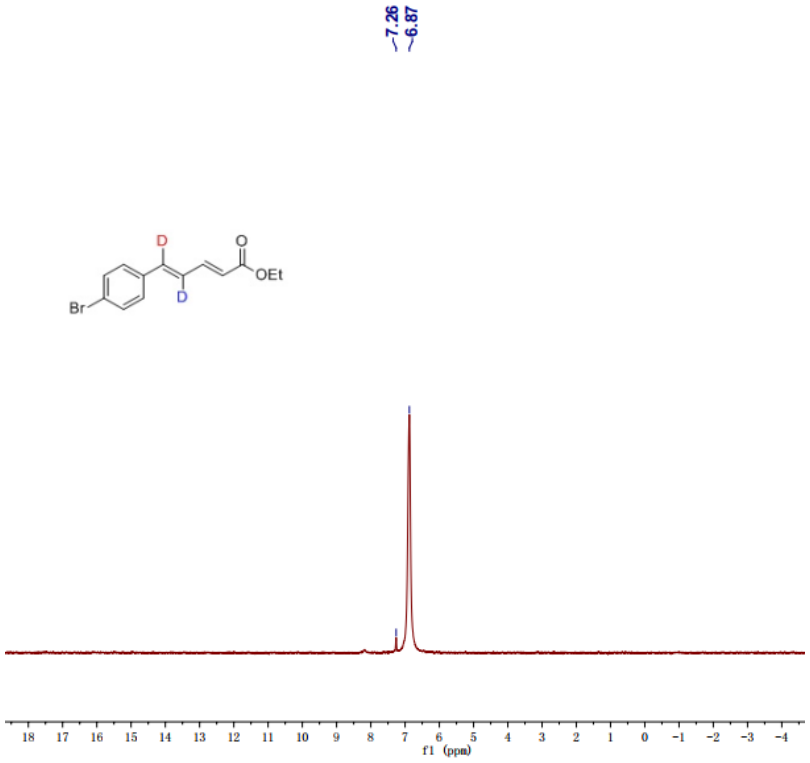
^{1}H NMR of **18**



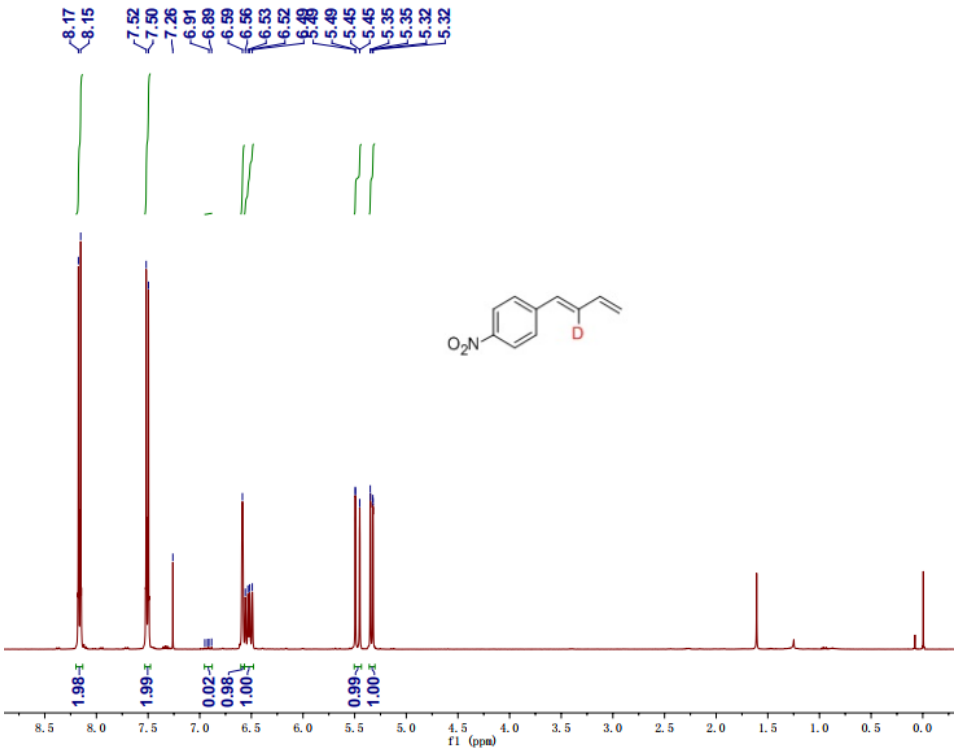
^{13}C NMR of **18**



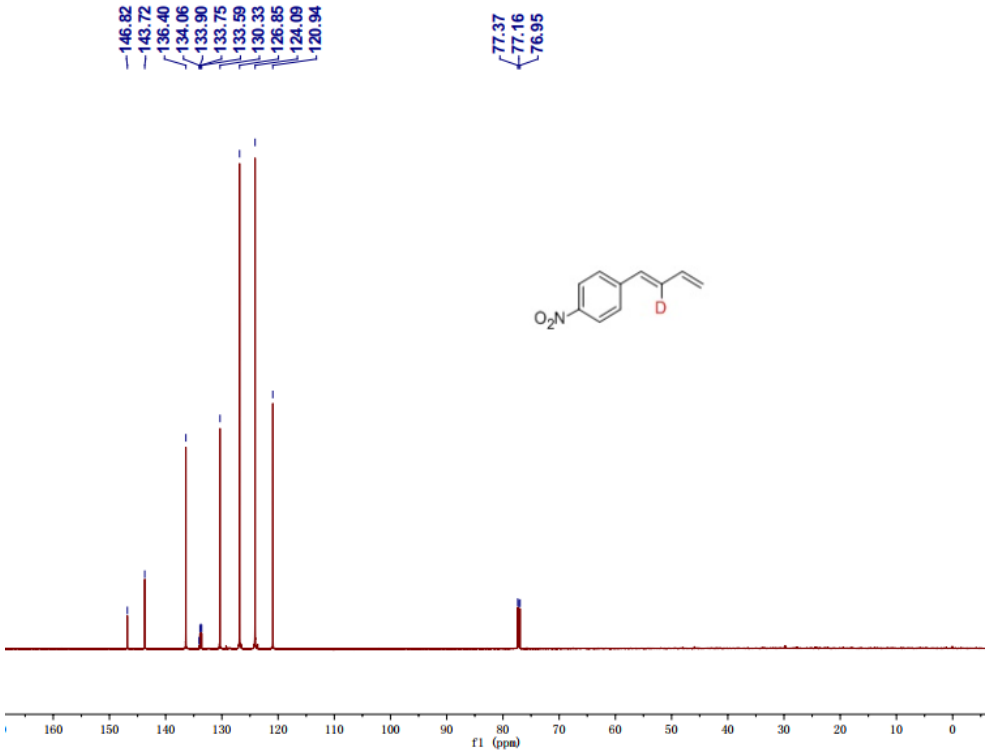
^{2}H NMR of **18**



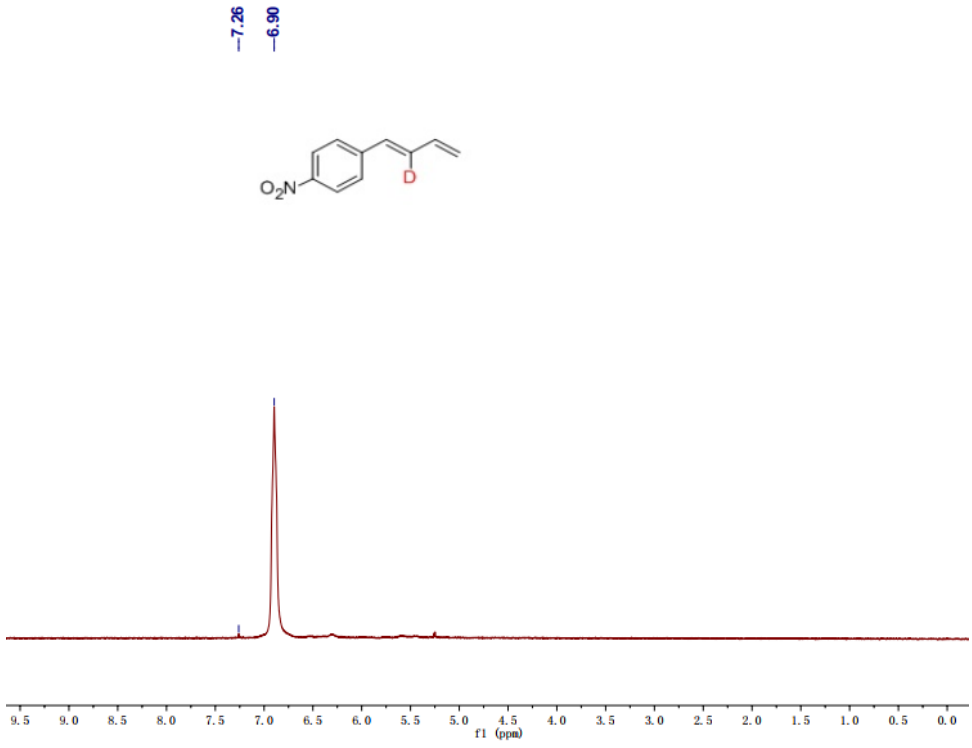
^{1}H NMR of **20**



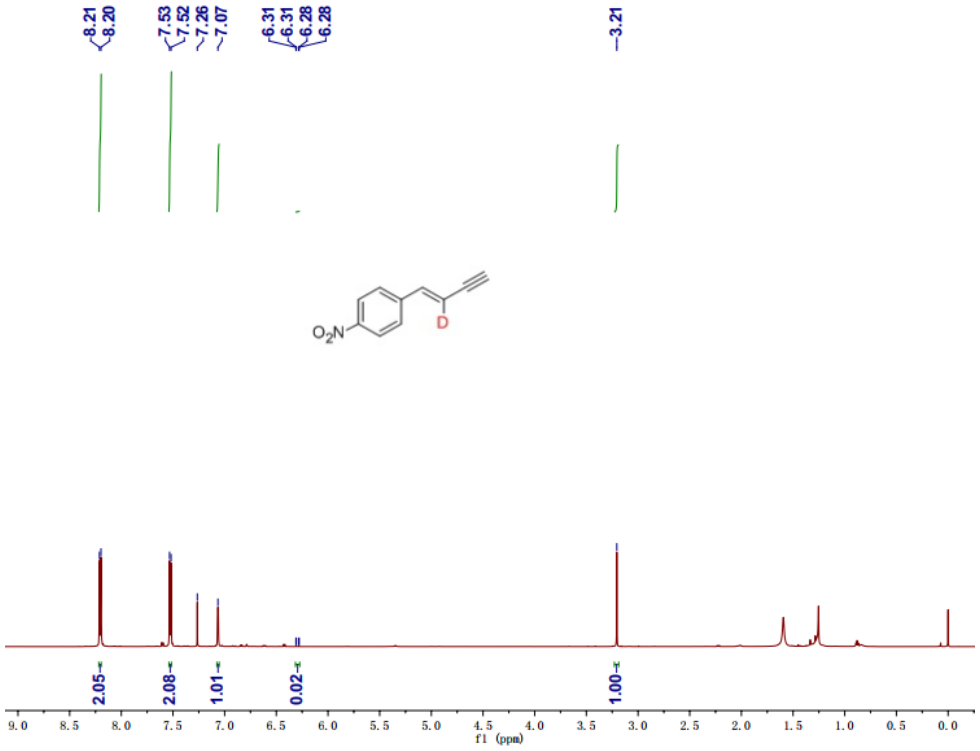
^{13}C NMR of **20**



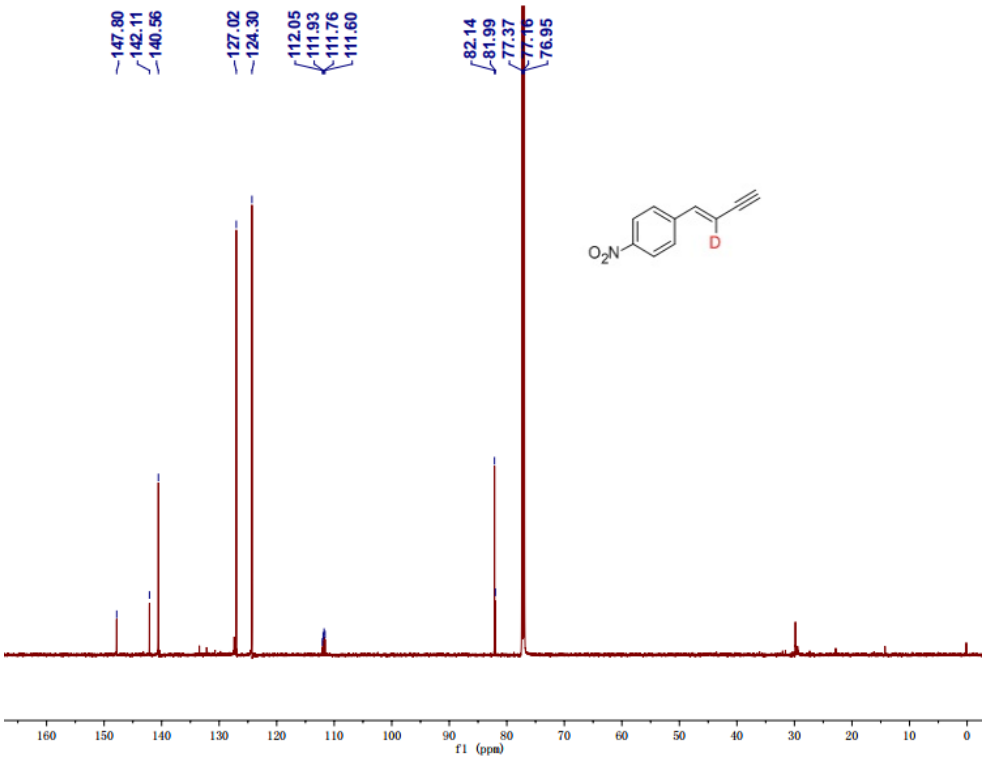
^{2}H NMR of **20**



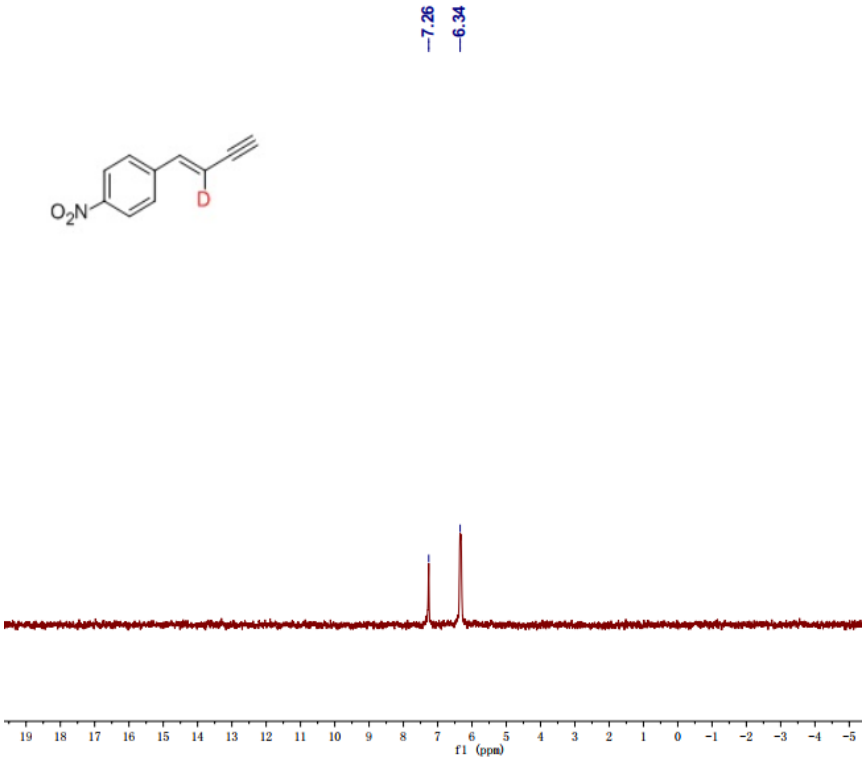
^{1}H NMR of **21**



^{13}C NMR of **21**



^{2}H NMR of **21**


7.26
6.34
O2N
D
19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3 -4 -5
f1 (ppm)