Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information

Concise synthesis of chiral γ-butenolides via an allylation/lactonization cascade

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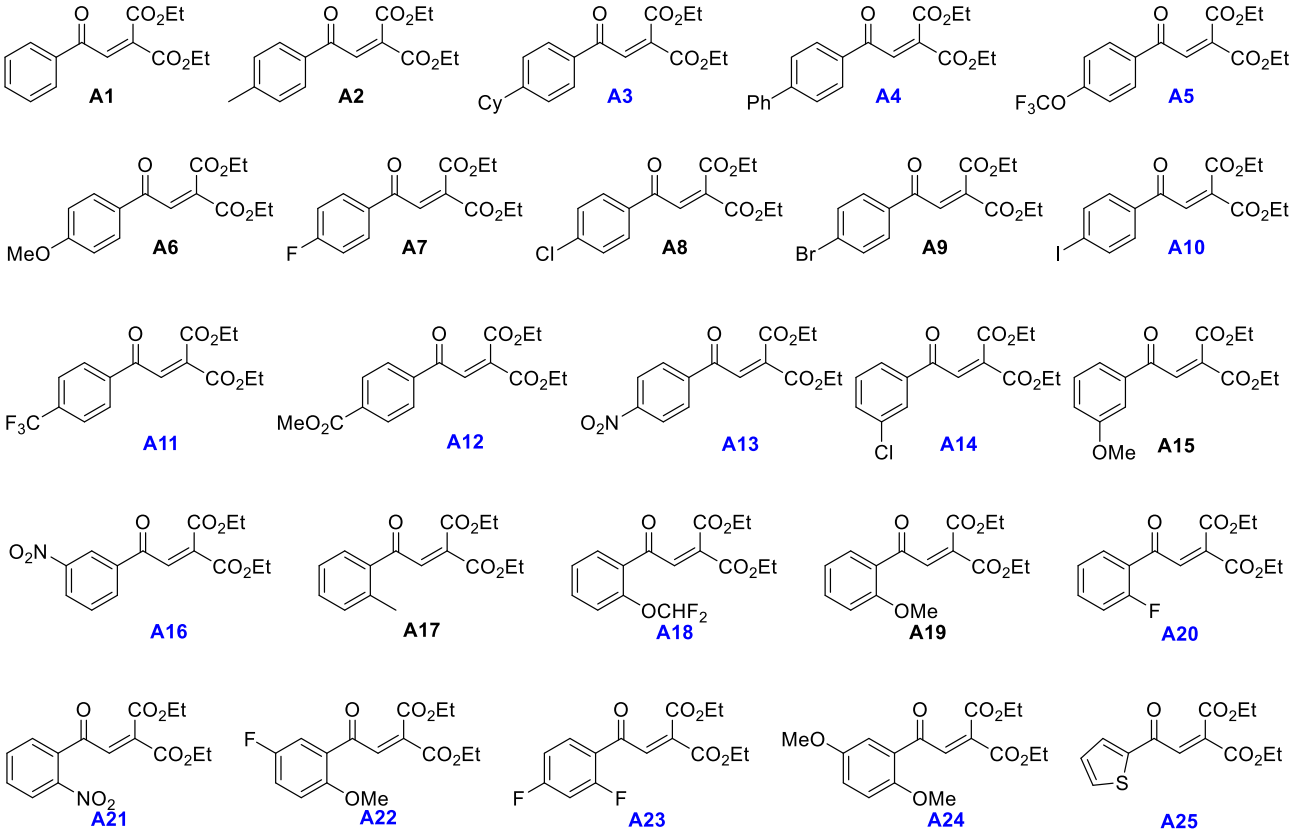
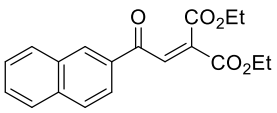
(A) General information

^{1}H NMR spectra were recorded on Bruker ASCEND^{TM} operating at 400 MHz. Chemical shifts were recorded in ppm from tetramethylsilane with the solvent resonance as the internal standard ($CDCl_3$, δ = 7.26). Data were reported as follows: chemical shift (ppm), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, dd = doublet of doublets, dt = doublet of triplets), coupling constants (Hz), integration. $^{13}C\{^{1}H\}$ NMR data were collected on commercial instruments (101 MHz) with complete proton decoupling. Chemical shifts were reported in ppm from tetramethylsilane with the solvent resonance as internal standard ($CDCl_3$, δ = 77.0). $^{19}F\{^{1}H\}$ NMR spectra were collected on a bruker ASCEND^{TM} 400M (376 MHz) in $CDCl_3$ with complete proton decoupling. Enantiomeric excesses (ee) were determined by HPLC analysis by using the corresponding commercial chiralpak column as stated in the experimental procedures at 25 °C. Optical rotations were reported as follows: $[\alpha]_{\lambda}^{T}$ = (*c* = g/100 mL, in CH_2Cl_2, unless otherwise noted, λ = 589 nm). IR was detected by Bruker Tensor II spectrometer with Plantium ATR accessory. HRMS was recorded on a Q Exactive hybrid quadrupole-Orbitrap mass spectrometer (ESI). All reactions were carried out in flame-dried reaction flasks, and all reactions involving air-sensitive reagents were performed under nitrogen atmosphere. Solvents were dried and distilled prior to use according to the standard methods. Metal salts obtained from commercial sources were used without further purification. The chiral *N*,*N*′-dioxide ligands[1], potassium allyltrifluoroborate[2], and enone diesters[3] were synthesized by the same procedure in the literature.

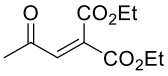
(B) Characterization of the substrates

All the substrates were synthesized according to the methods reported in the literature[2,3], and the NMR of the known substrates was also consistent with the literature reports, and the NMR characterization of the other new compounds (the blue-marked ones) were as follows:

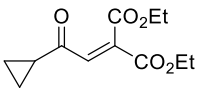




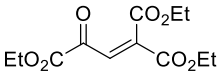
A26



A27



A28



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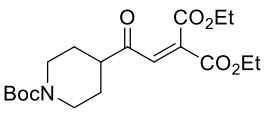
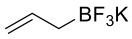
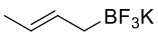


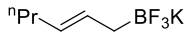
A30



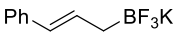
B1



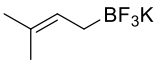
B2



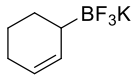
B3



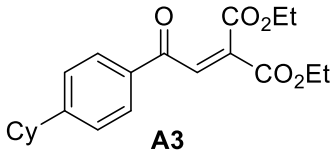
B4



B5

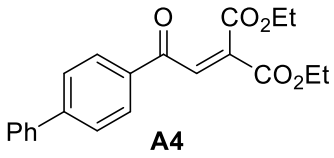


B6



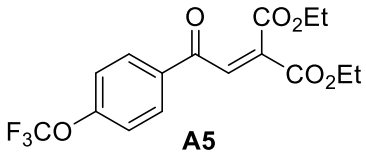
A3

^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 7.93 – 7.88 (m, 2H), 7.85 (s, 1H), 7.37 – 7.30 (m, 2H), 4.34 (q, *J* = 7.2 Hz, 2H), 4.30 (q, *J* = 7.2 Hz, 2H), 2.65 – 2.53 (m, 1H), 1.94 – 1.80 (m, 4H), 1.80 – 1.72 (m, 1H), 1.50 – 1.38 (m, 4H), 1.35 (t, *J* = 7.2 Hz, 3H), 1.29–1.26 (m, 1H), 1.25 (t, *J* = 7.2 Hz, 4H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 188.57, 164.66, 162.96, 155.16, 136.26, 135.43, 133.99, 129.09, 127.45, 62.39, 61.91, 44.80, 34.00, 26.65, 25.97, 14.03, 13.75; **ESI-HRMS** calcd for [$C_{21}H_{26}NO_5$+Na^+]: 381.1673, found 381.1667;



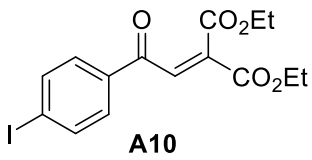
A4

^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 8.33 – 7.17 (m, 10H), 4.61 – 4.02 (m, 4H), 1.55 – 1.00 (m, 6H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 188.57, 164.64, 162.94, 146.91, 139.52, 136.55, 135.23, 134.81, 129.48, 129.06, 128.59, 127.56, 127.34, 62.50, 62.03, 14.07, 13.81; **ESI-HRMS** calcd for [$C_{21}H_{20}NO_5$+Na^+]: 375.1203, found 375.1195;



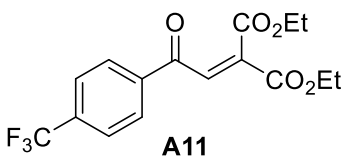
A5

^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 8.08 – 8.00 (m, 2H), 7.81 (s, 1H), 7.38 – 7.30 (m, 2H), 4.33 (dq, *J* = 19.1, 7.1 Hz, 4H), 1.36 (t, *J* = 7.2 Hz, 3H), 1.27 (t, *J* = 7.2 Hz, 3H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 187.68, 164.31, 162.69, 153.34 (q, $J_{F\text{-}C}$ = 1.8 Hz), 136.99, 134.66, 134.20, 130.91, 120.22 (q, $J_{F\text{-}C}$ = 259.3 Hz), 116.36, 62.55, 62.06, 13.97, 13.70; **^{19}F{^{1}H} NMR** (377 MHz, Chloroform-*d*) *δ* –57.65; **ESI-HRMS** calcd for [$C_{16}H_{15}F_3O_6$+Na^+]: 383.0713, found 383.0708;



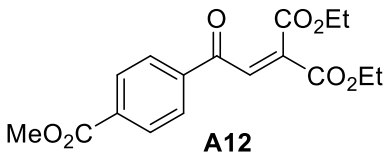
A10

^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 7.92 – 7.82 (m, 2H), 7.78 (s, 1H), 7.72 – 7.64 (m, 2H), 4.33 (dq, *J* = 18.4, 7.1 Hz, 4H), 1.36 (t, *J* = 7.1 Hz, 3H), 1.27 (t, *J* = 7.1 Hz, 3H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 188.48, 164.38, 162.75, 138.32, 136.93, 135.31, 134.60, 130.03, 102.71, 62.58, 62.09, 14.04, 13.79; **ESI-HRMS** calcd for [$C_{15}H_{15}IO_5$+Na^+]: 424.9857, found 424.9849;



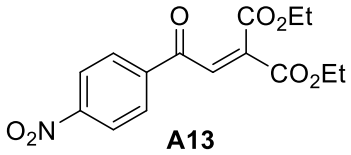
A11

^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 8.12 – 8.06 (m, 2H), 7.82 (s, 1H), 7.79 (d, *J* = 8.2 Hz, 2H), 4.34 (dq, *J* = 21.7, 7.1 Hz, 2H), 1.37 (t, *J* = 7.2 Hz, 1H), 1.27 (t, *J* = 7.1 Hz, 1H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 188.36, 164.20, 162.62, 138.64, 137.36, 135.27 (q, $J_{F\text{-}C}$ = 32.9 Hz), 134.45, 129.12, 126.00 (q, *J* = 3.8 Hz), 123.40 (q, *J* = 272.8 Hz), 62.65, 62.15, 13.98, 13.72; **ESI-HRMS** calcd for [$C_{16}H_{15}F_3O_5$+Na^+]: 367.0764, found 367.0757;



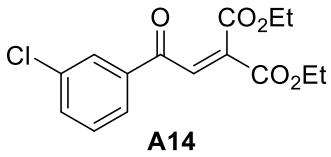
A12

^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 8.20 – 8.13 (m, 2H), 8.06 – 7.99 (m, 2H), 7.83 (s, 1H), 4.33 (dq, *J* = 25.4, 7.1 Hz, 4H), 3.97 (s, 3H), 1.37 (t, *J* = 7.1 Hz, 3H), 1.27 (t, *J* = 7.1 Hz, 3H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 188.75, 165.97, 164.29, 162.71, 139.14, 137.11, 134.78, 134.72, 130.10, 128.71, 62.62, 62.13, 52.62, 14.04, 13.77; **ESI-HRMS** calcd for [$C_{18}H_{18}O_7$+Na$^+$]: 357.0945, found 357.0939;



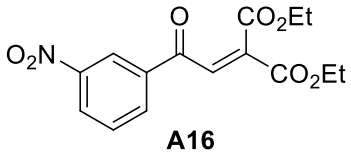
A13

^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 8.40 – 8.33 (m, 2H), 8.20 – 8.08 (m, 2H), 7.81 (s, 1H), 4.35 (dq, *J* = 21.6, 7.1 Hz, 4H), 1.37 (t, *J* = 7.1 Hz, 3H), 1.29 (t, *J* = 7.1 Hz, 3H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 187.88, 164.04, 162.49, 150.82, 140.34, 137.80, 134.07, 129.81, 124.16, 62.78, 62.28, 14.02, 13.79; **ESI-HRMS** calcd for [$C_{15}H_{15}NO_7$+Na$^+$]: 344.0741, found 344.0735; **ESI-HRMS** calcd for [$C_{15}H_{15}NO_7$+Na$^+$]: 344.0741, found 344.0735;



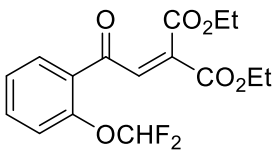
A14

^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 7.94 (t, *J* = 1.9 Hz, 1H), 7.88 – 7.81 (m, 1H), 7.78 (s, 1H), 7.60 (ddd, *J* = 8.0, 2.1, 1.0 Hz, 1H), 7.46 (t, *J* = 7.9 Hz, 1H), 4.33 (dq, *J* = 20.1, 7.2 Hz, 4H), 1.36 (t, *J* = 7.1 Hz, 3H), 1.28 (t, *J* = 7.2 Hz, 3H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 187.98, 164.29, 162.69, 137.52, 137.14, 135.36, 134.56, 134.13, 130.31, 128.73, 126.92, 62.61, 62.12, 14.03, 13.76; **ESI-HRMS** calcd for [$C_{15}H_{15}ClO_5$+Na$^+$]: 333.0501, 335.0471, found 333.0495, 335.0463;



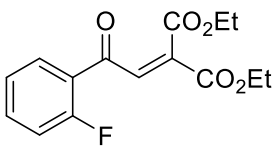
A16

^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 8.80 (t, *J* = 2.0 Hz, 1H), 8.50 (ddd, *J* = 8.2, 2.3, 1.1 Hz, 1H), 8.31 (dt, *J* = 7.9, 1.4 Hz, 1H), 7.83 (s, 1H), 7.76 (t, *J* = 8.0 Hz, 1H), 4.36 (dq, *J* = 20.5, 7.2 Hz, 4H), 1.38 (t, *J* = 7.2 Hz, 3H), 1.29 (t, *J* = 7.2 Hz, 3H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 187.24, 164.11, 162.49, 148.59, 138.03, 137.27, 134.19, 133.73, 130.34, 128.33, 123.57, 62.80, 62.28, 14.03, 13.80; **ESI-HRMS** calcd for [$C_{15}H_{15}NO_7$+Na$^+$]: 344.0741, found 344.0736;



A18

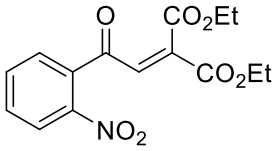
^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 7.82 (dd, *J* = 7.8, 1.8 Hz, 1H), 7.71 (s, 1H), 7.60 (ddd, *J* = 8.3, 7.4, 1.8 Hz, 1H), 7.34 (td, *J* = 7.6, 1.1 Hz, 1H), 7.24 (dd, *J* = 8.3, 1.2 Hz, 1H), 6.60 (t, $J_{F\text{-}H}$ = 72.9 Hz, 1H), 4.31 (dq, *J* = 17.1, 7.1 Hz, 4H), 1.34 (t, *J* = 7.1 Hz, 3H), 1.28 (t, *J* = 7.1 Hz, 3H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 188.99, 164.52, 162.89, 149.97 (t, *J* = 2.8 Hz), 138.07, 134.78, 134.75, 131.14, 129.76, 125.95, 120.04, 115.79 (t, *J* = 262.6 Hz), 62.35, 61.99, 13.97, 13.76; **^{19}F{^{1}H} NMR** (377 MHz, Chloroform-*d*) *δ* –81.19; **ESI-HRMS** calcd for [$C_{16}H_{16}F_2O_6$+Na$^+$]: 365.0808, found 365.0802;



A20

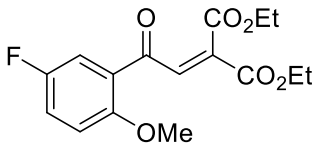
^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 7.87 (td, *J* = 7.6, 1.9 Hz, 1H), 7.77 (d, *J* = 3.9 Hz, 1H), 7.65 – 7.55 (m, 1H), 7.32 – 7.24 (m, 1H), 7.22 – 7.14 (m, 1H), 4.34 (qd, *J* = 7.1, 1.8 Hz, 4H), 1.33 (dt, *J* = 15.1, 7.2 Hz, 6H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 186.86, 186.83, 164.64, 162.87, 162.07 (d, $J_{F\text{-}C}$ = 256.4 Hz), 137.01 (d, $J_{F\text{-}C}$ = 7.1 Hz), 136.09 (d, $J_{F\text{-}C}$ = 1.8 Hz), 135.89 (d, $J_{F\text{-}C}$ = 9.1 Hz), 131.09 (d, $J_{F\text{-}C}$ = 1.8 Hz), 124.95 (d, $J_{F\text{-}C}$ = 11.6 Hz), 124.83 (d, $J_{F\text{-}C}$ = 3.4 Hz),

116.85 (d, J_{F-C} = 22.9 Hz), 62.43, 62.01, 14.01, 13.81; **^{19}F{^{1}H} NMR** (377 MHz, Chloroform-*d*) δ –108.90; **ESI-HRMS** calcd for [$C_{15}H_{15}FO_5$+Na^+]: 317.0796, found 317.0792;



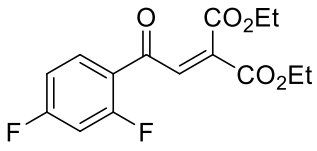
A21

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.18 (dd, *J* = 8.2, 1.2 Hz, 1H), 7.82 – 7.76 (m, 1H), 7.74 – 7.68 (m, 1H), 7.56 – 7.51 (m, 1H), 4.30 (q, *J* = 7.1 Hz, 2H), 4.22 (q, *J* = 7.2 Hz, 2H), 1.31 (td, *J* = 7.2, 1.2 Hz, 6H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): δ 189.68, 164.19, 162.45, 146.18, 136.07, 135.31, 134.59, 134.48, 131.85, 129.16, 124.38, 62.67, 62.18, 13.95, 13.78; **ESI-HRMS** calcd for [$C_{15}H_{15}NO_7$+Na^+]: 344.0741, found 344.0735;



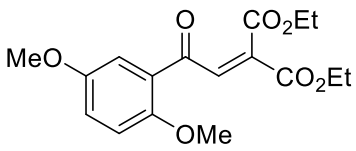
A22

^{1}H NMR (400 MHz, Chloroform-*d*): δ 7.82 (s, 1H), 7.51 – 7.42 (m, 1H), 7.30 – 7.20 (m, 1H), 7.01 – 6.91 (m, 1H), 4.33 (q, *J* = 7.1 Hz, 4H), 3.91 (s, 3H), 1.33 (dt, *J* = 13.9, 7.1 Hz, 6H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): δ 188.56 (d, J_{F-C} = 1.8 Hz), 164.92, 163.25, 156.88 (d, J_{F-C} = 241.2 Hz), 155.77 (d, J_{F-C} = 2.0 Hz), 138.66, 133.97, 127.30 (d, J_{F-C} = 6.3 Hz), 121.73 (d, J_{F-C} = 23.6 Hz), 116.97 (d, J_{F-C} = 24.3 Hz), 113.37 (d, J_{F-C} = 7.5 Hz) 62.21, 61.86, 56.44, 14.02, 13.82; **^{19}F NMR{^{1}H}** (377 MHz, Chloroform-*d*) δ –122.56; **ESI-HRMS** calcd for [$C_{16}H_{17}FO_6$+Na^+]: 347.0902, found 347.0895;



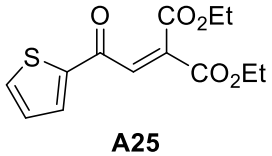
A23

^{1}H NMR (400 MHz, Chloroform-*d*): δ 7.94 (td, *J* = 8.6, 6.4 Hz, 1H), 7.73 (d, *J* = 4.0 Hz, 1H), 7.07 – 6.97 (m, 1H), 6.93 (ddd, *J* = 11.0, 8.6, 2.4 Hz, 1H), 4.34 (qd, *J* = 7.2, 3.1 Hz, 1H), 1.33 (dt, *J* = 14.1, 7.1 Hz, 1H) **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): δ 185.35 (d, J_{F-C} = 3.1 Hz), 167.89 (d, J_{F-C} = 12.4 Hz), 165.31 (d, J_{F-C} = 12.3 Hz), 164.54, 164.21 (d, J_{F-C} = 12.7 Hz), 162.76, 161.64 (d, J_{F-C} = 12.8 Hz), 136.71 (d, J_{F-C} = 7.4 Hz), 136.39 (d, J_{F-C} = 1.9 Hz), 133.17 (dd, J_{F-C} = 10.8, 3.4 Hz), 121.56 (dd, J_{F-C} = 11.8, 3.5 Hz), 112.76 (dd, J_{F-C} = 21.7, 3.4 Hz), 105.05 (dd, J_{F-C} = 26.8, 25.5 Hz), 62.48, 62.03, 13.98, 13.80; **^{19}F NMR** (377 MHz, Chloroform-*d*) δ -98.99, -99.02, -103.98, -104.01; **ESI-HRMS** calcd for [$C_{15}H_{14}F_2O_5$+Na^+]: 335.0702, found 335.0895;



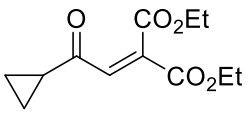
A24

^{1}H NMR (400 MHz, Chloroform-*d*): δ 7.87 (s, 1H), 7.30 (d, *J* = 3.2 Hz, 1H), 7.11 (dd, *J* = 9.1, 3.2 Hz, 1H), 6.94 (d, *J* = 9.1 Hz, 1H), 4.33 (qd, *J* = 7.2, 2.8 Hz, 4H), 3.88 (s, 3H), 3.79 (s, 3H), 1.33 (dt, *J* = 11.9, 7.2 Hz, 6H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): δ 189.33, 165.15, 163.41, 154.22, 153.73, 139.34, 133.48, 126.69, 122.53, 113.64, 113.60, 62.11, 61.78, 56.40, 55.83, 14.03, 13.86; **ESI-HRMS** calcd for [$C_{17}H_{20}O_7$+Na^+]: 359.1102, found 359.1094;



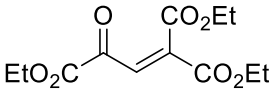
A25

^{1}H NMR (400 MHz, Chloroform-*d*): δ 7.85 (dd, *J* = 3.8, 1.2 Hz, 1H), 7.79 (dd, *J* = 4.9, 1.1 Hz, 1H), 7.74 (s, 1H), 7.20 (dd, *J* = 4.9, 3.9 Hz, 1H), 4.36 (dq, *J* = 10.4, 7.1 Hz, 4H), 1.34 (dt, *J* = 9.5, 7.1 Hz, 6H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): δ 180.24, 164.72, 162.75, 143.91, 137.15, 136.34, 133.86, 132.94, 128.72, 62.56, 62.06, 14.00, 13.84; **ESI-HRMS** calcd for [$C_{13}H_{14}O_5S$+Na^+]: 305.0455, found 305.0450;



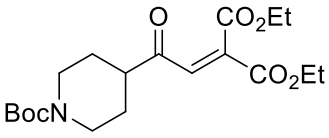
A28

^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 7.27 (s, 1H), 4.33 (dq, *J* = 15.8, 7.1 Hz, 4H), 2.13 (tt, *J* = 7.8, 4.5 Hz, 1H), 1.33 (td, *J* = 7.2, 1.6 Hz, 6H), 1.25 – 1.15 (m, 2H), 1.14 – 1.02 (m, 2H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 198.62, 164.84, 162.86, 135.50, 135.00, 62.41, 61.95, 22.33, 13.97, 13.86, 12.98; **ESI-HRMS** calcd for [$C_{12}H_{16}O_5$+Na^+]: 263.0890, found 263.0886;



A29

^{1}H NMR (600 MHz, Chloroform-*d*): *δ* 7.71 (s, 1H), 4.42 – 4.30 (m, 6H), 1.39 (t, *J* = 7.2 Hz, 3H), 1.35 (td, *J* = 7.2, 4.0 Hz, 6H); **^{13}C{^{1}H} NMR** (151 MHz, Chloroform-*d*): *δ* 181.45, 163.92, 162.12, 159.80, 139.31, 131.14, 63.28, 62.78, 62.45, 13.97, 13.82; **ESI-HRMS** calcd for [$C_{12}H_{16}O_7$+Na^+]: 295.0789, found 295.0783;

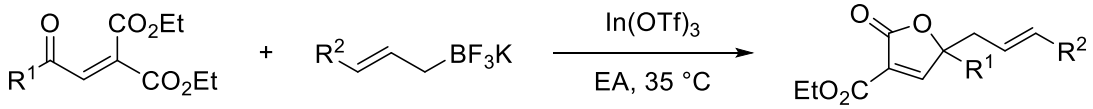


A30

^{1}H NMR (400 MHz, Chloroform-*d*): *δ* 7.24 (s, 1H), 4.40 – 4.25 (m, 4H), 4.15 – 4.02 (m, 2H), 2.85 (t, *J* = 12.8 Hz, 2H), 2.72 – 2.62 (m, 2H), 1.96 – 1.80 (m, 2H), 1.62 – 1.52 (m, 2H), 1.45 (s, 9H), 1.33 (td, *J* = 7.1, 3.0 Hz, 6H); **^{13}C{^{1}H} NMR** (101 MHz, Chloroform-*d*): *δ* 199.76, 164.61, 162.56, 154.54, 136.49, 134.49, 79.69, 79.67, 62.47, 61.99, 48.54, 48.52, 28.35, 26.68, 13.93, 13.82; **ESI-HRMS** calcd for [$C_{19}H_{29}NO_7$+Na^+]: 406.1837, found 406.1830;

(C) General procedures for the preparation of racemic products

1. General procedure for the racemic allylboration/lactonization.

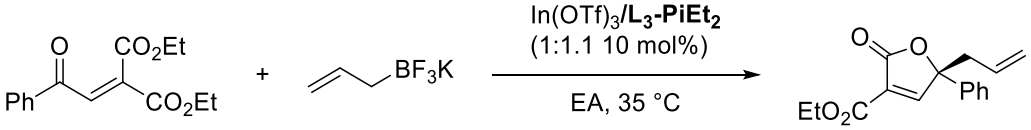


A **B** **C**

In(OTf)$_3$ (10 mol%, 5.6 mg), enone diesters **A** (0.10 mmol) and potassium allyltrifluoroborate **B** (0.20 mmol) were stirred in 1.0 mL of ethyl acetate (EA) at 35 °C in water bath till substrate **A** was fully consumed. The reaction mixture was directly subjected to flash column chromatography on silica gel and eluted with petroleum ether/ethyl acetate to afford the racemic product **C**.

(D) General procedures for the preparation of chiral products

1. Representative experimental procedure for the reaction of trifluoroacetophenone A1 and allyltrifluoroborate B1



A1 **B1** **C1**

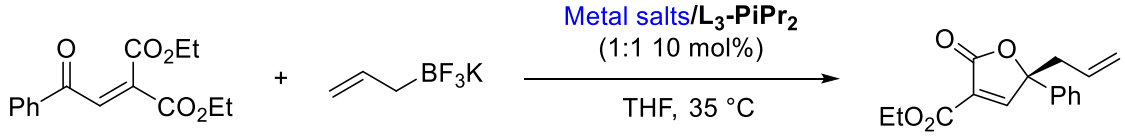
L$_3$-PiEt$_2$ (11 mol%, 6.5 mg), In(OTf)$_3$ (10 mol%, 5.6 mg) and enone diesters **A1** (0.10 mmol, 25 μL) were stirred in 1.0 mL of EA at 35 °C for 30 minutes under N_2 atmosphere. Then potassium allyltrifluoroborate **B1** (0.20 mmol, 30.0 mg) was added in the glovebox as one portion and the mixture was stirred at 35 °C

for another 10 minutes. The above steps and the reactions must be carried out under N_2 atmosphere. After the reaction was completed, the mixture was directly subjected to flash column chromatography on silica gel and eluted with petroleum ether/ethyl acetate (4/1, v/v) to afford the desired product **C1** as colorless oil.

(E) Optimization of reaction conditions

1. Optimization of the reaction conditions of allylation between enone diesters A1 and potassium allyltrifluoroborate B1

Table S1. Screening of the metal salts.

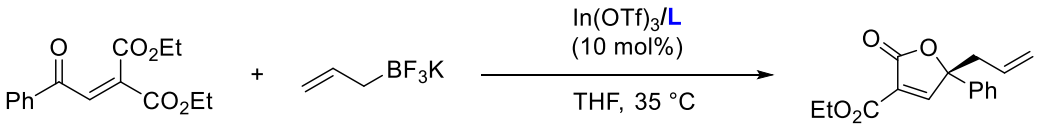


A1 **B1** **C1**

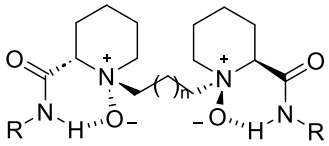
entry[a]	metal salts	reaction time	yield (%)[b]	ee (%)[c]
1	-	48 h	NR	-
2	$Ni(OTf)_2$	48 h	NR	-
3	$Cu(OTf)_2$	48 h	94	20
4	$Co(OTf)_2$	48 h	NR	-
5	$Mg(OTf)_2$	48 h	NR	-
6	$Zn(OTf)_2$	48 h	78	13
7	$Sc(OTf)_3$	48 h	NR	-
8	$In(OTf)_3$	2 h	99	62
9	$Ga(OTf)_3$	48 h	trace	-
10	$Al(OTf)_3$	48 h	trace	-
11	$Yb(OTf)_3$	48 h	NR	-

[a]All reactions were performed with **A1** (0.10 mmol), **B1** (0.20 mmol), metal salt (10 mol%), **L_3-PiPr$_2$** (10 mol%) and THF (1.0 mL) at 35 °C for indicated time. [b] Isolated yield. [c] Determined by HPLC analysis on Daicel chiralpak ID.

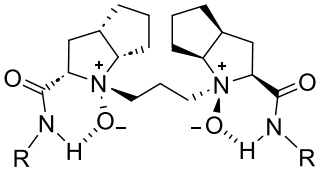
Table S2. Screening of the ligands.



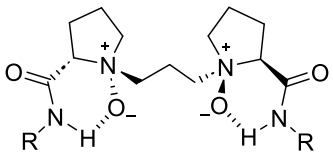
A1 **B1** **C1**



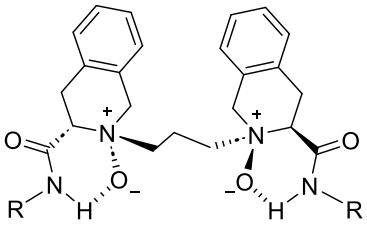
L3-PiPr2: R = 2,6-^{i}Pr$_2$C$_6$H$_3$ n = 1
L3-PiEt2: R = 2,6-Et$_2$C$_6$H$_3$ n = 1
L3-PiMe2: R = 2,6-Me$_2$C$_6$H$_3$ n = 1
L3-PiPh: R = Ph, n = 1
L3-PiMe3: R = 2,4,6-Me$_3$C$_6$H$_2$, n = 1
L3-PiPr3: R = 2,4,6-^{i}Pr$_3$C$_6$H$_2$, n = 1
L3-PiEt2Me: R = 2,6-Et$_2$-4-MeC$_6$H$_2$, n = 1
L3-PiF2: R = 2,6-F$_2$C$_6$H$_3$, n = 1
L2-PiMe2: R = 2,6-Me$_2$C$_6$H$_3$, n = 0
L2-PiEt2: R = 2,6-Et$_2$C$_6$H$_3$, n = 0
L3-Pi(OMe)2: R = 2,6-(OMe)$_2$C$_6$H$_3$, n = 1
L3-Pi(OEt)2: R = 2,6-(OEt)$_2$C$_6$H$_3$ n = 1
L3-Pi(OiPr)2: R = 2,6-(O^{i}Pr)$_2$C$_6$H$_3$ n = 1
L3-PiAd: R = Ad, n = 1
L3-Pi^{t}Bu: R = ^{t}Bu, n = 1



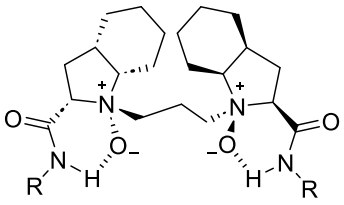
L3-RaPr2: R = 2,6-^{i}Pr$_2$C$_6$H$_3$
L3-RaEt2: R = 2,6-Et$_2$C$_6$H$_3$
L3-RaMe2: R = 2,6-Me$_2$C$_6$H$_3$
L3-RaPh: R = Ph
L3-RaEt3: R = 2,4,6-Et$_3$C$_6$H$_2$
L3-RaEt2Me: R = 2,6-Et$_2$-4-MeC$_6$H$_2$
L3-RaMe2Ad: R = 2,6-Me$_2$-4-AdC$_6$H$_2$



L3-PrPr2: R = 2,6-^{i}Pr$_2$C$_6$H$_3$



L3-TQPr2: R = 2,6-^{i}Pr$_2$C$_6$H$_3$



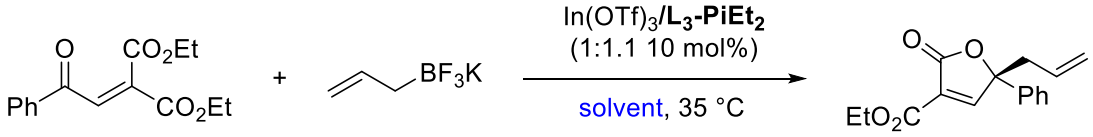
L3-PePr2: R = 2,6-^{i}Pr$_2$C$_6$H$_3$

entry[a]	L	yield (%)[b]	ee (%)[c]
1	**L3-PiPr2**	99	62
2	**L3-RaPr2**	78	85
3	**L3-PrPr2**	76	25
4	**L3-PePr2**	96	34
5	**L3-TQPr2**	99	0
6	**L3-PiPh**	99	40
7	**L3-PiMe2**	99	90
8	**L3-PiEt2**	99	93
9	**L3-PiPr3**	99	58
10[d]	**L3-PiPh**	99	56
11[d]	**L3-PiMe2**	99	90
12[d]	**L3-PiEt2**	99	93
13[d]	**L3-PrEt2**	99	14
14[d]	**L3-PeEt2**	99	9
15[d]	**L3-TQEt2**	99	48
13[d]	**L3-PiMe3**	99	76
14[d]	**L3-PiEt2Me**	99	78

15[d]	**L_3-PiF$_2$**	99	12
16[d]	**L_2-PiMe$_2$**	99	18
17[d]	**L_2-PiEt$_2$**	99	84
18[d]	**L_3-Pi(OMe)$_2$**	99	19
19[d]	**L_3-Pi(OEt)$_2$**	99	48
20[d]	**L_3-Pi(OiPr)$_2$**	99	76
21[d]	**L_3-PiAd**	99	76
22[d]	**L_3-Pi^{t}Bu**	99	72
23[d]	**L_3-RaPh**	99	30
24[d]	**L_3-RaMe$_2$**	99	69
25[d]	**L_3-RaEt$_2$**	99	58
26[d]	**L_3-RaEt$_2$Me**	99	70
27[d]	**L_3-RaEt$_3$**	74	45
28[d]	**L_3-RaMe$_2$Ad**	88	58

[a] All reactions were performed with **A1** (0.10 mmol), **B1** (0.20 mmol), metal salt (10 mol%), **L_3-PiPr$_2$** (10 mol%) and THF (1.0 mL) at 35 °C and work up after the **A1** was fully consumed (monitored by TLC). [b] Isolated yield. [c] Determined by HPLC analysis on Daicel chiralpak ID. [d] Metal salt/Ligand = 1: 1.1 (10 mol%).

Table S3. Screening of the solvents.

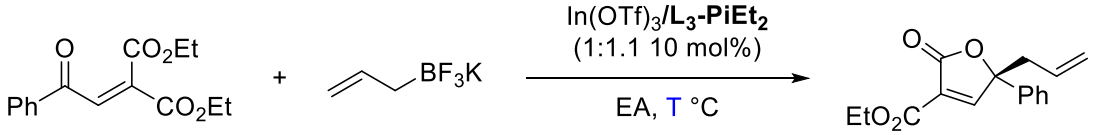


A1 **B1** **C1**

entry[a]	solvent	reaction time	yield (%)[b]	ee (%)[c]
1	DCM	4 h	99	95
2	THF	2 h	99	93
3	toluene	8 h	99	95
4	Et$_2$O	8 h	99	95
5	EA	10 min	99	95
6	MeCN	mess	-	-
7	1,4-dioxane	10 min	99	94
8	MTBE	8 h	99	94
9	2-Me-THF	2 h	99	94
10	DME	10 min	99	95
11	DMF	24 h	99	42

[a]All reactions were performed with **A1** (0.10 mmol), **B1** (0.20 mmol), metal salt (10 mol%), **L_3-PiEt$_2$** (11 mol%) and solvent (1.0 mL) at 35 °C and work up after the **A1** was fully consumed (monitored by TLC). [b] Isolated yield. [c] Determined by HPLC analysis on Daicel chiralpak ID.

Table S4. Screening of the reaction temperature.

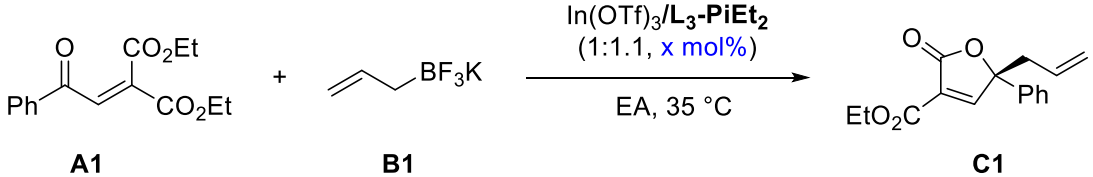


A1 **B1** **C1**

entry[a]	T (°C)	t	yield (%)[b]	ee (%)[c]
1	35	10 min	99	95
2	20	2 h	99	95
3	10	2 h	99	94
4	0	3 h	99	94
5	–10	5 h	99	95

[a] All reactions were performed with **A1** (0.10 mmol), **B1** (0.20 mmol), metal salt (10 mol%), **L₃-PiEt₂** (11 mol%) and solvent (1.0 mL) at T °C and work up after the **A1** was fully consumed (monitored by TLC). [b] Isolated yield. [c] Determined by HPLC analysis on Daicel chiralpak ID.

Table S5. Screening of the catalyst loading.

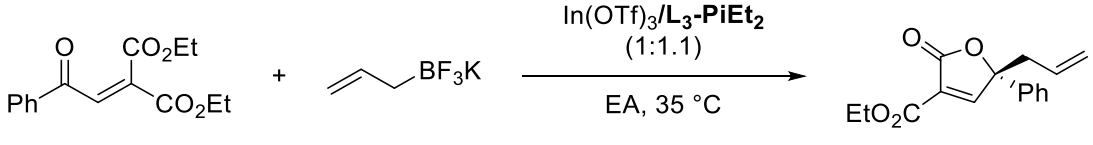


A1 **B1** **C1**

entry[a]	x	t	Yield (%)[b]	*ee* (%)[c]
1	10	10 min	99	95
2	8	2 h	99	95
3	5	12 h	72	94
4	2	12 h	Trace	-
5	1	12 h	Trace	-

[a] All reactions were performed with **A1** (0.10 mmol), **B1** (0.20 mmol), metal salt (10 mol%), **L₃-PiEt₂** (11 mol%) and solvent (1.0 mL) at 35 °C and work up after the **A1** was fully consumed (monitored by TLC). [b] Isolated yield. [c] Determined by HPLC analysis on Daicel chiralpak ID.

(F) Gram-scale synthesis of compound C1.

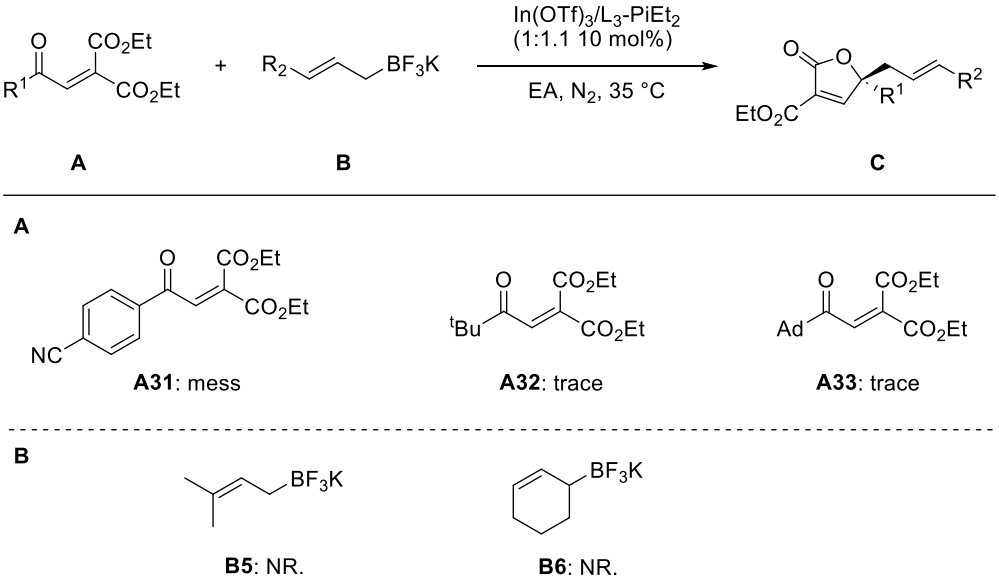


4 mmol 8 mmol 1.09 g
> 99% yied
93% ee

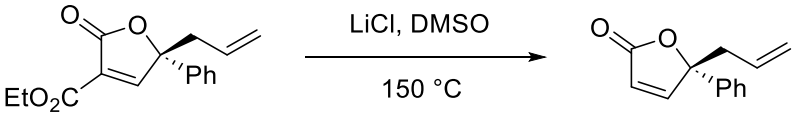
L₃-PiEt₂ (11 mol%, 260 mg), In(OTf)₃ (10 mol%, 224 mg) and enone diesters **A1** (4 mmol, 1.104 g) were stirred in 40 mL of EA at 35 °C in water bath for 30 minutes under N_2 atmosphere. Then potassium

allyltrifluoroborate **B1** (8 mmol, 1.184 g) was added in the glovebox as one portion and the mixture was stirred at 35 °C for another 30 minutes. The above steps and the reactions must be carried out under N_2 atmosphere. After the reaction was completed, the solvent was removed under vacuum and the mixture was purified by flash column chromatography on silica gel and eluted with petroleum ether/ethyl acetate (4/1, v/v) to afford the desired product **C1** as colorless oil.

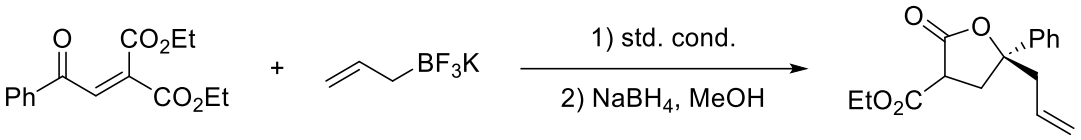
(G) Scope Limitation



(H) Transformation of compound C1



The products **C1** (0.2 mmol) and LiCl (2 mmol, 10 equiv) were added sequentially to the pre-dried reaction tube, then 2.0 mL of dimethyl sulfoxide (DMSO) was added, and the reaction was stirred in at 150 °C in an oil bath for 2 h. When the **C1** is fully consumed, the mixture was cooled to room temperature, and then extracted by ethyl acetate (3* 3 ML). the organic phase was combined and dried over Na_2SO_4, the product **D1** was obtained by column chromatography (petroleum ether/ethyl acetate = 9/1~4/1, v/v).



A1 **B1** **E1**

99% yield
1.1/1 dr
91/95% ee

The catalytic reaction (0.1 mmol scale) was carried out under standard reaction conditions, and after the reaction was completed, 0.2 mL of methanol was added to the reaction system, and the reaction was cooled in an ice water bath at 0 °C, and $NaBH_4$ (1.5 equiv) was added to the reaction system. After the reaction was completed (about 30 minutes), the reduction product **E1** was obtained directly by column chromatography separation (elute: petroleum ether/ethyl acetate = 6/1, v/v).

(I). Biological activity study

Anti-HCCLM3 cell proliferative activity assay

HCCLM3 cells were cultured to higher than 80% fusion rate in 10 mm dishes, trypsin-digested cells were diluted to the appropriate concentration and inoculated in 96-well plates. After 12-16 h of incubation in 37°C, 5% CO_2 incubator, the medium was aspirated, washed twice with phosphate buffered saline (PBS), and new medium was added, followed by the addition of the compound (20 μM) and dimethyl sulfoxide (DMSO) as a control. The medium was aspirated after 24 h, and a blank medium containing 10% (v/v) Cell Counting Kit-8 reagent (Selleck) was added for 1 h of incubation. Absorbance was then measured at 450 nm using a Varioskan Flash Multimode Reader (Thermo Fisher Scientific) and cell viability was calculated by GraphPad Prism 8.0, the data is represented as mean ± standard deviation (SD).

Table S6. Structures and activities of synthetic compounds

compound	HCCLM3 cell viability (% of control)	compound	HCCLM3 cell viability (% of control)
sorafeinb	20.70476	**C18**	120.5925
C1	140.8507	**C19**	116.0756
C2	137.5647	**C20**	104.8728
C3	65.44189	**C21**	133.3856
C4	63.67407	**C22**	135.5473
C5	95.99829	**C23**	140.0133
C6	123.491	**C24**	122.4767
C7	132.8001	**C25**	110.2258
C8	132.3812	**C26**	115.407
C9	123.0938	**C27**	116.0941
C10	107.3269	**C28**	125.4862
C11	116.404	**C29**	128.5559
C12	119.8826	**C30**	119.5556

C13	114.2488	**C31**	124.0899
C14	140.6541	**C32**	132.3831
C15	133.9822	**C33**	107.7849
C16	143.9308	**D1**	105.4745
C17	118.8482	**E1**	117.5245

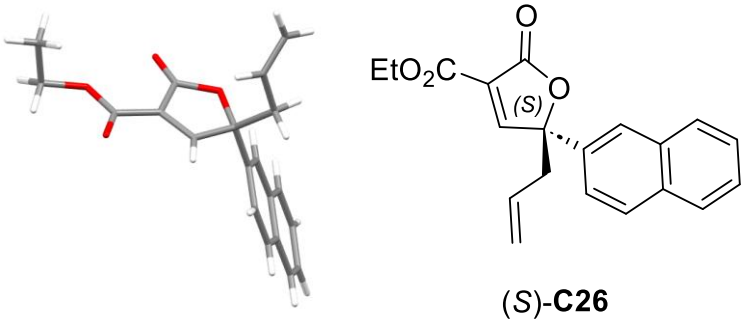
Table S7 IC_{50} of C3 and C4

entry	IC_{50} (μM)	
	HCCLM3	MHCC97L
C3	9.19	93.51
C4	14.99	121

(J). X-ray crystallography data

The absolute configuration of product **C26** and the newly generated chiral center was determined to be (*S*) by X-ray chromatography analysis. Single crystal of **C26** [$C_{20}H_{18}O_4$] was obtained by recrystallization in DCM at room temperature with slow vaporization. CCDC 2331720 (**C26**) contains the supplementary crystallographic data which can be obtained free of charge from The Cambridge Crystallographic Data Center.

For CCDC 2331720 (**C26**), The colourless crystal in rod-shape, with approximate dimensions of 0.228 × 0.441 × 0.530 mm^3, was selected and mounted for the single-crystal X-ray diffraction. The data set was collected by Bruker D8 Venture Photon II diffractometer at 173(2)K equipped with micro-focus Cu radiation source ($K\alpha$ = 1.54178 Å). Applied with face-indexed numerical absorption correction, the structure solution was solved and refinement was processed by SHELXTL (version 6.14) and OLEX 2.3 program package[4a, 4b, 4c, 4d]The structure was analyzed by ADDSYM routine implemented in PLATON suite and no higher symmetry was suggested[4e].



(*S*)-**C26**

Crystallographic Data for **C26**.

Formula	$C_{20}H_{18}O_4$
Formula mass (amu)	322.36
Space group	$P2_12_12_1$
a (Å)	6.3415(1)
b (Å)	8.4205(2)
c (Å)	30.8465(7)
α (deg)	90
β (deg)	90
γ (deg)	90
V ($Å^3$)	1647.16(6)
Z	4
λ (Å)	1.54178
T (K)	173(2)

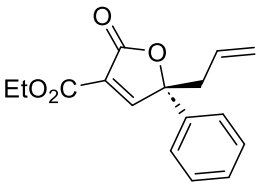
ρ_{calcd} (g cm^{-3})	1.300
$s\mu$ (mm^{-1})	0.735
Transmission factors	0.730-0.910
θ_{max} (deg)	68.267
No. of unique data, including $F_o^2 < 0$	3013
No. of unique data, with $F_o^2 > 2\sigma(F_o^2)$	2993
No. of variables	219
$R(F)$ for $F_o^2 > 2\sigma(F_o^2)$ [a]	0.0257
$R_w(F_o^2)$ [b]	0.0664
Goodness of fit	1.095

[a] $R(F) = \sum||F_o| - |F_c|| / \sum|F_o|$.

[b] $R_w(F_o^2) = [\sum[w(F_o^2 - F_c^2)^2] / \sum wF_o^4]^{1/2}$; $w^{-1} = [\sigma^2(F_o^2) + (Ap)^2 + Bp]$, where $p = [\max(F_o^2,0) + 2F_c^2] / 3$.

(K) Characterization of the products

Ethyl (*S*)-5-allyl-2-oxo-5-phenyl-2,5-dihydrofuran-3-carboxylate (C1)



C1

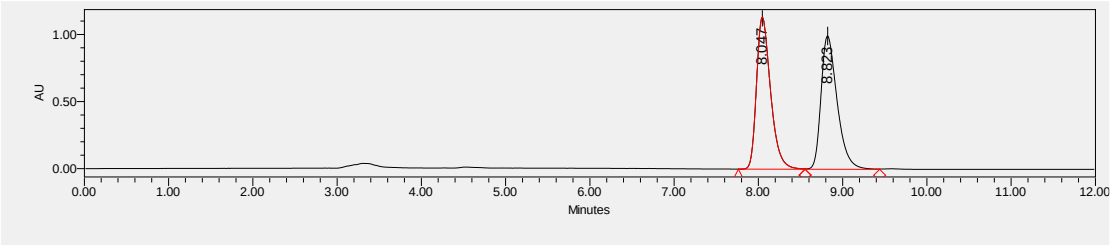
Results: colorless oil, 99% yield, 95 % *ee*; $[\alpha]^{22}_{D}$ = -92.9 (*c* = 0.95 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak ID, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 8.16 min, $t_{R(major)}$ = 8.93 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.33 (s, 1H), 7.45 – 7.30 (m, 5H), 5.61 (m, 1H), 5.20 – 5.10(m, 2H), 4.33 (q, *J* = 7.1 Hz, 2H), 2.92 (ddt, *J* = 14.4, 7.2, 1.1 Hz, 1H), 2.84 (ddt, *J* = 14.3, 7.0, 1.1 Hz, 1H), 1.35 (t, *J* = 7.1 Hz, 3H);

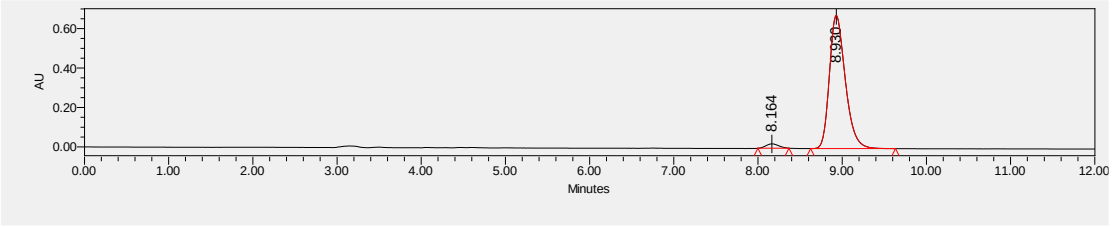
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.59, 164.94, 160.06, 137.23, 129.63, 129.06, 128.74, 125.16, 124.68, 121.23, 87.88, 61.85, 43.86, 14.14;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3083, 2983, 2981, 1774, 1721, 1641, 1448, 1370, 1335, 1258, 1066,1030, 799, 764, 700;

ESI-HRMS calcd for [$C_{16}H_{16}O_4$+Na^+]: 295.0941, fou nd 295.0938;

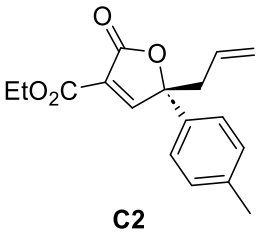


	Retention Time	Area	% Area	Height
1	8.047	13135899	49.94	1131785
2	8.823	13169363	50.06	993255



	Retention Time	Area	% Area	Height
1	8.164	228198	2.52	21984
2	8.930	8829116	97.48	675128

Ethyl (*S*)-5-allyl-2-oxo-5-(*p*-tolyl)-2,5-dihydrofuran-3-carboxylate (C2)



C2

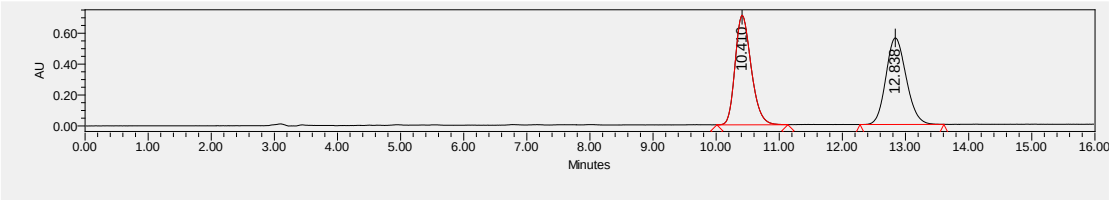
Results: colorless oil, 99% yield, 93 % *ee*; $[\alpha]^{23}_{D}$ = -98.5 (*c* = 0.62 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 10.43 min, $t_{R(major)}$ = 12.67 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.30 (s, 1H), 7.41 – 7.01 (m, 4H), 5.68 – 5.52 (m, 1H), 5.18 – 5.10 (m, 2H), 4.33 (q, *J* = 7.1 Hz, 2H), 2.90 (ddt, *J* = 14.4, 7.3, 1.1 Hz, 1H), 2.82 (ddt, *J* = 14.3, 7.0, 1.1 Hz, 1H), 2.35 (s, 3H), 1.35 (t, *J* = 7.1 Hz, 3H);

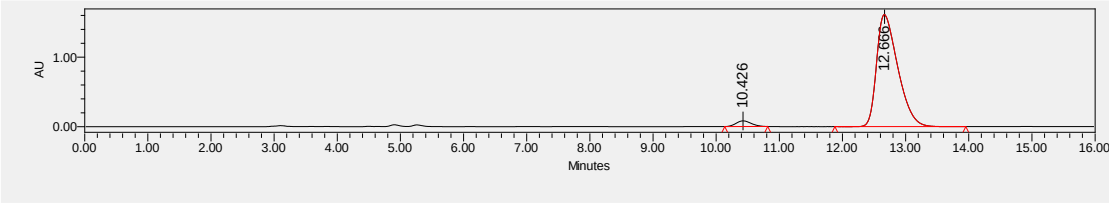
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.70, 165.14, 160.12, 138.71, 134.19, 129.77, 129.70, 125.10, 124.50, 121.10, 87.89, 61.81, 43.76, 21.09, 14.14;

IR (film): $\tilde{\nu}$ (cm^{-1}) 2985, 2923, 1780, 1722, 1642, 1264, 1075,1032, 800, 735, 702;

ESI-HRMS calcd for [$C_{17}H_{18}O_4$+Na^{+}]: 309.1098, found 295. 309.1093;

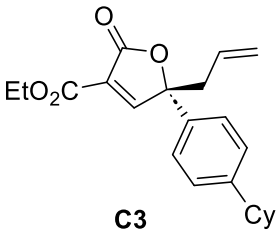


	Retention Time	Area	% Area	Height
1	13.083	22573274	50.13	935385
2	14.877	22454788	49.87	814348



	Retention Time	Area	% Area	Height
1	10.426	1368298	3.52	81847
2	12.666	37498867	96.48	1611753

Ethyl (*S*)-5-allyl-5-(4-cyclohexylphenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C3)



C3

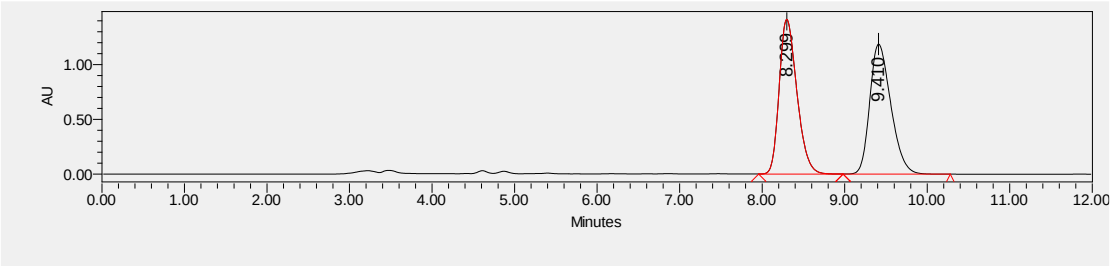
Results: colorless oil, 98% yield, 92 % *ee*; $[\alpha]^{22}_{D}$ = 92.2 (*c* = 1.10 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 8.41 min, $t_{R(major)}$ = 9.53 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.30 (s, 1H), 7.36 – 7.18 (m, 4H), 5.67 – 5.53 (m, 1H), 5.17 (s, 1H), 5.15 – 5.12 (m, 1H), 4.33 (q, *J* = 7.1 Hz, 2H), 2.92 (ddt, *J* = 14.3, 7.2, 1.1 Hz, 1H), 2.83 (ddt, *J* = 14.4, 7.2, 1.1 Hz, 1H), 2.50 (m, 1H), 1.89 – 1.65 (m, 6H), 1.46 – 1.38 (m, 4H), 1.35 (t, *J* = 7.1 Hz, 3H);

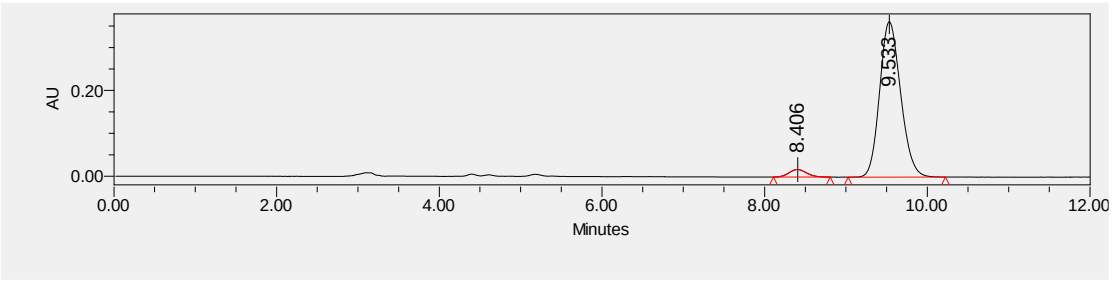
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.75, 165.20, 160.13, 148.82, 134.49, 129.78, 127.48, 125.13, 124.49, 121.10, 87.91, 61.80, 44.19, 43.71, 34.32, 34.31, 26.79, 26.06, 14.14;

IR (film): $\tilde{\nu}$ (cm^{-1}) 2924, 2850, 1782, 1723, 1448, 1370, 1314, 1074, 1032, 828, 799;

ESI-HRMS calcd for [$C_{22}H_{26}O_4$+Na^{+}]: 377.1724, found 377.1717;

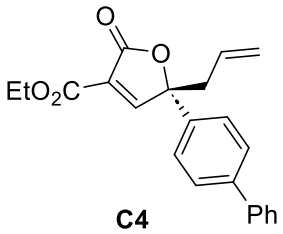


	Retention Time	Area	% Area	Height
1	8.299	21036944	49.98	1413372
2	9.410	21055800	50.02	1187552



	Retention Time	Area	% Area	Height
1	8.406	264158	3.91	17588
2	9.533	6483818	96.09	362040

Ethyl (*S*)-5-([1,1'-biphenyl]-4-yl)-5-allyl-2-oxo-2,5-dihydrofuran-3-carboxylate (C4)



C4

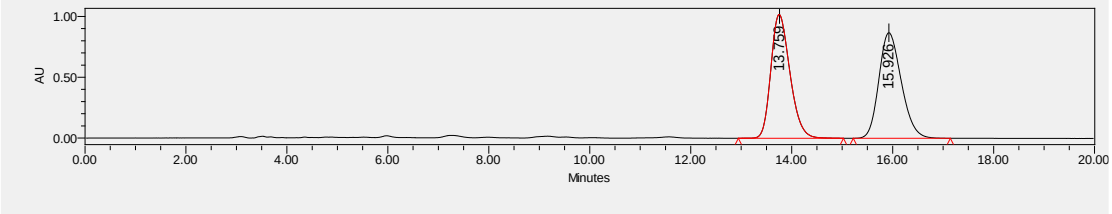
Results: white solid, 99% yield, 94 % *ee*; $[\alpha]^{23}_{D}$ = -129.9 (*c* = 0.668 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 13.82 min, $t_{R(major)}$ = 15.88 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.35 (s, 1H), 7.67 – 7.52 (m, 4H), 7.52 – 7.41 (m, 4H), 7.38 – 7.33 (m, 1H), 5.71- 5.57 (m, 1H), 5.20 (s, 1H), 5.19 – 5.14 (m, 1H), 4.34 (q, *J* = 7.1 Hz, 2H), 2.96 (ddt, *J* = 14.3, 7.3, 1.1 Hz, 1H), 2.87 (ddt, *J* = 14.4, 7.1, 1.1 Hz, 1H), 1.36 (t, *J* = 7.1 Hz, 3H);

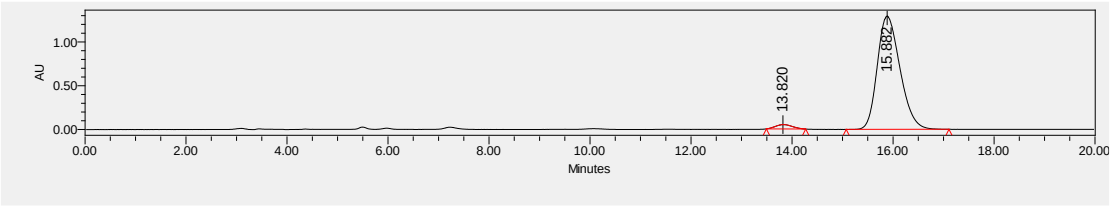
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.61, 164.87, 160.07, 141.72, 140.03, 136.09, 129.62, 128.93, 127.80, 127.74, 127.12, 125.66, 124.72, 121.33, 87.81, 61.88, 43.79, 29.72, 14.16;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3081, 2982, 2919, 1776, 1721, 1486, 1374, 1370, 1337, 1255, 1075, 1031, 840, 799, 767, 732, 697;

ESI-HRMS calcd for [$C_{22}H_{20}O_4$+Na^{+}]: 371.1254, found 371.1248;

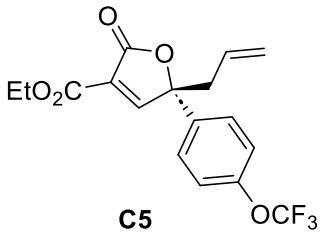


	Retention Time	Area	% Area	Height
1	13.759	26631164	49.87	1016790
2	15.926	26768694	50.13	867633



	Retention Time	Area	% Area	Height
1	13.820	1159021	2.79	50241
2	15.882	40311861	97.21	1295772

Ethyl (*S*)-5-allyl-2-oxo-5-(4-(trifluoromethoxy)phenyl)-2,5-dihydrofuran-3-carboxylate (C5)



C5

Results: colorless oil, 99% yield, 96 % *ee*; $[\alpha]^{23}_{D}$ = -73.8 (*c* = 1.31 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak ODH, *n*-hexane/*i*-PrOH 90/10, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 7.26 min, $t_{R(minor)}$ = 8.62 min;

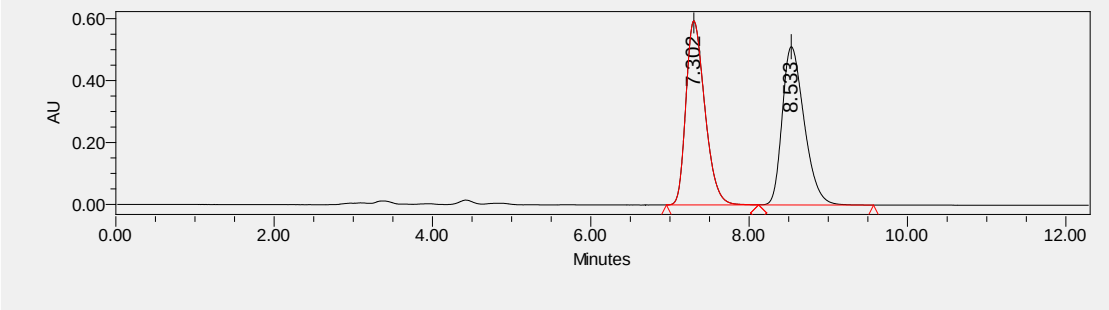
^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.31 (s, 1H), 7.50 – 7.40 (m, 2H), 7.30 – 7.22 (m, 2H), 5.67 – 5.53 (m, 1H), 5.24 – 5.11 (m, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 2.91 (ddt, *J* = 14.3, 7.3, 1.1 Hz, 1H), 2.83 (ddt, *J* = 14.3, 7.1, 1.2 Hz, 1H), 1.36 (t, *J* = 7.1 Hz, 3H);

^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.22, 164.19, 159.87, 149.29 (d, J_{F-C} = 2.0 Hz), 135.92, 129.21, 126.87, 125.03, 121.64, 121.43, 119.07, 87.28, 61.97, 43.89, 14.10;

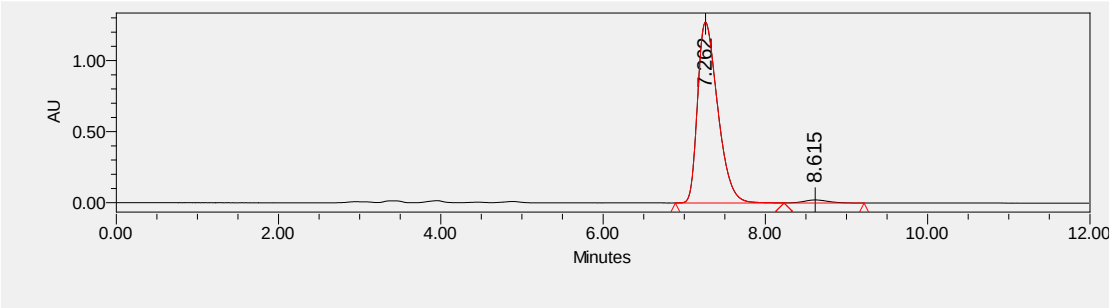
^{19}F{^{1}H} NMR (377 MHz, Chloroform-*d*) δ -57.90.

IR (film): $\tilde{\nu}$ (cm^{-1}) 3085, 2985, 2917, 1778, 1723, 1510, 1255, 1212, 1165, 1032, 800, 691;

ESI-HRMS calcd for [$C_{17}H_{15}F_3O_5$+Na^{+}]: 379.0764, found 379.0758;

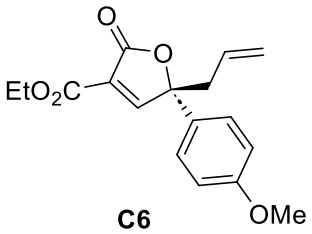


	Retention Time	Area	% Area	Height
1	7.302	9871296	50.00	594776
2	8.533	9870171	50.00	511540



	Retention Time	Area	% Area	Height
1	7.262	21870145	98.05	1271550
2	8.615	434847	1.95	21213

Ethyl (*S*)-5-allyl-5-(4-methoxyphenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C6)



C6

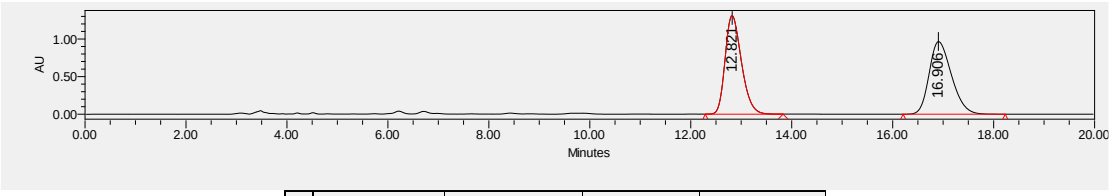
Results: colorless oil, 99% yield, 94 % *ee*; $[\alpha]^{23}_{D}$ = -104.8 (*c* = 0.546 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 12.94 min, $t_{R(major)}$ = 17.00 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.29 (s, 1H), 7.38 – 7.20 (m, 2H), 6.98 – 6.79 (m, 2H), 5.67 – 5.53 (m, 1H), 5.19 – 5.09 (m, 2H), 4.33 (q, *J* = 7.1 Hz, 2H), 3.81 (s, 3H), 2.89 (ddt, *J* = 14.3, 7.2, 1.1 Hz, 1H), 2.82 (ddt, *J* = 14.3, 7.0, 1.2 Hz, 1H), 1.35 (t, *J* = 7.1 Hz, 3H);

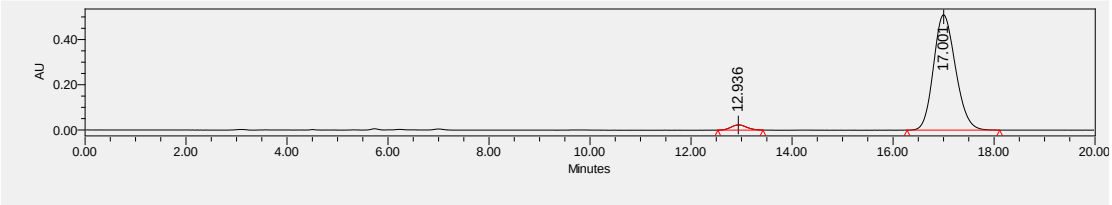
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.71, 165.12, 160.14, 159.78, 129.81, 129.03, 126.56, 124.45, 121.08, 114.36, 87.71, 61.81, 55.37, 43.74, 14.14;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3082, 2983, 2935, 1778, 1722, 1514, 1255, 1072, 1032, 800, 750;

ESI-HRMS calcd for [$C_{17}H_{18}O_5$+Na^+]: 325.1047, found 325.1041;

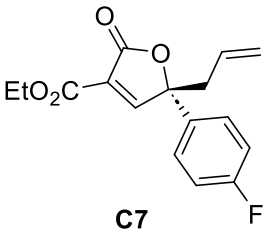


	Retention Time	Area	% Area	Height
1	12.821	29438208	49.86	1310921
2	16.906	29600763	50.14	965599



	Retention Time	Area	% Area	Height
1	12.936	496691	3.12	23024
2	17.001	15435871	96.88	510384

Ethyl (*S*)-5-allyl-5-(4-fluorophenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C7)



C7

Results: colorless oil, 91% yield, 96 % *ee*; $[\alpha]^{23}_{D}$ = -80.8 (*c* = 0.500 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 7.72 min, $t_{R(major)}$ = 8.57 min;

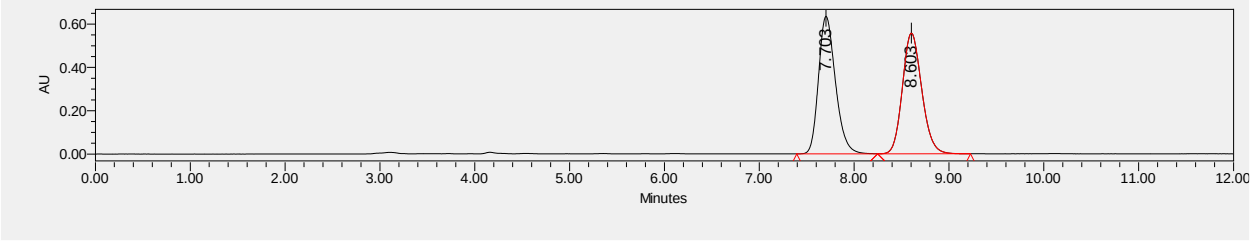
^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.30 (s, 1H), 7.43 – 7.32 (m, 2H), 7.16 – 7.04 (m, 2H), 5.66 – 5.52 (m, 1H), 5.21 – 5.07 (m, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 2.89 (ddt, *J* = 14.3, 7.4, 1.1 Hz, 1H), 2.81 (ddt, *J* = 14.3, 7.0, 1.1 Hz, 1H), 1.36 (t, *J* = 7.1 Hz, 3H);

^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.35, 164.51, 162.67 (d, J_{F-C} = 248.7 Hz) 159.97, 133.07 (d, J_{F-C} = 3.3 Hz), 129.42, 127.14 (d, J_{F-C} = 8.3 Hz), 124.87, 121.45, 116.05 (d, J_{F-C} = 21.8 Hz), 87.41, 61.93, 43.96, 14.12;

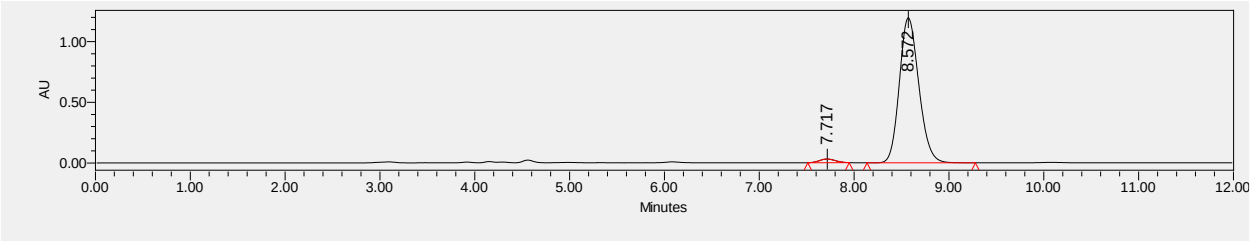
^{19}F{^{1}H} NMR (377 MHz, Chloroform-*d*): δ -112.58;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3083, 2985, 2929, 1781, 1723, 1511, 1275, 1260, 1075, 1032, 837, 800, 750;

ESI-HRMS calcd for [$C_{16}H_{15}FO_4$+Na^{+}]: 313.0847, found 313.0843;

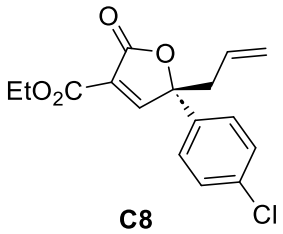


	Retention Time	Area	% Area	Height
1	7.703	7888260	50.05	635069
2	8.603	7871887	49.95	556858



	Retention Time	Area	% Area	Height
1	7.717	351238	2.02	30088
2	8.572	17013165	97.98	1195886

Ethyl (*S*)-5-allyl-5-(4-chlorophenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C8)



C8

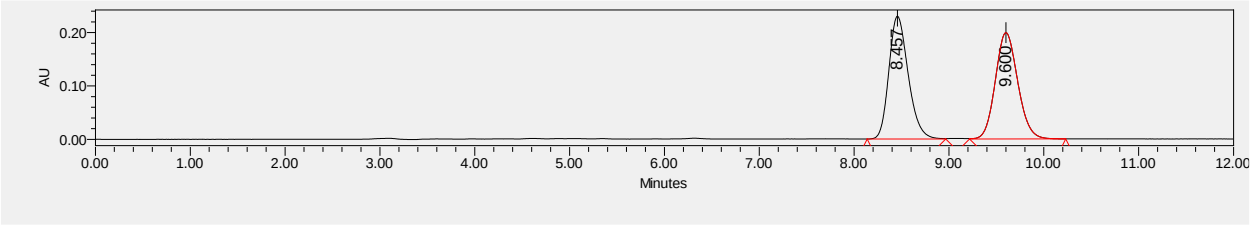
Results: colorless oil, 99% yield, 95 % *ee*; $[\alpha]^{19}_D$ = -105.5 (*c* = 0.584 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 8.51 min, $t_{R(major)}$ = 9.61 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.29 (s, 1H), 7.44 – 7.29 (m, 4H), 5.66 – 5.52 (m, 1H), 5.21 – 5.09 (m, 2H), 4.34 (q, J = 7.1 Hz, 2H), 2.89 (ddt, *J* = 14.3, 7.3, 1.1 Hz, 1H), 2.80 (ddt, *J* = 14.3, 7.0, 1.1 Hz, 1H), 1.36 (t, J = 7.2 Hz, 3H);

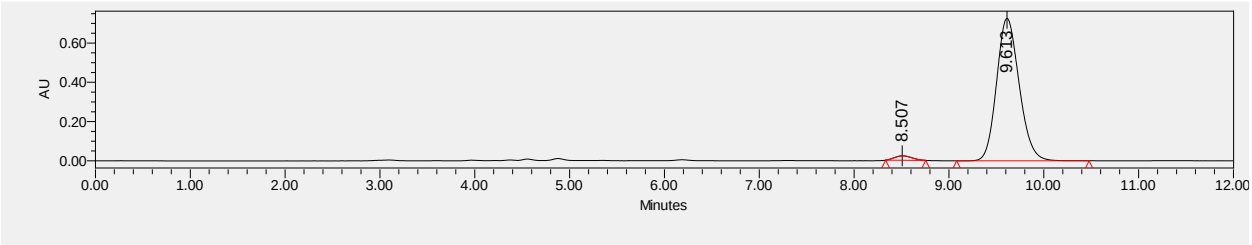
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.27, 164.28, 159.91, 135.73, 134.80, 129.29, 129.25, 126.64, 124.93, 121.55, 87.37, 61.95, 43.83, 14.12;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3084, 2983, 2927, 1777, 1722, 1493, 1371, 1314, 1275, 1260, 1093, 1070, 1031, 828, 799, 750;

ESI-HRMS calcd for [$C_{16}H_{15}{}^{35}ClO_4$+Na$^+$]: 329.0552, found 329.0547; calcd for [$C_{16}H_{15}{}^{37}ClO_4$+Na$^+$]: 331.0522, found 331.0514;

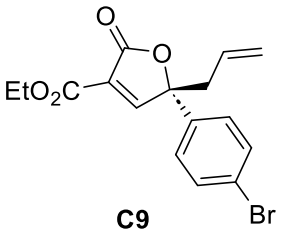


	Retention Time	Area	% Area	Height
1	8.457	3254406	49.98	229875
2	9.600	3257628	50.02	198968



	Retention Time	Area	% Area	Height
1	8.507	285714	2.33	22688
2	9.613	11997296	97.67	725595

Ethyl (*S*)-5-allyl-5-(4-bromophenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C9)



C9

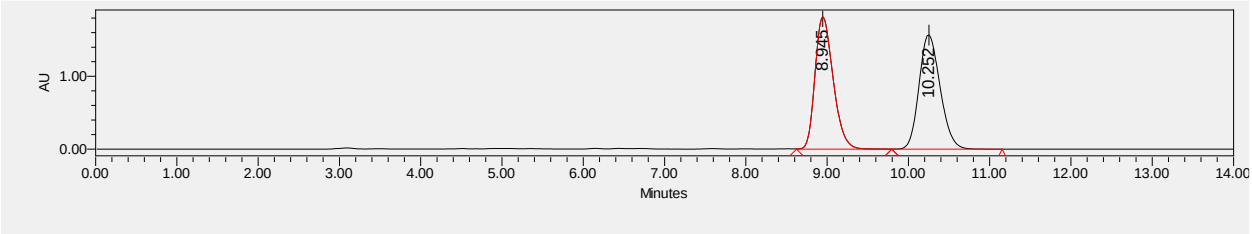
Results: colorless oil, 99% yield, 96 % *ee*; $[\alpha]^{23}_{D}$ = -96.0 (*c* = 0.650 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 9.02 min, $t_{R(major)}$ = 10.25 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.28 (s, 1H), 7.59 – 7.50 (m, 2H), 7.33 – 7.23 (m, 2H), 5.65 – 5.51 (m, 1H), 5.21 – 5.09 (m, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 2.88 (ddt, *J* = 14.3, 7.4, 1.1 Hz, 1H), 2.80 (ddt, *J* = 14.3, 7.0, 1.1 Hz, 1H), 1.35 (t, *J* = 7.1 Hz, 3H);

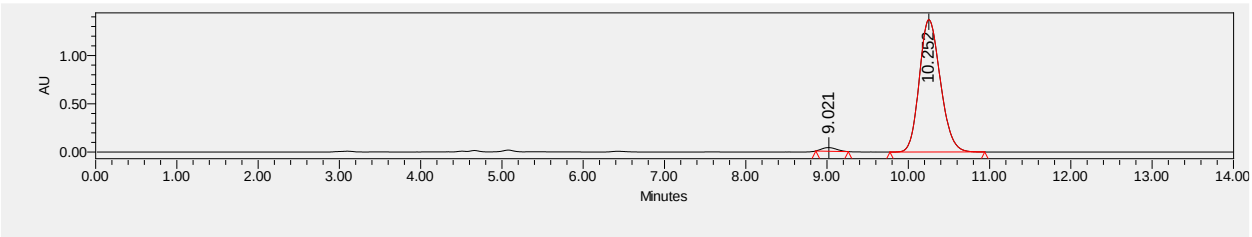
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.25, 164.20, 159.89, 136.27, 132.21, 129.26, 126.92, 124.95, 122.94, 121.58, 87.39, 61.96, 43.78, 14.13;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3085, 2983, 2928, 1778, 1722, 1488, 1396, 1370, 1314, 1275, 1259, 1074, 1030, 1010, 824, 799, 749;

ESI-HRMS calcd for [$C_{16}H_{15}{}^{79}BrO_4$+Na$^+$]: 373.0046, found 373.0041; calcd for [$C_{16}H_{15}{}^{37}ClO_4$+Na$^+$]: 375.0026, found 375.0020;

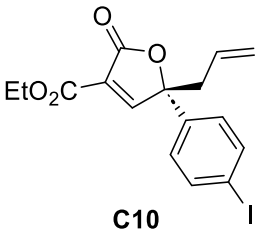


	Retention Time	Area	% Area	Height
1	8.945	28106627	49.85	1818342
2	10.252	28273166	50.15	1565329



	Retention Time	Area	% Area	Height
1	9.021	465659	1.85	37456
2	10.252	24642580	98.15	1371240

Ethyl (*S*)-5-allyl-5-(4-iodophenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C10)



C10

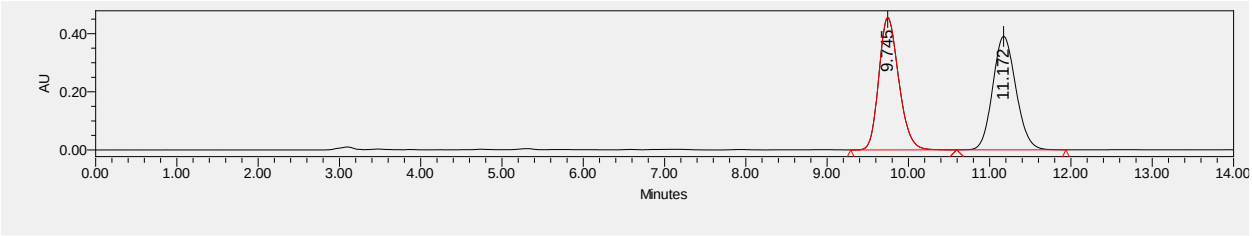
Results: colorless oil, 99% yield, 96 % *ee*; $[\alpha]^{23}_{D}$ = -98.9 (*c* = 0.750 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 9.79 min, $t_{R(major)}$ = 11.14 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.27 (s, 1H), 7.79 – 7.68 (m, 2H), 7.20 – 7.10 (m, 2H), 5.65 -5.51 (m, 1H), 5.21 – 5.08 (m, 2H), 4.33 (q, *J* = 7.1 Hz, 2H), 2.88 (ddt, *J* = 14.3, 7.3, 1.1 Hz, 1H), 2.79 (ddt, *J* = 14.4, 7.0, 1.1 Hz, 1H), 1.35 (t, *J* = 7.1 Hz, 3H);

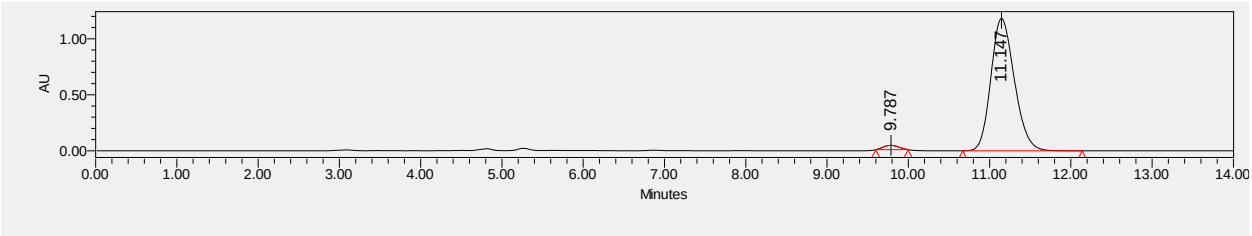
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.25, 164.20, 159.88, 138.16, 136.96, 129.26, 127.05, 124.93, 121.58, 94.60, 87.45, 61.95, 43.72, 14.13;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3083, 2982, 2927, 1778, 1722, 1486, 1393, 1370, 1314, 1275, 1259, 1066, 1031, 1005, 821, 799, 750;

ESI-HRMS calcd for [$C_{16}H_{15}IO_4$+Na$^+$]: 420.9908, found 420.9899;

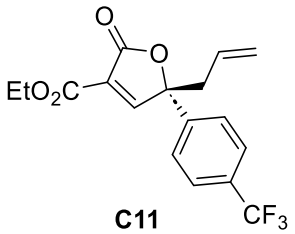


	Retention Time	Area	% Area	Height
1	9.745	7754559	50.00	455709
2	11.172	7755716	50.00	390068



	Retention Time	Area	% Area	Height
1	9.787	511835	2.11	38653
2	11.147	23721220	97.89	1182711

Ethyl (*S*)-5-allyl-2-oxo-5-(4-(trifluoromethyl)phenyl)-2,5-dihydrofuran-3-carboxylate (C11)



C11

Results: colorless oil, 99% yield, 96 % *ee*; $[\alpha]^{23}_{D}$ = -77.8 (*c* = 0.636 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 80/20, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 7.46 min, $t_{R(major)}$ = 8.13 min;

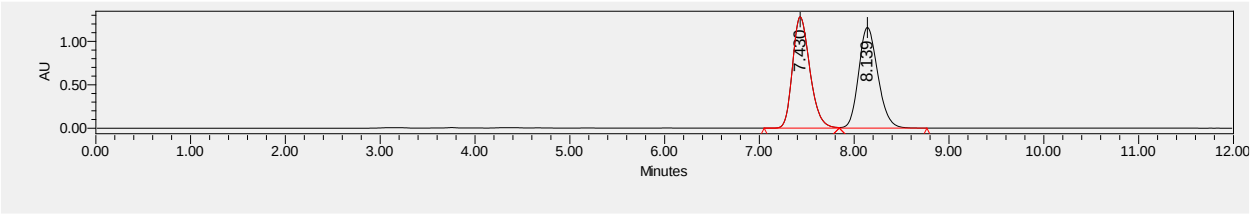
^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.32 (s, 1H), 7.68 (d, *J* = 8.3 Hz, 2H), 7.55 (d, *J* = 8.1 Hz, 2H), 5.67 – 5.53 (m, 1H), 5.23 – 5.11 (m, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 2.92 (ddt, *J* = 14.3, 7.3, 1.1 Hz, 1H), 2.84 (ddt, *J* = 14.3, 7.0, 1.1 Hz, 1H), 1.36 (t, *J* = 7.2 Hz, 3H);

^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.07, 163.84, 159.78, 141.20, 131.00 (d, J_{F-C} = 32.8 Hz), 129.02, 126.07 (q, J_{F-C} = 3.7 Hz), 125.69, 125.24, 123.68 (d, J_{F-C} = 272.2 Hz), 121.81, 87.36, 62.02, 43.89, 14.10;

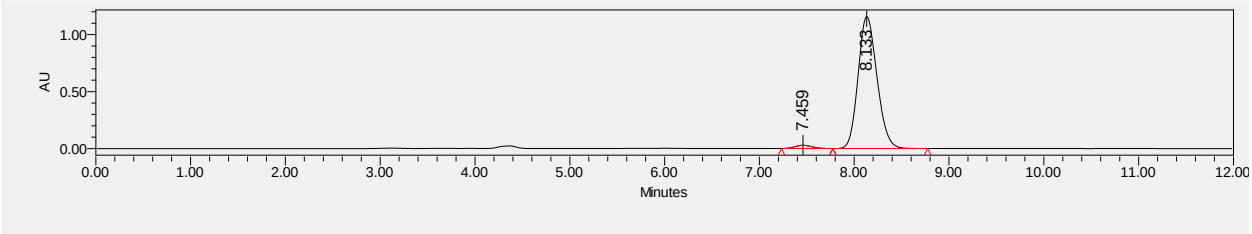
^{19}F{^{1}H} NMR (377 MHz, Chloroform-*d*): δ -62.81;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3085, 2985, 2916, 1778, 1723, 1323, 1276, 1260, 1166, 1123, 1069, 1031, 1017, 842, 800, 750;

ESI-HRMS calcd for [$C_{17}H_{15}F_3O_4$+Na^{+}]: 363.0815, found 363.0808;

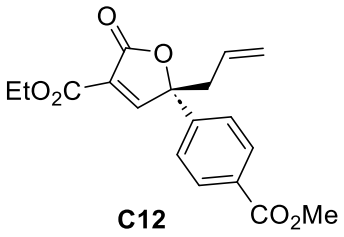


	Retention Time	Area	% Area	Height
1	7.430	16253391	49.94	1281793
2	8.139	16293344	50.06	1158629



	Retention Time	Area	% Area	Height
1	7.459	349526	2.14	28612
2	8.133	16009566	97.86	1157037

Ethyl (*S*)-5-allyl-5-(4-(methoxycarbonyl)phenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C12)



C12

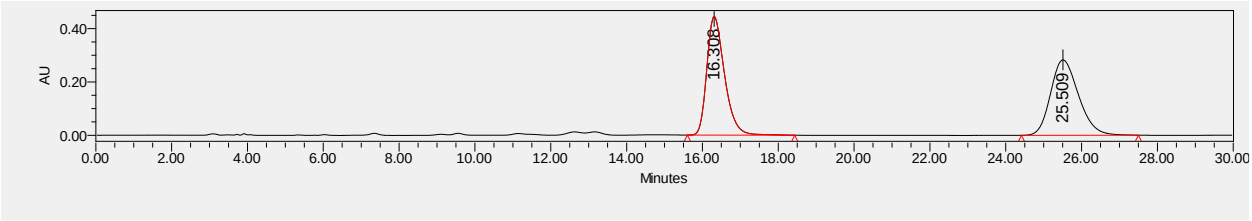
Results: colorless oil, 99% yield, 95 % *ee*; $[\alpha]^{23}_{D}$ = -106.9 (*c* = 0.598 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 16.46 min, $t_{R(major)}$ = 25.43 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.33 (s, 1H), 8.11 – 8.02 (m, 2H), 7.53 – 7.44 (m, 2H), 5.66 – 5.52 (m, 1H), 5.21 – 5.09 (m, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 3.93 (s, 4H), 2.92 (ddt, *J* = 14.3, 7.3, 1.1 Hz, 1H), 2.83 (ddt, *J* = 14.4, 7.0, 1.1 Hz, 1H), 1.36 (t, *J* = 7.1 Hz, 3H);

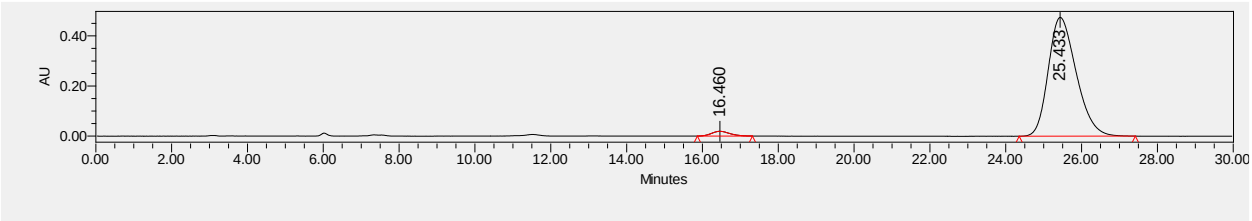
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.28, 166.19, 164.04, 159.86, 141.97, 130.52, 130.29, 129.16, 125.27, 125.12, 121.65, 87.62, 61.98, 52.36, 43.89, 14.12;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3083, 2985, 2954, 1782, 1722, 1436, 1279, 1190, 1112, 1070, 1032, 859, 800, 750;

ESI-HRMS calcd for [$C_{18}H_{18}O_6$+Na^{+}]: 353.0996, found 353.0991;

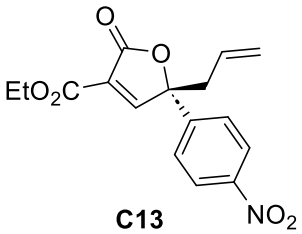


	Retention Time	Area	% Area	Height
1	16.308	14422810	49.94	444750
2	25.509	14454932	50.06	282688



	Retention Time	Area	% Area	Height
1	16.460	628630	2.52	18843
2	25.433	24282732	97.48	474155

Ethyl (*S*)-5-allyl-5-(4-nitrophenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C13)



C13

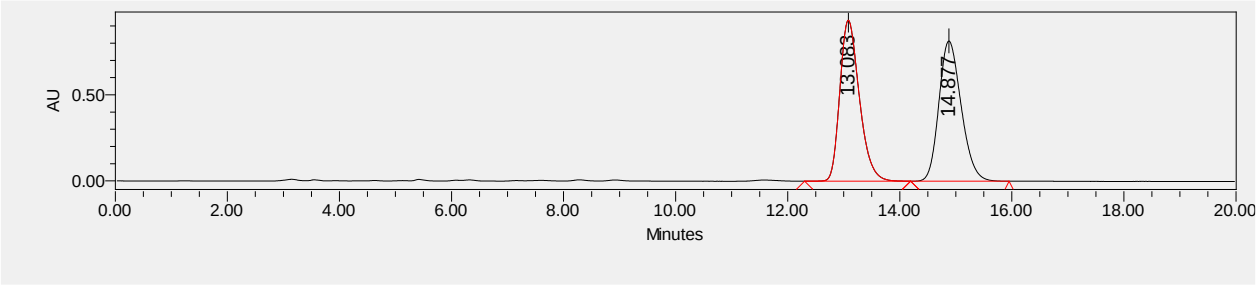
Results: colorless oil, 99% yield, 96% *ee*; $[\alpha]^{22}_{D}$ = -110.5 (*c* = 0.570 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 13.22 min, $t_{R(major)}$ = 14.91 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.35 (s, 1H), 8.33 – 8.22 (m, 2H), 7.66 – 7.58 (m, 2H), 5.66 -5.55 (m, 1H), 5.31 – 5.04 (m, 2H), 4.35 (q, *J* = 7.1 Hz, 2H), 2.94 (dd, *J* = 14.3, 7.5 Hz, 1H), 2.85 (dd, *J* = 14.3, 7.0 Hz, 1H), 1.36 (t, *J* = 7.1 Hz, 3H);

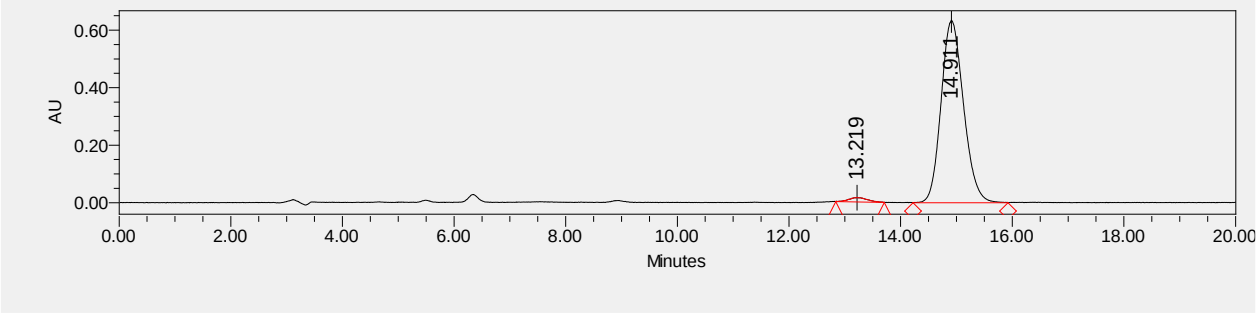
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 165.78, 163.20, 159.63, 147.91, 144.15, 128.71, 126.38, 125.54, 124.26, 122.15, 87.21, 62.13, 43.95, 14.10;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3085, 2983, 2928, 1781, 1722, 1521, 1349, 1315, 1067, 1030, 856, 799, 697;

ESI-HRMS calcd for [$C_{16}H_{15}NO_6$+Na^{+}]: 340.0792, found 340.0787;

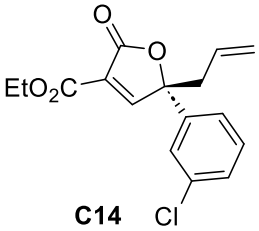


	Retention Time	Area	% Area	Height
1	13.083	22573274	50.13	935385
2	14.877	22454788	49.87	814348



	Retention Time	Area	% Area	Height
1	13.219	343107	1.90	15113
2	14.911	17709344	98.10	635365

Ethyl (*S*)-5-allyl-5-(3-chlorophenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C14)



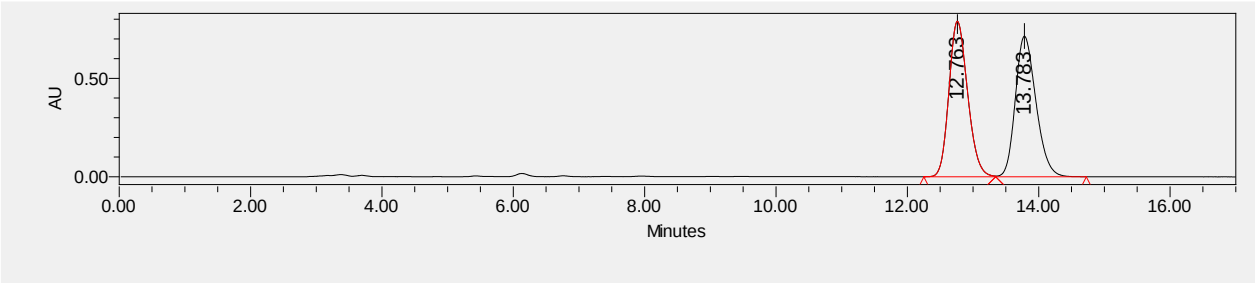
Results: colorless oil, 99% yield, 92% *ee*; $[\alpha]^{23}_{D}$ = -81.6 (*c* = 0.564 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 12.80 min, $t_{R(minor)}$ = 13.87 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.29 (s, 1H), 7.43 – 7.23 (m, 4H), 5.66 - 5.51 (m, 1H), 5.24 – 5.11 (m, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 2.90 (ddt, *J* = 14.3, 7.3, 1.1 Hz, 1H), 2.81 (ddt, *J* = 14.3, 7.0, 1.1 Hz, 1H), 1.36 (t, *J* = 7.1 Hz, 3H);

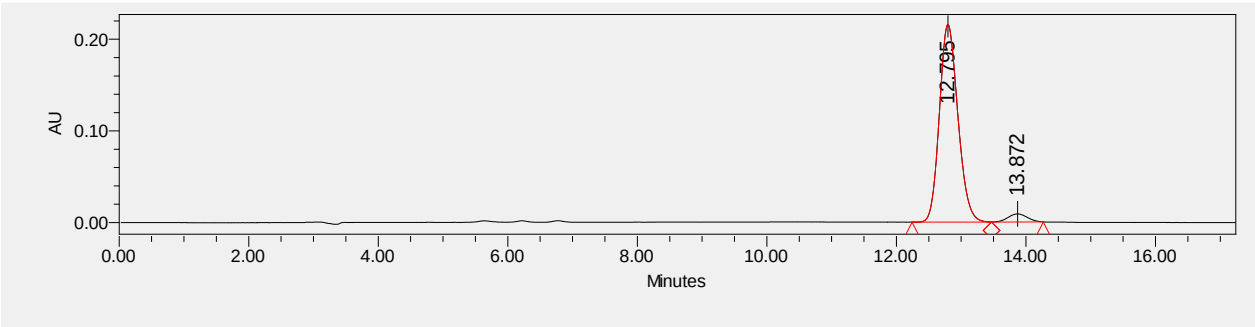
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.21, 164.10, 159.86, 139.20, 135.09, 130.36, 129.18, 128.95, 125.50, 125.03, 123.37, 121.64, 87.23, 61.97, 43.80, 14.12;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3084, 2983, 2927, 1780, 1723, 1371, 1338, 1315, 1259, 1069, 1137, 1032, 799, 749, 697;

ESI-HRMS calcd for [$C_{16}H_{15}{}^{35}ClO_4$+Na$^+$]: 329.0552, found 329.0562; calcd for [$C_{16}H_{15}{}^{37}ClO_4$+Na$^+$]: 331.0522, found 331.0530

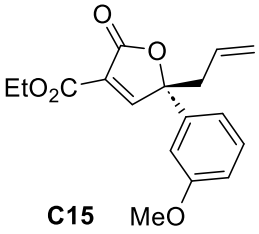


	Retention Time	Area	% Area	Height
1	12.763	15593422	50.07	789474
2	13.783	15551082	49.93	713779



	Retention Time	Area	% Area	Height
1	12.795	4271879	95.94	215580
2	13.872	180764	4.06	8840

Ethyl (*S*)-5-allyl-5-(3-methoxyphenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C15)



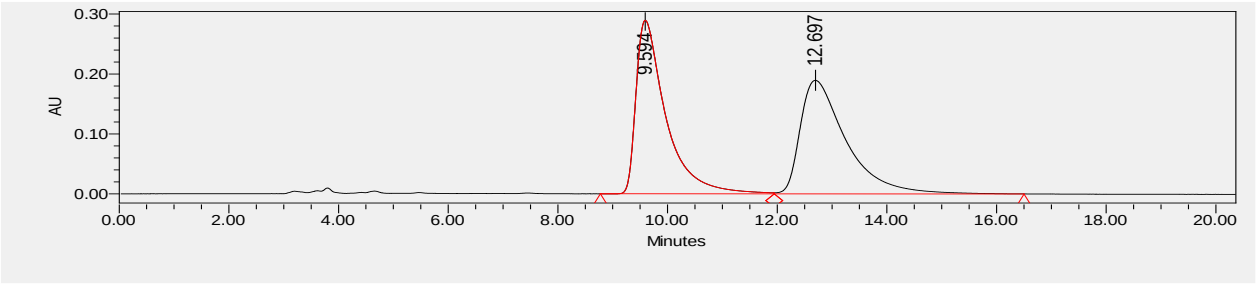
Results: colorless oil, 97% yield, 90% *ee*; $[\alpha]^{23}_{D}$ = -80.4 (*c* = 1.020 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak AYH, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 9.90 min, $t_{R(major)}$ = 13.18 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.30 (s, 1H), 7.35 - 7.29 (m, 1H), 6.98 – 6.84 (m, 3H), 5.60 (m, 1H), 5.20 – 5.10 (m, 2H), 4.33 (q, *J* = 7.1 Hz, 2H), 3.82 (s, 3H), 2.91 (ddt, *J* = 14.3, 7.2, 1.1 Hz, 1H), 2.81 (ddt, *J* = 14.3, 7.1, 1.1 Hz, 1H), 1.35 (t, *J* = 7.1 Hz, 3H);

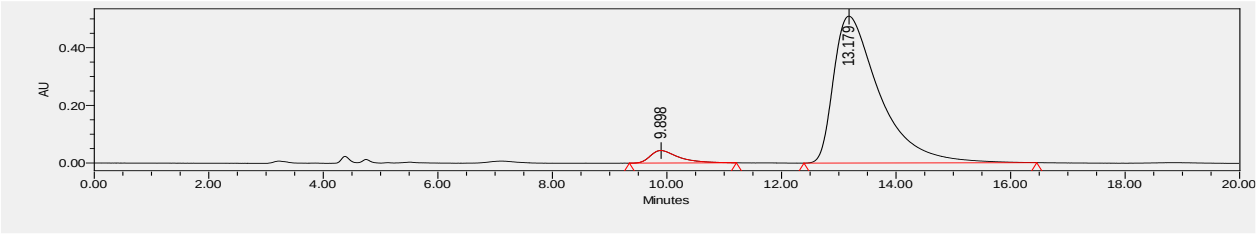
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.58, 164.86, 160.06, 160.04, 138.73, 130.10, 129.61, 124.58, 121.21, 117.36, 113.98, 111.05, 87.78, 61.85, 55.42, 43.88, 14.14;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3082, 2982, 2938, 1774, 1721, 1371, 1601, 1293, 1260, 1030, 991, 798, 750, 700;

ESI-HRMS calcd for [$C_{17}H_{18}O_5$+Na^{+}]: 325.1047, found 325.1042;

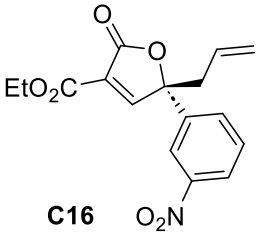


	Retention Time	Area	% Area	Height
1	9.594	10952119	49.88	289487
2	12.697	11003666	50.12	189564



	Retention Time	Area	% Area	Height
1	9.898	1495000	5.00	43474
2	13.179	28376500	95.00	509270

Ethyl (*S*)-5-allyl-5-(3-nitrophenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C16)



C16

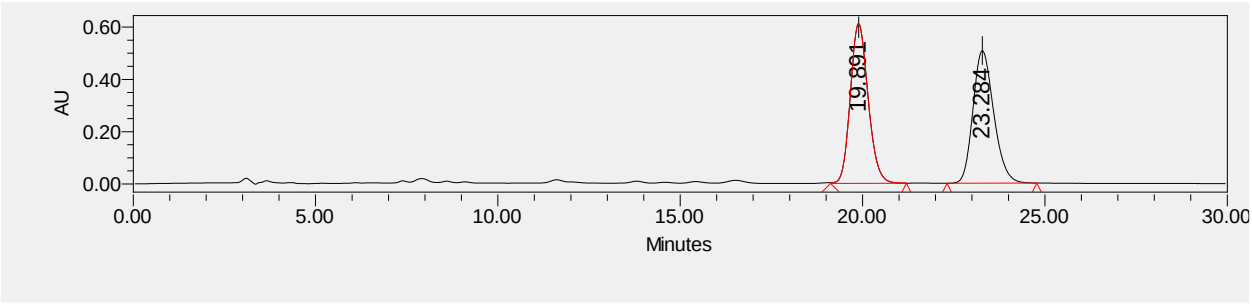
Results: colorless oil, 99% yield, 96% *ee*; $[\alpha]^{23}_{D}$ = -87.1 (*c* = 0.510 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 80/20, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 20.07 min, $t_{R(minor)}$ = 23.61 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.39 (s, 1H), 8.30 – 8.21 (m, 2H), 7.82 - 7.76 (m, 1H), 7.64 (t, *J* = 8.0 Hz, 1H), 5.68 - 5.55 (m, 1H), 5.25 – 5.13 (m, 2H), 4.35 (q, *J* = 7.2 Hz, 2H), 2.95 (ddt, *J* = 14.4, 7.5, 1.1 Hz, 1H), 2.88 (ddt, *J* = 14.3, 6.9, 1.1 Hz, 1H), 1.37 (t, *J* = 7.1 Hz, 3H);

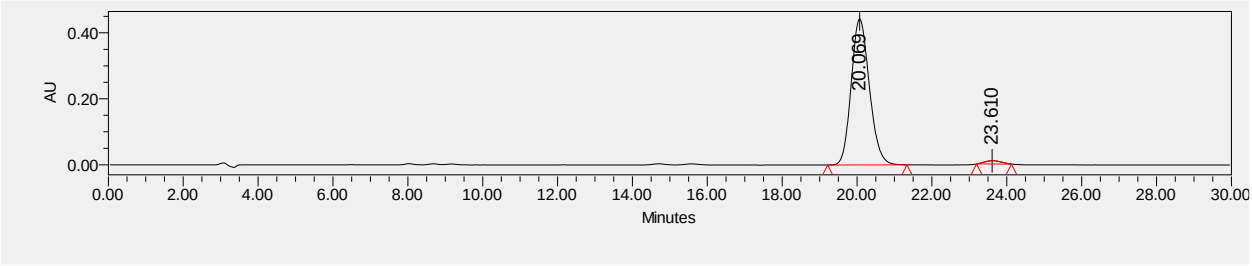
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 165.82, 163.24, 159.65, 148.45, 139.49, 131.30, 130.33, 128.76, 125.57, 123.74, 122.19, 120.50, 86.96, 62.12, 43.96, 14.11;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3088, 2984, 2922, 1779, 1722, 1530, 1348, 1275, 1259, 1067, 1030, 993, 799, 749, 690;

ESI-HRMS calcd for [$C_{16}H_{15}NO_6$+Na^{+}]: 340.0792, found 340.0786;

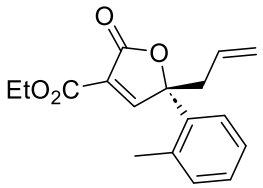


	Retention Time	Area	% Area	Height
1	19.891	20669973	50.73	610461
2	23.284	20075926	49.27	506762



	Retention Time	Area	% Area	Height
1	20.069	14926667	97.96	442305
2	23.610	310644	2.04	9953

Ethyl (*S*)-5-allyl-2-oxo-5-(*o*-tolyl)-2,5-dihydrofuran-3-carboxylate (C17)



C17

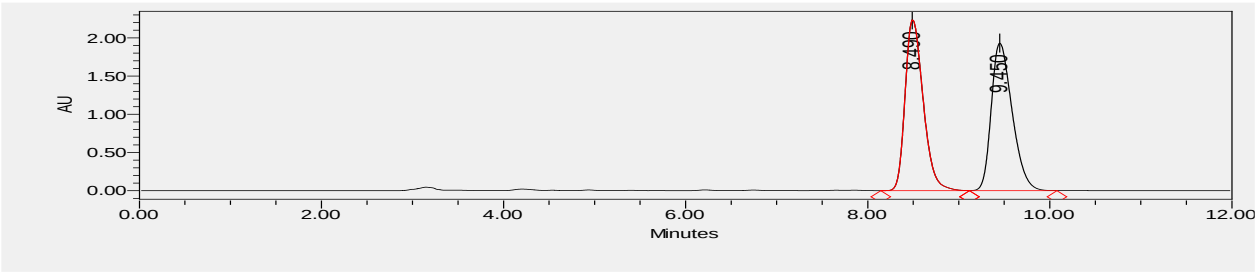
Results: colorless oil, 99% yield, 64% *ee*; $[\alpha]^{23}_{D}$ = -14.1 (*c* = 1.038 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 8.56 min, $t_{R(major)}$ = 9.50 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.57 (s, 1H), 7.36 – 7.14 (m, 4H), 5.64 – 5.49 (m, 1H), 5.19 – 5.08 (m, 2H), 4.35 (q, *J* = 7.1 Hz, 2H), 2.96 (ddt, *J* = 14.4, 7.4, 1.1 Hz, 1H), 2.90 (ddt, *J* = 14.4, 7.1, 1.2 Hz, 1H), 2.58 (s, 3H), 1.36 (t, *J* = 7.1 Hz, 3H);

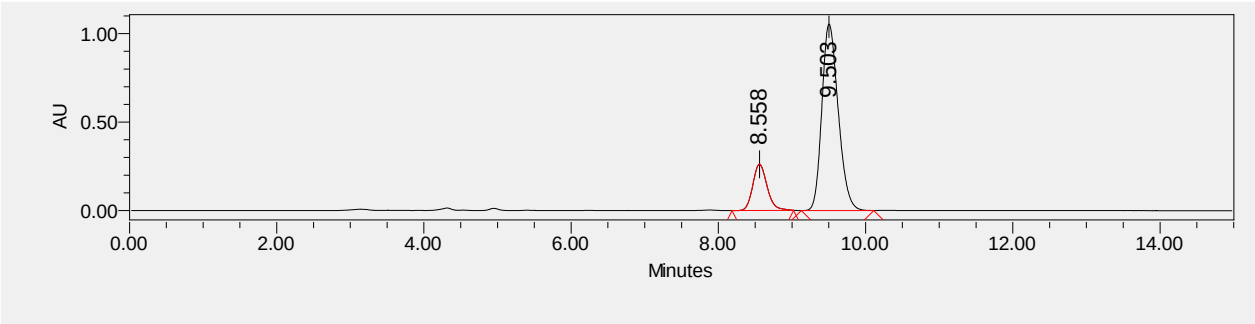
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.24, 164.26, 160.17, 135.56, 135.11, 133.01, 129.84, 128.81, 126.69, 126.35, 125.37, 121.01, 89.07, 61.88, 42.82, 21.85, 14.16;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3083, 2981, 2917, 2849, 1775, 1722, 1370, 1340, 1314, 1272, 1067, 1027, 799, 763, 725;

ESI-HRMS calcd for [$C_{17}H_{18}O_4$+Na^{+}]: 309.1098, found 309.1092;

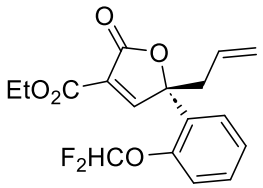


	Retention Time	Area	% Area	Height
1	8.490	30957931	50.14	2234624
2	9.450	30790944	49.86	1930321



	Retention Time	Area	% Area	Height
1	8.558	3521507	17.78	261806
2	9.503	16284902	82.22	1054212

Ethyl (*S*)-5-allyl-5-(2-(difluoromethoxy)phenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C18)



C18

Results: colorless oil, 99% yield, 98% *ee*; $[\alpha]^{23}_{D}$ = -113.2 (*c* = 0.608 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 80/20, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 8.33 min, $t_{R(minor)}$ = 9.22 min;

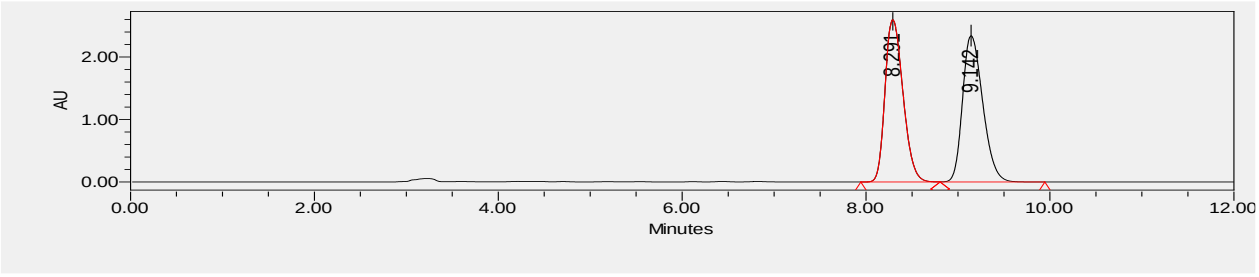
^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.61 (s, 1H), 7.64 (dd, *J* = 7.9, 1.7 Hz, 1H), 7.44 – 7.33 (m, 1H), 7.23 (td, *J* = 7.7, 1.1 Hz, 1H), 7.10 (dd, *J* = 8.2, 1.2 Hz, 1H), 6.69 (t, *J* = 72.9 Hz, 1H), 5.68 – 5.50 (m, 1H), 5.16 – 5.06 (m, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 3.00 (ddt, *J* = 14.4, 7.7, 1.1 Hz, 1H), 2.84 (ddt, *J* = 14.4, 6.9, 1.2 Hz, 1H), 1.36 (t, *J* = 7.1 Hz, 3H);

^{13}C{^{1}H}NMR (101 MHz, Chloroform-*d*): δ 166.26, 163.83, 160.06, 147.88 (t, J_{F-C} = 2.4 Hz), 130.46, 129.77, 127.79, 127.63, 125.74, 124.74, 120.97, 116.61, 116.05 (t, J_{F-C} = 259.1 Hz),, 87.03, 61.87, 41.89, 14.11;

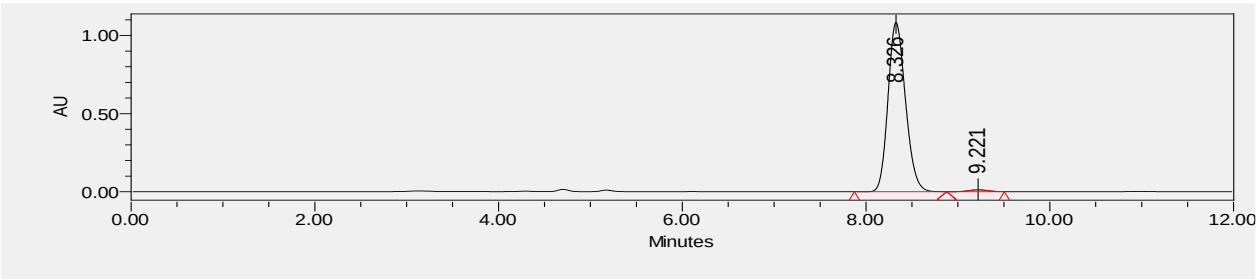
^{19}F{^{1}H}NMR (377 MHz, Chloroform-*d*) δ -79.35 ~ -80.31 (m, 2F).

IR (film): $\tilde{\nu}$ (cm^{-1}) 3083, 2985, 2917, 2849, 1784, 1724, 1372, 1339, 1316, 1276, 1226, 1117, 1048, 1030, 799, 762;

ESI-HRMS calcd for [$C_{17}H_{16}F_2O_5$+Na^{+}]: 361.0858, found 361.0851;

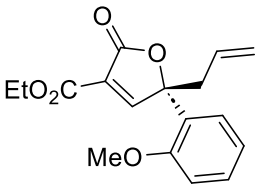


	Retention Time	Area	% Area	Height
1	8.291	35300426	49.69	2597170
2	9.142	35741795	50.31	2339275



	Retention Time	Area	% Area	Height
1	8.326	14315531	98.81	1083674
2	9.221	172471	1.19	12140

Ethyl (*S*)-5-allyl-5-(2-methoxyphenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C19)



C19

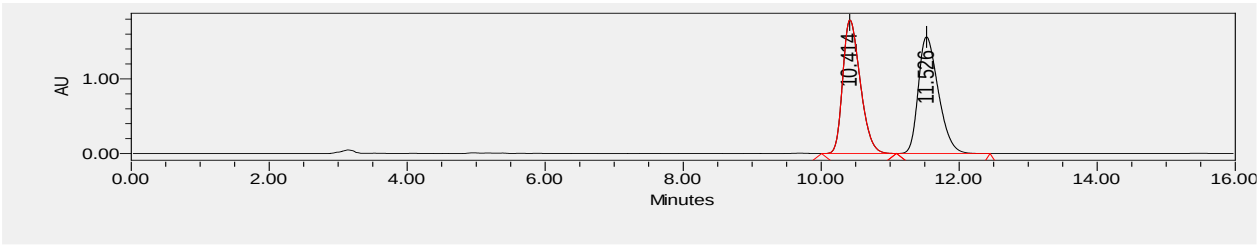
Results: colorless oil, 97% yield, 98% *ee*; $[\alpha]^{23}_{D}$ = -167.8 (*c* = 0.522 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 10.42 min, $t_{R(minor)}$ = 11.58 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.71 (s, 1H), 7.56 – 7.48 (m, 1H), 7.36 – 7.30 (m, 1H), 7.03 – 6.96 (m, 1H), 6.95 – 6.91 (m, 1H),5.65 - 5.53 (m, 1H), 5.13 – 5.03 (m, 2H), 4.33 (qd, *J* = 7.1, 0.8 Hz, 2H), 3.94 (s, 3H), 3.00 (ddt, *J* = 14.3, 7.4, 1.1 Hz, 1H), 2.89 (ddt, *J* = 14.3, 7.0, 1.1 Hz, 1H), 1.35 (t, *J* = 7.1 Hz, 3H);

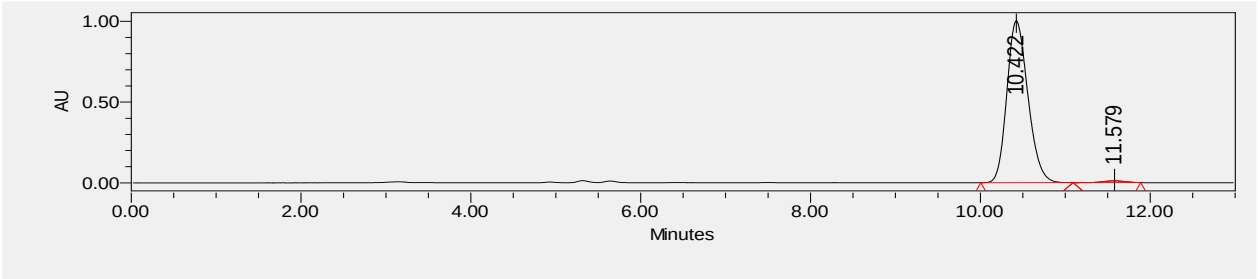
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.80, 165.37, 160.49, 155.10, 130.44, 130.09, 126.55, 125.51, 124.03, 121.45, 120.38, 111.01, 87.89, 61.69, 55.49, 41.12, 14.17;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3079, 2981, 2918, 2847, 1783, 1723, 1489, 1370, 1336, 1241, 1053, 1030, 799, 756;

ESI-HRMS calcd for [$C_{17}H_{18}O_5$+Na^+]: 325.1047, found 325.1042;

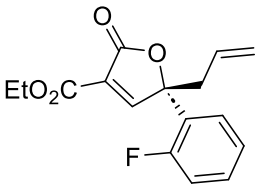


	Retention Time	Area	% Area	Height
1	10.414	31522259	50.00	1787290
2	11.526	31526418	50.00	1560743



	Retention Time	Area	% Area	Height
1	10.422	17269510	98.85	1001910
2	11.579	201729	1.15	11163

Ethyl (*S*)-5-allyl-5-(2-fluorophenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C20)



C20

Results: colorless oil, 99% yield, 96% *ee*; $[\alpha]^{23}_{D}$ = -92.6 (*c* = 0.568 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 80/20, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 9.33 min, $t_{R(minor)}$ = 9.97 min;

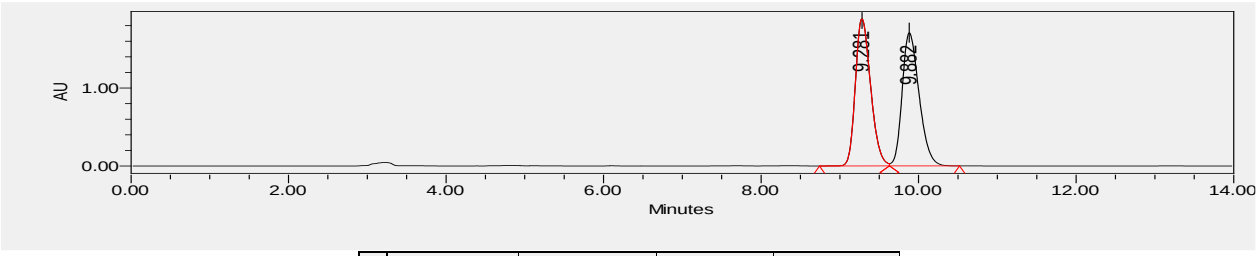
^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.52 (d, *J* = 3.4 Hz, 1H), 7.57 - 7.51 (m, 1H), 7.40 - 7.32 (m, 1H), 7.21 - 7.16 (m, 1H), 7.14- 7.07 (m, 1H), 5.68 – 5.53 (m, 1H), 5.18 – 5.06 (m, 2H), 4.34 (q, *J* = 7.2 Hz, 2H), 3.02 – 2.91 (m, 1H), 2.88 – 2.78 (m, 1H), 1.36 (t, *J* = 7.1 Hz, 3H);

^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.28, 163.63 (d, J_{F-C} = 6.6 Hz), 159.98, 158.66 (d, J_{F-C} = 245.3 Hz), 130.75 (d, J_{F-C} = 8.5 Hz), 129.49, 127.11 (d, J_{F-C} = 3.5 Hz), 125.13 (d, J_{F-C} = 3.2 Hz), 124.76 (d, J_{F-C} = 12.4 Hz), 124.70, 121.25, 116.06 (d, J_{F-C} = 22.1 Hz), 86.27 (d, J_{F-C} = 4.0 Hz), 61.87, 42.29 (d, J_{F-C} = 3.1 Hz), 14.13;

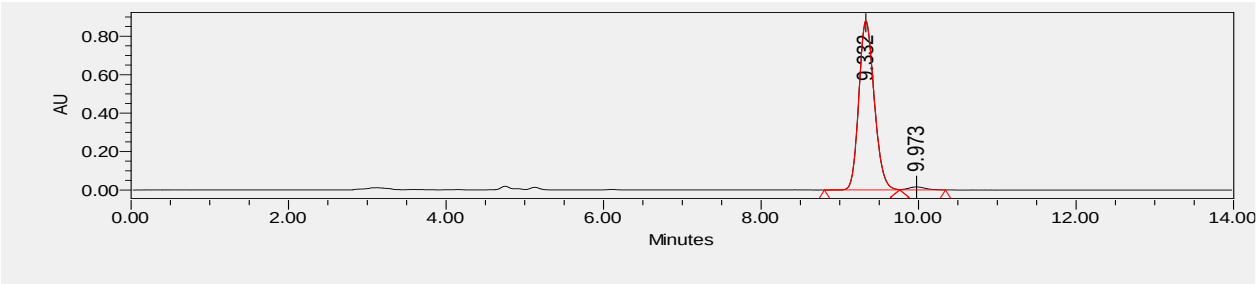
^{19}F{^{1}H} NMR (377 MHz, Chloroform-*d*) δ -114.18;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3083, 2982, 2920, 2850, 1787, 1724, 1486, 1370, 1337, 1316, 1221, 1039, 1028, 799, 763;

ESI-HRMS calcd for [$C_{16}H_{15}FO_4$+Na^+]: 313.0847, found 313.0842;

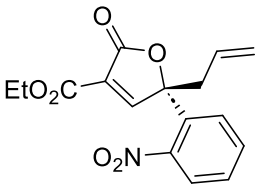


	Retention Time	Area	% Area	Height
1	9.281	25418216	49.90	1884810
2	9.882	25516042	50.10	1706978



	Retention Time	Area	% Area	Height
1	9.332	11939584	98.07	879245
2	9.973	234902	1.93	15696

Ethyl (*S*)-5-allyl-5-(2-nitrophenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C21)



C21

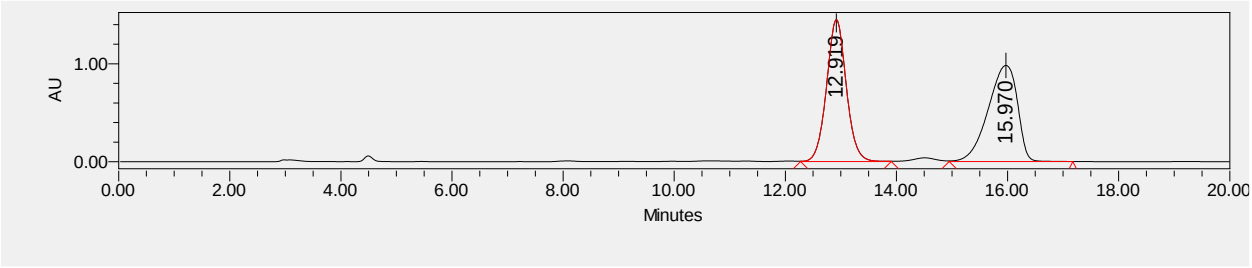
Results: colorless oil, 99% yield, 90% *ee*; $[\alpha]^{19}_{D}$ = +19.5 (*c* = 0.514 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak ADH, *n*-hexane/*i*-PrOH 90/10, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 12.96 min, $t_{R(minor)}$ = 15.77 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.64 (s, 1H), 7.69 – 7.62 (m, 1H), 7.57 – 7.51 (m, 1H), 5.68 – 5.53 (m, 1H), 5.19 – 5.10 (m, 3H), 4.34 (q, *J* = 7.1 Hz, 2H), 3.04 (dd, *J* = 14.5, 7.9 Hz, 1H), 2.91 (dd, *J* = 14.5, 6.6 Hz, 1H), 1.36 (t, *J* = 7.1 Hz, 3H);

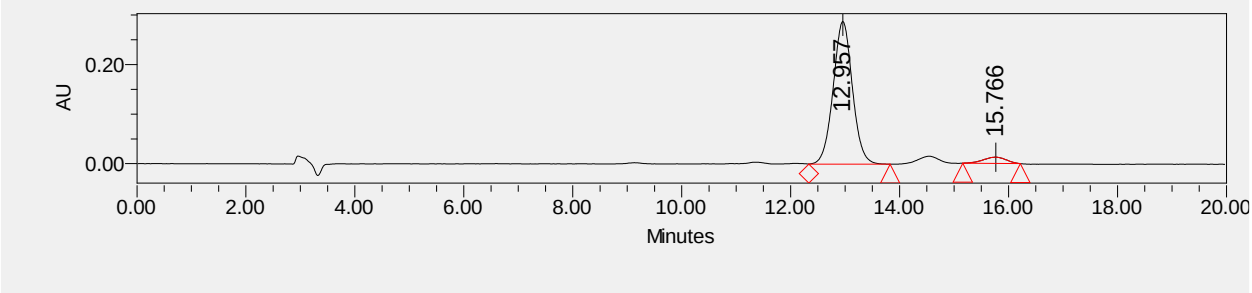
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 165.56, 163.38, 159.72, 148.38, 133.54, 131.04, 130.03, 129.32, 128.47, 125.81, 125.56, 121.77, 87.51, 62.02, 42.17, 14.11;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3089, 2985, 1787, 1725, 1536, 1371, 1260, 1067, 1028, 799, 750;

ESI-HRMS calcd for [$C_{16}H_{15}NO_6$+Na^{+}]: 340.0792, found 340.0788;

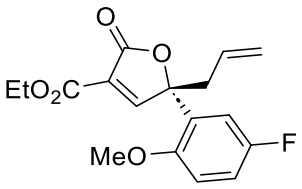


	Retention Time	Area	% Area	Height
1	12.919	35828677	49.94	1448734
2	15.970	35910994	50.06	981022



	Retention Time	Area	% Area	Height
1	12.957	7071941	95.05	287859
2	15.766	368598	4.95	12768

Ethyl (*S*)-5-allyl-5-(5-fluoro-2-methoxyphenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C22)



C22

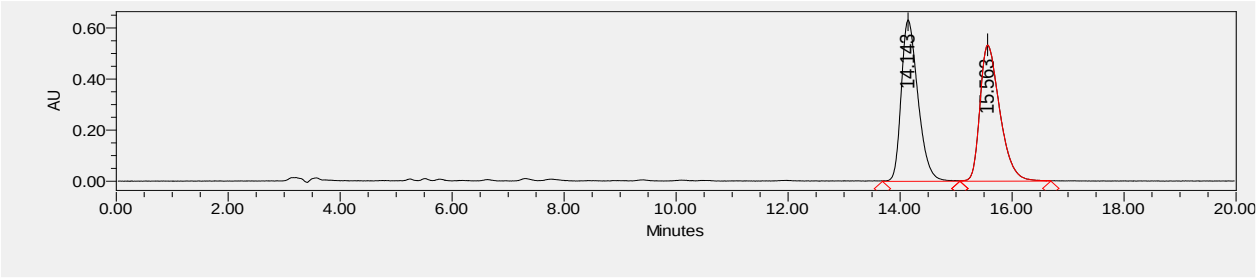
Results: colorless oil, 94% yield, 91% *ee*; $[\alpha]^{23}_{D}$ = -151.3 (*c* = 0.538 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak ID, *n*-hexane/*i*-PrOH 80/20, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 14.27 min, $t_{R(major)}$ = 15.52 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.67 (s, 1H), 7.30 – 7.23 (m, 1H), 7.05 – 6.97 (m, 1H), 6.86 (dd, *J* = 9.0, 4.3 Hz, 1H), 5.65 - 5.51 (m, 1H), 5.13 – 5.03 (m, 2H), 4.33 (qd, *J* = 7.1, 1.3 Hz, 2H), 3.93 (s, 3H), 2.99 (ddt, *J* = 14.2, 7.5, 1.1 Hz, 1H), 2.85 (ddt, *J* = 14.2, 7.0, 1.1 Hz, 1H), 1.36 (t, *J* = 7.1 Hz, 3H);

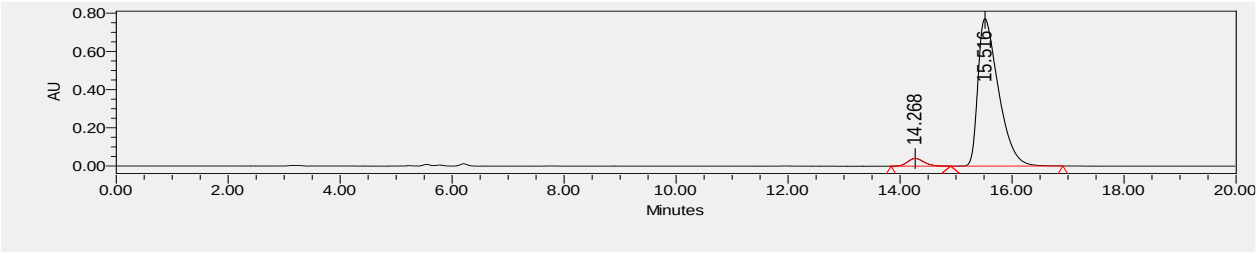
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.39, 164.62, 160.33, 157.23 (d, J_{F-C} = 240.4 Hz), 151.18 (d, J_{F-C} = 2.2 Hz), 130.07, 127.08 (d, J_{F-C} = 7.2 Hz), 124.38, 120.71, 115.88 (d, J_{F-C} = 23.0 Hz), 114.03 (d, J_{F-C} = 26.3 Hz), 111.94 (d, J_{F-C} = 8.0 Hz), 87.29, 61.80, 56.00, 40.97, 14.15;

IR (film): $\tilde{\nu}$ (cm^{-1}) 2982, 1786, 1725, 1496, 1274, 1249, 1031, 799, 749;

ESI-HRMS calcd for [$C_{17}H_{17}FO_5$+Na^{+}]: 343.0953, found 343.0947;

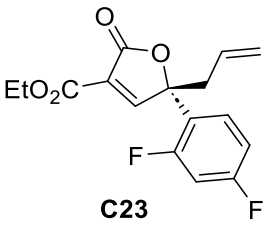


	Retention Time	Area	% Area	Height
1	14.143	13123174	50.04	632365
2	15.563	13104752	49.96	533807



	Retention Time	Area	% Area	Height
1	14.268	821756	4.01	40510
2	15.516	19655736	95.99	772038

Ethyl (*S*)-5-allyl-5-(5-fluoro-2-methoxyphenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C23)



C23

Results: colorless oil, 99% yield, 98% *ee*; $[\alpha]^{23}_{D}$ = -91.3 (*c* = 0.528 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 80/20, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 8.48 min, $t_{R(minor)}$ = 9.30 min;

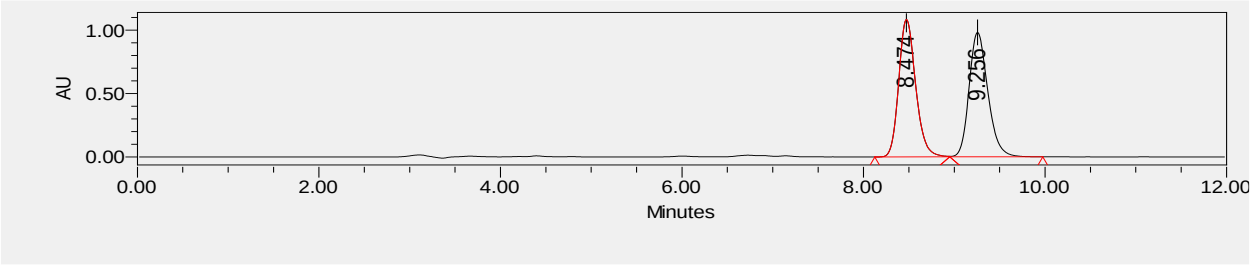
^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.48 (d, *J* = 3.5 Hz, 1H), 7.53 (td, *J* = 8.8, 6.2 Hz, 1H), 7.04 – 6.77 (m, 2H), 5.67 – 5.52 (m, 1H), 5.18 – 5.08 (m, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 2.98 – 2.87 (m, 1H), 2.85 – 2.74 (m, 1H), 1.36 (t, *J* = 7.1 Hz, 3H);

^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.03, 164.44 (d, J_{F-C} = 12.3 Hz), 163.24 (d, J_{F-C} = 6.5 Hz), 161.94 (d, J_{F-C} = 12.2 Hz), 159.99 (d, J_{F-C} = 11.9 Hz), 159.88, 157.52 (d, J_{F-C} = 11.9 Hz), 129.28, 128.31 (dd, J_{F-C} = 9.7, 5.2 Hz), 124.90, 121.45, 120.88 (dd, J_{F-C} = 12.9, 3.9 Hz), 112.25 (dd, J_{F-C} = 21.2, 3.4 Hz), 104.63 (t, J_{F-C} = 26.0 Hz), 85.88 (d, J_{F-C} = 4.2 Hz), 61.95, 42.39 (d, J_{F-C} = 3.0 Hz), 14.12;

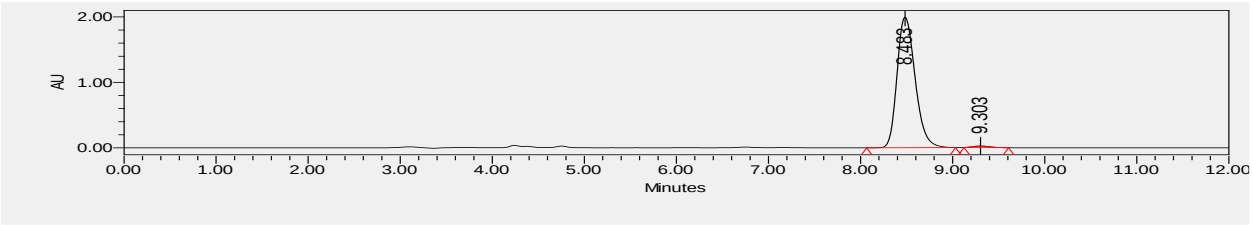
^{19}F NMR (377 MHz, Chloroform-*d*) δ -108.53 (d, *J* = 7.9 Hz), -110.26 (d, *J* = 8.2 Hz);

IR (film): $\tilde{\nu}$ (cm^{-1}) 3083, 2985, 2928, 1788, 1724, 1501, 1299, 1275, 1030, 799, 750;

ESI-HRMS calcd for [$C_{16}H_{14}F_2O_4$+Na^{+}]: 331.0753, found 331.0746;

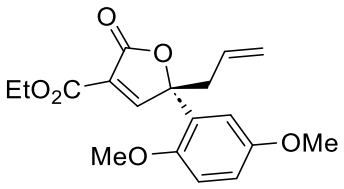


	Retention Time	Area	% Area	Height
1	8.474	14032262	49.92	1083078
2	9.256	14075757	50.08	980285



	Retention Time	Area	% Area	Height
1	8.483	27208458	98.92	1994188
2	9.303	297675	1.08	23586

Ethyl (*S*)-5-allyl-5-(2,5-dimethoxyphenyl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C24)



C24

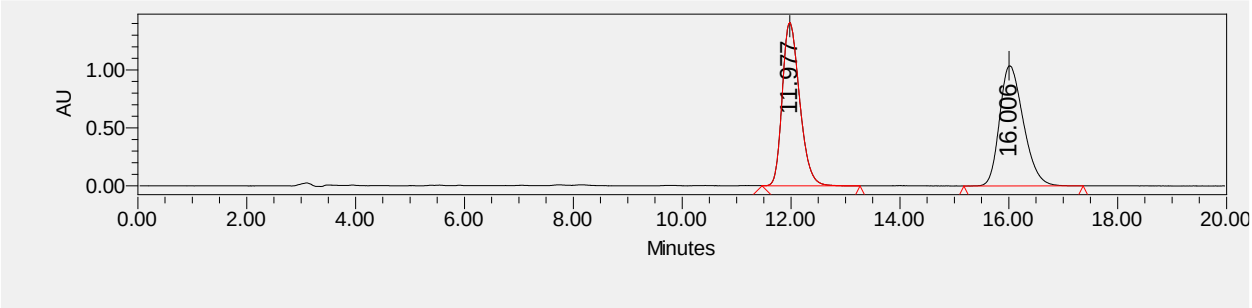
Results: colorless oil, 90% yield, 84% *ee*; $[\alpha]^{23}_{D}$ = -100.3 (*c* = 0.574 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 11.86 min, $t_{R(minor)}$ = 15.98 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.69 (s, 1H), 7.10 – 7.07 (m, 1H), 6.88 – 6.82 (m, 2H), 5.66 – 5.51 (m, 1H), 5.14 – 5.04 (m, 2H), 4.33 (qd, *J* = 7.1, 1.1 Hz, 2H), 3.89 (s, 3H), 3.76 (s, 3H), 2.99 (ddt, *J* = 14.3, 7.3, 1.1 Hz, 1H), 2.88 (ddt, *J* = 14.3, 7.1, 1.1 Hz, 1H), 1.35 (t, *J* = 7.1 Hz, 3H). ;

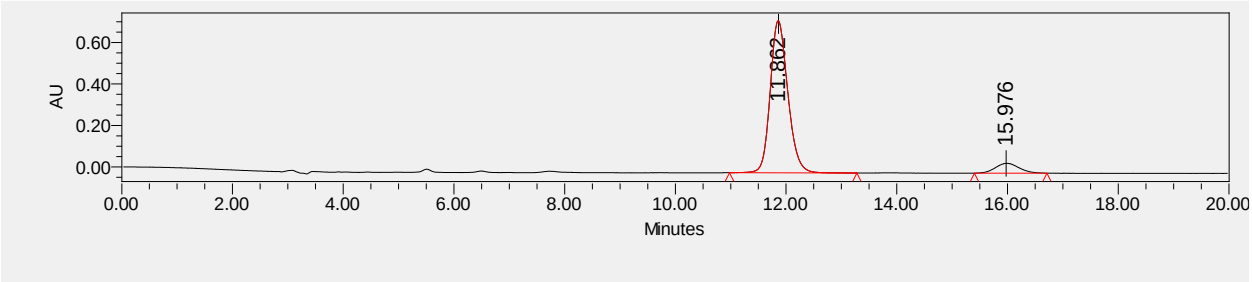
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.76, 165.27, 160.45, 154.06, 149.12, 130.35, 126.27, 124.02, 120.46, 114.87, 112.10, 112.05, 87.75, 61.70, 55.84, 41.11, 29.71, 14.16;

IR (film): $\tilde{\nu}$ (cm^{-1}) 2980, 2917, 2837, 1783, 1724, 1498, 1277, 1224, 1032, 799, 749;

ESI-HRMS calcd for [$C_{18}H_{20}O_6$+Na^+]: 355.1153, found 355.1147;

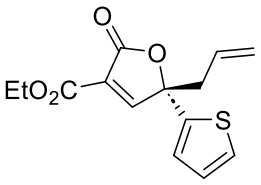


	Retention Time	Area	% Area	Height
1	11.977	31246040	49.80	1409772
2	16.006	31497367	50.20	1037208



	Retention Time	Area	% Area	Height
1	11.862	16180919	92.00	733742
2	15.976	1407213	8.00	47642

Ethyl (*S*)-5-allyl-2-oxo-5-(thiophen-2-yl)-2,5-dihydrofuran-3-carboxylate (C25)



C25

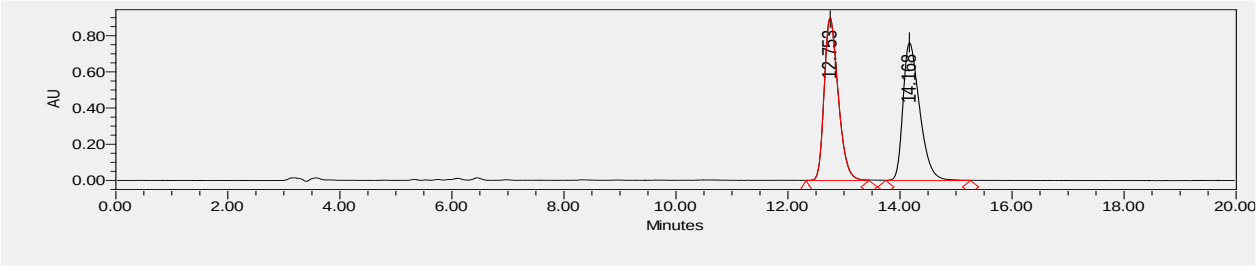
Results: colorless oil, 99% yield, 81% *ee*; $[\alpha]^{23}_{D}$ = -39.1 (*c* = 1.040 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IG, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 12.85 min, $t_{R(major)}$ = 14.24 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.21 (s, 1H), 7.35 (dd, *J* = 4.9, 1.4 Hz, 1H), 7.07 – 6.99 (m, 2H), 5.72 – 5.57 (m, 1H), 5.25 – 5.16 (m, 2H), 4.35 (q, *J* = 7.1 Hz, 2H), 2.99 (dq, *J* = 14.3, 7.2 Hz, 2H), 1.37 (t, *J* = 7.1 Hz, 3H);

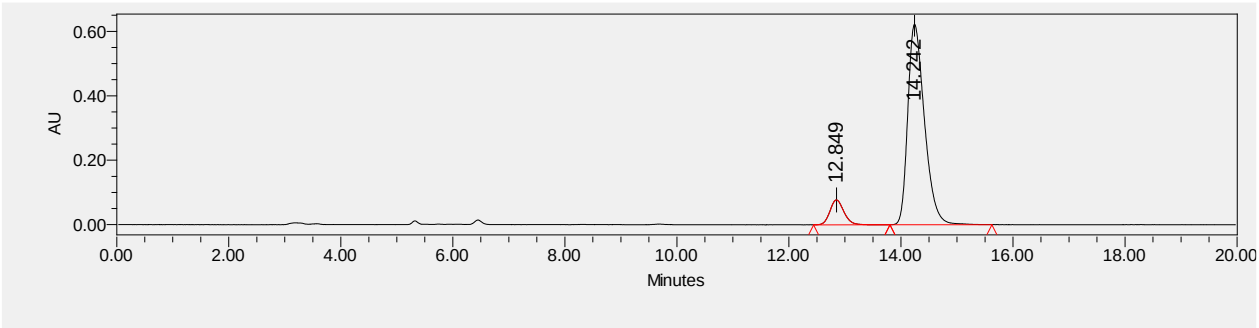
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.16, 163.75, 159.95, 139.53, 129.30, 127.35, 126.47, 125.39, 124.96, 121.65, 85.63, 61.97, 43.69, 14.13;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3083, 2982, 2917, 2837, 1777, 1722, 1641, 1370, 1336, 1311, 1252, 1062, 1024, 799, 708;

ESI-HRMS calcd for [$C_{14}H_{14}O_4S$ +Na^+]: 301.0505, found 301.0503;

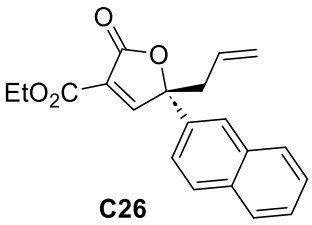


	Retention Time	Area	% Area	Height
1	12.753	15677683	49.88	898878
2	14.168	15755163	50.12	764329



	Retention Time	Area	% Area	Height
1	12.849	1349241	9.48	77479
2	14.242	12882167	90.52	622682

Ethyl (*S*)-5-allyl-5-(naphthalen-2-yl)-2-oxo-2,5-dihydrofuran-3-carboxylate (C26)



C26

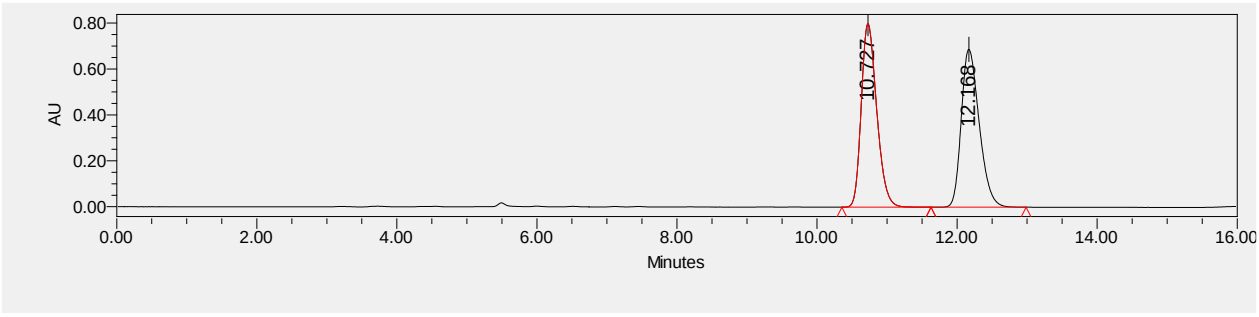
Results: white solid, 99% yield, 90% *ee*; $[\alpha]^{23}_{D}$ = -107.8 (*c* = 0.476 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak OXH, *n*-hexane/*i*-PrOH 80/20, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 10.74 min, $t_{R(minor)}$ = 12.24 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.44 (s, 1H), 7.92 – 7.79 (m, 4H), 7.57 – 7.43 (m, 3H), 5.70 – 5.56 (m, 1H), 5.22 – 5.11 (m, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 3.01 (ddt, *J* = 14.4, 7.3, 1.2 Hz, 1H), 2.93 (ddt, *J* = 14.3, 7.0, 1.1 Hz, 1H), 1.35 (t, *J* = 7.1 Hz, 3H);

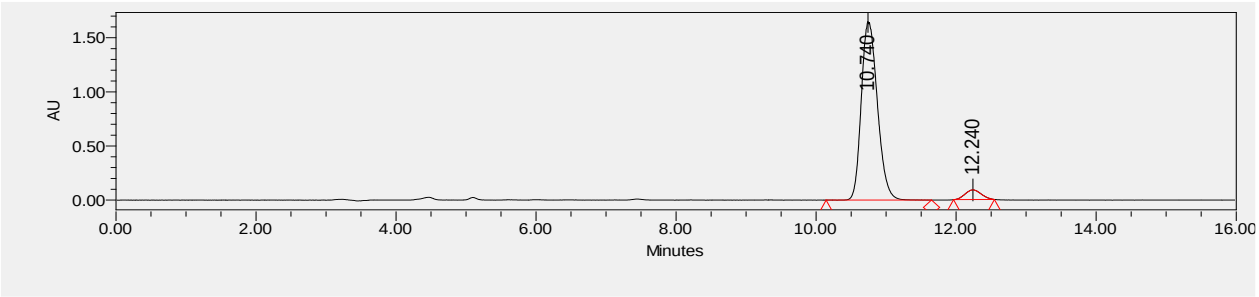
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.68, 164.93, 160.09, 134.43, 133.09, 132.99, 129.65, 129.03, 128.25, 127.70, 126.94, 126.91, 124.74, 124.51, 122.56, 121.29, 88.09, 61.89, 43.75, 14.15;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3082, 2983, 2931, 1777, 1722, 1641, 1370, 1275, 1260, 1069, 1032, 994,800, 750;

ESI-HRMS calcd for [$C_{20}H_{18}O_4$ +Na^{+}]: 345.1098, found 345.1092;

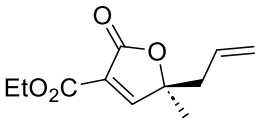


	Retention Time	Area	% Area	Height
1	10.727	12255389	50.05	799245
2	12.168	12233299	49.95	687564



	Retention Time	Area	% Area	Height
1	10.740	26361096	94.82	1650524
2	12.240	1439308	5.18	89778

Ethyl (*S*)-5-allyl-5-methyl-2-oxo-2,5-dihydrofuran-3-carboxylate (C27)



C27

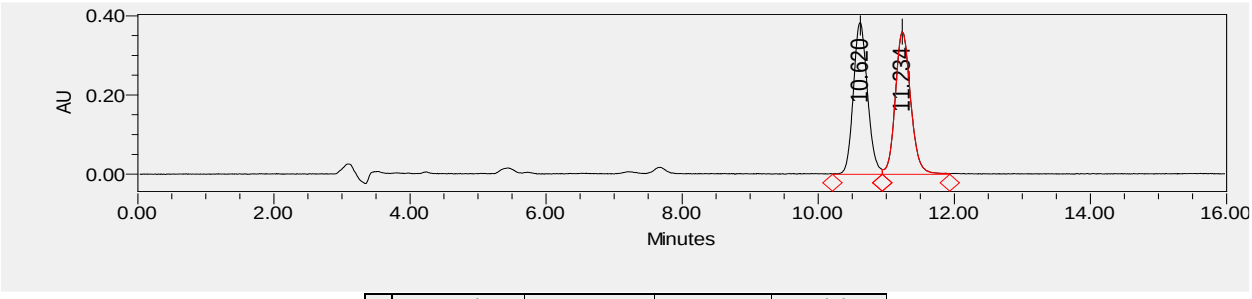
Results: colorless oil, 99% yield, 68% *ee*; $[\alpha]^{24}_{D}$ = +22.8 (*c* = 0.316 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak AZH, *n*-hexane/*i*-PrOH 85/15, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 10.64 min, $t_{R(major)}$ = 11.24 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.05 (s, 1H), 5.66 (ddt, *J* = 17.5, 10.3, 7.3 Hz, 1H), 5.20 – 5.11 (m, 2H), 4.32 (q, *J* = 7.1 Hz, 2H), 2.53 (dt, *J* = 7.4, 1.1 Hz, 1H), 1.50 (s, 3H), 1.35 (t, *J* = 7.1 Hz, 3H);

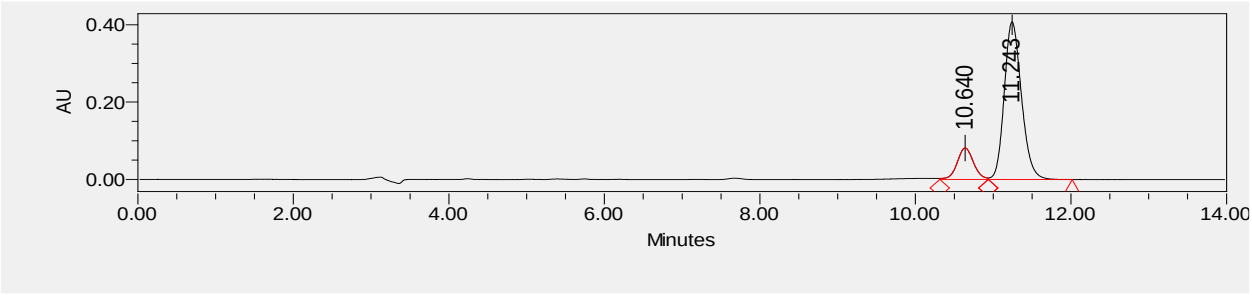
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.75, 166.33, 160.22, 130.23, 125.33, 120.93, 85.26, 61.77, 42.63, 23.13, 14.13;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3082, 2984, 2919, 1776, 1722, 1642, 1450, 1338, 1314, 1275, 1260, 1036,800, 764, 750;

ESI-HRMS calcd for [$C_{11}H_{14}O_4$+Na^+]: 233.0785, found 233.0782;

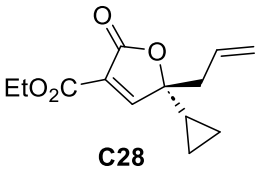


	Retention Time	Area	% Area	Height
1	10.620	5531467	49.48	382856
2	11.234	5647411	50.52	360186



	Retention Time	Area	% Area	Height
1	10.640	1193109	16.00	81434
2	11.243	6264700	84.00	407738

Ethyl (*R*)-5-allyl-5-cyclopropyl-2-oxo-2,5-dihydrofuran-3-carboxylate (C28)



C28

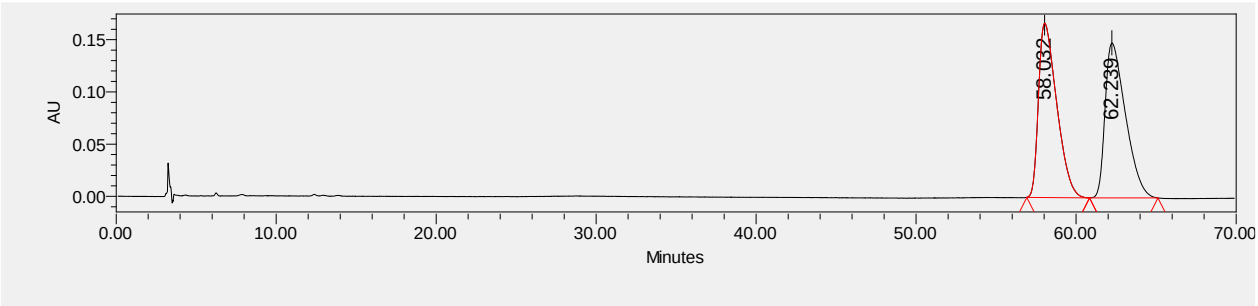
Results: colorless oil, 99% yield, 86% *ee*; $[\alpha]^{24}_{D}$ = +24.6 (*c* = 0.390 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IC, *n*-hexane/*i*-PrOH 95/5, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 57.79 min, $t_{R(minor)}$ = 62.72 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.02 (s, 1H), 5.78 – 5.62 (m, 1H), 5.23 – 5.13 (m, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 2.67 (d, *J* = 7.3 Hz, 1H), 1.37 (t, *J* = 7.1 Hz, 3H), 0.66 – 0.43 (m, 3H), 0.31 – 0.21 (m, 1H);

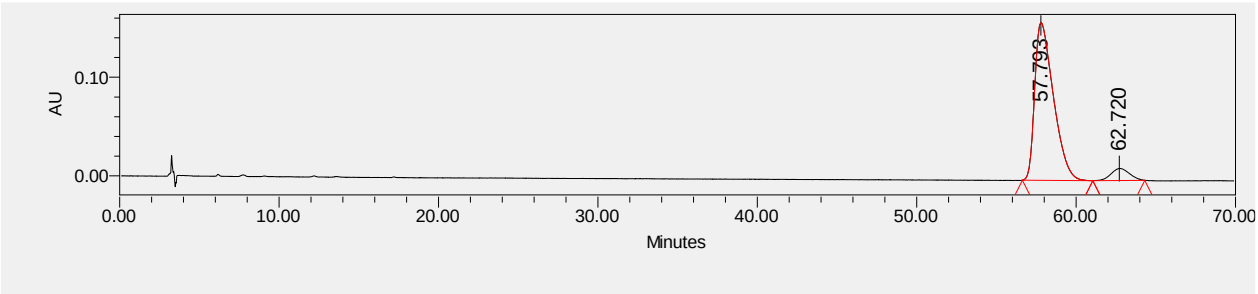
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.09, 164.45, 159.28, 129.33, 124.60, 119.85, 85.30, 60.93, 41.14, 15.88, 13.29, 1.16, 0.00;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3082, 3006, 2986, 2917, 2349, 1777, 1722, 1275, 1260, 1048, 995, 764, 750;

ESI-HRMS calcd for [$C_{13}H_{16}O_4$+Na^{+}]: 259.0941, found 259.0938;

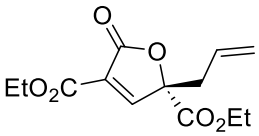


	Retention Time	Area	% Area	Height
1	58.032	13207767	50.09	167089
2	62.239	13161258	49.91	148402



	Retention Time	Area	% Area	Height
1	57.793	12998197	92.98	159771
2	62.720	982096	7.02	12190

Diethyl (*S*)-2-allyl-5-oxo-2,5-dihydrofuran-2,4-dicarboxylate (C29)



C29

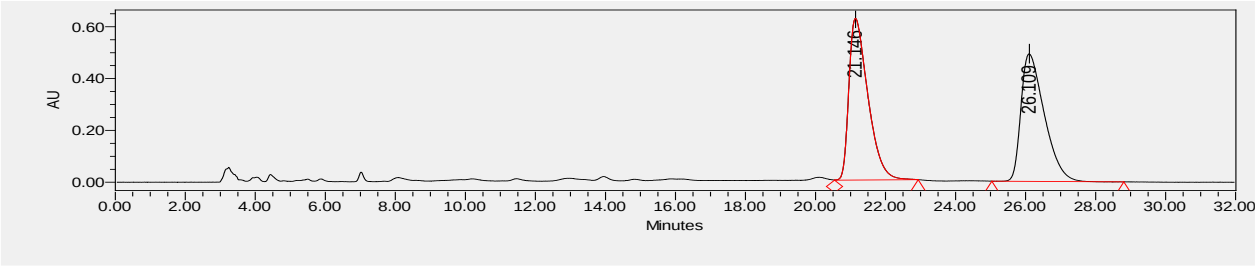
Results: colorless oil, 97% yield, 81% *ee*; $[\alpha]^{24}_{D}$ = -80.6 (*c* = 0.360 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IC, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 21.51 min, $t_{R(minor)}$ = 26.58 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.08 (s, 1H), 5.73 – 5.61 (m, 1H), 5.28 – 5.18 (m, 2H), 4.35 (q, *J* = 7.1 Hz, 2H), 4.26 (q, *J* = 7.1 Hz, 3H), 2.92 (dd, *J* = 14.2, 7.6 Hz, 1H), 2.77 (dd, *J* = 14.3, 6.9 Hz, 1H), 1.37 (t, *J* = 7.1 Hz, 3H), 1.31 (t, *J* = 7.2 Hz, 3H);

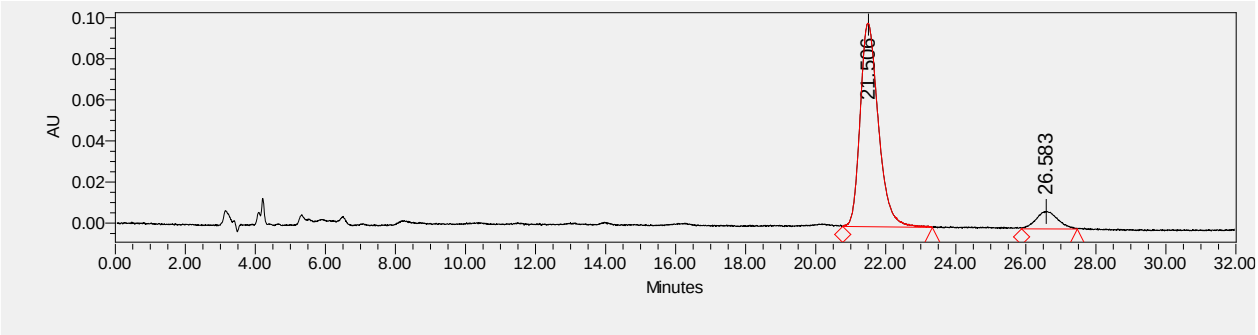
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.08, 165.81, 160.18, 159.50, 128.53, 126.55, 121.92, 86.56, 63.18, 62.08, 39.74, 14.09, 14.07;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3087, 2985, 2937, 1792, 1722, 1643, 1370, 1336, 1259, 1032, 764, 750;

ESI-HRMS calcd for [$C_{13}H_{16}O_6$+Na^{+}]: 291.0840, found 291.0834;

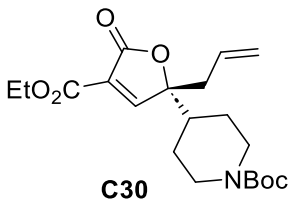


	Retention Time	Area	% Area	Height
1	21.146	23500919	50.79	624252
2	26.109	22768981	49.21	492343



	Retention Time	Area	% Area	Height
1	21.506	3566549	90.64	99022
2	26.583	368120	9.36	8504

***tert*-Butyl (*R*)-4-(2-allyl-4-(ethoxycarbonyl)-5-oxo-2,5-dihydrofuran-2-yl)piperidine-1-carboxylate (C30)**



C30

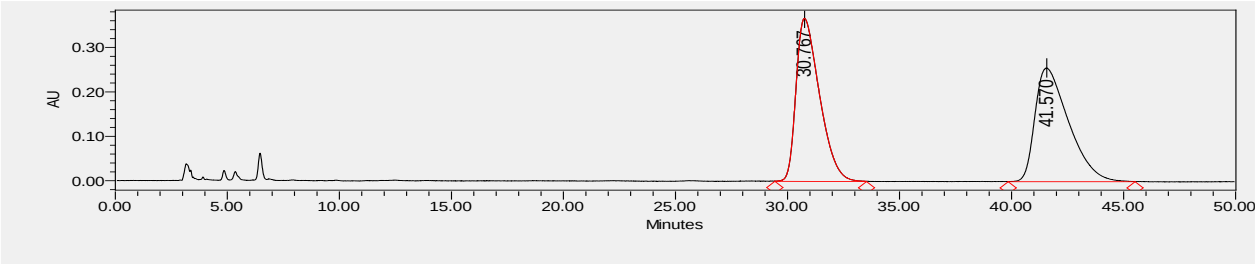
Results: colorless oil, 88% yield, 86% *ee*; $[\alpha]^{24}_{D}$ = -19.6 (*c* = 0.628 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak IC, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 31.46 min, $t_{R(major)}$ = 42.03 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.03 (s, 1H), 5.68 - 5.56 (m, 1H), 5.23 – 5.12 (m, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 4.19 (s, 3H), 2.69 – 2.50 (m, 4H), 2.03 – 1.91 (m, 1H), 1.85 – 1.62 (m, 2H), 1.45 (s, 9H), 1.37 (t, *J* = 7.1 Hz, 3H), 1.33 – 1.22 (m, 3H);

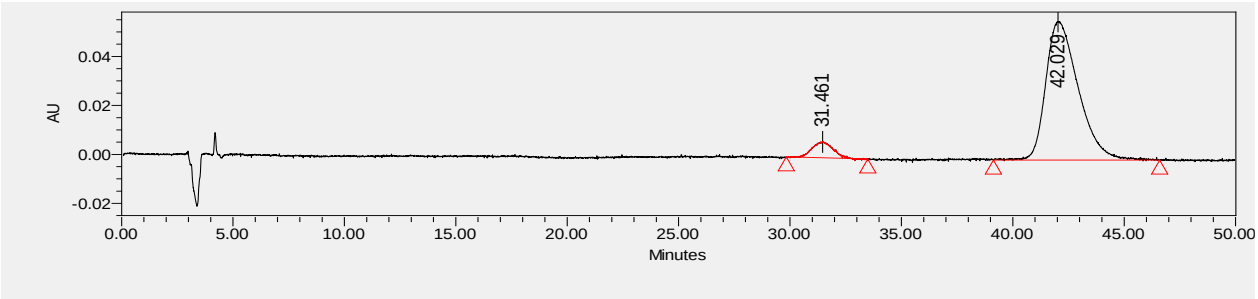
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.64, 164.60, 159.87, 154.46, 129.63, 126.64, 121.12, 89.20, 79.80, 61.87, 42.13, 38.80, 28.41, 26.84, 26.05, 14.13;

IR (film): $\tilde{\nu}$ (cm^{-1}) 2982, 1778, 1689, 1425, 1275, 1260, 1167, 764, 750;

ESI-HRMS calcd for [$C_{20}H_{29}NO_6$+Na^{+}]: 402.1888, found 402.1881;

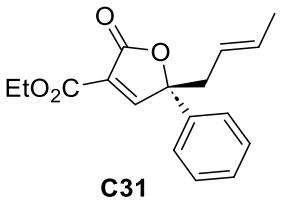


	Retention Time	Area	% Area	Height
1	30.767	26731085	50.02	366964
2	41.570	26706821	49.98	255823



	Retention Time	Area	% Area	Height
1	31.461	431040	6.97	6541
2	42.029	5755563	93.03	56630

Ethyl (*S*,*E*)-5-(but-2-en-1-yl)-2-oxo-5-phenyl-2,5-dihydrofuran-3-carboxylate (C31)



C31

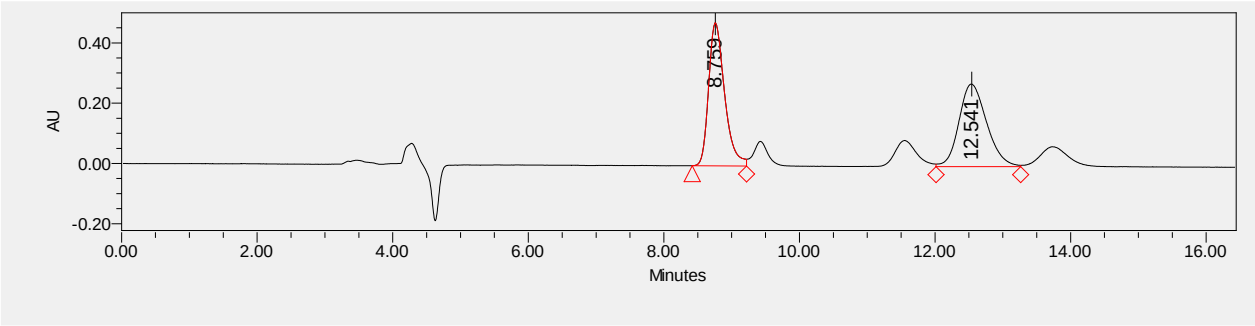
Results: colorless oil, 99% yield, 95% *ee*; $[\alpha]^{24}_{D}$ = -75.4 (*c* = 0.516 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak OJH, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 8.61 min, $t_{R(minor)}$ = 12.48 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.32 (s, 1H), 7.45 – 7.29 (m, 5H), 5.63 – 5.49 (m, 1H), 5.29 – 5.15 (m, 1H), 4.34 (q, *J* = 7.1 Hz, 2H), 2.81 (qdt, *J* = 14.3, 7.2, 1.2 Hz, 2H), 1.66 – 1.54 (m, 3H), 1.35 (t, *J* = 7.1 Hz, 3H);

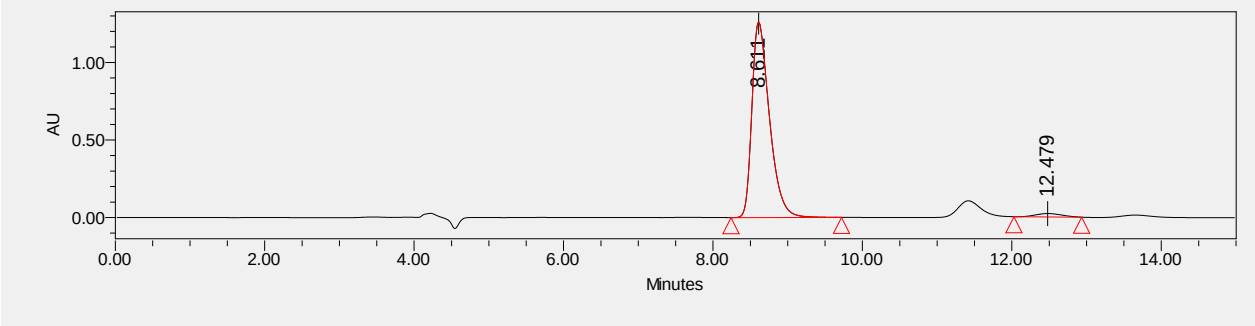
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.73, 165.28, 160.15, 137.47, 132.17, 128.99, 128.63, 125.19, 124.58, 121.94, 88.27, 61.81, 42.93, 18.05, 14.15;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3086, 2984, 2918, 1778, 1723, 1371, 1334, 1315, 1275, 1065, 1032, 800, 750, 700;

ESI-HRMS calcd for [$C_{17}H_{18}O_4$+Na^{+}]: 309.1098, found 309.1092;

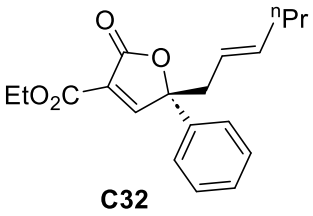


	Retention Time	Area	% Area	Height
1	8.759	7758425	49.93	474693
2	12.541	7779952	50.07	273811



	Retention Time	Area	% Area	Height
1	8.611	20600220	97.48	1259664
2	12.479	533189	2.52	21878

Ethyl (*S*,*E*)-5-(hex-2-en-1-yl)-2-oxo-5-phenyl-2,5-dihydrofuran-3-carboxylate (C32)



C32

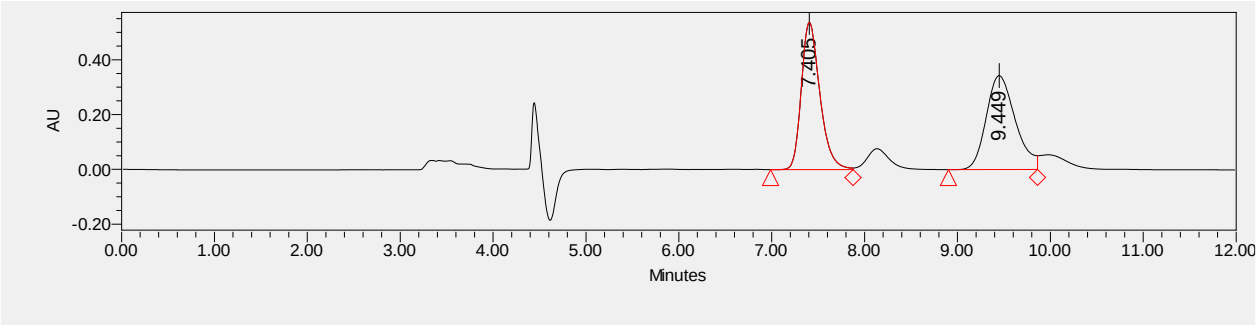
Results: colorless oil, 99% yield, 95% *ee*; $[\alpha]^{24}_{D}$ = -60.8 (*c* = 0.592 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak OJH, *n*-hexane/*i*-PrOH 75/25, 1.0 mL/min, λ = 210 nm, $t_{R(major)}$ = 7.30 min, $t_{R(minor)}$ = 9.40 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.31 (s, 1H), 7.44 – 7.29 (m, 5H), 5.60 – 5.45 (m, 1H), 5.27 – 5.15 (m, 1H), 4.33 (q, *J* = 7.1 Hz, 2H), 2.95 – 2.72 (m, 2H), 1.92 (q, *J* = 7.1 Hz, 1H), 1.35 (t, *J* = 7.1 Hz, 3H), 1.29 (q, *J* = 7.3 Hz, 2H), 0.80 (t, *J* = 7.3 Hz, 3H);

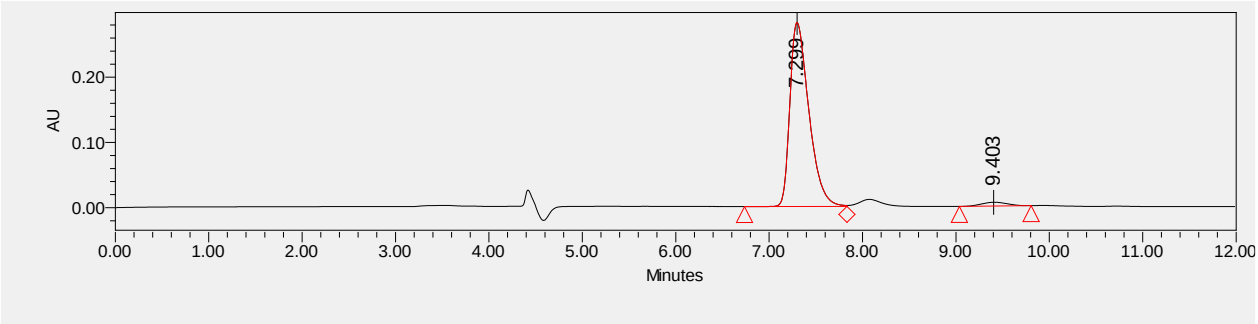
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.71, 165.29, 160.12, 137.60, 137.48, 128.97, 128.61, 125.19, 124.63, 120.99, 88.34, 61.78, 42.96, 34.55, 22.25, 14.15, 13.50;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3086, 2959, 2928, 2871, 1779, 1723, 1370, 1334, 1314, 1260, 1066, 1032, 800, 763, 750, 700;

ESI-HRMS calcd for [$C_{19}H_{22}O_4$+Na^{+}]: 337.1411, found 337.1405;

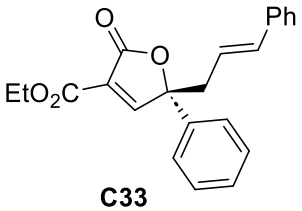


	Retention Time	Area	% Area	Height
1	7.405	7481332	50.01	537743
2	9.449	7478458	49.99	342907



	Retention Time	Area	% Area	Height
1	7.299	3979218	97.25	282076
2	9.403	112554	2.75	5920

Ethyl (*S*)-5-cinnamyl-2-oxo-5-phenyl-2,5-dihydrofuran-3-carboxylate (C33)



C33

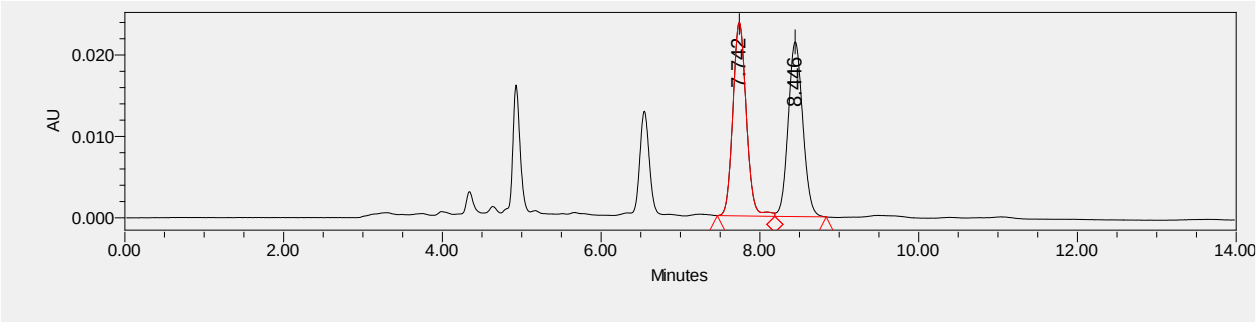
Results: white solid, 84% yield, 94% *ee*; $[\alpha]^{24}_{D}$ = -52.6 (*c* = 0.542 g/100 mL, λ = 589 nm, in DCM), HPLC (Daicel Chiralpak ADH, *n*-hexane/*i*-PrOH 70/30, 1.0 mL/min, λ = 210 nm, $t_{R(minor)}$ = 7.74 min, $t_{R(major)}$ = 8.57 min;

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.39 (s, 1H), 7.47 – 7.33 (m, 5H), 7.31 – 7.19 (m, 5H), 6.45 (d, *J* = 15.8 Hz, 1H), 5.96 (dt, *J* = 15.7, 7.3 Hz, 1H), 4.32 (q, *J* = 7.1 Hz, 2H), 3.06 (ddd, *J* = 14.3, 7.4, 1.3 Hz, 1H), 2.98 (ddd, *J* = 14.4, 7.2, 1.3 Hz, 1H), 1.33 (t, *J* = 7.1 Hz, 3H);

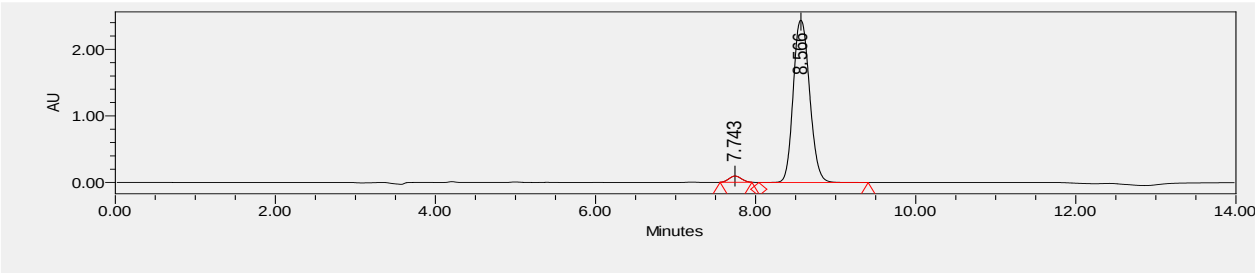
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 166.54, 165.05, 160.05, 137.21, 136.48, 135.81, 129.11, 128.80, 128.59, 127.84, 126.38, 125.23, 124.69, 120.86, 88.24, 61.88, 43.38, 14.13;

IR (film): $\tilde{\nu}$ (cm^{-1}) 3083, 3029, 2982, 2928, 1777, 1722, 1494, 1448, 1370, 1315, 1274, 1068, 1031, 800, 749, 700;

ESI-HRMS calcd for [$C_{22}H_{20}O_4$+Na^{+}]: 371.1254, found 371.1247;

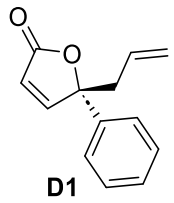


	Retention Time	Area	% Area	Height
1	7.742	278824	50.47	23783
2	8.446	273676	49.53	21453



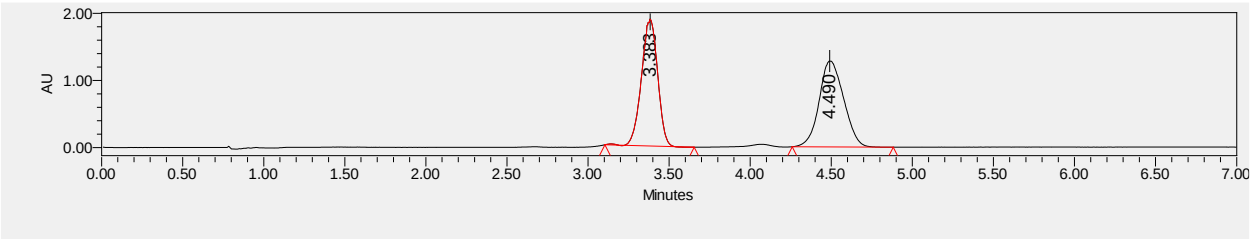
	Retention Time	Area	% Area	Height
1	7.743	1009841	2.83	94141
2	8.566	34687598	97.17	2437532

(*S*)-5-Allyl-5-phenylfuran-2(5H)-one (D1)

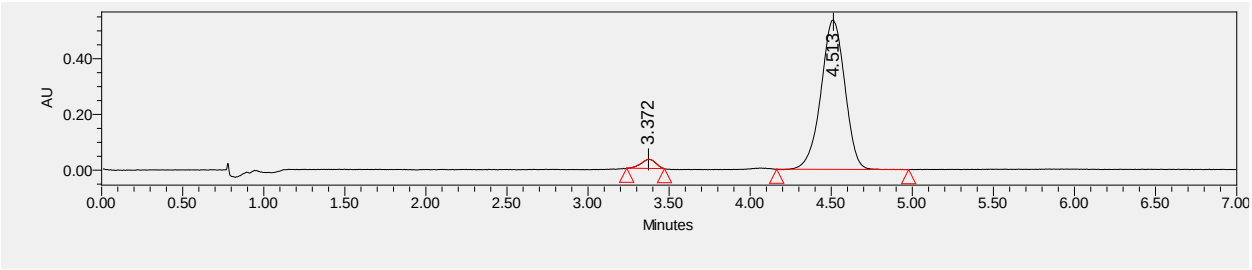


D1

Results: colorless oil, 40% yield, 93% *ee*; $[\alpha]^{24}_{D}$ = -128.5 (*c* = 0.474 g/100 mL, λ = 589 nm, in DCM), UPC^2 (Daicel Chiralpak IG, CO_2/MeOH 90/10, 1.5 mL/min, λ = 210 nm, $t_{R(minor)}$ = 3.37 min, $t_{R(major)}$ = 4.51 min;
^{1}H NMR (400 MHz, Chloroform-*d*): δ 7.65 (d, *J* = 5.6 Hz, 1H), 7.47 – 7.29 (m, 5H), 6.10 (d, *J* = 5.6 Hz, 1H), 5.61 (ddt, *J* = 16.6, 10.7, 7.2 Hz, 1H), 5.17 – 5.07 (m, 2H), 2.89 (ddt, *J* = 14.3, 7.2, 1.2 Hz, 1H), 2.79 (ddt, *J* = 14.3, 7.0, 1.1 Hz, 1H);
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): δ 172.08, 158.68, 138.58, 130.41, 128.83, 128.35, 125.12, 120.61, 120.47, 90.73, 44.05;
IR (film): $\tilde{\nu}$ (cm^{-1}) 3006, 2988, 1761, 1722, 1275, 1260, 1197, 930, 764, 750;
ESI-HRMS calcd for [$C_{13}H_{12}O_2$+Na$^+$]: 223.0730, found 223.0727;

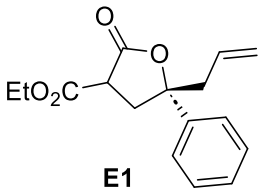


	Retention Time	Area	% Area	Height
1	3.383	13140011	49.45	1889894
2	4.490	13431946	50.55	1277987



	Retention Time	Area	% Area	Height
1	3.372	204929	3.60	32945
2	4.513	5479843	96.40	536495

Ethyl (5*S*)-5-allyl-2-oxo-5-phenyltetrahydrofuran-3-carboxylate (E1)



E1

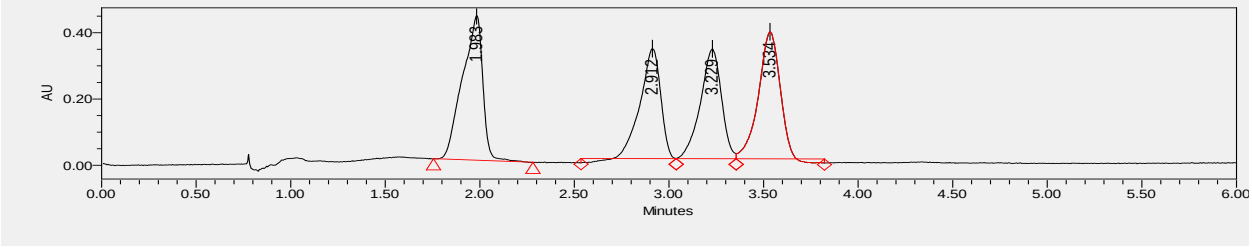
Results: colorless oil, 99% yield, 1.1/1 dr, 91/95% *ee*; $[\alpha]^{24}_{D}$ = -17.5 (*c* = 0.514 g/100 mL, λ = 589 nm, in DCM), UPC^2 (Daicel Chiralpak IG, CO_2/MeOH 90/10, 1.5 mL/min, λ = 210 nm, $t_{R(minor)}$ = 1.99 min, $t_{R(minor)}$ = 2.93 min $t_{R(major)}$ = 3.24 min, $t_{R(major)}$ = 3.55 min;

^{1}H NMR (400 MHz, Chloroform-*d*): diastereomer mixture, δ 7.43 – 7.26 (m, 5H), 5.73 – 5.56 (m, 1H), 5.20 – 5.05 (m, 2H), 4.26 (qd, *J* = 7.2, 1.6 Hz, 2H), 4.12 (q, *J* = 7.1 Hz, 2H), 3.78 (t, *J* = 9.4 Hz, 1H), 3.47 (dd, *J* = 11.4, 8.8 Hz, 1H), 2.96 – 2.57 (m, 4H), 1.30 (t, *J* = 7.1 Hz, 3H), 1.19 (t, *J* = 7.1 Hz, 3H);

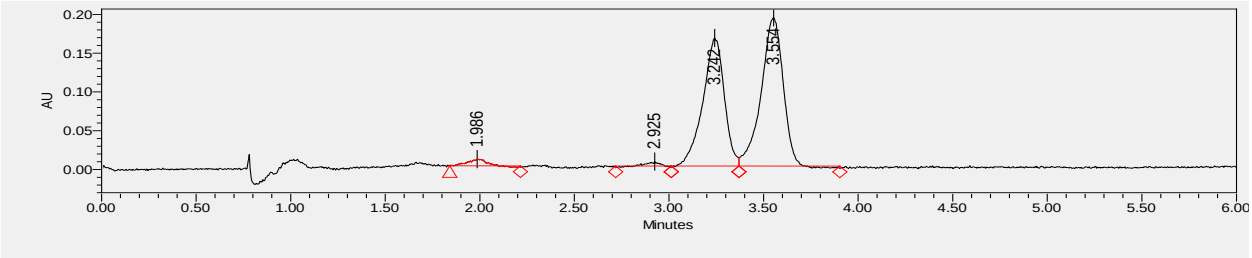
^{13}C{^{1}H} NMR (101 MHz, Chloroform-*d*): diastereomer mixture δ 171.26, 171.08, 167.62, 167.36, 142.90, 141.68, 131.17, 131.09, 128.70, 128.50, 128.07, 127.86, 124.73, 124.56, 120.80, 120.14, 87.52, 87.42, 62.24, 62.21, 47.41, 46.92, 46.63, 46.46, 37.63, 36.78, 14.09, 13.94;

IR (film): $\tilde{\nu}$ (cm^{-1}) 2983, 2928, 1777, 1734, 1275, 1260, 1177, 1019, 969, 764, 750, 702;

ESI-HRMS calcd for [$C_{16}H_{18}O_4$+Na$^+$]: 297.1098, found 297.1094;

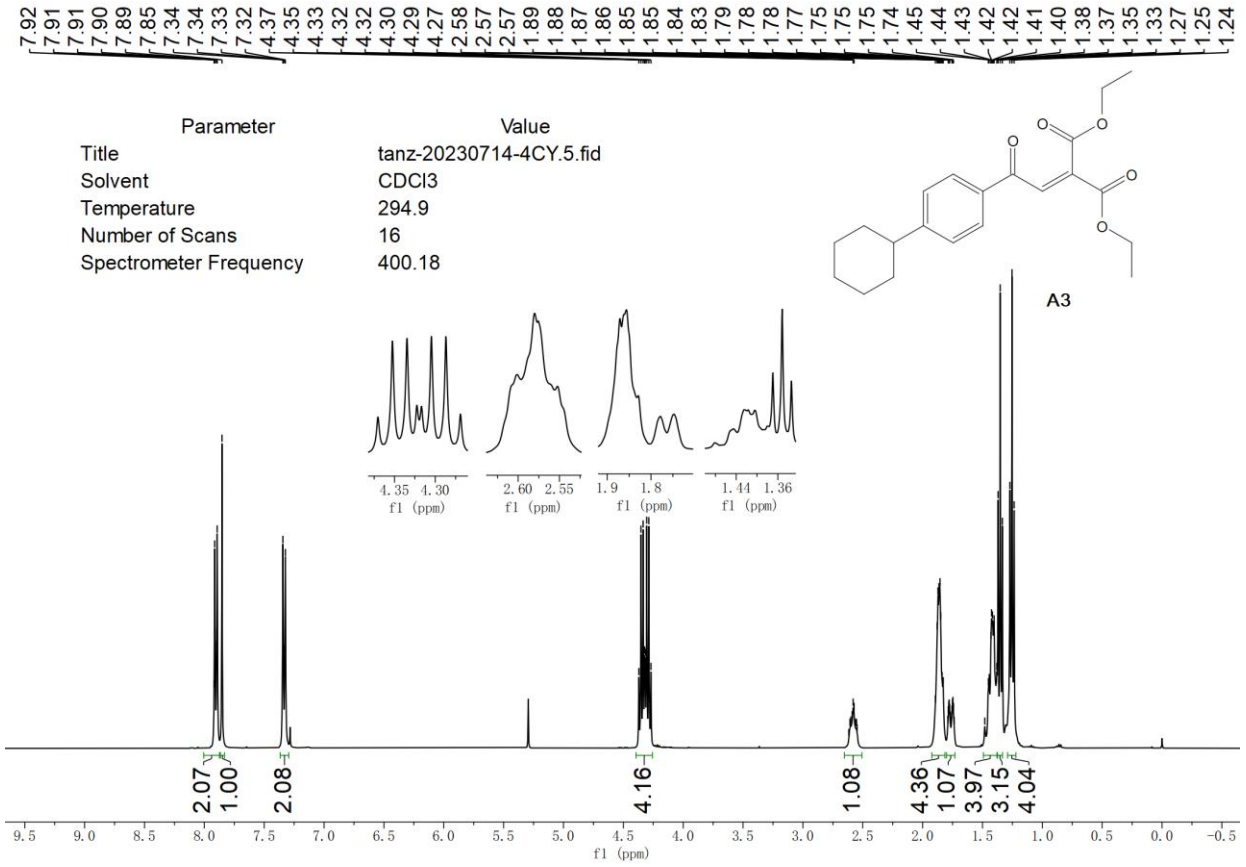


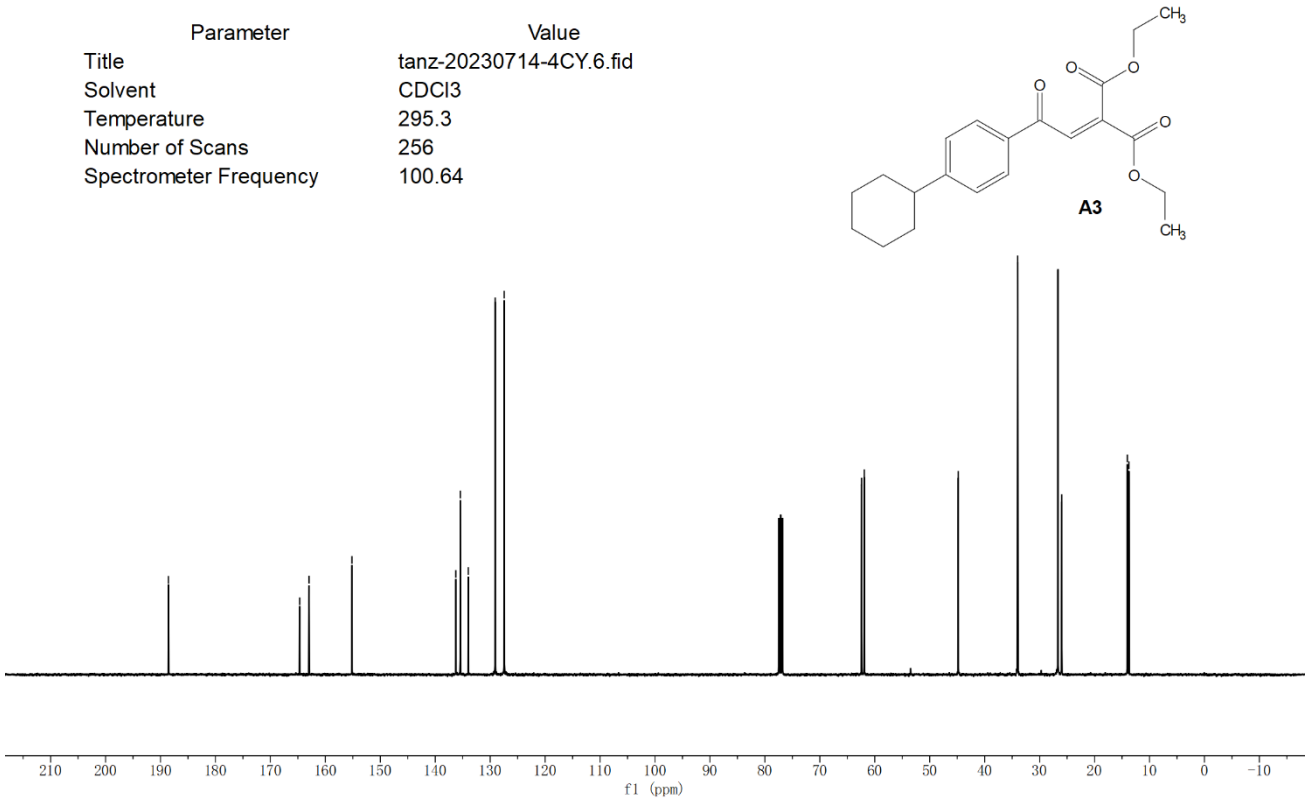
	Retention Time	Area	% Area	Height
1	1.983	3255850	28.24	436069
2	2.912	2592223	22.49	331467
3	3.229	2557871	22.19	331512
4	3.534	3122627	27.09	383318

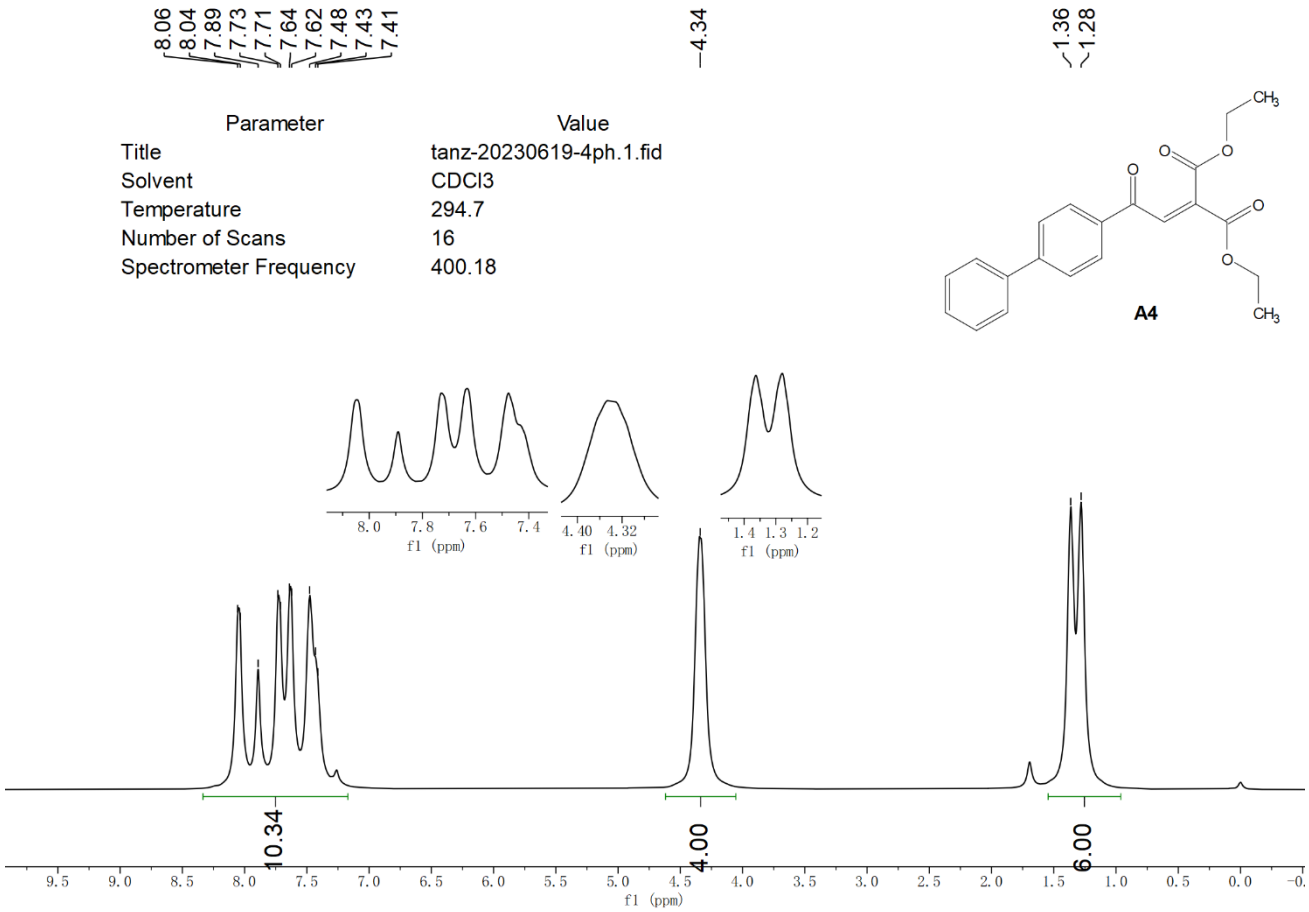


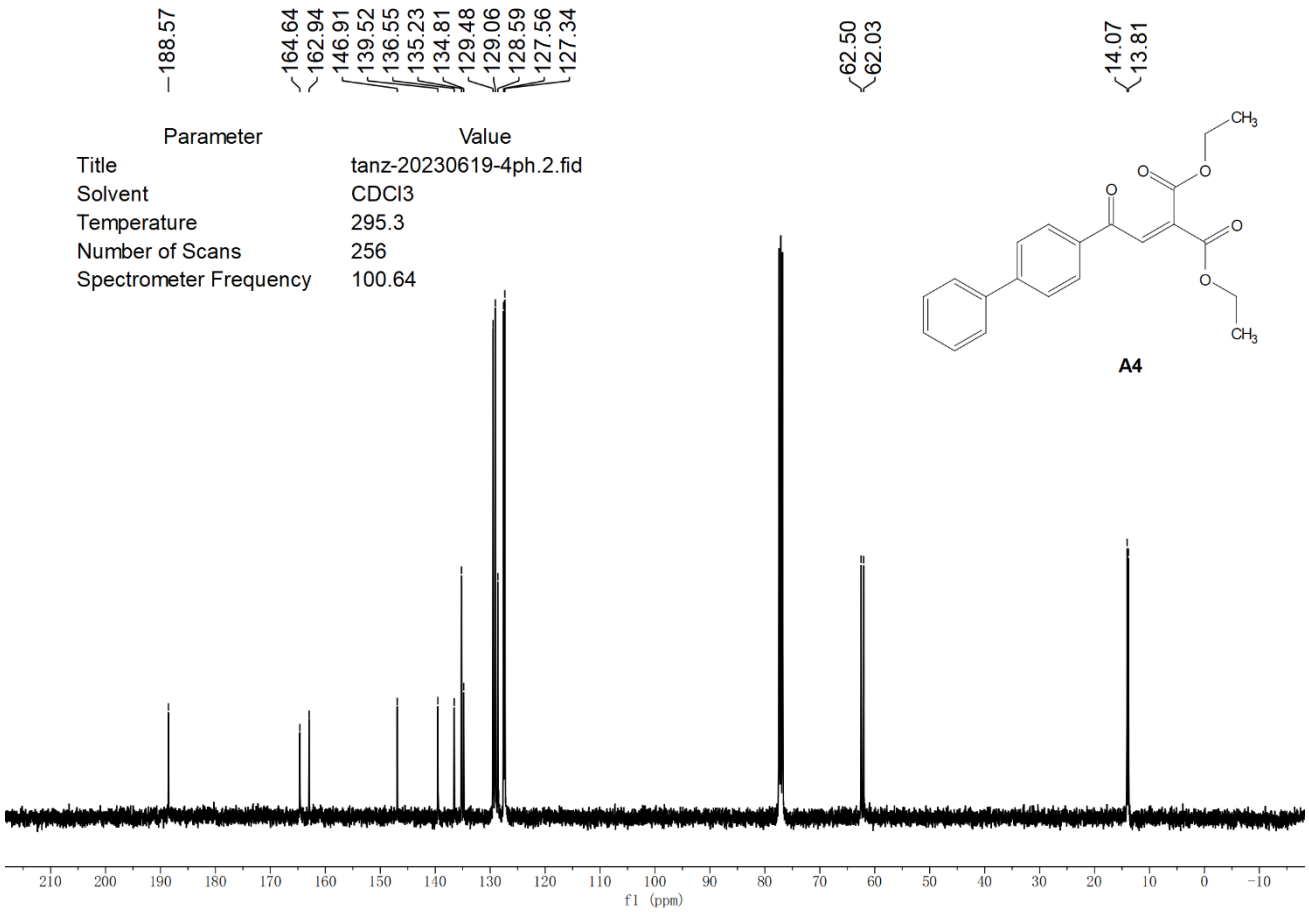
	Retention Time	Area	% Area	Height
1	1.986	66986	2.26	8689
2	2.925	31899	1.08	5877
3	3.242	1302012	43.90	165046
4	3.554	1564683	52.76	191612

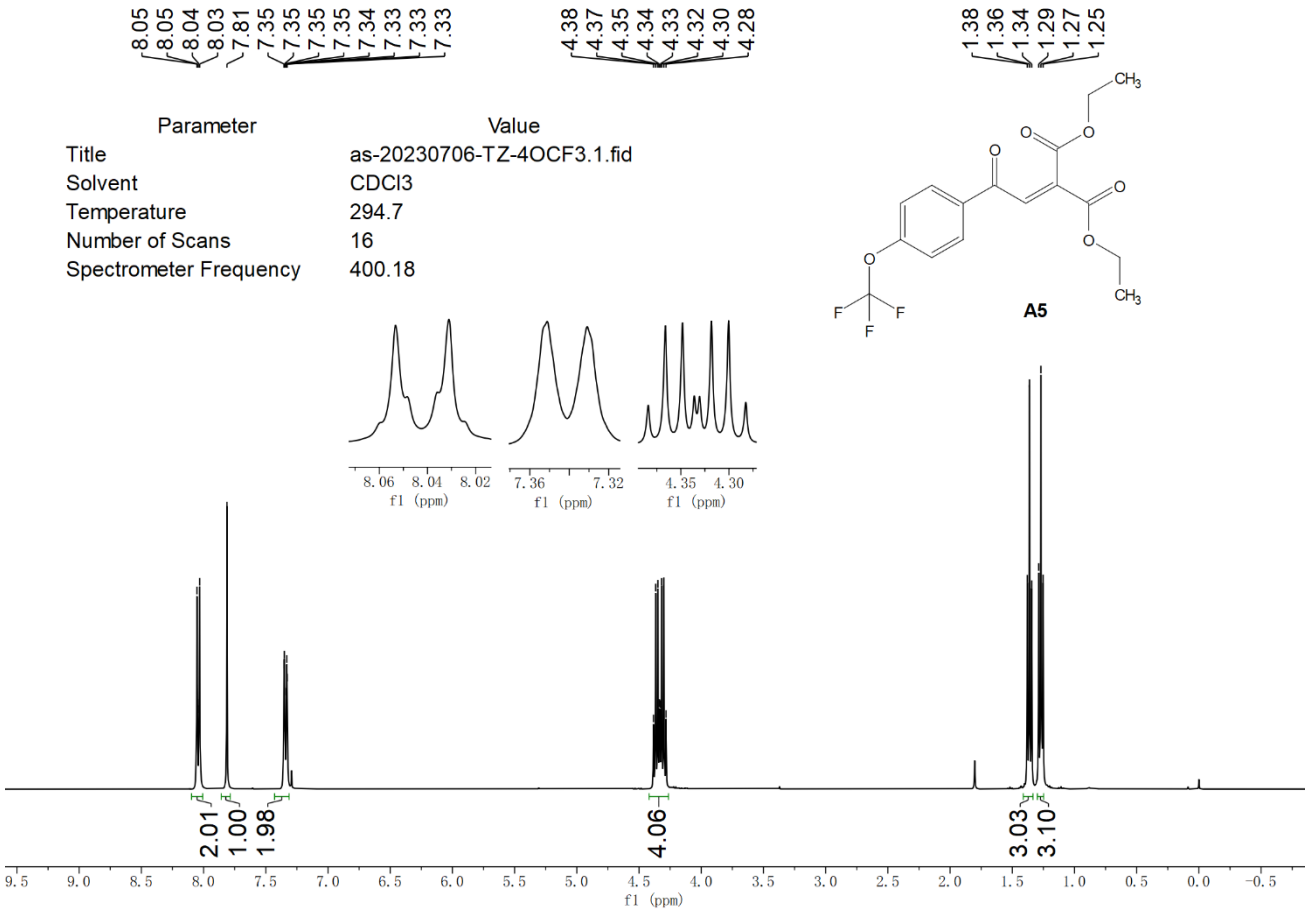
(K) Copies of NMR spectra

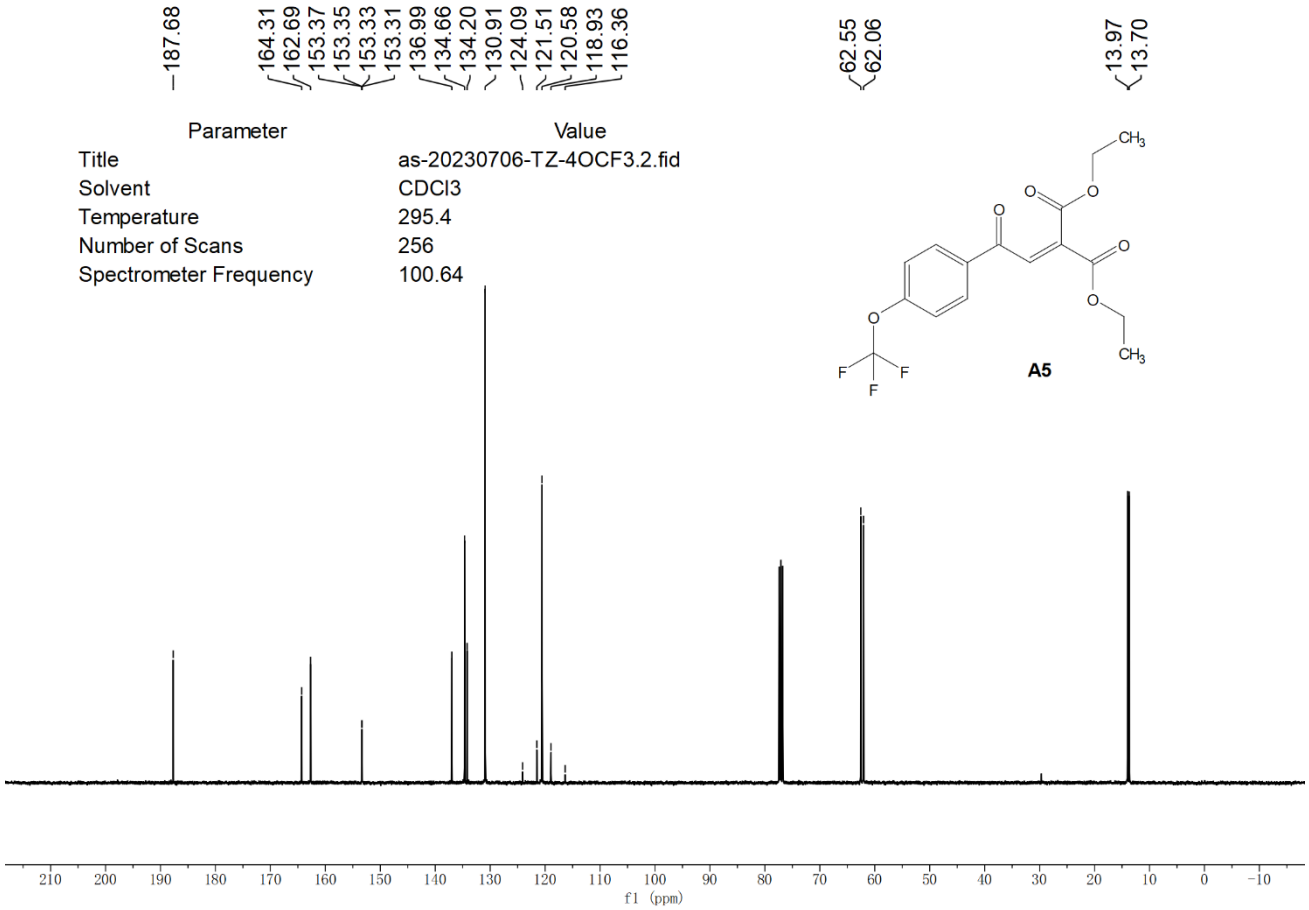


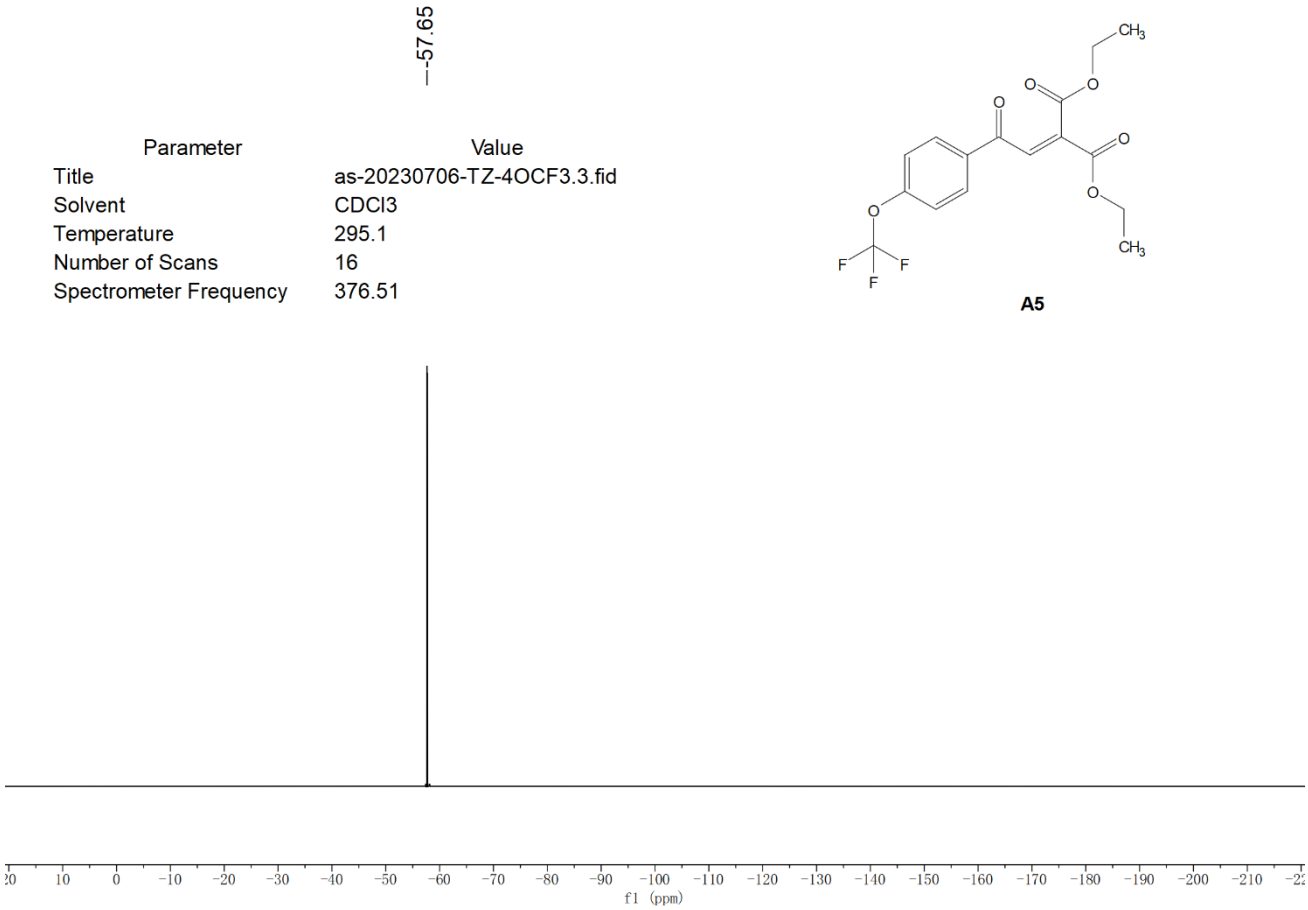



8.06
8.04
7.89
7.73
7.71
7.64
7.62
7.48
7.43
7.41
4.34
1.36
1.28
Parameter Value
Title tanz-20230619-4ph.1.fid
Solvent CDCl3
Temperature 294.7
Number of Scans 16
Spectrometer Frequency 400.18
A4
10.34
4.00
6.00
f1 (ppm)


188.57
164.64
162.94
146.91
139.52
136.55
135.23
134.81
129.48
129.06
128.59
127.56
127.34
62.50
62.03
14.07
13.81
Parameter Value
Title tanz-20230619-4ph.2.fid
Solvent CDCl3
Temperature 295.3
Number of Scans 256
Spectrometer Frequency 100.64
A4
f1 (ppm)


8.05 8.05 8.04 8.03 7.81 7.35 7.35 7.35 7.34 7.33 7.33 7.33
4.38 4.37 4.35 4.34 4.33 4.32 4.30 4.28
1.38 1.36 1.34 1.29 1.27 1.25
Parameter Value
Title as-20230706-TZ-4OCF3.1.fid
Solvent CDCl3
Temperature 294.7
Number of Scans 16
Spectrometer Frequency 400.18
A5
8.06 8.04 8.02
7.36 7.32
4.35 4.30
f1 (ppm)
2.01 1.00 1.98 4.06 3.03 3.10
f1 (ppm)

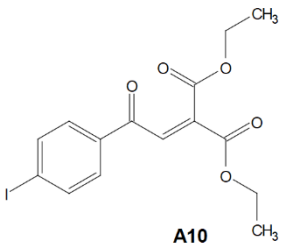

187.68
164.31 162.69 153.37 153.35 153.33 153.31 136.99 134.66 134.20 130.91 124.09 121.51 120.58 118.93 116.36
62.55 62.06
13.97 13.70
Parameter Value
Title as-20230706-TZ-4OCF3.2.fid
Solvent CDCl3
Temperature 295.4
Number of Scans 256
Spectrometer Frequency 100.64
A5
f1 (ppm)



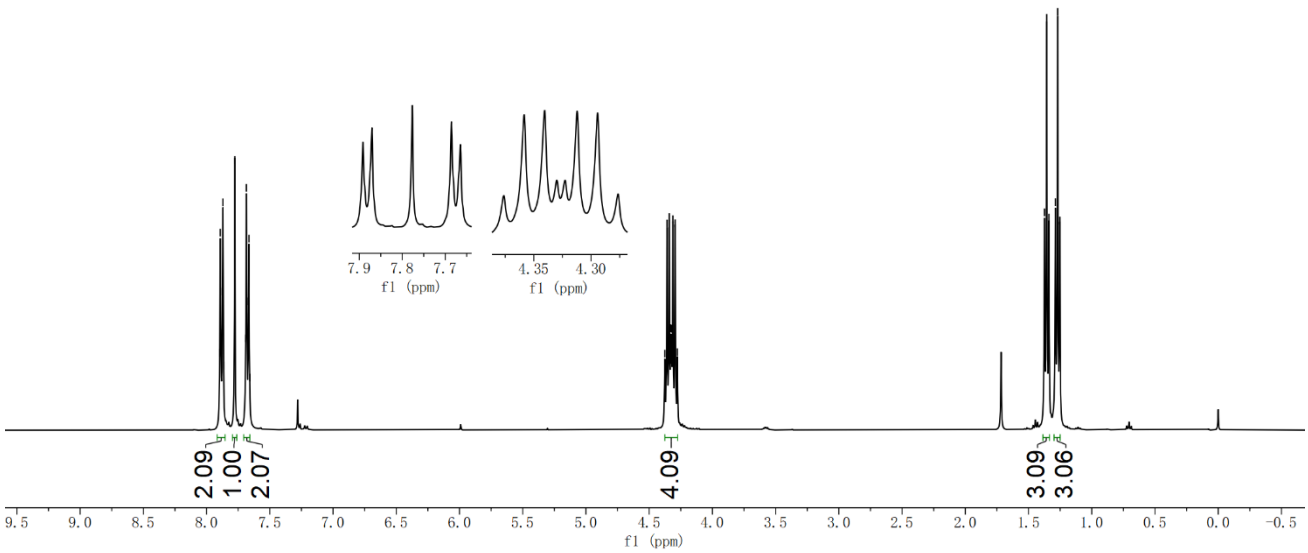
Parameter	Value
Title	as-20230706-TZ-4OCF3.3.fid
Solvent	CDCl3
Temperature	295.1
Number of Scans	16
Spectrometer Frequency	376.51

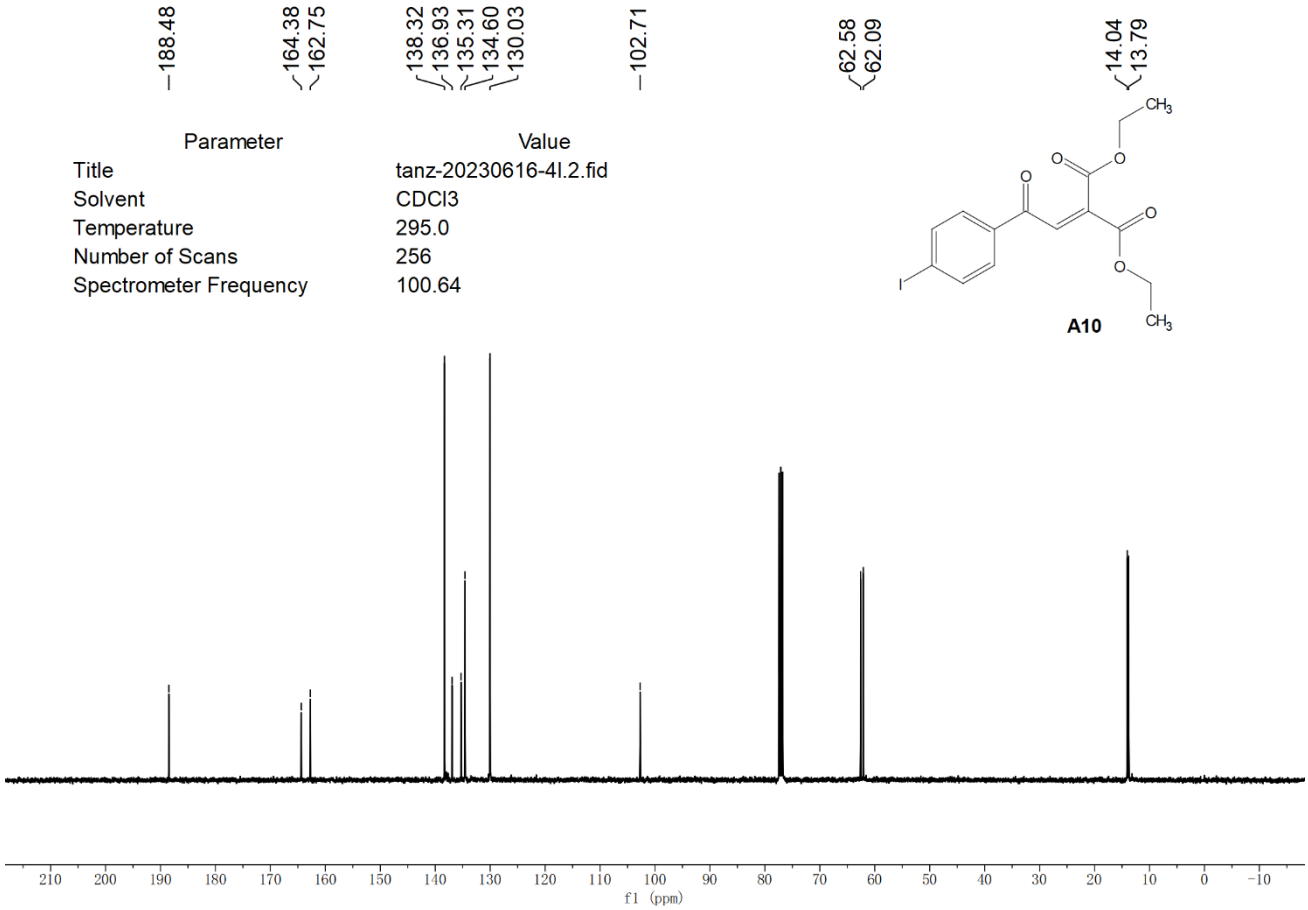
A5

Parameter	Value
Title	tanz-20230616-4I.1.fid
Solvent	CDCl3
Temperature	294.5
Number of Scans	16
Spectrometer Frequency	400.18



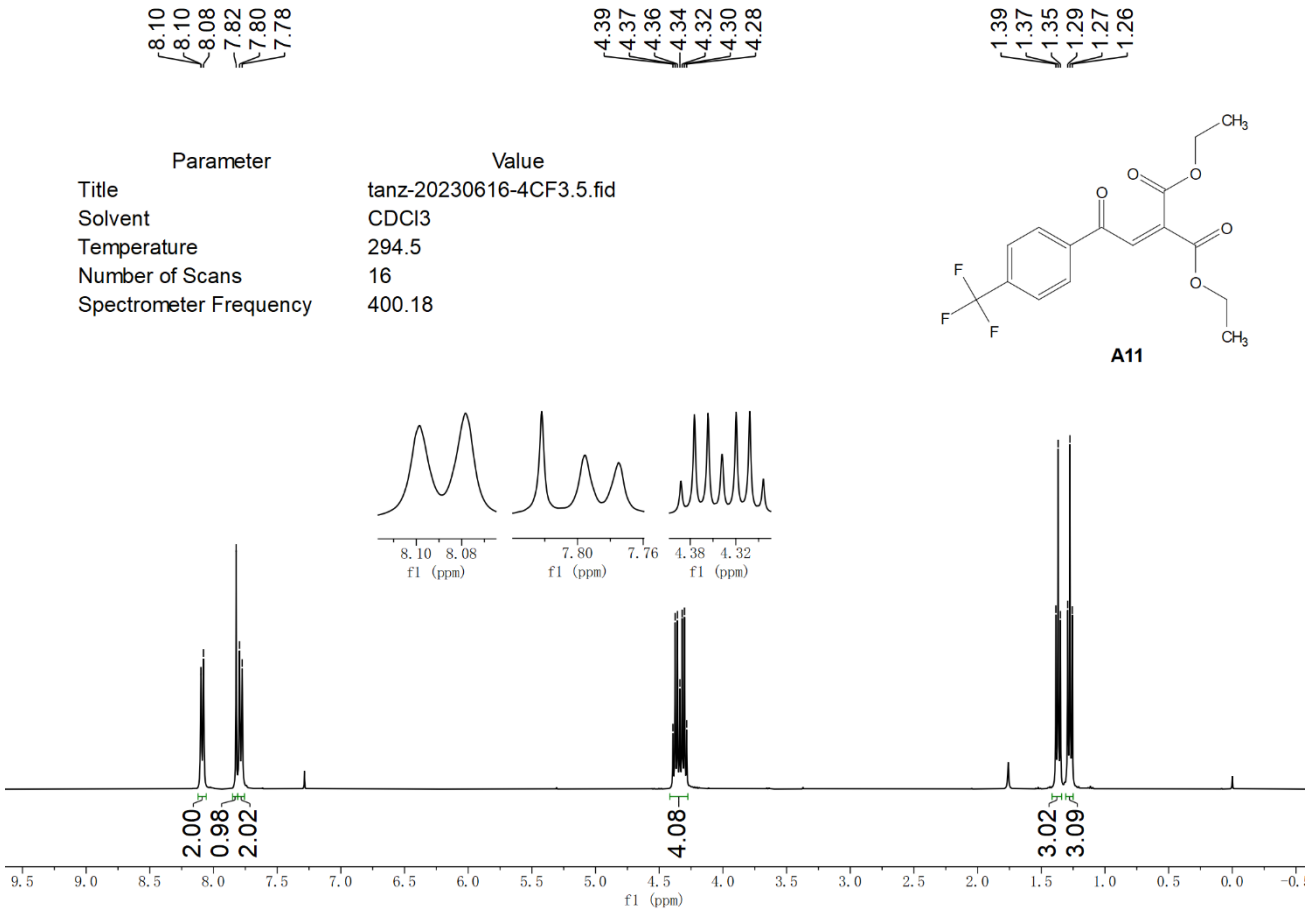
A10





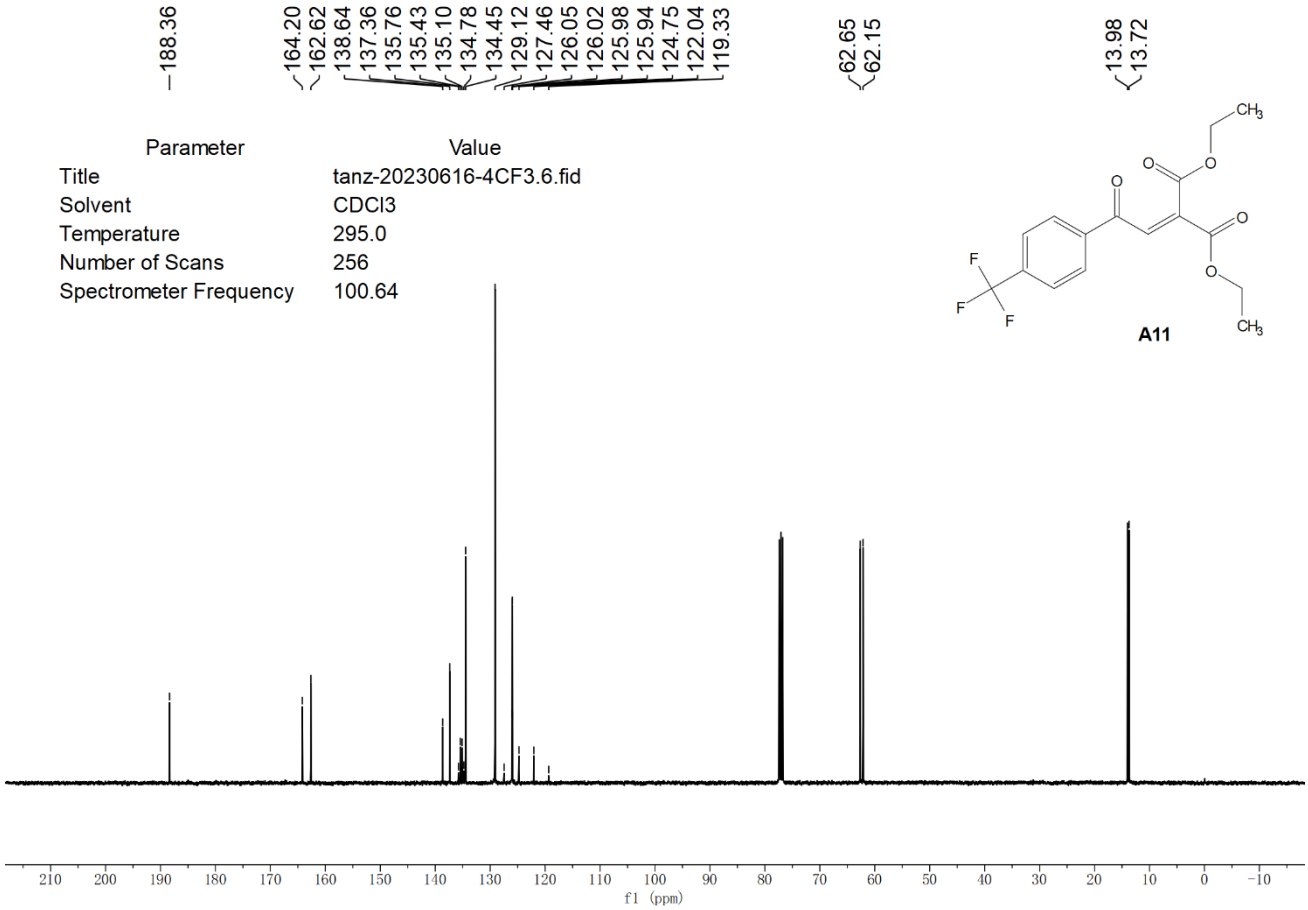
Parameter	Value
Title	tanz-20230616-4I.2.fid
Solvent	CDCl3
Temperature	295.0
Number of Scans	256
Spectrometer Frequency	100.64

A10

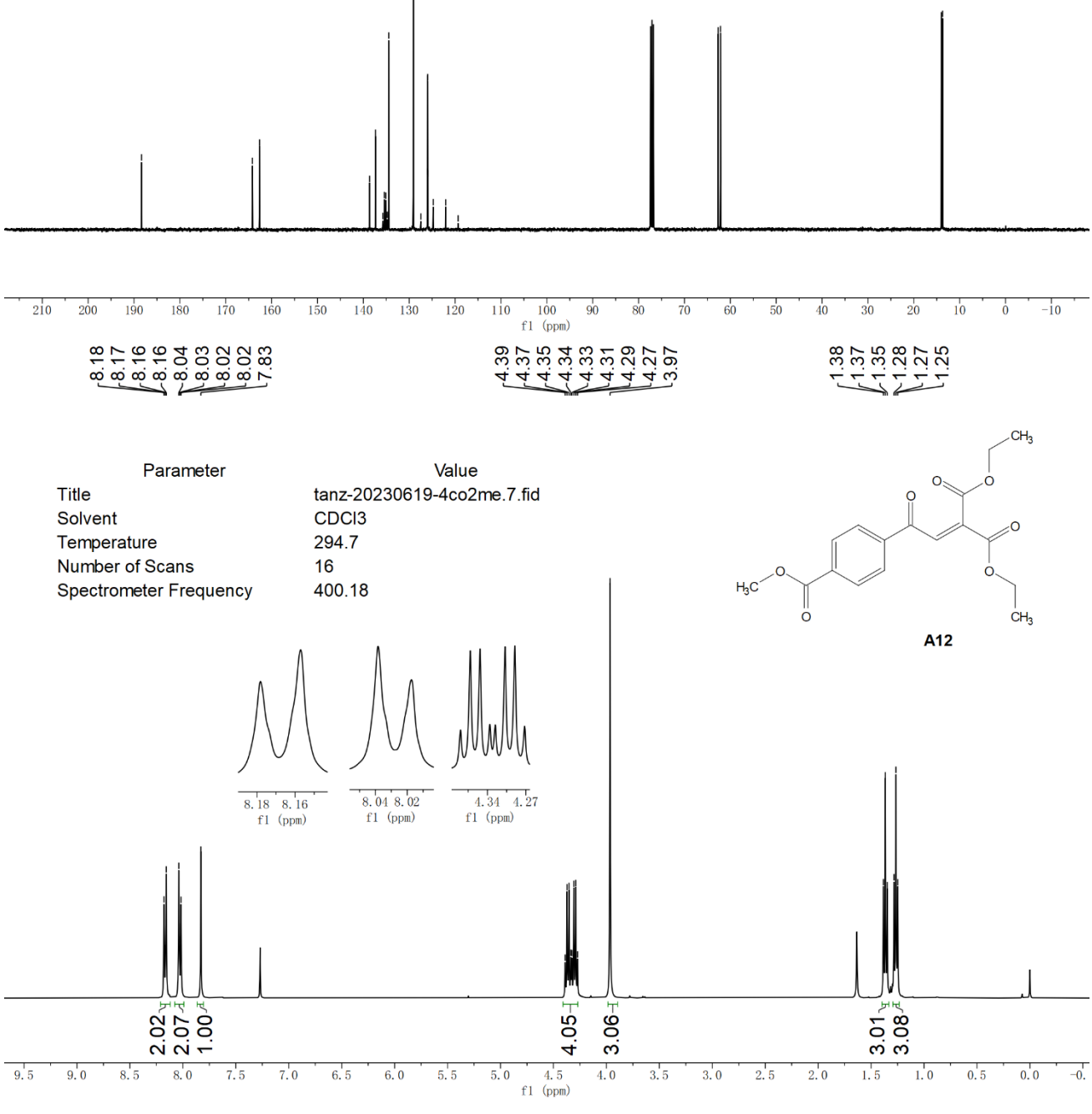


Parameter	Value
Title	tanz-20230616-4CF3.5.fid
Solvent	CDCl3
Temperature	294.5
Number of Scans	16
Spectrometer Frequency	400.18

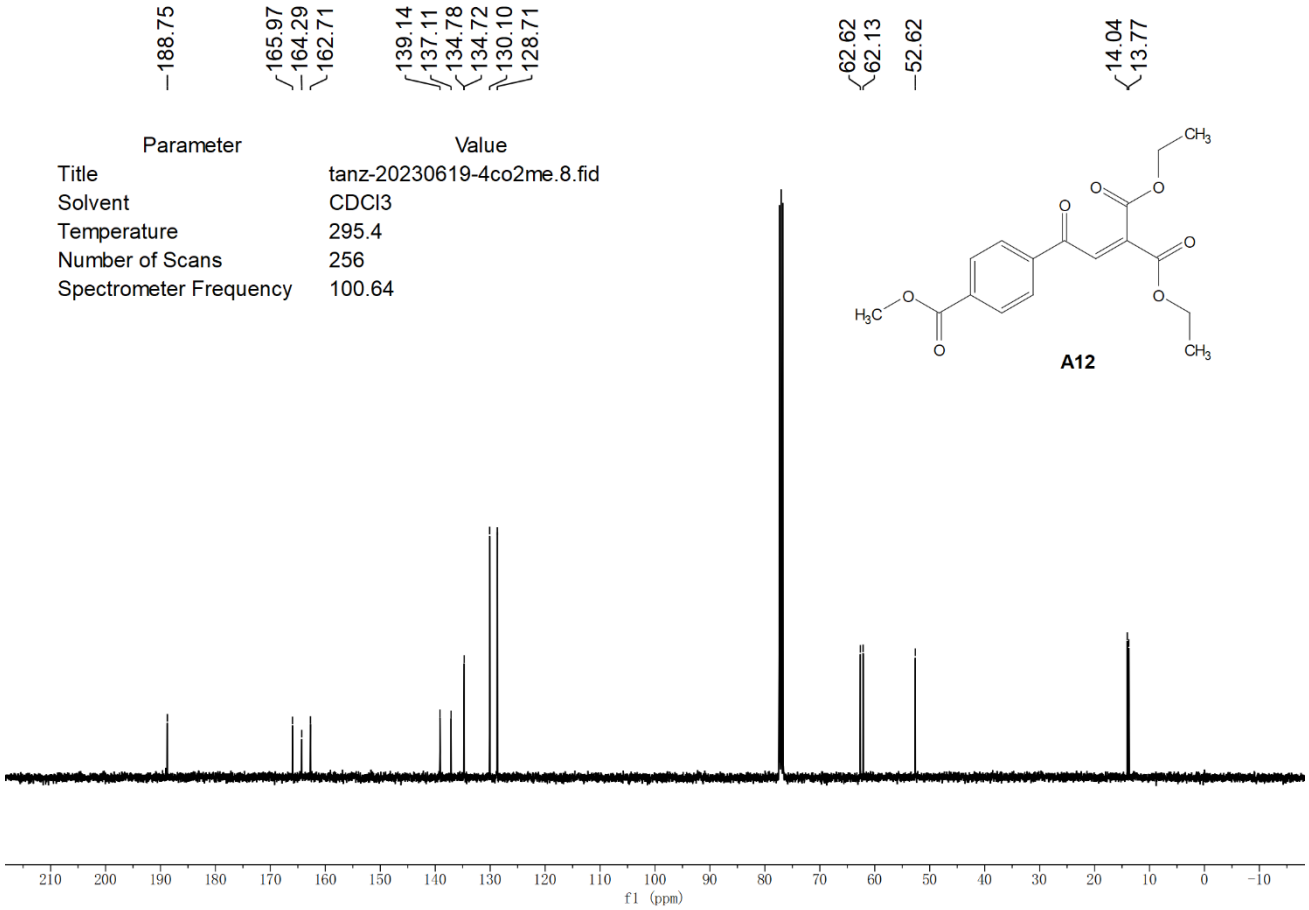
A11

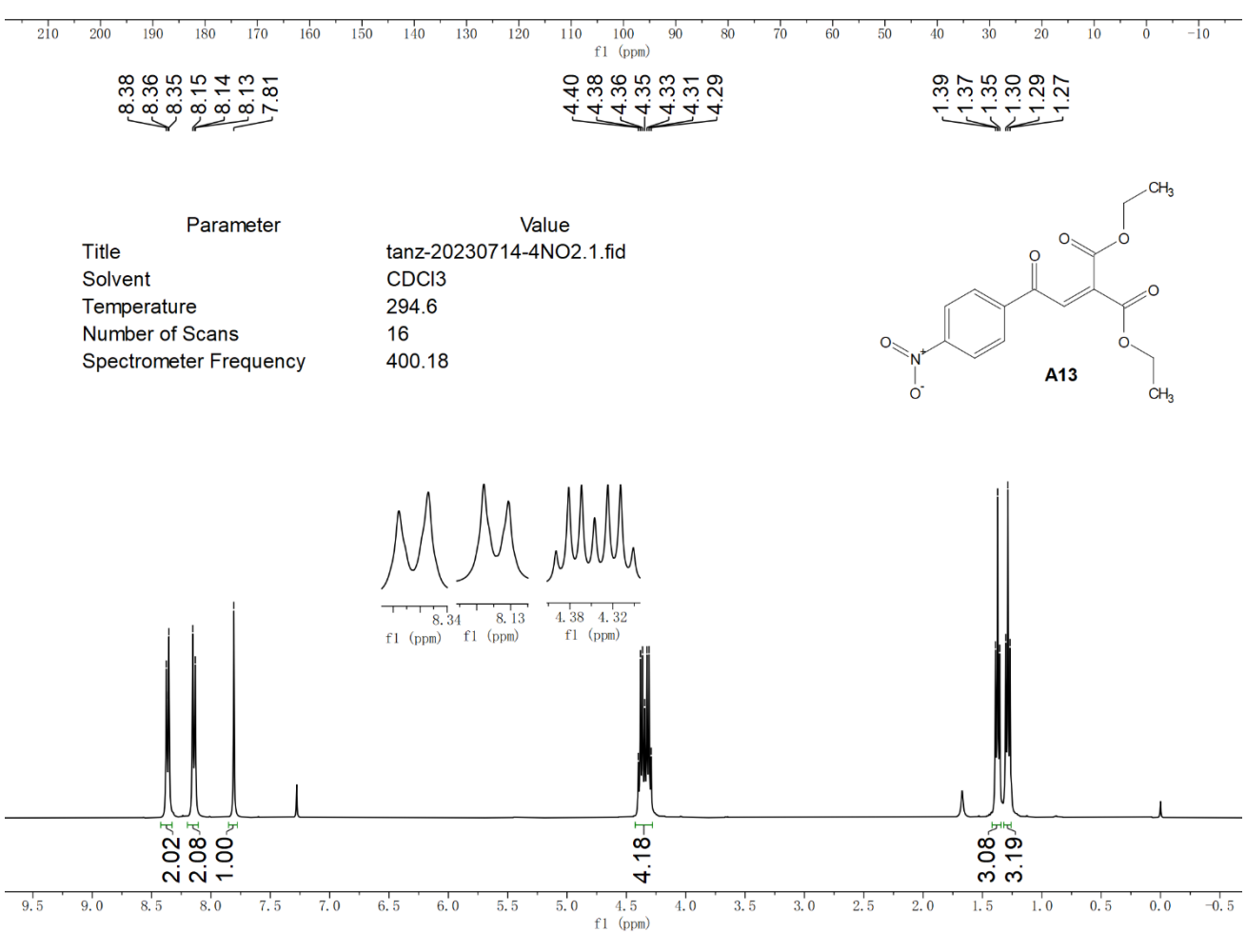

188.36
164.20
162.62
138.64
137.36
135.76
135.43
135.10
134.78
134.45
129.12
127.46
126.05
126.02
125.98
125.94
124.75
122.04
119.33
62.65
62.15
13.98
13.72
Parameter Value
Title tanz-20230616-4CF3.6.fid
Solvent CDCl3
Temperature 295.0
Number of Scans 256
Spectrometer Frequency 100.64
f1 (ppm)

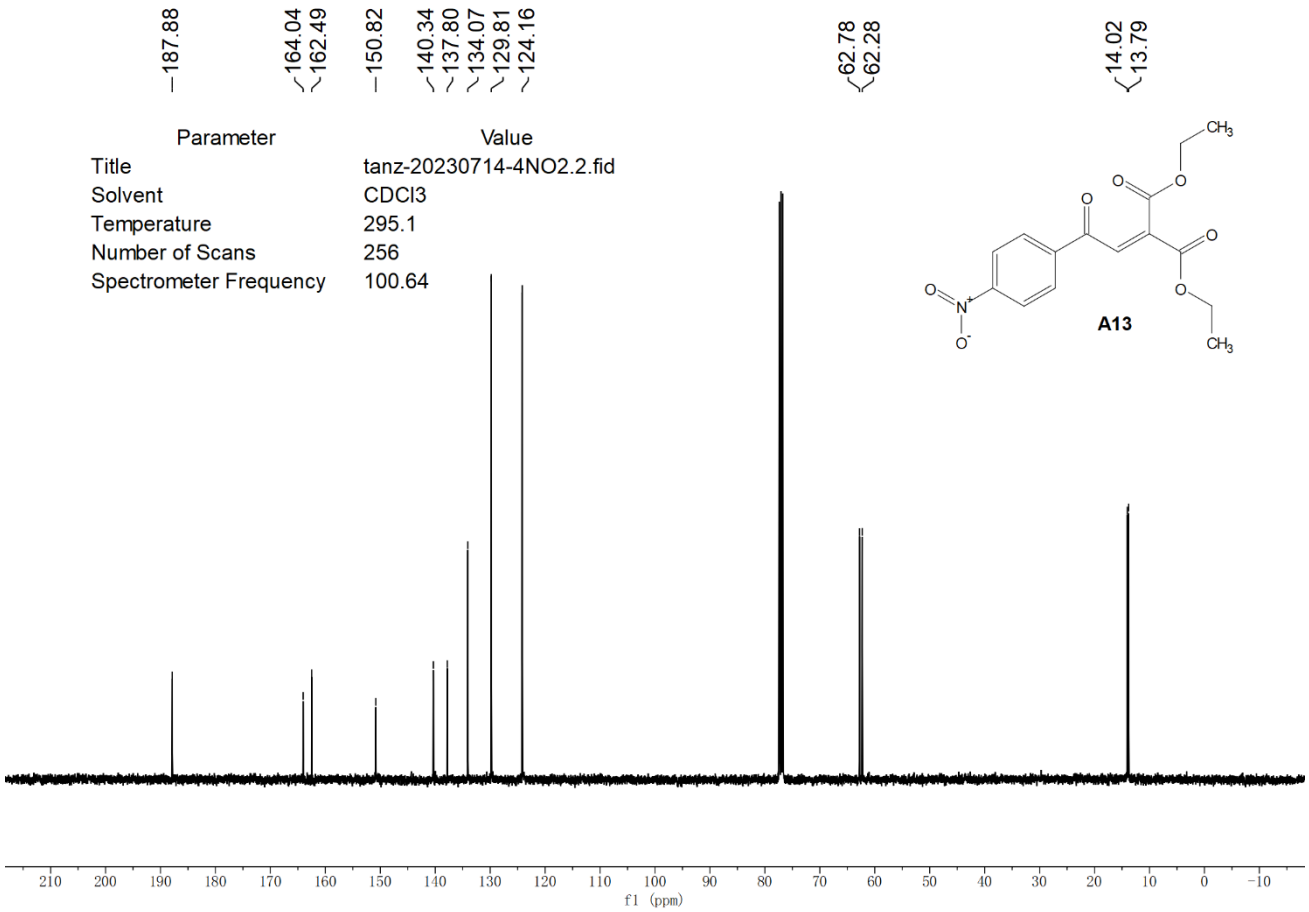
A11

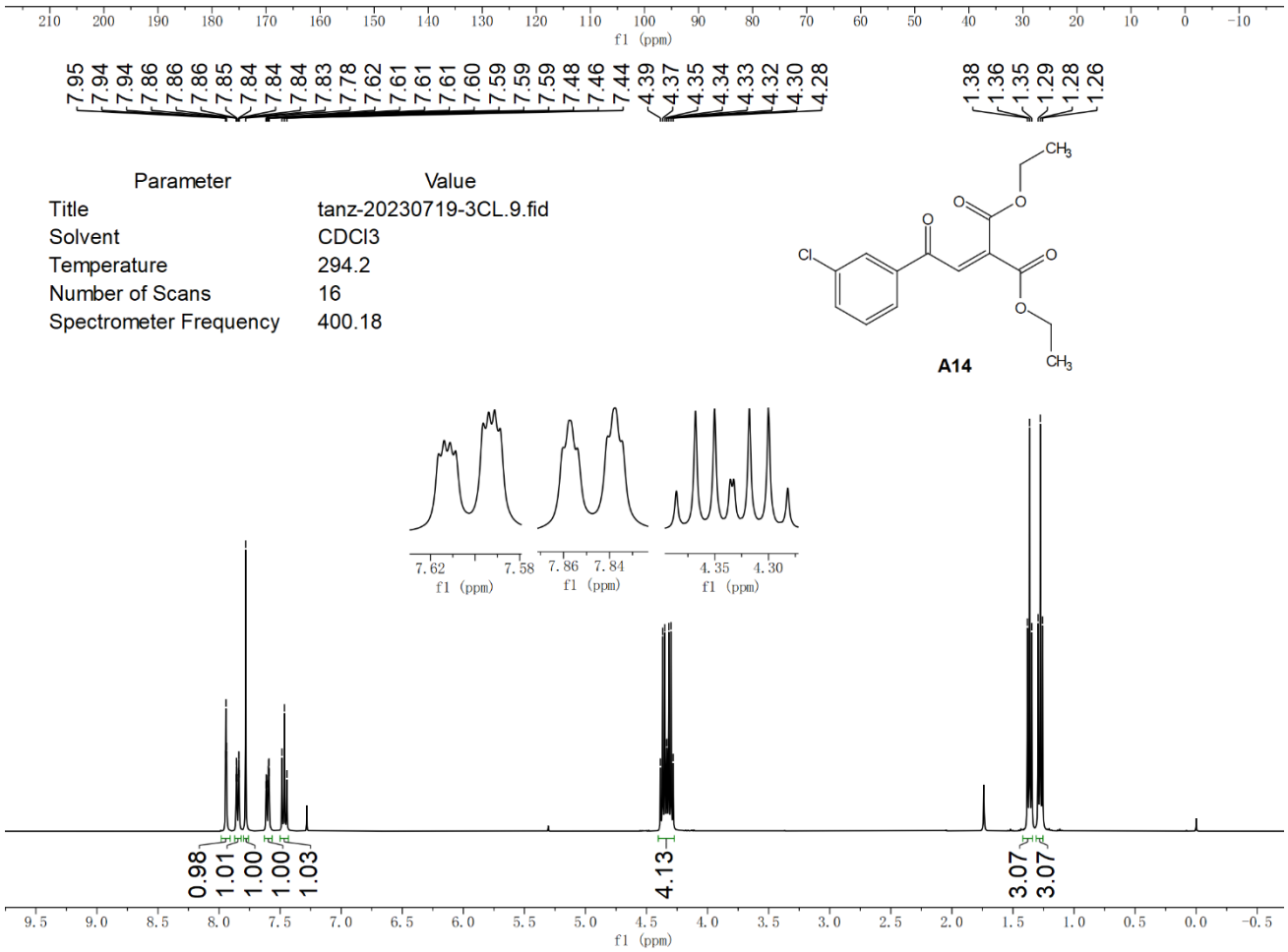

8.18
8.17
8.16
8.16
8.04
8.03
8.02
8.02
7.83
4.39
4.37
4.35
4.34
4.33
4.31
4.29
4.27
3.97
1.38
1.37
1.35
1.28
1.27
1.25
Parameter Value
Title tanz-20230619-4co2me.7.fid
Solvent CDCl3
Temperature 294.7
Number of Scans 16
Spectrometer Frequency 400.18
8.18 8.16
f1 (ppm)
8.04 8.02
f1 (ppm)
4.34 4.27
f1 (ppm)
2.02
2.07
1.00
4.05
3.06
3.01
3.08
f1 (ppm)

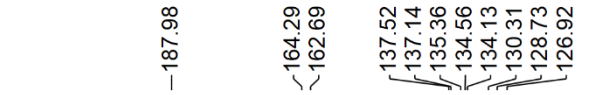
A12


188.75
165.97
164.29
162.71
139.14
137.11
134.78
134.72
130.10
128.71
62.62
62.13
52.62
14.04
13.77
Parameter Value
Title tanz-20230619-4co2me.8.fid
Solvent CDCl3
Temperature 295.4
Number of Scans 256
Spectrometer Frequency 100.64
A12
f1 (ppm)

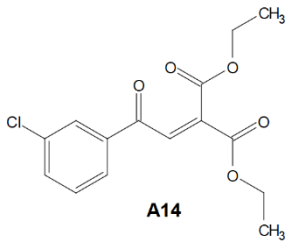

8.38
8.36
8.35
8.15
8.14
8.13
7.81
4.40
4.38
4.36
4.35
4.33
4.31
4.29
1.39
1.37
1.35
1.30
1.29
1.27
Parameter Value
Title tanz-20230714-4NO2.1.fid
Solvent CDCl3
Temperature 294.6
Number of Scans 16
Spectrometer Frequency 400.18
A13
8.34
8.13
4.38
4.32
f1 (ppm)
2.02
2.08
1.00
4.18
3.08
3.19


187.88
164.04
162.49
150.82
140.34
137.80
134.07
129.81
124.16
62.78
62.28
14.02
13.79
Parameter Value
Title tanz-20230714-4NO2.2.fid
Solvent CDCl3
Temperature 295.1
Number of Scans 256
Spectrometer Frequency 100.64
A13
f1 (ppm)

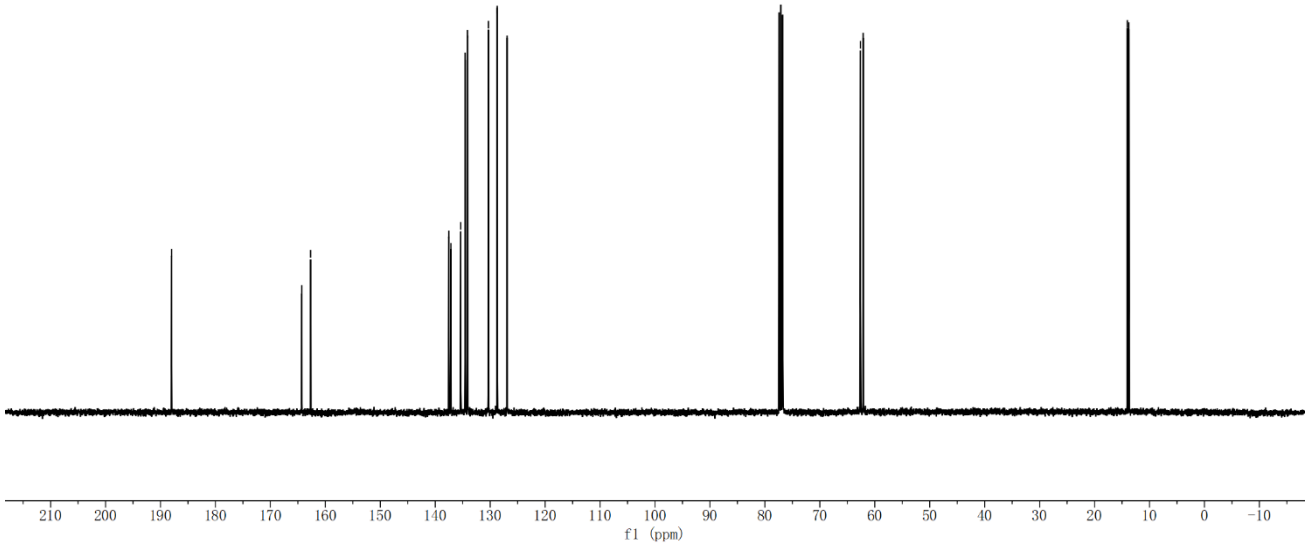

7.95 7.94 7.94 7.86 7.86 7.86 7.85 7.84 7.84 7.84 7.83 7.78 7.62 7.61 7.61 7.61 7.60 7.59 7.59 7.59 7.48 7.46 7.44 4.39 4.37 4.35 4.34 4.33 4.32 4.30 4.28
1.38 1.36 1.35 1.29 1.28 1.26
Parameter Value
Title tanz-20230719-3CL.9.fid
Solvent CDCl3
Temperature 294.2
Number of Scans 16
Spectrometer Frequency 400.18
A14
7.62 7.58 f1 (ppm)
7.86 7.84 f1 (ppm)
4.35 4.30 f1 (ppm)
0.98 1.01 1.00 1.00 1.03
4.13
3.07 3.07
f1 (ppm)

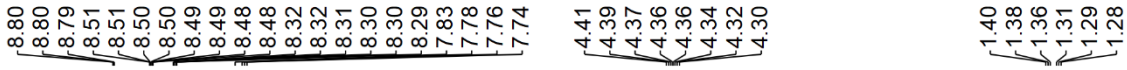


Parameter	Value
Title	tanz-20230719-3CL.10.fid
Solvent	CDCl3
Temperature	294.7
Number of Scans	256
Spectrometer Frequency	100.64

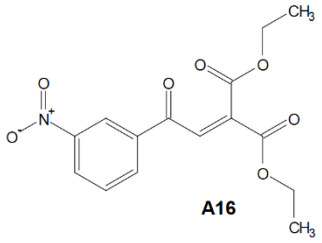


A14

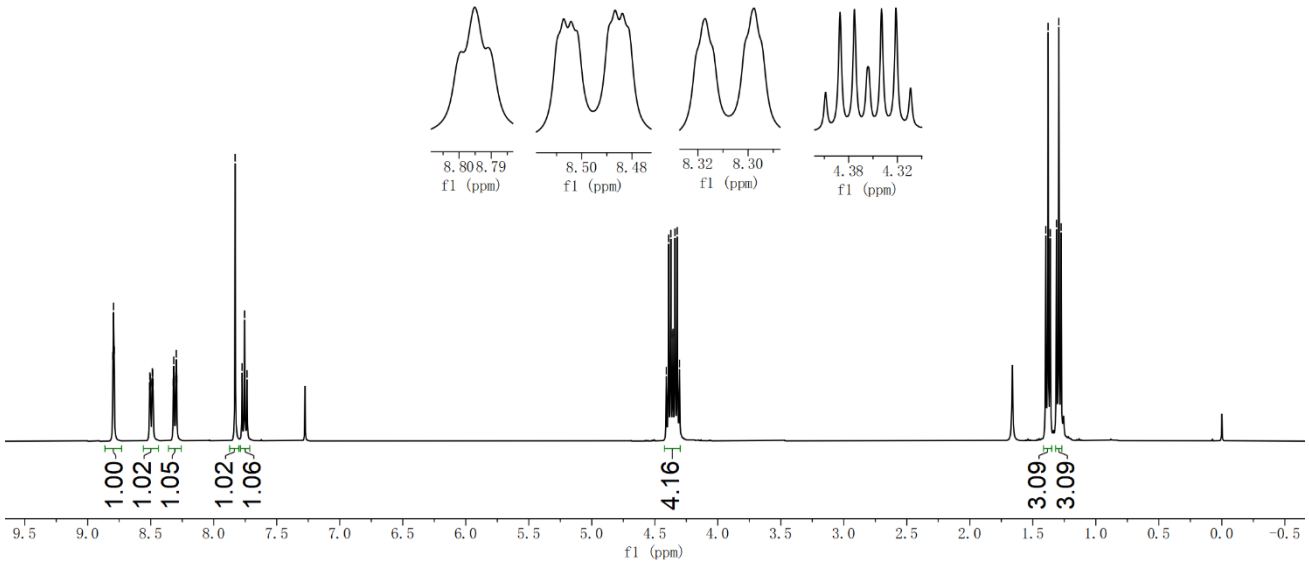


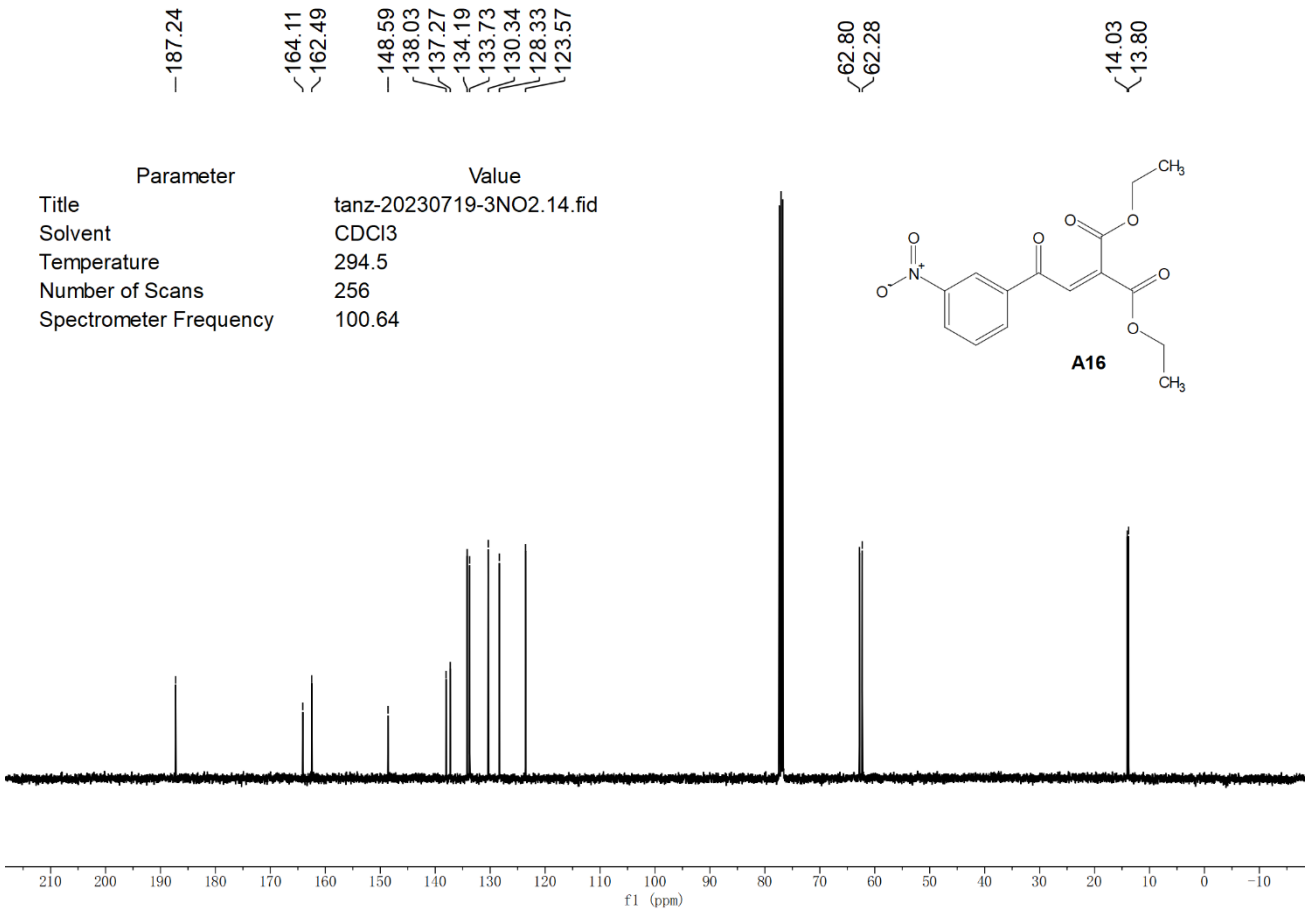


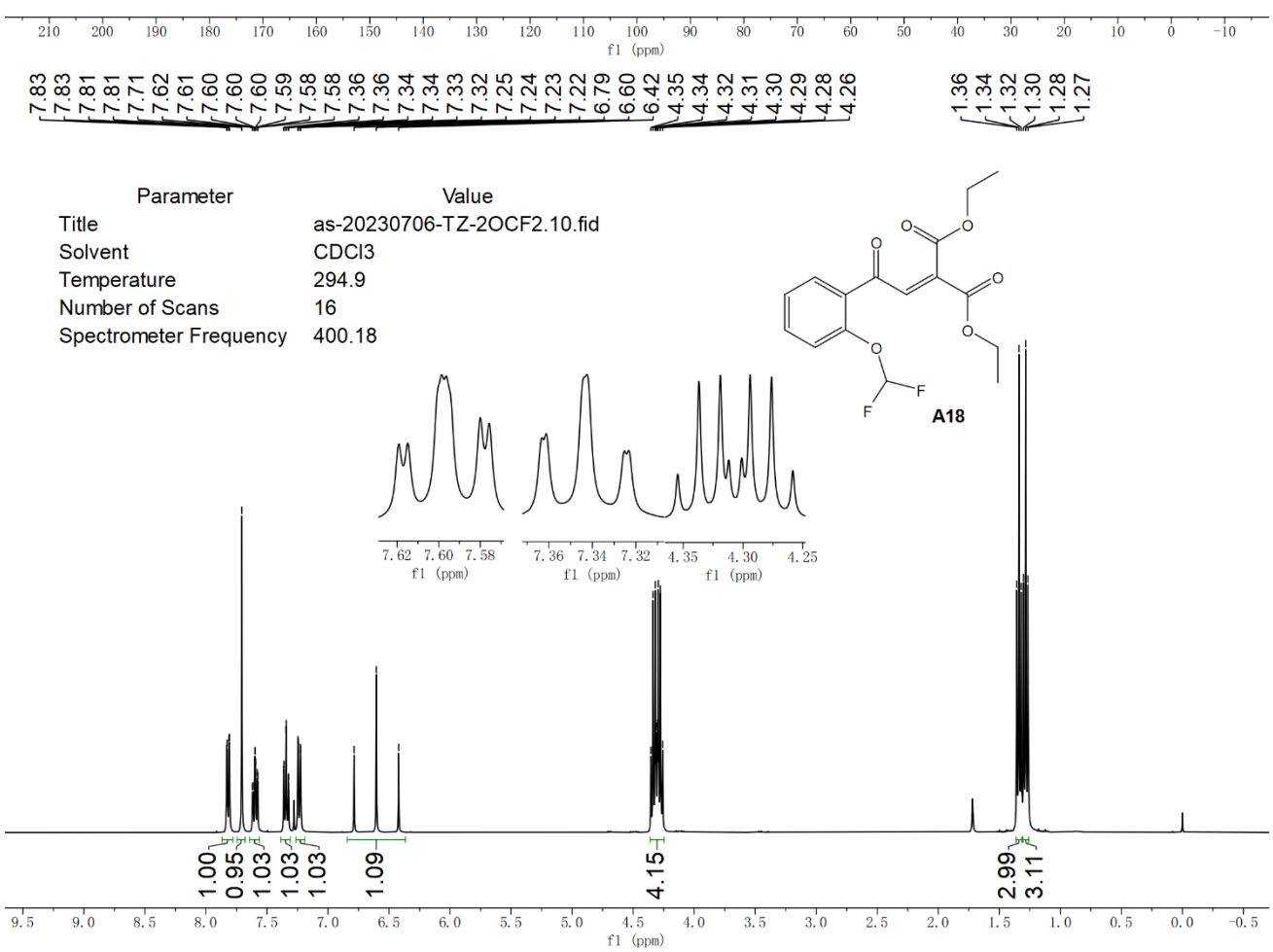
Parameter	Value
Title	tanz-20230719-3NO2.13.fid
Solvent	CDCl3
Temperature	294.0
Number of Scans	16
Spectrometer Frequency	400.18

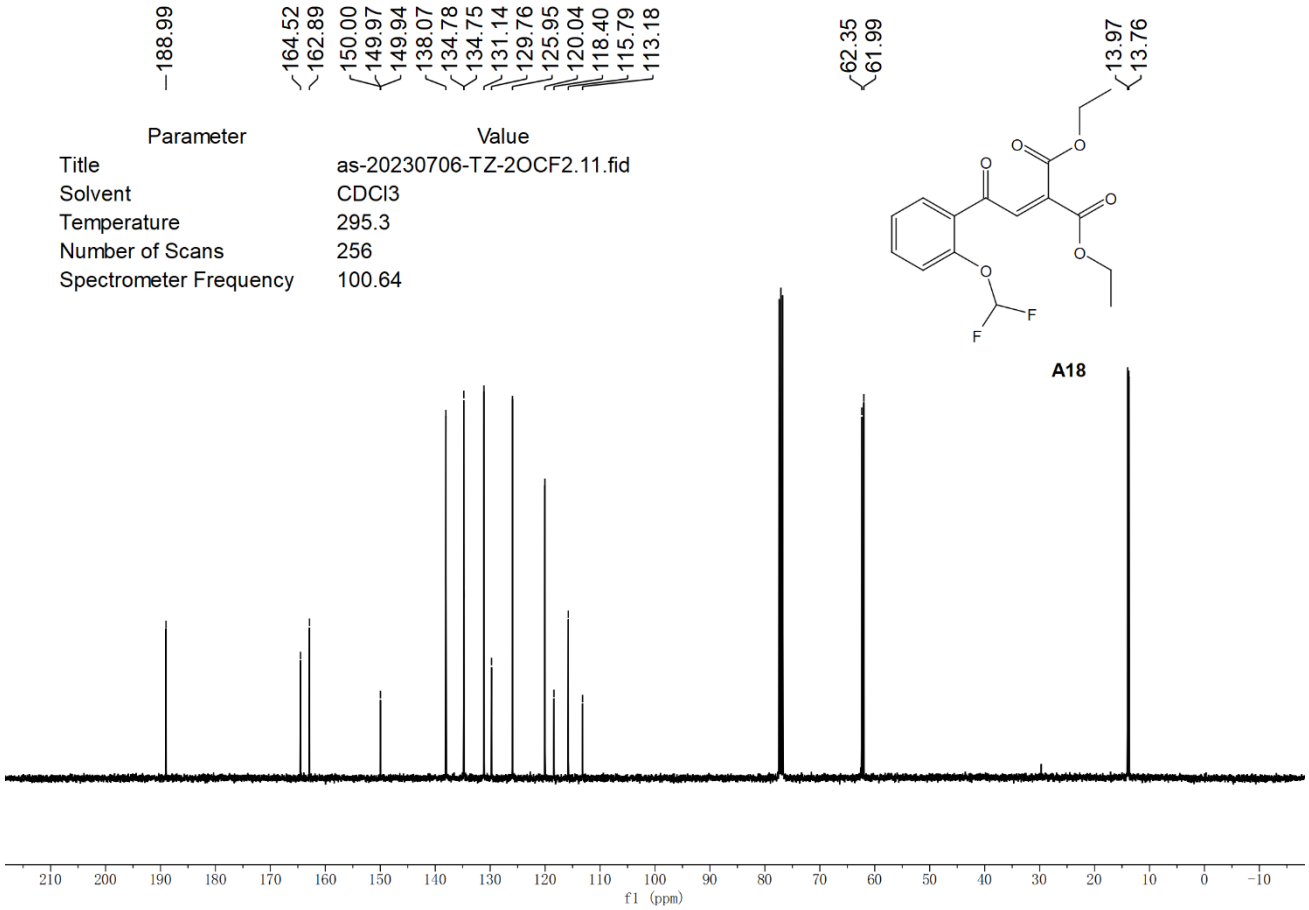


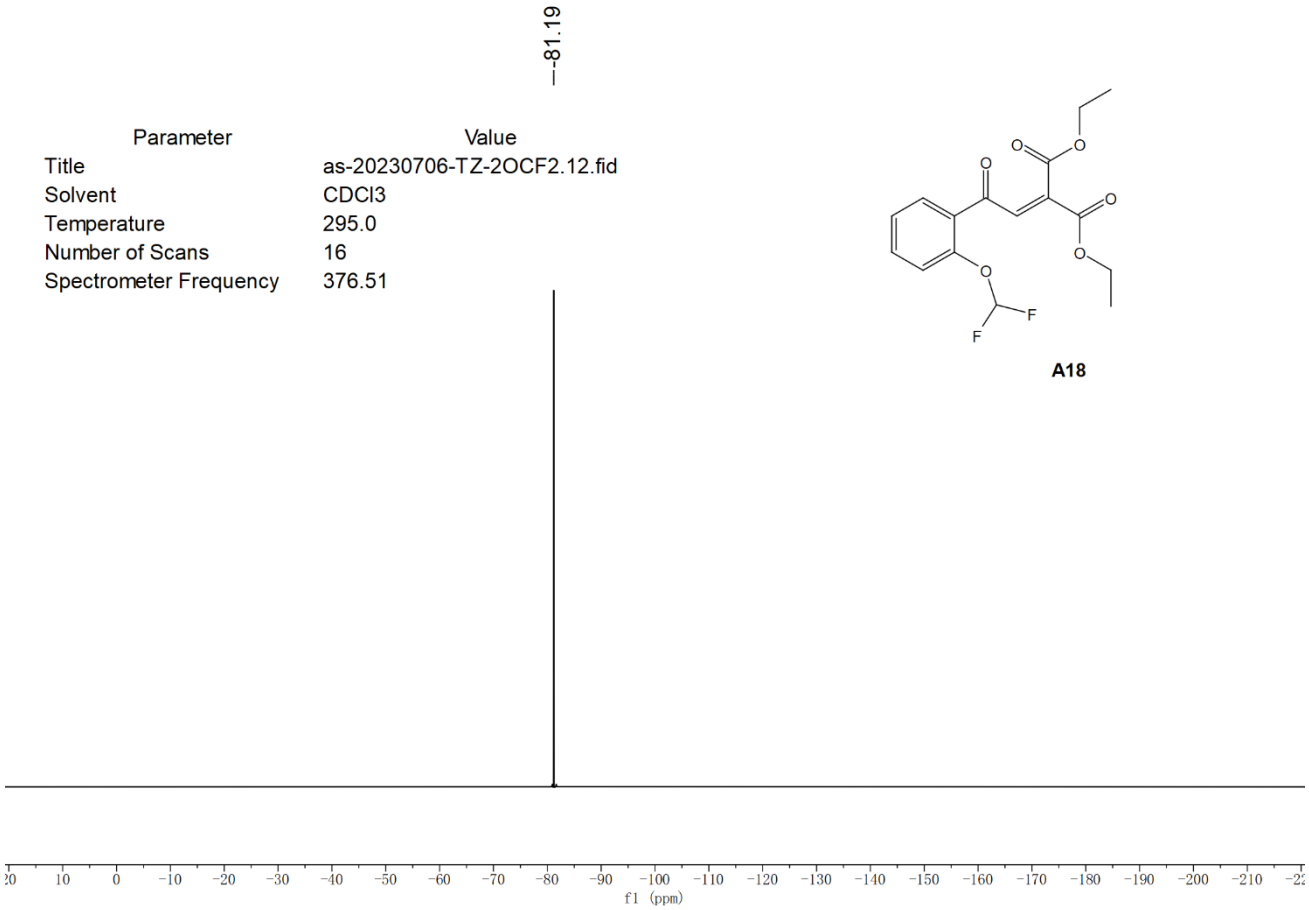
A16




187.24
164.11
162.49
148.59
138.03
137.27
134.19
133.73
130.34
128.33
123.57
62.80
62.28
14.03
13.80
Parameter Value
Title tanz-20230719-3NO2.14.fid
Solvent CDCl3
Temperature 294.5
Number of Scans 256
Spectrometer Frequency 100.64
A16
f1 (ppm)

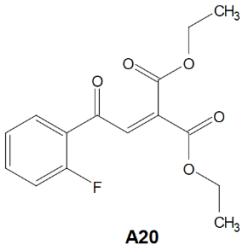

7.83
7.83
7.81
7.81
7.71
7.62
7.61
7.60
7.60
7.60
7.59
7.58
7.58
7.36
7.36
7.34
7.34
7.33
7.32
7.25
7.24
7.23
7.22
6.79
6.60
6.42
4.35
4.34
4.32
4.31
4.30
4.29
4.28
4.26
1.36
1.34
1.32
1.30
1.28
1.27
Parameter Value
Title as-20230706-TZ-2OCF2.10.fid
Solvent CDCl3
Temperature 294.9
Number of Scans 16
Spectrometer Frequency 400.18
A18
1.00
0.95
1.03
1.03
1.03
1.09
4.15
2.99
3.11
f1 (ppm)


188.99
164.52
162.89
150.00
149.97
149.94
138.07
134.78
134.75
131.14
129.76
125.95
120.04
118.40
115.79
113.18
62.35
61.99
13.97
13.76
Parameter Value
Title as-20230706-TZ-2OCF2.11.fid
Solvent CDCl3
Temperature 295.3
Number of Scans 256
Spectrometer Frequency 100.64
A18
f1 (ppm)

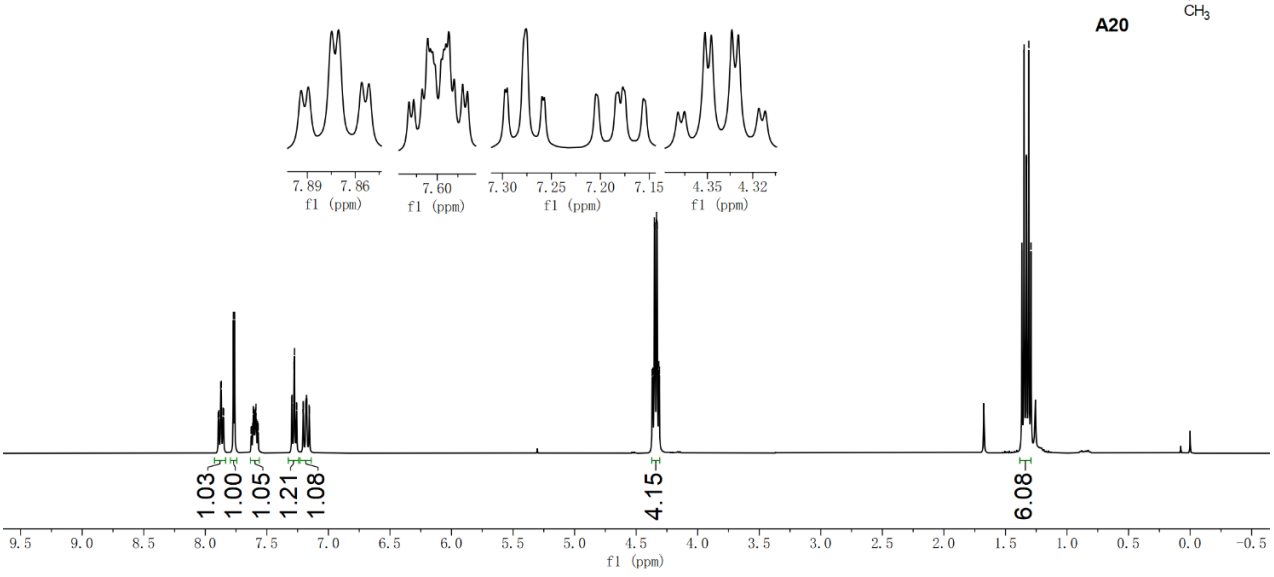

-81.19
Parameter Value
Title as-20230706-TZ-2OCF2.12.fid
Solvent CDCl3
Temperature 295.0
Number of Scans 16
Spectrometer Frequency 376.51
A18
f1 (ppm)

7.89 7.89 7.88 7.87 7.86 7.85 7.77 7.76 7.63 7.62 7.61 7.61 7.61 7.60 7.60 7.60 7.59 7.59 7.59 7.58 7.58 7.57 7.30 7.30 7.28 7.28 7.26 7.26 7.21 7.20 7.18 7.18 7.18 7.17 7.16 7.15 4.37 4.37 4.35 4.35 4.33 4.33 4.32 4.31 1.37 1.33 1.33 1.31 1.29

Parameter	Value
Title	as-20230706-TZ-2F.7.fid
Solvent	CDCl3
Temperature	294.8
Number of Scans	16
Spectrometer Frequency	400.18

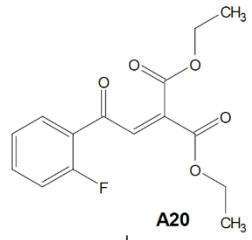


A20

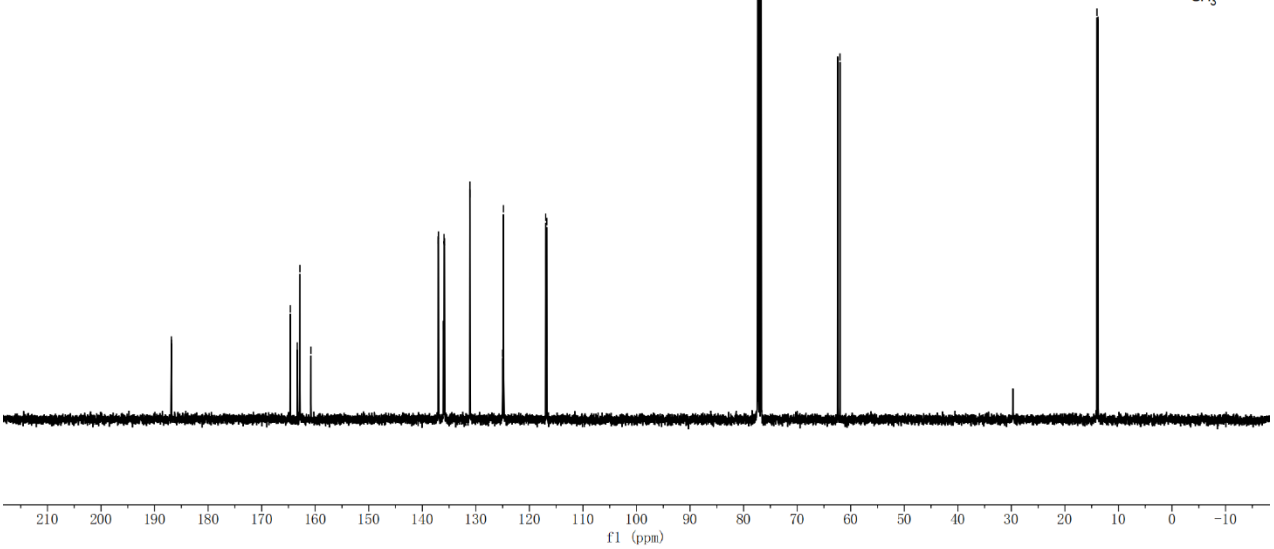


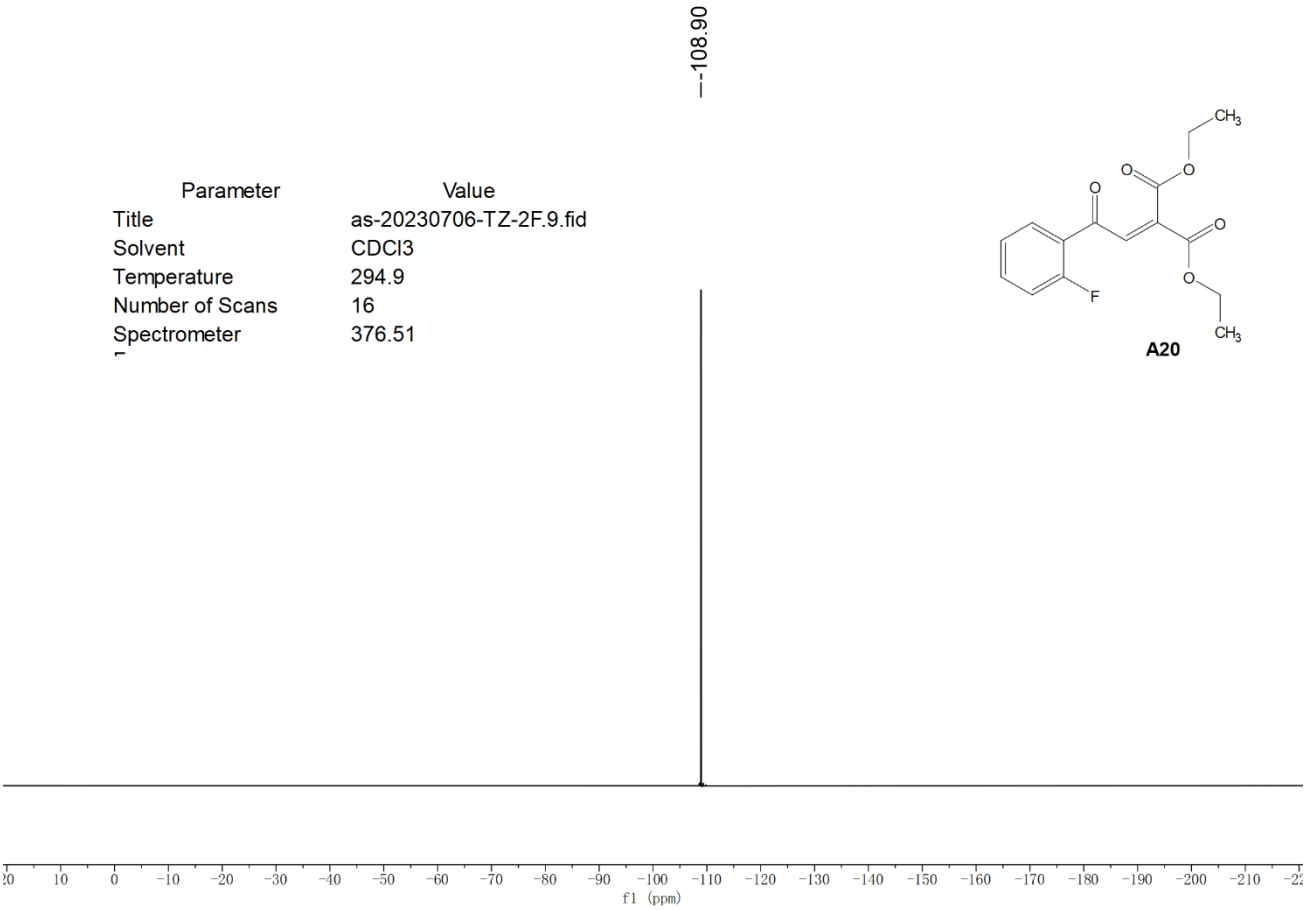
186.86 186.83 164.64 163.35 162.87 160.80 137.04 136.97 136.10 136.08 135.94 135.85 131.10 131.08 125.01 124.89 124.84 124.81 116.97 116.74 62.43 62.01 14.01 13.81

Parameter	Value
Title	as-20230706-TZ-2F.8.fid
Solvent	CDCl3
Temperature	295.2
Number of Scans	256
Spectrometer Frequency	100.64



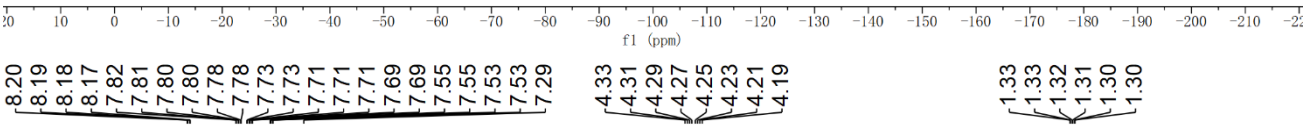
A20



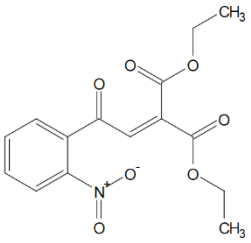


Parameter	Value
Title	as-20230706-TZ-2F.9.fid
Solvent	CDCl3
Temperature	294.9
Number of Scans	16
Spectrometer	376.51

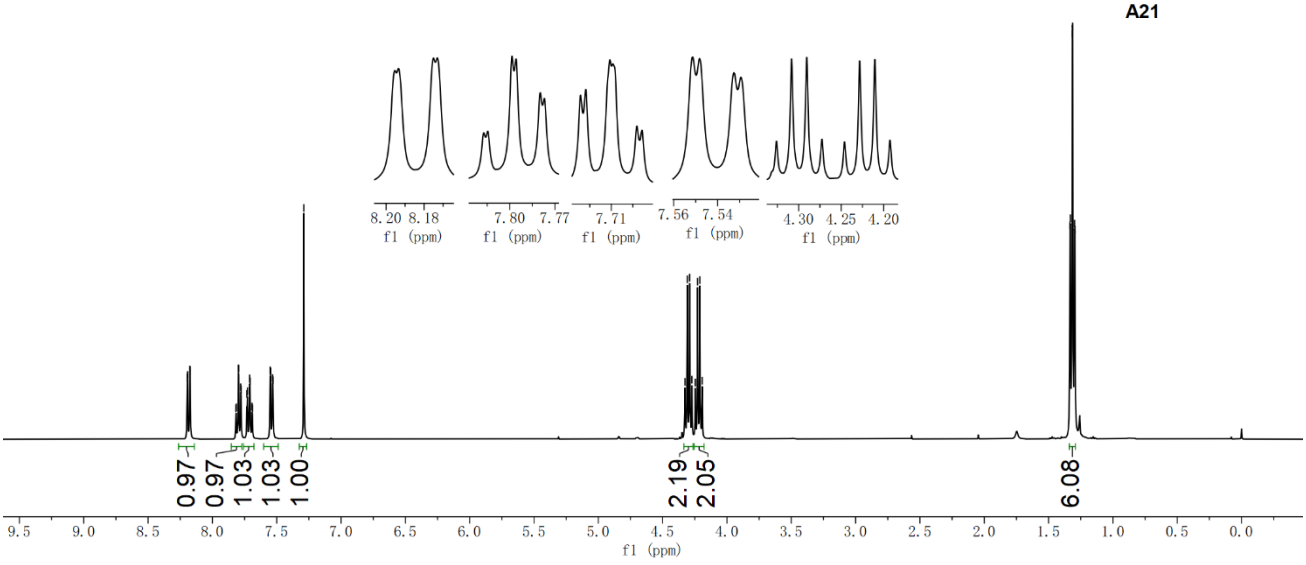
A20

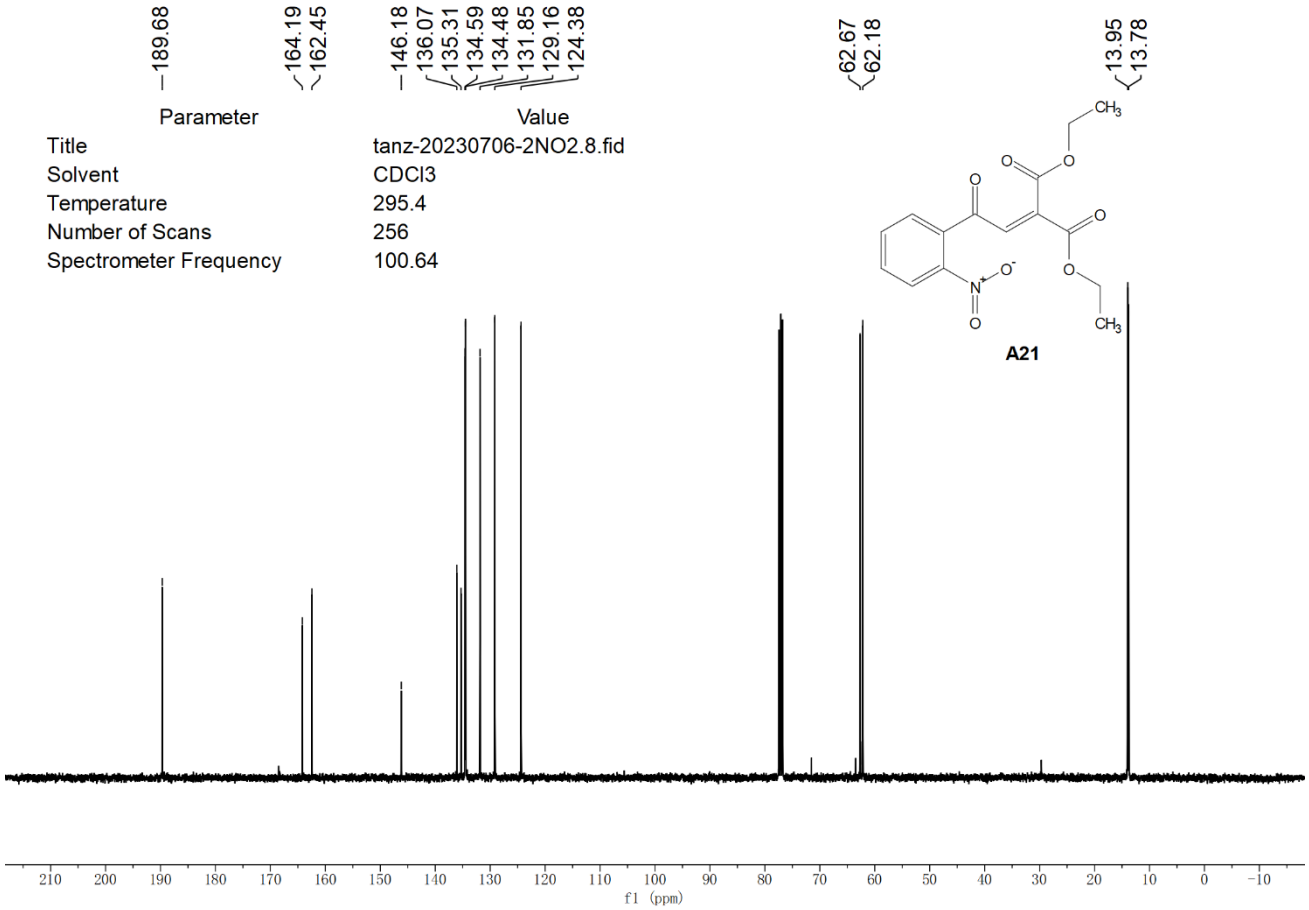


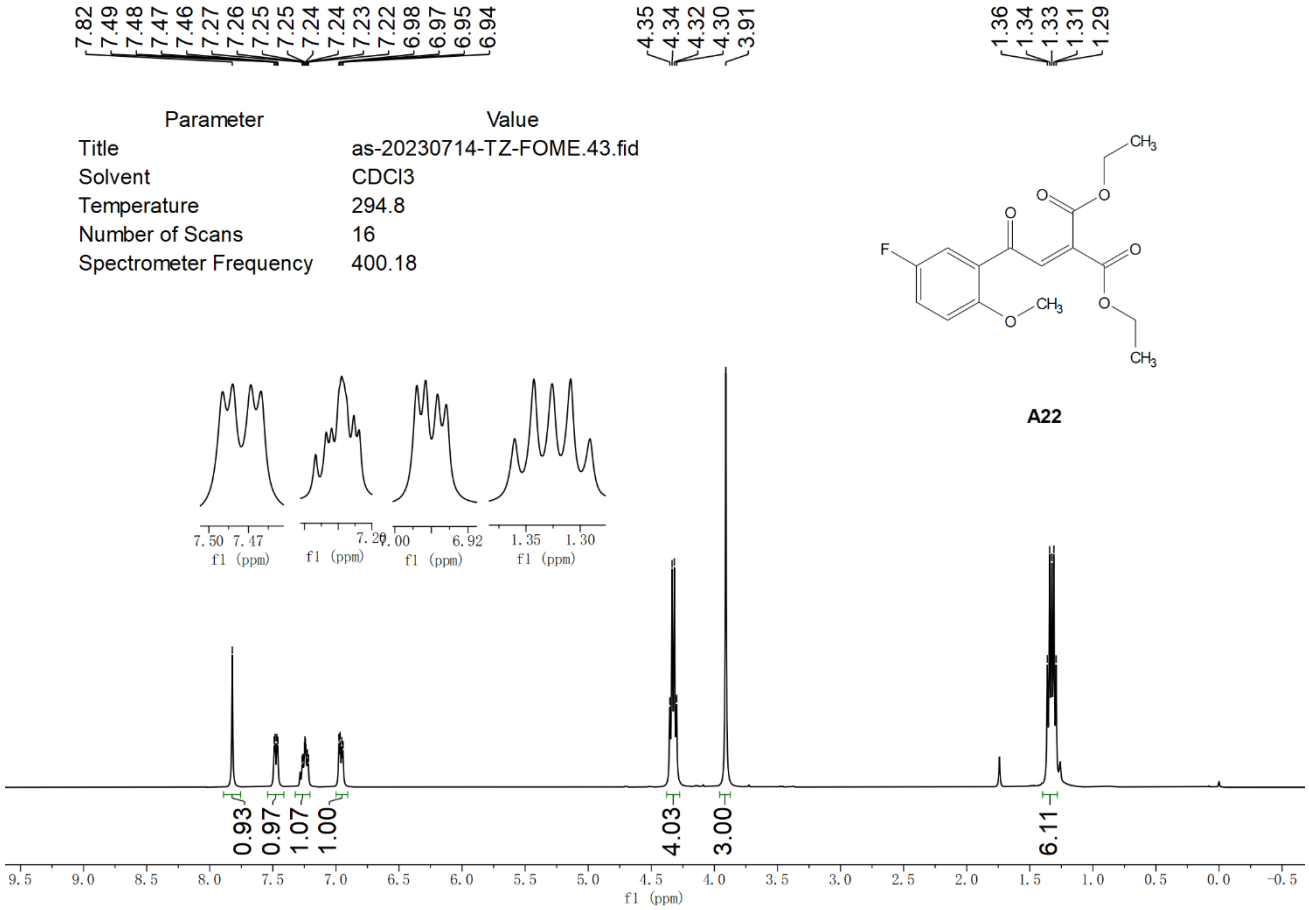
Parameter	Value
Title	tanz-20230706-2NO2.7.fid
Solvent	CDCl3
Temperature	294.8
Number of Scans	16
Spectrometer Frequency	400.18

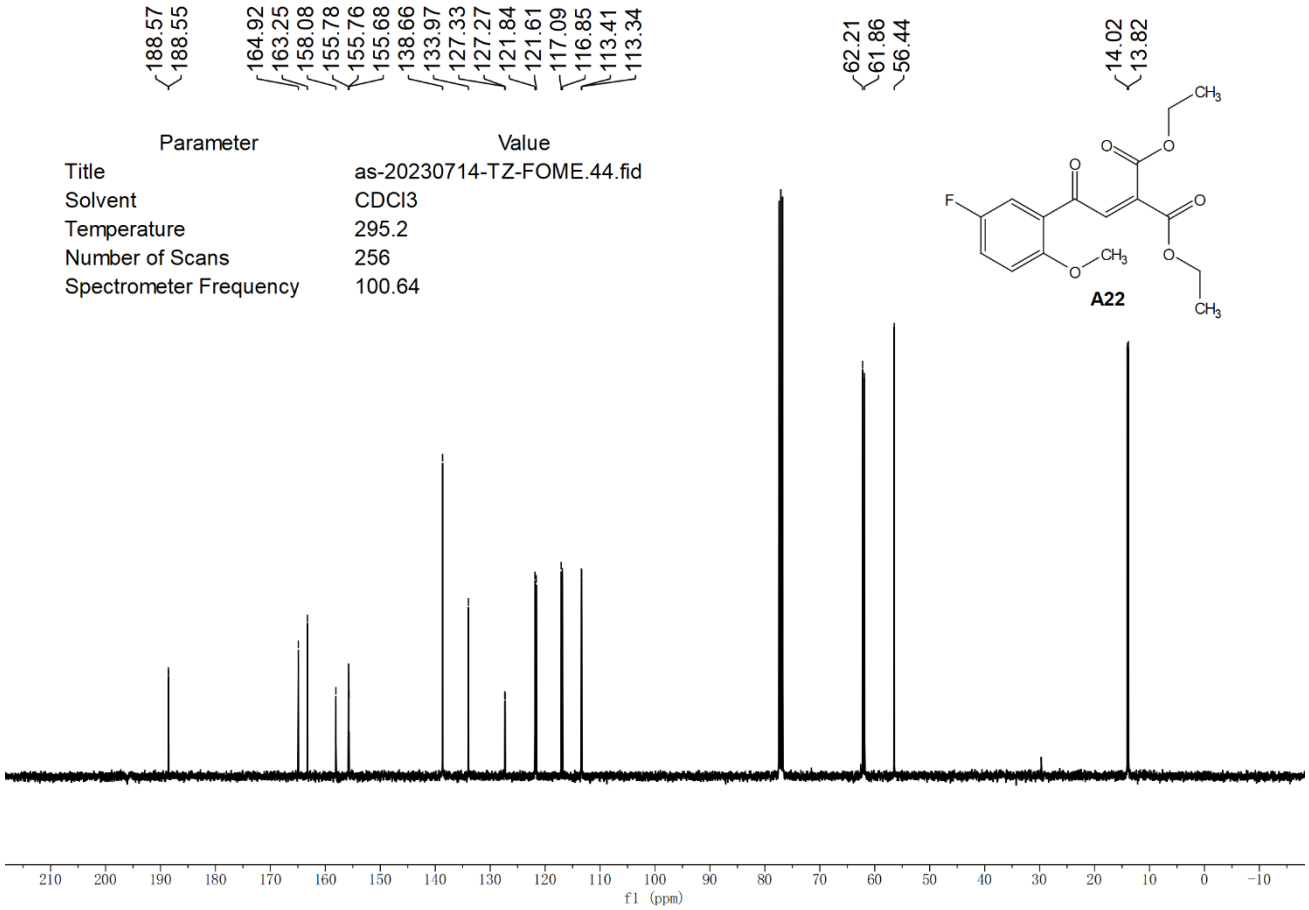


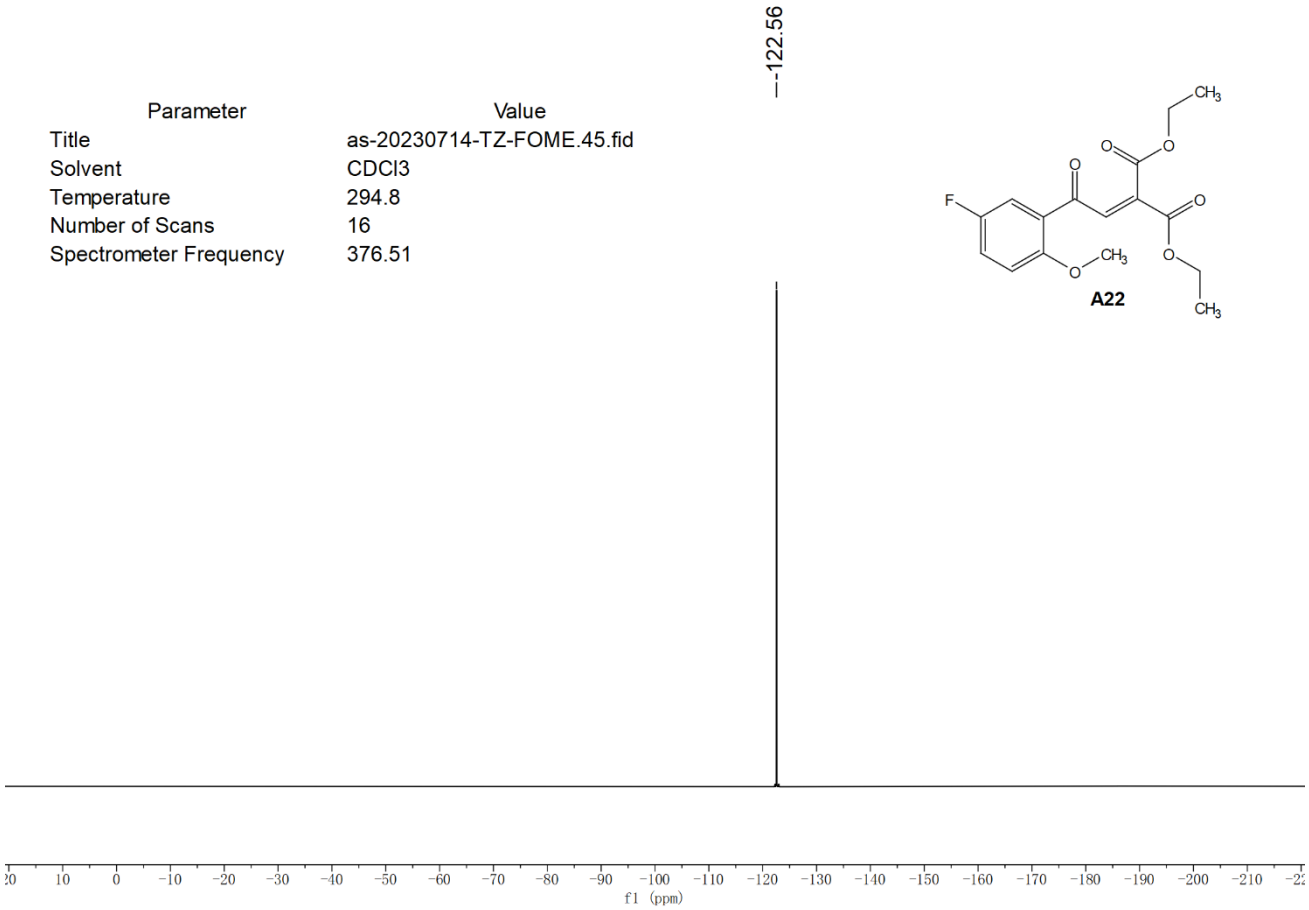
A21

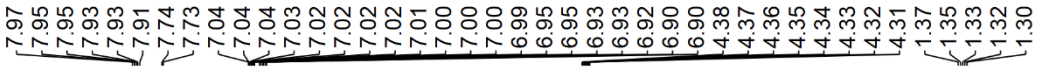



189.68
164.19
162.45
146.18
136.07
135.31
134.59
134.48
131.85
129.16
124.38
62.67
62.18
13.95
13.78
Parameter
Value
Title
tanz-20230706-2NO2.8.fid
Solvent
CDCl3
Temperature
295.4
Number of Scans
256
Spectrometer Frequency
100.64
A21
f1 (ppm)

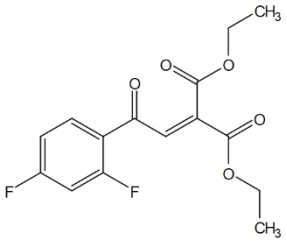

7.82
7.49
7.48
7.47
7.46
7.27
7.26
7.25
7.25
7.24
7.24
7.23
7.22
6.98
6.97
6.95
6.94
4.35
4.34
4.32
4.30
3.91
1.36
1.34
1.33
1.31
1.29
Parameter
Value
Title
as-20230714-TZ-FOME.43.fid
Solvent
CDCl3
Temperature
294.8
Number of Scans
16
Spectrometer Frequency
400.18
A22
0.93
0.97
1.07
1.00
4.03
3.00
6.11
f1 (ppm)


188.57
188.55
164.92
163.25
158.08
155.78
155.76
155.68
138.66
133.97
127.33
127.27
121.84
121.61
117.09
116.85
113.41
113.34
62.21
61.86
56.44
14.02
13.82
Parameter
Value
Title
as-20230714-TZ-FOME.44.fid
Solvent
CDCl3
Temperature
295.2
Number of Scans
256
Spectrometer Frequency
100.64
A22
f1 (ppm)

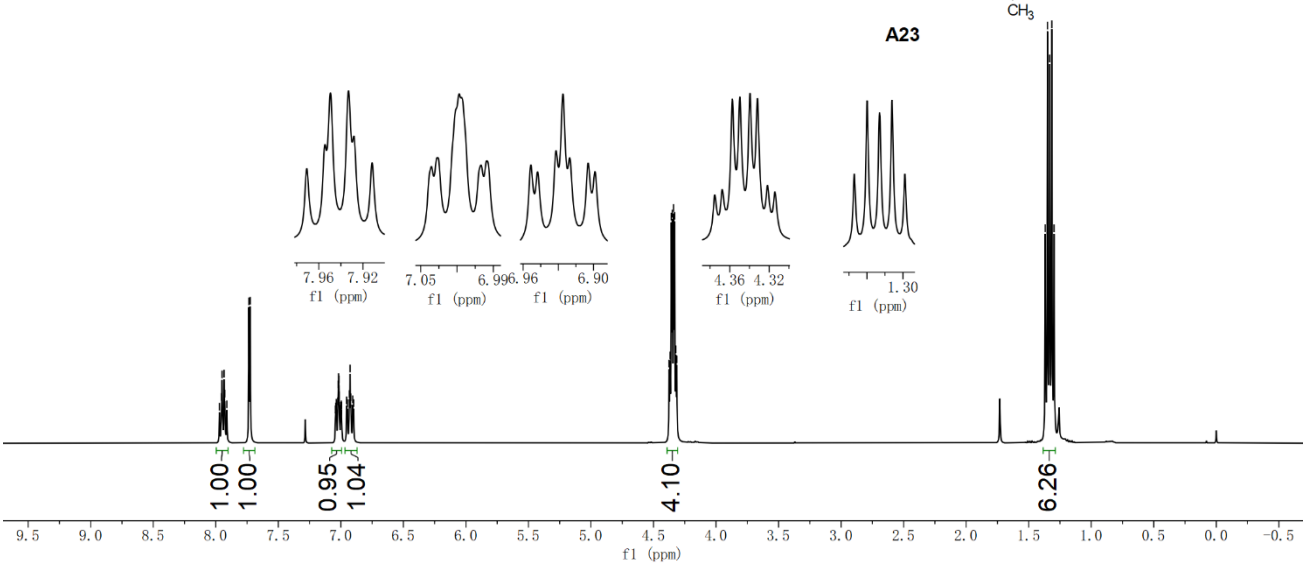

-122.56
Parameter
Value
Title
as-20230714-TZ-FOME.45.fid
Solvent
CDCl3
Temperature
294.8
Number of Scans
16
Spectrometer Frequency
376.51
A22
f1 (ppm)

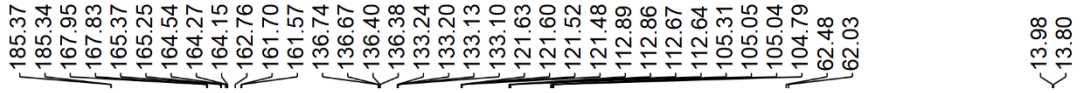


Parameter	Value
Title	as-20230714-TZ-242F.37.fid
Solvent	CDCl3
Temperature	294.6
Number of Scans	16
Spectrometer Frequency	400.18

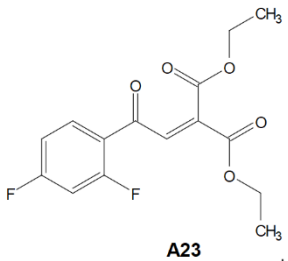


A23

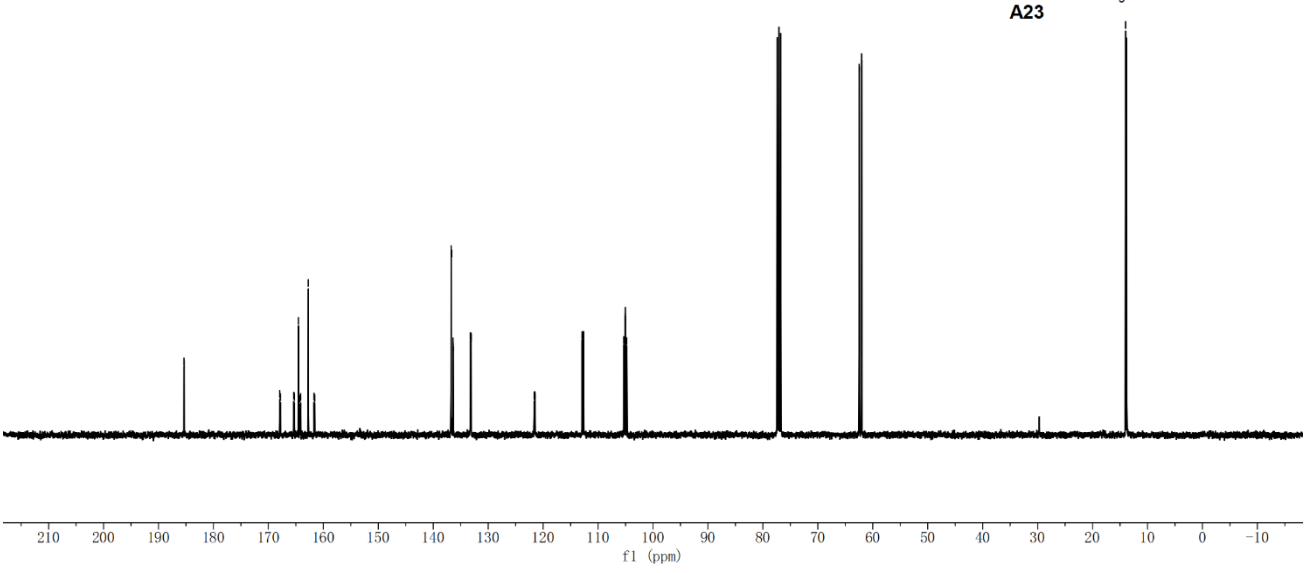


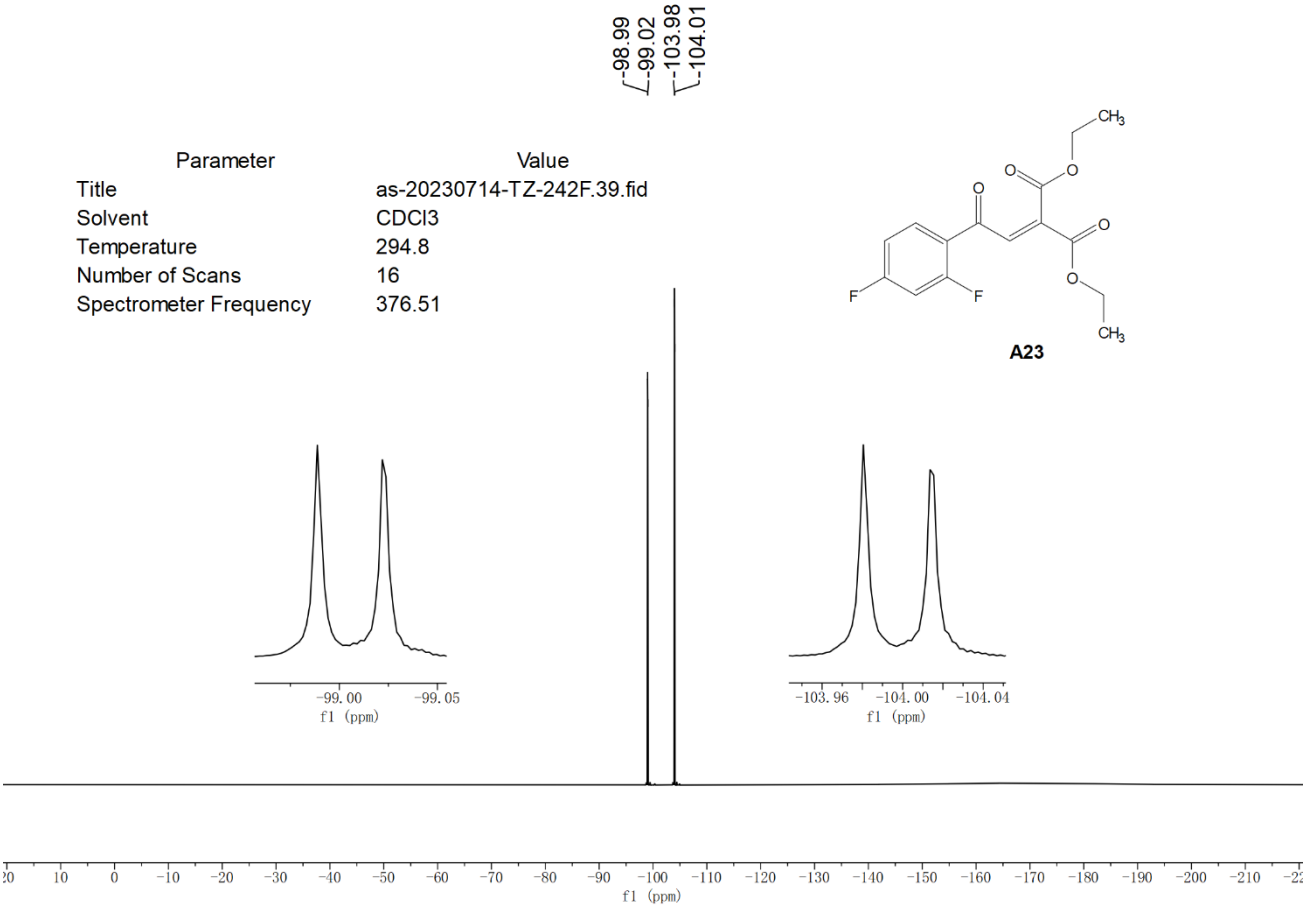


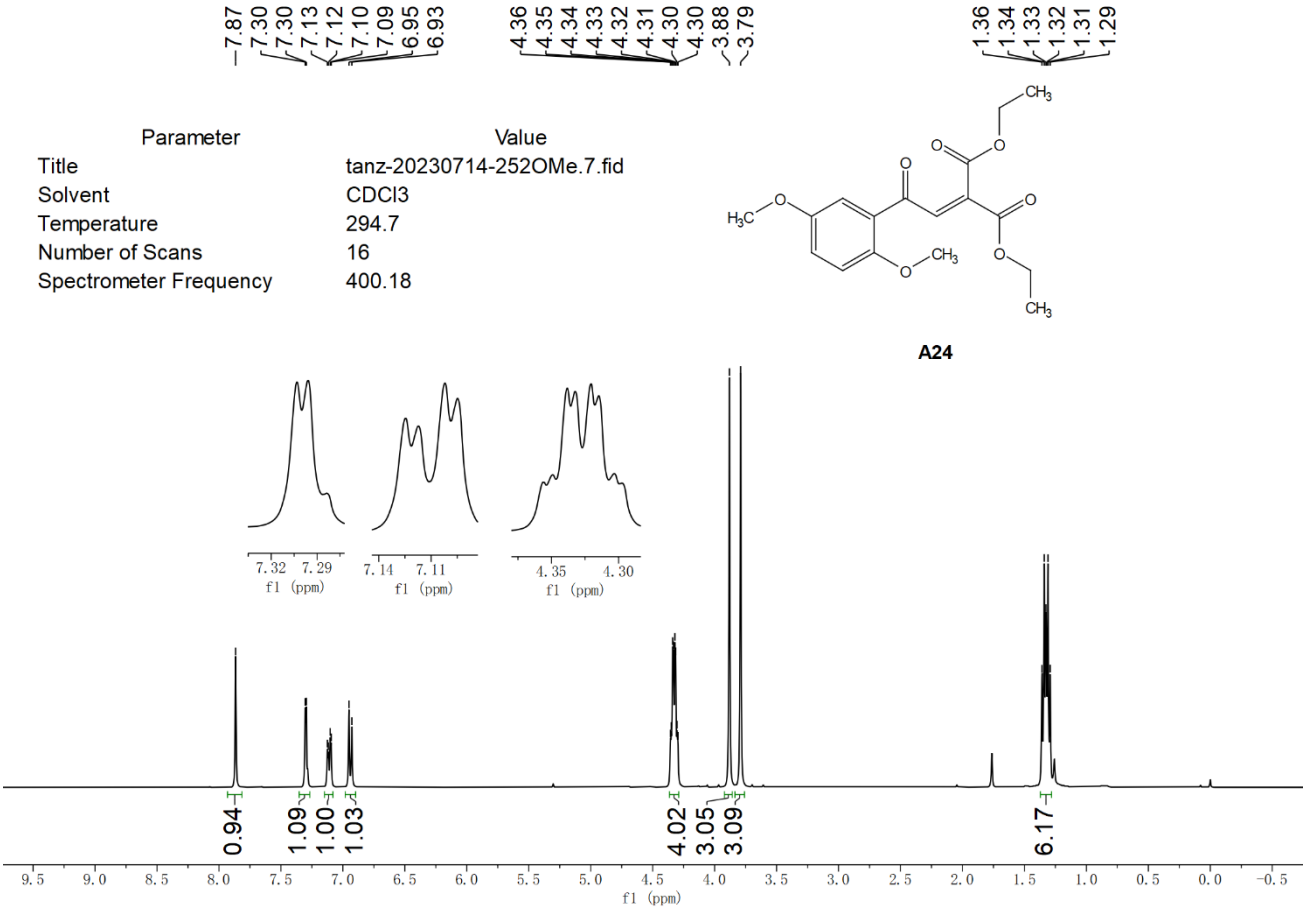
Parameter	Value
Title	as-20230714-TZ-242F.38.fid
Solvent	CDCl3
Temperature	295.1
Number of Scans	256
Spectrometer Frequency	100.64

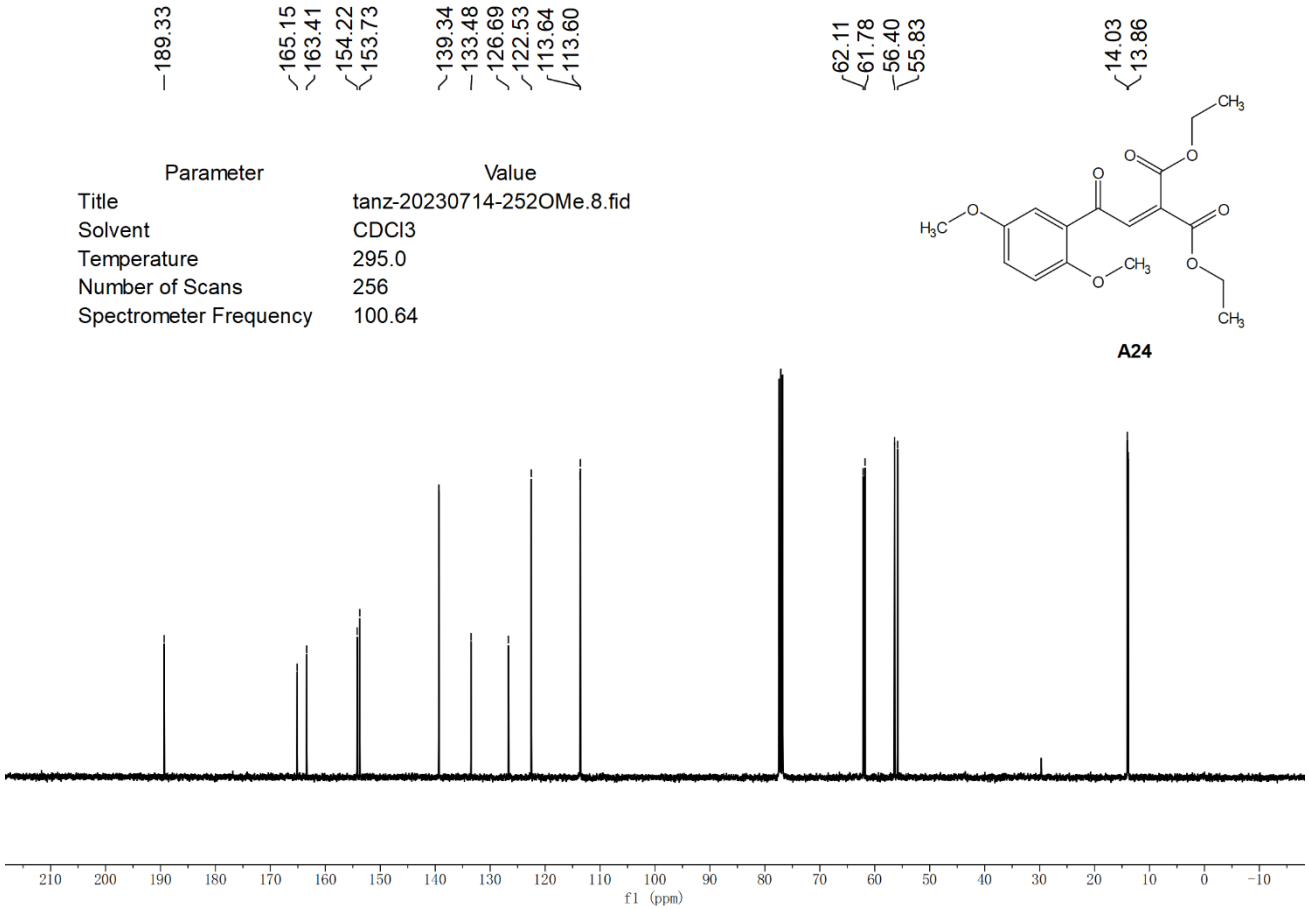


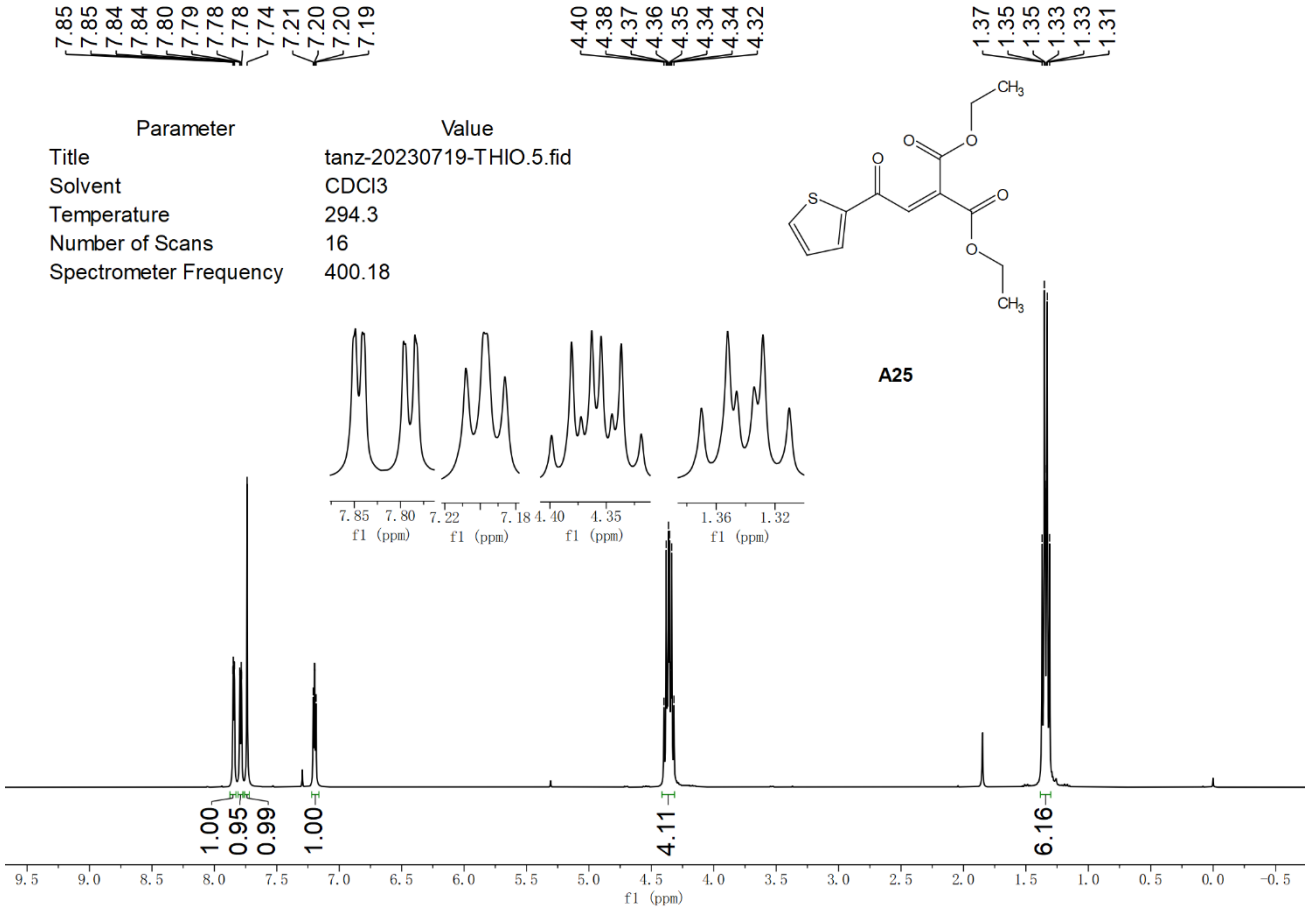
A23

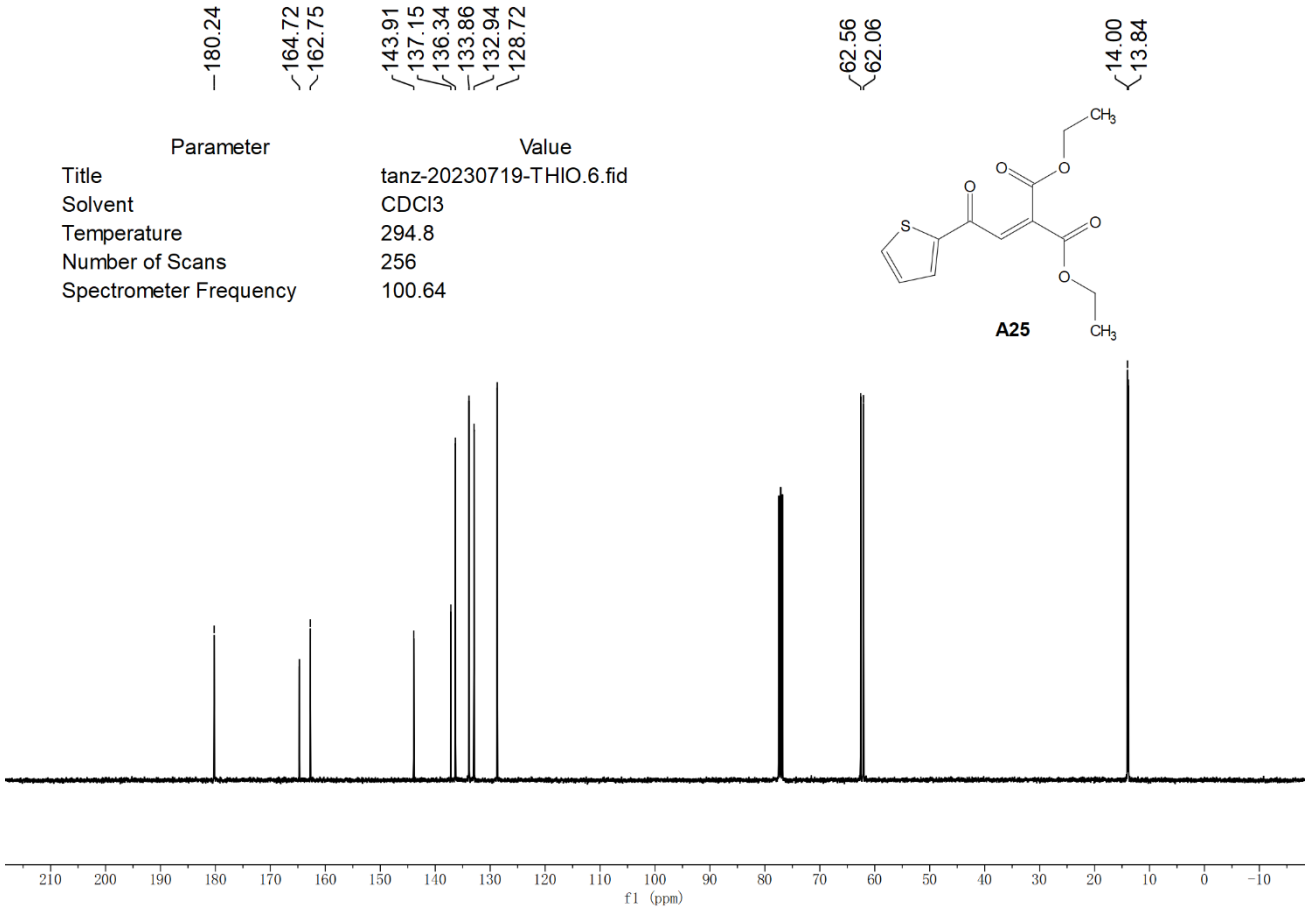


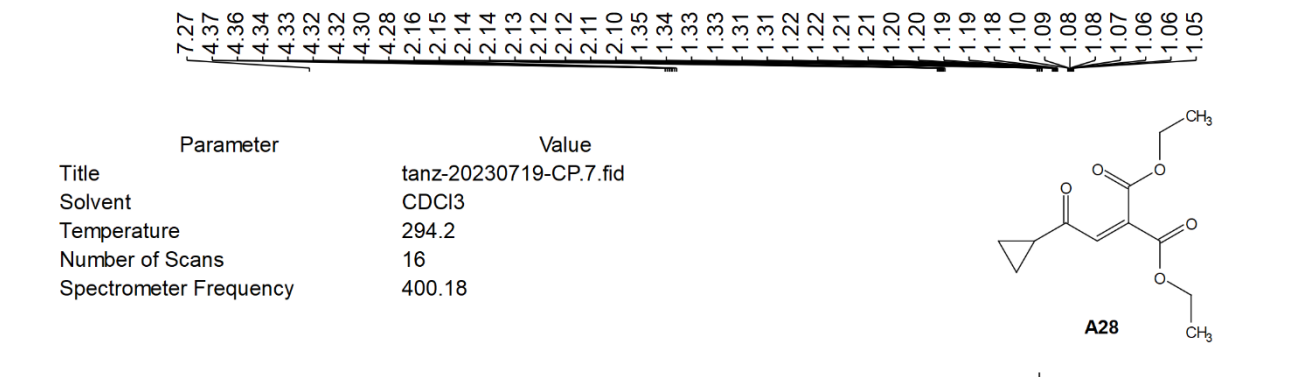

-98.99
-99.02
-103.98
-104.01
Parameter
Value
Title
as-20230714-TZ-242F.39.fid
Solvent
CDCl3
Temperature
294.8
Number of Scans
16
Spectrometer Frequency
376.51
A23
-99.00
-99.05
f1 (ppm)
-103.96
-104.00
-104.04
f1 (ppm)
f1 (ppm)

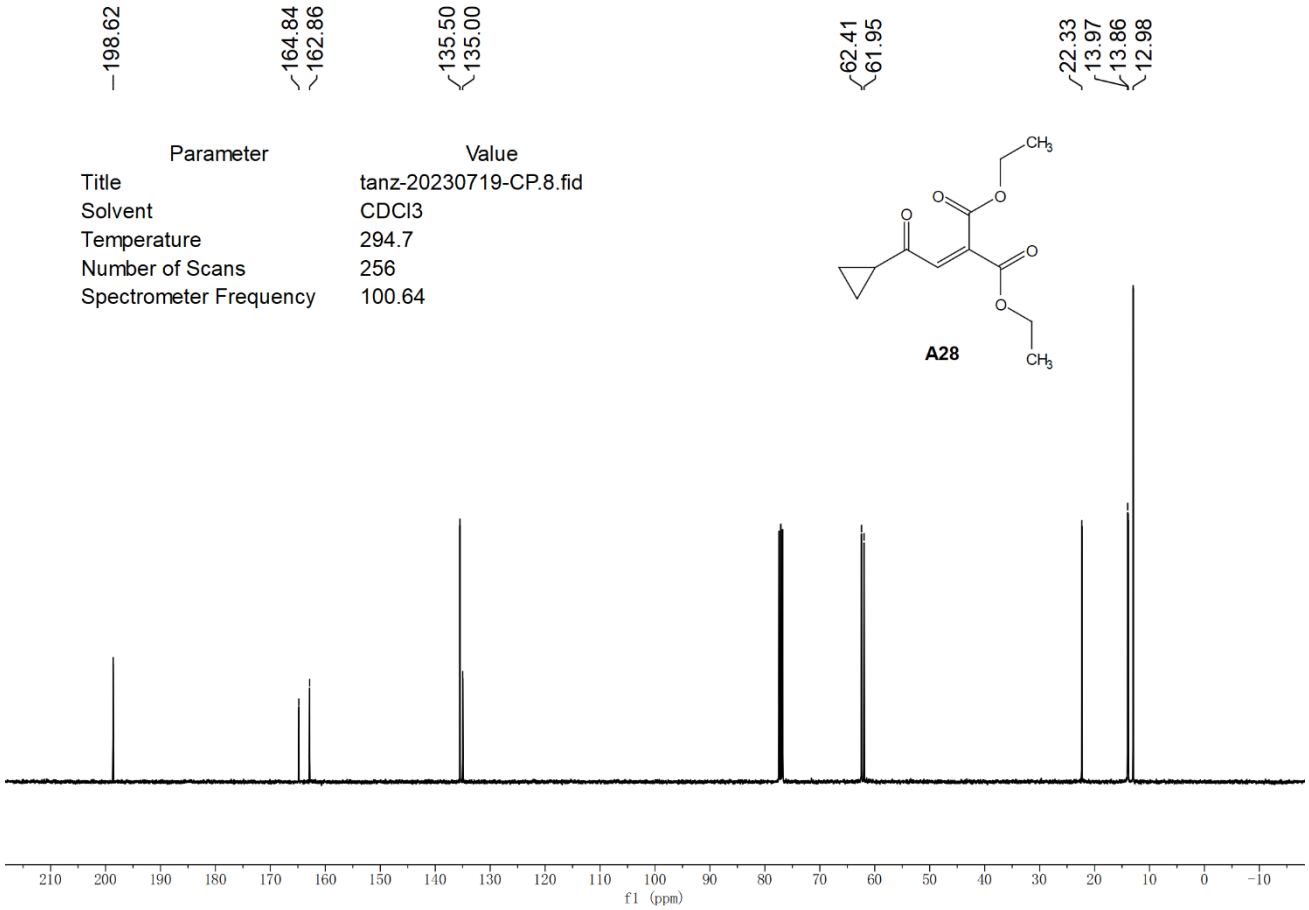

7.87
7.30
7.30
7.13
7.12
7.10
7.09
6.95
6.93
4.36
4.35
4.34
4.33
4.32
4.31
4.30
4.30
3.88
3.79
1.36
1.34
1.33
1.32
1.31
1.29
Parameter
Value
Title
tanz-20230714-252OMe.7.fid
Solvent
CDCl3
Temperature
294.7
Number of Scans
16
Spectrometer Frequency
400.18
A24
7.32
7.29
f1 (ppm)
7.14
7.11
f1 (ppm)
4.35
4.30
f1 (ppm)
0.94
1.09
1.00
1.03
4.02
3.05
3.09
6.17
f1 (ppm)

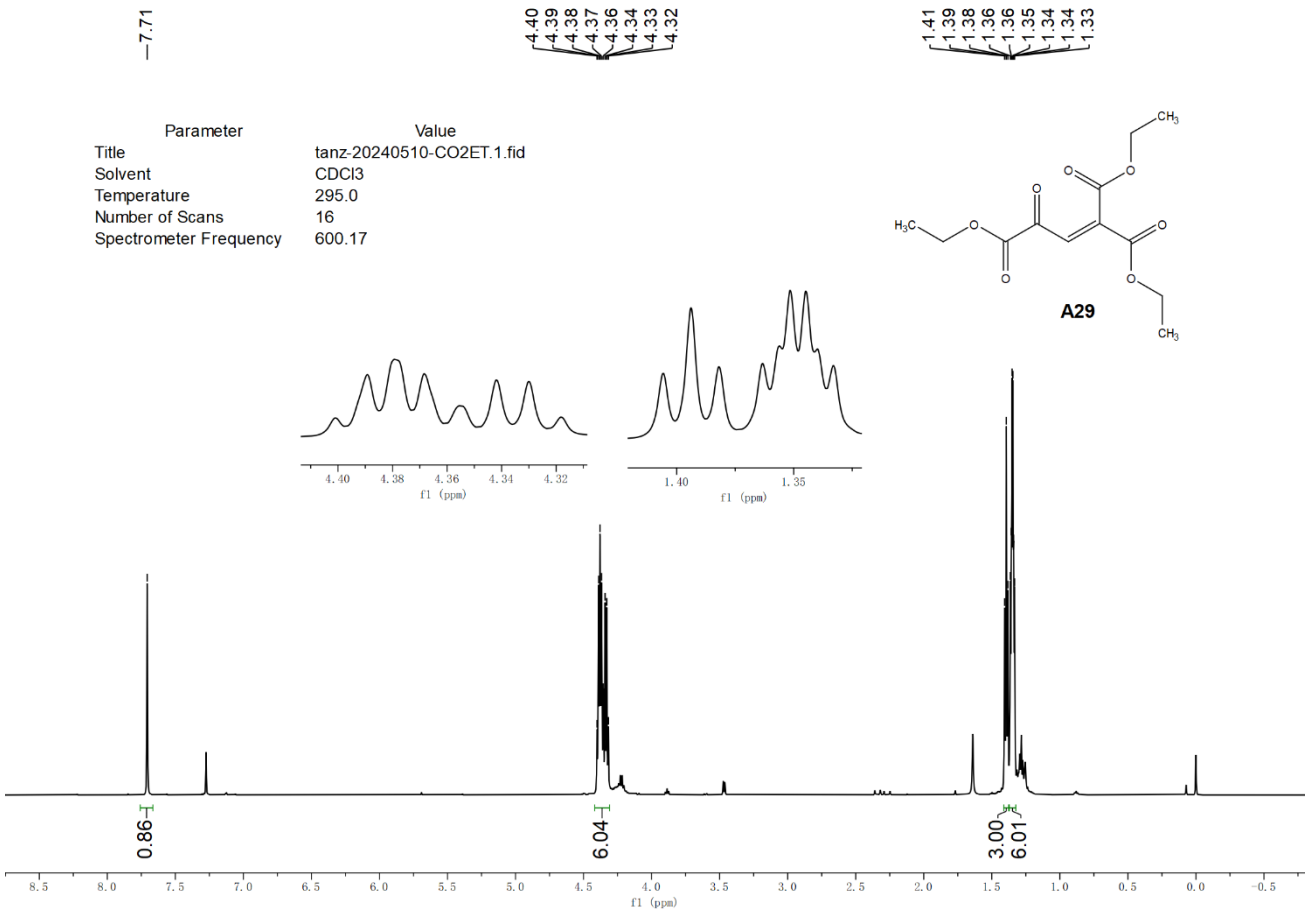

189.33
165.15
163.41
154.22
153.73
139.34
133.48
126.69
122.53
113.64
113.60
62.11
61.78
56.40
55.83
14.03
13.86
Parameter Value
Title tanz-20230714-252OMe.8.fid
Solvent CDCl3
Temperature 295.0
Number of Scans 256
Spectrometer Frequency 100.64
A24
f1 (ppm)

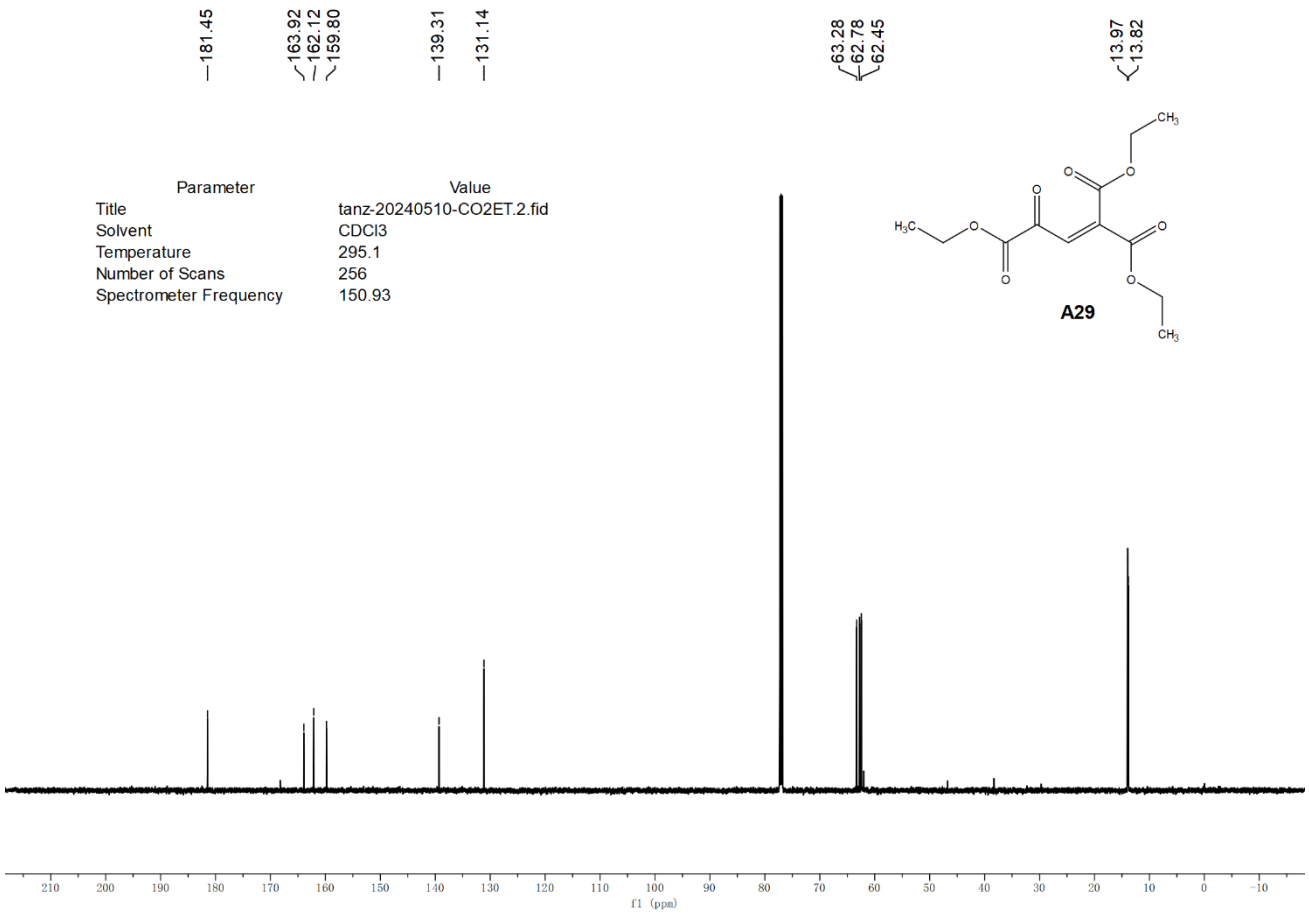

7.85
7.85
7.84
7.84
7.80
7.79
7.78
7.78
7.74
7.21
7.20
7.20
7.19
4.40
4.38
4.37
4.36
4.35
4.34
4.34
4.32
1.37
1.35
1.35
1.33
1.33
1.31
Parameter Value
Title tanz-20230719-THIO.5.fid
Solvent CDCl3
Temperature 294.3
Number of Scans 16
Spectrometer Frequency 400.18
A25
1.00
0.95
0.99
1.00
4.11
6.16
f1 (ppm)

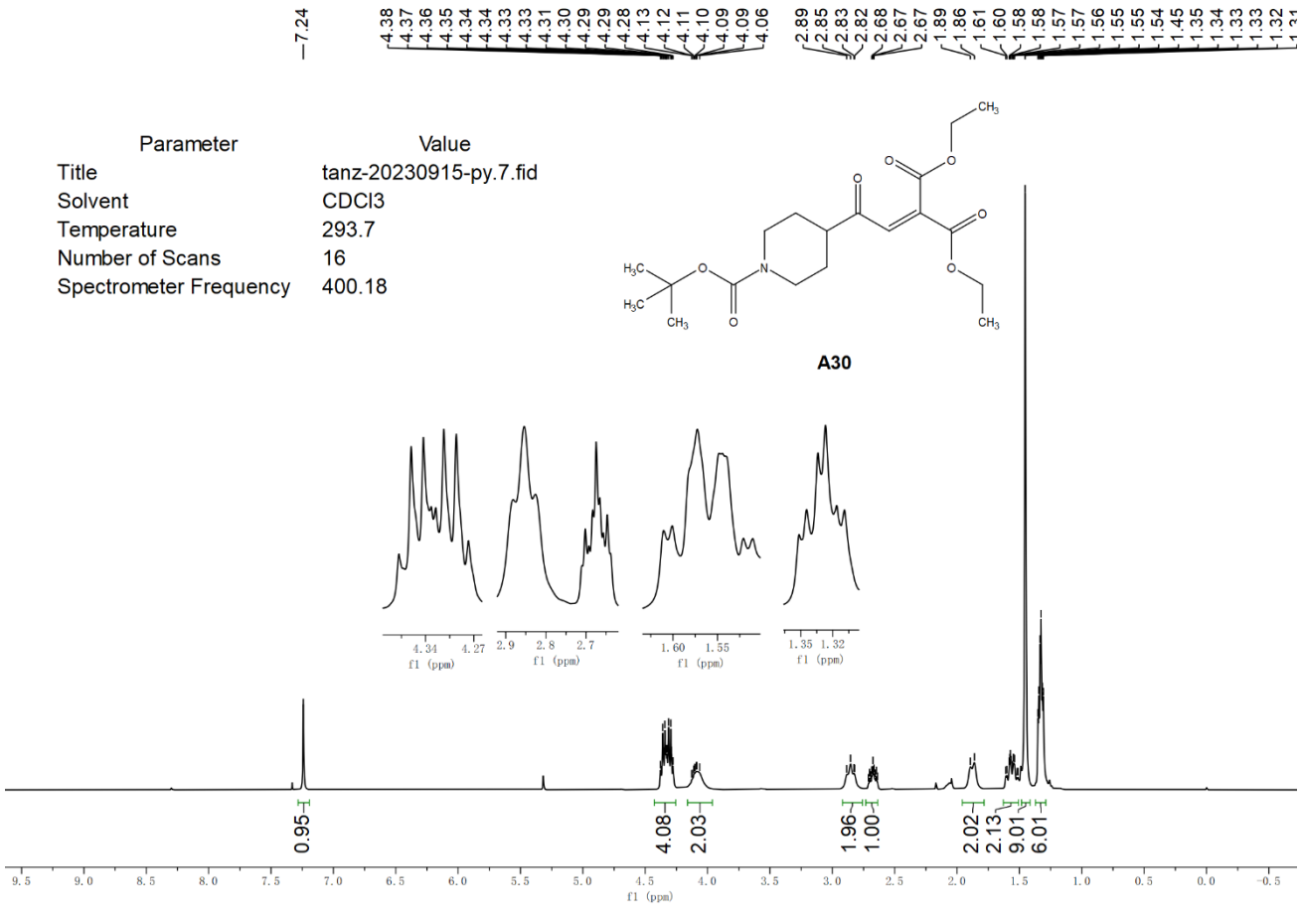

180.24
164.72
162.75
143.91
137.15
136.34
133.86
132.94
128.72
62.56
62.06
14.00
13.84
Parameter Value
Title tanz-20230719-THIO.6.fid
Solvent CDCl3
Temperature 294.8
Number of Scans 256
Spectrometer Frequency 100.64
A25
f1 (ppm)


7.27
4.37
4.36
4.34
4.33
4.32
4.32
4.30
4.28
2.16
2.15
2.14
2.14
2.13
2.12
2.12
2.11
2.10
1.35
1.34
1.33
1.33
1.31
1.31
1.22
1.22
1.21
1.21
1.20
1.20
1.19
1.19
1.18
1.10
1.09
1.08
1.08
1.07
1.06
1.06
1.05
Parameter Value
Title tanz-20230719-CP.7.fid
Solvent CDCl3
Temperature 294.2
Number of Scans 16
Spectrometer Frequency 400.18
A28
4.35 4.30
2.16 2.12
1.34 1.32
1.22 1.18
1.08 1.05
0.95
4.00
1.00
6.00
1.94
1.95
f1 (ppm)


198.62
164.84
162.86
135.50
135.00
62.41
61.95
22.33
13.97
13.86
12.98
Parameter Value
Title tanz-20230719-CP.8.fid
Solvent CDCl3
Temperature 294.7
Number of Scans 256
Spectrometer Frequency 100.64
A28
f1 (ppm)


7.71
4.40
4.39
4.38
4.37
4.36
4.34
4.33
4.32
1.41
1.39
1.38
1.36
1.36
1.35
1.34
1.34
1.33
Parameter Value
Title tanz-20240510-CO2ET.1.fid
Solvent CDCl3
Temperature 295.0
Number of Scans 16
Spectrometer Frequency 600.17
A29
0.86
6.04
3.00
6.01
f1 (ppm)


181.45
163.92
162.12
159.80
139.31
131.14
63.28
62.78
62.45
13.97
13.82
Parameter Value
Title tanz-20240510-CO2ET.2.fid
Solvent CDCl3
Temperature 295.1
Number of Scans 256
Spectrometer Frequency 150.93
A29
f1 (ppm)


7.24
Parameter Value
Title tanz-20230915-py.7.fid
Solvent CDCl3
Temperature 293.7
Number of Scans 16
Spectrometer Frequency 400.18
A30
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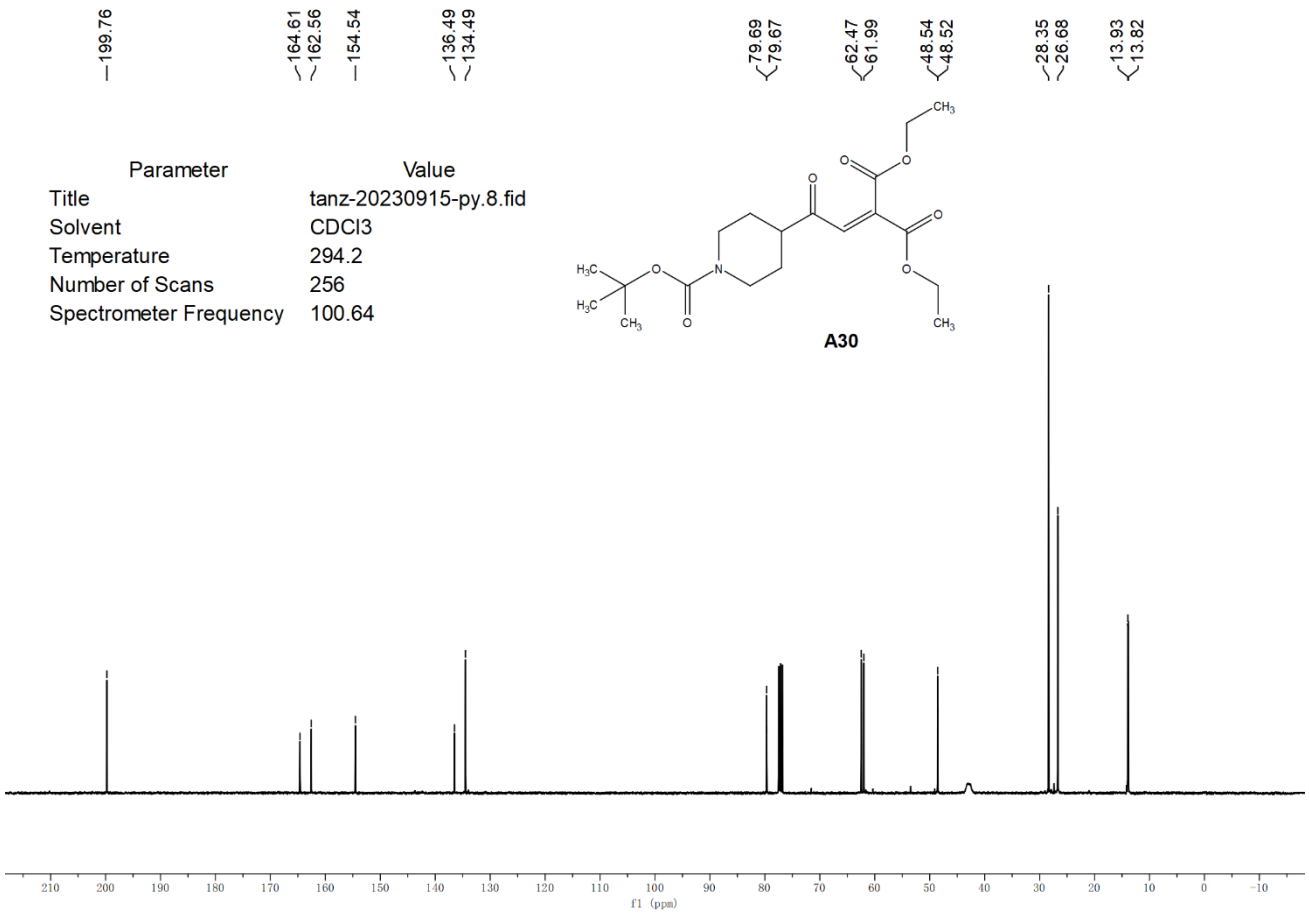
4.08
2.03
1.96
1.00
2.02
2.13
9.01
6.01
f1 (ppm)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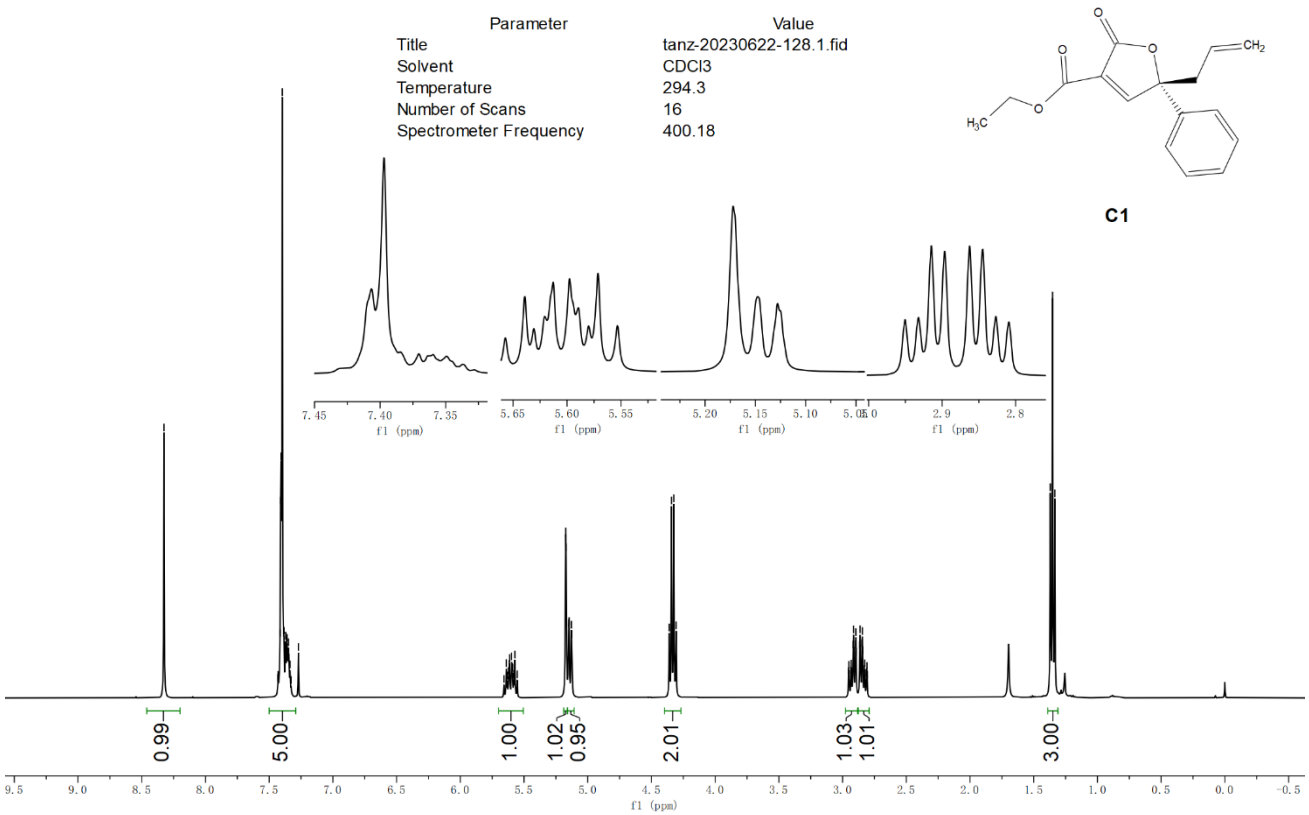
154.54
136.49
134.49
79.69
79.67
62.47
61.99
48.54
48.52
28.35
26.68
13.93
13.82
Parameter Value
Title tanz-20230915-py.8.fid
Solvent CDCl3
Temperature 294.2
Number of Scans 256
Spectrometer Frequency 100.64
A30
f1 (ppm)


Parameter Value
Title tanz-20230622-128.1.fid
Solvent CDCl3
Temperature 294.3
Number of Scans 16
Spectrometer Frequency 400.18
C1
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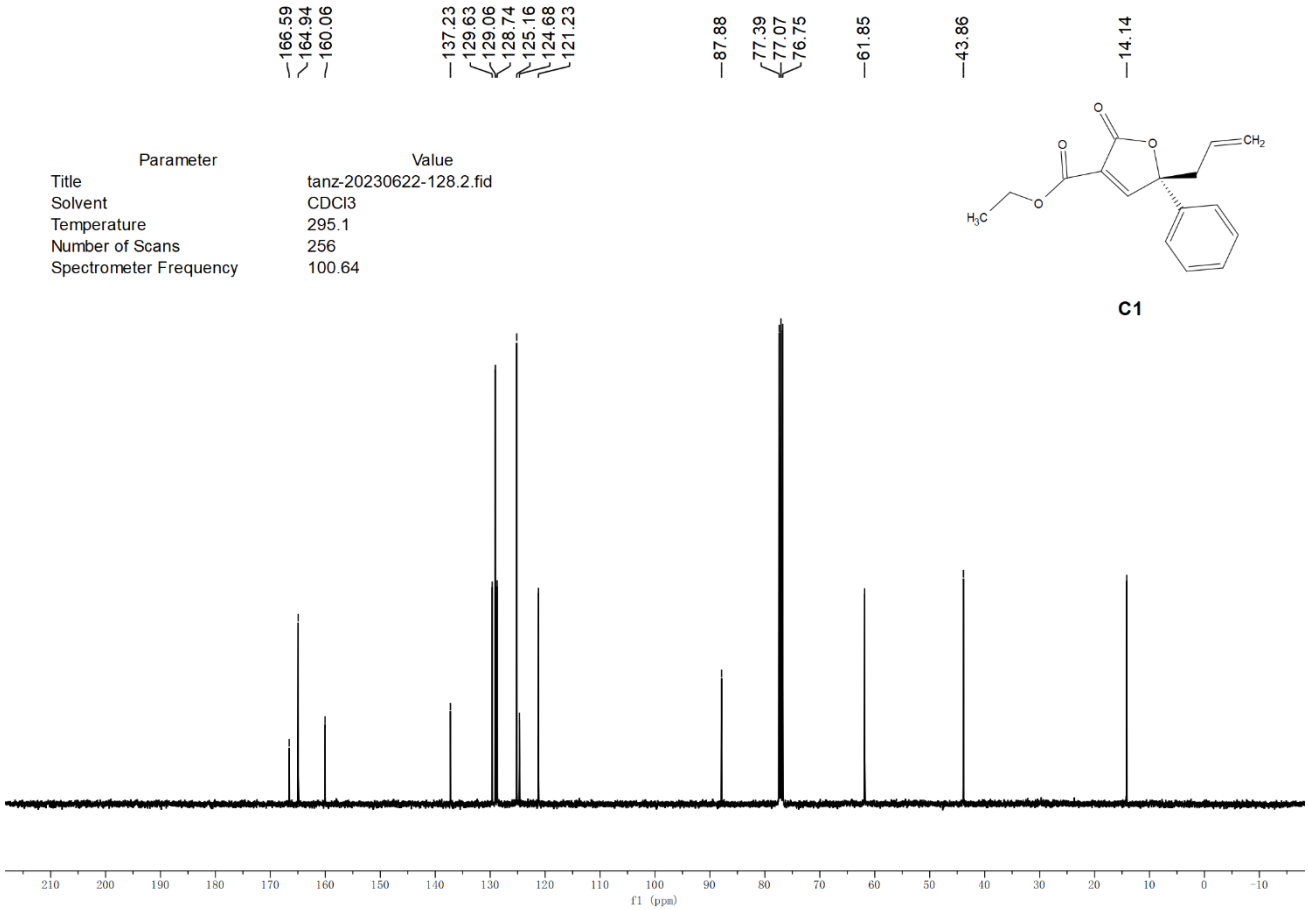
5.00
1.00
1.02
0.95
2.01
1.03
1.01
3.00
f1 (ppm)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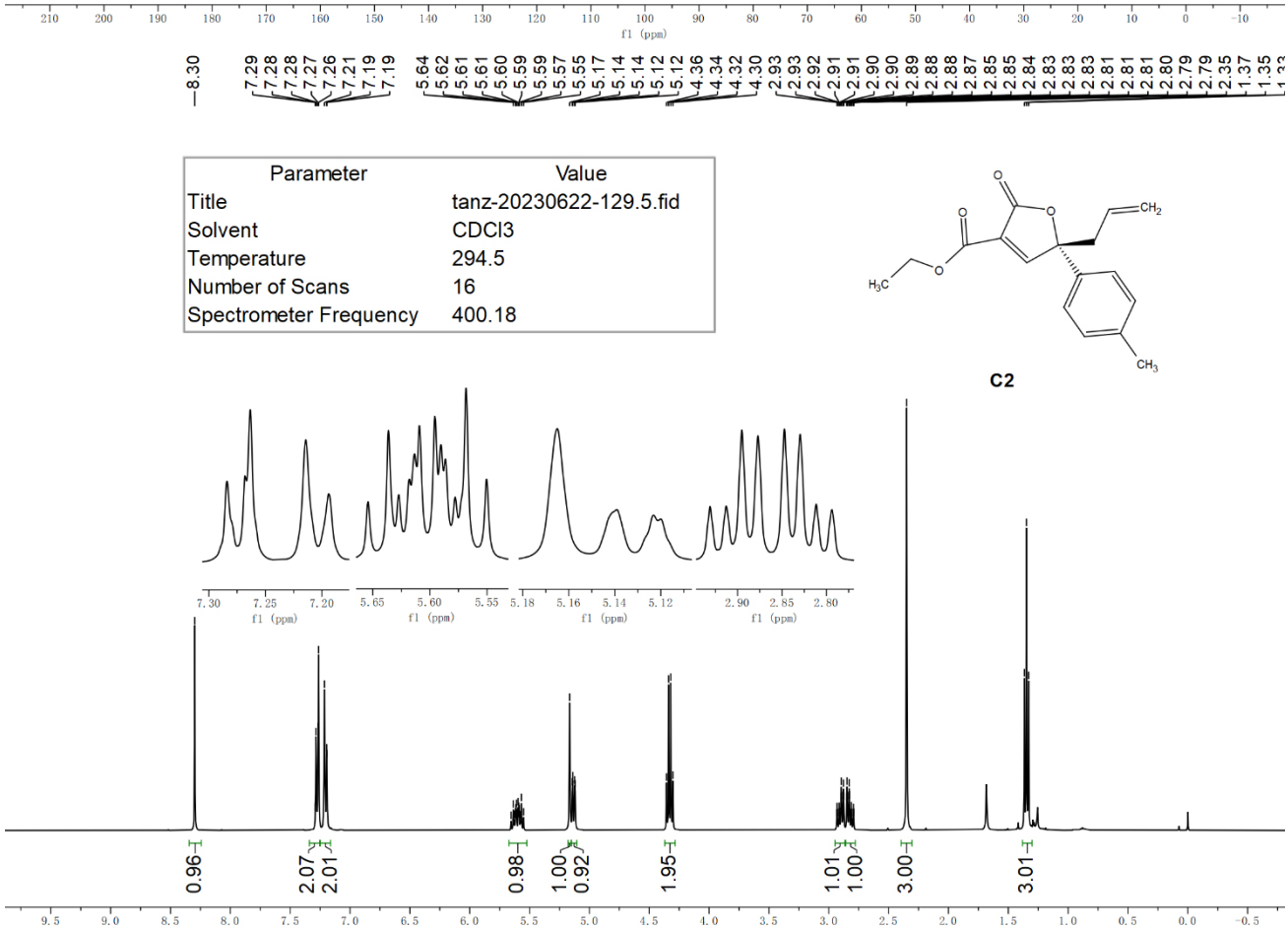
164.94
160.06
137.23
129.63
129.06
128.74
125.16
124.68
121.23
87.88
77.39
77.07
76.75
61.85
43.86
14.14
Parameter Value
Title tanz-20230622-128.2.fid
Solvent CDCl3
Temperature 295.1
Number of Scans 256
Spectrometer Frequency 100.64
C1
f1 (ppm)


8.30
7.29
7.28
7.28
7.27
7.26
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7.19
7.19
5.64
5.62
5.61
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5.60
5.59
5.59
5.57
5.55
5.17
5.14
5.14
5.12
5.12
4.36
4.34
4.32
4.30
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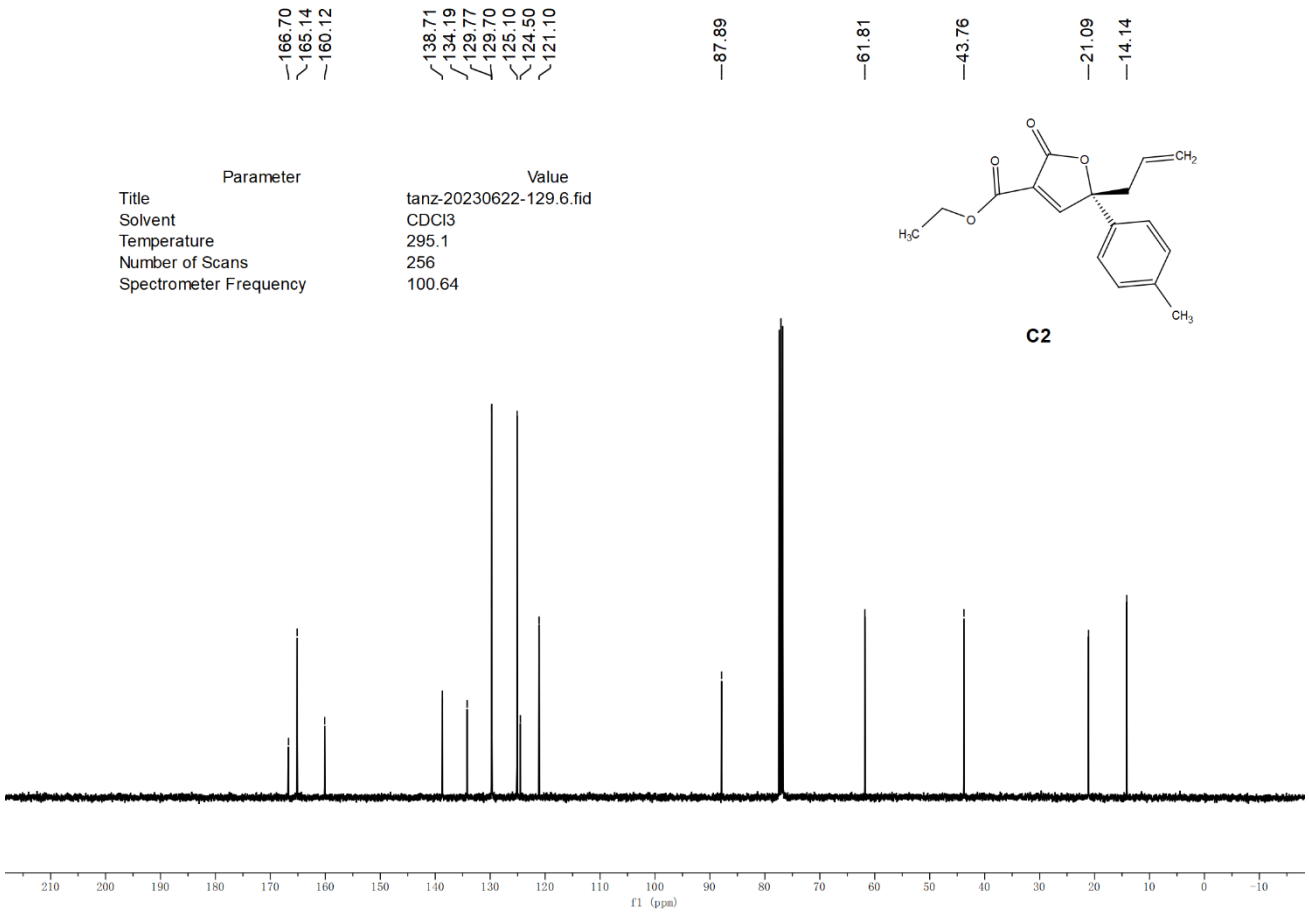
2.92
2.91
2.91
2.90
2.90
2.89
2.88
2.88
2.87
2.85
2.85
2.84
2.83
2.83
2.83
2.81
2.81
2.81
2.80
2.79
2.79
2.35
1.37
1.35
Parameter Value
Title tanz-20230622-129.5.fid
Solvent CDCl3
Temperature 294.5
Number of Scans 16
Spectrometer Frequency 400.18
C2
0.96
2.07
2.01
0.98
1.00
0.92
1.95
1.01
1.00
3.00
3.01
f1 (ppm)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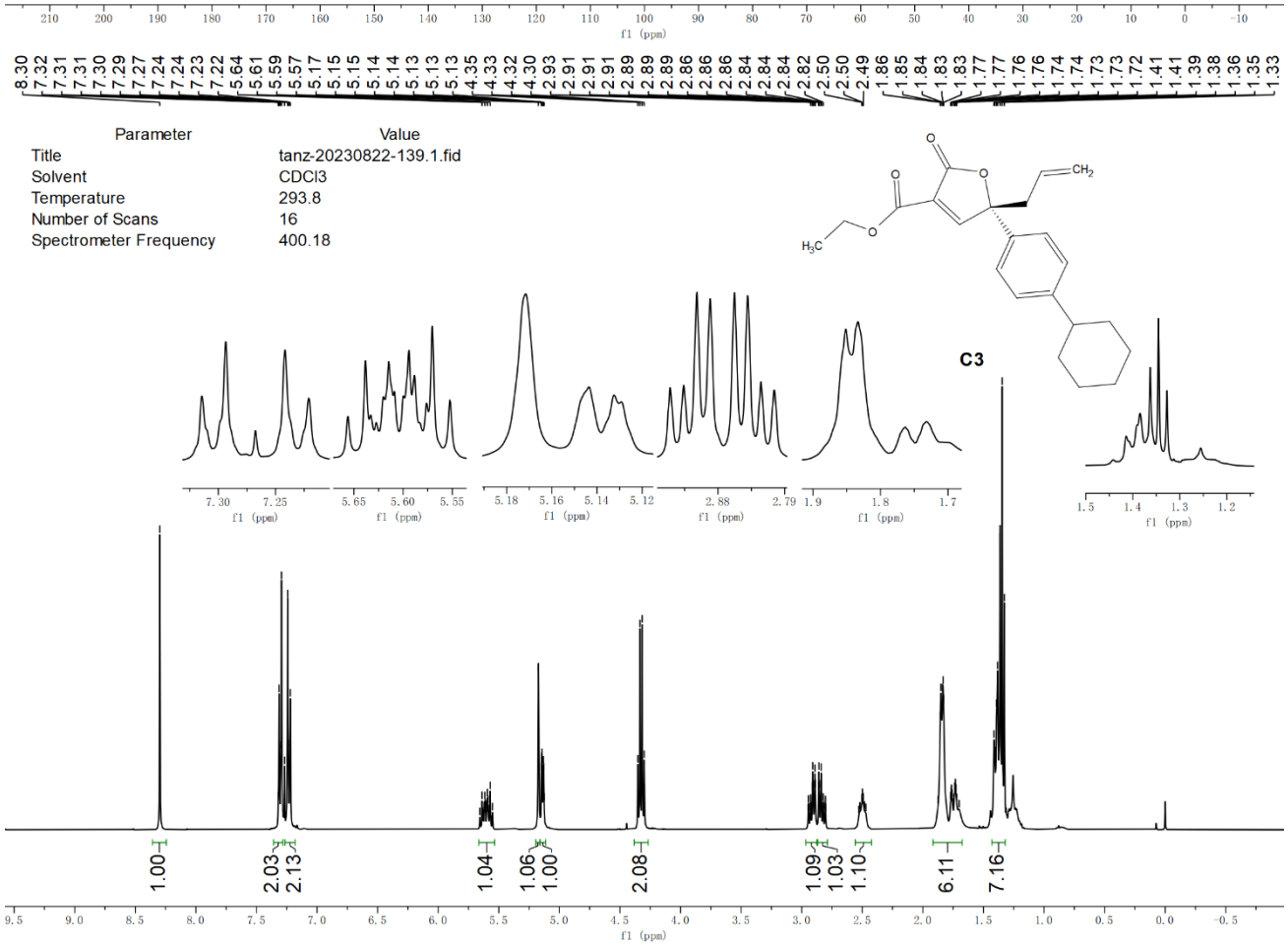
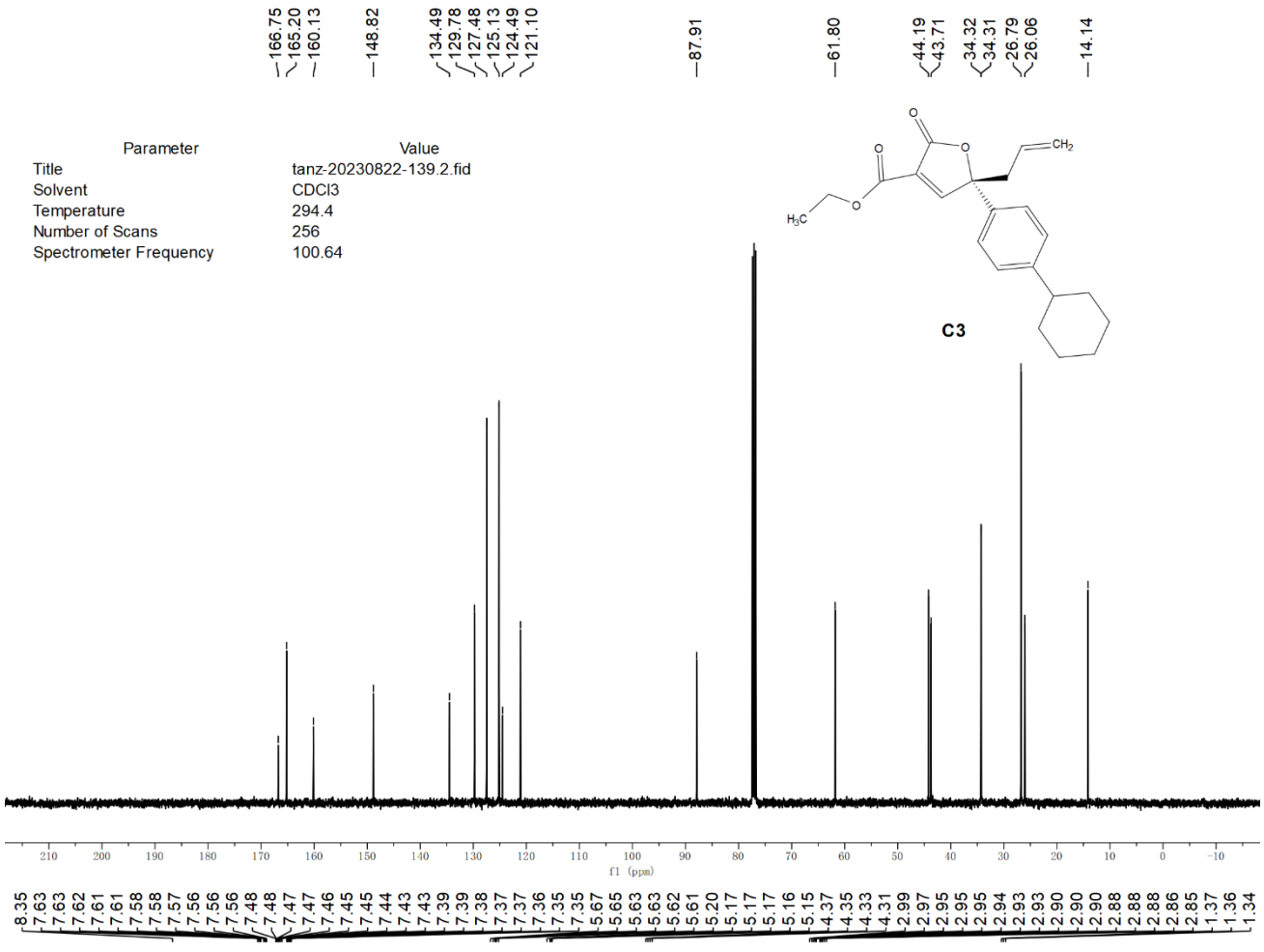
160.12
138.71
134.19
129.77
129.70
125.10
124.50
121.10
87.89
61.81
43.76
21.09
14.14
Parameter Value
Title tanz-20230622-129.6.fid
Solvent CDCl3
Temperature 295.1
Number of Scans 256
Spectrometer Frequency 100.64
C2
f1 (ppm)


Parameter Value
Title tanz-20230822-139.1.fid
Solvent CDCl3
Temperature 293.8
Number of Scans 16
Spectrometer Frequency 400.18
C3
1.00
2.03
2.13
1.04
1.06
1.00
2.08
1.09
1.03
1.10
6.11
7.16
f1 (ppm)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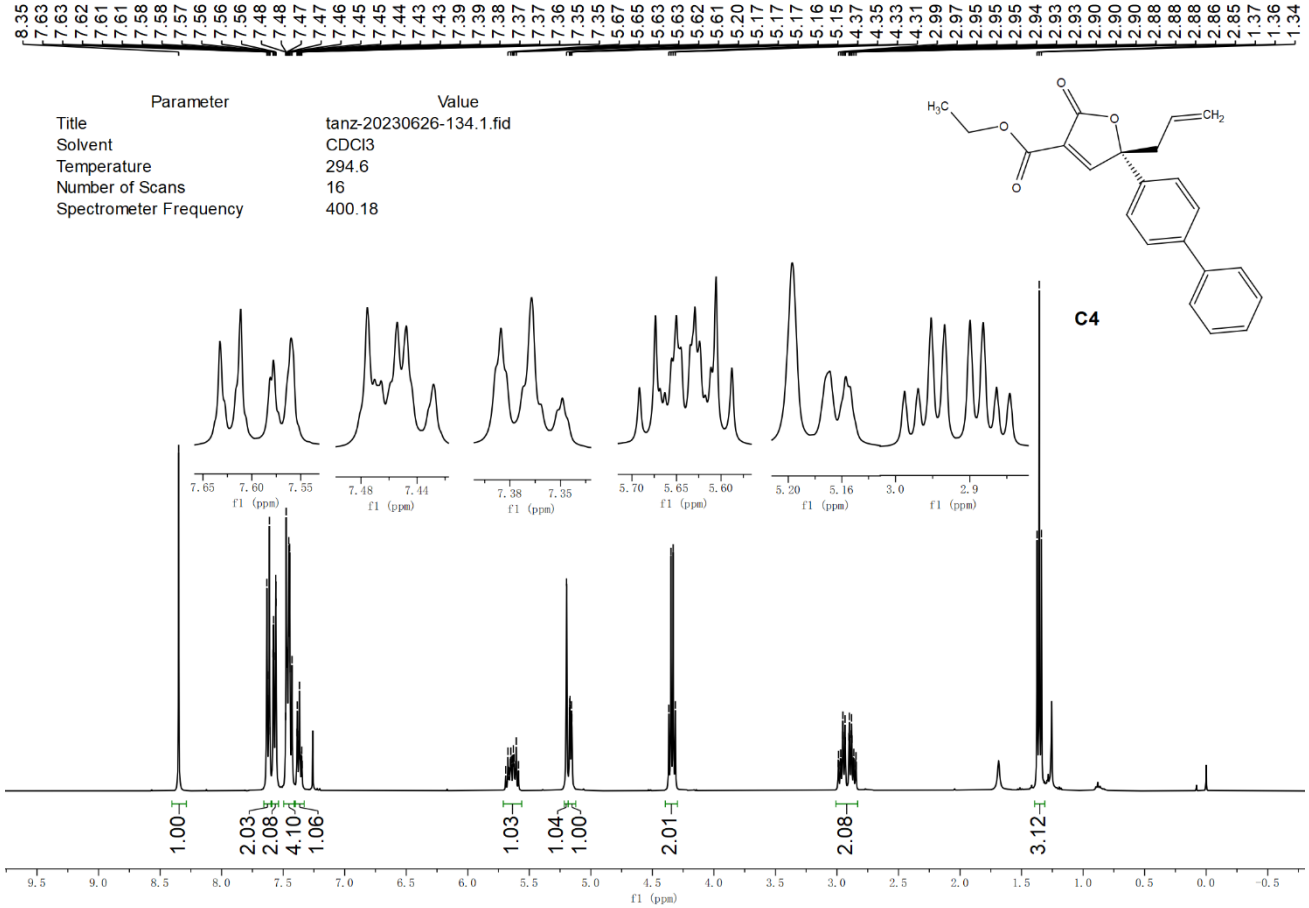
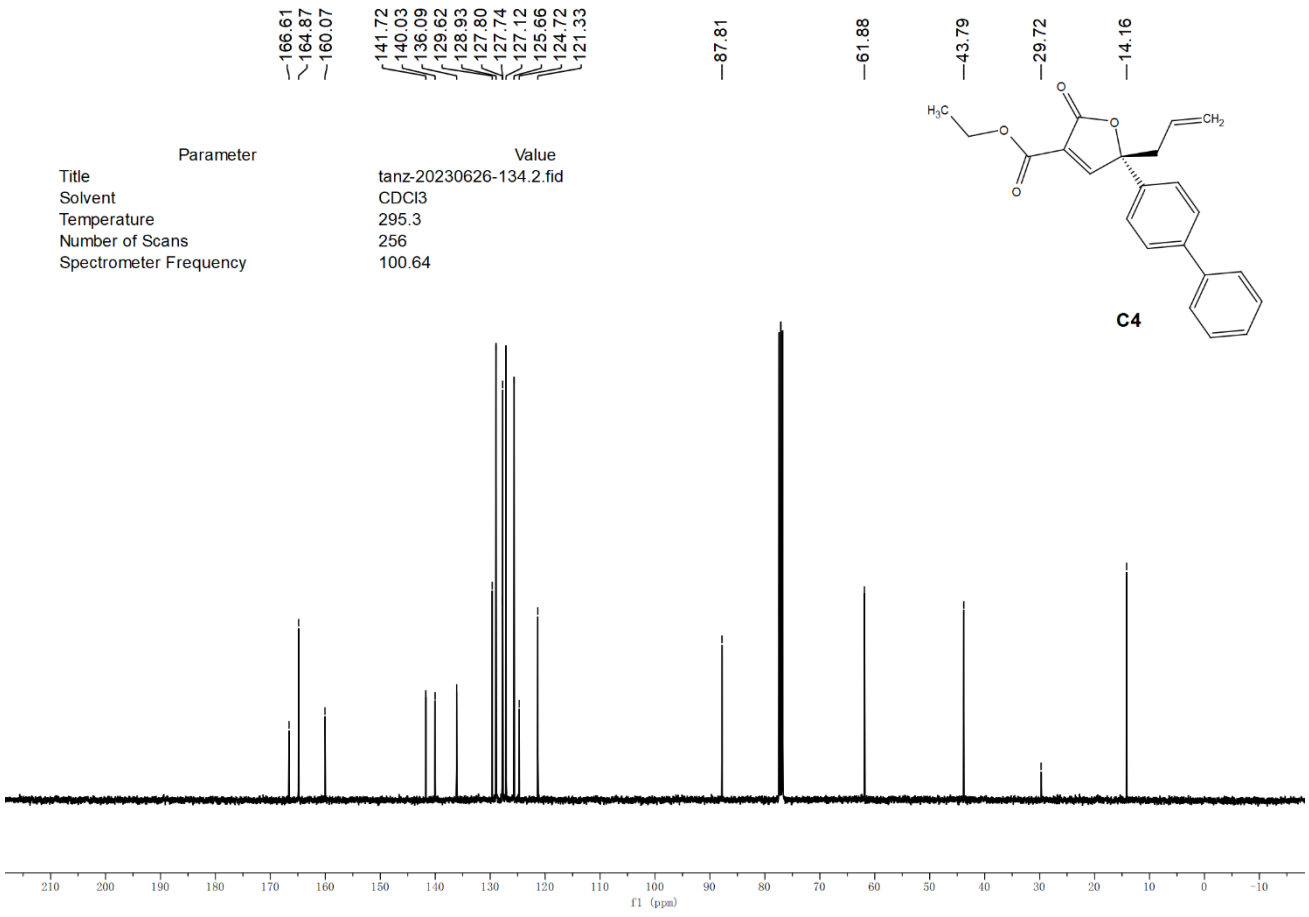
160.13
148.82
134.49
129.78
127.48
125.13
124.49
121.10
87.91
61.80
44.19
43.71
34.32
34.31
26.79
26.06
14.14
Parameter
Value
Title
tanz-20230822-139.2.fid
Solvent
CDCl3
Temperature
294.4
Number of Scans
256
Spectrometer Frequency
100.64
C3
f1 (ppm)


Parameter
Value
Title
tanz-20230626-134.1.fid
Solvent
CDCl3
Temperature
294.6
Number of Scans
16
Spectrometer Frequency
400.18
C4
1.00
2.03
2.08
4.10
1.06
1.03
1.04
1.00
2.01
2.08
3.12
f1 (ppm)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164.87
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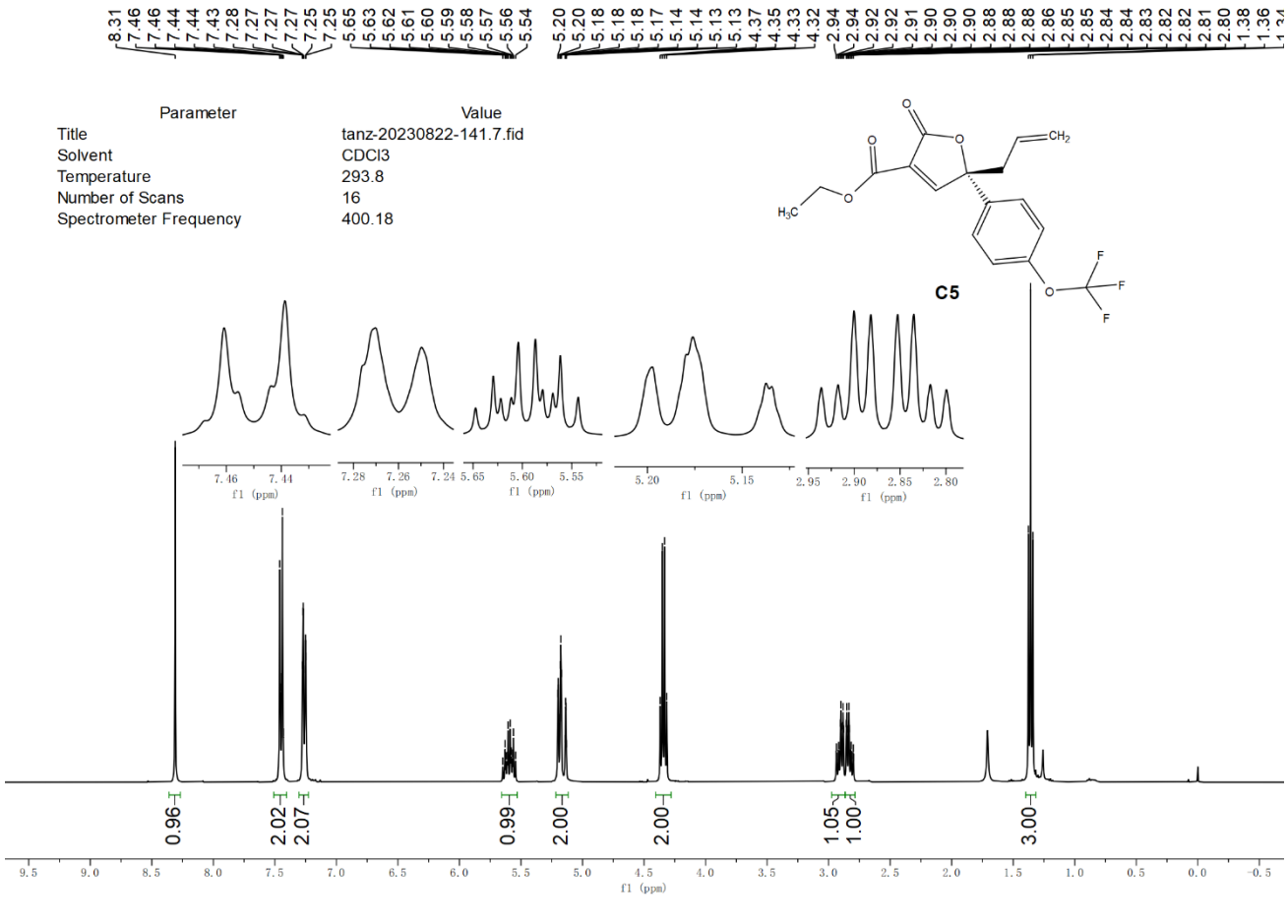
141.72
140.03
136.09
129.62
128.93
127.80
127.74
127.12
125.66
124.72
121.33
87.81
61.88
43.79
29.72
14.16
Parameter
Value
Title
tanz-20230626-134.2.fid
Solvent
CDCl3
Temperature
295.3
Number of Scans
256
Spectrometer Frequency
100.64
C4
f1 (ppm)


8.31
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7.44
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7.28
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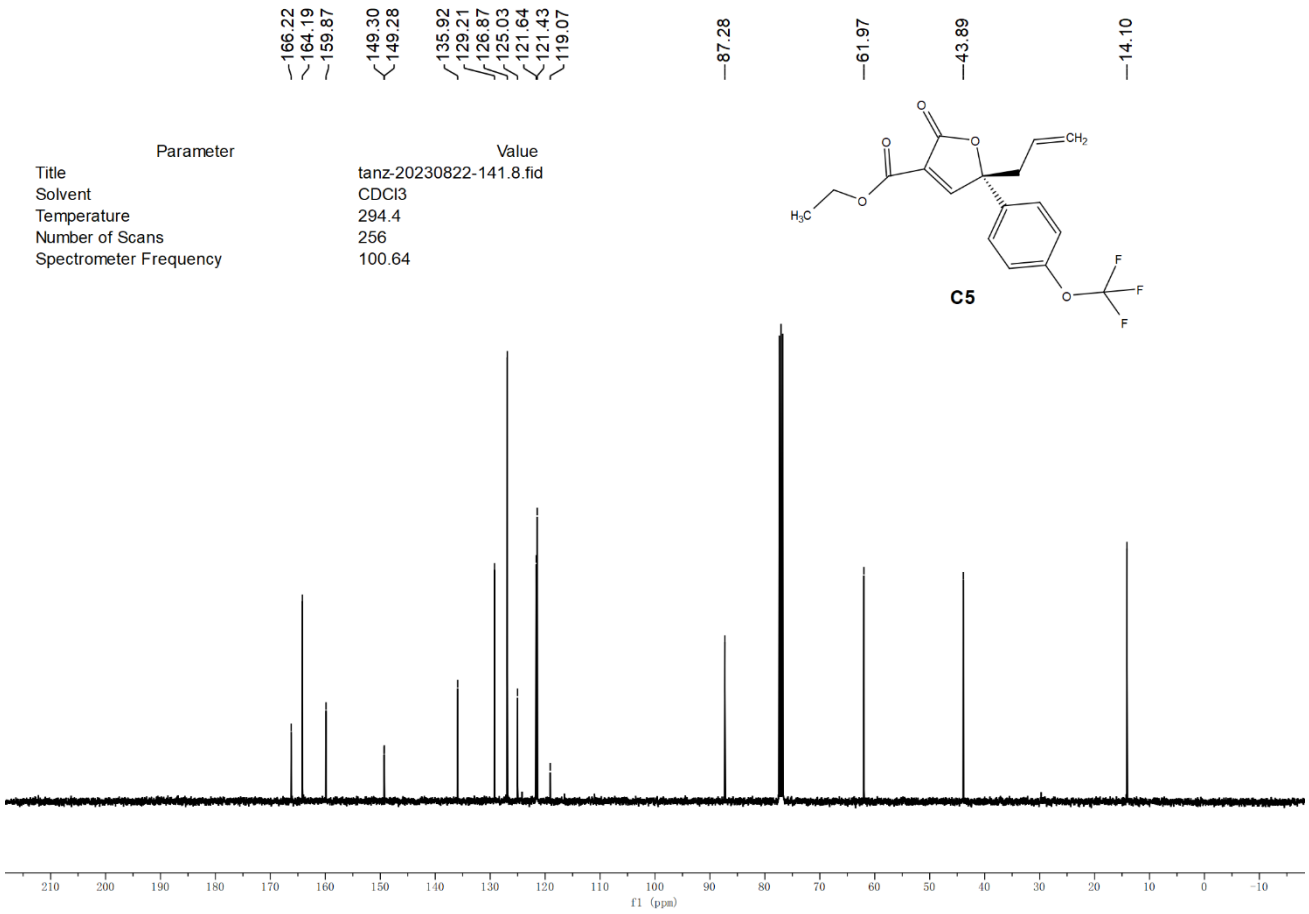
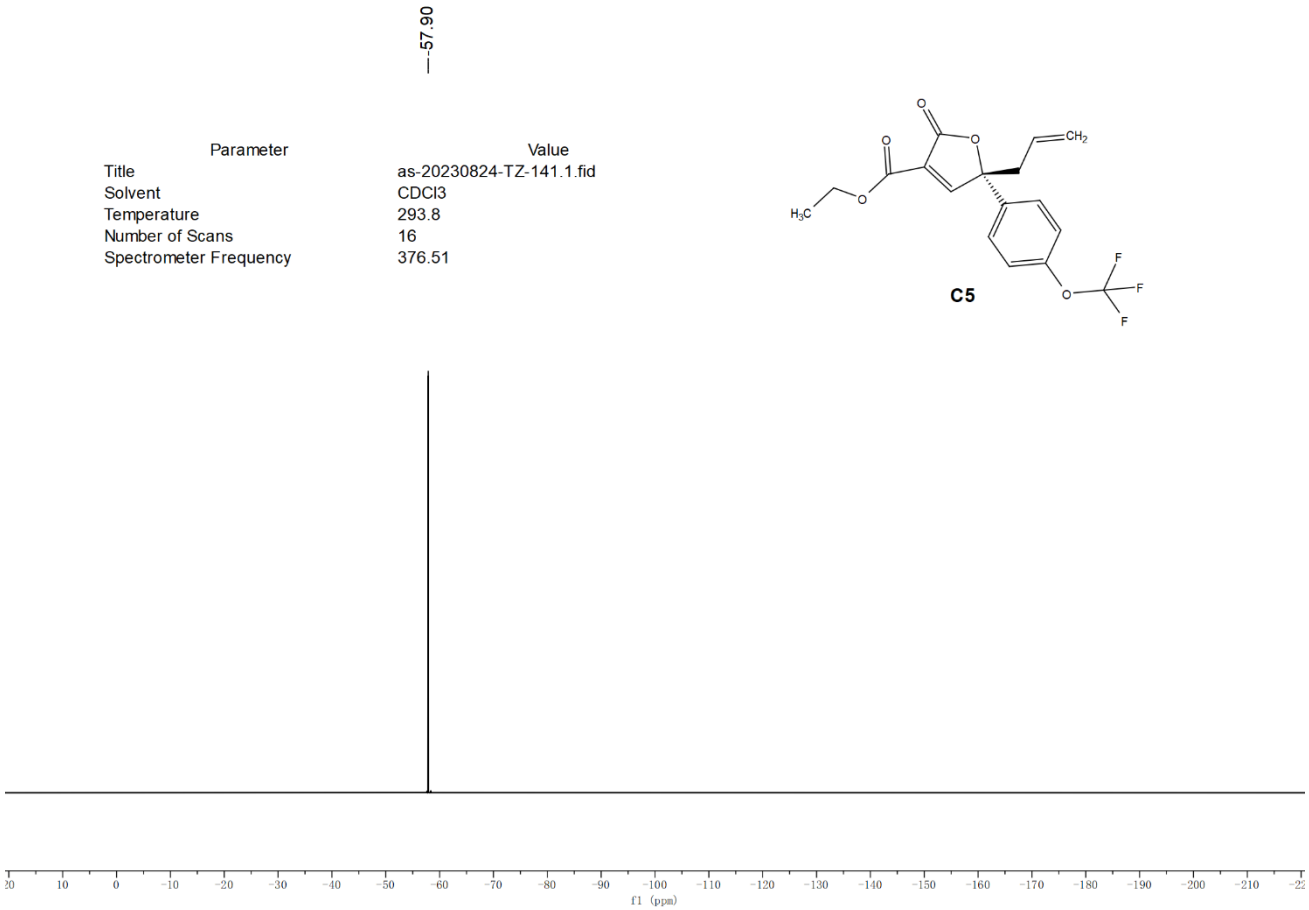
7.27
7.25
5.65
5.63
5.62
5.61
5.60
5.59
5.58
5.57
5.56
5.54
5.20
5.20
5.18
5.18
5.17
5.14
5.13
5.13
4.37
4.35
4.33
4.32
2.94
2.94
2.92
2.92
2.91
2.90
2.90
2.90
2.88
2.88
2.88
2.86
2.85
2.85
2.84
2.84
2.83
2.82
2.82
2.81
2.80
1.38
1.36
Parameter
Value
Title
tanz-20230822-141.7.fid
Solvent
CDCl3
Temperature
293.8
Number of Scans
16
Spectrometer Frequency
400.18
C5
0.96
2.02
2.07
0.99
2.00
2.00
1.05
1.00
3.00
f1 (ppm)



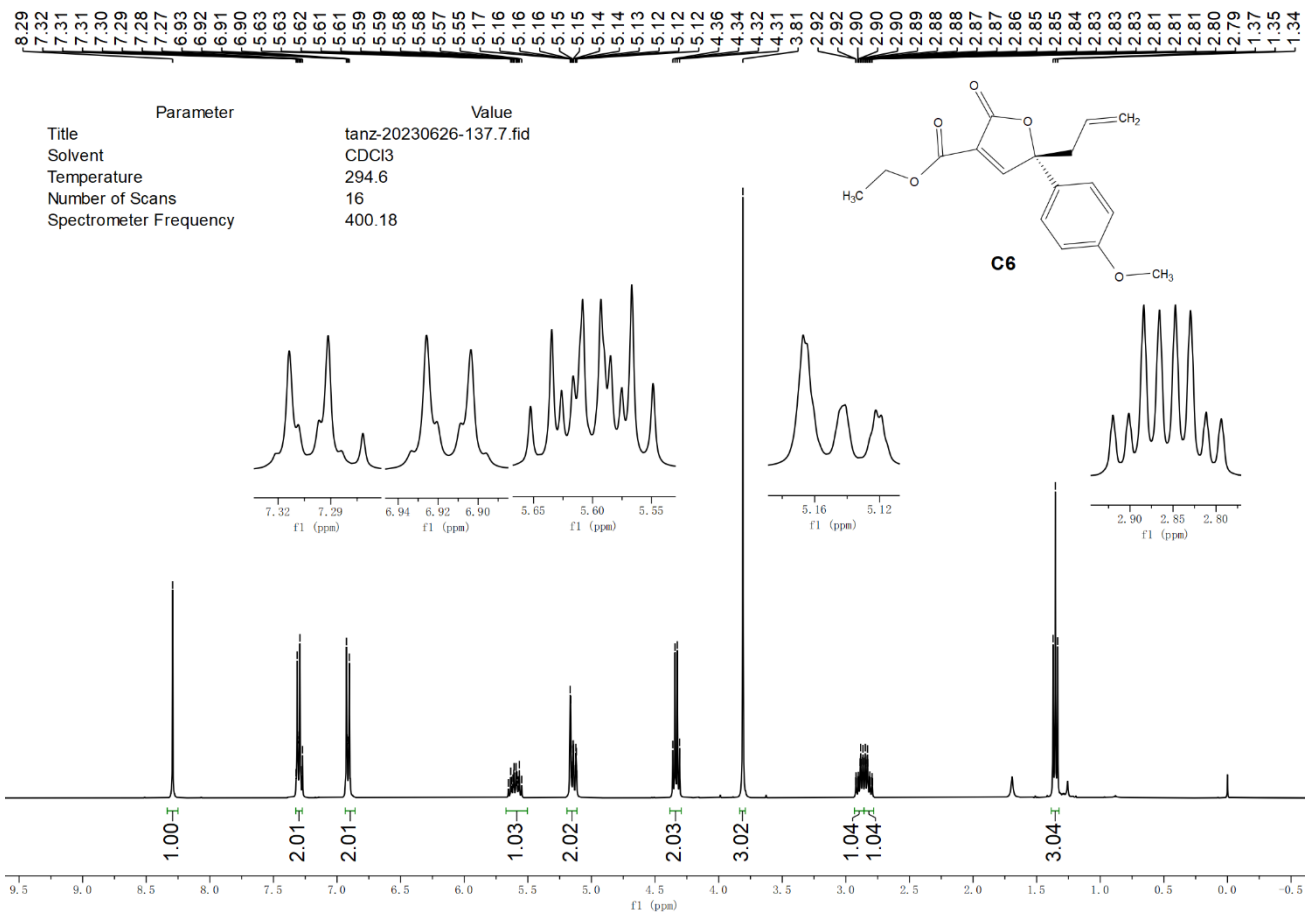
Parameter	Value
Title	tanz-20230822-141.8.fid
Solvent	CDCl3
Temperature	294.4
Number of Scans	256
Spectrometer Frequency	100.64

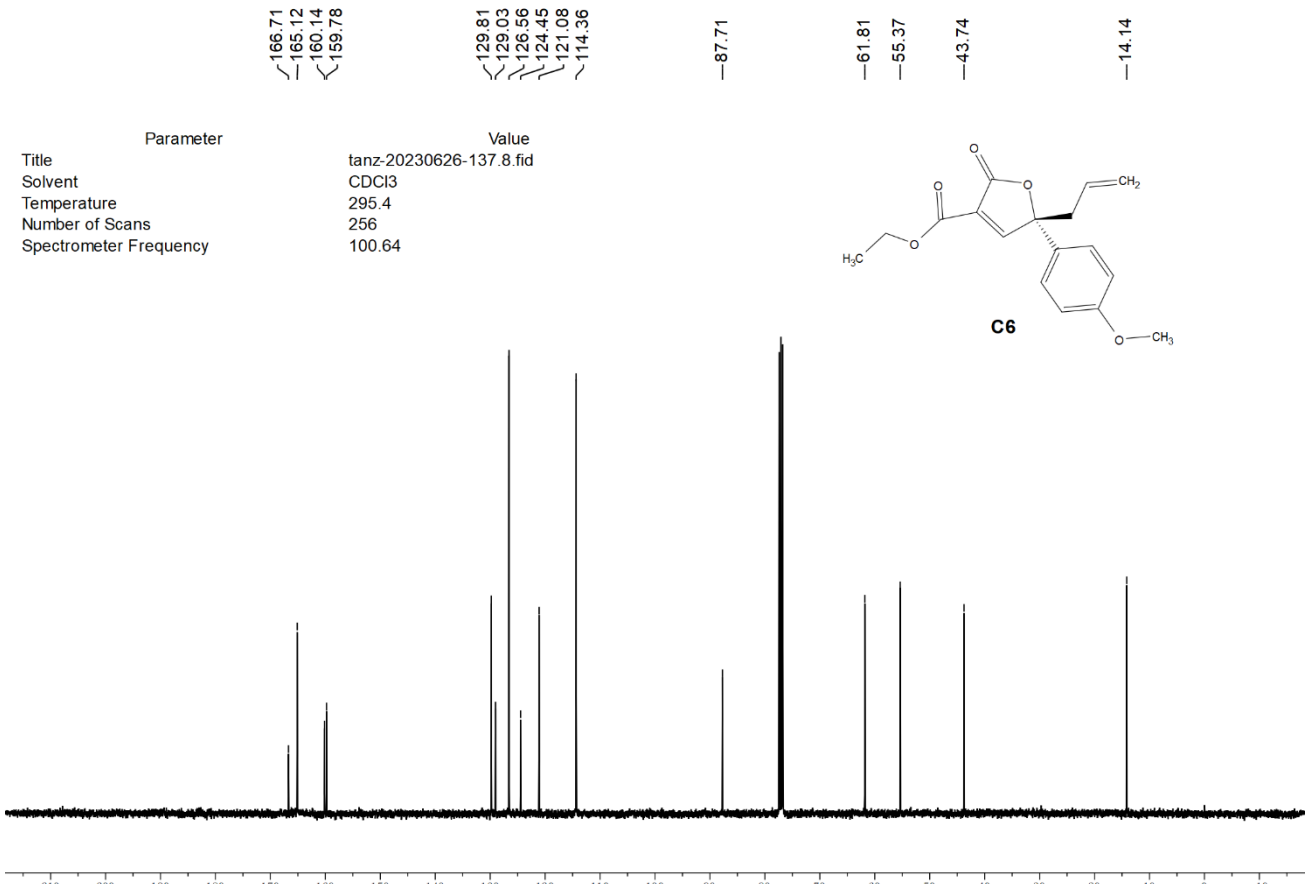
C5

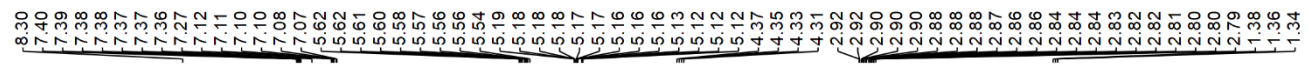


Parameter	Value
Title	as-20230824-TZ-141.1.fid
Solvent	CDCl3
Temperature	293.8
Number of Scans	16
Spectrometer Frequency	376.51

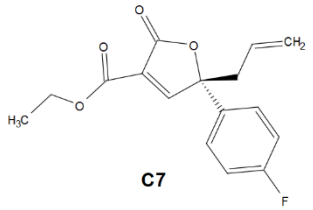
C5


8.29 7.32 7.31 7.31 7.30 7.29 7.28 7.27 6.93 6.92 6.91 6.90 5.63 5.62 5.61 5.61 5.59 5.59 5.58 5.58 5.57 5.55 5.17 5.16 5.16 5.15 5.15 5.14 5.14 5.13 5.12 5.12 5.12 4.36 4.34 4.32 4.31 3.81 2.92 2.92 2.90 2.90 2.90 2.89 2.88 2.88 2.87 2.87 2.86 2.85 2.85 2.84 2.83 2.83 2.83 2.81 2.81 2.81 2.80 2.79 1.37 1.35 1.34
Parameter Value
Title tanz-20230626-137.7.fid
Solvent CDCl3
Temperature 294.6
Number of Scans 16
Spectrometer Frequency 400.18
C6
1.00 2.01 2.01 1.03 2.02 2.03 3.02 1.04 1.04 3.04
f1 (ppm)

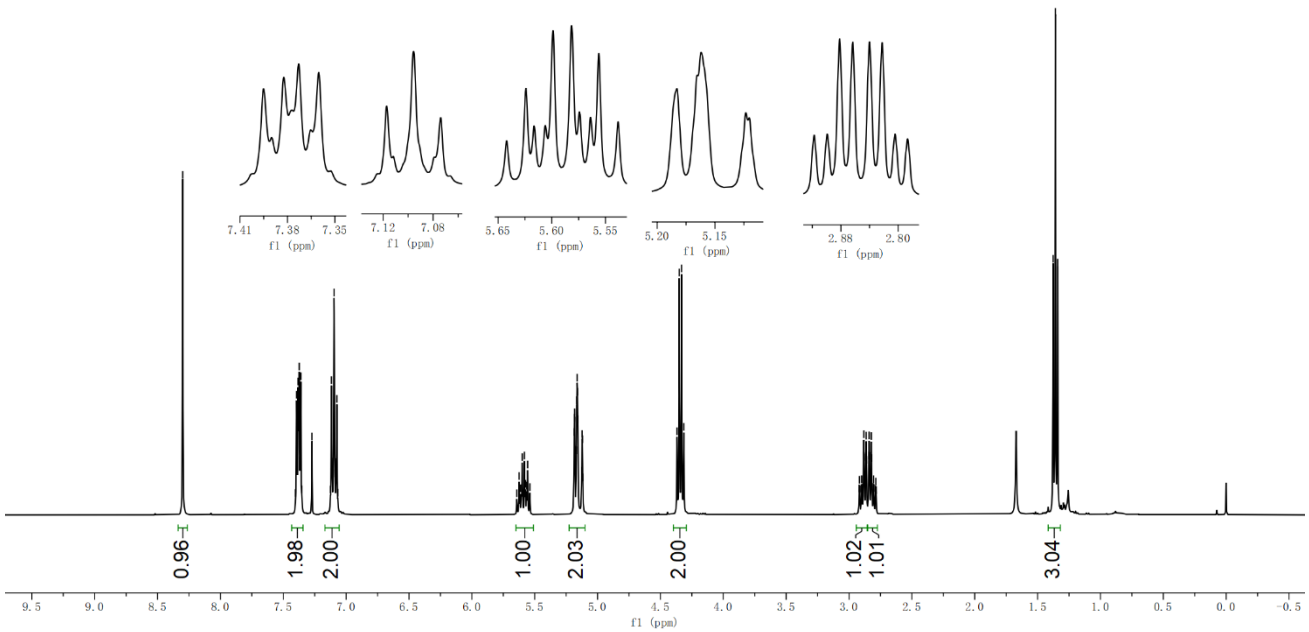

166.71 165.12 160.14 159.78 129.81 129.03 126.56 124.45 121.08 114.36 87.71 61.81 55.37 43.74 14.14
Parameter Value
Title tanz-20230626-137.8.fid
Solvent CDCl3
Temperature 295.4
Number of Scans 256
Spectrometer Frequency 100.64
C6
f1 (ppm)



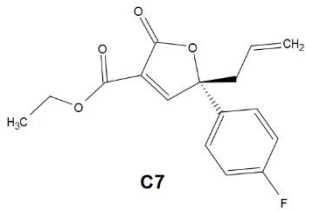
Parameter	Value
Title	as-20230622-TZ-130.1.fid
Solvent	CDCl3
Temperature	294.7
Number of Scans	16
Spectrometer Frequency	400.18



C7

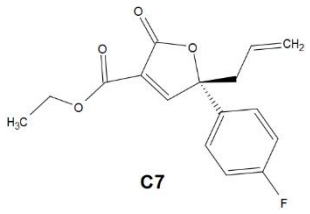


Parameter	Value
Title	as-20230622-TZ-130.2.fid
Solvent	CDCl3
Temperature	295.2
Number of Scans	256
Spectrometer Frequency	100.64

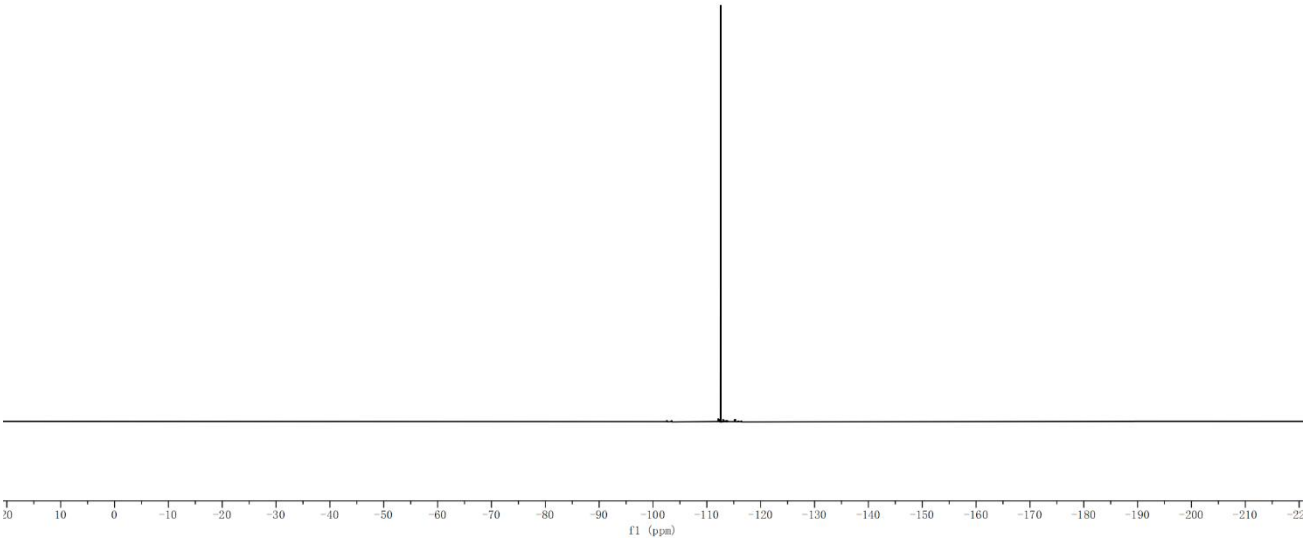


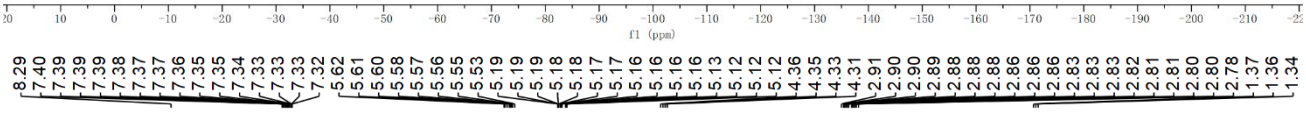
C7

Parameter	Value
Title	as-20230622-TZ-130.3.fid
Solvent	CDCl3
Temperature	295.0
Number of Scans	16
Spectrometer Frequency	376.51

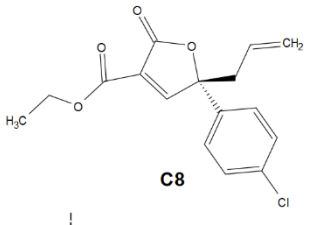


C7

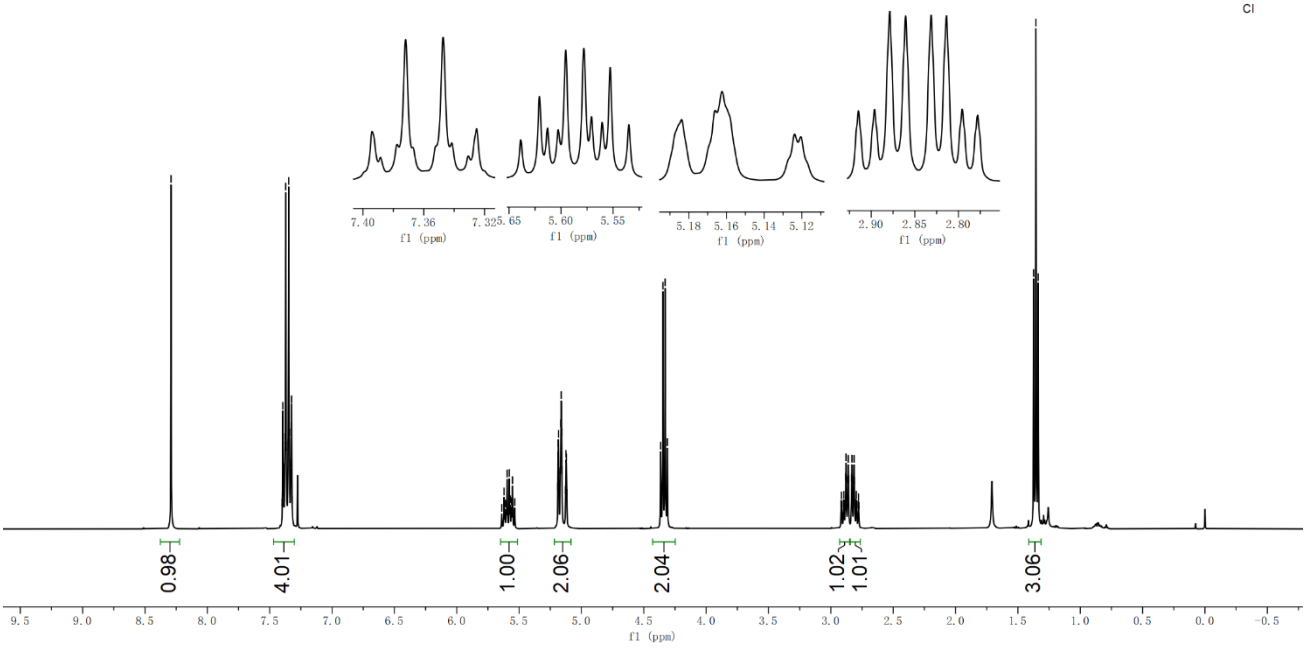


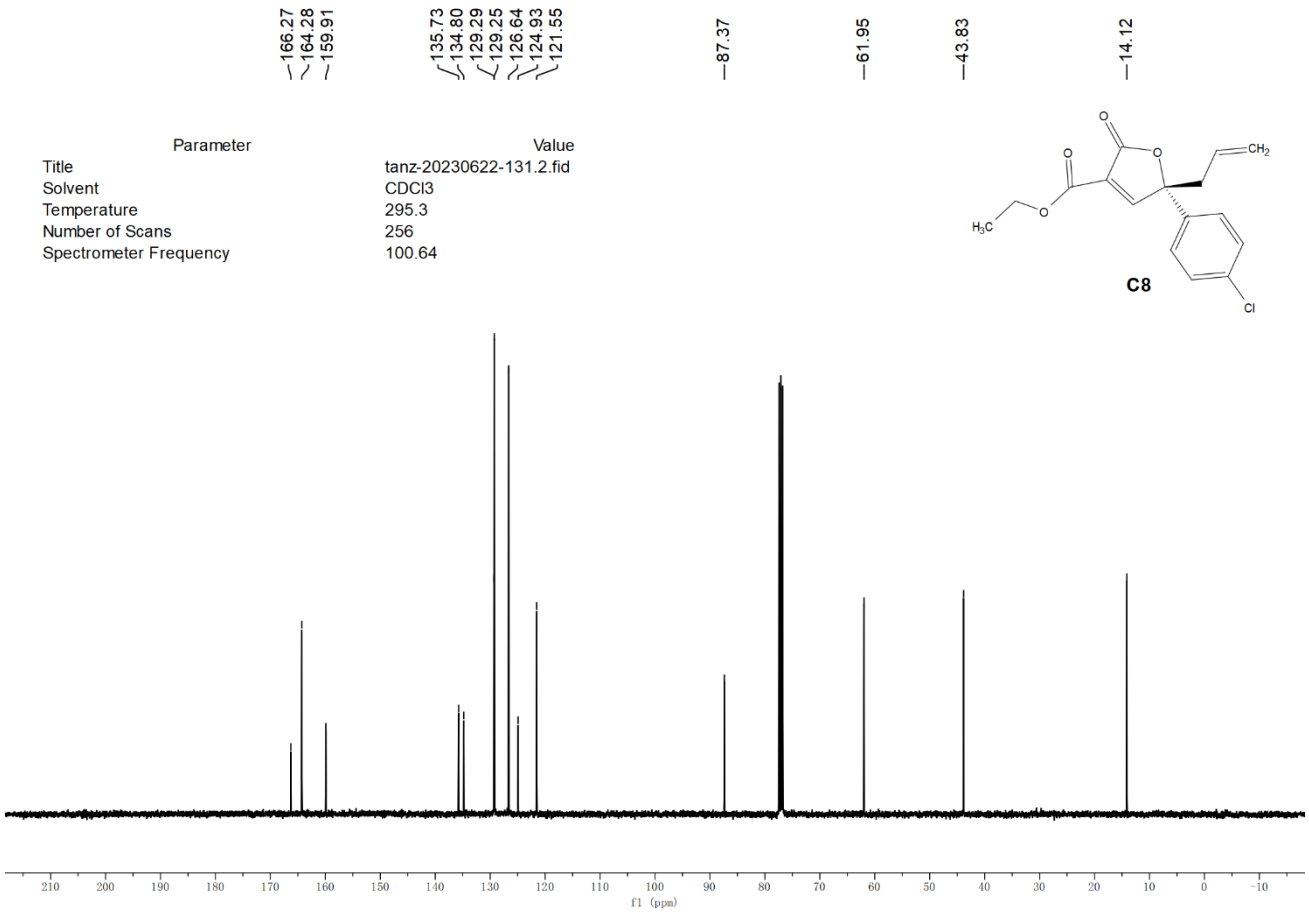


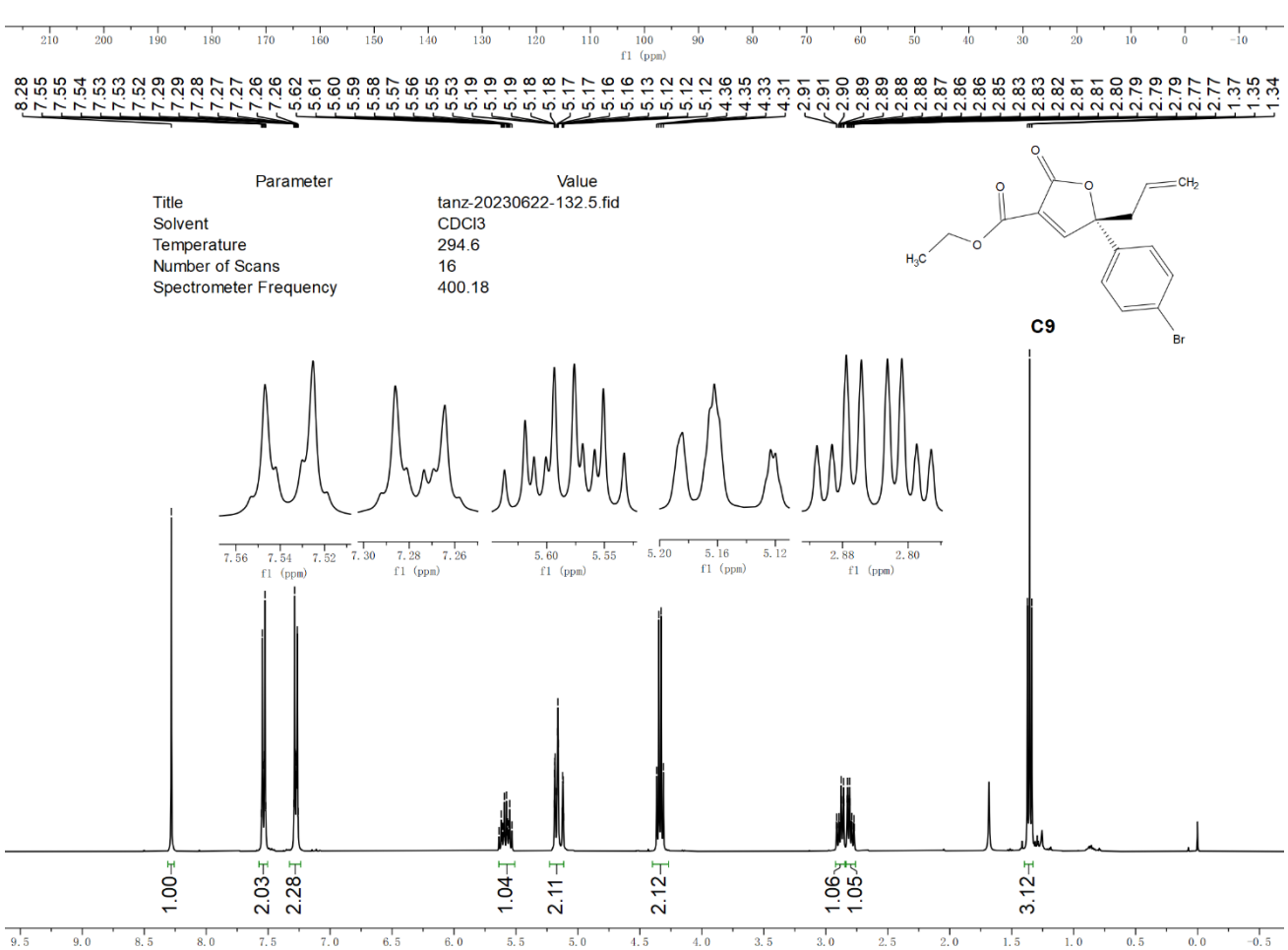
Parameter	Value
Title	tanz-20230622-131.1.fid
Solvent	CDCl3
Temperature	294.6
Number of Scans	16
Spectrometer Frequency	400.18

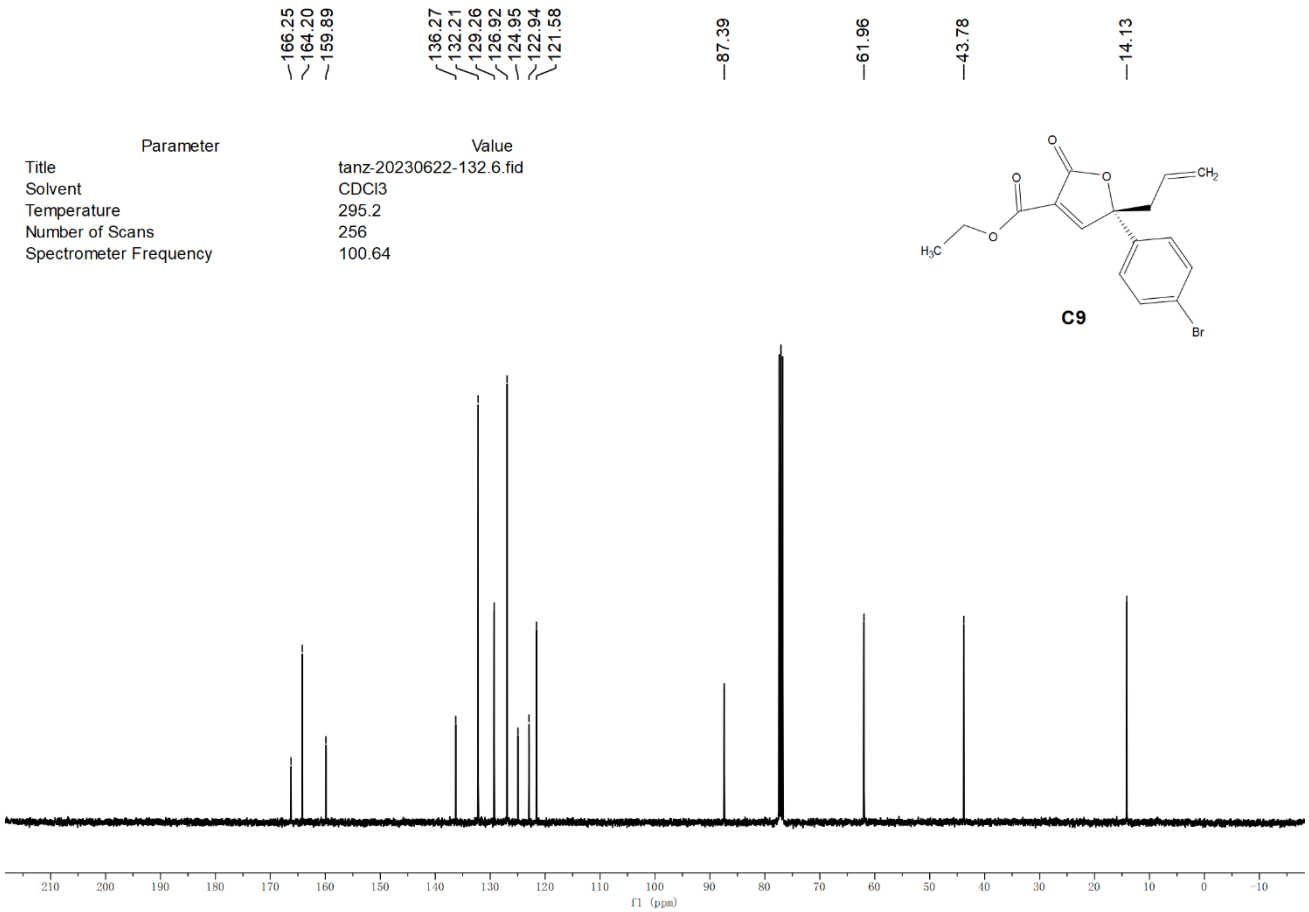


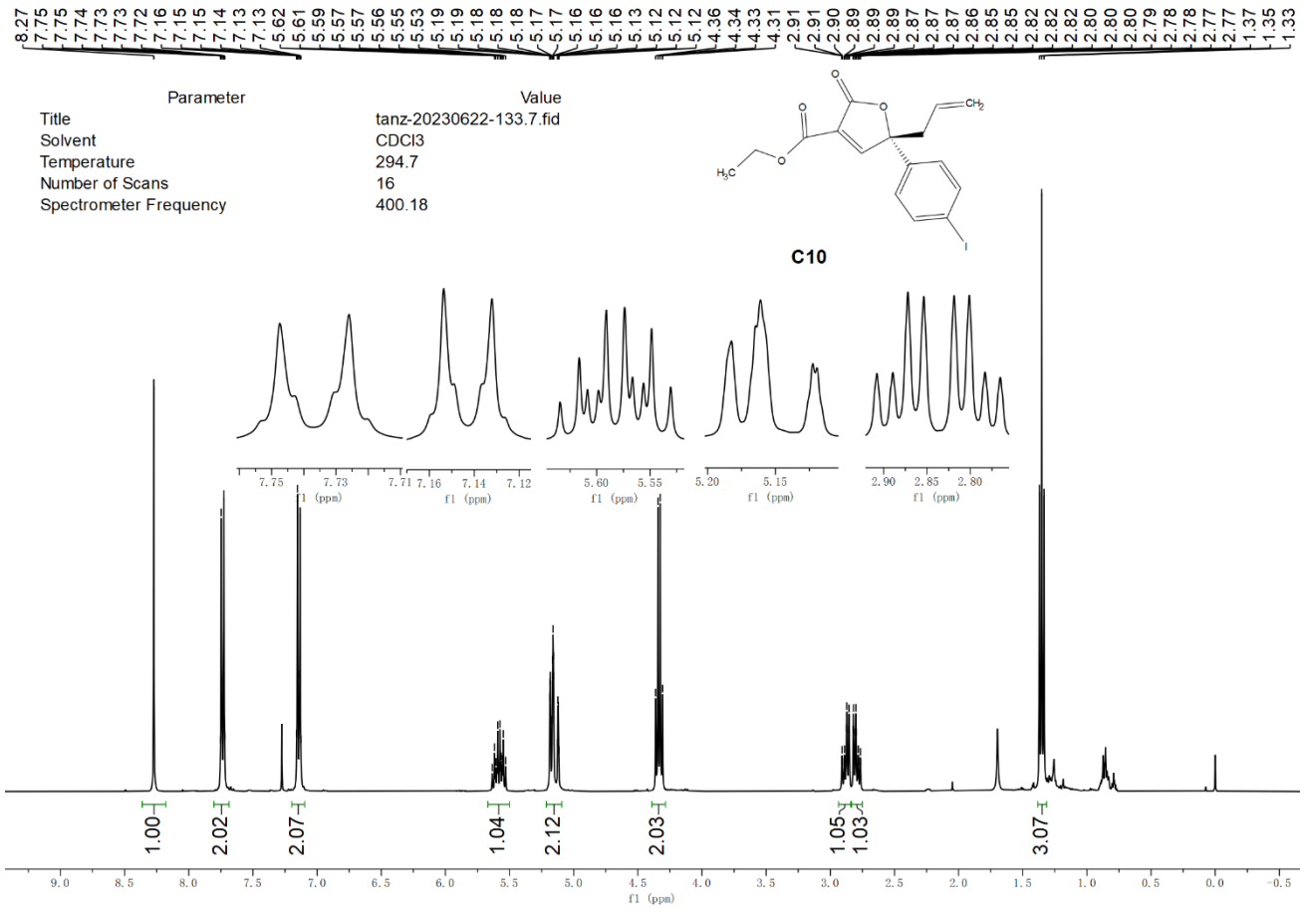
C8

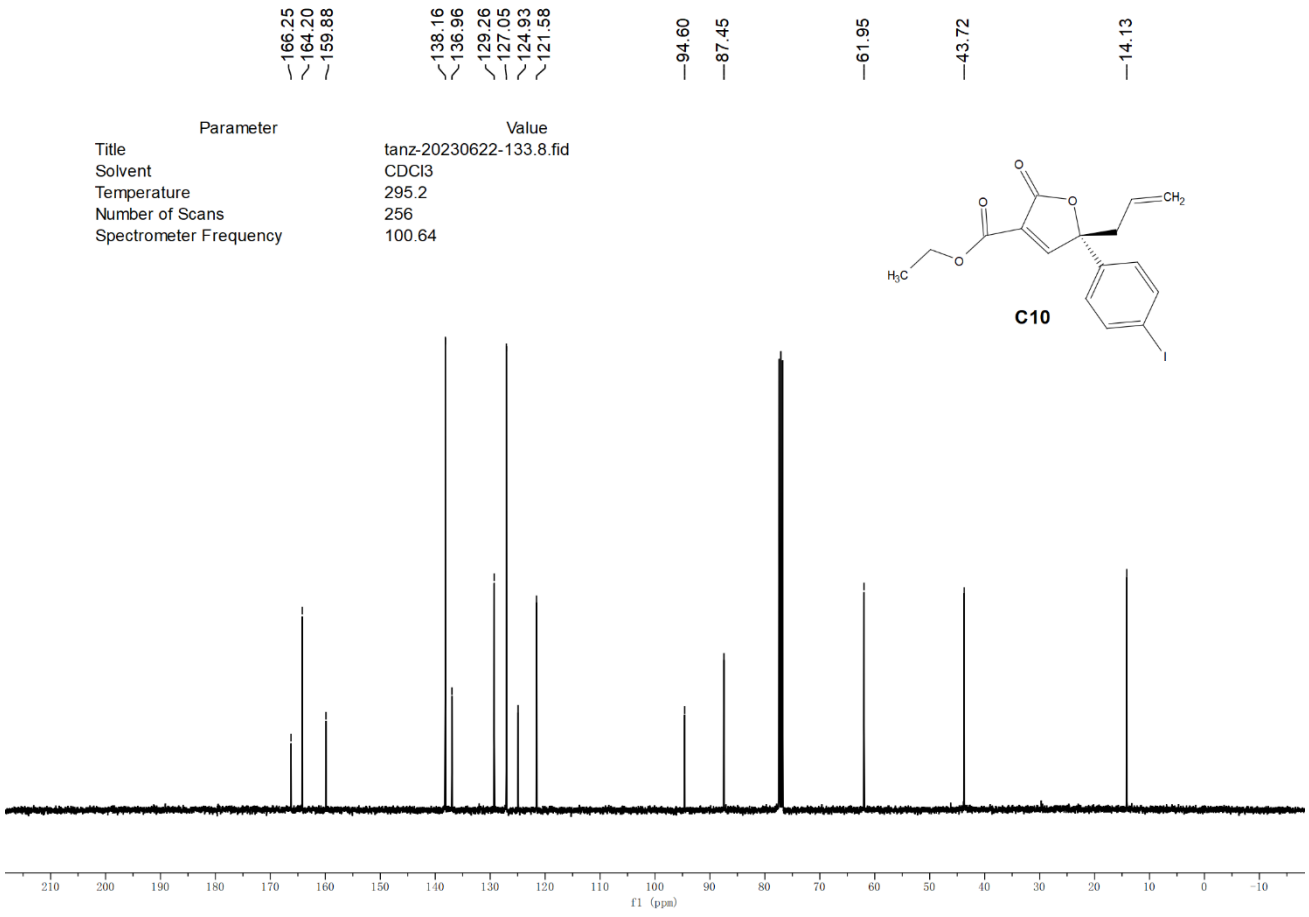


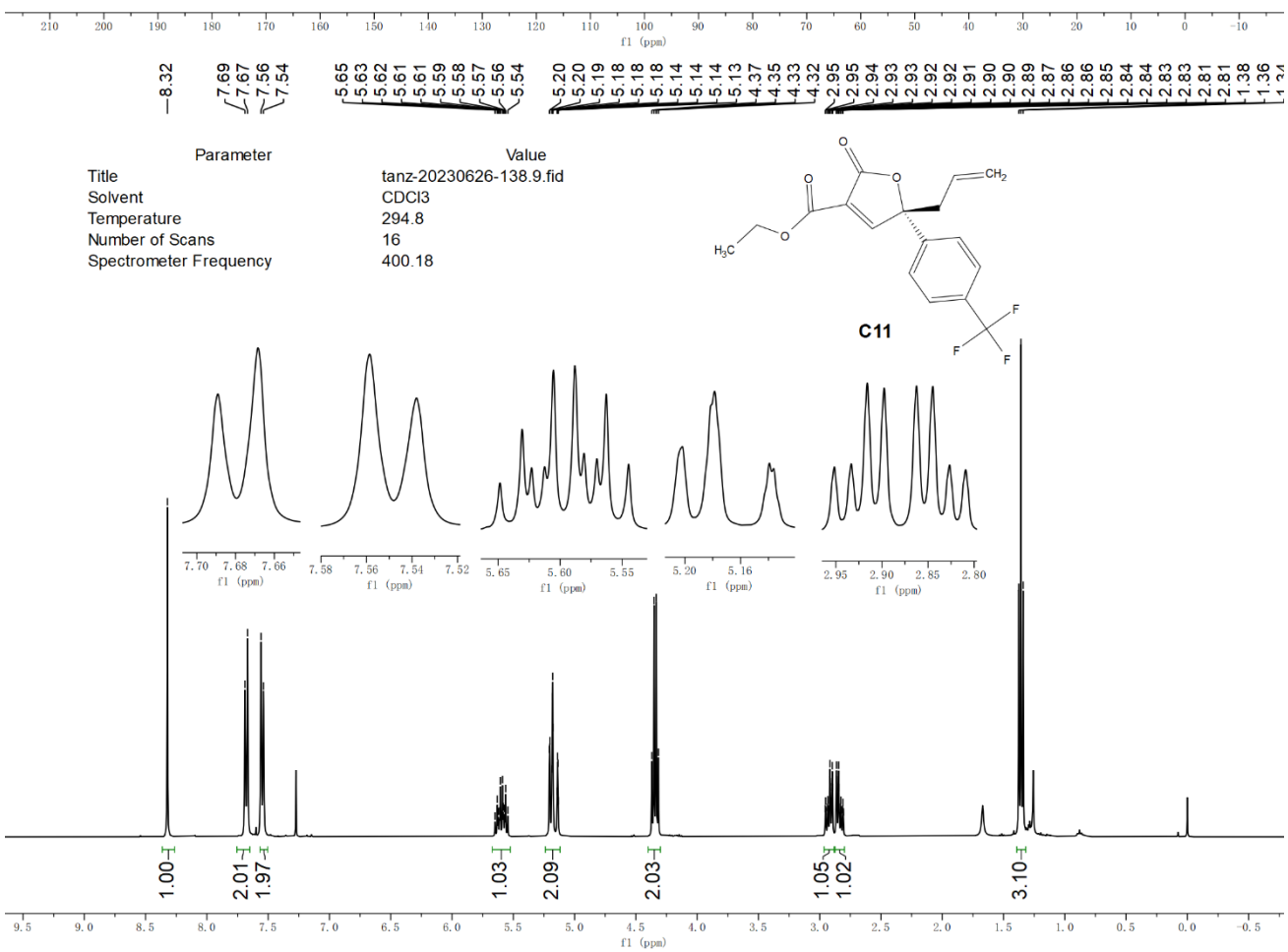

166.27
164.28
159.91
135.73
134.80
129.29
129.25
126.64
124.93
121.55
87.37
61.95
43.83
14.12
Parameter
Value
Title
tanz-20230622-131.2.fid
Solvent
CDCl3
Temperature
295.3
Number of Scans
256
Spectrometer Frequency
100.64
C8
f1 (ppm)

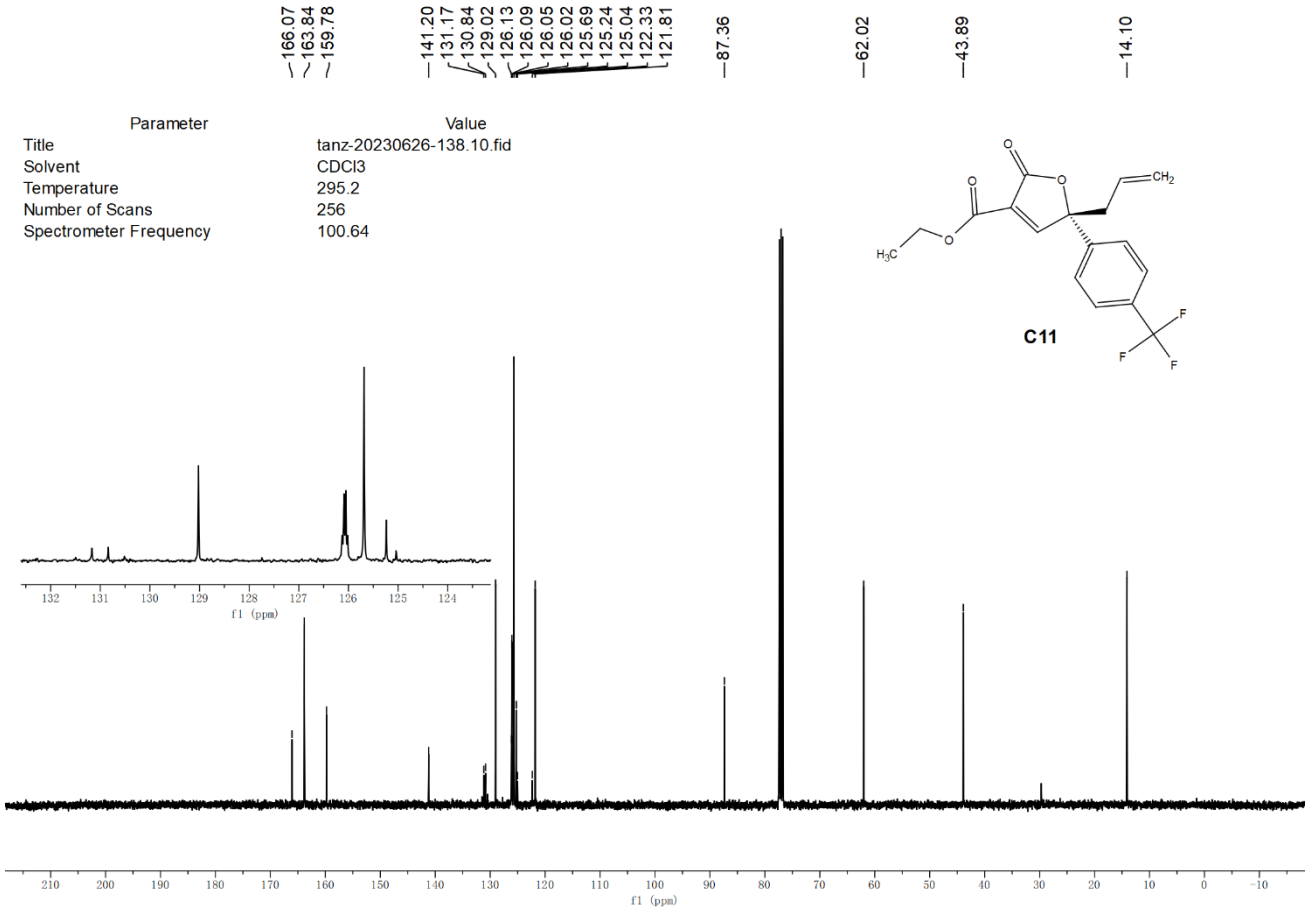

Parameter
Value
Title
tanz-20230622-132.5.fid
Solvent
CDCl3
Temperature
294.6
Number of Scans
16
Spectrometer Frequency
400.18
C9
1.00
2.03
2.28
1.04
2.11
2.12
1.06
1.05
3.12
f1 (ppm)

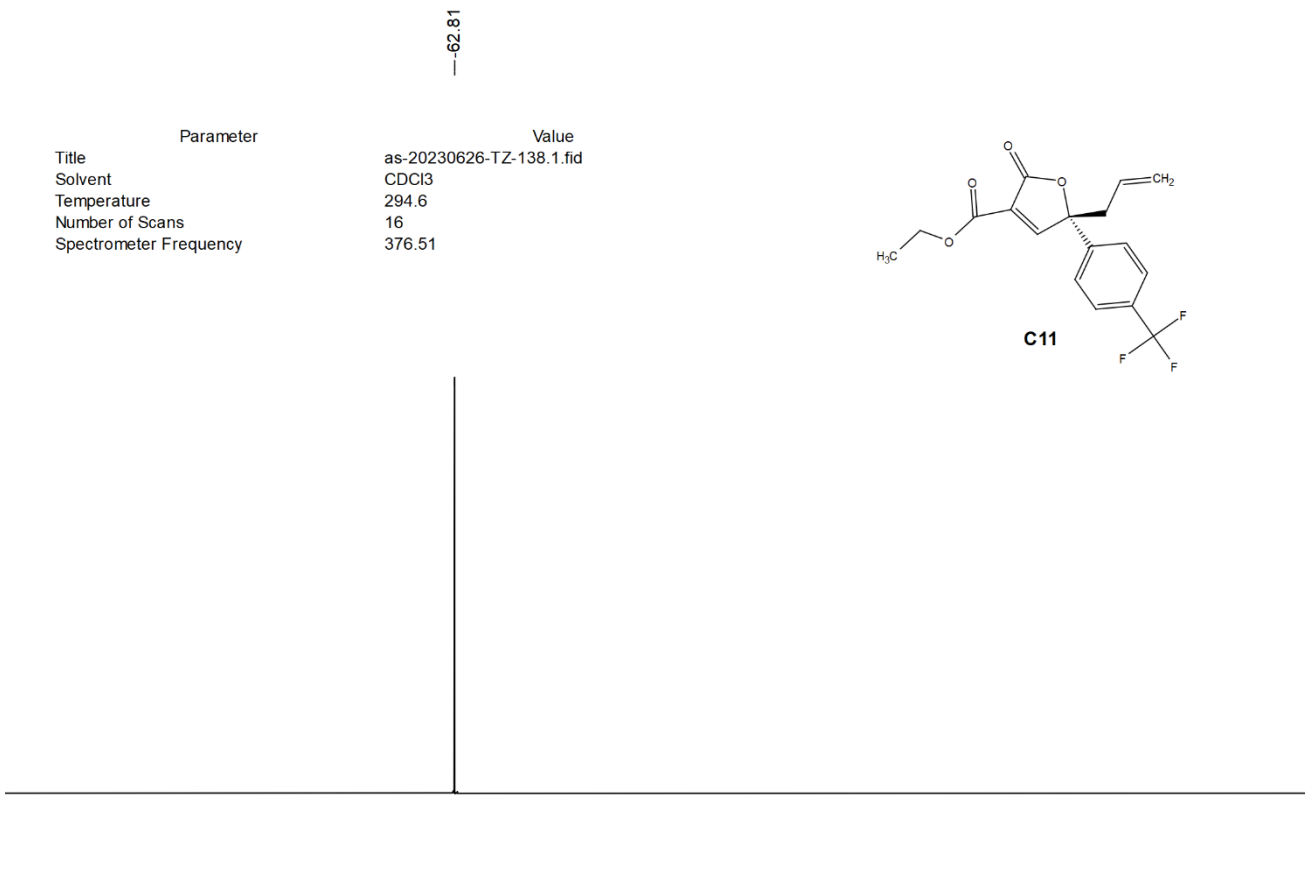

166.25
164.20
159.89
136.27
132.21
129.26
126.92
124.95
122.94
121.58
87.39
61.96
43.78
14.13
Parameter
Value
Title
tanz-20230622-132.6.fid
Solvent
CDCl3
Temperature
295.2
Number of Scans
256
Spectrometer Frequency
100.64
C9
f1 (ppm)

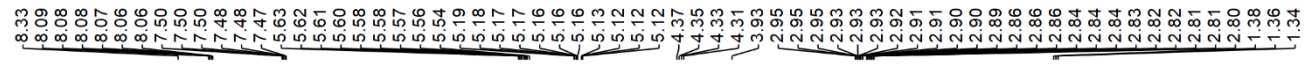

Parameter
Value
Title
tanz-20230622-133.7.fid
Solvent
CDCl3
Temperature
294.7
Number of Scans
16
Spectrometer Frequency
400.18
C10
1.00
2.02
2.07
1.04
2.12
2.03
1.05
1.03
3.07
f1 (ppm)


166.25
164.20
159.88
138.16
136.96
129.26
127.05
124.93
121.58
94.60
87.45
61.95
43.72
14.13
Parameter
Value
Title
tanz-20230622-133.8.fid
Solvent
CDCl3
Temperature
295.2
Number of Scans
256
Spectrometer Frequency
100.64
C10
f1 (ppm)

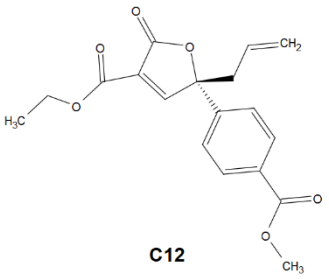

8.32
7.69
7.67
7.56
7.54
5.65
5.63
5.62
5.61
5.61
5.59
5.58
5.57
5.56
5.54
5.20
5.20
5.19
5.18
5.18
5.14
5.14
5.14
5.13
4.37
4.35
4.33
4.32
2.95
2.95
2.94
2.93
2.93
2.92
2.92
2.91
2.90
2.90
2.89
2.87
2.86
2.86
2.85
2.84
2.84
2.83
2.83
2.81
2.81
1.38
1.36
Parameter
Value
Title
tanz-20230626-138.9.fid
Solvent
CDCl3
Temperature
294.8
Number of Scans
16
Spectrometer Frequency
400.18
C11
1.00
2.01
1.97
1.03
2.09
2.03
1.05
1.02
3.10
f1 (ppm)


166.07
163.84
159.78
141.20
131.17
130.84
129.02
126.13
126.09
126.05
126.02
125.69
125.24
125.04
122.33
121.81
87.36
62.02
43.89
14.10
Parameter
Value
Title
tanz-20230626-138.10.fid
Solvent
CDCl3
Temperature
295.2
Number of Scans
256
Spectrometer Frequency
100.64
C11
f1 (ppm)


62.81
Parameter
Value
Title
as-20230626-TZ-138.1.fid
Solvent
CDCl3
Temperature
294.6
Number of Scans
16
Spectrometer Frequency
376.51
C11
f1 (ppm)

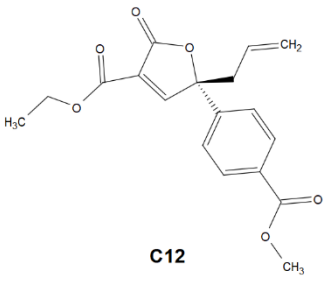


Parameter	Value
Title	tanz-20230626-136.5.fid
Solvent	CDCl3
Temperature	294.7
Number of Scans	16
Spectrometer Frequency	400.18

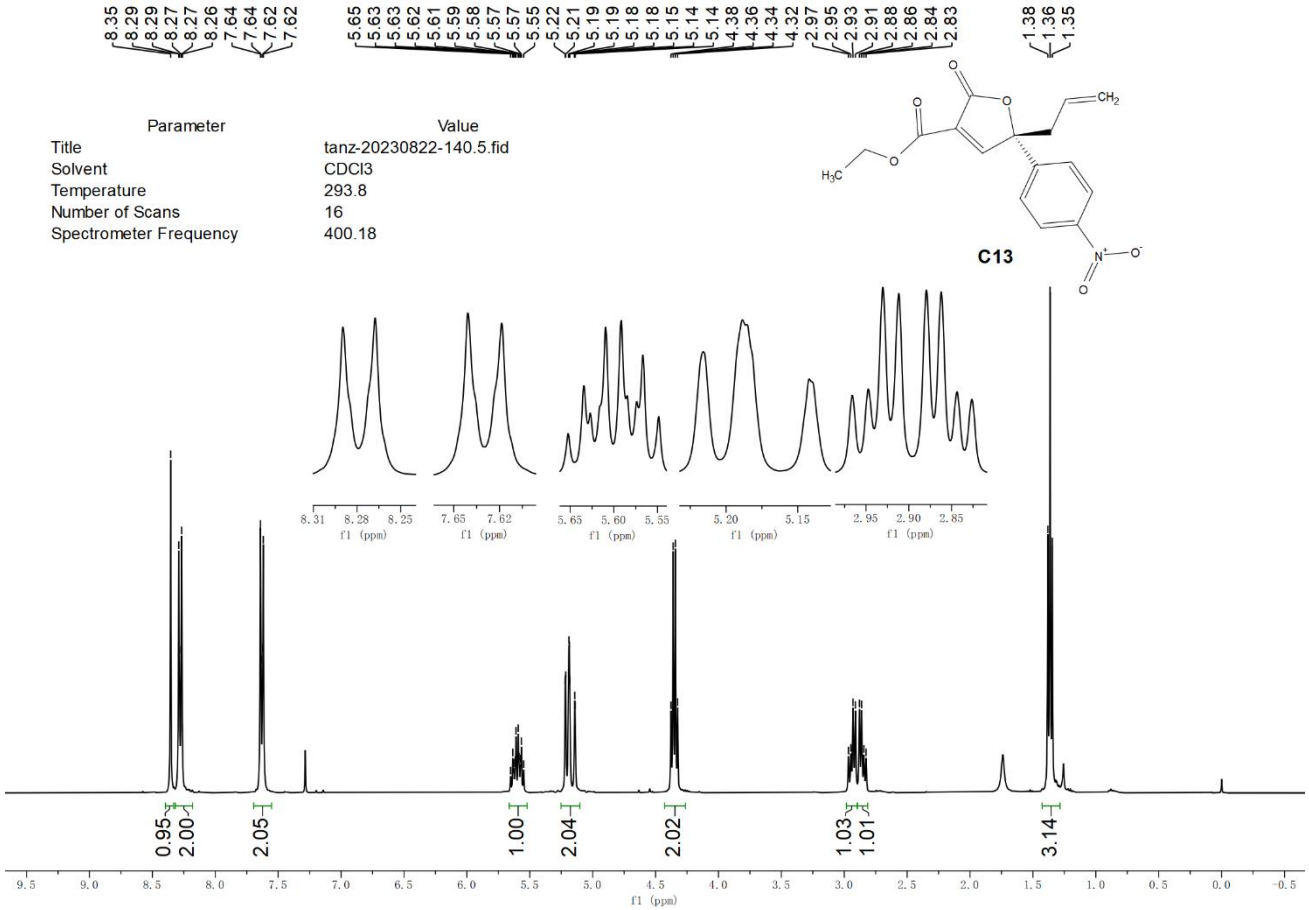


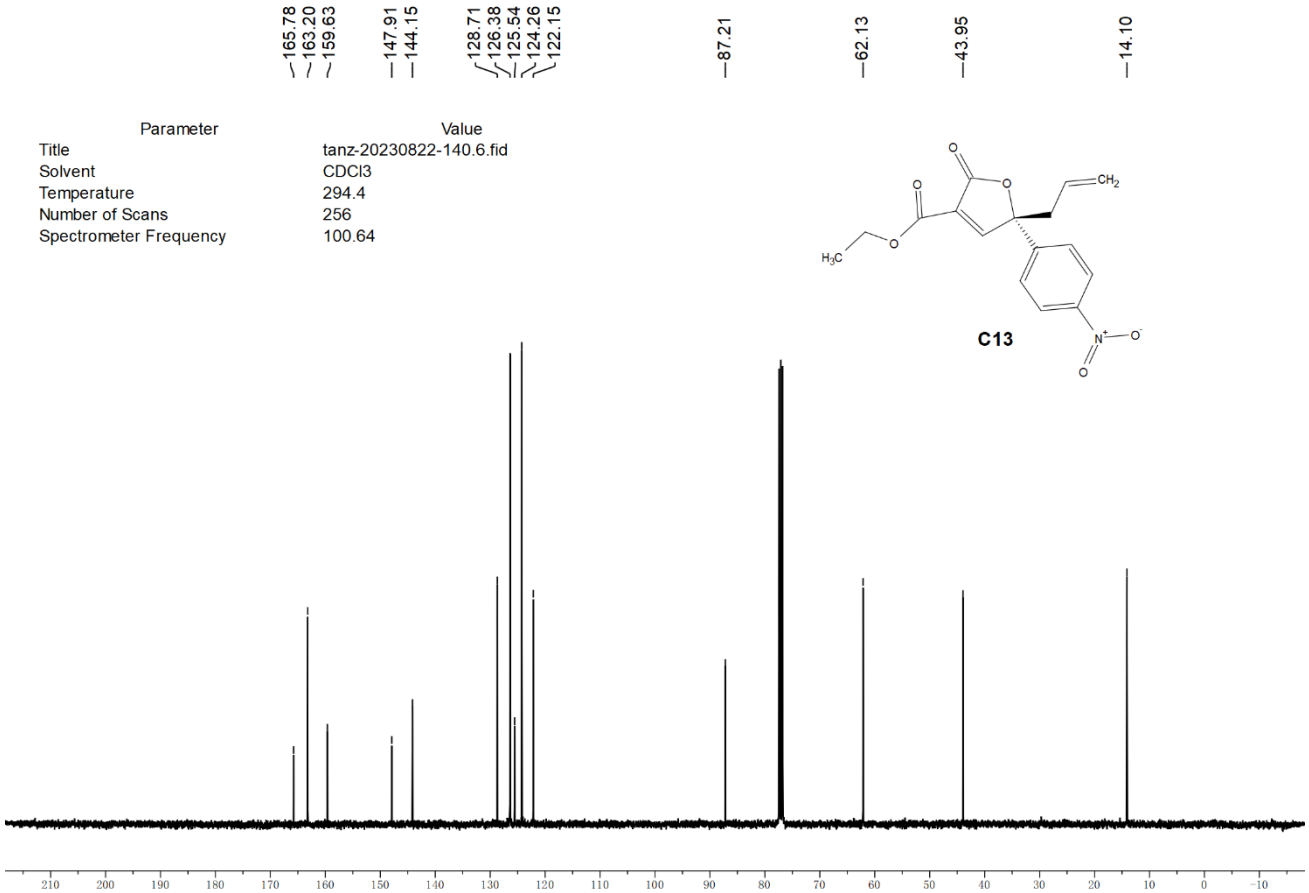
C12

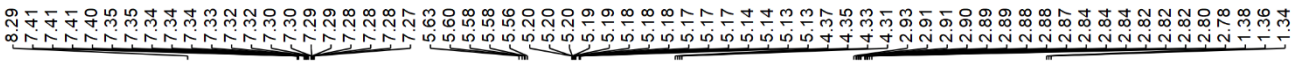
Parameter	Value
Title	tanz-20230626-136.6.fid
Solvent	CDCl3
Temperature	295.3
Number of Scans	256
Spectrometer Frequency	100.64



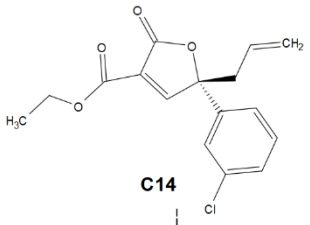
C12


8.35 8.29 8.29 8.27 8.27 8.26 7.64 7.64 7.62 7.62
5.65 5.63 5.63 5.62 5.61 5.59 5.58 5.57 5.57 5.55 5.22 5.21 5.19 5.19 5.18 5.18 5.15 5.14 5.14 4.38 4.36 4.34 4.32 2.97 2.95 2.93 2.91 2.88 2.86 2.84 2.83
1.38 1.36 1.35
Parameter Value
Title tanz-20230822-140.5.fid
Solvent CDCl3
Temperature 293.8
Number of Scans 16
Spectrometer Frequency 400.18
C13
0.95 2.00 2.05 1.00 2.04 2.02 1.03 1.01 3.14
f1 (ppm)

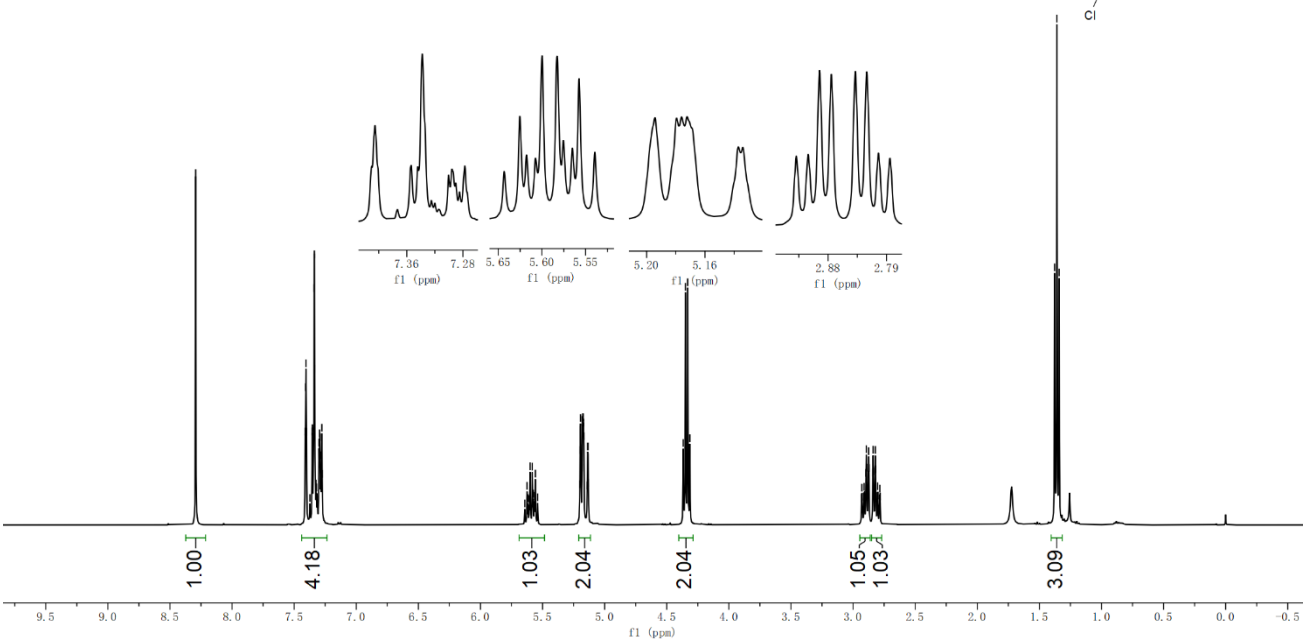

165.78 163.20 159.63 147.91 144.15 128.71 126.38 125.54 124.26 122.15 87.21 62.13 43.95 14.10
Parameter Value
Title tanz-20230822-140.6.fid
Solvent CDCl3
Temperature 294.4
Number of Scans 256
Spectrometer Frequency 100.64
C13
f1 (ppm)



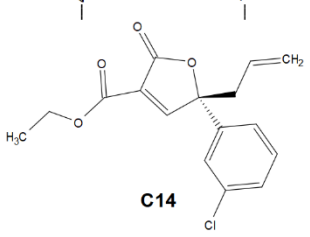
Parameter	Value
Title	tanz-20230822-143.11.fid
Solvent	CDCl3
Temperature	293.9
Number of Scans	16
Spectrometer Frequency	400.18



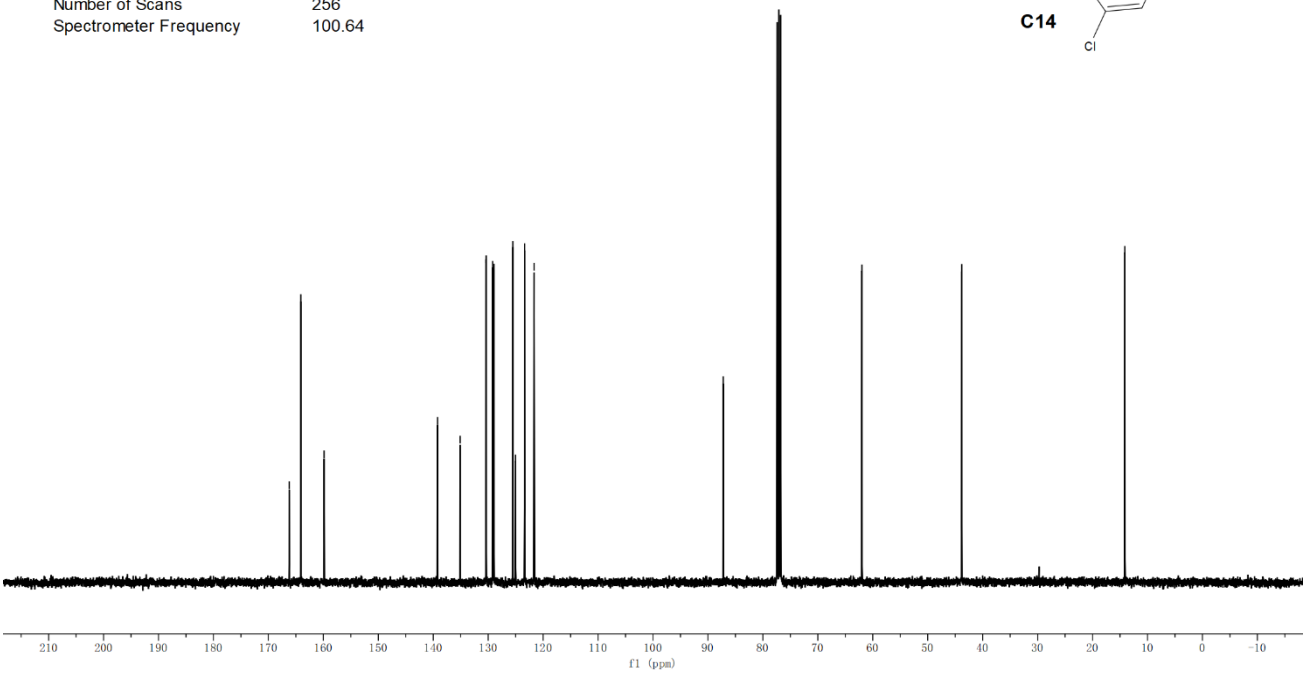
C14

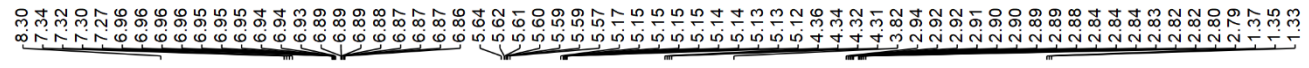


Parameter	Value
Title	tanz-20230822-143.12.fid
Solvent	CDCl3
Temperature	294.3
Number of Scans	256
Spectrometer Frequency	100.64

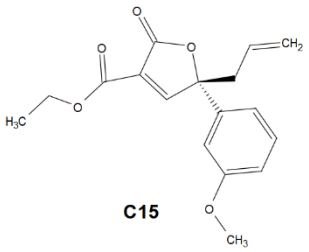


C14



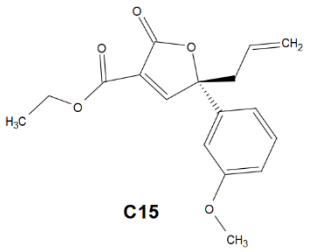


Parameter	Value
Title	tanz-20230822-142.9.fid
Solvent	CDCl3
Temperature	293.9
Number of Scans	16
Spectrometer Frequency	400.18



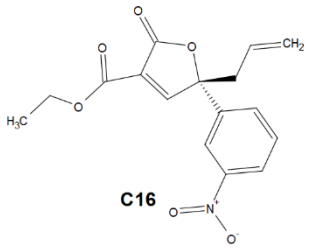
C15

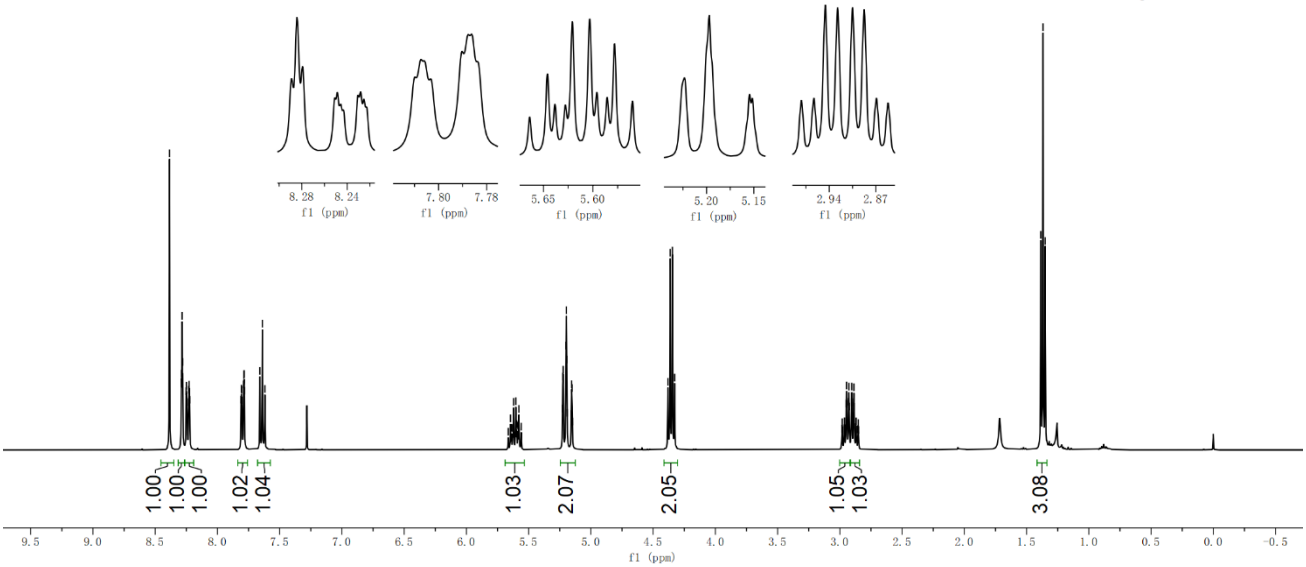
Parameter	Value
Title	tanz-20230822-142.10.fid
Solvent	CDCl3
Temperature	294.4
Number of Scans	256
Spectrometer Frequency	100.64

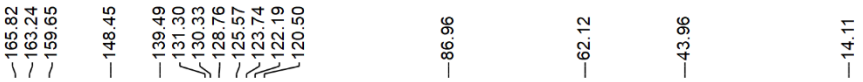


C15

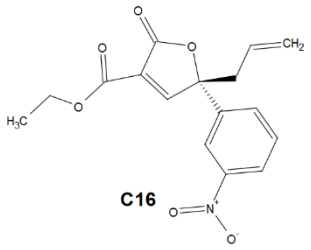
Parameter	Value
Title	tanz-20230902-154.1.fid
Solvent	CDCl3
Temperature	293.9
Number of Scans	16
Spectrometer Frequency	400.18

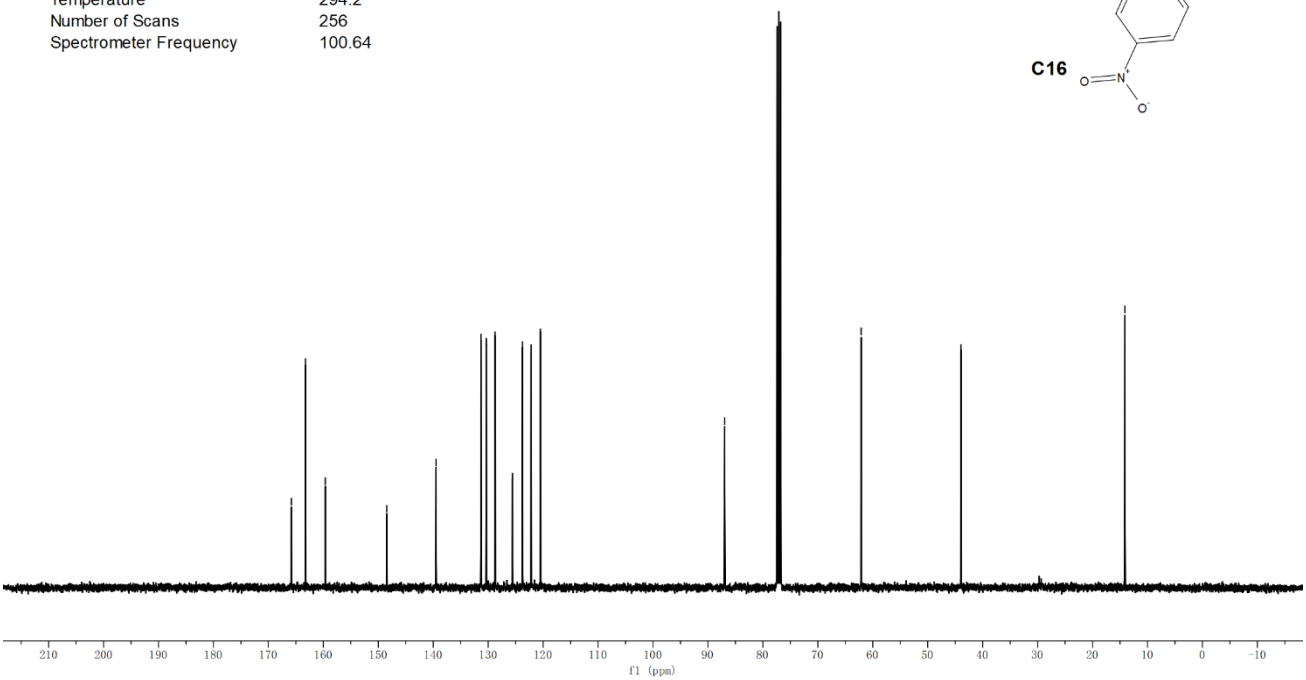


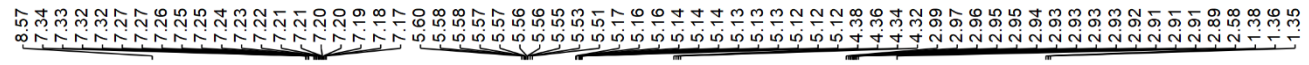




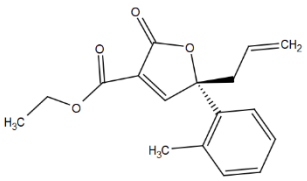
Parameter	Value
Title	tanz-20230902-154.2.fid
Solvent	CDCl3
Temperature	294.2
Number of Scans	256
Spectrometer Frequency	100.64



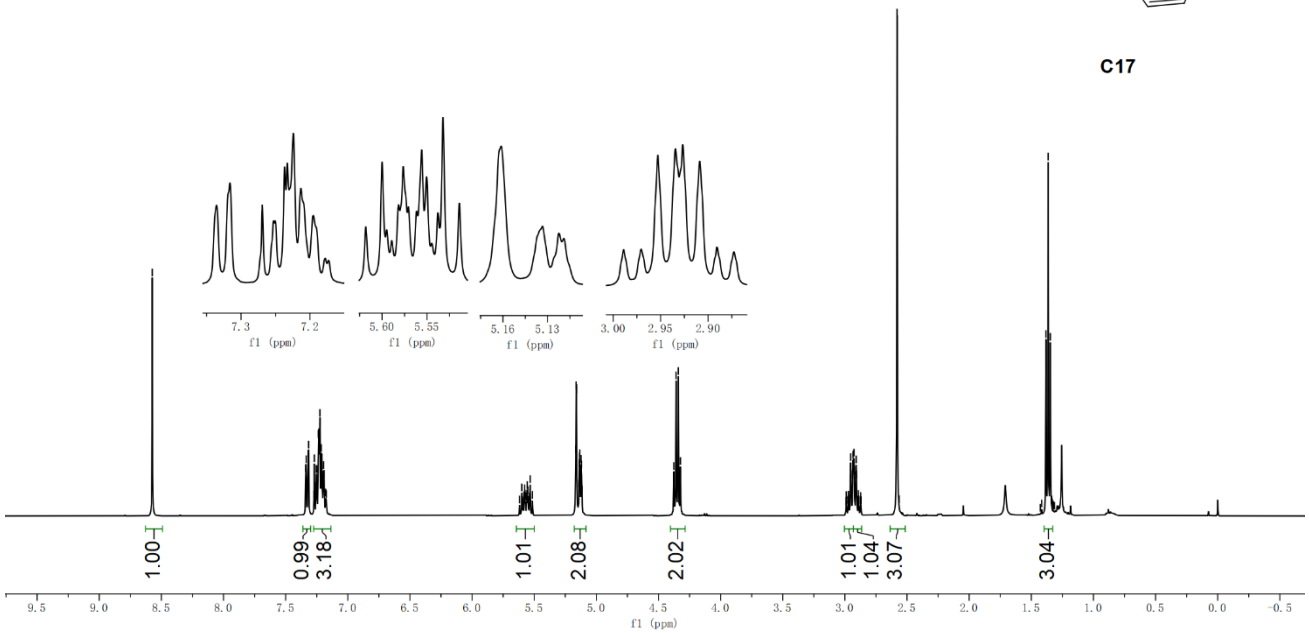




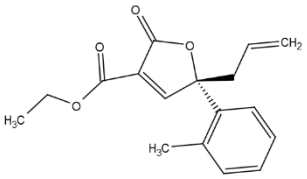
Parameter	Value
Title	tanz-20230824-144.1.fid
Solvent	CDCl3
Temperature	293.7
Number of Scans	16
Spectrometer Frequency	400.18



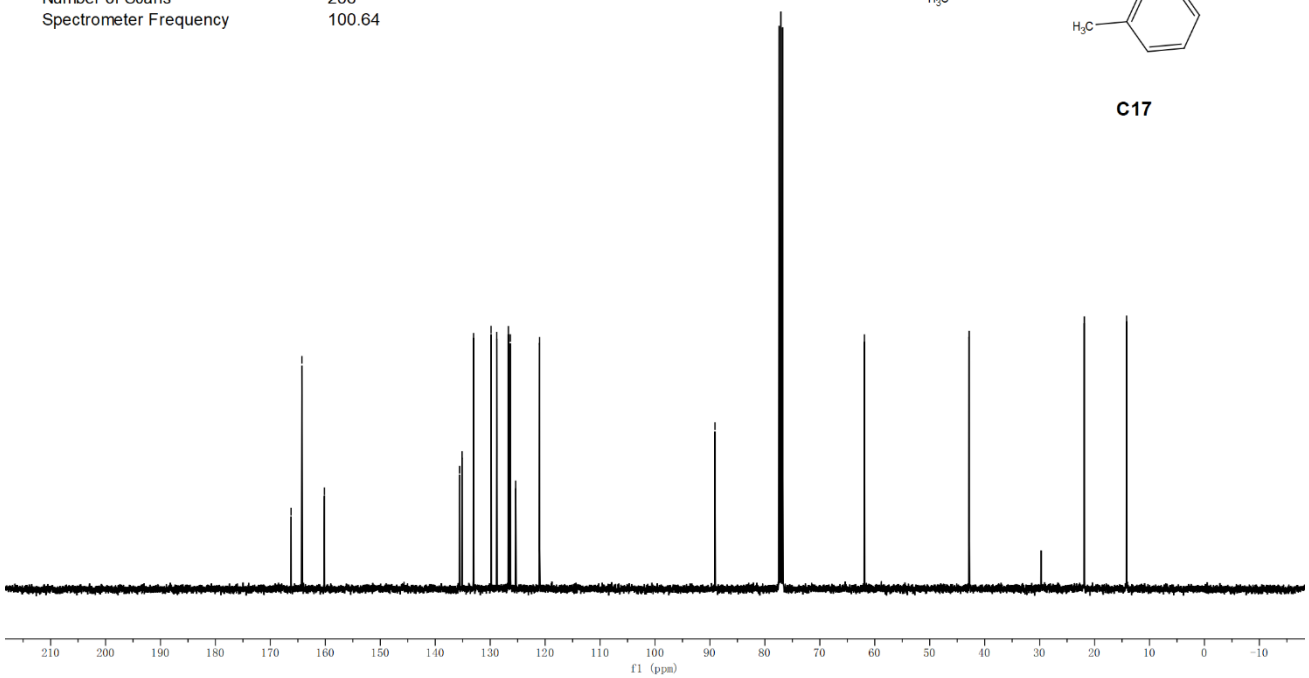
C17

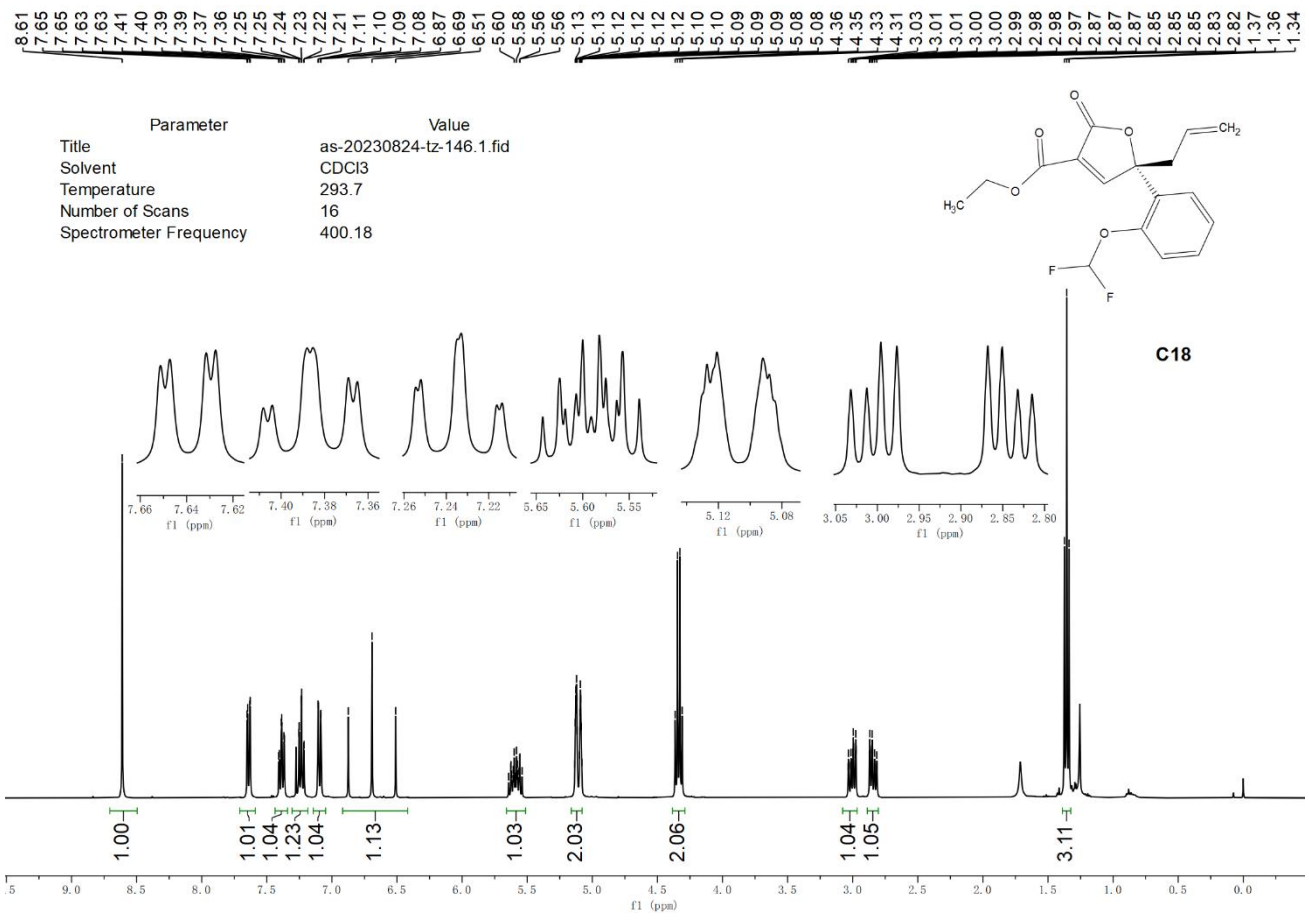


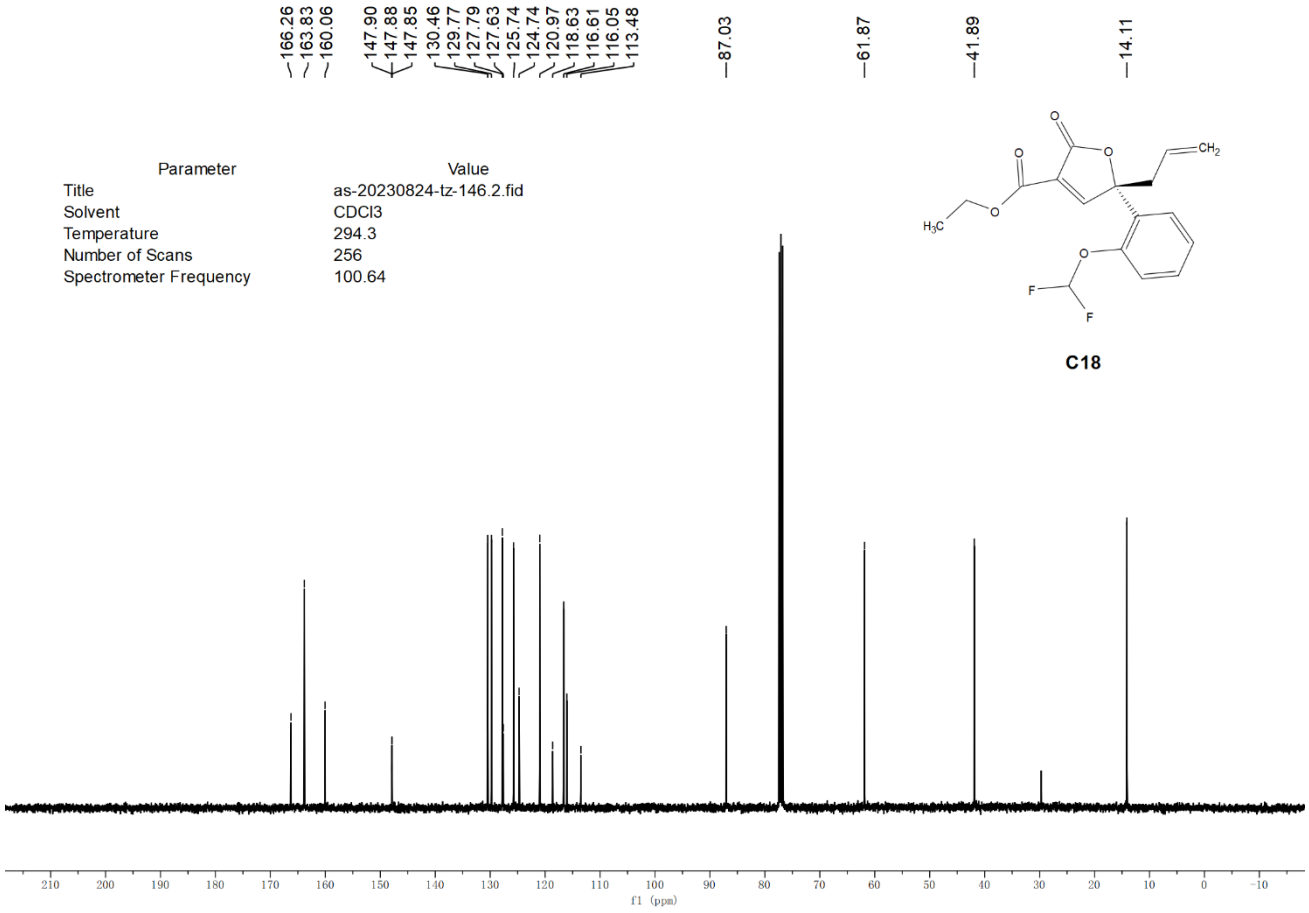
Parameter	Value
Title	tanz-20230824-144.2.fid
Solvent	CDCl3
Temperature	294.2
Number of Scans	256
Spectrometer Frequency	100.64



C17

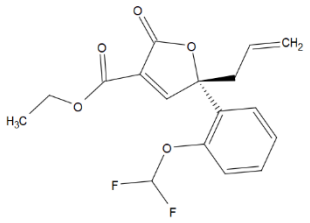



8.61 7.65 7.65 7.63 7.63 7.41 7.40 7.39 7.39 7.37 7.36 7.25 7.25 7.24 7.23 7.22 7.21 7.11 7.10 7.09 7.08 6.87 6.69 6.51 5.60 5.58 5.56 5.56 5.13 5.13 5.12 5.12 5.12 5.12 5.10 5.10 5.09 5.09 5.09 5.08 5.08 4.36 4.35 4.33 4.31 3.03 3.01 3.01 3.00 3.00 2.99 2.98 2.98 2.97 2.87 2.87 2.87 2.85 2.85 2.85 2.83 2.82 1.37 1.36 1.34
Parameter Value
Title as-20230824-tz-146.1.fid
Solvent CDCl3
Temperature 293.7
Number of Scans 16
Spectrometer Frequency 400.18
C18
1.00 1.01 1.04 1.23 1.04 1.13 1.03 2.03 2.06 1.04 1.05 3.11
f1 (ppm)

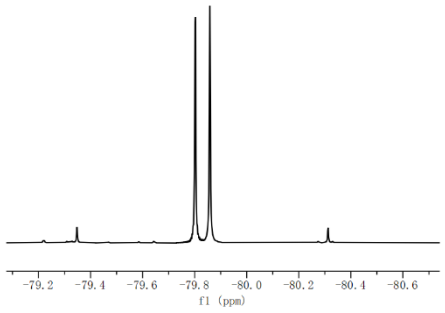

166.26 163.83 160.06 147.90 147.88 147.85 130.46 129.77 127.79 127.63 125.74 124.74 120.97 118.63 116.61 116.05 113.48 87.03 61.87 41.89 14.11
Parameter Value
Title as-20230824-tz-146.2.fid
Solvent CDCl3
Temperature 294.3
Number of Scans 256
Spectrometer Frequency 100.64
C18
f1 (ppm)

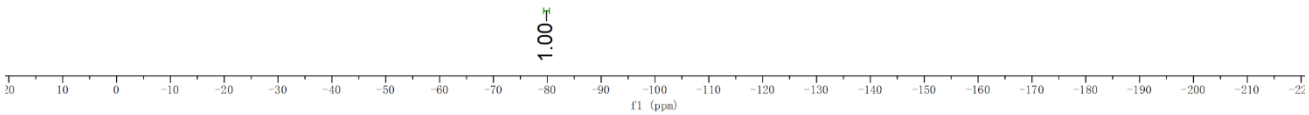
-79.35
-79.80
-79.86
-80.31

Parameter	Value
Title	as-20230824-tz-146.3.fid
Solvent	CDCl3
Temperature	293.9
Number of Scans	16
Spectrometer Frequency	376.51



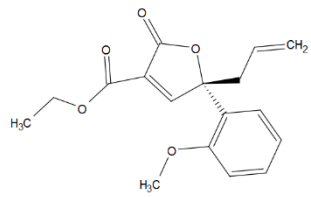
C18



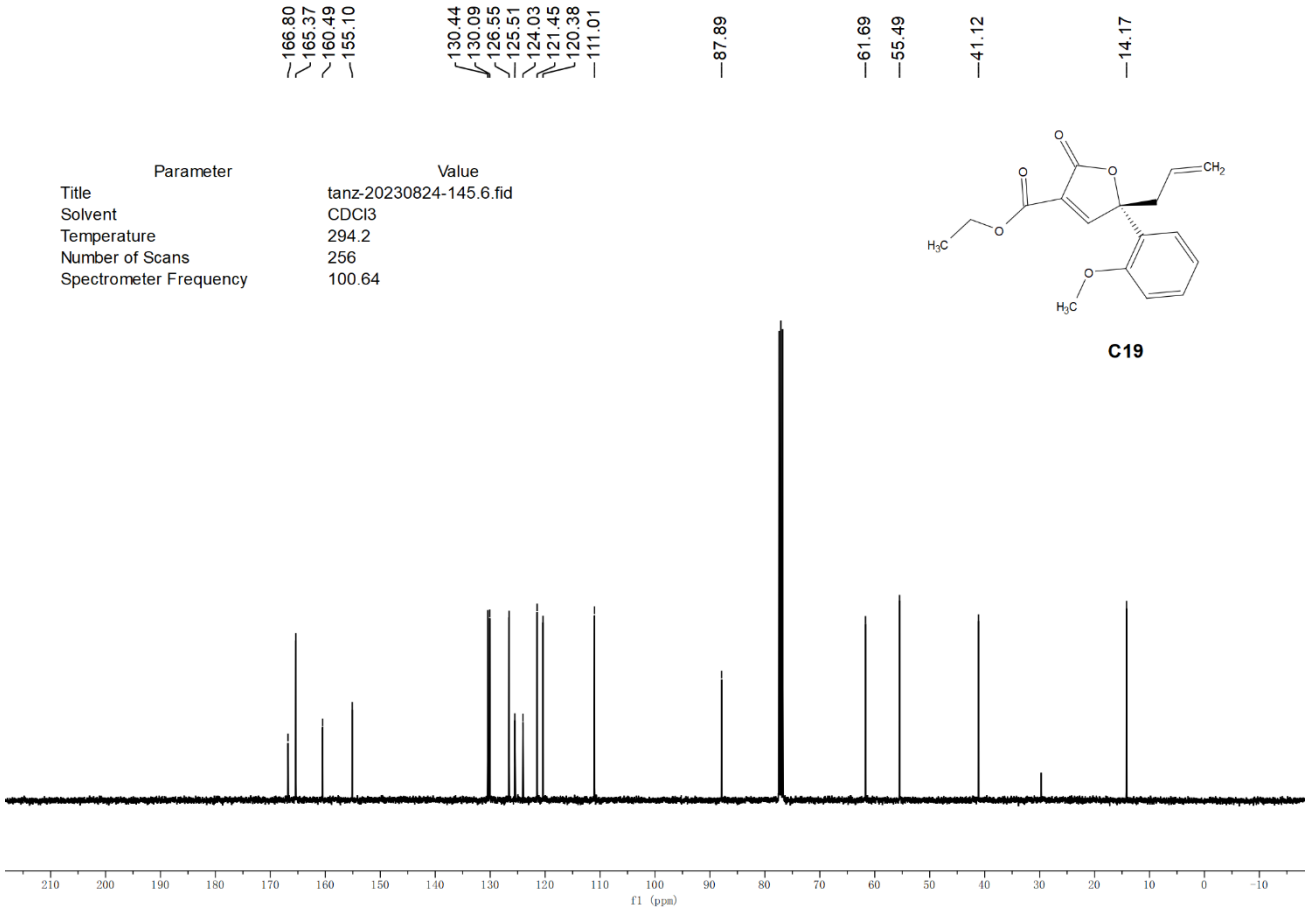


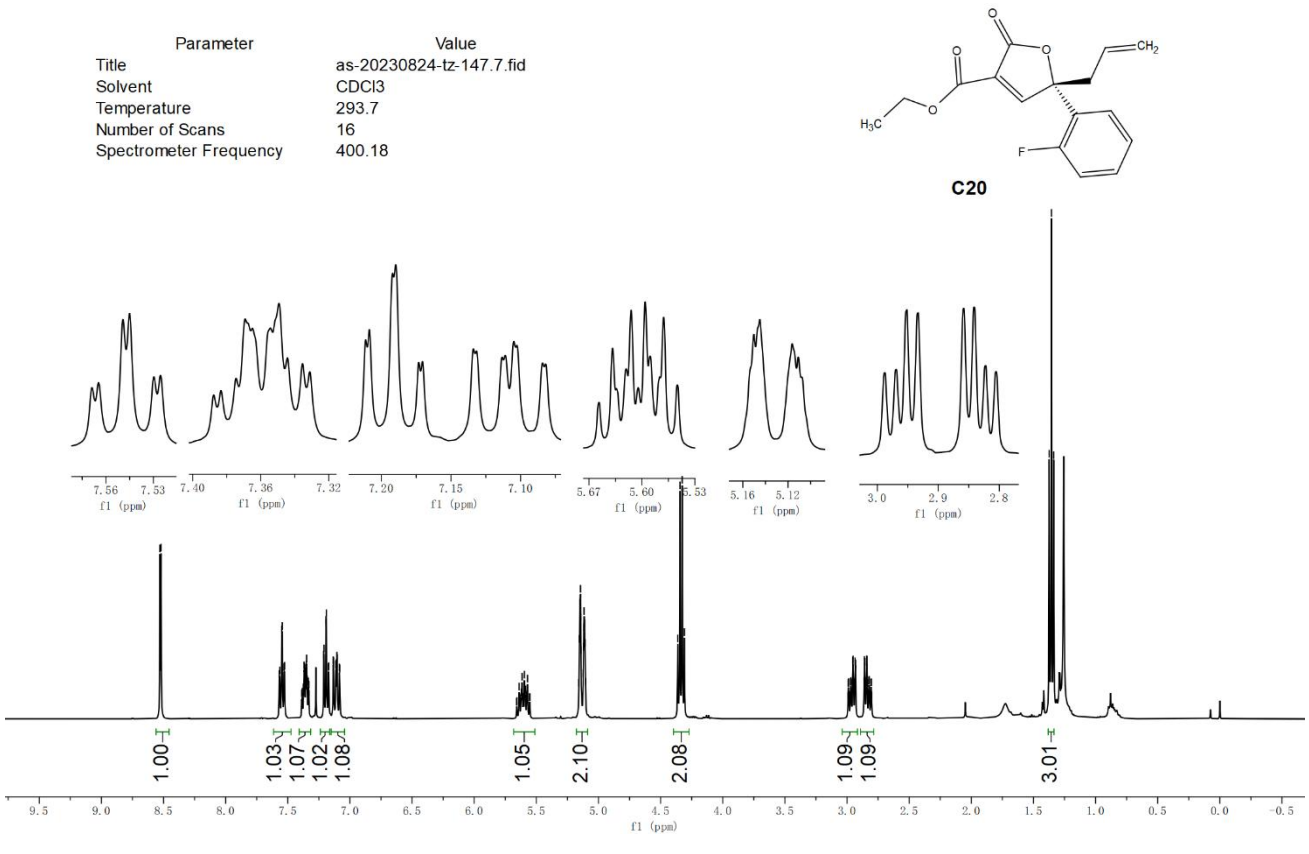
8.71 7.53 7.53 7.51 7.51 7.35 7.35 7.33 7.33 7.33 7.33 7.31 7.31 7.01 7.00 6.99 6.98 6.97 6.96 6.94 6.94 6.92 6.92 5.62 5.60 5.58 5.55 5.10 5.10 5.09 5.09 5.07 5.07 5.06 5.06 4.35 4.35 4.34 4.33 4.32 4.32 4.30 3.94 3.02 3.00 2.99 2.99 2.98 2.97 2.97 2.97 2.92 2.92 2.91 2.90 2.90 2.90 2.88 2.86 1.37 1.35 1.33

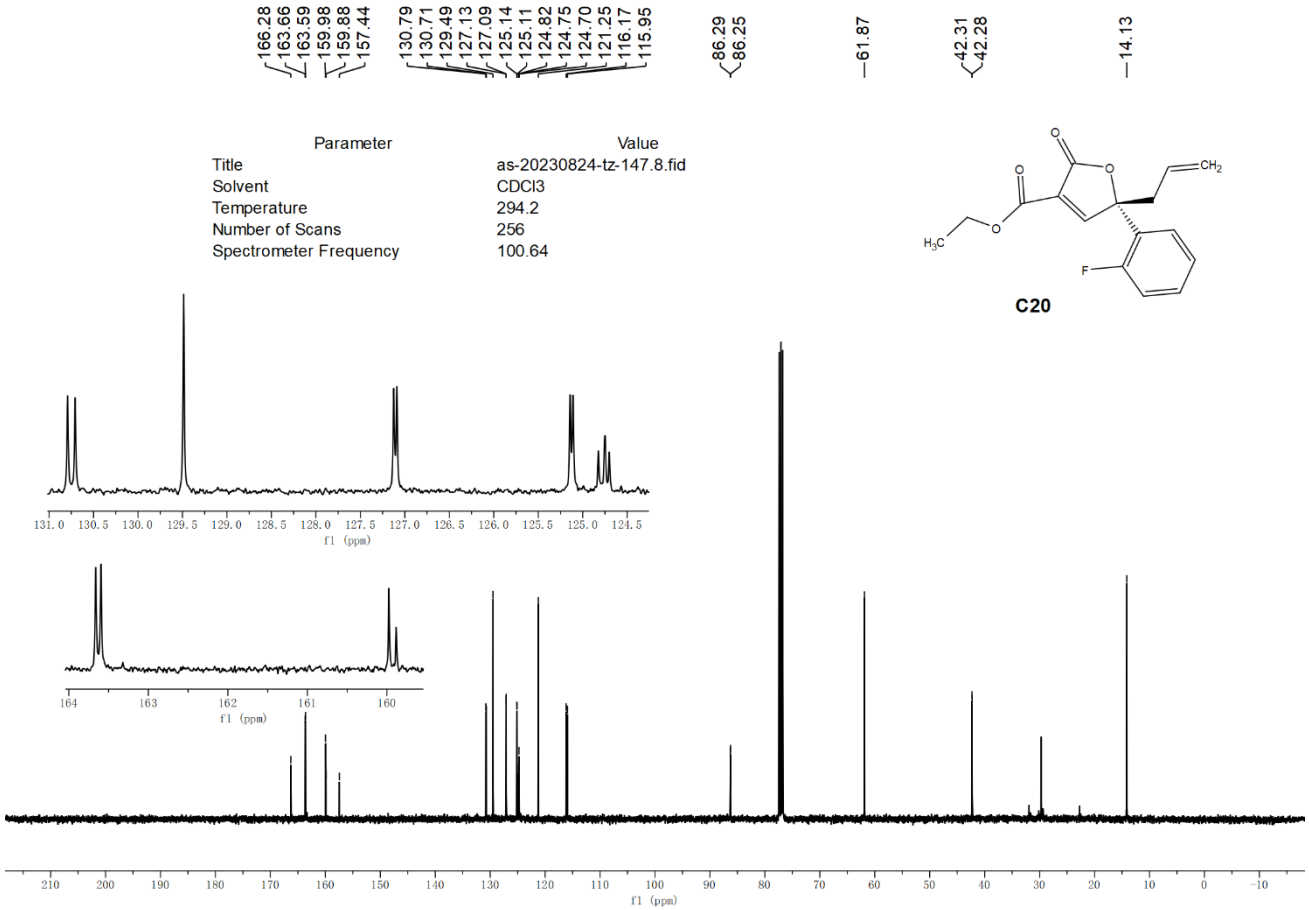
Parameter	Value
Title	tanz-20230824-145.5.fid
Solvent	CDCl3
Temperature	293.7
Number of Scans	16
Spectrometer Frequency	400.18



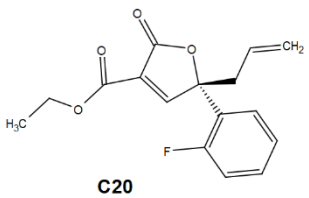
C19

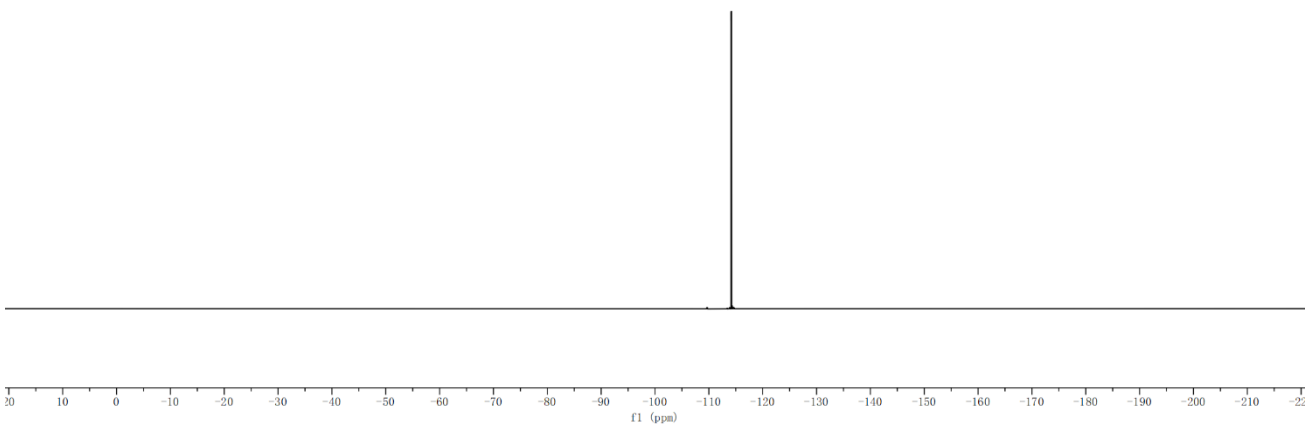

166.80
165.37
160.49
155.10
130.44
130.09
126.55
125.51
124.03
121.45
120.38
111.01
87.89
61.69
55.49
41.12
14.17
Parameter
Value
Title
tanz-20230824-145.6.fid
Solvent
CDCl3
Temperature
294.2
Number of Scans
256
Spectrometer Frequency
100.64
C19
f1 (ppm)

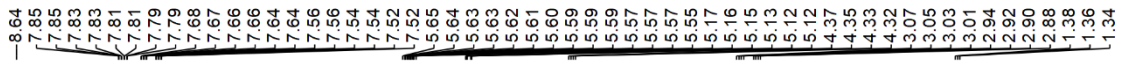

Parameter
Value
Title
as-20230824-tz-147.7.fid
Solvent
CDCl3
Temperature
293.7
Number of Scans
16
Spectrometer Frequency
400.18
C20
1.00
1.03
1.07
1.02
1.08
1.05
2.10
2.08
1.09
1.09
3.01
f1 (ppm)



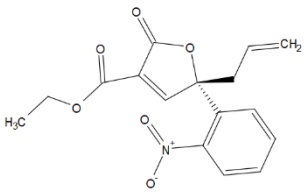
Parameter	Value
Title	as-20230824-tz-147.9.fid
Solvent	CDCl3
Temperature	293.9
Number of Scans	16
Spectrometer Frequency	376.51



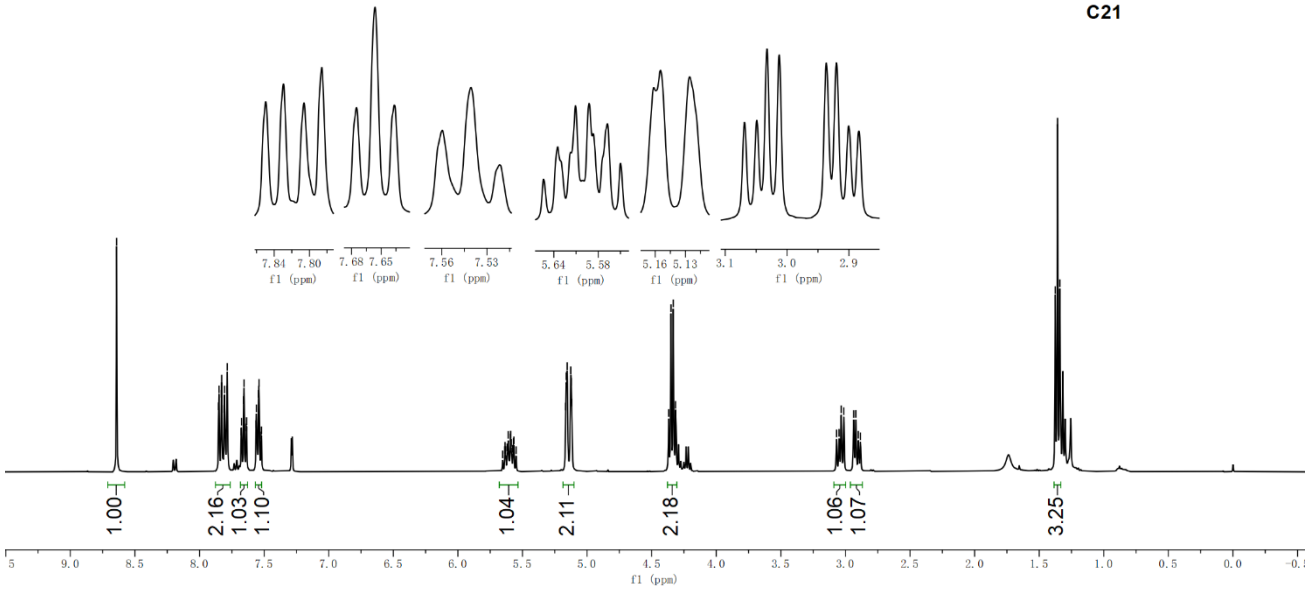


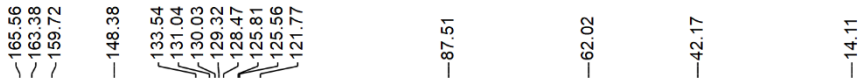


Parameter	Value
Title	tanz-20230824-148.1.fid
Solvent	CDCl3
Temperature	293.8
Number of Scans	16
Spectrometer Frequency	400.18

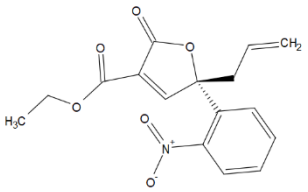


C21

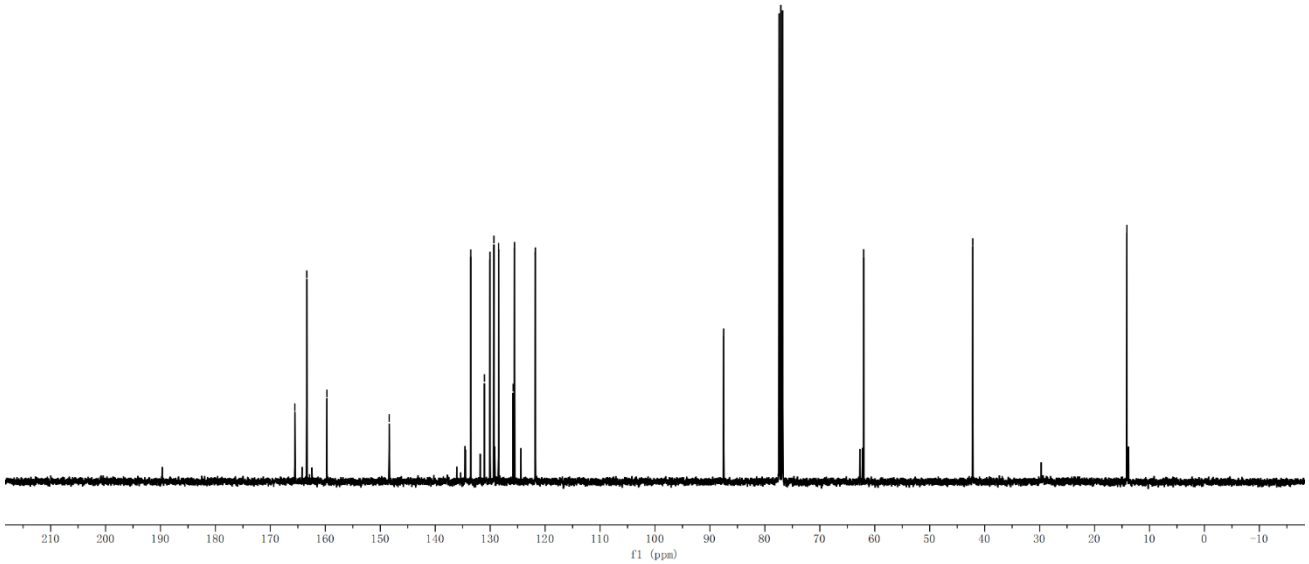


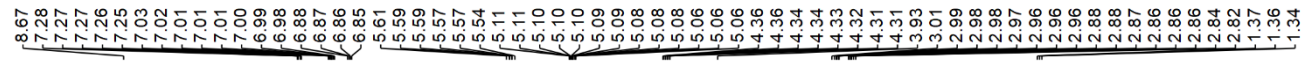


Parameter	Value
Title	tanz-20230824-148.2.fid
Solvent	CDCl3
Temperature	294.3
Number of Scans	256
Spectrometer Frequency	100.64

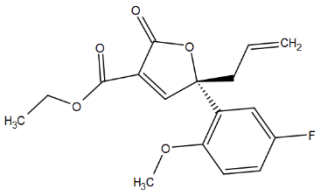


C21

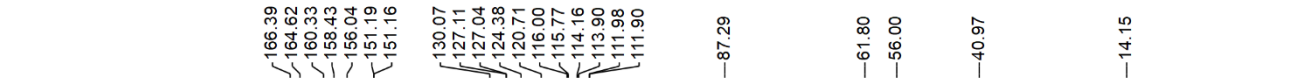




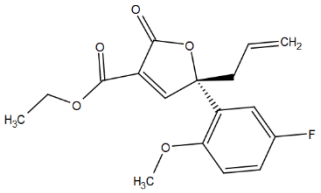
Parameter	Value
Title	as-20230902-TZ-157.1.fid
Solvent	CDCl3
Temperature	293.8
Number of Scans	16
Spectrometer Frequency	400.18



C22

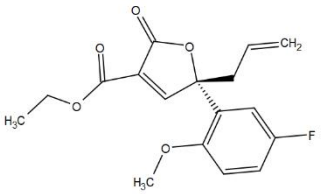


Parameter	Value
Title	as-20230902-TZ-157.2.fid
Solvent	CDCl3
Temperature	294.4
Number of Scans	256
Spectrometer Frequency	100.64



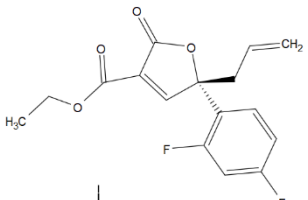
C22

Parameter	Value
Title	as-20230902-TZ-157.3.fid
Solvent	CDCl3
Temperature	294.0
Number of Scans	16
Spectrometer Frequency	376.51

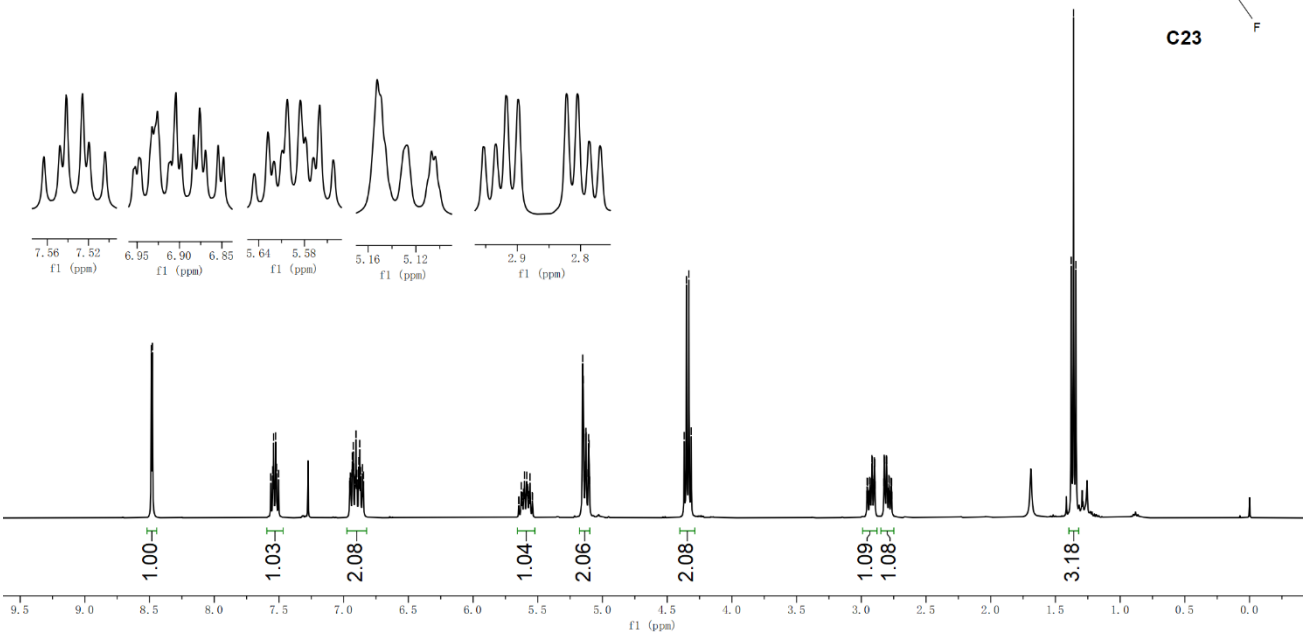


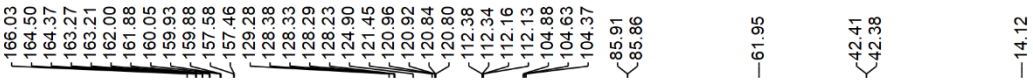
C22

Parameter	Value
Title	as-20230902-TZ-158.7.fid
Solvent	CDCl3
Temperature	293.7
Number of Scans	16
Spectrometer Frequency	400.18

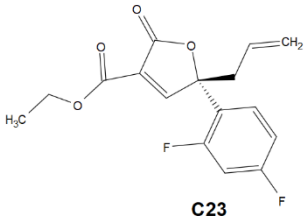


C23





Parameter	Value
Title	as-20230902-TZ-158.8.fid
Solvent	CDCl3
Temperature	294.3
Number of Scans	256
Spectrometer Frequency	100.64



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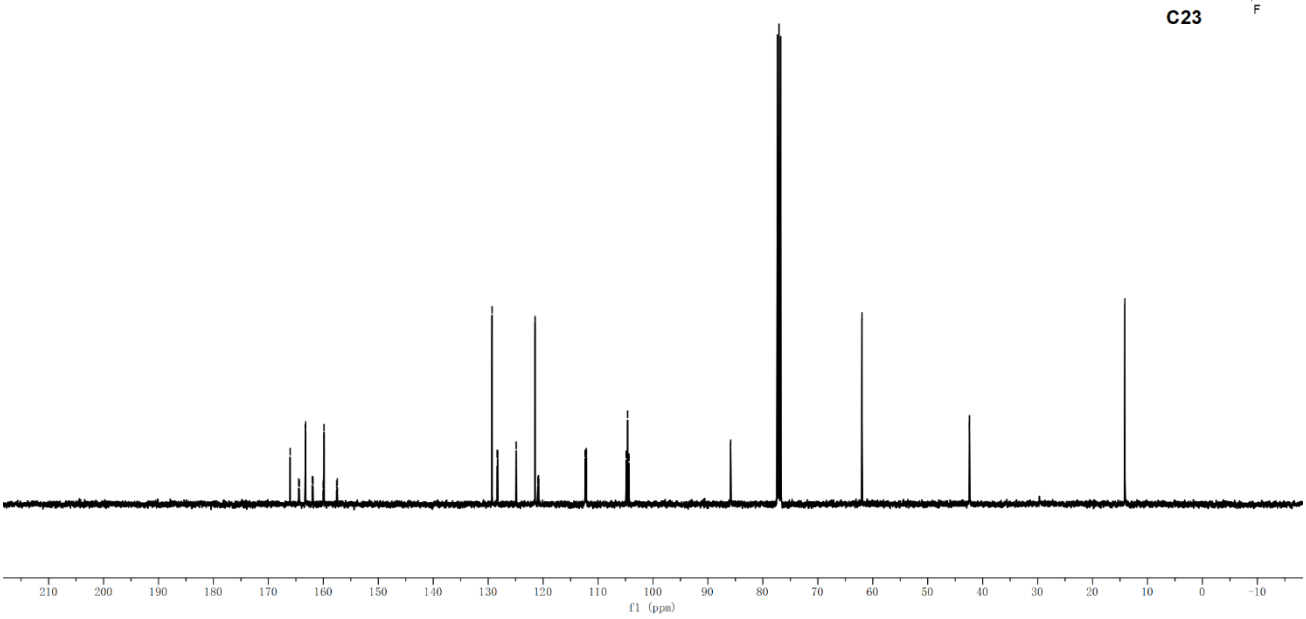
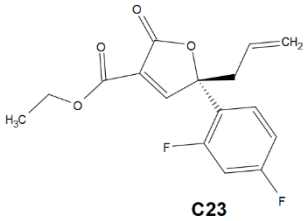
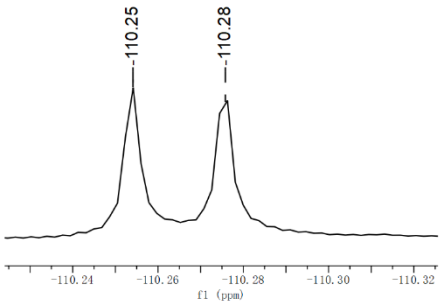
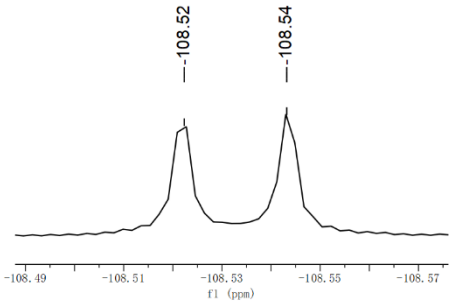


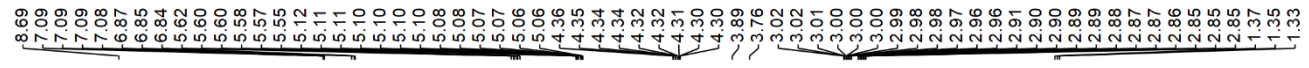
Parameter	Value
Title	as-20230902-TZ-158.9.fid
Solvent	CDCl3
Temperature	293.9
Number of Scans	16
Spectrometer Frequency	376.51



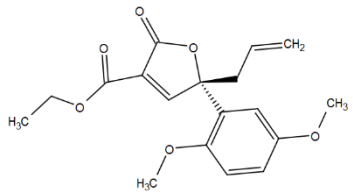
C23



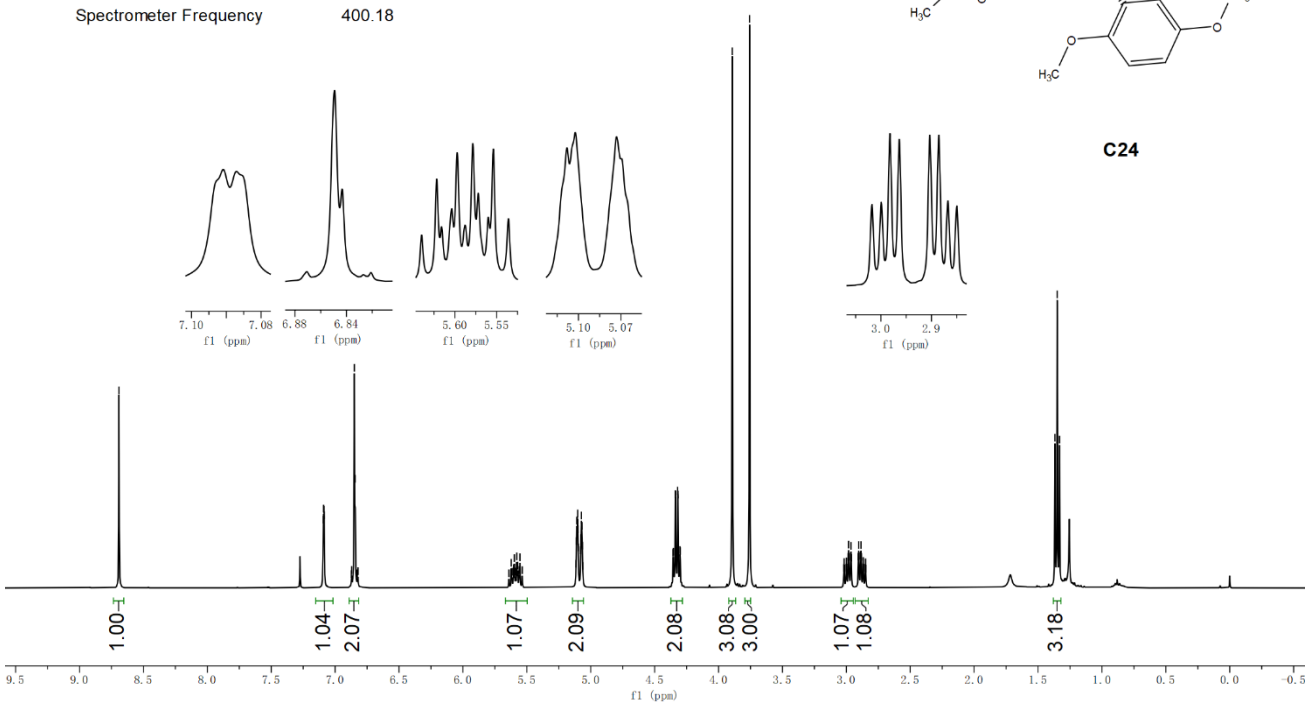




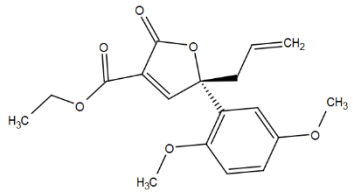
Parameter	Value
Title	tanz-20230907-159.1.fid
Solvent	CDCl3
Temperature	293.7
Number of Scans	16
Spectrometer Frequency	400.18



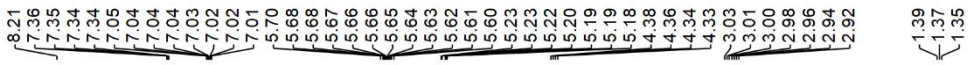
C24



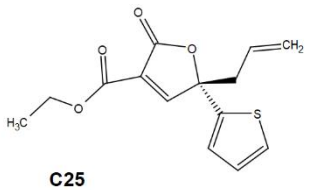
Parameter	Value
Title	tanz-20230907-159.2.fid
Solvent	CDCl3
Temperature	294.2
Number of Scans	256
Spectrometer Frequency	100.64



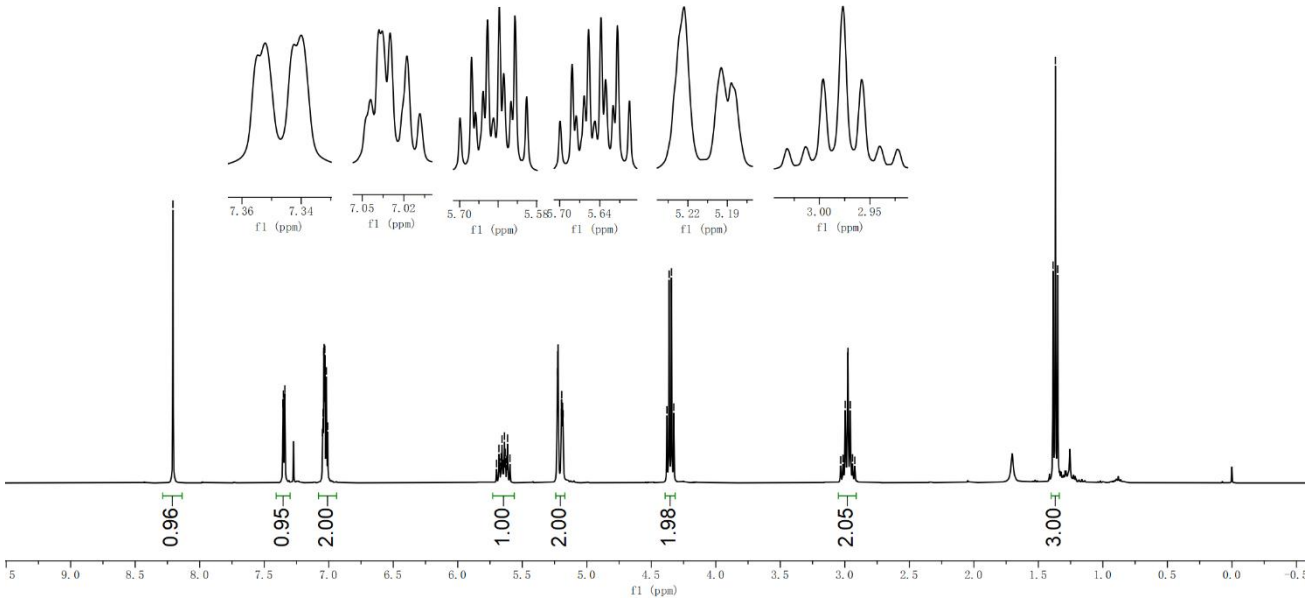
C24



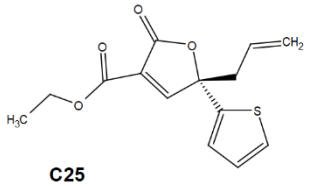
Parameter	Value
Title	tanz-20230902-156.7.fid
Solvent	CDCl3
Temperature	293.8
Number of Scans	16
Spectrometer Frequency	400.18



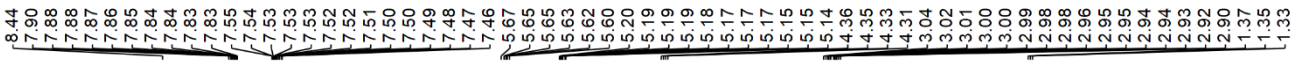
C25



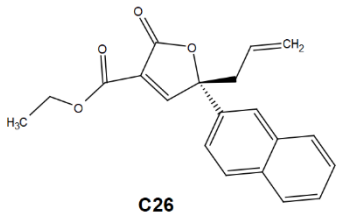
Parameter	Value
Title	tanz-20230902-156.8.fid
Solvent	CDCl3
Temperature	294.3
Number of Scans	256
Spectrometer Frequency	100.64



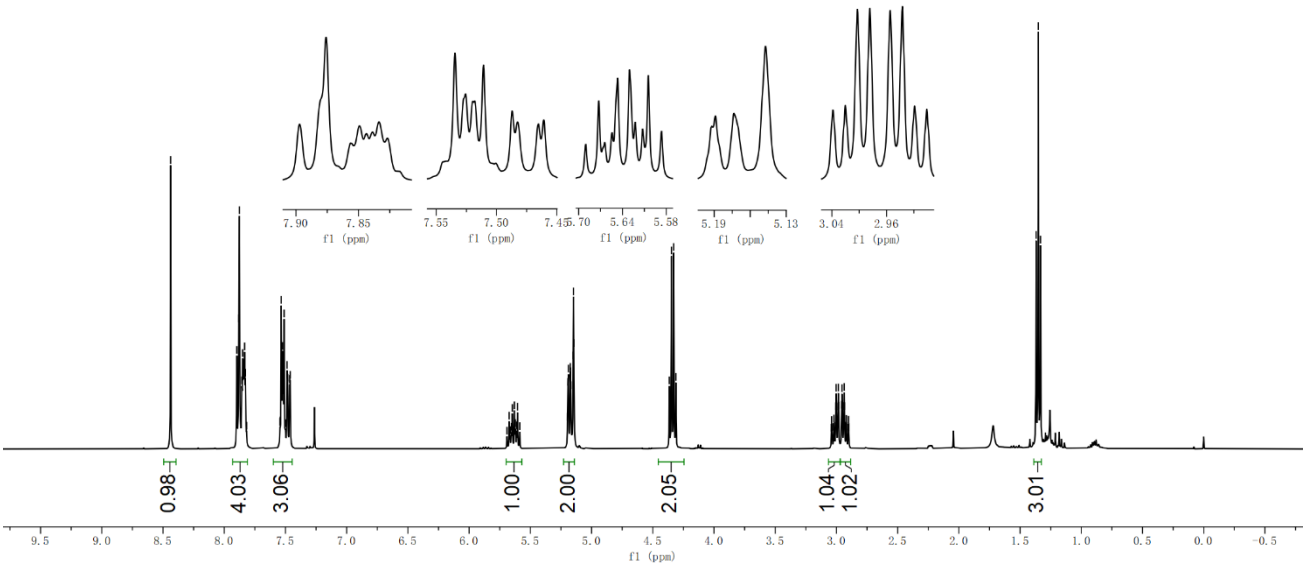
C25

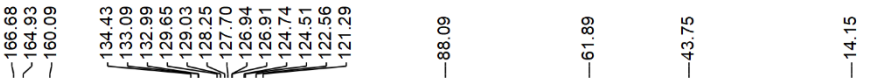


Parameter	Value
Title	tanz-20230902-155.5.fid
Solvent	CDCl3
Temperature	293.9
Number of Scans	16
Spectrometer Frequency	400.18

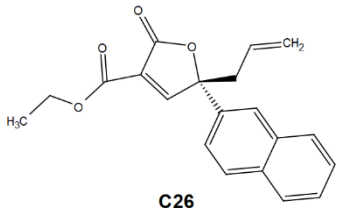


C26

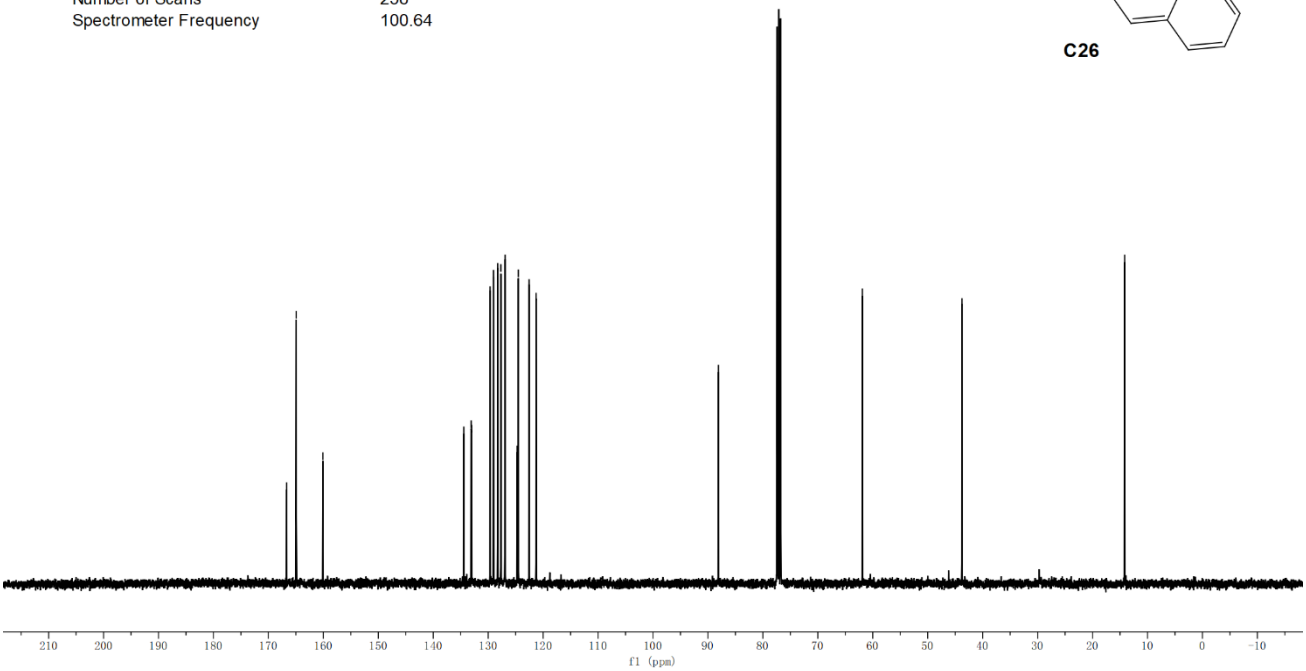


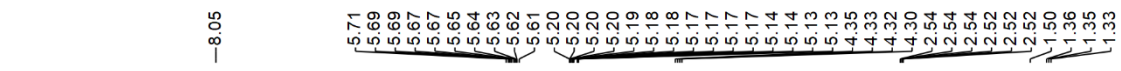


Parameter	Value
Title	tanz-20230902-155.6.fid
Solvent	CDCl3
Temperature	294.3
Number of Scans	256
Spectrometer Frequency	100.64

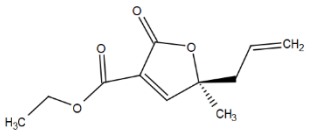


C26

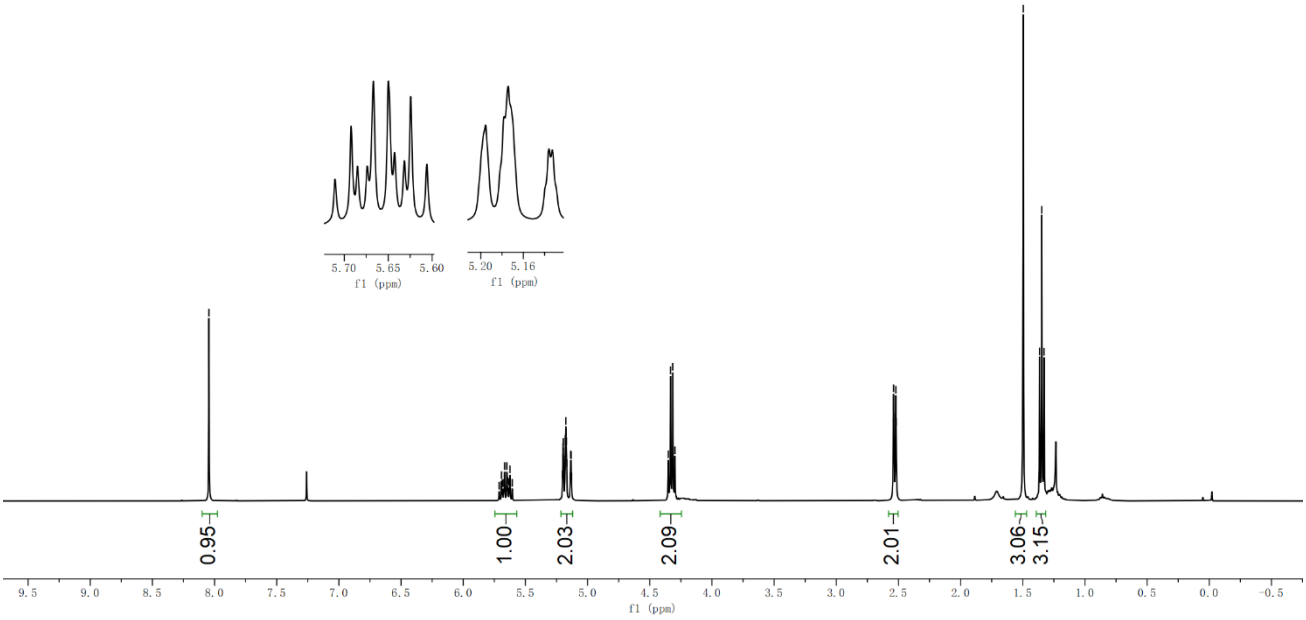


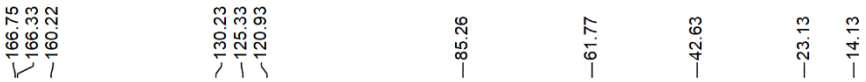


Parameter	Value
Title	tanz-20230907-161.9.fid
Solvent	CDCl3
Temperature	293.8
Number of Scans	16
Spectrometer Frequency	400.18

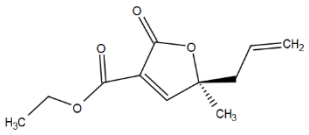


C27

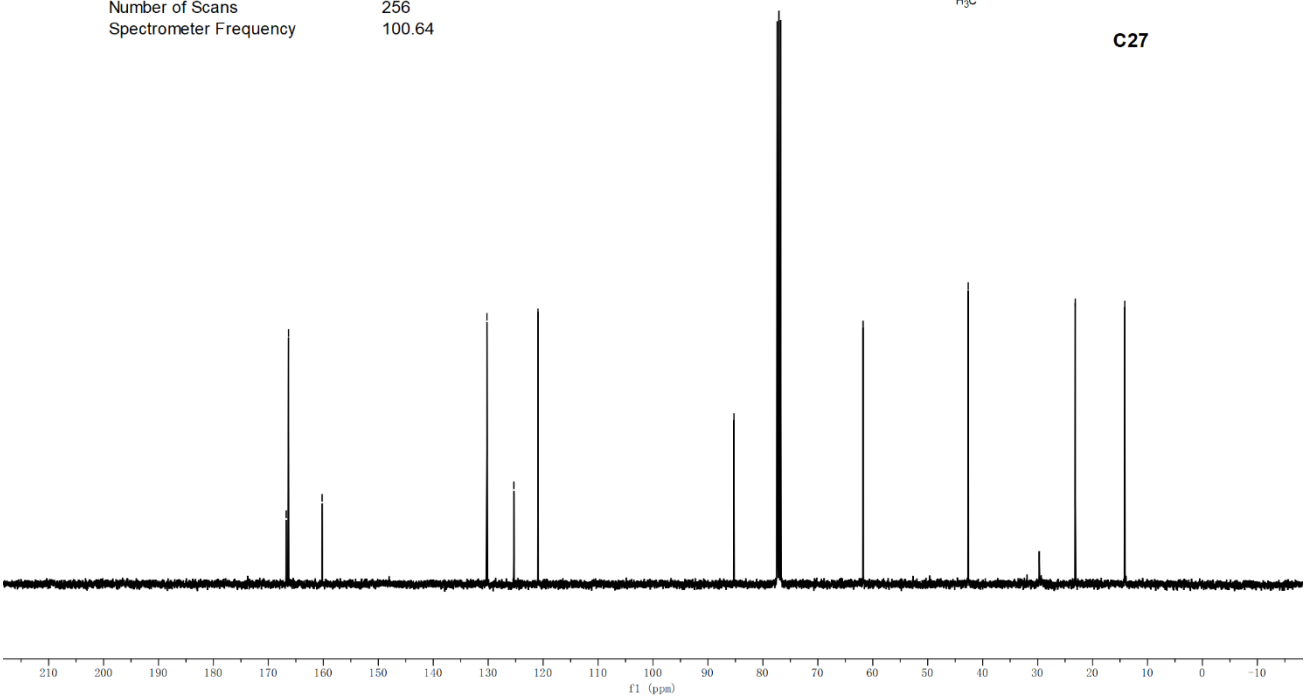




Parameter	Value
Title	tanz-20230907-161.10.fid
Solvent	CDCl3
Temperature	294.1
Number of Scans	256
Spectrometer Frequency	100.64

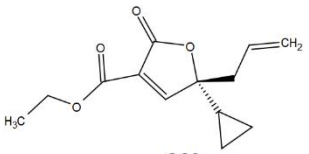


C27

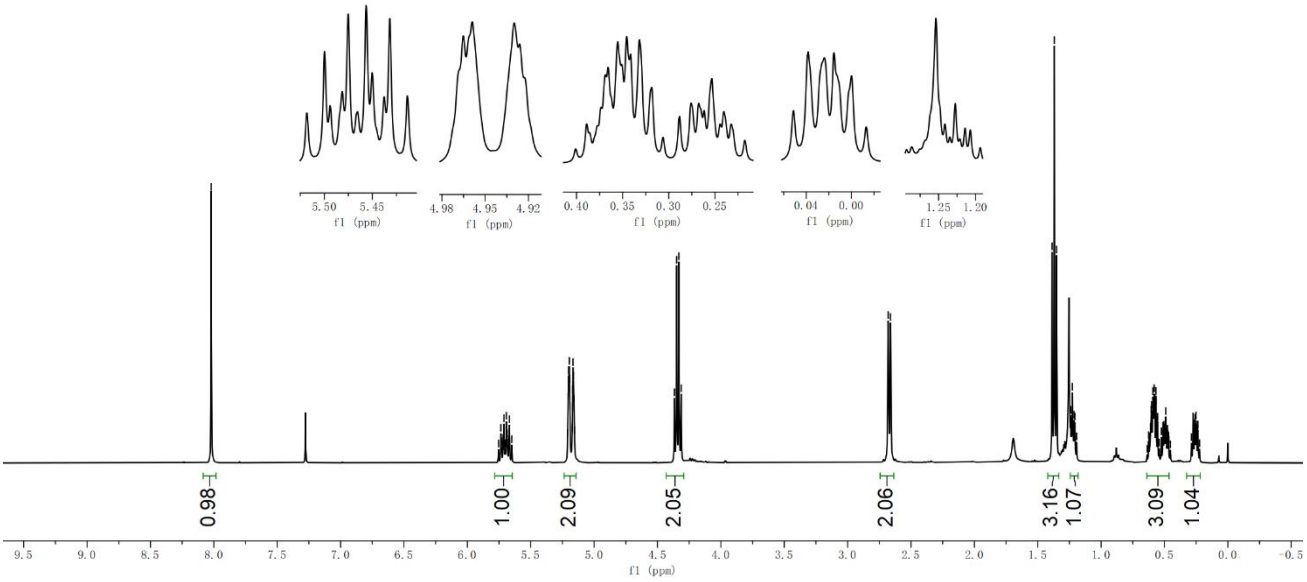


8.02 5.74 5.71 5.69 5.67 5.21 5.20 5.20 5.20 5.20 5.19 5.19 5.17 5.17 5.17 5.17 5.16 5.16 5.15 4.37 4.35 4.33 4.31 2.68 2.66 1.39 1.37 1.35 1.24 1.23 1.23 1.22 1.21 1.21 0.61 0.61 0.60 0.60 0.59 0.59 0.58 0.58 0.57 0.57 0.56 0.55 0.52 0.51 0.51 0.50 0.50 0.50 0.49 0.49 0.48 0.47 0.27 0.27 0.26 0.26 0.25 0.25 0.25 0.24 0.24

Parameter	Value
Title	tanz-20230907-162.9.fid
Solvent	CDCl3
Temperature	293.8
Number of Scans	16
Spectrometer Frequency	400.18

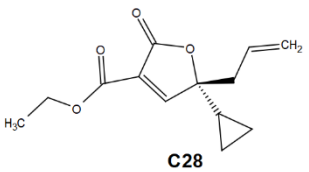


C28

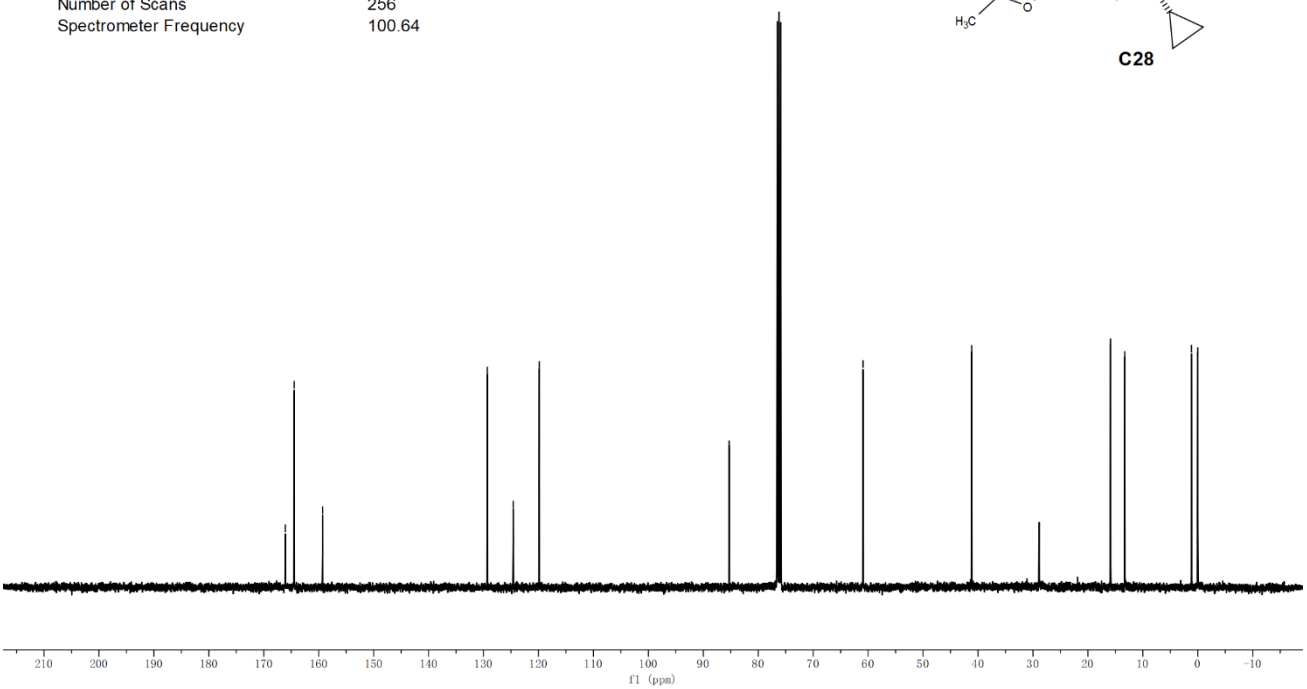


166.09 164.45 159.28 129.33 124.60 119.85 85.30 60.93 41.14 15.88 13.29 1.16 0.00

Parameter	Value
Title	tanz-20230907-162.10.fid
Solvent	CDCl3
Temperature	294.2
Number of Scans	256
Spectrometer Frequency	100.64

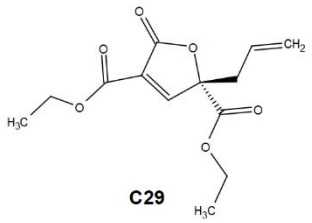


C28

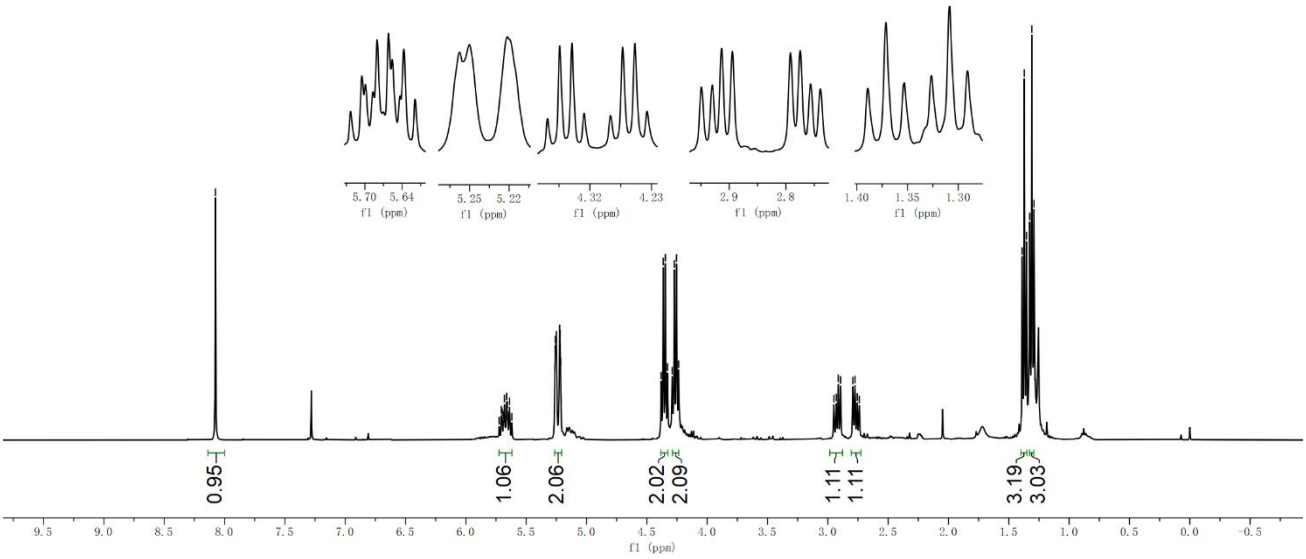


8.08 5.72 5.70 5.70 5.69 5.68 5.67 5.66 5.66 5.64 5.64 5.62 5.26 5.25 5.22 5.22 5.21 5.21 4.38 4.36 4.35 4.33 4.29 4.27 4.25 4.24 2.95 2.93 2.91 2.89 2.79 2.77 2.76 2.74 1.39 1.37 1.35 1.33 1.31 1.29

Parameter	Value
Title	tanz-20230921-167.5.fid
Solvent	CDCl3
Temperature	293.8
Number of Scans	16
Spectrometer Frequency	400.18

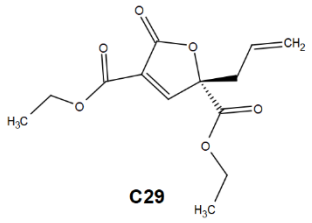


C29

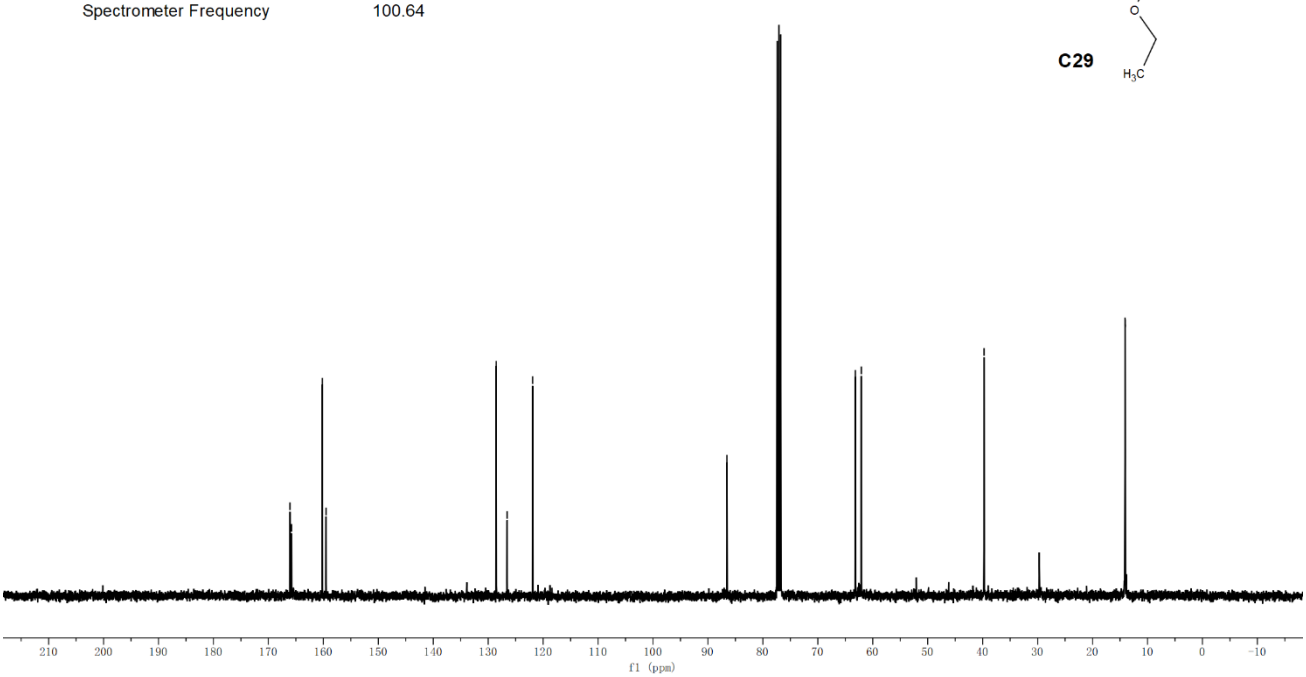


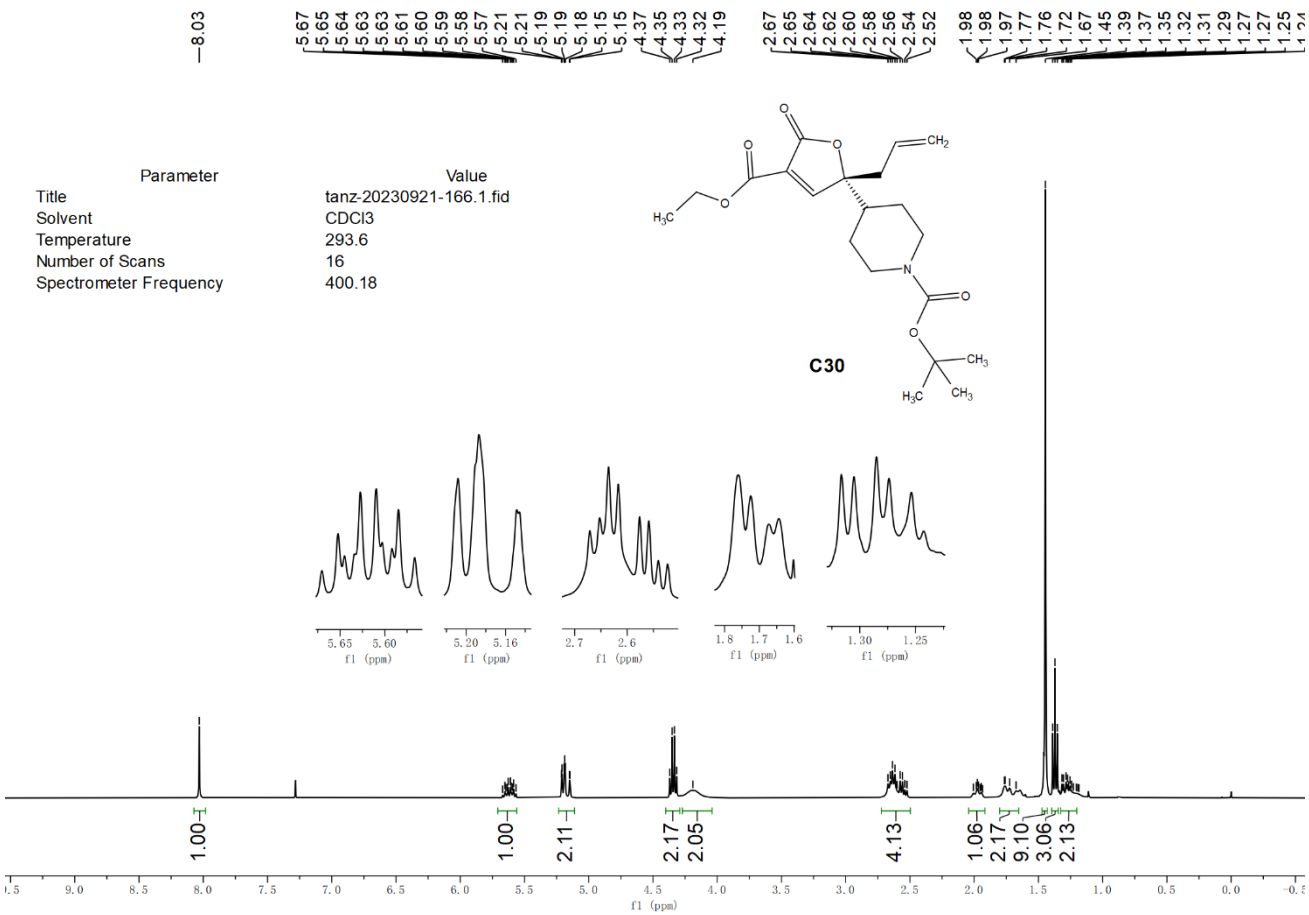
166.08 165.81 160.18 159.50 128.53 126.55 121.92 86.56 63.18 62.08 39.74 14.09 14.07

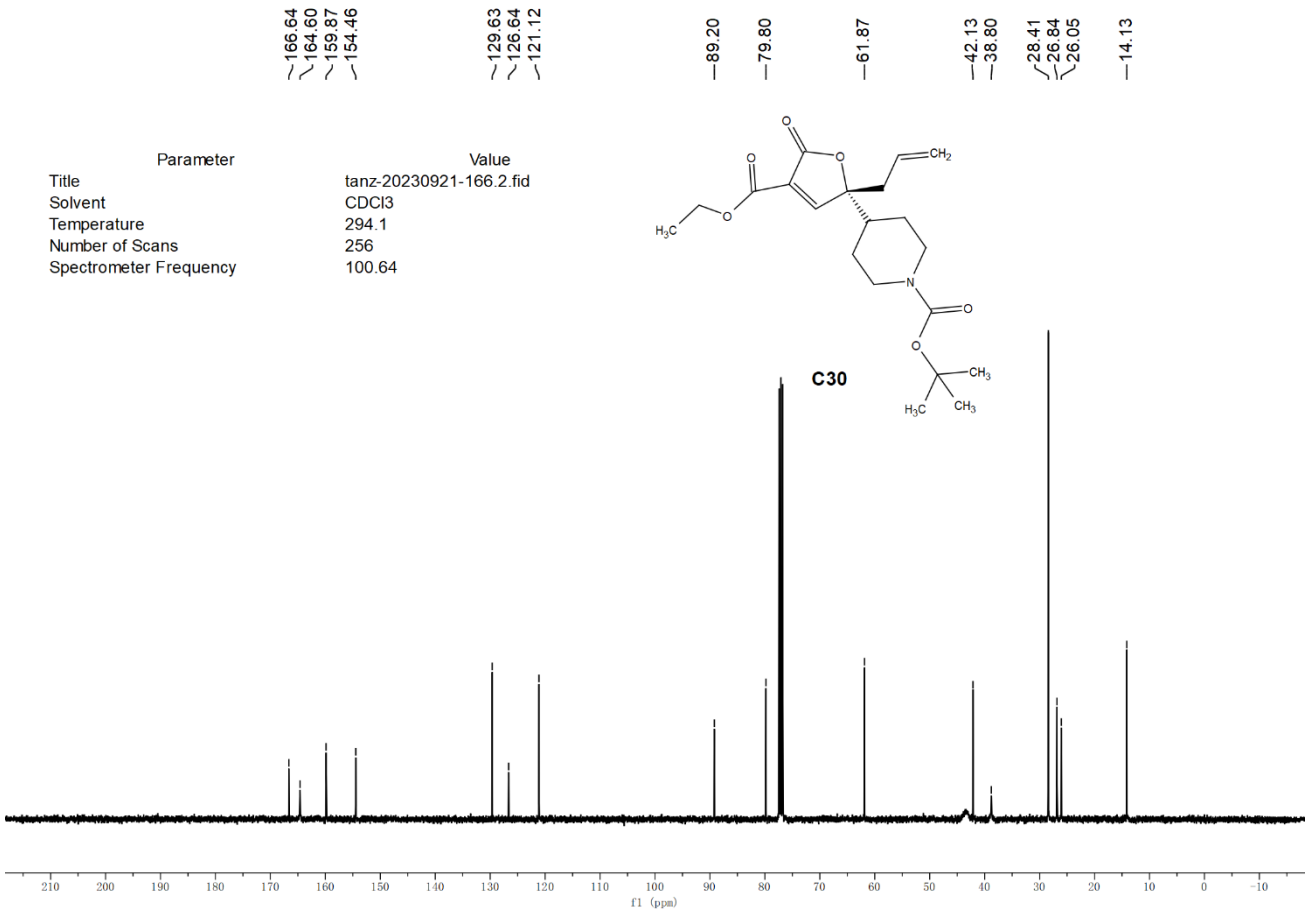
Parameter	Value
Title	tanz-20230921-167.6.fid
Solvent	CDCl3
Temperature	294.3
Number of Scans	256
Spectrometer Frequency	100.64

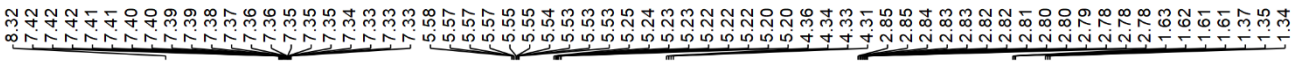


C29

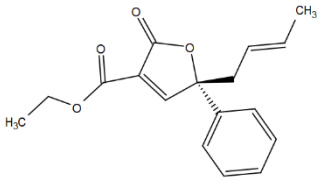



8.03
5.67 5.65 5.64 5.63 5.63 5.61 5.60 5.59 5.58 5.57 5.21 5.21 5.19 5.19 5.18 5.15 5.15
4.37 4.35 4.33 4.32 4.19
2.67 2.65 2.64 2.62 2.60 2.58 2.56 2.54 2.52
1.98 1.98 1.97 1.77 1.76 1.72 1.67 1.45 1.39 1.37 1.35 1.32 1.31 1.29 1.27 1.27 1.25
Parameter Value
Title tanz-20230921-166.1.fid
Solvent CDCl3
Temperature 293.6
Number of Scans 16
Spectrometer Frequency 400.18
C30
5.65 5.60 f1 (ppm)
5.20 5.16 f1 (ppm)
2.7 2.6 f1 (ppm)
1.8 1.7 1.6 f1 (ppm)
1.30 1.25 f1 (ppm)
1.00 1.00 2.11 2.17 2.05 4.13 1.06 2.17 9.10 3.06 2.13
f1 (ppm)

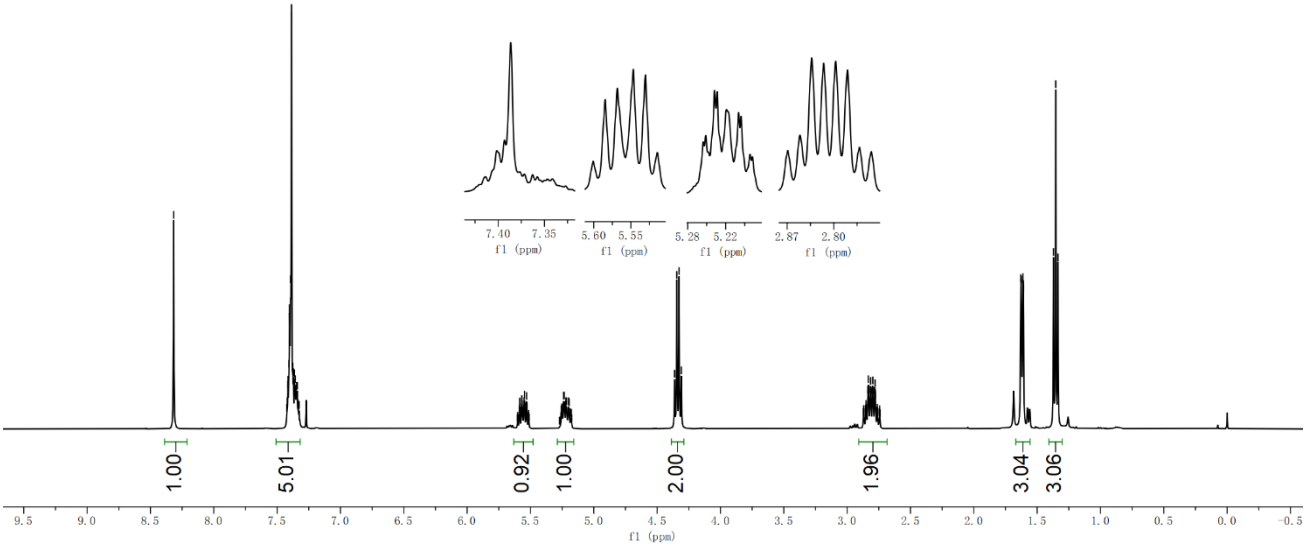

166.64 164.60 159.87 154.46
129.63 126.64 121.12
89.20 79.80 61.87
42.13 38.80 28.41 26.84 26.05 14.13
Parameter Value
Title tanz-20230921-166.2.fid
Solvent CDCl3
Temperature 294.1
Number of Scans 256
Spectrometer Frequency 100.64
C30
f1 (ppm)

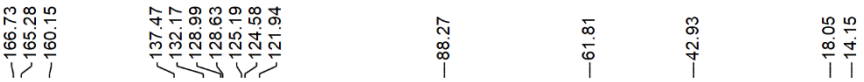


Parameter	Value
Title	tanz-20231122-168.1.fid
Solvent	CDCl3
Temperature	293.3
Number of Scans	16
Spectrometer Frequency	400.18

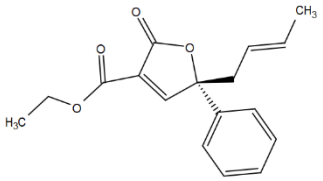


C31

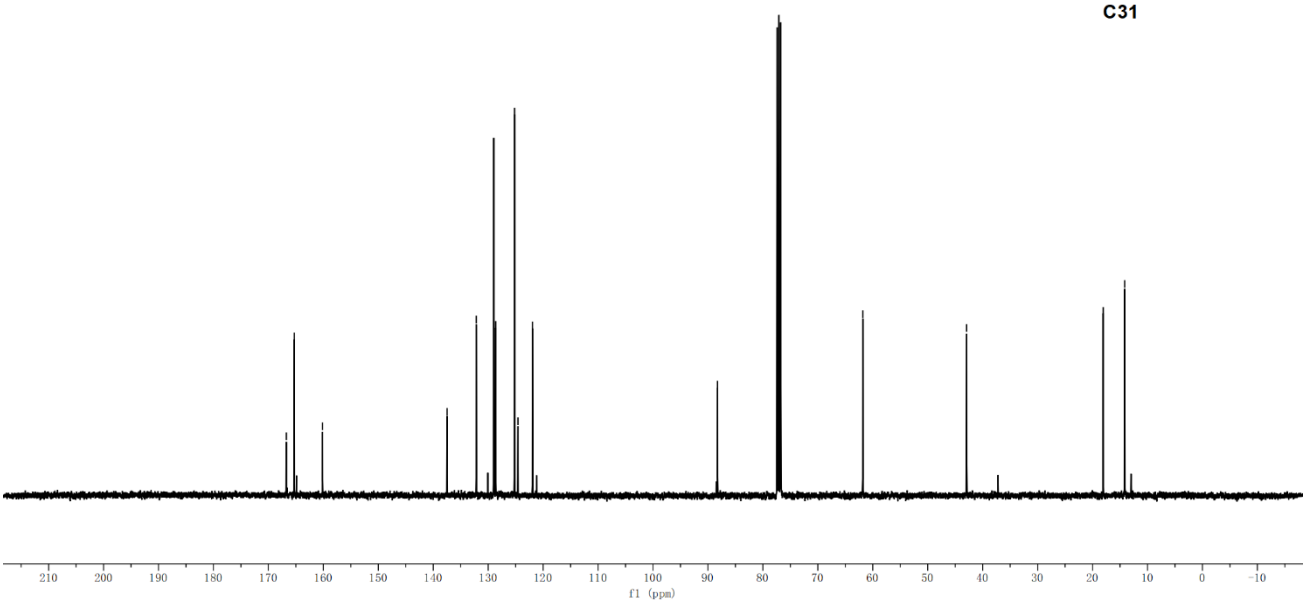


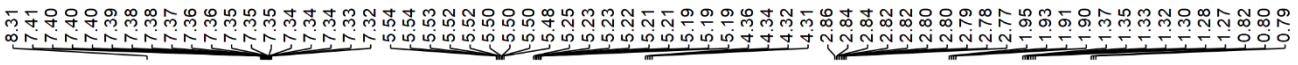


Parameter	Value
Title	tanz-20231122-168.2.fid
Solvent	CDCl3
Temperature	293.9
Number of Scans	256
Spectrometer Frequency	100.64

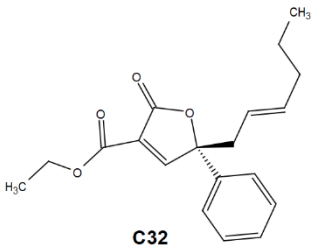


C31

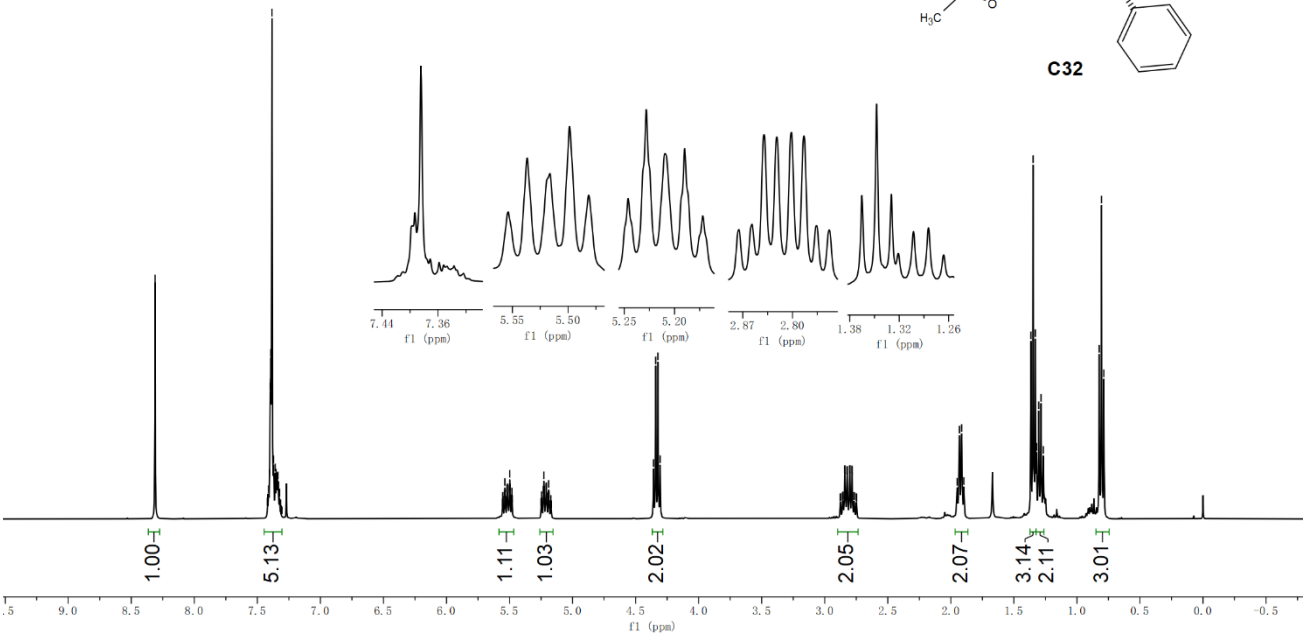




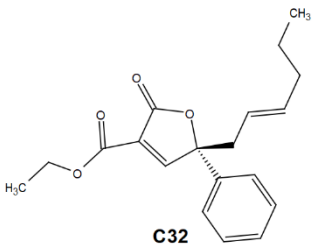
Parameter	Value
Title	tanz-20231122-169.5.fid
Solvent	CDCl3
Temperature	293.6
Number of Scans	16
Spectrometer Frequency	400.18



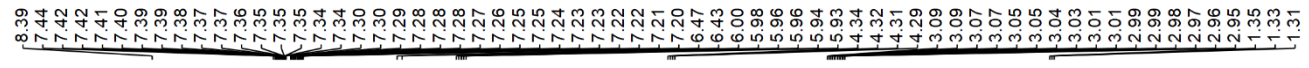
C32



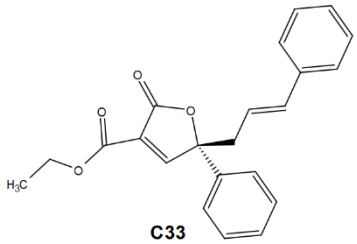
Parameter	Value
Title	tanz-20231122-169.6.fid
Solvent	CDCl3
Temperature	294.0
Number of Scans	256
Spectrometer Frequency	100.64



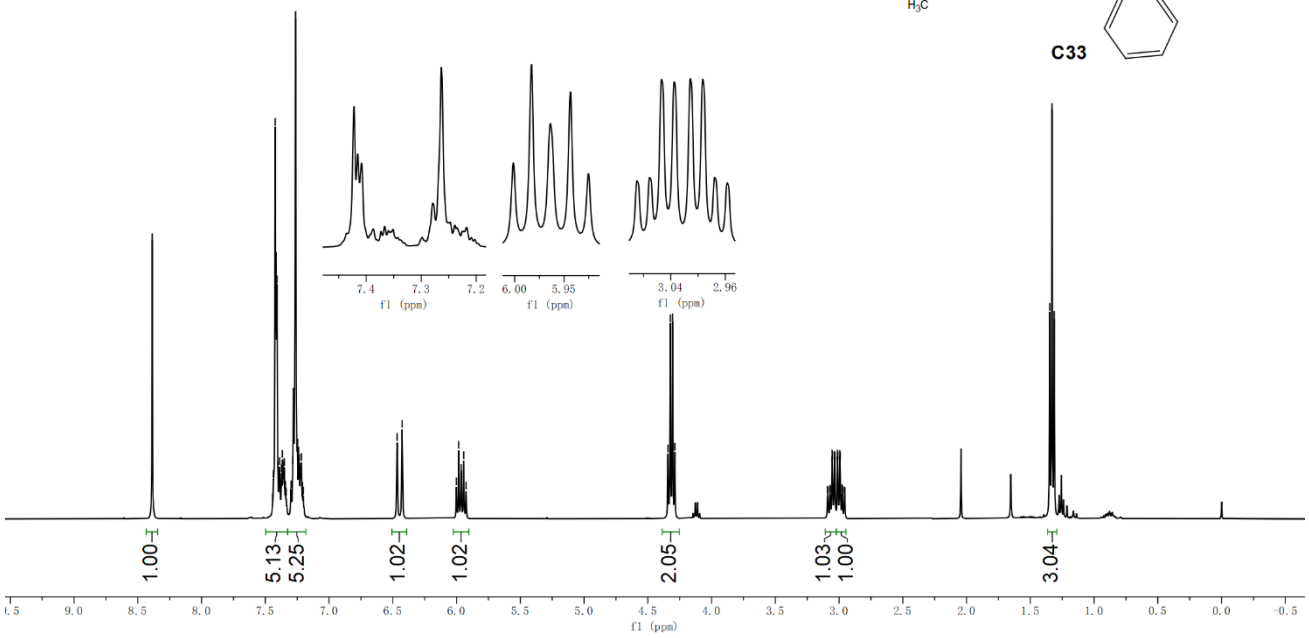
C32



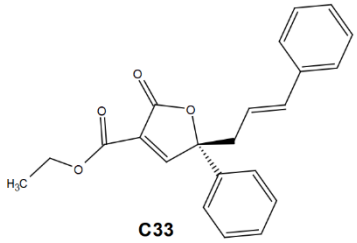
Parameter	Value
Title	tanz-20231220-YHAY-tz-1.1.fid
Solvent	CDCl3
Temperature	293.6
Number of Scans	16
Spectrometer Frequency	400.18



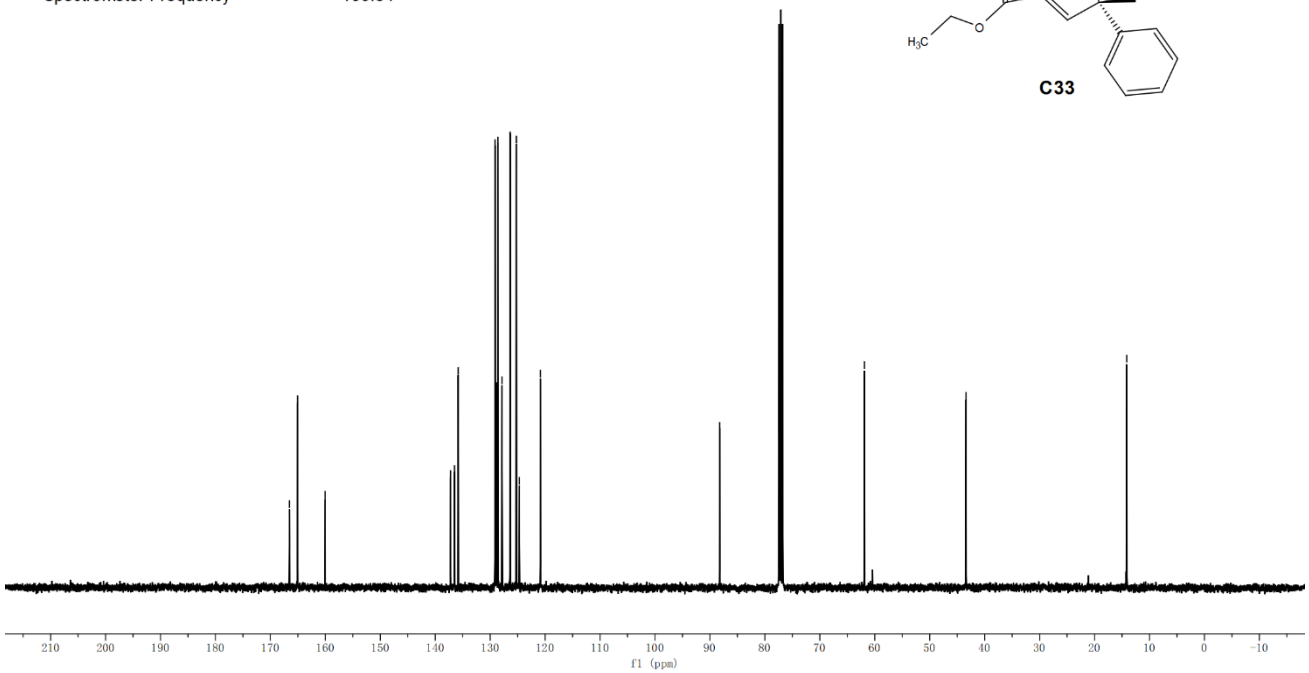
C33

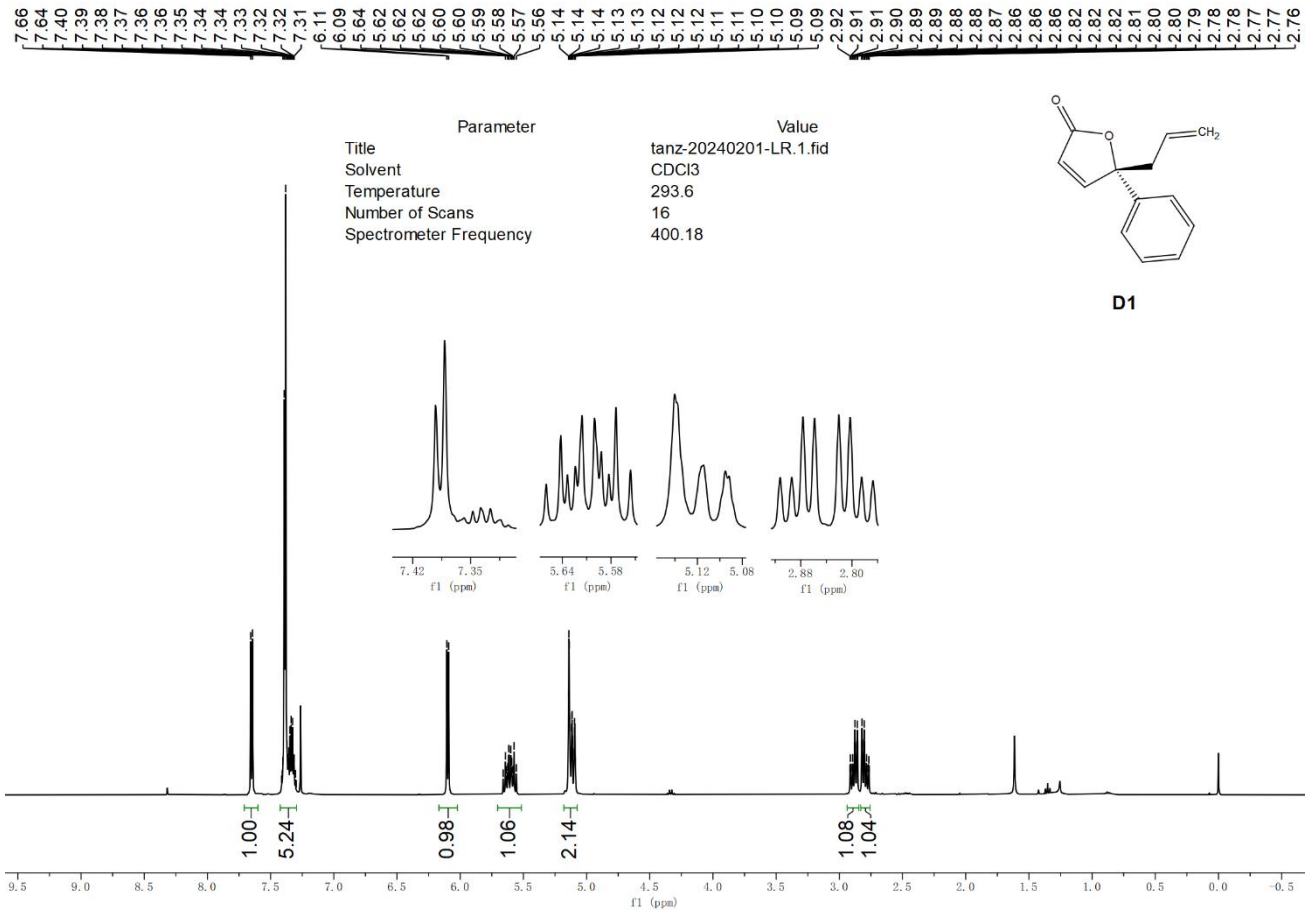


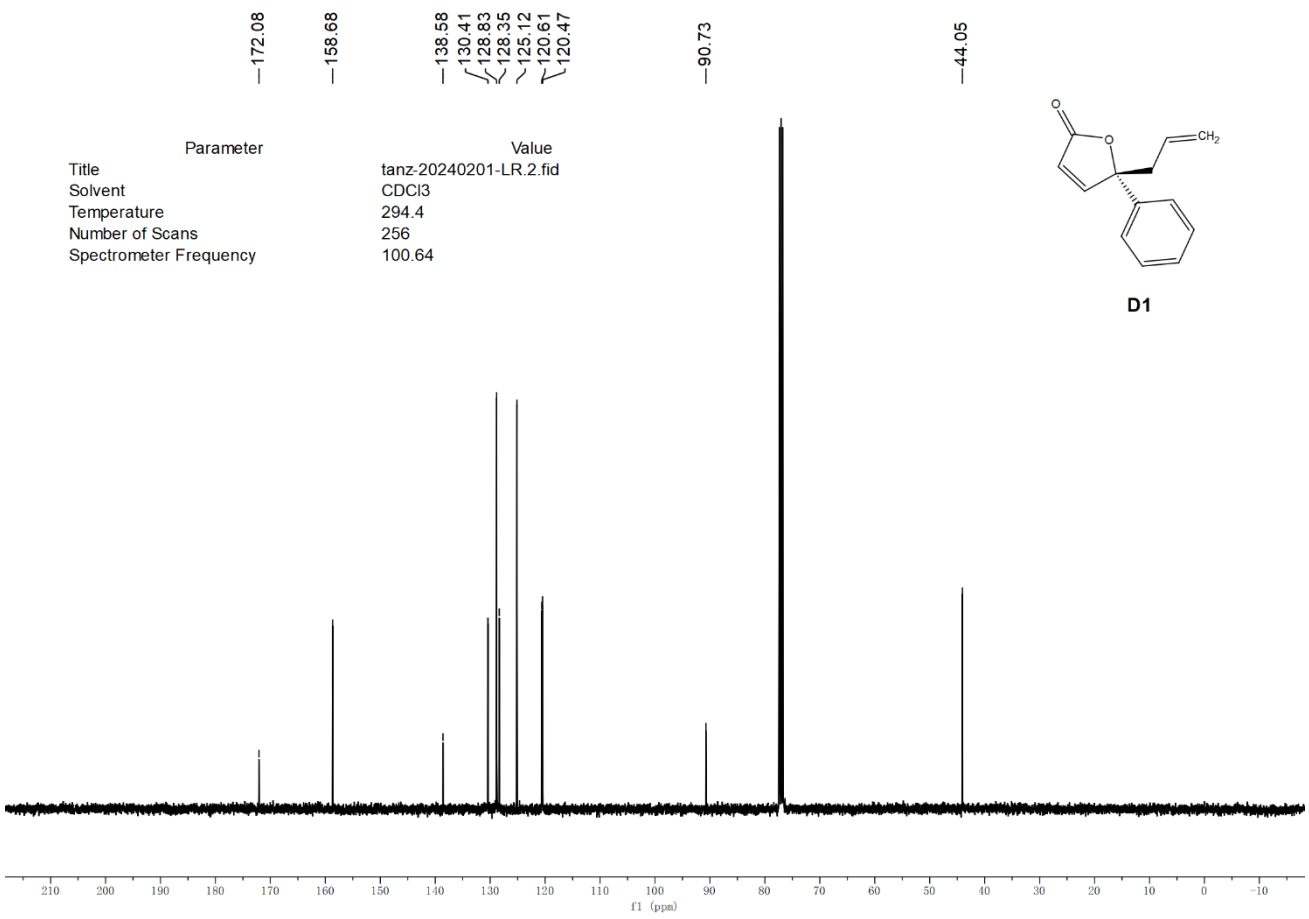
Parameter	Value
Title	tanz-20231220-YHAY-tz-1.2.fid
Solvent	CDCl3
Temperature	293.8
Number of Scans	256
Spectrometer Frequency	100.64

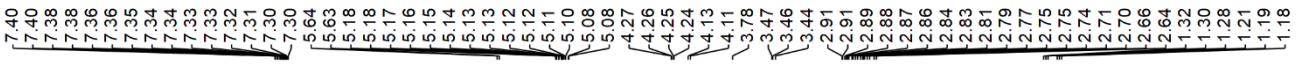


C33

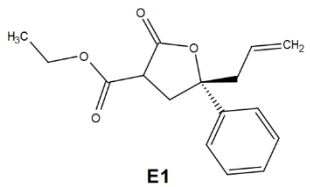



7.66 7.64 7.40 7.39 7.38 7.37 7.36 7.36 7.35 7.34 7.34 7.33 7.32 7.32 7.31 6.11 6.09 5.64 5.62 5.62 5.62 5.60 5.60 5.59 5.58 5.57 5.56 5.14 5.14 5.14 5.13 5.13 5.12 5.12 5.12 5.11 5.11 5.10 5.10 5.09 5.09 2.92 2.91 2.91 2.90 2.89 2.89 2.88 2.88 2.87 2.86 2.86 2.86 2.82 2.82 2.82 2.81 2.80 2.80 2.79 2.78 2.78 2.77 2.77 2.76
Parameter Value
Title tanz-20240201-LR.1.fid
Solvent CDCl3
Temperature 293.6
Number of Scans 16
Spectrometer Frequency 400.18
D1
7.42 7.35 f1 (ppm)
5.64 5.58 f1 (ppm)
5.12 5.08 f1 (ppm)
2.88 2.80 f1 (ppm)
1.00 5.24 0.98 1.06 2.14 1.08 1.04
f1 (ppm)

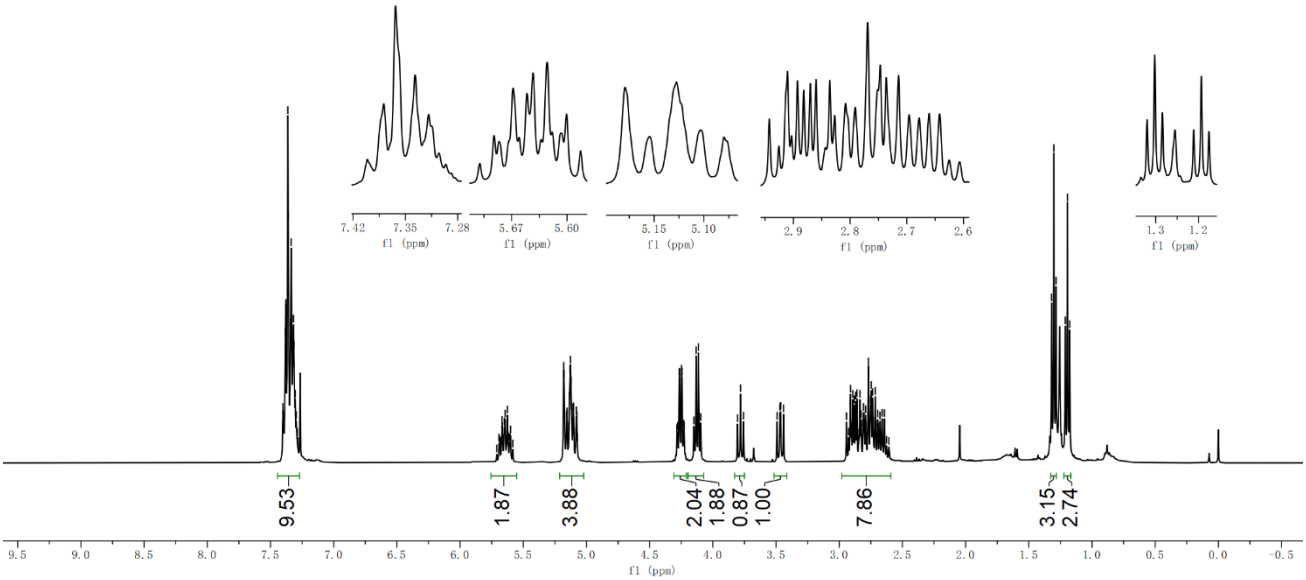

172.08 158.68 138.58 130.41 128.83 128.35 125.12 120.61 120.47 90.73 44.05
Parameter Value
Title tanz-20240201-LR.2.fid
Solvent CDCl3
Temperature 294.4
Number of Scans 256
Spectrometer Frequency 100.64
D1
f1 (ppm)

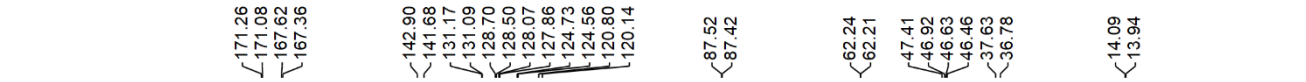


Parameter	Value
Title	tanz-20240201-199.1.fid
Solvent	CDCl3
Temperature	293.8
Number of Scans	16
Spectrometer Frequency	400.18

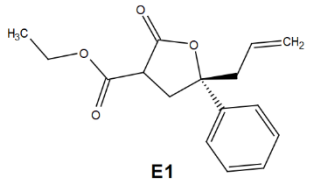


E1





Parameter	Value
Title	tanz-20240201-199.2.fid
Solvent	CDCl3
Temperature	294.3
Number of Scans	256
Spectrometer Frequency	100.64



E1

(L) References

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[2] Wu, Q. Shao, G. Yang and W. Zhang, *Chem. Eur. J.*, 2018, **24**, 1241–1245.
[3] M. Wu, Z. Han, H. Ni, N. Wang, K. Ding and Y. Lu, *Chem. Sci.*, 2022, **13**, 3161–3168.
[4] (*a*) G. M. Sheldrick, *Acta Cryst.* 2008, **A64**, 112–122. (*b*) G. M. Sheldrick, *Acta Cryst.* 2015, **A71**, 3–8. (*c*) G. M. Sheldrick, *Acta Cryst*. 2015, **C71**, 3–8. (*d*) O.V. Dolomanov, L.J. Bourhis, R.J. Gildea, J. A. K. Howard, H. Puschmann, *J. Appl. Cryst*. 2009, **42**, 339–341. (*e*) A. L. Spek, *J. Appl. Cryst.* 2003, **36**, 7–13.