Electronic Supplementary Material (ESI) for Chemical Communications

Gold-catalysed cascade rearrangements of ynamide propargyl esters

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Electronic Supplementary Information

Table of Contents

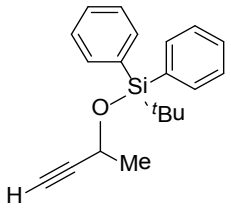
General Information

All reactions were carried out using anhydrous solvents and under an inert atmosphere of nitrogen, unless stated. All reaction vessels were flame dried before use. Solvents were obtained by passing through anhydrous alumina columns using an Innovative Technology Inc. PS-400-7 solvent purification system. All reagents were purchased from commercial suppliers: Acros Organics, Alfa Aesar, Sigma Aldrich or Novabiochem and used without further purification. All reactions were monitored by thin layer chromatography (TLC) using pre-coated MN Alugram Sil G/UV254 silica gel 60 aluminium backed plates. TLC plates were developed using standard techniques, UV light followed by a chemical dip, usually $KMnO_4$ and gentle heating. Flash chromatography was performed on chromatography grade, silica 60Å particle size 35-70 micron from Fisher Scientific using the solvent system as stated.

NMR spectroscopy (^{1}H and ^{13}C) was performed on Brüker Avance 250 (^{1}H 250 MHz), Brüker Avance 300 (^{1}H 300 MHz and ^{13}C 75 MHz), Brüker Avance 400 (^{1}H 400 MHz and ^{13}C 100 MHz) and Brüker Avance 500 (^{1}H 500 MHz and ^{13}C 125 MHz) as stated. Chemical shifts are reported in parts per million (ppm) relative to tetramethylsilane (TMS) ($\delta = 0.00$). Coupling constants are reported in Hertz (Hz) and signal multiplicity is denoted as singlet (s), doublet (d), triplet (t), quartet (q), septet (sept), multiplet (m), and broad (br). Mass spectroscopy was performed on a Brüker μTOF using electrospray ionisation (ESI) in either positive or negative ionisation as stated. Infra-red spectroscopy was carried out using a Perkin Elmer Spectrum RX FT-IR system with KBr plates, using a thin film. Melting points were determined using a Bibby Scientific Melting point apparatus Stuart SMP10 digital.

Experimental Data

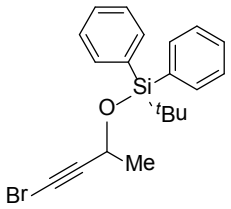
But-3-yn-2-yloxy)(*tert*-butyl)diphenylsilane[1]



To a solution of 3-butyn-2-ol (900 µL, 11.4 mmol, 1 equiv.) in THF (35 mL) was added triethylamine (3.30 mL, 22.7 mmol, 2 equiv.), TBDPSCl (3.20 mL, 12.5 mmol, 1.1 equiv.) and DMAP (140 mg, 1.14 mmol, 10 mol%). The resultant mixture was stirred at rt for 18 h, diluted with hexane (150 mL) and washed with NH_4Cl (sat) (150 mL) and brine (150 mL) and dried over $MgSO_4$, filtered and concentrated *in vacuo*. Purification via flash chromatography, eluting with 100 % Pet, afforded the title compound as a clear oil (3.27 g, 94 %).

FTIR (thin film) υ_{max}: 3306, 3072, 3050, 2983, 2960, 2932, 2891, 2858; ^{1}H NMR (250 MHz, $CDCl_3$) δ_H: 7.71–7.57 (4H, m), 7.40–7.24 (6H, m), 4.38 (1H, dq, J = 6.5, 2.1 Hz), 2.25 (1H, d, J = 2.1 Hz), 1.31 (3H, d, J = 6.5 Hz), 1.00 (9H, s); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C 136.4, 136.2, 134.1, 133.8, 130.2, 130.1, 128.0, 127.9, 86.5, 71.0, 31.3, 27.3, 25.6, 19.6; MS (ESI:+ve) *m/z*: calcd for $C_{20}H_{24}NaOSi$: 331.1294, found: 331.1496 [M + Na^+].

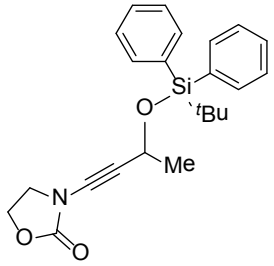
4-Bromobut-3-yn-2-yloxy)(*tert*-butyl)diphenylsilane[2]



To a solution of the silyl ether **271** (10.0 g, 33.0 mmol, 1 equiv.) in acetone (180 mL) was added *N*-bromosuccinimide (6.46 g, 36.3 mmol, 1.1 equiv.) and $AgNO_3$ (560 mg, 3.30 mmol, 10 mol%). The resultant mixture was stirred at rt for 3 h, diluted with $CHCl_3$ (180 mL), filtered through a pad of celite and concentrated *in vacuo*. Purification via flash chromatography, eluting with 100 % Pet, afforded the title product (11.25 g, 88 %) as a light yellow oil.

FTIR (film/cm^{-1}) υ_{max}: 3076, 2985, 2964, 2932, 2894, 2864; ^{1}H NMR (250 MHz, $CDCl_3$) δ_H: 7.68–7.56 (4H, m), 7.39–7.25 (6H, m), 4.37 (1H, q, J = 6.5 Hz), 1.31 (3H, d, J = 6.5Hz) 0.99 (9H, s); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 136.3, 136.2, 134.0, 133.8, 130.2, 130.1, 128.0, 127.9, 82.7, 61.2, 44.3, 27.2, 25.4, 19.6; MS (ESI:+ve) *m/z*: calcd for $C_{20}H_{23}NaOSiBr$: 409.0599, found: 409.0580 [M + Na$^+$].

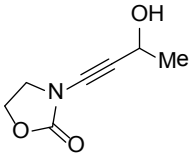
3-(3-(*tert*-Butyldiphenylsilyloxy)but-1-ynyl)oxazolidin-2-one[3]



To a solution of **272** (1.50 g, 3.80 mmol, 1.1 equiv.) and oxazolidinone (300 mg, 3.50 mmol, 1 equiv.) in toluene (50 mL) was added $CuSO_4.5H_2O$ (175 mg, 0.70 mmol, 20 mol%), 1,10-phenanthroline (250 mg, 1.40 mmol, 40 mol%) and K_3PO_4 (1.50 g, 7.00 mmol, 2 equiv.). The suspension was then refluxed for 48 h, filtered through celite and concentrated *in vacuo*. Purification via flash chromatography, eluting with 4:1 Pet/EtOAc, afforded the title compound as a white powder (0.88g, 64%). Recrysallisation (Pet/CH_2Cl_2) afforded the title compound as colourless crystals.

MP: 110–112; FTIR (film/cm^{-1}) υ_{max}: 2929, 2856, 2262, 1777; ^{1}H NMR (250 MHz, $CDCl_3$) δ_H: 7.71–7.59 (4H, m), 7.36–7.26 (6H, m), 4.58 (1H, q, J = 6.5), 4.25 (2H, t, J = 8.0 Hz), 3.51 (2H, m), 1.37 (3H, d, J = 6.5 Hz), 0.99 (9H, s); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 156.2, 136.4, 136.2, 134.3, 134.1, 130.1, 129.9, 128.0, 127.8, 74.6, 73.9, 63.2, 60.5, 47.0, 27.3, 25.5, 19.5; MS (ESI:+ve) *m/z*: calcd for $C_{23}H_{28}NO_3Si$: 394.1838, found: 394.1822 [M + H$^+$]

3-(3-Hydroxybut-1-ynyl)oxazolidin-2-one[2]

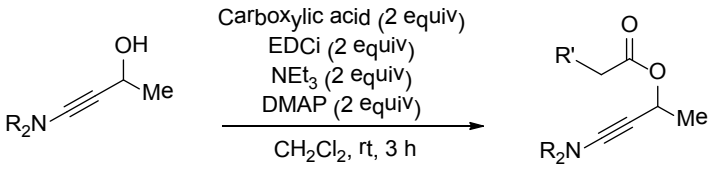


To a solution of the protected ynamide **274** (3.00g, 7.60 mmol, 1 equiv.) in THF (175 mL) was added TBAF (1M in THF, 15.2 mL, 15.2 mmol, 2 equiv.) at 0 ^{o}C. The resultant solution was then warmed to rt,

after 40 min the reaction mixture was hydrolysed with NH_4Cl (sat) (25 mL) and extracted with EtOAc (3 × 25 mL). The combined extracts were dried over $MgSO_4$, filtered and concentrated *in vacuo*. The crude material was purified by rapid filtration through silica gel, eluting with 100% EtOAc, to give alcohol **266** as a clear oil (1.03 g, 87%).

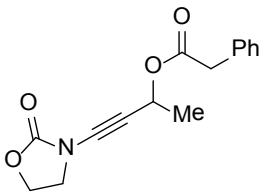
FTIR (film/cm^{-1}) υ_{max}: 3245, 2924, 2854, 1765; ^1H NMR (250 MHz, $CDCl_3$) δ_H: 4.68 (1H, q, J = 6.6 Hz), 4.48–4.26 (2H, m), 3.94–3.87 (2H, m), 2.49 (1H, br s), 1.47 (3H, d, J = 6.6Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 156.3, 74.1, 73.4, 63.1, 58.3, 46.8, 24.2; MS (ESI:+ve) *m/z*: calcd for $C_7H_9NNaO_3$: 178.0480, found: 178.0476 [M + Na^+].

***General procedure for the preparation of ynamide esters*[157]**



To a solution of EDCi (2 equiv) in CH_2Cl_2 was successively added triethylamine (2 equiv), DMAP (20 mol%), carboxylic acid (2 equiv) and *N*-substituted propargylic alcohol (1 equiv.). After 3 hours at room temperature the resultant solution was washed with 10% citric acid (3 x 10 mL), $NaHCO_3$ (sat) (3 x 10 mL) and brine (10 mL). The organic extract was then dried over $MgSO_4$ and concentrated *in vacuo*. The crude mixture was then subjected to column chromatography for purification, eluting with 4:1 Pet/EtOAc.

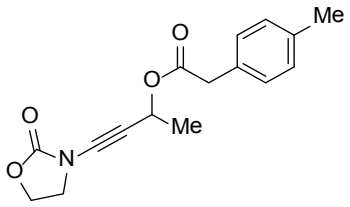
4-(2-Oxooxazolidin-3-yl)but-3-yn-2-yl 2-phenylacetate (1a)



Prepared according to general procedure using 3-(3-hydroxybut-1-ynyl)oxazolidin-2-one (290 mg, 1.89 mmol, 1 equiv.), phenylacetic acid (510 mg, 3.78 mmol, 2 equiv.), EDCi (720 mg, 3.78 mmol, 2 equiv.), triethylamine (550 µL, 3.78 mmol, 2 equiv.), DMAP (50 mg, 0.76 mmol, 20 mol%) and CH_2Cl_2 (30 mL). Purification was achieved by recrystallization from CH_2Cl_2/hexane to afford **1a** as colourless crystals (0.45 g, 88 %).

MP: 115–116; FTIR (film/cm^{-1}) υ_{max}: 3031, 2991, 2915, 2262, 1760, 1733; ^{1}H NMR (250 MHz, $CDCl_3$) δ_H: 7.40-7.30 (5H, m), 5.64 (1H, q, J = 6.8 Hz) 4.46 (2H, m), 3.92 (2H, m), 3.66 (2H, s), 1.55 (3H, d, J = 6.8 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 170.5, 155.9, 133.7, 129.3, 128.6, 127.1, 75.1, 70.1, 63.1, 61.0, 46.7, 41.2, 21.3; MS (ESI:+ve) *m/z*: calcd for $C_{15}H_{15}NNaO_4$: 296.0899, found: 296.0899 $[M + Na]^+$.

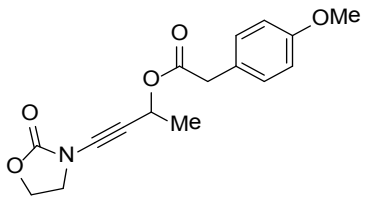
4-(2-Oxooxazolidin-3-yl)but-3-yn-2-yl 2-(p-tolyl)acetate (1b)



Prepared according to general procedure using; 3-(3-hydroxybut-1-ynyl)oxazolidin-2-one (331 mg, 2.14 mmol, 1 equiv.), 2-(*p*-tolyl)acetic acid (643 mg, 4.28 mmol, 2 equiv.), EDCi (821 mg, 4.28 mmol, 2 equiv.), NEt_3 (591 µL, 4.28 mmol, 2 equiv.), DMAP (53 mg, 0.43 mmol, 20 mol%) and CH_2Cl_2 (40 mL). Purification was achieved by flash chromatography affording ester **1b** as an orange solid (0.64 g, 99%). Recrystallisation (Pet/ CH_2Cl_2) afforded the title compound as yellow crystals.

MP: 103–105 °C; FTIR (film/cm^{-1}) υ_{max}: 2986, 2264, 1768, 1735, 1520; ^{1}H NMR (300 MHz, $CDCl_3$) δ_H: 7.20 – 7.17 (2H, m), 7.16 – 7.13 (2H, m), 5.62 (1H, q, J = 6.7 Hz), 4.46 – 4.41 (2H, m), 3.93 – 3.88 (2H, m), 3.60 (2H, s), 2.35 (3H, s), 1.53 (3H, d, J = 6.7 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 171.1, 155.9, 137.1, 130.7, 129.2, 129.1, 77.2, 70.2, 63.0, 61.0, 46.7, 40.8, 21.3, 21.1; MS (ESI:+ve) *m/z*: calcd for $C_{16}H_{17}NO_4Na$: 310.1055, found: 310.1039 $[M + Na]^+$

4-(2-Oxooxazolidin-3-yl)but-3-yn-2-yl 2-(4-methoxyphenyl)acetate (1c)

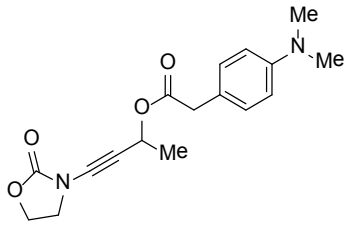


Prepared according to general procedure using; 3-(3-hydroxybut-1-ynyl)oxazolidin-2-one (343 mg, 1.89 mmol, 1 equiv.), 2-(4-methoxyphenyl)acetic acid (732 mg, 3.78 mmol, 2 equiv.), EDCi (844 mg, 4.36

mmol, 2 equiv.), triethylamine (603 µL, 4.36 mmol, 2 equiv.), DMAP (0.03g, 0.22 mmol, 20 mol%) and CH_2Cl_2 (35 mL). Purification was achieved by flash chromatography yielding ester **1c** as a yellow solid (0.53g, 79%). Recrystallisation (Pet/ CH_2Cl_2) afforded the title compound as yellow crystals.

MP: 74–76 °C; FTIR (film/cm^{-1}) υ_{max}: 2941, 2838, 2264, 1769, 1735, 1612, 1512; ^{1}H NMR (300 MHz, $CDCl_3$) δ_H: 7.24–7.16 (2H, m), 6.91–6.82 (2H, m), 5.61 (1H, q, J = 6.8 Hz), 4.47–4.38 (2H, m), 3.93–3.84 (2H, m), 3.80 (3H, s), 3.57 (2H, s), 1.52 (3H, d, J = 6.8 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 171.2, 159.1, 138.0, 130.7, 126.1, 114.4, 77.6, 70.6, 63.4, 61.4, 55.7, 47.1, 40.8, 21.7; MS (ESI:+ve) *m/z*: calcd for $C_{16}H_{18}NO_5$: 304.1185, found: 304.1190 $[M + H]^+$.

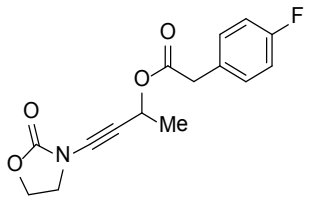
4-(2-Oxooxazolidin-3-yl)but-3-yn-2-yl 2-(4-(dimethylamino)phenyl)acetate (1d)



Prepared according to general procedure using; 3-(3-hydroxybut-1-ynyl)oxazolidin-2-one (674 mg, 4.40 mmol, 1 equiv.), 2-(4-(dimethylamino)phenyl)acetic acid (1.57 g, 8.80 mmol, 2 equiv.), EDCi (1.73 g, 8.8 mmol, 2 equiv.), triethylamine (1.21 mL, 8.80 mmol, 2 equiv.), DMAP (106 mg, 0.88 mmol, 20 mol%) and CH_2Cl_2 (60 mL). Purification was achieved by flash chromatography yielding ester **1d** as a yellow solid (0.93 g, 68%). Recrystallisation (Pet/ CH_2Cl_2) afforded the title compound as yellow crystals.

MP: 133–135 °C; FTIR (film/cm^{-1}) υ_{max}: 2982, 2890, 2268, 1773, 1735, 1615; ^{1}H NMR (250 MHz, $CDCl_3$) δ_H:7.18-7.11 (2H, m), 6.73-6.65 (2H, m), 5.60 (1H, q, J = 6.7 Hz), 4.40 (2H, dd, J = 7.6, 6.6 Hz), 3.87 (2H, dd, J = 7.6, 6.6Hz), 3.52 (2H, s), 2.92 (6H, s), 1.51 (3H, d, J = 6.7 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 171.2, 155.9, 129.9, 121.5, 122.8, 75.0, 70.3, 63.0, 60.8, 46.7, 40.7, 40.2, 21.4; MS (ESI:+ve) *m/z*: calcd for $C_{17}H_{21}N_2O_4$: 317.1501, found: 317.1498 $[M + H]^+$

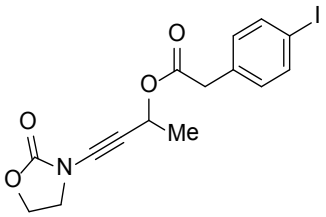
4-(2-Oxooxazolidin-3-yl)but-3-yn-2-yl 2-(4-fluorophenyl)acetate (1e)



Prepared according to general procedure using; 3-(3-hydroxybut-1-ynyl)oxazolidin-2-one (674 g, 4.40 mmol, 1 equiv.), 2-(4-fluorophenyl)acetic acid (1.35 g, 8.80 mmol, 2 equiv.), EDCi (1.73 g, 8.80 mmol, 2 equiv.), triethylamine (1.21 mL, 8.80 mmol, 2 equiv.), DMAP (106 mg, 0.88 mmol, 20 mol%) and CH_2Cl_2 (60 mL). Purification was achieved by flash chromatography yielding ester **1e** as an amorphous yellow solid (0.72g, 57%).

FTIR (film/cm^{-1}) υ_{max}: 2982, 2890, 2267, 1769, 1734, 1603; ^{1}H NMR (250 MHz, $CDCl_3$) δ_H: 7.30-7.17 (2H, m), 7.05-6.94 (2H, m), 6.60 (1H, q, *J* = 6.7 Hz), 4.42 (2H, dd, *J* = 8.0, 6.7 Hz), 3.87 (2H, dd, *J* = 8.0, 6.7 Hz), 3.59 (2H, s), 1.51 (3H, d, *J* = 6.7 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 170.4, 162.0 (d, J = 245.8 Hz), 155.8, 130.9, 130.8, 129.4 (d J = 4.6 Hz), 115.4 (d, J = 22.1 Hz), 75.2, 70.0, 63.1, 61.2, 46.7, 40.4, 21.4; MS (ESI:+ve) *m/z*: calcd for $C_{15}H_{14}FNNaO_4$: 314.0805, found: 314.0787 $[M + Na]^+$

4-(2-Oxooxazolidin-3-yl)but-3-yn-2-yl 2-(4-iodophenyl)acetate (1f)

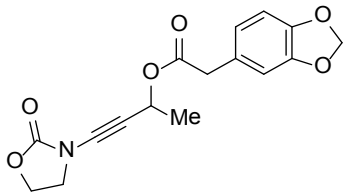


Prepared according to general procedure using; 3-(3-hydroxybut-1-ynyl)oxazolidin-2-one (342 mg, 2.21 mmol, 1 equiv.), 2-(4-iodophenyl)acetic acid (904 mg, 3.42 mmol, 2 equiv.), EDCi (843 mg, 3.42 mmol, 2 equiv.), triethylamine (598 mL, 3.42 mmol, 2 equiv.), DMAP (27 mg, 0.22 mmol, 20 mol%) and CH_2Cl_2 (30 mL). Purification was achieved by flash chromatography yielding ester **1f** as a yellow solid (0.62g, 71%). Recrystallisation (Pet/ CH_2Cl_2) afforded the title compound as yellow crystals.

MP: 92–94 °C; FTIR (film/cm^{-1}) υ_{max}: 2988, 2263, 1766, 1732, 1589; ^{1}H NMR (300 MHz, $CDCl_3$) δ_H: 7.65 (2H, app.d, *J* = 8.5 Hz), 7.04 (2H, app. d, *J* = 8.5 Hz), 5.60 (1H, q, *J* = 6.9 Hz), 4.45 (1H, d, *J* = 7.8

Hz), 4.42 (1H, d, *J* = 6.6 Hz), 3.90 (1H, d, *J* = 6.6 Hz), 3.87 (1H, d, *J* = 7.8 Hz), 3.57 (2H, s), 1.51 (3H, d, *J* = 6.9 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 169.9, 155.9, 137.6, 133.3, 131.4, 92.7, 75.5, 69.9, 63.1, 61.3, 46.7, 40.7, 21.4; MS (ESI:+ve) *m/z*: calcd for: $C_{15}H_{14}NO_4INa$, 421.9866 found: 422.0001 $[M + Na]^+$

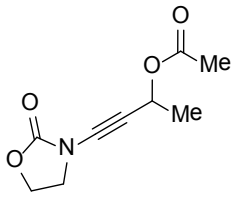
4-(2-Oxooxazolidin-3-yl)but-3-yn-2-yl 2-(benzo[d][1,3]dioxol-5-yl)acetate (1g)



Prepared according to general procedure using; 3-(3-hydroxybut-1-ynyl)oxazolidin-2-one (671 g, 4.40 mmol, 1 equiv.), 2-(benzo[*d*][1,3]dioxol-5-yl)acetic acid (1.58 g, 8.80 mmol, 2 equiv.), EDCi (1.72 g, 8.80 mmol, 2 equiv.), triethylamine (1.21 mL, 8.80 mmol, 2 equiv.), DMAP (106 mg, 0.88 mmol, 20 mol%) and CH_2Cl_2 (60 mL). Purification was achieved by flash chromatography yielding ester **1g** as a yellow solid (0.81 g, 60%). Recrystallisation (Pet/ CH_2Cl_2) afforded the title compound as yellow crystals.

MP: 107–109 °C; FTIR (film/cm^{-1}) υ_{max}: 2982, 2890, 2267, 1768, 1733, 1613; ^{1}H NMR (250 MHz, $CDCl_3$) δ_H: 6.79-6.67 (3H, m), 5.93 (2H, s), 5.59 (1H, q, *J* = 6.7 Hz), 4.41 (2H, dd, *J* = 7.8, 6.7 Hz), 3.88 (2H, dd, *J* = 7.8, 6.7 Hz), 3.52 (2H, s), 1.51 (3H, d, *J* = 6.7 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 170.6, 155.9, 147.2, 146.8, 127.2, 122.5, 109.7, 108.3, 101.0, 75.2, 70.1, 63.0, 61.1, 46.7, 40.8, 21.4; MS (ESI:+ve) *m/z*: calcd for $C_{16}H_{15}NNaO_6$: 340.0797, found: 340.0776.

4-(2-Oxooxazolidin-3-yl)but-3-yn-2-yl acetate[4] (1h)

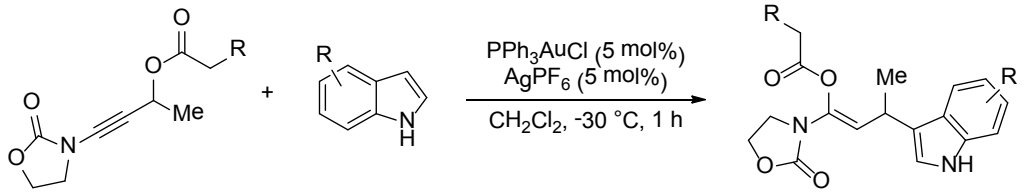


Acetic anhydride (356 µL, 3.77 mmol, 1.1 equiv.), Et_3N (715 µL, 5.15 mmol, 1.75 equiv.) and DMAP (42 mg, 0.34 mmol, 10 mol%) were added to a round bottomed flask containing CH_2Cl_2 (20 mL) followed by 3-(3-hydroxybut-1-ynyl)oxazolidin-2-one (531mg, 3.43 mmol, 1 equiv.) in CH_2Cl_2 (5 mL)

was added and the reaction was allowed to stir at room temperature for 3 hours. Upon completion, the reaction was concentrated *in vacuo* and subjected to column chromatography, eluting with 2:1 Pet/EtOAc, affording **1h** as a clear oil (603 mg, 89 %).

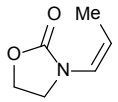
FTIR (thin film) υ_{max}: 2968, 2938, 2877, 2267, 1770, 1712; ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 5.59 (1H, q, J = 6.7 Hz), 4.46–4.42 (2H, m), 3.94–3.90 (2H, m), 2.07 (3H, s), 1.53 (3H, d, J = 6.7 Hz); ^{13}C NMR (125 MHz, $CDCl_3$) δ_C: 169.9, 155.9, 74.9, 70.2, 63.0, 60.6, 46.7, 21.4, 21.1; HRMS (ESI, +ve) *m/z*: calcd. for $C_9H_{11}NO_4Na$: 220.0586, found: 220.0585 $[M + Na]^+$.

General procedure for the [3,3]-rearrangement and nucleophilic addition of ynamido esters



To a solution of indole (1 equiv.) and ynamido ester (1 equiv.) in CH_2Cl_2 at -30 °C was added PPh_3AuCl (2.5 mol%) followed by $AgPF_6$ (2.5 mol%) portion-wise after 10 min. A further addition of PPh_3AuCl (2.5 mol%) followed by $AgPF_6$ (2.5 mol%) portion-wise after 20 min, before stirring for a further 25 min. Upon consumption of starting material, the reaction was filtered through a pad of silica and concentrated *in vacuo*. Purification was achieved by flash chromatography, eluting with 2:1 Pet/EtOAc.

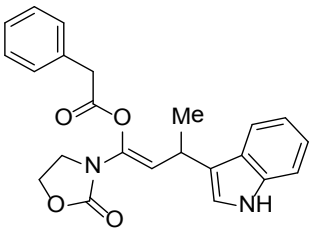
(*Z*)-3-(But-2-enoyl)oxazolidin-2-one (*Z*-2)



To a solution of **1a** (50 mg, 0.18 mmol, 1 equiv.) in CH_2Cl_2 (2 mL) was added $AuCl(PPh_3)$ (4.5 mg, 0.01 mmol, 5 mol%) and $AgSbF_6$ (3.4 mg, 0.01 mmol, 5 mol%). The reaction mixture was allowed to stir at room temperature for 5 minutes before being filitered through a pad of silica. Purification by flash chromatography afforded ***Z*-2** as a light yellow oil (1 mg, 4%).

FTIR (film/cm^{-1}) υ_{max}: 2981, 2920, 1770, 1679, 1628; ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 7.03 (1H, dq, J = 11.7, 1.8 Hz), 6.49 (1H, dq, J = 11.7, 7.3 Hz), 4.42 (2H, app. t, J = 8.0 Hz), 4.07 (2H, app. t, J = 8.0 Hz), 2.16 (3H, dd, J = 7.3, 1.8 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 165.2, 153.5, 146.8, 119.7, 62.0, 42.5, 16.2; MS (ESI:+ve) *m/z*: calcd for $C_7H_9NO_3Na$: 178.0480, found: 178.0495, $[M + Na]^+$.

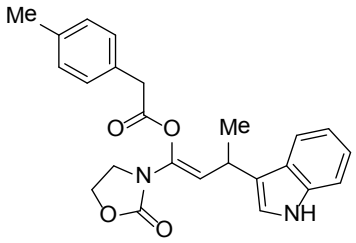
(*Z*)-3-(1H-Indol-3-yl)-1-(2-oxooxazolidin-3-yl)but-1-en-1-yl 2-phenylacetate (4a)



Prepared according to general procedure D using, indole (21 mg, 0.18 mmol, 1 equiv.), **1a** (50 mg, 0.18 mmol, 1 equiv.), $AuCl(PPh_3)$ (4.5 mg, 0.01 mmol, 5 mol%), $AgPF_6$ (2.3 mg, 0.01 mmol, 5 mol%) and CH_2Cl_2 (2 mL). Purification by flash chromatography afforded enamide **4a** as a light yellow oil (65 mg, 93%).

FTIR (thin film) υ_{max}: 3659, 3408, 2981, 2972, 2889, 1758, 1686, 1621; ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 8.06 (1H, br.s), 7.55 (1H, d, J = 7.8 Hz), 7.35–7.32 (5H, m), 7.19 (1H, app.t, J = 7.8 Hz), 7.10 (1H, app.t, J = 7.8 Hz), 6.93 (1H, d, J = 2.3 Hz), 5.23 (1H, d, J = 9.6 Hz), 4.26 (2H, app.t, J = 8.1Hz), 3.80 (2H, s), 3.77–3.71 (1H, m), 3.69–3.63 (2H, m), 1.42 (3H, d, J = 6.8 Hz); ^{13}C NMR (125 MHz, $CDCl_3$) δ_C: 169.4, 154.4, 136.5, 136.3, 133.0, 129.5, 128.8, 127.5, 126.5, 122.0, 120.4, 119.7, 119.3, 119.3, 114.6, 111.2, 61.7, 45.3, 40.7, 27.7, 20.8; HRMS (ESI, +ve) *m/z*: calcd. for $C_{23}H_{22}N_2O_4Na$: 413.1483, found: 413.1477 $[M + Na]^+$.

(*Z*)-3-(1H-Indol-3-yl)-1-(2-oxooxazolidin-3-yl)but-1-en-1-yl 2-(*p*-tolyl)acetate (4b)

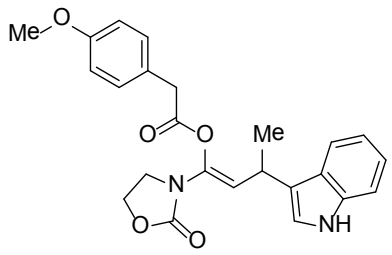


Prepared according to the general procedure using, indole (20 mg, 0.17 mmol, 1 equiv.), **1b** (50 mg, 0.17 mmol, 1 equiv.), $AuCl(PPh_3)$ (4.3 mg, 0.01 mmol, 5 mol%), $AgPF_6$ (2.2 mg, 0.01 mmol, 5 mol%) and CH_2Cl_2 (2 mL). Purification by flash chromatography afforded enamide **4b** as a light yellow oil (60 mg, 85%).

FTIR (thin film) υ_{max}: 3414, 2980, 2890, 1760, 1685; ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 7.95 (1H, br. s), 7.53 (1H, d, J = 7.9 Hz), 7.35 (1H, d, J = 7.9 Hz), 7.23–7.16 (3H, m), 7.15–7.06 (3H, m), 6.96 (1H, d, J = 1.9 Hz), 5.25 (1H, d, J = 9.7 Hz), 4.33–4.25 (2H, m), 3.77 (2H, s), 3.76–3.66 (3H, m), 2.33 (3H, s),

1.41 (3H, d, J = 7.1 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ_C: 169.6, 154.5, 137.2, 136.5, 136.3, 129.9, 1295, 129.3, 126.6, 122.1, 1203, 119.9, 119.4, 119.3, 114.7, 111.1, 61.7, 45.4, 40.3, 27.7, 21.1, 20.9; HRMS (ESI, +ve) *m/z*: calcd. for $C_{24}H_{24}N_2O_4Na$: 427.1634, found: 427.1695 $[M + Na]^+$.

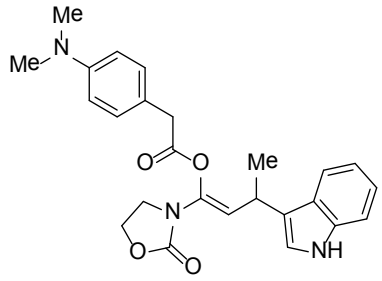
(*Z*)-3-(1H-Indol-3-yl)-1-(2-oxooxazolidin-3-yl)but-1-en-1-yl 2-(4-methoxyphenyl)acetate (4c)



Prepared according to the general procedure using, indole (19 mg, 0.17 mmol, 1 equiv.), **1c** (50 mg, 0.17 mmol, 1 equiv.), $AuCl(PPh_3)$ (4.1 mg, 0.01 mmol, 5 mol%), $AgPF_6$ (2.1 mg, 0.01 mmol, 5 mol%) and CH_2Cl_2 (2 mL). Purification by flash chromatography afforded enamide **4c** as a light brown oil (51 mg, 74%).

FTIR (thin film) υ_{max}: 3384, 2959, 2927, 1756, 1691, 1612; ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 8.08 (1H, br. s), 7.59 (1H, app. d, J = 7.9 Hz), 7.38 (1H, app. d, J = 7.9 Hz), 7.30–7.19 (2H, m), 7.16–7.11 (1H, m), 7.01–6.97 (1H, m), 6.95–6.85 (2H, m), 5.28 (1H, d, J = 9.6 Hz), 4.31 (2H, app. t, J = 8.2 Hz), 3.89–3.63 (8H, m), 1.46 (3H, d, J = 7.0 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ_C: 169.8, 159.0, 154.6, 136.5, 136.3, 130.6, 126.5, 125.1, 122.0, 120.4, 119.8, 119.4, 119.3, 114.7, 114.2, 111.2, 61.8, 55.3, 45.4, 39.8, 27.7, 20.9; HRMS (ESI, +ve) *m/z*: calcd. for: $C_{24}H_{24}N_2O_5Na$, 443.1583 found: 443.1648 $[M + Na]^+$.

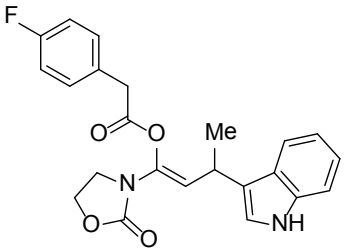
(Z)-3-(1H-Indol-3-yl)-1-(2-oxooxazolidin-3-yl)but-1-en-1-yl 2-(4-(dimethylamino)phenyl)acetate (4d)



Prepared according to the general procedure using, indole (37 mg, 0.32 mmol, 1 equiv.), **1d** (100 mg, 0.32 mmol, 1 equiv.), $AuCl(PPh_3)$ (7.8 mg, 0.02 mmol, 5 mol%), $AgPF_6$ (4.0 mg, 0.02 mmol, 5 mol%) and CH_2Cl_2 (4 mL). Purification by flash chromatography afforded enamide **4d** as a light yellow oil (119 mg, 87%).

FTIR (thin film) υ_{max}: 3406, 2981, 2980, 1751, 1683, 1614, 1522; ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 8.01 (1H, br. s), 7.56 (1H, app. d, J = 8.0 Hz), 7.33 (1H, app. d, J = 8.0 Hz), 7.23–7.12 (3H, m), 7.08 (1H, app. t, J = 7.5 Hz), 6.95 (1H, d, J = 1.8 Hz), 6.68 (2H, app. d, J = 8.6 Hz), 5.30 (1H, d, J = 9.7 Hz), 4.26 (2H, app. t, J = 8.1 Hz), 3.80–3.61 (5H, m), 2.92 (6H, s), 1.41 (3H, d, J = 7.0 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ_C: 170.1, 154.6, 149.8, 136.6, 136.2, 130.1, 126.5, 121.9, 120.9, 120.4, 119.8, 119.5, 119.3, 115.0, 113.0, 111.2, 61.8, 45.3, 40.8, 39.8, 27.7, 21.0; HRMS (ESI, +ve) *m/z*: calcd. for C25H28N3O4: 434.2080, found: 434.2084 $[M + Na]^+$.

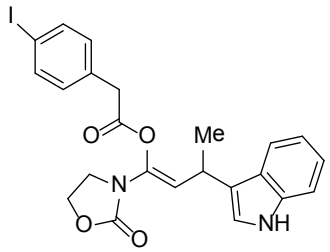
(*Z*)-3-(1H-Indol-3-yl)-1-(2-oxooxazolidin-3-yl)but-1-en-1-yl 2-(4-fluorophenyl)acetate (4e)



Prepared according to the general procedure using, indole (21 mg, 0.18 mmol, 1 equiv.), **1e** (50 mg, 0.18 mmol, 1 equiv.), $AuCl(PPh_3)$ (4.5 mg, 0.01 mmol, 5 mol%), $AgPF_6$ (2.3 mg, 0.01 mmol, 5 mol%) and CH_2Cl_2 (2 mL). Purification by flash chromatography afforded enamide **4e** as a light pink oil (55 mg, 79%).

FTIR (thin film) υ_{max}: 3383, 2959, 1924, 2854, 1754, 1696; ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 8.07 (1H, br. s), 7.60–7.56 (2H, m), 7.42–7.37 (1H, m), 7.33–7.27 (2H, m), 7.27–7.20 (1H, m), 7.17–7.12 (1H, m), 7.07–7.00 (2H, m), 7.00–6.99 (1H, m), 5.22 (1H, d, *J* = 9.1 Hz), 4.38–4.31 (2H, m), 3.83 (2H, s), 3.82–3.72 (3H, m), 1.46 (3H, d, *J* = 7.3 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ_C:169.2, 154.3 (d, J = 245.4 Hz), 136.5 (d, *J* = 6.1 Hz), 134.2, (d, *J* = 15.3 Hz), 131.1 (d, *J* = 7.6 Hz), 128.8, 126.5, 122.1, 120.3, 119.7, 119.4, 119.3, 115.7, 115.5, 114.1, 111.2, 61.7, 45.5, 39.7, 27.7, 20.7; HRMS (ESI, +ve) *m/z*: calcd. for $C_{23}H_{21}N_2O_4FNa$: 431.1383, found: 431.1489 $[M + Na]^+$.

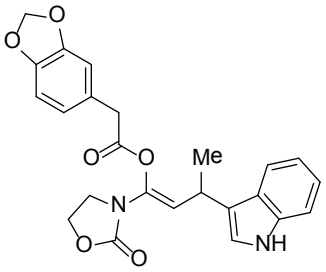
(*Z*)-3-(1H-Indol-3-yl)-1-(2-oxooxazolidin-3-yl)but-1-en-1-yl 2-(4-iodophenyl)acetate (4f)



Prepared according to the general procedure using, indole (15 mg, 0.13 mmol, 1 equiv.), **1f** (50 mg, 0.13 mmol, 1 equiv.), $AuCl(PPh_3)$ (3 mg, 0.006 mmol, 5 mol%), $AgPF_6$ (1.6 mg, 0.006 mmol, 5 mol%) and CH_2Cl_2 (2 mL). Purification by flash chromatography afforded enamide **4f** as an orange solid (60 mg, 92%). Recrystallisation (Pet/ CH_2Cl_2) afforded the title compound as orange crystals.

MP: 127–129 °C; FTIR (thin film) υ_{max}: 3261, 2971, 2911, 1772, 1720, 1683; ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 8.07 (1H, br. s), 7.67 (2H, app. d, *J* = 8.4 Hz), 7.59–7.55 (1H, m), 7.42–7.37 (1H, m), 7.27–7.22 (1H, m), 7.19–7.14 (1H, m), 7.07 (2H, app. d, *J* = 8.4 Hz), 7.01–7.00 (1H, m), 5.21 (1H, d, *J* = 9.6 Hz), 4.40-4.36 (2H, m), 3.79 (2H, s), 3.79–3.72 (3H, m), 1.47 (3H, d, *J* = 7.0 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ_C: 168.8, 154.3, 137.8, 136.5, 134.3, 134.1, 132.6, 131.5, 129.4, 126.5, 122.1, 120.4, 119.7, 119.5, 119.3, 114.1, 111.3, 93.1, 61.7, 45.6, 40.1, 27.7, 21.1; HRMS (ESI, +ve) *m/z*: calcd. for $C_{23}H_{21}N_2O_4INa$: 539.0444, found: 539.0490 $[M + Na]^+$.

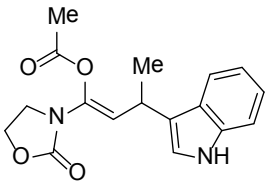
(*Z*)-3-(1H-Indol-3-yl)-1-(2-oxooxazolidin-3-yl)but-1-en-1-yl 2-(benzo[d][1,3]dioxol-5-yl)acetate (4g)



Prepared according to the general procedure using, indole (18 mg, 0.16 mmol, 1 equiv.), **1g** (50 mg, 0.16 mmol, 1 equiv.), $AuCl(PPh_3)$ (4.0 mg, 0.01 mmol, 5 mol%), $AgPF_6$ (2.0 mg, 0.01 mmol, 5 mol%) and CH_2Cl_2 (2 mL). Purification by flash chromatography afforded enamide **4g** as a light brown oil (26 mg, 38%).

FTIR (thin film) υ_{max}: 3385, 2966, 1770, 1706; ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 8.03 (1H, br. s), 7.64–7.49 (2H, m), 7.39 (1H, app.d, J = 8.0 Hz), 7.26–7.18 (1H, m), 7.17–7.11 (1H, m), 7.01 (1H, app. d, J = 1.8 Hz), 6.85 (1H, s), 6.79 (1H, s), 5.98–5.94 (2H, m), 5.26 (1H, d, J = 9.6 Hz), 4.34 (2H, t, J = 8.1 Hz), 3.84–3.69 (5H, m), 1.47 (3H, d, J = 7.0 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ_C: 169.6, 154.5, 147.9, 136.5, 136.4, 126.5, 122.7, 122.1, 120.4, 119.8, 119.3, 114.6, 111.2, 110.0, 108.5, 101.1, 61.7, 45.5, 40.3, 27.7, 20.9; HRMS (ESI, +ve) *m/z*: calcd. for, $C_{24}H_{22}N_2O_6Na$: 457.1376 found: 457.1411 $[M + Na]^+$.

(*Z*)-3-(1H-Indol-3-yl)-1-(2-oxooxazolidin-3-yl)but-1-en-1-yl acetate (4h)

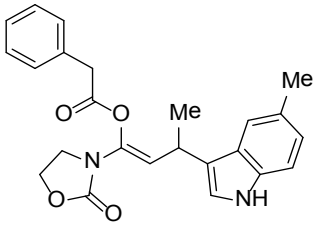


Prepared according to general procedure D using, indole (30 mg, 0.25 mmol, 1 equiv.), **1h** (50 mg, 0.25 mmol, 1 equiv.), $AuCl(PPh_3)$ (6.0 mg, 0.013 mmol, 5 mol%), $AgPF_6$ (5.0 mg, 0.013 mmol, 5 mol%) and CH_2Cl_2 (2 mL). Purification by flash chromatography afforded enamide **4h** as a brown oil (70 mg, 89%).

FTIR (thin film) υ_{max}: 3658, 3407, 2981, 2972, 2889, 1754, 1685, 1621; ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 8.14 (1H, br.s), 7.69 (1H, d, J = 7.7 Hz), 7.36 (1H, d, J = 7.7 Hz), 7.20 (1H, app.t, J = 7.5 Hz), 7.13 (1H, app.t, J = 7.5 Hz), 7.01 (1H, d, J = 1.6 Hz), 5.19 (1H, d, J = 9.6 Hz), 4.31 (2H, app.t, J = 8.3 Hz), 3.95–

3.86 (1H, m), 3.78–3.73 (2H, m), 2.27 (3H, s), 1.51 (3H, d, J = 6.8 Hz); ^{13}C NMR (125 MHz, $CDCl_3$) δ_C: 167.8, 154.4, 136.6, 136.4, 134.3, 126.6, 122.0, 120.4, 119.7, 119.3, 114.1, 111.3, 61.7, 45.5, 27.8, 20.8, 20.3; HRMS (ESI, +ve) *m/z*: calcd. for $C_{17}H_{18}N_2O_4Na$: 337.1164, found: 337.1176 $[M + Na]^+$.

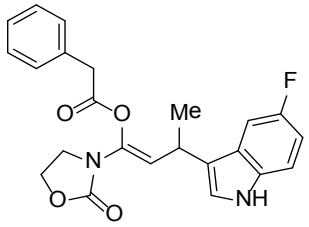
(*Z*)-3-(5-Methyl-1H-indol-3-yl)-1-(2-oxooxazolidin-3-yl)but-1-en-1-yl 2-phenylacetate (4i)



Prepared according to the general procedure using, 5-methyl indole (24 mg, 0.18 mmol, 1 equiv.), **1a** (50 mg, 0.18 mmol, 1 equiv.), $AuCl(PPh_3)$ (4.5 mg, 0.01 mmol, 5 mol%), $AgPF_6$ (2.3 mg, 0.01 mmol, 5 mol%) and CH_2Cl_2 (2 mL). Purification by flash chromatography afforded enamide **4i** as a light yellow oil (65 mg, 89%).

FTIR (thin film) υ_{max}: 3659, 3407, 2981, 2972, 2889, 1755, 1689, 1627; ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 7.95 (1H, br.s), 7.63–7.50 (1H, m), 7.40–7.32 (5H, m), 7.27 (1H, d, J = 8.3 Hz), 7.06 (1H, dd, J = 8.3, 1.6 Hz), 6.93 (1H, dd, J = 2.6, 0.7 Hz), 5.29 (1H, d, J = 9.6 Hz), 4.31 (2H, app.t, J = 8.1 Hz), 3.86 (2H, s), 3.79–3.66 (3H, m), 2.51 (3H, s), 1.44 (3H, d, J = 6.9 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ_C: 169.4, 154.5, 136.3, 134.9, 133.1, 129.5, 128.8, 128.4, 127.5, 126.7, 123.6, 120.5, 119.2, 119.0, 114.9, 110.9, 61.7, 45.4, 40.7, 27.7, 21.6, 21.0; HRMS (ESI, +ve) *m/z*: calcd. for $C_{24}H_{24}N_2O_4Na$: 427.1634, found: 427.1615 $[M + Na]^+$.

(*Z*)-3-(5-Fluoro-1H-indol-3-yl)-1-(2-oxooxazolidin-3-yl)but-1-en-1-yl 2-phenylacetate (4k)

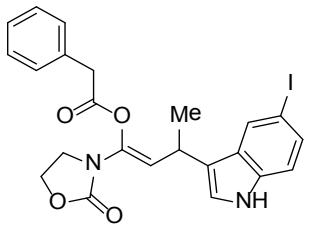


Prepared according to general procedure using, 5-fluoroindole (25 mg, 0.18 mmol, 1 equiv.), **1a** (50 mg, 0.18 mmol, 1 equiv.), $AuCl(PPh_3)$ (4.5 mg, 0.01 mmol, 5 mol%), $AgPF_6$ (2.3 mg, 0.01 mmol, 5 mol%)

and CH_2Cl_2 (2 mL). Purification by flash chromatography afforded enamide **4k** as a pink oil (74 mg, 99%).

FTIR (thin film) υ_{max}: 3359, 2959, 2924, 1754, 1697; ^{1}H NMR (400 MHz, $(CD_3)_2CO$) δ_H: 10.07 (1H, br. s), 7.43–7.39 (2H, m), 7.38–7.32 (3H, m), 7.32–7.22 (2H, m), 7.21–7.18 (1H, m), 6.89 (1H, td, *J* = 9.2, 2.6 Hz), 5.29 (1H, d, *J* = 9.9 Hz), 4.39–4.32 (2H, m), 3.94 (2H, s), 3.88–3.76 (2H, m), 3.75–3.66 (1H, m), 1.37 (3H, d, *J* = 7.0 Hz); ^{13}C NMR (100 MHz, $(CD_3)_2CO$) δ_C: 168.9, 157.3 (d, *J* = 231.6 Hz), 154.0, 136.9, 133.9, 133.6, 129.6, 128.5, 127.2, 127.0 (d, *J* = 8.8 Hz), 122.9, 119.4 (d, *J* = 4.6 Hz), 112.4, 112.1 (d, *J* = 8.8 Hz), 109.3 (d, *J* = 24.6 Hz), 103.8 (d, *J* = 24.6 Hz), 61.7, 45.0, 40.1, 27.4, 20.5; HRMS (ESI, +ve) *m/z*: calcd. for $C_{23}H_{21}N_2O_4FNa$: 431.1383, found: 431.1399 $[M + Na]^+$.

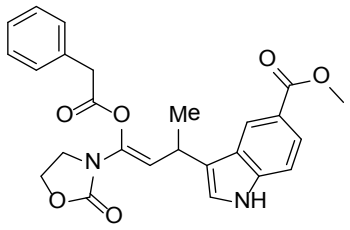
(*Z*)-3-(5-Iodo-1H-indol-3-yl)-1-(2-oxooxazolidin-3-yl)but-1-en-1-yl 2-phenylacetate (4j)



Prepared according to general procedure D using, 5-iodoindole (45 mg, 0.18 mmol, 1 equiv.), **1a** (50 mg, 0.18 mmol, 1 equiv.), $AuCl(PPh_3)$ (4.5 mg, 0.01 mmol, 5 mol%), $AgPF_6$ (2.3 mg, 0.01 mmol, 5 mol%) and CH_2Cl_2 (2 mL). Purification by flash chromatography afforded enamide **4j** as a orange solid (87 mg, 92%). Recrystallisation (Pet/ CH_2Cl_2) afforded the title compound as orange crystals.

MP: 135–136 °C; FTIR (thin film) υ_{max}: 3261, 2970, 2911, 1772, 1720, 1683; ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 8.15 (1H, br. s), 7.91–7.87 (1H, m), 7.46 (1H, dd, *J* = 8.5, 1.7 Hz), 7.42–7.33 (5H, m), 7.15 (1H, d, *J* = 8.5 Hz), 6.94–6.91 (1H, m), 5.32 (1H, d, *J* = 9.7 Hz), 4.36–4.30 (2H, m), 3.84 (2H, s), 3.75–3.69 (2H, m), 3.68–3.57 (1H, m), 1.38 (3H, d, *J* = 7.0 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ_C: 169.3, 154.7, 136.3, 135.6, 133.0, 130.3, 129.4, 129.1, 128.9, 128.1, 127.7, 121.3, 119.2, 114.6, 113.3, 82.8, 61.8, 45.2, 40.9, 27.5, 21.2; HRMS (ESI, +ve) *m/z*: calcd. for $C_{23}H_{21}N_2O_4INa$: 539.0444, found: 539.0472 $[M + Na]^+$.

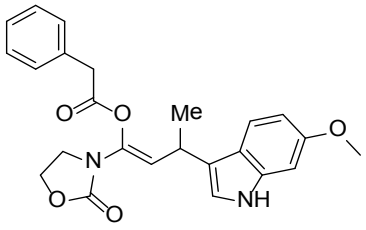
(*Z*)-Methyl 3-(4-(2-oxooxazolidin-3-yl)-4-(2-phenylacetoxy)but-3-en-2-yl)-1H-indole-5-carboxylate (4l)



Prepared according to general procedure D using, indole (32 mg, 0.18 mmol, 1 equiv.), **1a** (50 mg, 0.18 mmol, 1 equiv.), $AuCl(PPh_3)$ (4.5 mg, 0.01 mmol, 5 mol%), $AgPF_6$ (2.3 mg, 0.01 mmol, 5 mol%) and CH_2Cl_2 (2 mL). Purification by flash chromatography afforded enamide **4l** as an orange oil (43 mg, 53%).

FTIR (thin film) υ_{max}: 3383, 2957, 2923, 2854, 1760, 1703, 1617; ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 8.46 (1H, br. s), 8.42–8.39 (1H, m), 7.92 (1H, dd, J = 7.0, 1.5 Hz), 7.38–7.29 (6H, m), 7.02–7.00 (1H, m), 5.39 (1H, d, J = 9.7 Hz), 4.34–4.28 (2H, m), 4.00 (3H, s), 3.84 (2H, s), 3.80–3.67 (3H, m), 1.43 (1H, d, J = 7.0 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ_C: 169.3, 168.3, 154.7, 139.2, 136.3, 133.0, 129.4, 128.8, 127.6, 126.0, 123.3, 122.4, 121.9, 121.3, 121.1, 114.7, 111.0, 61.8, 51.9, 45.2, 40.8, 27.9, 21.4; HRMS (ESI, +ve) *m/z*: calcd. for $C_{25}H_{25}N_2O_6$: 449.1713, found: 449.1749 $[M + H]^+$.

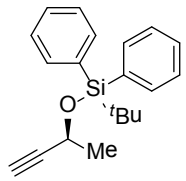
(*Z*)-3-(6-Methoxy-1H-indol-3-yl)-1-(2-oxooxazolidin-3-yl)but-1-en-1-yl 2-phenylacetate (4m)



Prepared according to general procedure D using, 6-methoxy indole (27 mg, 0.18 mmol, 1 equiv.), **1a** (50 mg, 0.18 mmol, 1 equiv.), $AuCl(PPh_3)$ (4.5 mg, 0.01 mmol, 5 mol%), $AgPF_6$ (2.3 mg, 0.01 mmol, 5 mol%) and CH_2Cl_2 (2 mL). Purification by flash chromatography afforded enamide **4m** as a light brown oil (70 mg, 92%).

FTIR (thin film) υ_{max}: 3401, 2981, 1754, 1684, 1628, 1628; ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 7.96 (1H, s), 7.40 (1H, d, *J* = 8.6 Hz), 7.39–7.32 (5H, m), 6.88–6.84 (2H, m), 6.80 (1H, dd, *J* = 8.6, 2.2 Hz), 5.23 (1H, d, *J* = 9.6 Hz), 3.88 (3H, s), 3.86 (2H, s), 3.74–3.66 (3H, m), 1.43 (3H, d, *J* = 7.0 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ_C: 169.4, 156.5, 154.5, 137.3, 136.3, 133.1, 129.5, 128.8, 127.5, 121.0, 120.0, 119.7, 119.1, 114.7, 109.3, 94.7, 61.7, 55.7, 45.4, 40.7, 27.7, 20.8; HRMS (ESI, +ve) *m/z*: calcd. for $C_{24}H_{24}N_2O_5Na$: 443.1583, found: 443.1575 $[M + Na]^+$.

(*S*)-(But-3-yn-2-yloxy)(*tert*-butyl)diphenylsilane

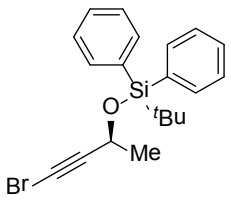


To a solution of (*S*)-3-butyn-2-ol (15.0 g, 214 mmol, 1 equiv.) in THF (200 mL) was added triethylamine (59.1 mL, 428 mmol, 2 equiv.), TBDPSCl (64.7g, 235 mmol, 1.1 equiv.) and DMAP (2.61 g, 21.4 mmol, 10 mol%). The resultant mixture was stirred at rt for 18 h, diluted with hexane (300 mL) and washed with NH_4Cl (sat) (250 mL) and brine (250 mL) and dried over $MgSO_4$, filtered and concentrated *in vacuo*. Purification via flash chromatography, eluting with 100 % Pet, afforded the title compound as a clear oil (66.0 g, 99 %).

$[\alpha]_D^{20}$= +65 .0 (*c* 1, CH_2Cl_2)

All other data as previously stated.

(*S*)-((4-Bromobut-3-yn-2-yl)oxy)(*tert*-butyl)diphenylsilane



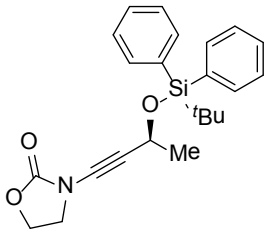
To a solution of the silyl ether (*S*)-but-3-yn-2-yloxy)(*tert*-butyl)diphenylsilane (66.0 g, 214 mmol, 1 equiv.) in acetone (250 mL) was added *N*-bromosuccinimide (41.6 g, 235 mmol, 1.1 equiv.) and $AgNO_3$ (3.63 g, 21.4 mmol, 10 mol%). The resultant mixture was stirred at rt for 3 h, diluted with $CHCl_3$ (250

mL), filtered through a pad of celite and concentrated *in vacuo*. Purification via flash chromatography, eluting with 100 % Pet, afforded the title compound as a light yellow oil (65.0 g, 78 %).

$[\alpha]_D^{20}$= +10.3 (*c* 1, CH_2Cl_2)

All other data as previously stated.

(*S*)-3-(3-((*tert*-Butyldiphenylsilyl)oxy)but-1-yn-1-yl)oxazolidin-2-one

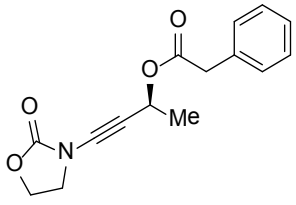


To a solution of the bromo-alkyne (*S*)-(4-bromobut-3-yn-2-yl)oxy)(*tert*-butyl)diphenylsilane (5.00 g, 12.9 mmol, 1.1 equiv.) and oxazolidinone (1.02 g, 11.8 mmol, 1 equiv.) in toluene (250 mL) was added $CuSO_4.5H_2O$ (586 mg, 2.35 mmol, 20 mol%), 1,10-phenanthroline (847 mg, 4.70 mmol, 40 mol%) and K_3PO_4 (4.99 g, 23.5 mmol, 2 equiv.). The suspension was then refluxed for 48 h, filtered through celite and concentrated *in vacuo*. Purification via flash chromatography, eluting with 4:1 Pet/EtOAc, afforded the title compound as a white powder (3.14 g, 68%).

$[\alpha]_D^{20}$= -115.5 (*c* 2, $CHCl_3$)

All other data as previously stated.

(*S*)-4-(2-Oxooxazolidin-3-yl)but-3-yn-2-yl 2-phenylacetate (S-1a)



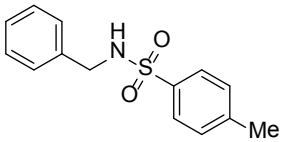
To a solution of the protected ynamide **(***S*)-3-(3-((*tert*-butyldiphenylsilyl)oxy)but-1-yn-1-yl)oxazolidin-2-one (3.00g, 7.60 mmol, 1 equiv.) in THF (175 mL) was added TBAF (1M in THF, 15.2 mL, 15.2 mmol, 2 equiv.) at 0 ^oC. The resultant solution was then warmed to rt, after 40 min the reaction mixture was

hydrolysed with NH_4Cl (sat) (25 mL) and extracted with EtOAc (3 × 25 mL). The combined extracts were dried over $MgSO_4$, filtered and concentrated *in vacuo*. The crude material was passed through silica gel, eluting with 100% EtOAc, and used without further purification. To a solution of EDCi (1.80g, 9.43 mmol, 2 equiv.) in CH_2Cl_2 (70 mL) was successively added triethylamine (1.31 mL, 9.43 mmol, 2 equiv.), DMAP (115 mg, 0.94 mmol, 20 mol%), phenylacetic acid (1.28g, 9.43 mmol, 2 equiv.) and crude propargylic alcohol **(*S*)-266**. After 3 hours at room temperature the resultant solution was washed with 10% citric acid (3 x 10 mL), $NaHCO_3$ (sat) (3 x 10 mL) and brine (10 mL). The organic extract was then dried over $MgSO_4$ and concentrated *in vacuo*. The crude mixture was then subjected to column chromatography, eluting with 4:1 Pet/EtOAc, to afford the title compound **S-1a** as a white solid (888 mg, 43% over two steps).

$[\alpha]_D^{20}$= -122 (*c* 1, $CHCl_3$)

All data as previously stated.

***N*-Benzyl-4-methylbenzenesulfonamide**

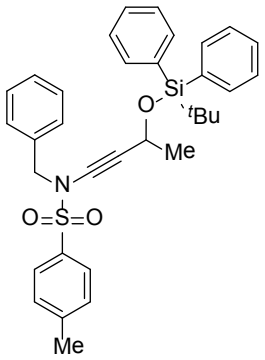


To benzylamine (10.4 mL, 96 mmol, 1 equiv.) and triethylamine (20 mL, 143 mmol, 1.5 equiv.) in CH_2Cl_2 (500 mL), was added 4-methylbenzene-1-sulfonyl chloride (18.2 g, 96 mmol, 1 equiv.) in small portions. The reaction was allowed to stir at room temperature for 1 hour before being quenched by water (300 mL). The aqueous layer was extracted with dichloromethane (3 x 200 mL), then the organic extracts were combined, dried over Na_2SO_4 and concentrated *in vacuo*. The residue was recrystallised (CH_2Cl_2/Petroleum ether) to afford **268** as a colourless crystals (25.0g, 99%).

^{1}H NMR (300 MHz, $(CD_3)_2CO$) δ_H: 7.67 (2H, app. d, J = 8.4 Hz), 7.29 (2H, app. d, J = 8.4 Hz), 7.21–7.07 (5H, m), 6.76 (1H, br. t, J = 6.5 Hz), 4.00 (2H, d, J = 6.5 Hz), 2.32 (3H, s); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 144.2, 139.2, 139.0, 130.8, 129.6, 129.1, 128.5, 128.3, 48.1, 21.8.

All other data in accordance with literature precedence.[193]

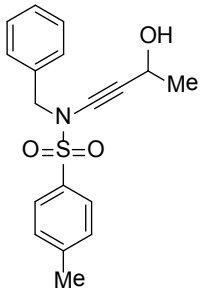
_N_-Benzyl-_N_-(3-((tert-butyldiphenylsilyl)oxy)but-1-yn-1-yl)-4- methylbenzenesulfonamide



To a solution of *N*-benzyl-4-methylbenzenesulfonamide (962 mg, 3.68 mmol, 1 equiv.) in pyridine (16 mL) at 0 °C was added KHMDS (1M in THF, 3.68 mL, 3.68 mmol, 1 equiv.) over 4 minutes. The reaction was allowed to stir for 10 minutes before a solution of CuI (702 mg, 3.68 mmol, 1 equiv.) in pyridine (8 mL) was added. The reaction mixture was allowed to warm to room temperature and stirred for 2 hours. A solution of 4-bromobut-3-yn-2-yloxy)(*tert*-butyl)diphenylsilane (2.85 g, 7.37 mmol, 2 equiv.) in toluene (12 mL) was then added over 1 hour, with the resultant mixture being allowed to stir for 20 hours. The reaction was then diluted with Et_2O (50 mL) and washed with 2:1 brine/concentrated NH_4OH (3 x 50 mL). The combined aquesous washings were then extracted with Et_2O (50 mL). The organic extracts were combined, dried with $MgSO_4$, filtered and concentrated *in vacuo*. Purification was achieved by flash chromatography (8:1 Pet/EtOAc) to afford the title compound as a yellow oil (1.51g, 72%).

FTIR (thin film) υ_{max}: 3071, 2956, 2930, 2890, 2857, 2246, 1597; ^{1}H NMR (300 MHz, $CDCl_3$) δ_H: 7.72–7.50 (6H, m), 7.41–7.04 (13H, m), 4.45 (1H, q, J = 6.5 Hz), 4.32 (1H, d, J = 13.6 Hz), 4.20 (1H, d, J = 13.6 Hz), 2.35 (3H, s), 1.25 (3H, d, J = 6.5 Hz), 0.96 (9H, s); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 144.5, 136.0, 135.8, 134.9, 133.8, 129.7, 128.7, 128.5, 128.2, 127.8, 127.7, 127.6, 77.6, 73.7, 60.2, 55.4, 26.9, 25.2, 21.7, 19.3; HRMS (ESI, +ve) *m/z*: calcd. for $C_{34}H_{38}NOSSi$: 568.2342, found: 568.2356 $[M + Na]^+$.

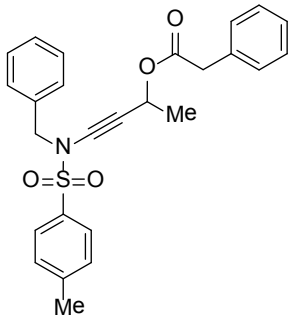
_N_-Benzyl-_N_-(3-hydroxybut-1-yn-1-yl)-4-methylbenzenesulfonamide



To a solution of *N*-benzyl-*N*-(3-((tert-butyldiphenylsilyl)oxy)but-1-yn-1-yl)-4-methylbenzenesulfonamide (1.51 g, 2.67 mmol, 1 equiv.) in THF (75 mL) was added TBAF (1M in THF, 5.34 mL, 5.34 mmol, 2 equiv.) at 0 ^{o}C. The resultant solution was then warmed to rt, after 40 min the reaction mixture was hydrolysed with NH_4Cl (sat) (25 mL) and extracted with EtOAc (3 x 25 mL). The combined extracts were dried over $MgSO_4$, filtered and concentrated *in vacuo*. The crude material was purified by rapid filtration through silica gel, eluting with 2:1 Pet/EtOAc, to give alcohol *N*-benzyl-*N*-(3-hydroxybut-1-yn-1-yl)-4-methylbenzenesulfonamide as a yellow oil (527 mg, 60%).

FTIR (film/cm^{-1}) υ_{max}: 3375, 3035, 2983, 2930, 2245, 1596; ^{1}H NMR (300 MHz, $CDCl_3$) δ_H: 7.70–7.64 (2H, m), 7.35–7.15 (7H, m), 4.51–4.36 (3H, m), 2.36 (3H, s), 1.24 (3H, d, J = 6.7 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 144.7, 134.8, 134.6, 124.4, 129.7, 128.9, 128.5, 128.4, 127.7, 77.8, 73.5, 58.4, 55.4, 24.2, 21.6, 19.0; MS (ESI:+ve) *m/z*: calcd for $C_{18}H_{19}NO_3SNa$: 352.0984, found: 352.1113 [M + Na^{+}].

4-(*N*-Benzyl-4-methylphenylsulfonamido)but-3-yn-2-yl 2-phenylacetate (6)

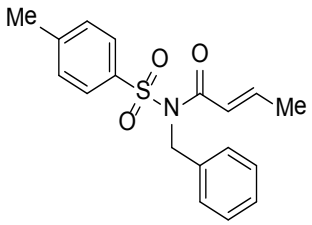


Prepared according to general procedure, using *N*-benzyl-*N*-(3-hydroxybut-1-yn-1-yl)-4-methylbenzenesulfonamide (527 mg, 1.60 mmol, 1 equiv.), phenylacetic acid (435 mg, 3.20 mmol, 2 equiv.), EDCi (613 mg, 3.20 mmol, 2 equiv.), NEt_3 (445 µL, 3.20 mmol, 2 equiv.), DMAP (39 mg, 0.32

mmol, 20 mol%), CH_2Cl_2 (75 mL). Purification was achieved by flash chromatography, eluting with 8:1 Pet/EtOAc, affording **6** as a yellow oil (489 mg, 68%).

FTIR (film/cm^{-1}) υ_{max}: 3030, 2990, 2246, 1736, 1597; ^{1}H NMR (300 MHz, $CDCl_3$) δ_H: 7.72 (2H, app. d, *J* = 8.5 Hz), 7.36–7.17 (12H, m), 5.47 (1H, q, *J* = 6.6 Hz), 4.51 (1H, d, *J* = 14.3 Hz), 4.40 (1H, d, *J* = 14.3 Hz), 3.57 (2H, s), 2.43 (3H, s), 1.36 (3H, d, *J* = 6.6 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 170.4, 144.6, 134.5, 134.3, 133.8, 129.7, 129.2, 128.9, 128.6, 128.5, 128.3, 127.8, 127.1, 78.8, 70.6, 61.2, 55.4, 41.2, 21.7, 21.1; MS (ESI:+ve) *m/z*: calcd for $C_{26}H_{25}NO_4SNa$: 470.1402, found:470.1432 [M + Na^+].

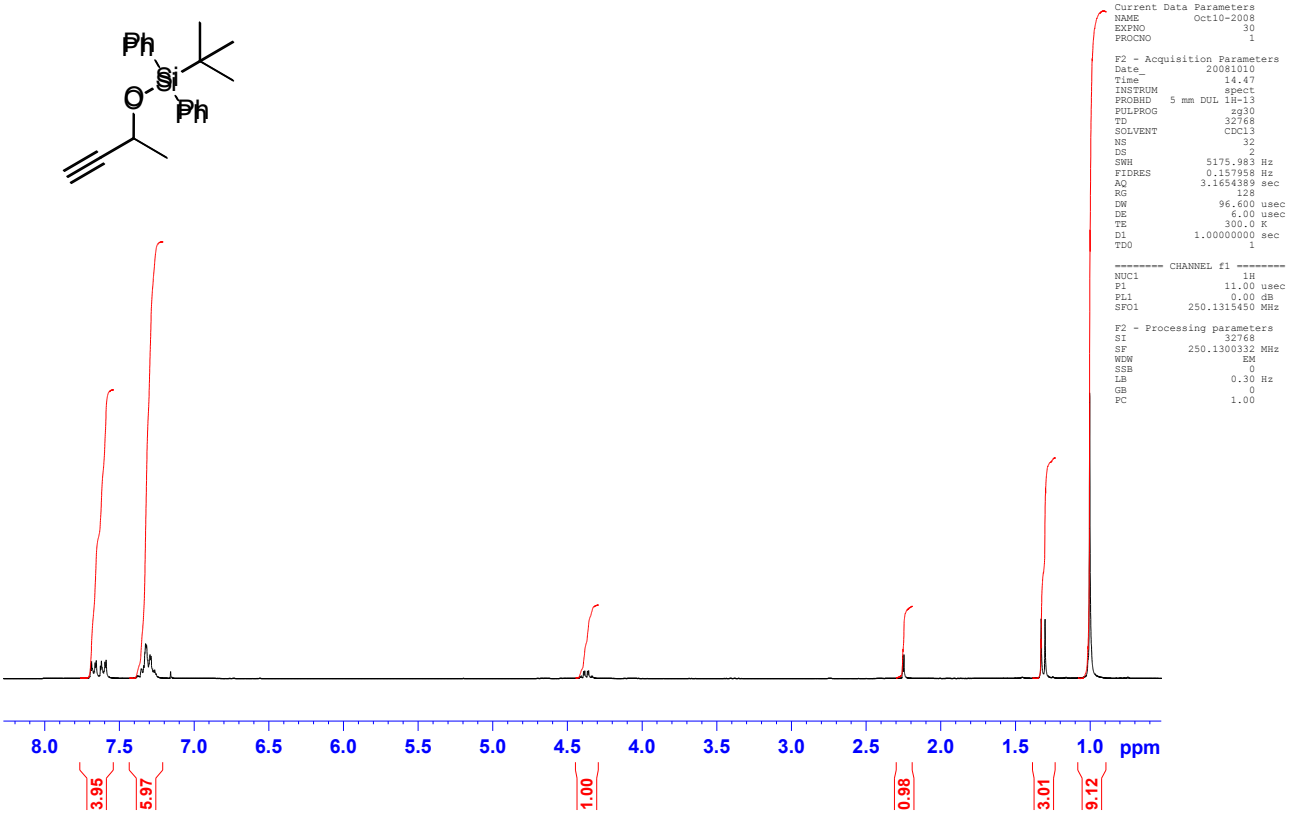
(*E*)-*N*-Benzyl-*N*-tosylbut-2-enamide (*E*-7)

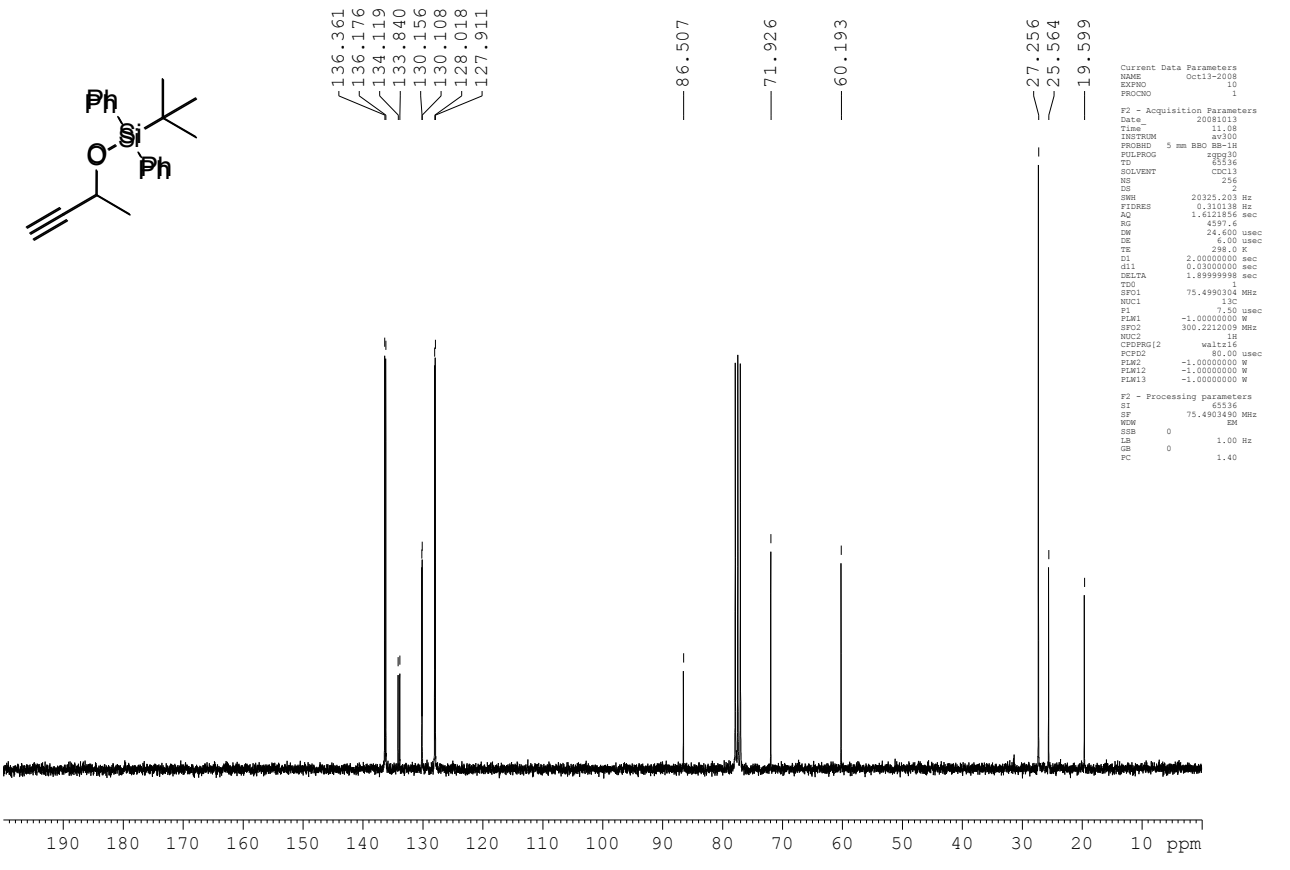


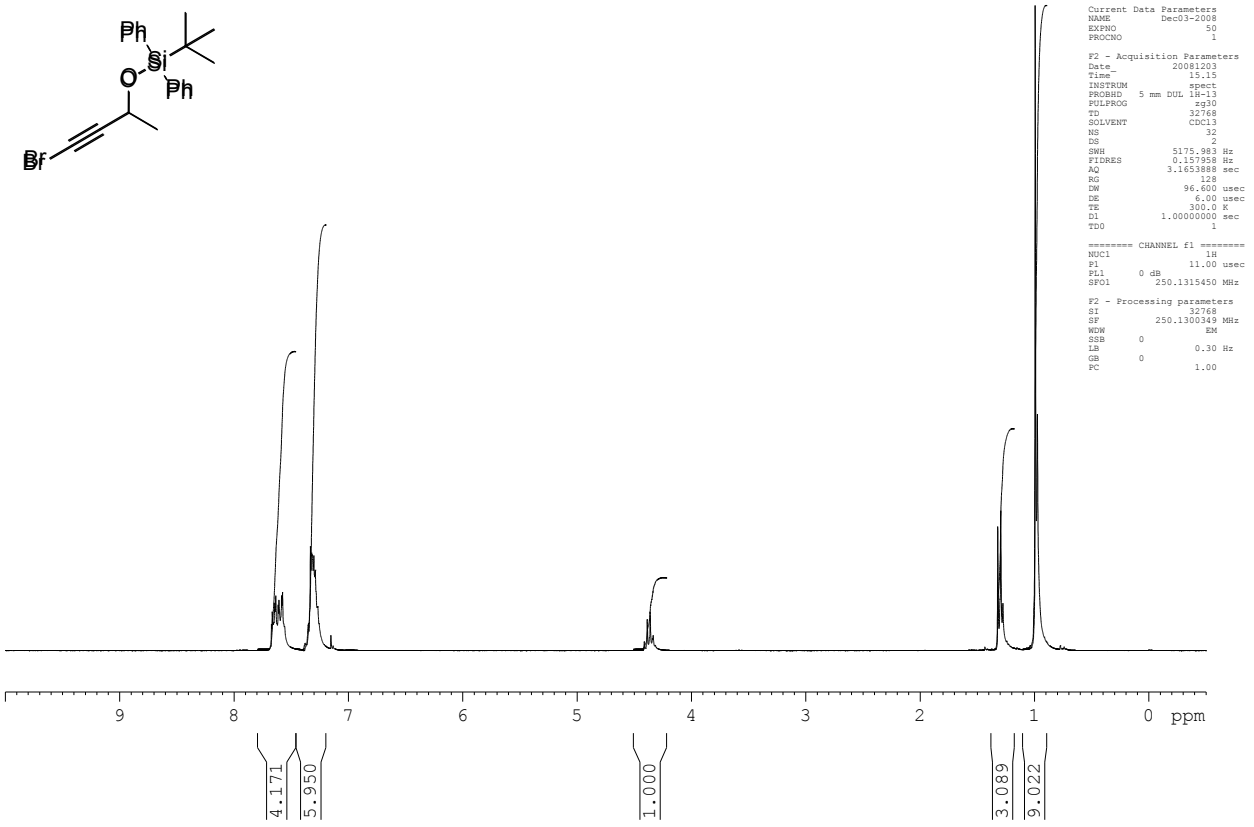
Prepared according to general procedure, using **6** (100 mg, 0.22 mmol, 1 equiv.), AuCl(PPh_3) (5.4 mg, 0.01 mmol, 5 mol%), $AgPF_6$ (2.8 mg, 0.01 mmol, 5 mol%) and CH_2Cl_2 (4 mL). Purification by flash chromatography afforded ***E*-7** as a light orange oil (70 mg, 95%, 6:1 *E*/*Z*).

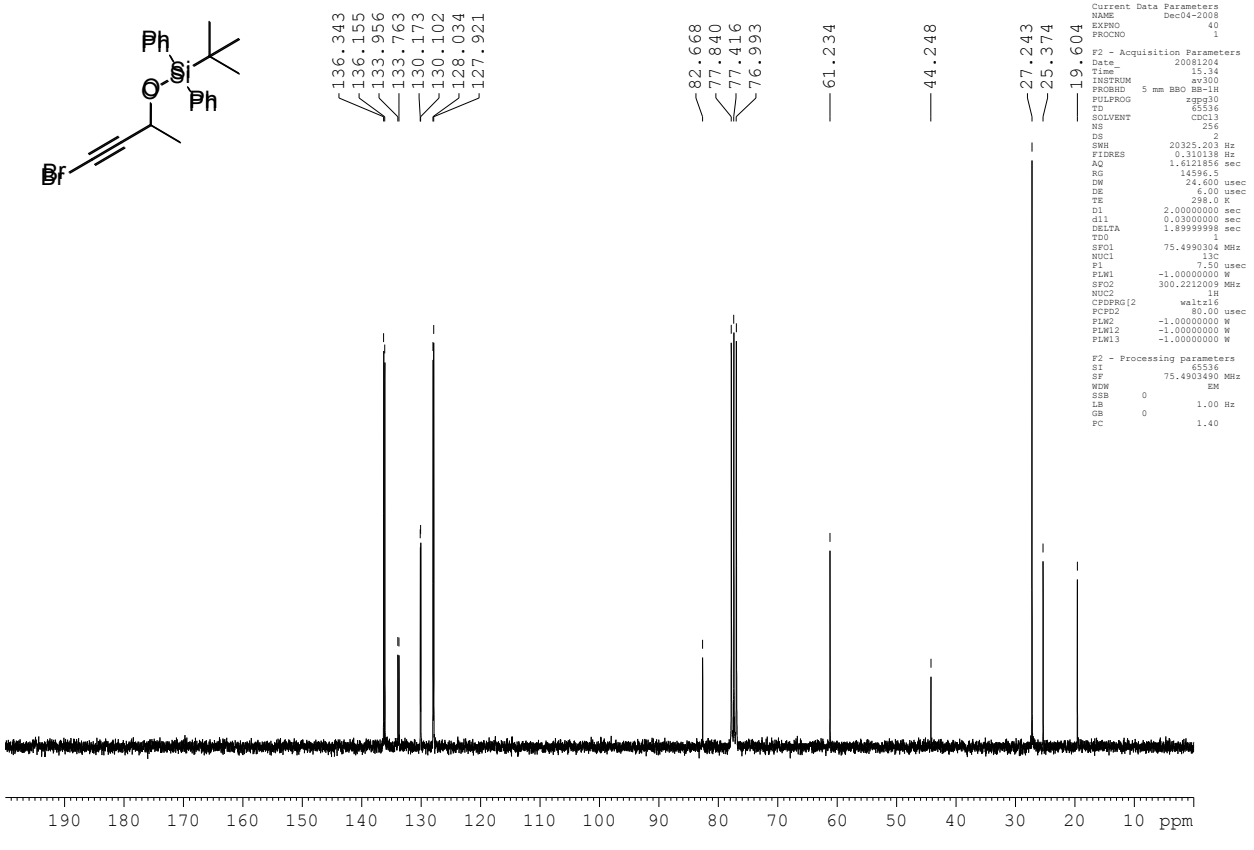
FTIR (film/cm^{-1}) υ_{max}: 3031, 2974, 1708, 1683, 1635, 1597; ^{1}H NMR (500 MHz, $CDCl_3$) $\delta_{H\ Major\ isomer}$: 7.70–7.65 (2H, m), 7.44–7.28 (7H, m), 7.00 (1H, dq, *J* = 15.0, 7.0 Hz), 6.63 (1H, dq, *J* = 15.0, 7.0 Hz), 5.13 (2H, s), 2.44 (3H, s), 1.85 (3H, dd, *J* = 7.0, 1.7 Hz); $\delta_{H\ Minor\ isomer}$ 7.70–7.65 (2H, m), 7.44–7.28 (7H, m), 6.40 (1H, dq, *J* = 11.6, 7.0 Hz), 6.21 (1H, dq, *J* = 11.6, 7.0 Hz), 5.13 (2H, s), 2.44 (3H, s), 1.90 (3H, dd, *J* = 7.0, 1.7 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) $\delta_{C\ Major\ isomer}$ 177.6, 166.0, 146.7, 144.7, 136.8, 133.7, 129.6, 129.4, 128.7, 127.8, 122.9, 41.1, 21.5 18.5; $\delta_{C\ Minor\ isomer}$ 177.6, 166.0, 146.5, 144.7, 136.8, 133.7, 129.6, 129.3, 128.7, 127.8, 122.0, 41.1, 21.6, 15.8; MS (ESI:+ve) *m/z*: calcd for $C_{18}H_{19}NO_3SNa$: 352.0984, found: 352.1095, [M + $Na]^+$.

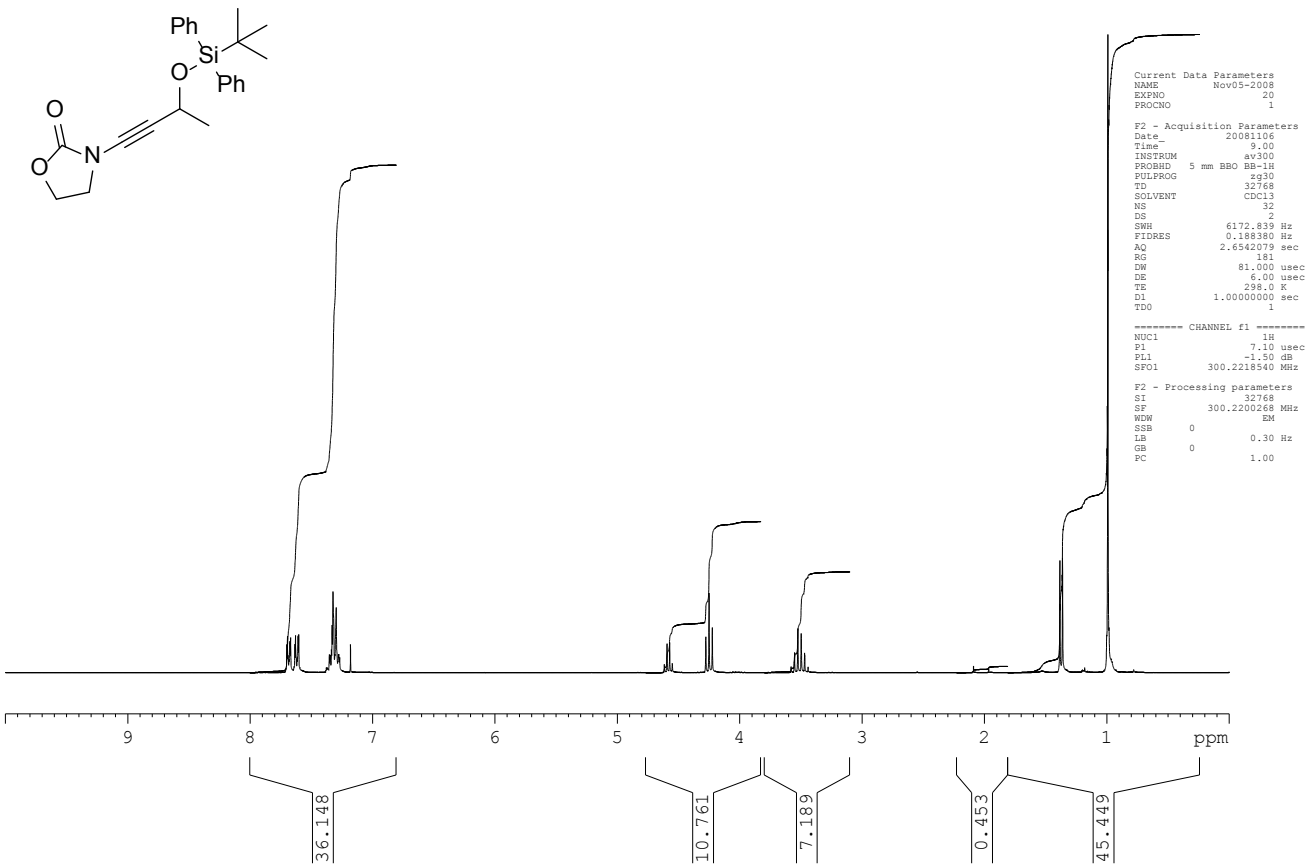
^{1}H and ^{13}C NMR Spectra

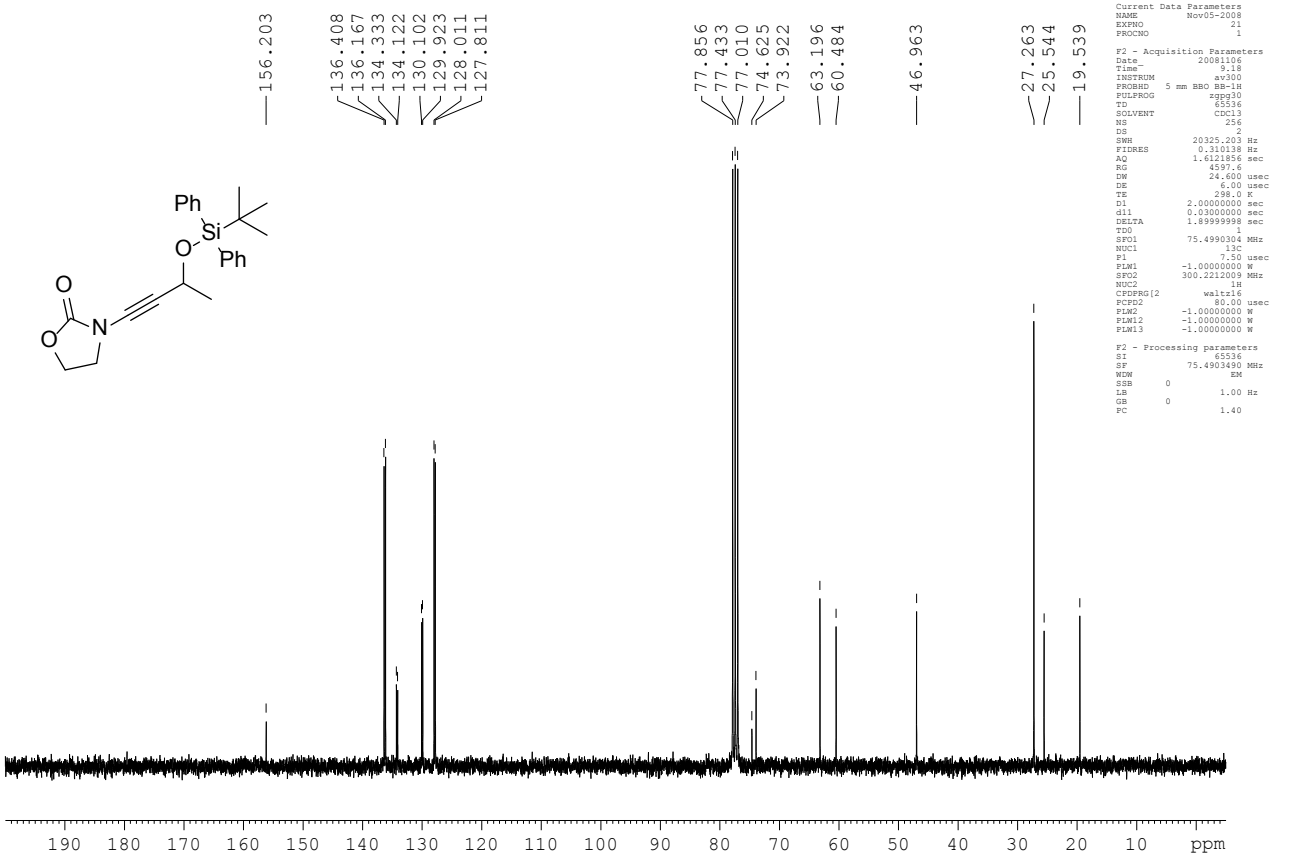


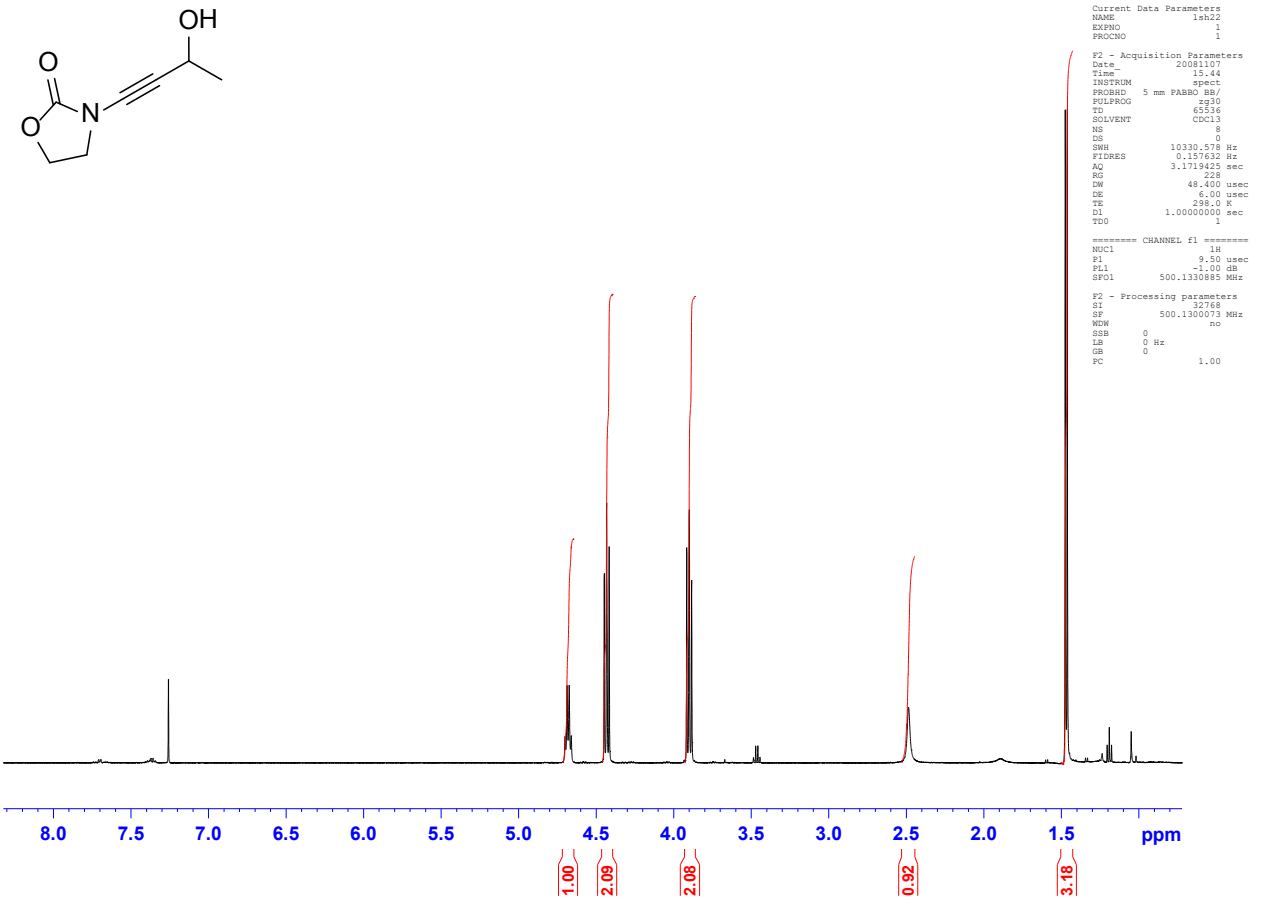


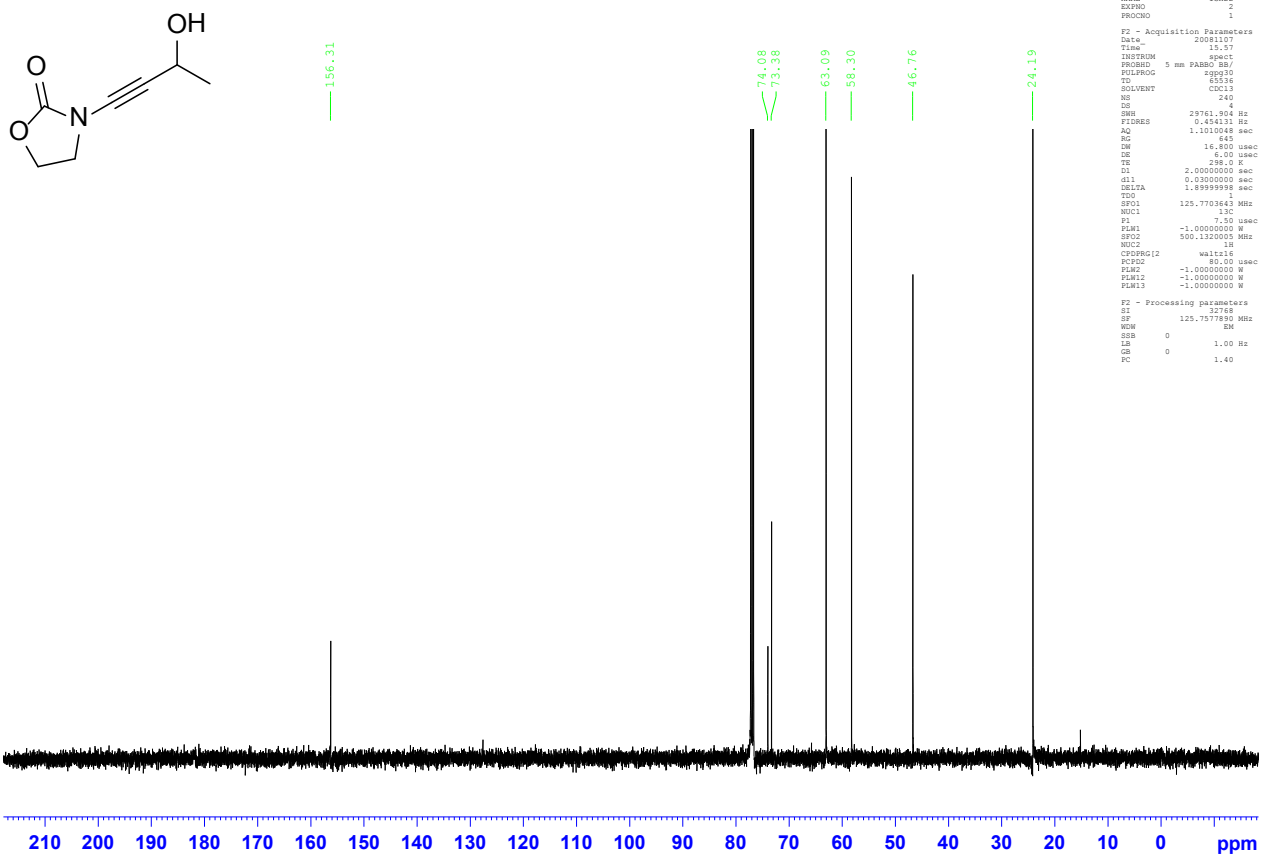


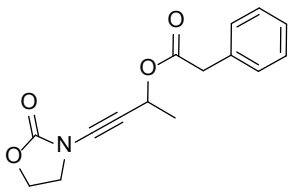


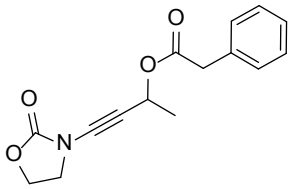


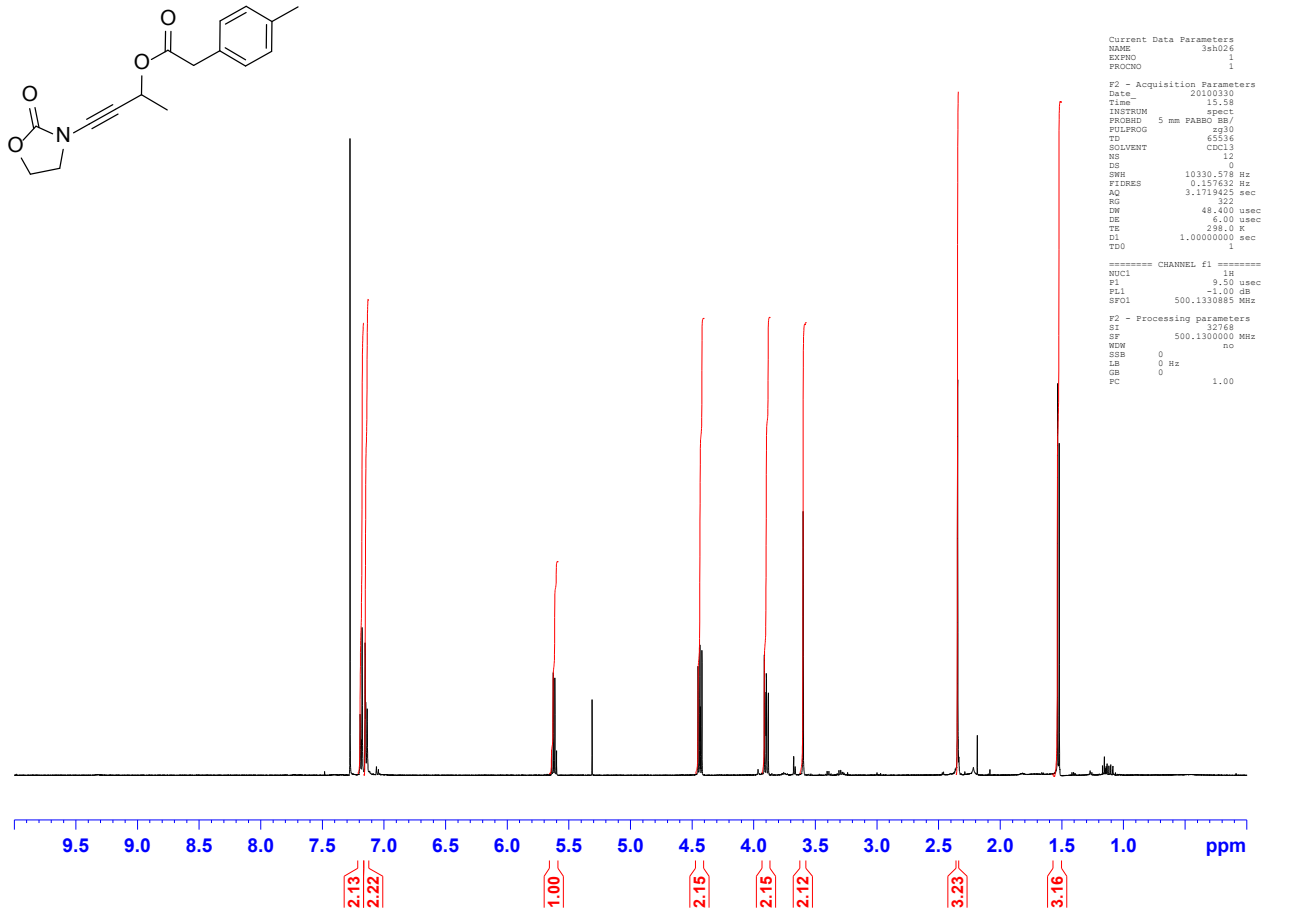


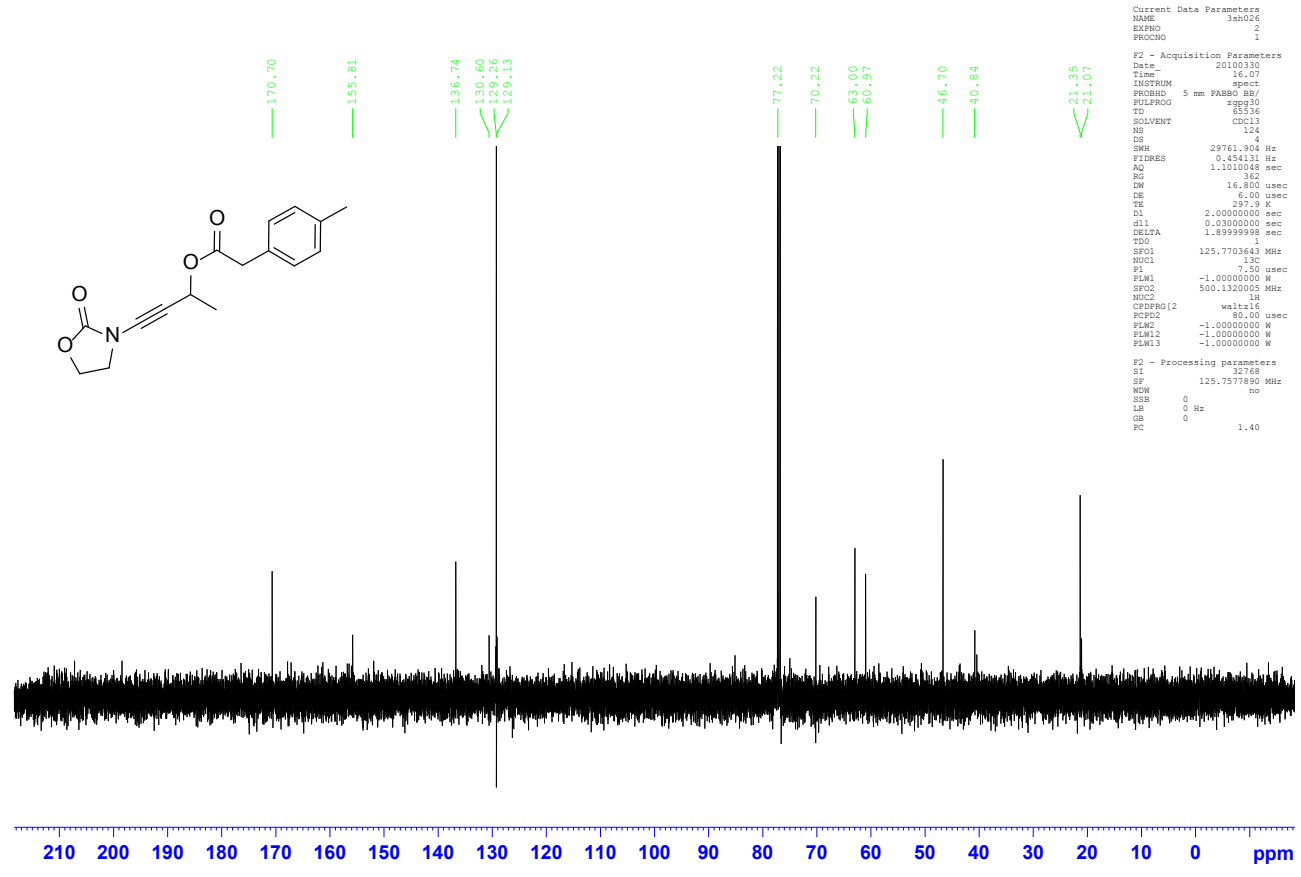


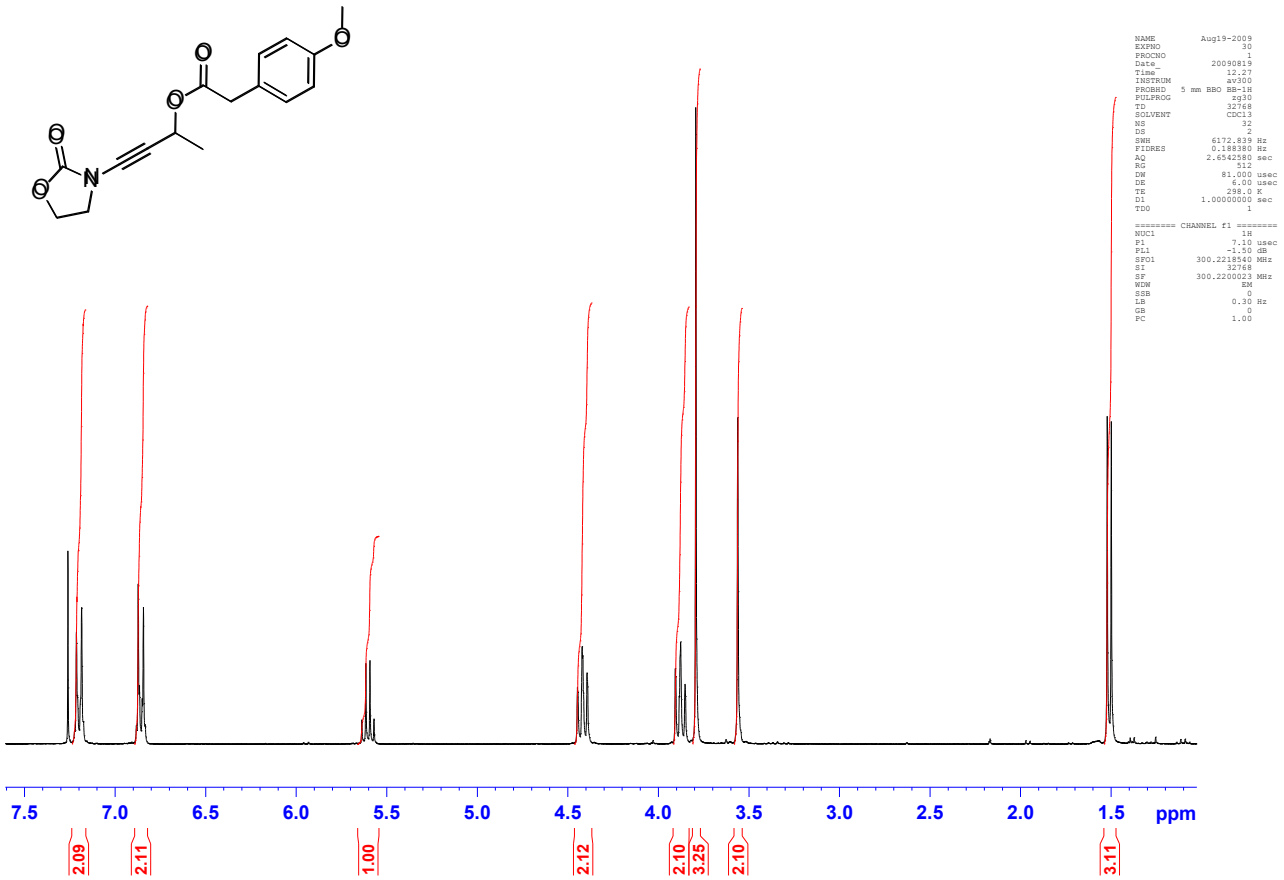


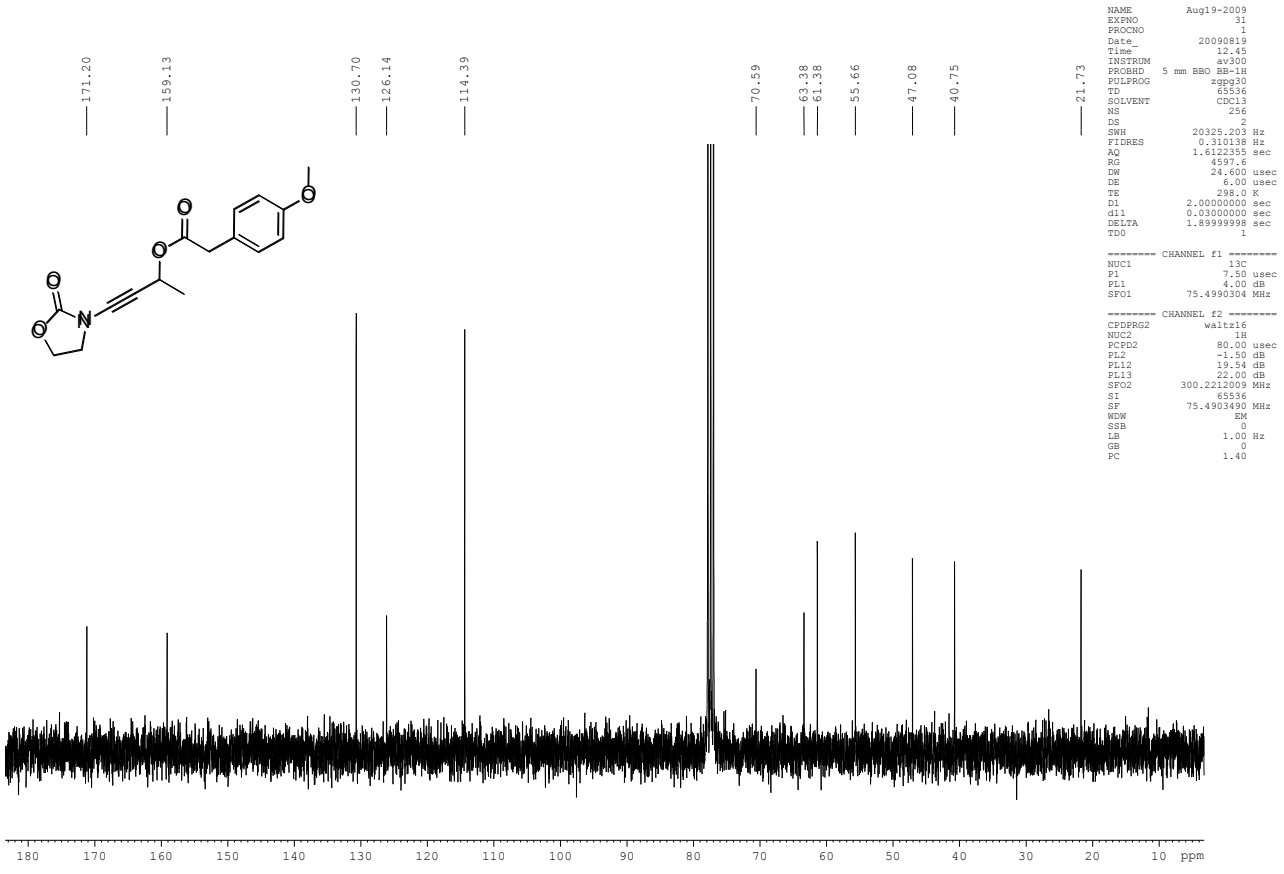


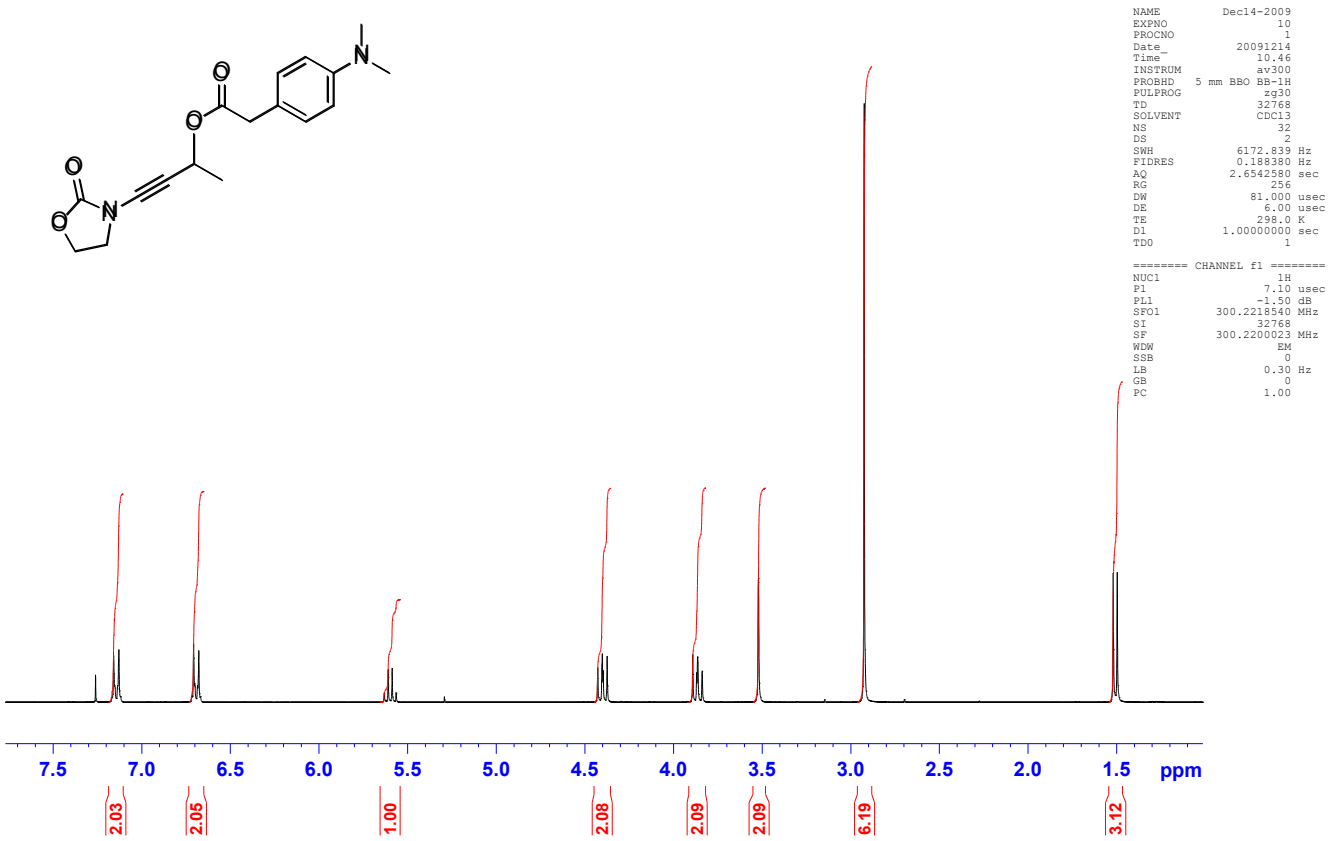


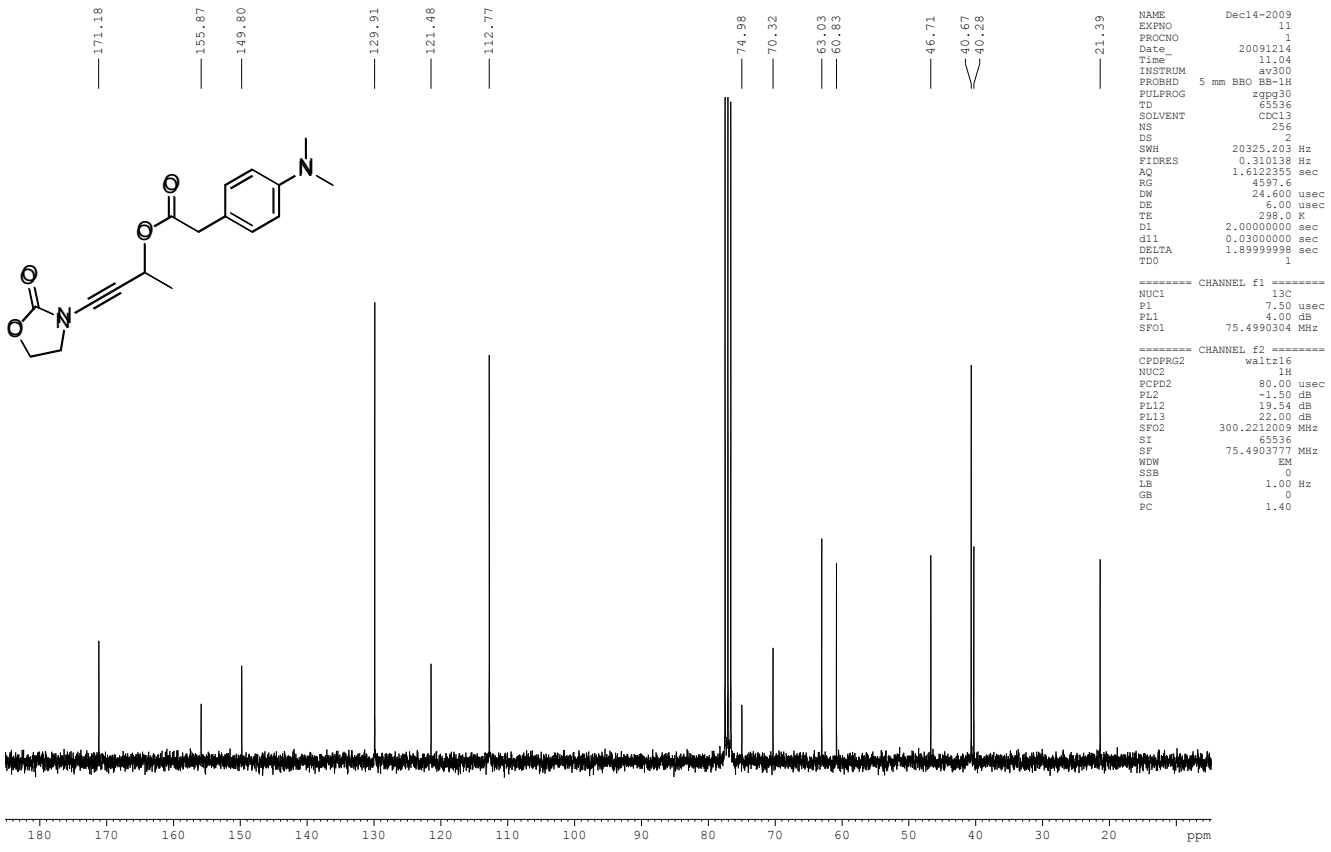


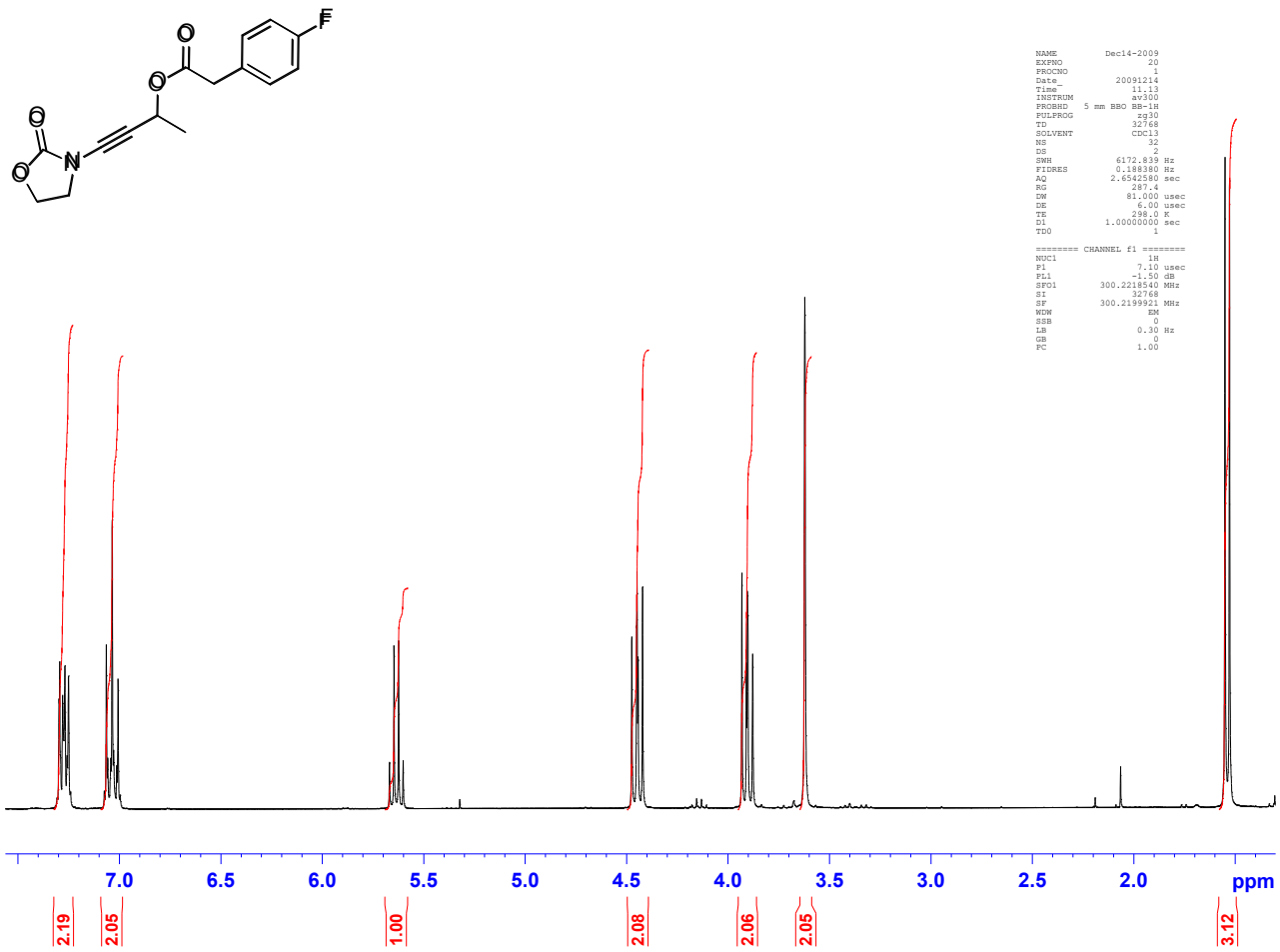








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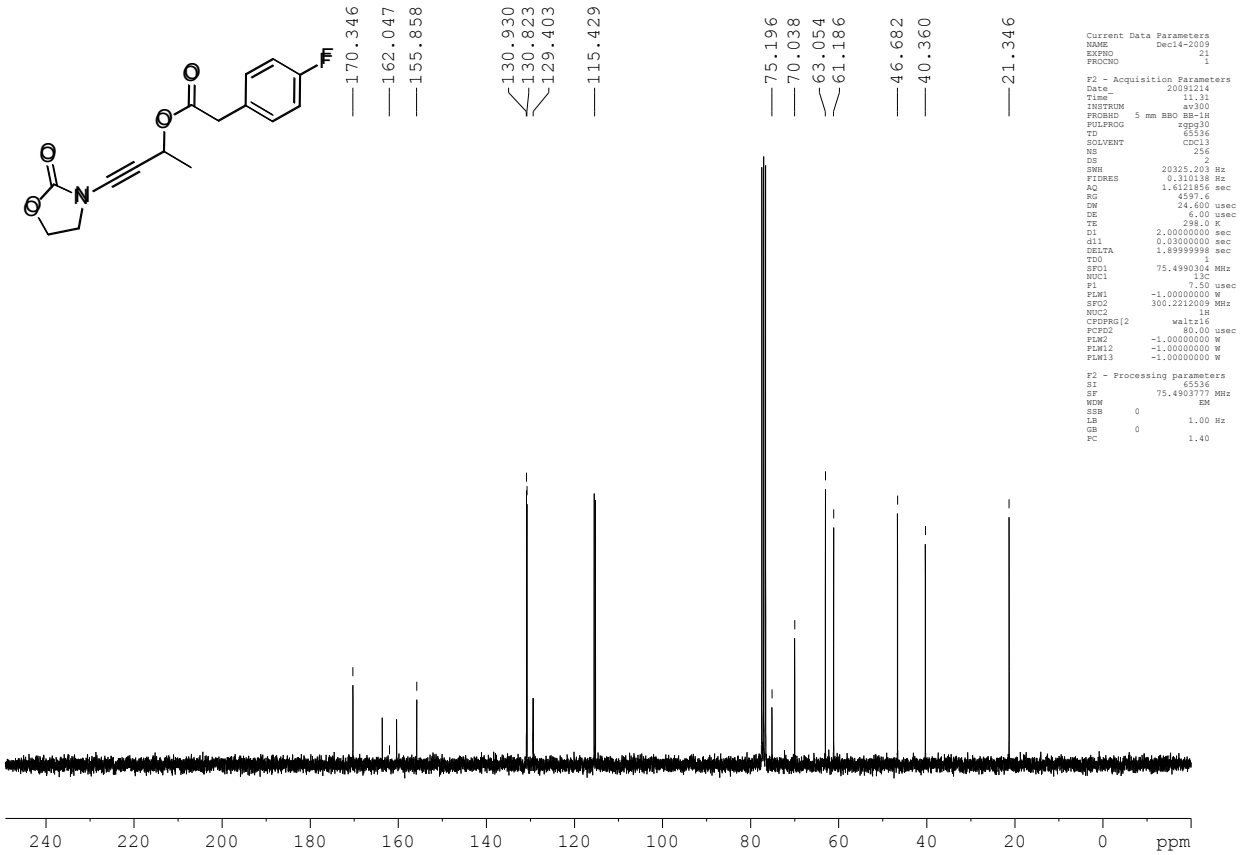
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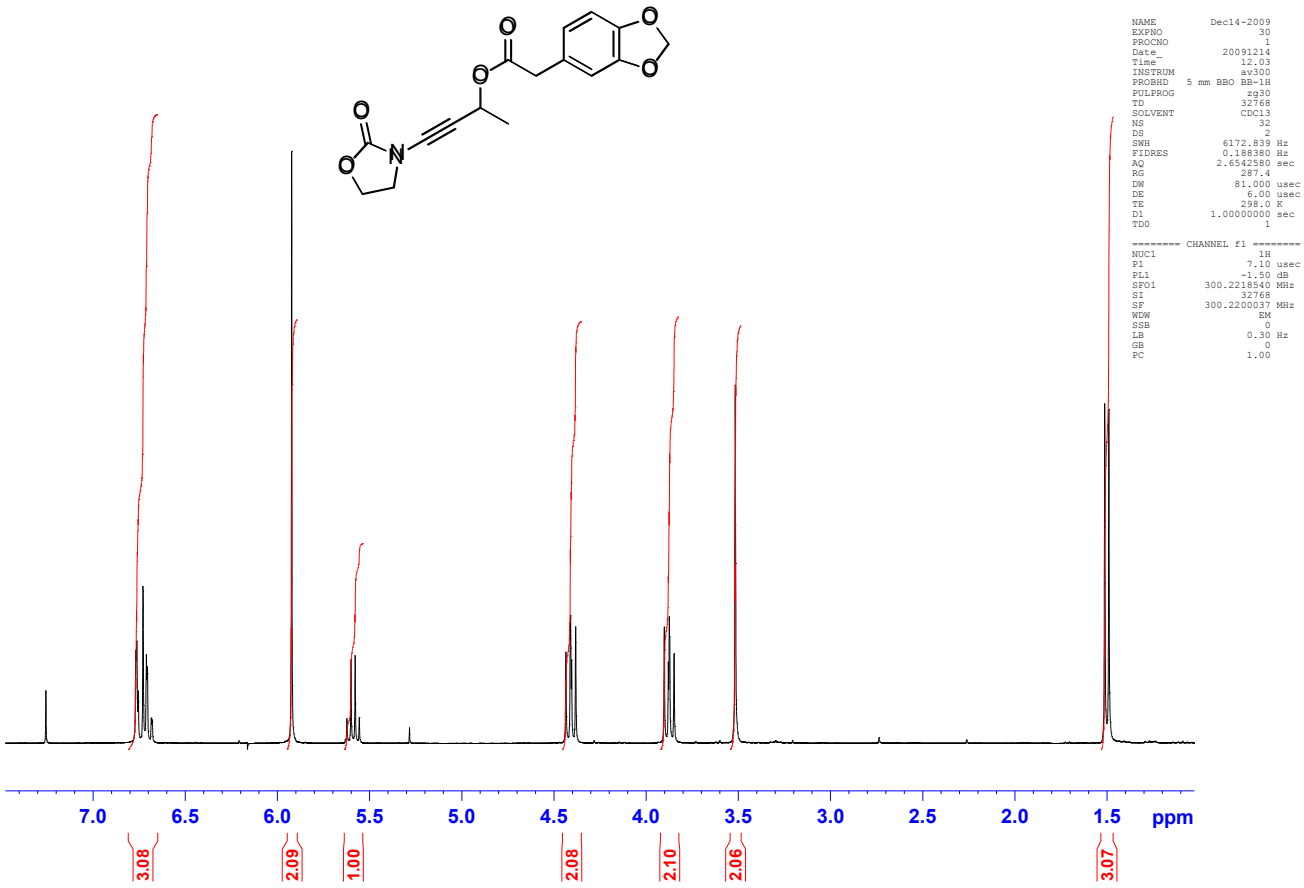

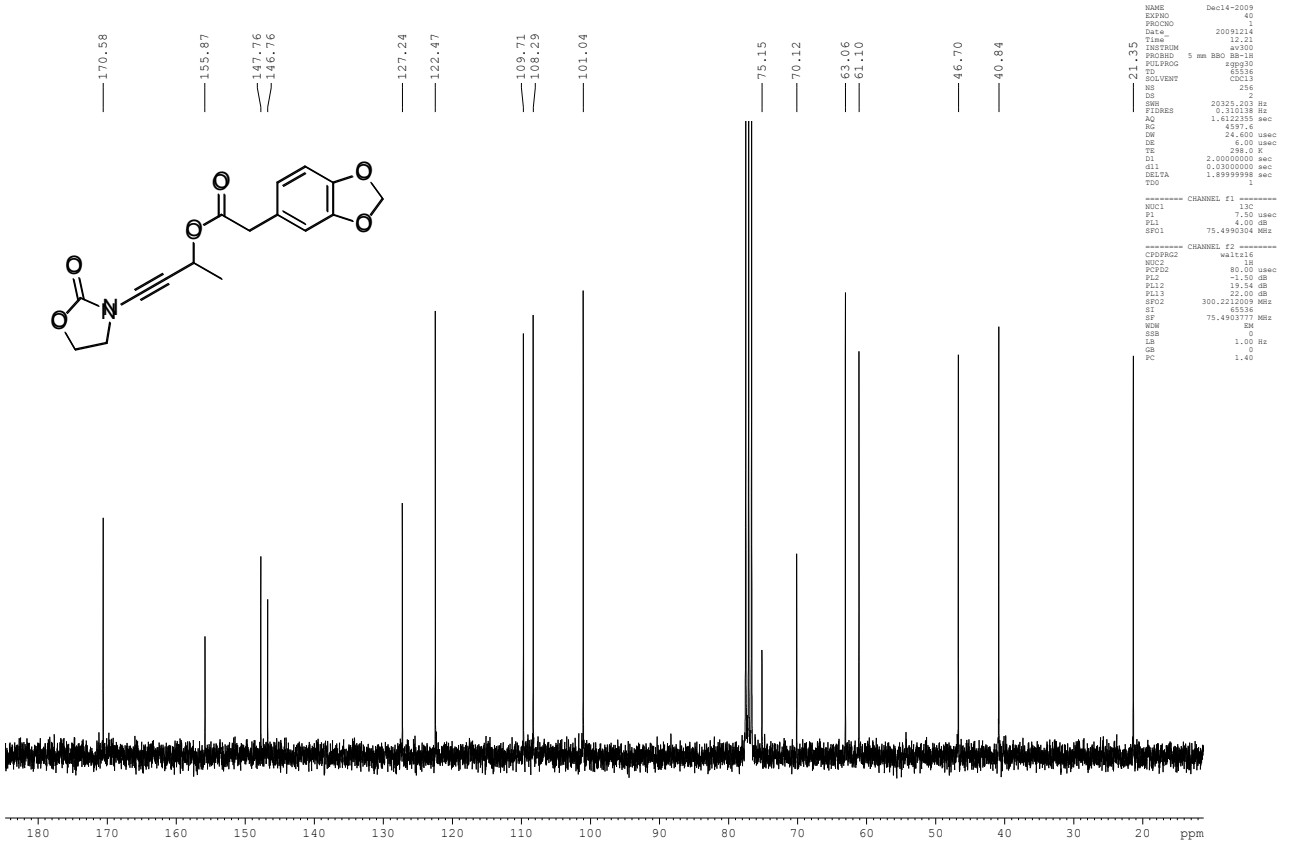

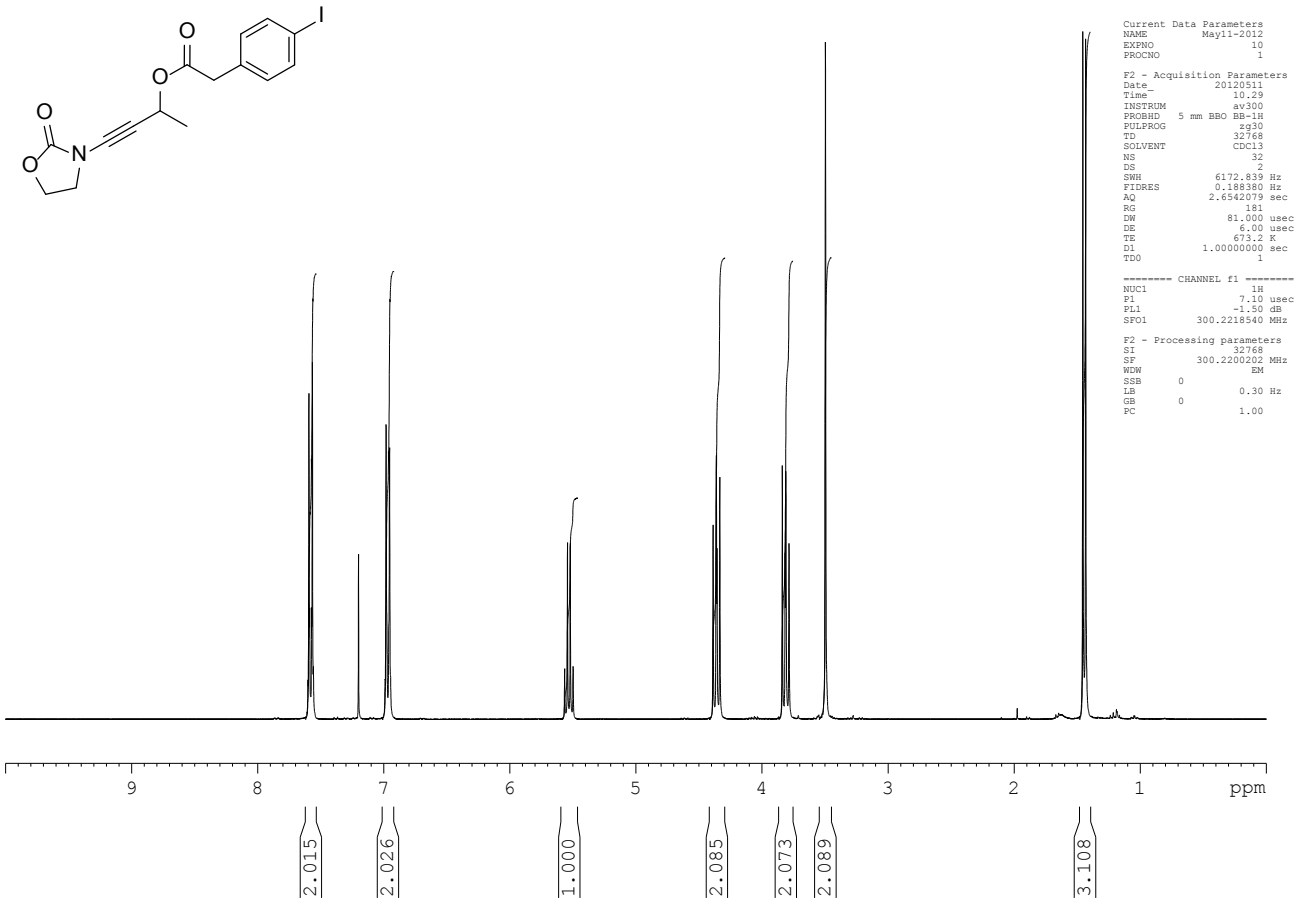

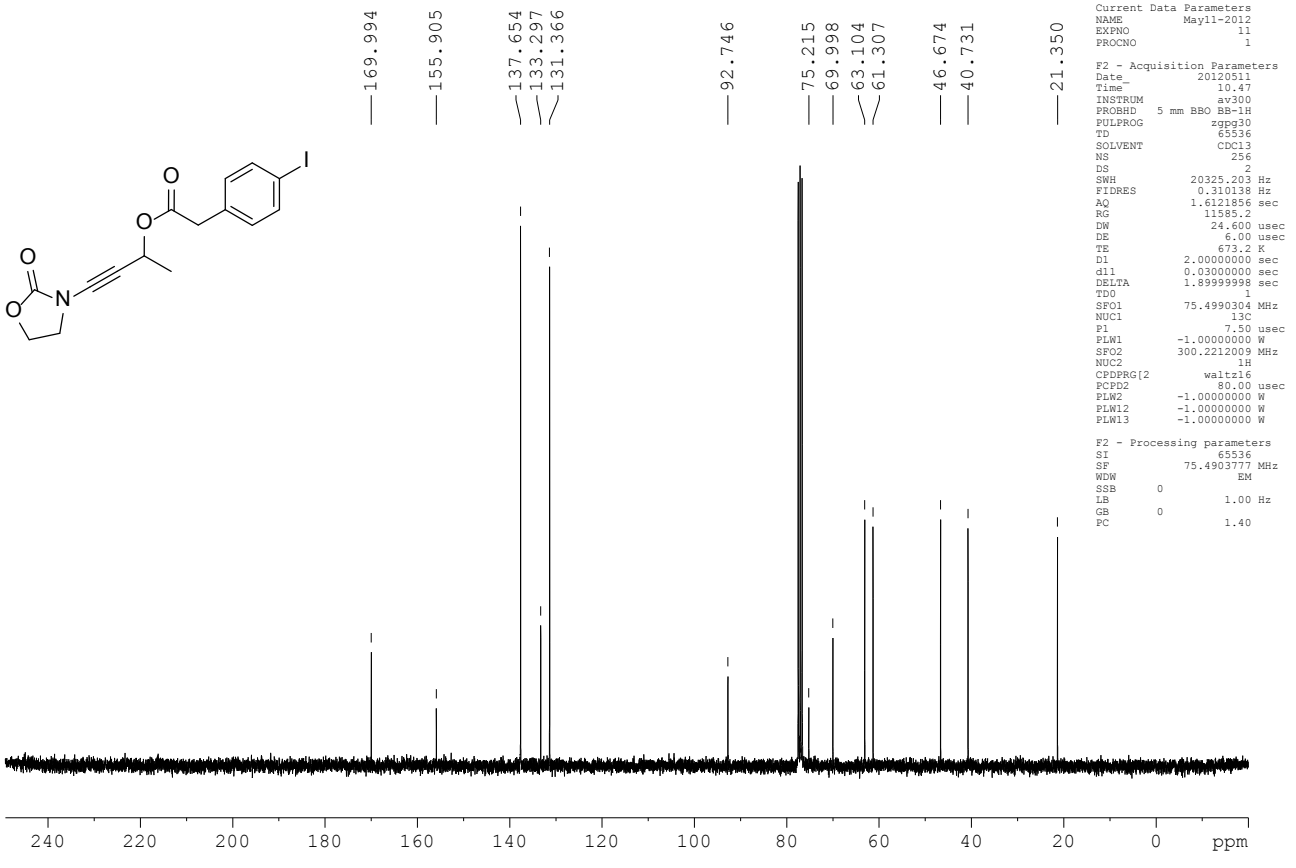

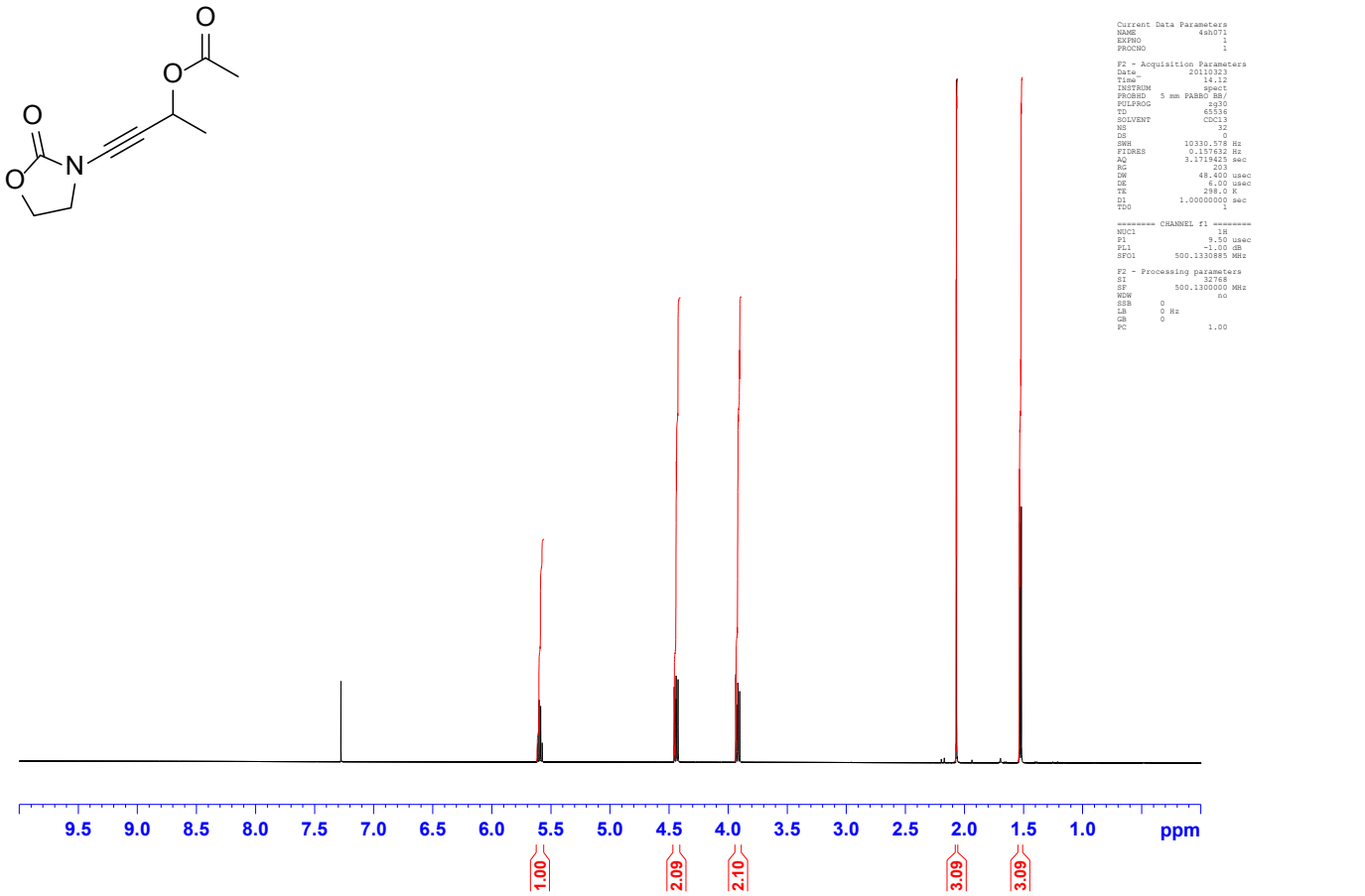

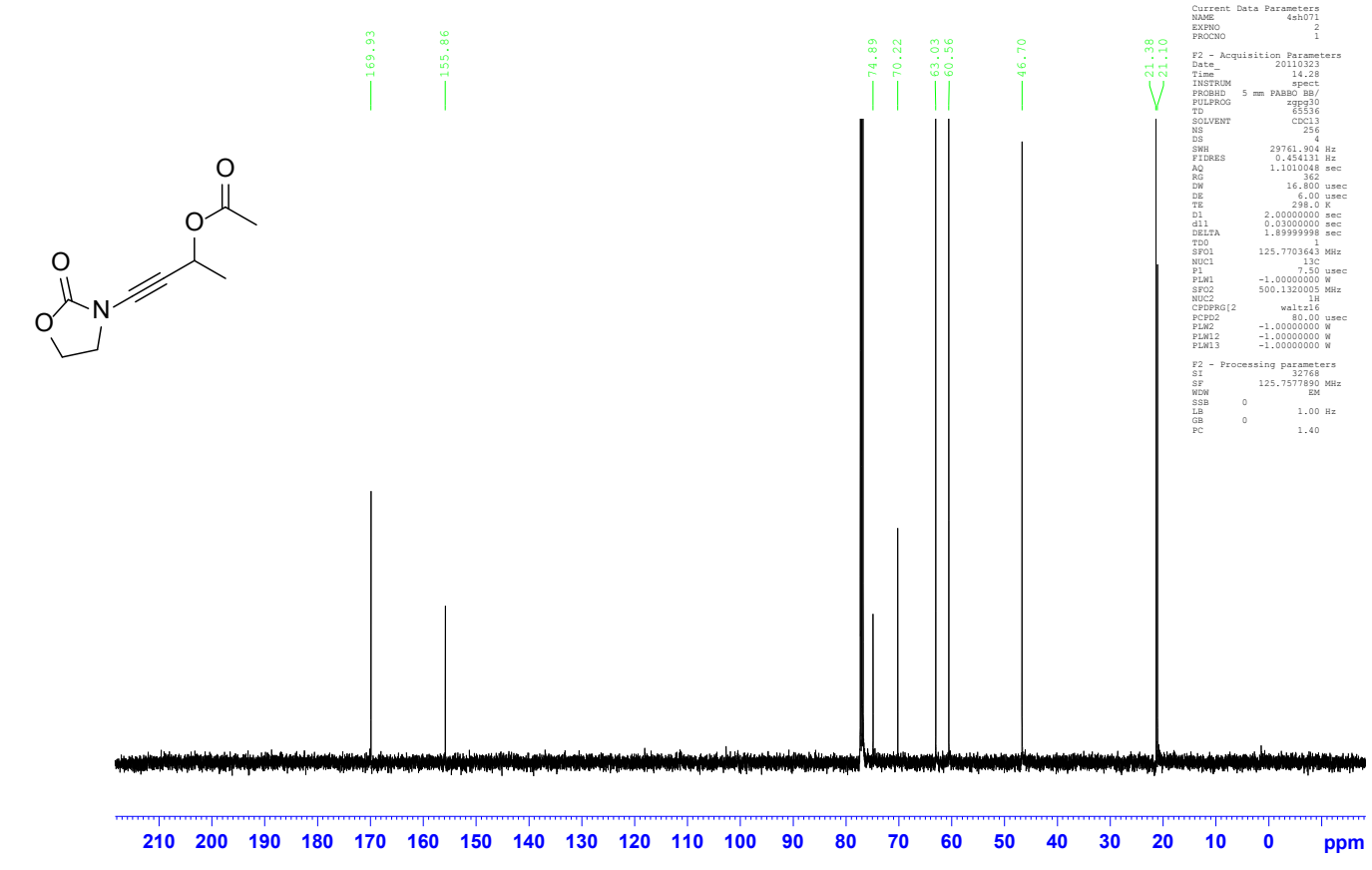

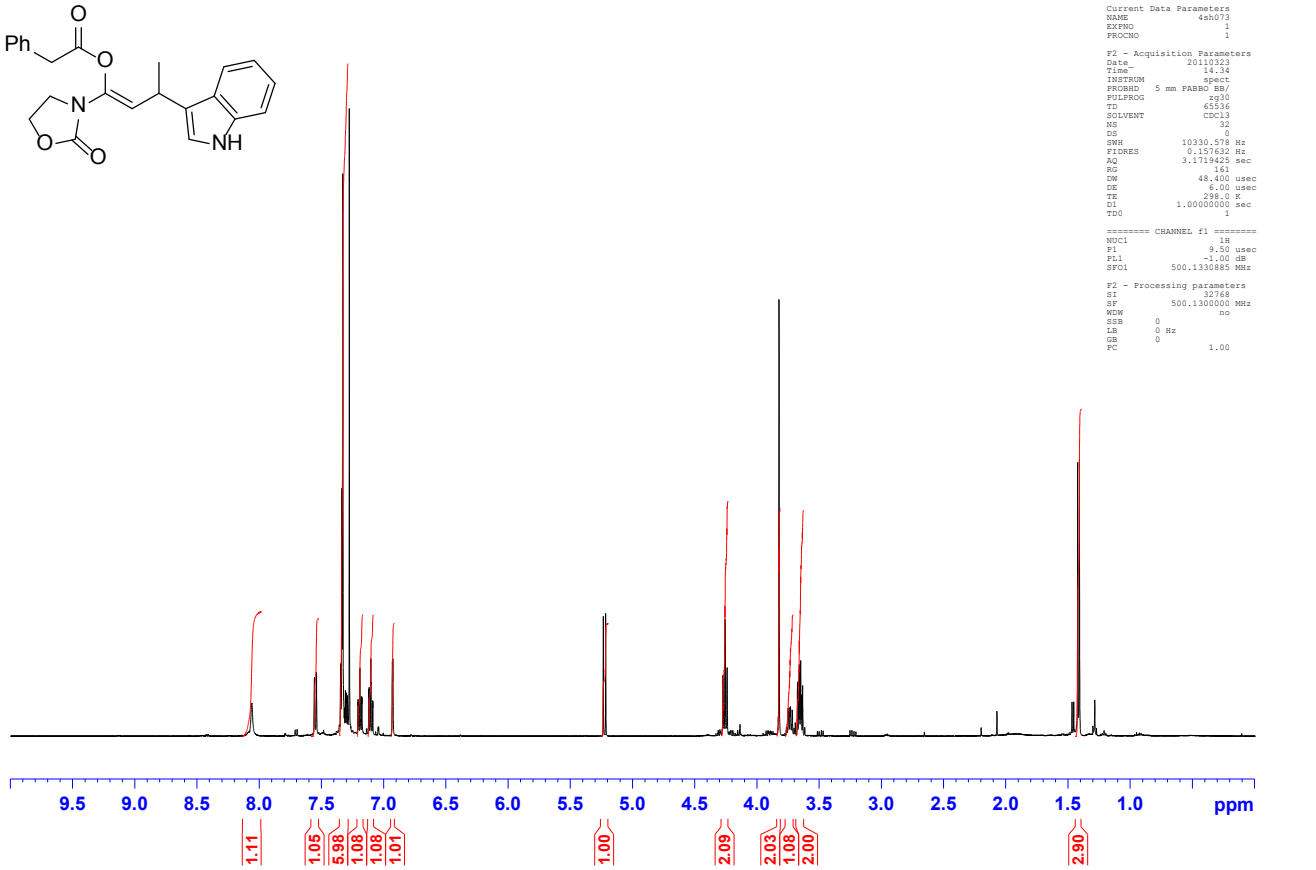

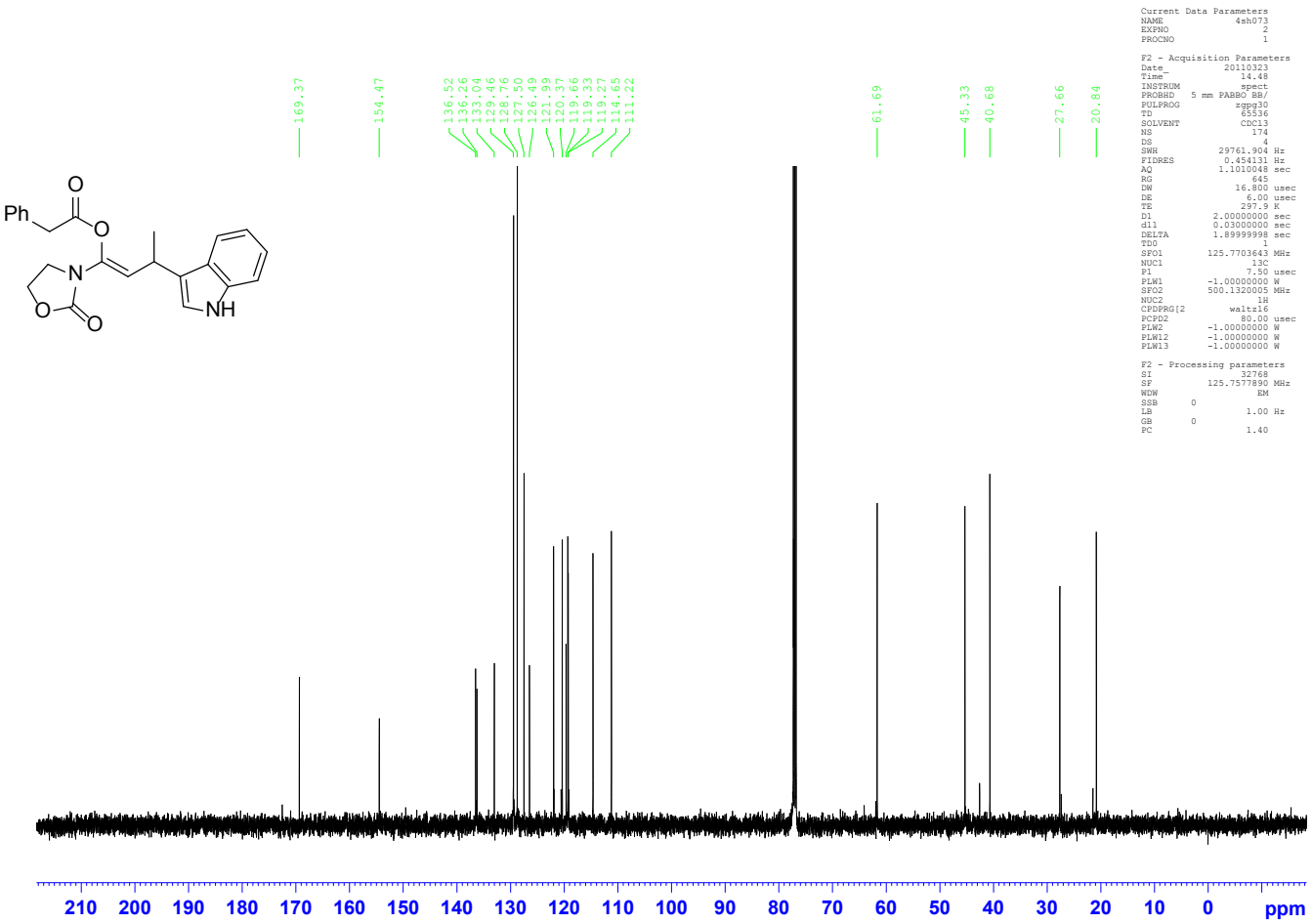

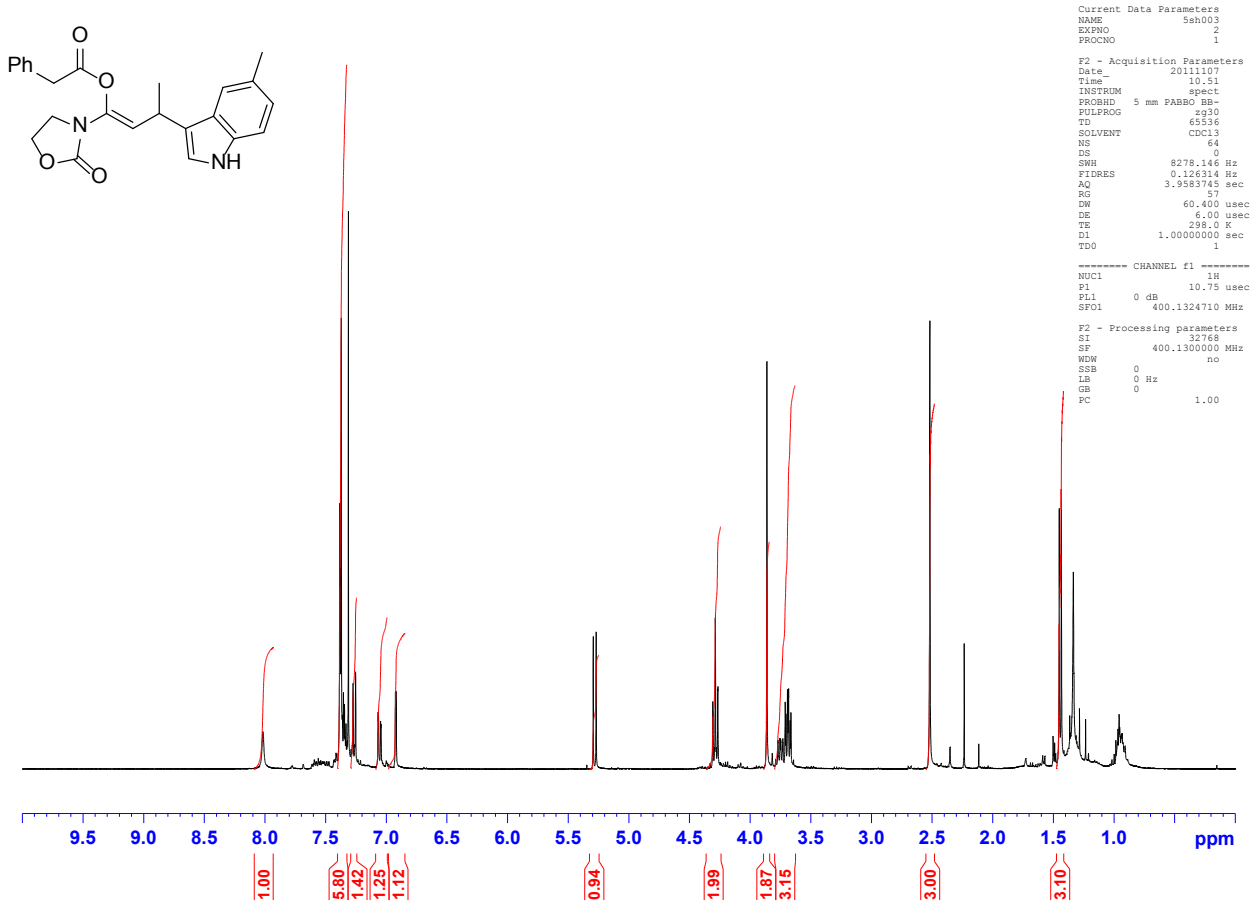

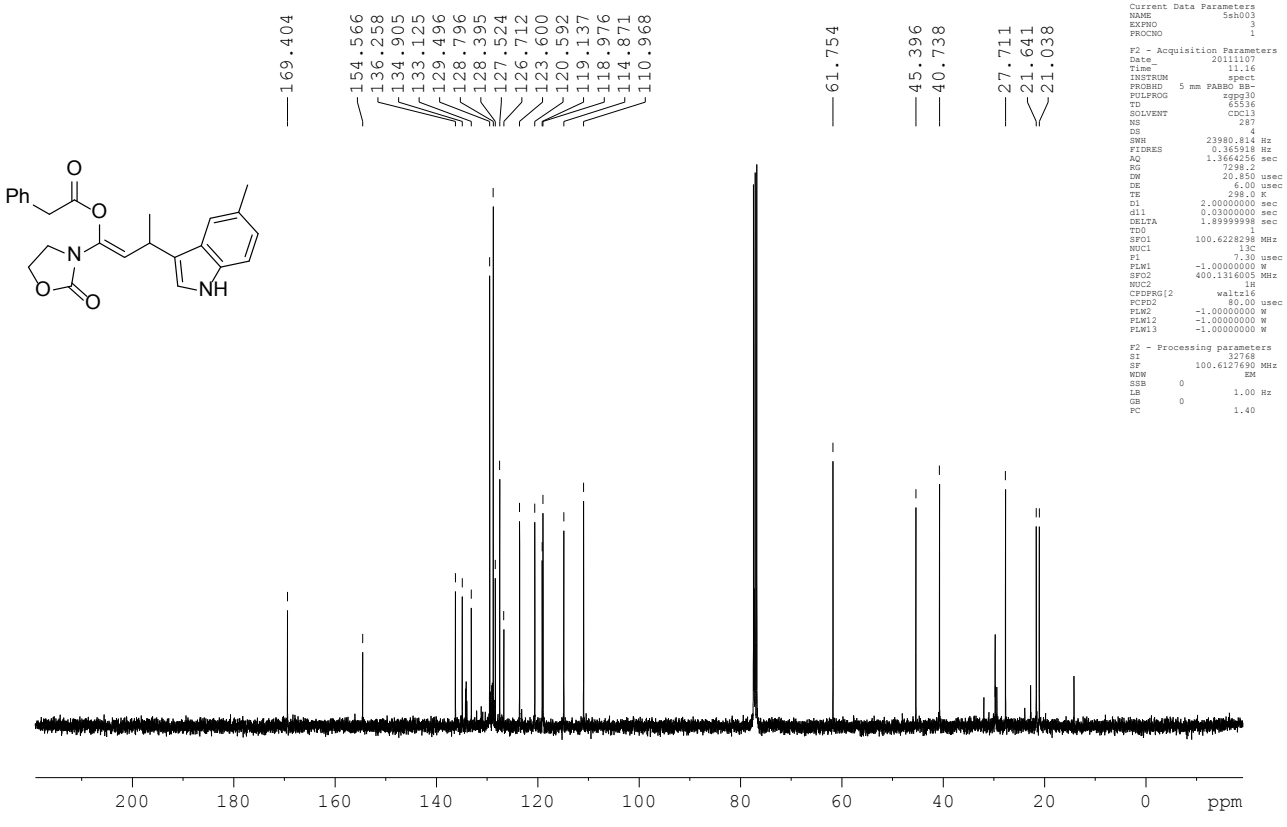

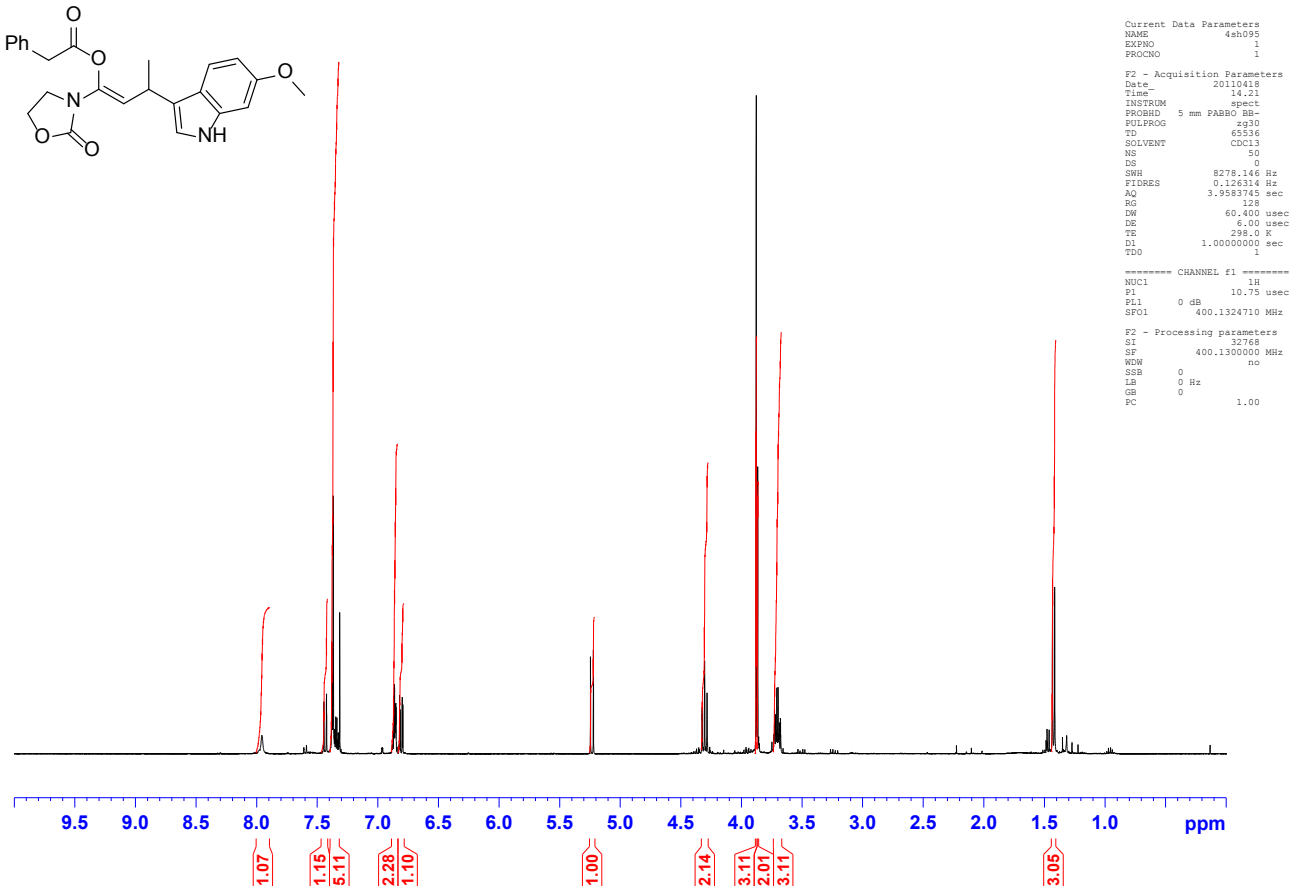

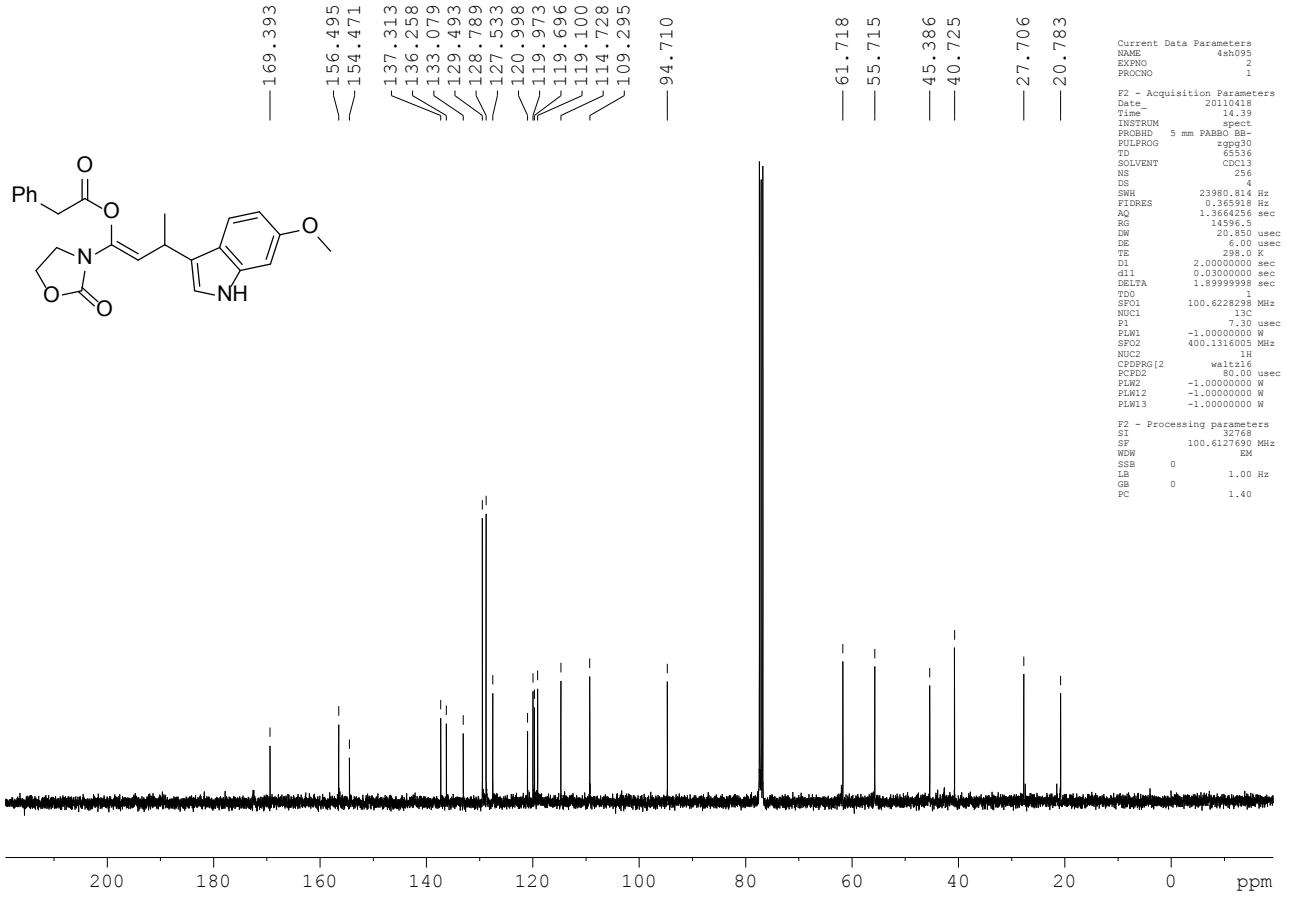

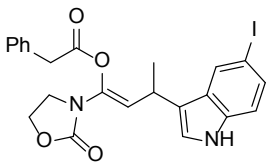

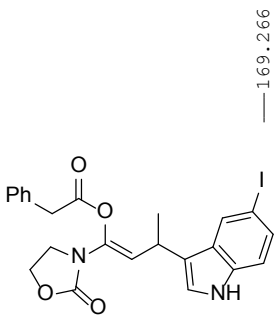

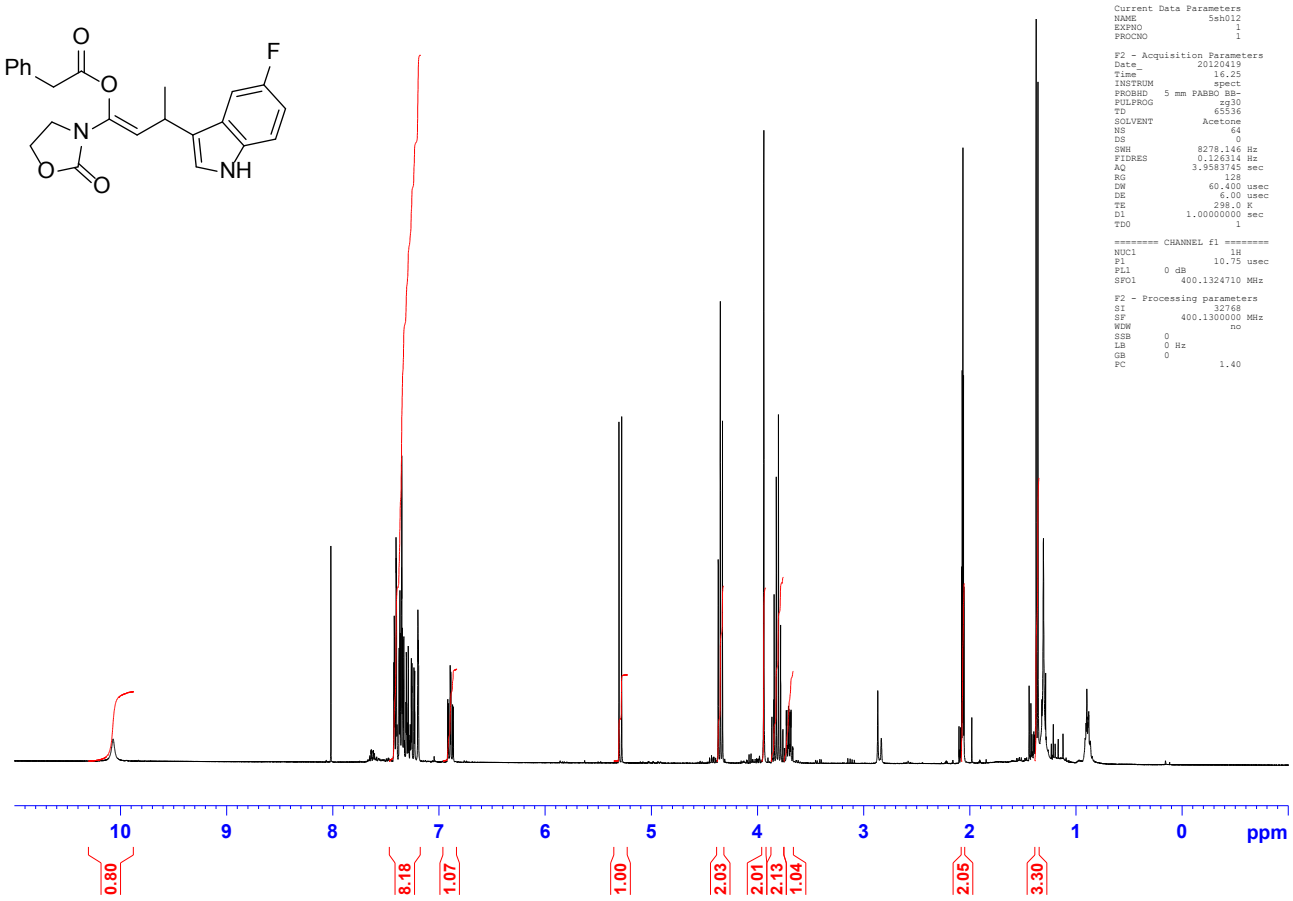

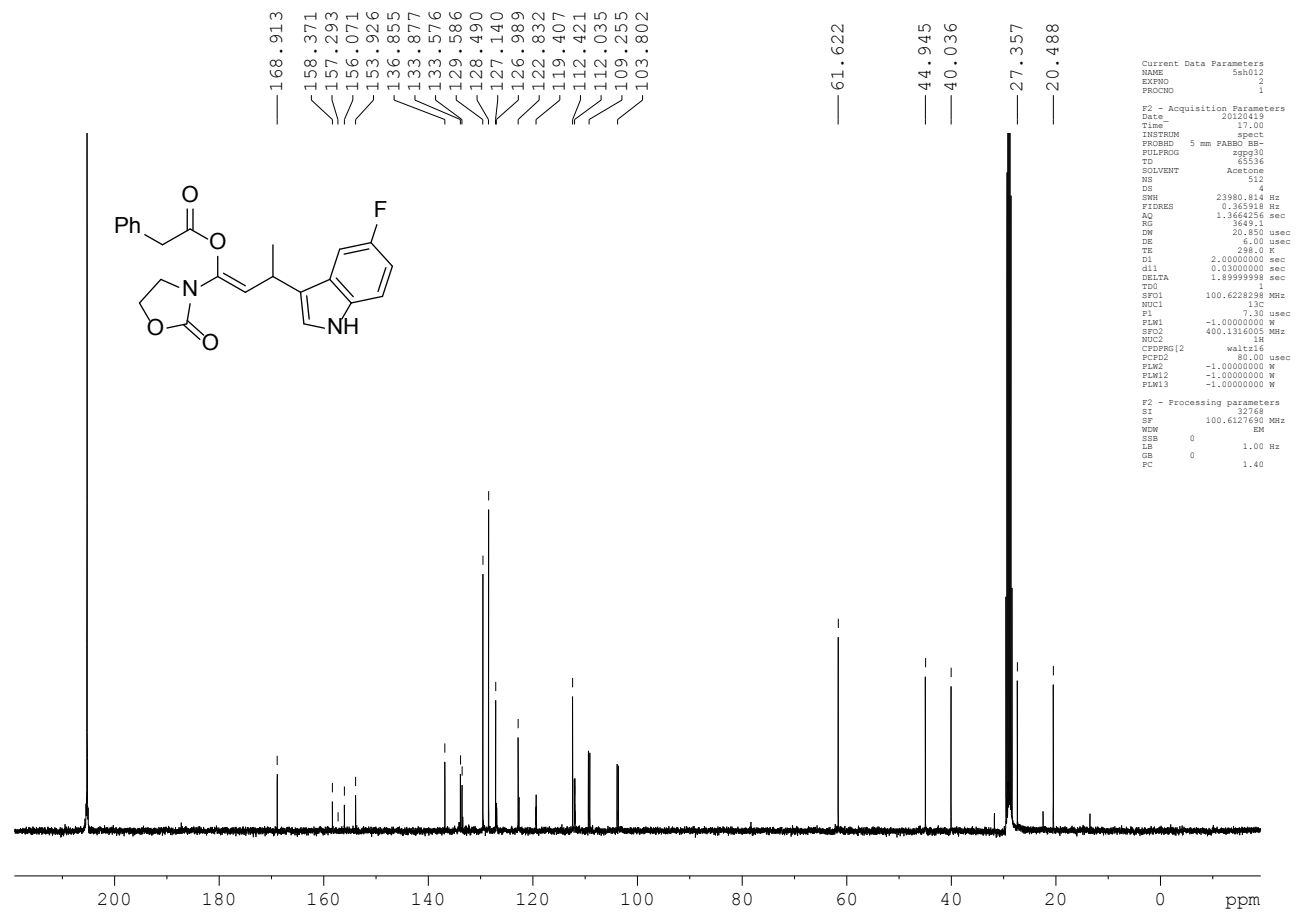

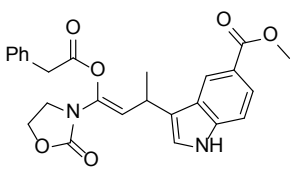


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Current Data Parameters
NAME                  5sh007
EXPNO                      1
PROCNO                     1

F2 - Acquisition Parameters
Date_              20120419
Time                  14.45
INSTRUM                spect
PROBHD    5 mm PABBO BB-
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                       64
DS                        0
SWH                8278.146 Hz
FIDRES             0.126314 Hz
AQ                 3.9583745 sec
RG                      128
DW                   60.400 usec
DE                    6.00 usec
TE                   298.0 K
D1                 1.00000000 sec
TD0                        1

======== CHANNEL f1 ========
NUC1                      1H
P1                     10.75 usec
PL1             0 dB
SFO1              400.1324710 MHz

F2 - Processing parameters
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SF                400.1300000 MHz
WDW                         no
SSB             0
LB              0 Hz
GB              0
PC                        1.00
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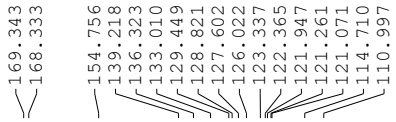

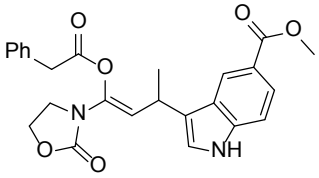


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Current Data Parameters
NAME                  5sh007
EXPNO                      2
PROCNO                     1

F2 - Acquisition Parameters
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Time                  15.04
INSTRUM                spect
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PULPROG             zgpg30
TD                    65536
SOLVENT               CDCl3
NS                      256
DS                        4
SWH               23980.814 Hz
FIDRES             0.365918 Hz
AQ                 1.3664256 sec
RG                    5160.6
DW                   20.850 usec
DE                    6.00 usec
TE                   298.0 K
D1                 2.00000000 sec
d11                0.03000000 sec
DELTA              1.89999998 sec
TD0                        1
SFO1              100.6228298 MHz
NUC1                      13C
P1                     7.30 usec
PLW1              -1.00000000 W
SFO2              400.1316005 MHz
NUC2                      1H
CPDPRG[2               waltz16
PCPD2                 80.00 usec
PLW2              -1.00000000 W
PLW12             -1.00000000 W
PLW13             -1.00000000 W

F2 - Processing parameters
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SF                100.6127690 MHz
WDW                         no
SSB             0
LB              0 Hz
GB              0
PC                        1.00
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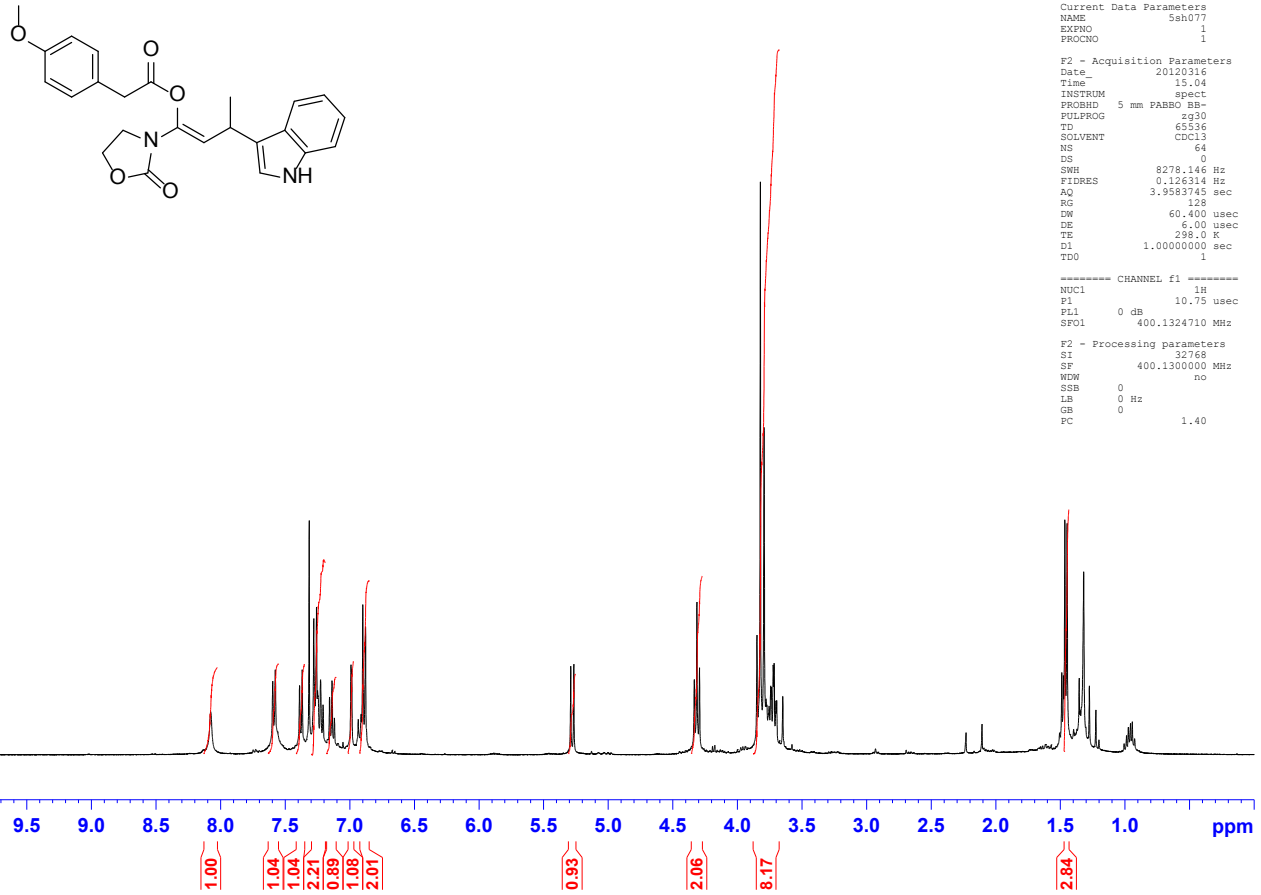

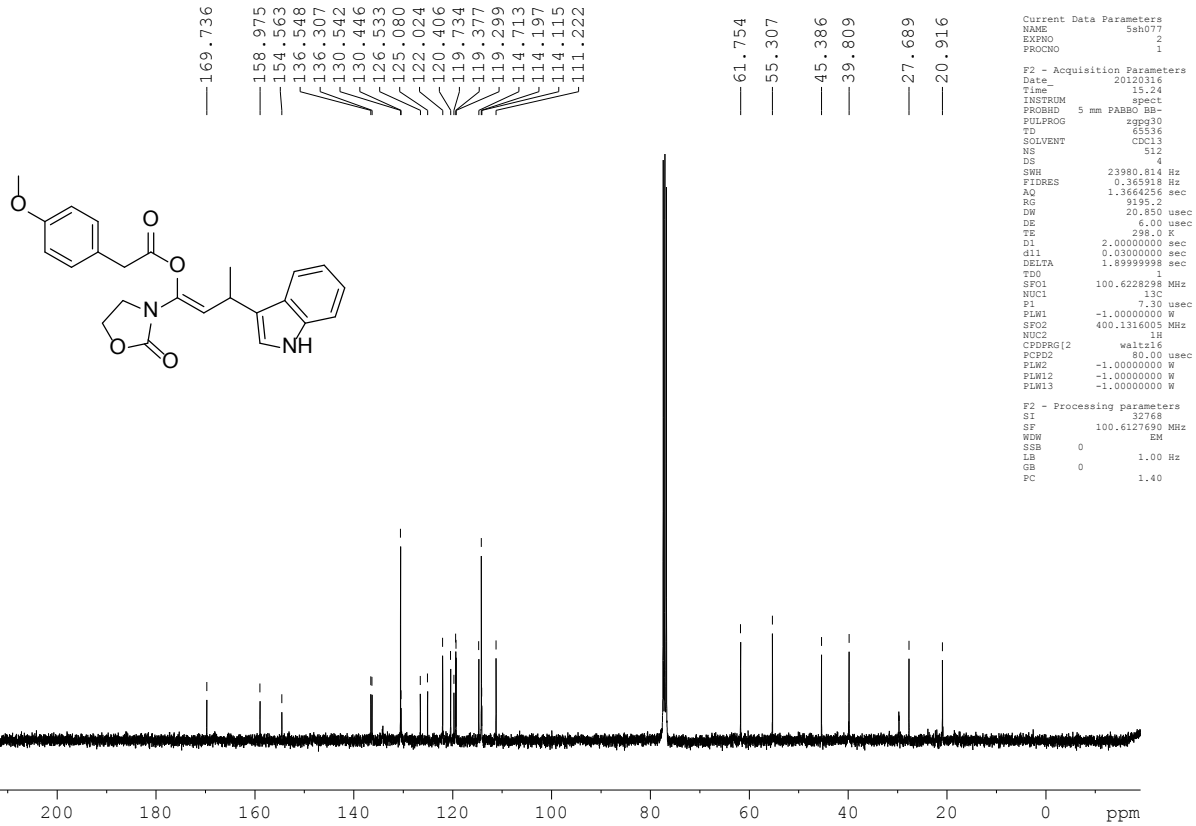

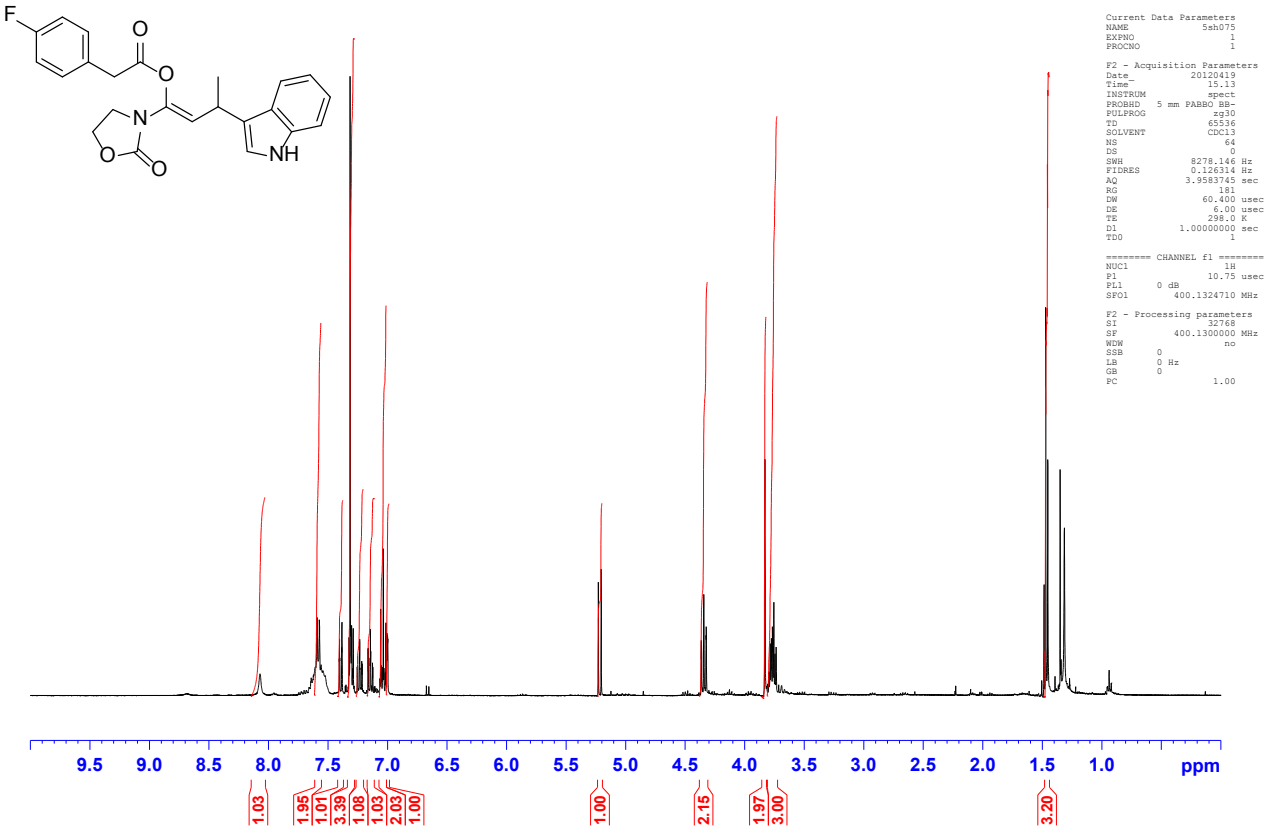

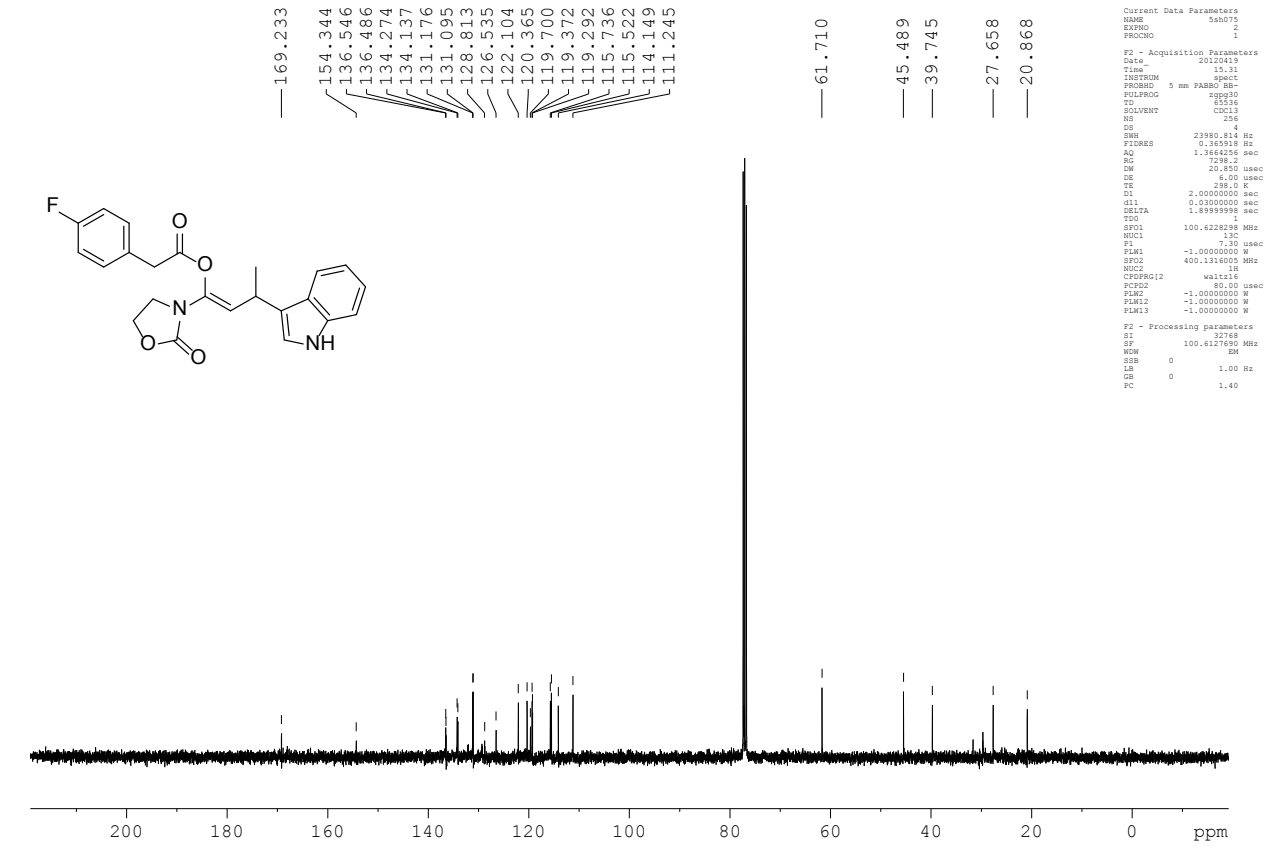

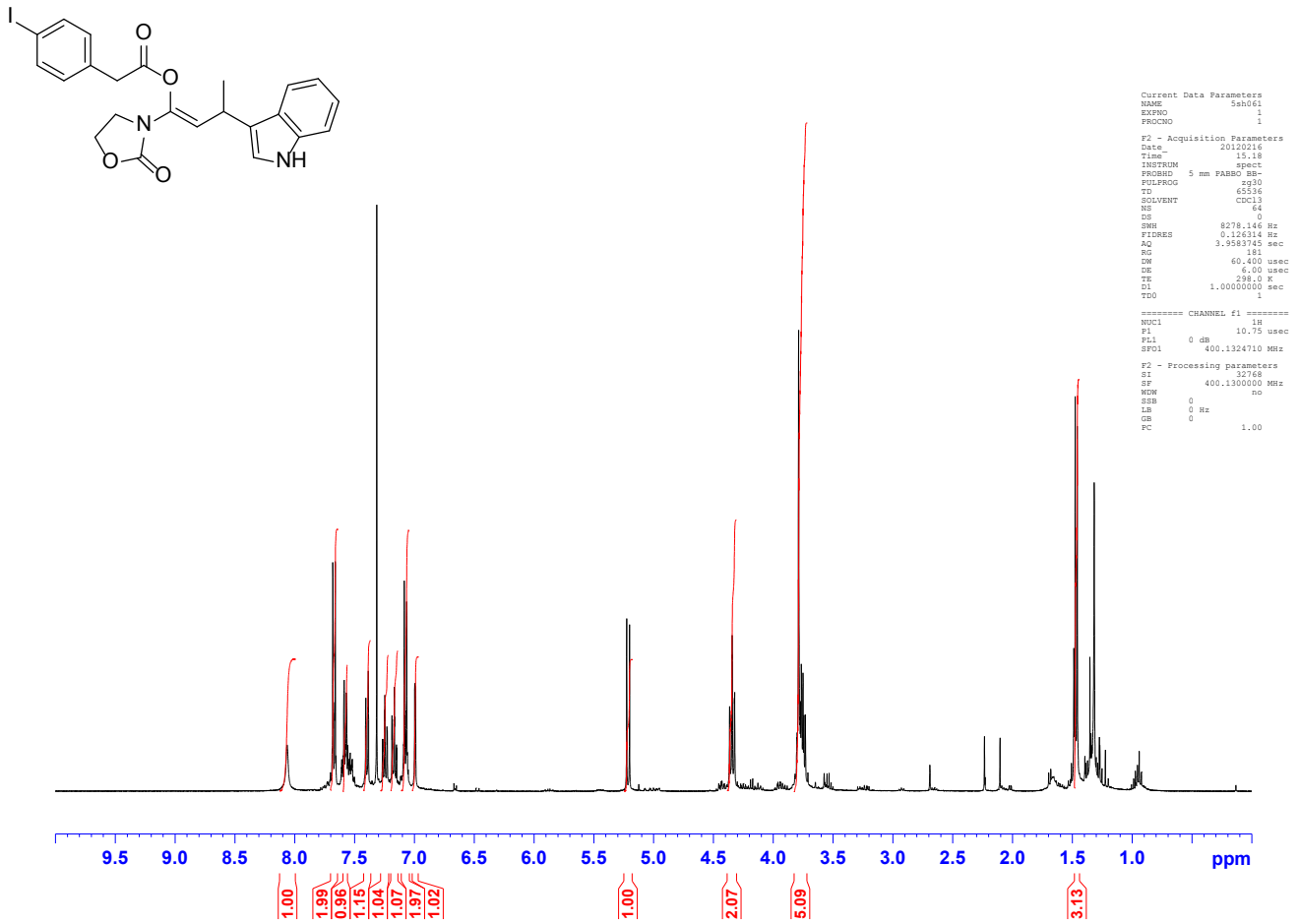

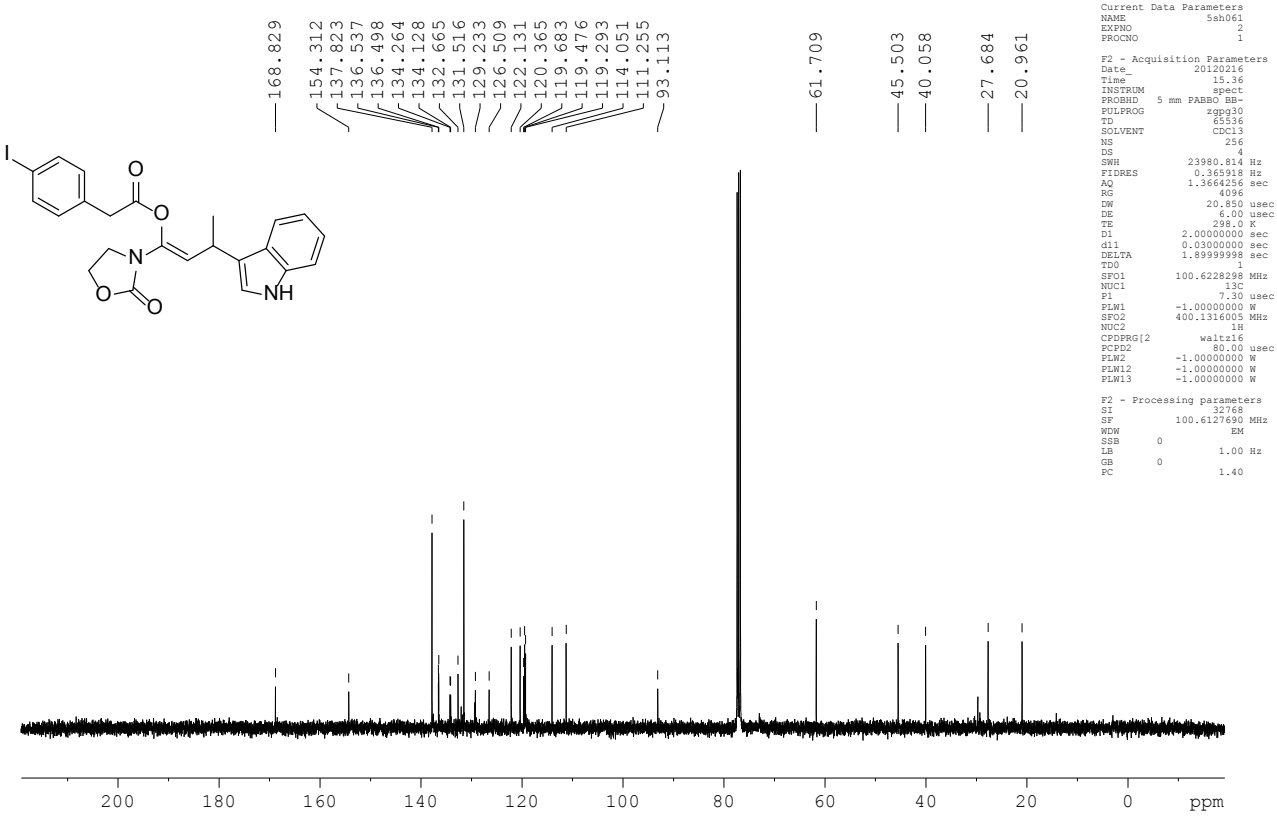

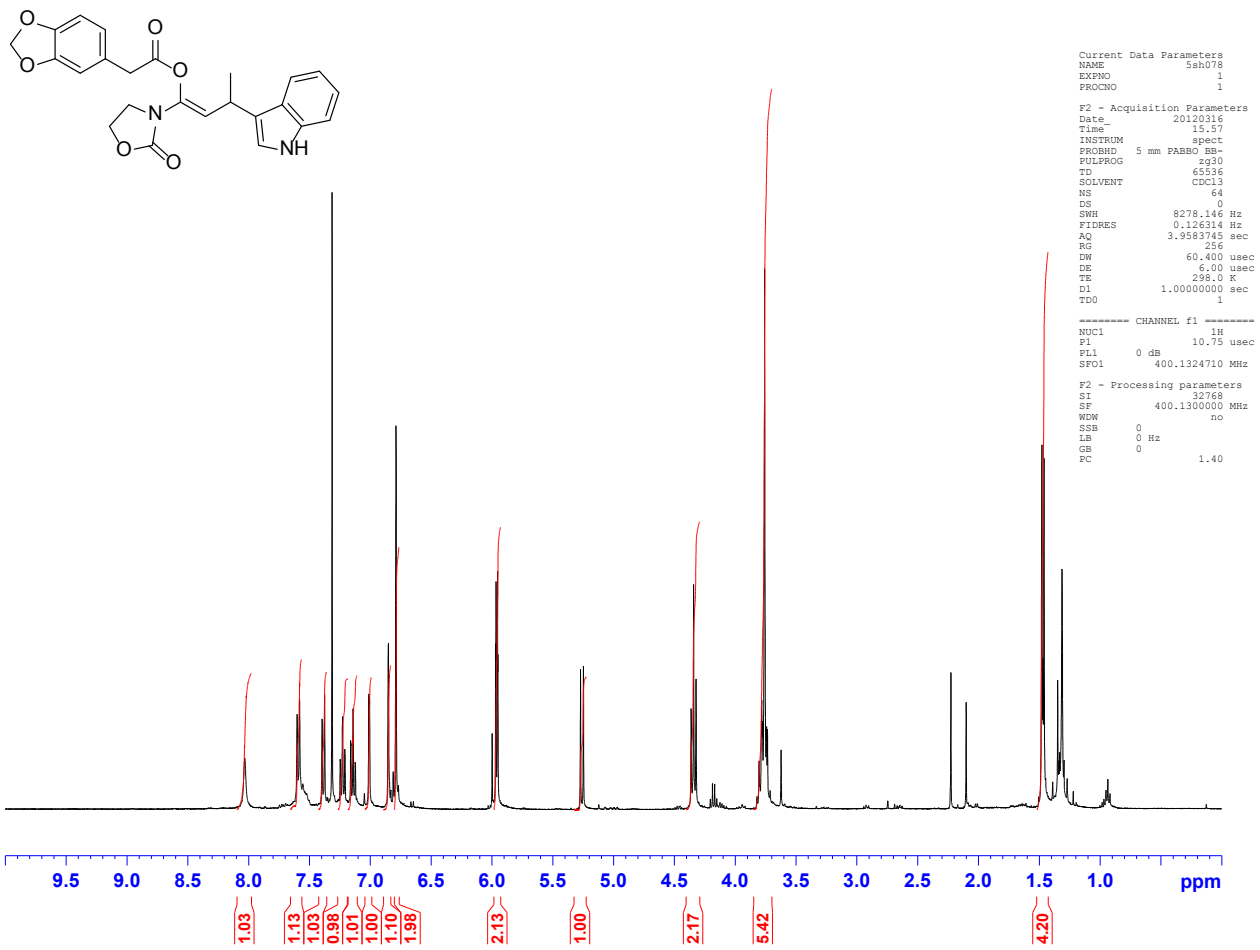

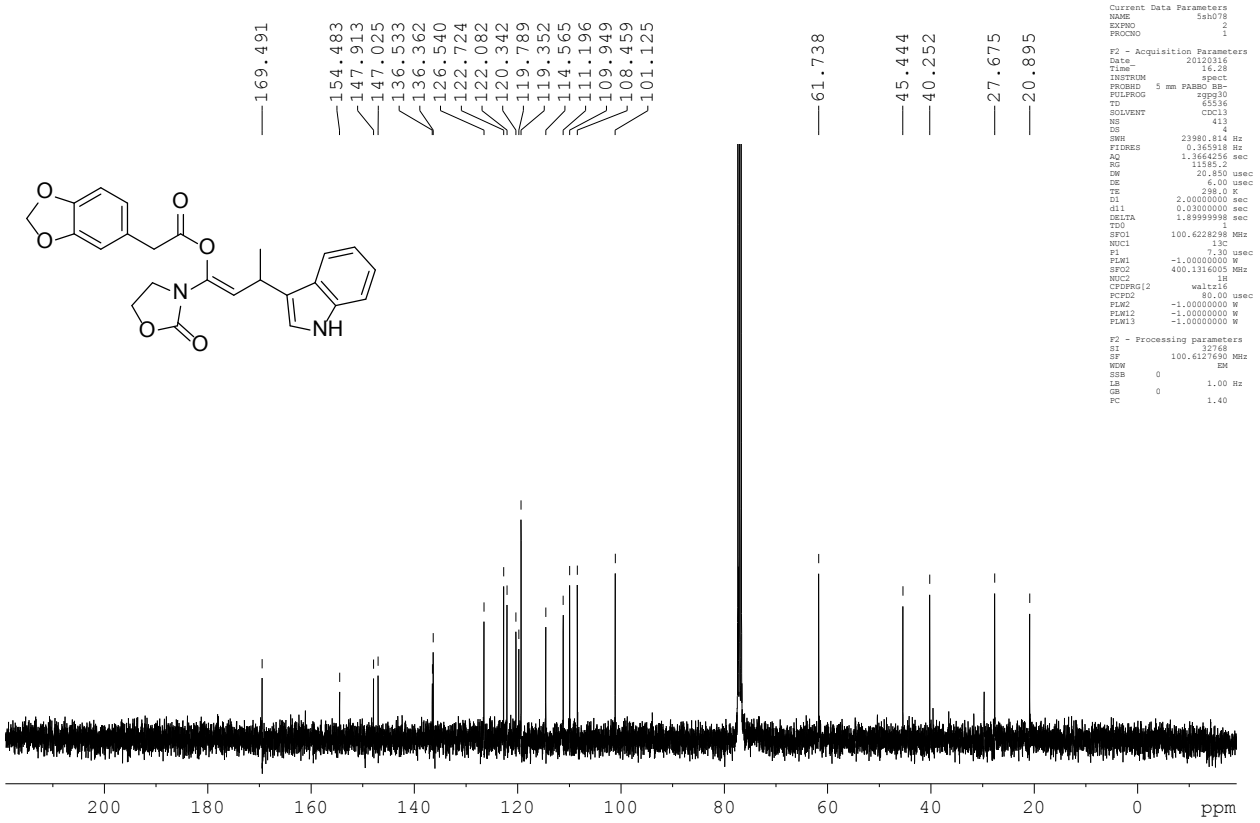

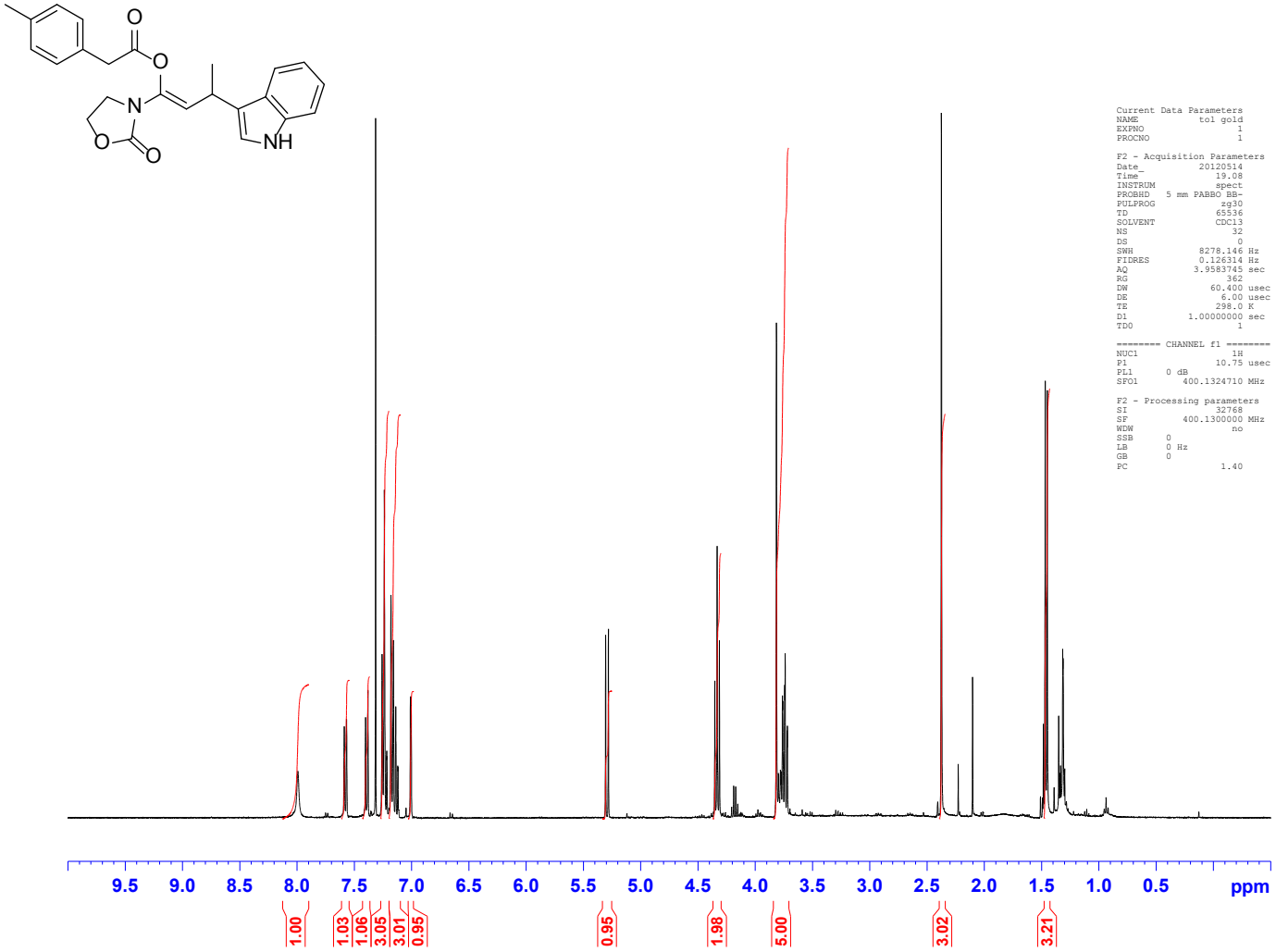

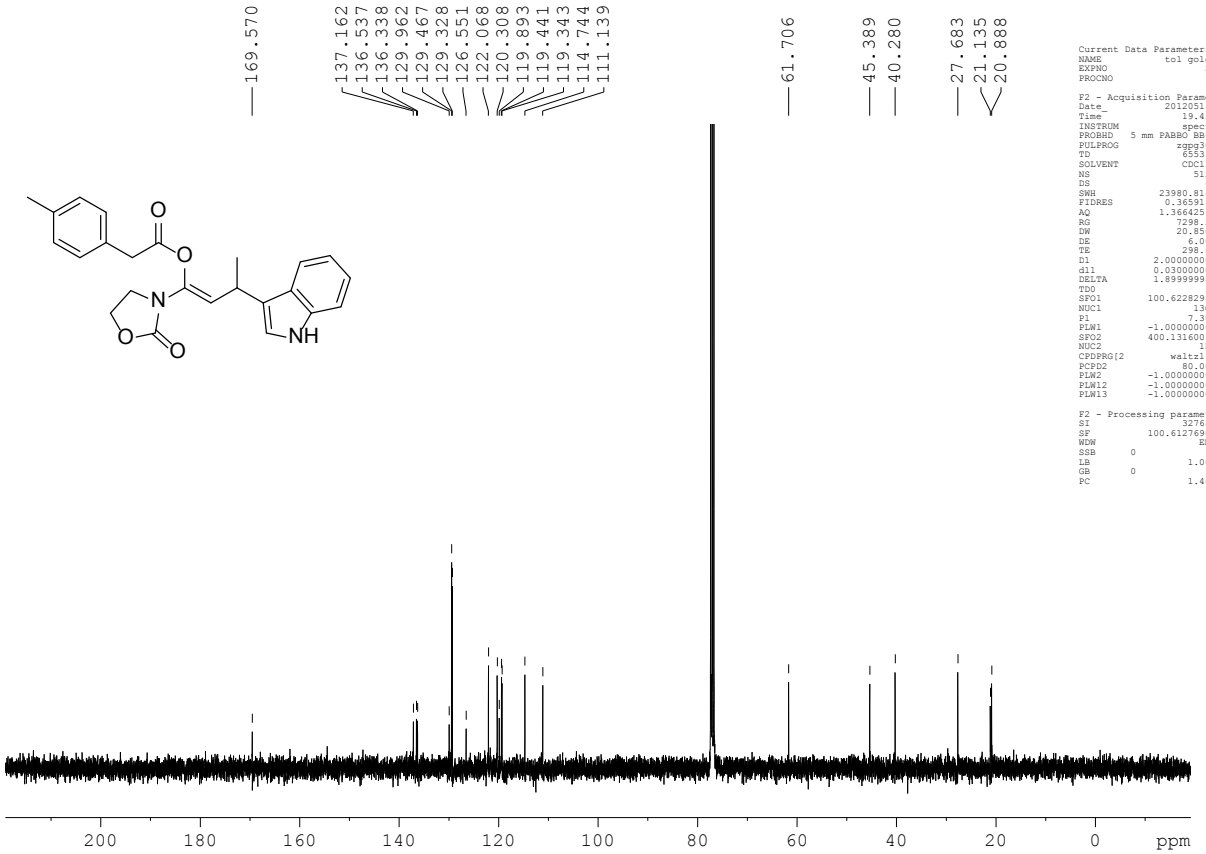

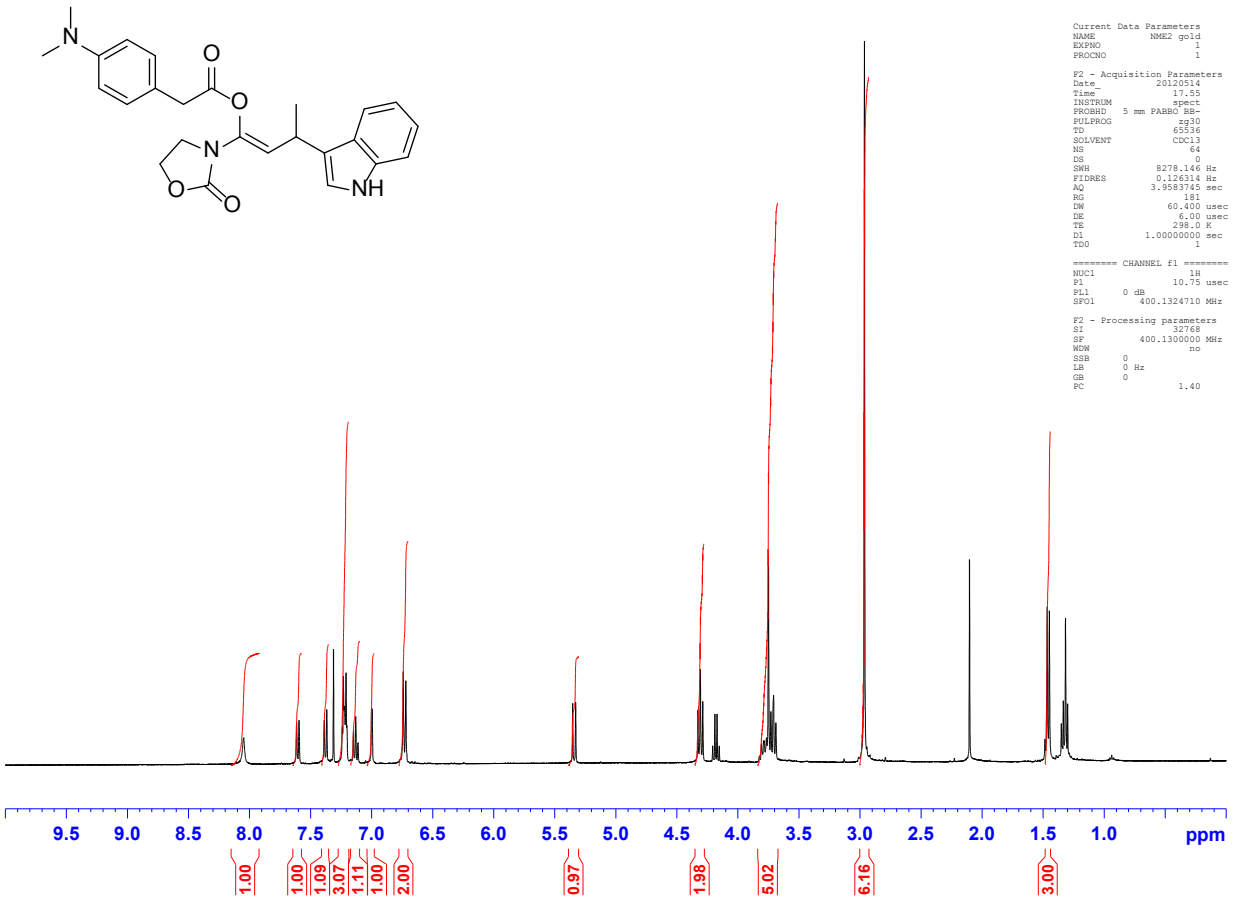

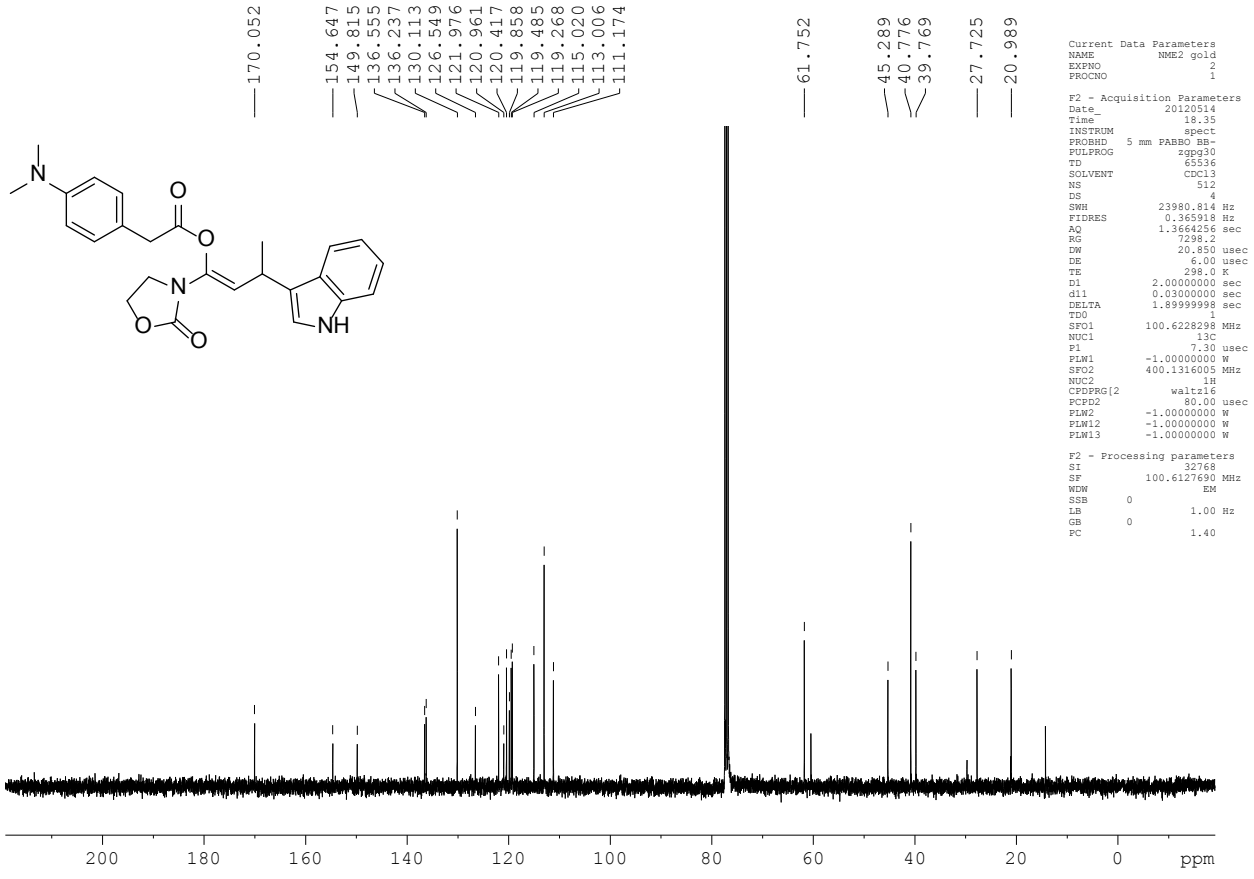

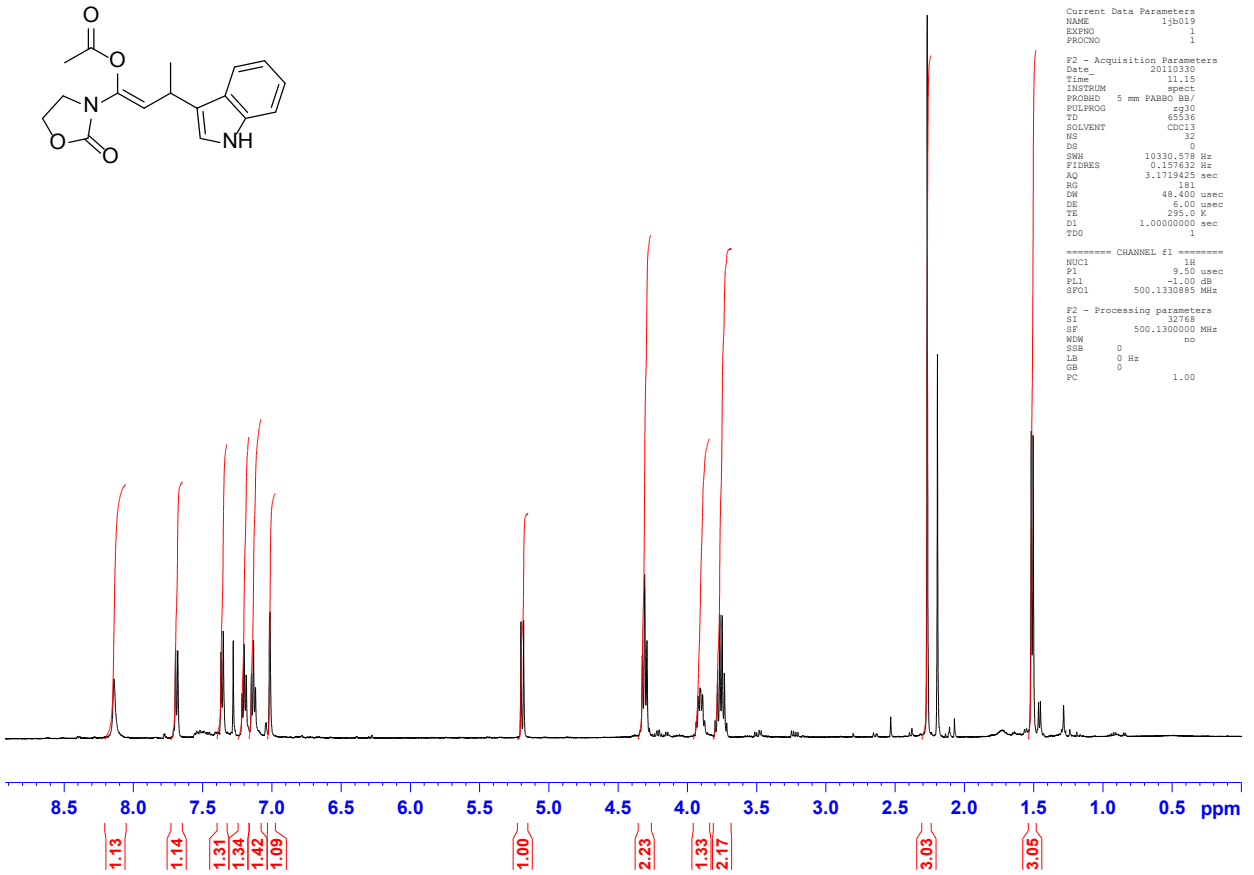

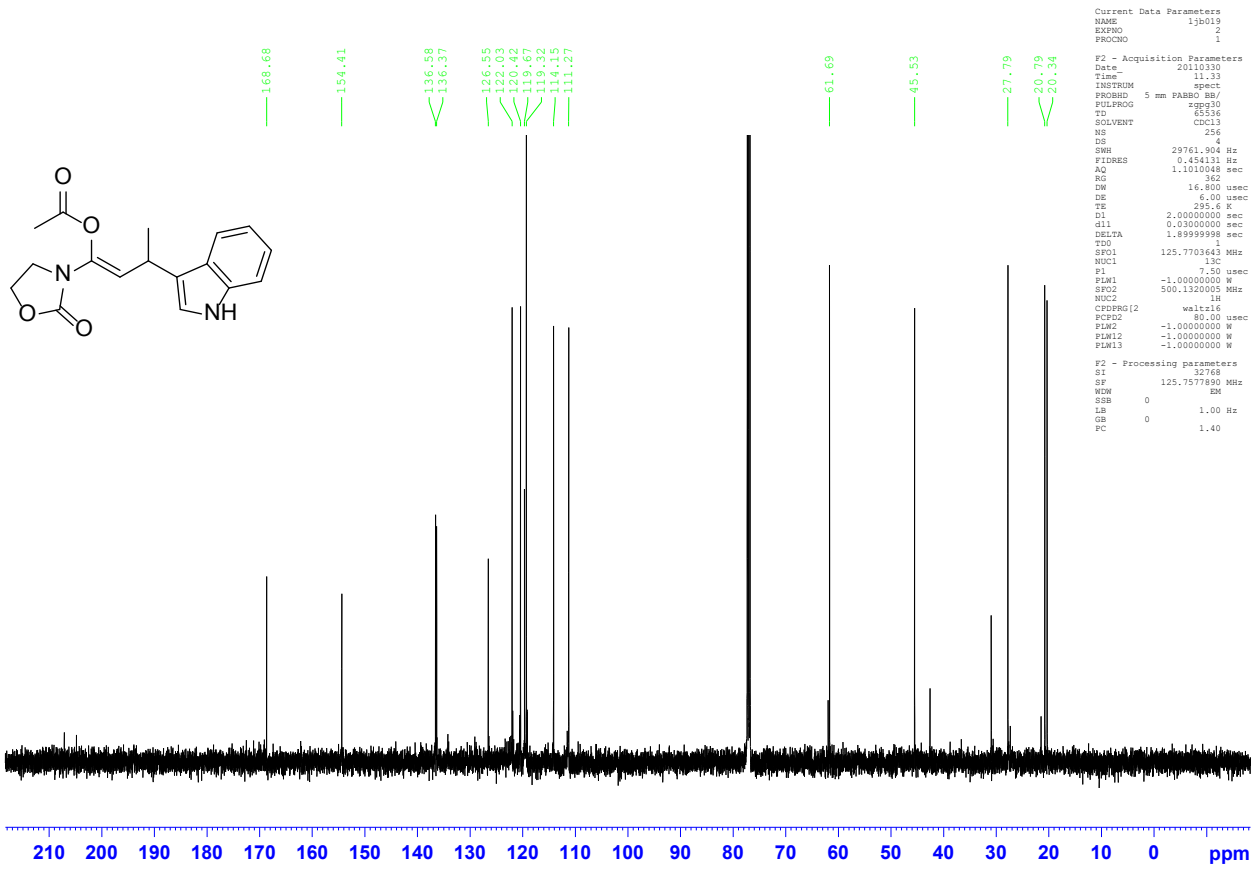

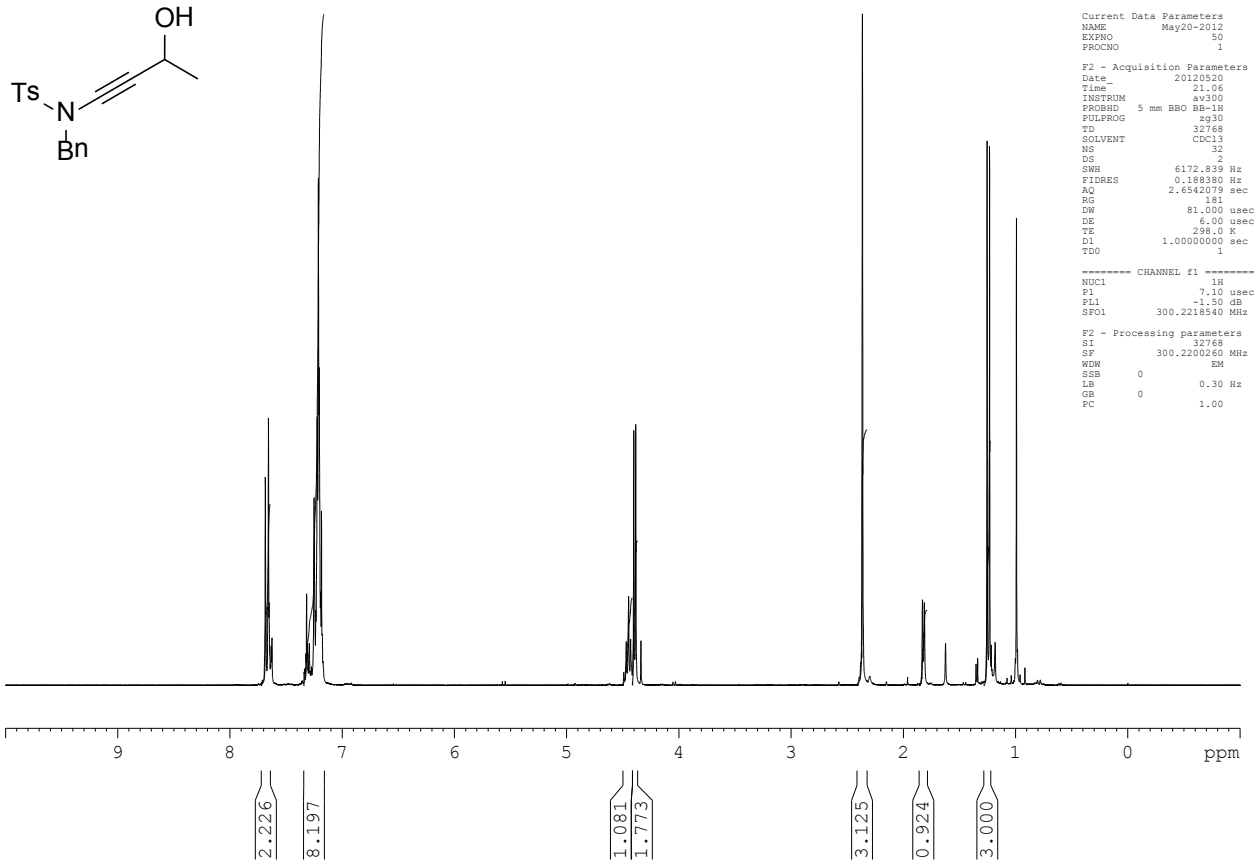

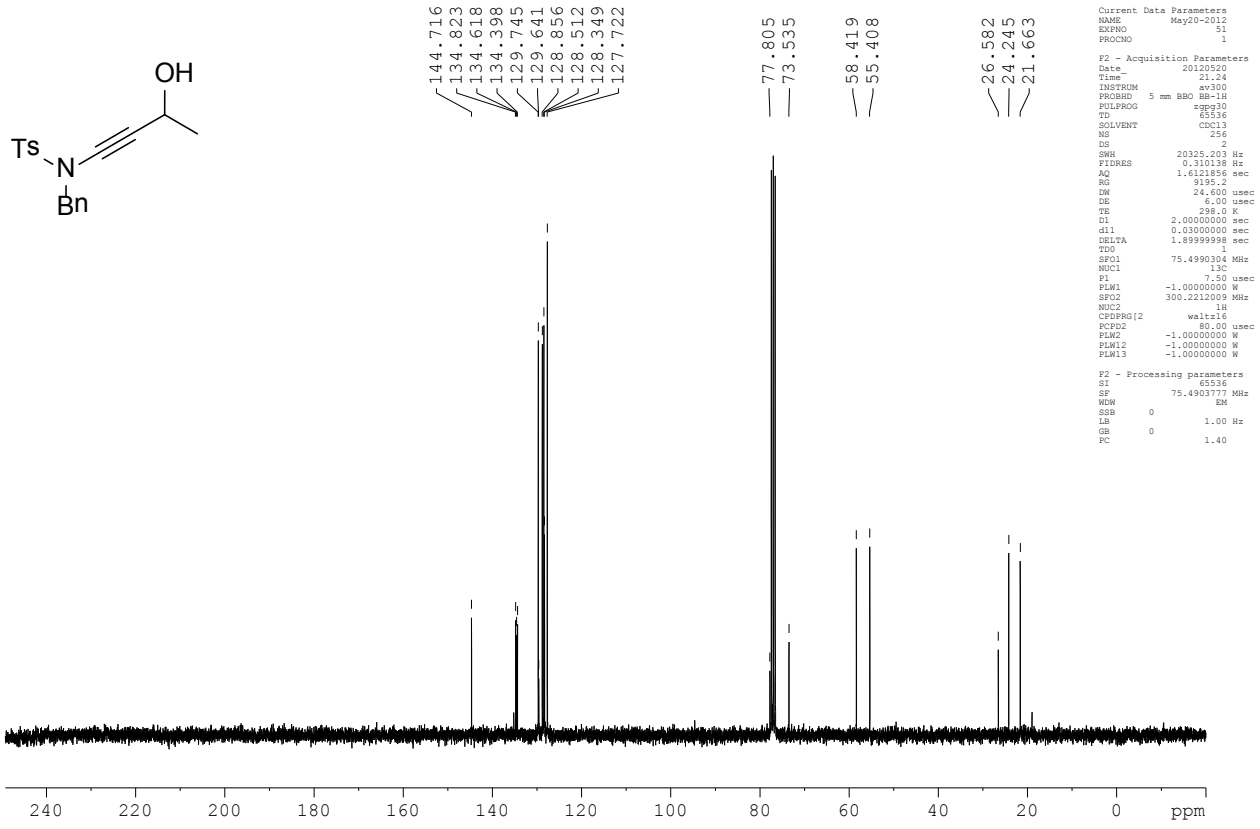

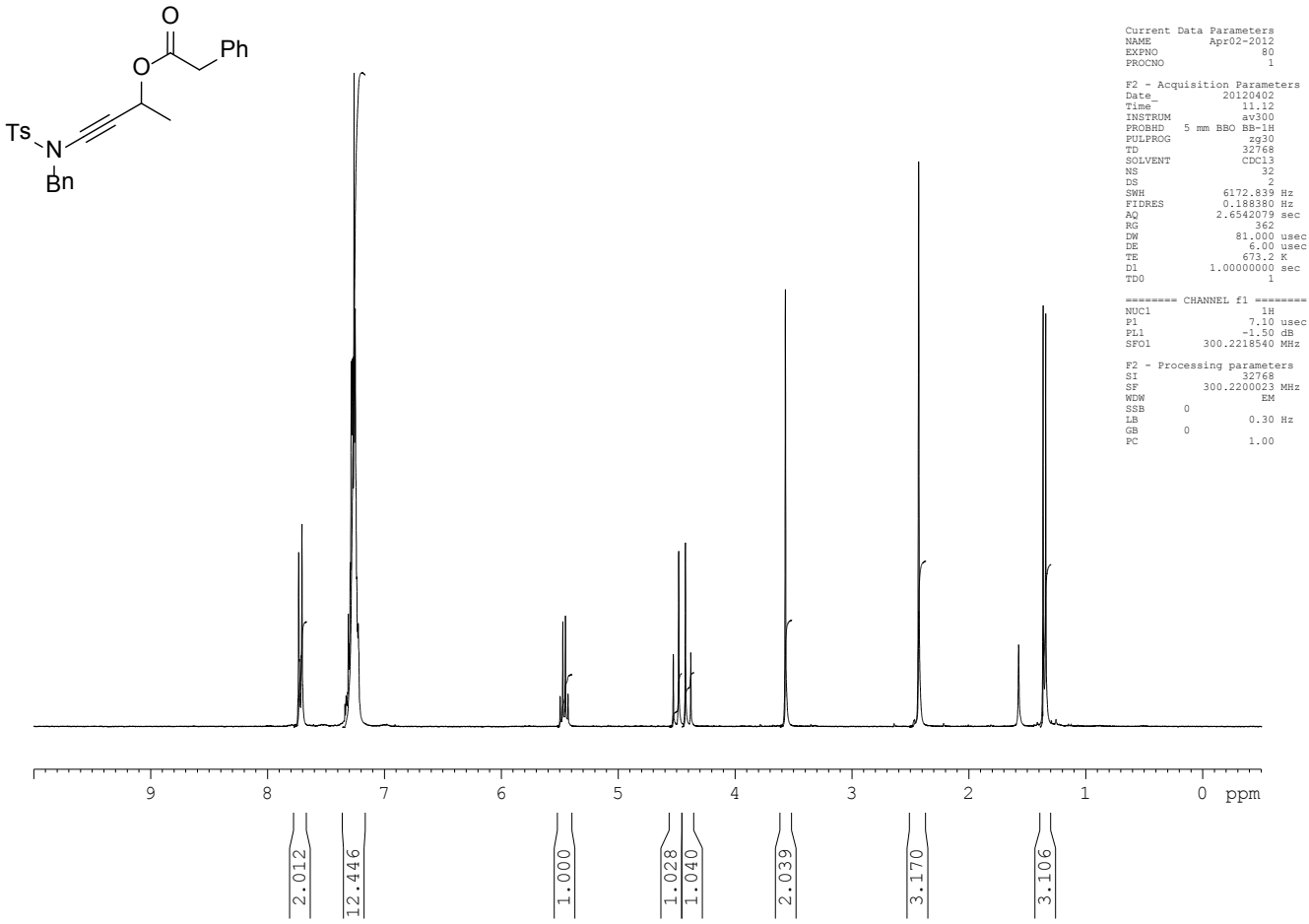

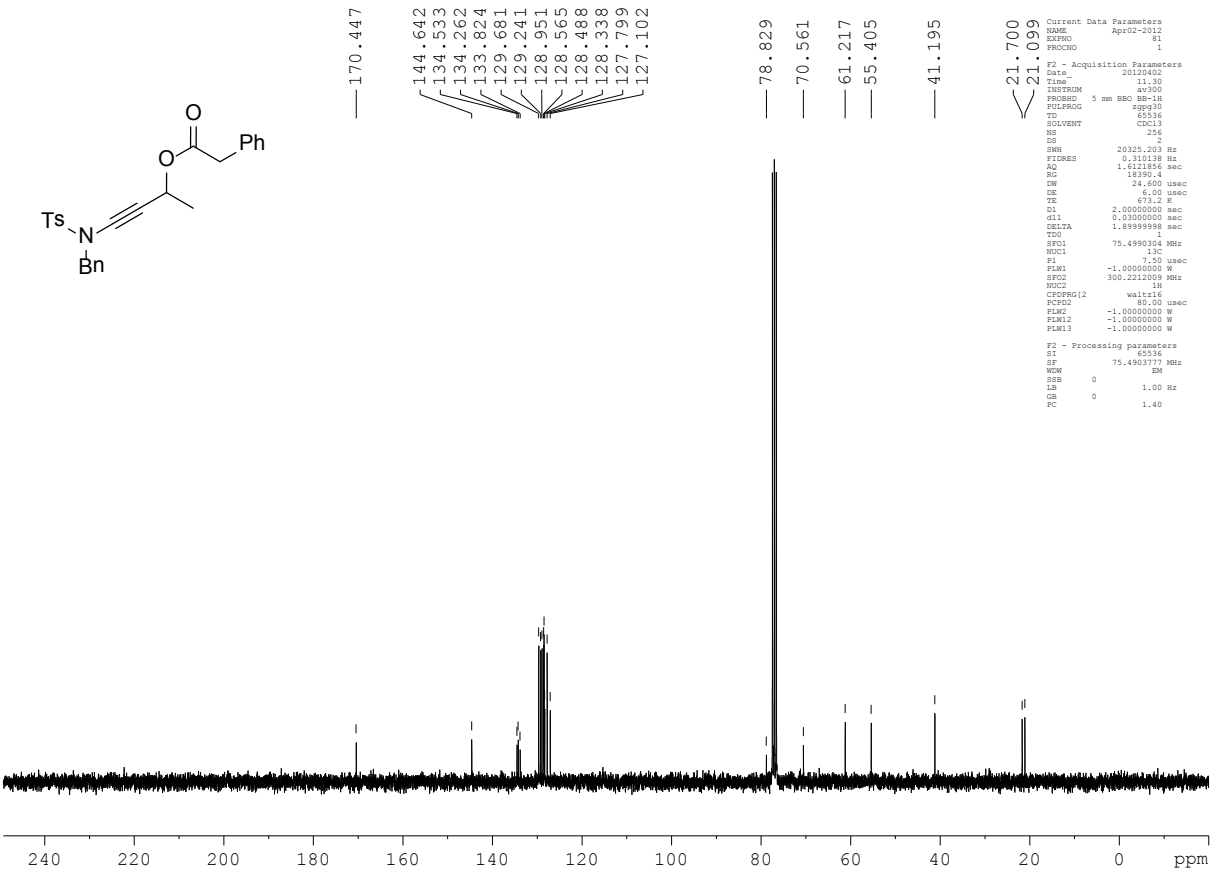

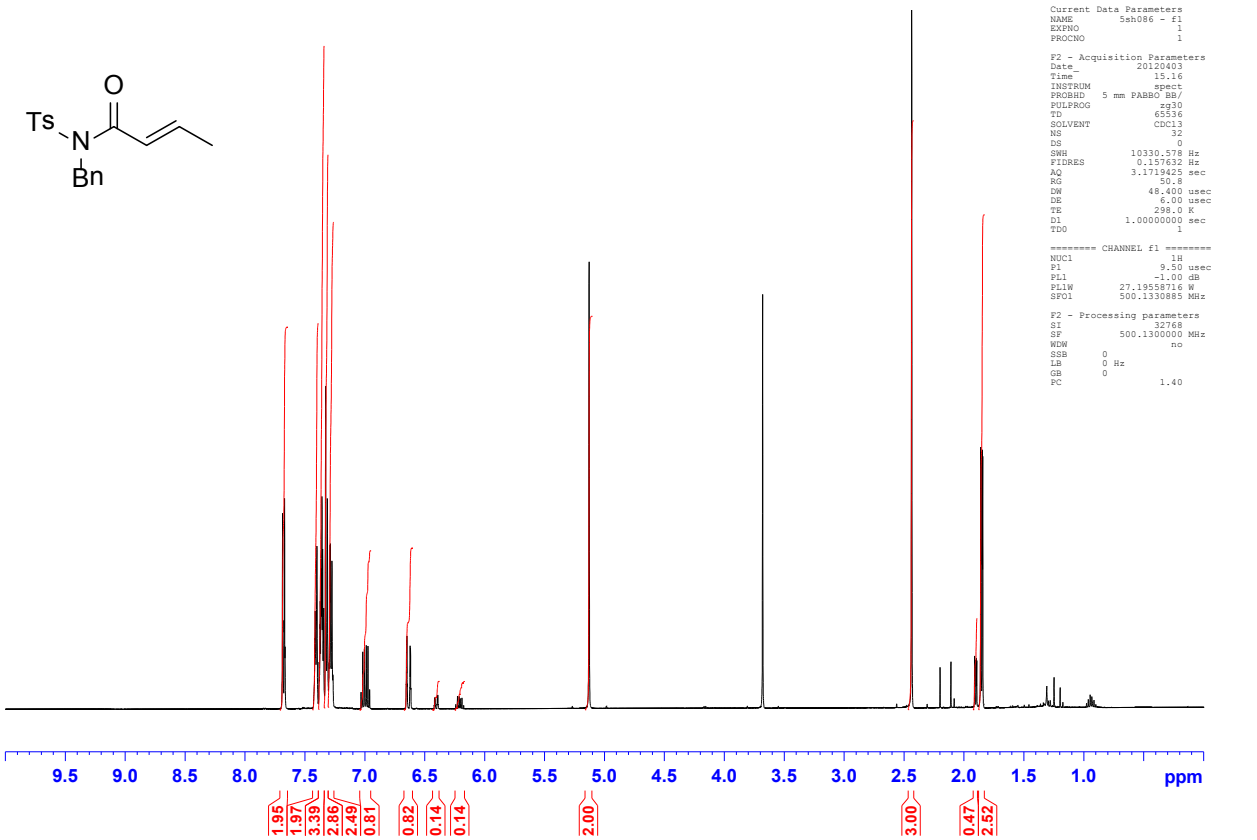

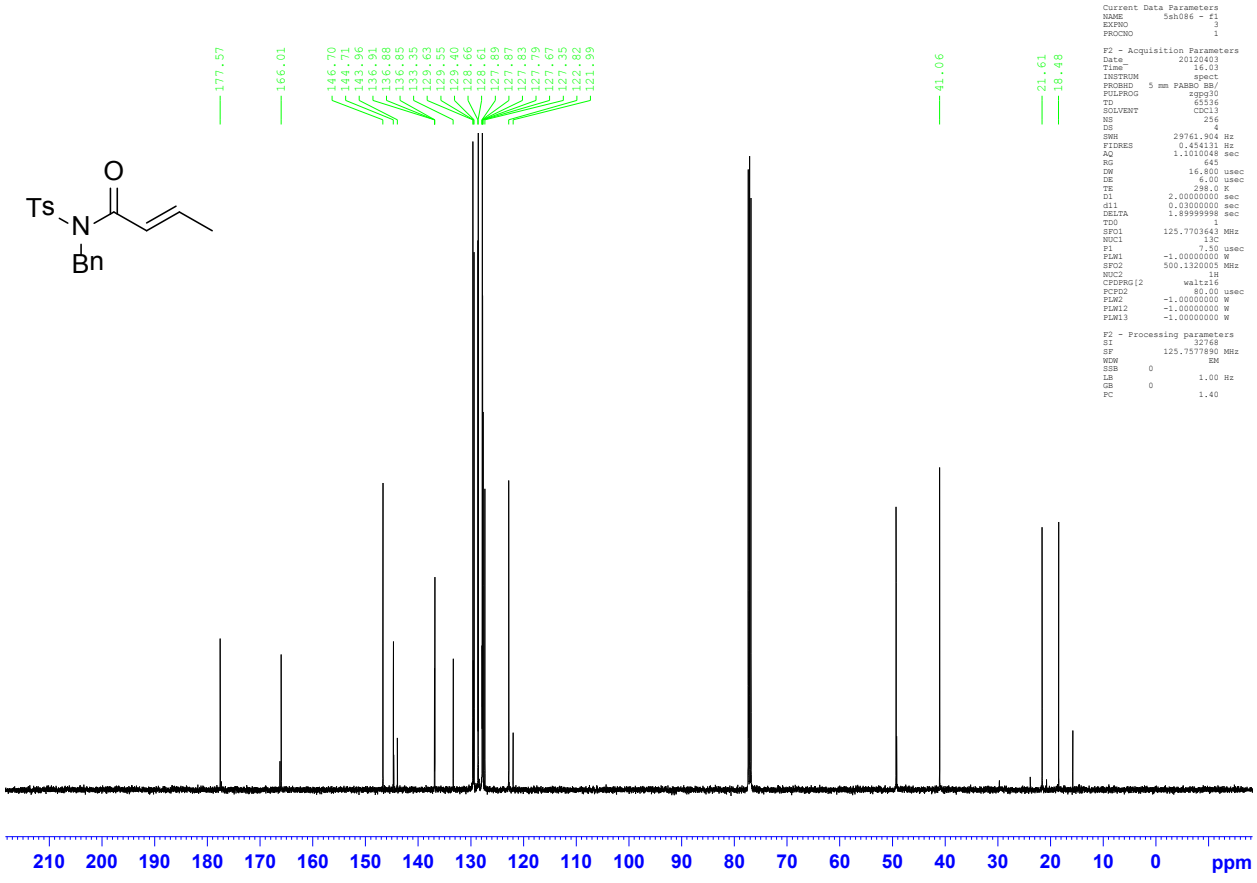

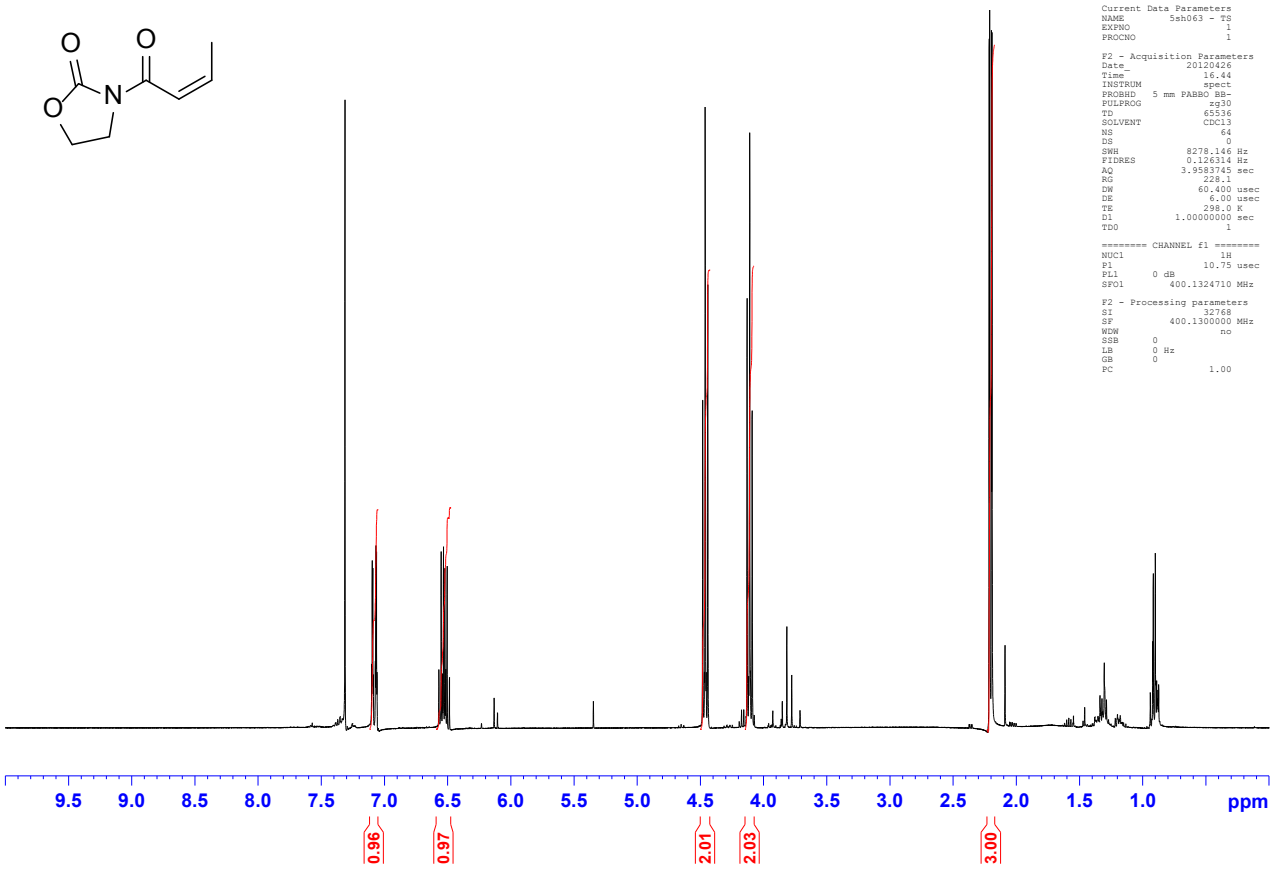

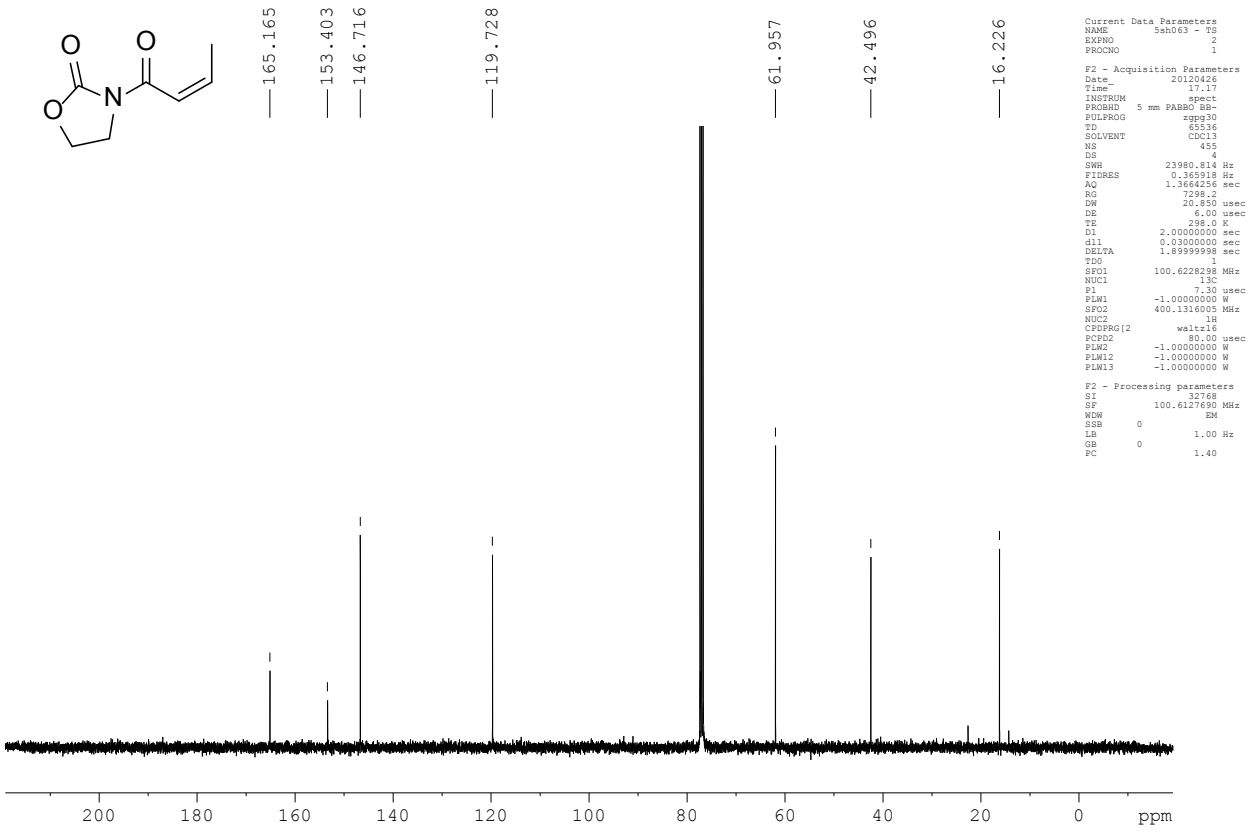

References

(1) D. Grée, V. Madiot and R. Grée, *Tetrahedron Lett.* 1999, **40**, 6399.
(2) M. Barbazanges, C. Meyer, J. Cossy, *Org. Lett.* 2007, **9**, 3245.
(3) M. O. Frederick, J. A. Mulder, M. R. Tracey, R. P. Hsung, J. Huang, K. C. M Kurtz,. L. Shen and C. J., Douglas, *J. Am. Chem. Soc.* 2003, **125**, 2368.
(4) Sheppard, G. S.; Wang, J.; Kawai, M.; Fidanze, S. D.; BaMaung, N. Y.; Erickson, S. A.; Barnes, D. M.; Tedrow, J. S.; Kolaczkowski, L.; Vasudevan, A.; Park, D. C.; Wang, G. T.; Sanders, W. J.; Mantei, R. A.; Palazzo, F.; Tucker-Garcia, L.; Lou, P.; Zhang, Q.; Park, C. H.; Kim, K. H.; Petros, A.; Olejniczak, E.; Nettesheim, D.; Hajduk, P.; Henkin, J.; Lesniewski, R.; Davidsen, S. K. and Bell, R. L., *J. Med. Chem.* 2006**, 49**, 3832.