Supporting Information

Ruthenium (II) catalyzed C-3 site selective alkenylation of indole derivatives via C–H activation

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1. General Information:[1]

Reactions were performed using borosil sealed tube vial under N2 atmosphere. Column chromatography was done by using 230-400 mesh silica gel of Acme synthetic chemicals company. A gradient elution was performed by using distilled petroleum ether and ethyl acetate. Merck TLC Silica gel 60 F254 aluminum plates were used. TLC plates detected under UV light at 254 nm and vanillin. ^{1}H-NMR and ^{13}C-NMR were recorded on Bruker AV 400 MHz spectrometer using DMSO-d_6 as the deuterated solvent.[2] Multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, quint = quintet, sept = septet, m = multiplet, dd = double of doublet, br = broad signal), integration, and coupling constants (*J*) in hertz (Hz). ^{1}HNMR chemical shifts are reported in ppm relative to the TMS (= 0) and ^{13}C-NMR chemical shifts are reported in ppm. IR spectra were recorded on a Shimadzu FT-IR spectrometer. HRMS signal analysis was performed using micro TOF Q-II mass spectrometer. Reagents and starting materials were purchased from Sigma Aldrich, TCI, Avra, Spectrochem and other commercially available sources, used without further purification unless otherwise noted.

Abbreviation:

THF (tetrahydrofuran), DMF (*N*,*N'*-dimethylformamide), DCE (1,2-dichloroethane), DME (1,2-dimethoxyethane), MeOH (methanol), DCM (dichloromethane), EtOAc (ethyl acetate), Et_3N (triethylamine), DIPEA (*N*,*N'*-diisopropylethylamine), TFA (trifluoroacetic acid), Me (methyl), Et (ethyl), Bn (benzyl), PMB (*p*-methoxy benzyl), Ph (phenyl), TEMPO ((2,2,6,6-Tetramethylpiperidin-1-yl)oxyl) and BHT (2,6-di-*tert*-butyl-4-methylphenol), RT (room temperature), n.d. (not detected).

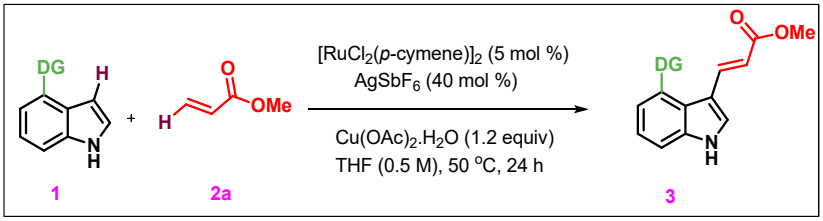
2. Optimization details:

$[RuCl_2(p\text{-cymene})]_2$:

Ruthenium(II) complexes, such as $[RuCl_2(p\text{-cymene})]_2$, are commonly used as catalysts in various organic transformations, including hydrogenation, transfer hydrogenation, and C–H activation reactions. For $[RuCl_2(p\text{-cymene})]_2$, the TON (Turnover Number): can vary widely depending on the specific reaction. In some hydrogenation reactions or C–H activations, TON values range from 500 to 2000, indicating its high efficiency in catalytic cycles. In transfer hydrogenation reactions, the TON for $[RuCl_2(p\text{-cymene})]_2$ typically reaches values up to 1000, depending on the substrate and reaction conditions. Reported TOFs (Turnover Frequency) for $[RuCl_2(p\text{-cymene})]_2$ in transfer hydrogenation reactions can range from 10 to 100 h^{-1}, with higher TOFs observed in more efficient systems or when optimized reaction conditions (temperature, solvent, etc.) are employed. The catalyst $[RuCl_2(p\text{-cymene})]_2$ exhibited a TOF of 50 h^{-1} in hydrogenation reactions under optimized conditions. The lifetime of $[RuCl_2(p\text{-cymene})]_2$ in catalytic reactions depends on the specific conditions and substrates involved. It generally has good stability under standard reaction conditions (moderate temperature and inert atmosphere). Over time, the catalyst may deactivate due to the formation of inactive ruthenium species or degradation of the p-cymene ligand. Studies suggest it remains active for several hours to multiple reaction cycles, especially in transfer hydrogenation. The catalyst remained active for 8 hours, after which a gradual decrease in activity was observed, potentially due to ligand degradation. $[RuCl_2(p\text{-cymene})]_2$ can be reused, but its activity may decrease after multiple cycles due to metal leaching, catalyst aggregation, or ligand degradation. In some cases, reusability is reported for 2 to 5 cycles with a slight drop in catalytic efficiency. After three reaction cycles, the catalyst retained 85% of its original activity, demonstrating moderate reusability. The catalyst can often be recovered through filtration or precipitation methods, but recovery efficiency depends on the reaction system and workup. Recycling efficiency might decrease due to loss of active species during handling. The catalyst could be recovered and recycled, but after three cycles, a significant drop in activity was observed due to partial deactivation.The choice of solvent and reaction conditions (e.g., base, co-solvents, temperature) can significantly influence both the TON and TOF values, as well as the stability and reusability of the catalyst. Careful optimization of conditions may extend the lifetime and improve the recyclability of the catalyst.

For the optimization of reaction conditions, reactions were performed according to General Procedure (**see section 3.2**).

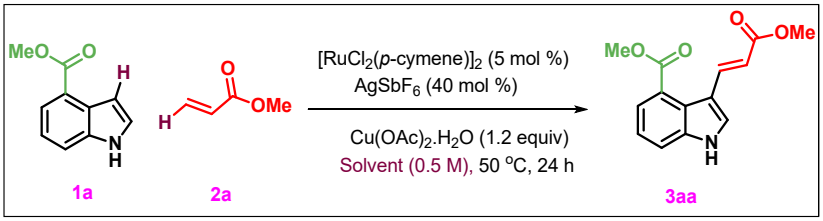
Table S1. Screening of Directing groups[a]



Entry	Directing Group (DG)	Observation (yield)
1	-CHO	n.d.
2	-CH_2OH	n.d.
3	-COOMe	52%
4	absence of DG	n.d.

[a]Reaction conditions: **1** (1.0 equiv), **2a** (3.0 equiv), $[RuCl_2(p\text{-cymene})]_2$ (5 mol %), $AgSbF_6$ (20 mol %), $Cu(OAc)_2 \cdot H_2O$ (1.2 equiv), THF (0.5 M), 50 °C, 24 h.

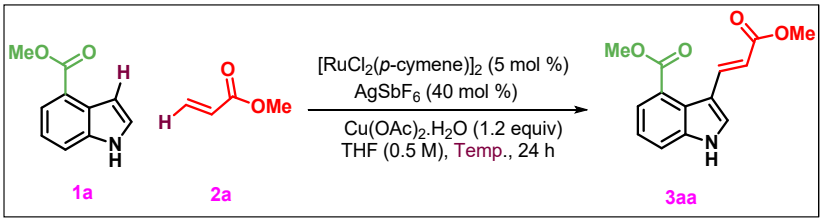
Table S2. Screening of solvents[a]



Entry	Solvent (0.5 M)	Isolated yield of 3aa
1	DMF	24%
2	DCE	34%
3	Dioxane	73%
4	DME	46%
5	THF	81%

[a]Reaction conditions: **1a** (1.0 equiv), **2a** (3.0 equiv), $[RuCl_2(p\text{-cymene})]_2$ (5 mol %), $AgSbF_6$ (20 mol %), $Cu(OAc)_2 \cdot H_2O$ (1.2 equiv), solvent (0.5 M), 50 °C, 24 h.

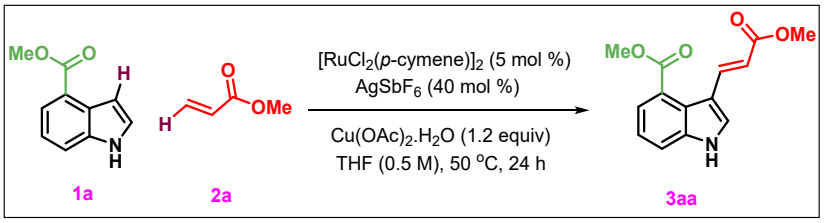
Table S3. Screening of **temperature**[a]



Entry	**Temperature (ºC)**	Isolated yield of **3aa**
1	RT	16%
2	50	81%
3	80	61%
4	100	52%

[a]Reaction conditions: **1a** (1.0 equiv), **2a** (3.0 equiv), $[RuCl_2(p\text{-cymene})]_2$ (5 mol %), $AgSbF_6$ (20 mol %), $Cu(OAc)_2 \cdot H_2O$ (1.2 equiv), THF (0.5 M), at **temp (°C),** 24 h.

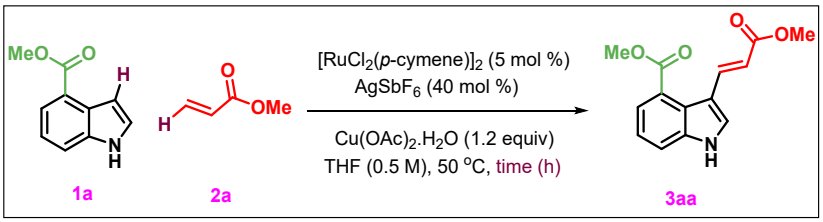
Table S4. **Screening of starting material equivalency and coupling partner equivalency**[a]



Entry	**Equivalency of 1a**	**Equivalency of 2a**	Isolated yield of **3aa**
1	1 equiv	1.2 equiv	55%
2	1 equiv	2 equiv	67%
3	1 equiv	3 equiv	81%
4	1 equiv	5 equiv	77%
3	2 equiv	1 equiv	51%

[a]Reaction conditions: **1a** (equiv), **2a** (equiv), $[RuCl_2(p\text{-cymene})]_2$ (5 mol %), $AgSbF_6$ (40 mol %), $Cu(OAc)_2 \cdot H_2O$ (1.2 equiv), THF (0.5 M), 50 °C, 24 h.

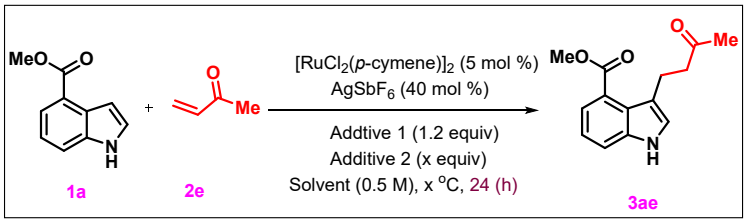
Table S5. Screening of **time**[a]



Entry	Time (h)	Isolated yield of **3aa**
1	8 h	45%
2	16 h	72%
3	24 h	88%
4	48 h	78%

[a]Reaction conditions: **1a** (1.0 equiv), **2a** (3equiv), $[RuCl_2(p\text{-cymene})]_2$ (5 mol %), $AgSbF_6$ (40 mol %), $Cu(OAc)_2 \cdot H_2O$ (1.2 equiv), THF (0.5 M), 50 °C, time (h).

Table S6. Screening of reaction conditions with vinyl methyl ketone[a]

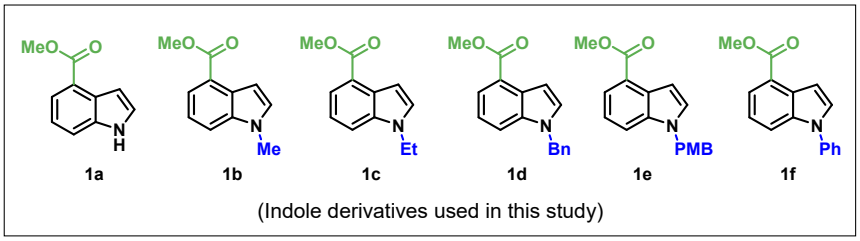


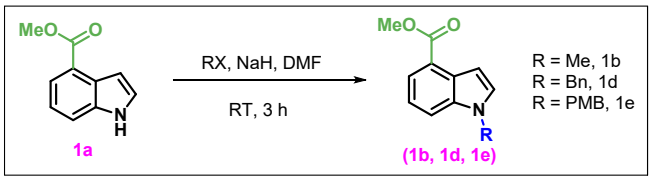
Entry	Additive 1	Additive 2 (equiv)	Temp.	Solvent	Isolated yield of **3ae**
1	$Cu(OAc)_2 \cdot H_2O$	--	50 °C	THF	76%
2	$Cu(OAc)_2 \cdot H_2O$	--	50 °C	DCE	27%
3	$Cu(OAc)_2 \cdot H_2O$	AcOH (4)	50 °C	THF	38%
4	$Cu(OAc)_2 \cdot H_2O$	AcOH (4)	50 °C	DCE	16%
5	--	AcOH (4)	50 °C	DCE	9%
6	--	PivOH (4)	50 °C	DCE	trace
7	--	AcOH (4)	100 °C	DCE	n.d.
8	Cu(OAc)2.H2O	$NaHCO_3$ (1)	50 °C	DCE	n.d.

[a]Reaction conditions: **1a** (1.0 equiv), **2a** (3.0 equiv), $[RuCl_2(p\text{-cymene})]_2$ (5 mol %), $AgSbF_6$ (40 mol %), $Cu(OAc)_2 \cdot H_2O$ (1.2 equiv), additive 2 (x equiv), solvent (0.5 M), (x) °C, 24 h.

3. Experimental details:

3.1 Starting materials preparation:[3]

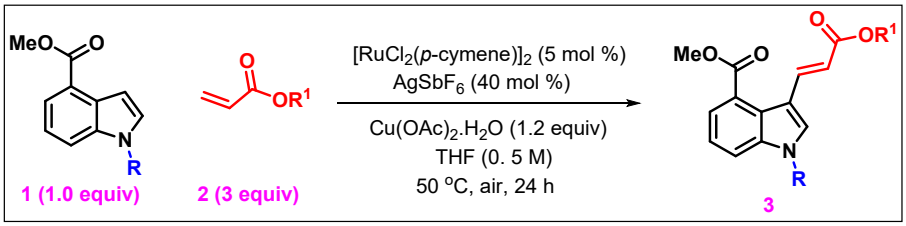




Substrates *N*-substituted 1*H*-indole-4-carboxylates (**1b, 1d and 1e**) were prepared according to the reported procedure.[3] All substrates **1** are known compounds and their spectral data were in agreement with the corresponding literature values.

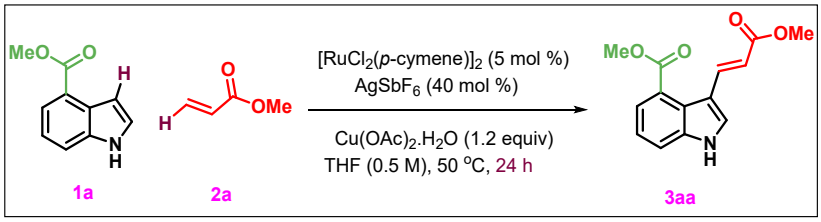
To a well stirred solution of methyl 1*H*-indole-4-carboxylate (**1a**, 5.71 mmol, 1.0 equiv), in DMF (0.2 M) was added sodium hydride (60% in mineral oil, 8.56 mmol, 1.5 equiv) at 0 °C under nitrogen atmosphere. The reaction mixture was stirred at 0 °C for 30 minutes followed by the addition of alkyl halide (6.85 mmol, 1.2 equiv). The reaction mixture was warmed to ambient temperature and stirred under N_2 for 12 h. After that, reaction mixture was quenched with aqueous ammonium chloride solution and extracted with ethyl acetate (3 x 30 mL), dried over anhydrous Na_2SO_4. The organic layer was filtered, concentrated under reduced pressure. The residue was purified by column chromatography on silica gel using EtOAc:Hexane gradient elution to give the corresponding product **1**. **1b, 1d and 1e** were synthesized using the same procedure. **1a**, **1c** and **1f** were commercially available from different sources.

3.2 General procedure for C3 alkenylation of indole-4-carboxylates:



To a flame-dried teflon-screw-capped tube was equipped with a magnetic stir bar, $[RuCl_2(p\text{-cymene})]_2$ (0.05 mmol, 5 mol %), THF (0.5 M), methyl indole-4-carboxylate **1** (0.2 mmol, 1.0 equiv), acrylate **2** (0.60 mmol, 3.0 equiv), $Cu(OAc)_2.H_2O$ (0.24 mmol, 1.2 equiv) were added sequentially under air and $AgSbF_6$ (0.4 mmol, 40 mol%) were added inside the glove box and sealed. The sealed tube was directly put into a pre-heated aluminum block at 50 °C and stirred for 24 h. After 24 h, the reaction mixture was diluted with EtOAc and passed through a short pad of celite, the solvent was evaporated under reduced pressure and the crude product was purified by silica gel column chromatography to obtain **3**.

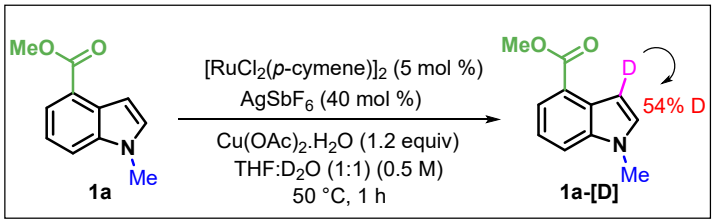
3.3 3 mmol scale reaction:



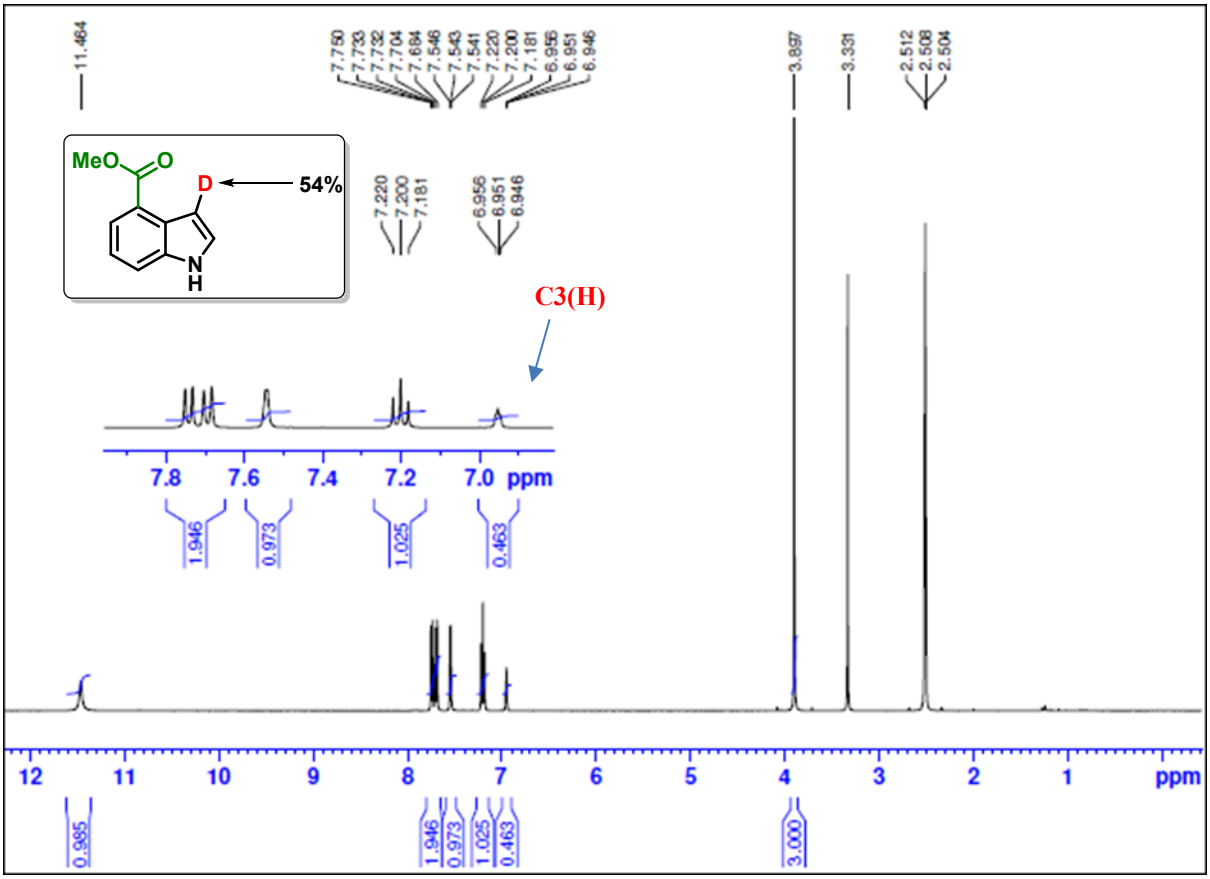
To a flame-dried teflon-screw-capped tube was equipped with a magnetic stir bar, $[RuCl_2(p\text{-cymene})]_2$ (96 mg, 0.16 mmol, 5 mol %), THF (0.5 M), methyl 1*H*-indole-4-carboxylate **1a** (550 mg, 3.14 mmol), methyl acrylate **2a** (810 mg, 9.42 mmol, 3.0 equiv), $Cu(OAc)_2.H_2O$ (752 mg, 3.77 mmol, 1.2 equiv) were added sequentially under air and $AgSbF_6$ (432 mg, 1.28 mmol, 40 mol %) were added inside the glove box and sealed. The sealed tube was directly put into a pre-heated aluminum block at 50 °C and stirred for 24 h. After completion of the reaction, the resulting mixture was cooled down to room temperature, diluted with EtOAc, filtered through a short pad of celite. The filtrate was pre-absorbed on silica gel and concentrated by rotary evaporator. The crude product was purified by silica gel column chromatography (EtOAc:Hexane = 40:60) to afford the product **3aa** with 78% yield.

4. Mechanistic studies:

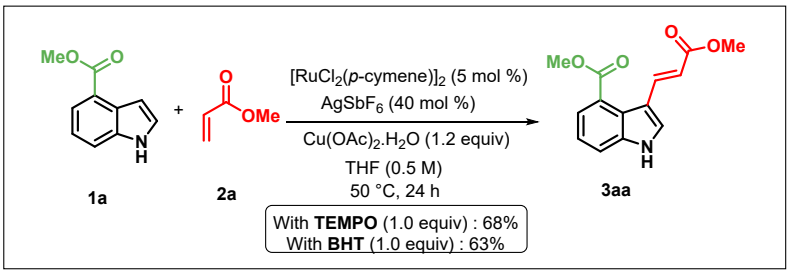
4.1 Deuterium labelling experiments:



In an oven dried screw cap Schlenk tube equipped with stir bar was purged with nitrogen was charged with methyl 1H-indole-4-carboxylate **1a** (50 mg, 0.28 mmol, 1.0 equiv), [RuCl2(*p*-cymene)]2 (9 mg, 0.014 mmol, 5 mol%), AgSbF6 (40 mg, 0.112 mmol, 40 mol%), Cu(OAc)2·H2O (62.2 mg, 0.32 mmol, 1.2 equiv). The tube was purged with nitrogen followed by addition of THF and D_2O (1:1) (0.5 M) *via* syringe. The reaction mixture allowed to stir at 50 °C for 1 h. Then the reaction mixture was cooled to room temperature, and the solvents were removed under reduced pressure. The 54% H/D exchange was calculated by ^1H NMR analysis of crude mixture.



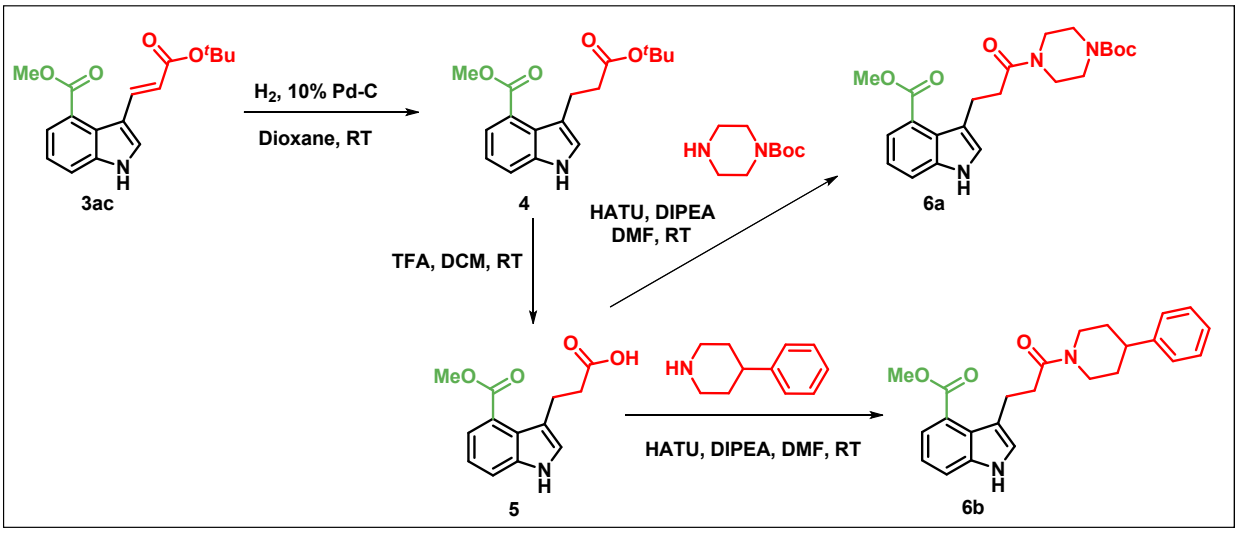
4.2 Radical Process Experiments:



In an oven dried screw cap Schlenk tube equipped with stir bar was purged with nitrogen was charged with methyl 1*H*-indole-4-carboxylate **1a** (50 mg, 0.28 mmol, 1.0 equiv), methyl acrylate (73.7 mg, 0.84 mmol, 3.0 equic), [RuCl2(*p*-cymene)]2 (9 mg, 0.014 mmol, 5 mol%), AgSbF6 (40 mg, 0.112 mmol, 40 mol%,), Cu(OAc)2·H2O (62.2 mg, 0.32 mmol, 1.2 equiv), TEMPO (4.5 mg, 0.28 mmol, 1 equiv) or BHT (6.3 mg, 0.28 mmol, 1 equiv) followed by THF (0.5 M). The reaction mixture was vigorously stirred in a preheated aluminum block at 50 ºC for 24 h. After completion of reaction as monitored by TLC analysis, the reaction mixture was cooled to room temperature and diluted with DCM and passed through a short pad of celite, the solvent was evaporated under reduced pressure

and the residue was purified by column chromatography using EtOAc/DCM (1:1) mixture on silica gel to give the pure product **3aa** (Yield 68% and 63% with TEMPO and BHT respectively).

5. Synthetic Applications:



Procedure for synthesis of methyl 3-(3-(*tert*-butoxy)-3-oxopropyl)-1*H*-indole-4-carboxylate (4): To a stirred solution of **3ac** (500 mg, 1.66 mmol) in 1,4-dioxane (8 mL) was added 10% Pd-C (70 mg) at room temperature under nitrogen atmosphere. The reaction mixture was stirred at room temperature under bladder pressure of H_2 gas (1 atm) for 3 h. After completion of reaction, the reaction mixture was filtered through a celite pad and the filtrate was concentrated under reduced pressure. The crude product was purified by silica gel column chromatography using EtOAc:Hexane gradient elution to afford methyl 3-(3-(*tert*-butoxy)-3-oxopropyl)-1*H*-indole-4-carboxylate **4** as an off-white solid (443 mg, yield = 88%).

Procedure for synthesis of 3-(4-(methoxycarbonyl)-1*H*-indol-3-yl)propanoic acid (5):

To a stirred solution of methyl 3-(3-(*tert*-butoxy)-3-oxopropyl)-1*H*-indole-4-carboxylate (**4**, 200 mg, 0.66 mmol) in DCM (1.2 mL) was added TFA (225 mg, 1.98 mmol, 568 µL) at 0 °C. The reaction mixture was stirred at room temperature for 3 h. After completion of reaction, the reaction mixture was concentrated under reduced pressure and triturated with MTBE and dried to afford 3-(4-(methoxycarbonyl)-1*H*-indol-3-yl)propanoic acid **5** as an off-white solid (150 mg, yield = 92%).

Procedure for synthesis of methyl 3-(3-(4-(tert-butoxycarbonyl)piperazin-1-yl)-3-oxopropyl)-1H-indole-4-carboxylate (6a):

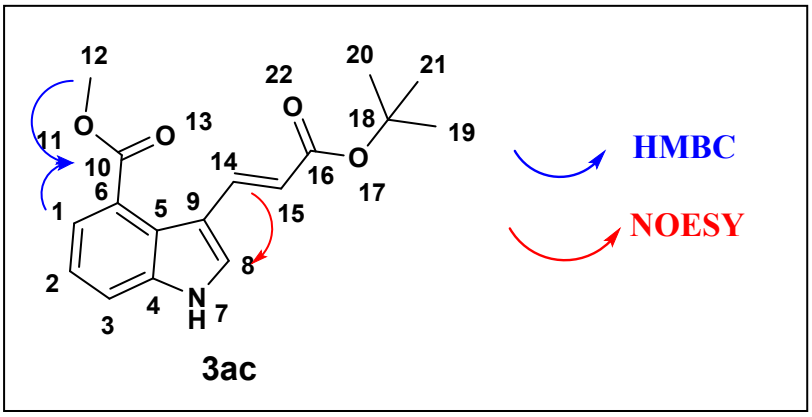
To a stirred mixture of 3-(4-(methoxycarbonyl)-1*H*-indol-3-yl)propanoic acid (**5**, 50 mg, 0.202 mmol) and 1-Boc-piperazine (56.5 mg, 0.30 mmol) in DMF (0.9 mL) were added HATU (115 mg, 0.30 mmol) and DIPEA (130.7 mg, 1.011 mmol, 176 µL) at room temperature under nitrogen atmosphere. The reaction mixture was stirred at room temperature for 12 h. After completion of reaction, the reaction mixture was concentrated diluted with water and extracted with EtOAc (2 x 10 mL). Combined organic layers were dried over sodium sulphate, filtered, and concentrated under reduced pressure. The crude product was purified by silica gel column chromatography using EtOAc:Hexane gradient elution to afford methyl 3-(3-(4-(*tert*-butoxycarbonyl)piperazin-1-yl)-3-oxopropyl)-1*H*-indole-4-carboxylate **6a** (67.5 mg, yield = 80%).

Procedure for synthesis of methyl 3-(3-oxo-3-(4-phenylpiperidin-1-yl)propyl)-1H-indole-4-carboxylate (6b):

To a stirred mixture of 3-(4-(methoxycarbonyl)-1*H*-indol-3-yl)propanoic acid (**5**, 50 mg, 0.202 mmol) and 4-phenylpiperidine (48.9 mg, 0.30 mmol) in DMF (0.9 mL) were added HATU (115 mg, 0.30 mmol) and DIPEA (130.7 mg, 1.011 mmol, 176 µL) at room temperature under nitrogen atmosphere. The reaction mixture was stirred at room temperature for 12 h. After completion of reaction, the reaction mixture was concentrated diluted with water and extracted with EtOAc (2 x 10 mL). Combined organic layers were dried over sodium sulphate, filtered, and concentrated under reduced pressure. The crude product was purified by silica gel column chromatography using EtOAc:Hexane gradient elution to afford methyl 3-(3-oxo-3-(4-phenylpiperidin-1-yl)propyl)-1*H*-indole-4-carboxylate **6b** as an off-white solid (65.5 mg, yield = 83%).

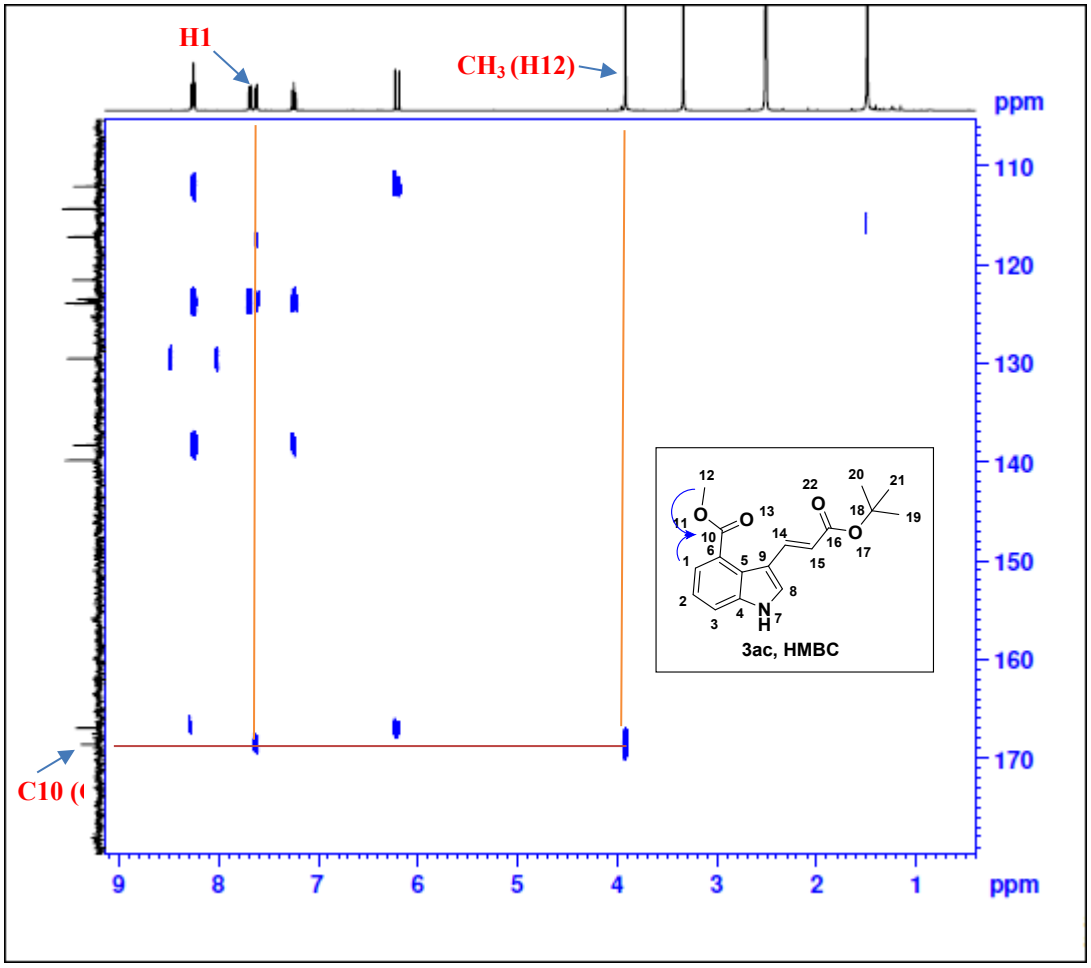
6. Characterization data for C3-alkenylated indole-4-methylcarboxylate:

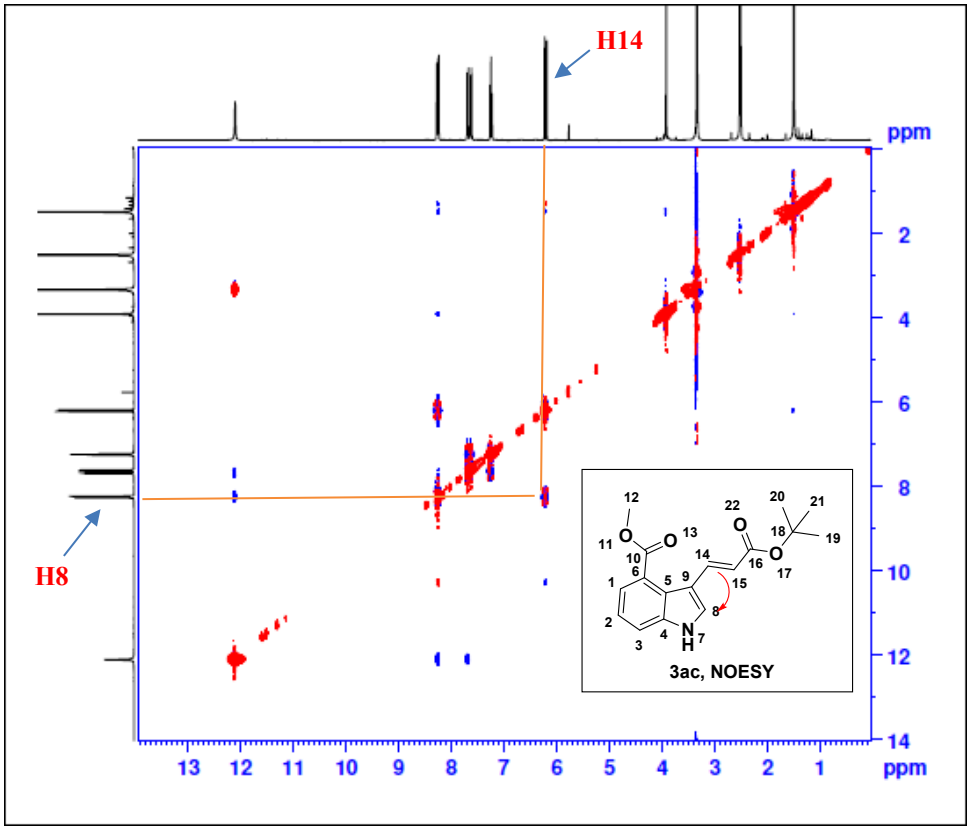
6.1 Structure elucidation of C3-alkenylated product (3ac) with heteronuclear multiple bond correlation (HMBC) and nuclear bverhauser effect spectroscopy (NOESY):



- **HMBC:** Ester carbonyl -C10 at 168.4ppm showing correlation with ester methyl (H12) at 3.92ppm and aromatic doublet proton (H1) at 7.62ppm.
- **NOESY:** Vinyl -CH (H14) at 6.24ppm showing enhancement with indole ring singlet proton H8 at 8.25ppm.

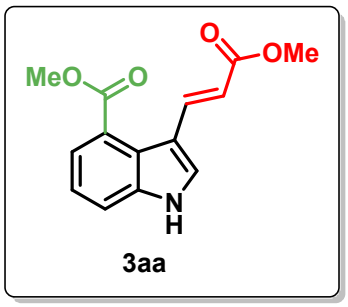
Based on the correlations by HMBC and NOESY, the structure of **3ac** has been confirmed.


H1
CH3 (H12)
ppm
110
120
130
140
150
160
170
9
8
7
6
5
4
3
2
1
ppm
C10 (
3ac, HMBC

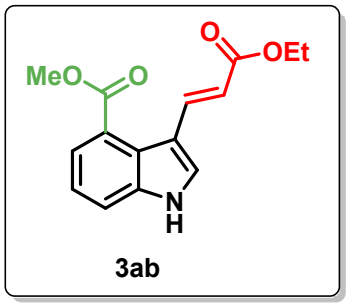


6.2 Experimental characterization data for products

1) **Methyl (*E*)-3-(3-methoxy-3-oxoprop-1-en-1-yl)-1*H*-indole-4-carboxylate (3aa):** Prepared as shown in general procedure to obtain the product as off-white solid; Yield = 81% (86 mg); m.p.= 135-137 °C; R_f = 0.2 (Ethyl Acetate/Hexane : 40/60); **^{1}H NMR (400 MHz, DMSO-d_6):** δ 12.17 (s, 1H, NH), 8.39 (d, J = 15.60 Hz, 1H), 8.28 (s, 1H), 7.68 (dd, J = 6.40, 9.60 Hz, 2H), 7.26 (t, J = 7.60 Hz, 1H), 6.31 (d, J = 15.60 Hz, 1H), 3.91 (s, 3H, OMe), 3.70 (s, 3H, OMe) ppm; **^{13}C NMR (100 MHz, DMSO-d_6)** δ 168.4 (C=O), 167.9 (C=O), 141.0, 138.3, 129.8, 124.1, 123.6, 123.4, 121.6, 117.3, 112.1, 112.0, 52.4 (OCH_3), 51.4 (OCH_3) ppm; **IR (neat)**: 3235 (N-H), 3117 (C-H), 3073 (C-H), 2996 (C-H), 2950 (C-H), 1709 (C=O), 1679 (C=O), 1604 (C=C), 1347 (C-N), 1284 (C-O), 1250 (C-O), 1176 (C-O), 1054 (C-N), 993, 853, 743, 602 (C-H) cm^{-1}; **HRMS (ESI)** (*m/z*): Calculated for $C_{14}H_{14}NO_4$ $[M + H]^+$: 260.0923, found: 260.0949.

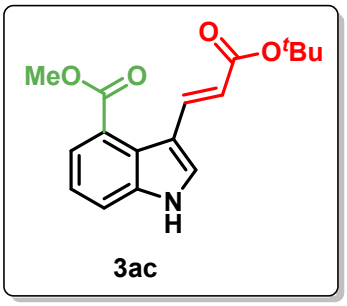


2) **Methyl (*E*)-3-(3-ethoxy-3-oxoprop-1-en-1-yl)-1*H*-indole-4-carboxylate (3ab):** Prepared as shown in general procedure to obtain the product as an off-white solid; Yield = 79% (88 mg); m.p.= 137-139 °C; R_f = 0.2 (Ethyl Acetate/Hexane : 40/60); **^{1}H NMR (400 MHz, DMSO-*d*$_6$)**: δ 12.14 (s, 1H, NH), 8.36 (dd, *J* = 0.80, 16.00 Hz, 1H), 8.28 (s, 1H), 7.70 (dd, *J* = 1.20, 8.00 Hz, 1H), 7.64 (dd, *J* = 1.20, 7.60 Hz, 1H), 7.25 (t, *J* = 8.00 Hz, 1H), 6.30 (d, *J* = 16.00 Hz, 1H), 4.16 (q, *J* = 7.20 Hz, 2H, O**CH$_2$**CH$_3$), 3.91 (s, 3H, OMe), 1.26 (t, *J* = 7.20 Hz, 3H, OCH$_2$**CH$_3$**) ppm; **^{13}C NMR (100 MHz, DMSO-*d*$_6$)** δ 168.5 (C=O), 167.4 (C=O), 140.7, 138.3, 129.7, 124.0, 123.6, 123.4, 121.6, 117.2, 112.5, 112.0, 59.8 (OCH$_2$), 52.3 (OCH$_3$), 14.8 (OCH$_2$CH$_3$) ppm; **IR (neat):** 3231 (N-H), 2987 (C-H), 2942 (C-H), 2901 (C-H), 2845 (C-H), 1714 (C=O), 1677 (C=O), 1604 (C=C), 1369 (C-H), 1340 (C-N), 1246 (C-O), 1176 (C-O), 1148, 747, 708, 602 cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{15}H_{16}NO_4$ $[M + H]^+$: 274.1079, found: 274.1086.



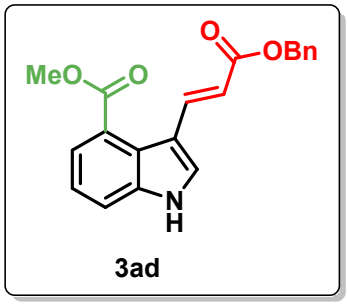
3ab

3) **Methyl (*E*)-3-(3-(tert-butoxy)-3-oxoprop-1-en-1-yl)-1*H*-indole-4-carboxylate (3ac):** Prepared as shown in general procedure to obtain the product as a white solid, Yield = 69% (78 mg); m.p.= 128-130 °C; R_f = 0.2 (Ethyl Acetate/Hexane : 40/60); **^{1}H NMR (400 MHz, DMSO-*d*$_6$)** δ 12.11 (s, 1H, NH), 8.28-8.23 (m, 1H), 7.68 (dd, *J* = 0.80, 8.20 Hz, 1H), 7.62 (dd, *J* = 1.20, 7.40 Hz, 1H), 7.24 (t, *J* = 7.60 Hz, 1H), 6.21 (d, *J* = 15.60 Hz, 1H), 3.91 (s, 3H, OCH$_3$), 1.49 (s, 9H, *tert*-butyl) ppm; **^{13}C NMR (100 MHz, DMSO-*d*$_6$)** δ 168.5 (C=O), 166.9 (C=O), 139.7, 138.2, 129.4, 123.8, 123.6 , 123.4, 121.5, 117.1, 114.3, 112.0, 79.3 (C-O, *tert*-Bu), 52.3 (OCH$_3$), 28.4 (*tert*-Bu) ppm; **IR (neat)**: 3293 (N-H), 3099 (C-H), 3056 (C-H), 2972 (C-H), 1714 (C=O, ester), 1675 (C=O, ketone), 1604 (C=C), 1353 (C-N), 1250 (C-O), 1151 (C-H), 1053 (C-N), 749, 713, 596 cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{17}H_{20}NO_4$ $[M + H]^+$: 302.1392, found: 302.1411.



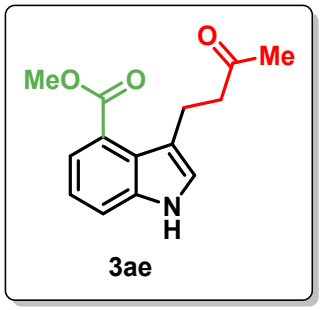
3ac

4) **Methyl (*E*)-3-(3-(benzyloxy)-3-oxoprop-1-en-1-yl)-1*H*-indole-4-carboxylate (3ad):** Prepared as shown in general procedure to obtain the product as a white solid, Yield = 88% (92 mg); m.p.= 102-104 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **^{1}H-NMR (400 MHz, DMSO-d_6):** δ 12.19 (s, 1H, NH), 8.45 (d, J = 15.60 Hz, 1H), 8.30 (d, J = 2.80 Hz, 1H), 7.71-7.64 (m, 2H), 7.46-7.35 (m, 5H), 7.25 (t, J = 8.00 Hz, 1H), 6.37(d, 16.0 Hz, 1H), 5.21 (s, 2H, OCH_2Ph), 3.86 (s, 3H, OCH_3)ppm; **^{13}C NMR (100 MHz, DMSO-d_6)** δ 168.5 (C=O, ester), 167.2 (C=O, ketone), 141.3, 138.3, 137.1, 129.9, 128.9, 128.4, 128.3, 124.1, 123.6, 123.4, 121.6, 117.3, 112.0, 65.4 (C-O, benzyloxy), 52.3 (OCH_3) ppm; **IR (neat):** 3278 (N-H), 3093, 3032, 2994, 2950, 1709, 1677 (C=O), 1604 (C=C), 1373 (C-N), 1341 (C-O), 1246 (C-O), 1194, 1166, 752 (C-H), 695 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{20}H_{18}NO_4$ $[M + H]^+$: 336.1205, found: 336.1236.



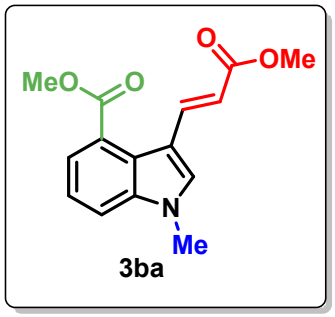
3ad

5) **Methyl 3-(3-oxobutyl)-1*H*-indole-4-carboxylate (3ae):** Prepared as shown in general procedure to obtain the product as a white solid, Yield = 76% (78 mg); m.p.= 108-109 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **^{1}H-NMR (400 MHz, DMSO-d_6):** δ 11.25 (s, 1H, NH), 7.58 (dd, J = 0.80, Hz, 1H), 7.45 (d, J = 6.80 Hz, 1H), 7.29 (d, J = 2.00 Hz, 1H), 7.14 (t, J = 7.60 Hz, 1H), 3.86 (s, 3H, OCH_3), 2.98 (t, J = 8.00 Hz, 2H, CH_2), 2.67 (t, J = 7.20 Hz, 2H, CH_2), 2.10 (s, 3H, $COCH_3$) ppm; **^{13}C NMR (100 MHz, DMSO-d_6)** δ 208.7 (C=O, ketone), 168.9 (C=O, ester), 138.1, 126.3, 124.0, 123.6, 121.7, 120.3, 116.2, 114.3, 52.2 (OCH_3), 44.7 (CH_2), 30.1 (CH_2), 21.7 (CH_3) ppm; **IR (neat):** 3357 (N-H), 3131 (C-H), 3062 (C-H), 2994 (C-H), 2946 (C-H), 1728 (C=O), 1709 (C=O), 1438 (C-H), 1345 (C-N), 1263 (C-O), 1192 (C-H), 1142 (C-H), 1038 (C-O), 749 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{14}H_{16}NO_3$ $[M + H]^+$: 246.1130, found: 246.1151.



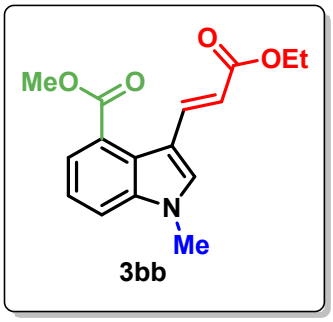
3ae

6) **Methyl (*E*)-3-(3-methoxy-3-oxoprop-1-en-1-yl)-1-methyl-1*H*-indole-4-carboxylate (3ba):** Prepared as shown in general procedure to obtain the product as a white solid; Yield = 78% (82 mg); m.p.= 93-95°C; R_f = 0.2 (Ethyl Acetate/Hexane : 20/80); **^{1}H NMR (400 MHz, DMSO-*d*$_6$)** δ 8.37 (d, *J* = 16.00 Hz, 1H), 8.28 (s, 1H), 7.80 (dd, *J* = 0.80, 8.40 Hz, 1H), 7.69 (dd, *J* = 0.80, 7.20 Hz, 1H), 7.33 (t, *J* = 8.00 Hz, 1H), 6.24 (d, *J* = 15.60 Hz, 1H), 3.92 (s, 3H, OCH_3), 3.89 (s, 3H, OCH_3), 3.70 (s, 3H, OCH_3) ppm; **^{13}C NMR (100 MHz, DMSO-*d*$_6$)** δ 168.3 (C=O), 167.8 (C=O), 140.5, 138.7, 133.7, 124.3, 124.1, 123.5, 121.6, 115.7, 111.9, 110.9, 52.5 (OCH_3), 51.4 (OCH_3), 33.7 (NCH_3) ppm; **IR (neat):** 3108 (C-H), 3035 (C-H), 2952 (C-H), 1705 (C=O), 1680 (C=O), 1612 (C=C), 1341 (C-N), 1263 (C-O), 1196 (C-H), 745 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{15}H_{16}NO_4$ $[M + H]^+$: 274.1079, found: 274.1083.



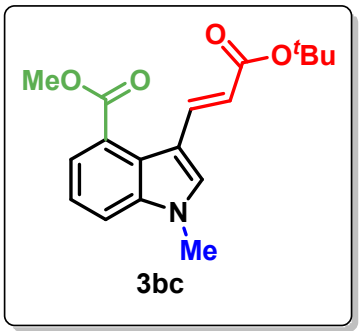
3ba

7) **Methyl (*E*)-3-(3-ethoxy-3-oxoprop-1-en-1-yl)-1-methyl-1*H*-indole-4-carboxylate (3bb):** Prepared as shown in general procedure to obtain the product as a white solid; Yield = 68% (76 mg); m.p.= 85-88 °C; R_f = 0.2 (Ethyl Acetate/Hexane : 20/80); **^{1}H NMR (400 MHz, DMSO-*d*$_6$)** δ 8.33 (d, *J* = 0.40 Hz, 1H), 8.28 (s, 1H), 7.80 (dd, *J* = 1.20, 8.20 Hz, 1H), 7.68 (dd, *J* = 0.80, 7.60 Hz, 1H), 7.31 (t, *J* = 7.60 Hz, 1H), 6.23 (d, *J* = 15.60 Hz, 1H), 4.16 (q, *J* = 7.20 Hz, 2H, OCH_2CH_3), 3.92 (s, 3H, OCH_3), 3.88 (s, 3H, NCH_3), 1.26 (t, *J* = 7.20 Hz, 3H, OCH_2CH_3) ppm; **^{13}C NMR (100 MHz, DMSO-*d*$_6$)** δ 168.4 (C=O), 167.3 (C=O), 140.2, 138.6, 133.6, 124.2, 124.0, 123.6, 121.6, 115.6, 112.3, 110.9, 59.8 (OCH_2), 52.4 (OCH_3), 33.7 (NCH_3), 14.8 (OCH_2CH_3) ppm; **IR (neat):** 2985 (C-H), 2932 (C-H), 2849 (C-H), 1695 (C=O), 1612 (C=C), 1526 (C=C), 1448 (C-H), 1338 (C-N), 1248 (C-O), 1162 (C-H), 1129 (C-H), 1050 (C-O), 878 (C-H), 751 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{16}H_{18}NO_4$ $[M + H]^+$: 288.1236, found: 288.1247.



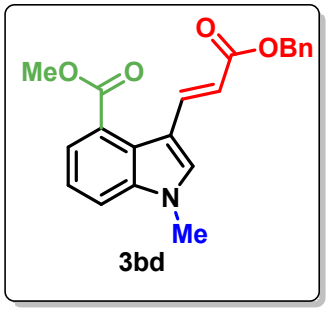
3bb

8) **Methyl (*E*)-3-(3-(tert-butoxy)-3-oxoprop-1-en-1-yl)-1-methyl-1*H*-indole-4-carboxylate (3bc):** Prepared as shown in general procedure to obtain the product as a white solid; Yield = 72% (82 mg); m.p.= 120-125 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **^{1}H-NMR (400 MHz, DMSO-d_6):** δ 8.26 (s, 1H), 8.22 (dd, J = 0.40, 15.80 Hz, 1H), 7.78 (dd, J = 1.20, 8.20 Hz, 1H), 7.66 (dd, J = 0.80, 7.40 Hz, 1H), 7.31 (dd, J = 7.60, 8.20 Hz, 1H), 6.14 (d, J = 16.00 Hz, 1H), 3.92 (s, 3H, OCH_3), 3.87 (s, 3H, NCH_3), 1.49 (s, 9H, *tert*-butyl) ppm; **^{13}C NMR (100 MHz, DMSO-d_6)** δ 168.4 (C=O), 166.8 (C=O), 139.3, 138.6, 133.3, 124.0, 123.6, 121.5, 115.6, 114.2, 110.9, 79.3, 52.4 (OCH_3), 33.7 (*tert*-butyl), 28.4 (*tert*-butyl) ppm; **IR (neat):** 3006 (C-H), 2978 (C-H), 2922 (C-H), 2845 (C-H), 1695 (C=O, ester), 1612 (C=C), 1528 (C-H), 1451 (C-H), 1336 (C-N), 1254 (C-O), 1127 (C-H), 745 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{18}H_{22}NO_4$ $[M + H]^+$: 316.1549, found: 316.1556.



3bc

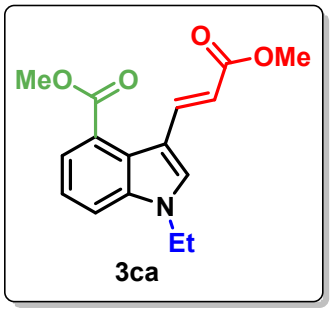
9) **Methyl (*E*)-3-(3-(benzyloxy)-3-oxoprop-1-en-1-yl)-1-methyl-1*H*-indole-4-carboxylate (3bd):** Prepared as shown in general procedure to obtain the product as a white solid; Yield = 83% (88 mg); m.p.= 92-94 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **^{1}H-NMR (400 MHz, DMSO-d_6):** δ 8.43 (d, J = 16.00 Hz, 1H), 8.31 (s, 1H), 7.80 (dd, J = 0.40, 8.20 Hz, 1H), 7.68 (dd, J = 0.80, 7.20 Hz, 1H), 7.46-7.31 (m, 7H), 6.30 (d, J = 16.00 Hz, 1H), 5.21 (s, 2H, OCH_2Bn), 3.88 (s, 3H, OCH_3), 3.87 (s, 3H, NCH_3) ppm; **^{13}C NMR (100 MHz, DMSO-d_6):** δ 168.3 (C=O), 167.18 (C=O), 140.8, 138.6, 137.1, 133.8, 128.9, 128.3, 124.3, 124.0, 123.5, 121.6, 115.7, 111.8, 110.9, 65.5, 52.4 (OCH_3), 33.7 (NCH_3) ppm; **IR (neat):** 3030 (C-H), 2948 (C-H), 2845 (C-H), 1705 (C=O), 1612 (C=C), 1528 (C-H), 1340 (C-N), 1129 (C-O), 752 (C-H), 697 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{21}H_{20}NO_4$ $[M + H]^+$: 350.1392, found: 350.1377.



3bd

10) Methyl *(E)*-1-ethyl-3-(3-methoxy-3-oxoprop-1-en-1-yl)-1*H*-indole-4-carboxylate (3ca):

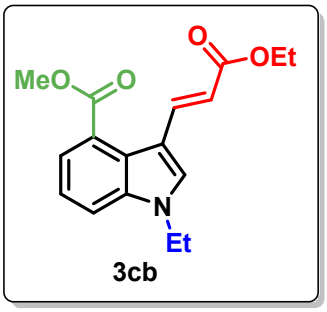
Prepared as shown in general procedure to obtain the product as a white solid; Yield = 80% (82 mg); m.p.= 94-96°C; R_f = 0.3 (Ethyl Acetate/Hexane : 20/80); **^{1}H NMR (400 MHz, DMSO-d_6)** δ 8.35 (d, J = 15.60 Hz, 1H), 8.36 (s, 1H), 7.86 (d, J = 8.00 Hz, 1H), 7.67 (d, J = 7.20 Hz, 1H), 7.31 (t, J = 8.00 Hz, 1H), 6.28 (d, J = 16.00 Hz, 1H), 4.31 (q, J = 7.20 Hz, 2H, CH_2CH_3), 3.92 (s, 3H, OCH_3), 3.70 (s, 3H, NCH_2CH_3) ppm; **^{13}C NMR (100 MHz, DMSO-d_6)** δ 168.4 (C=O), 167.8 (C=O), 140.4, 137.7, 132.1, 124.20, 124.20, 123.7, 121.6, 115.6, 112.0, 111.1, 52.5 (OCH_3), 51.4 (OCH_3), 41.5 (NCH_2), 15.6 (NCH_3) ppm; **IR (neat):** 3100 (C-H), 2952 (C-H), 1709 (C=O), 1615 (C=C), 1524 (C-H), 1440 (C-H), 1345 (C-N), 1248 (C-O), 1161 (C-O), 752 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{16}H_{18}NO_4$ $[M + H]^+$: 288.1236, found: 288.1231.



3ca

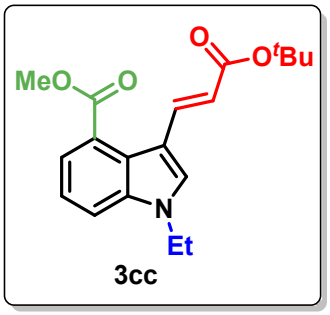
11) Methyl (*E*)-3-(3-ethoxy-3-oxoprop-1-en-1-yl)-1-ethyl-1*H*-indole-4-carboxylate (3cb):

Prepared as shown in general procedure to obtain the product as a white solid; Yield = 76% (78 mg); m.p.= 79-83 °C; R_f = 0.3 (Ethyl Acetate/Hexane : 20/80); **^{1}H NMR (400 MHz, DMSO-d_6)** δ 8.36 (s, 1H), 8.31 (d, J = 0.40 Hz, 1H), 7.86 (dd, J = 0.80, 8.20 Hz, 1H), 7.66 (dd, J = 0.80, 7.40 Hz, 1H), 7.31 (t, J = 7.60 Hz, 1H), 6.27 (d, J = 16.00 Hz, 1H), 4.30 (q, J = 7.20 Hz, 2H, OCH_2), 4.16 (q, J = 7.20 Hz, 2H, NCH_2), 3.92 (s, 3H, OCH_3), 1.42 (t, J = 7.20 Hz, 3H, OCH_2CH_3), 1.26 (t, J = 7.20 Hz, 3H, NCH_2CH_3) ppm; **^{13}C NMR (100 MHz, DMSO-d_6)** δ 168.4 (C=O), 167.3 (C=O), 140.2, 137.7, 132.0, 124.1, 124.0, 123.7, 121.6, 115.5, 112.4, 111.2, 59.8 (OCH_2CH_3), 52.4 (OCH_3), 41.5 (NCH_2CH_3), 15.5 (OCH_2CH_3), 14.7 (NCH_2CH_3) ppm; **IR (neat):** 2978 (C-H), 2952 (C-H), 2903 (C-H), 1703 (C=O), 1619 (C=C), 1526 (C-H), 1440 (C-H), 1343 (C-N), 1250 (C-O), 1151 (C-O), 1030 (C-O), 870 (C-H), 751 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{17}H_{20}NO_4$ $[M + H]^+$: 302.1392, found: 302.1384.



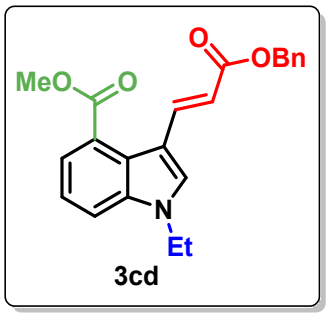
3cb

12) **Methyl (*E*)-3-(3-(tert-butoxy)-3-oxoprop-1-en-1-yl)-1-ethyl-1*H*-indole-4-carboxylate (3cc):** Prepared as shown in general procedure to obtain the product as a white solid; Yield = 72% (76 mg); m.p.= 113-116 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **^{1}H-NMR (400 MHz, DMSO-d_6):** δ 8.33 (s, 1H), 8.21 (dd, J = 0.40, 15.80 Hz, 1H), 7.84 (dd, J = 0.80, 8.40 Hz, 1H), 7.64 (dd, J = 0.80, 7.60 Hz, 1H), 7.30 (dd, J = 7.60, 8.00 Hz, 1H), 6.18 (d, J = 16.00 Hz, 1H), 4.29 (q, J = 7.20 Hz, 2H, OCH_2CH_3), 3.92 (s, 3H, OCH3), 1.49 (s, 9H, *tert*-butyl), 1.41 (t, J = 7.20 Hz, 3H, CH_2CH_3) ppm; **^{13}C NMR (100 MHz, DMSO-d_6)** δ 168.4 (C=O), 166.8 (C=O), 139.2, 137.6, 131.8, 124.1, 123.9, 123.7, 121.5, 115.5, 114.3, 111.2, 79.3 (C-3 *tert*-butyl), 52.4 (OCH_3), 28.4 (*tert*-butyl), 15.5 (ethyl) ppm; **IR (neat):** 2976 (C-H), 2935 (C-H), 2847 (C-H), 1701 (C=O), 1617 (C=C), 1524 (C-H), 1438 (C-H), 1347 (C-N), 1254 (C-O), 1138 (C-O), 754 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{19}H_{24}NO_4$ $[M + H]^+$: 330.1705, found: 330.1698.



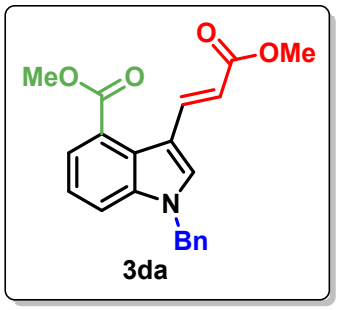
3cc

13) **Methyl (*E*)-3-(3-(benzyloxy)-3-oxoprop-1-en-1-yl)-1-ethyl-1*H*-indole-4-carboxylate (3cd):** Prepared as shown in general procedure to obtain the product as an off-white solid; Yield = 82% (79 mg); m.p.= 108-110 °C; R_f = 0.2 (Ethyl Acetate/Hexane : 40/60); **^{1}H NMR (400 MHz, DMSO-d_6)** δ 8.42 (s, 1H), 8.38 (s, 1H), 7.86 (d, J = 7.60 Hz, 1H), 7.66 (d, J = 0.40 Hz, 1H), 7.46-7.26 (m, 6H), 6.34 (d, J = 16.00 Hz, 1H), 5.21 (s, 2H, OCH_2Bn), 4.30 (q, J = 7.20 Hz, 2H, OCH_2CH_3), 3.86 (s, 3H, OCH_3), 1.42 (t, J = 7.20 Hz, 3H, CH_3) ppm; **^{13}C NMR (100 MHz, DMSO-d_6)** δ 168.4 (C=O), 167.2 (C=O), 140.8, 137.7, 137.1, 132.2, 128.9, 128.7, 128.3, 128.2, 124.2, 123.7, 121.6, 115.6, 111.9, 111.1, 65.4 ($O\underline{CH_2}Bn$), 52.4 (OCH_3), 41.5 ($N\underline{CH_2}CH_3$), 15.5 ($NCH_2\underline{CH_3}$) ppm; **IR (neat):** 3103 (C-H), 3080 (C-H), 2981 (C-H), 2950 (C-H), 2883 (C-H), 1714 (C=O), 1612 (C=C), 1526 (C-H), 1440 (C-H), 1377 (C-H), 1345 (C-O), 1287 (C-O), 1194 (C-H), 1146 (C-H), 752 (C-H), 698 (C-H); **HRMS (ESI)** *(m/z)*: Calculated for $C_{22}H_{22}NO_4$ $[M + H]^+$: 364.1549, found: 364.1516.



3cd

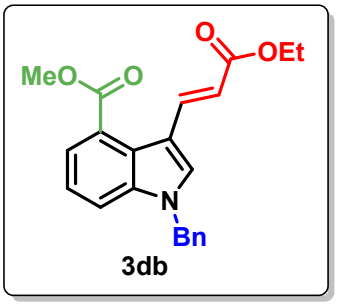
14) Methyl (*E*)-1-benzyl-3-(3-methoxy-3-oxoprop-1-en-1-yl)-1*H*-indole-4-carboxylate (3da):



3da

Prepared as shown in general procedure to obtain the product as a white solid; Yield = 74% (68 mg); m.p.= 101-103°C; R_f = 0.4 (Ethyl Acetate/Hexane : 20/80); **^{1}H NMR (400 MHz, DMSO-d_6)** δ 8.50 (s, 1H), 8.33 (d, J = 0.40 Hz, 1H), 7.83 (dd, J = 0.80, 8.00 Hz, 1H), 7.65 (dd, J = 0.80, 7.60 Hz, 1H), 7.35-7.25 (m, 6H), 6.30 (d, J = 16.00 Hz, 1H), 5.53 (s, 2H, O$\underline{CH_2}$Bn), 3.91 (s, 3H, OCH_3), 3.71 (s, 3H, OCH_3)ppm; **^{13}C NMR (100 MHz, DMSO-d_6)** δ 168.3 (C=O), 167.7 (C=O), 140.3, 137.9, 137.4, 133.1, 129.1, 128.1, 127.6, 124.3, 124.2, 123.8, 121.9, 116.0, 112.6, 111.6, 52.5 (N$\underline{CH_2}$Bn), 51.5 (OCH_3), 50.1 (OCH_3) ppm; **IR (neat):** 3084 (C-H), 3030 (C-H), 2943 (C-H), 2844 (C-H), 1703 (C=O, ester), 1619 (C=C), 1567 (C-H), 1431 (C-H), 1343 (C-O), 1168 (C-H), 751 (C-H), 698 (C-H) cm^{-1}; **HRMS-ESI** (*m/z*)**: HRMS (ESI)** *(m/z)*: Calculated for $C_{21}H_{20}NO_4$ $[M + H]^+$: 350.1392, found: 350.1358.

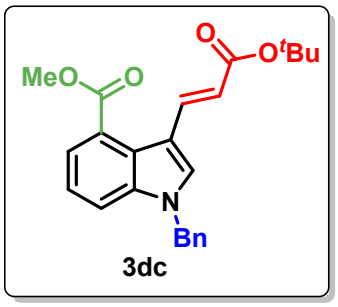
15) Methyl (*E*)-1-benzyl-3-(3-ethoxy-3-oxoprop-1-en-1-yl)-1*H*-indole-4-carboxylate (3db):



3db

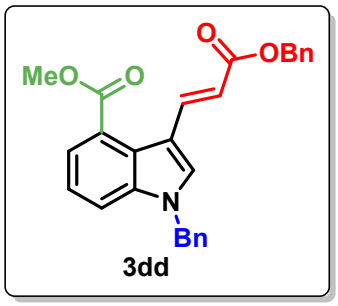
Prepared as shown in general procedure to obtain the product as an off-white solid; Yield = 71% (82 mg); m.p.= 60-64 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 20/80); **^{1}H NMR (400 MHz, DMSO-d_6)** δ 8.50 (s, 1H), 8.31 (d, J = 0.80 Hz, 1H), 7.83 (dd, J = 0.80, 8.20 Hz, 1H), 7.64 (dd, J = 0.80, 7.60 Hz, 1H), 7.35-7.25 (m, 6H), 6.29 (d, J = 15.60 Hz, 1H), 5.53 (s, 2H, O$\underline{CH_2}$Bn), 4.17 (q, J = 7.20 Hz, 2H, O$\underline{CH_2}CH_3$), 3.91 (s, 3H, OCH_3), 1.26 (t, J = 6.80 Hz, 3H, $OCH_2\underline{CH_3}$) ppm; **^{13}C NMR (100 MHz, DMSO-d_6)** δ 168.4 (C=O), 167.3 (C=O), 140.0, 137.9, 137.5, 133.1, 129.2, 129.1, 128.2, 127.7, 127.6 124.3, 124.2, 123.9, 121.9, 116.0, 113.0, 111.6, 59.9 (O$\underline{CH_2}CH_3$), 52.5 (N$\underline{CH_2}$Bn), 50.1 (OCH_3), 14.8 ($OCH_2\underline{CH_3}$) ppm; **IR (neat):** 3103 (C-H), 3063 (C-H), 2981 (C-H), 2901 (C-H), 1694 (C=O), 1619 (C=C), 1530 (C-H), 1438 (C-H), 1338 (C-O), 1254 (C-O), 1173 (C-H), 1039 (C-H), 736 (C-H), 698 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{22}H_{22}NO_4$ $[M + H]^+$: 364.1549, found: 364.1541.

16) Methyl (*E*)-1-benzyl-3-(3-(*tert*-butoxy)-3-oxoprop-1-en-1-yl)-1*H*-indole-4-carboxylate (3dc): Prepared as shown in general procedure to obtain the product as a white solid; Yield = 69% (83 mg); m.p.= 111-115 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **^{1}H-NMR (400 MHz, DMSO-*d*$_6$)**: δ 8.48 (s, 1H), 8.20 (dd, *J* = 0.80, 15.80 Hz, 1H), 7.82 (dd, *J* = 0.80, 8.20 Hz, 1H), 7.62 (dd, *J* = 1.20, 7.40 Hz, 1H), 7.35-7.24 (m, 6H), 6.20 (d, *J* = 15.60 Hz, 1H), 5.51 (s, 2H, O$\underline{CH_2}$Bn), 3.91 (s, 3H, OCH_3), 1.49 (s, 9H, *tert*-butyl) ppm; **^{13}C NMR (100 MHz, DMSO-*d*$_6$)** δ 168.4, 166.7, 139.0, 137.8, 137.5, 132.8, 129.1, 128.1, 127.7, 124.2, 124.0, 123.9, 121.8, 115.9, 114.8, 111.6, 79.4 (*tert*-butyl), 52.5 (O$\underline{CH_2}$Bn), 50.1 (OCH_3), 28.4 (*tert*-butyl) ppm; **IR (neat):** 3101 (C-H), 3062 (C-H), 2978 (C-H), 2864 (C-H), 1701 (C=O), 1623 (C=C), 1530 (C-H), 1433 (C-H), 1340 (C-O), 1286 (C-O), 1142 (C-H), 747 (C-H), 697 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{24}H_{26}NO_4$ $[M + H]^+$: 392.1862, found: 392.1849.



3dc

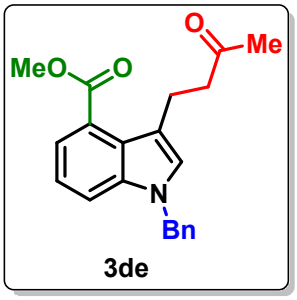
17) Methyl (*E*)-1-benzyl-3-(3-(benzyloxy)-3-oxoprop-1-en-1-yl)-1*H*-indole-4-carboxylate (3dd): Prepared as shown in general procedure to obtain the product as an off-white solid; Yield = 76% (98 mg); m.p.= 96-98 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **1H-NMR (400 MHz, DMSO-*d*$_6$):** δ 8.53 (s, 1H), 8.40 (d, *J* = 15.60 Hz, 1H), 7.83 (d, *J* = 8.00 Hz, 1H), 7.65 (d, *J* = 7.20 Hz, 1H), 7.46-7.39 (m, 4H), 7.37-7.25 (m, 7H), 6.36 (d, *J* = 16.00 Hz, 1H), 5.53 (s, 2H, N$\underline{CH_2}$Bn), 5.22 (s, 2H, O$\underline{CH_2}$Bn), 3.86 (s, 3H, OCH_3) ppm; **^{13}C NMR (100 MHz, DMSO-*d*$_6$)** δ 168.3 (C=O), 167.1 (C=O), 140.6, 137.9, 137.4, 137.1, 133.2, 129.1, 128.9, 128.3, 128.3, 128.2, 127.6, 124.3, 123.8, 121.9, 116.0, 112.5, 111.5, 65.5 (O$\underline{CH_2}$Bn 52.4 (N$\underline{CH_2}$Bn), 50.1 (OCH_3) ppm; **IR (neat):** 3103 (C-H), 3032 (C-H), 2946 (C-H), 2847 (C-H), 1709 (C=O), 1681 (C=O), 1612 (C=C), 1526 (C-



3dd

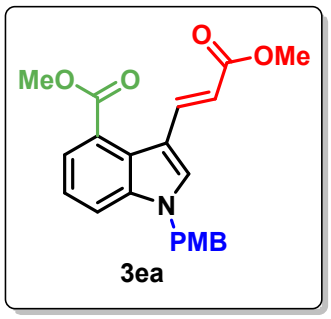
H), 1433 (C-H), 1254 (C-O), 1222 (C-O), 1144 (C-H), 747 (C-H), 695 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{27}H_{24}NO_4$ $[M + H]^+$: 426.1705, found: 426.1697.

18) **Methyl 1-benzyl-3-(3-oxobutyl)-1*H*-indole-4-carboxylate (3de):** Prepared as shown in general procedure to obtain the product as an off-white solid; Yield = 66% (78 mg); m.p.= 82-84 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **^{1}H-NMR (400 MHz, DMSO-d_6):** δ 7.67 (dd, J = 0.80, 8.00 Hz, 1H), 7.47 (s, 1H), 7.44 (d, J = 0.80 Hz, 1H), 7.35-7.13 (m, 6H), 5.42 (s, 2H, O$\underline{CH_2}$Bn), 3.86 (s, 3H, OCH_3), 2.97 (t, J = 8.00 Hz, 2H, CH_2), 2.69 (t, J = 7.20 Hz, 2H, CH_2), 2.09 (s, 3H, $COCH_3$) ppm; **^{13}C NMR (100 MHz, DMSO-d_6):** δ 208.5, 168.8, 138.4, 137.6, 130.1, 129.0, 127.8, 127.3, 124.6, 124.1, 121.8, 120.7, 114.7, 114.2, 52.3 (N$\underline{CH_2}$Bn), 49.4 (OCH_3), 44.4 (CO$\underline{CH_2}$), 30.1 (CO$\underline{CH_3}$), 21.5 (CH_2) ppm; **IR (neat):** 3063 (C-H), 3028 (C-H), 2994 (C-H), 2926 (C-H), 1701 (C=O), 1433 (C-H), 1326 (C-O), 1258 (C-H), 1192 (C-O), 1142 (C-H), 1040 (C-H), 1038 (C-H), 743 (C-H), 702 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{21}H_{22}NO_3$ $[M + H]^+$: 336.1600, found: 336.1589.



3de

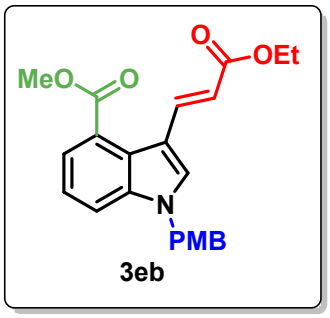
19) **Methyl (*E*)-3-(3-methoxy-3-oxoprop-1-en-1-yl)-1-(4-methoxybenzyl)-1*H*-indole-4-carboxylate (3ea):** Prepared as shown in general procedure to obtain the product as a white solid; Yield = 68% (64 mg); m.p.= 90-93 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 20/80); **^{1}H NMR (400 MHz, DMSO-d_6):** δ 8.47 (s, 1H), 8.33 (d, J = 0.40 Hz, 1H), 7.86 (dd, J = 0.80, 8.20 Hz, 1H), 7.64 (dd, J = 1.20, 7.40 Hz, 1H), 7.29-7.25 (m, 3H), 6.89 (d, J = 2.00 Hz, 2H), 6.28 (d, J = 15.60 Hz, 1H), 5.44 (s, 2H, $\underline{CH_2}$PMB), 3.91 (s, 3H, OCH_3), 3.70 (s, 3H, PMBO$\underline{CH_3}$), 3.70 (s, 3H, OCH_3) ppm; **^{13}C NMR (100 MHz, DMSO-d_6):** δ 168.3, 167.7, 159.2, 140.3, 137.8, 132.9, 129.3, 129.2, 124.3, 124.2, 123.8, 121.8, 116.1, 114.5, 112.4, 111.4, 55.5 (PMBO$\underline{CH_3}$), 52.5 (NCH_2), 51.5 (OCH_3), 49.6 (OCH_3)ppm; **IR (neat):** 3103 (C-H), 3028 (C-H), 2942 (C-H), 2838 (C-H), 1725 (C=O), 1682 (C=O), 1608 (C=C), 1515 (C-



3ea

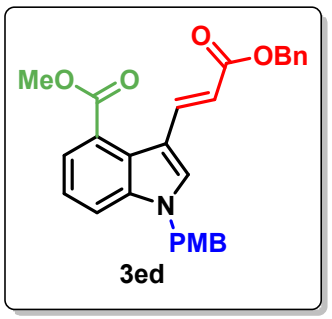
H), 1433 (C-H), 1276 (C-O), 1235 (C-O), 1174 (C-H), 1144 (C-H), 1026 (C-O), 747 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{22}H_{22}NO_5$ $[M + H]^+$: 380.1498, found: 380.1475.

20) Methyl (*E*)-3-(3-ethoxy-3-oxoprop-1-en-1-yl)-1-(4-methoxybenzyl)-1*H*-indole-4-carboxylate (3eb): Prepared as shown in general procedure to obtain the product as a white solid; Yield = 76% (68 mg); m.p.= 70-72 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 20/80); **^{1}H NMR (400 MHz, DMSO-d_6):** δ 8.48 (s, 1H), 8.30 (d, J = 0.80 Hz, 1H), 7.86 (dd, J = 0.80, 8.40 Hz, 1H), 7.63 (dd, J = 0.80, 7.20 Hz, 1H), 7.29-7.25 (m, 3H), 6.89 (d, J = 2.00 Hz, 2H), 6.28 (d, J = 15.60 Hz, 1H), 5.43 (s, 2H, N$\underline{CH_2}$PMB), 4.17 (q, J = 7.20 Hz, 2H, O$\underline{CH_2}CH_3$), 3.91 (s, 3H, OCH_3), 3.70 (s, 3H, OCH_3), 1.26 (t, J = 7.20 Hz, 3H, $OCH_2\underline{CH_3}$) ppm; **^{13}C NMR (100 MHz, DMSO-d_6):** δ 168.4 (C=O), 167.3 (C=O), 159.2, 140.0, 137.7, 132.8, 129.3, 129.2, 124.3, 124.1, 123.8, 121.7, 116.0, 114.5, 112.8, 111.5, 59.8 (O$\underline{CH_2}CH_3$), 55.5 (OCH_3), 52.4 (OCH_3), 49.6 (OCH_3), 14.7 ($OCH_2\underline{CH_3}$) ppm; **IR (neat):** 3101 (C-H), 3032 (C-H), 2972 (C-H), 2844 (C-H), 1723 (C=O), 1684 (C=O), 1610 (C=C), 1515 (C-H), 1438 (C-H), 1258 (C-O), 1146 (C-H), 1051 (C-O), 982 (C-O), 743 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{23}H_{24}NO_5$ $[M + H]^+$: 394.1654, found: 394.1639.



3eb

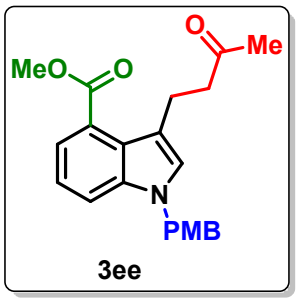
21) Methyl (*E*)-3-(3-(benzyloxy)-3-oxoprop-1-en-1-yl)-1-(4-methoxybenzyl)-1*H*-indole-4-carboxylate (3ed): Prepared as shown in general procedure to obtain the product as a white solid; Yield = 81% (88 mg); m.p.= 104-106 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **^{1}H-NMR (400 MHz, DMSO-d_6):** δ 8.50 (s, 1H), 8.39 (d, J = 15.60 Hz, 1H), 7.86 (d, J = 8.00 Hz, 1H), 7.64 (d, J = 7.20 Hz, 1H), 7.46-7.35 (m, 5H), 7.29-7.25 (m, 3H), 6.88 (d, J = 8.80 Hz, 2H), 6.35 (d, J = 15.60 Hz, 1H), 5.43 (s, 2H, O$\underline{CH_2}$(Bn)), 5.21 (s, 2H, N$\underline{CH_2}$(PMB)), 3.86 (s, 3H, OCH_3), 3.70 (s, 3H, OCH_3) ppm; **^{13}C**



3ed

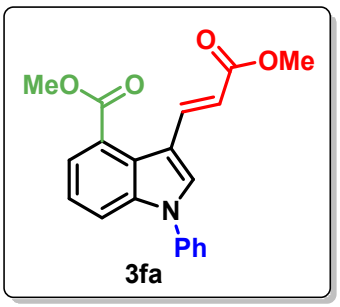
NMR (100 MHz, DMSO-d_6): δ 168.3 (C=O), 167.1 (C=O), 159.2, 140.6, 137.8, 137.1, 133.0, 129.2, 128.9, 128.3, 128.3, 124.2, 123.8, 121.8, 116.1, 114.5, 112.3, 111.4, 65.5 (O$\underline{CH_2}$(Bn)), 55.5 (OCH_3), 52.4 (OCH_3), 49.6 (N$\underline{CH_2}$(PMB)) ppm; **IR (neat):** 3106 (C-H), 3032 (C-H), 2948 (C-H), 2838 (C-H), 1723 (C=O), 1631 (C=C), 1608 (C=C), 1513 (C-H), 1433 (C-H), 1253 (C-O), 1172 (C-H), 747 (C-H), 693 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{28}H_{26}NO_5$ $[M + H]^+$: 456.1811, found: 456.1793.

22) **Methyl 1-(4-methoxybenzyl)-3-(3-oxobutyl)-1*H*-indole-4-carboxylate (3ee):** Prepared as shown in general procedure to obtain the product as a ccolorless gum; Yield = 69% (78 mg); R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **^{1}H-NMR (400 MHz, DMSO-d_6):** δ 7.69 (d, J = 8.00 Hz, 1H), 7.45 (d, J = 6.40 Hz, 2H), 7.18-7.14 (m, 3H), 6.86 (d, J = 8.80 Hz, 2H), 5.33 (s, 2H, O$\underline{CH_2}$(PMB)), 3.86 (s, 3H, OCH_3), 3.70 (s, 3H, OCH_3), 2.96 (t, J = 7.60 Hz, 2H, CH_2), 2.68 (t, J = 7.20 Hz, 2H, CH_2), 2.10 (s, 3H, CO$\underline{CH_3}$) ppm; **^{13}C NMR (100 MHz, DMSO-d_6):** δ 208.5 (C=O), 208.5, 159.0, 137.5, 130.3, 128.8, 124.6, 124.0, 121.7, 120.6, 114.8, 114.0, 55.5 (OCH_3(PMB)), 52.6 (OCH_3), 48.9 (CH_2), 44.5 (CH_2), 30.1 (CO$\underline{CH_3}$), 21.0 (CH_2) ppm; **IR (neat):** 3065 (C-H), 2998 (C-H), 2948 (C-H), 2838 (C-H), 1709 (C=O), 1608 (C=C), 1511 (C-H), 1435 (C-H), 1246 (C-O), 1174 (C-H), 1146 (C-H), 1034 (C-H), 820 (C-H), 749 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{22}H_{24}NO_4$ $[M + H]^+$: 366.1705, found: 366.1697.



3ee

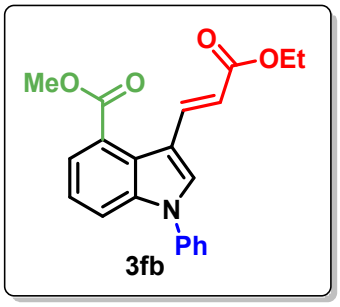
23) **Methyl (*E*)-3-(3-methoxy-3-oxoprop-1-en-1-yl)-1-phenyl-1*H*-indole-4-carboxylate (3fa):** Prepared as shown in general procedure to obtain the product as a white solid; Yield = 59% (57 mg); m.p.= 119-120 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 20/80); **^{1}H NMR (400 MHz, DMSO-d_6):** δ 8.55 (s, 1H), 8.32 (d, J = 0.40 Hz, 1H), 7.76-7.73 (m, 2H), 7.76-7.63 (m, 4H), 7.56-7.48 (m, 1H), 7.35 (t, J = 8.00 Hz, 1H), 6.46 (d, J = 16.00 Hz, 1H), 3.95 (s, 3H, OCH_3), 3.72 (s, 3H, OCH_3) ppm; **^{13}C NMR (100 MHz, DMSO-d_6):** δ 168.3 (C=O), 167.7 (C=O), 139.6, 138.0, 137.6, 132.3, 130.4, 128.4, 125.5, 124.8, 124.6, 124.2, 122.8, 115.8, 114.0, 113.3, 52.6 (OCH_3), 51.6 (OCH_3) ppm; **IR**



3fa

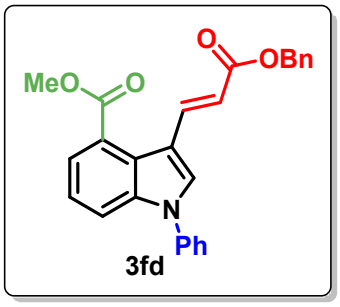
(neat): 3050 (C-H), 2991 (C-H), 2942 (C-H), 1716 (C=O), 1623 (C=C), 1539 (C-H), 1504 (C-H), 1429 (C-H), 1256 (C-O), 1159 (C-H), 745 (C-H), 702 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{20}H_{18}NO_4$ $[M + H]^+$: 336.1236, found: 336.1222.

24) **Methyl (*E*)-3-(3-ethoxy-3-oxoprop-1-en-1-yl)-1-phenyl-1*H*-indole-4-carboxylate (3fb):** Prepared as shown in general procedure to obtain the product as a white solid; Yield = 61% (58 mg); m.p.= 104-106 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 20/80); **^{1}H NMR (400 MHz, DMSO-d_6):** δ 8.55 (s, 1H), 8.29 (d, J = 0.80 Hz, 1H), 7.76-7.71 (m, 2H), 7.68-7.62 (m, 4H), 7.55-7.51 (m, 1H), 7.35-7.33 (m, 1H), 6.46 (d, J = 16.00 Hz, 1H), 4.18 (q, J = 7.20 Hz, 2H, $O\underline{CH_2}CH_3$), 3.95 (s, 3H, OCH_3), 1.27 (t, J = 6.80 Hz, 3H, $OCH_2\underline{CH_3}$) ppm; **^{13}C NMR (100 MHz, DMSO-d_6):** δ 168.3 (C=O), 167.2 (C=O), 139.3, 138.0, 137.6, 132.1, 130.4, 128.4, 125.4, 124.7, 124.6, 124.3, 122.8, 115.8, 114.4, 113.3, 59.9 ($O\underline{CH_2}CH_3$), 52.6 (OCH_3), 14.7 ($OCH_2\underline{CH_3}$) ppm; **IR (neat):** 3049 (C-H), 2978 (C-H), 2899 (C-H), 1705 (C=O), 1649 (C=C), 1536 (C-H), 1436 (C-H), 1265 (C-O), 1151 (C-H), 743 (C-H), 702 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{21}H_{20}NO_4$ $[M + H]^+$: 350.1392, found: 350.1378.



3fb

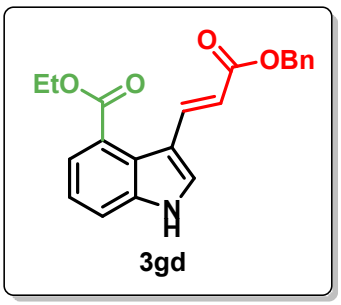
25) **Methyl (*E*)-3-(3-(benzyloxy)-3-oxoprop-1-en-1-yl)-1-phenyl-1*H*-indole-4-carboxylate (3fd):** Prepared as shown in general procedure to obtain the product as a white solid; Yield = 68% (87 mg); m.p.= 90-92 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **^{1}H-NMR (400 MHz, DMSO-d_6):** δ 8.58 (s, 1H), 8.38 (d, J = 16.00 Hz, 1H), 7.76-7.72 (m, 2H), 7.66-7.64 (m, 4H), 7.53 (d, J = 6.00 Hz, 1H), 7.47-7.33 (m, 6H), 6.52 (d, J = 16.00 Hz, 1H), 5.23 (s, 2H, $\underline{CH_2}$(Bn)), 3.90 (s, 3H, OCH_3) ppm; **^{13}C NMR (100 MHz, DMSO-d_6):** δ 168.3 (C=O), 167.0 (C=O), 139.9, 138.0, 137.6, 137.0, 132.4, 130.4, 128.9, 128.4, 125.4, 124.8, 124.6, 124.2, 122.9, 115.9, 114.0, 113.2, 65.6 ($O\underline{CH_2}$(Bn)), 52.5 (OCH_3) ppm; **IR (neat):** 3142 (C-H), 3062 (C-H), 2950 (C-H), 2842 (C-H), 1703 (C=O), 1595 (C=C), 1537 (C-H), 1502



3fd

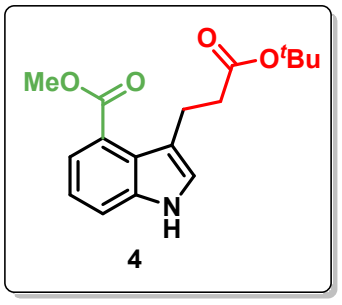
(C-H), 1435 (C-H), 1259 (C-O), 1194 (C-H), 1138 (C-H), 972 (C-H), 736 (C-H), 695 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{26}H_{22}NO_4$ $[M + H]^+$: 412.1549, found: 412.1541.

26) Ethyl (*E*)-3-(3-(benzyloxy)-3-oxoprop-1-en-1-yl)-1H-indole-4-carboxylate **(3gd):** Prepared as shown in general procedure to obtain the product as a white solid; Yield = 82% (93 mg); m.p.= 115-117 °C; R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **^{1}H-NMR (400 MHz, DMSO-d_6):** δ 12.17 (s, 1H, NH), 8.41 (dd, J = 0.80, 15.80 Hz, 1H, CH=CHCOOBn), 8.30 (s, 1H), 7.69 (dd, J = 0.80, 8.20 Hz, 1H), 7.45-7.33 (m, 5H, OBn), 7.28-7.22 (m, 1H), 6.37 (d, J = 15.60 Hz, 1H, CH=CHCOOBn), 5.20 (s, 2H, OCH_2Bn), 4.33 (q, J = 7.20, 2H, OCH_2CH_3), 1.31 (t, J = 7.20 Hz, OCH_2CH_3) ppm; **^{13}C NMR (100 MHz, DMSO-d_6):** δ 168.2 (C=O), 167.2 (C=O), 141.2, 138.3, 137.1, 129.9, 128.8, 128.5, 128.4, 123.9, 123.8, 123.5, 121.6, 117.1, 112.0, 111.9, 65.4 (OCH_2Ph), 61.2 (OCH_2CH_3), 14.4 (OCH_2CH_3) ppm; **IR (neat):** 3235 (N-H), 1703 (C=O), 1671 (C=O), 1593 (C=C), 1341 (C-N), 1246 (C-O), 1187 (C-O), 1164 (C-O), 1053, 1041, 1000 (C-H), 846 (C-H), 769 (C-H), 751 (C-H) cm^{-1}; **HRMS (ESI)** *(m/z)*: Calculated for $C_{21}H_{20}NO_4$ $[M + H]^+$: 350.1392, found: 350.1401.



3gd

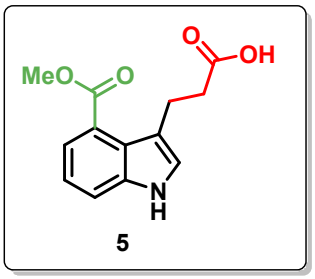
27) **Methyl 3-(3-(*tert*-butoxy)-3-oxopropyl)-1*H*-indole-4-carboxylate (4):** Prepared as shown in general procedure to obtain the product as a white solid; Yield = 88% (443 mg); m.p.= 101-103 °C; R_f = 0.2 (Ethyl Acetate/Hexane : 40/60); **^{1}H NMR (400 MHz, DMSO-d_6):** δ 11.25 (s, 1H, NH), 7.59 (dd, J = 0.80, 8.00 Hz, 1H), 7.45 (dd, J = 0.80, 7.40 Hz, 1H), 7.30 (d, J = 2.40 Hz, 1H), 7.14 (t, J = 7.60 Hz, 1H), 3.87 (s, 3H, OCH_3), 3.01 (t, J = 7.60 Hz, 2H, CH_2), 2.42 (t, J = 7.60 Hz, 2H, CH_2), 1.37 (s, 9H, *tert*-butyl) ppm; **^{13}C NMR (100 MHz, DMSO-d_6):** δ 172.4 (C=O), 168.9 (C=O), 138.1, 126.5, 123.9, 123.5, 121.7, 120.3, 116.2, 113.9, 79.8 (C-O *tert*-butyl), 52.1 (OCH_3), 36.7 (CH_2), 28.2 ((*tert*-butyl), 23.1 (CH_2) ppm; **IR (neat):** 3354 (C-H), 3123 (C-H), 3043 (C-H), 2978 (C-H), 1697 (C=O), 1431 (C-H), 1351 (C-H), 1313 (C-H), 1269 (C-O), 1196 (C-H), 1136



4

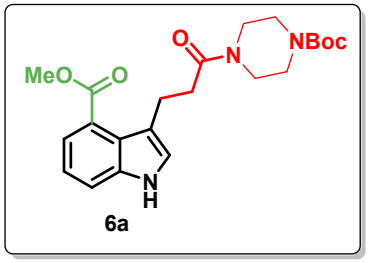
(C-H), 1051 (C-O), 1026 (C-H), 846 (C-H), 751 cm^{-1}; **HRMS-ESI** (*m/z*)**:** Calculated for $C_{17}H_{22}NO_4$ $[M + H]^+$: 304.1549, found: 304.1532.

28) 3-(4-(methoxycarbonyl)-1*H*-indol-3-yl)propanoic acid (5): Prepared as shown in general procedure to obtain the product as a white solid; Yield = 92% (150 mg); m.p.= 124-126 °C; R_f = 0.2 (Ethyl Acetate/Hexane : 40/60); **^{1}H NMR (400 MHz, DMSO-*d*$_6$):** δ 12.02 (s, 1H, COOH), 11.25 (s, 1H, NH), 7.59 (dd, *J* = 0.40, Hz, 1H), 7.46 (dd, *J* = 0.80, 7.20 Hz, 1H), 7.31 (d, *J* = 2.40 Hz, 1H), 7.14 (t, *J* = 8.00 Hz, 1H), 3.85 (s, 3H, OCH_3), 3.02 (t, *J* = 7.60 Hz, 2H, CH_2), 2.46 (t, *J* = 7.20 Hz, 2H, CH_2) ppm; **^{13}C NMR (100 MHz, DMSO-*d*$_6$):** δ 174.6 (C=O, carboxylic acid), 168.9 (C=O, ester), 138.1, 126.4, 124.0, 123.5, 121.7, 120.3, 116.2, 114.2, 52.2 (OCH_3), 35.6 (CH_2), 22.9 (CH_2) ppm; **IR (neat):** 3315 (O-H), 2993 (C-H), 2924 (C-H), 2849 (C-H), 1723 (C=O, carboxylic acid), 1688 (C=O), 1442 (C-H), 1295 (C-O), 1271 (C-H), 1209 (C-H), 1176 (C-H), 1053 (C-O), 834 (C-H), 747 (C-H) cm^{-1}; **HRMS-ESI** (*m/z*)**:** Calculated for $C_{13}H_{14}NO_4$ $[M + H]^+$: 280.0923, found: 280.0912.



5

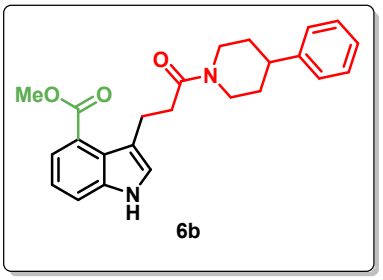
29) Methyl 3-(3-(4-(*tert*-butoxycarbonyl)piperazin-1-yl)-3-oxopropyl)-1*H*-indole-4-carboxylate (6a): Prepared as shown in general procedure to obtain the product as a white solid; Yield = 80% (67.5 mg); m.p.= 131-133; R_f = 0.2 (Ethyl Acetate/Hexane : 40/60); **^{1}H NMR (400 MHz, DMSO-*d*$_6$):** δ 11.26 (s, 1H, NH), 7.59 (dd, *J* = 0.80, 8.00 Hz, 1H), 7.45 (dd, *J* = 0.80, 7.20 Hz, 1H), 7.34 (s, 1H), 7.14 (t, *J* = 7.60 Hz, 1H), 3.86 (s, 3H, OCH_3), 3.44-3.38 (m, 4H, piperazine protons), 3.28-3.19 (m, 4H, piperazine protons), 3.01 (t, *J* = 8.00 Hz, 2H, CH_2), 2.56 (t, *J* = 7.60 Hz, 2H, CH_2), 1.40 (s, 9H, *tert*-butyl) ppm; **^{13}C NMR (100 MHz, DMSO-*d*$_6$) :**δ 171.0 (C=O), 168.9 (C=O), 154.2, 138.1, 126.6, 124.1, 123.6, 121.7, 120.3, 116.2, 114.5, 79.5, 52.2, 45.0, 43.7, 41.2, 34.3, 28.4, 28.3, 28.2, 23.1 ppm; **IR (neat):** 3261 (N-H), 3050 (C-H), 2974 (C-H), 2931 (C-H), 2862 (C-H), 1692 (C=O), 1615 (C=C), 1416 (C-H), 1364 (C-H), 1248 (C-O), 1196 (C-H), 1162 (C-H), 1049 (C-O), 995



6a

(C-H), 749 (C-H) cm^{-1}; **HRMS-ESI** (*m/z*)**:** Calculated for $C_{22}H_{30}N_3O_5$ $[M + H]^+$: 416.2185, found: 416.2179.

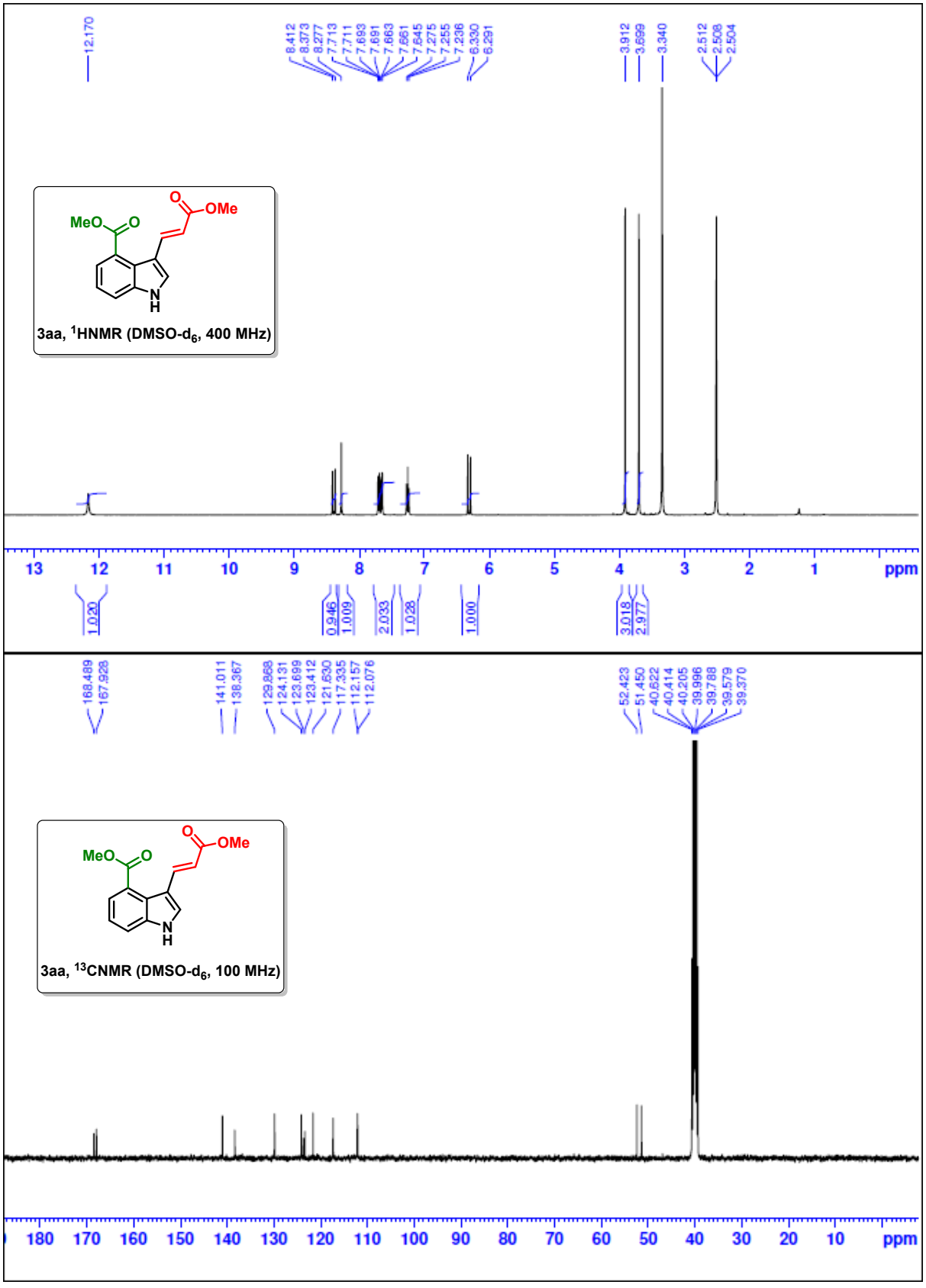
30) Methyl 3-(3-oxo-3-(4-phenylpiperidin-1-yl)propyl)-1*H*-indole-4-carboxylate (6b):

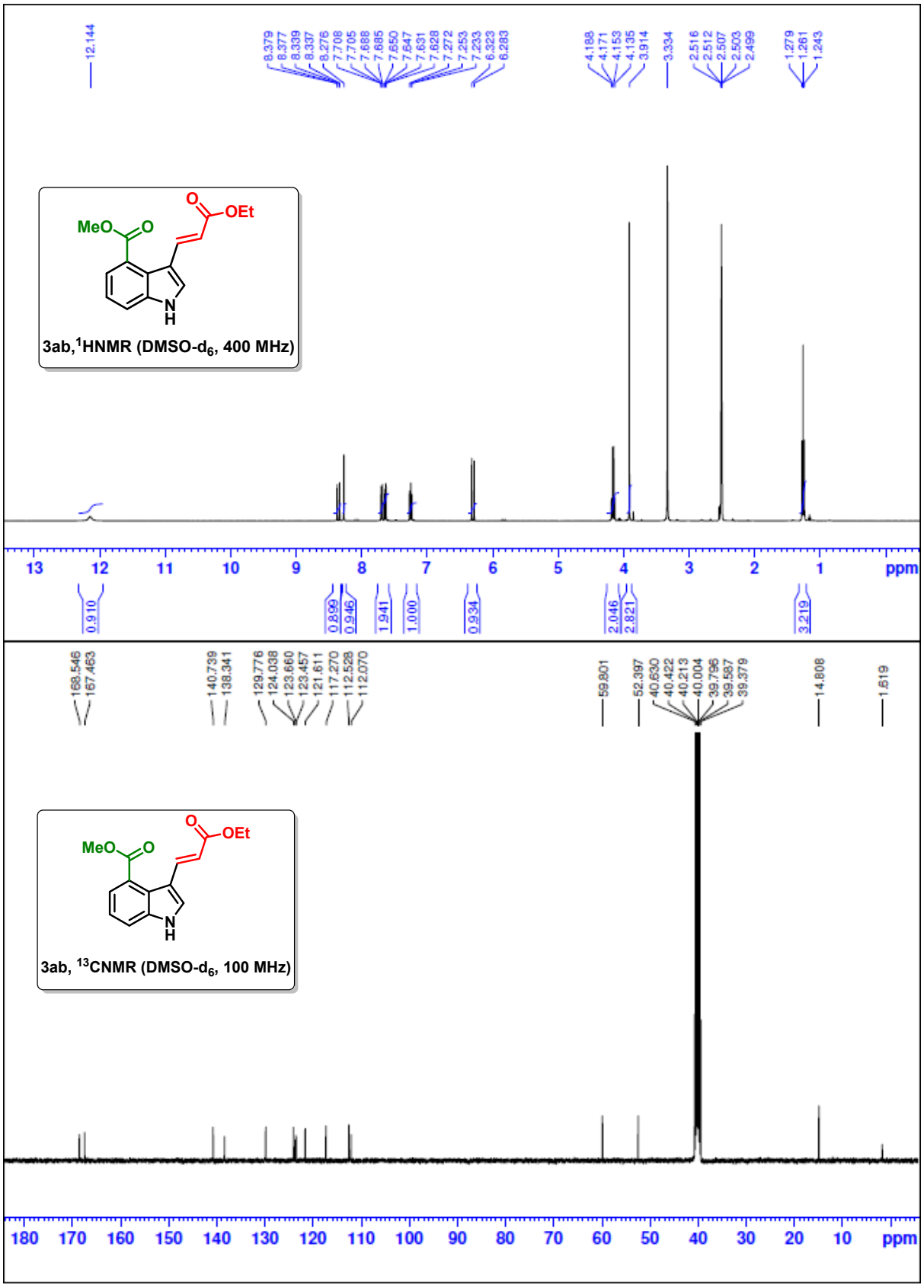


6b

Prepared as shown in general procedure to obtain the product as a white solid; Yield = 83% (65.5 mg); m.p.= 138-140; R_f = 0.4 (Ethyl Acetate/Hexane : 40/60); **^{1}H-NMR (400 MHz, DMSO-d_6):** δ 11.31 (s, 1H, NH), 7.59 (dd, J = 0.80, 8.00 Hz, 1H), 7.45 (dd, J = 1.20, 7.40 Hz, 1H), 7.35 (d, J = 2.40 Hz, 1H), 7.32-7.28 (m, 2H), 7.21-7.11 (m, 4H), 4.57 (d, J = 13.20 Hz, 1H), 3.94-3.88 (m, 4H), 3.06-3.02 (m, 3H), 2.71-2.50 (m, 4H), 1.73-1.64 (m, 2H), 1.35-1.30 (m, 2H) ppm; **^{13}C NMR (100 MHz, DMSO-d_6):** δ 170.6 (C=O), 169.0 (C=O), 146.1, 138.1, 128.8, 127.1, 126.7, 126.6, 124.1, 123.6, 121.6, 120.2, 116.1, 114.6, 52.2 (OCH_3), 46.0, 40.6, 34.2, 33.6, 33.3, 23 ppm; **IR (neat):** 3214 (N-H), 3028 (C-H), 2994 (C-H), 2939 (C-H), 2853 (C-H), 1712 (C=O, ester), 1604 (C=C), 1433 (C-H), 1347 (C-H), 1265 (C-O), 1194 (C-H), 1140 (C-H), 1049 (C-O), 1006 (C-H), 747 (C-H), 698 (C-H) cm^{-1}; **HRMS-ESI** (*m/z*)**:** Calculated for $C_{24}H_{27}N_2O_3$ $[M + H]^+$: 391.2022, found: 391.2013.

7. Copies of NMR spectra of products:

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7.631
7.628
7.272
7.253
7.233
6.323
6.283
4.188
4.171
4.153
4.135
3.914
3.334
2.516
2.512
2.507
2.503
2.499
1.279
1.261
1.243
MeO
O
O
OEt
N
H
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12
11
10
9
8
7
6
5
4
3
2
1
ppm
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0.946
1.941
1.000
0.934
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2.821
3.219
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167.463
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138.341
129.776
124.038
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123.457
121.611
117.270
112.528
112.070
59.801
52.397
40.630
40.422
40.213
40.004
39.796
39.587
39.379
14.808
1.619
MeO
O
O
OEt
N
H
3ab, [13]CNMR (DMSO-d6, 100 MHz)
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150
140
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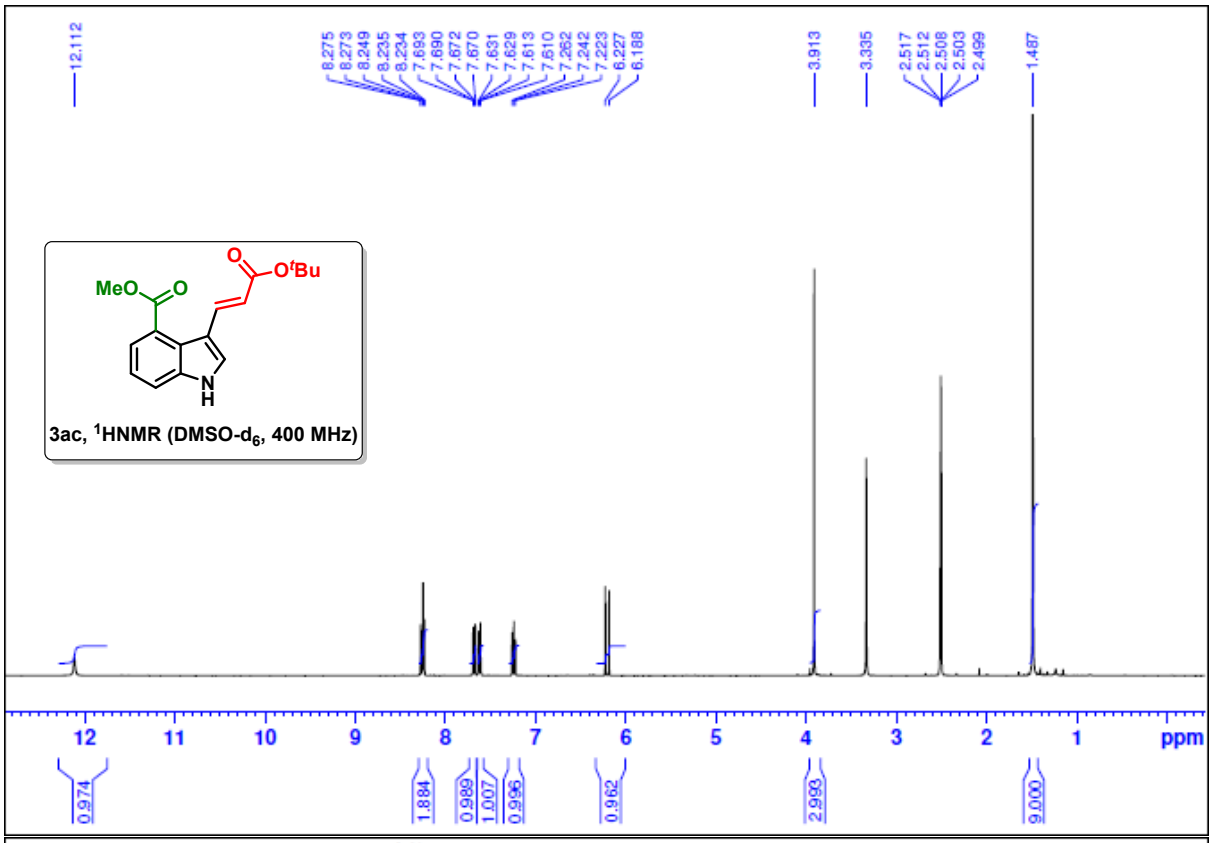
120
110
100
90
80
70
60
50
40
30
20
10
ppm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7.670
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7.610
7.262
7.242
7.223
6.227
6.188
3.913
3.335
2.517
2.512
2.508
2.503
2.499
1.487
MeO
O
O
O
tBu
N
H
3ac, 1HNMR (DMSO-d6, 400 MHz)
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11
10
9
8
7
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1
ppm
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0.962
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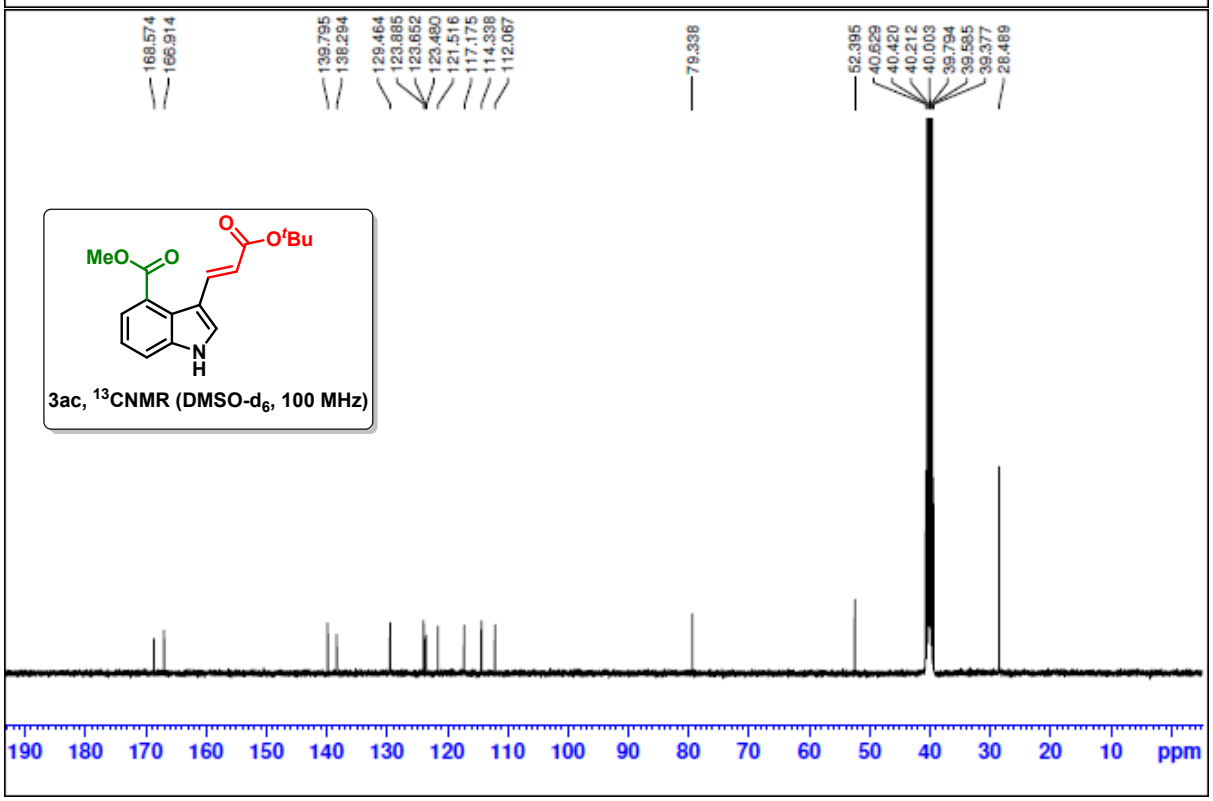
9.000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79.338
52.395
40.629
40.420
40.212
40.003
39.794
39.585
39.377
28.469
MeO
O
O
O
tBu
N
H
3ac, 13CNMR (DMSO-d6, 100 MHz)
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150
140
130
120
110
100
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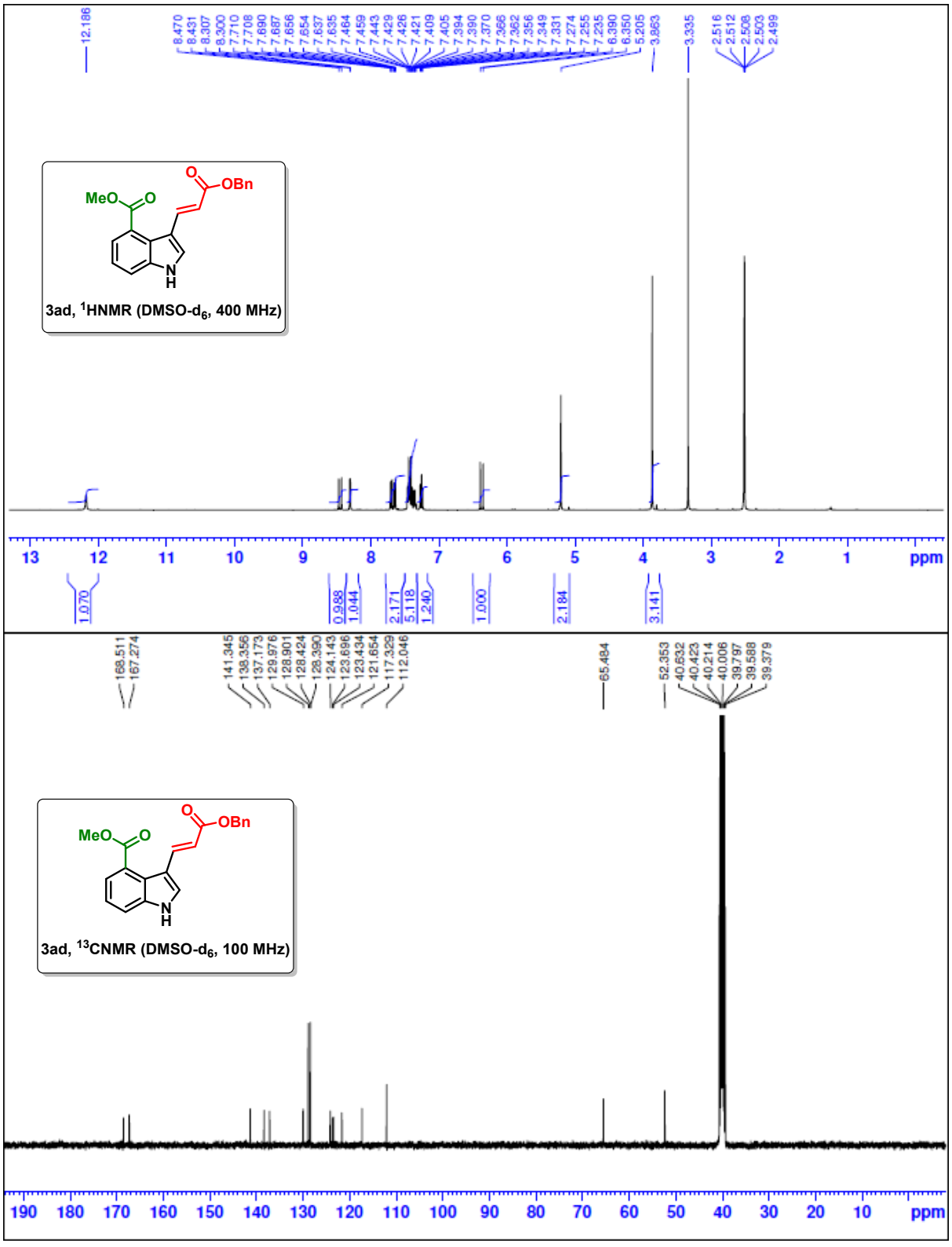
80
70
60
50
40
30
20
10
ppm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7.654
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7.464
7.459
7.443
7.429
7.426
7.421
7.409
7.405
7.394
7.390
7.370
7.366
7.362
7.356
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7.274
7.255
7.235
6.390
6.350
5.205
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3.335
2.516
2.512
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2.499
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O
O
OBn
N
H
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12
11
10
9
8
7
6
5
4
3
2
1
ppm
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1.044
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5.118
1.240
1.000
2.184
3.141
168.511
167.274
141.345
138.356
137.173
129.976
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124.143
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123.434
121.654
117.329
112.046
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52.353
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40.214
40.006
39.797
39.588
39.379
MeO
O
O
OBn
N
H
3ad, 13CNMR (DMSO-d6, 100 MHz)
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150
140
130
120
110
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70
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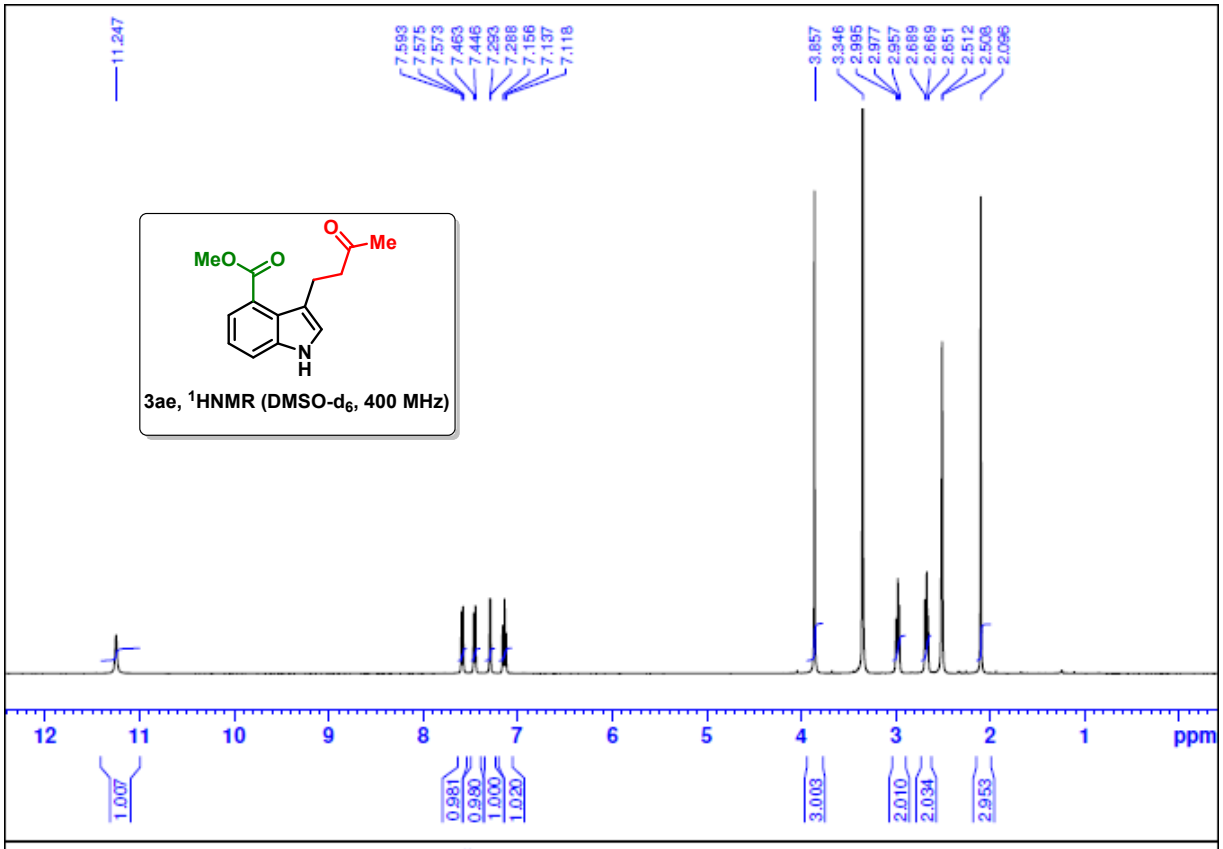
20
10
ppm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2.995
2.977
2.957
2.689
2.669
2.651
2.512
2.508
2.096
MeO
O
O
Me
N
H
3ae, 1HNMR (DMSO-d6, 400 MHz)
12
11
10
9
8
7
6
5
4
3
2
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ppm
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1.000
1.020
3.003
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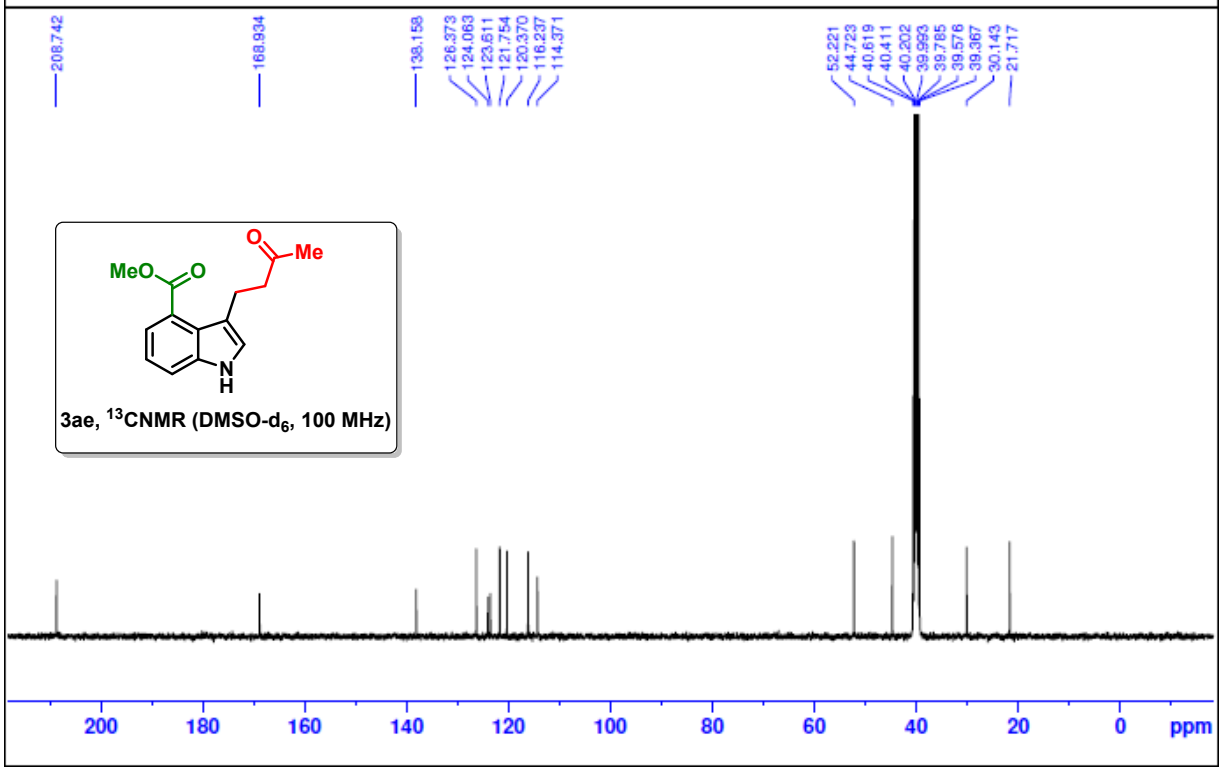
2.034
2.953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40.619
40.411
40.202
39.993
39.785
39.576
39.367
30.143
21.717
MeO
O
O
Me
N
H
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120
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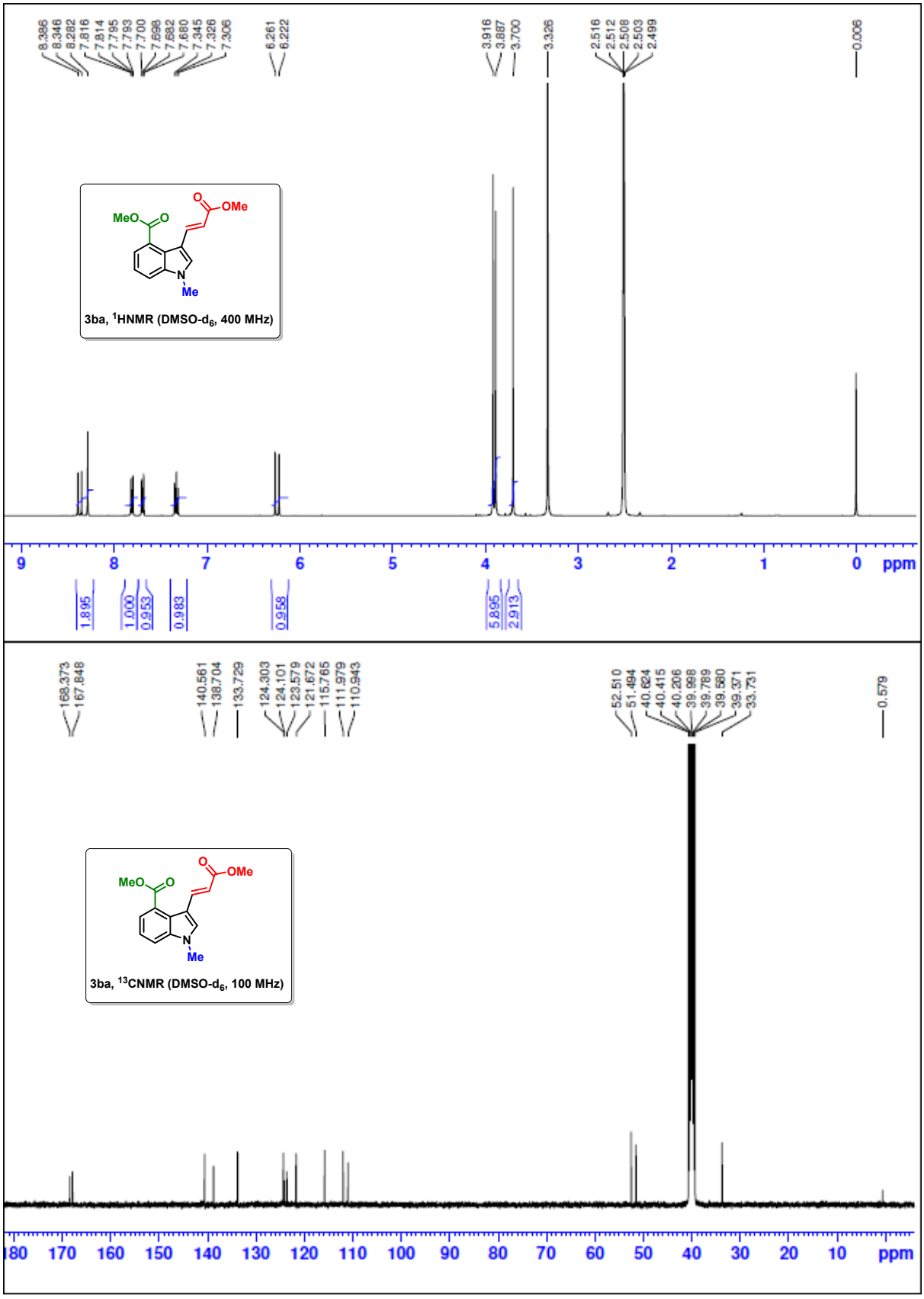
60
40
20
0
ppm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7.682
7.680
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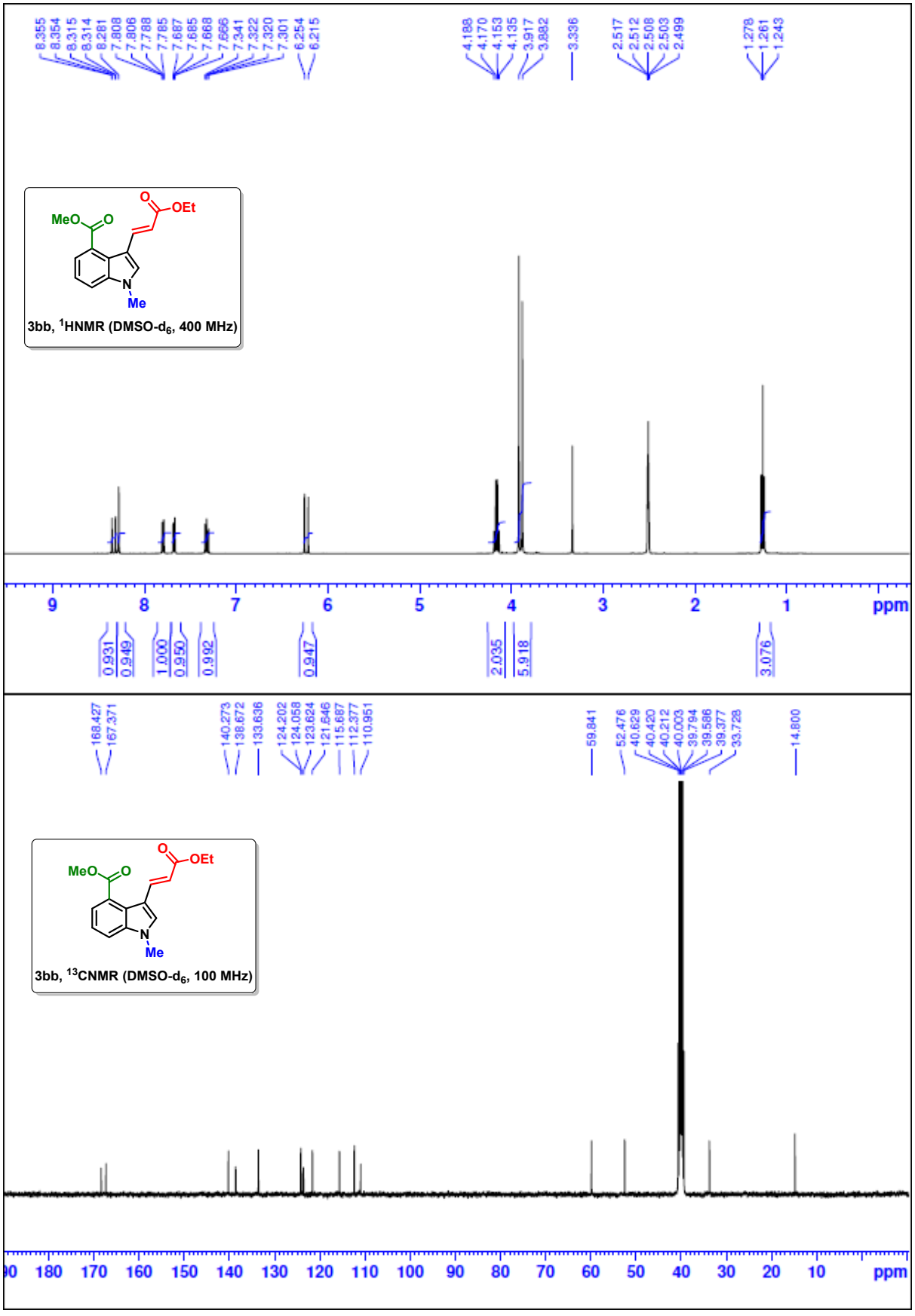
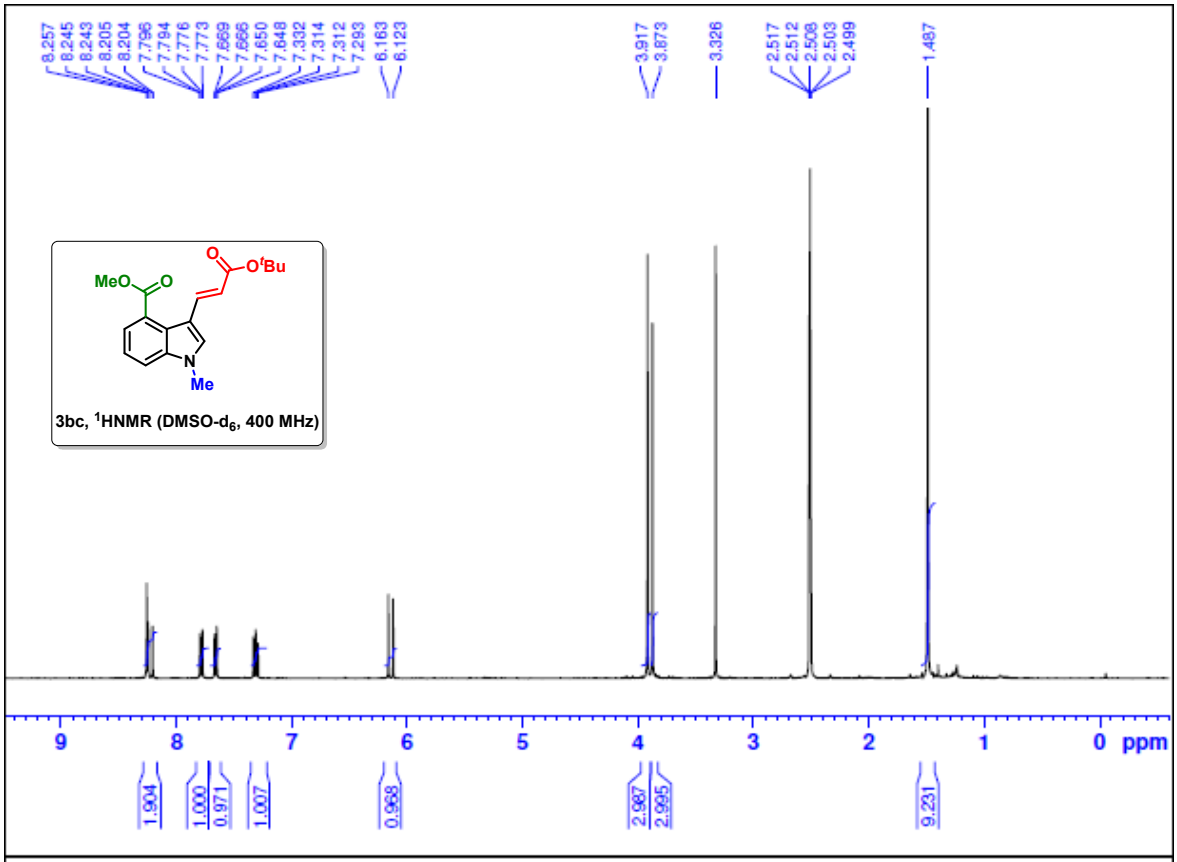
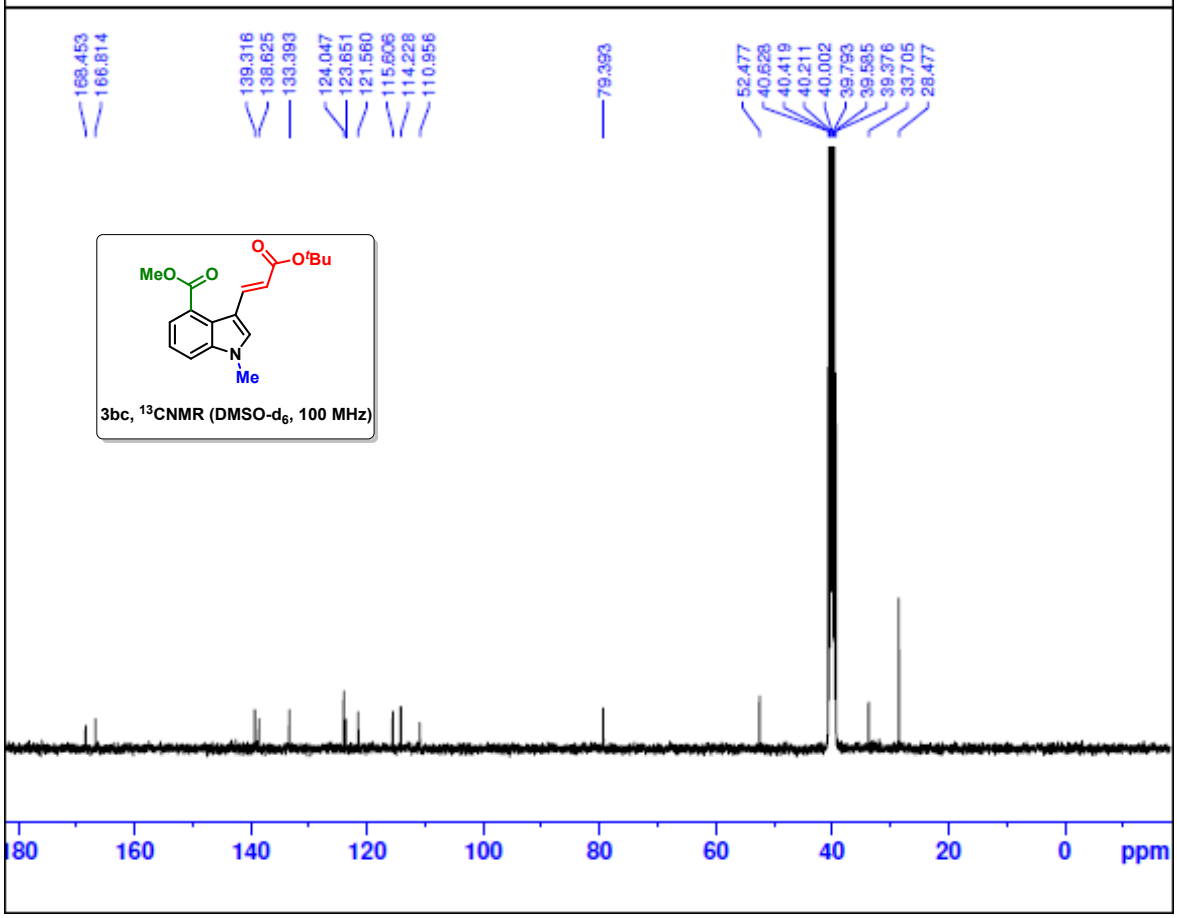
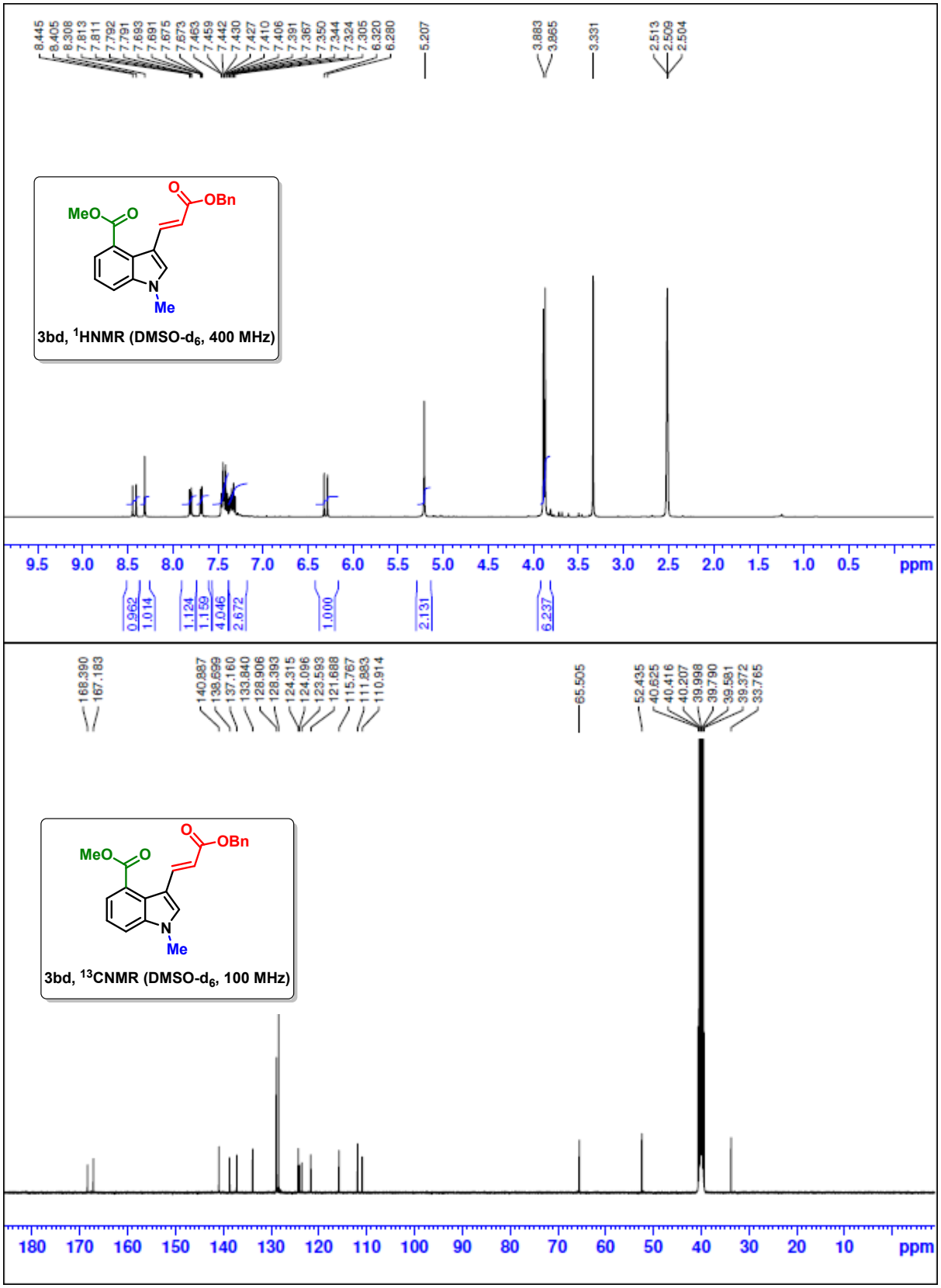
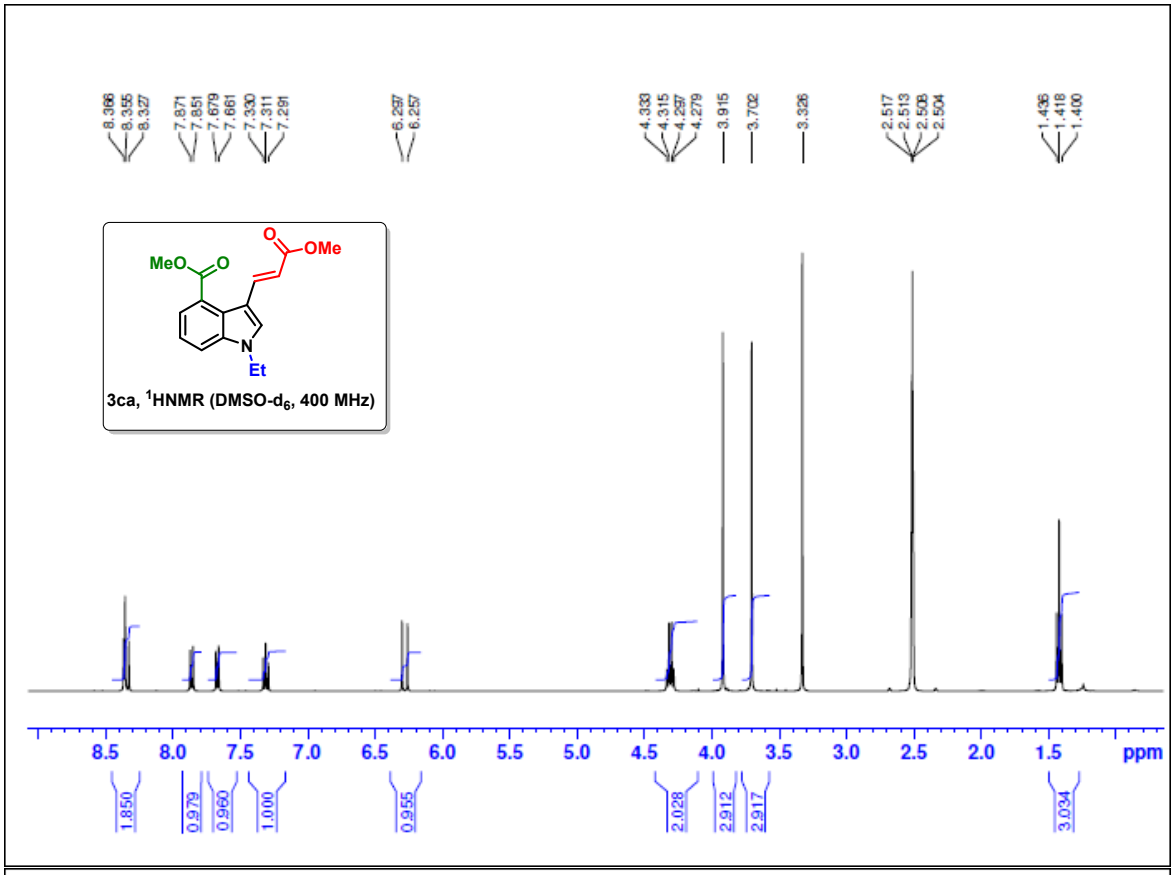
7.306
6.261
6.222
3.916
3.887
3.700
3.326
2.516
2.512
2.508
2.503
2.499
0.006
MeO
O
O
OMe
N
Me
3ba, 1HNMR (DMSO-d6, 400 MHz)
9
8
7
6
5
4
3
2
1
0
ppm
1.895
1.000
0.953
0.983
0.958
5.895
2.913
168.373
167.848
140.561
138.704
133.729
124.303
124.101
123.579
121.672
115.765
111.979
110.943
52.510
51.494
40.624
40.415
40.206
39.998
39.789
39.580
39.371
33.731
0.579
MeO
O
O
OMe
N
Me
3ba, 13CNMR (DMSO-d6, 100 MHz)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

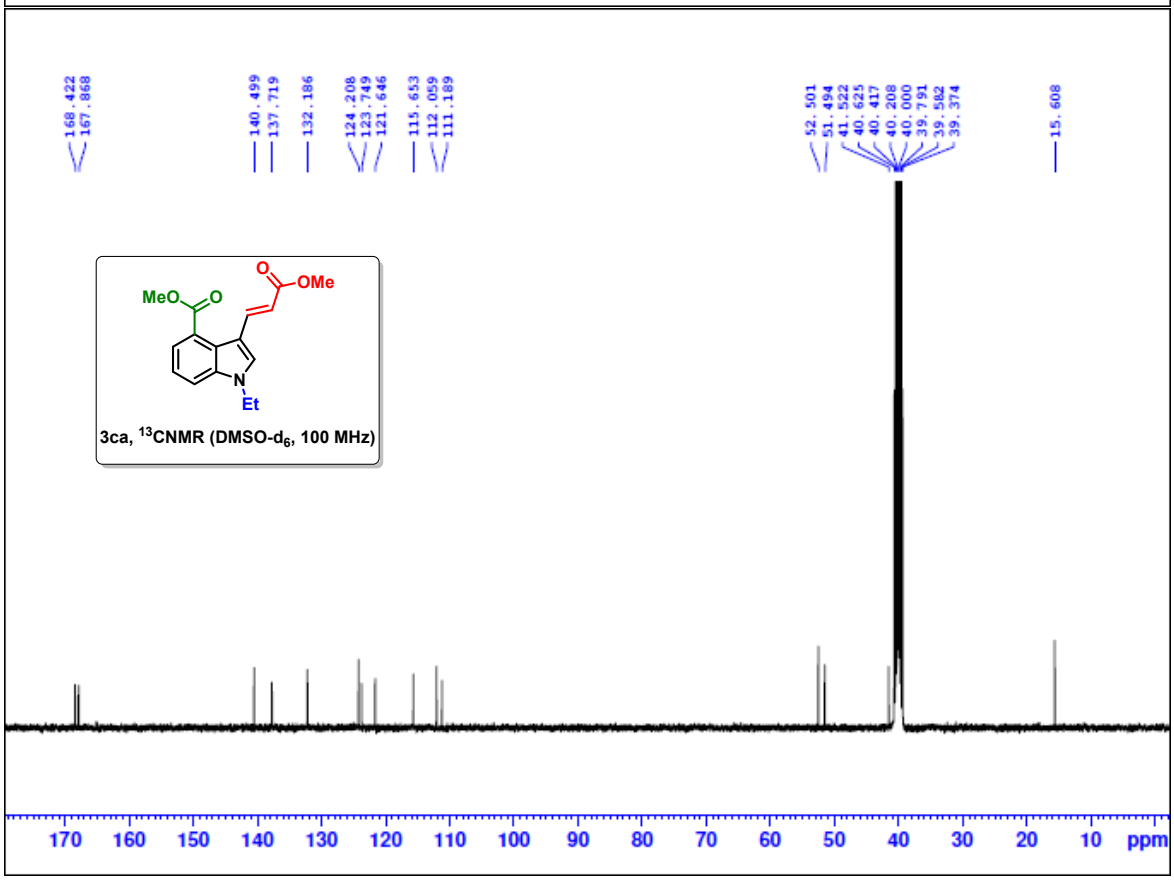

8.355
8.354
8.315
8.314
8.281
7.808
7.806
7.788
7.785
7.687
7.685
7.668
7.666
7.341
7.322
7.320
7.301
6.254
6.215
4.188
4.170
4.153
4.135
3.917
3.882
3.336
2.517
2.512
2.508
2.503
2.499
1.278
1.261
1.243
MeO
O
O
OEt
N
Me
3bb, 1HNMR (DMSO-d6, 400 MHz)
9
8
7
6
5
4
3
2
1
ppm
0.931
0.949
1.000
0.950
0.992
0.947
2.035
5.918
3.076
168.427
167.371
140.273
138.672
133.636
124.202
124.058
123.624
121.646
115.687
112.377
110.951
59.841
52.476
40.629
40.420
40.212
40.003
39.794
39.586
39.377
33.728
14.800
MeO
O
O
OEt
N
Me
3bb, 13CNMR (DMSO-d6, 100 MHz)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

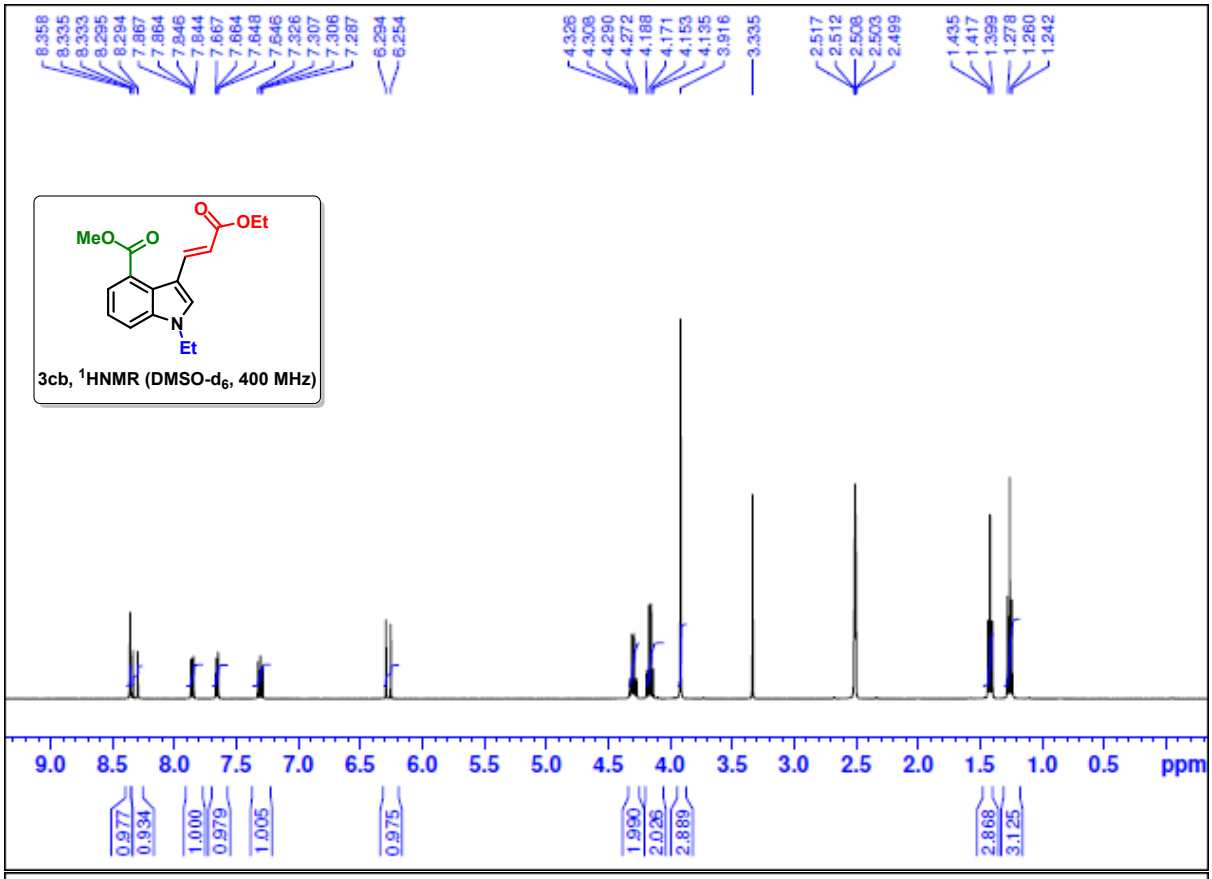

8.257
8.245
8.243
8.205
8.204
7.796
7.794
7.776
7.773
7.669
7.666
7.650
7.648
7.332
7.314
7.312
7.293
6.163
6.123
3.917
3.873
3.326
2.517
2.512
2.508
2.503
2.499
1.487
MeO
O
O
O'Bu
N
Me
3bc, 1HNMR (DMSO-d6, 400 MHz)
9
8
7
6
5
4
3
2
1
0
ppm
1.904
1.000
0.971
1.007
0.968
2.987
2.995
9.231

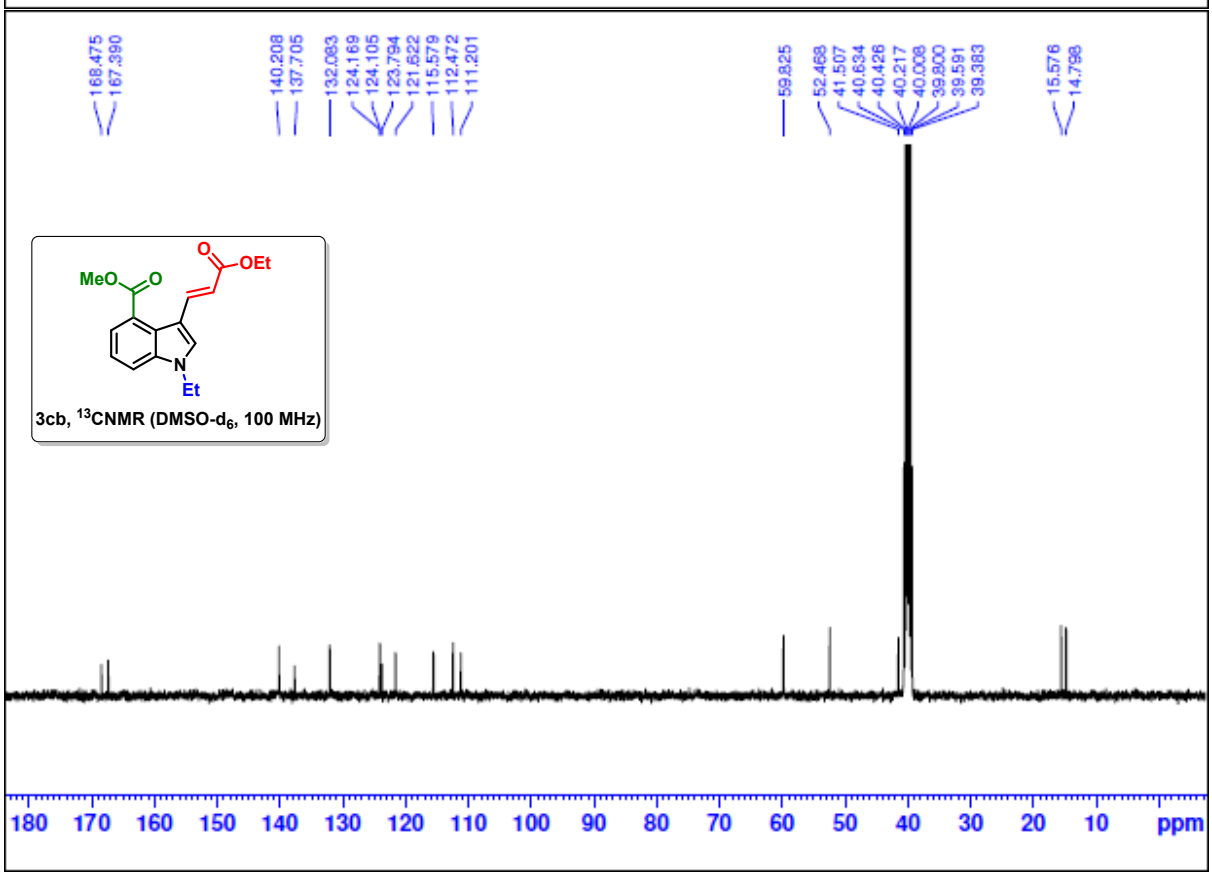

168.453
166.814
139.316
138.625
133.393
124.047
123.651
121.560
115.606
114.228
110.956
79.393
52.477
40.628
40.419
40.211
40.002
39.793
39.585
39.376
33.705
28.477
MeO
O
O
O'Bu
N
Me
3bc, 13CNMR (DMSO-d6, 100 MHz)
180
160
140
120
100
80
60
40
20
0
ppm

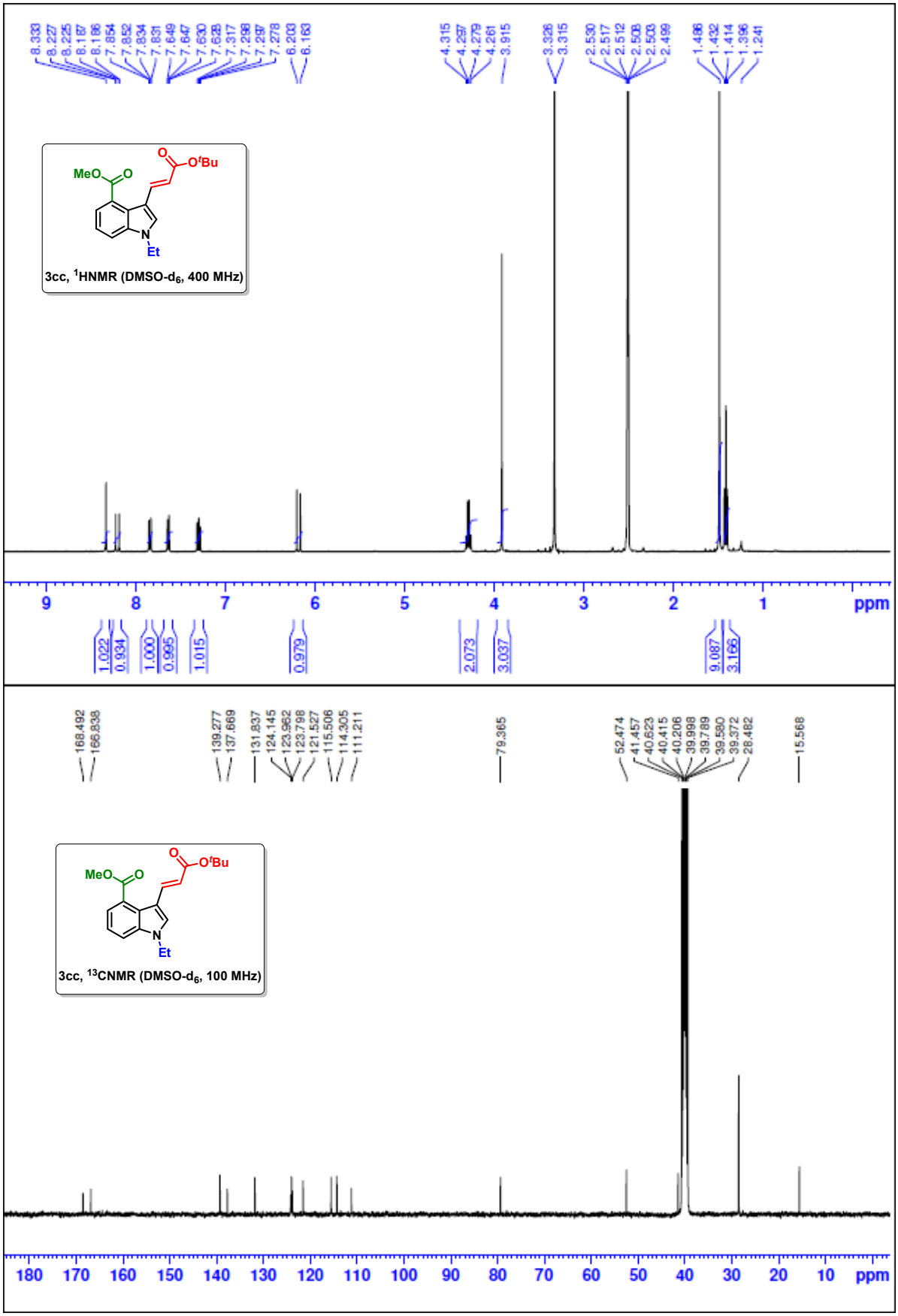

8.445
8.405
8.308
7.813
7.811
7.792
7.791
7.693
7.691
7.675
7.573
7.463
7.459
7.442
7.430
7.427
7.410
7.406
7.391
7.367
7.350
7.344
7.324
7.305
6.320
6.280
5.207
3.883
3.865
3.331
2.513
2.509
2.504
MeO
O
O
OBn
N
Me
3bd, 1HNMR (DMSO-d6, 400 MHz)
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
0.962
1.014
1.124
1.159
4.046
2.672
1.000
2.131
6.237
168.390
167.183
140.887
138.699
137.160
133.840
128.906
128.393
124.315
124.096
123.583
121.688
115.767
111.883
110.914
65.505
52.435
40.625
40.416
40.207
39.998
39.790
39.581
39.372
33.765
MeO
O
O
OBn
N
Me
3bd, 13CNMR (DMSO-d6, 100 MHz)
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

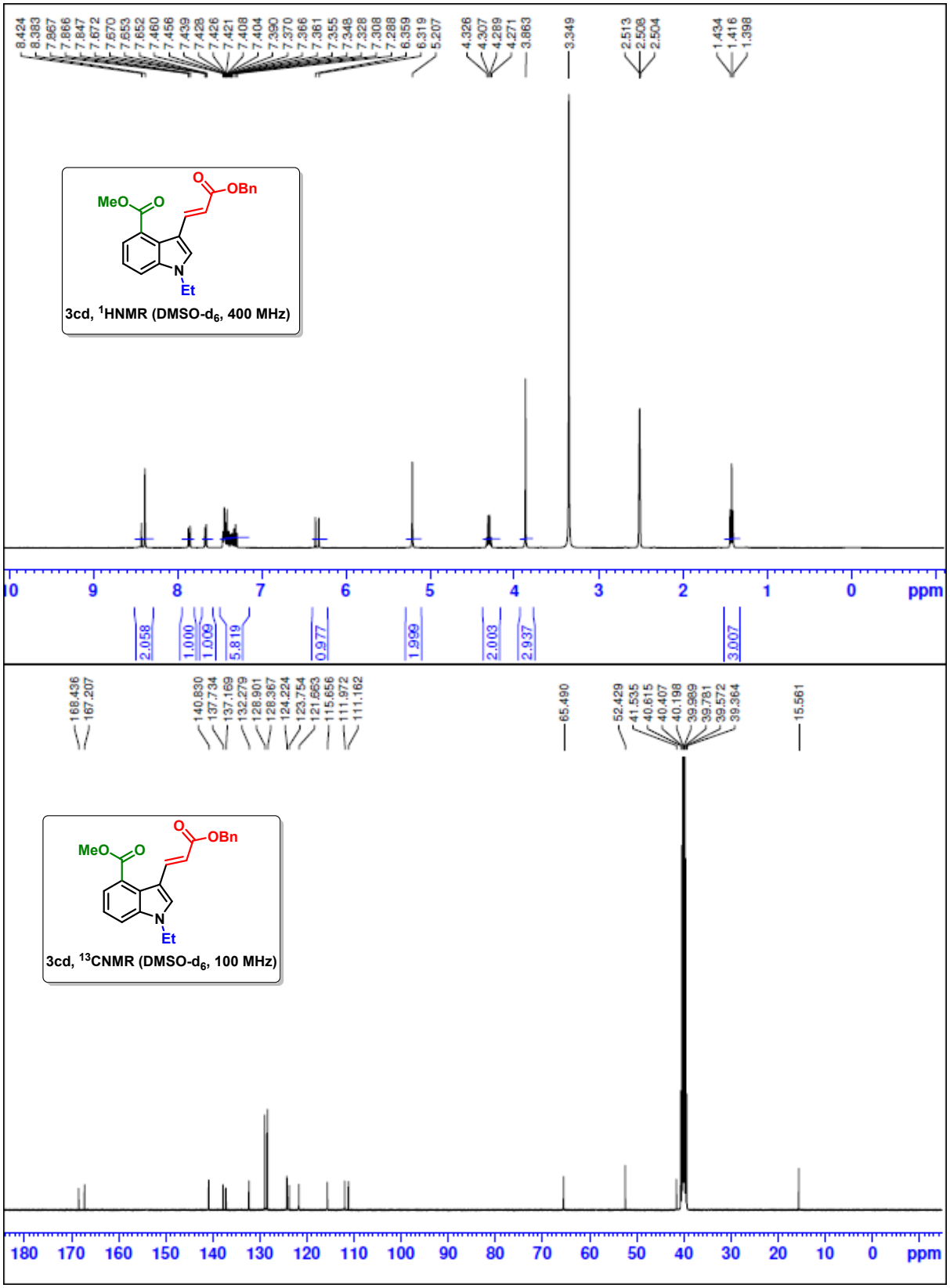

8.366
8.355
8.327
7.871
7.851
7.679
7.661
7.330
7.311
7.291
6.297
6.257
4.333
4.315
4.297
4.279
3.915
3.702
3.326
2.517
2.513
2.508
2.504
1.436
1.418
1.400
MeO
O
O
OMe
N
Et
3ca, ^{1}HNMR (DMSO-d$_6$, 400 MHz)
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
ppm
1.850
0.979
0.960
1.000
0.955
2.028
2.912
2.917
3.034

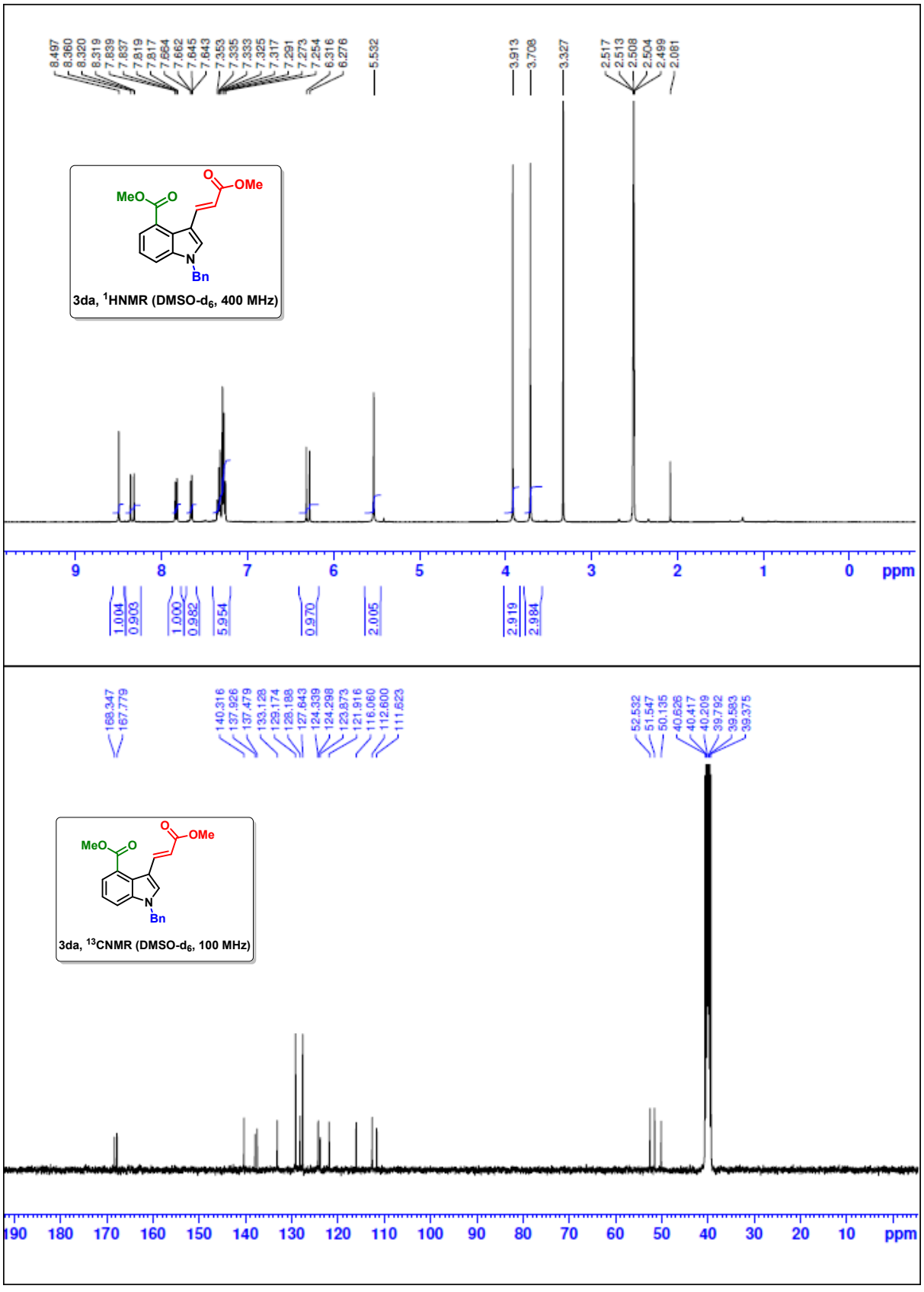

168.422
167.868
140.499
137.719
132.186
124.208
123.749
121.646
115.653
112.059
111.189
52.501
51.494
41.522
40.625
40.417
40.208
40.000
39.791
39.582
39.374
15.608
MeO
O
O
OMe
N
Et
3ca, ^{13}CNMR (DMSO-d$_6$, 100 MHz)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

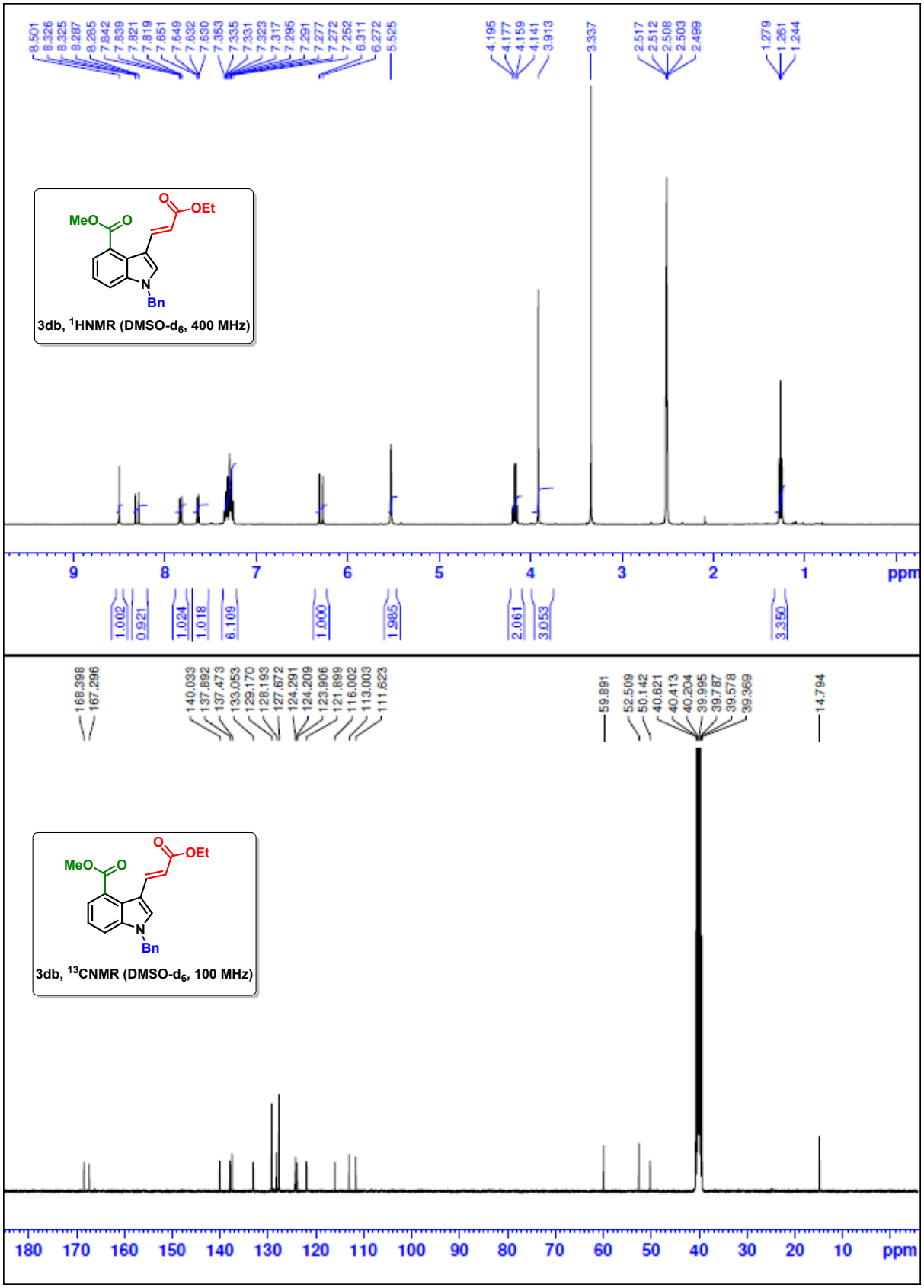

8.358
8.335
8.333
8.295
8.294
7.867
7.864
7.846
7.844
7.667
7.664
7.648
7.646
7.326
7.307
7.306
7.287
6.294
6.254
4.326
4.308
4.290
4.272
4.188
4.171
4.153
4.135
3.916
3.335
2.517
2.512
2.508
2.503
2.499
1.435
1.417
1.399
1.278
1.260
1.242
MeO
O
O
OEt
N
Et
3cb, ^{1}HNMR (DMSO-d$_6$, 400 MHz)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
0.977
0.934
1.000
0.979
1.005
0.975
1.990
2.025
2.889
2.868
3.125

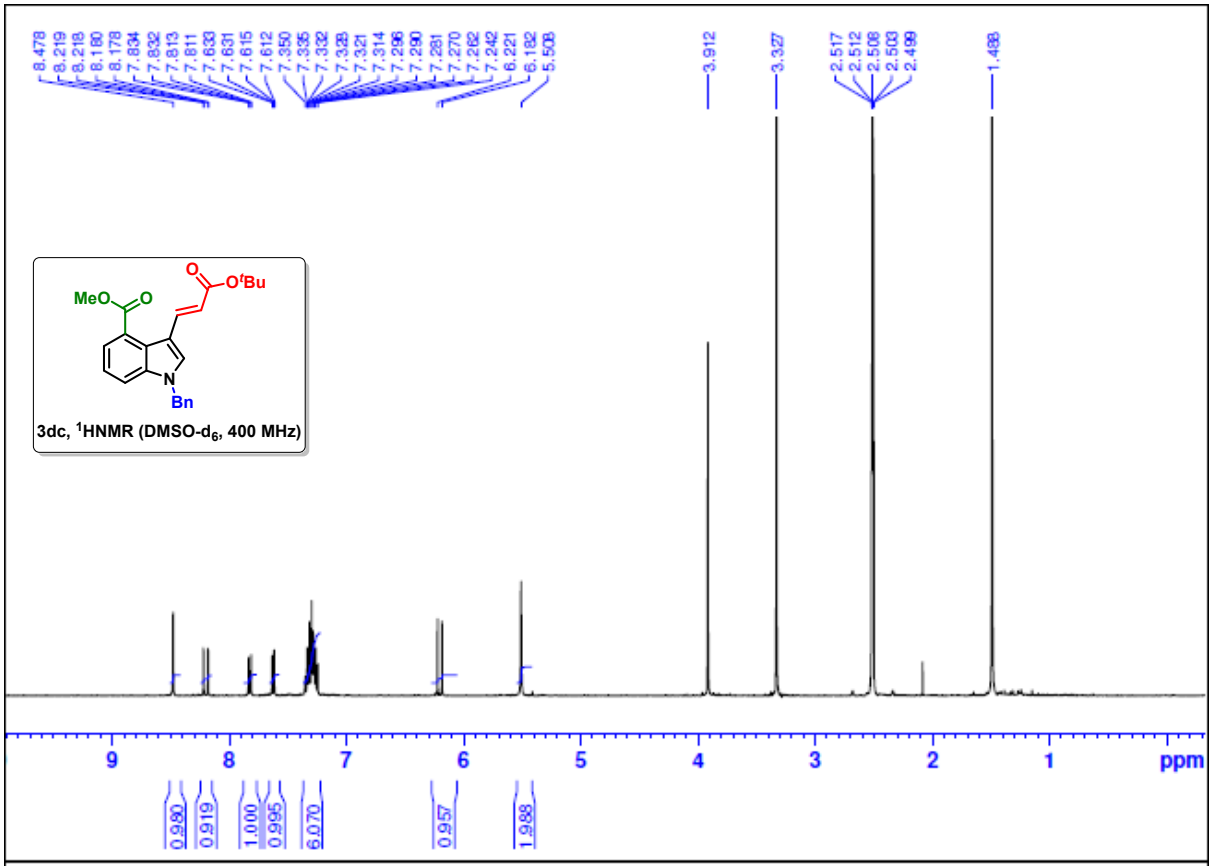

168.475
167.390
140.208
137.705
132.083
124.169
124.105
123.794
121.622
115.579
112.472
111.201
59.825
52.468
41.507
40.634
40.426
40.217
40.008
39.800
39.591
39.383
15.576
14.798
MeO
O
O
OEt
N
Et
3cb, ^{13}CNMR (DMSO-d$_6$, 100 MHz)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

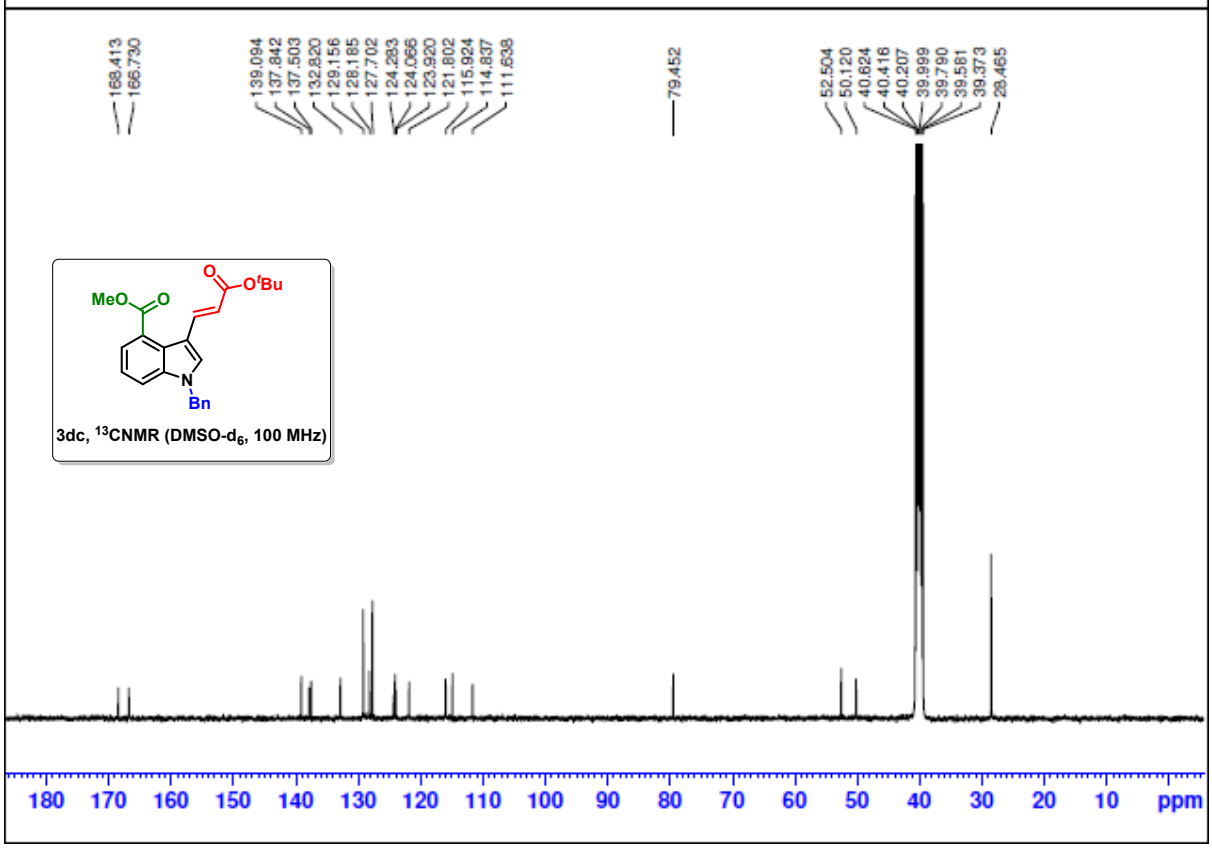

8.333
8.227
8.225
8.187
8.186
7.854
7.852
7.834
7.831
7.649
7.647
7.630
7.628
7.317
7.298
7.297
7.278
6.203
6.163
4.315
4.297
4.279
4.261
3.915
3.326
3.315
2.530
2.517
2.512
2.508
2.503
2.499
1.486
1.432
1.414
1.396
1.241
MeO
O
O
O'Bu
N
Et
3cc, 1HNMR (DMSO-d6, 400 MHz)
9
8
7
6
5
4
3
2
1
ppm
1.022
0.934
1.000
0.995
1.015
0.979
2.073
3.037
9.087
3.166
168.492
166.838
139.277
137.669
131.837
124.145
123.962
123.798
121.527
115.506
114.305
111.211
79.365
52.474
41.457
40.623
40.415
40.206
39.998
39.789
39.580
39.372
28.462
15.568
MeO
O
O
O'Bu
N
Et
3cc, 13CNMR (DMSO-d6, 100 MHz)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

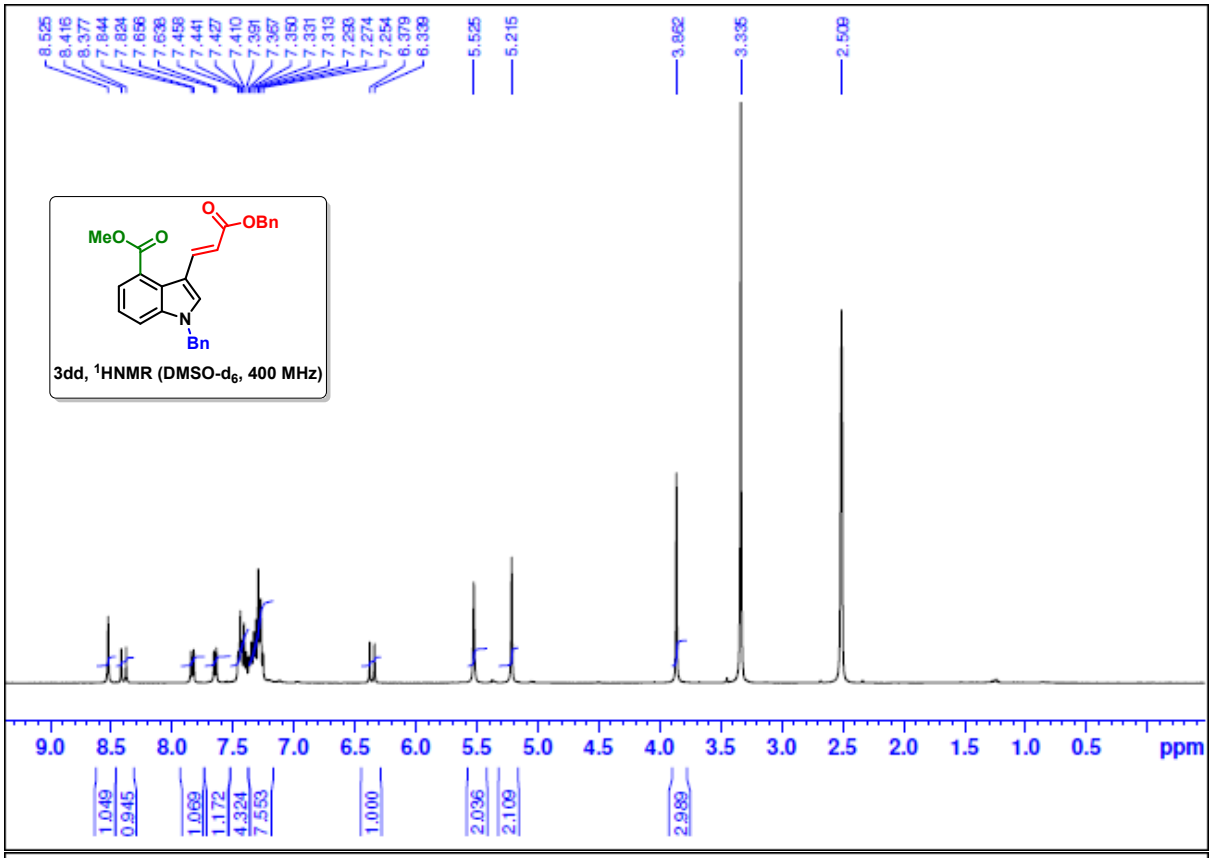

8.424
8.383
7.867
7.866
7.647
7.672
7.670
7.653
7.652
7.460
7.456
7.439
7.428
7.426
7.421
7.408
7.404
7.390
7.370
7.366
7.361
7.355
7.348
7.328
7.308
7.288
6.359
6.319
5.207
4.326
4.307
4.289
4.271
3.863
3.349
2.513
2.508
2.504
1.434
1.416
1.398
MeO
O
O
OBn
N
Et
3cd, 1HNMR (DMSO-d6, 400 MHz)
10
9
8
7
6
5
4
3
2
1
0
ppm
2.058
1.000
1.009
5.819
0.977
1.999
2.003
2.937
3.007
168.436
167.207
140.830
137.734
137.169
132.279
128.901
128.367
124.224
123.754
121.663
115.656
111.972
111.162
65.490
52.429
41.535
40.615
40.407
40.198
39.989
39.781
39.572
39.364
15.561
MeO
O
O
OBn
N
Et
3cd, 13CNMR (DMSO-d6, 100 MHz)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

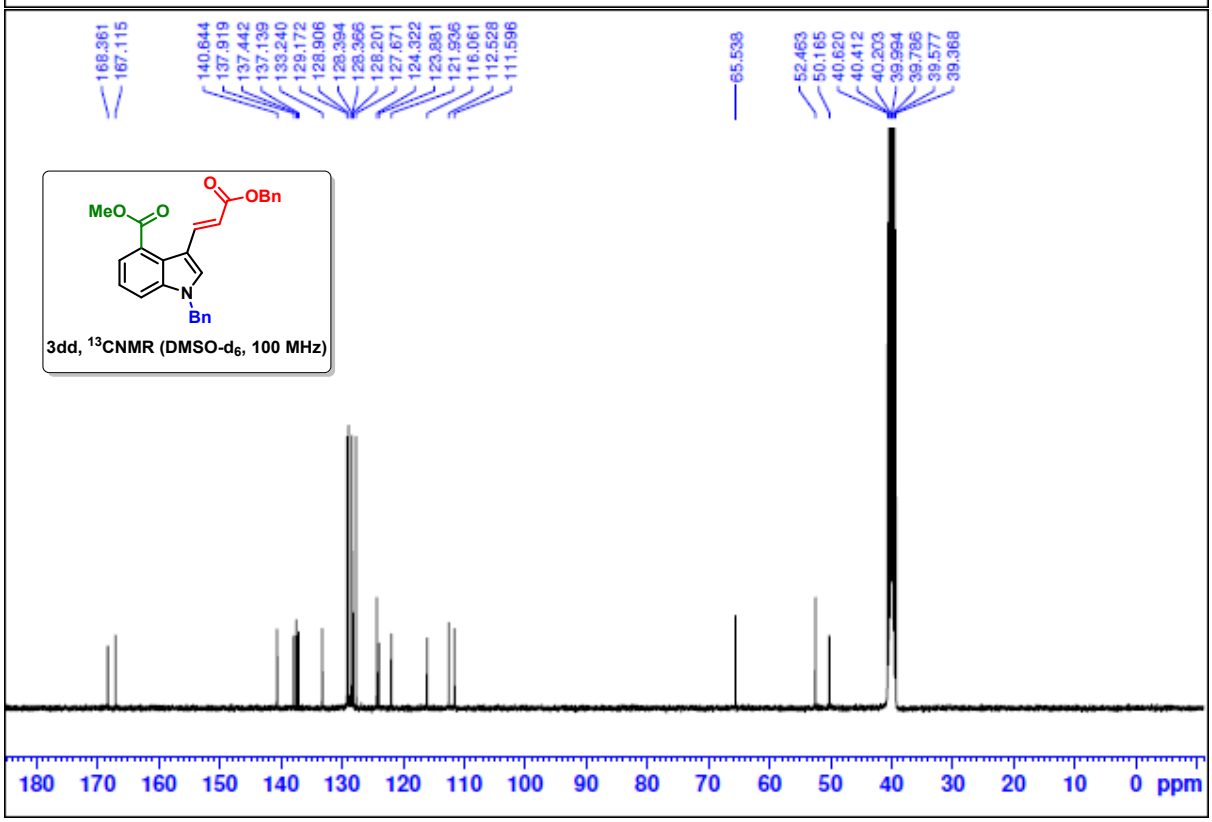

8.497
8.360
8.320
8.319
7.839
7.837
7.819
7.817
7.664
7.662
7.645
7.643
7.353
7.335
7.333
7.325
7.317
7.291
7.273
7.254
6.316
6.276
5.532
3.913
3.708
3.327
2.517
2.513
2.508
2.504
2.499
2.081
MeO
O
O
OMe
N
Bn
3da, 1HNMR (DMSO-d6, 400 MHz)
9
8
7
6
5
4
3
2
1
0
ppm
1.004
0.903
1.000
0.982
5.954
0.970
2.005
2.919
2.984
168.347
167.779
140.316
137.926
137.479
133.128
129.174
128.188
127.643
124.339
124.298
123.873
121.916
116.060
112.600
111.623
52.532
51.547
50.135
40.626
40.417
40.209
39.792
39.583
39.375
MeO
O
O
OMe
N
Bn
3da, 13CNMR (DMSO-d6, 100 MHz)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

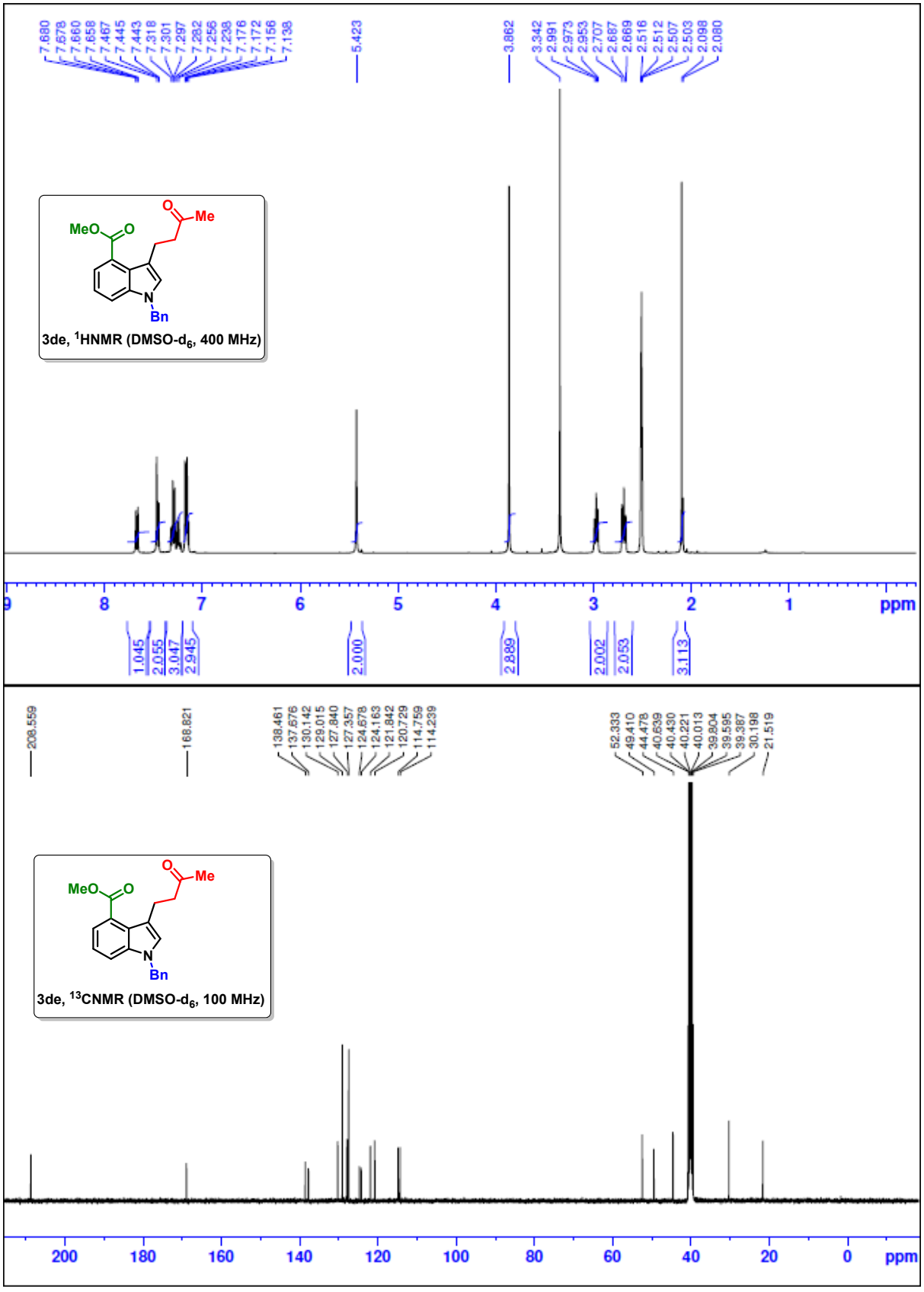

8.501
8.326
8.325
8.287
8.285
7.842
7.839
7.821
7.819
7.651
7.649
7.632
7.630
7.353
7.335
7.331
7.323
7.317
7.295
7.291
7.277
7.272
7.252
6.311
6.272
5.525
4.195
4.177
4.159
4.141
3.913
3.337
2.517
2.512
2.508
2.503
2.499
1.279
1.261
1.244
MeO
O
O
OEt
N
Bn
3db, ^{1}HNMR (DMSO-d$_6$, 400 MHz)
9
8
7
6
5
4
3
2
1
ppm
1.002
0.921
1.024
1.018
6.109
1.000
1.985
2.061
3.053
3.350
168.398
167.296
140.033
137.892
137.473
133.053
129.170
128.193
127.672
124.291
124.209
123.906
121.899
116.002
113.003
111.823
59.891
52.509
50.142
40.621
40.413
40.204
39.995
39.787
39.578
39.369
14.794
MeO
O
O
OEt
N
Bn
3db, ^{13}CNMR (DMSO-d$_6$, 100 MHz)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

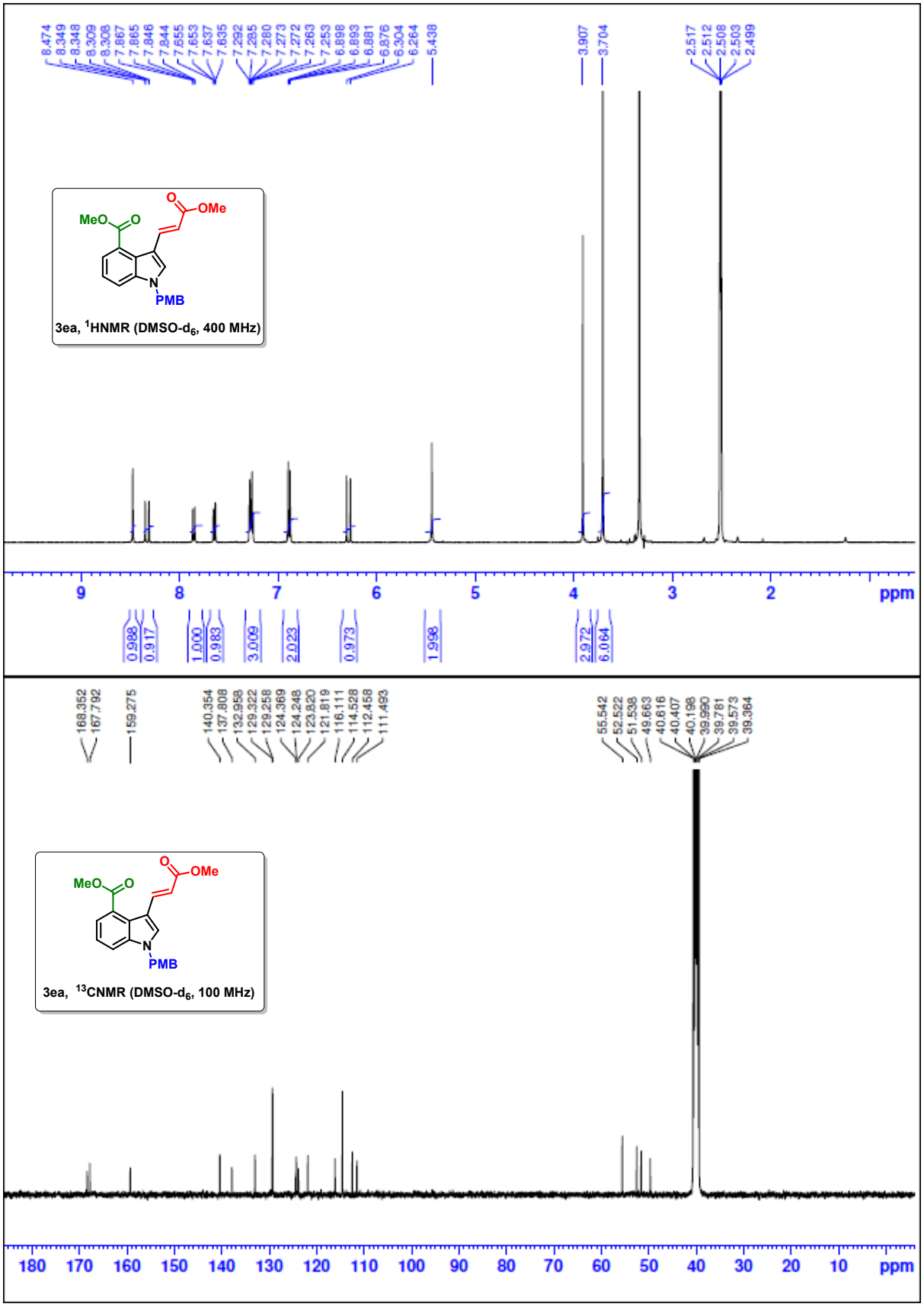

8.478
8.219
8.218
8.180
8.178
7.834
7.832
7.813
7.811
7.633
7.631
7.615
7.612
7.350
7.335
7.332
7.328
7.321
7.314
7.296
7.290
7.281
7.270
7.262
7.242
6.221
6.192
5.508
3.912
3.327
2.517
2.512
2.506
2.503
2.499
1.488
MeO
O
O
O'Bu
N
Bn
3dc, 1HNMR (DMSO-d6, 400 MHz)
9
8
7
6
5
4
3
2
1
ppm
0.990
0.919
1.000
0.995
6.070
0.957
1.988

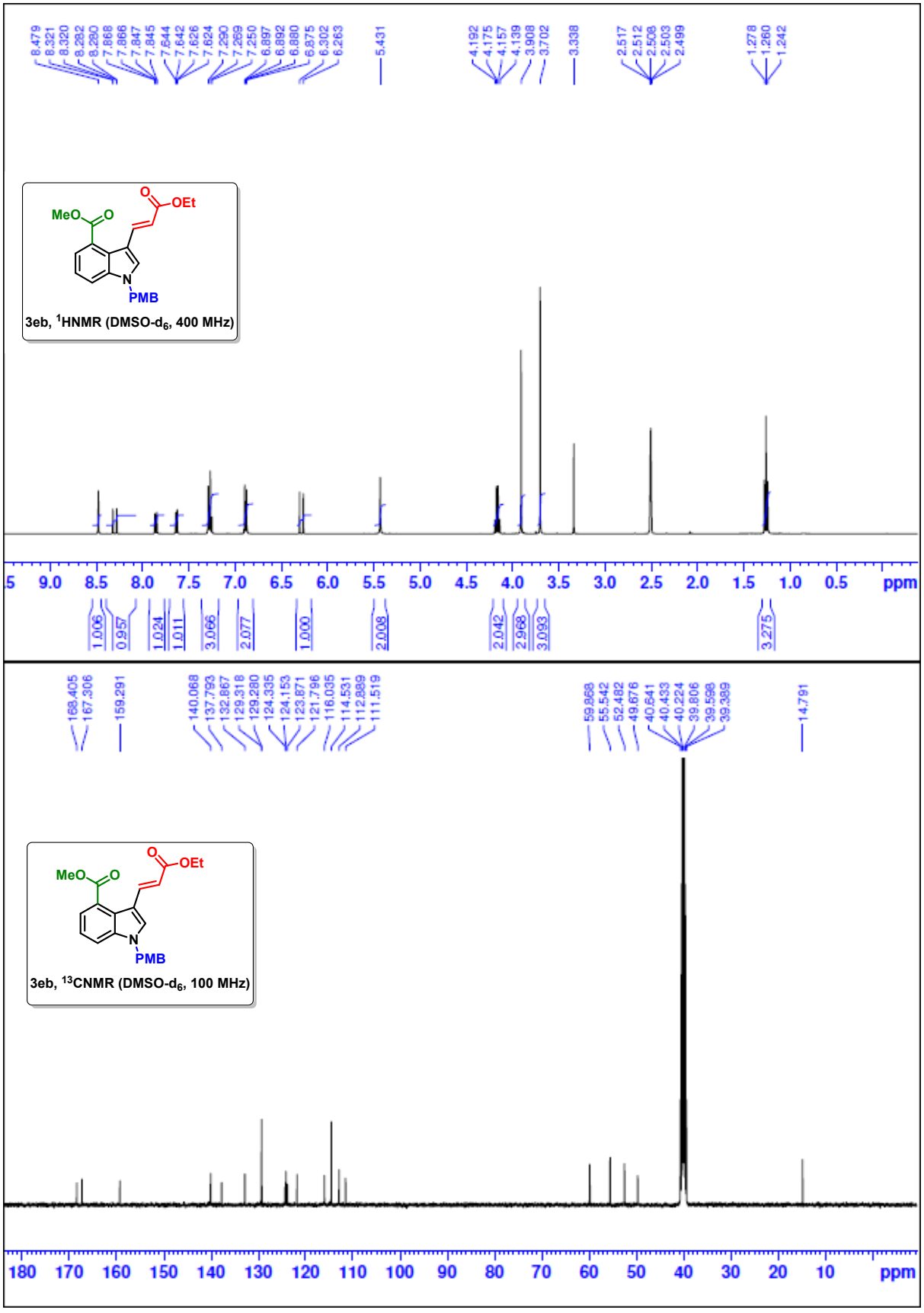

168.413
166.730
139.094
137.842
137.503
132.820
129.156
128.185
127.702
124.283
124.066
123.920
121.802
115.924
114.837
111.638
79.452
52.504
50.120
40.624
40.416
40.207
39.999
39.790
39.581
39.373
28.465
MeO
O
O
O'Bu
N
Bn
3dc, 13CNMR (DMSO-d6, 100 MHz)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

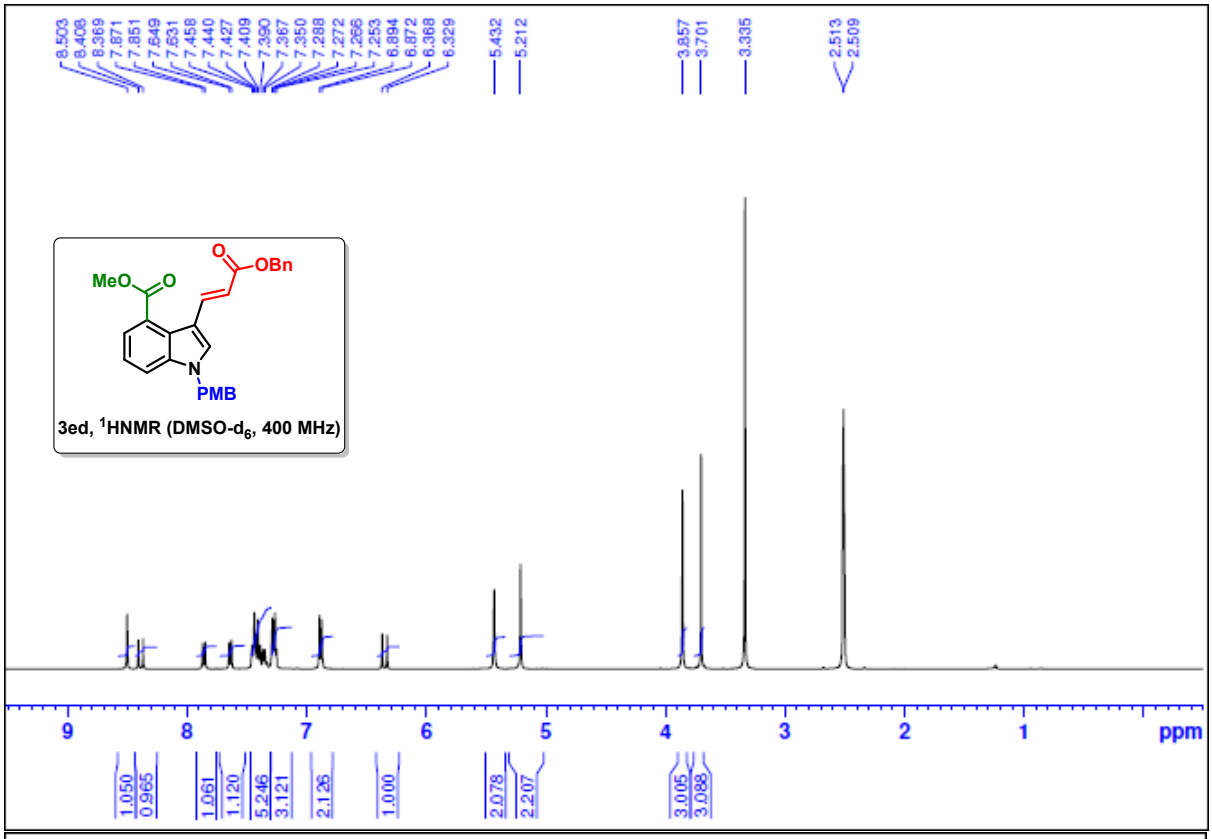

8.525
8.416
8.377
7.844
7.824
7.656
7.639
7.458
7.441
7.427
7.410
7.391
7.367
7.350
7.331
7.313
7.293
7.274
7.254
6.379
6.339
5.525
5.215
3.862
3.335
2.509
MeO
O
O
OBn
N
Bn
3dd, 1HNMR (DMSO-d6, 400 MHz)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.049
0.945
1.069
1.172
4.324
7.553
1.000
2.036
2.109
2.989

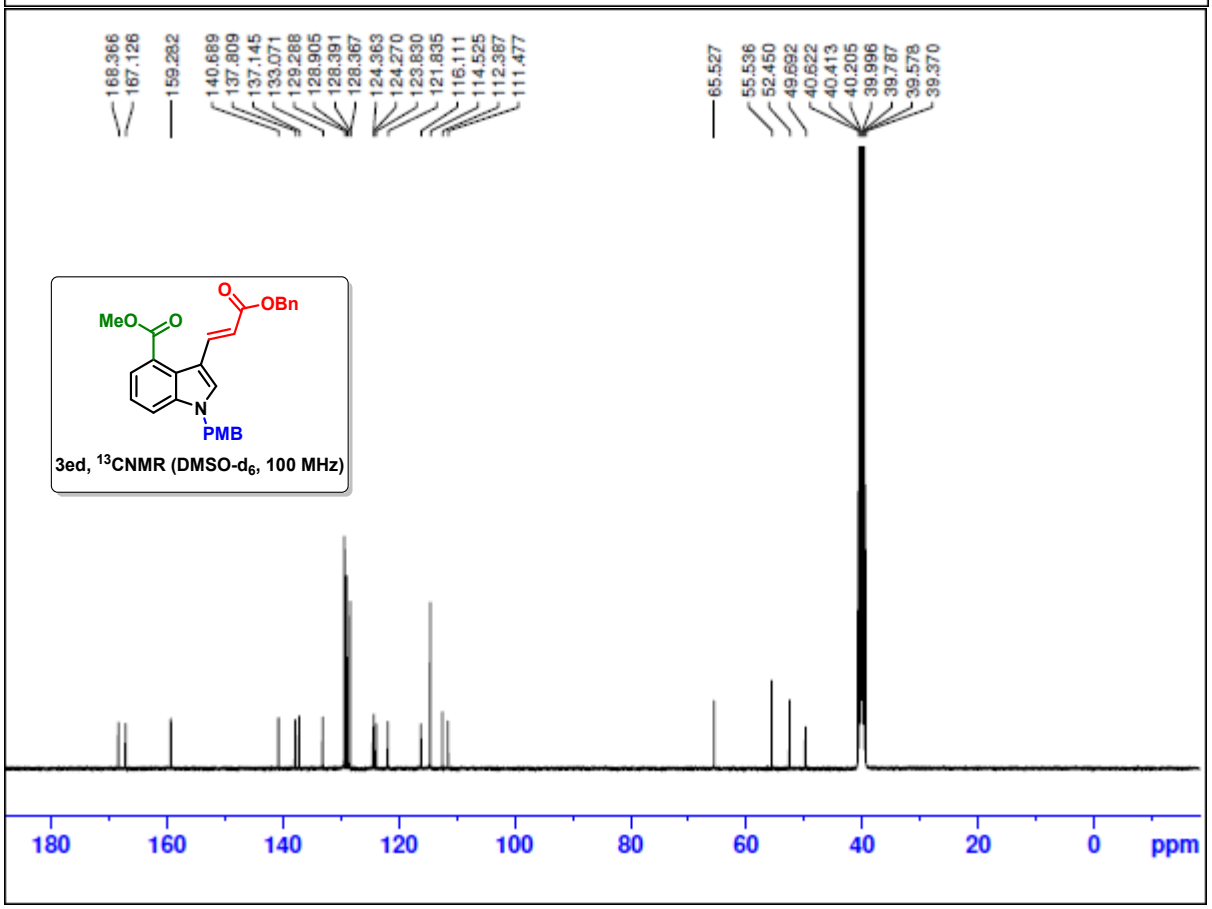

168.361
167.115
140.644
137.919
137.442
137.139
133.240
129.172
128.906
128.394
128.366
128.201
127.671
124.322
123.881
121.936
116.061
112.528
111.596
65.538
52.463
50.165
40.620
40.412
40.203
39.994
39.786
39.577
39.368
MeO
O
O
OBn
N
Bn
3dd, 13CNMR (DMSO-d6, 100 MHz)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

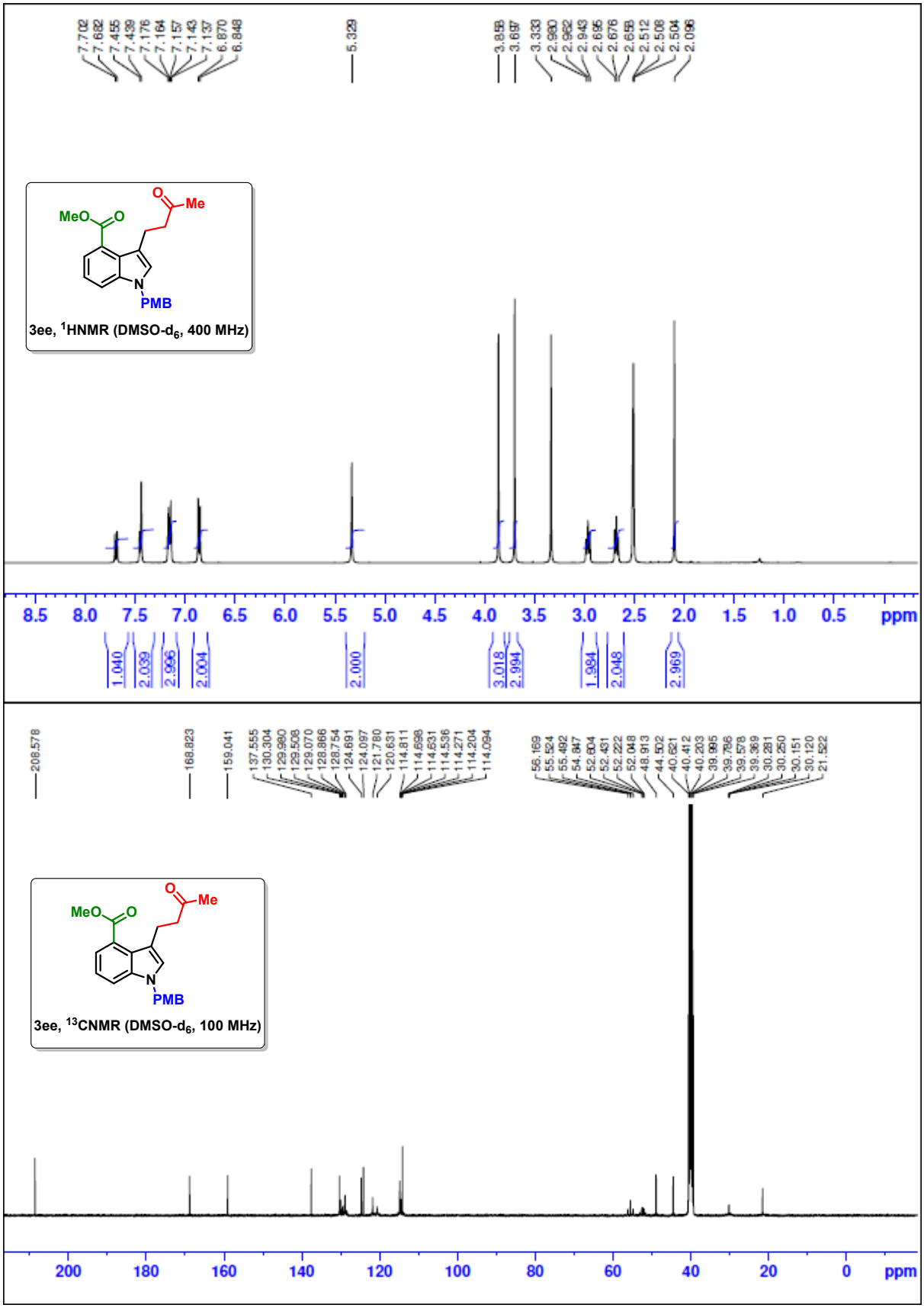

7.680
7.678
7.660
7.658
7.467
7.445
7.443
7.318
7.301
7.297
7.282
7.256
7.238
7.176
7.172
7.156
7.138
5.423
3.862
3.342
2.991
2.973
2.953
2.707
2.687
2.669
2.516
2.512
2.507
2.503
2.098
2.080
MeO
O
O
Me
N
Bn
3de, ^{1}HNMR (DMSO-d$_6$, 400 MHz)
9
8
7
6
5
4
3
2
1
ppm
1.045
2.055
3.047
2.945
2.000
2.889
2.002
2.053
3.113
206.559
168.821
138.461
137.676
130.142
129.015
127.840
127.357
124.678
124.163
121.842
120.729
114.759
114.239
52.333
49.410
44.478
40.639
40.430
40.221
40.013
39.804
39.595
39.387
30.198
21.519
MeO
O
O
Me
N
Bn
3de, ^{13}CNMR (DMSO-d$_6$, 100 MHz)
200
180
160
140
120
100
80
60
40
20
0
ppm

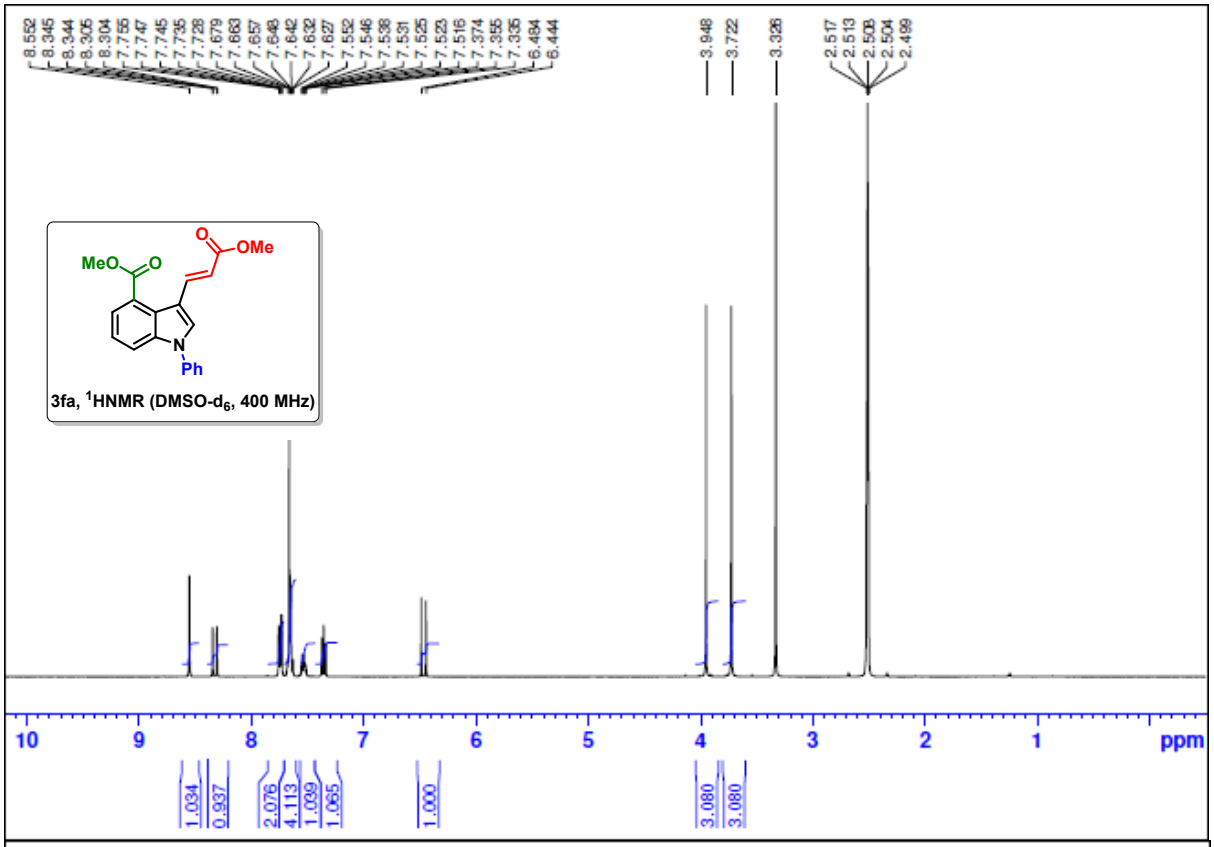

8.474
8.349
8.348
8.309
8.308
7.867
7.865
7.846
7.844
7.655
7.653
7.637
7.635
7.292
7.285
7.280
7.273
7.272
7.263
7.253
6.898
6.893
6.881
6.876
6.304
6.264
5.438
3.907
3.704
2.517
2.512
2.508
2.503
2.499
MeO
O
OMe
N
PMB
3ea, 1HNMR (DMSO-d6, 400 MHz)
9
8
7
6
5
4
3
2
ppm
0.988
0.917
1.000
0.983
3.009
2.023
0.973
1.998
2.972
6.064
168.352
167.792
159.275
140.354
137.808
132.958
129.322
129.258
124.369
124.248
123.820
121.819
116.111
114.528
112.458
111.493
55.542
52.522
51.538
49.663
40.616
40.407
40.198
39.990
39.781
39.573
39.364
MeO
O
OMe
N
PMB
3ea, 13CNMR (DMSO-d6, 100 MHz)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

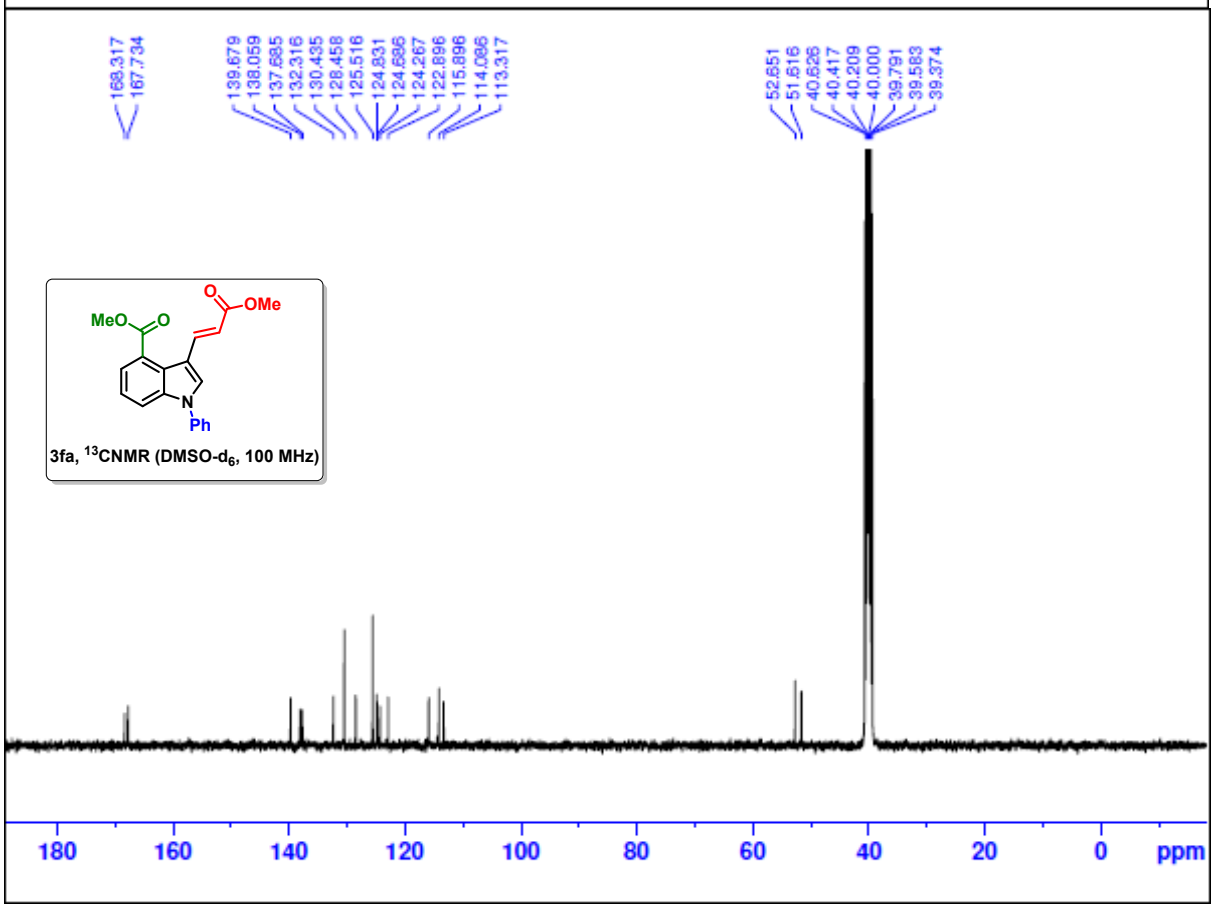

3eb, ^{1}HNMR (DMSO-d$_6$, 400 MHz)
3eb, ^{13}CNMR (DMSO-d$_6$, 100 MHz)
MeO
OEt
PMB

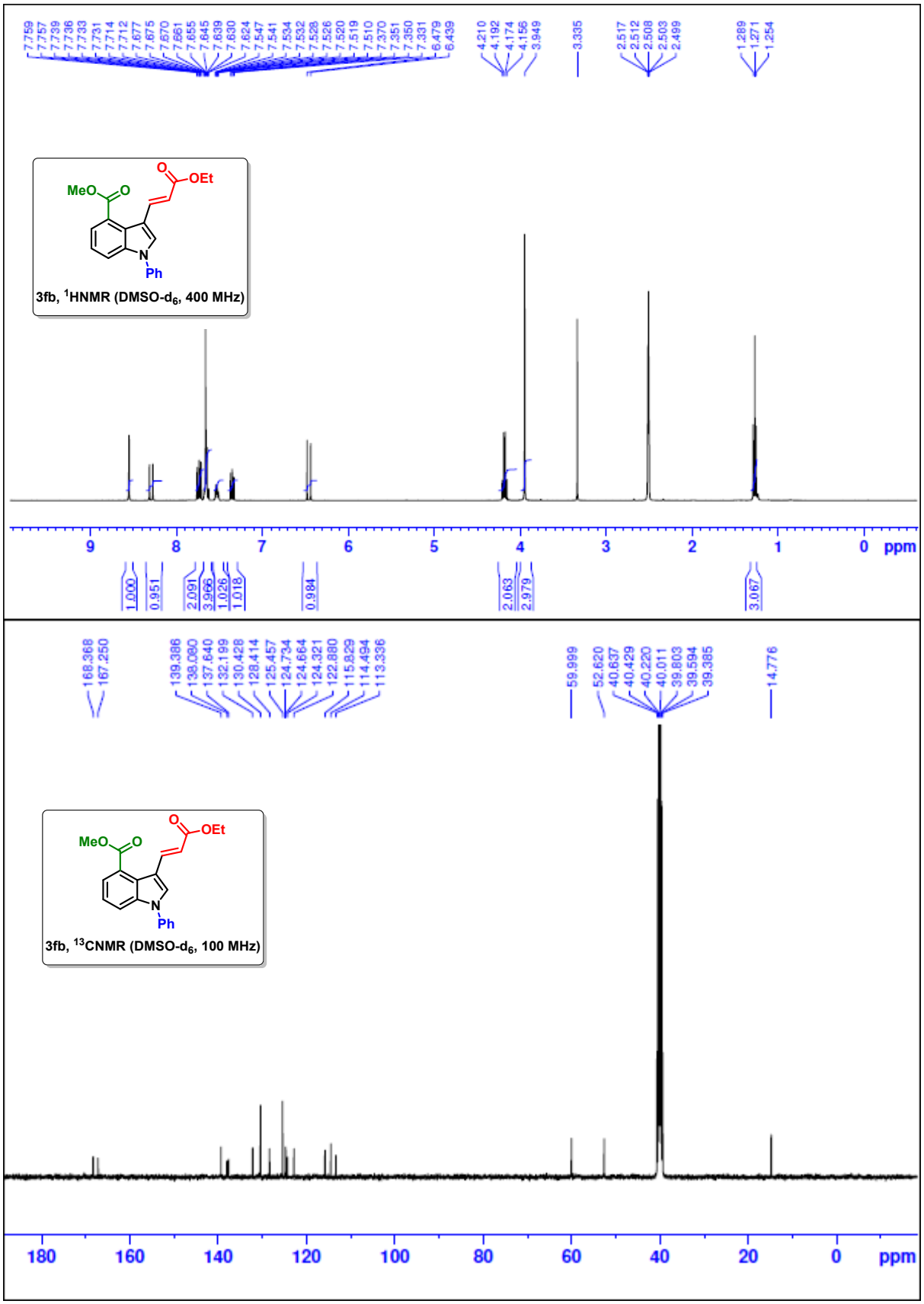

8.503
8.408
8.369
7.871
7.851
7.649
7.631
7.458
7.440
7.427
7.409
7.390
7.367
7.350
7.288
7.272
7.266
7.253
6.894
6.872
6.368
6.329
5.432
5.212
3.857
3.701
3.335
2.513
2.509
MeO
O
O
OBn
N
PMB
3ed, ^{1}HNMR (DMSO-d$_6$, 400 MHz)
9
8
7
6
5
4
3
2
1
ppm
1.050
0.965
1.061
1.120
5.246
3.121
2.126
1.000
2.078
2.207
3.005
3.088

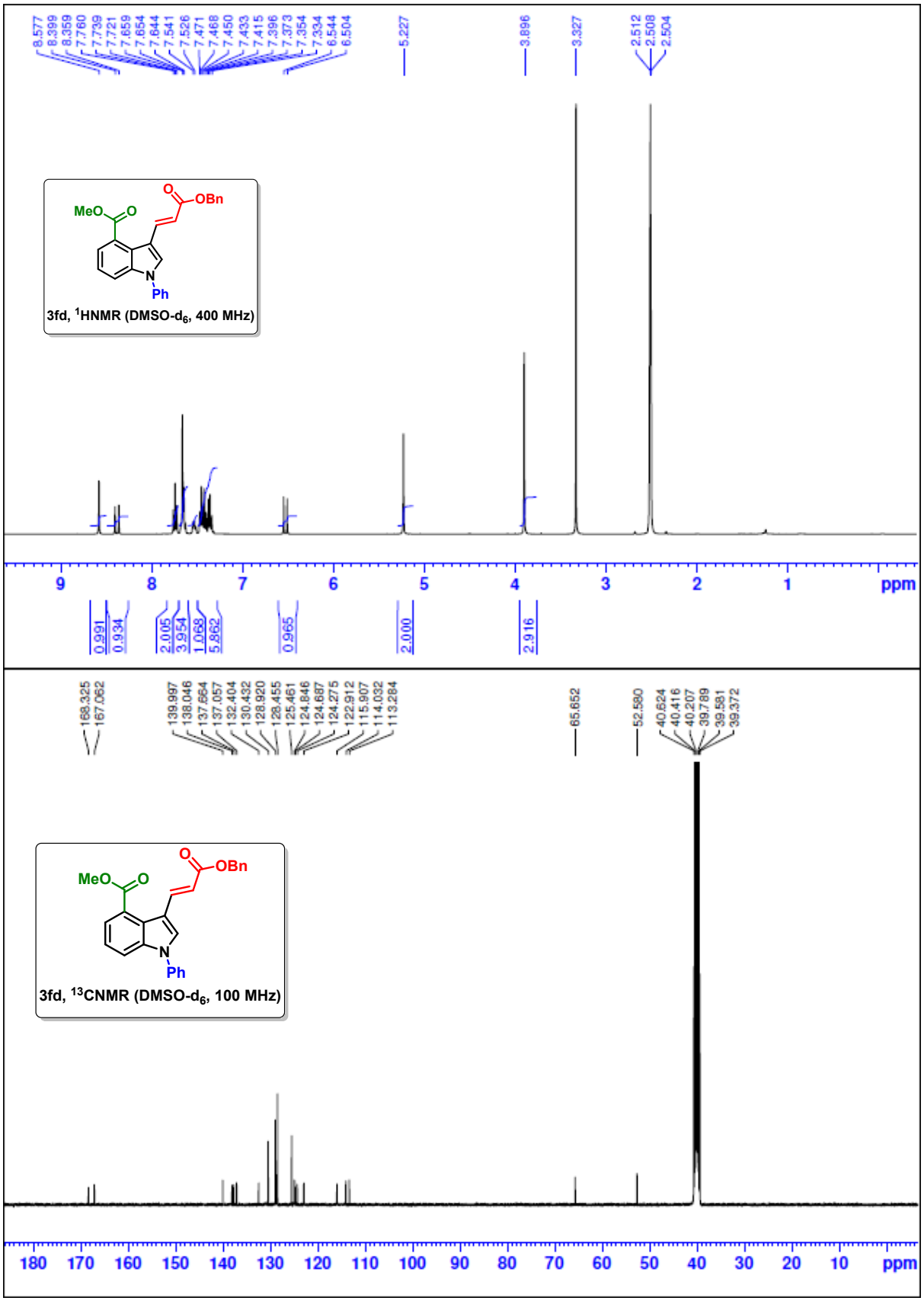

168.366
167.126
159.282
140.689
137.809
137.145
133.071
129.288
128.905
128.391
128.367
124.363
124.270
123.830
121.835
116.111
114.525
112.387
111.477
65.527
55.536
52.450
49.692
40.622
40.413
40.205
39.996
39.787
39.578
39.370
MeO
O
O
OBn
N
PMB
3ed, ^{13}CNMR (DMSO-d$_6$, 100 MHz)
180
160
140
120
100
80
60
40
20
0
ppm

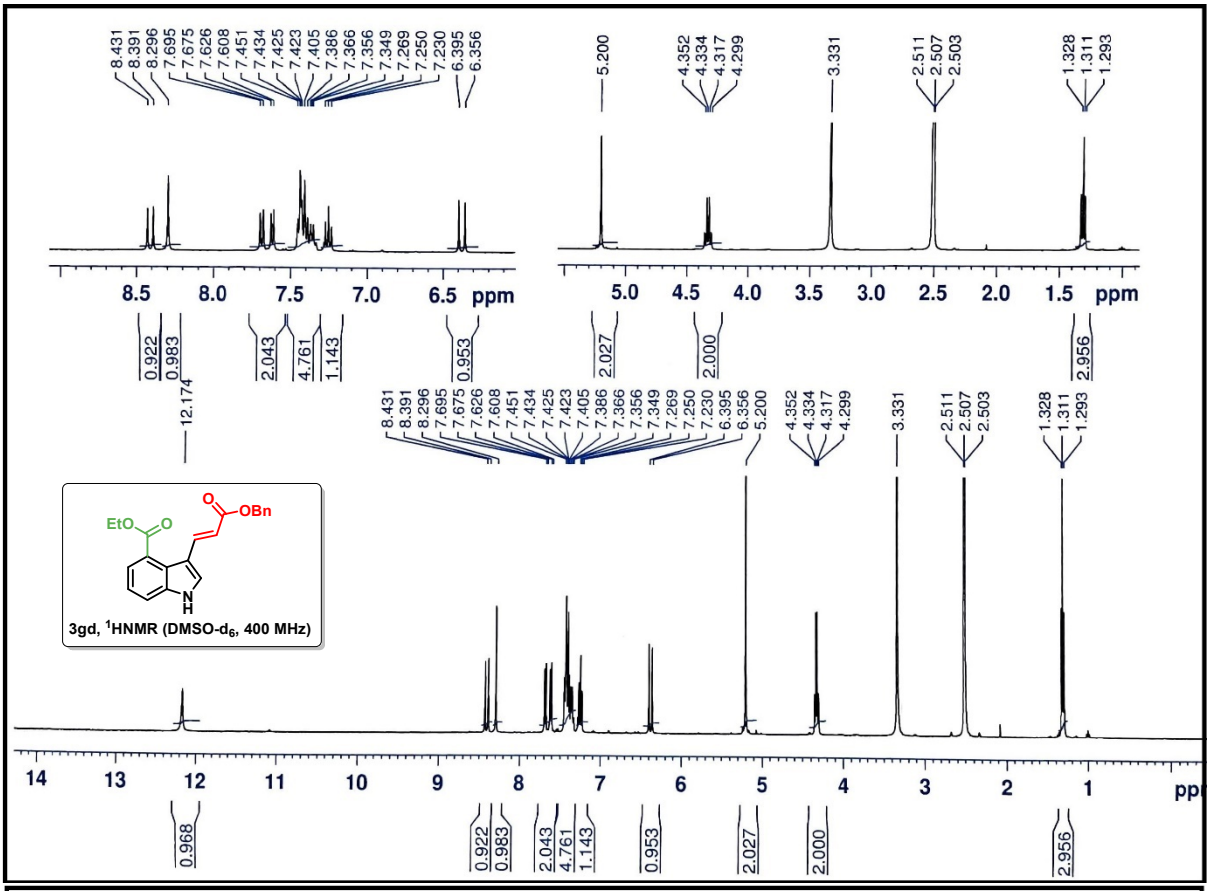

7.702
7.682
7.455
7.439
7.176
7.164
7.157
7.143
7.137
6.870
6.848
5.329
3.853
3.697
3.333
2.980
2.962
2.943
2.695
2.676
2.658
2.512
2.508
2.504
2.096
MeO
O
O
Me
N
PMB
3ee, 1HNMR (DMSO-d6, 400 MHz)
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.040
2.039
2.996
2.004
2.000
3.018
2.994
1.984
2.048
2.969
208.578
168.823
159.041
137.555
130.304
129.980
129.508
129.070
128.866
128.754
124.691
124.097
121.780
120.631
114.811
114.698
114.631
114.536
114.271
114.204
114.094
56.169
55.524
55.492
54.847
52.804
52.431
52.222
52.048
48.913
44.502
40.621
40.412
40.203
39.995
39.786
39.578
39.369
30.281
30.250
30.151
30.120
21.522
MeO
O
O
Me
N
PMB
3ee, 13CNMR (DMSO-d6, 100 MHz)
200
180
160
140
120
100
80
60
40
20
0
ppm

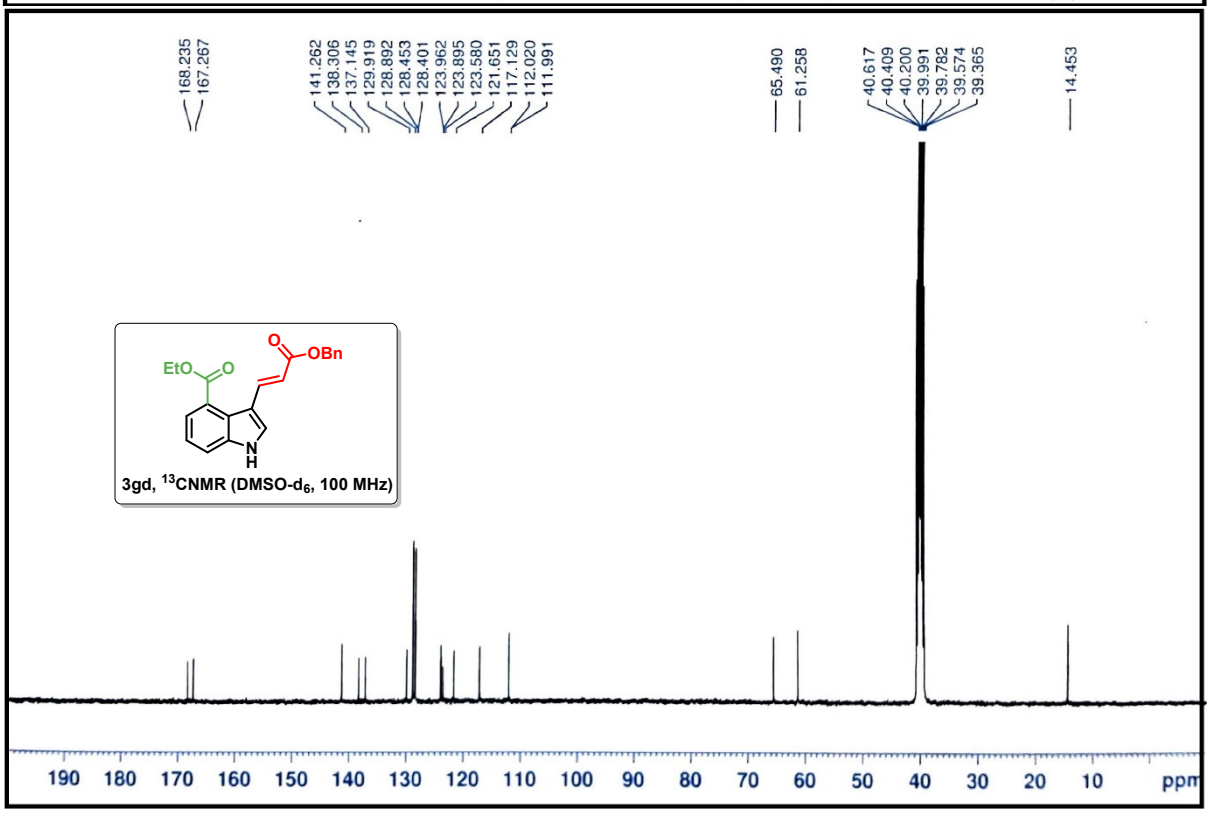

8.552
8.345
8.344
8.305
8.304
7.755
7.747
7.745
7.735
7.728
7.679
7.663
7.657
7.648
7.642
7.632
7.627
7.552
7.546
7.538
7.531
7.525
7.523
7.516
7.374
7.355
7.335
6.494
6.444
3.948
3.722
3.326
2.517
2.513
2.508
2.504
2.499
MeO
O
O
OMe
N
Ph
3fa, 1HNMR (DMSO-d6, 400 MHz)
10
9
8
7
6
5
4
3
2
1
ppm
1.034
0.937
2.076
4.113
1.039
1.065
1.000
3.080
3.080

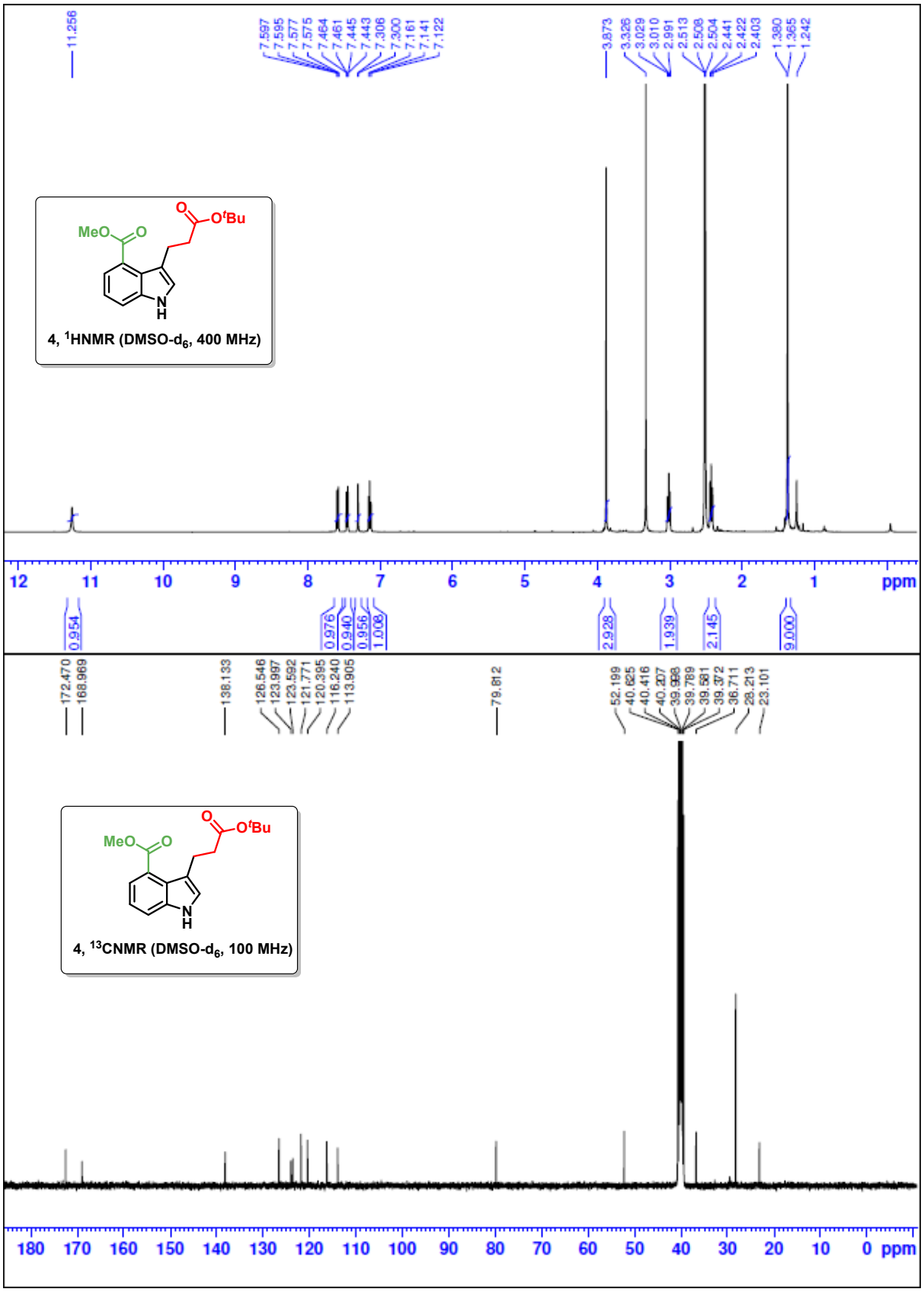

168.317
167.734
139.679
138.059
137.685
132.316
130.435
128.458
125.516
124.831
124.686
124.267
122.896
115.896
114.086
113.317
52.651
51.616
40.626
40.417
40.209
40.000
39.791
39.583
39.374
MeO
O
O
OMe
N
Ph
3fa, 13CNMR (DMSO-d6, 100 MHz)
180
160
140
120
100
80
60
40
20
0
ppm

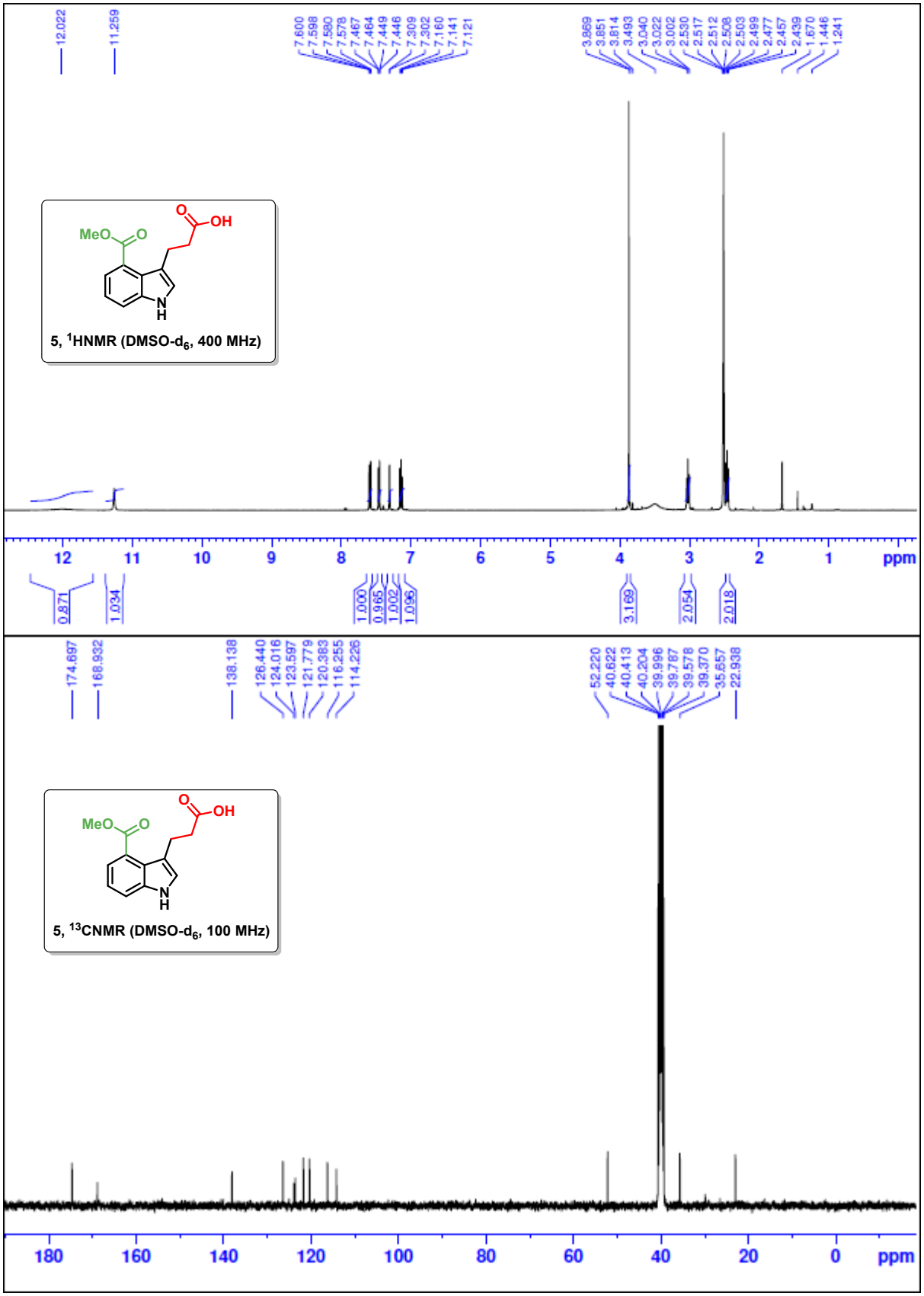

7.759
7.757
7.739
7.736
7.733
7.731
7.714
7.712
7.677
7.675
7.670
7.661
7.655
7.645
7.639
7.630
7.624
7.547
7.541
7.534
7.532
7.528
7.526
7.520
7.519
7.510
7.370
7.351
7.350
7.331
6.479
6.439
4.210
4.192
4.174
4.156
3.949
3.335
2.517
2.512
2.508
2.503
2.499
1.289
1.271
1.254
MeO
O
O
OEt
N
Ph
3fb, 1HNMR (DMSO-d6, 400 MHz)
9
8
7
6
5
4
3
2
1
0
ppm
1.000
0.951
2.091
3.966
1.026
1.018
0.984
2.063
2.979
3.067
168.368
167.250
139.386
138.080
137.640
132.199
130.428
128.414
125.457
124.734
124.664
124.321
122.880
115.829
114.494
113.336
59.999
52.620
40.637
40.429
40.220
40.011
39.803
39.594
39.385
14.776
MeO
O
O
OEt
N
Ph
3fb, 13CNMR (DMSO-d6, 100 MHz)
180
160
140
120
100
80
60
40
20
0
ppm

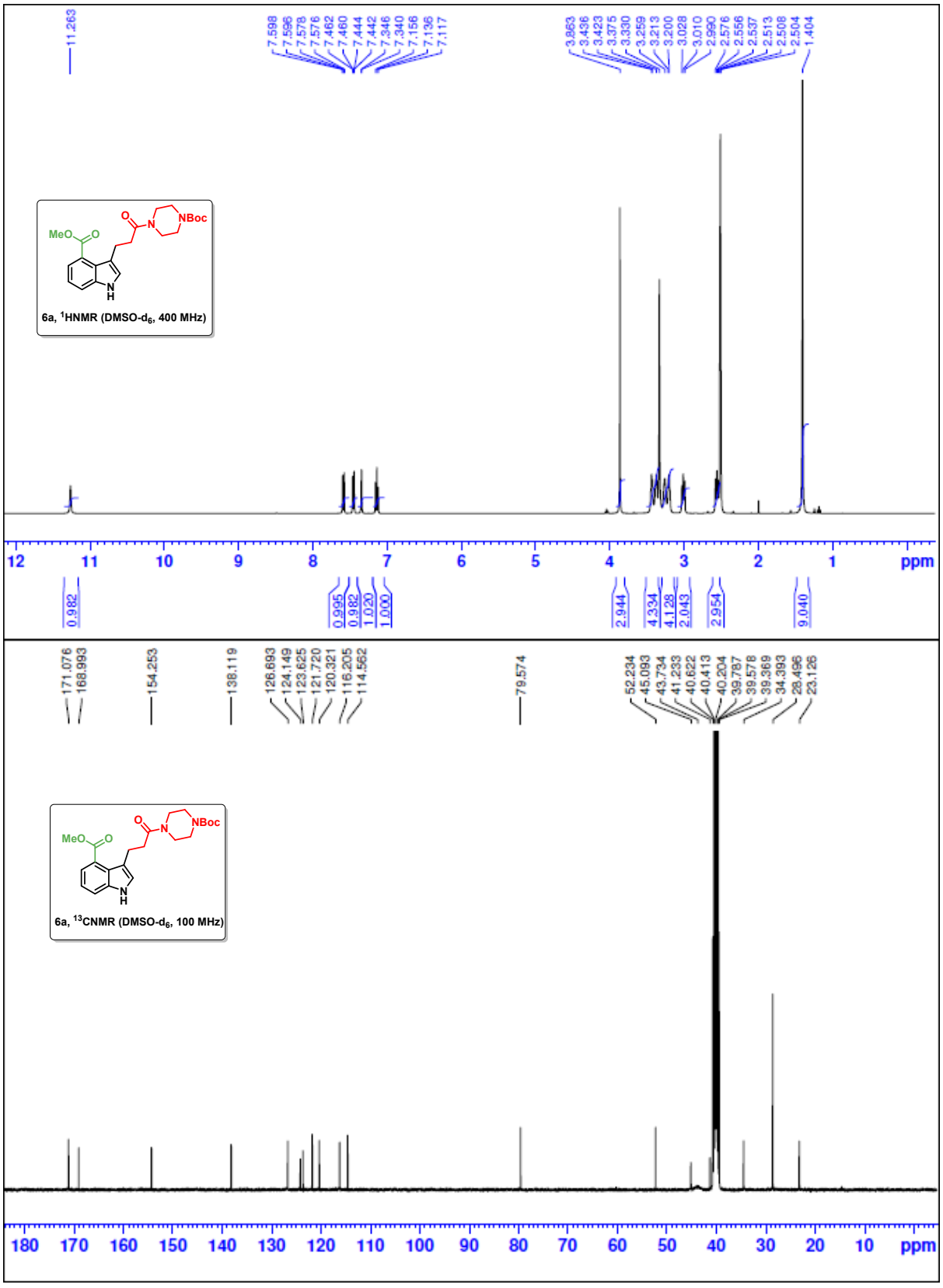

8.577
8.399
8.359
7.760
7.739
7.721
7.659
7.654
7.644
7.541
7.526
7.471
7.468
7.450
7.433
7.415
7.396
7.373
7.354
7.334
6.544
6.504
5.227
3.896
3.327
2.512
2.508
2.504
MeO
O
O
OBn
N
Ph
3fd, ^{1}HNMR (DMSO-d$_6$, 400 MHz)
9
8
7
6
5
4
3
2
1
ppm
0.991
0.934
2.005
3.954
1.068
5.862
0.965
2.000
2.916
168.325
167.062
139.997
138.046
137.664
137.057
132.404
130.432
128.920
128.455
125.461
124.846
124.687
124.275
122.912
115.907
114.032
113.284
65.652
52.580
40.624
40.416
40.207
39.789
39.581
39.372
MeO
O
O
OBn
N
Ph
3fd, ^{13}CNMR (DMSO-d$_6$, 100 MHz)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

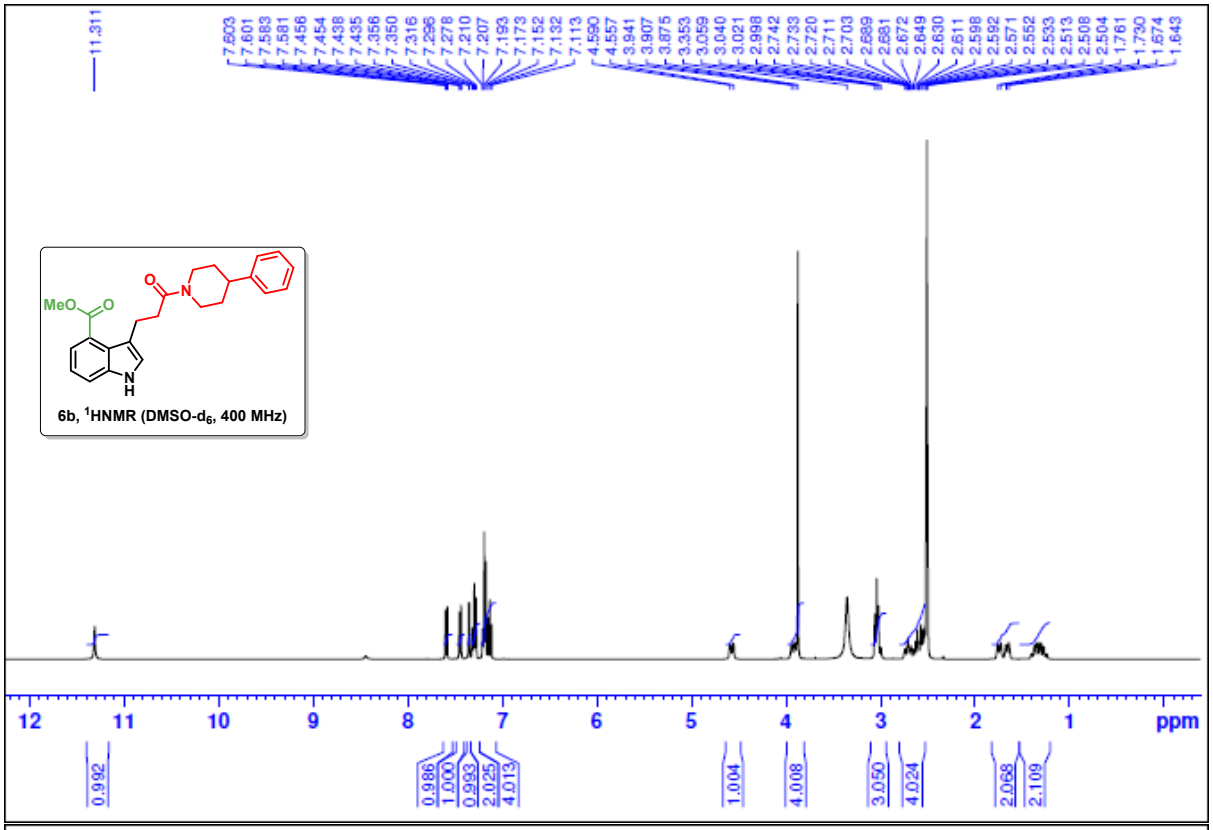

3gd, ^{1}HNMR (DMSO-d$_6$, 400 MHz)

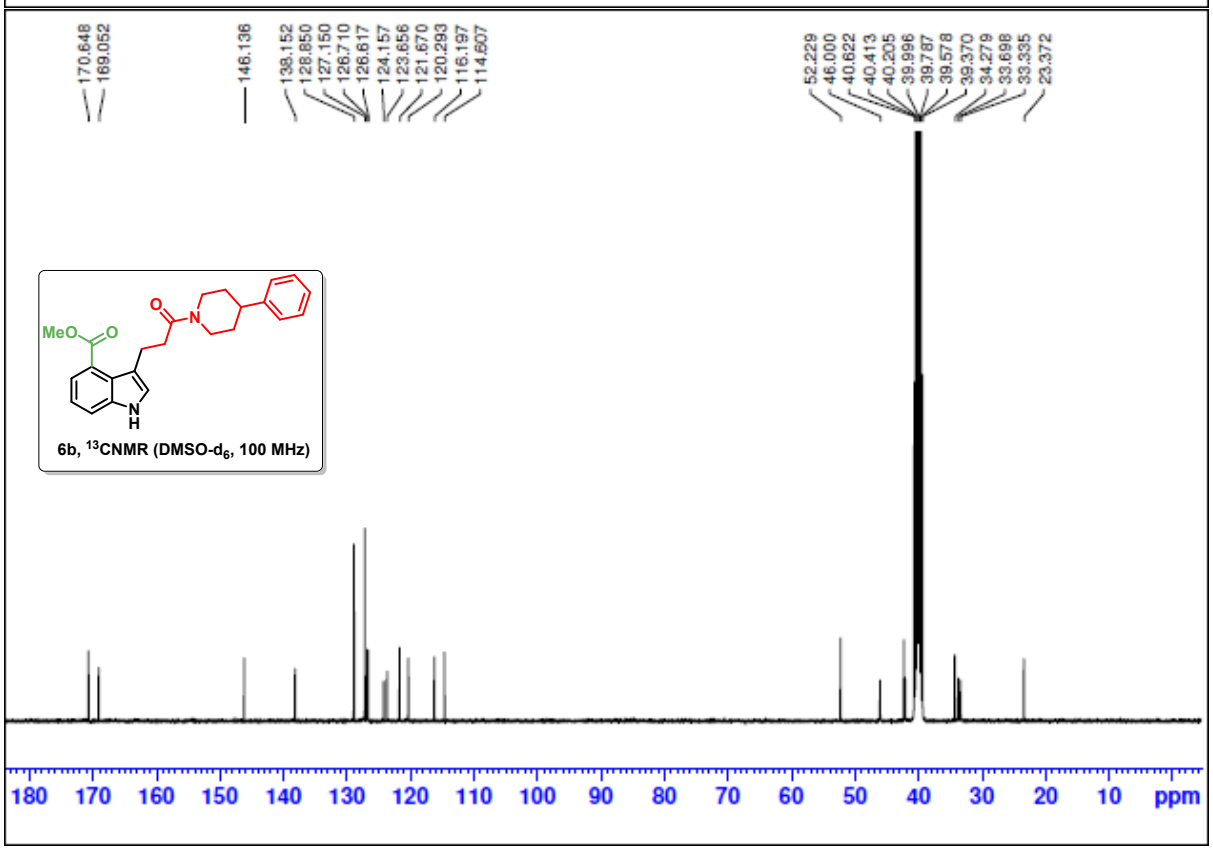

3gd, ^{13}CNMR (DMSO-d$_6$, 100 MHz)


11.256
7.597
7.595
7.577
7.575
7.464
7.461
7.445
7.443
7.306
7.300
7.161
7.141
7.122
3.873
3.326
3.029
3.010
2.991
2.513
2.508
2.504
2.441
2.422
2.403
1.380
1.365
1.242
MeO
O
O
O
tBu
N
H
4, 1HNMR (DMSO-d6, 400 MHz)
12
11
10
9
8
7
6
5
4
3
2
1
ppm
0.954
0.976
0.940
0.956
1.008
2.928
1.939
2.145
9.000
172.470
168.969
138.133
126.546
123.997
123.592
121.771
120.385
116.240
113.905
79.812
52.199
40.625
40.416
40.207
39.998
39.789
39.581
39.372
36.711
28.213
23.101
MeO
O
O
O
tBu
N
H
4, 13CNMR (DMSO-d6, 100 MHz)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0 ppm


12.022
11.259
7.600
7.598
7.580
7.578
7.467
7.464
7.449
7.446
7.309
7.302
7.160
7.141
7.121
3.869
3.851
3.814
3.493
3.040
3.022
3.002
2.530
2.517
2.512
2.508
2.503
2.499
2.477
2.457
2.439
1.670
1.446
1.241
MeO
O
O
OH
N
H
5, 1HNMR (DMSO-d6, 400 MHz)
12
11
10
9
8
7
6
5
4
3
2
1
ppm
0.871
1.034
1.000
0.965
1.002
1.096
3.169
2.054
2.018
174.697
168.932
138.138
126.440
124.016
123.597
121.779
120.383
116.255
114.226
52.220
40.622
40.413
40.204
39.996
39.787
39.578
39.370
35.657
22.938
MeO
O
O
OH
N
H
5, 13CNMR (DMSO-d6, 100 MHz)
180
160
140
120
100
80
60
40
20
0
ppm


11.263
7.598
7.596
7.578
7.576
7.462
7.460
7.444
7.442
7.346
7.340
7.156
7.136
7.117
3.863
3.436
3.423
3.375
3.330
3.259
3.213
3.200
3.028
3.010
2.990
2.576
2.556
2.537
2.513
2.508
2.504
1.404
MeO
O
O
N
NBoc
N
H
6a, ^{1}HNMR (DMSO-d$_6$, 400 MHz)
12
11
10
9
8
7
6
5
4
3
2
1
ppm
0.982
0.995
0.982
1.020
1.000
2.944
4.334
4.128
2.043
2.954
9.040
171.076
168.993
154.253
138.119
126.693
124.149
123.625
121.720
120.321
116.205
114.562
79.574
52.234
45.093
43.734
41.233
40.622
40.413
40.204
39.787
39.578
39.369
34.393
28.496
23.126
MeO
O
O
N
NBoc
N
H
6a, ^{13}CNMR (DMSO-d$_6$, 100 MHz)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


6b, ^{1}HNMR (DMSO-d$_6$, 400 MHz)
ppm


6b, ^{13}CNMR (DMSO-d$_6$, 100 MHz)
ppm

8. References

1 S. R. Mohanty, B. V. Pati, S. K. Banjare, G. K. D. Adhikari and P. C. Ravikumar, *J. Org. Chem.*, 2021, **86**, 1074.

2 H. E. Gottlieb, V. Kotlyar and A. Nudelman, *J. Org. Chem.*, 1997, **62**, 7512-7515.

3 (a) M. Kitano, A. Kojima, K. Nakano, A. Miyagisi, T. Noguchi and N. Ohashi, *Chem. Pharm. Bull.*, 1999, **47**, 1538; (b) 5-HT3 Receptor Modulators, Methods of making and use thereof (WO2011/8572, 2011, A2).

4 (a) S. R. Mohanty, N. Prusty, T. Nanda, S. K. Banjare and P. C. Ravikumar, *J. Org. Chem.*, 2022, **87**, 6189; (b) P. P. Jadhav, N. M. Kahar and S. G. Dawande, *Org. Lett.*, 2021, **23**, 8673.