Highly Versatile *β*-C(sp^3)–H Iodination of Ketones Using a Practical Auxiliary

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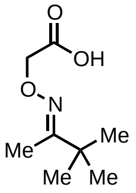
General Information

Ketones were obtained from the commercial sources or synthesized following literature procedures, and used to prepare the corresponding substrates. Aminooxyacetic acid hemihydrochloride was obtained from Combi-Blocks. I_2 was obtained from TCI. $PhI(OAc)_2$ was obtained from Sigma-Aldrich. Solvents were obtained from Sigma-Aldrich, Alfa-Aesar and Acros and used directly without further purification. Analytical thin layer chromatography was performed on 0.25 mm silica gel 60-F254. Visualization was carried out with UV light and Vogel's permanganate. ^{1}H NMR was recorded on Bruker AMX-400 instrument (400 MHz) or Bruker DRX-600 instrument (600 MHz). Chemical shifts were quoted in parts per million (ppm) referenced to 0.0 ppm for tetramethylsilane. The following abbreviations (or combinations thereof) were used to explain multiplicities: s = singlet, d = doublet, t = triplet, q =quartet, m = multiplet, br = broad. Coupling constants, *J*, were reported in Hertz unit (Hz). ^{13}C NMR spectra were recorded on Bruker AMX-400 instrument (100 MHz) or Bruker DRX-600 instrument (150 MHz), and were fully decoupled by broad band proton decoupling. ^{19}F NMR spectra were recorded on Bruker AMX-400 instrument (100 MHz), and were fully decoupled by broad band proton decoupling. Chemical shifts were reported in ppm referenced to either the center line of a triplet at 77.0 ppm of chloroform-*d* or the center line of a multiplet at 29.84 ppm of acetone-d^6. In the ^{13}C NMR analysis, peaks that correspond to those of the polyfluoroarylamide auxiliary appeared as nearly invisible, complex sets of multiplets; they were omitted in the following spectroscopic analysis. High-resolution mass spectra (HRMS) were recorded on an Agilent Mass spectrometer using ESI-TOF (electrospray ionization-time of flight).

Substrate Structures



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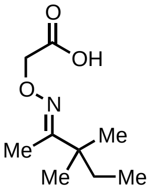

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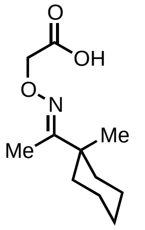

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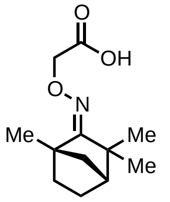

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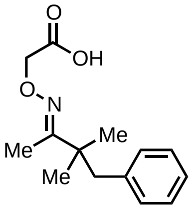

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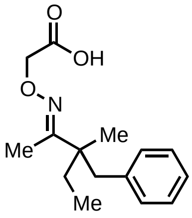

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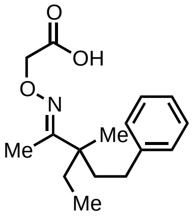

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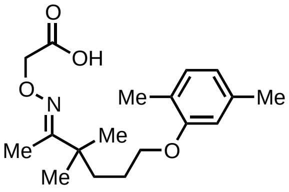

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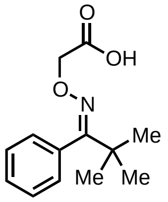

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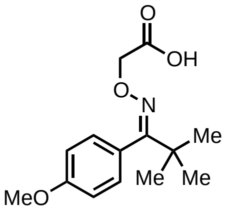
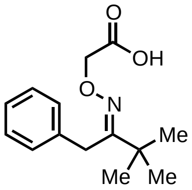
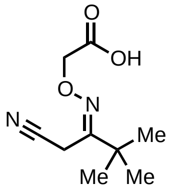


1j



1k



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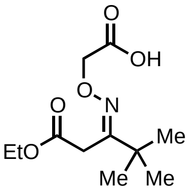

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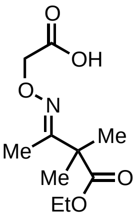

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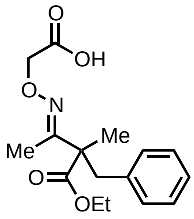

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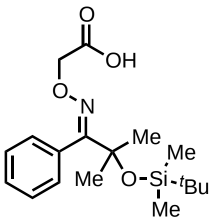

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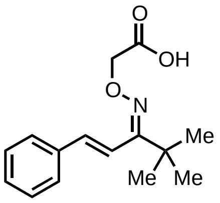

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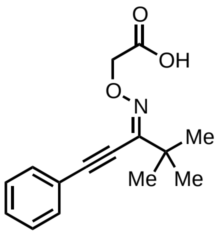
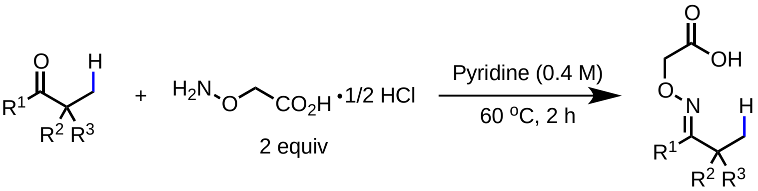


1r

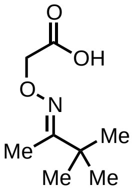
Experimental Section

Substrate Preparation

Ketones for substrates **1a**, **1b**, **1d**, **1i**, **1l**, **1m** and **1p** are commercial available. Ketones for substrates **1e**, **1f** and **1g** were synthesized following literature procedures.[1] Ketones for substrates **1c** and **1h** were synthesized by the reaction between corresponding carboxylic acids and MeLi. The procedure can be found in literature.[2] Ketone for substrate **1j** was synthesized following literature procedures.[3] Ketone for substrate **1k** was synthesized following literature procedures.[2] Ketones for substrates **1n** and **1o** were synthesized following literature procedures.[4] Ketone for substrate **1q** was synthesized following literature procedures.[5] Ketone for substrate **1r** was synthesized following literature procedures.[6]

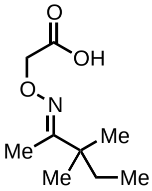


Ketone (2 mmol, 1 equiv) and aminooxyacetic acid hemihydrochloride (4 mmol, 437 mg, 2 equiv) were weighed into an oven dried 50 mL round bottom flask with a magnetic stir bar under air. 5 mL Pyridine was added and the mixture was stirred at 60 °C for 2 h. Upon completion, most pyridine was evaporated under vacuum. The resulting mixture was diluted with EtOAc (50 mL) and washed successively with water (100 mL) and diluted HCl aqueous solution (100 mL, ca. 0.01 M). The organic phase was dried with anhydrous Na_2SO_4 and the solvent was removed under vacuum. Notably, the pure compounds were obtained in good yields for all cases without chromatography.



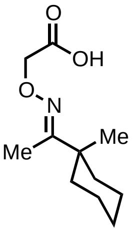
(*E*)-2-(((3,3-dimethylbutan-2-ylidene)amino)oxy)acetic acid (1a)

White solid. ^1H NMR (600 MHz, $CDCl_3$) δ 4.59 (s, 2H), 1.90 (s, 3H), 1.12 (s, 9H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 174.41, 166.90, 69.93, 37.30, 27.44, 10.88. HRMS (ESI-TOF) Calcd for $C_8H_{14}NO_3^-$ [M-H]$^-$: 172.0979, found: 172.0972.



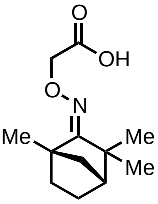
(*E*)-2-(((3,3-dimethylpentan-2-ylidene)amino)oxy)acetic acid (1b)

White solid. ^1H NMR (600 MHz, $CDCl_3$) δ 4.58 (s, 2H), 1.86 (s, 3H), 1.47 (q, *J* = 7.2 Hz, 2H), 1.08 (s, 6H), 0.76 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 174.73, 165.83, 70.05, 40.67, 32.74, 24.97, 10.79, 8.81. HRMS (ESI-TOF) Calcd for $C_9H_{16}NO_3^-$ [M-H]$^-$: 186.1136, found: 186.1132.



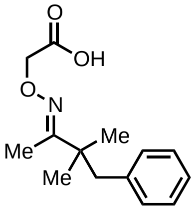
(*E*)-2-(((1-(1-methylcyclohexyl)ethylidene)amino)oxy)acetic acid (1c)

Colorless oil. ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.60 (s, 2H), 1.88 (s, 3H), 1.82-1.79 (m, 2H), 1.51-1.31 (m, 8H), 1.07 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 174.06, 166.24, 69.81, 40.78, 35.20, 35.15, 26.05, 25.97, 22.35. HRMS (ESI-TOF) Calcd for $C_{11}H_{18}NO_3^-$ [M-H]$^-$: 212.1292, found: 212.1287.



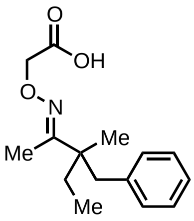
2-(((*E*)-((1*S*,4*R*)-1,3,3-trimethylbicyclo[2.2.1]heptan-2-ylidene)amino)oxy)acetic acid (1d)

1d was synthesized following the general procedures except the reaction temperature is 120 ^{o}C and the reaction time is 12 h. White solid. ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.51 (s, 2H), 1.87-1.84 (m, 1H), 1.81-1.78 (m, 1H), 1.75-1.73 (m, 1H), 1.61-1.59 (m, 2H), 1.44-1.38 (m, 2H), 1.30 (s, 3H), 1.28 (s, 3H), 1.21 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 176.60, 173.20, 69.98, 50.55, 48.49, 45.04, 43.31, 34.19, 25.11, 23.26, 22.47, 16.88. HRMS (ESI-TOF) Calcd for $C_{12}H_{18}NO_3^-$ [M-H]$^-$: 224.1292, found: 224.1288.



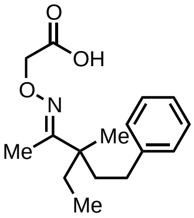
(*E*)-2-(((3,3-dimethyl-4-phenylbutan-2-ylidene)amino)oxy)acetic acid (1e)

Pale yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.27-7.19 (m, 3H), 7.06-7.04 (m, 2H), 4.52 (s, 2H), 2.74 (s, 2H), 1.96 (s, 3H), 1.09 (s, 6H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 174.64, 165.30, 137.90, 130.26, 127.81, 126.25, 70.12, 46.05, 41.36, 25.11, 11.65. HRMS (ESI-TOF) Calcd for $C_{14}H_{18}NO_3^-$ [M-H]$^-$: 248.1292, found: 248.1297.



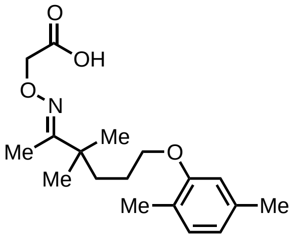
(*E*)-2-(((3-benzyl-3-methylpentan-2-ylidene)amino)oxy)acetic acid (1f)

Pale yellow oil. ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.26-7.23 (m, 2H), 7.21-7.19 (m, 1H), 7.05-7.04 (m, 2H), 4.54 (ABq, *J* = 16.8 Hz, 2H), 2.82 (d, *J* = 13.8 Hz, 1H), 2.67 (d, *J* = 13.8 Hz, 1H), 1.94 (s, 3H), 1.71-1.65 (m, 1H), 1.42-1.36 (m, 1H), 0.99 (s, 3H), 0.80 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 173.94, 164.61, 137.76, 130.27, 127.83, 126.26, 70.01, 45.12, 44.97, 31.10, 20.78, 11.70, 8.64. HRMS (ESI-TOF) Calcd for $C_{15}H_{20}NO_3^-$ [M-H]$^-$: 262.1449, found: 262.1442.



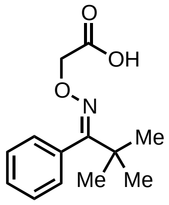
(*E*)-2-(((3-ethyl-3-methyl-5-phenylpentan-2-ylidene)amino)oxy)acetic acid (1g)

Pale yellow oil. ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.28-7.25 (m, 2H), 7.18-7.14 (m, 3H), 4.63 (s, 2H), 2.52 (td, *J* = 5.4 Hz, *J* = 13.2 Hz, 1H), 2.38 (td, *J* = 4.8 Hz, *J* = 13.2 Hz, 1H), 1.86 (s, 3H), 1.83-1.78 (m, 1H), 1.66-1.54 (m, 2H), 1.47-1.41 (m, 1H), 1.12 (s, 3H), 0.78 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 174.43, 164.66, 142.62, 128.36, 128.25, 125.73, 69.89, 44.07, 41.00, 31.70, 30.77, 20.68, 10.89, 8.38. HRMS (ESI-TOF) Calcd for $C_{16}H_{22}NO_3^-$ [M-H]$^-$: 276.1605, found: 276.1609.



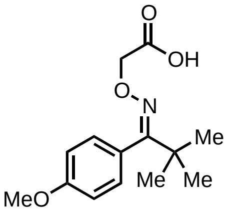
(*E*)-2-(((6-(2,5-dimethylphenoxy)-3,3-dimethylhexan-2-ylidene)amino)oxy)acetic acid (1h)

Colorless oil. ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.00 (d, *J* = 7.2 Hz, 1H), 6.66 (d, *J* = 7.6 Hz, 1H), 6.60 (s, 1H), 4.60 (s, 2H), 3.92-3.88 (m, 2H), 2.30 (s, 3H), 2.17 (s, 3H), 1.90 (s, 3H), 1.66-1.63 (m, 4H), 1.14 (s, 6H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 173.98, 166.02, 156.92, 136.48, 130.28, 123.48, 120.67, 111.88, 69.85, 67.78, 40.31, 36.65, 25.48, 24.78, 21.38, 15.78, 10.85. HRMS (ESI-TOF) Calcd for $C_{18}H_{26}NO_4^-$ [M-H]$^-$: 320.1867, found: 320.1862.



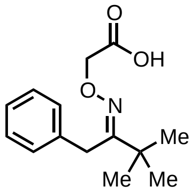
(*Z*)-2-(((2,2-dimethyl-1-phenylpropylidene)amino)oxy)acetic acid (1i)

White solid. ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.42-7.39 (m, 2H), 7.37-7.34 (m, 1H), 7.12-7.10 (m, 2H), 4.51 (s, 2H), 1.17 (s, 9H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 174.65, 168.26, 127.91, 127.90, 127.35, 127.34, 70.23, 37.48, 28.16. HRMS (ESI-TOF) Calcd for $C_{13}H_{16}NO_3^-$ [M-H]$^-$: 234.1136, found: 234.1130.



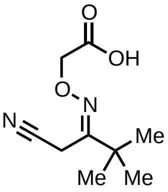
(*Z*)-2-(((1-(4-methoxyphenyl)-2,2-dimethylpropylidene)amino)oxy)acetic acid (1j)

White solid. ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.06-7.04 (m, 2H), 6.95-6.92 (m, 2H), 4.54 (s, 2H), 3.82 (s, 3H), 1.16 (s, 9H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 174.14, 168.57, 159.15, 128.59, 125.62, 113.47, 70.04, 55.14, 37.71, 28.17. HRMS (ESI-TOF) Calcd for $C_{14}H_{18}NO_4^-$ [M-H]$^-$: 262.1241, found: 262.1247.



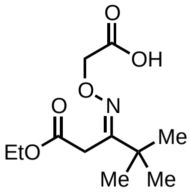
(*E*)-2-(((3,3-dimethyl-1-phenylbutan-2-ylidene)amino)oxy)acetic acid (1k)

Pale yellow oil. ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.28-7.25 (m, 2H), 7.23-7.22 (m, 2H), 7.19-7.17 (m, 1H), 4.63 (s, 2H), 3.81 (s, 2H), 1.11 (s, 9H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 174.94, 167.09, 136.77, 128.43, 128.25, 126.08, 69.95, 37.81, 31.80, 28.13. HRMS (ESI-TOF) Calcd for $C_{14}H_{18}NO_3^-$ [M-H]$^-$: 248.1292, found: 248.1299.



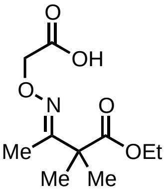
(*E*)-2-(((1-cyano-3,3-dimethylbutan-2-ylidene)amino)oxy)acetic acid (1l)

Colorless oil. ^{1}H NMR (600 MHz, CDCl$_3$) δ 4.75 (s, 2H), 3.36 (s, 2H), 1.19 (s, 9H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 174.19, 157.34, 115.14, 70.19, 37.46, 27.14, 13.66. HRMS (ESI-TOF) Calcd for $C_9H_{13}N_2O_3^-$ [M-H]$^-$: 197.0932, found: 197.0939.



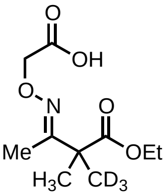
(*E*)-2-(((1-ethoxy-4,4-dimethyl-1-oxopentan-3-ylidene)amino)oxy)acetic acid (1m)

Colorless oil. ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.64 (s, 2H), 4.21 (q, *J* = 7.2 Hz, 2H), 3.42 (s, 2H), 1.28 (t, *J* = 7.2 Hz, 3H), 1.12 (s, 9H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 172.06, 170.18, 162.19, 70.92, 62.10, 37.31, 31.53, 26.96, 13.97. HRMS (ESI-TOF) Calcd for $C_{11}H_{18}NO_5^-$ [M-H]$^-$: 244.1190, found: 244.1185.



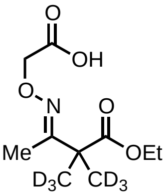
(*E*)-2-(((4-ethoxy-3,3-dimethyl-4-oxobutan-2-ylidene)amino)oxy)acetic acid (1n)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.65 (s, 2H), 4.16 (q, *J* = 7.2 Hz, 2H), 1.89 (s, 3H), 1.37 (s, 6H), 1.24 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 174.70, 174.20, 161.35, 70.02, 61.17, 48.95, 23.04, 14.02, 12.46. HRMS (ESI-TOF) Calcd for $C_{10}H_{16}NO_5^-$ [M-H]$^-$: 230.1034, found: 230.1030.



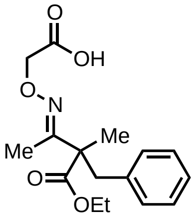
(*E*)-2-(((4-ethoxy-3-methyl-3-dueteratedmethyl-4-oxobutan-2-ylidene)amino)oxy)acetic acid (1n-*d*^{3})

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.65 (s, 2H), 4.16 (q, *J* = 7.2 Hz, 2H), 1.88 (s, 3H), 1.36 (s, 3H), 1.24 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 174.75, 174.60, 161.17, 70.00, 61.14, 48.74, 22.93, 14.01, 12.43. HRMS (ESI-TOF) Calcd for $C_{10}H_{13}D_3NO_5^-$ [M-H]$^-$: 233.1222, found: 233.1217.



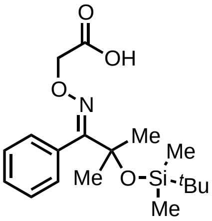
(*E*)-2-(((4-ethoxy-3,3-didueteratedmethyl-4-oxobutan-2-ylidene)amino)oxy)acetic acid (1n-*d*^{6})

Pale yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.65 (s, 2H), 4.16 (q, *J* = 7.2 Hz, 2H), 1.88 (s, 3H), 1.24 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 174.77, 174.61, 161.15, 70.00, 61.13, 48.52, 29.78, 14.02, 12.42. HRMS (ESI-TOF) Calcd for $C_{10}H_{10}D_6NO_5^-$ [M-H]$^-$: 236.1411, found: 236.1414.



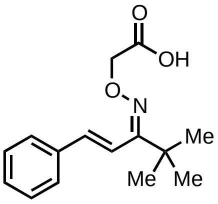
(*E*)-2-(((3-benzyl-4-ethoxy-3-methyl-4-oxobutan-2-ylidene)amino)oxy)acetic acid (1o)

Pale yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24-7.20 (m, 3H), 7.09-7.07 (m, 2H), 4.63 (s, 2H), 4.16 (q, *J* = 7.2 Hz, 2H), 3.25 (d, *J* = 13.6 Hz, 1H), 3.06 (d, *J* = 13.6 Hz, 1H), 1.91 (s, 3H), 1.26 (s, 3H), 1.24 (t, *J* = 8.8 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 174.33, 173.60, 160.37, 136.65, 130.35, 128.01, 126.70, 70.08, 61.24, 53.82, 41.05, 20.19, 14.01, 13.30. HRMS (ESI-TOF) Calcd for $C_{16}H_{20}NO_5^-$ [M-H]$^-$: 306.1347, found: 306.1340.



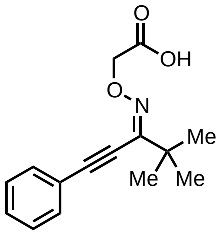
(*E*)-6,6,8,8,9,9-hexamethyl-5-phenyl-3,7-dioxa-4-aza-8-siladec-4-en-1-oic acid (1p)

White solid. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.43-7.34 (m, 3H), 7.26-7.24 (m, 2H), 4.57 (s, 2H), 1.48 (s, 6H), 0.77 (s, 9H), 0.02 (s, 6H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 174.26, 165.76, 132.70, 128.17, 128.11, 127.65, 75.58, 70.14, 29.18, 25.75, 18.09, -2.16. HRMS (ESI-TOF) Calcd for $C_{18}H_{28}NO_4Si^-$ [M-H]$^-$: 350.1793, found: 350.1790.



2-(((*E*)-((*E*)-4,4-dimethyl-1-phenylpent-1-en-3-ylidene)amino)oxy)acetic acid (1q)

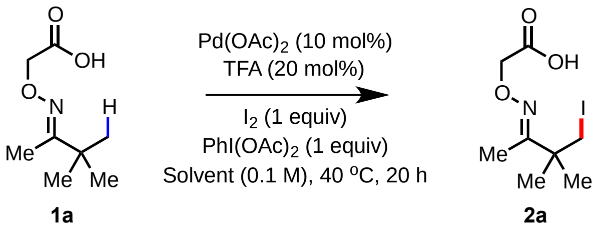
Pale yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.49-7.47 (m, 2H), 7.42 (d, *J* = 16.8 Hz, 1H), 7.38-7.35 (m, 2H), 7.33-7.30 (m, 1H), 6.64 (d, *J* = 16.8 Hz, 1H), 4.67 (s, 2H), 1.24 (s, 9H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 173.28, 163.69, 139.88, 136.47, 128.93, 128.74, 127.00, 116.29, 70.31, 37.70, 28.63. HRMS (ESI-TOF) Calcd for $C_{15}H_{18}NO_3^-$ [M-H]$^-$: 260.1292, found: 260.1299.



(*Z*)-2-(((4,4-dimethyl-1-phenylpent-1-yn-3-ylidene)amino)oxy)acetic acid (1r)
Pale yellow oil. ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.54-7.52 (m, 2H), 7.39-7.34 (m, 3H), 4.72 (s, 2H), 1.26 (s, 9H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 173.92, 152.03, 132.13, 129.51, 128.40, 121.70, 101.73, 78.71, 70.52, 37.39, 28.06. HRMS (ESI-TOF) Calcd for $C_{15}H_{16}NO_3^-$ [M-H]$^-$: 258.1136, found: 258.1132.

Optimization of C(sp^3)–H Iodination

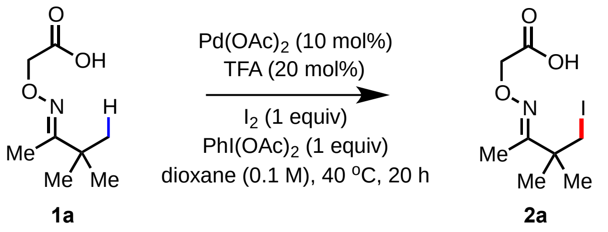
Solvent Screening[a,b]



Solvent	^{1}H NMR yield	Solvent	^{1}H NMR yield
DCM	30%	Et_2O	38%
DCE	21%	TBME	26%
EtOAc	35%	CH_3CN	0%
$C_6F_5CF_3$	23%	*t*-AmylOH	7%
$CHCl_3$	30%	DMF	0%
THF	37%	1,4-dioxane	66% (2.7:1)[c]

[a] Conditions: **1a** (0.1 mmol, 1.0 equiv), $Pd(OAc)_2$ (10 mol%), TFA (20 mol%), I_2 (1.0 equiv), $PhI(OAc)_2$ (1.0 equiv), solvent (1.0 mL), 40 °C, under air, 20 h. [b] The yield was determined by ^{1}H NMR analysis of the crude product using CH_2Br_2 as the internal standard. [c] The numbers in parenthesis indicate the ratio of mono:di.

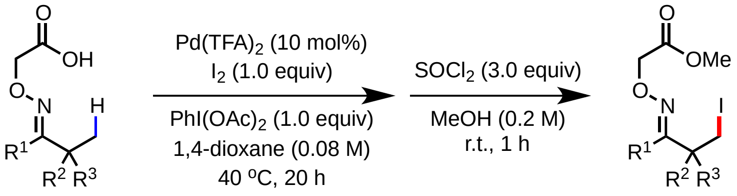
Condition Screening[a,b,c]



Condition	^{1}H NMR yield	Condition	^{1}H NMR yield
$Pd(TFA)_2$	69% (2.0:1)	$PhI(OAc)_2$ (1.5 eq.) I_2 (1.5 eq.)[d]	Messy, poor mass balance
50 °C	55% (2.7:1)	$PhI(OAc)_2$ (0.75 eq.) I_2 (0.75 eq.)[d]	78% (1.4:1)
30 °C	51% (6.3:1)	under N_2[d]	70% (4.3:4.7:1)
w/o TFA	71% (3.6:4.2:1)	1,4-dioxane (0.13 M)[d]	80% (15:11:1)
w/o TFA $Pd(TFA)_2$	81% (14:12:1)	1,4-dioxane (0.08 M)[d]	88% (1:1.3)

[a] Conditions: **1a** (0.1 mmol, 1.0 equiv), $Pd(OAc)_2$ (10 mol%), TFA (20 mol%), I_2 (1.0 equiv), $PhI(OAc)_2$ (1.0 equiv), 1,4-dioxane (1.0 mL), 40 °C, under air, 20 h. [b] The yield was determined by ^{1}H NMR analysis of the crude product using CH_2Br_2 as the internal standard. [c] The numbers in parenthesis indicate the ratio of mono:di or mono:di:tri (if applicable). [d] Without TFA, use $Pd(TFA)_2$ instead of $Pd(OAc)_2$.

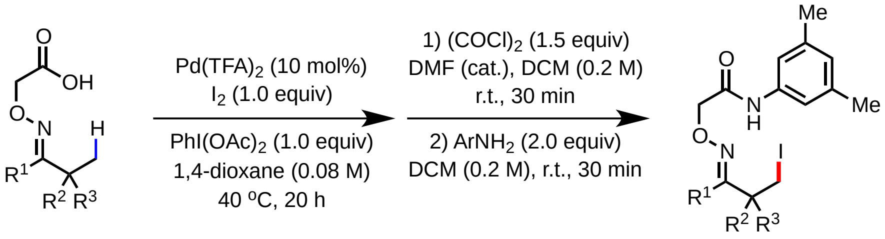
C(sp^3)–H Iodination



1

2

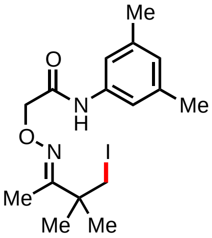
General Procedures for the C(sp^3)–H Iodination of UV Active Ketones: Substrate **1** (0.10 mmol), Pd(TFA)$_2$ (0.01 mmol, 3.3 mg), I$_2$ (0.10 mmol, 25.4 mg) and PhI(OAc)$_2$ (0.10 mmol, 32.2 mg) were weighed into a reaction vial (10 mL) with a magnetic stir bar under air. 1,4-Dioxane (1.25 mL) was added, and the vial was sealed with a cap. The reaction mixture was stirred at 40 °C for 20 hours. Upon completion, the reaction mixture was cooled to room temperature and diluted with EtOAc. Then the reaction mixture was filtered through a plug of silicon gel and transferred to a reaction vial (10 mL) with a magnetic stir bar. The solvent was evaporated under vacuum. Anhydrous MeOH (0.5 mL) was added to the mixture. SOCl$_2$ (0.30 mmol, 22 μL) was added dropwise at room temperature. The vial was sealed with a cap. The reaction mixture was stirred at room temperature for 1 hour. Upon completion, the reaction mixture was cooled to room temperature and the solvent was removed under vacuum. The resulting mixture was purified by preparative thin-layer chromatography.



1

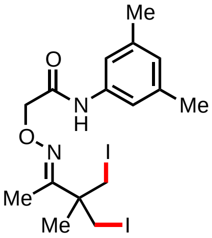
2

General Procedures for the C(sp^3)–H Iodination of UV Inactive Ketones: Substrate **1** (0.10 mmol), Pd(TFA)$_2$ (0.01 mmol, 3.3 mg), I$_2$ (0.10 mmol, 25.4 mg) and PhI(OAc)$_2$ (0.10 mmol, 32.2 mg) were weighed into a reaction vial (10 mL) with a magnetic stir bar under air. 1,4-Dioxane (1.25 mL) was added, and the vial was sealed with a cap. The reaction mixture was stirred at 40 °C for 20 hours. Upon completion, the reaction mixture was cooled to room temperature and diluted with EtOAc. Then the reaction mixture was filtered through a plug of silicon gel and transferred to a reaction vial (10 mL) with a magnetic stir bar. The solvent was evaporated under vacuum. Anhydrous DCM (0.5 mL) and DMF (ca. 10 μL) were added to the mixture. (COCl)$_2$ (0.15 mmol, 13 μL) was added dropwise at room temperature. The vial was sealed with a cap. The reaction mixture was stirred at room temperature for 30 min before excess (COCl)$_2$ and solvent were evaporated. To the mixture was added anhydrous DCM (0.5 mL), followed by the dropwise addition of 3,5-dimethylaniline (0.2 mmol, 25 μL) to the mixture at room temperature. The vial was sealed with a cap. The reaction mixture was stirred at room temperature for 30 min. Upon completion, the reaction mixture was diluted with EtOAc. Then the reaction mixture was filtered through a plug of celite and the solvent was removed under vacuum. The resulting mixture was purified by preparative thin-layer chromatography.



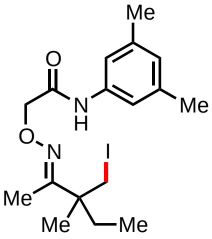
(*E*)-*N*-(3,5-dimethylphenyl)-2-(((4-iodo-3,3-dimethylbutan-2-ylidene)amino)oxy)acetamide (2a-mono)

Substrate **1a** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), **2a-mono** was obtained as a colorless oil (14.1 mg, 35%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.86 (br s, 1H), 7.19 (s, 2H), 6.76 (s, 1H), 4.62 (s, 2H), 3.31 (s, 2H), 2.29 (s, 6H), 1.96 (s, 3H), 1.29 (s, 6H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 168.32, 163.16, 138.66, 136.98, 126.25, 117.88, 73.01, 41.14, 25.46, 21.34, 18.61, 10.85. HRMS (ESI-TOF) Calcd for $C_{16}H_{24}IN_2O_2^+$ $[M+H]^+$: 403.0877, found: 403.0873.



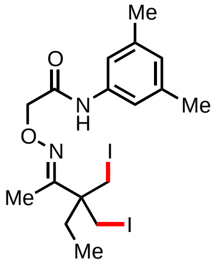
(*E*)-*N*-(3,5-dimethylphenyl)-2-(((4-iodo-3-(iodomethyl)-3-methylbutan-2-ylidene)amino)oxy)acetamide (2a-di)

Substrate **1a** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), **2a-di** was obtained as a colorless oil (26.4 mg, 50%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.75 (br s, 1H), 7.19 (s, 2H), 6.76 (s, 1H), 4.65 (s, 2H), 3.46 (ABq, *J* = 10.2 Hz, 4H), 2.29 (s, 6H), 2.02 (s, 3H), 1.41 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.87, 160.45, 138.67, 136.81, 126.34, 117.88, 73.21, 43.67, 23.74, 21.33, 15.46, 11.62. HRMS (ESI-TOF) Calcd for $C_{16}H_{23}I_2N_2O_2^+$ $[M+H]^+$: 528.9843, found: 528.9849.



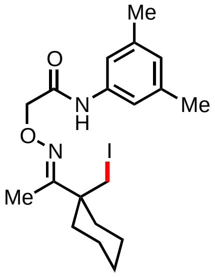
(*E*)-*N*-(3,5-dimethylphenyl)-2-(((3-(iodomethyl)-3-methylpentan-2-ylidene)amino)oxy)acetamide (2b-mono)

Substrate **1b** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), **2b-mono** was obtained as a colorless oil (12.5 mg, 30%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.83 (br s, 1H), 7.18 (s, 2H), 6.76 (s, 1H), 4.63 (ABq, *J* = 16.2 Hz, 2H), 3.31 (ABq, *J* = 10.2 Hz, 2H), 2.29 (s, 6H), 1.93 (s, 3H), 1.76-1.70 (m, 1H), 1.56-1.51 (m, 1H), 1.20 (s, 3H), 0.83 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 168.33, 162.34, 138.68, 136.98, 126.24, 117.81, 73.05, 44.45, 30.46, 25.54, 22.63, 21.34, 17.88, 11.02, 9.38. HRMS (ESI-TOF) Calcd for $C_{17}H_{26}IN_2O_2^+$ $[M+H]^+$: 417.1033, found: 417.1029.



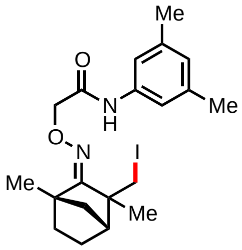
(*E*)-*N*-(3,5-dimethylphenyl)-2-(((4-iodo-3-(iodomethyl)-3-methylbutan-2-ylidene)amino)oxy)acetamide (2b-di)

Substrate **1b** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), **2b-di** was obtained as a colorless oil (29.0 mg, 55%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.72 (br s, 1H), 7.18 (s, 2H), 6.76 (s, 1H), 4.65 (s, 2H), 3.48 (ABq, *J* = 10.8 Hz, 4H), 2.29 (s, 6H), 2.01 (s, 3H), 1.73 (q, *J* = 7.2 Hz, 2H), 0.82 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.81, 159.63, 138.69, 136.78, 126.34, 117.80, 73.23, 46.91, 27.87, 21.33, 15.41, 11.84, 9.62. HRMS (ESI-TOF) Calcd for $C_{17}H_{25}I_2N_2O_2^+$ $[M+H]^+$: 543.0000, found: 543.0007.



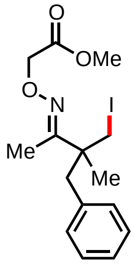
(*E*)-*N*-(3,5-dimethylphenyl)-2-(((1-(1-(iodomethyl)cyclohexyl)ethylidene)amino)oxy)acetamide (2c)

Substrate **1c** was iodinated following the general iodination procedure except the reaction time is 3 hours. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), **2c** was obtained as a colorless oil (26.5 mg, 60%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.89 (br s, 1H), 7.20 (s, 2H), 6.75 (s, 1H), 4.64 (s, 2H), 3.29 (s, 2H), 2.29 (s, 6H), 2.02-1.99 (m, 2H), 1.91 (s, 3H), 1.53-1.31 (m, 8H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 168.46, 161.85, 138.60, 136.97, 126.21, 117.93, 73.04, 44.14, 33.77, 25.84, 22.49, 21.32, 18.20, 10.62. HRMS (ESI-TOF) Calcd for $C_{19}H_{28}IN_2O_2^+$ $[M+H]^+$: 443.1190, found: 443.1196.



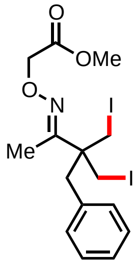
N-(3,5-dimethylphenyl)-2-(((E)-((1S,4R)-3-(iodomethyl)-1,3-dimethylbicyclo[2.2.1]heptan-2-ylidene)amino)oxy)acetamide (2d)

Substrate **1d** was iodinated following the general iodination procedure except the reaction time is 3 hours and the reaction time is 3 h. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), **2d** was obtained as a colorless oil (19.1 mg, 42%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.84 (br s, 1H), 7.16 (s, 2H), 6.77 (s, 1H), 4.55 (s, 2H), 3.45 (ABq, J = 10.2 Hz, 2H), 2.30 (s, 6H), 2.02-1.97 (m, 1H), 1.96-1.93 (m, 1H), 1.92-1.87 (m, 2H), 1.74-1.68 (m, 1H), 1.58-1.56 (m, 1H), 1.49-1.44 (m, 1H), 1.40 (s, 3H), 1.37 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 171.68, 168.39, 138.73, 137.07, 126.26, 117.65, 73.36, 54.54, 47.64, 45.62, 43.05, 32.19, 26.10, 23.06, 22.84, 21.39, 8.31. HRMS (ESI-TOF) Calcd for $C_{20}H_{28}IN_2O_2^+$ $[M+H]^+$: 455.1190, found: 455.1195.



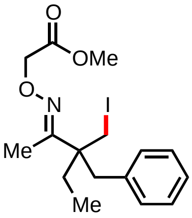
(E)-methyl 2-(((3-benzyl-4-iodo-3-methylbutan-2-ylidene)amino)oxy)acetate (2e-mono)

Substrate **1e** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : Acetone = 20:1 as eluent), **2e-mono** was obtained as a colorless oil (15.6 mg, 40%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.28-7.27 (m, 2H), 7.24-7.21 (m, 1H), 7.16-7.15 (m, 2H), 4.58 (s, 2H), 3.73 (s, 3H), 3.29 (ABq, J = 10.2 Hz, 2H), 2.90 (ABq, J = 13.8 Hz, 2H), 1.93 (s, 3H), 1.20 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 170.57, 160.68, 136.94, 130.24, 128.06, 126.61, 70.53, 51.79, 44.48, 43.28, 23.68, 17.84, 11.84. HRMS (ESI-TOF) Calcd for $C_{15}H_{21}INO_3^+$ $[M+H]^+$: 390.0561, found: 390.0555.



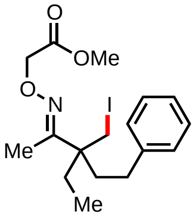
(E)-methyl 2-(((3-benzyl-4-iodo-3-(iodomethyl)butan-2-ylidene)amino)oxy)acetate (2e-di)

Substrate **1e** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : Acetone = 20:1 as eluent), **2e-di** was obtained as a colorless oil (20.6 mg, 40%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.30-7.21 (m, 5H), 4.54 (s, 2H), 3.70 (s, 3H), 3.43 (ABq, *J* = 10.2 Hz, 4H), 2.97 (s, 2H), 2.00 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 170.20, 157.66, 135.89, 129.72, 128.29, 127.13, 70.74, 51.85, 47.19, 40.04, 15.86, 12.64. HRMS (ESI-TOF) Calcd for $C_{15}H_{20}I_2NO_3^+$ [M+H]$^+$: 515.9527, found: 515.9532.



(*E*)-methyl 2-(((3-benzyl-3-(iodomethyl)pentan-2-ylidene)amino)oxy)acetate (2f)

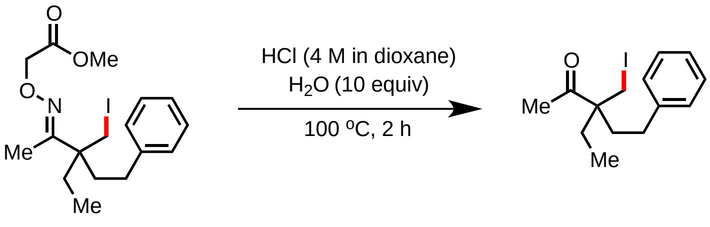
Substrate **1f** was iodinated following the general iodination procedure except the reaction time is 3 hours. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), **2f** was obtained as a colorless oil (29.0 mg, 72%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.28-7.25 (m, 2H), 7.23-7.20 (m, 3H), 4.54 (ABq, *J* = 16.2 Hz, 2H), 3.70 (s, 3H), 3.24 (ABq, *J* = 11.4 Hz, 2H), 2.87 (ABq, *J* = 14.4 Hz, 2H), 1.99 (s, 3H), 1.68-1.61 (m, 2H), 0.82 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 170.52, 159.60, 136.90, 129.96, 128.10, 126.57, 70.45, 51.74, 47.73, 40.23, 28.90, 16.00, 12.31, 8.33. HRMS (ESI-TOF) Calcd for $C_{16}H_{23}INO_3^+$ [M+H]$^+$: 404.0717, found: 404.0721.



(*E*)-methyl 2-(((3-ethyl-3-(iodomethyl)-5-phenylpentan-2-ylidene)amino)oxy)acetate (2g)

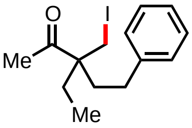
Substrate **1g** was iodinated following the general iodination procedure except the reaction time is 3 hours. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), **2g** was obtained as a colorless oil (30.9 mg, 74%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.29-7.27 (m, 2H), 7.20-7.17 (m, 3H), 4.64 (s, 2H), 3.73 (s, 3H), 3.50 (ABqd, J_1 = 1.2 Hz, J_2 = 10.8 Hz, 2H), 2.47 (td, J_1 = 4.8 Hz, J_2 = 13.2 Hz, 1H), 2.28 (td, J_1 = 4.8 Hz, J_2 = 13.2 Hz, 1H), 1.94 (s, 3H), 1.93-1.88 (m, 1H), 1.76-1.70 (m, 1H), 1.69-1.64 (m, 1H), 1.58-1.52 (m, 1H), 0.74 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 170.54, 159.74, 141.87, 128.42, 128.33, 125.90, 70.40, 51.76, 46.42, 38.82, 30.16, 28.97, 15.11, 11.53, 7.75. HRMS (ESI-TOF) Calcd for $C_{17}H_{25}INO_3^+$ [M+H]$^+$: 418.0874, found: 418.0880.

1 mmol Scale reaction: Substrate **1g** (1.0 mmol, 291 mg), $Pd(TFA)_2$ (0.1 mmol, 33 mg), I_2 (1.0 mmol, 254 mg) and $PhI(OAc)_2$ (1.0 mmol, 322 mg) were weighed into a Schlenk tube (100 mL) with a magnetic stir bar under air. 1,4-Dioxane (12.5 mL) was added, and the tube was sealed with a cap. The reaction mixture was stirred at 40 °C for 20 hours. Upon completion, the reaction mixture was cooled to room temperature and diluted with EtOAc. Then the reaction mixture was filtered through a plug of silicon gel and transferred to a round bottom flask (100 mL) with a magnetic stir bar. The solvent was evaporated under vacuum. Anhydrous MeOH (5 mL) was added to the mixture. $SOCl_2$ (3.0 mmol, 0.22 mL) was added dropwise at room temperature. The reaction mixture was stirred at room temperature for 1 hour. Upon completion, the reaction mixture was cooled to room temperature and the solvent was removed under vacuum. The resulting mixture was purified by chromatography using Hexane/EtOAc (20:1 to 10:1) mixtures as the eluent to give 325 mg of **2g** as a colorless oil (78% yield).



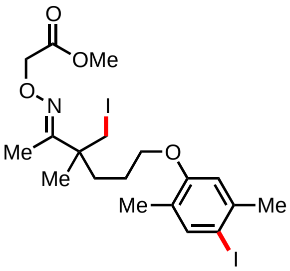
2g **2g-Ketone**, 70%

The removal of auxiliary: **2g** (0.05 mmol, 20.9 mg) was weighed into a reaction vial (10 mL) with a magnetic stir bar under air. 9.0 μL of H_2O (10 equiv) and 0.5 mL of HCl (4 M in dioxane) were added, and the vial was sealed with a cap. The reaction mixture was stirred at 100 °C for 2 hours. Upon completion, the reaction mixture was cooled to room temperature and the solvent was removed under vacuum. The resulting mixture was purified by preparative thin-layer chromatography by using toluene/EtOAc (100:1) as the eluent to give 11.6 mg of **2g-Ketone** (70% yield).



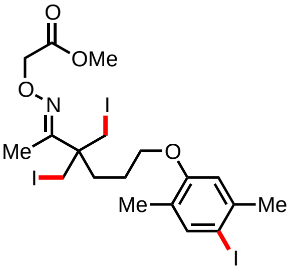
3-ethyl-3-(iodomethyl)-5-phenylpentan-2-one (2g-Ketone)

Colorless oil (11.6 mg, 70%). ^1H NMR (600 MHz, $CDCl_3$) δ 7.30-7.28 (m, 2H), 7.22-7.17 (m, 3H), 3.50 (q, J = 10.8 Hz, 2H), 2.51-2.46 (m, 1H), 2.30-2.26 (m, 1H), 2.23 (s, 3H), 2.04-1.98 (m, 1H), 1.96-1.90 (m, 1H), 1.82-1.73 (m, 2H), 0.80 (t, J = 7.2 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 209.25, 141.20, 128.55, 128.26, 126.19, 54.41, 38.04, 30.41, 28.63, 26.02, 12.15, 8.24. HRMS (ESI-TOF) Calcd for $C_{14}H_{20}IO^+$ $[M+H]^+$: 331.0553, found: 331.0560.



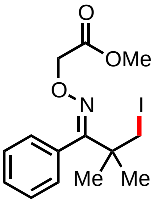
(*E*)-methyl 2-(((6-(4-iodo-2,5-dimethylphenoxy)-3-(iodomethyl)-3-methylhexan-2-ylidene)amino)oxy)acetate (2h-mono)

Substrate **1h** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Toluene : EtOAc = 100:1 as eluent), **2h-mono** was obtained as a colorless oil (29.4 mg, 50%). ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.51 (s, 1H), 6.67 (s, 1H), 4.62 (s, 2H), 3.90-3.87 (m, 2H), 3.74 (s, 3H), 3.37 (ABq, *J* = 10.8 Hz, 2H), 2.37 (s, 3H), 2.13 (s, 3H), 1.91 (s, 3H), 1.84-1.80 (m, 1H), 1.68-1.63 (m, 3H), 1.22 (s, 3H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 170.58, 160.35, 157.27, 139.97, 139.43, 126.41, 112.58, 89.04, 70.44, 67.63, 51.76, 43.22, 34.37, 27.96, 24.59, 23.97, 18.20, 15.32, 11.12. HRMS (ESI-TOF) Calcd for $C_{19}H_{28}I_2NO_4^+$ $[M+H]^+$: 588.0102, found: 588.0106.



(*E*)-methyl 2-(((6-(4-iodo-2,5-dimethylphenoxy)-3,3-bis(iodomethyl)hexan-2-ylidene)amino)oxy)acetate (2h-di)

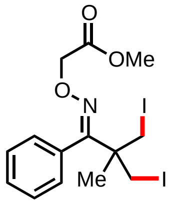
Substrate **1h** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Toluene : EtOAc = 100:1 as eluent), **2h-di** was obtained as a colorless oil (21.4 mg, 30%). ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.51 (s, 1H), 6.67 (s, 1H), 4.64 (s, 2H), 3.89 (t, *J* = 6.0 Hz, 2H), 3.74 (s, 3H), 3.51 (ABq, *J* = 10.8 Hz, 4H), 2.36 (s, 3H), 2.13 (s, 3H), 1.97 (s, 3H), 1.86-1.83 (m, 2H), 1.66-1.62 (m, 2H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 170.30, 157.88, 157.12, 140.02, 139.48, 126.34, 112.48, 89.17, 70.62, 67.13, 51.84, 46.02, 31.95, 27.96, 25.19, 15.96, 15.38, 11.62. HRMS (ESI-TOF) Calcd for $C_{19}H_{27}I_3NO_4^+$ $[M+H]^+$: 713.9069, found: 713.9062.



(*E*)-methyl 2-(((3-iodo-2-(iodomethyl)-2-methyl-1-phenylpropylidene)amino)oxy)acetate (2i-mono)

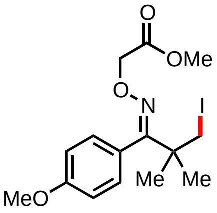
Substrate **1i** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : Acetone = 20:1 as eluent), **2i-mono** was obtained as a colorless oil (11.3 mg, 30%). ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.43-7.40 (m, 2H), 7.38-7.35 (m, 1H), 7.25-7.23 (m, 2H), 4.55 (s, 2H), 3.75 (s, 3H), 3.36 (s, 2H), 1.28 (s, 6H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 170.52, 162.74, 132.95, 128.25, 128.08, 127.40, 70.63, 51.74, 40.74, 26.72, 19.84. HRMS (ESI-TOF) Calcd for $C_{14}H_{19}INO_3^+$ $[M+H]^+$: 376.0404, found:

376.0400.



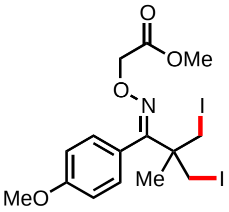
(*E*)-methyl 2-(((3-iodo-2-(iodomethyl)-2-methyl-1-phenylpropylidene)amino)oxy)acetate (2i-di)

Substrate **1i** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : Acetone = 20:1 as eluent), **2i-di** was obtained as a colorless oil (21.5 mg, 43%). ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.45-7.42 (m, 2H), 7.40-7.38 (m, 1H), 7.34-7.32 (m, 2H), 4.57 (s, 2H), 3.76 (s, 3H), 3.49 (ABq, *J* = 10.8 Hz, 4H), 1.41 (s, 3H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 170.22, 159.30, 132.08, 128.79, 128.31, 127.38, 70.83, 51.87, 43.11, 24.88, 17.66. HRMS (ESI-TOF) Calcd for $C_{14}H_{18}I_2NO_3^+$ [M+H]$^+$: 501.9371, found: 501.9375.



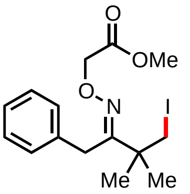
(*E*)-methyl 2-(((3-iodo-1-(4-methoxyphenyl)-2,2-dimethylpropylidene)amino)oxy)acetate (2j-mono)

Substrate **1j** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : Acetone = 20:1 as eluent), **2j-mono** was obtained as a colorless oil (11.7 mg, 29%). ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.20-7.17 (m, 2H), 6.95-6.93 (m, 2H), 4.56 (s, 2H), 3.82 (s, 3H), 3.75 (s, 3H), 3.33 (s, 2H), 1.28 (s, 6H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 170.57, 162.62, 159.33, 128.76, 124.97, 113.58, 70.61, 55.15, 51.73, 40.92, 26.70, 20.02. HRMS (ESI-TOF) Calcd for $C_{15}H_{21}INO_4^+$ [M+H]$^+$: 406.0510, found: 406.0515.



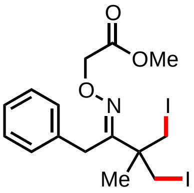
(*E*)-methyl 2-(((3-iodo-2-(iodomethyl)-1-(4-methoxyphenyl)-2-methylpropylidene)amino)oxy)acetate (2j-di)

Substrate **1j** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : Acetone = 20:1 as eluent), **2j-di** was obtained as a colorless oil (22.3 mg, 42%). ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.28-7.26 (m, 2H), 6.97-6.94 (m, 2H), 4.57 (s, 2H), 3.82 (s, 3H), 3.76 (s, 3H), 3.48 (ABq, *J* = 10.8 Hz, 4H), 1.41 (s, 3H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 170.27, 159.72, 159.26, 128.79, 124.04, 113.76, 70.80, 55.18, 51.85, 43.30, 24.84, 17.79. HRMS (ESI-TOF) Calcd for $C_{15}H_{20}I_2NO_4^+$ [M+H]$^+$: 531.9476, found: 531.9471.



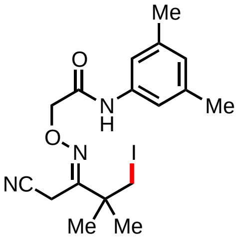
(*E*)-methyl 2-(((4-iodo-3,3-dimethyl-1-phenylbutan-2-ylidene)amino)oxy)acetate (2k-mono)

Substrate **1k** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : Acetone = 10:1 as eluent), **2k-mono** was obtained as a colorless oil (9.7 mg, 25%). ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.30-7.27 (m, 4H), 7.22-7.18 (m, 1H), 4.66 (s, 2H), 3.82 (s, 2H), 3.78 (s, 3H), 3.34 (s, 2H), 1.18 (s, 6H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 170.56, 161.85, 136.30, 128.52, 128.47, 126.23, 70.58, 51.81, 40.89, 31.78, 26.69, 20.17. HRMS (ESI-TOF) Calcd for $C_{15}H_{21}INO_3^+$ [M+H]$^+$: 390.0561, found: 390.0569.



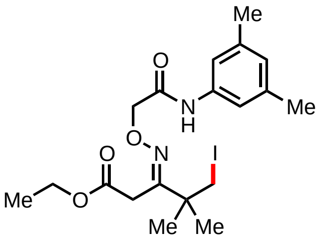
(*E*)-methyl 2-(((4-iodo-3-(iodomethyl)-3-methyl-1-phenylbutan-2-ylidene)amino)oxy)acetate (2k-di)

Substrate **1k** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : Acetone = 10:1 as eluent), **2k-di** was obtained as a colorless oil (25.8 mg, 50%). ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.30-7.29 (m, 4H), 7.24-7.20 (m, 1H), 4.70 (s, 2H), 3.85 (s, 2H), 3.79 (s, 3H), 3.45 (ABq, *J* = 10.2 Hz, 4H), 1.28 (s, 3H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 170.24, 158.72, 135.61, 128.64, 126.56, 70.82, 51.92, 43.41, 32.11, 24.85, 17.74. HRMS (ESI-TOF) Calcd for $C_{15}H_{20}I_2NO_3^+$ [M+H]$^+$: 515.9527, found: 515.9520.



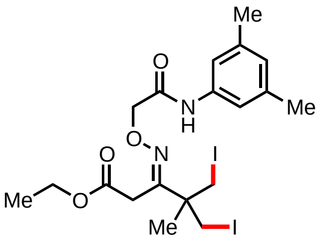
(*E*)-2-(((1-cyano-4-iodo-3,3-dimethylbutan-2-ylidene)amino)oxy)-*N*-(3,5-dimethylphenyl) acetamide (2l)

Substrate **1l** was iodinated following the general iodination procedure except the reaction temperature is 80 °C. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 2:1 as eluent), **2l** was obtained as a colorless oil (21.4 mg, 50%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.06 (br s, 1H), 7.28 (s, 2H), 6.76 (s, 1H), 4.81 (s, 2H), 3.35 (s, 2H), 3.29 (s, 2H), 2.29 (s, 6H), 1.36 (s, 6H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 166.71, 154.24, 138.61, 137.06, 126.33, 117.78, 115.38, 74.28, 41.36, 25.44, 21.36, 15.99, 14.26. HRMS (ESI-TOF) Calcd for $C_{17}H_{23}IN_3O_2^+$ $[M+H]^+$: 428.0829, found: 428.0822.



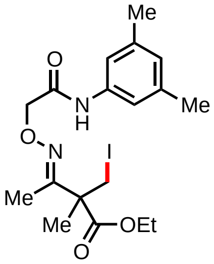
(*E*)-ethyl 3-((2-((3,5-dimethylphenyl)amino)-2-oxoethoxy)imino)-5-iodo-4,4-dimethylpentanoate (2m-mono)

Substrate **1m** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), the iodinated products were obtained as 3.4:1 (mono:di) inseparable mixtures (**2m-mono**, 26.1 mg, 55%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.63 (br s, 1H), 7.40 (s, 2H), 6.75 (s, 1H), 4.68 (s, 2H), 4.24 (q, *J* = 7.2 Hz, 2H), 3.42 (s, 2H), 3.31 (s, 2H), 2.30 (s, 6H), 1.30 (t, *J* = 7.2 Hz, 3H), 1.28 (s, 6H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 169.29, 168.21, 157.74, 138.34, 137.86, 125.83, 117.73, 73.51, 61.83, 40.63, 31.77, 25.58, 21.43, 17.59, 14.04. HRMS (ESI-TOF) Calcd for $C_{19}H_{28}IN_2O_4^+$ $[M+H]^+$: 475.1088, found: 475.1084.



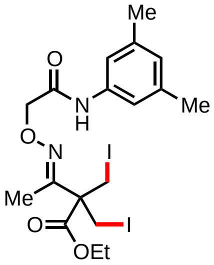
(*E*)-ethyl 3-((2-((3,5-dimethylphenyl)amino)-2-oxoethoxy)imino)-5-iodo-4-(iodomethyl)-4-methylpentanoate (2m-di)

Substrate **1m** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), the iodinated products were obtained as 3.4:1 (mono:di) inseparable mixtures (**2m-di**, 10.2 mg, 17%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.60 (br s, 1H), 7.40 (s, 2H), 6.75 (s, 1H), 4.71 (s, 2H), 4.25 (q, *J* = 7.2 Hz, 2H), 3.47 (s, 2H), 3.46 (ABq, *J* = 10.8 Hz, 4H), 2.30 (s, 6H), 1.42 (s, 3H), 1.31 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 168.80, 167.79, 154.89, 138.36, 137.76, 125.91, 117.72, 73.80, 62.06, 43.30, 32.34, 29.44, 24.00, 17.60, 15.43. HRMS (ESI-TOF) Calcd for $C_{19}H_{27}I_2N_2O_4^+$ $[M+H]^+$: 601.0055, found: 601.0051.



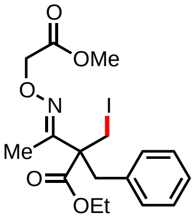
(*E*)-ethyl 3-((2-((3,5-dimethylphenyl)amino)-2-oxoethoxy)imino)-2-(iodomethyl)-2-methylbutanoate (2n-mono)

Substrate **1n** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), the iodinated products were obtained as 4.0:1 (mono:di) inseparable mixtures (**2n-mono**, 24.8 mg, 54%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.75 (br s, 1H), 7.18 (s, 2H), 6.77 (s, 1H), 4.66 (ABq, *J* = 16.2 Hz, 2H), 4.28-4.17 (m, 2H), 3.59 (ABq, *J* = 10.2 Hz, 2H), 2.30 (s, 6H), 1.97 (s, 3H), 1.50 (s, 3H), 1.27 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR of mixture (150 MHz, $CDCl_3$) δ 170.70, 167.78, 167.42, 167.16, 158.93, 156.69, 138.71, 138.70, 136.87, 136.72, 126.43, 126.34, 117.83, 117.76, 73.49, 73.27, 62.96, 62.05, 56.71, 53.06, 22.05, 21.32, 14.12, 14.08, 12.74, 12.64, 11.48, 10.59. HRMS (ESI-TOF) Calcd for $C_{18}H_{26}IN_2O_4^+$ $[M+H]^+$: 461.0932, found: 461.0939.



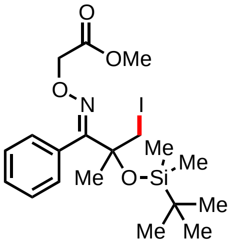
(*E*)-ethyl 3-((2-((3,5-dimethylphenyl)amino)-2-oxoethoxy)imino)-2,2-bis(iodomethyl)butanoate (2n-di)

Substrate **1n** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), the iodinated products were obtained as 4.0:1 (mono:di) inseparable mixtures (**2n-di**, 8.2 mg, 14%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.68 (br s, 1H), 7.18 (s, 2H), 6.77 (s, 1H), 4.70 (s, 2H), 4.28-4.17 (m, 2H), 3.78 (ABq, *J* = 9.6 Hz, 4H), 2.29 (s, 6H), 1.98 (s, 3H), 1.31 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR of mixture (150 MHz, $CDCl_3$) δ 170.70, 167.78, 167.42, 167.16, 158.93, 156.69, 138.71, 138.70, 136.87, 136.72, 126.43, 126.34, 117.83, 117.76, 73.49, 73.27, 62.96, 62.05, 56.71, 53.06, 22.05, 21.32, 14.12, 14.08, 12.74, 12.64, 11.48, 10.59. HRMS (ESI-TOF) Calcd for $C_{18}H_{25}I_2N_2O_4^+$ $[M+H]^+$: 586.9898, found: 586.9891.



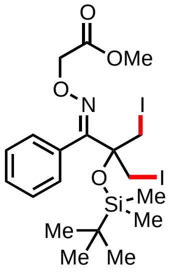
(*E*)-ethyl 2-benzyl-2-(iodomethyl)-3-((2-methoxy-2-oxoethoxy)imino)butanoate (2o)

Substrate **1o** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 5:1 as eluent), **2o** was obtained as 1.6:1 (**2o** : starting material) inseparable mixture (32.2 mg, 60%). ^{1}H NMR (600 MHz, CDCl$_3$) δ7.28-7.18 (m, 4H), 7.11-7.09 (m, 1H), 4.57 (ABq, *J* = 16.2 Hz, 2H), 4.27-4.18 (m, 2H), 3.73 (s, 3H), 3.41 (ABq, *J* = 11.4 Hz, 2H), 3.28 (ABq, *J* = 14.4 Hz, 2H), 1.93 (s, 3H), 1.28 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR of mixture (150 MHz, CDCl$_3$) δ 173.68, 170.47, 170.17, 170.13, 156.45, 136.99, 135.64, 130.42, 130.04, 128.26, 128.23, 127.94, 127.02, 126.53, 70.74, 70.52, 61.94, 61.06, 57.50, 53.74, 51.82, 51.73, 41.10, 37.69, 20.25, 14.07, 14.03, 13.26, 13.13, 9.90. HRMS (ESI-TOF) Calcd for $C_{24}H_{30}IN_2O_4^+$ [M+H]$^+$: 537.1245, found: 537.1240.



(*E*)-methyl 6-(iodomethyl)-6,8,8,9,9-pentamethyl-5-phenyl-3,7-dioxa-4-aza-8-siladec-4-en-1-oate (2p-mono)

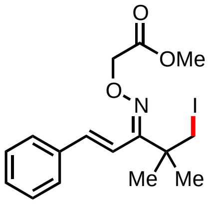
Substrate **1p** was iodinated following the general iodination procedure except the reaction temperature is 80 °C. After purification by preparative thin-layer chromatography (Toluene : EtOAc = 100:1 as eluent), **2p-mono** was obtained as a colorless oil (22.1 mg, 45%). ^{1}H NMR (600 MHz, CDCl$_3$) δ 7.40-7.34 (m, 5H), 4.58 (s, 2H), 3.76 (s, 3H), 3.42 (ABq, *J* = 9.6 Hz, 2H), 1.68 (s, 3H), 0.80 (s, 9H), 0.14 (s, 3H), 0.01 (s, 3H). ^{13}C NMR (150 MHz, CDCl$_3$) δ 170.42, 161.17, 131.92, 128.45, 128.22, 127.78, 76.40, 70.82, 51.81, 27.11, 25.89, 18.37, 17.86, -1.80, -2.48. HRMS (ESI-TOF) Calcd for $C_{19}H_{31}INO_4Si^+$ [M+H]$^+$: 492.1062, found: 492.1066.



(*E*)-methyl 6,6-bis(iodomethyl)-8,8,9,9-tetramethyl-5-phenyl-3,7-dioxa-4-aza-8-siladec-4-en-1-oate

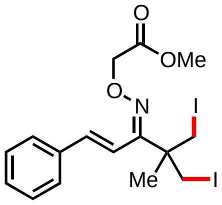
(2p-di)

Substrate **1p** was iodinated following the general iodination procedure except the reaction temperature is 80 °C. After purification by preparative thin-layer chromatography (Toluene : EtOAc = 100:1 as eluent), **2p-di** was obtained as a colorless oil (12.3 mg, 20%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.46-7.44 (m, 2H), 7.42-7.38 (m, 3H), 4.63 (s, 2H), 3.78 (s, 3H), 3.69 (ABq, *J* = 10.2 Hz, 4H), 0.92 (s, 9H), 0.15 (s, 6H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 170.05, 156.26, 130.90, 129.13, 128.42, 128.02, 76.21, 71.10, 51.98, 26.02, 18.68, 15.86, -2.14. HRMS (ESI-TOF) Calcd for $C_{19}H_{30}I_2NO_4Si^+$ $[M+H]^+$: 618.0028, found: 618.0020.



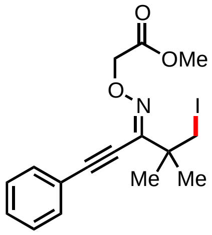
methyl 2-(((*E*)-((*E*)-5-iodo-4,4-dimethyl-1-phenylpent-1-en-3-ylidene)amino)oxy)acetate (2q-mono)

Substrate **1q** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : Acetone = 20:1 as eluent), **2q-mono** was obtained as a colorless oil (14.0 mg, 35%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.49-7.46 (m, 2H), 7.42 (d, *J* = 16.8 Hz, 1H), 7.37-7.34 (m, 2H), 7.32-7.29 (m, 1H), 6.56 (d, *J* = 16.8 Hz, 1H), 4.68 (s, 2H), 3.78 (s, 3H), 3.41 (s, 2H), 1.36 (s, 6H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 170.43, 158.24, 139.42, 136.52, 128.80, 128.69, 126.99, 116.05, 71.00, 51.86, 40.72, 26.84, 20.24. HRMS (ESI-TOF) Calcd for $C_{16}H_{21}INO_3^+$ $[M+H]^+$: 402.0561, found: 402.0555.



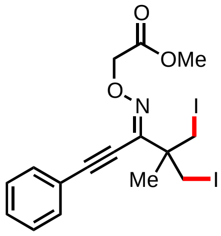
methyl 2-(((*E*)-((*E*)-5-iodo-4-(iodomethyl)-4-methyl-1-phenylpent-1-en-3-ylidene)amino)oxy)acetate (2q-di)

Substrate **1q** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 20:1 as eluent), **2q-di** was obtained as a colorless oil (18.4 mg, 35%). ^{1}H NMR (600 MHz, $CDCl_3$) δ7.49-7.47 (m, 2H), 7.42 (d, *J* = 16.8 Hz, 1H), 7.38-7.36 (m, 2H), 7.33-7.31 (m, 1H), 6.49 (d, *J* = 16.8 Hz, 1H), 4.69 (s, 2H), 3.79 (s, 3H), 3.55 (ABq, *J* = 10.2 Hz, 4H), 1.52 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 170.16, 155.74, 140.17, 136.13, 129.06, 128.74, 127.08, 115.43, 71.17, 51.96, 43.13, 24.92, 17.60. HRMS (ESI-TOF) Calcd for $C_{16}H_{20}I_2NO_3^+$ $[M+H]^+$: 527.9527, found: 527.9521.



(*E*)-methyl 2-(((5-iodo-4,4-dimethyl-1-phenylpent-1-yn-3-ylidene)amino)oxy)acetate (2r-mono)

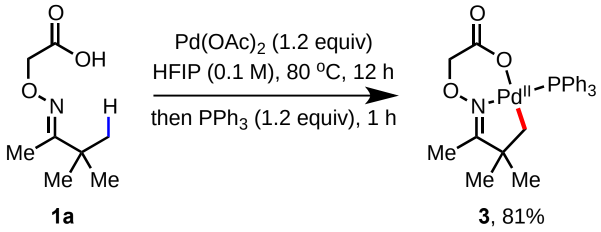
Substrate **1r** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 10:1 as eluent), the iodinated products were obtained as 1.9:1 (mono:di) inseparable mixtures (**2r-mono**, 20.7 mg, 52%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.55-7.53 (m, 2H), 7.38-7.34 (m, 3H), 4.73 (s, 2H), 3.78 (s, 3H), 3.45 (s, 2H), 1.39 (s, 6H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 169.70, 146.92, 132.15, 129.59, 128.40, 121.55, 101.62, 78.23, 71.19, 51.92, 40.46, 26.18, 16.11. HRMS (ESI-TOF) Calcd for $C_{16}H_{19}INO_3^+$ $[M+H]^+$: 400.0404, found: 400.0400.



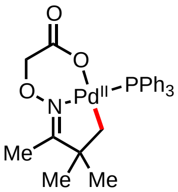
(*E*)-methyl 2-(((3-iodo-2-(iodomethyl)-2-methyl-1-phenylpropylidene)amino)oxy)acetate (2r-di)

Substrate **1r** was iodinated following the general iodination procedure. After purification by preparative thin-layer chromatography (Hexane : EtOAc = 10:1 as eluent), the iodinated products were obtained as 1.9:1 (mono:di) inseparable mixtures (**2r-di**, 8.4 mg, 16%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.56-7.54 (m, 2H), 7.43-7.39 (m, 3H), 4.75 (s, 2H), 3.79 (s, 3H), 3.59 (ABq, J = 10.2 Hz, 4H), 1.54 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 169.96, 143.74, 132.21, 129.87, 128.47, 121.15, 102.03, 77.69, 71.39, 52.02, 42.89, 24.71, 18.97. HRMS (ESI-TOF) Calcd for $C_{16}H_{18}I_2NO_3^+$ $[M+H]^+$: 525.9371, found: 525.9377.

The Synthesis and Characterization of Palladacycle



The General Procedures for the Palladacycle Synthesis: Substrate **1a** (0.1 mmol, 17.3 mg) and $Pd(OAc)_2$ (0.12 mmol, 27.0 mg) were weighed into a reaction vial (10 mL) with a magnetic stir bar under air. HFIP (1.0 mL) was added, and the vial was sealed with a cap. The reaction mixture was stirred at 80 °C for 12 hours. Upon completion, the reaction mixture was cooled to room temperature and PPh_3 (0.12 mmol, 31.4 mg) was added. The reaction was stirred for anther 1 h at 80 °C. Upon completion, the reaction mixture was cooled to room temperature and diluted with EtOAc. Then the reaction mixture was filtered through a plug of celite. The solvent was removed under vacuum and the resulting mixture was purified by preparative thin-layer chromatography with EtOAc : MeOH = 10:1 as the eluent.



Palladacycle (3)

Substrate **1a** was palladated following the general procedures. After purification by preparative thin-layer chromatography (EtOAc : MeOH = 10:1 as eluent), **3** was obtained as a white solid (43.7 mg, 81%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.60-7.56 (m, 6H), 7.46-7.39 (m, 9H), 4.57 (s, 2H), 1.95 (s, 3H), 1.57 (d, *J* = 3.6 Hz, 2H), 1.11 (s, 6H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 178.99, 172.54, 134.04 (d, *J* = 12.0 Hz), 130.60, 128.57, 128.49, 76.00, 50.26, 40.35, 28.65, 12.24. HRMS (ESI-TOF) Calcd for $C_{26}H_{28}NO_3PPd$ $[M+H]^+$: 539.0842, found: 539.0850.

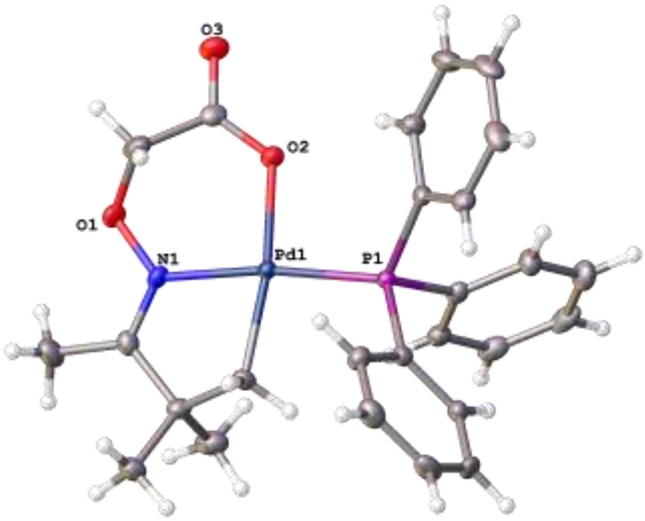


Table 1. Crystal data and structure refinement for palladacycle **3**.

Identification code	ZRY-12-142-4
Empirical formula	C26 H28 N O3 P Pd
Formula weight	539.86
Temperature	100.0 K
Wavelength	0.71073 Å
Crystal system	Monoclinic
Space group	P 21/c
Unit cell dimensions	a = 13.5418(12) Å = 90°.
	b = 12.5775(14) Å = 110.150(3)°.
	c = 14.9257(17) Å = 90°.
Volume	2386.6(4) Å3
Z	4
Density (calculated)	1.503 Mg/m3
Absorption coefficient	0.872 mm-1
F(000)	1104
Crystal size	0.3 x 0.24 x 0.19 mm3
Theta range for data collection	2.907 to 27.945°.
Index ranges	-14<=h<=17, -16<=k<=16, -19<=l<=16
Reflections collected	24974
Independent reflections	5704 [R(int) = 0.0292]
Completeness to theta = 25.242°	99.7 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.2622 and 0.2255
Refinement method	Full-matrix least-squares on F2
Data / restraints / parameters	5704 / 0 / 292
Goodness-of-fit on F2	1.035
Final R indices [I>2sigma(I)]	R1 = 0.0235, wR2 = 0.0563
R indices (all data)	R1 = 0.0313, wR2 = 0.0603
Extinction coefficient	n/a
Largest diff. peak and hole	0.430 and -0.398 e.Å-3

Table 2. Atomic coordinates (x 104) and equivalent isotropic displacement parameters (Å2x 103) for palladacycle **3**. U(eq) is defined as one third of the trace of the orthogonalized Uij tensor.

	x	y	z	U(eq)
Pd(1)	2380(1)	4394(1)	4072(1)	14(1)
P(1)	2951(1)	5660(1)	5194(1)	14(1)
O(1)	1864(1)	2305(1)	2964(1)	25(1)
O(2)	2476(1)	3053(1)	4983(1)	21(1)
N(1)	1840(1)	3422(1)	2919(1)	18(1)
O(3)	2738(1)	1325(1)	5254(1)	30(1)
C(16)	2269(2)	6364(2)	6676(1)	23(1)
C(24)	4103(2)	8766(2)	4245(1)	28(1)
C(21)	3368(1)	6901(1)	4804(1)	16(1)
C(9)	4067(1)	5295(1)	6245(1)	17(1)
C(26)	2928(2)	7879(2)	4892(1)	20(1)
C(20)	921(2)	6073(2)	5155(1)	21(1)
C(25)	3293(2)	8810(2)	4606(1)	27(1)
C(15)	1978(1)	6060(1)	5721(1)	17(1)
C(14)	4020(2)	4326(2)	6684(1)	23(1)
C(10)	4901(2)	5987(2)	6668(1)	22(1)
C(22)	4168(2)	6864(2)	4412(1)	21(1)
C(2)	1232(2)	5015(2)	2094(1)	20(1)
C(18)	465(2)	6712(2)	6471(2)	29(1)
C(17)	1508(2)	6686(2)	7050(2)	29(1)
C(1)	2071(2)	5472(1)	2999(1)	20(1)
C(4)	124(2)	5315(2)	2083(2)	30(1)
C(19)	161(2)	6403(2)	5528(2)	25(1)
C(5)	1312(1)	3814(2)	2100(1)	20(1)
C(8)	2635(1)	2109(1)	4743(1)	20(1)
C(23)	4543(2)	7793(2)	4142(2)	26(1)
C(11)	5671(2)	5726(2)	7532(1)	27(1)
C(13)	4797(2)	4071(2)	7546(2)	29(1)
C(7)	2747(2)	1946(2)	3764(2)	25(1)
C(3)	1392(2)	5462(2)	1194(1)	25(1)
C(6)	795(2)	3145(2)	1242(2)	31(1)
C(12)	5614(2)	4775(2)	7965(1)	30(1)

Table 3. Bond lengths [Å] and angles [°] for palladacycle **3**.

Pd(1)-P(1)	2.2463(5)
Pd(1)-O(2)	2.1424(13)
Pd(1)-N(1)	2.0303(15)
Pd(1)-C(1)	2.0289(18)
P(1)-C(21)	1.8227(18)
P(1)-C(9)	1.8228(18)
P(1)-C(15)	1.8235(18)
O(1)-N(1)	1.4068(19)
O(1)-C(7)	1.441(2)
O(2)-C(8)	1.280(2)
N(1)-C(5)	1.283(2)
O(3)-C(8)	1.225(2)
C(16)-H(16)	0.9500
C(16)-C(15)	1.395(3)
C(16)-C(17)	1.390(3)
C(24)-H(24)	0.9500
C(24)-C(25)	1.379(3)
C(24)-C(23)	1.392(3)
C(21)-C(26)	1.393(2)
C(21)-C(22)	1.398(3)
C(9)-C(14)	1.396(3)
C(9)-C(10)	1.394(3)
C(26)-H(26)	0.9500
C(26)-C(25)	1.393(3)
C(20)-H(20)	0.9500
C(20)-C(15)	1.388(3)
C(20)-C(19)	1.392(3)
C(25)-H(25)	0.9500
C(14)-H(14)	0.9500
C(14)-C(13)	1.390(3)
C(10)-H(10)	0.9500
C(10)-C(11)	1.389(3)
C(22)-H(22)	0.9500
C(22)-C(23)	1.388(3)
C(2)-C(1)	1.546(2)
C(2)-C(4)	1.543(3)
C(2)-C(5)	1.513(3)
C(2)-C(3)	1.537(3)
C(18)-H(18)	0.9500
C(18)-C(17)	1.380(3)
C(18)-C(19)	1.379(3)
C(17)-H(17)	0.9500

C(1)-H(1A)	0.9900
C(1)-H(1B)	0.9900
C(4)-H(4A)	0.9800
C(4)-H(4B)	0.9800
C(4)-H(4C)	0.9800
C(19)-H(19)	0.9500
C(5)-C(6)	1.491(3)
C(8)-C(7)	1.535(3)
C(23)-H(23)	0.9500
C(11)-H(11)	0.9500
C(11)-C(12)	1.376(3)
C(13)-H(13)	0.9500
C(13)-C(12)	1.386(3)
C(7)-H(7A)	0.9900
C(7)-H(7B)	0.9900
C(3)-H(3A)	0.9800
C(3)-H(3B)	0.9800
C(3)-H(3C)	0.9800
C(6)-H(6A)	0.9800
C(6)-H(6B)	0.9800
C(6)-H(6C)	0.9800
C(12)-H(12)	0.9500

O(2)-Pd(1)-P(1)	98.90(4)
N(1)-Pd(1)-P(1)	171.69(5)
N(1)-Pd(1)-O(2)	89.41(6)
C(1)-Pd(1)-P(1)	92.24(5)
C(1)-Pd(1)-O(2)	168.01(6)
C(1)-Pd(1)-N(1)	79.46(7)
C(21)-P(1)-Pd(1)	115.73(6)
C(21)-P(1)-C(9)	103.57(8)
C(21)-P(1)-C(15)	104.58(8)
C(9)-P(1)-Pd(1)	115.67(6)
C(9)-P(1)-C(15)	101.90(8)
C(15)-P(1)-Pd(1)	113.75(6)
N(1)-O(1)-C(7)	110.58(13)
C(8)-O(2)-Pd(1)	122.12(12)
O(1)-N(1)-Pd(1)	124.45(11)
C(5)-N(1)-Pd(1)	119.72(13)
C(5)-N(1)-O(1)	115.16(15)
C(15)-C(16)-H(16)	119.9
C(17)-C(16)-H(16)	119.9
C(17)-C(16)-C(15)	120.12(18)
C(25)-C(24)-H(24)	119.8

C(25)-C(24)-C(23)	120.38(18)
C(23)-C(24)-H(24)	119.8
C(26)-C(21)-P(1)	122.43(14)
C(26)-C(21)-C(22)	119.22(17)
C(22)-C(21)-P(1)	118.35(14)
C(14)-C(9)-P(1)	117.80(14)
C(10)-C(9)-P(1)	122.35(14)
C(10)-C(9)-C(14)	119.55(17)
C(21)-C(26)-H(26)	119.9
C(21)-C(26)-C(25)	120.25(18)
C(25)-C(26)-H(26)	119.9
C(15)-C(20)-H(20)	119.7
C(15)-C(20)-C(19)	120.56(18)
C(19)-C(20)-H(20)	119.7
C(24)-C(25)-C(26)	120.01(18)
C(24)-C(25)-H(25)	120.0
C(26)-C(25)-H(25)	120.0
C(16)-C(15)-P(1)	121.62(14)
C(20)-C(15)-P(1)	119.12(14)
C(20)-C(15)-C(16)	119.26(17)
C(9)-C(14)-H(14)	120.2
C(13)-C(14)-C(9)	119.60(19)
C(13)-C(14)-H(14)	120.2
C(9)-C(10)-H(10)	119.8
C(11)-C(10)-C(9)	120.36(19)
C(11)-C(10)-H(10)	119.8
C(21)-C(22)-H(22)	119.8
C(23)-C(22)-C(21)	120.40(18)
C(23)-C(22)-H(22)	119.8
C(4)-C(2)-C(1)	109.72(17)
C(5)-C(2)-C(1)	109.65(15)
C(5)-C(2)-C(4)	108.11(16)
C(5)-C(2)-C(3)	109.84(16)
C(3)-C(2)-C(1)	110.19(16)
C(3)-C(2)-C(4)	109.29(16)
C(17)-C(18)-H(18)	119.6
C(19)-C(18)-H(18)	119.6
C(19)-C(18)-C(17)	120.86(19)
C(16)-C(17)-H(17)	120.1
C(18)-C(17)-C(16)	119.8(2)
C(18)-C(17)-H(17)	120.1
Pd(1)-C(1)-H(1A)	109.8
Pd(1)-C(1)-H(1B)	109.8
C(2)-C(1)-Pd(1)	109.33(12)

C(2)-C(1)-H(1A)	109.8
C(2)-C(1)-H(1B)	109.8
H(1A)-C(1)-H(1B)	108.3
C(2)-C(4)-H(4A)	109.5
C(2)-C(4)-H(4B)	109.5
C(2)-C(4)-H(4C)	109.5
H(4A)-C(4)-H(4B)	109.5
H(4A)-C(4)-H(4C)	109.5
H(4B)-C(4)-H(4C)	109.5
C(20)-C(19)-H(19)	120.3
C(18)-C(19)-C(20)	119.40(19)
C(18)-C(19)-H(19)	120.3
N(1)-C(5)-C(2)	113.87(16)
N(1)-C(5)-C(6)	122.99(18)
C(6)-C(5)-C(2)	123.11(17)
O(2)-C(8)-C(7)	118.18(16)
O(3)-C(8)-O(2)	124.55(18)
O(3)-C(8)-C(7)	117.23(17)
C(24)-C(23)-H(23)	120.1
C(22)-C(23)-C(24)	119.71(19)
C(22)-C(23)-H(23)	120.1
C(10)-C(11)-H(11)	120.1
C(12)-C(11)-C(10)	119.7(2)
C(12)-C(11)-H(11)	120.1
C(14)-C(13)-H(13)	119.9
C(12)-C(13)-C(14)	120.1(2)
C(12)-C(13)-H(13)	119.9
O(1)-C(7)-C(8)	114.92(16)
O(1)-C(7)-H(7A)	108.5
O(1)-C(7)-H(7B)	108.5
C(8)-C(7)-H(7A)	108.5
C(8)-C(7)-H(7B)	108.5
H(7A)-C(7)-H(7B)	107.5
C(2)-C(3)-H(3A)	109.5
C(2)-C(3)-H(3B)	109.5
C(2)-C(3)-H(3C)	109.5
H(3A)-C(3)-H(3B)	109.5
H(3A)-C(3)-H(3C)	109.5
H(3B)-C(3)-H(3C)	109.5
C(5)-C(6)-H(6A)	109.5
C(5)-C(6)-H(6B)	109.5
C(5)-C(6)-H(6C)	109.5
H(6A)-C(6)-H(6B)	109.5
H(6A)-C(6)-H(6C)	109.5

H(6B)-C(6)-H(6C)	109.5
C(11)-C(12)-C(13)	120.62(19)
C(11)-C(12)-H(12)	119.7
C(13)-C(12)-H(12)	119.7

Symmetry transformations used to generate equivalent atoms:

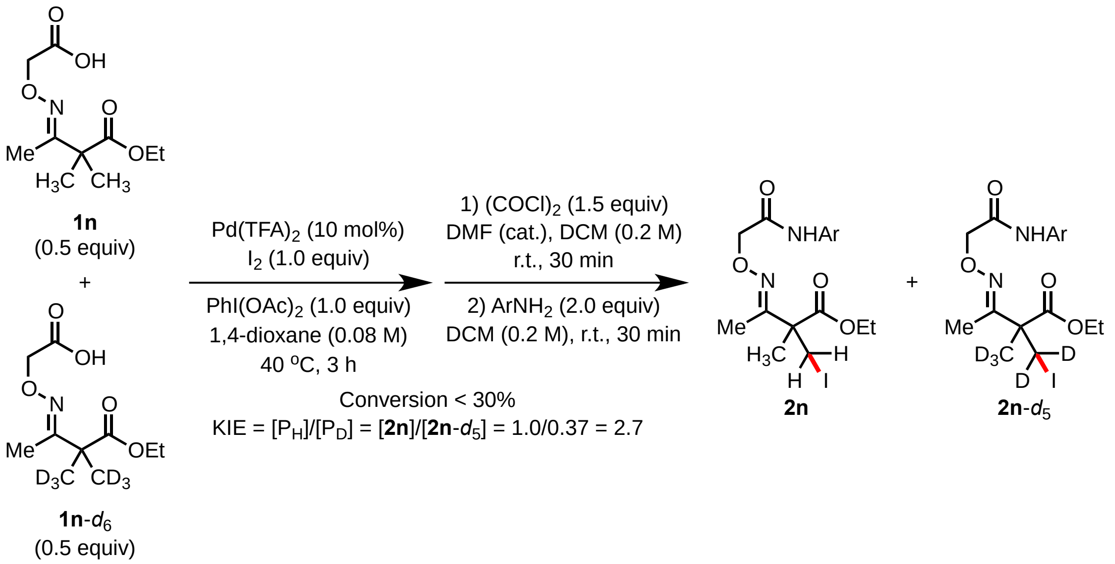
Table 4. Anisotropic displacement parameters (Å2x 103) for palladacycle **3**. The anisotropic displacement factor exponent takes the form: -2 2[h2 a*2U11 + ... + 2 h k a* b* U12]

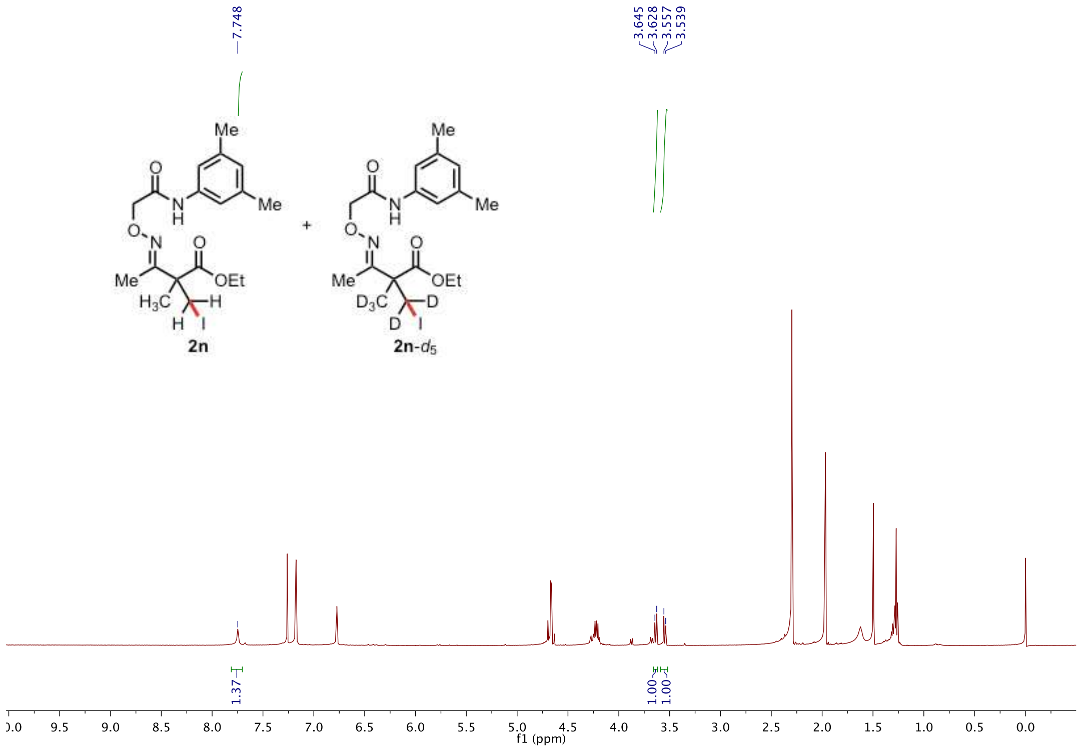
	U11	U22	U33	U23	U13	U12
Pd(1)	17(1)	12(1)	14(1)	0(1)	5(1)	1(1)
P(1)	16(1)	12(1)	14(1)	0(1)	5(1)	1(1)
O(1)	36(1)	13(1)	23(1)	-2(1)	7(1)	-2(1)
O(2)	29(1)	15(1)	21(1)	2(1)	9(1)	1(1)
N(1)	21(1)	14(1)	20(1)	-2(1)	8(1)	-1(1)
O(3)	43(1)	18(1)	28(1)	6(1)	11(1)	1(1)
C(16)	25(1)	25(1)	21(1)	-3(1)	9(1)	0(1)
C(24)	44(1)	21(1)	18(1)	1(1)	10(1)	-11(1)
C(21)	21(1)	15(1)	12(1)	0(1)	4(1)	-1(1)
C(9)	19(1)	18(1)	15(1)	-1(1)	5(1)	4(1)
C(26)	29(1)	18(1)	15(1)	-1(1)	9(1)	2(1)
C(20)	23(1)	19(1)	22(1)	3(1)	7(1)	1(1)
C(25)	47(1)	13(1)	20(1)	0(1)	12(1)	2(1)
C(15)	18(1)	14(1)	20(1)	1(1)	10(1)	0(1)
C(14)	26(1)	22(1)	21(1)	2(1)	6(1)	2(1)
C(10)	21(1)	22(1)	21(1)	0(1)	6(1)	2(1)
C(22)	23(1)	18(1)	22(1)	0(1)	9(1)	0(1)
C(2)	21(1)	20(1)	18(1)	1(1)	4(1)	0(1)
C(18)	32(1)	20(1)	44(1)	2(1)	26(1)	3(1)
C(17)	36(1)	28(1)	27(1)	-3(1)	17(1)	2(1)
C(1)	27(1)	17(1)	15(1)	1(1)	6(1)	-1(1)
C(4)	26(1)	30(1)	34(1)	8(1)	10(1)	4(1)
C(19)	20(1)	20(1)	37(1)	5(1)	12(1)	1(1)
C(5)	20(1)	23(1)	17(1)	-3(1)	6(1)	-3(1)
C(8)	16(1)	18(1)	22(1)	2(1)	3(1)	0(1)
C(23)	28(1)	29(1)	23(1)	0(1)	11(1)	-8(1)
C(11)	19(1)	39(1)	21(1)	-5(1)	4(1)	0(1)
C(13)	34(1)	28(1)	22(1)	9(1)	8(1)	8(1)
C(7)	30(1)	16(1)	31(1)	2(1)	13(1)	6(1)
C(3)	29(1)	26(1)	19(1)	3(1)	6(1)	-1(1)
C(6)	41(1)	29(1)	19(1)	-3(1)	4(1)	-8(1)
C(12)	24(1)	46(1)	18(1)	7(1)	3(1)	11(1)

Table 5. Hydrogen coordinates (x 104) and isotropic displacement parameters (Å2x 10 3) for palladacycle **3**.

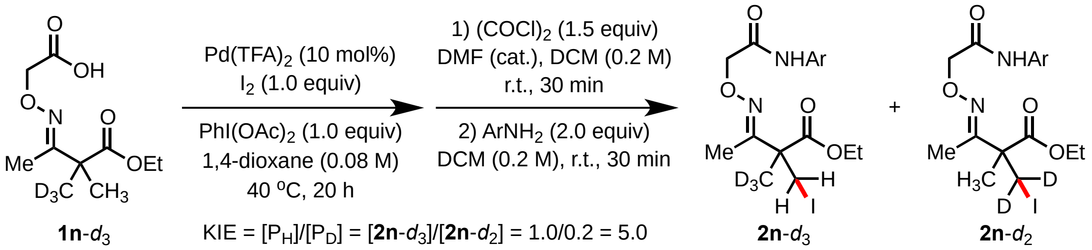
	x	y	z	U(eq)
H(16)	2989	6352	7071	28
H(24)	4362	9403	4065	33
H(26)	2376	7912	5148	25
H(20)	716	5854	4507	26
H(25)	2985	9474	4660	32
H(14)	3460	3843	6396	28
H(10)	4944	6641	6365	26
H(22)	4457	6198	4330	25
H(18)	-52	6947	6725	34
H(17)	1707	6887	7702	34
H(1A)	1811	6140	3188	24
H(1B)	2723	5633	2866	24
H(4A)	40	5079	2678	45
H(4B)	-407	4968	1541	45
H(4C)	34	6088	2023	45
H(19)	-560	6415	5137	30
H(23)	5097	7766	3889	31
H(11)	6235	6203	7821	33
H(13)	4769	3413	7849	34
H(7A)	3385	2326	3757	30
H(7B)	2856	1179	3680	30
H(3A)	1443	6238	1239	38
H(3B)	794	5261	630	38
H(3C)	2041	5171	1142	38
H(6A)	1298	2991	919	47
H(6B)	189	3527	804	47
H(6C)	557	2477	1437	47
H(12)	6138	4598	8557	36

Measurement of the Kinetic Isotope Effect



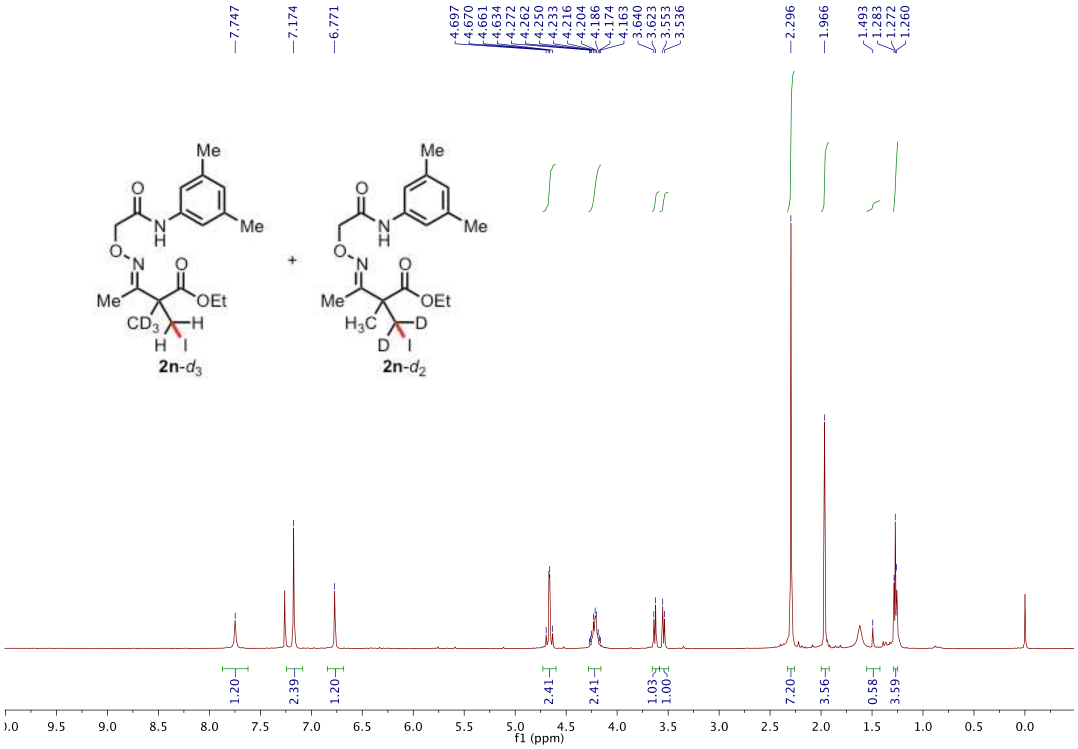


General Procedures for the Intermolecular KIE Experiment: Substrate **1n** (0.05 mmol, 11.6 mg), **1n**-*d*$_6$ (0.05 mmol, 11.9 mg), Pd(TFA)$_2$ (0.01 mmol, 3.3 mg), I$_2$ (0.10 mmol, 25.4 mg) and PhI(OAc)$_2$ (0.10 mmol, 32.2 mg) were weighed into a reaction vial (10 mL) with a magnetic stir bar under air. 1,4-Dioxane (1.25 mL) was added, and the vial was sealed with a cap. The reaction mixture was stirred at 40 ºC for 3 hours. Upon completion, the reaction mixture was cooled to room temperature and diluted with EtOAc. Then the reaction mixture was filtered through a plug of silicon gel and transferred to a reaction vial (10 mL) with a magnetic stir bar. The solvent was evaporated under vacuum. Anhydrous DCM (0.5 mL) and DMF (ca. 10 μL) were added to the mixture. (COCl)$_2$ (0.15 mmol, 13 μL) was added dropwise at room temperature. The vial was sealed with a cap. The reaction mixture was stirred at room temperature for 30 min before excess $(COCl)_2$ and solvent were evaporated. To the mixture was added anhydrous DCM (0.5 mL), followed by the dropwise addition of 3,5-dimethylaniline (0.2 mmol, 25μL) to the mixture at room temperature. The vial was sealed with a cap. The reaction mixture was stirred at room temperature for 30 min. Upon completion, the reaction mixture was diluted with EtOAc. Then the reaction mixture was filtered through a plug of celite and the solvent was removed under vacuum. The resulting mixture was purified by preparative thin-layer chromatography. The ratio (KIE value) of **2n** to **2n**-d_5 was determined by ^{1}H NMR analysis.



1n-d_3 **2n**-d_3 **2n**-d_2

KIE = $[P_H]/[P_D]$ = [**2n**-d_3]/[**2n**-d_2] = 1.0/0.2 = 5.0



General Procedures for the Intramolecular KIE Experiment: Substrate **1n**-d_3 (0.10 mmol, 23.4 mg), $Pd(TFA)_2$ (0.01 mmol, 3.3 mg), I_2 (0.10 mmol, 25.4 mg) and $PhI(OAc)_2$ (0.10 mmol, 32.2 mg) were weighed into a reaction vial (10 mL) with a magnetic stir bar under air. 1,4-Dioxane (1.25 mL) was added, and the vial was sealed with a cap. The reaction mixture was stirred at 40 °C for 20 hours. Upon completion, the reaction mixture was cooled to room temperature and diluted with EtOAc. Then the reaction mixture was filtered through a plug of silicon gel and transferred to a reaction vial (10 mL) with a magnetic stir bar. The solvent was evaporated under vacuum. Anhydrous DCM (0.5 mL) and DMF (ca. 10 μL) were added to the mixture. $(COCl)_2$ (0.15 mmol, 13 μL) was added dropwise at room temperature. The vial was sealed with a cap. The reaction mixture was stirred at room temperature for 30 min before excess $(COCl)_2$ and solvent were evaporated. To the mixture was added anhydrous DCM (0.5 mL), followed by the dropwise addition of 3,5-dimethylaniline (0.2 mmol, 25μL) to the mixture at room temperature. The vial was sealed with a cap. The reaction mixture was stirred at room temperature for 30 min. Upon completion, the reaction mixture was diluted with EtOAc. Then the reaction mixture was filtered through a plug of celite and the solvent was removed under vacuum. The resulting mixture was purified by preparative thin-layer chromatography. The ratio (KIE value) of **2n**-d_3 to **2n**-d_2 was determined by ^{1}H NMR analysis.

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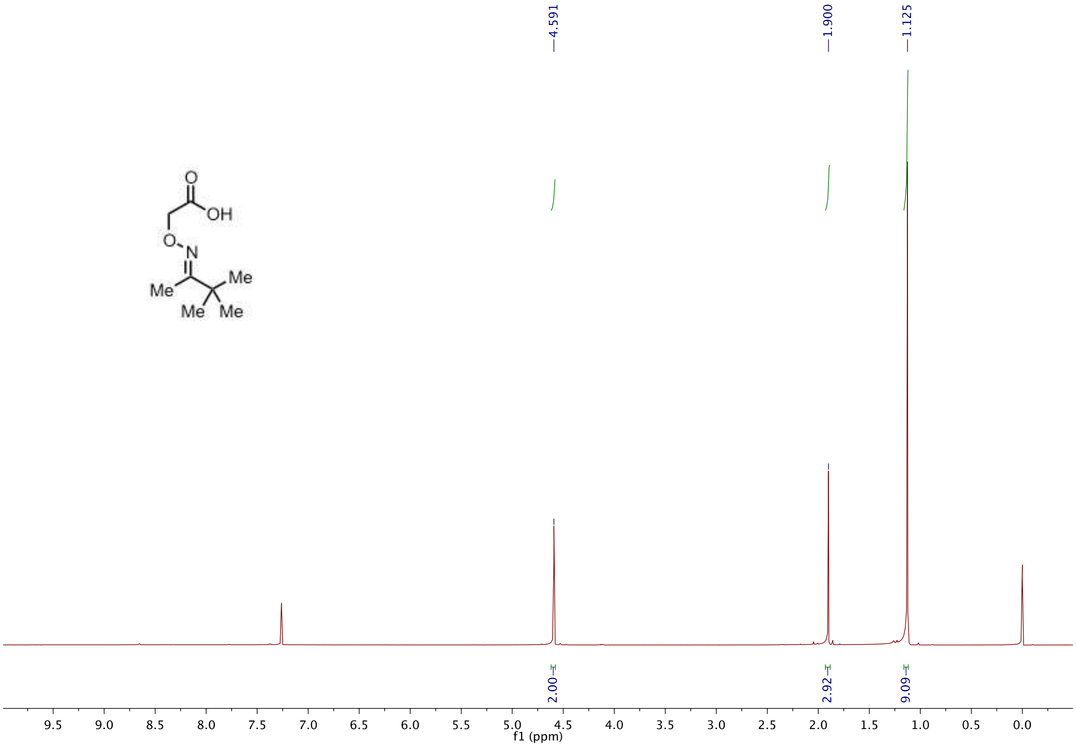
^{1}H and ^{13}C NMR Spectra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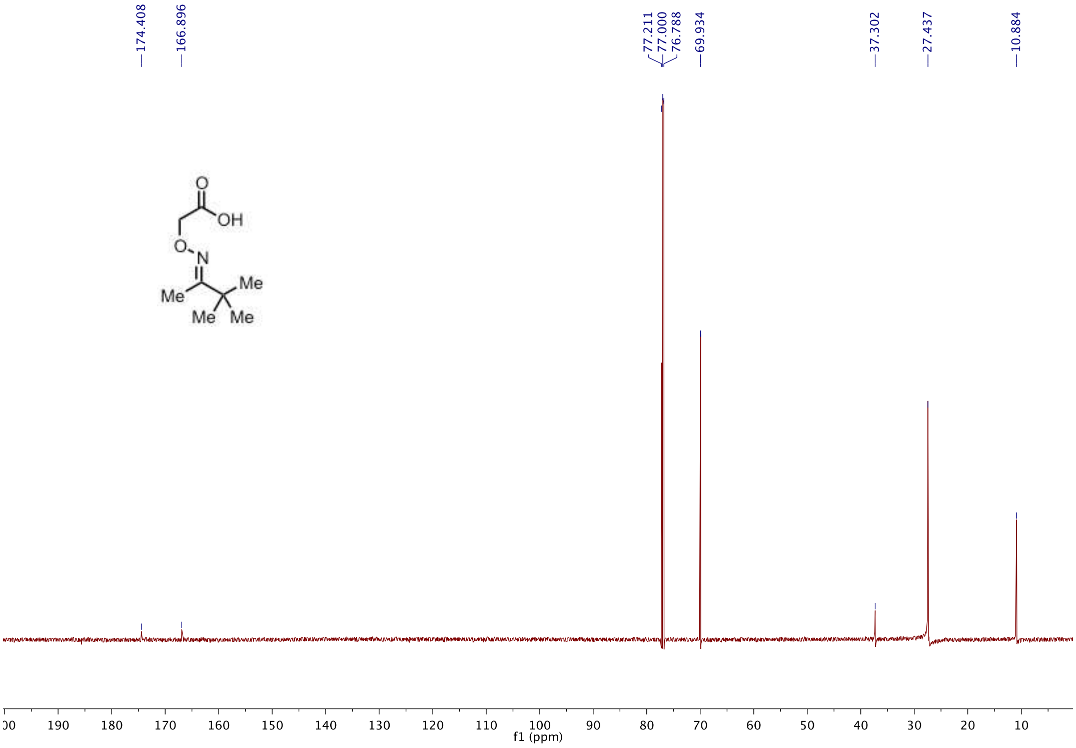
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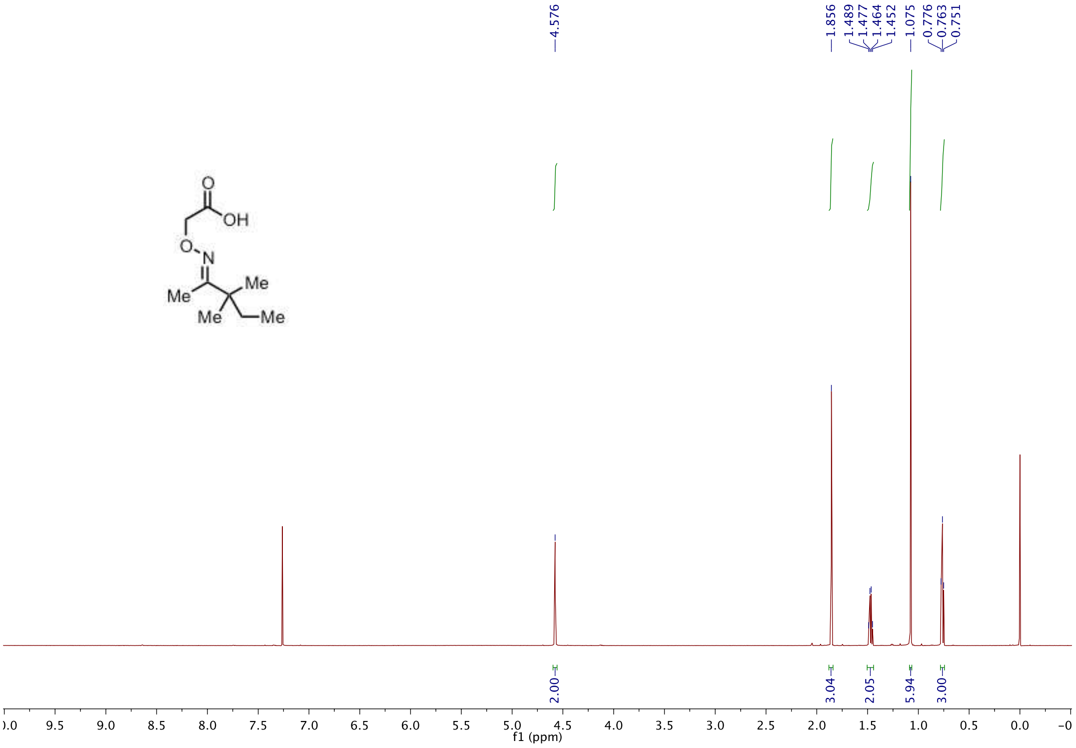
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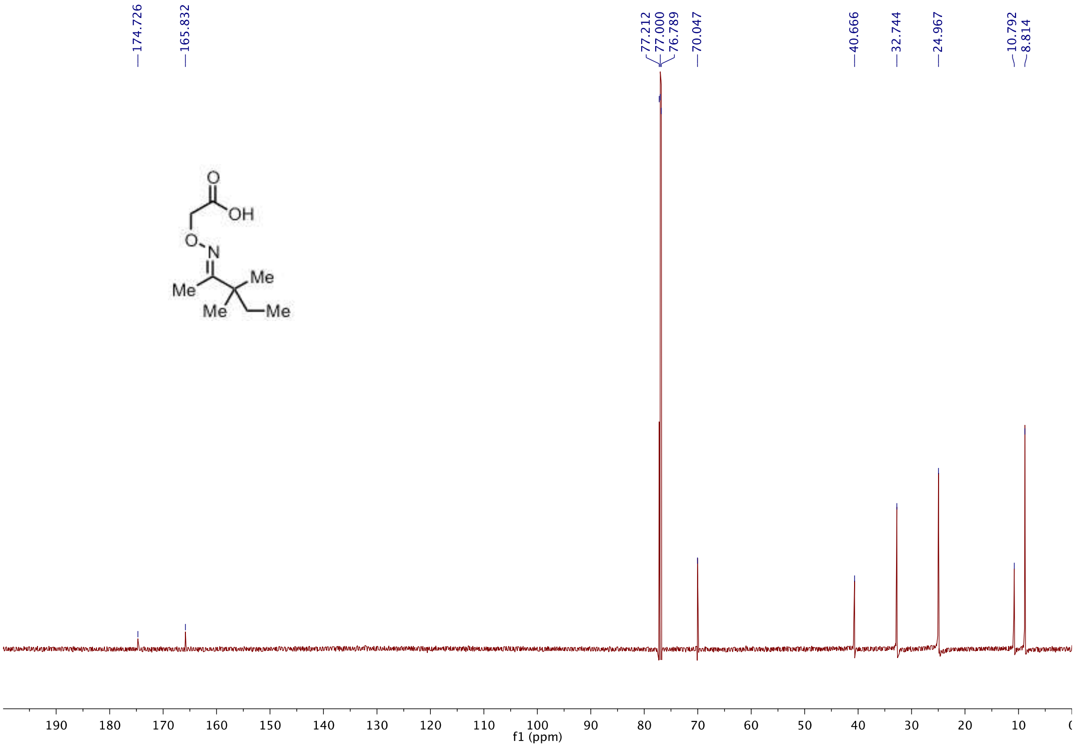
f1 (ppm)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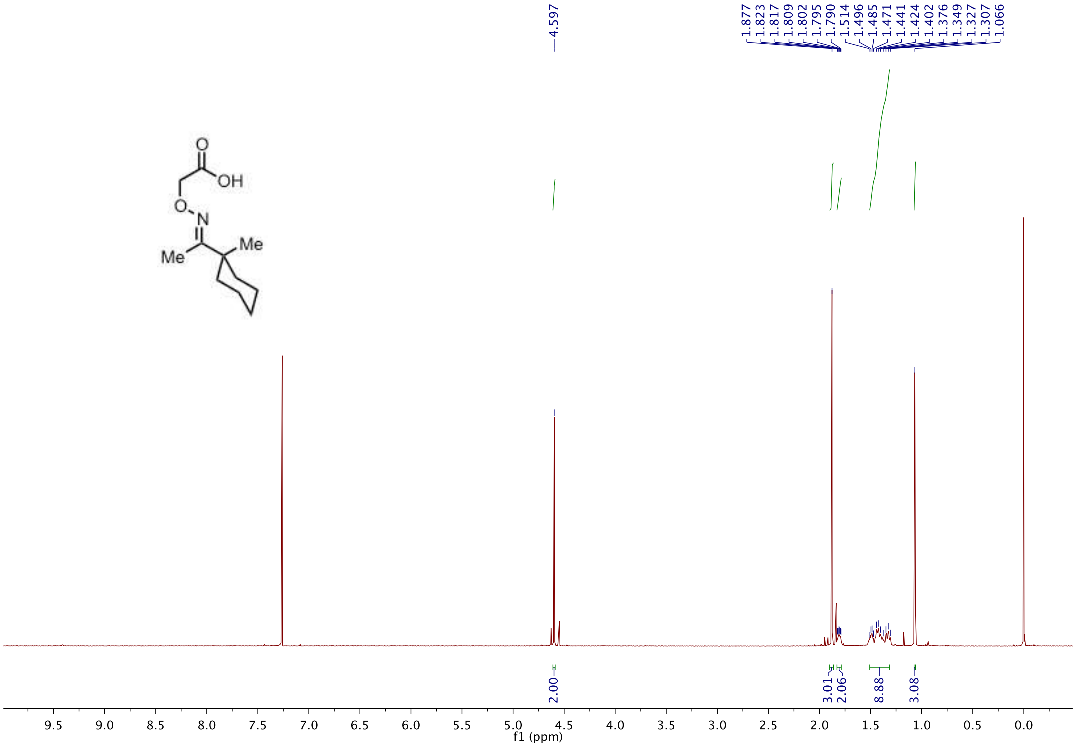
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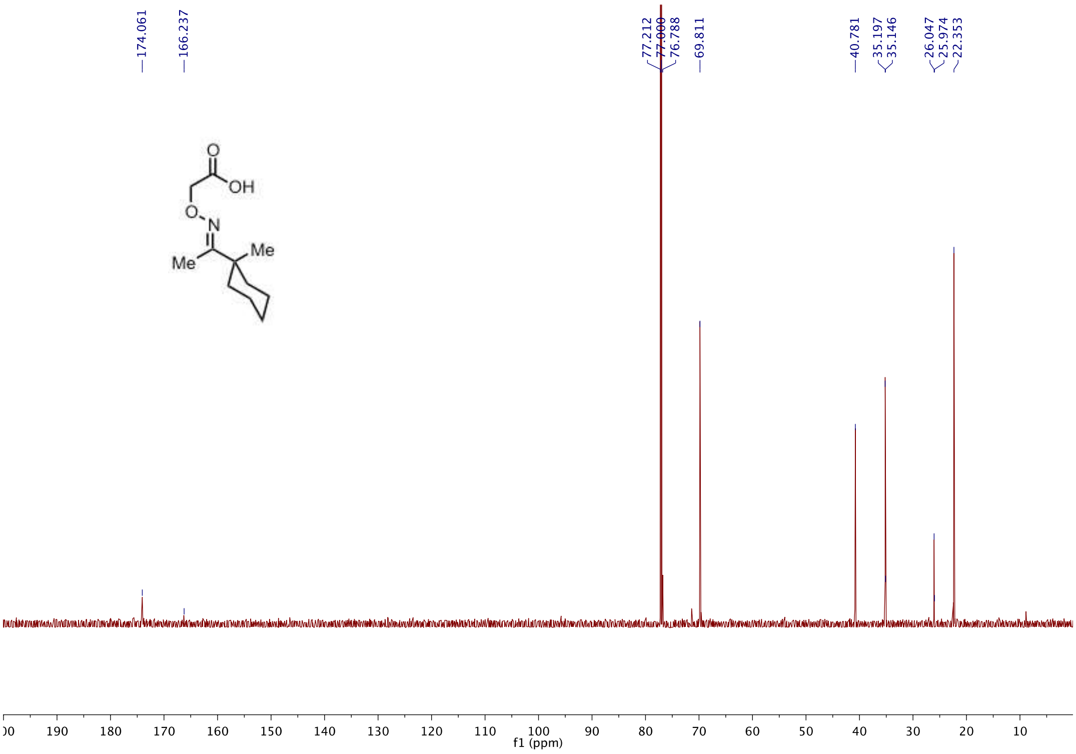
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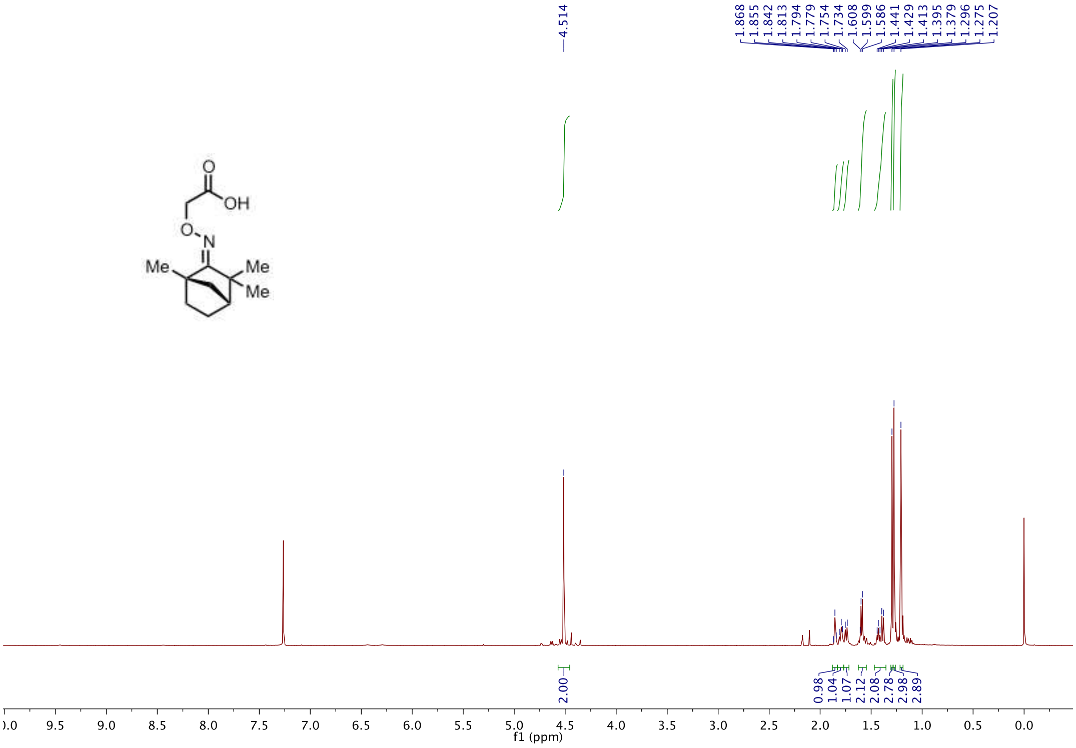
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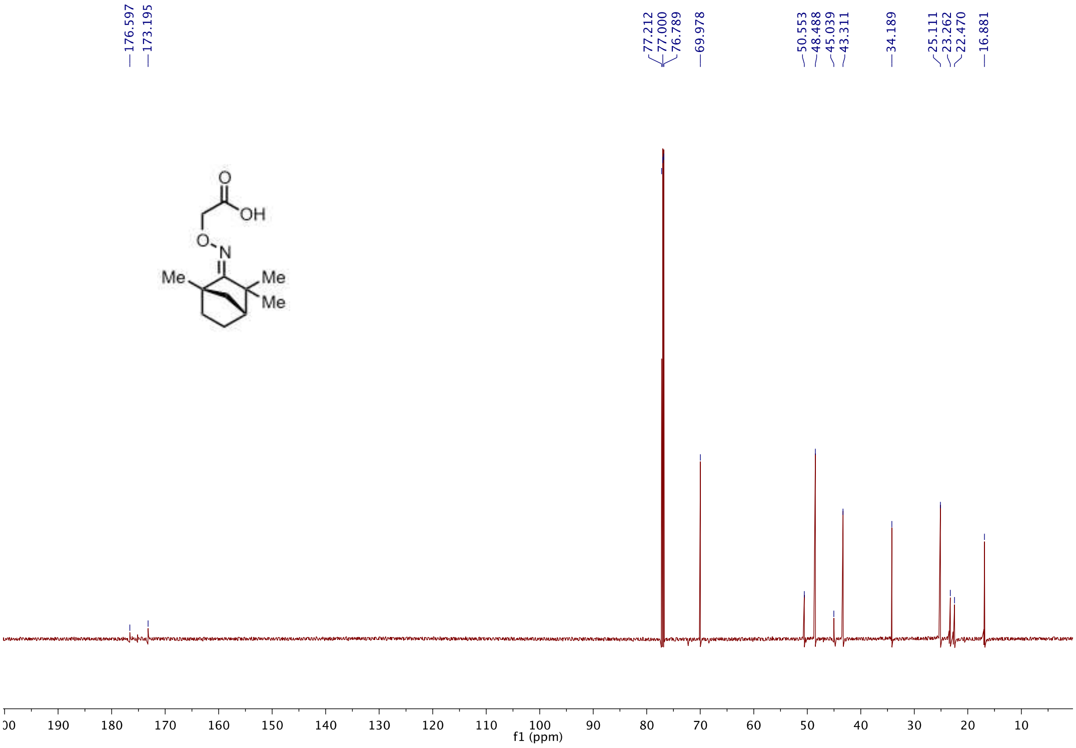
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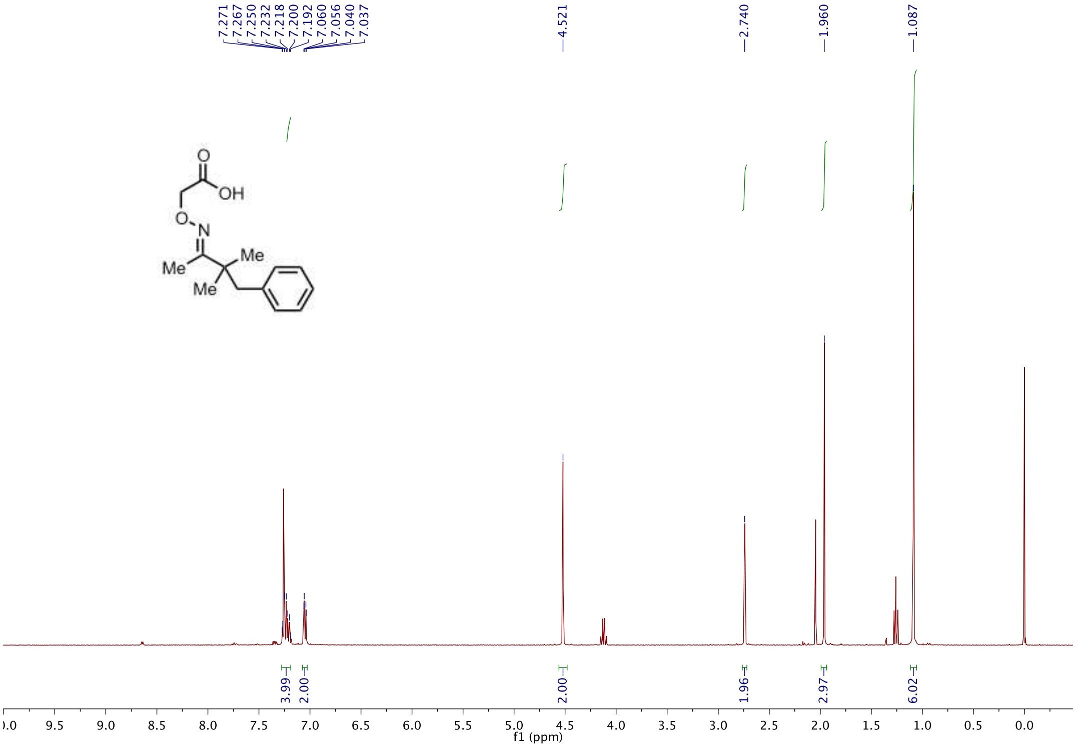
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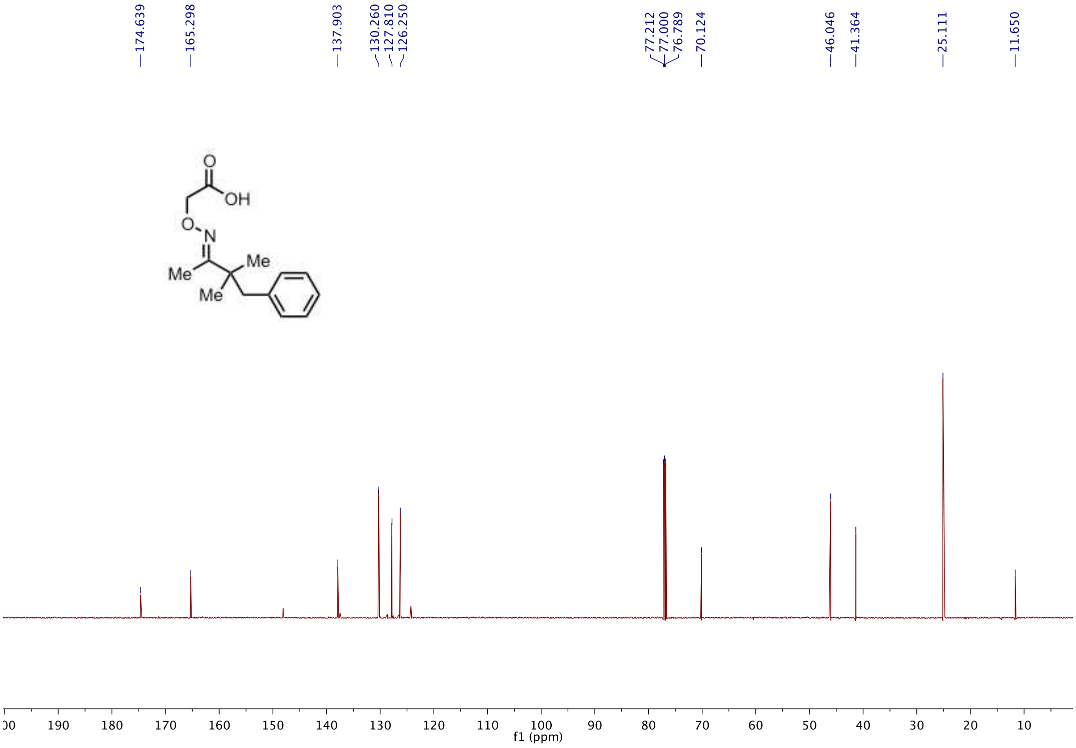
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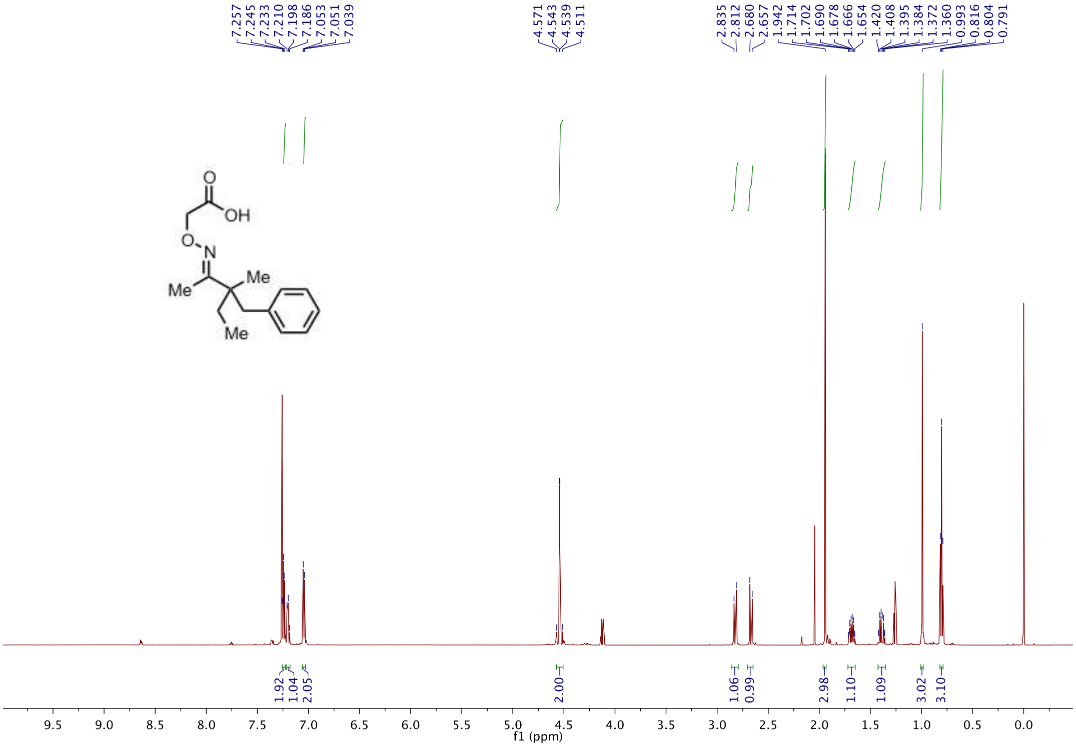
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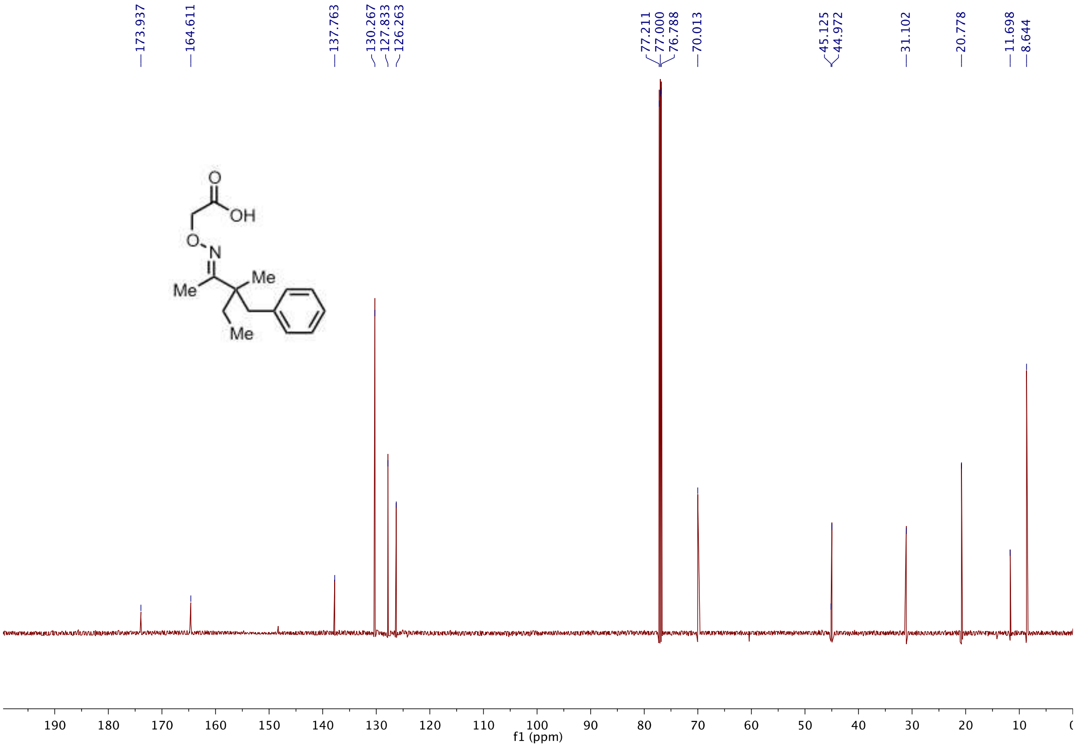
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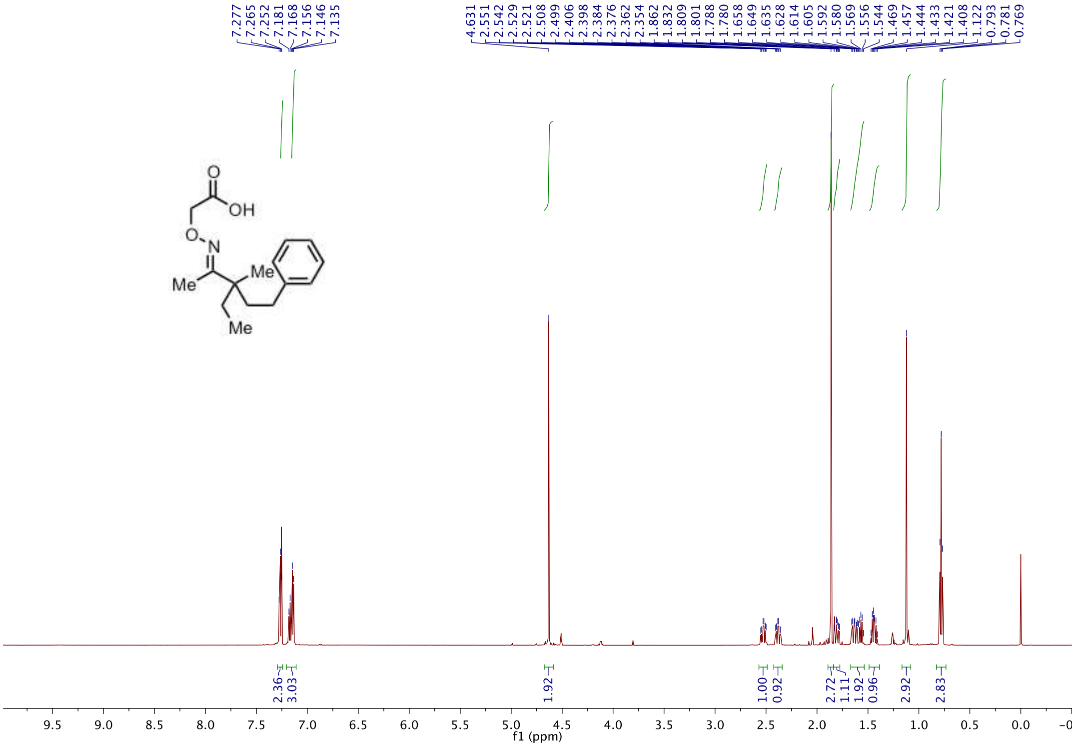
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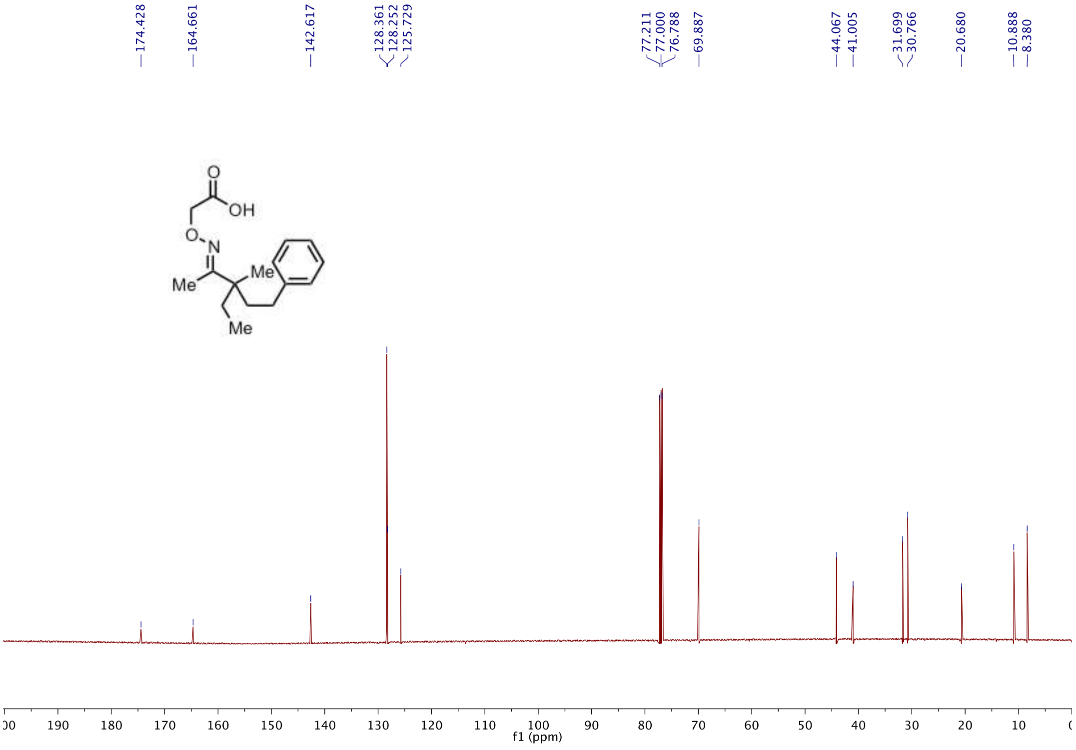
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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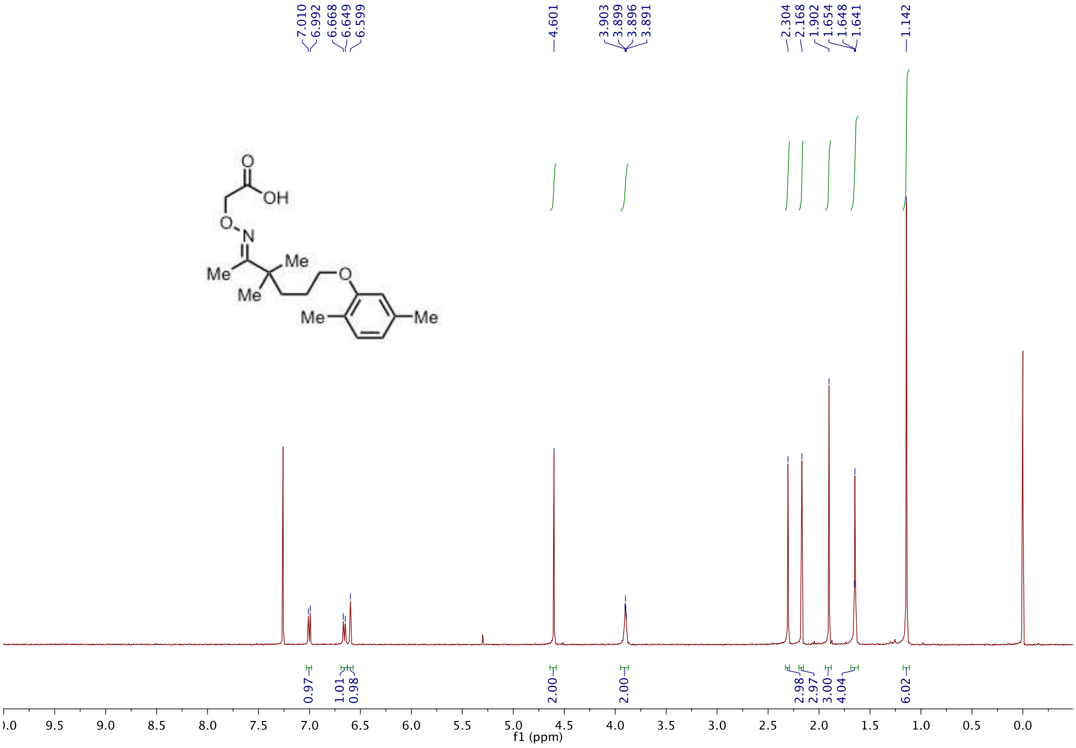
142.617
128.361
128.252
125.729
77.211
77.000
76.788
69.887
44.067
41.005
31.699
30.766
20.680
10.888
8.380
O
OH
O
N
Me
Me
Me
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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6.668
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6.599
4.601
3.903
3.899
3.896
3.891
2.304
2.168
1.902
1.654
1.648
1.641
1.142
O
OH
O
N
Me
Me
Me
O
Me
Me
0.97
1.01
0.98
2.00
2.00
2.98
2.97
3.00
4.04
6.02
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.5
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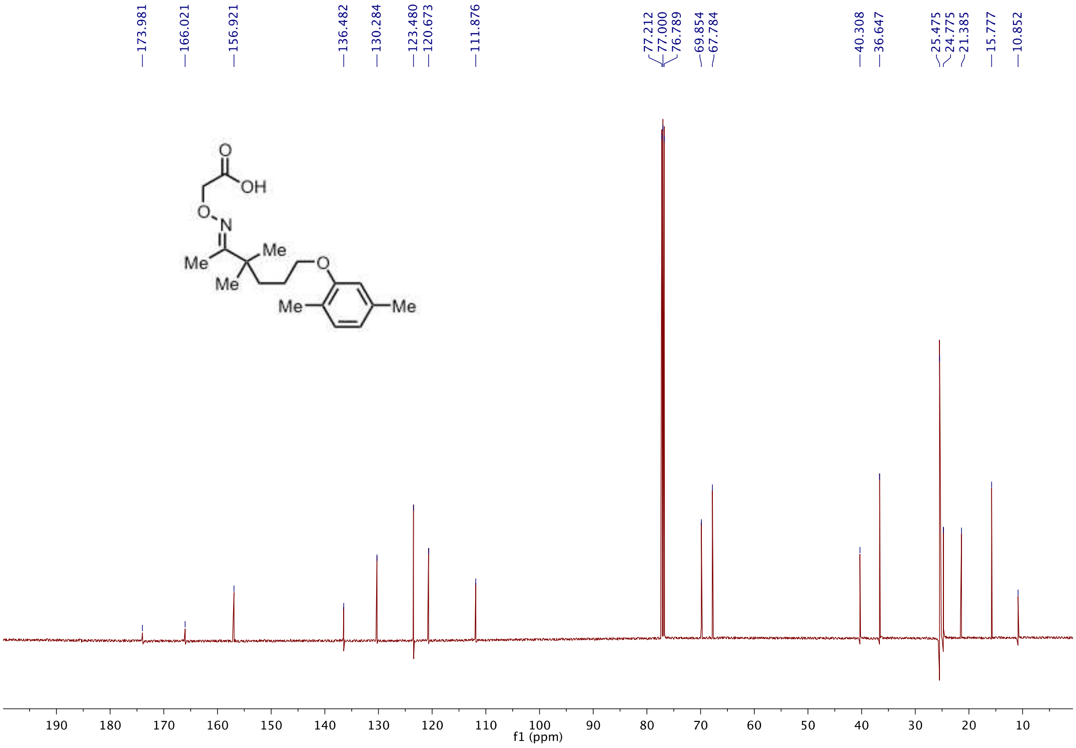
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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156.921
136.482
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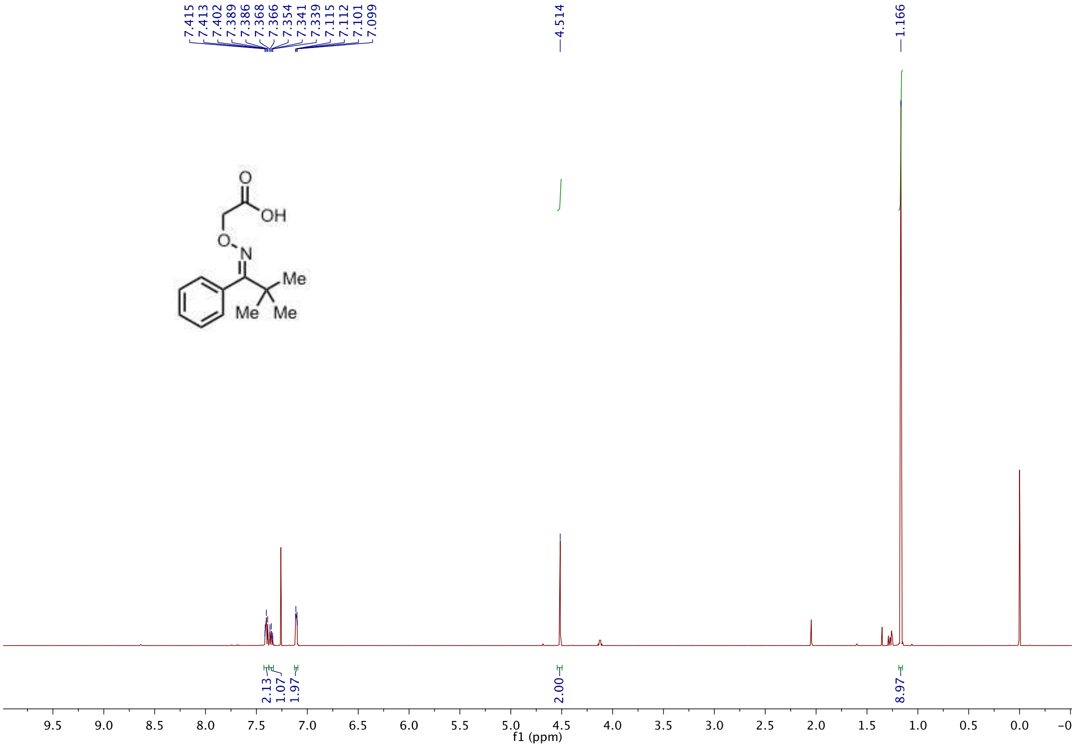
120.673
111.876
77.212
77.000
76.789
69.854
67.784
40.308
36.647
25.475
24.775
21.385
15.777
10.852
O
OH
O
N
Me
Me
Me
O
Me
Me
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)



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7.413
7.402
7.389
7.386
7.368
7.366
7.354
7.341
7.339
7.115
7.112
7.101
7.099
4.514
1.166
O
OH
O
N
Me
Me
Me
2.13
1.07
1.97
2.00
8.97
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
0.0
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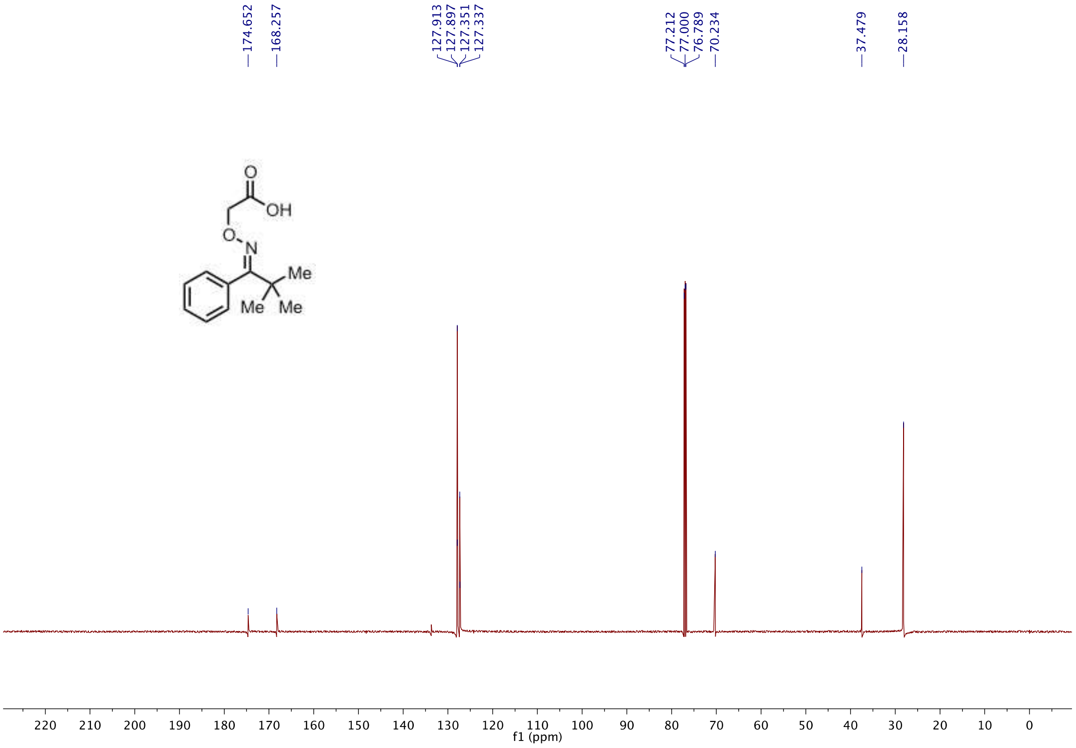
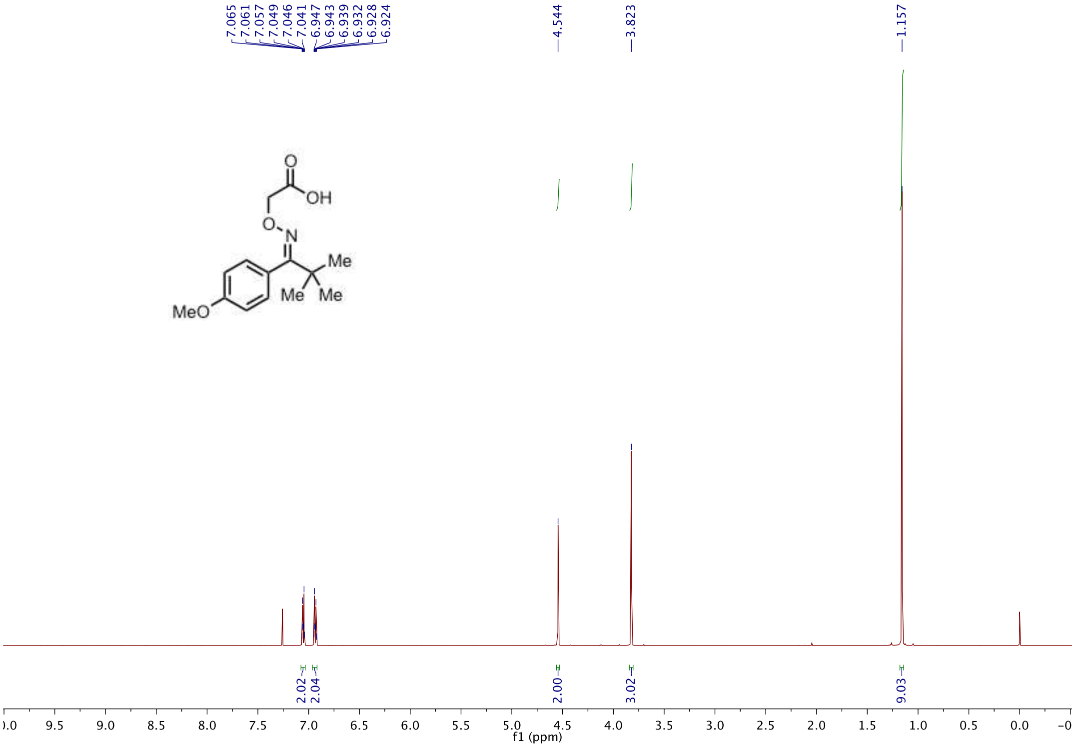
f1 (ppm)



174.652
168.257
127.913
127.897
127.351
127.337
77.212
77.000
76.789
70.234
37.479
28.158
O
OH
O
N
Me
Me
Me
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.065
7.061
7.057
7.049
7.046
7.041
6.947
6.943
6.939
6.932
6.928
6.924
4.544
3.823
1.157
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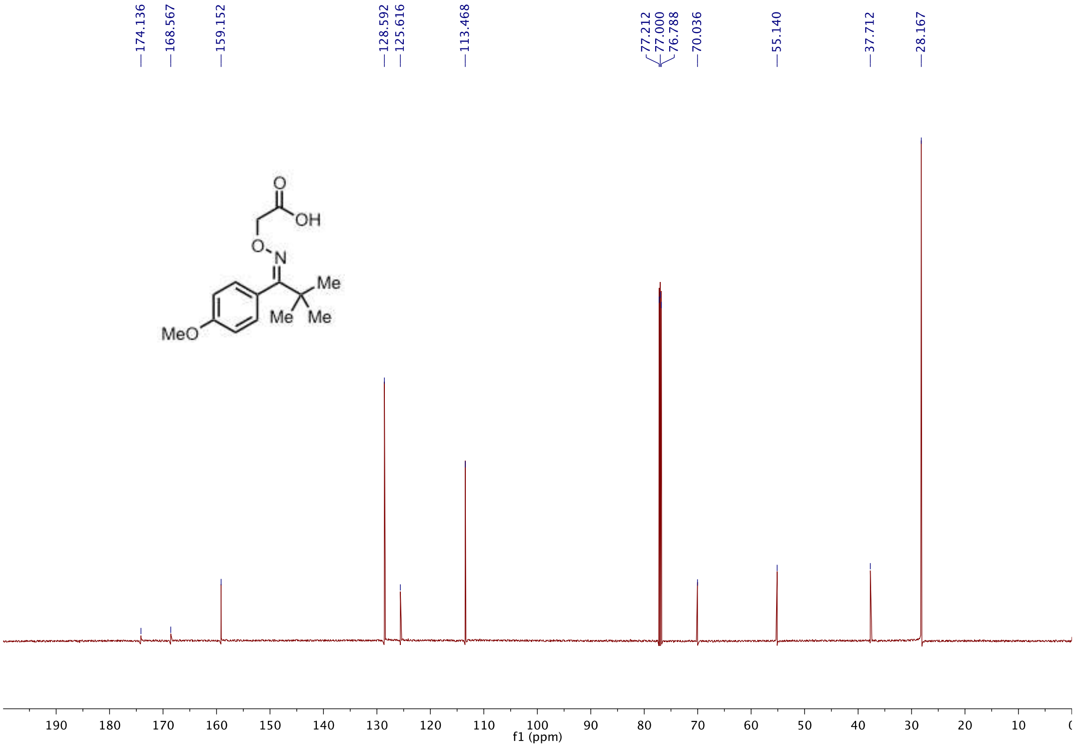
OH
O
N
Me
Me
Me
MeO
2.02
2.04
2.00
3.02
9.03
f1 (ppm)


174.136
168.567
159.152
128.592
125.616
113.468
77.212
77.000
76.788
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55.140
37.712
28.167
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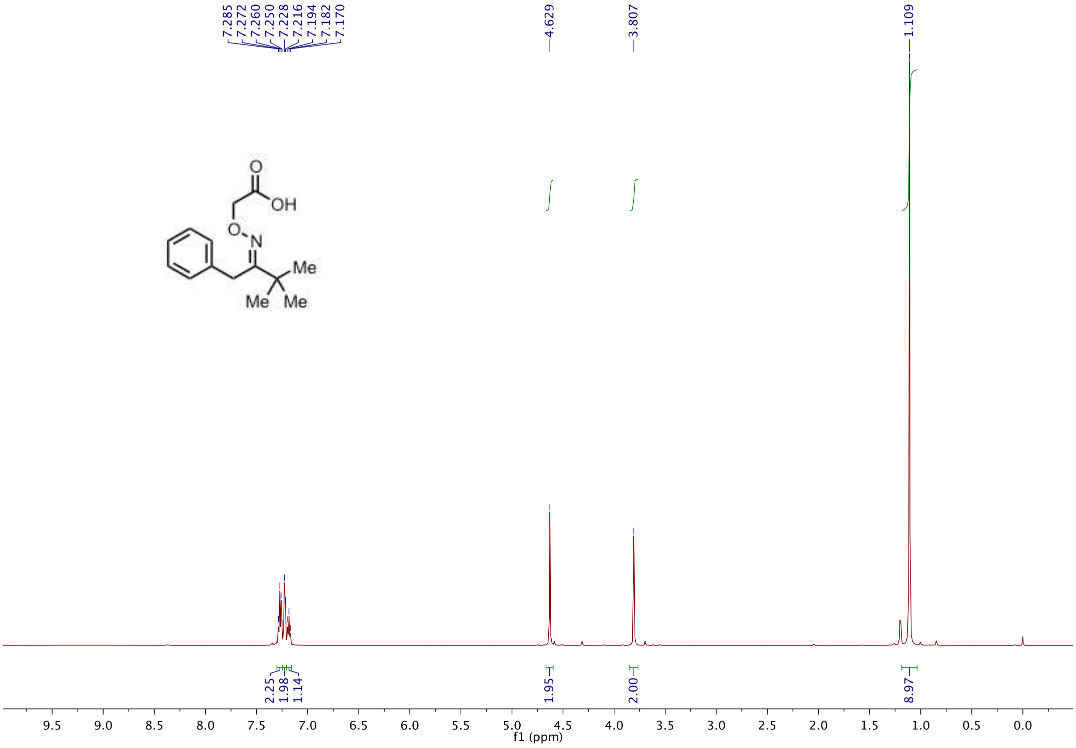
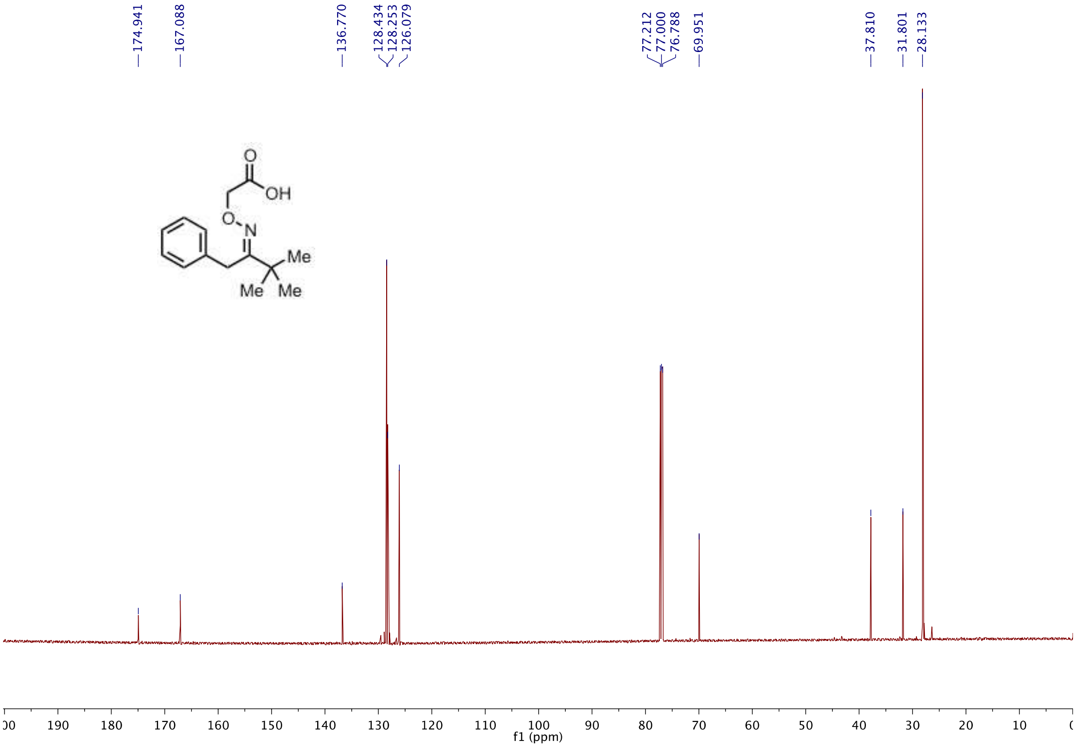
OH
O
N
Me
Me
Me
MeO
f1 (ppm)


7.285
7.272
7.260
7.250
7.228
7.216
7.194
7.182
7.170
4.629
3.807
1.109
O
OH
O
N
Me
Me
Me
2.25
1.98
1.14
1.95
2.00
8.97
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
0.0
f1 (ppm)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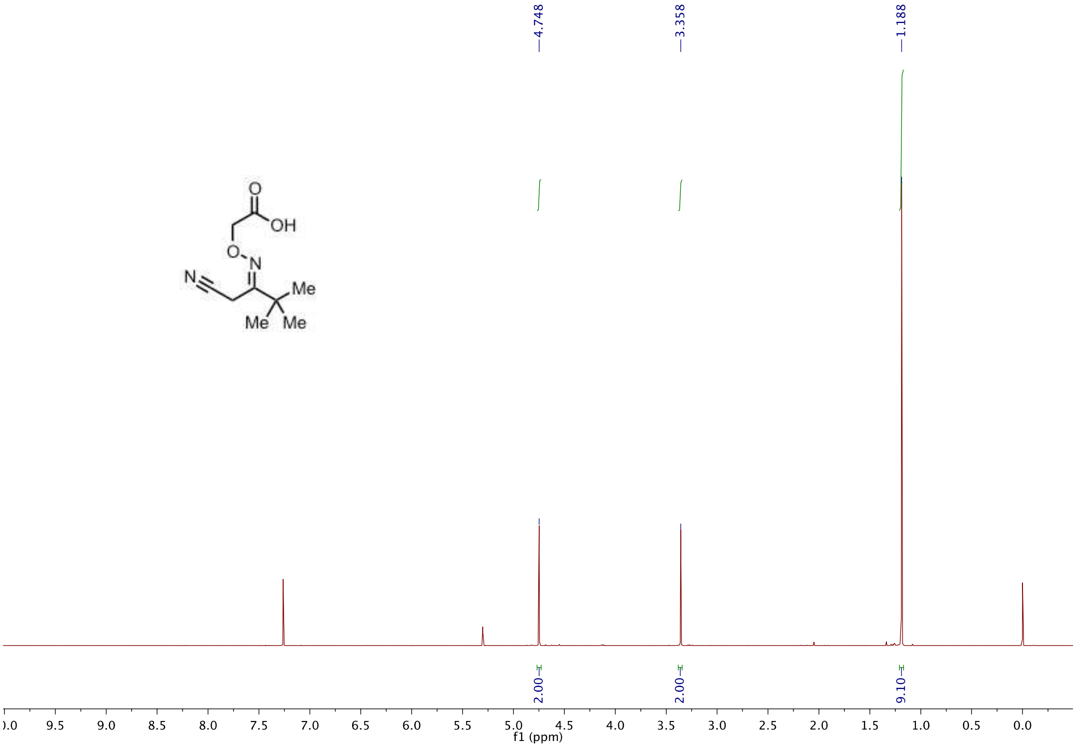
167.088
136.770
128.434
128.253
126.079
77.212
77.000
76.788
69.951
37.810
31.801
28.133
O
OH
O
N
Me
Me
Me
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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3.358
1.188
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OH
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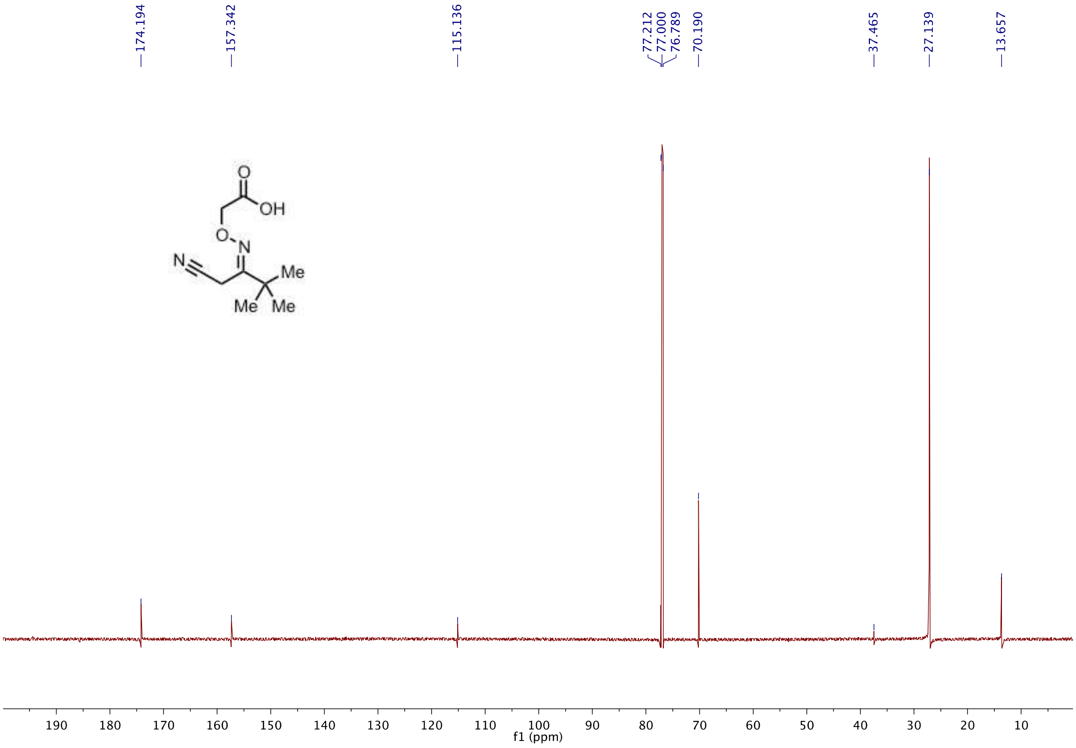
N
Me
Me
Me
2.00
2.00
9.10
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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157.342
115.136
77.212
77.000
76.789
70.190
37.465
27.139
13.657
O
OH
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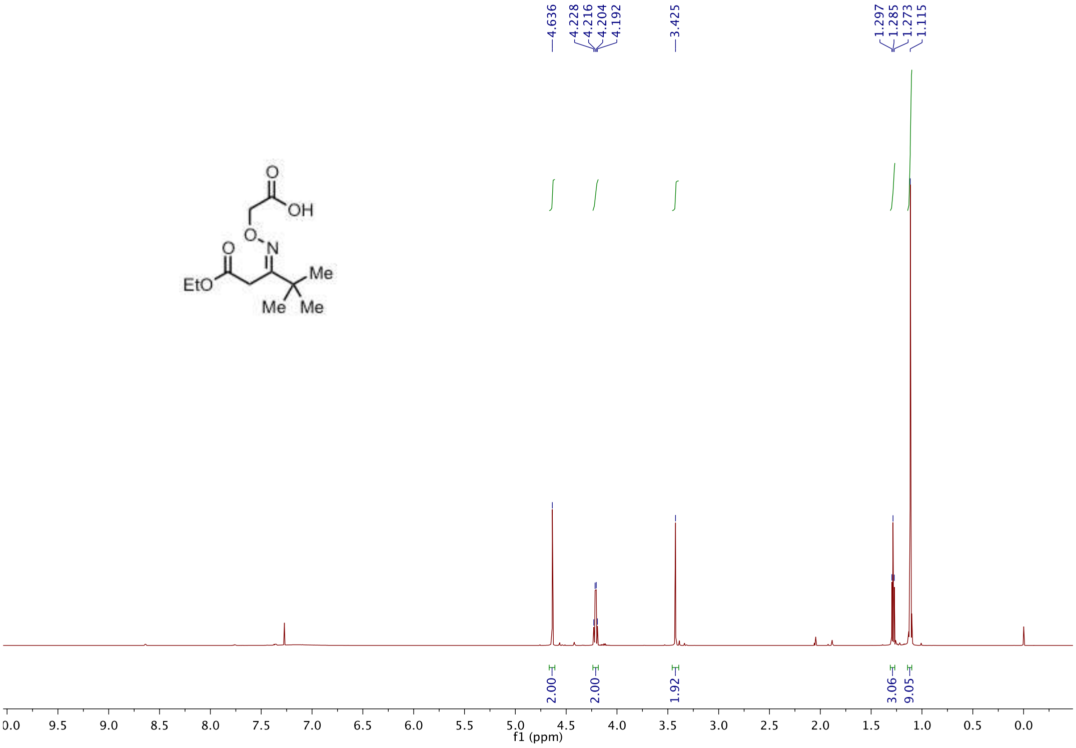
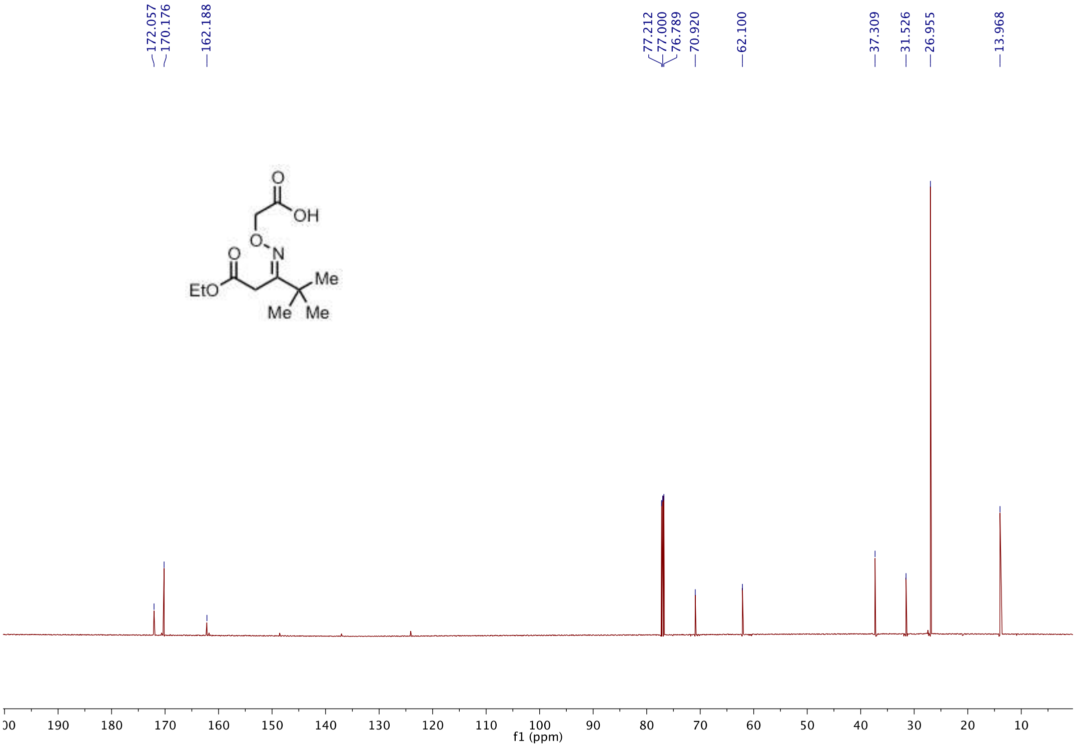
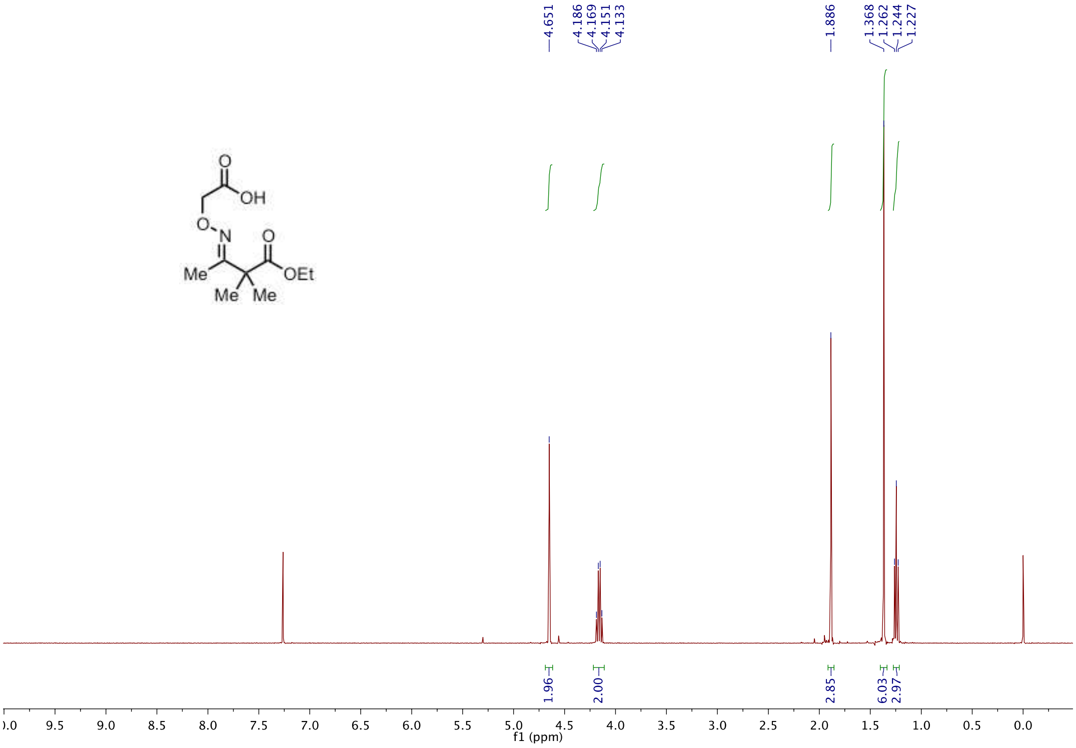
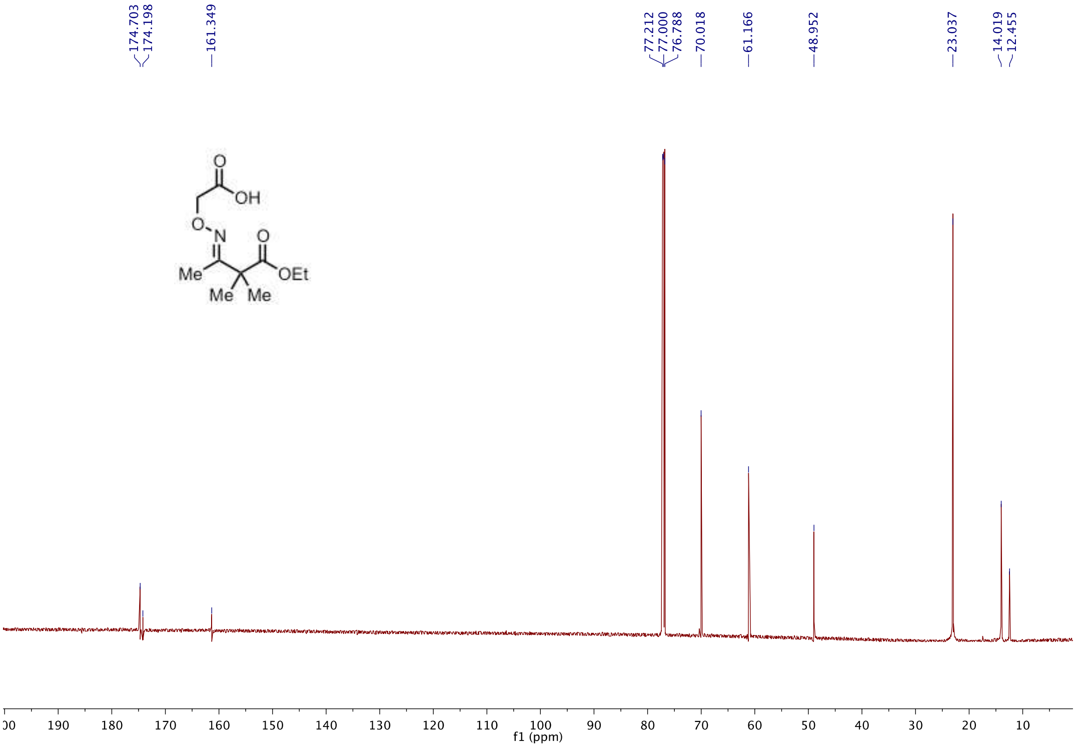
N
N
Me
Me
Me
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


4.636
4.228
4.216
4.204
4.192
3.425
1.297
1.285
1.273
1.115
OH
O
O
N
O
EtO
Me
Me
Me
2.00
2.00
1.92
3.06
9.05
0.0 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 0.0
f1 (ppm)


172.057
170.176
162.188
77.212
77.000
76.789
70.920
62.100
37.309
31.526
26.955
13.968
OH
O
O
N
O
EtO
Me
Me
Me
00 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


4.651
4.186
4.169
4.151
4.133
1.886
1.368
1.262
1.244
1.227
O
OH
O
N
O
Me
OEt
Me
Me
1.96
2.00
2.85
6.03
2.97
).0
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
0.0
f1 (ppm)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174.198
161.349
77.212
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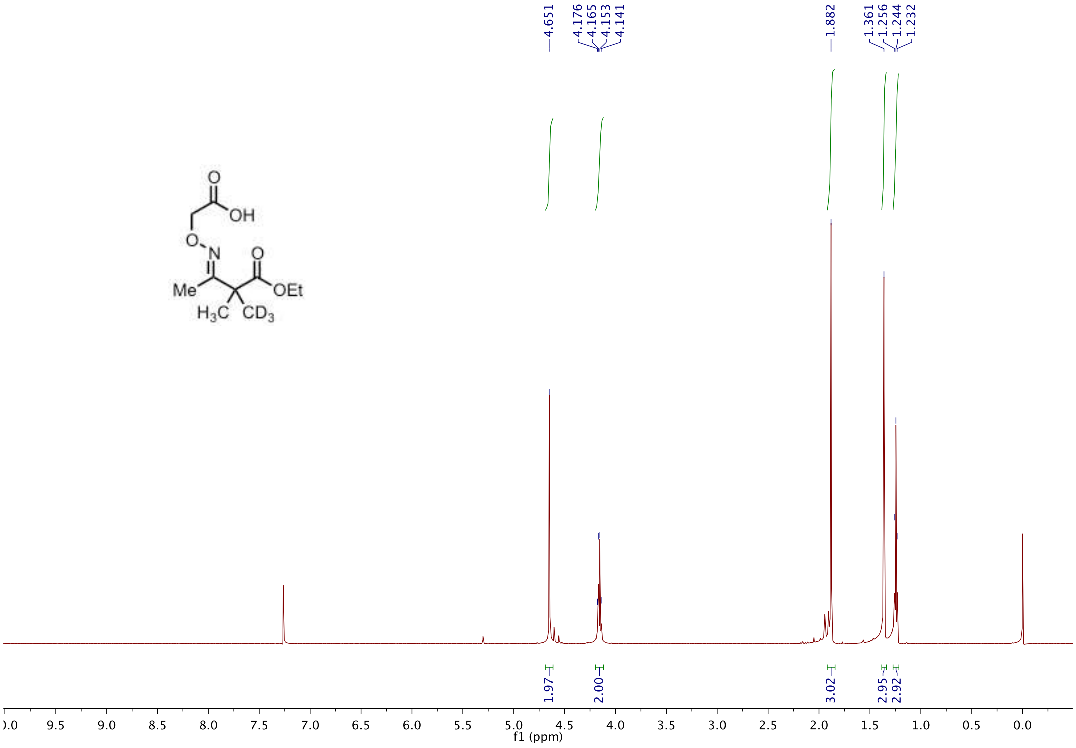
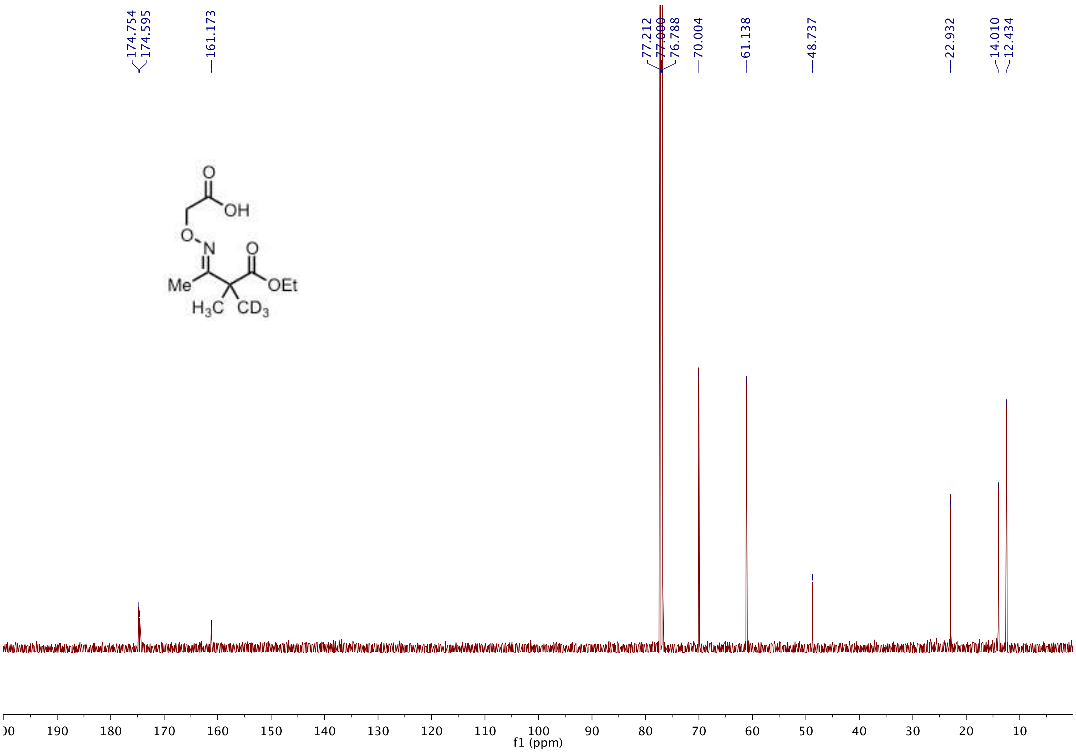
76.788
70.018
61.166
48.952
23.037
14.019
12.455
O
OH
O
N
O
Me
OEt
Me
Me
)0
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


4.651
4.176
4.165
4.153
4.141
1.882
1.361
1.256
1.244
1.232
1.97
2.00
3.02
2.95
2.92
OH
O
N
O
Me
OEt
H_3C
CD_3
f1 (ppm)
0.0 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 0.0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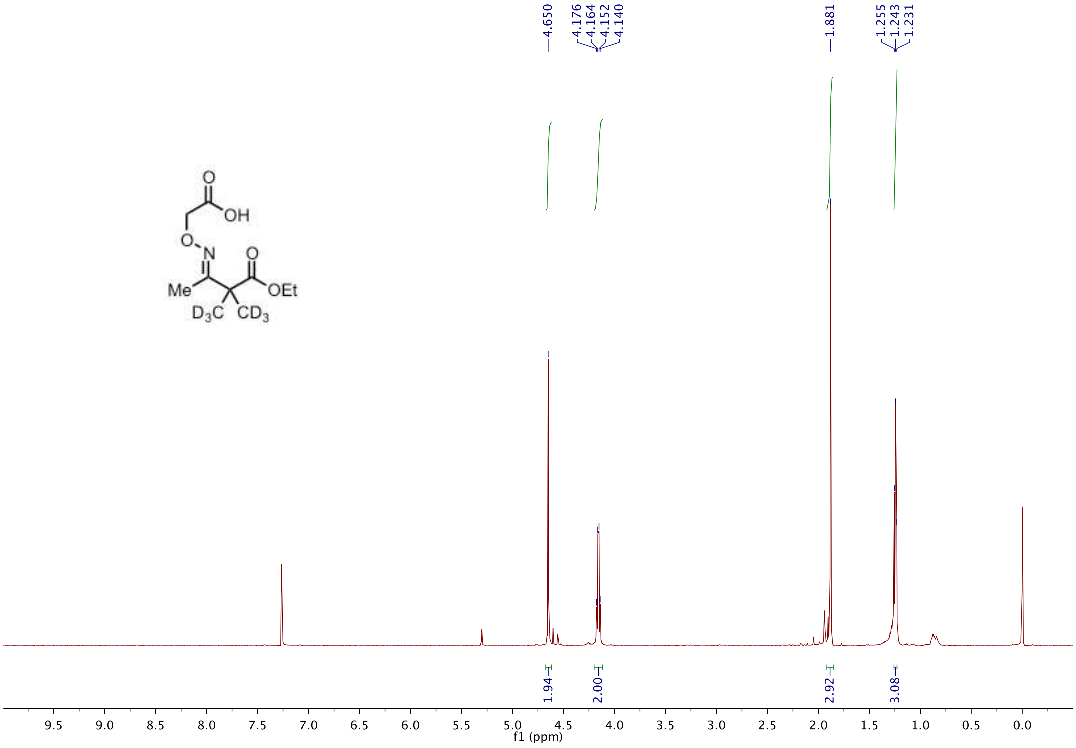
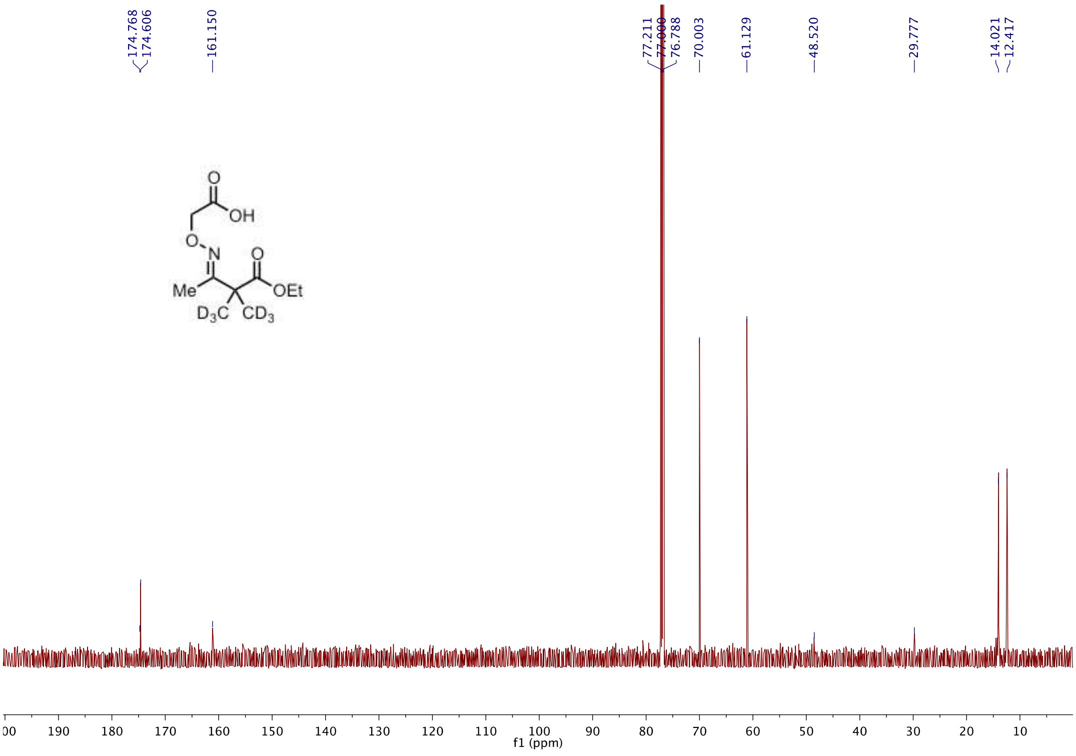
174.595
161.173
77.212
77.000
76.788
70.004
61.138
48.737
22.932
14.010
12.434
OH
O
N
O
Me
OEt
H_3C
CD_3
f1 (ppm)
00 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10


4.650
4.176
4.164
4.152
4.140
1.881
1.255
1.243
1.231
O
OH
O
N
O
Me
OEt
D_3C
CD_3
1.94
2.00
2.92
3.08
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
0.0
f1 (ppm)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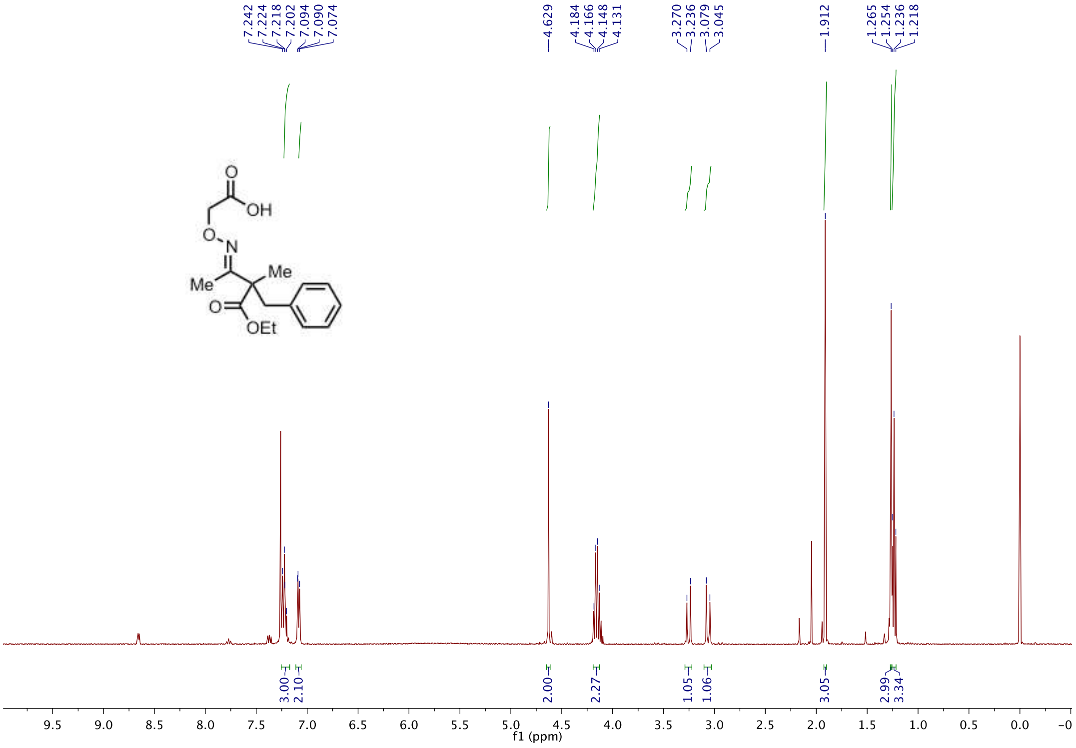
77.211
77.000
76.788
70.003
61.129
48.520
29.777
14.021
12.417
O
OH
O
N
O
Me
OEt
D_3C
CD_3
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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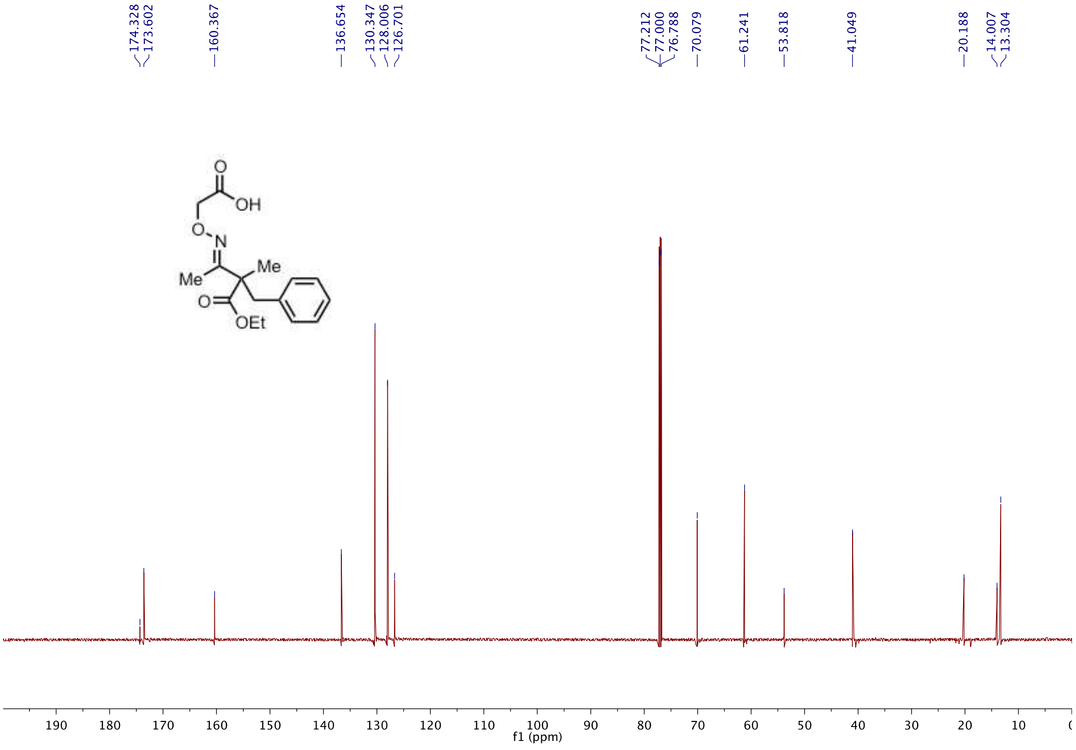
7.202
7.094
7.090
7.074
4.629
4.184
4.166
4.148
4.131
3.270
3.236
3.079
3.045
1.912
1.265
1.254
1.236
1.218
3.00
2.10
2.00
2.27
1.05
1.06
3.05
2.99
3.34
OH
O
N
Me
Me
O
OEt
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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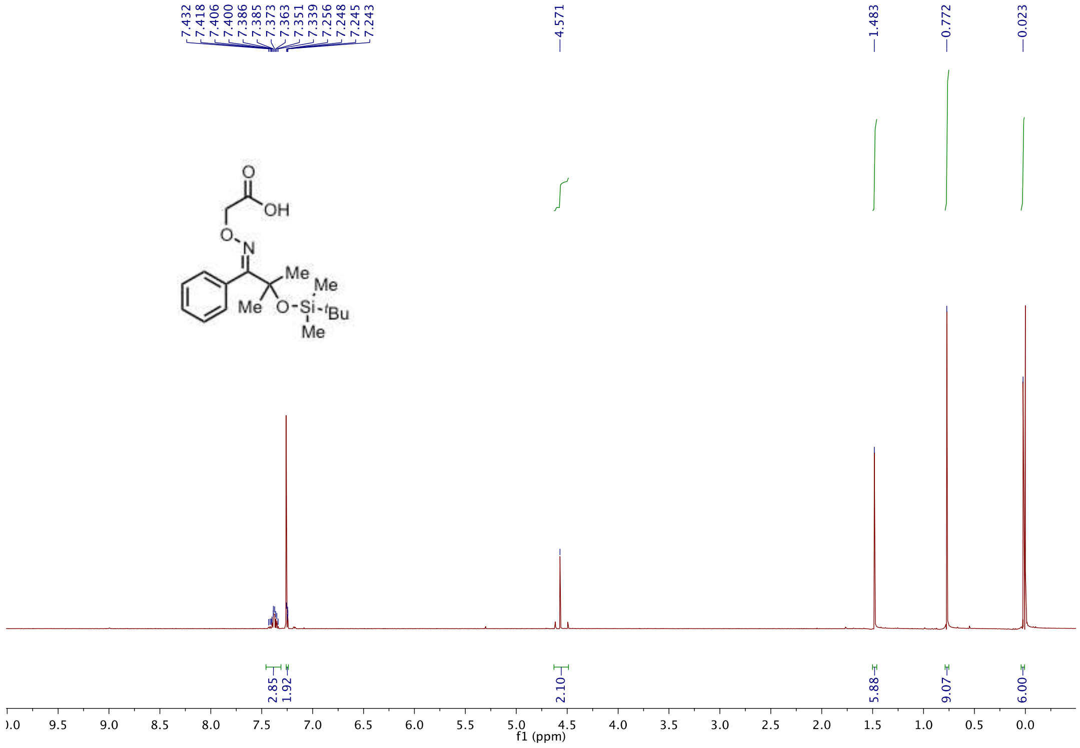
130.347
128.006
126.701
77.212
77.000
76.788
70.079
61.241
53.818
41.049
20.188
14.007
13.304
OH
O
N
Me
Me
O
OEt
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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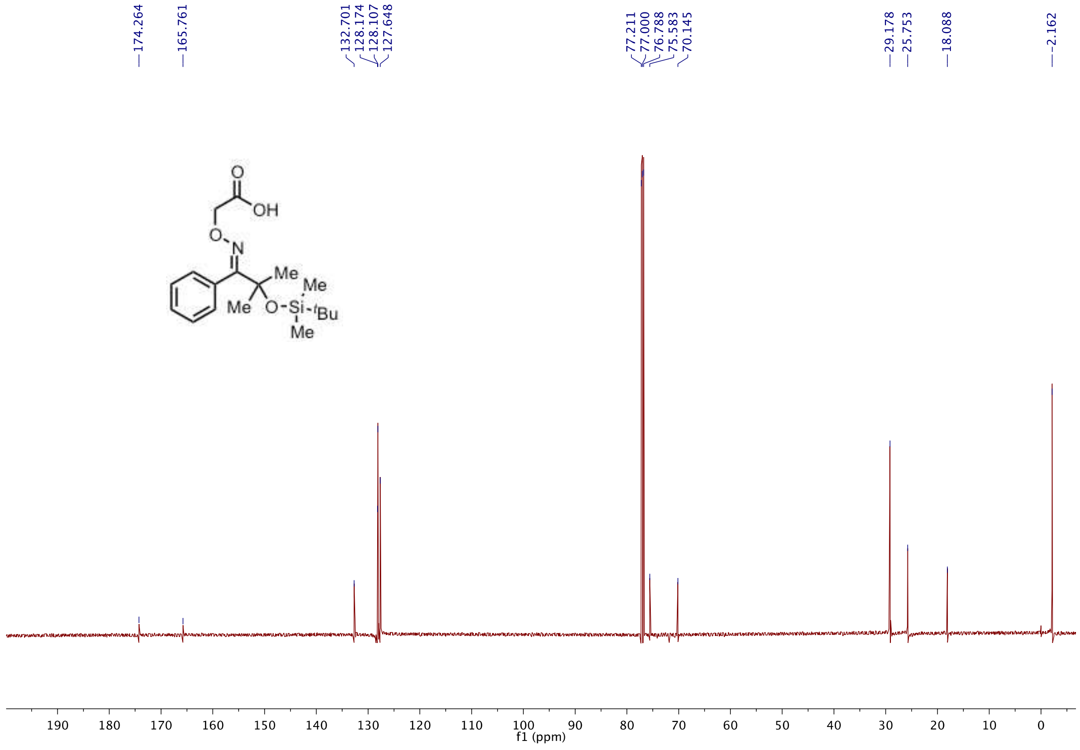
7.400
7.386
7.385
7.373
7.363
7.351
7.339
7.256
7.248
7.245
7.243
4.571
1.483
0.772
0.023
O
OH
O
N
Me
Me
Me
O-Si-^{t}Bu
Me
2.85
1.92
2.10
5.88
9.07
6.00
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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132.701
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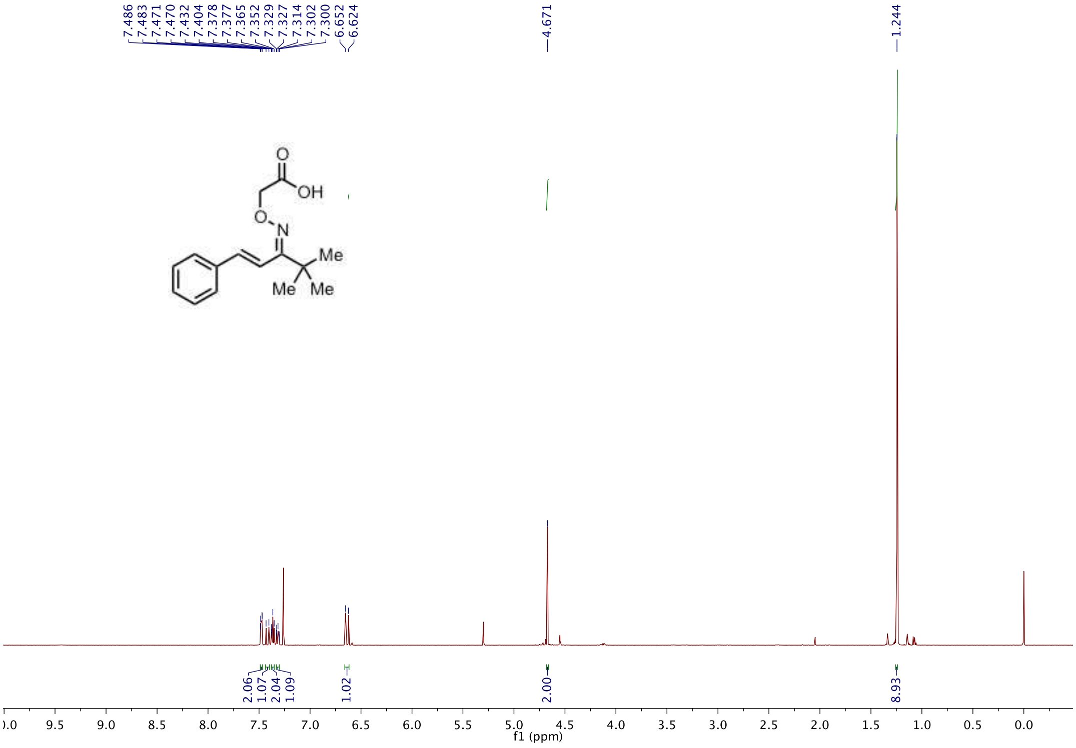
128.107
127.648
77.211
77.000
76.788
75.583
70.145
29.178
25.753
18.088
-2.162
O
OH
O
N
Me
Me
Me
O-Si-^{t}Bu
Me
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.404
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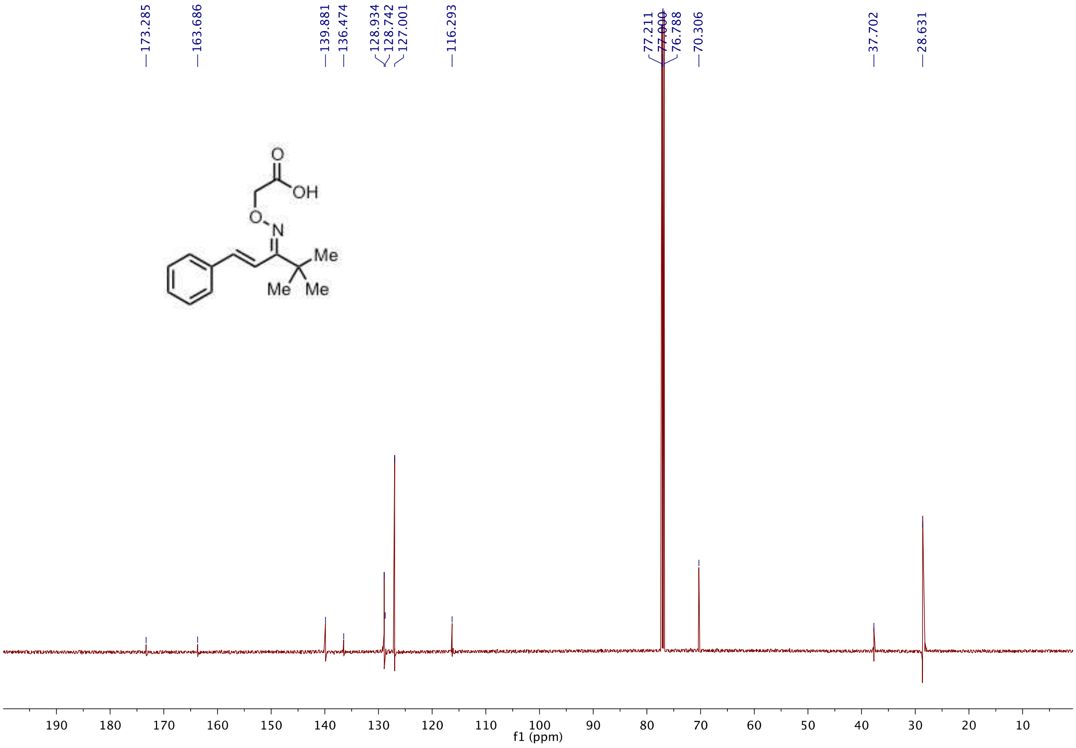
7.377
7.365
7.352
7.329
7.327
7.314
7.302
7.300
6.652
6.624
4.671
1.244
O
OH
O
N
Me
Me
Me
2.06
1.07
2.04
1.09
1.02
2.00
8.93
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


173.285
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128.742
127.001
116.293
77.211
77.000
76.788
70.306
37.702
28.631
O
OH
O
N
Me
Me
Me
190
180
170
160
150
140
130
120
110
100
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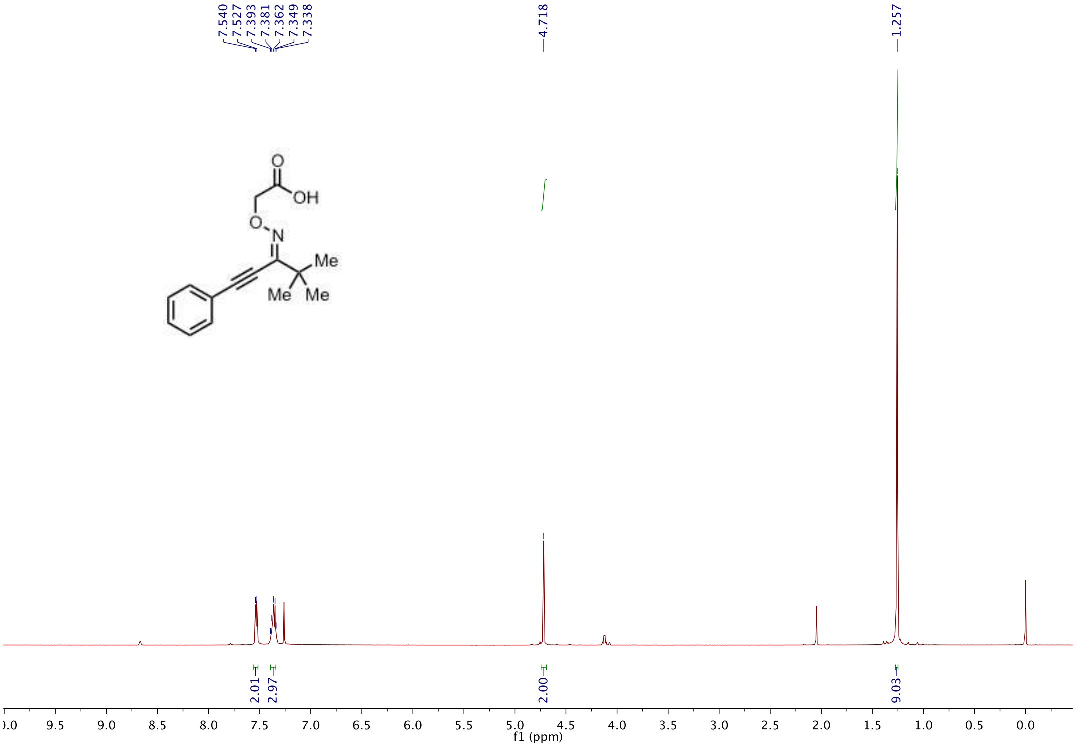
80
70
60
50
40
30
20
10
f1 (ppm)



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7.527
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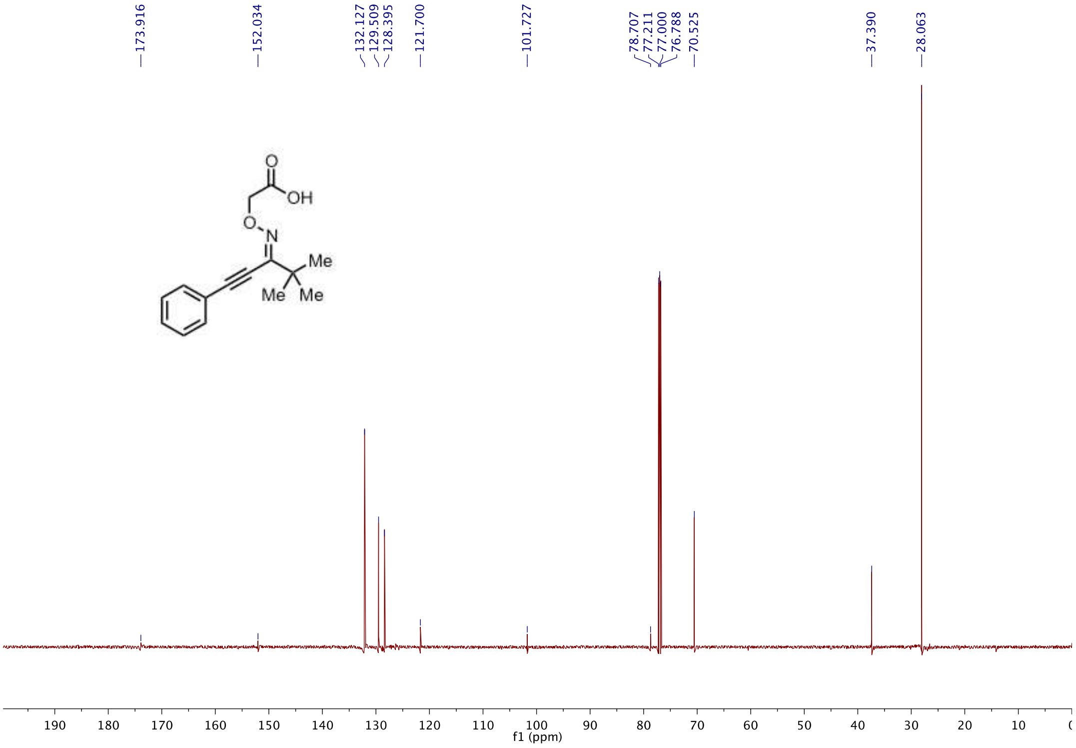
7.362
7.349
7.338
4.718
1.257
O
OH
O
N
Me
Me
Me
2.01
2.97
2.00
9.03
.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)



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128.395
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101.727
78.707
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77.000
76.788
70.525
37.390
28.063
O
OH
O
N
Me
Me
Me
190
180
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120
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100
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80
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60
50
40
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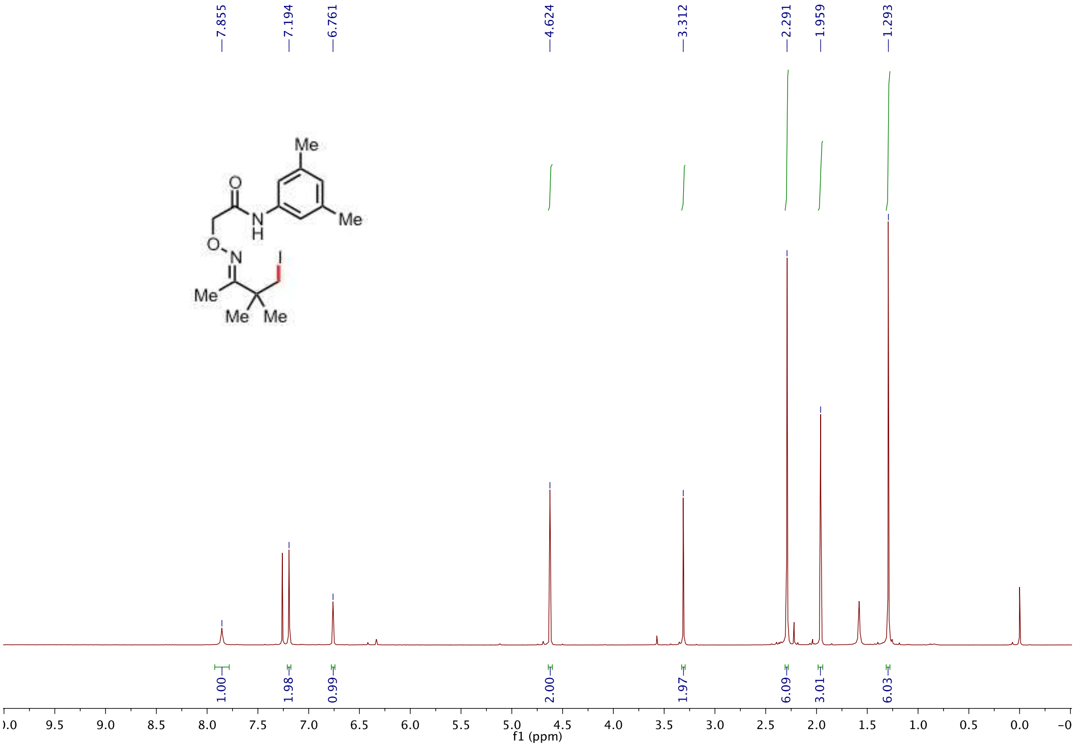
20
10
f1 (ppm)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1.293
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O
N
I
Me
Me Me
1.00
1.98
0.99
2.00
1.97
6.09
3.01
6.03
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
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5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
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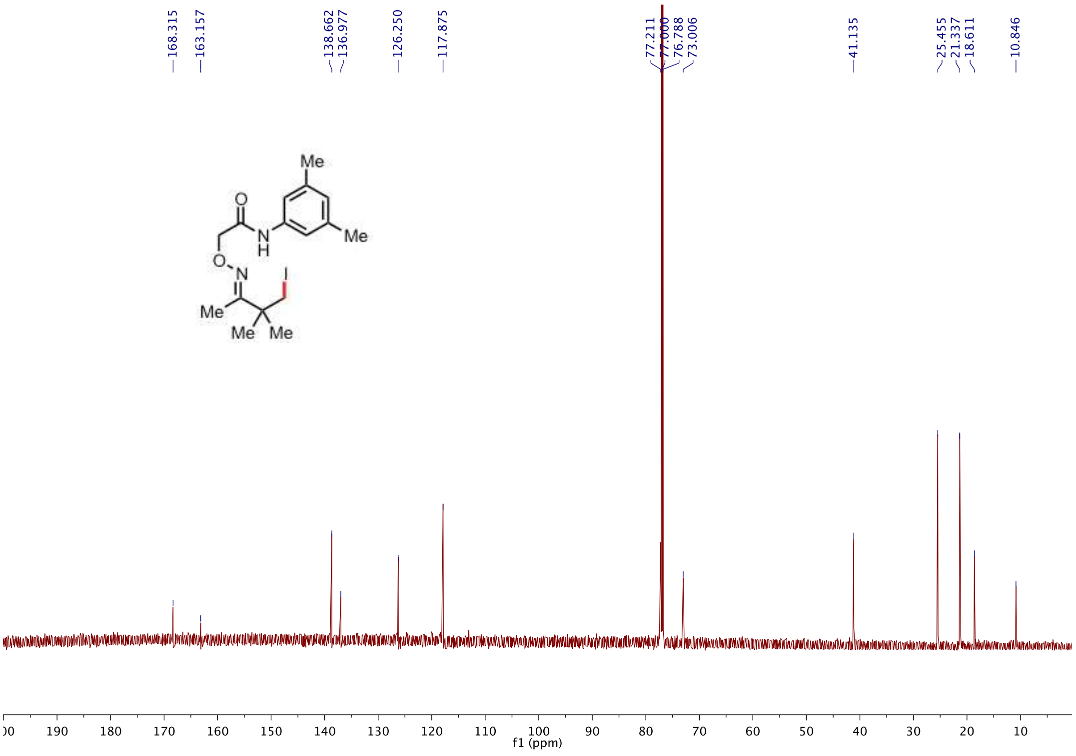
f1 (ppm)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77.000
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21.337
18.611
10.846
Me
O
N
H
Me
O
N
I
Me
Me Me
200
190
180
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150
140
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120
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100
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60
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30
20
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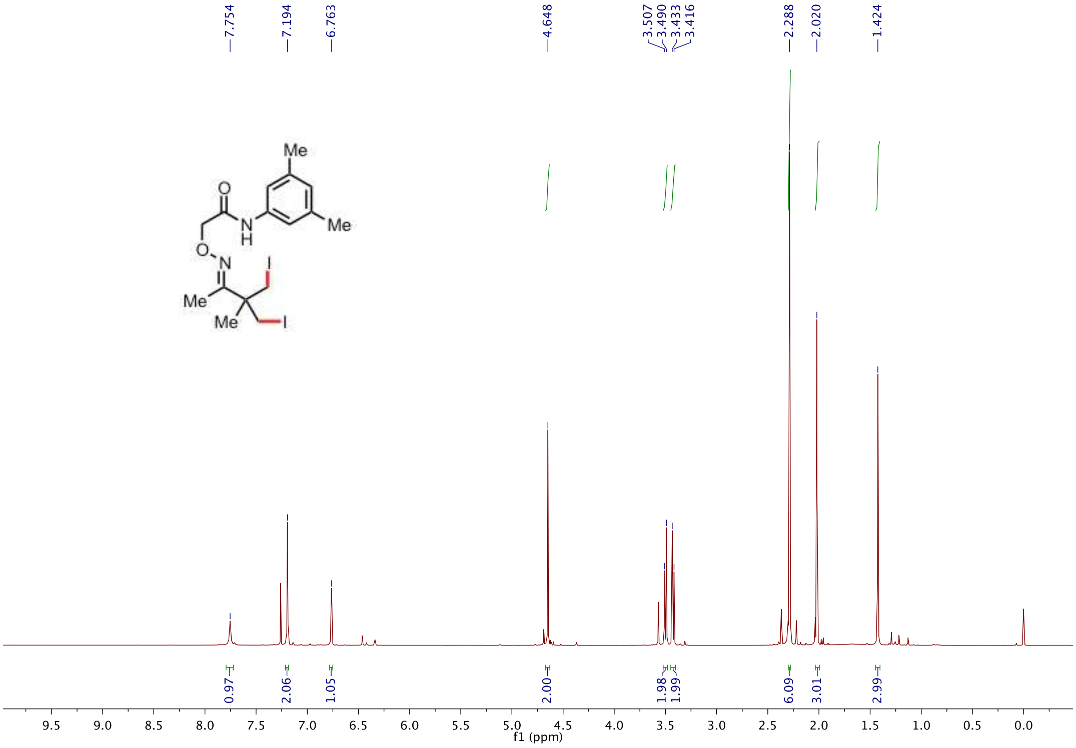
f1 (ppm)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3.416
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2.020
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2.06
1.05
2.00
1.98
1.99
6.09
3.01
2.99
Me
O
N
H
Me
O
N
I
Me
Me
I
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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3.5
3.0
2.5
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1.0
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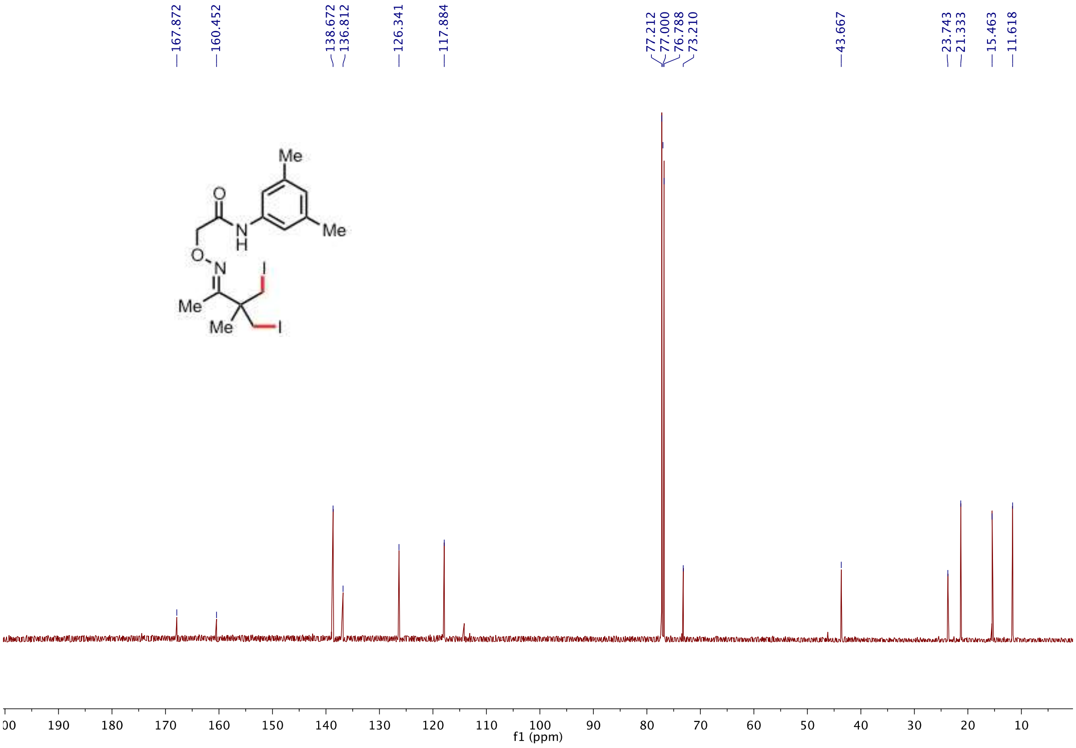
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77.000
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73.210
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23.743
21.333
15.463
11.618
Me
O
N
H
Me
O
N
I
Me
Me
I
190
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140
130
120
110
100
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80
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60
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40
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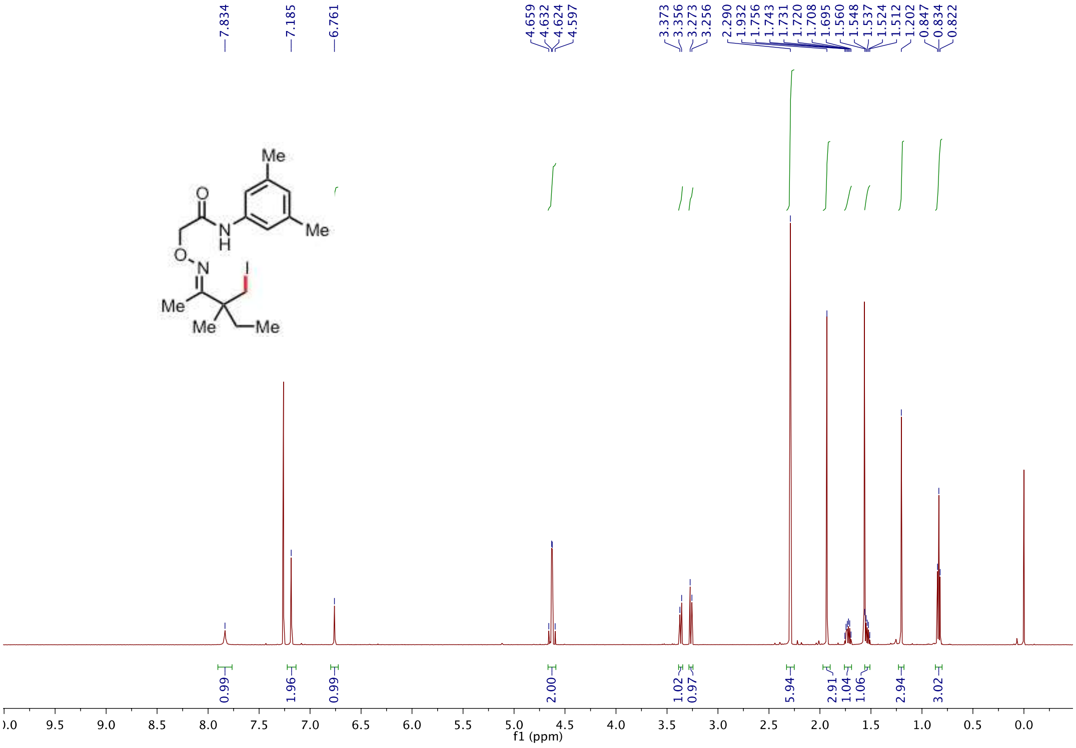
20
10
f1 (ppm)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3.373
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3.273
3.256
2.290
1.932
1.756
1.743
1.731
1.720
1.708
1.695
1.560
1.548
1.537
1.524
1.512
1.202
0.847
0.834
0.822
Me
O
N
H
Me
O
N
I
Me
Me
Me
0.99
1.96
0.99
2.00
1.02
0.97
5.94
2.91
1.04
1.06
2.94
3.02
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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3.0
2.5
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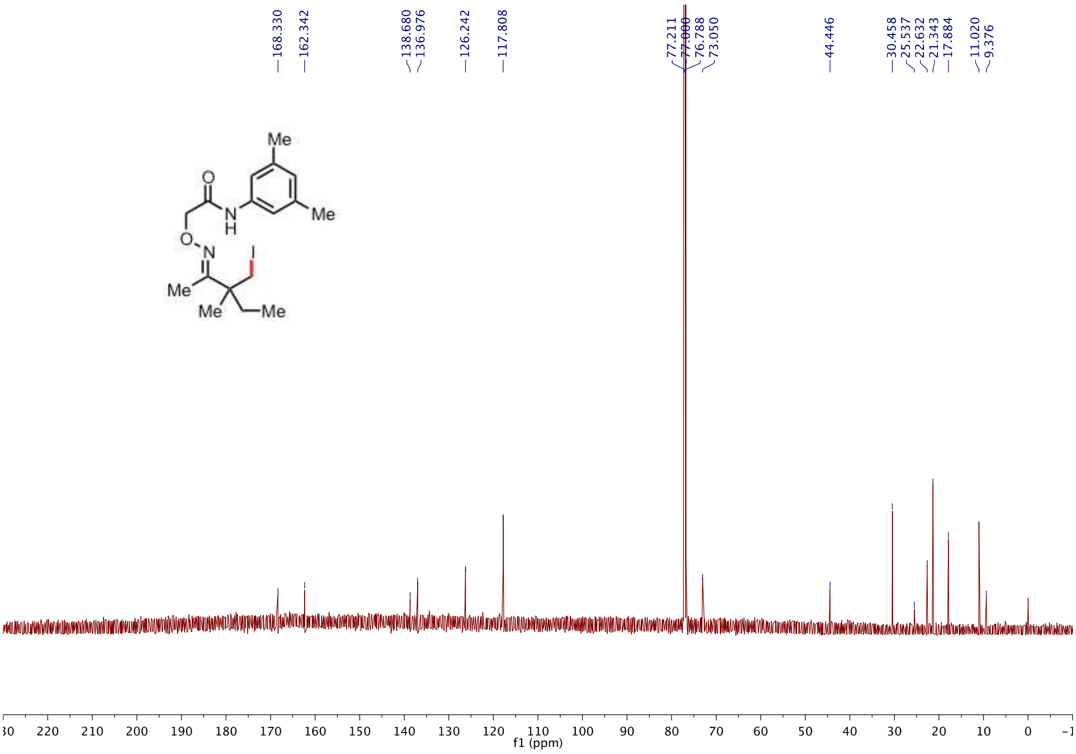
0.0
f1 (ppm)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77.000
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73.050
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30.458
25.537
22.632
21.343
17.884
11.020
9.376
Me
O
N
H
Me
O
N
I
Me
Me
Me
230
220
210
200
190
180
170
160
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140
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120
110
100
90
80
70
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50
40
30
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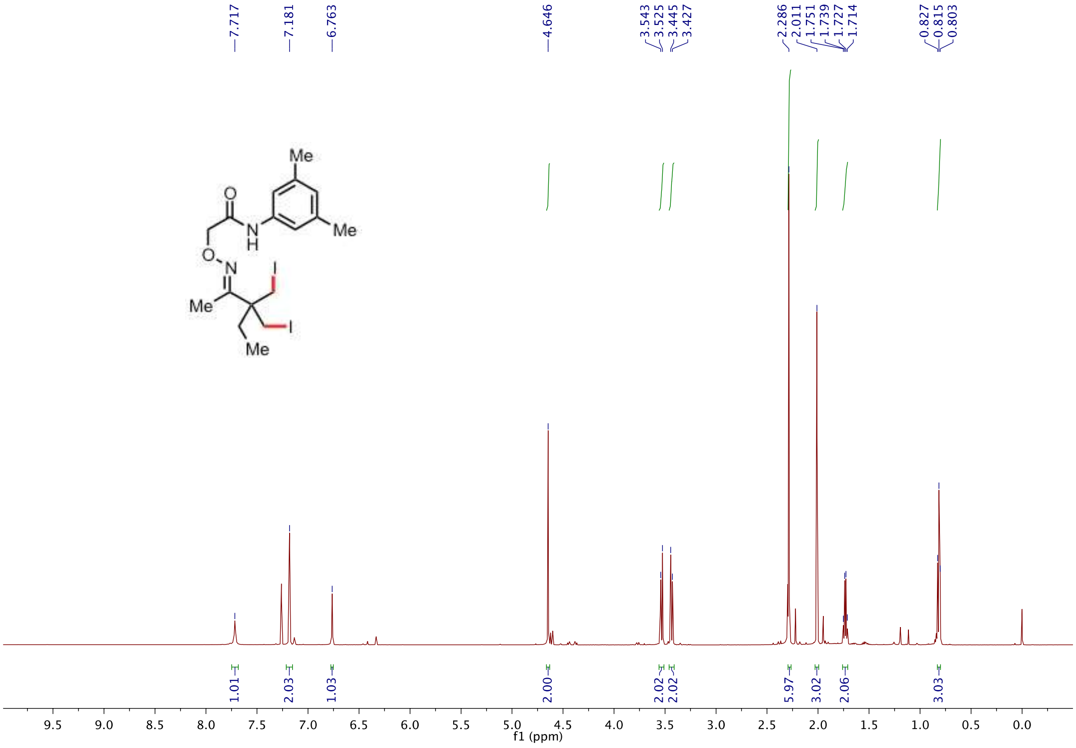
-10
f1 (ppm)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3.445
3.427
2.286
2.011
1.751
1.739
1.727
1.714
0.827
0.815
0.803
Me
O
N
H
Me
O
N
I
Me
I
Me
1.01
2.03
1.03
2.00
2.02
2.02
5.97
3.02
2.06
3.03
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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3.0
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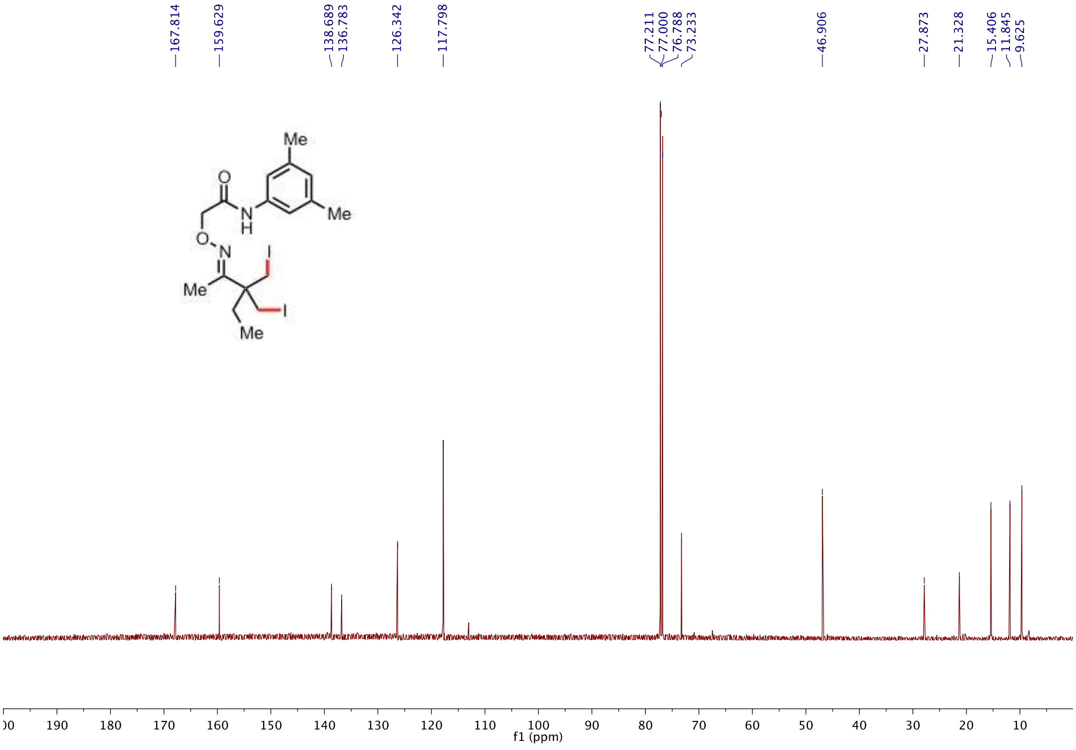
0.0
f1 (ppm)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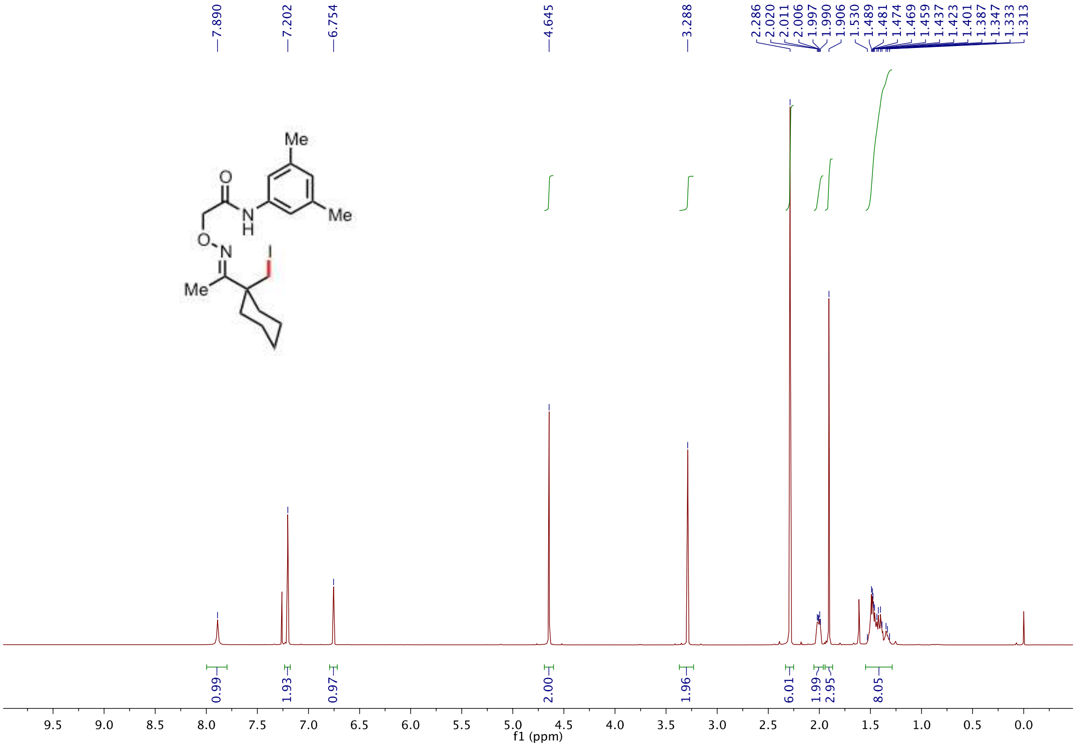
117.798
77.211
77.000
76.788
73.233
46.906
27.873
21.328
15.406
11.845
9.625
Me
O
N
H
Me
O
N
I
Me
I
Me
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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2.286
2.020
2.011
2.006
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1.990
1.906
1.530
1.489
1.481
1.474
1.469
1.459
1.437
1.423
1.401
1.387
1.347
1.333
1.313
Me
O
N
H
Me
O
N
I
Me
0.99
1.93
0.97
2.00
1.96
6.01
1.99
2.95
8.05
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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3.5
3.0
2.5
2.0
1.5
1.0
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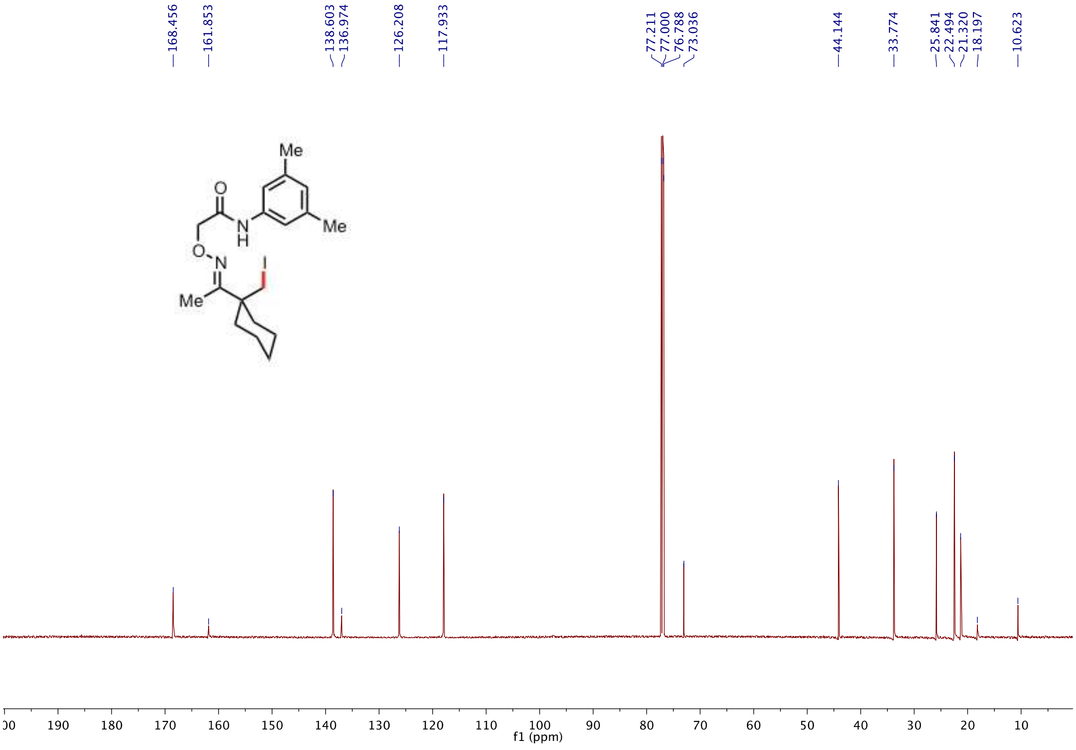
0.0
f1 (ppm)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77.211
77.000
76.788
73.036
44.144
33.774
25.841
22.494
21.320
18.197
10.623
Me
O
N
H
Me
O
N
I
Me
00
190
180
170
160
150
140
130
120
110
100
90
80
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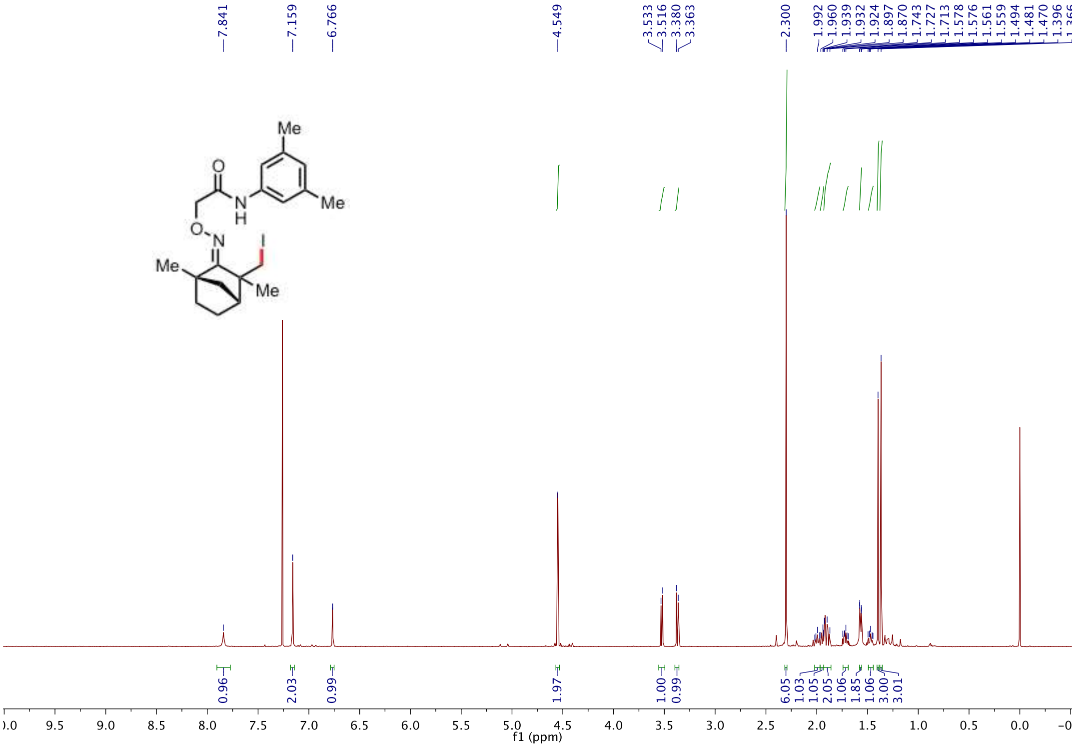
60
50
40
30
20
10
f1 (ppm)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3.363
2.300
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1.960
1.939
1.932
1.924
1.897
1.870
1.743
1.727
1.713
1.578
1.576
1.561
1.559
1.494
1.481
1.470
1.396
Me
O
N
H
Me
O
N
I
Me
Me
0.96
2.03
0.99
1.97
1.00
0.99
6.05
1.03
1.05
2.05
1.06
1.85
1.06
3.00
3.01
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
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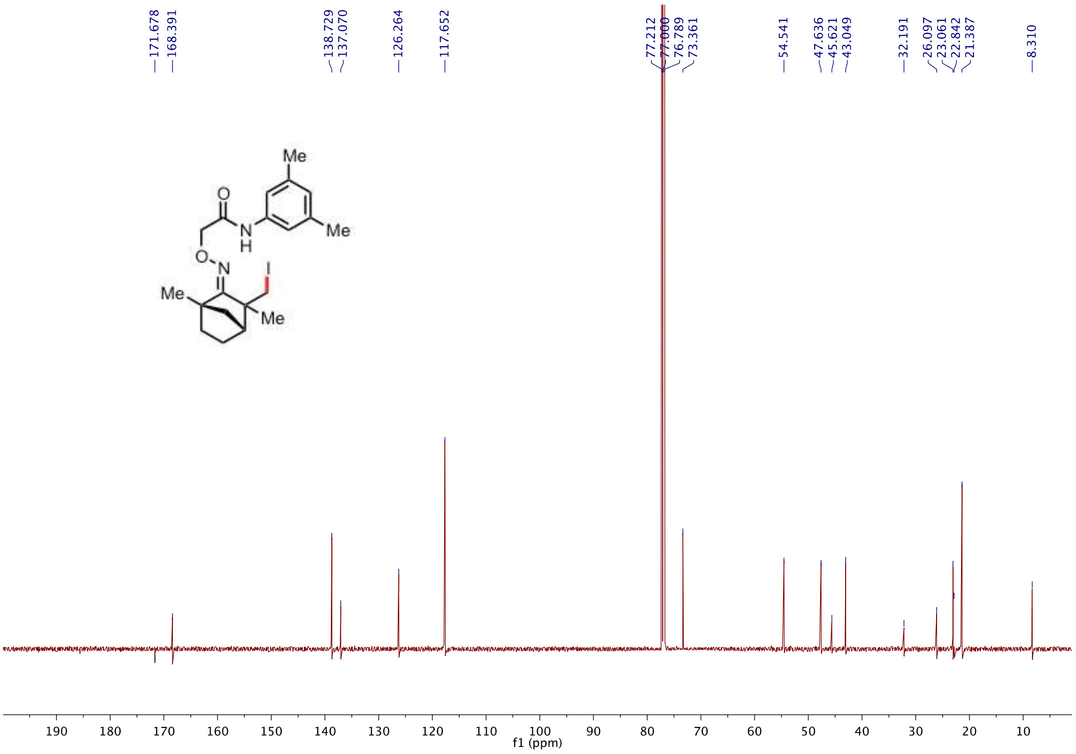
0.0
f1 (ppm)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77.000
76.789
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54.541
47.636
45.621
43.049
32.191
26.097
23.061
22.842
21.387
8.310
Me
O
N
H
Me
O
N
I
Me
Me
190
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160
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140
130
120
110
100
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80
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60
50
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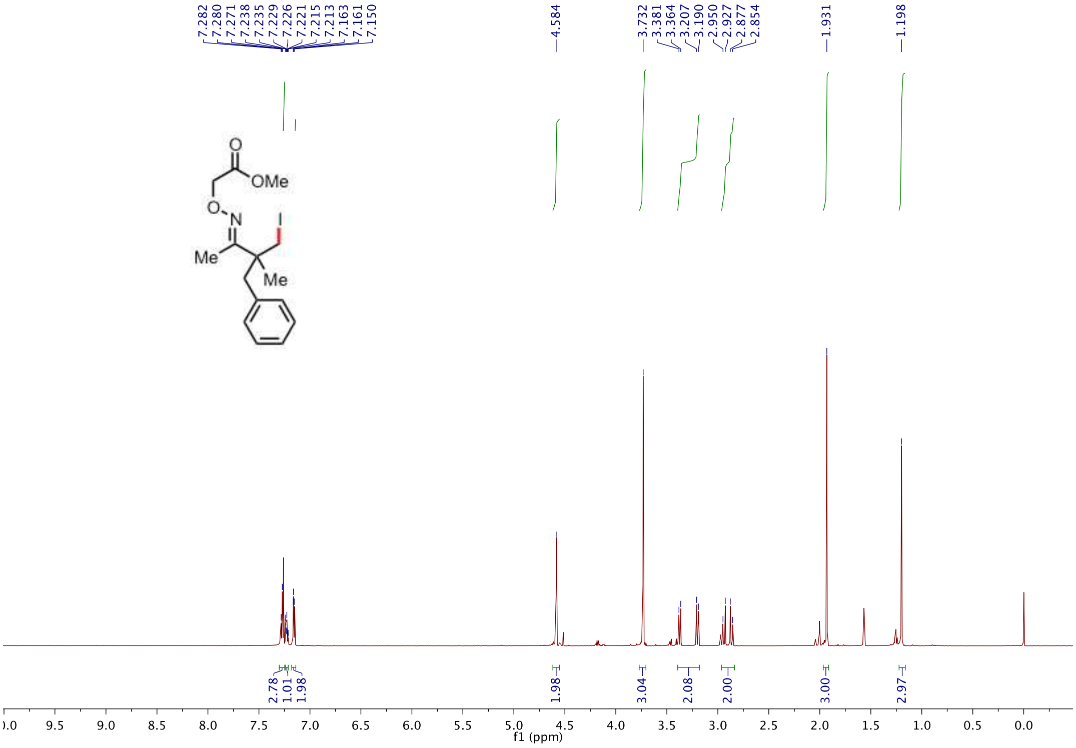
30
20
10
f1 (ppm)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7.235
7.229
7.226
7.221
7.215
7.213
7.163
7.161
7.150
4.584
3.732
3.381
3.364
3.207
3.190
2.950
2.927
2.877
2.854
1.931
1.198
O
OMe
O
N
I
Me
Me
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1.01
1.98
1.98
3.04
2.08
2.00
3.00
2.97
.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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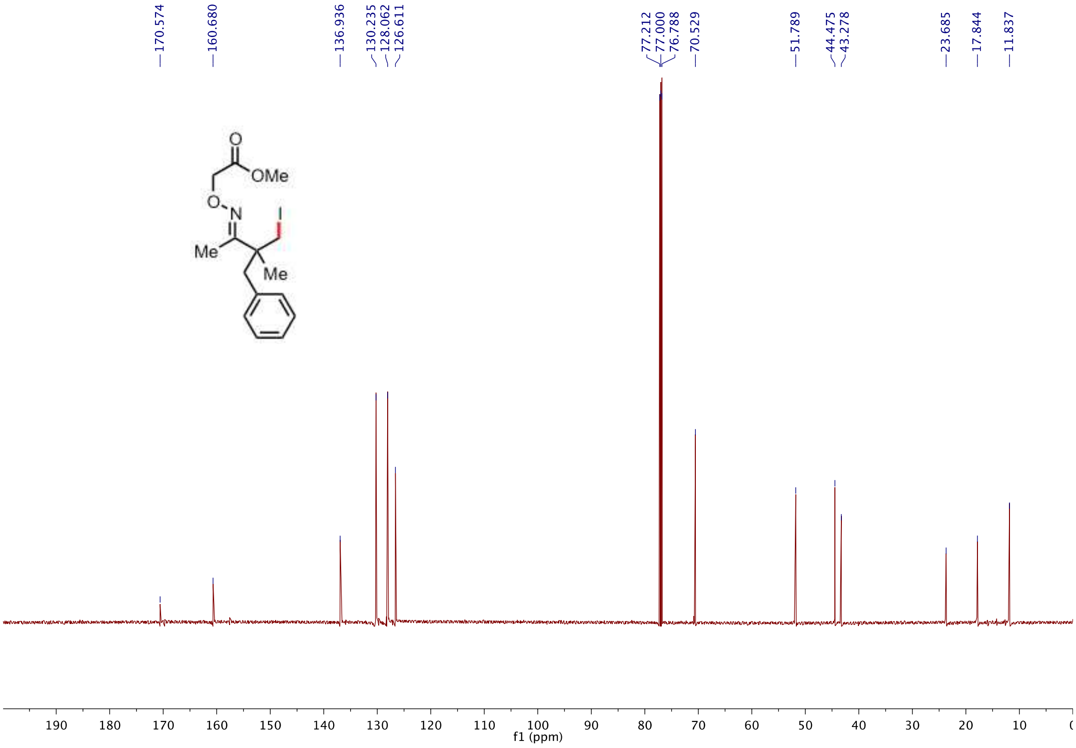
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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77.000
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70.529
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44.475
43.278
23.685
17.844
11.837
O
OMe
O
N
I
Me
Me
190
180
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160
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140
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120
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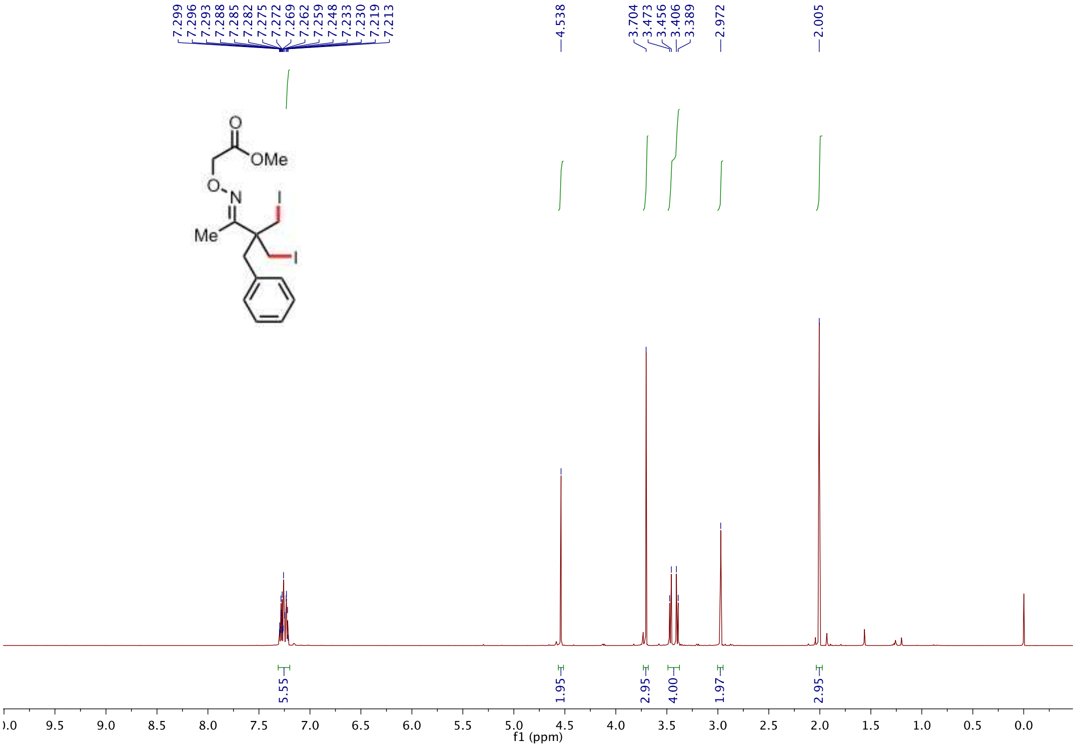
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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7.272
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7.262
7.259
7.248
7.233
7.230
7.219
7.213
4.538
3.704
3.473
3.456
3.406
3.389
2.972
2.005
O
OMe
O
N
I
Me
I
5.55
1.95
2.95
4.00
1.97
2.95
10.0
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9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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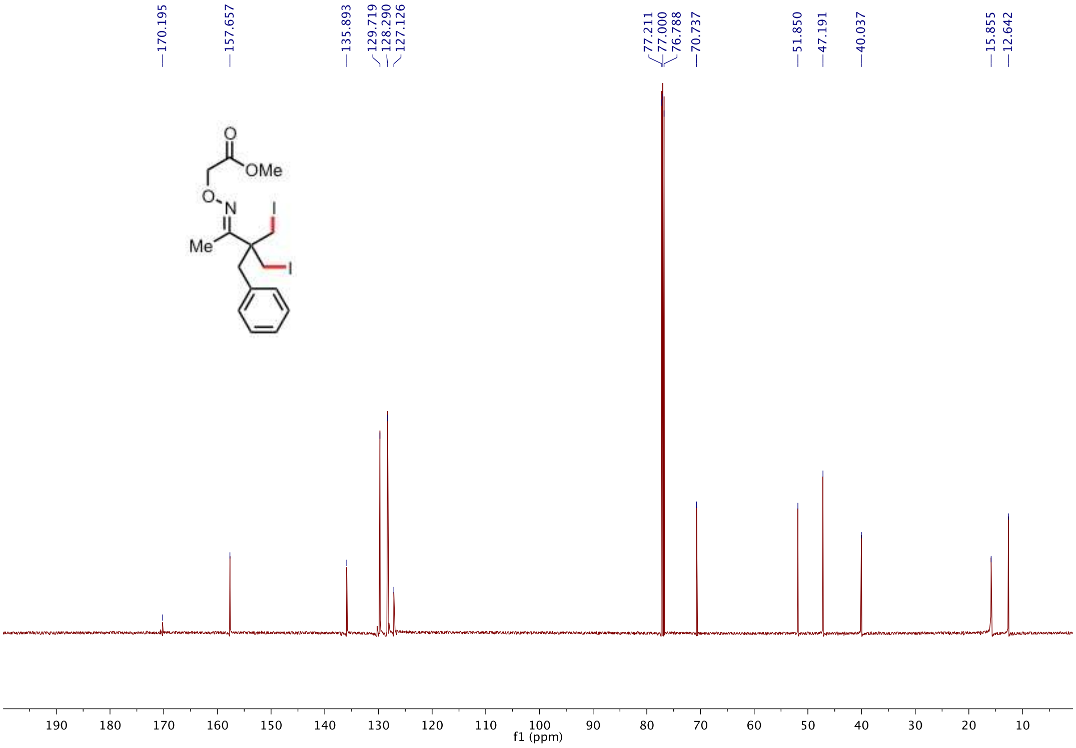
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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40.037
15.855
12.642
O
OMe
O
N
I
Me
I
190
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140
130
120
110
100
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80
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60
50
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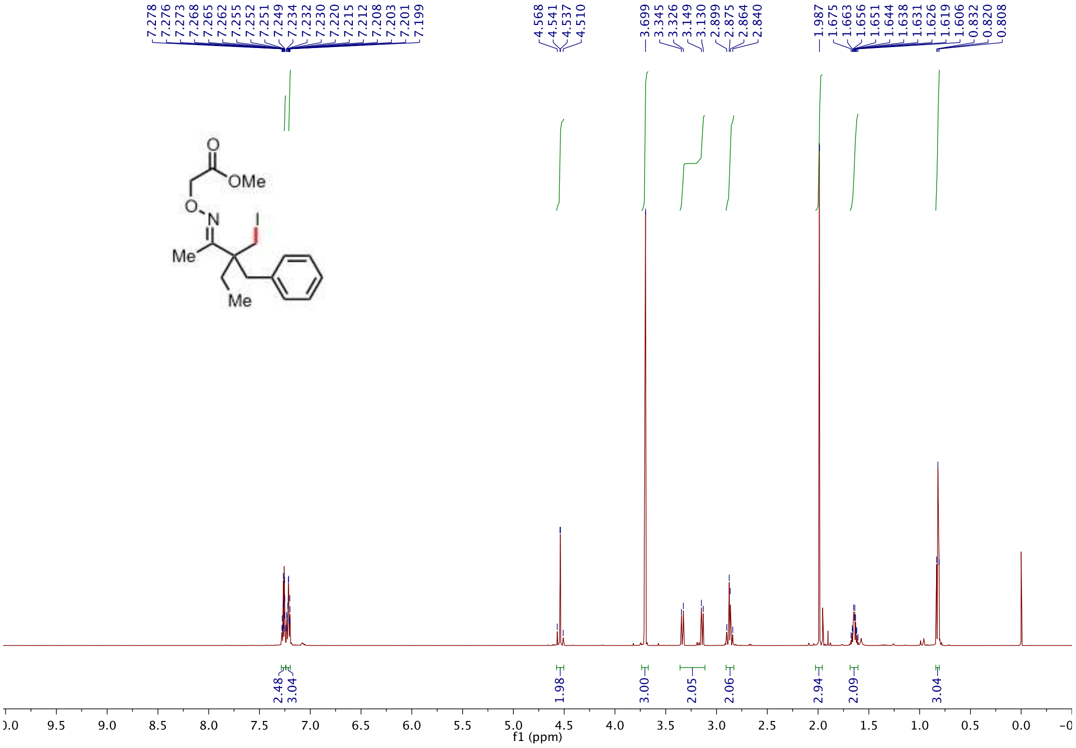
30
20
10
f1 (ppm)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7.251
7.249
7.234
7.232
7.230
7.220
7.215
7.212
7.208
7.203
7.201
7.199
4.568
4.541
4.537
4.510
3.699
3.345
3.326
3.149
3.130
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2.875
2.864
2.840
1.987
1.675
1.663
1.656
1.651
1.644
1.638
1.631
1.626
1.619
1.606
0.832
0.820
0.808
O
OMe
O
N
I
Me
Me
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3.00
2.05
2.06
2.94
2.09
3.04
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8.5
8.0
7.5
7.0
6.5
6.0
5.5
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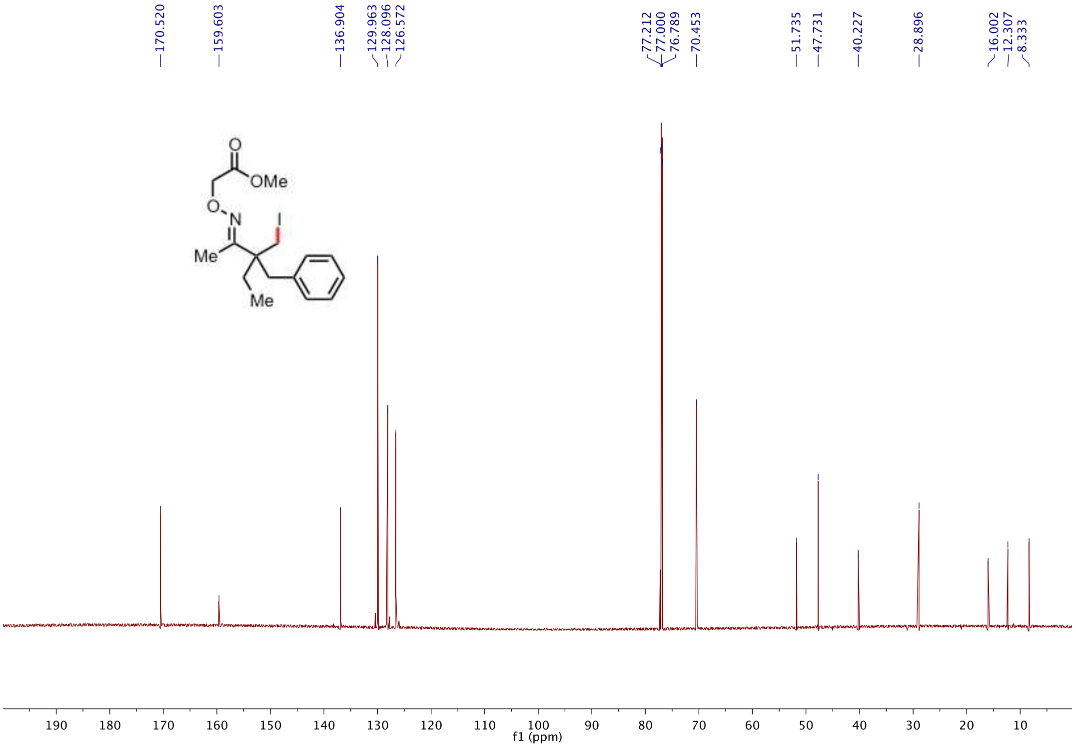
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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77.000
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70.453
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47.731
40.227
28.896
16.002
12.307
8.333
O
OMe
O
N
I
Me
Me
190
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140
130
120
110
100
90
80
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60
50
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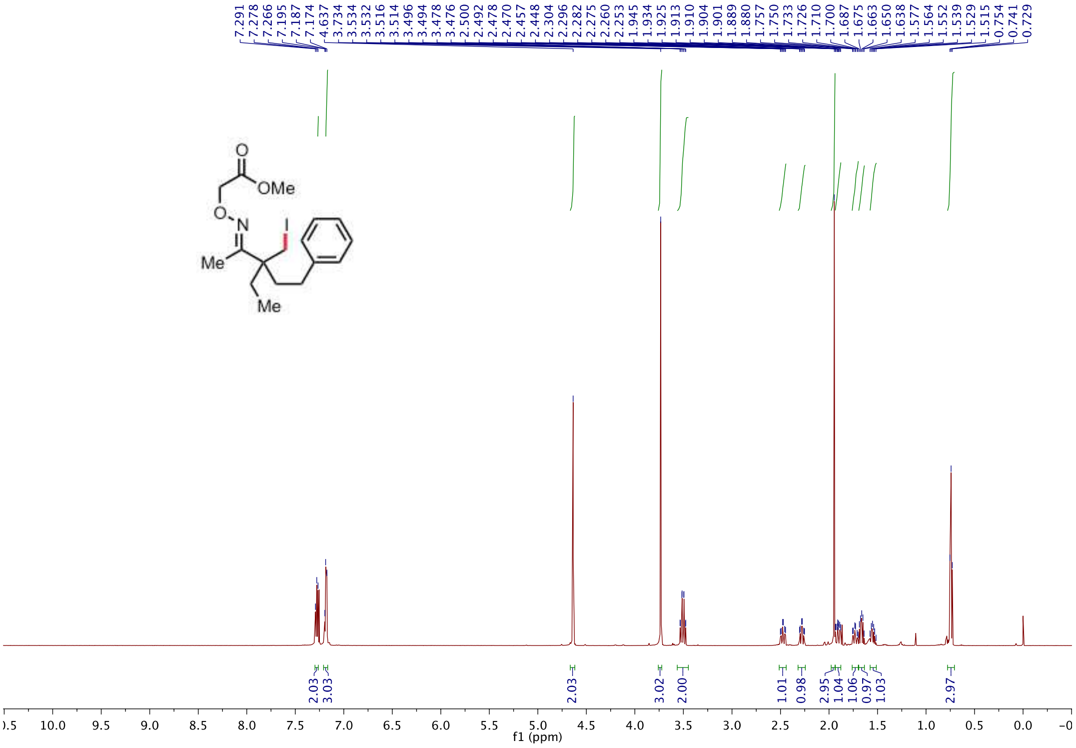
20
10
f1 (ppm)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3.494
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2.478
2.470
2.457
2.448
2.304
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2.282
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2.260
2.253
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1.934
1.925
1.913
1.910
1.904
1.901
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1.757
1.750
1.733
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1.710
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1.539
1.529
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0.729
O
OMe
O
N
I
Me
Me
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3.03
2.03
3.02
2.00
1.01
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2.95
1.04
1.06
0.97
1.03
2.97
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.5
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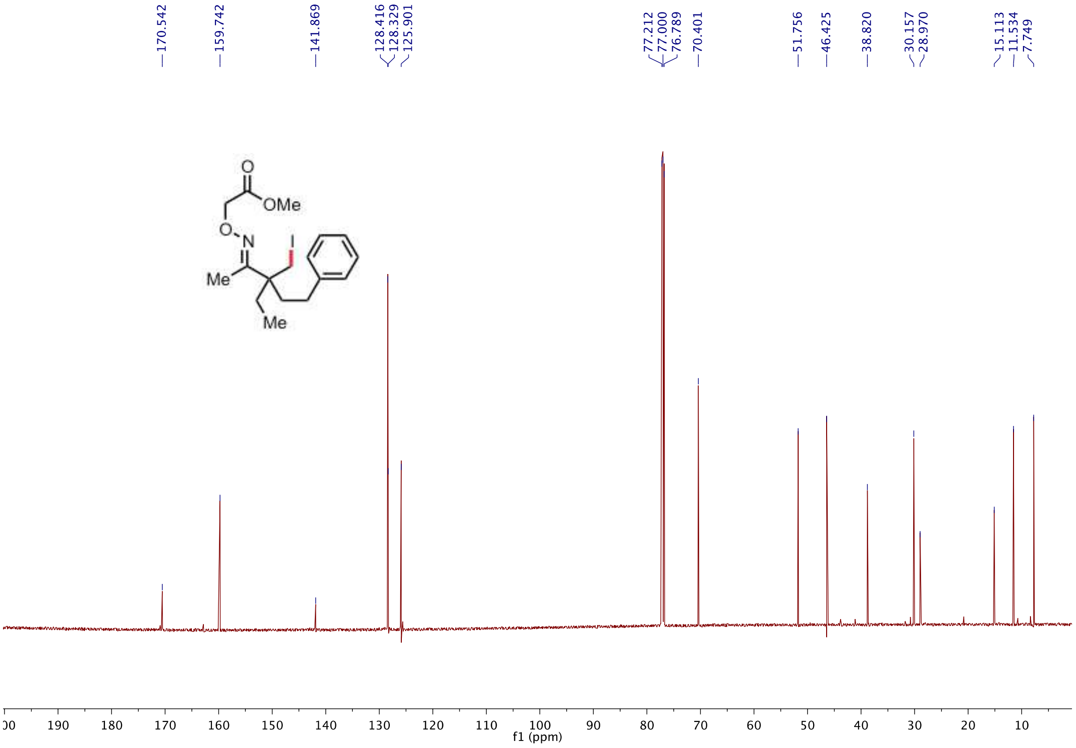
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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77.000
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70.401
51.756
46.425
38.820
30.157
28.970
15.113
11.534
7.749
O
OMe
O
N
I
Me
Me
190
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100
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80
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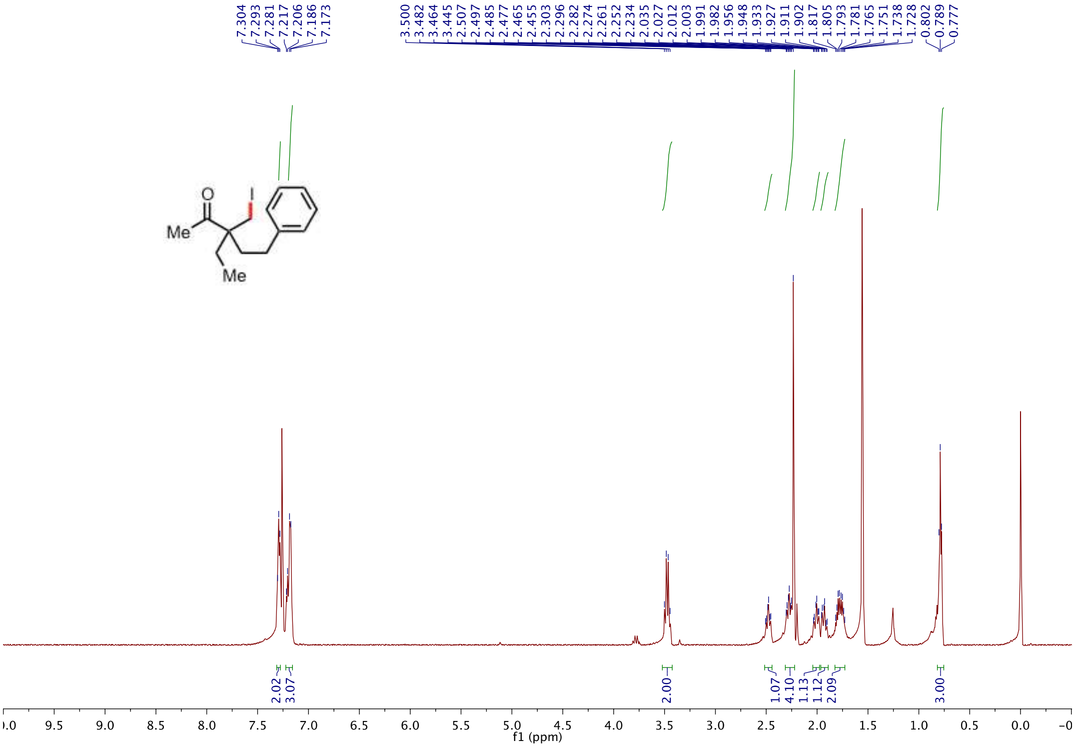
f1 (ppm)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2.497
2.485
2.477
2.465
2.455
2.303
2.296
2.282
2.274
2.261
2.252
2.234
2.035
2.027
2.012
2.003
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1.956
1.948
1.933
1.927
1.911
1.902
1.817
1.805
1.793
1.781
1.765
1.751
1.738
1.728
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0.789
0.777
O
I
Me
Me
2.02
3.07
2.00
1.07
4.10
1.13
1.12
2.09
3.00
.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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4.0
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3.0
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2.0
1.5
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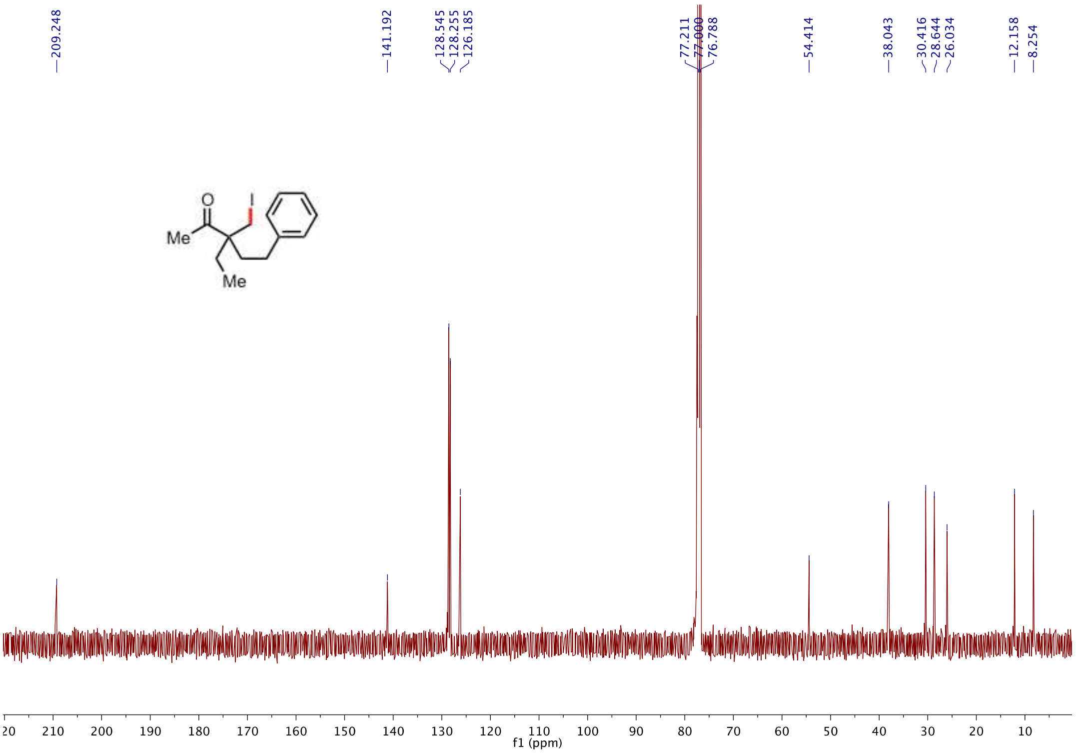
-0
f1 (ppm)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76.788
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26.034
12.158
8.254
O
I
Me
Me
20
210
200
190
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120
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100
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80
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50
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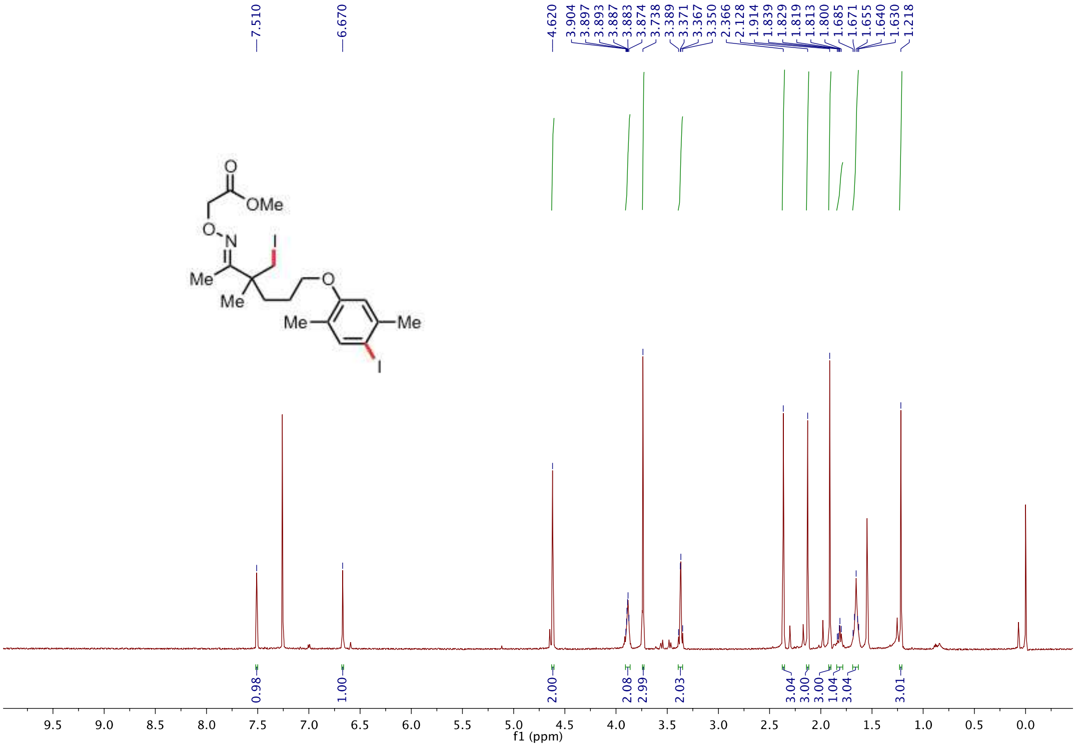
20
10
f1 (ppm)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3.350
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1.839
1.829
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1.813
1.800
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1.671
1.655
1.640
1.630
1.218
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OMe
O
N
I
Me
Me
O
Me
Me
I
0.98
1.00
2.00
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2.99
2.03
3.04
3.00
3.00
1.04
3.04
3.01
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9.0
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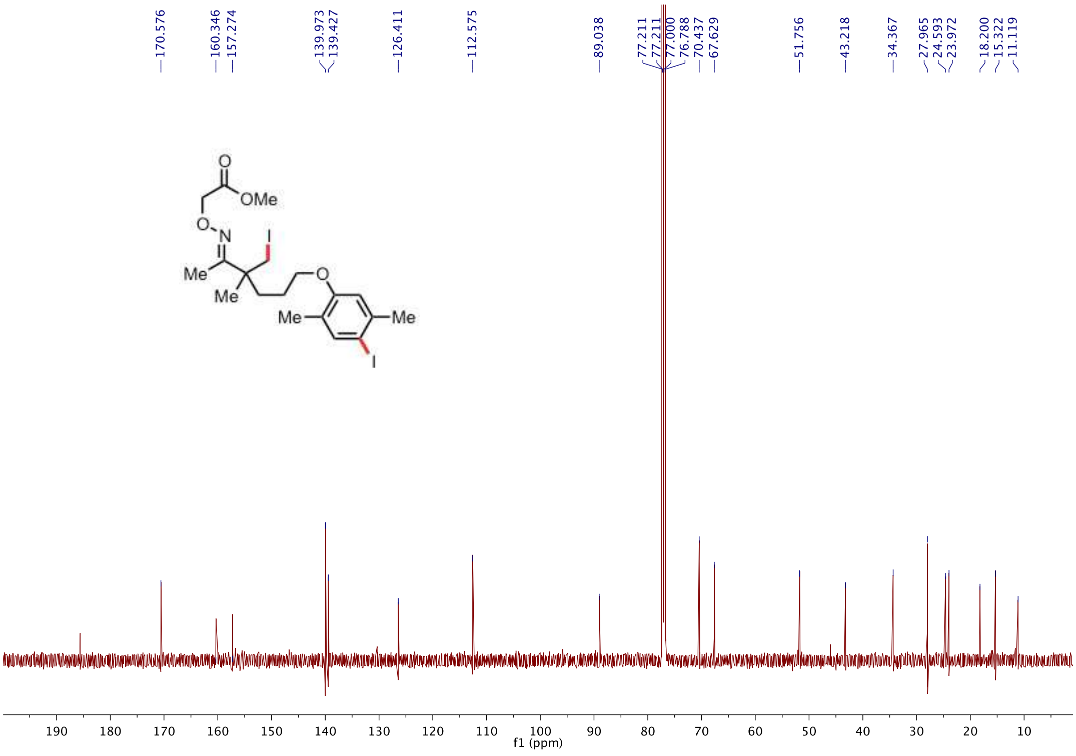
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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157.274
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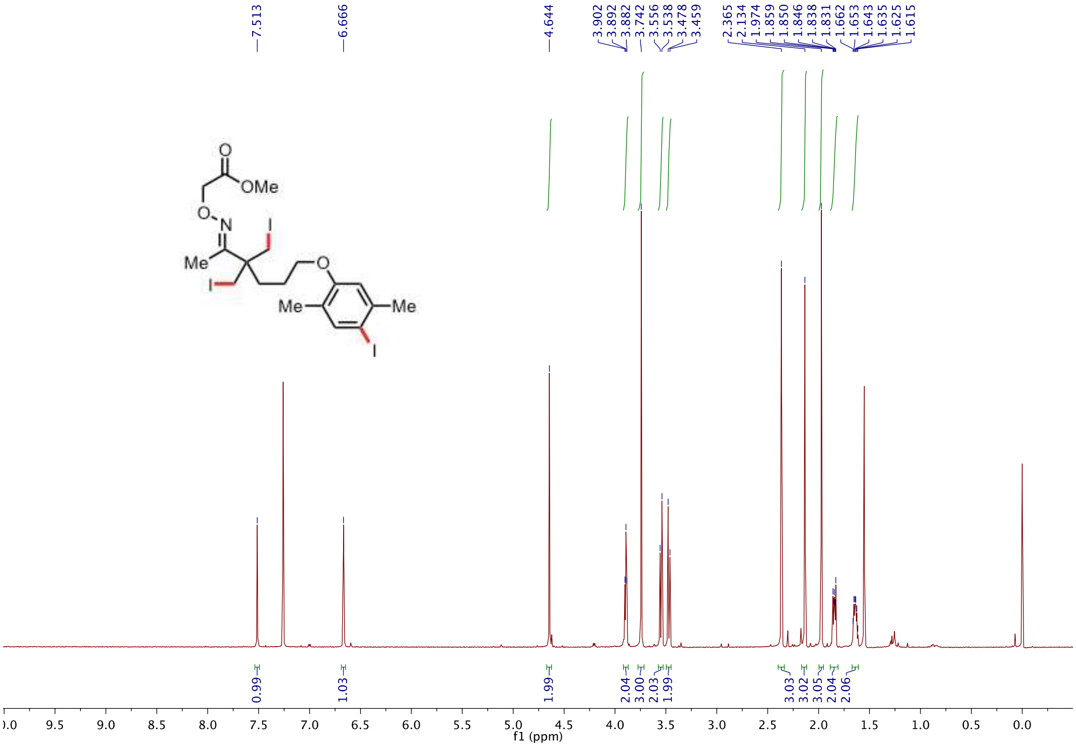
139.427
126.411
112.575
89.038
77.211
77.211
77.000
76.788
70.437
67.629
51.756
43.218
34.367
27.965
24.593
23.972
18.200
15.322
11.119
O
OMe
O
N
I
Me
Me
O
Me
Me
I
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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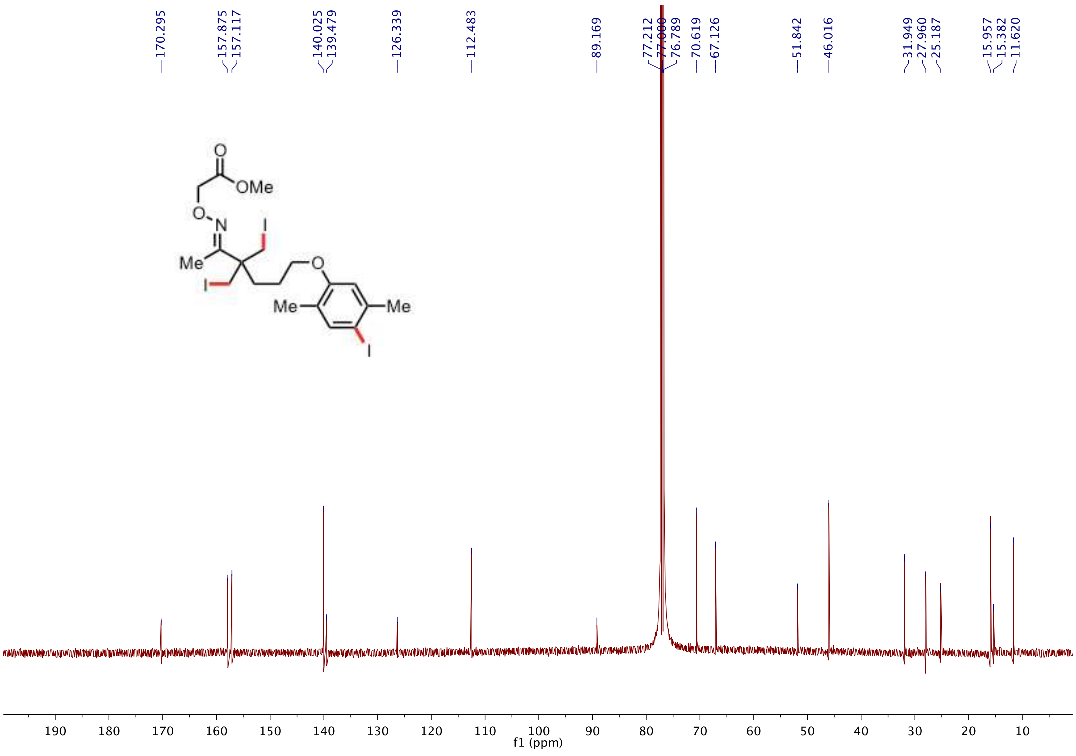
6.666
4.644
3.902
3.892
3.882
3.742
3.556
3.538
3.478
3.459
2.365
2.134
1.974
1.859
1.850
1.846
1.838
1.831
1.662
1.653
1.643
1.635
1.625
1.615
OMe
O
N
I
Me
O
Me
Me
I
I
0.99
1.03
1.99
2.04
3.00
2.03
1.99
3.03
3.02
3.05
2.04
2.06
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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157.117
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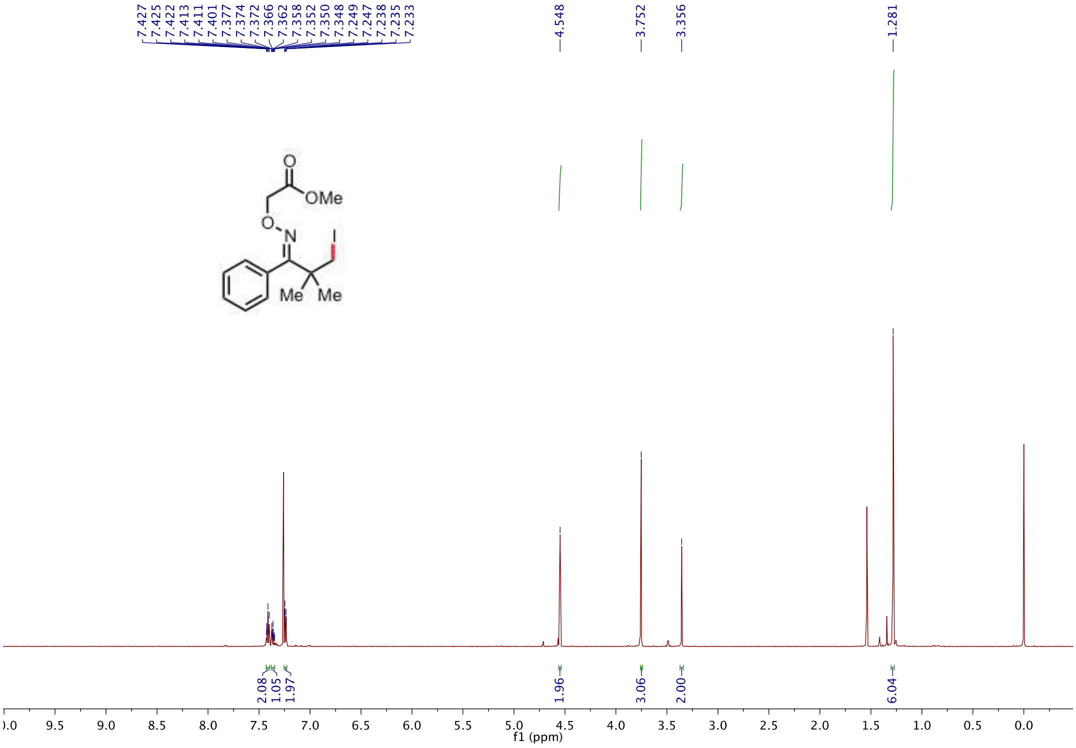
139.479
126.339
112.483
89.169
77.212
77.000
76.789
70.619
67.126
51.842
46.016
31.949
27.960
25.187
15.957
15.382
11.620
OMe
O
N
I
Me
O
Me
Me
I
I
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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7.422
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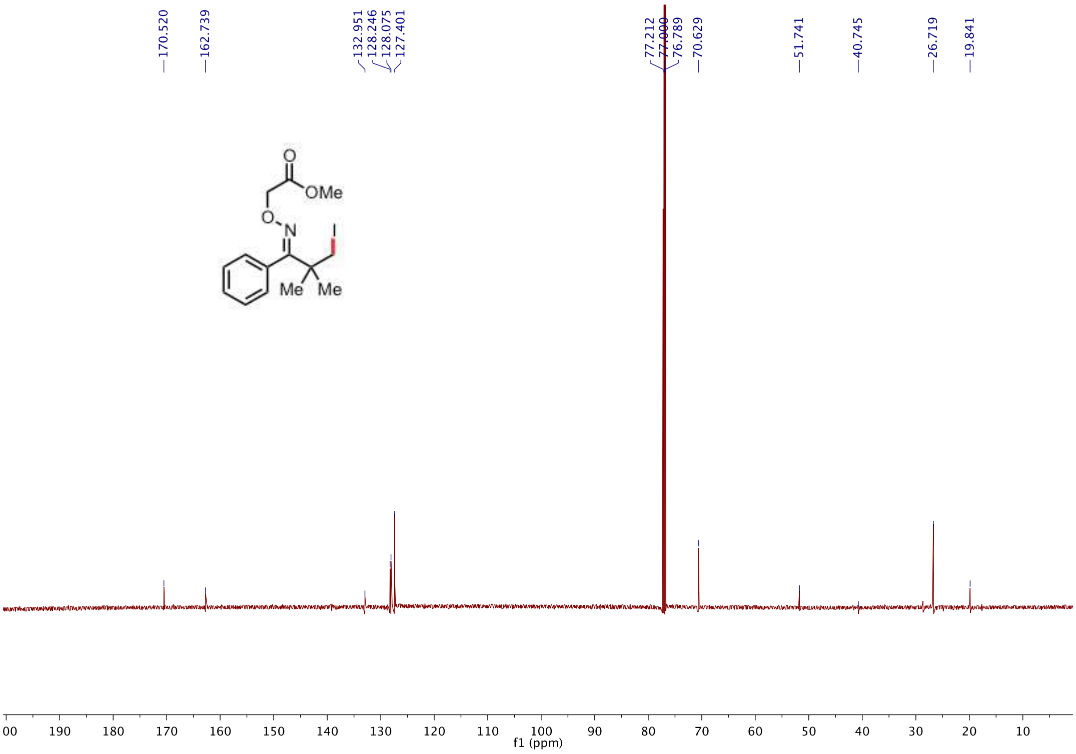
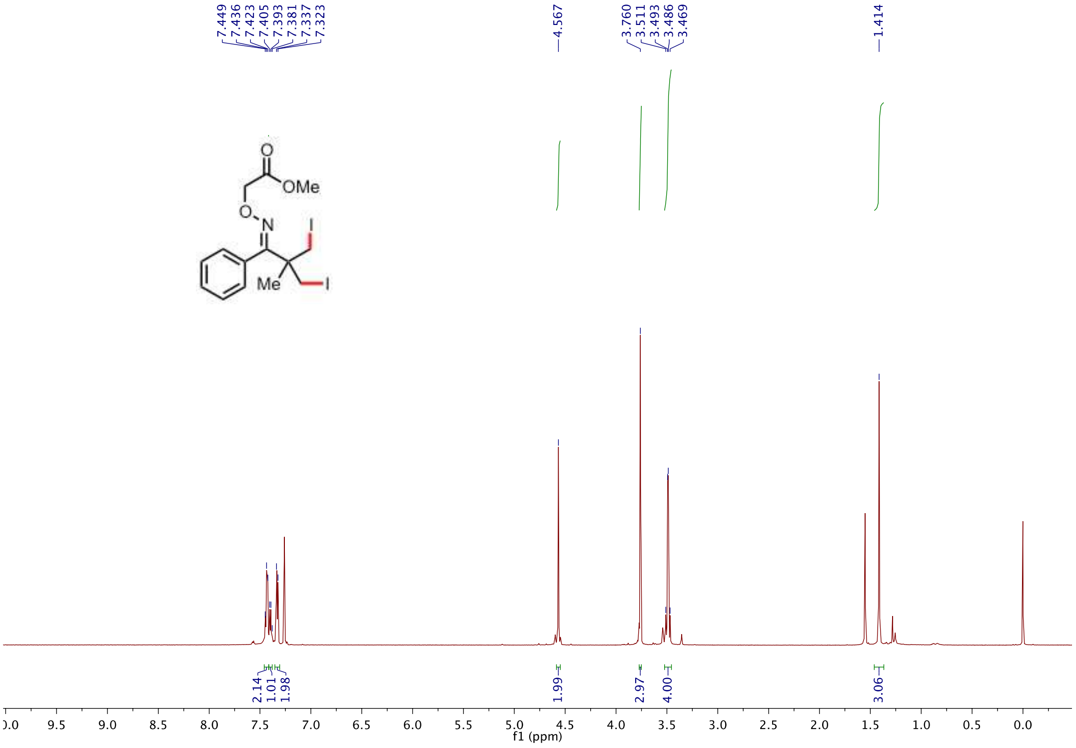
7.411
7.401
7.377
7.374
7.372
7.366
7.362
7.358
7.352
7.350
7.348
7.249
7.247
7.238
7.235
7.233
4.548
3.752
3.356
1.281
O
OMe
O
N
I
Me
Me
2.08
1.05
1.97
1.96
3.06
2.00
6.04
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


170.520
162.739
132.951
128.246
128.075
127.401
77.212
77.000
76.789
70.629
51.741
40.745
26.719
19.841
O
OMe
O
N
I
Me
Me
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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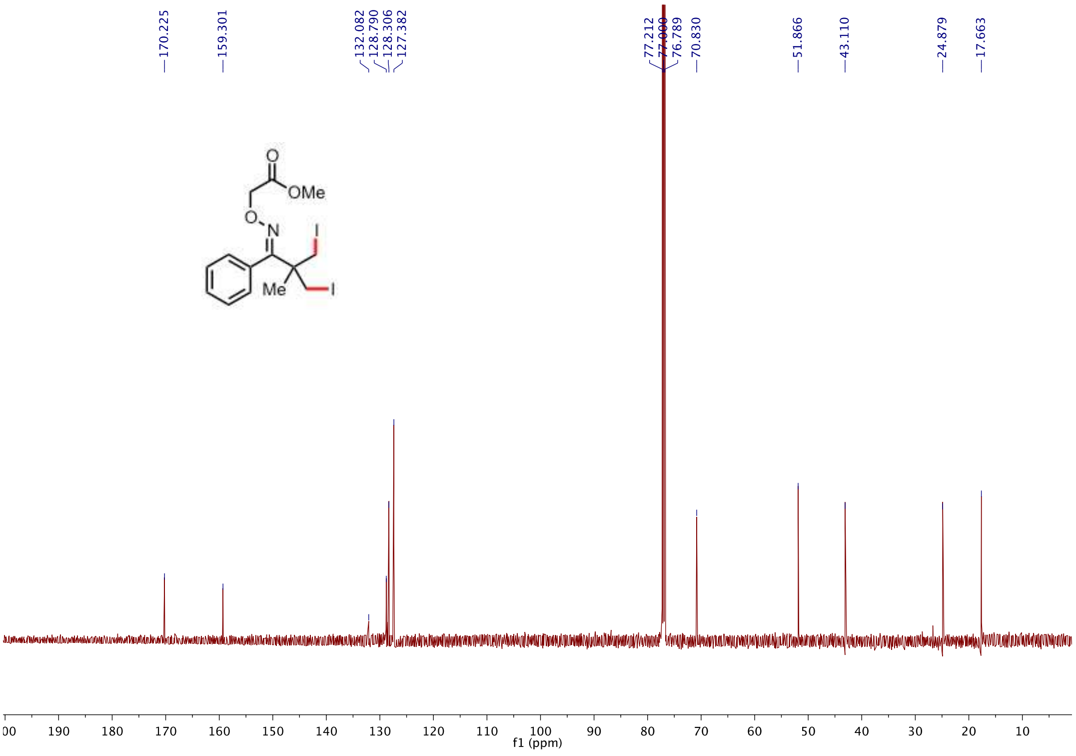
7.436
7.423
7.405
7.393
7.381
7.337
7.323
4.567
3.760
3.511
3.493
3.486
3.469
1.414
O
OMe
O
N
I
Me
I
2.14
1.01
1.98
1.99
2.97
4.00
3.06
0.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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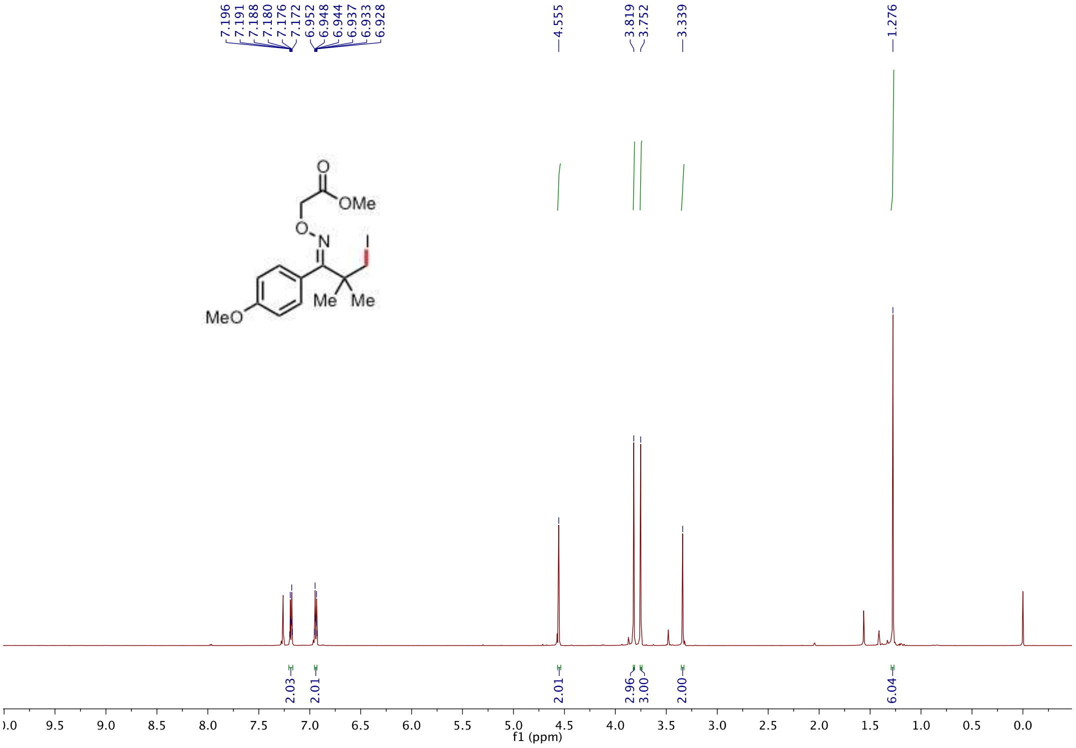
128.790
128.306
127.382
77.212
77.000
76.789
70.830
51.866
43.110
24.879
17.663
O
OMe
O
N
I
Me
I
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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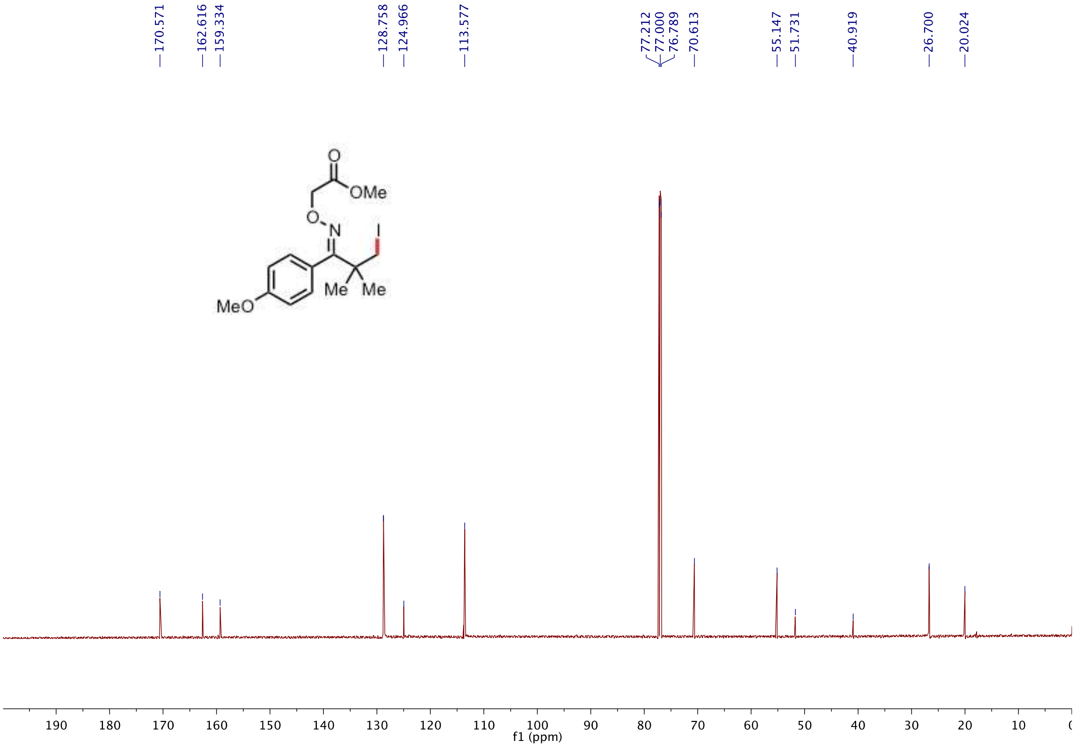
7.191
7.188
7.180
7.176
7.172
6.952
6.948
6.944
6.937
6.933
6.928
4.555
3.819
3.752
3.339
1.276
OMe
O
N
I
Me
Me
MeO
2.03
2.01
2.01
2.96
3.00
2.00
6.04
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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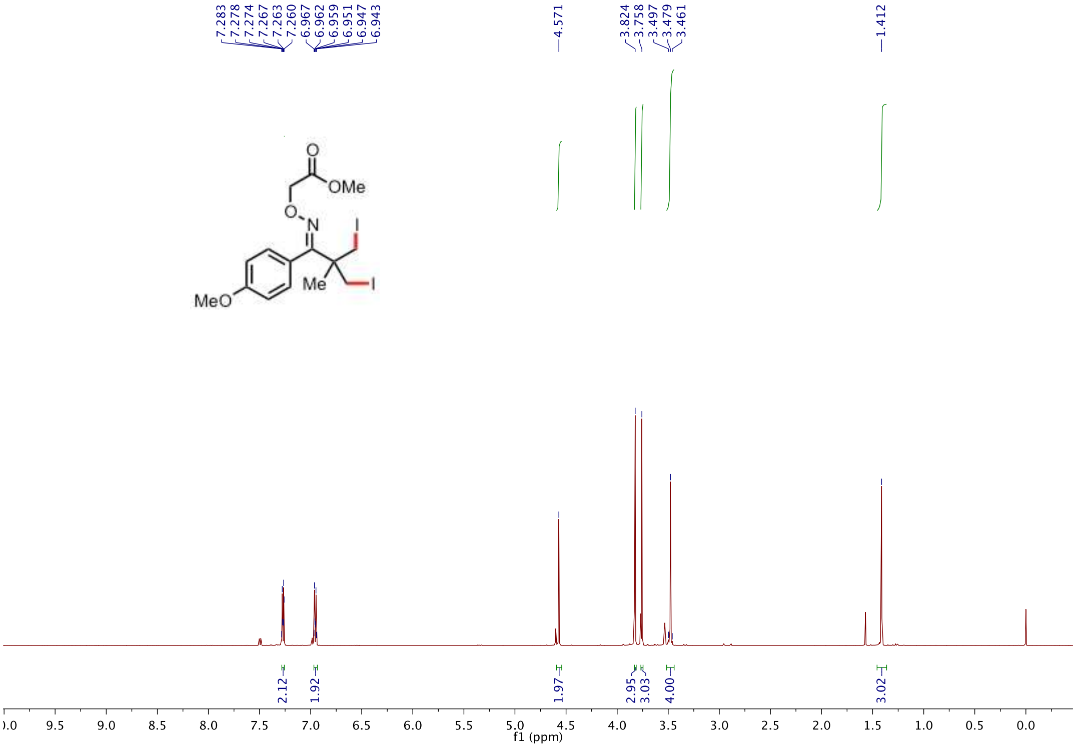
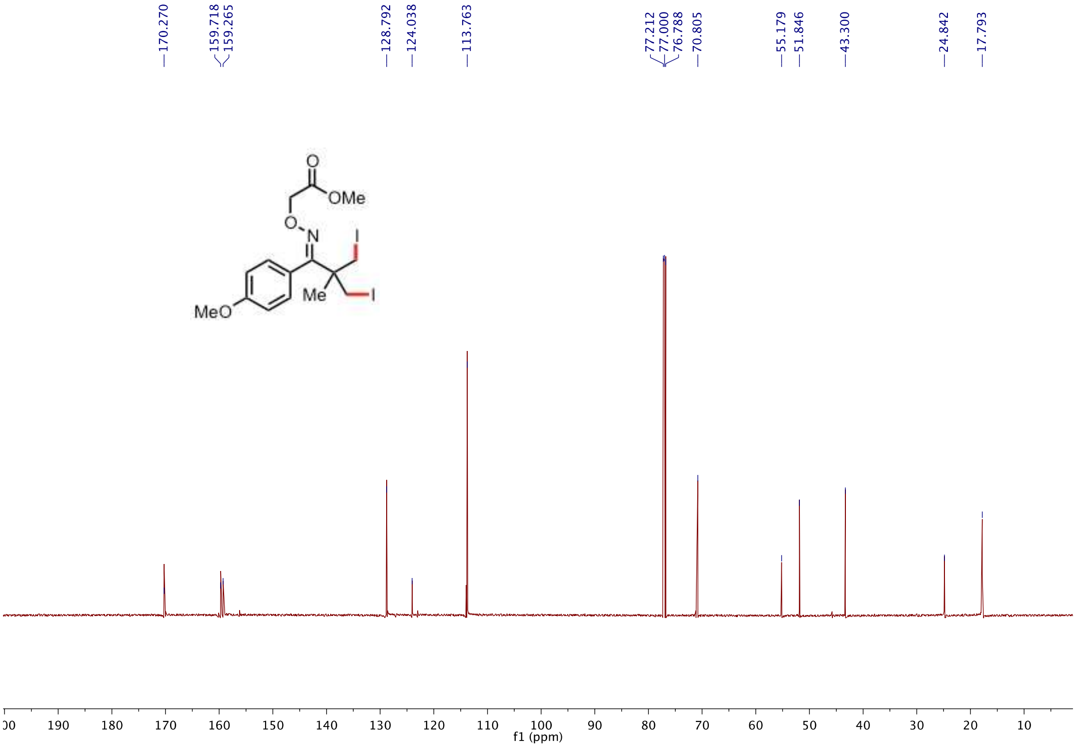
159.334
128.758
124.966
113.577
77.212
77.000
76.789
70.613
55.147
51.731
40.919
26.700
20.024
OMe
O
N
I
Me
Me
MeO
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.283
7.278
7.274
7.267
7.263
7.260
6.967
6.962
6.959
6.951
6.947
6.943
4.571
3.824
3.758
3.497
3.479
3.461
1.412
O
OMe
O
N
I
Me
I
MeO
2.12
1.92
1.97
2.95
3.03
4.00
3.02
10.0
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
0.0
f1 (ppm)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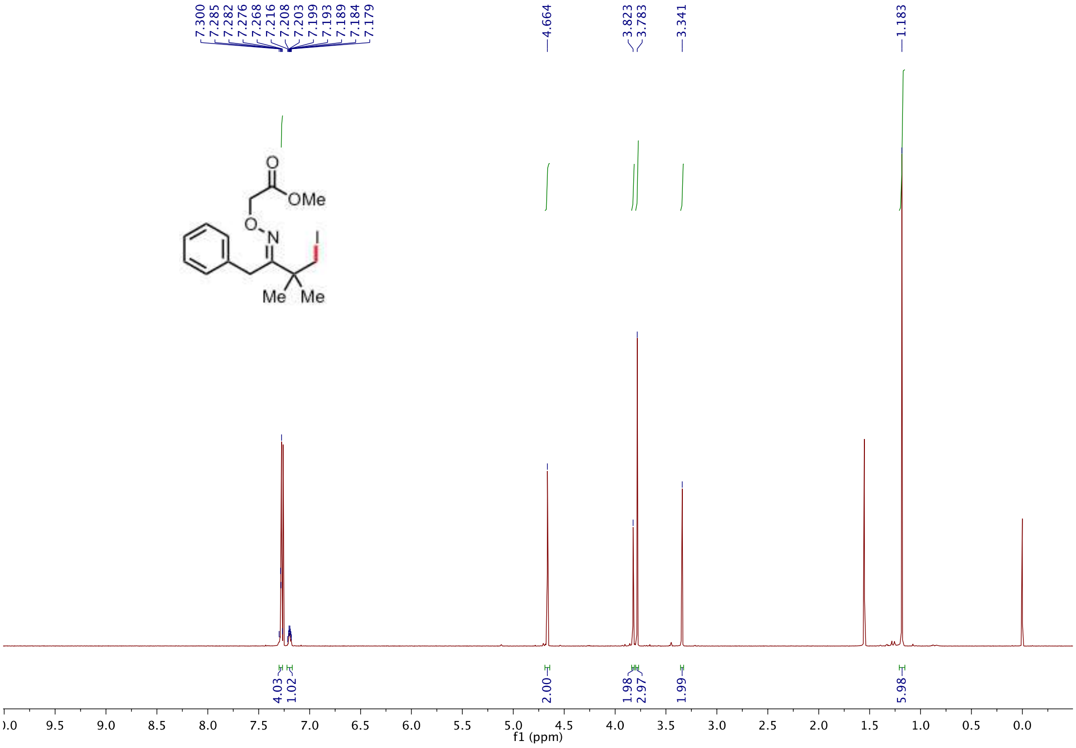
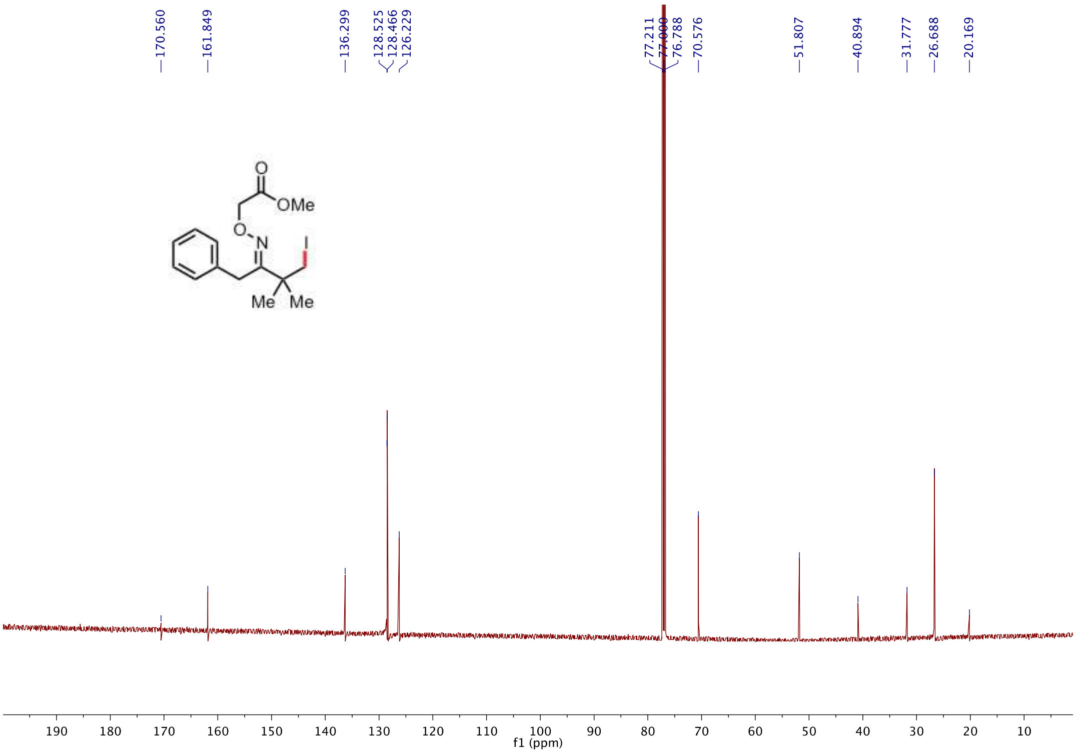
159.265
128.792
124.038
113.763
77.212
77.000
76.788
70.805
55.179
51.846
43.300
24.842
17.793
O
OMe
O
N
I
Me
I
MeO
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


7.300
7.285
7.282
7.276
7.268
7.216
7.208
7.203
7.199
7.193
7.189
7.184
7.179
4.664
3.823
3.783
3.341
1.183
O
OMe
O
N
I
Me
Me
4.03
1.02
2.00
1.98
2.97
1.99
5.98
).0
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
0.0
f1 (ppm)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128.466
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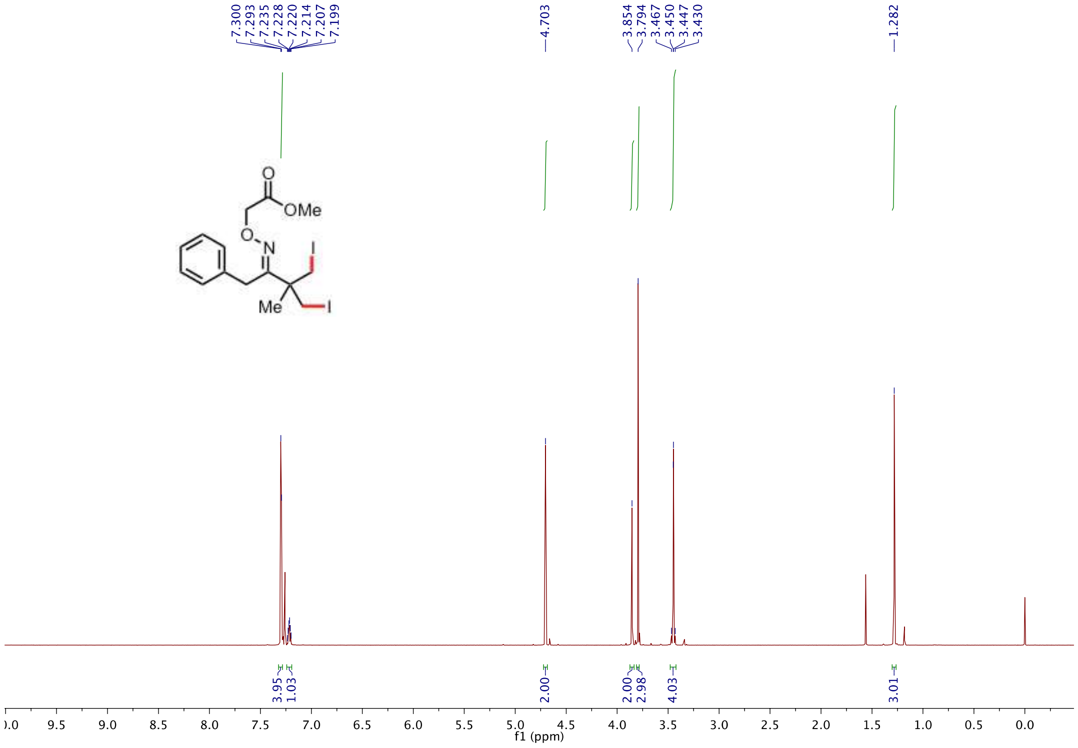
77.211
77.000
76.788
70.576
51.807
40.894
31.777
26.688
20.169
O
OMe
O
N
I
Me
Me
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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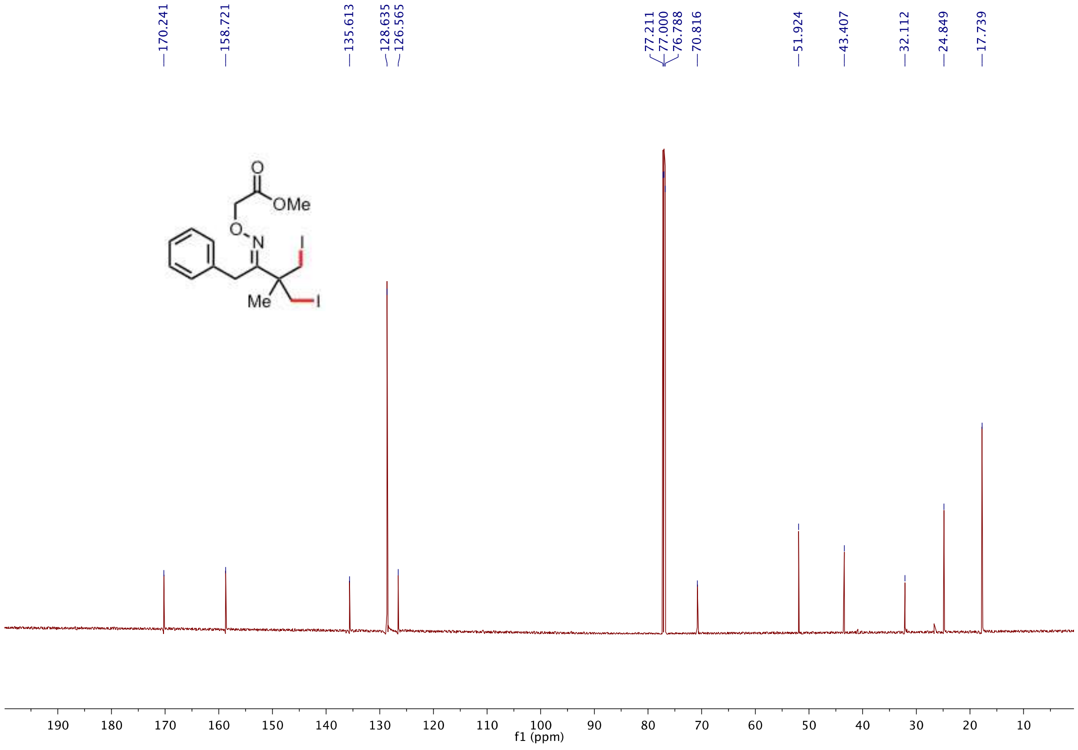
7.235
7.228
7.220
7.214
7.207
7.199
4.703
3.854
3.794
3.467
3.450
3.447
3.430
1.282
OMe
O
N
I
Me
3.95
1.03
2.00
2.00
2.98
4.03
3.01
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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158.721
135.613
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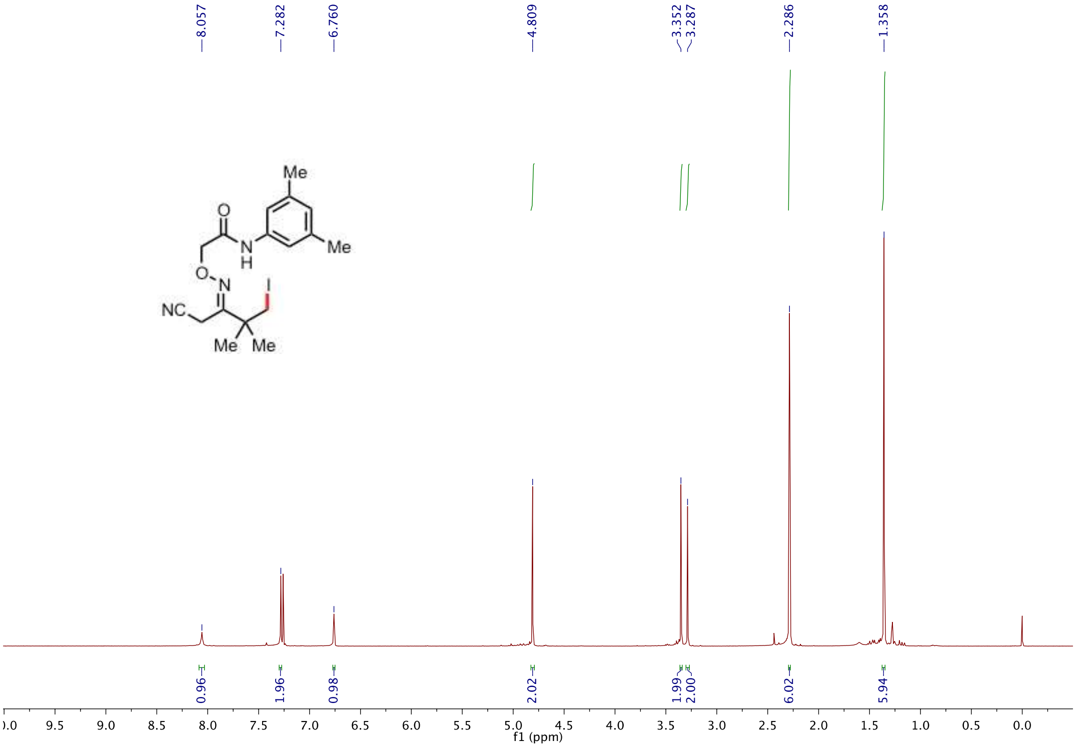
77.211
77.000
76.788
70.816
51.924
43.407
32.112
24.849
17.739
OMe
O
N
I
Me
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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6.760
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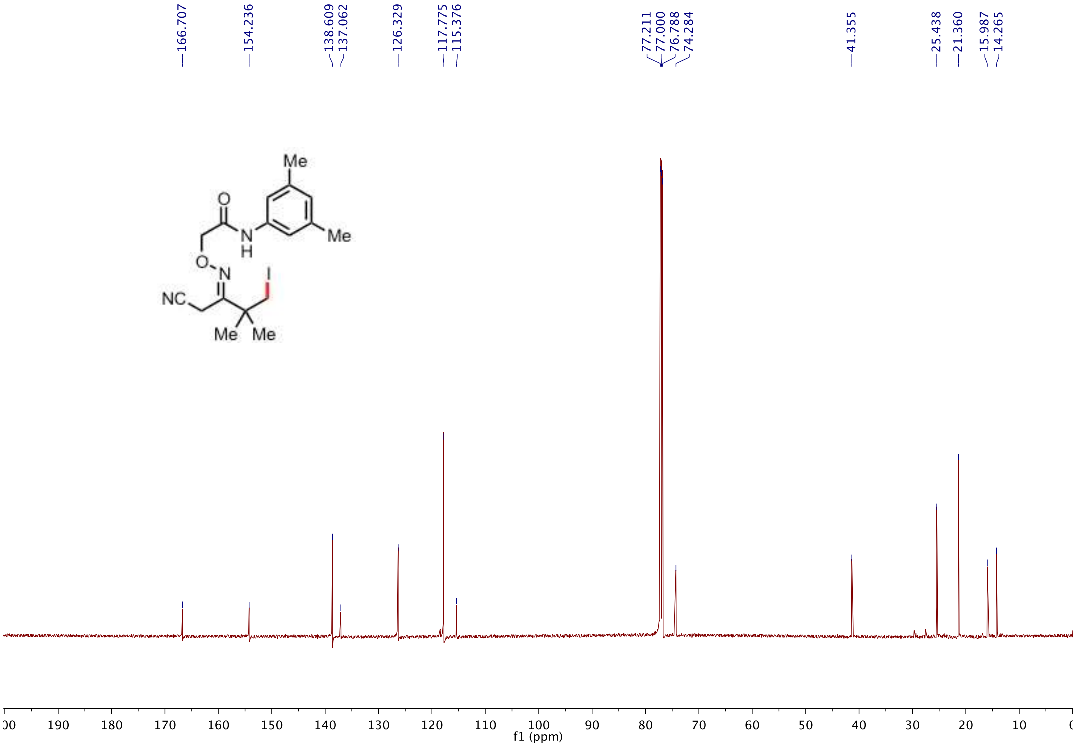
3.287
2.286
1.358
Me
O
N
H
Me
O
N
I
NC
Me
Me
0.96
1.96
0.98
2.02
1.99
2.00
6.02
5.94
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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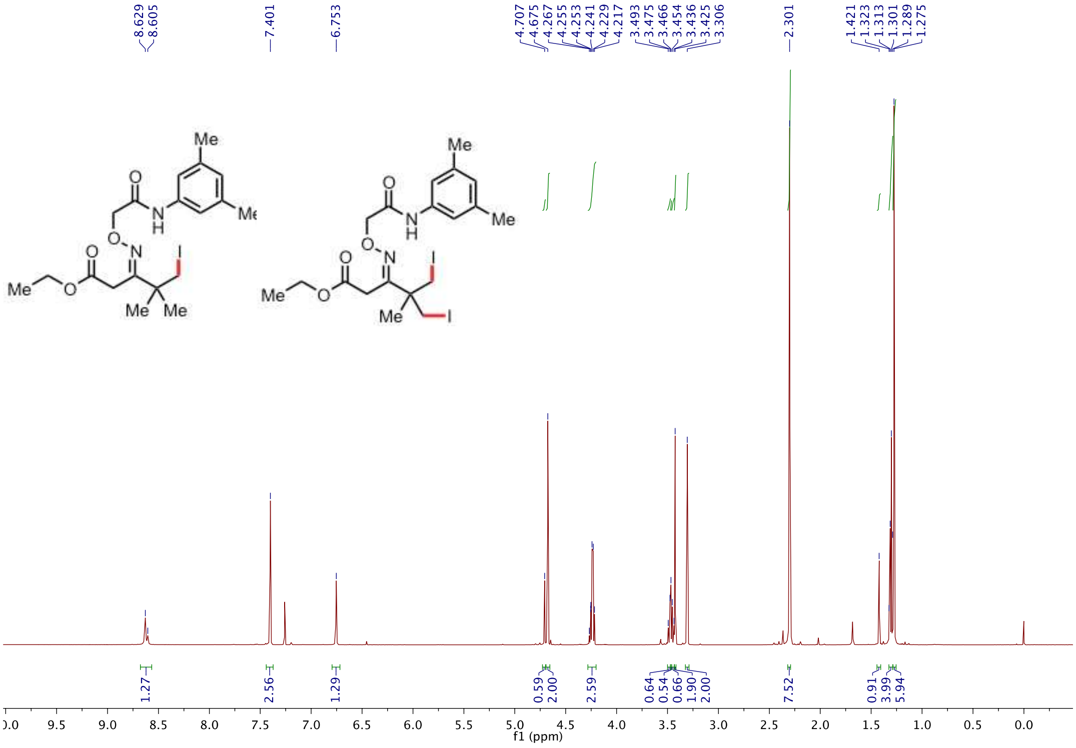
137.062
126.329
117.775
115.376
77.211
77.000
76.788
74.284
41.355
25.438
21.360
15.987
14.265
Me
O
N
H
Me
O
N
I
NC
Me
Me
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.401
6.753
4.707
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4.255
4.253
4.241
4.229
4.217
3.493
3.475
3.466
3.454
3.436
3.425
3.306
2.301
1.421
1.323
1.313
1.301
1.289
1.275
Me
O
N
H
Me
O
N
I
Me
O
O
Me
Me
1.27
2.56
1.29
0.59
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2.59
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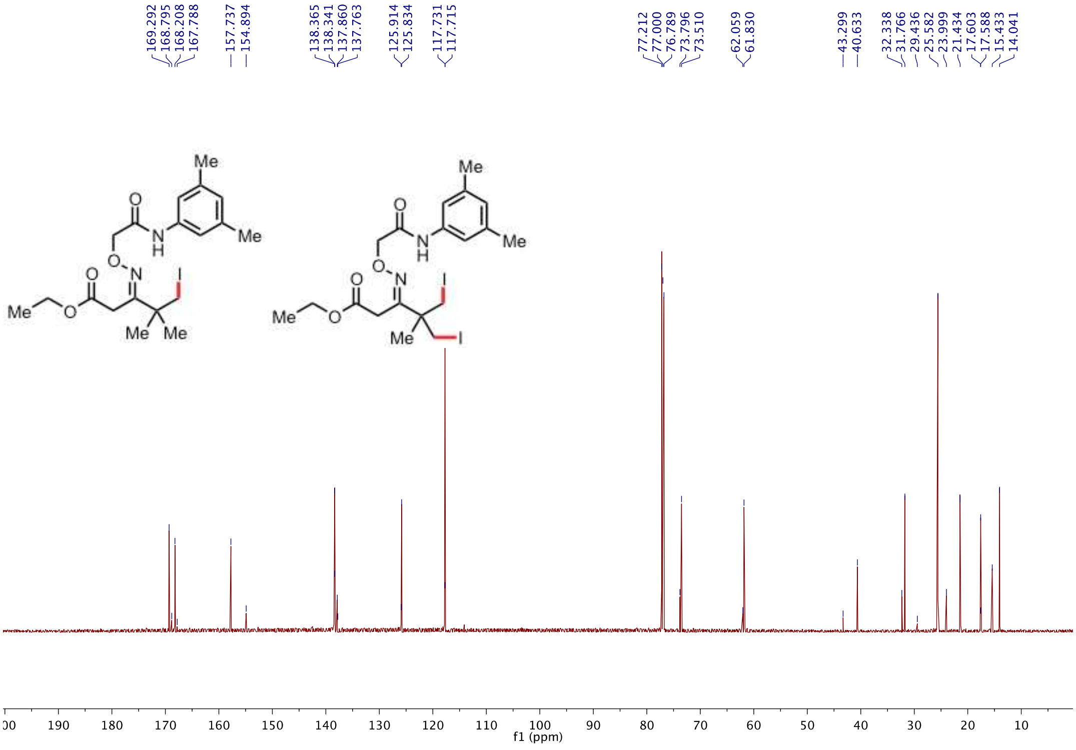
0.54
0.66
1.90
2.00
7.52
0.91
3.99
5.94
f1 (ppm)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167.788
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154.894
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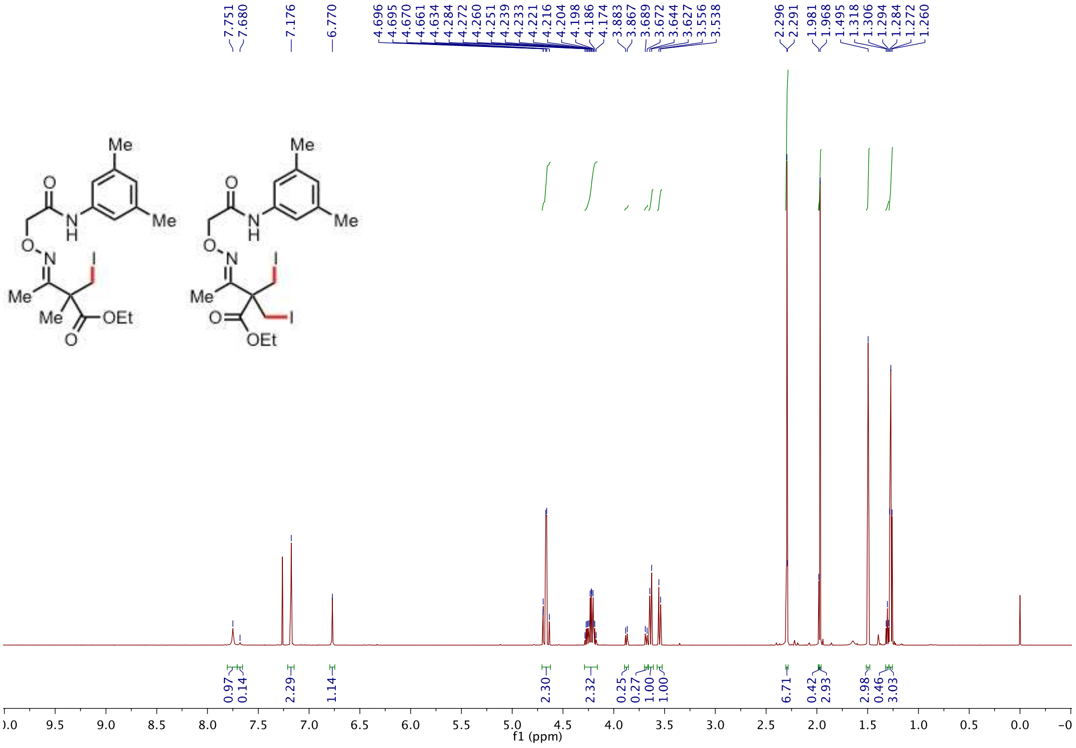
138.341
137.860
137.763
125.914
125.834
117.731
117.715
77.212
77.000
76.789
73.796
73.510
62.059
61.830
43.299
40.633
32.338
31.766
29.436
25.582
23.999
21.434
17.603
17.588
15.433
14.041
Me
O
N
H
Me
O
N
I
Me
O
O
Me
Me
f1 (ppm)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4.661
4.634
4.284
4.272
4.260
4.251
4.239
4.233
4.221
4.216
4.204
4.198
4.186
4.174
3.883
3.867
3.689
3.672
3.644
3.627
3.556
3.538
2.296
2.291
1.981
1.968
1.495
1.318
1.306
1.294
1.284
1.272
1.260
Me
O
N
H
Me
O
N
I
Me
Me
OEt
O
Me
O
N
H
Me
O
N
I
Me
O
I
OEt
0.97
0.14
2.29
1.14
2.30
2.32
0.25
0.27
1.00
1.00
6.71
0.42
2.93
2.98
0.46
3.03
10.0
9.5
9.0
8.5
8.0
7.5
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6.5
6.0
5.5
5.0
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4.0
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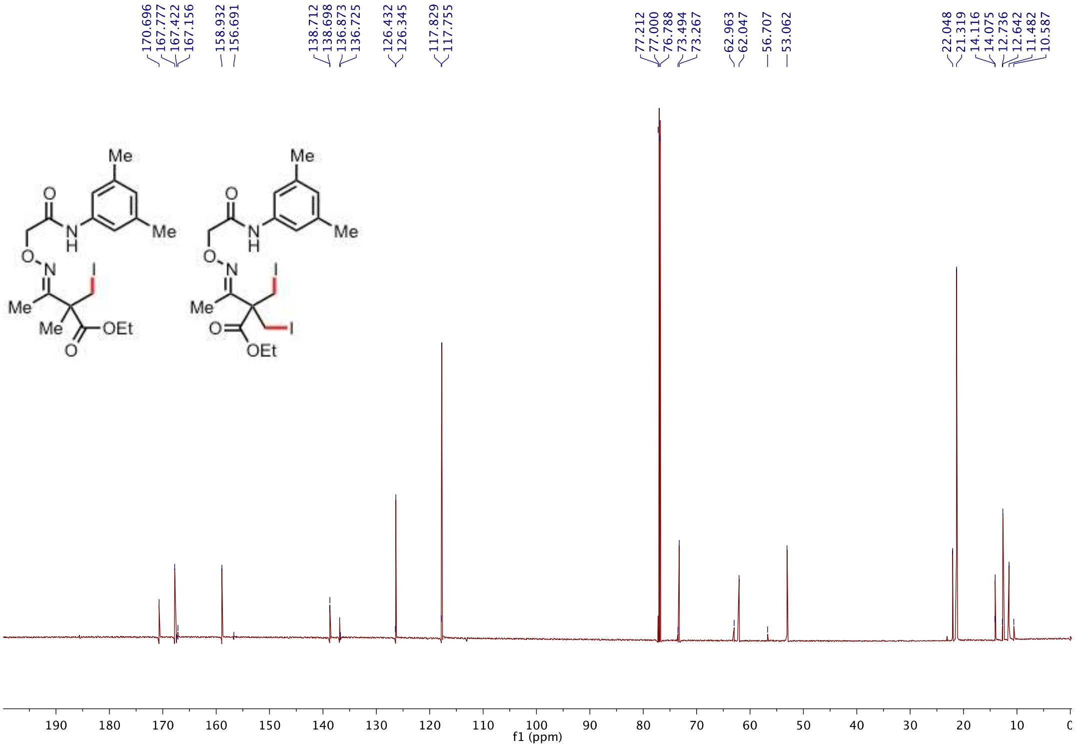
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0
f1 (ppm)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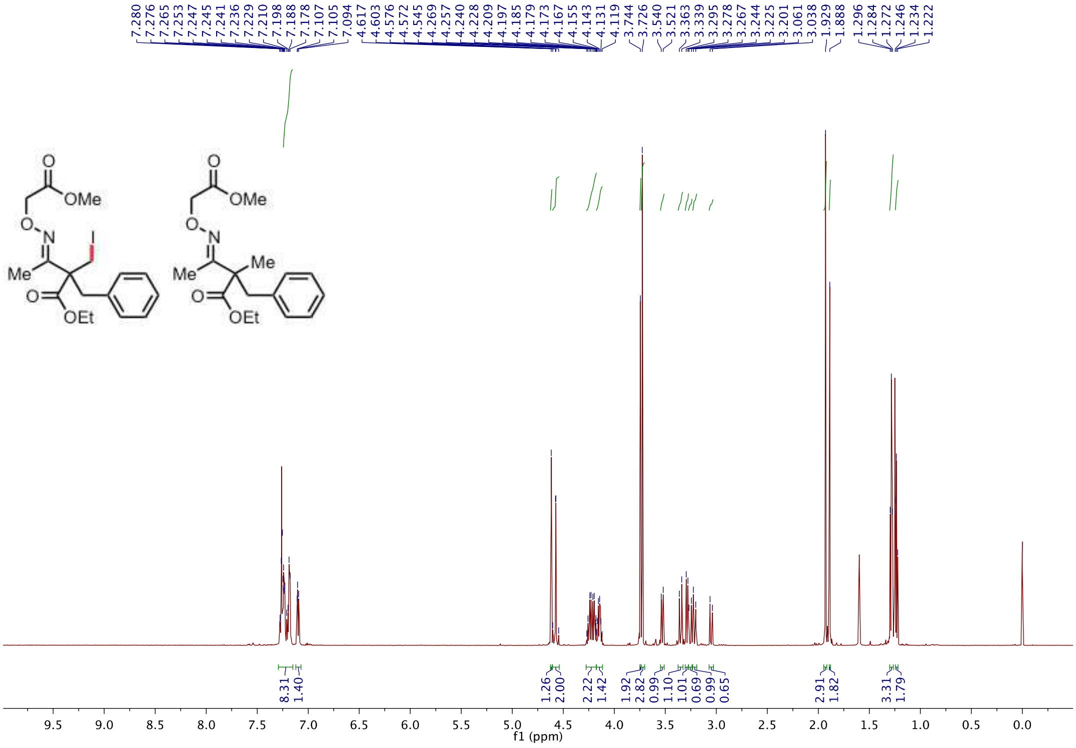
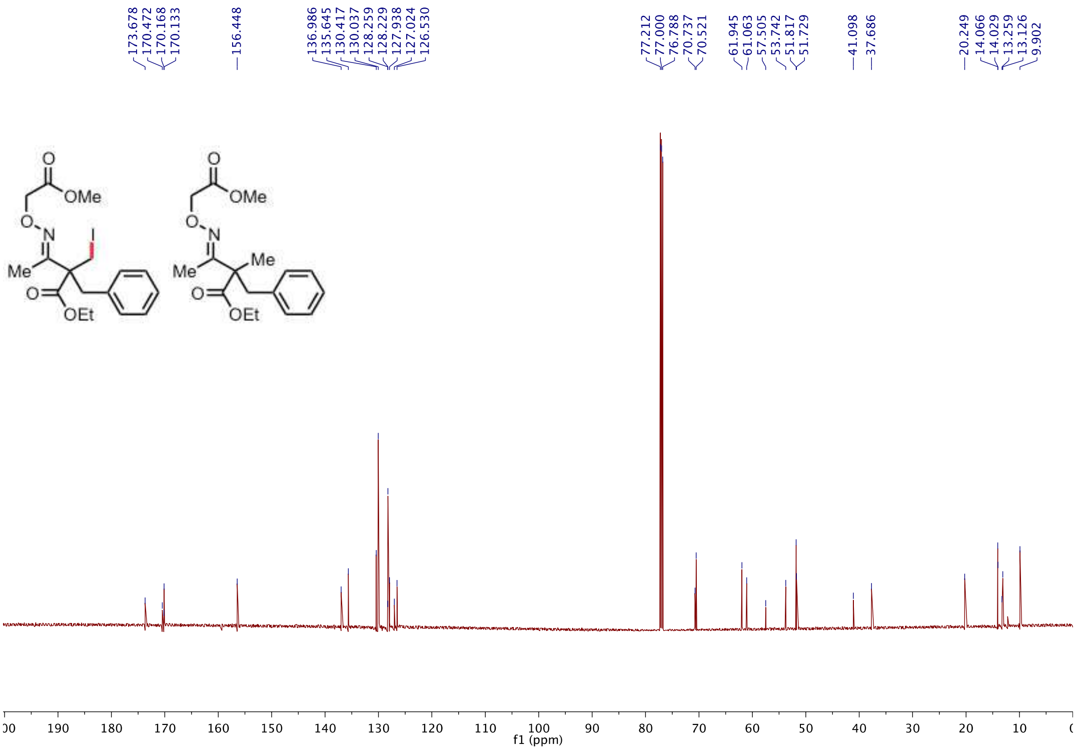
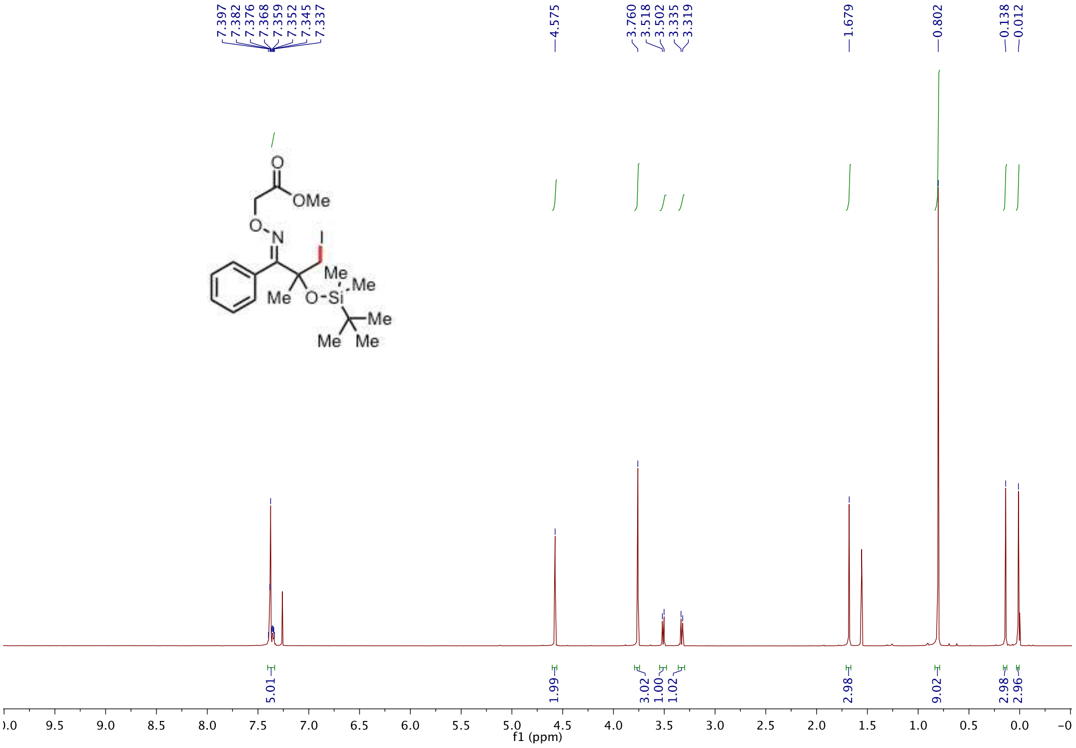
167.156
158.932
156.691
138.712
138.698
136.873
136.725
126.432
126.345
117.829
117.755
77.212
77.000
76.788
73.494
73.267
62.963
62.047
56.707
53.062
22.048
21.319
14.116
14.075
12.736
12.642
11.482
10.587
Me
O
N
H
Me
O
N
I
Me
Me
OEt
O
Me
O
N
H
Me
O
N
I
Me
O
I
OEt
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.280 7.276 7.265 7.253 7.247 7.245 7.241 7.236 7.229 7.210 7.198 7.188 7.178 7.107 7.105 7.094 4.617 4.603 4.576 4.572 4.545 4.269 4.257 4.240 4.228 4.209 4.197 4.185 4.179 4.173 4.167 4.155 4.143 4.131 4.119 3.744 3.726 3.540 3.521 3.363 3.339 3.295 3.278 3.267 3.244 3.225 3.201 3.061 3.038 1.929 1.888 1.296 1.284 1.272 1.246 1.234 1.222
8.31 1.40 1.26 2.00 2.22 1.42 1.92 2.82 0.99 1.10 1.01 0.69 0.99 0.65 2.91 1.82 3.31 1.79
OMe
O
N
I
Me
Me
OEt
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 0.0
f1 (ppm)


173.678 170.472 170.168 170.133 156.448 136.986 135.645 130.417 130.037 128.259 128.229 127.938 127.024 126.530 77.212 77.000 76.788 70.737 70.521 61.945 61.063 57.505 53.742 51.817 51.729 41.098 37.686 20.249 14.066 14.029 13.259 13.126 9.902
OMe
O
N
I
Me
Me
OEt
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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7.382
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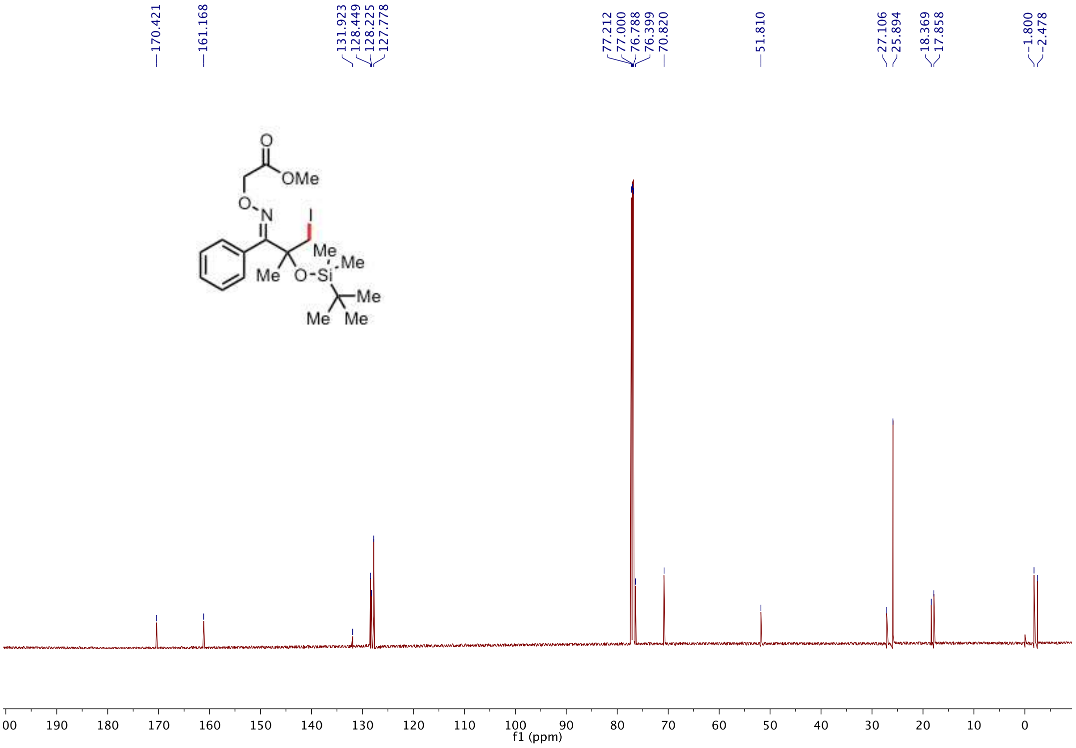
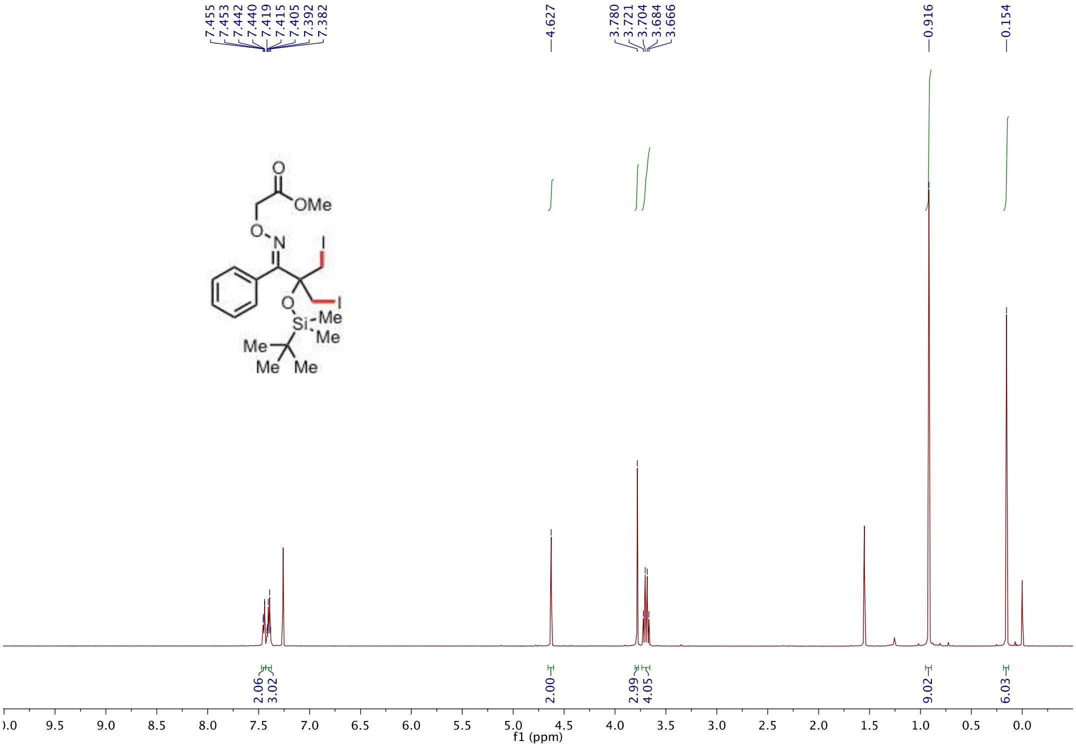
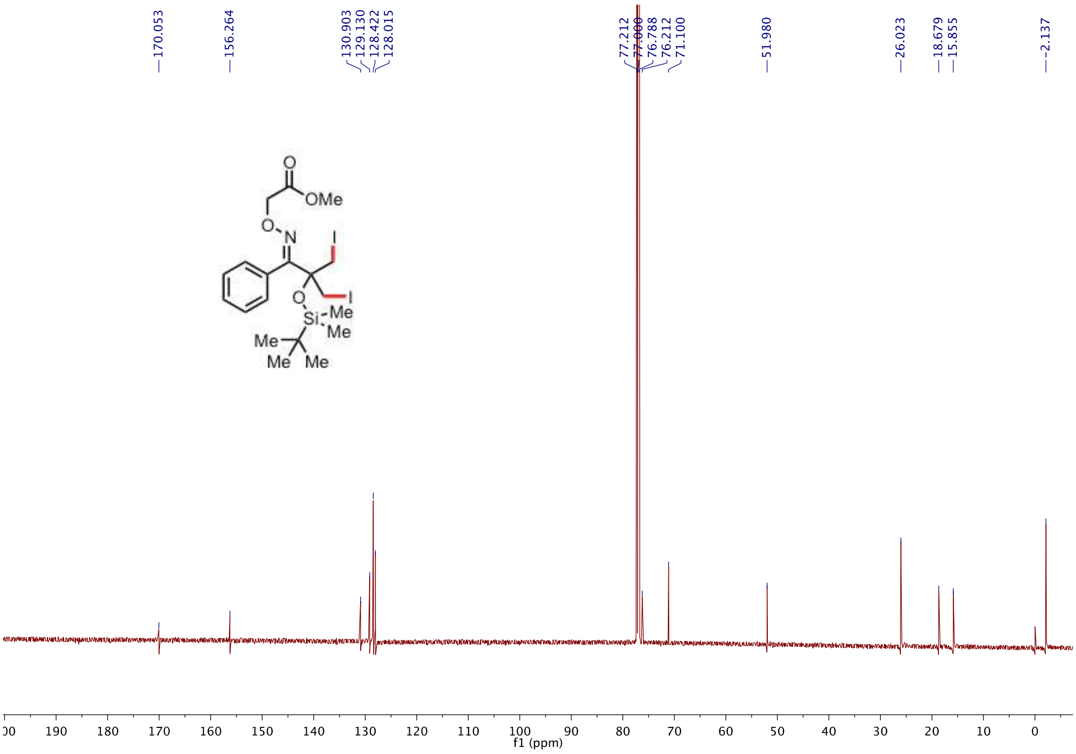
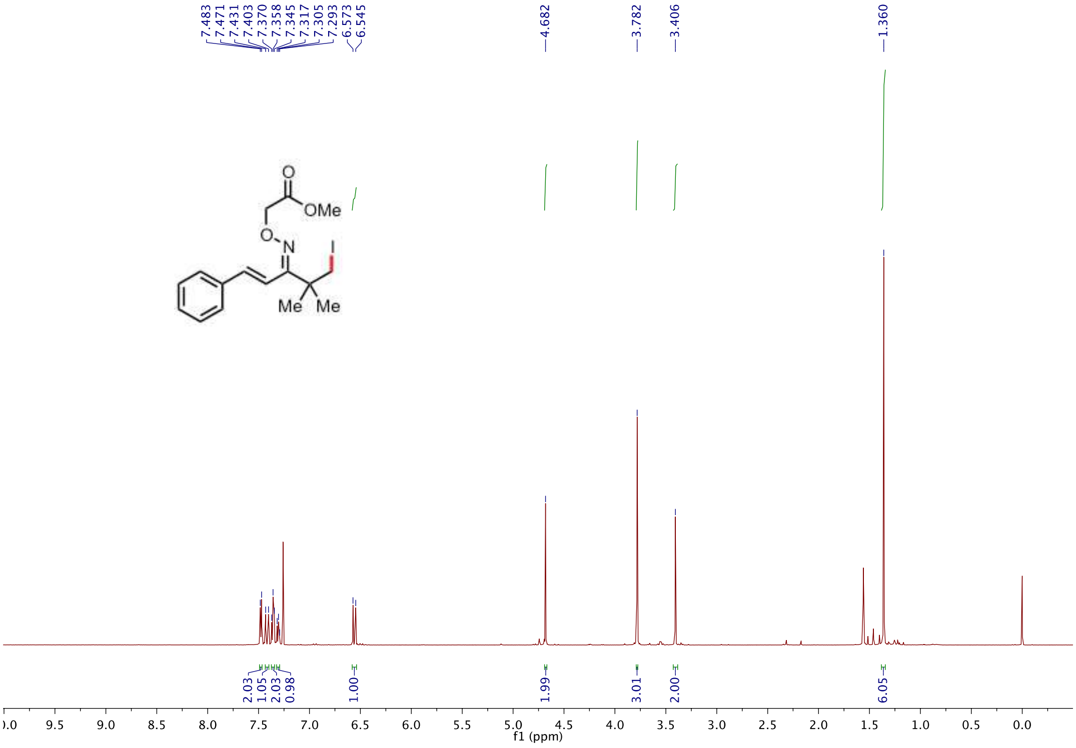
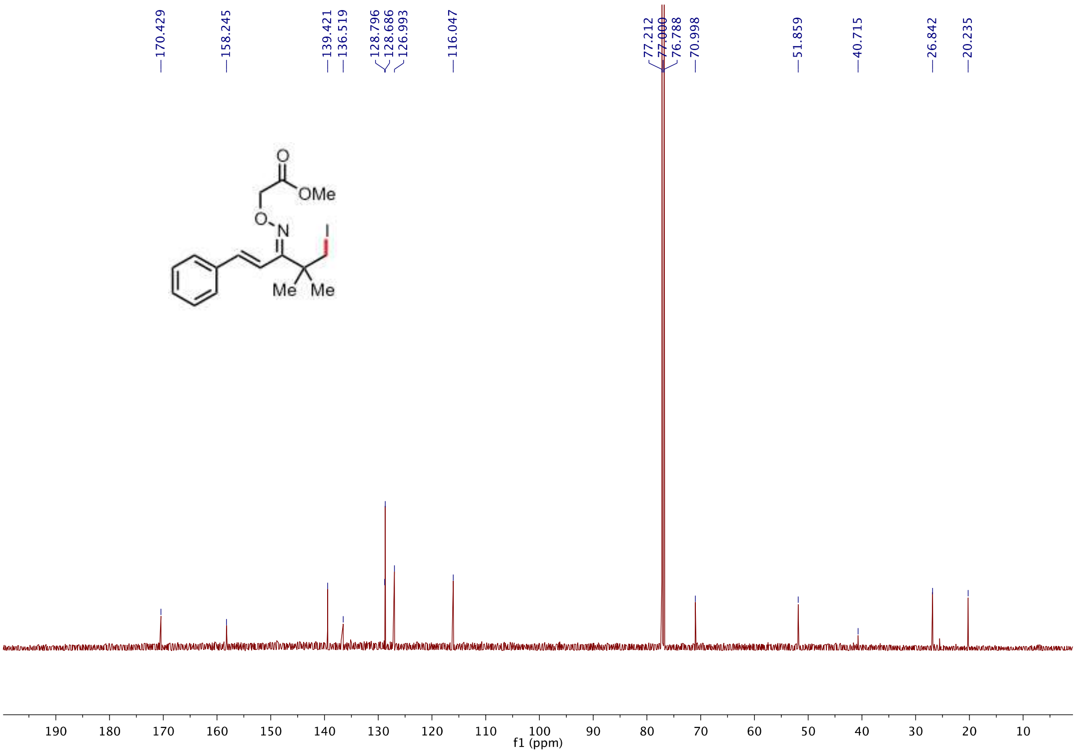
7.368
7.359
7.352
7.345
7.337
4.575
3.760
3.518
3.502
3.335
3.319
1.679
0.802
0.138
0.012
OMe
O
O
N
I
Me
Me
Me
O
Si
Me
Me
Me
5.01
1.99
3.02
1.00
1.02
2.98
9.02
2.98
2.96
).0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0
f1 (ppm)

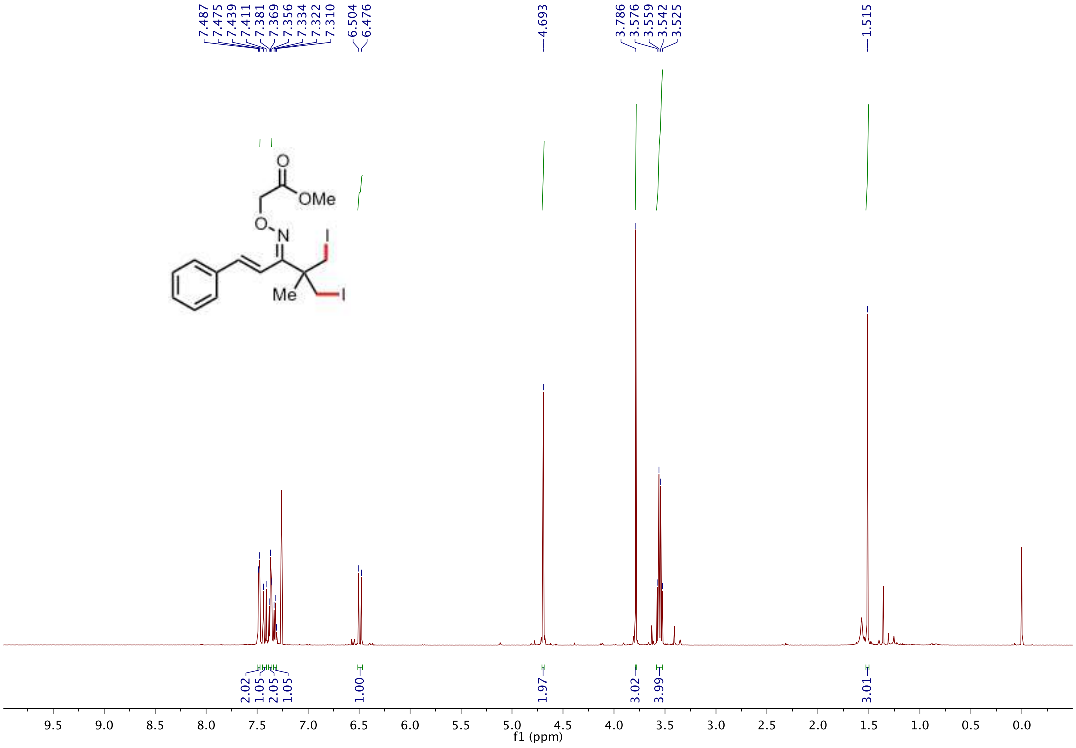

170.421
161.168
131.923
128.449
128.225
127.778
77.212
77.000
76.788
76.399
70.820
51.810
27.106
25.894
18.369
17.858
−1.800
−2.478
OMe
O
O
N
I
Me
Me
Me
O
Si
Me
Me
Me
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

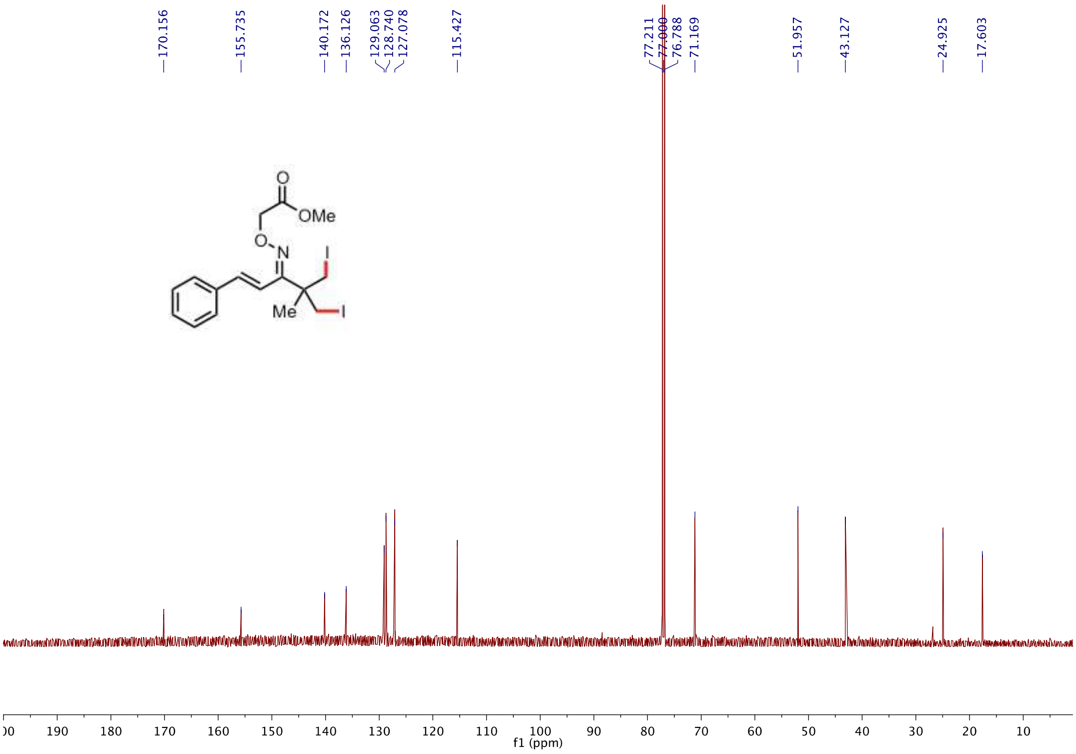

7.455
7.453
7.442
7.440
7.419
7.415
7.405
7.392
7.382
4.627
3.780
3.721
3.704
3.684
3.666
0.916
0.154
OMe
O
N
I
I
O
Si
Me
Me
Me
Me
Me
2.06
3.02
2.00
2.99
4.05
9.02
6.03
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

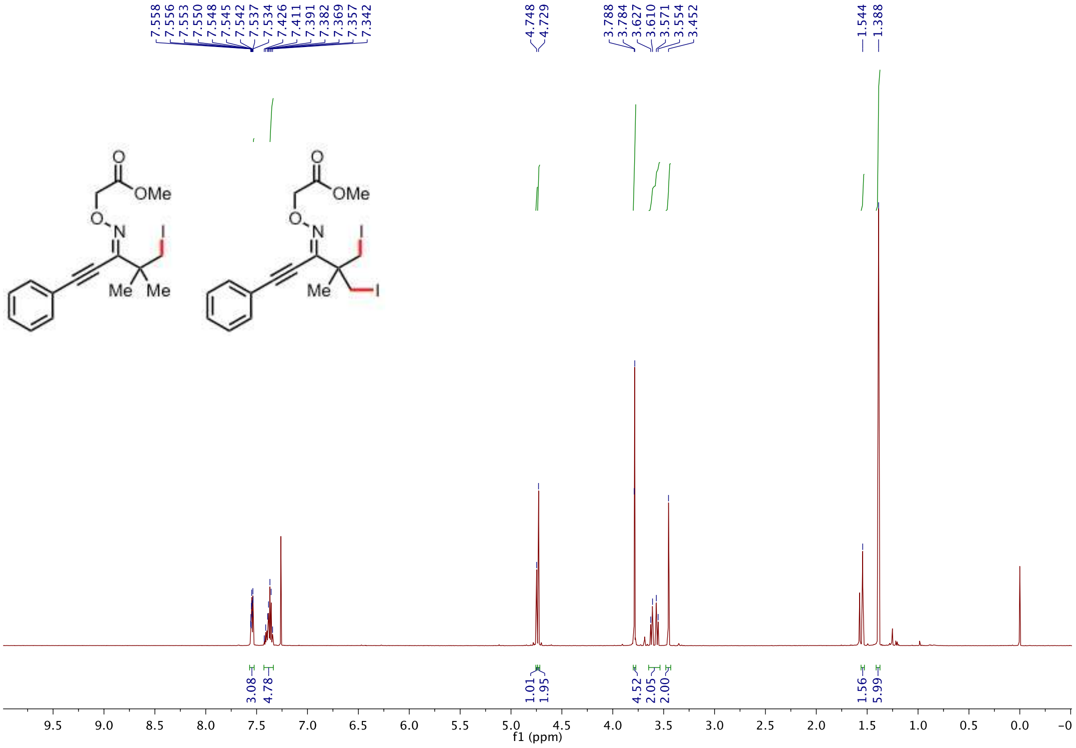

170.053
156.264
130.903
129.130
128.422
128.015
77.212
77.000
76.788
76.212
71.100
51.980
26.023
18.679
15.855
-2.137
OMe
O
N
I
I
O
Si
Me
Me
Me
Me
Me
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

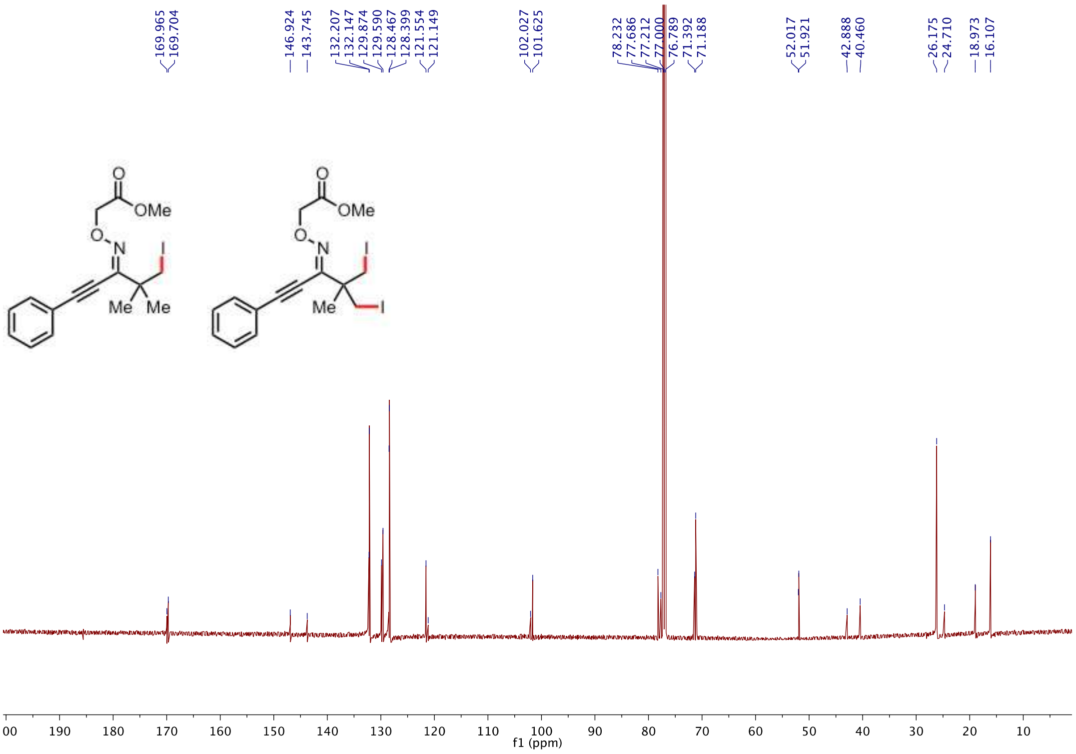

7.483
7.471
7.431
7.403
7.370
7.358
7.345
7.317
7.305
7.293
6.573
6.545
4.682
3.782
3.406
1.360
O
OMe
O
N
I
Me
Me
2.03
1.05
2.03
0.98
1.00
1.99
3.01
2.00
6.05
.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

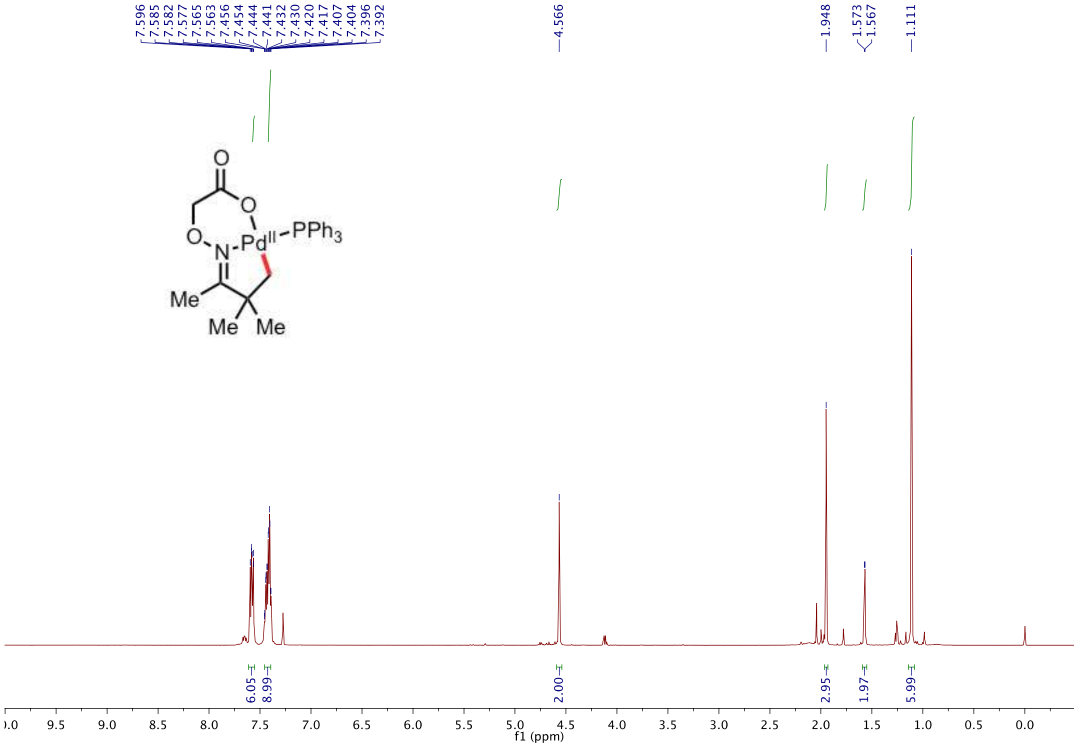

170.429
158.245
139.421
136.519
128.796
128.686
126.993
116.047
77.212
77.000
76.788
70.998
51.859
40.715
26.842
20.235
O
OMe
O
N
I
Me
Me
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

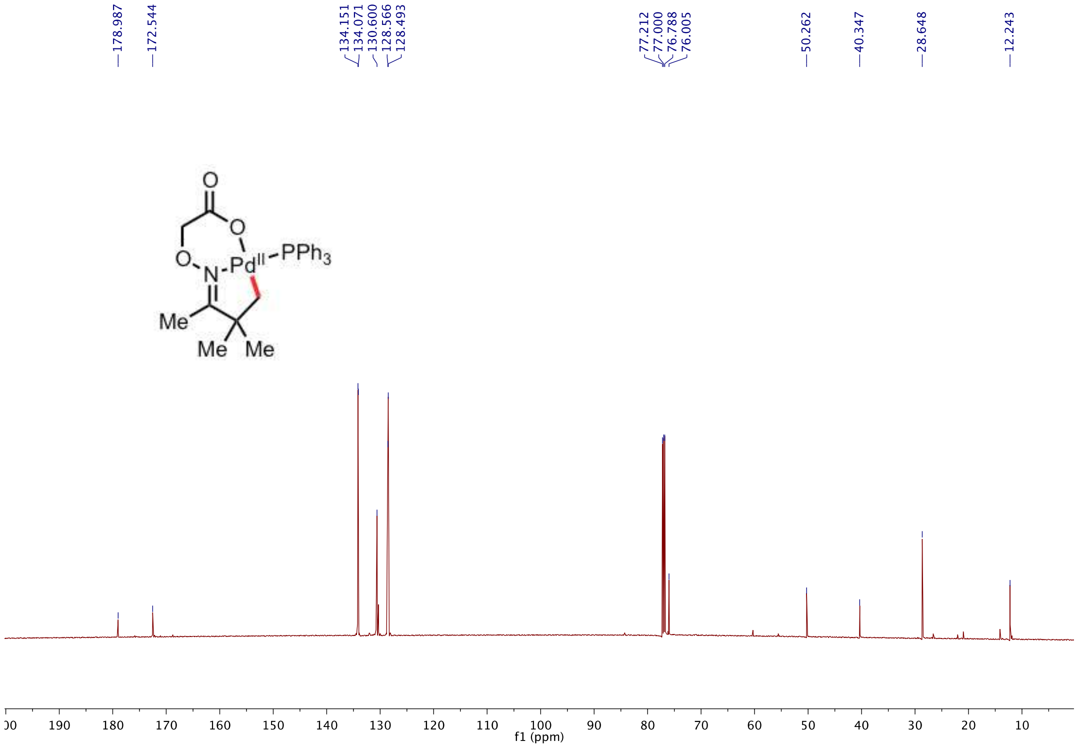

7.487
7.475
7.439
7.411
7.381
7.369
7.356
7.334
7.322
7.310
6.504
6.476
4.693
3.786
3.576
3.559
3.542
3.525
1.515
O
OMe
O
N
I
Me
I
2.02
1.05
2.05
1.05
1.00
1.97
3.02
3.99
3.01
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


170.156
155.735
140.172
136.126
129.063
128.740
127.078
115.427
77.211
77.000
76.788
71.169
51.957
43.127
24.925
17.603
O
OMe
O
N
I
Me
I
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


7.558
7.556
7.553
7.550
7.548
7.545
7.542
7.537
7.534
7.426
7.411
7.391
7.382
7.369
7.357
7.342
4.748
4.729
3.788
3.784
3.627
3.610
3.571
3.554
3.452
1.544
1.388
O
OMe
O
N
I
Me
Me
O
OMe
O
N
I
Me
I
3.08
4.78
1.01
1.95
4.52
2.05
2.00
1.56
5.99
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
0.0
−0
f1 (ppm)


169.965
169.704
146.924
143.745
132.207
132.147
129.874
129.590
128.467
128.399
121.554
121.149
102.027
101.625
78.232
77.686
77.212
77.000
76.789
71.392
71.188
52.017
51.921
42.888
40.460
26.175
24.710
18.973
16.107
O
OMe
O
N
I
Me
Me
O
OMe
O
N
I
Me
I
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


7.596
7.585
7.582
7.577
7.565
7.563
7.456
7.454
7.444
7.441
7.432
7.430
7.420
7.417
7.407
7.404
7.396
7.392
4.566
1.948
1.573
1.567
1.111
O
O
O
N
Pd^{II}
PPh$_3$
Me
Me
Me
6.05
8.99
2.00
2.95
1.97
5.99
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
0.0
f1 (ppm)


178.987
172.544
134.151
134.071
130.600
128.566
128.493
77.212
77.000
76.788
76.005
50.262
40.347
28.648
12.243
O
O
O
N
Pd^{II}
PPh$_3$
Me
Me
Me
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)