

1. Characterization of the perovskites

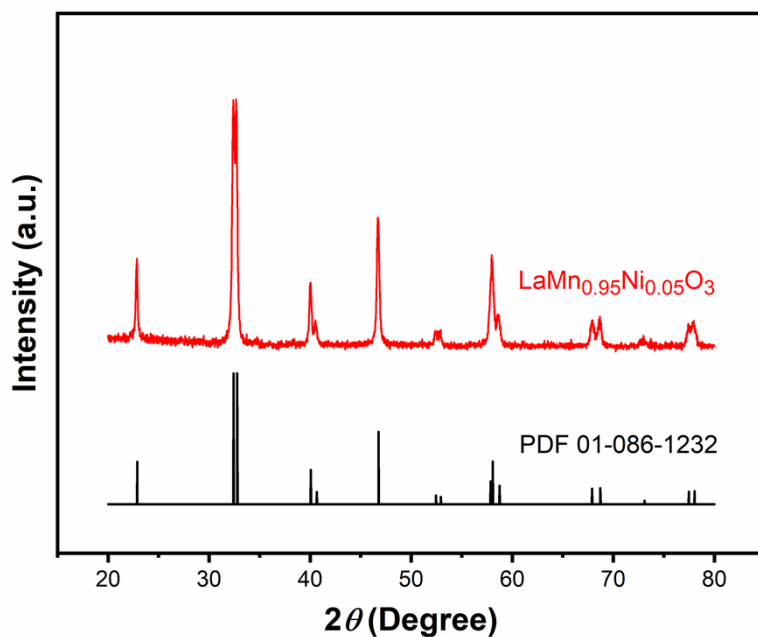


Fig. S1. X-ray diffraction patterns of $\text{LaMn}_{0.95}\text{Ni}_{0.05}\text{O}_3$. This is identical to Fig. 1 of the manuscript.

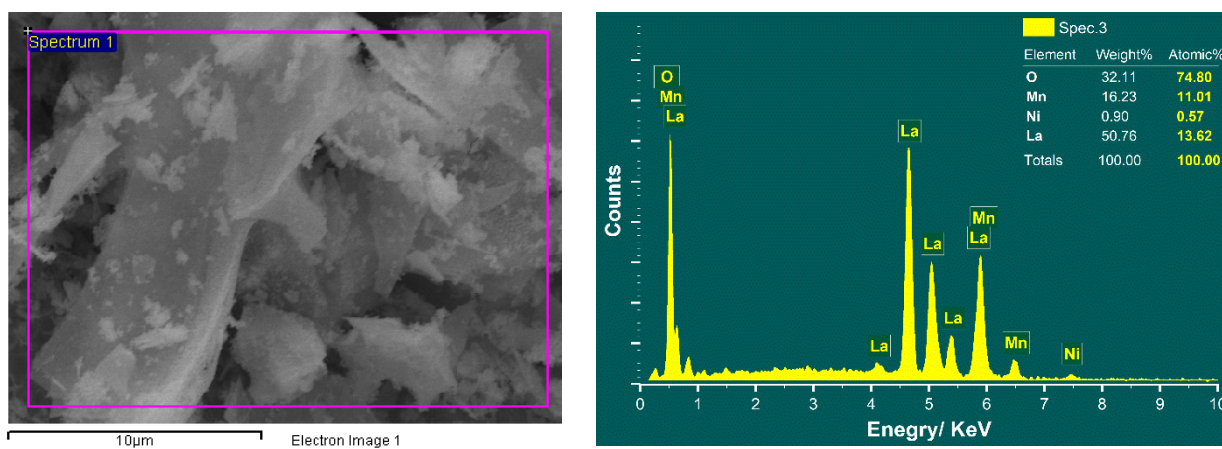


Fig. S2. SEM-EDX spectrum of $\text{LaMn}_{0.95}\text{Ni}_{0.05}\text{O}_3$.

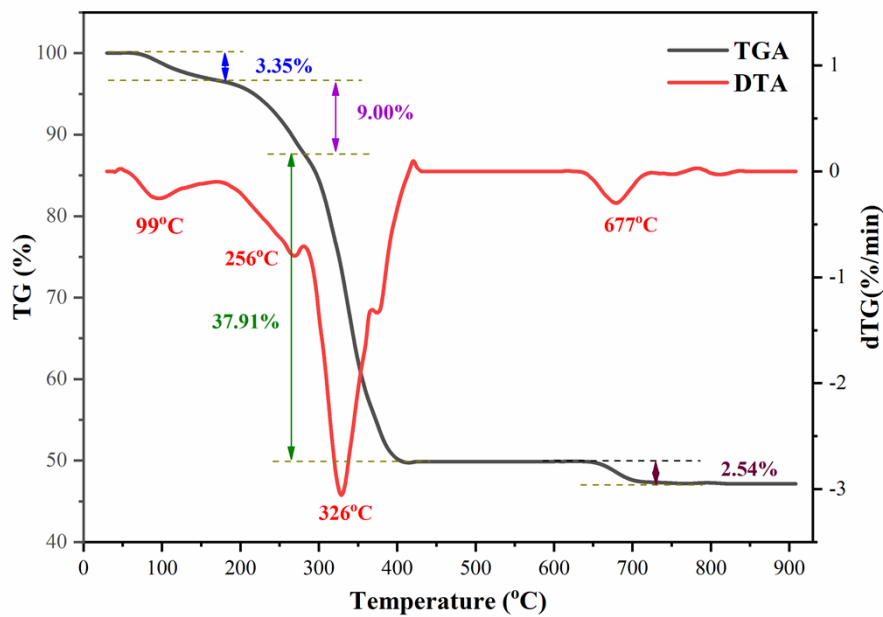


Fig. S3. TGA/DTA curve of $\text{LaMn}_{0.95}\text{Ni}_{0.05}\text{O}_3$.

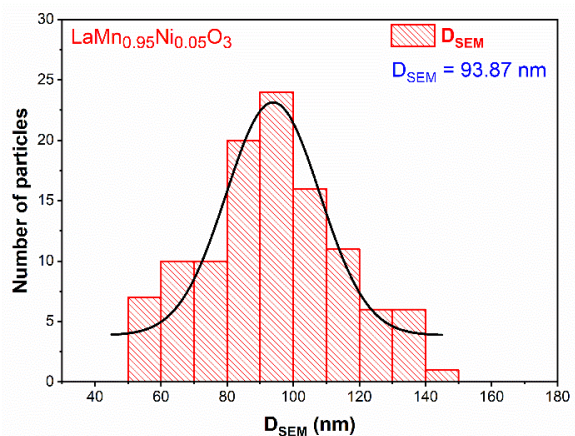


Fig. S4. FE-SEM image (left) and particle size distribution histogram (right) of $\text{LaMn}_{0.95}\text{Ni}_{0.05}\text{O}_3$.

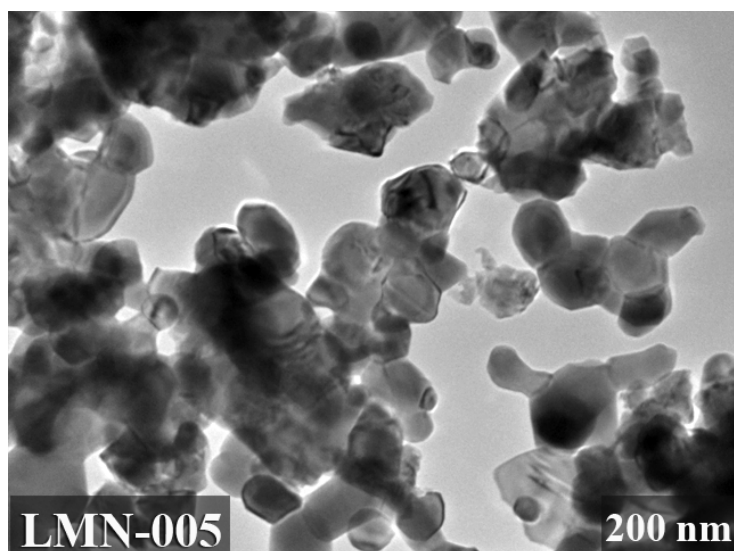


Fig. S5. TEM image of $\text{LaMn}_{0.95}\text{Ni}_{0.05}\text{O}_3$.

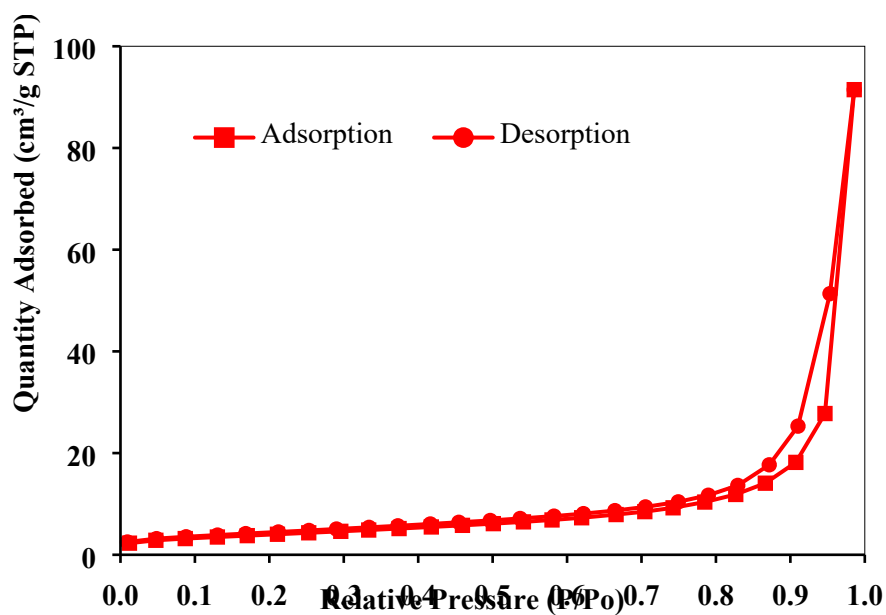
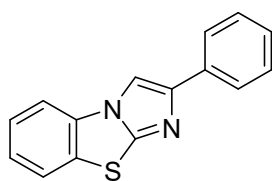


Fig. S6. Nitrogen physisorption isotherm of $\text{LaMn}_{0.95}\text{Ni}_{0.05}\text{O}_3$ at 77K.

2. Characterization of compounds

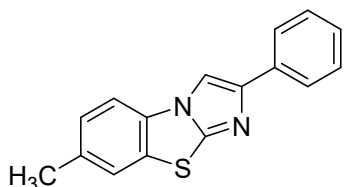
2-Phenylbenzo[d]imidazo[2,1-b]thiazole (3aa)



Yellow solid, 35 mg (70% yield). This compound is known [1].

^1H NMR (600 MHz, CDCl_3 , ppm) δ 7.94 (s, 1H), 7.87 (d, $J = 7.2$ Hz, 2H), 7.67 (d, $J = 7.9$ Hz, 1H), 7.57 (d, $J = 8.0$ Hz, 1H), 7.44 – 7.40 (m, 3H), 7.34 – 7.27 (m, 2H). ^{13}C NMR (151 MHz, CDCl_3 , ppm) δ 148.12, 147.69, 133.82, 132.17, 130.31, 128.75, 127.55, 126.20, 125.22, 124.89, 124.40, 112.65, 106.88.

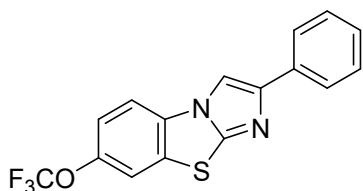
7-Methyl-2-phenylbenzo[*d*]imidazo[2,1-*b*]thiazole (3ba)



Yellow solid, 38 mg (72% yield). This compound is known [2].

^1H NMR (500 MHz, CDCl_3 , ppm) δ 7.91 (s, 1H), 7.88 – 7.84 (m, 2H), 7.47 (s, 1H), 7.46 (d, $J = 8.4$ Hz, 1H), 7.44 – 7.37 (m, 2H), 7.31 – 7.26 (m, 1H), 7.24 – 7.20 (m, 1H), 2.45 (s, 3H). ^{13}C NMR (126 MHz, CDCl_3 , ppm) δ 147.98, 147.42, 135.03, 133.92, 130.33, 130.16, 128.72, 127.43, 127.15, 125.17, 124.46, 112.25, 106.82, 21.36.

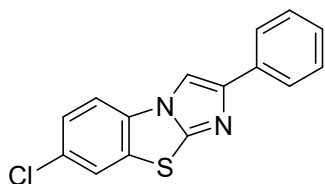
2-Phenyl-7-(trifluoromethoxy)benzo[*d*]imidazo[2,1-*b*]thiazole (3ca)



Yellow solid, 47 mg (70% yield).

^1H NMR (500 MHz, CDCl_3 , ppm) δ 7.95 (s, 1H), 7.88 – 7.84 (m, 2H), 7.60 (d, $J = 8.8$ Hz, 1H), 7.59 (s, 1H), 7.46 – 7.39 (m, 2H), 7.35 – 7.28 (m, 2H). ^{13}C NMR (126 MHz, CDCl_3 , ppm) δ 148.20, 148.05, 145.85 (d, $J = 1.9$ Hz), 133.47, 131.60, 130.82, 128.79, 127.80, 125.26, 120.50 (d, $J = 258.0$ Hz), 119.78, 117.63, 113.15, 107.00. HRMS (ESI, m/z): calcd for $\text{C}_{16}\text{H}_{10}\text{F}_3\text{N}_2\text{OS}$ [$\text{M}+\text{H}^+$] 335.0460, found: 335.0467.

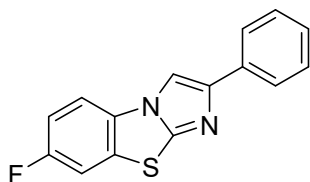
7-Chloro-2-phenylbenzo[*d*]imidazo[2,1-*b*]thiazole (3da)



Yellow solid, 32 mg (56% yield). This compound is known [1].

^1H NMR (500 MHz, CDCl_3 , ppm) δ 7.91 (s, 1H), 7.86 – 7.83 (m, 2H), 7.67 (d, $J = 2.0$ Hz, 1H), 7.51 (d, $J = 8.6$ Hz, 1H), 7.45 – 7.38 (m, 3H), 7.34 – 7.27 (m, 1H). ^{13}C NMR (126 MHz, CDCl_3 , ppm) δ 148.05, 147.86, 133.53, 131.72, 130.78, 130.35, 128.77, 127.73, 126.61, 125.25, 124.16, 113.27, 106.94.

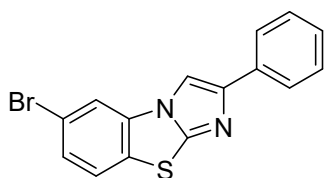
7-Fluoro-2-phenylbenzo[*d*]imidazo[2,1-*b*]thiazole (3ea)



Yellow solid, 32 mg (62% yield).

^1H NMR (600 MHz, CDCl_3 , ppm) δ 7.92 (s, 1H), 7.88 – 7.83 (m, 2H), 7.54 (dd, $J = 8.8, 4.3$ Hz, 1H), 7.46 – 7.38 (m, 3H), 7.33 – 7.28 (m, 1H), 7.17 (td, $J = 8.7, 2.5$ Hz, 1H). ^{13}C NMR (126 MHz, CDCl_3 , ppm) δ 159.76 (d, $J = 245.5$ Hz), 147.87, 147.76, 133.66, 131.64 (d, $J = 10.2$ Hz), 128.76, 127.64, 125.21, 113.88 (d, $J = 24.6$ Hz), 113.26 (d, $J = 9.0$ Hz), 111.52 (d, $J = 27.3$ Hz), 106.95. One carbon signal could not be located. HRMS (ESI, m/z): calcd for $\text{C}_{15}\text{H}_{10}\text{FN}_2\text{S}$ [$\text{M}+\text{H}^+$] 269.0543, found: 269.0549.

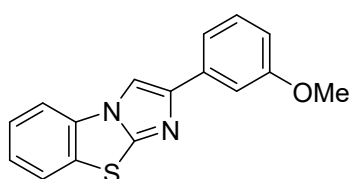
6-Bromo-2-phenylbenzo[*d*]imidazo[2,1-*b*]thiazole (3fa)



Yellow solid, 40 mg (61% yield).

^1H NMR (600 MHz, CDCl_3 , ppm) δ 7.92 (s, 1H), 7.88 – 7.83 (m, 2H), 7.77 (d, $J = 1.8$ Hz, 1H), 7.55 (d, $J = 8.4$ Hz, 1H), 7.45 (dd, $J = 8.5, 1.8$ Hz, 1H), 7.42 (t, $J = 7.7$ Hz, 2H), 7.33 – 7.29 (m, 1H). ^{13}C NMR (151 MHz, CDCl_3 , ppm) δ 148.38, 148.15, 133.47, 133.06, 129.21, 128.79, 127.88, 127.80, 125.44, 125.28, 119.57, 115.93, 106.85. HRMS (ESI, m/z): calcd for $\text{C}_{15}\text{H}_{10}^{79}\text{BrN}_2\text{S}$ [$\text{M}+\text{H}^+$] 328.9743, found: 328.9751.

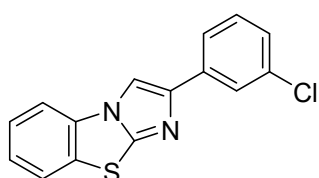
2-(3-Methoxyphenyl)benzo[*d*]imidazo[2,1-*b*]thiazole (3ab)



Yellow solid, 38 mg (68% yield). This compound is known [2].

^1H NMR (600 MHz, CDCl_3 , ppm) δ 7.97 (s, 1H), 7.70 (d, $J = 8.0$ Hz, 1H), 7.61 (d, $J = 8.0$ Hz, 1H), 7.51 – 7.42 (m, 3H), 7.36 – 7.31 (m, 2H), 6.86 (dd, $J = 8.1, 2.4$ Hz, 1H), 3.89 (s, 3H). ^{13}C NMR (126 MHz, CDCl_3 , ppm) δ 160.11, 148.07, 147.59, 135.22, 132.20, 130.37, 129.74, 126.24, 124.95, 124.44, 117.67, 113.83, 112.69, 110.31, 107.12, 55.40.

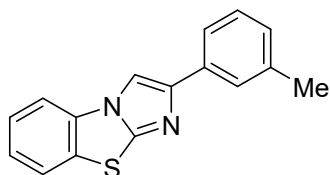
2-(3-Chlorophenyl)benzo[*d*]imidazo[2,1-*b*]thiazole (3ac)



Yellow solid, 32 mg (57% yield).

^1H NMR (600 MHz, CDCl_3 , ppm) δ 7.96 (s, 1H), 7.87 (t, $J = 1.8$ Hz, 1H), 7.74 (dt, $J = 7.7, 1.3$ Hz, 1H), 7.72 – 7.69 (m, 1H), 7.60 (d, $J = 8.0$ Hz, 1H), 7.46 (td, $J = 7.8, 1.1$ Hz, 1H), 7.38 – 7.31 (m, 2H), 7.28 – 7.22 (m, 1H). ^{13}C NMR (126 MHz, CDCl_3 , ppm) δ 148.37, 146.32, 135.64, 134.76, 132.07, 130.36, 129.97, 127.45, 126.31, 125.30, 125.11, 124.47, 123.23, 112.72, 107.39. HRMS (ESI, m/z): calcd for $\text{C}_{15}\text{H}_{10}^{35}\text{ClN}_2\text{S}$ [$\text{M}+\text{H}^+$] 285.0248, found: 285.0258.

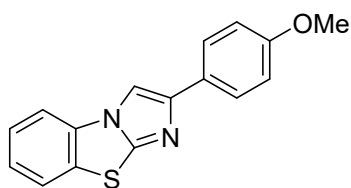
2-(*m*-Tolyl)benzo[*d*]imidazo[2,1-*b*]thiazole (3ad)



Yellow solid, 41 mg (77% yield).

^1H NMR (600 MHz, CDCl_3 , ppm) δ 7.96 (s, 1H), 7.74 (s, 1H), 7.72 – 7.68 (m, 1H), 7.65 (d, $J = 7.7$ Hz, 1H), 7.62 – 7.59 (m, 1H), 7.45 (td, $J = 7.8, 1.1$ Hz, 1H), 7.34 (td, $J = 8.0, 1.1$ Hz, 1H), 7.31 (t, $J = 7.6$ Hz, 1H), 7.12 (d, $J = 7.5$ Hz, 1H), 2.42 (s, 3H). ^{13}C NMR (151 MHz, CDCl_3 , ppm) δ 148.07, 147.85, 138.41, 133.70, 132.25, 130.36, 128.64, 128.35, 126.21, 125.98, 124.86, 124.43, 122.28, 112.64, 106.82, 21.49. HRMS (ESI, m/z): calcd for $\text{C}_{16}\text{H}_{13}\text{N}_2\text{S}$ [$\text{M}+\text{H}^+$] 265.0794, found: 265.0799.

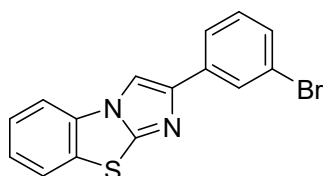
2-(4-Methoxyphenyl)benzo[d]imidazo[2,1-b]thiazole (3ae)



Yellow solid, 46 mg (82% yield). This compound is known [1].

^1H NMR (600 MHz, CDCl_3 , ppm) δ 7.87 (s, 1H), 7.82 – 7.77 (m, 2H), 7.71 – 7.67 (m, 1H), 7.61 – 7.56 (m, 1H), 7.44 (td, $J = 7.8, 1.1$ Hz, 1H), 7.32 (td, $J = 8.0, 1.1$ Hz, 1H), 6.98 – 6.93 (m, 2H), 3.85 (s, 3H). ^{13}C NMR (151 MHz, CDCl_3 , ppm) δ 159.25, 147.94, 147.67, 132.28, 130.26, 126.71, 126.50, 126.17, 124.71, 124.39, 114.18, 112.55, 105.84, 55.35.

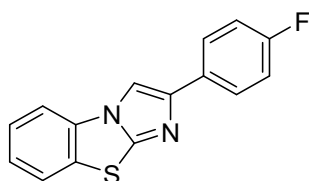
2-(3-Bromophenyl)benzo[d]imidazo[2,1-b]thiazole (3af)



Yellow solid, 40 mg (61% yield). This compound is known [1].

^1H NMR (600 MHz, CDCl_3 , ppm) δ 8.03 (t, $J = 1.6$ Hz, 1H), 7.97 (s, 1H), 7.79 (d, $J = 7.8$ Hz, 1H), 7.71 (d, $J = 8.0$ Hz, 1H), 7.61 (d, $J = 8.0$ Hz, 1H), 7.49 – 7.44 (m, 1H), 7.41 (ddd, $J = 7.9$, 1.8, 0.9 Hz, 1H), 7.38 – 7.33 (m, 1H), 7.28 (d, $J = 7.8$ Hz, 1H). ^{13}C NMR (151 MHz, CDCl_3 , ppm) δ 148.38, 146.17, 135.90, 132.06, 130.37, 130.26, 128.19, 126.32, 125.12, 124.47, 123.68, 122.96, 112.72, 107.40. One carbon signal could not be located.

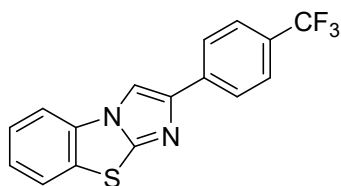
2-(4-Fluorophenyl)benzo[d]imidazo[2,1-b]thiazole (3ag)



Yellow solid, 29 mg (53% yield).

^1H NMR (600 MHz, CDCl_3 , ppm) δ 7.91 (s, 1H), 7.86 – 7.81 (m, 2H), 7.71 (d, $J = 8.5$ Hz, 1H), 7.61 (d, $J = 8.0$ Hz, 1H), 7.46 (td, $J = 7.8$, 1.1 Hz, 1H), 7.35 (td, $J = 8.0$, 1.1 Hz, 1H), 7.13 – 7.08 (m, 2H). ^{13}C NMR (151 MHz, CDCl_3 , ppm) δ 162.41 (d, $J = 246.5$ Hz), 148.21, 146.83, 132.16, 130.31, 130.05 (d, $J = 3.3$ Hz), 126.89 (d, $J = 7.9$ Hz), 126.27, 124.97, 124.46, 115.66 (d, $J = 21.7$ Hz), 112.65, 106.54. HRMS (ESI, m/z): calcd for $\text{C}_{15}\text{H}_{10}\text{FN}_2\text{S}$ [$\text{M}+\text{H}^+$] 269.0543, found: 269.0555.

2-(4-(Trifluoromethyl)phenyl)benzo[d]imidazo[2,1-b]thiazole (3ah)

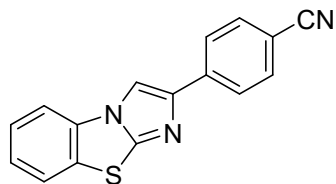


Yellow solid, 33 mg (50% yield). This compound is known [1].

^1H NMR (600 MHz, CDCl_3 , ppm) δ 8.04 (s, 1H), 7.97 (d, $J = 8.1$ Hz, 2H), 7.74 – 7.70 (m, 1H), 7.66 (d, $J = 8.1$ Hz, 2H), 7.64 – 7.61 (m, 1H), 7.47 (td, $J = 7.8$, 1.1 Hz, 1H), 7.37 (td, $J = 8.0$, 1.1 Hz, 1H). ^{13}C NMR (151 MHz, CDCl_3 , ppm) δ 148.65, 146.23, 137.24, 132.03, 130.41,

129.30 (q, $J = 32.4$ Hz), 125.74 (q, $J = 3.8$ Hz), 125.45 (q, $J = 278.9$ Hz), 125.27, 125.20, 112.79, 107.94. Two carbon signals could not be located.

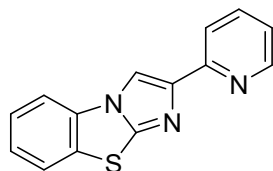
4-(Benzo[d]imidazo[2,1-b]thiazol-2-yl)benzonitrile (3ai)



Yellow solid, 31 mg (57% yield).

^1H NMR (600 MHz, CDCl_3 , ppm) δ 8.08 (s, 1H), 7.97 (d, $J = 8.3$ Hz, 2H), 7.76 – 7.71 (m, 1H), 7.69 (d, $J = 8.3$ Hz, 2H), 7.67 – 7.62 (m, 1H), 7.51 – 7.46 (m, 1H), 7.43 – 7.37 (m, 1H). ^{13}C NMR (151 MHz, CDCl_3 , ppm) δ 148.94, 138.23, 132.64, 131.92, 130.45, 126.46, 125.51, 125.48, 124.59, 119.08, 112.88, 110.64. Two carbon signals could not be located. HRMS (ESI, m/z): calcd for $\text{C}_{16}\text{H}_{10}\text{N}_3\text{S}$ [$\text{M}+\text{H}^+$] 276.0590, found: 276.0599.

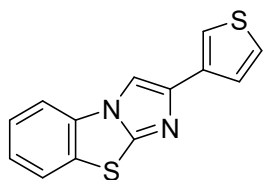
2-(Pyridin-2-yl)benzo[d]imidazo[2,1-b]thiazole (3aj)



Yellow solid, 28 mg (55% yield).

^1H NMR (500 MHz, CDCl_3 , ppm) δ 8.58 (ddd, $J = 4.8, 1.6, 0.8$ Hz, 1H), 8.40 (s, 1H), 8.07 – 7.05 (m, 1H), 7.75 (td, $J = 7.7, 1.8$ Hz, 1H), 7.73 – 7.68 (m, 1H), 7.67 – 7.60 (m, 1H), 7.45 (td, $J = 7.9, 1.1$ Hz, 1H), 7.35 (td, $J = 8.0, 1.1$ Hz, 1H), 7.19 (ddd, $J = 7.5, 4.8, 1.1$ Hz, 1H). ^{13}C NMR (126 MHz, CDCl_3 , ppm) δ 152.72, 149.33, 148.10, 147.59, 136.87, 132.11, 130.43, 126.36, 125.17, 124.40, 122.26, 119.75, 112.92, 109.87. HRMS (ESI, m/z): calcd for $\text{C}_{14}\text{H}_{10}\text{N}_3\text{S}$ [$\text{M}+\text{H}^+$] 252.0590, found: 252.0595.

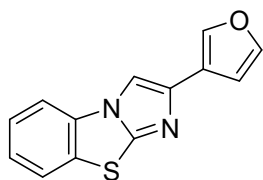
2-(Thiophen-3-yl)benzo[d]imidazo[2,1-b]thiazole (3ak)



Yellow solid, 30 mg (59% yield).

^1H NMR (600 MHz, CDCl_3 , ppm) δ 7.85 (s, 1H), 7.72 – 7.69 (m, 2H), 7.61 – 7.58 (m, 1H), 7.47 – 7.44 (m, 2H), 7.37 (dd, $J = 5.0, 3.0$ Hz, 1H), 7.36 – 7.32 (m, 1H). ^{13}C NMR (151 MHz, CDCl_3 , ppm) δ 148.05, 143.96, 135.52, 132.22, 130.32, 126.24, 126.15, 125.39, 124.87, 124.44, 120.31, 112.60, 106.75. HRMS (ESI, m/z): calcd for $\text{C}_{13}\text{H}_9\text{N}_2\text{S}_2$ [$\text{M}+\text{H}^+$] 257.0202, found: 257.0211.

2-(Furan-3-yl)benzo[d]imidazo[2,1-b]thiazole (3al)



Yellow solid, 31 mg (64% yield). This compound is known [1].

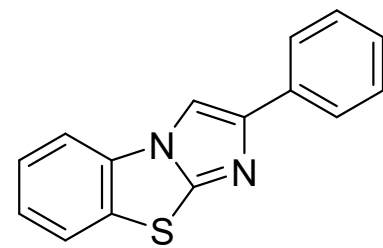
^1H NMR (600 MHz, CDCl_3 , ppm) δ 7.89 (s, 1H), 7.71 – 7.67 (m, 1H), 7.61 – 7.57 (m, 1H), 7.48 – 7.43 (m, 2H), 7.34 (td, $J = 8.0, 1.1$ Hz, 1H), 6.79 – 6.74 (m, 1H), 6.49 (dd, $J = 3.3, 1.8$ Hz, 1H). ^{13}C NMR (151 MHz, CDCl_3 , ppm) δ 149.38, 148.42, 141.51, 139.73, 132.07, 130.34, 126.30, 124.99, 124.41, 112.68, 111.51, 106.64, 105.73.

References

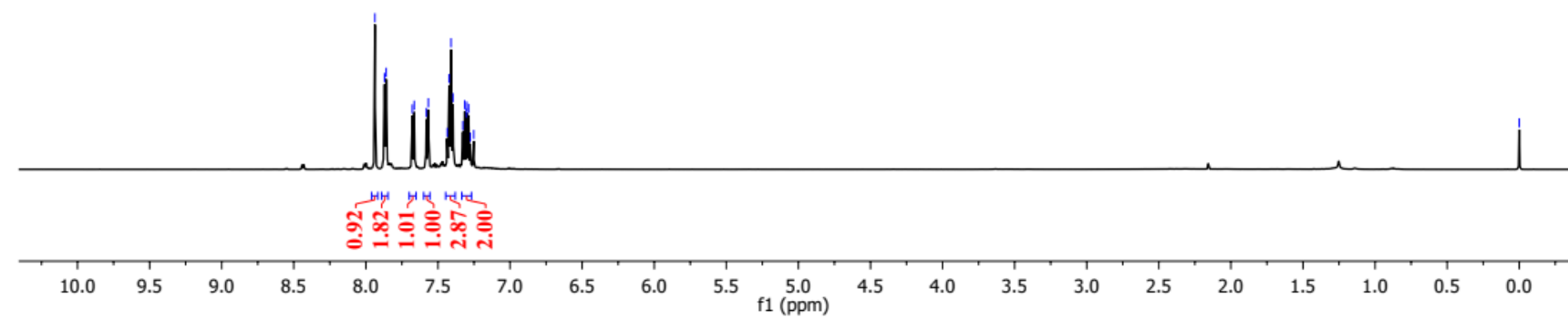
- [1]. S. Mishra, K. Monir, S. Mitra, A. Hajra, *Org. Lett.* **2014**, *16*, 6084.
- [2]. S. G. Balwe, Y. T. Jeong, *RSC Adv.* **2016**, *6*, 107225.

7.94
7.87
7.86
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7.66
7.58
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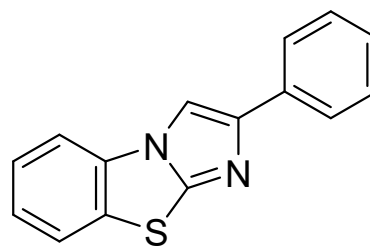


3aa, Scheme 1

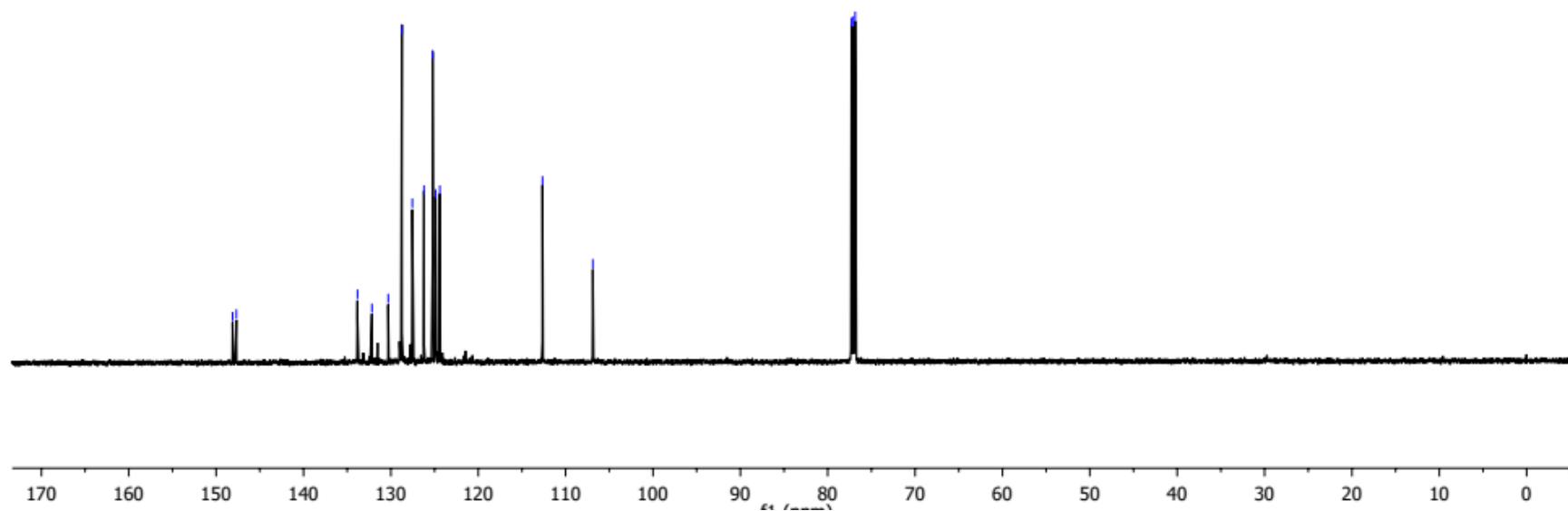


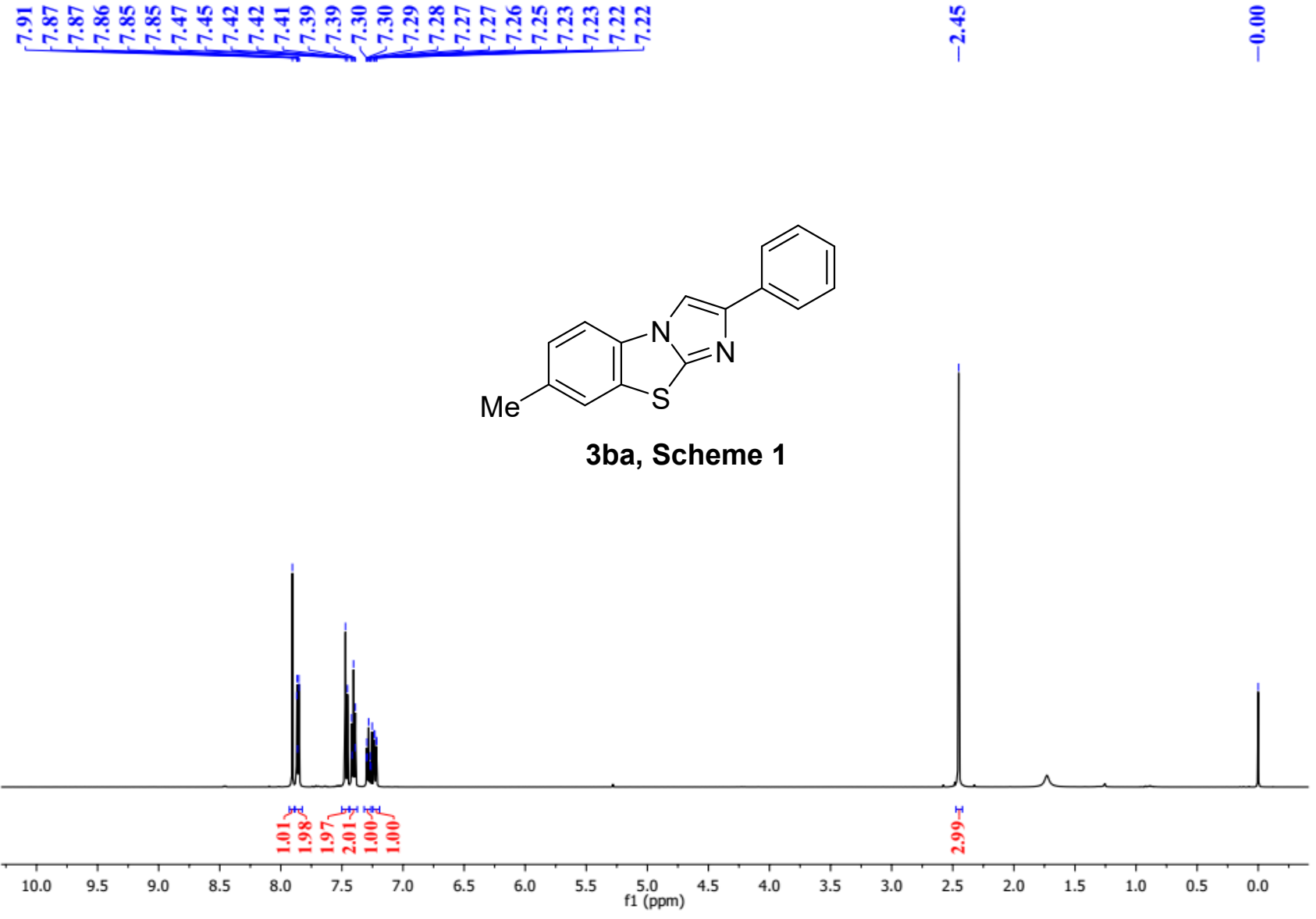
148.12
147.69
133.82
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130.31
128.75
127.55
126.20
125.22
124.89
124.40
— 112.65
— 106.88

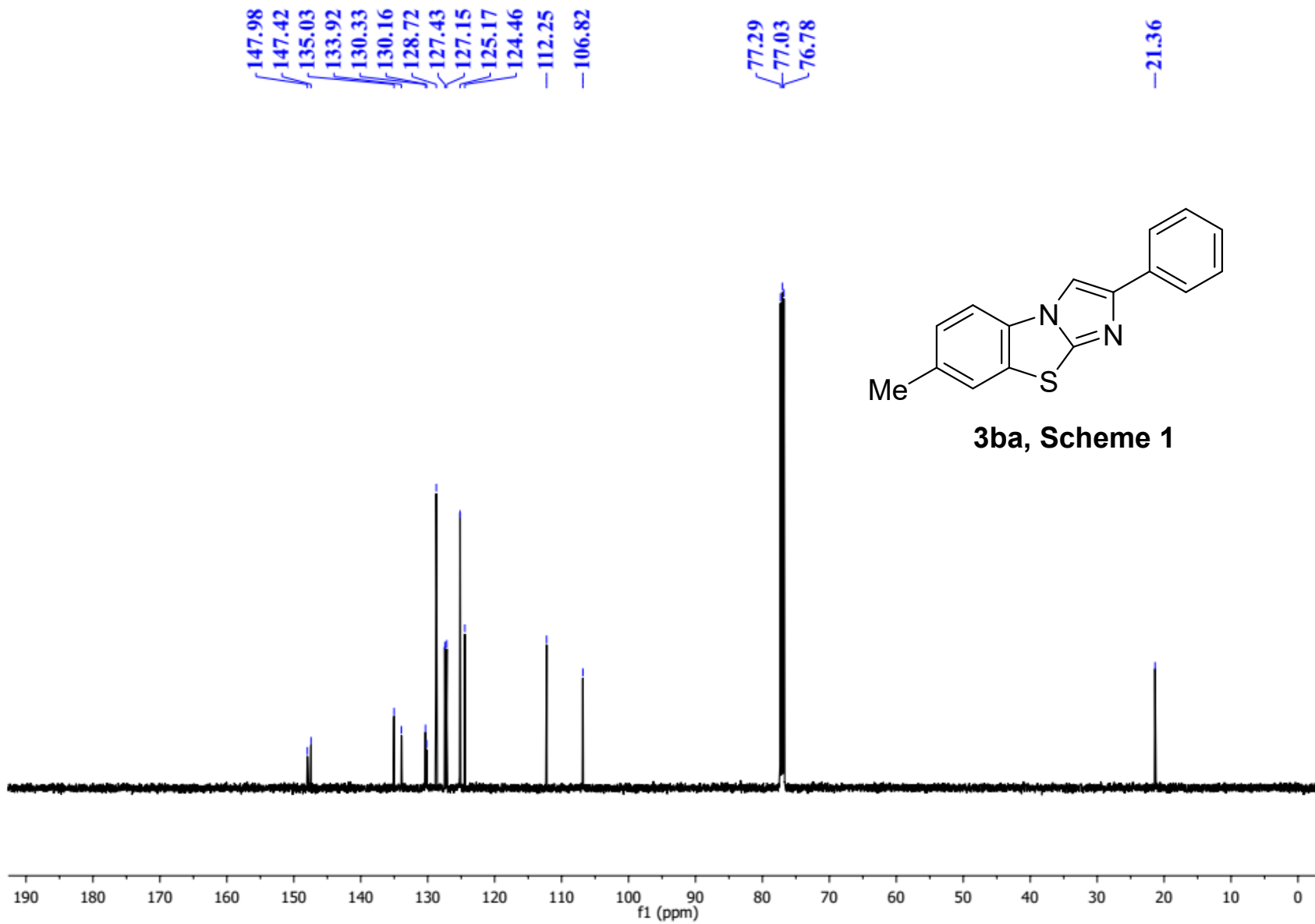
77.28
77.07
76.86

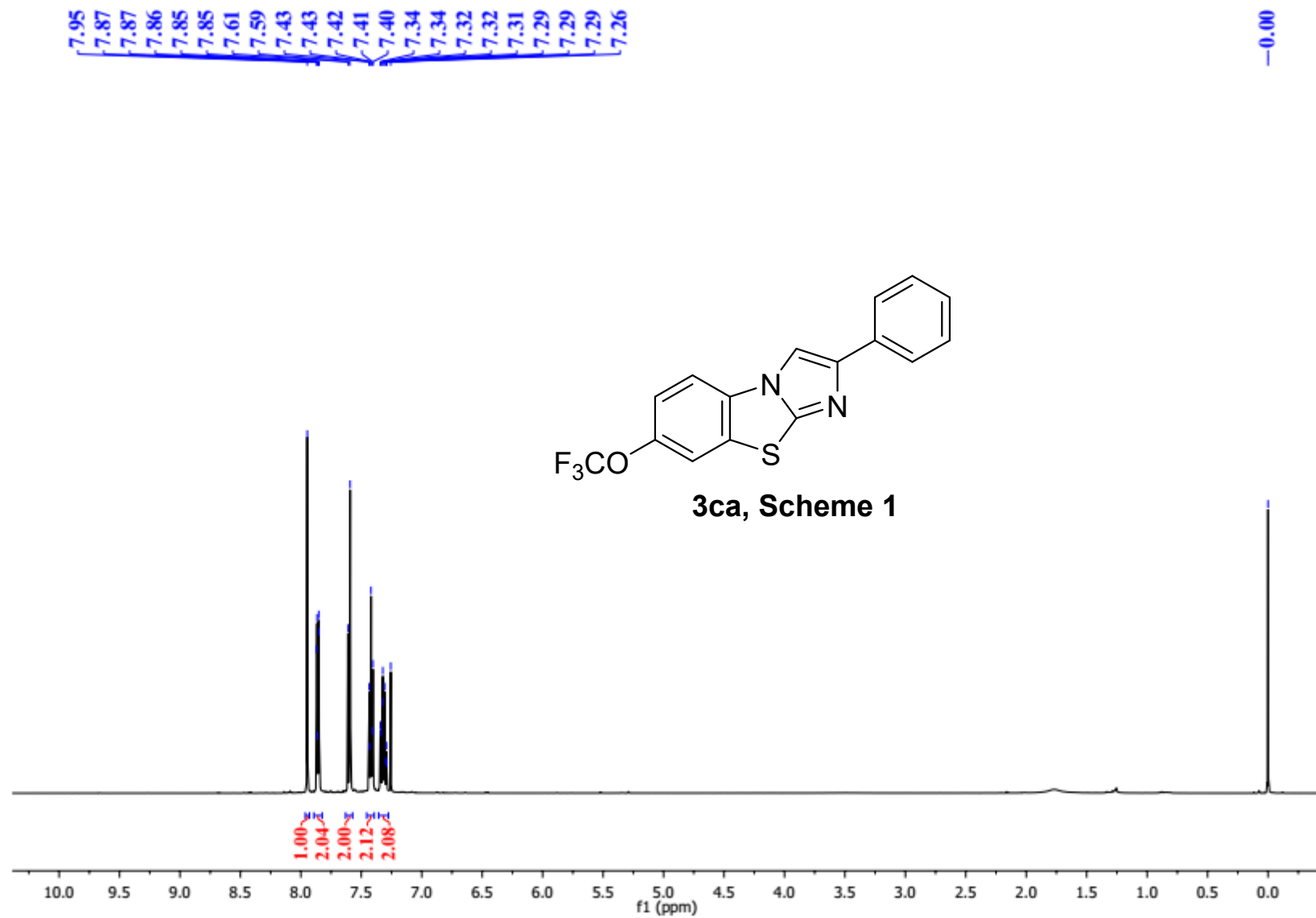


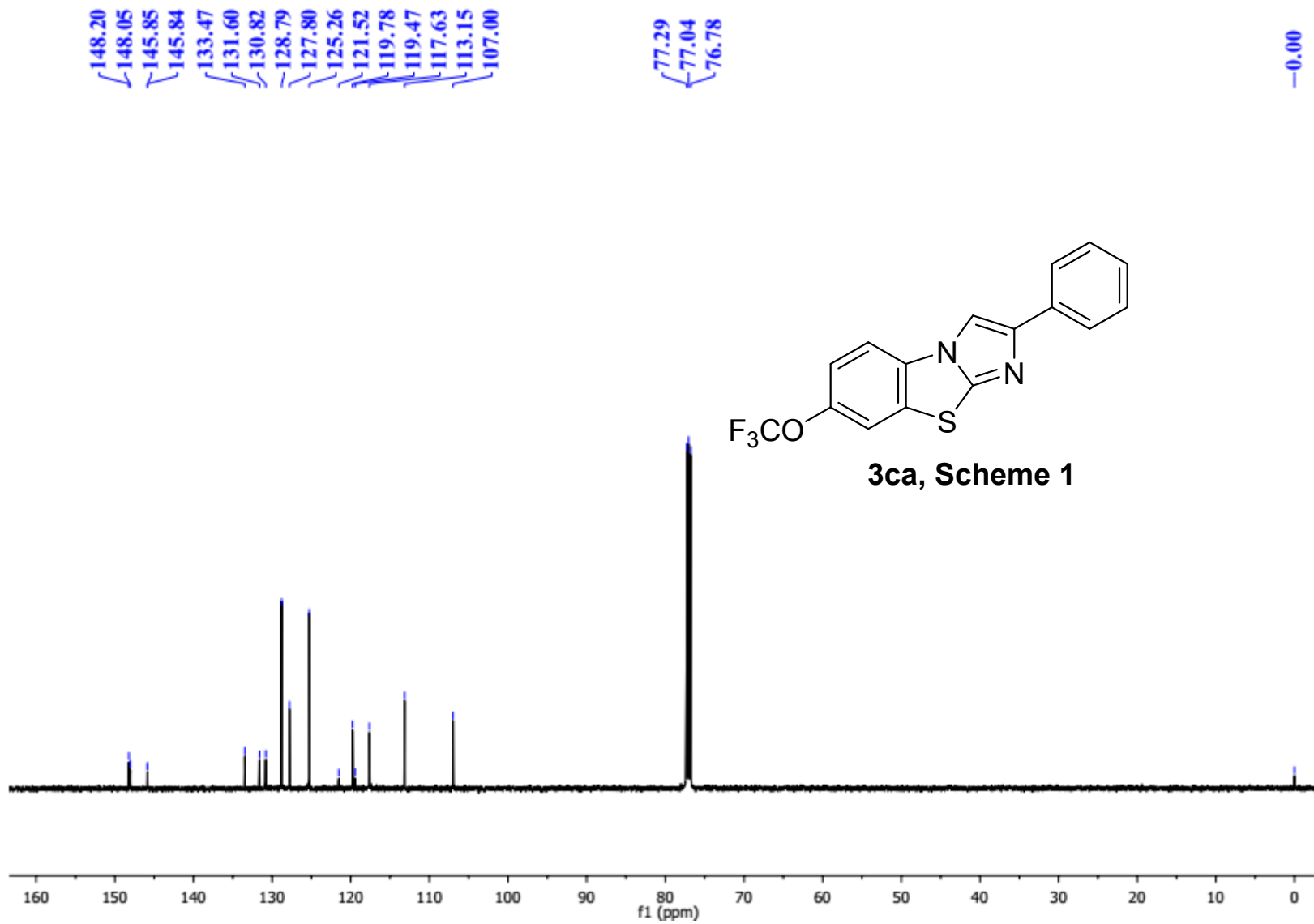
3aa, Scheme 1

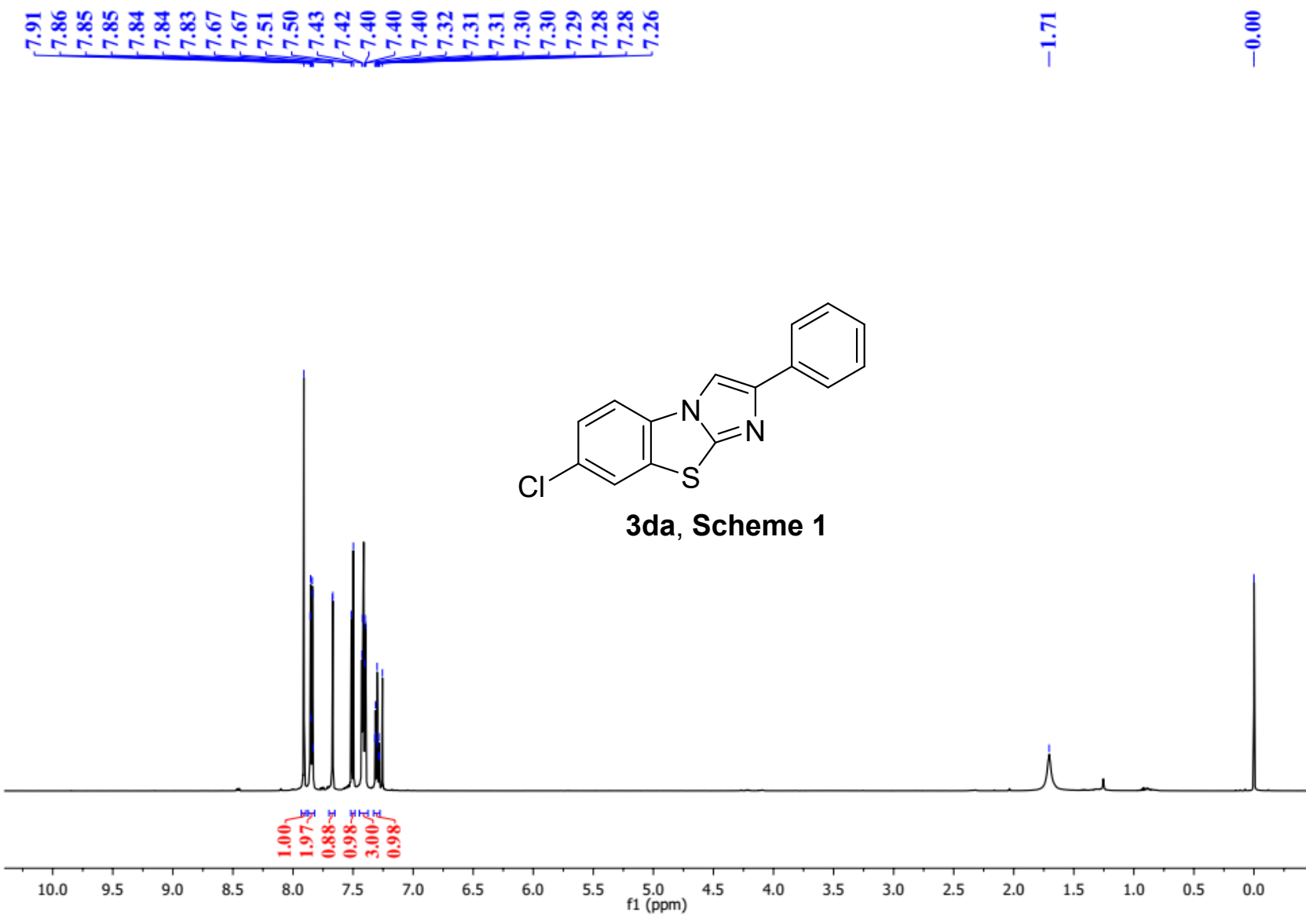


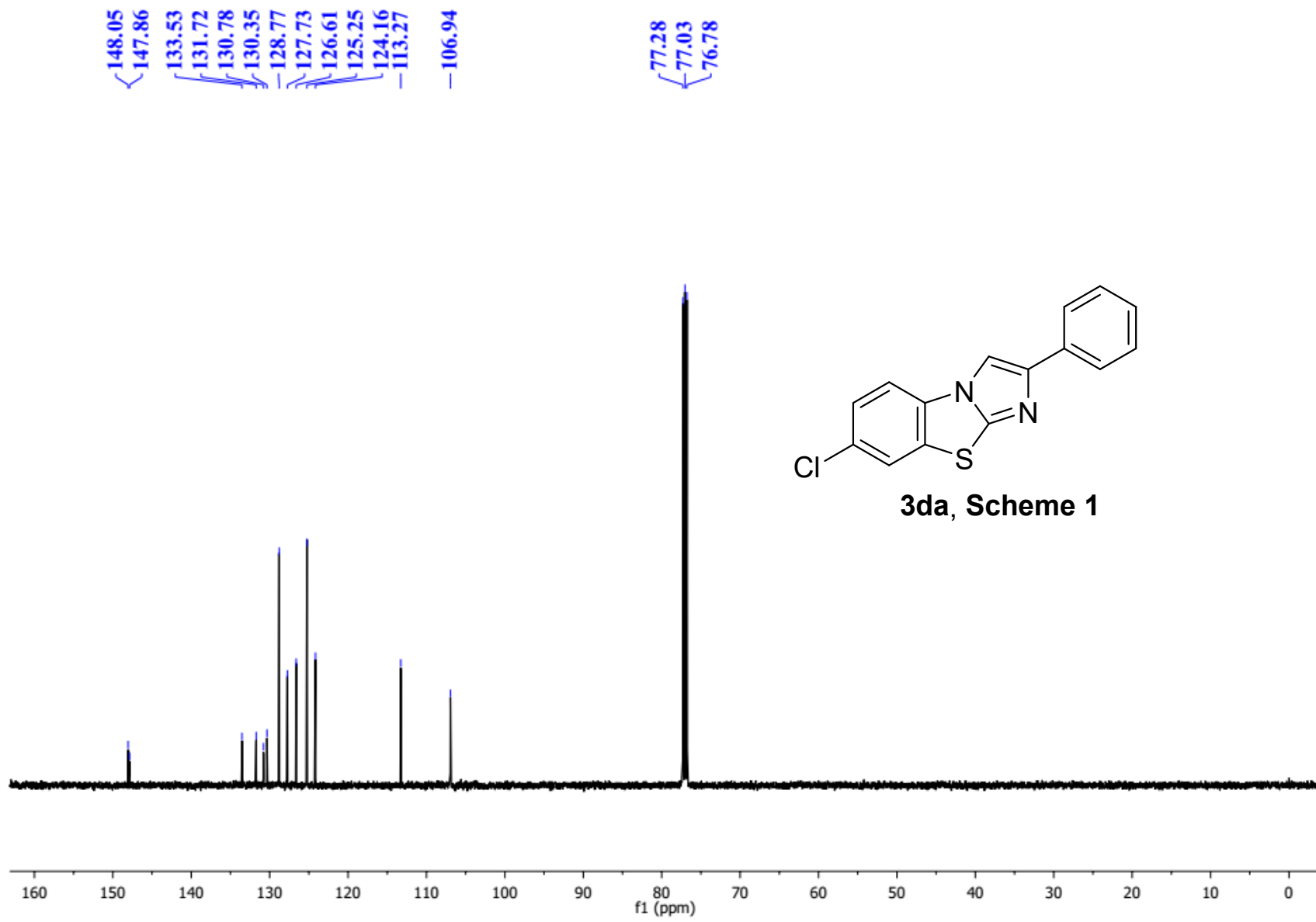






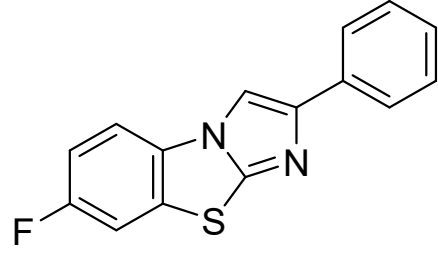




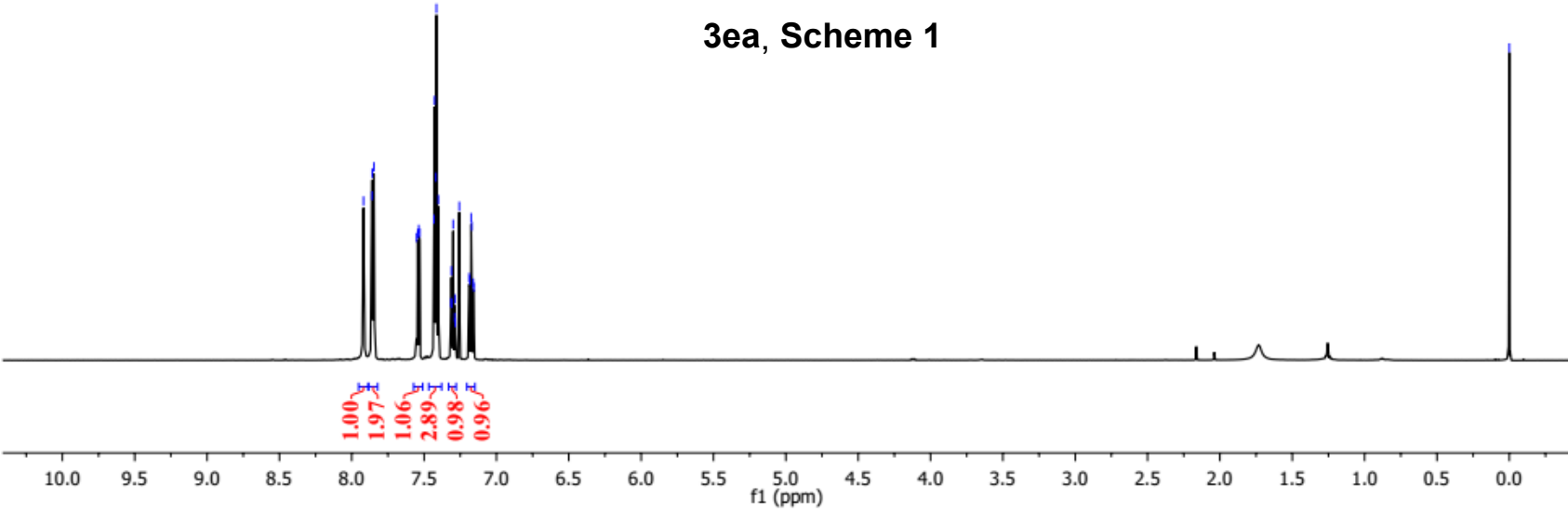


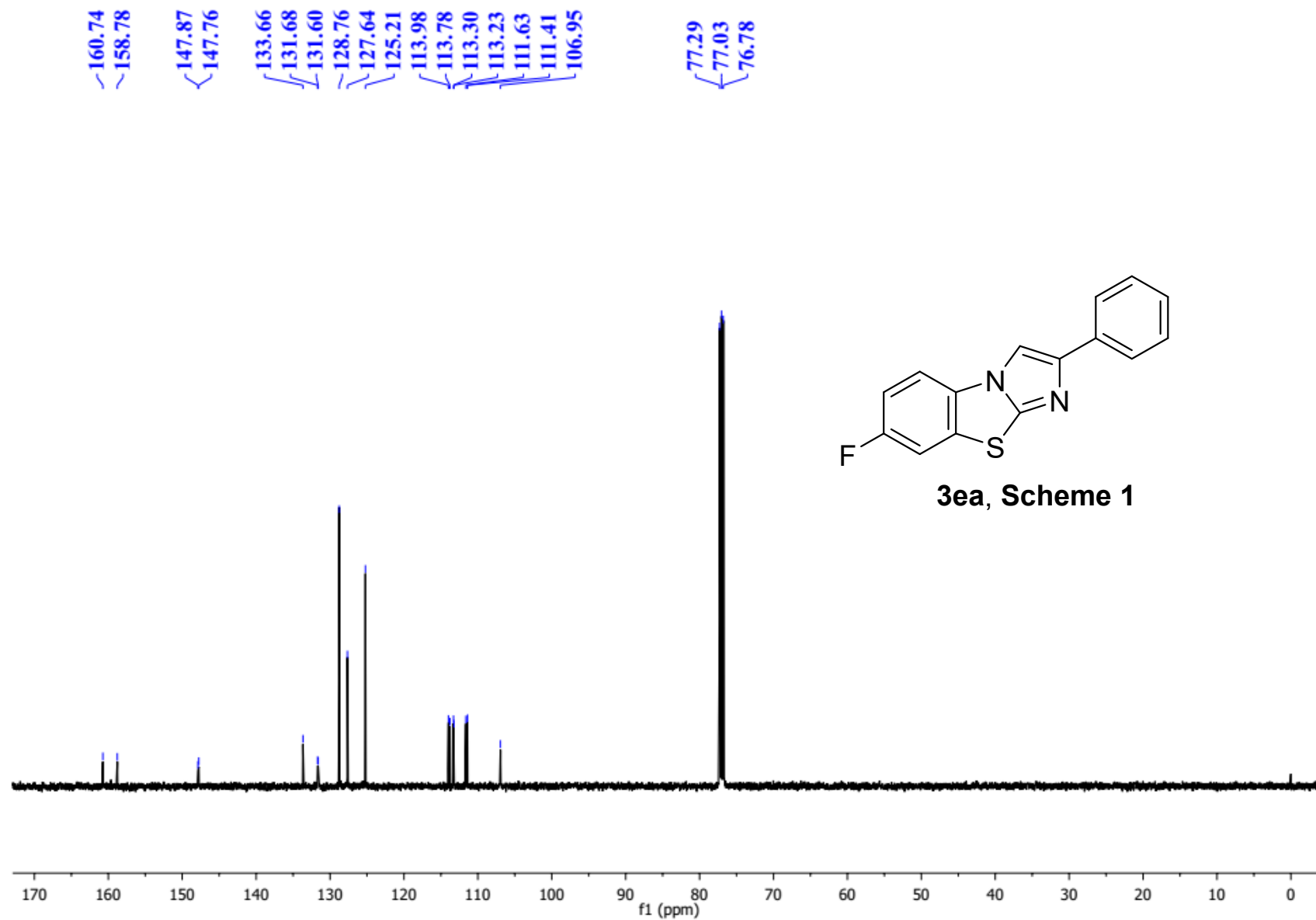
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7.86
7.85
7.55
7.54
7.54
7.53
7.43
7.43
7.42
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7.40
7.31
7.31
7.31
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7.17
7.16
7.16

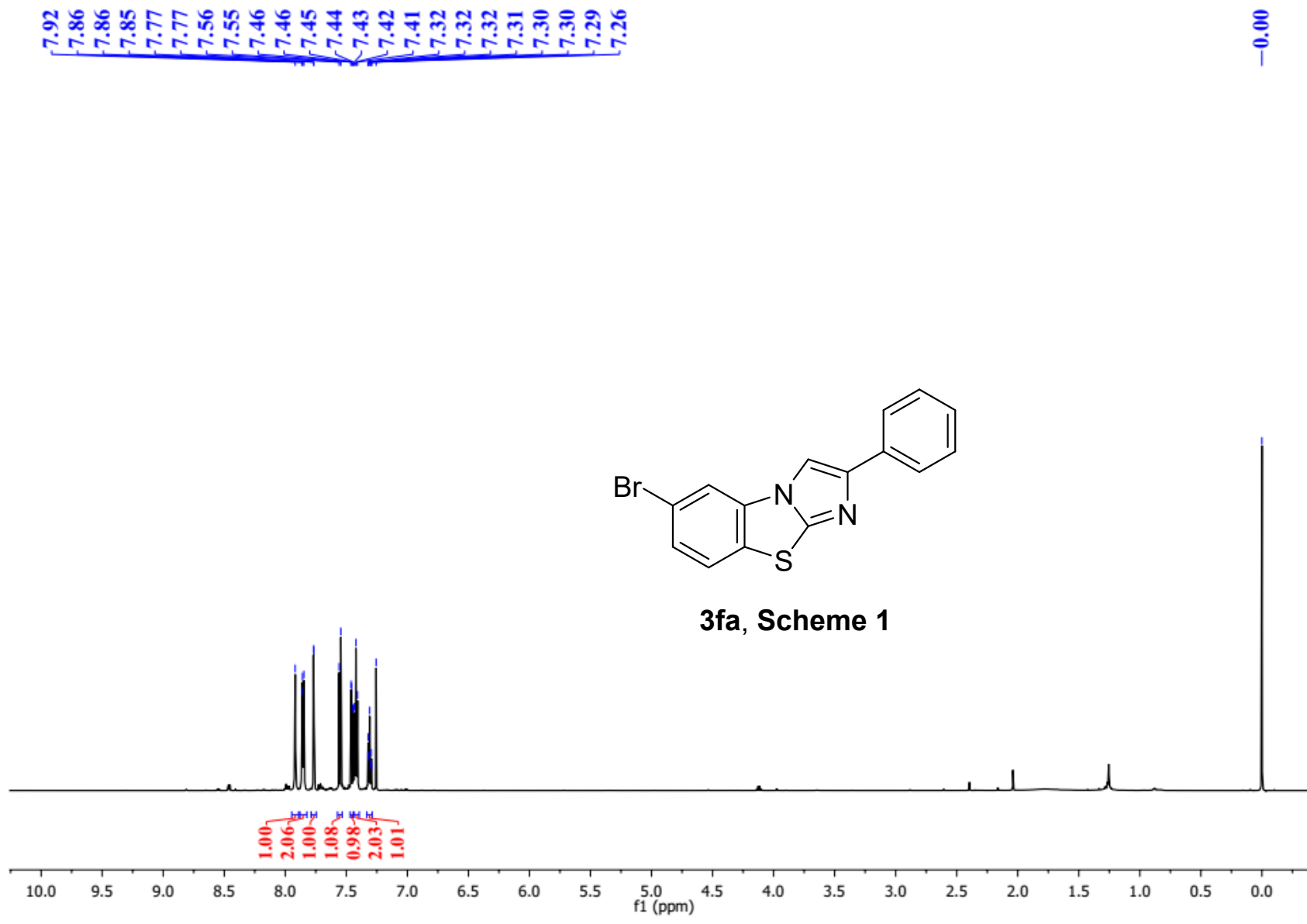
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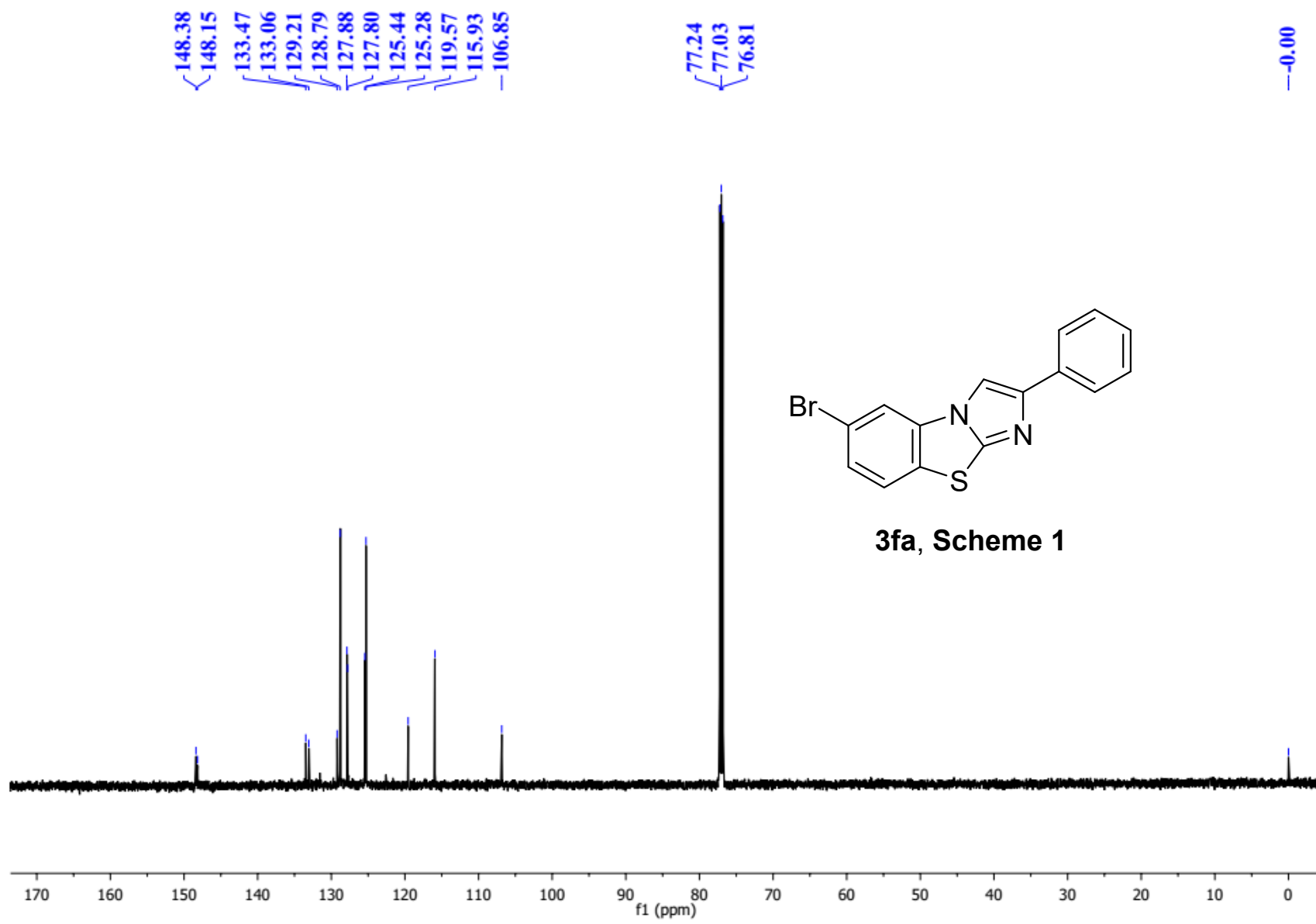


3ea, Scheme 1







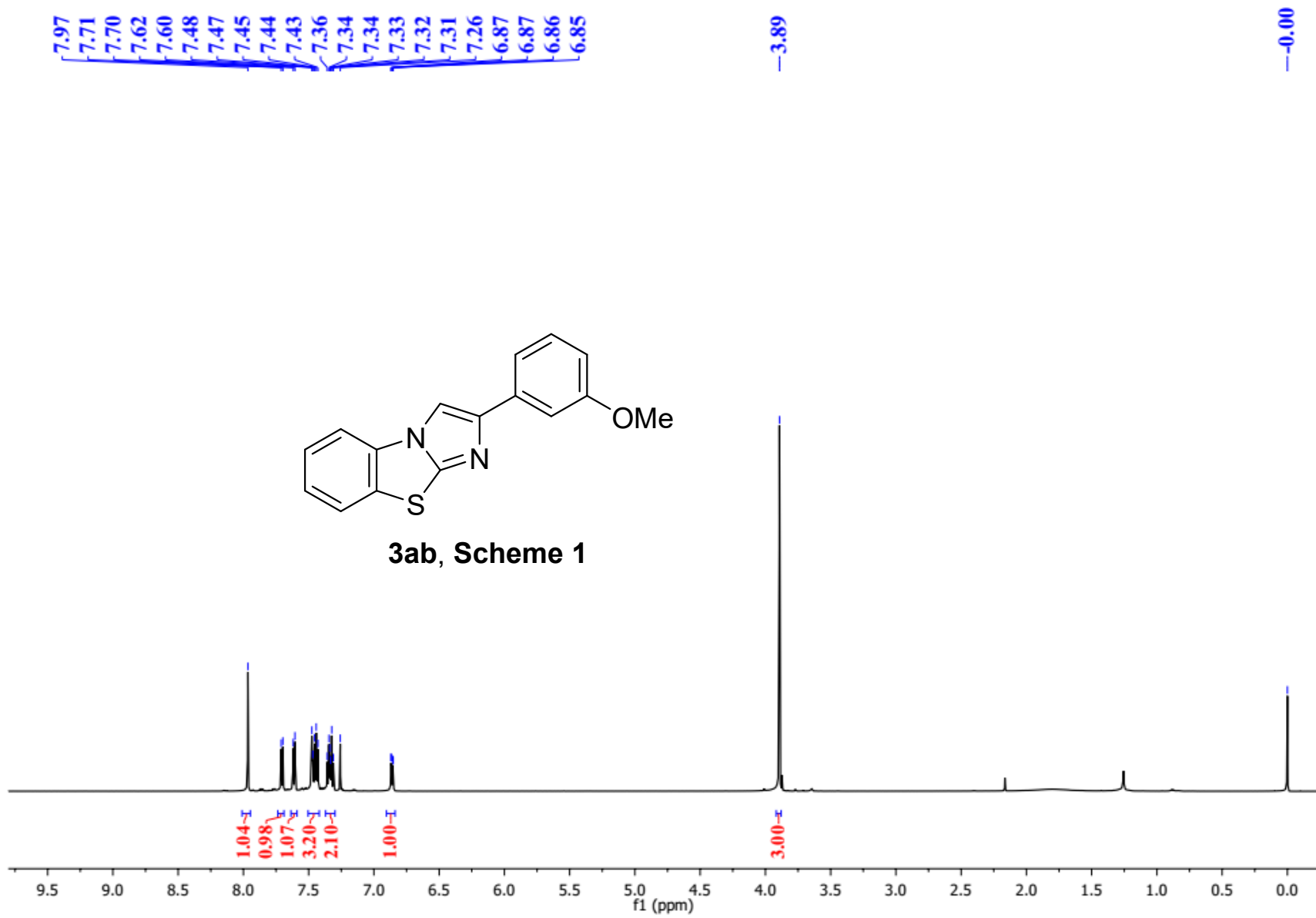


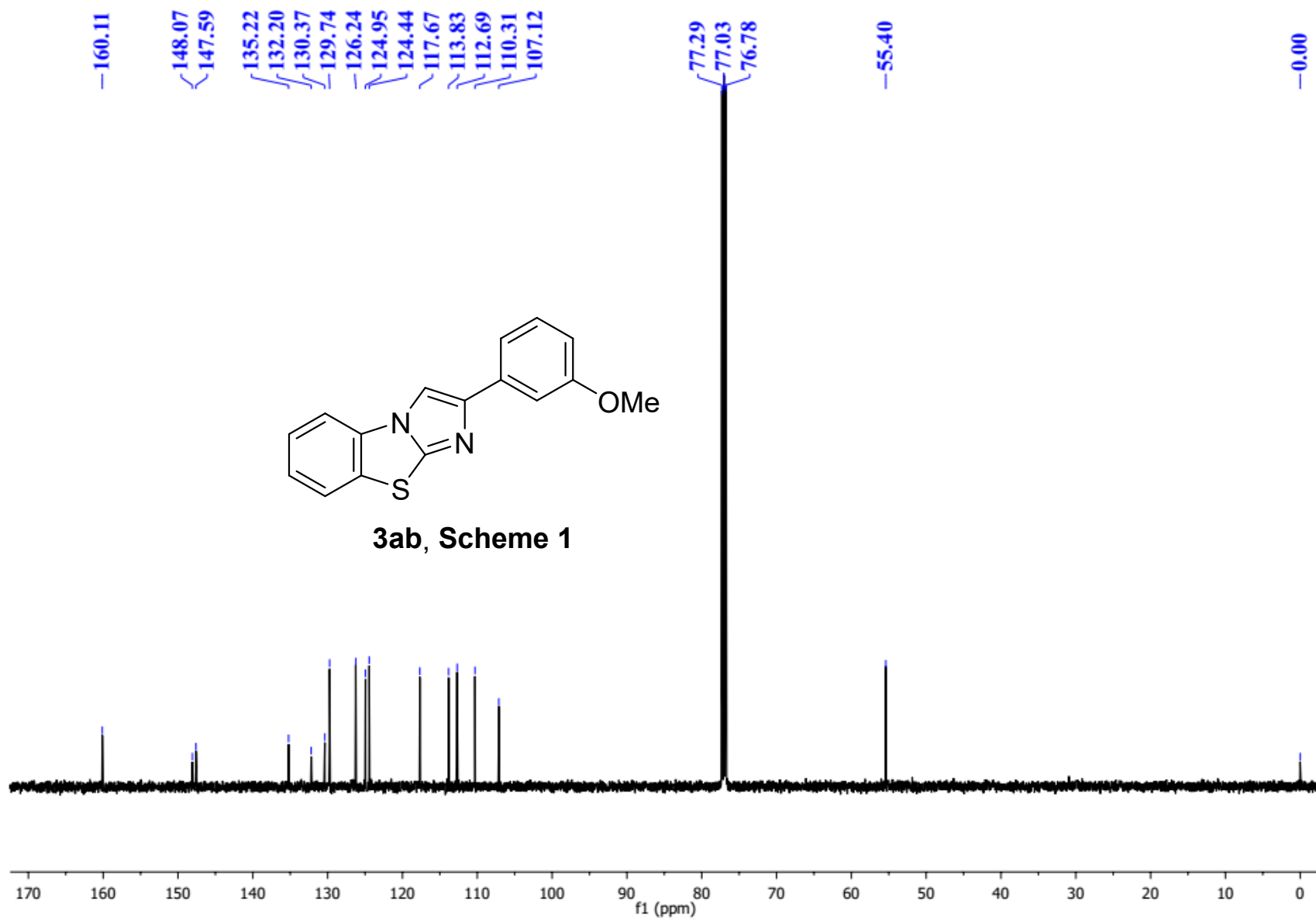
148.38
148.15
133.47
133.06
129.21
128.79
127.88
127.80
125.44
125.28
119.57
115.93
106.85

77.24
77.03
76.81

-0.00

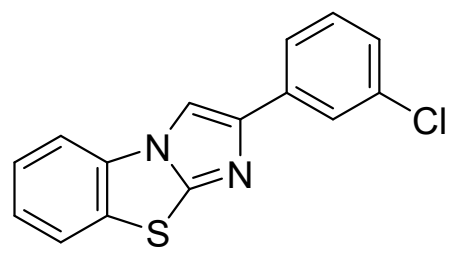
3fa, Scheme 1



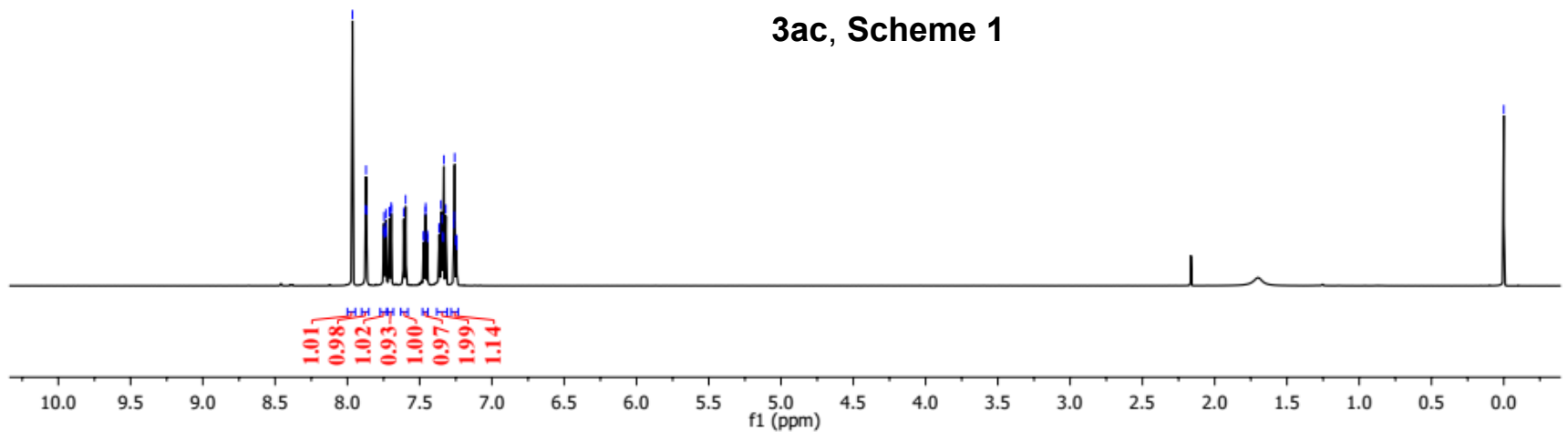


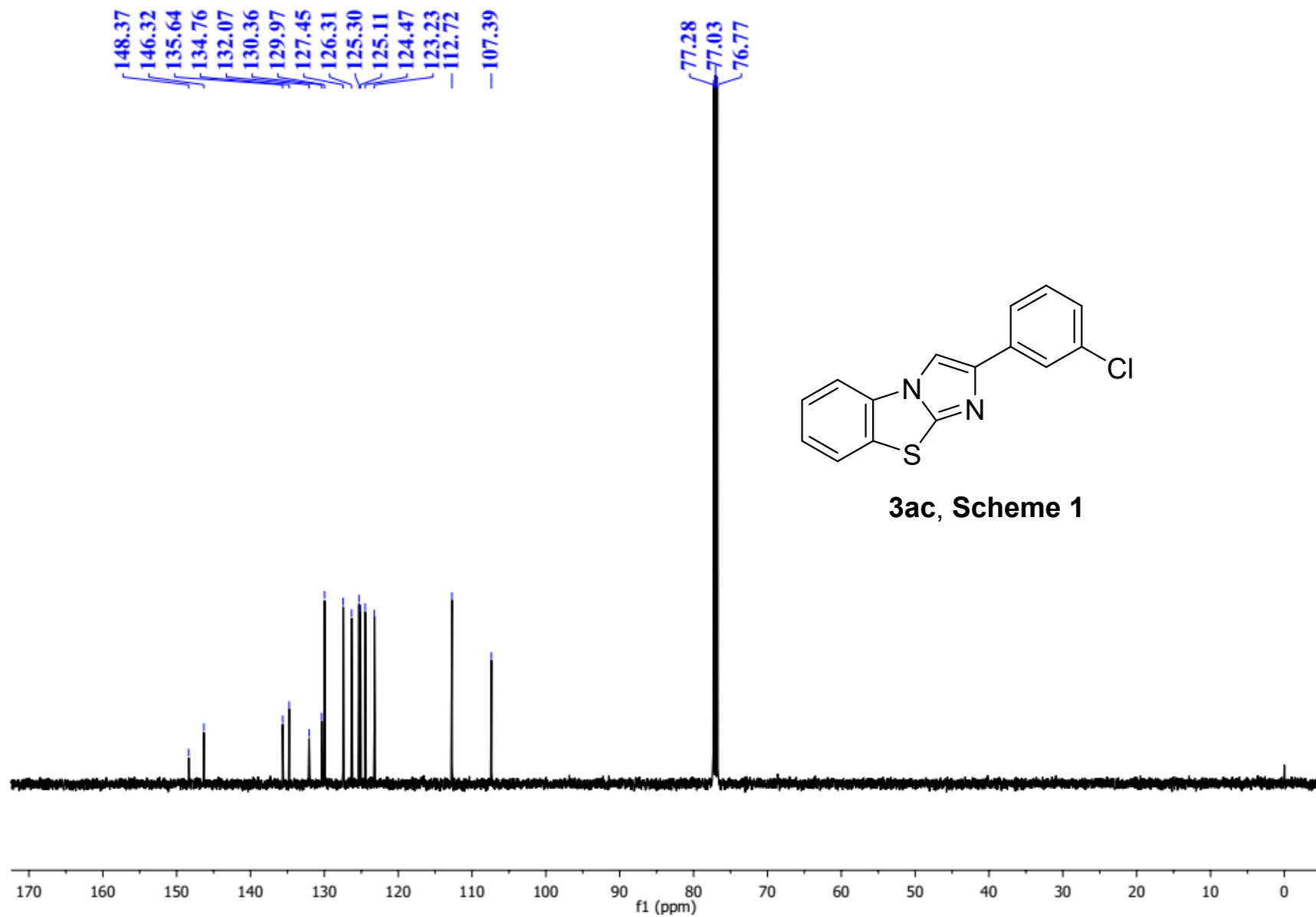
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7.87
7.87
7.75
7.75
7.74
7.74
7.73
7.73
7.71
7.71
7.70
7.70
7.61
7.60
7.47
7.47
7.46
7.46
7.45
7.45
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7.24

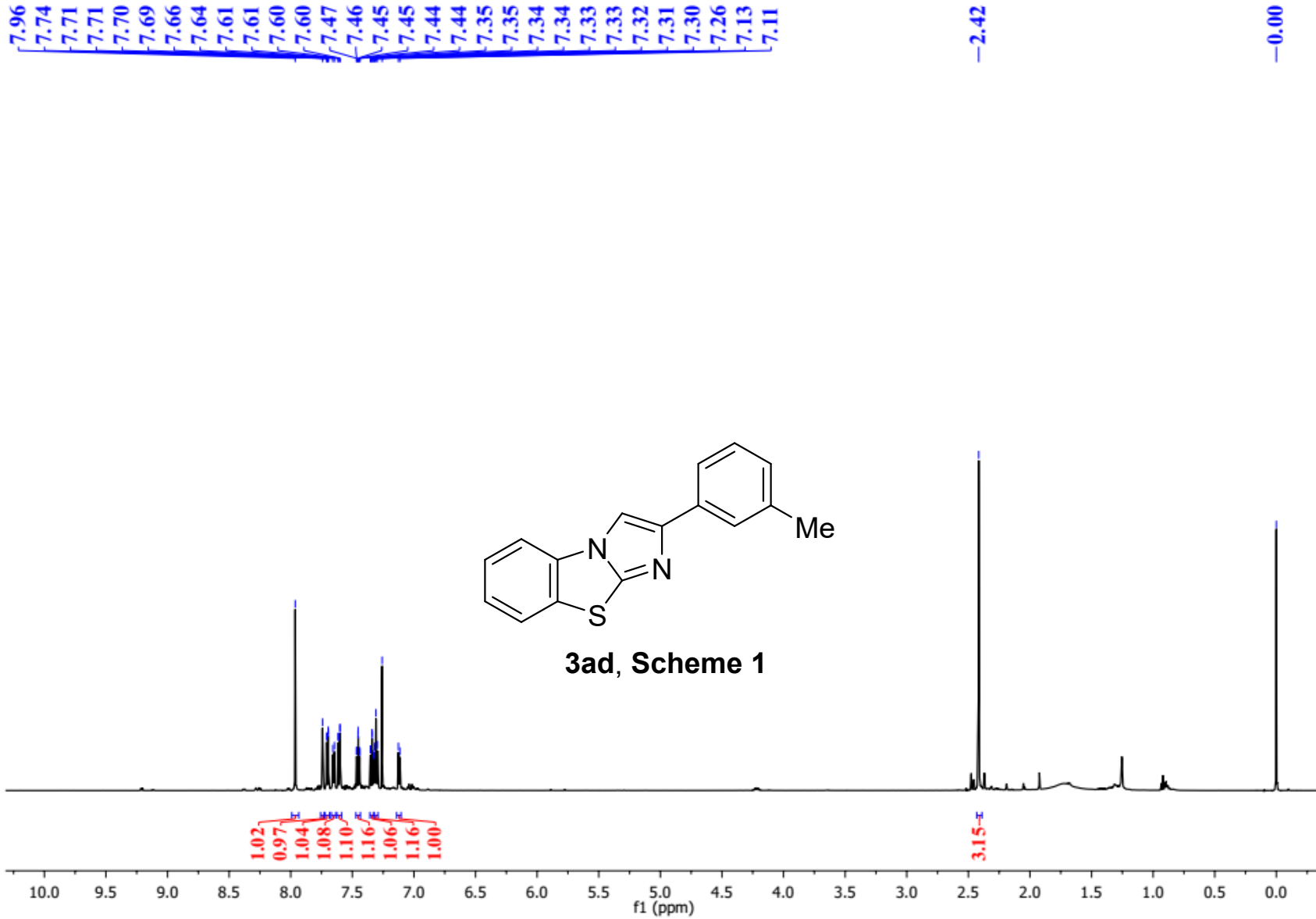
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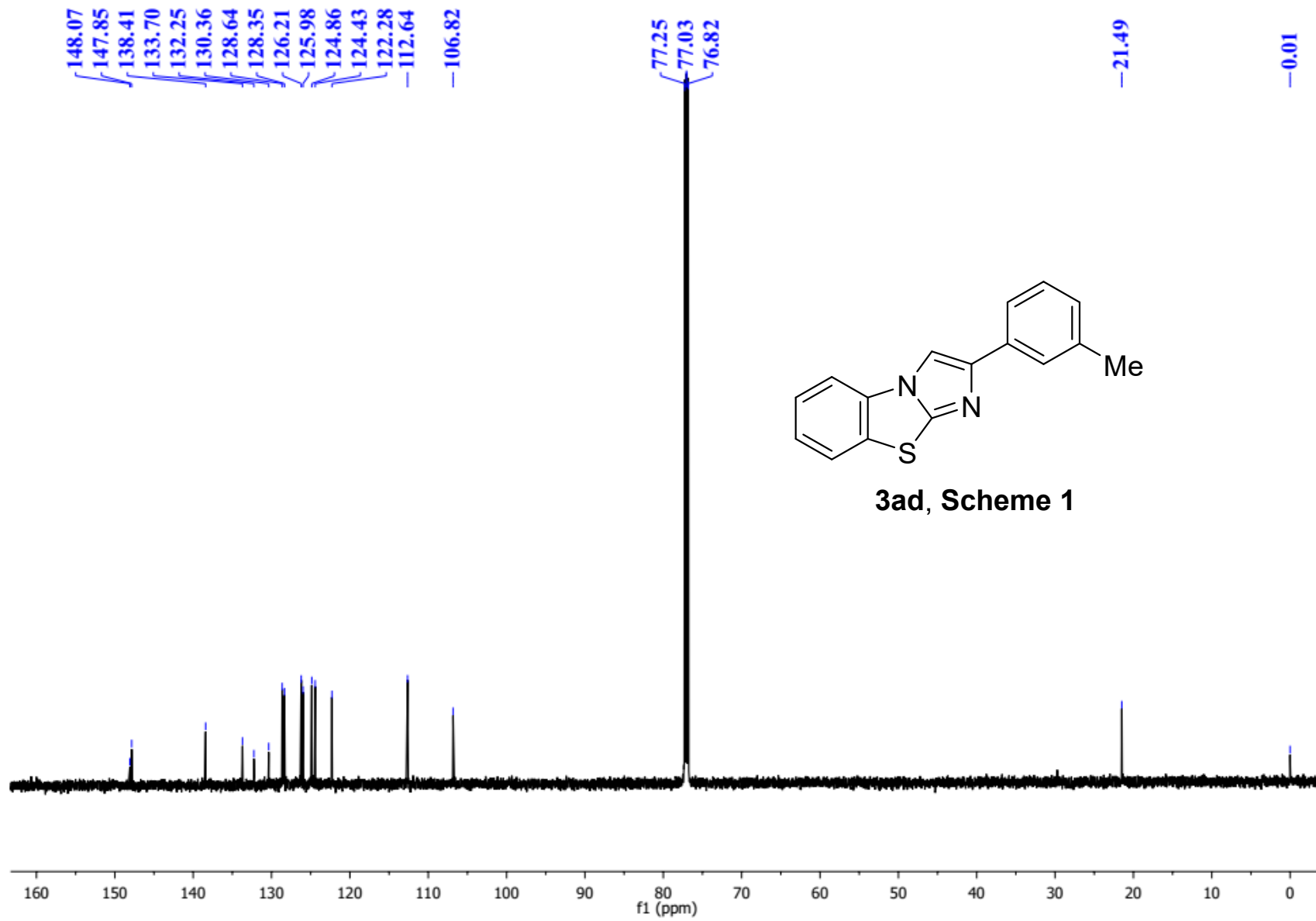


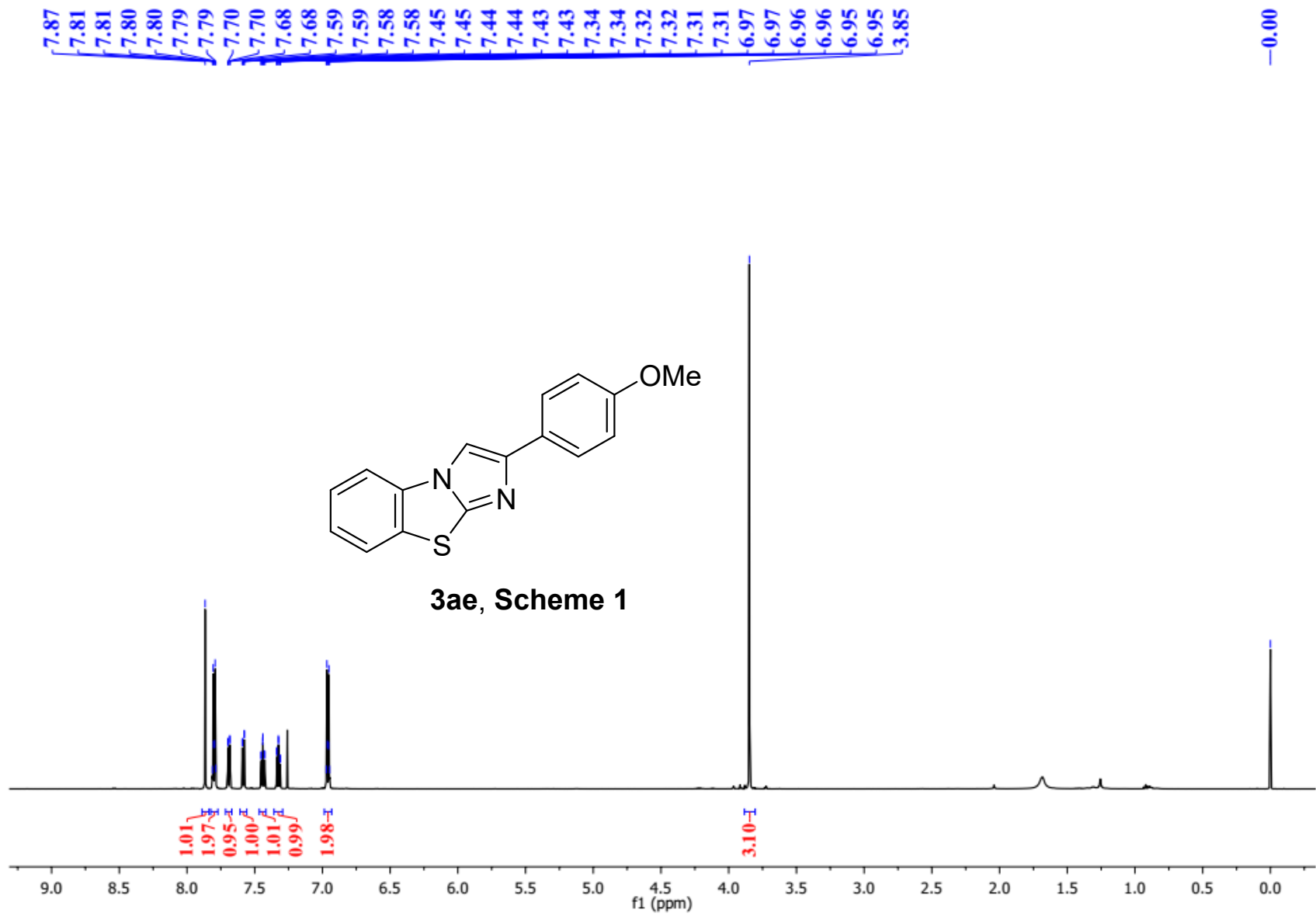
3ac, Scheme 1

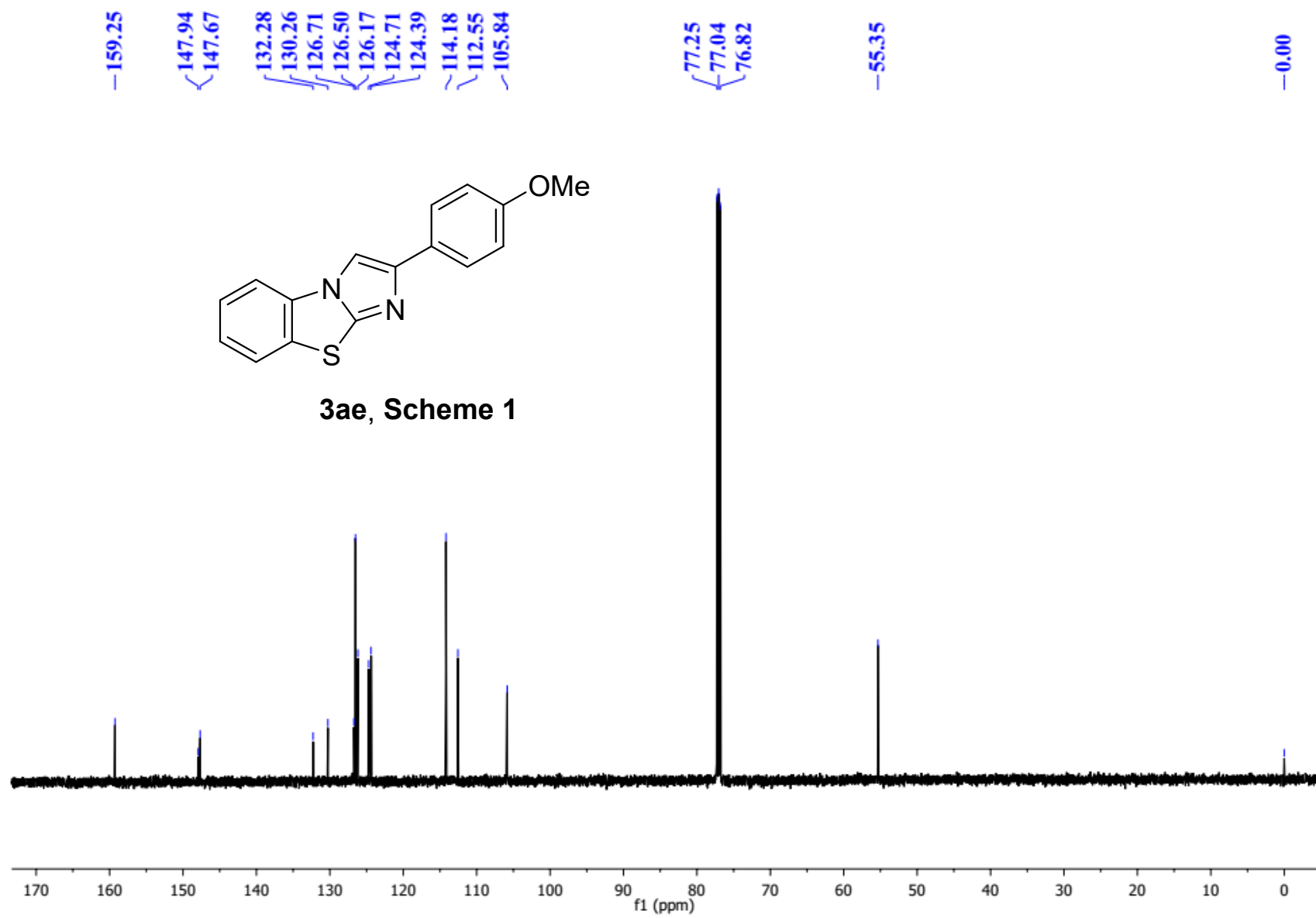


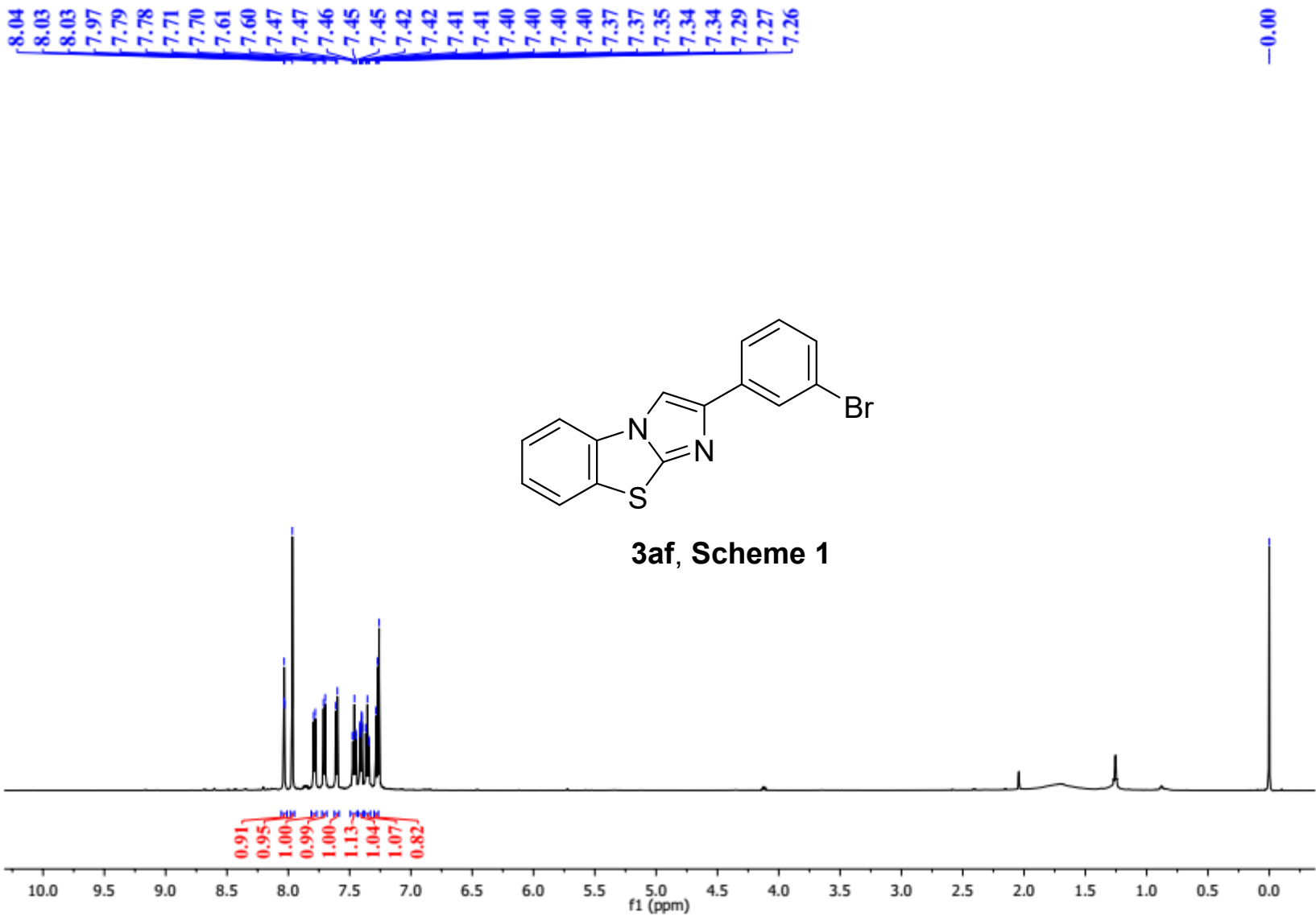


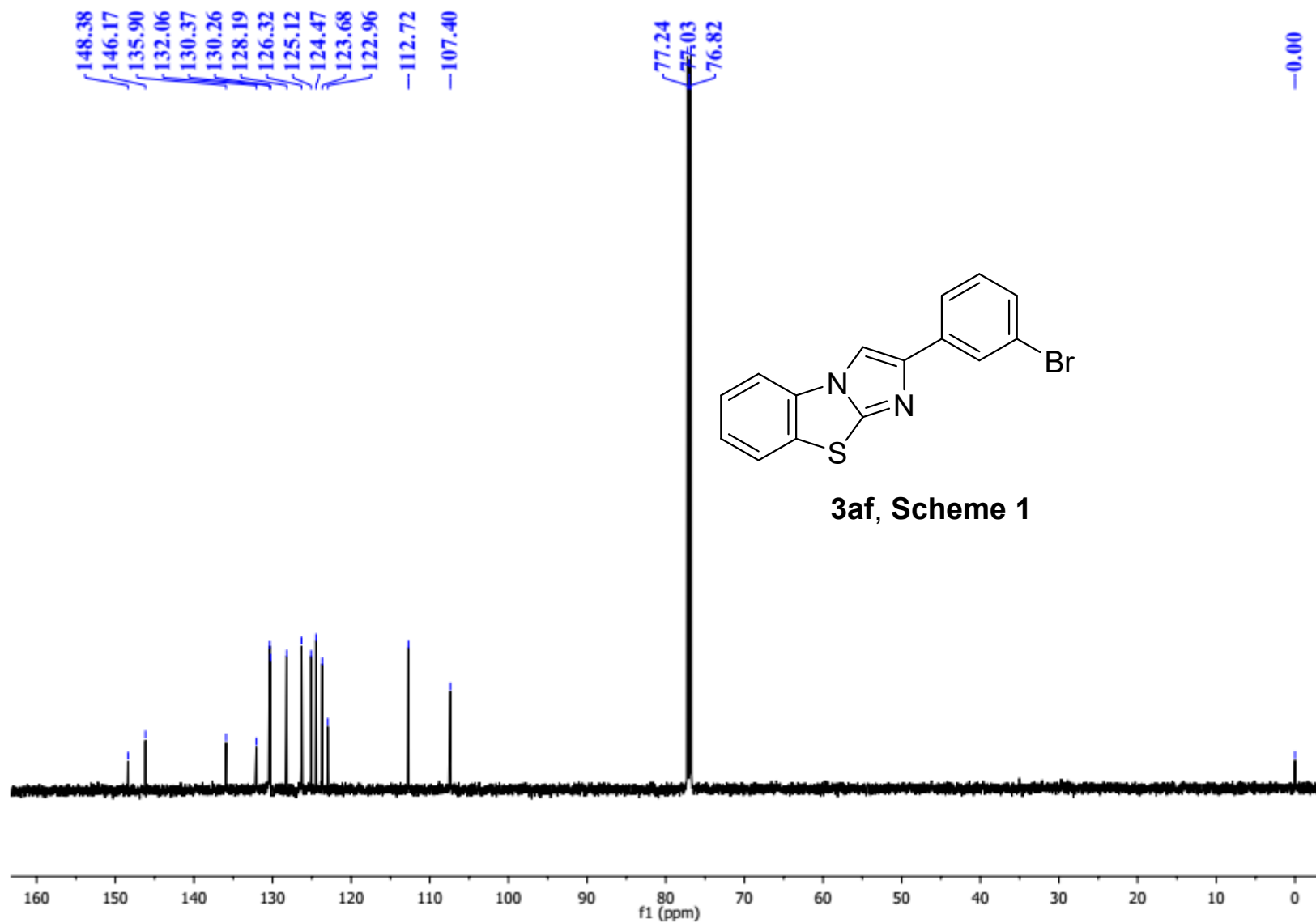




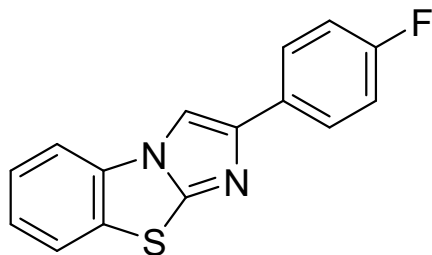




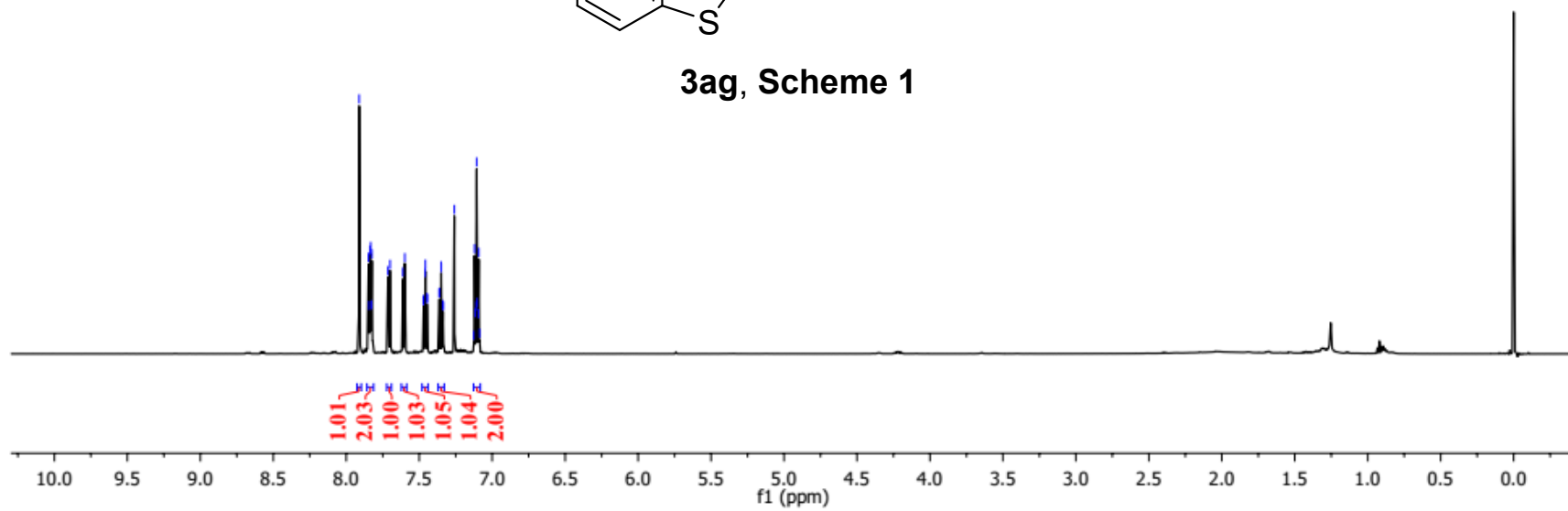


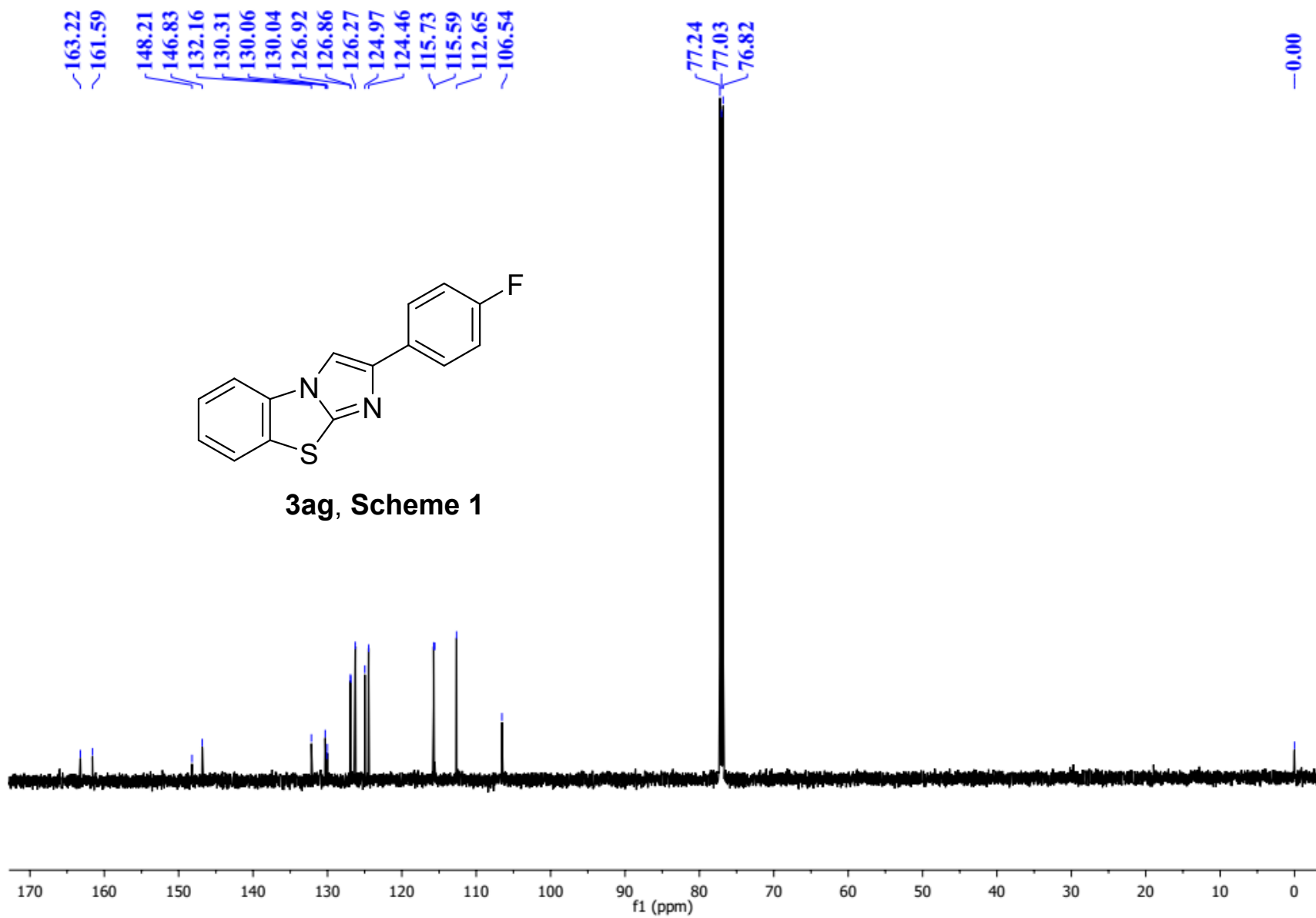


7.91
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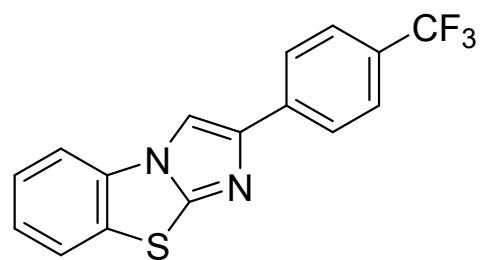
3ag, Scheme 1



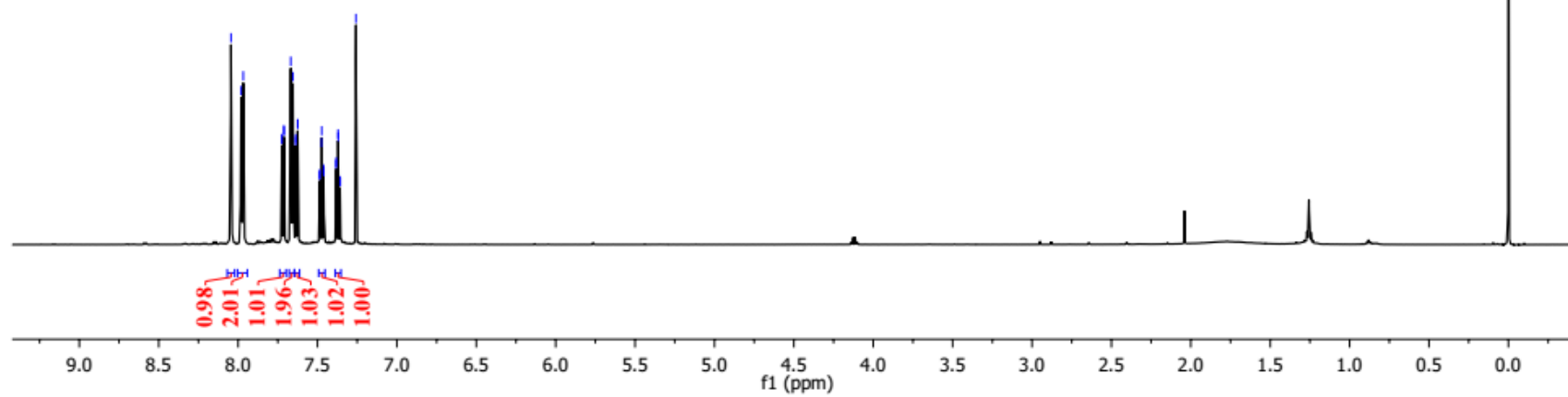


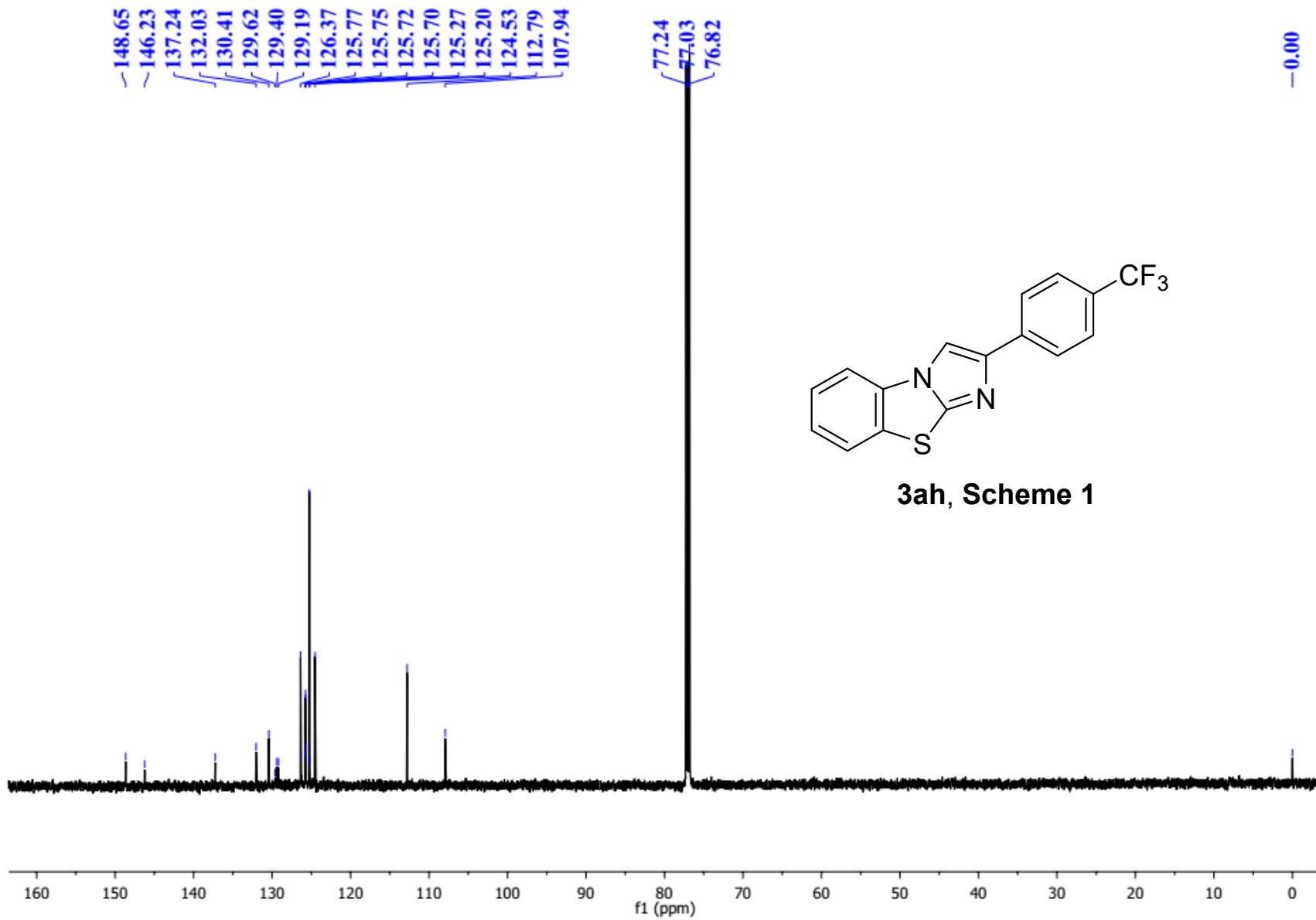
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7.71
7.67
7.65
7.64
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7.62
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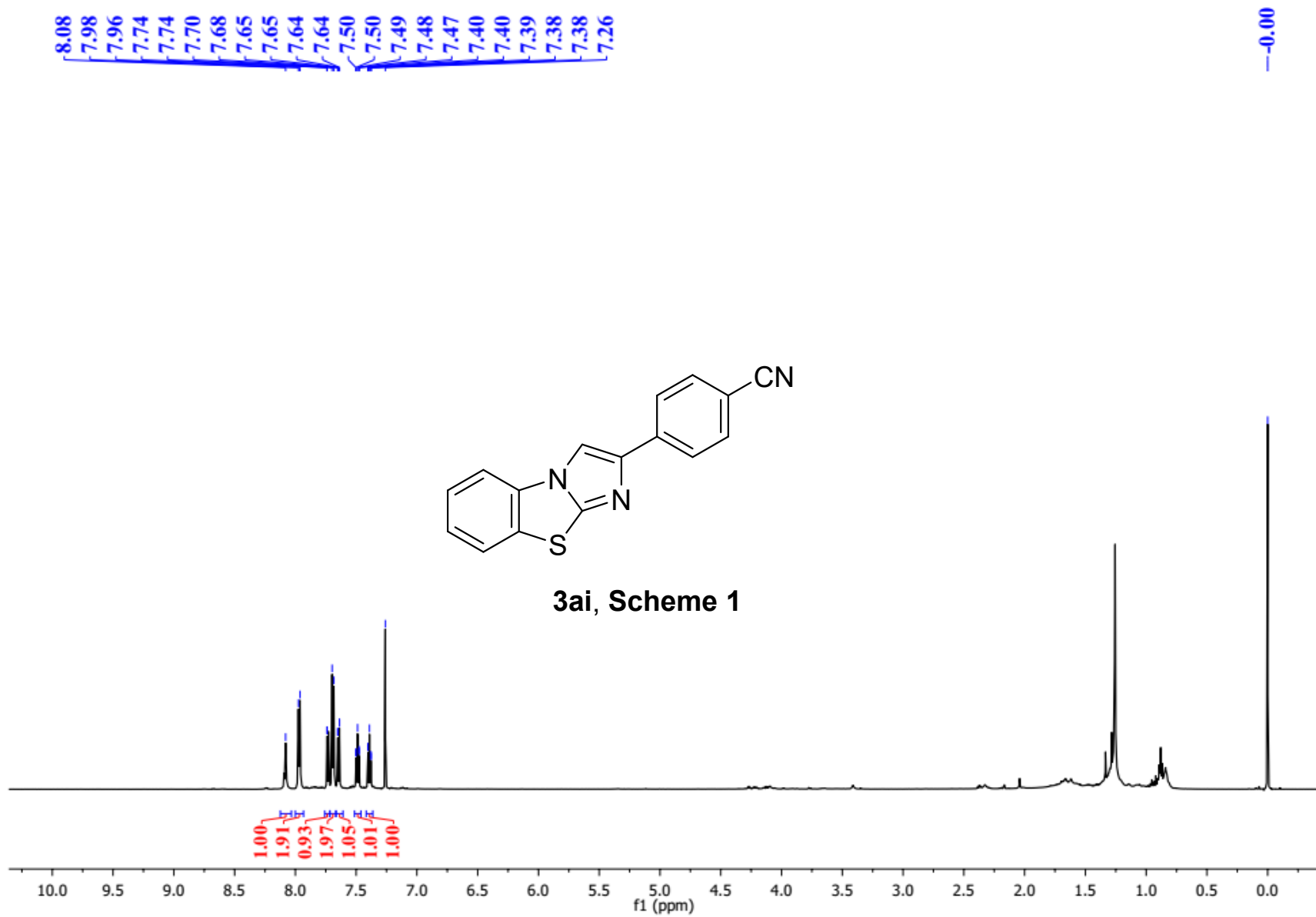
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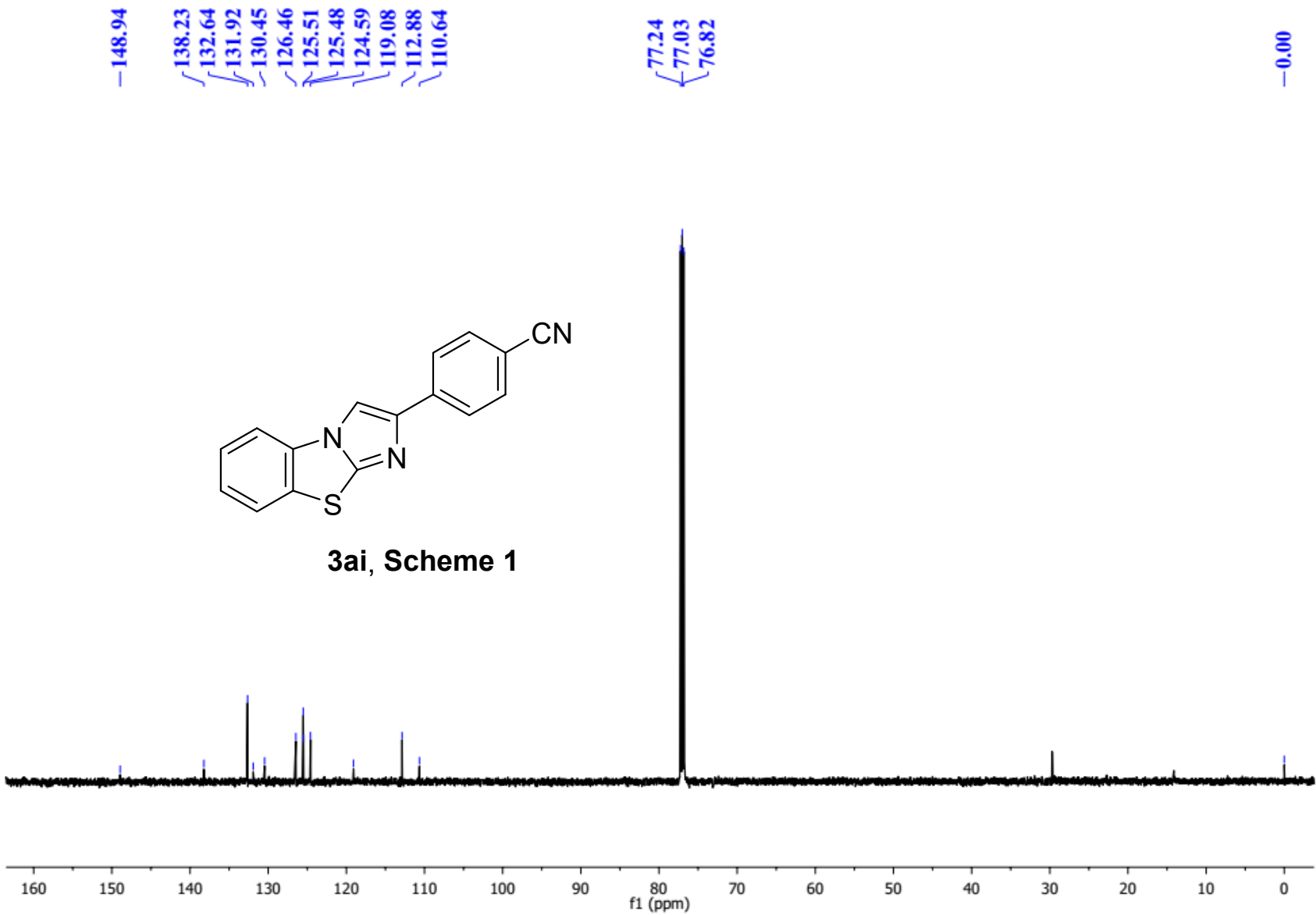


3ah, Scheme 1

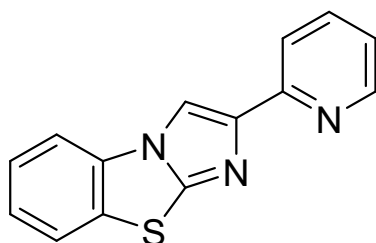




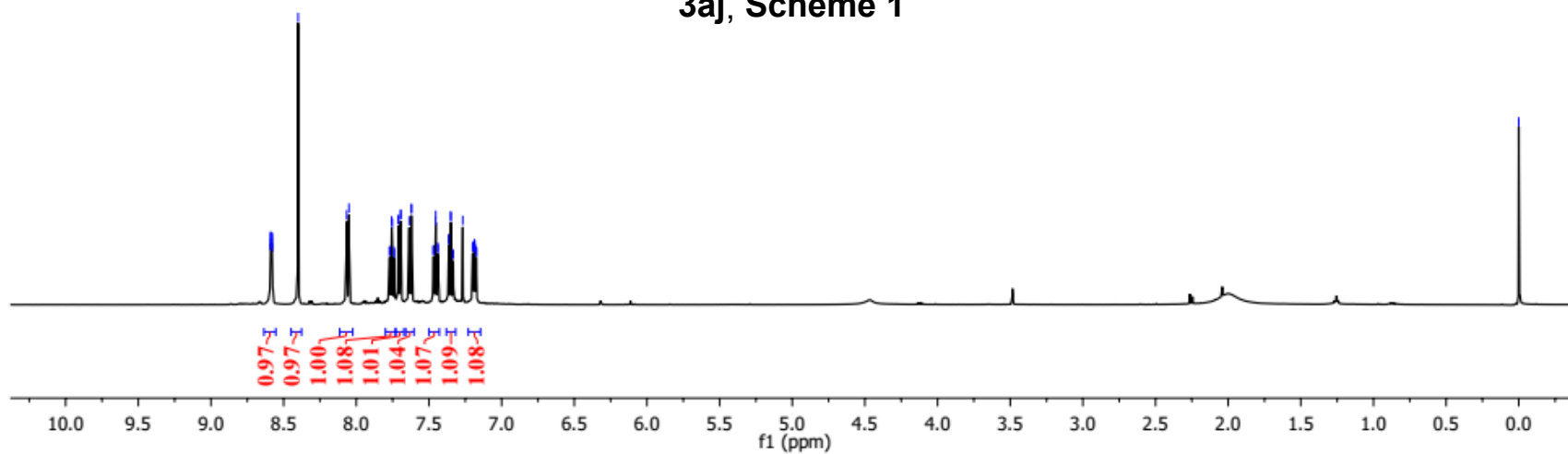


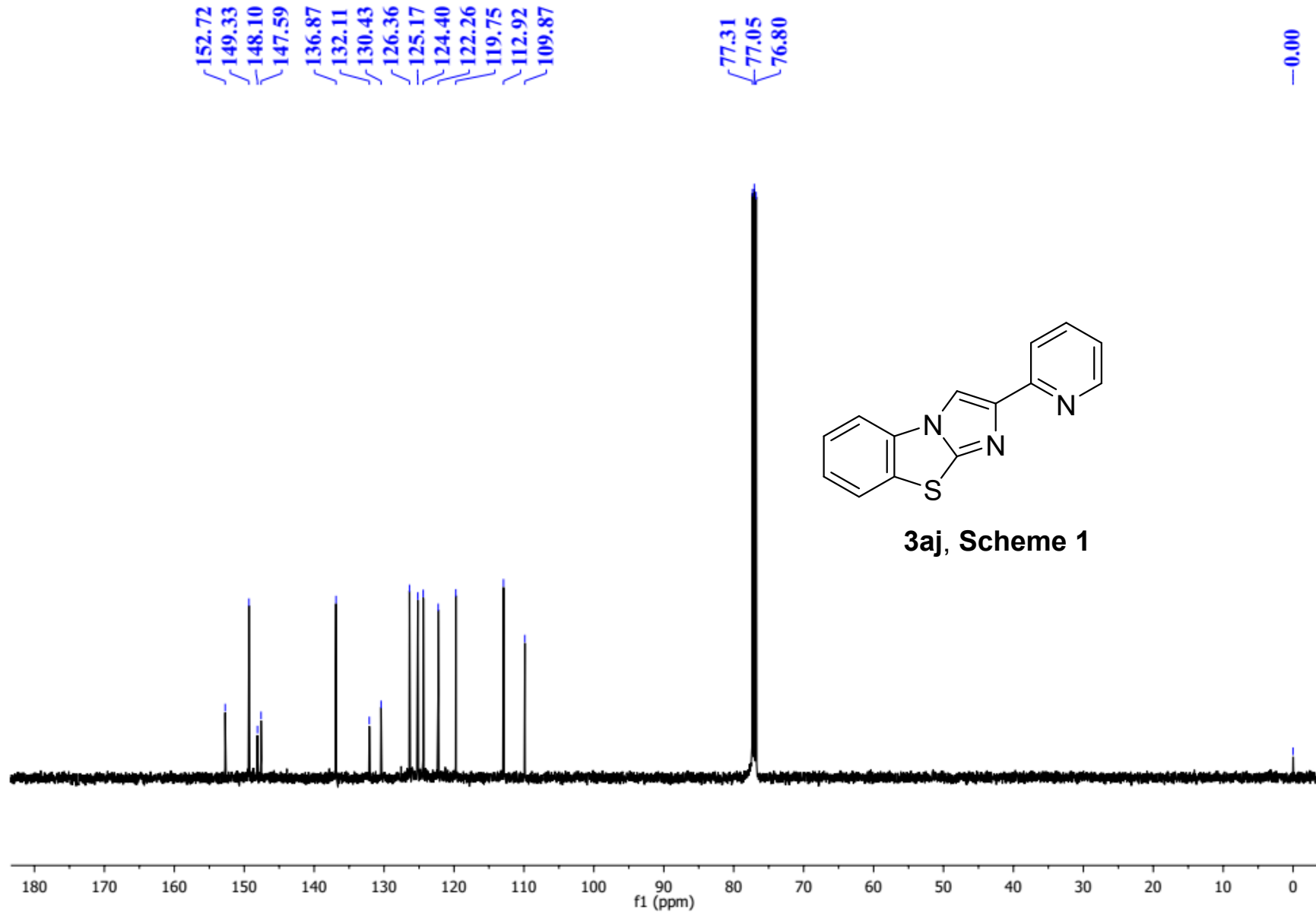


8.59
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8.07
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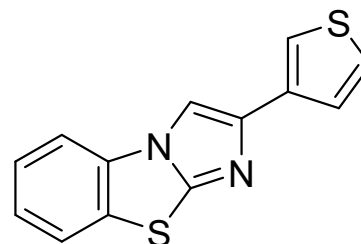


3aj, Scheme 1





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7.33



3ak, Scheme 1

