Supplementary Information for:

# Bioconjugatable, PEGylated Hydroporphyrins for Photochemistry and Photomedicine. Narrow-Band, Near-Infrared-Emitting Bacteriochlorins

Nuonuo Zhang, Jianbing Jiang, Mengran Liu, Masahiko Taniguchi, Amit Kumar Mandal,
Rosemary B. Evans-Storms, J. Bruce Pitner,
David F. Bocian, Dewey Holten and Jonathan S. Lindsey

## Table of Contents



## 1. Scale-Up Procedures

Several bacteriochlorins were prepared at somewhat larger scale than in the procedures described in the body of the paper. Bacteriochlorin **B2** was prepared in a larger scale (~40 mg) starting from bacteriochlorin precursor **10**. The Suzuki coupling reaction of bacteriochlorin **1** (270 mg) with **9** afforded **10** (465 mg, 90% yield, to be compared to 85% yield for the smaller scale synthesis). A portion of the sample of bacteriochlorin **10** (200 mg) was consumed for the reactions of 15-bromination and 15-acylation (Suzuki coupling) to afford bacteriochlorin **13** (60 mg, 25% yield; to be compared to a 31% yield for the smaller scale synthesis). The subsequent deprotection (97%) and PEGylation (77%) were conducted to afford the target bacteriochlorin **B2** (~40 mg). **B4** was also prepared in a larger scale (20 mg). Summaries and comparisons of the smaller- and larger-scale synthesis for **B2** and **B4** are listed in Table S1.

**Table S1.** Summaries and comparisons for the smaller- and larger-scale synthesis of **B2** and **B4**.

| Cmpd | Smaller scale | | | Larger scale | | |
|---|---|---|---|---|---|---|
| | Purification[a] | Time | Total yield | Purification[a] | Time | Total yield |
| **B2** | Column chromatography (2 steps), solvent wash (2 steps) | 5 d | 22%[b] | Column chromatography (2 steps), solvent wash (2 steps) | 7 d | 17%[b] |
| **B4** | Column chromatography (3 steps), solvent wash (2 steps) | 6 d | 3%[c] | Column chromatography (3 steps), solvent wash (2 steps) | 8 d | 6%[c] |

[a]The aqueous/organic wash is not included. [b]Calculated from four continuous reaction steps for the conversion of **10** to **B2**. [c]Calculated from four continuous reaction steps for the conversion of **15** to **B4**.

**Synthesis protocols:**

Bacteriochlorin **B2.** A mixture of **14** (25.0 mg, 30.5 μmol), $Cs_2CO_3$ (200 mg, 613 μmol) and **PEG$_4$-NHS** (410 mg, 1.23 mmol) in DMF (375 μL) was stirred under argon for 2.5 h. The reaction mixture was diluted with saturated aqueous $NaHCO_3$ (2.5 mL) and stirred for 4 h. The remaining reaction protocol, purification procedure and characterization data (ESI-MS data were not obtained) were essentially identical with those in the body of the paper to afford the title bacteriochlorin (40.0 mg, 77% yield).

Bacteriochlorin **B4.** A solution of **18** (17.0 mg, 13.0 μmol) in $CH_2Cl_2$ (2.80 mL) was stirred under argon for 2 min, followed by addition of TFA (0.280 mL). After 1 h, the reaction mixture was diluted with $CHCl_3$ (~3 mL) and dried under vacuum to thoroughly remove the $CH_2Cl_2$ and TFA. This procedure ($CHCl_3$ addition – solvent removal) was repeated twice, whereupon the mixture was dried under vacuum. Tributylamine (20 μL) was added to the solid residue, and the resulting suspension was sonicated for 3 min. A mixture of THF and hexanes (1:2) was then added, and the resulting suspension was sonicated (5 min) and centrifuged. The supernatant was discarded to afford a greenish solid. A mixture of the resulting bacteriochlorin (11.8 mg, 13.0 μmol), $Cs_2CO_3$ (20.0 mg, 64.7 μmol, 5 equiv) and **PEG$_4$-NHS** (134 mg, 0.410 mmol, 34 equiv) in DMF (2.8 mL) was stirred under argon for 2 h. The remaining reaction protocol, purification procedure and characterization data (ESI-MS data were not obtained) were essentially identical with those in the body of the paper to afford the title bacteriochlorin (20.0 mg, 86% yield).

Bacteriochlorin **13.** A solution of **10** (200 mg, 187 μmol) in THF (375 mL) was treated with NBS (40.0 mg, 224 μmol) in THF (2.25 mL) at room temperature for 1.5 h. The reaction mixture was diluted with $CH_2Cl_2$ and washed with saturated aqueous $NaHCO_3$. The organic layer was dried ($Na_2SO_4$) and concentrated to afford a red solid, which was transferred to a Schlenk flask. Samples of **12** (154 mg, 0.463 mmol), $Pd(PPh_3)_4$ (43.6 mg, 37.7 μmol), and $Cs_2CO_3$ (187 mg, 0.572 mmol) were placed in the Schlenk flask, and the mixture was dried and deaerated under high vacuum for 30 min. Toluene/DMF [9.5 mL (2:1), deaerated by bubbling with argon for 30 min] was added to the Schlenk flask under argon, and the resulting mixture was deaerated by three freeze-pump-thaw cycles. The remaining reaction protocol, purification procedure and characterization data (ESI-MS data were not obtained) were essentially identical with those in the body of the paper to afford the title bacteriochlorin (60.0 mg, 25% yield).

Bacteriochlorin **14.** A solution of **13** (50.0 mg, 39.2 μmol) in $CH_2Cl_2$ (2.35 mL) was stirred under argon for 2 min followed by the addition of TFA (1.51 mL). After 1 h, the reaction mixture was diluted with $CHCl_3$ and dried under an argon flow. Tributylamine (642 μL, 2.70 mol) was added to the solid residue, and the mixture was sonicated for 3 min. The remaining reaction protocol, purification procedure and characterization data (ESI-MS data were not obtained) were essentially identical with those in the body of the paper to afford the title bacteriochlorin (31.0 mg, 97% yield).

Bacteriochlorin **15.** A mixture of bacteriochlorin **2** (298 mg, 443 μmol), **9** (450 mg, 964 μmol), $Pd(PPh_3)_4$ (306 mg, 265 μmol), $Cs_2CO_3$ (432 mg, 1.33 mmol) and toluene/DMF [45 mL

(2:1), deaerated by bubbling with argon for 1 h] was added to a Schlenk flask and deaerated by three freeze-pump-thaw cycles. The remaining reaction protocol, and purification procedure and characterization data (ESI-MS were not obtained) were essentially identical with those in the body of the paper to afford the title bacteriochlorin (326 mg, 62% yield).

Bacteriochlorin **16.** A solution of **15** (326 mg, 275 μmol) in THF (63.0 mL) was treated with NBS (54.0 mg, 303 μmol) in THF (3.00 mL) at room temperature under argon for 40 min. The remaining reaction protocol, purification procedure and characterization data (ESI-MS data were not obtained) were essentially identical with those in the body of the paper to afford the title bacteriochlorin (250 mg, 72% yield).

Bacteriochlorin **18.** A mixture of **16** (250 mg, 198 μmol), $Pd_2(dba)_3$ (75.0 mg, 90.0 μmol, 0.45 equiv) and P(*o*-tol)$_3$ (150 mg, 475 μmol, 2.4 equiv) was dried under high vacuum in a Schlenk flask for 1 h. Toluene/DMF [19.5 mL (2:1), deaerated by bubbling with argon for 30 min] was added to the Schlenk flask under argon, and the resulting mixture was deaerated by three freeze-pump-thaw cycles. 6-Heptynoic acid (**17**, 250 μL, 2.00 mmol, 10 equiv) was added after the second freeze-pump-thaw cycle. The remaining reaction protocol, purification procedure and characterization data (ESI-MS data were not obtained) were essentially identical with those in the body of the paper to afford the title bacteriochlorin (45.0 mg, 17% yield). A mixture of debrominated bacteriochlorin **15** and starting bacteriochlorin **16** (1:1 determined by $^1$H NMR spectroscopy, ~130 mg) was recovered after chromatography.

## 2. Exploratory Syntheses Towards PEGylated Bacteriochlorins

Several other target bacteriochlorins were also designed with expectation to tune the wavelength or to explore complementary synthetic methodologies. Three target compounds shown in Chart S1 were attempted. None of these target compounds was obtained due to synthetic difficulties encountered with the intermediates. Here, the "S" terminology is included to denote that these compounds are part of the Supplementary Information section and do not appear in the body of the paper.

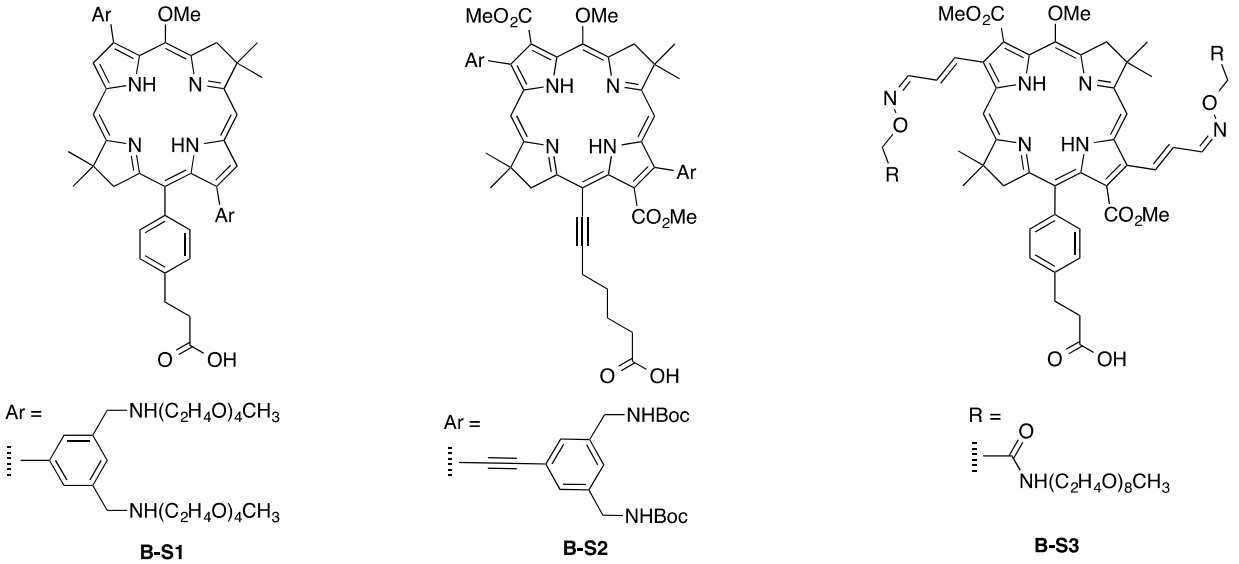
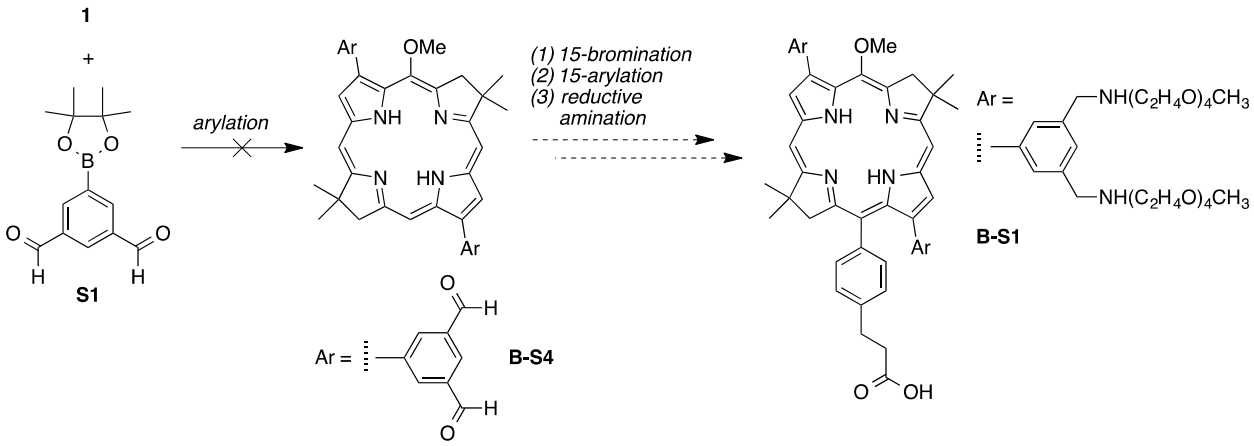



**Chart S1.** Attempted target bacteriochlorins.

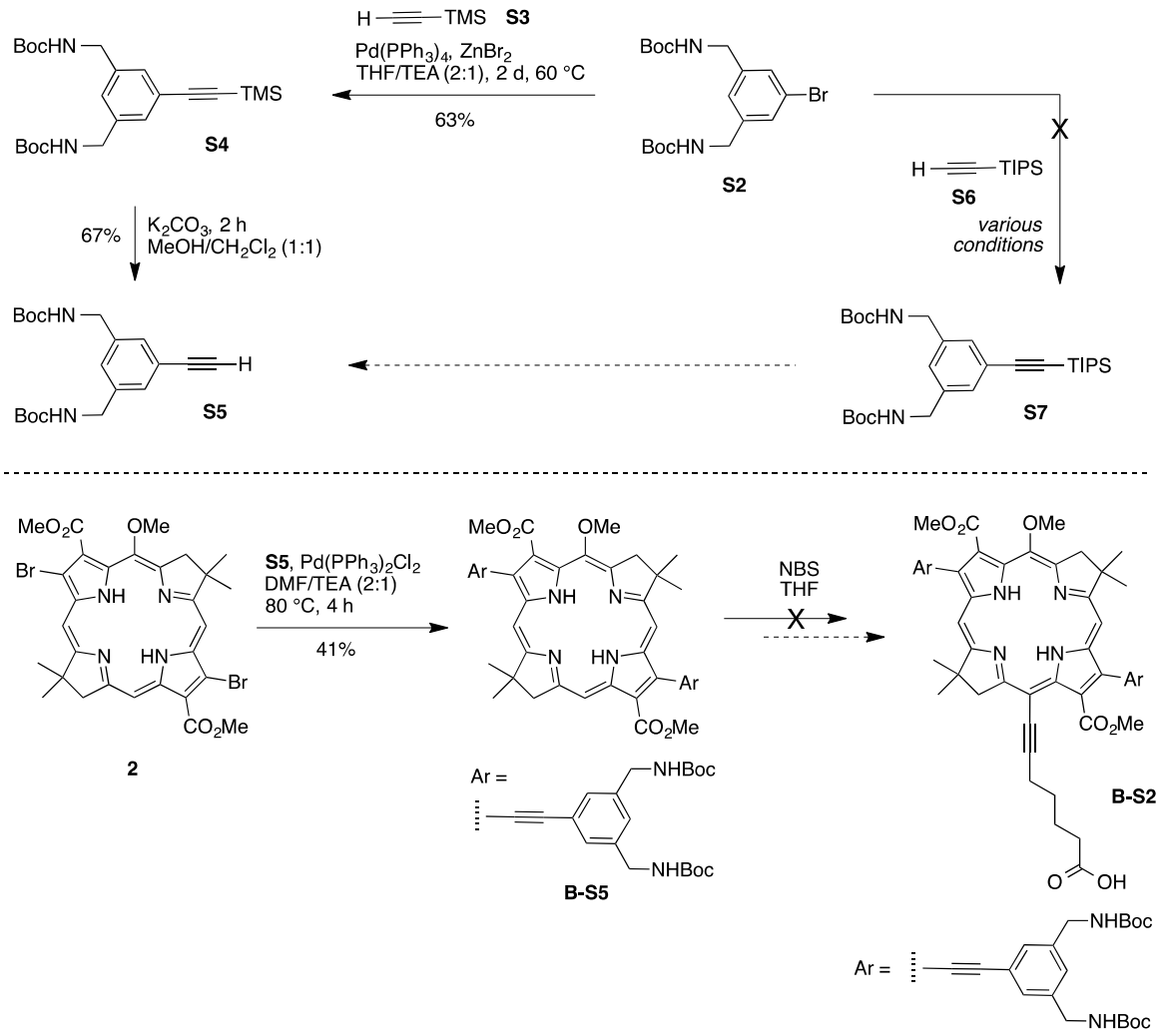
Bacteriochlorin **B-S1** was designed with expectation of a $Q_y$ absorption band at ~730 nm. The Suzuki coupling reaction of bacteriochlorin **1** with compound **S1**[11] failed to afford the tetraformylbacteriochlorin **B-S4** (Scheme S1). This was a surprise, since a similar Suzuki coupling reaction with 15-bromo-2,12-bis(4-methylphenyl)bacteriochlorin using the same coupling partner successfully afforded the corresponding 15-(3,5-diformyl)-2,12-bis (4-methylphenyl)bacteriochlorin in 81% yield.[11] This synthesis failure may stem from a difference in reactivity of the bacteriochlorin *meso* (15- ) and β (3- and 13-) positions.[11]




**Scheme S1.** Attempted synthesis of a PEGylated bacteriochlorin.

Previous studies revealed that attachment of 3,13-diethynyl groups shifted the $Q_y$ absorption band of the bacteriochlorin to 749 nm, to be compared with 729 nm for the parent 3,13-dibromobacteriochlorin.[37] In a separate study,[11] a bathochromic shift of 18 nm was achieved by incorporating an ethynyl group at the 15-position of a 2,12-di-*p*-tolyl-5-methoxybacteriochlorin. Accordingly, incorporation of three ethynyl groups (2-, 12-, and 15-positions) with a 3,13-dicarboethoxybacteriochlorin was expected to cause a bathochomic shift of the $Q_y$ band from 749 nm to ~795 nm.

Treatment of Boc-protected 3,5-diamino-1-bromobenzene **S2** with trimethylsilylacetylene (**S3**) under Pd-catalysis conditions afforded **S4** in 63% yield (Scheme S2).[S1] The resulting compound **S4** was subjected to trimethylsilyl (TMS) group removal by potassium carbonate in a mixed solvent of methanol and dichloromethane[S2] to give the Sonogashira coupling partner **S5** in 67% yield. The use of triisopropylsilylacetylene (**S6**) instead of trimethylsilylacetylene (**S3**) failed to afford the desired product **S7** under various conditions. All conditions examined for both routes are summarized in Table S2.




**Scheme S2.** Attempted synthesis of a PEGylated bacteriochlorin.

**Table S2.** Reaction conditions examined for the Sonogashira reaction.

| Entry | Reaction conditions[a,b] | Observed | Detected by |
|---|---|---|---|
| 1 | Pyridine, $Pd(PPh_3)_2Cl_2$ (0.01 eq), **S6** (2 eq), CuI (0.2 eq), 80 °C, 16 h | unknown | $^1$H NMR |
| 2 | THF/TEA (3:2), $Pd(PPh_3)_2Cl_2$ (0.05 eq), **S6** (3 eq), CuI (0.4 eq), 80 °C, 16 h | unknown | $^1$H NMR |
| 3 | Pyridine, $Pd(PPh_3)_2Cl_2$ (0.05 eq), **S3** (3 eq), CuI (0.4 eq), 80 °C, 36 h | unknown | $^1$H NMR |
| 4 | THF/*i*-$Pr_3N$ (3:2), $Pd(PPh_3)_2Cl_2$ (0.05 eq), **S3** (3 eq), CuI (0.4 eq), 80 °C, 36 h | unknown | $^1$H NMR |
| 5 | DMF/TEA (3:2), $Pd(PPh_3)_2Cl_2$ (0.05 eq), **S3** (3 eq), CuI (0.4 eq), 80 °C, 24 h | unknown | $^1$H NMR |
| 6 | THF/TEA (2:1), $Pd(PPh_3)_4$ (0.03 eq), **S3** (3 eq), $ZnBr_2$ (0.67 eq), 60 °C, 2 d | product **S4** | $^1$H NMR, $^{13}$C NMR, ESI-MS |

[a]Concentrations of **S2** are 0.40 M for entry 1, 0.24 M for entries 2–5, and 0.30 M for entry 6. [b]All equivalents in the brackets are relative to compound **S2**.

Sonogashira coupling reaction of bacteriochlorin **2** with coupling partner **S5** under copper-free Sonogashira conditions[11,35] gave Boc-protected bacteriochlorin **B-S5** in 41% yield (Scheme S2). Treatment of bacteriochlorin **B-S5** with NBS, however, failed to give the 15-brominated bacteriochlorin under various neutral and basic conditions, with the starting bacteriochlorin **B-S5** unreacted or decomposed (Table S3).

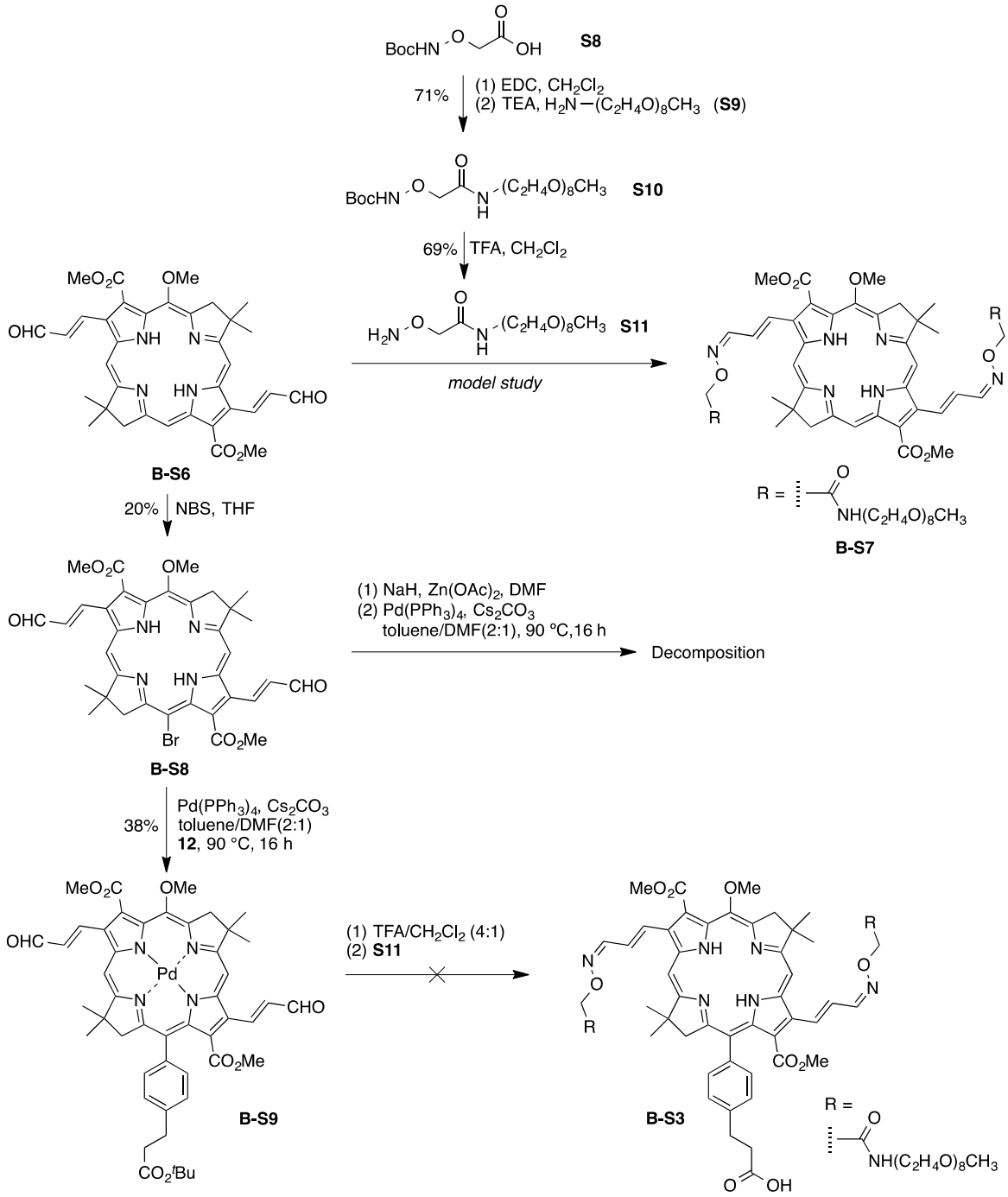
**Table S3.** Reaction conditions for 15-bromination.

| Entry | Reaction condition[a] | Observation[b] |
|---|---|---|
| 1 | NBS (1.0 eq), THF, 40 min, rt | SM[c] |
| 2 | NBS (2.0 eq), THF, 2 h, rt | SM[c] |
| 3 | NBS (3.0 eq), THF, 20 min, rt | SM[c] |
| 4 | NBS (6.0 eq), THF, 10 min, rt | decomposed |
| 5 | NBS (1.0 eq), $CH_3CN$, 16 h, rt | SM[c] |
| 6 | NBS (1.1 eq), $CH_2Cl_2$, pyridine (150 eq), 50 min, rt | SM[c] |

[a]The concentration of **B-S5** in THF was 4 mM for entries 1–5 and 5.5 mM for entry 6. A stock solution of NBS (0.1 M in THF) was used for all entries. [b]Confirmed by MALDI-MS and absorption spectroscopy. [c]Starting bacteriochlorin **B-S5** was detected.

Bacteriochlorin **B-S3** bearing an extended π-electron conjugation was designed to tune the wavelength to ~800 nm. The PEG unit was incorporated at the final step via Schiff's base formation. This route entailed the preparation of a PEGylated aminooxy compound **S11** as described below (Scheme S3): (i) EDC-mediated coupling reaction of a Boc-protected aminooxy

carboxylic acid (**S8**) with $PEG_8$-amine **S9** to afford compound **S10** in 71% yield, and (ii) cleavage of the Boc group to give **S11** in 69% yield. Both **S10** and **S11** were used directly for the next step without column chromatography purification.




**Scheme S3.** Synthesis of a PEGylated bacteriochlorin.

A model study of the reactivity of the 3-oxopropenyl substituent toward the aminooxy group was examined with known bacteriochlorin **B-S6**[S3] and **S11**. The resulting mixture consisted of the starting bacteriochlorin **B-S6**, mono-oxime (structure not shown) and di-oxime product **B-S7** (Scheme S3 and Table S4). Variation of the reaction conditions did not improve

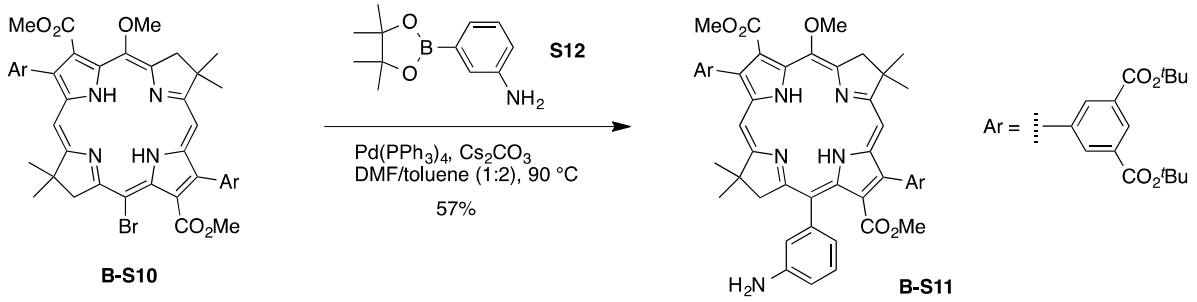
the product yield (Table S4). Silica column chromatography was not effective in separating the three components, either. A second problem for this route was the unexpected Pd-insertion during the Suzuki coupling reaction at the bacteriochlorin 15-position for the introduction of a bioconjugatable tether. The Pd-metalated bacteriochlorin is undesirable because of a short-lived fluorescence lifetime, precluding any further photophysical studies or applications. Treatment with 80% TFA in dichloromethane was not successful in removing the chelated palladium. By contrast with the Pd-metalated bacteriochlorin, zinc bacteriochlorins typically exhibit satisfactory fluorescence properties. Accordingly, the bacteriochlorin was subjected to zinc metalation, following by Suzuki coupling at the 15-position; however, the bacteriochlorin decomposed during the Suzuki coupling step as determined by MALDI-MS and absorption spectroscopy. In short, derivatization of the 3-oxopropenyl substituent was not achieved.

**Table S4.** Reaction conditions for oxime formation.[a]

| Entry | Catalyst | Solvent[c] | Temp. | Results[d] |
|---|---|---|---|---|
| 1 | aniline (100 eq) | $CH_2Cl_2$/DMSO/$NH_4OAc$ = 2:1:0.2 | rt | 1:1:1 |
| 2 | aniline (500 eq) | $CH_2Cl_2$ | rt to 60 °C | 1:2:3 |
| 3 | N/A | $CH_2Cl_2/C_2H_5OH$ = 1:1 | 80 °C | 1:1:1 |
| 4[b] | N/A | $NH_4OAc/CH_2Cl_2$ = 1:1 | rt | 1:2:3 |

[a]10 mM of bacteriochlorin **B-S6** and ~20 equiv of **S11**. [b]Starting bacteriochlorin is the product mixture from entry 2. [c]$NH_4OAc$ buffer: pH 4.5, 100 mM. [d]**B-S6**/mono-oxime/**B-S7**.

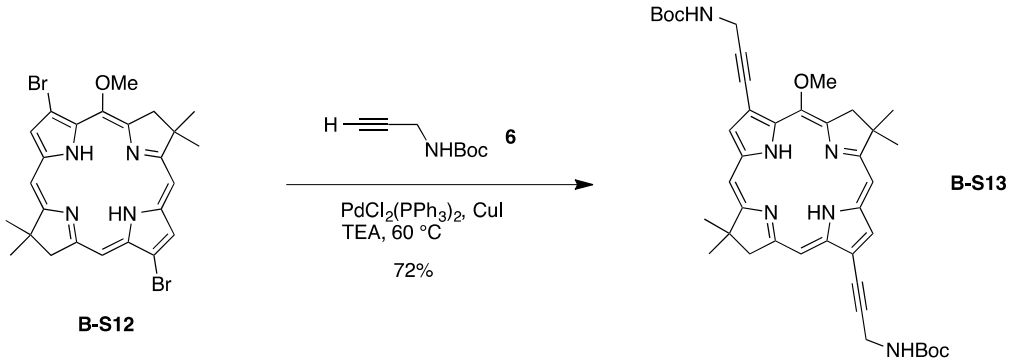
Bacteriochlorin **B-S11** was initially designed as an intermediate for elaboration to a water-soluble bioconjugatable bacteriochlorin (Scheme S4). The Suzuki coupling reaction of dibromobacteriochlorin **B-S10**[38] and **S12** proceeded smoothly. The position of the $Q_y$ absorption band of **B-S11** (742 nm) was quite close to several other bacteriochlorins,[38] however, so further exploration was not pursued.




**Scheme S4.** Synthesis of a versatile bacteriochlorin building block.

Bacteriochlorin **B-S13** was designed to prepare a water-soluble bacteriochlorin by quaternization of two primary amines (Scheme S5). The Sonogashira coupling reaction of dibromobacteriochlorin **B-S12**[12] and ethyne **6** proceeded smoothly. However, studies in

parallel revealed that even four ammonium units on a bacteriochlorin did not afford the desirable water-solubility.[15]




**Scheme S5.** Synthesis of a versatile bacteriochlorin building block.

**Non-commercial compounds.** Compounds **S1**,[11] **S2**,[S4] **B-S6**,[S3] **B-S10**,[38] and **B-S12**[12] were prepared as described in the literature.

***tert*-Butyl 6-heptynoate.** A mixture of 6-heptynoic acid (**17**, 1.0 g, 7.9 mmol), di-*tert*-butyl dicarbonate (2.3 g, 10 mmol) and $MgCl_2$ (75 mg, 0.79 mmol) in *tert*-butyl alcohol (4.0 mL) was stirred under argon for 16 h. The crude reaction mixture was diluted with water and extracted with ethyl acetate. The organic extract was dried ($Na_2SO_4$), concentrated and chromatographed [silica, hexanes/ethyl acetate (24:1)] to afford a viscous colorless liquid (0.98 g, 68%): $^1$H NMR (400 MHz, $CDCl_3$) δ 1.48 (s, 9H), 1.50–1.59 (m, 2H), 1.67–1.74 (m, 2H), 1.95–1.96 (m, 1H), 2.19–2.26 (m, 4H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 18.4, 24.4, 28.1, 28.3, 35.2, 68.7, 80.3, 84.3, 173.0; ESI-MS obsd 205.1199, calcd 205.1196 [$(M + Na)^+$, M = $C_{11}H_{18}O_2$].

**2-[3,5-Bis(*tert*-butoxycarbonylaminomethyl)phenyl]-1-trimethylsilylacetylene (S4).** Following a reported procedure,[S1] a mixture of **S2** (1.0 g, 2.4 mmol), $Pd(PPh_3)_4$ (80 mg, 0.07 mmol, 0.03 equiv) and $ZnBr_2$ (0.40 g, 1.8 mmol, 0.67 equiv) was dried and deaerated under high vacuum for 30 min in a Schlenk flask. A mixture of THF/triethylamine [12 mL (2:1), bubbled with argon for 30 min] was added, and the resulting mixture was deaerated by two freeze-pump-thaw cycles. Trimethylsilylacetylene (**S3**, 1.0 mL) was added, and the reaction mixture was subjected to a third freeze-pump-thaw cycle. The reaction mixture was stirred at 60 °C for 2 days. The resulting mixture was allowed to cool to room temperature, washed with brine and water, and dried over $Na_2SO_4$. After removal of the solvent under vacuum, hexanes (10 mL) was added. The resulting suspension was sonicated (2 min) and centrifuged. The supernatant was discarded to afford a brown solid (0.70 g, 63%): mp 169–170 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 0.24 (s, 9H), 1.46 (s, 18H), 4.28 (s, 4H), 4.84 (s, 2H), 7.16 (s, 1H), 7.30 (s, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 28.5, 44.2, 80.0, 95.0, 104.5, 124.0, 127.1, 130.2, 140.2, 156.3; ESI-MS obsd 455.2335, calcd 455.2337 [$(M + Na)^+$, M = $C_{23}H_{36}N_2O_4Si$].

**[3,5-Bis(*tert*-butoxycarbonylaminomethyl)phenyl]acetylene (S5).** Following a reported procedure,[S2] a mixture of **S4** (0.66 g, 1.5 mmol) and $K_2CO_3$ (0.50 g, 3.6 mmol, 2.4 equiv) in MeOH/$CH_2Cl_2$ (6.6 mL, 1:1) was stirred at room temperature for 2 h. Water was added to the reaction mixture, and the resulting solution was extracted with $CH_2Cl_2$. The combined extract was washed with water, dried ($Na_2SO_4$), concentrated under vacuum, and

chromatographed [silica, $CH_2Cl_2$/ethyl acetate (10:1 to 5:1)] to yield a pale white solid (0.37 g, 67%): mp 132–133 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 1.45 (s, 18H), 3.05 (s, 1H), 4.26 (d, $J$ = 5.6 Hz, 4H), 4.92 (s, 2H), 7.16 (s, 1H), 7.29 (s, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 29.0, 44.2, 79.2, 80.0, 83.8, 123.0, 127.2, 130.2, 140.3, 156.3; ESI-MS obsd 383.1939, calcd 383.1941 [(M + Na)$^+$, M = $C_{20}H_{28}N_2O_4$].

**2-*tert*-Butoxycarbonylaminooxy-*N*-(2,5,8,11,14,17,20,23-octaoxapentacosan-25-yl)–acetamide (S10).** A mixture of carboxylic acid **17** (287 mg, 1.50 mmol) and EDC (288 mg, 1.50 mmol) in $CH_2Cl_2$ (3.00 mL) was stirred for 5 min, followed by addition of amine **S9** (575 mg, 1.5 mmol) and TEA (209 μL, 1.50 mmol). The reaction mixture was stirred at room temperature for 16 h. The reaction mixture was diluted with $CH_2Cl_2$ and washed one time with saturated $NaHCO_3$ solution and then with 2 N HCl solution. The organic phase was separated and dried ($MgSO_4$) to afford a colorless oil (595 mg, 71%): $^1$H NMR (300 MHz, $CDCl_3$) δ 1.48 (s, 9H), 3.38 (s, 3H), 3.50–3.66 (m, 32H), 4.33 (s, 2H), 7.92 (br, 1H), 8.32 (s, 1H); $^{13}$C NMR (75 MHz, $CDCl_3$) δ 28.4, 39.1, 59.2, 69.7, 70.2, 70.6, 70.69, 70.74, 72.1, 76.0, 82.5, 157.7, 169.3; ESI-MS obsd 557.3272, calcd 557.3280 [(M + H)$^+$, M = $C_{24}H_{48}N_2O_{12}$].

**2-Aminooxy-*N*-(2,5,8,11,14,17,20,23-octaoxapentacosan-25-yl)acetamide (S11).** A sample of **S10** (162 mg, 0.290 mmol) in $CH_2Cl_2$ (1.00 mL) was stirred under argon for 2 min, followed by the addition of TFA (1.00 mL). After 1 h, the solvent was removed with a stream of argon, and the reaction residue was washed with saturated aqueous $NaHCO_3$. The organic layer was separated, dried ($Na_2SO_4$) and concentrated to afford a colorless oil (92.0 mg, 69%): $^1$H NMR (300 MHz, $CDCl_3$, the two amine protons were not observed) δ 3.38 (s, 3H), 3.51–3.66 (m, 31H), 4.14 (s, 2H), 5.95 (s, 1H), 6.99 (br, 1H); $^{13}$C NMR (75 MHz, $CDCl_3$) δ 38.8, 59.3, 69.9, 70.2, 70.5, 70.8, 72.2, 75.2, 76.3, 170.4; ESI-MS obsd 457.2756, calcd 457.2756 [(M + H)$^+$, M = $C_{19}H_{40}N_2O_{10}$].

**3,13-Dimethoxycarbonyl-2,12-bis[2-(3,5-bis(*tert*-butoxycarbonylaminomethyl)–phenyl)ethynyl]-5-methoxy-8,8,18,18-tetramethylbacteriochlorin (B-S5).** Following a reported procedure,[35] a mixture of **2** (4.0 mg, 3.2 μmol), $Pd(PPh_3)_2Cl_2$ (1.0 mg, 1.5 μmol, 0.20 equiv) and **S5** (8.0 mg, 24 μmol, 4.0 equiv) was dried and deaerated under high vacuum in a Schlenk flask for 1 h. DMF (0.80 mL) and triethylamine (0.40 mL) (bubbled with argon for 1 h for each) were added, and the resulting mixture was deaerated by three freeze-pump-thaw cycles. The reaction mixture was stirred at 80 °C for 4 h. The reaction mixture was allowed to cool to room temperature and then washed with brine and water. The organic layer was separated, dried ($Na_2SO_4$), concentrated to dryness and chromatographed [silica, $CH_2Cl_2$/ethyl acetate (5:1 to 2:1)] to afford a red solid (3.0 mg, 41%): $^1$H NMR (300 MHz, $CDCl_3$) δ −1.18 (s, 1H), −0.89 (s, 1H), 1.52 (s, 36H), 1.95 (s, 6H), 1.97 (s, 6H), 4.25 (s, 3H), 4.32−4.34 (m, 9H), 4.45 (s, 8H), 5.04 (s, 4H), 7.31 (s, 2H), 7.65 (s, 2H), 7.70 (s, 2H), 8.77 (s, 1H), 8.92 (s, 1H), 9.55 (s, 1H) ; $^{13}$C NMR (100 MHz, $CDCl_3$) δ 28.7, 31.0, 31.2, 44.6, 46.0, 46.3, 47.9, 51.6, 52.4, 53.5, 64.6, 80.0, 82.9, 85.5, 95.8, 97.5, 98.9, 99.2, 101.0, 115.5, 118.0, 120.7, 124.0, 124.5, 127.0, 127.2, 128.8, 130.0, 135.7, 135.7, 135.9, 137.2, 140.3, 156.2, 157.9, 162.8, 165.8, 167.8, 170.6, 173; MALDI-MS obsd 1234.2789; ESI-MS obsd 1233.6212, calcd 1233.6231 [(M + H)$^+$, M = $C_{69}H_{84}N_8O_{13}$]; $\lambda_{abs}$ ($CH_2Cl_2$) 383, 553, 791 nm.

**15-Bromo-2,12-bis(3-oxoprop-1-enyl)-3,13-dimethoxycarbonyl-5-methoxy-8,8,18,18-tetramethylbacteriochlorin (B-S8).** Following a standard procedure,[11] a solution of **B-S6** (5.8 mg, 9.3 μmol) in dry THF (3.1 mL) was treated dropwise (10 min) with a solution of NBS (11 mg, 6.0 equiv) in dry THF (0.56 mL), and the resulting mixture was stirred at room temperature

under argon for 1 h. The reaction mixture was diluted with $CH_2Cl_2$ and washed with saturated aqueous $NaHCO_3$. The organic layer was separated, dried ($Na_2SO_4$) and concentrated. Column chromatography [silica, $CH_2Cl_2$/ethyl acetate (50:1 to 25:1)] afforded a red solid (1.3 mg, 20%): $^1$H NMR (300 MHz, $CDCl_3$) δ –0.83 (s, 1H), –0.58 (s, 1H), 1.92 (s, 6H), 1.93 (s, 6H), 4.21 (s, 3H), 4.28 (s, 3H), 4.29 (s, 2H), 4.31 (s, 3H), 4.36 (s, 2H), 7.19 (dd, *J* = 16.2, 7.5 Hz, 2H), 8.54 (s, 1H), 8.63 (s, 1H), 8.70 (d, *J* = 16.2 Hz, 2H), 10.07 (t, *J* = 7.5 Hz 2H); MALDI-MS obsd 702.2023, calcd 703.1762 [$(M + H)^+$, M = $C_{35}H_{35}BrN_4O_7$]; $\lambda_{abs}$ ($CH_2Cl_2$) 345, 393, 787 nm.

**15-[4-(2-(*tert*-Butoxycarbonyl)ethyl)phenyl]-2,12-bis(3-oxoprop-1-enyl)-3,13-dimeth –oxycarbonyl-5-methoxy-8,8,18,18-tetramethylbacteriochlorin (B-S9).** Samples of **B-S8** (6.0 mg, 8.5 μmol), $Pd(PPh_3)_4$ (3.9 mg, 3.4 μmol), $Cs_2CO_3$ (11 mg, 34 μmol) and **12** (11 mg, 34 μmol) were placed in a Schlenk flask, and the resulting mixture was deaerated under high vacuum for 1 h. Toluene/DMF [0.8 mL (2:1, deaerated by bubbling with argon for 1 h] was added to the Schlenk flask under argon and deaerated by three freeze-pump-thaw cycles. The reaction mixture was stirred at 90 °C for 16 h. The reaction mixture was cooled to room temperature, concentrated to dryness, diluted with ethyl acetate and washed with saturated aqueous $NaHCO_3$. The organic layer was separated, dried ($Na_2SO_4$), concentrated and chromatographed [silica, $CH_2Cl_2$/ethyl acetate (50:1 to 25:1)] to provide a red solid (3.0 mg, 38%): MALDI-MS obsd 931.0782, calcd 933.2685 [$(M+H)^+$, M = $C_{48}H_{50}N_4O_9Pd$]; $\lambda_{abs}$ ($CH_2Cl_2$) 339, 380, 561, 800 nm. $^1$H NMR spectroscopy was tried, but an informative spectrum was not obtained.

**15-(3-Aminophenyl)-2,12-bis[3,5-bis(*tert*-butoxycarbonyl)phenyl]-3,13-dimethoxy– carbonyl-5-methoxy-8,8,18,18-tetramethylbacteriochlorin (B-S11).** Following a general procedure,[S5] samples of **B-S10** (9.2 mg, 8.0 μmol), Suzuki coupling partner **S12** (8.8 mg, 40 μmol), $Pd(PPh_3)_4$ (2.8 mg, 2.4 μmol), $K_2CO_3$ (13 mg, 96 μmol) and toluene/DMF [0.80 mL (2:1, deaerated by bubbling with argon for 45 min] were added to a Schlenk flask, whereupon the mixture was deaerated by three freeze-pump-thaw cycles. The reaction mixture was stirred at 90 °C for 20 h. The reaction mixture was cooled to room temperature, concentrated to dryness, diluted with $CH_2Cl_2$ and washed with saturated aqueous $NaHCO_3$. The organic layer was separated, dried ($Na_2SO_4$) and concentrated. Column chromatography [twice, silica, $CH_2Cl_2$/ethyl acetate (47:3)] afforded a red solid (5.5 mg, 62%): $^1$H NMR ($CDCl_3$, 300 MHz) δ –1.40 (br, 1H), –1.09 (br, 1H), 1.64 (s, 18H), 1.66 (s, 18H), 1.74 (s, 3H), 1.77 (s, 3H), 1.83 (s, 3H), 1.85 (s, 3H), 3.52 (s, 3H), 3.86 (s, 2H), 4.20 (s, 3H), 4.30 (s, 3H), 4.37 (s, 2H), 6.93 (d, *J* = 2.4 Hz, 1H), 7.10 (s, 2H), 7.41 (t, *J* = 2.4 Hz, 1H), 8.50 (s, 1H), 8.60 (s, 1H), 8.75 (d, *J* = 1.8 Hz, 2H), 8.86 (s, 1H), 8.88 (s, 1H), 8.90 (d, *J* = 1.8 Hz, 2H), the two pyrrolic protons were not observed; MALDI-MS obsd 1161.8424; ESI-MS MS obsd 1060.5585, calcd 1060.5591 [$(M + H)^+$, M = $C_{67}H_{77}N_5O_{13}$]; $\lambda_{abs}$ ($CH_2Cl_2$) 374, 527, 742 nm.

**3,13-Bis[3-(*N*-*tert*-butoxycarbonylamino)prop-1-ynyl]-5-methoxy-8,8,18,18-tetra– methylbacteriochlorin (B-S13).** Following a general procedure,[37] samples of **B-S12** (22 mg, 40 μmol), Sonogashira coupling partner **6** (62 mg, 0.40 mmol), $PdCl_2(PPh_3)_2$ (5.6 mg, 8.0 μmol) and TEA (2.0 mL, deaerated by bubbling with argon for 45 min) were added to a Schlenk flask, whereupon the mixture was deaerated by three freeze-pump-thaw cycles. The reaction mixture was stirred at 60 °C for 18 h. The reaction mixture was cooled to room temperature, concentrated to dryness, diluted with $CH_2Cl_2$ and washed with saturated aqueous $NaHCO_3$. The organic layer was separated, dried ($Na_2SO_4$) and concentrated. Column chromatography [silica, $CH_2Cl_2$/TEA (99:1 to 49:1)] afforded a green solid (5.5 mg, 72%): $^1$H NMR ($CDCl_3$, 300 MHz) δ –1.86 (br, 1H), –1.66 (br, 1H), 1.56 (s, 9H), 1.57 (s, 9H), 1.92 (s, 12H), 4.38–4.41 (m,

7H), 4.57 (br, 4H), 5.12 (br, 2H), 8.49 (s, 1H), 8.50 (s, 1H), 8.68 (d, $J$ = 1.5 Hz, 1H), 8.70 (d, $J$ = 1.5 Hz, 1H), 8.80 (s, 1H); $^{13}$C NMR ($CDCl_3$, 100 MHz) δ 28.7, 31.0, 31.2, 45.7, 45.9, 51.9, 64.7, 78.3, 80.7, 89.6, 92.8, 96.5, 97.3, 97.6, 111.9, 116.5, 125.0, 125.8, 131.4, 134.3, 135.6, 135.9, 138.4, 154.8, 161.4, 170.0, 170.6; MALDI-MS obsd 708.1287; ESI-MS obsd 706.3841, calcd 706.3837 [M = $C_{61}H_{80}N_8O_9$]; $\lambda_{abs}$ ($CH_2Cl_2$) 354, 365, 376, 518, 743 nm.

## 3. Additional Photophysics Studies

A relatively low quantum yield of **B5** (0.017) was observed in neat water, compared with a value of 0.075 in DMSO. This diminution upon examination in aqueous solution was also observed with hydrophilic chlorins[S6] and bacteriochlorins.[43] Herein, **B5** was examined in seven different solvents with distinct dielectric constants, and quantum yields were calculated using 2,12-di-*p*-tolyl-5-methoxybacteriolchlorin in toluene ($\Phi_f$ = 0.18) as the standard. The results are listed in Table S5. The highest $\Phi_f$ value (0.082) was obtained in toluene, which is the least polar solvent among those screened, while the lowest $\Phi_f$ (0.016) was obtained in water.

**Table S5.** Solvent effects on the fluorescence properties of **B5**.

| Solvent | Dielectric constant | Absorption | | Emission | | $\Phi_f$ |
|---|---|---|---|---|---|---|
| | | $\lambda_{max}$ (nm) | fwhm (nm) | $\lambda_{max}$ (nm) | fwhm (nm) | |
| Toluene | 2.4 | 811 | 33 | 820 | 30 | 0.082 |
| $CH_2Cl_2$ | 8.9 | 810 | 35 | 821 | 30 | 0.054 |
| $CH_3OH$ | 33 | 806 | 36 | 819 | 38 | 0.044 |
| DMSO | 47 | 810 | 34 | 821 | 34 | 0.075 |
| $H_2O$ | 80 | 819 | 42 | 831 | 34 | 0.017 |
| $D_2O$ | 80 | 819 | 43 | 832 | 36 | 0.025 |
| Formamide | 111 | 816 | 39 | 827 | 34 | 0.043 |

The absorption and emission spectra of **8** in DMF are shown in Figure S2.

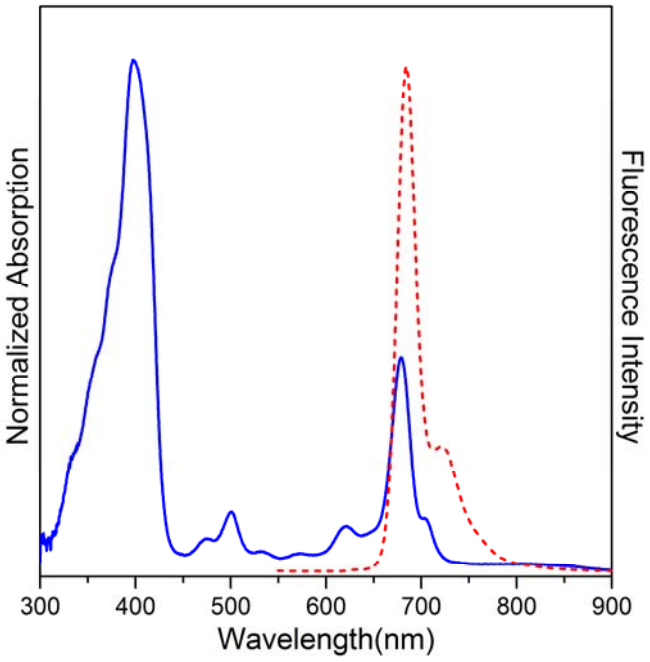



**Figure S2.** Absorption (solid) and fluorescence (dashed) spectra for **8** in DMF. The fluorescence was obtained using excitation at the Soret maximum.

## 4. Flow Cytometry Data

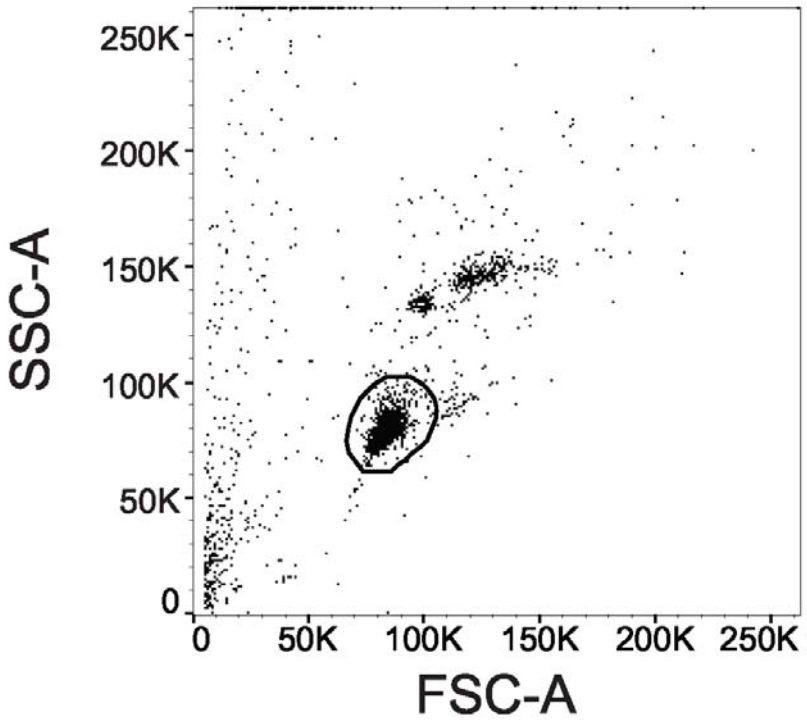



**Figure S3.** Dot plot of side-scattered light (SSC) versus forward-scattered light (FSC), which provide a measure of granularity and size, respectively. Selection of beads for subsequent analyses was achieved by gating around the major population of single beads, as shown.

## 5. References


S1 A. Florian, M. J. Mayoral, V. Stepanenko and G. Fernandez, *Chem. Eur. J.*, 2012, **18**, 14957–14961.

S2 H. N. Nakayama, T. Morita and S. Kimura, *J. Phys. Chem. C*, 2010, **114**, 4669–4674.

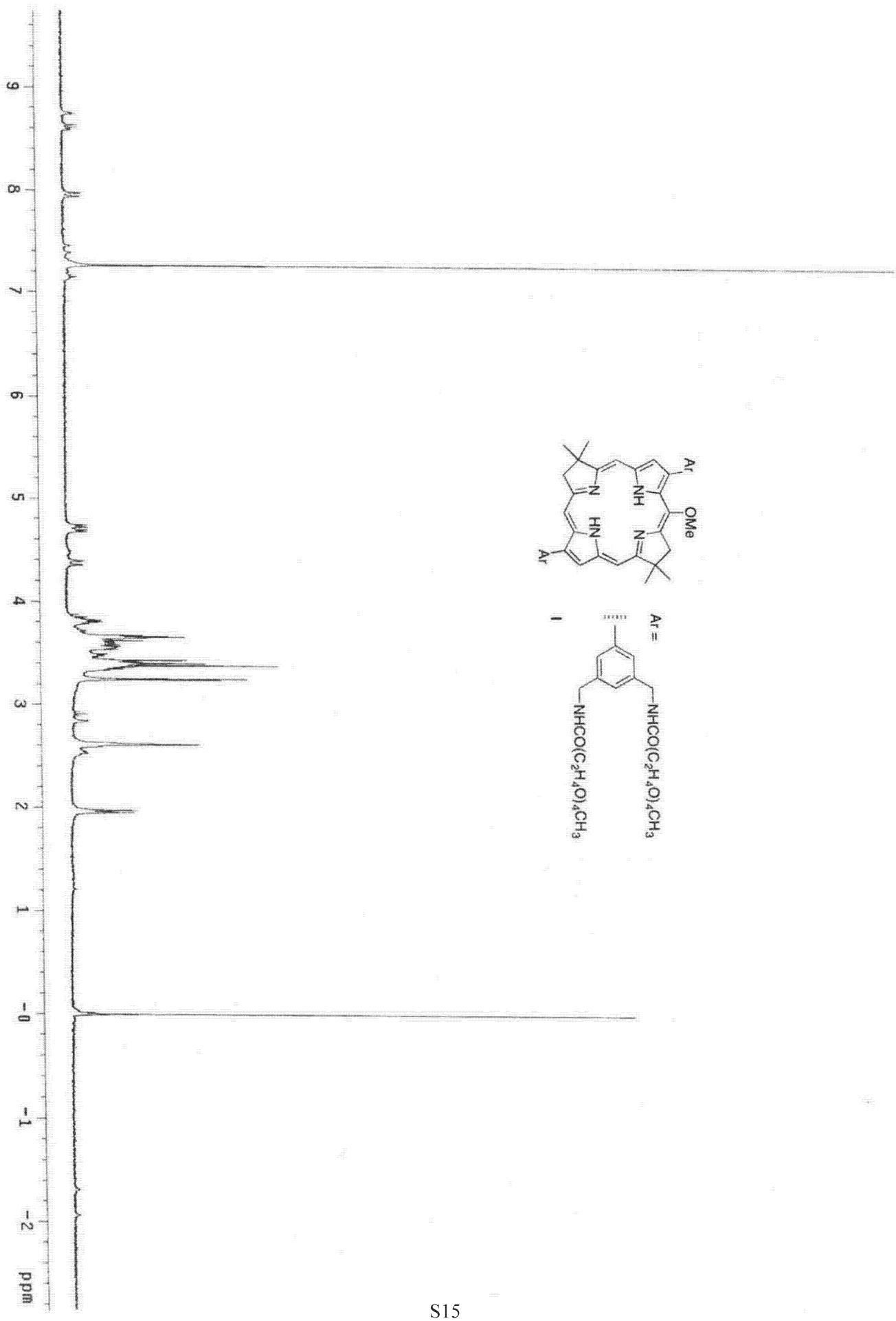
S3 E. Yang, N. Zhang, M. Krayer, M. Taniguchi, J. R. Diers, C. Kirmaier, J. S. Lindsey, D. F. Bocian and D. Holten, *Photochem. Photobiol*., 2015, **92**, 111–125.

S4 B. Sookcharoenpinyo, E. Klein, Y. Ferrand, D. B. Walker, P. R. Brotherhood, C. Ke, M. P. Crump and A. P. Davis, *Angew. Chem. Int. Ed*., 2012, **51**, 4586–4590.

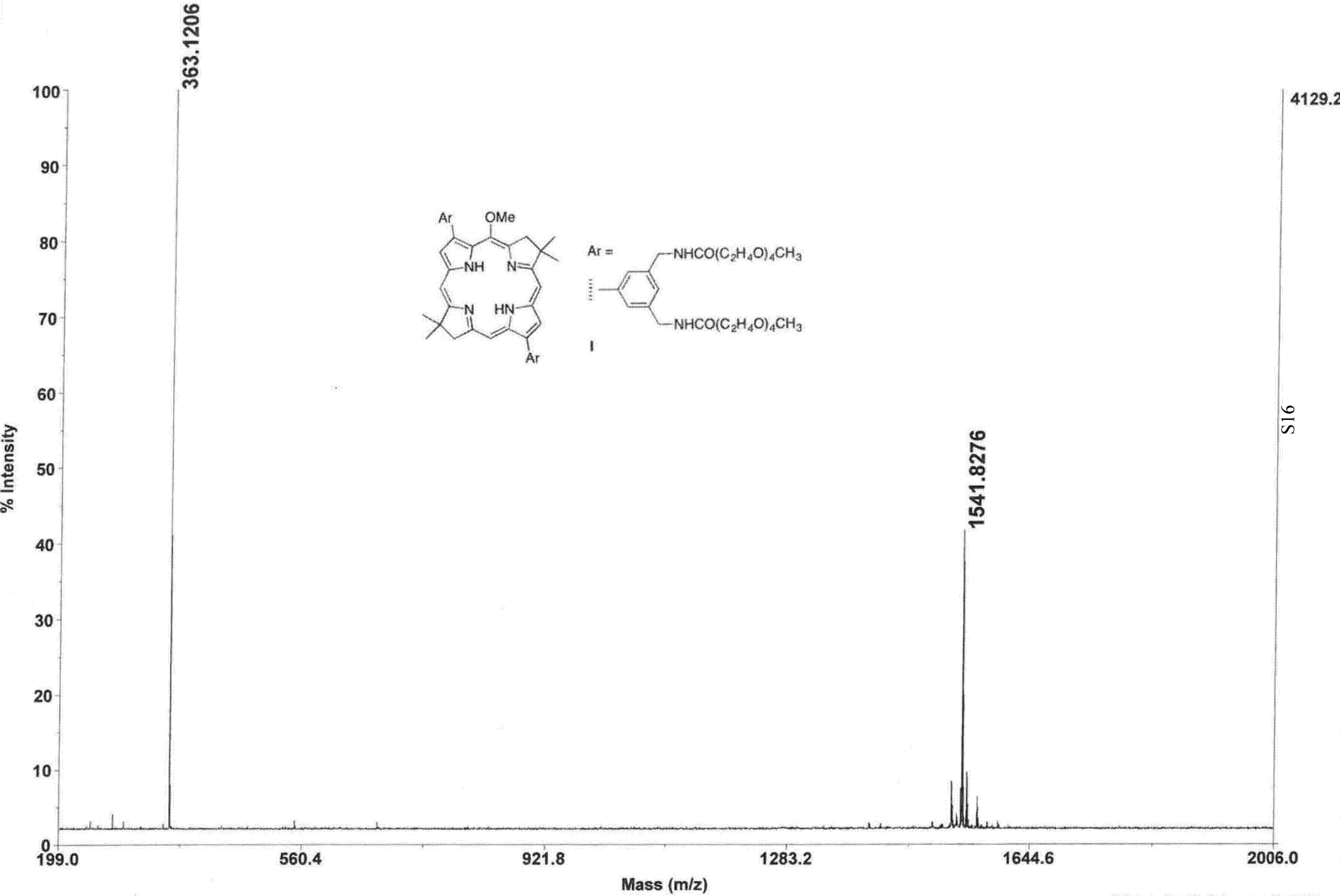
S5 K. R. Reddy, J. Jiang, M. Krayer, M. A. Harris, J. W. Springer, E. Yang, J. Jiao, D. M. Niedzwiedzki, D. Pandithavidana, P. S. Parkes-Loach, C. Kirmaier, P. A. Loach, D. F. Bocian, D. Holten and J. S. Lindsey, *Chem. Sci.* 2013, **4**, 2036–2053.

S6 K. E. Borbas, V. Chandrashaker, C. Muthiah, H. L. Kee, D. Holten and J. S. Lindsey, *J. Org. Chem*., 2008, **73**, 3145–3158.


## 6. Spectra


9
8
7
6
5
4
3
2
1
-0
-1
-2
ppm
Ar
OMe
N
NH
HN
N
Ar
I
Ar =
NHCO(C2H4O)4CH3
NHCO(C2H4O)4CH3

TOF/TOF™ Reflector Spec #1 MC[BP = 363.1, 4129]

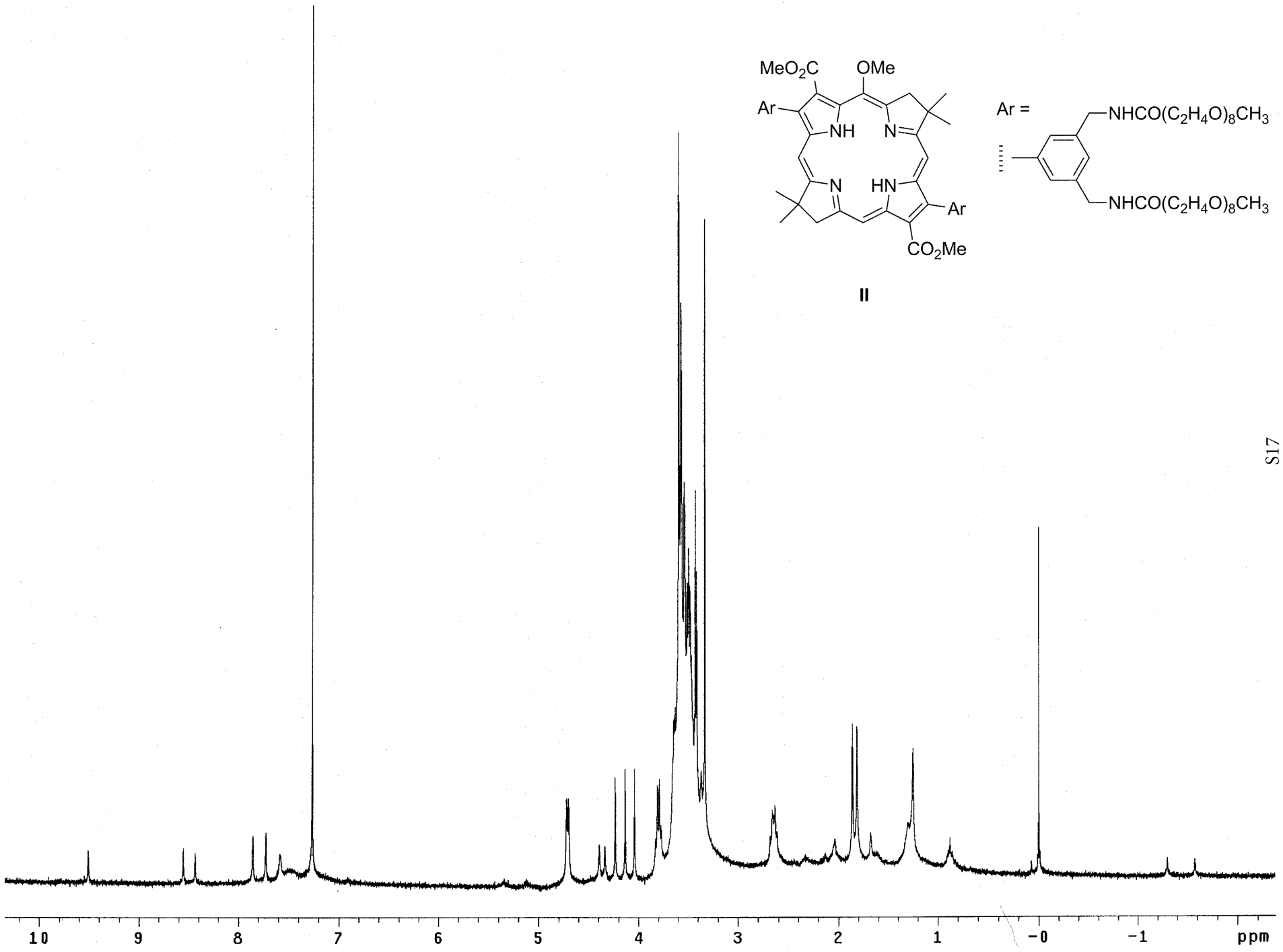



I

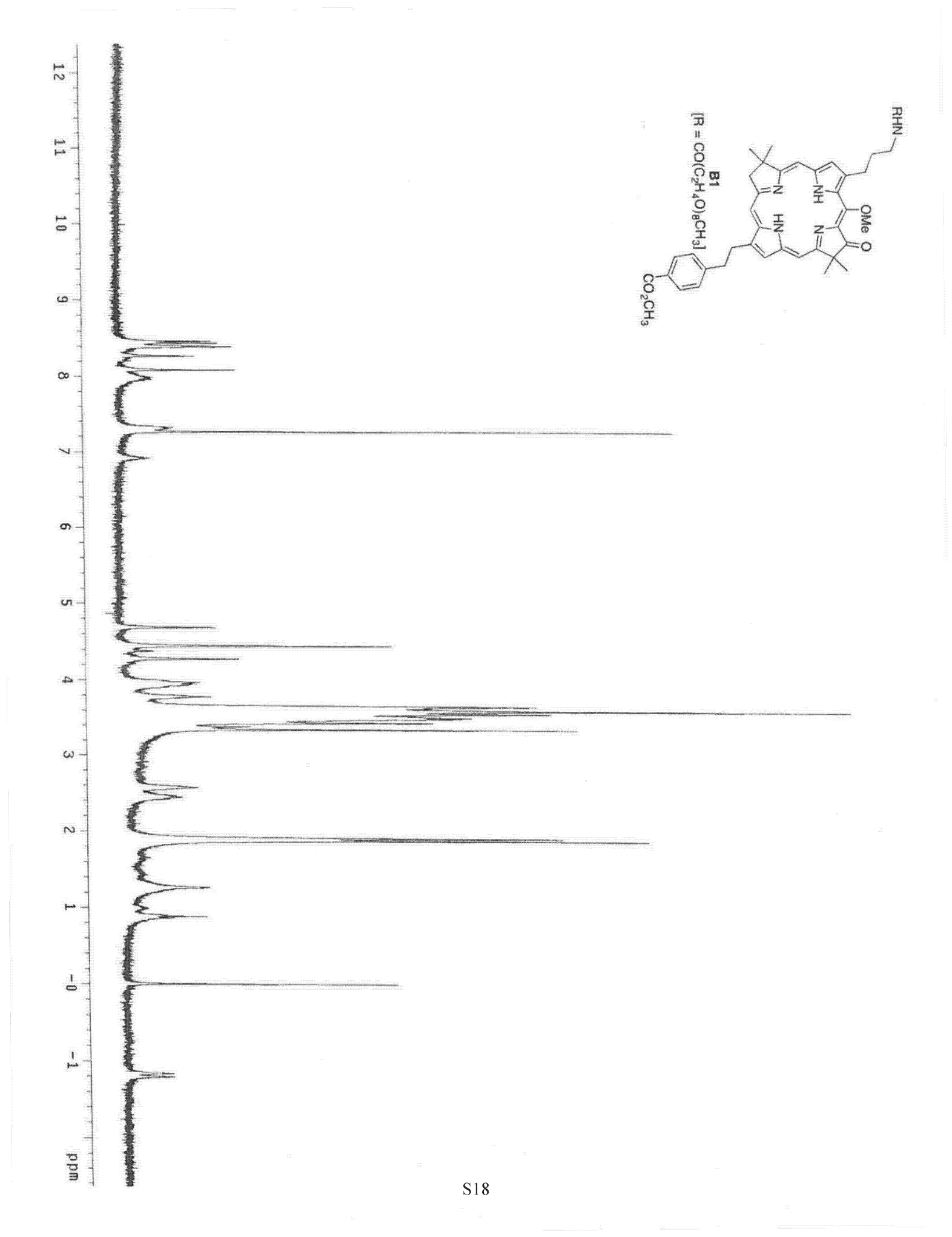


Printed: 11:40, February 13, 2014

:\AB SCIEX\TOFTOF Data\ExportT2D\User Project 1\Lindsey\JIMMY\2-14-14\G1_MS.t2d

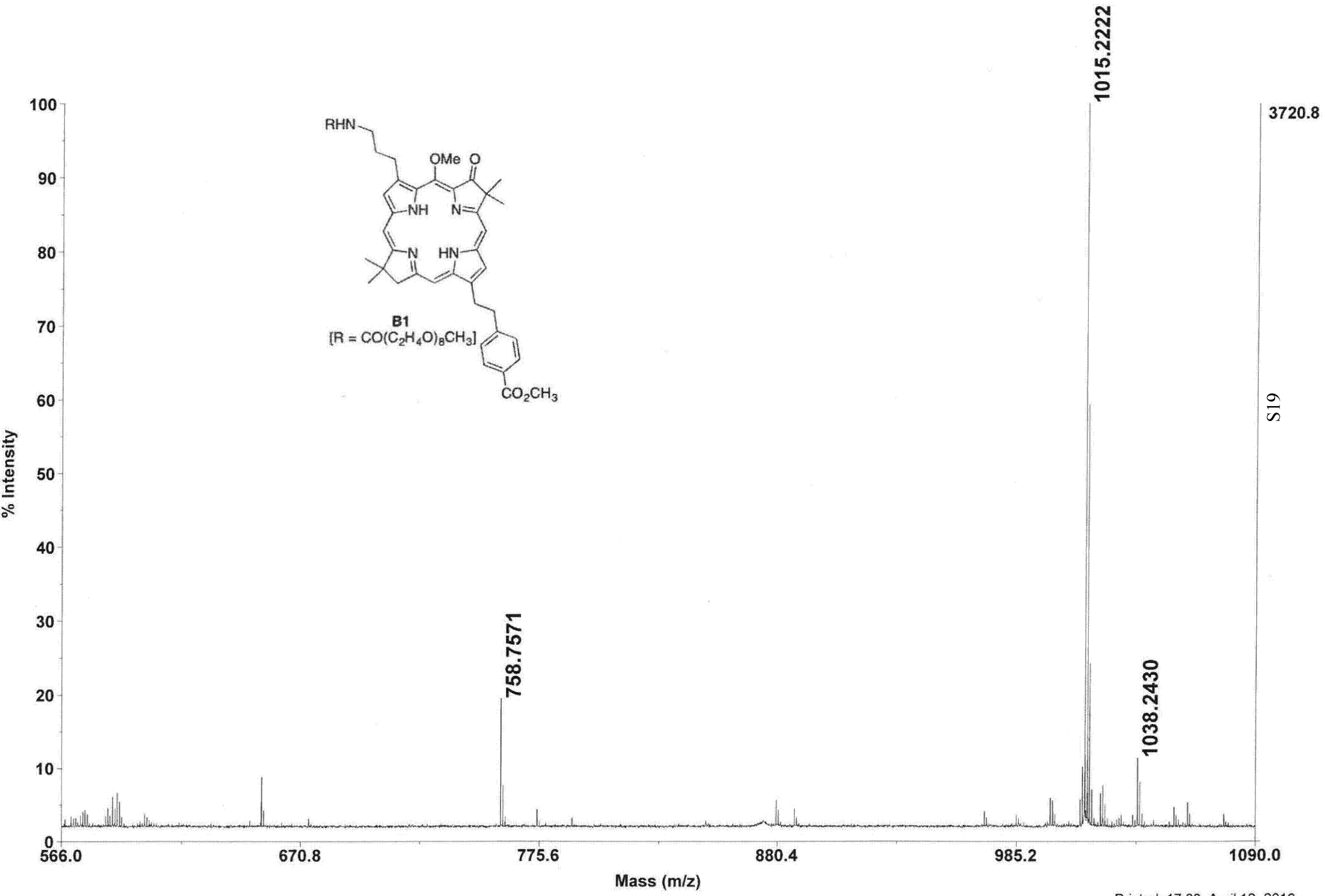

MeO2C
OMe
Ar
NH
N
N
HN
Ar
CO2Me
Ar =
NHCO(C2H4O)8CH3
NHCO(C2H4O)8CH3
10
9
8
7
6
5
4
3
2
1
-0
-1
ppm

**II**


RHN
OMe O
NH
HN
N
N
B1
[R = CO(C2H4O)8CH3]
CO2CH3
12
11
10
9
8
7
6
5
4
3
2
1
−0
−1
ppm

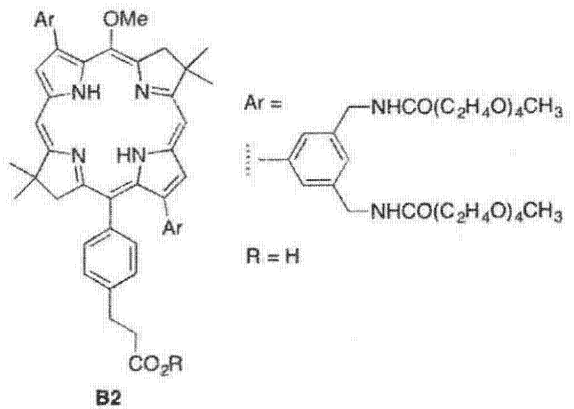
*AB Sciex TOF/TOF™ Series Explorer™ 72098*

**TOF/TOF™ Reflector Spec #1 MC[BP = 364.9, 20030]**

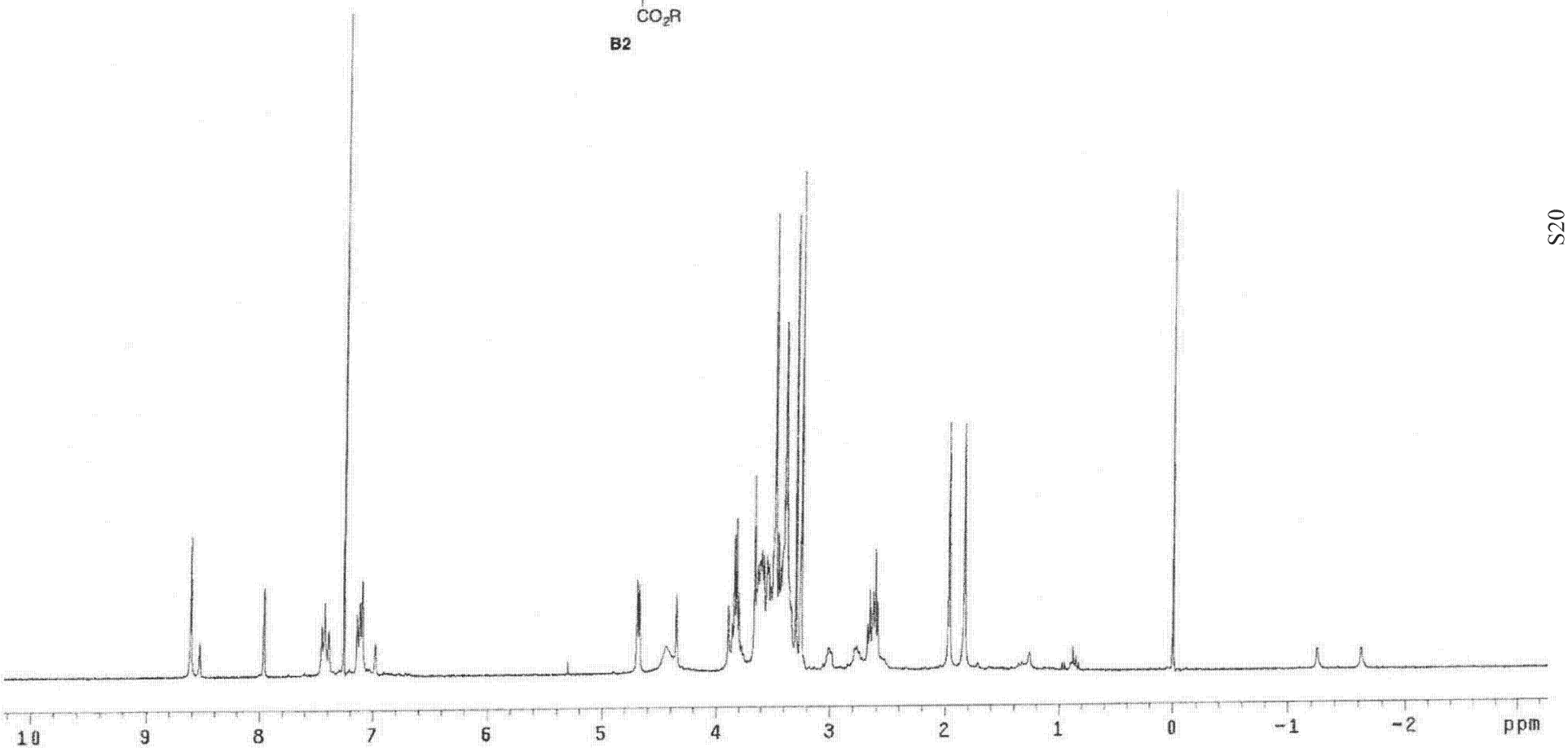




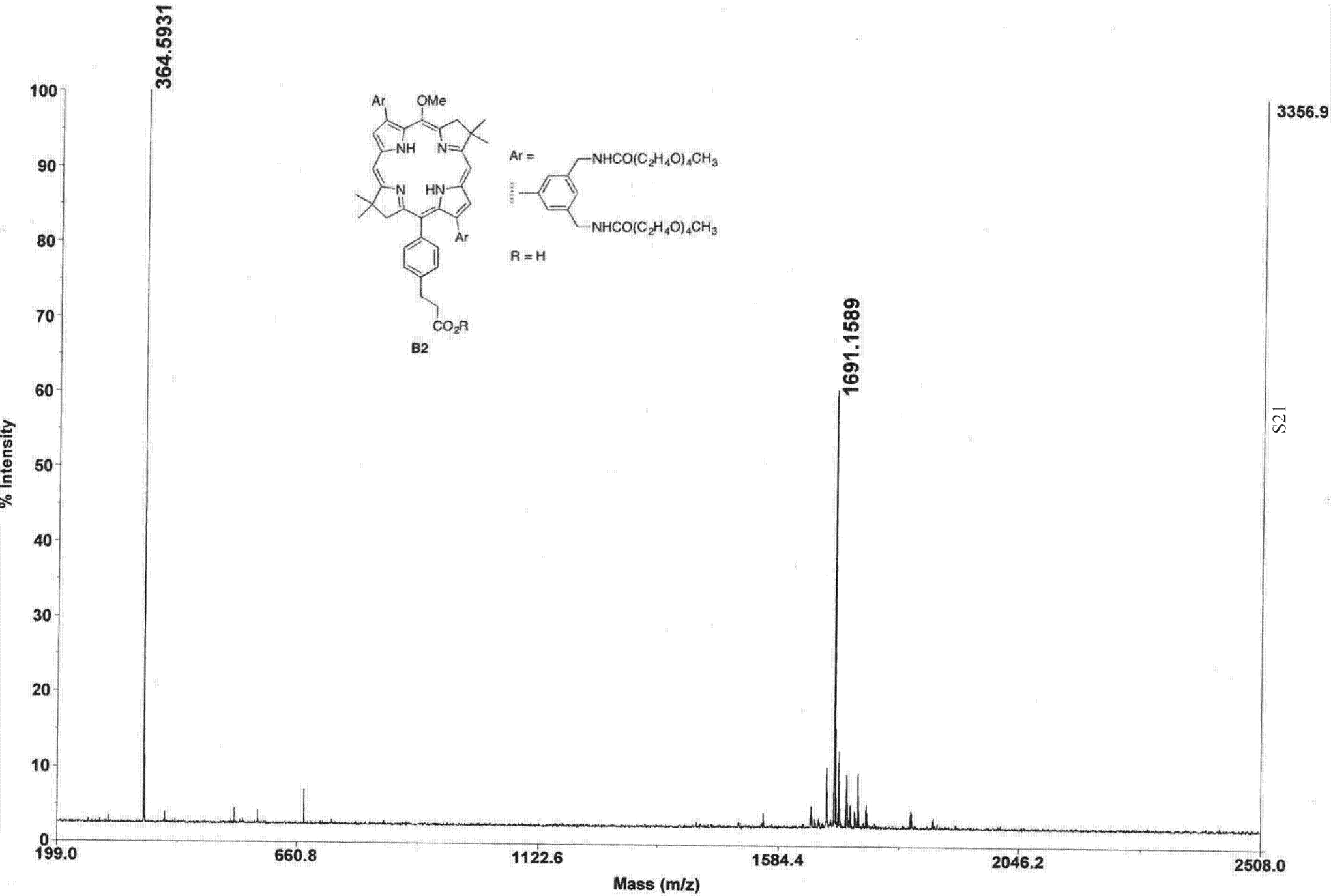

Printed: 17:00, April 12, 2016


Ar
OMe
NH
N
N
HN
Ar
CO2R
Ar =
NHCO(C2H4O)4CH3
NHCO(C2H4O)4CH3
R = H

**B2**

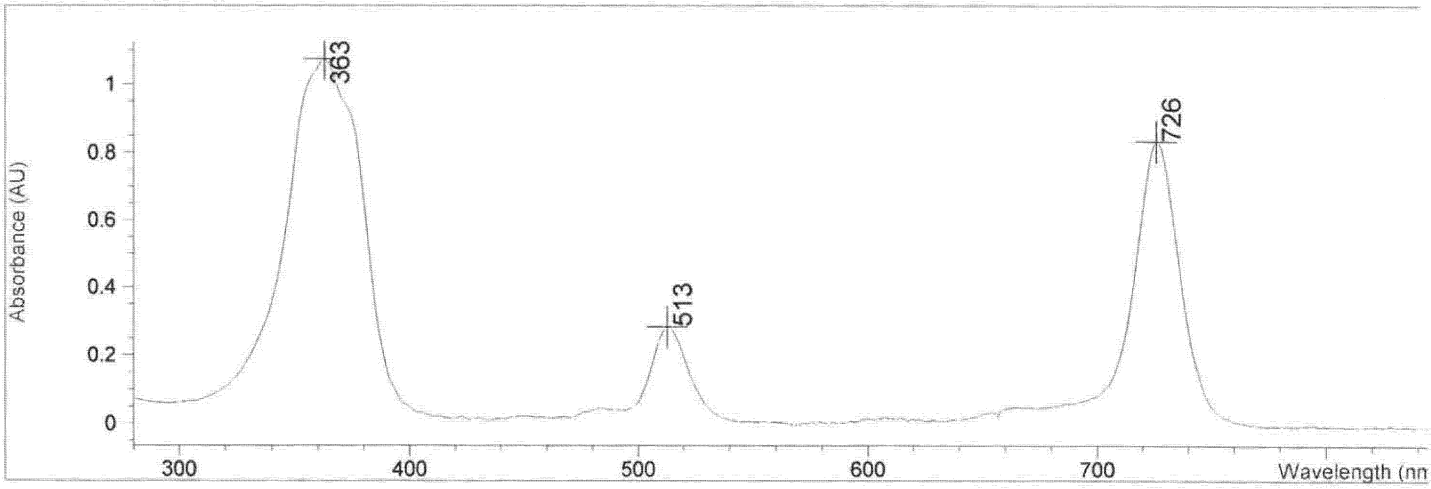

10
9
8
7
6
5
4
3
2
1
0
-1
-2
ppm

TOF/TOF™ Reflector Spec #1 MC[BP = 364.6, 3357]



Method file : <untitled>
Information : Default Method
Data File : C:\Chem32\1\DATA\JIMMY\grouped data\J121A, C-PEG4-CO2H IN WATER.SD
Created : 2/28/14 16:32:33

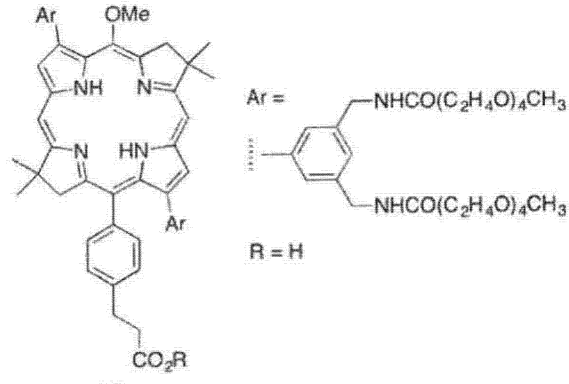
Overlaid Spectra:



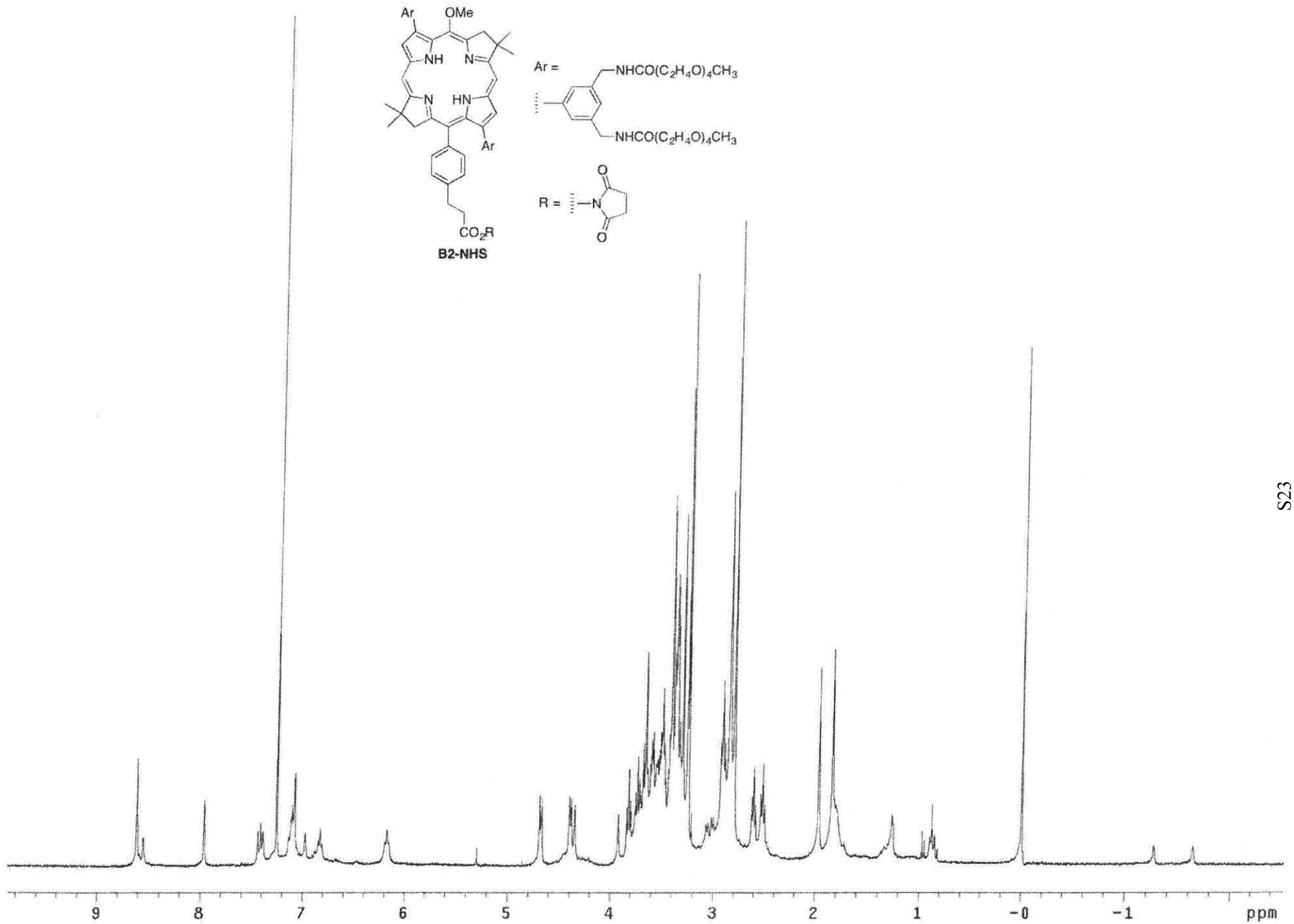

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 363.0 | 1.07390 |
| 1 | | 726.0 | 0.83307 |
| 1 | | 513.0 | 0.28301 |

Report generated by : Lindsey Lab Signature: .....

*** End Spectrum/Peak Report ***

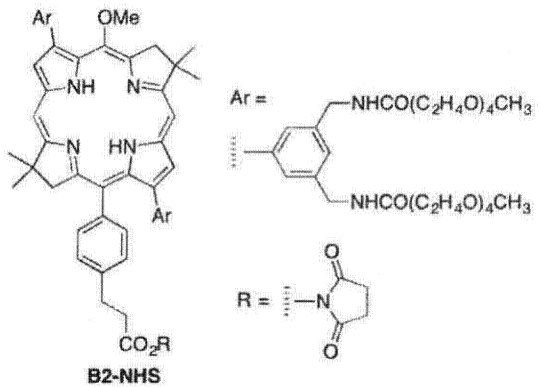



**B2**


Ar
OMe
NH
N
N
HN
Ar
CO2R
B2-NHS
Ar =
NHCO(C2H4O)4CH3
NHCO(C2H4O)4CH3
R =
O
N
O
9
8
7
6
5
4
3
2
1
-0
-1
ppm

AB Sciex TOF/TOF™ Series Explorer™ 72098

TOF/TOF™ Reflector Spec #1 MC[BP = 1788.1, 5692]




B2-NHS



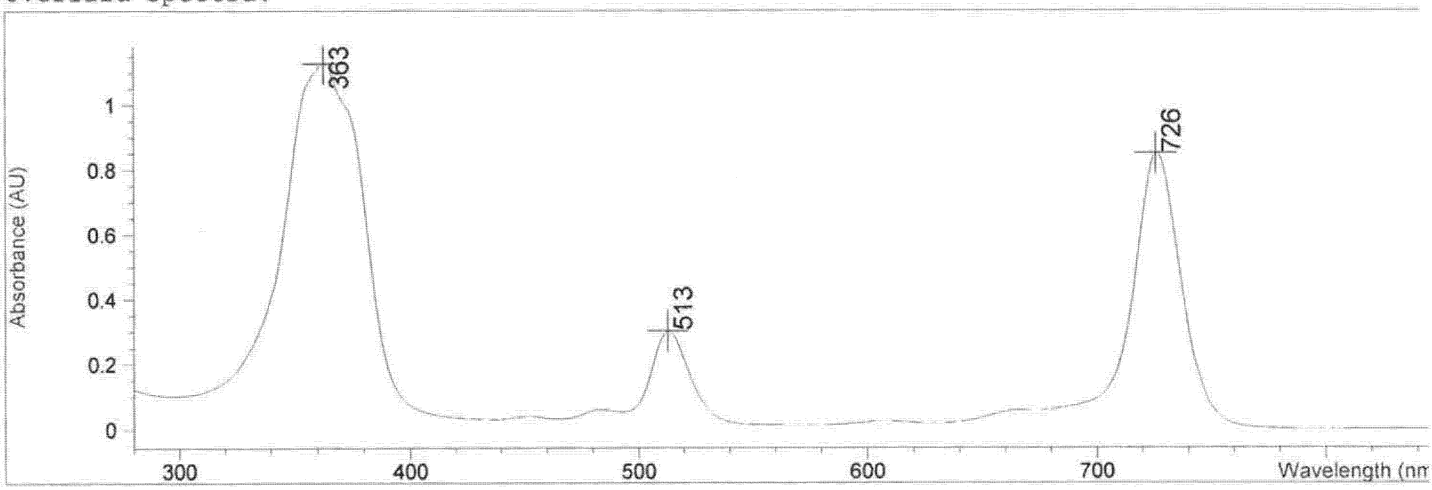




S24

Method file : <untitled>
Information : Default Method
Data File : C:\Chem32\1\DATA\JIMMY\grouped data\J122, C-PEG4-NHS IN WATER.SD
Created : 2/17/14 12:57:21

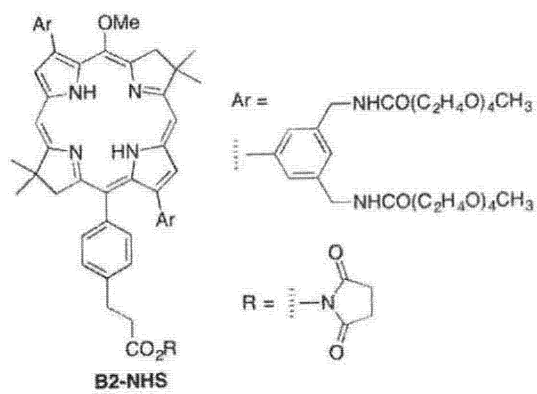
Overlaid Spectra:



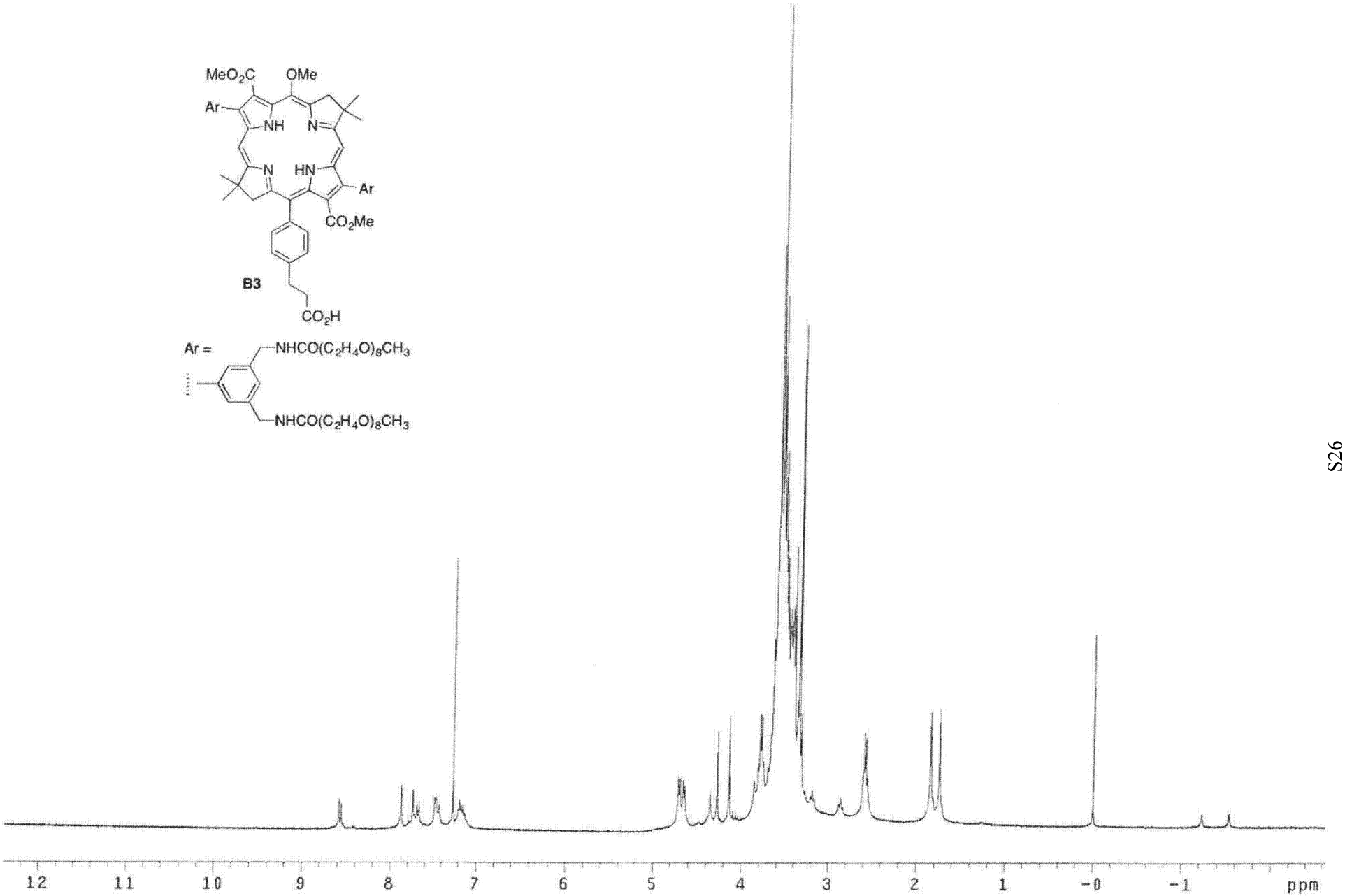

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 363.0 | 1.12830 |
| 1 | | 726.0 | 0.85066 |
| 1 | | 513.0 | 0.30418 |

Report generated by : Lindsey Lab Signature: .....

*** End Spectrum/Peak Report ***

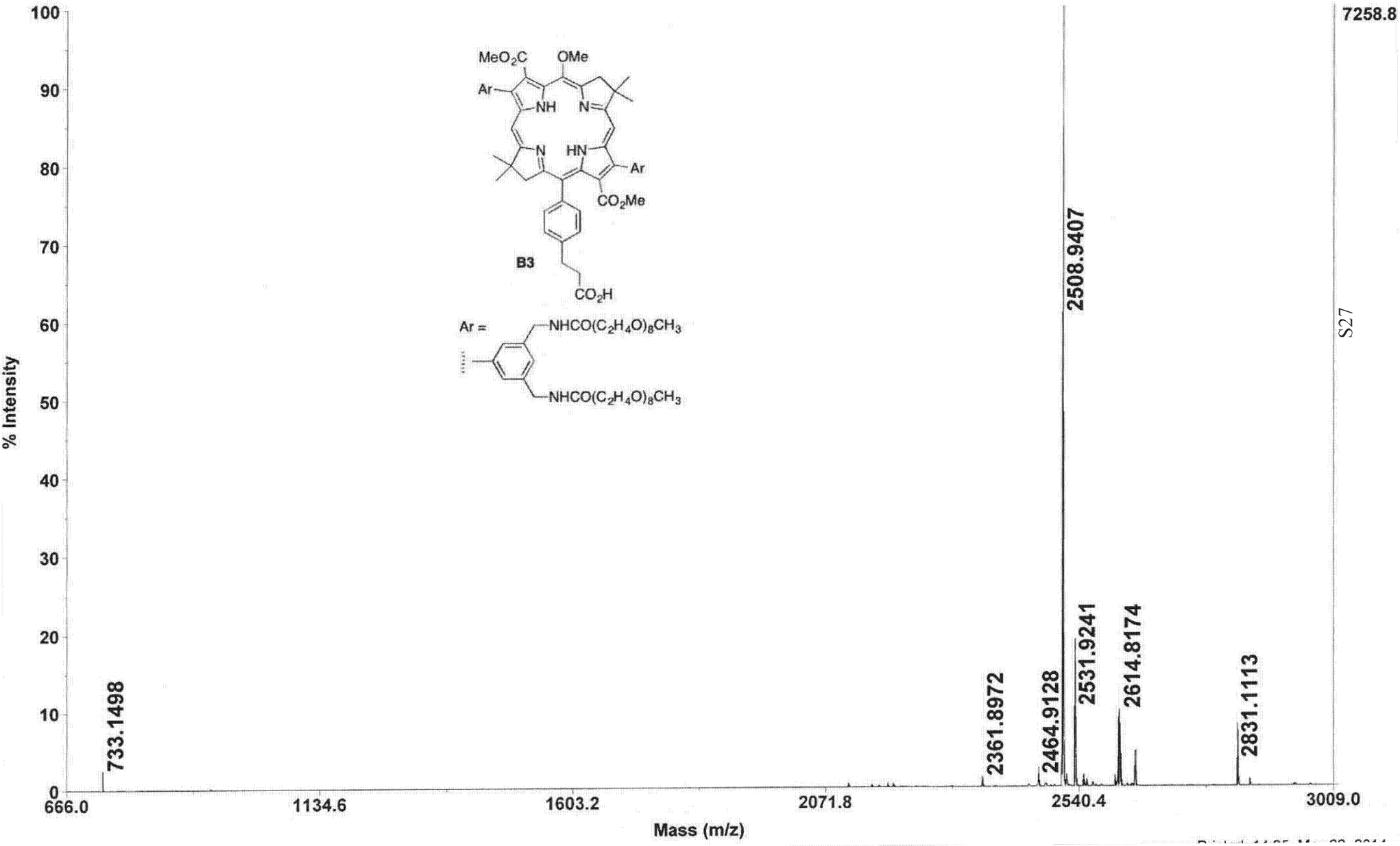



B2-NHS


MeO2C
OMe
Ar
NH
N
N
HN
Ar
CO2Me
B3
CO2H
Ar =
NHCO(C2H4O)8CH3
NHCO(C2H4O)8CH3
12
11
10
9
8
7
6
5
4
3
2
1
-0
-1
ppm

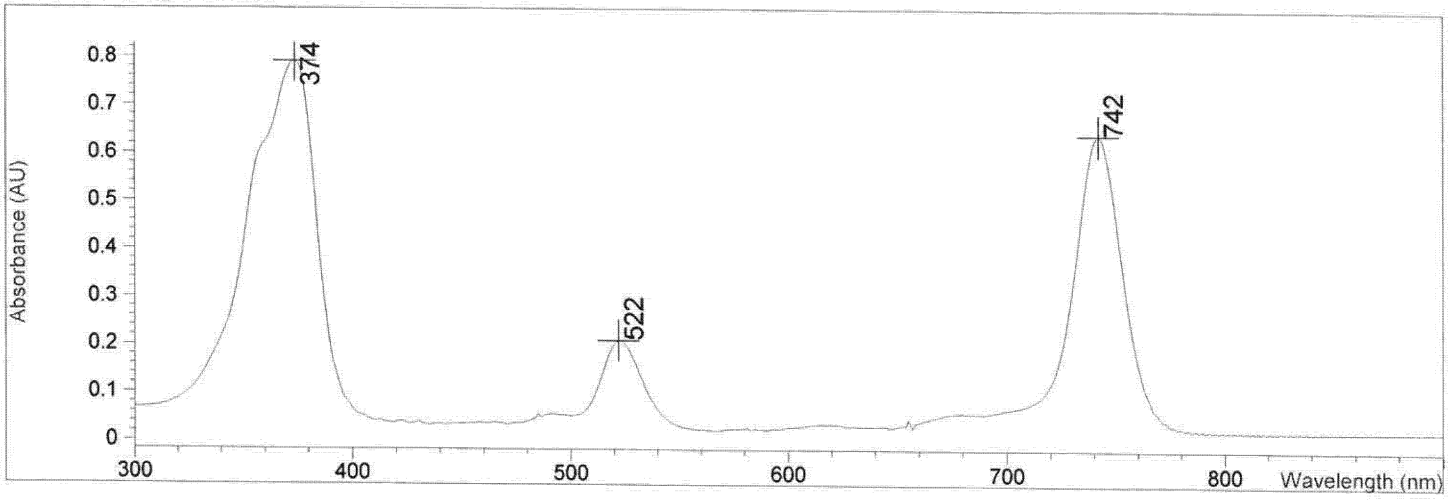
AB Sciex TOF/TOF™ Series Explorer™ 72098

TOF/TOF™ Reflector Spec #1[BP = 2510.0, 7259]



Method file : <method not saved>
Information : Default Method
Data File : C:\CHEM32\1\DATA\NUONUO\20140515\PRO-C-ES-NHPEG8-C-COOH(H2O).SD
Created : 5/15/14 11:36:24

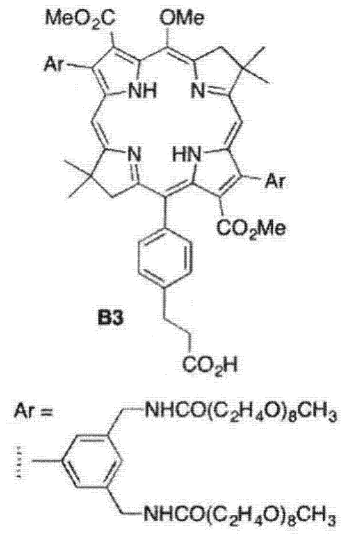
Overlaid Spectra:

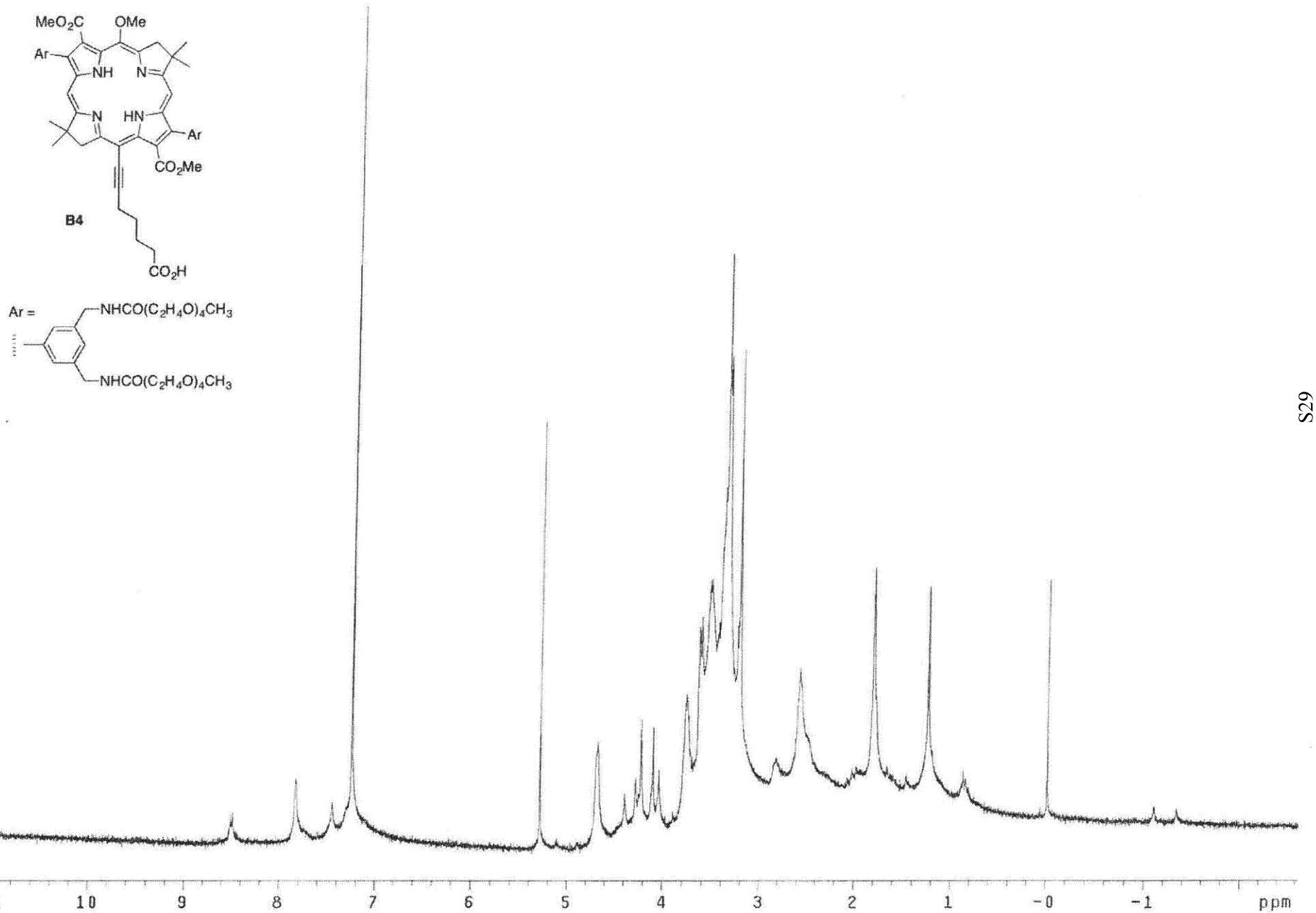



| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 374.0 | 0.79088 |
| 1 | | 742.0 | 0.64072 |
| 1 | | 522.0 | 0.20961 |

Report generated by : jon Signature: .....

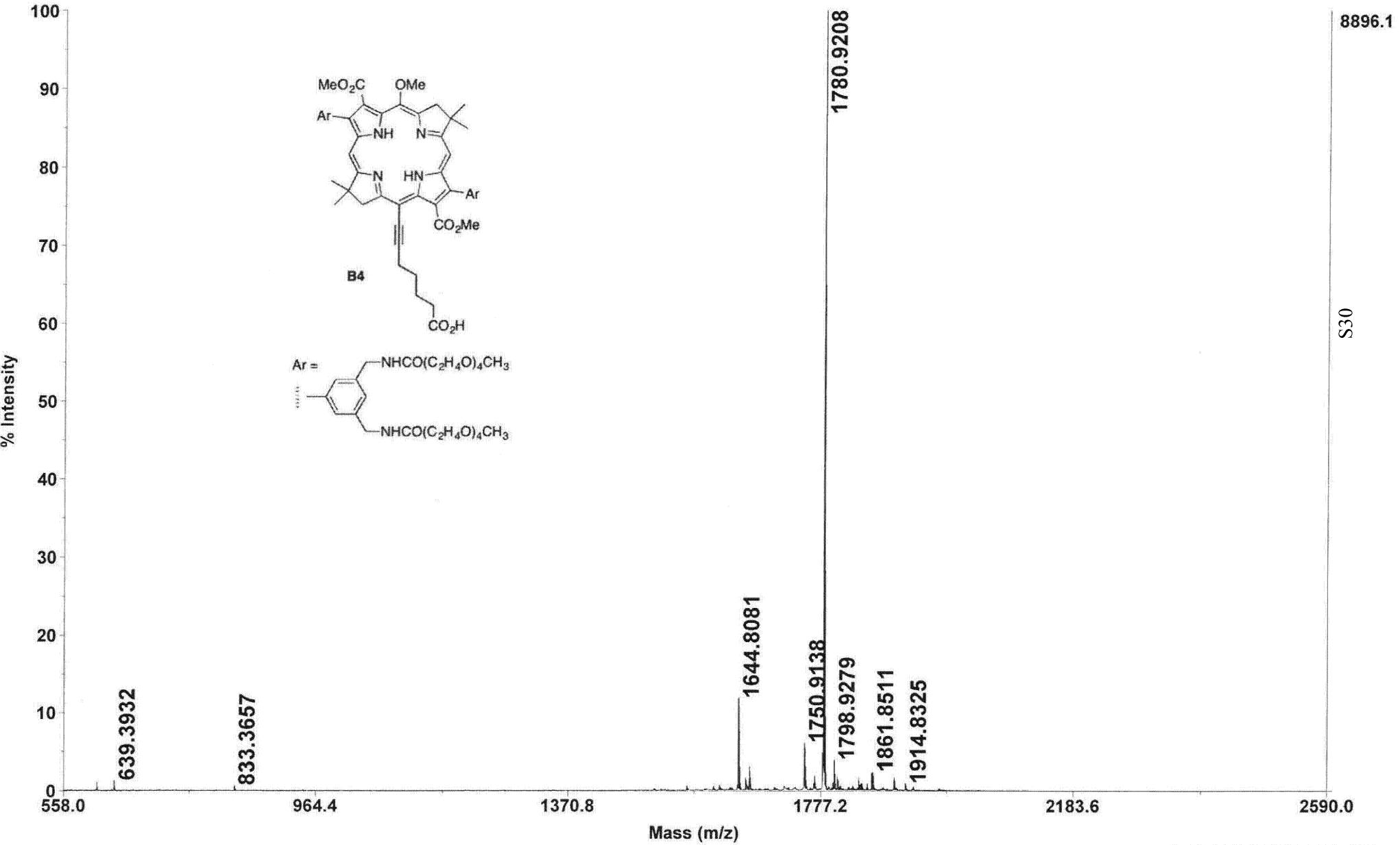
*** End Spectrum/Peak Report ***




MeO2C
OMe
Ar
NH
N
N
HN
Ar
CO2Me
CO2H
B4
Ar =
NHCO(C2H4O)4CH3
NHCO(C2H4O)4CH3
11
10
9
8
7
6
5
4
3
2
1
-0
-1
ppm

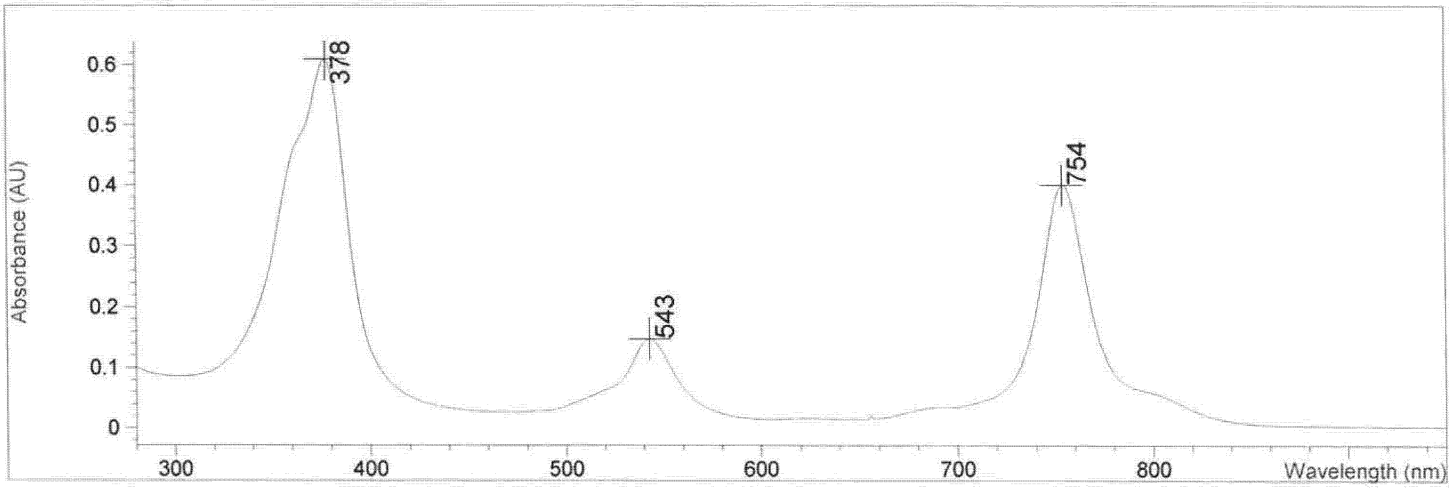
*AB Sciex TOF/TOF™ Series Explorer™ 72098*

**TOF/TOF™ Reflector Spec #1[BP = 234.1, 19091]**



Method file : <method not saved>
Information : Default Method
Data File : C:\CHEM32\1\DATA\NUONUO\20140815\PRO-C-ES-YNL-COOH-NHPEG4(H2O).SD
Created : 8/15/14 10:36:59

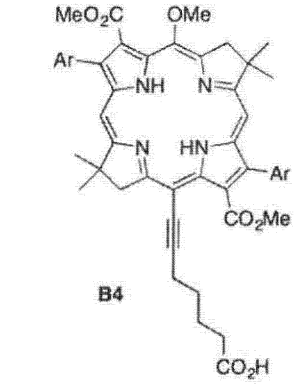
Overlaid Spectra:

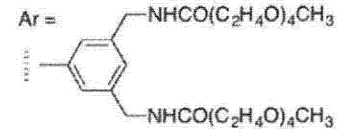


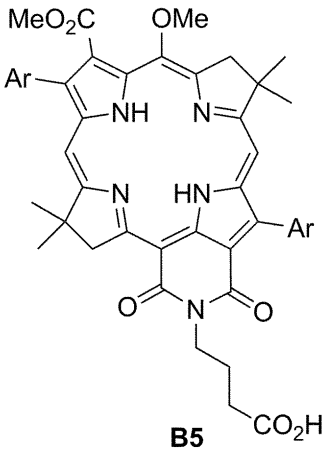

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 378.0 | 0.60888 |
| 1 | | 754.0 | 0.39976 |
| 1 | | 543.0 | 0.14745 |

Report generated by : jon Signature: .....

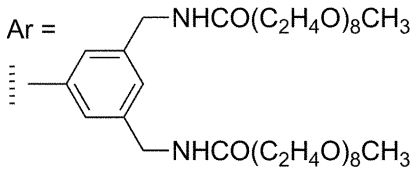
*** End Spectrum/Peak Report ***




MeO2C
OMe
Ar
NH
N
N
HN
Ar
O
N
O
CO2H

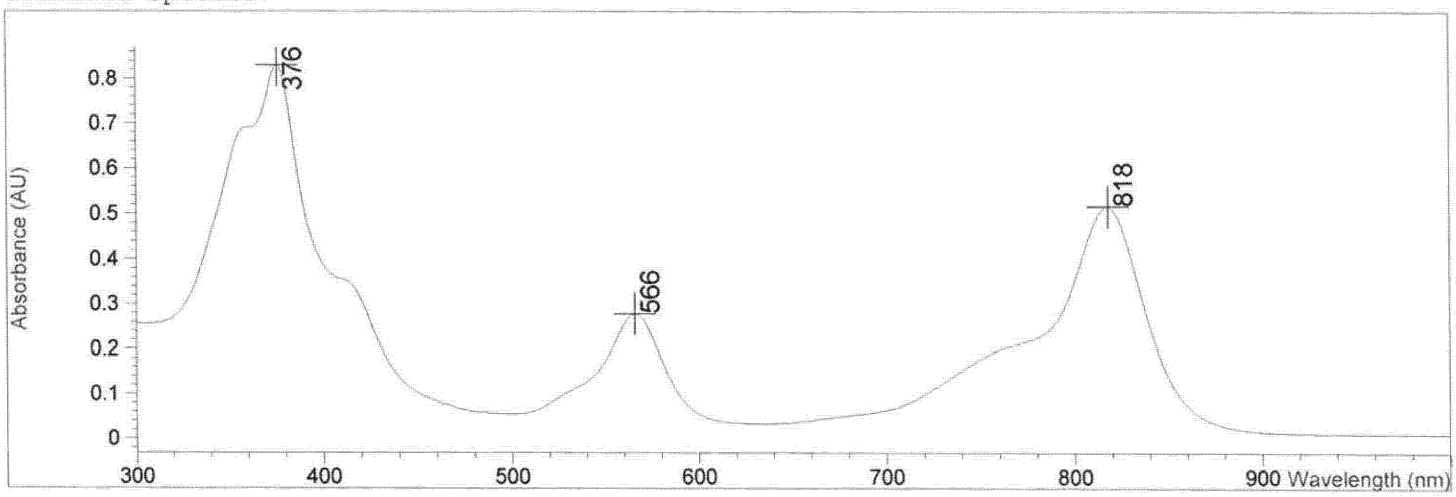
**B5**


Ar =
NHCO(C2H4O)8CH3
NHCO(C2H4O)8CH3


9
8
7
6
5
4
3
2
1
-0
ppm

Method file : <method not saved>
Information : Default Method
Data File : C:\CHEM32\1\DATA\NUONUO\20140424\PRO-C-ES-NHPEG8-I-COOH(H2O).SD
Created : 4/24/14 16:08:52

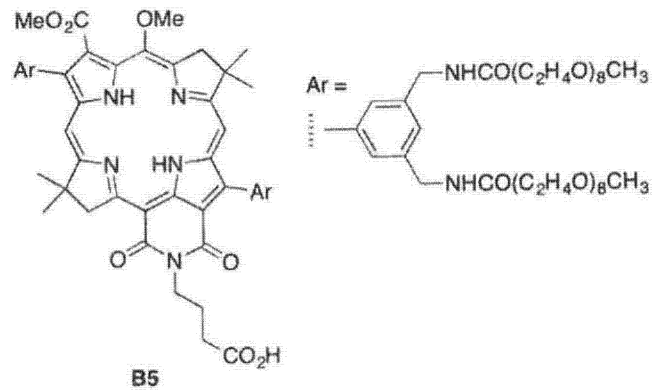
Overlaid Spectra:




| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 376.0 | 0.82934 |
| 1 | | 818.0 | 0.51598 |
| 1 | | 566.0 | 0.27738 |

Report generated by : jon Signature: .....

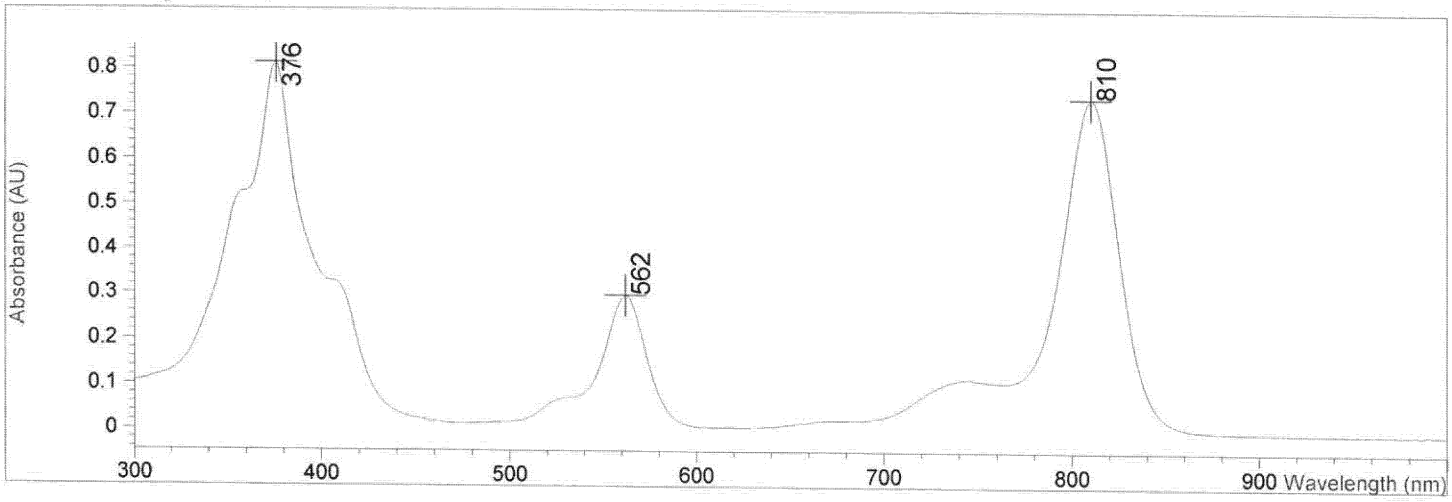
*** End Spectrum/Peak Report ***




B5

Method file : <untitled>
Information : Default Method
Data File : C:\CHEM32\1\DATA\NUONUO\20140411\PRO-C-ES-NHBOC-COOBUT(DCM)-1.SD
Created : 4/11/14 17:58:09

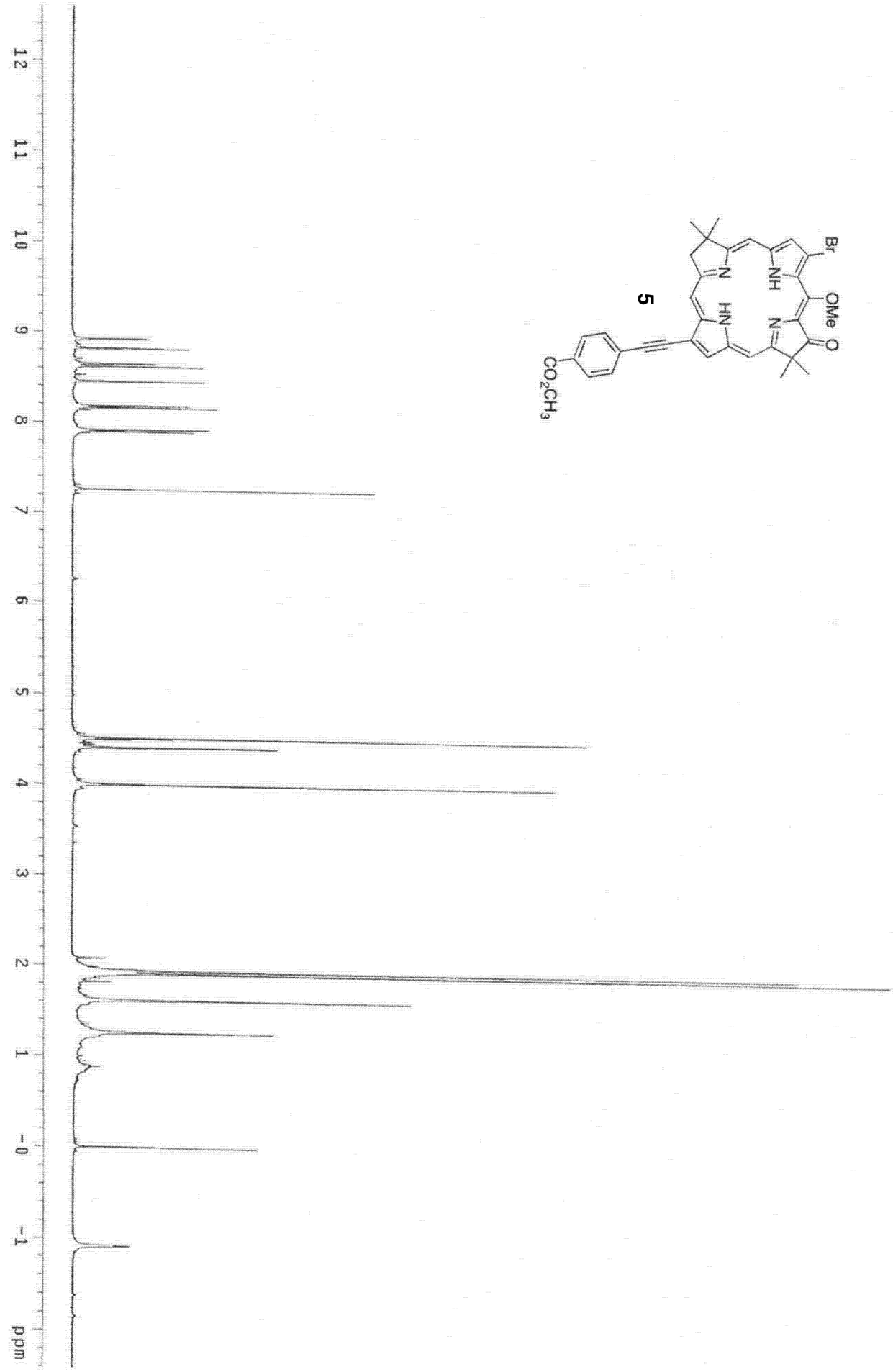
Overlaid Spectra:




| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 376.0 | 0.81293 |
| 1 | | 810.0 | 0.73882 |
| 1 | | 562.0 | 0.29771 |

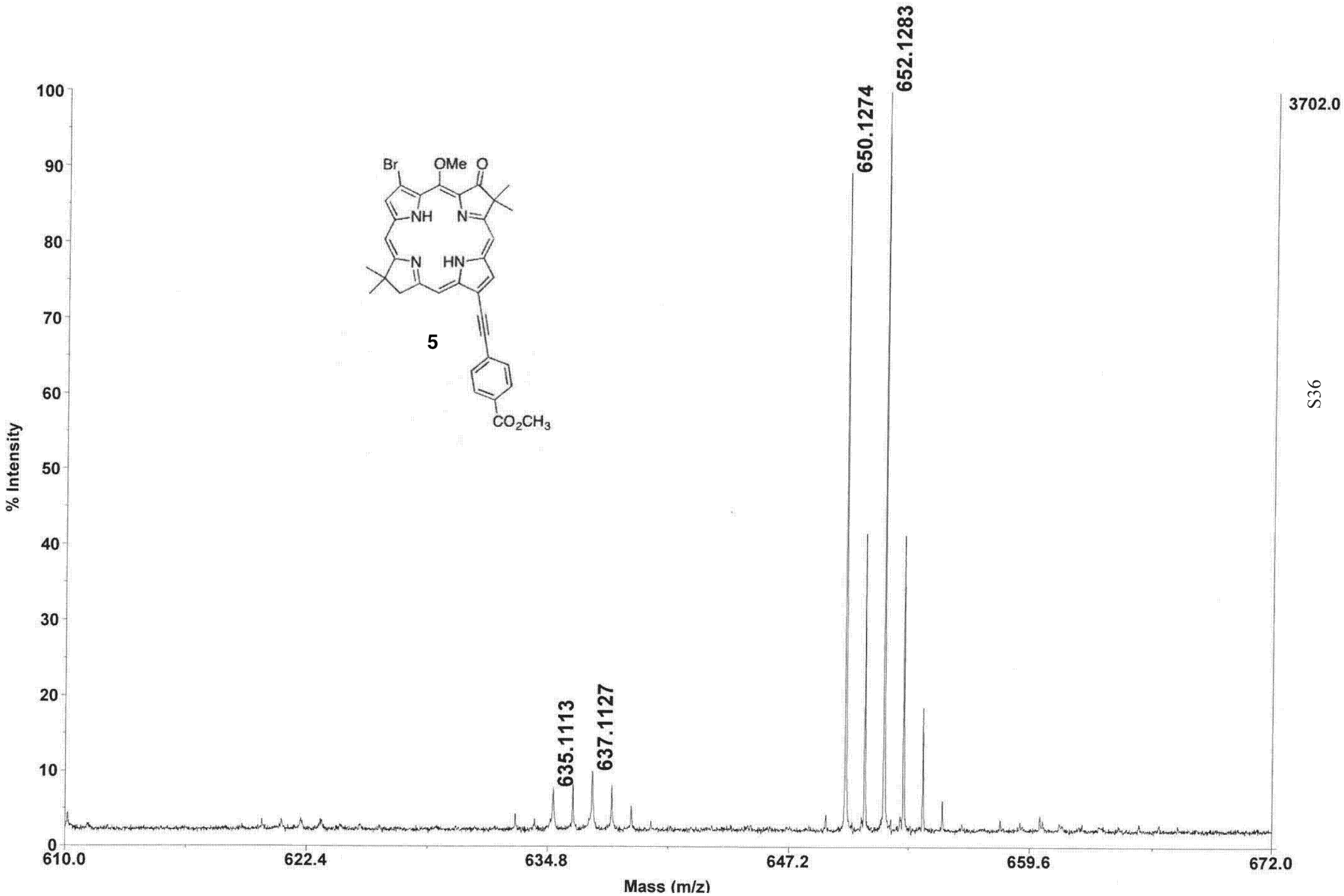
Report generated by : Lindsey Lab Signature: .....

*** End Spectrum/Peak Report ***


5
Br
OMe
O
NH
HN
N
N
CO2CH3
12
11
10
9
8
7
6
5
4
3
2
1
-0
-1
ppm

*AB Sciex TOF/TOF™ Series Explorer™ 72098*

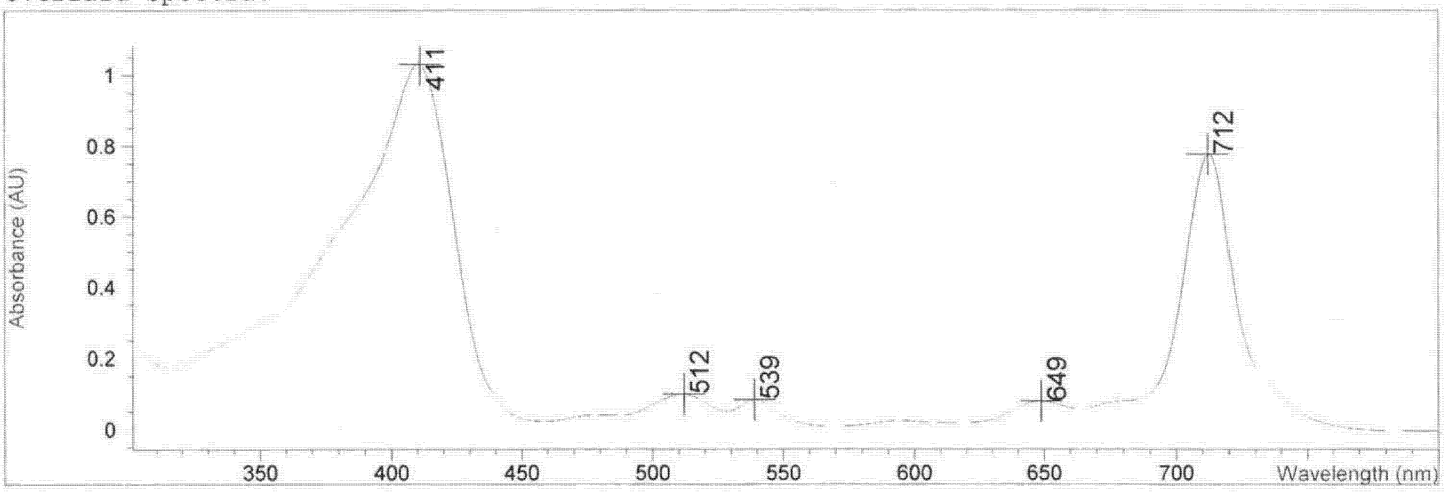
**TOF/TOF™ Reflector Spec #1 MC[BP = 364.1, 24324]**



Spectrum/Peak Report Date 7/21/2015 Time 11:33:48 Page 1 of 1

Method file : <untitled>
Information : Default Method
Data File : <untitled>

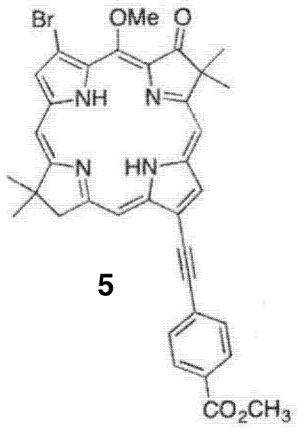
Overlaid Spectra:



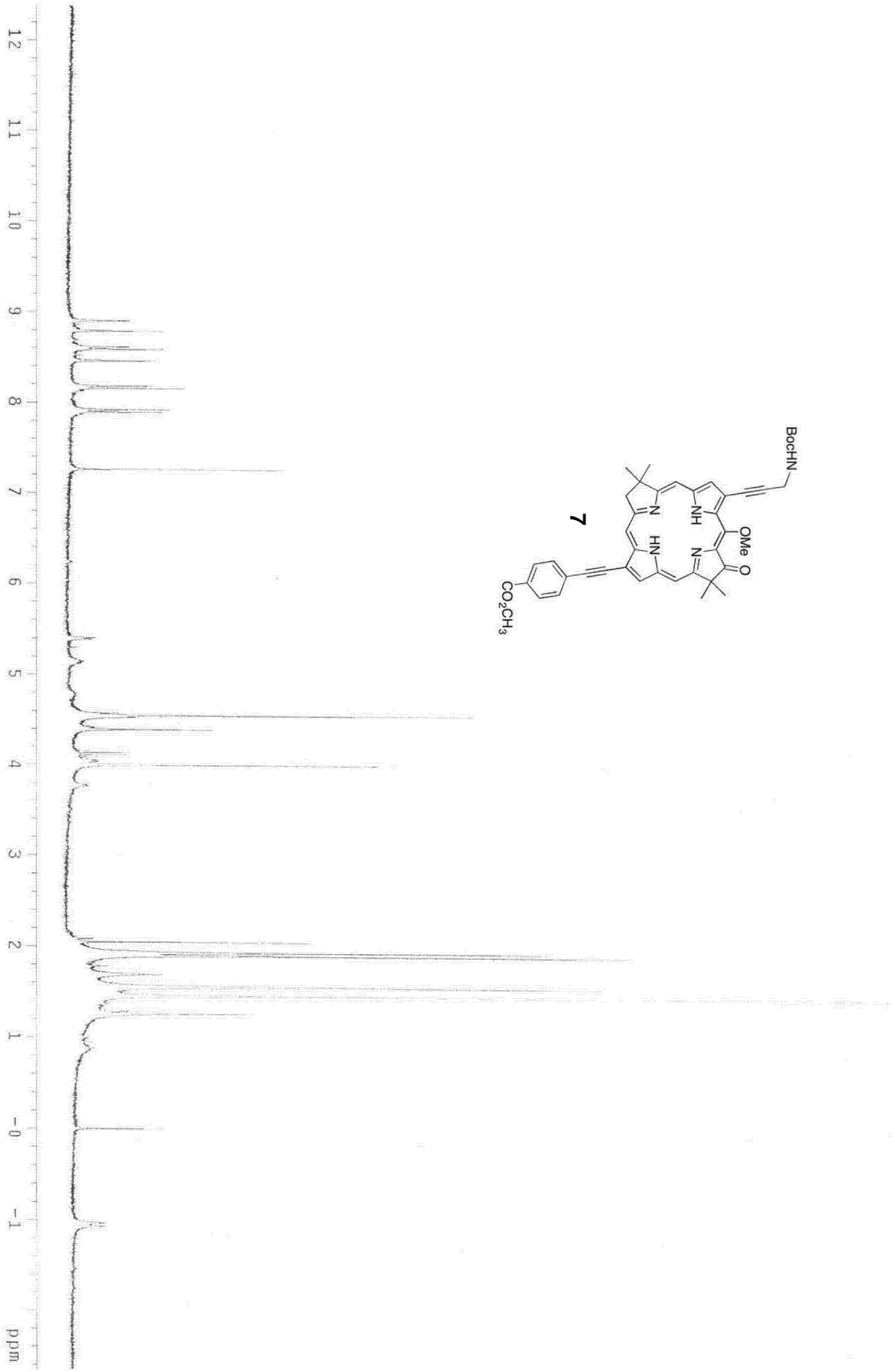

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 411.0 | 1.03010 |
| 1 | | 712.0 | 0.77704 |
| 1 | | 512.0 | 9.9096E-2 |
| 1 | | 539.0 | 8.3821E-2 |
| 1 | | 649.0 | 7.9855E-2 |

Report generated by : Lindsey Lab Signature: .....

*** End Spectrum/Peak Report ***

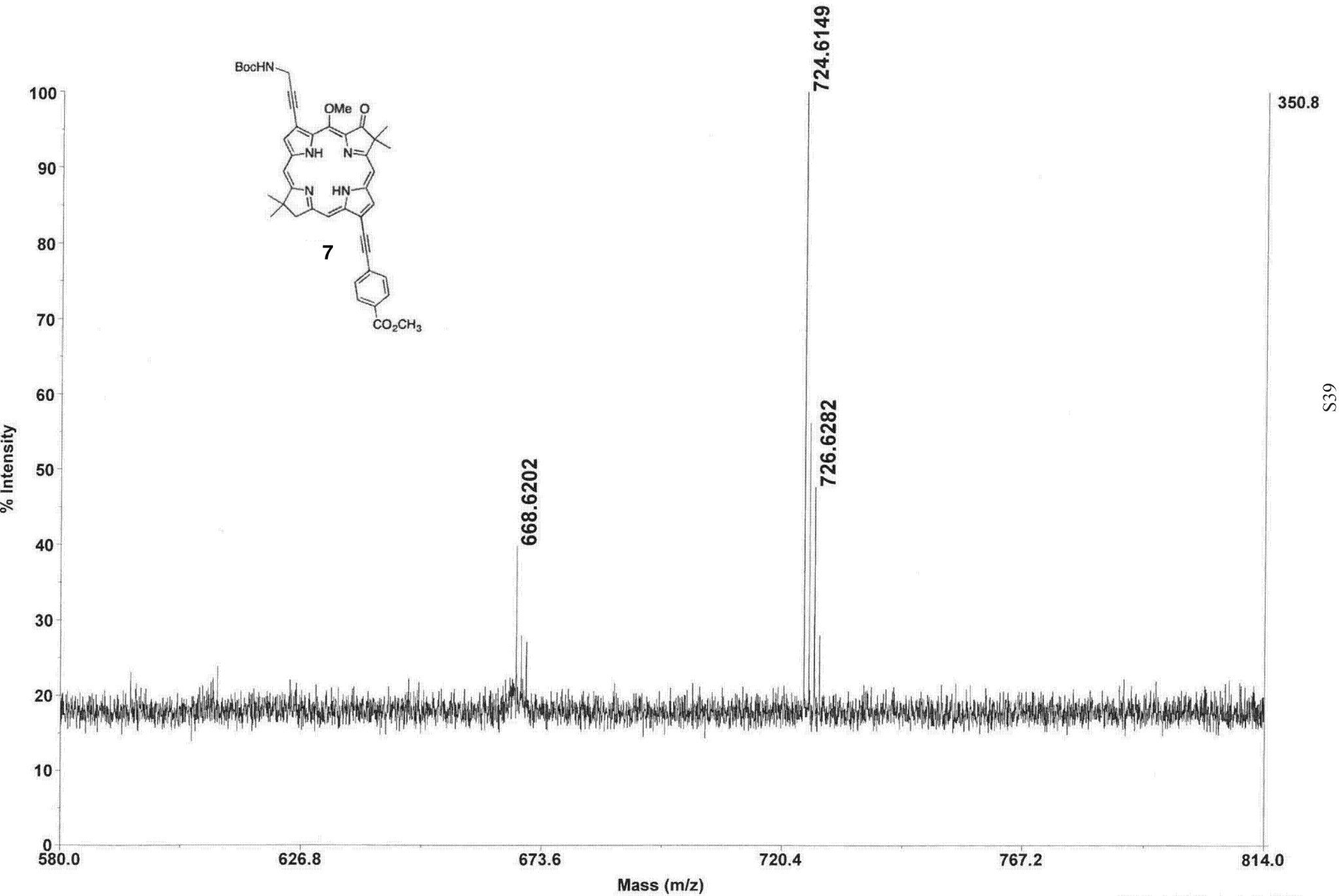



**5**


12
11
10
9
8
7
6
5
4
3
2
1
−0
−1
ppm
BocHN
NH
HN
N
N
OMe
O
CO2CH3
7

*AB Sciex TOF/TOF™ Series Explorer™ 72098*

**TOF/TOF™ Reflector Spec #1 MC[BP = 363.8, 3994]**

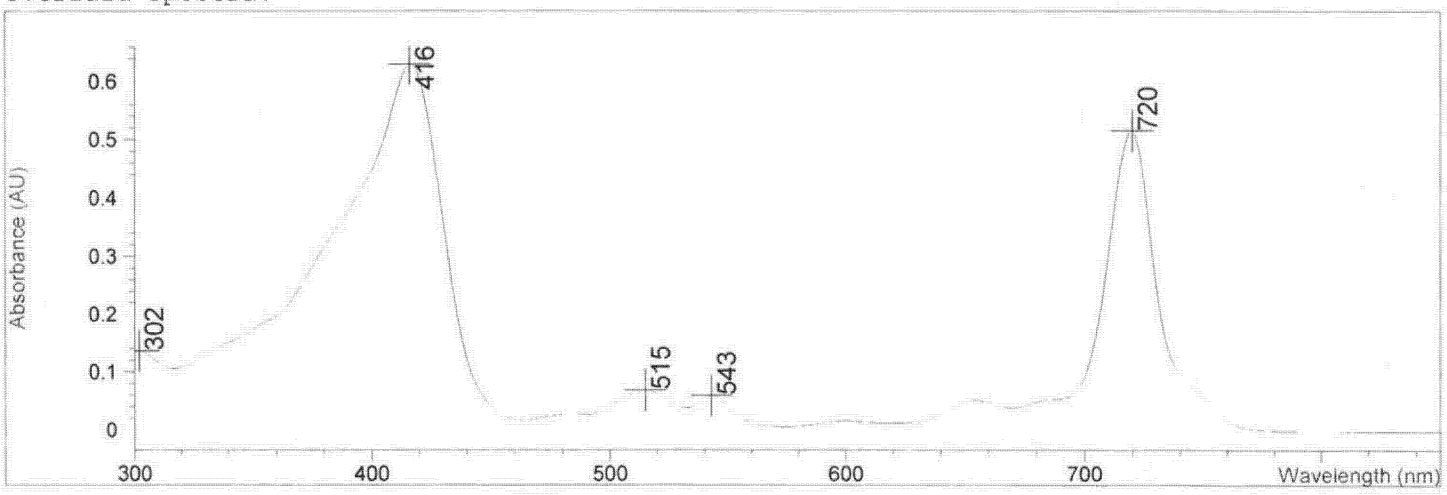



Printed: 16:51, April 12, 2016

C:\AB SCIEX\TOFTOF Data\ExportT2D\User Project 1\Lindsey\Mengran\070815\A14_MS.t2d

Method file : <untitled>
Information : Default Method
Data File : <untitled>

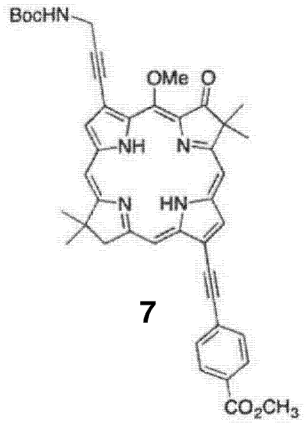
Overlaid Spectra:



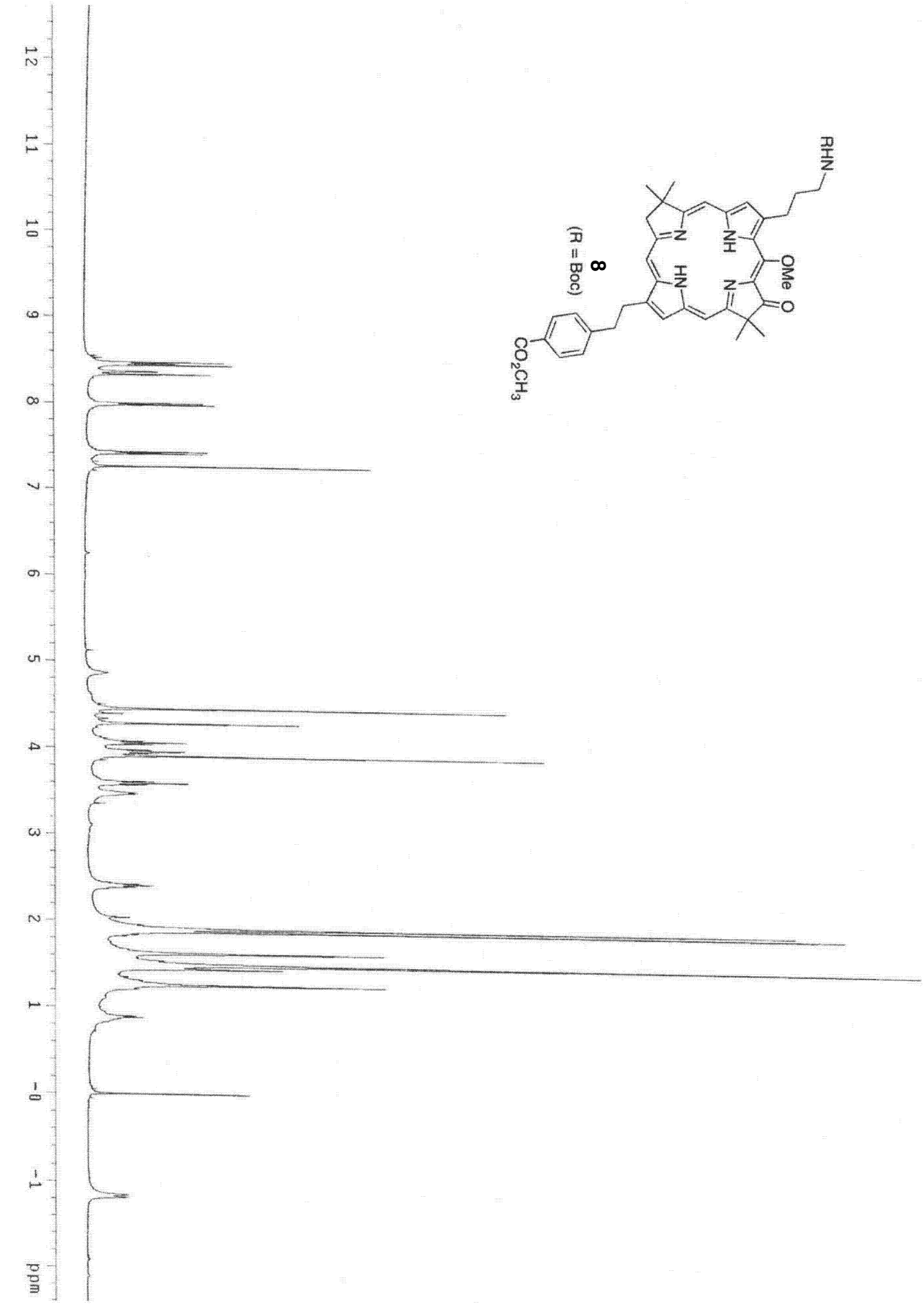

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 416.0 | 0.63036 |
| 1 | | 720.0 | 0.51545 |
| 1 | | 302.0 | 0.13659 |
| 1 | | 515.0 | 6.8746E-2 |
| 1 | | 543.0 | 5.9453E-2 |

Report generated by : Lindsey Lab Signature: .....

*** End Spectrum/Peak Report ***

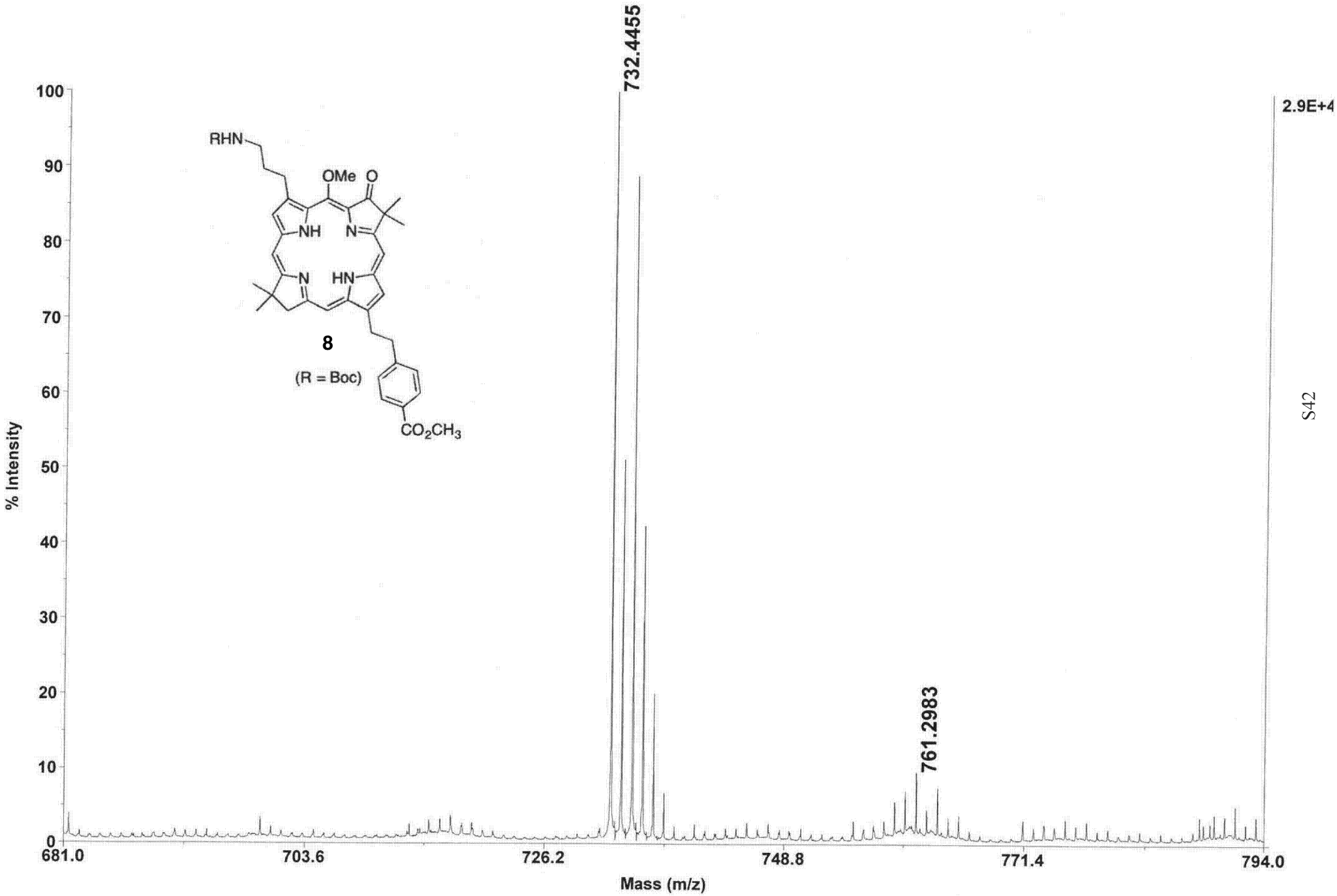



**7**


RHN
OMe O
NH
HN
N
N
CO2CH3
8
(R = Boc)
12
11
10
9
8
7
6
5
4
3
2
1
-0
-1
ppm

*AB Sciex TOF/TOF™ Series Explorer™ 72098*

**TOF/TOF™ Reflector Spec #1 MC[BP = 549.9, 31953]**

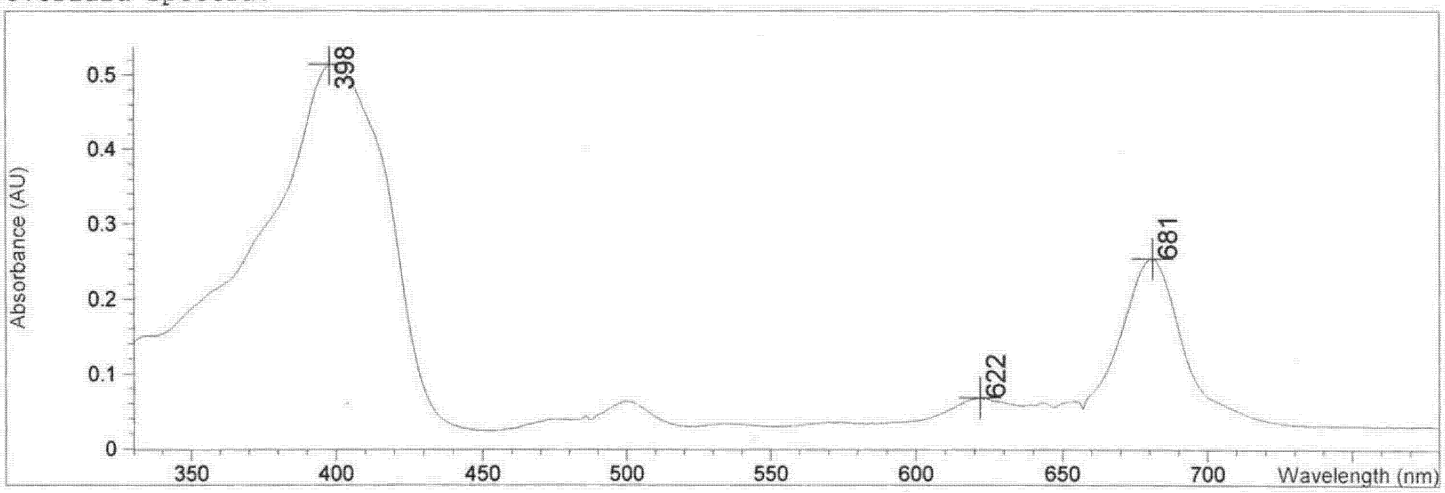





Printed: 16:47, April 12, 2016

Method file : <method not saved>
Information : Default Method
Data File : <data not saved>

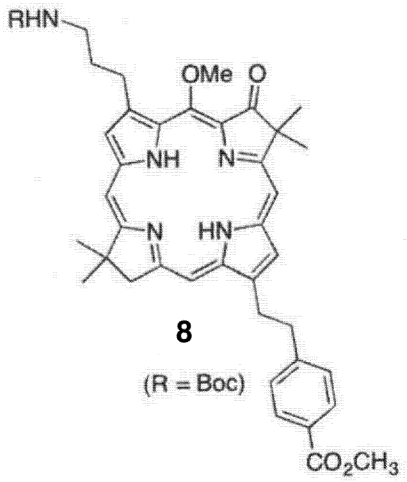
Overlaid Spectra:




| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 398.0 | 0.51381 |
| 1 | | 681.0 | 0.25373 |
| 1 | | 622.0 | 6.7577E-2 |

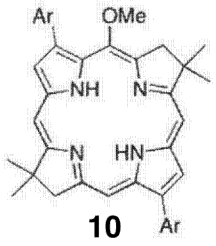
Report generated by : jon Signature: .....

*** End Spectrum/Peak Report ***

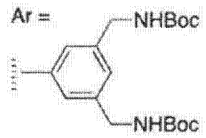


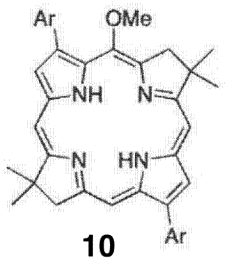

**8**

(R = Boc)

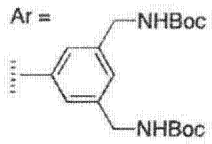



**10**




Ar
OMe
NH
N
N
HN
Ar

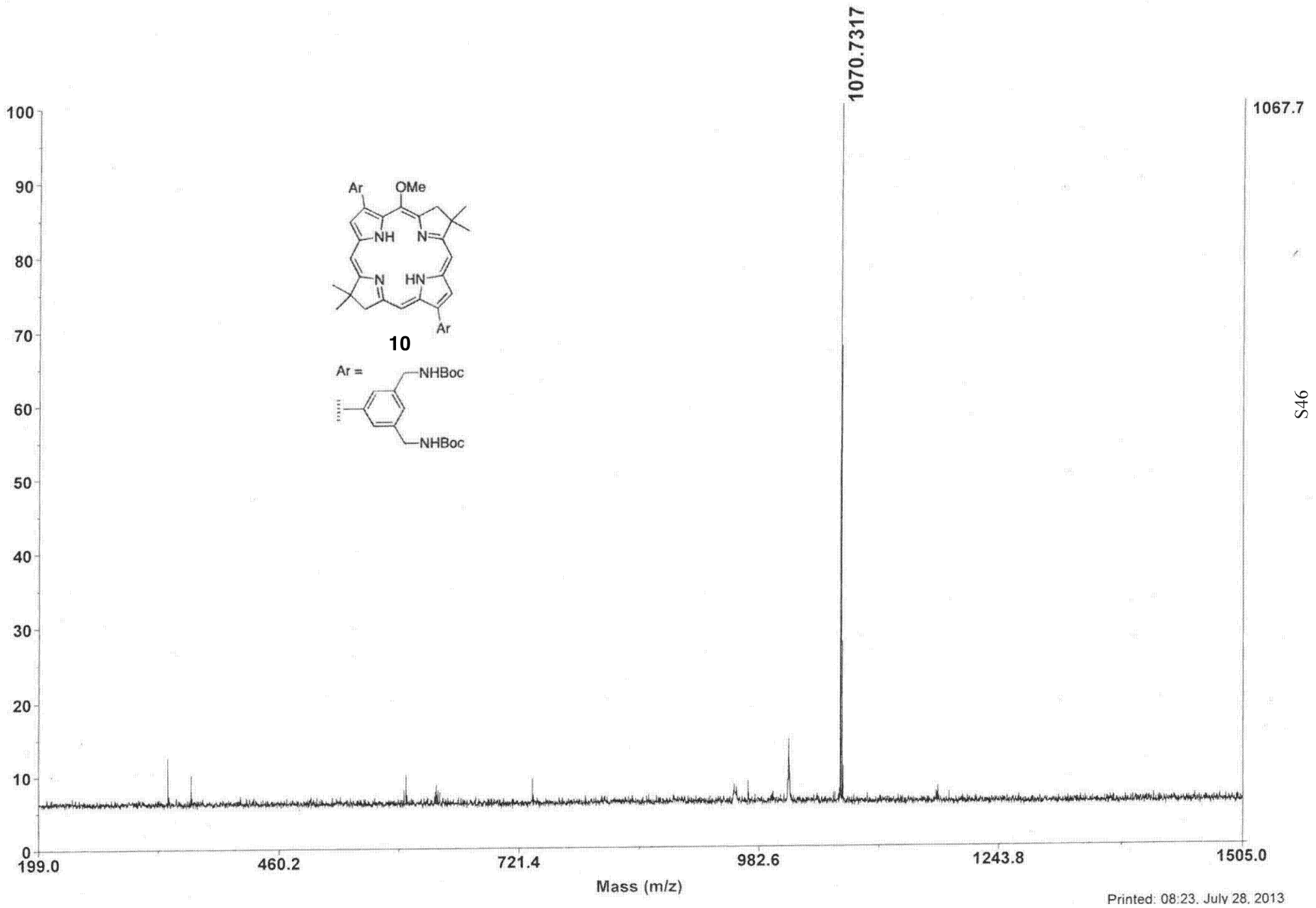
**10**


Ar =
NHBoc
NHBoc


180
160
140
120
100
80
60
40
20
ppm

*B Sciex TOF/TOF™ Series Explorer™ 72098*

TOF/TOF™ Reflector Spec #1 MC[BP = 1070.7, 1068]

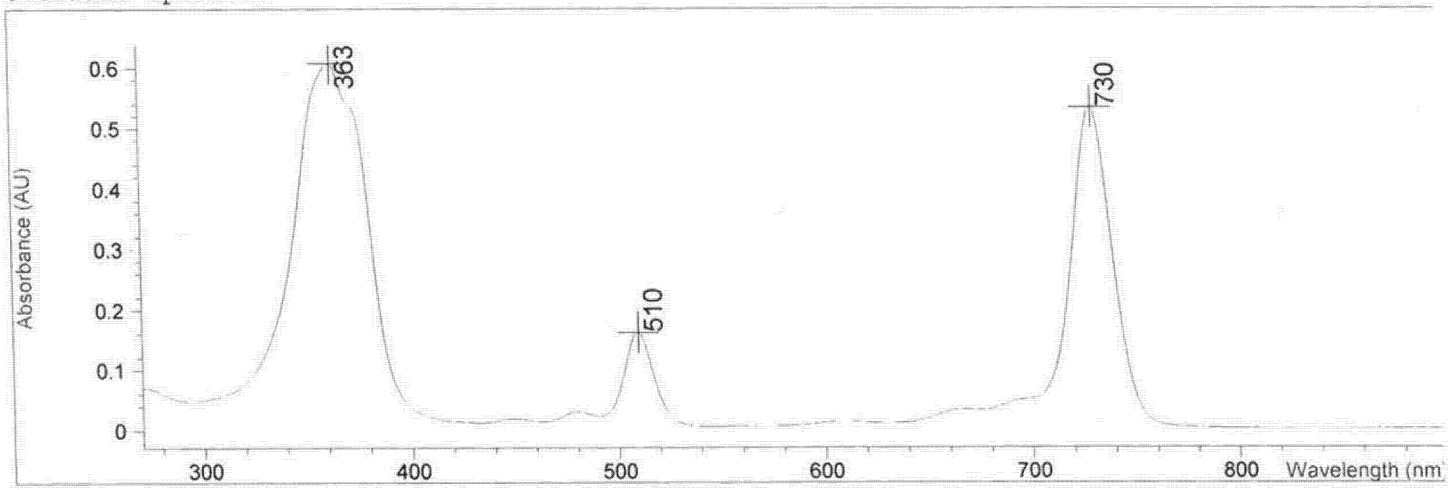





Printed: 08:23, July 28, 2013

Method file : <untitled>
Information : Default Method
Data File : C:\CHEM32\1\DATA\JIMMY\GROUPED DATA\UVVIS JIMMY A\TEMP\J91, PRO-AM - RE-TAKEN.SD Created : 4/17/15 14:07:57

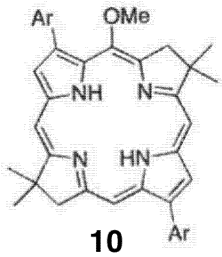
Overlaid Spectra:



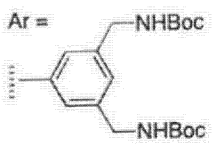

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 363.0 | 0.60798 |
| 1 | | 730.0 | 0.53354 |
| 1 | | 510.0 | 0.16280 |

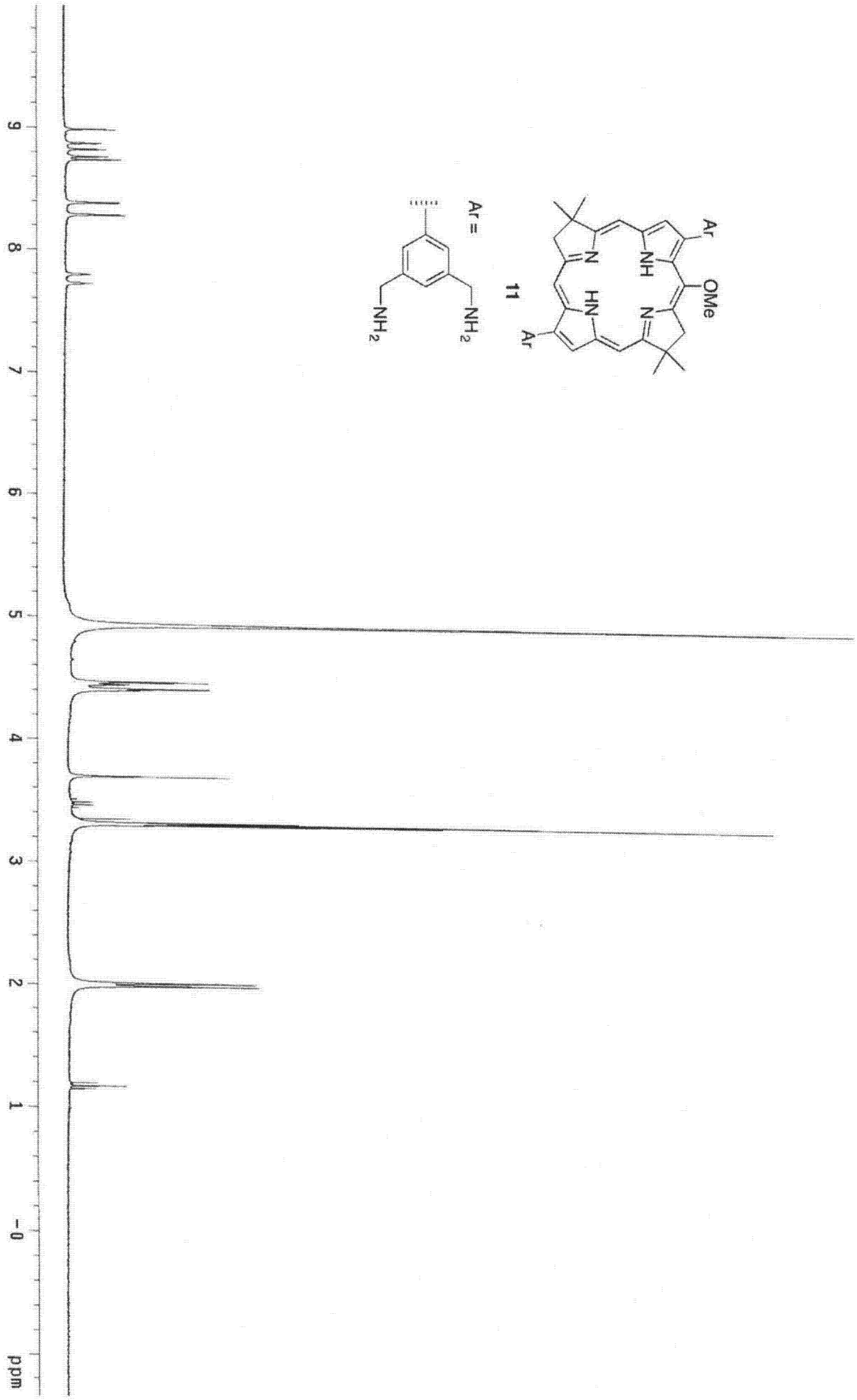
Report generated by : Lindsey Lab Signature: .....

*** End Spectrum/Peak Report ***

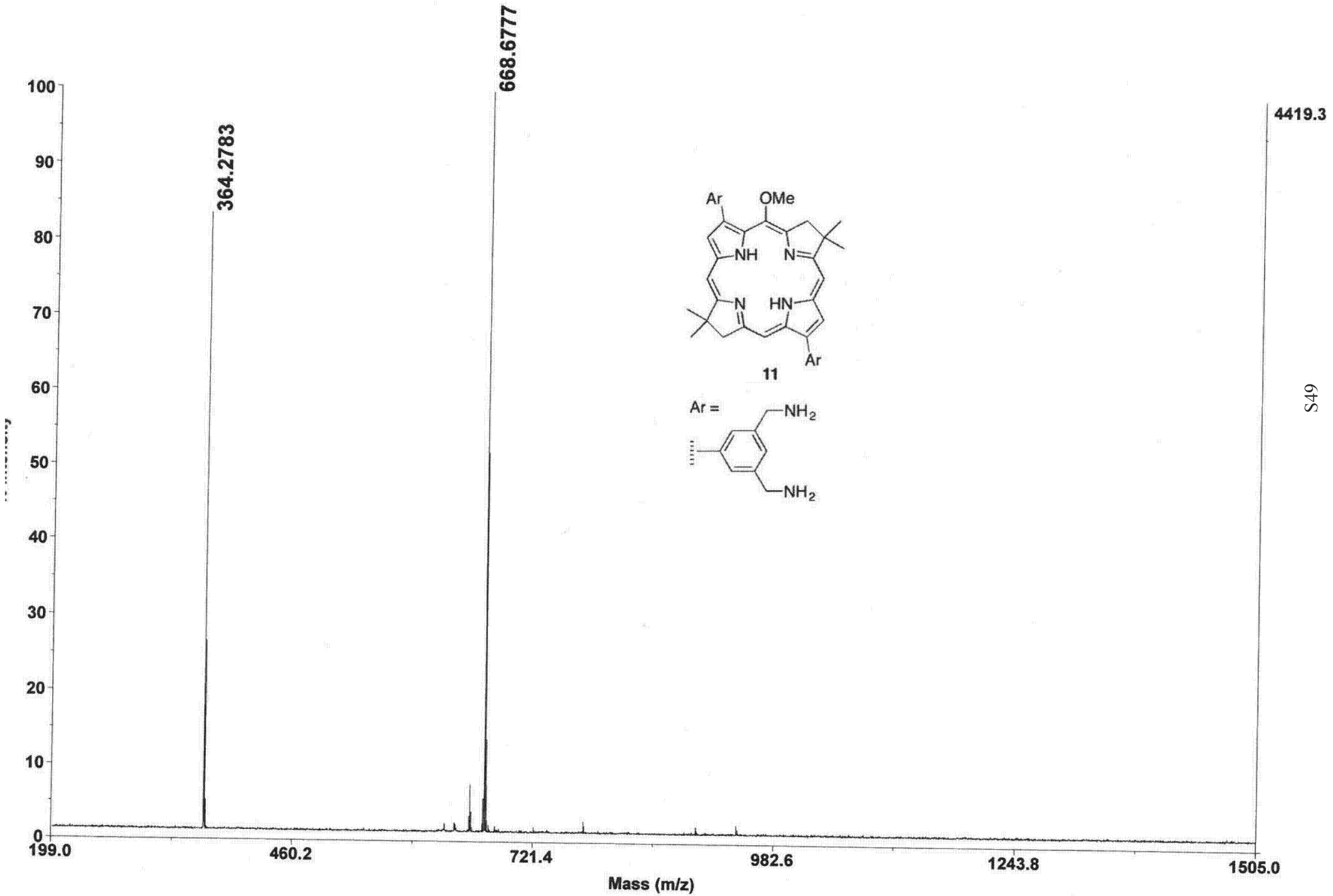



**10**



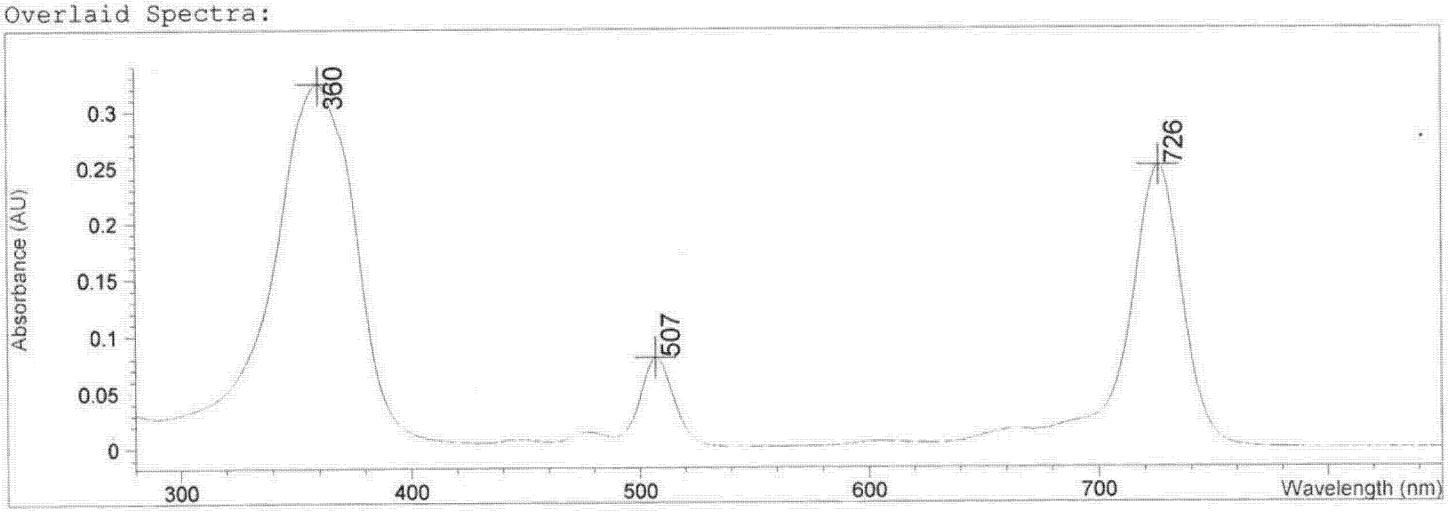

Ar =
NH2
NH2
11
Ar
NH
OMe
N
HN
N
Ar
9
8
7
6
5
4
3
2
1
-0
ppm

TOF/TOF™ Reflector Spec #1 MC[BP = 668.7, 4419]



Method file : <untitled>
Information : Default Method
Data File : C:\CHEM32\1\DATA\JIMMY\J93A IN METHANOL,.SD Created : 4/8/15 14:20:55

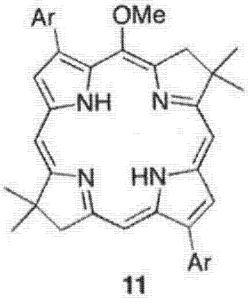
Overlaid Spectra:



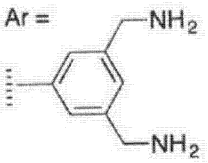

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 360.0 | 0.32428 |
| 1 | | 726.0 | 0.24971 |
| 1 | | 507.0 | 8.0328E-2 |

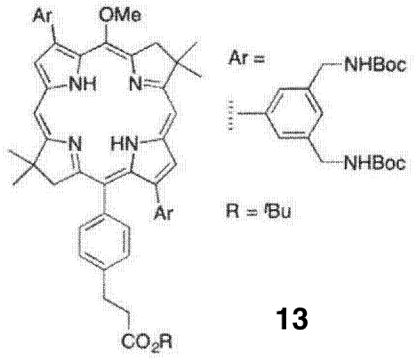
Report generated by : Lindsey Lab Signature: .....

*** End Spectrum/Peak Report ***

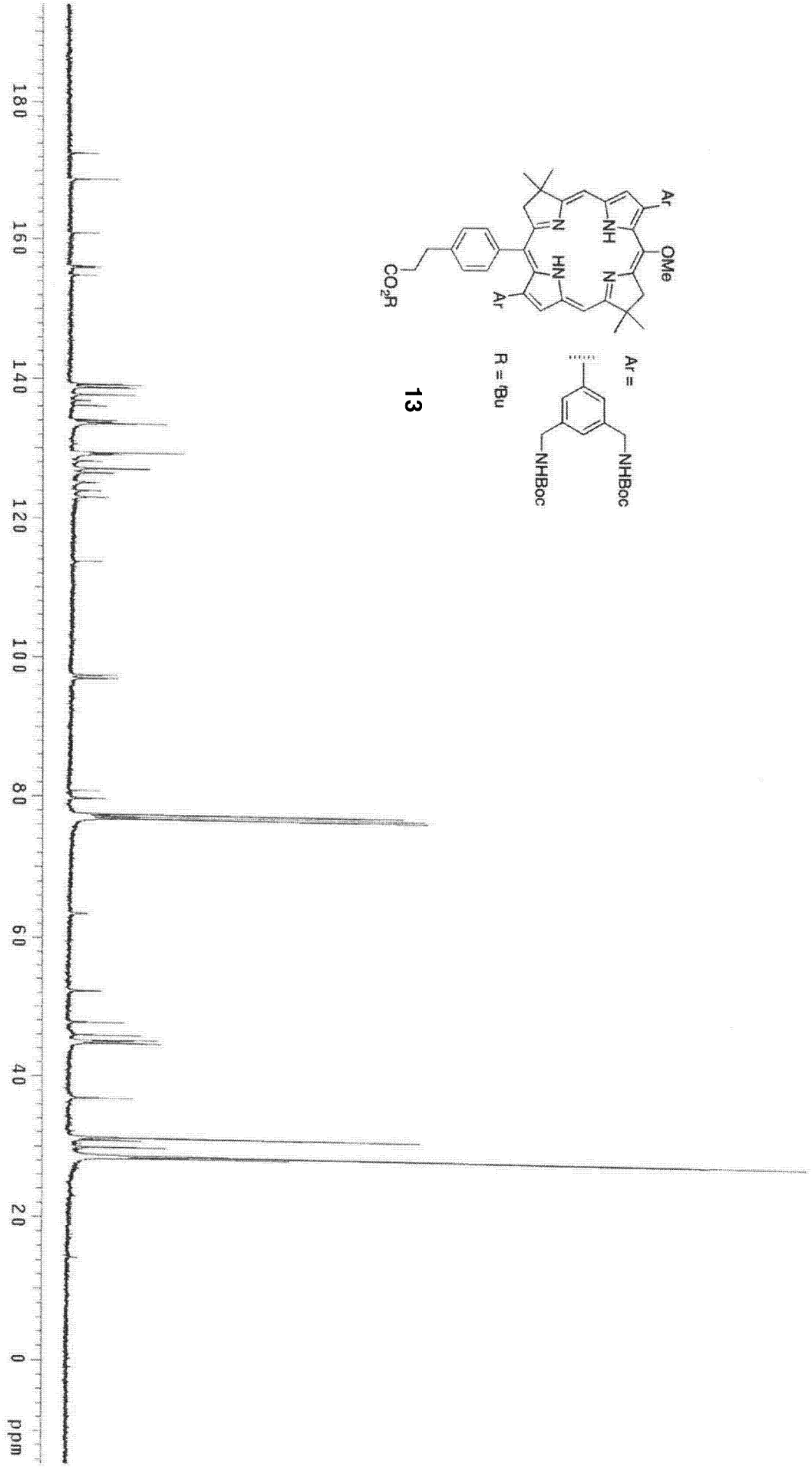



**11**



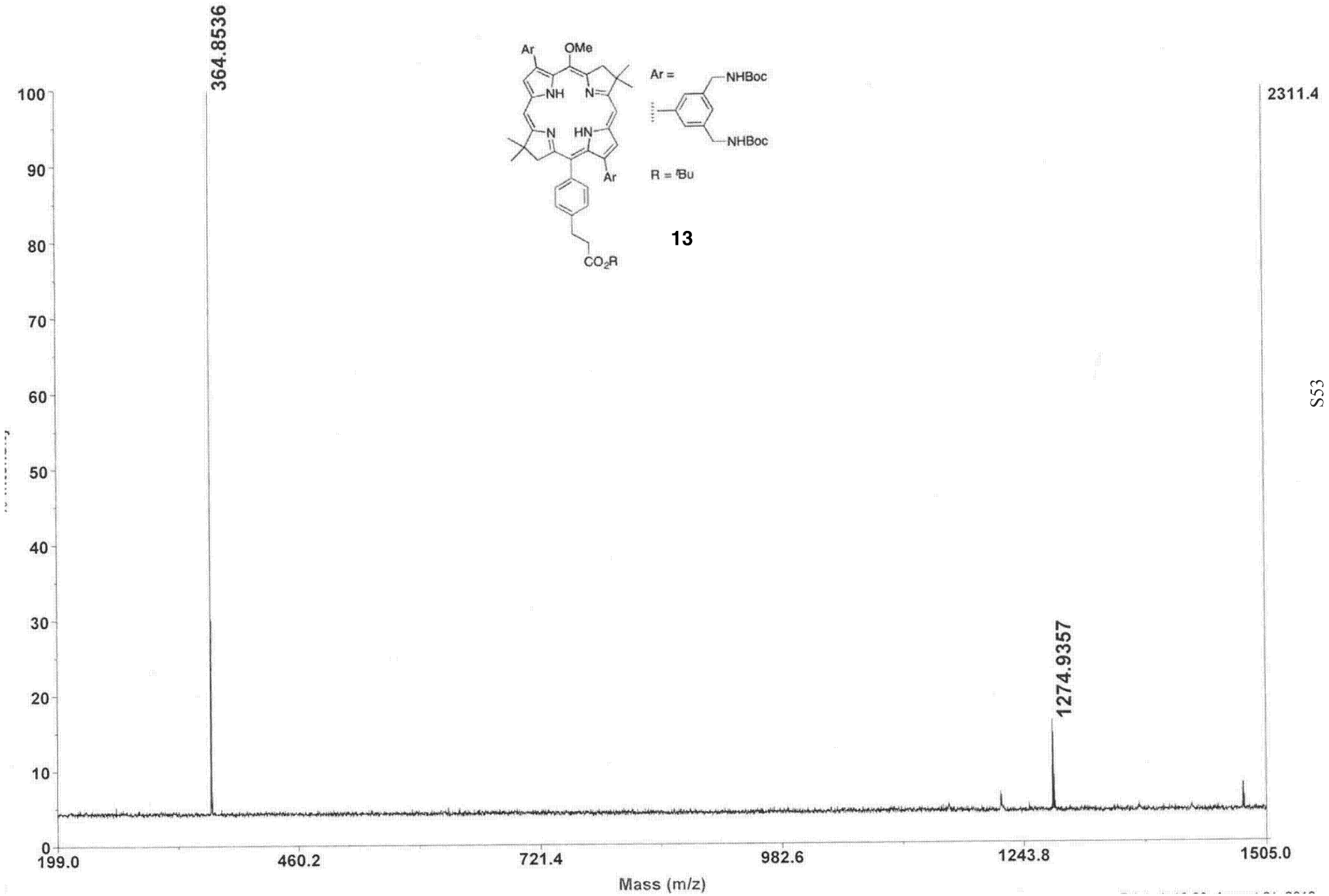



**13**


Ar
OMe
NH
N
HN
N
Ar
CO2R
13
R = tBu
Ar =
NHBoc
NHBoc
180
160
140
120
100
80
60
40
20
0
ppm

*B Sciex TOF/TOF™ Series Explorer™ 72098*

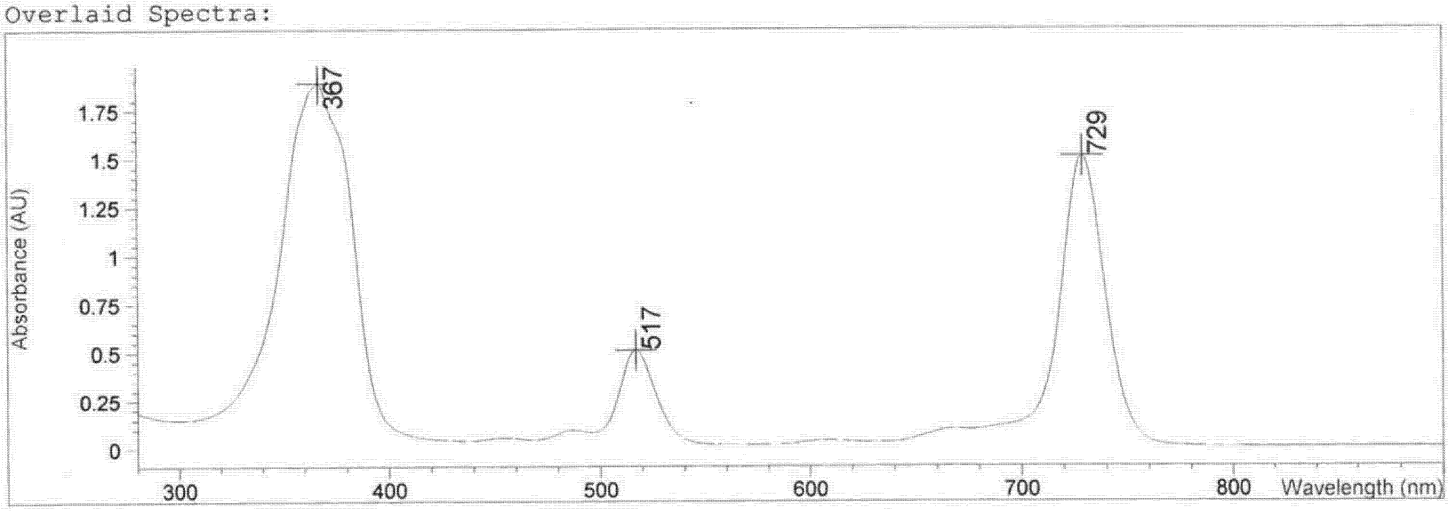
TOF/TOF™ Reflector Spec #1 MC[BP = 364.9, 2311]




**13**

Method file : <untitled>
Information : Default Method
Data File : C:\Chem32\1\DATA\JIMMY\grouped data\J94, PRO-AM-CO2TBU.SD
Created : 8/23/13 14:03:18

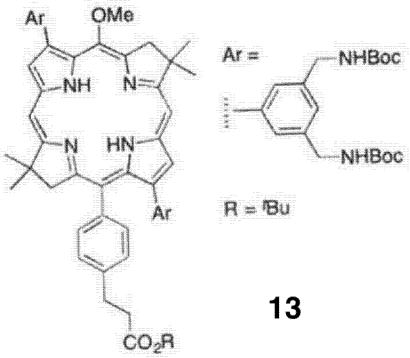
Overlaid Spectra:



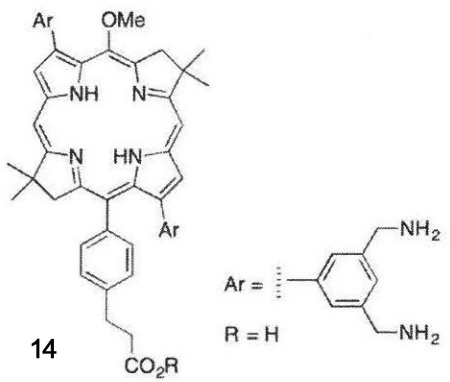

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 367.0 | 1.89200 |
| 1 | | 729.0 | 1.50690 |
| 1 | | 517.0 | 0.51017 |

Report generated by : Lindsey Lab Signature: .....

*** End Spectrum/Peak Report ***

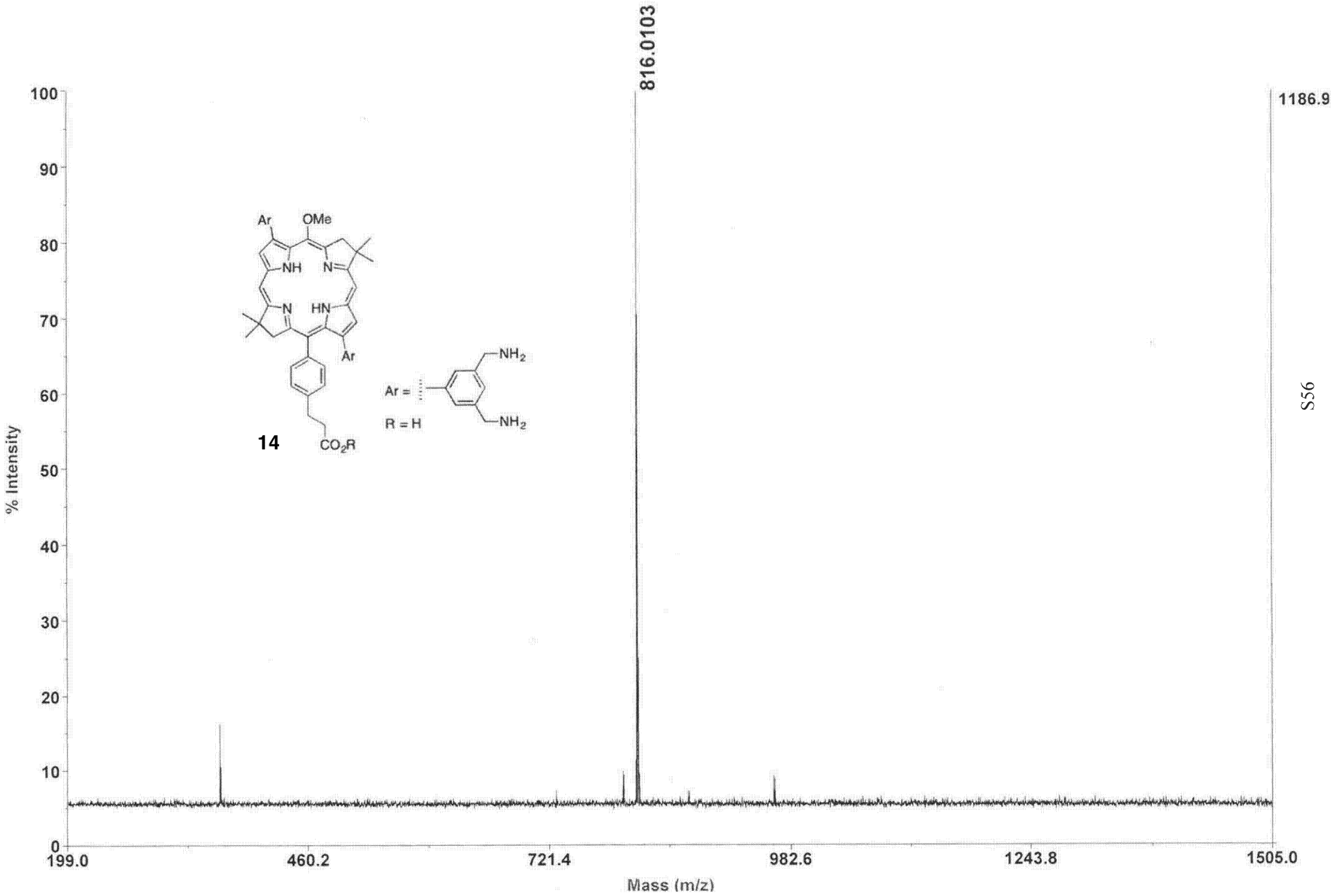



**13**



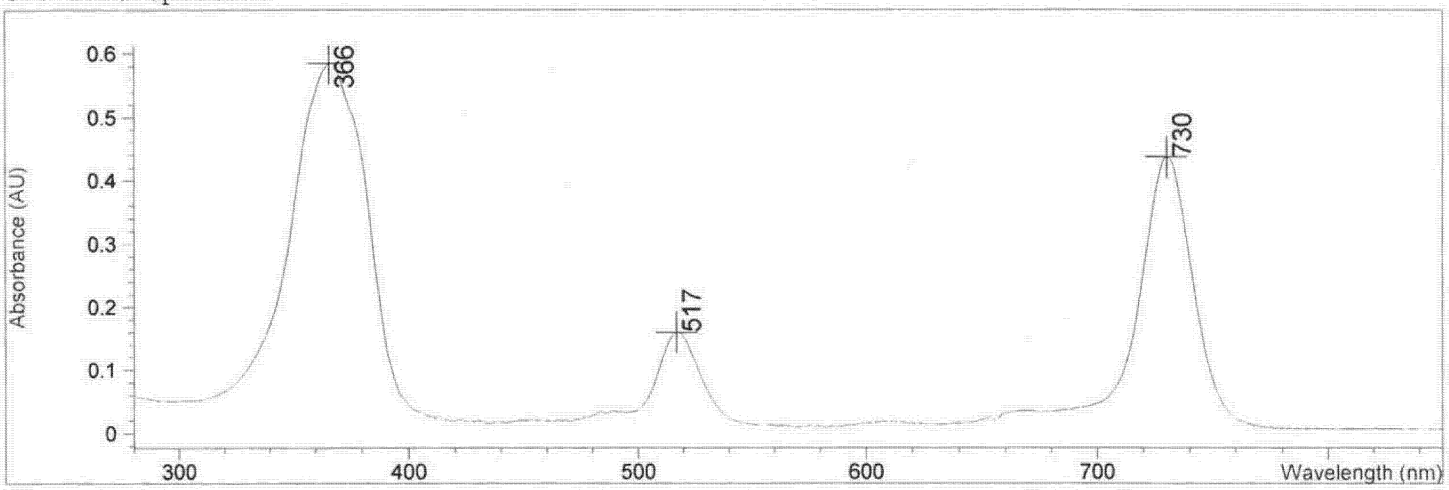

14

TOF/TOF™ Reflector Spec #1 MC[BP = 816.0, 1187]



Method file : <untitled>
Information : Default Method
Data File : C:\Chem32\1\DATA\JIMMY\grouped data\J115A, AM-COOH IN METHANOL.SD
Created : 9/5/13 10:31:21

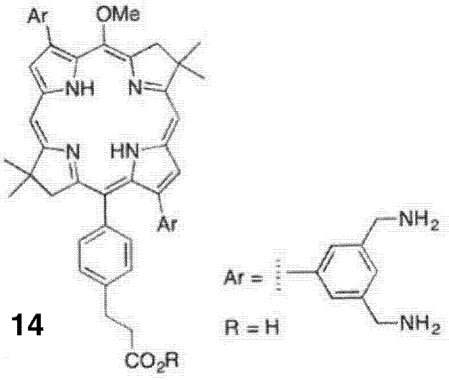
Overlaid Spectra:



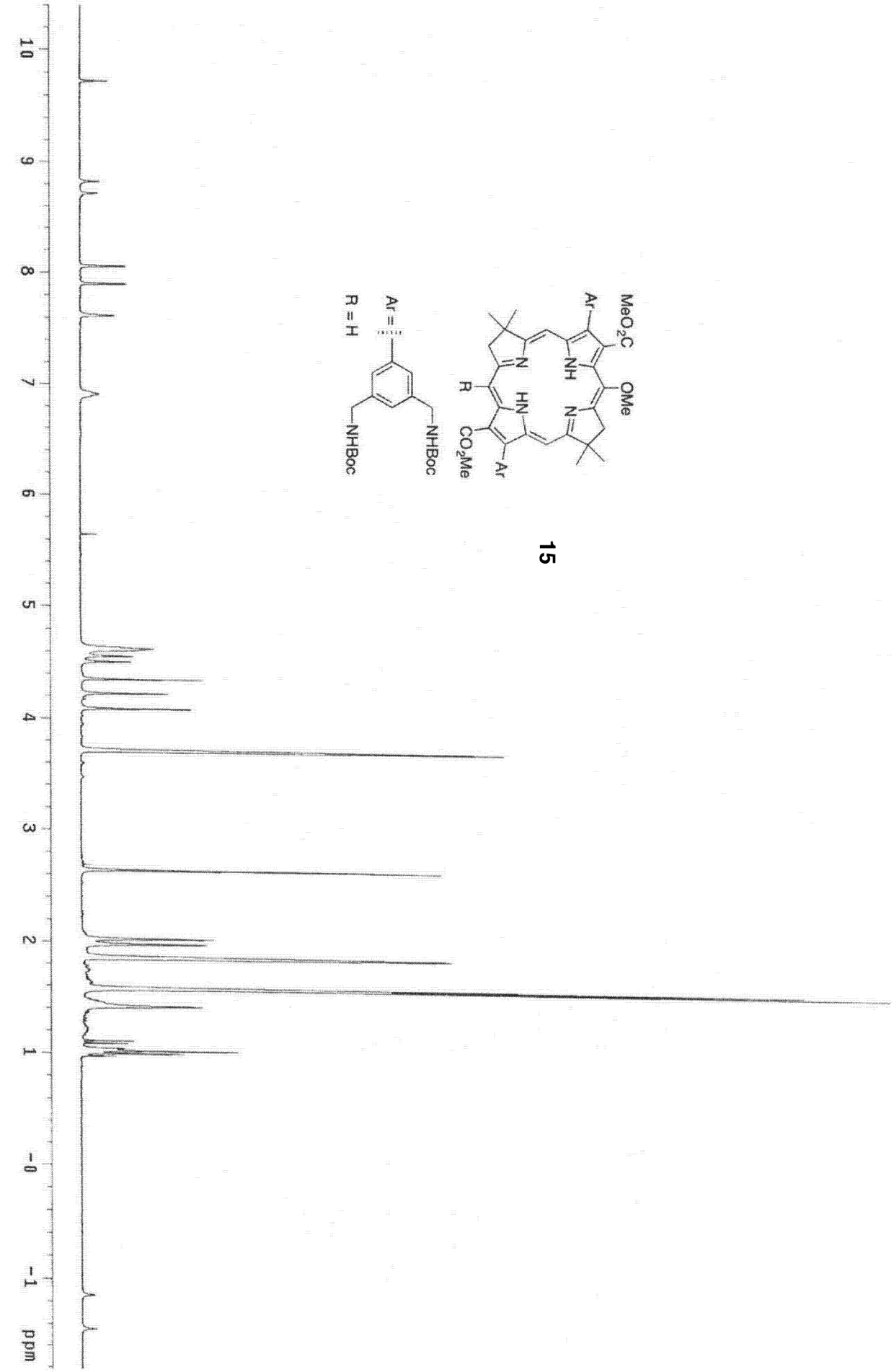

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 366.0 | 0.58456 |
| 1 | | 730.0 | 0.43757 |
| 1 | | 517.0 | 0.15903 |

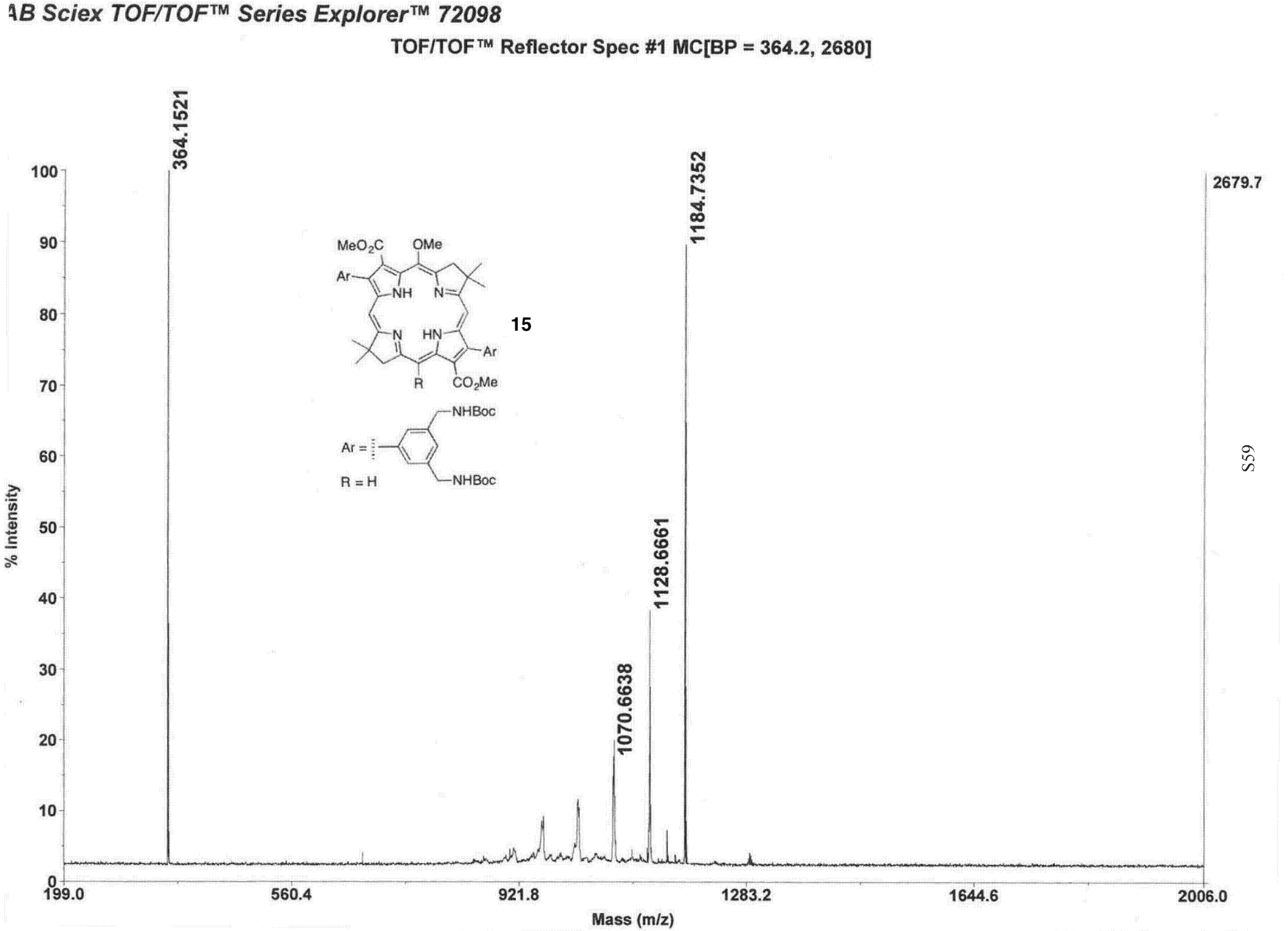
Report generated by : Lindsey Lab Signature: .....

*** End Spectrum/Peak Report ***



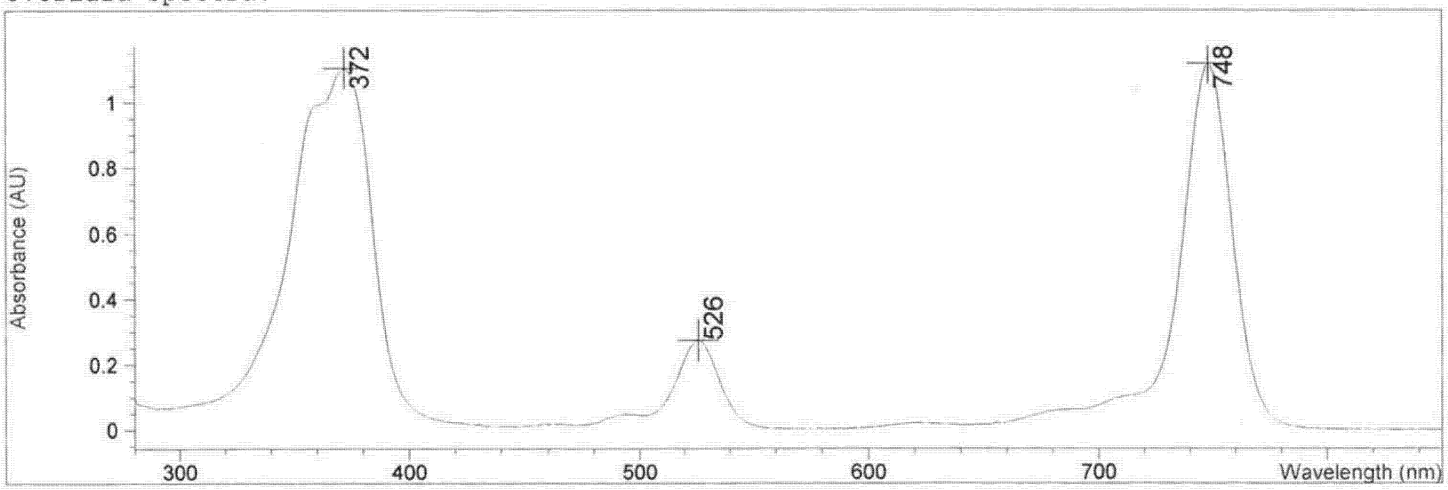

**14**


MeO2C
Ar
OMe
NH
N
HN
N
R
CO2Me
Ar
15
Ar =
R = H
NHBoc
NHBoc
10
9
8
7
6
5
4
3
2
1
-0
-1
ppm


AB Sciex TOF/TOF™ Series Explorer™ 72098
TOF/TOF™ Reflector Spec #1 MC[BP = 364.2, 2680]
364.1521
1184.7352
2679.7
1128.6661
1070.6638
MeO2C
OMe
Ar
NH
N
N
HN
Ar
R
CO2Me
15
NHBoc
Ar =
R = H
NHBoc
% Intensity
100
90
80
70
60
50
40
30
20
10
0
199.0
560.4
921.8
1283.2
1644.6
2006.0
Mass (m/z)

Method file : <untitled>
Information : Default Method
Data File : C:\Chem32\1\DATA\JIMMY\grouped data\J123, C-ES-NHBOC IN THF.SD
Created : 2/12/14 15:24:16

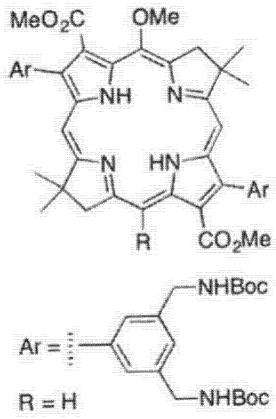
Overlaid Spectra:



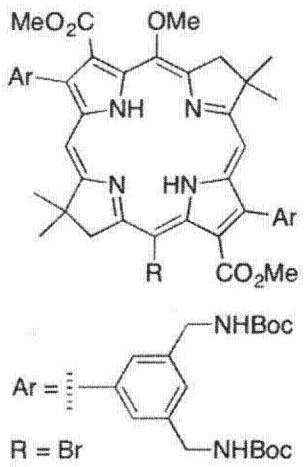

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 748.0 | 1.11890 |
| 1 | | 372.0 | 1.10520 |
| 1 | | 526.0 | 0.27391 |

Report generated by : Lindsey Lab Signature: .....

*** End Spectrum/Peak Report ***



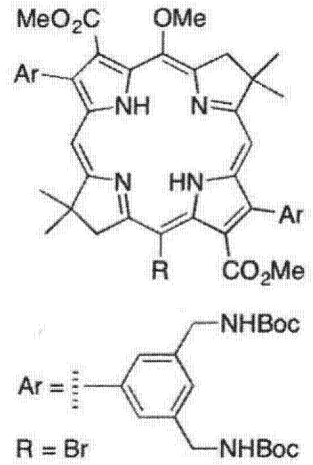

**15**


MeO2C
OMe
Ar
NH
N
N
HN
Ar
R
CO2Me
NHBoc
Ar =
R = Br
NHBoc

**16**


8
7
6
5
4
3
2
1
-0
-1
ppm

TOF/TOF™ Reflector Spec #1 MC[BP = 364.4, 1896]




16





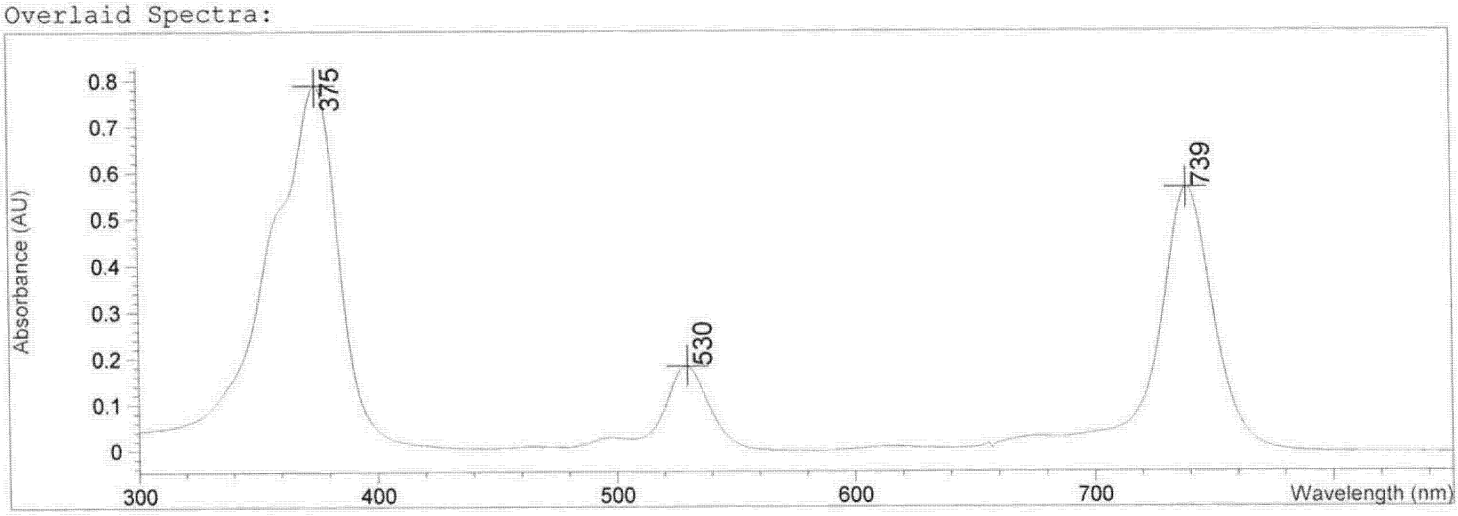

Printed: 17:07, February 26, 2014

C:\AB SCIEX\TOFTOF Data\ExportT2D\User Project 1\Lindsey\JIMMY\2-25-14\L19_MS.t2d

Spectrum/Peak Report Date 2/25/2014 Time 15:02:48 Page 1 of 1

Method file : <untitled>
Information : Default Method
Data File : C:\CHEM32\1\DATA\JIMMY\PRO-C-ES-NHBOC-BR.SD Created : 2/25/14 15:01:43

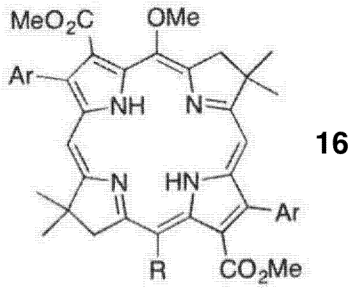
Overlaid Spectra:



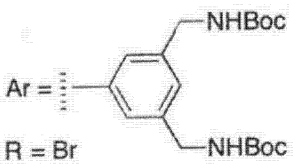

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 375.0 | 0.78810 |
| 1 | | 739.0 | 0.56406 |
| 1 | | 530.0 | 0.18271 |

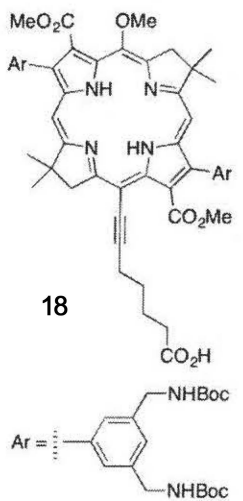
Report generated by : Lindsey Lab Signature: .....

*** End Spectrum/Peak Report ***

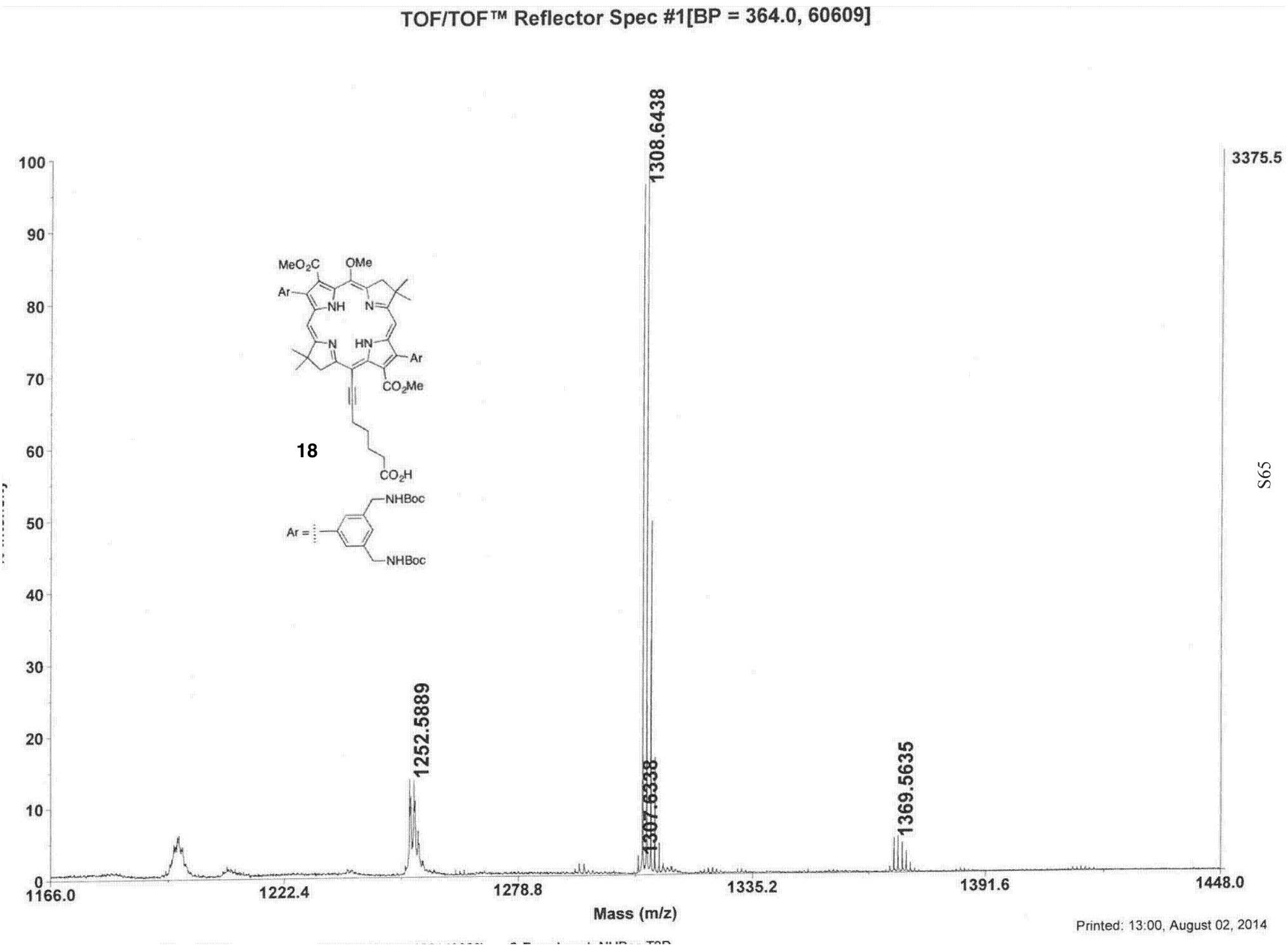



**16**



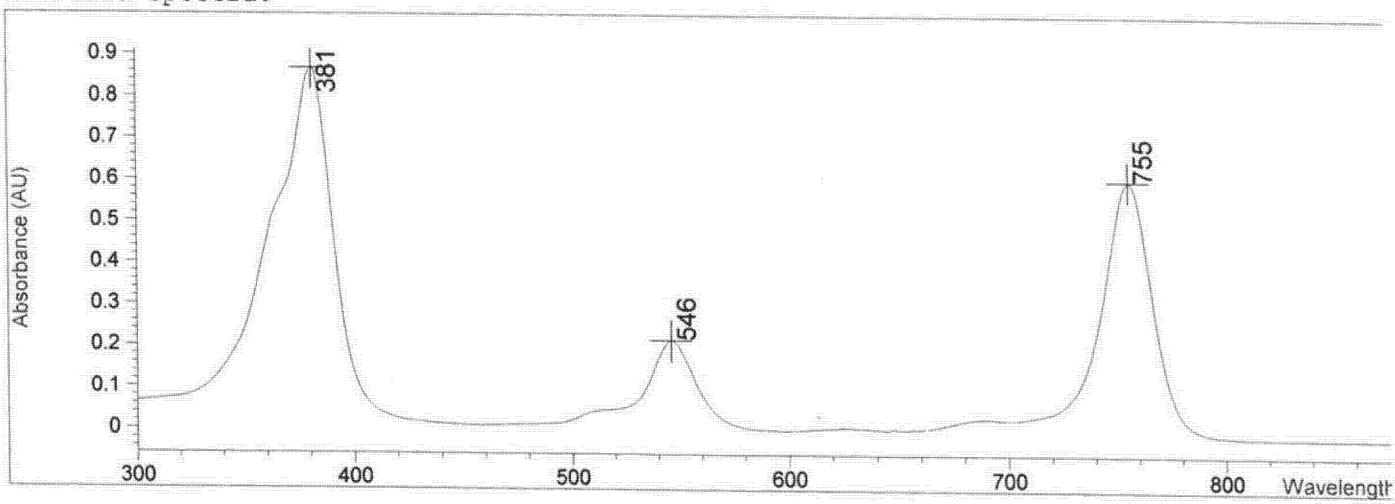



18


TOF/TOF™ Reflector Spec #1[BP = 364.0, 60609]
1308.6438
3375.5
1252.5889
1307.6338
1369.5635
100
90
80
70
60
50
40
30
20
10
0
1166.0
1222.4
1278.8
1335.2
1391.6
1448.0
Mass (m/z)
MeO2C
OMe
Ar
NH
N
N
HN
Ar
CO2Me
CO2H
18
Ar =
NHBoc
NHBoc
Printed: 13:00, August 02, 2014

Method file : <method not saved>
Information : Default Method
Data File : C:\Chem32\1\DATA\nuonuo\20140728\PRO-C-ES-YNL-COOH-NHBOC(DCM).SD
Created : 7/29/14 18:15:13

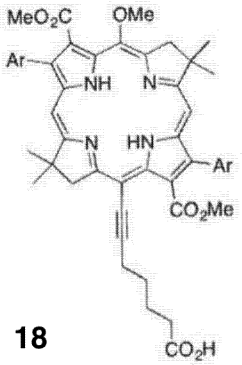
Overlaid Spectra:



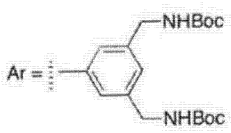

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 381.0 | 0.86713 |
| 1 | | 755.0 | 0.60377 |
| 1 | | 546.0 | 0.21494 |

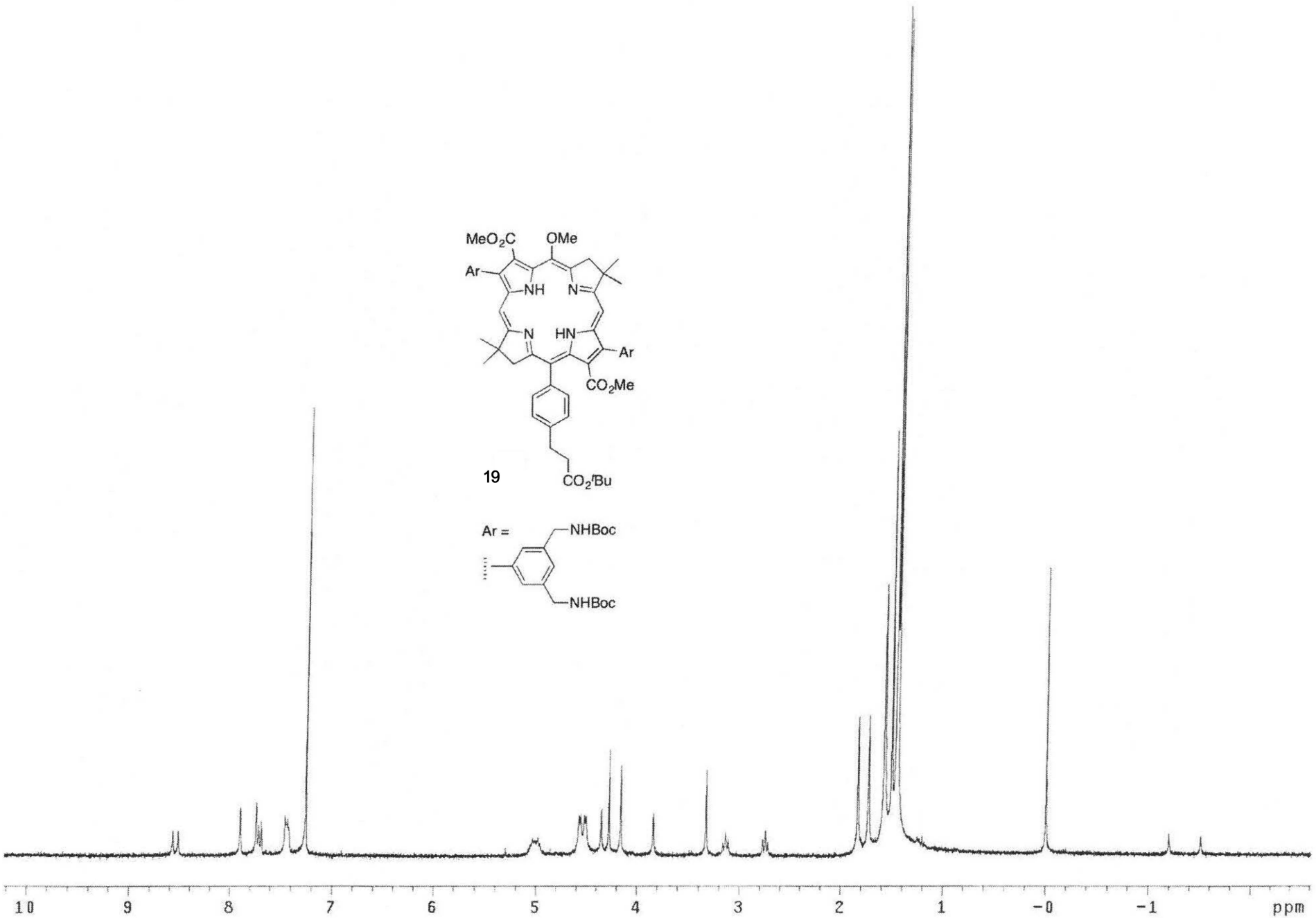
Report generated by : jon Signature: .....

*** End Spectrum/Peak Report ***



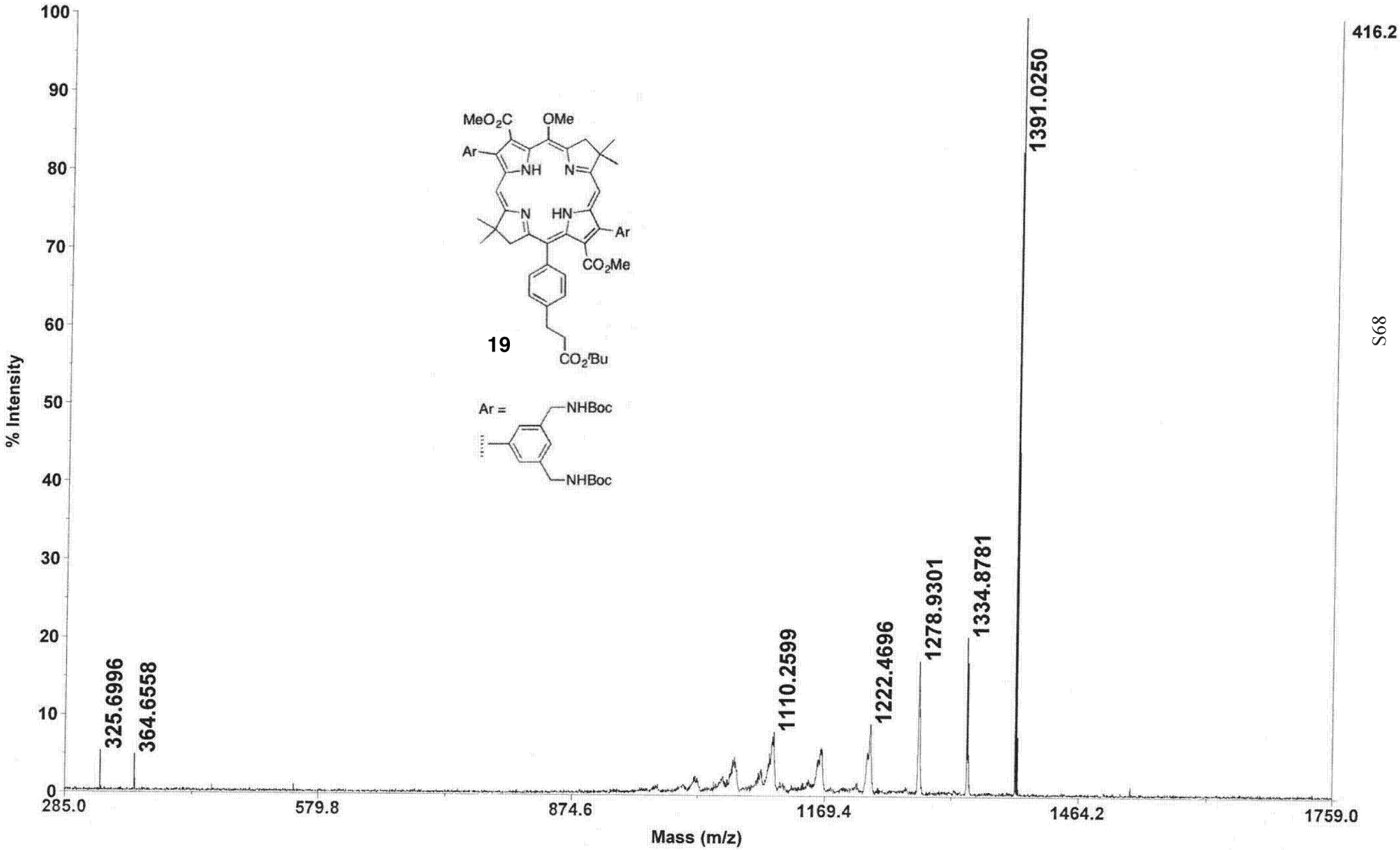

**18**




MeO2C
OMe
Ar
NH
N
N
HN
Ar
CO2Me
CO2tBu
19
Ar =
NHBoc
NHBoc
10
9
8
7
6
5
4
3
2
1
-0
-1
ppm

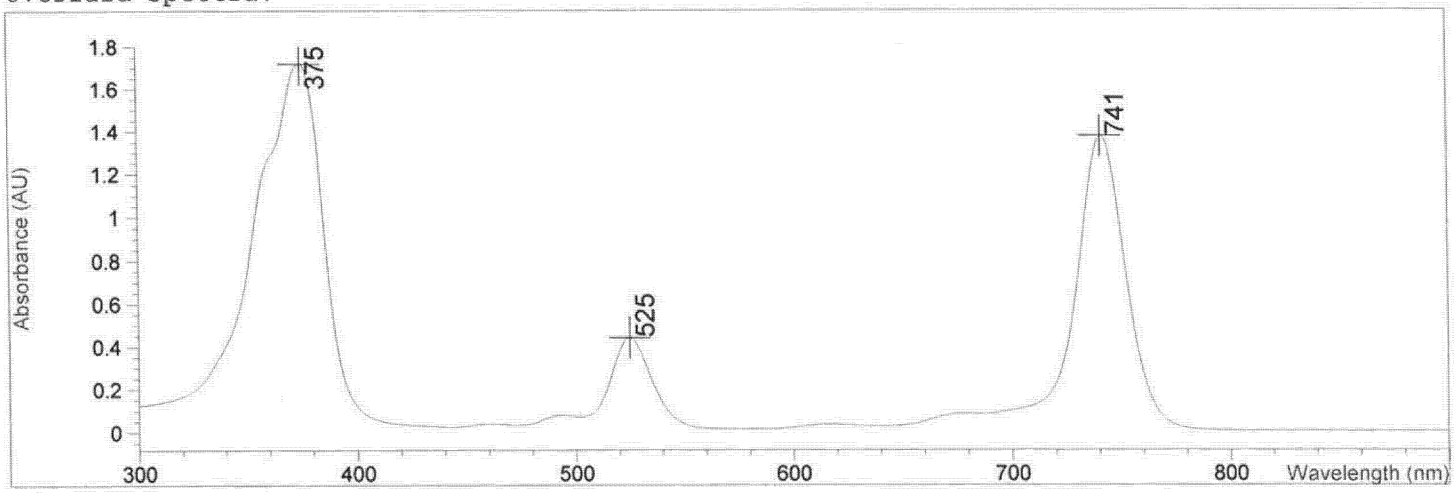
*AB Sciex TOF/TOF™ Series Explorer™ 72098*

**TOF/TOF™ Reflector Spec #1[BP = 1392.0, 416]**



Method file : <method not saved>
Information : Default Method
Data File : C:\CHEM32\1\DATA\NUONUO\20140513\PRO-C-ES-NHBOC-C-COOBUT(DCM).SD
Created : 5/13/14 10:07:17

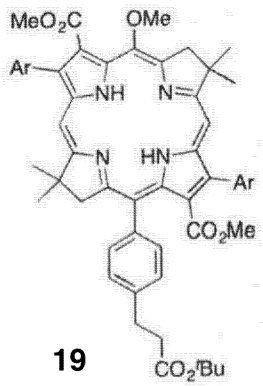
Overlaid Spectra:



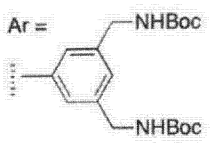

| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 375.0 | 1.71840 |
| 1 | | 741.0 | 1.37560 |
| 1 | | 525.0 | 0.44172 |

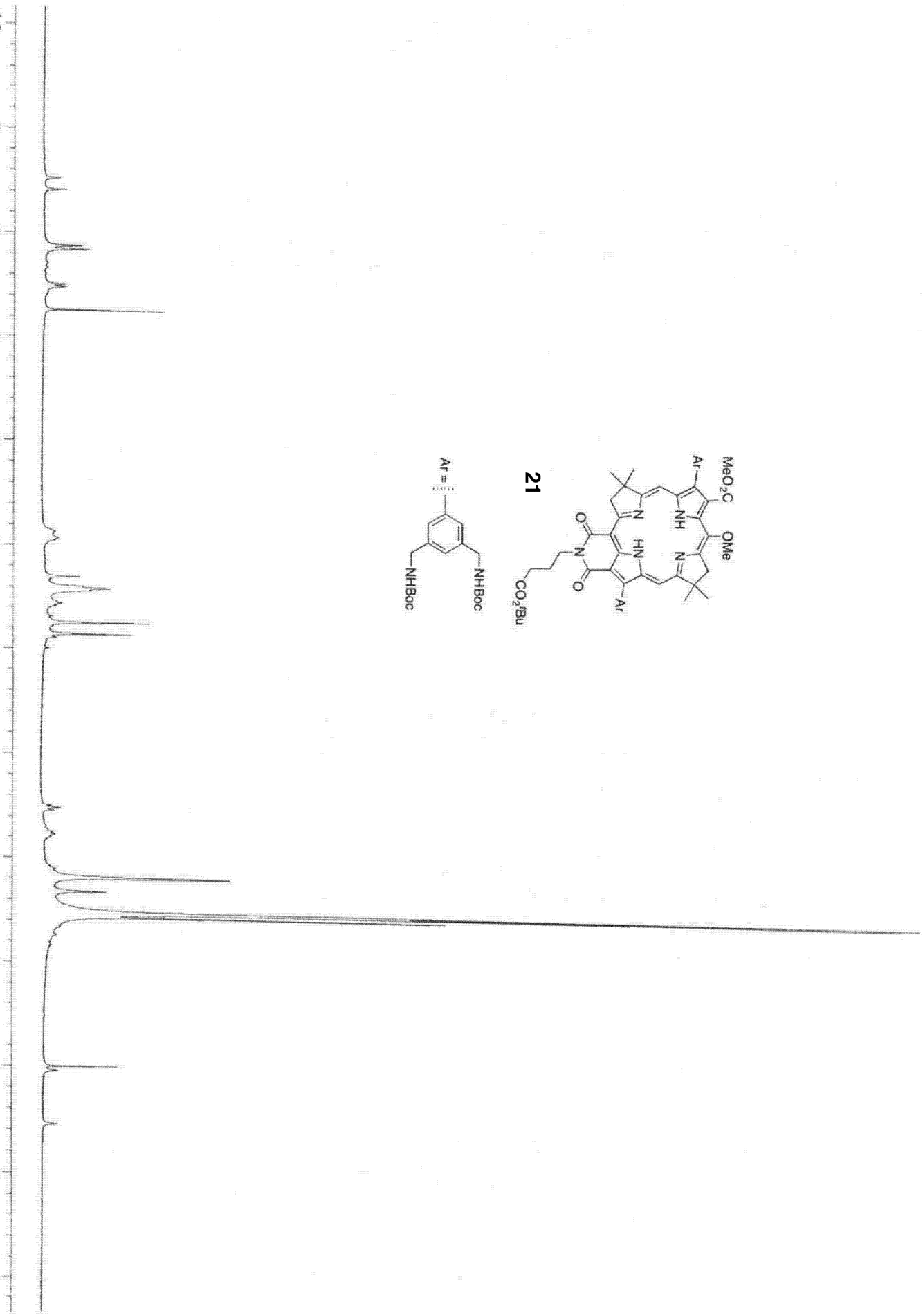
Report generated by : jon Signature: .....

*** End Spectrum/Peak Report ***



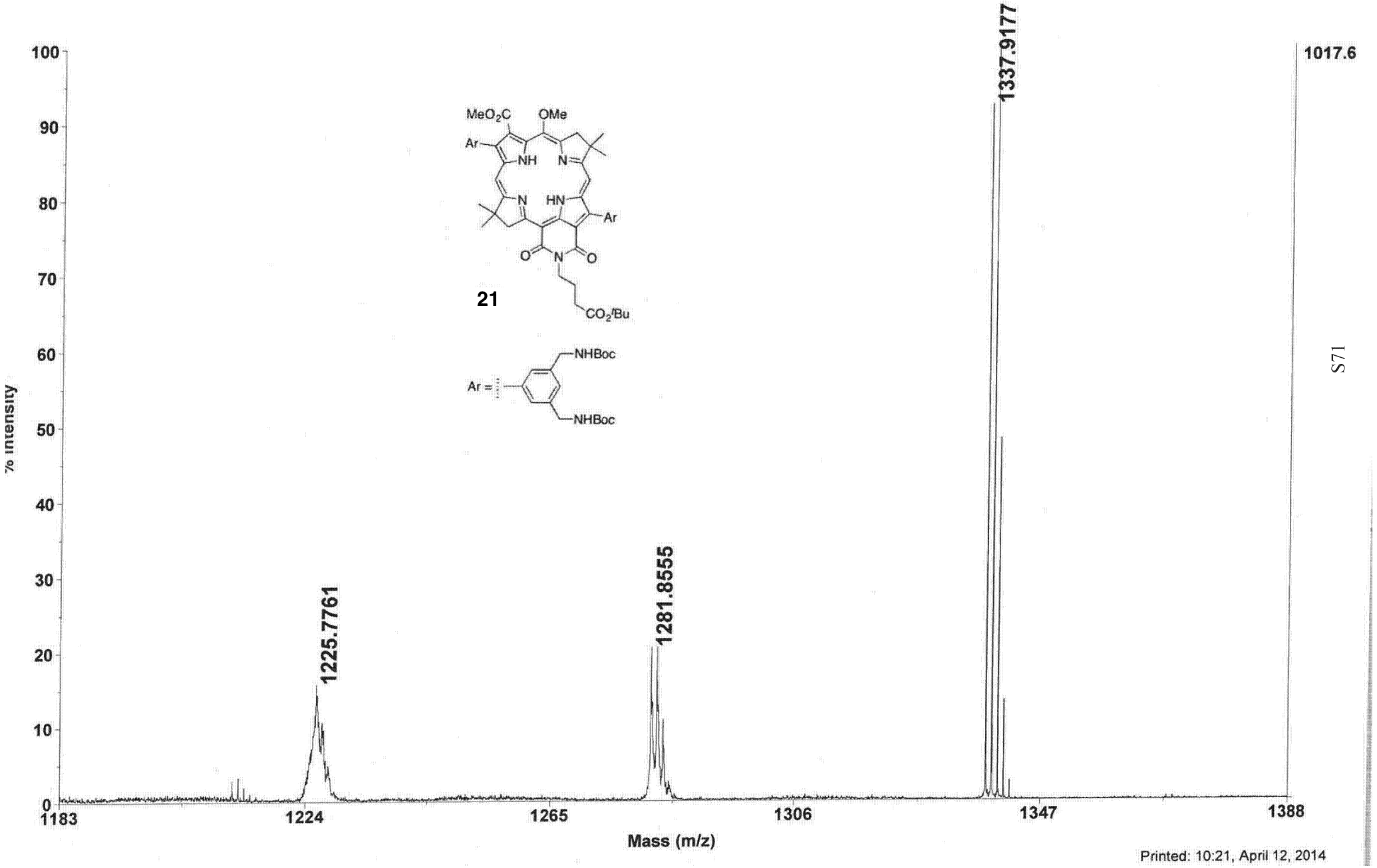

**19**




10
9
8
7
6
5
4
3
2
1
-0
-1
ppm
MeO2C
Ar
OMe
NH
N
HN
N
O
N
O
Ar
CO2tBu
21
Ar =
NHBoc
NHBoc

AB Sciex TOF/TOF™ Series Explorer™ 72098

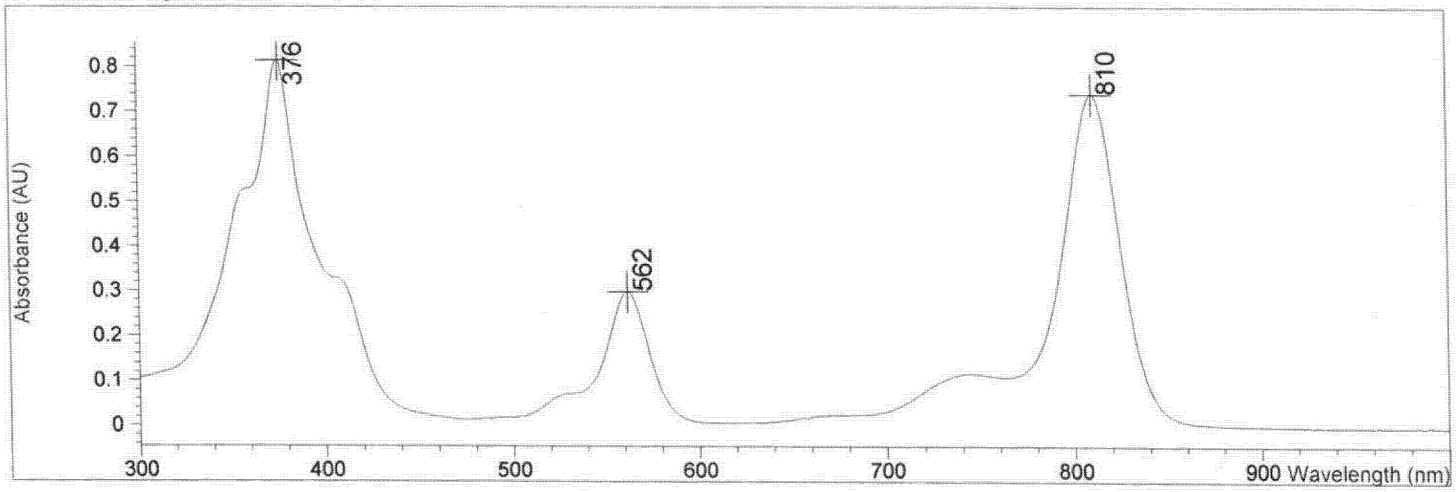
TOF/TOF™ Reflector Spec #1[BP = 364.1, 8763]




Printed: 10:21, April 12, 2014

Method file : <untitled>
Information : Default Method
Data File : C:\CHEM32\1\DATA\NUONUO\20140411\PRO-C-ES-NHBOC-COOBUT(DCM)-1.SD
Created : 4/11/14 17:58:09

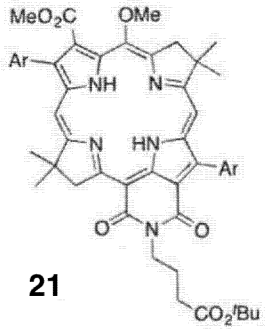
Overlaid Spectra:




| # | Name | Peaks(nm) | Abs(AU) |
|---|---|---|---|
| 1 | | 376.0 | 0.81293 |
| 1 | | 810.0 | 0.73882 |
| 1 | | 562.0 | 0.29771 |

Report generated by : Lindsey Lab Signature: .....

*** End Spectrum/Peak Report ***




**21**