*Supporting Information for*

# Asymmetric Mukaiyama Aldol Reaction of Nonactivated Ketones Catalyzed by *allo*-Threonine-Derived Oxazaborolidinone

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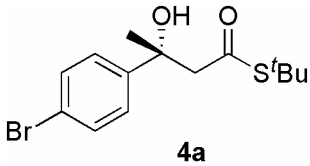
**Table of Contents:**

**General.** Dichloromethane was dried and distilled over $CaH_2$. $Et_2O$ and toluene was distilled from sodium benzophenone ketyl. The following compounds were prepared according to a literature procedure; ketone **2d**,[1] *O*-benzoyl-*N*-tosyl-(L)-*allo*-threonine ,[2] and silyl ketene acetals **3a**[3], **3b**[4].




**4a**

***S-tert*-Butyl (*R*)-3-(4-Bromophenyl)-3-hydroxybutanethioate (4a)** *(Typical Procedure for Asymmetric Aldol Reaction*; Table 1, entry 9). To a solution of *O*-benzoyl-*N*-tosyl-(L)-*allo*-threonine (75.5 mg, 0.200 mmol) in dry $CH_2Cl_2$ (2.0 mL) under argon atmosphere at room temperature was added dichlorophenylborane (28.5 μL, 0.22 mmol). After being stirred for 30 min, the mixture was concentrated in vacuo. To a solution of the resulting OXB **1** in dry toluene (0.5 mL) at –10 °C were added *p*-bromoacetophenone (**2a**) (199 mg, 1.00 mmol) and silyl ketene acetal **3b** (306 mg, 1.50 mmol). After being stirred at –10 °C for 48 h, the reaction mixture was quenched by the addition of saturated aqueous $NaHCO_3$ and filtered. The filtrate was extracted three times with ethyl acetate, dried ($Na_2SO_4$), and concentrated in vacuo. The residue was dissolved in aqueous 1N HCl (10 mL) and THF (10 mL) at room temperature. After being for 3 h, the mixture was poured into aqueous $NaHCO_3$ and extracted three times with ethyl acetate. The organic layers were dried ($Na_2SO_4$) and concentrated in vacuo. Purification of the residue by flash chromatography ($SiO_2$, 2% ethyl acetate in hexane) gave, in the order of elution, 225 mg (68%) of (*R*)-**4a** (94% ee) and 26.1 mg (13%) of **7** (44% ee). **4a**: $[\alpha]^{18}_D$ 28.1 (*c* 1.05, $CHCl_3$); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.36 (9H, s), 1.50 (3H, s), 2.86 (1H, d, *J* = 15.5), 3.02 (1H, d, *J* = 15.4), 4.35 (1H, s), 7.29–7.32 (2H, m), 7.43–7.46 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 29.5, 30.1, 49.0, 54.9, 73.9, 120.8, 126.6, 131.2, 145.6, 201.3. HRMS (EI) calcd for $C_{14}H_{19}BrO_2S$ 330.0289, found 330.0267. The ee value of **4a** was determined by HPLC analysis using a Chiralcel OD column (1 mL/min, 0.1% *i*-PrOH in hexane); retention times: 34.6 min (major *R*-enantiomer) and 42.6 min (minor *S*-enantiomer).

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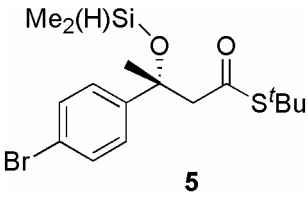
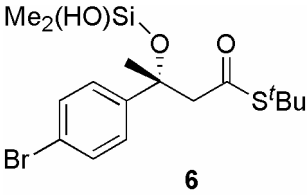
[1] Percec, V.; Bera, T. K.; De, B. B.; Sanai, Y.; Smith, J.; Holerca, M. N.; Barboiu, B. *J. Org. Chem.* **2001**, *66*, 2104–2117.
[2] Wang, X.; Adachi, S.; Iwai, H.; Takatsuki, H.; Fujita, K.; Kubo, M.; Oku, A.; Harada, T. *J. Org. Chem*. **2003**, *68*, 10046–10057.
[3] Kita, Y.; Segawa, J.; Haruta, J.; Yasuda, H.; Tamura, Y. *J. Chem. Soc., Perkin Trans. 1* **1982**, 1099–1104.
[4] Harada, T.; Adachi, S.; Wang, X. *Org. Lett.* **2004**, *6,* 4877–4879.



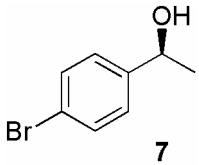

**5**

***S-tert*-Butyl (*R*)-3-(4-Bromophenyl)-3-dimethylsilyloxybutanethioate (5):** $^1$H NMR (500 MHz, $CDCl_3$) δ 0.15 (3H, d, *J* = 2.8 Hz), 0.23 (3H, d, *J* = 2.8 Hz), 1.36 (9H, s), 1.79 (3H, s), 2.81 (1H, d, *J* = 13.6 Hz), 2.86 (1H, d, *J* = 13.6 Hz), 4.71 (1H, sept, *J* = 2.8 Hz), 7.25–7.29 (2H, m), 7.42–7.46 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 0.2, 0.4, 27.7, 29.5, 48.0, 58.7, 76.1, 120.9, 127.1, 131.0, 145.8, 196.7; HRMS (EI) calcd for $C_{16}H_{25}BrO_2SSi$ 388.0528, found 388.0528. The ee value (91%; Table 1, entry 2) was determined after transforming (aqueous 1N HCl, THF, room temperature) to **4a** by HPLC analysis using a Chiralcel OD column.




**6**

***S-tert*-Butyl (*R*)-3-(4-Bromophenyl)-3-(hydroxydimethylsilyloxy)butanethioate (6):** $^1$H NMR (500 MHz, $CDCl_3$) δ 0.18 (3H, s), 0.19 (3H, s), 1.35 (9H, s), 1.76 (3H, s), 2.91 (1H, d, *J* = 13.6 Hz), 2.93 (1H, d, *J* = 13.6 Hz), 3.15 (1H, s), 7.26–7.29 (2H, m), 7.43–7.46 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 0.7, 0.9, 29.5, 29.7, 48.4, 58.4, 76.5, 120.8, 127.0, 131.0, 146.2, 198.4; FT-IR (liquid film) 3409 (br), 1668 $cm^{-1}$; HRMS (FAB/*m*-MBA + NaI) calcd for $C_{16}H_{25}BrNaO_3SSi$ ($M+Na^+$) 427.0375, found 427.0388. The ee value (90%; Table 1, entry 2) was determined after transforming (aqueous 1N HCl, THF, room temperature) to **4a** by HPLC analysis using a Chiralcel OD column.

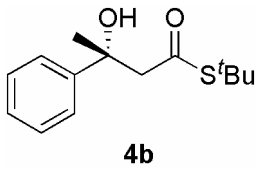



**7**

**(*S*)-1-(4-Bromophenyl)methanol (7):**[5] $[\alpha]^{21}_D$ –20.6 (*c* 1.07, MeOH) (44% ee), lit.[5] $[\alpha]^{21}_D$ 32.9 (*c* 1.39, MeOH) for >99% ee, *R* enantiomer; $^1$H NMR (500 MHz, $CDCl_3$) δ 1.46 (3H, d, *J* = 6.5 Hz), 2.01 (1H, br s), 4.85 (1H, q, *J* = 6.5 Hz), 7.22–7.25 (2H, m), 7.45–7.47 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 25.2, 69.7, 121.1, 127.1, 131.5, 144.7. The ee value was determined by GC analysis using a BETA DEX™

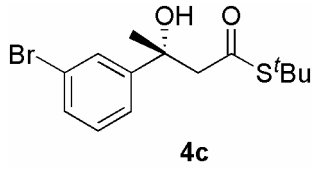
[5] Mathre, D. J.; Thompson, A. S.; Douglas, A. W.; Hoogsteen, K.; Carroll, J. D.; Corley, E. G.; Grabowski, E. J. J. *J. Org. Chem.* **1993**, *58*, 2880–2888.

225 (m) column (30 m, 1.8 kg/cm$^2$, initial temperature 80 ºC, 2 ºC/min ramp to 200 ºC); retention times: 39.0 min (minor *R*-enantiomer) and 39.4 min (major *S*-enantiomer).



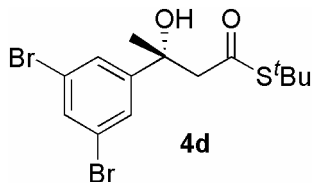

**4b**

***S-tert*-Butyl (*R*)-3-Hydroxy-3-phenylbutanethioate (4b):** $[\alpha]^{18}_D$ 31.3 (*c* 1.31, $CHCl_3$) (91% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.35 (9H, s), 1.54 (3H, s), 2.88 (1H, d, *J* = 15.3 Hz), 3.06 (1H, d, *J* = 15.3 Hz), 4.30 (1H, s), 7.22 (1H, br t, *J* = 7.3 Hz), 7.31–7.34 (2H, m), 7.43–7.45 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 29.5, 30.1, 48.7, 55.3, 74.0, 124.6, 126.7, 128.1, 146.4, 201.3. HRMS (EI) calcd for $C_{14}H_{20}O_2S$ 252.1184, found 252.1187. Anal. calcd for $C_{14}H_{20}O_2S$: C, 66.63; H, 7.99. Found: C, 66.24; H, 8.32. The ee value was determined by HPLC analysis using a Chiralcel OD column (1 mL/min, 0.1%, *i*-PrOH in hexane); retention times: 17.6 min (major *R*-enantiomer) and 21.6 min (minor *S*-enantiomer). The absolute stereochemistry was determined by correlation (*vide infra*).




**4c**

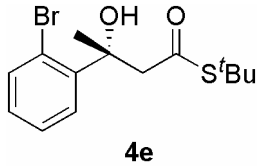
***S-tert*-Butyl (*R*)-3-(3-Bromophenyl)-3-hydroxybutanethioate (4c):** $[\alpha]^{18}_D$ 34.8 (*c* 1.72, $CHCl_3$) (91% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.36 (9H, s), 1.51 (3H, s), 2.85 (1H, d, *J* = 15.4 Hz), 3.01 (1H, d, *J* = 15.4 Hz), 4.36 (1H, s), 7.19 (1H, t, *J* = 4.1 Hz), 7.33–7.37 (2H, m), 7.61 (1H, t, *J* = 1.9 Hz); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 29.5, 30.0, 49.0, 54.9, 73.8, 122.5, 123.3, 128.1, 129.7, 129.9, 148.9, 201.2; HRMS (EI) calcd for $C_{14}H_{19}BrO_2S$ 330.0289, found 330.0286. The ee value was determined by HPLC analysis using a Chiralpak AD-H column (1 mL/min, 0.5%, *i*-PrOH in hexane); retention times: 21.9 min (minor *S*-enantiomer) and 23.0 min (major *R*-enantiomer). The absolute stereochemistry was assumed by analogy.




**4d**

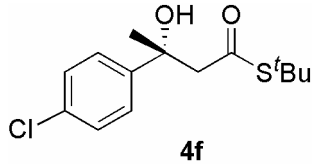
***S-tert*-Butyl (*R*)-3-(3,5-Dibromophenyl)-3-hydroxybutanethioate (4d):** $[\alpha]^{16}_D$ 39.8 (*c* 1.02, $CHCl_3$) (94% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.38 (9H, s), 1.50 (3H, s), 2.84 (1H, d, *J* = 15.4 Hz), 2.98 (1H, d, *J* = 15.4 Hz), 4.40 (1H, s), 7.52 (2H, d, *J* = 1.7 Hz), 7.54 (1H, t, *J* = 1.7 Hz); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 29.5, 29.9, 49.3, 54.6, 73.6, 122.9, 127.0, 132.5, 150.6, 201.1; HRMS (EI) calcd for

$C_{14}H_{18}Br_2O_2S$ 409.9374, found 409.9374. The ee value was determined by HPLC analysis using a Chiralpak AD-H column (1 mL/min, 0.5%, *i*-PrOH in hexane); retention times: 11.7 min (major *R*-enantiomer) and 16.6 min (minor *S*-enantiomer). The absolute stereochemistry was assumed by analogy.



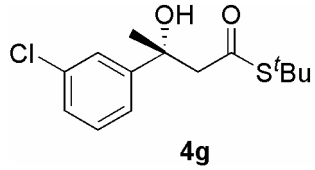

**4e**

***S-tert*-Butyl (*R*)-3-(2-Bromophenyl)-3-hydroxybutanethioate (4e):** $[\alpha]^{16}_D$ 100.7 (*c* 1.06, $CHCl_3$) (92% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.29 (9H, s), 1.62 (3H, s), 3.00 (1H, d, *J* = 15.1 Hz), 3.78 (1H, d, *J* = 15.1 Hz), 4.66 (1H, s), 7.08 (1H, dt, *J* = 1.6 and 7.6 Hz), 7.29 (1H, dd, *J* = 1.2 and 8.3 Hz), 7.56 (1H, dd, *J* = 1.2 and 7.9 Hz), 7.83 (1H, dd, *J* = 1.7 and 8.0 Hz); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 26.9, 29.4, 48.6, 52.0, 74.8, 119.9, 127.4, 128.4, 128.7, 134.8, 144.0, 201.8; HRMS (FAB/*m*-NBA) calcd for $C_{14}H_{20}BrO_2S$ ($M+H^+$) 331.0367, found 331.0372. The ee value was determined by HPLC analysis using a Chiralpak AD-H column (1 mL/min, 0.5%, *i*-PrOH in hexane); retention times: 17.2 min (major *R*-enantiomer) and 20.8 min (minor *S*-enantiomer). The absolute stereochemistry was assumed by analogy.




**4f**

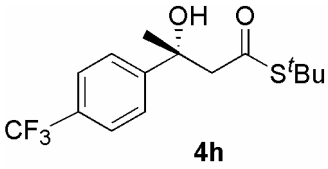
***S-tert*-Butyl (*R*)-3-(4-Chlorophenyl)-3-hydroxybutanethioate (4f):** $[\alpha]^{18}_D$ 23.5 (*c* 1.09, $CHCl_3$) (93% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.35 (9H, s), 1.50 (3H, s), 2.85 (1H, d, *J* = 15.4 Hz), 3.02 (1H, d, *J* = 15.4 Hz), 4.35 (1H, s), 7.27–7.30 (2H, m), 7.35–7.38 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 29.5, 30.1, 48.9, 55.0, 73.8, 126.2, 128.2, 132.6, 145.1, 201.2; HRMS (EI) calcd for $C_{14}H_{19}ClO_2S$ 286.0794, found 286.0781. The ee value was determined by HPLC analysis using a Chiralpak AD-H column (1 mL/min, 0.5%, *i*-PrOH in hexane); retention times: 23.1 min (minor *S*-enantiomer) and 30.8 min (major *R*-enantiomer). The absolute stereochemistry was assumed by analogy.




**4g**

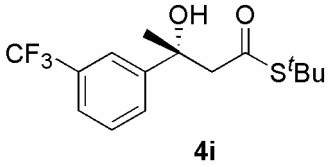
***S-tert*-Butyl (*R*)-3-(3-Chlorophenyl)-3-hydroxybutanethioate (4g):** $[\alpha]^{18}_D$ 26.1 (*c* 1.00, $CHCl_3$) (95% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.36 (9H, s), 1.51 (3H, s), 2.85 (1H, d, *J* = 15.4 Hz), 3.01 (1H, d, *J* = 15.4 Hz), 4.36 (1H, s), 7.18–7.30 (3H, m), 7.45 (1H, t, *J* = 1.9 Hz); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 29.4, 30.0, 49.0, 54.9, 73.8, 122.9, 125.2, 127.0, 129.4, 134.1, 148.6, 201.2; HRMS (EI) calcd for

$C_{14}H_{19}ClO_2S$ 286.0794, found 286.0801. The ee value was determined by HPLC analysis using a Chiralpak AD-H column (1 mL/min, 0.5%, *i*-PrOH in hexane); retention times: 17.7 min (minor *S*-enantiomer) and 22.6 min (major *R*-enantiomer). The absolute stereochemistry was assumed by analogy.



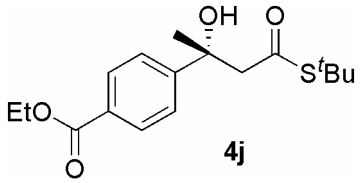

**4h**

***S-tert*-Butyl (*R*)-3-(4-Trifluoromethylphenyl)-3-hydroxybutanethioate (4h):** $[\alpha]^{18}_D$ 28.7 (*c* 1.15, $CHCl_3$) (92% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.34 (9H, s), 1.53 (3H, s), 2.90 (1H, d, *J* = 15.5 Hz), 3.06 (1H, d, *J* = 15.5 Hz), 4.43 (1H, s), 7.55–7.60 (4H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 29.4, 30.1, 49.0, 54.8, 74.0, 124.2 (q, *J* = 272 Hz), 125.1 (q, *J* = 4 Hz), 125.2, 129.1 (q, *J* = 32 Hz), 150.5, 201.2; HRMS (EI) calcd for $C_{15}H_{19}F_3O_2S$ 320.1058, found 320.1051. The ee value was determined by HPLC analysis using a Chiralpak AD-H column (1 mL/min, 0.5%, *i*-PrOH in hexane); retention times: 20.4 min (minor *S*-enantiomer) and 23.0 min (major *R*-enantiomer). The absolute stereochemistry was assumed by analogy.




**4i**

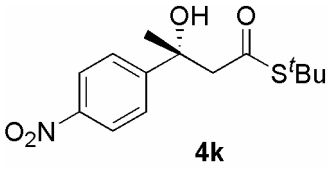
***S-tert*-Butyl (*R*)-3-(3-Trifluoromethylphenyl)-3-hydroxybutanethioate (4i):** $[\alpha]^{13}_D$ 20.4 (*c* 1.01, $CHCl_3$) (94% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.32 (9H, s), 1.54 (3H, s), 2.88 (1H, d, *J* = 15.3 Hz), 3.05 (1H, d, *J* = 15.3 Hz), 4.45 (1H, s), 7.44 (1H, br t, *J* = 7.7 Hz), 7.49 (1H, br d, *J* = 7.8 Hz), 7.62 (1H, br d, *J* = 7.7 Hz), 7.72 (1H, br s); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 29.3, 30.0, 48.9, 54.9, 73.9, 121.7 (q, *J* = 4 Hz), 123.7 (q, *J* = 4 Hz), 124.2 (q, *J* = 272 Hz), 128.2, 128.6, 130.4 (q, *J* = 32 Hz), 147.6, 201.2; HRMS (EI) calcd for $C_{15}H_{19}F_3O_2S$ 320.1058, found 320.1054. The ee value was determined by HPLC analysis using a Chiralpak AD-H column (1 mL/min, 0.5%, *i*-PrOH in hexane); retention times: 11.4 min (major *R*-enantiomer) and 14.6 min (minor *S*-enantiomer). The absolute stereochemistry was assumed by analogy.




**4j**

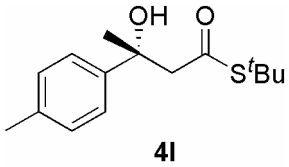
***S-tert*-Butyl (*R*)-3-(4-Ethoxycarbonylphenyl)-3-hydroxybutanethioate (4j):** $[\alpha]^{21}_D$ 17.0 (*c* 1.05, $CHCl_3$) (94% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.34 (9H, s), 1.39 (3H, t, *J* = 7.1 Hz), 1.52 (3H, s), 2.90

(1H, d, $J$ = 15.5 Hz), 3.08 (1H, d, $J$ = 15.5 Hz), 4.37 (2H, q, $J$ = 7.1 Hz), 4.41 (1H, s), 7.49–7.51 (2H, m), 7.99–8.01 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 14.3, 29.5, 30.1, 49.0, 54.8, 60.8, 74.1, 124.7, 129.0, 129.5, 151.5, 166.5, 201.2; HRMS (FAB/*m*-NBA) calcd for $C_{17}H_{25}O_4S$ ($M+H^+$) 325.1474, found 325.1466. The ee value was determined by HPLC analysis using a Chiralpak AD-H column (1 mL/min, 4%, *i*-PrOH in hexane); retention times: 17.0 min (minor *S*-enantiomer) and 18.6 min (major *R*-enantiomer). The absolute stereochemistry was assumed by analogy.



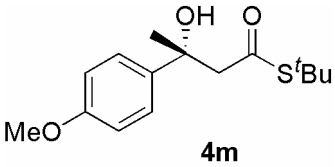

**4k**

***S-tert*-Butyl (*R*)-3-Hydroxy-3-(4-nitrophenyl)butanethioate (4k):** $[\alpha]^{18}_D$ 31.0 (*c* 1.89, $CHCl_3$) (98% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.34 (9H, s), 1.53 (3H, s), 2.92 (1H, d, $J$ = 15.6 Hz), 3.08 (1H, d, $J$ = 15.6 Hz), 4.52 (1H, s), 7.59–7.63 (2H, m), 8.17–8.20 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 29.4, 30.1, 49.3, 54.5, 74.1, 123.4, 125.8, 146.9, 153.9, 201.1; HRMS (EI) calcd for $C_{14}H_{19}NO_4S$ 297.1035, found 297.1030. The ee value was determined by HPLC analysis using a Chiralcel OD column (1 mL/min, 1%, *i*-PrOH in hexane); retention times: 18.6 min (major *R*-enantiomer) and 29.9 min (minor *S*-enantiomer). The absolute stereochemistry was assumed by analogy.




**4l**

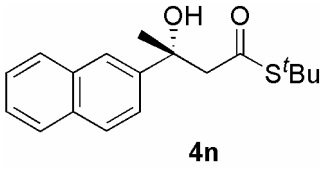
***S-tert*-Butyl (*R*)-3-Hydroxy-3-(4-methylphenyl)butanethioate (4*l*):** $[\alpha]^{21}_D$ 17.4 (*c* 1.00, $CHCl_3$) (92% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.38 (9H, s), 1.53 (3H, s), 2.33 (3H, s), 2.88 (1H, d, $J$ = 15.4 Hz), 3.04 (1H, d, $J$ = 15.4 Hz), 4.25 (1H, s), 7.13–7.15 (2H, m), 7.32–7.34 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 20.9, 29.5, 30.1, 48.7, 55.3, 73.9, 124.5, 128.8, 136.2, 143.6, 201.3. HRMS (EI) calcd for $C_{15}H_{22}O_2S$ 266.1341, found 266.1340. The ee value was determined by HPLC analysis using a Chiralcel OD column (1 mL/min, 0.1%, *i*-PrOH in hexane); retention times: 17.2 min (major *R*-enantiomer) and 20.6 min (minor *S*-enantiomer). The absolute stereochemistry was assumed by analogy.




**4m**

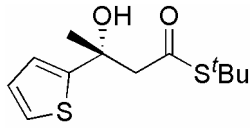
***S-tert*-Butyl (*R*)-3-Hydroxy-3-(4-methoxyphenyl)butanethioate (4m):** $[\alpha]^{18}_D$ 20.2 (*c* 1.62, $CHCl_3$) (81% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.37 (9H, s), 1.52 (3H, s), 2.86 (1H, d, $J$ = 15.4 Hz), 3.03 (1H, d,

$J$ = 15.3 Hz), 3.80 (3H, s), 4.25 (1H, s), 6.85–6.88 (2H, m), 7.34–7.37 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 29.5, 30.2, 48.7, 55.2, 55.4, 73.8, 113.4, 125.8, 138.8, 158.3, 201.4; HRMS (EI) calcd for $C_{15}H_{22}O_3S$ 282.1290, found 282.1286. The ee value was determined by HPLC analysis using a Chiralcel OD column (1 mL/min, 0.5%, *i*-PrOH in hexane); retention times: 15.6 min (major *R*-enantiomer) and 19.1 min (minor *S*-enantiomer). The absolute stereochemistry was assumed by analogy.



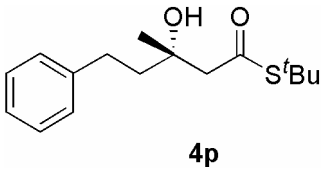

**4n**

***S-tert*-Butyl (*R*)-3-Hydroxy-3-(2-naphthyl)butanethioate (4n):** $[\alpha]^{19}_D$ 23.0 (*c* 1.00, $CHCl_3$) (97% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.32 (9H, s), 1.63 (3H, s), 2.98 (1H, d, $J$ = 15.5 Hz), 3.17 (1H, d, $J$ = 15.5 Hz), 4.45 (1H, s), 7.44–7.49 (2H, m), 7.54 (1H, dd, $J$ = 1.8 and 8.6 Hz), 7.80–7.86 (3H, m), 7.94 (1H, br s); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 29.5, 30.1, 48.9, 55.1, 74.3, 123.2, 123.3, 125.7, 126.0, 127.4, 127.9, 128.2, 132.3, 133.1, 143.9, 201.4; HRMS (EI) calcd for $C_{18}H_{22}O_2S$ 302.1340, found 302.1349. The ee value was determined by HPLC analysis using a Chiralcel OD column (1 mL/min, 0.1%, *i*-PrOH in hexane); retention times: 7.2 min (major *R*-enantiomer) and 13.9 min (minor *S*-enantiomer). The absolute stereochemistry was assumed by analogy.



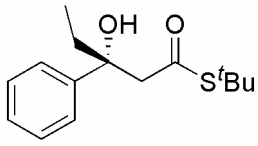

**4o**

***S-tert*-Butyl (*R*)-3-Hydroxy-(2-thienyl)butanethioate (4o):** $[\alpha]^{18}_D$ 11.7 (*c* 1.32, $CHCl_3$) (55% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.40 (9H, s), 1.62 (3H, s), 2.91 (1H, d, $J$ = 15.4 Hz), 3.07 (1H, d, $J$ = 15.4 Hz), 4.61 (1H, br s), 6.89 (1H, dd, $J$ = 1.2 and 3.6 Hz), 6.92 (1H, dd, $J$ = 3.6 and 5.0 Hz), 7.17 (1H, dd, $J$ = 1.2 and 5.0 Hz); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 29.5, 30.8, 48.9, 55.7, 73.2, 122.2, 123.9, 126.6, 151.8, 201.0; HRMS (EI) calcd for $C_{12}H_{18}O_2S_2$ 258.0748, found 258.0754. The ee value was determined by HPLC analysis using a Chiralpak AD-H column (1 mL/min, 0.5%, *i*-PrOH in hexane); retention times: 11.6 min (major *R*-enantiomer) and 13.1 min (minor *S*-enantiomer). The absolute stereochemistry was assumed by analogy.




**4p**

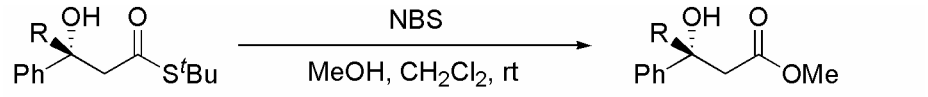
***S-tert*-Butyl (*S*)-3-Hydroxy-3-methyl-5-phenylpentanethioate (4p)** $[\alpha]^{18}_{D}$ –2.6 (*c* 1.48, $CHCl_3$) (52% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 1.31 (3H, s), 1.50 (9H, s), 1.80–1.86 (2H, m), 2.65 (1H, d, *J* = 15.1 Hz), 2.70–2.74 (3H, m), 3.60 (1H, s), 7.18–7.22 (3H, m), 7.27–7.30 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 26.7, 29.6, 30.3, 43.9, 48.7, 53.7, 72.2, 125.7, 128.26, 128.33, 142.2, 201.4; HRMS (EI) calcd for $C_{16}H_{24}O_2S$ 280.1497, found 280.1490. The ee value was determined by HPLC analysis using a Chiralcel OD column (1 mL/min, 1%, *i*-PrOH in hexane); retention times: 14.2 min (major *S*-enantiomer) and 16.8 min (minor *R*-enantiomer). The absolute stereochemistry was assumed by analogy.




**4q**

***S-tert*-Butyl (*R*)-3-Hydroxy-3-phenylpentanethioate (4q):** $[\alpha]^{18}_{D}$ 16.3 (*c* 1.61, $CHCl_3$) (for 66% ee); $^1$H NMR (500 MHz, $CDCl_3$) δ 0.76 (3H, t, *J* = 7.4 Hz), 1.32 (9H, s), 1.81 (2H, m), 2.89 (1H, d, *J* = 15.3 Hz), 3.06 (1H, d, *J* = 15.3 Hz), 4.24 (1H, s), 7.22 (1H, m), 7.30–7.33 (2H, m), 7.37–7.39 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 7.7, 29.5, 35.5, 48.7, 53.9, 76.7, 125.3, 126.6, 127.9, 144.7, 201.7; HRMS (EI) calcd for $C_{15}H_{22}O_2S$ 266.1341, found 266.1347. The ee value was determined by HPLC analysis using a Chiralcel OD column (1 mL/min, 0.1%, *i*-PrOH in hexane); retention times: 12.6 min (major *R*-enantiomer) and 14.2 min (minor *S*-enantiomer). The absolute stereochemistry was determined by correlation (*vide infra*).

**Absolute Structure Determination of 4b and 4q.** Treatment of **4b** (91% ee) with NBS in methanol and dichloromethane[6] gave **11a** (90% ee) in 80% yield. The absolute configuration of **4b** was determined to be *R* based on the specific rotation of methyl ester **11a**. The *R* stereochemistry of **4q** was established also by transforming it to methyl ester **11b**.




**4b**; R = Me (91% ee)
**4q**; R = Et (66 % ee)

**11a**; R = Me (80% yield, 90% ee)
**11b**; R = Et (50% yield, 65% ee)

*O*-Methyl (*R*)-3-Hydroxy-3-phenylbutanoate (**11a**): To a solution of **4b** (108 mg, 0.428 mmol, 91% ee) and methanol (0.47 mL, 12 mmol) in $CH_2Cl_2$ (1.3 mL) at room temperature was added *N*-bromosuccinimide (91.3 mg, 0.513 mmol). After being stirred for 1 h at room temperature, the mixture

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[6] Minato, H.; Kodama, H.; Miura, T.; Kobayashi, M. *Chem. Lett.* **1977**, 413–416.

was extracted twice with ethyl acetate. The mixture was poured into aqueous $NaHCO_3$ and extracted three times with ethyl acetate. The organic layers were dried ($Na_2SO_4$) and concentrated in vacuo. Purification of the residue by flash chromatography (20–50% ethyl acetate in hexane) gave 66.3 mg (80% yield) of (*R*)-**8a**: $[\alpha]^{21}_D$ 6.5 (*c* 1.49, EtOH) (90% ee), lit.[7] $[\alpha]^{24}_D$ –5.6 (*c* 1.09, EtOH) for 83% ee, *S* enantiomer; $^1$H NMR (500 MHz, $CDCl_3$) δ 1.55 (3H, s), 2.81 (1H, d, *J* = 16.0 Hz), 2.99 (1H, d, *J* = 16.0 Hz), 3.60 (3H, s), 4.33 (1H, br s), 7.24 (1H, m), 7.32–7.35 (2H, m), 7.44–7.46 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 30.5, 46.1, 51.6, 72.6, 124.3, 126.8, 128.2, 146.8, 173.0. The ee value was determined by HPLC analysis using a Chiralcel OD column (1 mL/min, 1%, *i*-PrOH in hexane); retention times: 13.5 min (major *R*-enantiomer) and 15.6 min (minor *S*-enantiomer).

*O*-Methyl (*R*)-3-Hydroxy-3-phenylpentanoate (**11b**): The compound was prepared in 52% yield from **4q** (66% ee) according to a procedure similar to that described above. (*R*)-**8b**: $[\alpha]^{21}_D$ –0.97 (*c* 1.03, EtOH) (65% ee), lit.[8] $[\alpha]^{14}_D$ 1.64 (*c* 0.85, EtOH) for 77% ee, *S* enantiomer; $^1$H NMR (500 MHz, $CDCl_3$) δ 0.76 (3H, t, *J* = 7.4 Hz), 1.77–1.85 (2H, m), 2.81 (1H, d, *J* = 16.0 Hz), 2.98 (1H, d, *J* = 16.0 Hz), 3.57 (3H, s), 4.28 (3H, s), 7.23 (1H, m), 7.31–7.34 (2H, m), 7.38–7.40 (2H, m); $^{13}$C NMR (125.8 MHz, $CDCl_3$) δ 7.8, 35.8, 44.7, 51.7, 75.1, 125.1, 126.7, 128.1, 145.1, 173.4. The ee value was determined by HPLC analysis using a Chiralcel OJ column (1 mL/min, 0.7% *i*-PrOH in hexane); retention times: 13.8 min (major *R*-enantiomer) and 16.5 min (minor *S*-enantiomer).

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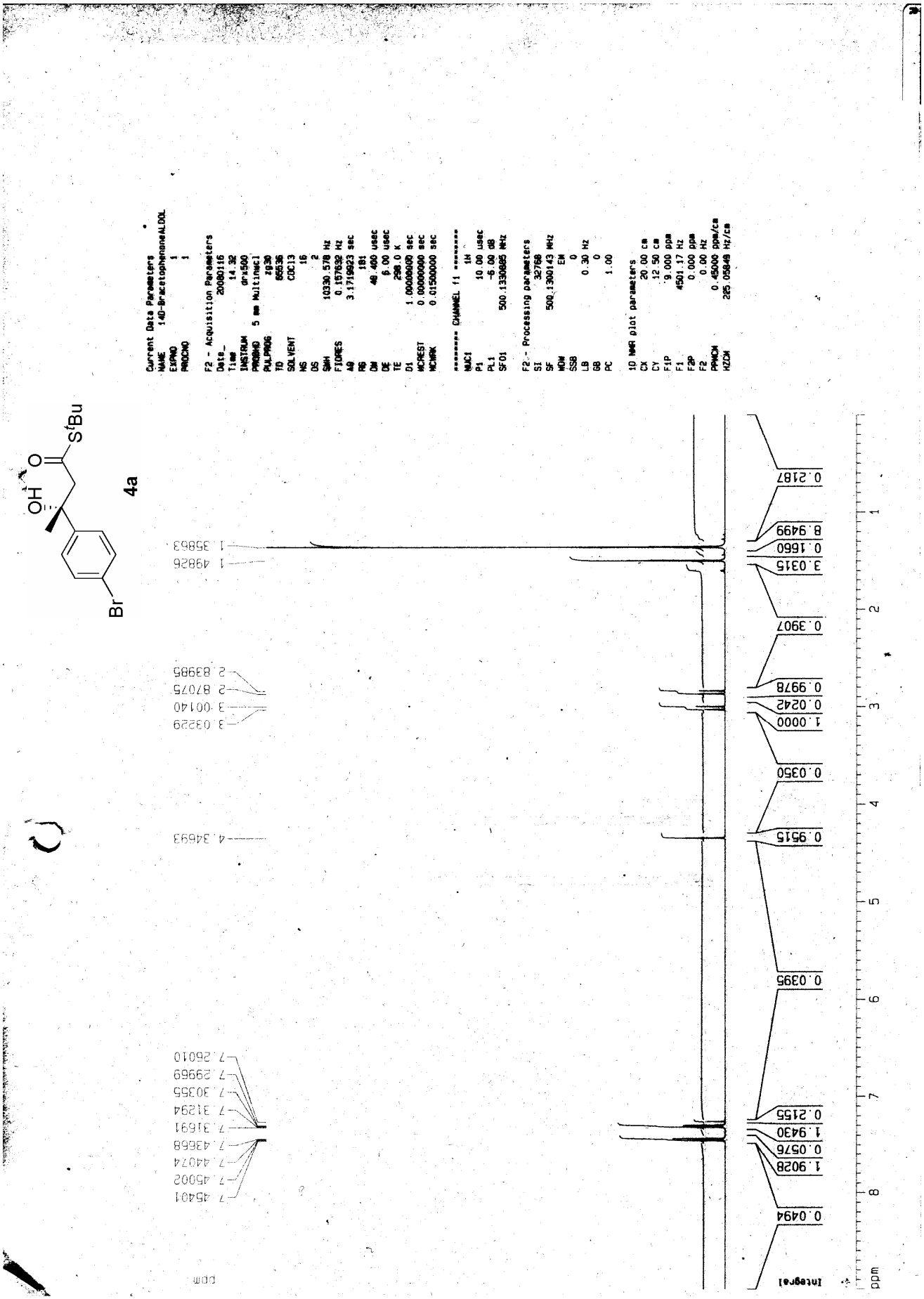
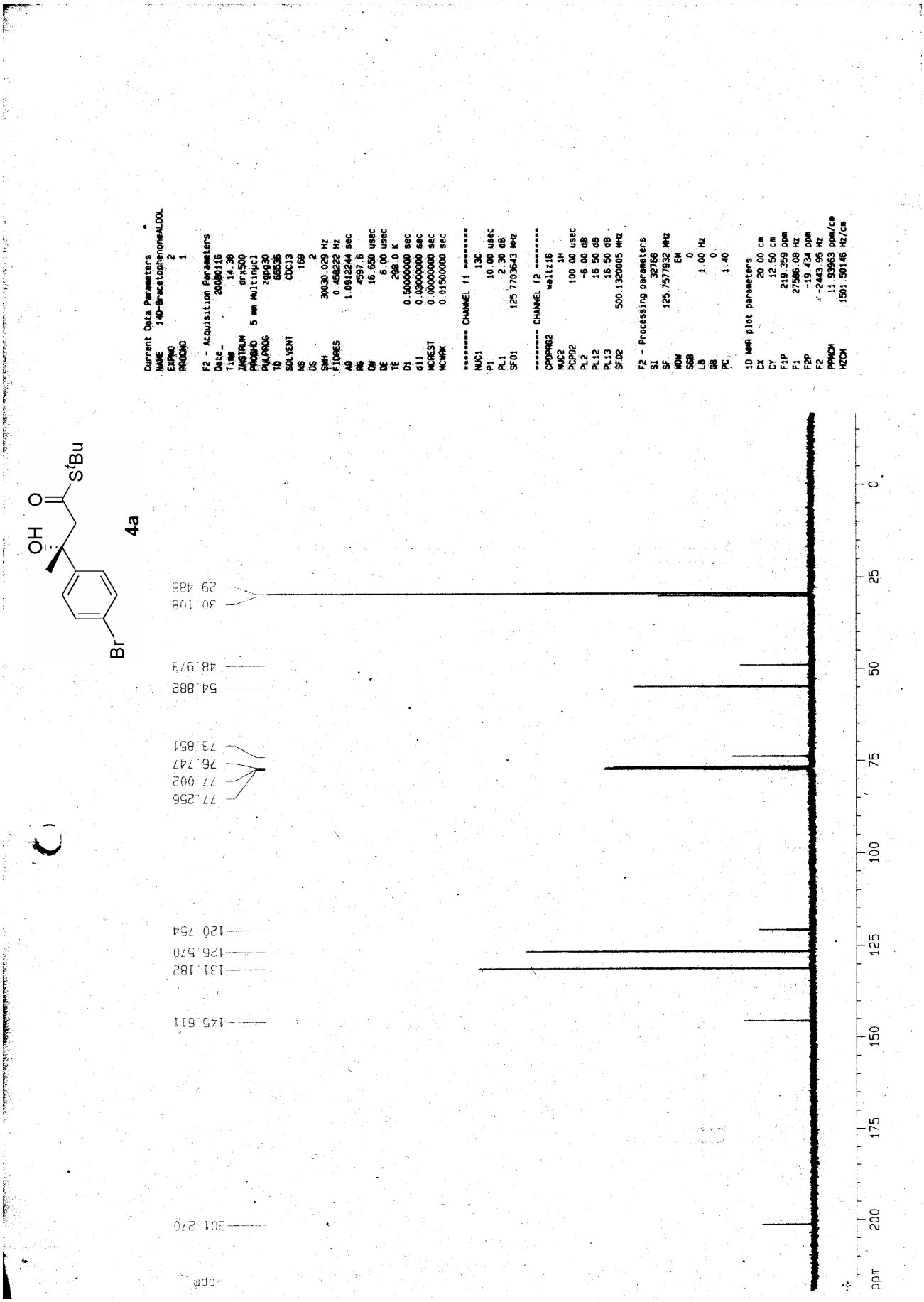
[7] Denmark, S. E.; Fan, Y.; Eastgate, M. D. *J. Org. Chem.* **2005**, *70*, 5235–5248.
[8] Oisaki, K.; Zhao, D.; Kanai, M.; Shibasaki, M. *J. Am. Chem. Soc.* **2006**, *128*, 7164–7165.

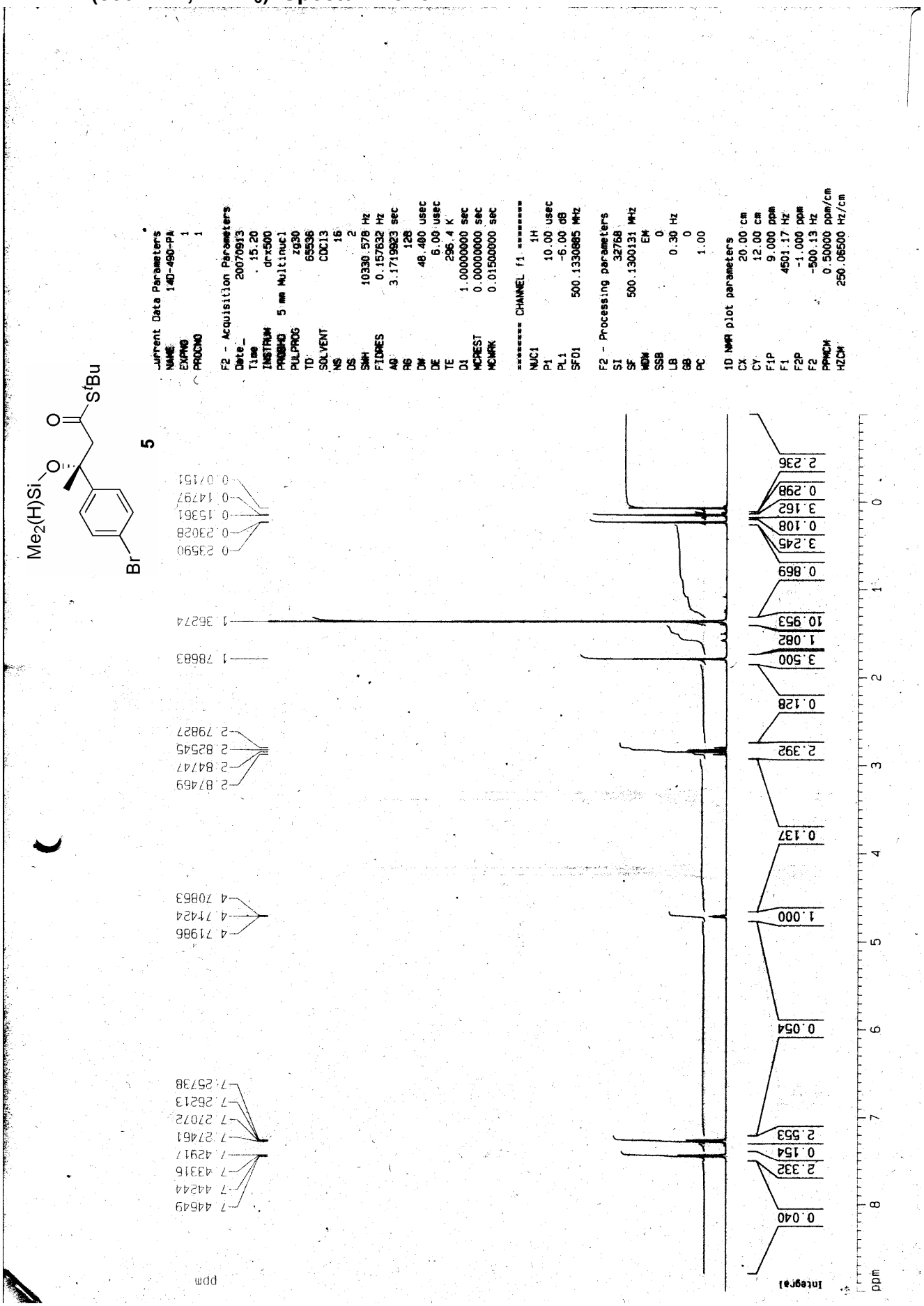
**$^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4a**



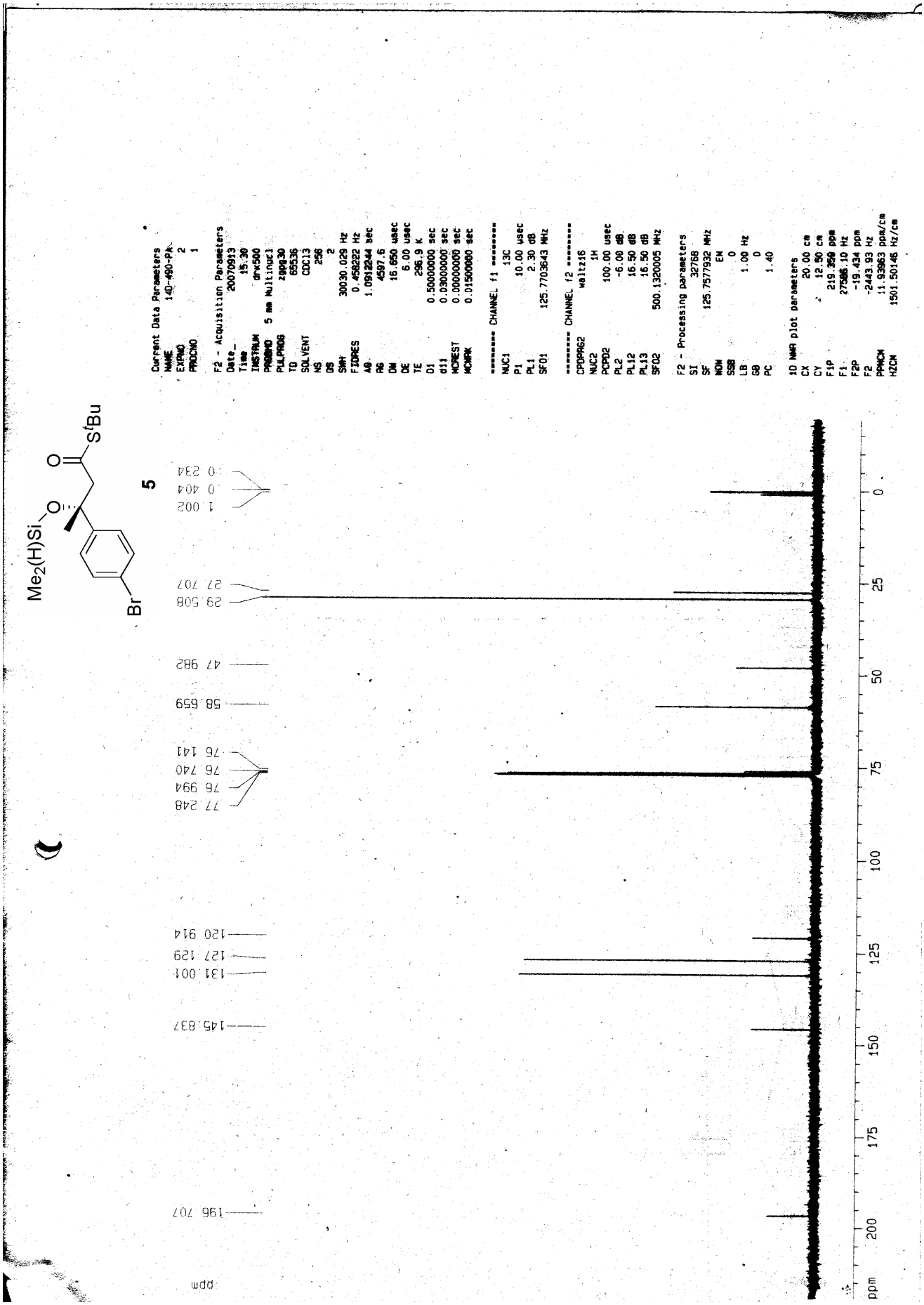
## $^{13}C$ NMR (125.8 MHz, $CDCl_3$) Spectrum of 4a



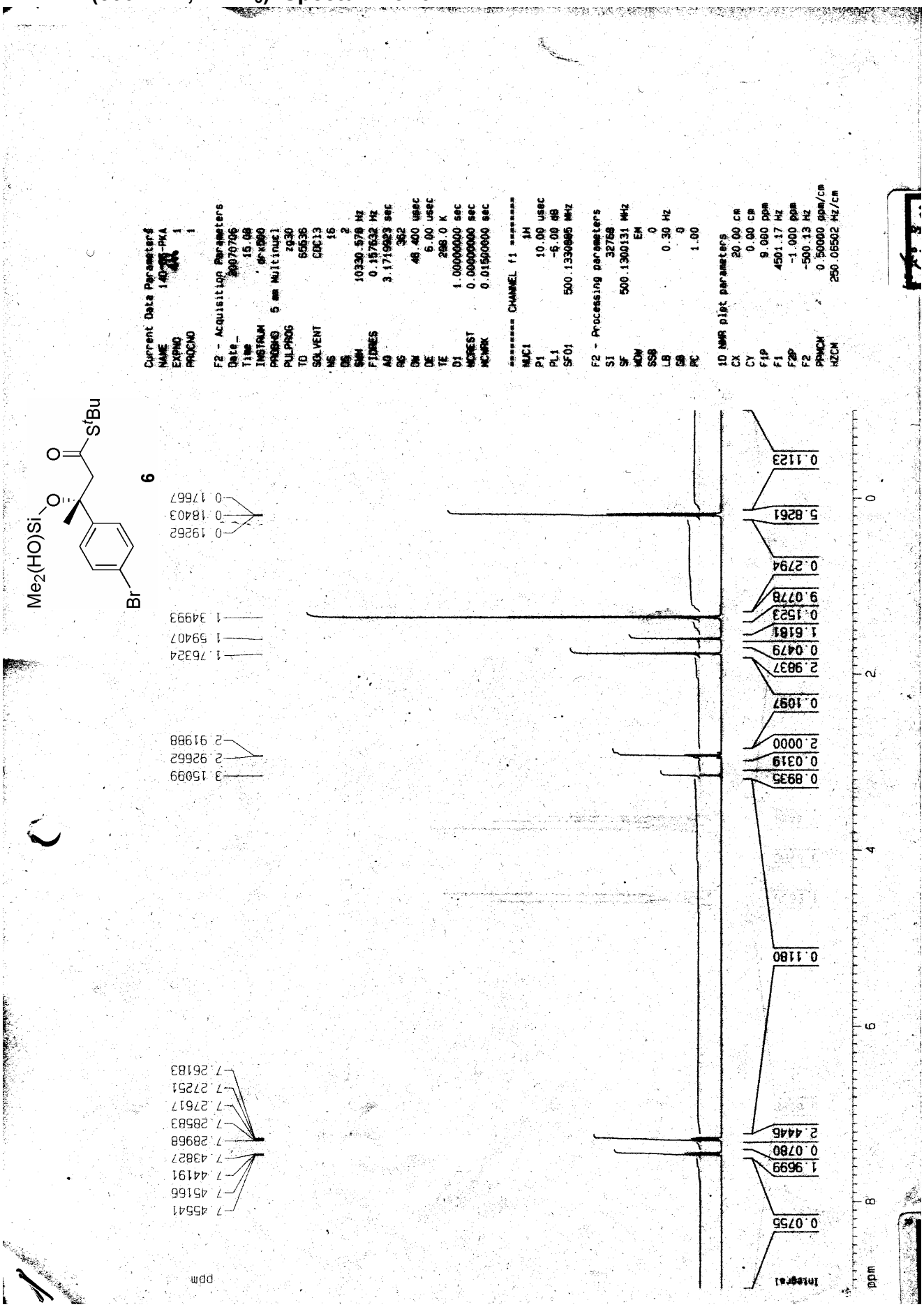
**$^1$H NMR (500 MHz, $CDCl_3$) Specturm of 5**



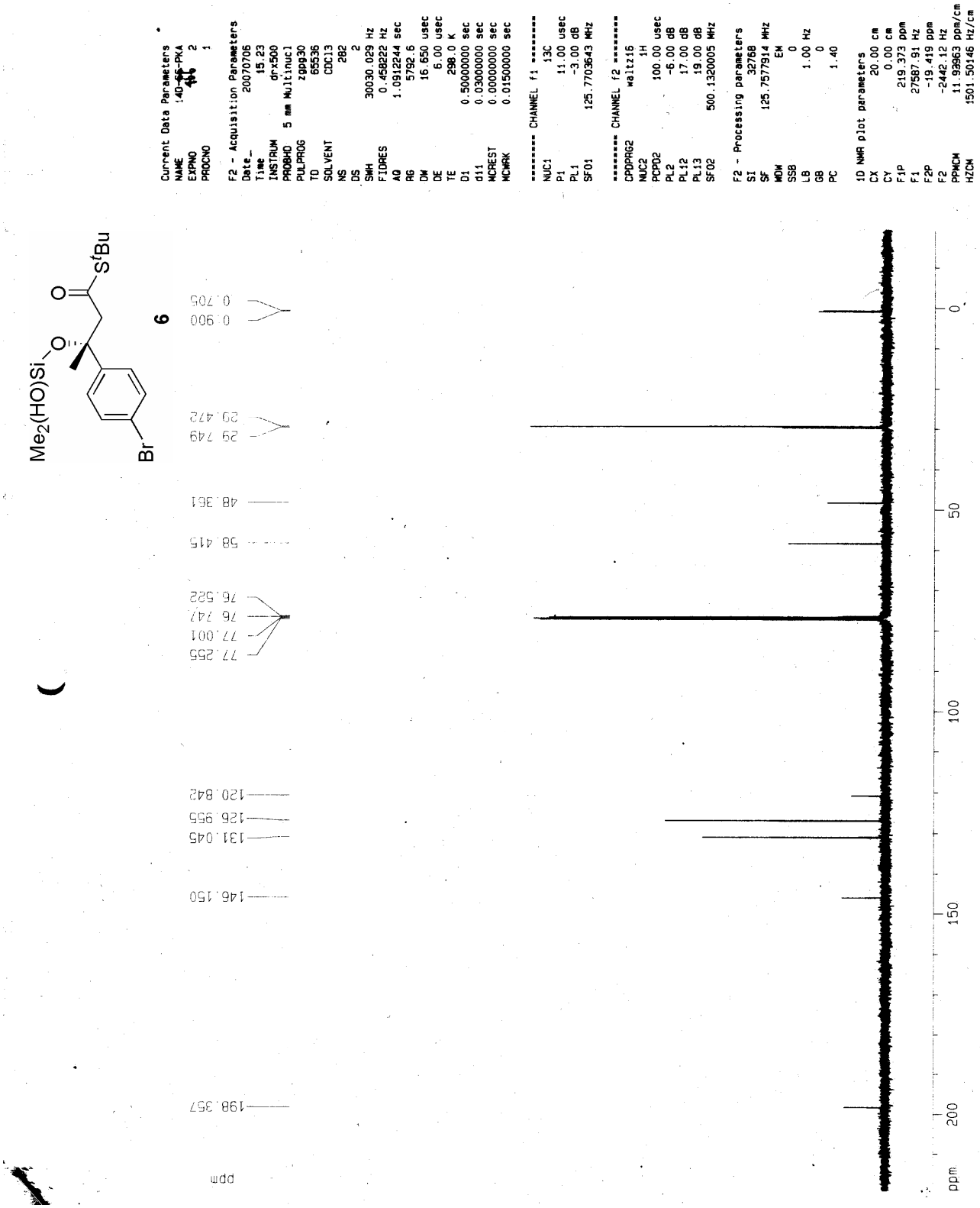
**$^{13}$C NMR (125.8 MHz, $CDCl_3$) Spectrum of 5**



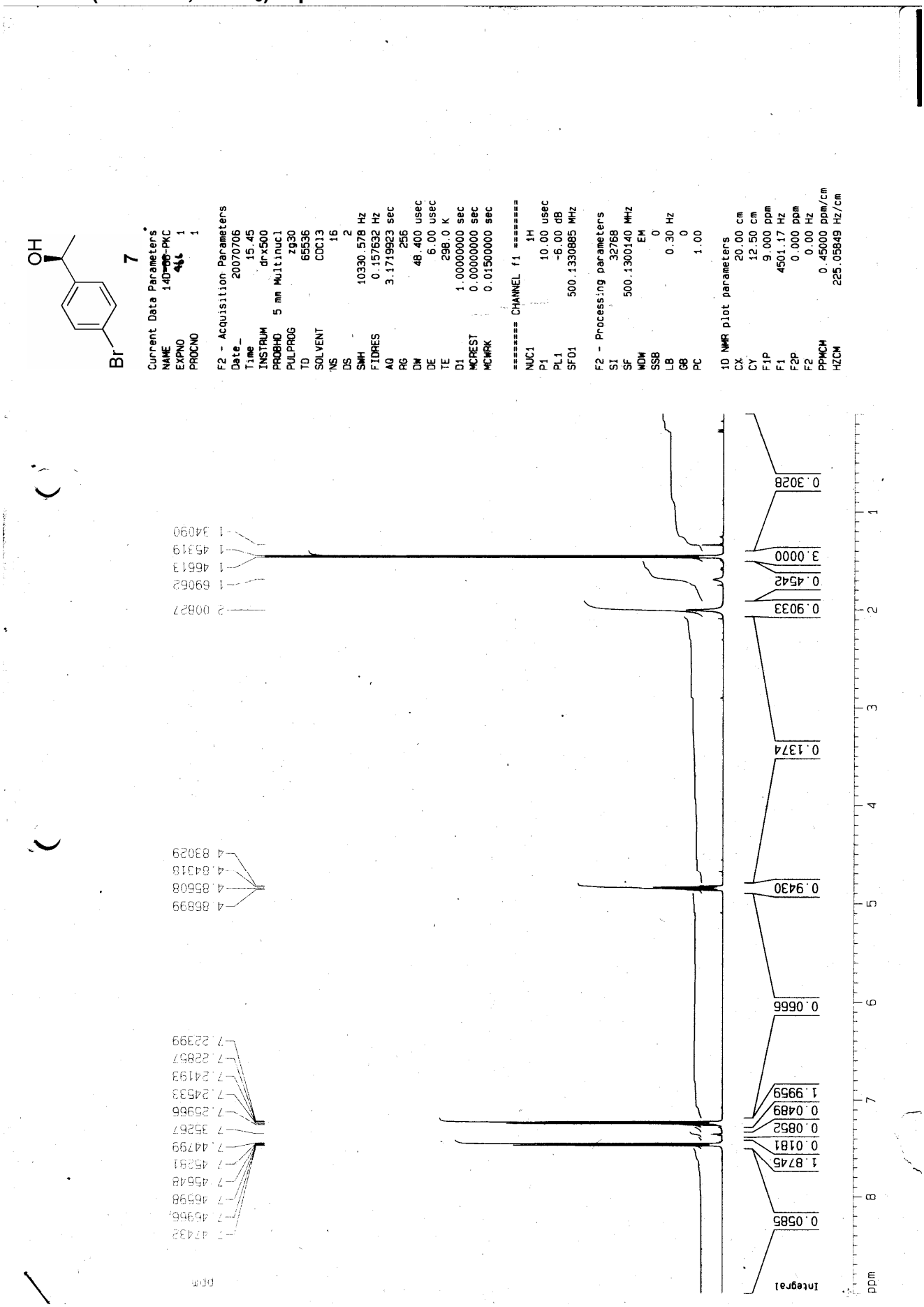
**$^1$H NMR (500 MHz, $CDCl_3$) Specturm of 6**



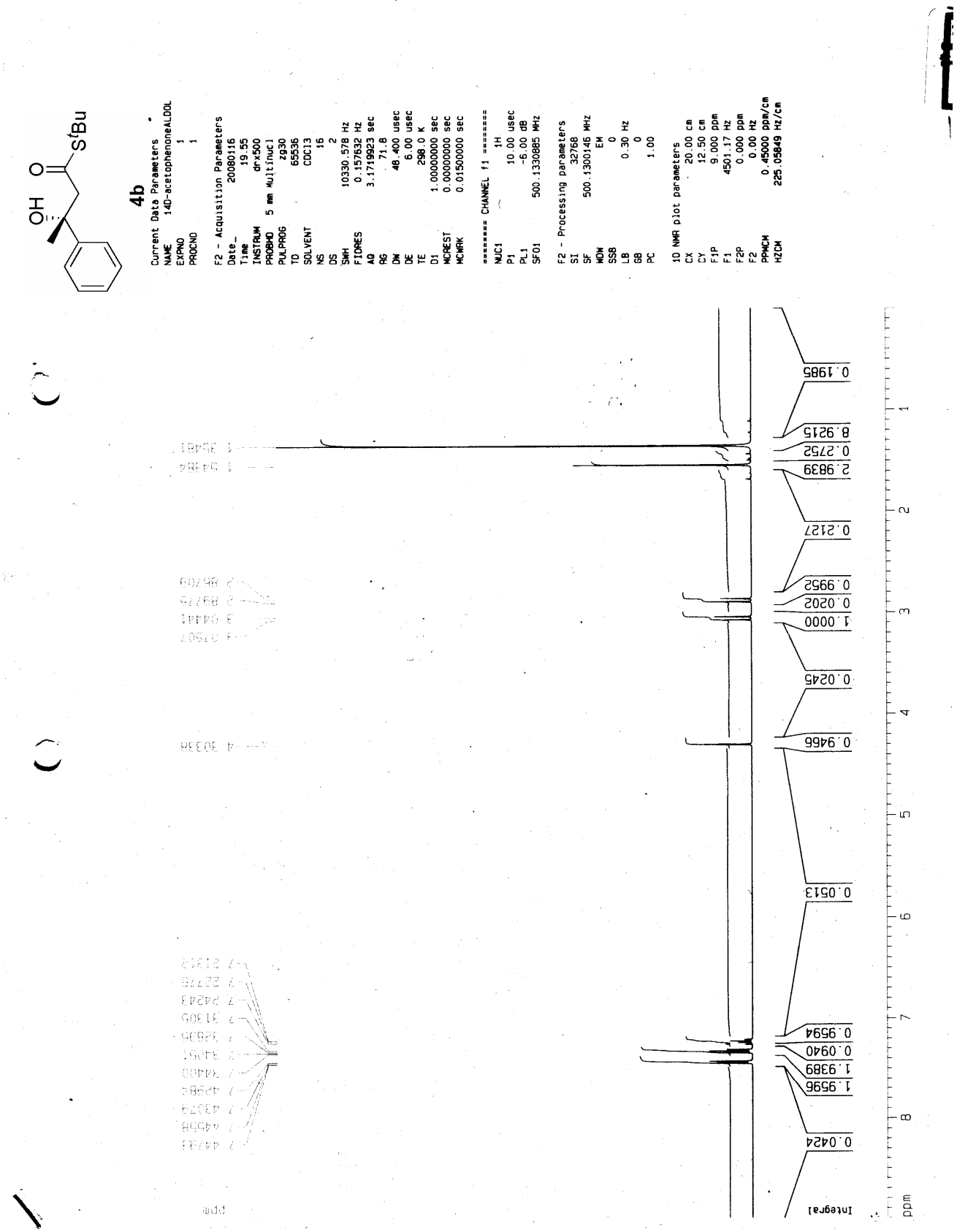
## $^{13}C$ NMR (125.8 MHz, $CDCl_3$) Spectrum of 6



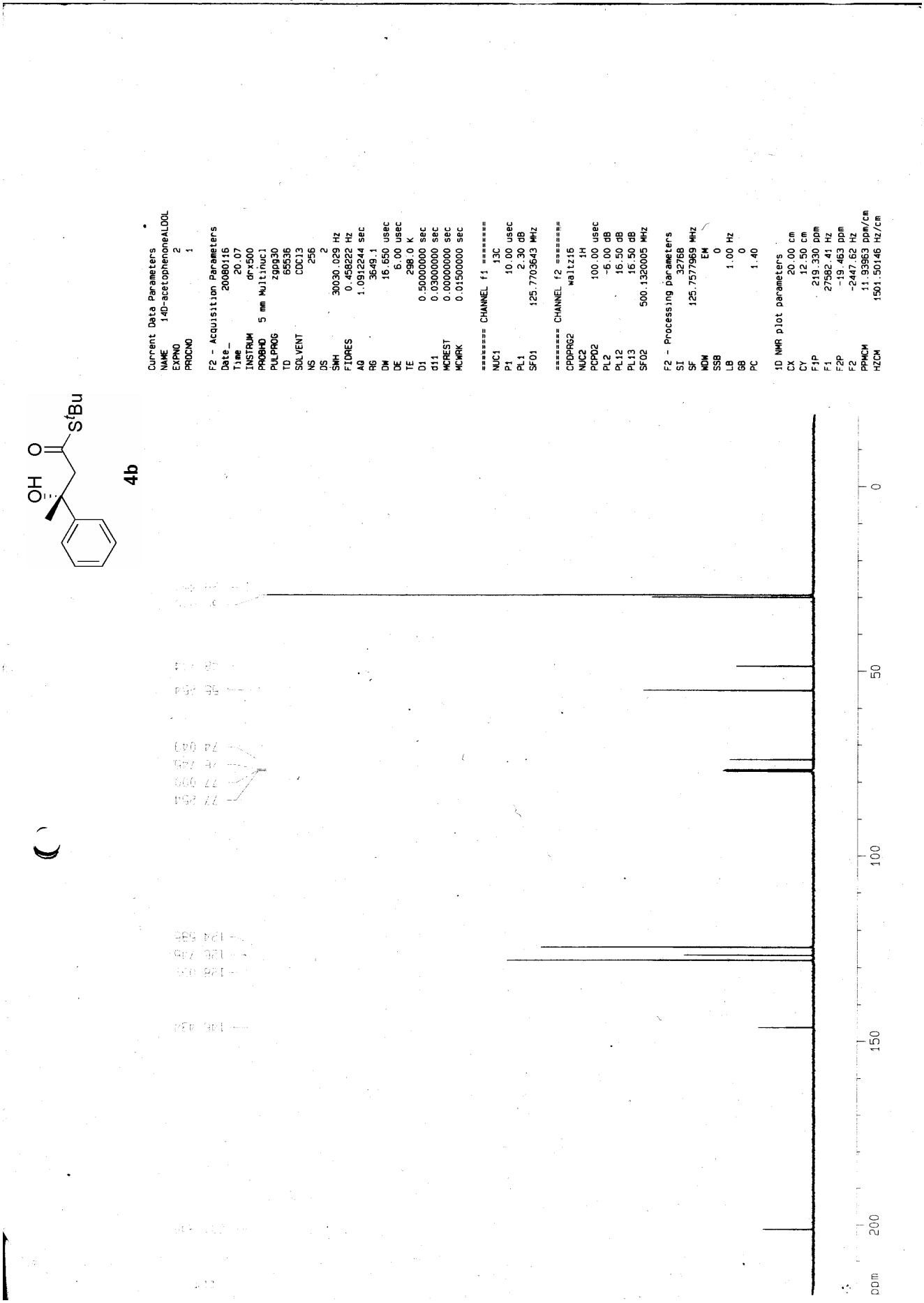
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 7



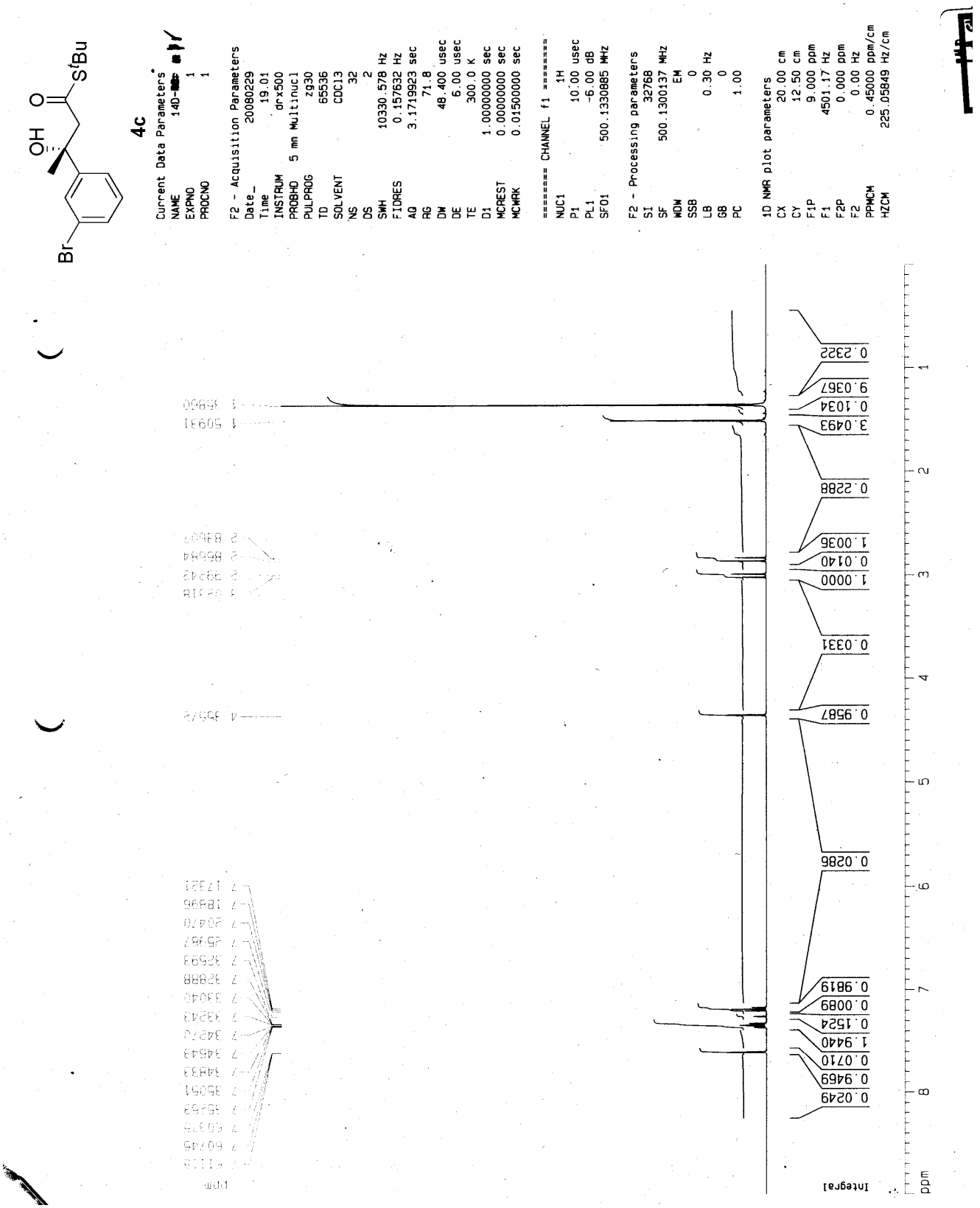
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4b



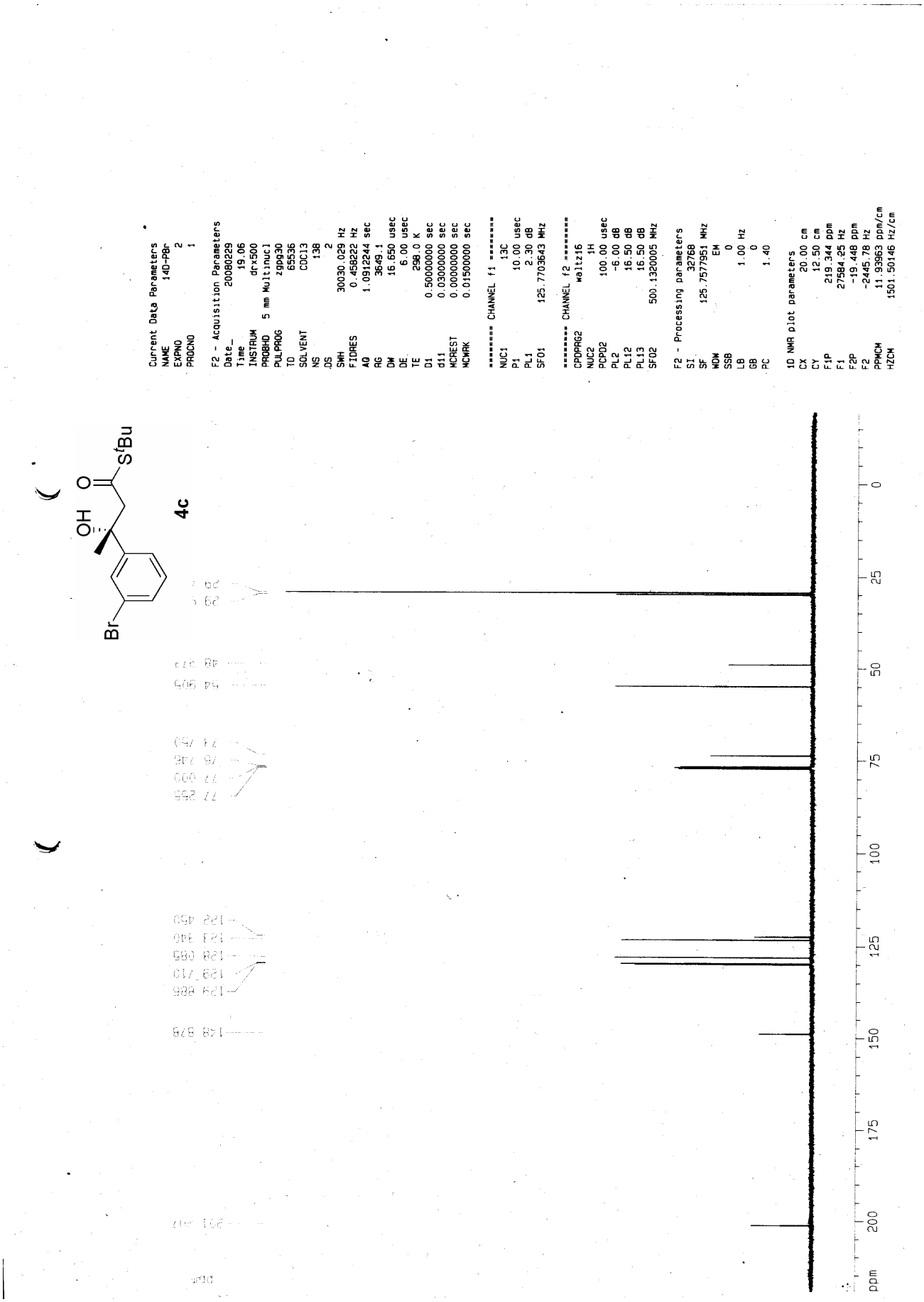
## $^{13}$C NMR (125.8 MHz, $CDCl_3$) Spectrum of 4b



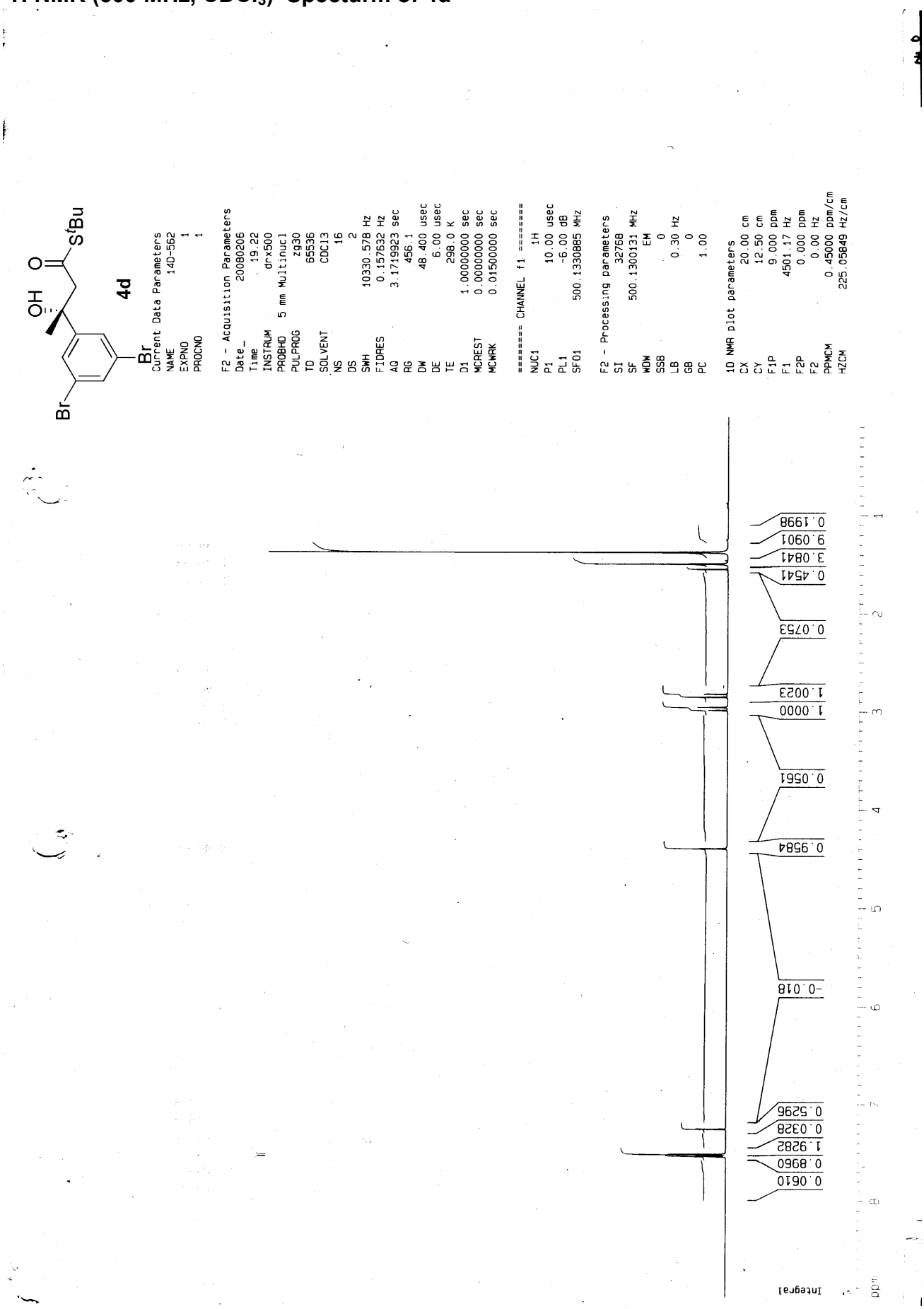
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4c



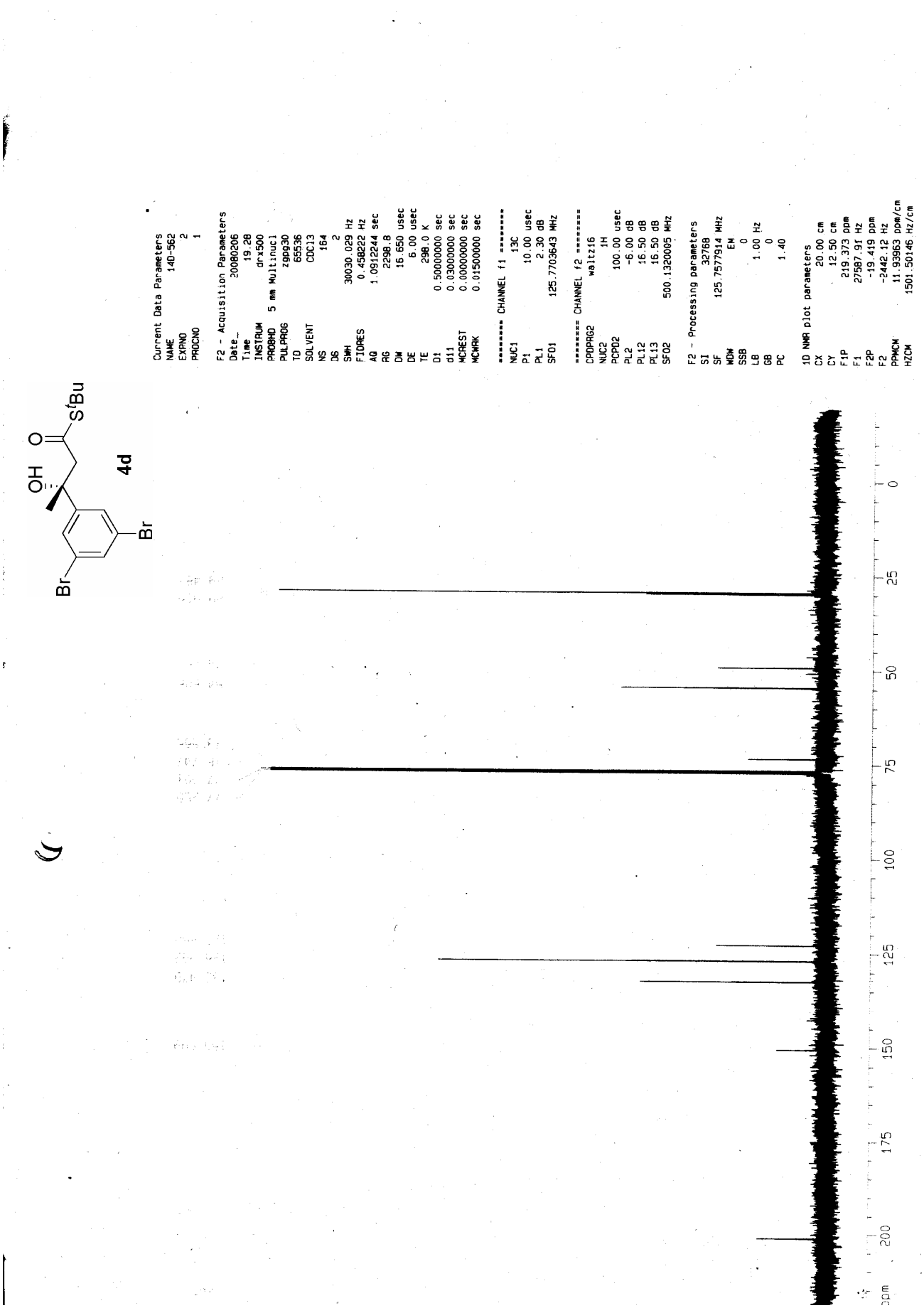
## $^{13}C$ NMR (125.8 MHz, $CDCl_3$) Spectrum of 4c



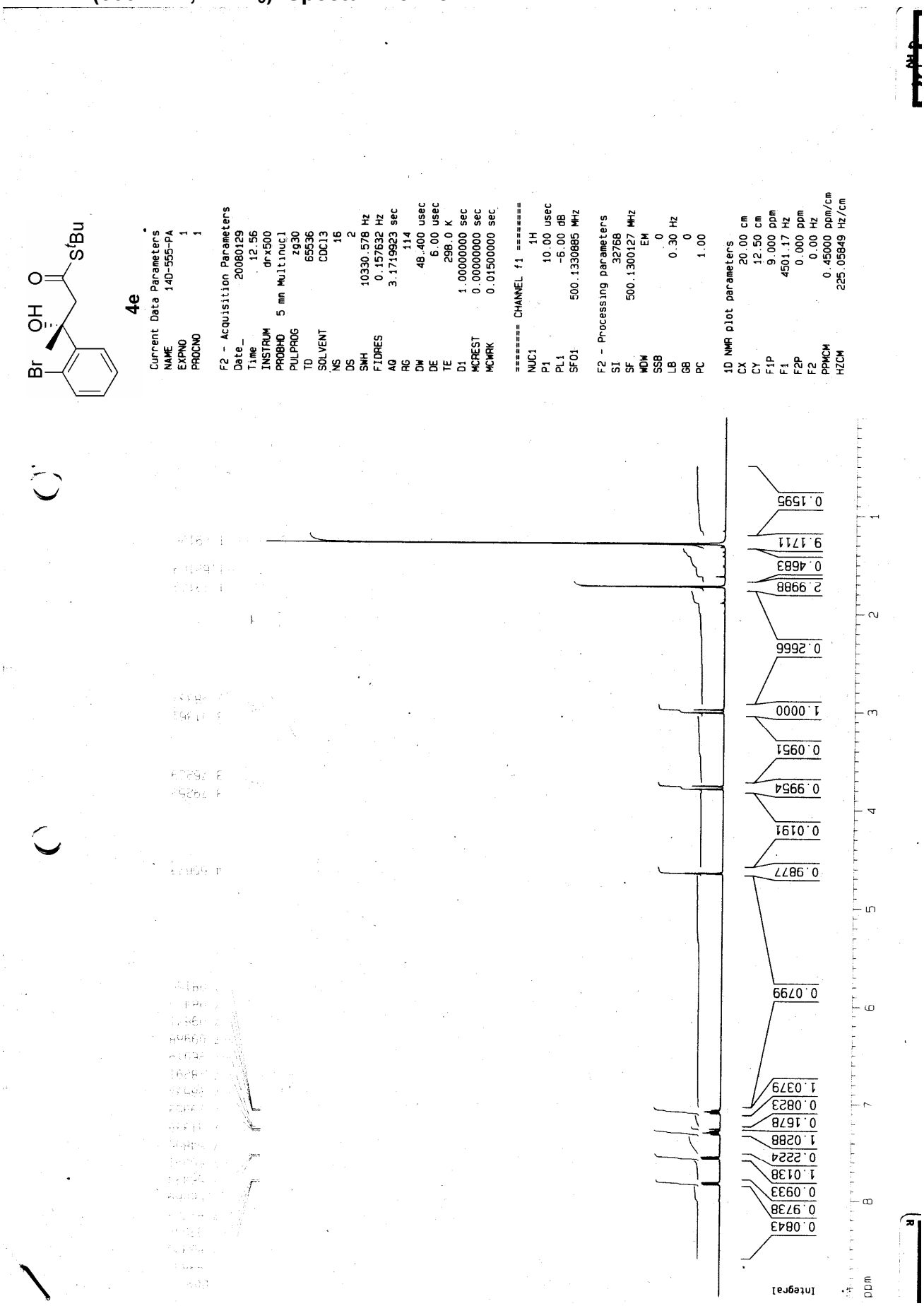
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4d



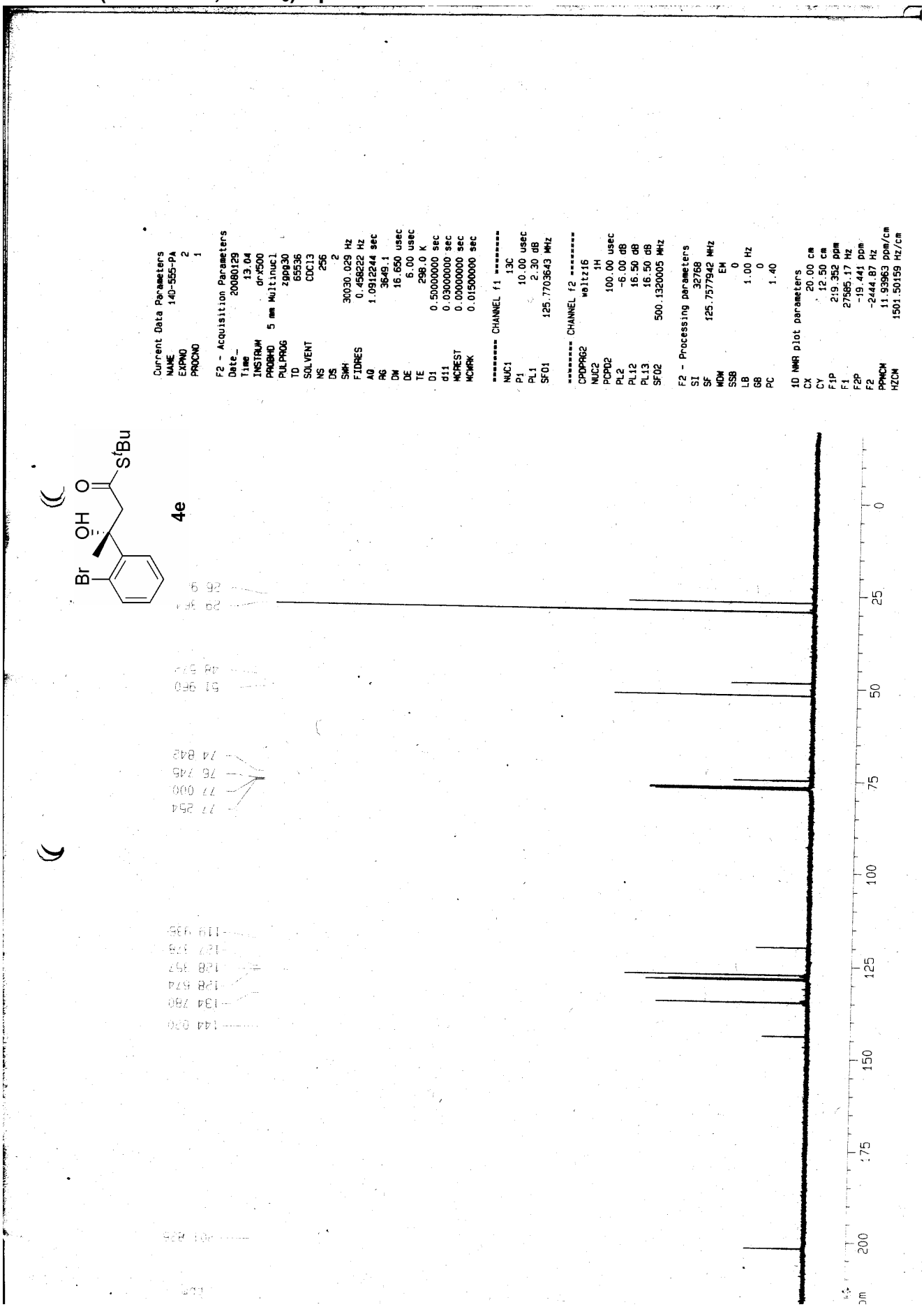
## $^{13}C$ NMR (125.8 MHz, $CDCl_3$) Spectrum of 4d



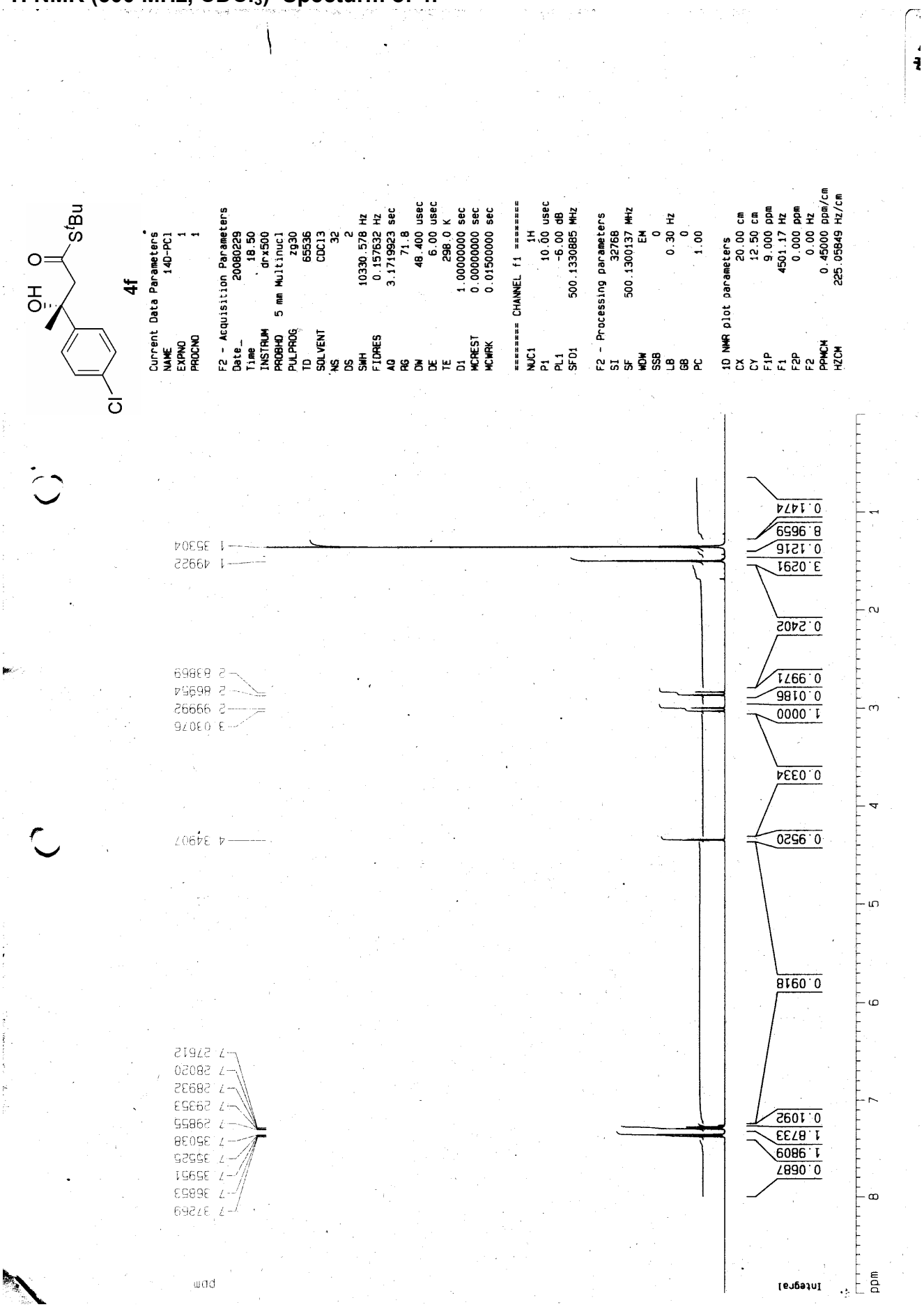
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4e



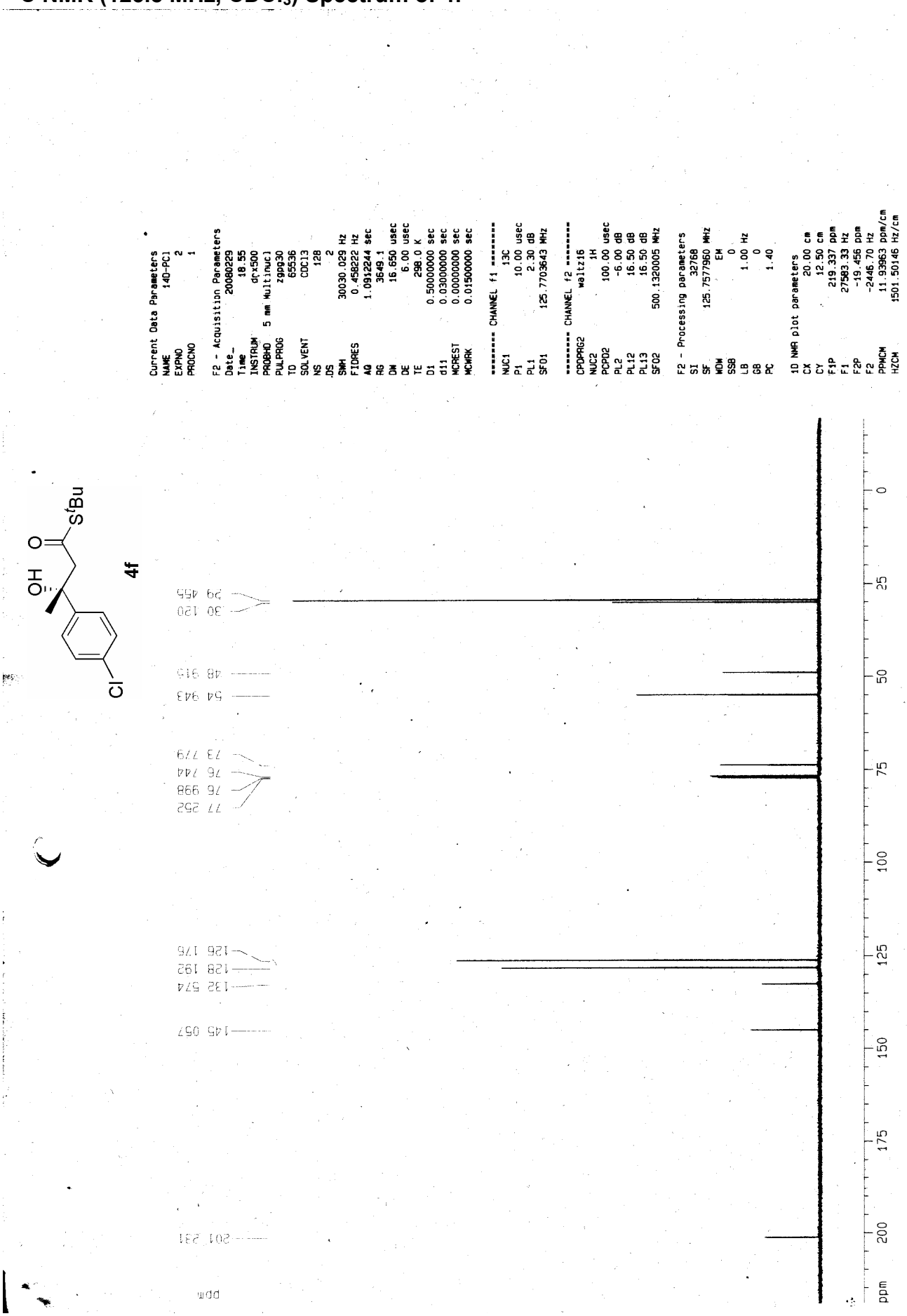
## $^{13}C$ NMR (125.8 MHz, $CDCl_3$) Spectrum of 4e



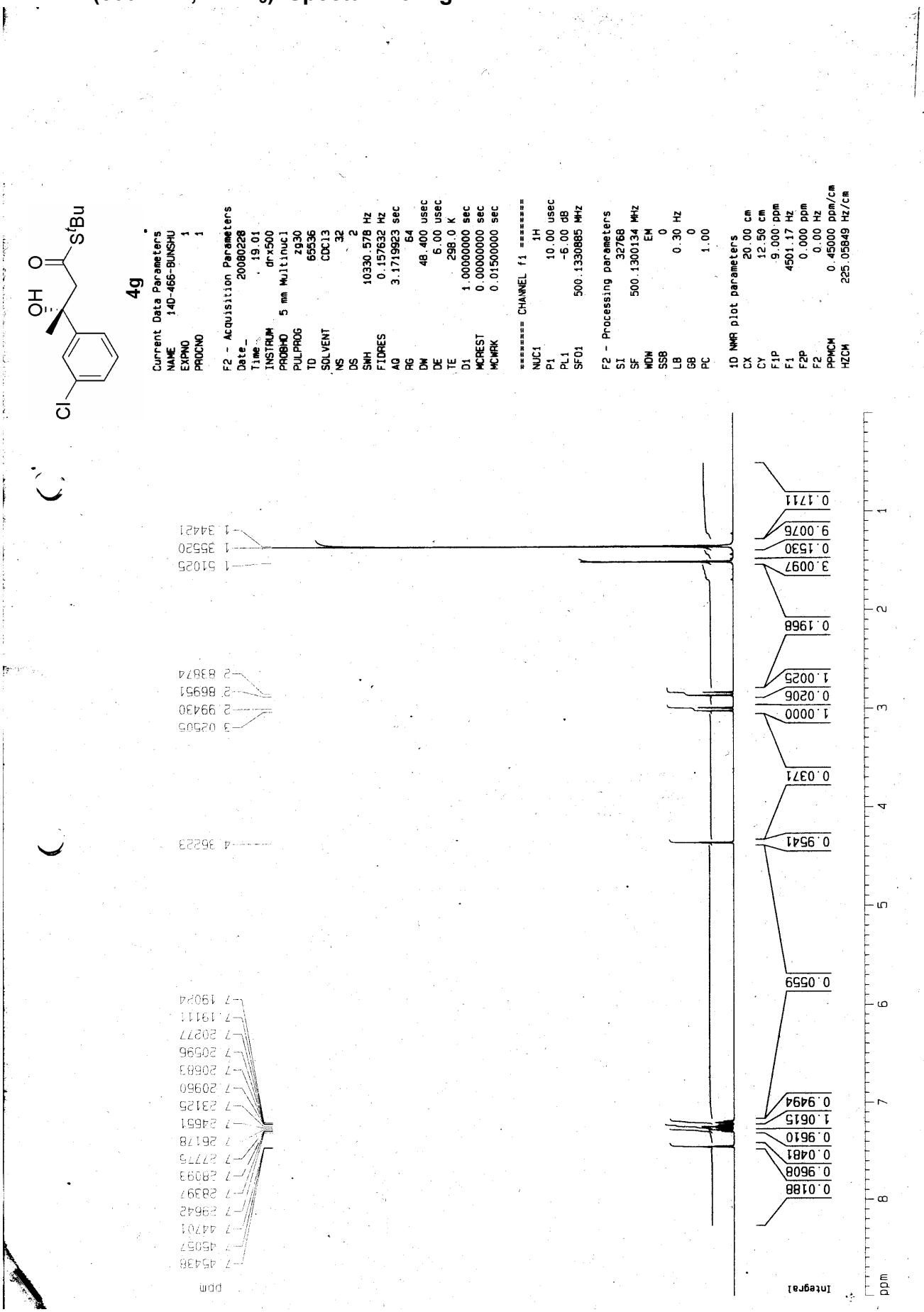
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4f



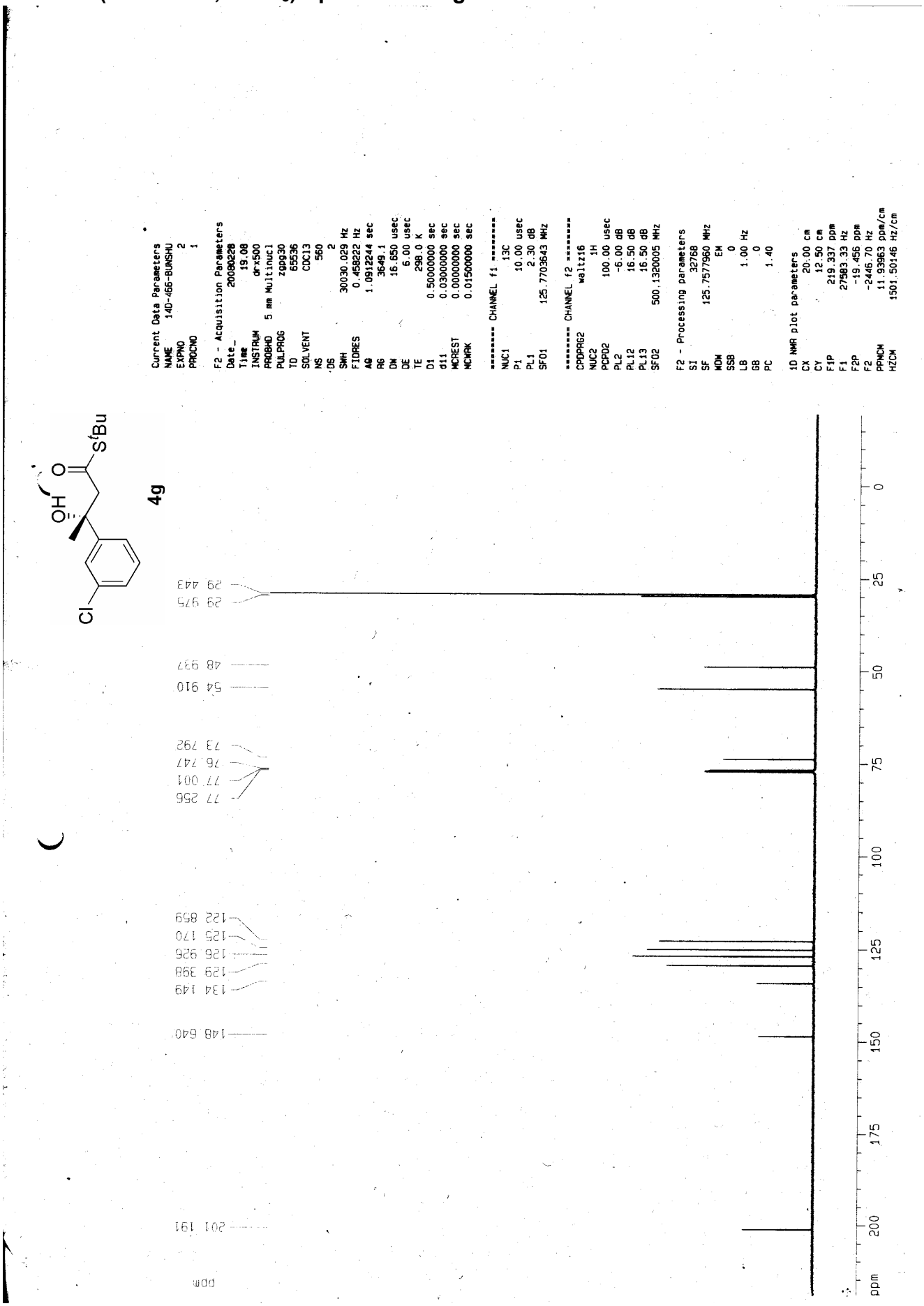
## $^{13}C$ NMR (125.8 MHz, $CDCl_3$) Spectrum of 4f



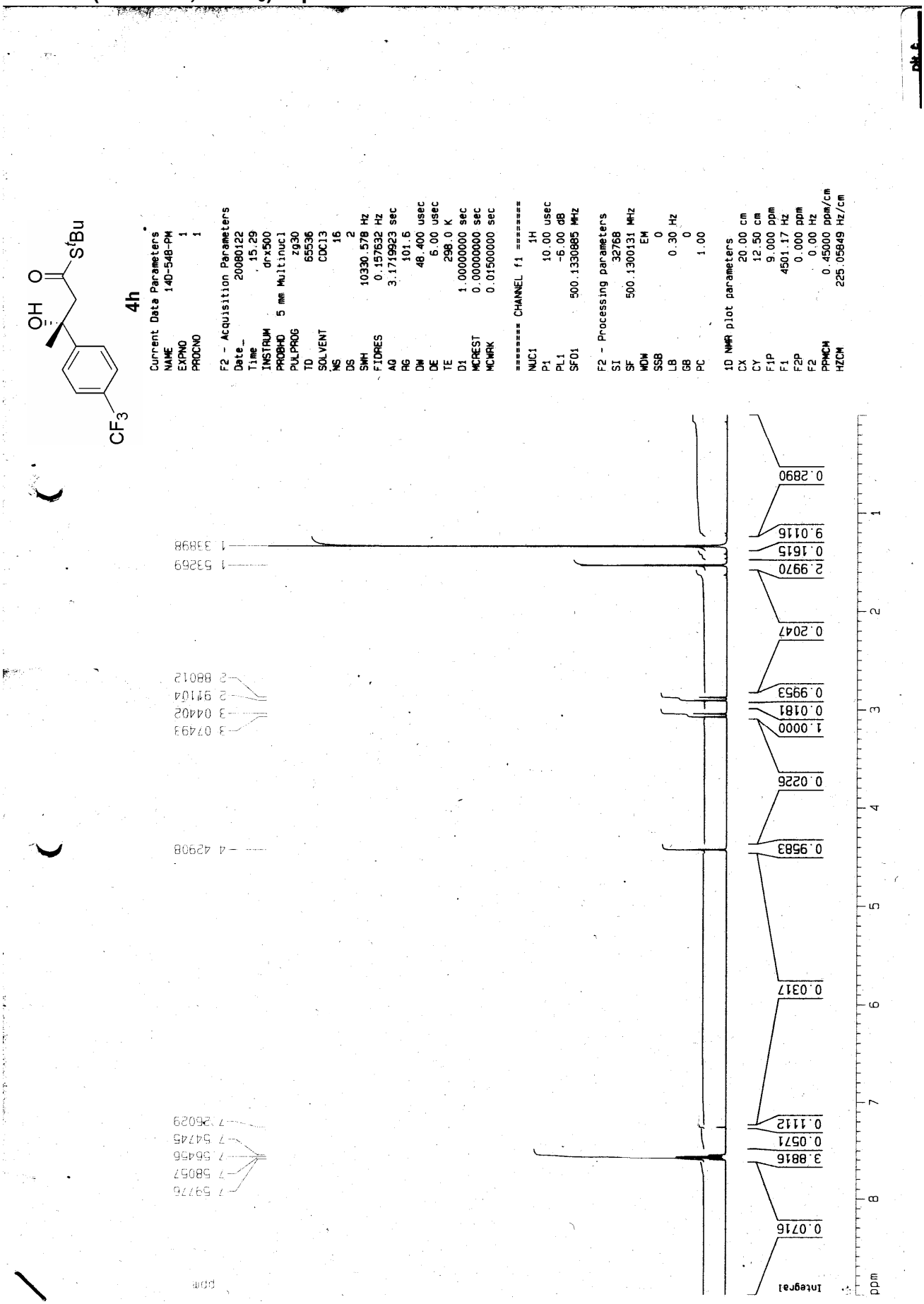
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4g



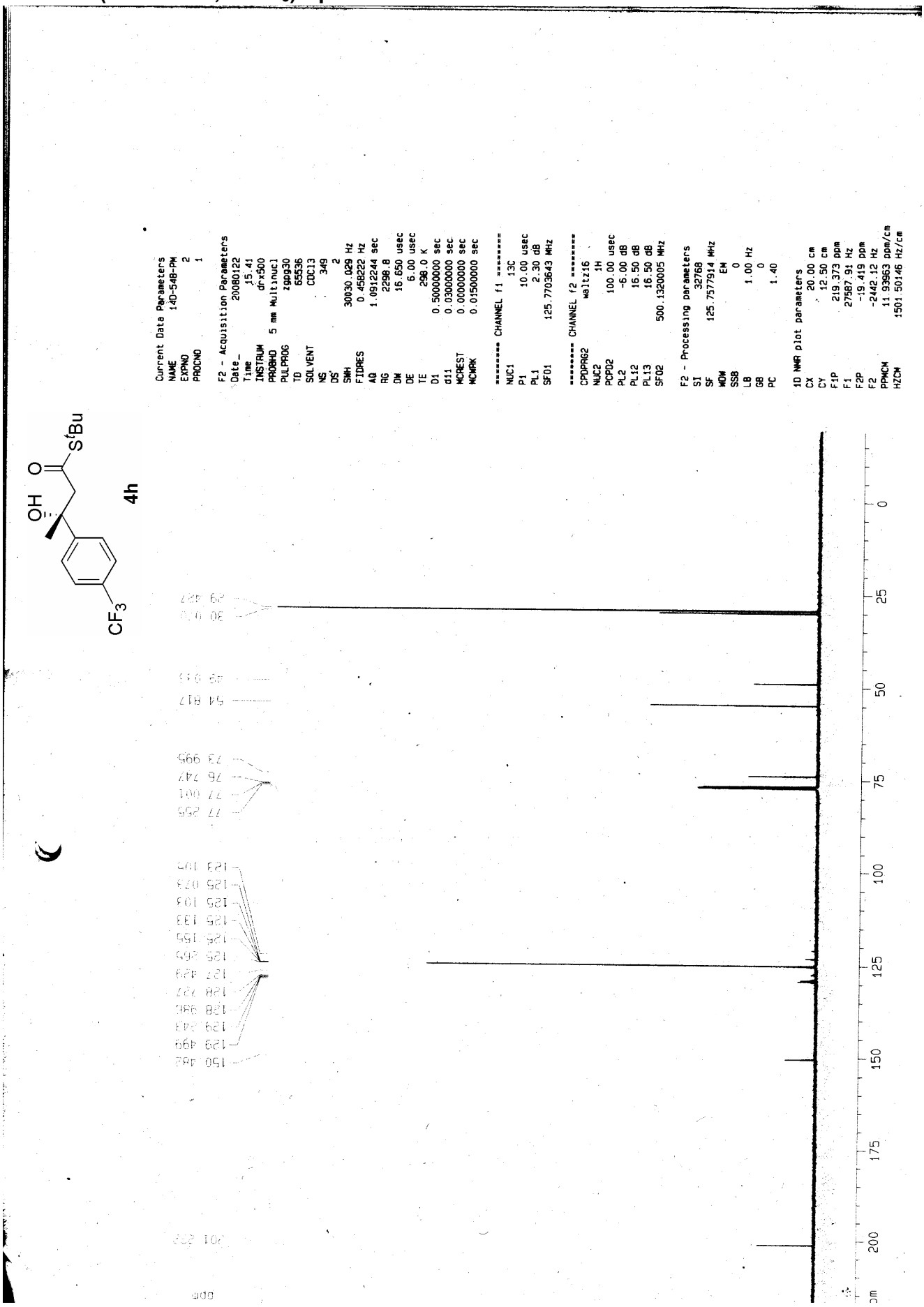
## $^{13}$C NMR (125.8 MHz, $CDCl_3$) Spectrum of 4g



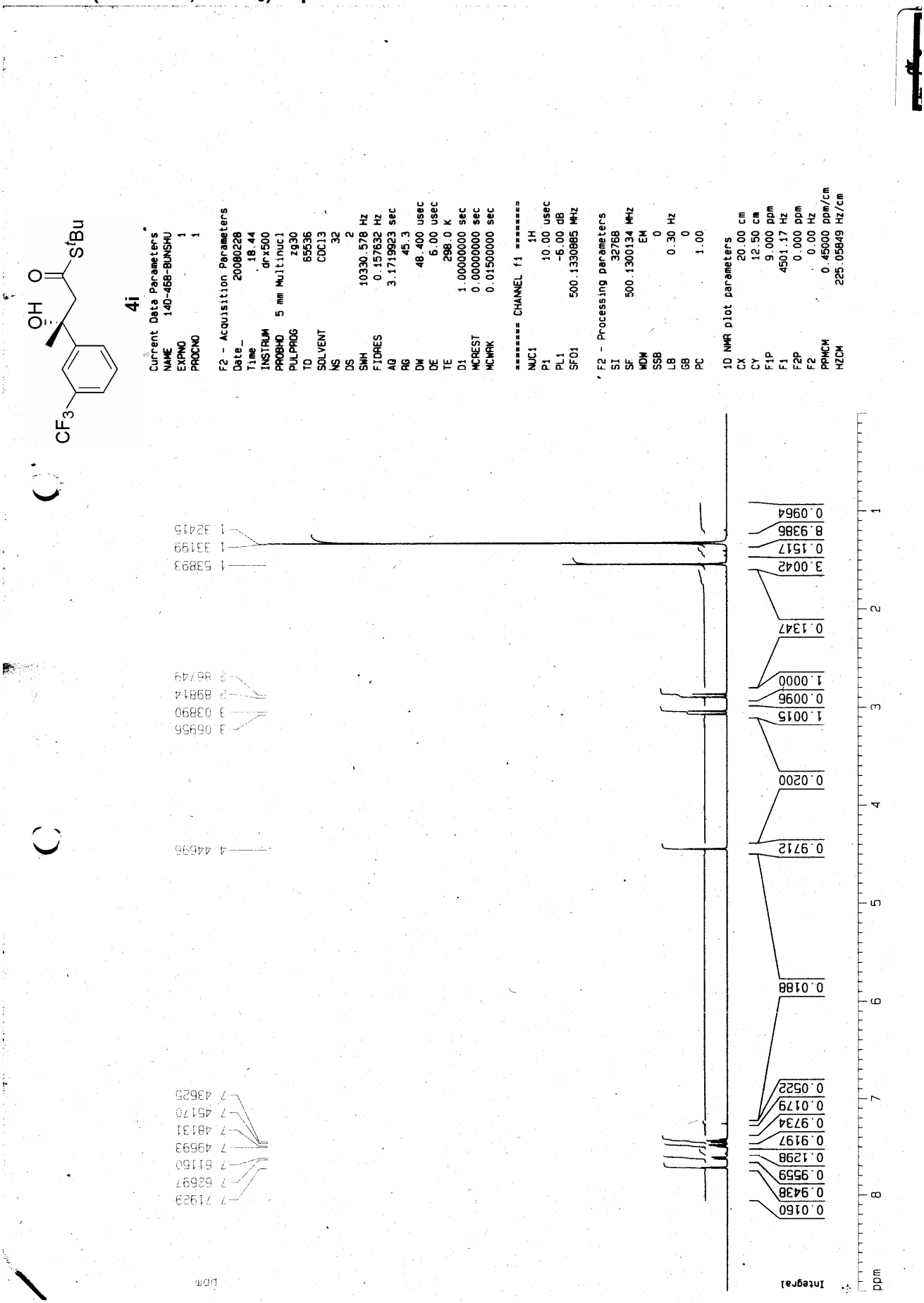
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4h



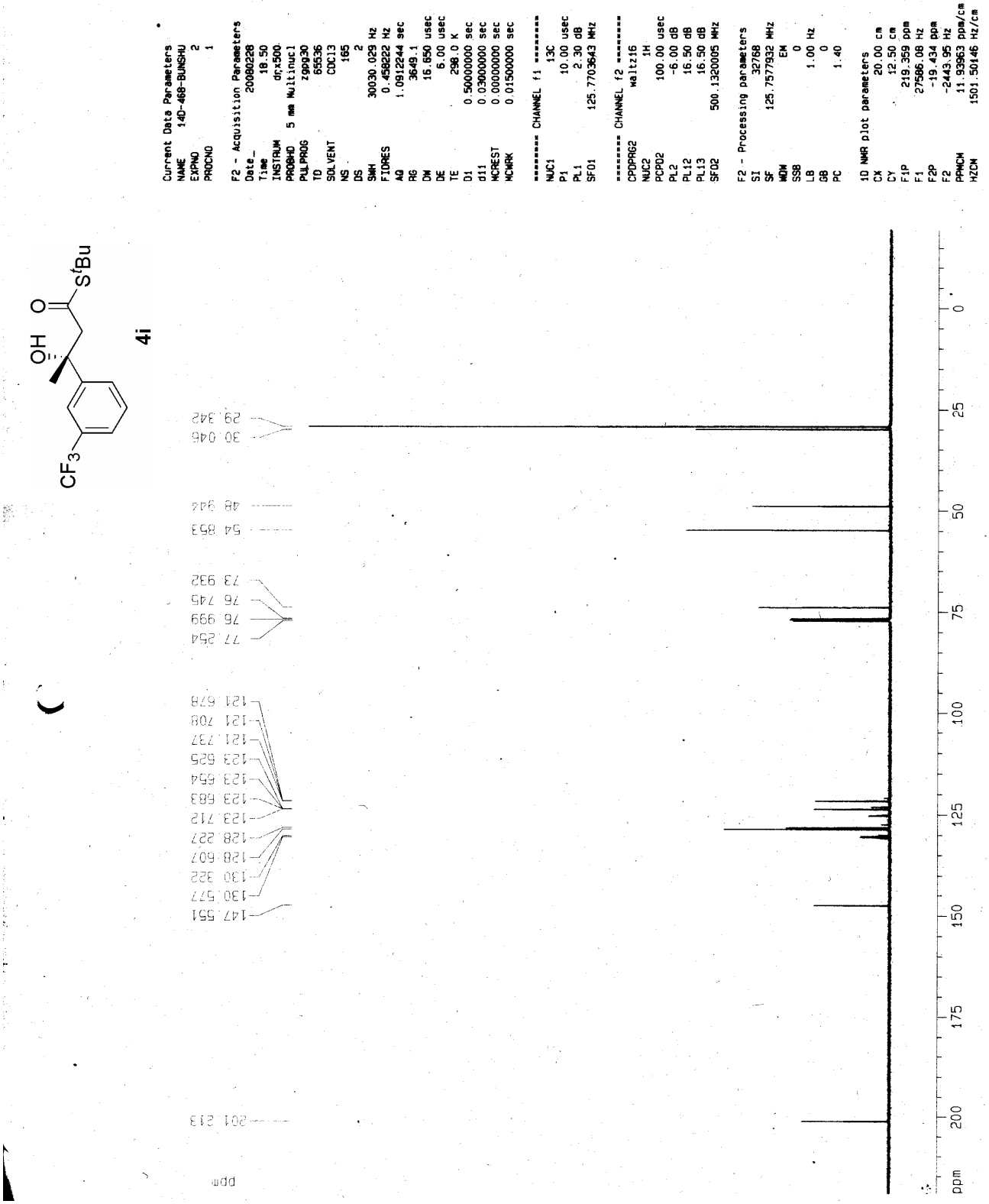
## $^{13}$C NMR (125.8 MHz, $CDCl_3$) Spectrum of 4h



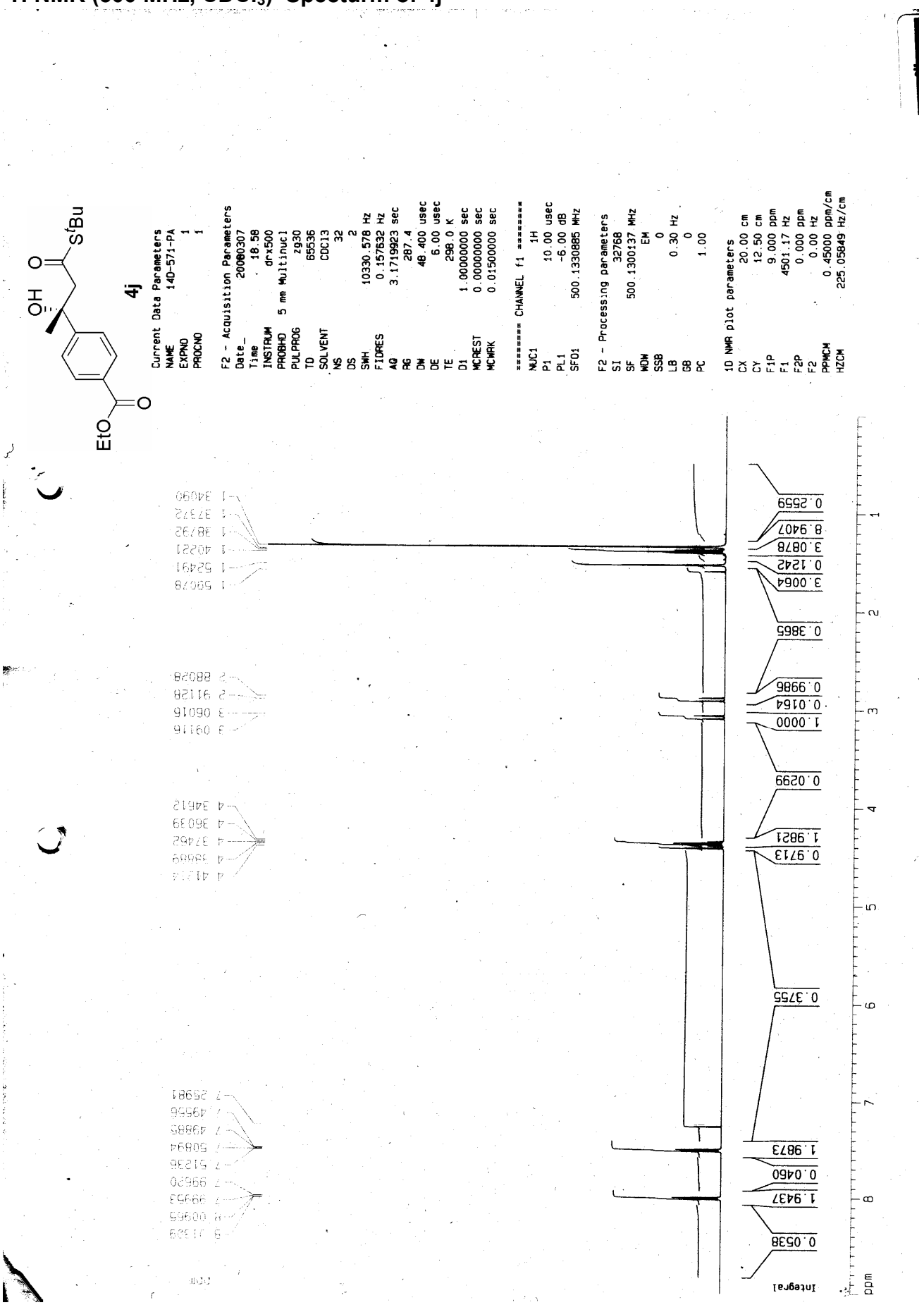
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4i



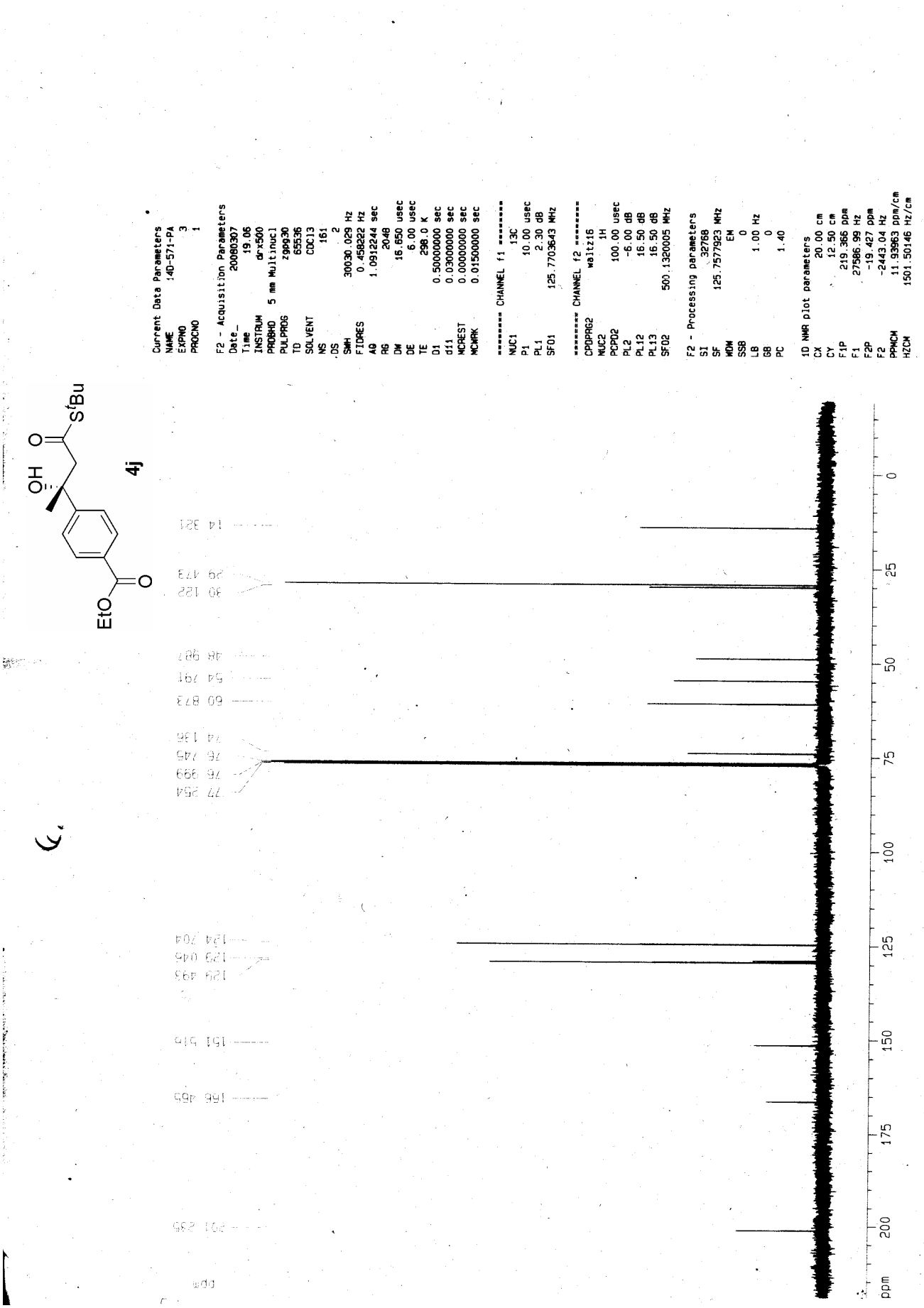
## $^{13}C$ NMR (125.8 MHz, $CDCl_3$) Spectrum of 4i



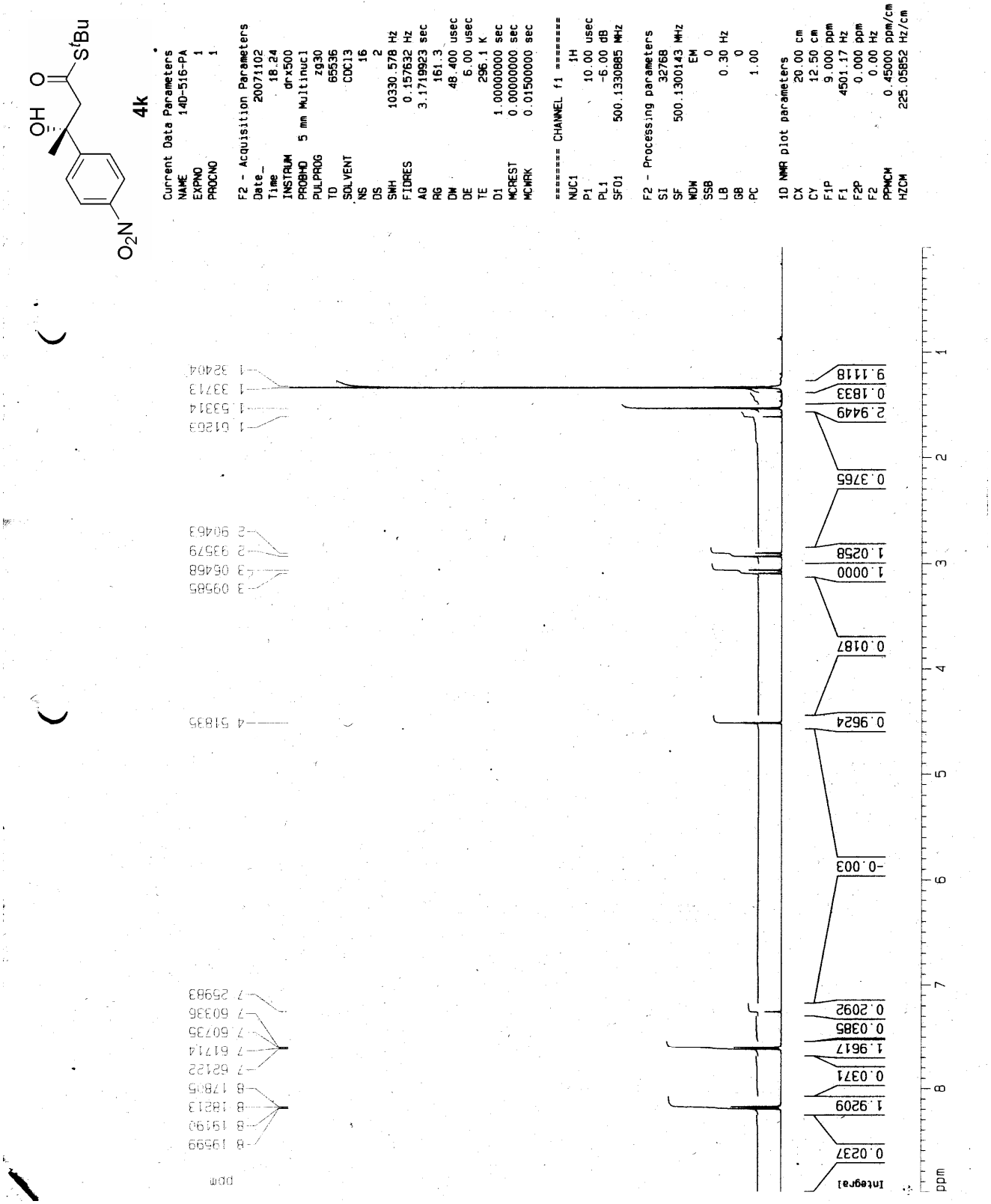
**$^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4j**



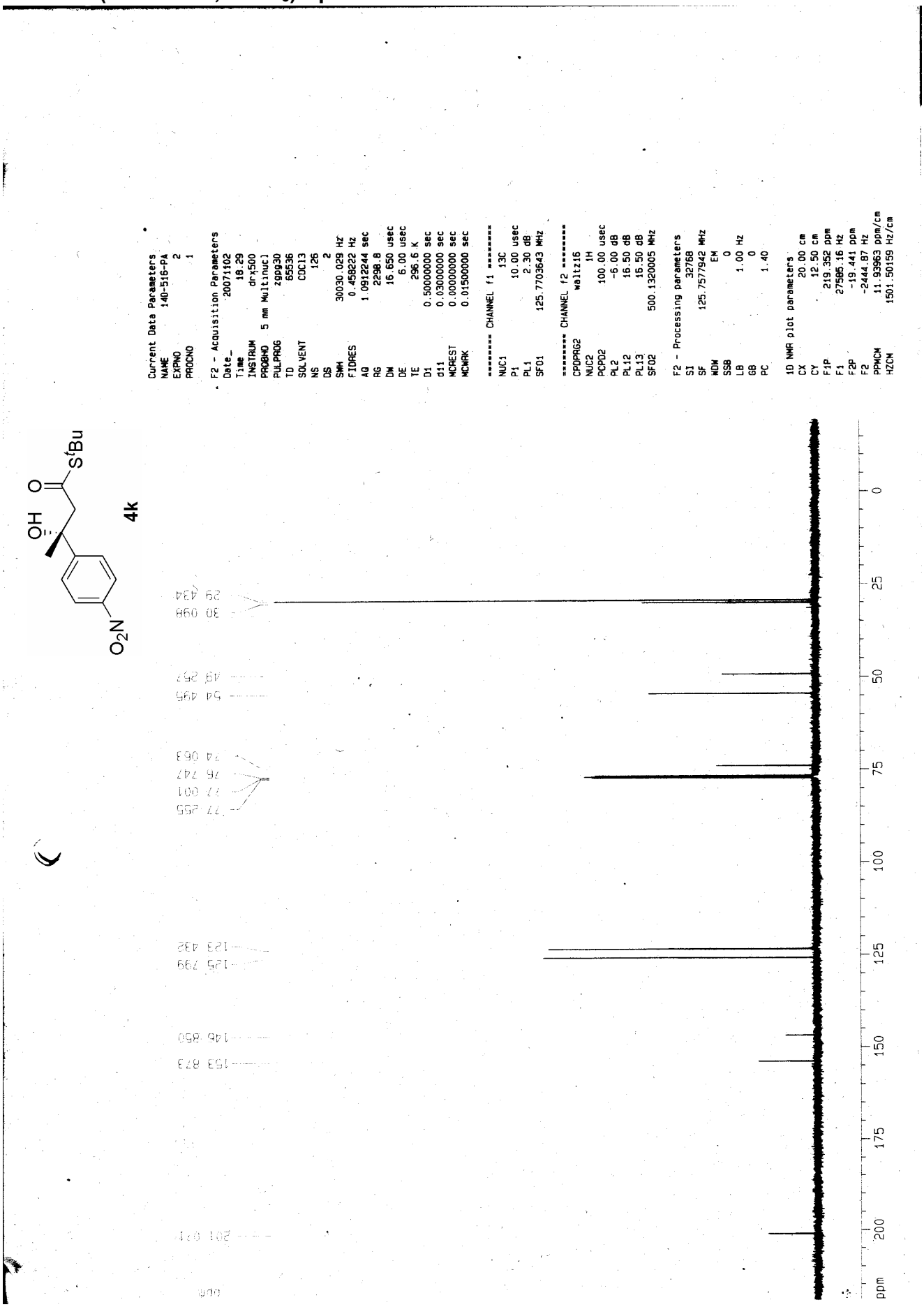
## $^{13}$C NMR (125.8 MHz, $CDCl_3$) Spectrum of 4j



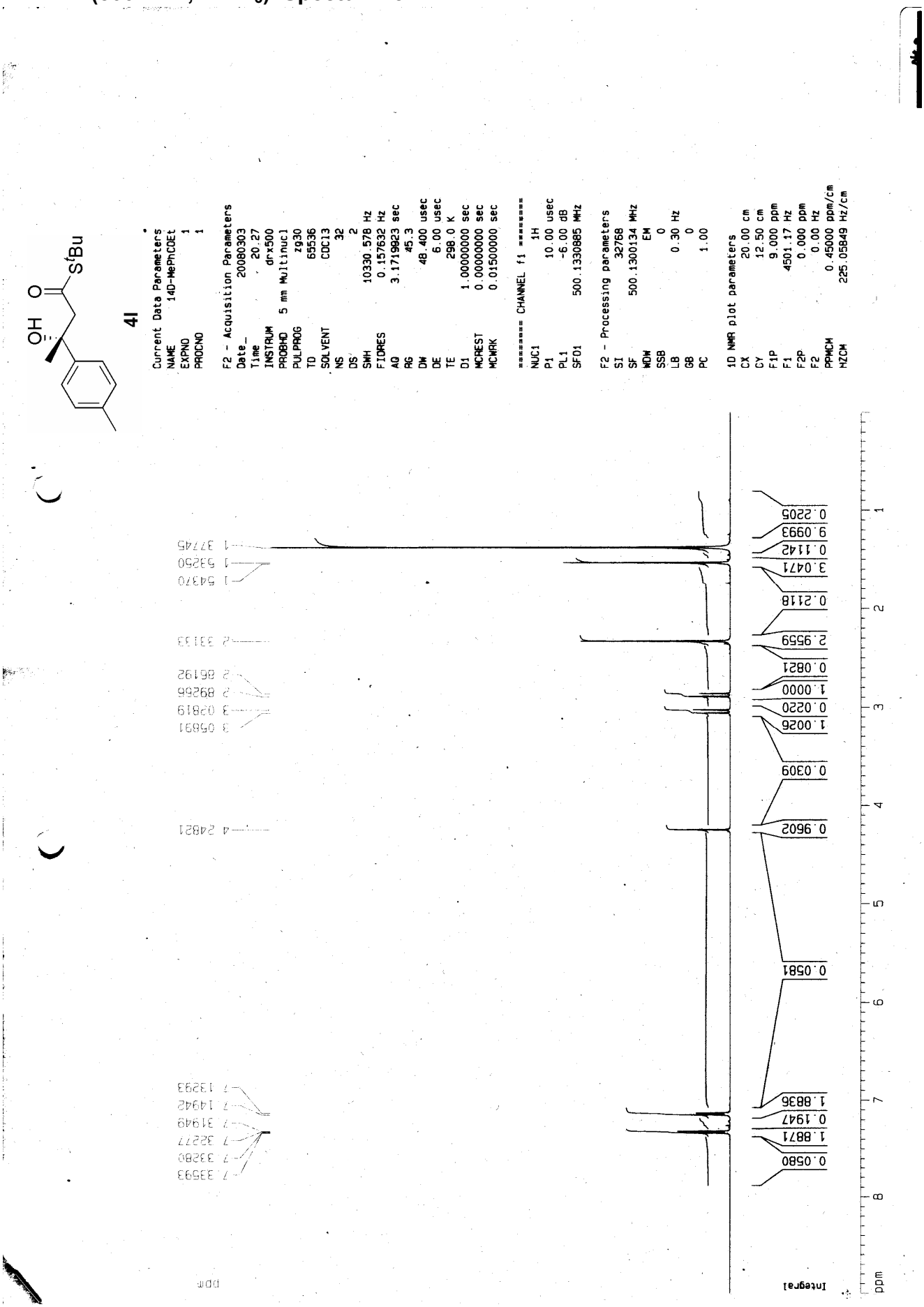
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4k



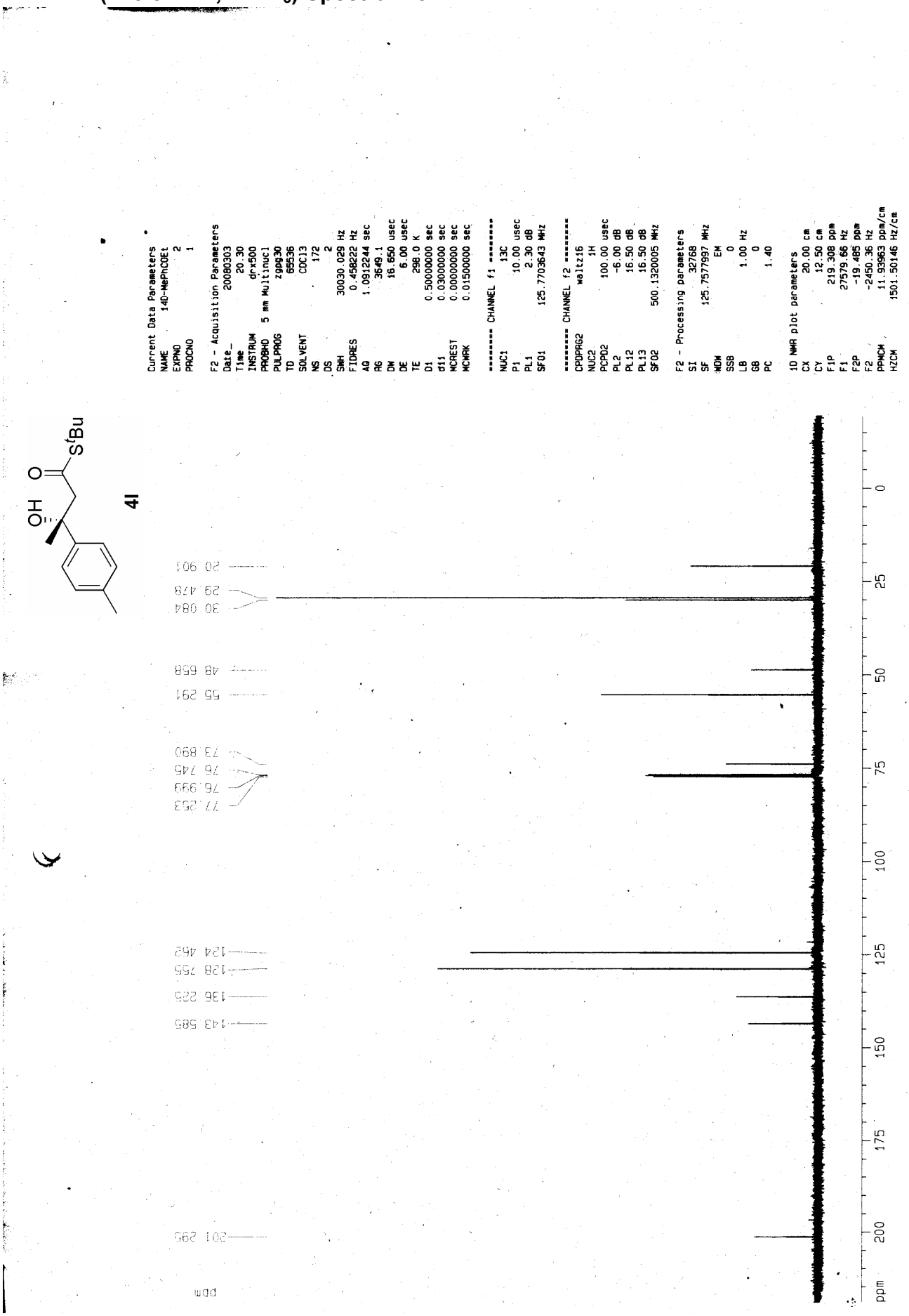
## $^{13}C$ NMR (125.8 MHz, $CDCl_3$) Spectrum of 4k



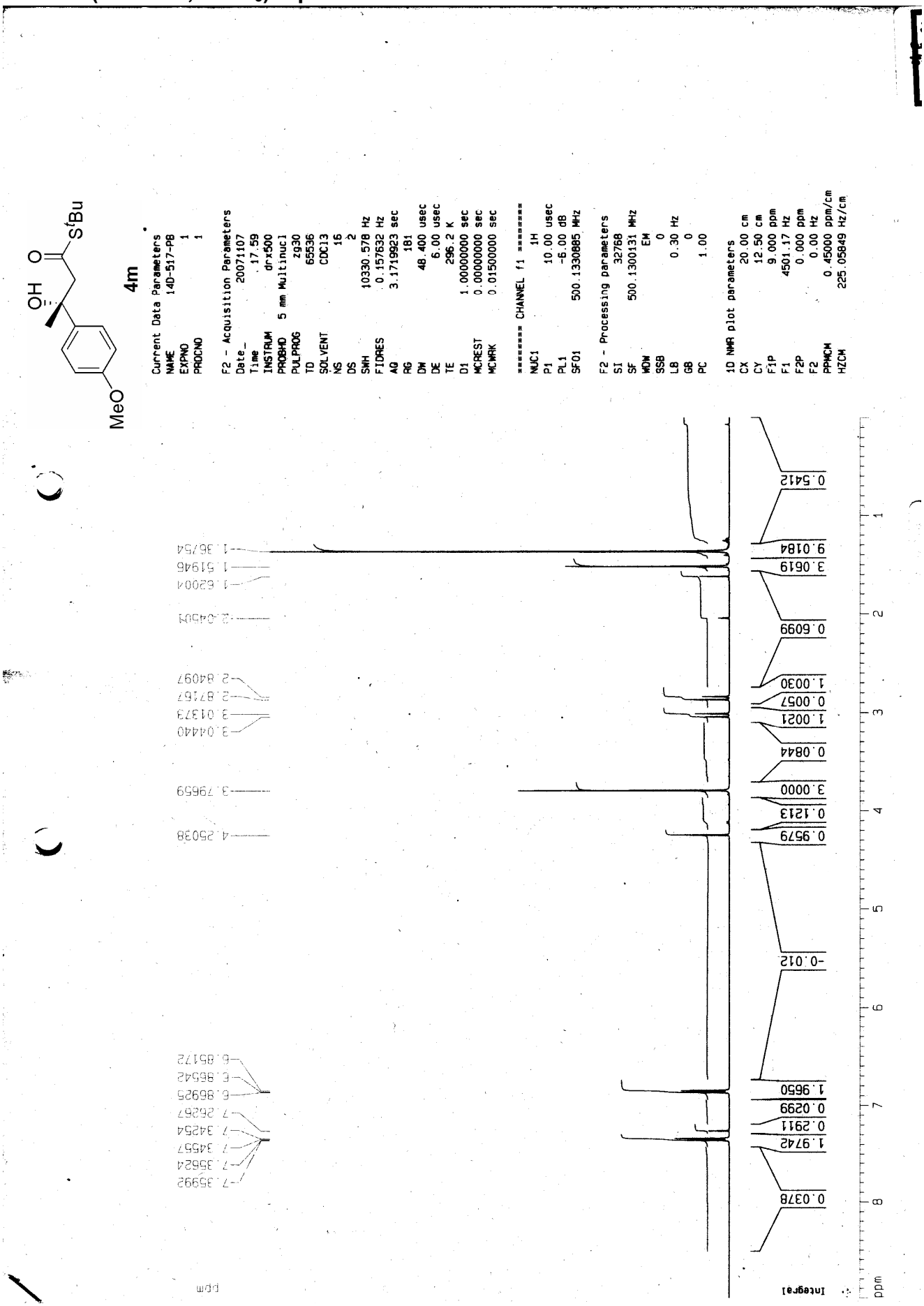
**$^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4l**



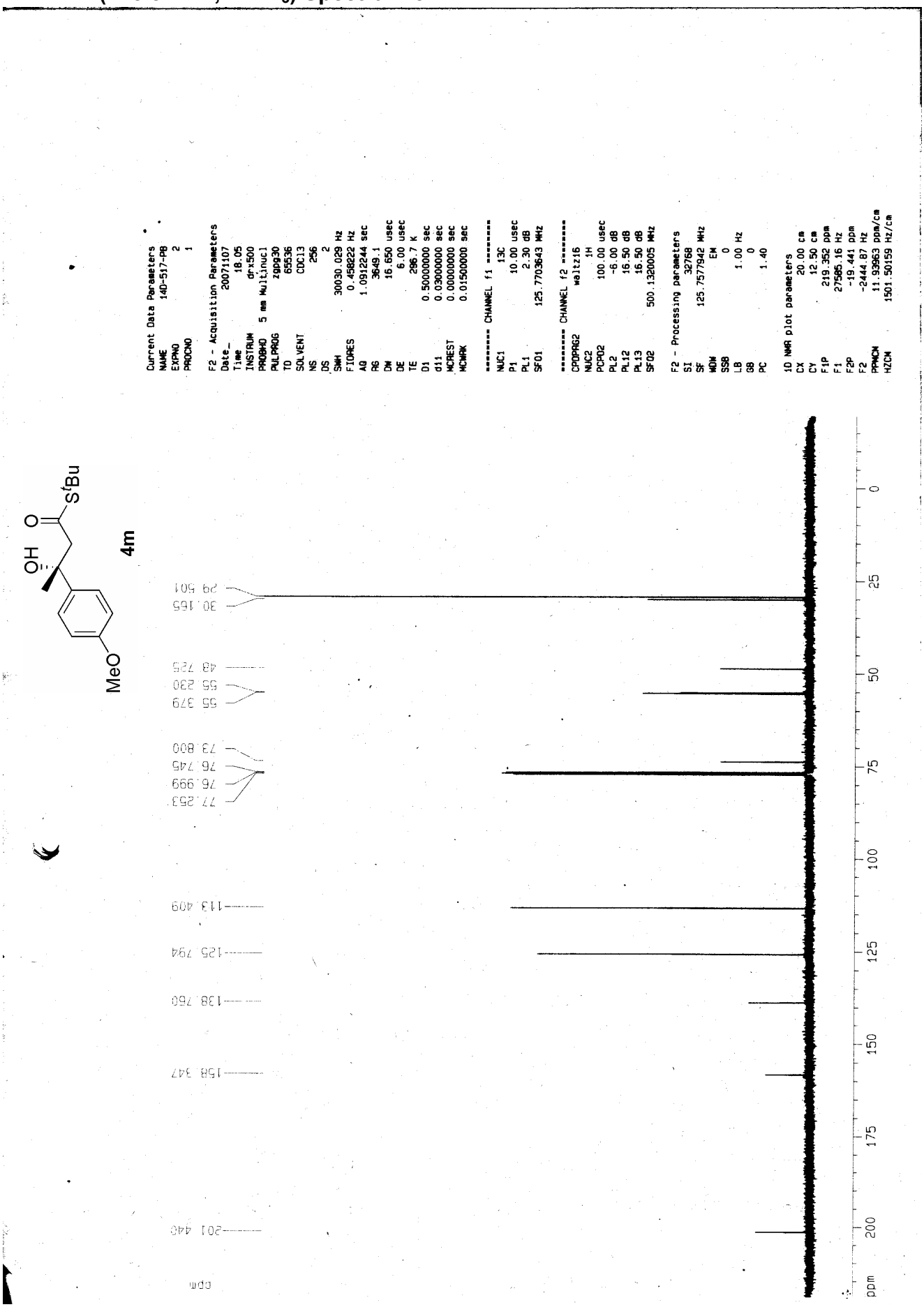
## $^{13}C$ NMR (125.8 MHz, $CDCl_3$) Spectrum of 4l



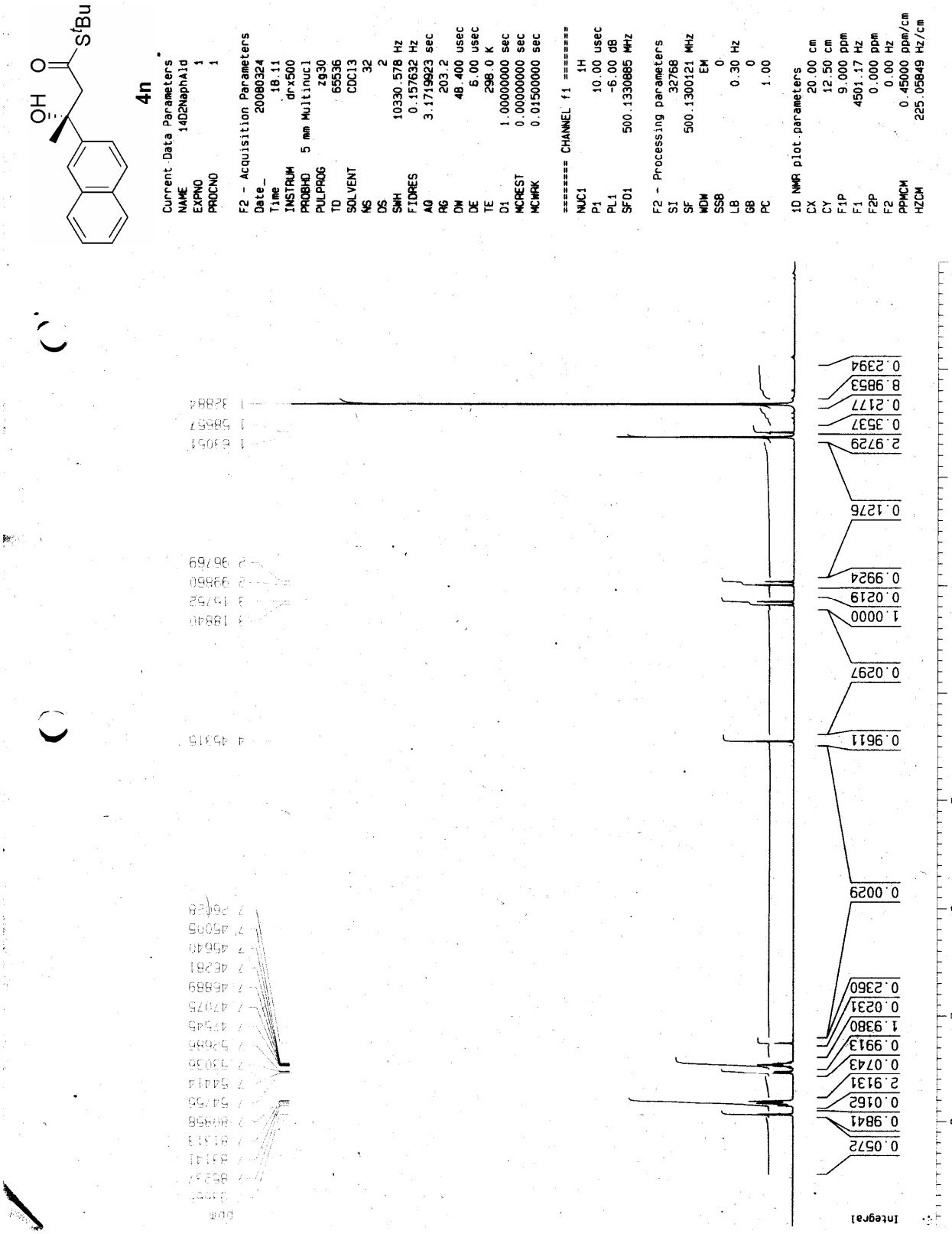
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4m



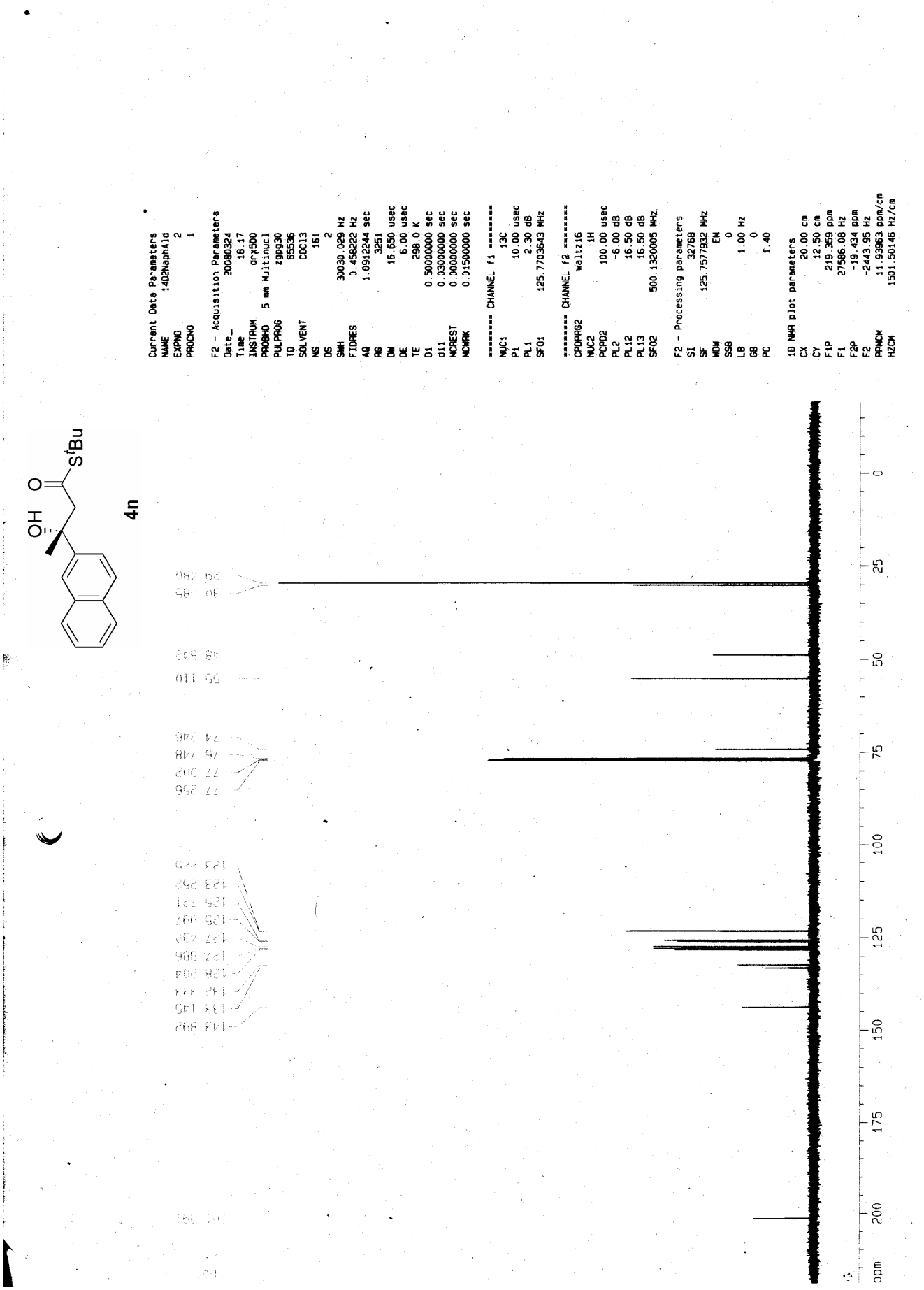
## $^{13}$C NMR (125.8 MHz, $CDCl_3$) Spectrum of 4m



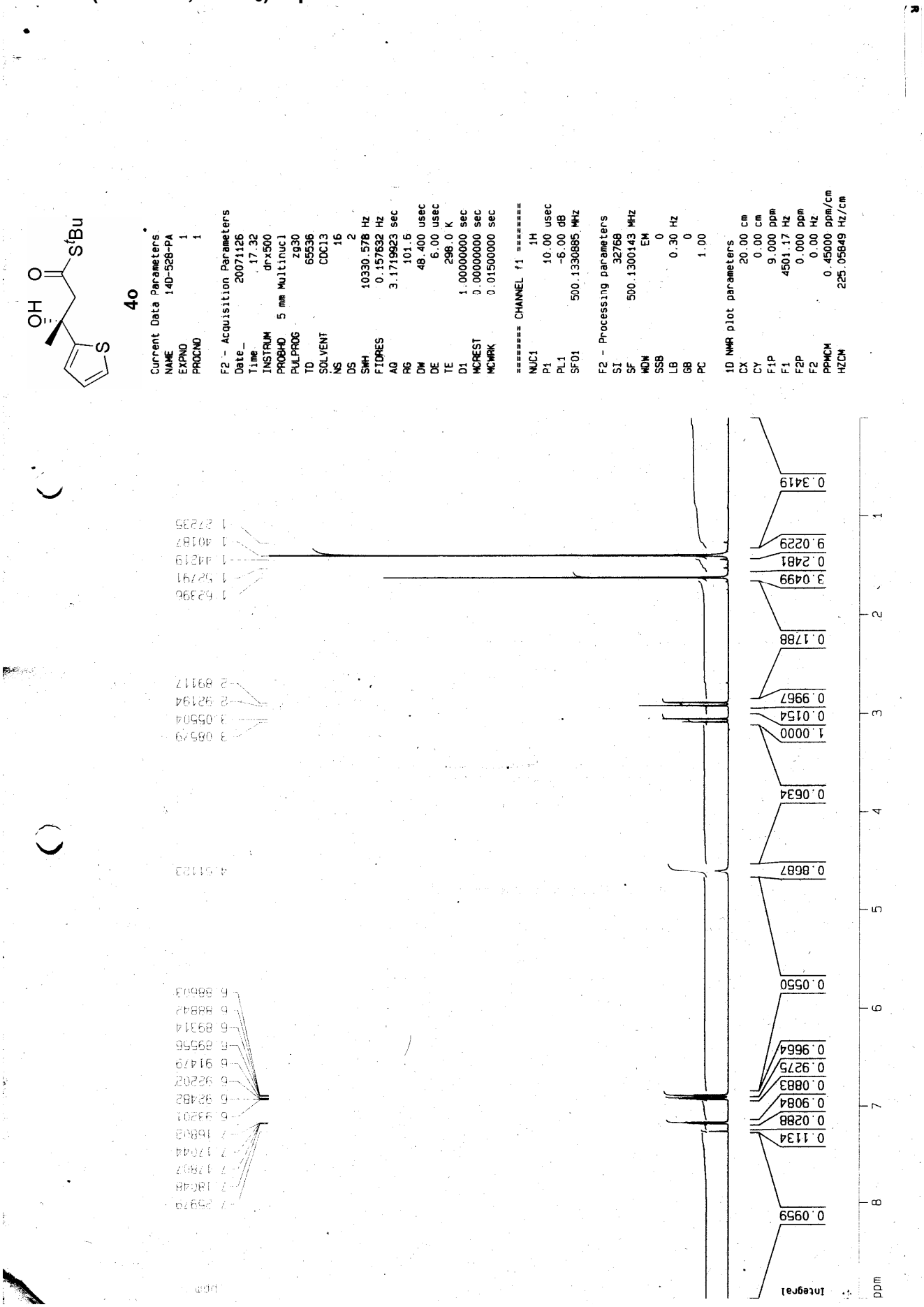
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4n



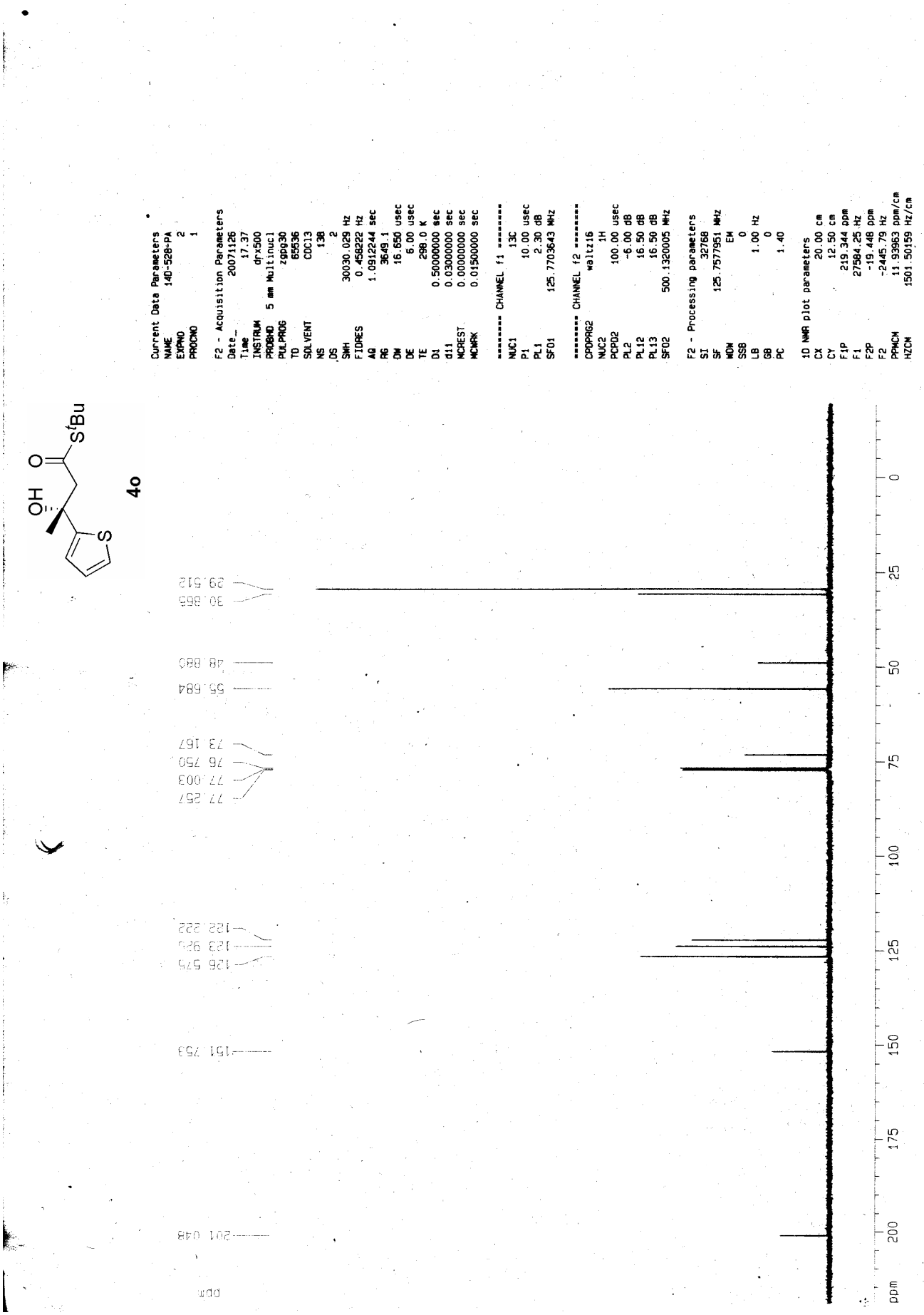
## $^{13}C$ NMR (125.8 MHz, $CDCl_3$) Spectrum of 4n



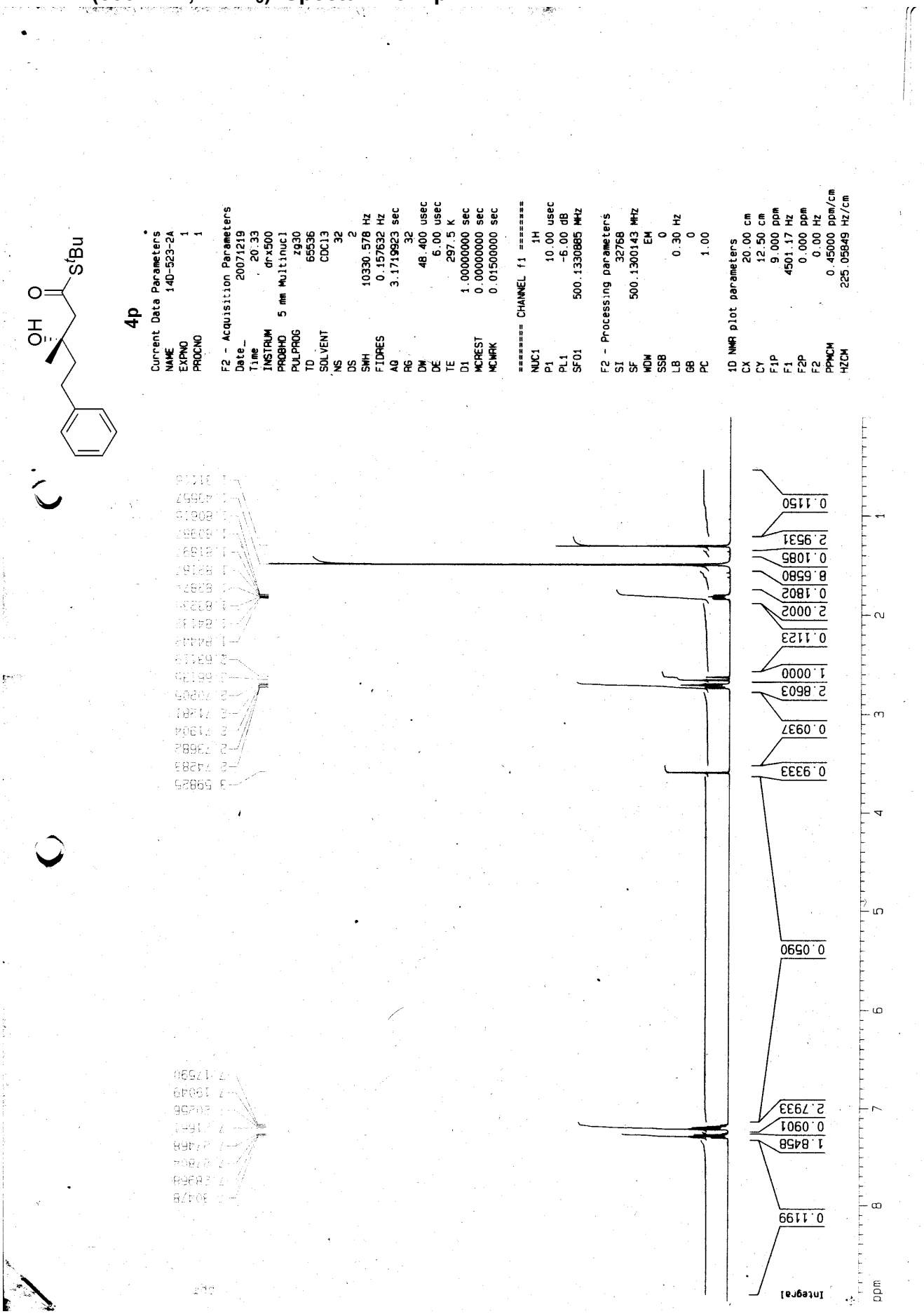
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4o



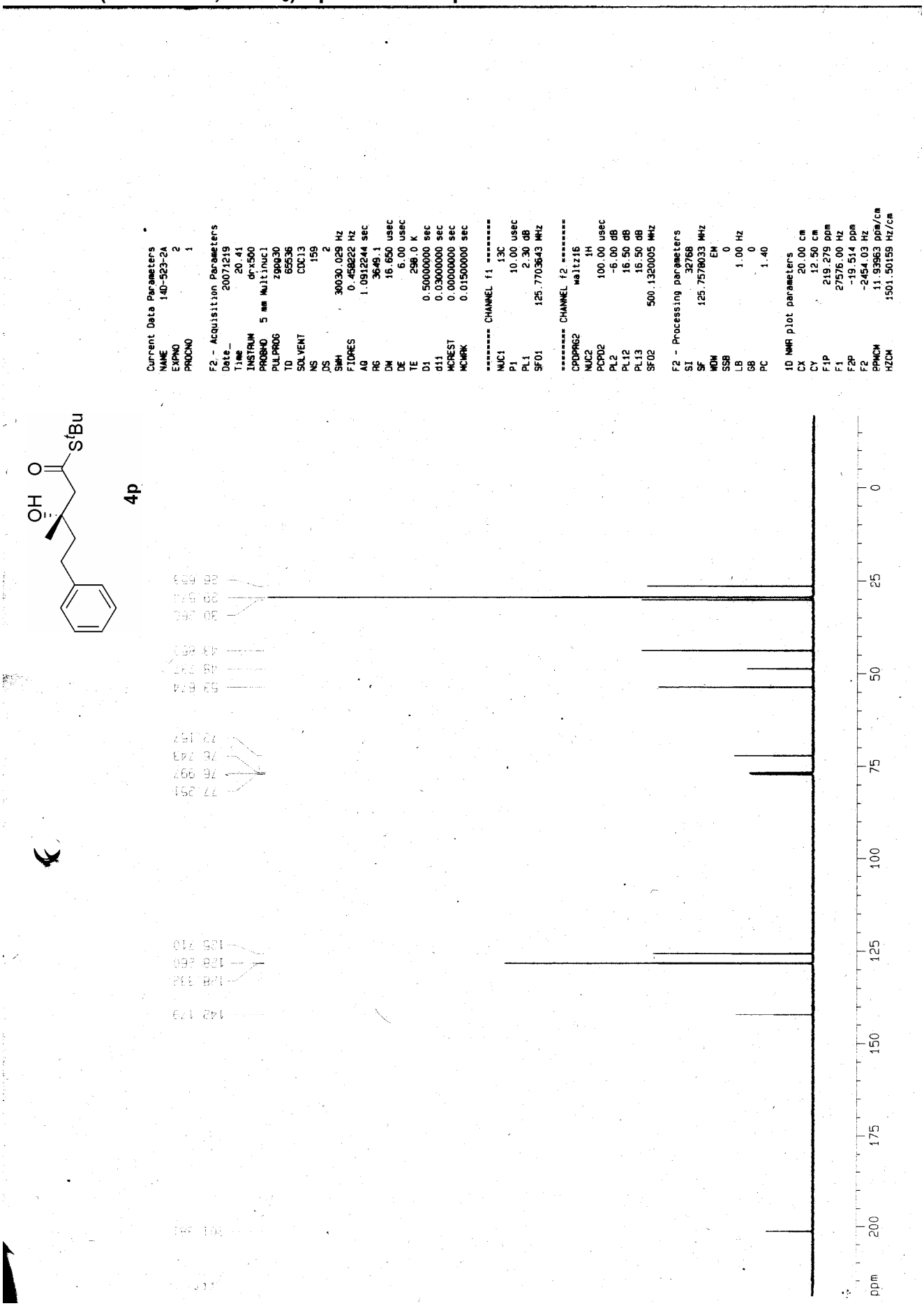
## $^{13}C$ NMR (125.8 MHz, $CDCl_3$) Spectrum of 4o



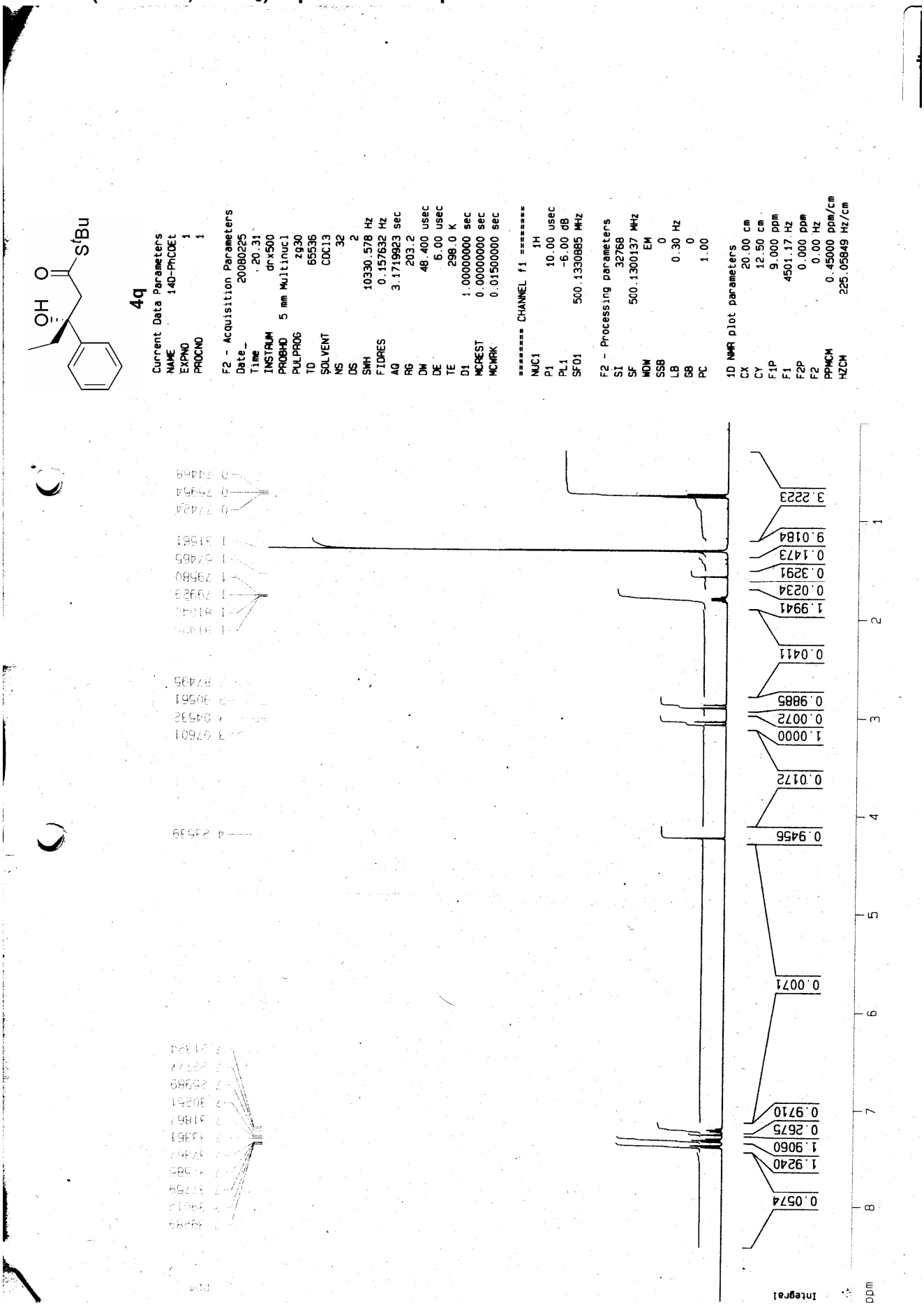
## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4p



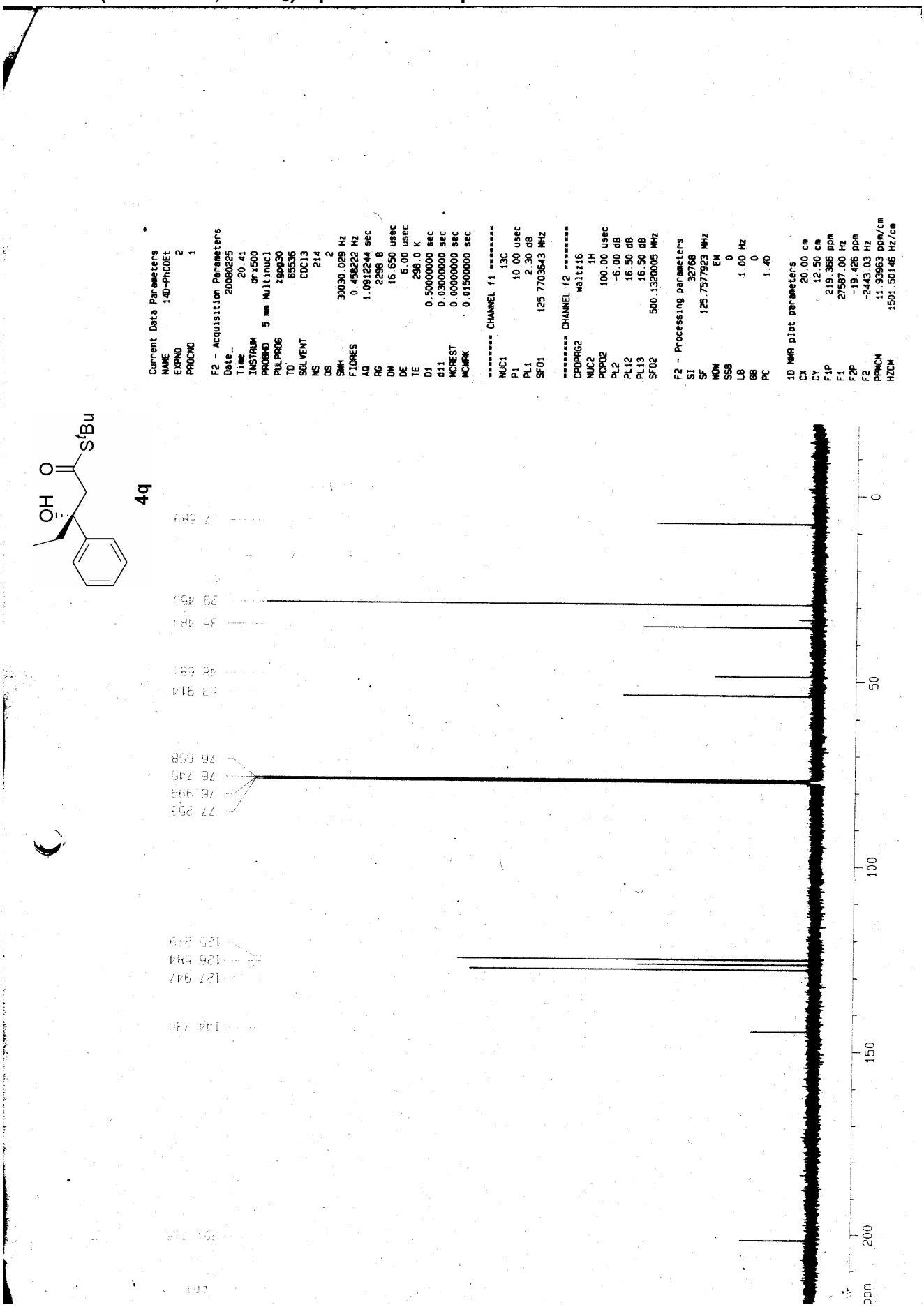
## $^{13}$C NMR (125.8 MHz, $CDCl_3$) Spectrum of 4p



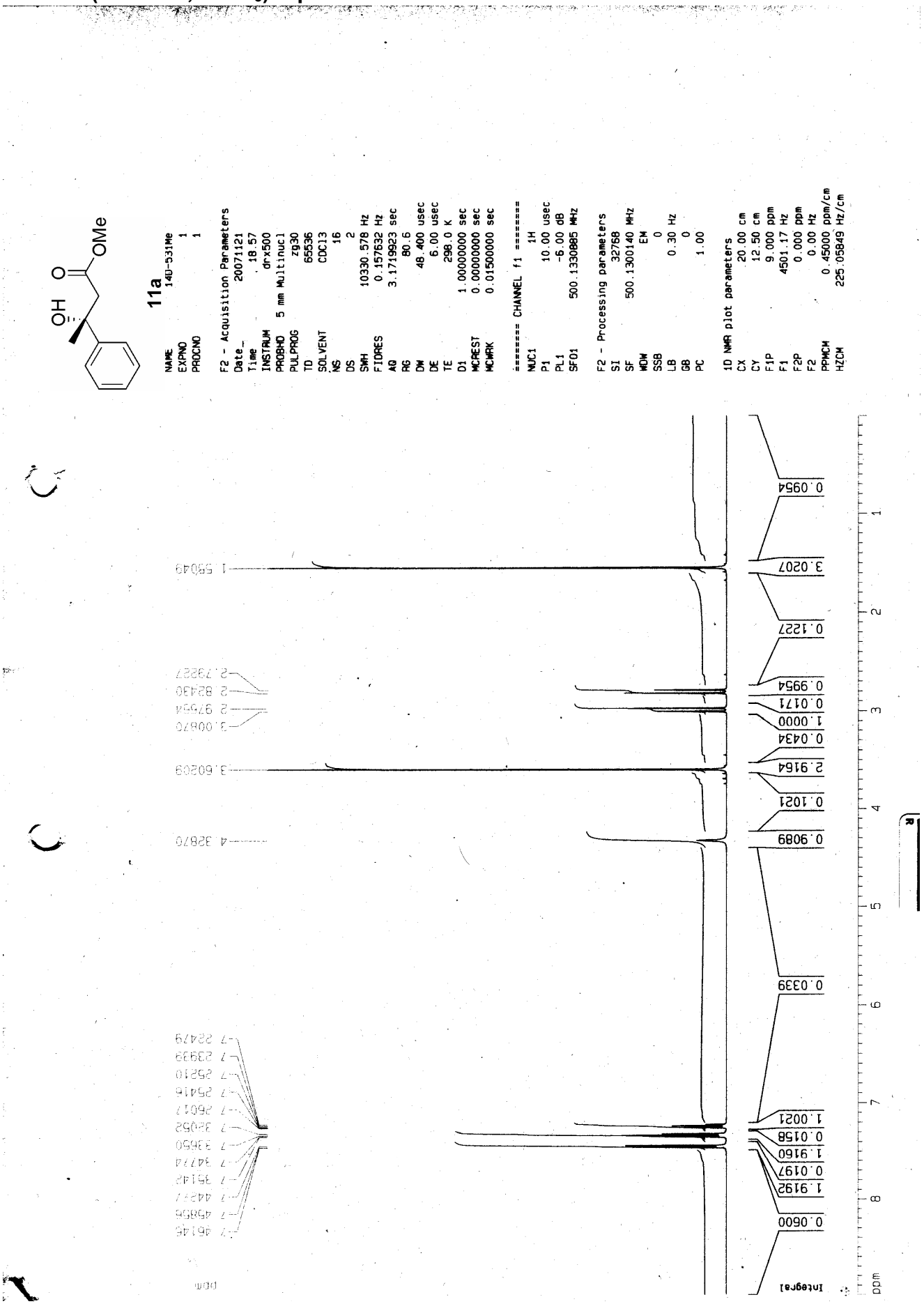
**$^1$H NMR (500 MHz, $CDCl_3$) Specturm of 4q**



## $^{13}$C NMR (125.8 MHz, $CDCl_3$) Spectrum of 4q



## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 11a



## $^1$H NMR (500 MHz, $CDCl_3$) Specturm of 11b