Mild water-promoted deacetalisation of aromatic acyclic acetals

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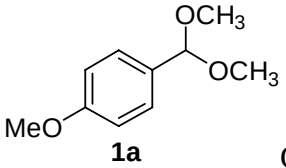
The majority of the acetals used in this study are either commercially available or have been previously described and characterised. The latter are referenced. The few that have not been previously described are provided with analytical details. NMR spectra are also provided.

General experimental procedure:

The reactions were performed in neat deionised water unless otherwise indicated. No special precautions were taken to exclude oxygen and standard round bottomed flasks were used. To 12.5 mmol of the acetal were added 15 mL of deionised water. The reaction vessel was heated to 80 °C for the determined period of time after which the water was simply removed by evaporation thereof. Alternatively, diethyl ether (3 × 5 mL) could be used with which to extract the organic material from the aqueous layer. The organic phase was dried with anhydrous magnesium sulphate and the volatile component removed under vacuum. In all cases the products were isolated directly in >98% purity as determined by ^{1}H NMR and GC analyses without further need for purification. The aldehyde or ketone products were compared spectroscopically with their commercially available counterparts.

In instances where the reactions were performed under pressure, stainless steel autoclaves fitted with a PTFE liner, a pressure gauge, filler fitting with a tap valve (needle type) and pressure relief safety device were used (Caution: high pressure reactions should be performed only by suitably trained personnel who understand the risks involved, making use of appropriate pressure vessels). The acetal was weighed directly into the PTFE liner which was then placed inside the pressure vessel. The relevant aqueous solvent mixture as indicated in the main text of this manuscript was added to the acetal and the pressure vessel sealed and pressurised with nitrogen from a high pressure cylinder. The vessels was heated in an oil bath to the temperature and for the time indicated in the main text of this article. At the end of the reaction the pressure vessel was cooled and de-pressurised inside a fume hood. The reaction contents were then treated as usual (see above) to isolate the products.



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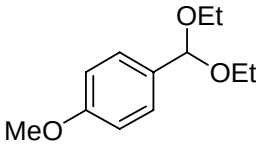
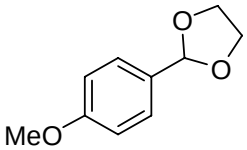
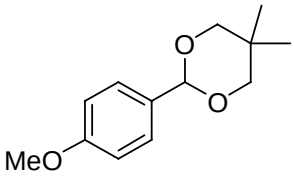


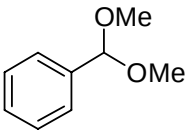
2a Mansilla, H.; Afonso, M, M. *Synth. Commun.* **2008**, *38*, 2607.



3a Ren, Y.-M.; Cai, C. *Tetrahedron Let.* **2008**, *49*, 7110.



4a Bandgar, B. P.; Gaikwad, N. B. *Monatsh. Chem.* **1998**, *129*, 719.



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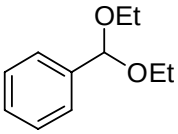

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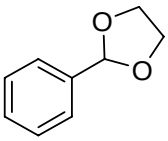

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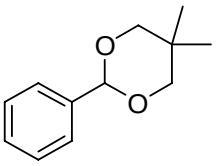
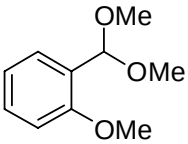
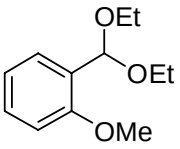


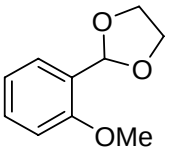
4b Bandgar, B. P.; Gaikwad, N. B. *Monatsh. Chem.* **1998**, *129*, 719.



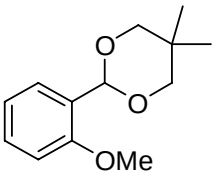
1c Clerici, A.; Pastori, N.; Porta, O. *Tetrahedron* **1998**, *54*, 15679.



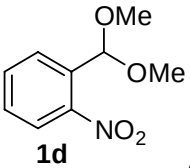
2c Baldoli, C.; Maiorana, S.; Licandro, E.; Casiraghi, L.; Zinzalla, G.; Seneci, P.; De Magistris, E.; Paio, A.; Marchioro, C. *J. Comb. Chem.* **2003**, *5*, 809.



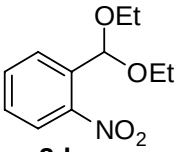
3c Moghaddam, F. M.; Sharifi, A. *Synth. Commun.* **1995**, *25*, 2457.



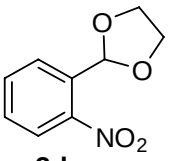
4c Prepared according to Williams, D. B. G.; Lawton, M. *Green Chem.* **2008**, *10*, 914; (12.5 mmol scale, 92% yield). ^{1}H NMR ($CDCl_3$, 300 MHz): 7.63 (dd, 1H, J = 7.7, 1.7 Hz), 7.21 (ddd,1H, J = 8.1, 7.7, 1.7 Hz), 6.97 (t, 1H, J = 7.7 Hz), 6.87 (d, 1H, J = 8.1 Hz), 5.77 (s, 1H), 3.82 (s, 3H), 3.74 (d, 2H, J = 11.0 Hz), 3.66 (d, 2H, J = 11.0 Hz), 1.31 (s, 3H), 0.77 (s, 3H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): δ 157.6, 130.0, 127.1, 125.7, 120.8, 110.6, 96.8, 77.9, 55.6, 30.3, 23.1, 21.9; IR ν_{max} 2948, 2859, 1498, 1394, 1245, 1086, 988 cm^{-1}; CI-HRMS $C_{13}H_{14}O_3$ $[M]^+$ calcd 222.1256, found 222.1253.



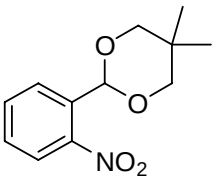
1d Akue-Gedu, R.; Gautret, P.; Lelieur, J.-P.; Rigo, B. *Synthesis* **2007**, 3319.



2d Gopinath, R.; Haque, Sk. J.; Patel, B. K. *J. Org. Chem.* **2002**, *67*, 5842



3d Banik, B. K.; Chapa, M.; Marquez, J.; Cardona, M. *Tetrahedron Lett.* **2005**, *46*, 2341.



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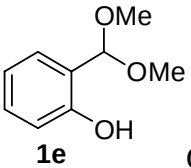

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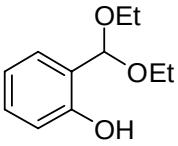
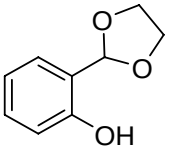


2e Du, Y.; Tian, F. *Synth. Commun*. **2005**, *35*, 2703.



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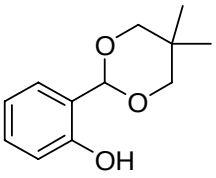

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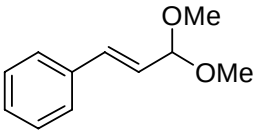
119.7, 117.2, 103.2, 77.6, 30.3, 23.0, 21.8; IR (ν_{max} cm^{-1}) 3335, 2958, 2872, 1491, 1476, 1384, 1242, 1086; CI-HRMS $C_{15}H_{29}O_2$ $[M-H]^+$ calcd 241.2162, found 241.2166.



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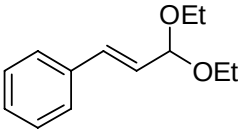

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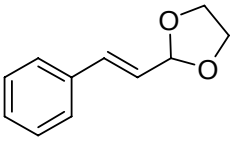

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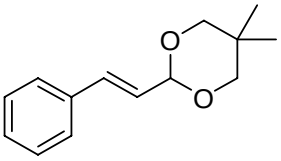

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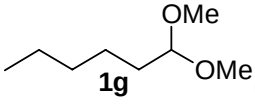

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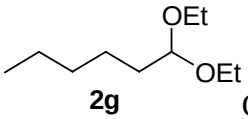

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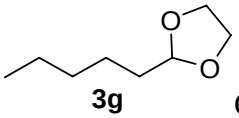

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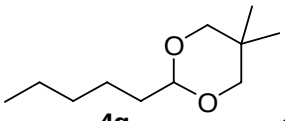

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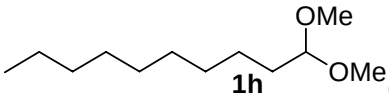

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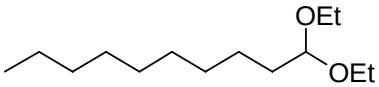

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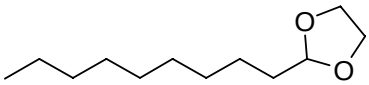

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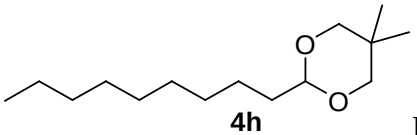
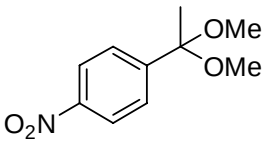
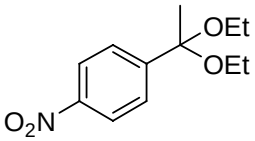


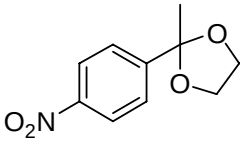
4h Horsfall, J. G.; Lukens, R. J. *Conn. Agr. Expt. Sta., New Haven, Bull.* 1965, 673, 1. (NMR and MS data given here due to lack of general access to this reference: Prepared according to Williams, D. B. G., Lawton, M. *Green Chem.* **2008**, *10*, 914; (12.5 mmol scale, 96% yield). ^{1}H NMR ($CDCl_3$, 300 MHz): 4.36 (t, 1H, J = 5.0 Hz), 3.55 (d, 2H, J = 11.1 Hz), 3.37 (d, 2H, J = 11.1 Hz), 1.62-1.54 (m, 2H), 1.39-1.20 (m, 14H), 1.14 (s, 3H), 0.83 (t, 3H, J = 6.8 Hz) 0.67 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 102.3, 77.2, 34.9, 31.8, 30.1, 29.52, 29.48, 29.3, 24.0, 22.9, 22.6, 21.8, 14.1, 14.1; IR (ν_{max} cm^{-1}): 2925, 2853, 1468, 1394, 1119, 1106, 908; CI-HRMS $C_{15}H_{29}O_2$ $[M-H]^+$ calcd 241.2162, found 241.2166.



6a Novak, M.; Roy, K. R. *J. Org. Chem.* **1984**, *49*, 4584.



7a Ma, Y.-R.; Jin, T.-S.; Shi, S.-X.; Li, T.-S. *Synth. Commun.* **2003**, *33*, 2103.



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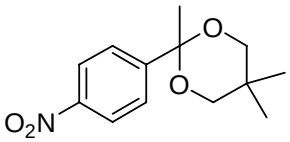
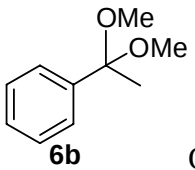


9a Prepared according to Williams, D.B.G., Lawton, M. *Green Chem.* **2008**, *10*, 914; (12.5 mmol scale, 89% yield). ^{1}H NMR ($CDCl_3$, 300 MHz): δ 8.21 (d, 2H, *J* = 8.9 Hz), 7.58 (d, 2H, *J* = 8.9 Hz), 3.41 (d, 2H, *J* = 11.0 Hz), 3.29 (d, 2H, *J* = 11.0 Hz), 1.50 (s, 3H), 1.23 (3, 3H), .058 (s, 3H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): δ 148.9, 147.5, 127.7, 123.8, 99.5, 71.7, 31.4, 29.8, 22.6, 21.6; IR (ν_{max} cm^{-1}): 2948, 2872, 1512, 1349, 1182, 1076; CI-HRMS $C_{13}H_{18}O_4N$ $[M+H]^+$ calcd 252.1236 found 252.1239.



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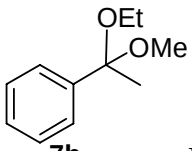

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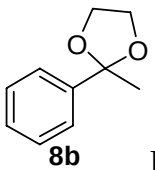

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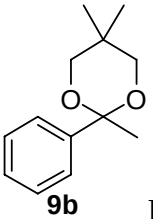
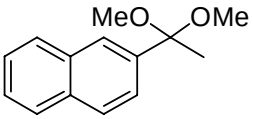
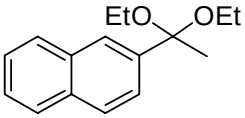


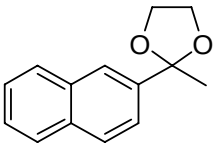
9b Bandgar, B. P.; Gaikwad, N. B. *Monatsh. Chem.* **1998**, *129*, 719.



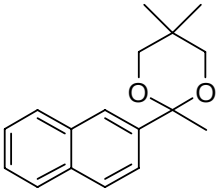
6c Kerti, G.; Kurtan, T.; Borbas, A.; Szabo, Z. B.; Liptak, A.; Szilagyi, L.; Illyes-Tuende, Z.; Benyei, A.; Antus, S.; Watanabe, M.; Castiglioni, E.; Pescitelli, G.; Salvadori, P. *Tetrahedron*. **2008**, *64*, 1676.



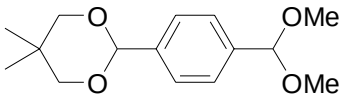
7c Prepared from 2-acetonaphthone (2.128 g, 12.5 mmol scale) according to Williams, D.B.G.; Lawton, M. *Green Chem.* **2008**, *10*, 914 (2.718 g, 11.1 mmol, 89% yield). ^{1}H NMR ($CDCl_3$, 300 MHz): δ 8.03 (br s, 1H), 7.89-7.79 (m, 2H), 7.81 (d, 1H, J = 8.7 Hz), 7.60 (dd, 1H, J = 7.8, 1.8 Hz), 7.49-7.42 (m, 2H), 3.59-3.48 (m, 2H), 3.45-3.35 (m, 2H), 1.63 (s, 3H), 1.24 (t, 6H, J = 6.9 Hz); ^{13}C NMR ($CDCl_3$, 75.5 MHz): δ 141.3, 133.1, 132.7, 128.4, 127.7, 127.5, 125.8 (2C), 125.2, 124.3, 101.3, 56.8, 27.0, 15.4, 15.2; IR (ν_{max} cm^{-1}): 2976, 1371, 1277, 1132, 1048, 906; CI-HRMS $C_{14}H_{15}O$ $[M\text{-}C_2H_5O]^+$ calcd 199.1123, found 199.1127.



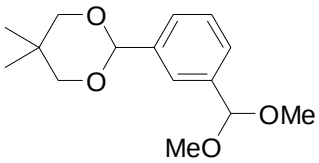
8c Hyder, Z.; Ruan, J.; Xiao, J. *Chem. Eur. J.* **2008**, *14*, 5555.



9c Grosu, I.; Ple, G.; Mager, S.; Mesaros, E.; Dulau, A.; Gego, C. *Tetrahedron* **1998**, *54*, 2905.



11 Nao, H.; Kiyoshi, K.; Hisashi, S.; Tsuneo, S. *Synlett* **2004**, *6*, 1074.

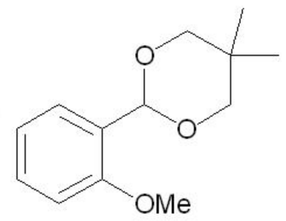


13 Prepared according to Nao, H.; Kiyoshi, K.; Hisashi, S.; Tsuneo, S. *Synlett* **2004**, *6*, 1074, as for the synthesis of **11**. ^{1}H NMR ($CDCl_3$, 300 MHz): 7.61 (s, 1H), 7.49 (d, J = 7.5 Hz, 2H), 7.36 (t, J = 7.5 Hz, 1H), 5.38 (s, 2H), 3.75 (d, J = 10.8 Hz, 2H), 3.61 (d, J = 10.8 Hz, 2H), 3.31 (s, 3H), 3.29 (s, 3H), 1.26 (s, 3H), 0.77 (s, 3H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): δ 138.5, 128.1, 127.1, 126.7, 126.2, 125.1, 102.7, 101.6, 77.6, 52.7, 52.5, 30.2, 23.0, 21.8; IR ν_{max} 2954, 2831, 1450, 1349, 1159, 1101, 1052 cm^{-1}; CI-HRMS $C_{15}H_{23}O_4$ $[M+H]^+$ calcd 267.1596, found 267.1592.

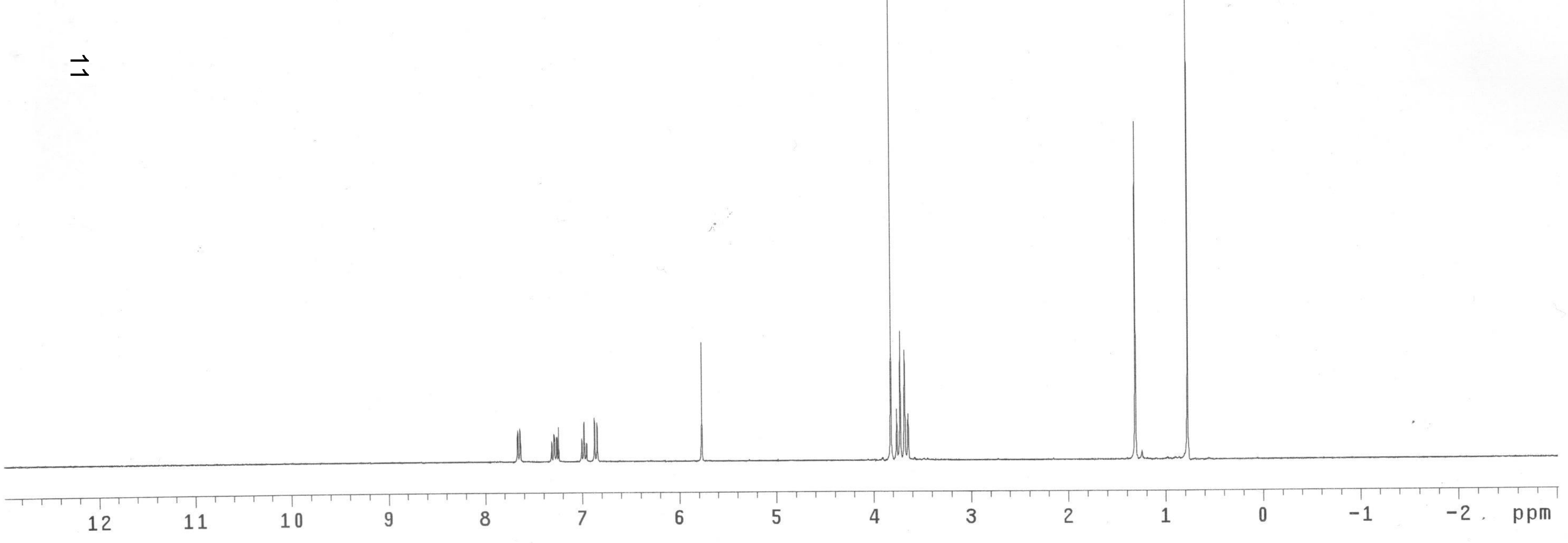
STANDARD 1H OBSERVE

Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: 1
GEMINI-300BB "kmr300"

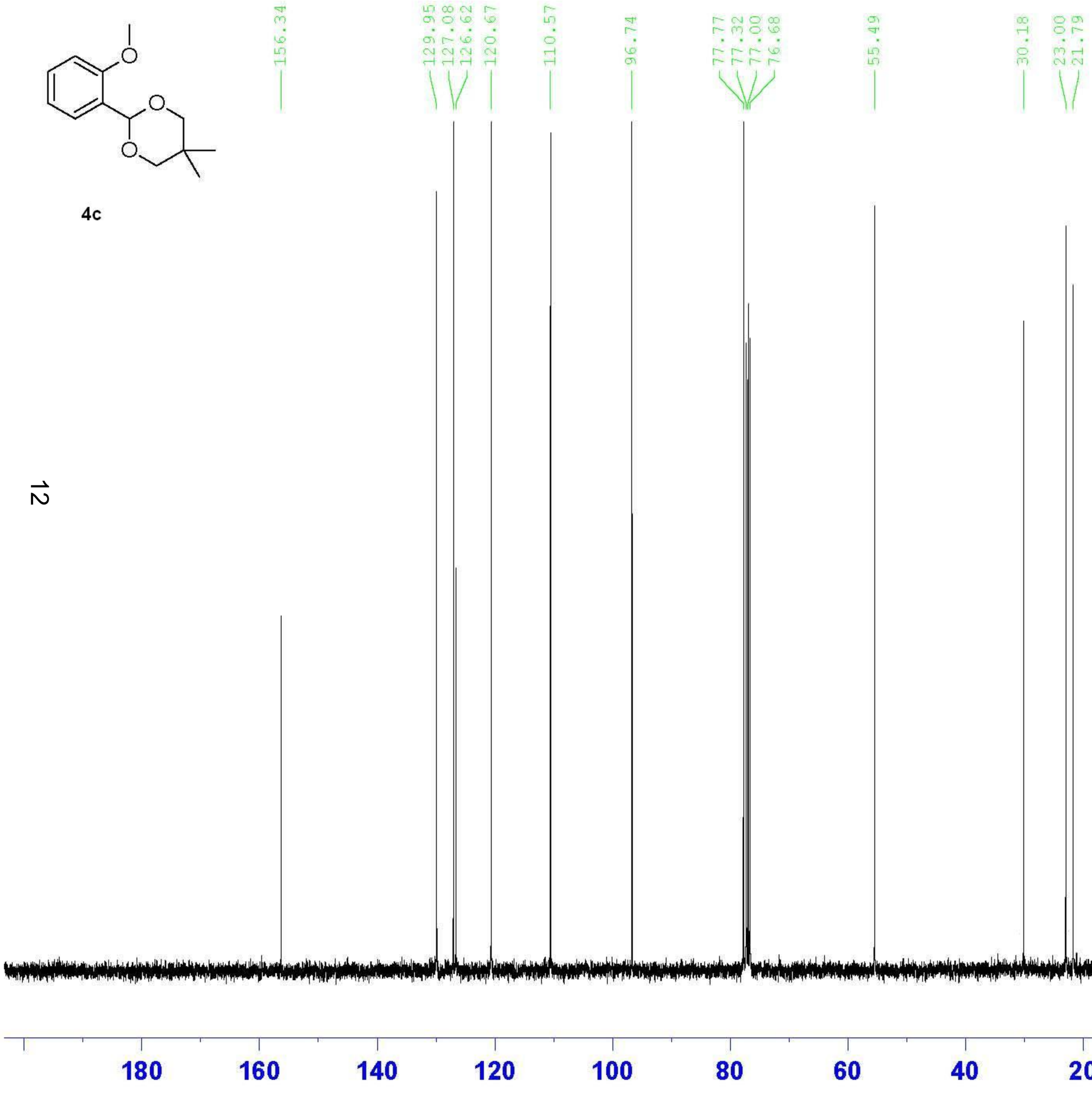
Relax. delay 1.000 sec
Pulse 88.7 degrees
Acq. time 2.000 sec
Width 4800.0 Hz
Single scan
OBSERVE H1, 300.0575472 MHz
DATA PROCESSING
FT size 32768
Total time 0 min, 4 sec



11

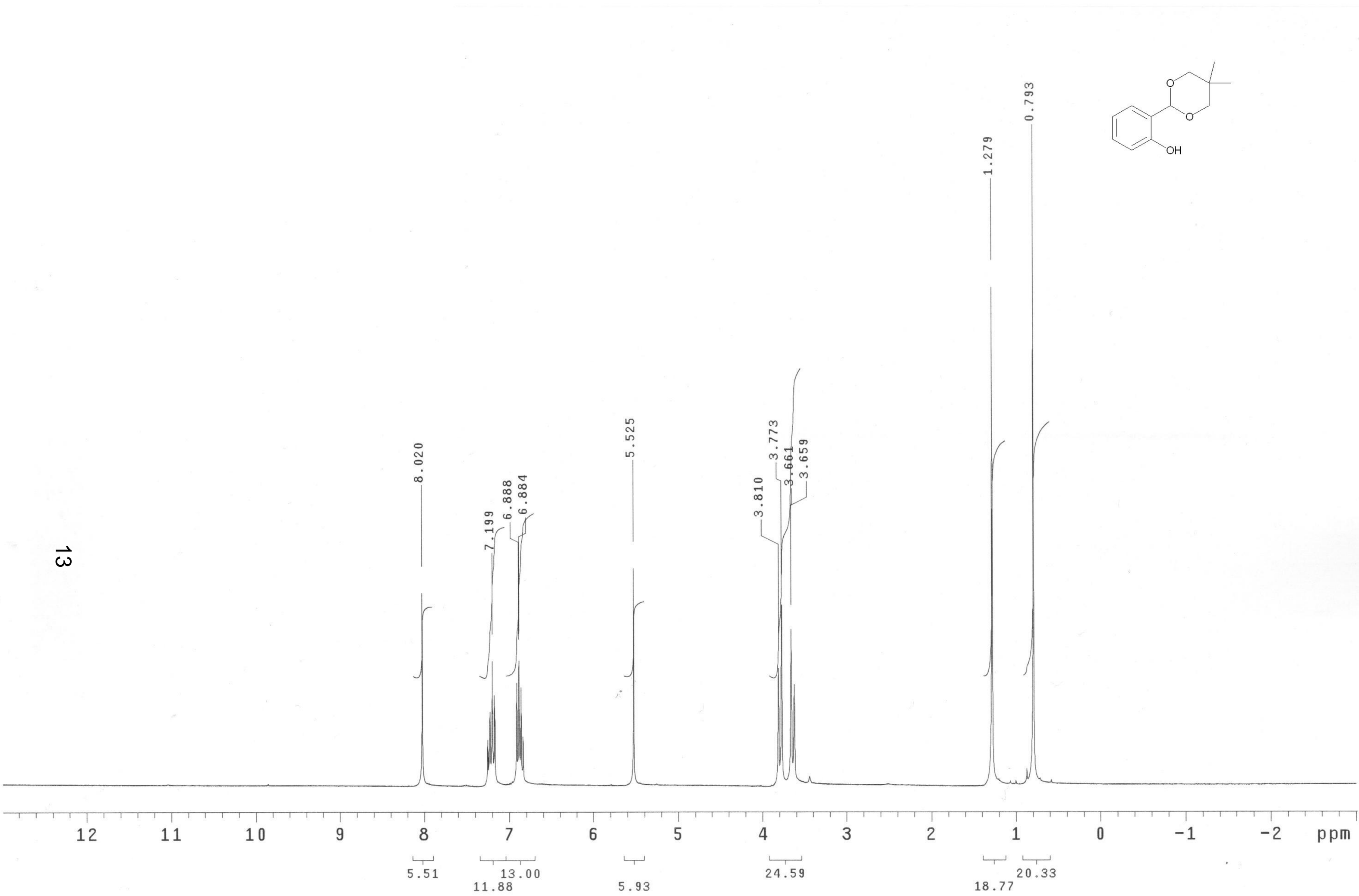


4c



12

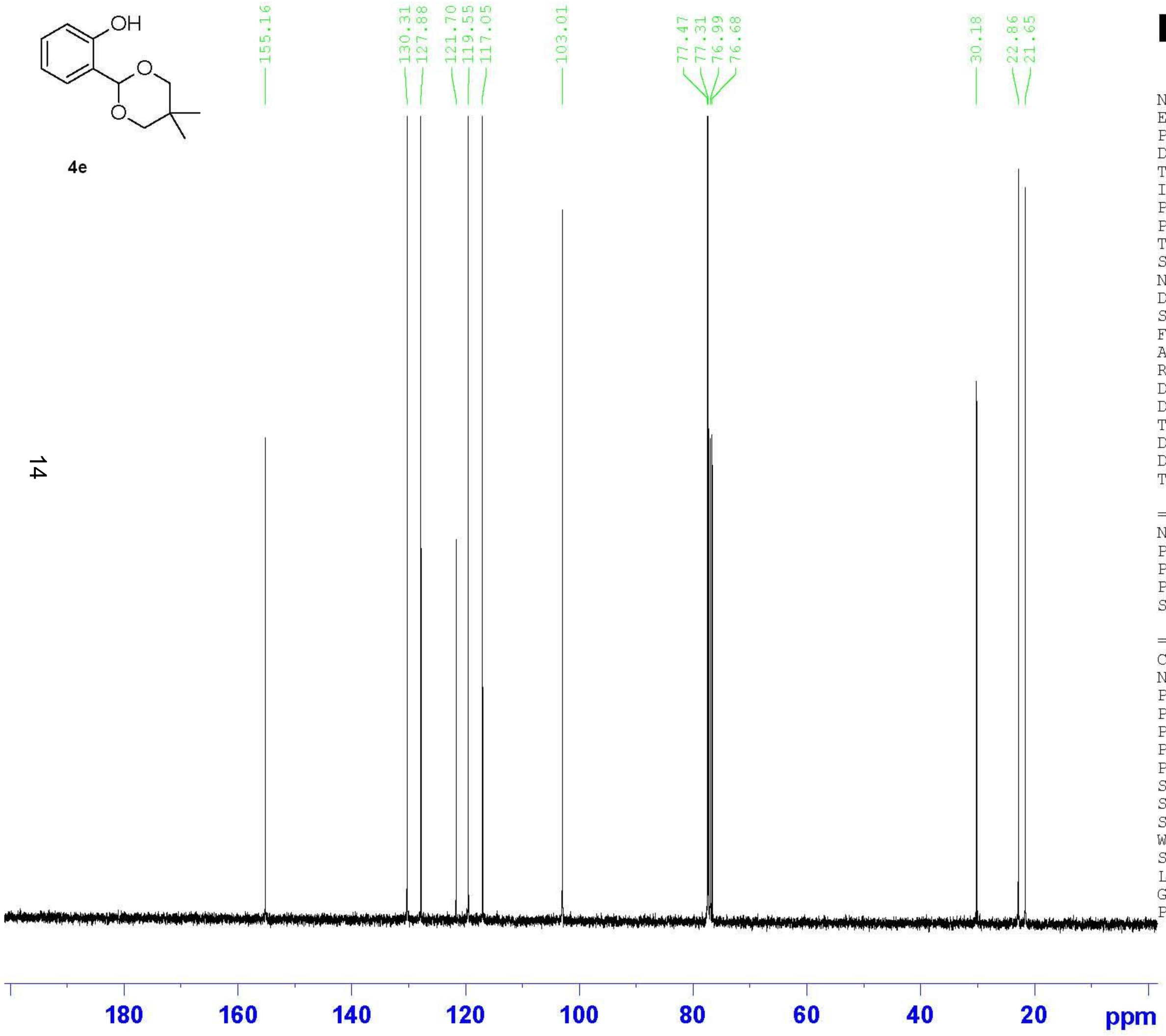
NAME	A28
EXPNO	1
PROCNO	1
Date_	20100831
Time	10.42
INSTRUM	spect
PROBHD	5 mm PABBO BB-
PULPROG	zgig30
TD	65536
SOLVENT	CDCl3
NS	128
DS	4
SWH	24038.461 Hz
FIDRES	0.366798 Hz
AQ	1.3631988 sec
RG	128
DW	20.800 usec
DE	6.50 usec
TE	296.2 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	13C
P1	9.60 usec
PL1	-1.50 dB
PL1W	51.80275345 W
SFO1	100.6328888 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	90.00 usec
PL2	-3.00 dB
PL12	15.30 dB
PL2W	23.05461311 W
PL12W	0.34100270 W
SFO2	400.1716007 MHz
SI	32768
SF	100.6228393 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40



13

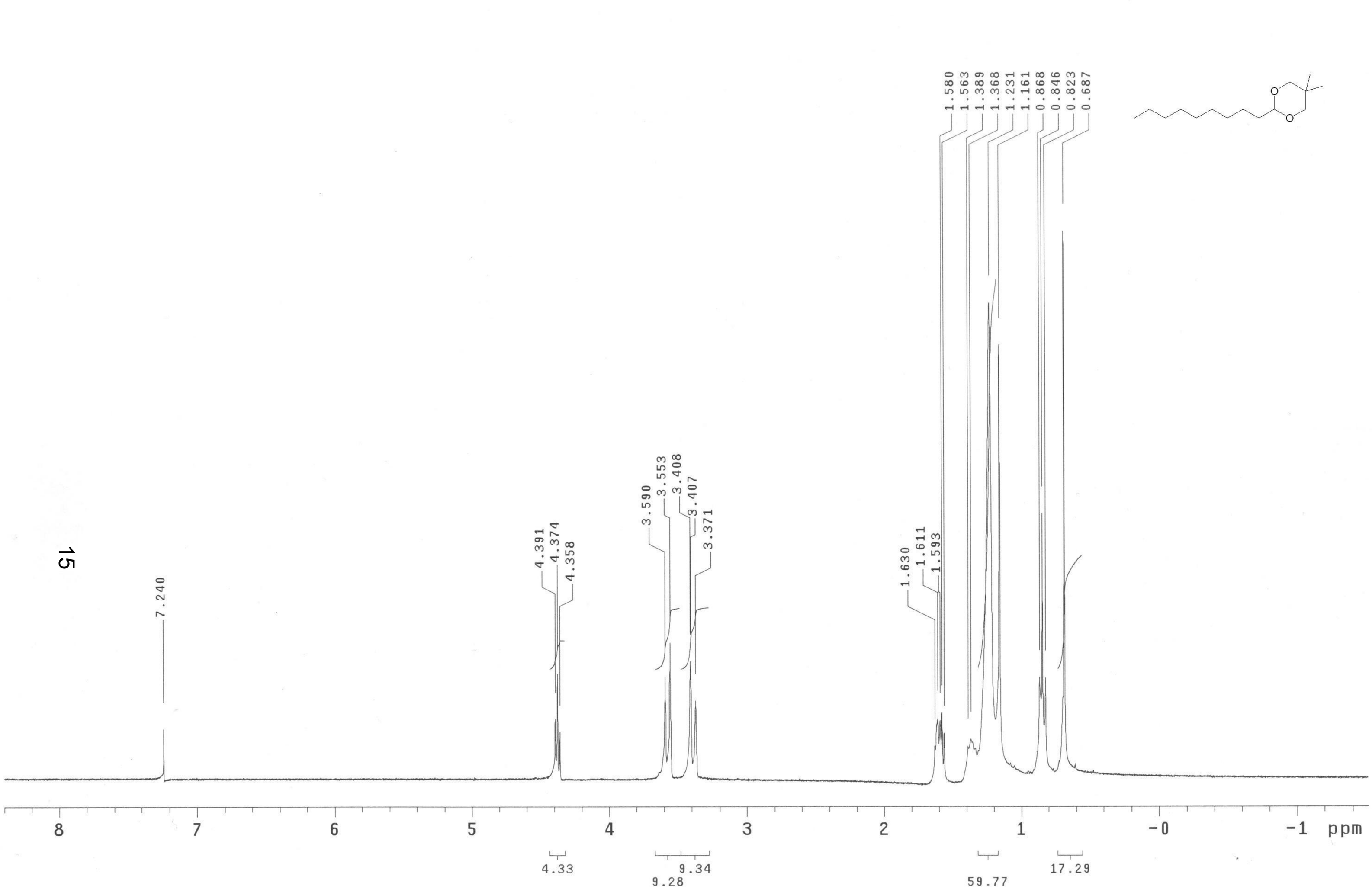
PULSE SEQUENCE Relax. delay 1.000 sec Pulse 6.3 degrees Acq. time 2.000 sec Width 4800.0 Hz 12 repetitions	OBSERVE H1, 300.0575460	DATA PROCESSING FT size 32768 Total time 1 minute			STANDARD 1H OBSERVE Pulse Sequence: s2pul Solvent: CDCl3 Ambient temperature GEMINI-300 "kmr300"

4e

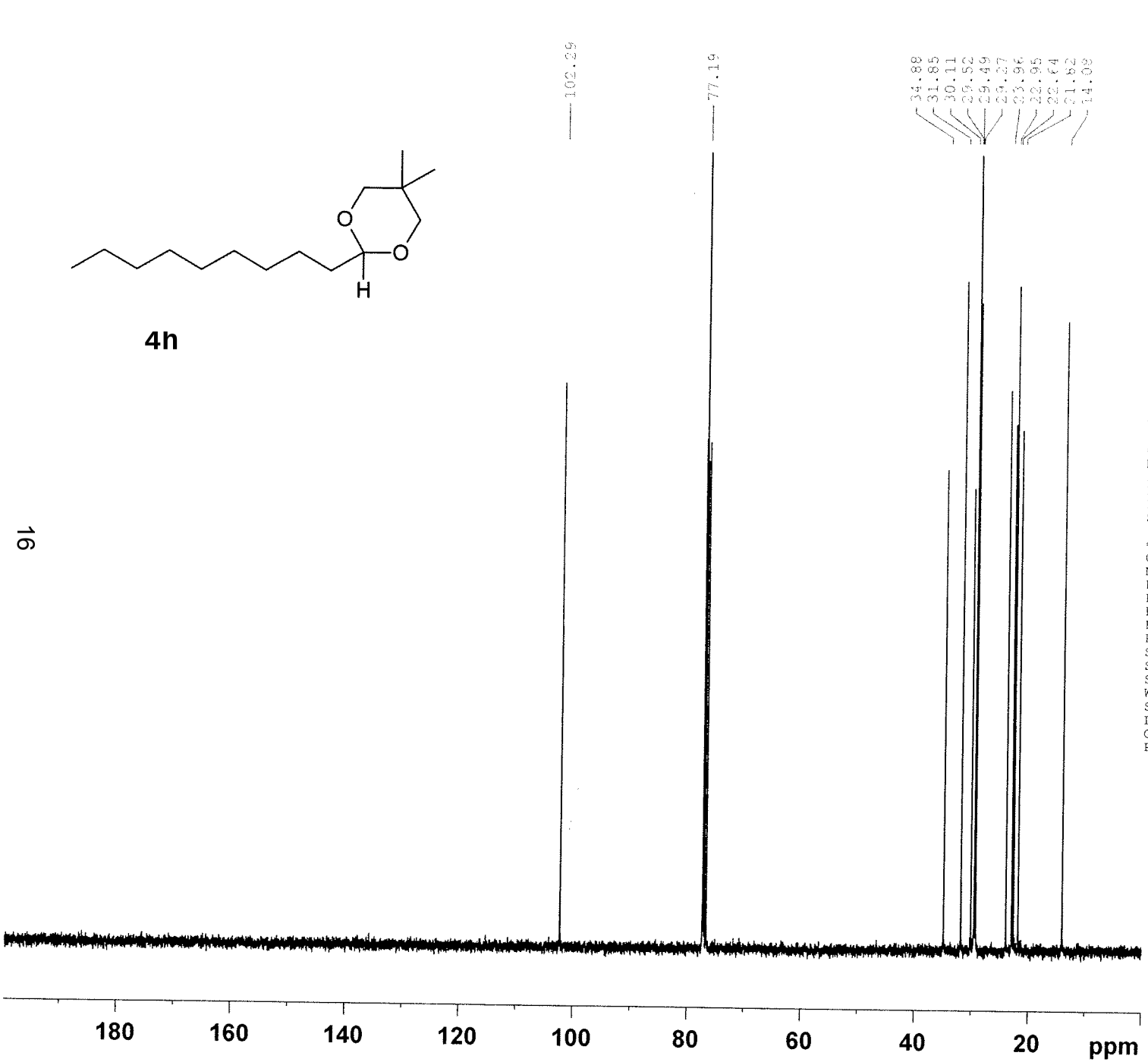


BRUKER

NAME	A30-1H
EXPNO	3
PROCNO	1
Date_	20100831
Time	9.57
INSTRUM	spect
PROBHD	5 mm PABBO BB-
PULPROG	zgig30
TD	65536
SOLVENT	CDCl3
NS	128
DS	4
SWH	24038.461 Hz
FIDRES	0.366798 Hz
AQ	1.3631988 sec
RG	101
DW	20.800 usec
DE	6.50 usec
TE	296.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	13C
P1	9.60 usec
PL1	-1.50 dB
PL1W	51.80275345 W
SFO1	100.6328888 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	90.00 usec
PL2	-3.00 dB
PL12	15.30 dB
PL2W	23.05461311 W
PL12W	0.34100270 W
SFO2	400.1716007 MHz
SI	32768
SF	100.6228422 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40



PULSE SEQUENCE Relax. delay 1.000 sec Pulse 6.3 degrees Acq. time 2.000 sec Width 4800.0 Hz 12 repetitions	OBSERVE H1, 300.0575463	DATA PROCESSING FT size 32768 Total time 1 minute			STANDARD 1H OBSERVE Pulse Sequence: s2pul Solvent: CDCl3 Ambient temperature GEMINI-300 "kmr300"



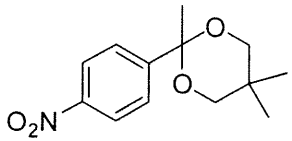
BRUKER

NAME	Aug31-2010-HH-10-cycl-acetal
EXPNO	11
PROCNO	1
Date_	20100831
Time	8.53
INSTRUM	spect
PROBHD	5 mm PABBO BB-
PULPROG	zgig30
TD	65536
SOLVENT	CDCl3
NS	150
DS	4
SWH	24038.461 Hz
FIDRES	0.366798 Hz
AQ	1.3631988 sec
RG	101
DW	20.800 usec
DE	6.50 usec
TE	295.8 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	13C
P1	9.60 usec
PL1	-1.50 dB
PL1W	51.80275345 W
SFO1	100.6328888 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	90.00 usec
PL2	-3.00 dB
PL12	15.30 dB
PL2W	23.05461311 W
PL12W	0.34100270 W
SFO2	400.1716007 MHz
SI	32768
SF	100.6228293 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40

STANDARD 1H OBSERVE

Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: honours_paranitrocyclicacetal
GEMINI-300BB "kmr300"

Relax. delay 1.000 sec
Pulse 126.0 degrees
Acq. time 2.000 sec
Width 4800.0 Hz
60 repetitions
OBSERVE H1, 300.0575455 MHz
DATA PROCESSING
FT size 32768
Total time 9 hr, 22 min, 46 sec



17

8.243
8.213
7.613
7.607
7.584
3.446
3.407
3.322
3.285
1.521
1.247
0.590

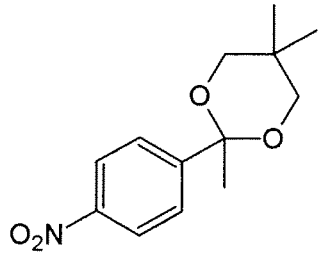
9 8 7 6 5 4 3 2 1 ppm

7.02
8.63
25.78
19.65
20.13
18.79

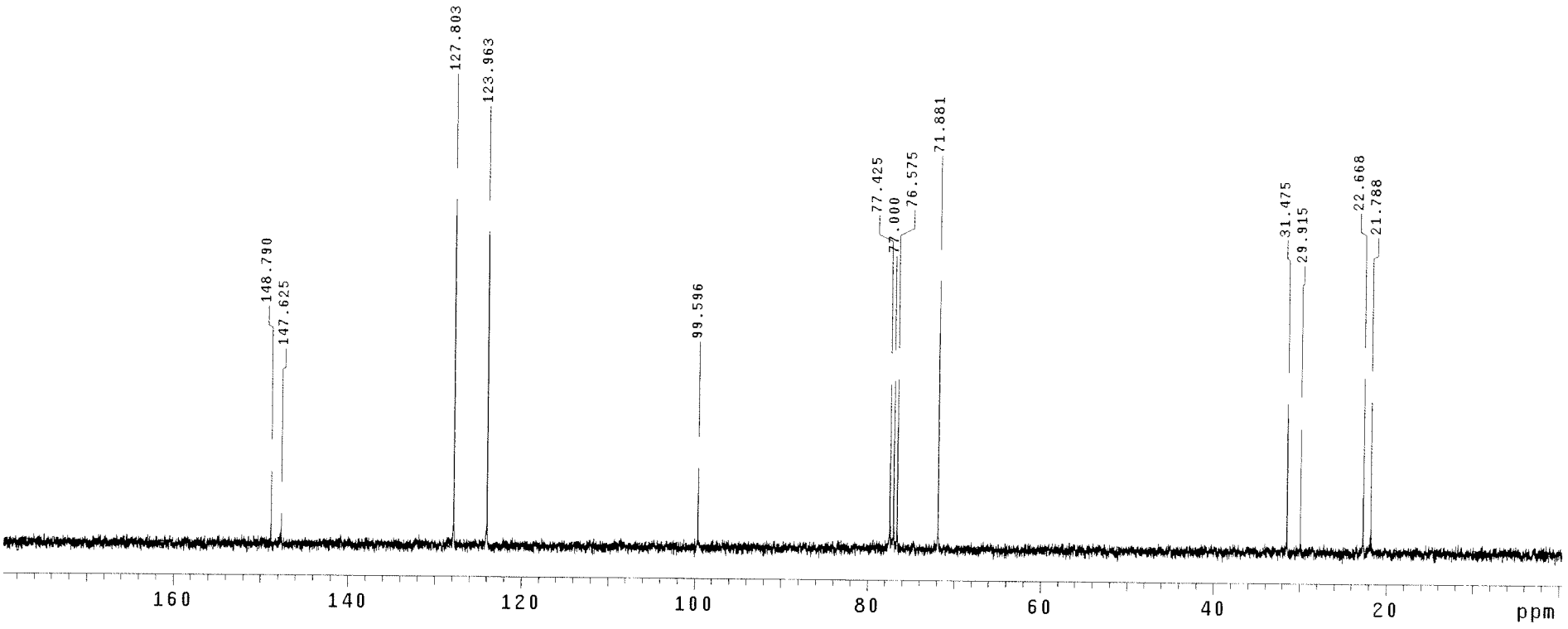
13C OBSERVE

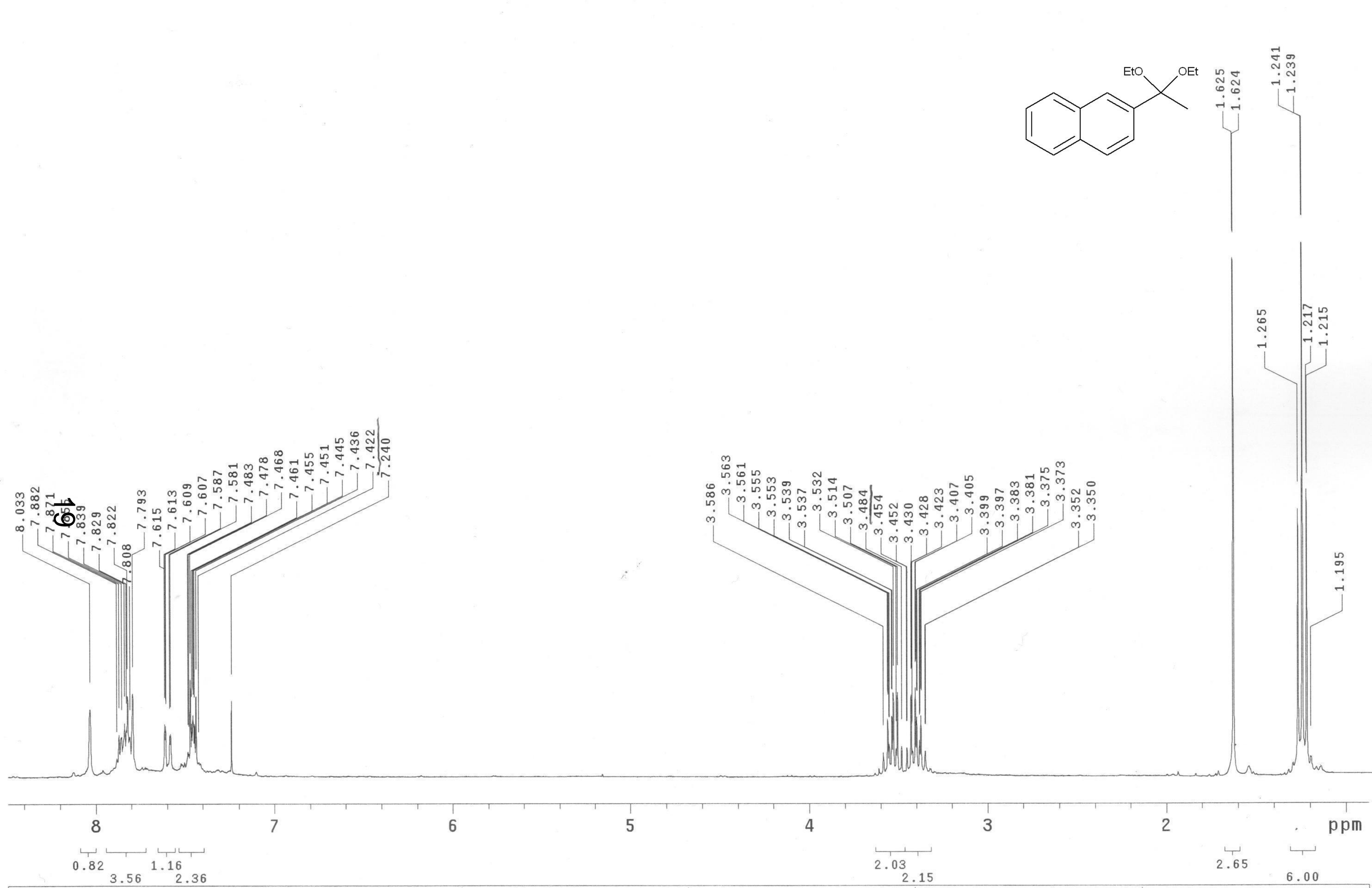
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: p_nitrobenz_propanediol_13C
GEMINI-300BB "kmr300"

Pulse 42.3 degrees
Acq. time 1.815 sec
Width 18761.7 Hz
256 repetitions
OBSERVE C13, 75.4495295 MHz
DECOUPLE H1, 300.0590418 MHz
Power 37 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 16 min, 58 sec



9a



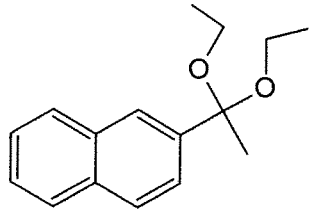


PULSE SEQUENCE Relax. delay 1.000 sec Pulse 88.7 degrees Acq. time 2.000 sec Width 4800.0 Hz 28 repetitions	OBSERVE H1, 300.0575478	DATA PROCESSING FT size 32768 Total time 1 minute			STANDARD 1H OBSERVE Pulse Sequence: s2pul Solvent: CDCl3 Ambient temperature GEMINI-300 "kmr300"

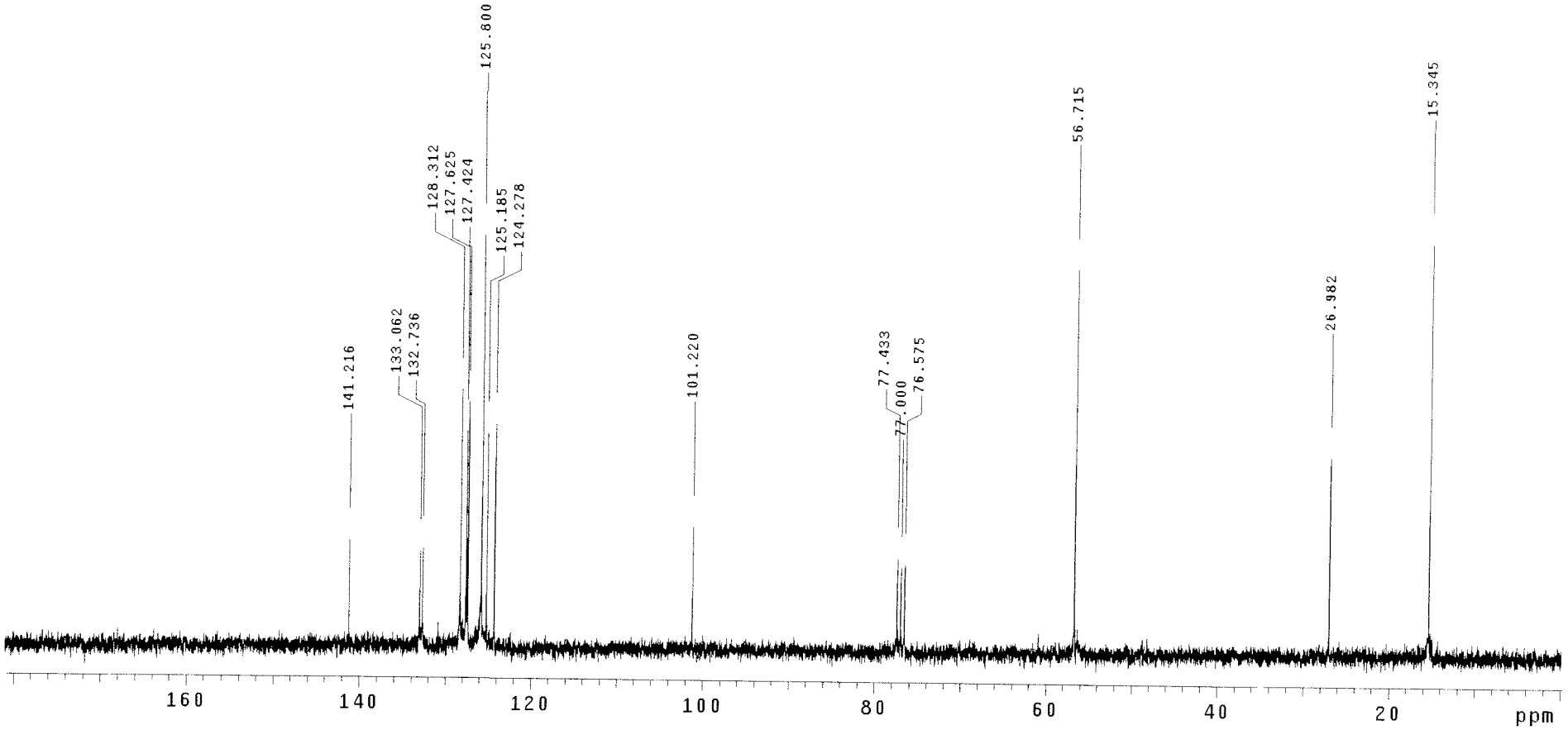
OEt_napthyl_Ketone

Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: OEt_napthylketone_13C
GEMINI-300BB "kmr300"

Pulse 42.3 degrees
Acq. time 1.815 sec
Width 18761.7 Hz
60 repetitions
OBSERVE C13, 75.4495404 MHz
DECOUPLE H1, 300.0590418 MHz
Power 37 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 8 min, 29 sec



7c

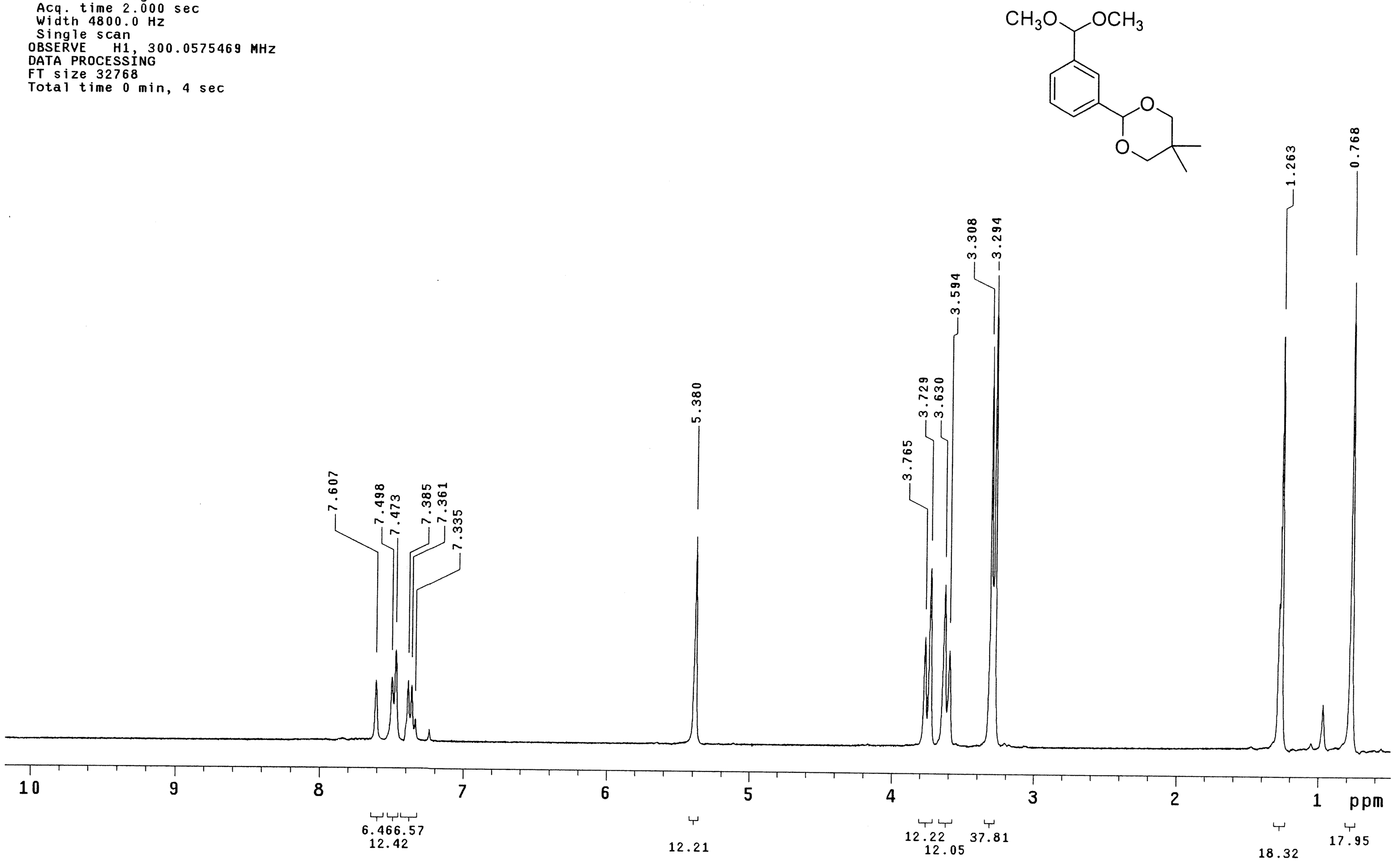


A25-clean

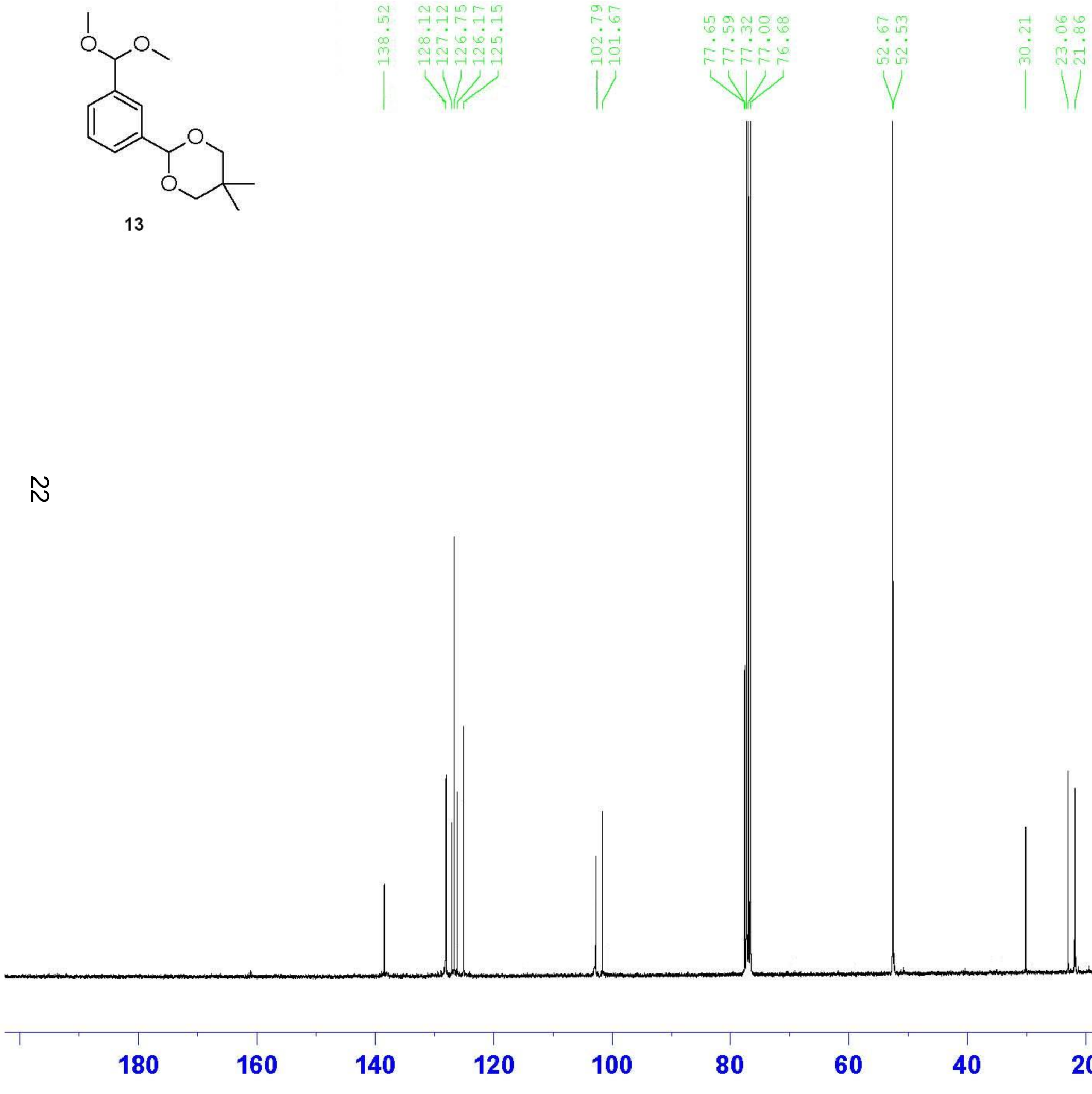
Pulse Sequence: s2pul

Solvent: CDCl3
Ambient temperature
GEMINI-300BB "kmr300"

Relax. delay 1.000 sec
Pulse 9.0 degrees
Acq. time 2.000 sec
Width 4800.0 Hz
Single scan
OBSERVE H1, 300.0575469 MHz
DATA PROCESSING
FT size 32768
Total time 0 min, 4 sec



13



BRUKER

NAME	A24b
EXPNO	2
PROCNO	1
Date_	20100902
Time	1.36
INSTRUM	spect
PROBHD	5 mm PABBO BB-
PULPROG	zgig30
TD	65536
SOLVENT	CDCl3
NS	8192
DS	4
SWH	24038.461 Hz
FIDRES	0.366798 Hz
AQ	1.3631988 sec
RG	114
DW	20.800 usec
DE	6.50 usec
TE	296.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	13C
P1	9.60 usec
PL1	-1.50 dB
PL1W	51.80275345 W
SFO1	100.6328888 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	90.00 usec
PL2	-3.00 dB
PL12	15.30 dB
PL2W	23.05461311 W
PL12W	0.34100270 W
SFO2	400.1716007 MHz
SI	32768
SF	100.6228312 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40