Electronic Supplementary Information

Dithiocarbamate-modified cellulose-based sorbents with high storage stability for selective removal of arsenite and hazardous heavy metals

Futo Morita,[†a] Keisuke Nakakubo,[†a] Koki Yunoshita,[†a] Masaru Endo,[a,b] Foni B. Biswas,[a,c] Tatsuya Nishimura,[a] Asami S. Mashio,[a] Hiroshi Hasegawa,*[a] Tsuyoshi Taniguchi,*[a] Katsuhiro Maeda*[a,d]

[a]*Graduate School of Natural Science and Technology, Kanazawa University, Kakuma-machi, Kanazawa 920-1192, Japan.*
[b]*Daicel Corporation, 1239 Shinzaike, Aboshi-ku, Himeji, Hyogo 671-1283, Japan.*
[c]*Department of Chemistry, University of Chittagong, Chittagong 4331, Bangladesh.*
[d]*Nano Life Science Institute (WPI-NanoLSI), Kanazawa University, Kakuma-machi, Kanazawa 920-1192, Japan.*
E-mail: hhiroshi@se.kanazawa-u.ac.jp, tsuyoshi@p.kanazawa-u.ac.jp, maeda@se.kanazawa-u.ac.jp
†These authors contributed equally.

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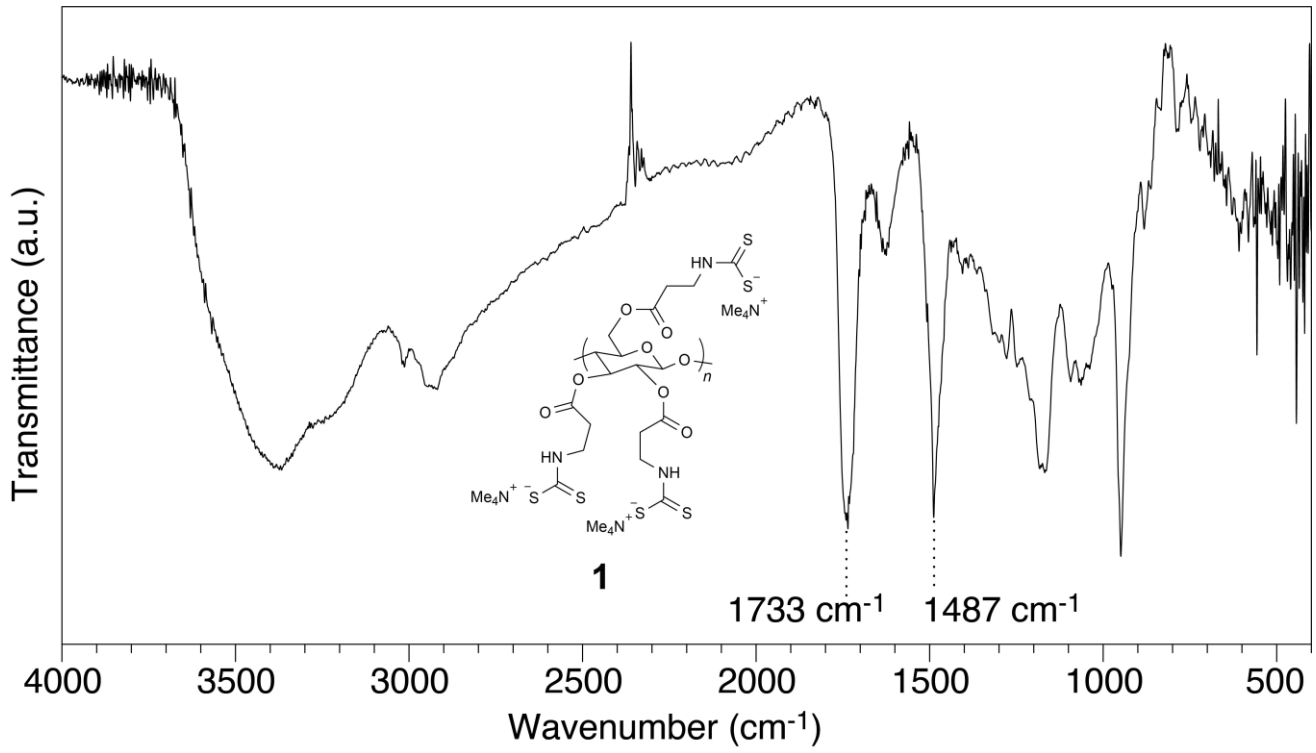
1. The result of batch sorption experiments for various metals

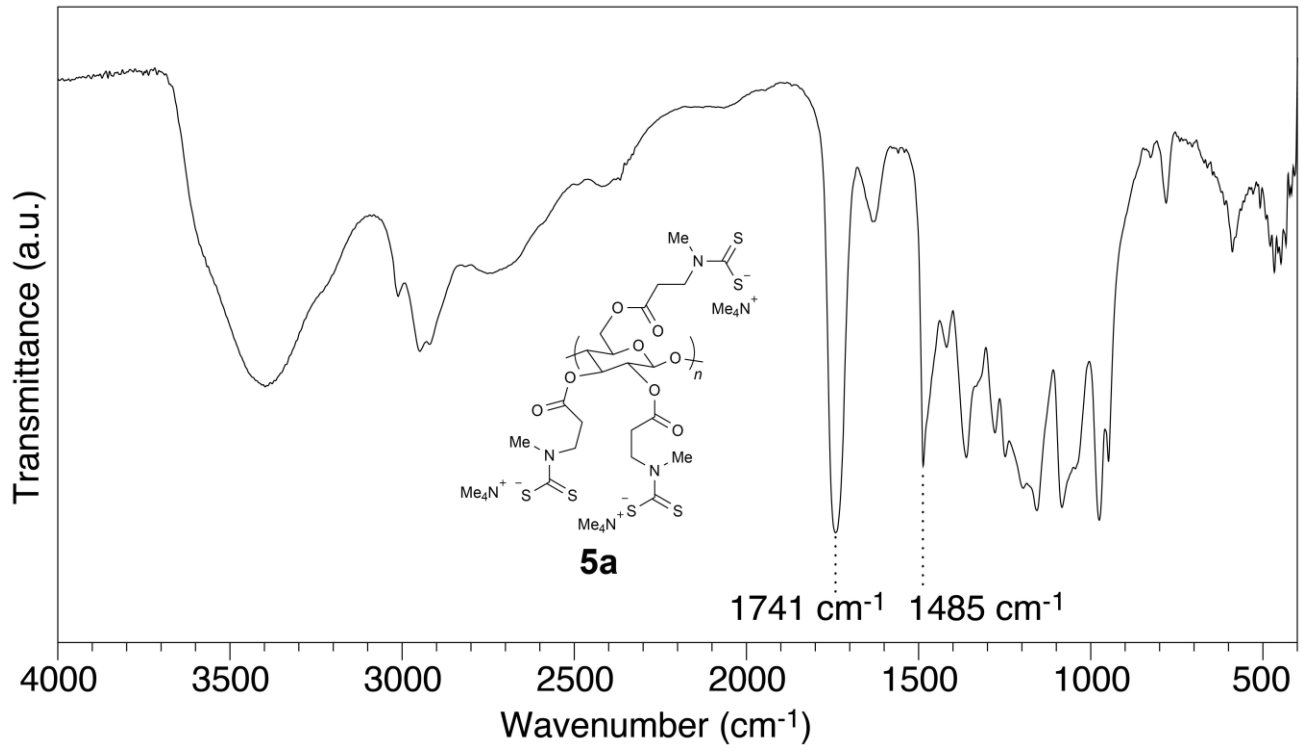
Metal	Removal (%)	Metal	Removal (%)	Metal	Removal (%)
Be(II)	2.0 ± 1.5	Al(III)	0	Cu(II)	99.6 ± 0.01
Mg(II)	0	Ti(IV)	95.4 ± 0.1	Zn(II)	99.7 ± 0.04
Ca(II)	0	V(IV)	95.9 ± 1.6	Ga(III)	93.1 ± 1.2
Sr(II)	3.3 ± 0.4	Mn(III)	13.5 ± 0.9	Cd(II)	99.5 ± 0.02
Ba(II)	1.6 ± 0.6	Fe(III)	97.0 ± 0.5	In(III)	100 ± 0.09
Sc(III)	3.5 ± 0.6	Co(II)	100 ± 0.1	Pb(II)	100 ± 0.8
Y(III)	3.0 ± 0.3	Ni(II)	99.6 ± 0.04	Bi(III)	94.0 ± 0.6

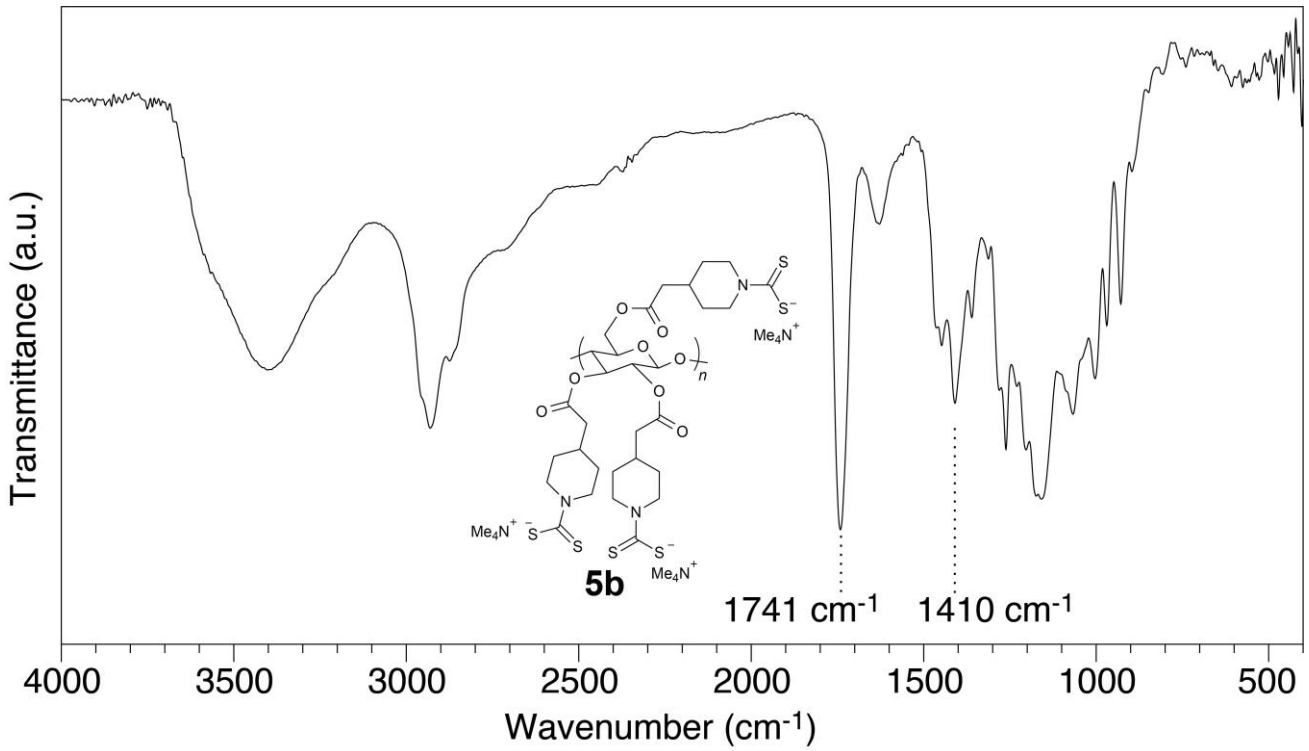
2. IR spectra of DTC compounds

2-1. DTC compound 1 (previously reported)[1]



2-2. DTC compounds 5a–d




Transmittance (a.u.)
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3000
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2000
1500
1000
500
Wavenumber (cm-1)
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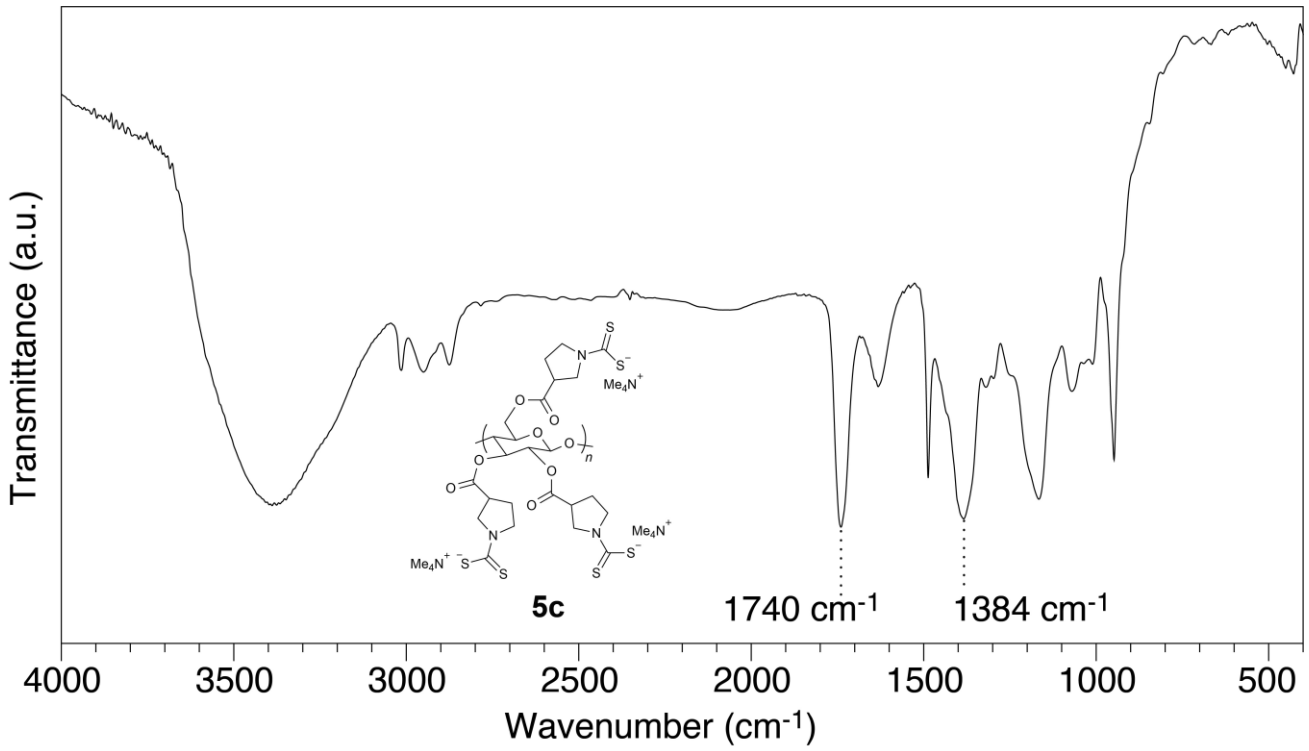
1410 cm-1
5b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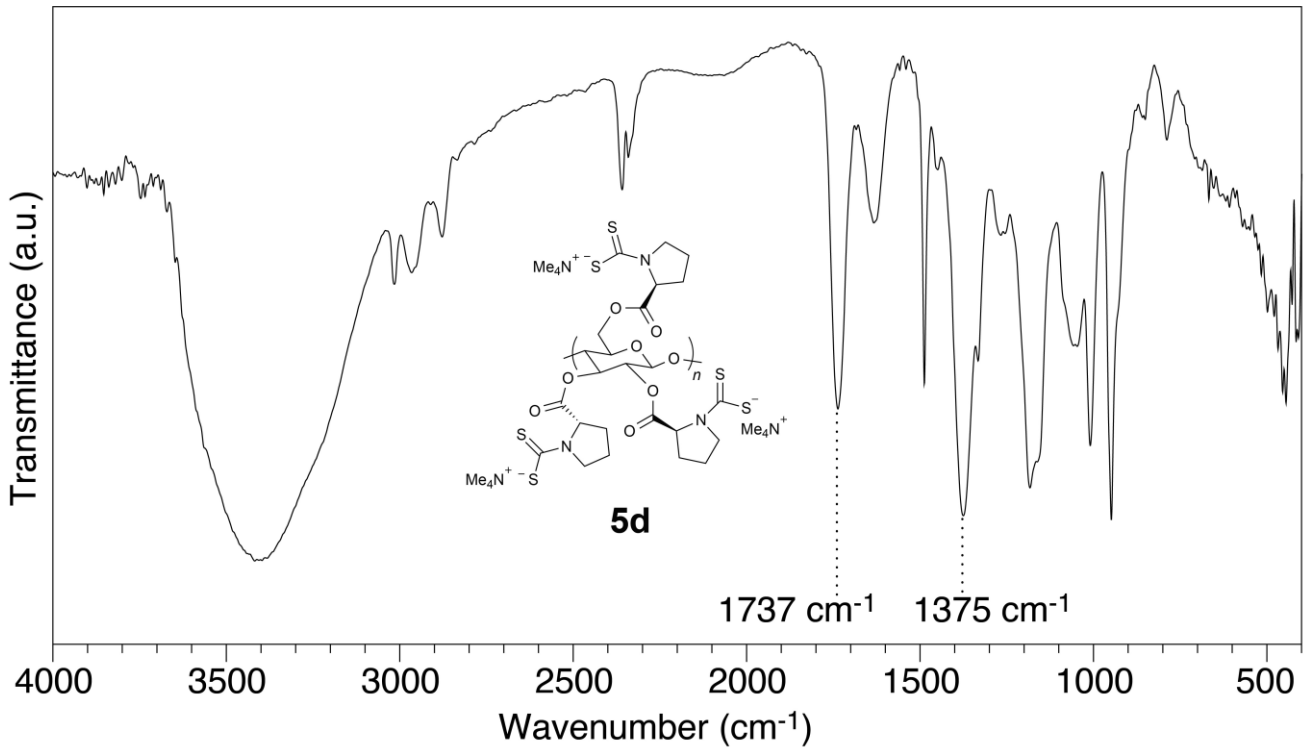
5c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Wavenumber (cm-1)
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3500
3000
2500
2000
1500
1000
500
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1375 cm-1
5d

2-3. IR spectra of 1 and 5d after a storage at 40 °C for 2 weeks under air

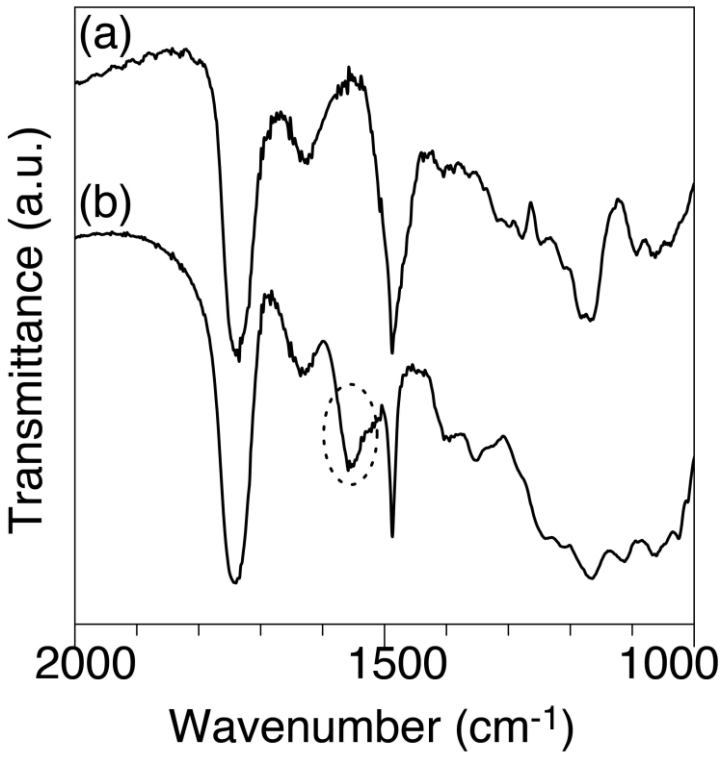


Fig. S1. IR spectrum of DTC compound **1** (a) and a new chracteristic signal appeared at around 1560 cm^{-1} after 2 weeks (b).

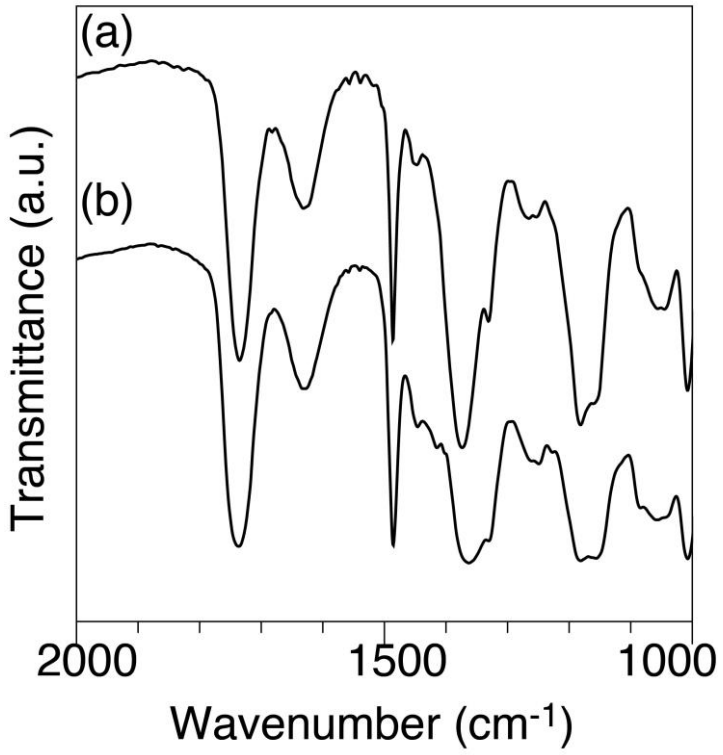
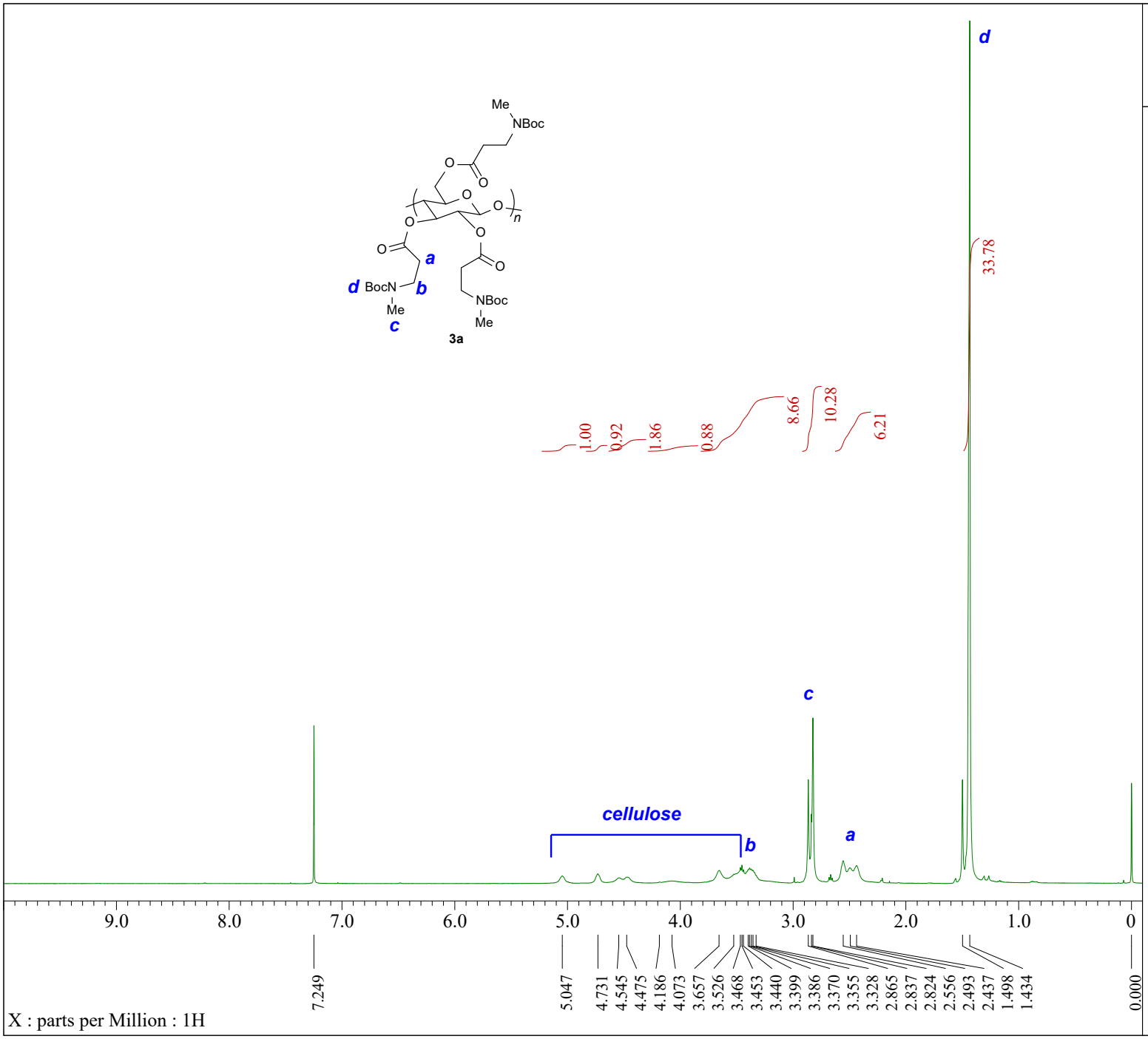


Fig. S2. IR spectrum of DTC compound **5d** (a) and the spectrum hardly changed after 2 weeks (b).

3. References

1. K. Nakakubo, H. Hasegawa, M. Ito, K. Yamazaki, M. Miyaguchi, F. B. Biswas, T. Ikai and K. Maeda, *J. Hazard. Mater.,* 2019, **380**, 120816.

4. Copies of NMR spectra of synthesized compounds



JEOL Solutions for Innovation

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Solvent           = CHLOROFORM-D
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Revision_Time     =  4-JUN-2020 10:41:58
Current_Time      =  4-JUN-2020 10:43:02

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Irr_Offset        = 5.0[ppm]
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Tri_Freq          = 500.15991521[MHz]
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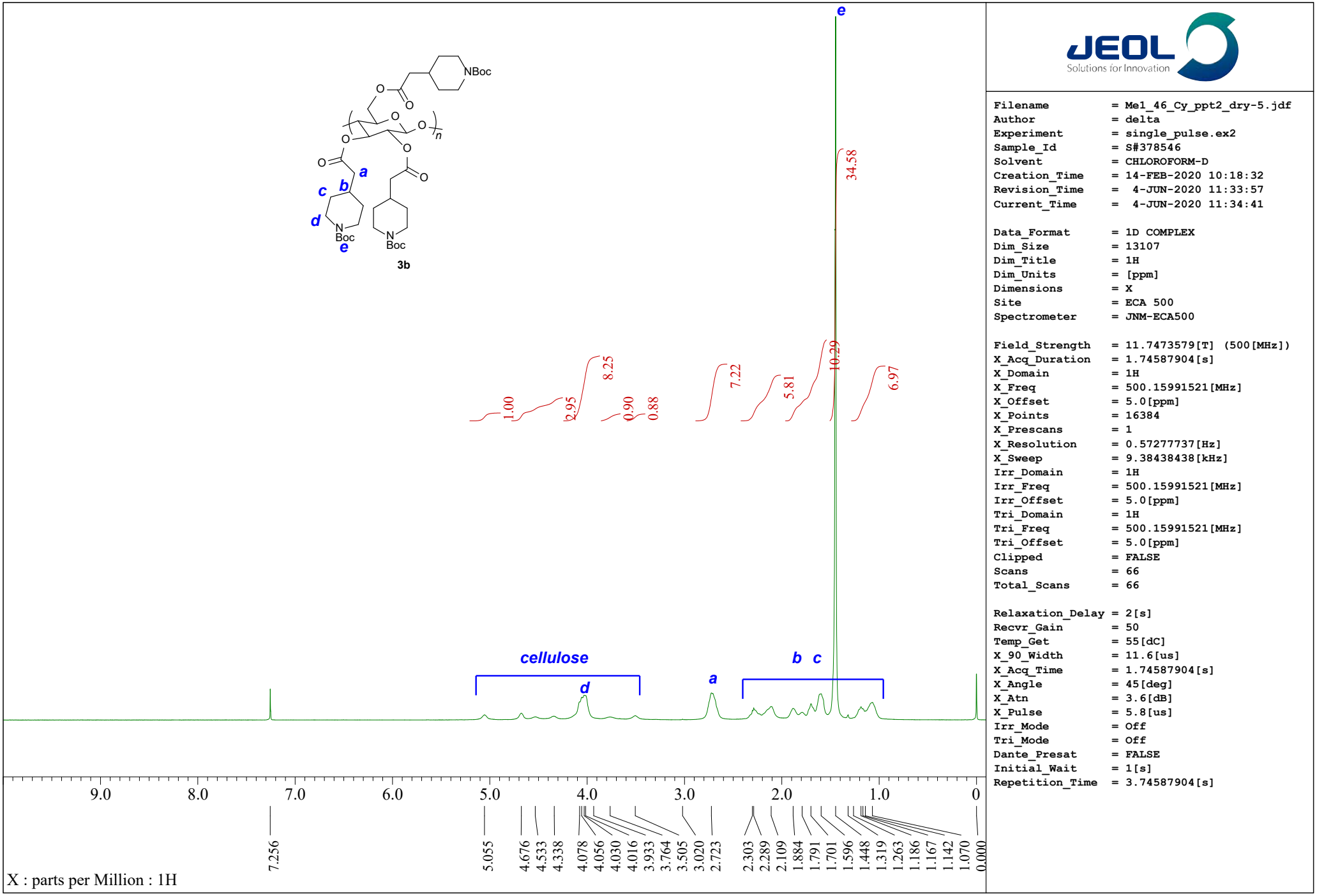

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Author            = delta
Experiment        = single_pulse.ex2
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Spectrometer      = JNM-ECA500

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X_Resolution      = 0.57277737[Hz]
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Irr_Offset        = 5.0[ppm]
Tri_Domain        = 1H
Tri_Freq          = 500.15991521[MHz]
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Total_Scans       = 66

Relaxation_Delay  = 2[s]
Recvr_Gain        = 50
Temp_Get          = 55[dC]
X_90_Width        = 11.6[us]
X_Acq_Time        = 1.74587904[s]
X_Angle           = 45[deg]
X_Atn             = 3.6[dB]
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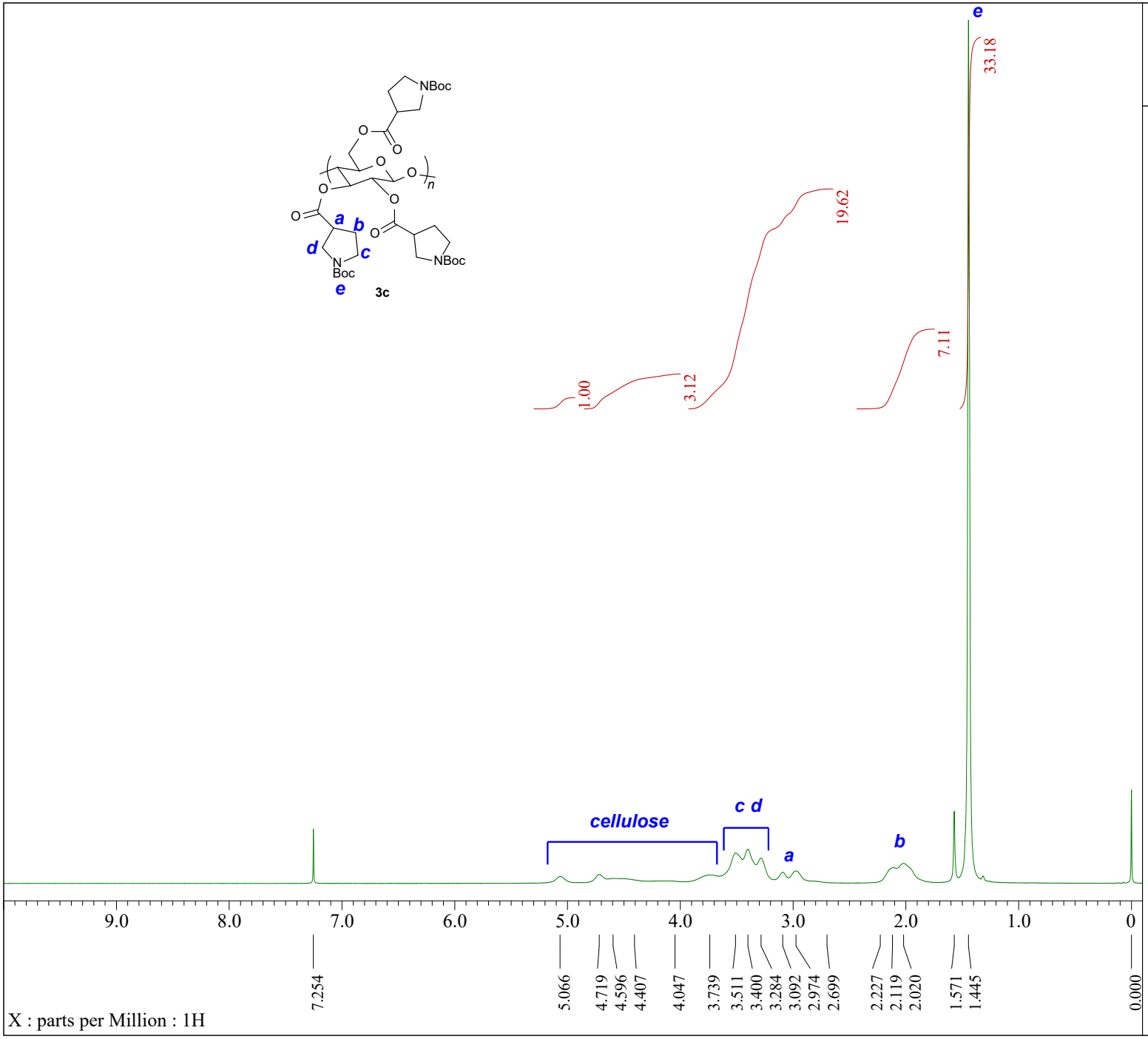

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Filename          = ME1_47DMCCy5-3_ppt3-5.jdf
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Solvent           = CHLOROFORM-D
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Spectrometer      = JNM-ECA500

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X_Offset          = 5.0[ppm]
X_Points          = 16384
X_Prescans        = 1
X_Resolution      = 0.57277737[Hz]
X_Sweep           = 9.38438438[kHz]
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Irr_Freq          = 500.15991521[MHz]
Irr_Offset        = 5.0[ppm]
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Tri_Freq          = 500.15991521[MHz]
Tri_Offset        = 5.0[ppm]
Clipped           = FALSE
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Total_Scans       = 67

Relaxation_Delay = 2[s]
Recvr_Gain        = 48
Temp_Get          = 55[dC]
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X_Atn             = 3.6[dB]
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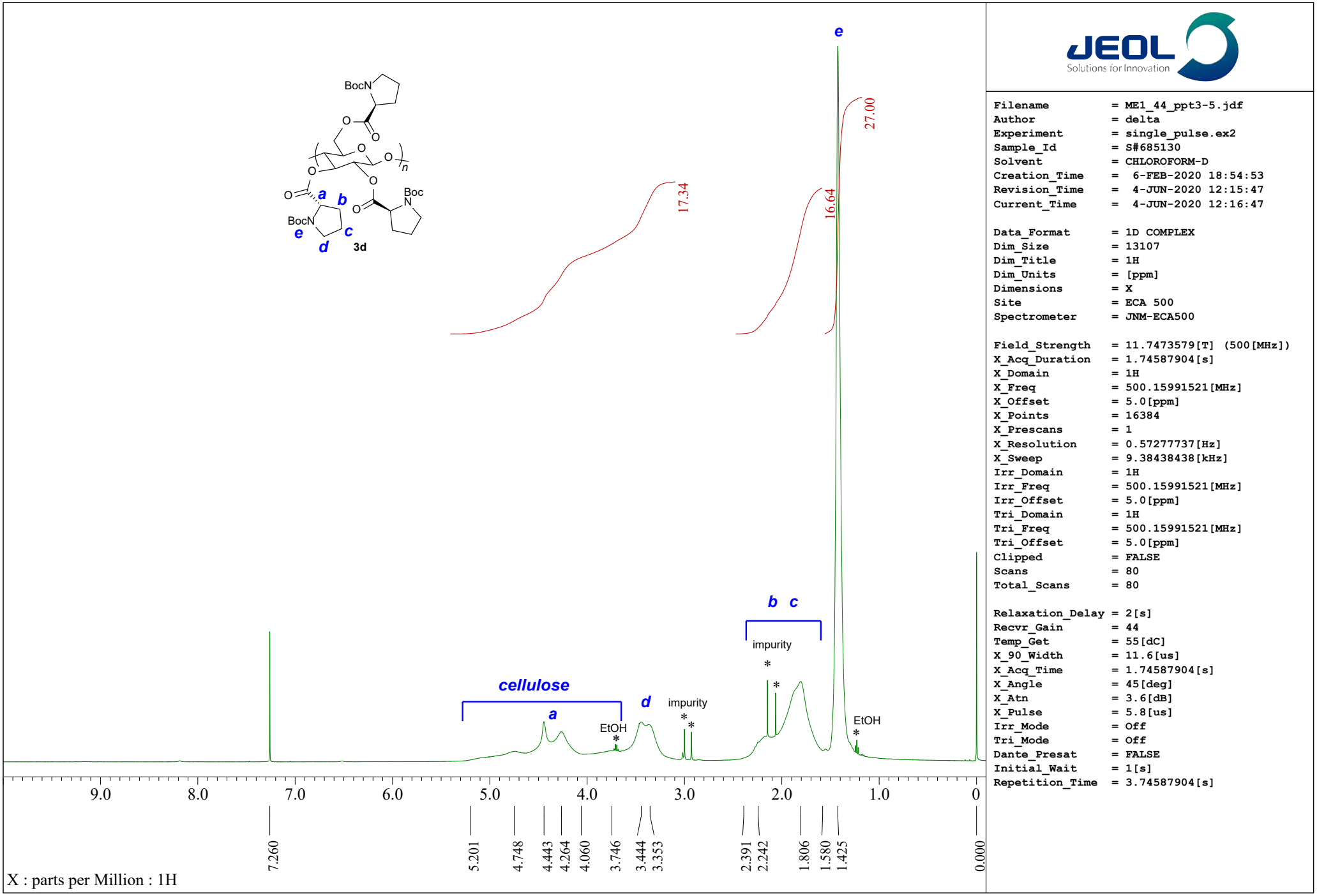

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Experiment        = single_pulse.ex2
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Revision_Time     =  4-JUN-2020 12:15:47
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Spectrometer      = JNM-ECA500

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Temp_Get          = 55[dC]
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X_Atn             = 3.6[dB]
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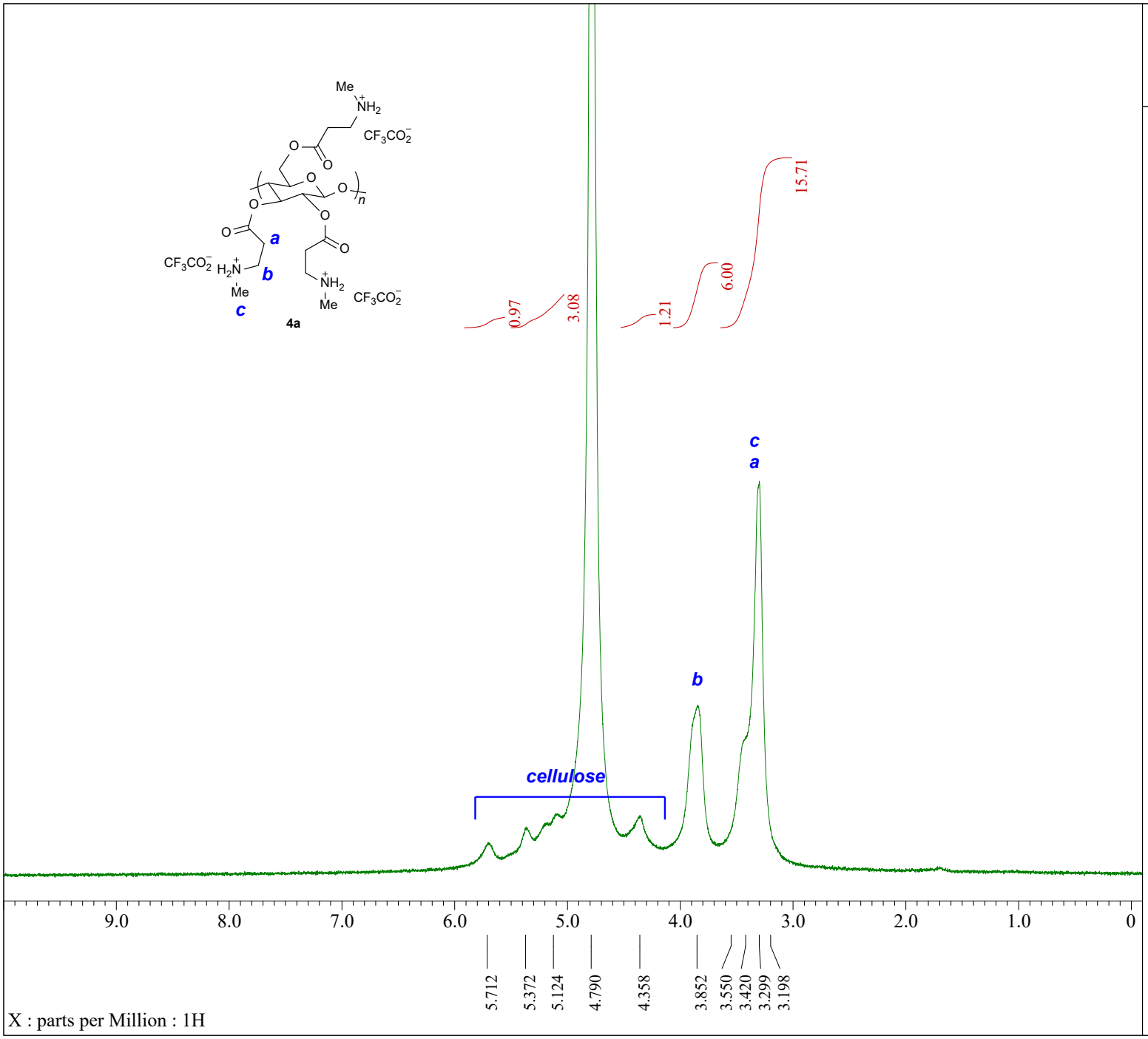

JEOL Solutions for Innovation

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Spectrometer      = JNM-ECA500

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X_Points          = 16384
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X_Sweep           = 9.38438438[kHz]
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Irr_Freq          = 500.15991521[MHz]
Irr_Offset        = 5.0[ppm]
Tri_Domain        = 1H
Tri_Freq          = 500.15991521[MHz]
Tri_Offset        = 5.0[ppm]
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Recvr_Gain        = 66
Temp_Get          = 80[dC]
X_90_Width        = 11.6[us]
X_Acq_Time        = 1.74587904[s]
X_Angle           = 45[deg]
X_Atn             = 3.6[dB]
X_Pulse           = 5.8[us]
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Tri_Mode          = Off
Dante_Presat      = FALSE
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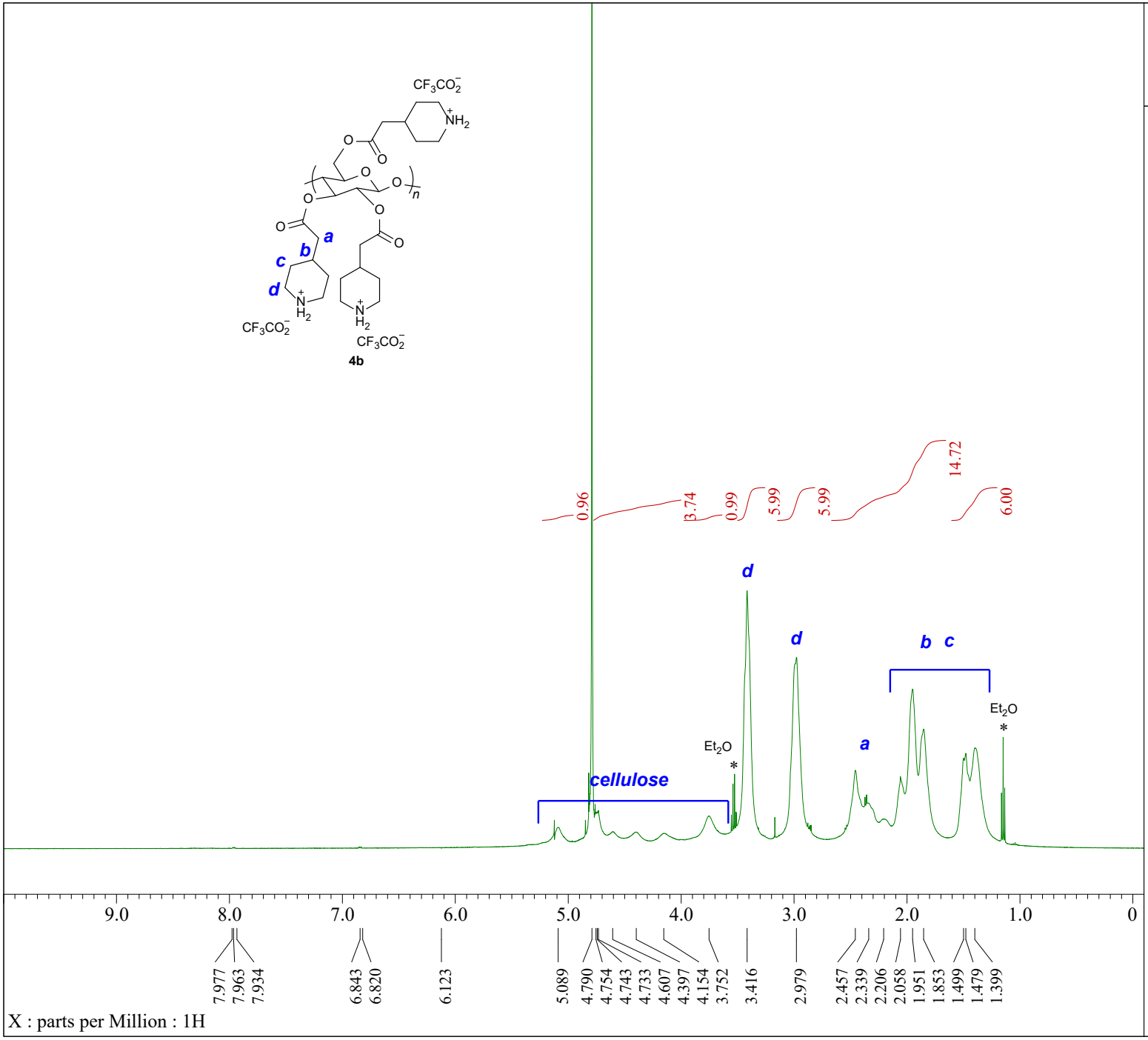


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X_Offset          = 5.0[ppm]
X_Points          = 16384
X_Prescans        = 1
X_Resolution      = 0.57277737[Hz]
X_Sweep           = 9.38438438[kHz]
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Irr_Freq          = 500.15991521[MHz]
Irr_Offset        = 5.0[ppm]
Tri_Domain        = 1H
Tri_Freq          = 500.15991521[MHz]
Tri_Offset        = 5.0[ppm]
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Total_Scans       = 64

Relaxation_Delay  = 2[s]
Recvr_Gain        = 40
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X_Acq_Time        = 1.74587904[s]
X_Angle           = 45[deg]
X_Atn             = 3.6[dB]
X_Pulse           = 5.7[us]
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Tri_Mode          = Off
Dante_Presat      = FALSE
Initial_Wait      = 1[s]
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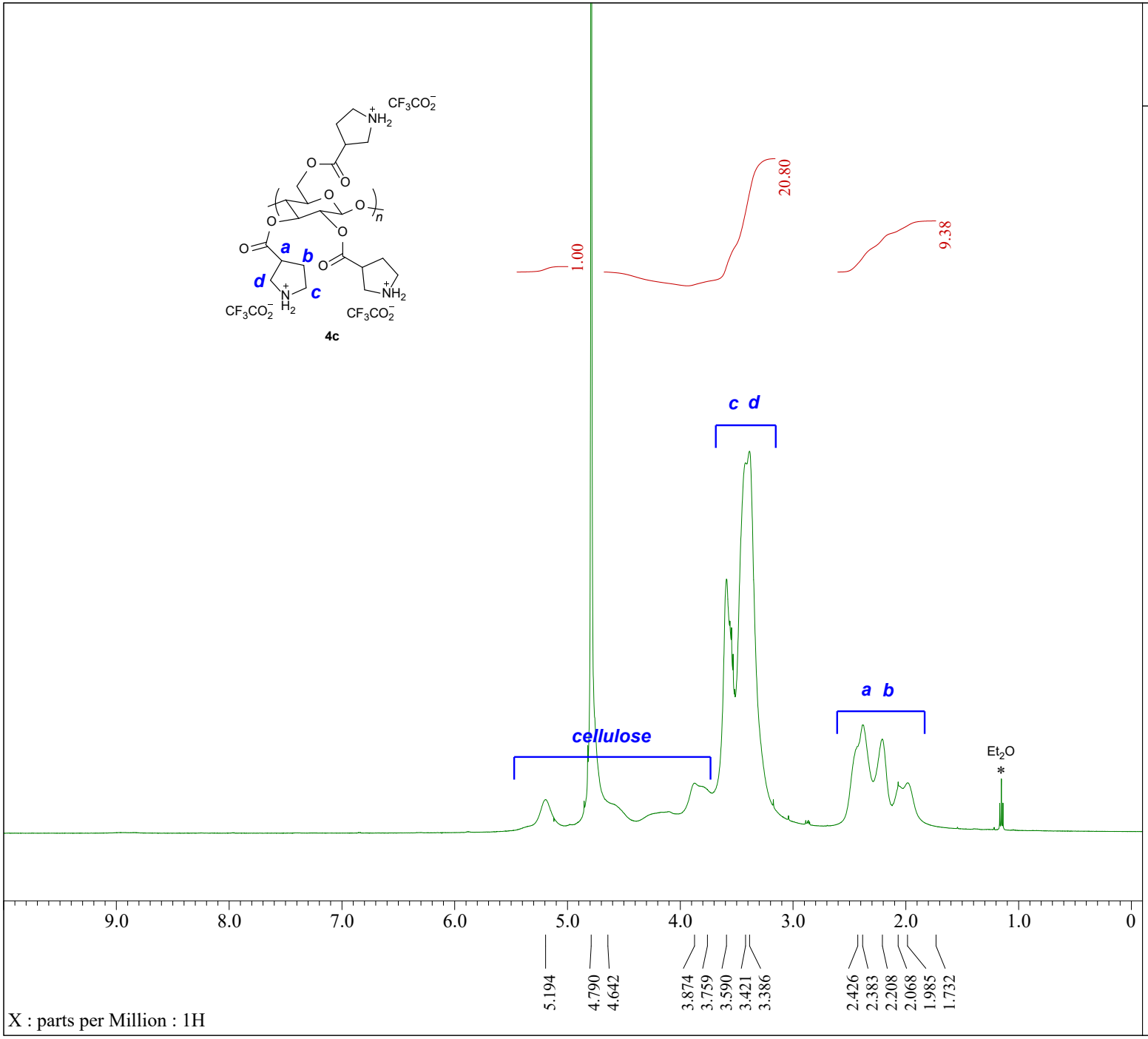


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Revision_Time     =  4-JUN-2020 14:07:47
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Irr_Freq          = 500.15991521[MHz]
Irr_Offset        = 5.0[ppm]
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Tri_Freq          = 500.15991521[MHz]
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Clipped           = FALSE
Scans             = 64
Total_Scans       = 64

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Recvr_Gain        = 36
Temp_Get          = 20.6[dC]
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X_Atn             = 3.6[dB]
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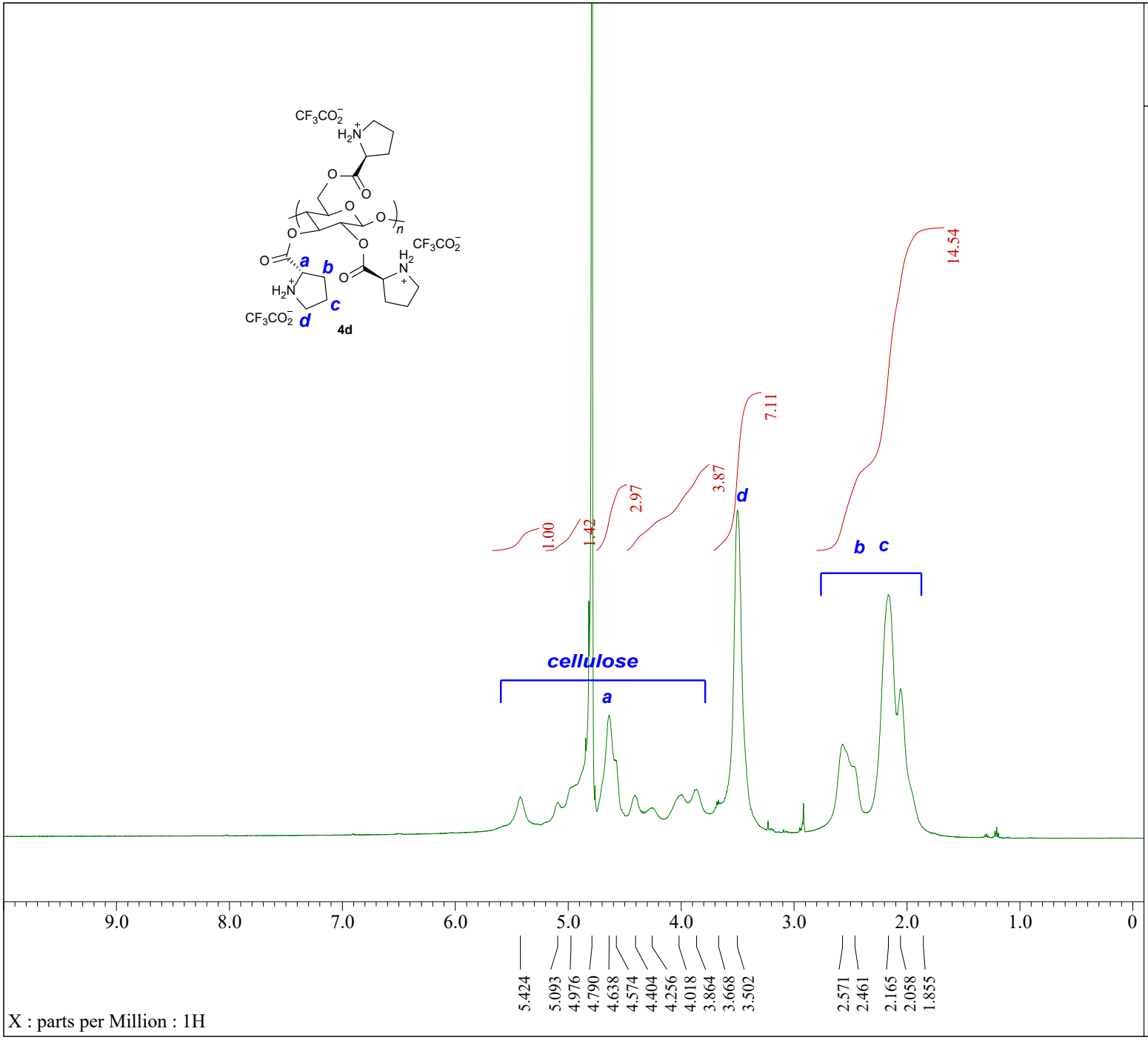


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Revision_Time     =  4-JUN-2020 14:39:03
Current_Time      =  4-JUN-2020 14:39:39

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Spectrometer      = JNM-ECA500

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X_Resolution      = 0.57277737[Hz]
X_Sweep           = 9.38438438[kHz]
Irr_Domain        = 1H
Irr_Freq          = 500.15991521[MHz]
Irr_Offset        = 5.0[ppm]
Tri_Domain        = 1H
Tri_Freq          = 500.15991521[MHz]
Tri_Offset        = 5.0[ppm]
Clipped           = FALSE
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Relaxation_Delay  = 2[s]
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X_90_Width        = 11.4[us]
X_Acq_Time        = 1.74587904[s]
X_Angle           = 45[deg]
X_Atn             = 3.6[dB]
X_Pulse           = 5.7[us]
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Tri_Mode          = Off
Dante_Presat      = FALSE
Initial_Wait      = 1[s]
Repetition_Time   = 3.74587904[s]
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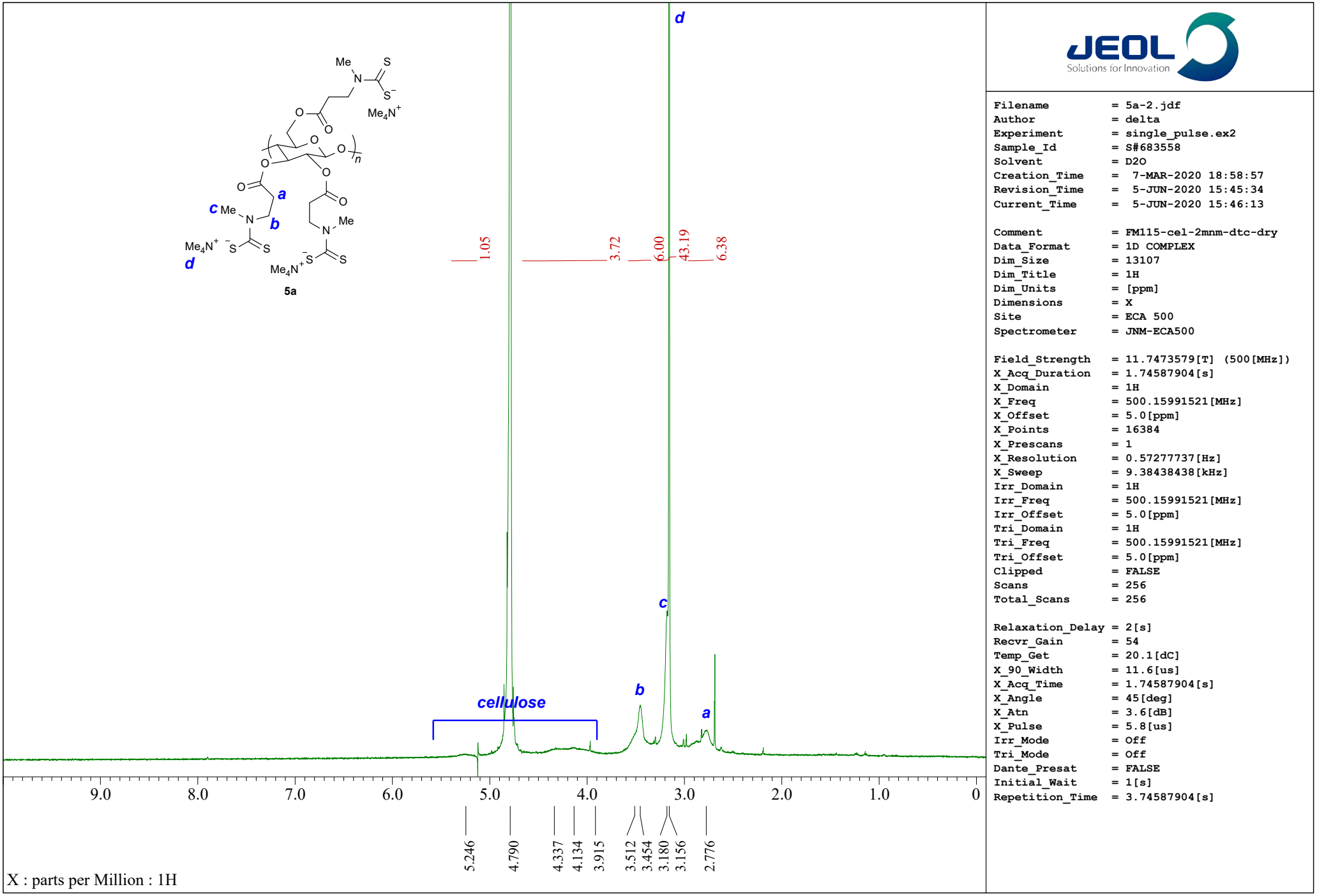

5a

JEOL Solutions for Innovation

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Spectrometer      = JNM-ECA500

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X_Acq_Duration    = 1.74587904[s]
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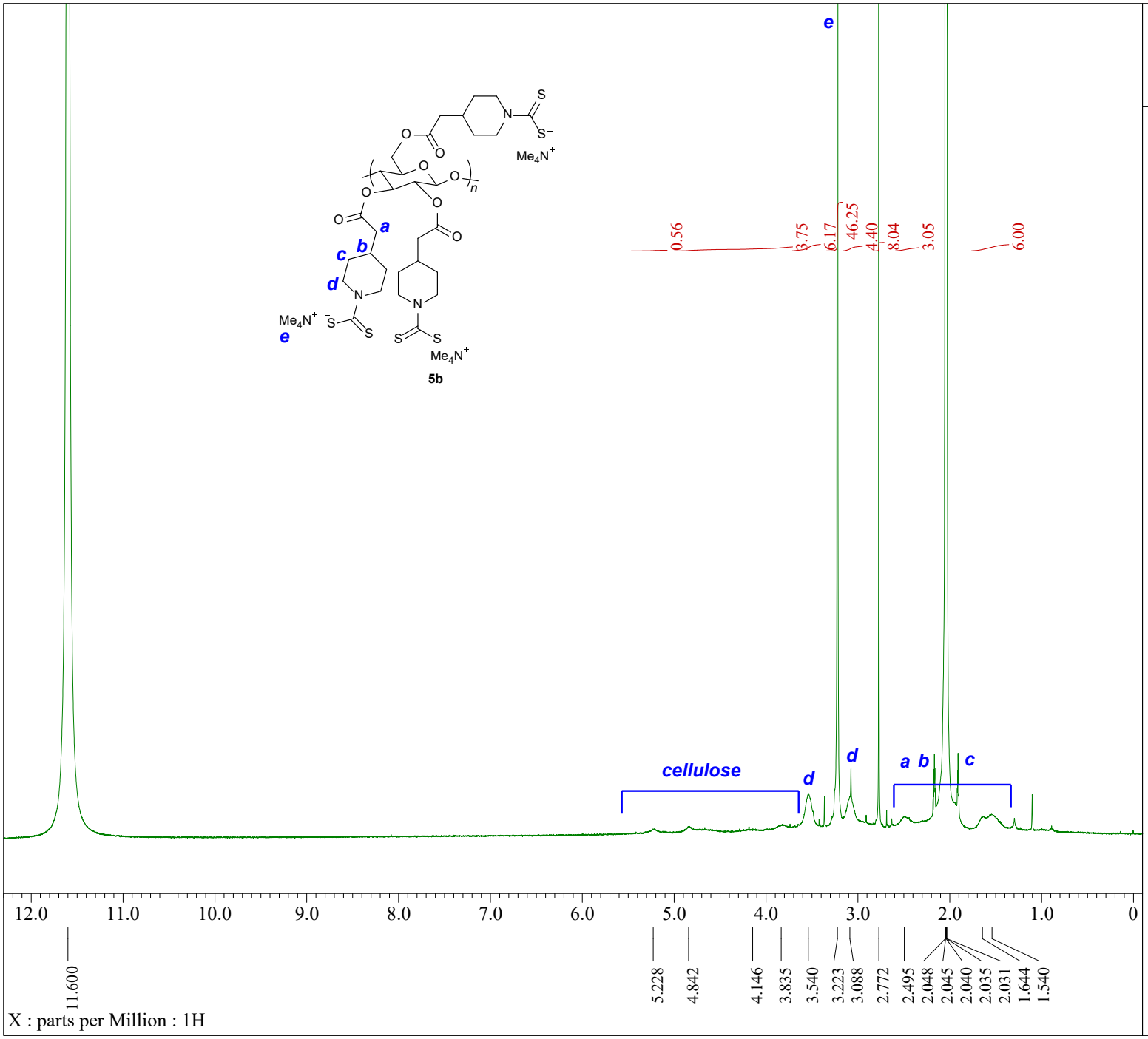
X_Freq            = 500.15991521[MHz]
X_Offset          = 5.0[ppm]
X_Points          = 16384
X_Prescans        = 1
X_Resolution      = 0.57277737[Hz]
X_Sweep           = 9.38438438[kHz]
Irr_Domain        = 1H
Irr_Freq          = 500.15991521[MHz]
Irr_Offset        = 5.0[ppm]
Tri_Domain        = 1H
Tri_Freq          = 500.15991521[MHz]
Tri_Offset        = 5.0[ppm]
Clipped           = FALSE
Scans             = 256
Total_Scans       = 256

Relaxation_Delay  = 2[s]
Recvr_Gain        = 54
Temp_Get          = 20.1[dC]
X_90_Width        = 11.6[us]
X_Acq_Time        = 1.74587904[s]
X_Angle           = 45[deg]
X_Atn             = 3.6[dB]
X_Pulse           = 5.8[us]
Irr_Mode          = Off
Tri_Mode          = Off
Dante_Presat      = FALSE
Initial_Wait      = 1[s]
Repetition_Time   = 3.74587904[s]
```



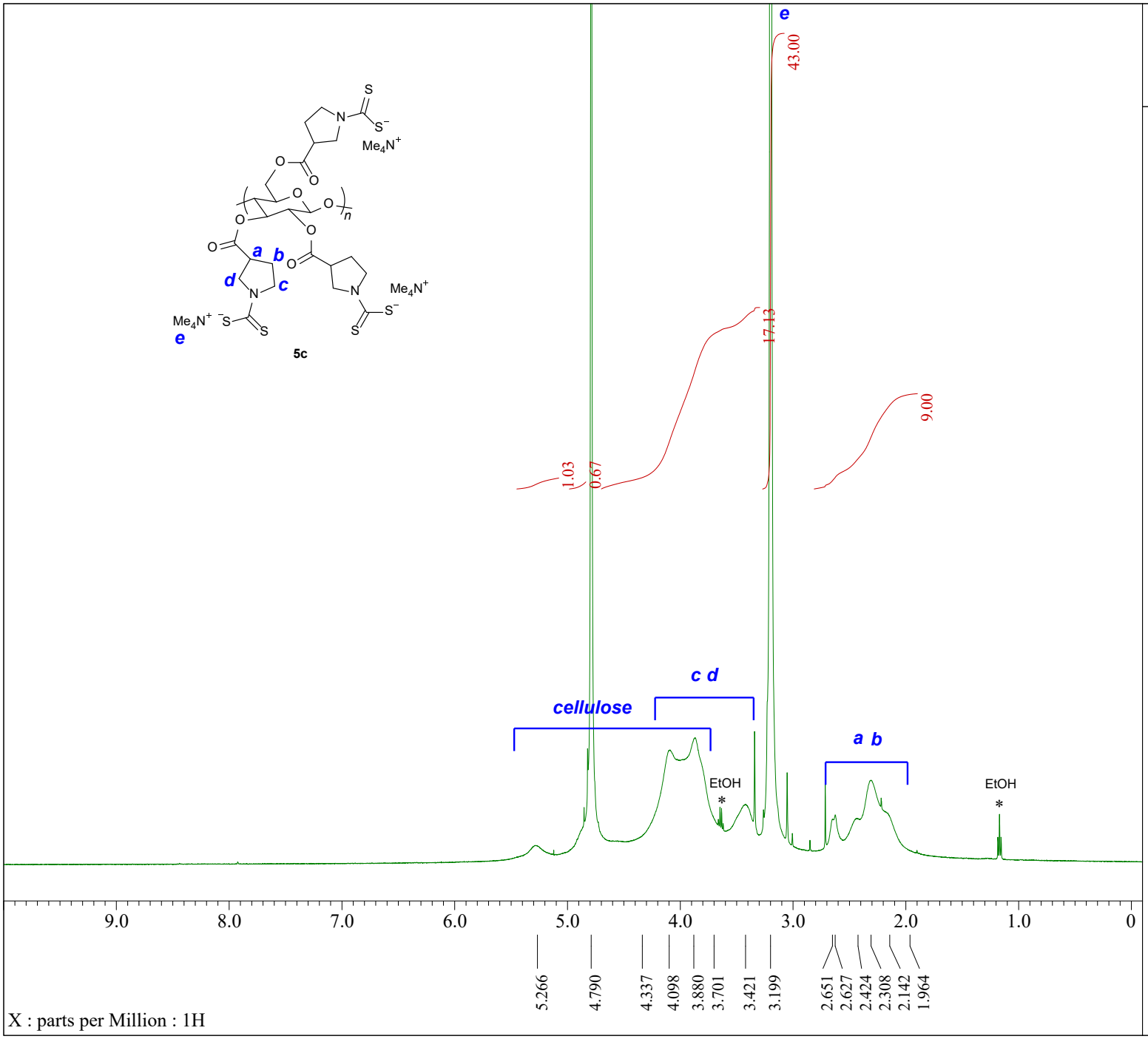
JEOL Solutions for Innovation

```
Filename          = FM30-cel-pa-dtc-dry-7.jdf
Author            = delta
Experiment        = single_pulse.ex2
Sample_Id         = S#714873
Solvent           = ACETIC_ACID-D3
Creation_Time     = 18-JUL-2019 20:03:18
Revision_Time     =  4-JUN-2020 16:05:15
Current_Time      =  4-JUN-2020 16:08:45

Data_Format       = 1D COMPLEX
Dim_Size          = 13107
Dim_Title         = 1H
Dim_Units         = [ppm]
Dimensions        = X
Site              = ECA 500
Spectrometer      = JNM-ECA500

Field_Strength    = 11.7473579[T] (500[MHz])
X_Acq_Duration    = 1.74587904[s]
X_Domain          = 1H
X_Freq            = 500.15991521[MHz]
X_Offset          = 5.0[ppm]
X_Points          = 16384
X_Prescans        = 1
X_Resolution      = 0.57277737[Hz]
X_Sweep           = 9.38438438[kHz]
Irr_Domain        = 1H
Irr_Freq          = 500.15991521[MHz]
Irr_Offset        = 5.0[ppm]
Tri_Domain        = 1H
Tri_Freq          = 500.15991521[MHz]
Tri_Offset        = 5.0[ppm]
Clipped           = FALSE
Scans             = 256
Total_Scans       = 256

Relaxation_Delay  = 2[s]
Recvr_Gain        = 50
Temp_Get          = 21[dC]
X_90_Width        = 11.6[us]
X_Acq_Time        = 1.74587904[s]
X_Angle           = 45[deg]
X_Atn             = 3.6[dB]
X_Pulse           = 5.8[us]
Irr_Mode          = Off
Tri_Mode          = Off
Dante_Presat      = FALSE
Initial_Wait      = 1[s]
Repetition_Time   = 3.74587904[s]
```



5c

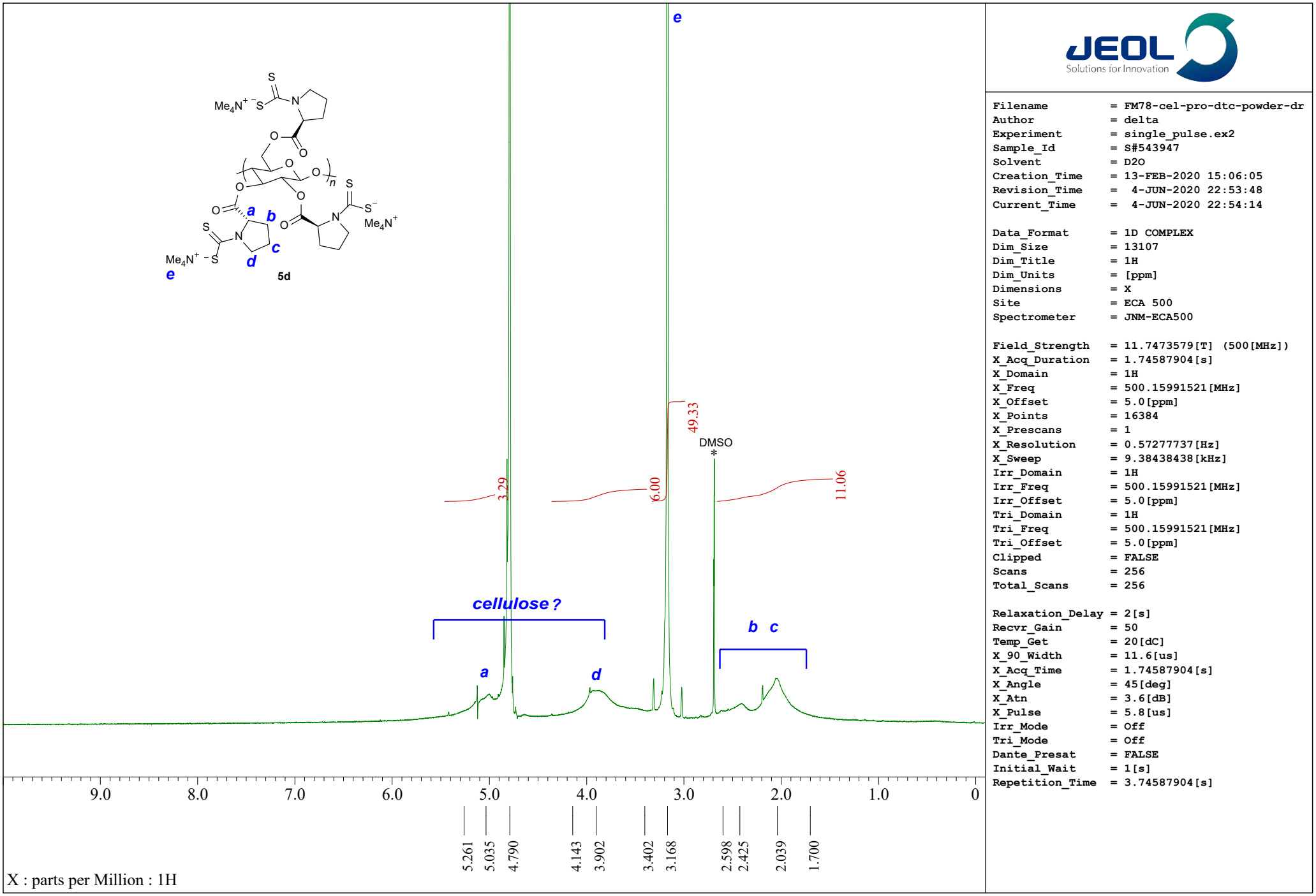
JEOL Solutions for Innovation

```
Filename          = FM36-cel-prc-dtc-r.t.-4.jd
Author            = delta
Experiment        = single_pulse.ex2
Sample_Id         = S#499551
Solvent           = D2O
Creation_Time     = 13-SEP-2019 14:04:50
Revision_Time     =  4-JUN-2020 22:44:01
Current_Time      =  4-JUN-2020 22:44:06

Comment           = FM36-cel-prc-dtc-r.t.
Data_Format       = 1D COMPLEX
Dim_Size          = 13107
Dim_Title         = 1H
Dim_Units         = [ppm]
Dimensions        = X
Site              = ECA 500
Spectrometer      = JNM-ECA500

Field_Strength    = 11.7473579[T] (500[MHz])
X_Acq_Duration    = 1.74587904[s]
X_Domain          = 1H
X_Freq            = 500.15991521[MHz]
X_Offset          = 5.0[ppm]
X_Points          = 16384
X_Prescans        = 1
X_Resolution      = 0.57277737[Hz]
X_Sweep           = 9.38438438[kHz]
Irr_Domain        = 1H
Irr_Freq          = 500.15991521[MHz]
Irr_Offset        = 5.0[ppm]
Tri_Domain        = 1H
Tri_Freq          = 500.15991521[MHz]
Tri_Offset        = 5.0[ppm]
Clipped           = FALSE
Scans             = 256
Total_Scans       = 256

Relaxation_Delay  = 2[s]
Recvr_Gain        = 46
Temp_Get          = 21.6[dC]
X_90_Width        = 11.6[us]
X_Acq_Time        = 1.74587904[s]
X_Angle           = 45[deg]
X_Atn             = 3.6[dB]
X_Pulse           = 5.8[us]
Irr_Mode          = Off
Tri_Mode          = Off
Dante_Presat      = FALSE
Initial_Wait      = 1[s]
Repetition_Time   = 3.74587904[s]
```



JEOL Solutions for Innovation

```
Filename          = FM78-cel-pro-dtc-powder-dr
Author            = delta
Experiment        = single_pulse.ex2
Sample_Id         = S#543947
Solvent           = D2O
Creation_Time     = 13-FEB-2020 15:06:05
Revision_Time     =  4-JUN-2020 22:53:48
Current_Time      =  4-JUN-2020 22:54:14

Data_Format       = 1D COMPLEX
Dim_Size          = 13107
Dim_Title         = 1H
Dim_Units         = [ppm]
Dimensions        = X
Site              = ECA 500
Spectrometer      = JNM-ECA500

Field_Strength    = 11.7473579[T] (500[MHz])
X_Acq_Duration    = 1.74587904[s]
X_Domain          = 1H
X_Freq            = 500.15991521[MHz]
X_Offset          = 5.0[ppm]
X_Points          = 16384
X_Prescans        = 1
X_Resolution      = 0.57277737[Hz]
X_Sweep           = 9.38438438[kHz]
Irr_Domain        = 1H
Irr_Freq          = 500.15991521[MHz]
Irr_Offset        = 5.0[ppm]
Tri_Domain        = 1H
Tri_Freq          = 500.15991521[MHz]
Tri_Offset        = 5.0[ppm]
Clipped           = FALSE
Scans             = 256
Total_Scans       = 256

Relaxation_Delay  = 2[s]
Recvr_Gain        = 50
Temp_Get          = 20[dC]
X_90_Width        = 11.6[us]
X_Acq_Time        = 1.74587904[s]
X_Angle           = 45[deg]
X_Atn             = 3.6[dB]
X_Pulse           = 5.8[us]
Irr_Mode          = Off
Tri_Mode          = Off
Dante_Presat      = FALSE
Initial_Wait      = 1[s]
Repetition_Time   = 3.74587904[s]
```