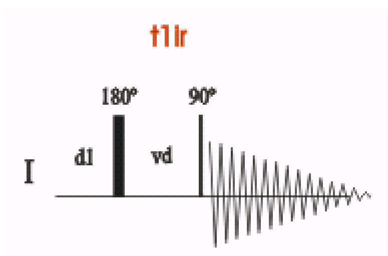
T1 relaxation experiment

Introduction

When an NMR sample sits in the magnet, the applied static magnetic field B_0 will generate the equilibrium magnetization M_0 along +z axis. When a RF pulse is allied to the sample, the net magnetization will be rotated away from +z axis. T1 relaxation (aka longitudinal or spin-lattice) is the process by which the net magnetization goes back to its initial maximum value ($M_{z,eq}$) parallel to B_0.

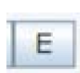
The inversion-recovery experiment measures T_1 relaxation times of any nucleus. If the net magnetization is placed along the -z axis, it will gradually return to its equilibrium position along the +z axis at a rate governed by T1. The equation governing this behavior as a function of the time t after its displacement is:

$$M_z(t) = M_{z,\mathrm{eq}}\left(1 - 2e^{-t/T_1}\right)$$



The basic pulse sequence consists of an 180^0 pulse that inverts the magnetization to the -z axis. During the following delay, relaxation along the longitudinal plane takes place. Magnetization comes back to the original equilibrium z-magnetization. A 90^0 pulse creates transverse magnetization. The experiment is repeated for a series of delay values taken from a variable delay list. A 1D spectrum is obtained for each value of vd and stored in a pseudo 2D dataset. The longer the recycle delay (d1) is, the more precise the T1 measurement is. Ideally d1 should be set to 5*T1. A rough estimation of the T1 value can be calculated from the null-point value by using T1=tnull/ln2.

Setting up proton T1 Experiment

1) To set up a T1 experiment, start with recording a normal proton spectrum to adjust the spectral sweep width **SWH**, acquisition time **aq** and other parameter if necessary.
2) Create new dataset and load "**Proton_T1"** parameter set. Update the parameters with the ones you obtained from last step. The recycle delay **D1** should be ~2-5*T1. Adjust **NS** accordingly to give sufficient S/N (**fig 1**).
3) Edit the "t1delay" by clicking on 

at VDLIST line in **fig 1. Fig 2** is a good starting list.
4) Change the "TD" value for F1 dimension to the number in your VDLIST (**fig 3**)
5) Collect the pseudo 2D T1 dataset

Fig 1. ACQUPARS display in "pulse program parameters" view

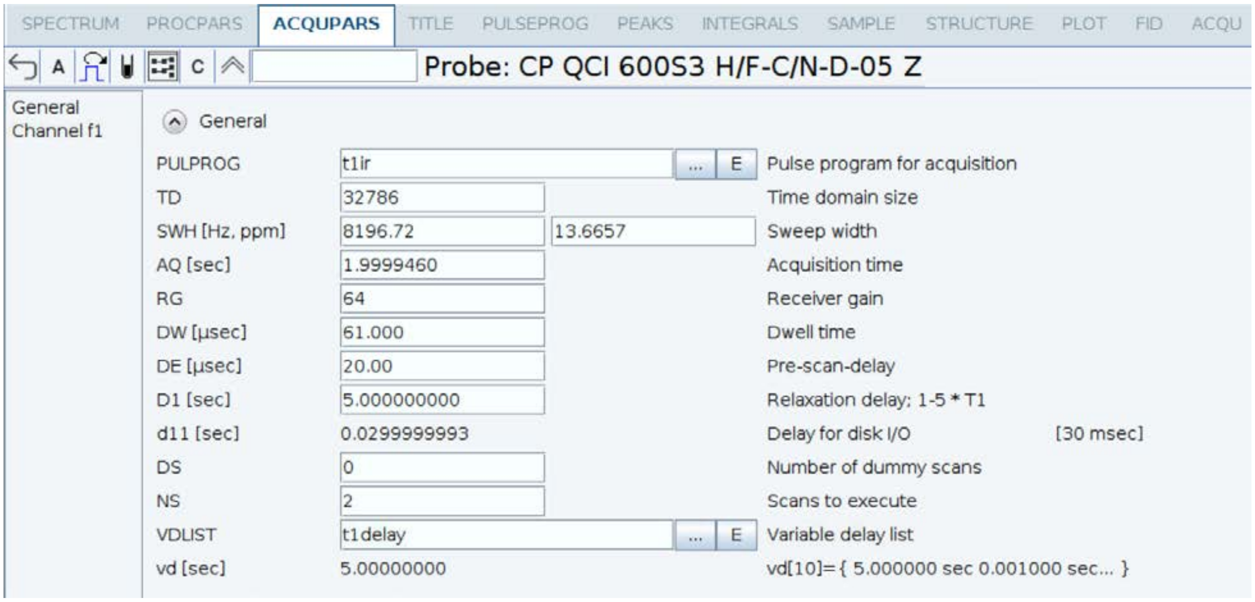


Fig 2. An example of t1delay list with 8 delays

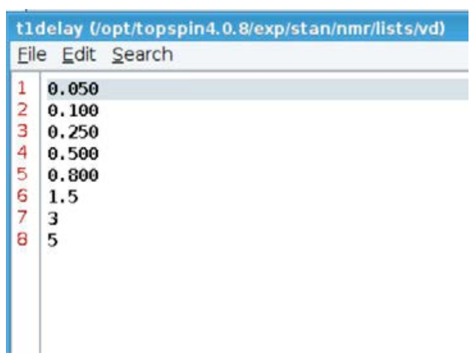
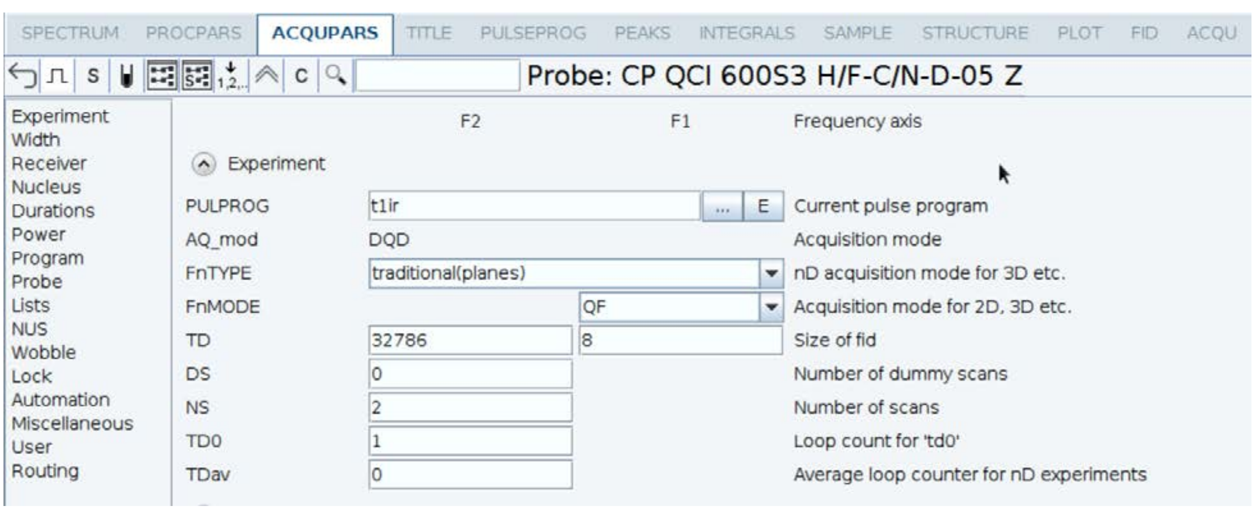


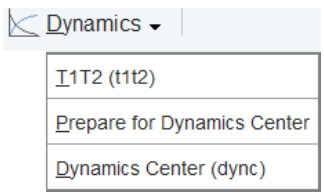
Fig 3. ACQUPARS display in "all acquisition parameters" view



Processing

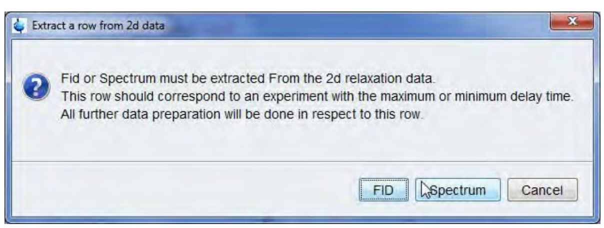
1) Process and adjust phase for the dataset. Use **rser n** (n is the number of total delays) to read out the last fid. Process and phase correct it. On the Adjust Phase toolbar, click **Save for spectrum**. 

2) Go back to pseudo 2D T1 dataset by closing the 1D window
3) At the command prompt, type **xf2** to process only the F2 axis. Type **abs2** to baseline correct the rows.
4) On the menu bar, click **Applications**.
5) On the **Dynamics** button, click the drop-down arrow to see more options and in the list, select **T1/T2 Module**.

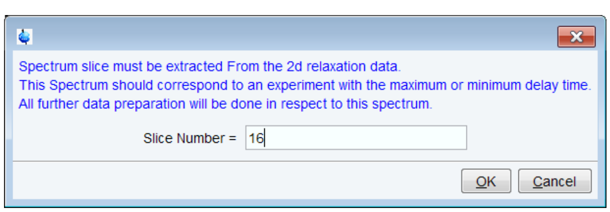


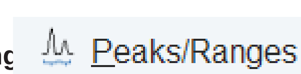
6) The flow buttons change to determine the T1 / T2 relaxation times. While executing the steps below, message windows will be displayed. Please read each message thoroughly and follow the instructions. On the Workflow button bar, click **Fid**

7) In the Extract a row from 2d data window, click **Spectrum**

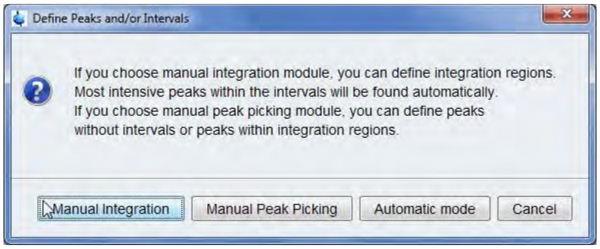


8) Enter Slice Number = **n** (the last one).



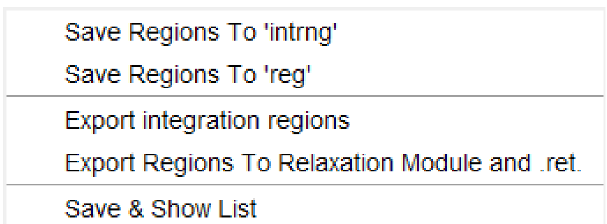
9) On the Workflow button bar, click **Peaks/Ranges** 

10) In the Define Peaks and/or Integrals window, click **Manual Integration**.

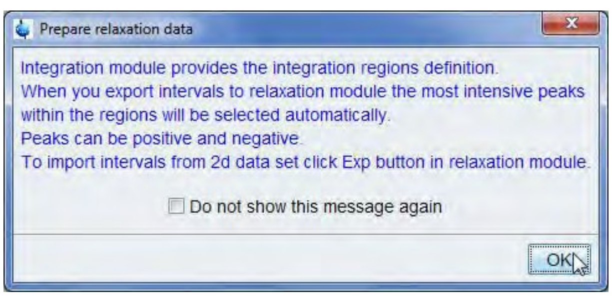


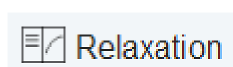
11) Define the regions by drawing an integral over the peaks of interest, On the Integration toolbar, click **Save/export integration regions** 

12) In the list, select **Export Region To Relaxation Module**.



13) In the Prepare relaxation data window, click **OK**



14) On the Workflow button bar, select **Relaxation**. 

15) By default, the selected areas are peak-picked, and the first peak is displayed in the Relaxation window.

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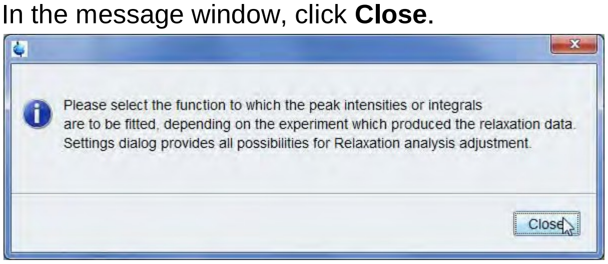
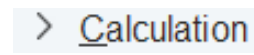
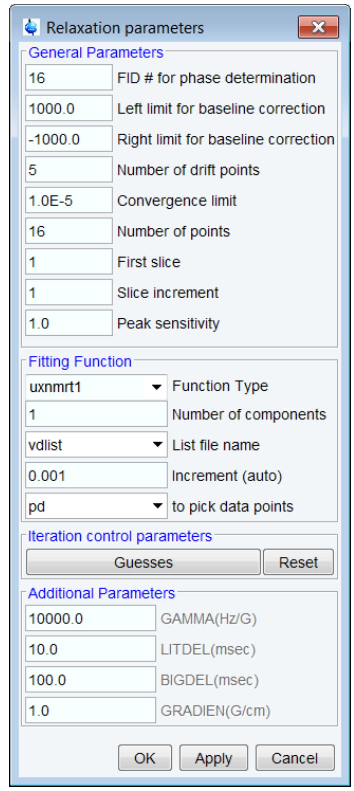
16) On the Workflow button bar, select **Fitti** 

17) In the message window, click **Close**.

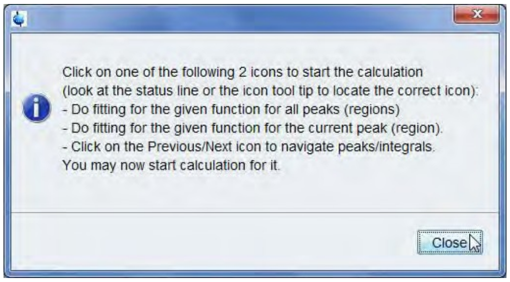


18) In the Relaxation parameters window, click **OK** and select **Area** as Fitting type.

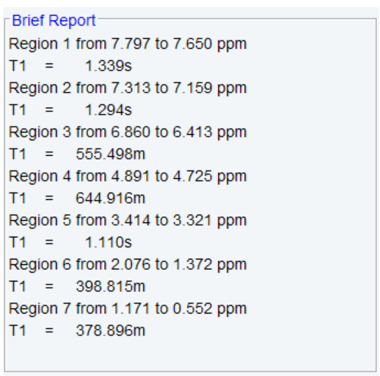
19) On the Workflow button bar, select **Calculation**. 



20) In the message window, click **Close**.



21) In the T1/T2 tools bar, click **Calculate fit for all peaks** 



22) On the Workflow button bar, select **Report**