AST460: Small Radio Telescope: Reading data files in IDL

Literature:

- **SRT Manual** has basic information about the telescope, observing setup, various parameters used for setting up the frequency resolution etc. and also data file structure.
- Available on the class web page.

- **HW#6 posted** !

2.3m Small Radio Telescope (SRT) on Sterling roof

1st Built in 2011!
2nd built in Dec 2012

Reading SRT data files

- To practice we will use the file located in the class Data directory (/d/leffe/astro_460/Class_2014/Data): jheup_68_13oct14.rad
- Please copy this file to your directory and your working area
- Later you will have your personal observing files which you will process.

Output .rad data format:

- Telescope data files have extension .rad and have a well-defined format:
- To see what's in the file, in Unix type: more jheup_68_13oct14.rad
- Data files look like:

* STATION LAT= 43.07 DEG LONGW= 89.67

2005:148:10:55:41 92.0 5.0 0.0 0.0 1419.75 0.00781250 1 64 4.7 5.9 10.5 20.1 40.1 70.2 107.5 154.3 218.1 219.9 223.5……..….

...

- Each line of data contains a spectrum, and various information about the telescope pointing and frequency setting.
- the output data file is an ASCII file with spaces as delimiters
- Comments executed by the telescope are shown with * in the first column (these are lines read from your observing script)
- If the file already exists the data are appended to the existing file. This can look messy.

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2005:148:10:55:41 92.0 5.0 0.0 0.0 1419.75 0.00781250 1 64 4.7 5.9 10.5 20.1 40.1 70.2 107.5 154.3 218.1 219.9 223.5……

- Field 0 - time (yyyy:ddd:hh:mm:ss)
- Field 1 - azimuth(deg)
- Field 2 - elevation(deg)
- Field 3 - azimuth offset(deg)
- Field 4 - elevation offset(deg)
- Field 5 - first frequency bin (in MHz)
- Field 6 - digital frequency separation (in MHz) = freq. channel width
- Field 7 - digital spectrometer mode
- Field 8 - number of frequency channels
- Field 9 – data value (in uncalibrated temperature units) at first frequency channel
- field 10 – data value at second frequency channel
- Etc etc

- Note: IDL counts from 0.

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Reading your SRT file in IDL

Step 1. Let's try to read file called jheup_68_13oct14.rad in IDL:

IDL> temp=ascii_template(' jheup_68_13oct14.rad**')**

This will open ASCII Template window. You will see line after line of your .rad file.

- Set 'Comment String to Ignore' to be * [we are saying that lines starting with * are not data lines].
- 'Data Starts at Line' = 7 [you may need to change this if your file had other information]. This allows us to exclude a few scans/spectra taken at the start. I suggest starting at the scan right after "noisecal"
- Please note here the 1st scan after "noisecal" had CAL ON, and the 2nd scan had "CAL OFF" – so these two scans are for calibration, and essentially we can count under the 300sec integration all scans from number 3 onward
- Click on Next; next window will show you all selected data lines
- Click Next;
- On the 3rd window, click on "Group All", under 'Type' select Floating Point for your data type, and note (write down) what's given under 'Name', e.g. FIELD001. Click Finish.

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Working with 'dat' variable in IDL

Step 2. IDL> dat=read_ascii(' jheup_68_13oct14.rad **',template=temp)**

Your data table now exists as variable 'dat'.

Step 3. 'dat' is an idl data structure containing all scans/spectra. As it's easier to work with simple 2D arrays, do:

IDL> d=dat.field001

3. You can now save the 2d array d for future work:

IDL> save, d, filename='jheup_68_13oct14.sav**'**

- Steps 1-3 should be done once for a data file, and after this point you can simply restore the above .sav idl and work with it. Now need to go through steps 1-3 again (this takes some time so is best to do once).

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Working with 'd' variable in IDL

- When you are ready to restore and use your saved 'd' variable do (either in IDL window or in your IDL code):

IDL> **restore, '**jheup_68_13oct14.sav**'**

IDL> **help, d** will show something like:
Array[165, 30]

This means that 'd' is a 2d array (or a table) of data values, with 165 entries in the x-direction and 30 entries in the y-direction. Each data scan has (in this example) 165 fields, and there are 30 scans in total. Each scan is essentially a spectrum.

- For each scan, fields 0 to 8 show the basic scan info, and fields 9 to 164 are pure data (intensity) values. So, to plot data values (or the HI spectrum) for scan #3 do:

IDL> **plot, d[9:164, 2]** {note: IDL counts from 0 !}

- To print Azimuth offset value for scan #3 do:

IDL> **print, d[3, 2]**

- Fields 5 to 8 can be used to build the frequency array.

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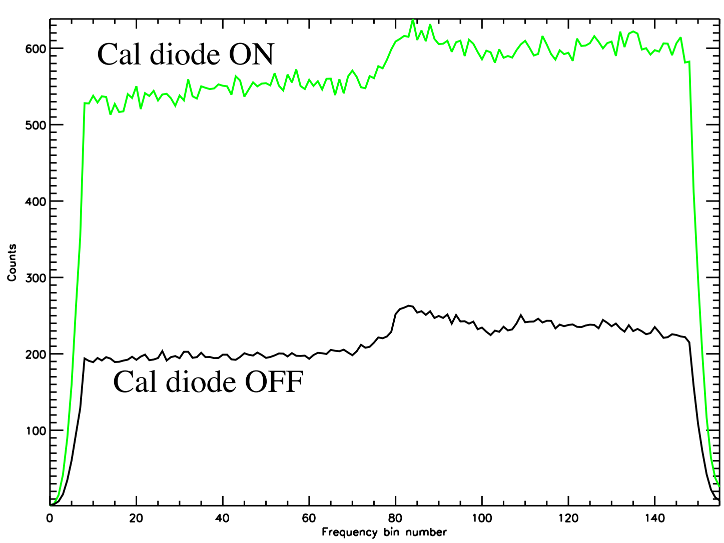
Reminder: calibration procedure



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New Calibration Procedure

Observed HI spectrum when diode is OFF. Affected by the gain.

$$P^{cal-off}(\nu) = G(\nu)[T_{sys} + T_{HI}(\nu)]$$

Observed HI spectrum when diode is ON

$$P^{cal-on}(\nu) = G(\nu)[T_{sys} + T_{HI}(\nu) + T_{cal}]$$

Spectral gain function = spectral baseline largely due to receiver filters

$$G(\nu) = \frac{P^{cal-on}(\nu) - P^{cal-off}(\nu)}{T_{cal}}$$

Observed HI spectrum when diode is OFF. Corrected for the gain.

$$T_{sys} + T_{HI}(\nu) = \frac{P^{cal-off}(\nu)}{G(\nu)}$$

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