HartRAO Spectroscopy: Calibrating Spectroscopic data

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How to scale the system counts

- The system register voltages from the antennas as system counts
- A noise diode is used with lab values for "temperatures", the "cold" and the "hot" load.

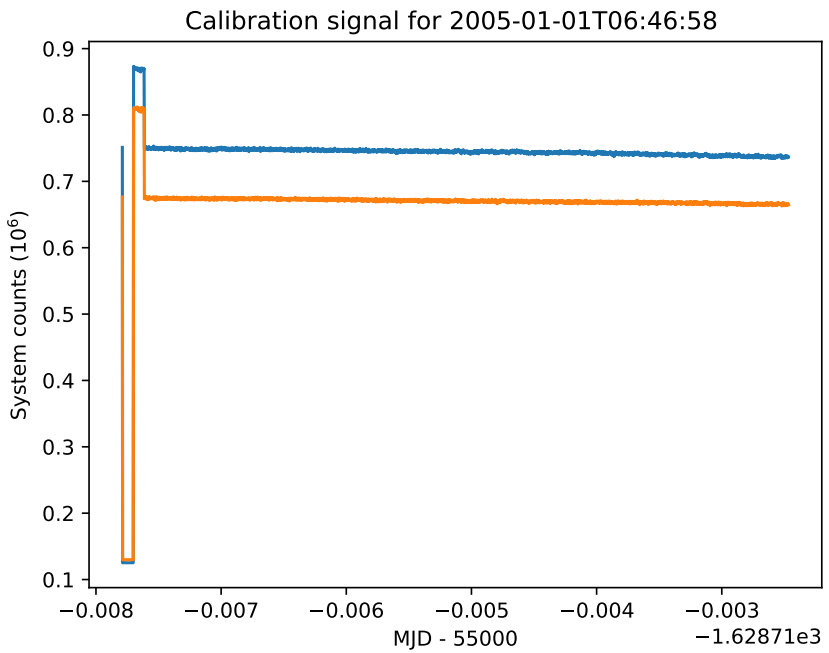
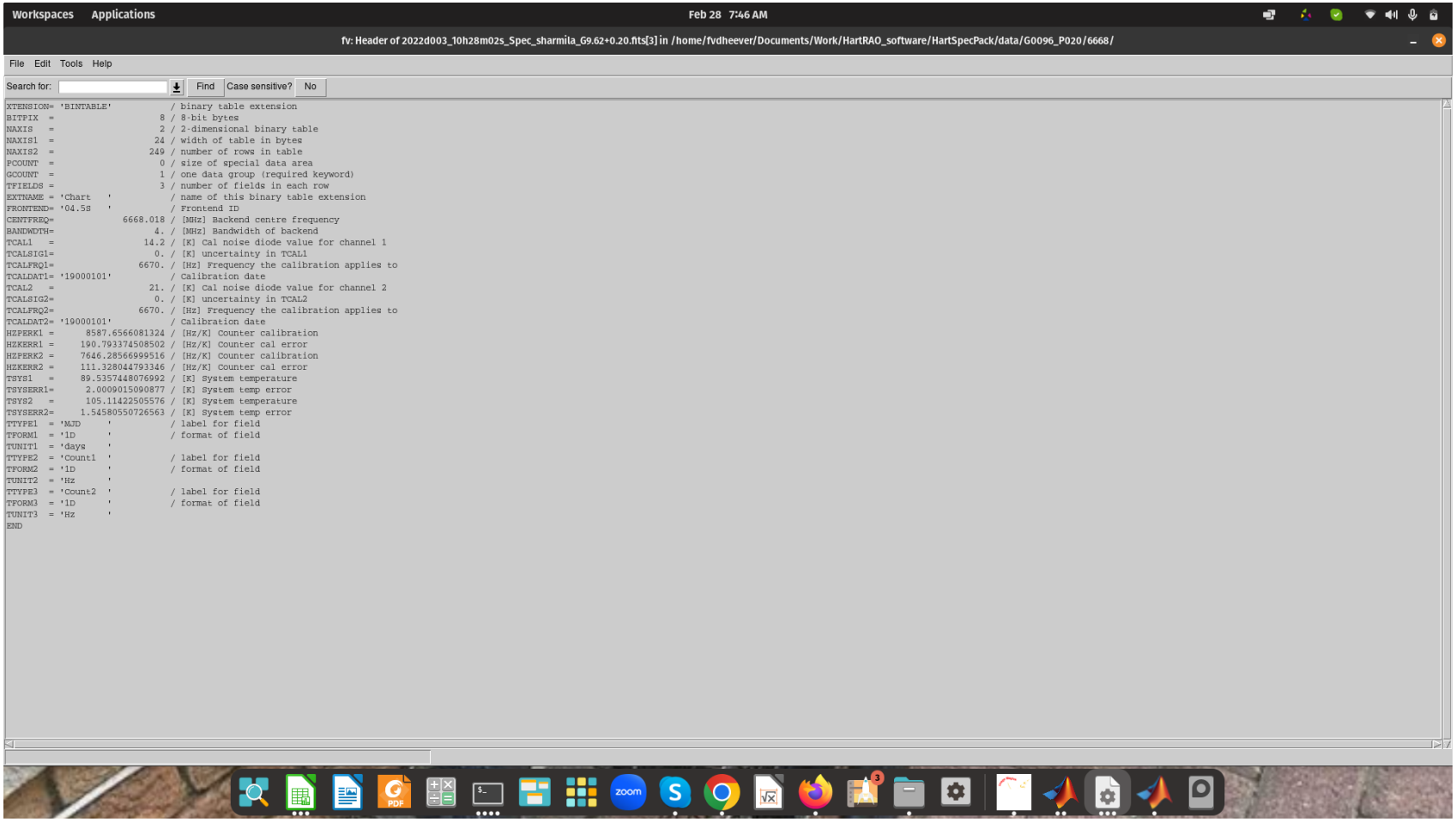


Figure 1: Blue: Left Circularly Polarized (LCP) radiation, Orange: Right Circularly Polarized (RCP)radiation

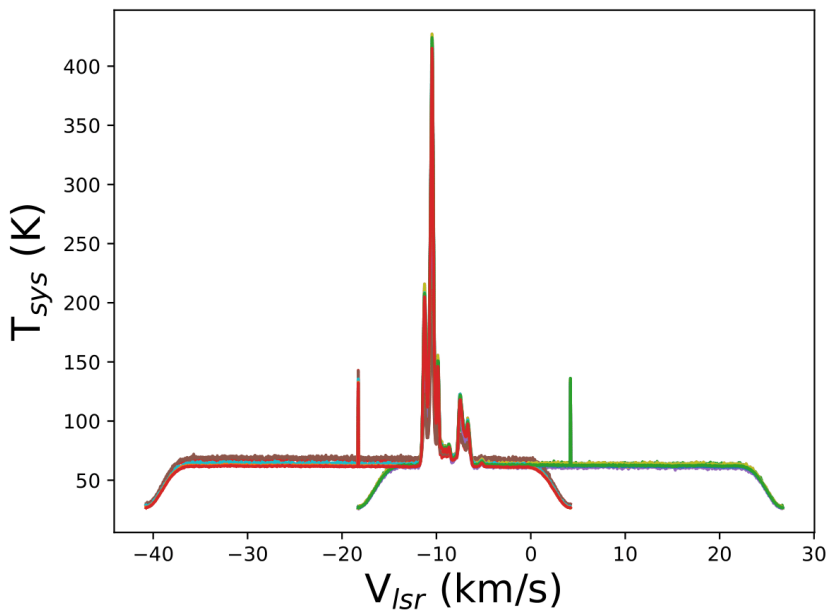
How to get the T_{sys}

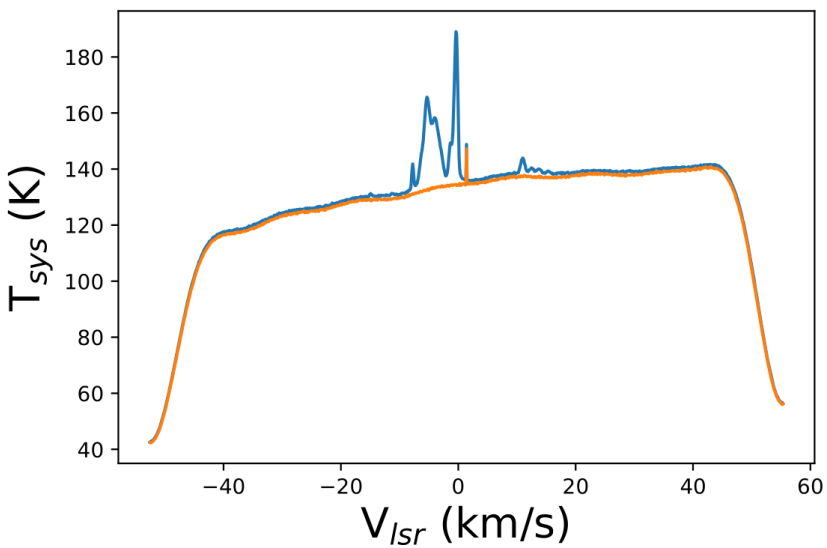
- Header information that shows the conversion factor to get from system counts to T_{sys}.



Converting to T_{sys}

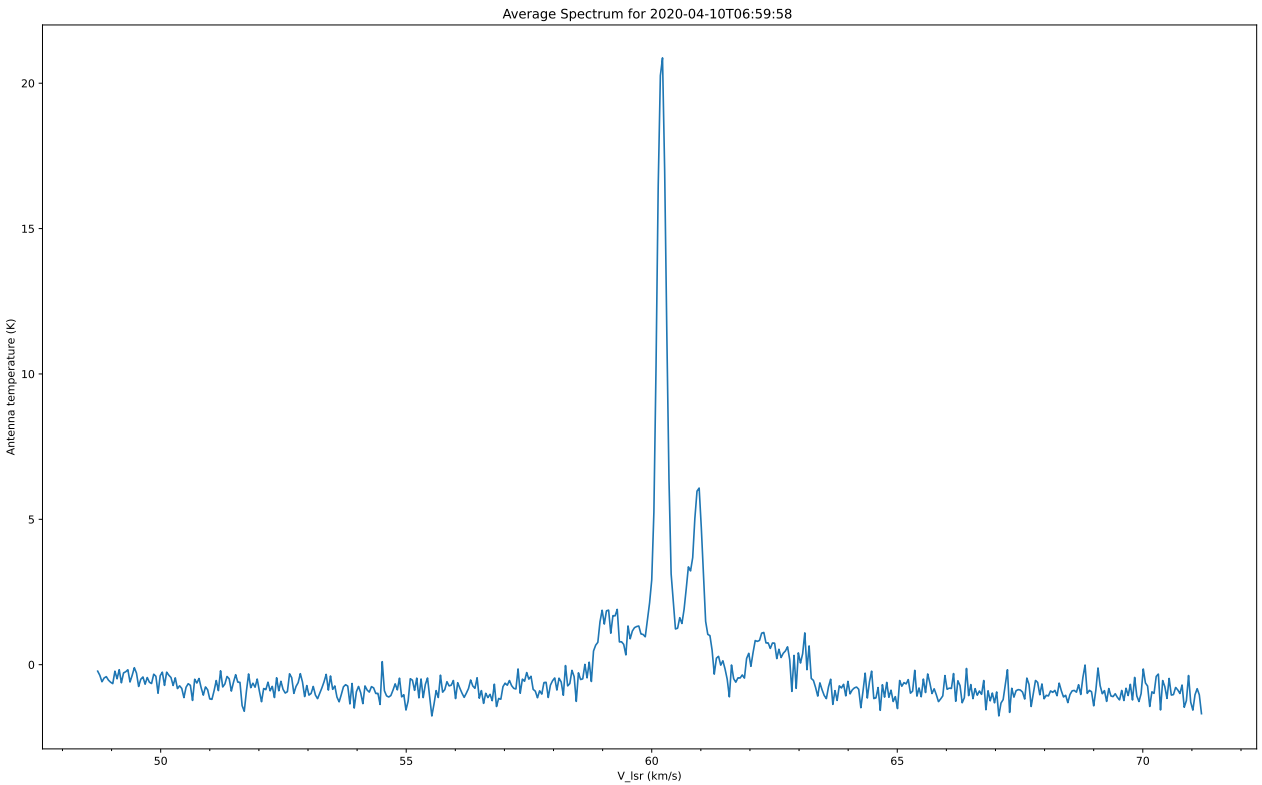
- An example of frequency-switching and position-switching after conversion to T_{sys} has been done





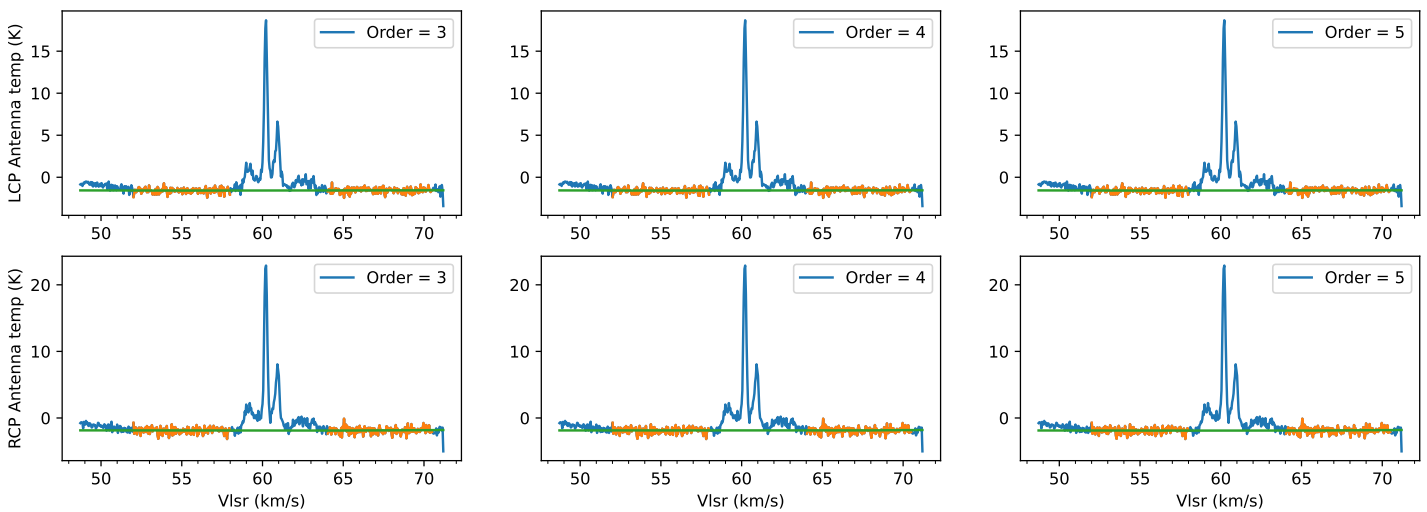
Data Calibration step 1

1. Calculate the Average spectrum using both LCP and RCP to obtain a better Signal-to-Noise ratio (SNR). This average spectrum is then used to choose the parts of the spectrum WHERE there is no Signal, also known as the Baseline blocks.



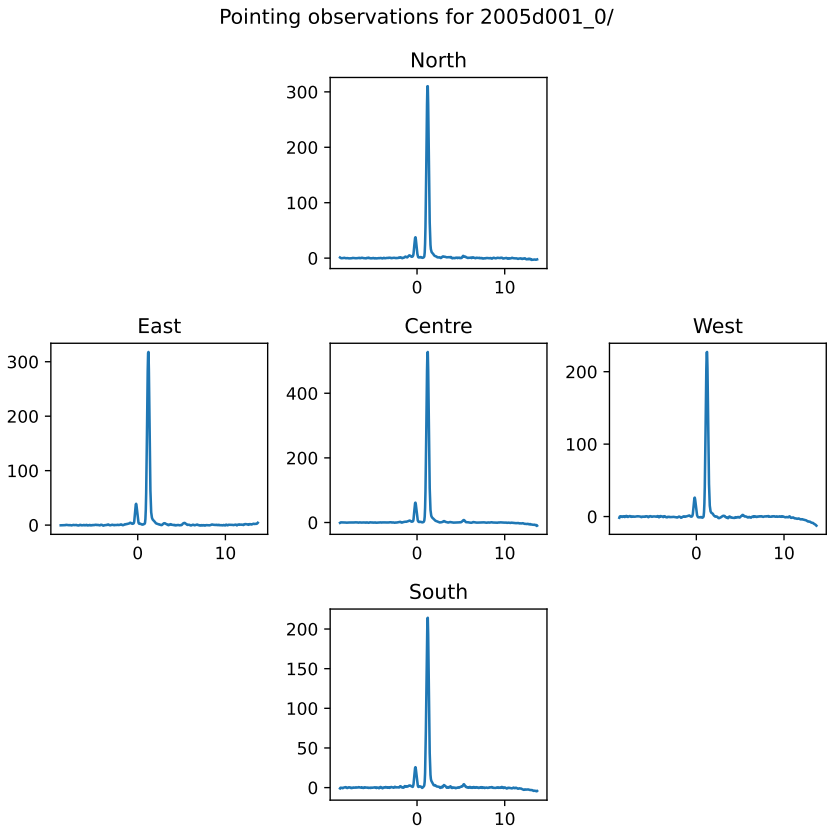
Data Calibration step 2

2 Polynomials are then fitted through the spectra using the Baseline blocks. This is repeated for each LCP and RCP spectrum, including all the pointing observations. The polynomial fits are then used to pull the individual spectra down to ZERO.



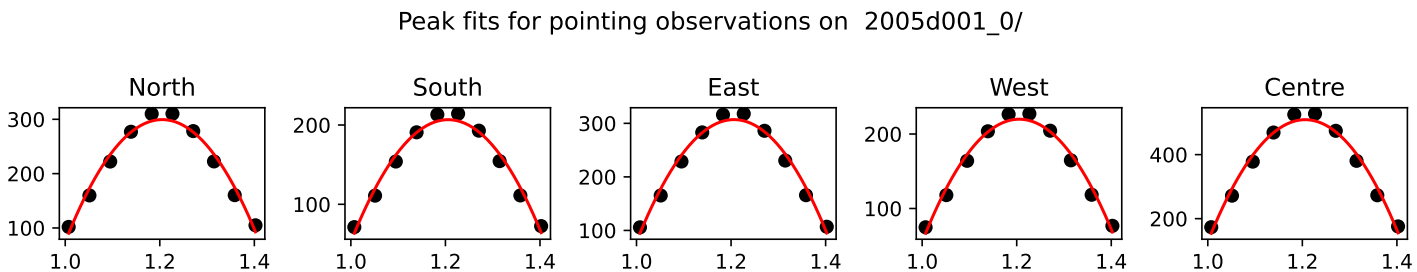
Data Calibration step 3

3 The pointing observations are used to calculate the pointing correction factor.



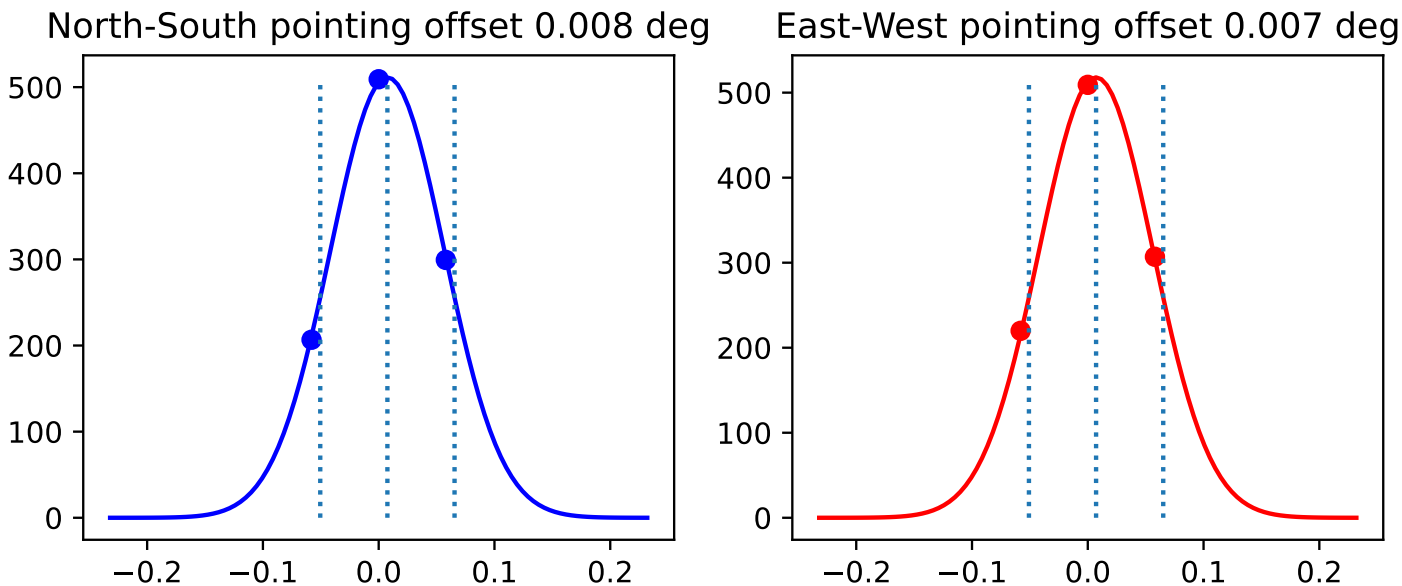
Data Calibration step 3

3 After polynomial subtraction, the maximum values of the pointing observations are used to determine the pointing correction factor. A Gaussian is fitted to the peak of each of the pointing observations.



Data Calibration step 4

4 The values obtained from the Gaussian fits are then used to determine the offsets in the N-C-S direction as well as the E-C-W direction. The offsets are then used to determine the pointing correction factor.



Data calibration step 5-9

5 On-source observations are averaged to improve root mean square (RMS) noise. For high frequencies, the atmospheric correction factor is calculated for each pair of observations and applied before averaging.

6 The average spectrum is then multiplied by the pointing correction factor.

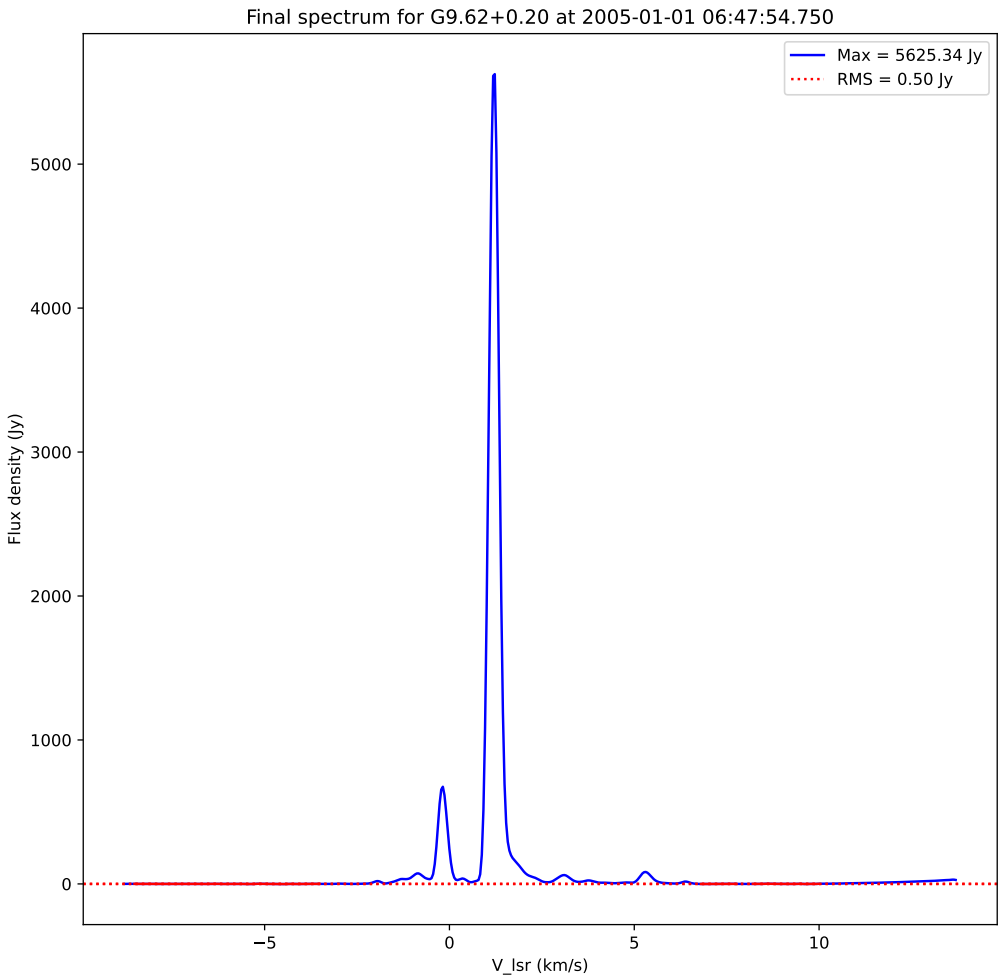
7 The PSS values for LCP and RCP is multiplied by the average spectrum of LCP and RCP and they are added to get I.

8 The software also tests (within the baseline blocks) if there are any weak signals greater than 2.5 times the RMS, which are then excluded from the baseline blocks, and the RMS noise is recalculated.

9 The final plot is created, which shows the RMS noise level and maximum flux.

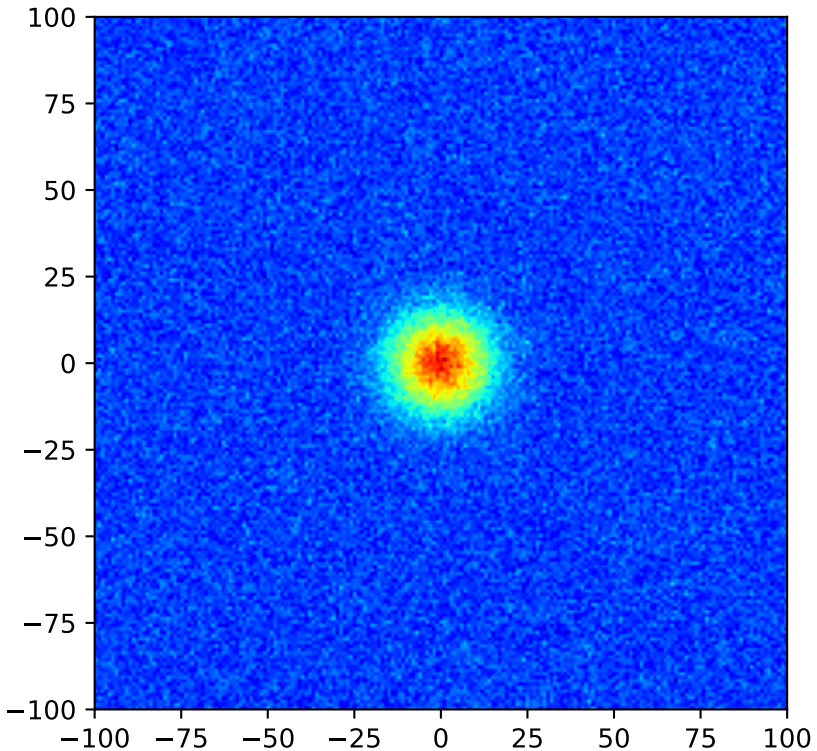
Data Calibrated

- Final spectrum after all calibration have been done.



Future functionality

- Adding GUI capabilities.
- 2D Gaussian fitting for pointing corrections
- Gaussian fitting/Automated Gaussian fitting for Maser features (possible machine learning application)



Future functionality

- Pulling in GPS data from Roelf's database to do atmospheric corrections. His GPS data could provide us with a 2D map of the Troposphere to better implement atmospheric correction.
- Display real-time map, similar to the all sky camera of where the observation is done.