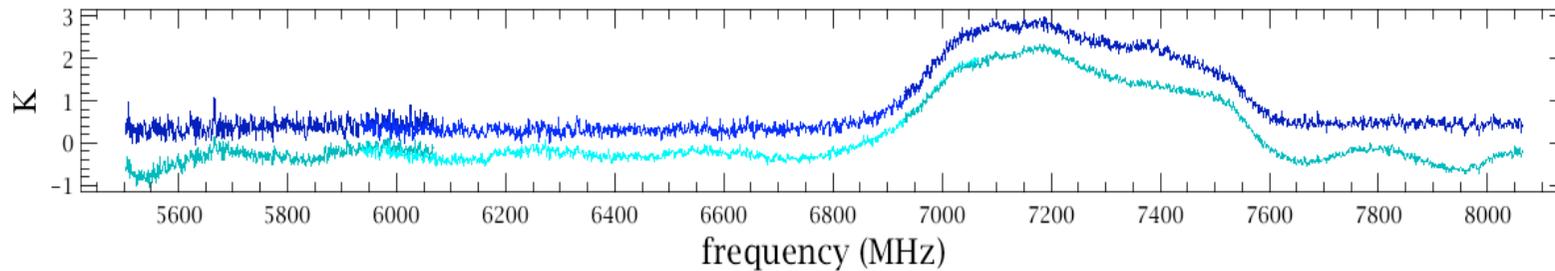# Improving Herschel HIFI HEB Baseline Reduction

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Introduction:

Bands 6 and 7 of Herschel's HIFI instrument suffer from a phase and amplitude shifting ripple that is dependent upon numerous receiver parameters, such as mixer current. While one can attempt to fit a sinusoid to the ripple, this quickly becomes insufficient for a desirable signal to noise ratio.

Extending upon a technique pioneered by Ronan Higgins of the HIFI ICC, we have come up with a faster, more comprehensive way to reduce HEB baselines. We will demonstrate this technique using the data of the Herschel Inner Galaxy Gas Survey (HIGGS) project. Bands 6 and 7 are the high frequency bands with a bandwidth of 2.4 GHz. These bands use hot electron bolometers (HEBs). The frequency range is 1430.2 GHz to 1901.8 GHz.

The graph:

In the graph above, the dark blue is the processed data, while the light blue is the unprocessed data. The differing colors within the lines show the three sub-bands. After processing, we can see that a flat baseline remains. All of the science data is preserved. The program distinguishes between the science data and noise by comparing portions of the data to a catalog of spectra taken when the instrument is not pointed at the target.

How do we reduce the baseline?

Before beginning our process, we do necessary housekeeping and do the standard level 1 processing of the data.

In the subsequent process, first the data is binned by flux, splitting it into smaller, easier to deal with chunks. The spectra can also be split up based on frequency, depending on the desired result. After binning, we extract information such as the average flux and other information that we might need. The bins are then stitched back together. The catalog of baselines is generated. A match between the baseline of the dataset and a spectrum in the catalog is attempted. If a match is found, the match is subtracted from the baseline, leaving a flat baseline.

The previous method involved doing an FFT. The running time for this was on the order of days. The current method does not do this and thus has a running time around 30 minutes (depending on the data input into the program). The program is much faster because it bins the data. This binning is also how the match between the baseline of the data and the catalog is made.

Problems solved with this program:

We fixed the very long running time by streamlining the program and making its memory usage more efficient. The baseline subtraction is also improved. We now get a good match fairly quickly. HIPE does not have good garbage collection, so we manually garbage collect to reduce the running time. The running time is currently around 30 minutes, which is much improved from the previous running time of several days. We get better matching of spectra than previously because we have a better algorithm for the matching. This means that we are left with a flatter baseline.

Next step?

The program should be cleaned up for better efficiency. While much progress has been made on the running time, there is still much room for improvement. We can also improve the garbage collection to make the running time faster. Additional algorithms for processing should be examined and possibly implemented. Further testing and troubleshooting are also necessary.