HERSCHEL SPIRE FTS FEATURE FINDER DATA ACQUISITION

{ NICHOLAS SWIDINSKY AND BRADEN GAIL} UNIVERSITY OF LETHBRIDGE, DEPARTMENT OF PHSYICS AND ASTRONOMY

1. INTRODUCTION

The Herschel Space observatory provided the first full-sky broad-band access to the cosmos in the Far-Infrared (FIR) spectrum, using the three focal plane instruments on-board. One instrument was the Spectral and Photometric Imaging Receiver (SPIRE) which came equipped with a photometric camera and a Fourier Transform Spectrometer (FTS). The University of Lethbridge's contribution to SPIRE was the SPIRE FTS Feature Finder FF which was an automated procedure that fitted spectral data and stored it in catalogue entries. Through it's 2000 hour operation period the FF found 1802 observations. All data found from the FF are available publicly through the HSA, and any additional regarding SPIRE can be found in the SPIRE handbook.

Figure 1: Image of the Herschel Space Observatory launched in 2009 by the European Space Agency (ESA).

2. JUPYTER NOTEBOOK

A custom made jupyter notebook was initially created by J. Scott as a companion piece to the feature finder, designed to be used as an example of how to access and analyze FF data using the catalogue entries created by the FF which are organized by individual observation identifications (obsids). All the catalogue entries are stored in the SPIRE Automated Feature Extraction Catalogue (SAFECAT).

```
obsid = 1342204037
result = spio.get_observation(obsid, useFF=True, useHsa=True,
                              save_dir=save_dir, save=True)
cat = result['ff']['sparse_ext']['catalogue']
cont = result['ff']['sparse_ext']['continuum']
spec_hdu = result['HR_spectrum_ext']
spec_prod = spio.parse_sparse(cat, cont, spec_hdu=spec_hdu)

fig_kwargs = {'figsize': (8,4.5)}
fig, ax = tools.sparse_postcard(spec_prod, fig_kwargs=fig_kwargs)
plt.savefig("sparse_postcard_jupyter.png", dpi = 400)
```

Figure 2: Example code cell from the notebook. Cell creates the postcard found in figure 3 (Middle).

Our tasks for the notebook were as follows:

- Test and debug the notebook
- Implement new data acquisition functions
- implement new plotting functions
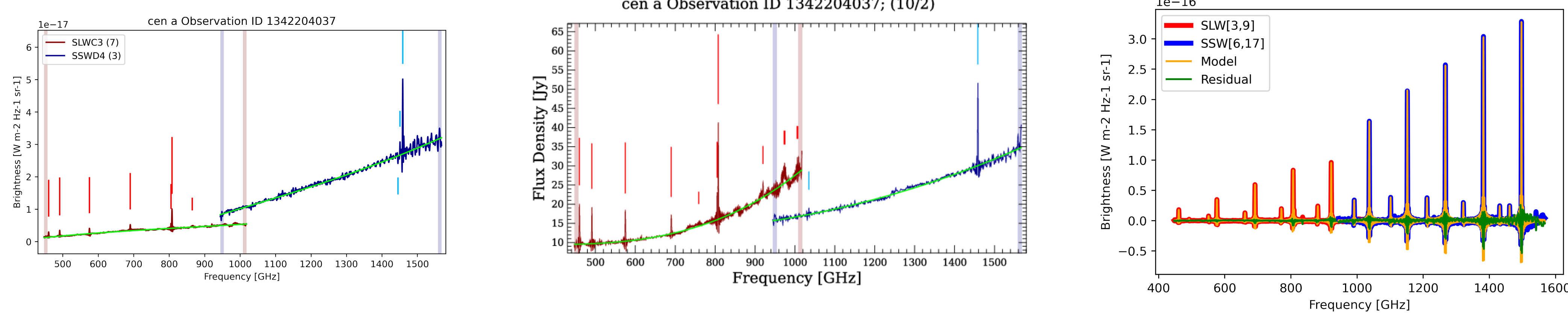- Create a custom python library to condense notebook

Figure 3: Left: Example of a Sparse observation postcard created in the jupyter notebook. **Middle:** official postcard for the same Sparse obsid. **Right:** Example of a spectral model created from FF parameters, which can be used to calculate integrated flux.

3. GRAPHICAL USER INTERFACE

A new custom graphical user interface (GUI) was created using the Tkinter library in python. The GUI links many of the notebooks features to buttons, drop down menus, or other graphical elements which allows the user to quickly access the features in an efficient manner. A few of the primary features include sorting through almost 300,000 table entries, displaying Fits File data, and creating photometer images for specific obsids. A full list of features is presented below:
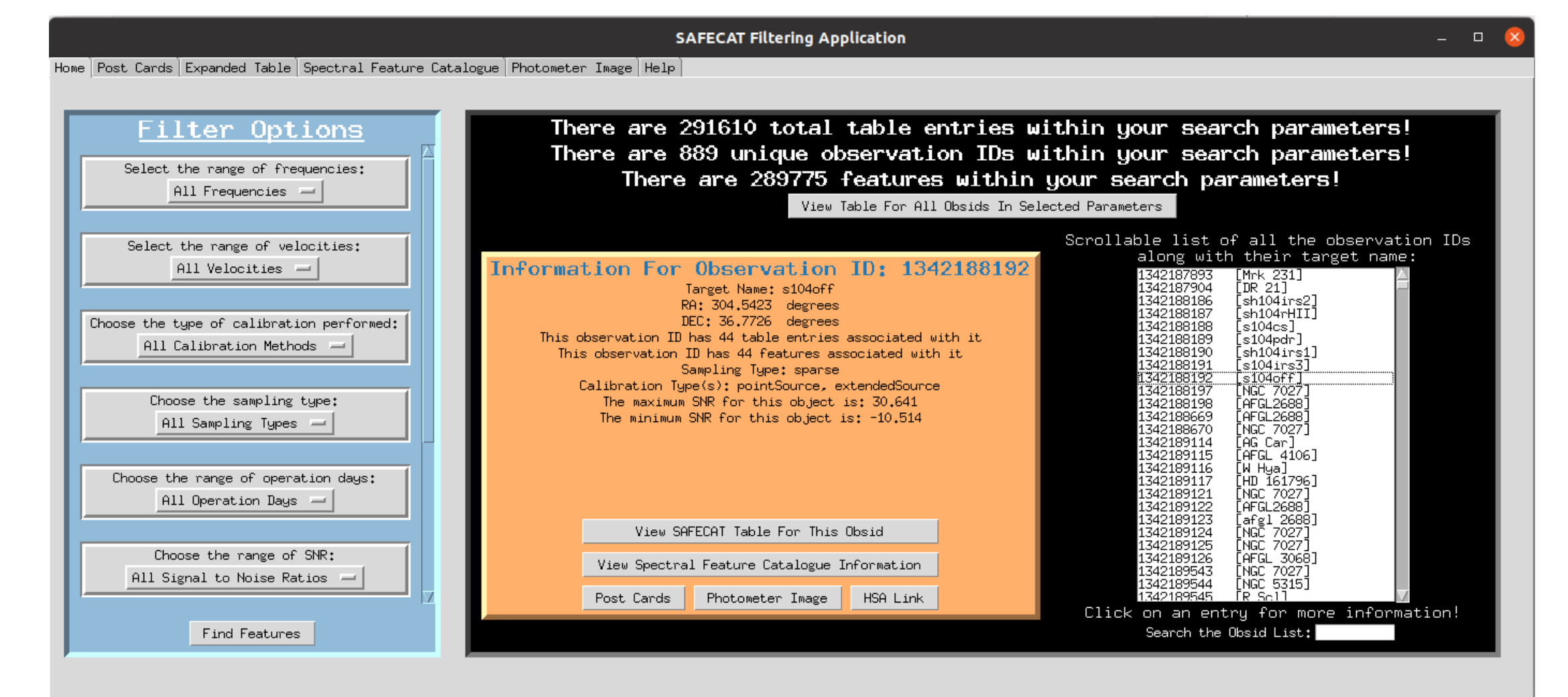
Figure 4: Main page of a custom made Graphical User Interface (GUI) designed by Braden Gail.

- Filter SAFECAT data using 9 different search criteria
- Display the filtered SAFECAT Table
- Display the Spectral Feature Catalogue Information for a specific obsid
- Find and display all associated postcards for a specific obsid
- Create and display a Photometer image for a specific obsids (if applicable)
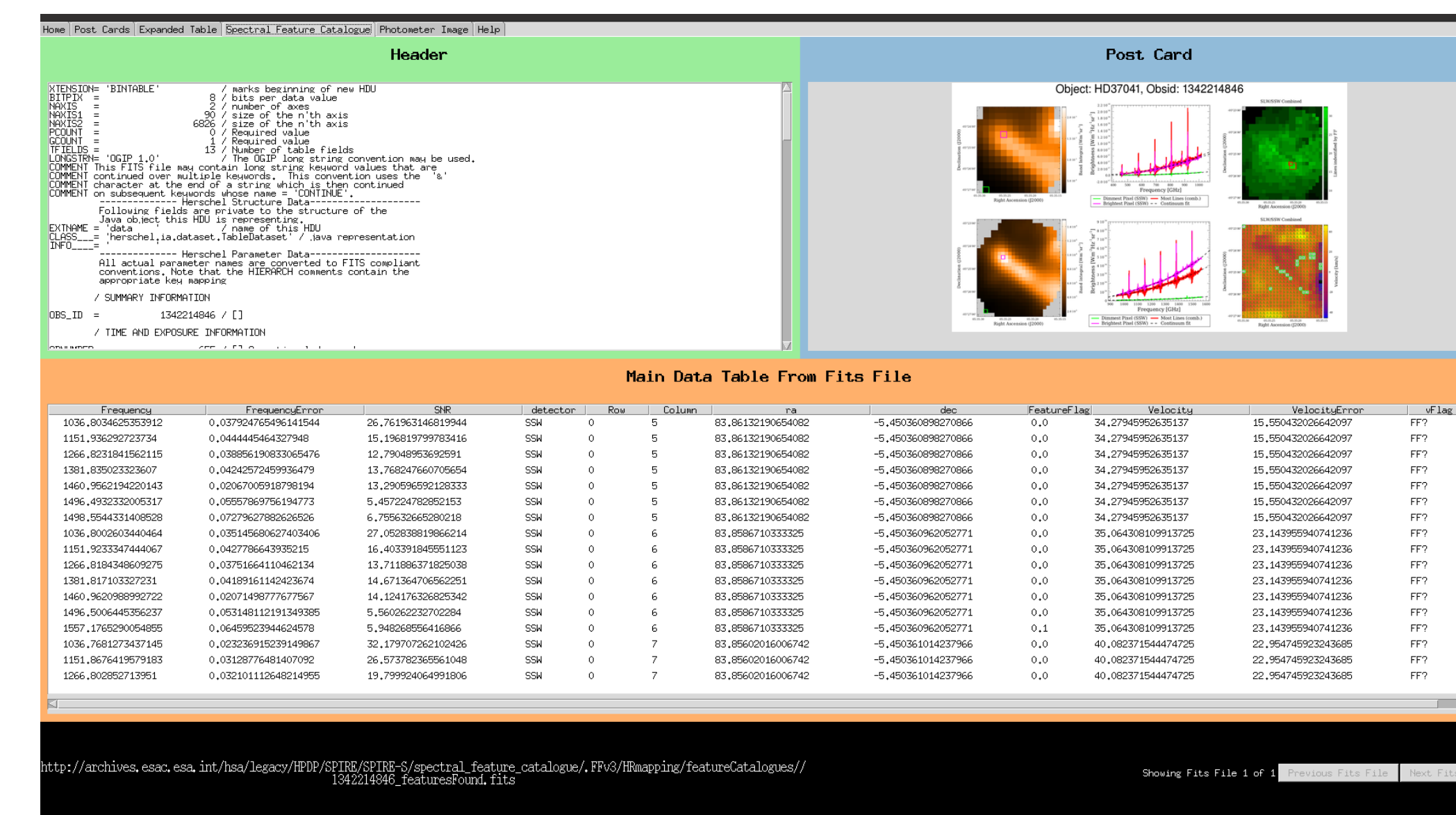- Supply an HSA link

Figure 5: Left: Spectral feature catalogue for the selected observation. Displays header information of the fits files, postcad, and SAFECAT table for the selected obsid. **Right:** expanded postcard for the selected obsid. High resolution images of all postcards can be downloaded from this page.

4. CONCLUSION

All of the associated FF products, including the Jupyter Notebook, are publicly available for use through the HSA. Additional information about SPIRE can be found in the SPIRE handbook. Special thanks to L. Spencer, J. Scott, C. Benson, and I. Valtchanov for the creation of the Feature Finder as well as assistance in the creation of the Jupyter Notebook.

5. REFERENCES

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[4] J Scott. et al., 2020, MNRAS, 496(4): 4923-4930. arXiv:2005.12462

[5] C Benson. et al., 2020, arXiv:2009.09014

Herschel Science Archive: