

# The FIFI-LS Pipeline at the SOFIA Data Center

## New Flux Calibration and Improvements



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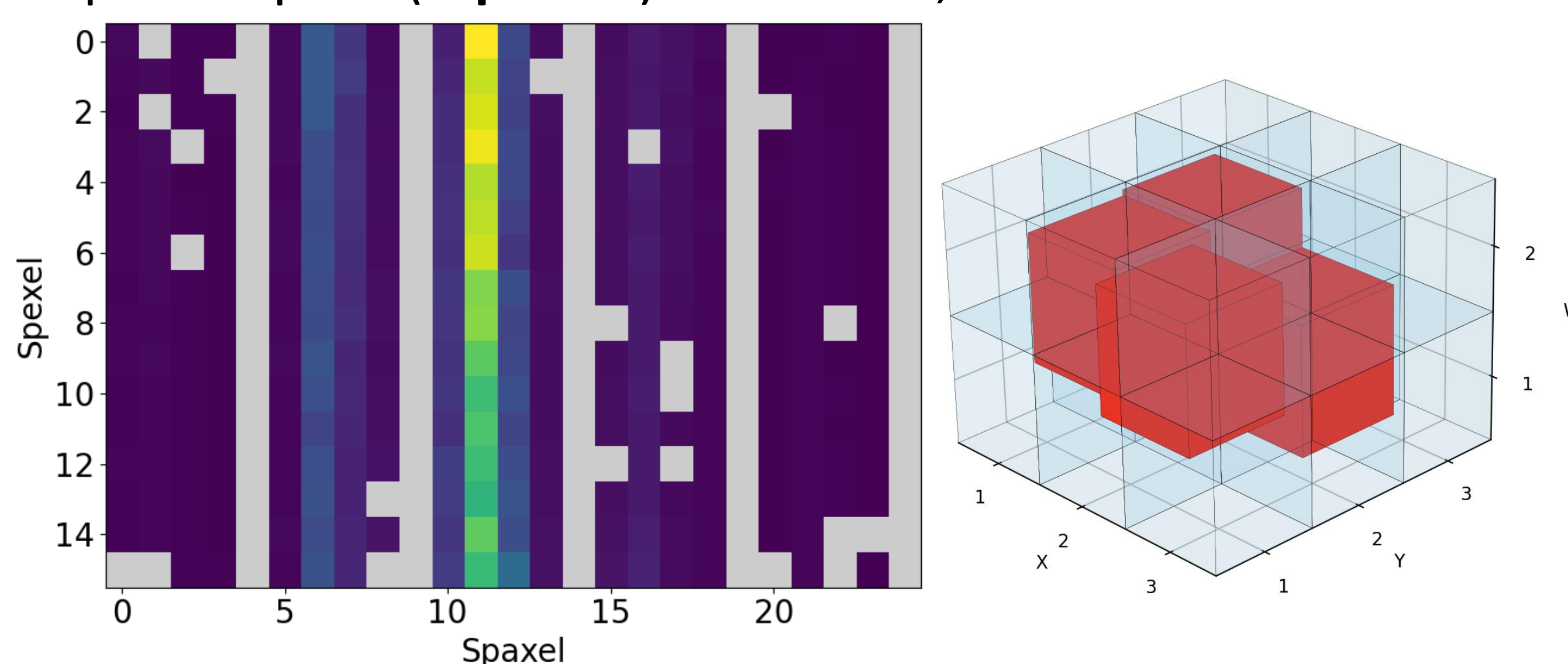
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### Introduction

Among the data pipeline enhancements being actively developed at the SOFIA Data Center (SDC, see poster B. Schulz) is a **new flux calibration** for SOFIA's field imaging spectrometer FIFI-LS. Calibration is performed by comparing planetary flux models with **over 7 years of far-infrared measurements of Mars**. Our method seeks to improve on previous iterations by utilising a **fully time-resolved model** of the Mars surface brightness, a **flux-conserving resampling algorithm**, and **photometric techniques** that account for the spatially uneven and undersampled Mars disk. We present details of our ongoing calibration efforts, as well as additional improvements within the Redux Pipeline Suite (see poster B. Greiner).

### Mars Observations

Between 2014 and 2022, FIFI-LS observed Mars over the entire wavelength range of the instrument, covering all combinations of filter configuration. Each individual file consists of an image with a spatial pixel ("spaxel") and spectral pixel ("spexel") dimension, shown below left.

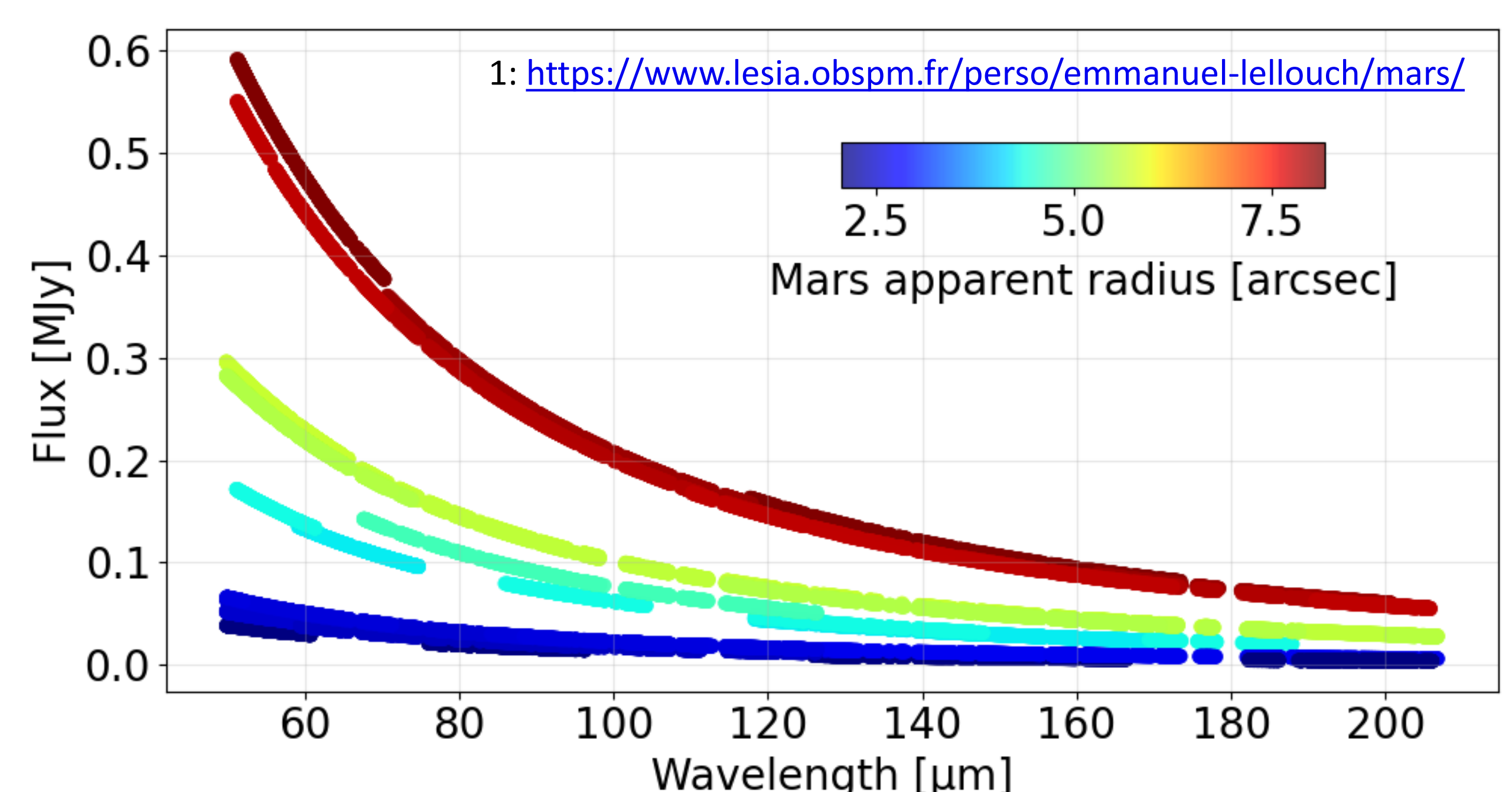


We resample these images by spectrally interpolating over dead pixels in the detector, and then "drizzling" the flux onto a finely sampled output grid, shown above right. The result is an evenly sampled **spatial-spectral cube**, for **each wavelength and timestamp** of a Mars observation.

### Modelling the Mars Brightness

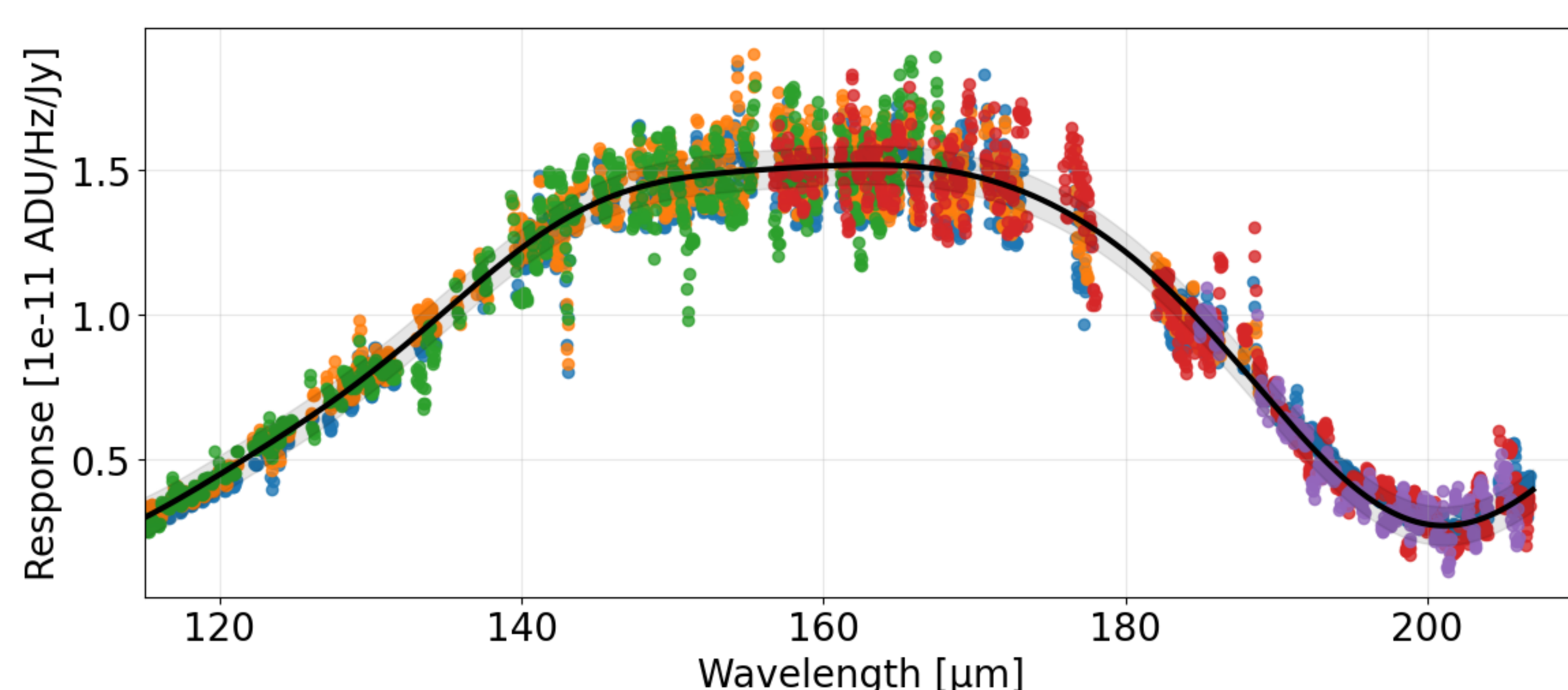
Every observed wavelength-timestamp pair is used as an input to the **Mars model of Lellouch & Amri 2006<sup>1</sup>**. The model calculates a time-resolved surface temperature map of Mars, and converts this into a flux based on the Mars-Earth separation. Modelled fluxes are shown below.

This improves upon previous calibrations which merely scaled a single dated Mars model to separations computed by ephemeris.



### Flux Response Curves

Now that we have obtained both observed and modelled Mars fluxes for each wavelength-timestamp pair, we divide these values to derive the wavelength-dependent **instrumental flux response** in detector units per Jansky.



Investigation is ongoing into the **scatter** in the response, shown above where each response datapoint is coloured by SOFIA flight. To counteract this, we scale each flight's datapoints by the deviation of that flight's median curve from the total median, as pioneered by Fadda *et al.* 2023.

### The FIFI-LS Pipeline

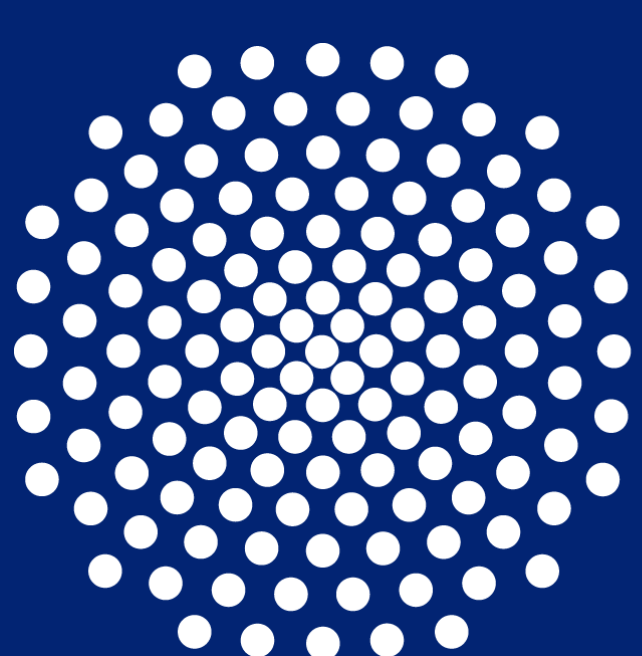
After accounting for instrumental and reduction-based artefacts in the response curves, we intend to perform **cross-calibration** with contemporary far-infrared measurements, such as those of Herschel-PACS.

This calibration is part of a broader project on the FIFI-LS pipeline, in preparation for a **complete re-reduction of all archived raw data**. Additional improvements include:

- Realtime telluric correction from ECMWF models (Fischer *et al.* 2021, Iserlohe *et al.* 2021, 2022)
- Data quality flags and filtering, pointing determination
- Science project-oriented flags for re-reduction
- Science-ready data products, spectral line fits, map mosaics



`pip install sofia-redux`



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The SDC is funded by the DLR Space Administration under grant number FKZ 500K2404