TIME: Probing the Epoch of Reionization and Star Formation with LIM

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The Epoch of Reionization, at a redshift of roughly $6 < z < 10$, is when the first stars and galaxies formed, and hydrogen gas in the universe became reionized. The Tomographic Ionized-carbon Mapping Experiment (TIME) is a mm-wavelength spectrometer that aims to study the epoch of reionization through its star formation by measuring spatial fluctuations in [CII] line intensity. TIME uses a method called line intensity mapping (LIM), which measures the integrated emission lines from all frequencies within a spatial region. This allows us to include signals from galaxies too faint to detect with standard galaxy redshift surveys. TIME's spectral range of 185-323 GHz corresponds to [CII]'s 157.7μm fine structure line redshifted from a z of 5-9, overlapping with the epoch of reionization.

The objective of my project was to build upon code written by Ryan Keenan to develop a data analysis pipeline for this instrument. Data obtained from TIME's 2019 engineering run and simulated data generated by Dongwoo Chung were used for the data analysis in this project. The pipeline involves data flagging, atmosphere removal through polynomial subtraction, and calibration. Scans with too little data, not representative of a Poisson distribution, or with high root mean squares were masked out, removing from analysis a large portion of our data obtained in the engineering run. Our data contains signals from various planets in our Solar System of known spectral radiance and effective temperature, from which we computed the calibration ratio of each detector through Planck's Law.

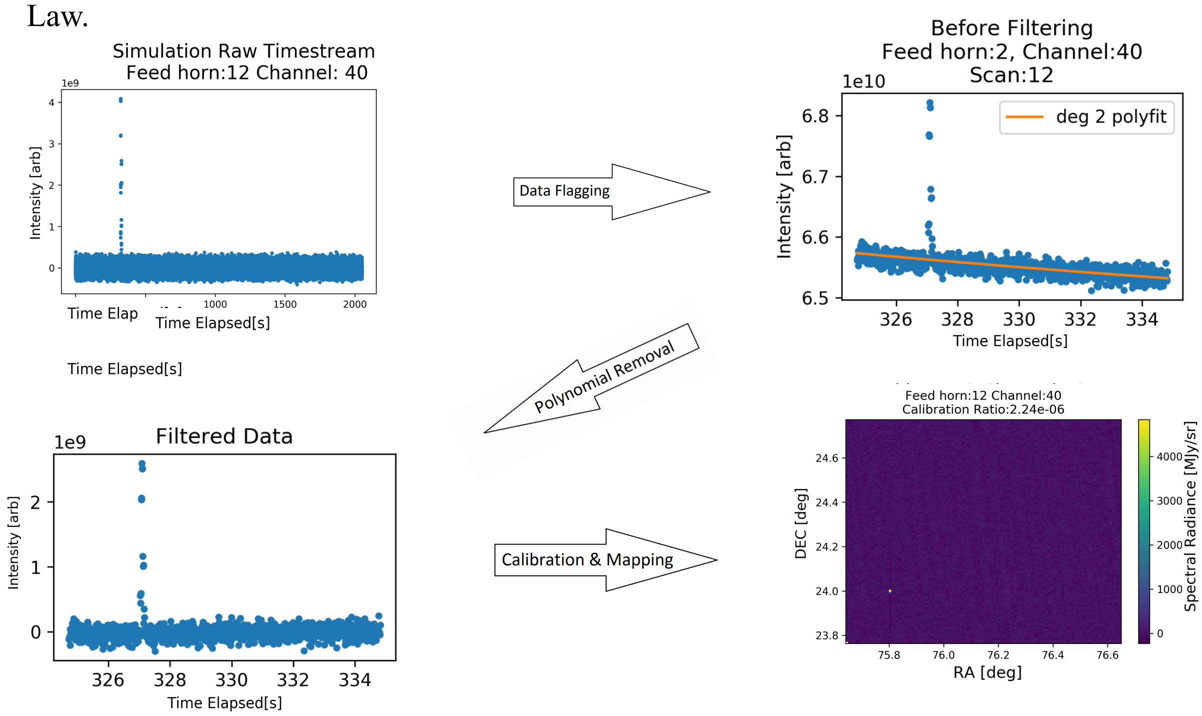

Figure 1. Steps in data analysis pipeline.

TIME's next deployment is scheduled for November 2021. With instrument updates we expect to obtain more data with improved optics, lower read-out noise and reduced noise from reflection to improve our analysis and calibration.