

Map-making with the Tianlai Cylinder Array

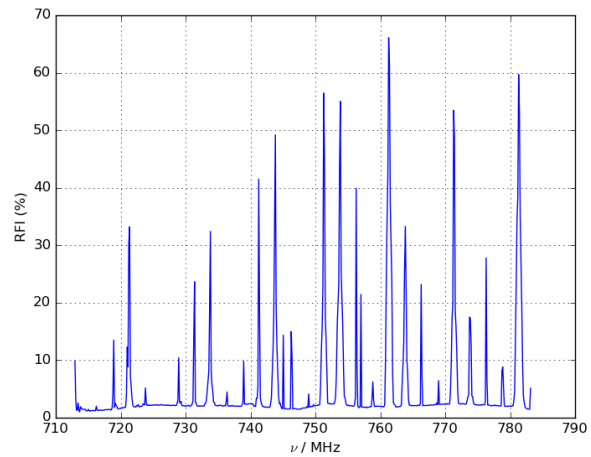
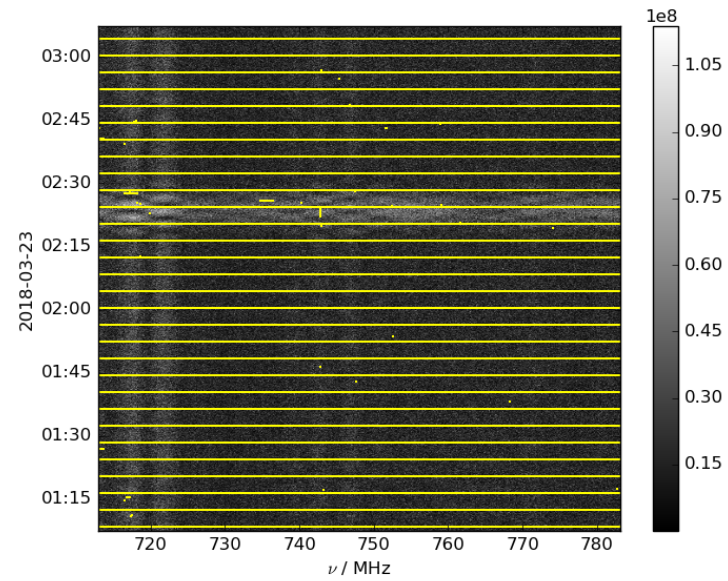
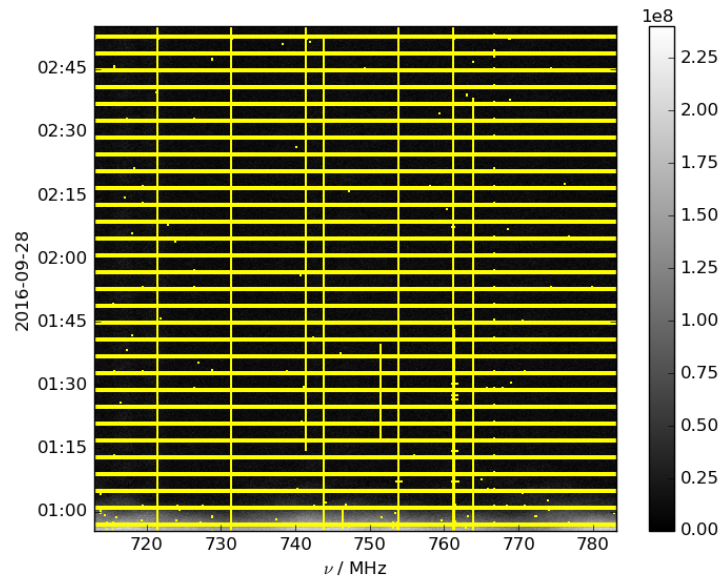
Shifan Zuo
October 27, 2021

Department of Astronomy, Tsinghua University

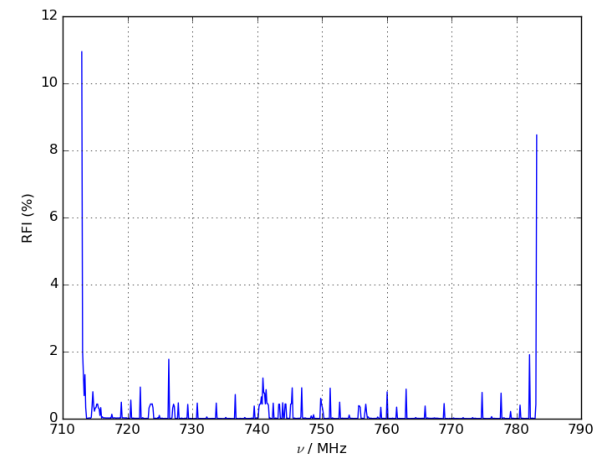
Data

- Two datasets observed by the cylinder pathfinder:
 - (1) one observed during September 27, 2016 to October 1, 2016, including 5 days data
 - (2) another observed during March 22, 2018 to March 28, including 6 days data
- Complement to each other to maximumly eliminate the effects of the Sun contamination.
- 576 available frequency points, between 710 MHz – 780 MHz.
- Use *tlpipe* (<https://github.com/TianlaiProject/tlpipe>) for data reduction.

RFI Flagging



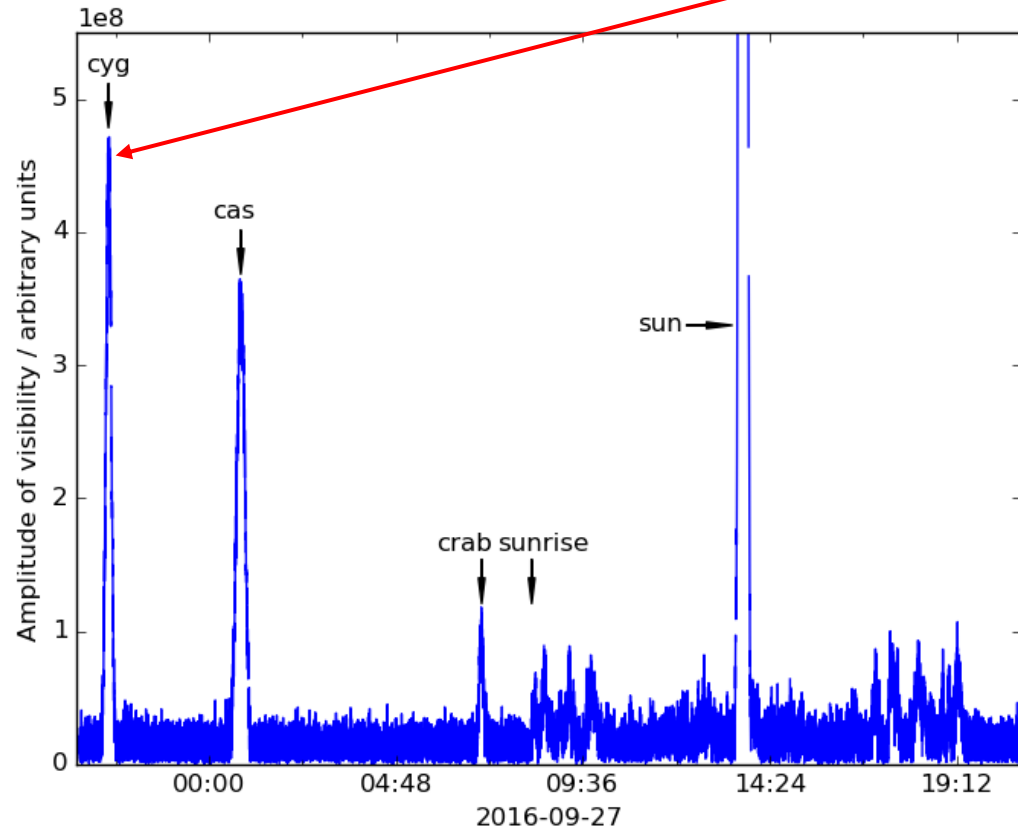
September 2016



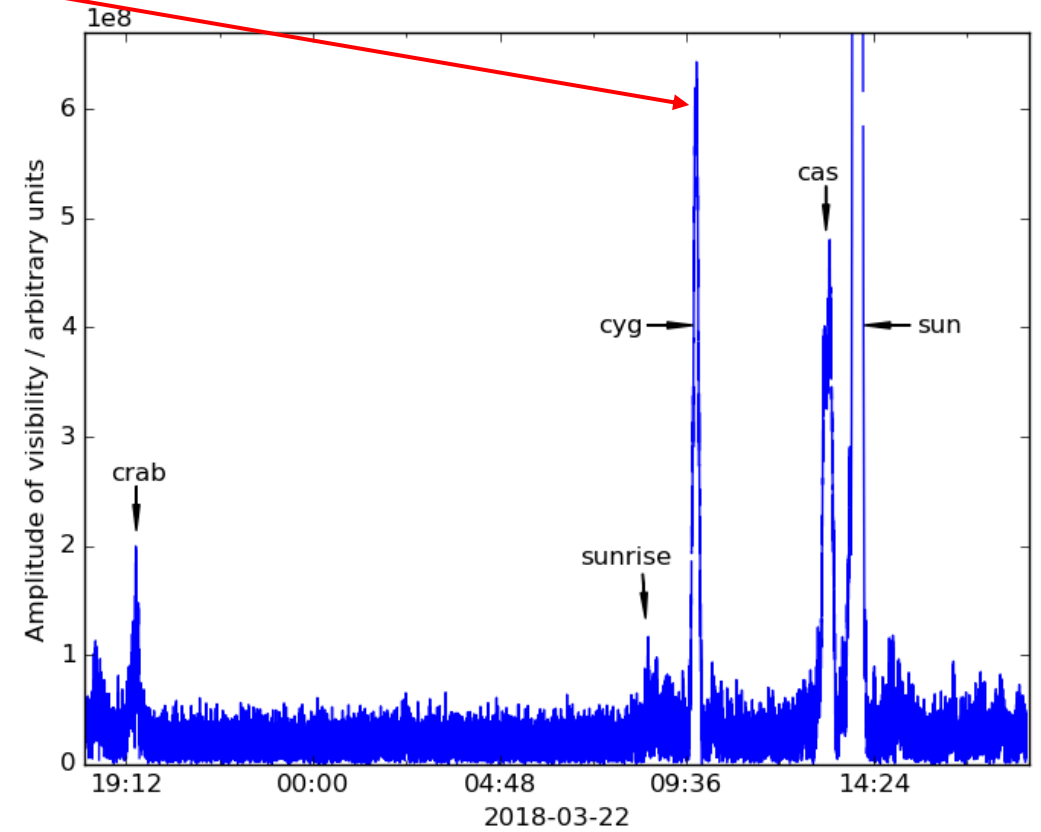
March 2018

Visibility

Use Cygnus A as calibrator.



September 2016



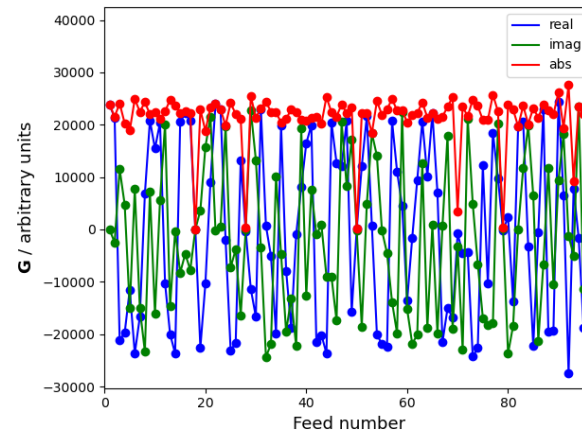
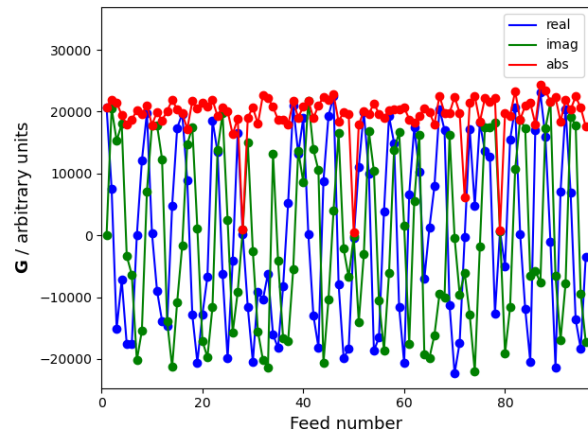
March 2018

Calibration

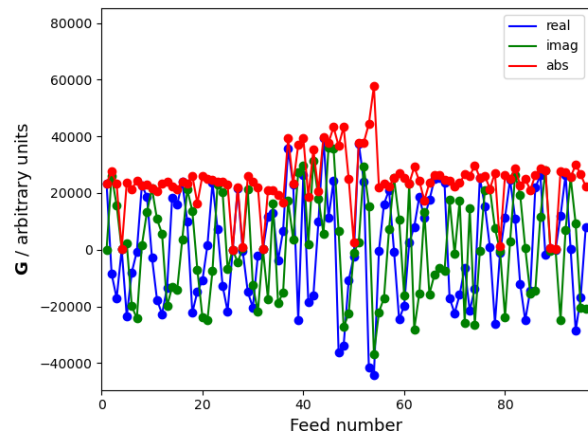
- Use the eigen-vector based calibration method

$$V_0 = S_c \mathbf{G} \mathbf{G}^\dagger, \quad \text{where} \quad G_i = g_i A_i(\hat{\mathbf{n}}_0) e^{-2\pi i \hat{\mathbf{n}}_0 \cdot \mathbf{u}_i},$$

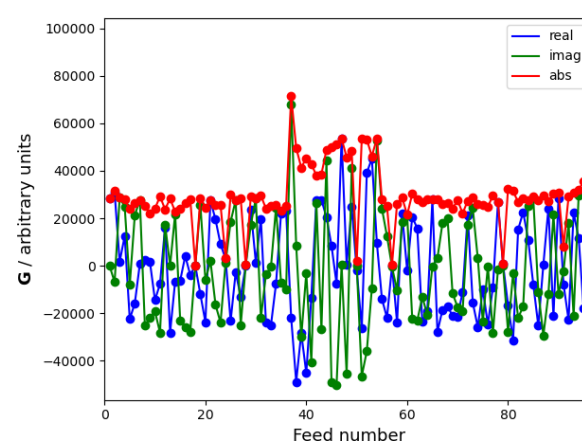
September 2016



March 2018



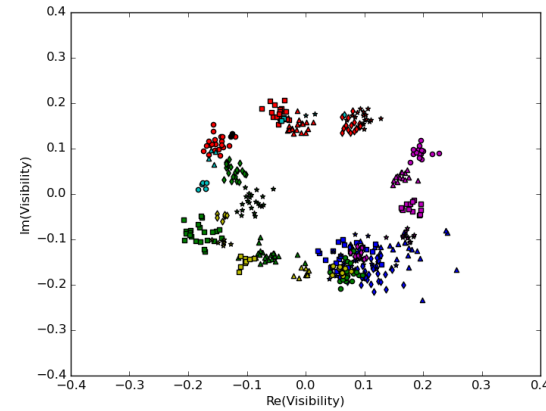
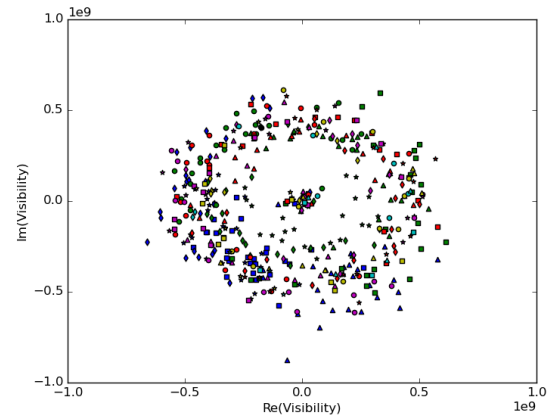
XX



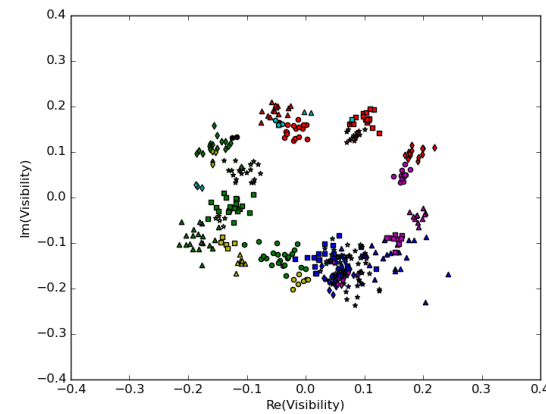
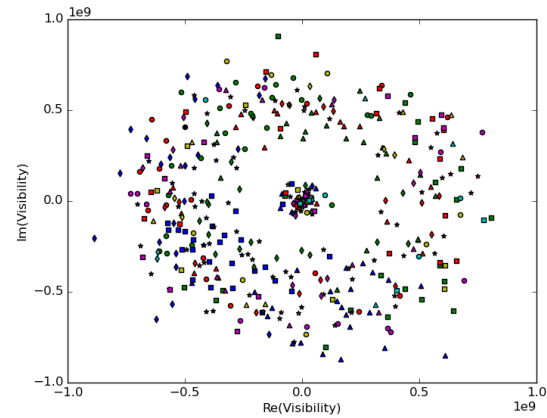
YY

Calibration Check for Redundant Baselines

September 2016



March 2018

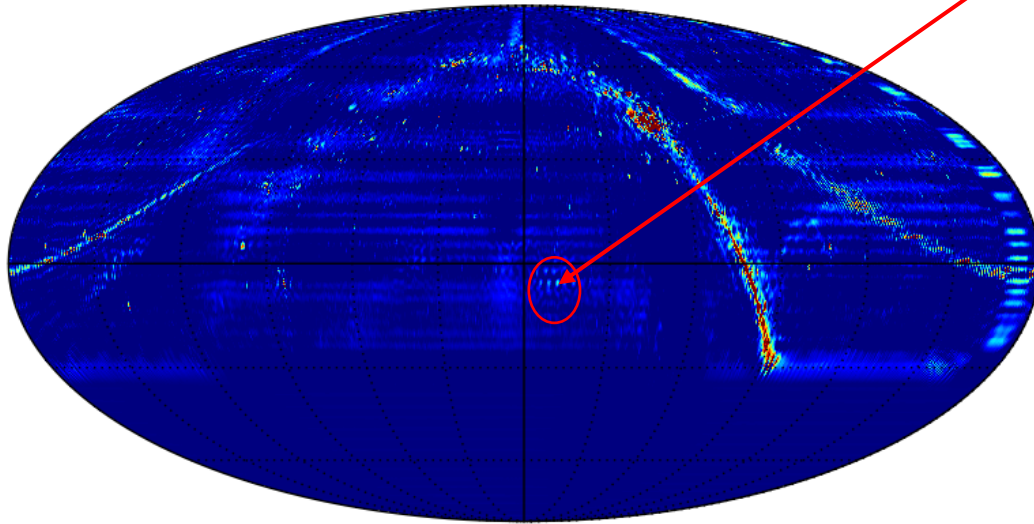


before calibration

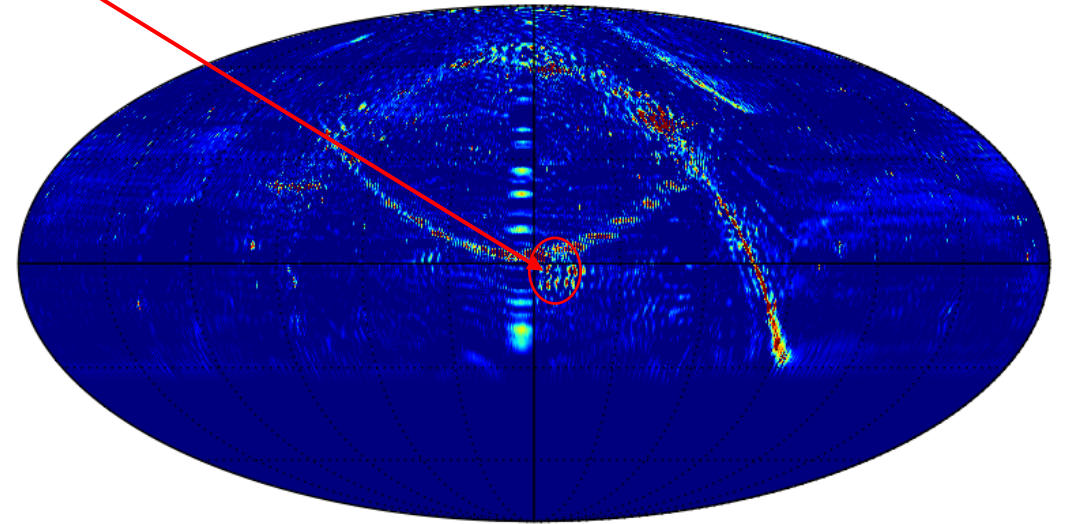
after calibration

Map-Making

Unknown interference



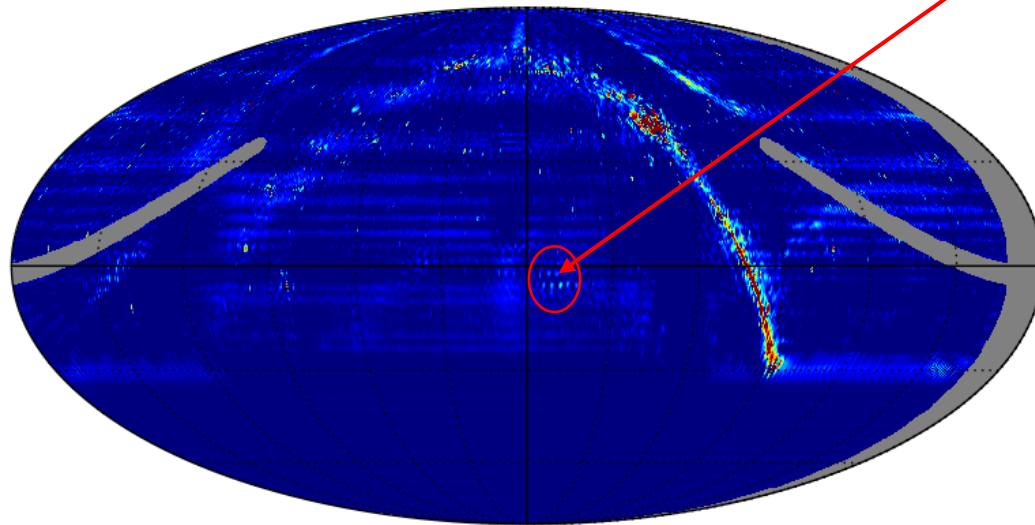
September 2016



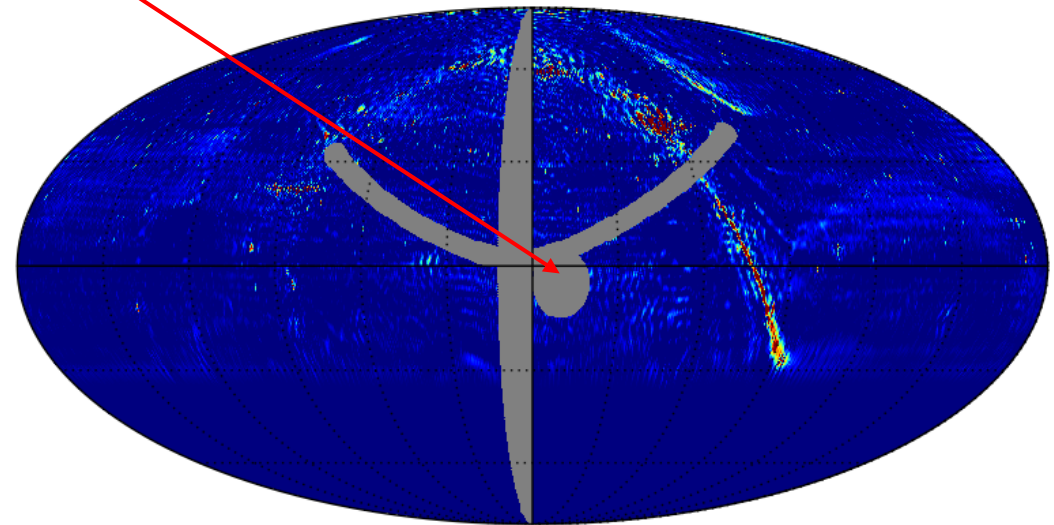
March 2018

Mask

Unknown interference

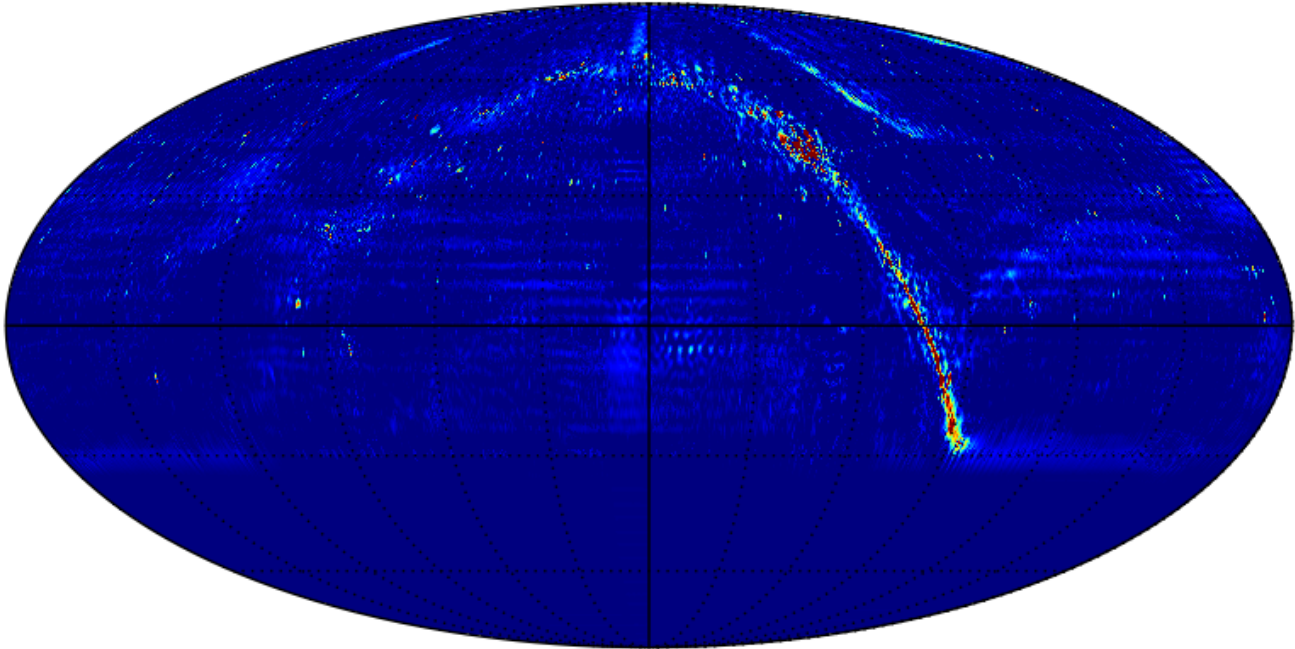


September 2016



March 2018

Synthesized Map

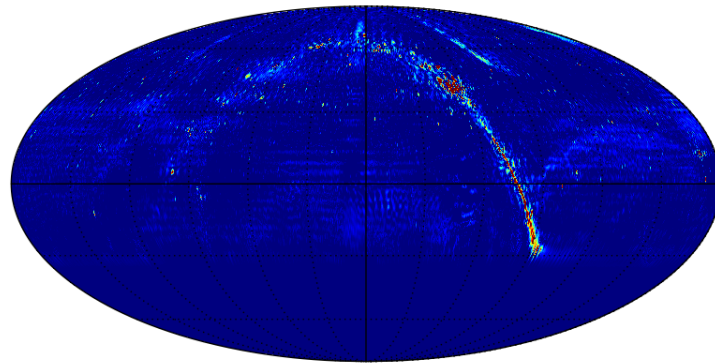


750 MHz

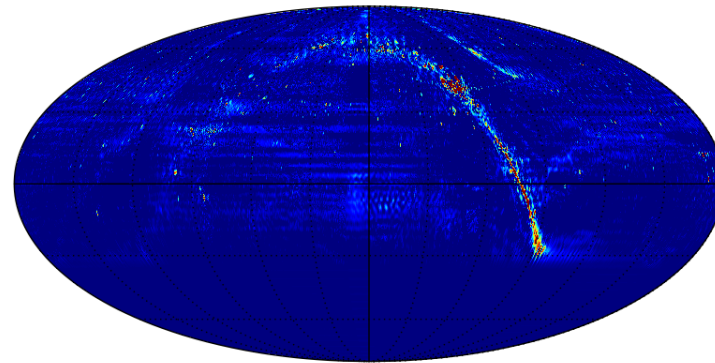
Made Maps

Map made by binning 4 adjacent frequency points.

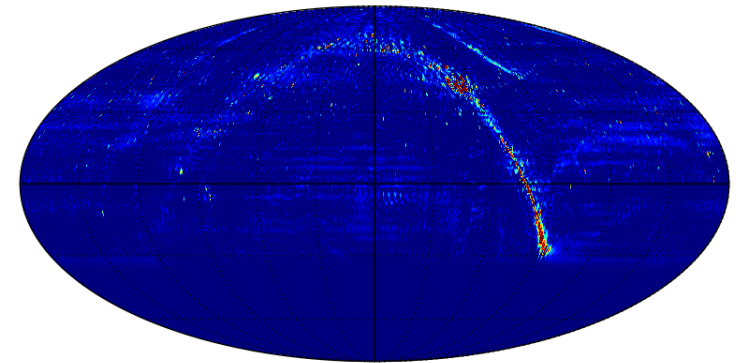
Finally got maps of 144 frequency points between 710 MHz – 780 MHz.



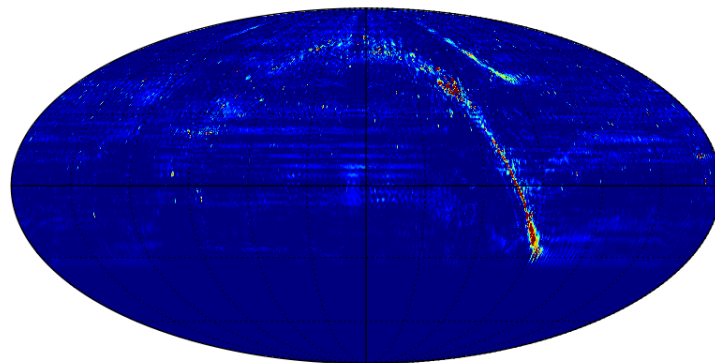
720 MHz



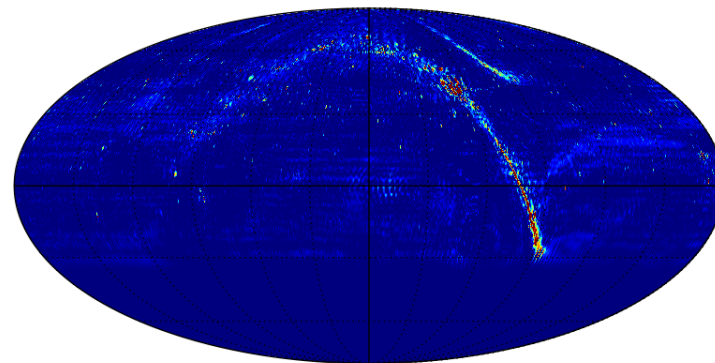
730 MHz



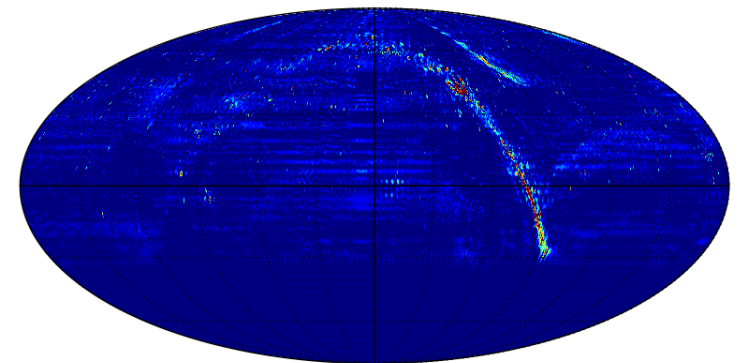
740 MHz



760 MHz

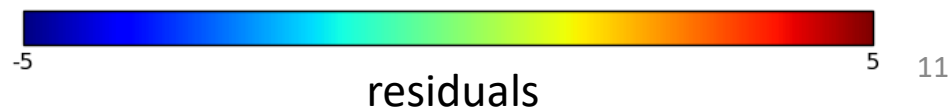
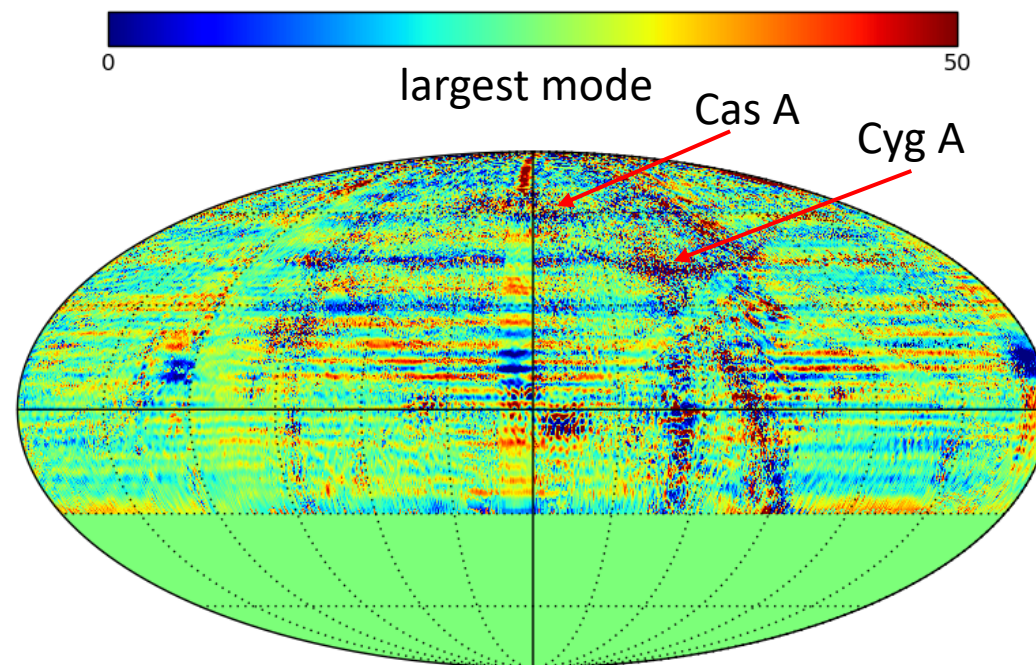
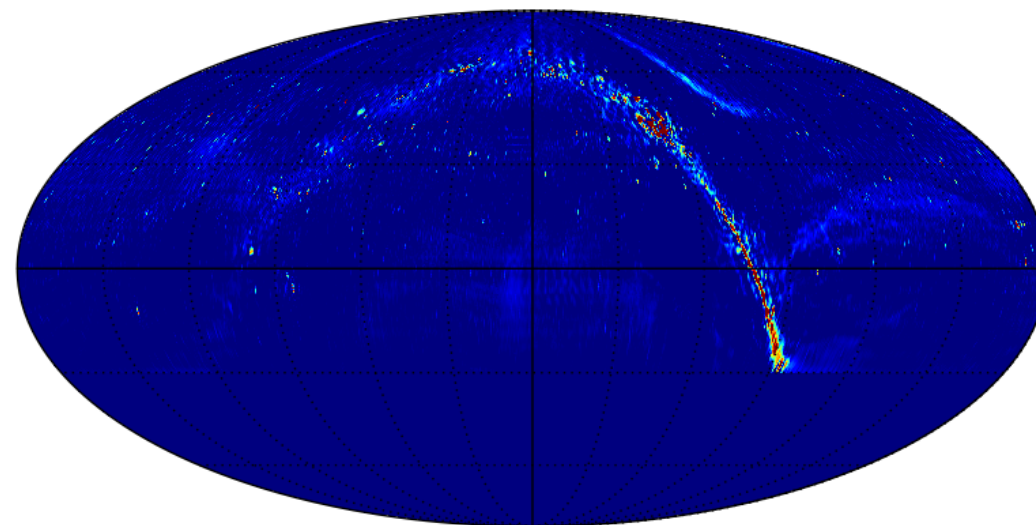
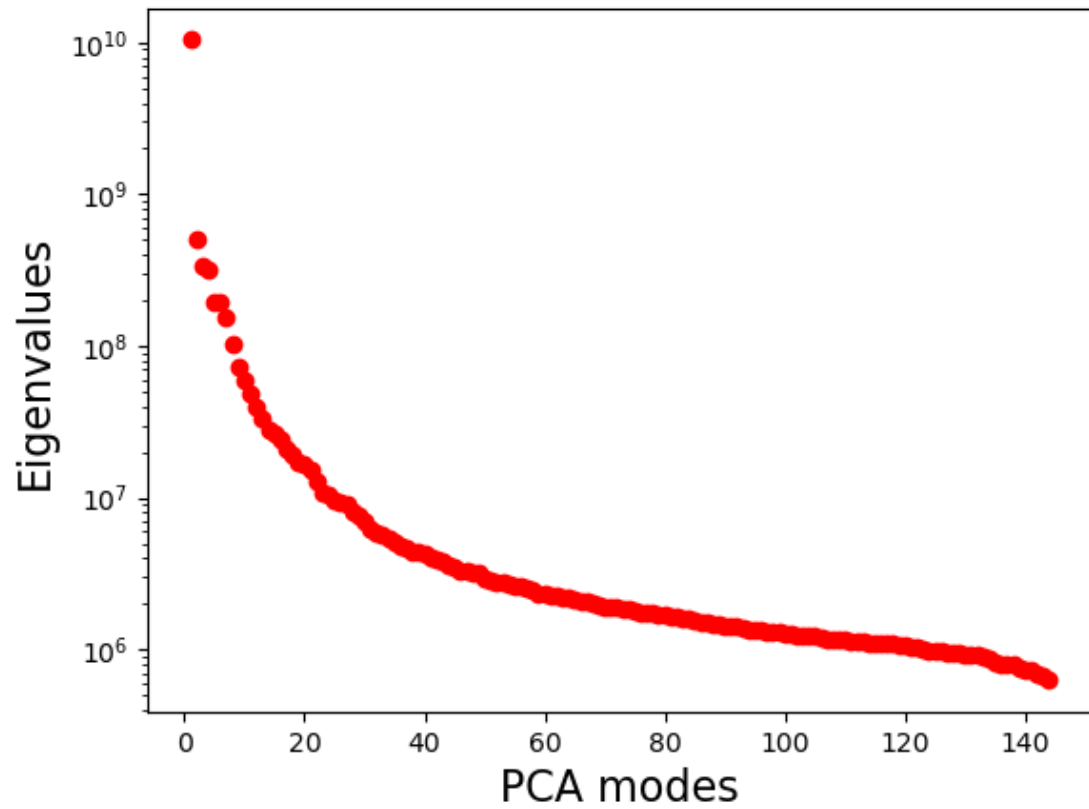


770 MHz

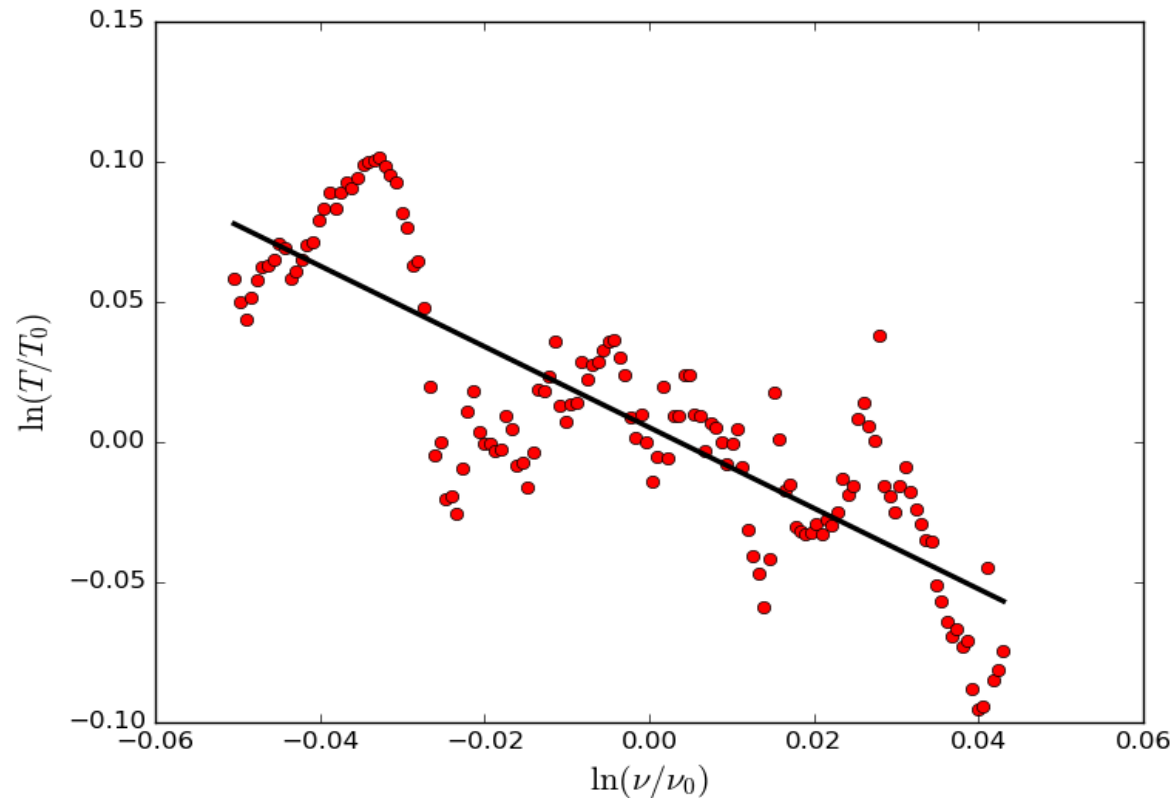


780 MHz

PCA Analysis



Frequency Spectrum of the Largest PCA Mode



$$T(\nu) = T_0 \left(\frac{\nu}{\nu_0} \right)^\beta,$$

where $\nu_0 = 750$ MHz and T_0 is the brightness temperature at ν_0 .
The slope of the fitted line give the spectral index $\beta = -1.441$.

Future works

- Better RFI flagging and calibration.
- Beam response measure and modeling.
- Build sky model for calibration.
- Reduct more data.
- Further analysis for the maps.
- ...