Exercising PS_cal

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Overview

- PS_cal is the point source calibration routine in the python analysis package
- The general algorithm has been described by Shifan Zuo
  - The visibility matrix is reduced using RPCA (Robust Principal Component Analysis)
  - The eigenvector corresponding to the largest eigenvalue is identified as the gain
  - The gain is corrected for point source flux, source phase difference, but not antenna response. (For short time intervals the antenna response is nearly constant and we normally consider a brief interval near the peak of the antenna response).
  - The gain is computed for each frequency bin, each time bin, and each polarization separately. The results for each time bin are combined to determine an average gain.

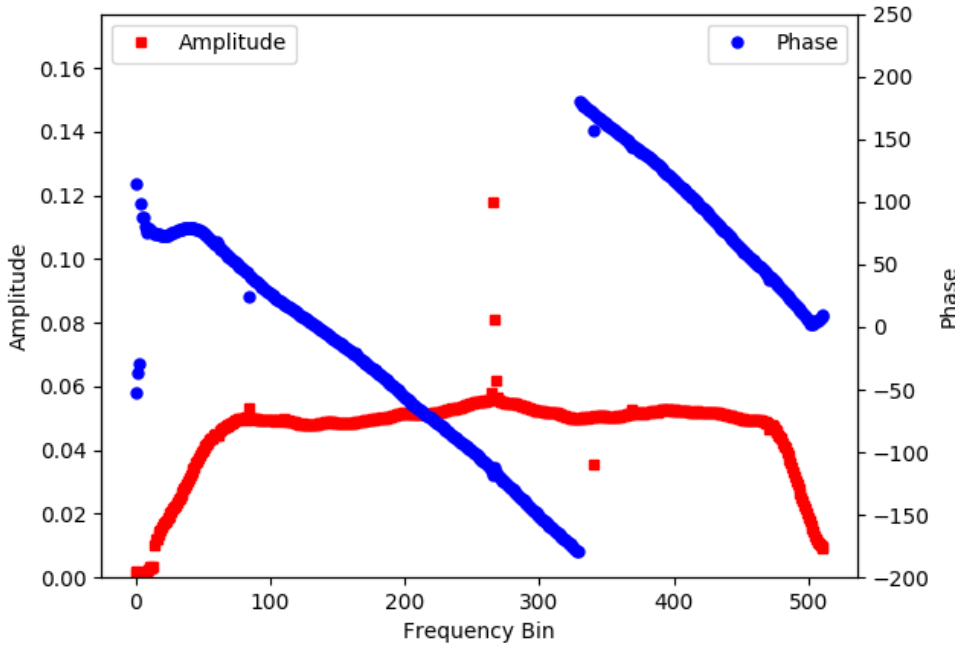
Modifications to PS_cal

- The final gain is calculated as the mean (with outlier rejection) of the gains over the time bins considered.
- Some checks on the validity of the gain solution have been eliminated in favor of a simple average with outlier rejection.
- A plot of the gain (amplitude and phase) versus time bin was created.
- A plot of gain (averaged over all time bins) versus frequency was created.

Data Examined

- 3srcNP_20180101214415_20180101224415.hdf5
- Use Cygnus A transit at sec1970=1514814992.0
- Dishes are not pointed towards the zenith (alt=56.08, az=314.03)

Plot of Gain versus Frequency for Dish 4x

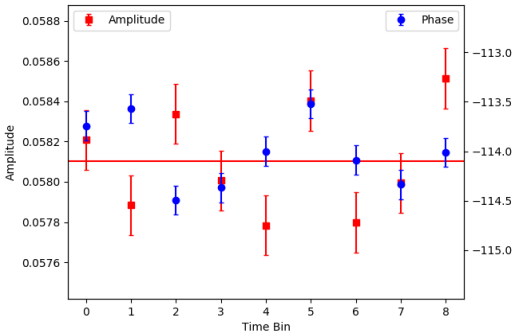


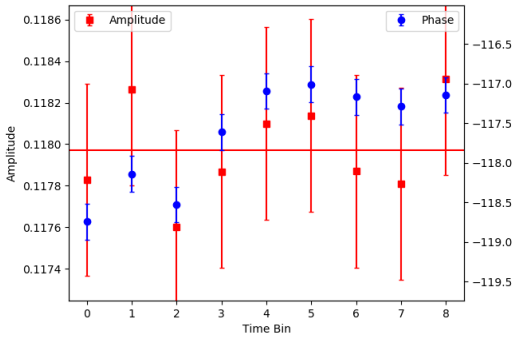
Note outliers around time bins 266 and 340

Gain verus Time Bins for Dish 4x Near Glitch at fbin=266

Solid red line indicates average

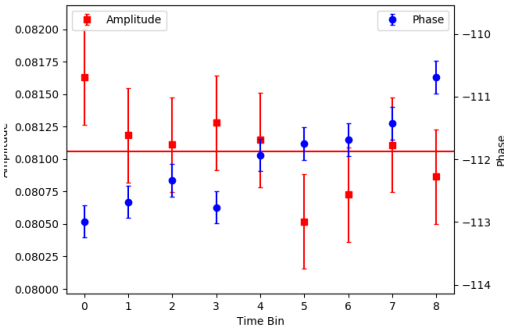
fbin=265

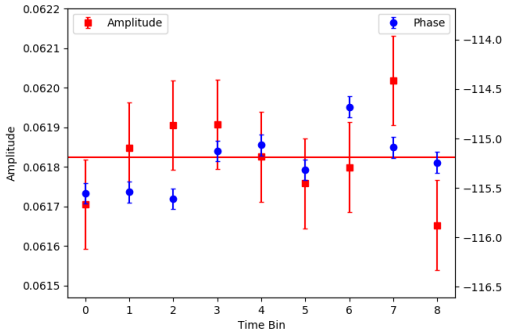




fbin=266

fbin=267



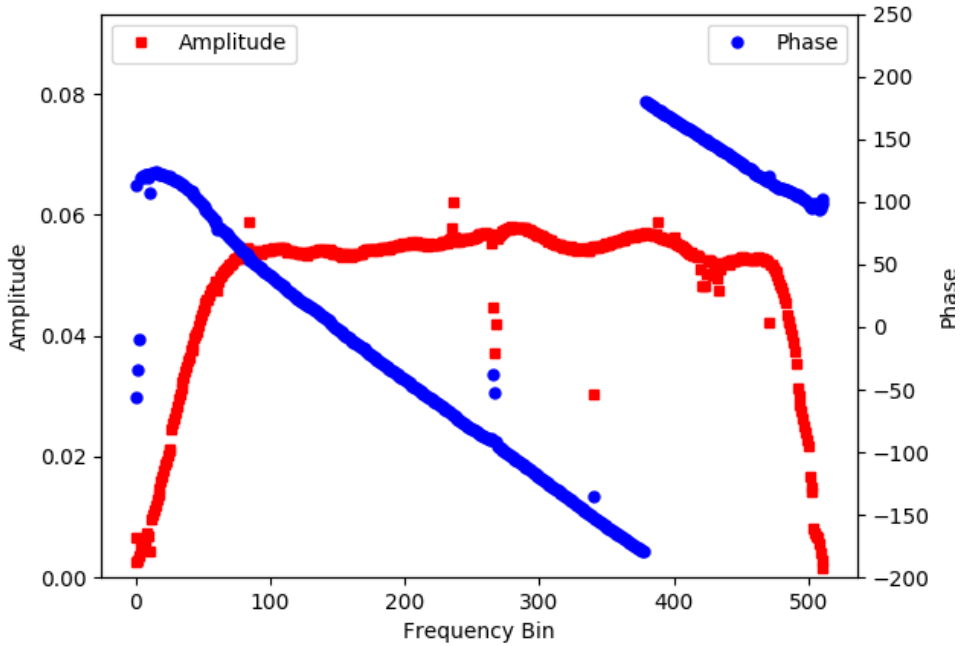


fbin=268

Conclusion

- Glitch at fbin is not a problem with outliers or averaging
- All time bins have frequency bin=266 significantly higher (0.1160) than a normal bin (0.0581) like frequency bin=265
- The above analysis is for the x polarization feeds. The y polarization feeds are processed independently. Do they show the same effect?

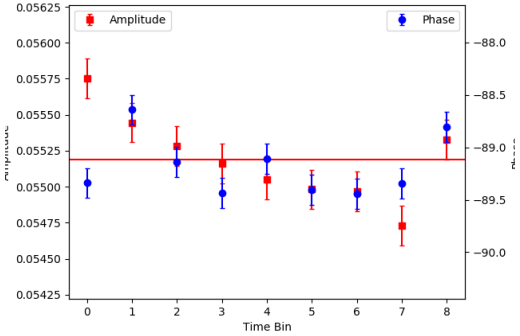
Plot of Gain versus Frequency for Dish 4y

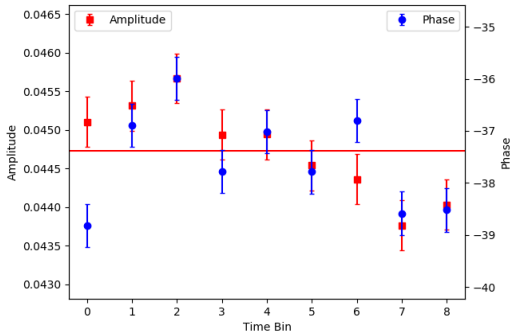


Gain verus Time Bins for Dish 4y Near Glitch at fbin=266

Solid red line indicates average

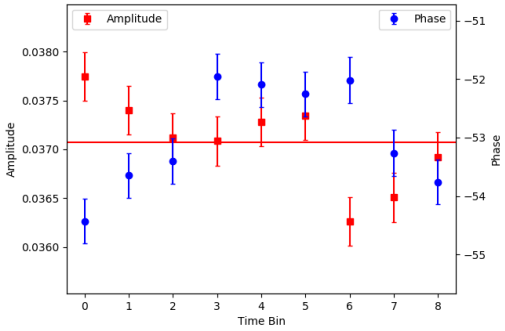
fbin=255

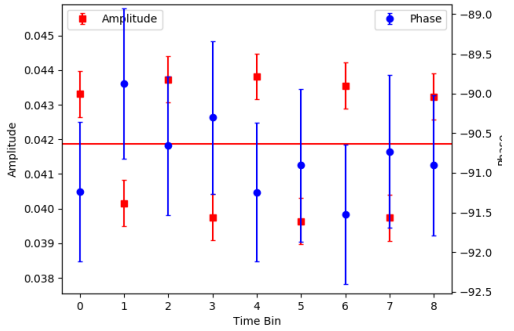




fbin=256

fbin=257



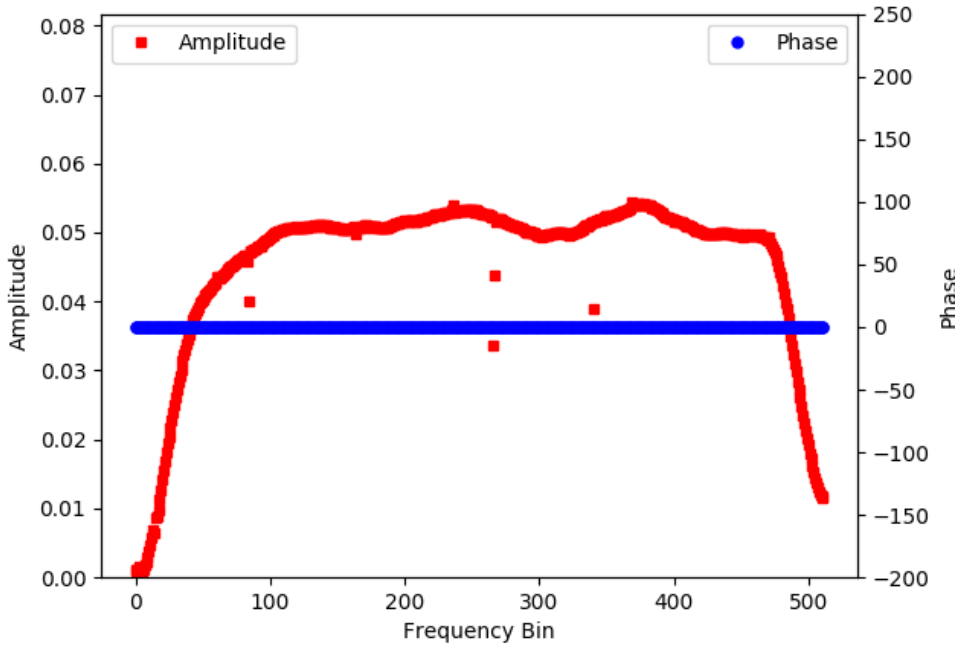


fbin=258

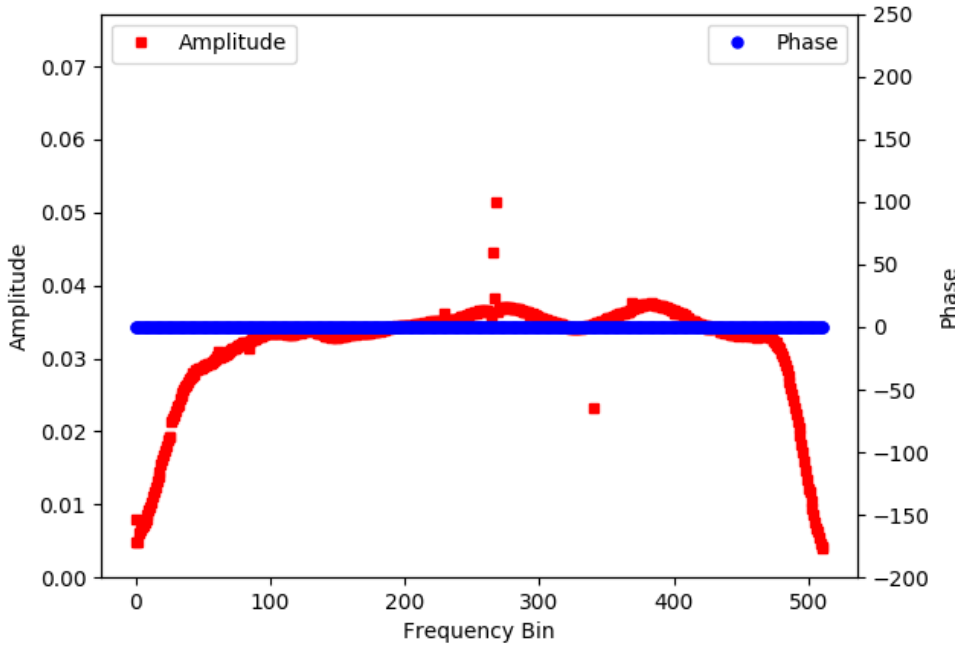
Conclusion

- Dish 4y also has a glitch around frequency bins 266 and 340.
- Other glitches are also apparent.
- It seems likely that there is a common mechanism making the frequency glitches in both x and y polarizations.
- Finally, look at some other dishes, but keep in mind that all the x gains are fit together and all the y gains are fit together. So if one frequency bin shows some anomalous behavior, it is not surprising to see all the other gains with the same polarization to also show glitches.

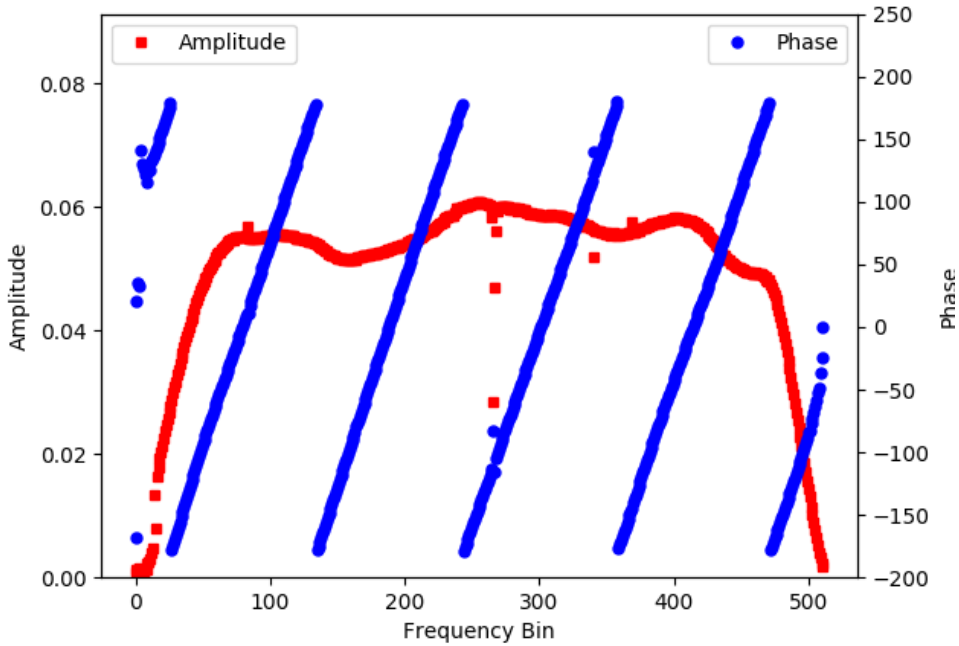
Dish 1x


Amplitude
Phase
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
250
200
150
100
50
0
−50
−100
−150
−200
0
100
200
300
400
500
Frequency Bin
Amplitude
Phase

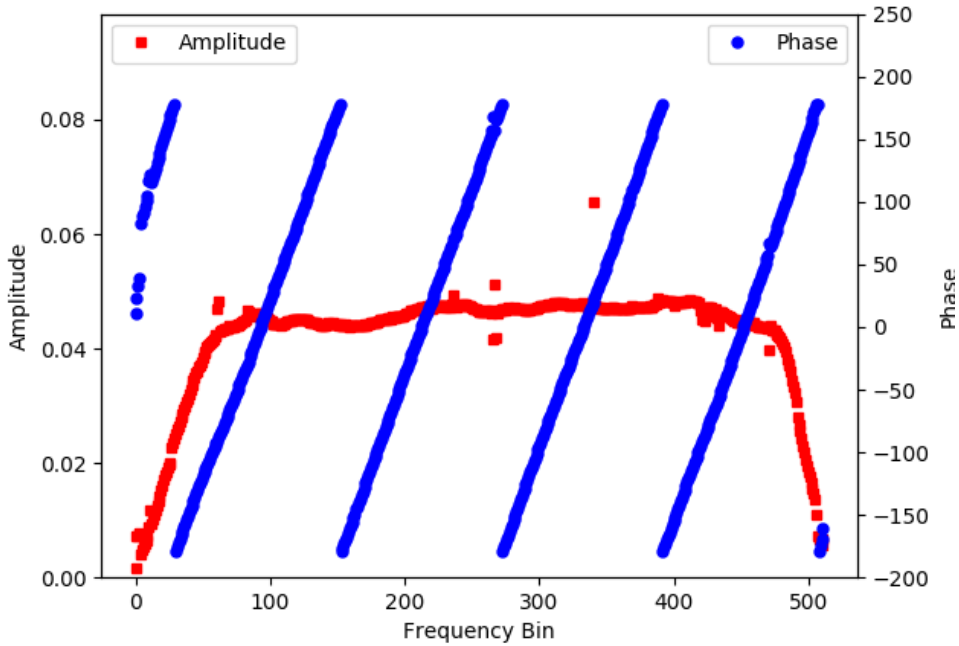
Dish 1y


Amplitude
Phase
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Amplitude
250
200
150
100
50
0
−50
−100
−150
−200
Phase
0
100
200
300
400
500
Frequency Bin

Dish 7x


Amplitude
Phase
0.08
0.06
0.04
0.02
0.00
Amplitude
250
200
150
100
50
0
−50
−100
−150
−200
Phase
0
100
200
300
400
500
Frequency Bin

Dish 7y


Amplitude
Phase
0.08
0.06
0.04
0.02
0.00
Amplitude
250
200
150
100
50
0
−50
−100
−150
−200
Phase
0
100
200
300
400
500
Frequency Bin

Conclusion

- Point source calibration using Cygnus A seems to generally yield consistent and (apparently) accurate results (<1%)
- Glitches appear to be real, but the code is not sufficiently well checked to rule out programing errors
- Behavior across time bins seems consistent.
- X and y polarizations show similar behavior. Why?