LST binned Low-band data analysis

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The preliminary results from the dual band analysis promoted us to examine the data binned over LST/GHA. The dual band analysis was done so far with data averaged over all LSTs.

Using the EDGES-estimate code, I tried to estimate the parameters of the absorption feature and the foreground only for the Low band LST binned data.

1.) Paper data:

We use the public release of the data from the loco page and fit for 4 absorption parameters and 5 linlog foreground parameters. The estimation was done using polychord using nlive = 1024. The values of the parameters obtained are shown in the plot below

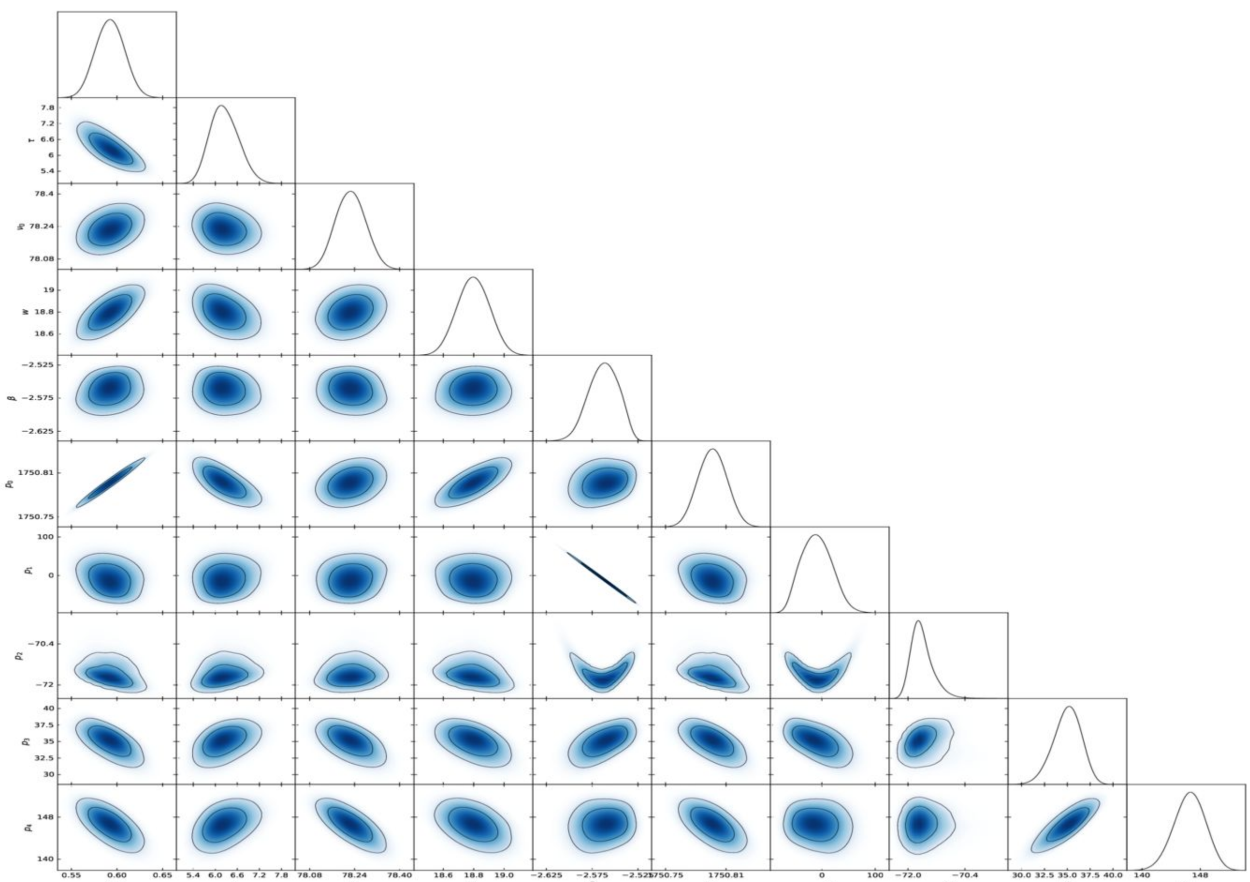

Fig1: Likelihood distributions for the foreground and 21cm model parameters. Beta and p1 are highly correlated with each other. And in the absorption parameters, the amplitude is seen to be correlated with the temperature at 75MHz.

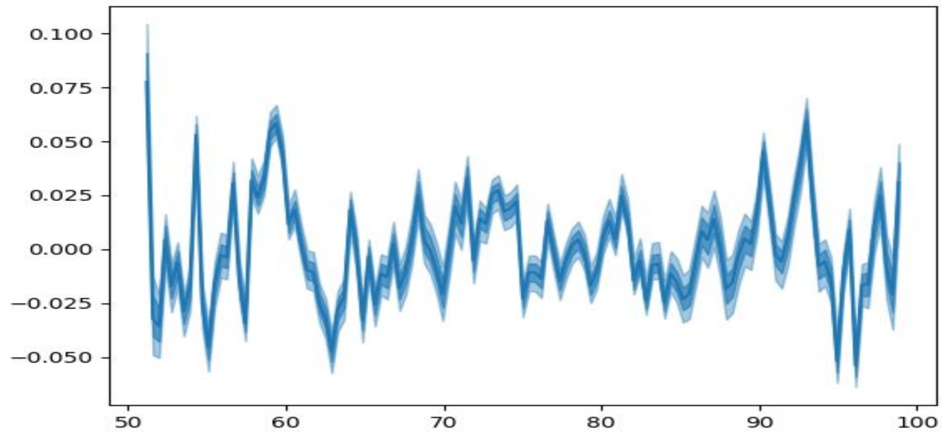

Fig2: Residues Vs Frequency obtained after fitting the data to the best fit foreground + absorption model.

<u>Notes</u>

-- We are able to reproduce the parameters reported in the Bowman 2018 paper with the edges estimate code

-- This provides a first step cross check

-- ***An important lesson learnt: The beta value had to be tightly constrained between -2.53 and -2.57.***

-- I don't see the high correlation between the foreground parameters as noted in the paper. Likely because I am using a different foreground model compared to the nature paper.

2.) Use the data I have - GHA binning & day averaging - My pipeline:

We reproduce the same results as in section 1 but now by binning and averaging the data using my pipeline. Days Used: 2016_258 to 2017_095. The plot below compares the data processed here with the online release data. The data from my pipeline is kept in the raw frequency resolution.

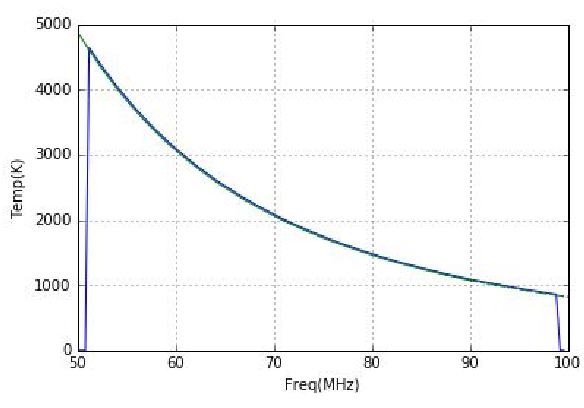

Fig3: Averaged spectra between GHA 6 to 18hr for all the days Vs Frequency. The two curves compare the data sets - a.) online release, b.) data averaged with my pipeline.

The data was fit in its raw frequency resolutions (with 8193 points) for the 5 linlog foreground parameters and 4 absorption parameters. The estimation was done with polychord using 1024 nlive similar to the previous section. In the first run, Beta was constrained with a prior being a normal distribution with the center at -2.5 and scale 0.1. The results of this run is shown below:

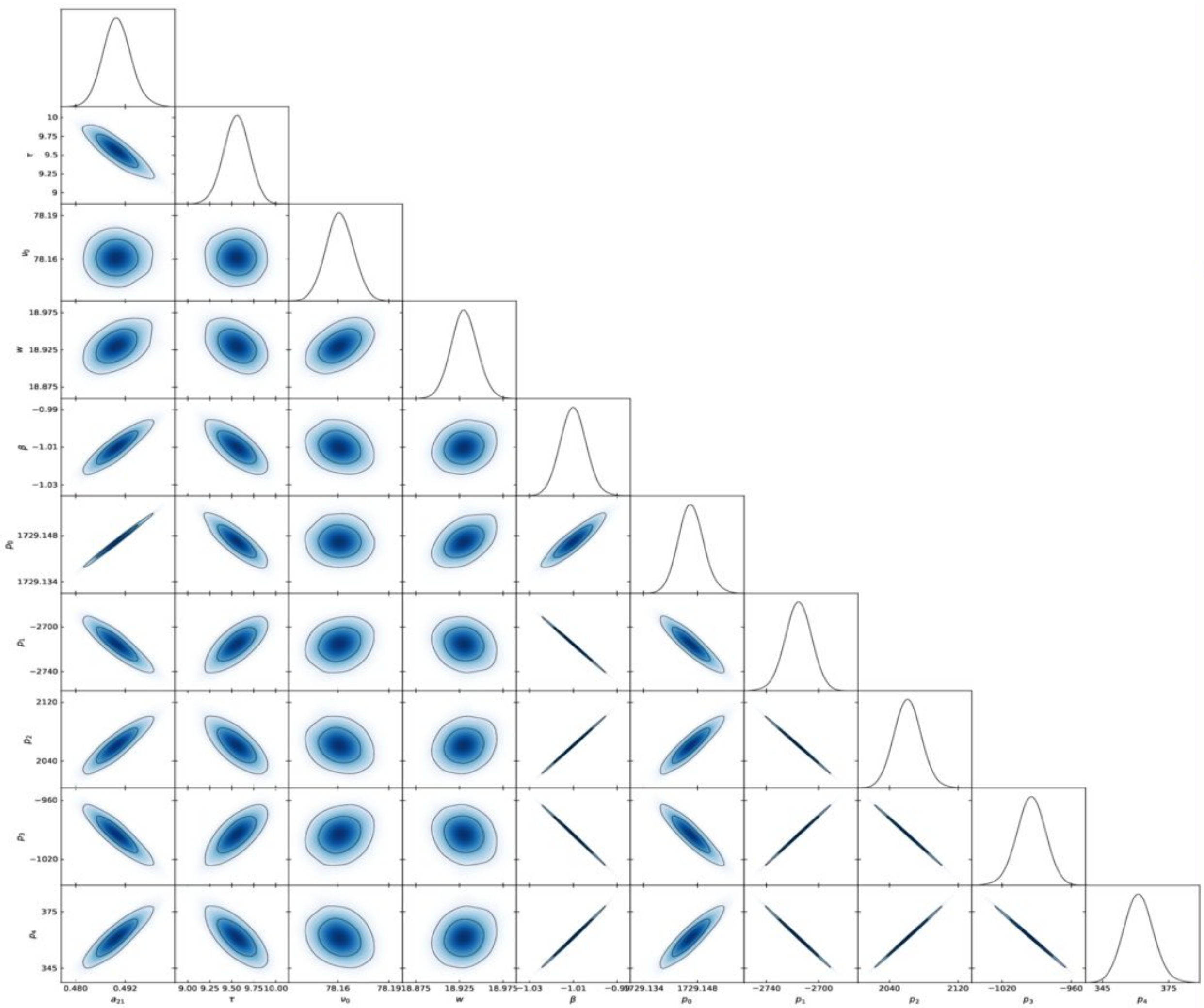

Fig4: Likelihood distributions for the foreground and 21cm model parameters. In addition to the absorption amplitude being correlated with the temperature at 75MHz, all the foreground parameters are seen to be highly correlated. ***The Beta value is too high.***

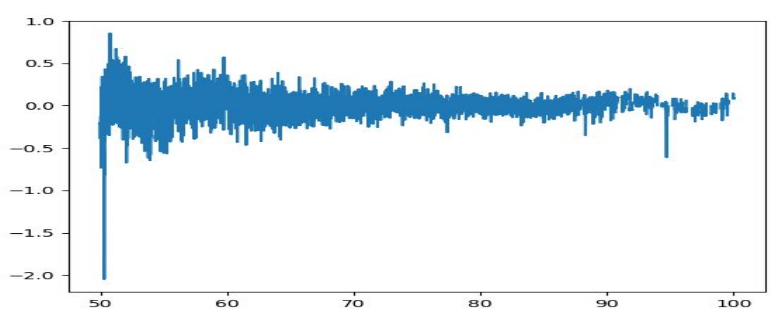

Fig5: Residues Vs Frequency obtained after fitting the data to the best fit foreground + absorption model.

In the second run, ***tighter constraints*** are placed on Beta with the prior being a normal distribution with the center at -2.5 and ***scale 0.02***. The results of this run is shown below:

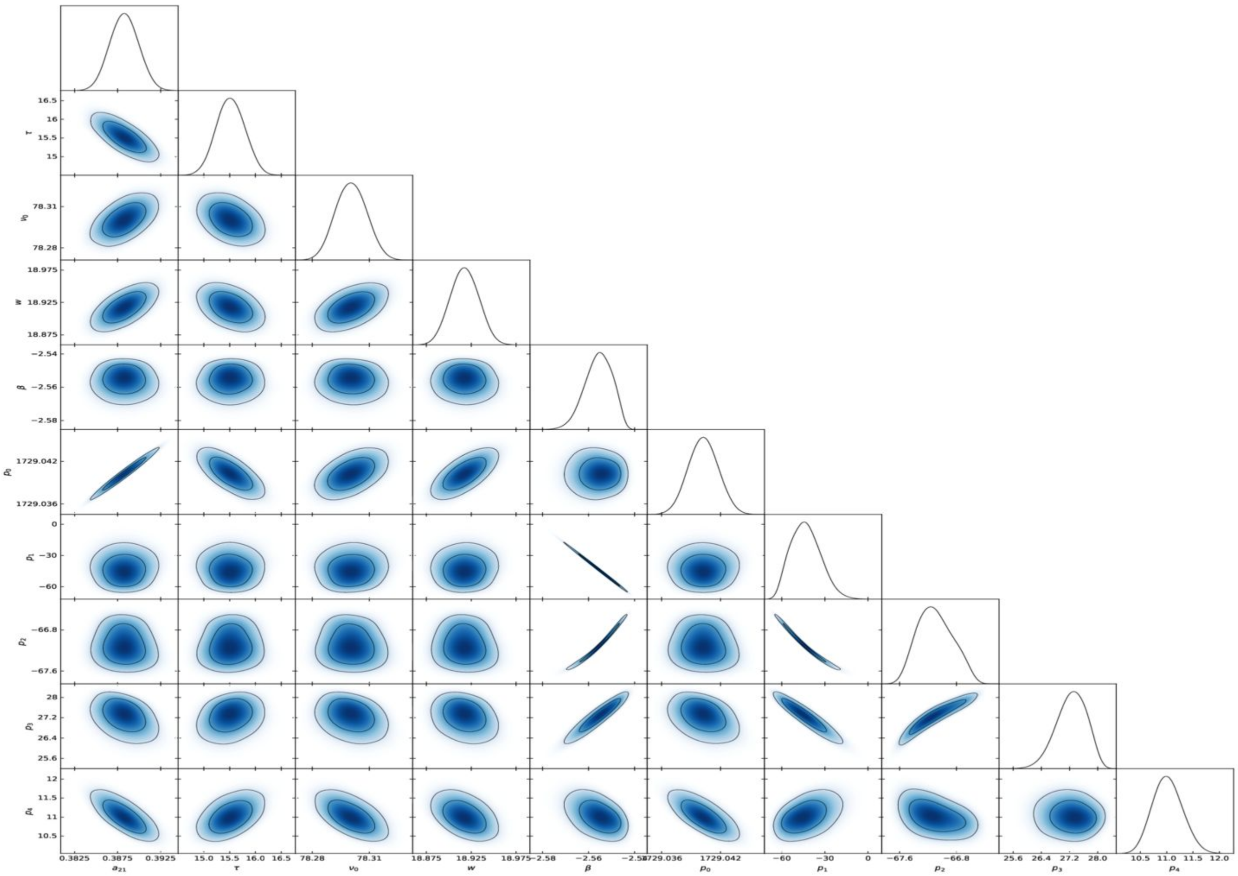

Fig6: Likelihood distributions for the foreground and 21cm model parameters. In comparison with fig1, more correlation is seen between the foreground parameters . And in the absorption parameters, the amplitude is seen to be correlated with the temperature at 75MHz.(as before). ***Tau is High!***

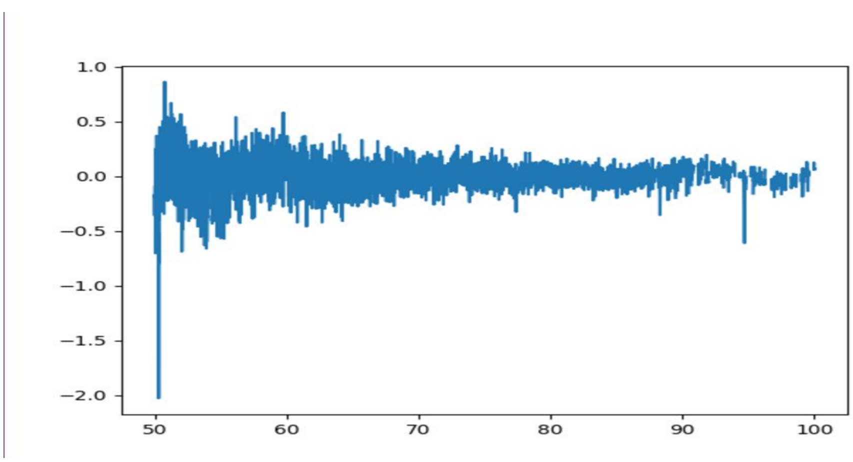

Fig7: Residues Vs Frequency obtained after fitting the data to the best fit foreground + absorption model.

<u>Notes:</u>

Optimal parameter values for paper data Vs My data:

Parameter	Paper data	Raw resolution (new averaging)
A21	592 mK +/- 244 uK	388mK +/-2.715 uK
tau	6.25 +/- 0.15	15.5 +/- 0.075
Width	18.8 MHz +/- 11.3KHz	18.9 MHz +/- 0.24 KHz
nu0	78.23 MHz +/- 2.8KHz	78.3 MHz +/- 0.065 KHz
Beta	-2.56 +/- 2.54e-4	-2.55 +/- 3.58e-5
T75/p0	1751 K +/- 200 uK	1729 K +/- 2.3uK
gamma/p1	-8.4 +/- 780	-43.3 +/- 107

3.) **Paper data - different prior beta:**

We use the public release of the data and fit for 4 absorption parameters and 5 linlog foreground parameters. The estimation was done using polychord using nlive = 1024. This analysis differs from the part one in the way that beta prior was changed from a normal distribution to a min = -2.7 and max = -2.4

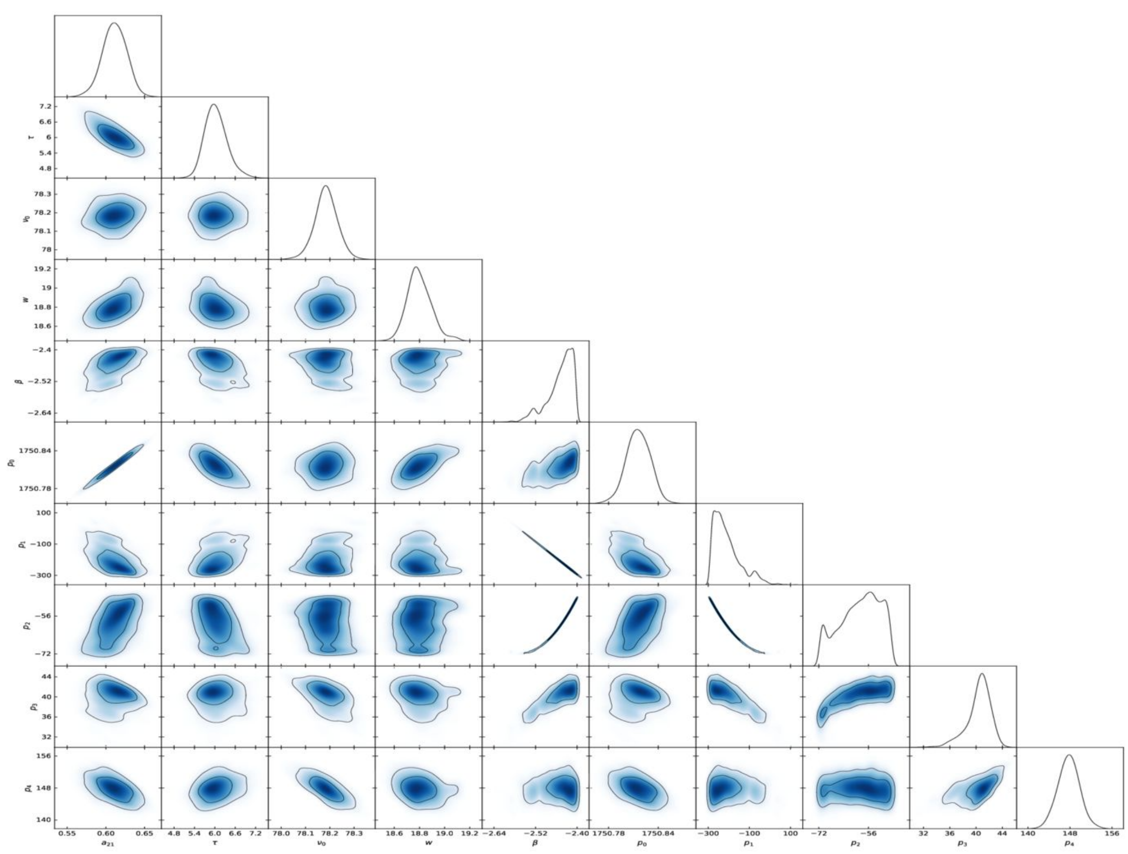

Fig8: Likelihood distributions for the foreground and 21cm model parameters.

The estimated beta values are seen to be reasonable. This prior limits resulted in reasonable estimates.

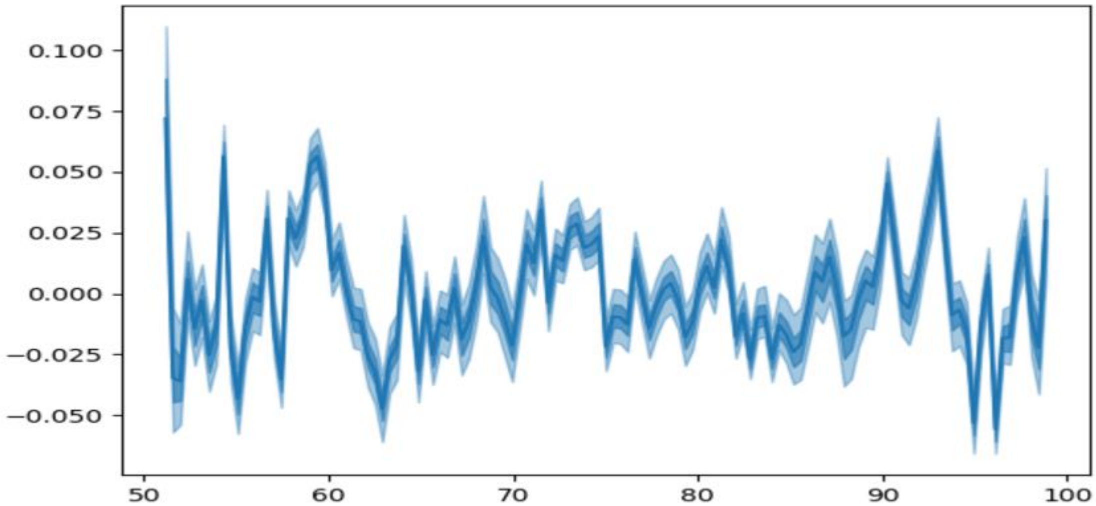

Fig9: Residues Vs Frequency obtained after fitting the data to the best fit foreground + absorption model.

4.) **Data binned into 4 GHA bins of 5 hour each**

Gaining confidence in my pipeline after I reproduced the Nature paper results, I proceed to analyse the time binned data. I divide the sky into four regions based on the half power beam width of the EDGES beam. The data are binned into 4 hour GHAs with the following centers: 2.5 hr, 8.5 hr, 14.5hr and 20.5 hr each separated by an hour. The data was left in the raw frequency resolution. For each data set I fit for different foreground parameters but the same absorption parameters. The polychord was run with n = 1024. The priors on beta was given to be -2.4 to -2.7 for all the four sets.

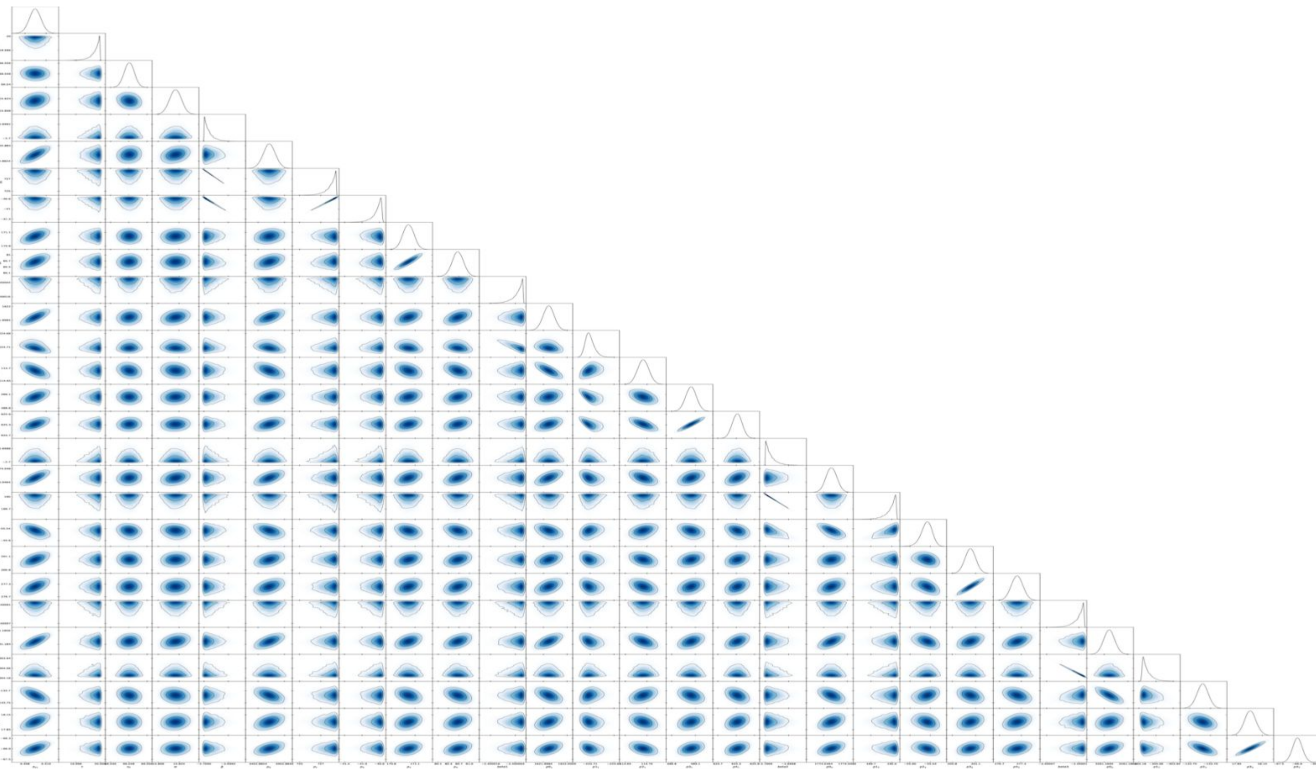

Fig10: Likelihood distributions for the four sets of foreground and 21cm model parameters.

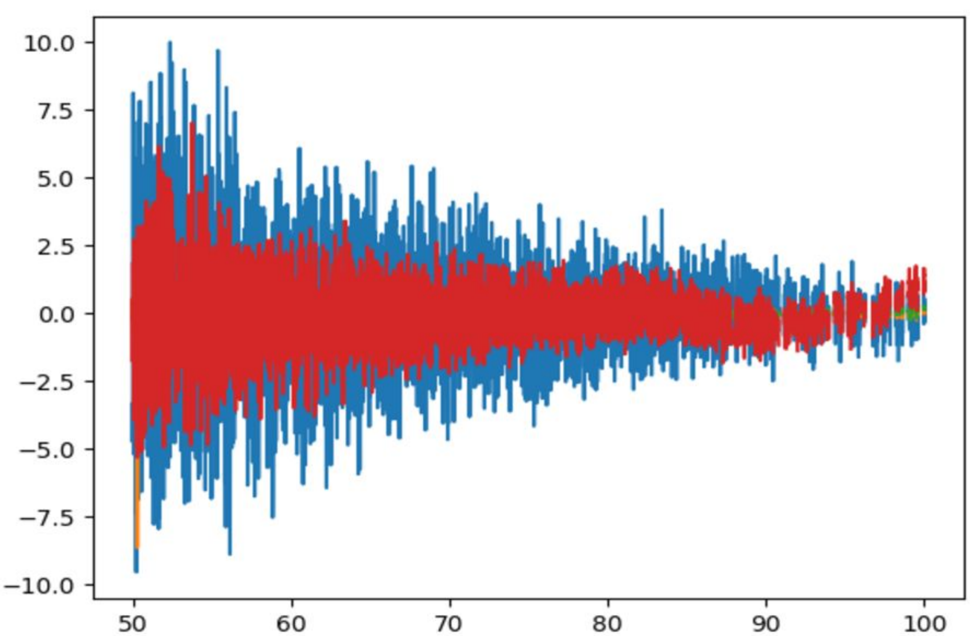

Fig11: Residues Vs Frequency obtained after fitting the data to the best fit foreground + absorption model.

5.) **<u>Data “beam-corrected” and binned into 4 GHA bins of 5 hour each</u>**
The data in the previous sections was not beam corrected. Here I correct the data for the lowband extended GP antenna beam and repeat the steps in 4.).

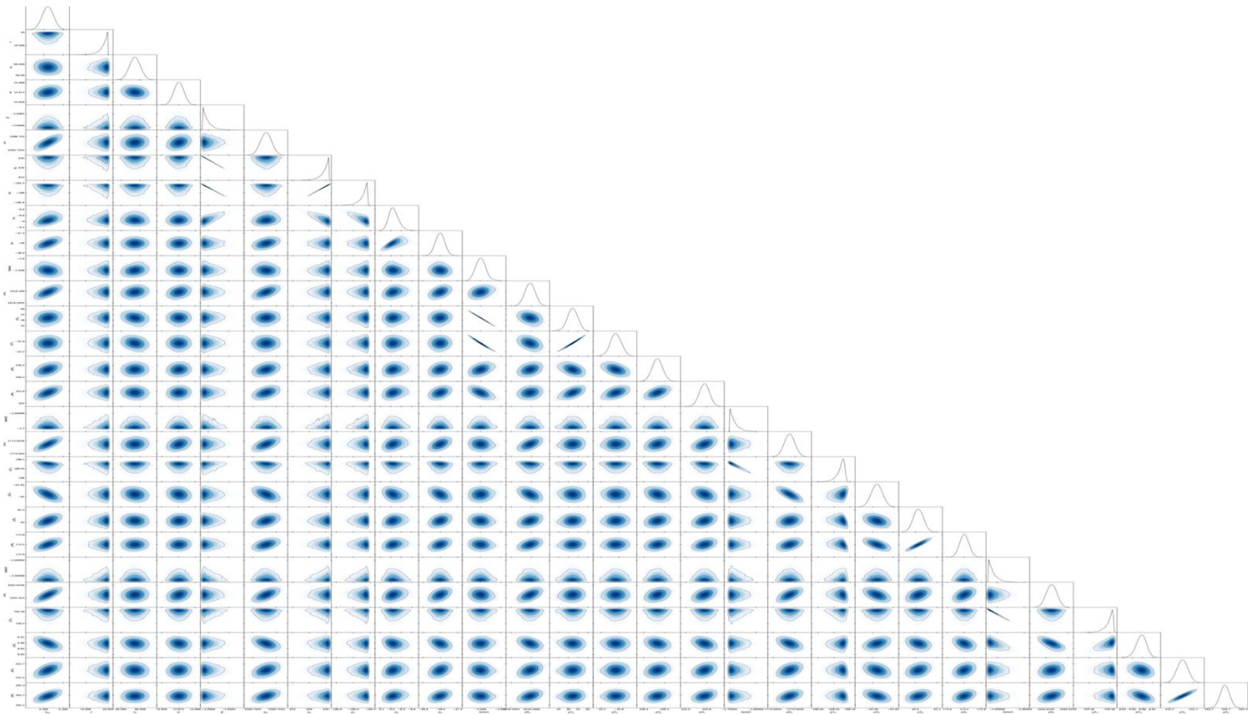

Fig12: Likelihood distributions for the foreground and 21cm model parameters.

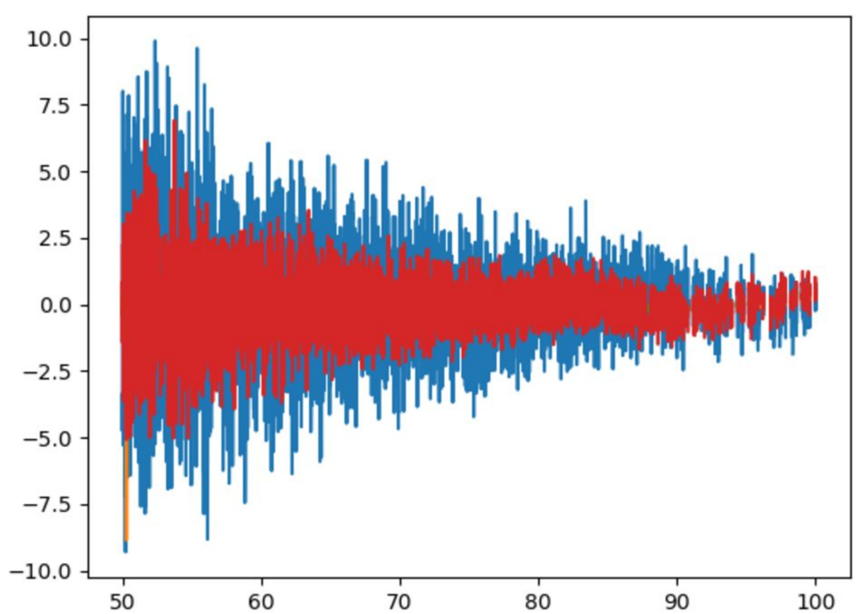

Fig13: Residues Vs Frequency obtained after fitting the data to the best fit foreground + absorption model.

The results are tabulated below:

Parameter	**Results**	**Beam corrected Results**	**Inference from the Lowband paper**
T75 (2.5 hr)	3402.8 K	3396 K	4500
Beta (2.5hr)	<-2.7	<-2.69	-2.46
Gamma (2.5 hr)	>729	>630	
T75 (8.5 hr)	1629 K	1618.2 K	2000
Beta (8.5hr)	>-2.4	-2.608	-2.56
Gamma (8.5 hr)	-224.71	51	
T75 (14.5 hr)	1774 K	1774 K	1700
Beta (14.5hr)	<-2.7	<-2.7	-2.57
Gamma (14.5 hr)	>190	188	
T75 (20.5 hr)	3261	3262	2200
Beta (20.5hr)	>-2.4	<-2.7	-2.5
Gamma (20.5 hr)	<-304	>700.5	
A21	409 mK	397 mK	
tau	>20.06	>20	
width	15.8 MHz	15.87 MHz	
nu0	66.048 MHz	66.068 MHz	