Summary of Data Analysis

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I ran all the experiments mentioned in the list provided. This is a summary of the data obtained for the Signal to Noise ratio and tempo2 residuals. The experiments were performed on data with integrations of 1, 4, 16, 64 and 256 subints (total subints were 804, which essentially made 1024 a template).

Signal to Noise:

Here are the signal to noise ratios obtained for the different subintegrations (calculated using *psrstat*) after collapsing all frequencies.

No of Subintegrations	SNR
1	54.27
4	87.84
16	135.00
64	214.52
256	432.25
804	812.73

Clearly, the Signal to Noise ratio is increasing as we integrate more subintegrations. This is expected behaviour since the signal keeps adding up and the noise keeps averaging out.

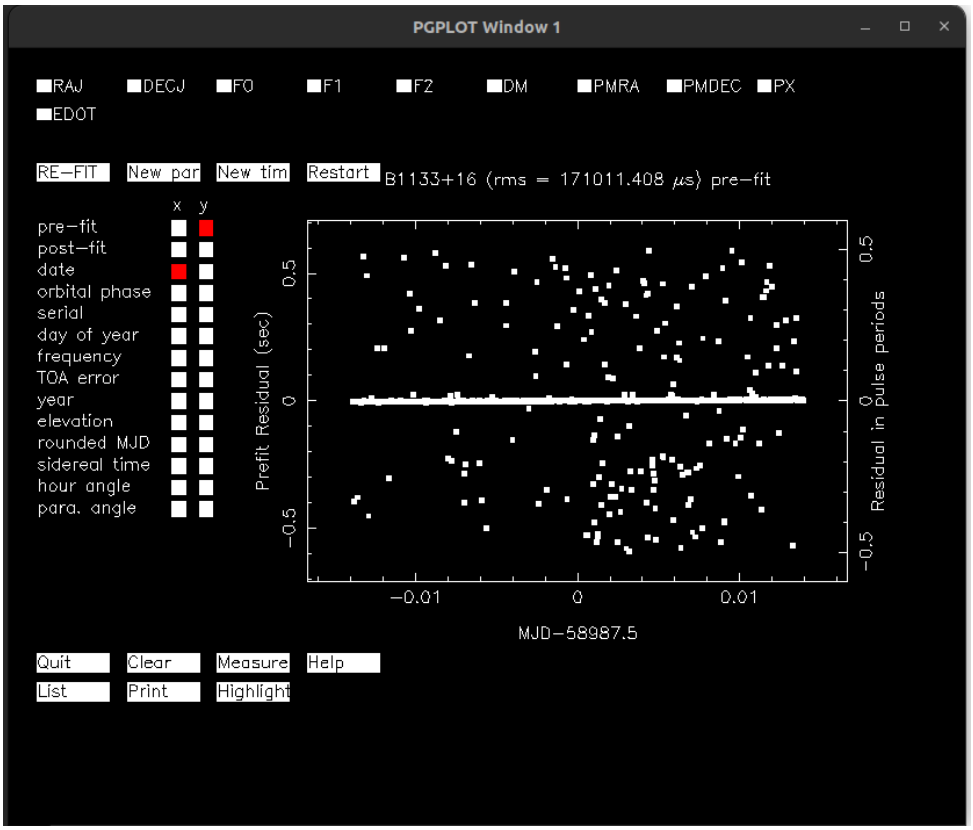
Tempo2 residuals:

I used *pat* to obtain the Frequency resolved time of arrivals. I used the full integration file as a template. I got the parameter ephemeris from ATNF. I input all these to tempo2 to obtain the residuals. However while fitting the parameters, I was unable to fit the DM. The fit would result in a DM of -76000, which is simply absurd. I am not really sure what the issue is here. Nevertheless, I have attached the residuals obtained from fitting the time period below.

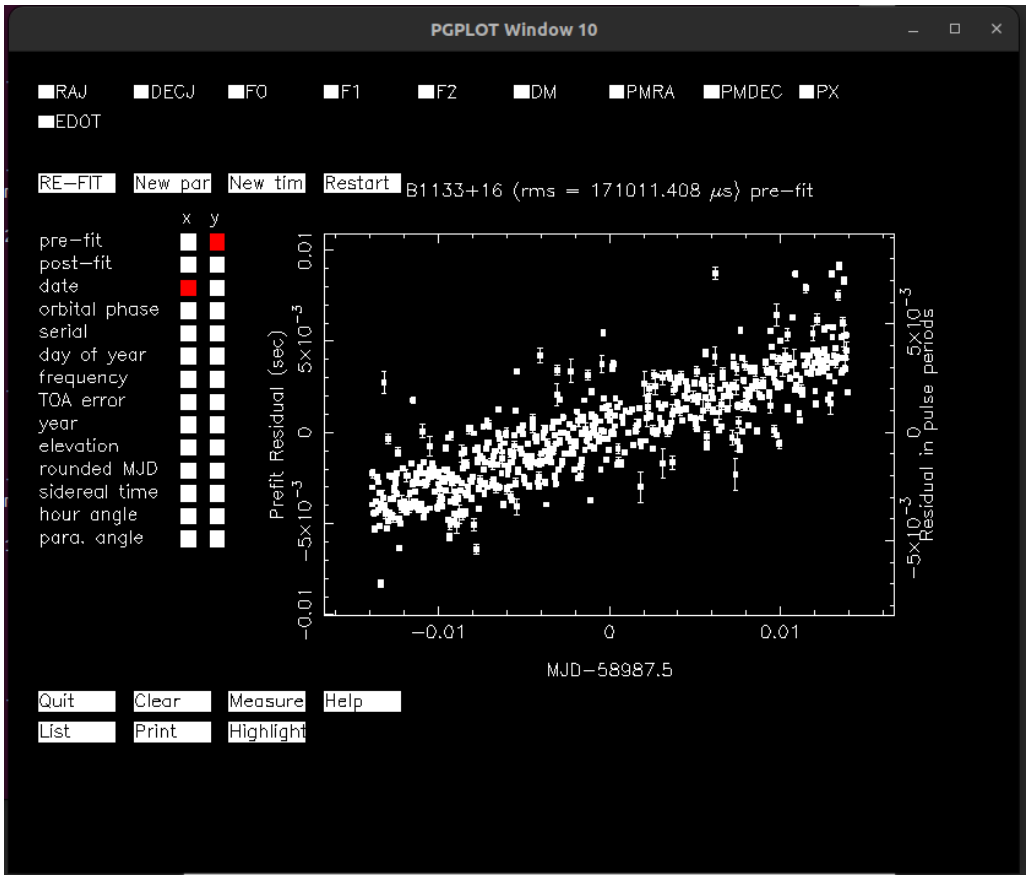
Before fitting the file, I also obtained a lot of outliers in the residue. Upon some research, it seems that it is caused by errors in the SNR, which are most likely the result of the subintegration time not being a factor of the time period. These outliers reduced as I increased the number of subintegrations, which does seem to support my hypothesis. I removed these points manually and did the fitting.

Below are the graphs I obtained and their respective residuals.

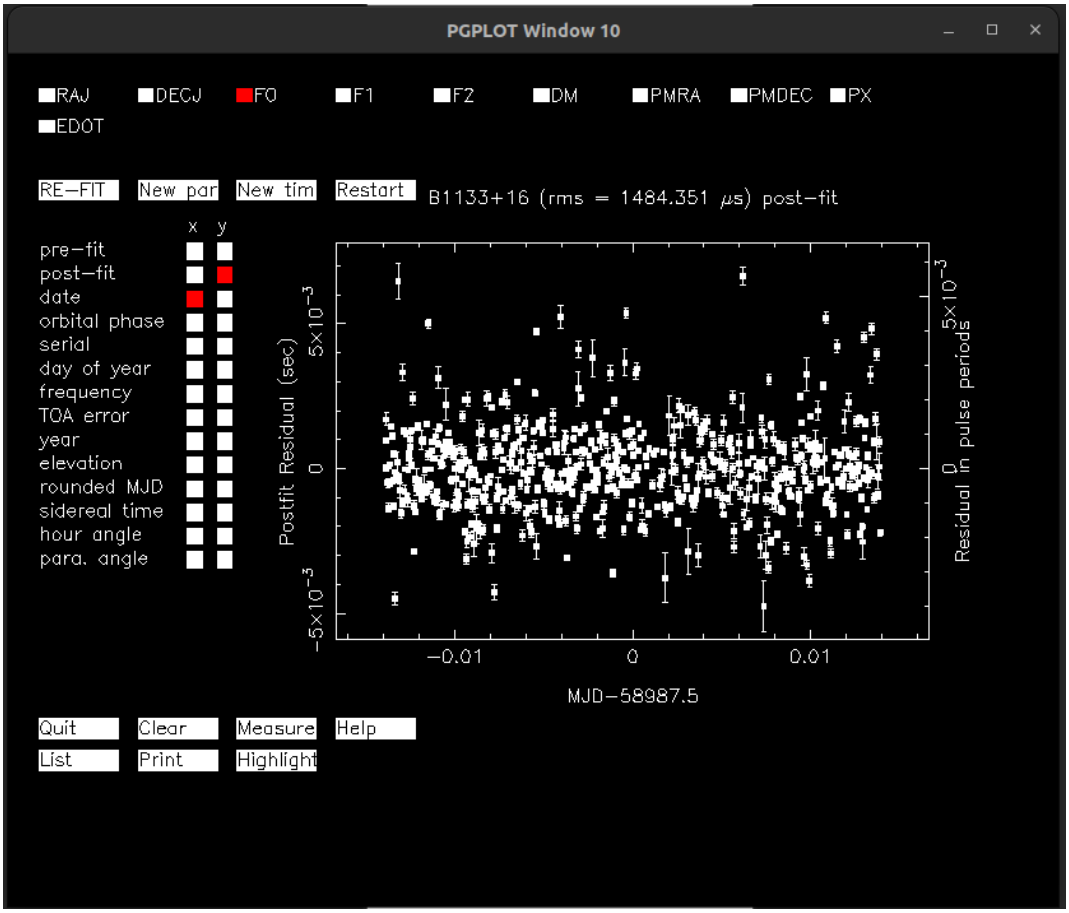
1 subintegration (original data):



After removing quite a few outliers, we get:



On fitting F0 (frequency), we get the following residuals. They are scattered randomly around 0

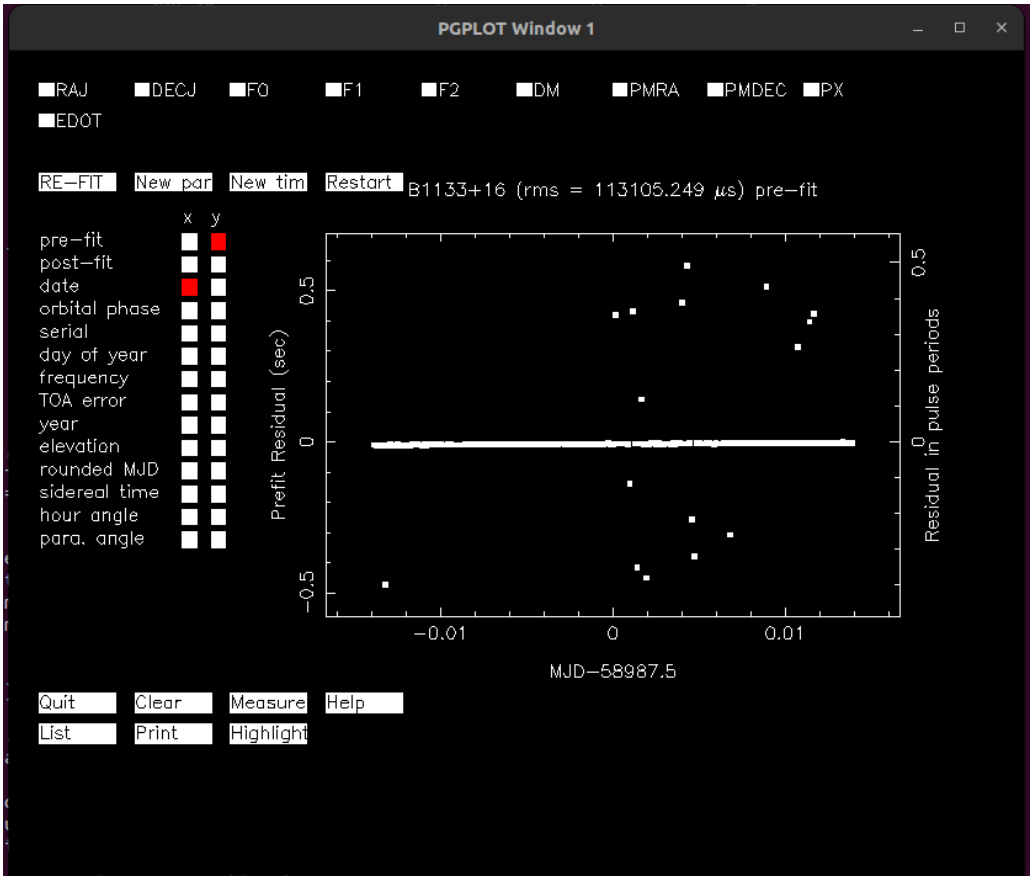


Residuals = 1484.351 μs

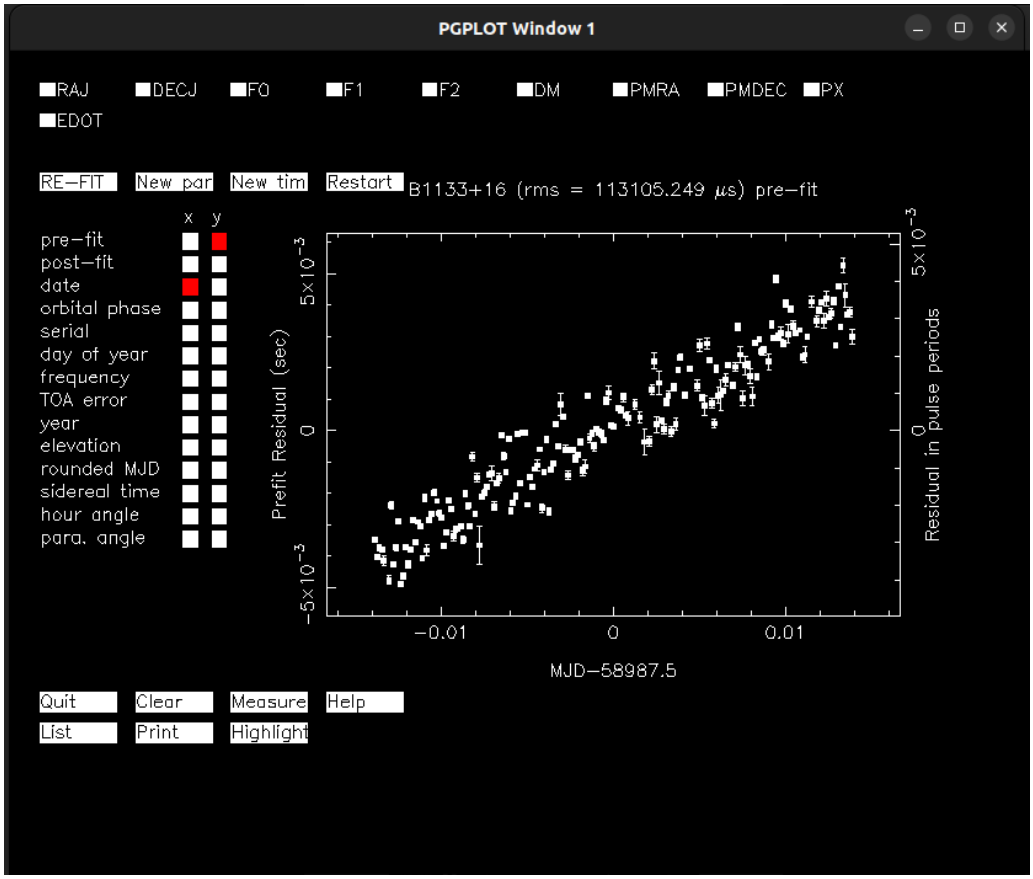
F0 (param) = 0.841812442909754 Hz
F0 (fit) = 0.841809505640194 Hz
Difference = 2.937 e-6

If I try to fit any other parameter like F1 or DM, I get a similar post-fit residual. However the value predicted for it is pretty absurd and nowhere close to the actual value.

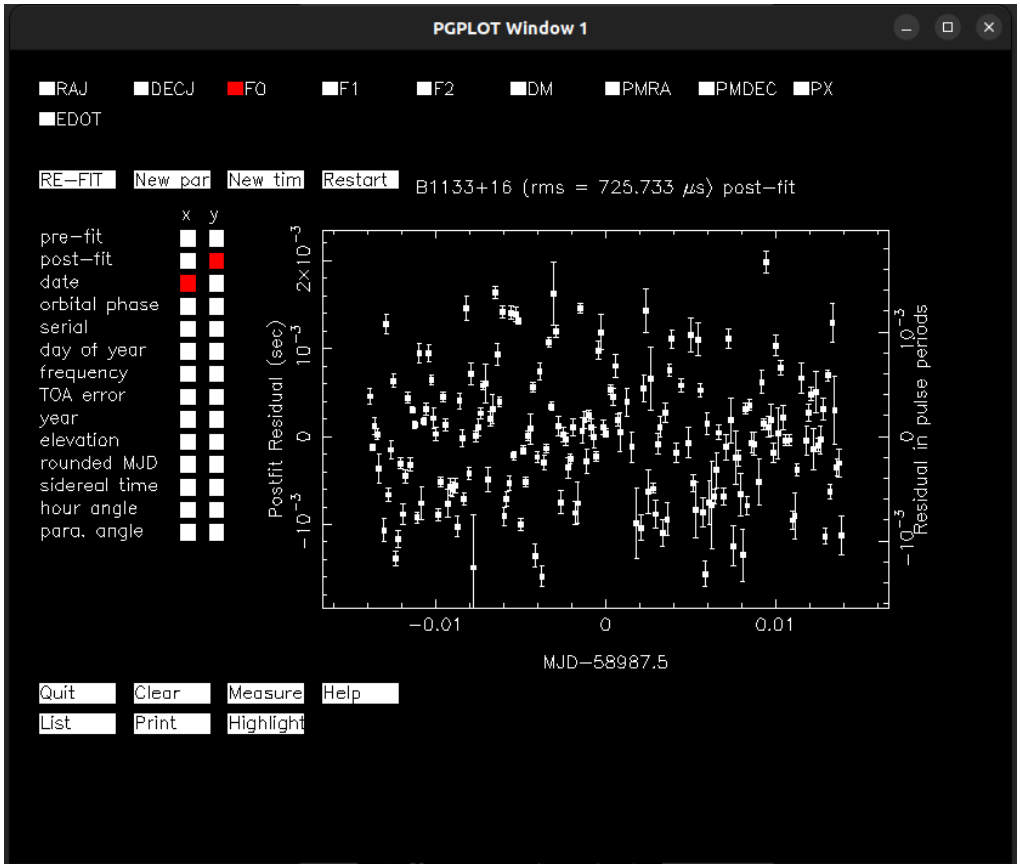
4 subintegrations:



A few outliers were seen. After removing them, we get:



On fitting F0, we get:

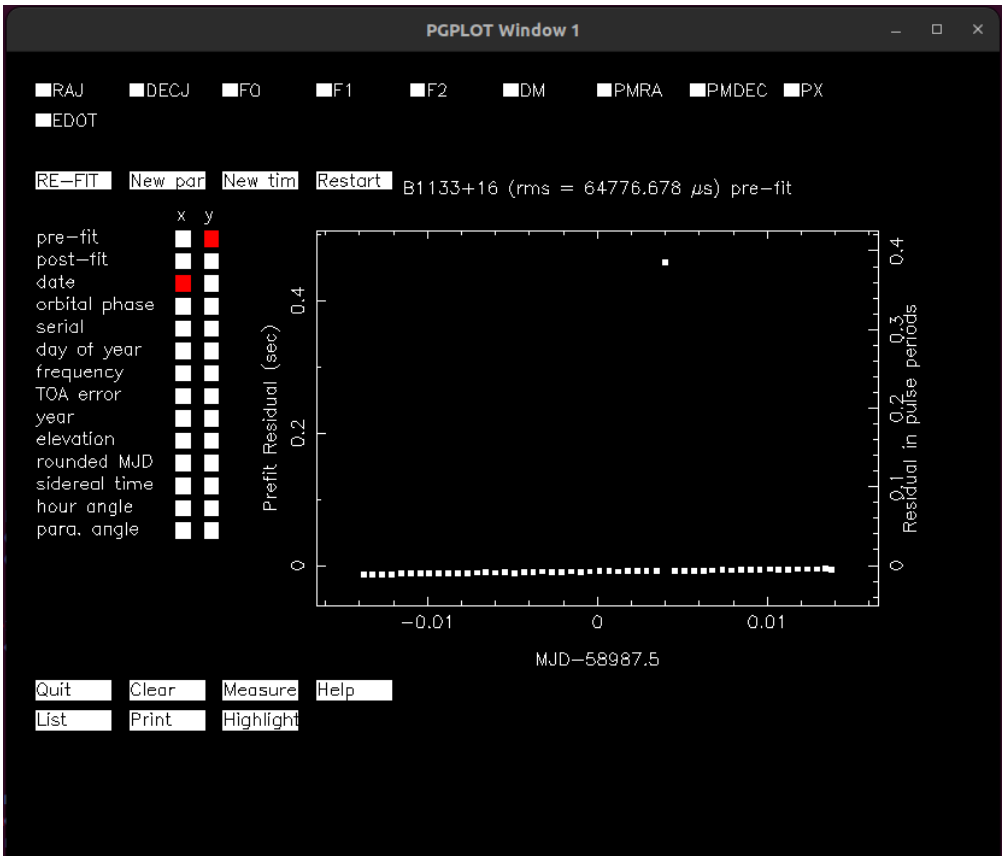


Residuals = 725.733 μs

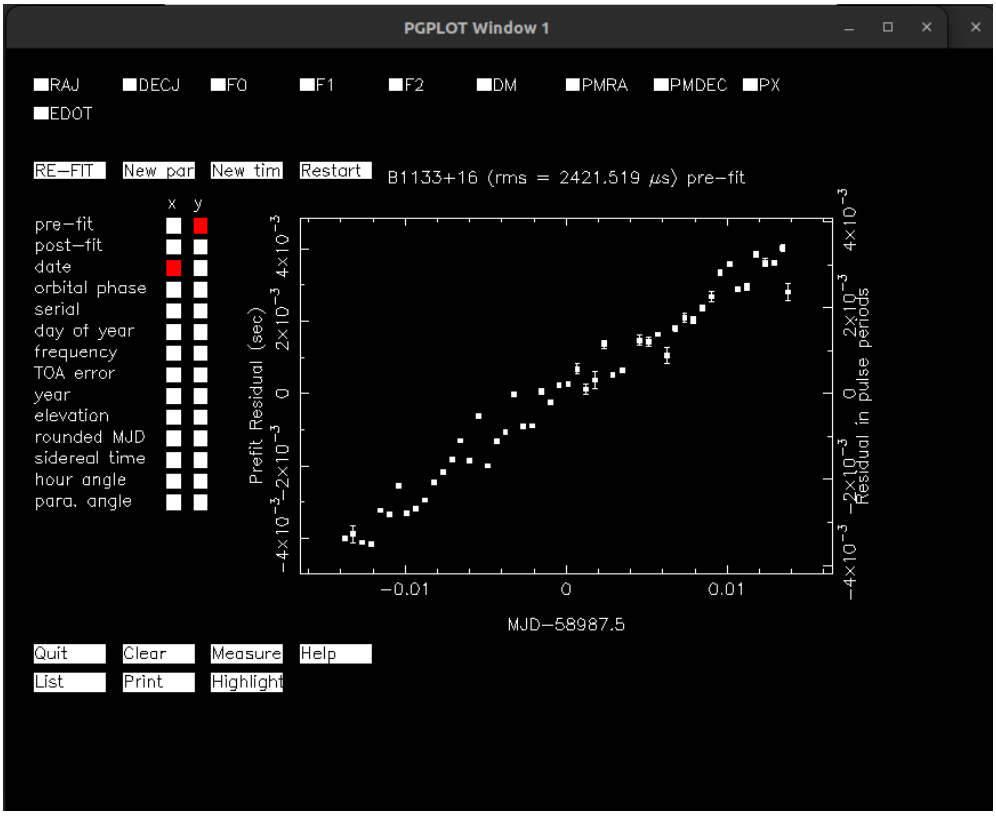
F0 (fit) = 0.841809613221413 Hz
Difference = 2.83 e-6

Once again, fitting any other quantity causes an issue. However, the residuals have decreased. This is expected since we are getting closer to the template.

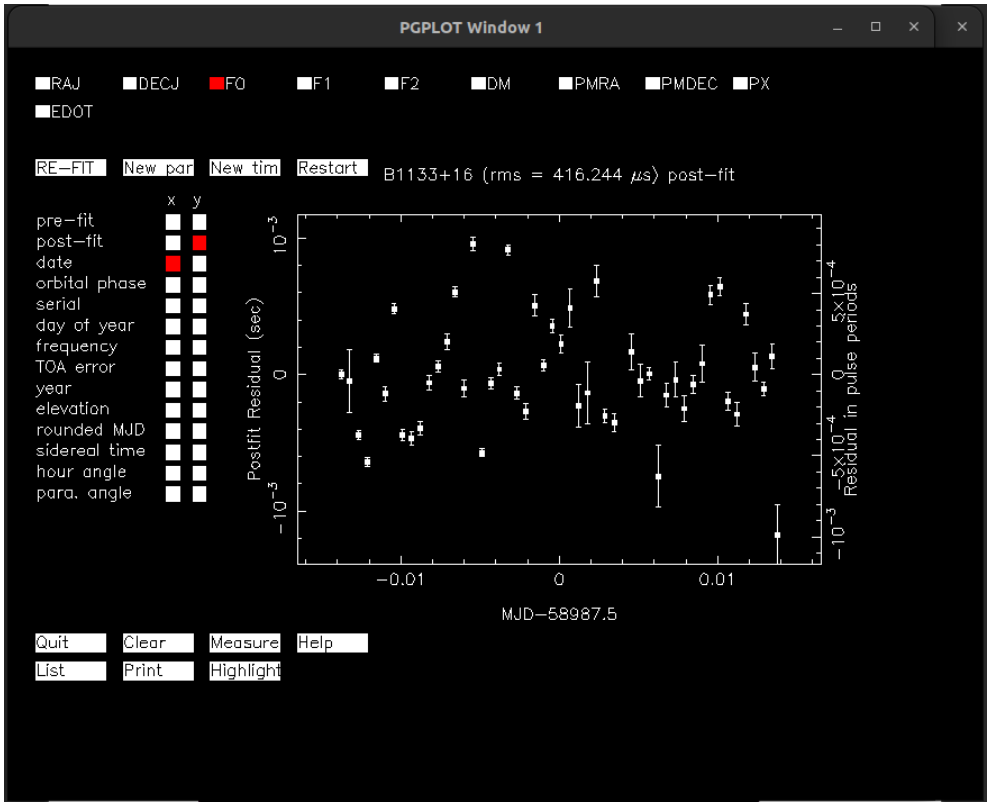
16 subintegrations:



Only one outlier, which we can remove and continue.



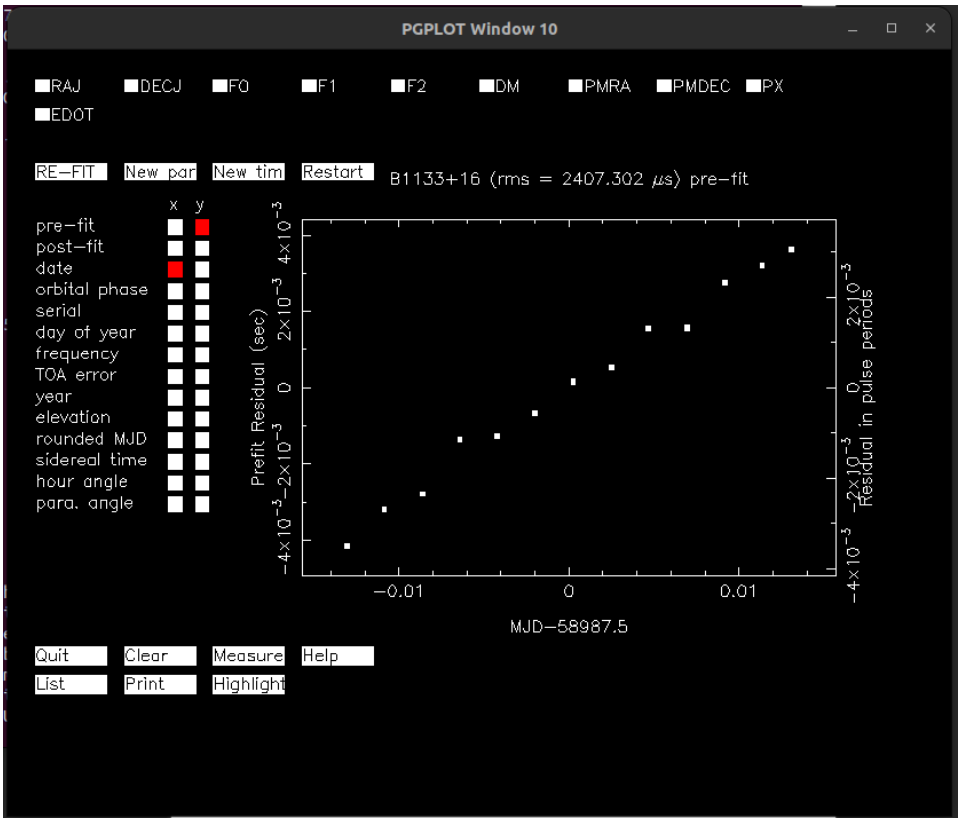
On fitting F0, we get:

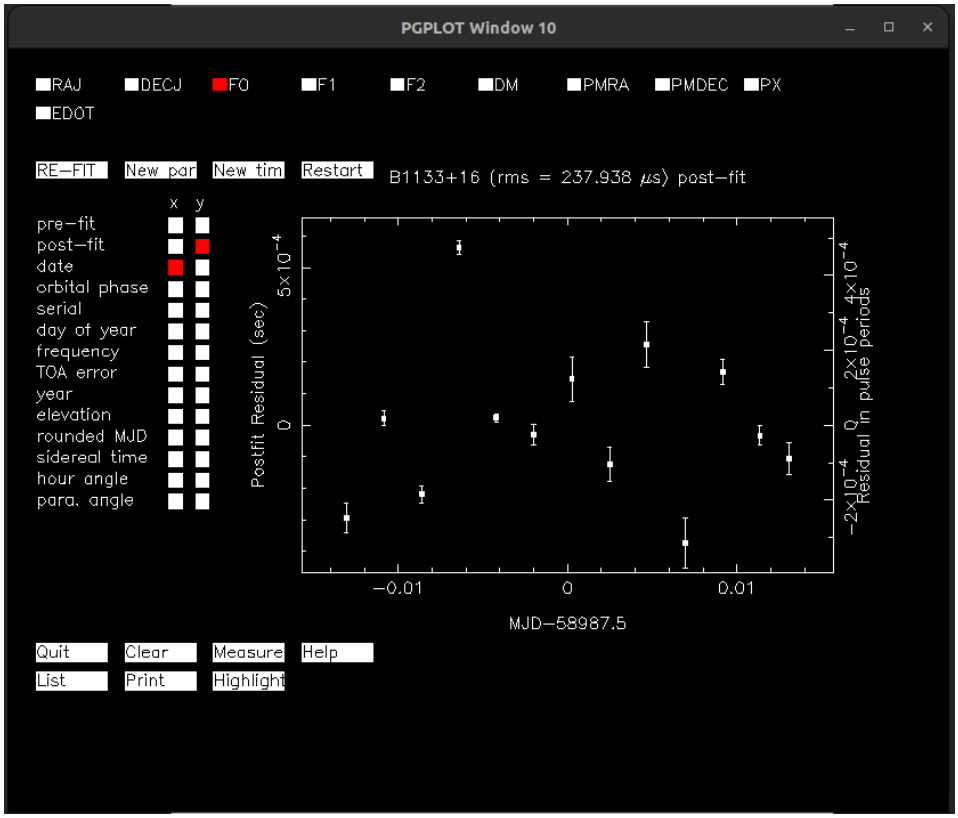


Residuals = 416.244 μs

F0 (fit) = 0.841809619718913 Hz
Difference = 2.823 e-6

64 subintegrations:

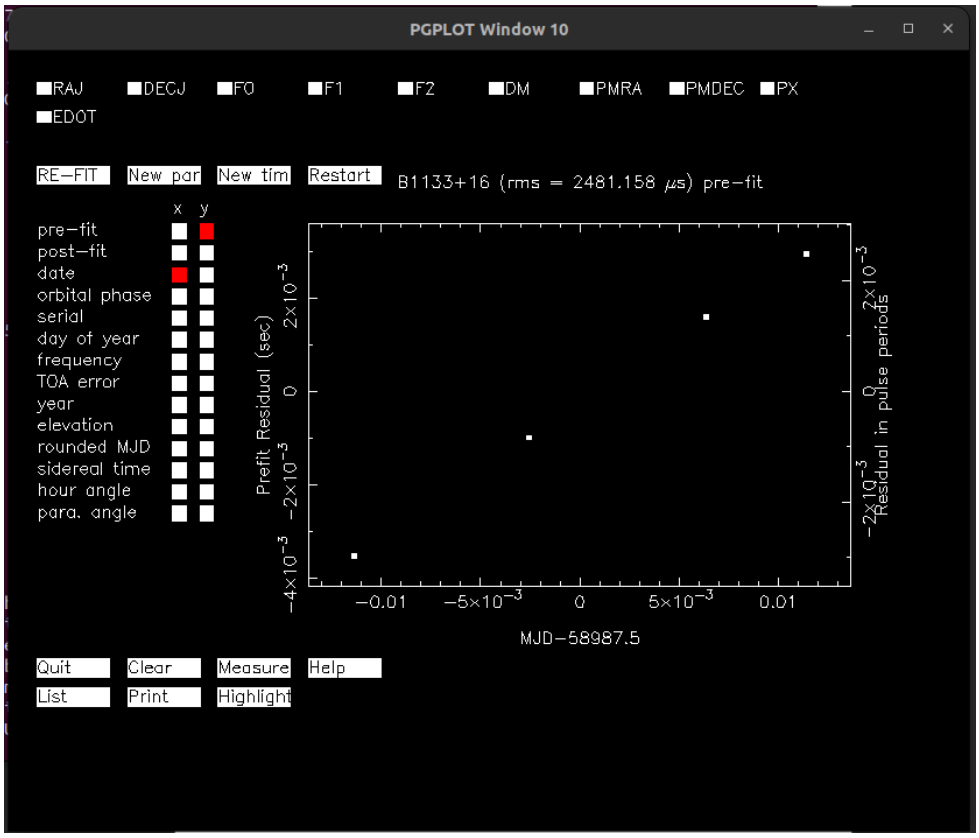


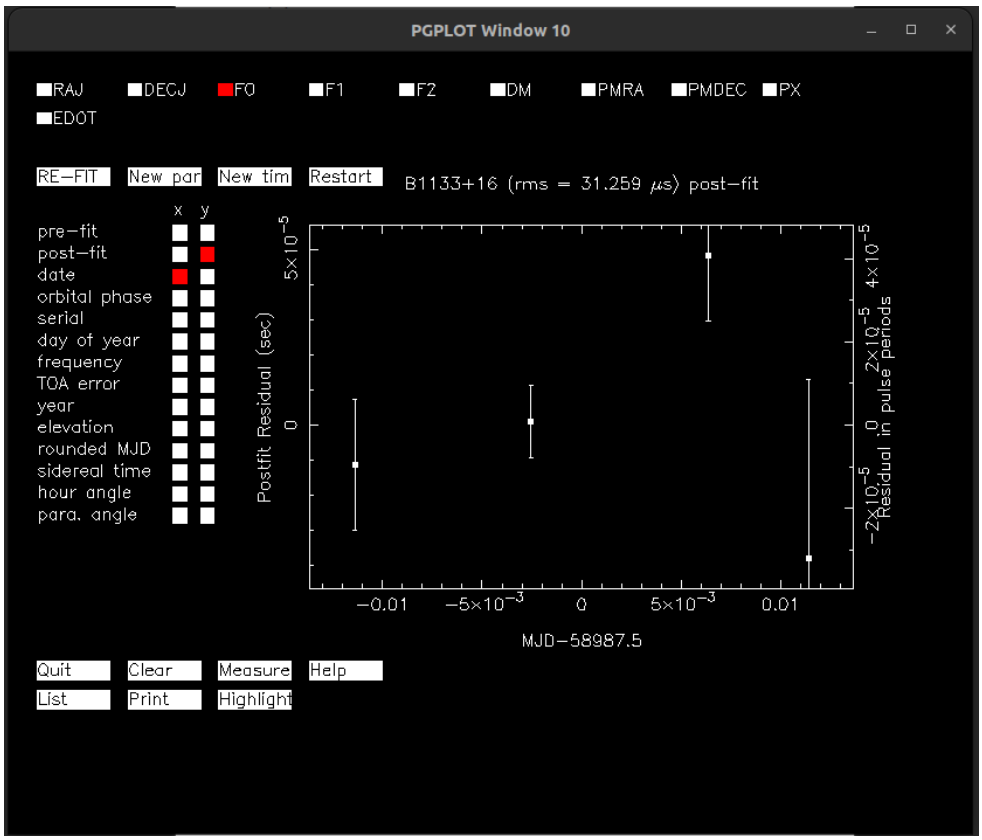


Residuals = 237.938 μs

F0 (fit) = 0.841809614235421 Hz
Difference = 2.829 e-6

256 subintegrations:





Residuals = 31.259 μs

F0 (fit) = 0.841809665648563 Hz
Difference = 2.777 e-6