Simulated PSP filter bank (signal processing) can be used to make simulated gain curves for the filter bank.

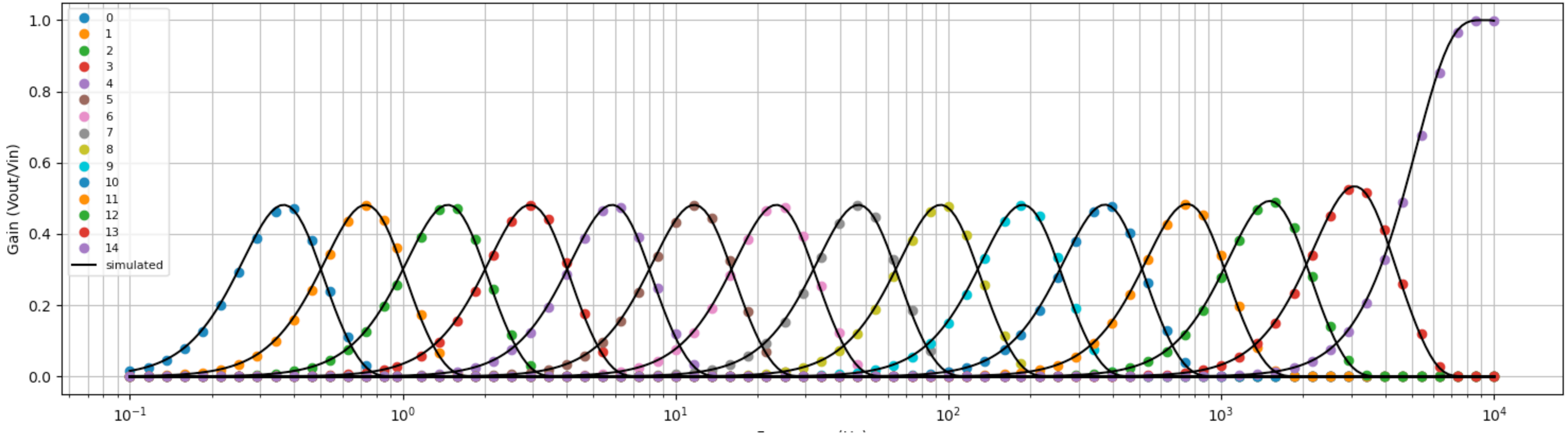
The simulated gain curves match those in IDL save file very well.

The simulated curve can be made with a finer frequency resolution than the curves in the the IDL save file have.

I'll use the simulated curves for developing frequency fitting algorithm.

Can also use the simulate filter bank on known test signals to see how well frequencies can be calculated from the peak values in the bins.

color dots = gain curves from IDL save file
black lines = simulated gain curves



Treat finding the narrowband frequency as a non-linear fitting problem.

Find the frequency that gives the minimum error between the measured peak values and the peak value expected for a perfect sine wave.

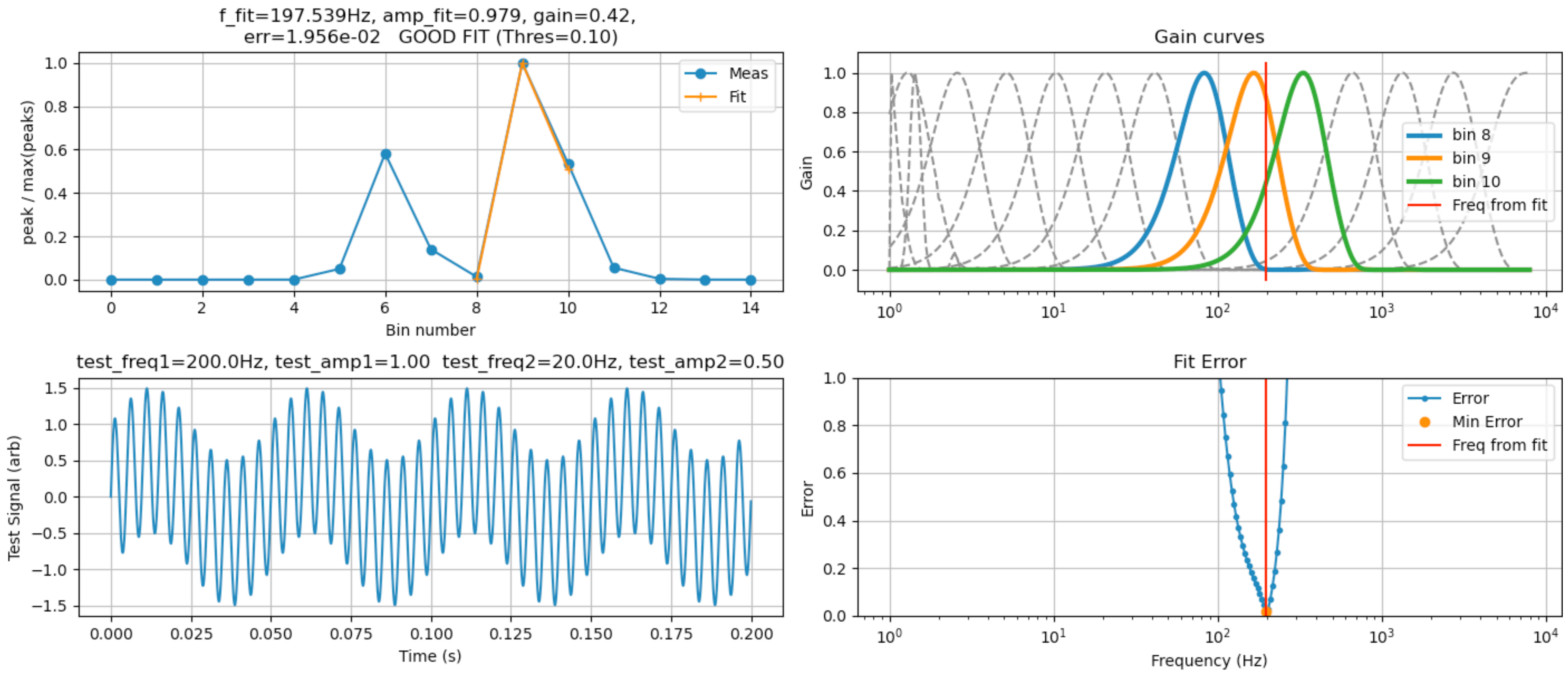
The minimum error can be used as a quality metric.

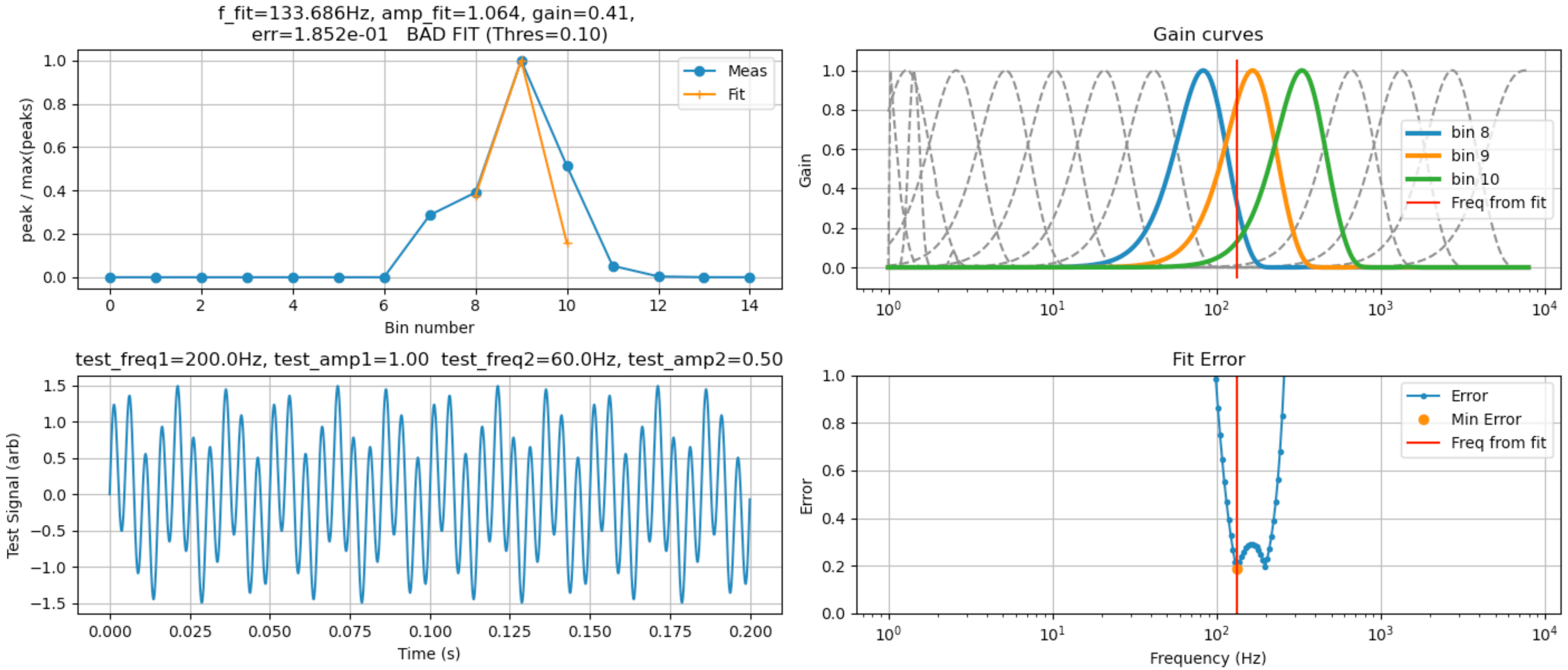
Currently using the mean of the absolute values of the residuals.

Below is an example of applying the fitting to a simulated signal using a **3 bin fit**.

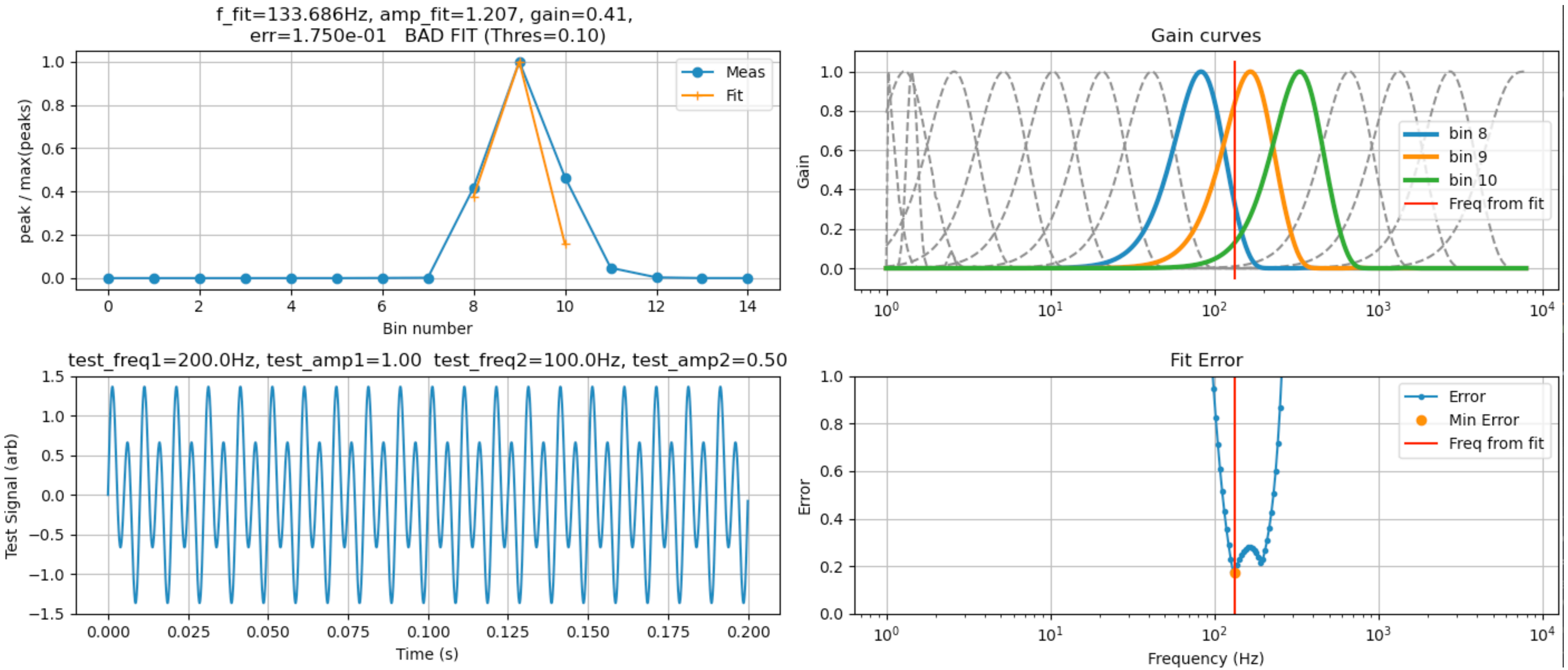
The test signal is the sum of two sine waves.

Then apply the simulated filter bank to the test signal to get the “measured” peaks.





f_fit=133.686Hz, amp_fit=1.064, gain=0.41,
err=1.852e-01 BAD FIT (Thres=0.10)
Meas
Fit
peak / max(peaks)
Bin number
Gain curves
bin 8
bin 9
bin 10
Freq from fit
Gain
test_freq1=200.0Hz, test_amp1=1.00 test_freq2=60.0Hz, test_amp2=0.50
Test Signal (arb)
Time (s)
Fit Error
Error
Min Error
Freq from fit
Frequency (Hz)



f_fit=133.686Hz, amp_fit=1.207, gain=0.41,
err=1.750e-01 BAD FIT (Thres=0.10)
Meas
Fit
peak / max(peaks)
Bin number
Gain curves
bin 8
bin 9
bin 10
Freq from fit
Gain
test_freq1=200.0Hz, test_amp1=1.00 test_freq2=100.0Hz, test_amp2=0.50
Test Signal (arb)
Time (s)
Fit Error
Error
Min Error
Freq from fit
Error
Frequency (Hz)

Example of a 3 bin fit to some PSP measurements.

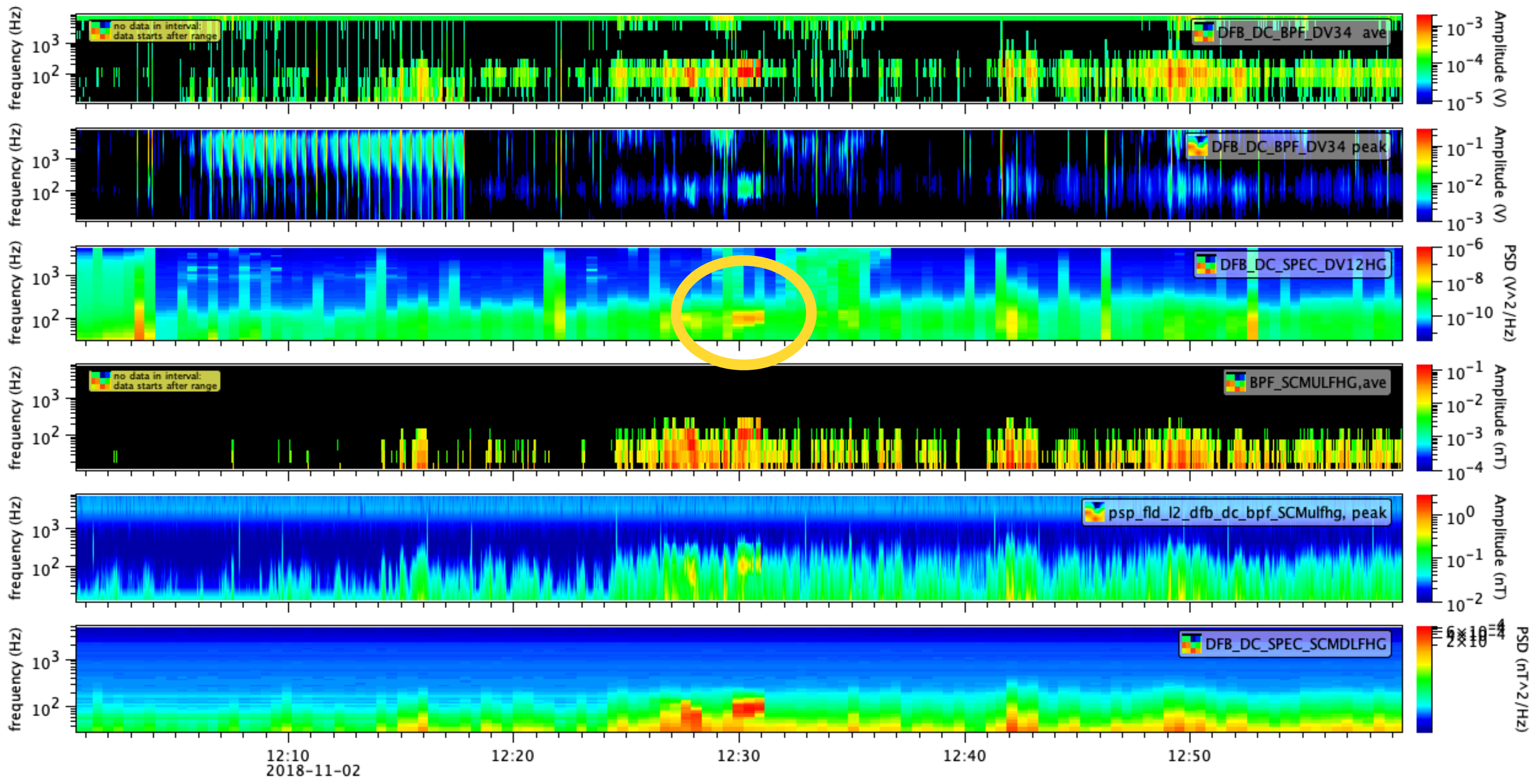
Error must be below threshold to be declared a good fit.

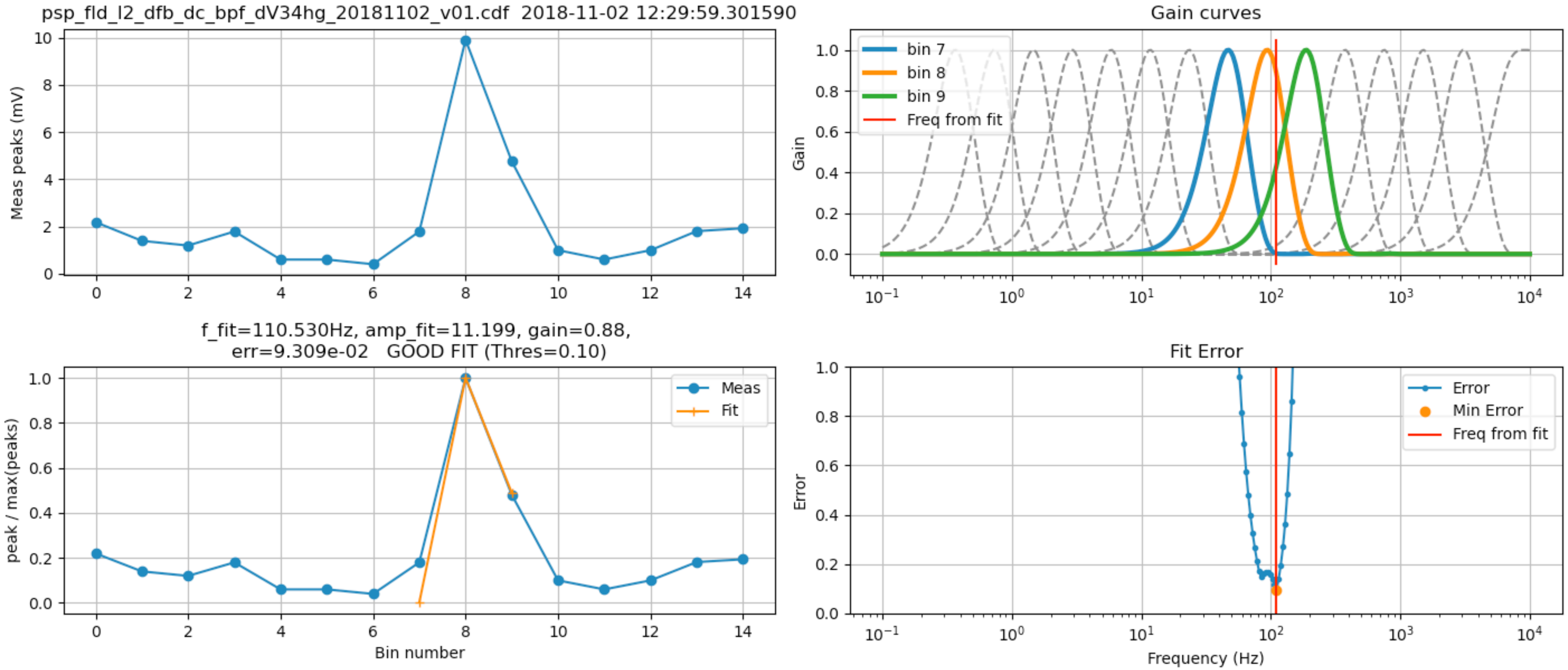
The example below has a good fit to narrow band model assumption.

Measured maximum peak = 10 mV

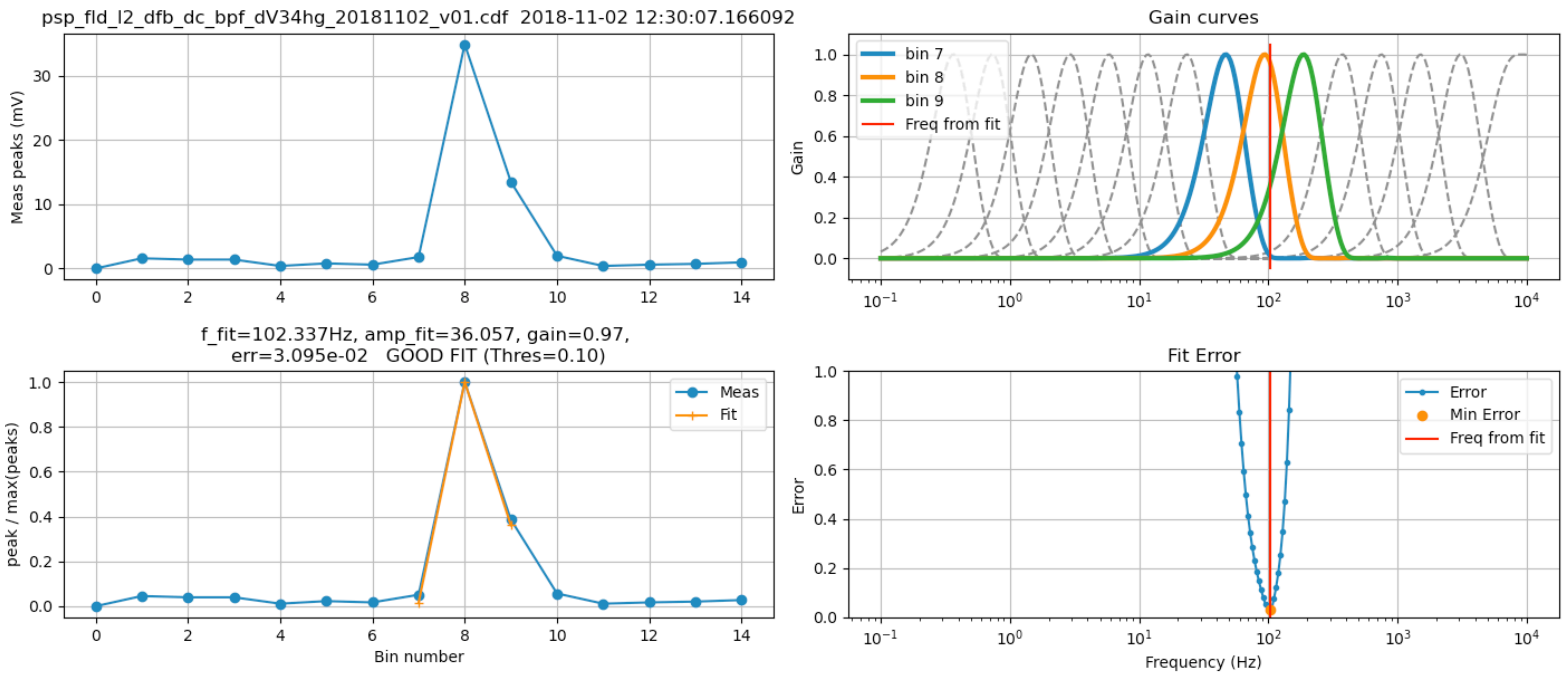
Fit value = 11.2 mV with F = 111 Hz

Note for the filter bank with 15 bins, the maximum allowed scaling factor on the peak is ~ 1.6

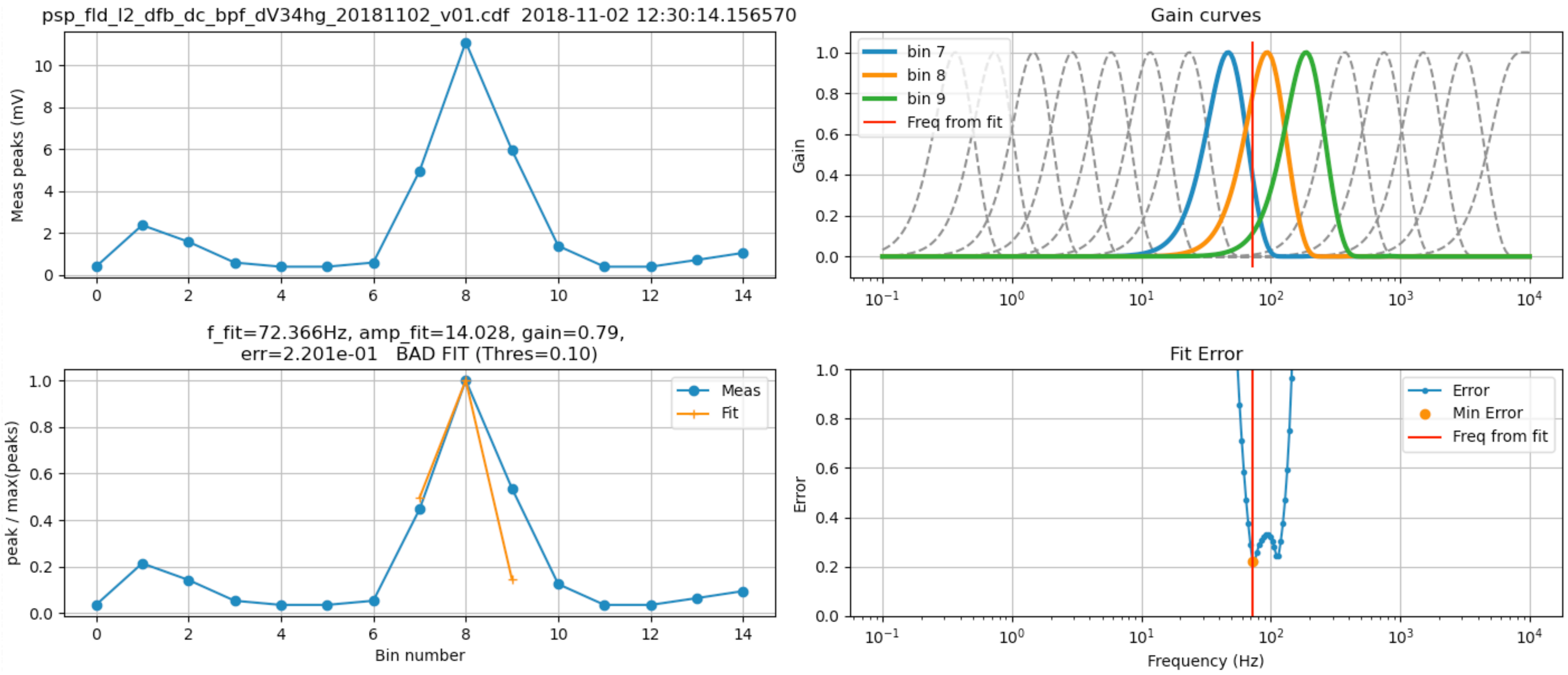




Another example of a 3 bin fit.

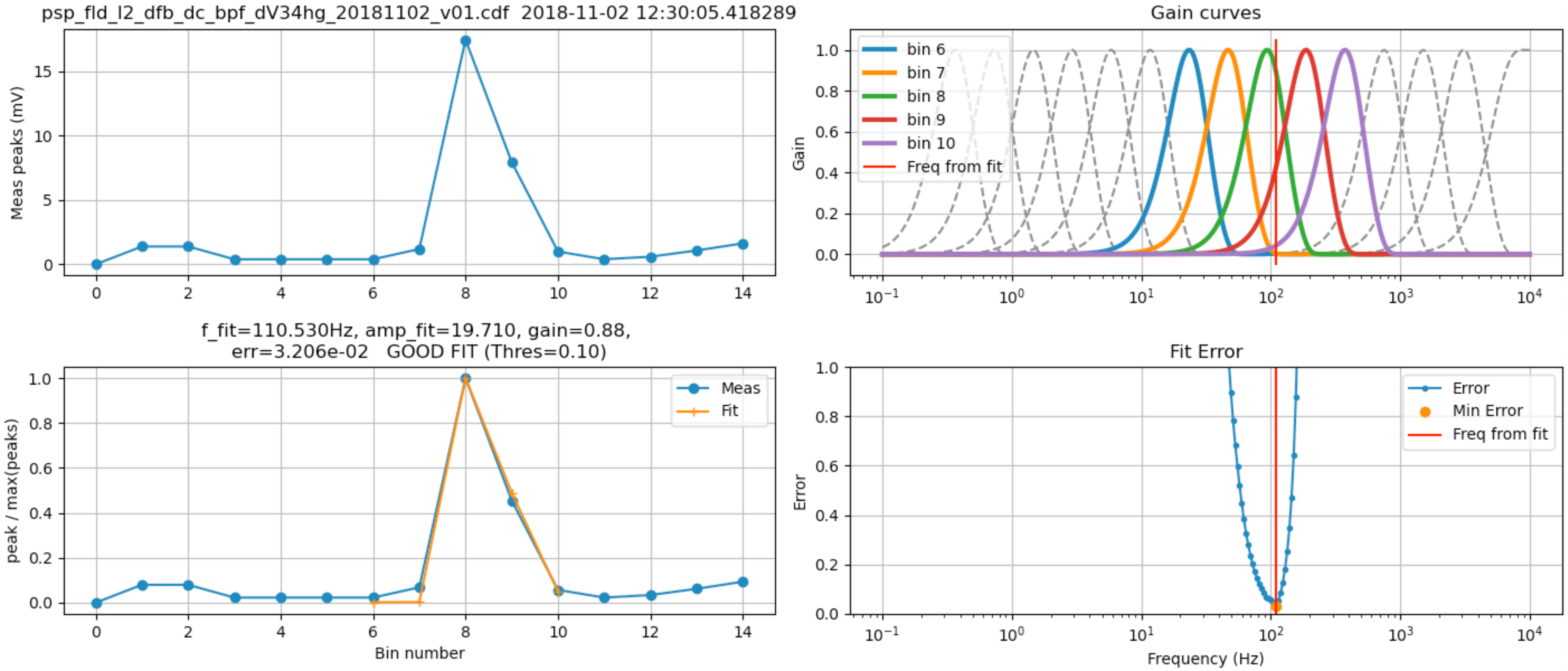


Another example of a 3 bin fit.

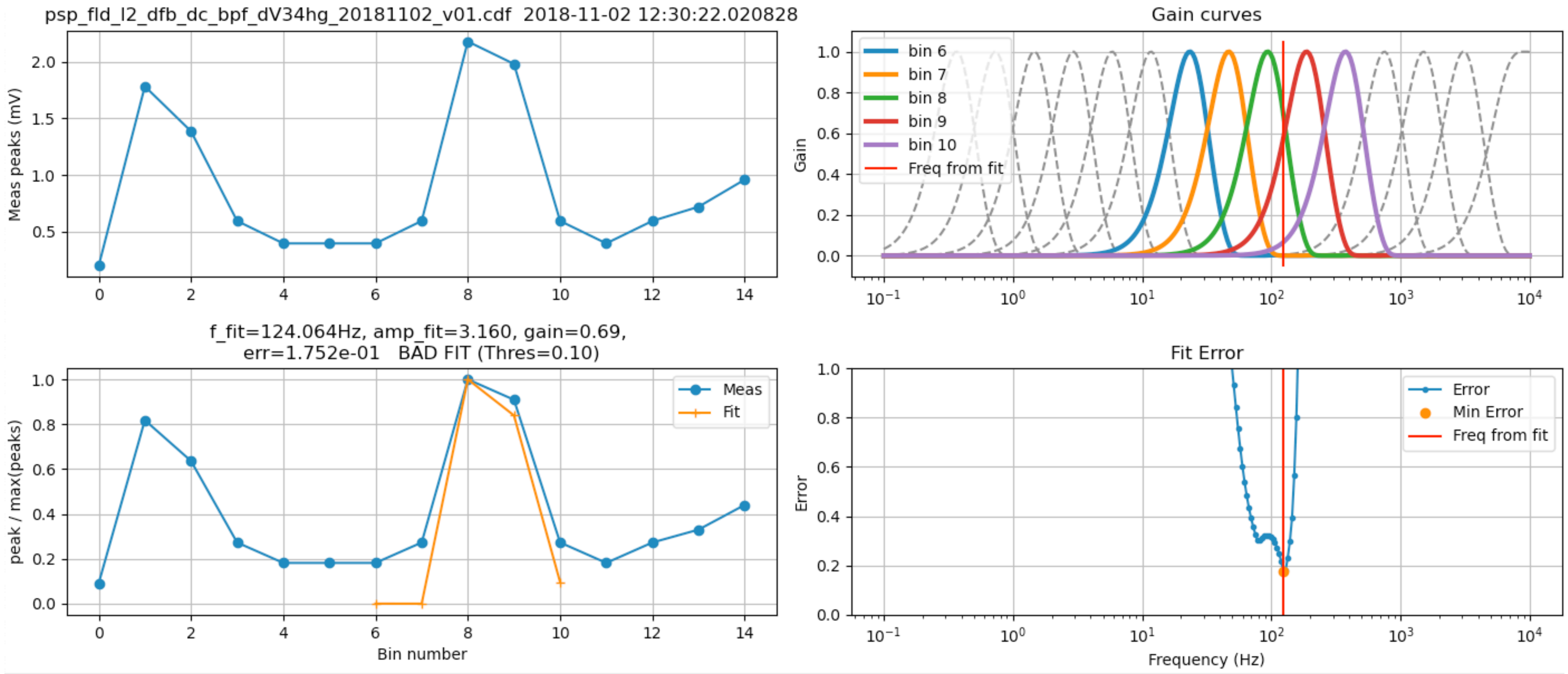


Example of a **5 bin fit**

This removes more of the low amplitude back ground noise than the 3 bin fit does.

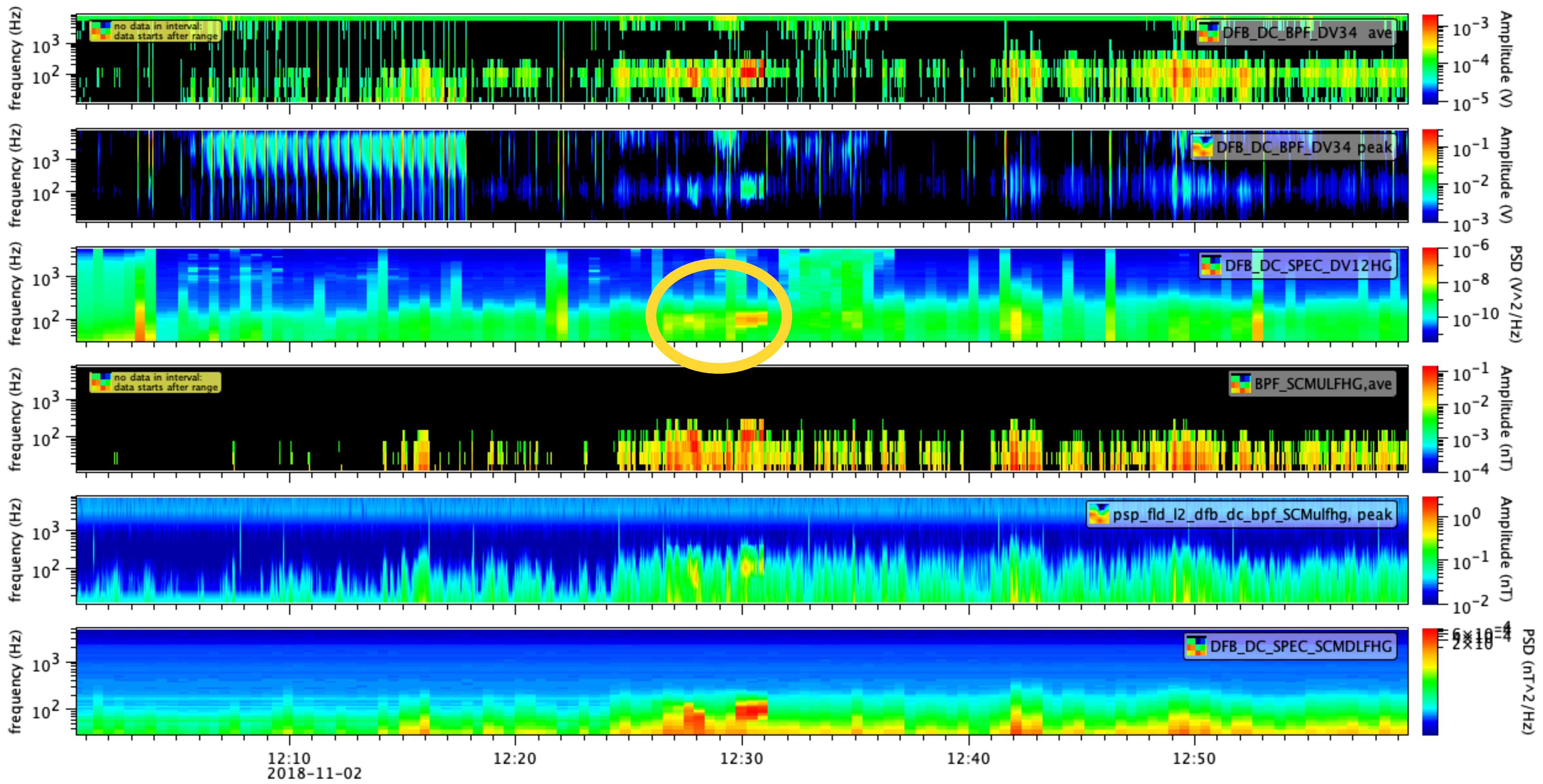


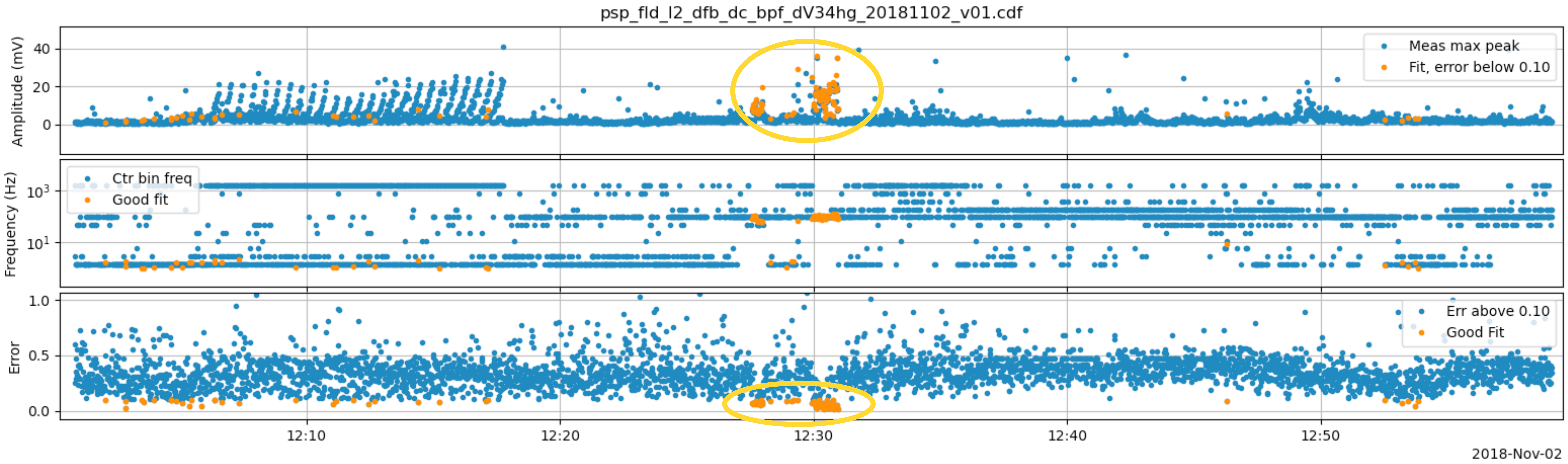
Example **5 bin fit.**



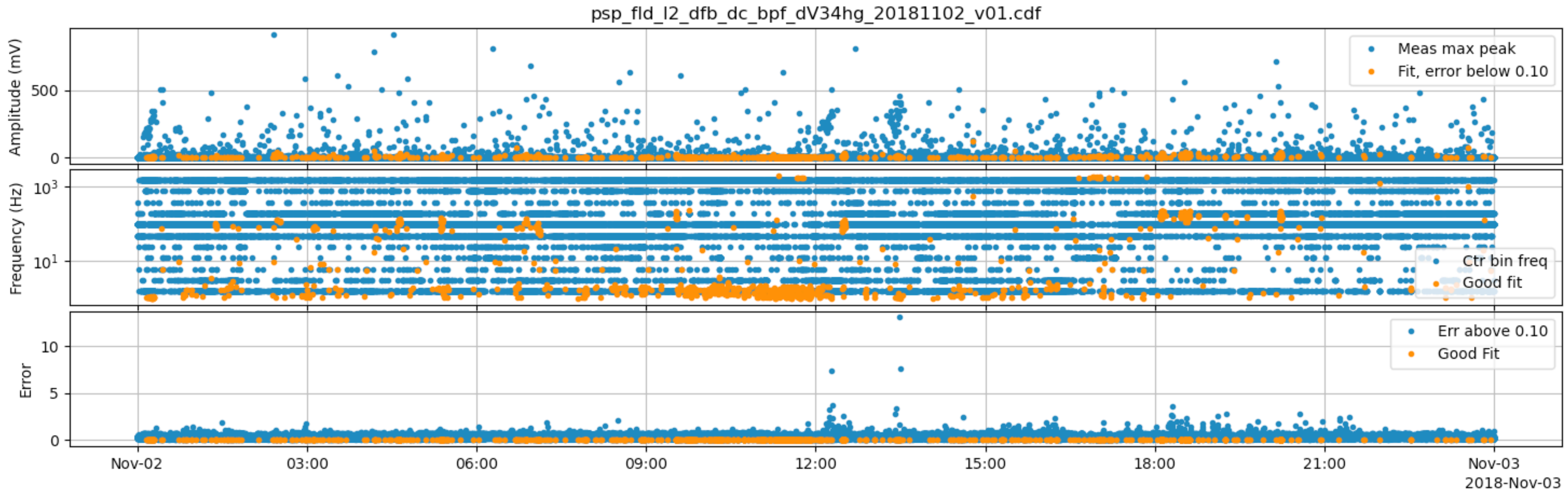
Fit results using **5 bin fit**. Error threshold = 0.1

Orange shows the times that have a good fit to the narrow band assumption.

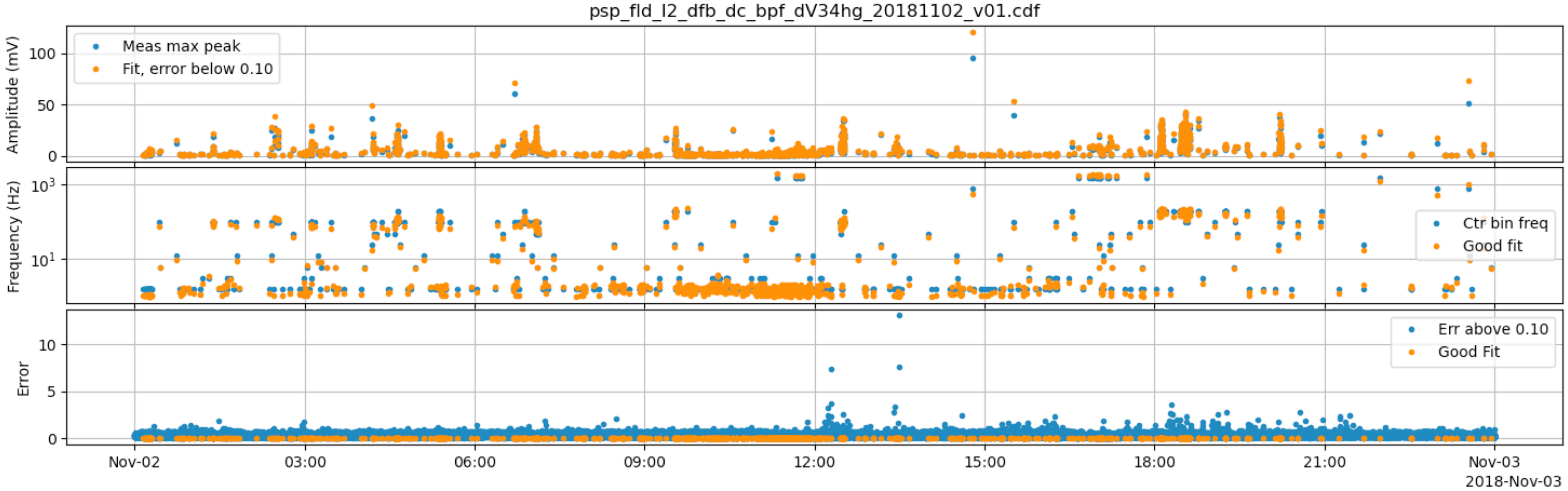




5 bin fit for the whole day showing all of the points including those with bad fits.

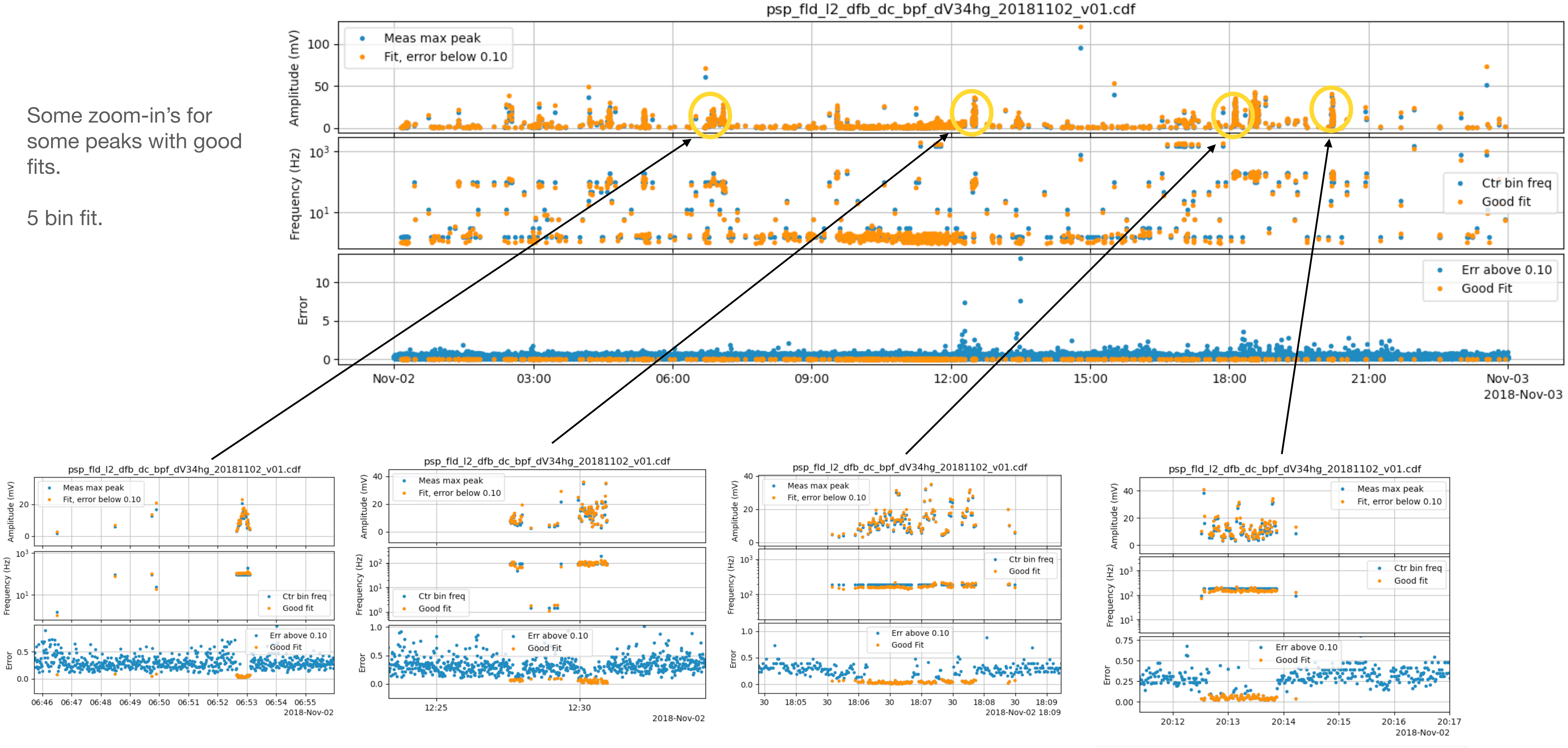


The same fit results but only showing points with good fits.



Some zoom-in's for some peaks with good fits.

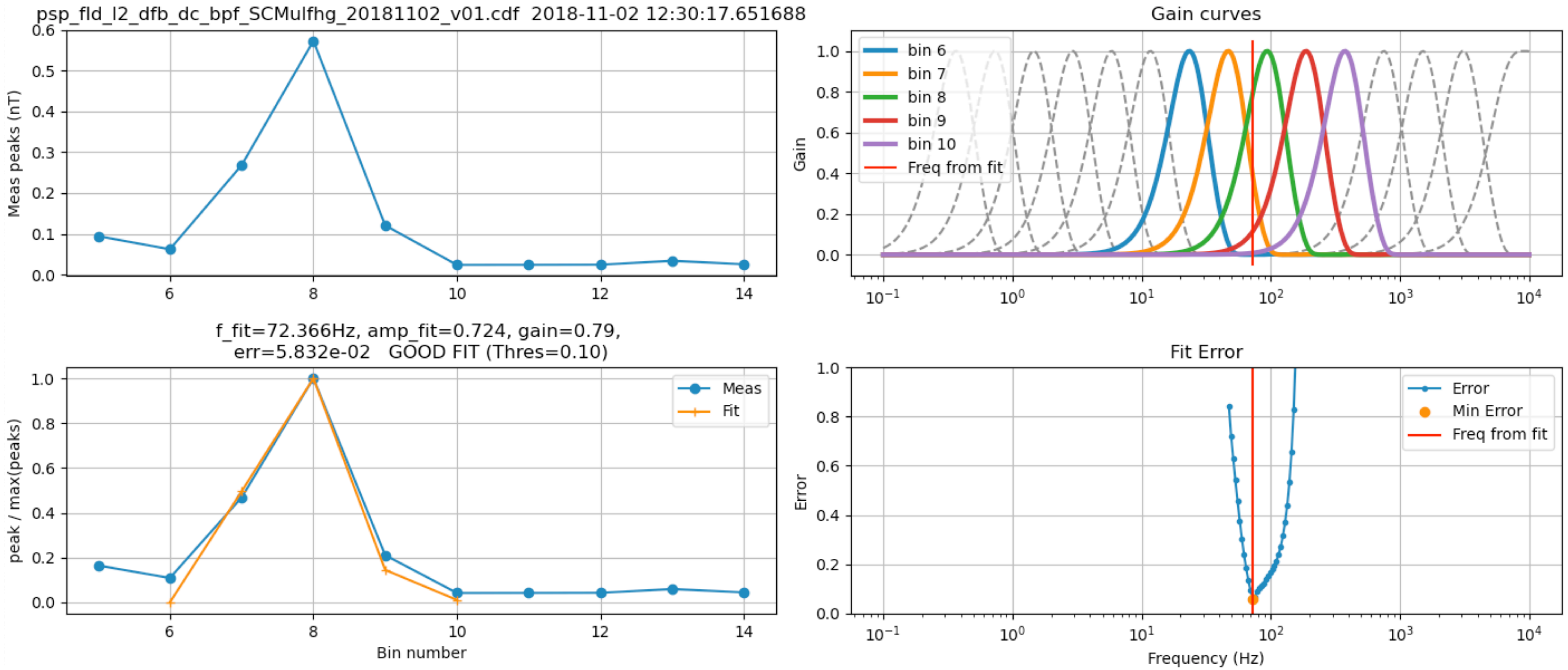
5 bin fit.



Added B

Use the same fit setting for B as for E.
5 bins, threshold = 0.1

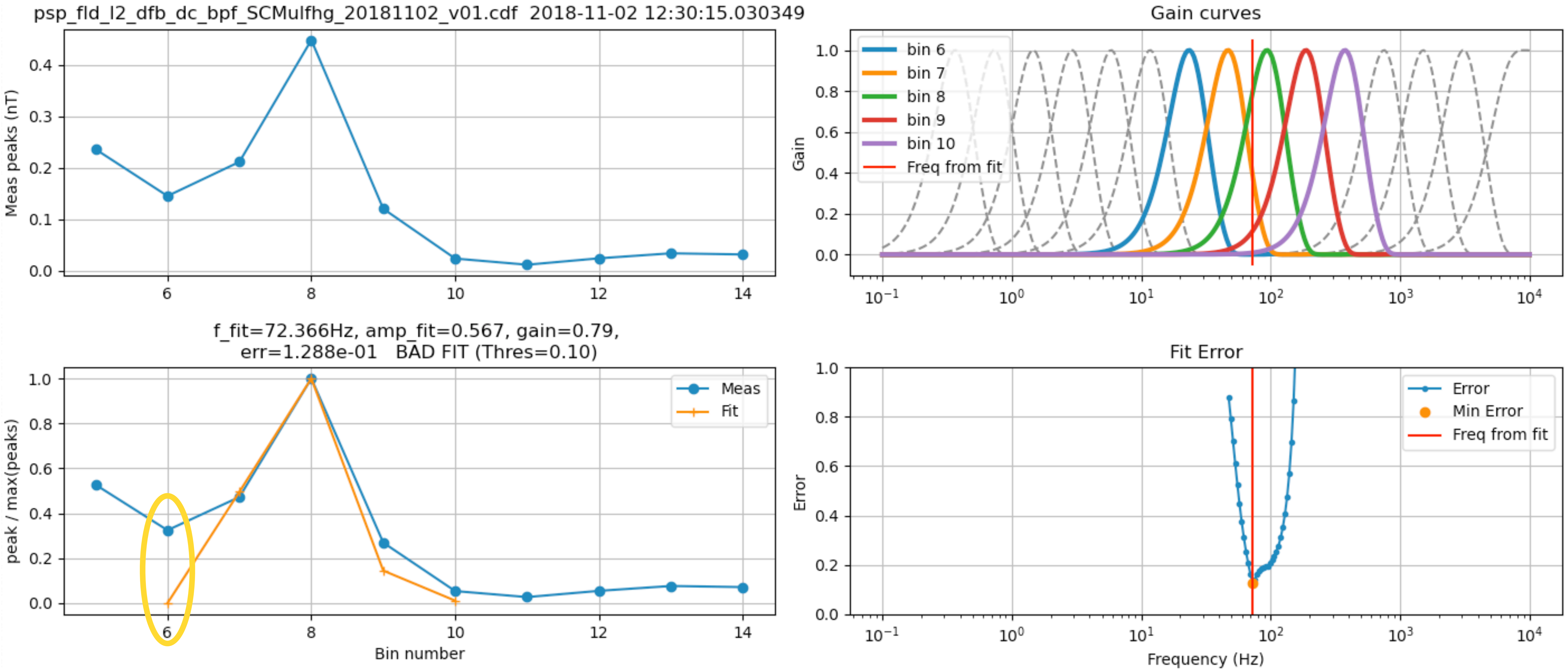
Example of a good B fit



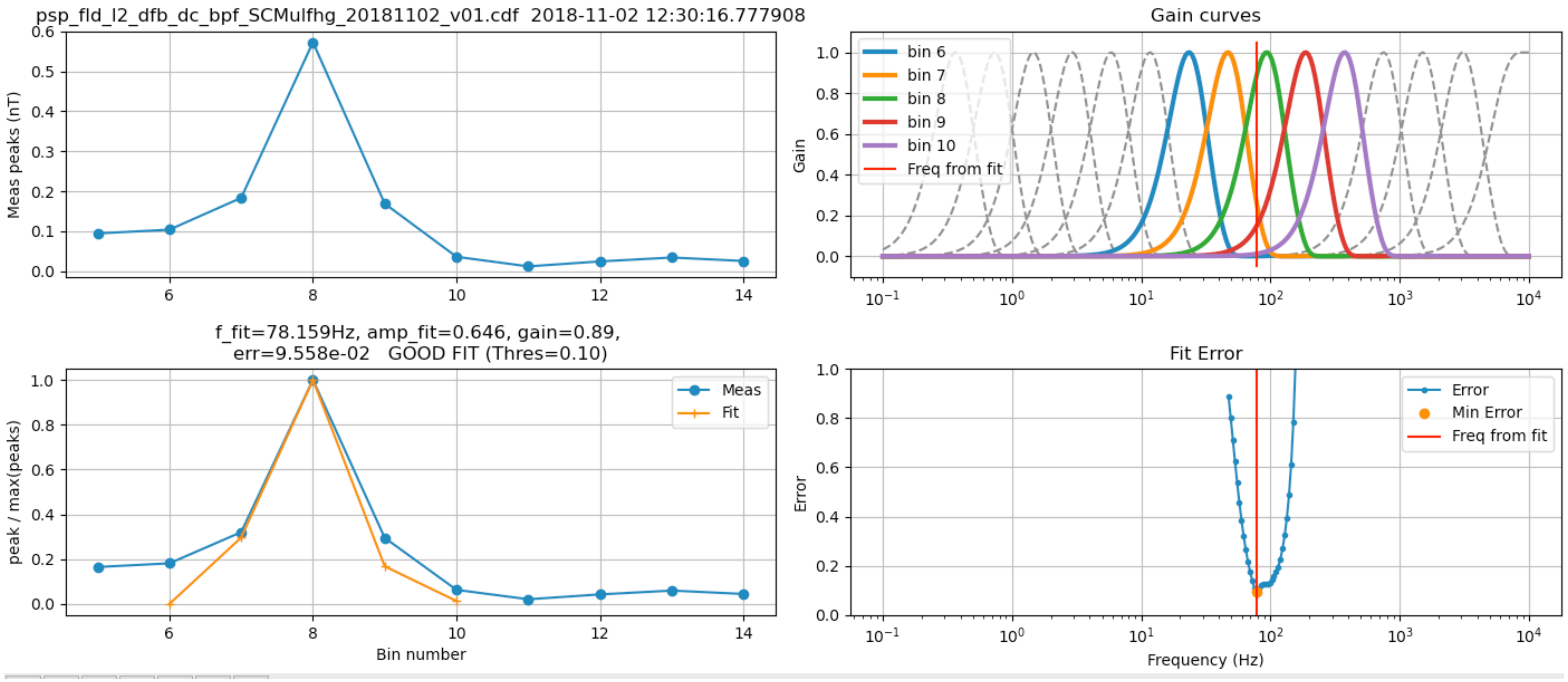
There are more bad fits for B than for E.

It seems to be because the amplitudes in the lowest bin is higher than expected for a sine wave.

Example of fit with error that just exceeded the threshold.



Example of a good B fit that had error just below the threshold.

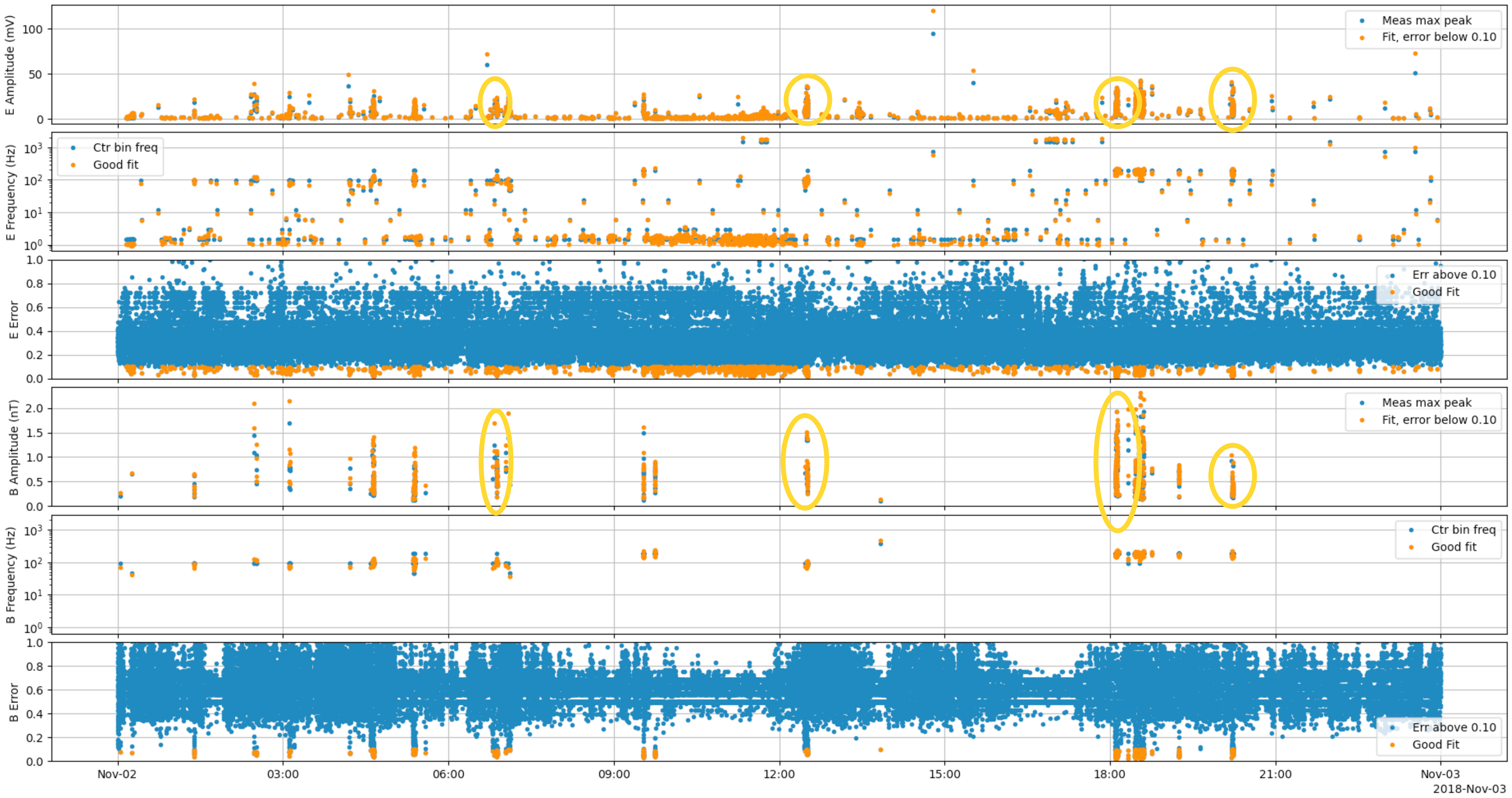


Added B fit.

Five bin fit with 0.1 threshold for both E and B.

Orange = Good fit.

Note: The five lowest bins in the B peaks contain NaN's and were excluded.



Some zoom-in's for some peaks with good fits.

E and B using the same Error threshold.

5 bin fit.