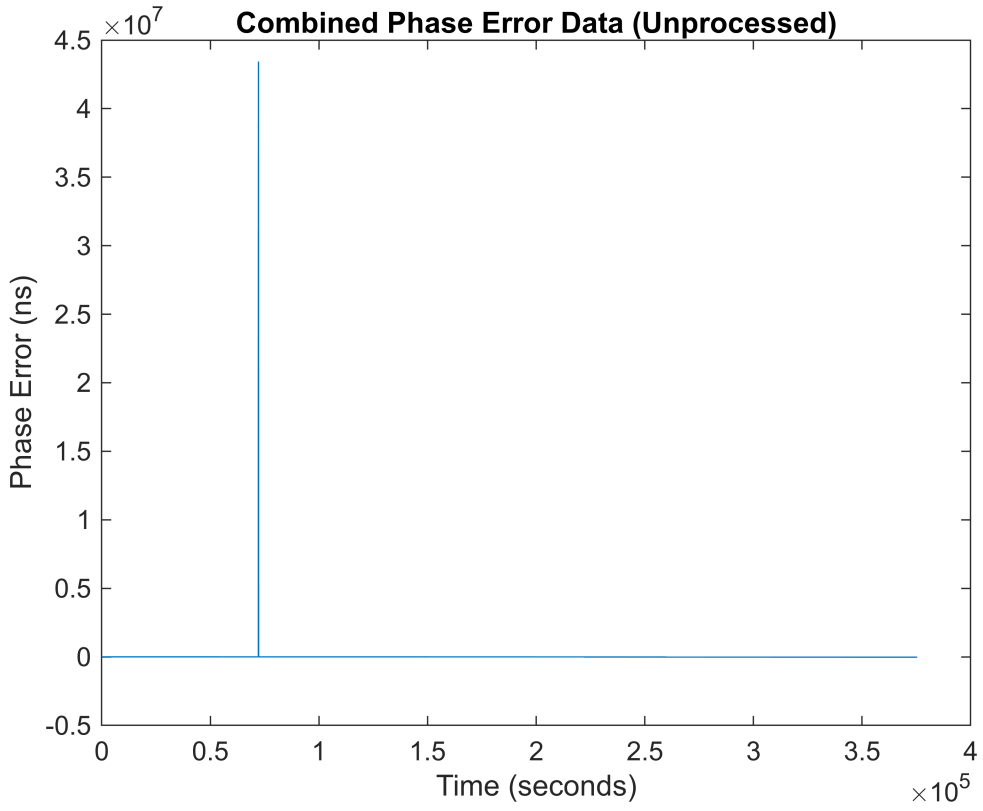
Import Data

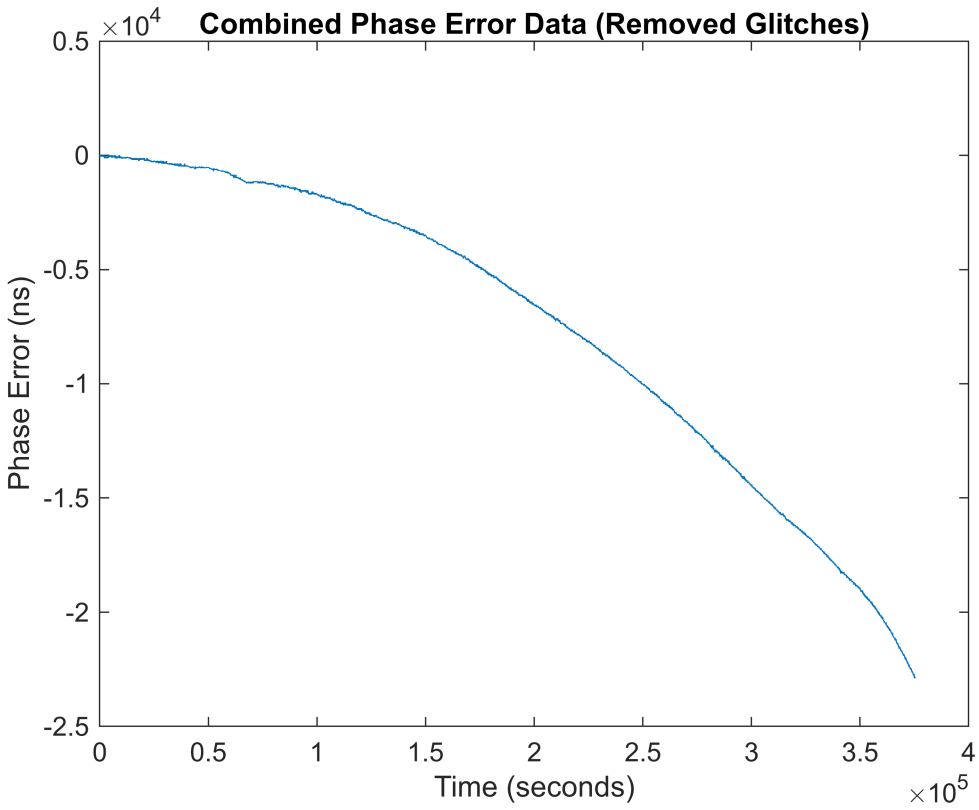
```
close all;
load("UnprocessedData_03-10-2025");
% data = [finalData(:,1), [finalData(1:63700,3);finalData(63701:end,4)]*-1,
finalData(:,2)];
% save("UnprocessedData_03-10-2025","data");
data(:,2) = data(:,2)*-1;
plot(data(:,1),data(:,2));
xlabel("Time (seconds)");
ylabel("Phase Error (ns)");
title("Combined Phase Error Data (Unprocessed)");
```



Remove Data Glitches (Outliers)

```
% Remove Outliers
phaseRange = 24000; %in nanoseconds
outliers = abs(data(:,2)) > phaseRange;
data(outliers,:) = [];
figure();
cla();
plot(data(:,1),data(:,2));
xlabel("Time (seconds)");
ylabel("Phase Error (ns)");
```

```
title("Combined Phase Error Data (Removed Glitches)");
```



Process data from the long-term lower-precision section of the test

```
longTermSection = data(69000:10:end,:);
fit = polyfit(longTermSection(:,1),longTermSection(:,2),15);
```

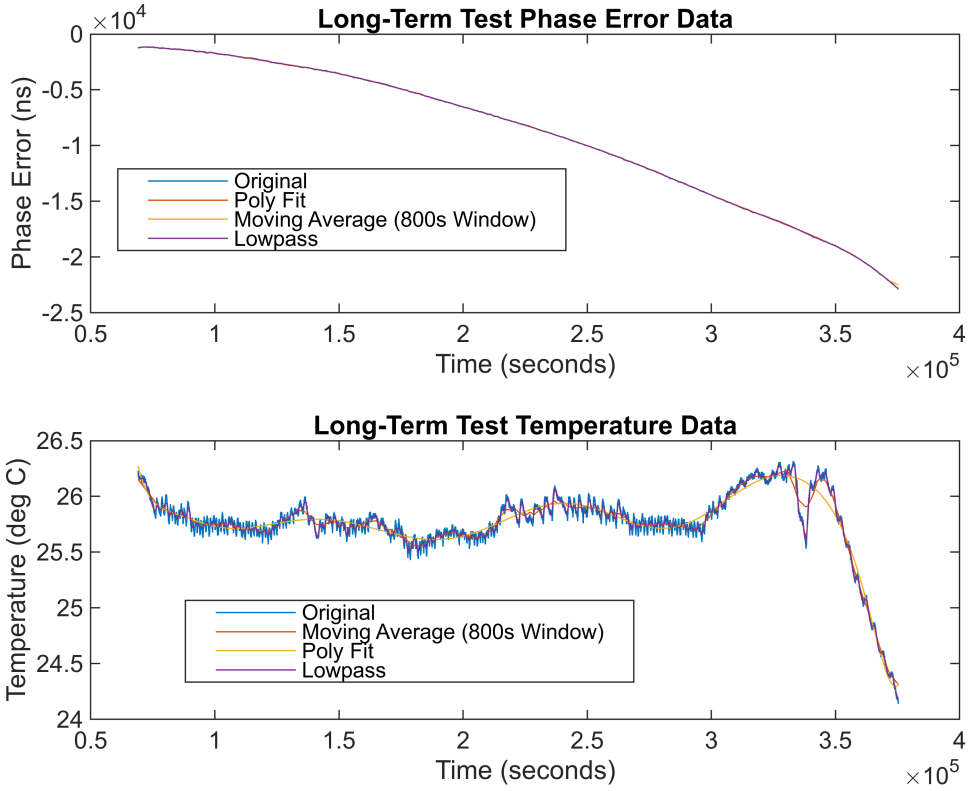
```
Warning: Polynomial is badly conditioned. Add points with distinct X values, reduce the degree of the
polynomial, or try centering and scaling as described in HELP POLYFIT.
```

```
phaseCurve = polyval(fit,longTermSection(:,1));

fitTemp = polyfit(longTermSection(:,1),longTermSection(:,3),15);
```

```
Warning: Polynomial is badly conditioned. Add points with distinct X values, reduce the degree of the
polynomial, or try centering and scaling as described in HELP POLYFIT.
```

```
tempCurve = polyval(fitTemp,longTermSection(:,1));

phaseAvg = movmean(longTermSection(:,2),800);
tempAvg = movmean(longTermSection(:,3),800);

phaseLowpass = lowpass(longTermSection(:,2),1/3000,1/10,"ImpulseResponse","iir");
tempLowpass = lowpass(longTermSection(:,3),1/3000,1/10,"ImpulseResponse","iir");

% movmean(longTermSection(:,2),10,)
```

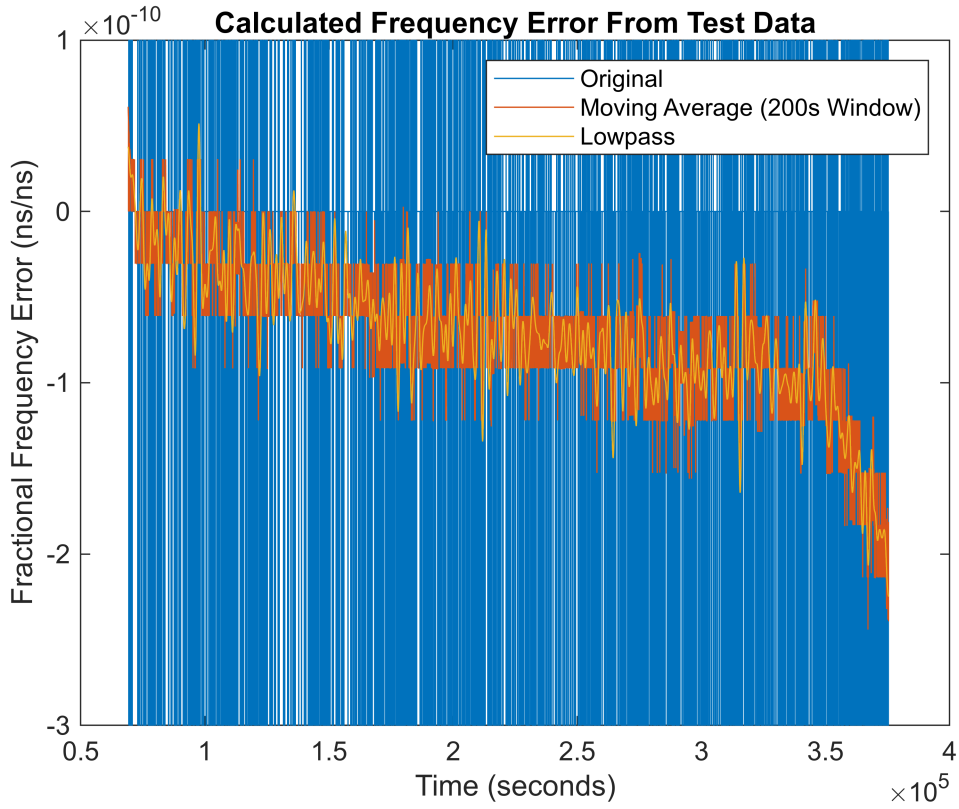
```
figure();
cla();
tiledlayout(2,1);
nexttile;
plot(longTermSection(:,1), longTermSection(:,2));
hold on;
plot(longTermSection(:,1), phaseCurve);
plot(longTermSection(:,1), phaseAvg);
plot(longTermSection(:,1), phaseLowpass);
xlabel("Time (seconds)");
ylabel("Phase Error (ns)");
title("Long-Term Test Phase Error Data");
legend(["Original" "Poly Fit" "Moving Average" "Lowpass"]);
nexttile;
plot(longTermSection(:,1), longTermSection(:,3));
hold on;
plot(longTermSection(:,1), tempAvg);
plot(longTermSection(:,1), tempCurve);
plot(longTermSection(:,1), tempLowpass);
xlabel("Time (seconds)");
ylabel("Temperature (deg C)");
title("Long-Term Test Temperature Data");
legend(["Original" "Moving Average" "Poly Fit" "Lowpass"]);

nexttile(1)
legend(["Original", "Poly Fit", "Moving Average (800s Window)" "Lowpass"],
"Position", [0.1556 0.7972 0.4000, 0.0976])

nexttile(2)
legend(["Original", "Moving Average (800s Window)", "Poly Fit" "Lowpass"],
"Position", [0.2145 0.1543 0.4, 0.0976])
```



The moving average processsing will be used. For temperature specifically, a lowpass filter should be applied for more accuracy (to simulate thermal capacitance of the CSAC)

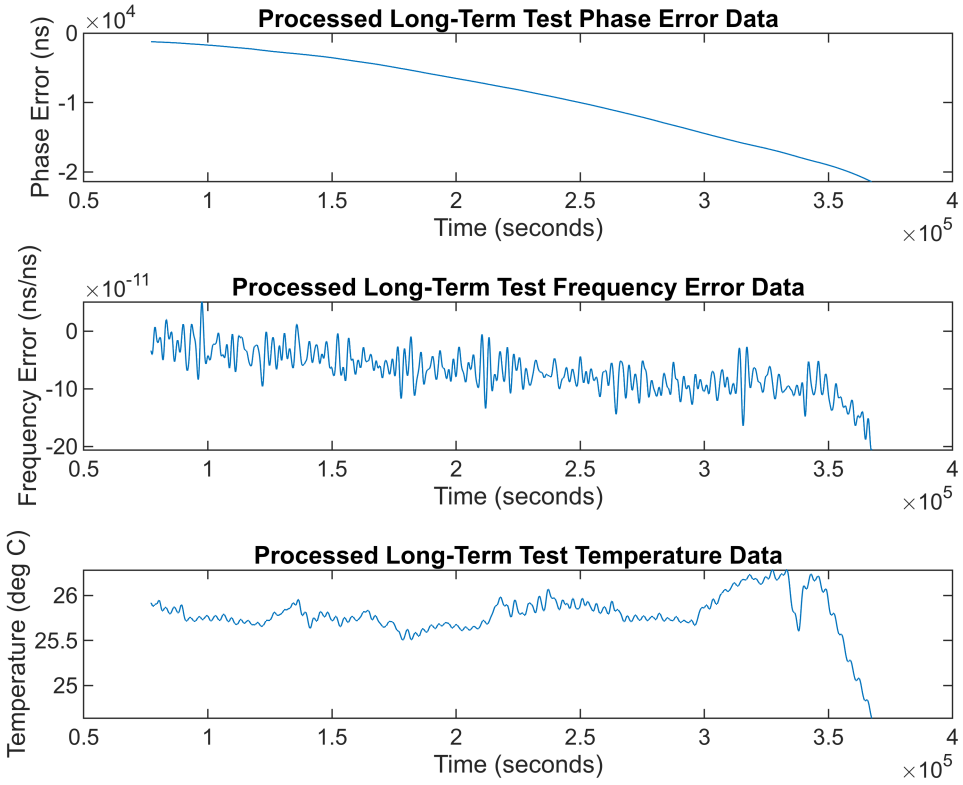
Calculate frequency error from phase error

```
figure();
cla();
diffs = [diff(longTermSection(:,1)) diff(longTermSection(:,2))];
derivative = (diffs(:,2) ./ diffs(:,1)) * 10^-9; %ADJUSTED FOR UNITS OF ns/ns!!
freqAvg = movmean(derivative,200);
freqLowpass = lowpass(derivative,1/3000,1/10,"ImpulseResponse","iir");
plot(longTermSection(2:end,1), derivative);
hold on;
plot(longTermSection(2:end,1), freqAvg);
plot(longTermSection(2:end,1), freqLowpass);
xlabel("Time (seconds)");
ylabel("Fractional Frequency Error (ns/ns)");
title("Calculated Frequency Error From Test Data");
legend(["Original", "Moving Average (200s Window)" "Lowpass"]);
ylim([-3*10^-10 10^-10]);
```



Display data to be exported

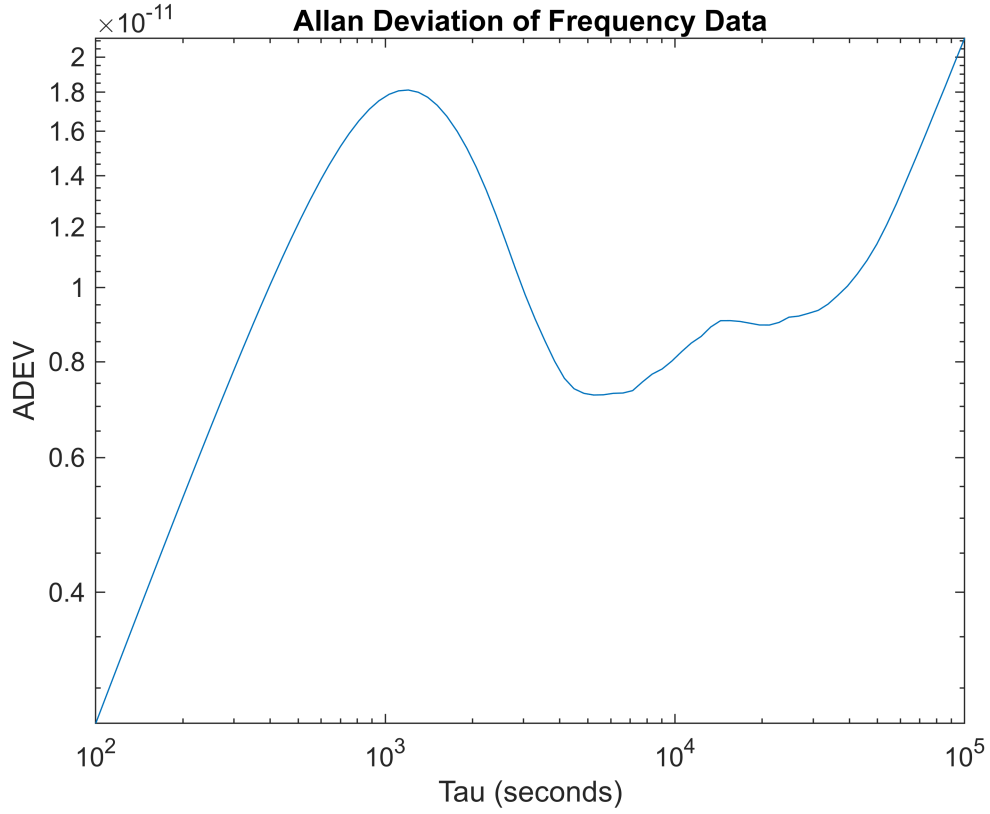
```
pad = 800;
compiledData = [longTermSection(pad+1:end-pad,1), phaseAvg(pad+1:end-pad),
freqLowpass(pad:end-pad), tempLowpass(pad+1:end-pad)];
figure();
cla();
tiledlayout(3,1);
nexttile;
plot(compiledData(:,1),compiledData(:,2));
xlabel("Time (seconds)");
ylabel("Phase Error (ns)");
title("Processed Long-Term Test Phase Error Data");
nexttile;
plot(compiledData(:,1),compiledData(:,3));
xlabel("Time (seconds)");
ylabel("Frequency Error (ns/ns)");
title("Processed Long-Term Test Frequency Error Data");
nexttile;
plot(compiledData(:,1),compiledData(:,4));
xlabel("Time (seconds)");
ylabel("Temperature (deg C)");
title("Processed Long-Term Test Temperature Data");
```




```
writematrix(compiledData,"ProcessedData_105hrs.csv");
```

Allan Deviation Plot

```
[AVAR, tau] = allanvar(freqLowpass,round(logspace(1,4,90)),0.1);
figure();
cla();
loglog(tau, sqrt(AVAR));
xlabel("Tau (seconds)");
ylabel("ADEV");
title("Allan Deviation of Frequency Data");
```


Allan Deviation of Frequency Data
×10^-11
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
ADEV
10^2
10^3
10^4
10^5
Tau (seconds)