Analysis of CO $^{60}\beta$-source data. Data set consists of 1805 time stamped waveforms recorded at 145 GSa/s.

In[775]:=
```
SetDirectory["~white/Desktop/4mm^2"];
Drop[FileNames[], 1] // Length;
ntrace = %
```

Out[777]= 1805

In[778]:=
```
Namelist = Drop[FileNames[], 1];
Namelist[[1]]
```

Out[779]= T00001.csv

In[780]:=
```
time = Transpose[Import[Namelist[[1]], "Data"]][[1]];
Dimensions[time];
half = % / 2
```

Out[782]= {7993}

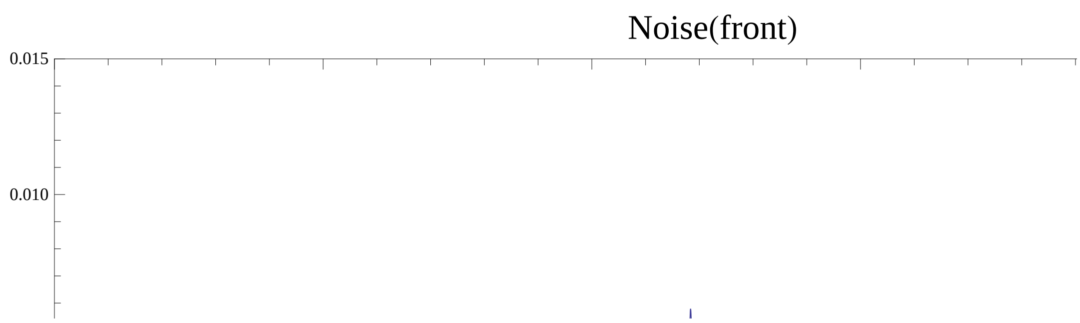
In[783]:=
```
front = Transpose[Import[Namelist[[1]], "Data"]][[2]];
offset = Mean[Take[front, 7693]]
```

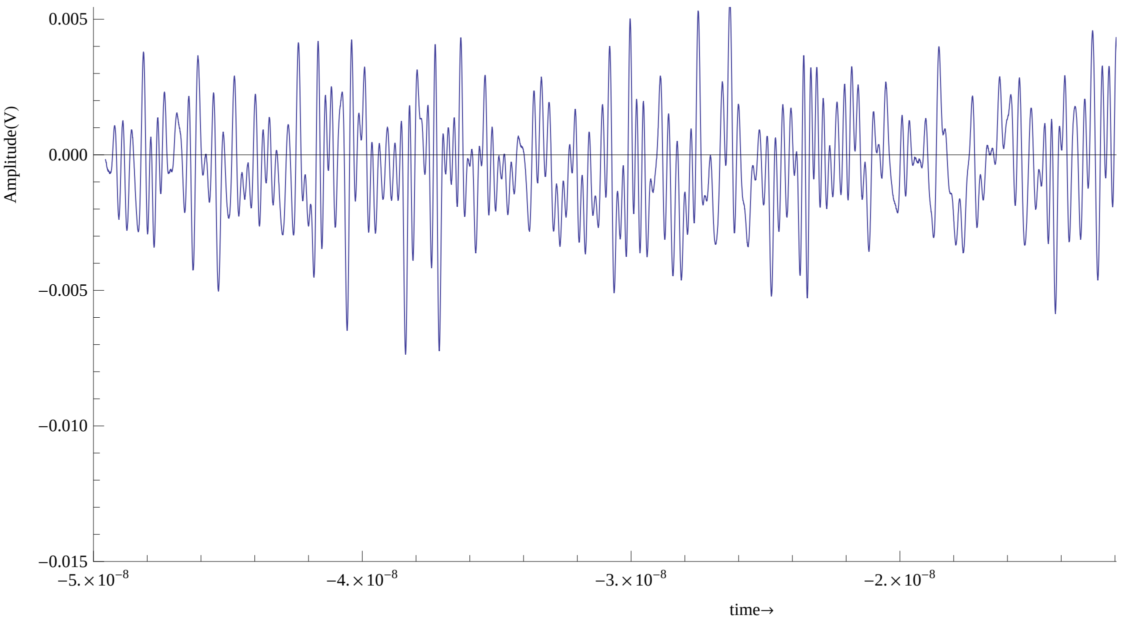
Out[784]= -0.000421501

Front and Back are the 2 APDs which face eachother. Front is closest to the CO ^{60} source.
The first 49 nanoseconds are used to extract the baseline correction which is typically ~1 mV.

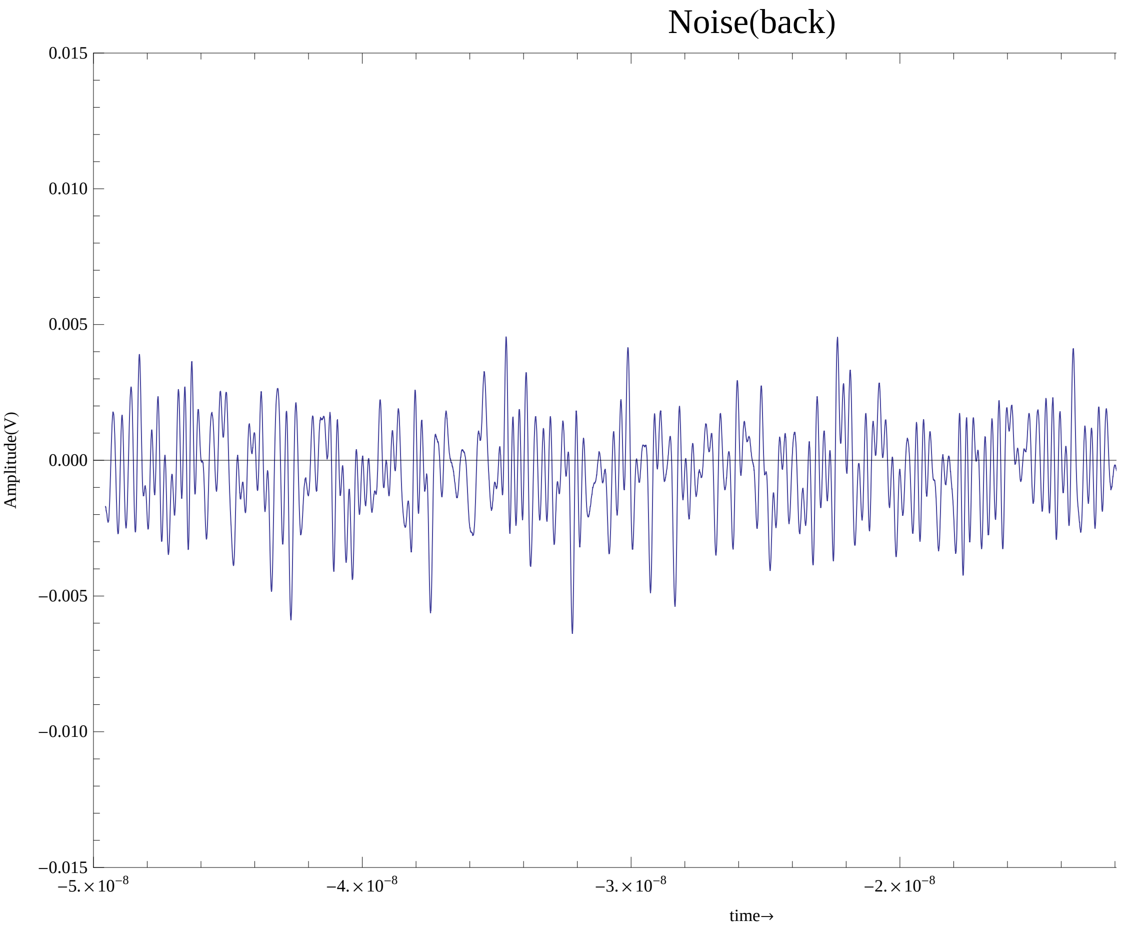
In[785]:=
```
offfront = ConstantArray[offset, 15986];
front1 = Take[front - offfront, 7693];
time1 = Take[time, 7693];
time2 = Drop[time1, -7460];
back = Transpose[Import[Namelist[[1]], "Data"]][[3]];
offset = Mean[Take[back, 7693]]
offback = ConstantArray[offset, 15986];
back1 = Take[back - offback, 7693];
GraphicsColumn[{ListPlot[Transpose[{time, front}], Joined → True, Frame → True,
   FrameLabel → {{"Amplitude(V)",}, {"time→", "Noise(front)"}},
   PlotRange → {{-0.00000005, -0.000000001}, {-.015, .015}}],
  ListPlot[Transpose[{time, back}], Joined → True, Frame → True,
   FrameLabel → {{"Amplitude(V)",}, {"time→", "Noise(back)"}},
   PlotRange → {{-0.00000005, -0.000000001}, {-.015, .015}}]}]
```

Out[790]= -0.000401331





Out[793]=



In[794]:=
```
dt = time[[2]] - time[[1]] // EngineeringForm
f = 1 / (time[[2]] - time[[1]]);
fftrange = f / 2
```

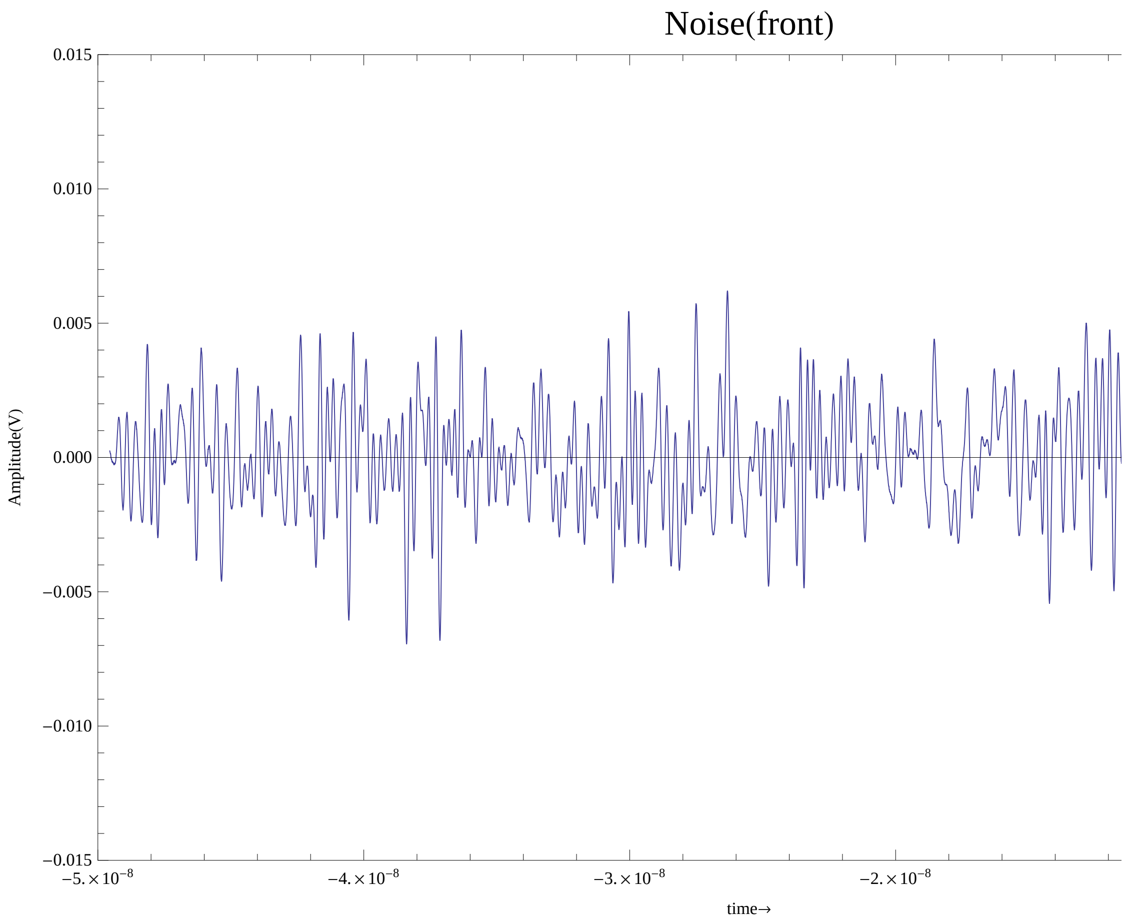
Out[794]//EngineeringForm=

6.2×10^{-12}

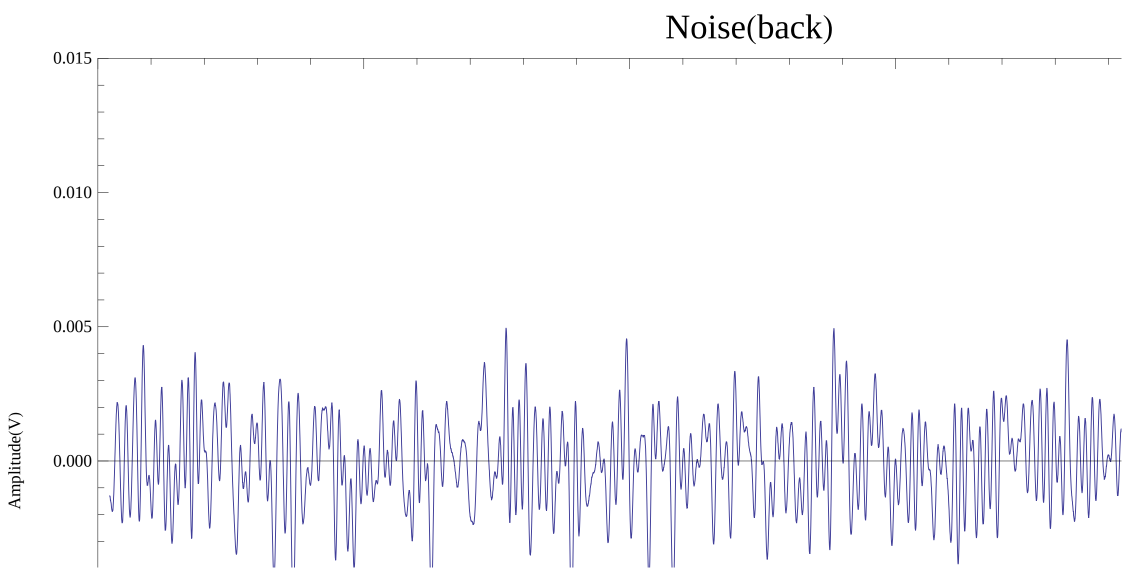
Out[796]= 8.06452×10^{10}

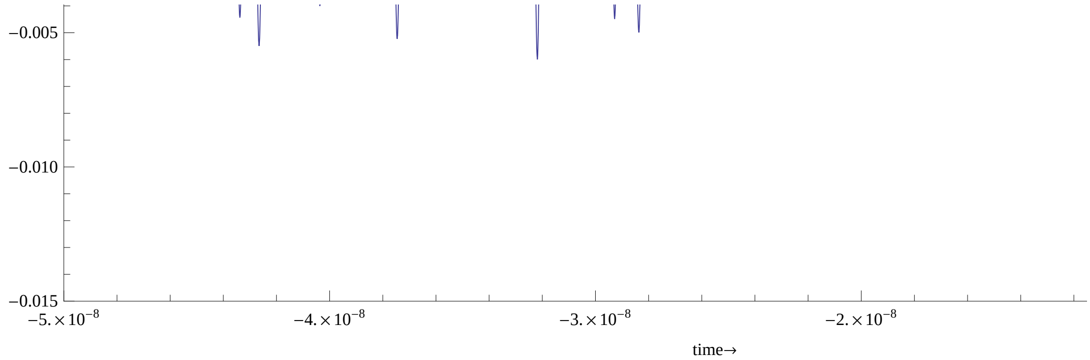
In[797]:=

```
GraphicsColumn[{ListPlot[Transpose[{time1, front1}], Joined → True, Frame → True,
   FrameLabel → {{"Amplitude(V)",}, {"time→", "Noise(front)"}},
   PlotRange → {{-0.00000005, -0.000000001}, {-.015, .015}}],
  ListPlot[Transpose[{time1, back1}], Joined → True, Frame → True,
   FrameLabel → {{"Amplitude(V)",}, {"time→", "Noise(back)"}},
   PlotRange → {{-0.00000005, -0.000000001}, {-.015, .015}}]}]
```



Out[797]=





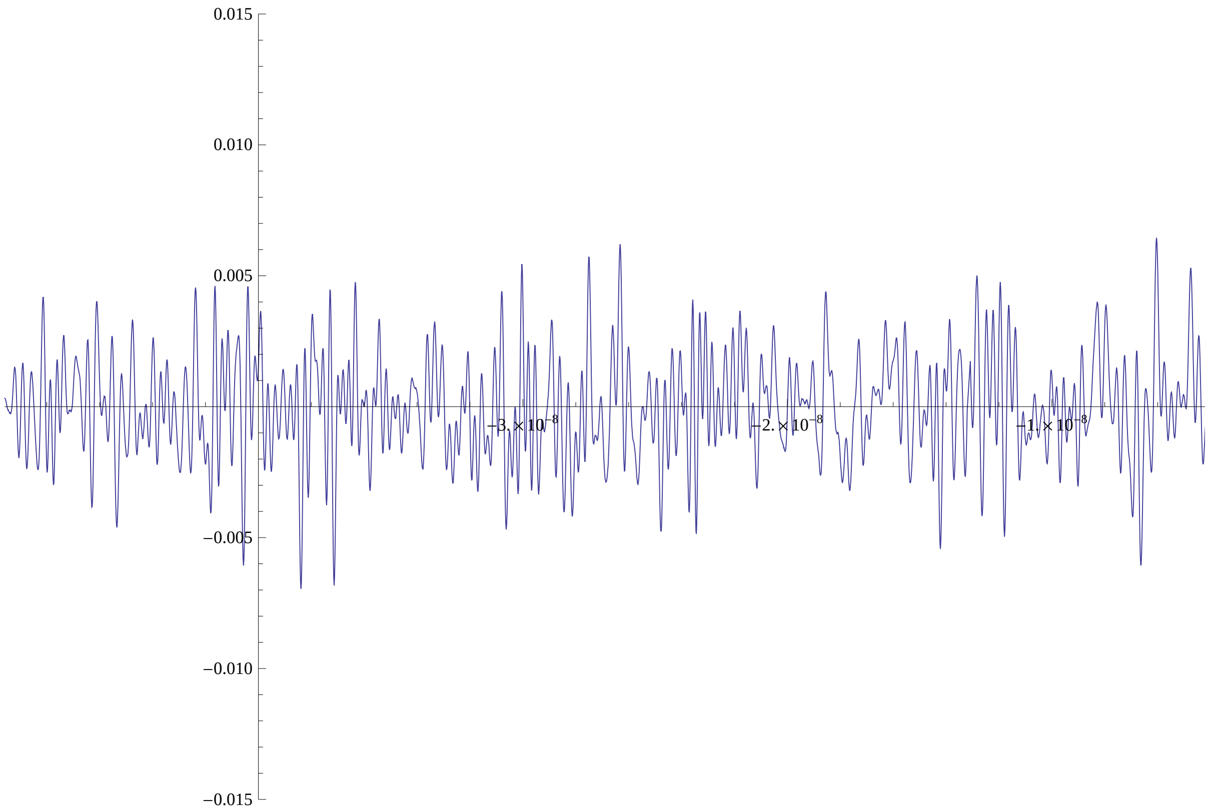
Noise Waveform as a function for later use

In[798]:=
```
Ff = Interpolation[Transpose[{time1, front1}], Method → "Spline"]
Fb = Interpolation[Transpose[{time1, back1}], Method → "Spline"]
Plot[Ff[x], {x, -4.9586 × 10^-8, -1.5117 × 10^-9},
 PlotRange → {{-4.9586 × 10^-8, -1.5117 × 10^-9}, {-.015, .015}}]
```

Out[798]= `InterpolatingFunction[{{-4.95526 × 10^-8, -1.4776 × 10^-9}}, <>]`

Out[799]= `InterpolatingFunction[{{-4.95526 × 10^-8, -1.4776 × 10^-9}}, <>]`

Out[800]=



In[801]:=
```
fftout1 = Abs[ FourierDCT[front1]];
df = fftrange / 7693;
```

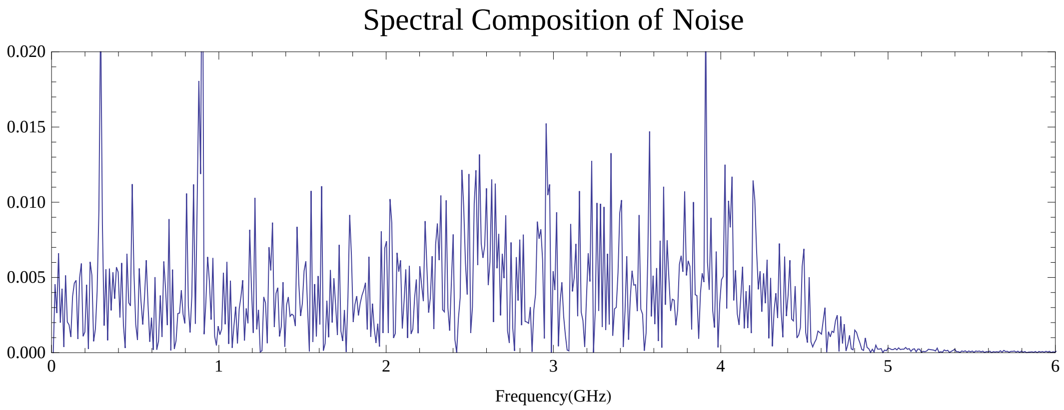
In[803]:=
```
freq = Range[df, fftrange, df] / 1 000 000 000.;
```

In[804]:=
```
fftnew = Transpose[{freq, fftout1}];
```

For this scope the Sampling frequency is much higher than the actual bandwidth. Therefore in the plots below there is a white noise distribution out to a few GHz. Above this (the scope bandwidth) there is an apparent reduction in noise. But in this region data are really reflecting the fact that high sampling frequency is really a figment of ' on - chip " interpolation.

In[805]:=
```
ListPlot[fftnew, Joined → True, AspectRatio → 0.3, ImageSize → Large, Frame → True,
 FrameLabel → {{, }, {"Frequency(GHz)", "Spectral Composition of Noise"}},
 PlotRange → {{0, 6}, {0, .02}}]
```

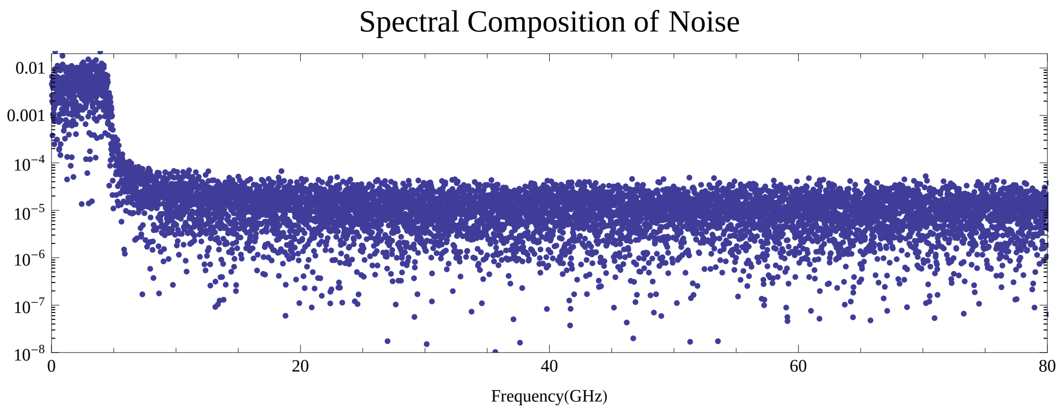
Out[805]=



This has zero frequency in element 1. The 7693- th element corresponds to 1/2 the sampling frequency.After that aliassing takes over and the frequency heads back to zero.

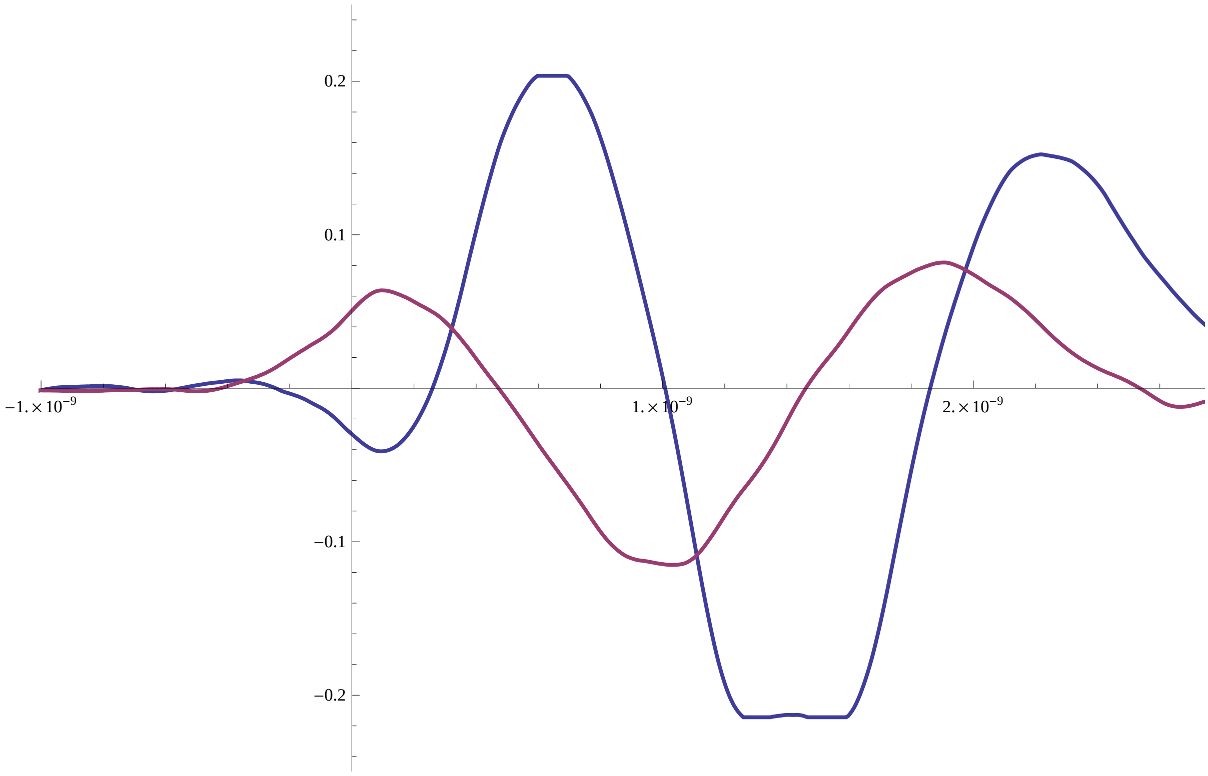
In[806]:=
```
ListLogPlot[fftnew, AspectRatio → 0.3, Frame → True,
 FrameLabel → {{, }, {"Frequency(GHz)", "Spectral Composition of Noise"}},
 ImageSize → Large, PlotRange → {{0, 80}, {10^-8, .02}}]
```

Out[806]=



In[807]:=
```
ListPlot[{Transpose[{time, front - offfront}], Transpose[{time, back - offback}]},
 Joined → True, PlotStyle → Thick, PlotRange → {{-10^-9, .3 × 10^-8}, {-.25, .25}}]
```

Out[807]=



In[808]:=
```
Wf = ConstantArray[0, 2];
Wb = ConstantArray[0, 2];
time = Transpose[Import[Namelist[[1]], "Data"]][[1]];
time2 = Drop[Drop[time, 7693], -7460];
Dimensions[time2]
```

Out[812]= {833}

```
Do[
 Clear[front, front2, back, back2];
 front = Transpose[Import[Namelist[[itrace]], "Data"]][[2]];
front2 =
  Drop[Drop[front - ConstantArray[Mean[Take[front, 7693]], 15 986], 7693], -7460];
Wf[[itrace]] = Interpolation[Transpose[{time2, front2}], Method → "Spline"];
 back = Transpose[Import[Namelist[[itrace]], "Data"]][[3]];
 back2 = Drop[Drop[back - ConstantArray[Mean[Take[back, 7693]], 15 986], 7693], -7460];
 Wb[[itrace]] = Interpolation[Transpose[{time2, back2}], Method → "Spline"];
 , {itrace, 2}]
```

Set::write : Tag Times in 0 {833} is Protected. ≫

Set::write : Tag Times in 0 {833} is Protected. ≫

In[814]:=
```
Zeroes = x /. FindRoot[Wb[[#]][x], {x, 1.5 × 10^-9}] & /@ Range[2];
Zeroes
```

Out[815]= $\{1.46078 \times 10^{-9},\ 1.54817 \times 10^{-9}\}$