Status Update

Progress overview

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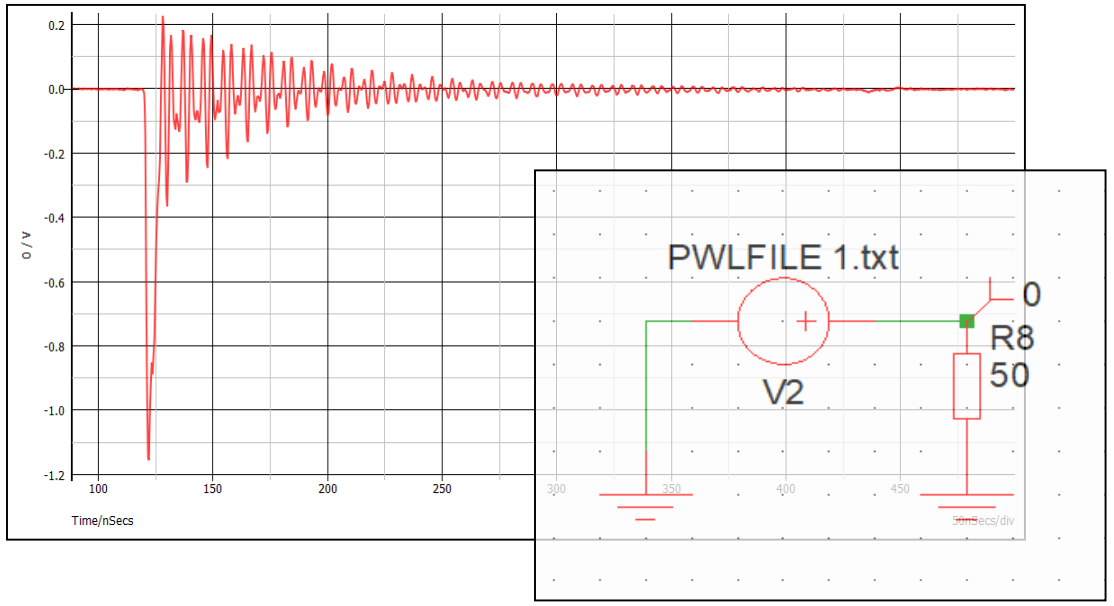
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

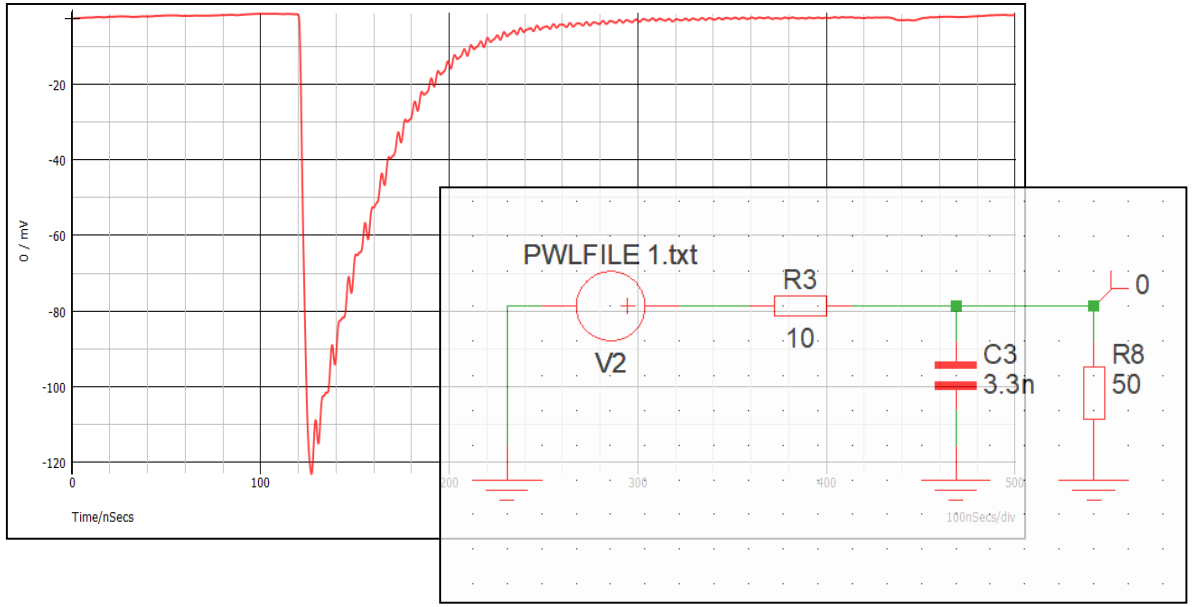
DESY.

Simulation

Faraday cup measurements

- Waveform capture from the two different Faraday cups
- Simulation of simple RC filter to observe the effect on charge measurement

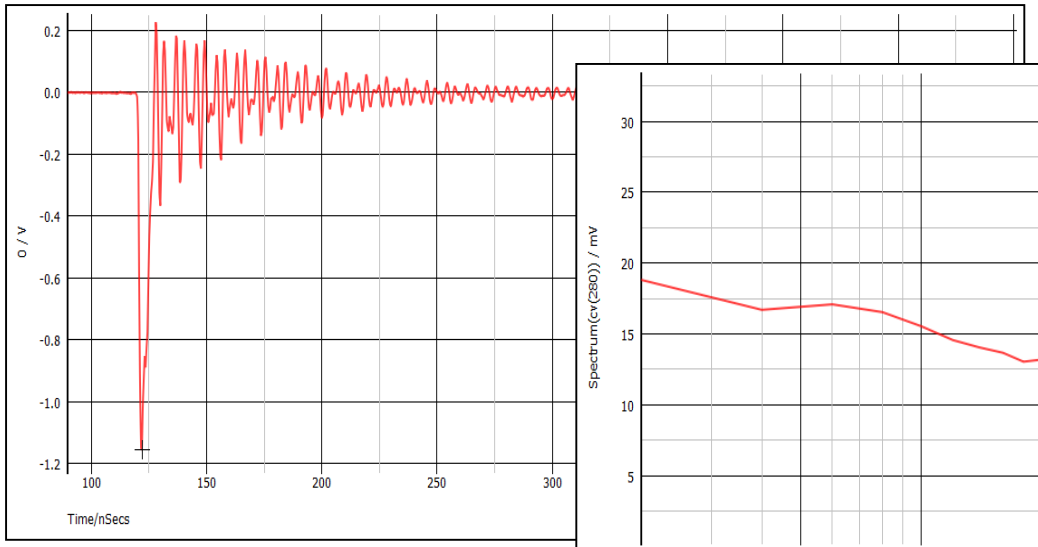


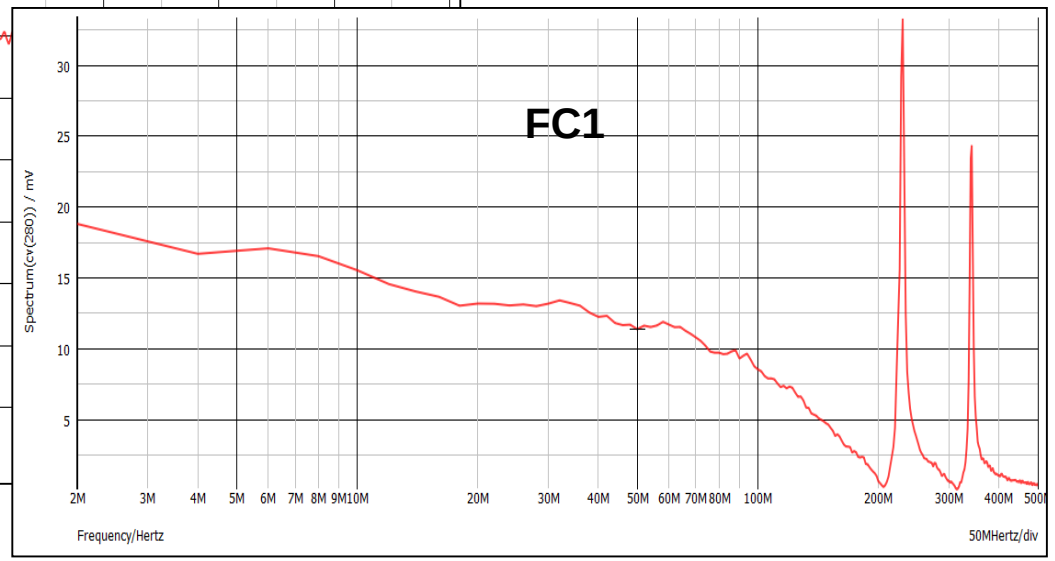


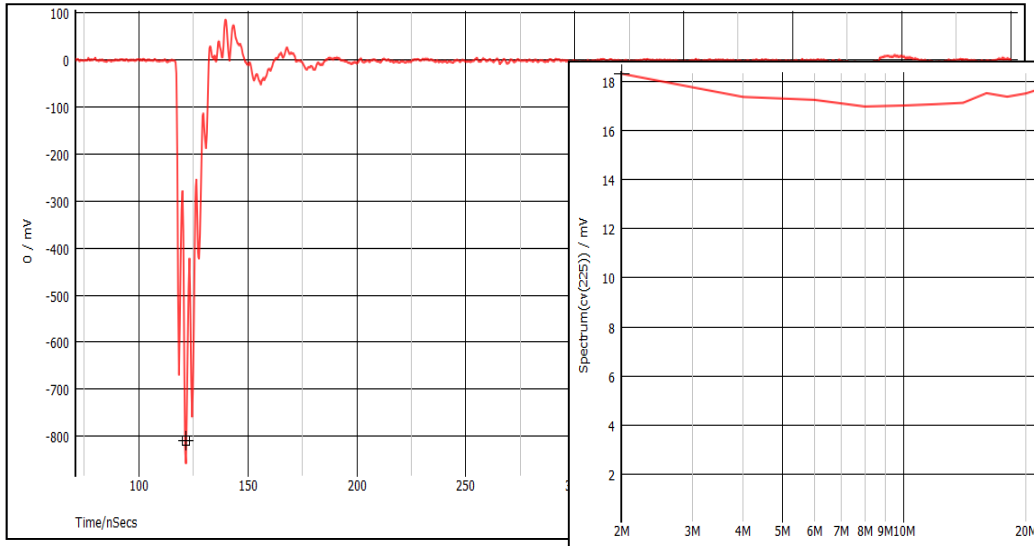
Simulation

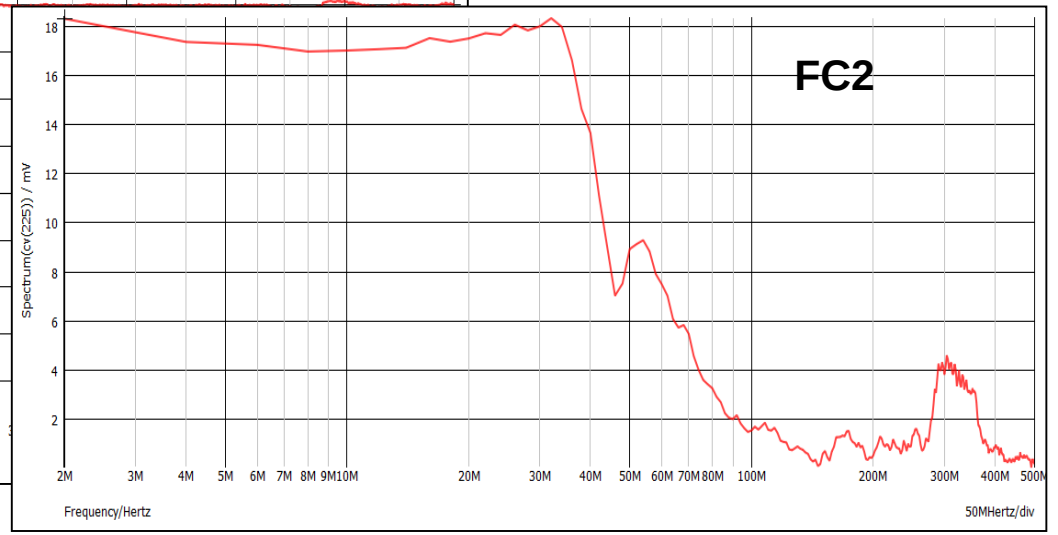
Faraday cup measurements

- Faraday cup signal frequency components
- Both the Cups have distinct frequency components
- The ringing can be a reflection effect or somehow related to design of the faraday cup





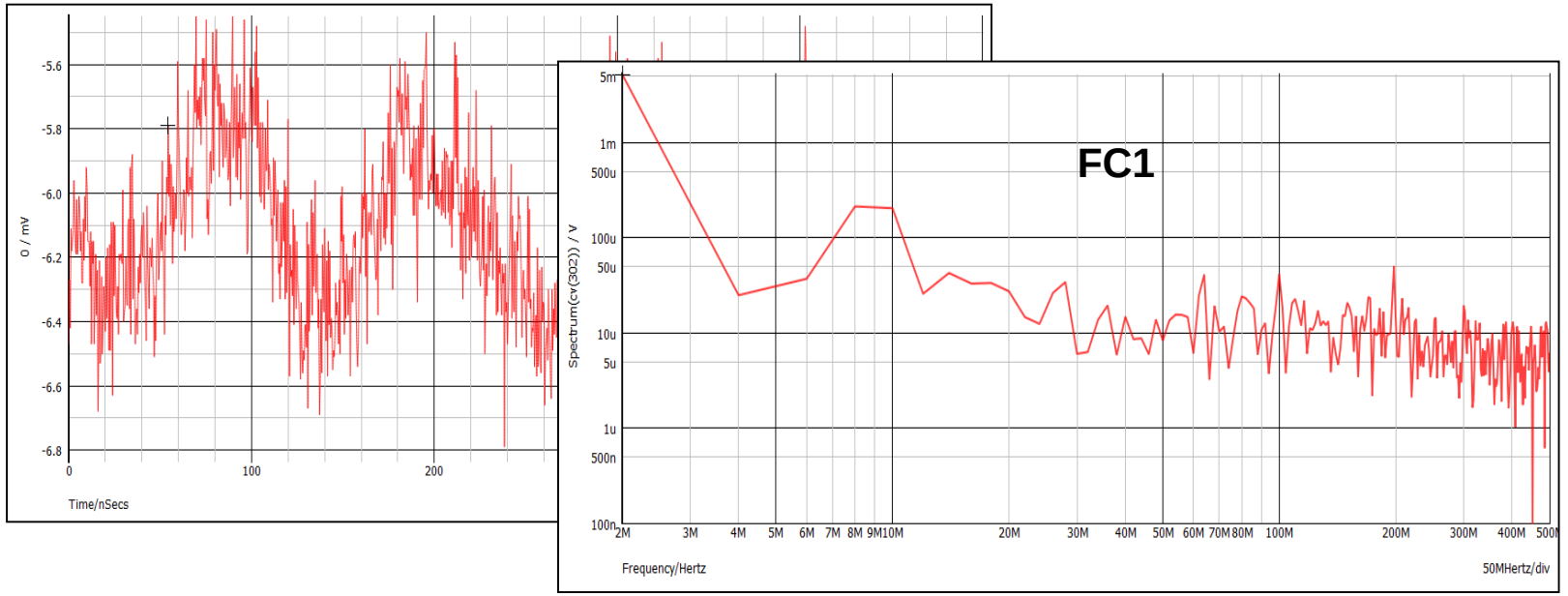


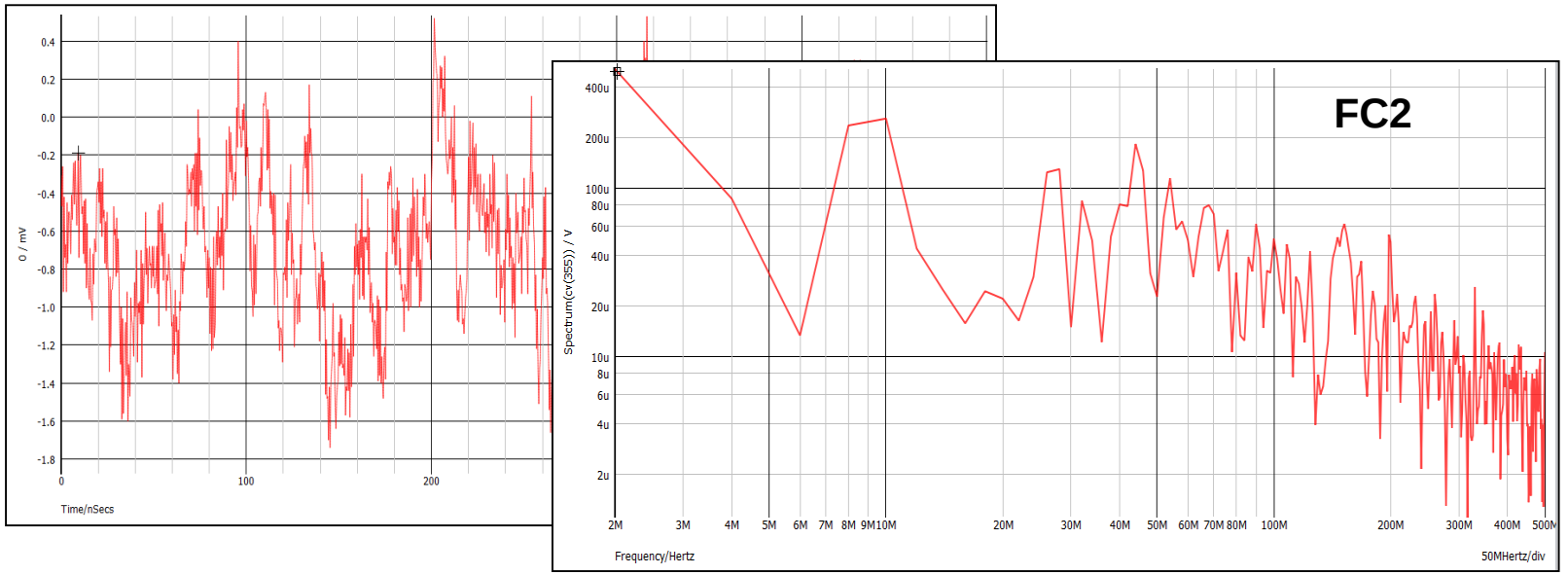


Simulation

Faraday cup measurements

- Base noise frequency components
- Both the Cups have similar frequency components i.e. 8-10Mhz component
- But the difference is that there is a significant offset in one of the Faraday cup signals





Simulation

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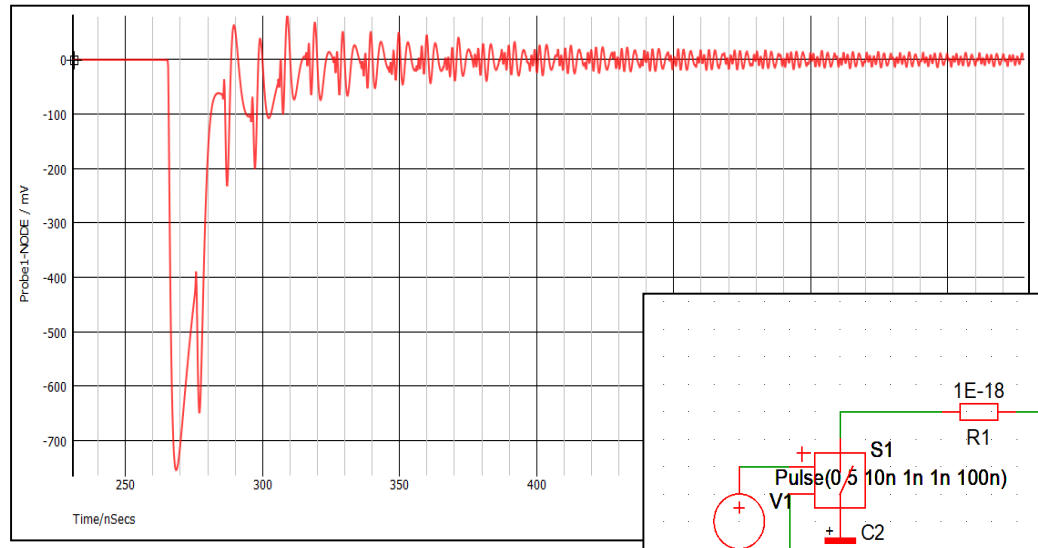
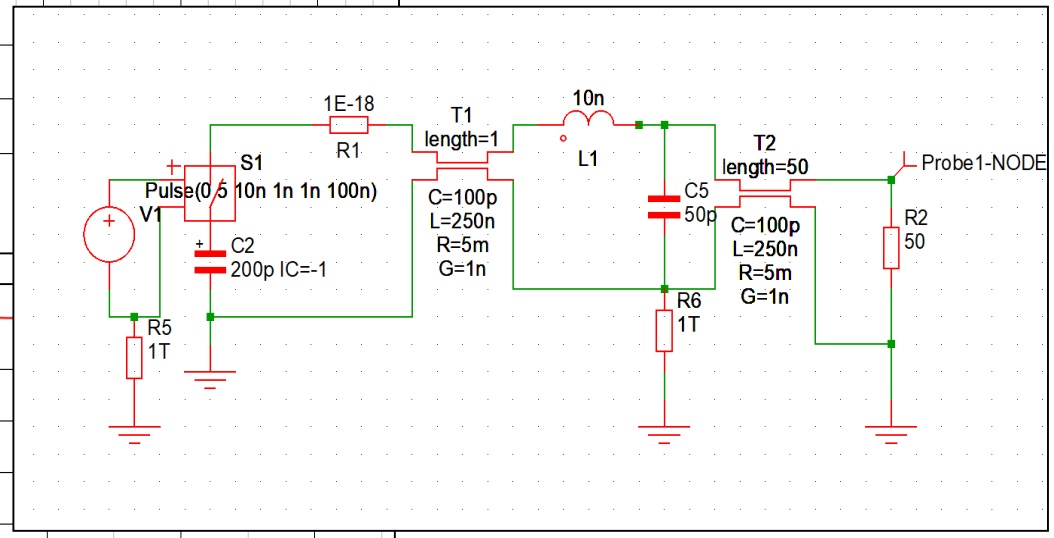
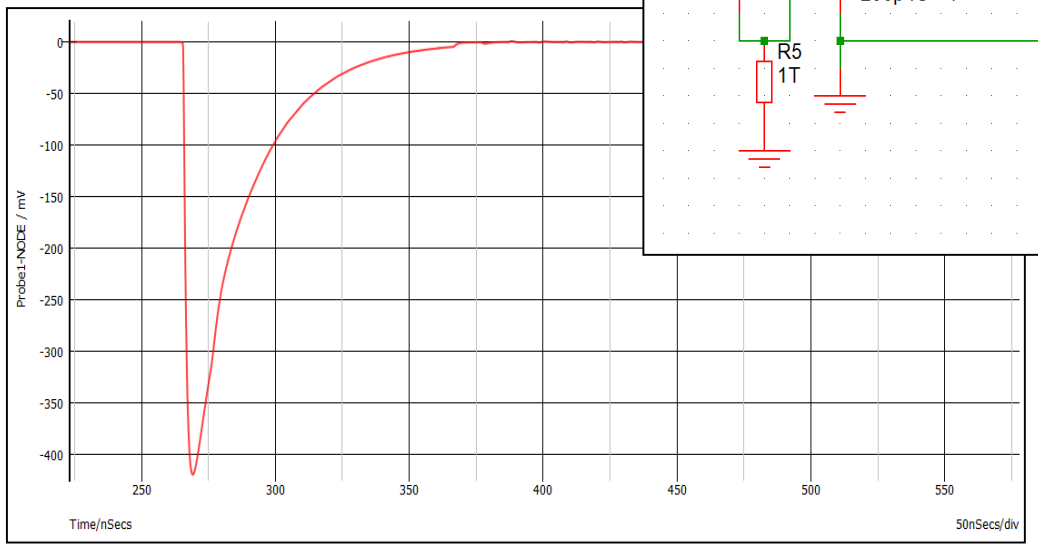
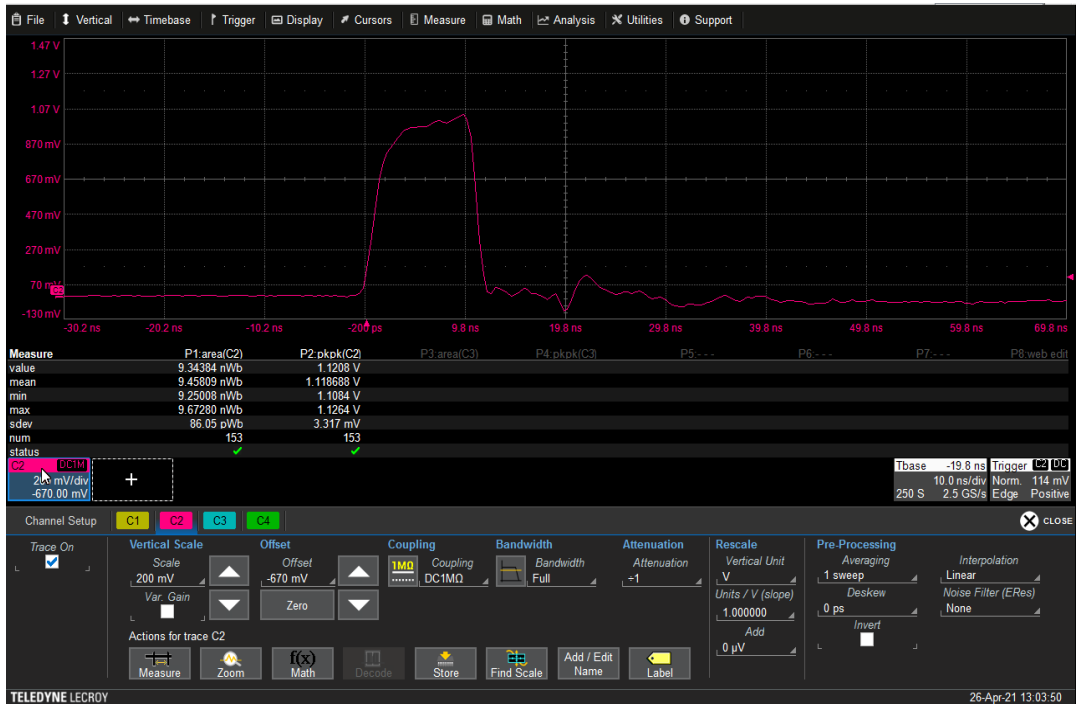






Scope measurements

Charge measurement dependency on scope configuration



The screenshots above represent same signal with different coarse vertical scale(no variable gain). In both scenarios the area calculated is different by ~1.5%(average of atleast 100 captures).

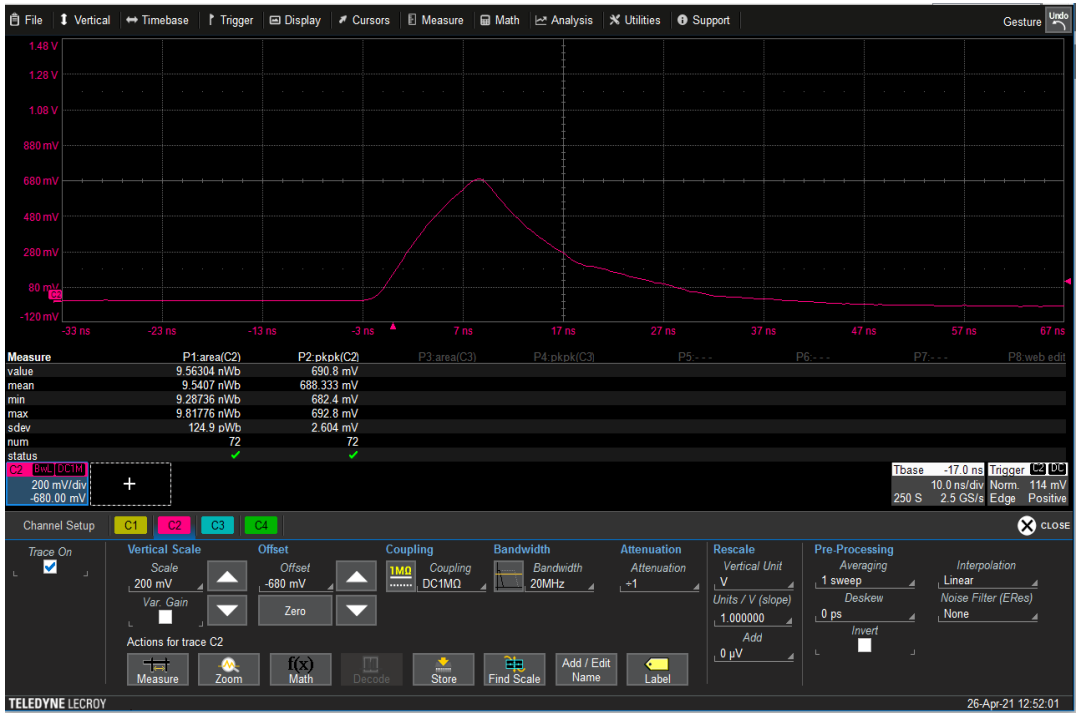
Area(left snapshot)=9.45809

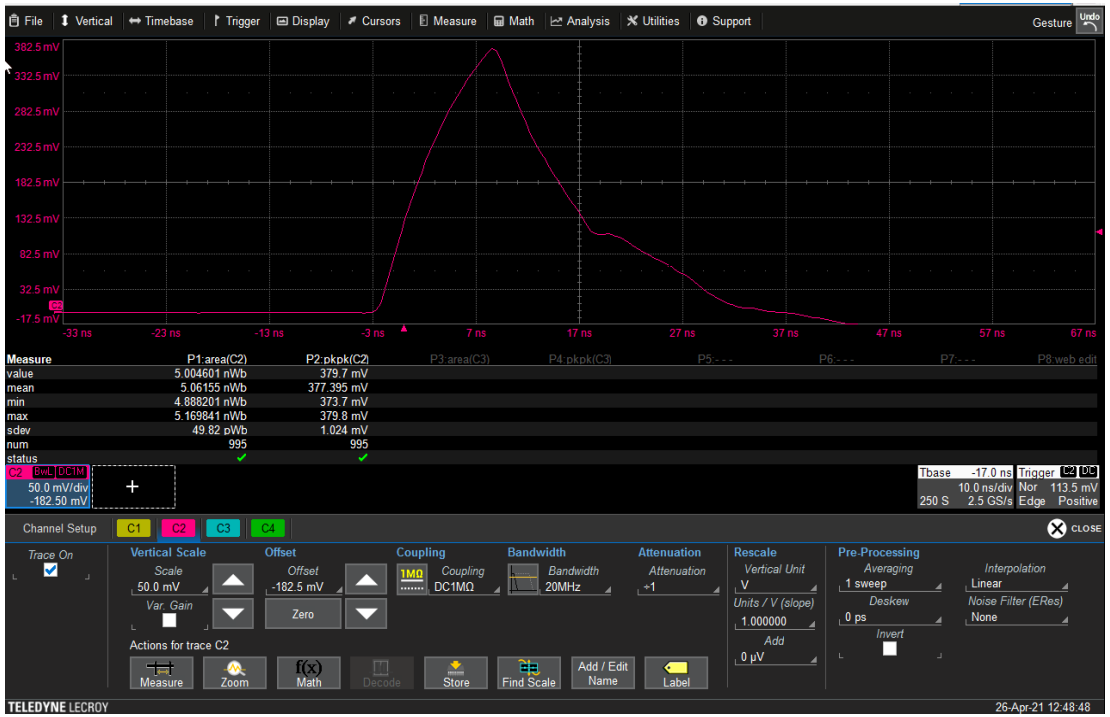
Area(right snapshot)=9.59538

Difference=0.14

Scope measurements

Effect of Scope's bandwidth limitation on vertical scale

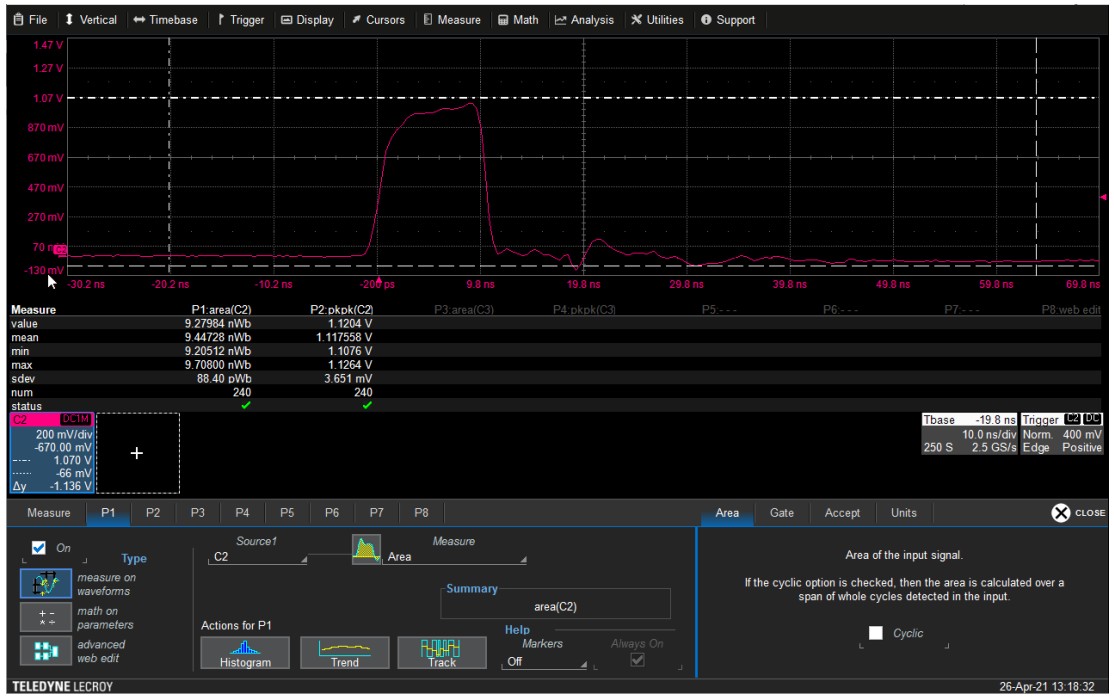


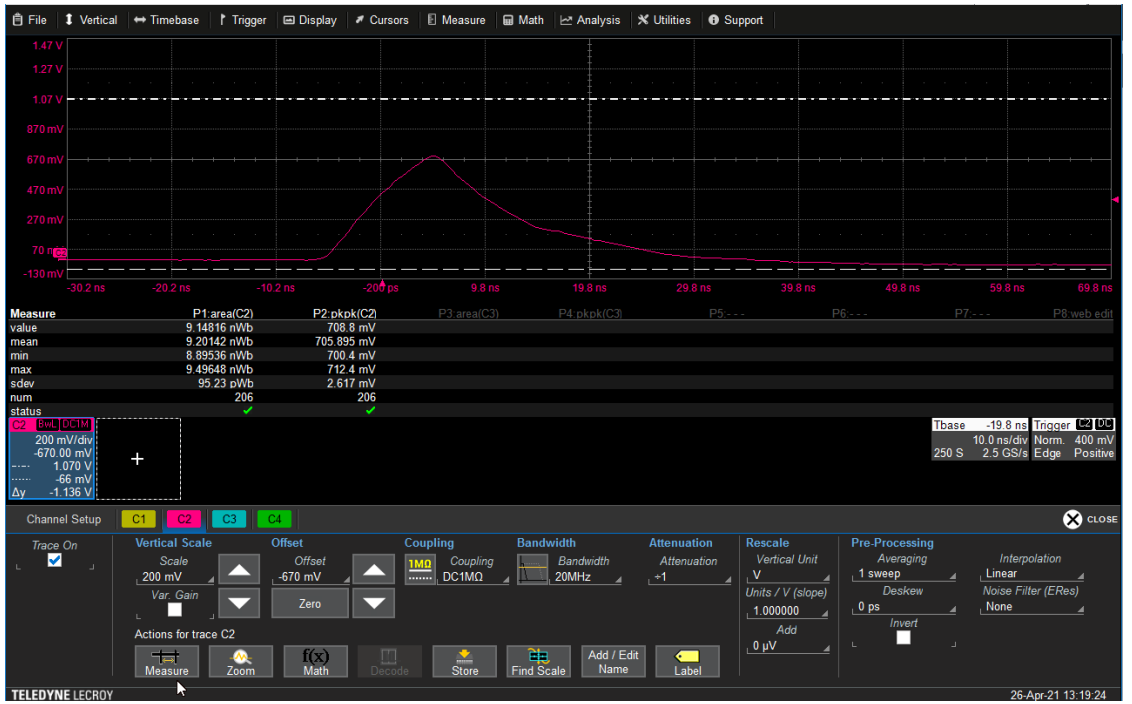


There is some weird behavior when the bandwidth limitation(20 Mhz) is turned on. The vertical scale behaves strangely when the vertical scale is decrease to fill the screen (for accurate measurement), the signal amplitude also drops without clipping of the signal. It can be seen in the above graphs as the input signal is unchanged but only the vertical scale is changed, this does not happen on other scope(tektronix). This effect appears even in the variable gain mode, when it occurs you can hear the relay inside the scope being triggered(Have already tried different scope of the same model, it also have the same behaviour)

Scope measurements

Effect of Scope's bandwidth limitation on charge calculations





Reducing the bandwidth of the scope does not effect the charge measurement, since the bandwidth limitation is essentially low pass filtering the charge would be retained. As it can be seen from the figures.

Area(left)=9.4472

Arean(right)=9.20142

The difference in the area is due to different vertical height of the same signal. But the difference is reduced significantly by using variable gain to have same vertical height for the signal as seen in the next slide

Scope measurements

Effect of Scope's bandwidth limitation on charge calculations

Scale(mV)	noise(mV)	full scale(8-divisions)(mV)	SNR(fullscale/noise)(dB)
1	0.145	8	34.83
2	0.145	16	40.85
5	0.15	40	48.51
10	0.155	80	54.25
20	0.185	160	58.73
50	0.275	400	63.25
100	0.5	800	64.08
200	1.75	1600	59.22
500	2.75	4000	63.25
1000	4.9	8000	64.25

Area(no BWL)=9.4472

Area(20MHz BWL)=9.20142

Area(20MHz BWL, height adjusted)=9.42147

The table on right is the vertical noise floor figures from the oscilloscope webpage.

Faraday cup measurements

Observing effect of long lines on the measurement

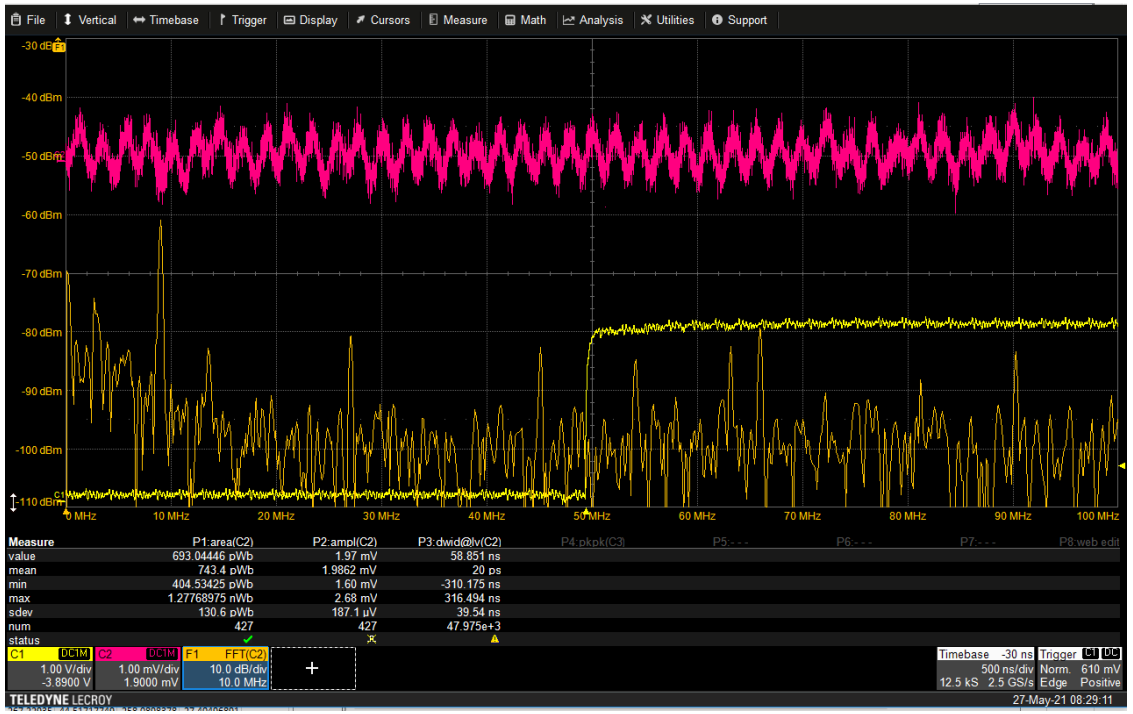
The signal is fed to the connection panel inside the tunnel for both the faraday cups(1&2) and as it can be seen the strange ripple effect is not due to any mismatch in the transmission line. This confirms the ringing noise is atleast not due to the mismatch of transmission line(from tunnel to the control room) as predicted by Mario and Marek. Now there can only be 2 reasons for ringing.

1) The cable connecting the Faraday cup to the connection panel is somehow mismatched or

2) It is an internal effect of the Faraday cup(geometry/mechanical design) since both the Faraday cups are constructed differently which might also explain the different nature of ringing

Scope measurements

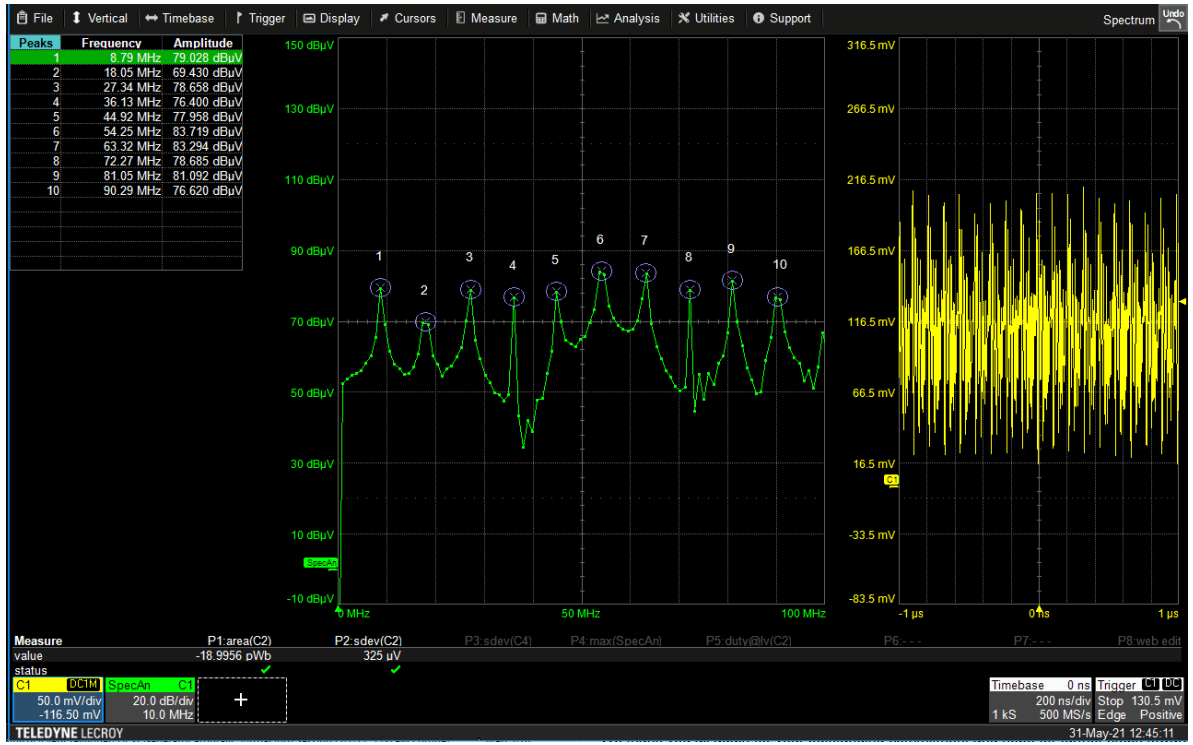
Shutdown FC1 base noise measurements



The base noise even when the tunnel is shutdown still have the 9Mhz component. But there is no offset which I had seen during the previous measurements on FC1 channel

Scope measurements

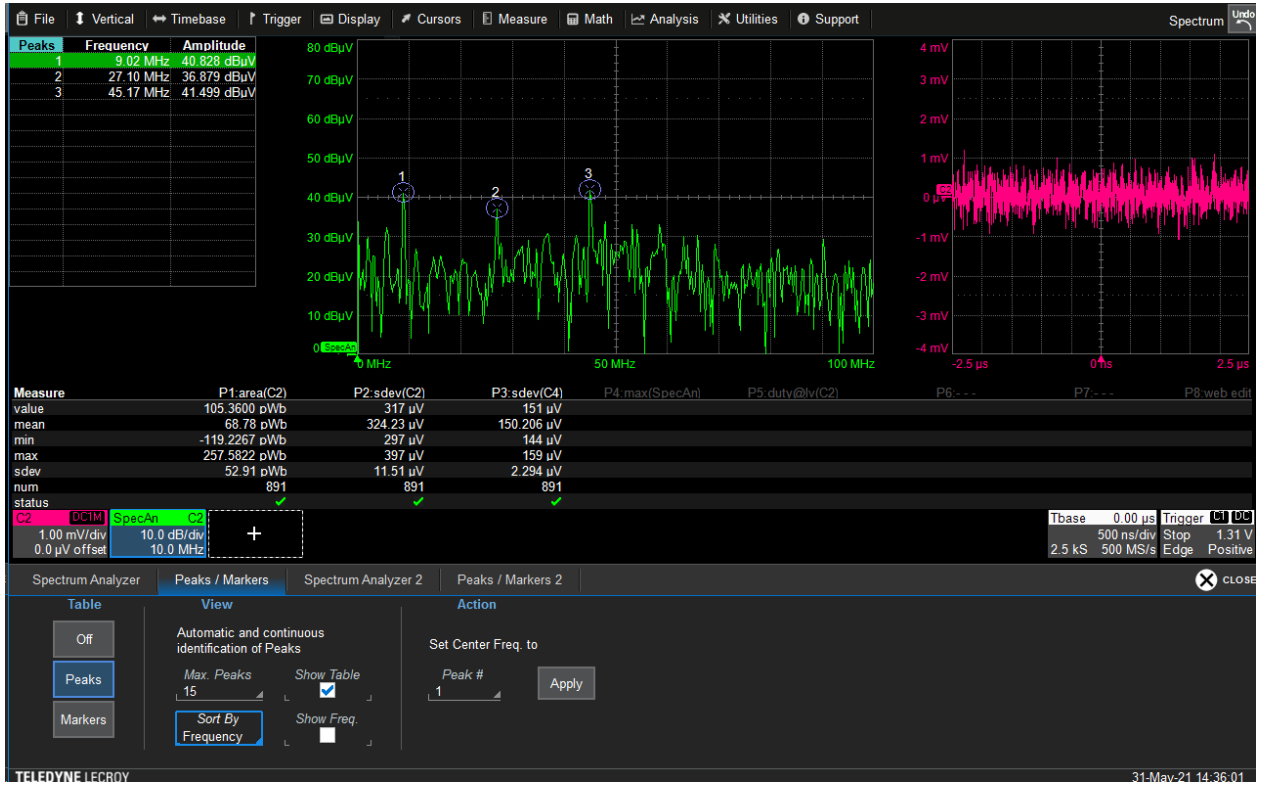
Shutdown FC1 base noise measurements



The 9Mhz component is also present on the main Trigger(10Hz).

Scope measurements

Shutdown FC2 base noise measurements



Scope measurements

Shutdown FC1 & FC2 base noise measurements

Faraday cup measurements

Using Filters to observe their effect on the charge measurement

I have done various measurement to with different filter to observe the effect on the charge measurement. The following measurements were performed.

1. The base noise measurement without the FC cable connected and only the trigger(10 hz) connected to the scope to observe if the base ~10Mhz noise is always present or it somehow couples with the FC cable.

2. Change the trigger to the charge measurement channel and measure using the script/software to compare difference of error between 10Hz triggered measurement and intrabunch measurement

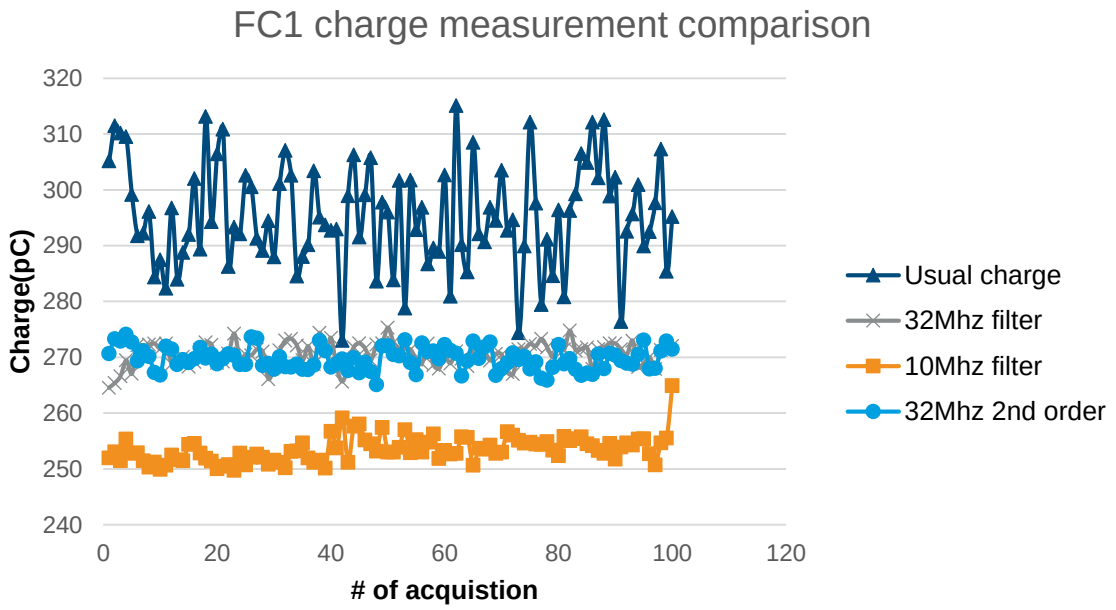
3. Using the first filter(32Mhz) the lowest usable charge and medium charge(without attenuators) scope measurement. And also with the script/software to see the effect on error before and after applying the filter.

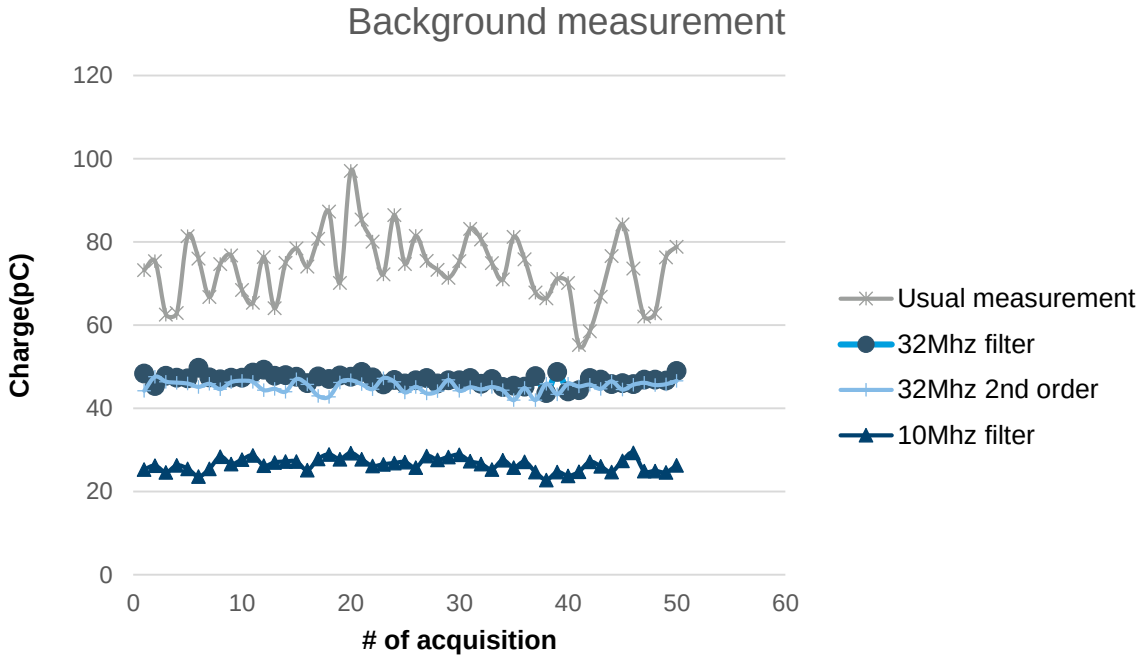
4. Using the other filter(10Mhz) and repeating the step 3 measurements.

5. Connecting both the filters in series and repeat the step 3 measurements.

FC1 measurements

Using Filters to observe their effect on the charge measurement





The effect of the filters is significant on FC1 as it can be seen on both background and charge measurement.

Charge measured by script (usual measurement)= 221.33 +/- 4.66 pC

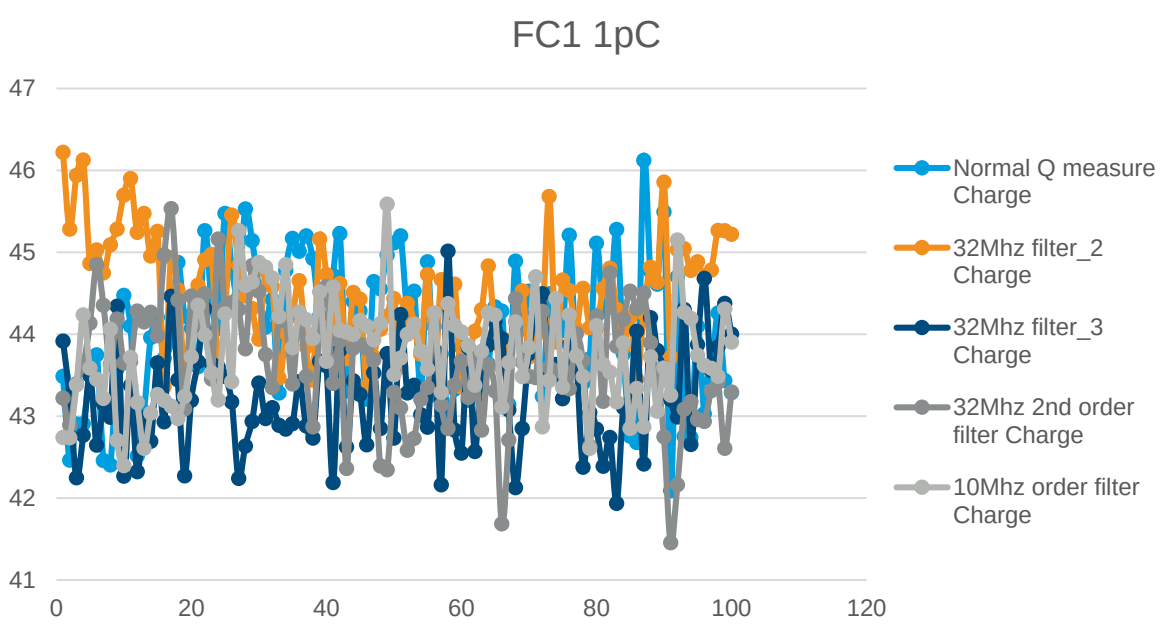
Charge measured by script (32 Mhz)= 223.67 +/- 1.64 pC

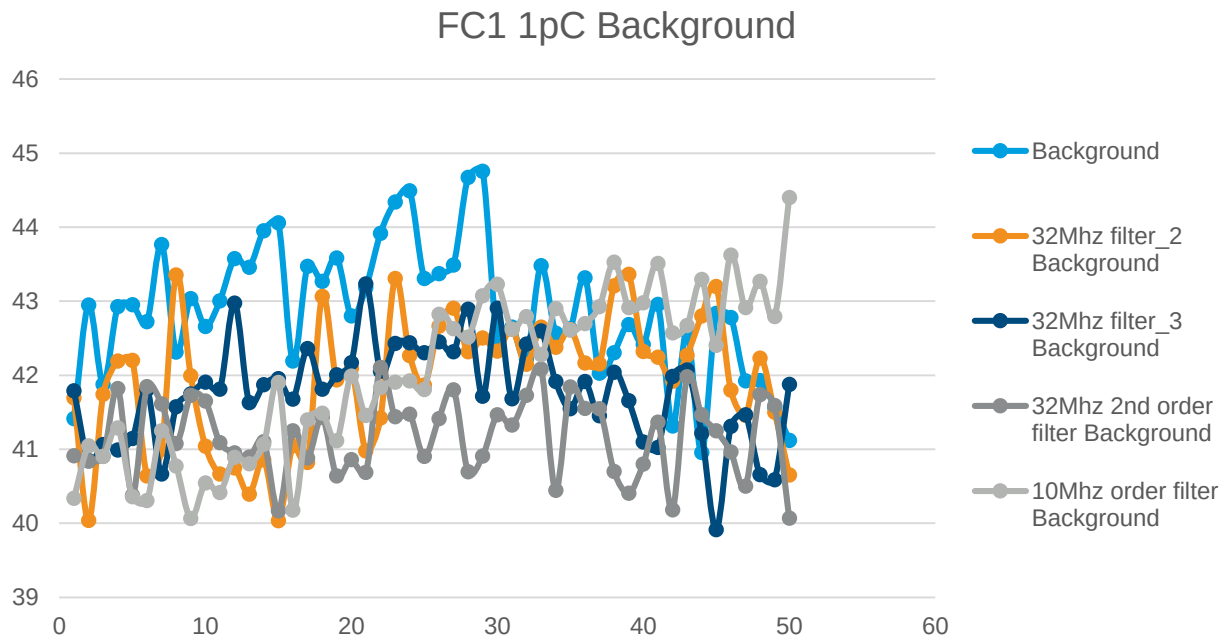
Charge measured by script (32 Mhz 2nd order)= 224.54 +/- 1.52 pC

Charge measured by script (10 Mhz)= 227.04 +/- 1.74 pC

FC1 measurements

Using Filters to observe their effect on the charge measurement





The effect of the filters is significant on FC1 as it can be seen on both background and charge measurement.

Charge measured by script (usual measurement)= 1.16 +/- 0.25i pC

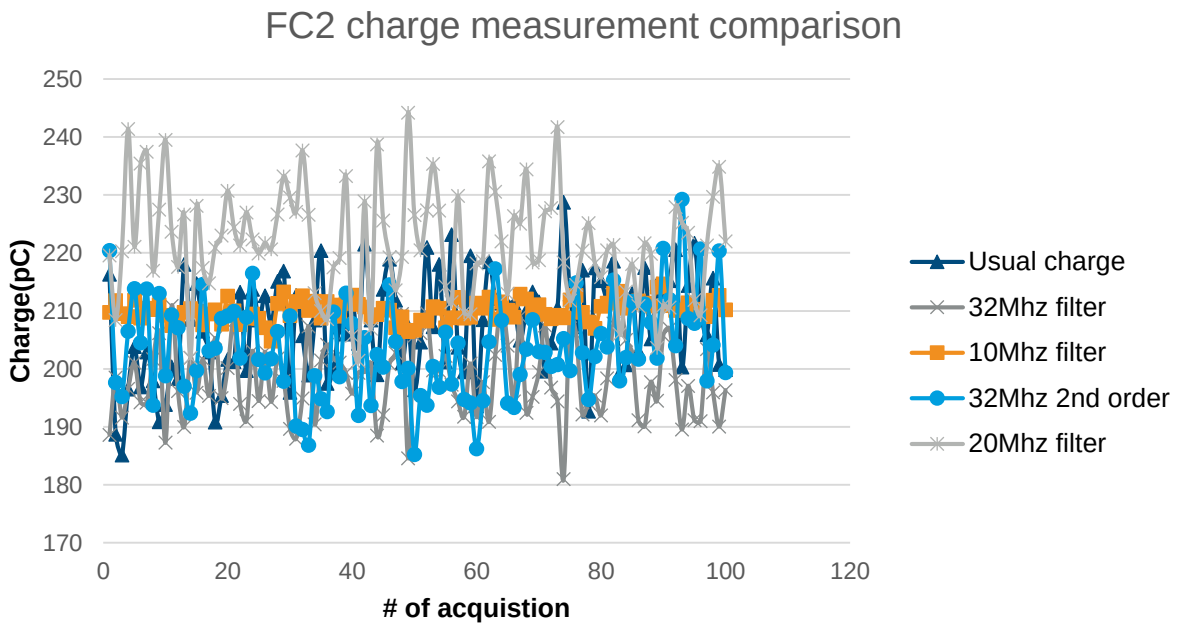
Charge measured by script (32 Mhz)= 0.36 +/- 1.27 pC, 2.58 +/- 0.57i pC, 1.5+/-0.11i pC

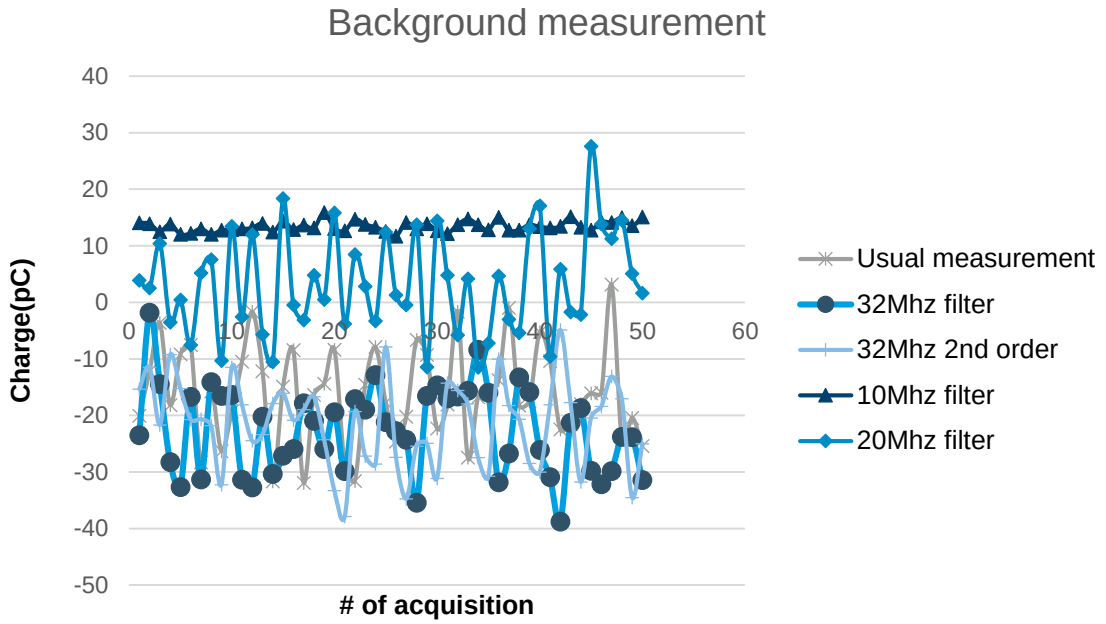
Charge measured by script (32 Mhz 2nd order)= 2.47 +/- 0.51 pC

Charge measured by script (10 Mhz)= 1.77 +/- 0.9i pC

FC2 measurements

Using Filters to observe their effect on the charge measurement





The effect of the filters is not as significant on FC2 as FC1.

Charge measured by script (usual measurement)= 223.61 +/- 2.14 pC

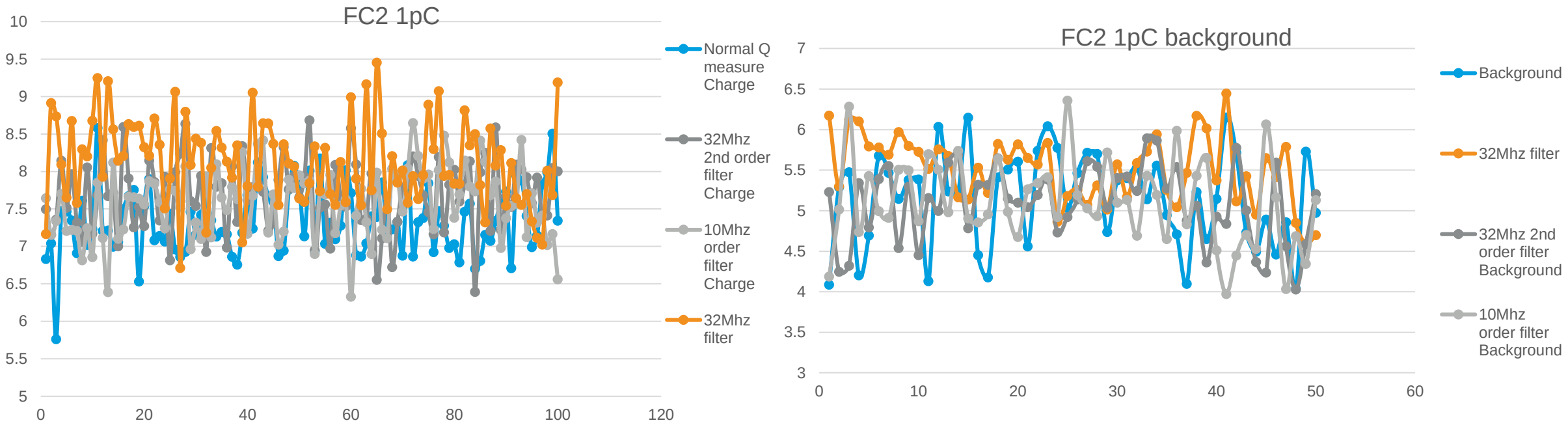
Charge measured by script (32 Mhz)= 220.79 +/- 4i pC

Charge measured by script (32 Mhz 2nd order)= 224.83 +/- 3.42 pC

Charge measured by script (10 Mhz)= 196.7 +/- 1.55 pC

FC2 measurements

Using Filters to observe their effect on the charge measurement



Charge measured by script (usual measurement)= 2.18 +/- 0.37i pC sigma cal = sqrt(sigma1^2- sigma2^2)

Charge measured by script (32 Mhz)= 2.61 +/- 0.38 pC

Charge measured by script (32 Mhz 2nd order)= 2.59 +/- 0.08 pC

Charge measured by script (10 Mhz)= 2.47 +/- 0.26i pC

Faraday cup measurements

Charge measurement error investigation

The assumption for all the measurements till now is that the noise is either due to environment but also the following points have to be verified before determining the source of noise and its elimination.

1. Is the variation/ noise real meaning is there variation/drift in laser pulses, is this already verified? Or how can I verify it.
2. Compare bunch variation to packet variation
3. Does the energy of the bunch somehow effect the noise
4. How much effect the Dark current has on the noise

I still have to learn a lot about the different configurations of gun, booster etc. and their effect on charge measurement/noise.

Thank you

Any Questions?