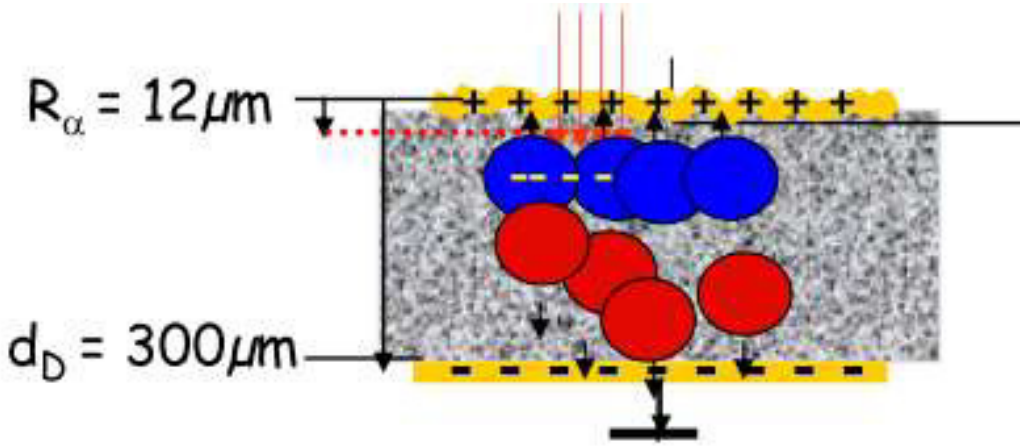
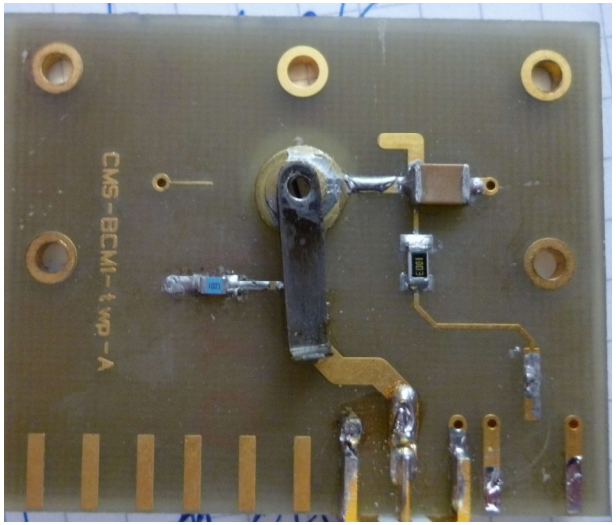
TCT setup

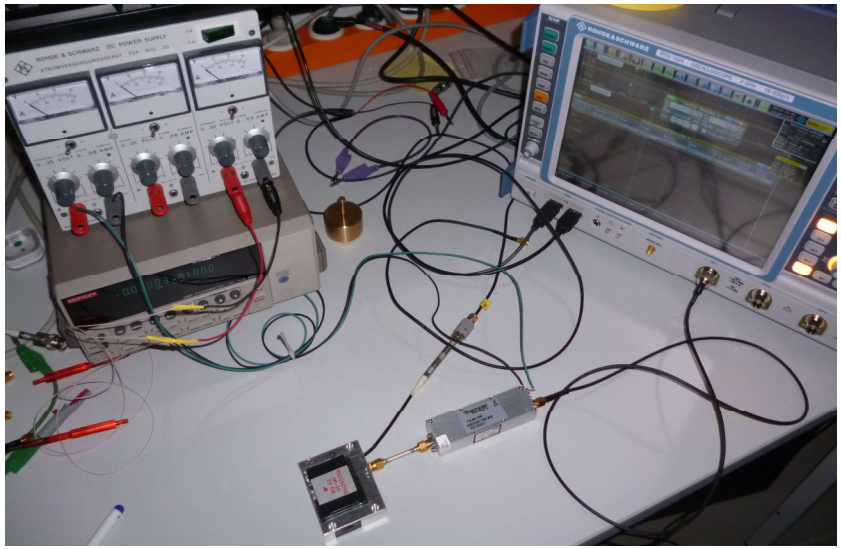
Inject a large amount of charge carriers near the surface and
Look at the transient current during charge transport in the detector
Allows to see the difference between electron and hole components
Allows to measure drift time => drift velocity => mobility
Allows to see the influence of internal field



Transient current due to induced charge – Ramo theorem

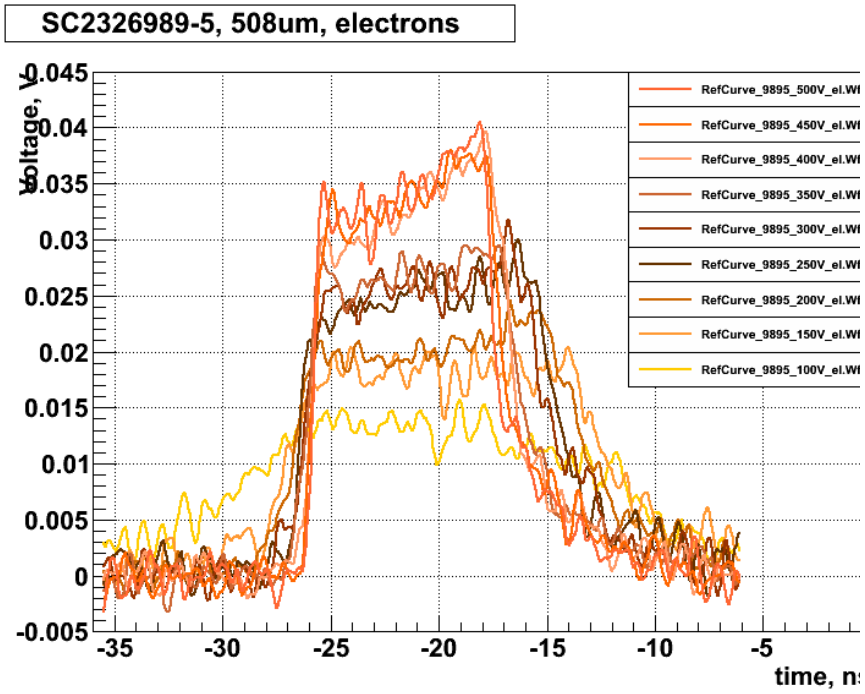
Experimental setup

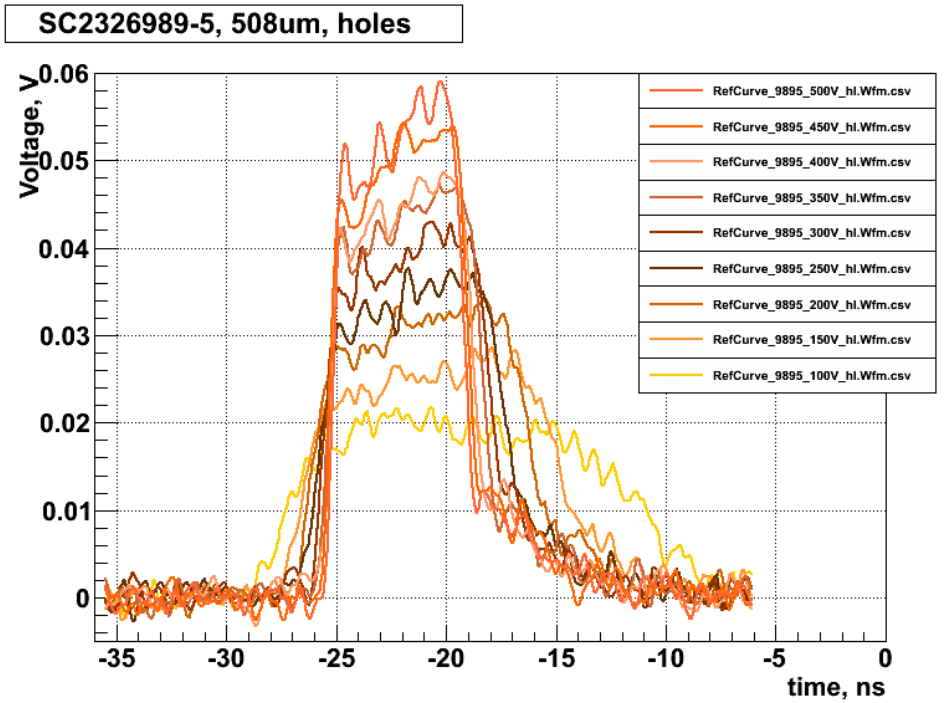




1GHz amplifier Miteq AM 1309
2GHz DSO

Results - diamond

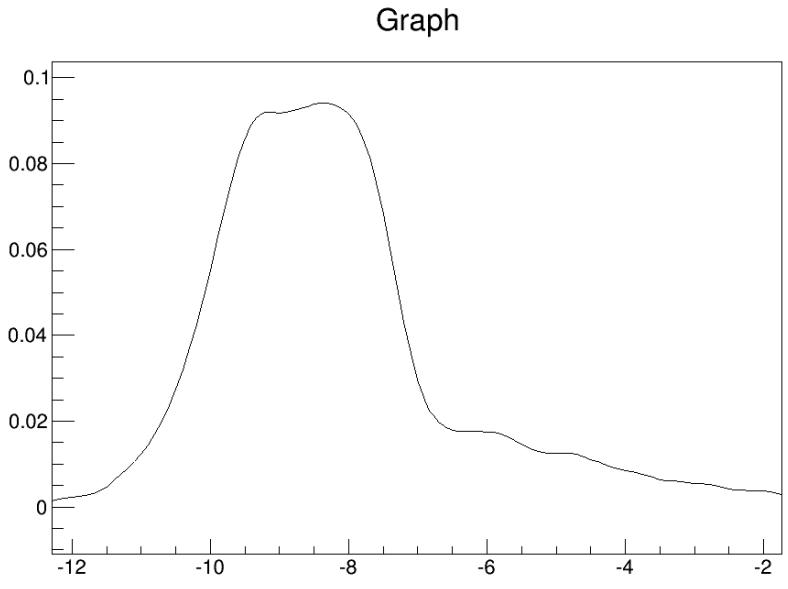




Single crystal CVD diamond SC 2326989-5, not damaged
100% charge collection, carrier lifetime > transit time
Hole drift time > electron drift time.

Data processing

Problems caused by working in selftriggering mode
1. Can trigger on noise spikes (partially suppressed by RF filtering on the trigger input, but still a problem for small signals)
2. Trigger jitter – triggering on different parts of the signal – fronts are smeared during averaging.



Risetime > 2 ns, while the amp bandwidth is 1GHz, so we expect ~1 ns. Not good enough

We need to find the rising edges of each waveform and align them before averaging

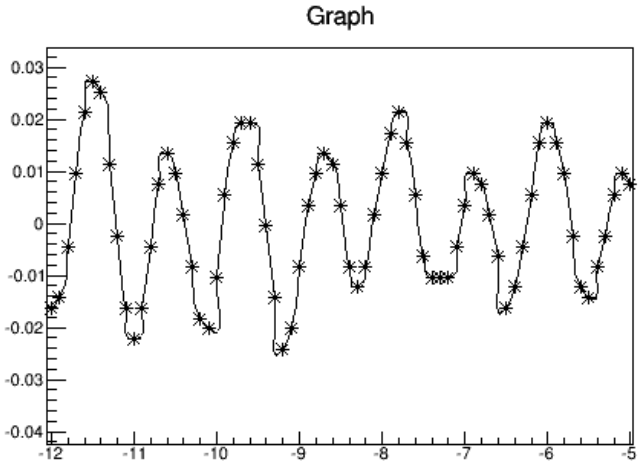
Data processing

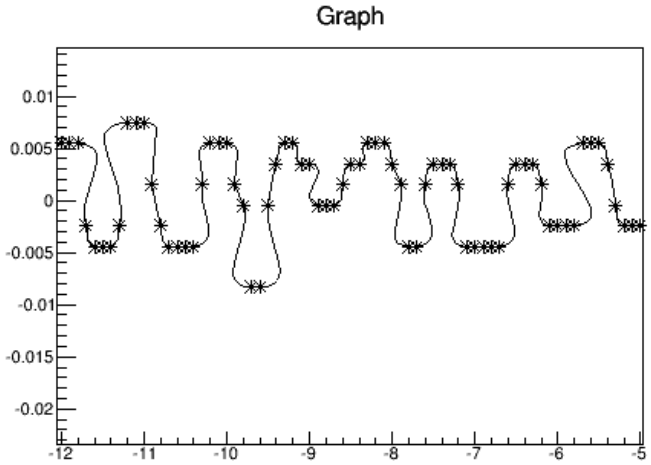
Median filter could be used as it preserves edges and smoothes the noise

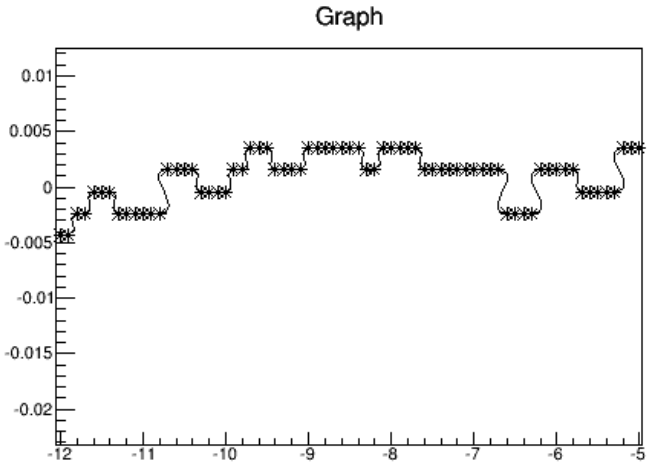
x = [2 80 6 3]
So, the median filtered output signal y will be:
y[1] = Median[2 2 80] = 2
y[2] = Median[2 80 6] = Median[2 6 80] = 6
y[3] = Median[80 6 3] = Median[3 6 80] = 6
y[4] = Median[6 3 3] = Median[3 3 6] = 3
i.e. y = [2 6 6 3]. x = [2 80 6 3]

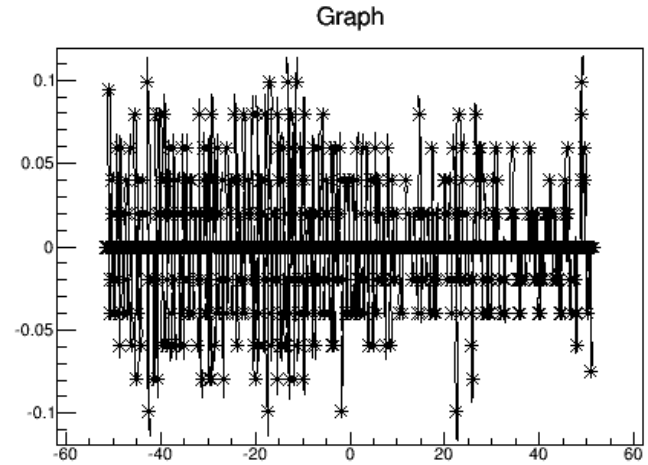
Median filter used to smooth the plot, then a derivative is calculated
By putting the cuts on signal max value and derivative max value
We can select proper waveforms
The derivative max point corresponds to ~ middle of the rising edge
=> Good time marker for waveform alignment

Data processing

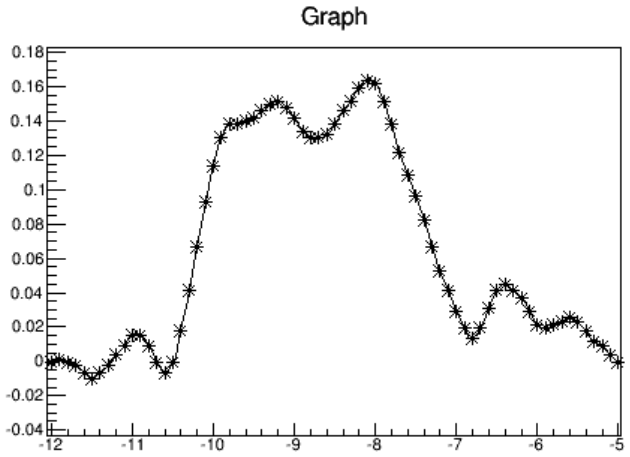


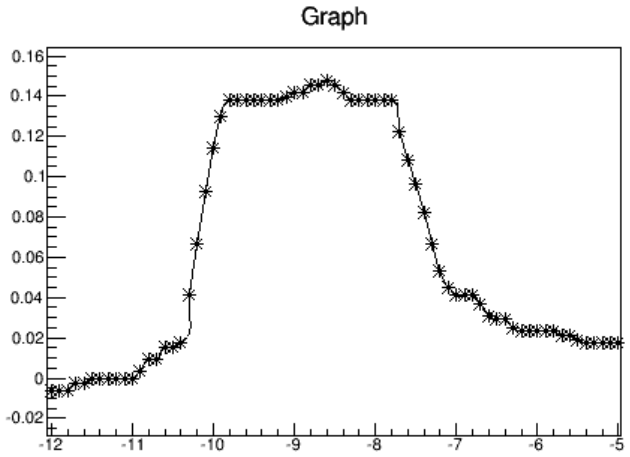


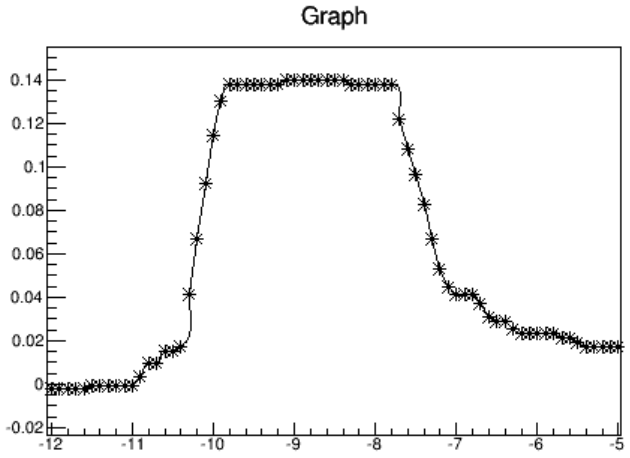


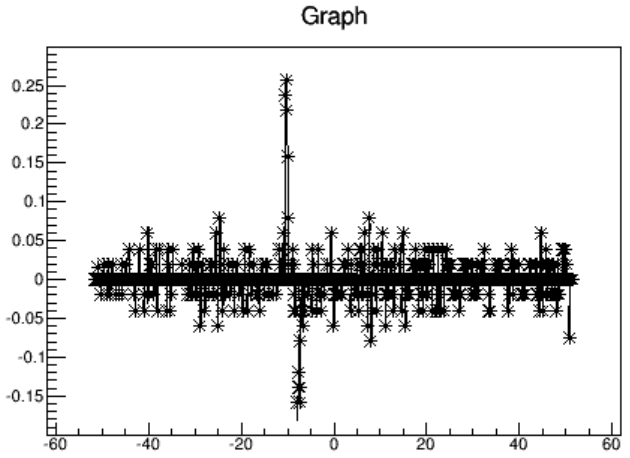


Data processing



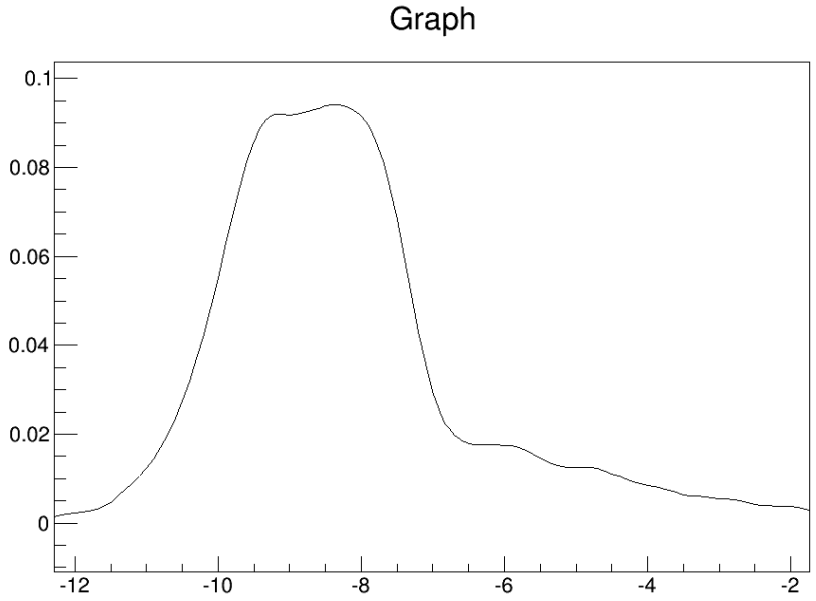


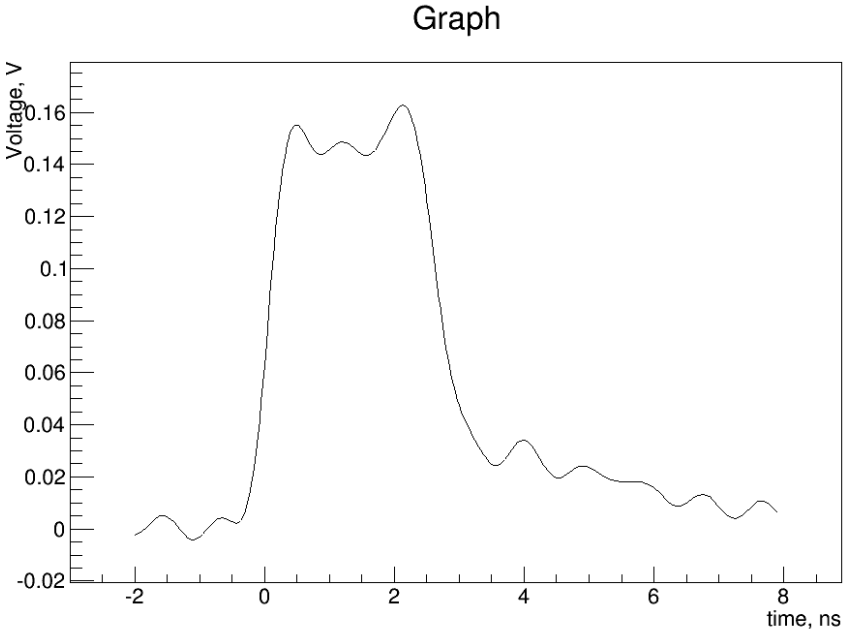




Data processing

Results after averaging





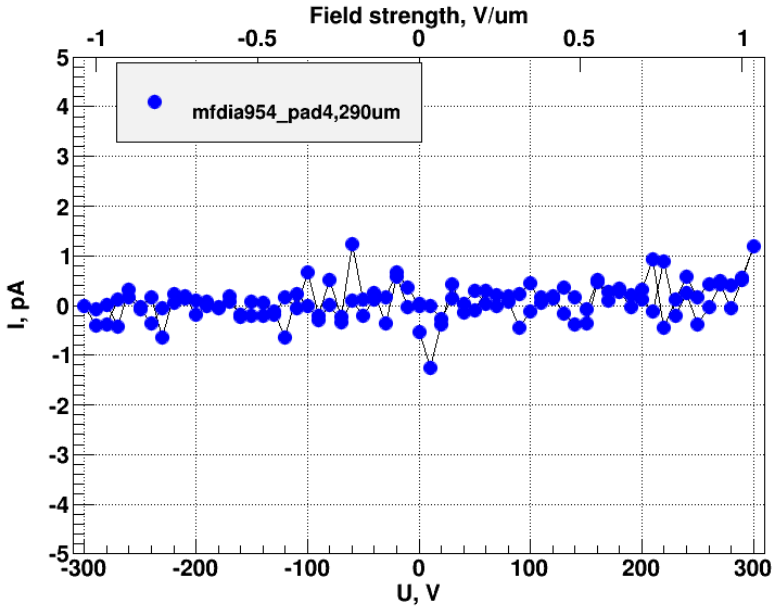
Simple averaging

Averaging after selection and alignment

Data from Mfdia 954

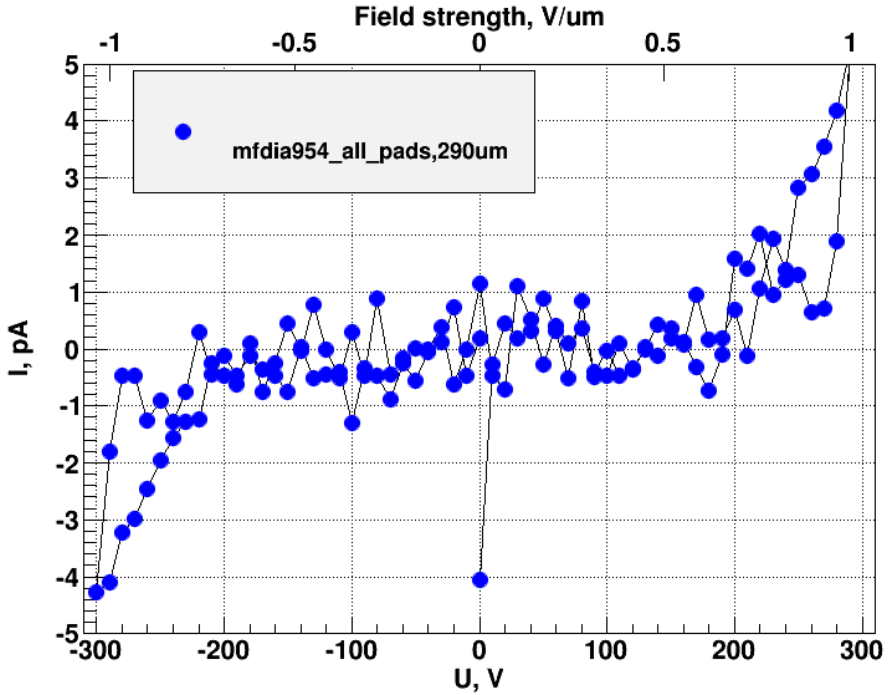
Diamond on iridium IV

Problem – GSI people reported currents ~10^-13. We have measured 10^-8. Partially solved



Pad4

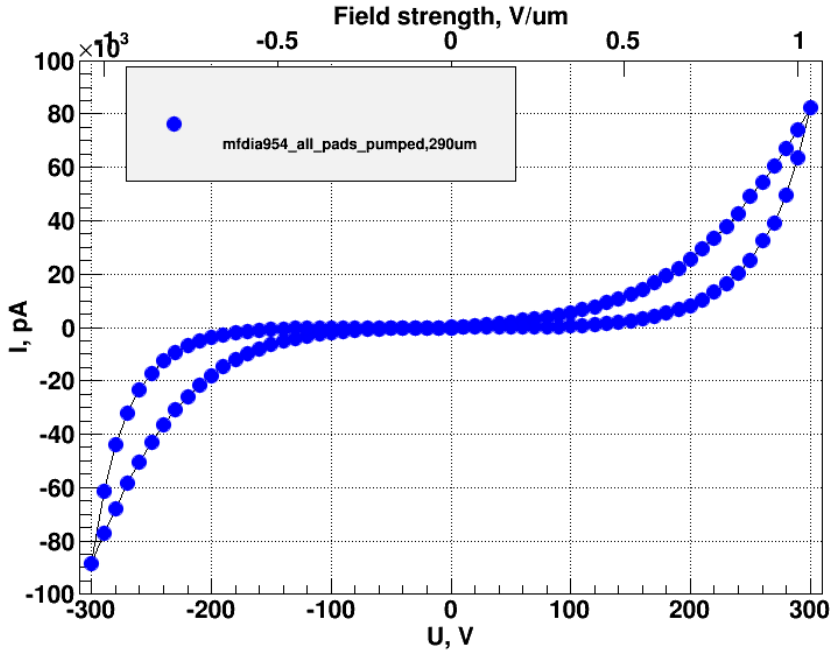
Sample reset with UV
All 4 pads similar
I ~ 10^-13



All 4 pads

Diamond on iridium IV

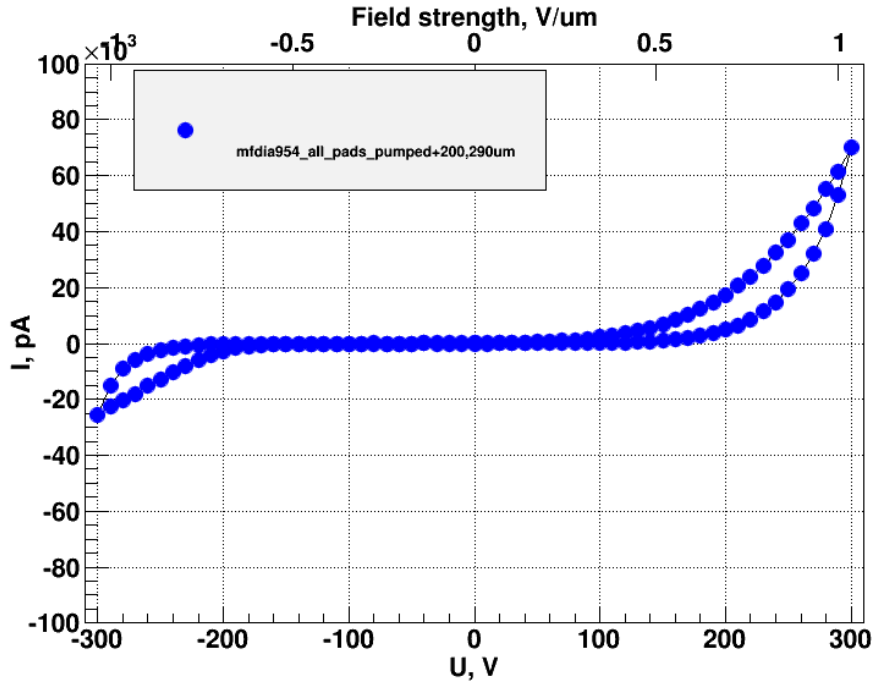
Sample irradiated with Sr source for 30 mins to 1 hour, then IV done



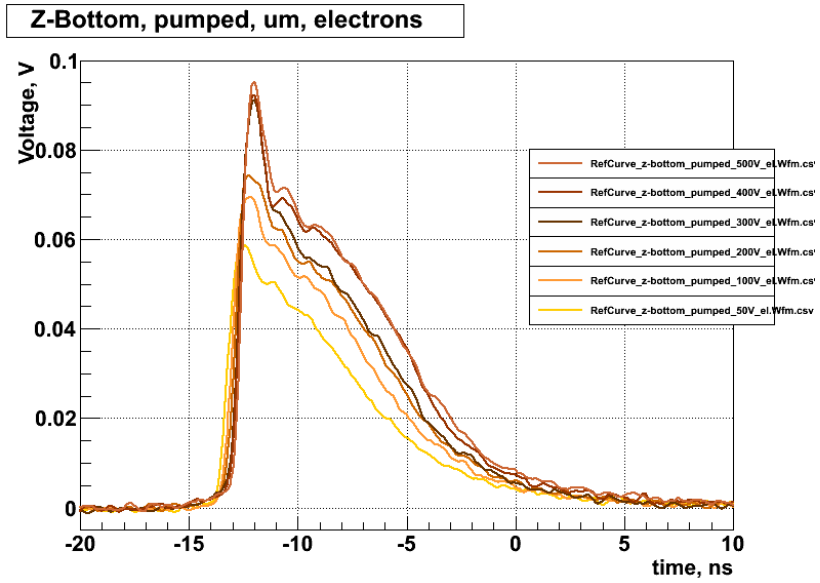
All 4 pads connected

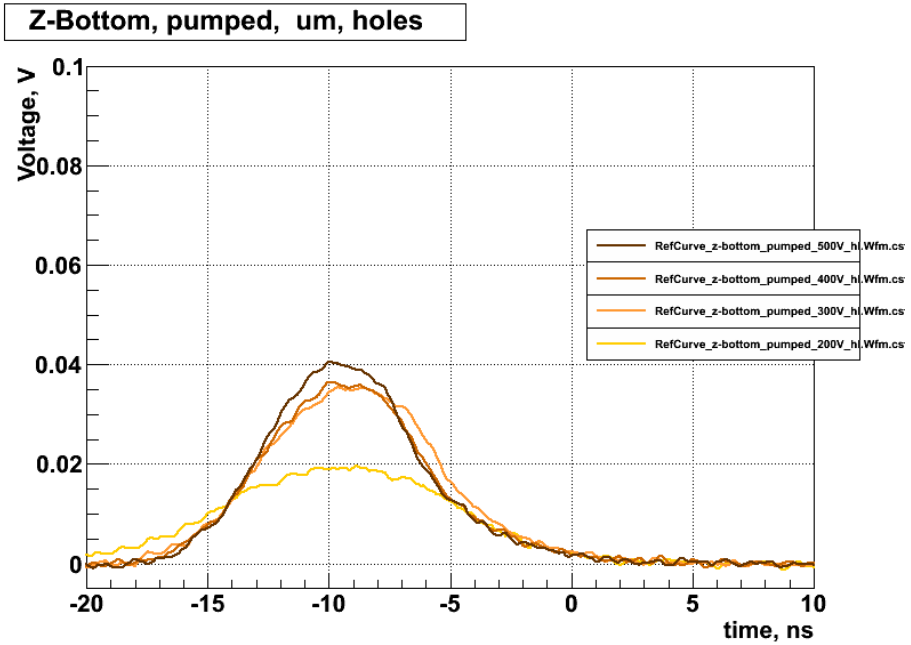
Irradiated @ 0V bias

Irradiated @ +200V bias



Results – damaged diamond

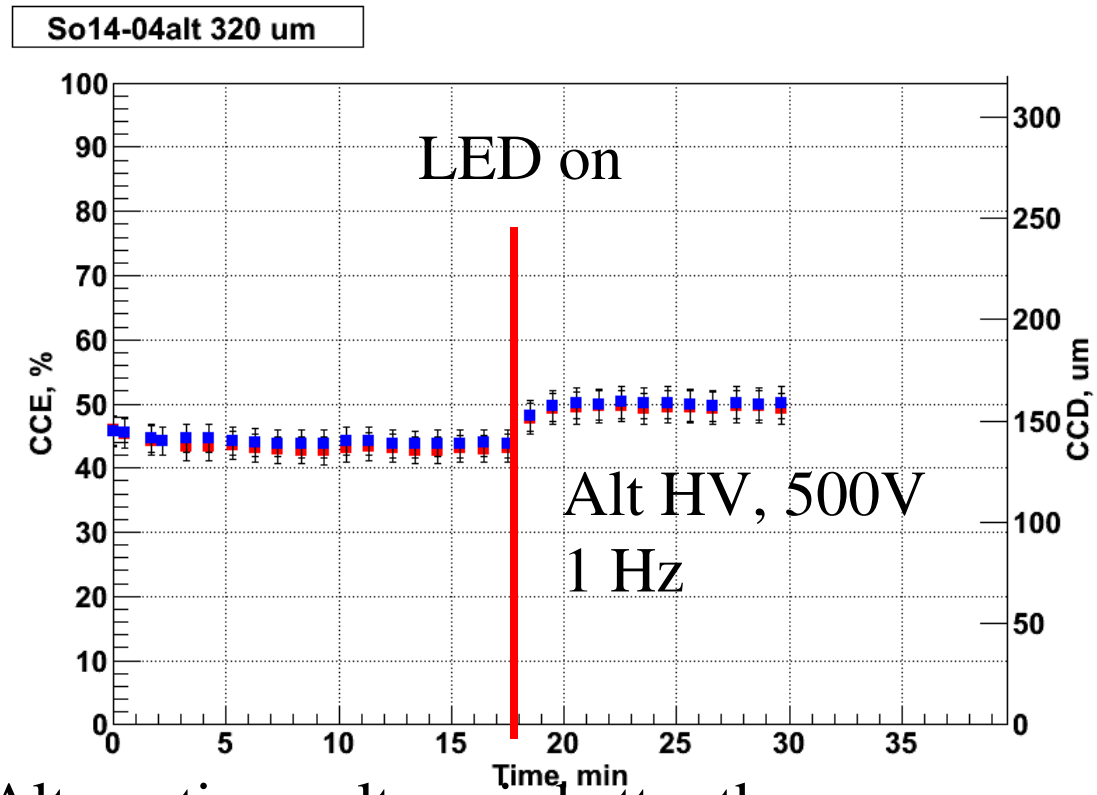


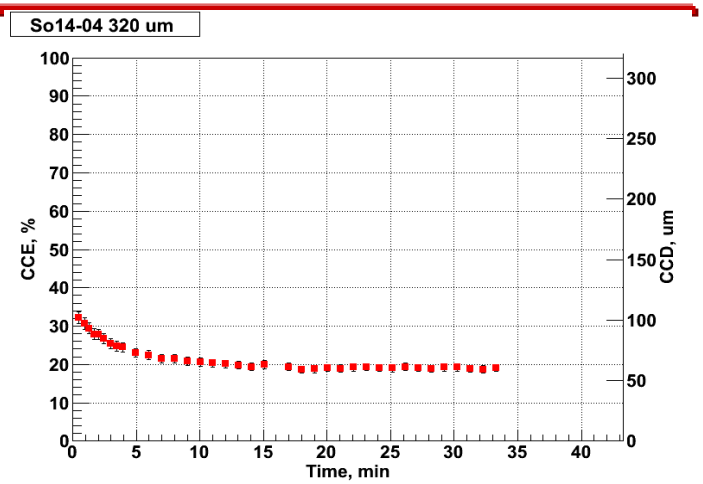


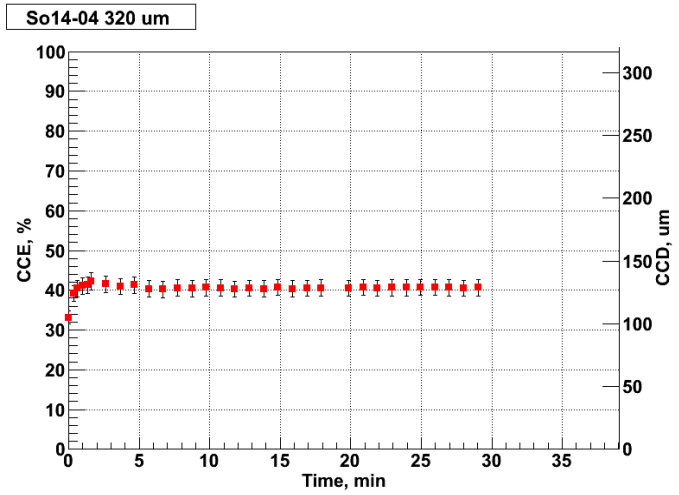
Diamond Z-Bottom, one of the BCM1F irradiated diamonds
Estimated dose

Looks like hole transport is more affected by irradiation
For electrons it looks like the lifetime is strongly affected
For holes the mechanism is not so clear
Possibly trapping @ releasing by fast traps

Effect of red light





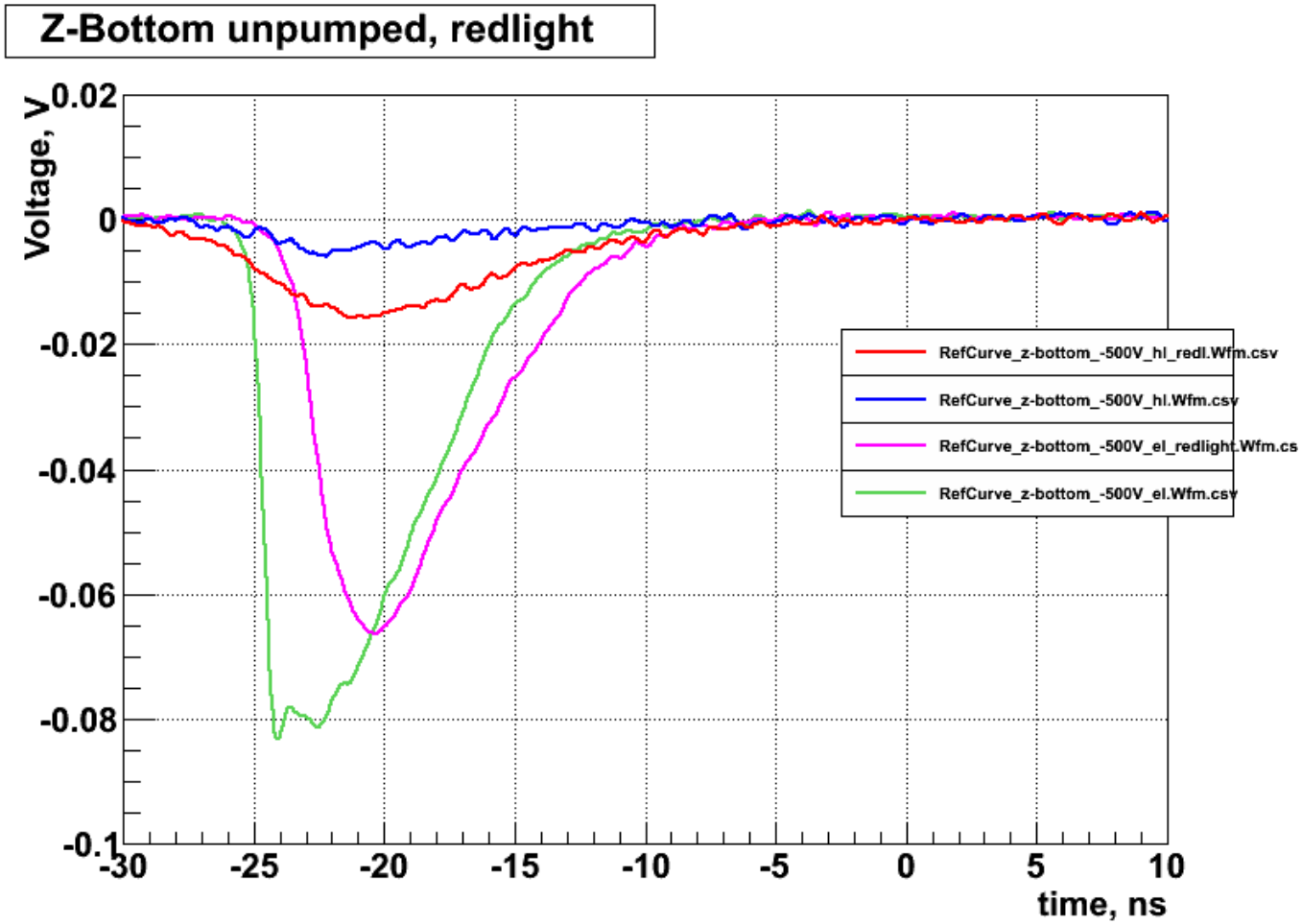


Alternating voltage is better then RL illumination.

Alt. Voltage + RL is even better. Why?

CCE ~ 20% with constant V and polarisation, 40% with RL, 45% with Alt. V, ~50% with both. **30% efficiency recovered**

Effect of red light



Looks like both electron and hole transport is affected,
Needs confirmation with other samples

Conclusion

The TCT setup is working. First results look interesting
Still a lot to do:
Better shielding, improve S/N ratio
Need to understand the amplifier behavior
Think about possibility of using a laser
Setup simulations.
Data analysis is very basic – what is needed
Include correction for amplifier transfer function
Compensate for trigger jitter, maybe a constant fraction software trigger.

We need to understand what could be done with this method
It is possible to study the space charge distribution, polarisation processes, traps. But the methodology is needed for that.