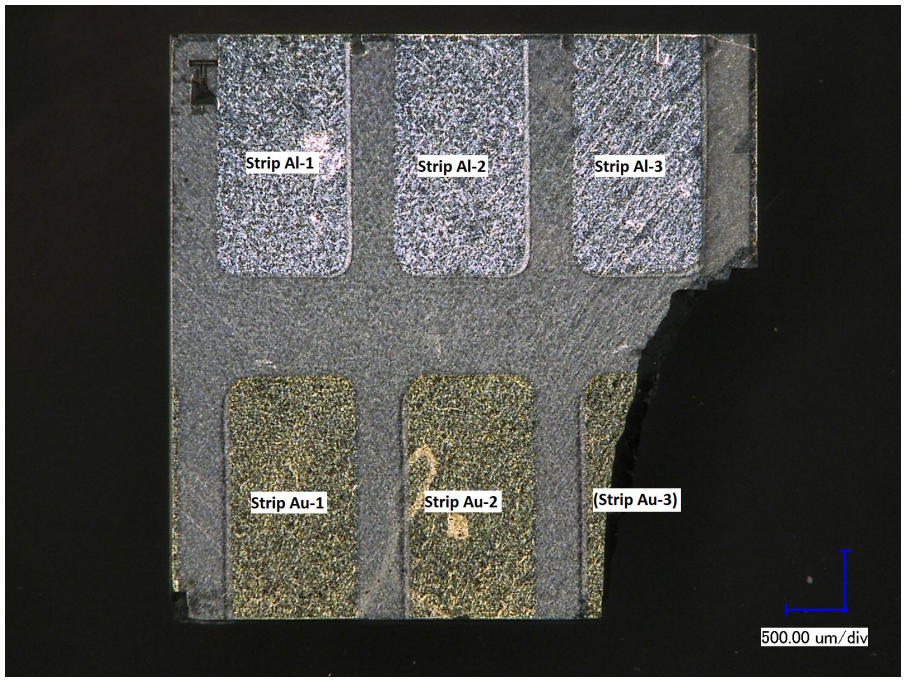
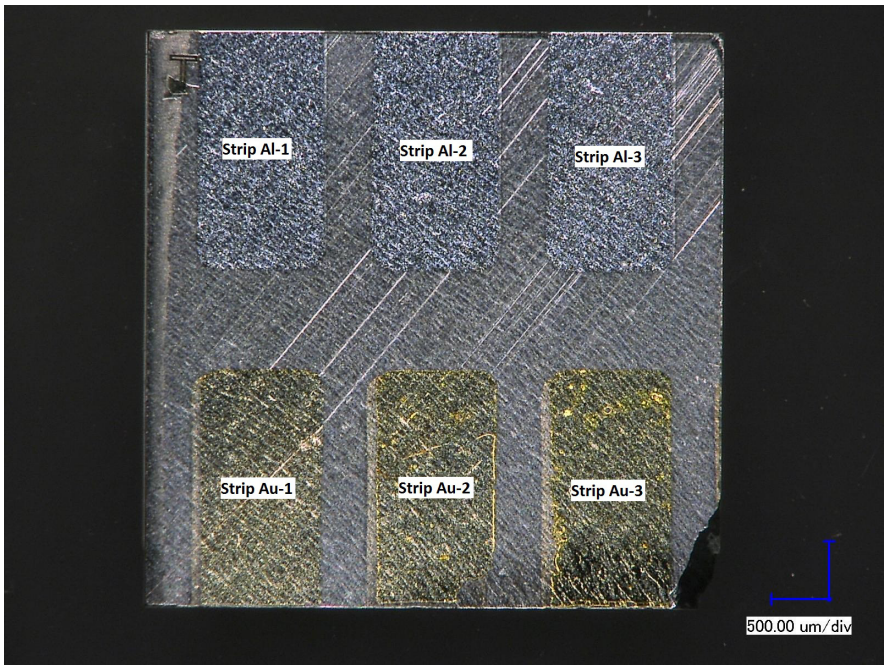
Sr^{90} tests of DOI Samples

K. Afanaciev

Samples



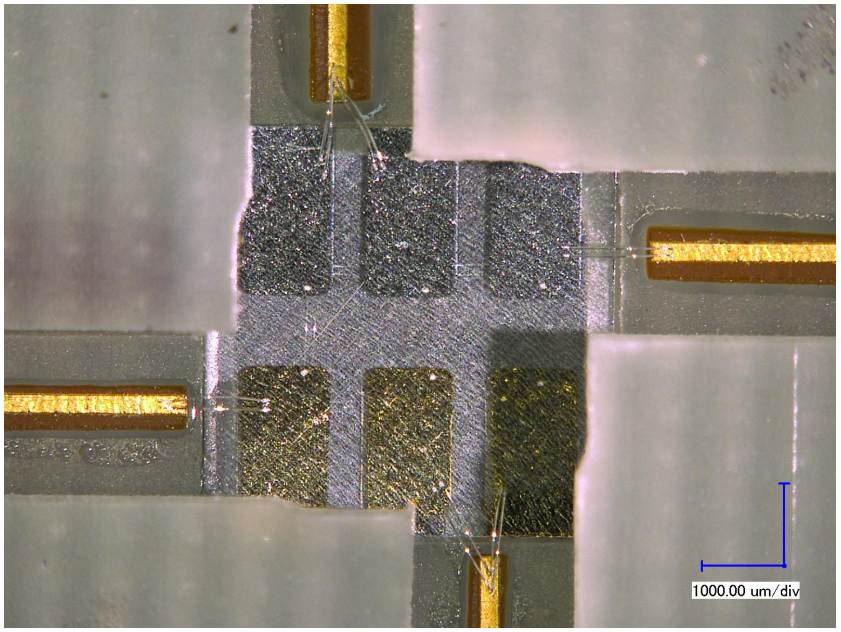
Doi 953, 270 µm

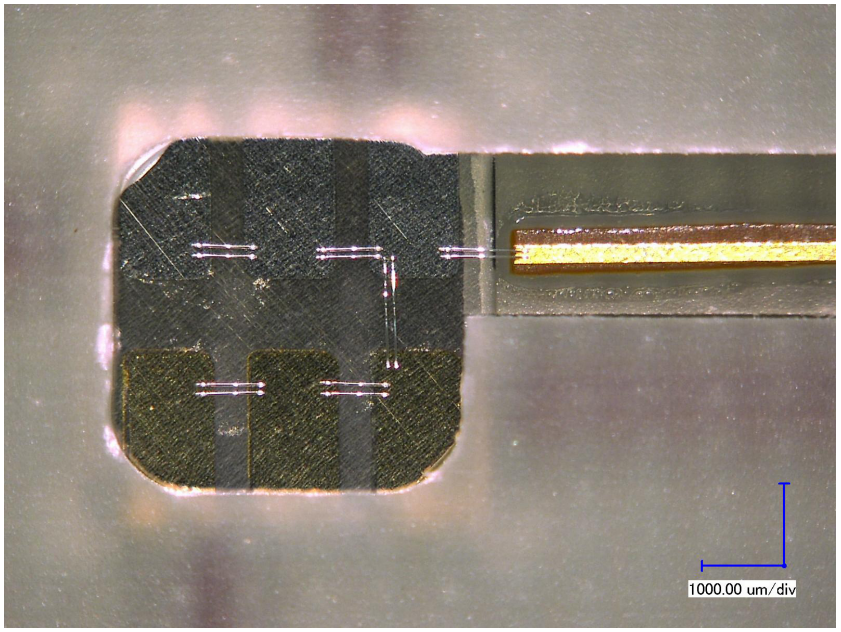


Doi 954, 265 µm

2x1 mm pad metallisation from microbeam tests
3 Al pads and 3 Cr+Au pads

Samples



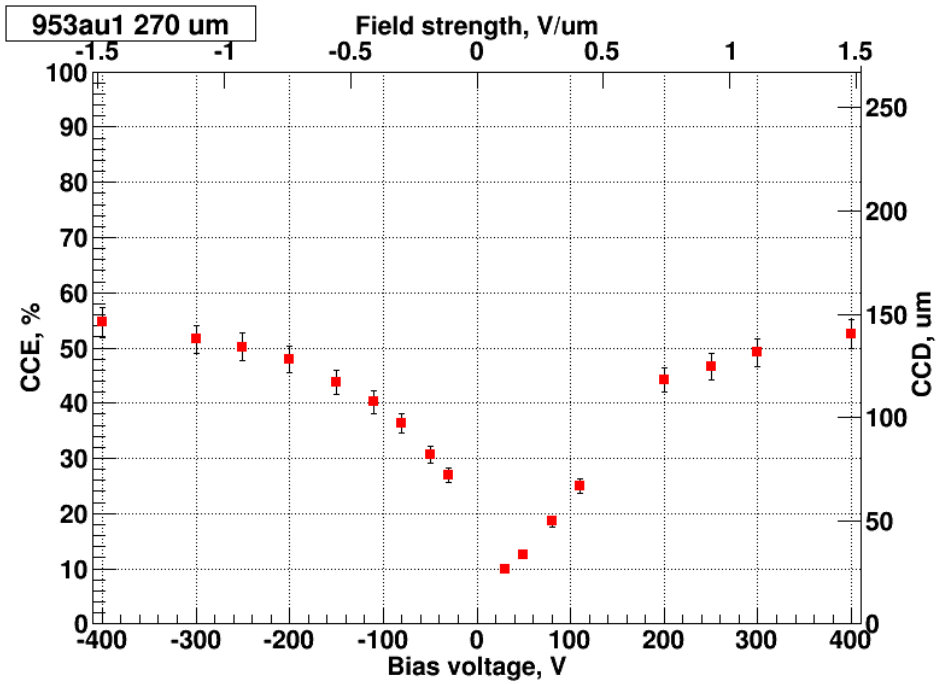


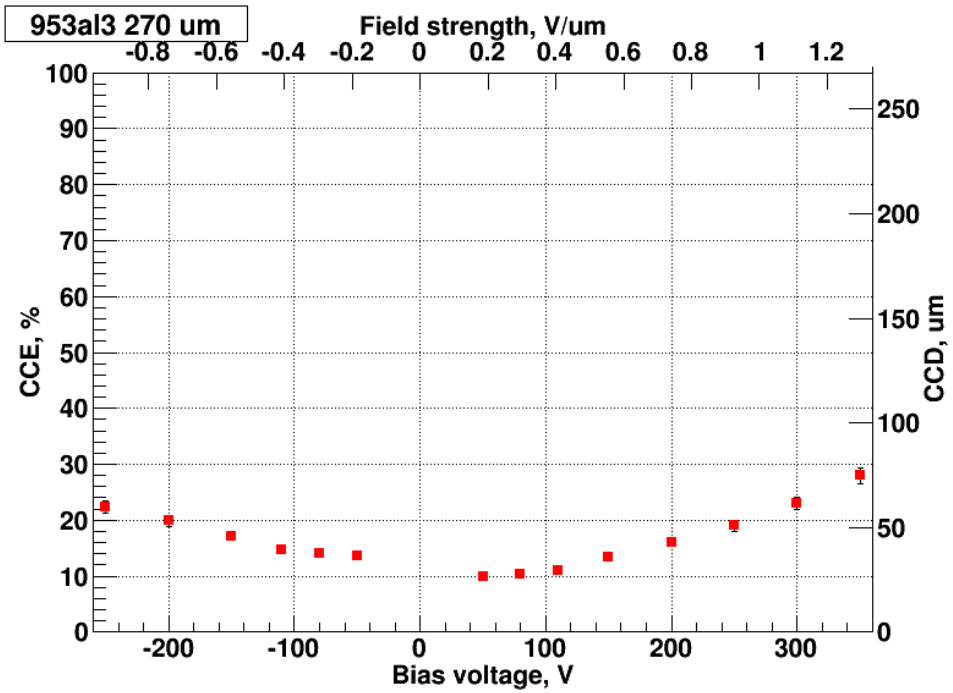
Samples mounted in frames, all pads connected together on substrate side. Pads Au1 and Al3 connected individually, pads Au2, Au3 and Al1, Al2 connected together.

Charge collection efficiency measured on Sr^{90} setup in Zeuthen

Due to technical difficulties (collimation and leakage currents over the edges) and limited time only pads Au1 and Al3 were measured.

DOI 953

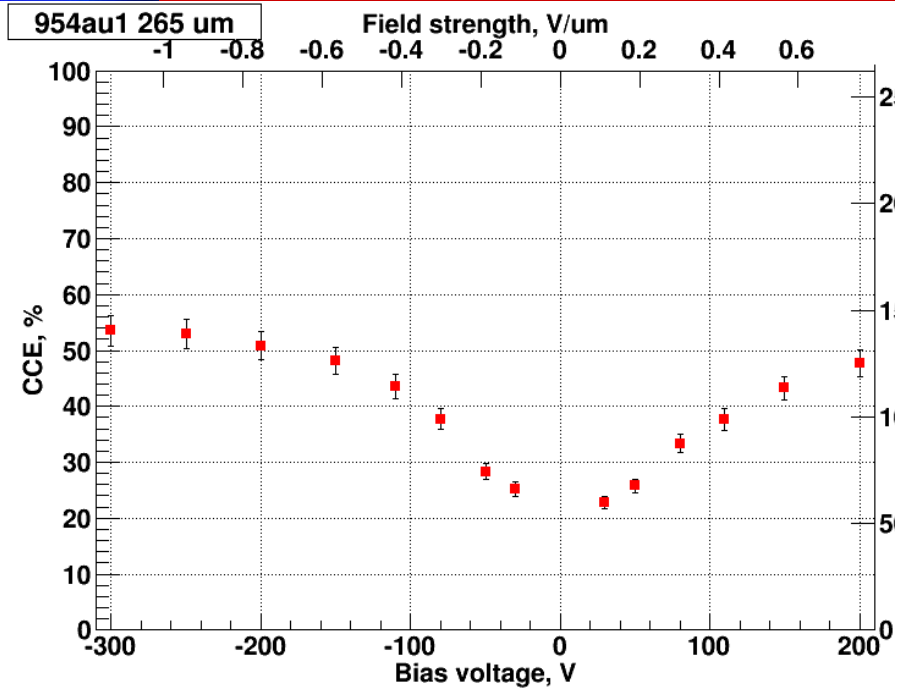


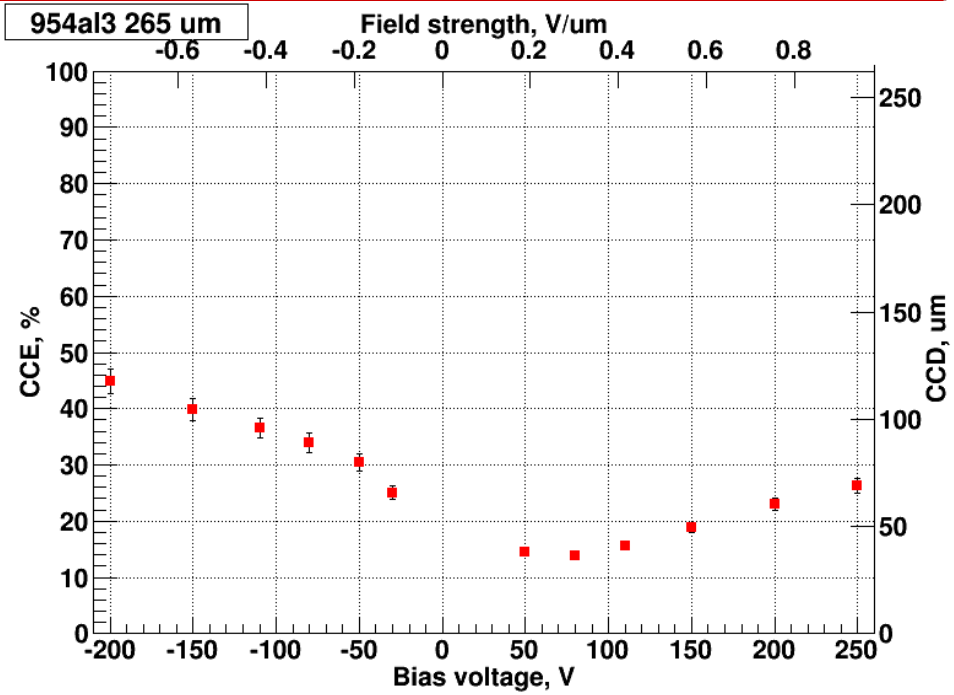


Negative branch corresponds to –HV applied to substrate

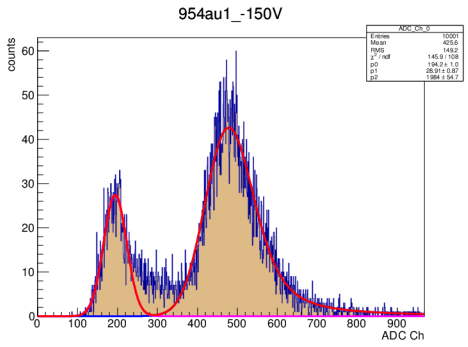
Pad Au1 shows CCE ~ 55% @ 400V, not completely saturated
Voltage limited by increase in noise at higher voltages
Pad Al3 demonstrates very strong polarisation and much lower signals
Either metallisation or non-homogeneity of the sample.

DOI 954

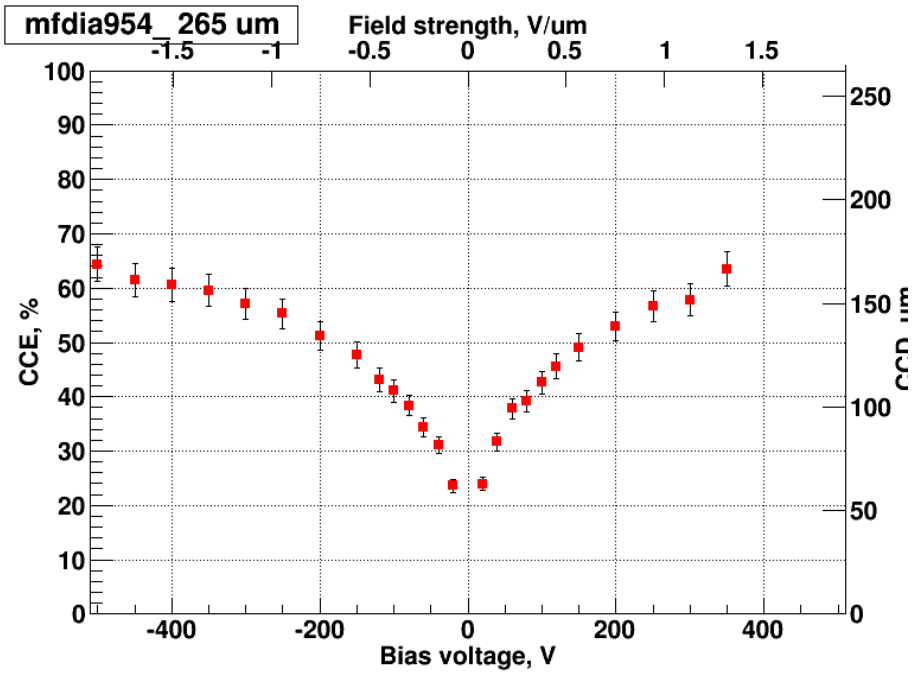


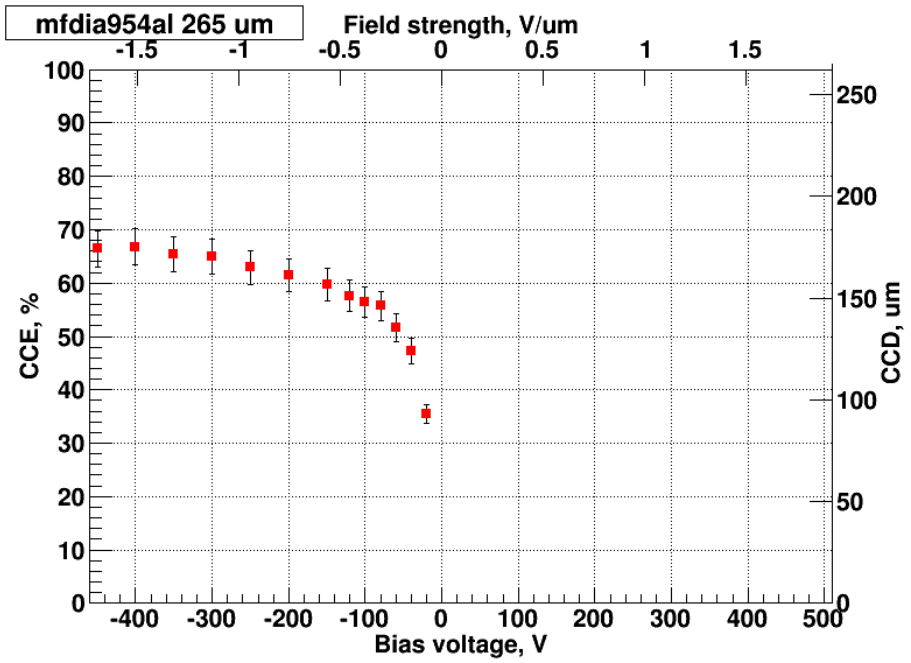


Similar results for negative branch, both asymmetric. Could be field configuration. CCE ~55% @ 300V, again limited by increased noise at higher voltages.



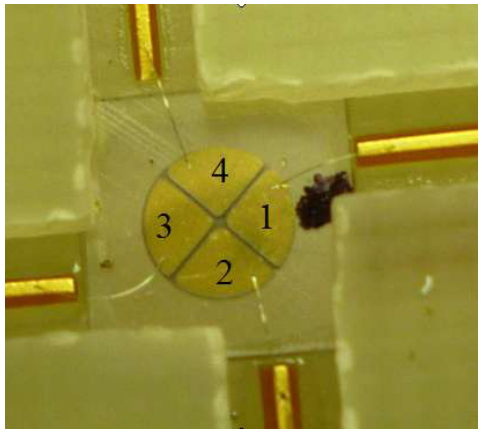
DOI 954





Measurements of 954 with previous metallisation.

Results are similar to the current measurements
Faster CCE saturation with alternating voltage suggests that there are some polarisation effects



Conclusions

Both samples 953 and 954 demonstrate CCE up to 60%
There is a difference between pad – either because of inhomogeneity or metallisation
All pads demonstrate polarisation behavior to some extent

Strange thing – after switching off HV signals of both polarities could be seen.

Part 2

Influence of illumination on radiation damaged single crystal diamond charge collection efficiency

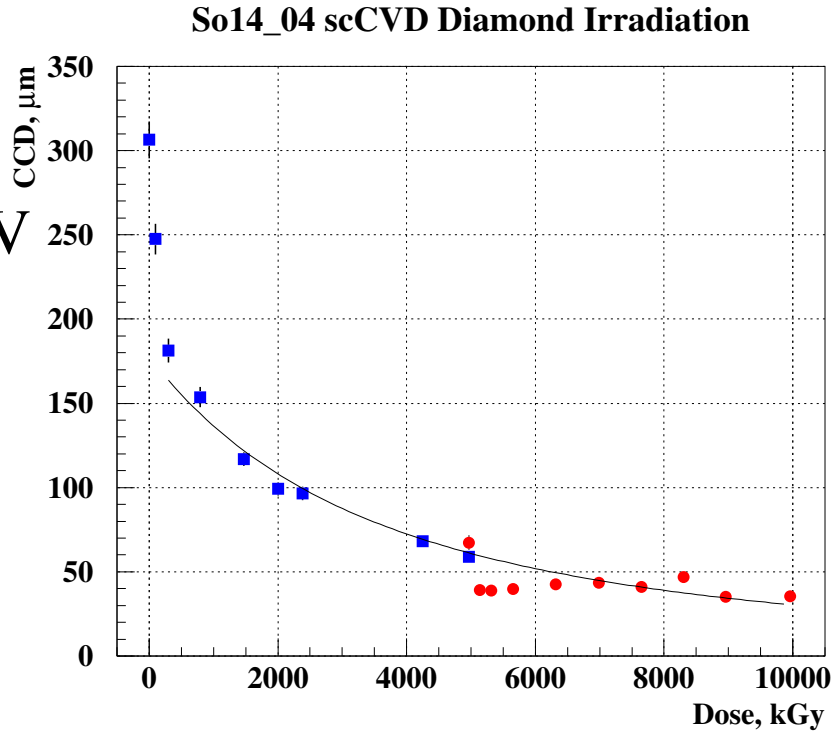
Experimantal setup

Diamond – So14-04, SC CVD by E6, irradiated to 5 MGy @ 2007 + 5 MGy more @ 2008 => Total ~10MGy by 10MeV electrons

Thickness 325 um

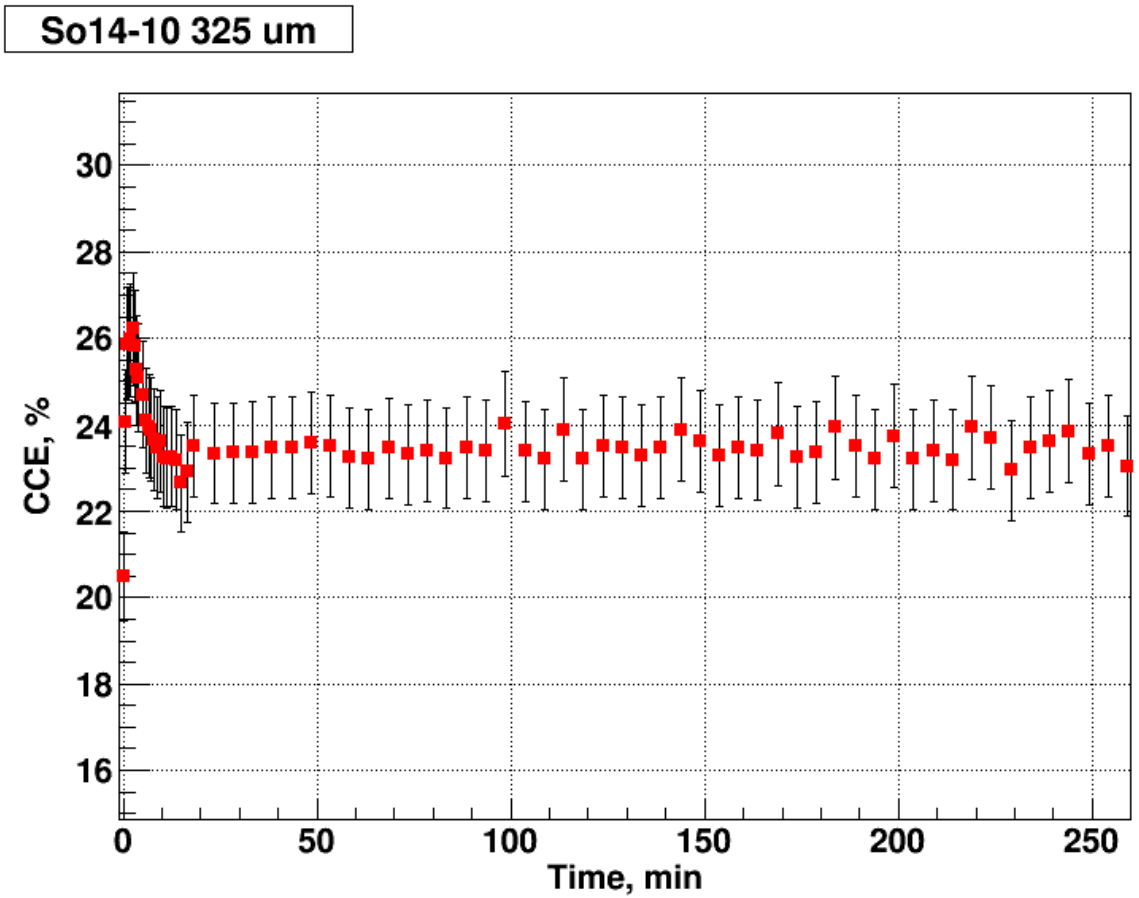
So14-10 a very similar SC diamond
Same thickness, same batch
Irradiated to ~1-1.5 MGy by 14 MeV electrons

Setup used – new CCE setup high counting rates.



Experimental setup

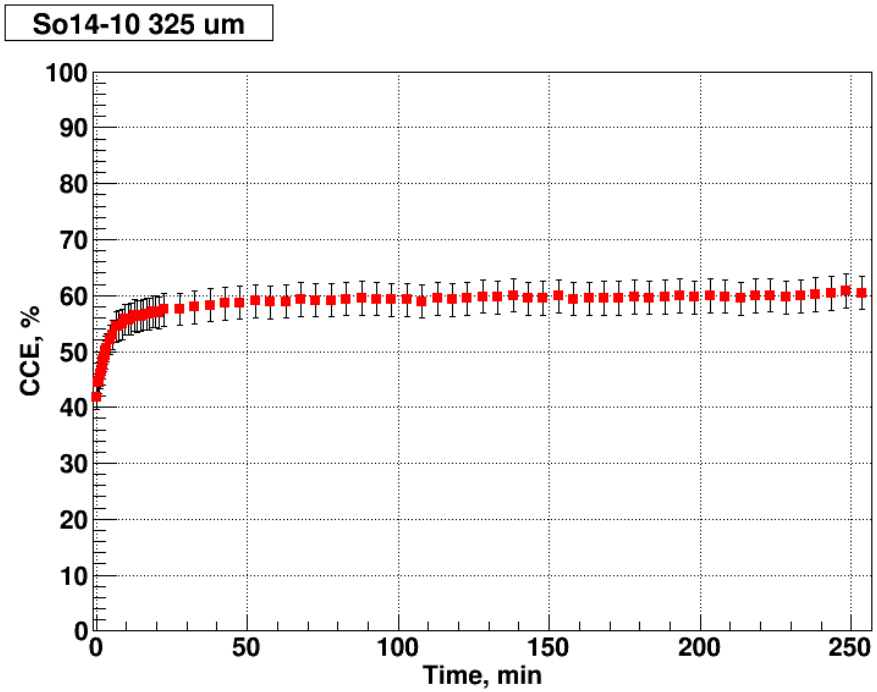
Diamond was “reset” by UV lamp for ~ 20 min before the first measurement. CCE was measured over time. @ 300V

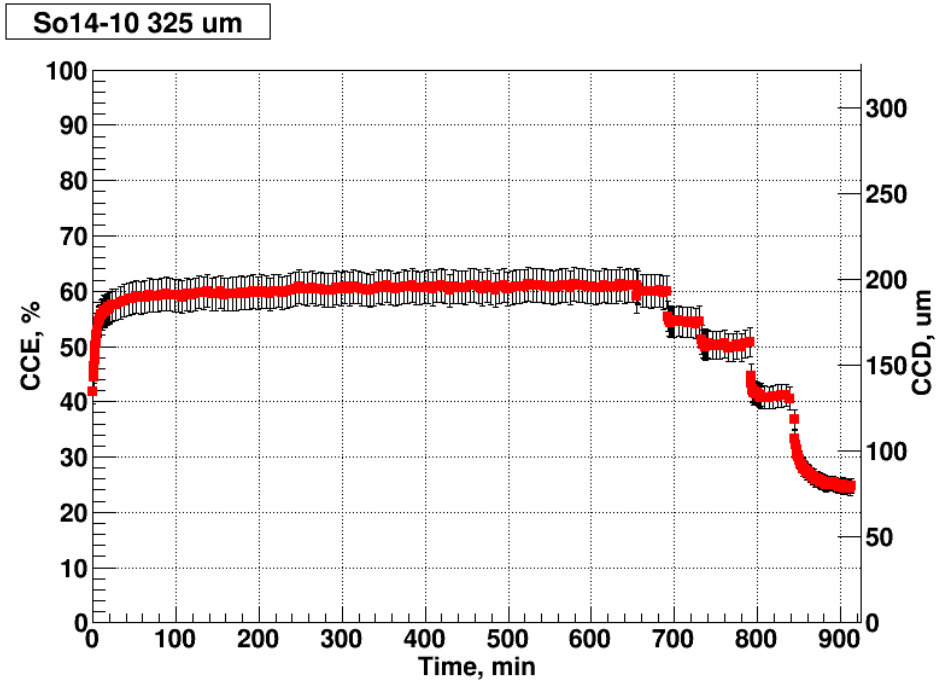


After switching on HV and source:
Fast (few minutes) increase in CCE
Relatively slow decrease in CCE over next 20-30 minutes
Stable signal

Illumination

Same process with illumination by red LED (635nm, 1.95eV)



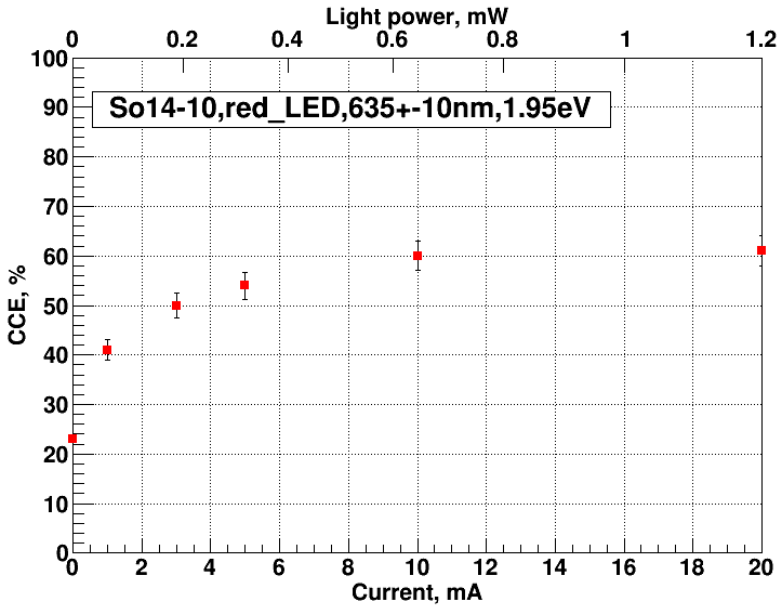


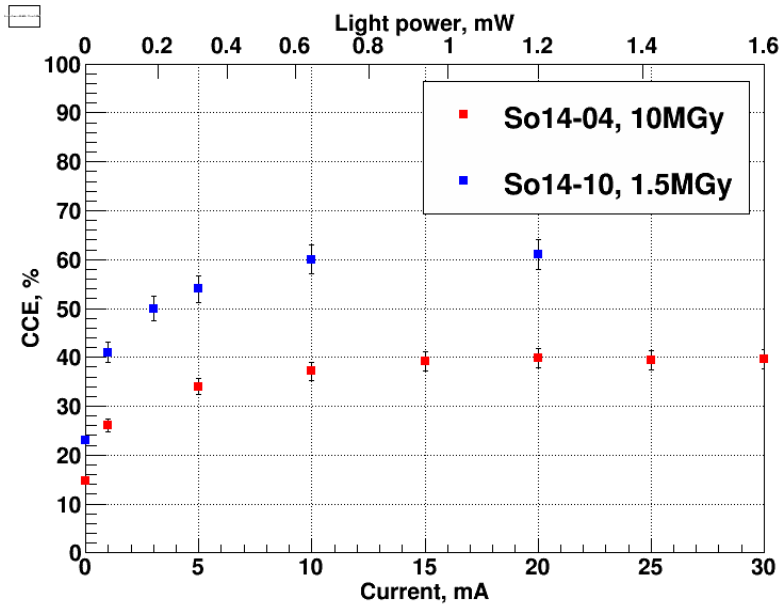
Slow (~20-30 min) increase in CCE to 60% from stable 23%

Stable effect over 10 hours

Steps are testt of different light intensities

Illumination





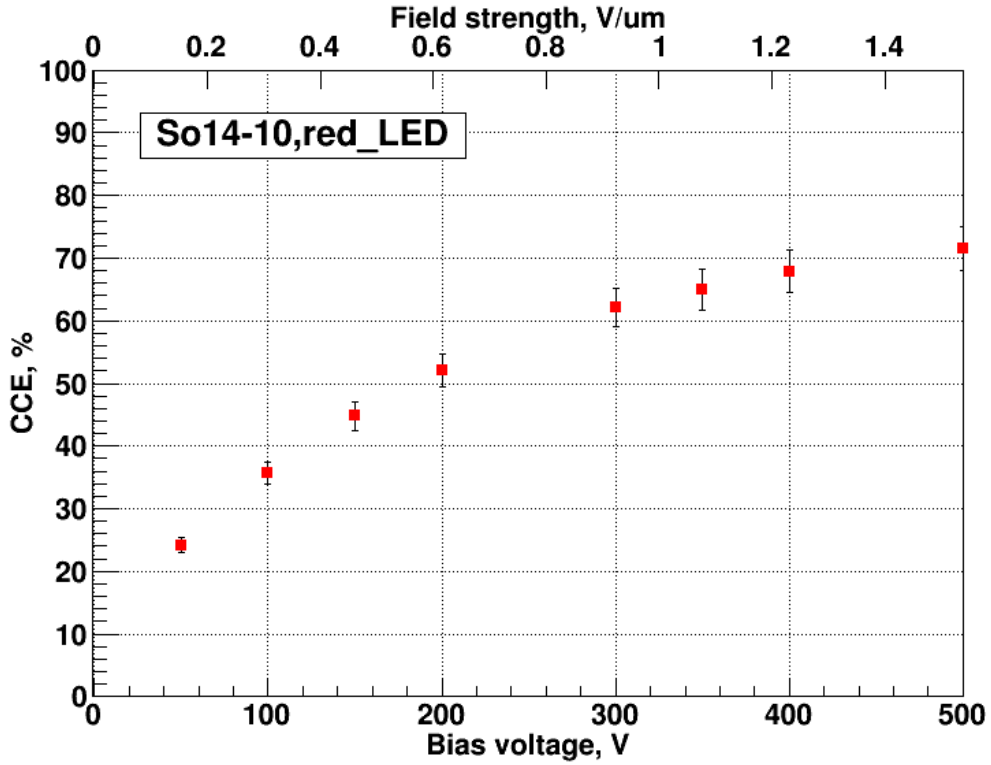
Effect depends on the intensity of light

There is a saturated value

Saturation is at similar power for two samples with order of magnitude difference in damage, i.e. does not depend on damage.

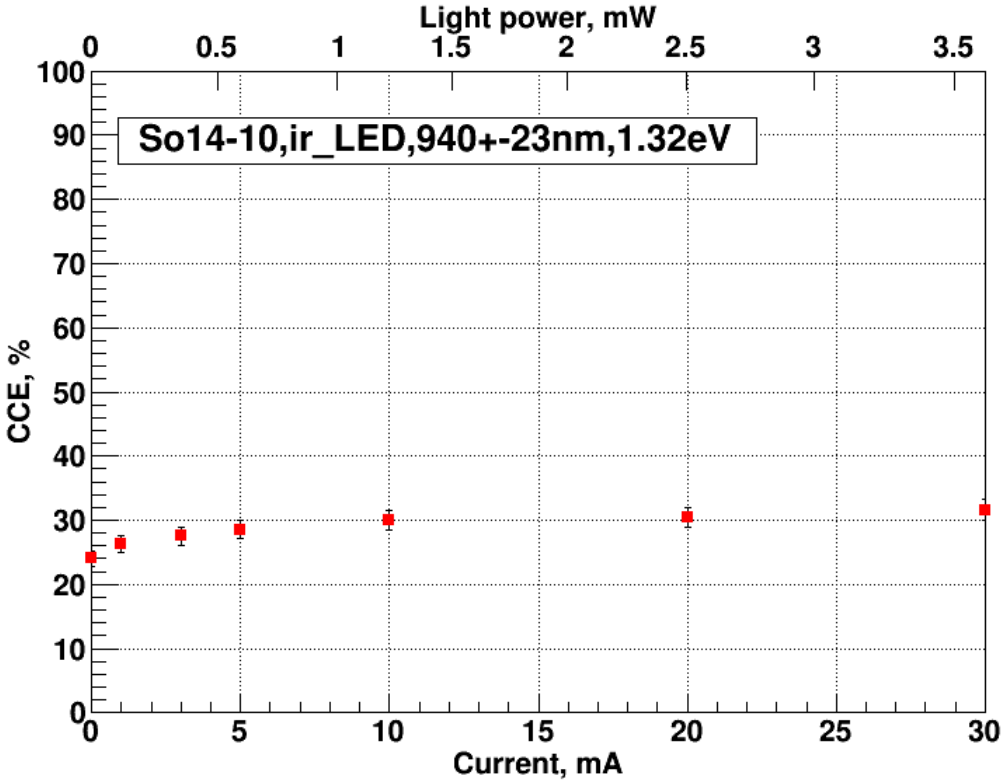
Amount of recovered CCE close to 2.5 times “stable” value for both

CCE vs HV



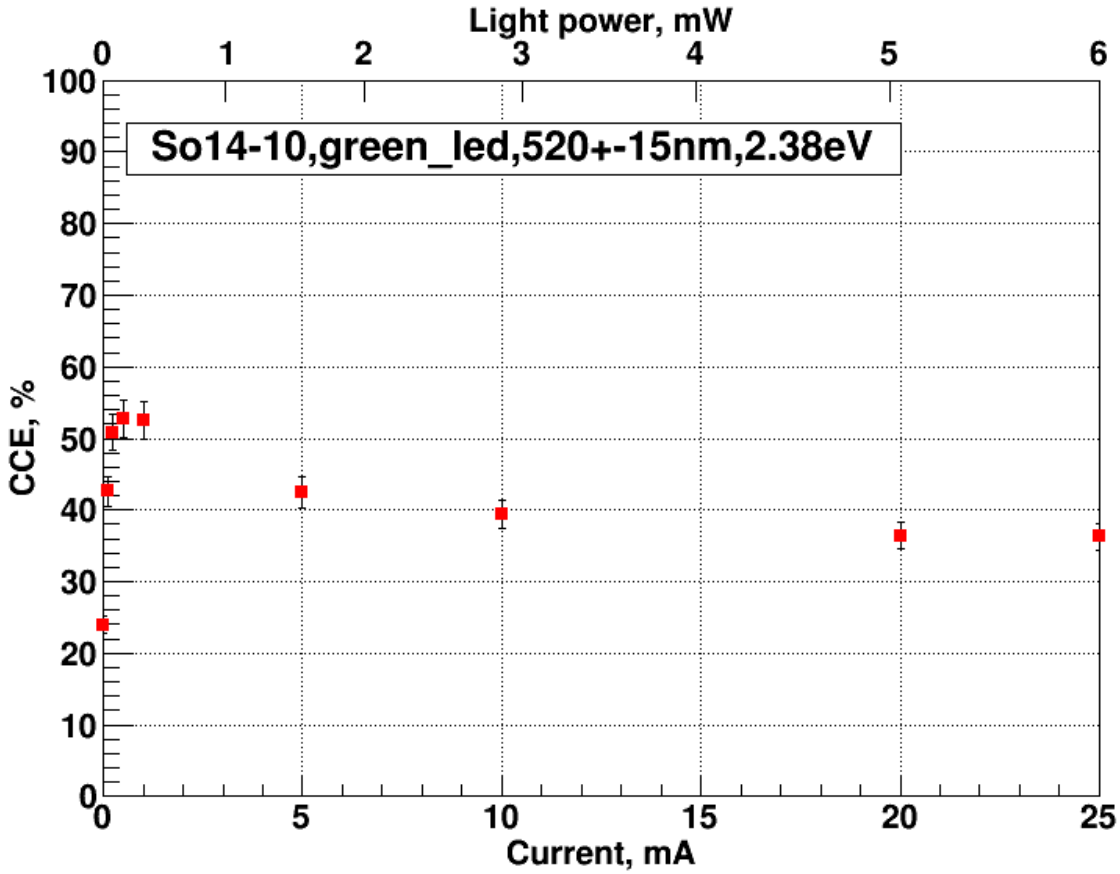
CCE vs HV still looks like it should for damaged diamond – no CCE saturation at low voltages (was ~100% @ 80V before irradiation)

Infrared



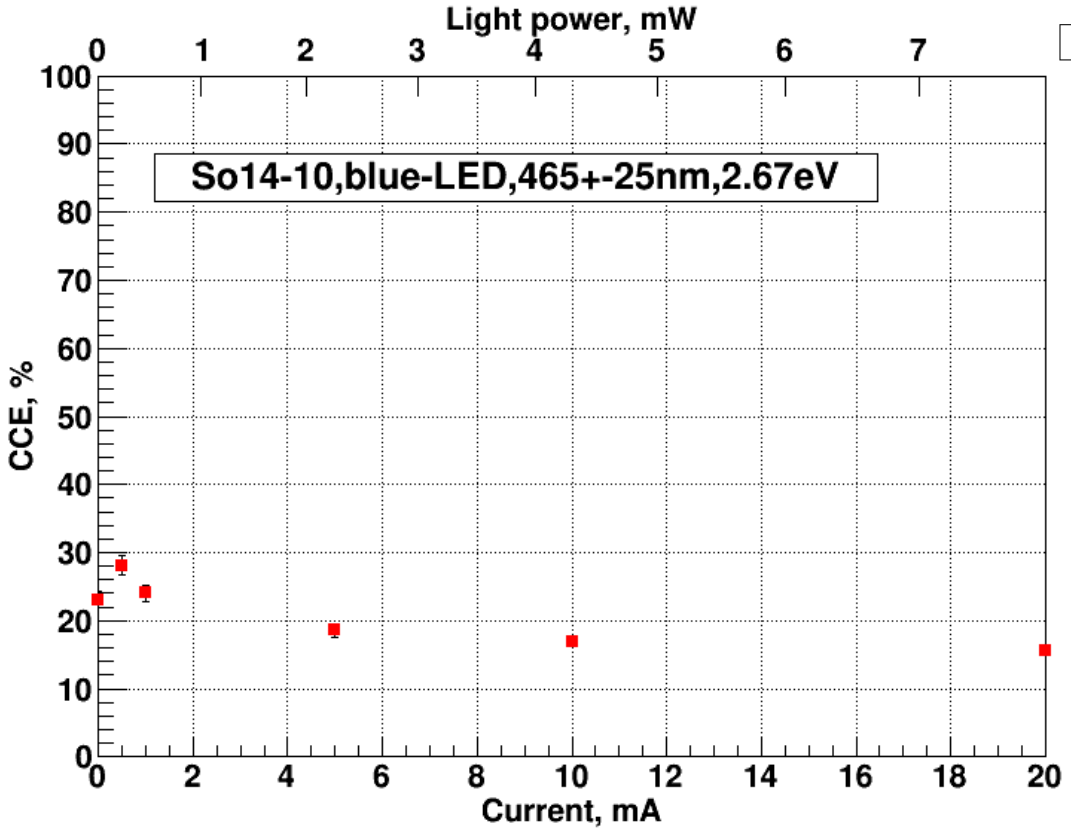
940nm IR LED (1.32 eV) there is an effect, but smaller

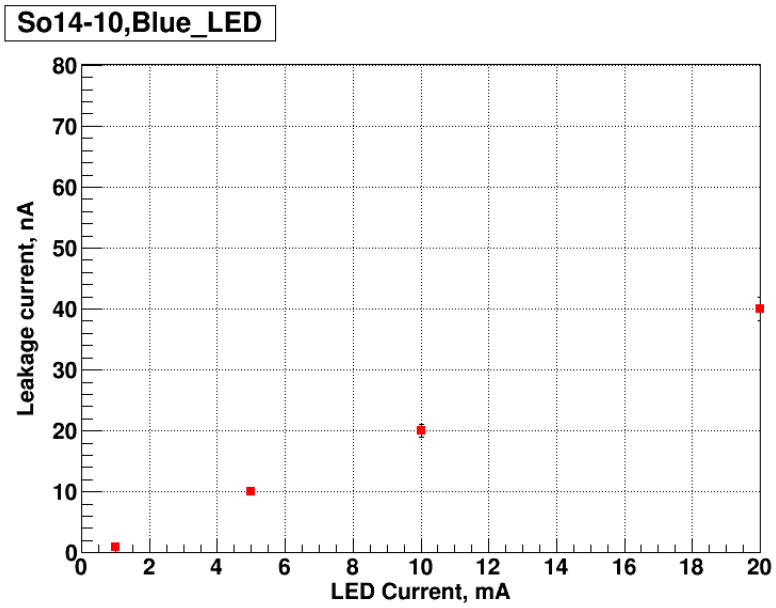
Green



520nm green LED (2.38 eV) – saturated at high intensities
Peak at low intensities, not as high as red

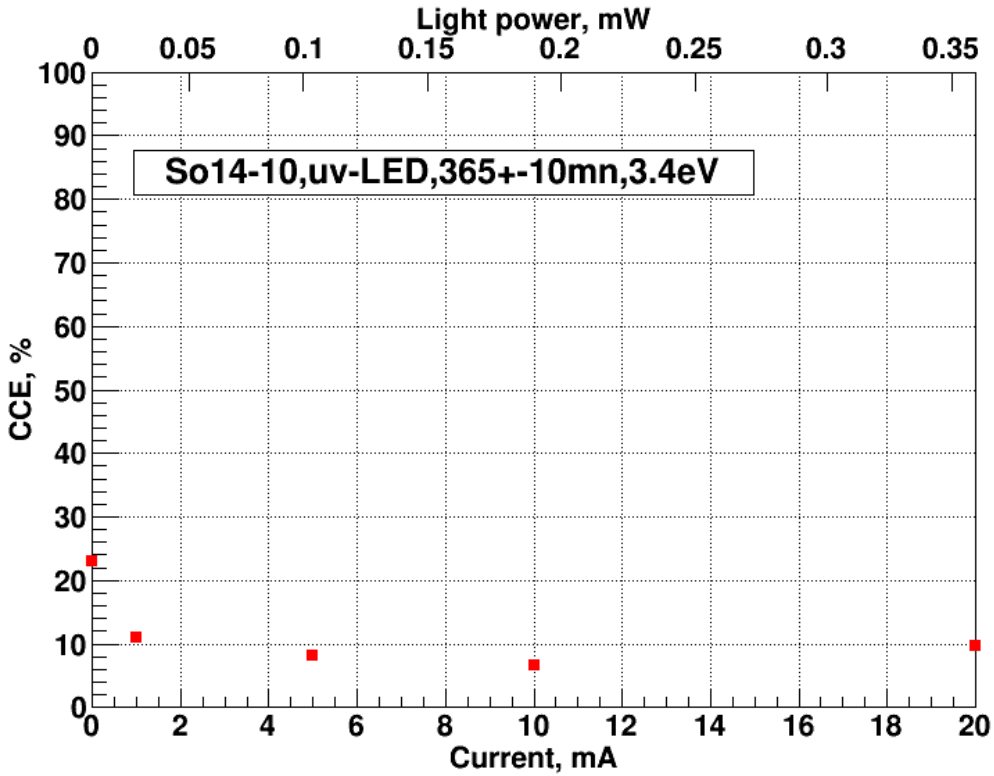
Blue

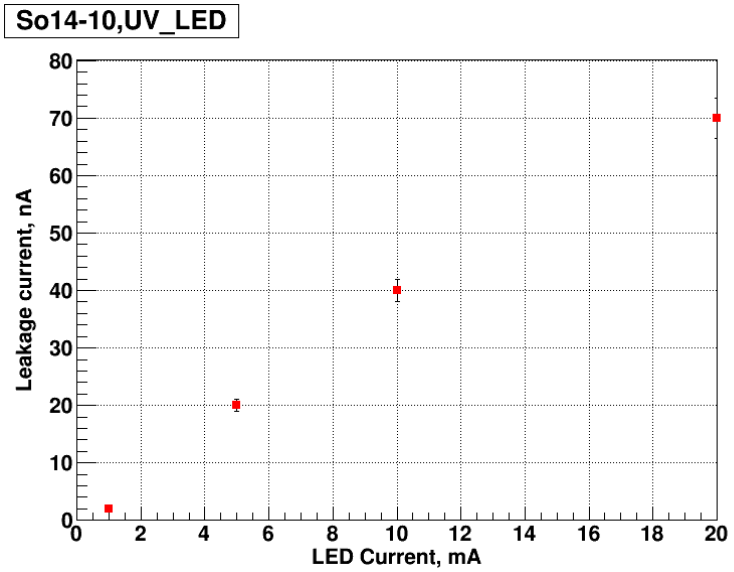




465nm blue LED (2.67 eV) – similar to green, but saturated value is lower than initial. Also, leakage current increases at high intensities. No increase in current observed for undamaged diamond

Ultra violet

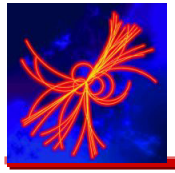




365nm UV LED (3.4 eV) – kills the signal, leakage current increases at high intensities.

No increase in current observed for undamaged diamond.

Diamond bandgap is 5.5eV = 225nm



Discussion

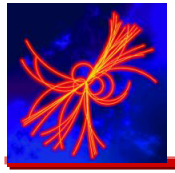
First steps of systematic study of illumination were done.
So far:

- Different wavelength give different results
- Intensity of illumination is important.
- There is a saturated value to the effect.
- Saturation does not depend on the amount of damage.
- Short wavelength light produces increase in leakage current.

- Probably could be used in practice for example in BCM

Looks like interaction with different trapping levels, but input from theoretical side needed.
Suggestions are welcome to possible experiments.
What about pCVD?

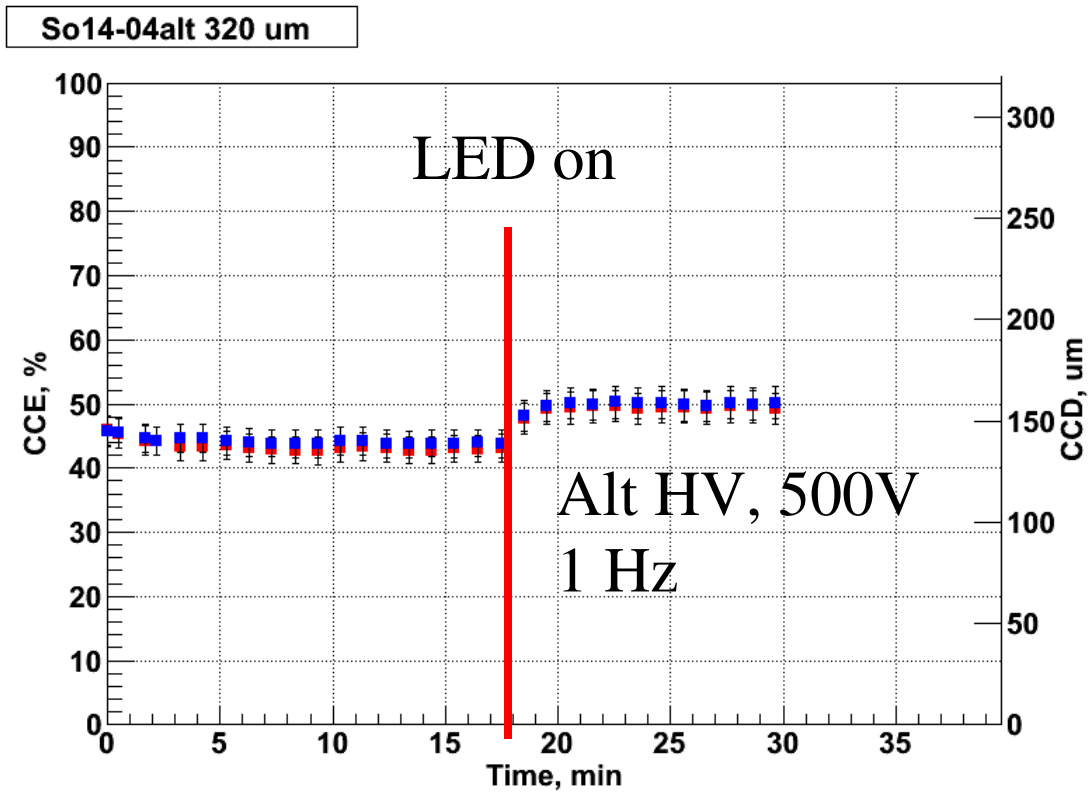
Backup



Light power

For comparison purposes only
The light power in the LED beam spot was measured by Advatec optical power meter.
I tried to keep the beam spot on diamond under study to the same size for all LEDs. No idea how much of the actual beam power was coupled to the sample.
For comparison, typical light intensity of ambient light in the lab is ~ 100-150 μW for 10x10mm light sensor.

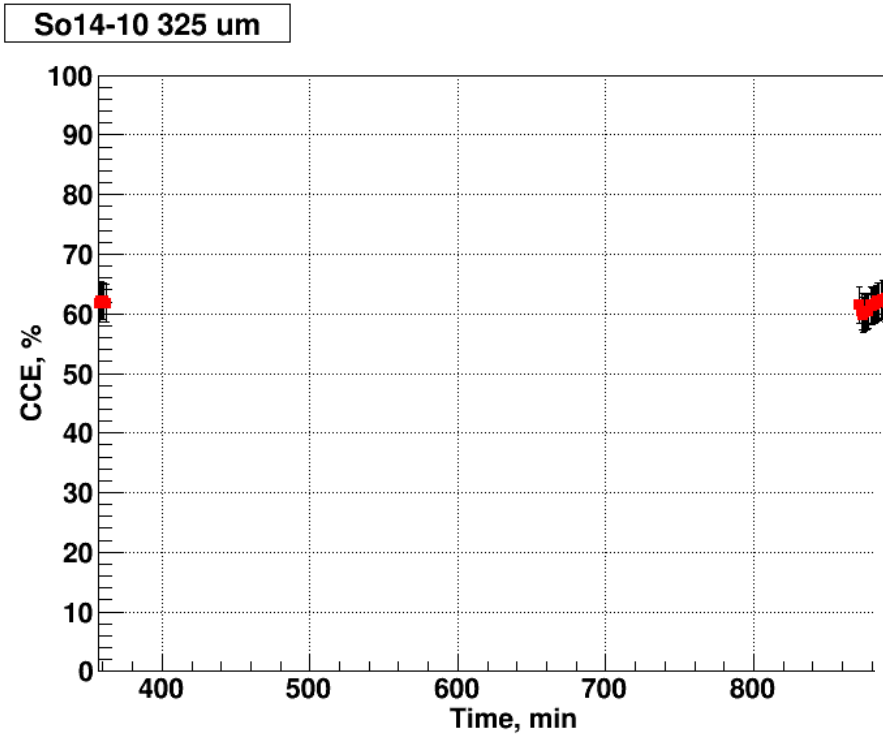
Light + alt HV

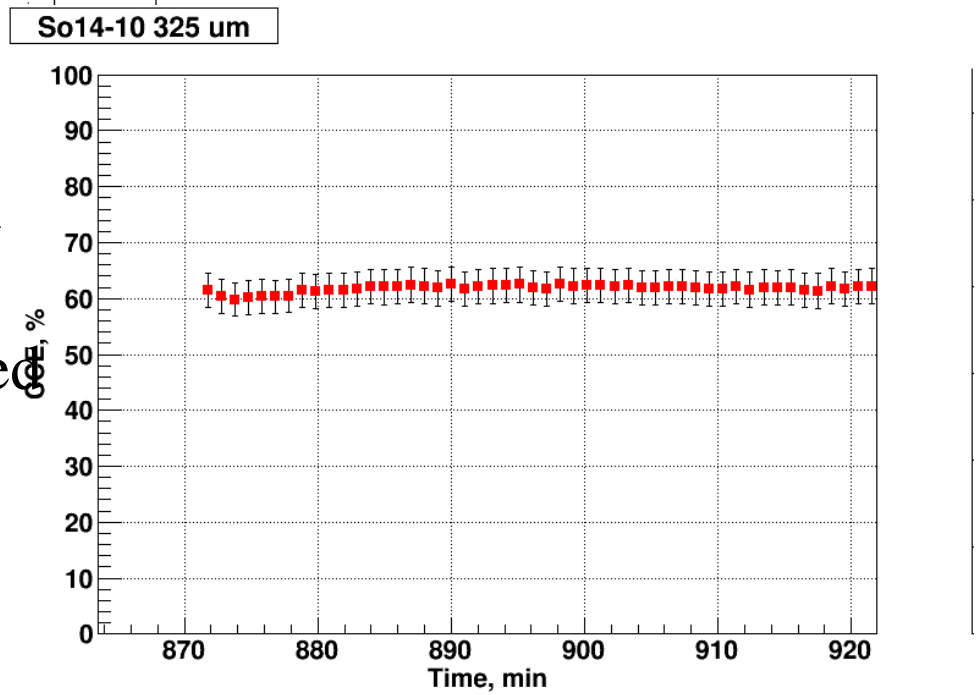


Alt. Voltage + RL is even better.

2013 fast test, not repeated so far

No source





Stable effect with source removed

Small transient effect