Development of an Edge-TCT setup at CERN

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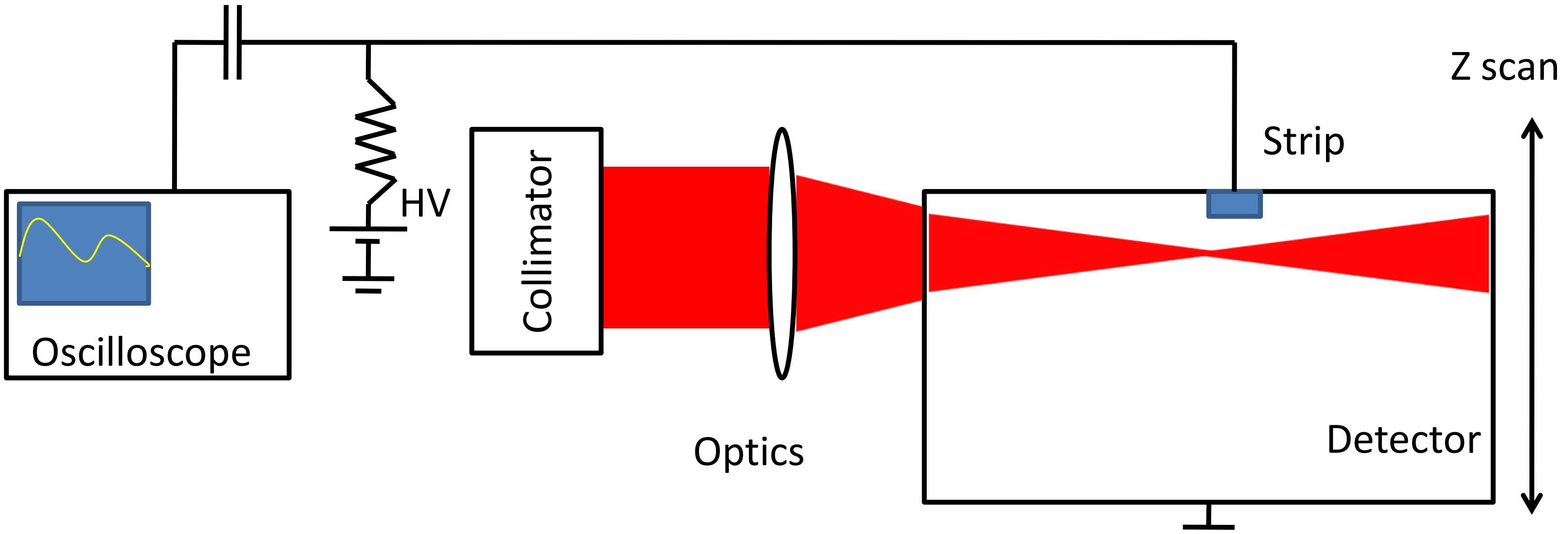
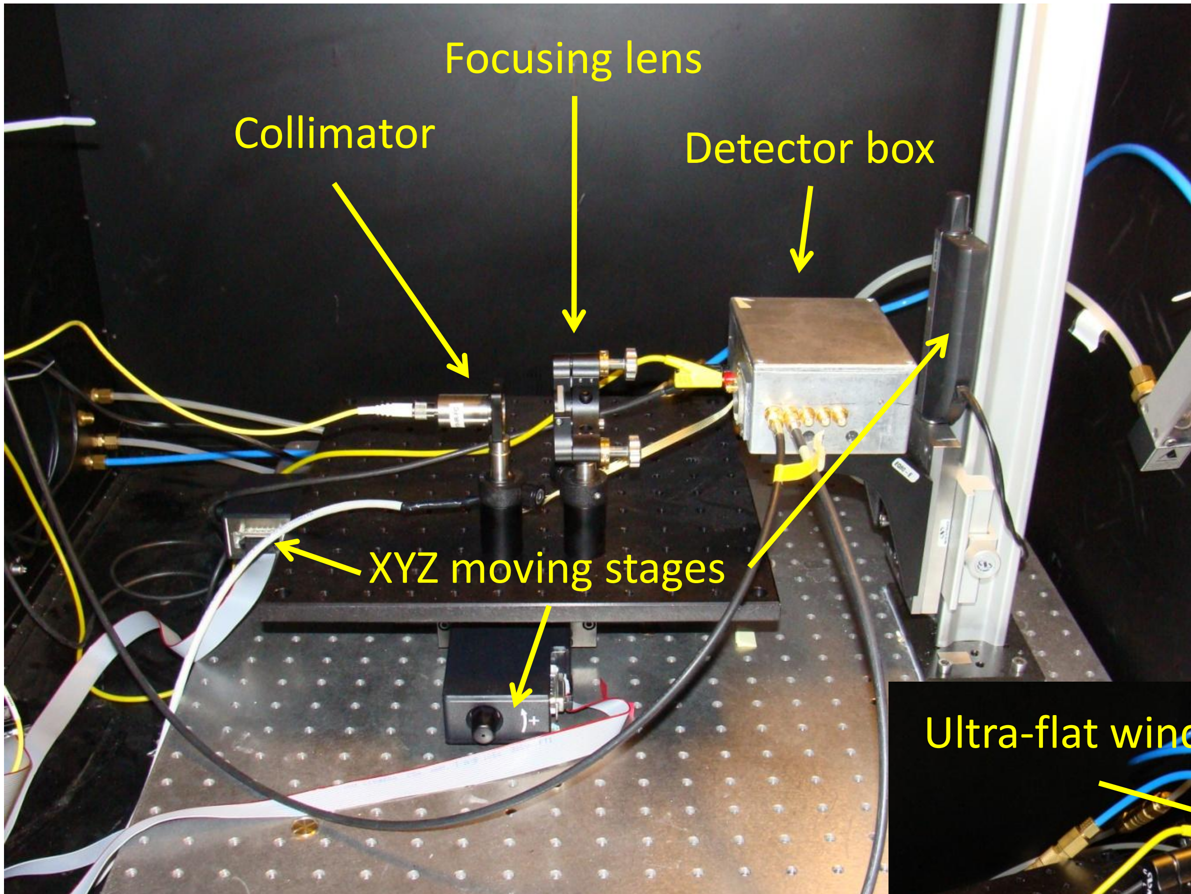
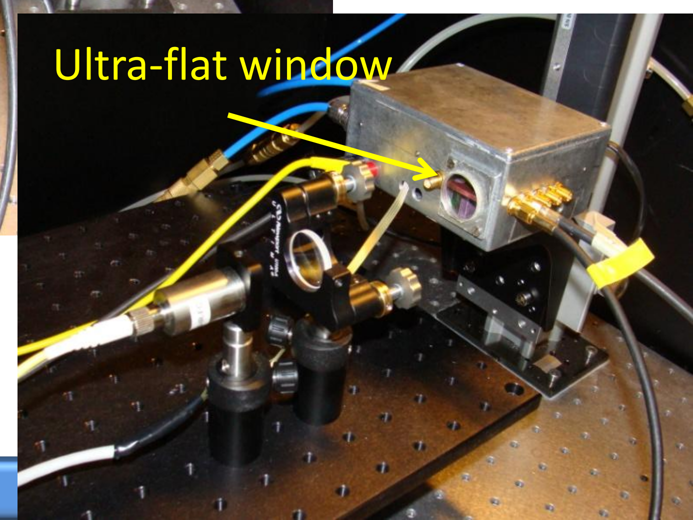
Motivations

- Edge-TCT (see G. Kramberger, 15th RD50 workshop) is a powerful technique allowing depth scan of silicon detectors (presently strips) in an extent similar to the grazing technique.
- A laser is used to generate a spatially localized charge cloud in a known depth of the detector and the drifting signal is read by an oscilloscope
- A scan is performed over the thickness of the detector, allowing the study of the detector characteristic (space charge, velocity profile etc.)



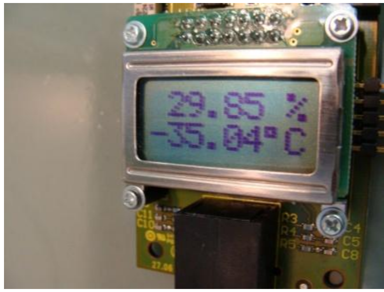
CERN ETCT-Setup



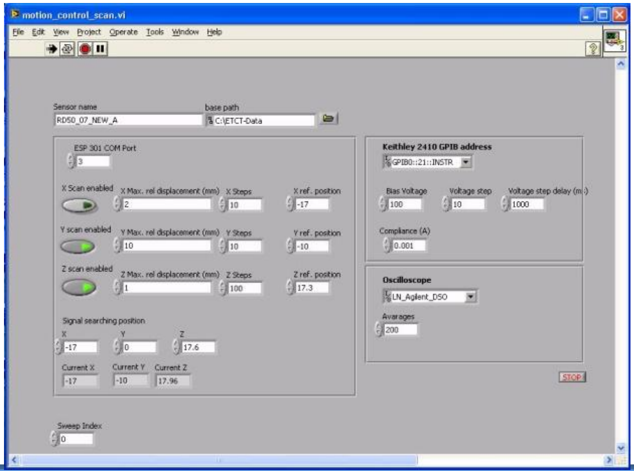


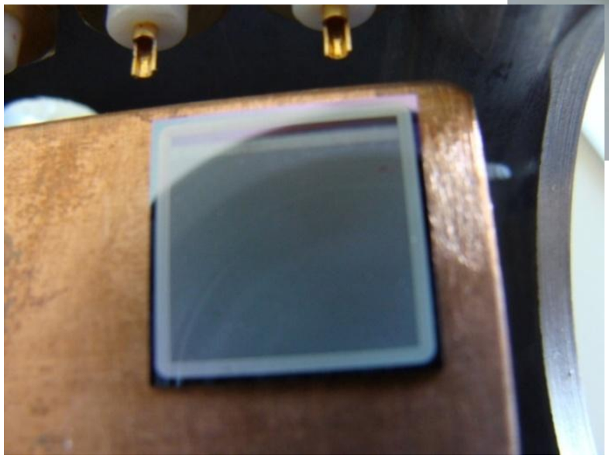
- The setup is enclosed in a shielding cabinet, provided with feed-throughs for dry air, water, fibers and signal/bias lines.

Technical data



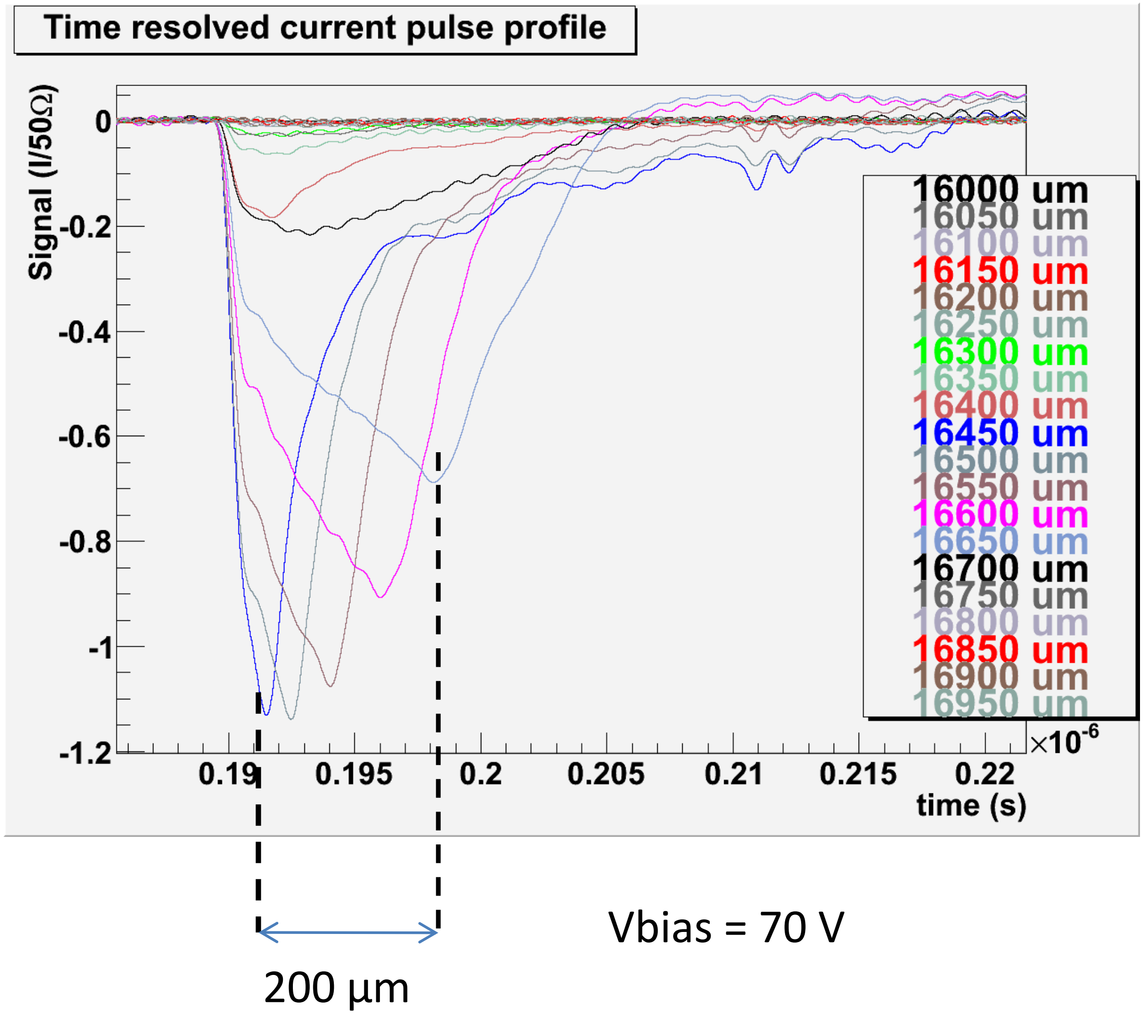
- 1060 nm fast-pulse laser (80 ps FWHM)
- Motorized stages for xyz motion with < 1 µm repeteability
- Peltier cooling: down to -35˚C (Humidity controlled with dry air flushing)
- 2.5 GHz Oscilloscope
- 1.5 GHz low noise – high gain (44 dB) Miteq Amplifier
- Large area detector support: up to 9 cm detector length
- All system automatically controlled by PC with Labview
- The analysis is a performed through a set of ROOT macros, purposely developed.





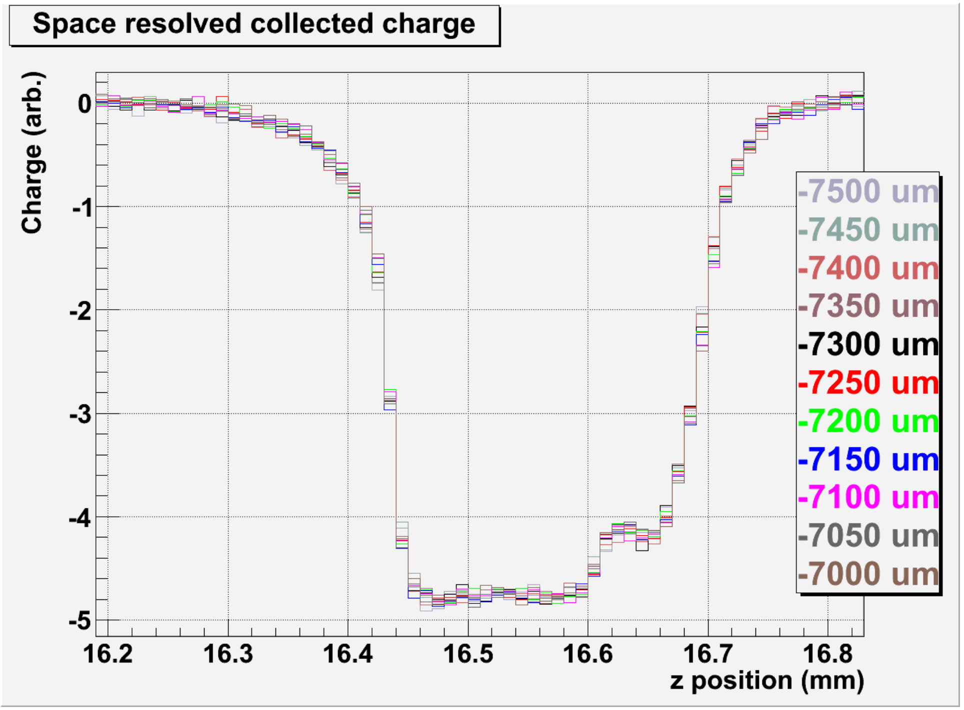
Time resolved current pulses

- Proof of principle: the setup was tested with a 300 μm, FZ n-on-p sample.
- The sample was not prepared (no polishing – just standard dicing cut)
- A good spatial resolution was still possible in the innermost region of the detector



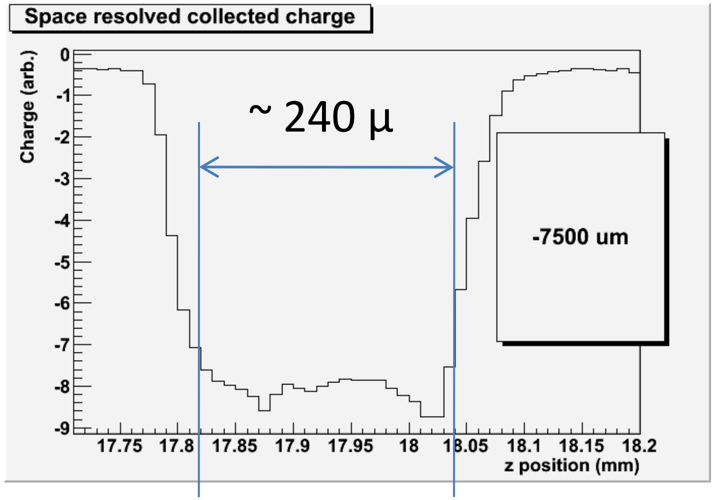
Vbias = 70 V

Space resolved collected charge.



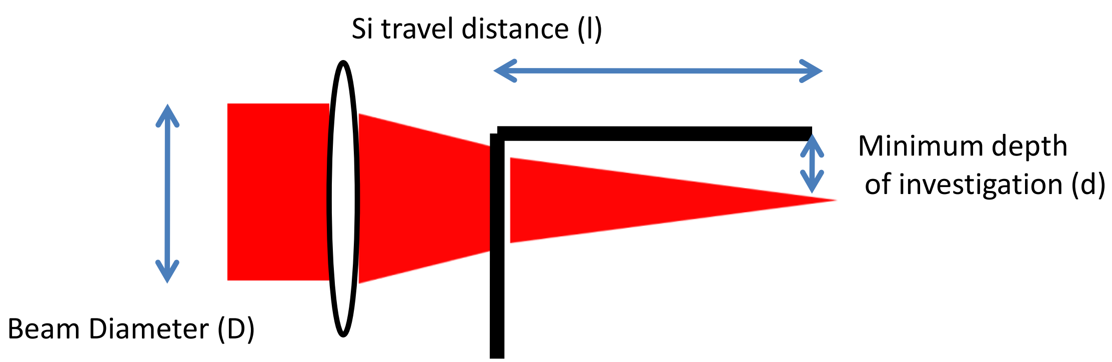
- Collected charge profile is not depending heavily on longitudinal focusing of the laser (almost collimated beam in a region of > 0.5 mm)
- Yet, the "rise" region is quite wide (~25 μm half width)
- Is this spread due to the fact that the detector side is not polished or to the actual characteristics of the beam?

Our best space resolution up to now…



Foreseen developments

- The current collimator provides a gaussian beam with a diameter of 7 mm, which is later focused by a converging lens (f=100 mm) under the strip. With this configuration is theoretically impossible to get a FWHM beam width of less than 20 µm after 1 mm of guard region penetration.
- A new collimator is expected to arrive, with a 800 µm diameter width. The theoretical limit in this case would be reduced to about 2 µm. Then we will be able to disentangle the beam spread due to the optics from the one due to the side-surface roughness of the silicon.
- "Hard polishing" (i.e., removing a significant thickness of silicon), has the double effect of smoothing the surface, while also reducing the distance light has to travel to get under the strip.



$$d = l \cdot \tan\left[\arcsin\frac{\sin\left(\arctan\frac{D}{2f}\right)}{n}\right]$$

With D=7 mm, d=10 µm

With D=0.8 mm, d=1 µm

Conclusions and further developments

- An Edge-TCT setup was built and tested at CERN. Already without sample preparation, a spatial resolution of ~25 µ is attainable. Further tests are going to be performed with a more collimated optics to test any improvement in this situation. We are also organizing a polishing campaign on some samples for later irradiation (polishing not possible on irradiated structures for safety reasons).
- Tests are going to be performed on the first irradiated strips as well as diodes. Since the divergence of the beam is already very contained there are good chances for testing this technique on diodes with carrier substrate (e.g. epitaxial diodes) to extend back-illumination standard TCT to those structures

Thank you!