

Annealing and charge collection measurements of p-type strip detectors irradiated with neutrons

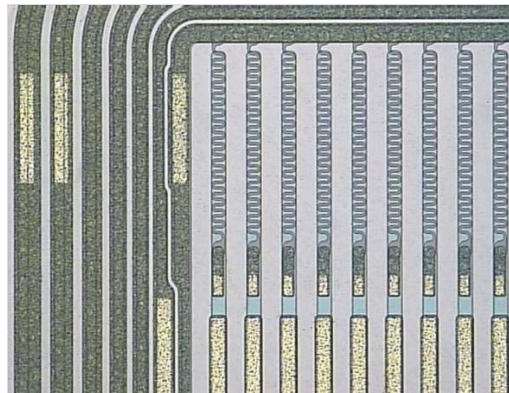
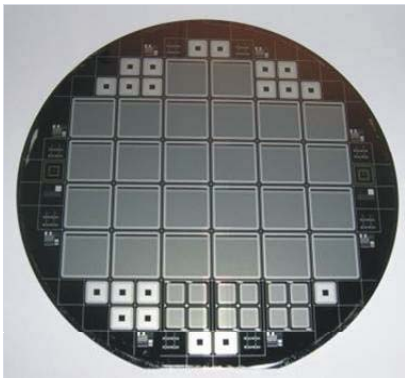
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Detectors and Irradiation

- Wafers Siltronic, <100>, P type FZ,
 - 300 +/- 15 μm , $r = 20 \text{ k}\Omega\cdot\text{cm}$
 - N strips on P-type material
Manufactured at CNM (Barcelona)
 - RD50 mask set
 - 130 strips, 80 μm pitch, 1cm^2
 - AC coupled, poly resistor bias
 - P-spray isolation
- Neutron irradiation at TRIGA nuclear reactor Jozef Stefan Institute in Ljubljana, Slovenia
 - 1 mm Cd shield thermal neutrons absorption
 - Dosimetry provided by the facility by activation measurements



FLUENCES

$1 \times 10^{14} \text{ n/cm}^2$

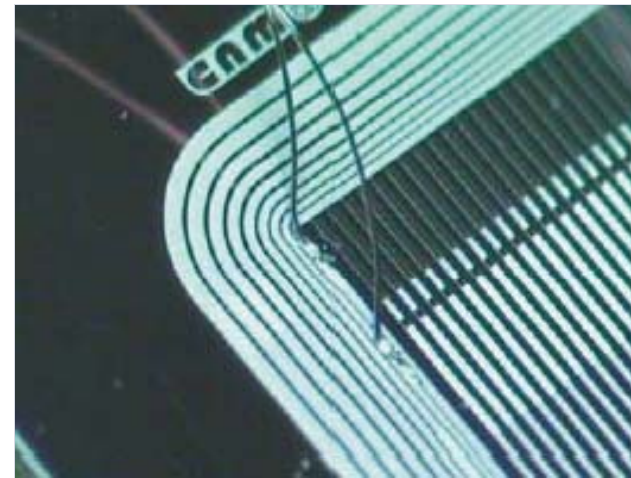
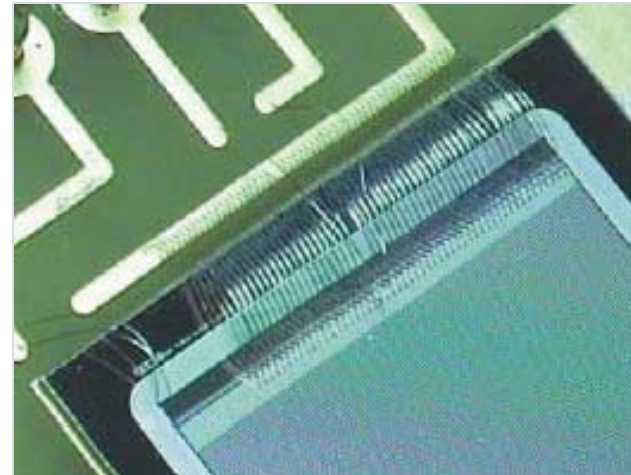
$1 \times 10^{15} \text{ n/cm}^2$

$2 \times 10^{15} \text{ n/cm}^2$

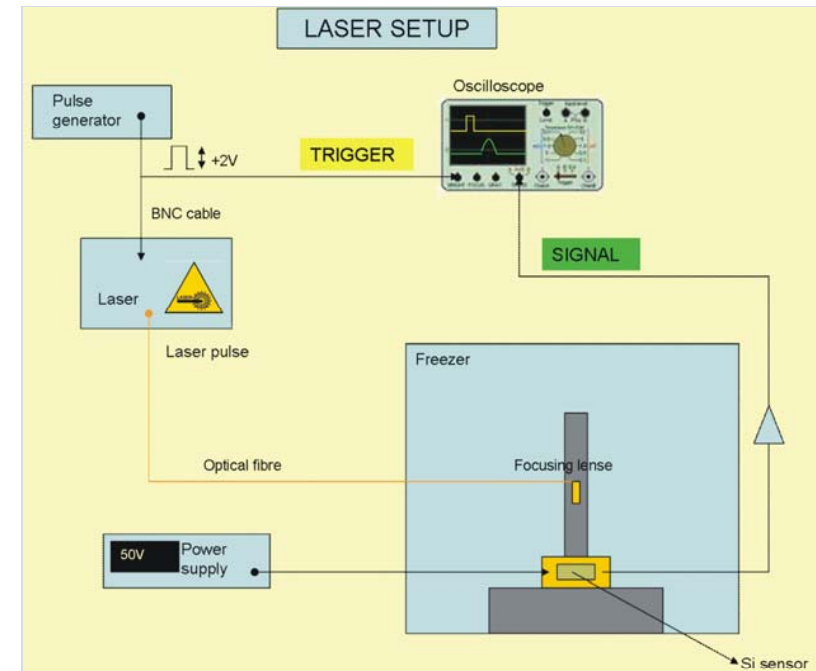
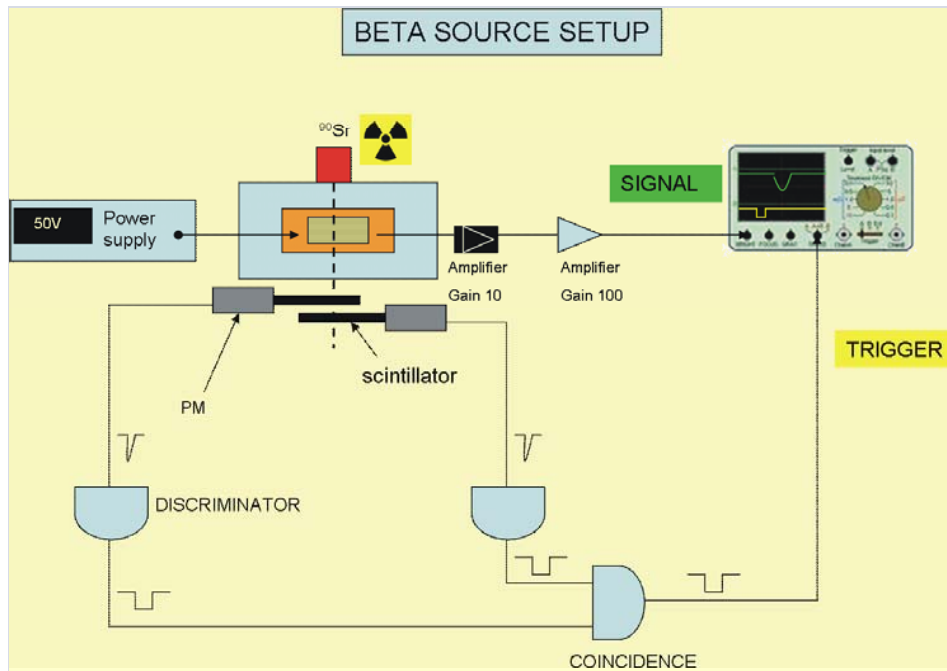
$1 \times 10^{16} \text{ n/cm}^2$

Measurements

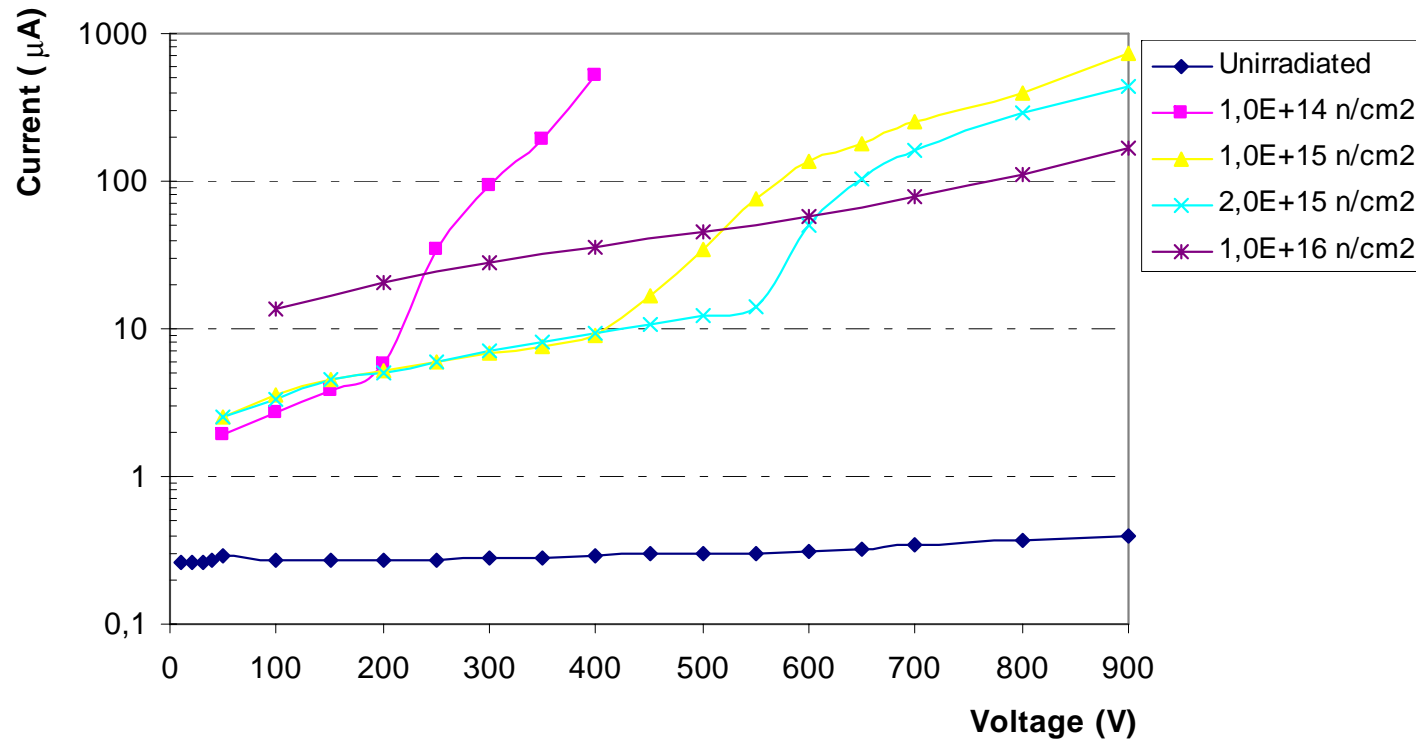
- Charge collection efficiency measurements Performed at IFIC (Valencia)
- All strips shorted
- Single channel readout electronics
- Pulsed laser measurements
 $\lambda=1060$ nm (Near Infrared)
- Laser energy of photons=1.17 eV
- Beta source (^{90}Sr : mip) measurements



Experimental setup

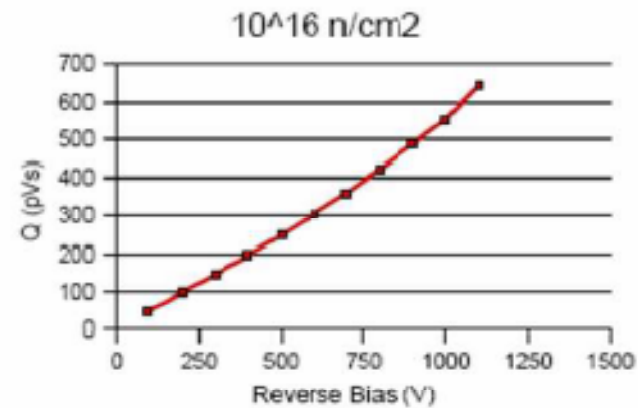
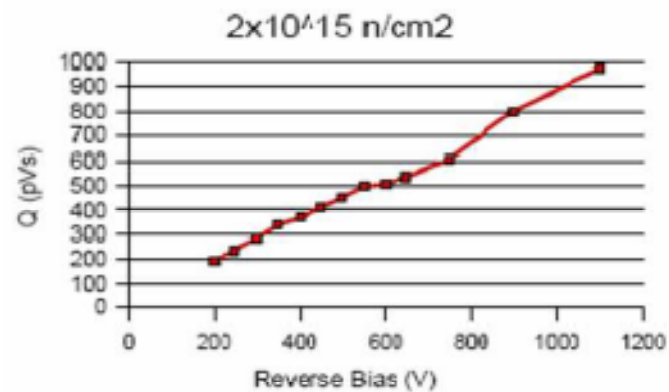
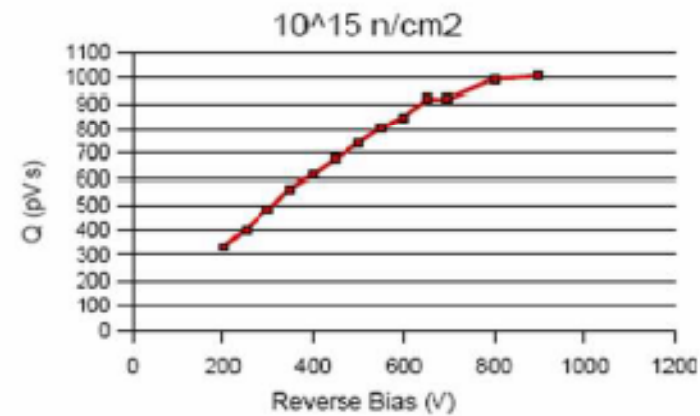
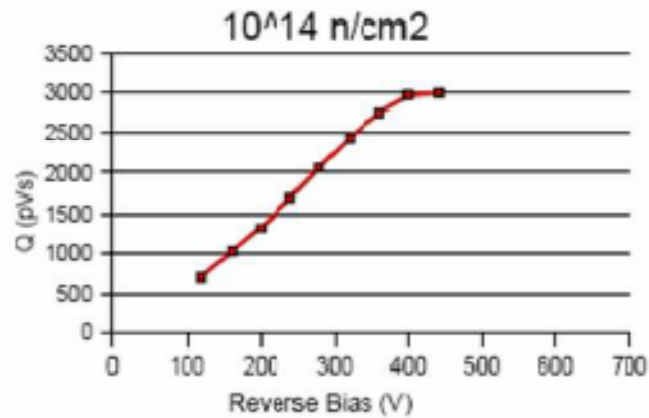


Reverse current

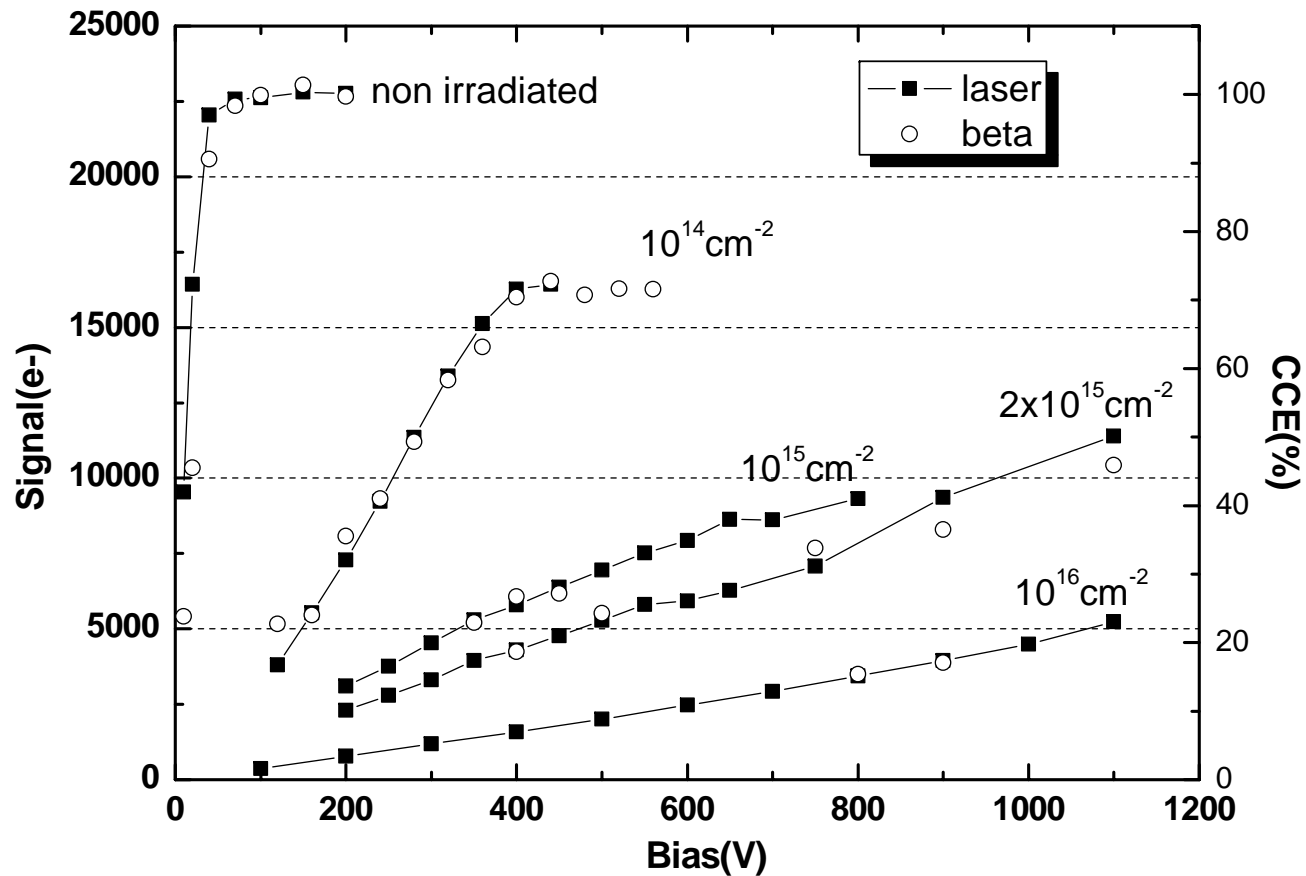


- Break voltage increases with fluence.
- For the sensor irradiated with 1×10^{13} n/cm² we observed very early break
- During the test the sensors were kept inside a freezer at -30°C

Laser illumination

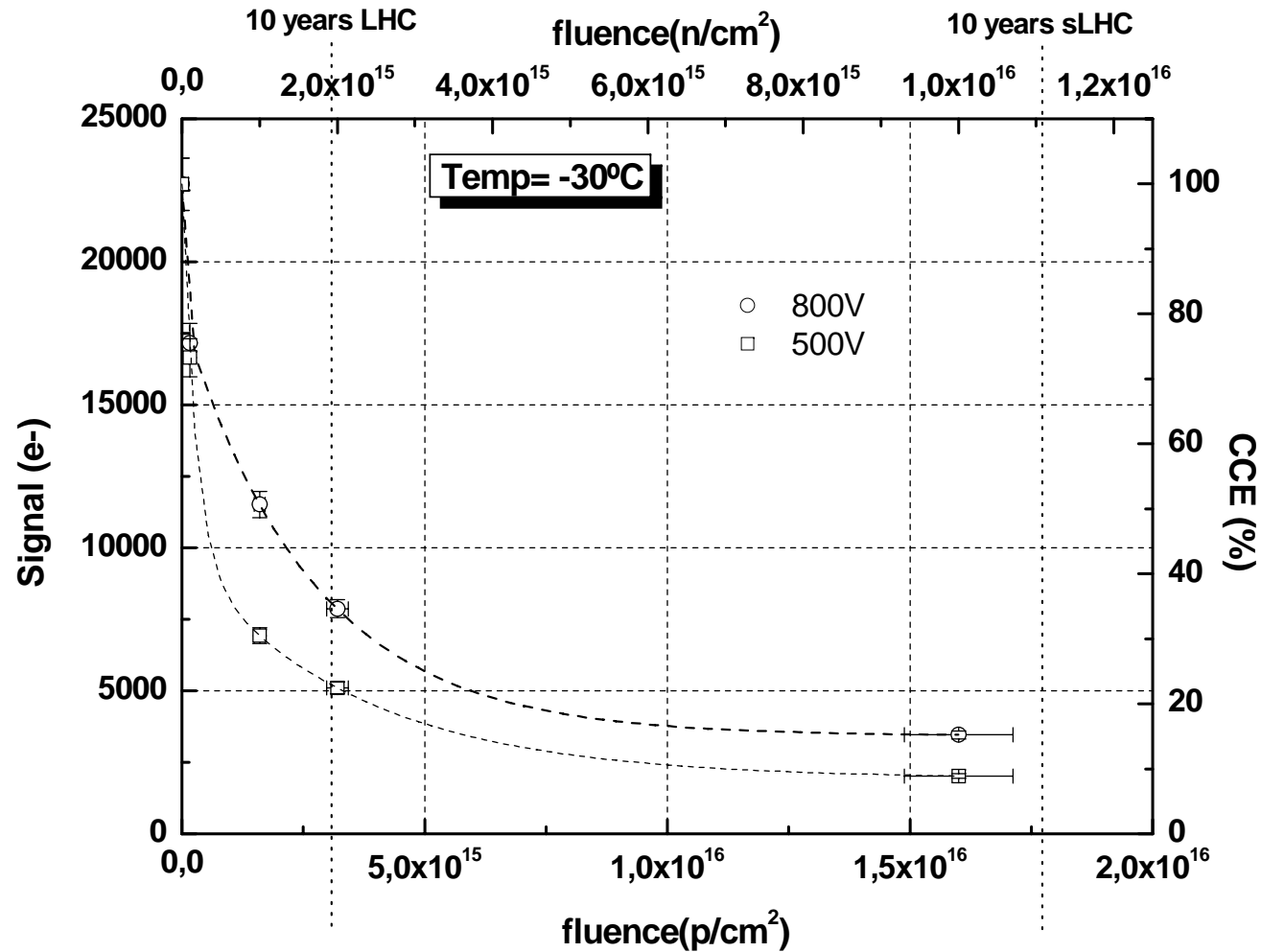


Experimental results – mip and laser



No annealing

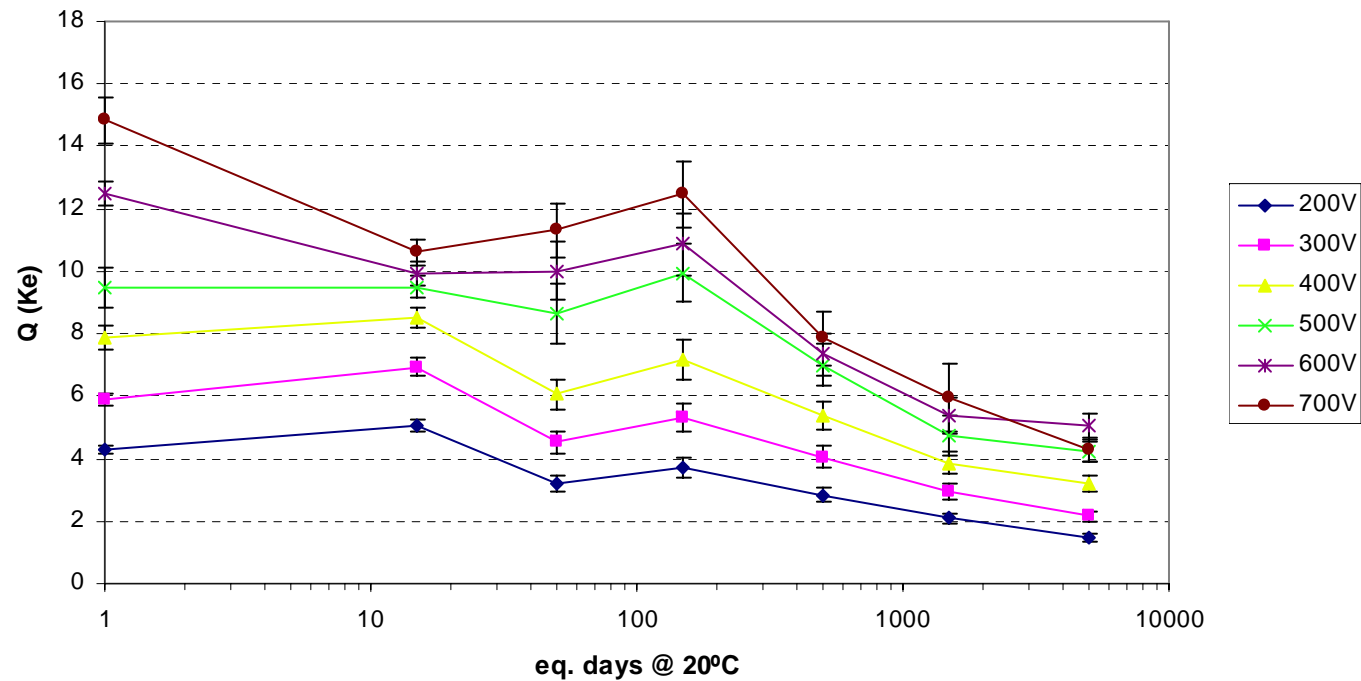
Charge collected at 500 and 800 V



No annealing

Annealing results

$$\Phi = 10^{15} \text{ neutrons/cm}^2$$



- Annealing by exposing the detector to 80°C at different times
- Measured at -30°C by laser illumination and calibrated with the β source

Conclusions

- Breakdown voltage depends on the irradiation fluences may be due to the changing of the bulk resistivity.
- Even after the highest neutron fluence (equivalent to 10 years of sLHC operation) the detectors are still operational and the signal generated at a bias of 800V is 3500 electrons.
- Charge collected is unaffected by short annealing times, however it decreases for $t > 200$ days.
- New p-type detectors on alternative substrates (Magnetic CZ and diffusion oxygenated FZ) are fabricated and under irradiations and will be characterized in the coming months