Charge collection of p-type detectors irradiated with neutrons

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Outline

I. Fabrication process
II. Irradiated p-type detectors
III. Laser/Source setup in Valencia
IV. I-V and Charge collected of irradiated p-type FZ sensors
    I. Source
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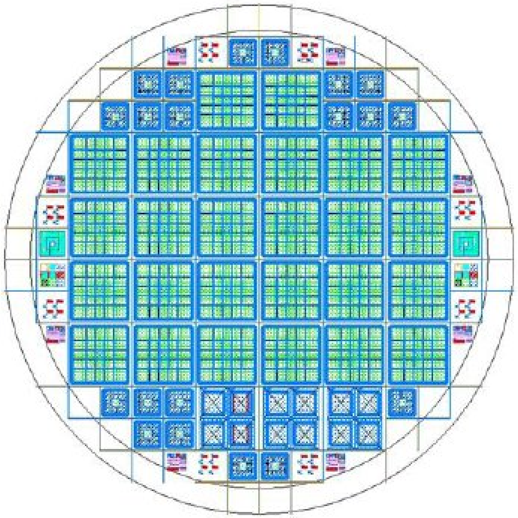
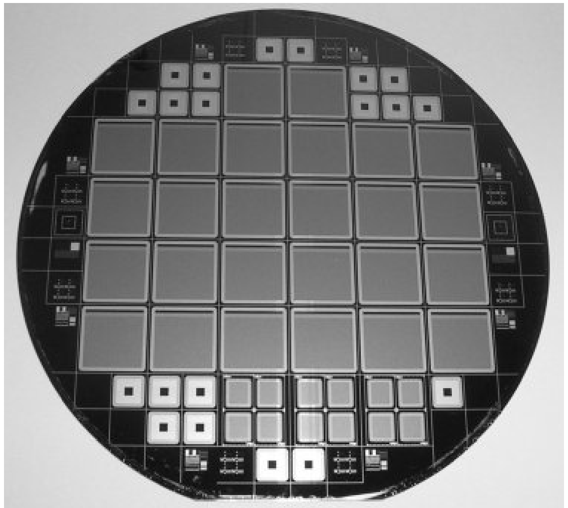
Fabrication process

- Detectors have been fabricated in the Clean Room facility of CNM-IMB

- RD50 Mask
    - Designed by the RD50 Collaboration
    - Double side processing
    - One metal layer



- Structures
    - 26 microstrips detectors
        - Polysilicon biasing resistors
        - Capacitive coupling
        - P-spray insulation
        - No p-stops
    - 20 pad detectors
    - 12 pixel detectors
    - 8 test structure sets



Irradiated p-type detectors

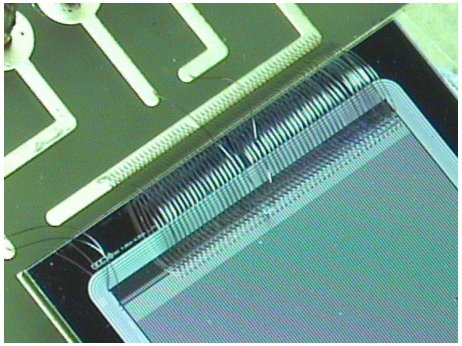
- Area: 1x1 cm^2
- 130 strips, width: 32 μm
- Pitch: 80 μm
- Thickness: 300 μm
- Multiple guard ring
- Surface isolation: p-spray
- FZ Silicon
- <100>

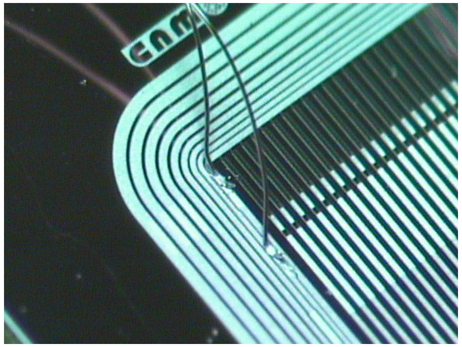
- Irradiation was done in Ljubljana with neutrons
- Each sensor was irradiated with five fluences:

FLUENCES
$1X10^{13}$ n/cm^2
$1x10^{14}$ n/cm^2
$1x10^{15}$ n/cm^2
$2x10^{15}$ n/cm^2
$1x10^{16}$ n/cm^2

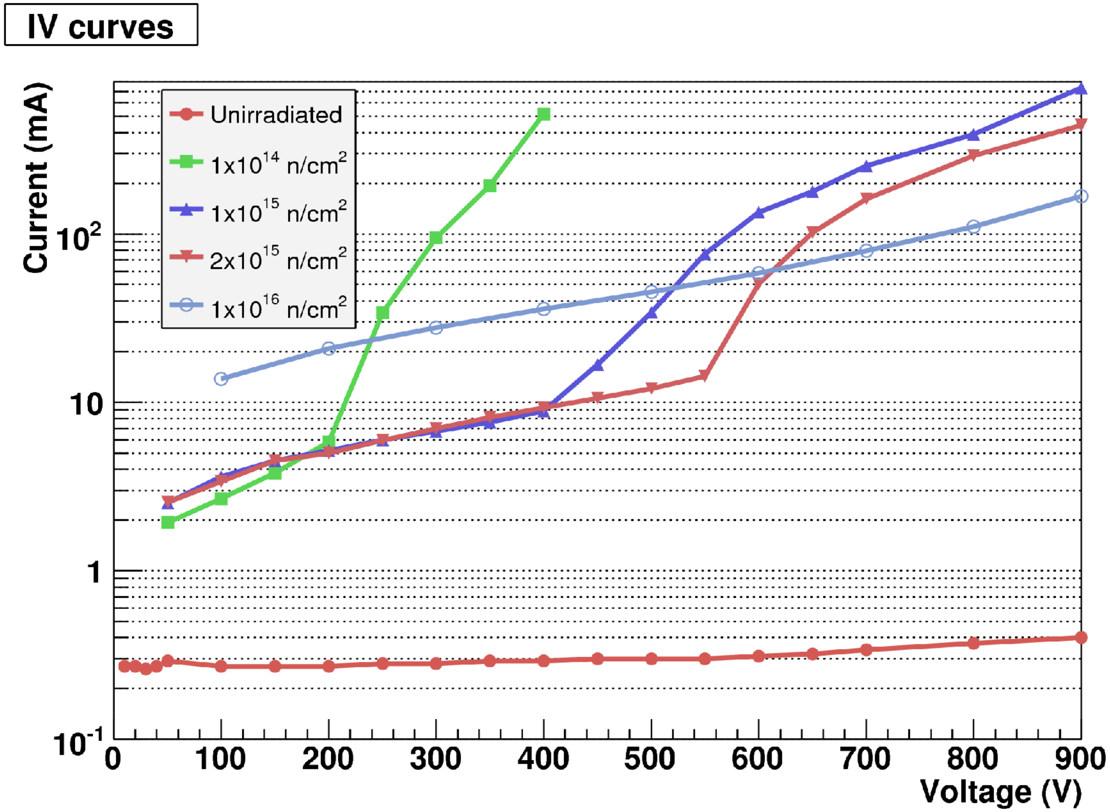
- No annealing

Wire bonding





I-V of irradiated p-type FZ sensors



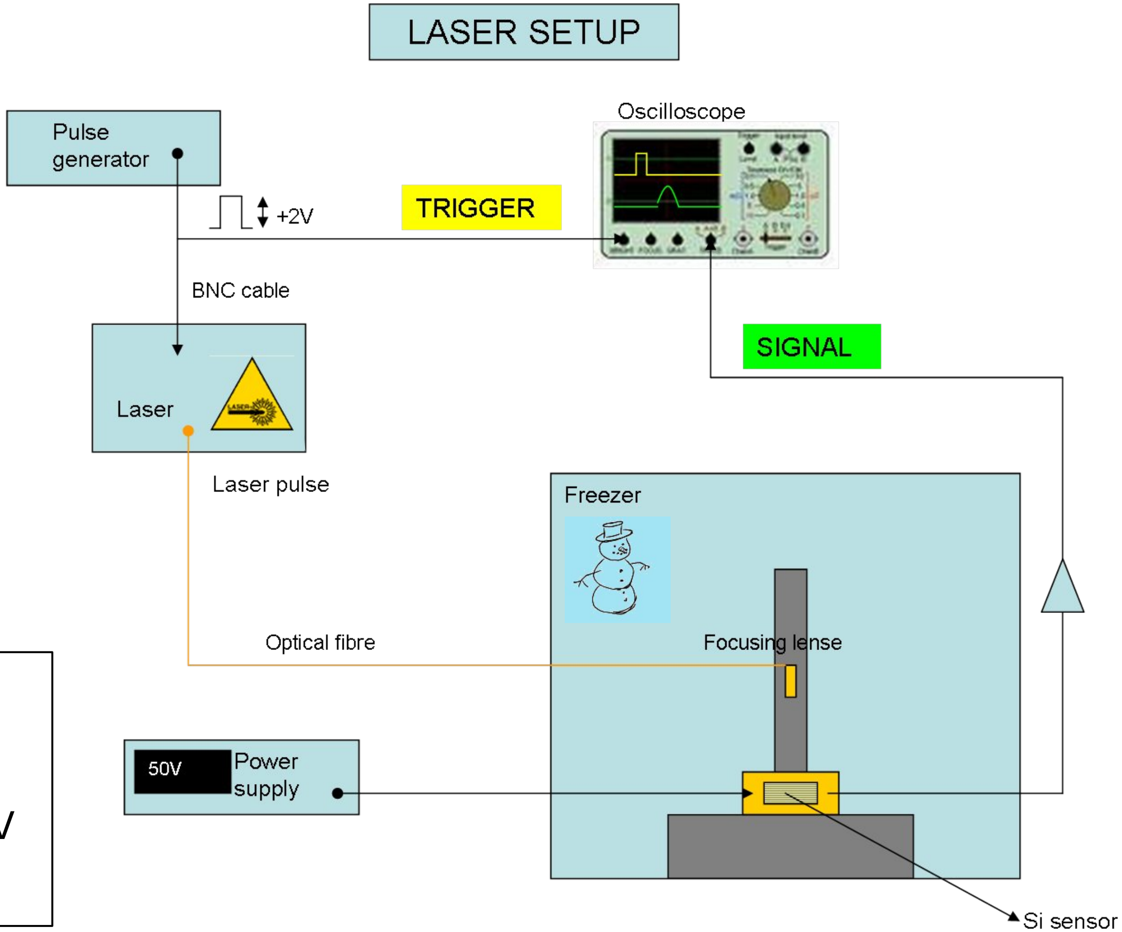
- Break voltage increases with fluence.
- For the sensor irradiated with $1x10^{13}$ n/cm^2 we observed very early break
    - 150 V → 1mA
- During the test the sensors were kept inside a freezer at $-30^{o}C$

Laser setup in Valencia

- Laser light is generated by exciting a laser source with a external pulsed signal

  (2 V and 1 MHz rate)

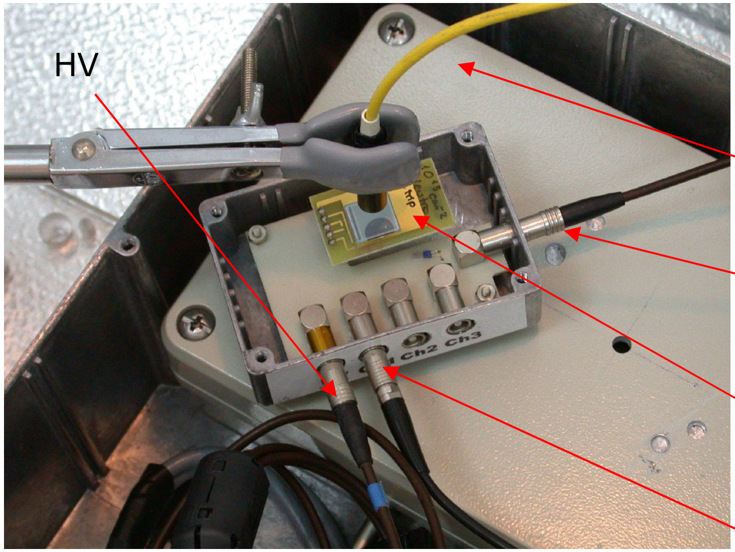
- This signal also can be used as a trigger



Laser properties:

- λ=1060 nm (Near Infrared)
- Laser energy of photons=1,170 eV

Pictures of the Laser setup



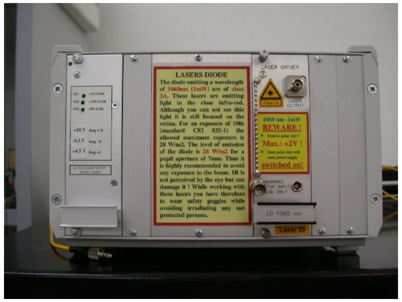
HV

Optical fibre

PT100 for temperature monitoring

Si sensor

Signal adquisition



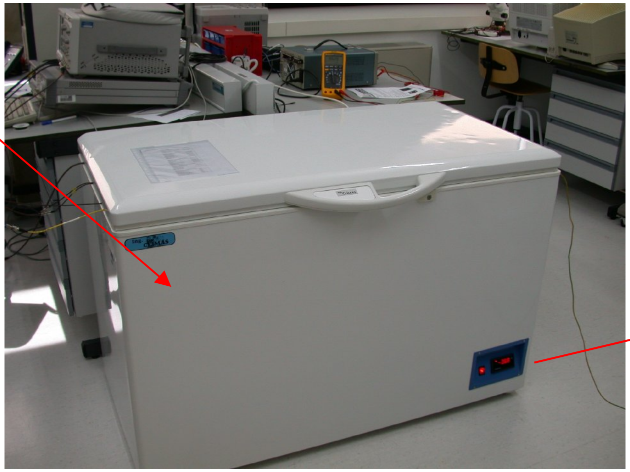
Laser

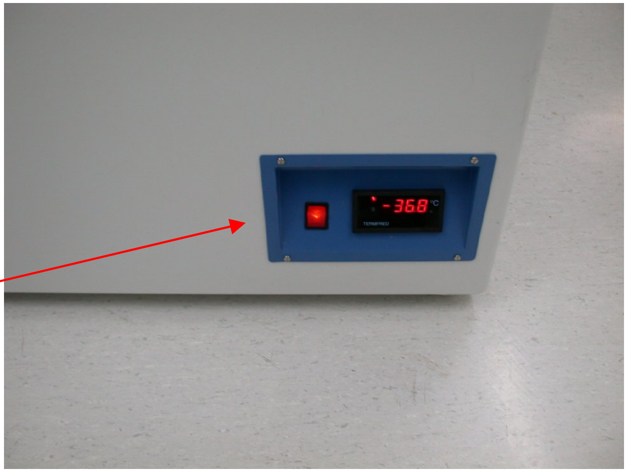
(manufactured by Maurice Glaser)

Pulse generator

Agilent 81130A

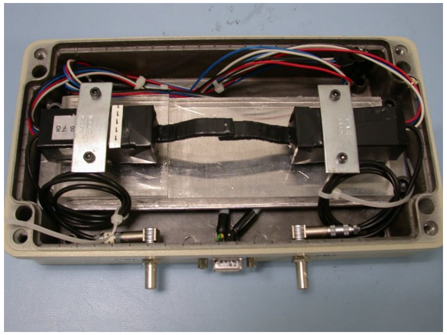
Freezer



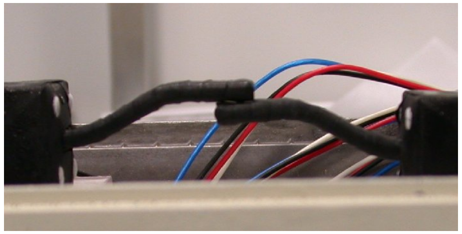


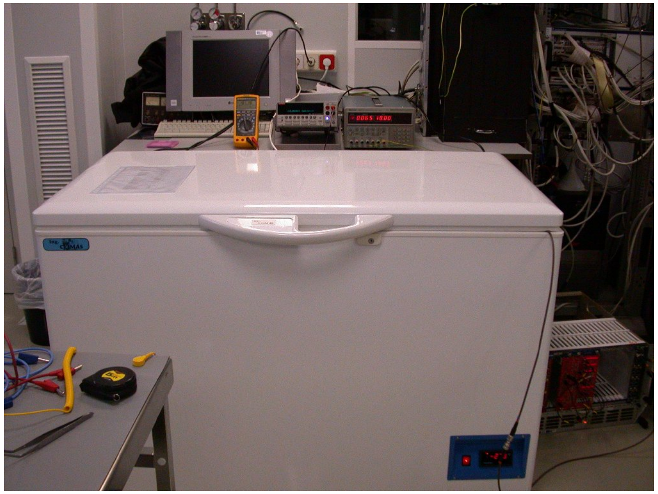
Pictures of the radioactive source setup

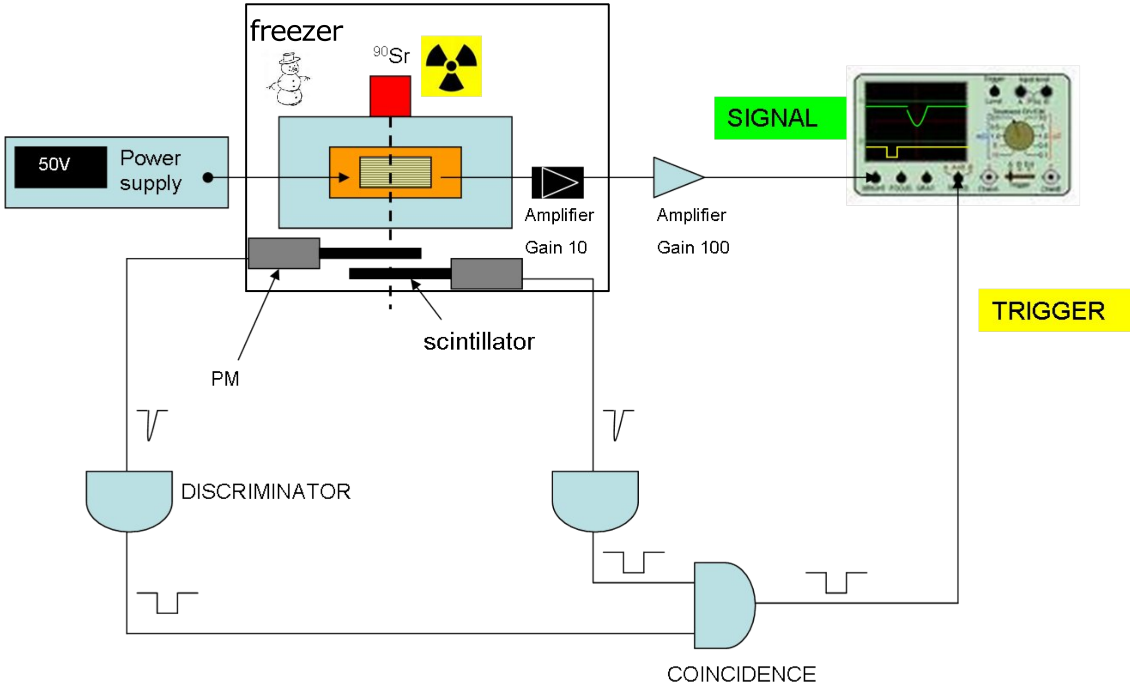
Photomultipliers and scintillators



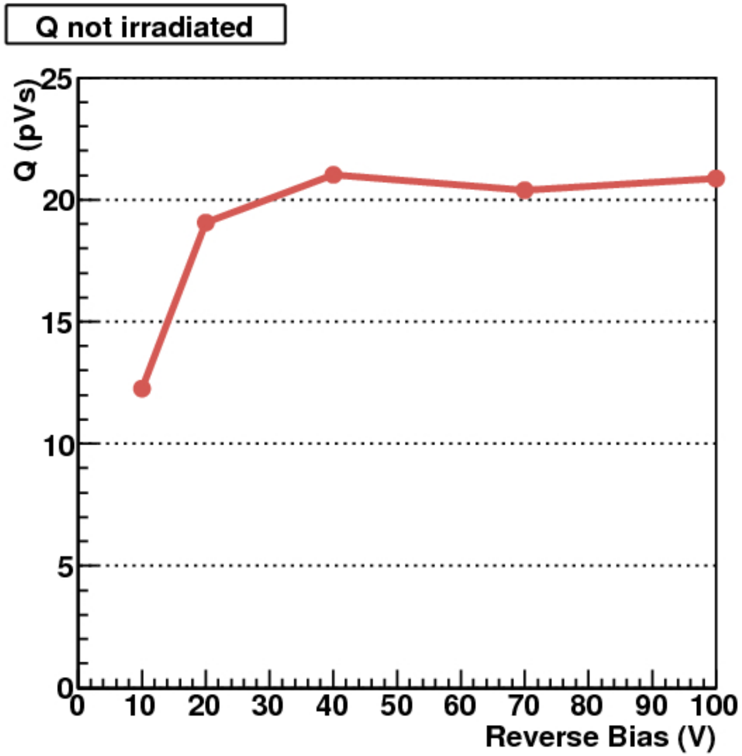
Scintillators

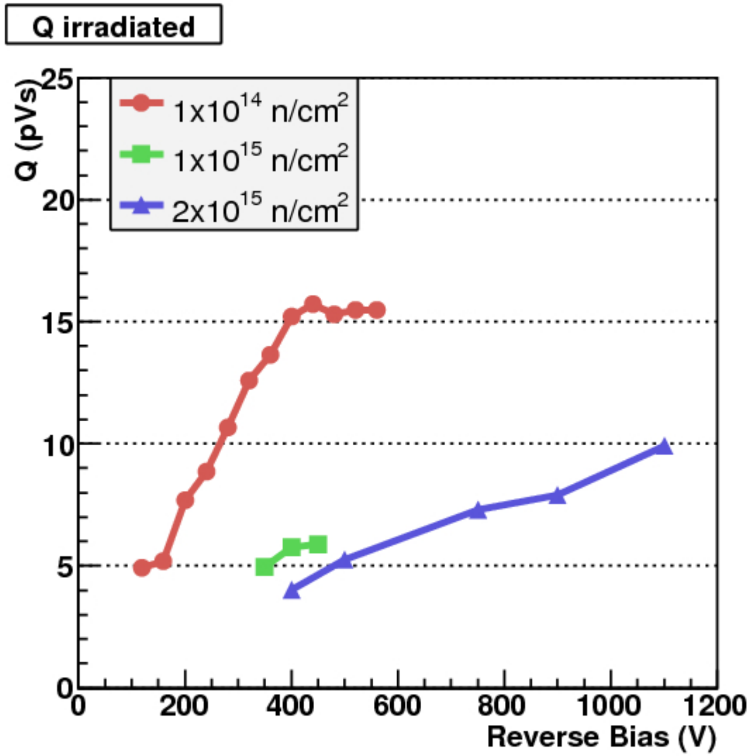






Source (^{90}Sr) Measurements

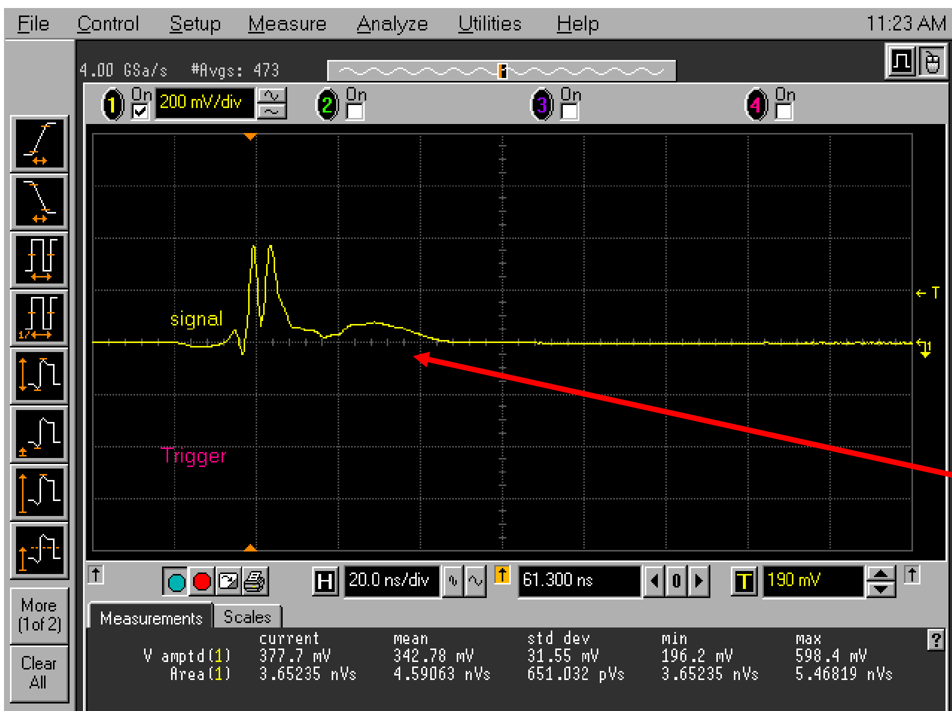




- T ~ -30^{o}C
- with 10^{14} n/cm^{2} we can see a plateau
- with greater fluences there is no plateau

Laser measurements – Avalanches ?

Fluence	Microdischarges appear at
$1x10^{15}$ n/cm^2	420 V
$2x10^{15}$ n/cm^2	200 V
$1x10^{16}$ n/cm^2	430 V

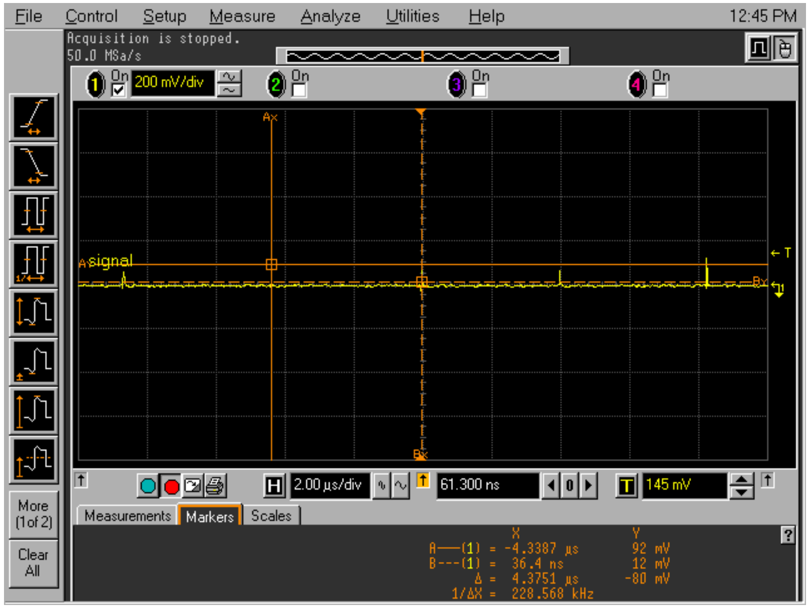


Avalanche form

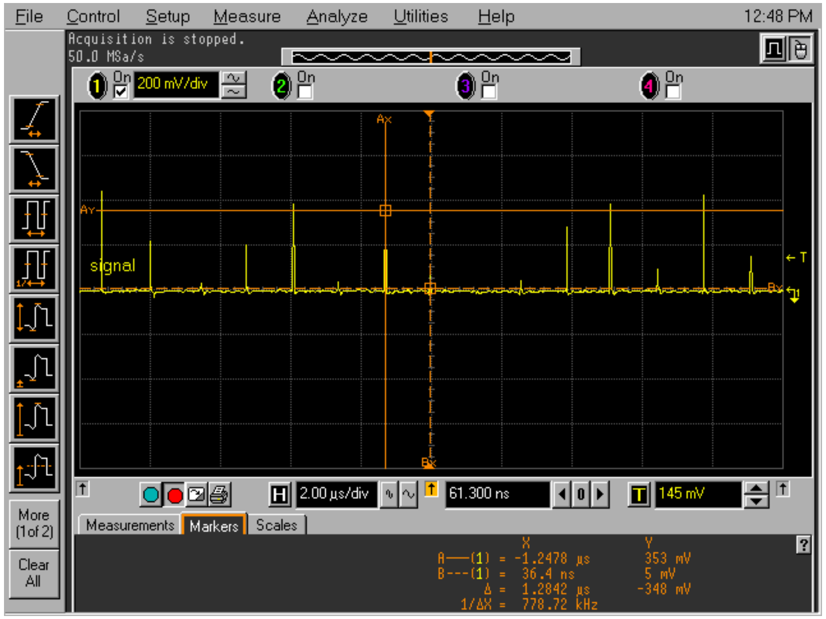
- from that voltage the charge collected does not make sense
- up to ~500 V they appear randomly
- at V > 500 V they appear with certain frequency and depend on the current

- For the detector irradiated with 10^{15} n/cm^2 :

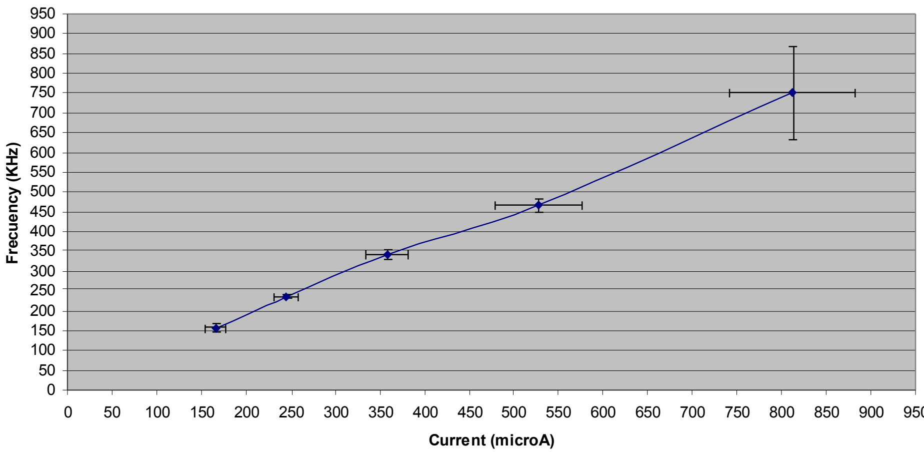
At 600 V



At 800 V

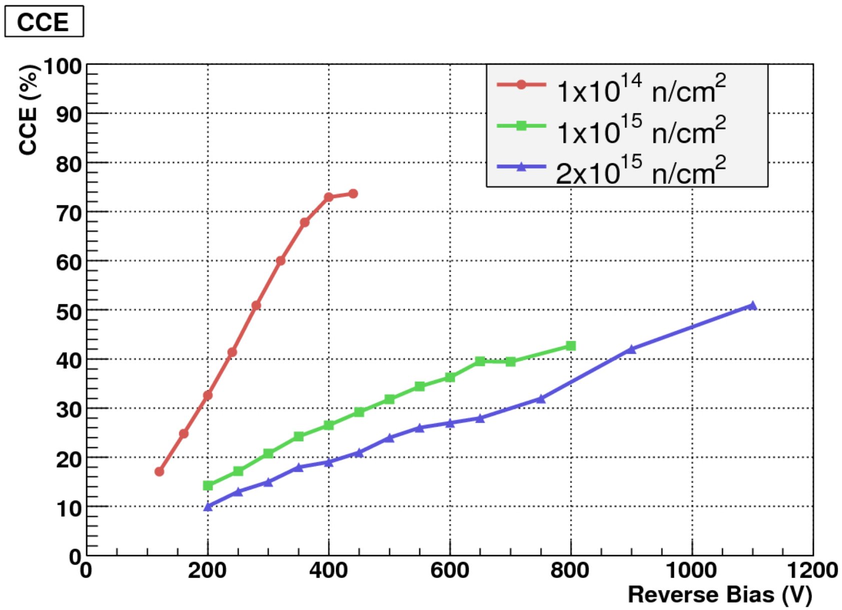


- The frecuency of the avalanches show a dependency on the current

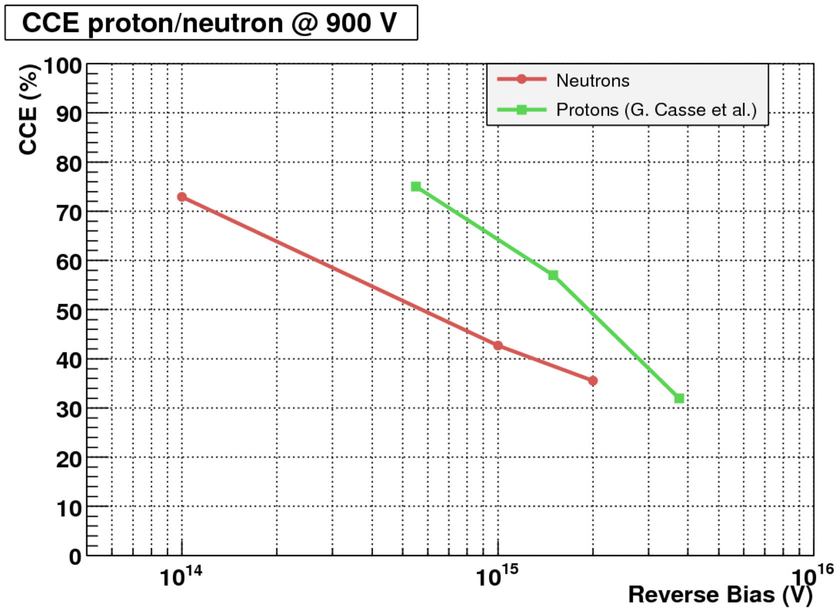


Laser measurements – CCE

- T ~ -30°C
- Scale laser measurements to math source measurements



	CCE (neutrons)	
Fluence	400 V	800 V
10^{14}	72.91	72.91
10^{15}	26.5	42.65
$2x10^{15}$	19	35.5



Summary and outlook

- P-type strip sensors have been fabricated in CNM-IMB and irradiated with neutrons at Ljubljana
- Studies with a Laser and source setup in Valencia
  - I-V measurements show late breaks with greater fluence
  - From 10^{15} n/cm^2 we can not see the plateau in the charge collection plot
- CCE is significantly smaller after neutron irradiation.
- Future work:
  - •Understand avalanches and breaks
    - •Use a thermal camera
  - •Annealing...