# Irradiation plans and operation scenario

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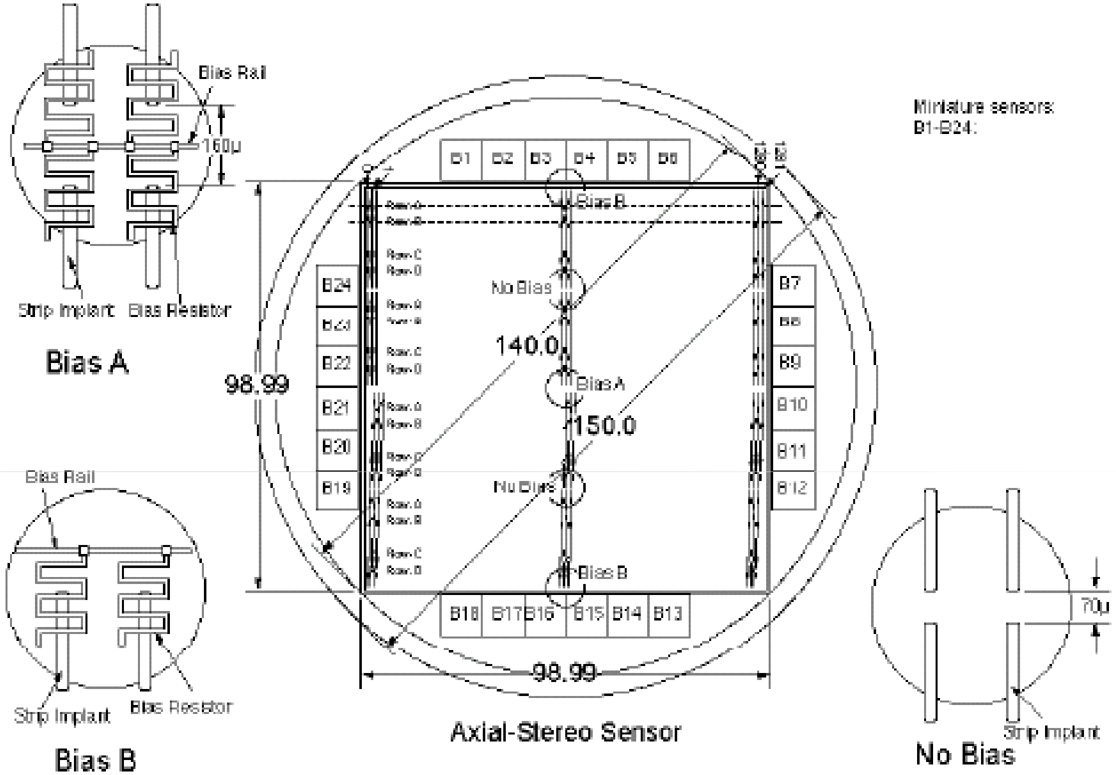
# ATLAS07

- Purpose
  - Full square
  - Usage in 2008
- Delivery target
  - Dec. 2007
- Wafer
  - 150 mm p-FZ(100)
  - 320 µm thick
- n-strip isolation
  - Individual p-stop
- Stereo
  - 40 mrad
  - Integrated in half area
  - Dead area: 2 mm

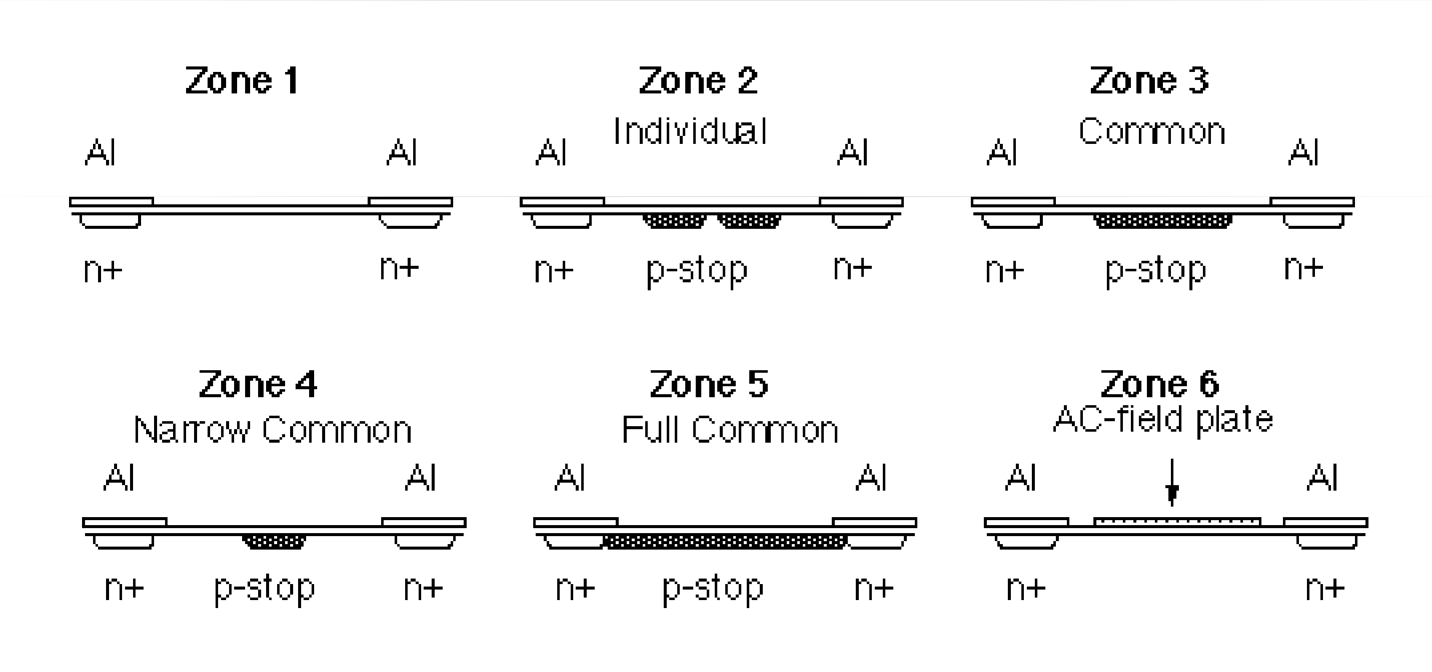



- Strip segments
  - 4 for SS (but still true for 4% limit?)
  - LS: segments wire-bonded

Y. Unno, 2007/5/2

# Miniature sensor description

Miniature detectors, 1x1 $cm^2$, ~75 μm strip pitch produced by HPK with different strip isolation methods on FZ and MCz p-type silicon substrates.



# Main Sensors from Pre-series

| | Pre-series | | Split1 | | Split2 | | Split3 | | Total |
|---|---|---|---|---|---|---|---|---|---|
| Isolation | p-stop | p-spray +p-stop | p-stop | | p-spray +p-stop | | p-spray only | | |
| Wafer | FZ1 | FZ1 | FZ1 | FZ2 | FZ1 | FZ2 | FZ1 | FZ2 | |
| KEK | 1 | | 2 | 4 | | | 2 | 1 | 10 |
| UK | | 3 | 4 | 4 | | | 8 | 8 | 27 |
| Freiburg | 1 | | 4 | 4 | | | | 1 | 10 |
| Geneva | 1 | | 5 | 6 | | | 2 | 1 | 15 |
| Valencia | | | 5 | 4 | | | | 1 | 10 |
| US | 3 | 6 | 20 | 22 | 0 | 0 | 4 | 5 | 60 |
| Total(Requests) | 6 | 9 | 40 | 44 | 0 | 0 | 16 | 17 | 132 |
| FZ1+FZ2 | 15 | | 84 | | 0 | | 33 | | |

- "p-spray+p-stop" have been delivered
  - UK 3, US 6
- KEK, Freiburg, Geneva are for "p-stop"
- Valencia is for series productions
- "p-stop" and series production are waiting for mask change

N. Unno

## Miniature sensors:

Continue irradiation at Ljubljana (V. Cindro), CERN-PS (M. Glaser), KEK (N. Unno) for further qualification of HPK microstrip sensors.

Issue to be investigated: strip isolation, performances after mixed (neutron + protons) irradiation. Statistical relevance of the results. Many miniature HPK detectors available soon (December?) from the pre-series detector run.

One possible option: investigating the oxide charge-up with **E** field. Bond al strips to common bar and apply 1V between metal and bias ring.

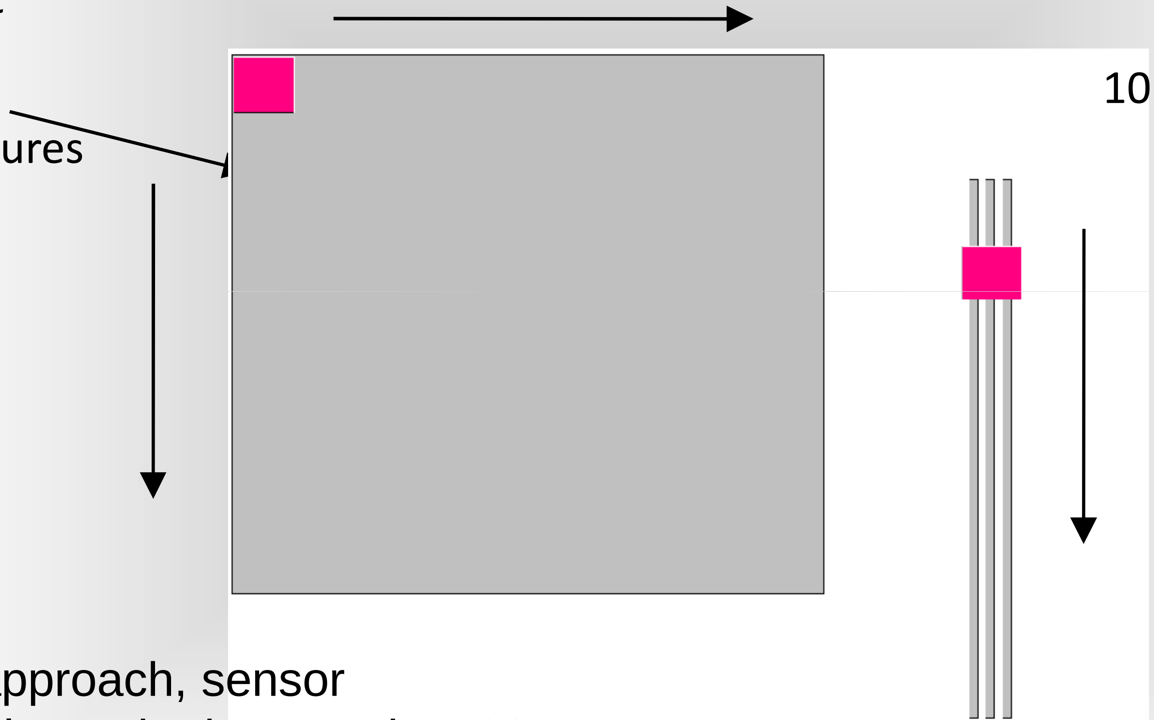
## Full size sensors:

Start irradiation of real size detectors under bias and with cooling. Also, possible to put field across the oxide.

Commissioning of the system (cool-box) for the irradiation of the full size devices.

Full size detector irradiation, under cooling and bias is only possible at the CERN-PS. Problem: they are big!

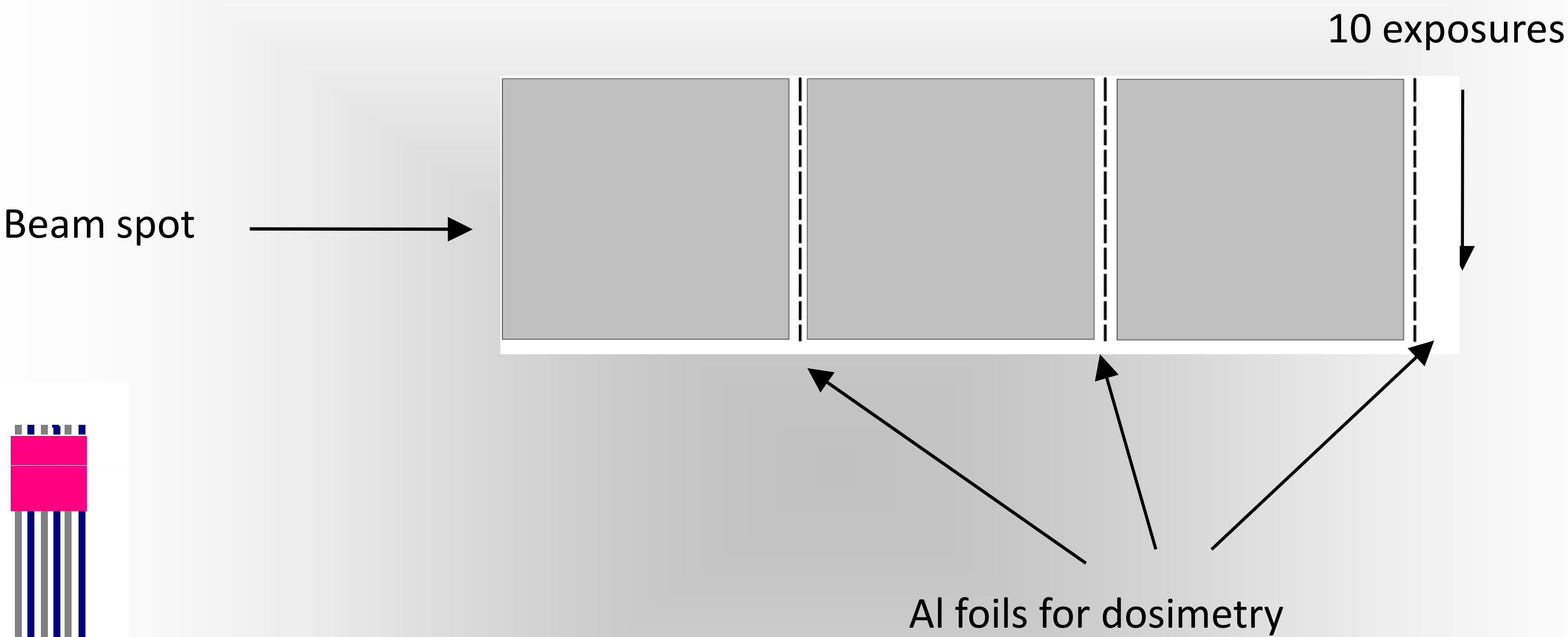
Problem: qualification fluence is now up to $1x10^{15}$ $cm^{-2}$. The devices are 10x10 $cm^2$, the CERN-PS flux about 1-3E13 $p/hour/cm^2$, with a beam spot of about $1cm^2$. So, to cover the entire surface we would need 100 exposure to final dose, with an anticipated irradiation time is ~ 400-140 days!!
Need at least a factor of 10 reduction in time.

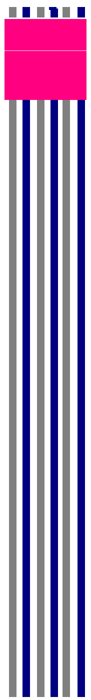



Standard approach, sensor perpendicular to the beam axis, 100 exposures.

New proposal: sensor parallel to the beam axis, 10 exposures.

# How many detectors is possible to irradiate? Lining up detectors for irradiation could be possible.



To have more control on dose can also be staggered.

Evaluate dose at different positions.

Motored cool box and biasing electronics, switching matrix for measurements to be revamp/prepared.

# Temperature management:

Beam on: irradiated detectors biased at 500V and cooled to (possibly) -25ºC to control the reverse current, avoid runaway and reduce the shot noise.

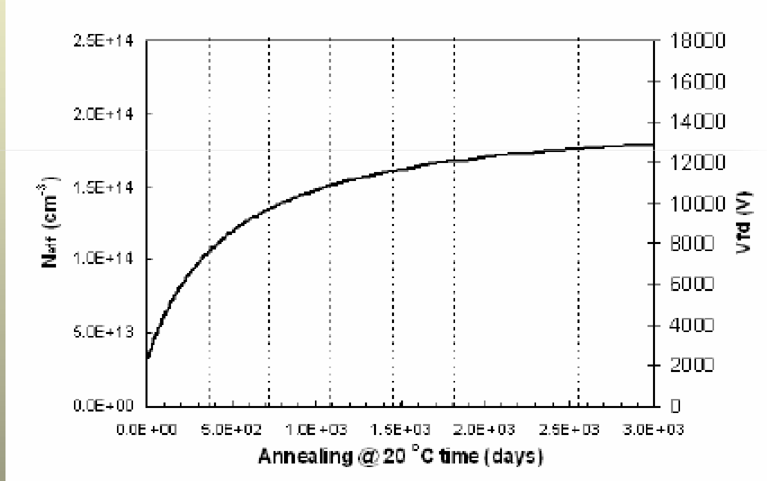
Beam off, “old” assumption:

Avoid warming up the irradiated detectors above 0ºC, even during beam down and reduce maintenance at room temperature to minimum.

$V_{FD}$ undergoes reverse annealing and becomes progressively higher if the detectors are kept above 0ºC.

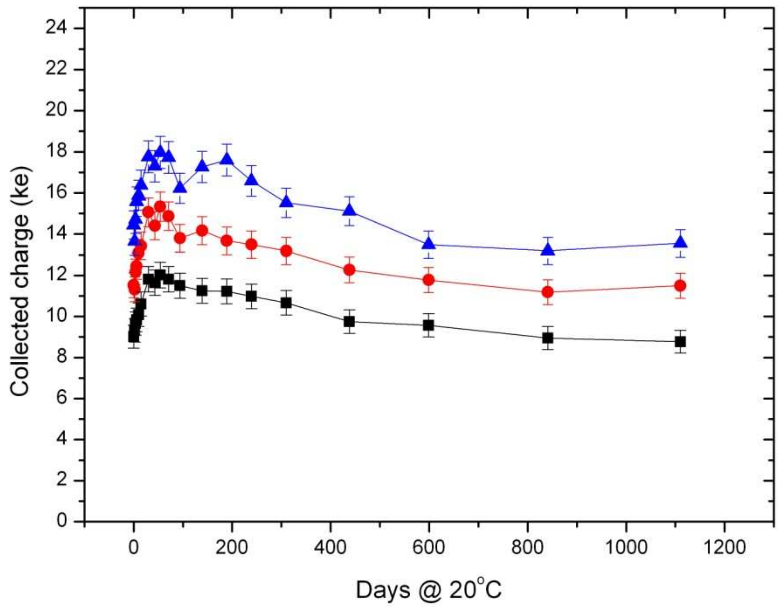
But what happens to the reverse current and the CCE of n-side readout detectors?

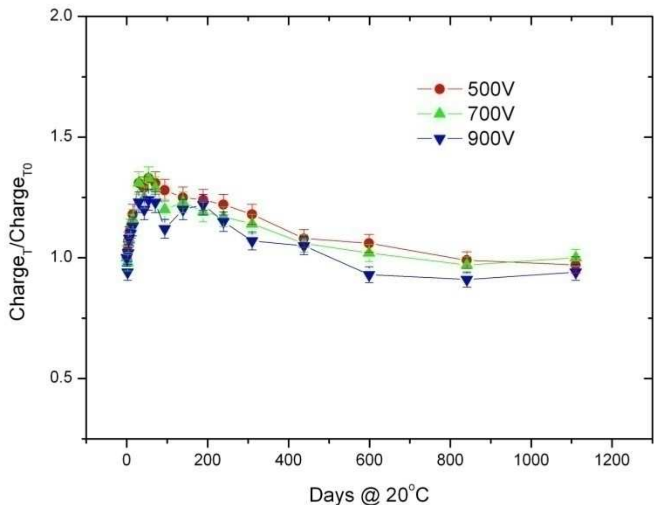
Initial $V_{FD}$ ~ 2800V

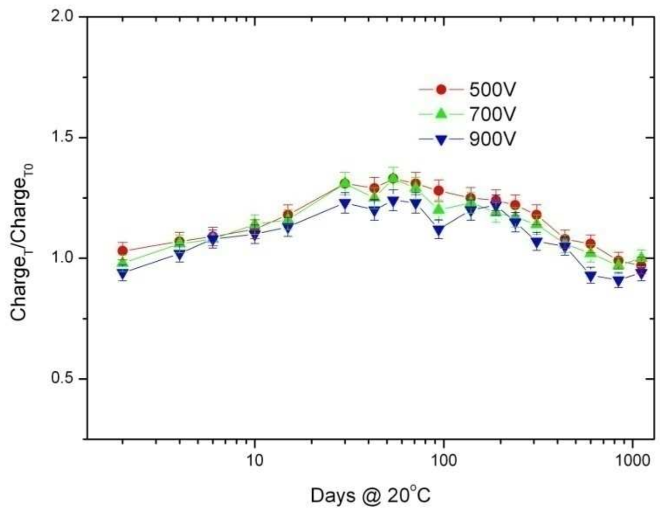



Predictions from RD48 parameters for Oxygen enriched devices (best scenario: after 7 RT annealing years the $V_{fd}$ goes from ~2800V to ~12000 V!

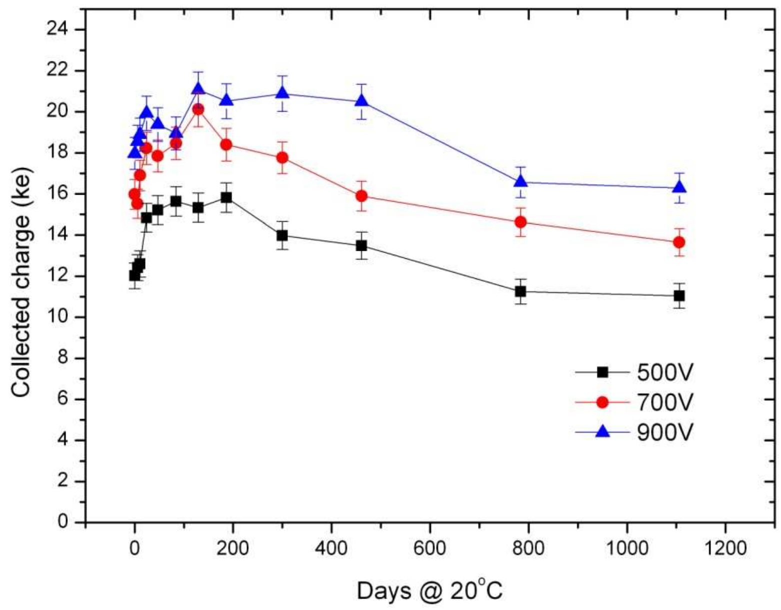
# "Fine step" Annealing of the colleted charge, HPK FZ n-in-p, 1E15 n cm$^{-2}$

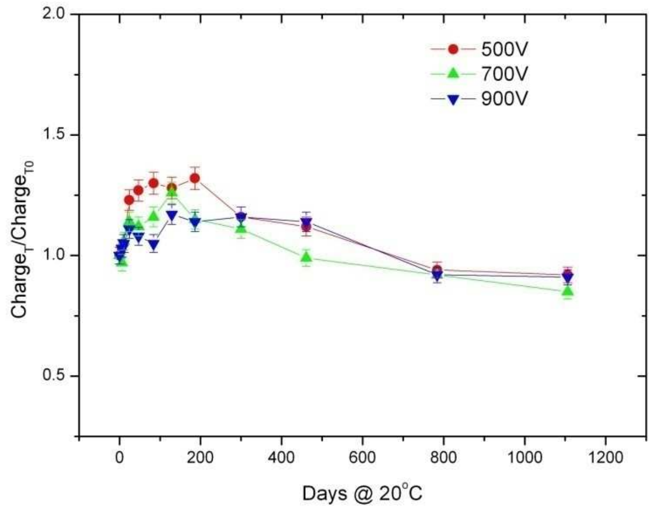


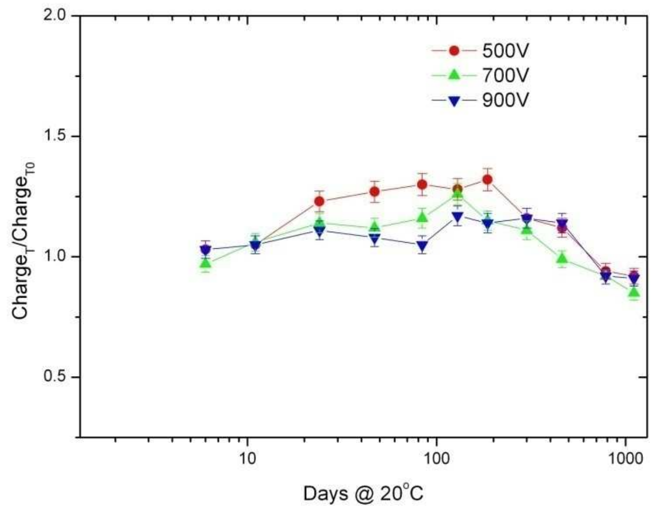



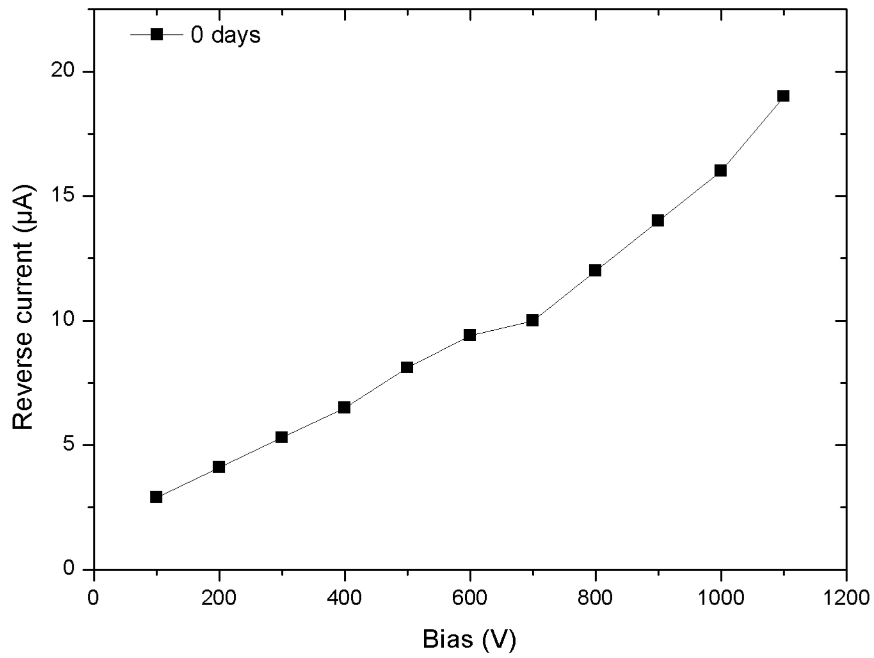
# "Fine step" Annealing of the colleted charge, Micron FZ n-in-p, 1E15 n cm$^{-2}$ (26MeV p irradiation)



# "Fine step" Annealing of the reverse current, HPK FZ n-in-p, 1E15 n cm$^{-2}$



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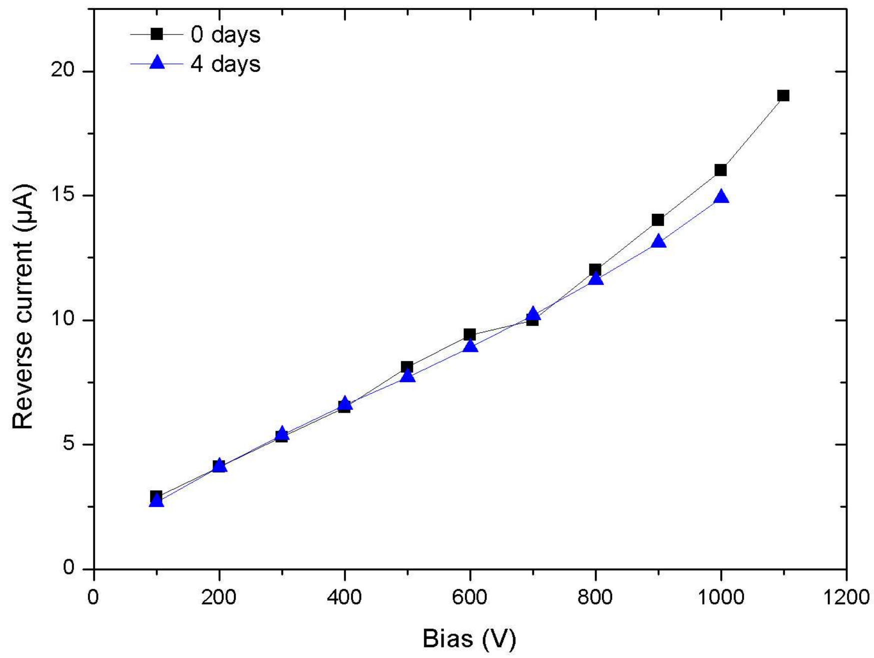

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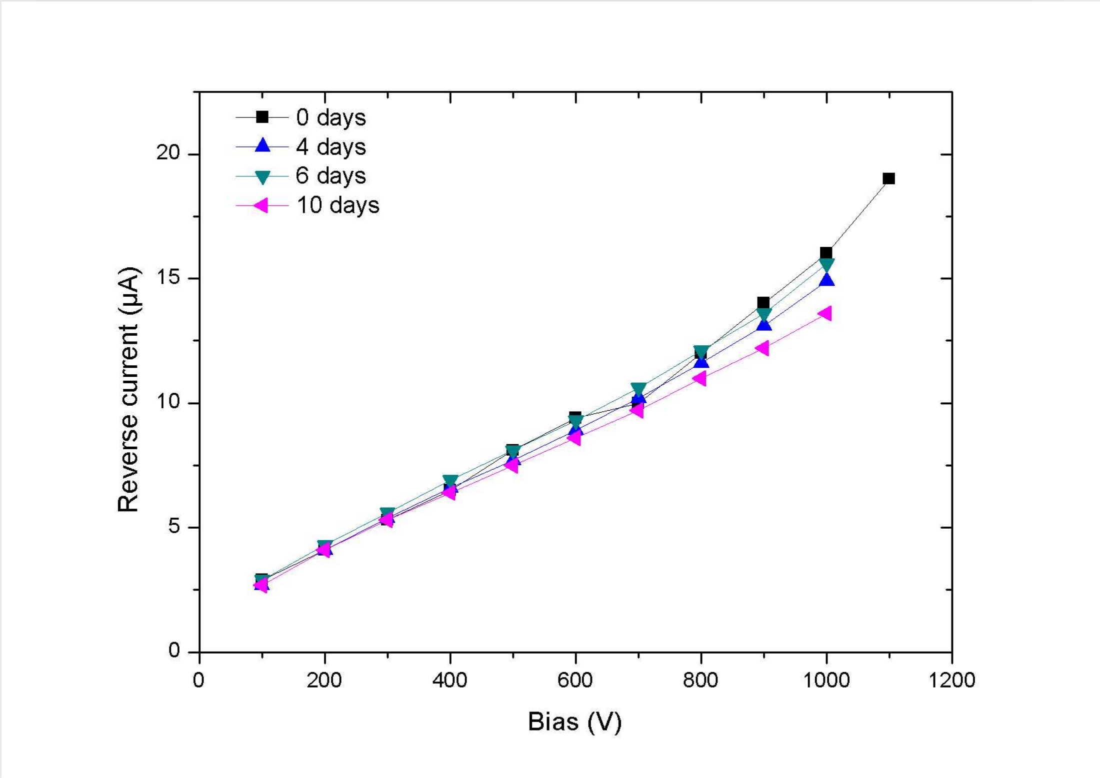

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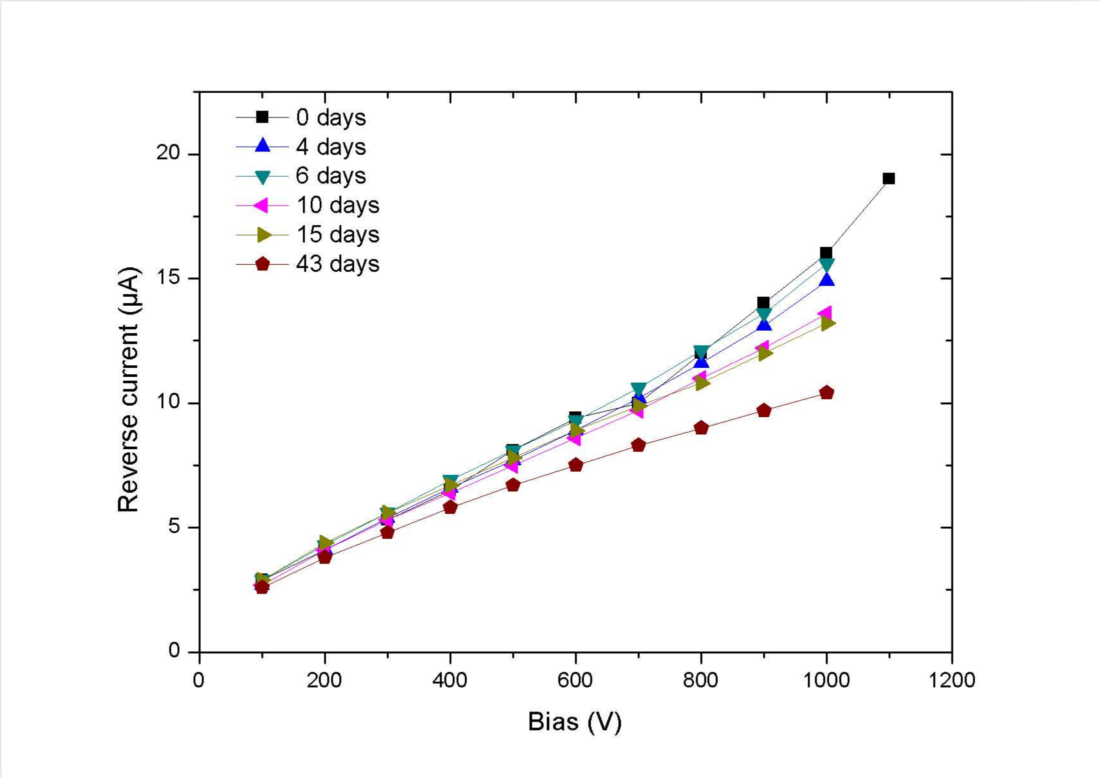

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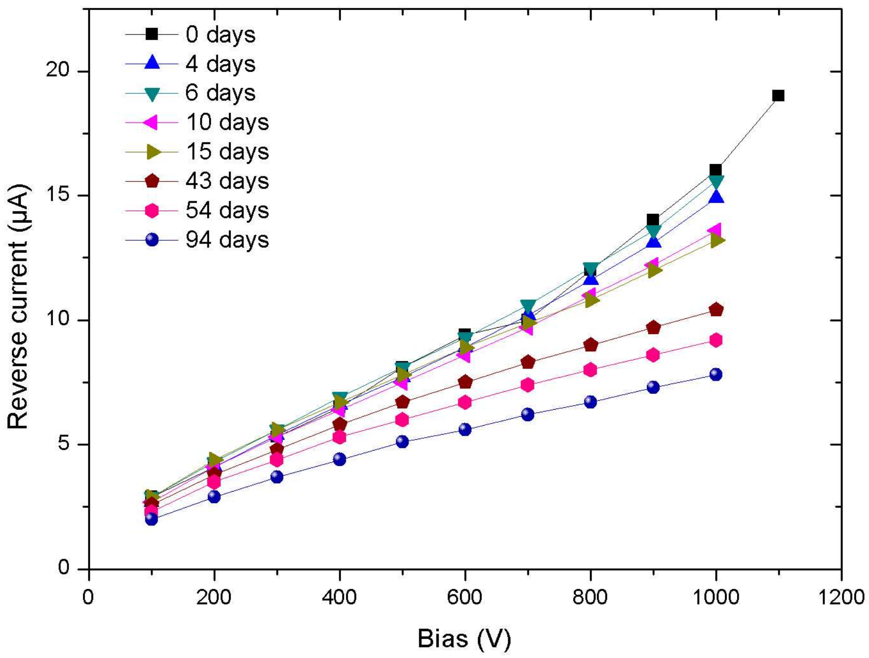

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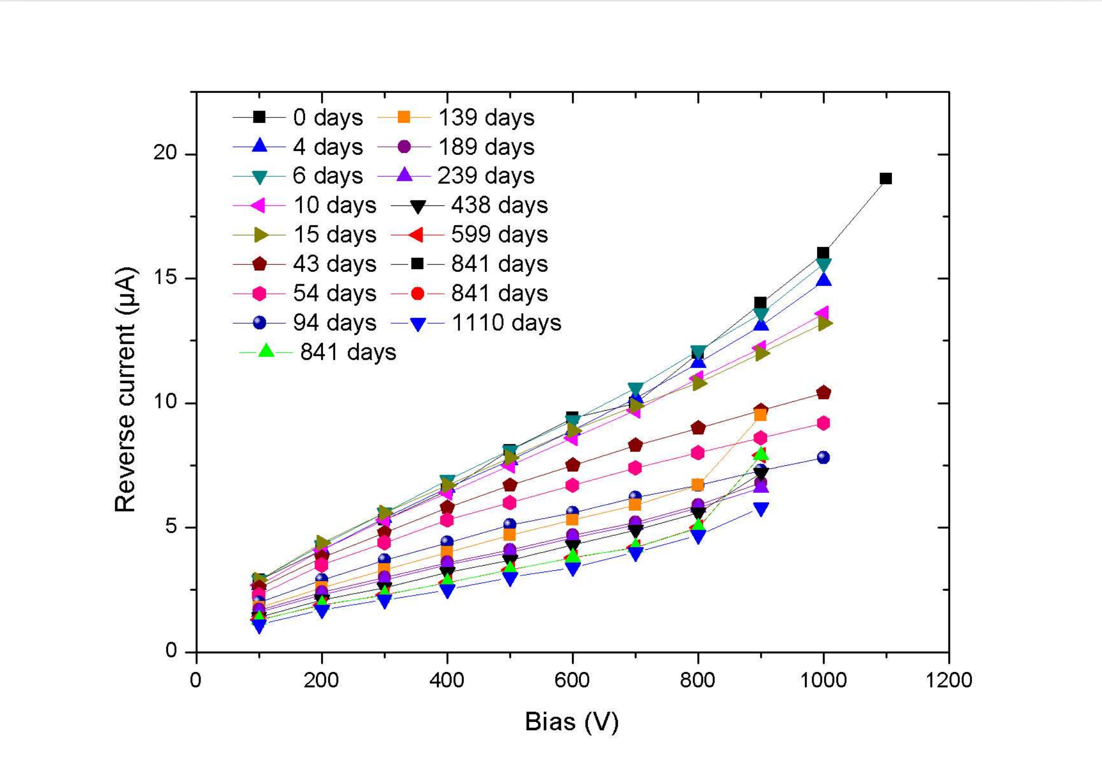
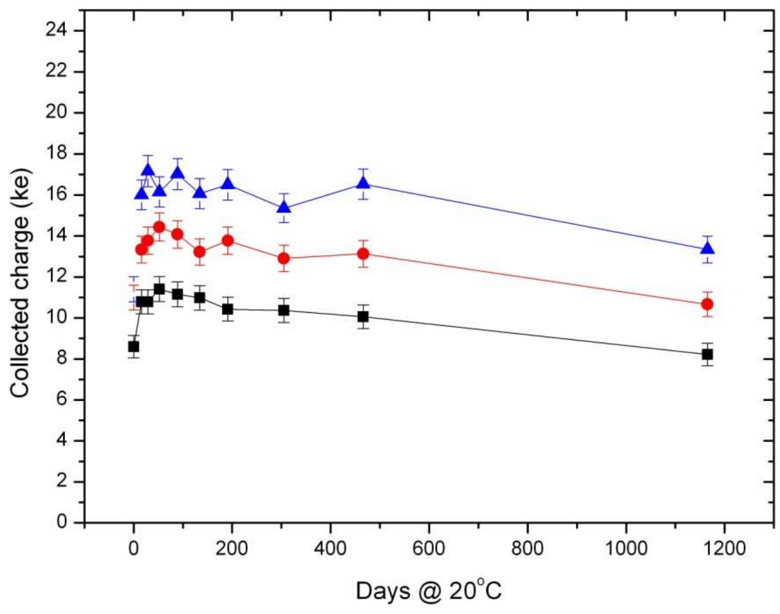
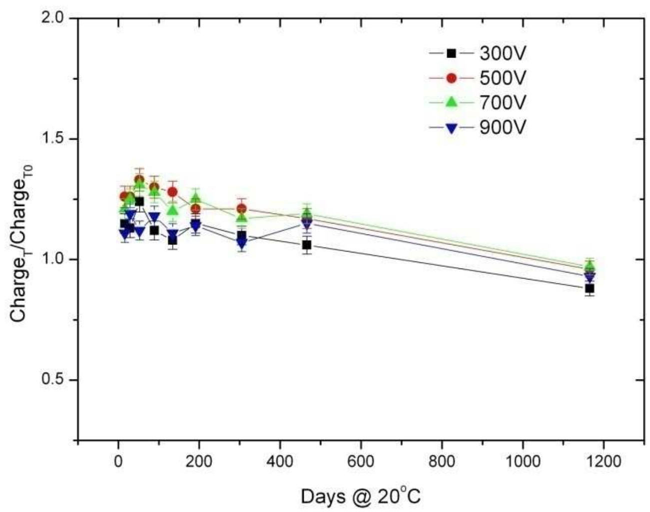
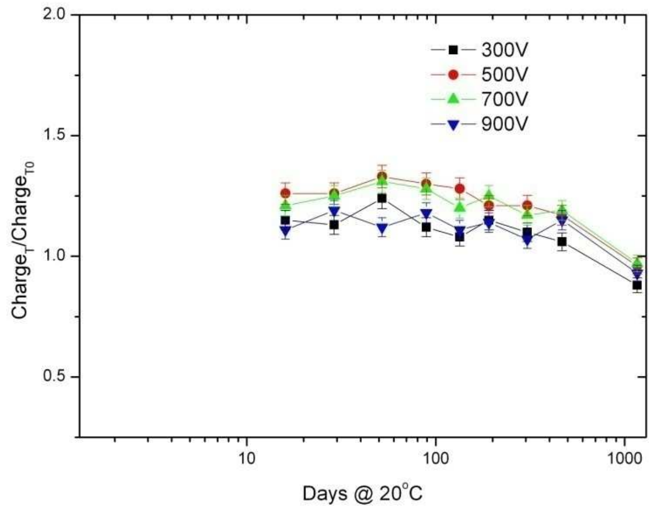


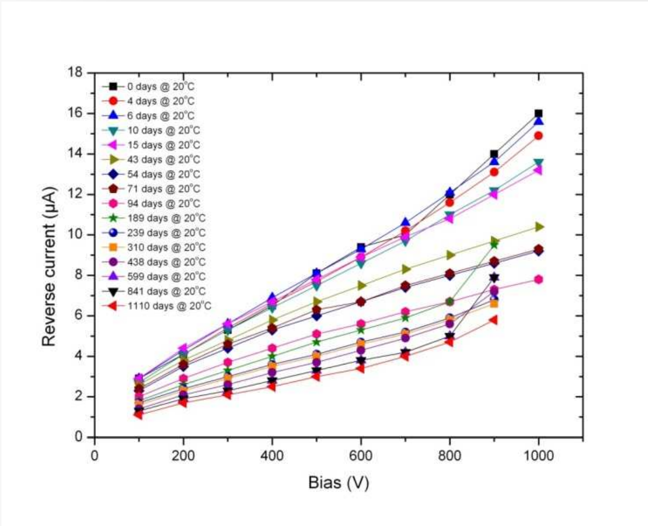
# "Fine step" Annealing of the colleted charge, Micron FZ n-in-n, 1.5E15 n $cm^{-2}$

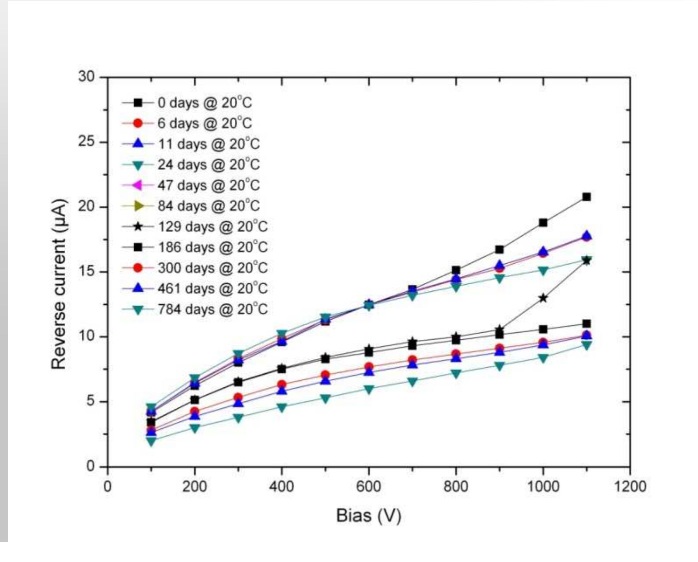


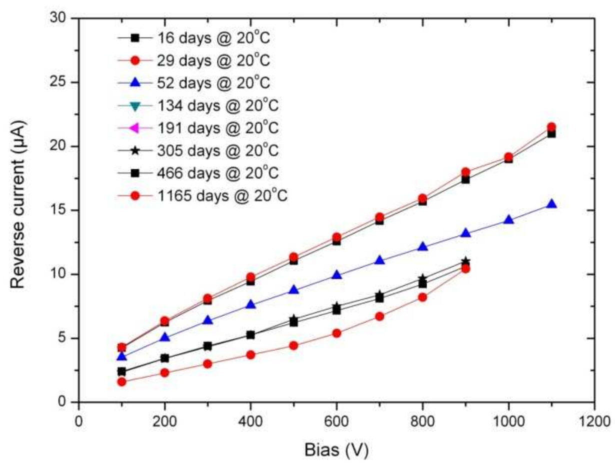



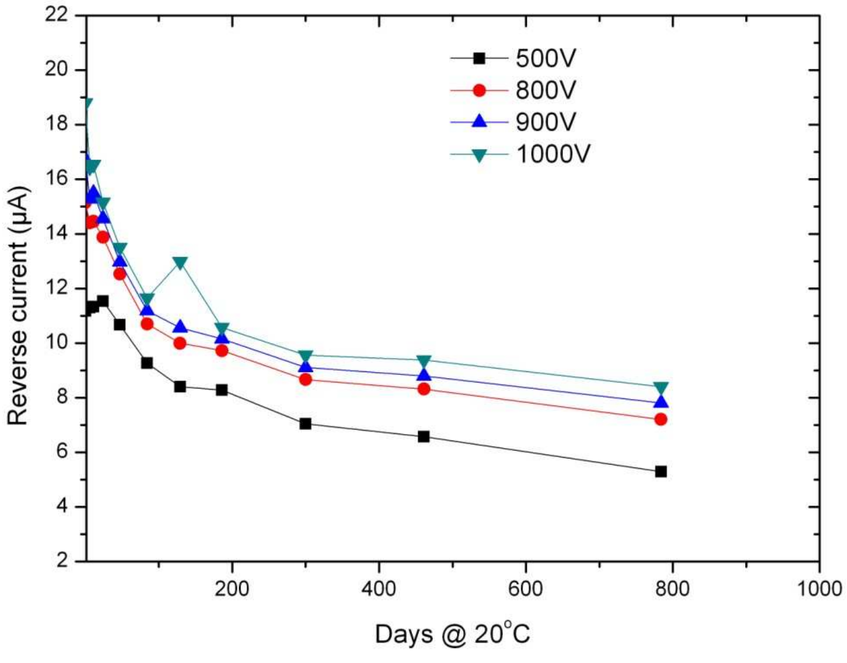
# “Fine step” Annealing of the reverse current, Micron FZ n-in-p, 1E15 n $cm^{-2}$ (26MeV p irradiation), Micron FZ n-in-n, 1.5E15 n $cm^{-2}$

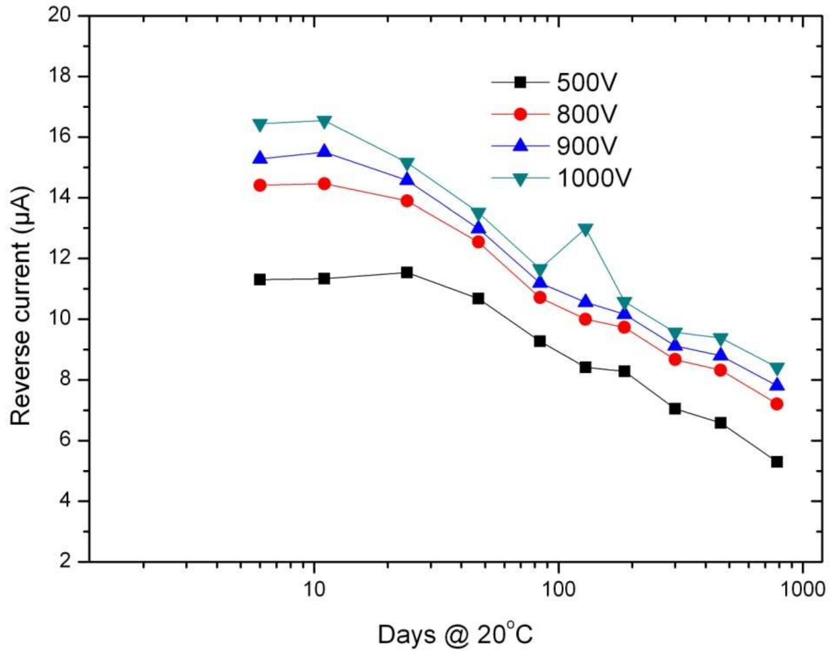


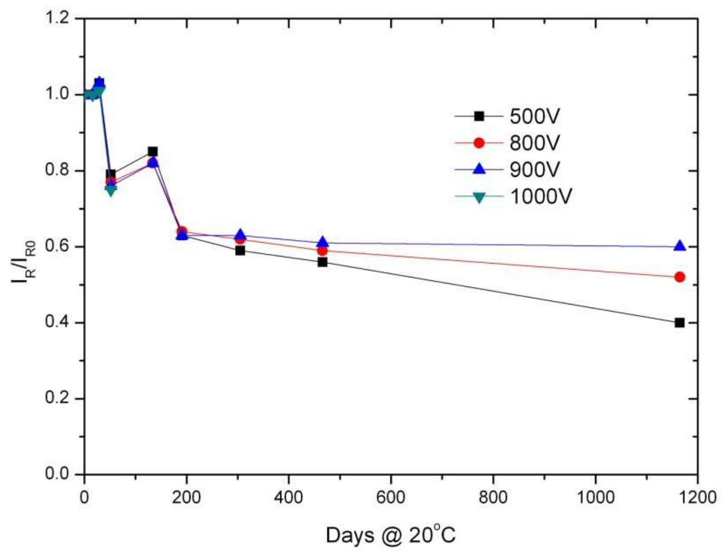



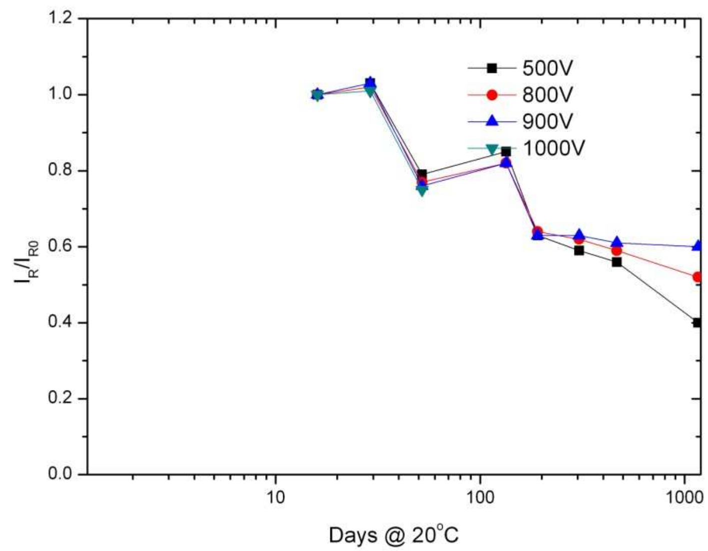
# "Fine step" Annealing of the reverse current, Micron FZ n-in-p, 1E15 n cm$^{-2}$ (26MeV p irradiation)



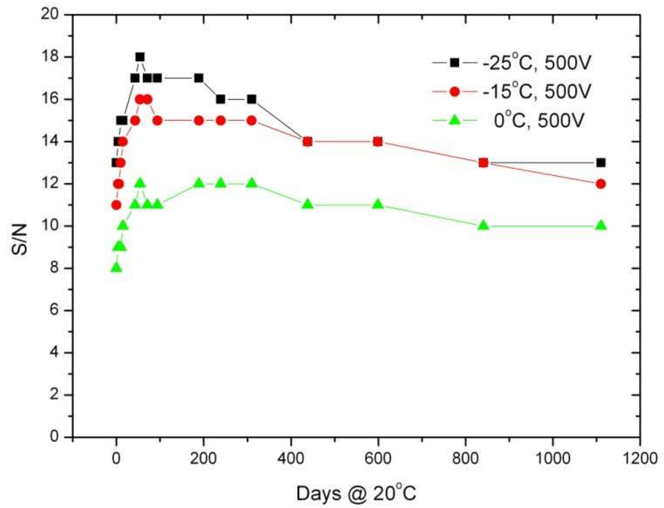
# “Fine step” Annealing of the reverse current, Micron FZ n-in-n, 1.5E15 n cm$^{-2}$

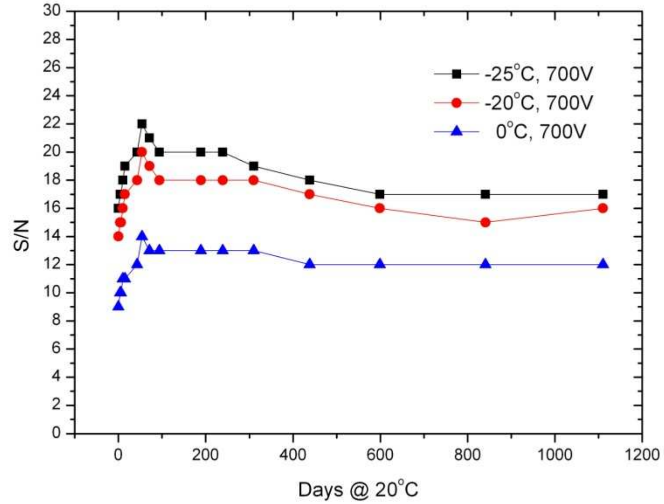


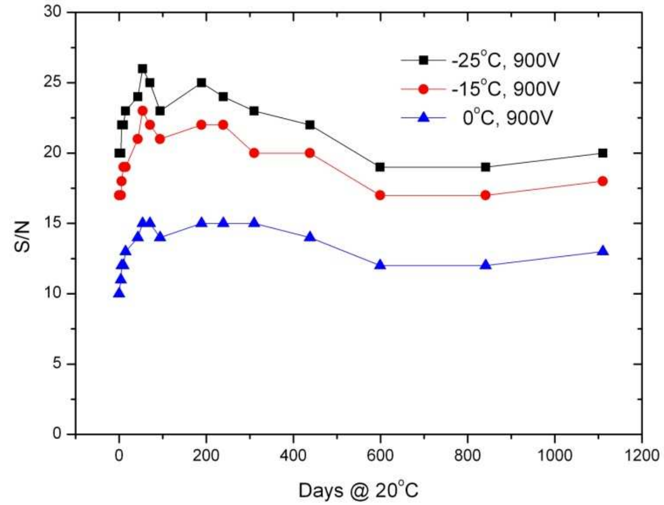



# “Fine step” Annealing of S/N, 1.5E15 n $cm^{-2}$

Noise is the sum in quadrature of shot noise and parallel noise (taken from the Beetle chip specs, and estimated as 650ENC)



# SUMMARY IRRADIATION PLANS

Need preparation for irradiation of large area sensors at CERN-PS. Activity should start now, outside the irradiation area, for preparing the cool-box, the scanning software, bias and monitoring hardware/software......

Continue irradiation of miniature detectors with various sources to monitor radiation tolerance, strip isolation, BD voltage .....

# SUMMARY ANNEALING

Controlled annealing (at $20^0$C) is a very useful tool to reduce power dissipation and recover fraction of S/N in heavily irradiated silicon detectors. Optimum annealing time is between 100-300 days for CCE (while no restriction is found with reverse current recovery).