



New CCE results with microstrip detectors made on various substrates

G. Casse, A. Affolder, M. Wormald

OUTLINE:

The charge collection efficiency of μ -strip sensors made with the RD50 mask set with various silicon substrates (n and p FZ and MCz) have been compared to different high doses of neutron and protons, well in the range of the anticipated fluences in SLHC.

Detectors: $1 \times 1 \text{ cm}^{-2}$, Readout: SCT128, Source: ^{90}Sr , Temperature: $\sim -20/25^\circ\text{C}$.

- FZ n-in-p (10 and $30 \text{ k}\Omega \text{ cm}^{-1}$)
- FZ p-in-n
- FZ n-in-n
- MCz p-in-n
- MCz n-in-n
- Epi p-in-n
- Epi n-in-n
- Various thicknesses FZ n-in-p and n-in-n

Irradiation

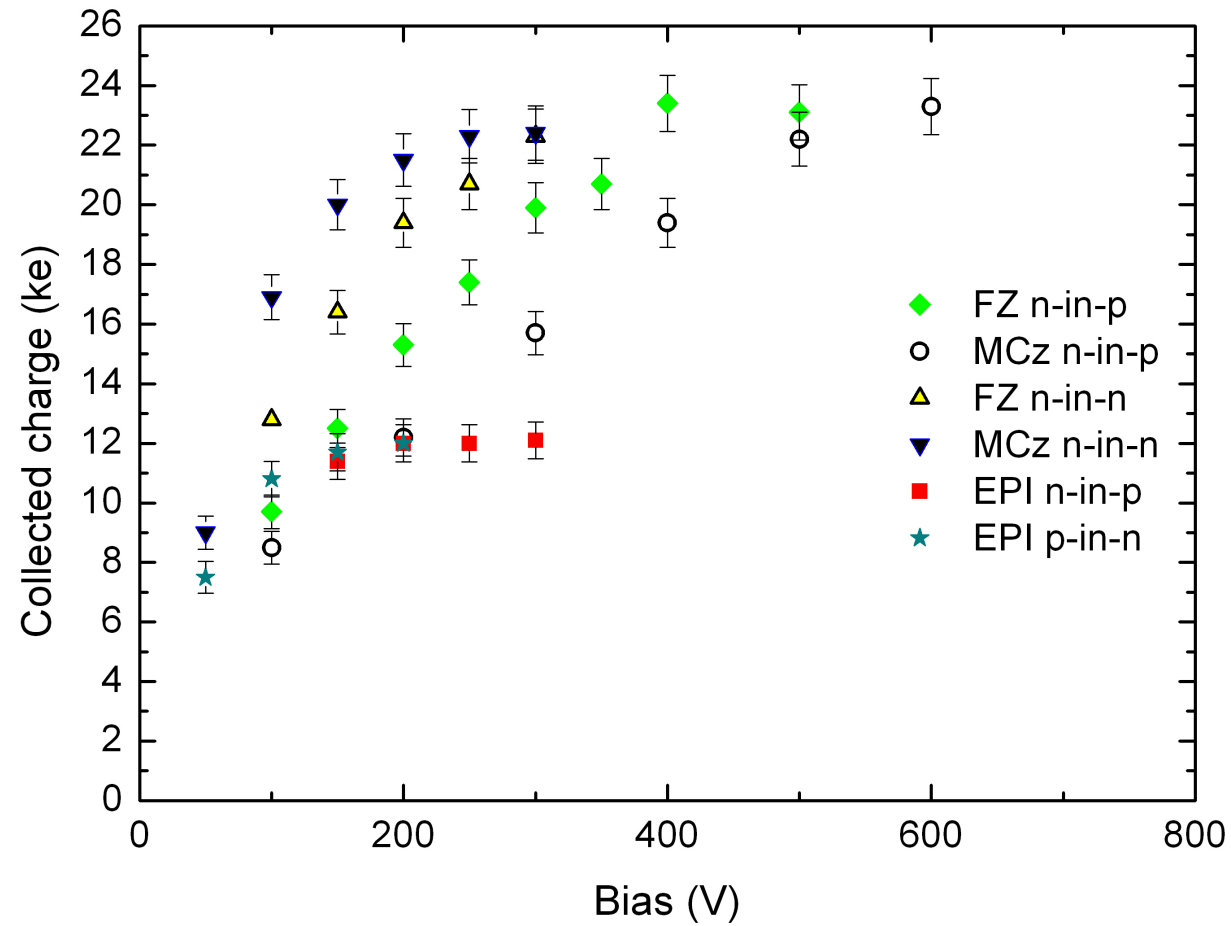
Many thanks to our RD50 collaborators:

Neutron irradiations, our gracious guests: JSI of Ljubljana (V. Cindro et al.).

24GeV/c protons, CERN/PS: M. Glaser et al.

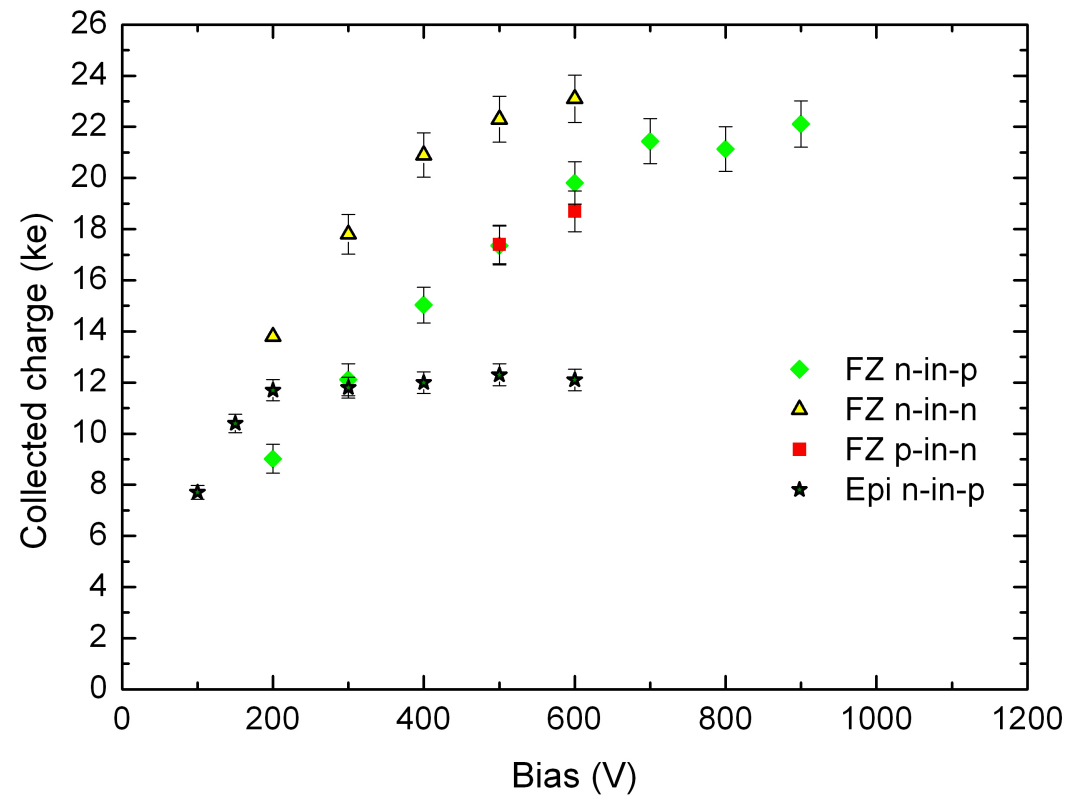
26 MeV protons Karlsruhe (W. de Boer et al).

Neutron irradiations: low doses (1×10^{14} n cm^{-2})

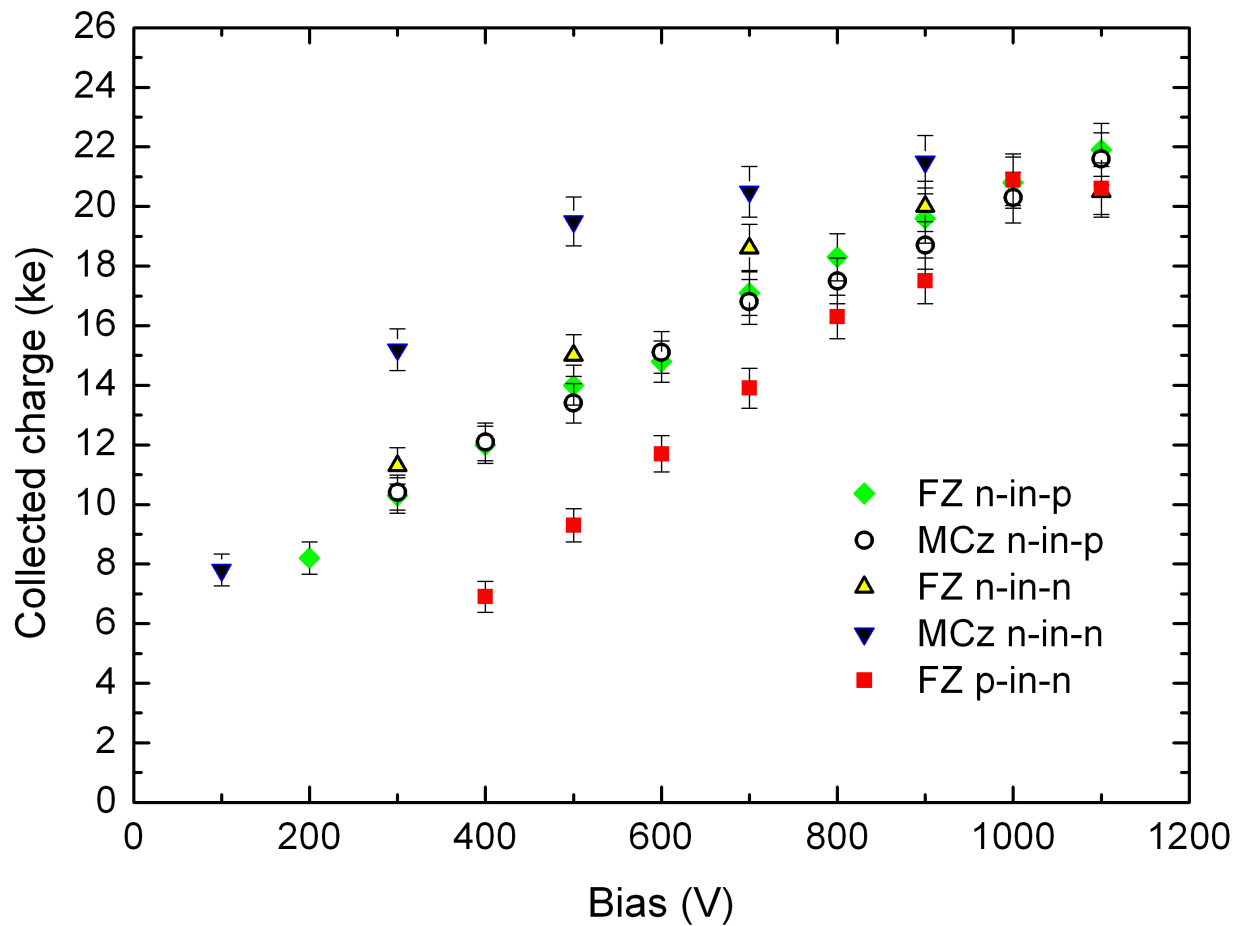


Neutron irradiations: still low doses (2×10^{14} n cm^{-2})

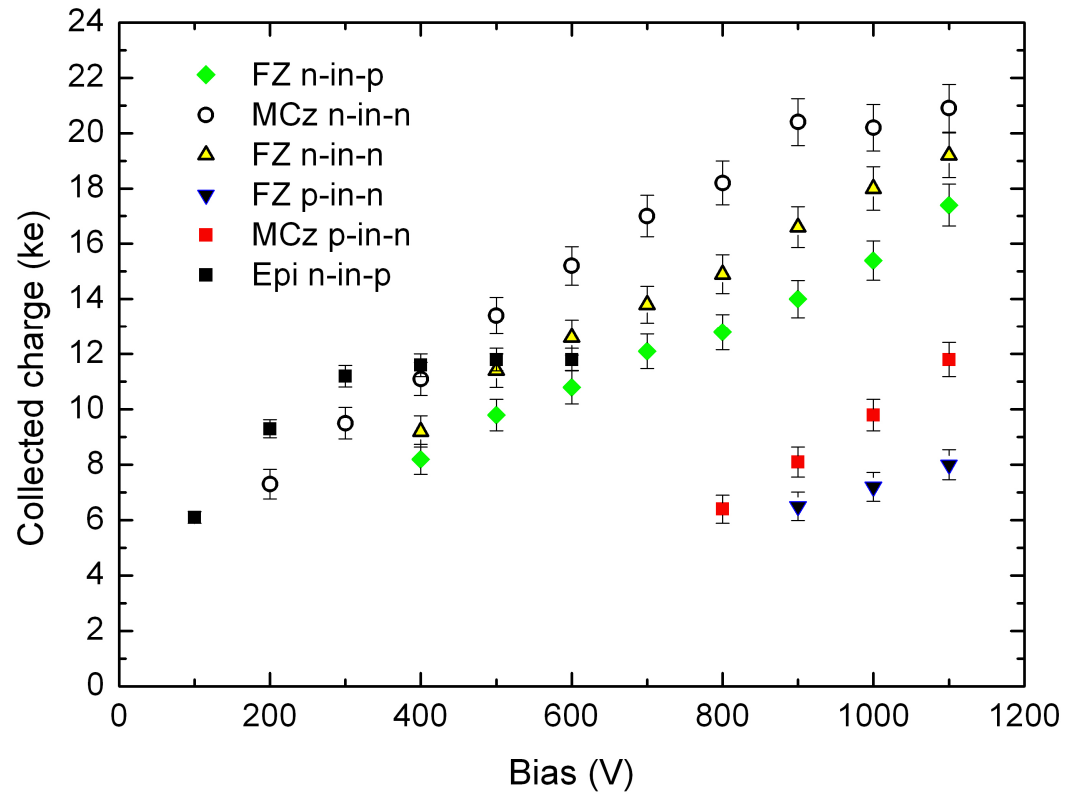
Epi detector irradiated to 3×10^{14} cm^{-2}).



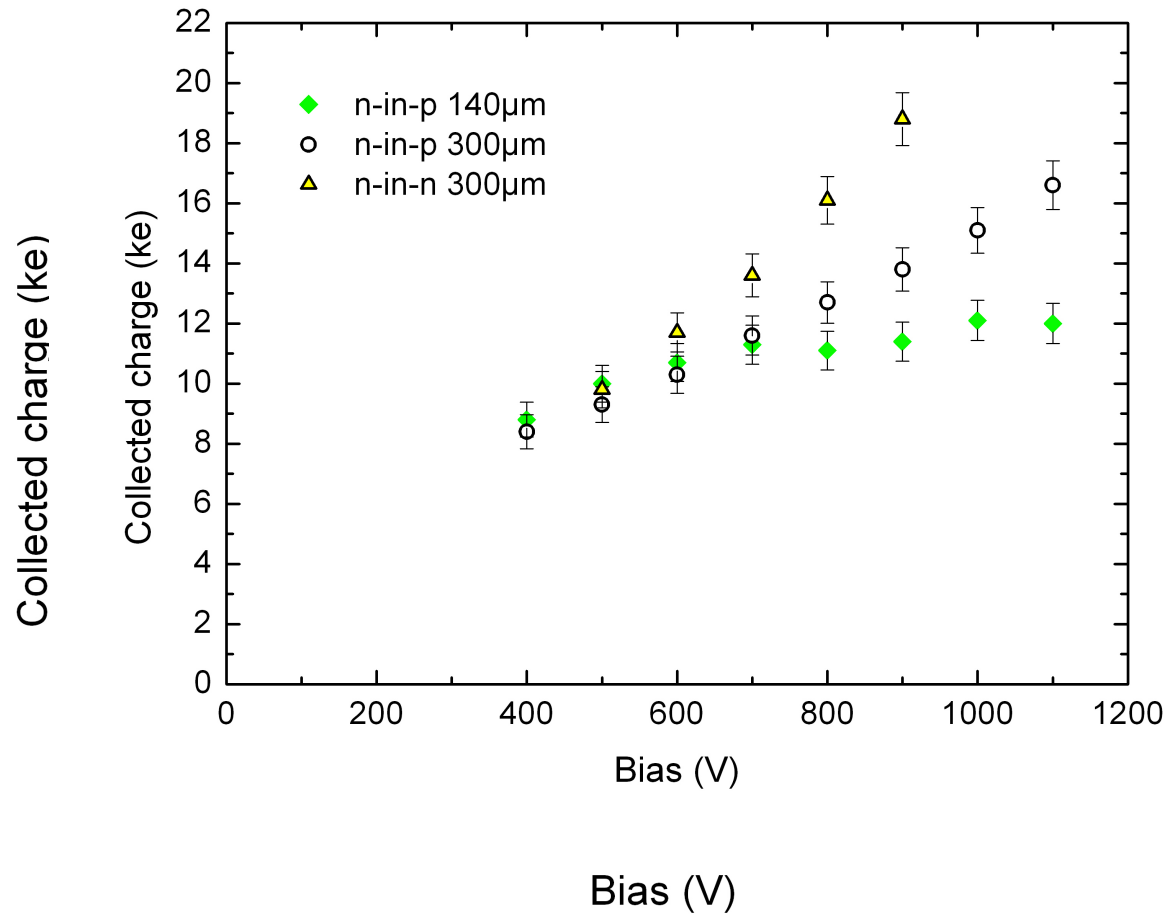
Neutron irradiations: low/medium doses (5×10^{14} n cm⁻²)



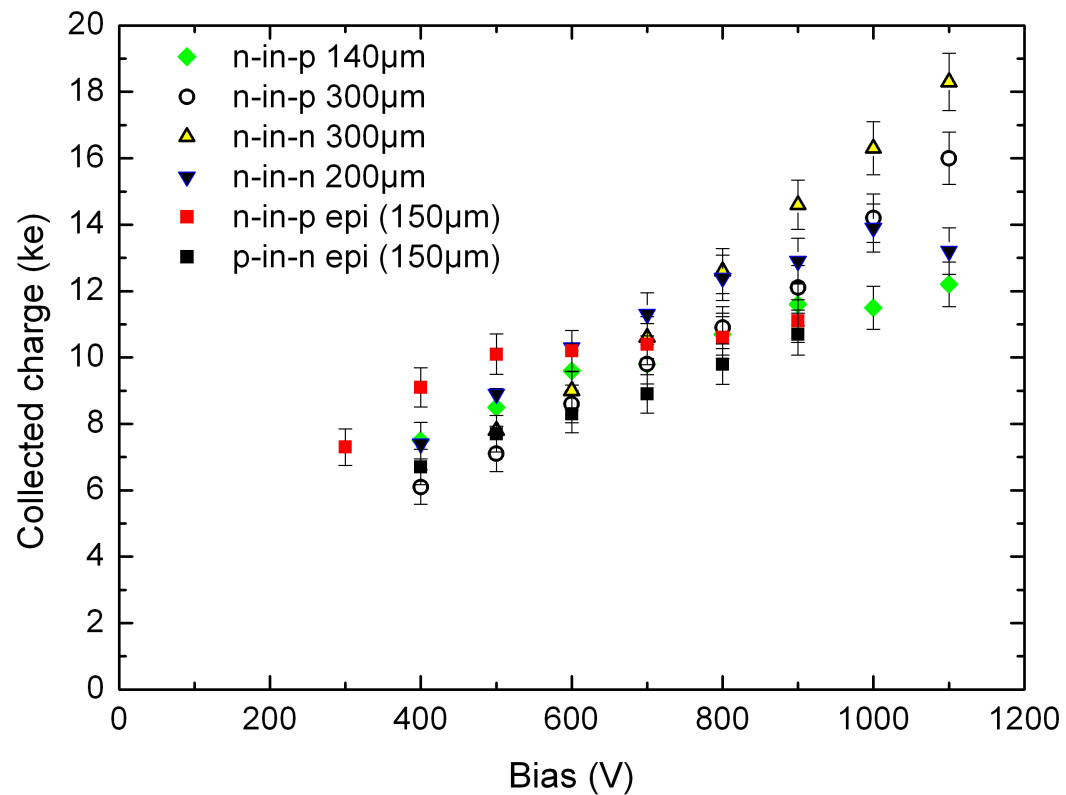
Neutron irradiations: medium doses (1×10^{15} n cm⁻²)



Neutron irradiations: medium/high doses (1.6×10^{15} n cm^{-2})

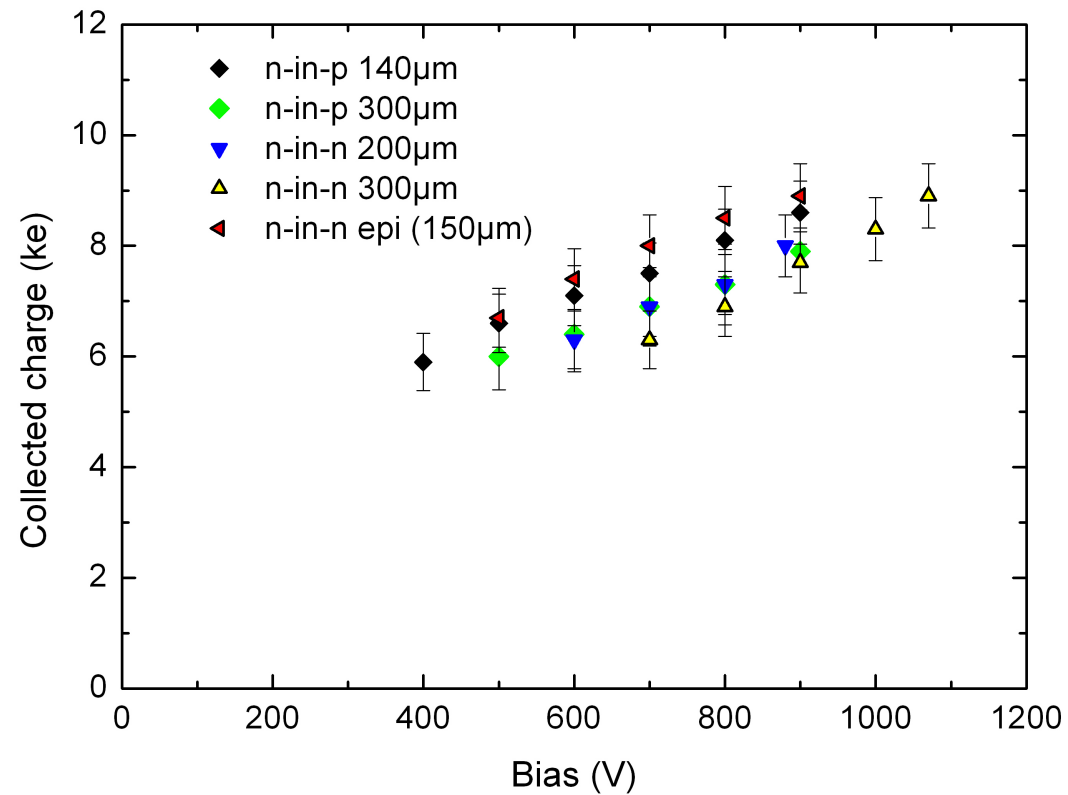


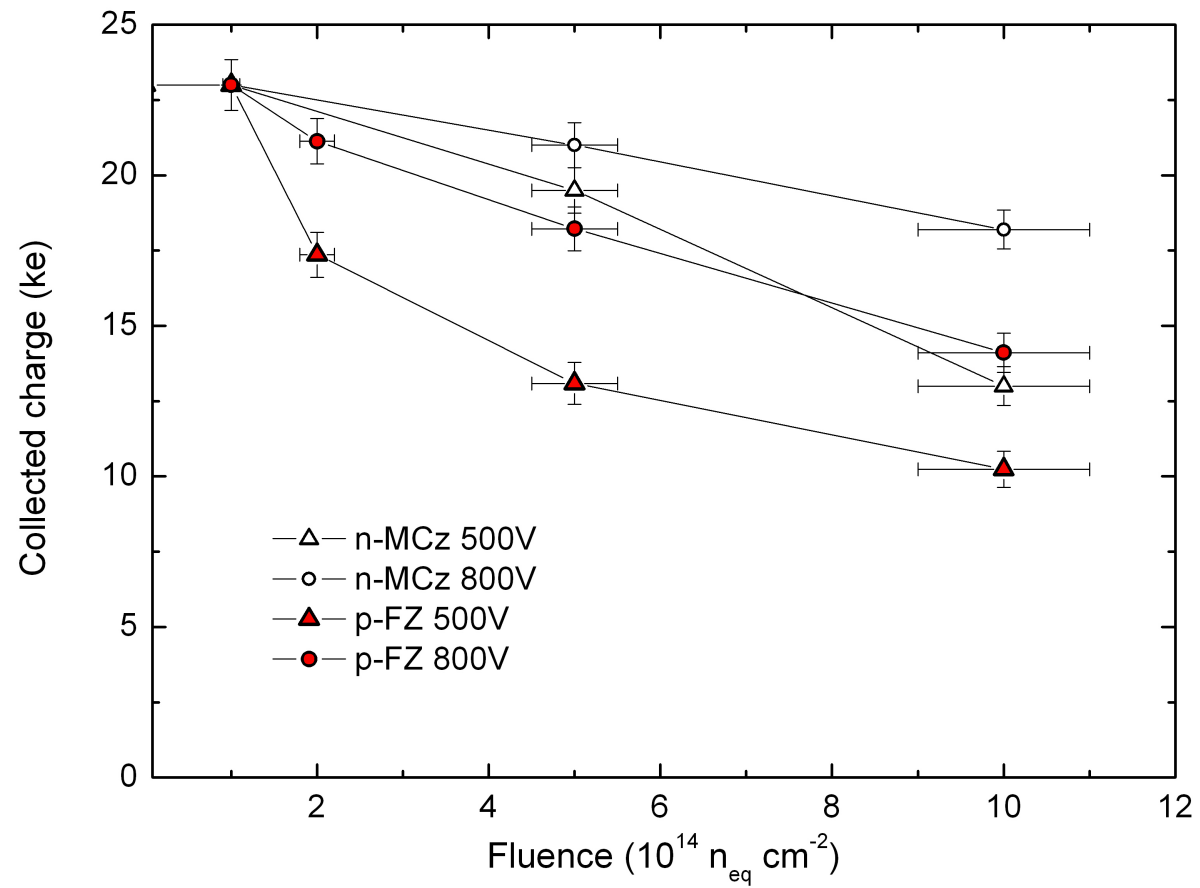
Neutron irradiations: high doses ($3 \times 10^{15} \text{ n cm}^{-2}$)



Neutron irradiations: very high doses (1×10^{16} n cm^{-2})

Epi detector irradiated to 8×10^{15} cm^{-2} .





Summary neutron irradiation

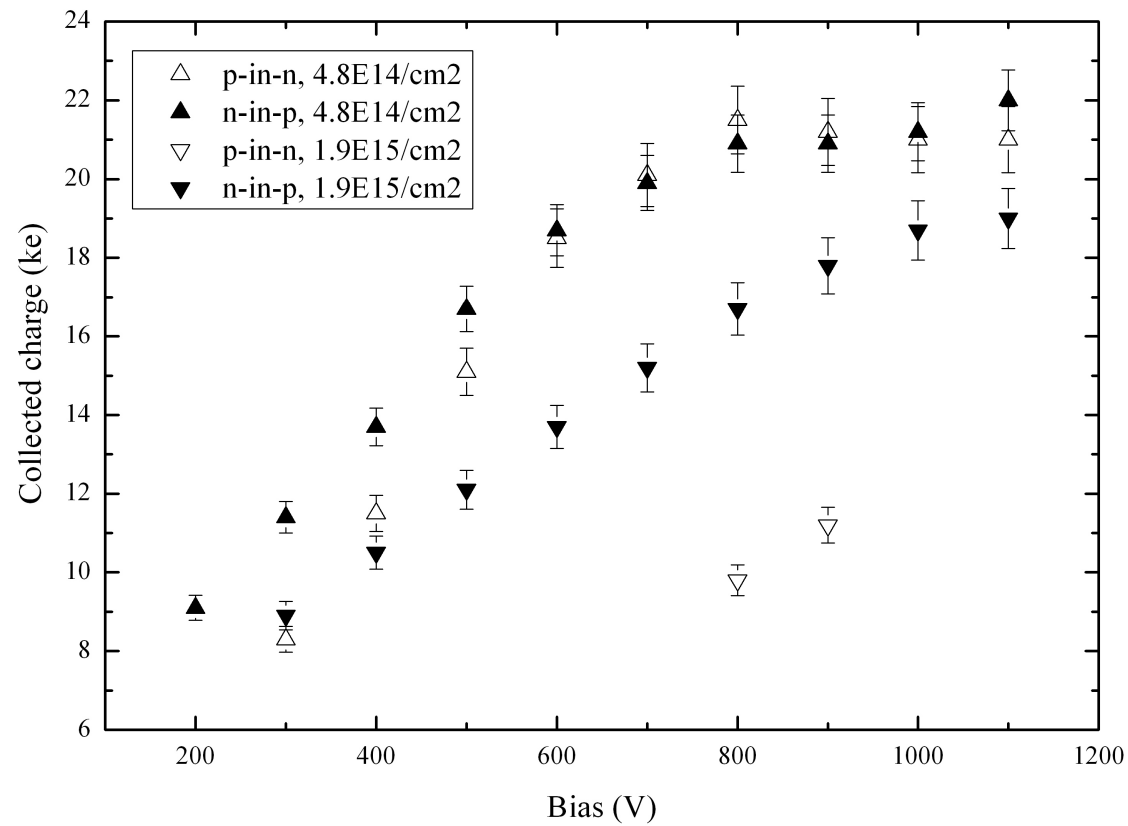
Thin vs thick: no sensitive difference even after 10^{16} cm⁻². Choice of thickness left to considerations other than radiation hardness.

Only significant improvement: n-MCz, which adds lower degradation of N_{eff} with Φ , to the advantage obtained by going through type inversion.

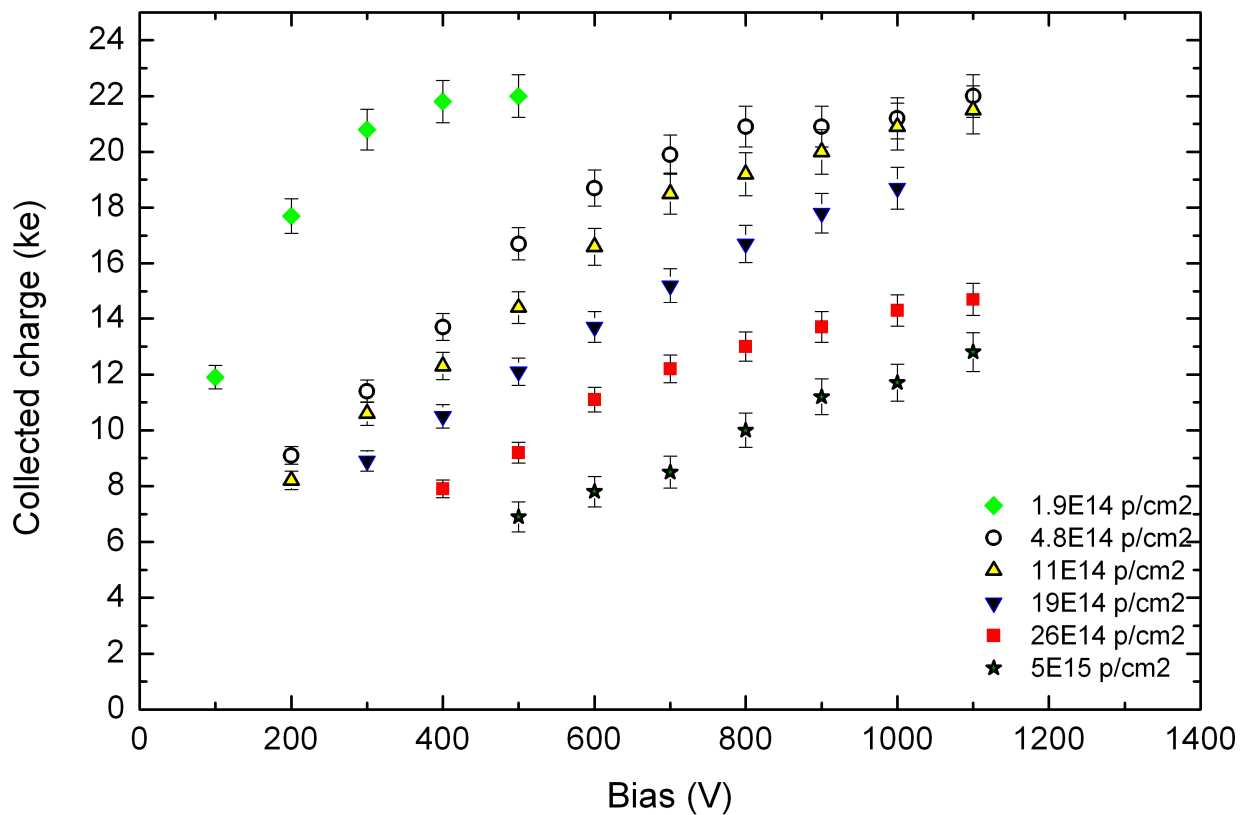
No significant advantage seen with epi n or p, although p-in-n epi shows a much bigger signal than other p-in-n sensors.

24GeV/c proton irradiations

N-side readout vs p-in-n

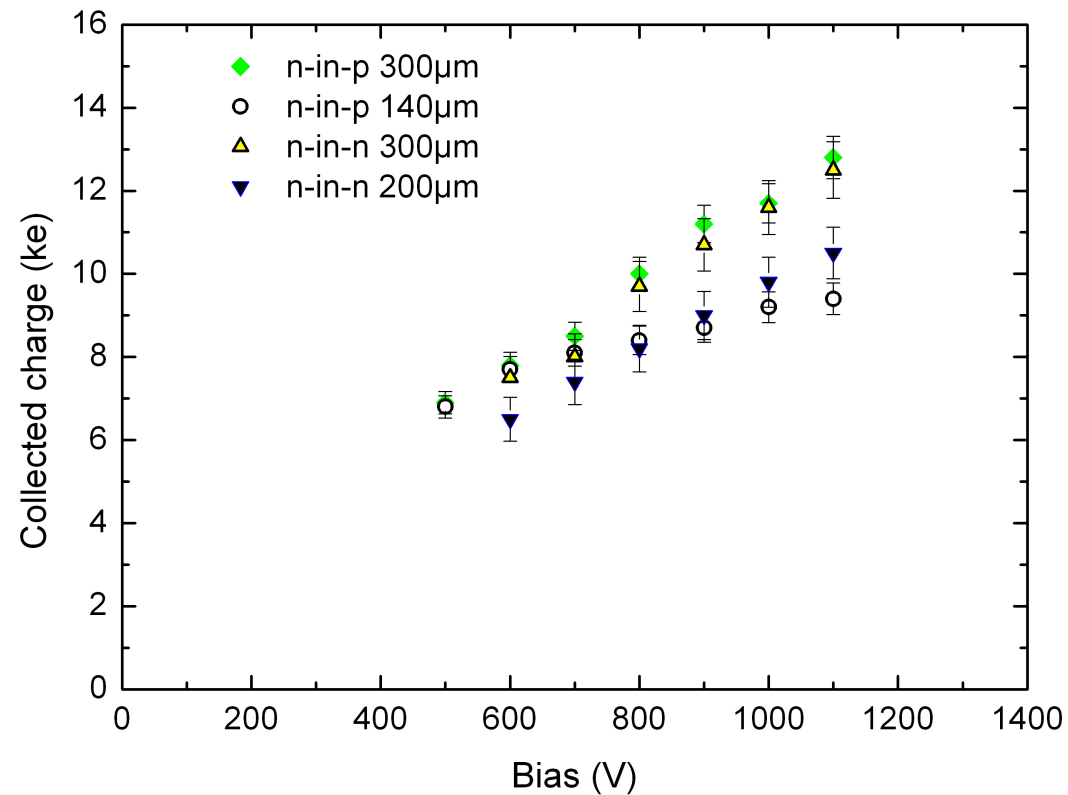


24GeV/c proton irradiations

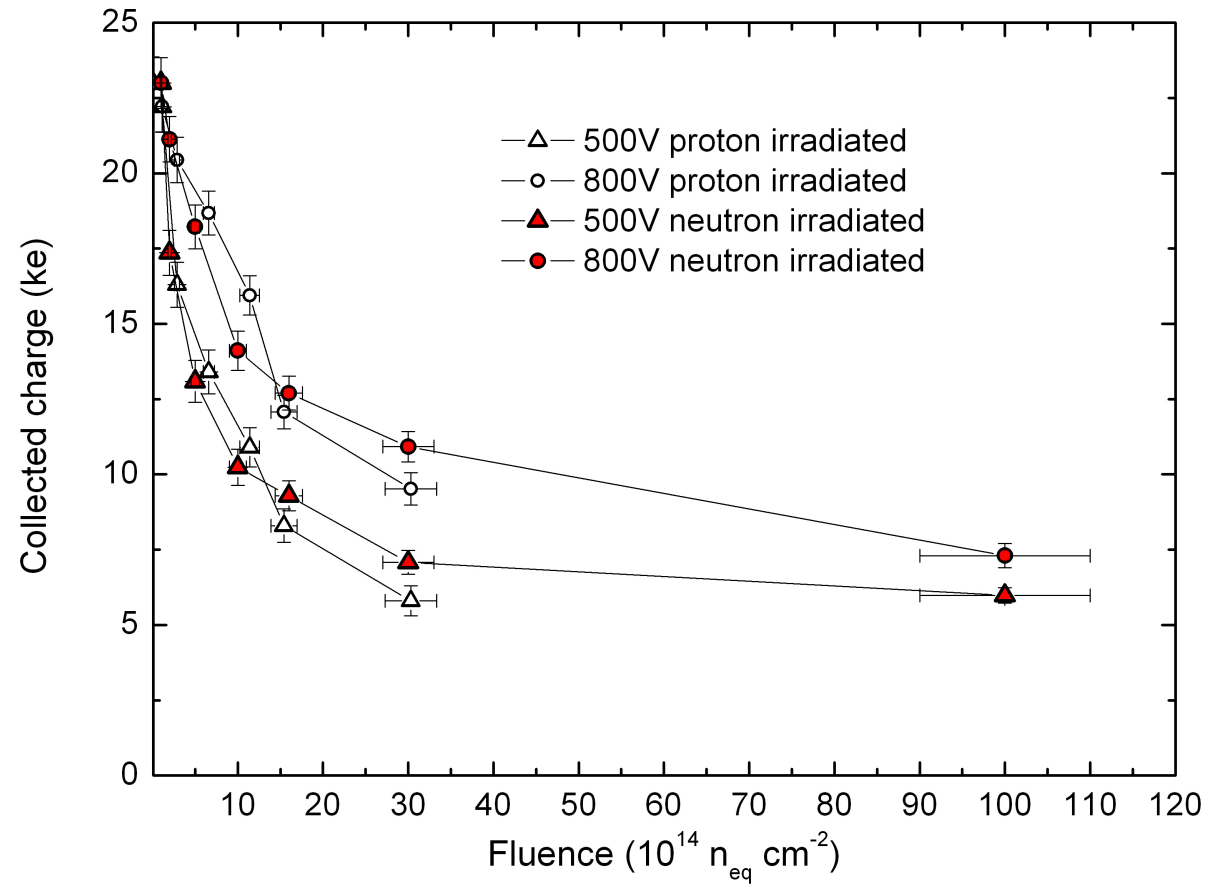


Thin vs thick, n vs p substrate, neutron and 24GeV/c proton irradiations

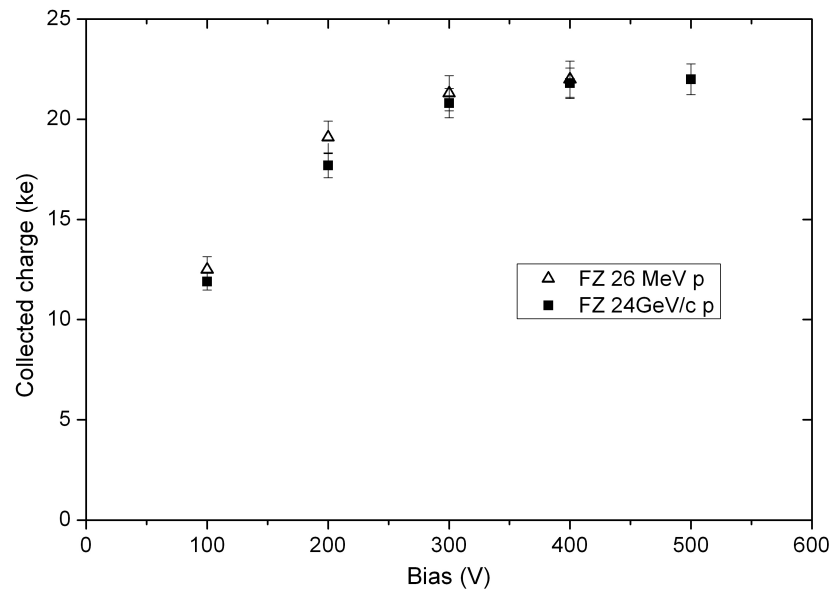
$5 \times 10^{15} \text{ cm}^{-2}$



24GeV/c proton irradiations vs neutron

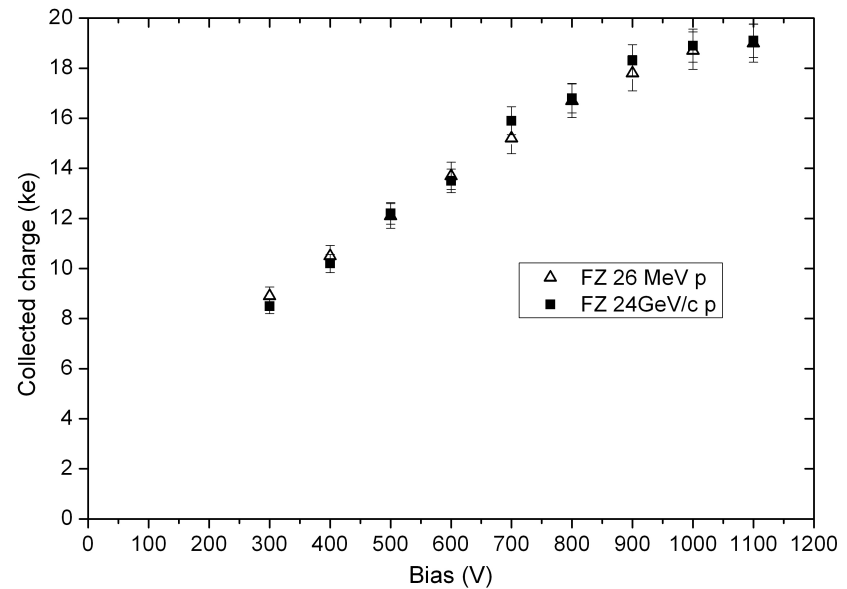


Low energy proton irradiations: comparison (with 24GeV/c p) of CCE for NIEL equivalent doses



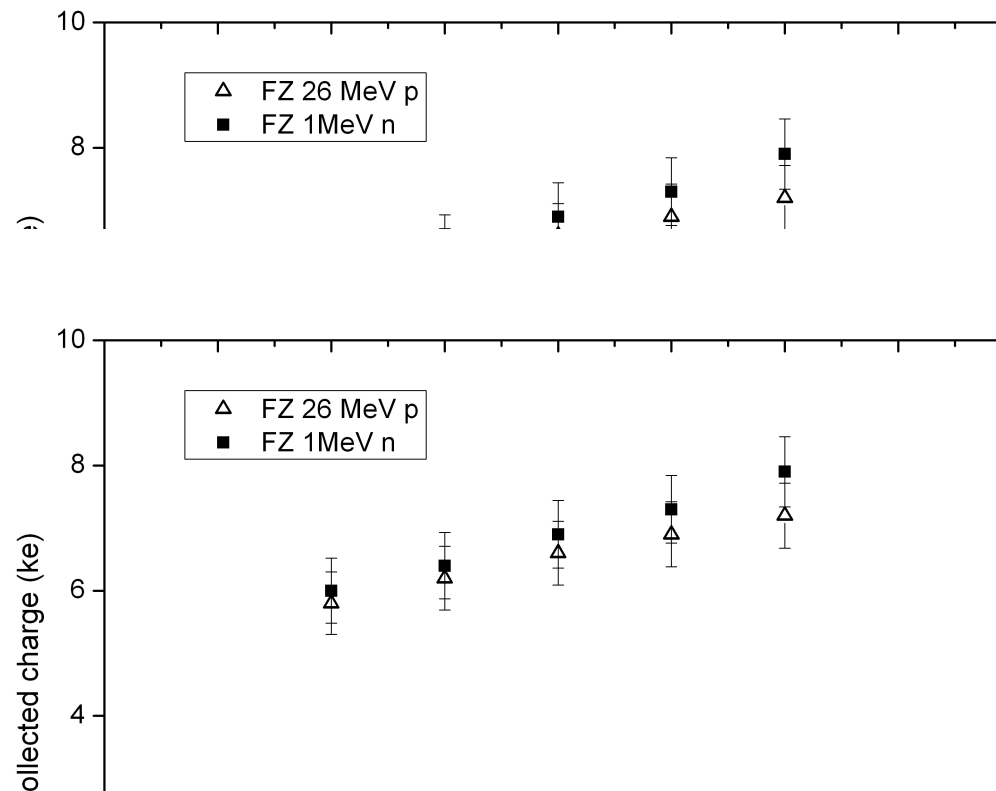
$1 \times 10^{14} \text{ n}_{\text{eq}} \text{ cm}^{-2}$

$1 \times 10^{15} \text{ n}_{\text{eq}} \text{ cm}^{-2}$

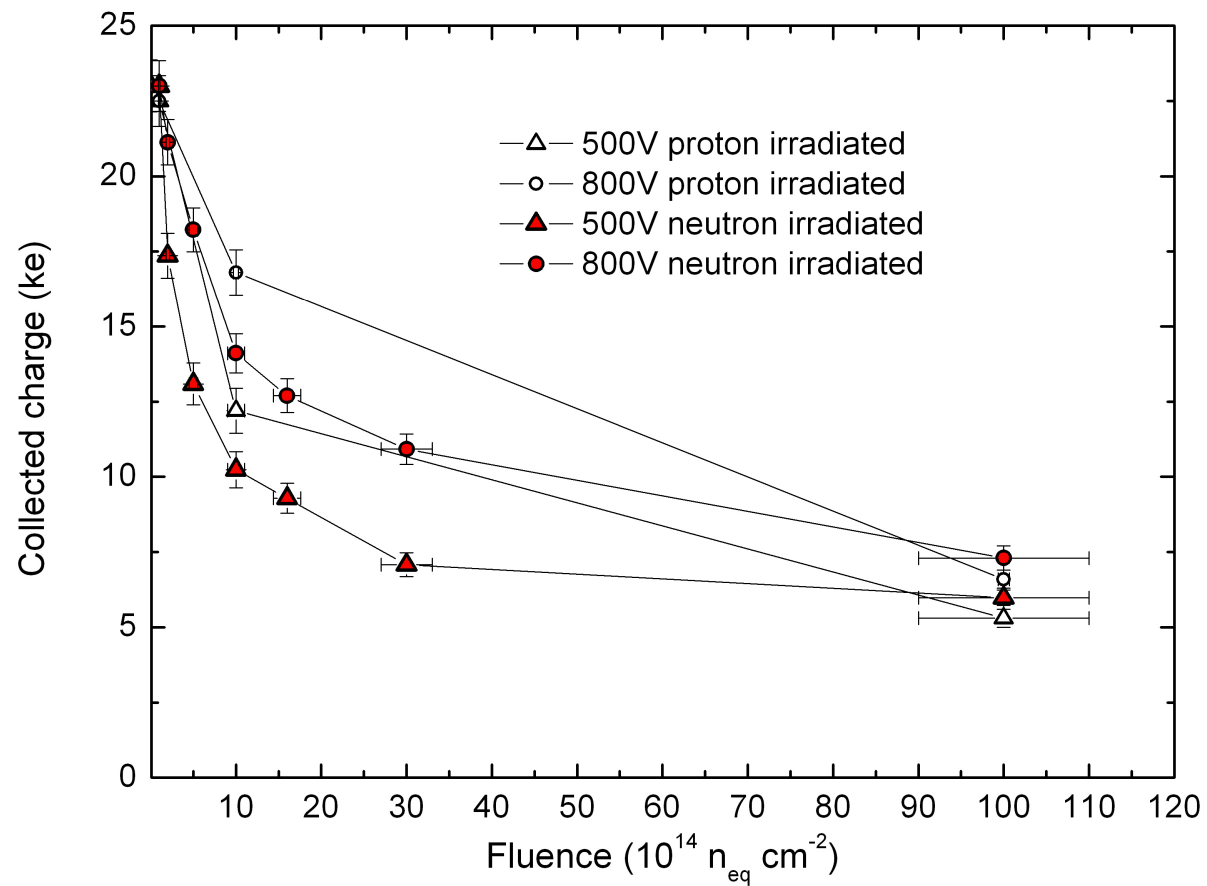


Low energy proton irradiations: comparison (with reactor neutron) of CCE for NIEL equivalent doses

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



Low energy proton irradiations vs neutron



Special effects: mixed irradiations (neutrons + protons)

