

Update on thin vs thick micro-strip detector studies

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CONTEXT:

The choice of thin silicon sensors seems to meet the requirements for lowering the material budget of the vertex detectors, providing at the same time accrued radiation hardness (at very high doses). But, how thin can they be? This certainly depends on the application and the characteristics of the detector system.

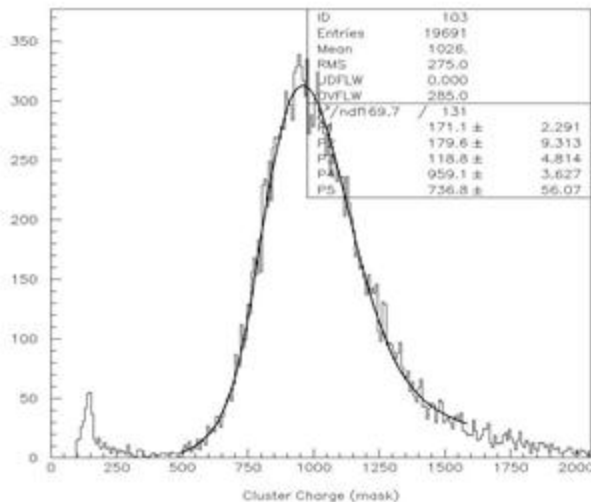
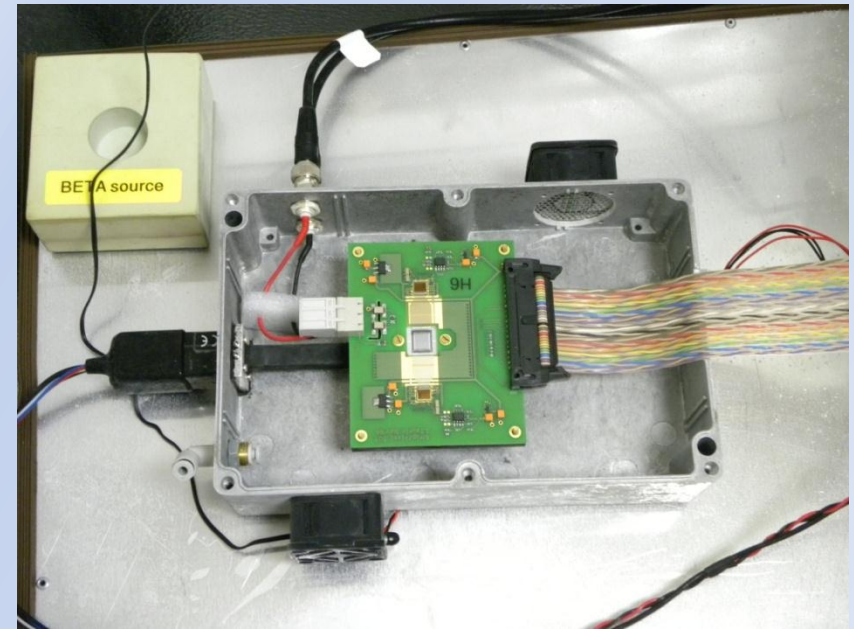
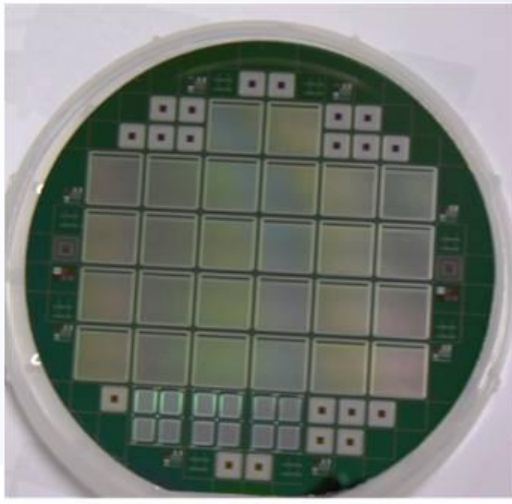
Microstrip detectors are not the configuration where reduced thickness can be pushed to the lower limits. Nonetheless studying the radiation hardness properties of thin microstrip sensors gives valuable indication on the change of their properties.

We show here the $CC(V)$ measurements of 50, 100, 140 and 300 μm thick after irradiation to doses of $2\text{E}16 \text{ n}_{\text{eq}} \text{ cm}^{-2}$.

Irradiation with reactor neutrons performed at the JSI reactor, usual thanks to V. Cindro et al., prtons Mauric Glaser et al.

The method

Sensors made by Micron Semiconductor on 4" wafers with thicknesses 50, 100, 140, 300 μm . $1 \times 1 \text{ cm}^2$, 80 μm pitch, n-in-p devices. The 50 μm thick would break (mechanically) when attached to the cooling block due to the different CTE. No measurements available after irradiation (when cooling is needed).



Mip signal from ^{90}Sr source

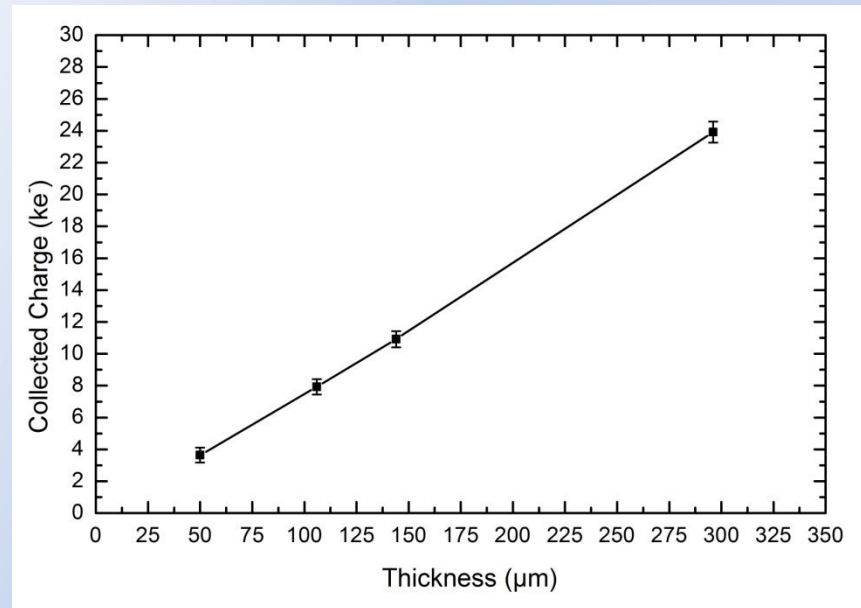
Analogue information from the Alibava board (equipped with Beetle chip)

Irradiations performed in the JSI Ljubljana research nuclear reactor

G. Casse 8th Trento Workshop, 18-20/02/2013

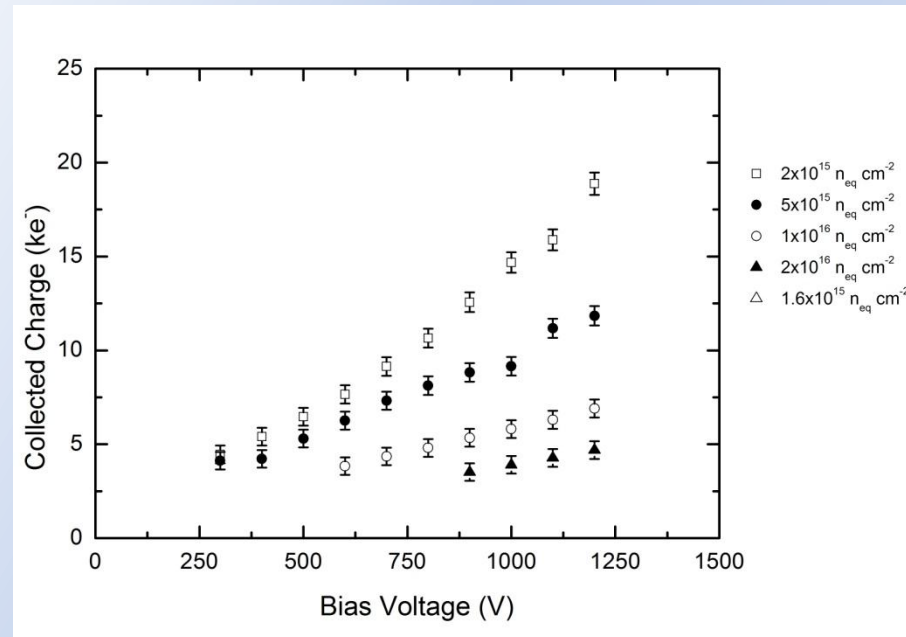
Measurements before irradiation

Charge Collection vs Bias (CC(V)) for the 50, 100, 140, 300 μm un-irradiated sensors. As expected the signal varies linearly with thickness



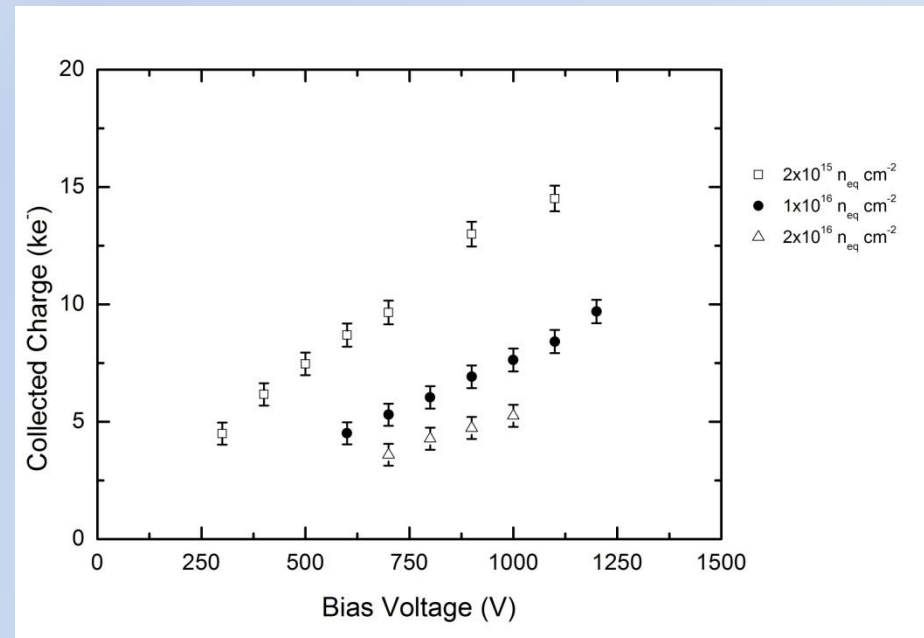
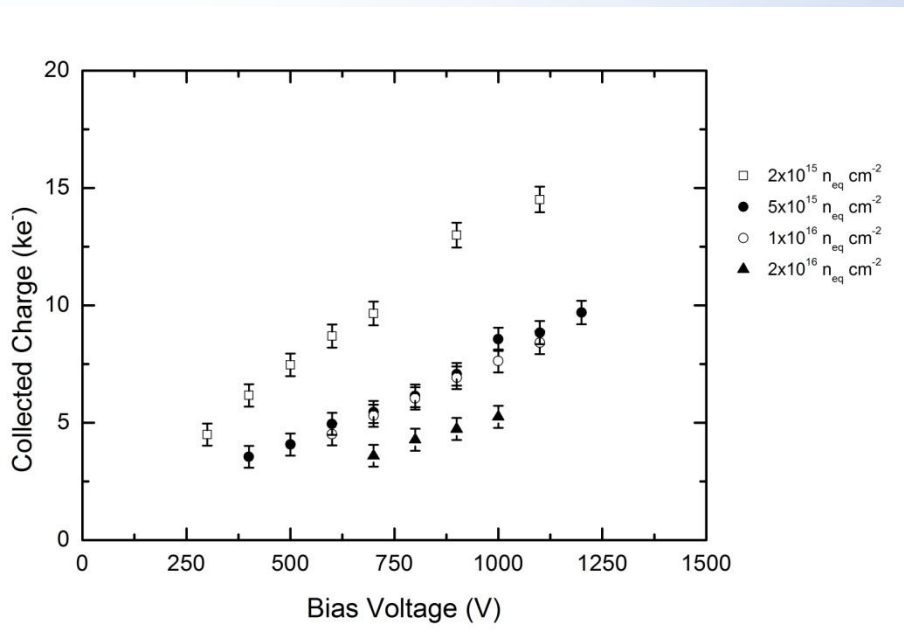
300 μm

Degradation of the CC(V) with neutron fluence for the 300 μm thick sensors.



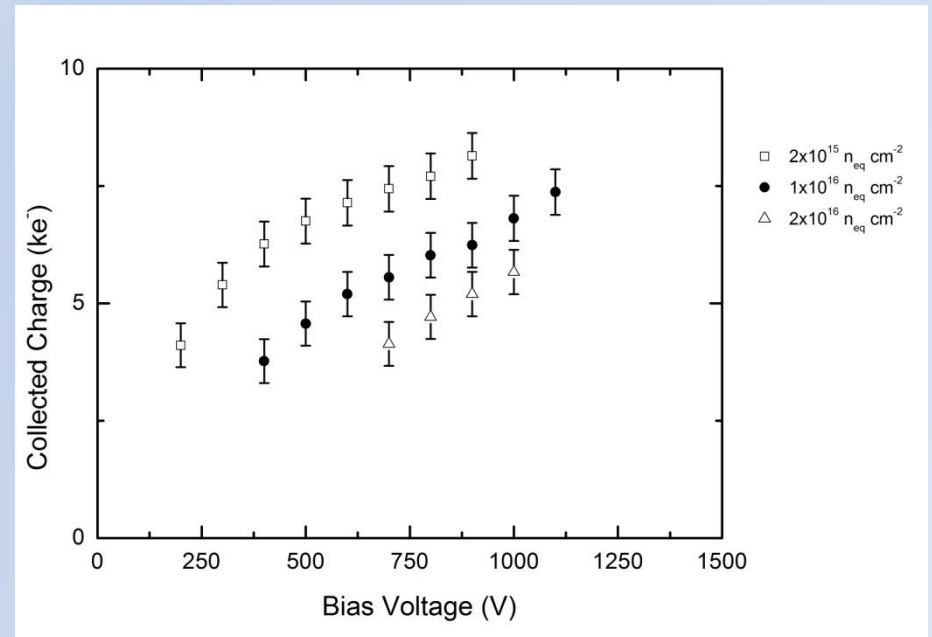
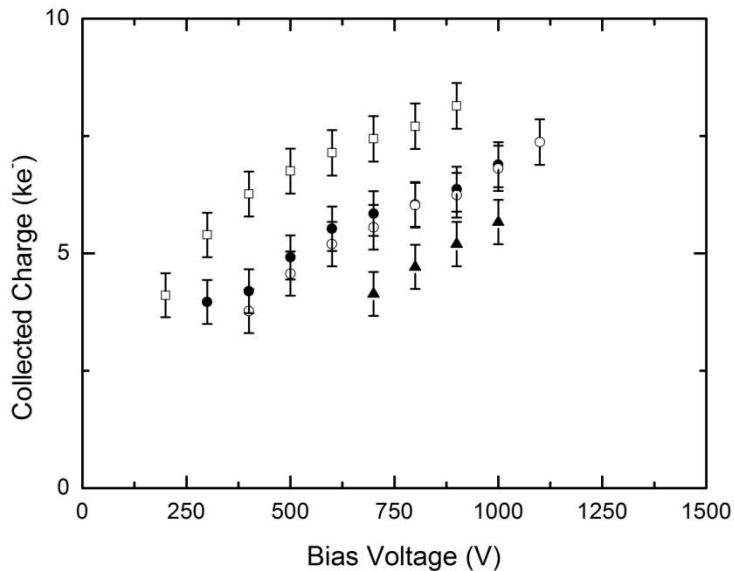
140 μm

Degradation of the CC(V) with neutron fluence for the 140 μm thick sensors. Likely mislabelling of one sensor, it looks like the irradiation dose of $5 \times 10^{15} \text{ n}_{\text{eq}} \text{ cm}^{-2}$ is missing.



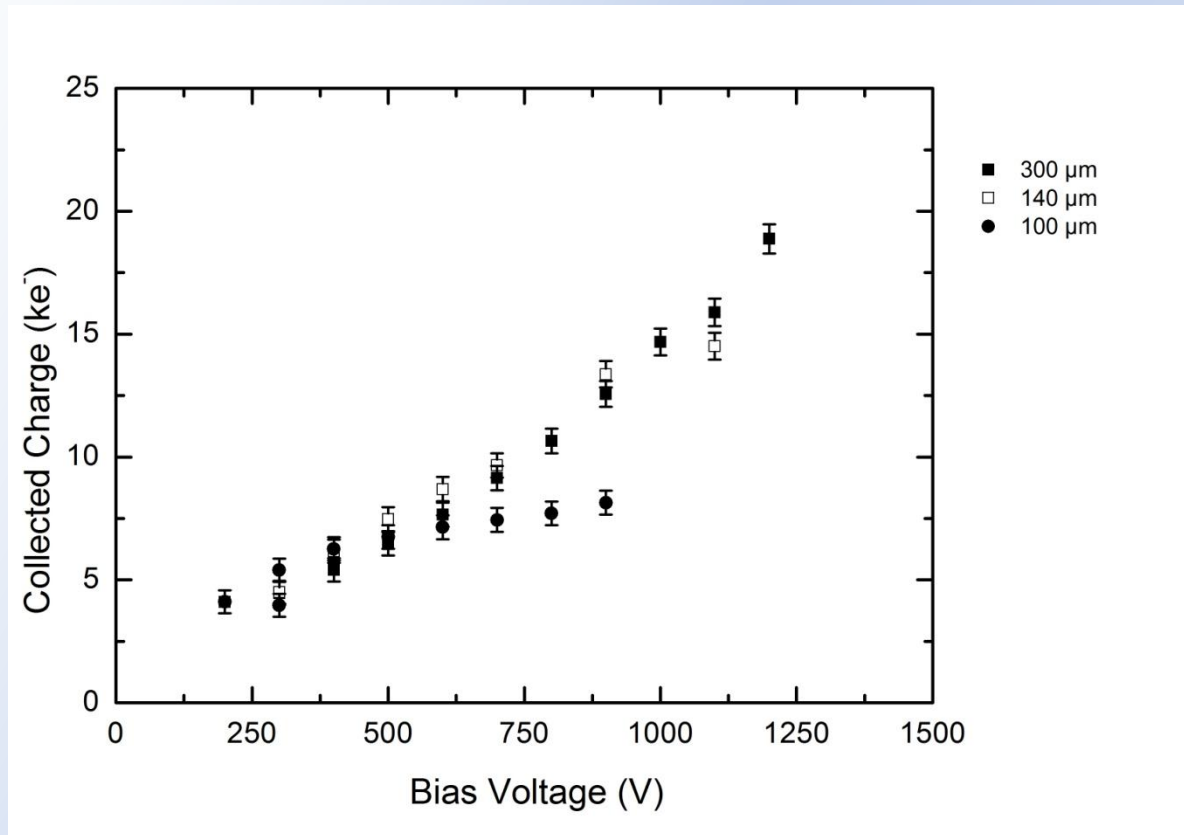
100 μm

Degradation of the CC(V) with neutron fluence for the 100 μm thick sensors. Likely mislabelling of one sensor, it looks like the irradiation dose of $5 \times 10^{15} \text{ n}_{\text{eq}} \text{ cm}^{-2}$ is missing.



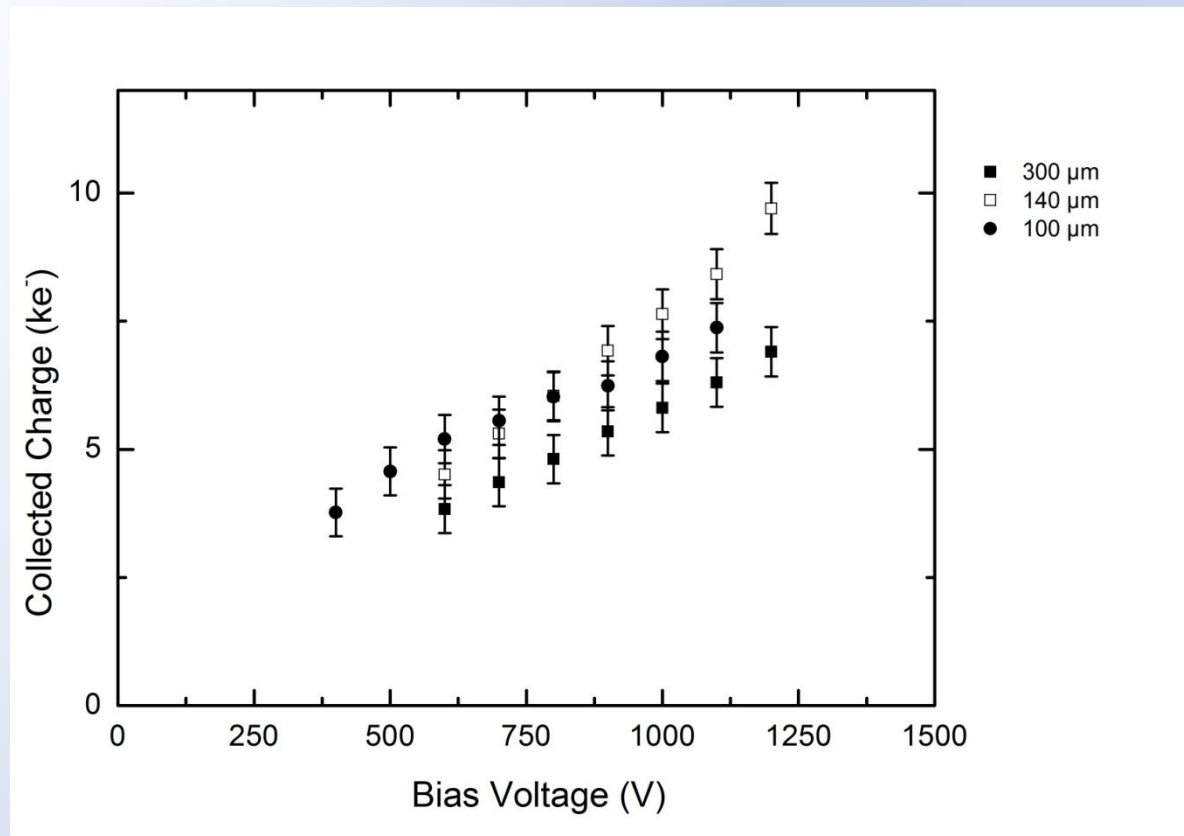
$$2 \times 10^{15} \text{ n}_{\text{eq}} \text{ cm}^{-2}$$

Comparison of the CC(V) after this dose for the 100, 140 and 300 μm thick sensors. Collected charge similar at low voltages.



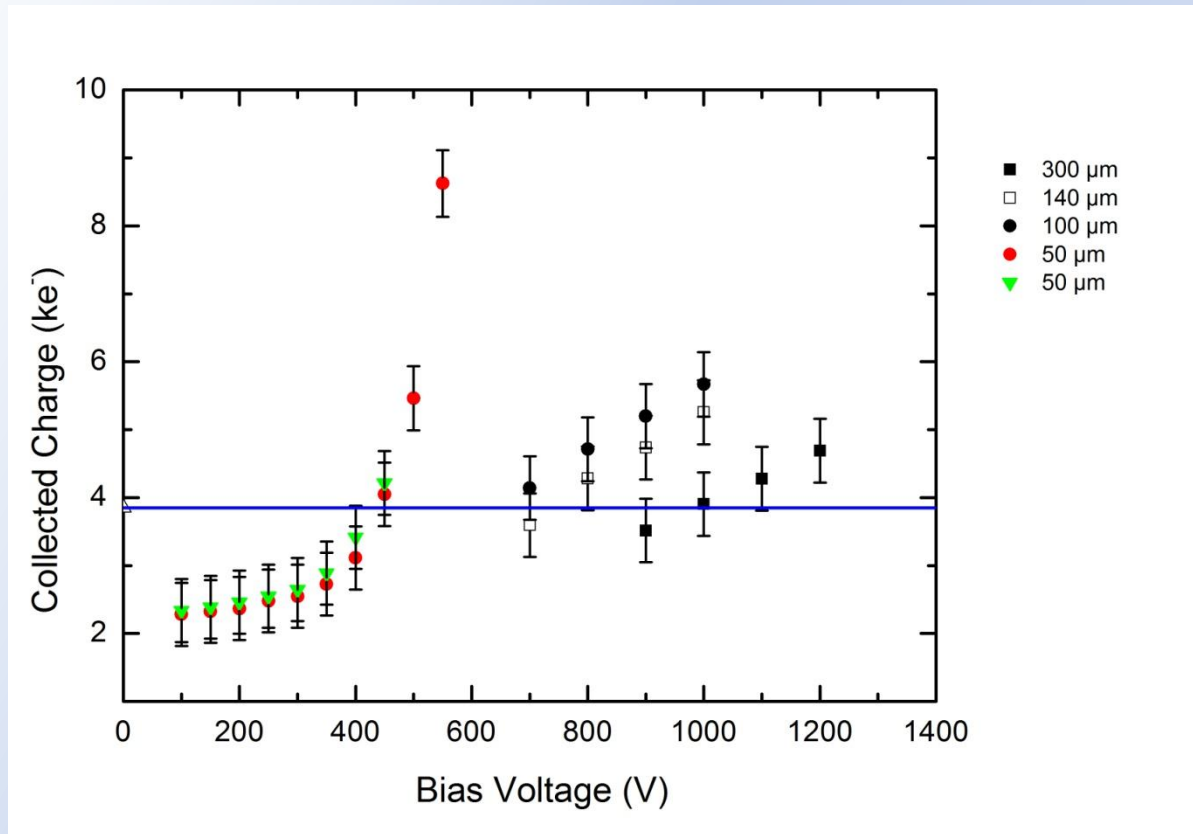
$$1 \times 10^{16} \text{ n}_{\text{eq}} \text{ cm}^{-2}$$

Comparison of the CC(V) after this dose for the 100, 140 and 300 μm thick sensors. Thinner sensor exhibit better collected charge at same applied bias voltage.

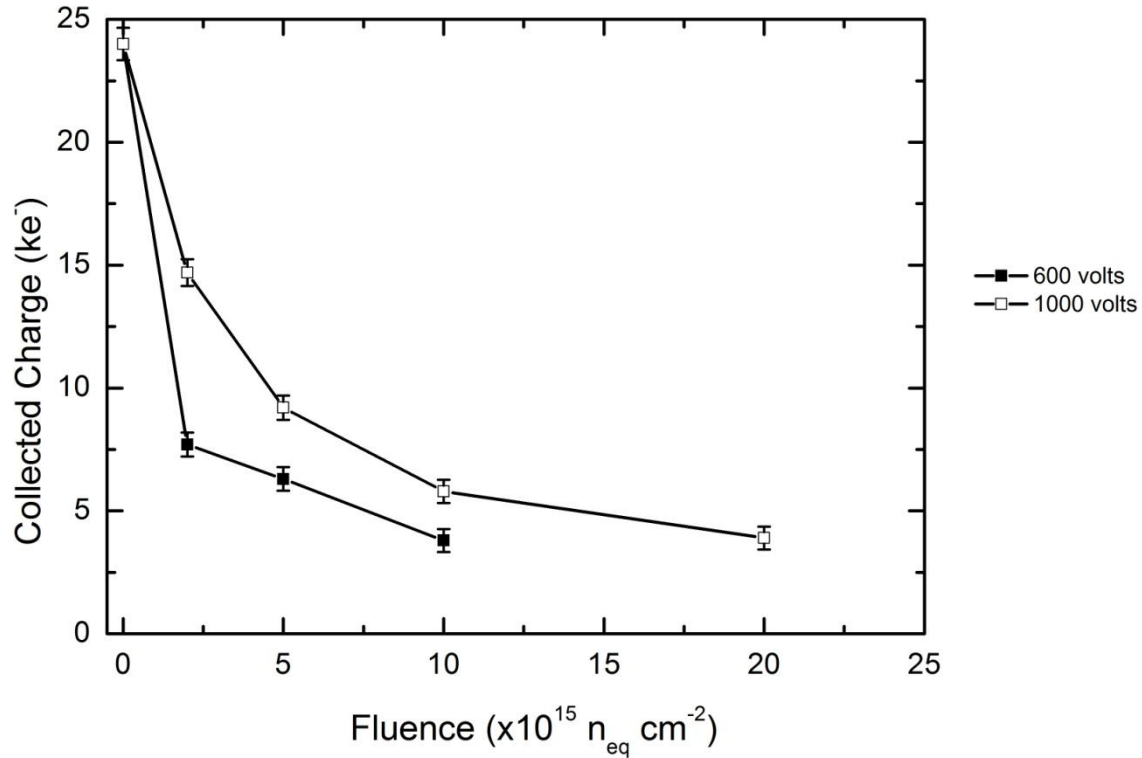


$$2 \times 10^{16} \text{ n}_{\text{eq}} \text{ cm}^{-2}$$

Comparison of the CC(V) after this dose for the 100, 140 and 300 μm thick sensors. Thinner sensor exhibit better collected charge at same applied bias voltage.

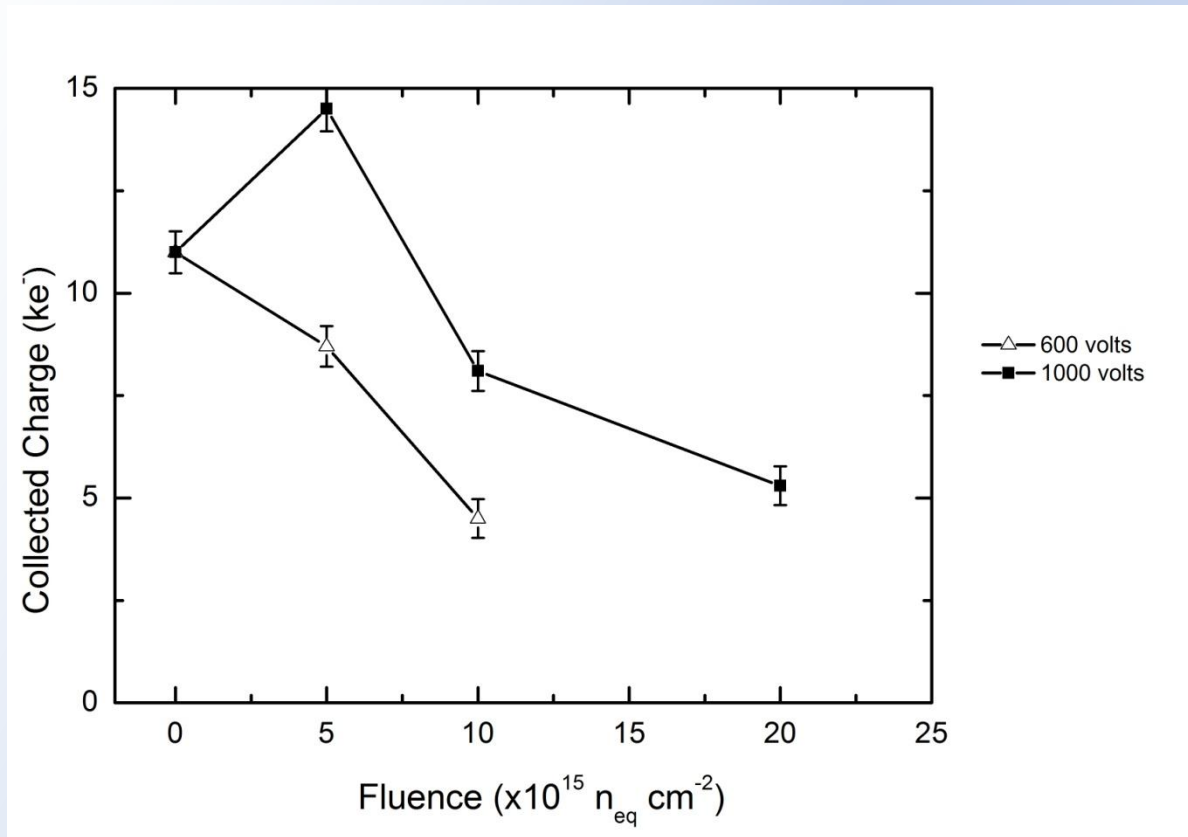


Degradation 300 μ m



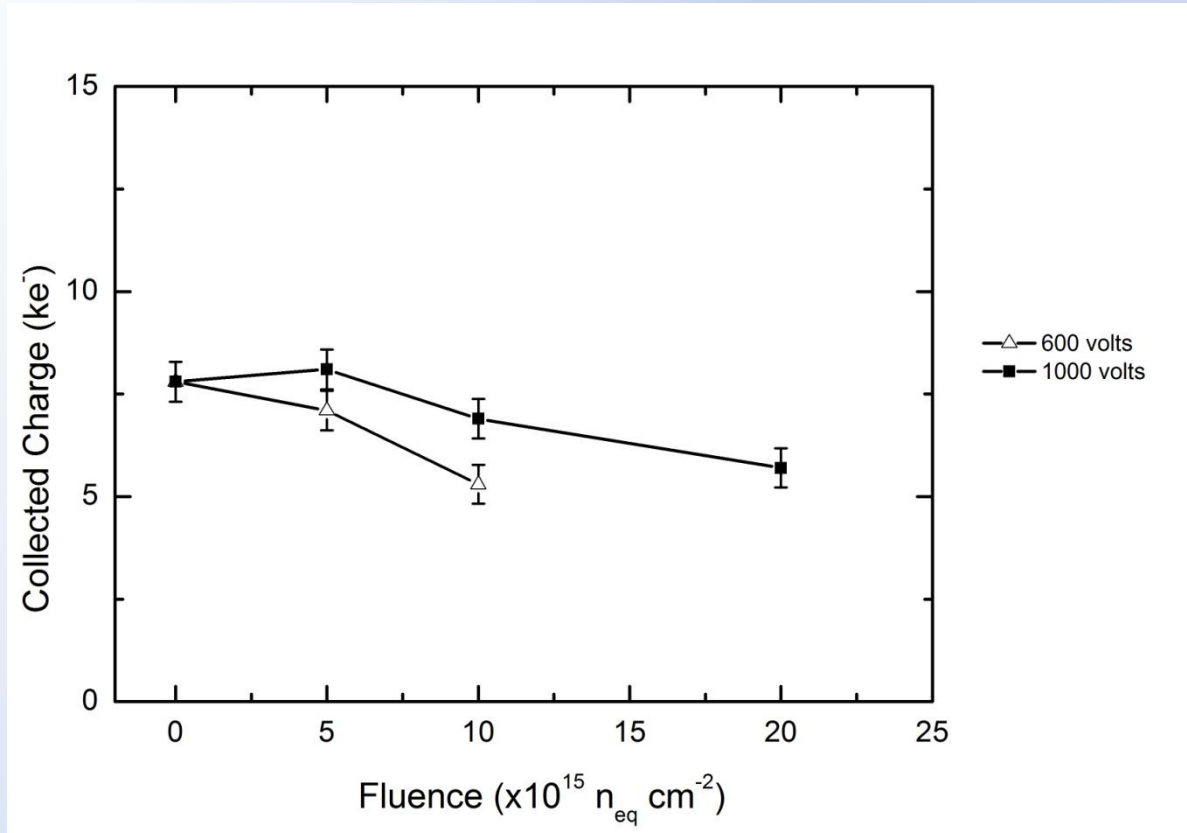
Degradation 140 μm

CC(V)



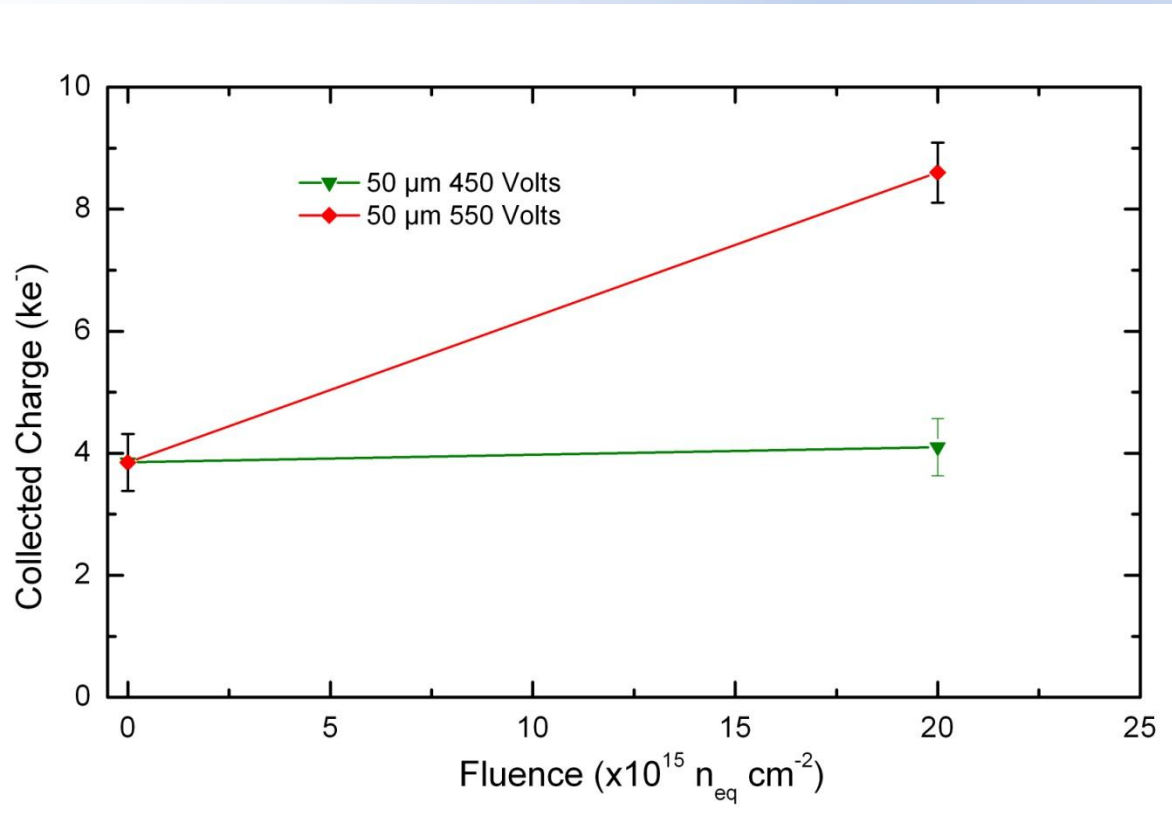
Degradation 100 μm

CC(V)



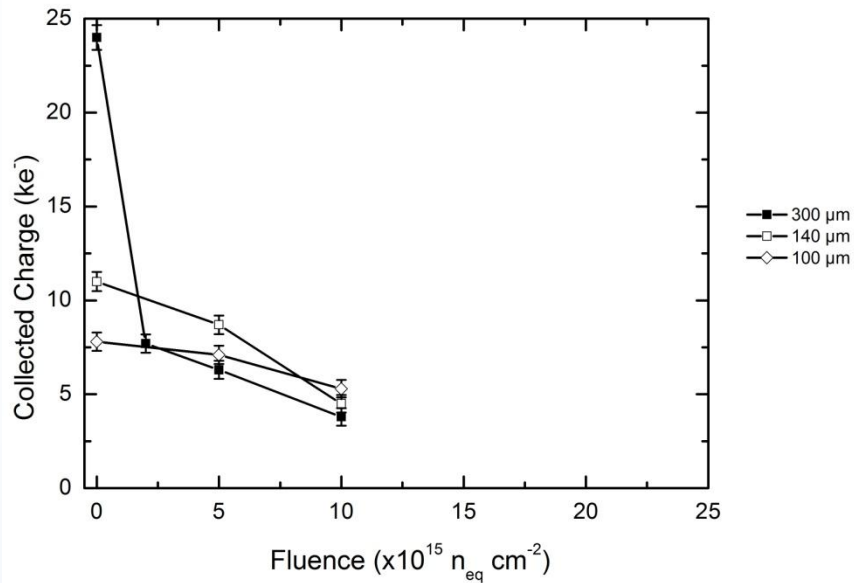
Degradation 50 μ m

CC(V)

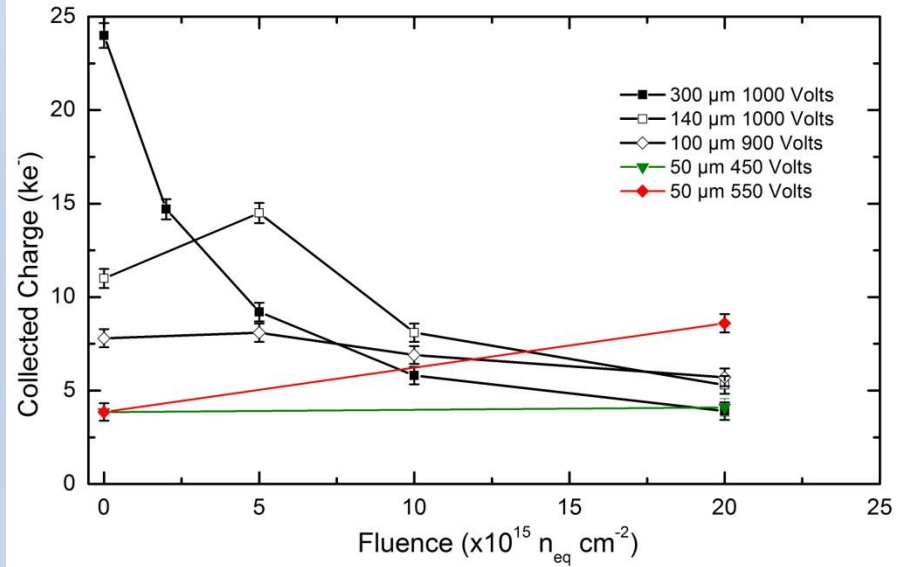


Degradation all thicknesses

600 V



1000 V



CONCLUSIONS

Thin sensors deliver higher charge collection than standard (300 μm) silicon sensors after about $2\text{E}15 \text{ n}_{\text{eq}} \text{ cm}^{-2}$. The thinnest 50 μm sensor exhibits no degradation of CCE between 0 to $2 \times 10^{16} \text{ neq cm}^{-2}$. 100 μm sensors also show an advantage towards the 140 μm thick after the highest dose ($2\text{E}15 \text{ n}_{\text{eq}} \text{ cm}^{-2}$).

We should study a wider range of fluences with extremely thin devices..

It is also possible that fine thickness tuning is key for experiment application (65, 75 μm thick devices should equally be studied). Mechanical reasons are also important in this respect.