Update on thin vs thick micro-strip detector studies

G. Casse, P. Dervan, D. Forshaw, A. Greenall, I. Tsurin, T. Huse,

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.

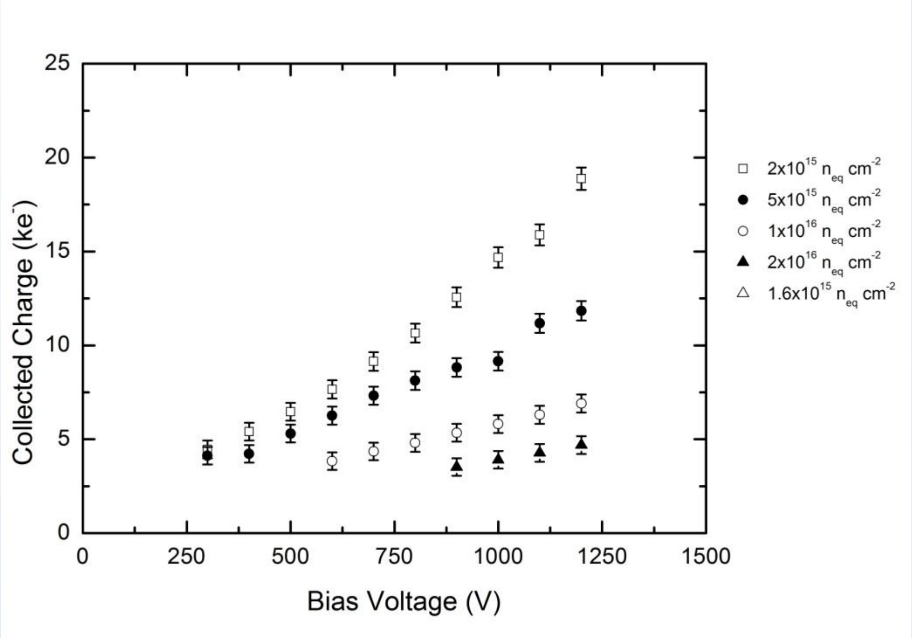
Microstrip detectors are not the configuration where reduced thickness can be pushed to the lower limits. Nonetheless studying the radiation hardness properties of thin microstrip sensors gives valuable indication on the change of their properties.

We show here the CC(V) measurements of 100, 140 and 300 μm thick after irradiation to doses of 2E16 n_{eq} cm^{-2}.

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

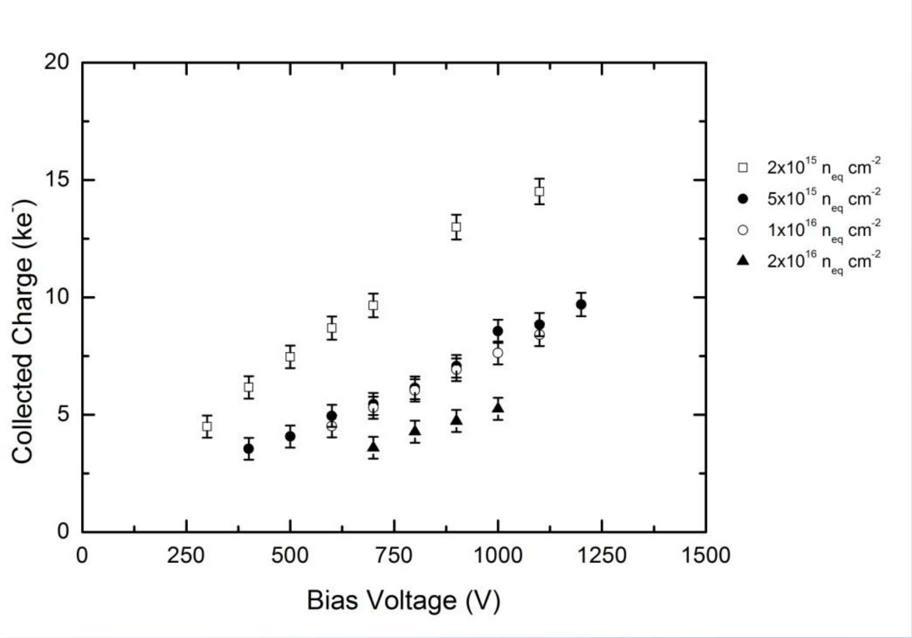
300μm

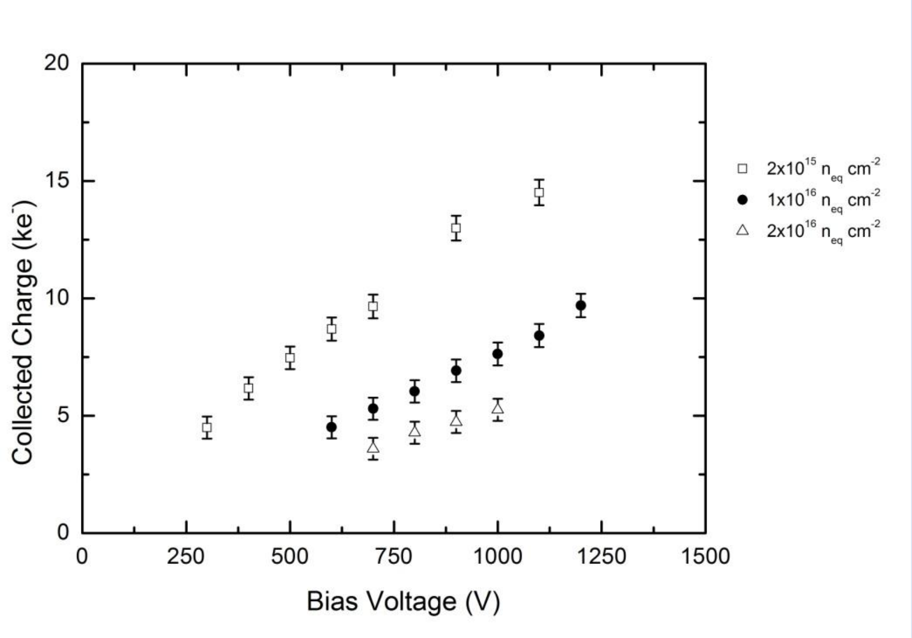
Degradation of the CC(V) with neutron fluence for the 300μm thick sensors.



140µm

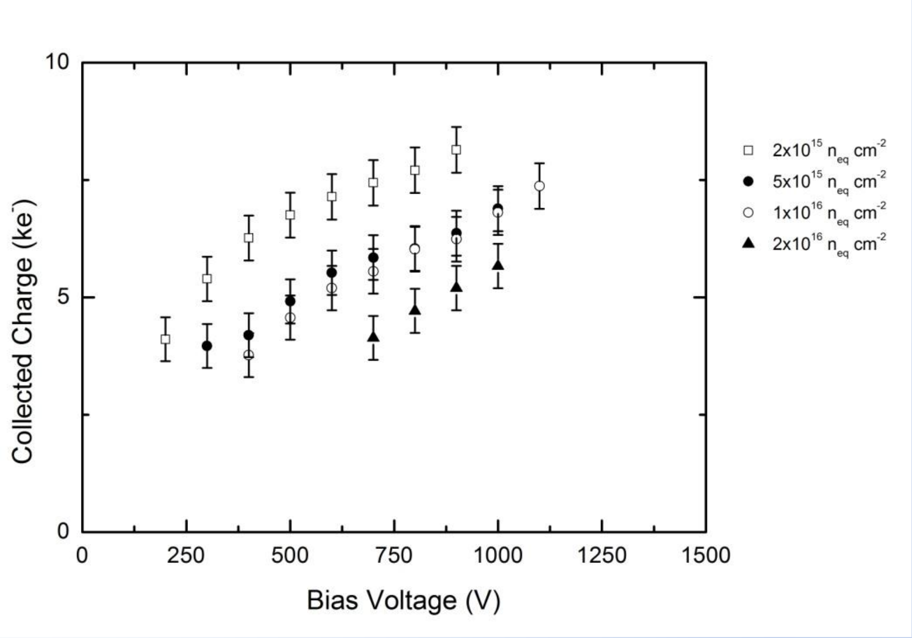
Degradation of the CC(V) with neutron fluence for the 140μm thick sensors. Likely mislabelling of one sensor, it looks like the irradiation dose of 5E15 $n_{eq}cm^{-2}$ is missing.

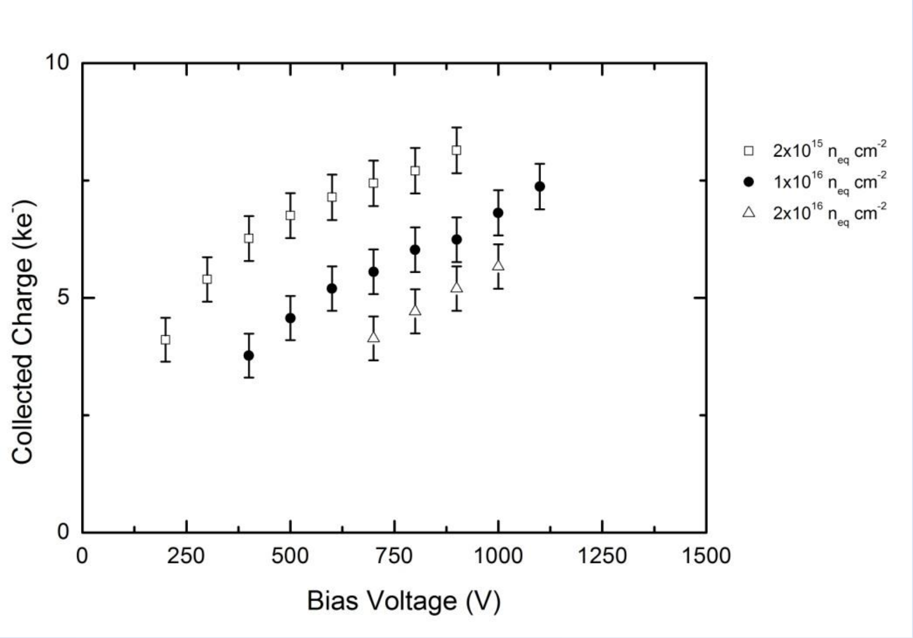




100μm

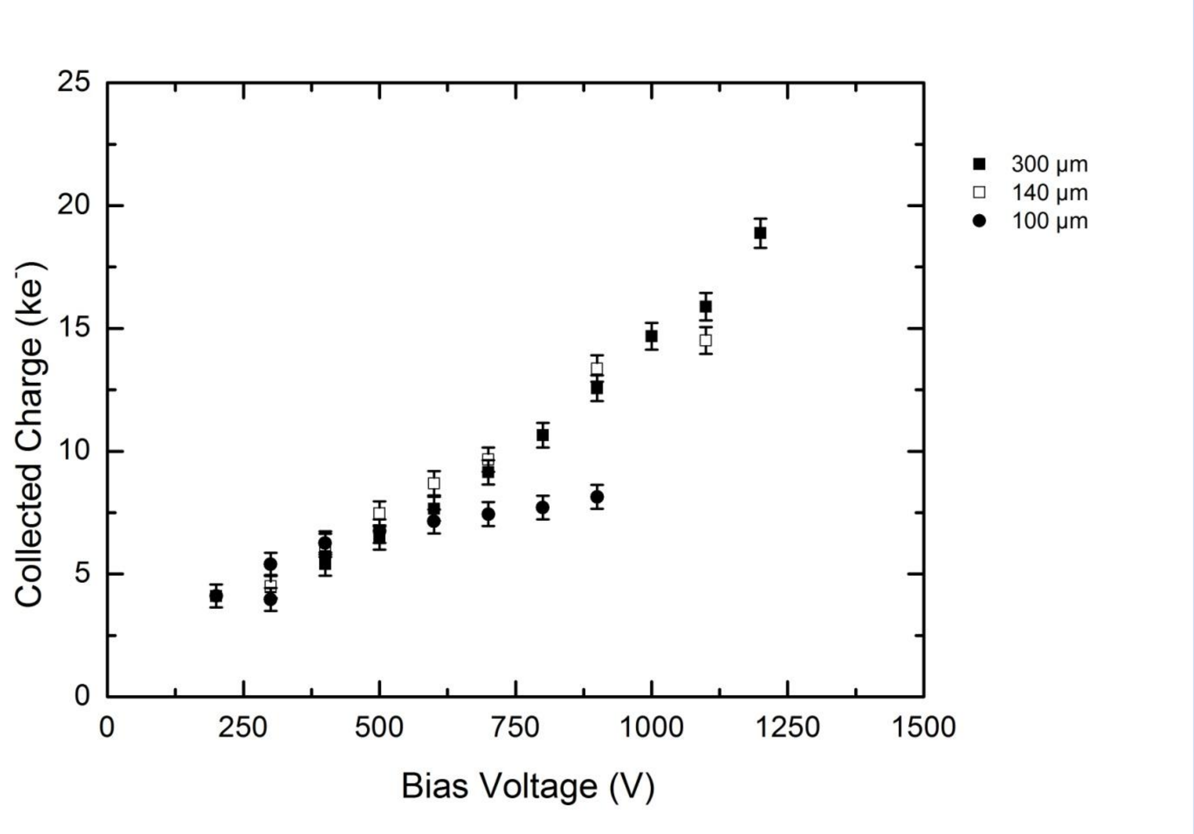
Degradation of the CC(V) with neutron fluence for the 100μm thick sensors. Likely mislabelling of one sensor, it looks like the irradiation dose of 5E15 $n_{eq}cm^{-2}$ is missing.





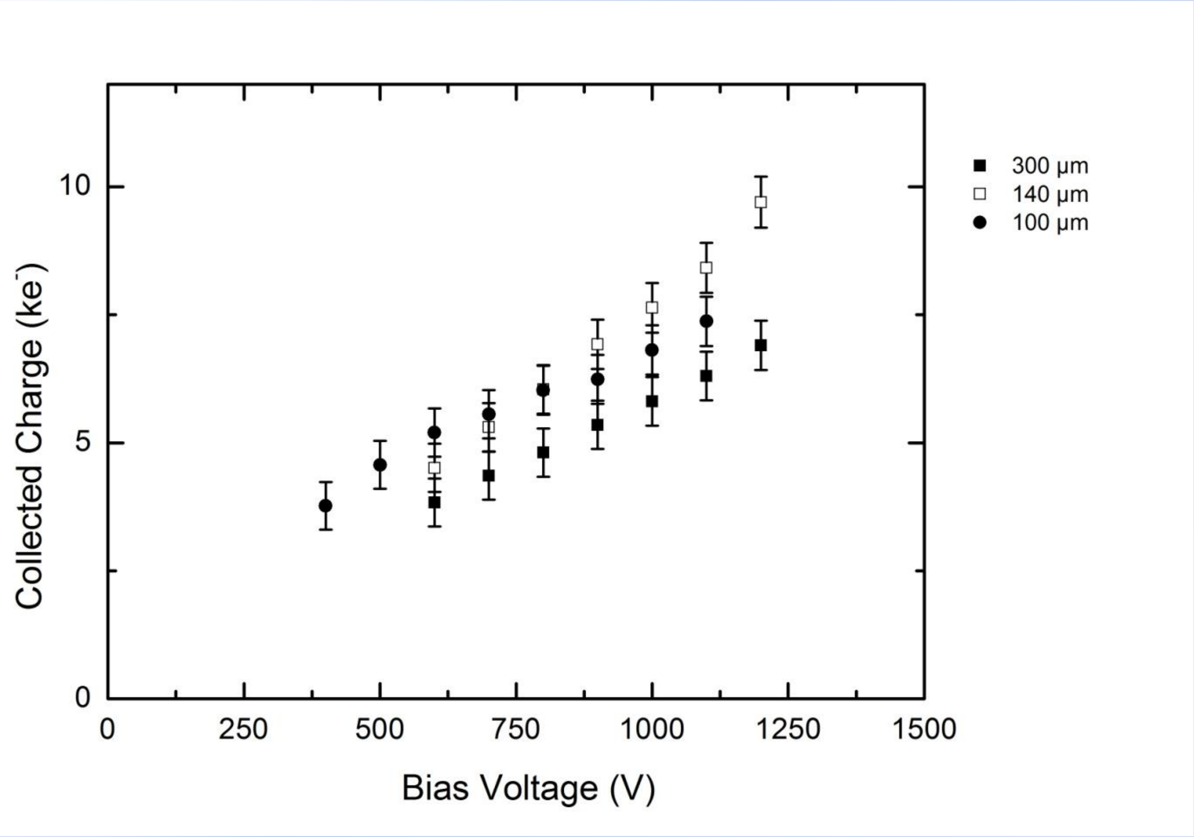
$2x10^{15}$ n_{eq} cm^{-2}

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



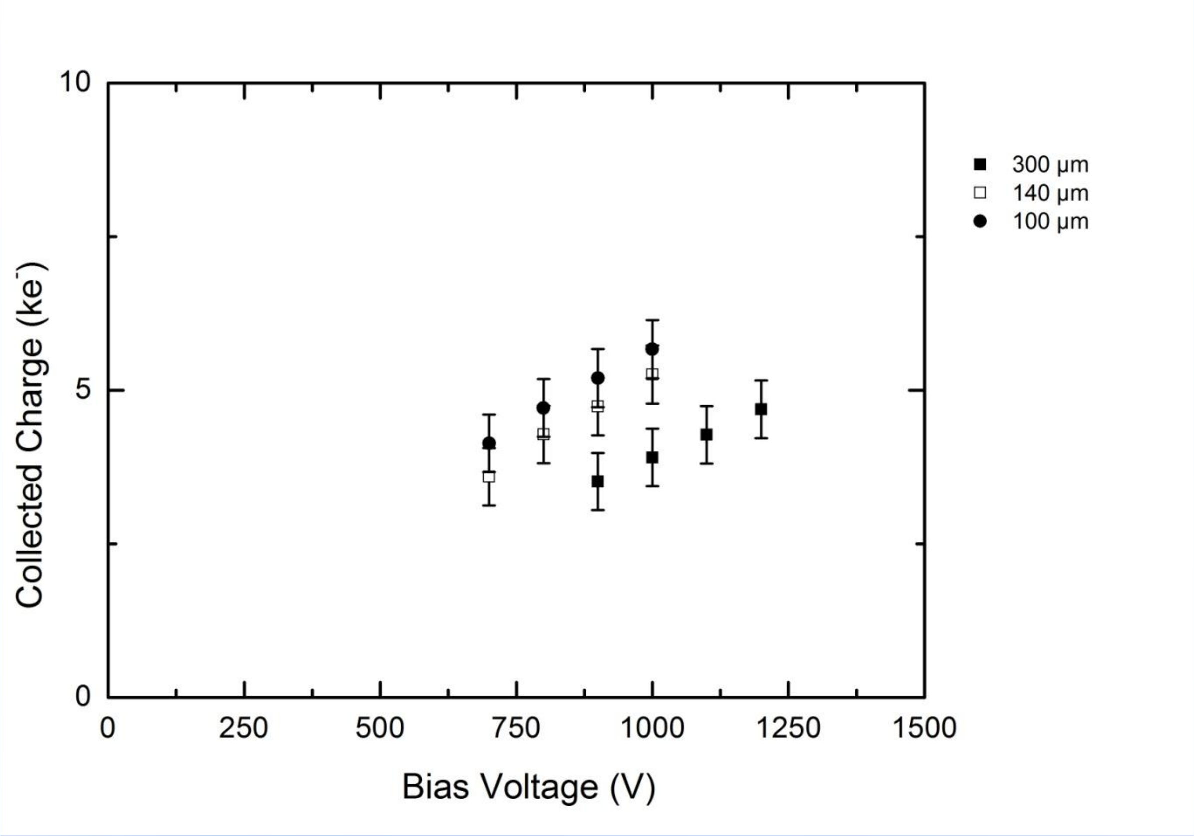
$1x10^{16}$ n_{eq} cm^{-2}

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

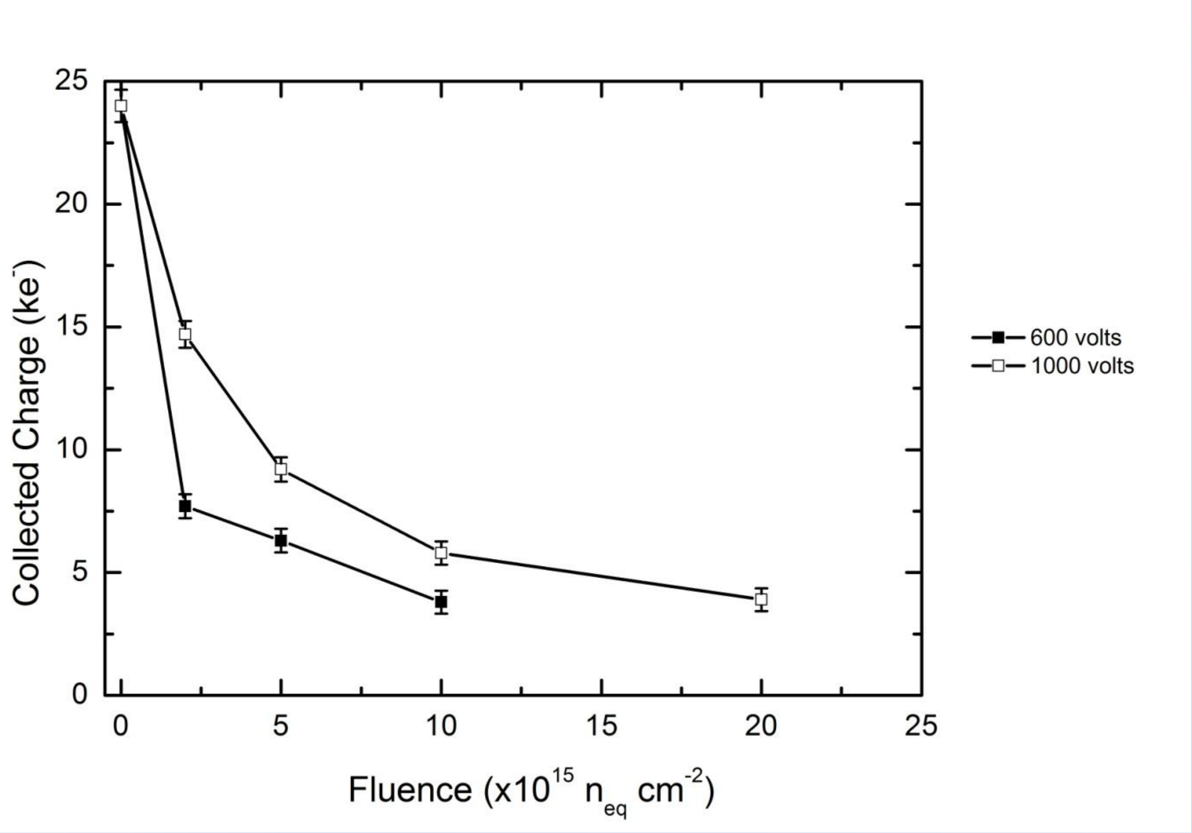


$2x10^{16}$ n_{eq} cm^{-2}

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

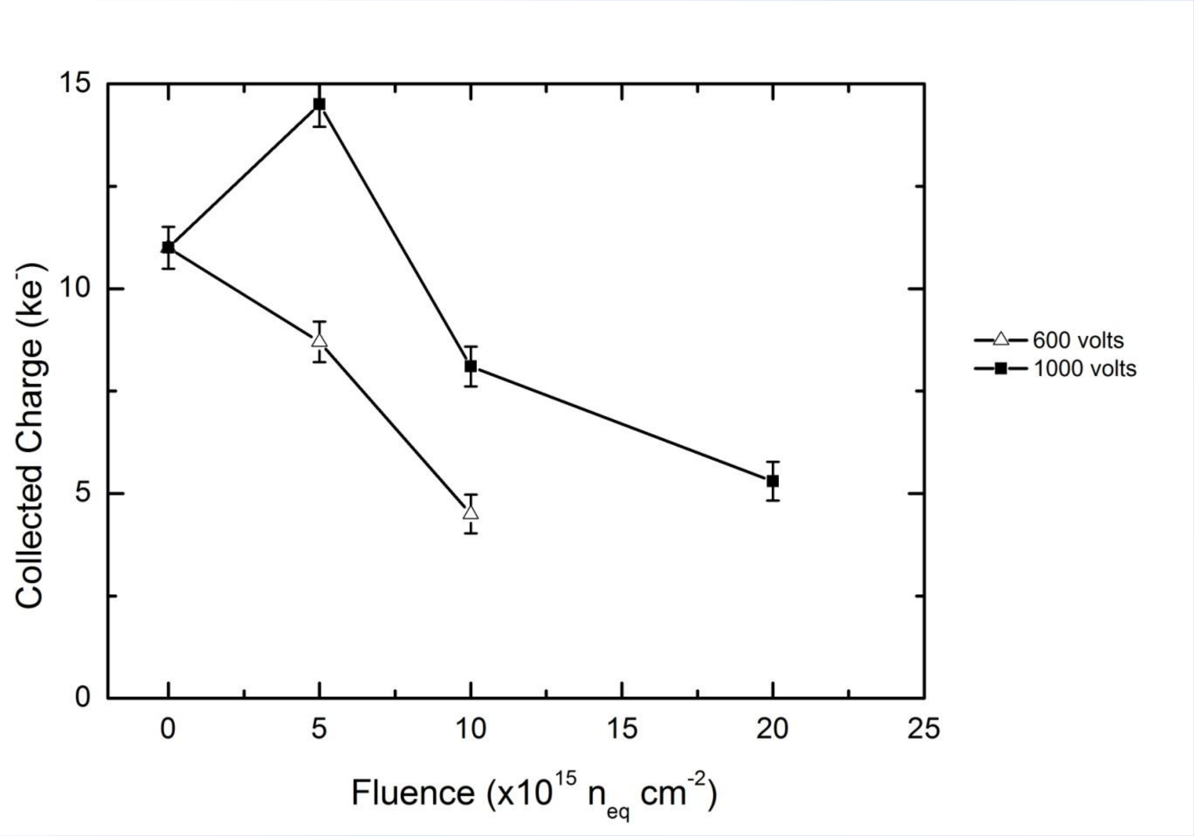


Degradation 300µm



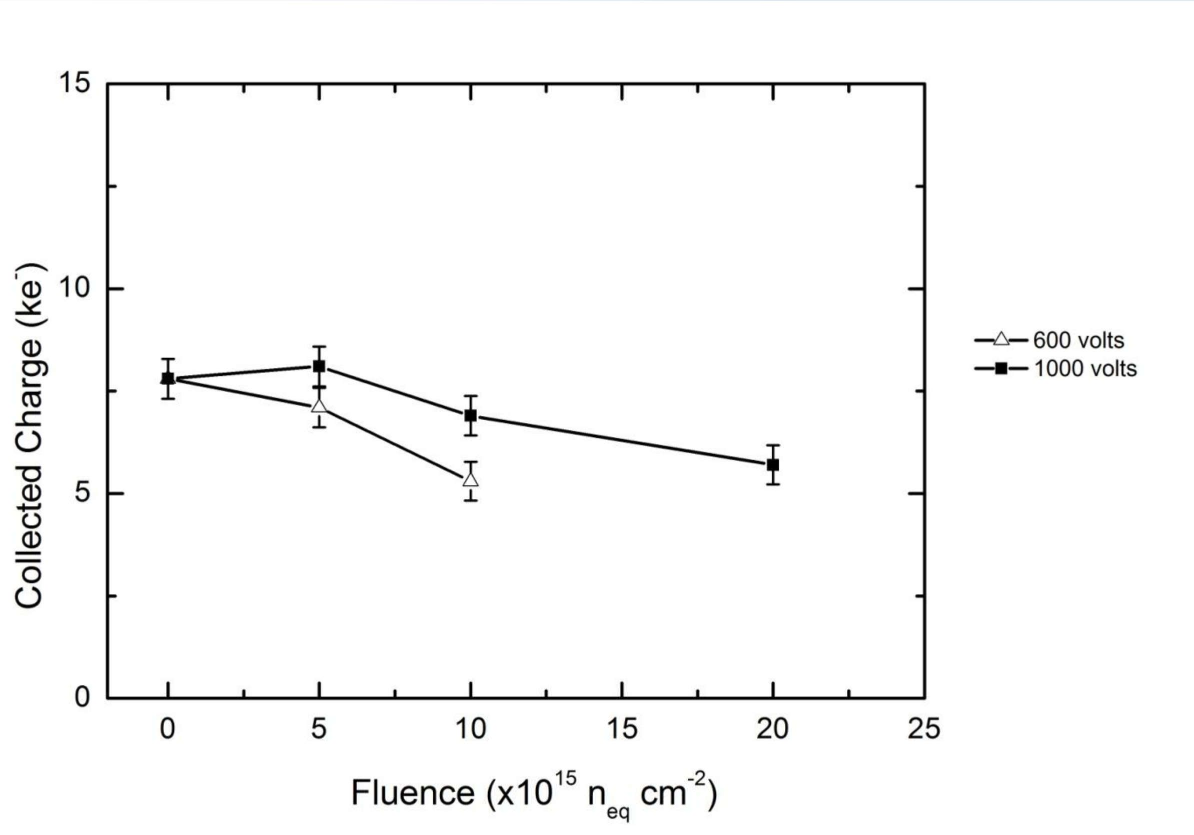
Degradation 140μm

CC(V)



Degradation 100µm

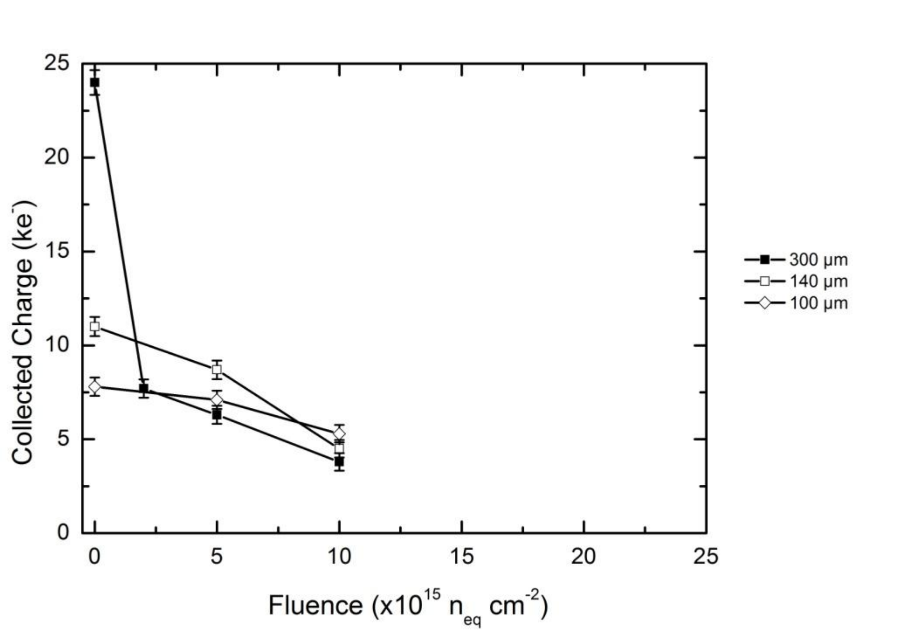
CC(V)

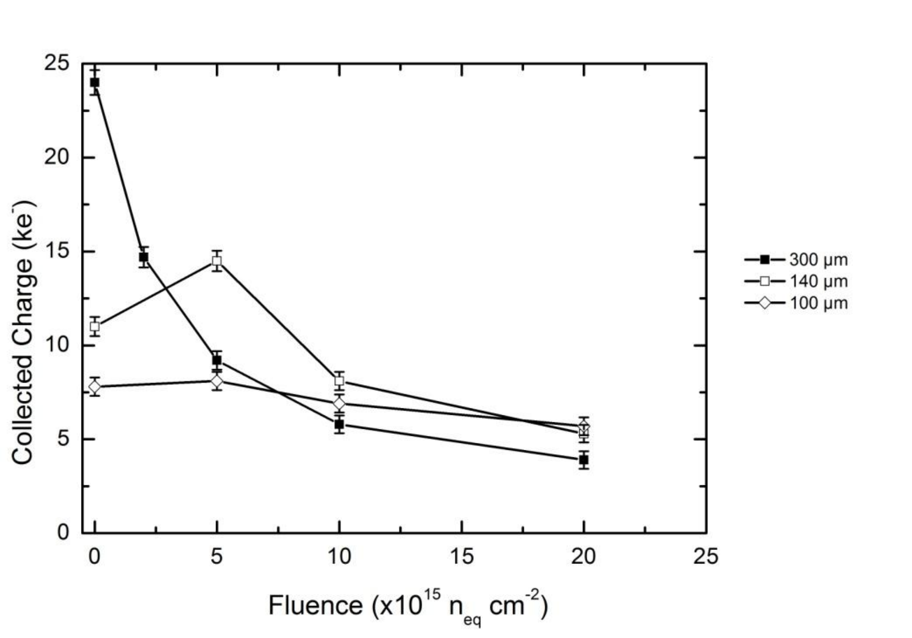


Degradation all thicknesses

600 V

1000 V





CONCLUSIONS

Thin sensors deliver higher charge collection than standard (300μm) silicon sensors after about 2E15 n_{eq} cm^{-2}. The thinnest 100μm sensors also show an advantage towards the 140μm thick after the highest dose (2E15 n_{eq} cm^{-2}).

We tried 50μm thick devices but the signal is hardly resolvable from the noise tail with microstrip electronics.

We would like to explore the effect of proton irradiation and of higher doses. It is also possible that 75μm thick devices can be usable with pour readout systems (typically Alibava, sct128...).