

# First results on the charge collection efficiency of heavily irradiated microstrip sensors fabricated on oxygenated p-type silicon.

G. Casse<sup>a)</sup>, P.P. Allport<sup>a)</sup>, S. Martí<sup>b)</sup>, M. Lozano<sup>c)</sup>, P.R. Turner<sup>a)</sup>

a) Uni. Of Liverpool – Physics departement - O. Lodge lab.

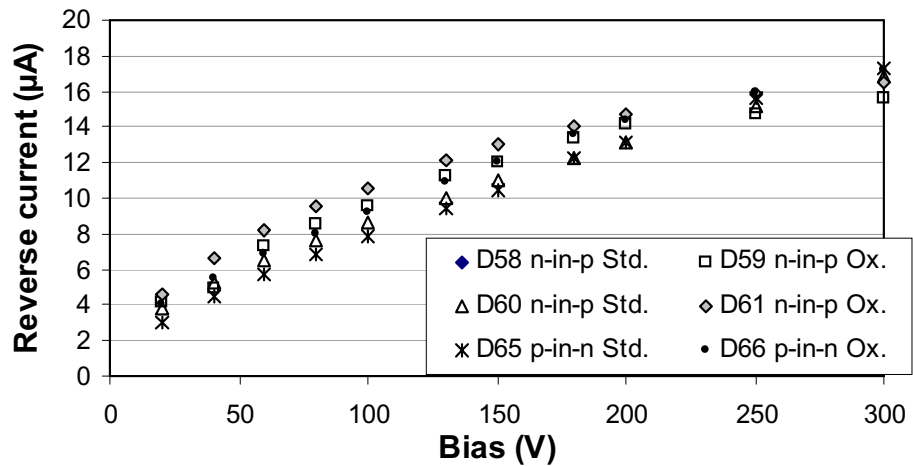
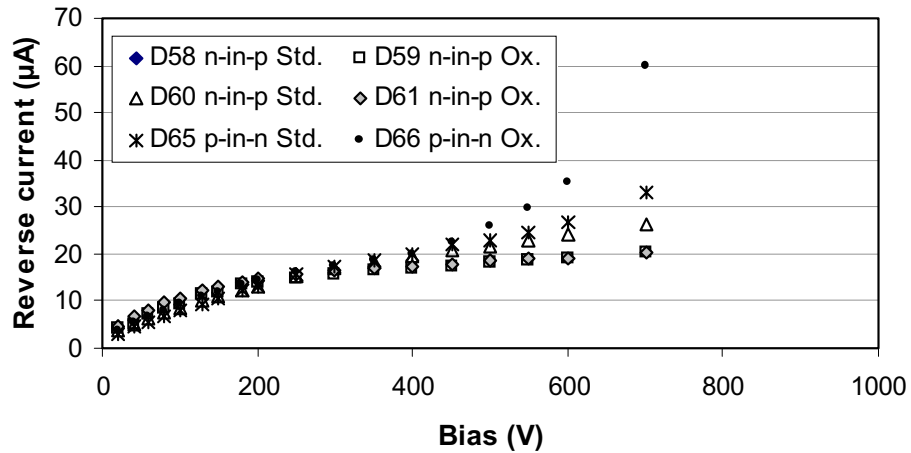
b) University of Valencia

c) CNM Barcelona

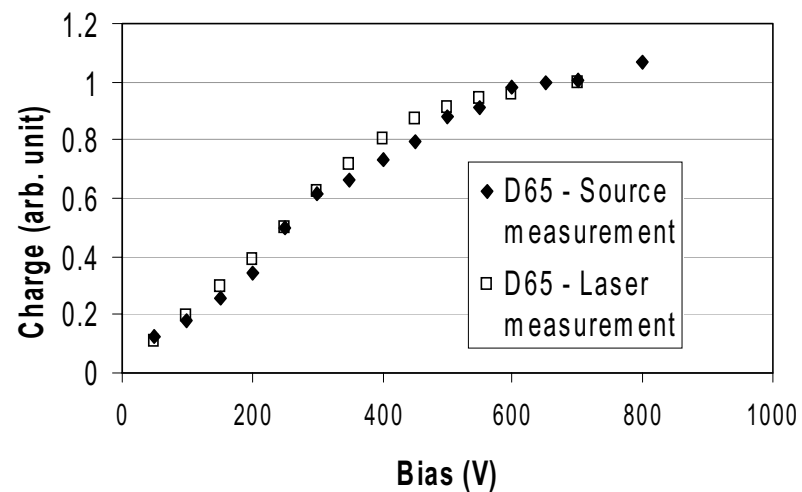
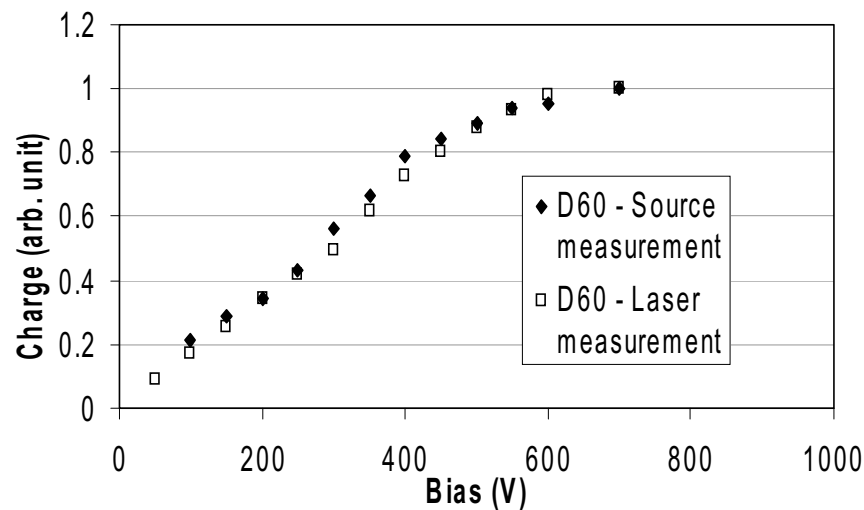
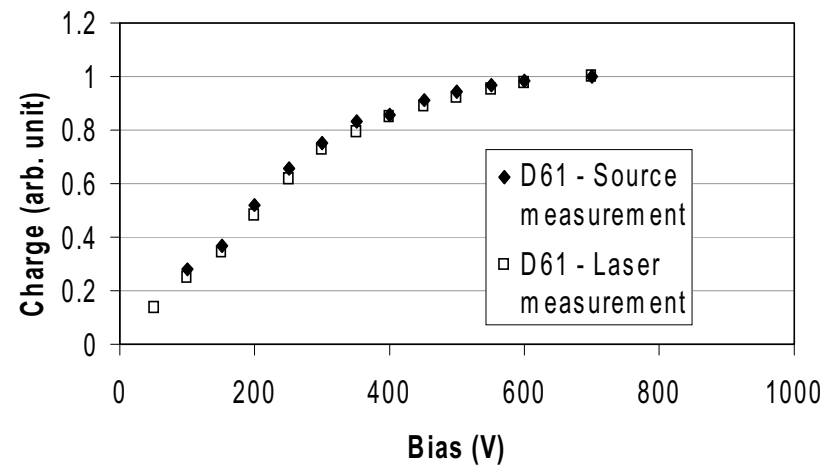
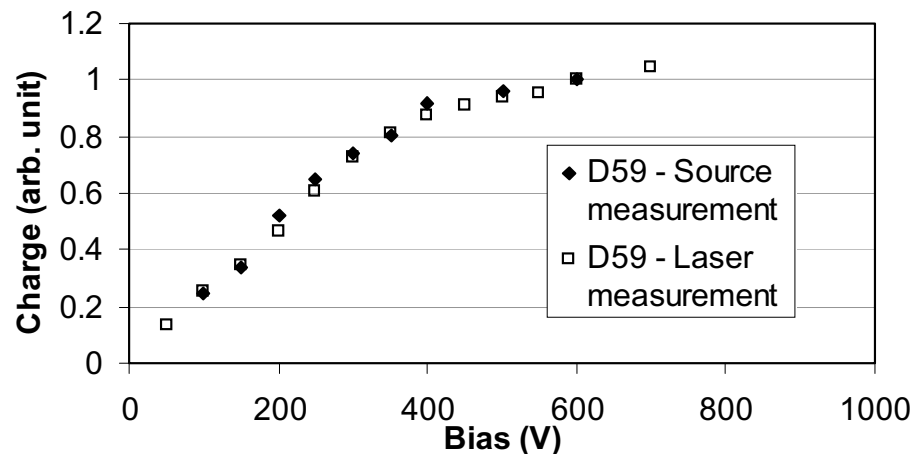
## OUTLINE:

- Oxygen enrichment of n-type and p-type substrates
- Production and irradiation of miniature detectors
- First results of irradiated miniature detectors made on p-type oxygenated wafers

# Reverse currents after $1.1 \cdot 10^{15} \text{ 24 GeV/c p cm}^{-2}$



Charge collection has been measured using a 1060 nm laser and a  $\beta$   $^{106}\text{Ru}$  source. Good agreement of results.



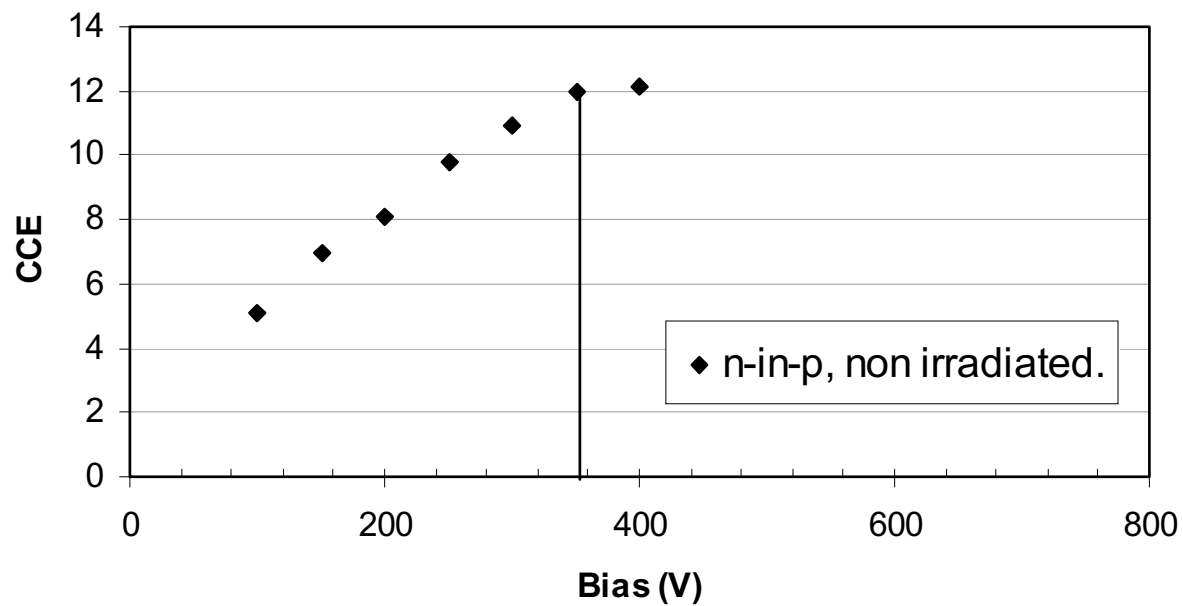
2 sets of variously flavoured detectors have been produced by CNM using a Liverpool designed mask-set. Four type of substrate were used: n-type with and without O, n-type with and without O. [O] calculated to be  $\geq 10^{17} \text{ cm}^{-3}$  throughout the wafer.

The 2 sets have been irradiated to 2.7 and 11.5  $10^{14} \text{ p cm}^{-2}$  in the CERN-PS, Irrad-1 facility, at room temperature and unbiased.

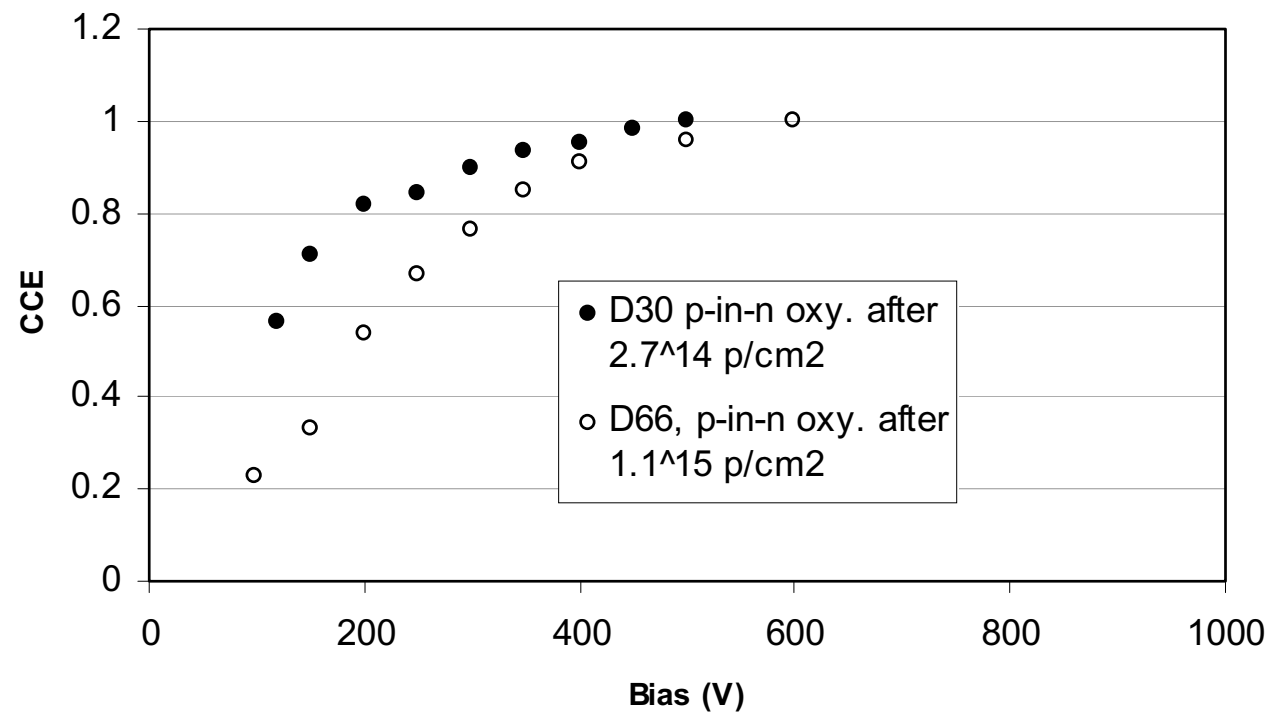
After irradiation they were kept at low temperature.

## Before irradiation: n-in-p detectors

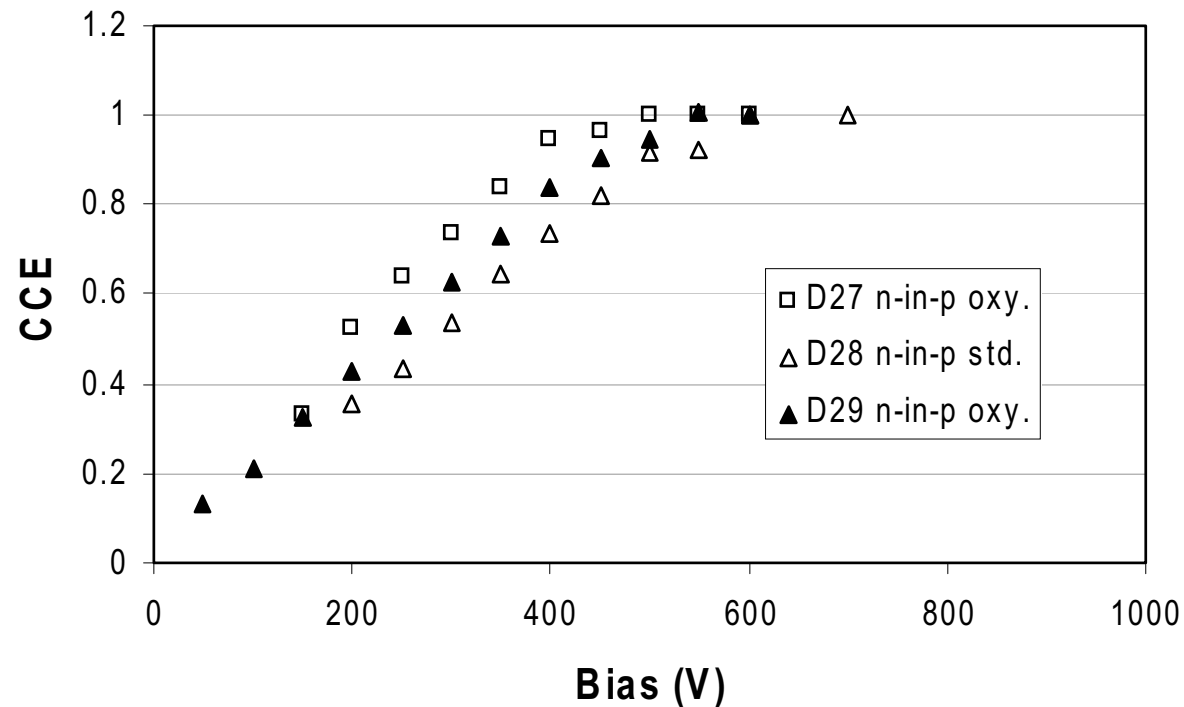
$$V_{fd} \sim 350 \text{ V}$$



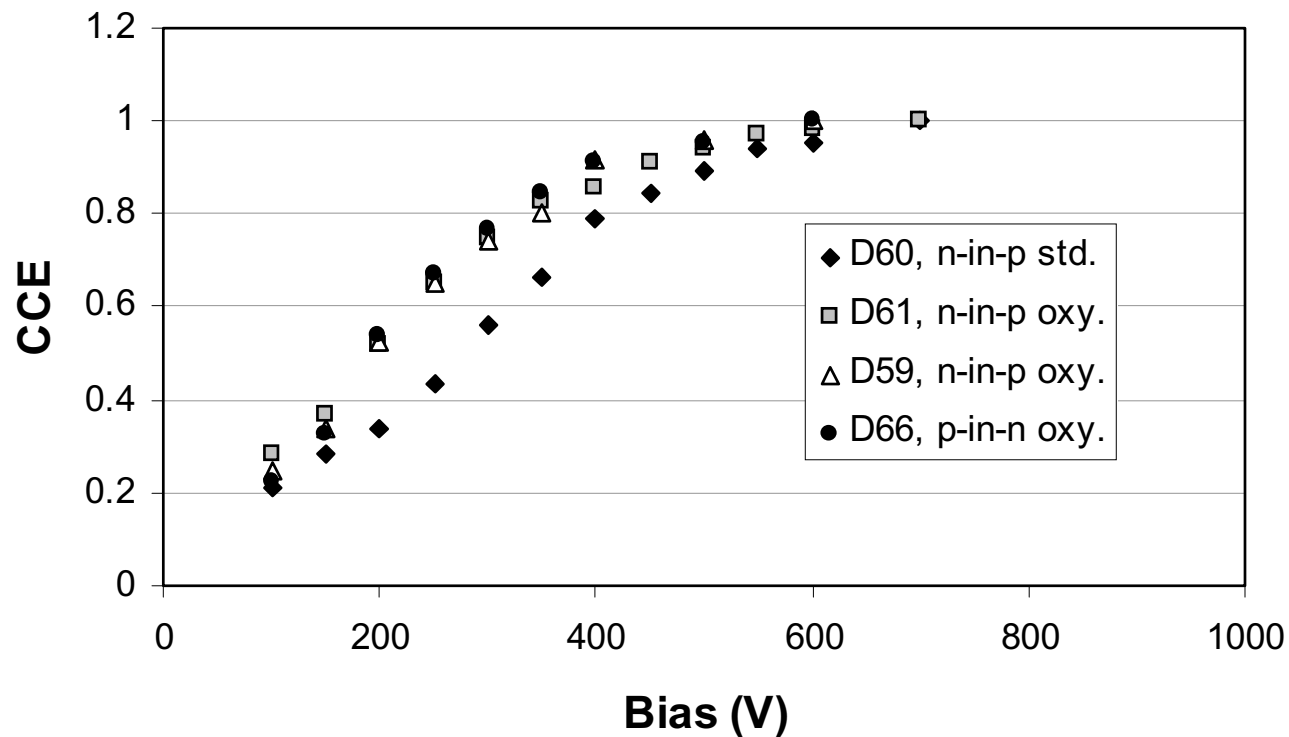
P-in-n with oxygenated substrate at the two different doses.



Charge collection with n-in-p detectors after  $2.7 \cdot 10^{14} \text{ p cm}^{-2}$ . The presence of oxygen has small influence on the full depletion voltage.

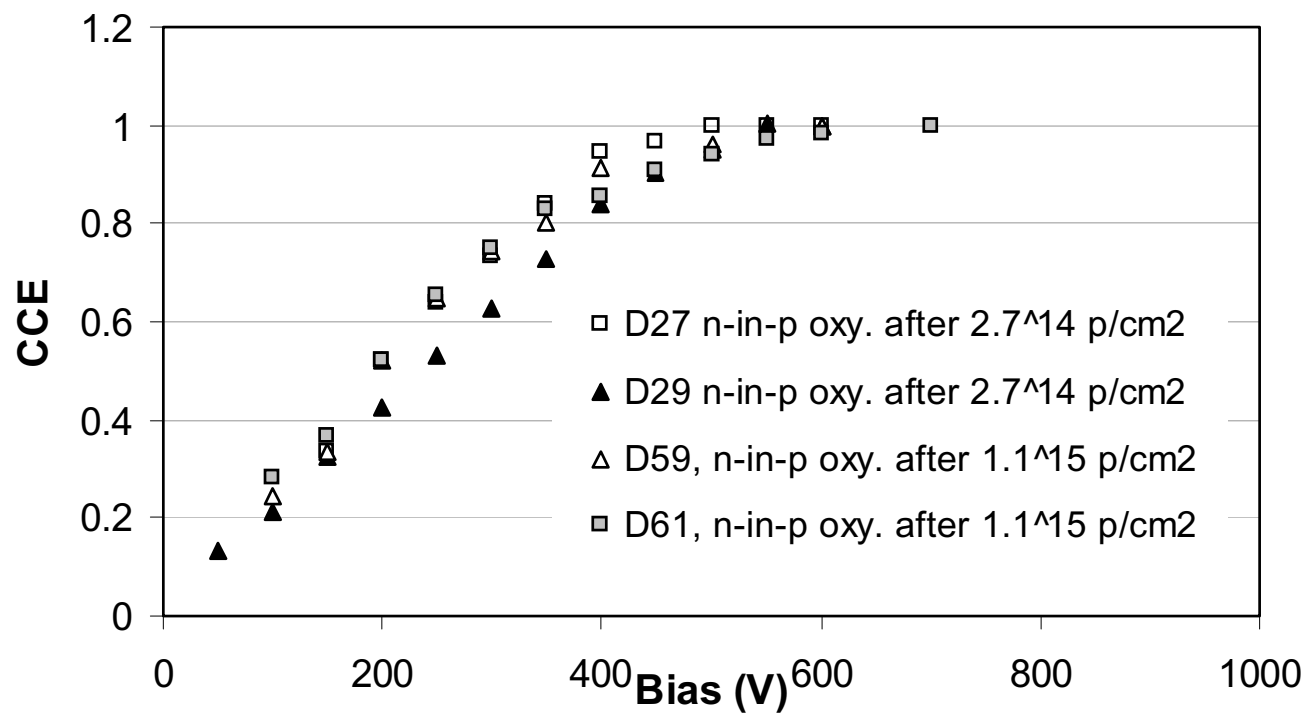


Charge collection with n-in-p detectors after  $1.1 \times 10^{15} \text{ p cm}^{-2}$ . Again, the presence of oxygen has small influence on the full depletion voltage.

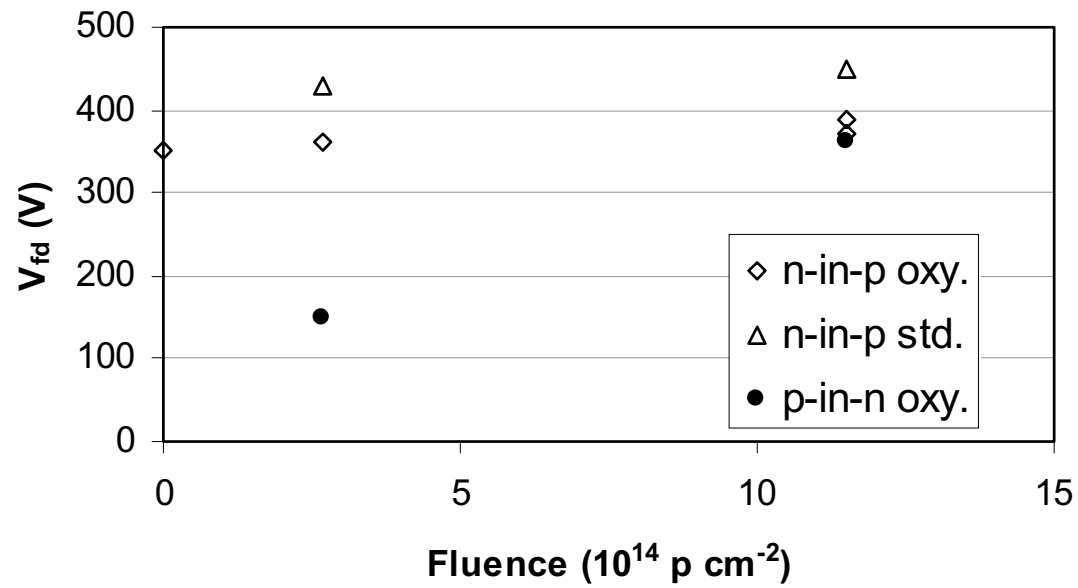




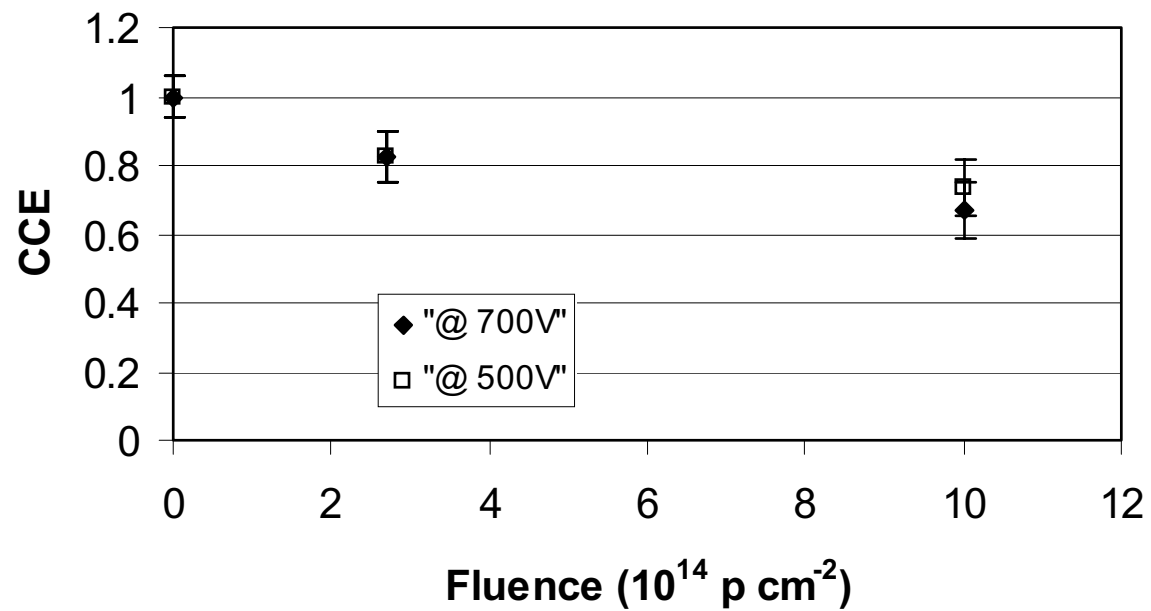
N-in-p with oxygenated substrate at the two different doses. The full depletion voltage does not vary much.



## $V_{fd}$ vs proton fluence



## Charge deficit vs proton fluence



## CONCLUSIONS

- Oxygenated p-type substrate has been successfully used to produce miniature micro-strip detectors
- The p-type substrates show CCE properties at least as good as n-type substrates
  - ⇒ since n-in-n micro-strip detectors show significantly lower voltages required for a given CCE, n-in-p should offer the same advantage but without the need for double-sided processing
- The oxygenated p-type detectors show less dependence of the full depletion voltage on dose.
  - ⇒ this may be due to the lower resistivity starting material and/or due to the non-inversion of the substrate
- Further studies with initial higher resistivity of the p-type substrate are needed to qualify this substrate as a detector material.