

Irradiated MCz-Sensors for a Testbeam

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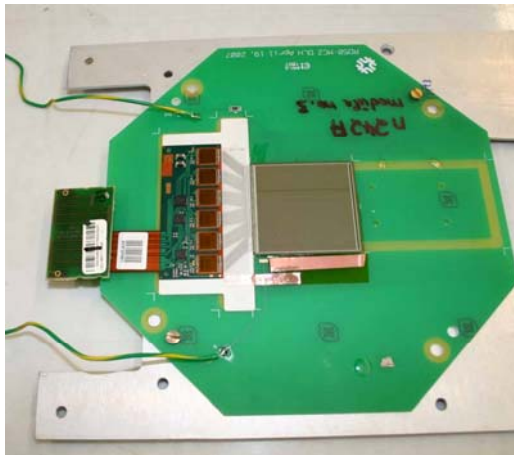
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Intention of the Beamtest

Open questions concerning the properties of irradiated Magnetic Czochralski sensors:



- Signal / Noise
- Efficiency
- Resolution
- Type-Inversion



Production of sensors → qualification of sensors → irradiation → testing of sensors → production of modules → testing → beamtest with a beam-telescope



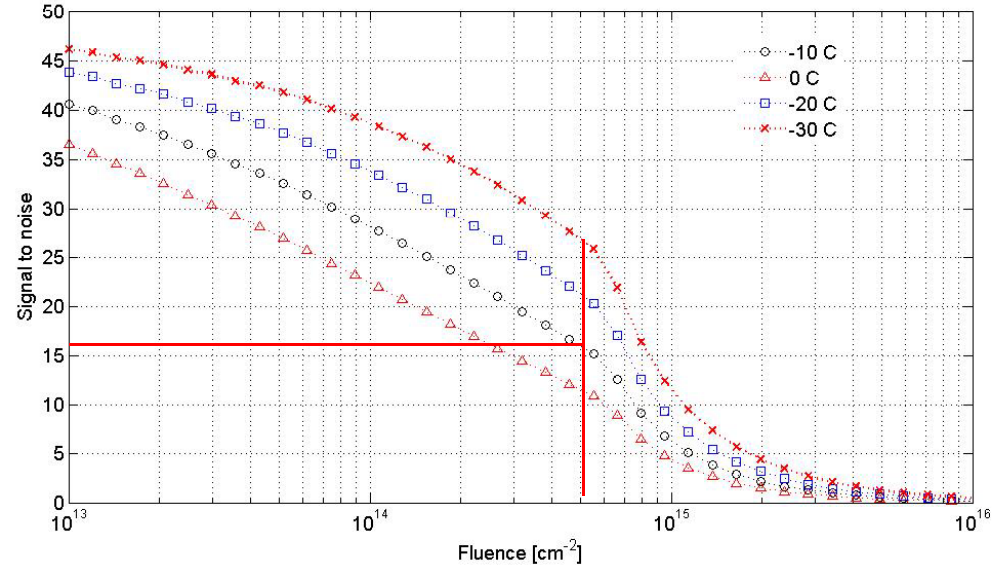
Results of the last Test



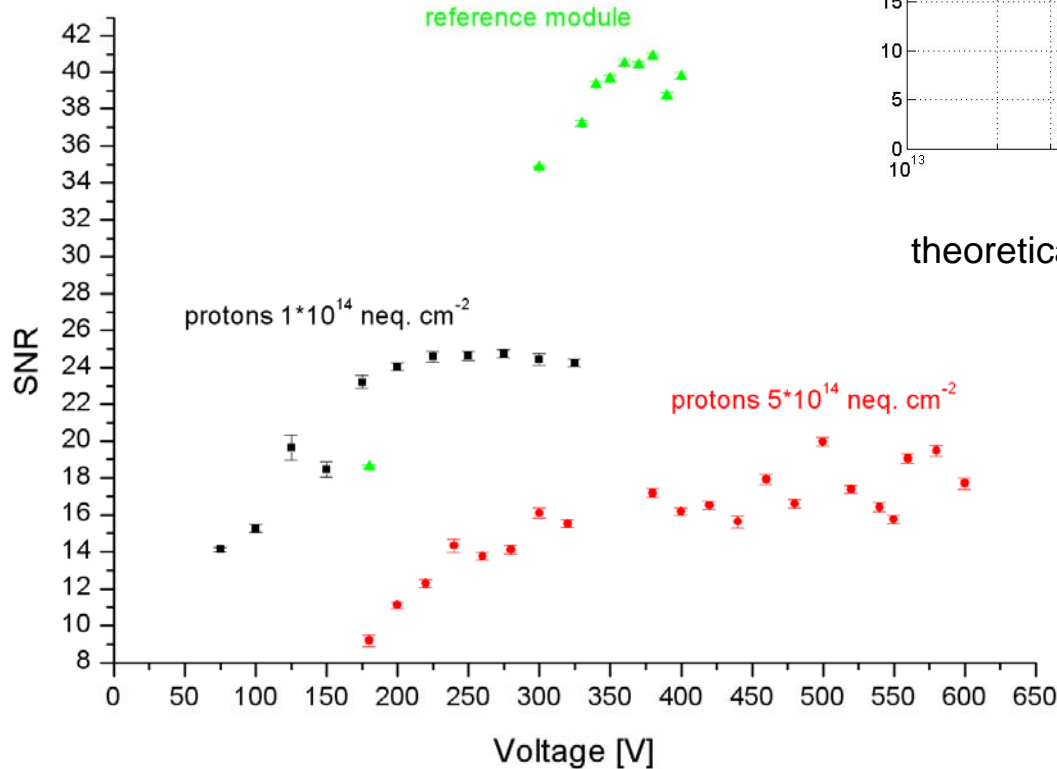
The results are very well conform with the prediction!

| Module: | SNR: |
|-----------|------|
| Reference | ~40 |
| 1E14p | ~24 |
| 5E14p | ~18 |

test results



theoretical prediction, simulation (Jaakko Härkönen)



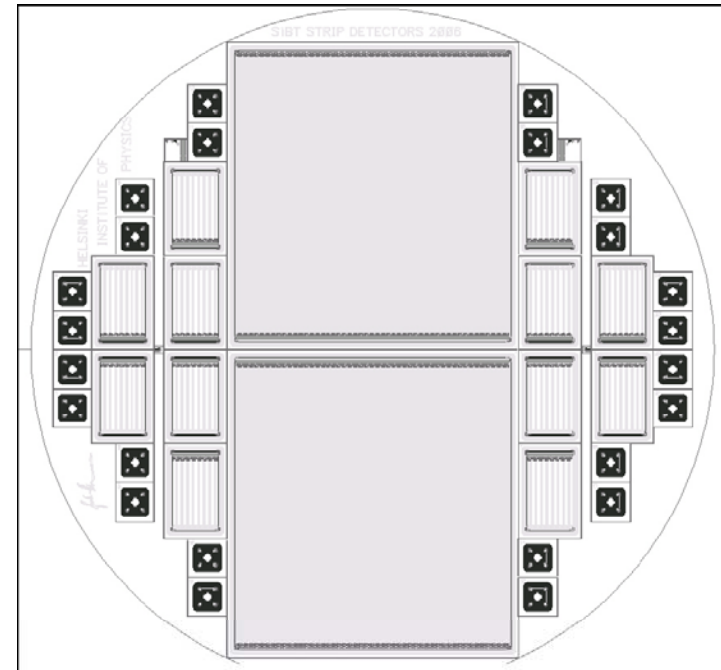
Aim of the new test:
Going to higher fluences
Mixed irradiations with protons and neutrons



Plan for the Fluences

| Irradiation plan for large MCz and Fz sensors | | |
|---|----------------|-----------|
| Material | Fluence | n/p mix % |
| MCz | 5.00E+14 | 20/80 |
| MCz | 8.00E+14 | 12/88 |
| MCz | 1.00E+15 | 10/90 |
| MCz | 2.00E+15 | 0/100 |
| MCz | 3.00E+15 | 0/100 |
| MCz | 3.00E+15 | 0/100 |
| MCz | non-irradiated | |
| MCz | non-irradiated | |
| Fz | 1.00E+14 | 100/0 |
| Fz | 1.00E+14 | 0/100 |
| Fz | 5.00E+14 | 20/80 |
| Fz | 5.00E+14 | 0/100 |

- Detector processing was done at the clean room of Helsinki University of Technology (TKK) Micro and Nanofabrication Centre (MINFAB)
- Materials: n-type Magnetic Czochralski (Okmetic) and Float Zone (Topsil; RD50 common order) silicon wafers
- 300 μ m thickness
- 768 channels, 50 μ m pitch
- Suitable for CMS 6-APV hybrid
- size 4.3 x 4.1 cm²
- MCz $V_{fd} \sim 350V$, FZ $V_{fd} < 10V$



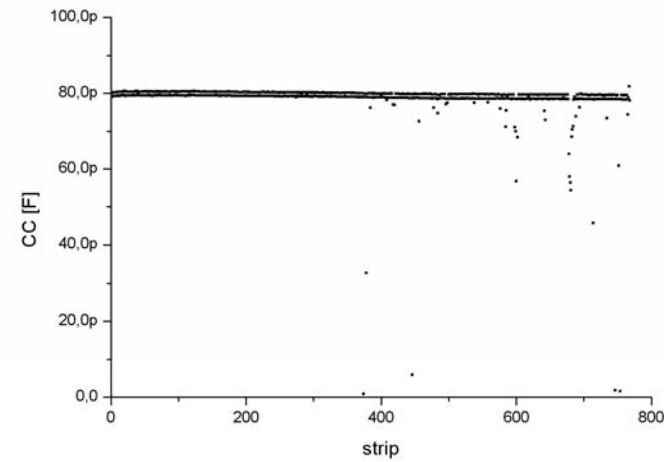
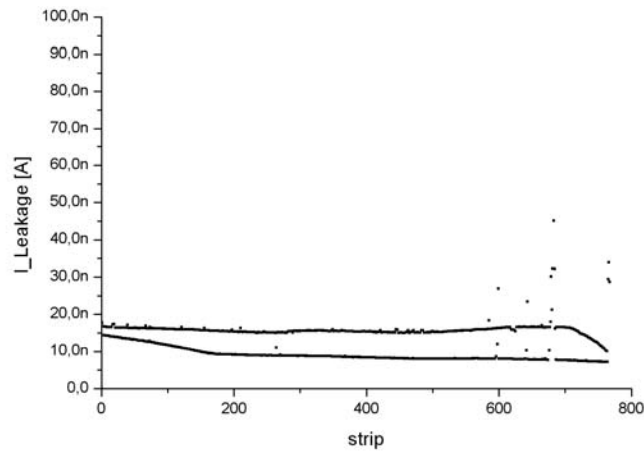
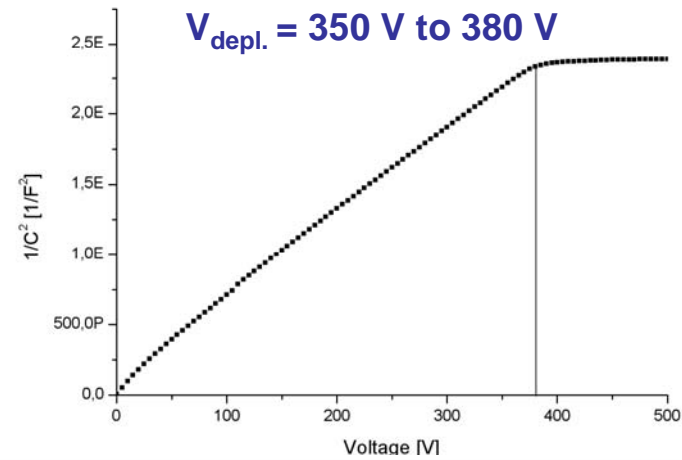
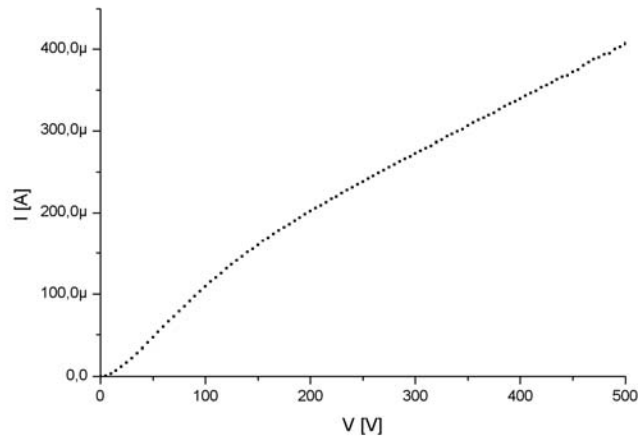
On one wafer:

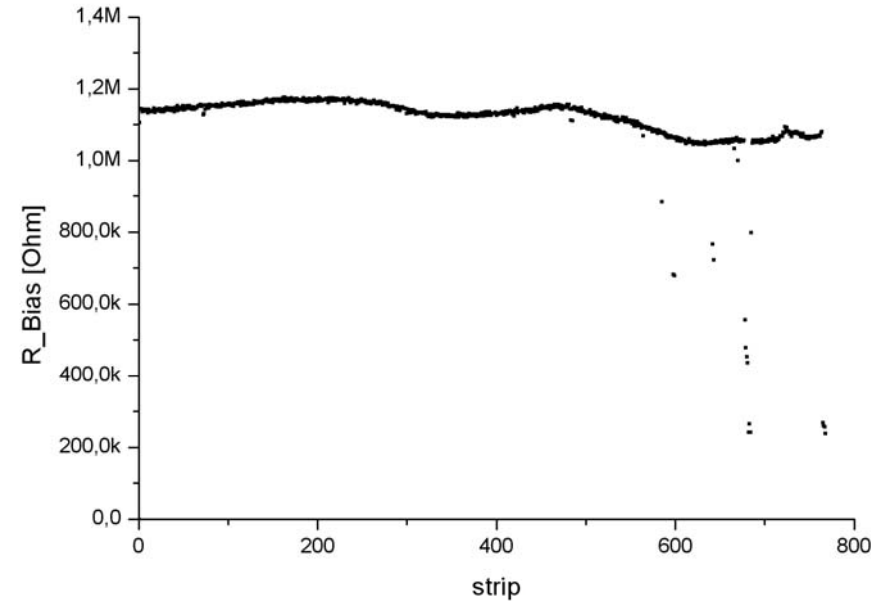
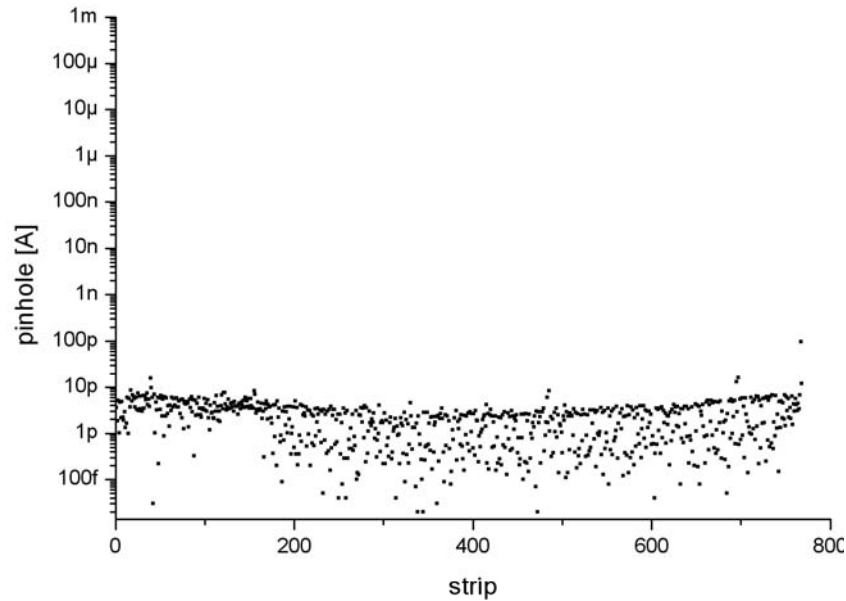
- 2 sensors
- 12 mini strip sensors 0.9x1.2 cm²
with 128 channels
- 24 diodes 0.25 x 0.25 cm²

Pitch adapters also processed in MINFAB
glass material with Cr-Al metallization



The sensors show a very good quality and all sensor parameters are well conform with the specifications.



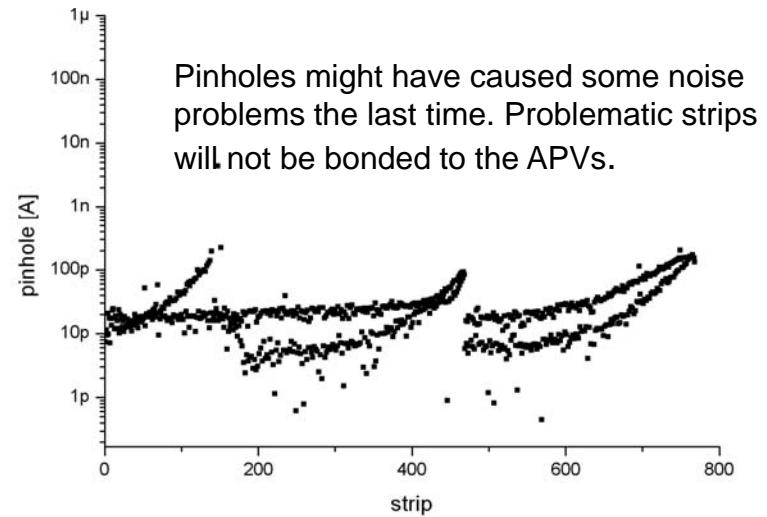
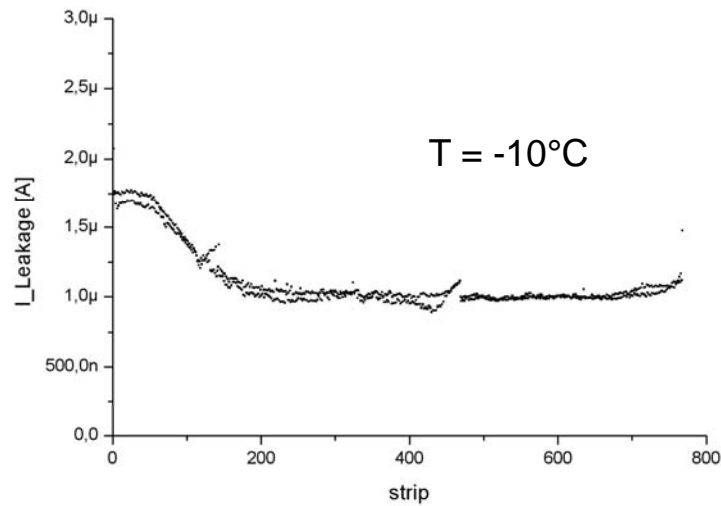
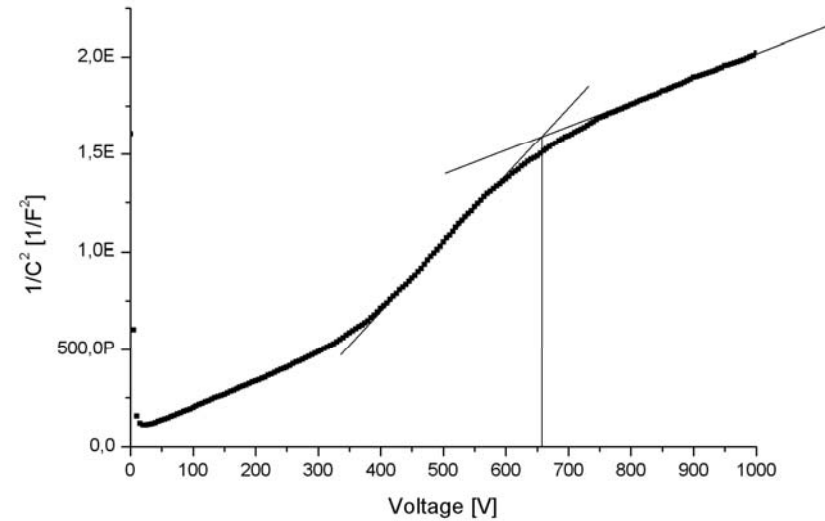
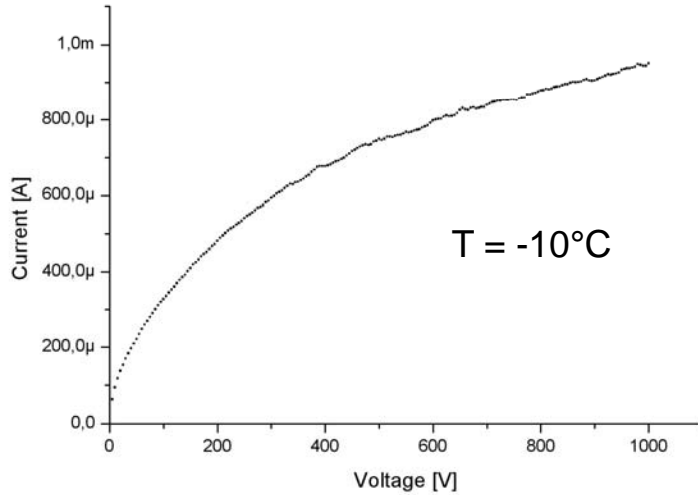


Sensors of the 2007 beamtest showed higher leakage currents and some problems with the coupling capacitance probably due to problems with the oxide. Nevertheless the test was successful and the results were promising.

→ No sensor problems this time. Good test results expected.

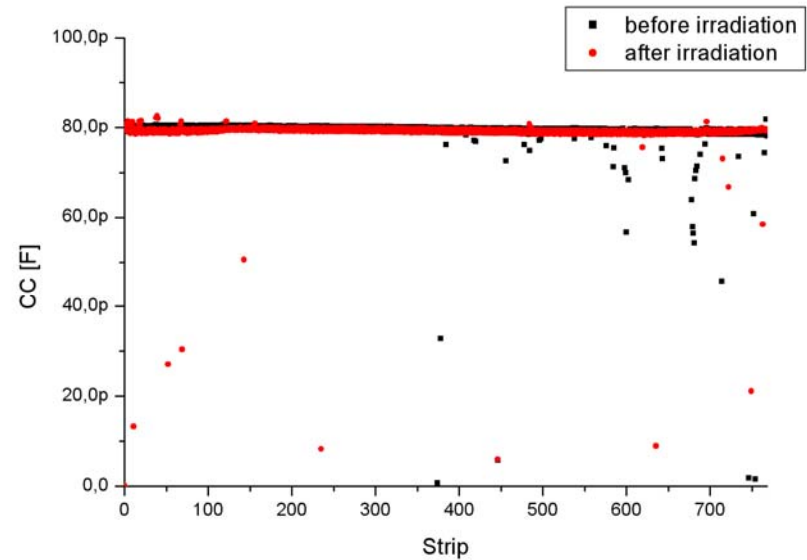
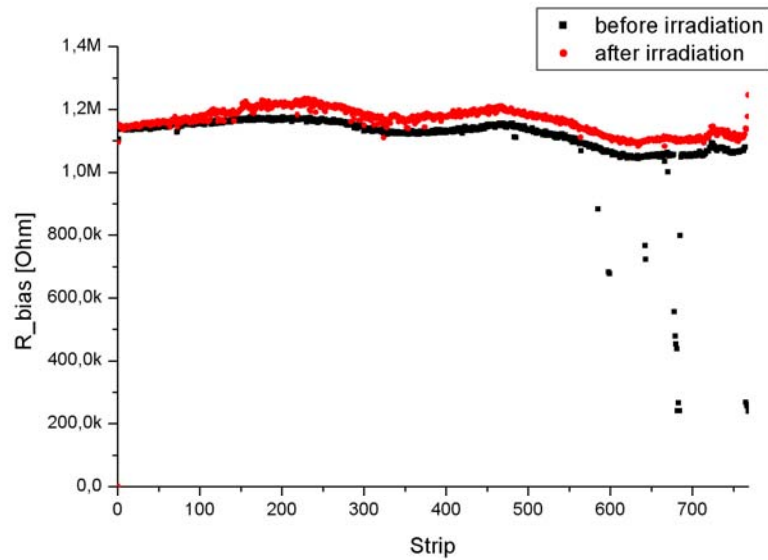


Fluence: $7.6 \cdot 10^{14}$ neq. protons / cm^2
Irradiation with neutrons followed



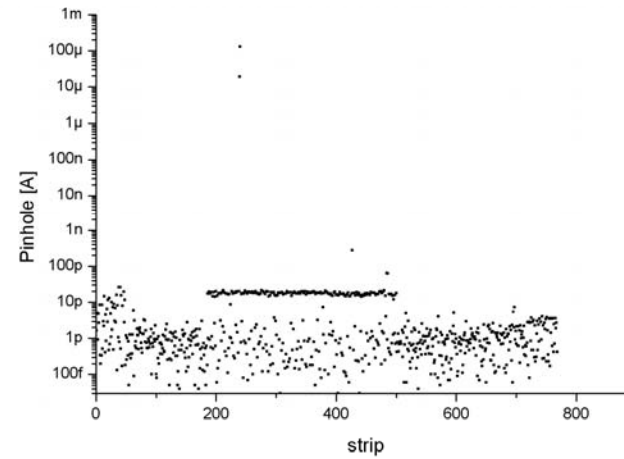
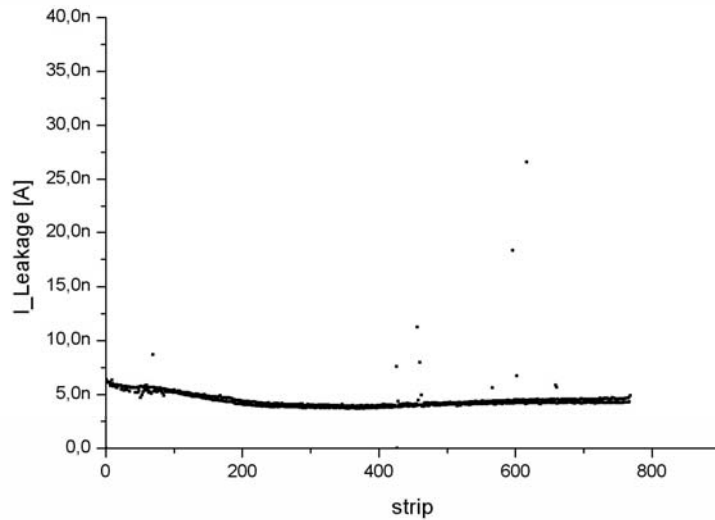
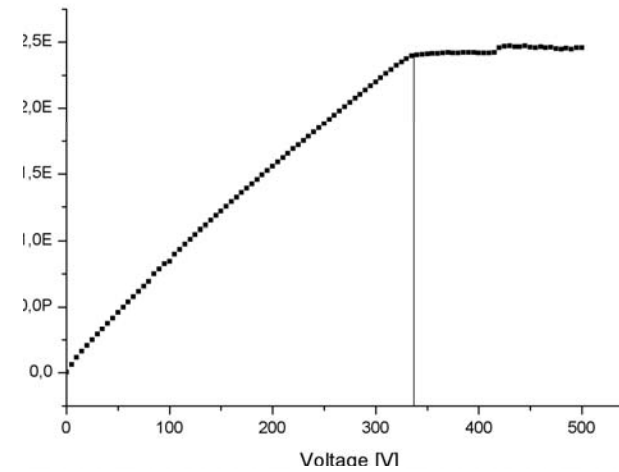
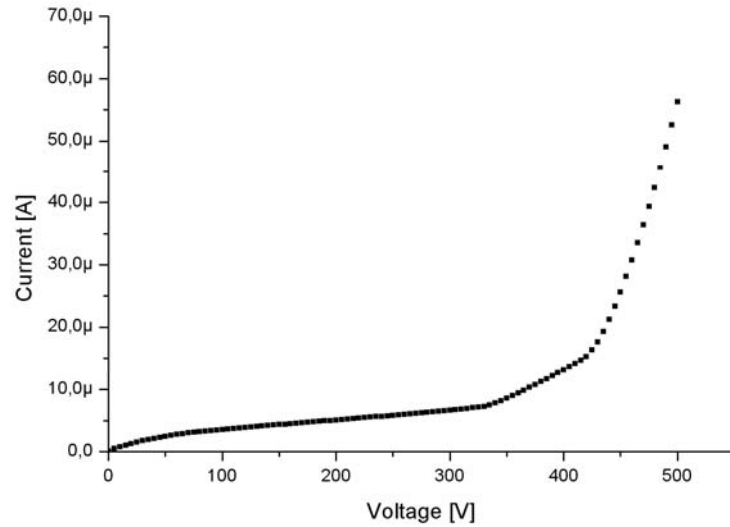


No changes in coupling capacitances and bias resistors.



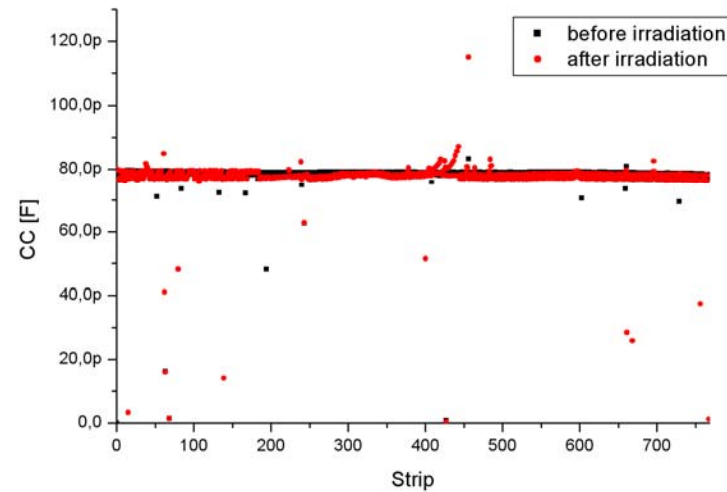
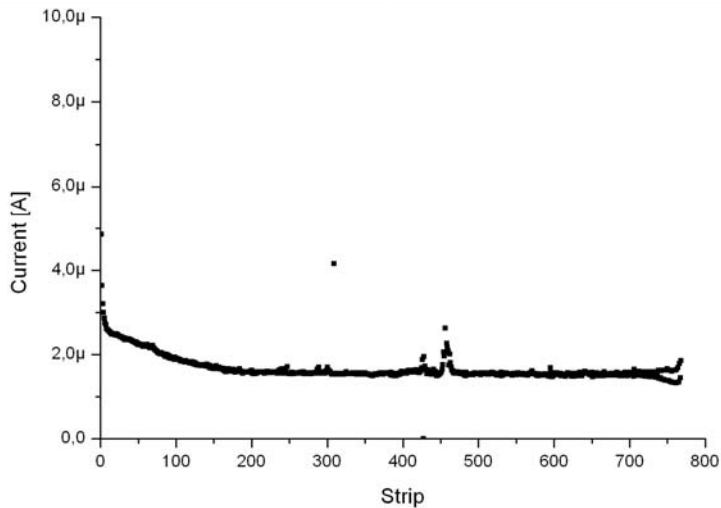
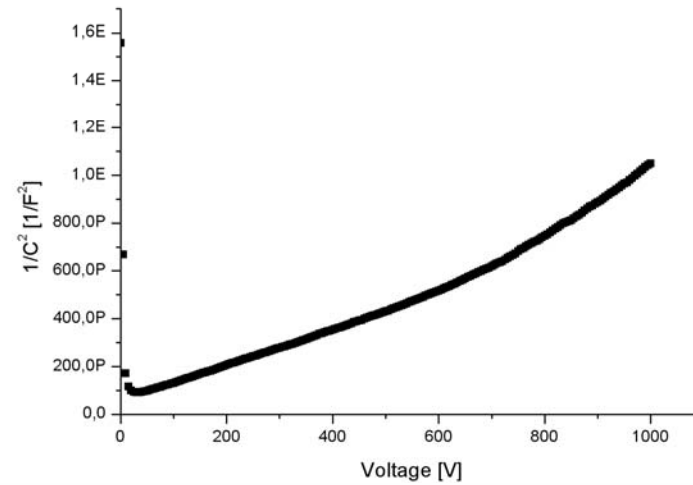
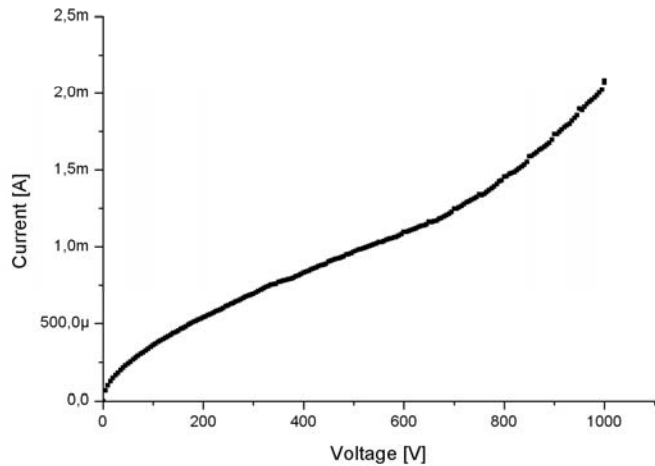


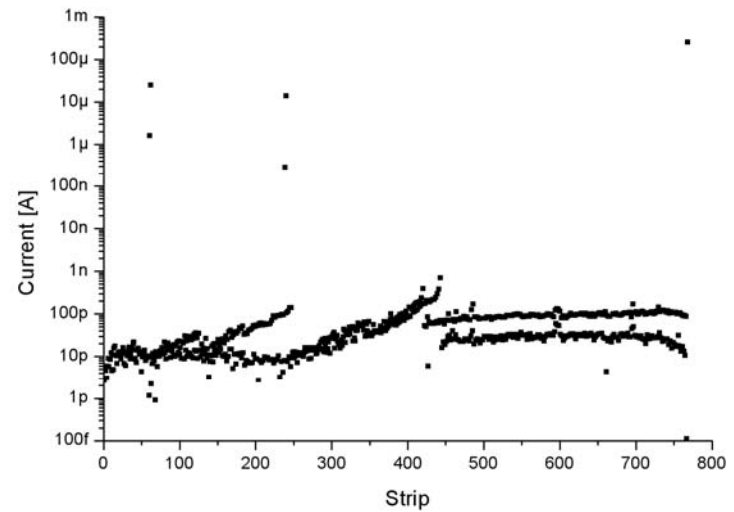
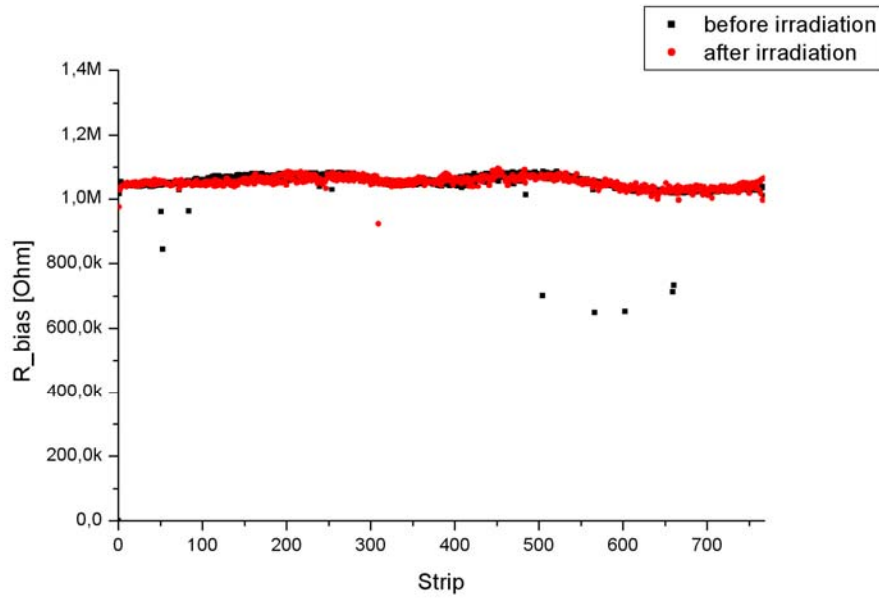
Sensor MCz0804A before Irradiation





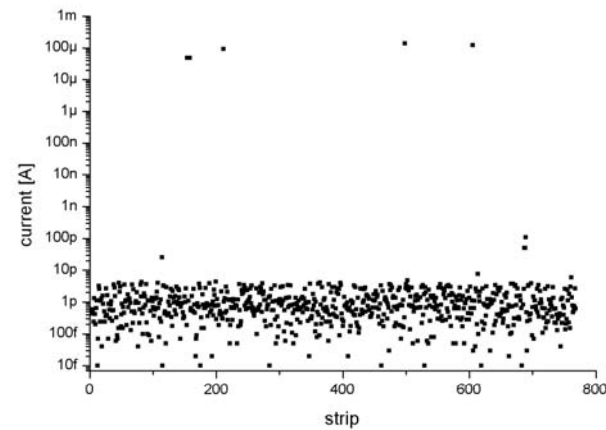
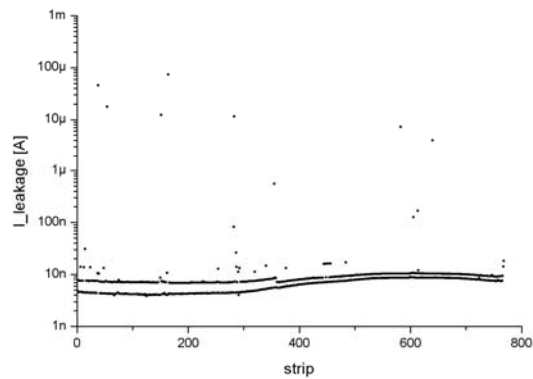
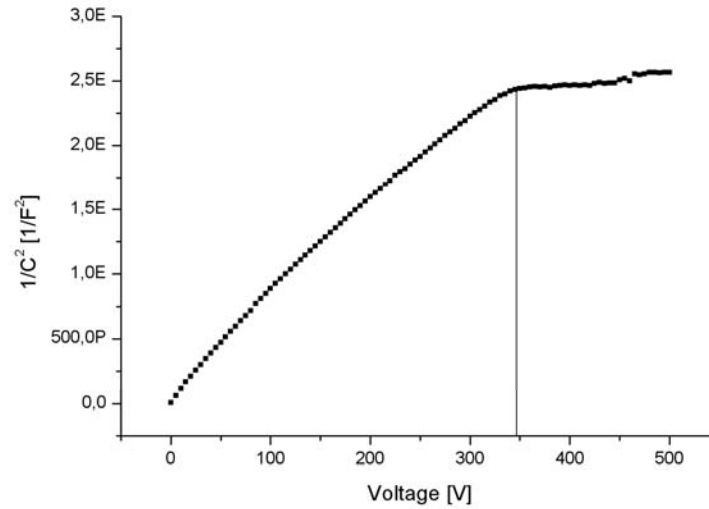
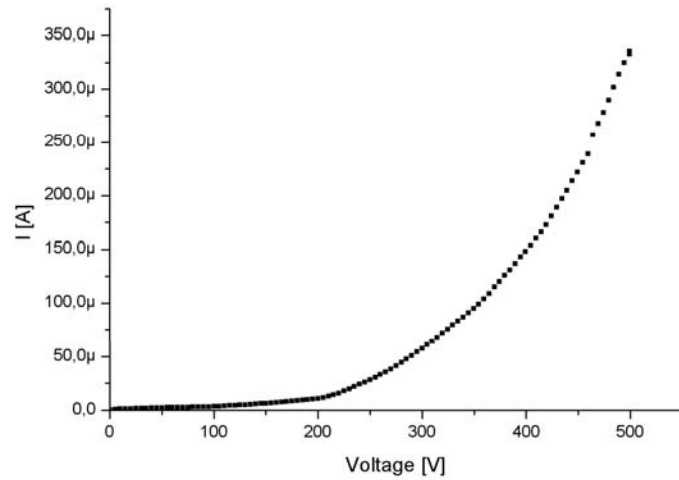
Fluence: $1.35 \cdot 10^{15}$ neq. protons / cm^2
Irradiation with neutrons followed





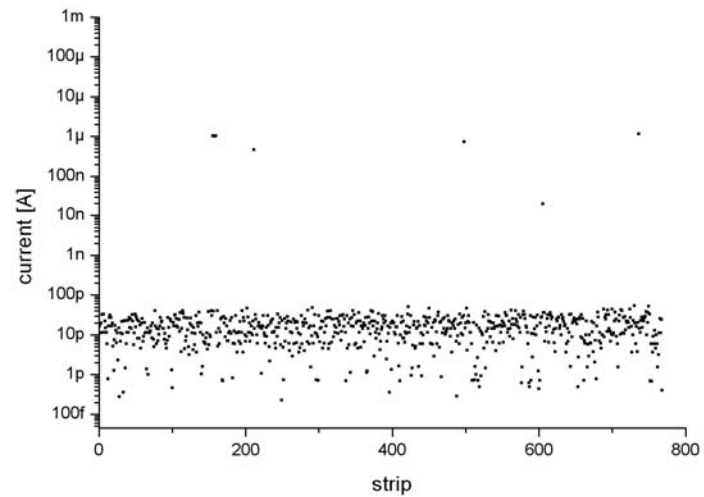
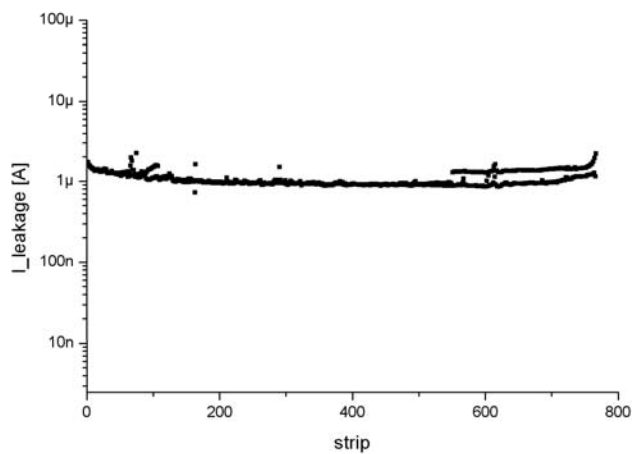
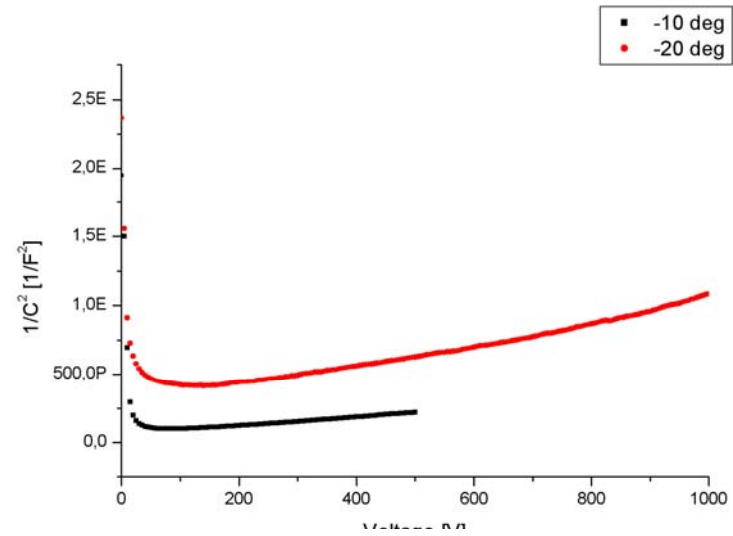
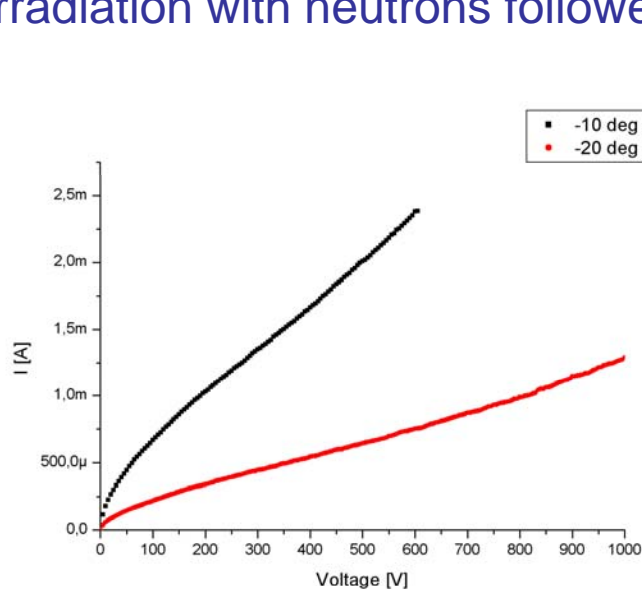


Sensor MCz0804B before Irradiation



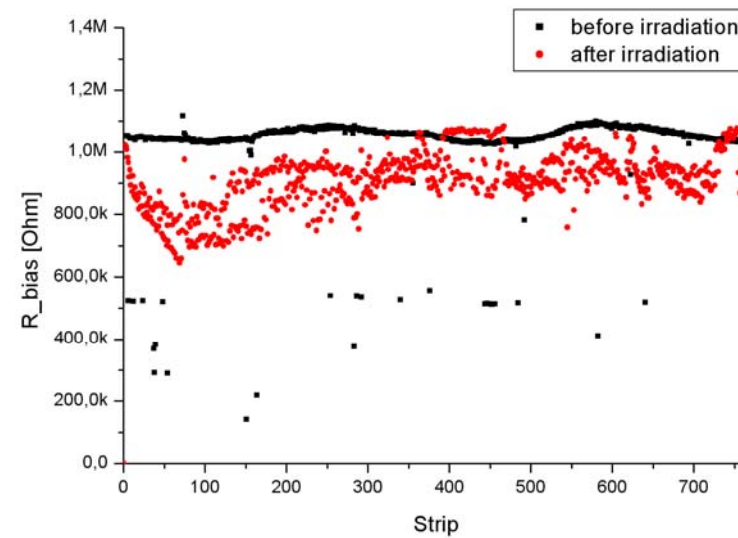
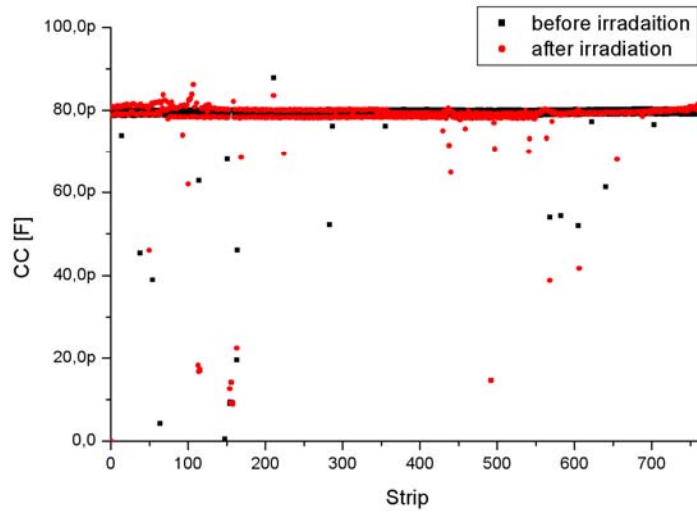


Fluence: $2.2 \cdot 10^{15}$ neq. protons / cm^2
Irradiation with neutrons followed





Sensor MCz0804B after Irradiation





Conclusion

- Sensors for the new testbeam are of a very good quality
- No problems with CC or ILeak like last year
- Proton irradiation was done, neutron irradiation has just been finished
- Qualification after proton irradiation showed good sensor properties
- Qualification after neutron irradiation will follow, no problems expected
- Module building will start soon, preparations have been done

→ Fundament for good testbeam results is there