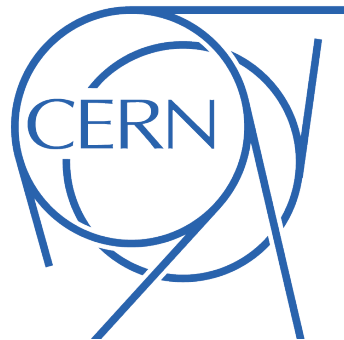


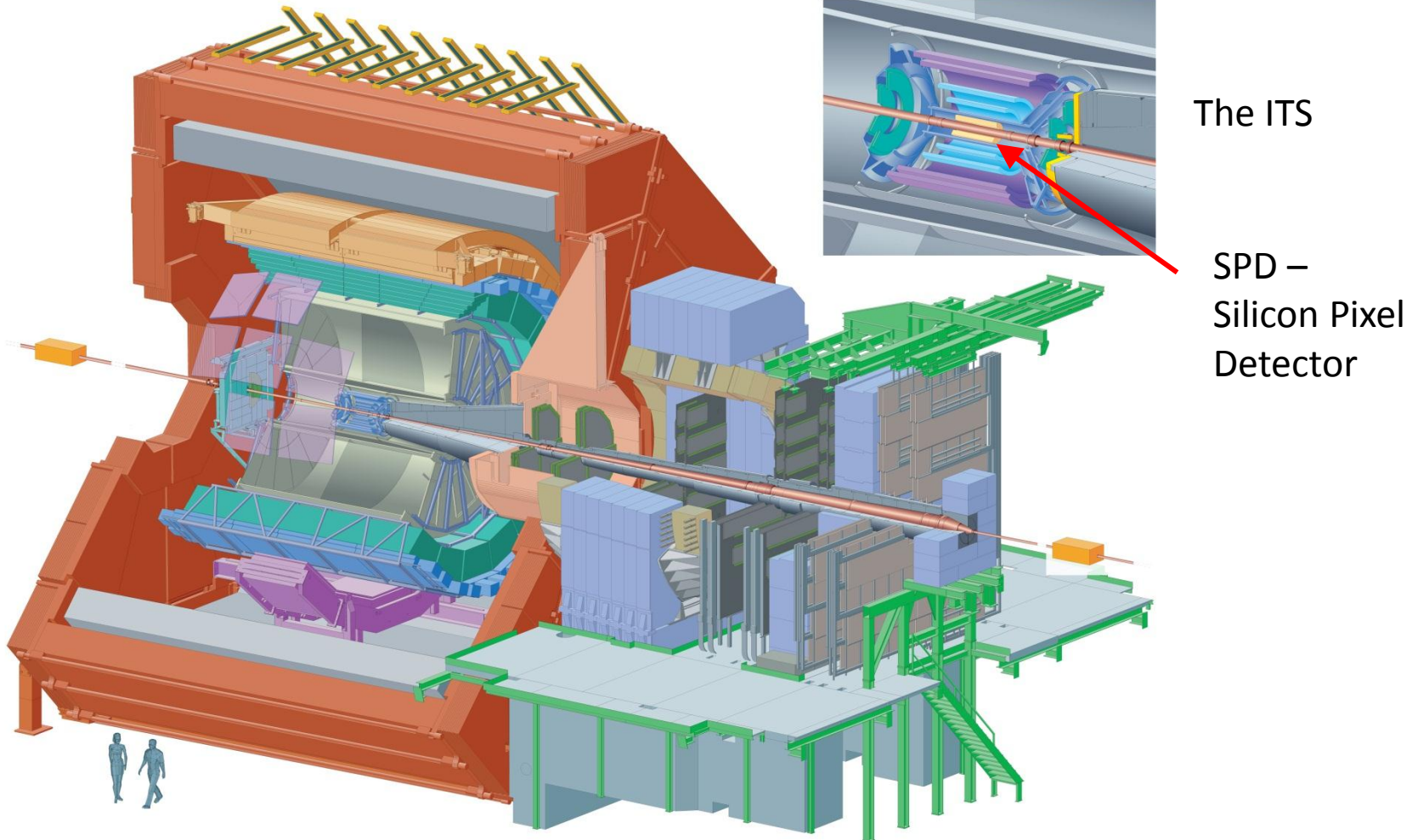
TPAC – One path to the ALICE ITS upgrade

Carl-Johan Haster – Summer student 2011



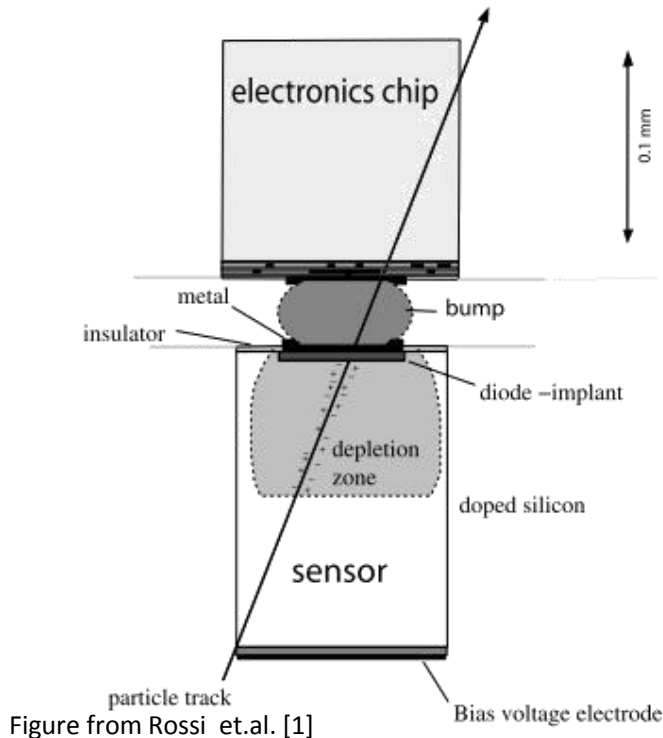
ALICE and its Inner Tracking System

Optimised for heavy ion collisions to study strongly interacting matter at the at high energy densities at LHC.



Hybrid vs. monolithic pixel sensors

Hybrid pixel



Currently two layers of SPD
($r=3.9$ cm and 7.6 cm)

Monolithic pixel

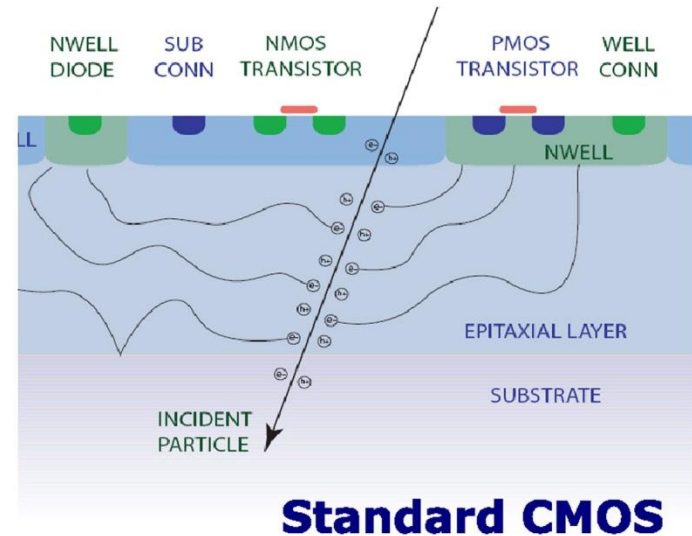


Figure from Stanitzki [2]

Upgrade has at least three layers of pixel detectors
– starting closer to the beampipe (first layer $\sim r=2.2$ cm)

Both technologies are being investigated for the upgrade

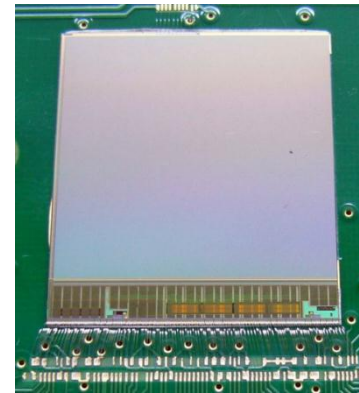
Different options of monolithic sensors

- INMAPS



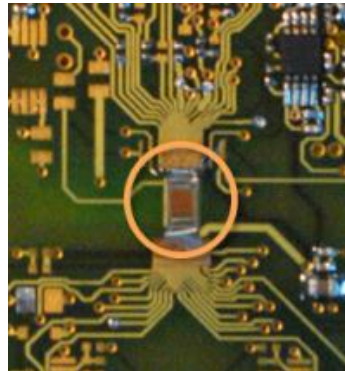
TPAC (SPIDER collaboration) [2]

- MISTRAL



ULTIMATE (STAR) [3]

- LePIX



Picture from FEE meeting in Bergamo [4]



SPiDeR

TPAC

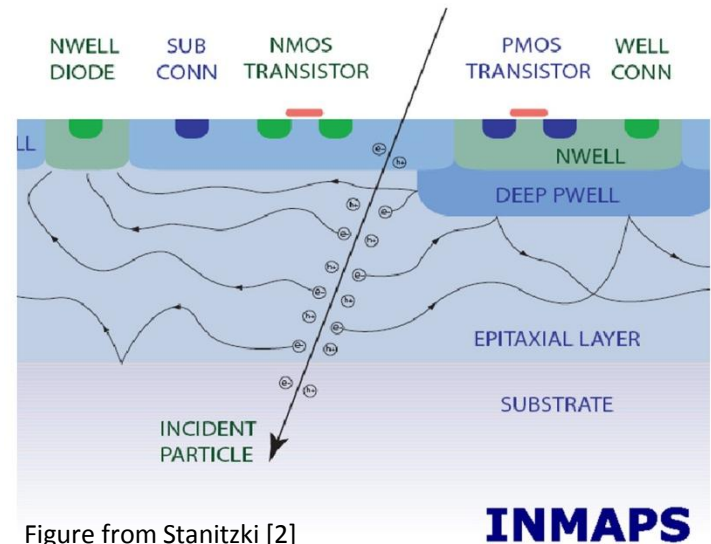


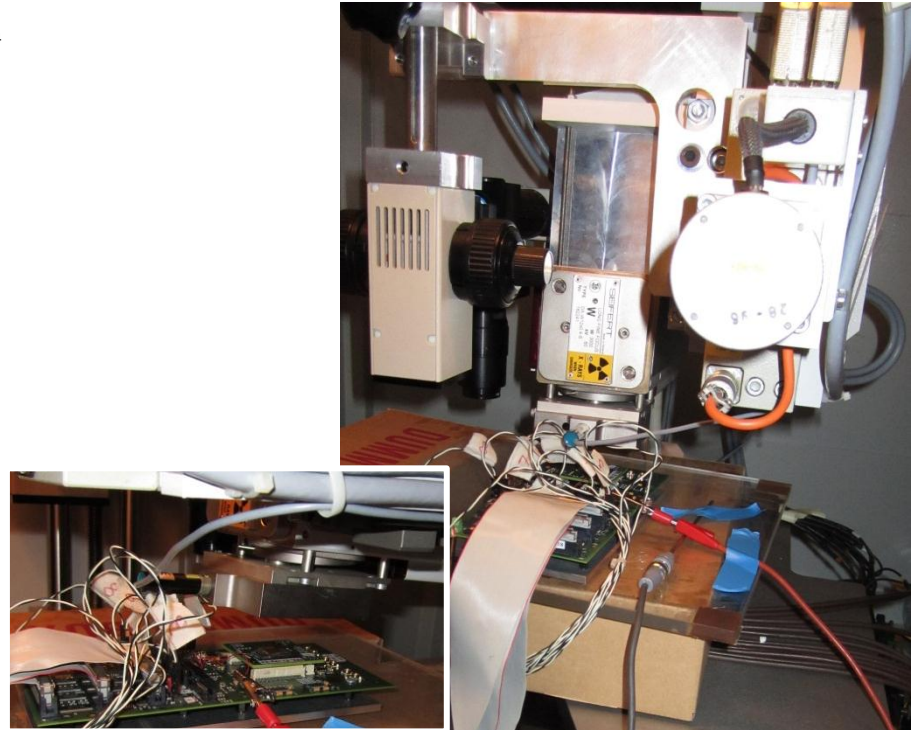
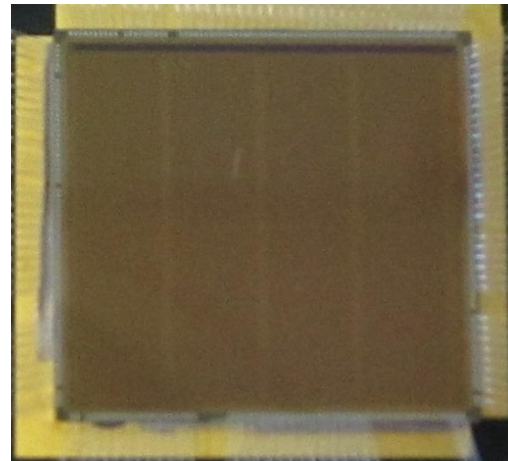
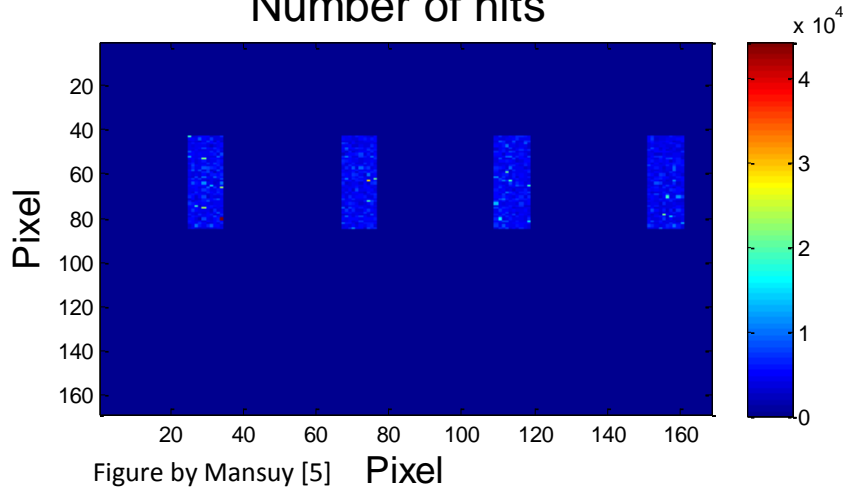
Figure from Stanitzki [2]

Deep p-well shields transistors
-> signal registered at diode

Is the INMAPS technology
suited as a starting point for the
new ITS?

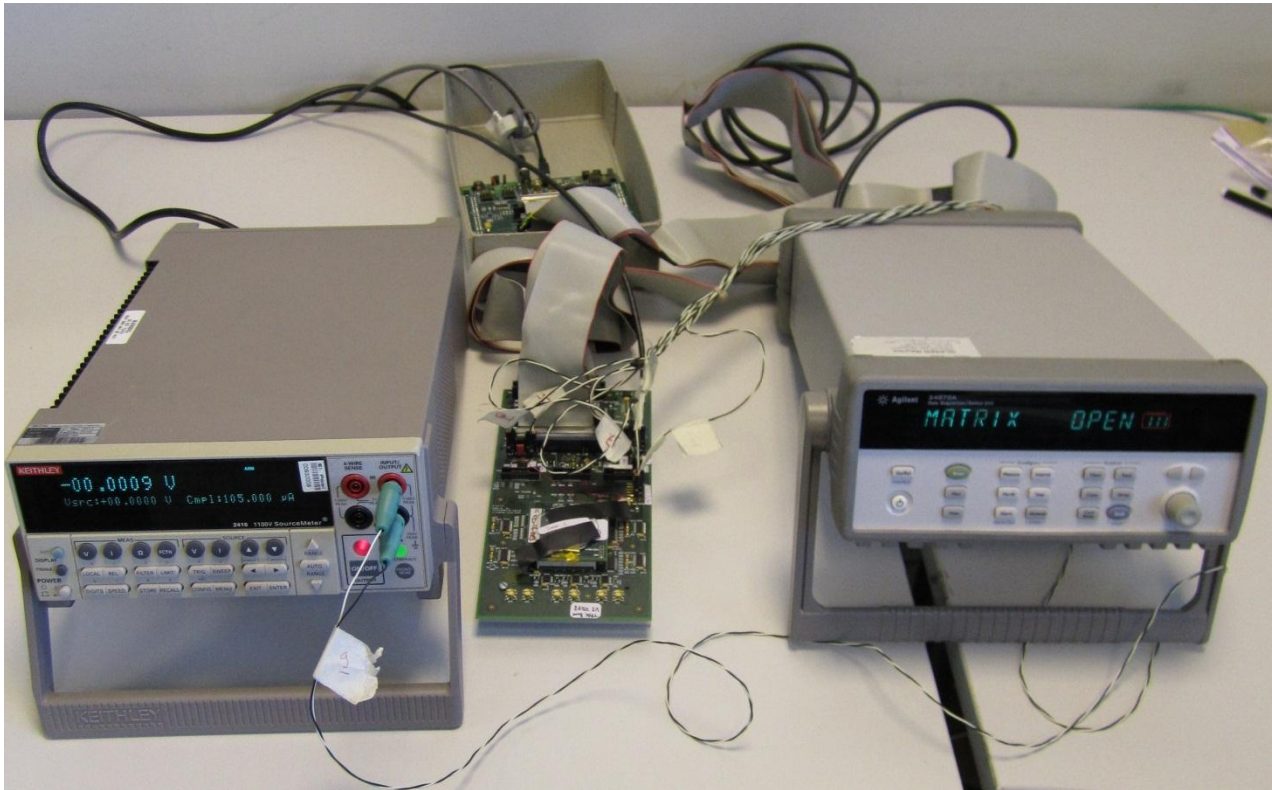
Irradiation tests

Number of hits



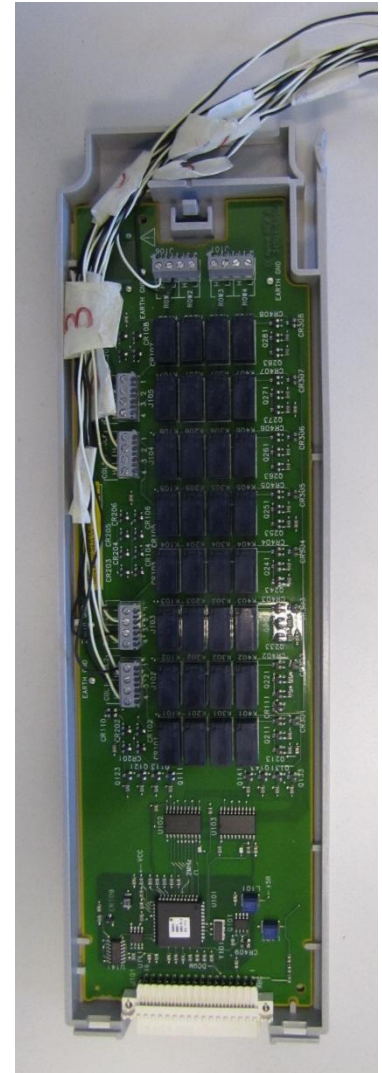
- Tungsten X-ray tube – 10 keV peak energy
- X-ray beam covering the whole sensor
- Dose rates between 3.3-33 krad/min
- Observe noise signals from the pixels
- Monitor 8 current values accessible on the readout card

Current monitoring - hardware



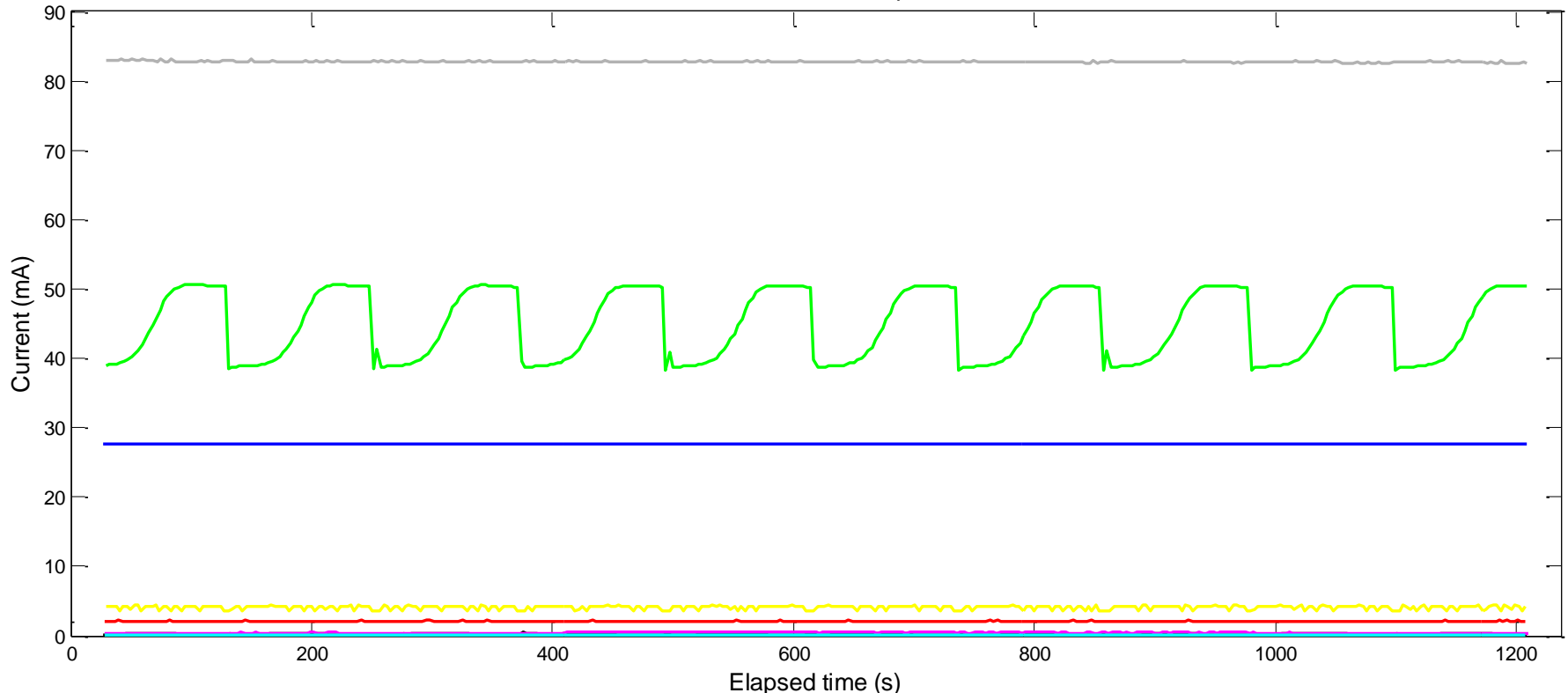
Voltmeter
Keithley 2410

Switch unit
Agilent 34970A with
Agilent 34904A (4x8 Matrix Switch)



Currents before irradiation

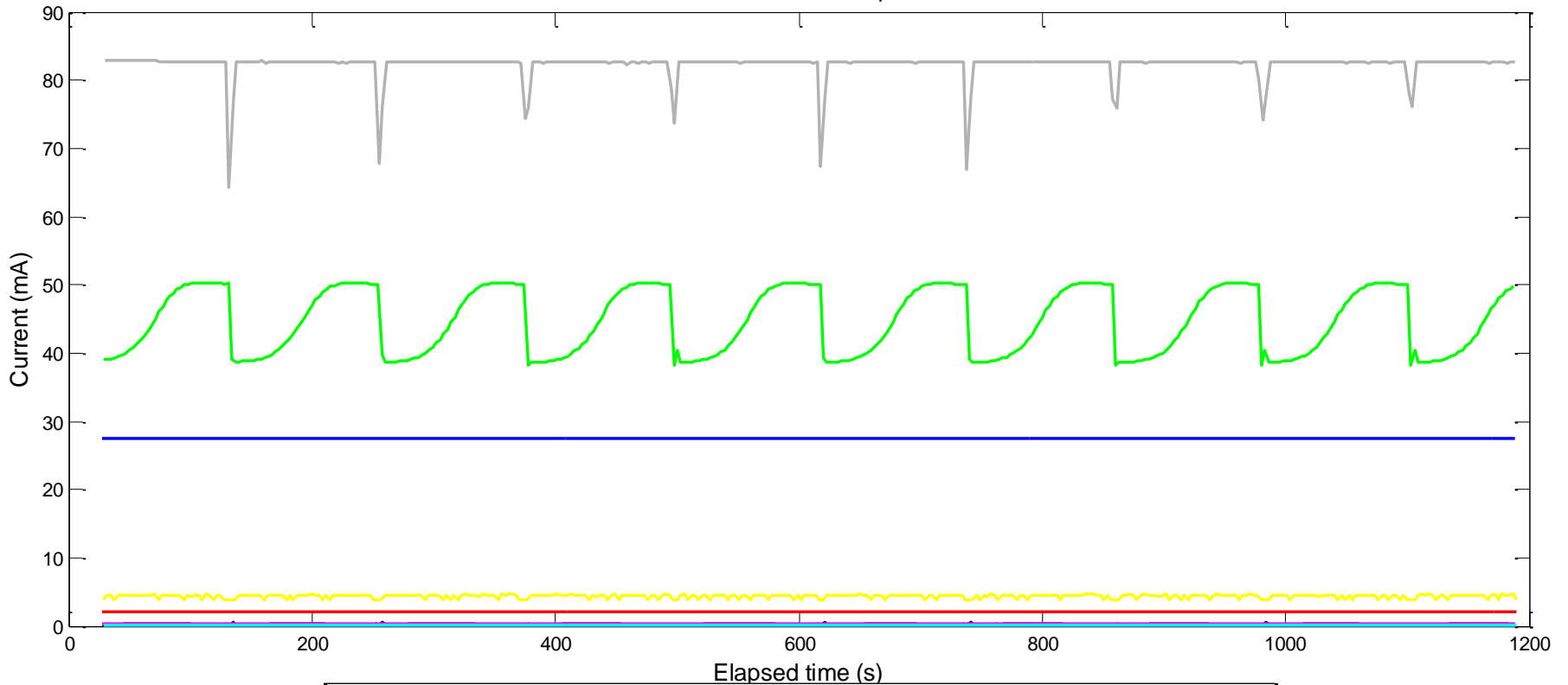
Standard resistivity 12 μm Epi layer with deep p-well (Sensor 6) - Currents before irradiation - Truncated data
 18/7/2011, 11:42 - Sensor temperature: 29.3 $^{\circ}\text{C}$



| | |
|------------------------|--|
| — VDD1V8mso, VSSmso: | Isolated 600 ns monostable power supply |
| — VDD1V8sram, VSSsram: | Isolated Powersupply for in-pixel config SRAMs |
| — VDD0, VSS0: | Digital I/O buffers |
| — VDD2V5dig: | SRAM write buffers: overdrive supply |
| — VDD1V8dig, VSSdig: | Digital logic: Row controllers, SRAM memories, |
| — VDD1V8dco, VSSdco: | Digital (second stage) comparator in the pixel and 200 ns monostable |
| — VDD1V8aco, VSSaco: | Analog (first stage) comparator in the pixel |
| — VDD1V8pix, VSSpix: | Analog pixel circuits: Front end preamplifiers and shapers |

Currents after 200 krad

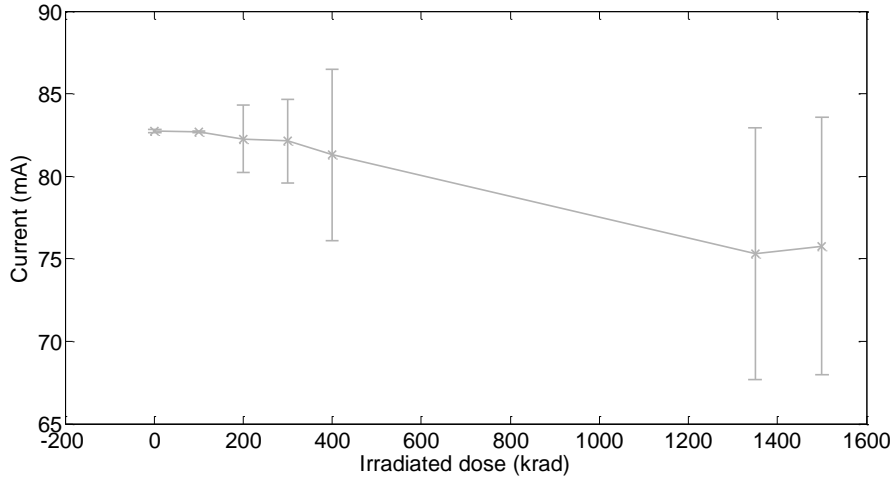
Standard resistivity 12 μm Epi layer with deep p-well (Sensor 6) - Currents after 200 krad irradiation - Truncated data
 18/7/2011, 15:26 - Sensor temperature: 28.0 $^{\circ}\text{C}$



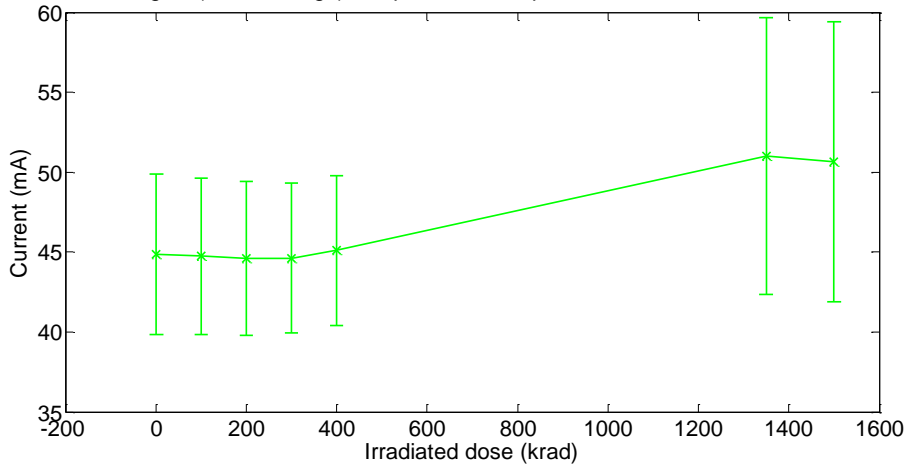
| | |
|------------------------|--|
| — VDD1V8mso, VSSmso: | Isolated 600 ns monostable power supply |
| — VDD1V8sram, VSSsram: | Isolated Powersupply for in-pixel config SRAMs |
| — VDD0, VSS0: | Digital I/O buffers |
| — VDD2V5dig: | SRAM write buffers: overdrive supply |
| — VDD1V8dig, VSSdig: | Digital logic: Row controllers, SRAM memories, |
| — VDD1V8dco, VSSdco: | Digital (second stage) comparator in the pixel and 200 ns monostable |
| — VDD1V8aco, VSSaco: | Analog (first stage) comparator in the pixel |
| — VDD1V8pix, VSSpix: | Analog pixel circuits: Front end preamplifiers and shapers |

Effect of irradiation on currents

Effect of irradiation on VDD1V8pix, VSSpix in sensor 6 - after irradiation
Analog pixel circuits: Front end preamplifiers and shapers



Effect of irradiation on VDD1V8dco, VSSdco in sensor 6 - after irradiation
Digital (second stage) comparator in the pixel and 200 ns monostable



- Small changes at low doses
- Increase in uncertainties due to spikes
- Effects on loading the sensor configuration observed at very high doses

Conclusions

- Calibrate the on-board power supply for the SRAM to study the calibration loading process
 - Need more granular dose steps
 - Experiment with varying dose rates
 - Investigate annealing behaviour
-
- Still early in the R&D phase

Picture references

1. Rossi, L., Fischer, P., Rohe, T. & Wermes, N. (2006). *Pixel Detectors: from Fundamentals to Applications*. Berlin: Springer.
2. Stanitzki, M. (2010). Nucl. Instr. and Meth. A doi:10.1016/j.nima.2010.11.166
3. L. Greiner et al., A MAPS based vertex detector for the STAR experiment at RHIC, Nuclear Instruments and Methods Section A, 2010, In Press, 10.1016/j.nima.2010.12.006
4. <http://indico.cern.ch/conferenceOtherViews.py?view=standard&confId=122027>
5. Mansuy, C. (2011). CERN – PH-AID-DT