Sezione di Torino

A Silicon Pixel Readout ASIC in CMOS 0.13 μm for the PANDA MVD

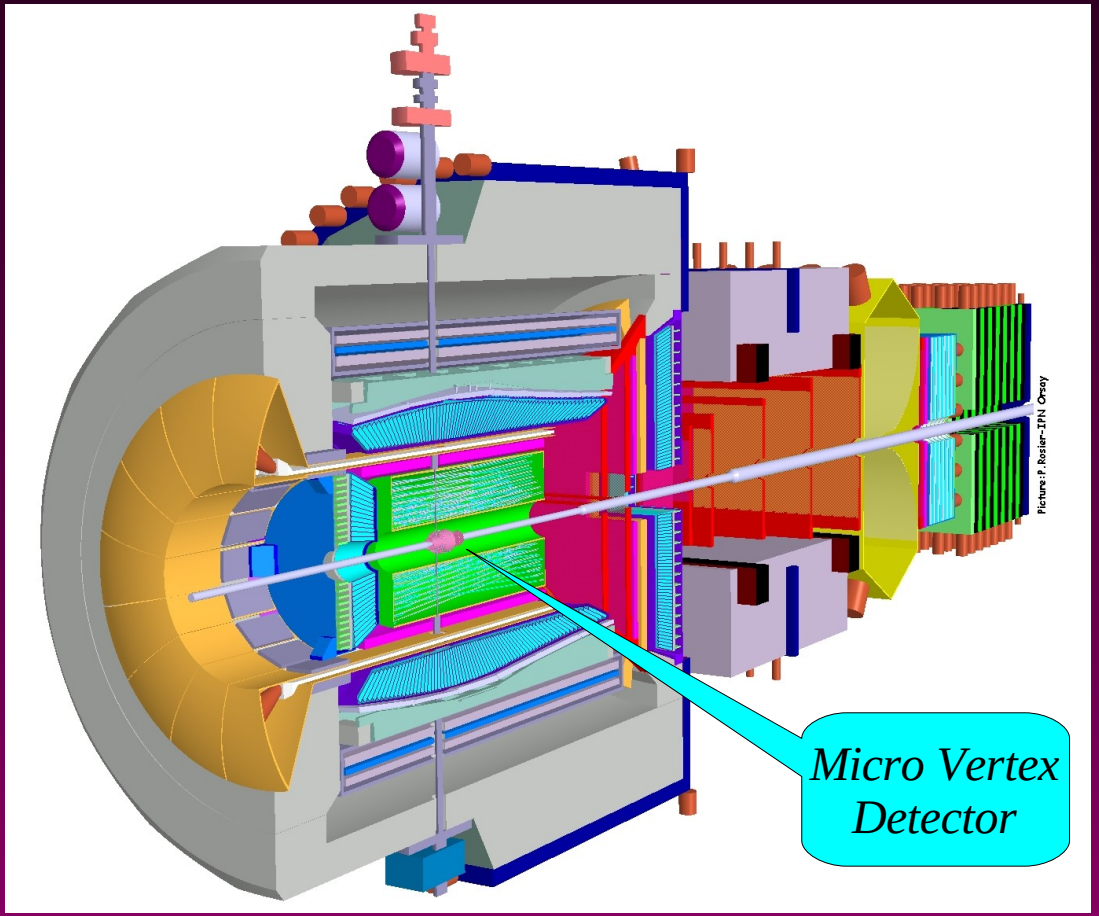
D. Calvo[1], T. Kugathasan[2], P. De Remigis[1], G.Mazza[1], M. Mignone[1], A. Rivetti[1], S. Salerno[1], T. Stockmanns[3] and R. Wheadon[1]

[1] *INFN sezione di Torino, Italy*
[2] *Università di Torino, Dip. di Fisica Sperimentale, Italy*
[3] *Forschungszentrum Jülich, Germany*

PANDA experiment

Sezione di Torino

- Located at the new FAIR facility in Darmstadt
- Fixed target detector at the High Energy Storage Ring for antiprotons at FAIR
- No trigger
- The silicon Micro Vertex Detector is the closest to the interaction point

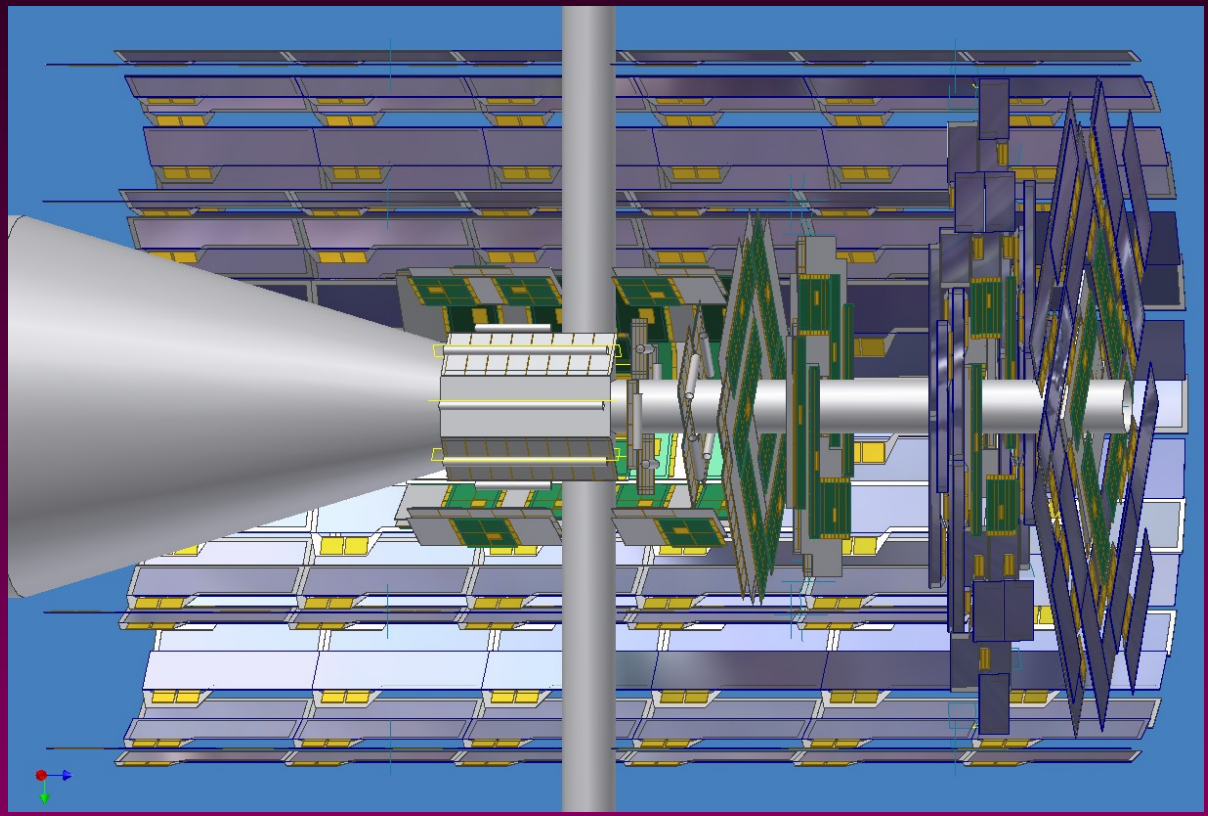


MVD

Sezione di Torino

General structure

- 4 barrels + 6 disk
- Inner layers (2) : SPD
- Outer layers (2) : SSD
- Forward : 2 SPD disks + 4 mixed disks
- SPD : 13 Mpixels, 0.15 m^2
- SSD : 70 kstrips, 0.5 m^2



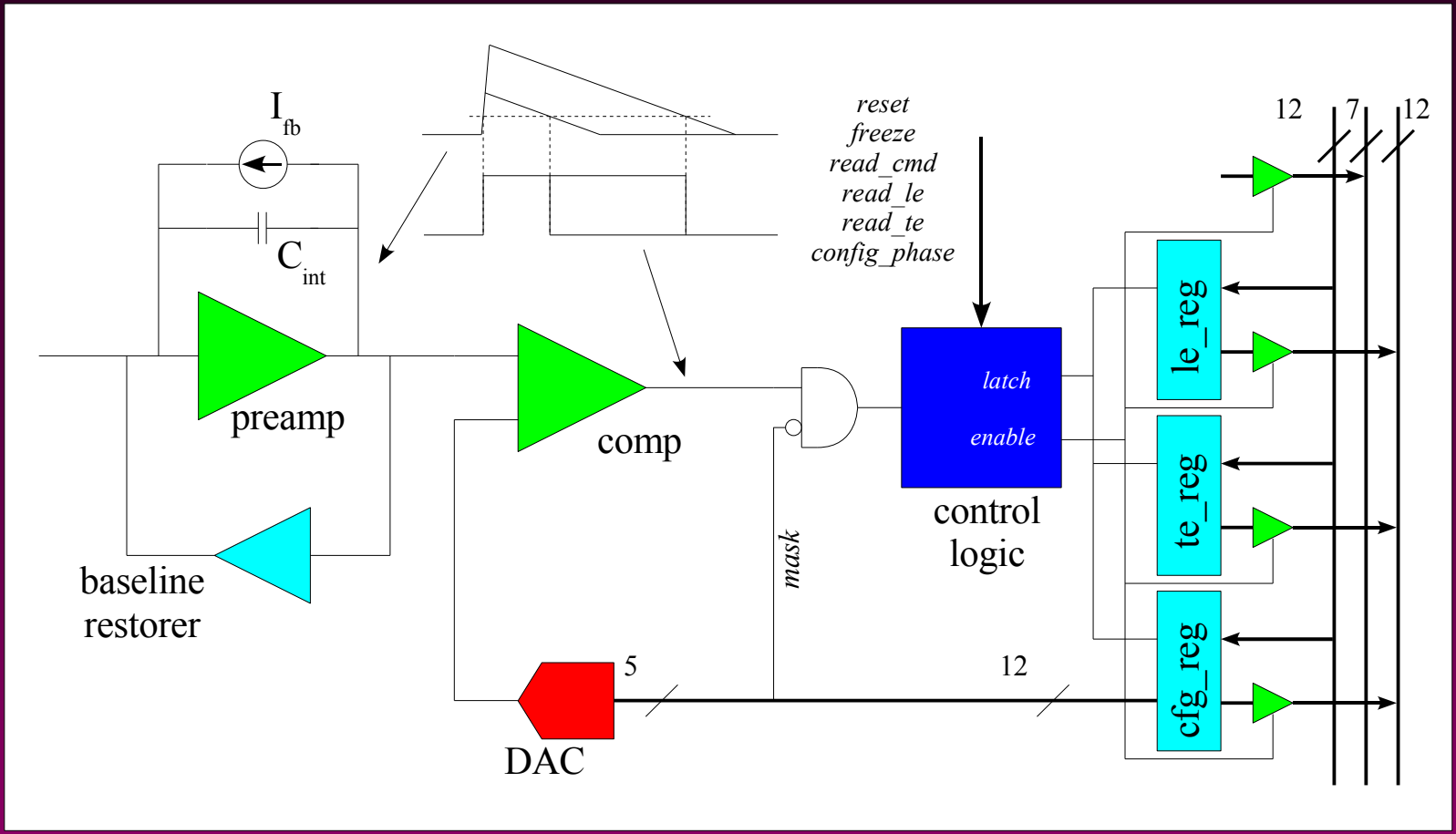
Specifications

Sezione di Torino

- Pixel size : 100x100 μm^2
- Input range : up to 100 fC
- Noise level : < 200 e^-
- Energy loss measurement via ToT *(7 bits)*
- Time measurement *(6 ns r.m.s.)*
- Self-triggering capability
- Maximum chip rate : 12.3 MHz
- Maximum data rate per chip (40 bits/hit) : ~500 MBit/s

Pixel schematic

Sezione di Torino



Pixel analog part

Sezione di Torino

- Gain : ~ 40 mV/fC
- Eight pixels with ~ 80 mV/fC
- Power consumption : 12 μW @ 1.2 V
- Simulated noise : ~ 200 e^-
- Selectable input polarity
- DAC controlled (5 bits, 100 mV range) comparator threshold

Pixel digital part

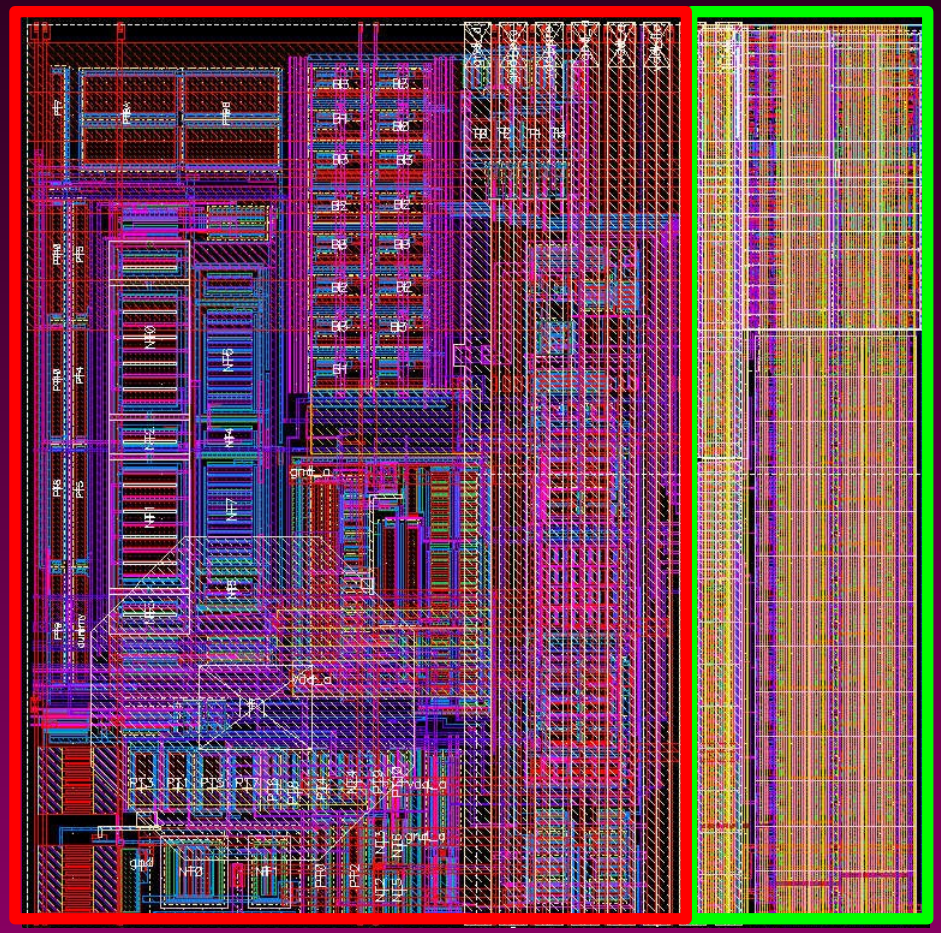
Sezione di Torino

- 12 bits leading edge, trailing edge and configuration registers
- SEU-hardened memory cells
- CMOS-level differential signals (except busy)
- 12 bits input bus for time stamp
- 12+7 bits output bus for data/address

Pixel cell

Sezione di Torino

Analogue

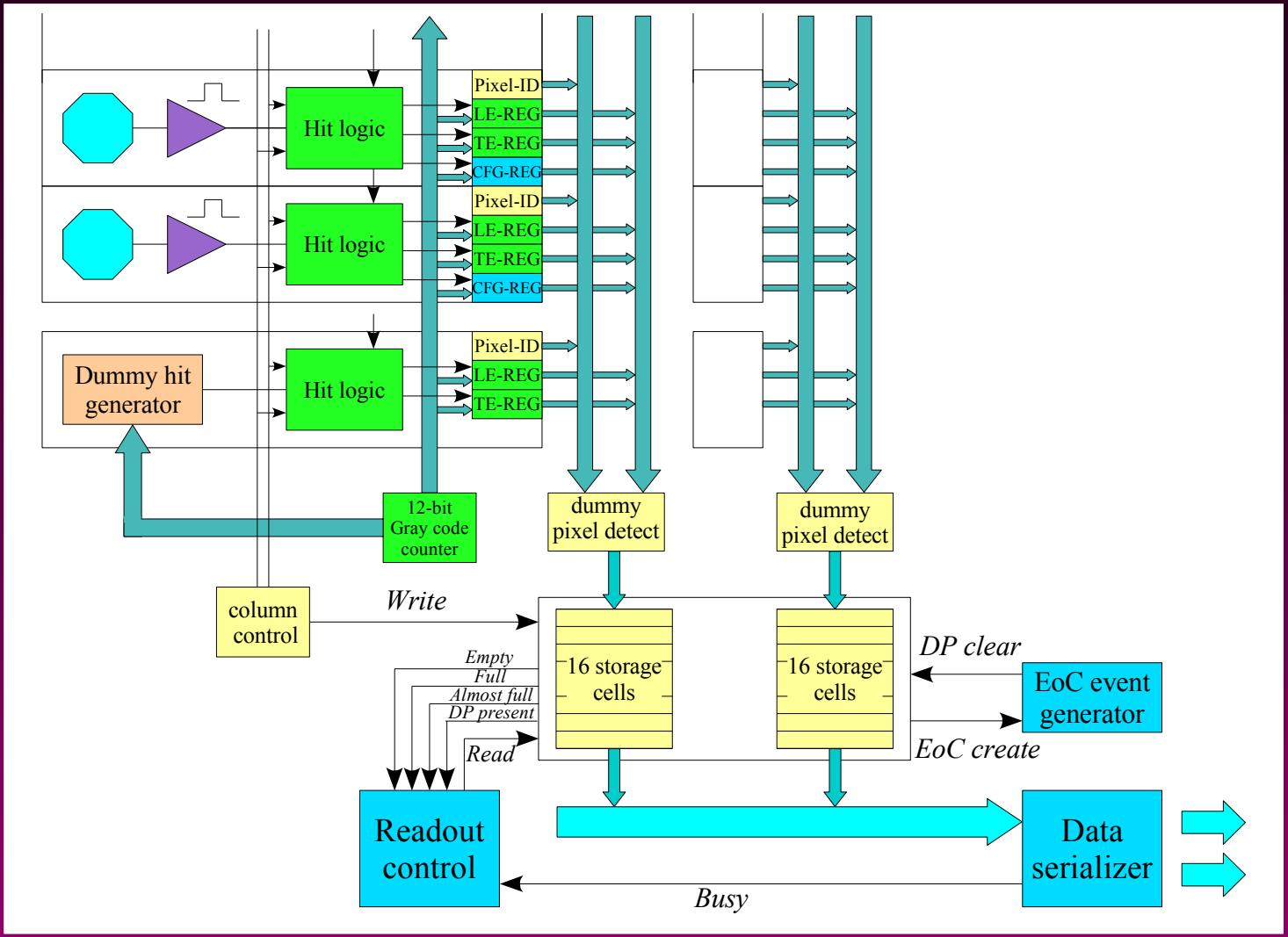


Digital

100 µm x100 µm
pixel cell

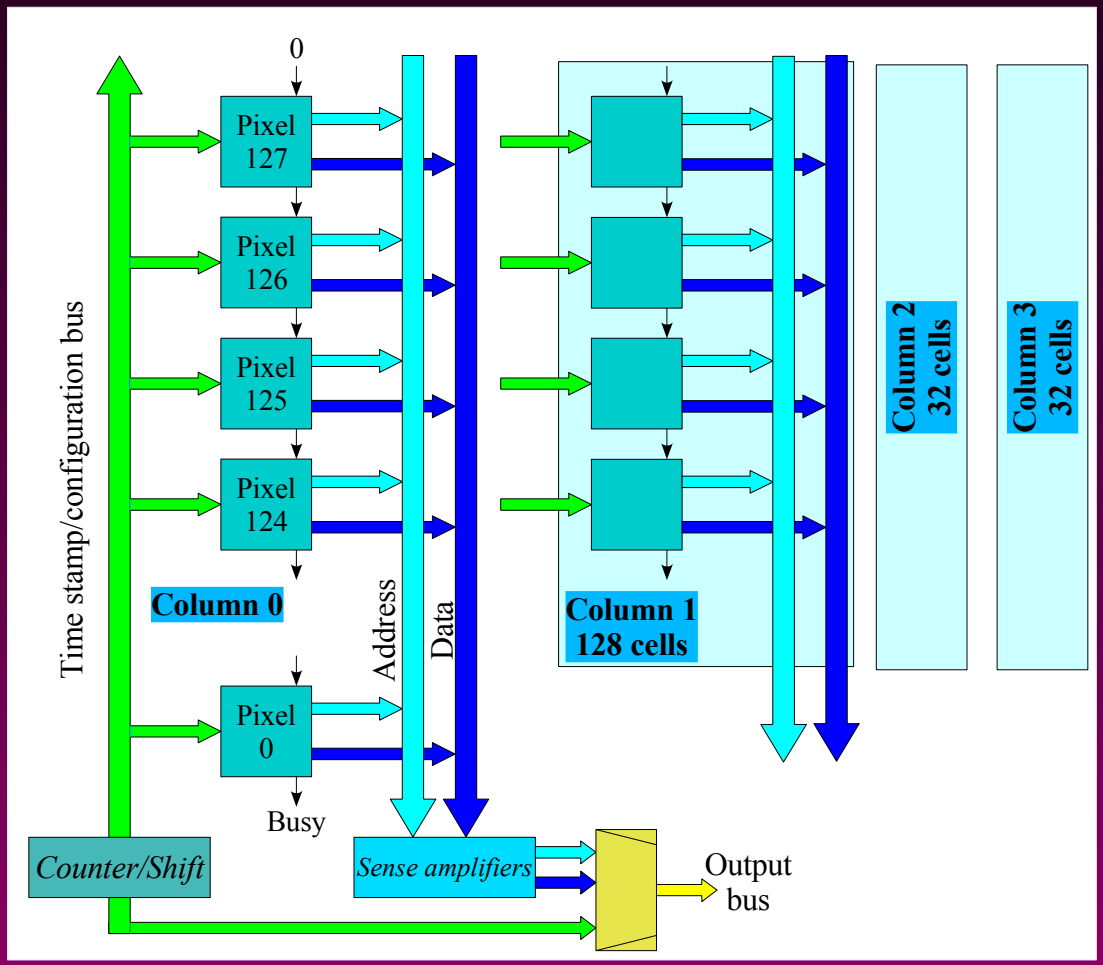
ASIC readout

Sezione di Torino



Prototype architecture

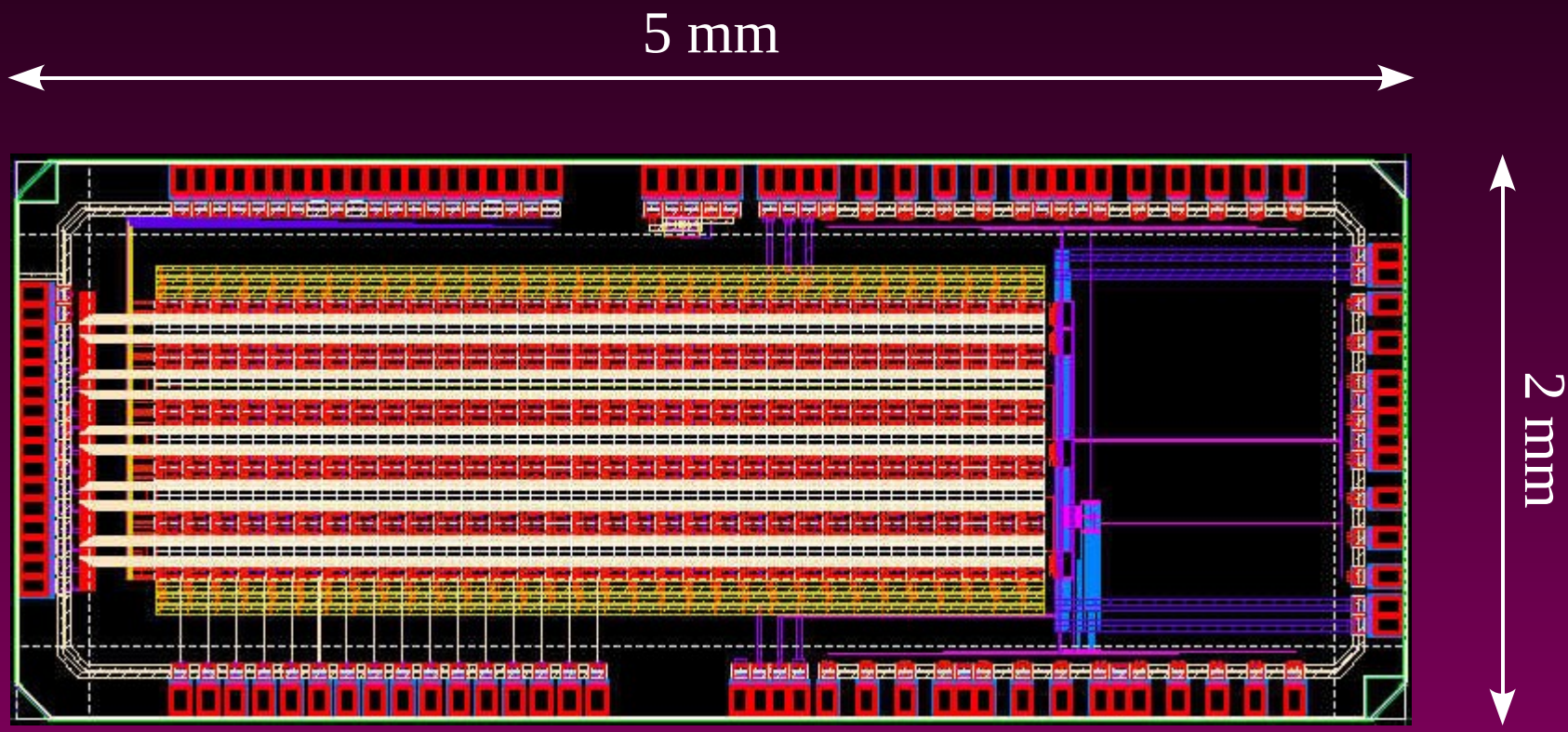
Sezione di Torino



- Two 128 cells columns
- Two 32 cells columns
- Full analogue cell
- Full column and sense amplfier
- Simplified readout logic
- CMOS 0.13 µm

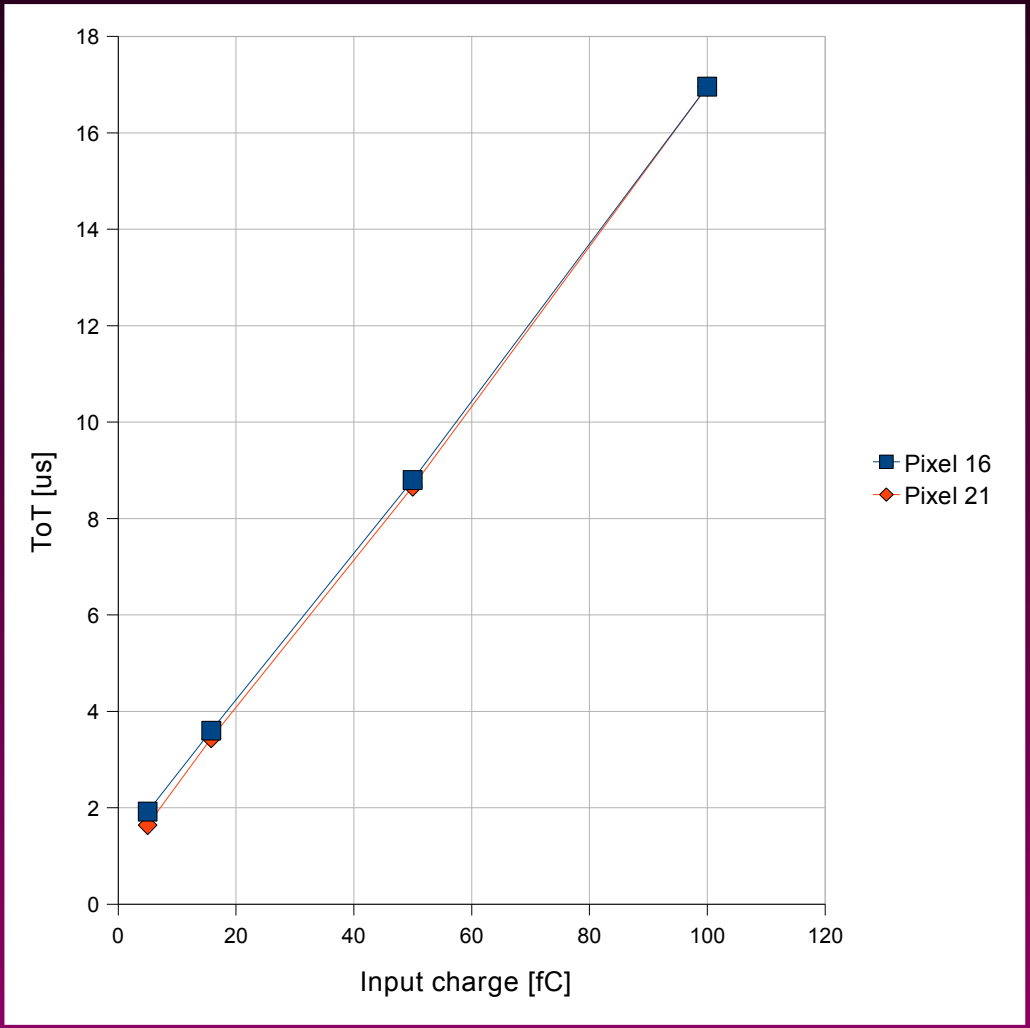
Prototype layout

Sezione di Torino

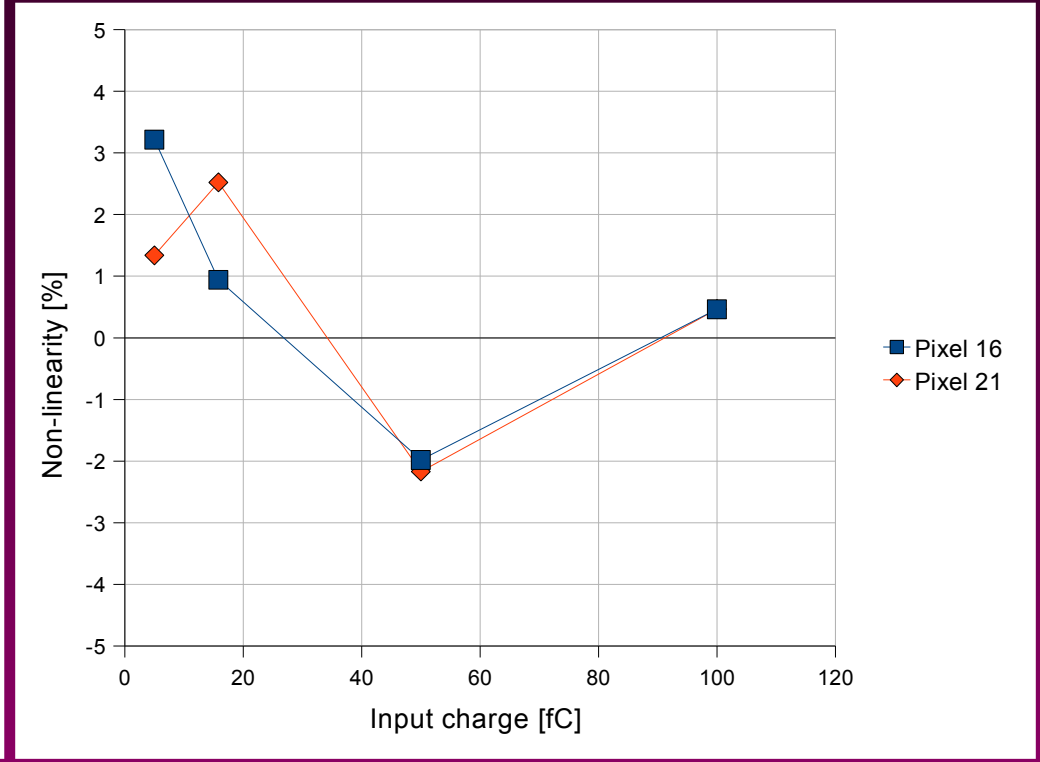


Tests - 1

Sezione di Torino

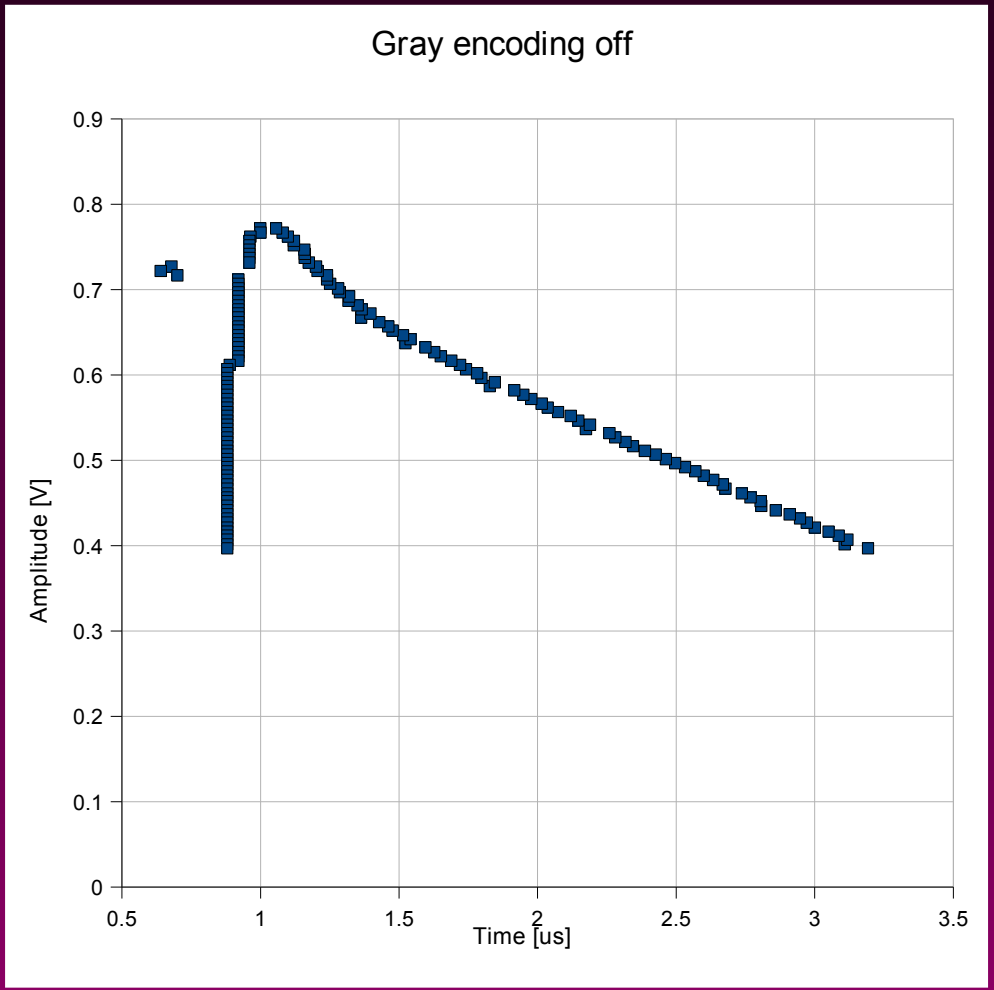


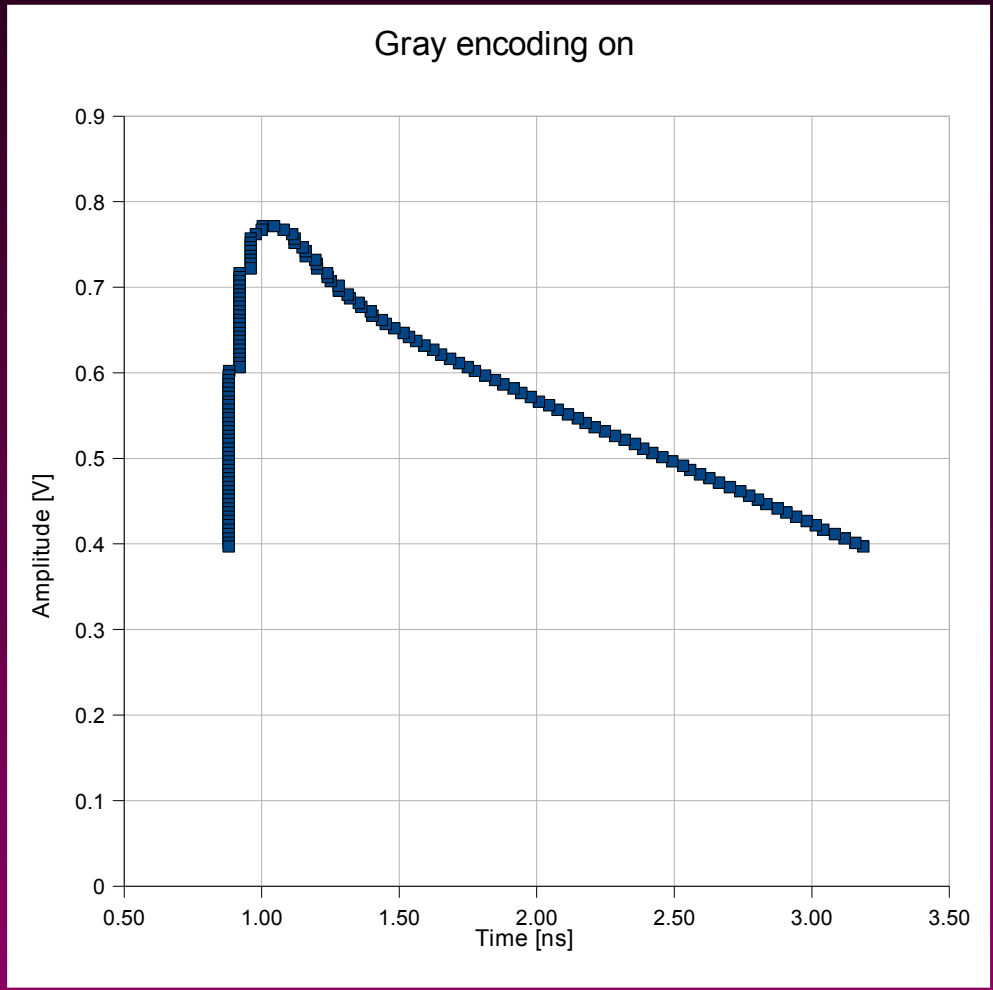
Average gain = 152 ns/fC
σ = 6 ns/fC



Tests – 2

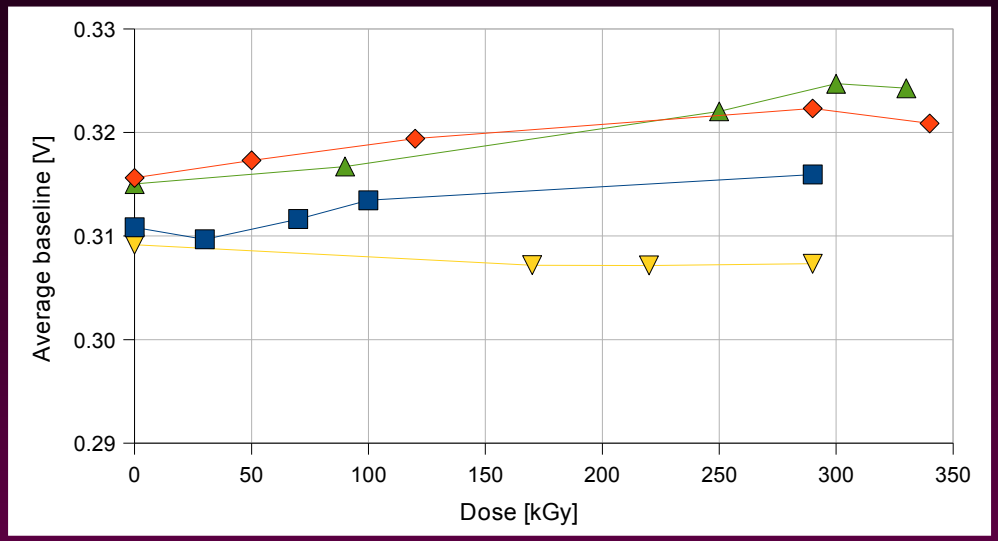
Sezione di Torino

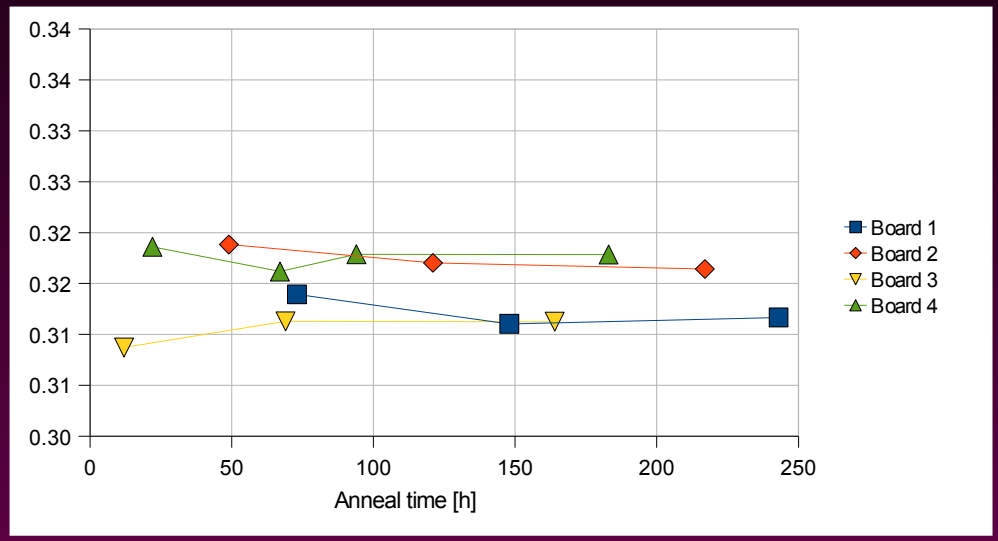


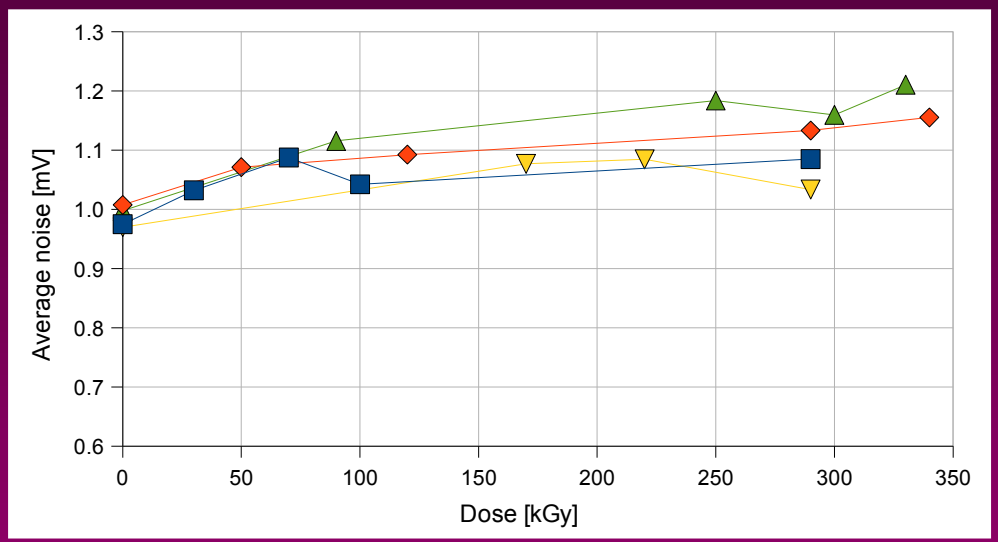


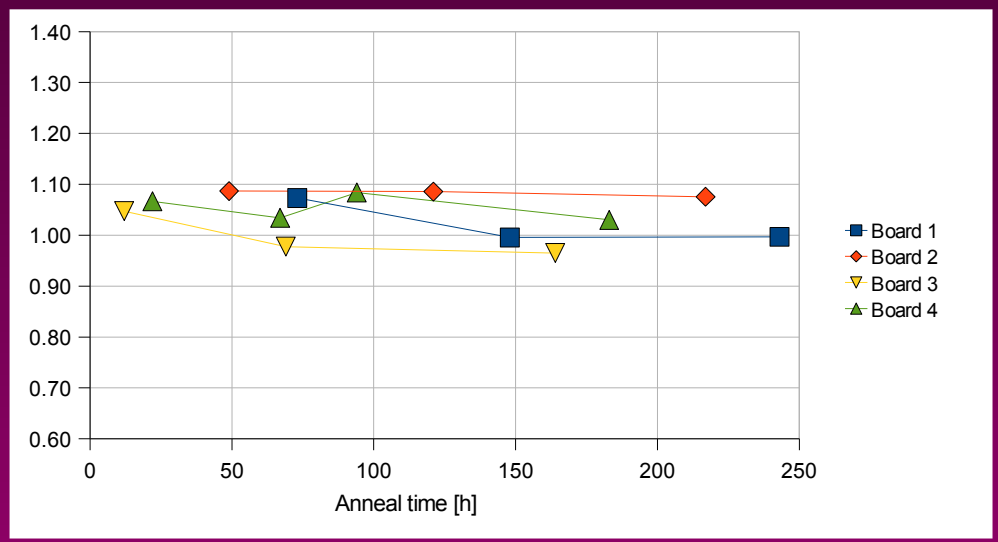
Irradiation tests - 1

Sezione di Torino



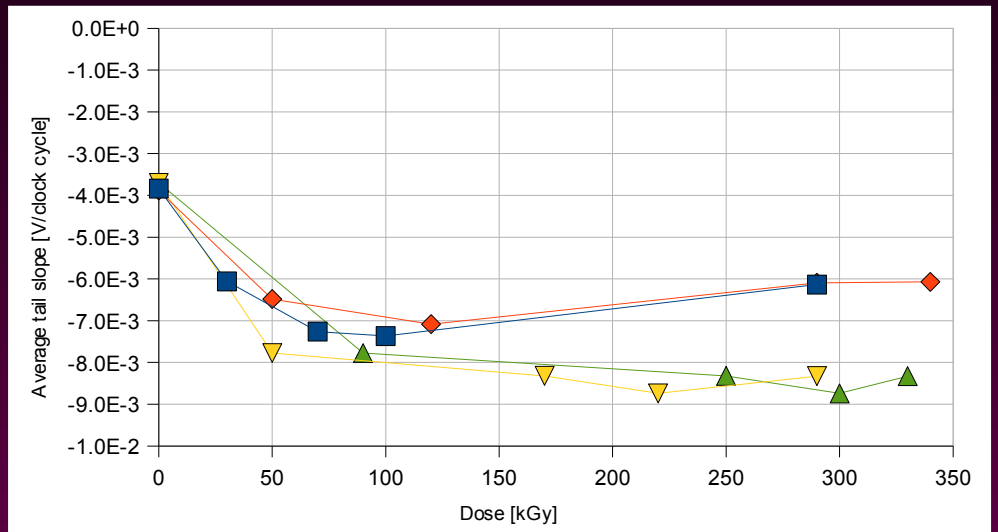


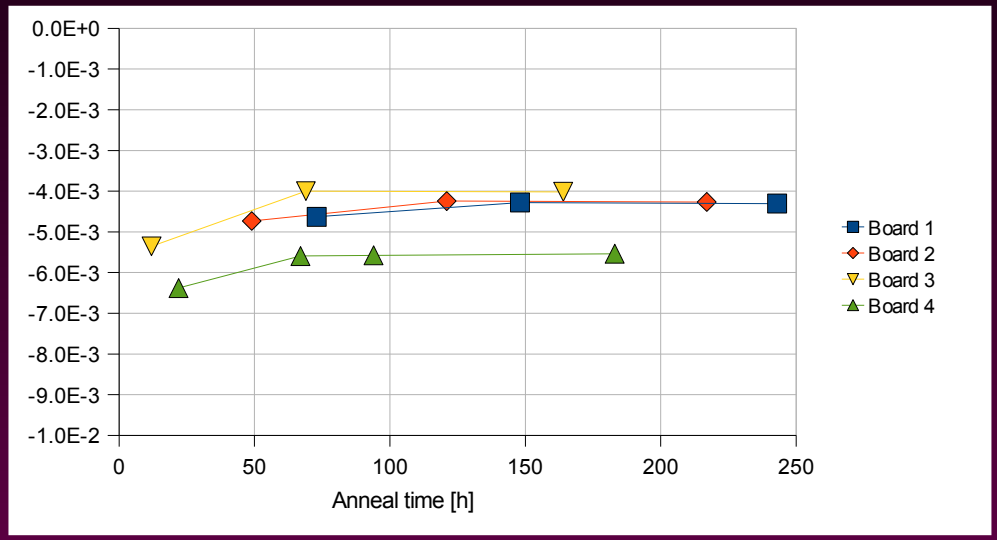


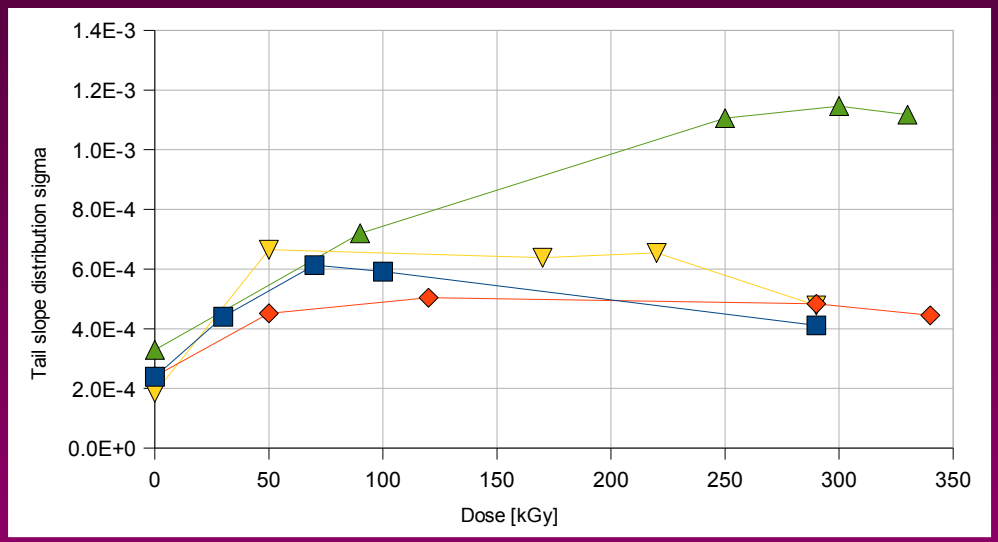


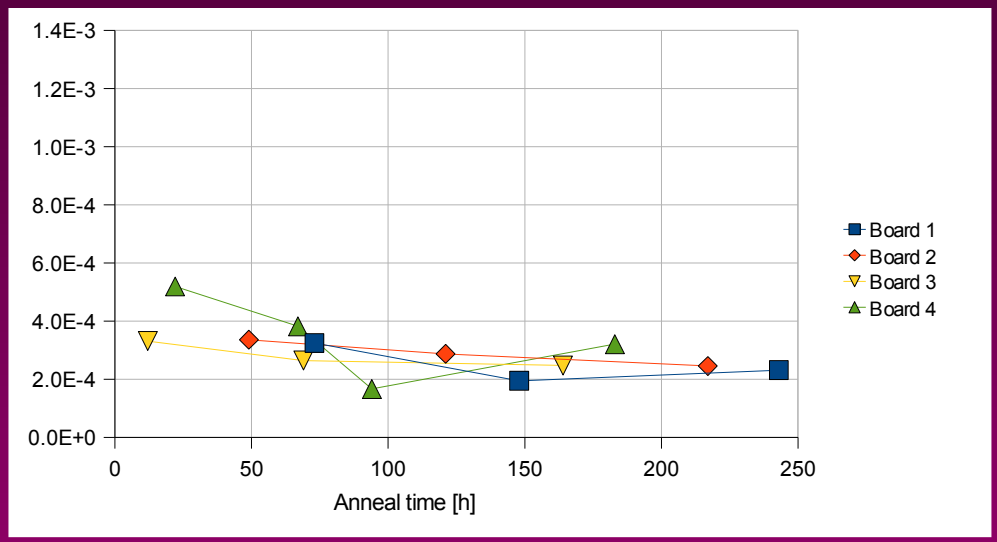
Irradiation tests - 2

Sezione di Torino





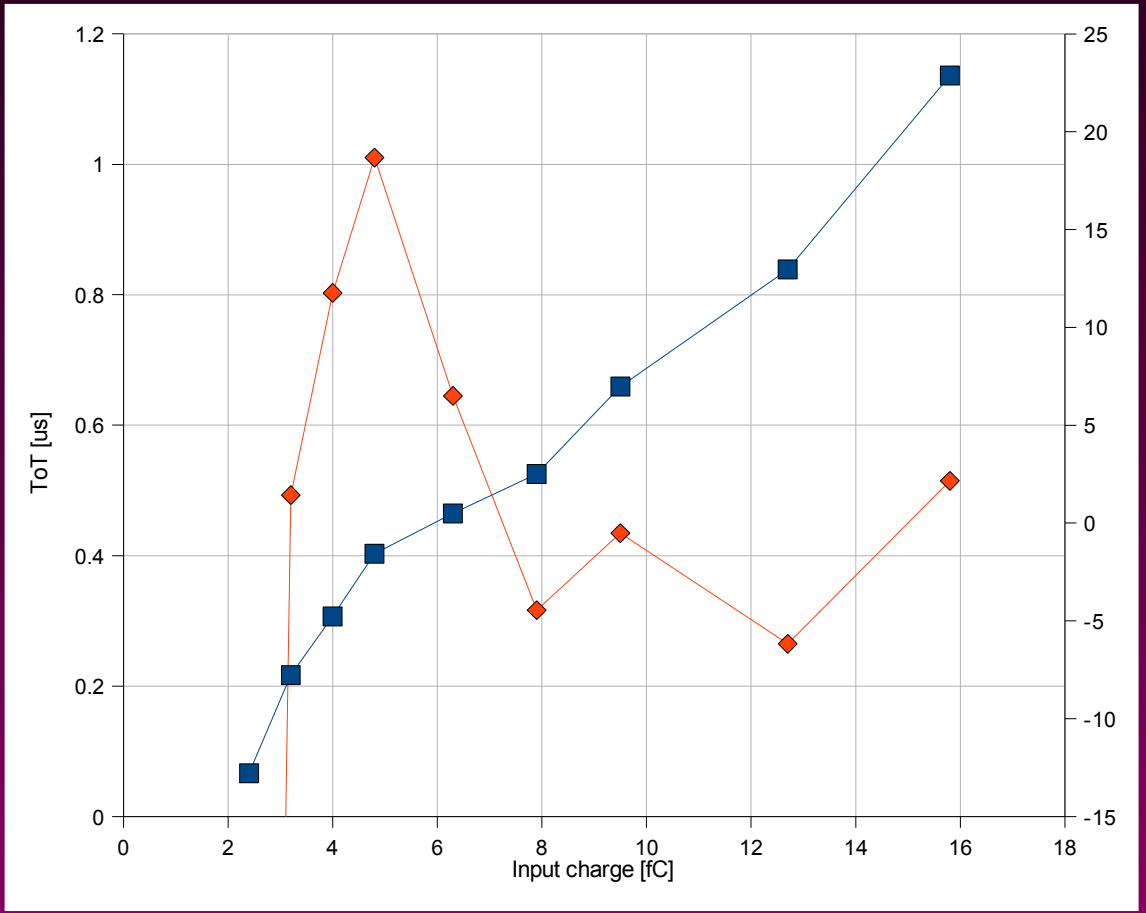




Conclusions

Sezione di Torino

- A custom solution has been adopted for the readout of the PANDA MVD pixel detector
- A reduced scale prototype has been designed and tested. The prototype includes two full size pixel column with a simplified readout logic
- Tests show good agreement between specifications and measurements
- Radiation tests show an overall good resistance to total dose. A critical point has been found and will be corrected
- SEU tolerance will be tested in the next months

Low range

Sezione di Torino