Perugia FOOT general meeting (december 2022)

Vertex and Inner Tracker summary

FOOT tracker mechanical setup:

- Final mechanical design available
- Electronic system support table ordered. We'll give start production beginning 2023.
- Inner Tracker readout electronics (Terasic boards) mechanical support under design.

Magnet system:

- Delivery foreseen june/july 2023

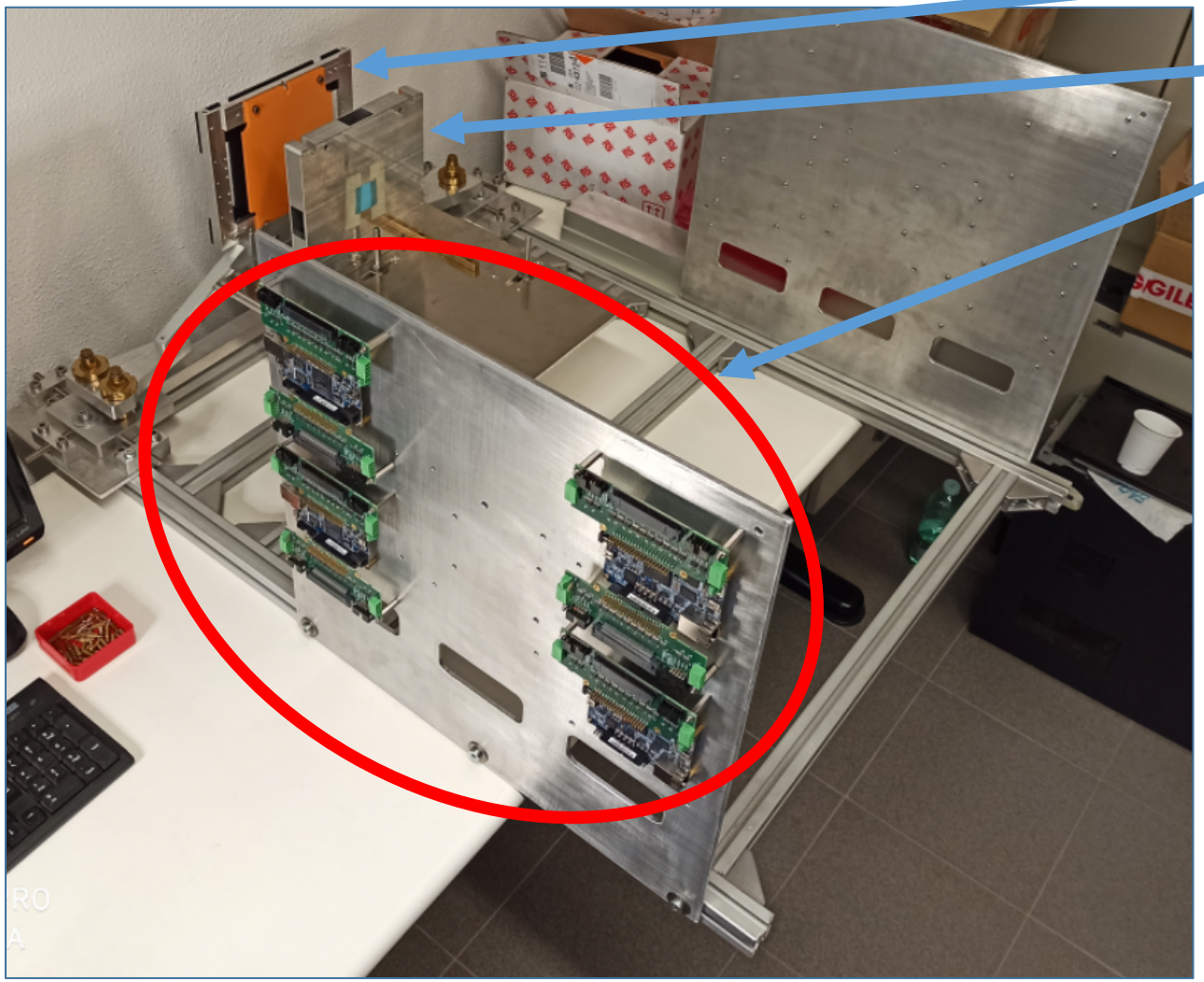
Pixel vertex detector:

- Used at GSI and at CNAO (last november) see 30 november Christian presentation.
- New Vertex readout board under production (DE0nano board compatible)

Inner Tracker:

- Plume ladder assembly process definition concluded in Strasbourg
- All production tools available
- **First module tested at LNF, wrong bonding discovered (bonding plan modified)**
- 10 modules assembled
- 1 ladder (out of 5) assembled (**problems in dead sensors!!!**) ⟸ SHOWSTOPPER
- All needed hardware/software pieces available
- Intermediate PC readout software (event building) written and tested at CNAO (for 2 channels out of 8 – extension to 8 not a problem)

FOOT pixel tracker status



- **Four final ladders in Frascati**
  (one tested)
- Fifth ladder (spare) to be assembled in Strasbourg
- Cabling to be done:
  - control cables
  - trigger cables
  - power cables
  - console USB cables

Overall arrangement
(not final) foreseen for test beam

PRIN 2022 (Approved)

«High performance DMAPS (Depleted Monolithic Active Pixel Sensor) for hadrontherapy»

«…….we propose this project with the aim of significantly **improving the capabilities of the pixel tracker**, particularly in terms of the **amount of data that can be collected for the same amount of time and spatial resolution**, which for obvious statistical reasons allows for greater accuracy of the measurements to be made……..»

We propose to improve the detection characteristics of the FOOT experiment's **vertex detector** by **using the MIMOSIS sensor**, recently developed for the CBM experiment by the In2p3 research group in Strasbourg.

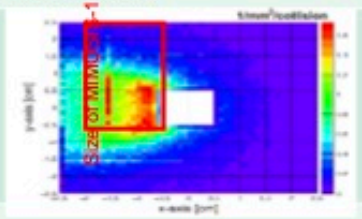
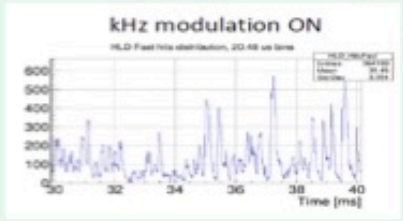
MIMOSIS-1 chip – full scale prototype of one CMOS sensor
✓Matrix dimension: 1024 columns. X 504 rows
✓Pixel dimension: 26.88 μm (height) x 30.24 μm (width)
✓Fabricated with Tower Semiconductor, 180 nm technology

A. Dorokhov (VCI 2022)

✓ Full-scale prototype of the sensor, MIMOSIS-1, extensively tested at lab and in beam, preliminary results for non-irradiated sensors:
- Fake hit rate < 10^{-5}
- Detection efficiency > 99 % at <220 e
- Resolution ~5 μm
- AC pixels show similar to DC pixels performances
- Possible advantages of AC pixels:
  - tune charge collection efficiency within same technology/split
  - more freedom to improve pixels in another technologies
  - applications beyond CBM, Cremlin+, future e+e- colliders

PRIN 2022 (Approved)

MIMOSIS: requirements for the sensor

	Target requirement	comments/complications
Spatial resolution	~5 µm	
Radiation length	~ 0.3 % X_0 (first station) ~ 0.5 % X_0 (other stations)	thickness ~50 µm
Power dissipation	< 200 mW/cm²	operates at vacuum - cooling
Operation temperature	- 40°C to +30°C	temperature gradient 5 K
Heavy Ion tolerance	10 Hz/mm²	
Rate (average/peak)	150/700 kHz/mm²	Fake hit rate < 10^{-5} pix / 5 µs
Time resolution	~5 µs	
Radiation hardness	~ 7x10^{13} n_{eq}/cm² ~ 5 Mrad	radiation gradient 100% over one sensor area
Occupancy gradients in space		 (MVD TDR)
Beam intensity fluctuations in time		 (HADES, GSI)

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Vienna Conference on Instrumentation, 2022 *A. Dorokhov, IPHC, Strasbourg, France*

Key points

Time resolution
- MIMOSIS 5 µs
- Ultimate (M28) 185,6 µs

MIMOSIS – global shutter
Ultimate (M28) – rolling shutter

MIMOSIS active area:
Active area: 30.935×13.520 mm2
Pixel pitch: 26.88 x 30.24 µm2

two sensors per plane:
Active area: about 30×30 mm2
(similar to FIRST vertex arrangement)

Add one station before target.

MIMOSIS2 arriving in Strasbourg those days