The Silicon Microstrip Tracker for the Mini.PAN experiment

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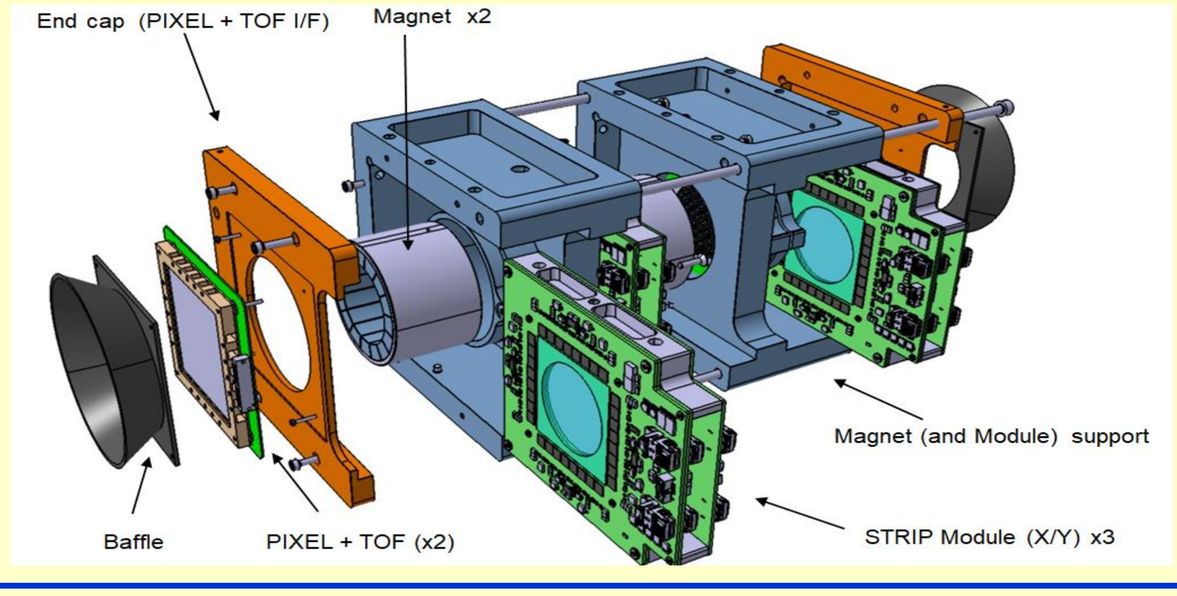
Mini.PAN Project TRACKER goals

- Validate a novel cosmic ray measurement instrument concept
- Develop a fine pitch silicon strip detector for the advanced option of the Strip X Detector
- Design and produce large pitch Strip Y detector
- Design and produce low noise and low power ASIC chips for Strip X detectors
- Develop ASIC chips for Strip Y detectors, with large dynamic range, multi-range readout, trigger output and good time resolution
- Design, produce and space qualify tracker modules

Mini.PAN Silicon TRACKER

- Three Tracker Modules. Each module made of:
  - Two Strip-X detectors with *25μm* readout pitch, providing a *2μm* spatial resolution, read-out by 32 IDEAS VA1140 → 2048 readout channels
  - One Strip-Y detector with *400μm* readout pitch, providing *115μm* spatial resolution read-out by one high dynamic range VATA GT7.2 chip → 128 readout channels
- Thin silicon strip sensor: 150μm
- Pitch adapter to fan-out to bonding pads directly implemented on the silicon wafer with double metal layer
- Low noise ASIC and analog readout
- Robust module design and assembly
- Thermal/mechanical system that ensures stability during operation
- Tracker power consumption 8W



PAN Silicon sensors characteristics

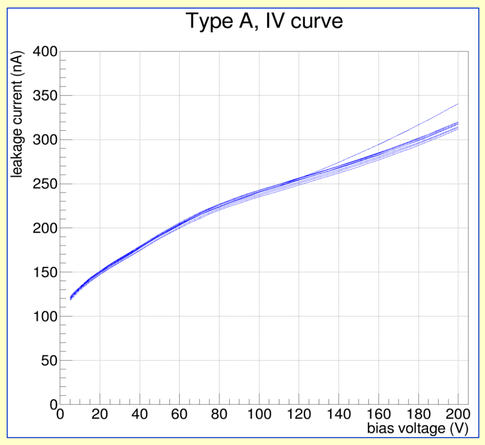
Device type	Single side AC-readout /double metal
Silicon Type	N-type, Phosphorus doped
Crystal orientation	<100>
Chip thickness	**150±15 μm**
Front and back side metal	AL
Full depletion voltage	Max. 50 V

Strip **X sensor** properties.

X sensor overall size	59000±20 μm x 59000±20 μm
Active area	51200 μm x 51200 μm
Number of Strips	**2048**
Strip pitch	25 μm
Strip width	13 μm
Readout AL width	10 μm
Readout PAD pitch	96 μm

Strip **Y sensor** properties.

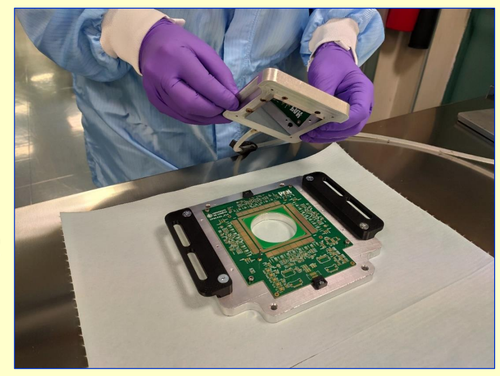
Y sensor overall size	59000±20 μm x 59000±20 μm
Active area	Circular with D=51200 μm
Number of Strips	**128**
Strip pitch	400 μm
Strip width	380 μm
Readout AL width	10 μm
Readout PAD pitch	91.2(2lines) μm

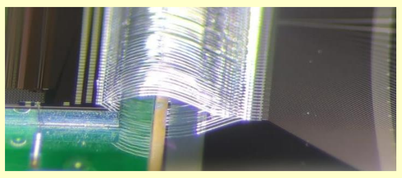


X Sensors electrical characterisation before assembly

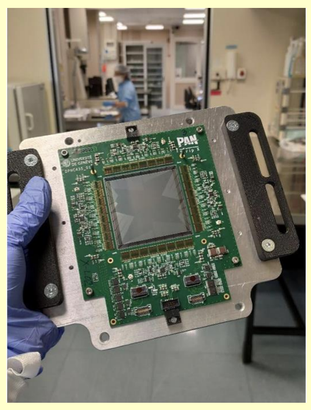
Detector Construction Steps:

- Alignment of PCB on a precise jig
- Dispensing of conductive glue EJ2189 and structural glue DC3145 grey
- Placement of silicon sensor on PCB and curing
- Wire bonding of sensors with the VA1140, respectively VATAGP7.2
- Qualification: electrical and mechanical test
- Integration of Strip-X and Strip-Y detectors in Tracker Modules
- Integration of Modules in Tracker
- Beam Tests and Space Qualifification
- 8 Strip-X detectors and 3 Strip-Y detectors already built

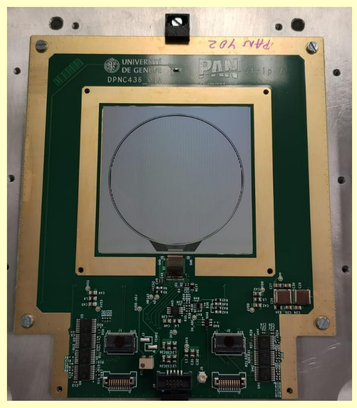




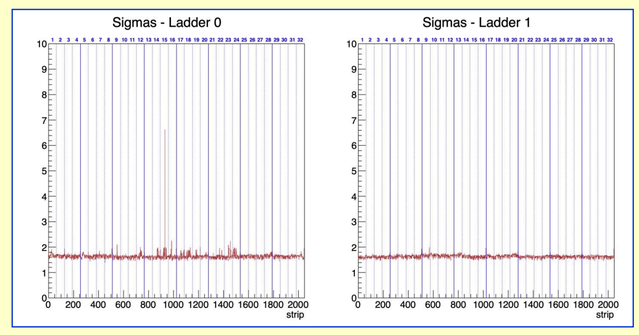
Ultrasonic wire bonding with a M17L F&K Delvotec machine



Strip X detector readout by 32 VA1140 on four sides

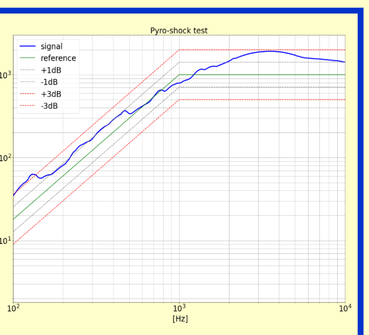


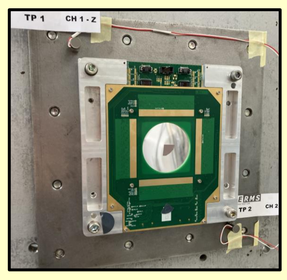
Strip Y detector readout by a VATAGP 7.2



Strip X detector calibration: standard deviation of ADC values per channel from a calibration run (CN subtracted): ~1.5-2.5 ADC units

PyroShock



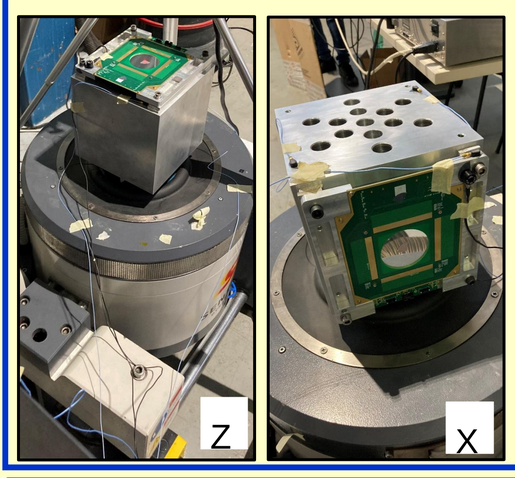


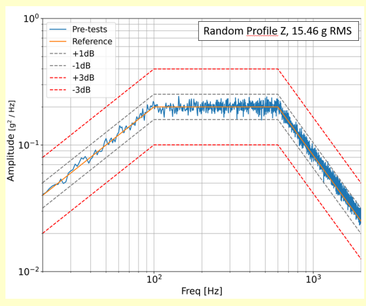
Resonance search → Pyro-shock test → Resonance search → Visual inspection

Space Qualification –Mechanical Tests

A Mechanical Tracker Module was built for space qualification with dummy X and Y sensors, respectively

Resonance search → Sine Sweep → Resonance search → Random → Resonance search → Visual inspection

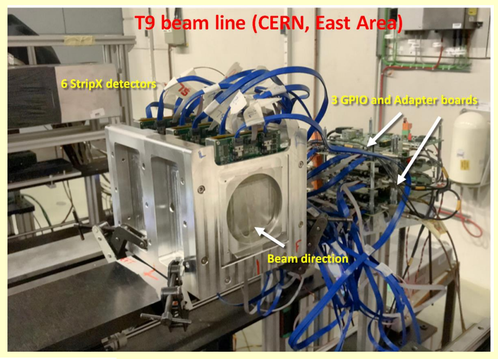


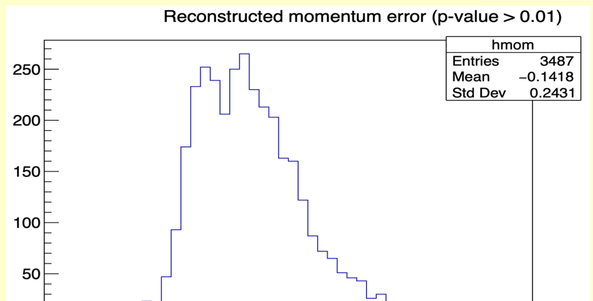


Performance Studies with Beam Test

The setup @ CERN, T9 beam line

- Particles π^-
- Momentum 10GeV/c
- Six Strip-X detectors





Preliminary results of the momentum resolution for 10 GeV/c $\pi-$.
The tracks displacement due to bending is of the order of a few channels on the last station

REFERENCE:
M. Duranti, *Development of a Penetrating particle ANalyzer for high-energy radiation measurements in deep space and interplanetary missions,* This Conference

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