HV-CMOS detectors for LHCb Mighty Tracker

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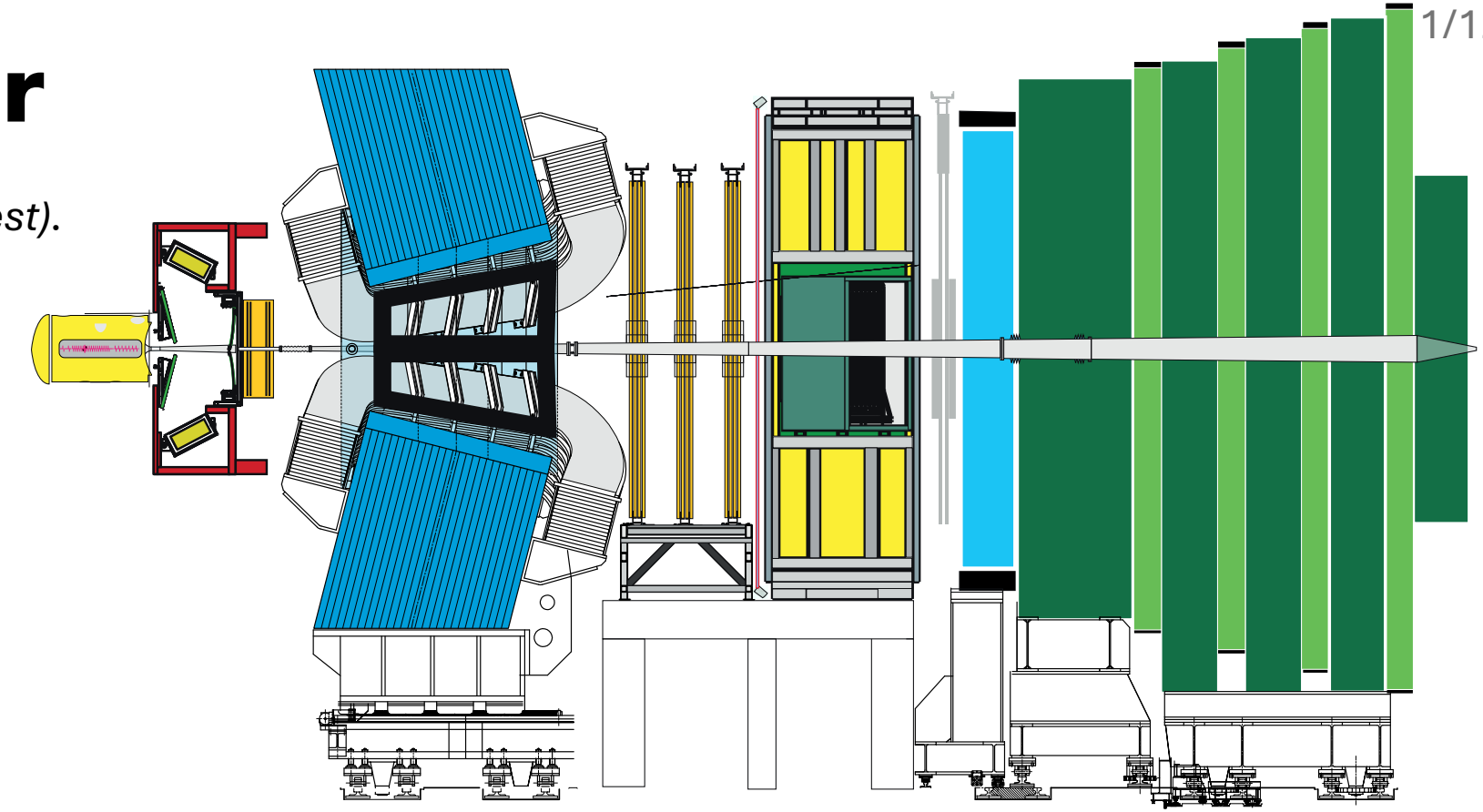
THE UNIVERSITY of EDINBURGH

Detector Informal Meeting PPE
4th February 2026

Mighty Tracker

Everyone knows LHCb *(b stands for best)*.



Mighty Tracker

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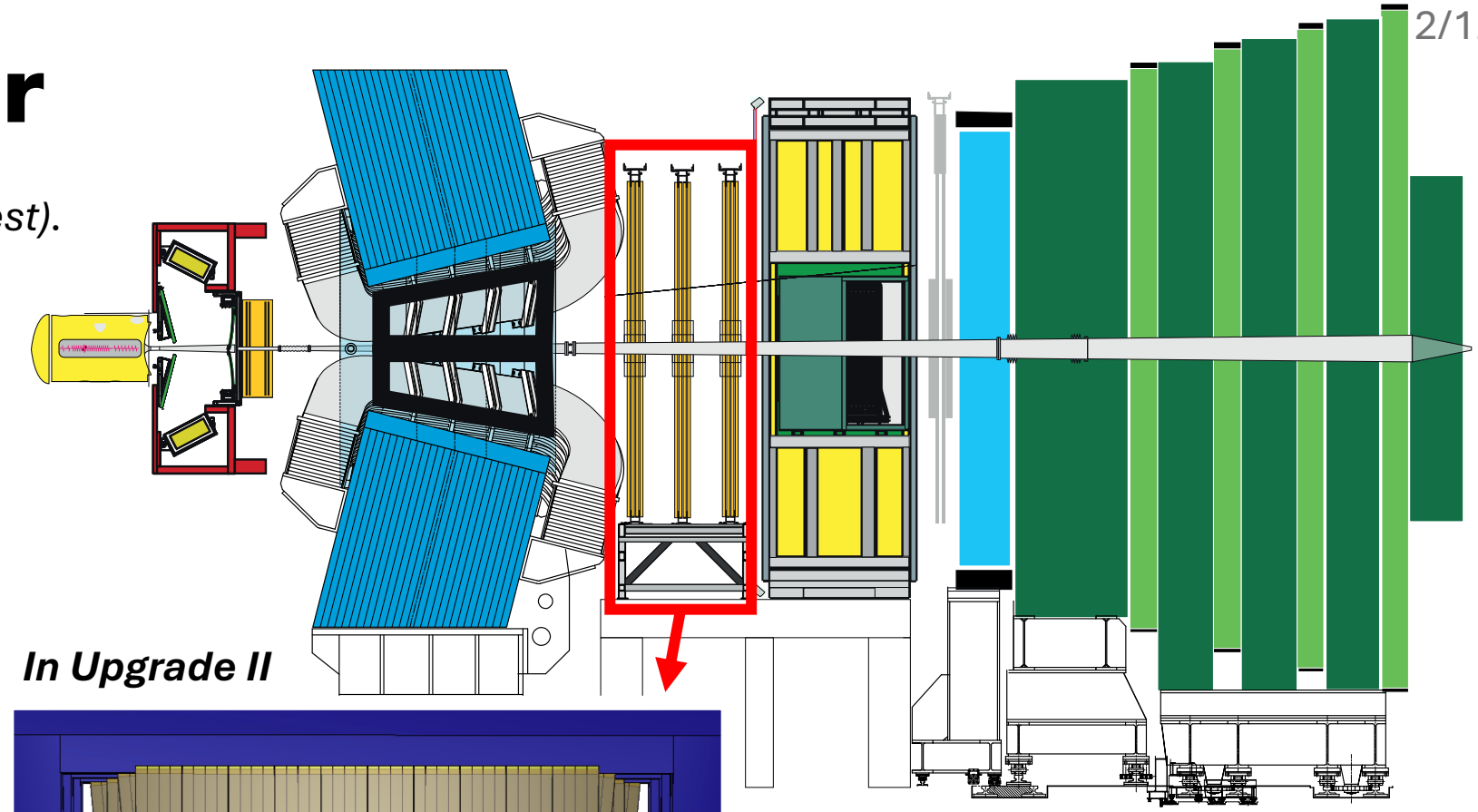
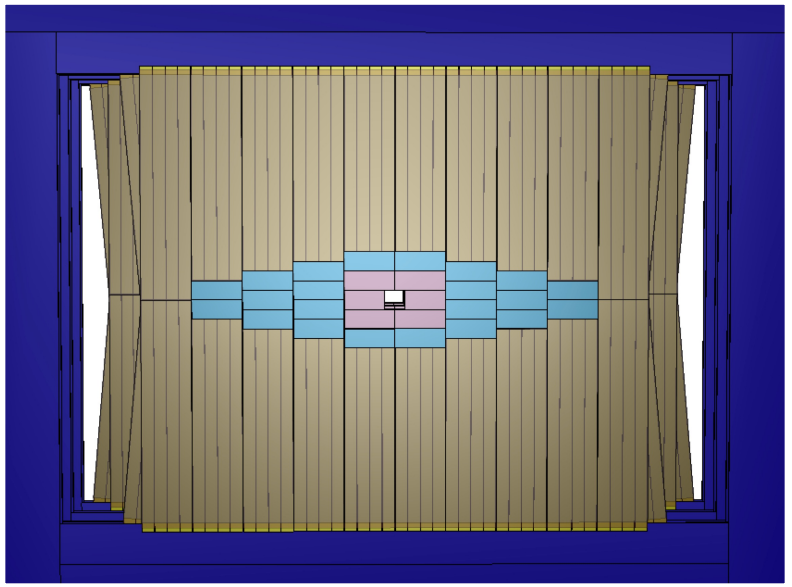
The **Mighty Tracker** is a proposed upgrade to the existing Scintillating Fiber *(SciFi)* tracker.



Currently...

In Upgrade II



Mighty Tracker

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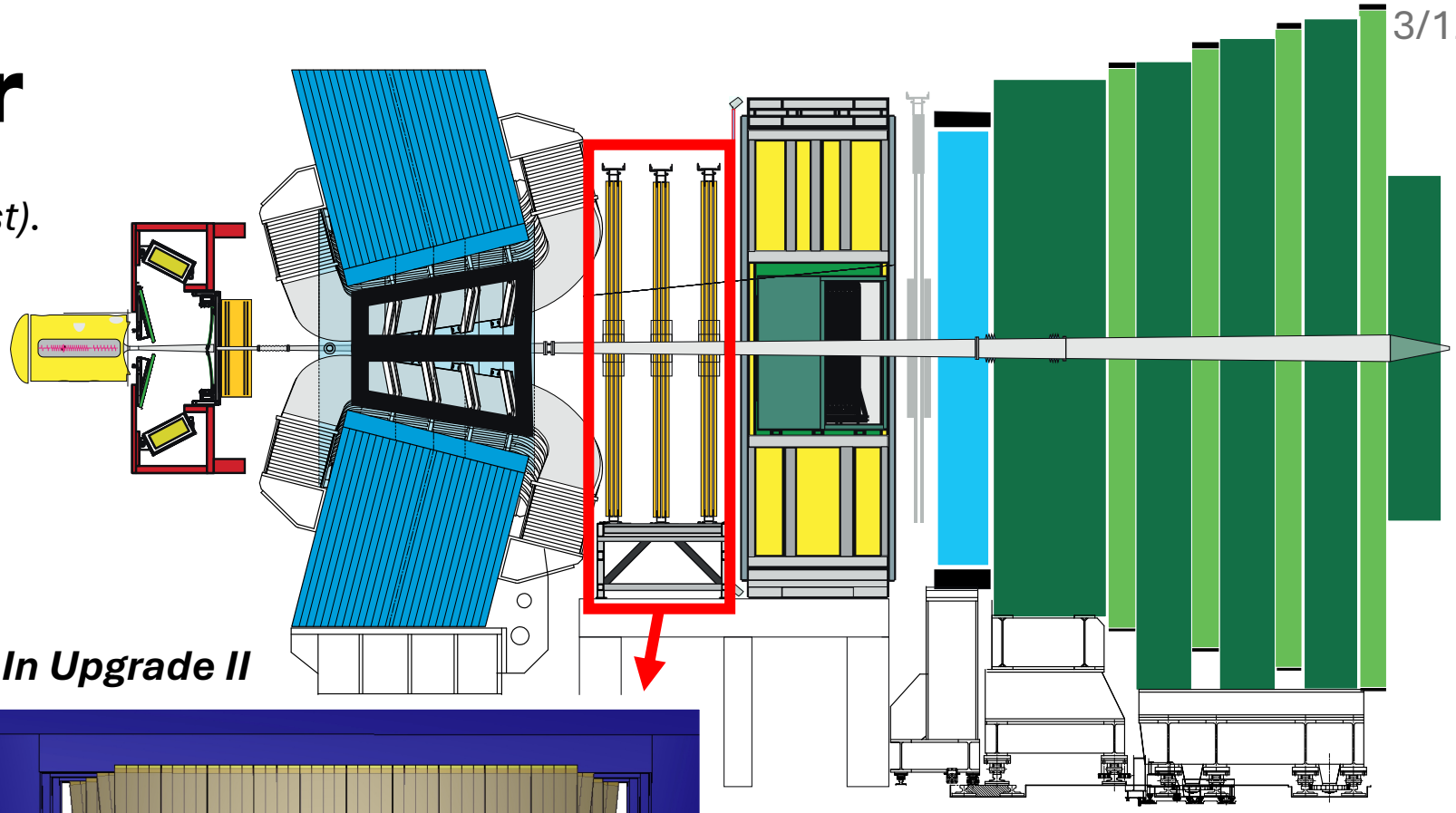
The **Mighty Tracker** is a proposed upgrade to the existing Scintillating Fiber *(SciFi)* tracker.

The center of Mighty Tracker will be instrumented with silicon pixel tracking detectors.

These tracking chips are what we are testing in Edinburgh! *(In part)*.



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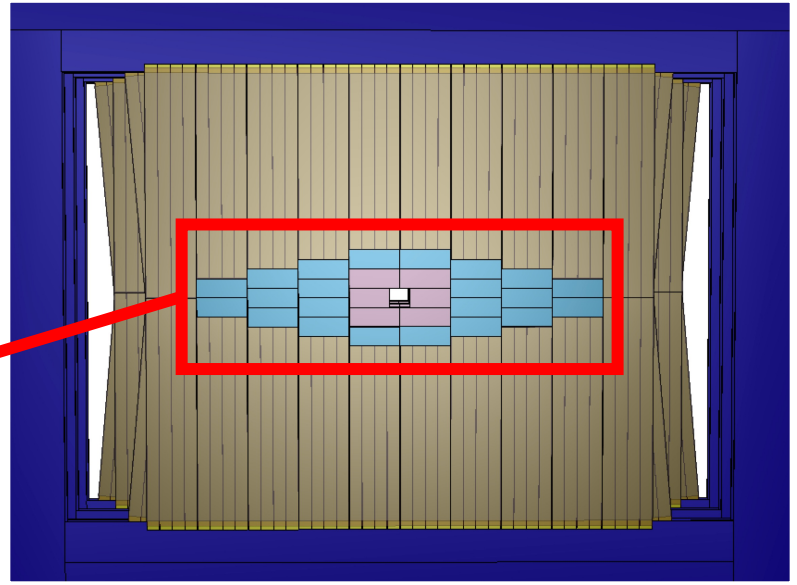
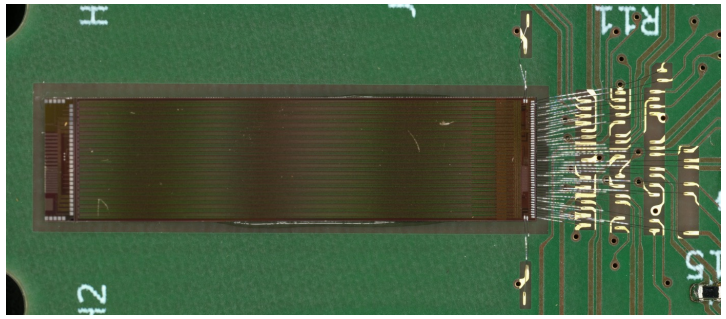


A prototype tracking chip

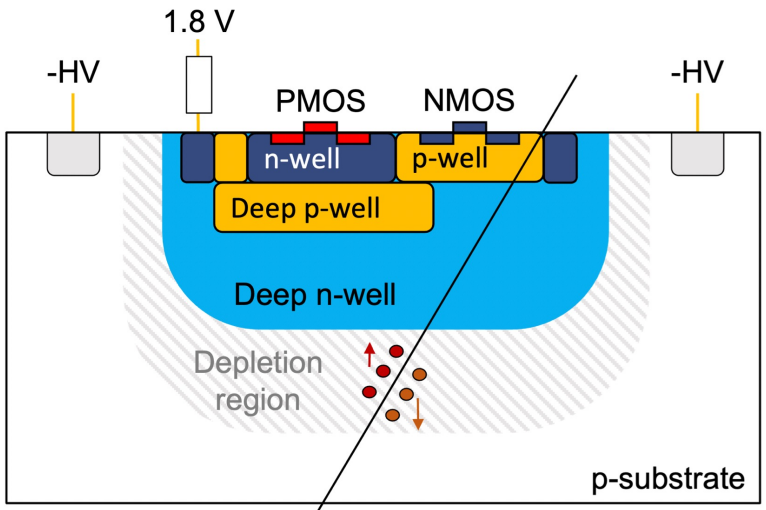


MightyPix1

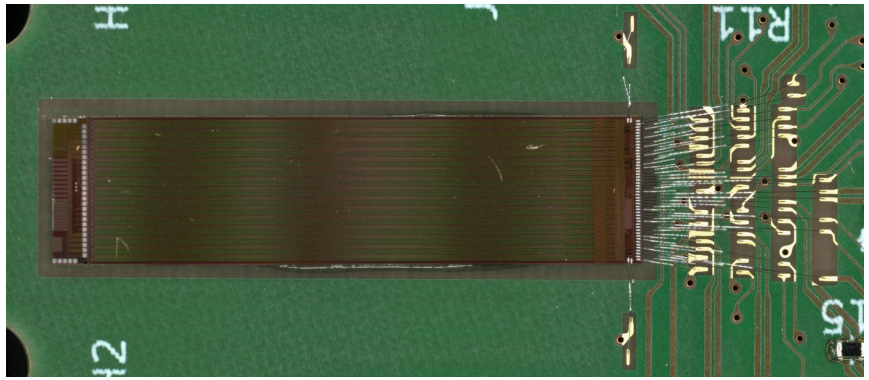
The first chip I was personally involved in testing was first iteration of the **MightyPix** chip. *A HV-CMOS detector.*

To do so we use a:
- GECCO board (passive breakout board for the chip carrier)
- NEXYS FPGA board (general use FPGA used as a DAQ)

Particle tracks are provided by a **90Sr** or **241Am** radioactive source.



HV-CMOS working principle

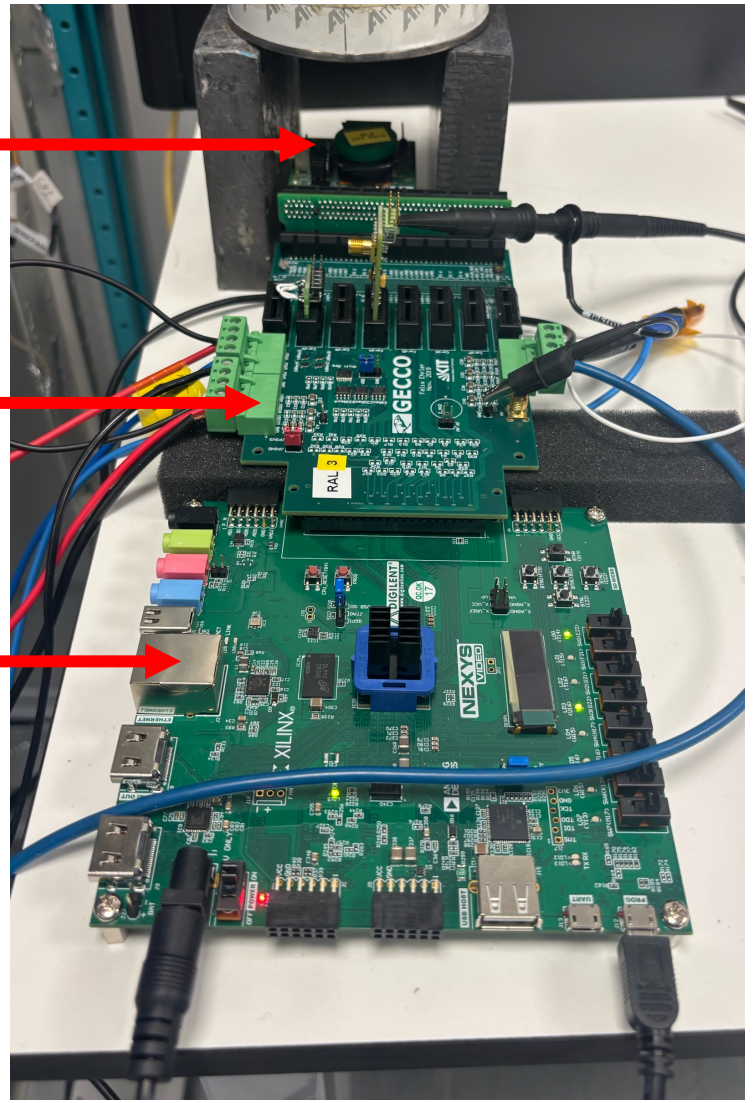


FIBbed MightyPix1 chip

MightyPix (+ source)

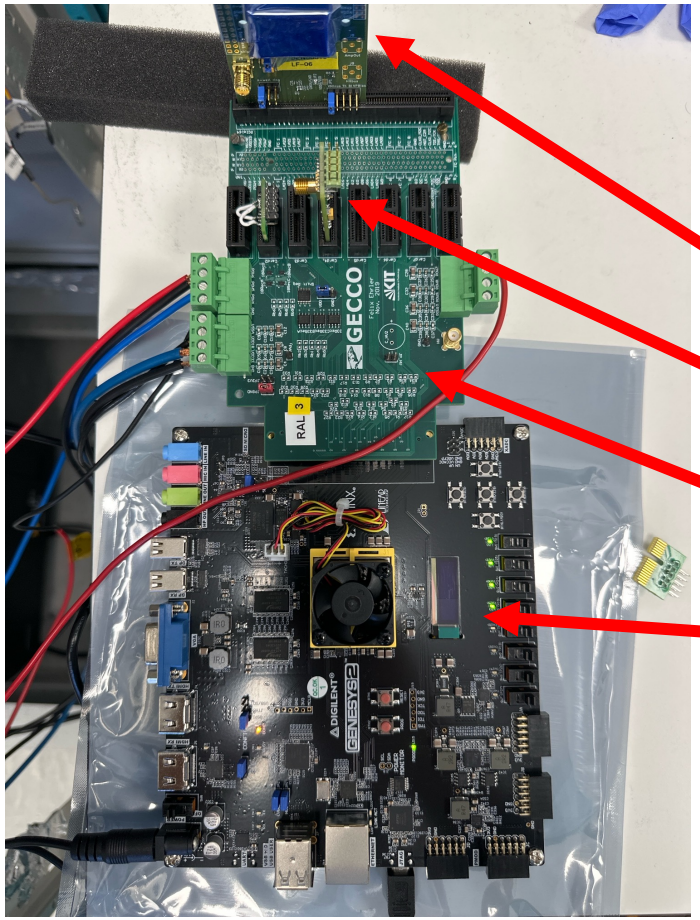
GECCO board

FPGA board



LF-MightyPix

The LF-MightyPix chips are a new implementation of the MightyPix design using the LFoundry 150nm CMOS process and an updated readout.



The LF-MightyPix is read out by:

LF-MightyPix carrier board

Injection &
configuration cards

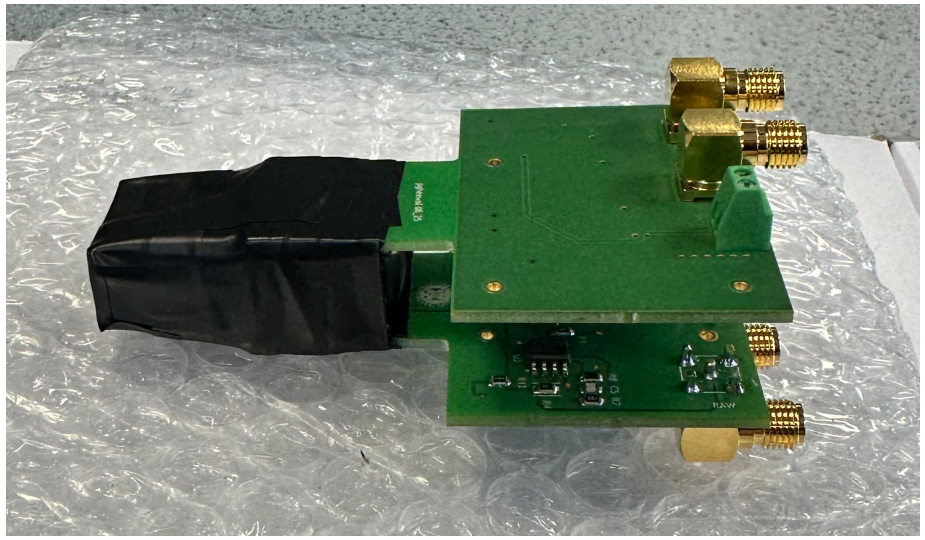
GECCO board

Genesys2 FPGA board
(Improved faster FPGA)

This is the main chip we are characterizing now!

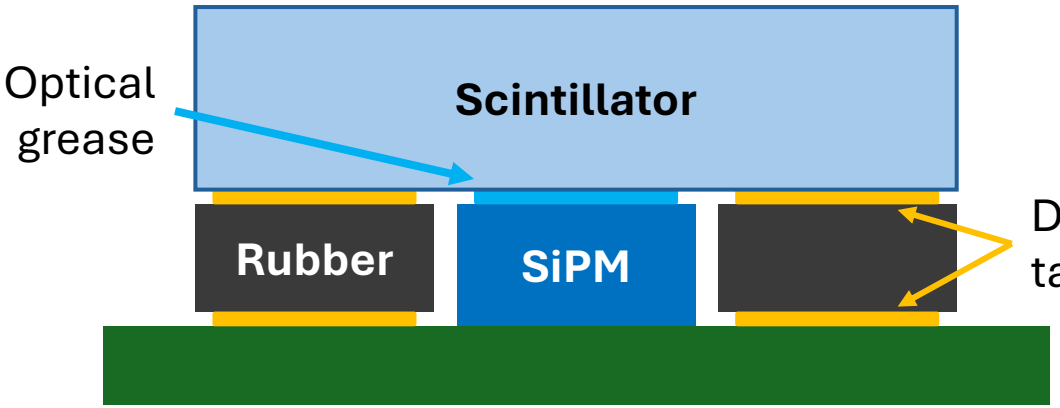
The LF-MightyPix (tiny!)

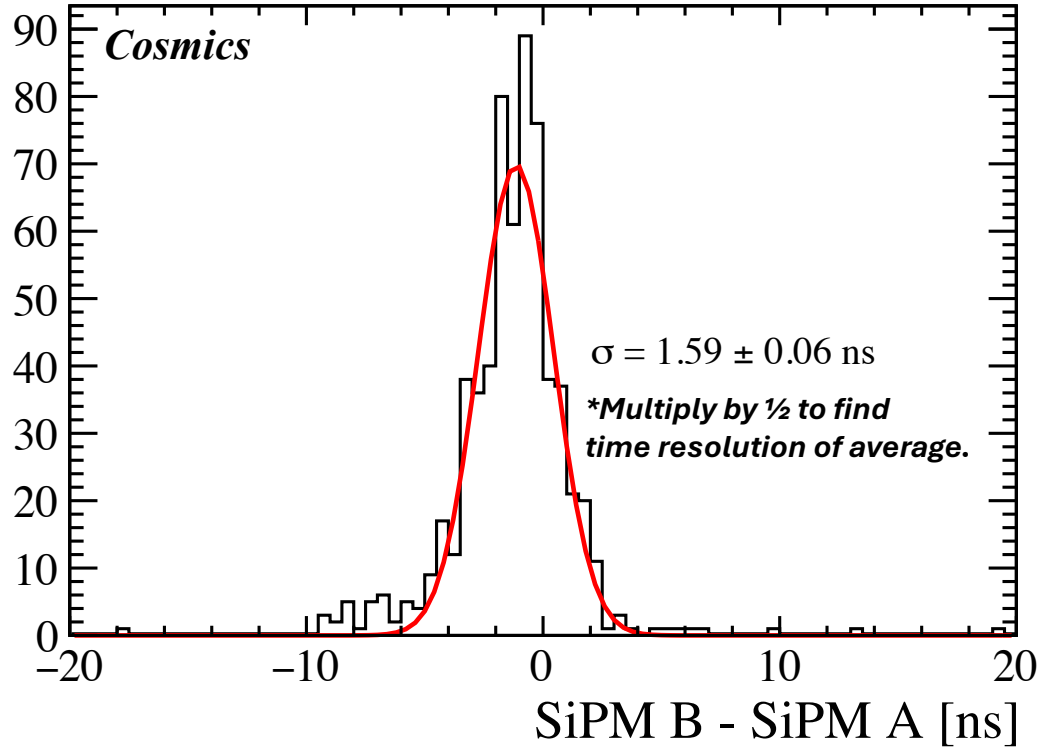
Time reference scintillator



One of the interesting features of these chips to characterize is their time resolution. To do so you (probably) need a good time reference.

To make a time reference Pratik designed a SiPM carrier board that, when coupled to a scintillator, timestamps a particle track with an **800ps** sigma!



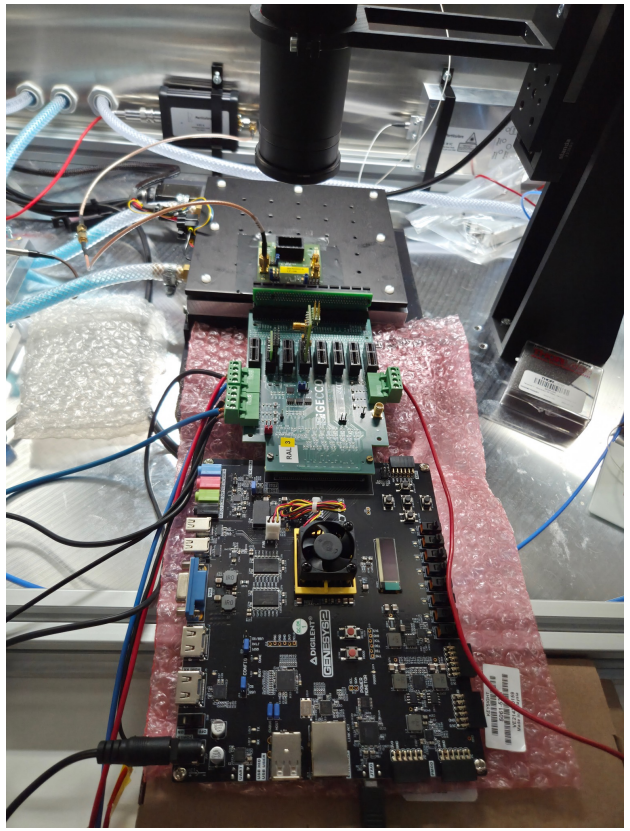


Laser studies – using TCT apparatus

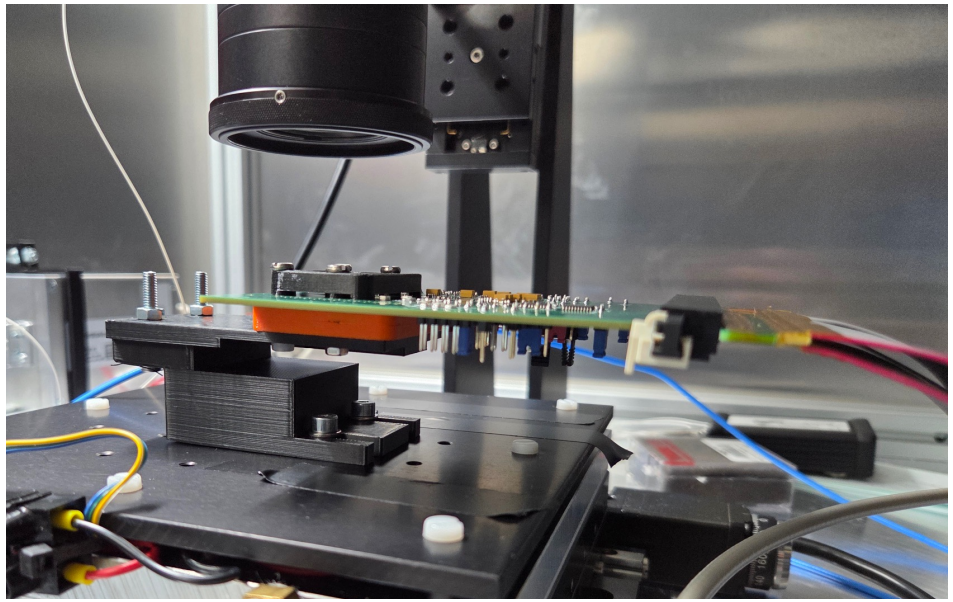
By using a 1065nm laser, a column of charge can be deposited in the silicon, similar to a particle track.

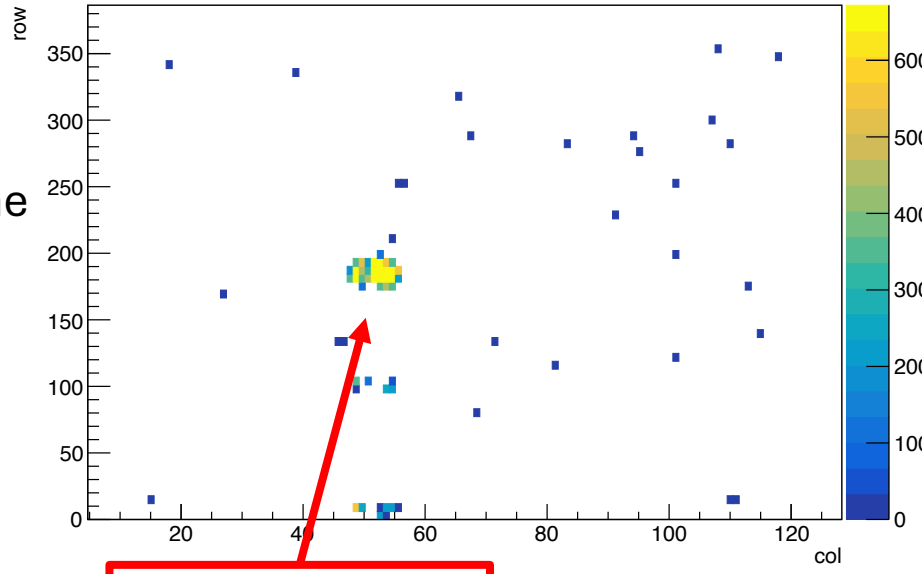
Giovanni is currently using the TCT apparatus developed by Ben to do incline track and timing studies with the LF-MightyPix and ATLASPix3.

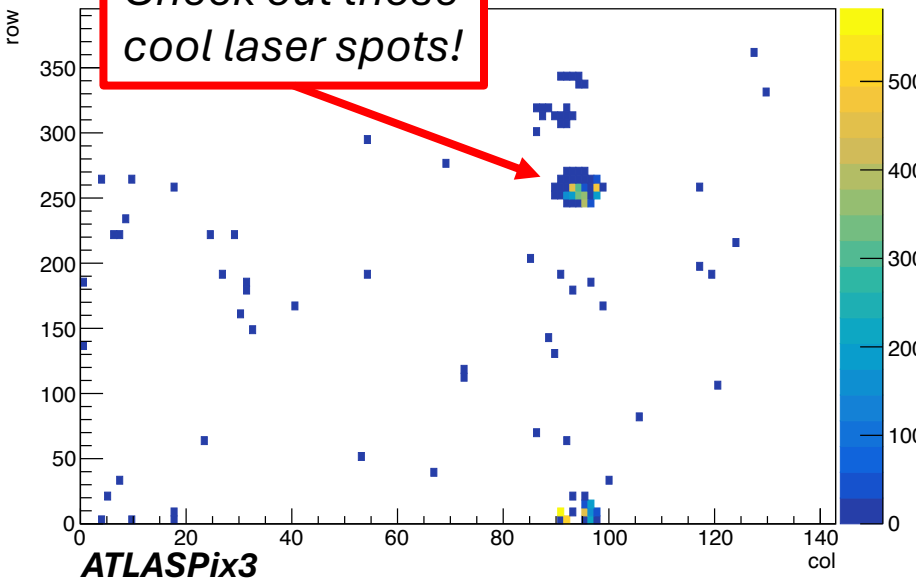
Very exciting!



← Readout chain is the same
↓ ATLASPix3 mounted on translation stage





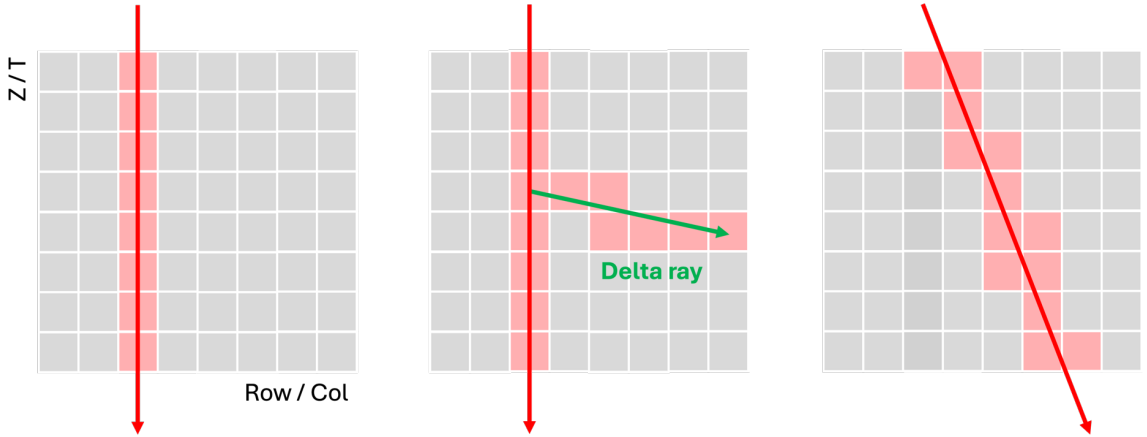


Cluster timing

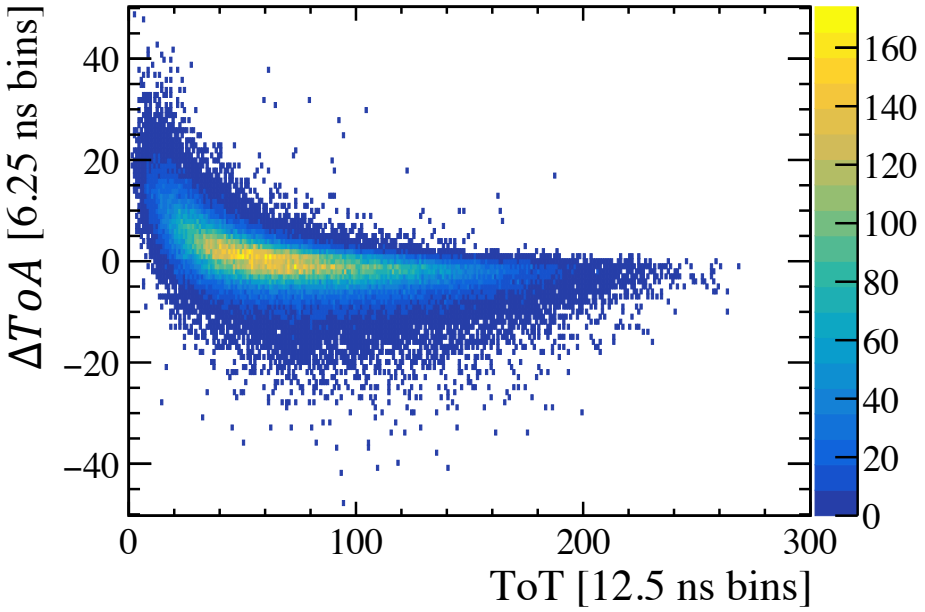
Interestingly, even without a time reference, we can start to study the time resolution of the sensor by leveraging the fact that “hits” within a cluster are in coincidence.

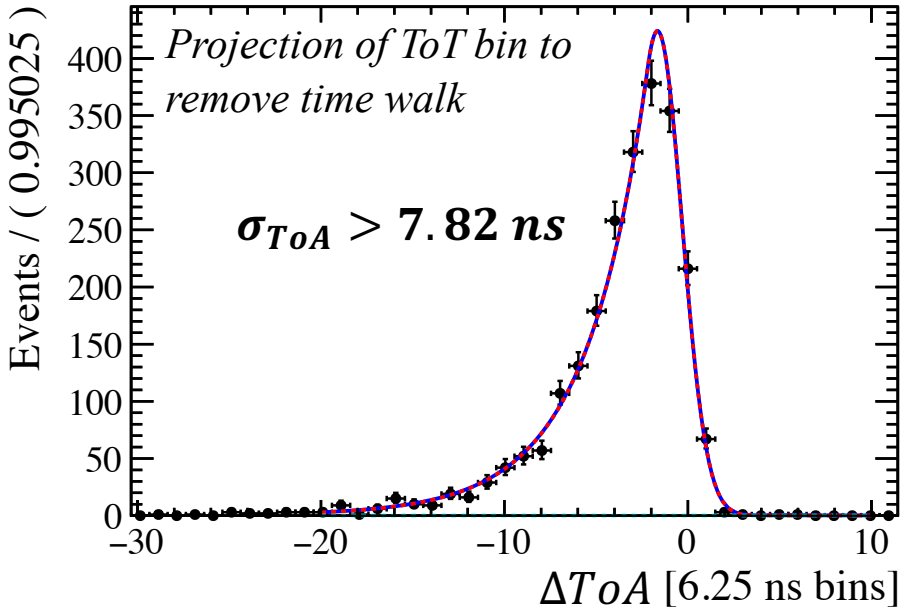
Therefore, by measuring the difference in time between a hit from a cluster, and the average time for the cluster, we can plot a timing distribution and obtain a resolution.

$$\Delta ToA_i = \overline{ToA_{Cl}} - ToA_i$$



Some possible tracks & clusters





This measurement is being improved by Giovanni with a time walk correction and promising results!

Readout development

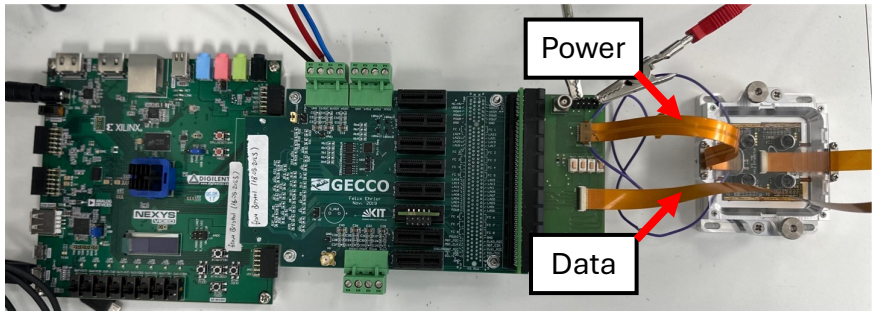
A future readout chain called **MARS** *(Mighty ASIC Readout System)* is being developed for future MightyPix prototypes. Not only do we have one *(pictured below)*, but we are involved in the early development for LF-MightyPix and beyond...

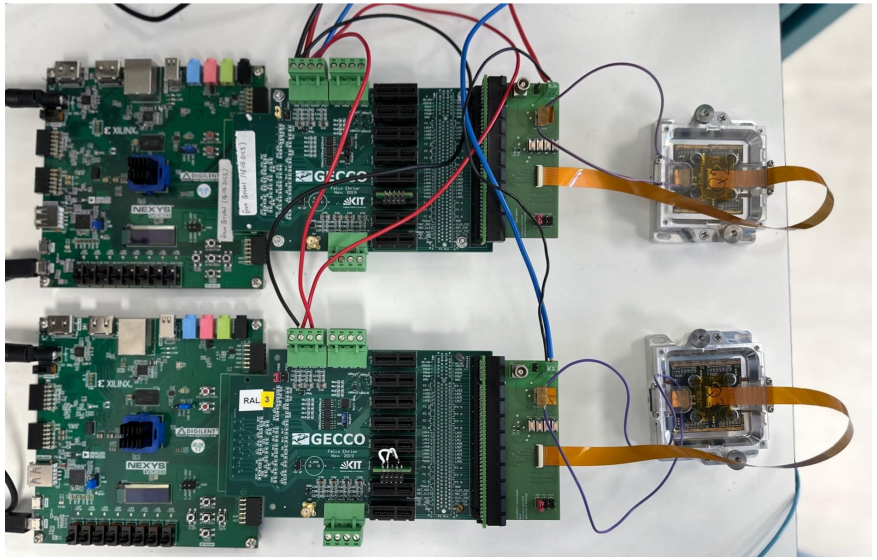
Excitingly, the main developer for MARS, Klaas, is one of the invited Friday seminar speakers!
So, we will return to this later in the year...

Serial powering

For the implementation in the MightyTracker, the sensors must be powered in series, limiting cabling (material budget) and power dissipation.

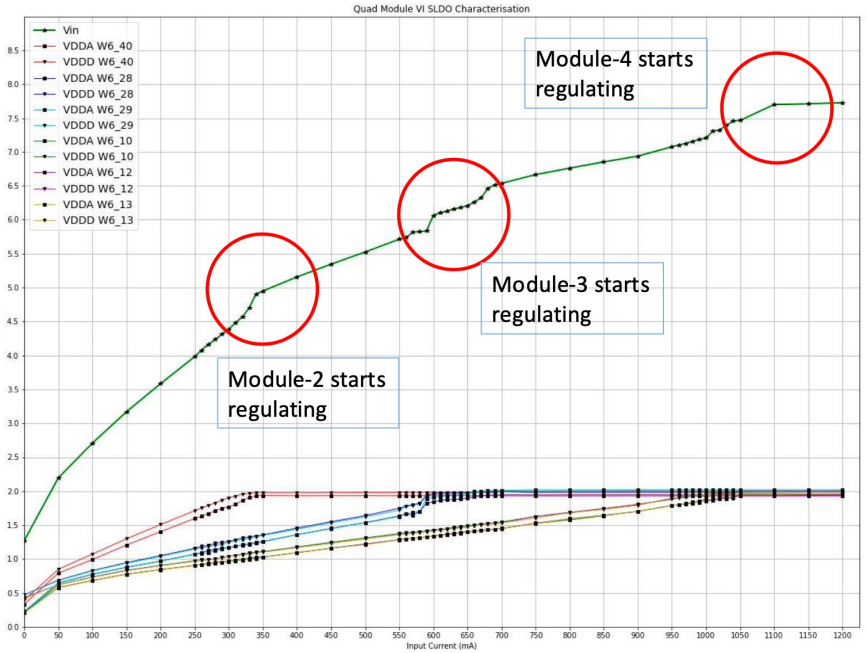
Voltage is regulated locally with a shunt low dropout regulator. Extensive testing of this system in ATLASPix3 has been done by Fuat.

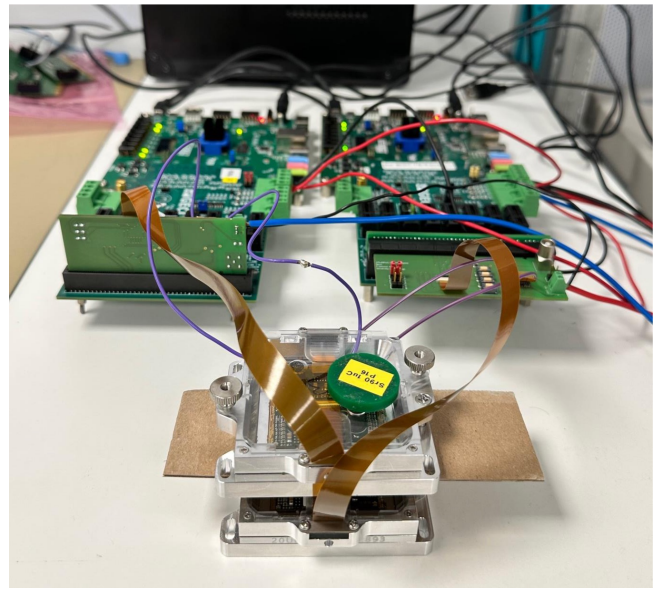




← 1 & 2 (in series) quad module readout

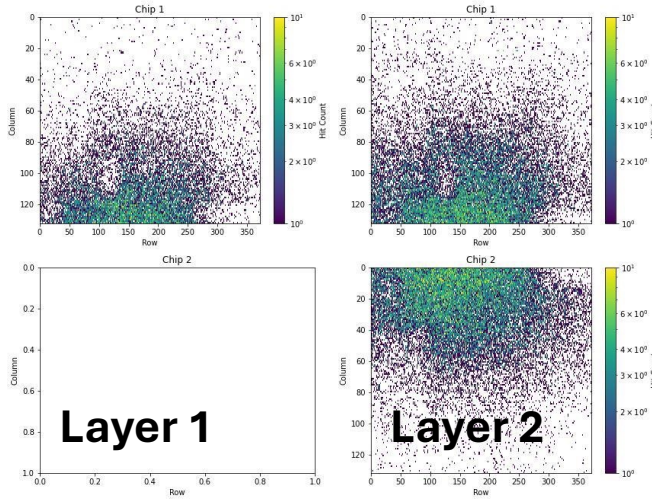
↓ Verification of voltage regulator





↑ 2 quad modules powered serially read out together

↓ Hitmaps = Success!

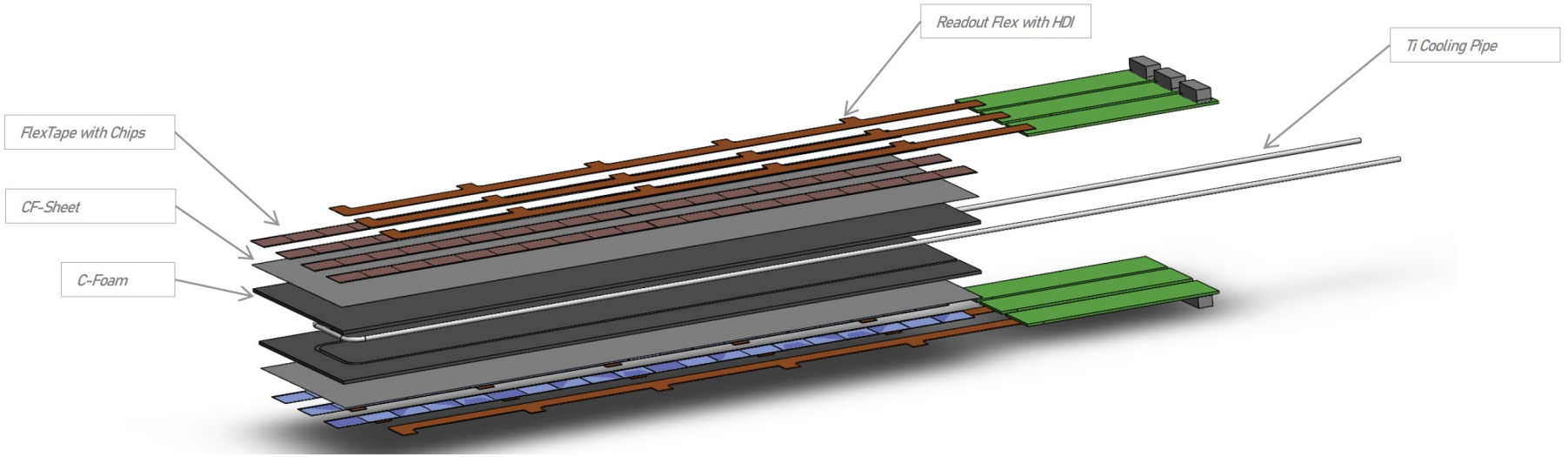


Mighty Tracker Flex PCB design

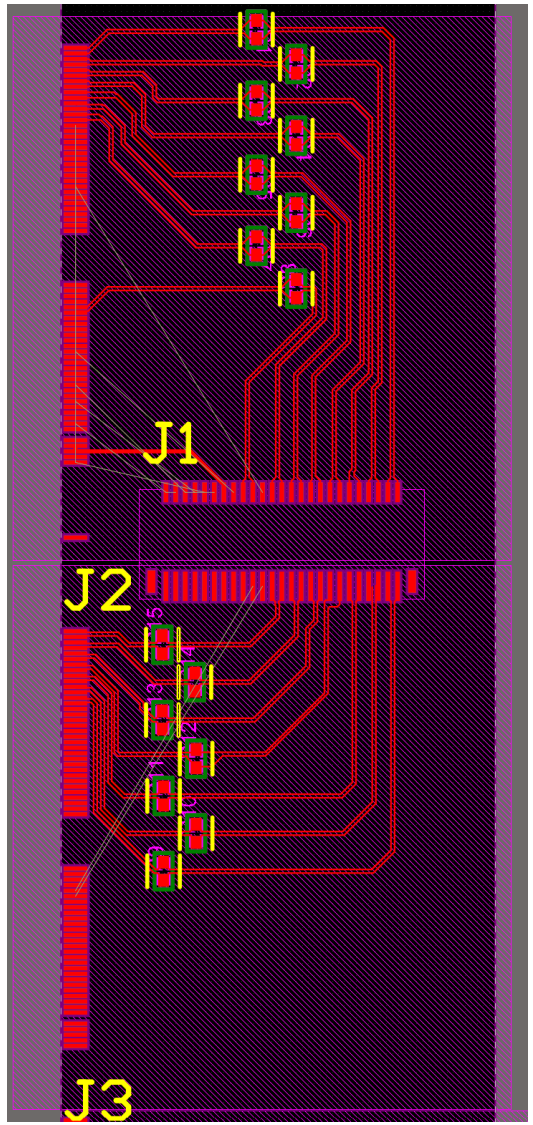
Edinburgh are involved in the design of the Mighty Tracker Flex PCB.

A recent design arranges chips in single column with a 50-pin connector accommodating multiple chip data lines.

Discussions on how to test mockup Flex PCBs in the lab are ongoing. Vector Network Analyser & RICH fast oscilloscope expected to be used.



Exploded Mighty Tracker module



Current Flex design

Things we have *(not including cleanroom equipment)*

HV-CMOS detectors
2x MightyPix1 (FIBbed & faulty)
1x LF-MightyPix
2x ATLASPix3 quad modules
1x ATLASPix3

Readout electronics
3x GECCO boards
3x NEXYS FPGA board
2x Genesys2 FPGA board
(1 on loan to Cambridge)
1x Enclustra mercury KX1
1x MARS board & adapter

Signal sources
- 90Sr
- 241Am
- TCT laser w/ tunable wavelength (via Ben)
1065 nm for silicon

Timing references / other interesting things
- Scintillator SiPM timing
- ATLASPix3 telescope
(for cosmics track reconstruction?)

Voltage supply
1x HV
2x LV (4 channels)

We love collaboration and interesting studies!
If you have an idea or want to use something - do ask!

Thank you!