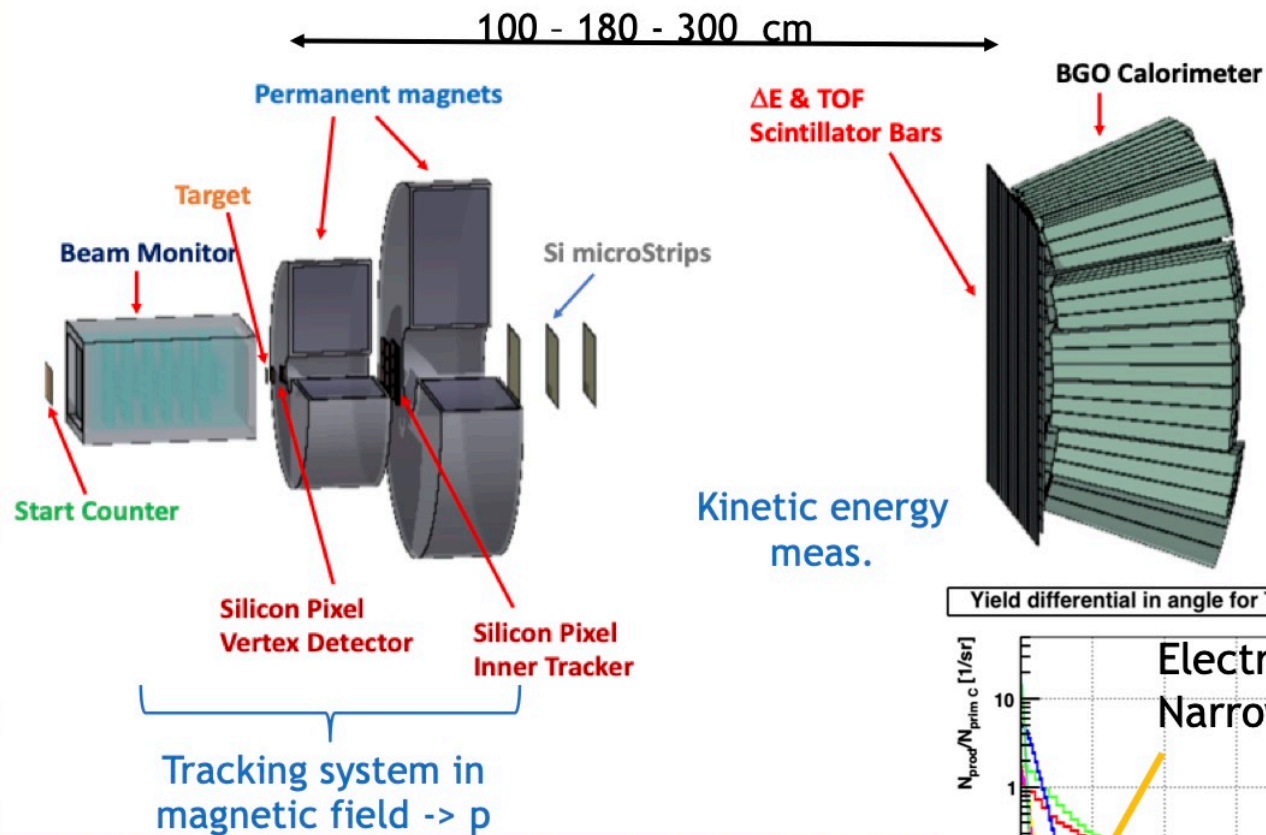


FOOT (FragmentatiOn Of Target) status

1. FOOT electronic setup
2. The magnet system
3. The FOOT Vertex detector
4. Inner Tracker (IT) status
5. IT ladders assembly
6. Conclusions

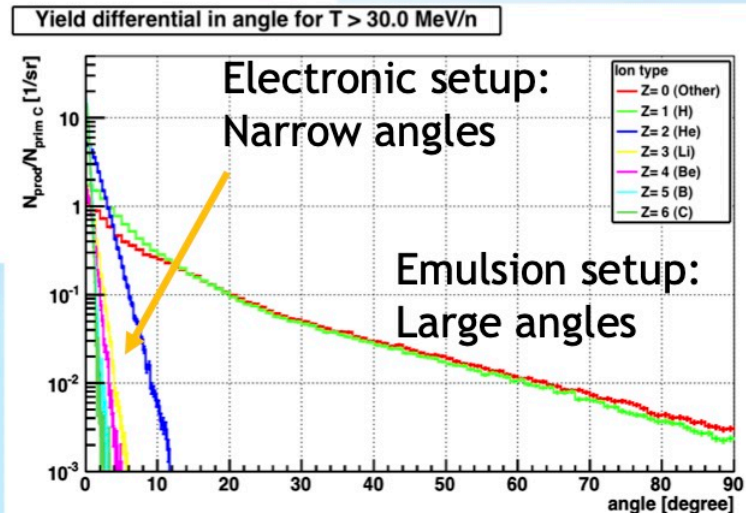


The FOOT electronic setup



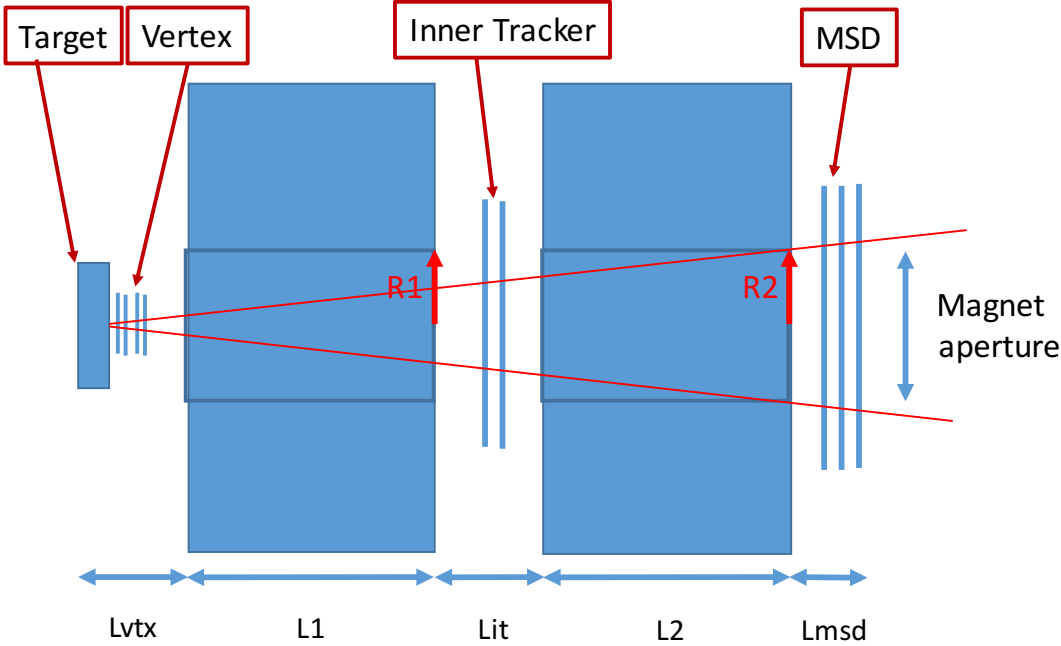
Z and A id by means of redundant combination of ΔE , ToF, p and E

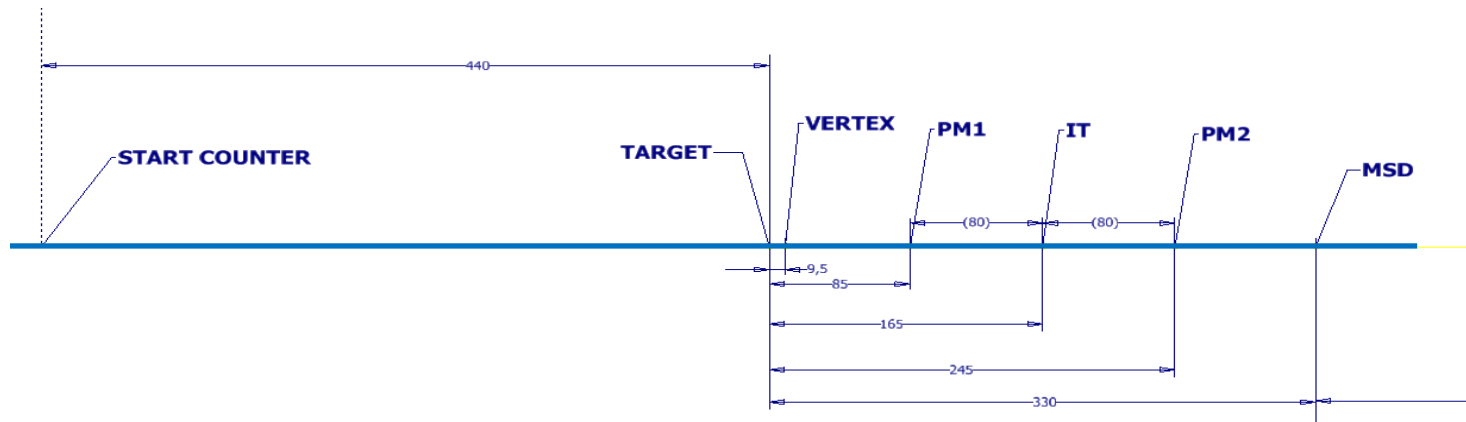
Electronic setup:
heavy fragments at narrow angle < 10 deg
Emulsion setup:
light fragments at large angle > 10 deg



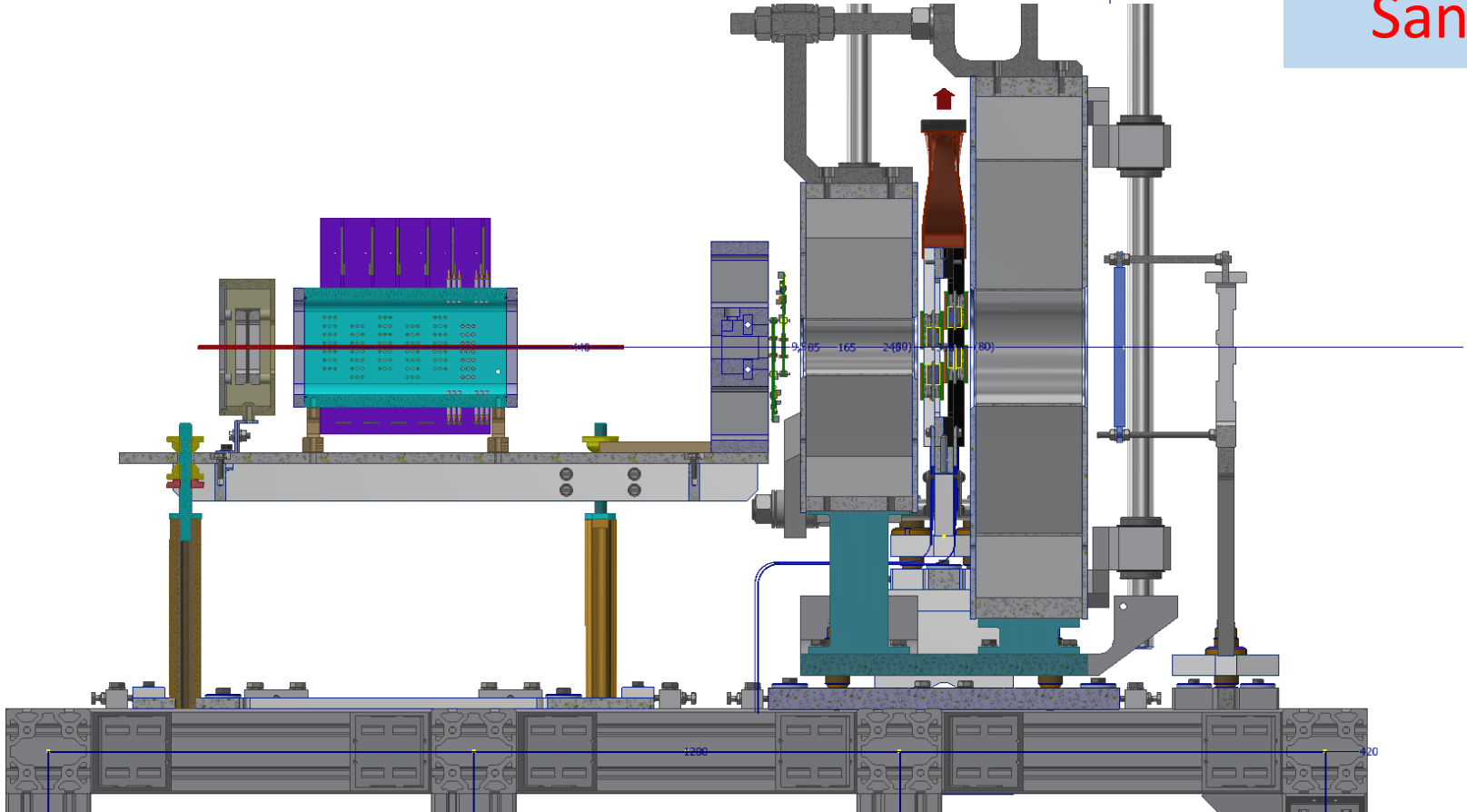
Magnetic system

				Radianti	Gradi
Lvtx	3,00	0,179	Accettanza M1 (gradi)	0,177	10,12
L1	11,00	0,177	Accettanza M2 (gradi)	0,175	10,02
Lit	5,00	0,171	Accettanza MSD (gradi)	0,169	9,70
L2	11,00	0,171	Accettanza IT1 (gradi)		
Lmsd	1,00		Accettanza IT2 (gradi)		
Rin1	2,50				
Rin2	5,30				
Dmsd	9,00				
ITdist	1,00				

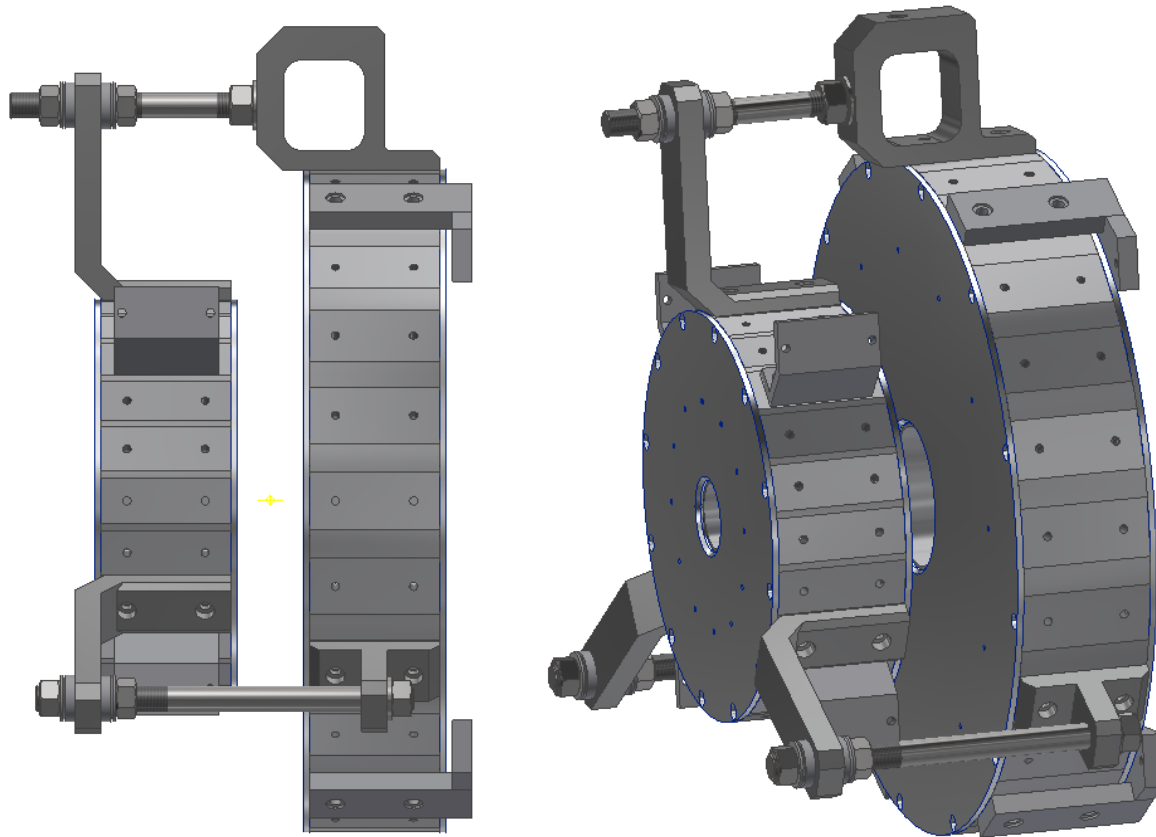




**FOOT Tracking region
Mechanical Layout:
designer
Sandro Tomassini**



	Z [mm]
TARGET	0
VERTEX	9.5
PM1	85
IT	165
PM2	245
MSD	330
S. COUNTER	- 440



Two Permanent Magnet Dipoles
in one assembly to avoid
handling issues (special toolings
required for safe handling)

Repulsion force: 2000 N @ 50
mm gap

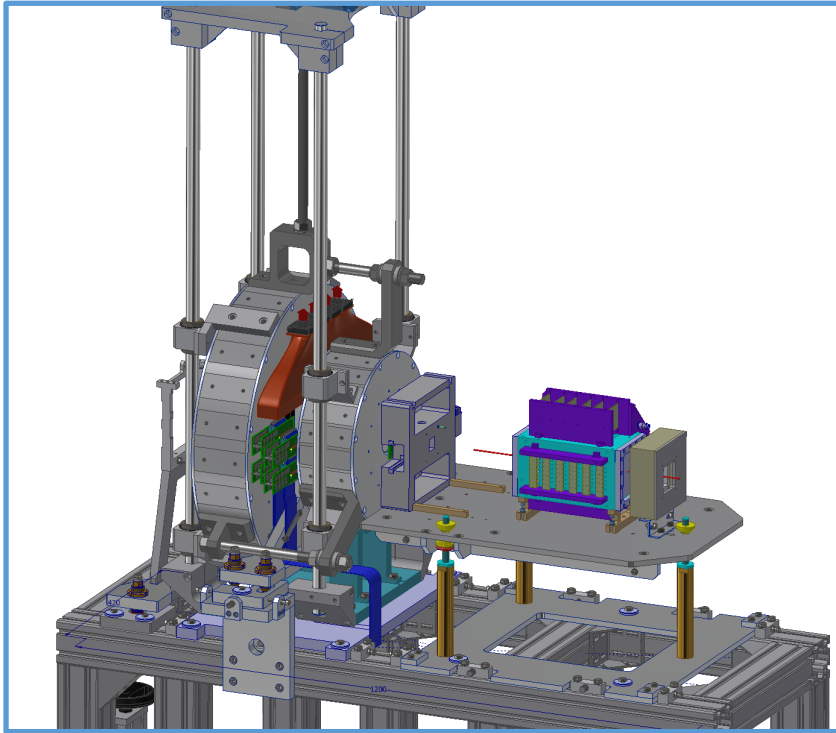
Weight: 250 kg

Magnetic field aligned at the
vendor

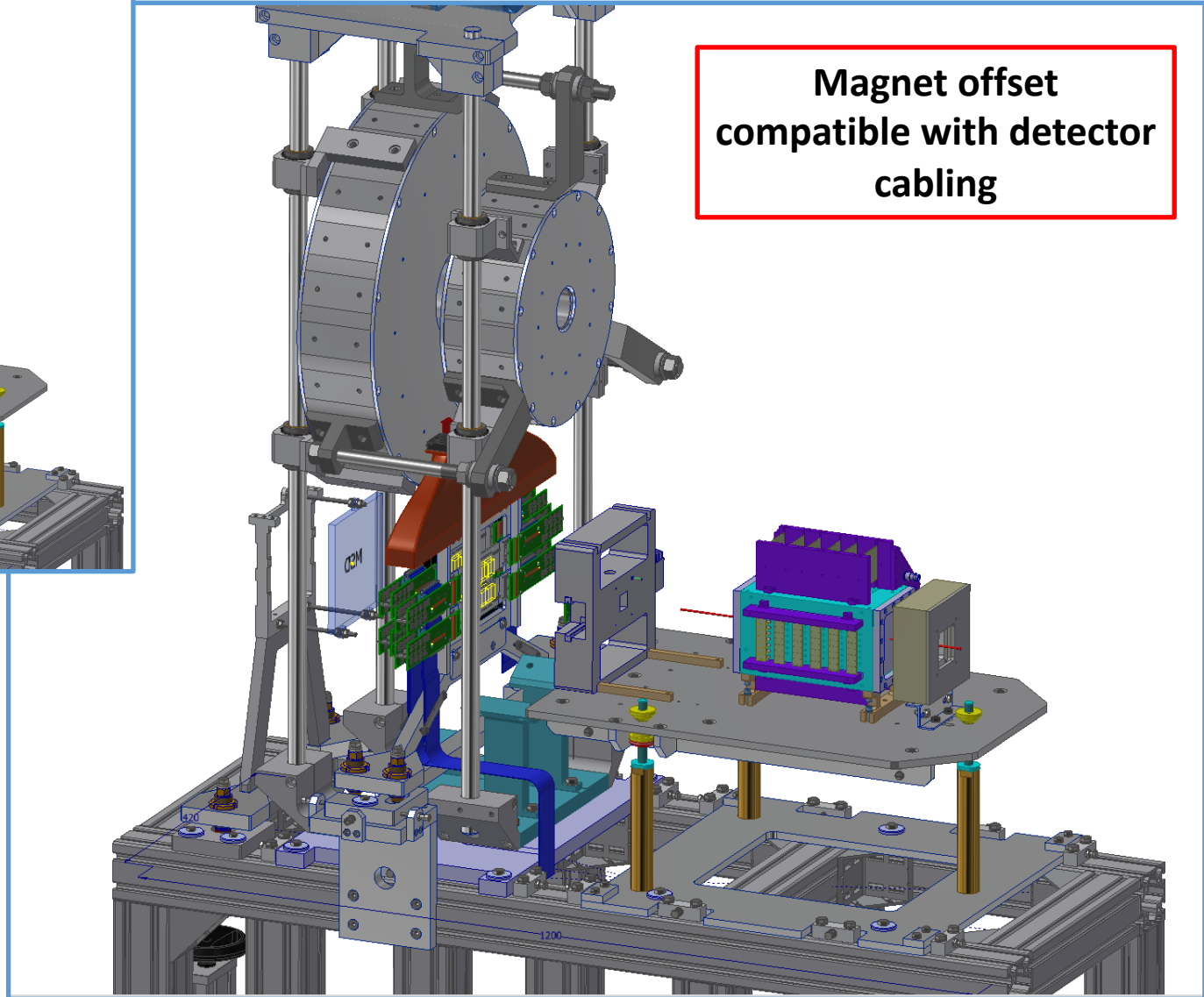
Magnetic map to be checked
at LNF after delivery

S. Tomassini, INFN-LNF- Research Division

Calibration with straight tracks

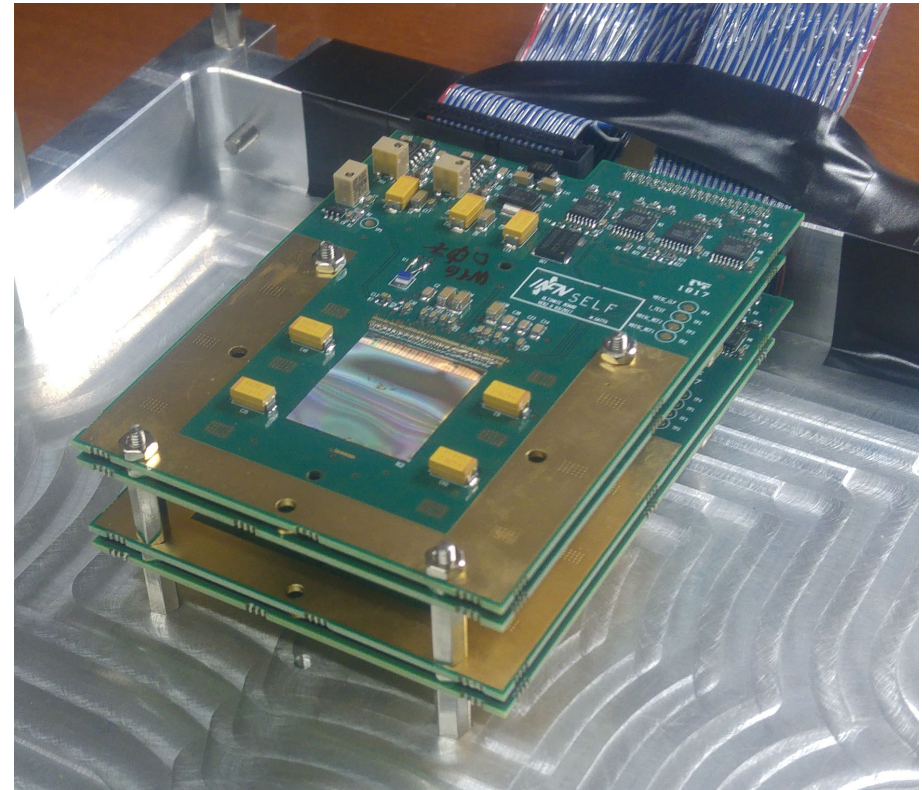
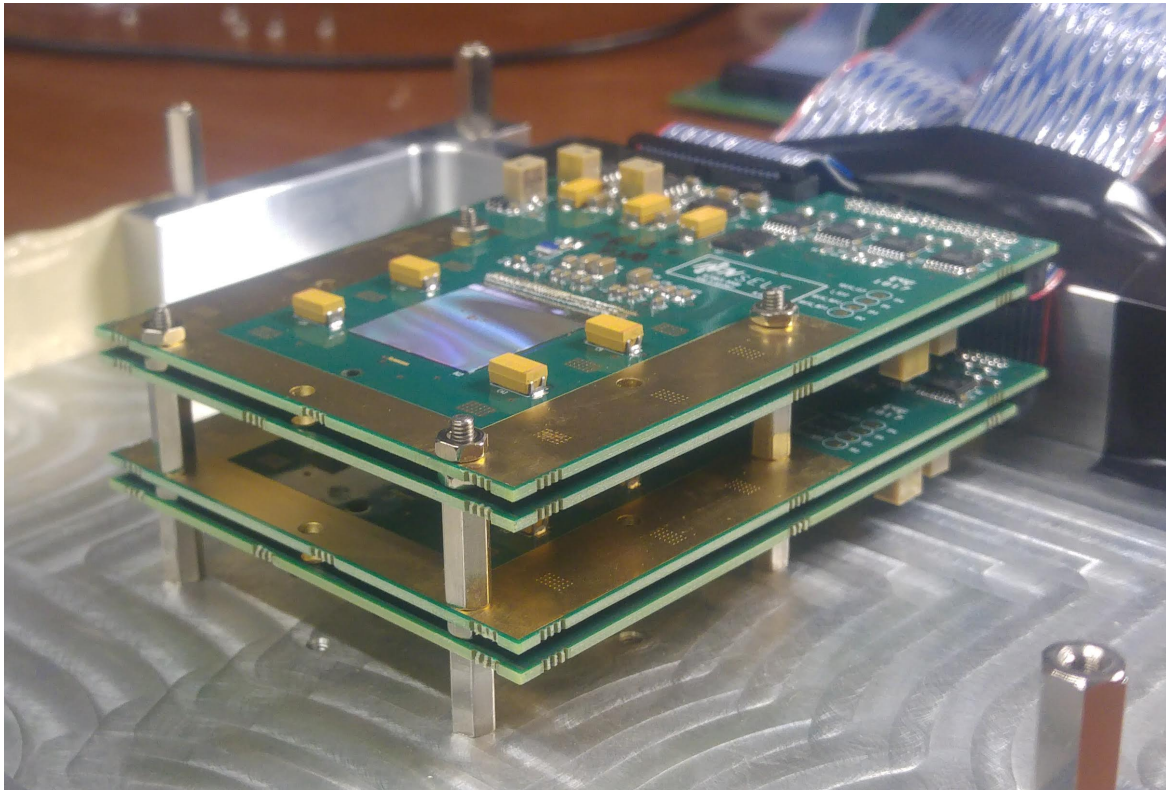


**Magnet offset
compatible with detector
cabling**

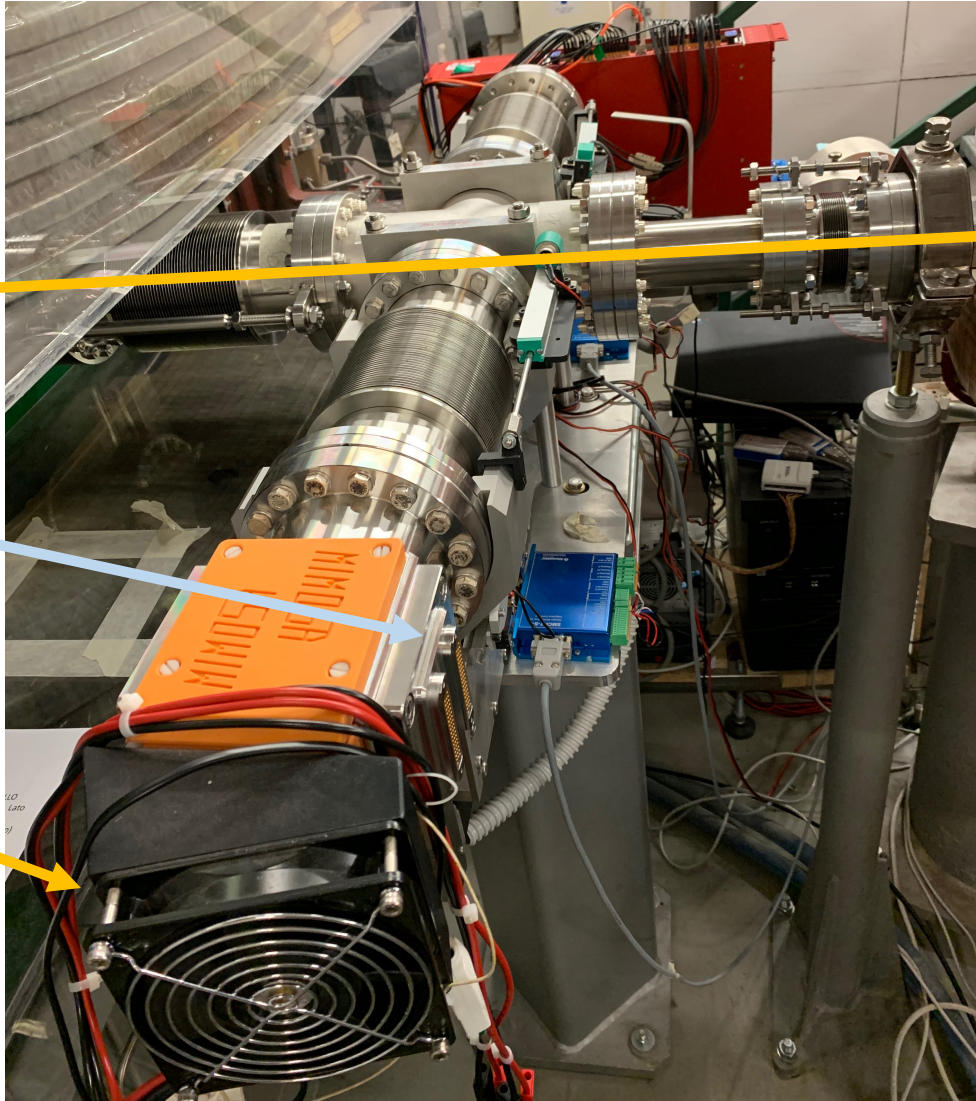


FOOT Vertex Tracker

- Four Ultimate boards, designed in Frascati (SEA), sensors glued and bonded in Strasbourg (IPHC - In2p3)
- Already used for data taking at GSI (Darmstadt)
- Already used for data taking at PADME (see next slide) **IN VACUUM**



Vertex: results from PADME



PADME beam line

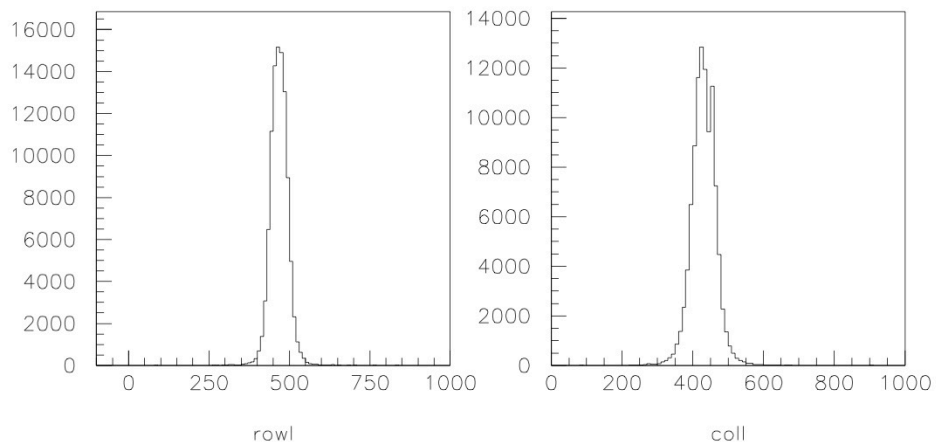
M28 signal connector

Cooling fan

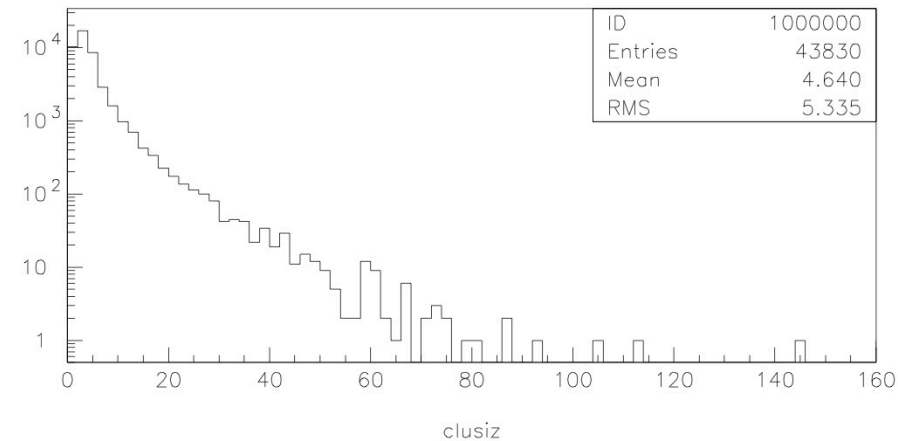
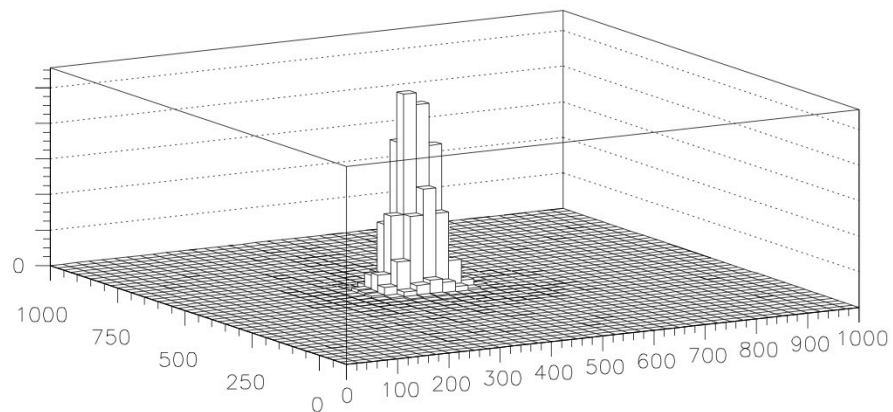
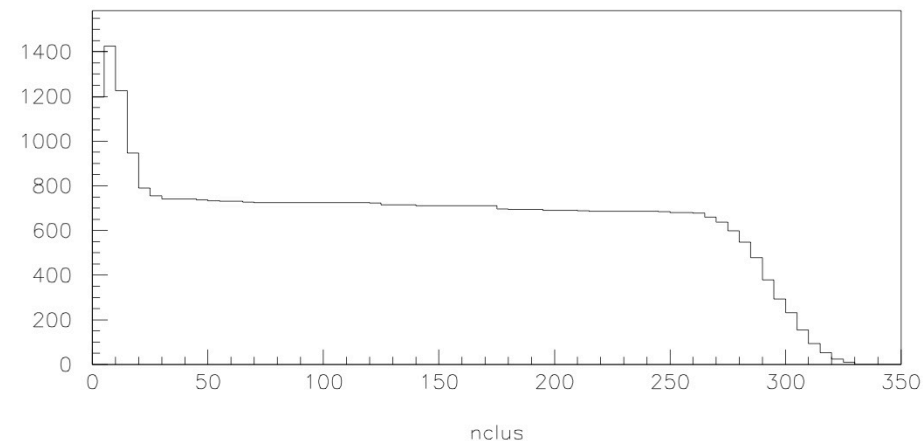
Vertex: results from PADME

Main goal of the measure: check maximum multiplicity allowed by Ultimate/M28
Collected about 1.5 Milion event without DAQ problems

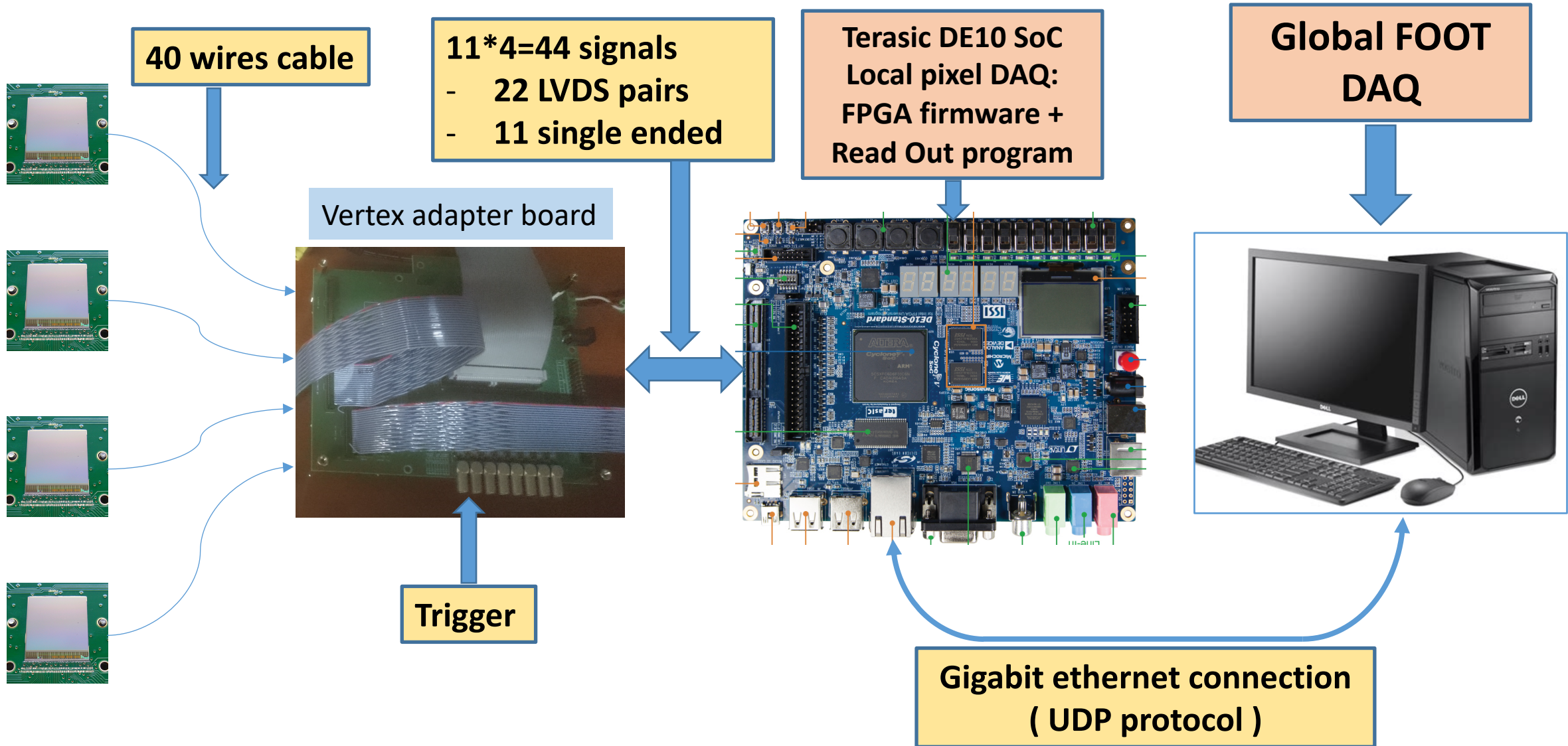
Beam profile (positrons @ about 500 MeV)



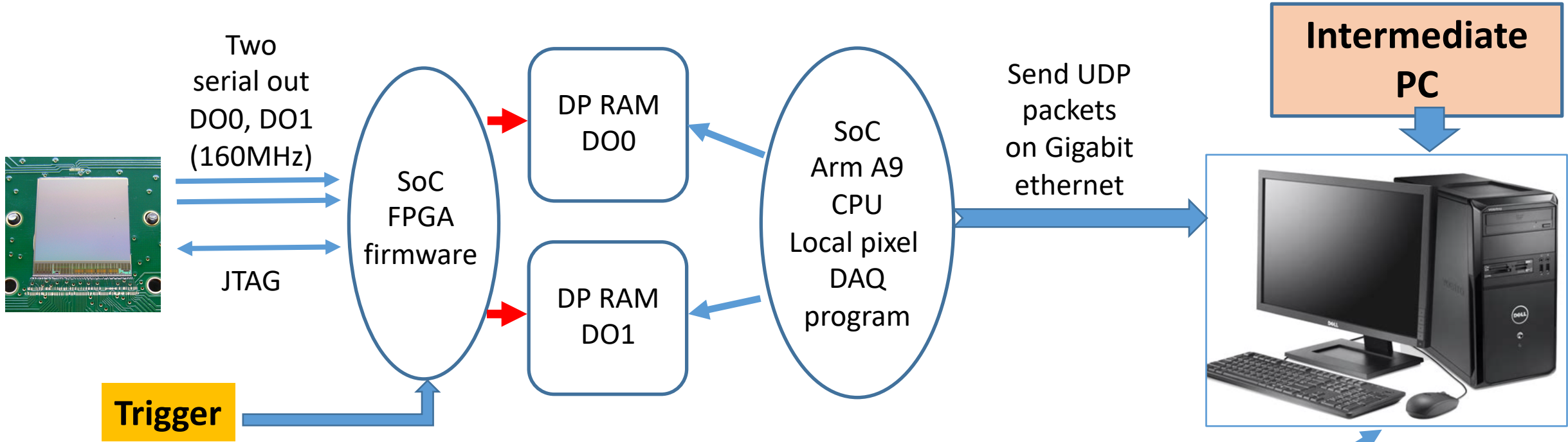
Cluster multiplicity and size



FOOT Vertex Readout Architecture



Readout Architecture logic (for both Vertex and IT)

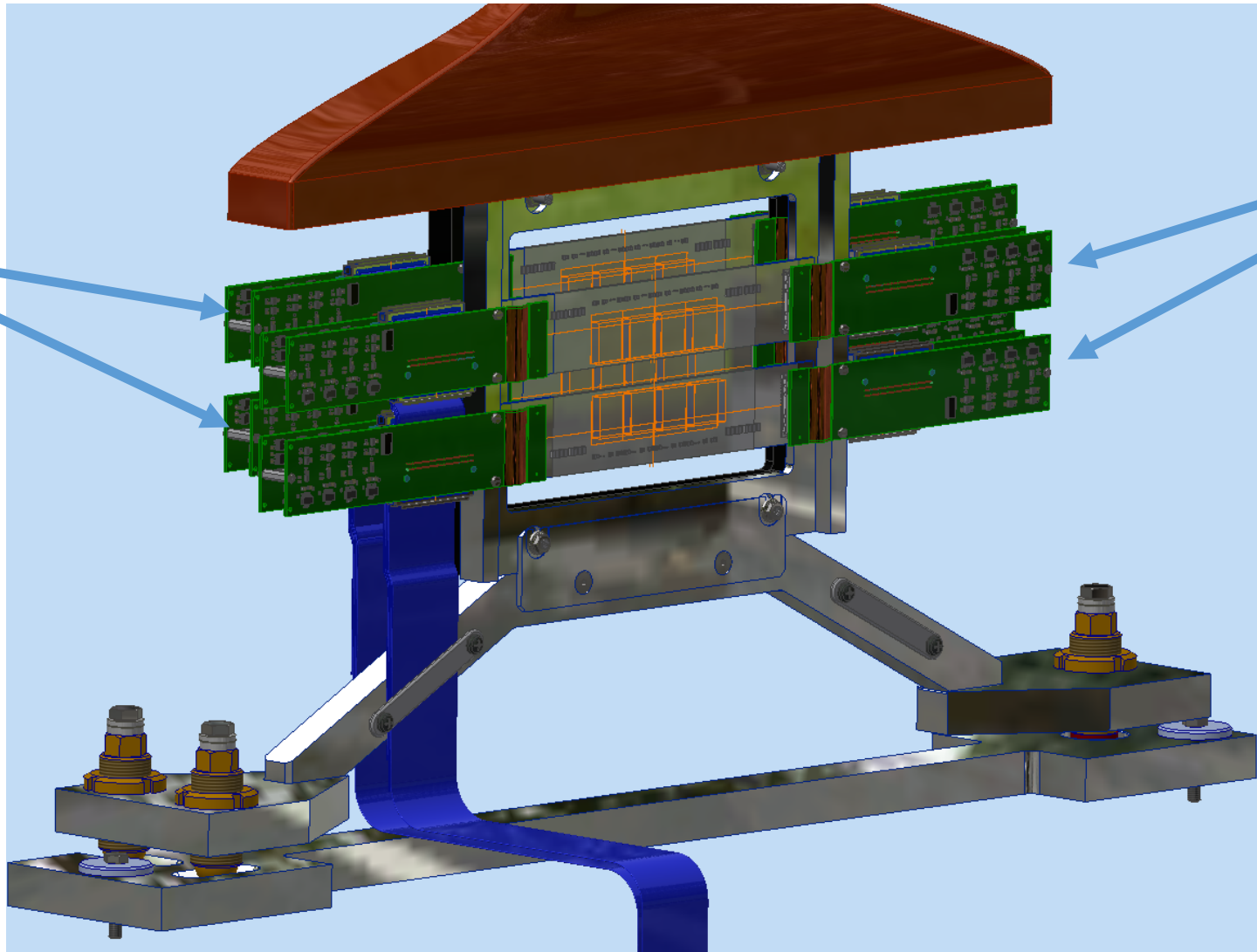


Architecture running also on PADME.
PADME trigger rate requirement at **50 Hz!!!!!!!!!!**

Data logger listening on sockets, one for each readout board and writing data on files.

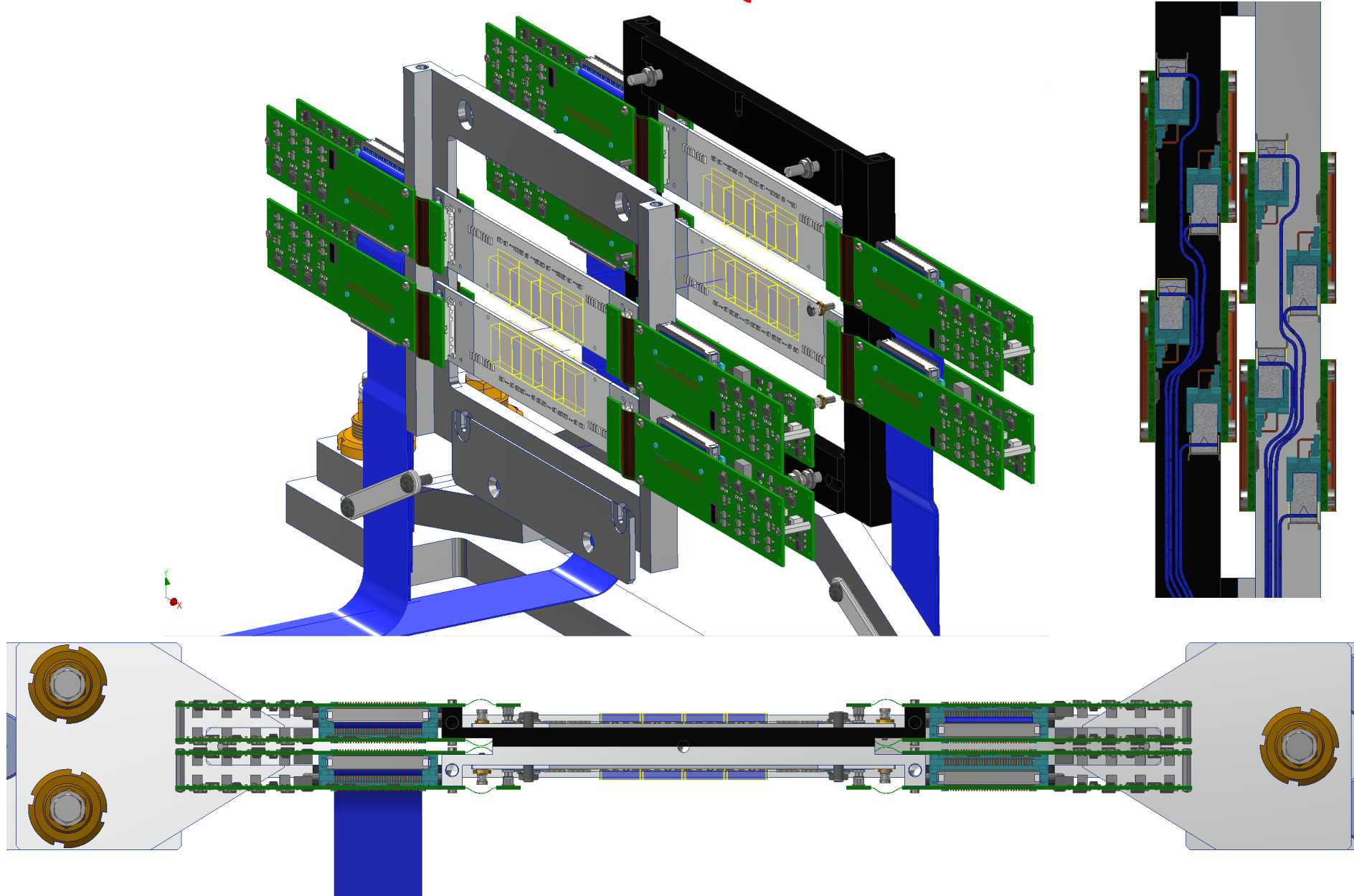
Inner Tracker (IT)

Two back ladders:
one PlumeM28
+
four
Adapter_Plume
M28
each



Two front ladders:
one PlumeM28
+
four
Adapter_Plume
M28
each

Inner Tracker INTEGRATION SEQUENCE



Inner Tracker (IT) status

Memorandum of Understanding between the Laboratori Nazionali di Frascati of the Istituto Nazionale di Fisica Nucleare (INFN-LNF) and the Institut Pluridisciplinaire Hubert Curien (IPHC) regarding the assembly of the FOOT inner tracker

1. Purpose

The purpose of this Memorandum is to document the understanding between the Laboratori Nazionali di Frascati (LNF) of the INFN, hereby represented by its Director, Dr. Fabio BOSSI, and the Institut Pluridisciplinaire Hubert Curien of Strasbourg (IPHC), hereby represented by its Director, Dr. Rémi BARILLON regarding the assembly work for the internal tracker of the FOOT experiment over the 2020-2021 timeframe.

2. Scientific and technical context

The FOOT experiment of INFN is run by a collaboration of different INFN sites and other institutes, including IPHC. The scientific goals of the experiment concern the measurement of nuclear fragmentation cross sections to be used in applied physics contexts such as medical physics and space radioprotection.

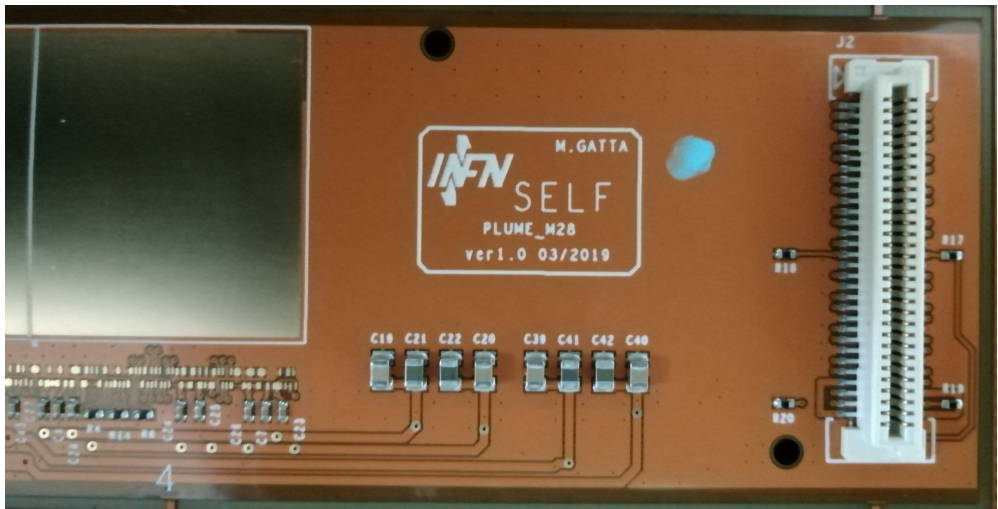
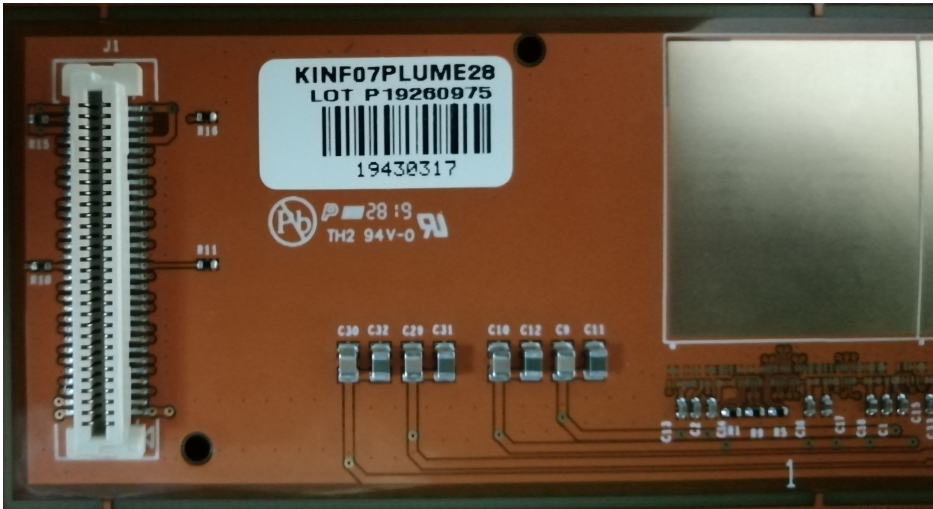
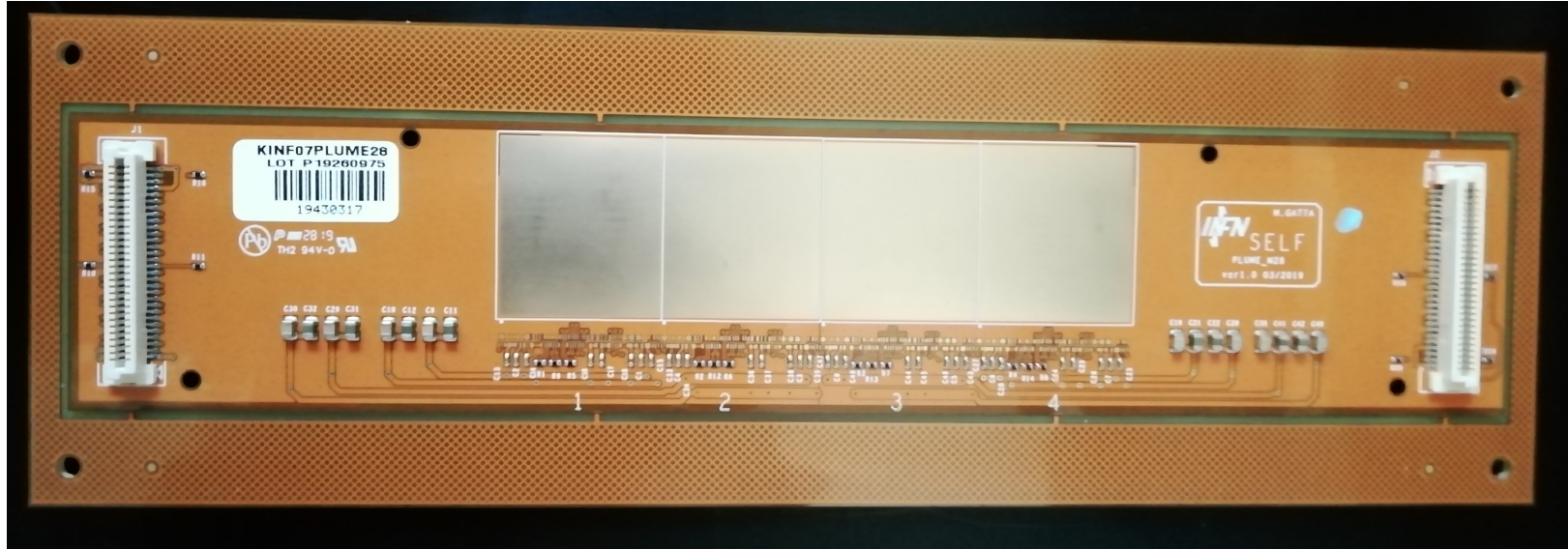
The apparatus currently under construction by the FOOT collaboration is a multi-detector, which includes a high precision inner tracker (ITR) made of 4 so-called detection *ladders*. Such ladders are built from the assembly of three main parts: CMOS pixel sensors, flex print cables and a spacer made of carbon-based foam.

**october 30,
2020
Final
signature of
MoU**

**december 4,
2020
Inner
Tracker
assembly
order issued**

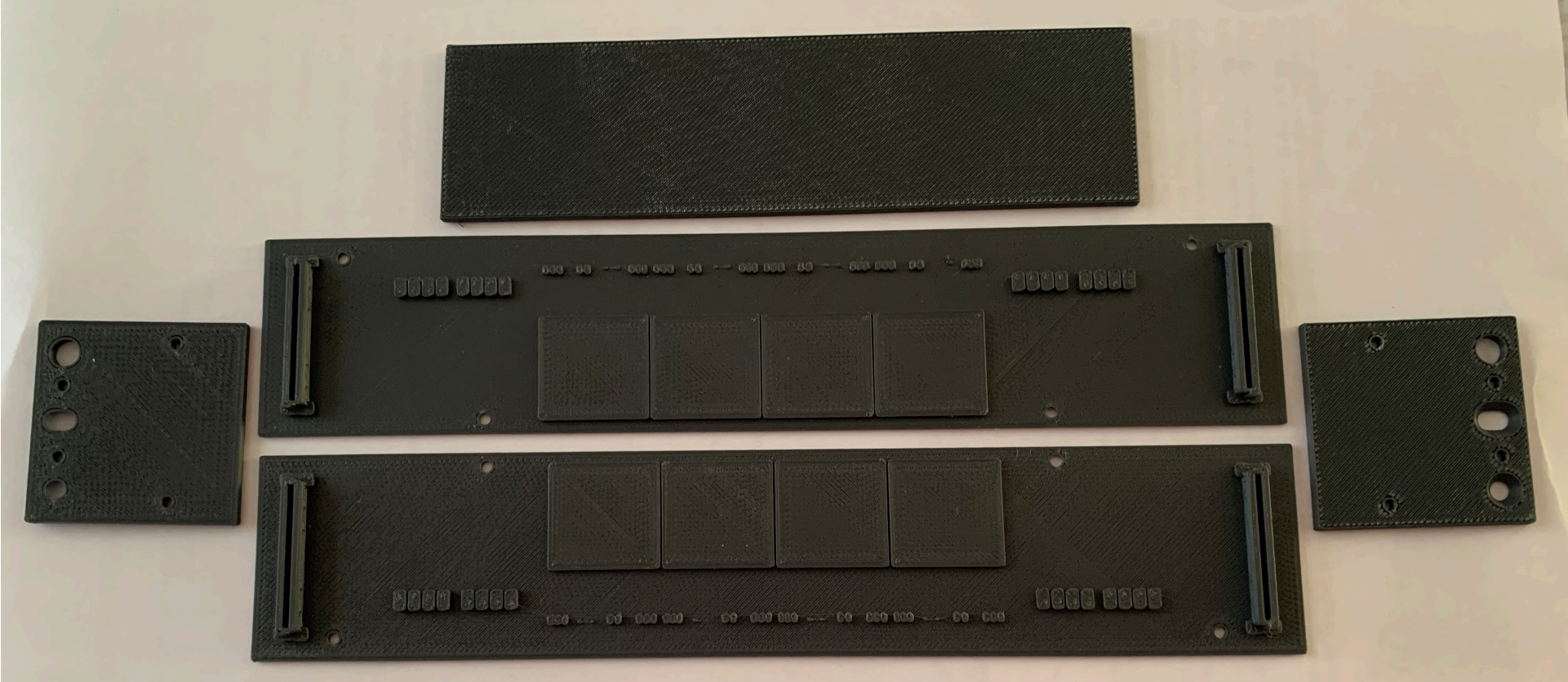
Inner Tracker (IT) status

The PlumeM28 first PCB prototypes

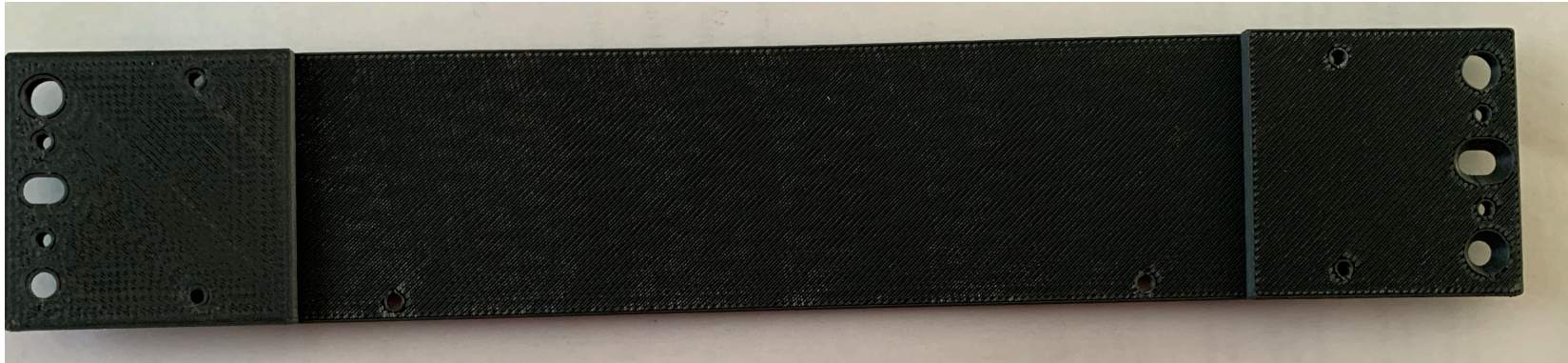


Inner Tracker (IT) status

3D pieces prototype for lab tests of assembly procedure



Inner Tracker (IT) status: Strasbourg activity

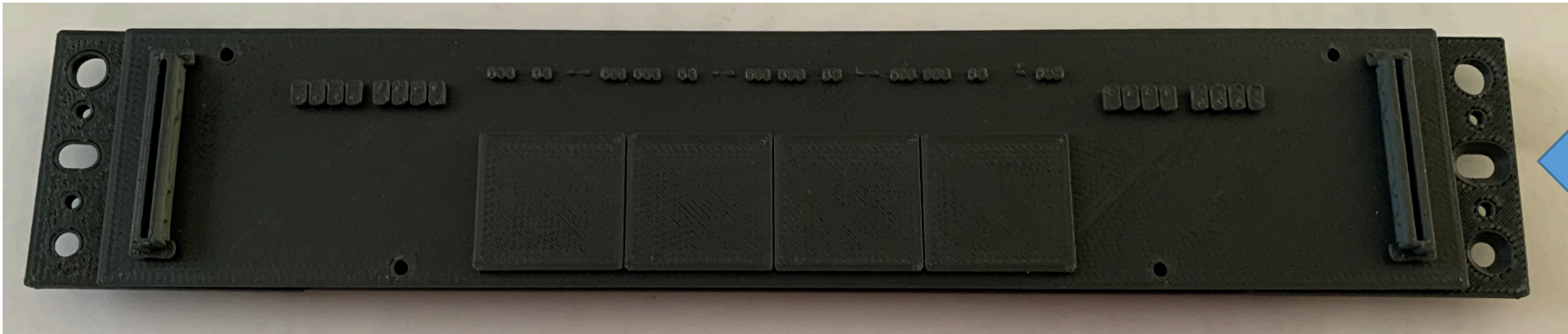


3D printed pieces

One module + 2 holders

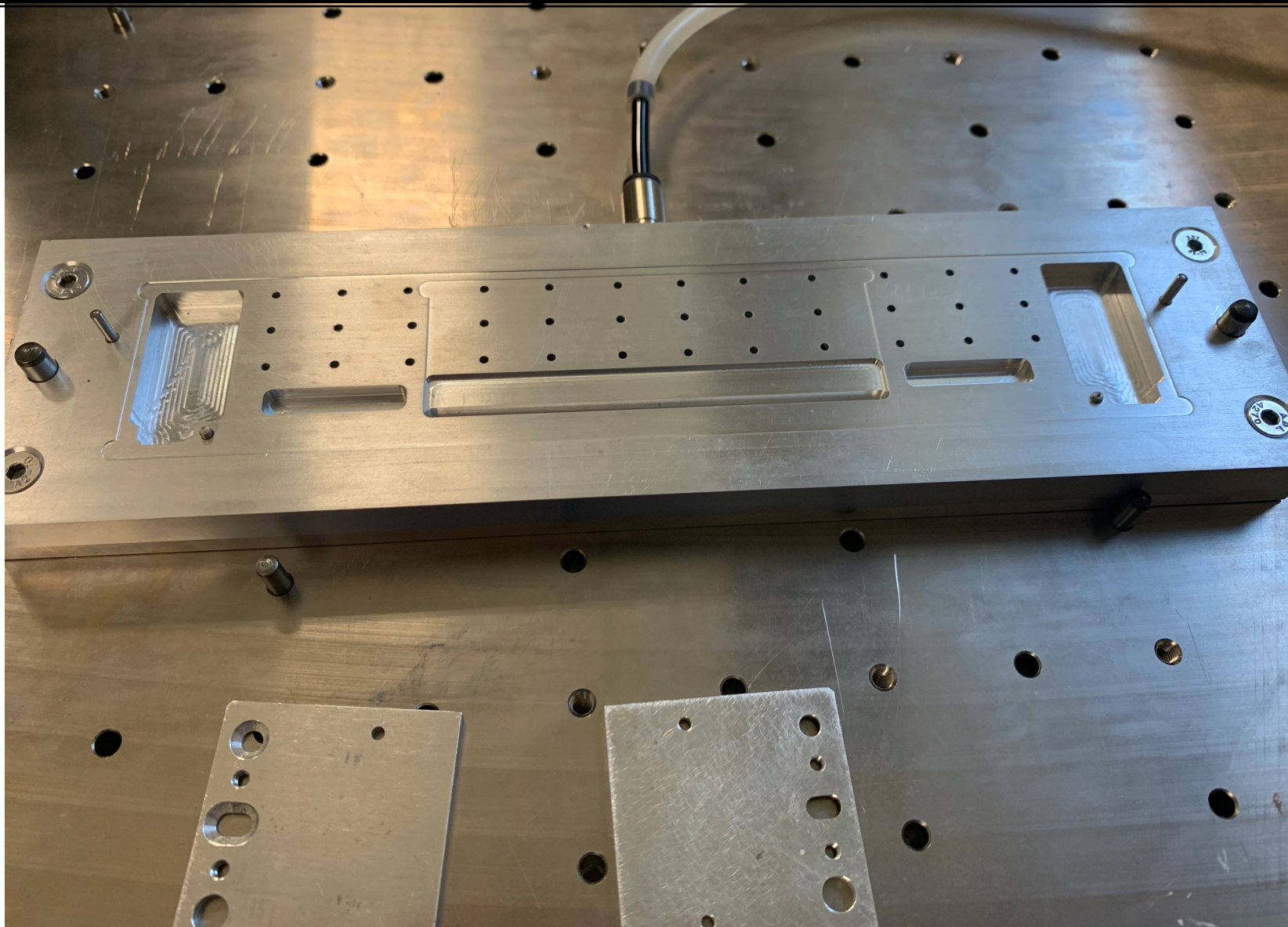


One module + 2 holders + foam

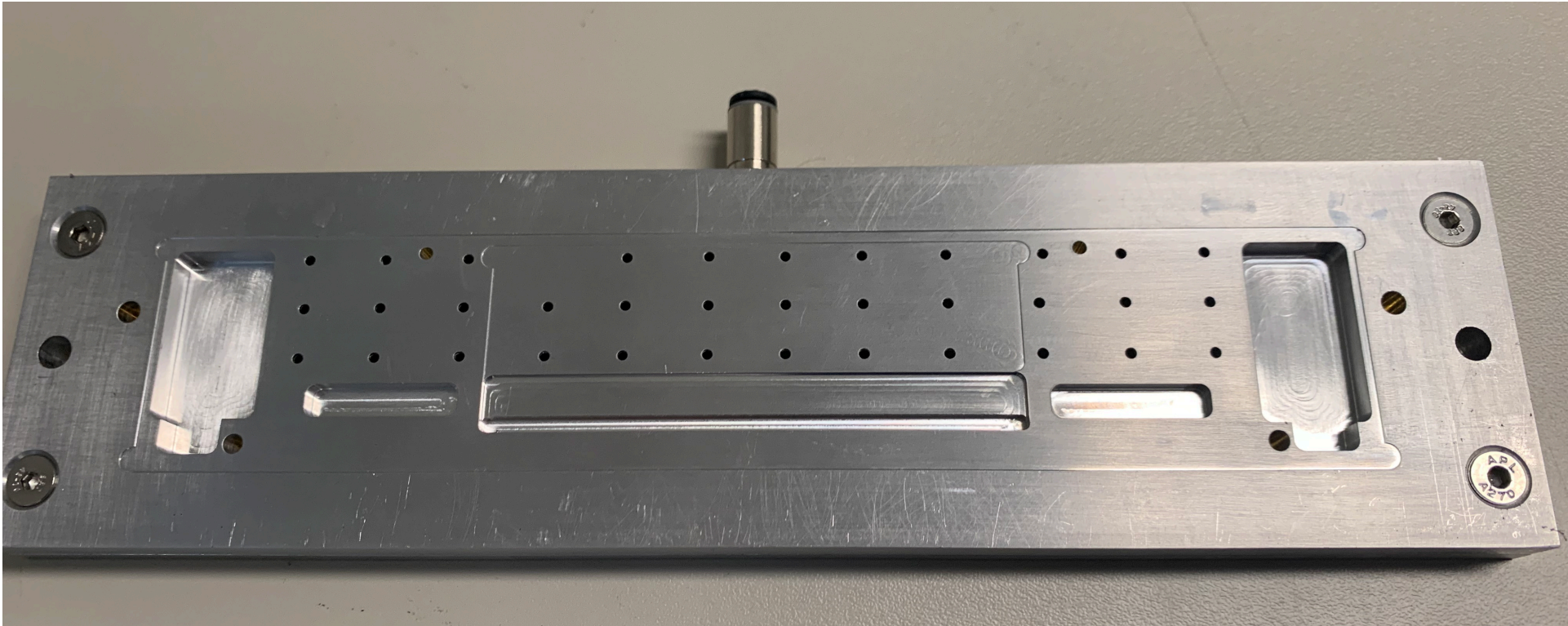


One module + 2 holders + foam + second module = one ladder

Inner Tracker (IT) final assembly jigs in Strasbourg



Inner Tracker (IT) final assembly jigs in Strasbourg

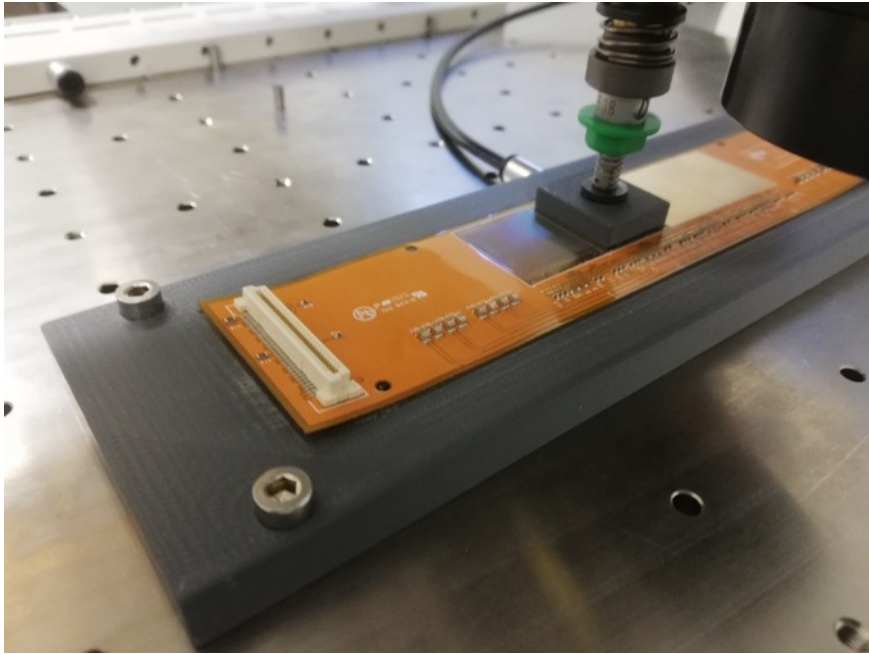
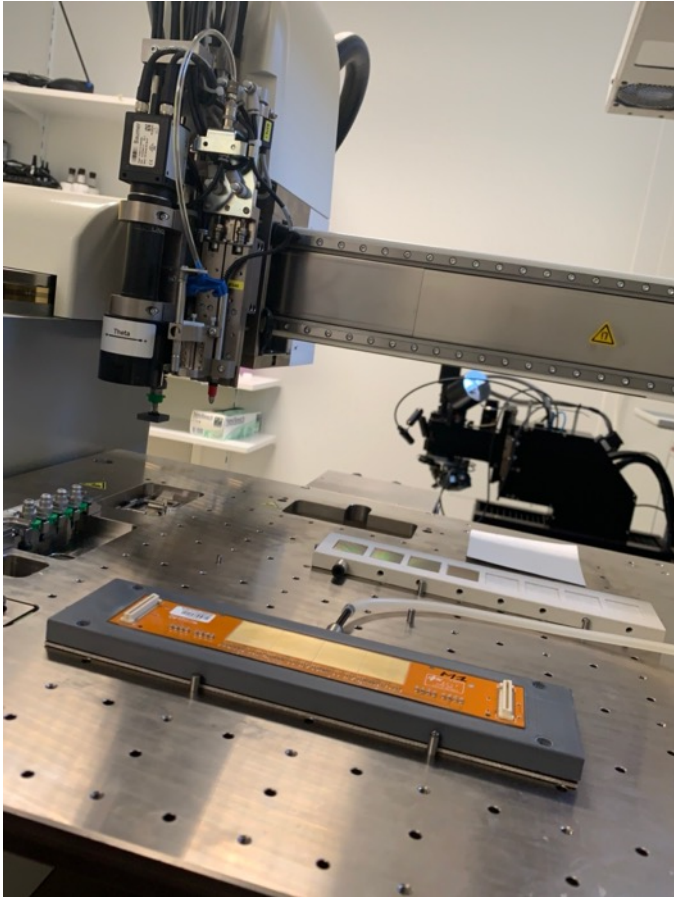


Inner Tracker (IT) list of needed components

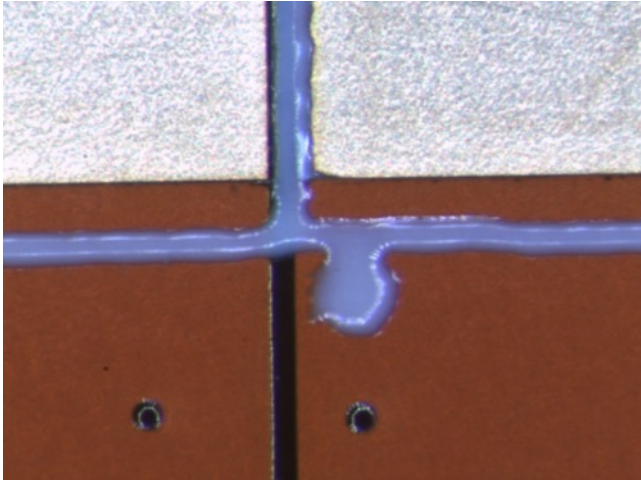
Overall for the IT we need 3 different PCBs:

- **PlumeM28** (kapton PCB) to hold the sensors
 - 1 PlumeM28 holds 4 sensors and is define a **module**. Two glued modules assembled with a RVC (**R**esistive **V**itreous **C**arbon foam) spacer thick 2mm forms a **Ladder**.
 - The Inner Tracker is composed by 4 Ladders covering (acceptance) about 8x8 cm.
- **Adapter_PlumeM28** (Flex-Rigid PCB) to collect signals from 2 sensors (half of PlumeM28) on each side of a module and houses transceivers, monitors currents and voltages and includes “interlock” circuitry. Each adapter_PlumeM28 is connected by a 68 wires flat cable to the subsequent CableAdapter_PlumeM28 board.
- **CableAdapter_PlumeM28** that translates all differential signals to single ended, provide the power supplies and master the Tigger, Busy, cloclk, etc... control signal.
 - Two of this boards (we need 16 of this boards) are connectet to a **DE10_nano_SoC**
- **DE10-Nano-SoC from Terasic** each of the 8 needed reads 4 M28 sensors from 2 different PlumeM28 ladders. Sends data via one Gigabit link to the intermediate PC.

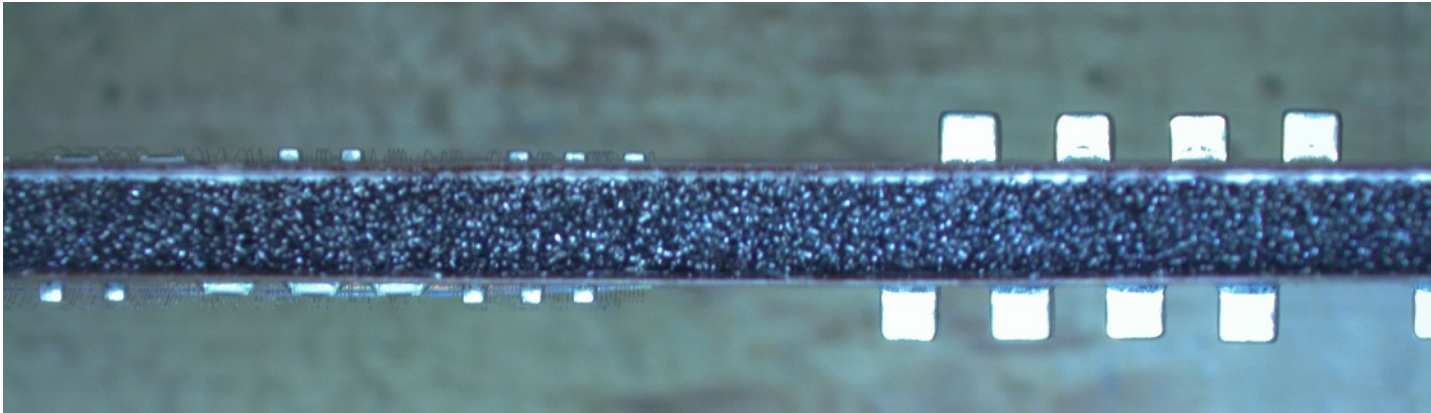
Inner Tracker ladder assembly in Strasbourg sensors (M28) placement



Inner Tracker ladder assembly in Strasbourg sensors (M28) placement and gluing



Dummy modules
Dummy stave
March 2021



Inner Tracker ladder assembly in Strasbourg

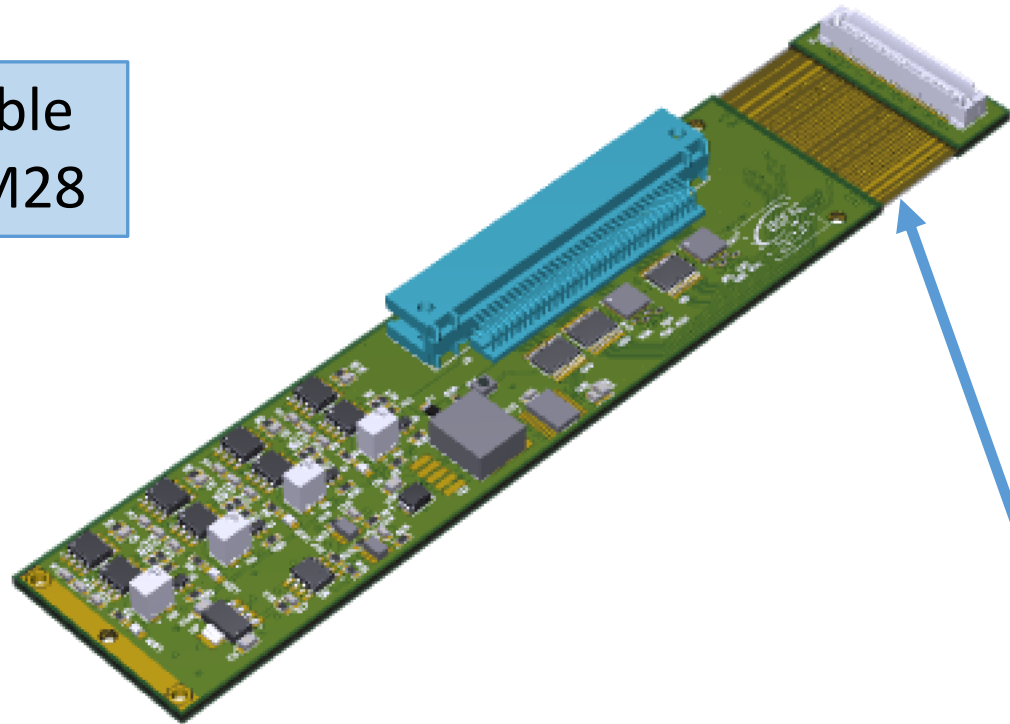
First real module produced



Inner Tracker (IT) status

The Adapter_PlumeM28 (produced only 4 prototypes)

Output 68 pins for flat cable to CableAdapter_PlumeM28

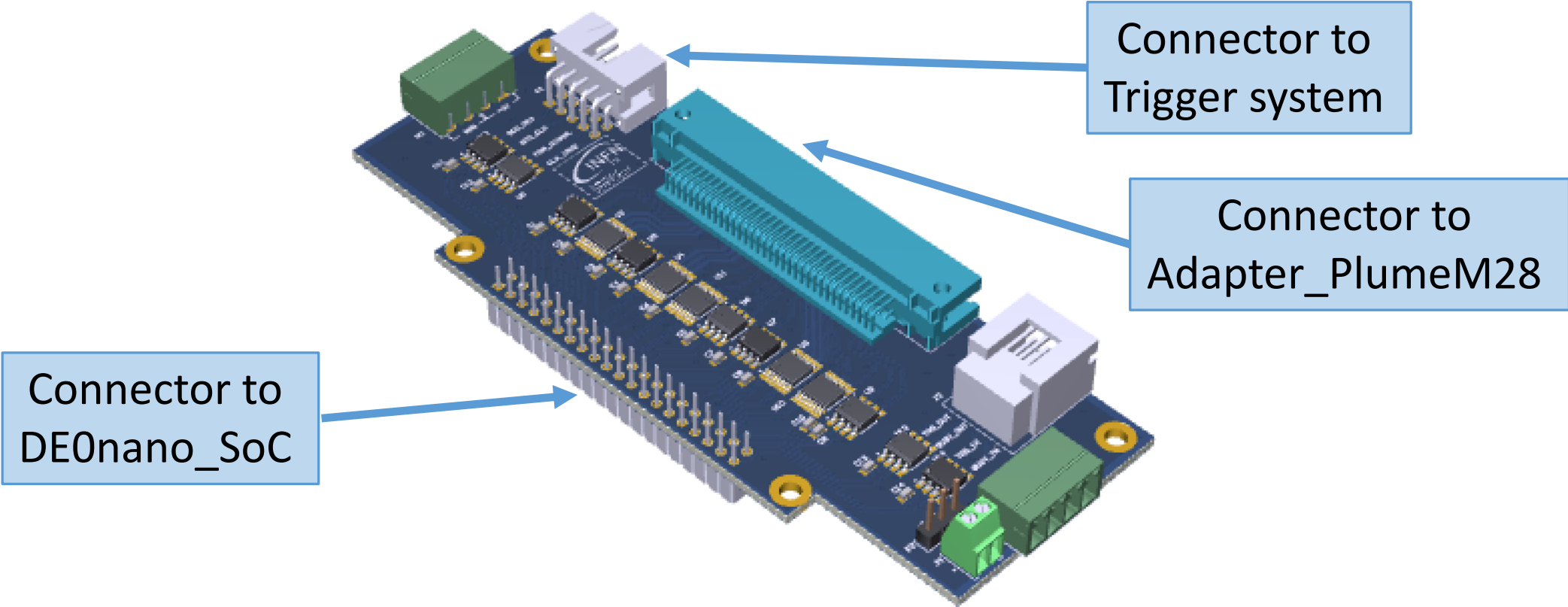


Connector to PlumeM28 side A/B

Kapton cable to mechanical Decouple the PlumeM28 to the Adapter

Inner Tracker (IT) status

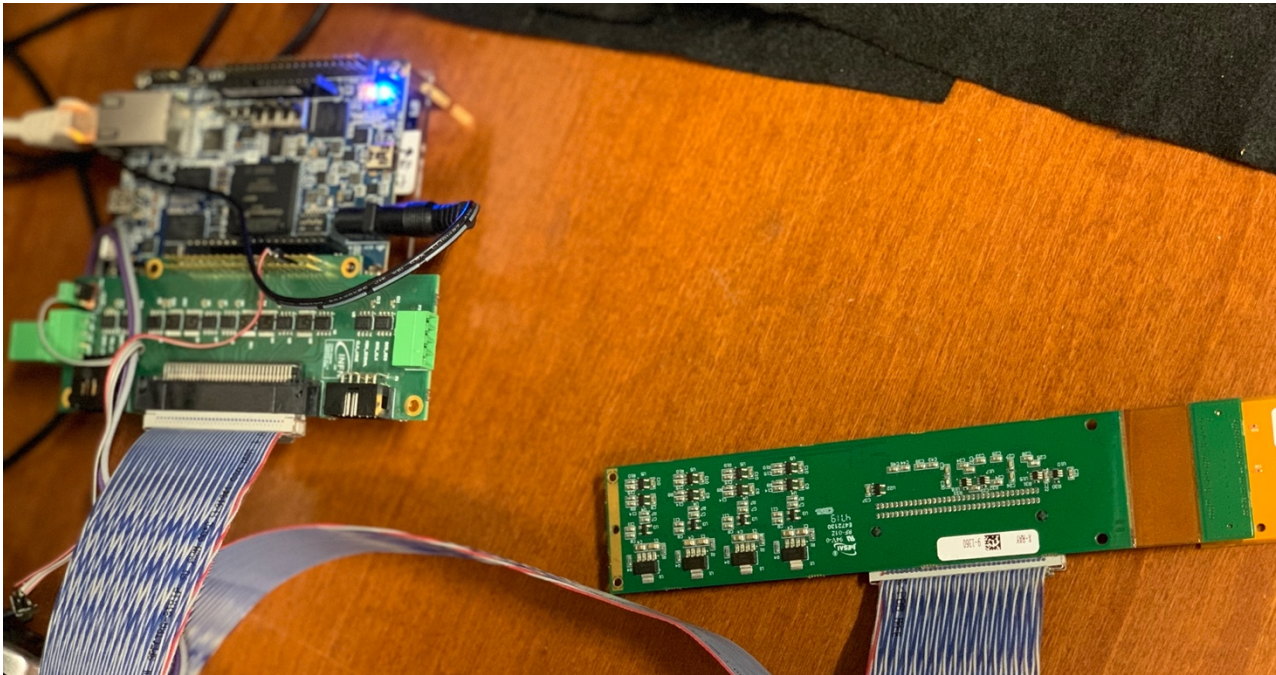
The CableAdapter_PlumeM28 (all produced)



Inner Tracker (IT) ladder test system (to be provided to Strabourg group for ladder production testing)



NOW under test in Frascati



The testing system we used is composed by three different pieces:

- The Terasic DE0 nano board.
- The CableAdapter_plume M28 connected to one of the GPIO connector of the Terasic board.
- The Adapter_PlumeM28 board connected to one of the two 60 pin connectors housing each the signals of 2 M28 sensors.

FOOT LNF richieste Gr. III - 2022

Ricercatori					
Nome	Età	Contratto	Qualifica	Aff.	%
1 Sanelli Claudio		Associato	Ass.Senior		0
2 Sciubba Adalberto		Associato	Prof. Ordinario	CSN III	100
Numero Totale Ricercatori			2	FTE: 1.00	

Tecnologi					
Nome	Età	Contratto	Qualifica	Aff.	%
1 Raffone Guido		Dipendente	Primo Tecnologo	CSN I	50
2 Spiriti Eleuterio		Dipendente	Primo Tecnologo	CSN III	60
3 Tomassini Sandro		Dipendente	Tecnologo	CSN I	10
Numero Totale Tecnologi			3	FTE: 1.20	

Tecnici					
Nome	Età	Contratto	Qualifica	Aff.	%
Numero Totale Tecnici			0	FTE: 0.00	

Richieste finanziarie 2022 FOOT LNF

- Richiesto slocco sub judice costruzione apparati (15Keuro) per produzione schede adapter_PlumeM28 (assemblate solo 4 prototipi)
- Per il 2022 si richiederà per costruzioni apparati il necessario (stima da definire in dettaglio) per la costruzione della meccanica di supporto dei magneti e dei rivelatori di tracciamento (Vertice ed Inner Tracker)

Conclusions

FOOT tracker mechanical setup:

- Final mechanical design under way (check of magnets mechanical constrains)

Pixel vertex detector:

- Tested at GSI
- Debugged and solved readout bugs at the BTF july 2019 test
- Deeply tested in PADME
- Recently tested with the general FOOT DAQ system at LNF
- Slow control firmware under development

Magnet system:

- Production started recently

Inner Tracker:

- Plume ladder assembly process definition concluded in Strasbourg
- All production tools available
- **First module produced (under test at LNF)**
- **Adapter_PlumeM28 boards to be produced**