Attività di Gruppo 3

- ALICE
  - Spettrometro per muoni
  - ITS3
  - Analisi dati
- NA60+/DiCE

Anagrafica

- **2025**

Ricercatori				
Nome	ALICE	TELE_NEURART (sinergico ALICE)	NA60+	Totale GR3
Bosin Andrea	1.0		0.0	1.0
Cicalò Corrado	0.7		0.1	0.8
De Falco Alessandro	0.7		0.1	0.8
Fionda Fiorella	0.8		0.2	1.0
Masoni Alberto	0.4	0.3	0.1	0.8
Mulliri Alice	0.5		0.5	1.0
Sarritzu Valerio	0.7		0.3	1.0
Usai Gianluca	0.5		0.5	1.0
Totale FTE Ricercatori	**5.3**	**0.3**	**1.8**	**7.4**
Tecnologi				
Mura Daniele	0.3	0.3	0.1	0.7
Sabayashi Siddhanta	0.7		0.3	1.0
Puggioni Carlo	0.5	0.3	0.2	1.0
Totale FTE Tecnologi	**1.5**	**0.6**	**0.6**	**2.7**
Tecnici				
Arba Mauro	0.2		0.1	0.3
La Delfa Luigi	0.1		0.1	0.2
Marras Davide	0.2		0.1	0.3
Tuveri Marcellino	0.1		0.1	0.2
Totale FTE Tecnici	0.6	0	0.4	1
Totale FTE Ric.+Tecn.	**6.8**	**0.9**	**2.4**	**10.1**

2026

Ricercatori				
Nome	ALICE	TELE_NEURART (sinergico ALICE)	NA60+	Totale GR3
Bosin Andrea	1.0		0.0	1.0
Cicalò Corrado	0.7		0.1	0.8
De Falco Alessandro	0.7		0.1	0.8
Fionda Fiorella	0.8		0.2	1.0
Masoni Alberto	0.4	0.3	0.1	0.8
Mulliri Alice	0.0		1.0	1.0
Sarritzu Valerio	0.7		0.3	1.0
Dukhishyam Mallick	0.7		0.3	1.0
Victor Feuillard	0.7		0.3	1.0
Usai Gianluca	0.5		0.5	1.0
Totale FTE Ricercatori	**6.2**	**0.3**	**2.9**	**9.4**
Tecnologi				
Mura Daniele	0.3	0.3	0.1	0.7
Sabayashi Siddhanta	0.7		0.3	1.0
Puggioni Carlo	0.5	0.3	0.2	1.0
Totale FTE Tecnologi	**1.5**	**0.6**	**0.6**	**2.7**
Tecnici				
Arba Mauro	0.2		0.1	0.3
La Delfa Luigi	0.1		0.1	0.2
Marras Davide	0.2		0.1	0.3
Tuveri Marcellino	0.1		0.1	0.2
Totale FTE Tecnici	0.6	0	0.4	1
Totale FTE Ric.+Tecn.	**7.7**	**0.9**	**3.5**	**12.1**

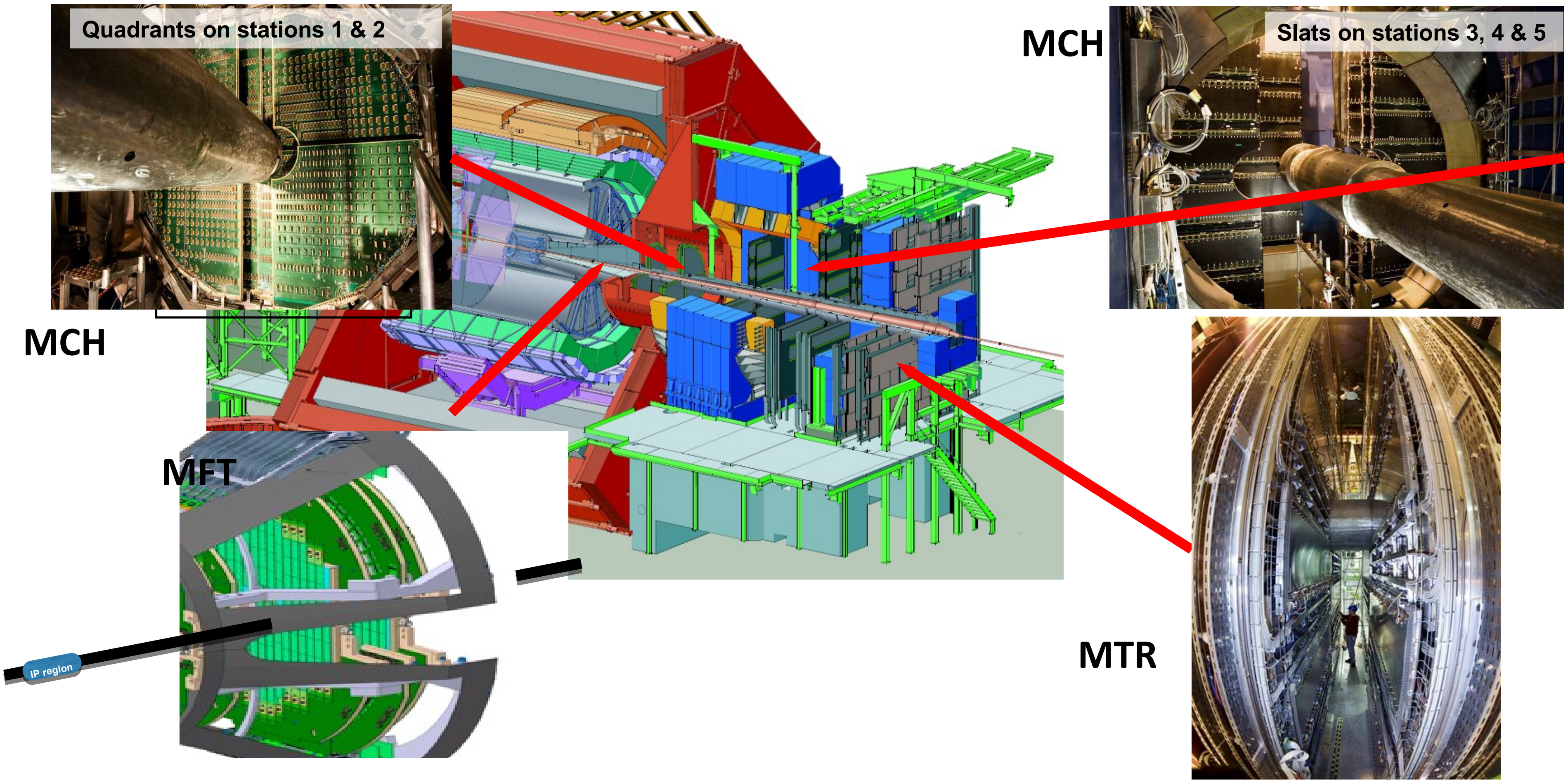
Metabolismo

- Il metabolismo viene calcolato sulla base degli FTE

- Missioni: (fte*1.05+4)*0.57 → 9.5 kEUR
- Consumo: fte * 0.5 → 6
- Seminari fte * 0.1 → 1
- Pubblicazioni fte * 0.2 → 2.5
- Inventario (10/2.7971) * ln(fte)^1.5 → 14

- Tot. non missioni = 23.5
- Tot. = 33

Il muon tracking



DCS

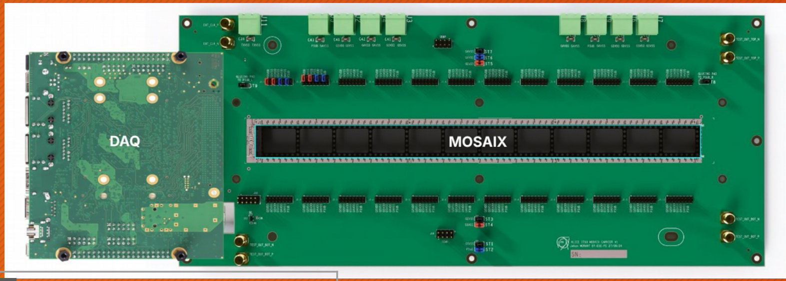
- Siamo responsabili del DCS del tracking (M.Arba)
- Nel 2025:
  - Riscrittura script di configurazione dell'elettronica in modo da renderlo più efficiente e più facilmente upgradabile
  - Intervento sul FRED Server (interfaccia tra il DCS e le CRU) per cambio configurazione da gestione per ogni singolo detector a parte commune ad ALICE e parte con gestione Muon Arm.
  - Manutenzione
- Nel 2026:
  - realizzazione di un tool per la riconfigurazione al volo di parte del rivelatore via DCS durante il run.

Presa dati 2025 e stop invernale 2025-26

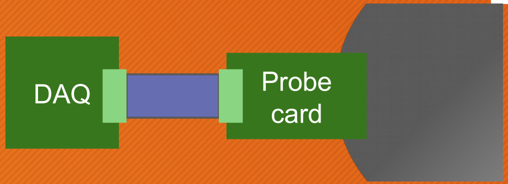
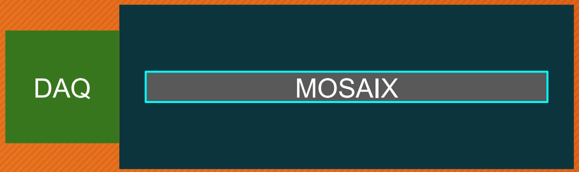
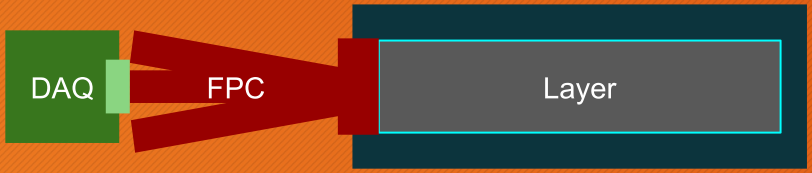
- Stop invernale 2025-26 più breve causa restart del fascio anticipato nel 2026
- Nel run Pb-Pb del 2025 ci si aspetta un miglioramento delle prestazioni del Sistema di tracking a causa della sostituzione dei quadranti della stazione 2 e la stabilizzazione del sistema di readout
- Test durante la prese dati in corso…
- Per ora sono previsti solo interventi di manutenzione di routine durante lo stop invernale (YETS) 2025-26
- Programma da rivalutare dopo la presa dati Pb-Pb di fine anno 2025

ITS 3 Readout electronics

WP3.3: Valerio Sarritzu, Markus Keil (CERN)



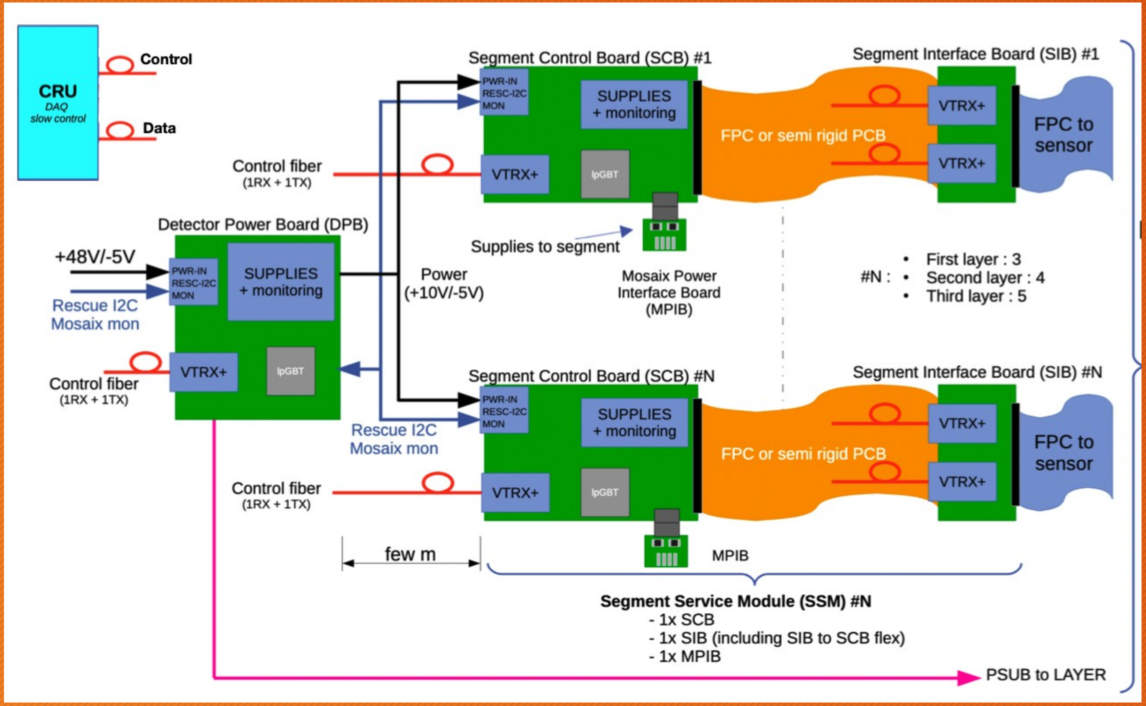
Preparazione del test del sensore di ITS3 + sviluppo software per operazione detector in ALICE.
Sviluppo sistema DAQ basato su FPGA +
Scenari di test:

1.	**Wafer probing**		**DAQ + probe card** **Test dei wafer per selezionare i migliori sensori per la caratterizzazione e costruzione del prototipo**
2.	**Lab & beam tests**		**DAQ + carrier card** **Caratterizzazione in laboratorio (es. threshold scan, fake hit rate, sorgente) e su beam (efficienza, risoluzione)**
3.	**Qualification model**		**DAQ + prototipo rivelatore** **Test funzionali durante l'integrazione meccanica e operazione del detector senza necessità della CRU**

ITS 3 Readout electronics

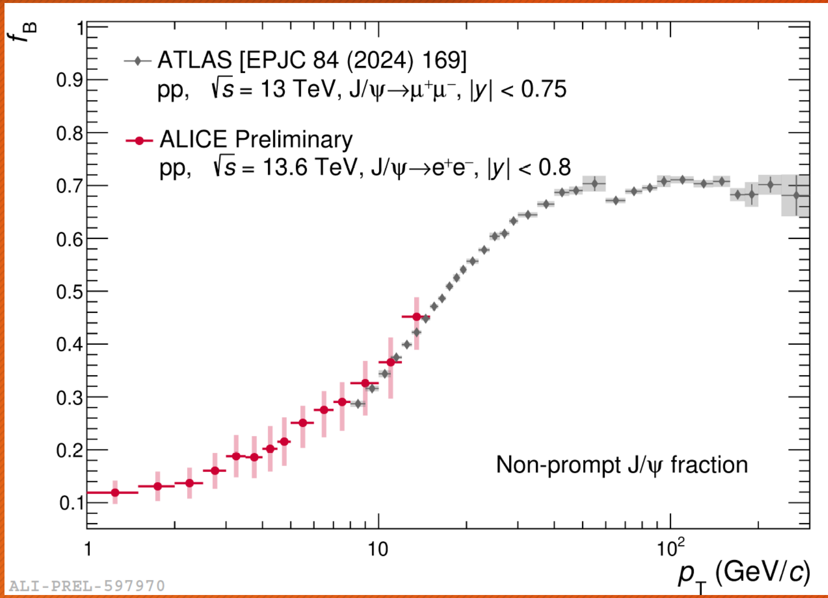
Cagliari is also involved in the readout electronics and services for ITS3 and has a coordination role (Sabyasachi Siddhanta).

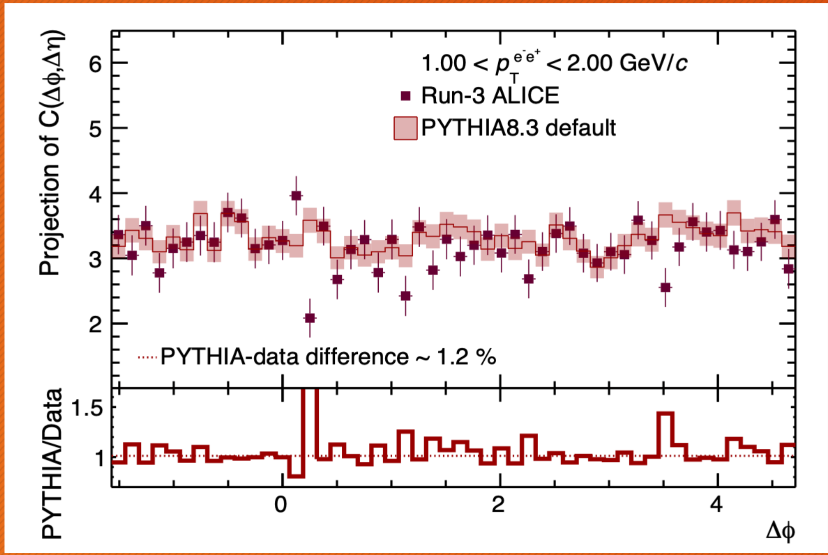
The first prototypes of the readout cards are being tested. Preparation ongoing for a qualification model with a half-detector with the associated test system, which would serve as a reference system.



Attività di analisi in dielettroni

- Fiorella Deputy physics coordinator (from June 2024)
- Run2 analyses:
  - Prompt and non-prompt J/Ψ-h correlations in pp at 13 TeV (in collaboration with L. Altenkamper, PhD Bergen) → publication accepted by JHEP in May 2025
  - J/Ψ production in jets in pp at 13 TeV (in collaboration with I. Lofnes, Postdoc Bergen) → paper proposal approved by the ALICE Collaboration, currently under internal review
- Run3 analyses:
  - Measurements of non-prompt J/Ψ fraction in pp at 13.6 TeV (in collaboration with S. Achyaria, postdoc Bari) → approved as preliminary at Quark Matter 2025
  - Prompt and non-prompt J/Ψ-h correlations in pp at 13.6 TeV (in collaboration with V. Feuillard, postdoc Cagliari and S. Achyaria, postdoc Bari) → results at performance level
-





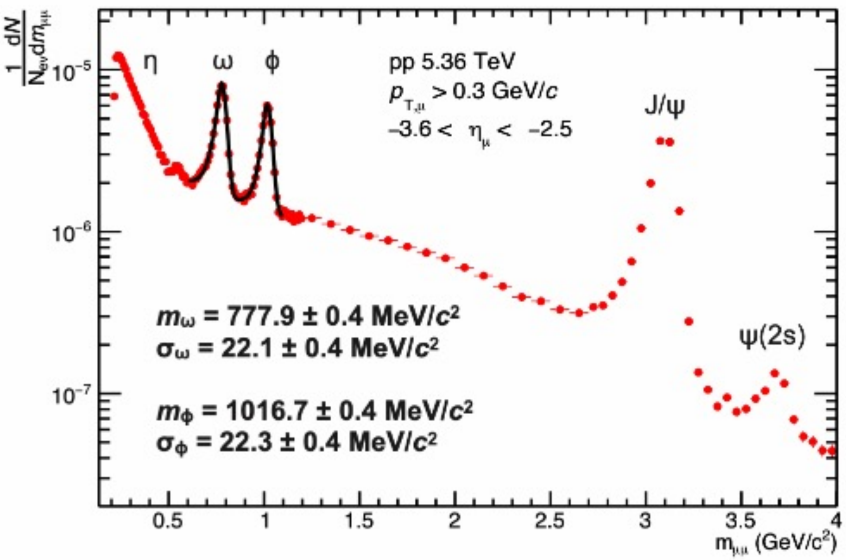
Prospettive per l'analisi in dimuoni

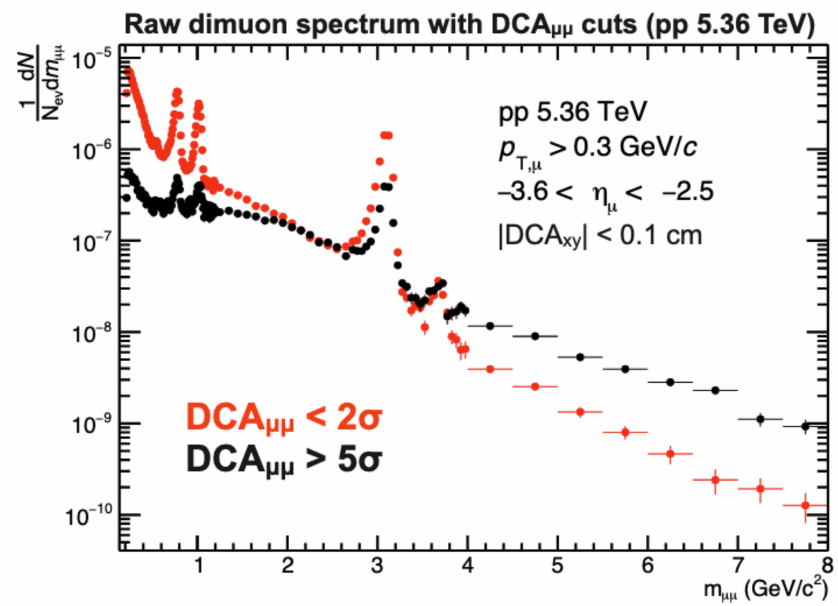
A Large Ion Collider Experiment

Raw spectrum in low-mass range

Completely resolved ω and ϕ peaks, with mass resolution of 2−3%
- Can easily measure ω and ϕ from μμ (or e.g. fit ω/ϕ cocktail to the peaks)

Clear sign of η→μμ (BR = 5.8 ± 0.8 ×10⁻⁶)
(Massive peaks of J/ψ and ψ(2s))





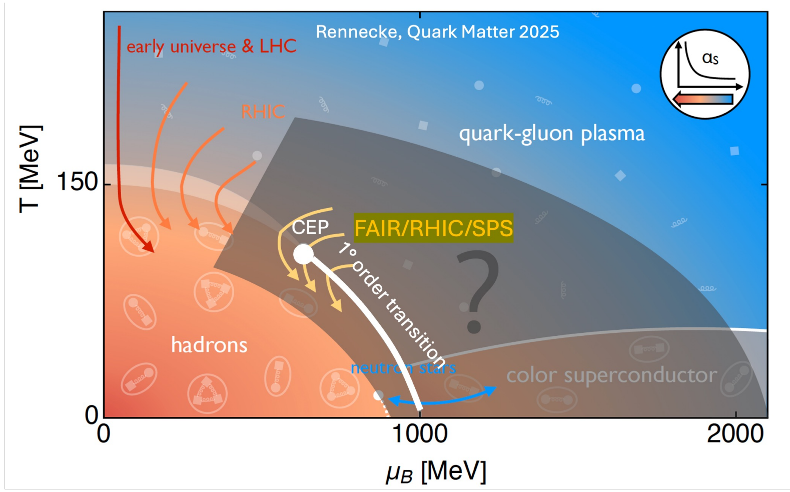
- Separation of prompt/non-prompt will be also important for DY/HF
- To be continued with new alignment and DCA_Z information

Richieste per il 2026

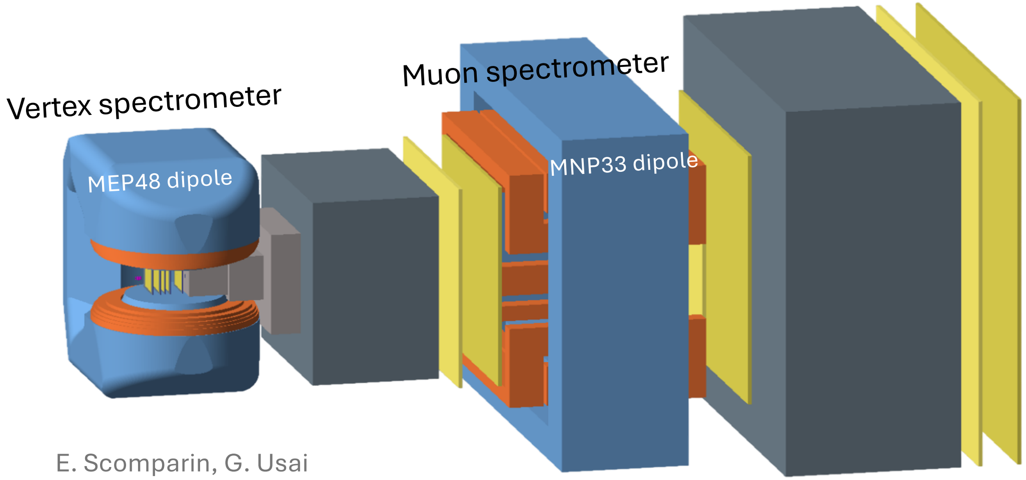
- **2 nuovi collaboratori**
- **Richieste totali (tutti i progetti ALICE)**
    - 98,5 Missioni
    - 13,5 Consumi
    - 122 Apparati (ITS3 e ALICE3)
    - 26 M&OB (contributo alla manutenzione del tracker)
    - 6 Altre voci (licenze, trasporti)

- **Richieste impegno officina:**
    - 10% M.Arba per DCS Muon Tracking
    - 10% M. Tuveri per interventi su ZDC

Study of Rare Probes of the Quark-Gluon Plasma at SPS Energies – NA60+/DiCE Experiment Proposal



- **NA60+/DiCE (Dilepton and Charm Experiment)** designed to explore the QCD phase diagram at high baryo-chemical potential (μ_B range ~220 - 500 MeV)
- **Unexplored region of phase diagram (ALICE3 focused at μ_B=0) with important goals:**
  - **Discovery of predicted critical point and first order phase transition**
  - **High-μ_B QGP**
- Vertex and muon spectrometers for high-precision dimuon and charm reconstruction



- Collaboration:
  - INFN (Ca, To, Pd), IP2I Lyon (France), Weiszmann Inst. (Israel), Berkeley, Rice Univ., Stony Brook(tbc) (USA), Tsukuba, Tokyo Univ. (Japan), Hefei Univ. (China)
- **Full INFN leadership for physics and advanced silicon sensors for vertex spectrometer**:
  - Measurements of thermal dileptons and charm
  - Silicon detector: large area monolithic active pixel sensors (synergy with ALICE ITS3)
  - 10-12 FTE

Status of the project

- **Proposal submitted to SPSC in May**: https://cds.cern.ch/record/2932302/
  - Presented at the SPSC meeting of 27-28 May
- **Strong support by CERN** (through Physics beyond Colliders):
  - Contribution to proposal of CERN BE, HSE and DT teams for magnets, integration, radio-protection, beam line
- Very **positive reception** of proposal:
  - Formal statement **for recommendation by SPSC expected by September**

SPSC draft minutes

The committee **acknowledges receipt** of a full proposal of the NA60+/DiCE (DiMuon and Charm Experiment)collaboration for a new experiment located on the H8 beam line of EHN1.

The SPSC **recognizes** that the NA60+/DiCE proposal adresses key open questions in heavy ion collisions by measuring rare hard and electro-magnetic probes of the quark gluon plasma at SPS energies. NA60+/DiCE aims at determinining the caloric curve which characterizes the nuclear phase diagram, providing evidence of a phase transition and observing for the first time the restoration of chiral symmerty.

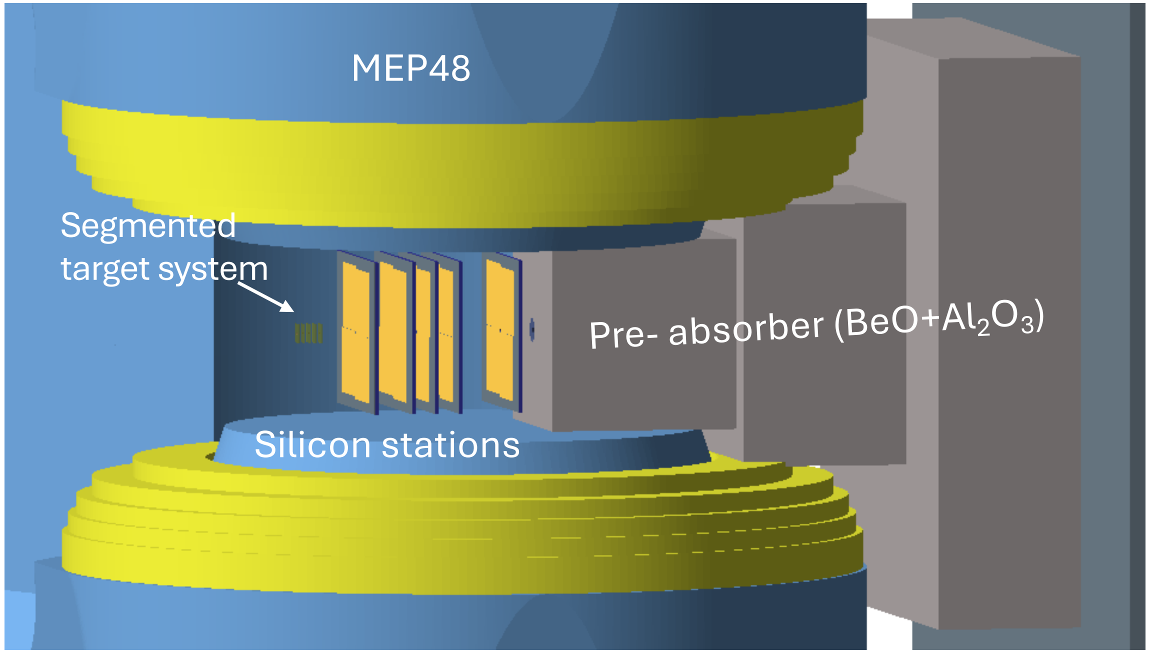
The SPSC **recognizes** that the detector concept is mature and that the technological developments presented in the proposal are solid and feasible within the mentioned schedule.

The SPSC **will continue to review** the proposal to understand in more detail its technological challenges, its physics reach and questions related to meeting the beam requirements of NA60+/DiCE on the H8 beam line.

- Construction during 2026-2029
- Overall cost (including expt. area integration, shielding, powering): 10.5 MCHF
- Cost of vertex detector (main interest of INFN): 2 MCHF (approximately 20% of total cost) divided over next 5 years
  - Discussion with French and US groups for contribution to silicon tracker
- Data taking from 2030 during LHC run4 and run5. SPS running also after HL-LHC:
  - Extended physics program possible for very high-statistics and high-precision measurements
  - Very advantageous ratio of scientific outcome from long-period data takings over limited financial investment

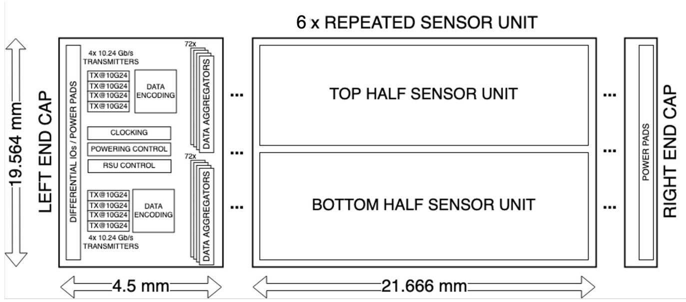
The Vertex Spectrometer's Pixel Detector – Precision at the Edge

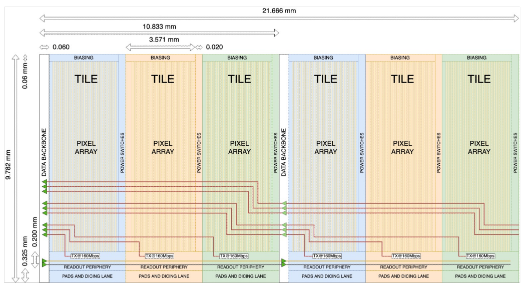
- Primary function of the vertex spectrometer (VS):
  - Measure the kinematic of muons and hadrons before the hadron absorber
  - Five identical silicon pixel stations positioned at 7 < z < 38 cm
- Requirements for silicon sensors:
  - Maximize pixel coverage across angular acceptance
  - Spatial resolution 5 μm
  - Only Si material budget <0.1% in 2 planes closest to targets
  - Operation at 150 kHz interaction rate
  - Max radiation hardness: 10^{14} 1 MeV n_{eq}/cm^2 over a decade of operation (first plane, region close to beam)



Silicon Pixel Technology – Breaking Area Boundaries

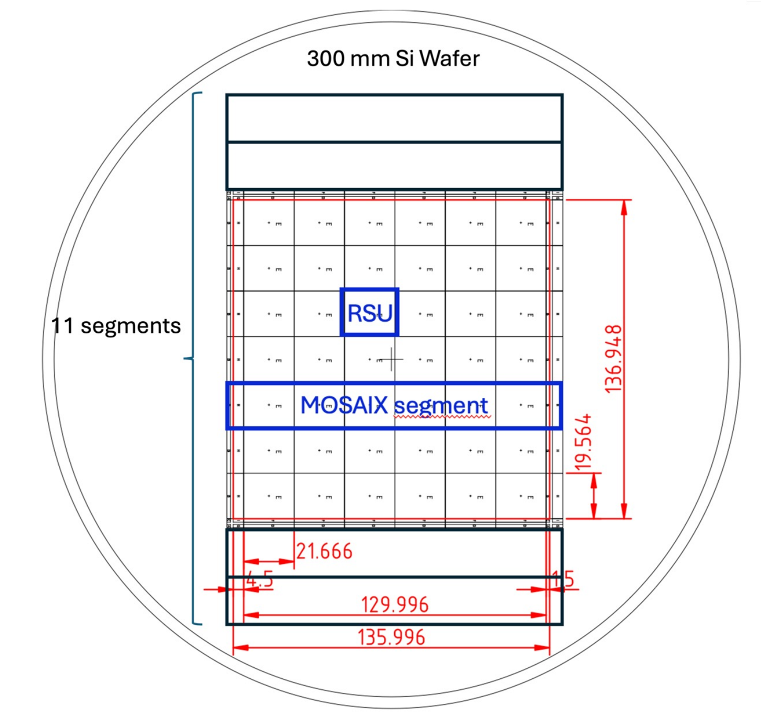
- ❑ Synergy with ALICE ITS3 project
- ❑ Basic units designed in reticle:
  - ○ RSU: 21.67x19.56 mm^2 pixel matrix
    - ▪ Pixel pitch 20.5 μm
  - ○ Digital periphery with 8 10.24 Gb/s serializers





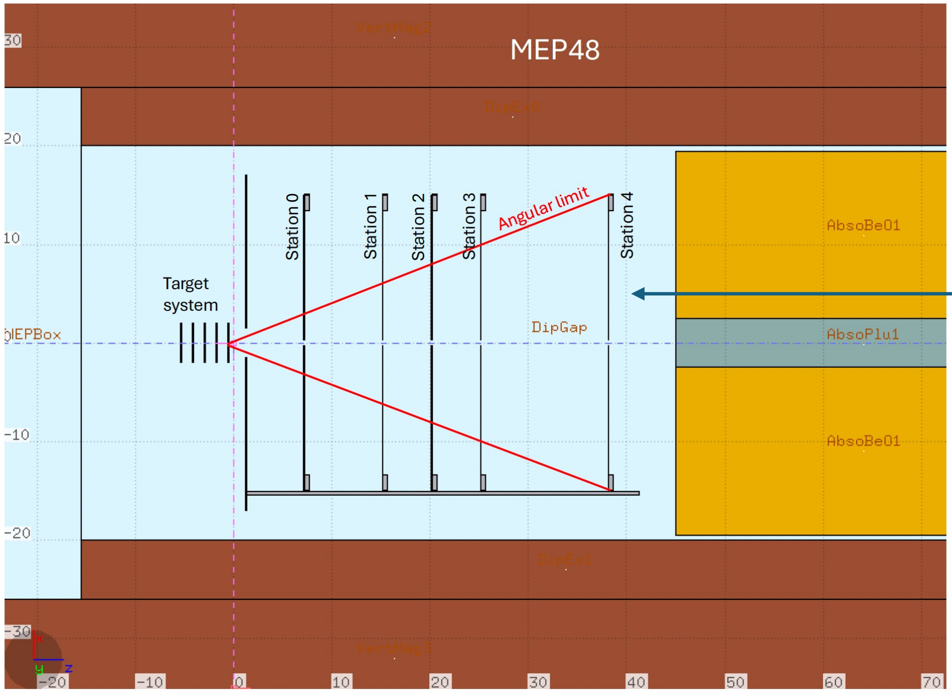
Top half-unit (bottom is mirrored)

- ❑ NA60+/DiCE sensor stitching plan:
  - ○ MOSAIX segment with 6 RSU
  - ○ 11 MOSAIX segments replicated vertically



Stitching plan validated by G. Aglieri, W. Snoeys - CERN

Silicon Pixel Technology – Breaking Area Boundaries



- Sensors with variable number of segments:
  - Advantage: increase sensor yield/wafer

- Largest silicon station inside MEP48:
  - 4 stitched 13.6x13.6 cm^2 sensors

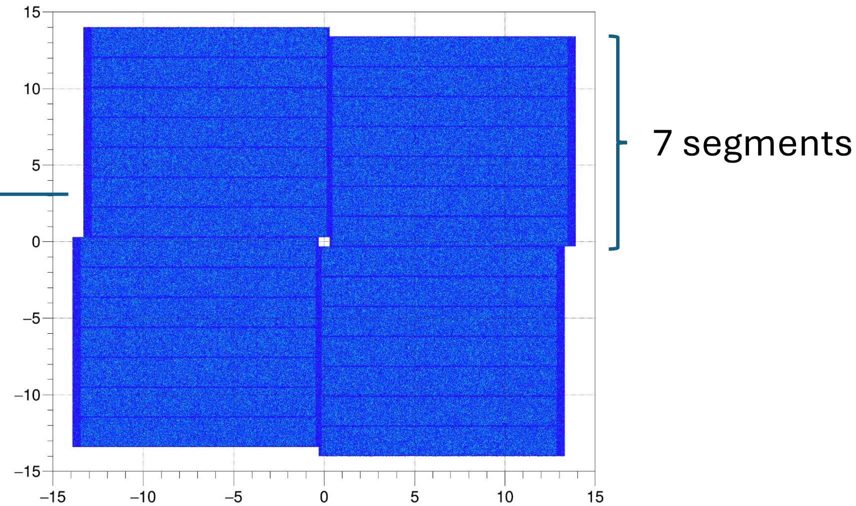
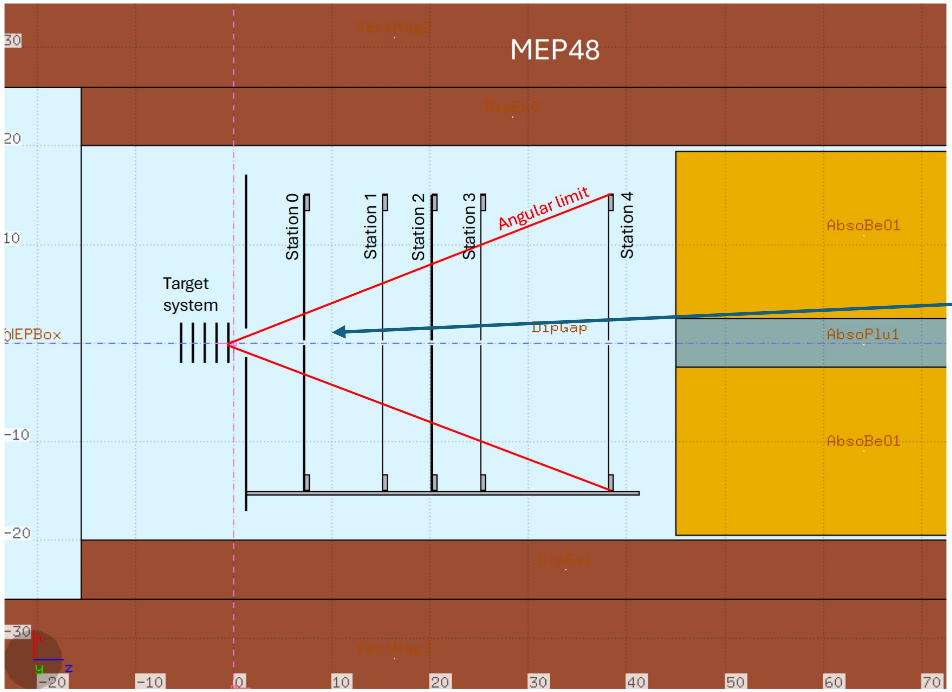


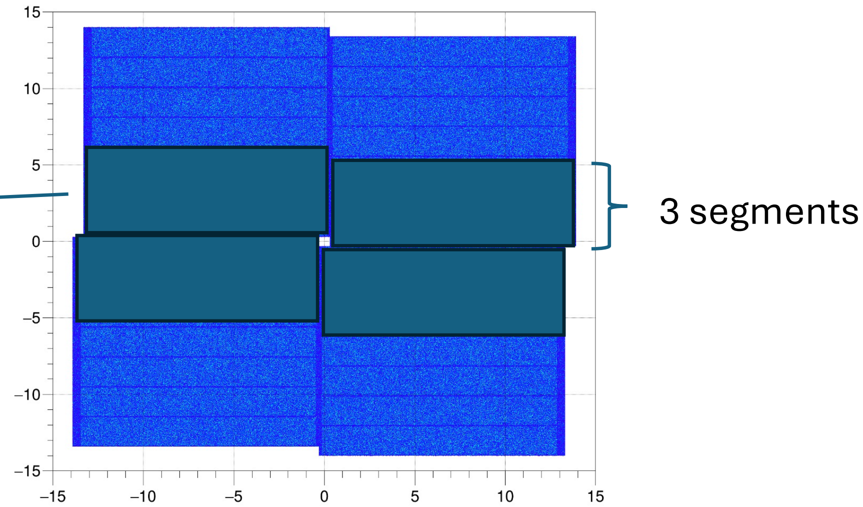
Table 1: MOSAIX readout segments by station.

Station	Instrumented segments/sensor	Instrumented segments/station
0	3	12
1	4	16
2	5	20
3	6	24
4	7	28

Silicon Pixel Technology – Breaking Area Boundaries



- ❑ Largest silicon station inside MEP48:
  - ○ 4 stitched 13.6x13.6 cm^2 sensors



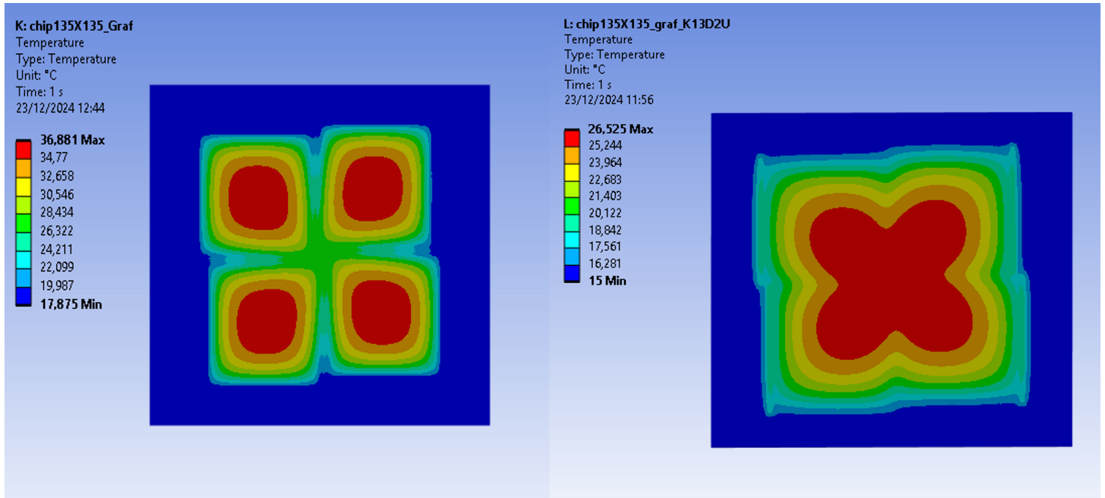
- ❑ Sensors with variable number of segments:
  - ○ Advantage: increase sensor yield/wafer

Table 1: MOSAIX readout segments by station.

Station	Instrumented segments/sensor	Instrumented segments/station
0	3	12
1	4	16
2	5	20
3	6	24
4	7	28

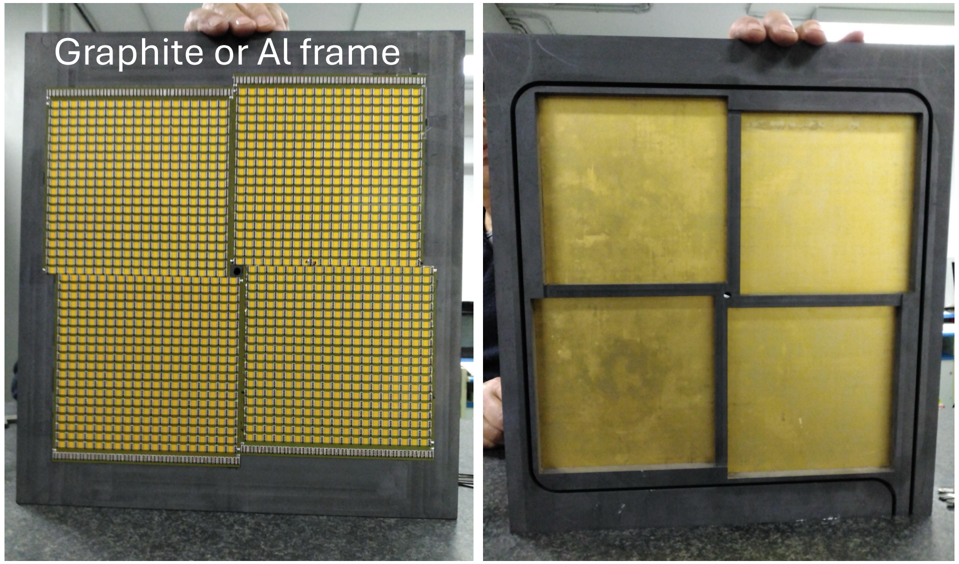
Cooling&Mechanics – Low Material Budget under Power

- ❑ Cooling imposes constraints to the mechanical system:
  - 40 mW/cm^2 power dissipation in pixel matrix (+ 790 mW/cm^2 in periphery)
  - Goal 25 °C over sensor surface



- ❑ COMSOL/ANSYS simulations:
  - Mixed water (18-20 °C)+ air cooling (1-2 m/s)
  - 0.4 mm carbon fiber substrate to improve heat dissipation in larger planes

- ❑ Carbon fiber substrate glued on periphery frame (graphite or aluminum):
  - Machined groove to accommodate a stainless steel pipe for water cooling



- ❑ Simulations calibrated on a test set-up:
  - PCBs with resistor arrays mounted on graphite frame to mimic power dissipation

Attività prevista nel 2026

- ❑ **Construction of prototype pixel planes**

SPSC referees:

- Detector prototypes: Within the SPSC, we discussed whether you would be well-advised to plan and carry out the construction of a telescope prototype of 3-4 tracking planes using the CMOS sensors coming from the first production run. The construction and test of such a telescope in beam, exercising the readout, alignment and track reconstruction by the NA60+ collaboration would be very beneficial for the construction of the final detector. Does NA60+ plan to ensure functionality of the final apparatus by constructing and testing a prototype? If not, could you please outline in more detail how you plan to ensure the functionality ?

- ❑ 2025: sblocco sub-judice di 170 kEuro per prima produzione sensori (12 wafer)
- ❑ 2026: richieste 300 kEuro per meccanica e elettronica di readout

Attività 2025/2026:

- Disegno frame piani in alluminio e produzione
- Sviluppo sistema pick/place per incollaggio sensori su piatti di fibra di carbonio
- Test di incollaggio con sensori dummy (in camera pulita)

} Servizio di meccanica

- Disegno e produzione flex (basato su design ITS3 fatto al CERN)
- Test elettronica readout basata su test system sviluppato al CERN

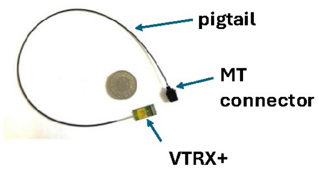
} Servizio elettronica

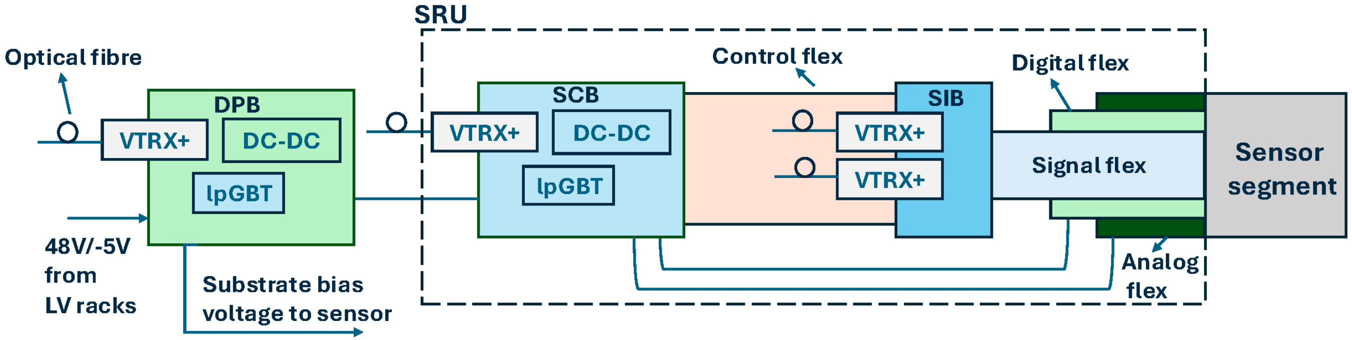
- Assemblaggio prototipi di piani con sensori (camera pulita) → servizio meccanica+elettronica

Backup

Vertex Spectrometer Readout Electronics

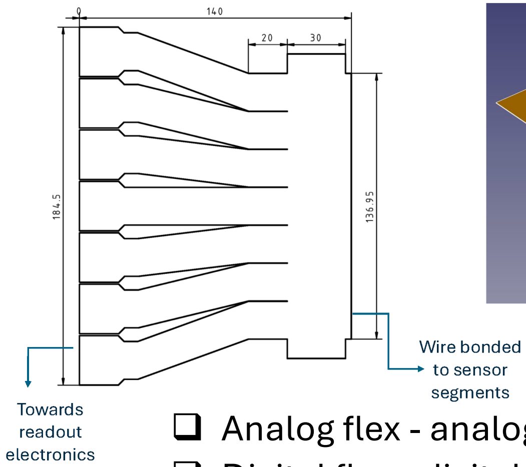
- ❑ Readout at segment level:
  - ○ Versatile Link+ protocol for HL-LHC
  - ○ High-speed bidirectional optical communication

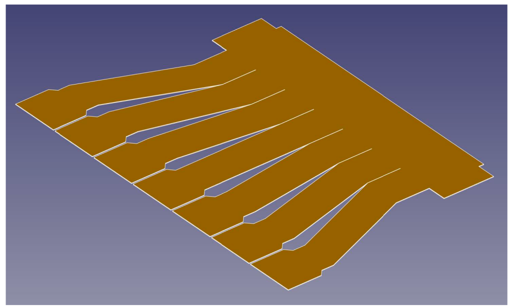




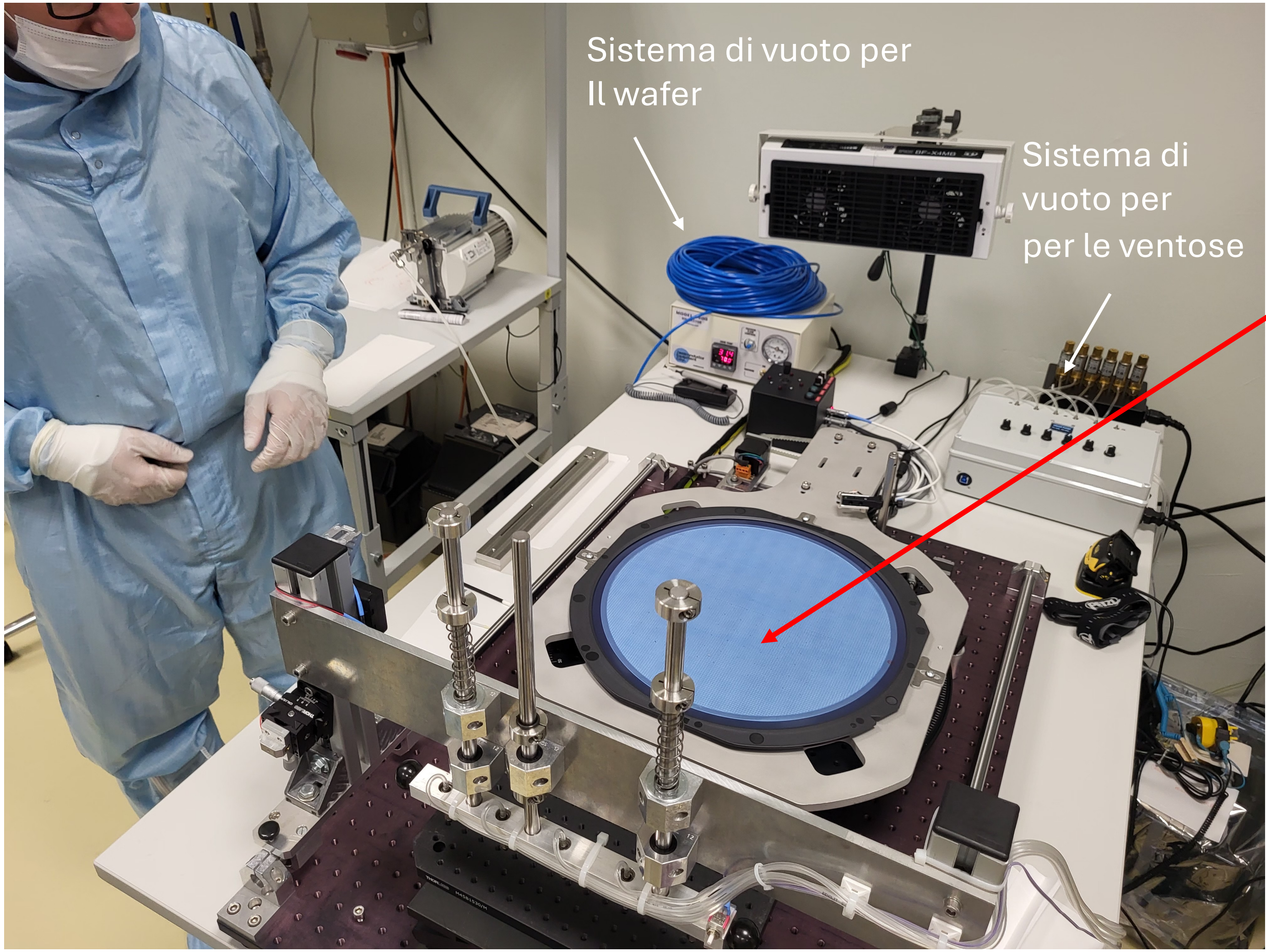
- ❑ Segment Readout Unit (SRU) formed by:
  - ○ Segment Interface Board (SIB):
    - ▪ 8 10.24 uplinks to ship data off detector
- ❑ Segment Control Board (SCB):
  - ○ Slow control
  - ○ DC/DC rad hard converters

- ❑ Detector Power Board (DPB):
  - ○ Supplies for SCB DC/DC converters
- ❑ Sensor bias voltage (-3 V)





- ❑ Analog flex - analog power domain of the sensor segment
- ❑ Digital flex - digital power domain of the sensor segment
- ❑ Signal flex - high-speed data lines of the sensor segment
- ❑ Control flex - connects the SCB to the SIB



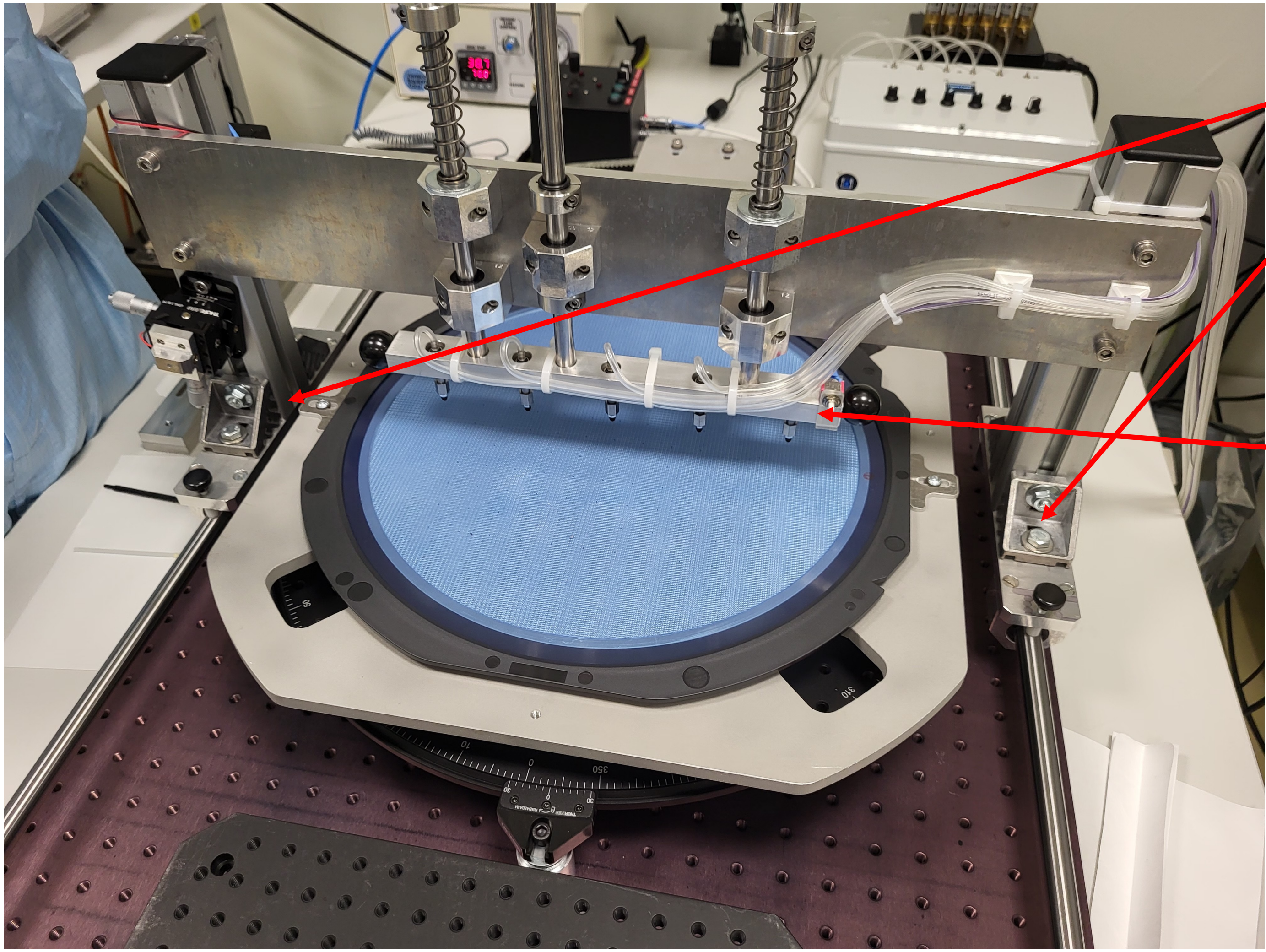
Sistema di pick and place dei sensori

Il wafer è messo sopra il disco blu (materiale plastico poroso? abbiamo dimenticato di chiedere dettagli)che si vede in foto

Il wafer con i sensori tagliati viene consegnato con la pellicola adesiva che deve essere rimossa

Sotto il disco c'è un sistema di aspirazione per fare aderire il wafer e per riscaldarlo

Quando la temperatura raggiunge circa 70 gradi i chip si staccano dalla pellicola adesiva



Carrello per far scorrere la barra delle ventore

Con questo sistema di ventose controllato da un sistema di vuoto si sollevano e movimentano i chip

Per i sensori con più segmenti verranno fatte due file di ventose