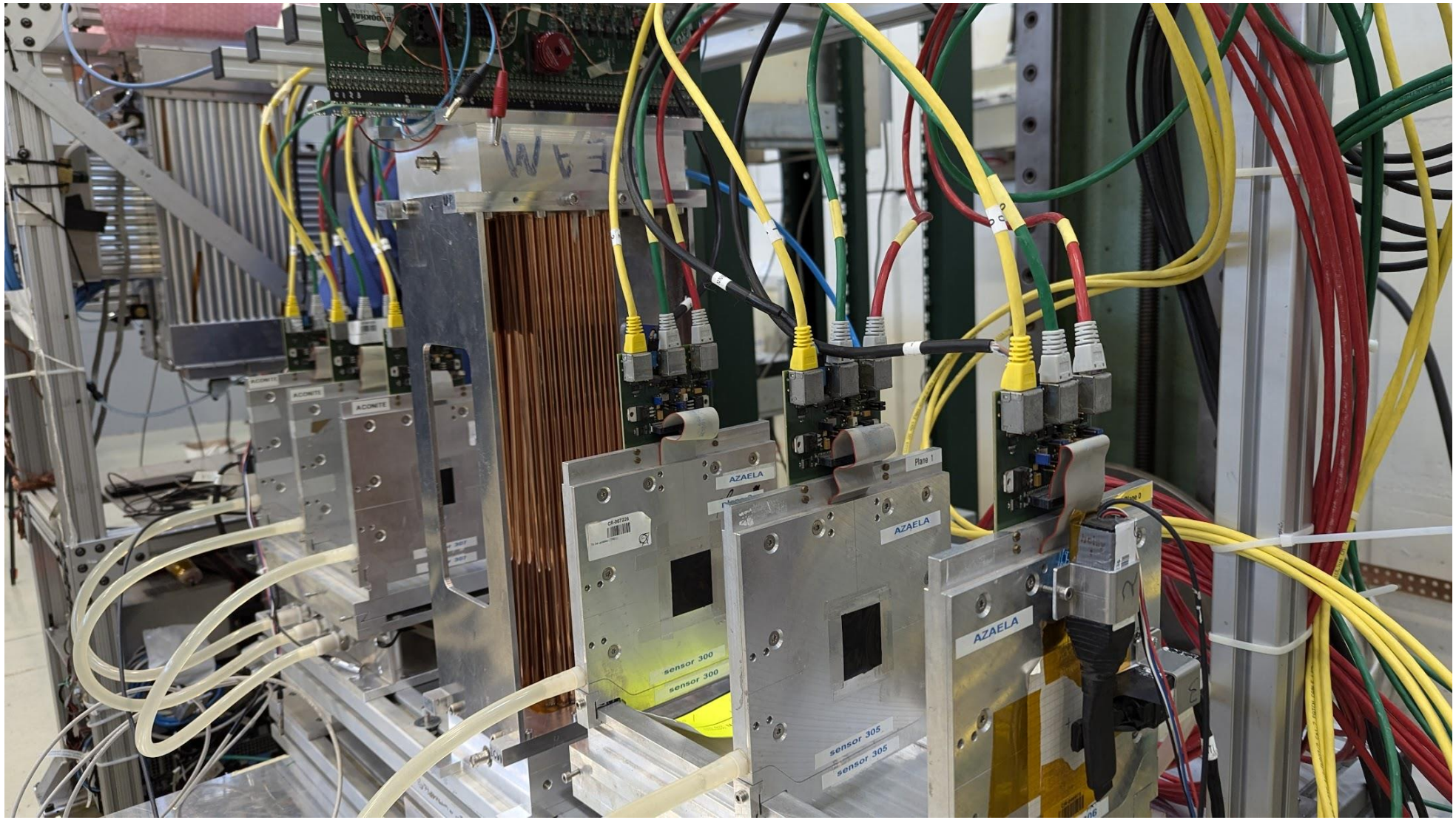
# Straw-Barrel status report




**Temur Enik on behalf of Straw Tracker Team**

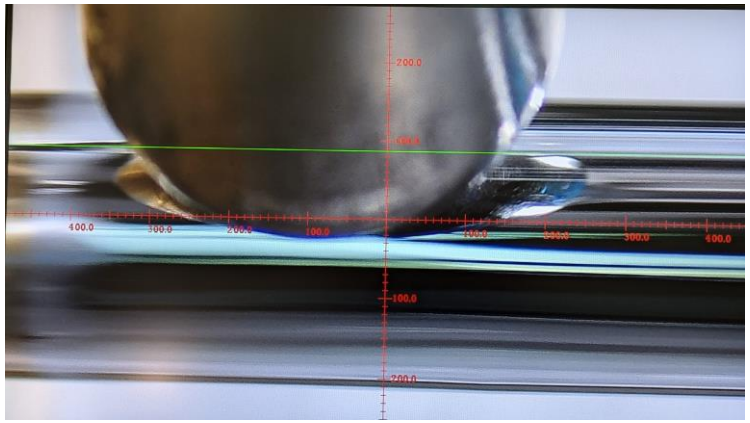
**06/11/2024**

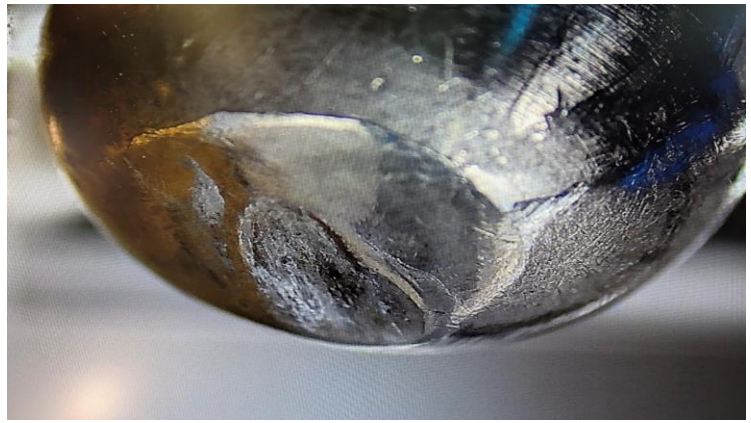
# Straw production line

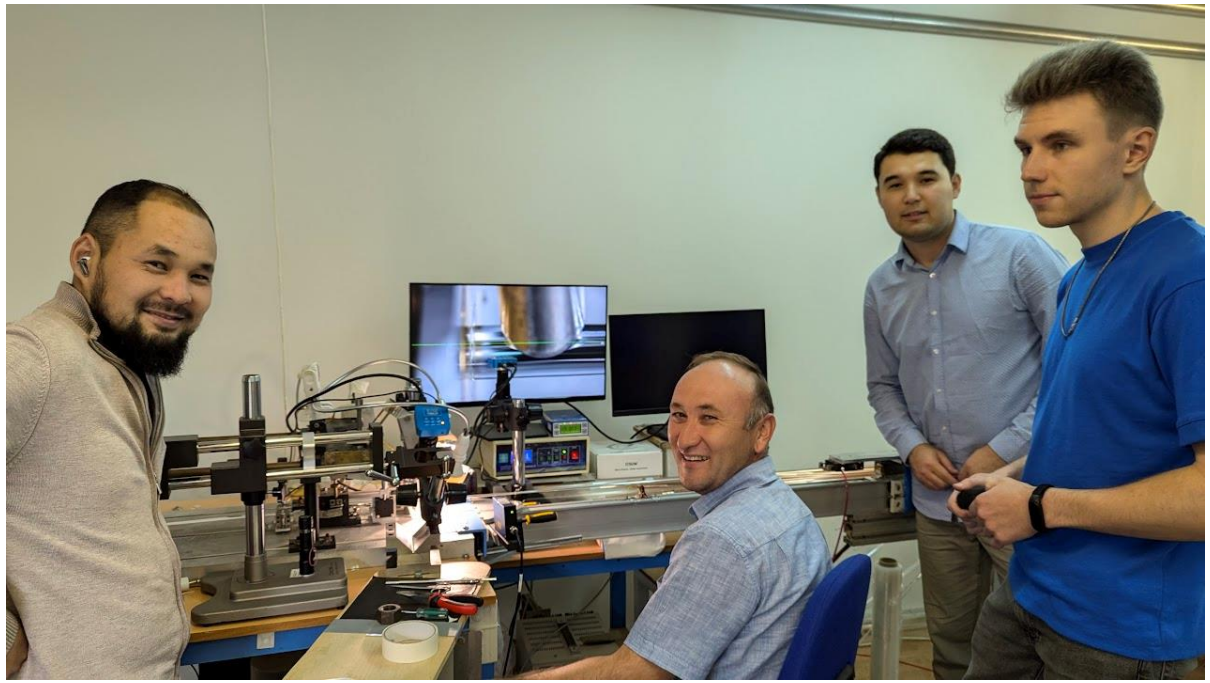
Au+Cu → Al+Al

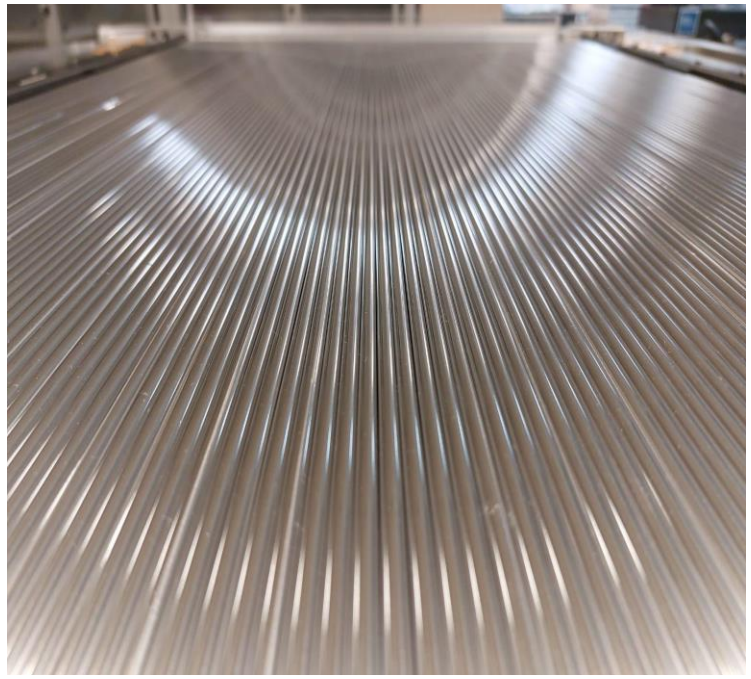
Al+Al → Al

- Productivity- 1m/min
- Length- 5.5m
- Diameter-from 10 mm
- Film thickness-36 microns
- Film is available in Russia
- Coating thickness 50-100nm
- Coating is carried out in the RF

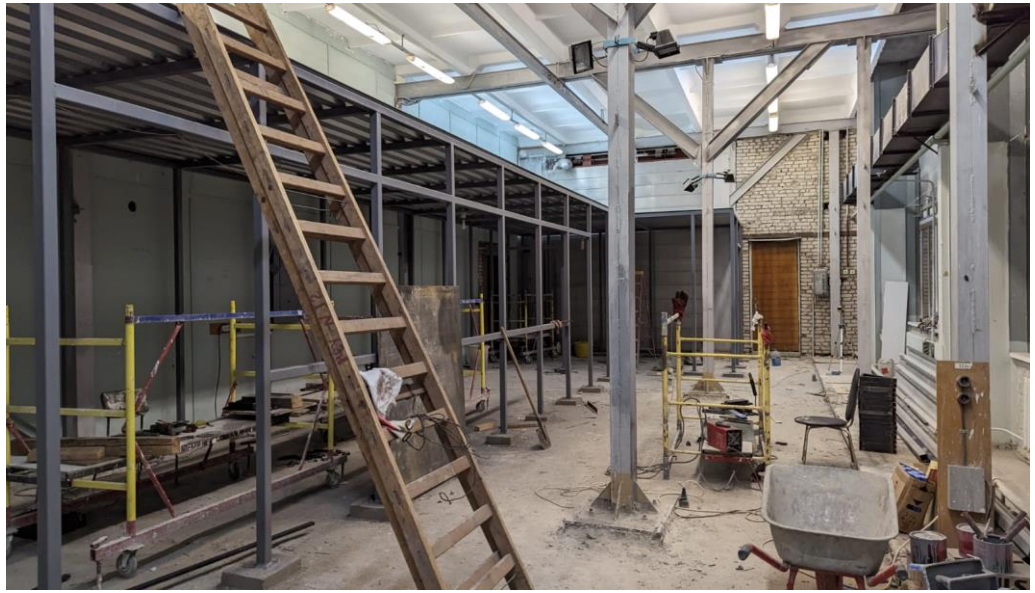




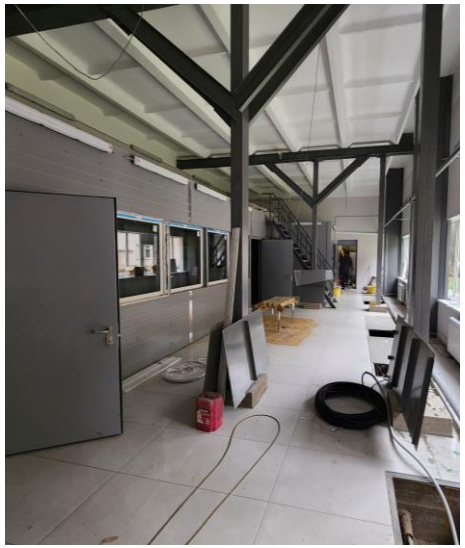




# New Straw production line and the Assembling lab at JINR







- Area ~200 sq.m., clean room~100 sq.m, machine shop and assembling hall~50 sq.m and 8,5 m high
- Double Production line length~12m
- The deadline is the beginning of the 1st quarter of 2025
- Commissioning works the beginning of the 1th quarter of 2025
- Necessary materials and equipment have been purchased
- Planned production ~60km straw

# New Straw production line and assembling place at INP(Almaty)



**«Big» room**

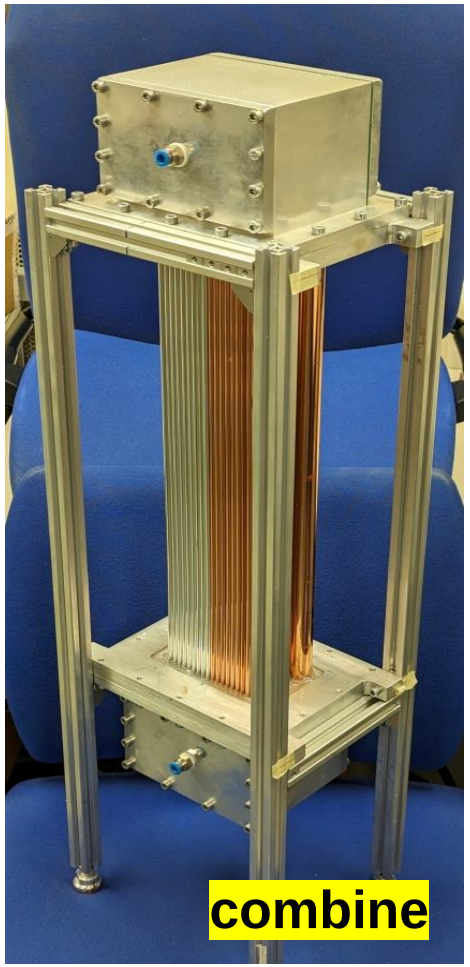
- Area ~250 sq.m., clean room~100 sq.m and 6,7 m high
- Double Production line length~12m
- Room renovation started in 2024
- Necessary materials and equipment have been purchased

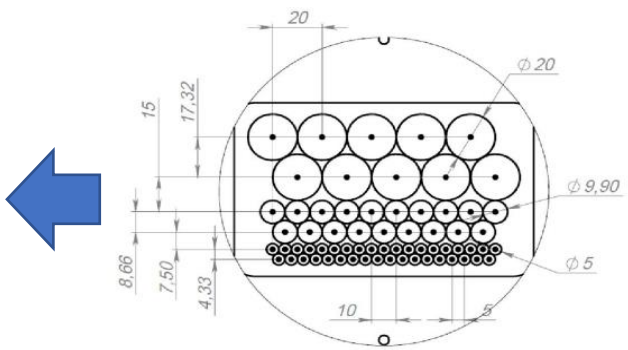
**«Small» room**

- Area ~60 sq.m., clean room~30 sq.m,
- Room renovation has been finished in March 2024
- Clean room is being built
- 5m straw welding machine will be installed
- The machine and related equipment is purchased

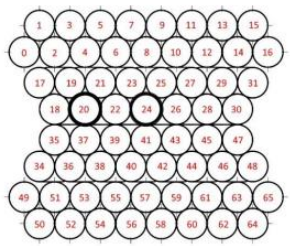
# Prototyping

- Small prototype production (lab and test beam straw and readout performance studies)
- development and prototyping of the construction elements (gas supply, sealing)
- development and optimization of the electrical connections (noise and x-talk reduction



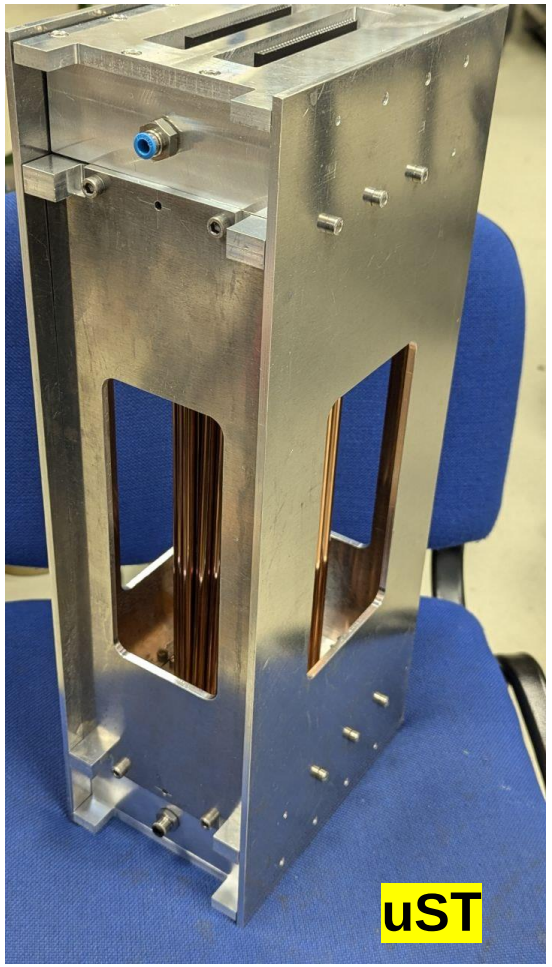



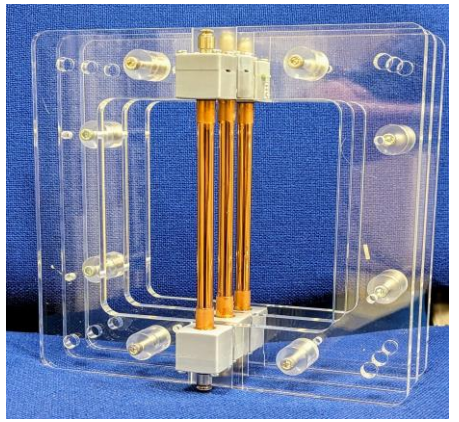

Prototype 1: 5 mm, 10 mm, and 20 mm tubes area

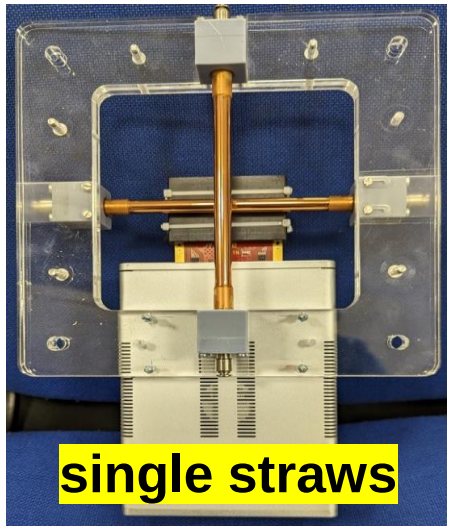


X
U
V
X

Prototype 2: 10 mm tube area only. Two planes of X, two planes of U (2°), two planes o V (−2°) and two planes of X.

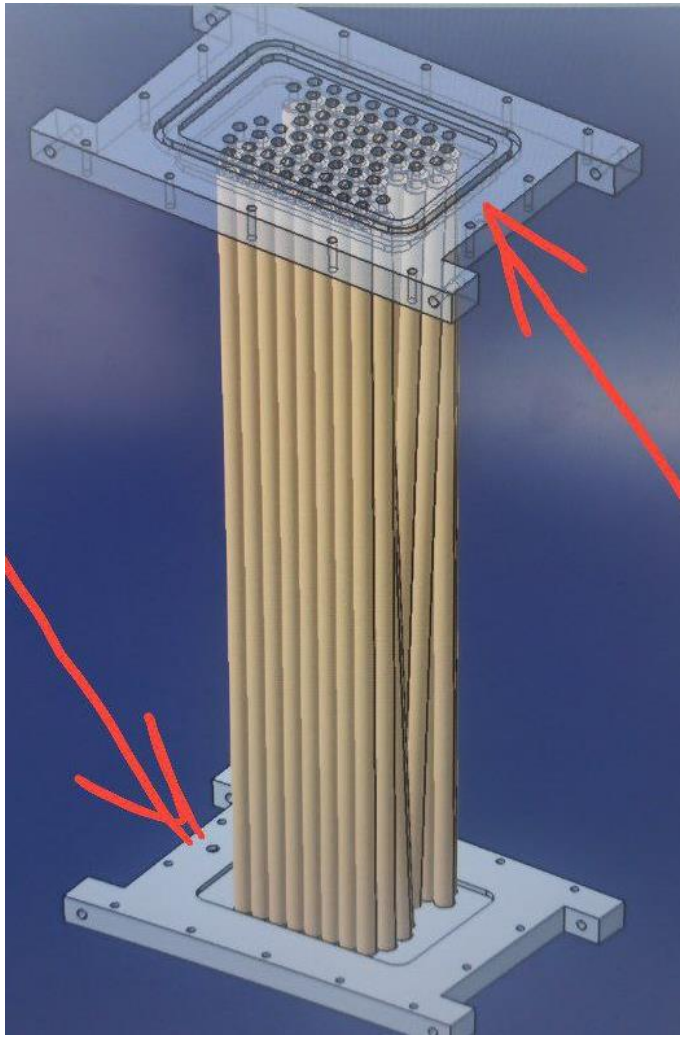


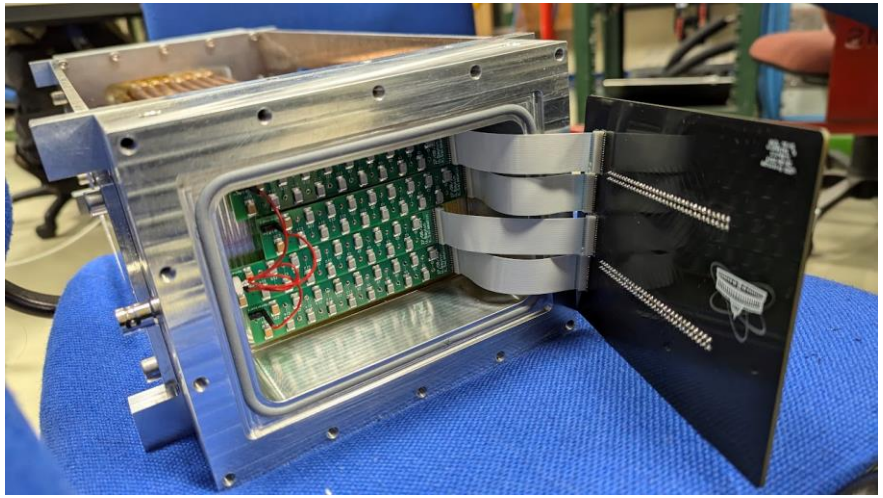



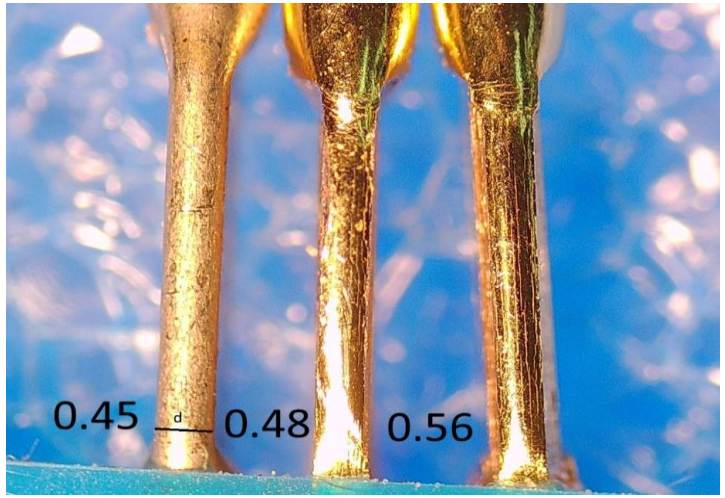


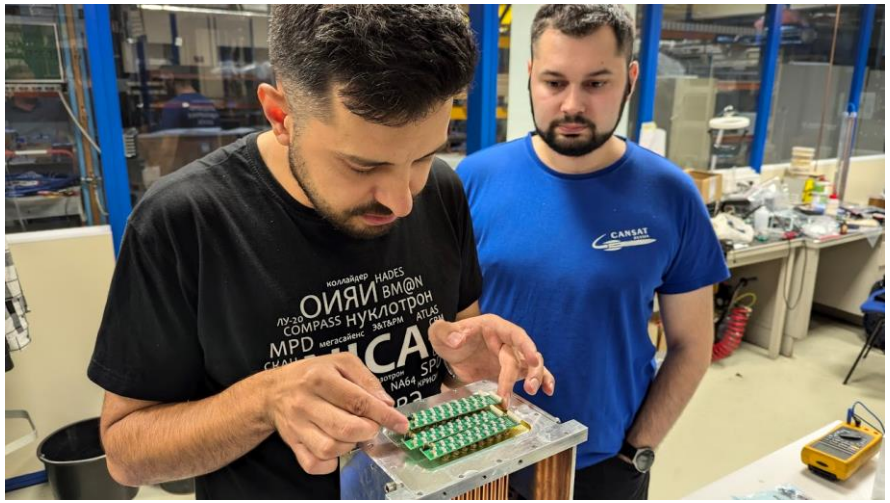
# Prototyping

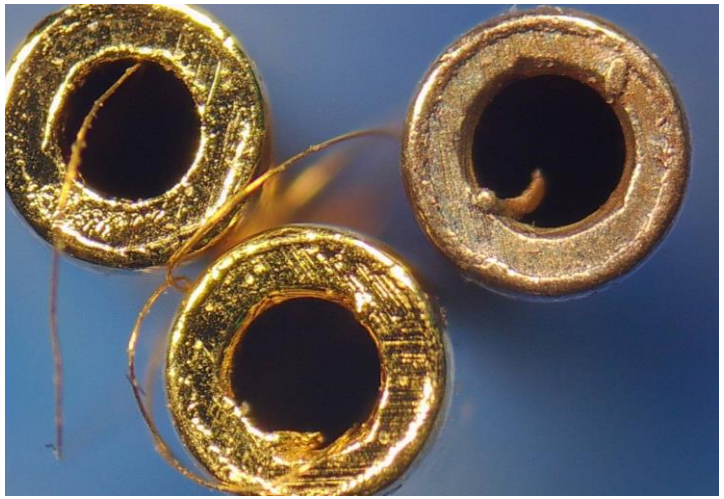
Connectors, HV distribution board, new pin, assembling, grounding



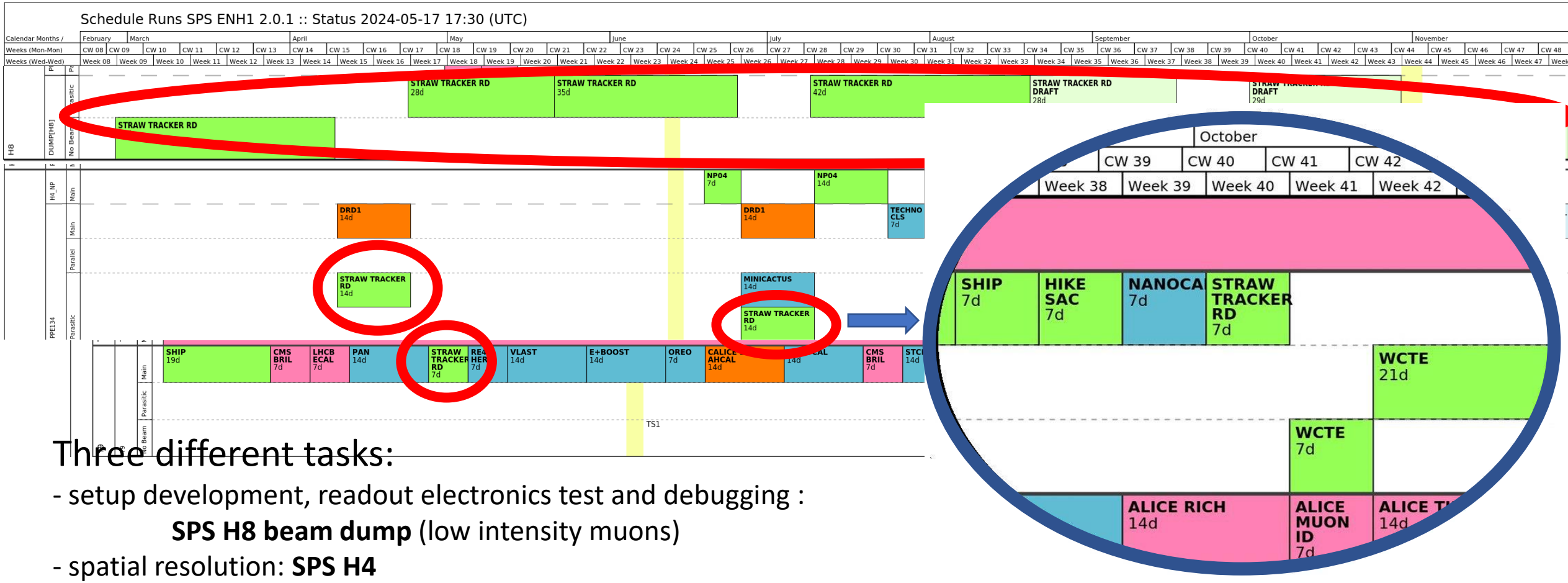






# Test beam periods 2024 at SPS and PS




Three different tasks:

- setup development, readout electronics test and debugging :
  **SPS H8 beam dump** (low intensity muons)
- spatial resolution: **SPS H4**
- charge measurements for low momentum particles: **PS T09**

| | | | | | | |
|---|---|---|---|---|---|---|
| T9 PS | | 08/05-15/05 | | | | 02/10-09/10 |
| H4 SPS | 10/04-24/04 | | 26/06-10/07 | | 18/09-02/10 | |
| H8 SPS dump | 10/04-26/10 | | | | | |

# Measurements of the straw performance and choice of the readout electronics parameters

- **Spatial resolution** (**SPS**)
  - – influence of the readout parameters
    - electronics noise, threshold
  - influence of the wire displacement
  - different operation conditions (gas gain, pressure dependence)
  - measurements in the magnetic field (H4)

- **Charge measurements (PS**, low momentum pi, mu, e)
  - charge distribution for different particle momenta
  - multiple scattering probability
  - electronics dynamic range for PID (protons are required, under discussion)
  - measurements at PNPI under discussion

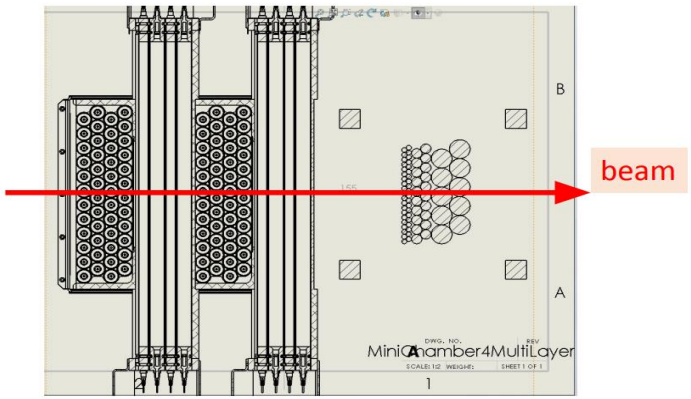
# Beam Test  activity SPS


Many thanks to Bing Zhou and the University of Michigan sMDT team for the fruitful collaboration.

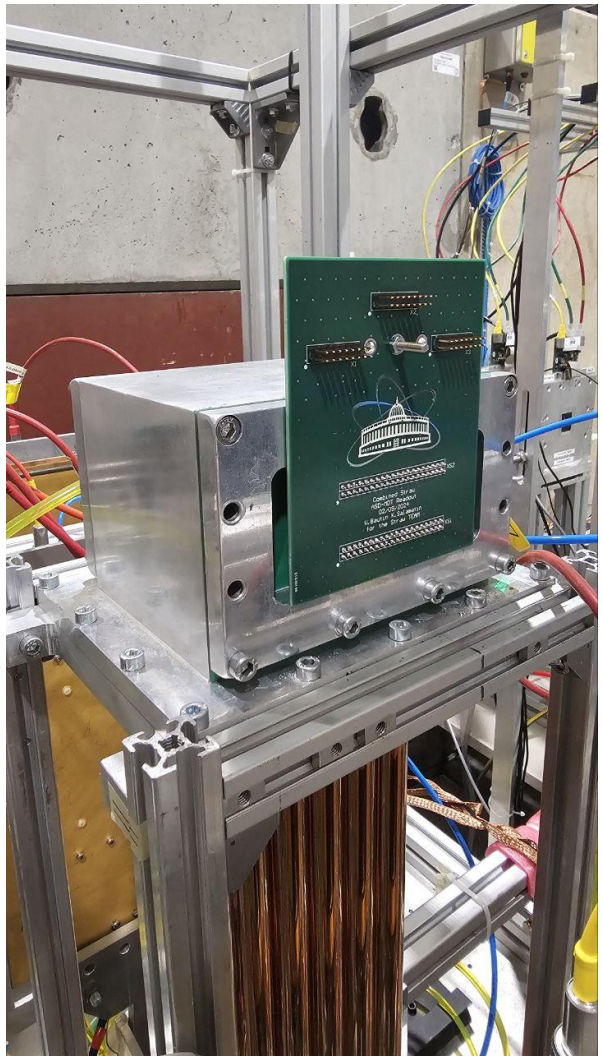
# Beam Test activity

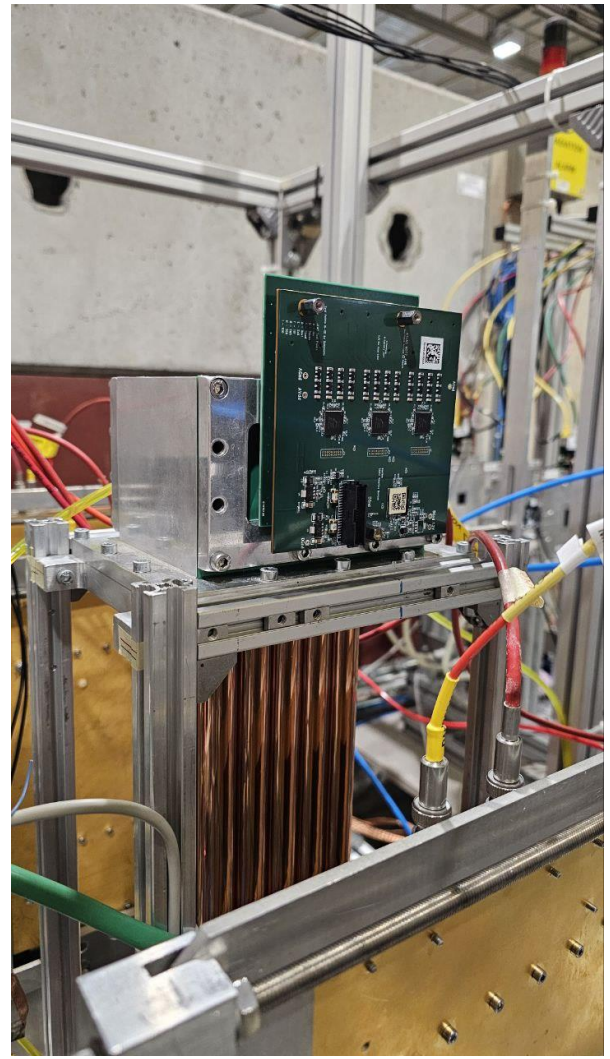
- sMDT telescope with total 16 tube layers (assembled in 4 mini-chambers, each with 4-layers, two in x and two in y directions); Single wire resolution ~100 μm, tracking slope ~0.4 mrad (in each direction). Tube diameter 15 mm
- Front-end electronics mezzanine mounted 3 ASD, 1 TDC 24 ch. With TDC resolution of 0.78ns
- MiniDAQ system capable to handle 100 kHz trigger rate and readout 500 channels
- Online monitoring
- Offline data analysis

The UM sMDT telescope
8-layers in x and y directions




Reference tracker large accepce with ASD readout





X-board and ASD readout for Straw prototype

# Beam Test activity

## sMDT front-end electronics – used for test beam readout

- ATLAS sMDT ASD (developed at MPI) and TDC (Michigan) are suitable for the straw readout and tracking with similarly expected gas gain (2-5 x$10^4$) and a drift time of a few hundred ns.
- Initial measurements at H4 beam line showing promising result to fit the 10mm straw readout within the charge/time dynamic rate of the sMDT Front—end electronics.

| ATLAS sMDT ASD Spec. | |
|---|---|
| Technology | CMOS 130nm |
| #. of channels | 8 |
| Power consumption | 10 mA/ch |
| Input capacitance | 60pF |
| Shaper | bipolar |
| Peaking time | 12 ns |
| Dynamic range | 5-100 fC |
| sensitivity | 8 mV/fC |
| ENC | 1 fC |
| Charge readout | ADC, ToT |

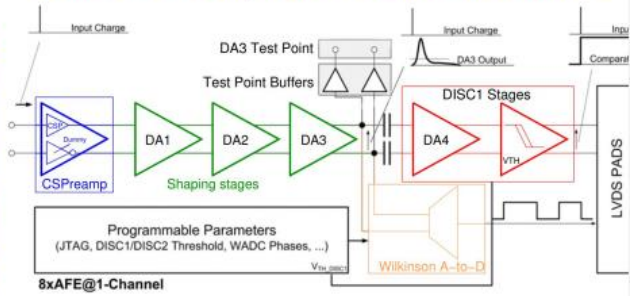
| ATLAS sMDT TDC Spec. | |
|---|---|
| Technology | CMOS 130nm |
| #. of channels | 24 |
| Package | BGA 144 |
| TDC LSB | 0.78 ns |
| Nonlinearity | +- 80 ps |
| Power consumption | 360 mW per chip |
| Dynamic range | 17 bits (102μs) |
| Output data rate | 320 Mbps x 2 |
| Max. hit rate | 400 kHz/ch |
| Mode | Lead/trail edge, pair |


Stacked mezzanine card

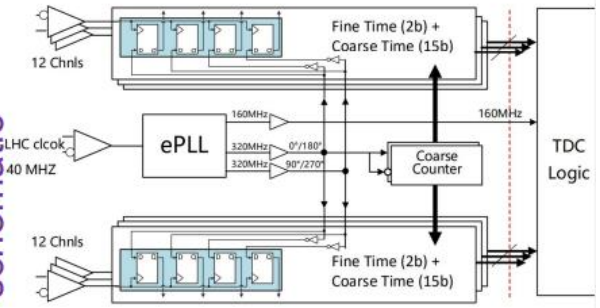

Flat mezzanine card

ATLAS sMDT/MDT Front-end Mezz

ASD schematic




TDC schematic




For details, see Vitaly's report Tue 05/11

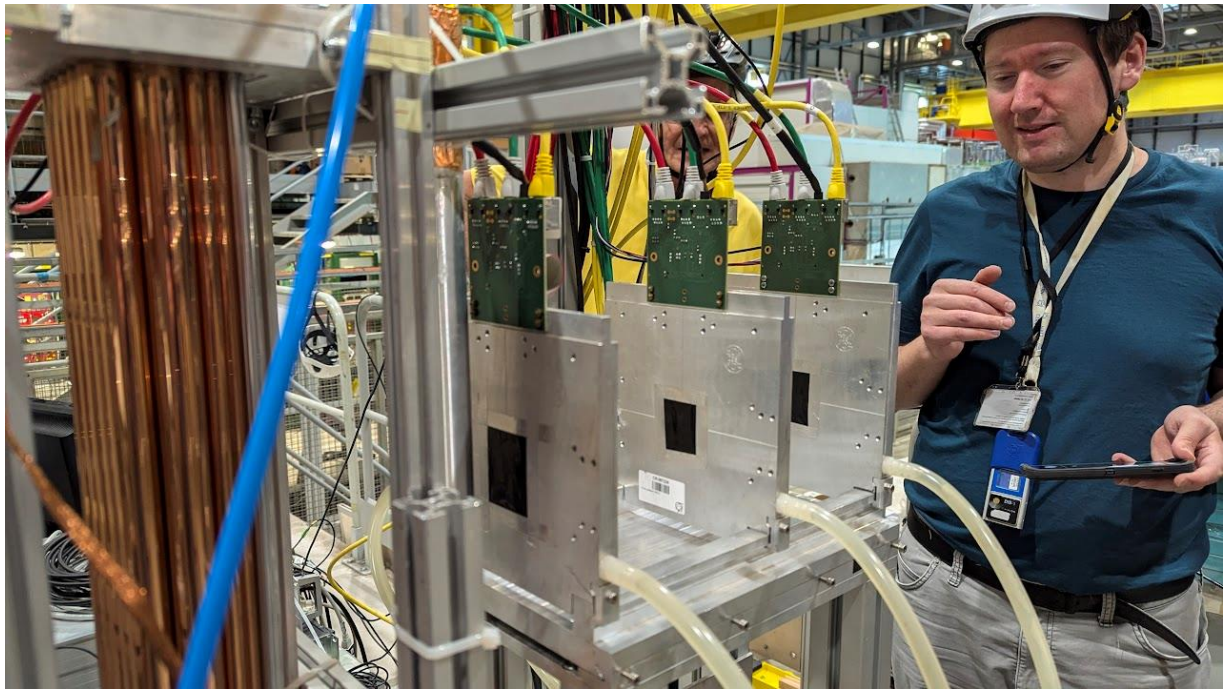
FEE for straw readout

# Beam Test activity

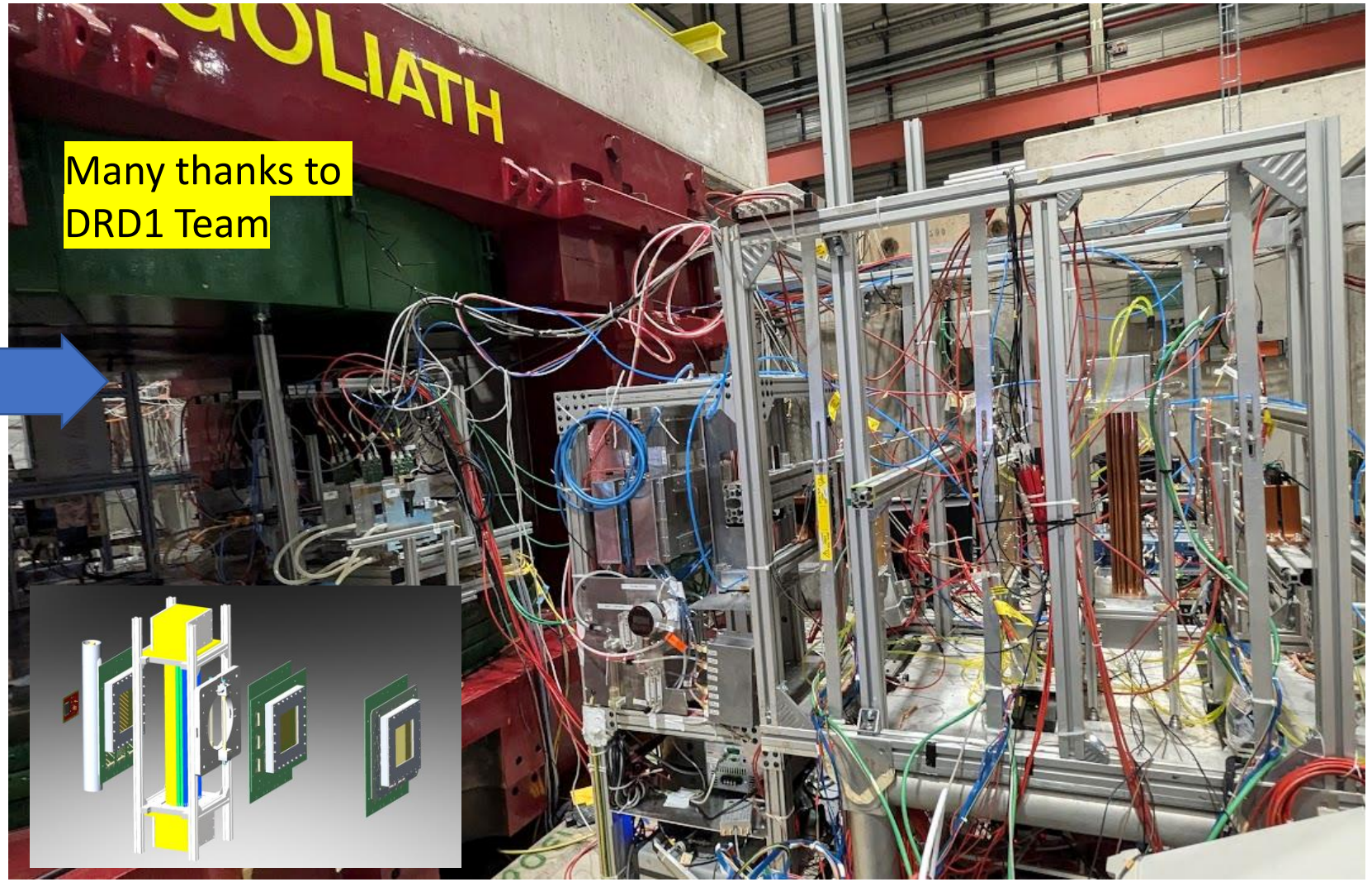
The AIDA-2020 Zero-suppressed Acquisition Located at the East-Area (AZALEA) telescope

- **Baseline: EUDET-type telescopes + AIDA2020 upgrades (WP5)**
  - Full package for the users: >99% eff. sensors ↔ TDAQ ↔ reconstruction SW
  - 50 µm thin sensor suitable for > ~1 GeV/c beam lines
  - Active area < 2x1 $cm^2$ & Pointing resolution: > 1.8 µm (Miomsa26 limits)
  - Avg. trigger rate < 1MHz & Time resolution: > 781 ps (AIDA TLU limits)

Many thanks to Manfred Jeitler and Andre Rummler



# Beam Test  activity H4 SPS CERN

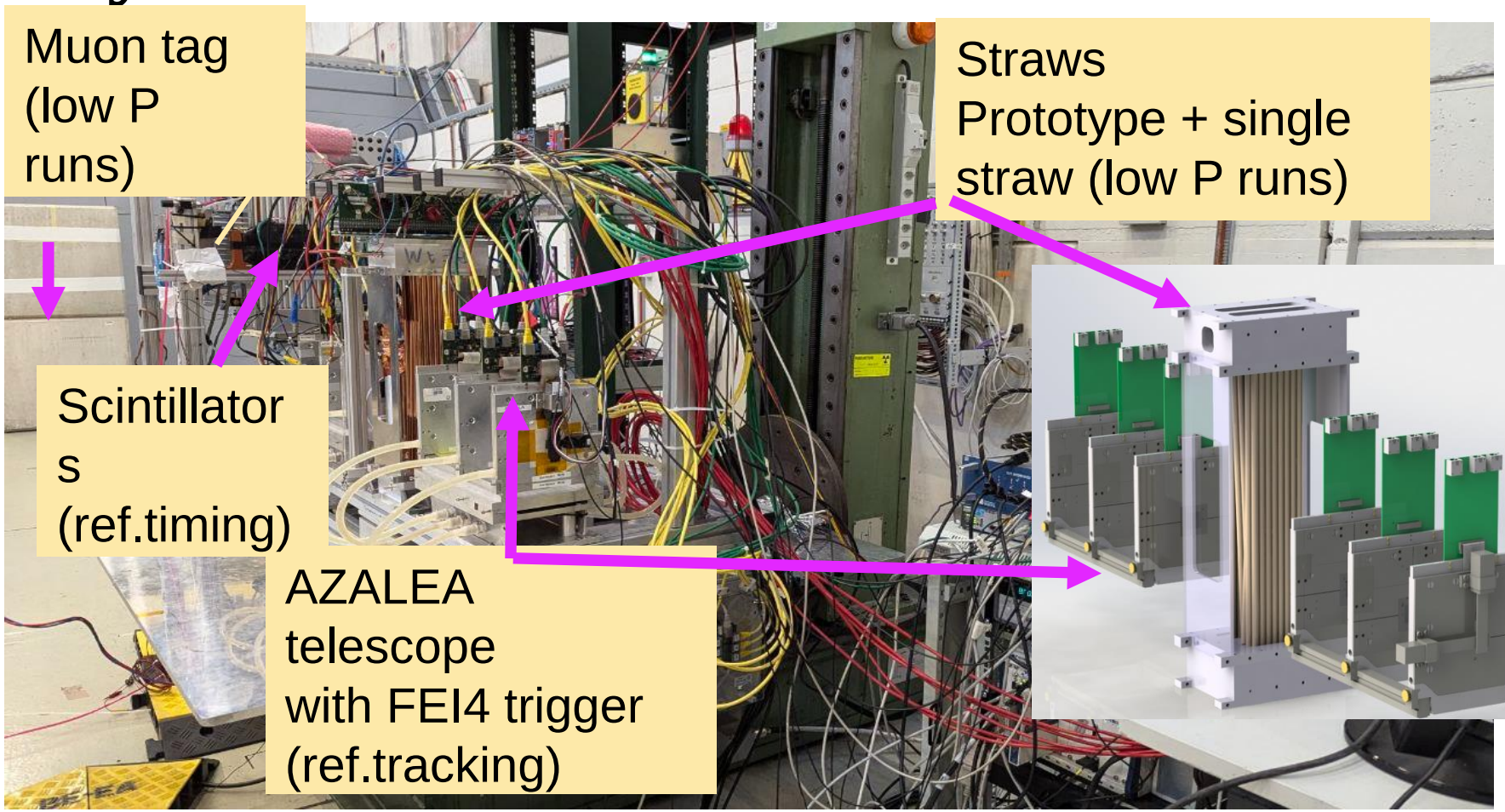



# Beam Test activity H4 SPS CERN

***- Ref. Tracking***
*(AZALEA)*

***- Ref. Timing***
*(scint ~200 ps)*

***- DUT:***
***tracker prototype***
*- VMM3 readout*
*- ASD readout*
*(UNI Michigan)*




***single straw – custom charge sensitive PA (1 us peaking time) + CAEN digitizer***

***- Additional downstream***
*TimePix4, sMDT drift tubes*

***Datataking: 02-09 October***

Many thanks to Dipanwita Banerjee

# Straw PS program

- ***High momenta*** *- timing performance*

  ***t vs R with VMM3 and ASD readouts***

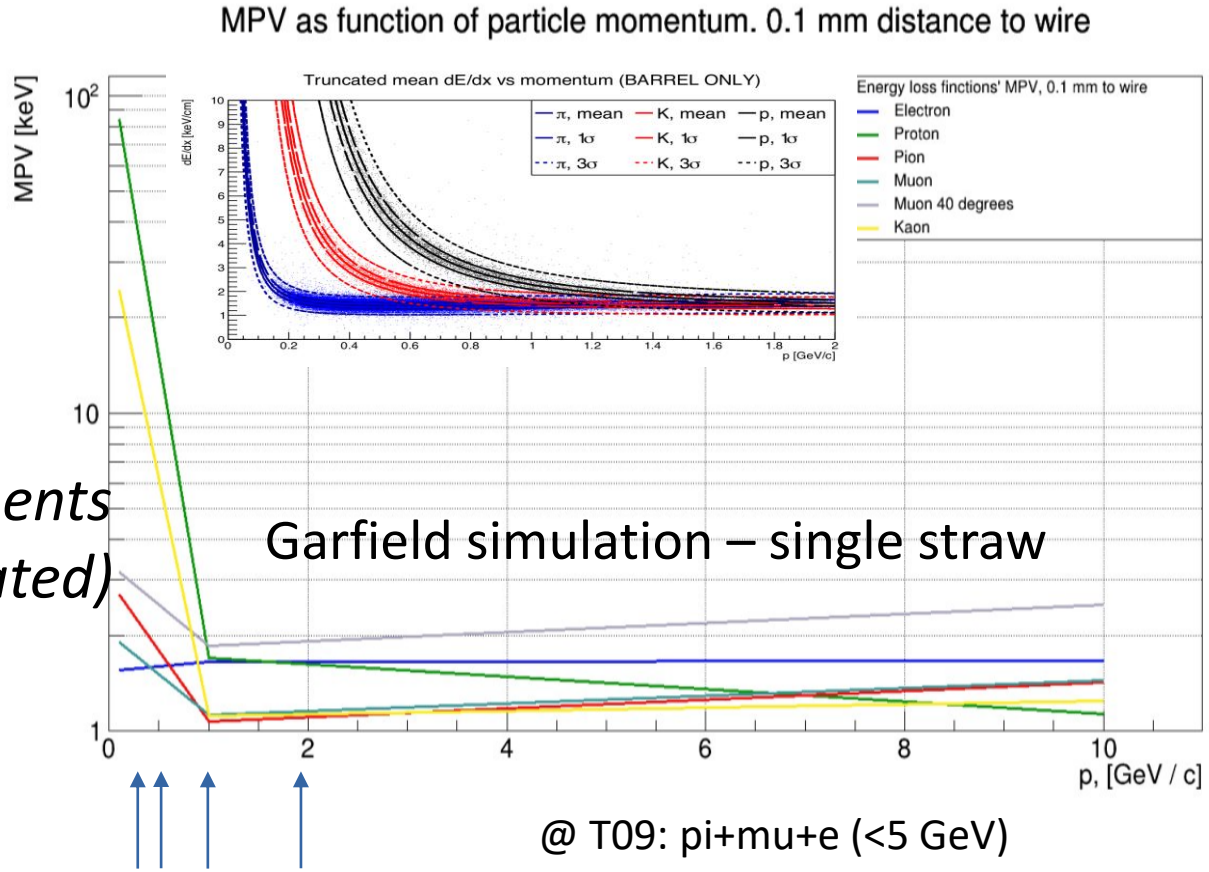
  *15, 5 and  GeV h+, large statistics*

- ***Low momenta <=2 GeV –*** *charge measurements*

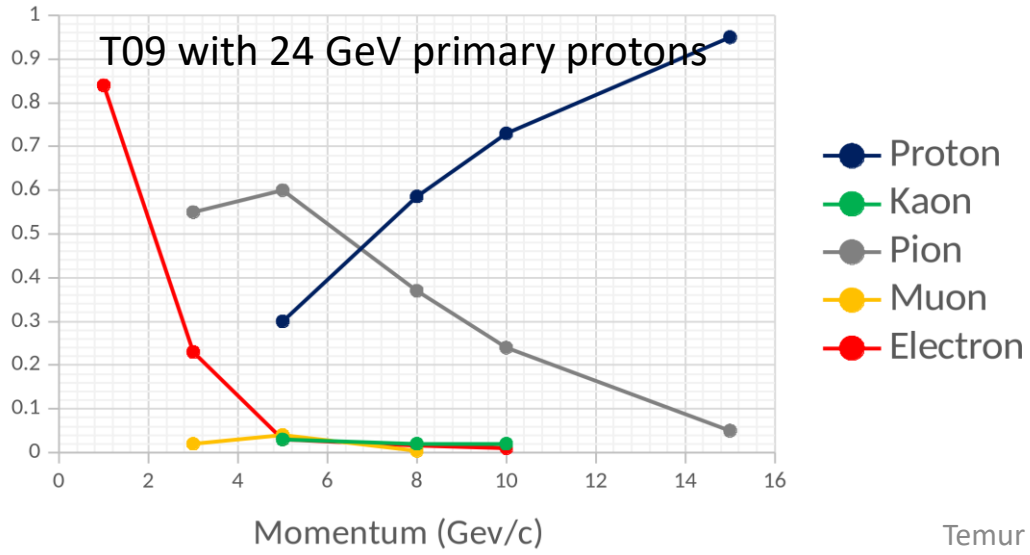
  *- 2, 1, 0.5, 0.3 GeV (purity to be evaluated)*

  ***- Q vs P (single straw)***

  ***- time-over-threshold vs P (ASD readout)***




@ T09: pi+mu+e (<5 GeV)




Electrons are tagged with the Cherenkov detector 15 mV threshold

Tried to veto muons behind the concrete block

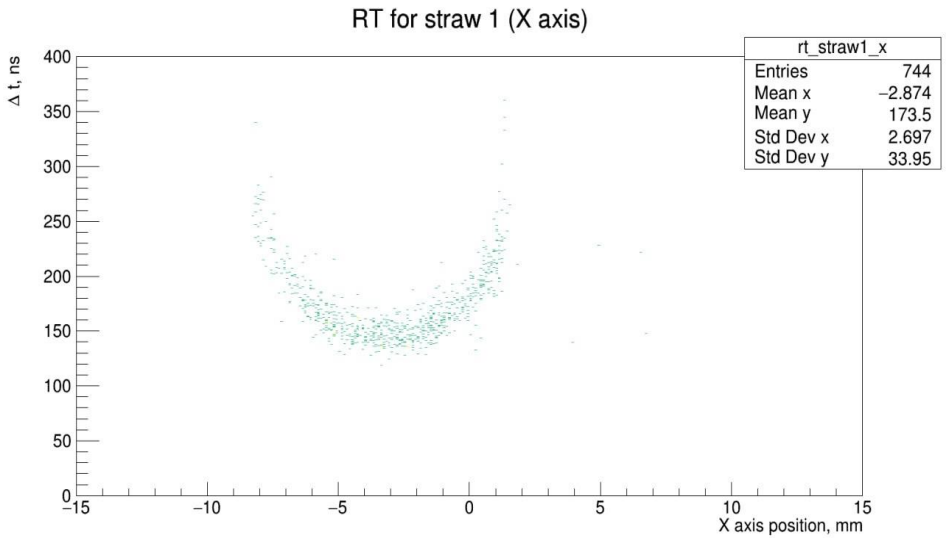
Last two days :

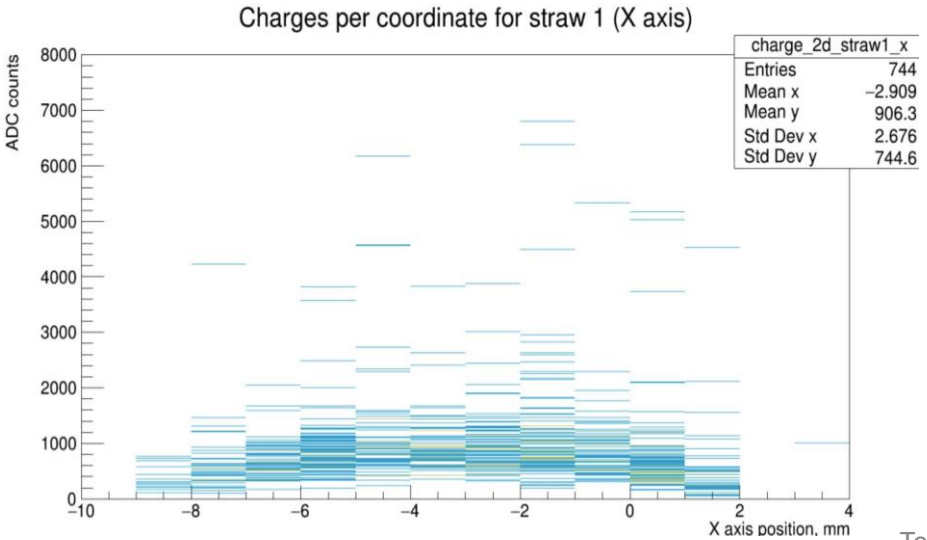
- decreased momenta of primary protons (down to 15 GeV)

=> higher population of low momentum hadrons

# Prompt results – just a first glance

Single straw + custom readout



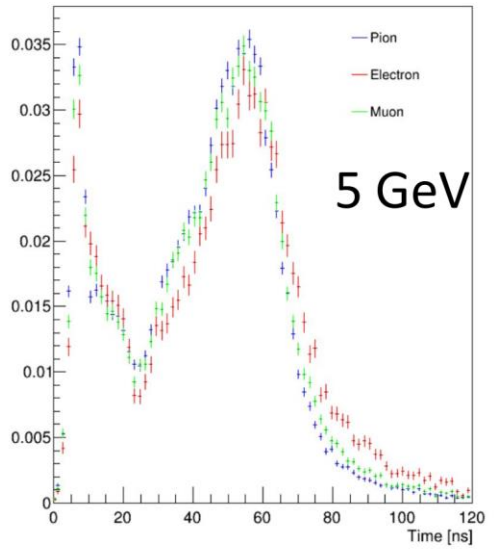




1 GeV

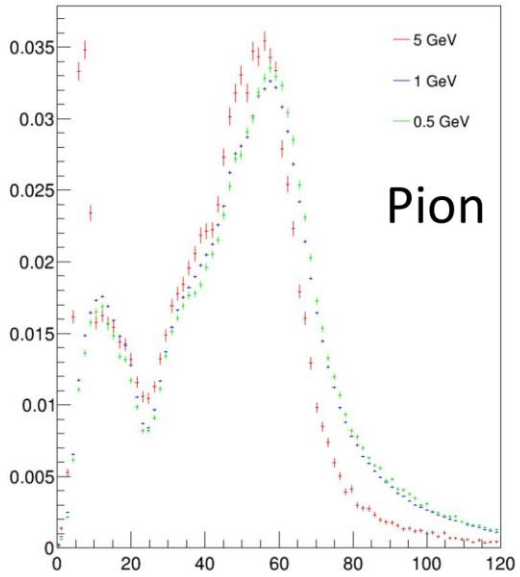
Preliminary

No selection

Prototype + ASD readout




TOT spectra




Straw beam tests

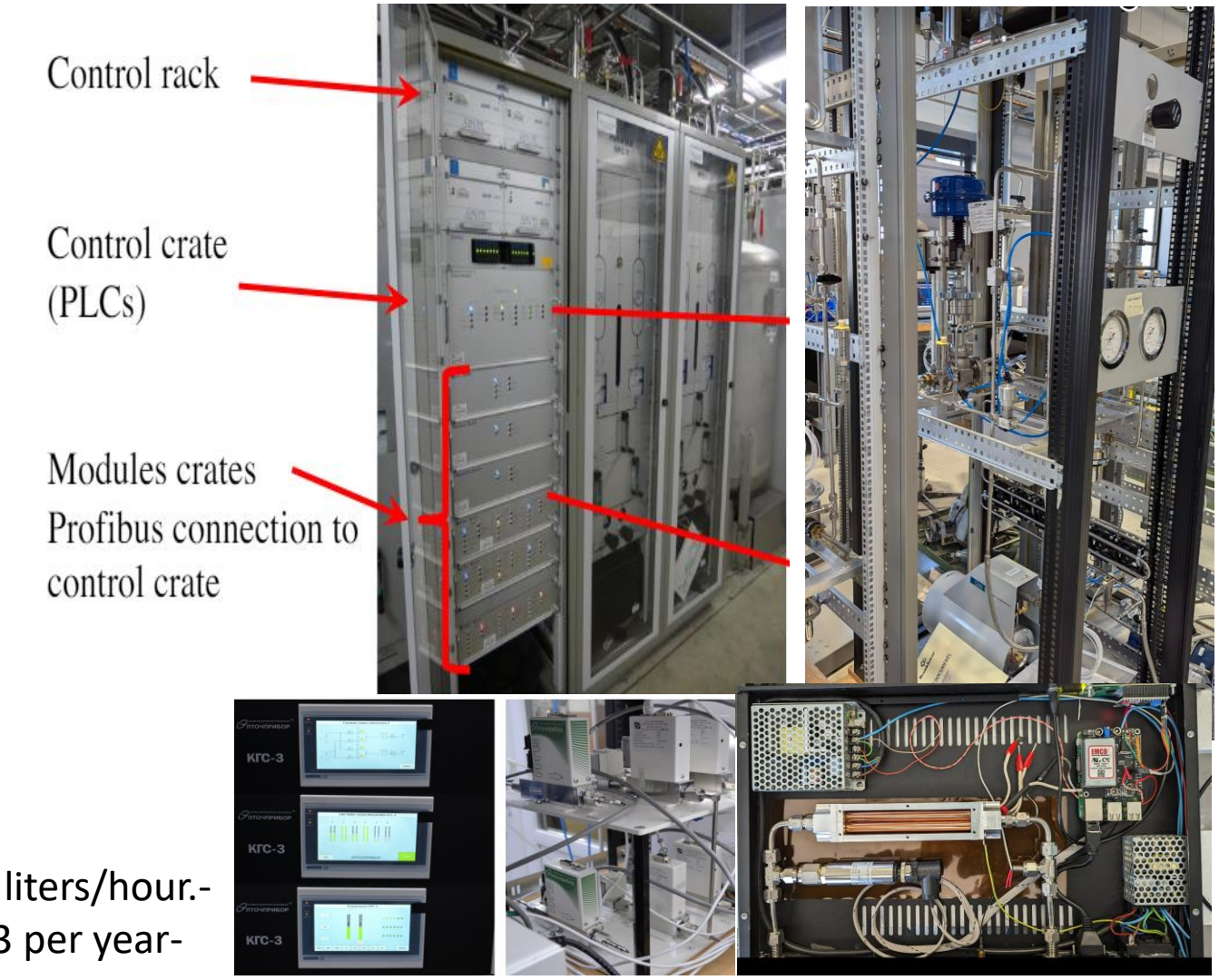
14:20 - 14:40

Presenter Dmitry Sosnov

# Gas System: design requirement

Gas systems (as detectors) are subject to severe requirements on material & gas for safe detector operation:

- Mainly (or exclusively) stainless steel pipe and components
- Need to validate most of the gas system components
- Documentation for QA and operation/maintenance follow up
- Monitoring of gas system operation
- Monitor of supply gases and mixture composition
- Evaluation of operational cost
- Flexible design to accommodate detector requirements/upgrades
- Careful evaluation of
  - resources for operation
  - resources for maintenance activity
  - Stability required
  - Balance requirements vs safety (as much as possible)




Straw-full system volume = 5 m3
Average gas consumption (70% Ar + 30% CO2) = 5000 liters/hour.-
Operating 4 months a year, ~500 hours, total 2500 m3 per year-

# Plans

- straw tracker prototyping
- new assembling and production lab spaces
  - recovery of the miniSPD setup
  - readout electronics prototyping
  - test beam measurements at SPS and PS, the corresponding data analysis and feedback to FEE developers
- - evaluating possibilities for the testbeam measurements at PNPI (Gatchina), INP (Almaty) and JINR
- concept development of the gas supply system
  - longevity study for straw and supporting element material
- LV and HV power supply development
- purchasing the necessary materials (tape, wire ..)

# Thank you for your attention