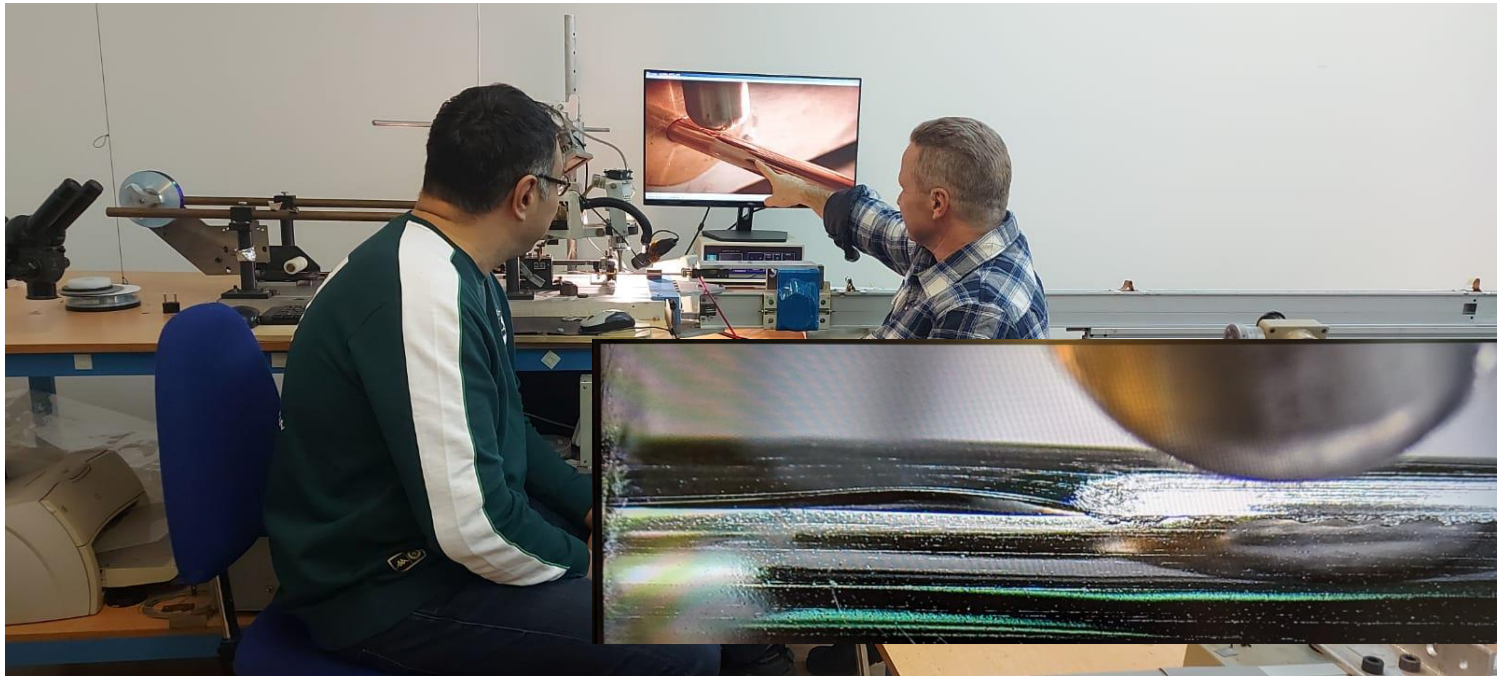
Straw-Barrel status report

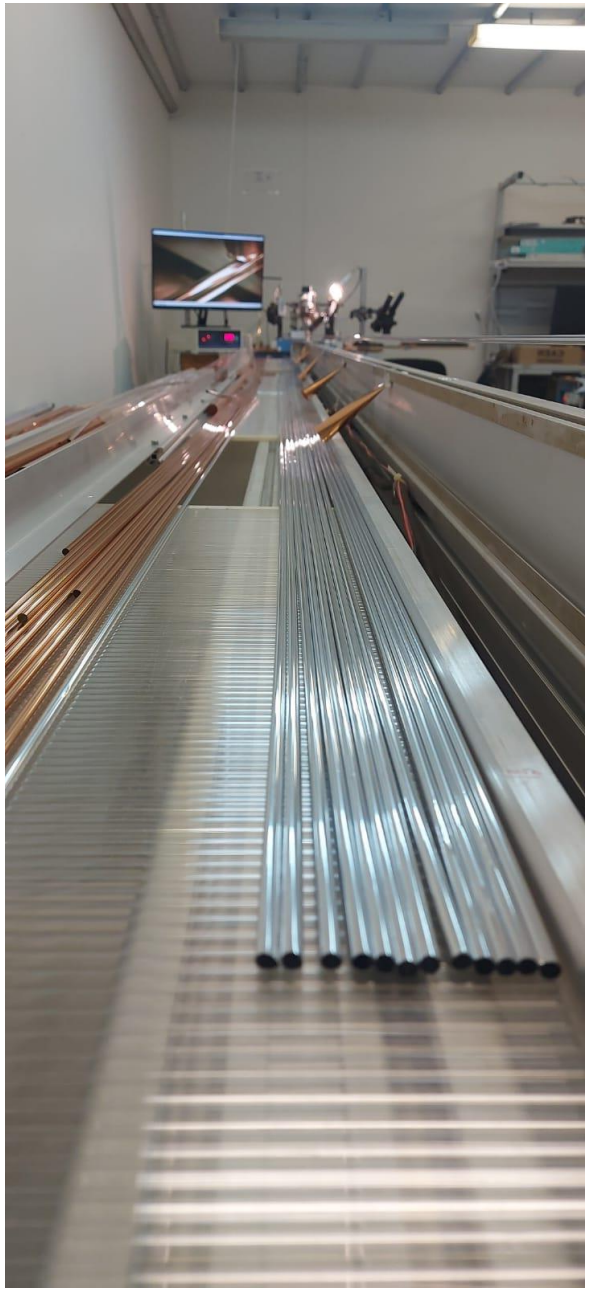
STRAW production line

- Productivity- 1m/min
- Length- 5.5m
- Diameter-from 10 mm

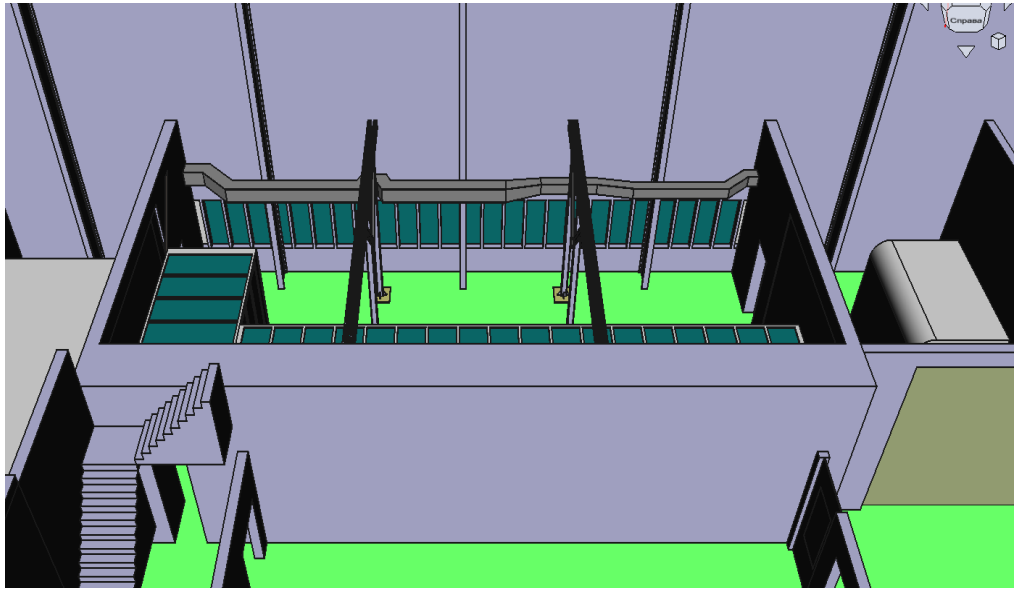
- Film thickness-36 microns
- Number of employees-10FTE
- Coating thickness 50-100nm
- Coating is carried out in the RF

- Produced ~20km straw
- Installed ~8000 straw
- After 10 years of operation non-working- 3 straw
- Film is available in Russia
- Number of employees-10FTE





New Straw production line and assembling place



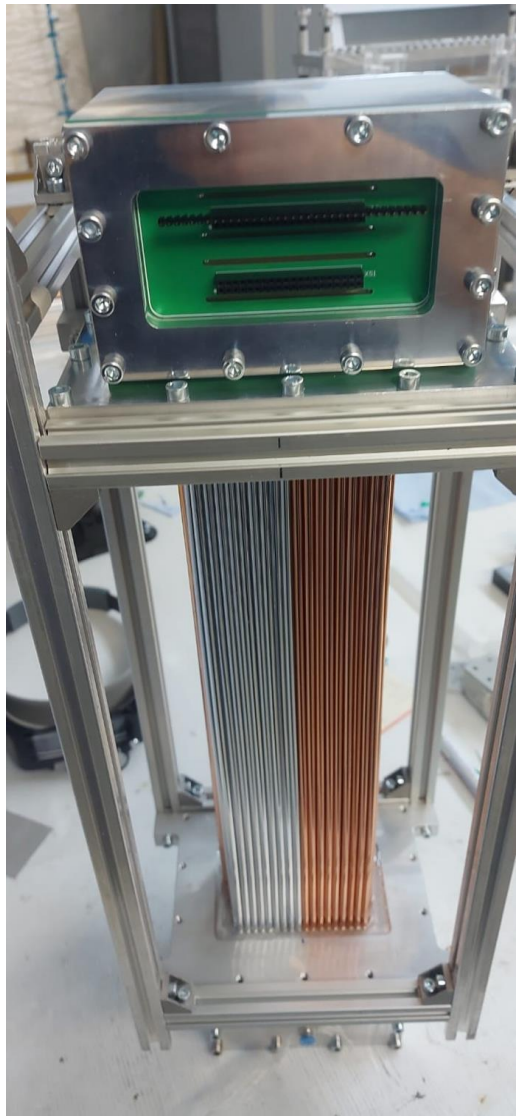
- Area ~200 sq.m., clean room~100 sq.m, machine shop and assembling hall~50 sq.m and 8,5 m high
- Double Production line length~12m
- The deadline is the beginning of the 3rd quarter of 2024
- Commissioning works-the beginning of the 4th quarter of 2024
- Necessary materials and equipment have been purchased
- Planned volume ~60km straw

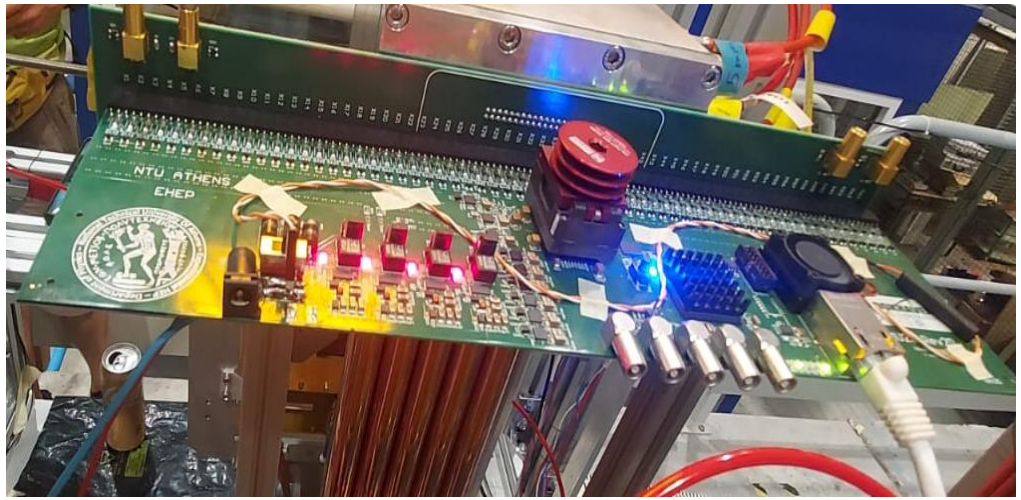
Measurements of the straw performance and choice of the readout electronics parameters

- **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)

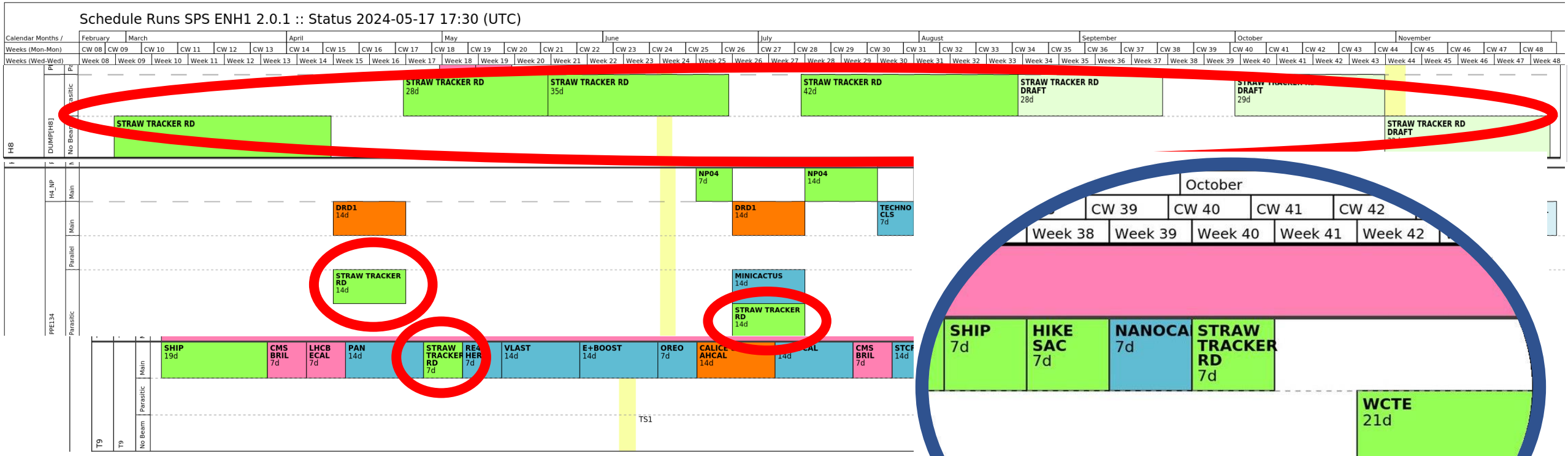
- **Charge measurements** (PS, low momentum pi, mu, e)
  - charge distribution for different particle momenta
  - multiple scattering probability
  - electronics dynamic range for PID (protons are required, under discussion)
  - measurements at PNPI under discussion

Beam Test activity





Test beam periods 2024 at SPS and PS

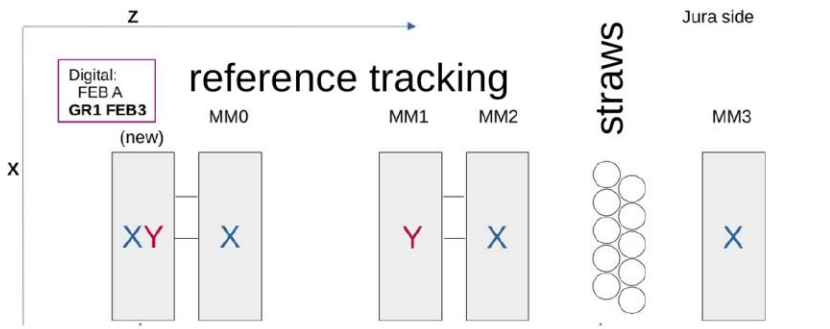


Three different tasks:

- 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					

The SPS setup



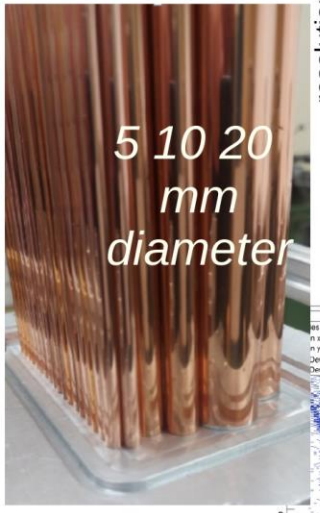
Reference tracking:

- MM detectors (250 um, 400 um) + Tiger readout (Torino University)

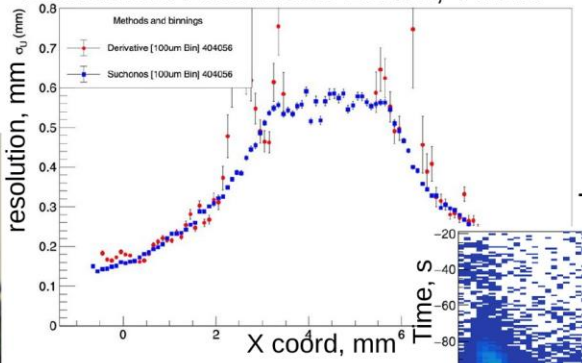
Under test: a **combined straw tracker prototype +** two types of readout: **Tiger and VMM3**

Goals:

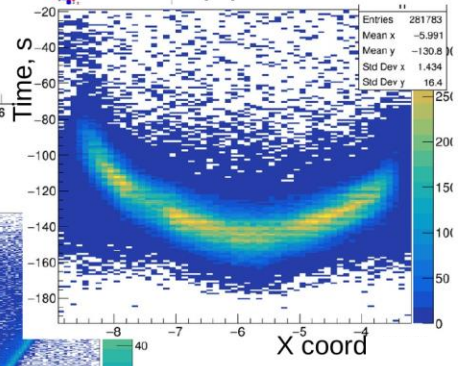
- evaluation of the realistic noise prediction and thresholds settings for the developing ASICs (Dune, DRD1-WP3)
- evaluation requirements for SHiP STT readout
- evaluation of TimeOverThreshold mode capability for straw readout with Tiger ASIC (to be continued at H8)
- evaluation of the charge measurement requirements for future PID optio (to be continued at PS T9)



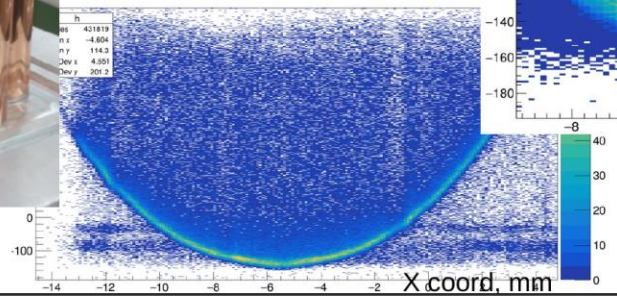
Coordinate resolution: **10mm**, VMM3



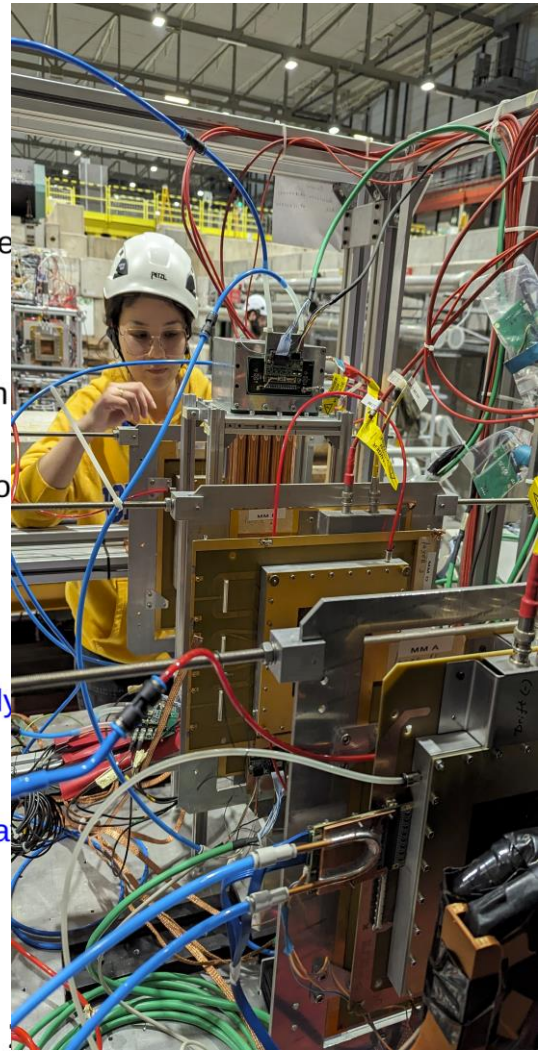
T(R), **5mm**



T(R), **20mm**



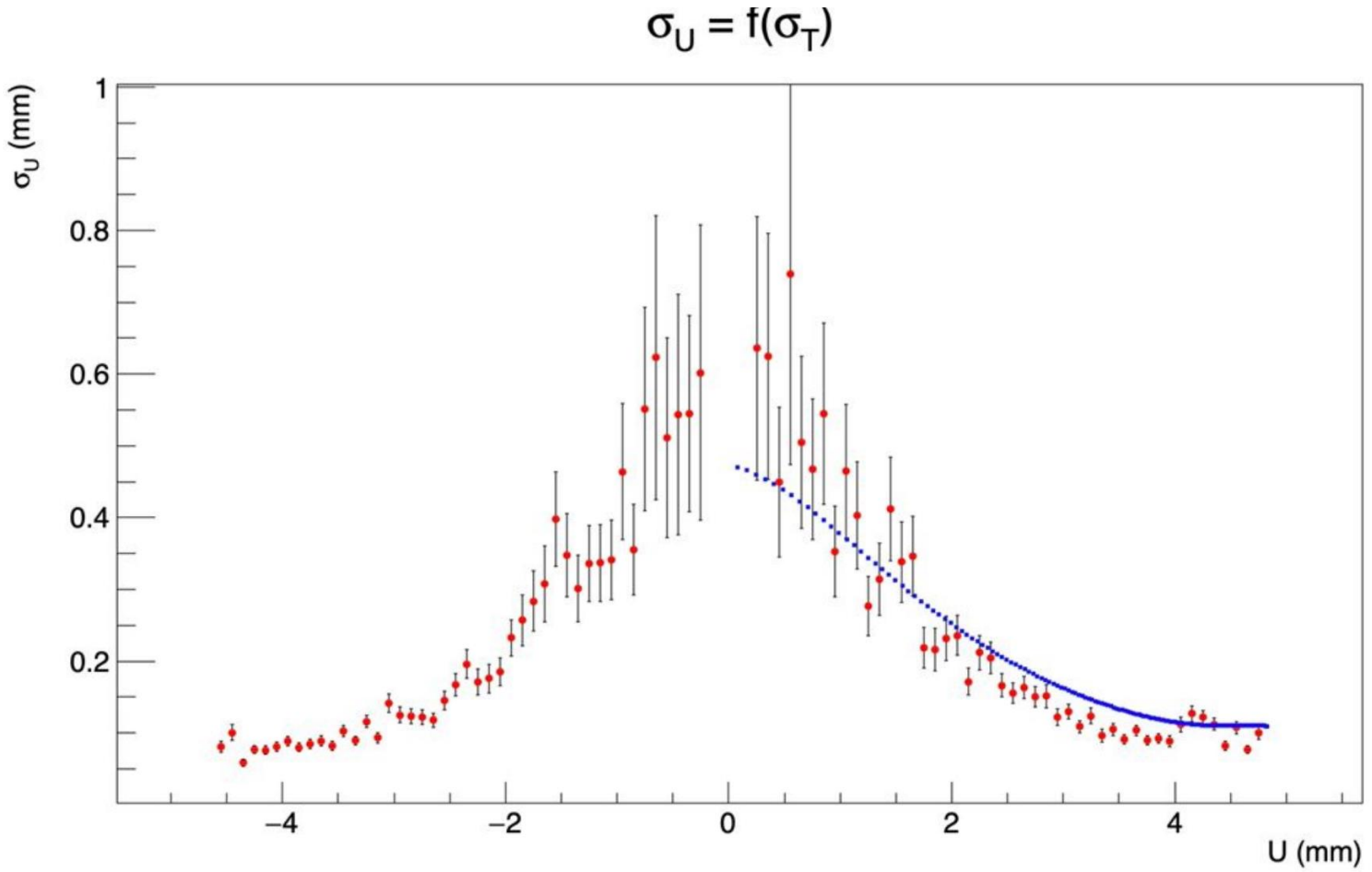
- ✔ Improved reference tracking resolution
- ✔ TIGER readout for high charge/high rate under study
- ✔ Upgraded TIGER FEB and cooling design
- ✔ Efficient data taking at H4, studies to be continued a
- ✔ Offline analysis started
- ✔ Very grateful to **RD51/DRD1** for support and infrastructure and to XXXX for great beam!



Validation with NA62 data

- good agreement between two independent analysis methods

- results similar to the resolution obtained with straw prototype and VMM3/TIGER

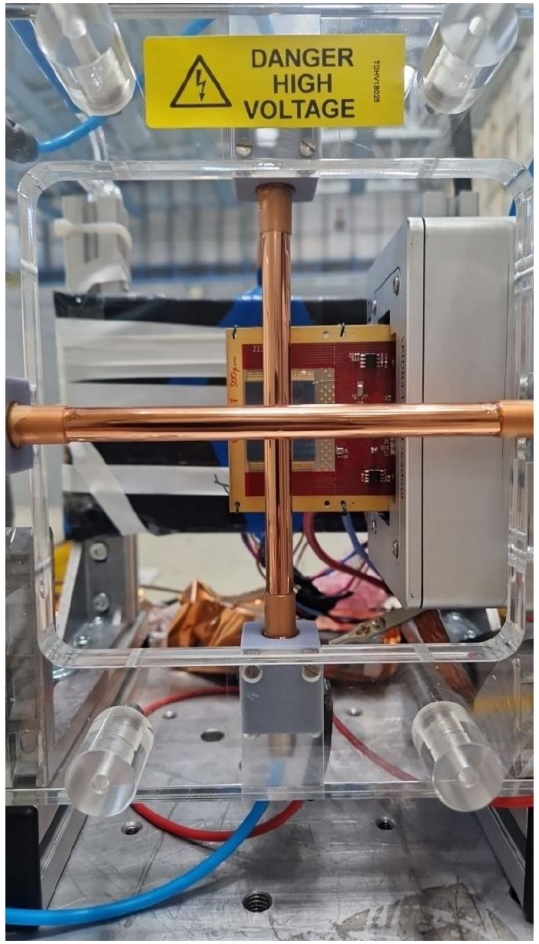


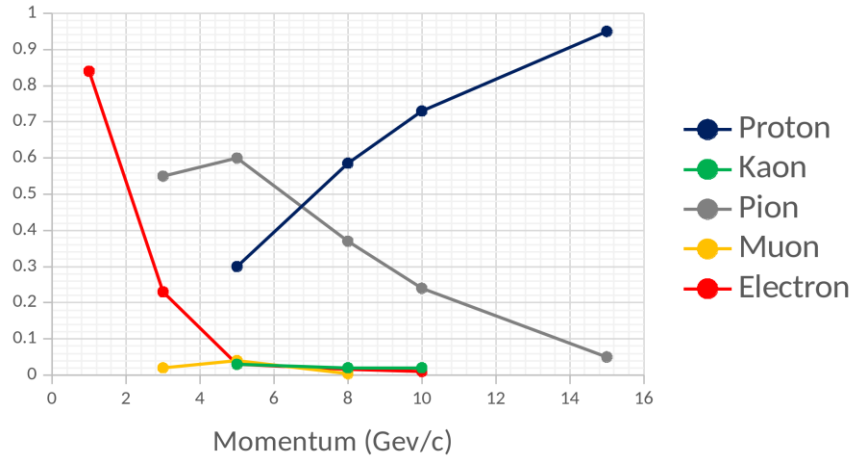
- see A.Chukanov's talk

The PS setup

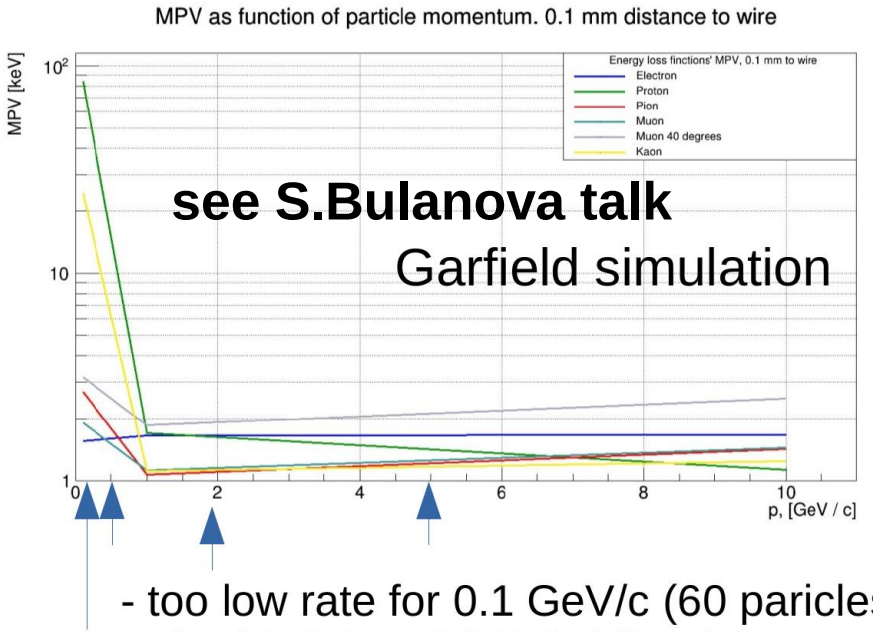
Straw PS setup 1

- Two straws read out with two custom PA
  - APIC (RD51) ~400 ns peaking time
  - JINR ~ 1 us peaking time
- Timepix detector
- scintillator





Goal: to understand PS T09 beam conditions for October measurements



see S.Bulanova talk

Garfield simulation

hadron beam

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

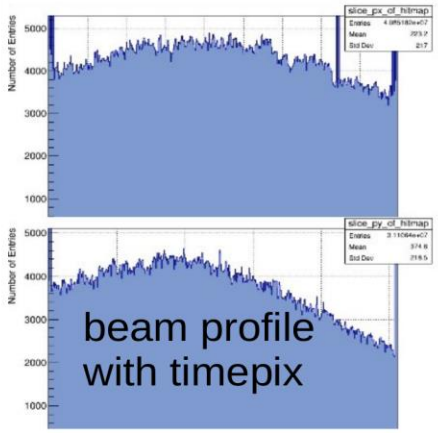
+ electron beam (reference)

Electrons are tagged
with the Cherenkov detector
15 mV threshold

- too low rate for 0.1 GeV/c (60 paricles/spill),
- ok with 0.3 and 0.5 GeV/c – but seems not the best region for us
- 1-2 GeV seems promising for charge resolution measurements
- for lower momenta – offline analysis of the collected data started

The PS setup

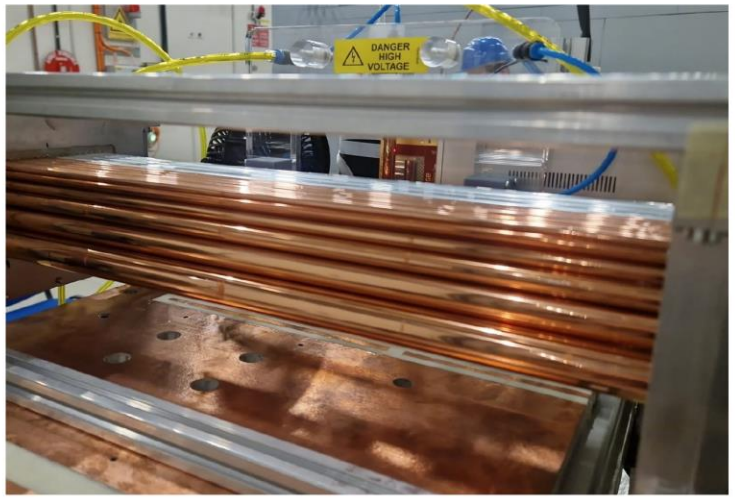
Data setup 1

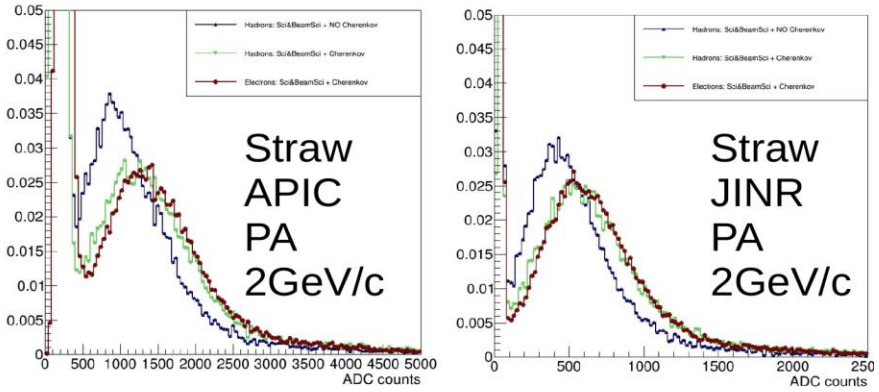


Data setup 2 = setup1 + tracker prototype (last night)

- VMM3 readout of the prototype (SPS runs) – not optimal for charge measurements

- but 10 (10mm) or 20 (5mm) straws on the beam axis





Straw: careful analysis + comparison to simulation is neede

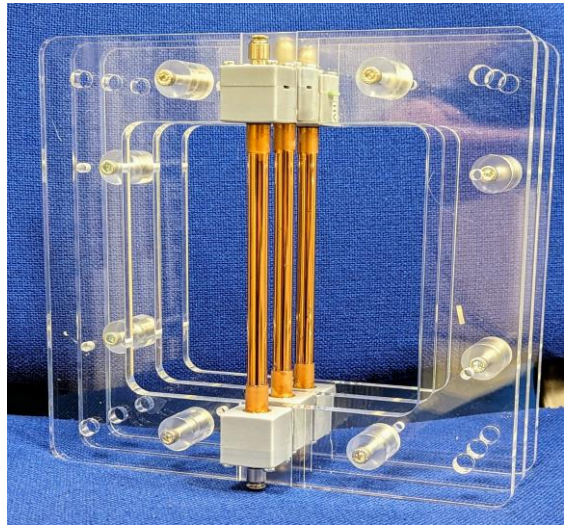
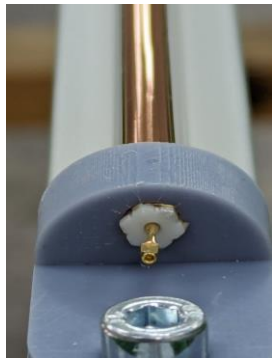
Feedback from PS:

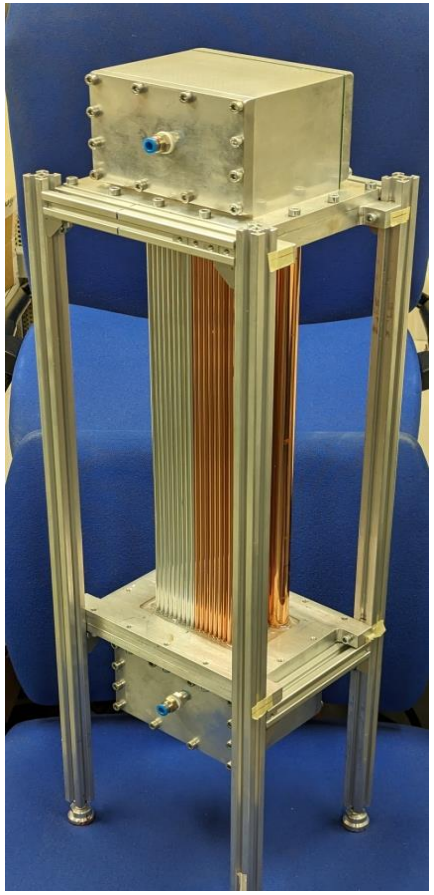
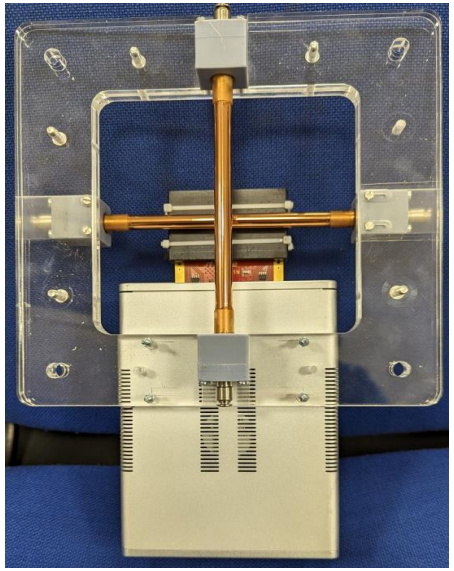
- will investigate possibility for **low momenta protons**

- for October TB it is possible to **increase intensity**

Prototyping

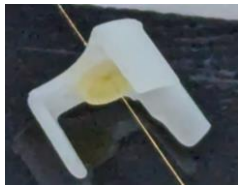
- Small prototype production (lab and test beam straw and readout performance studies)
- development and prototyping of the construction elements (gas supply, sealing)
- development and optimization of the electrical

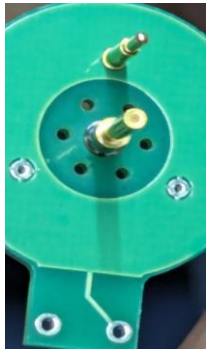
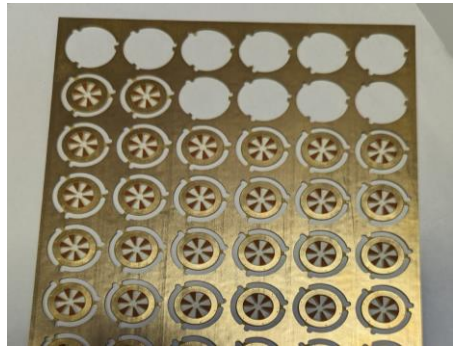





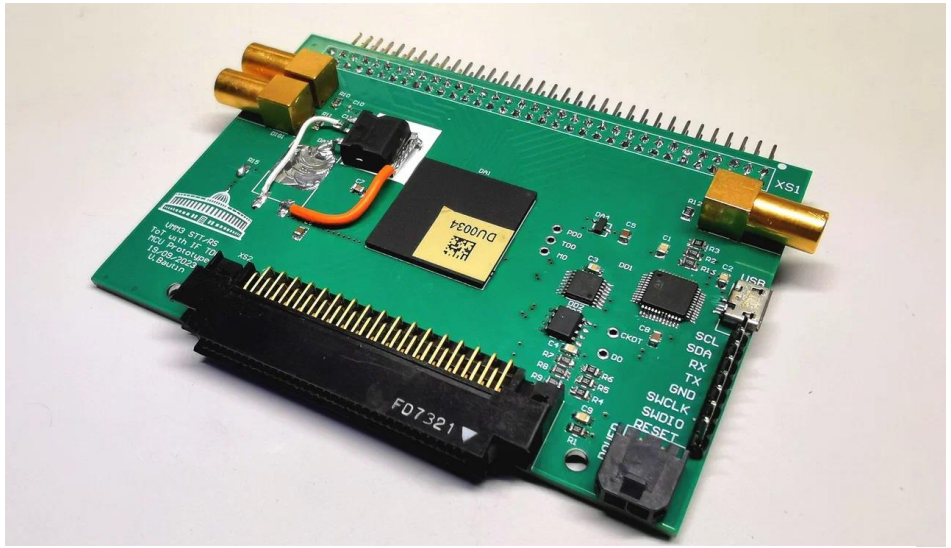


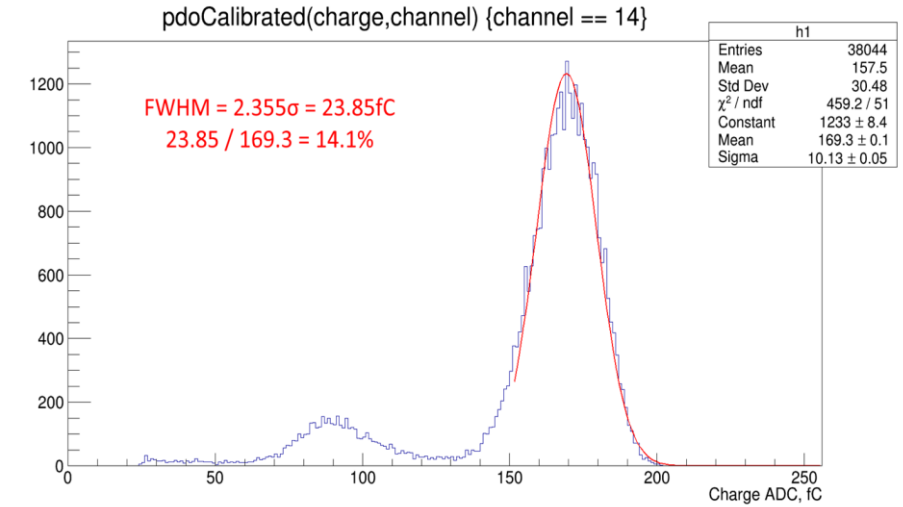



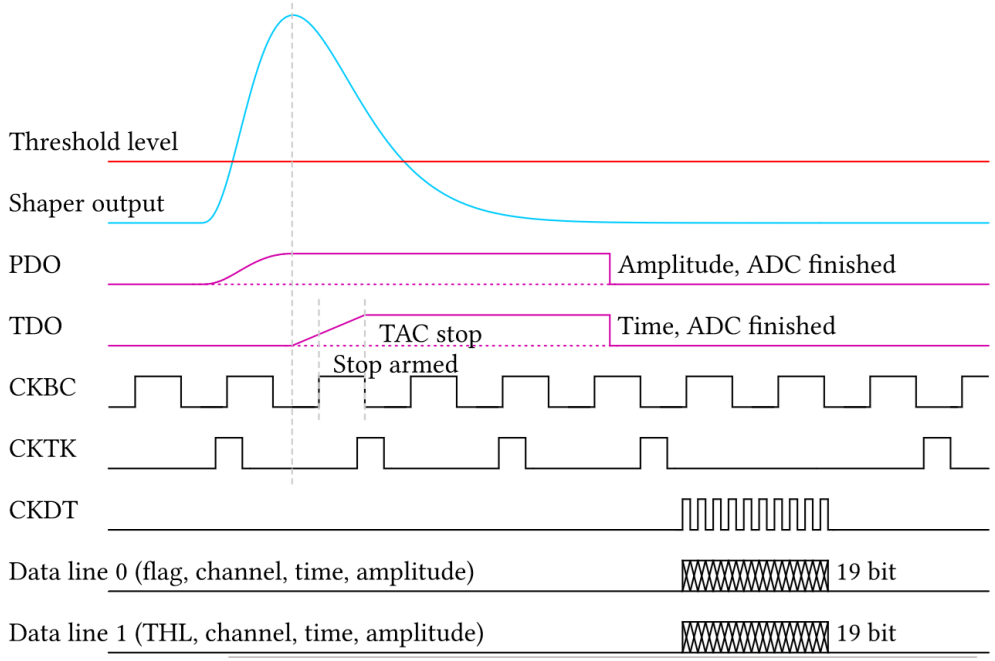




Electronic R&D

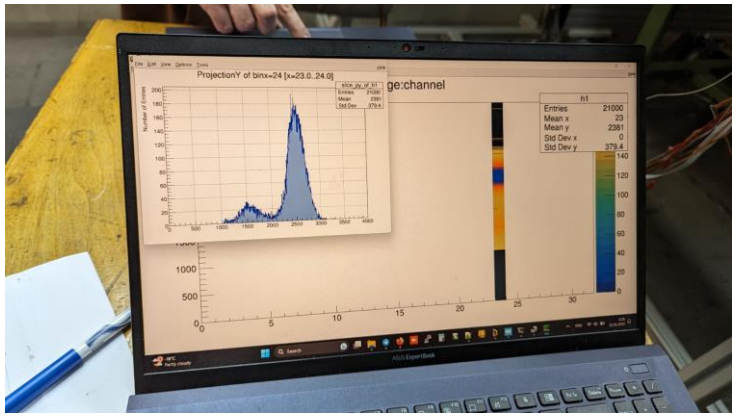
VMM3a PCB with microcontroller.

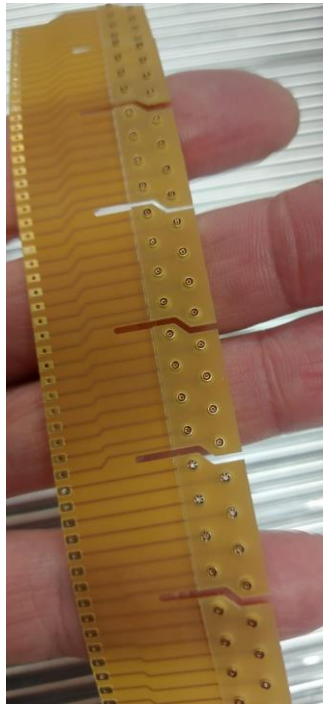






FEE на noname ASIC from De Geronimo





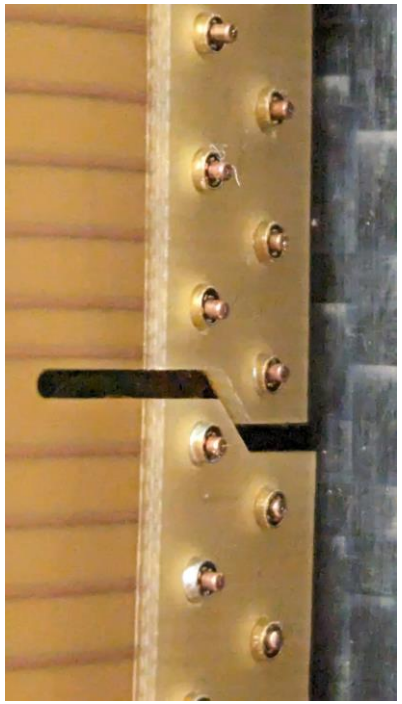


Table 1. ADC features on STM32G4 Series

Features	Values for STM32G4 Series
Number of ADCs	Up to 5
Resolution	12 bits (or 10, 8, 6 bits), 16 bits with oversampling
Number of input channels	Up to 42
ADC principle	Successive approximation register (SAR)
ADC clock frequency	Up to 60 MHz (up to 52 MHz in multiple-ADC operation case)
Sampling rate	Up to 4 Msps (up to 3.46 Msps in multiple-ADC operation case)
Sampling time	2.5 to 640.5 [ADC clock periods]
Supply voltage	V_{DDA} = 1.62 V to 3.6 V
Reference voltage	On dedicated VREF+ pin(1) (internal or external), V_{REF+} = 1.62 V to V_{DDA} (see datasheet)
Triggers	From external pins or internal peripherals (timers)
Conversion modes	Single, continuous, scan-selected channels, discontinuous mode
Others	Offset calibration, analog watchdog, hardware oversampling, offset compensation, gain compensation, interleaved mode (two ADCs coupled), sampling time controlled by trigger edges, bulb mode sampling

1. *In the LQFP128-pin packages, two VREF+ pins are available.*

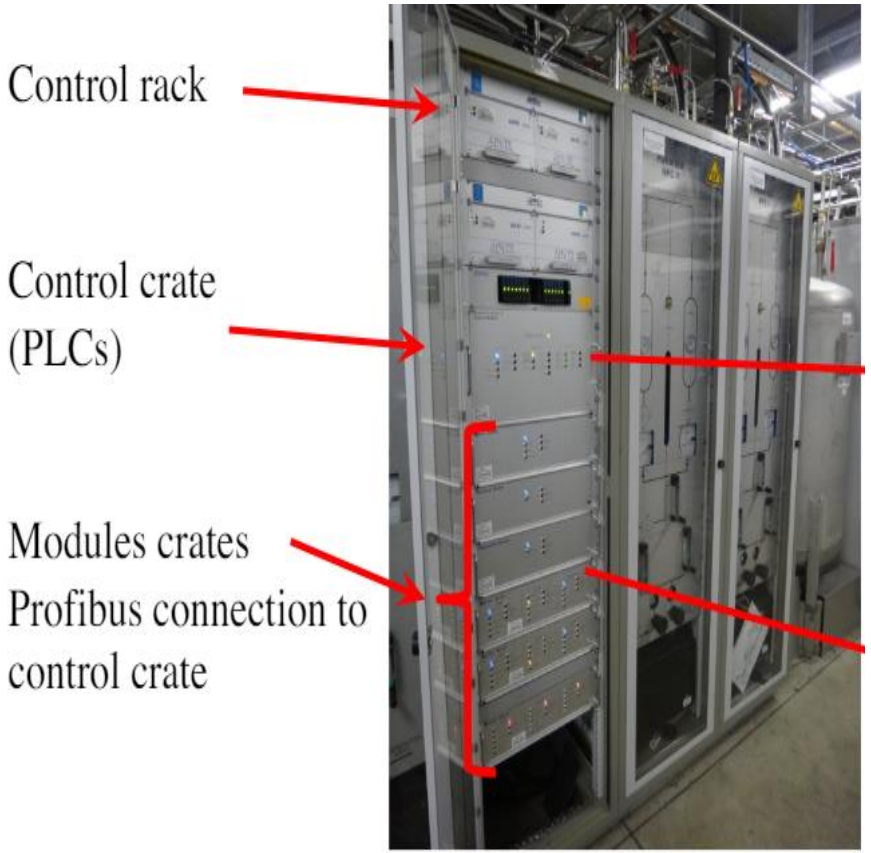
Contributions

- JINR – coordination, R&D, engineering and prototyping, straw production, lab and test beam data taking and analysis, readout development, gas system and aging (Karjavine’s team)
- PNPI - test beam data taking and analysis, simulation (Garfield++ and SPDroot), reconstruction
- INP (Almaty) - straw production, testbeam data taking, Garfield++ simulation
- Polytech (SPb) – DAQ
- TPU (Tomsk) – FEE
- NCPHEP (Minsk) – FEE (Solin)
- Ongoing discussion with Indian institutes (IIT Guwahati, Panjab University, NISER Bhubaneswar)

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)



Publications for 2023

Testbeam Measurements and Realistic Simulation for the SPD Straw Drift Tubes
•November 2023
•Physics of Atomic Nuclei 86(5):832-837

Straw signal modeling using Garfield++ interface to LTSPICE
•November 2023
•Journal of Physics Conference Series 2642(1):012005

Online Gas Gain Monitoring System
•October 2023
•Physics of Particles and Nuclei Letters 20(5):1240-1242

•**VMM3 ASIC as a potential front end electronics solution for future Straw Trackers**,
NIM,Volume 1047,2023,

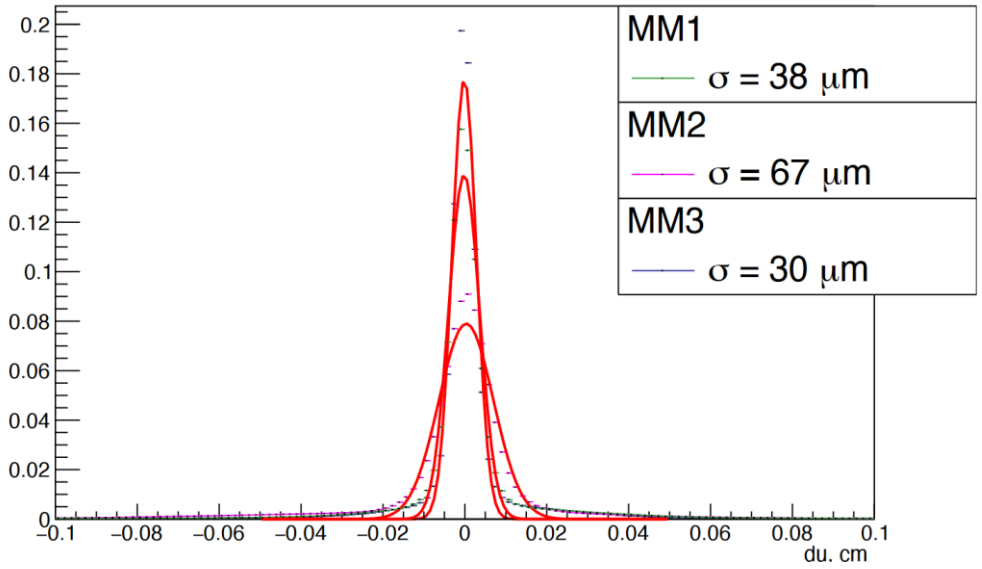
Plans

- 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 AANL(ErPhI,Erevan)
- concept development of the gas supply system
- longevity study for straw and supporting element material

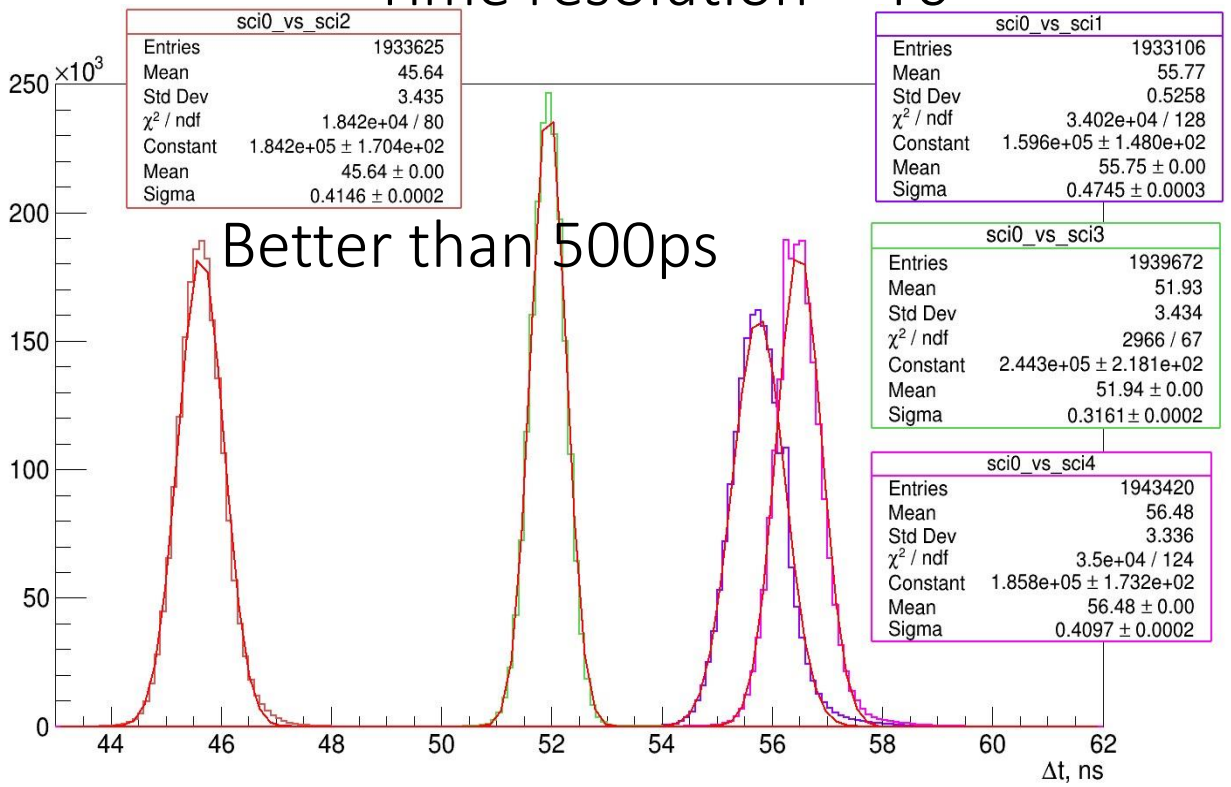
Backup

Reference tracking and timing

Reference tracking -- residuals



Time resolution -- T0



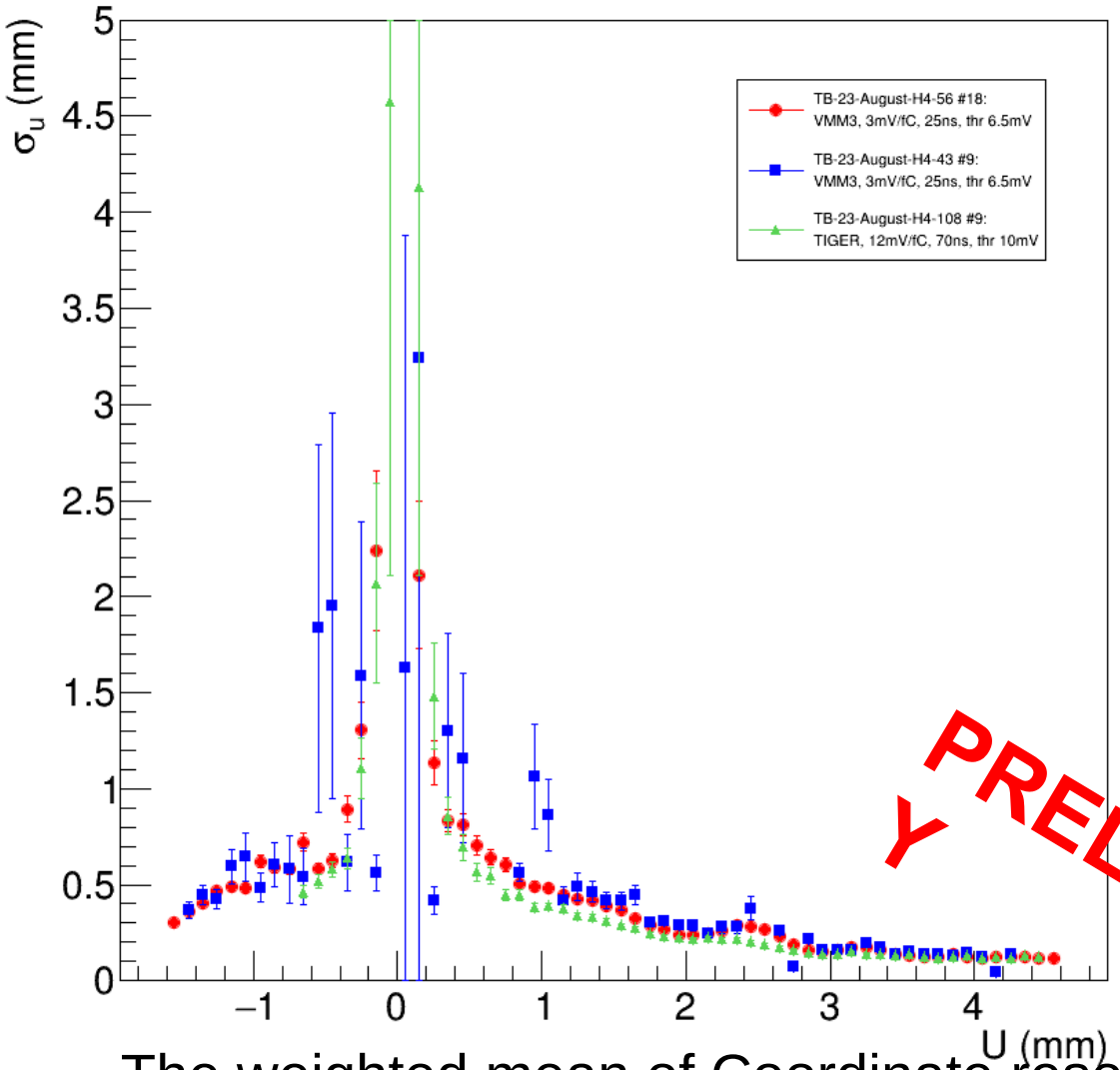
Better than 500ps

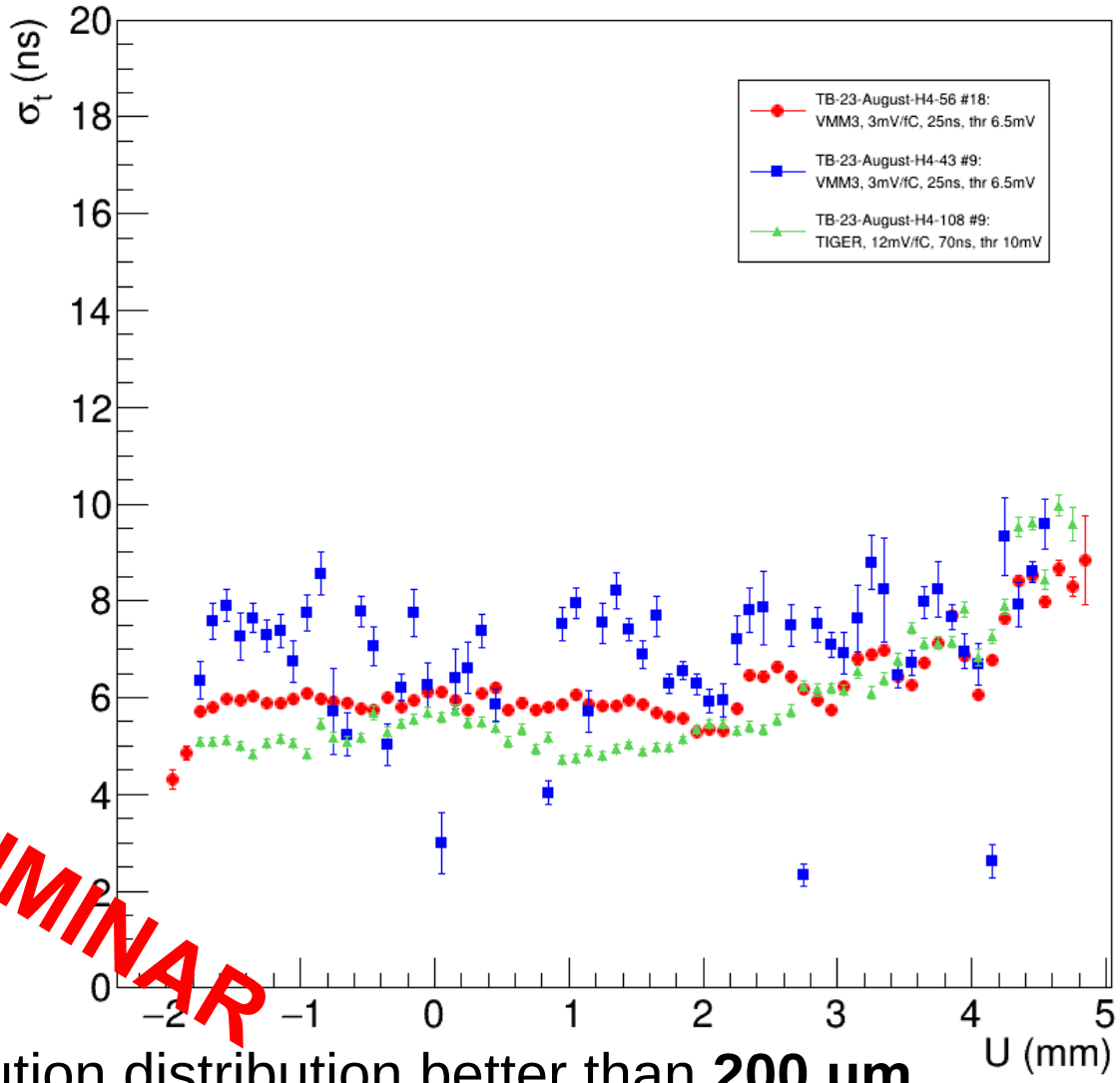
Work ongoing:

- accounting for the reference system uncertainty in the TB analysis

- improvement of the reference tracking resolution

10mm Straw Resolution





PRELIMINARY

The weighted mean of Coordinate resolution distribution better than **200 µm**

The best time ‘resolution’ is about **4-5 ns**

Analysis ongoing