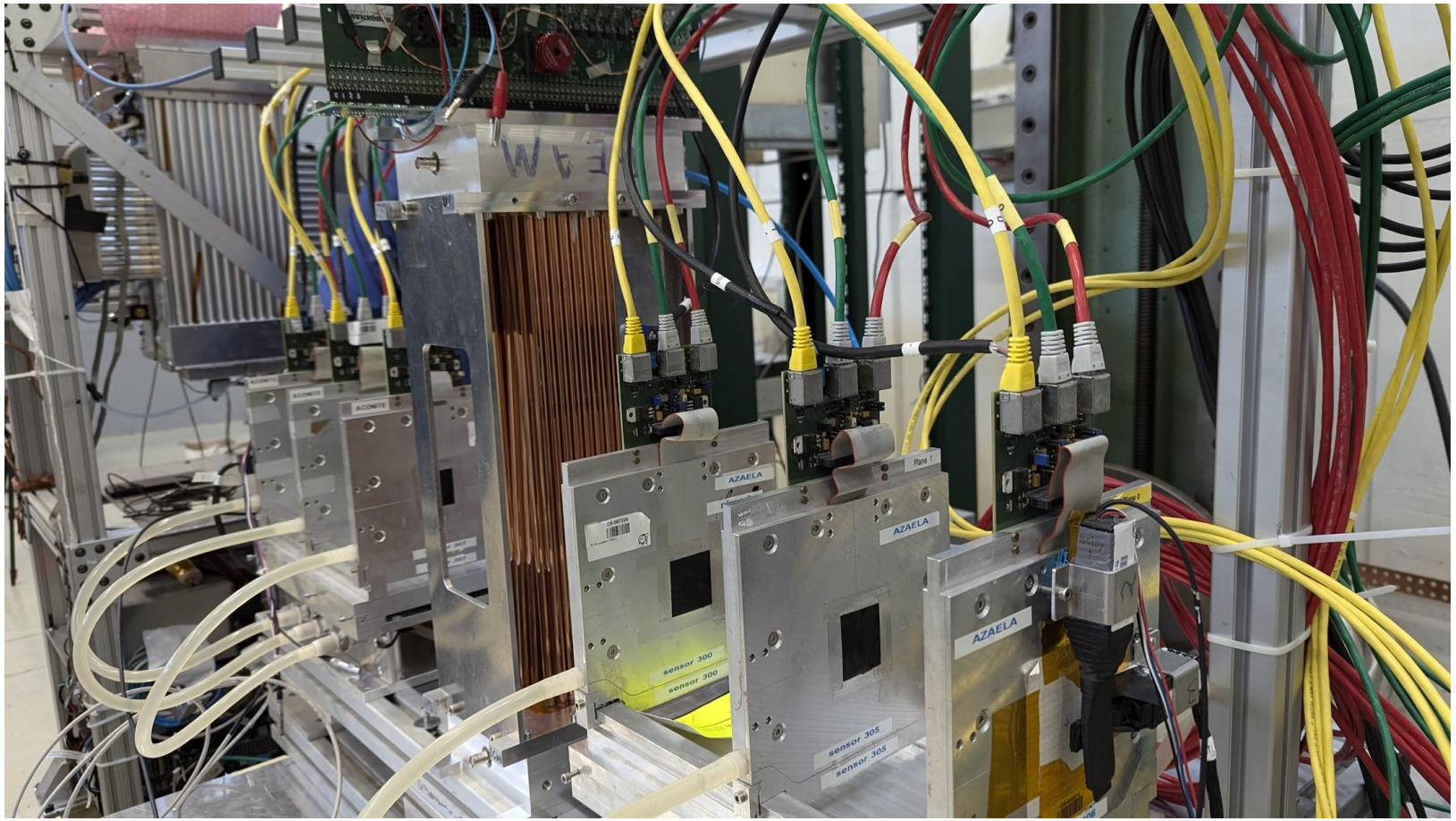
Straw-Barrel status report



Temur Enik on behalf of Straw Tracker Team **20/03/2025**

Straw Tracker Team

«механика»

- конструирование
- прототипирование
- моделирование
- производство компонентов
- сборка
- тестирование
- газообеспечение
- aging
- термостабилизация
- инфраструктура
-
-

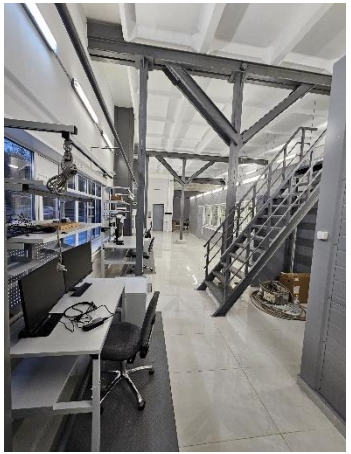
«электроника»

- технические требования
- подбор чипов
- прототипирование
- моделирование
- симуляция
- slow control электроника
- HV
- LV
- интеграция DAQ
- test beam
- cosmic test
-
-

«софт»

- SPDroot
- Garfield
- Geant4
- data taking
- data quality monitoring
- data analyses
- alignment
- slow control
- оптимизация геометрии
-
-

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 2th quarter of 2025
- Planned production ~60km straw
- We started to assemble a new production line

New Straw production line and assembling place at INP

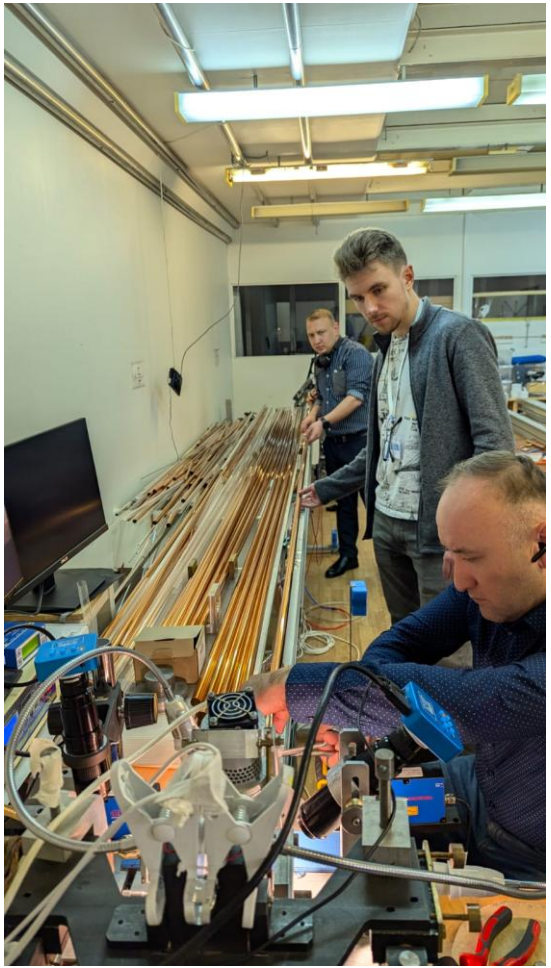
«Big» room

- 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

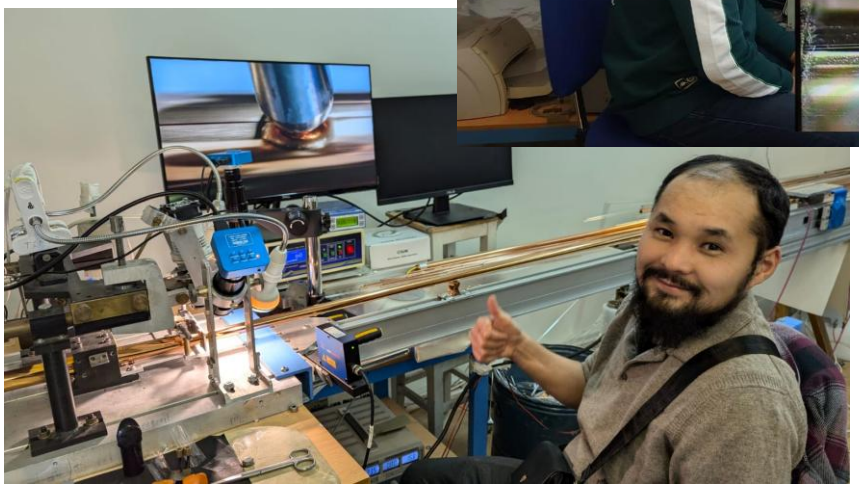
«Small» room

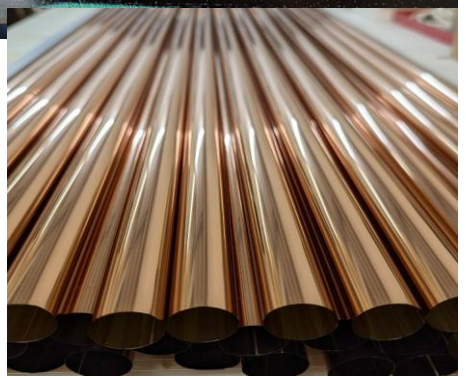
- Area ~60 sq.m., clean room~30 sq.m,
- Room renovation has been finished in March 2024
- Clean room is being built
- 5m straw welding machine will be installed
- The machine and related equipment is purchased

INP Personel traning at JINR Straw Production Site



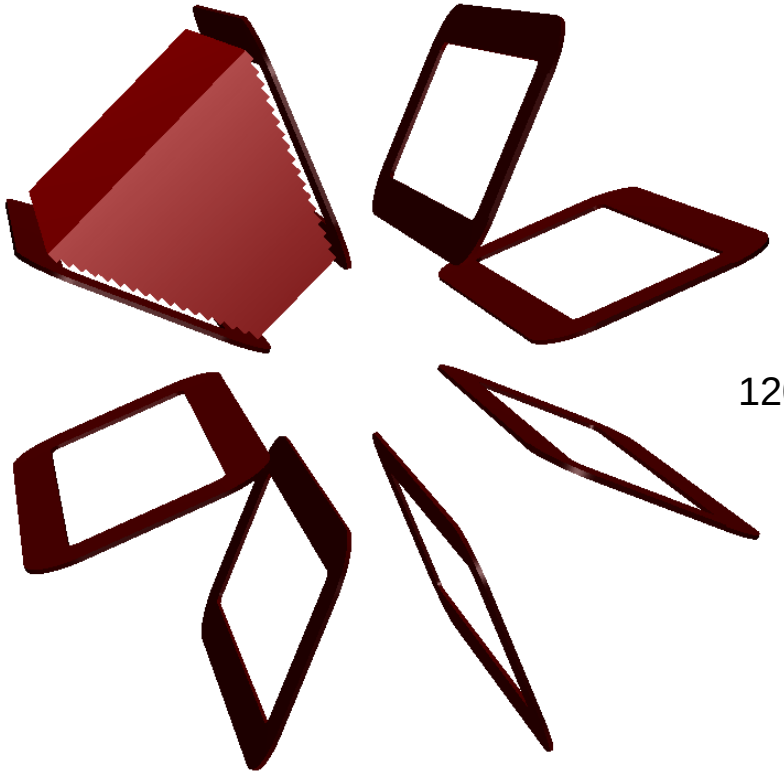
- added a new microscope with better resolution for visualization
- improved the seam positioning system
- production line speed ~3 km/month
- active work is underway in the field of R&D with colleagues from the INP
- One sextant requires about ~6 km of straws

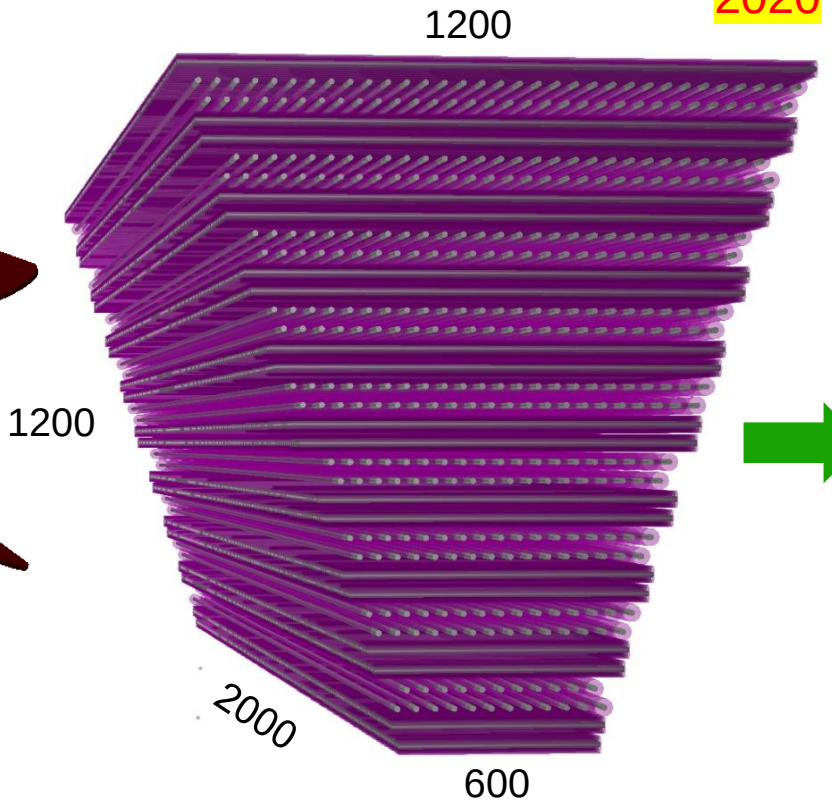


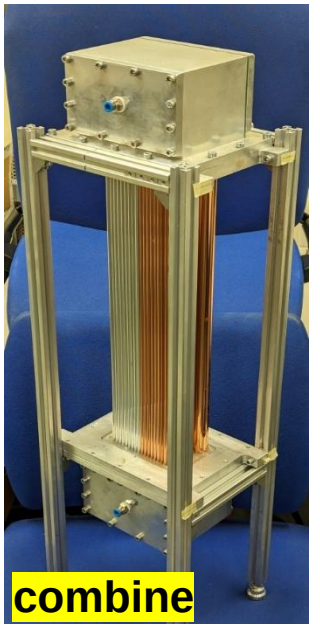


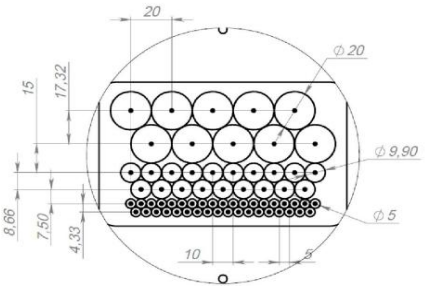
BARREL STRAW TRACKER

2020





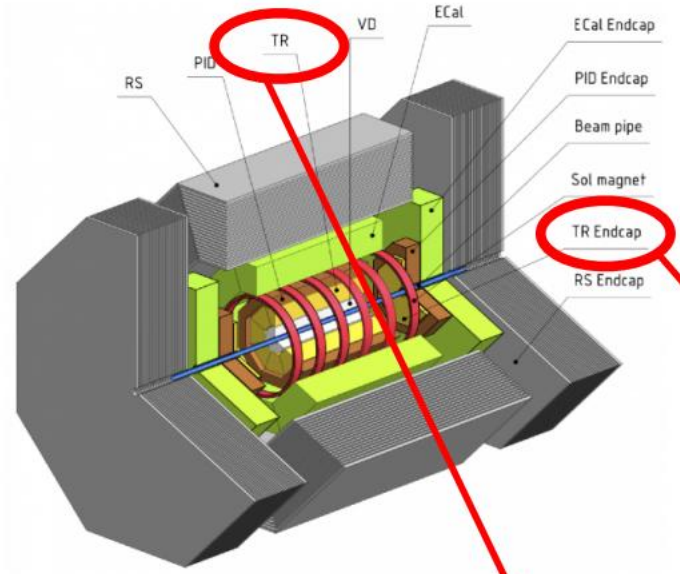




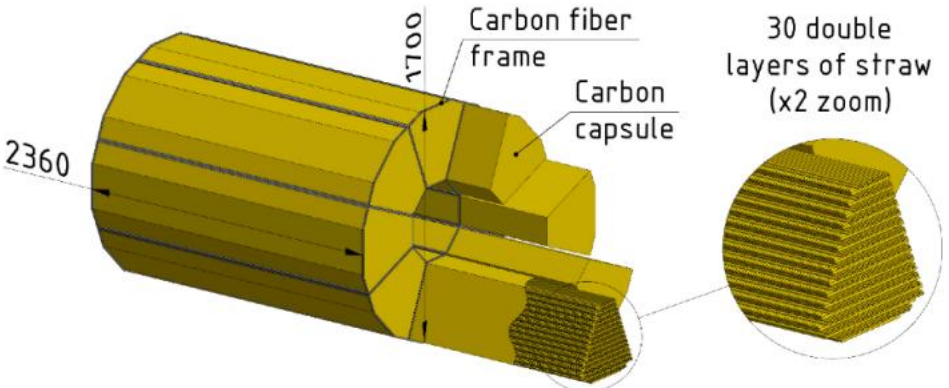
Prototype 1: 5 mm, 10 mm, and 20 mm tubes area

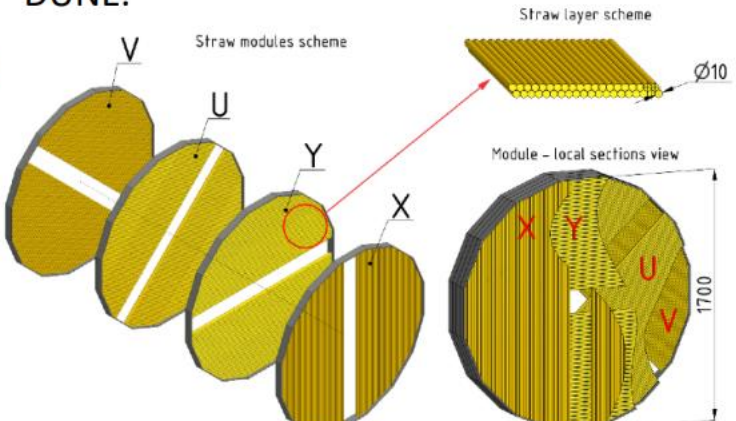
- 8 XY(optional UV) wedge-shaped straws stations inside the toroidal magnet
- Straw tube with 10mm diameter, in the center a 30mkm gold-plated tungsten wire
- Precision measurement ~150 mkm
- The number of layers and the number of straws are discussed.

Straw tracker 2022

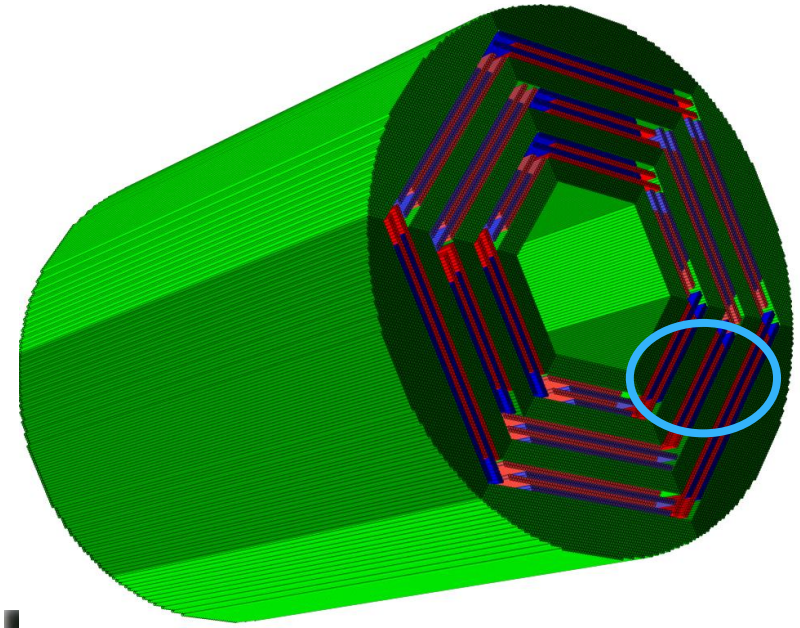


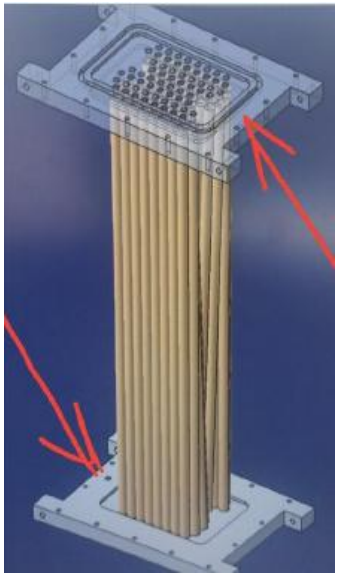
- Main tracker system of SPD
- Straw diameter 10mm thickness 36mkm PET
- Spatial resolution of 150mkm
- Barrel is made of 8 modules with up to 30 double-layers, with the ZUV orientation
- Endcaps are made of 12 double-layers with the XYUV orientation
- Vast experience in straw production in JINR for several experiment: COMPASS, NA-62, NA-64, SVD-2; prototypes for: CREAM, SHiP, COMET, DUNE.

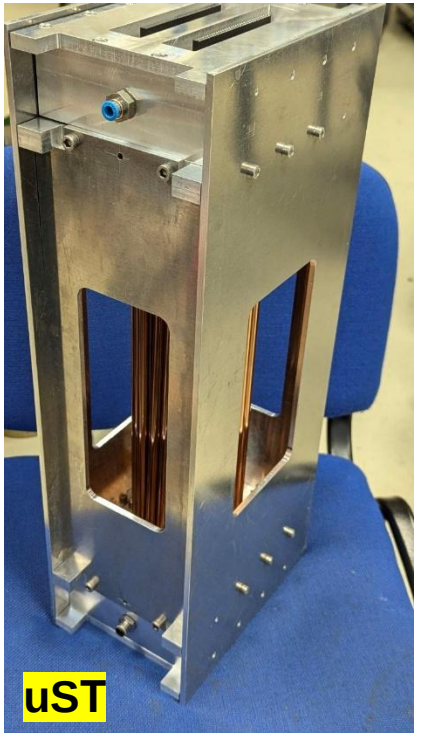


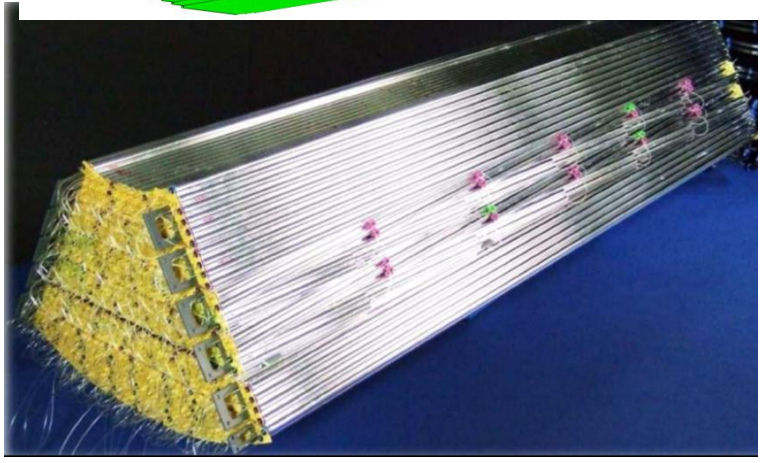


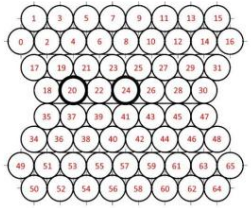
«косой» прототип







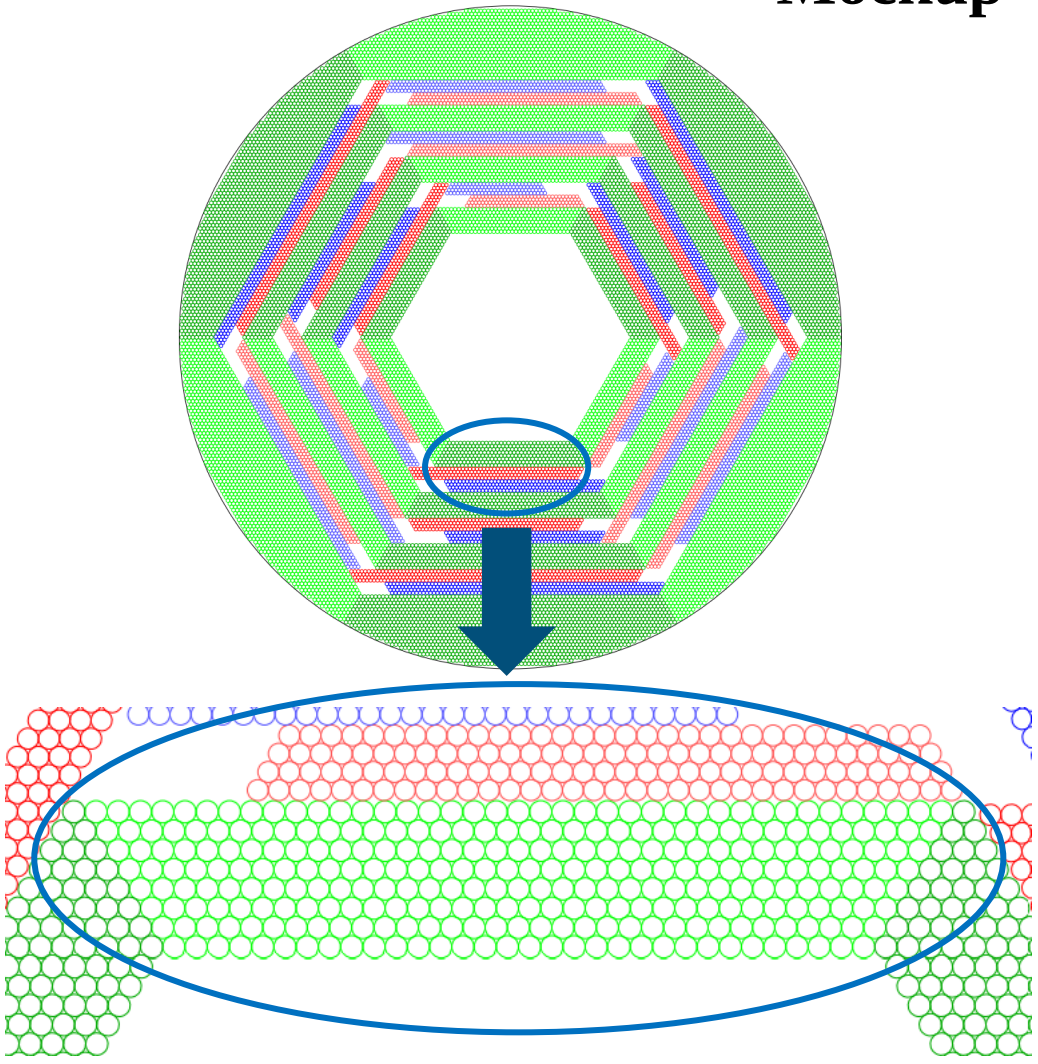




X
U
V
X

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.

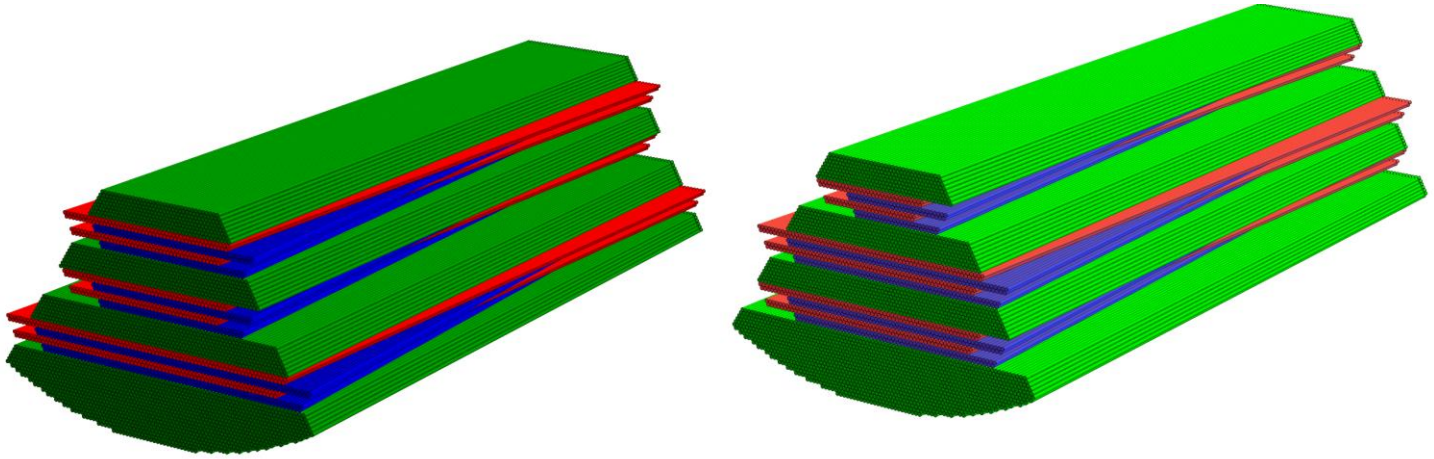
Mockup



Simulation studies – geometry optimization

see slides by R. Akhunzyanov at SPD Physics and MC (Feb25)

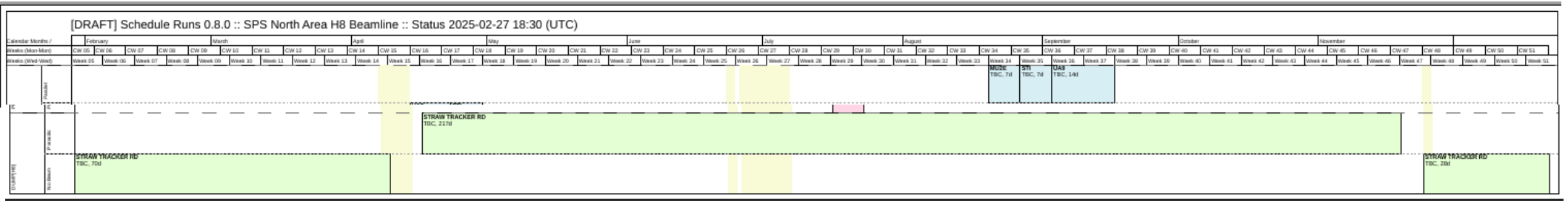
- basic optimization (SPDroot)



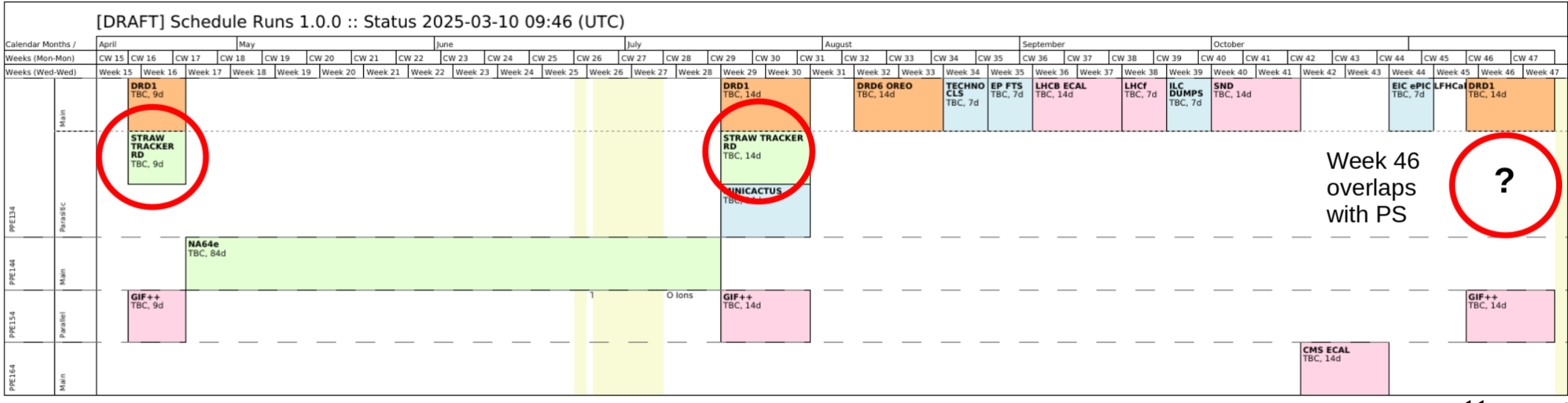
- performance-based optimization requires PR to be implemented in SPDroot – expected soon!
(see talk by V. Andreev at SPD Physics and MC yesterday)

SPS beam time 2025

Permanent setup at SPS H8 beam dump (high momentum muons, low intensity)

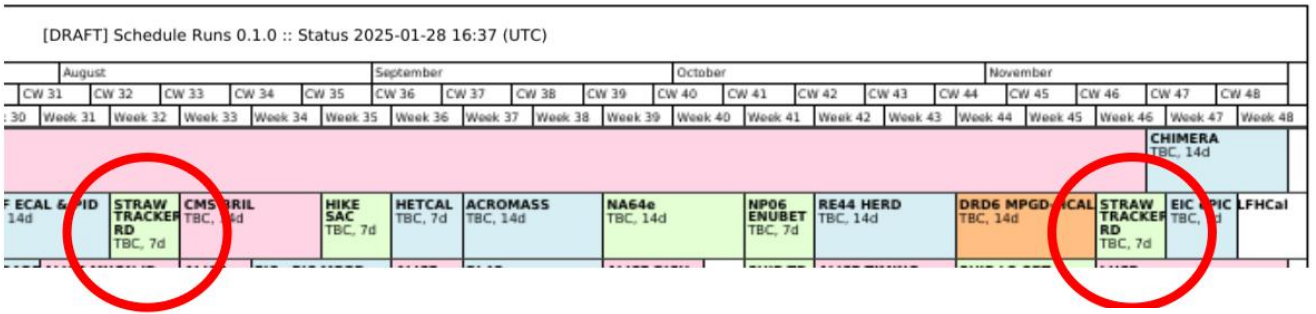


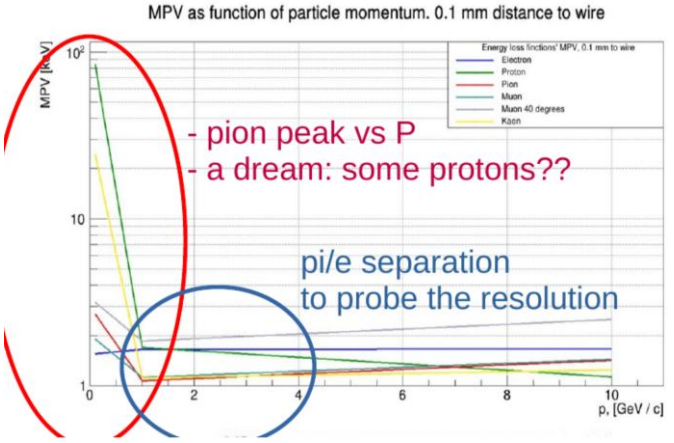
Two (three?) periods at SPS H4 (high momentum muons, high intensity)



PS beam time 2025

Two periods at PS T09 (low momenta hadrons and electrons)

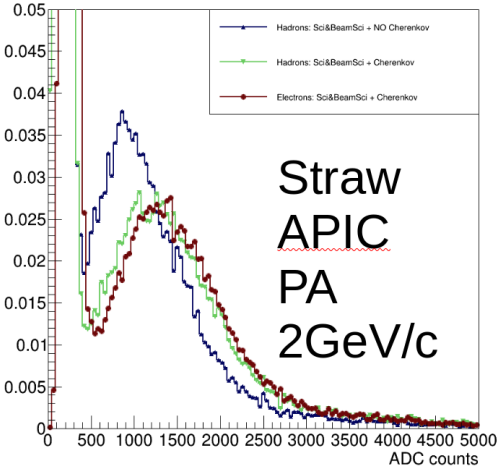


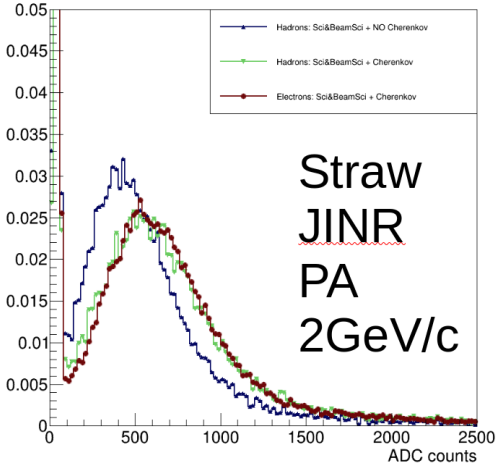


- ok for general charge resolution studies

- no low momenta protons for the dynamic range studies

=>



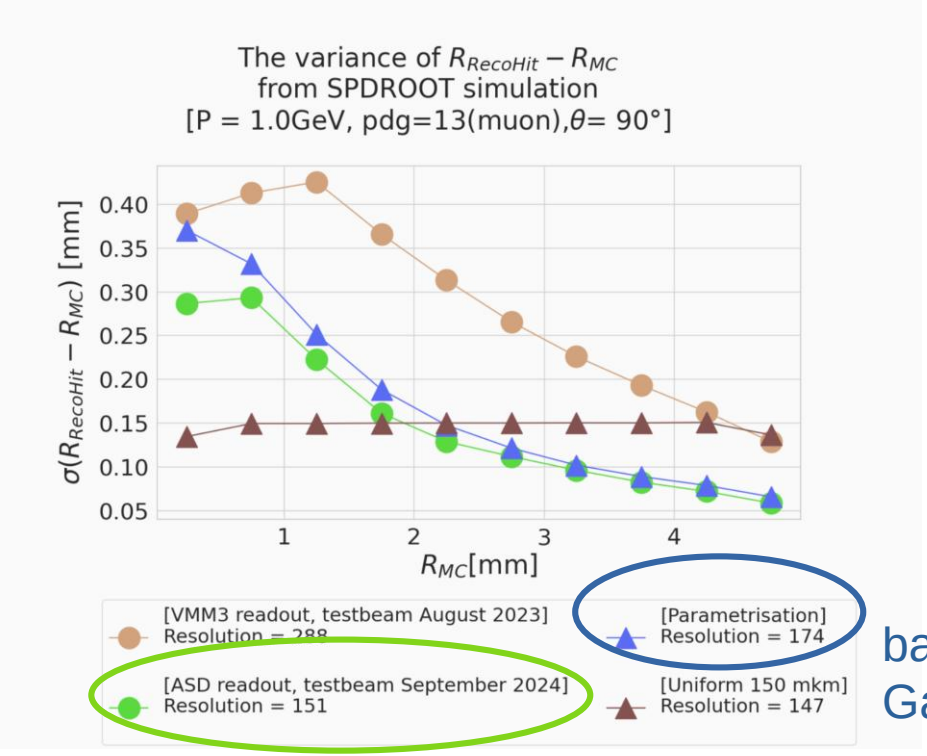


Low momenta protons at PNPI synchrocyclotron (June 2025)

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

Simulation studies – parametrization in SPDroot

Test beam 2024 – [see E. Mosalova at Phisics&MC Feb25]



based on Garfield/LTSpice

based on TB 2024 data

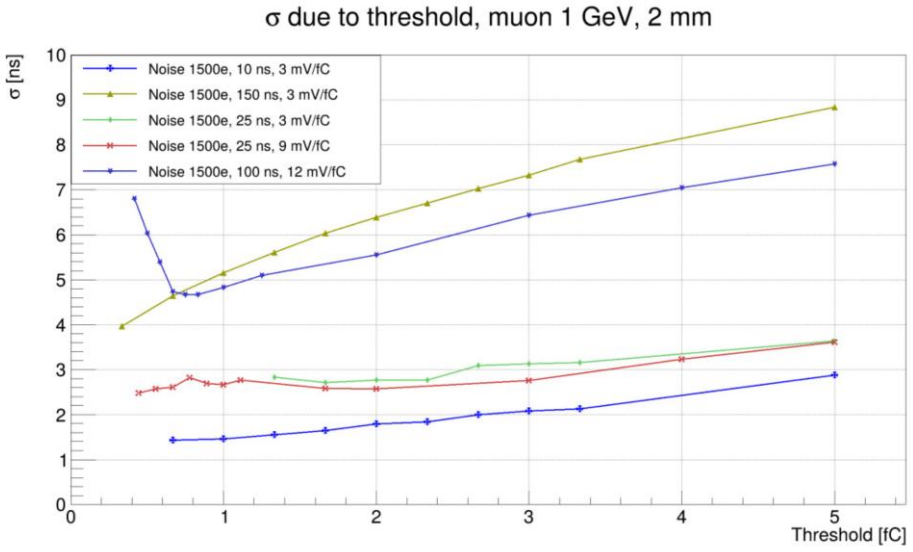
- good agreement between TB-2024 and Garfield/LTSpice prediction for perpendicular tracks

- Garfield/LTSpice prediction is used for a wide range of polar angles – to be finalized next month

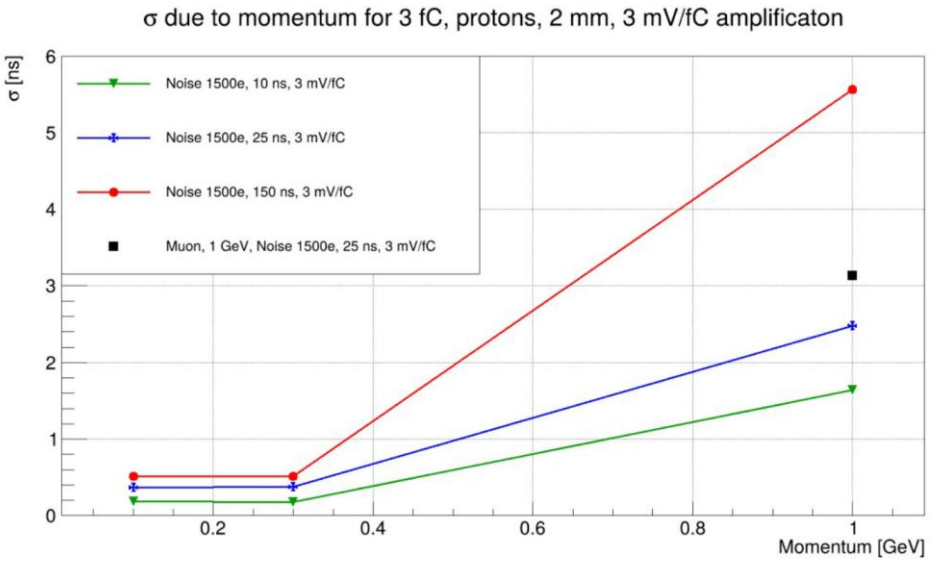
Simulation studies – electronics parameters with Garfield/LTSpice

see slides by S. Bulanova, V. Bautin at Tracker Simulation meeting

- time resolution vs threshold for different peaking time and gains (VMM-like model)



- time resolution vs particle momentum for low momenta protons

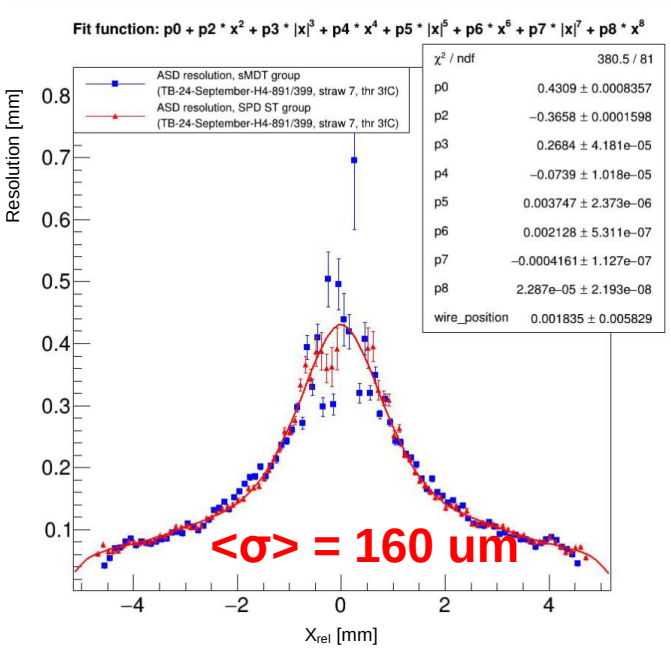


Studies on charge measurements (dynamic range, charge resolution) - ongoing

Test Beam data analysis

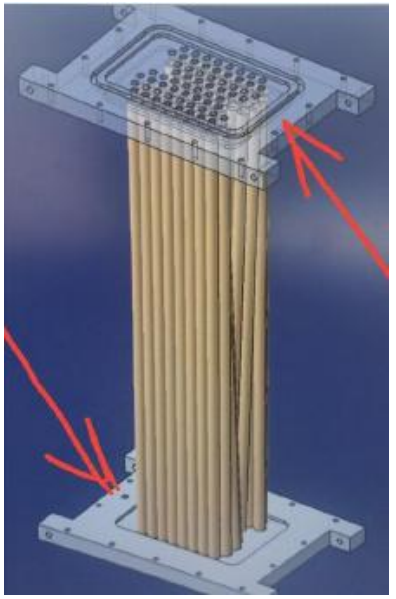
Test beam 2024 – see [D.Sosnov's talk at SPD Collaboration meeting]

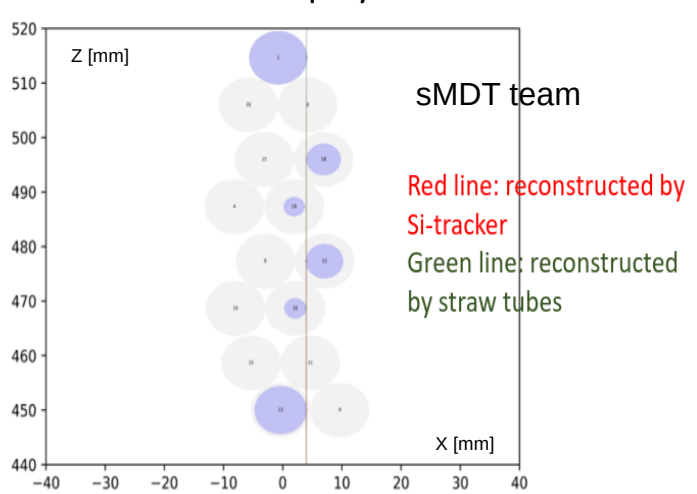
Input for SPDroot:



Further data treatment ongoing (together with Uni Michigan):

- efficiency vs R, x-talk (ASD read-out)
- tracking with stereo-angle

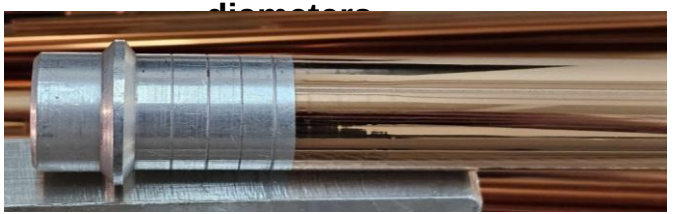




Straw Production: Quality and Acceptance Tests

- Continuous microscopic inspection of the welded seam (to be automatized using AI/ML);
- Continuous measurement of outer straw diameter during production at 1.3 bar absolute
- Measuring the inside diameter of a straw (both ends of the straw) using a gauge;
- Short-term high pressure test at 3 bar relative for ~10-20 sec;
- Long-term high pressure test at 1 bar relative for 100 days to reduce creep rate.

control of the inner diameters



laser for measuring outer diameter

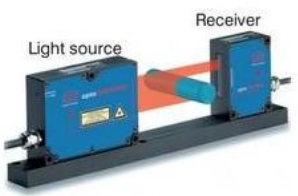
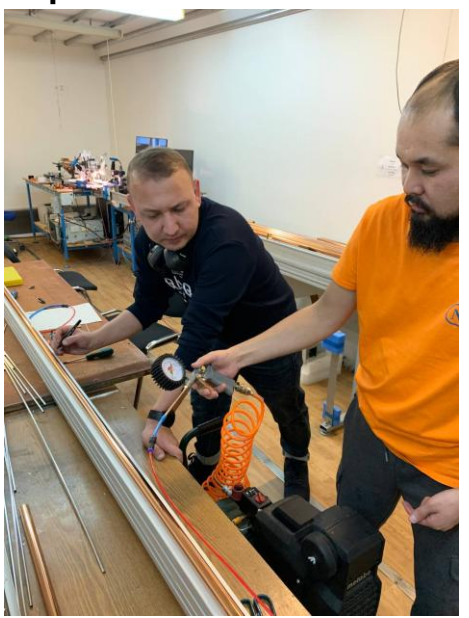


Fig. 5 Sensor unit SU

Fig. 6 Controller CU

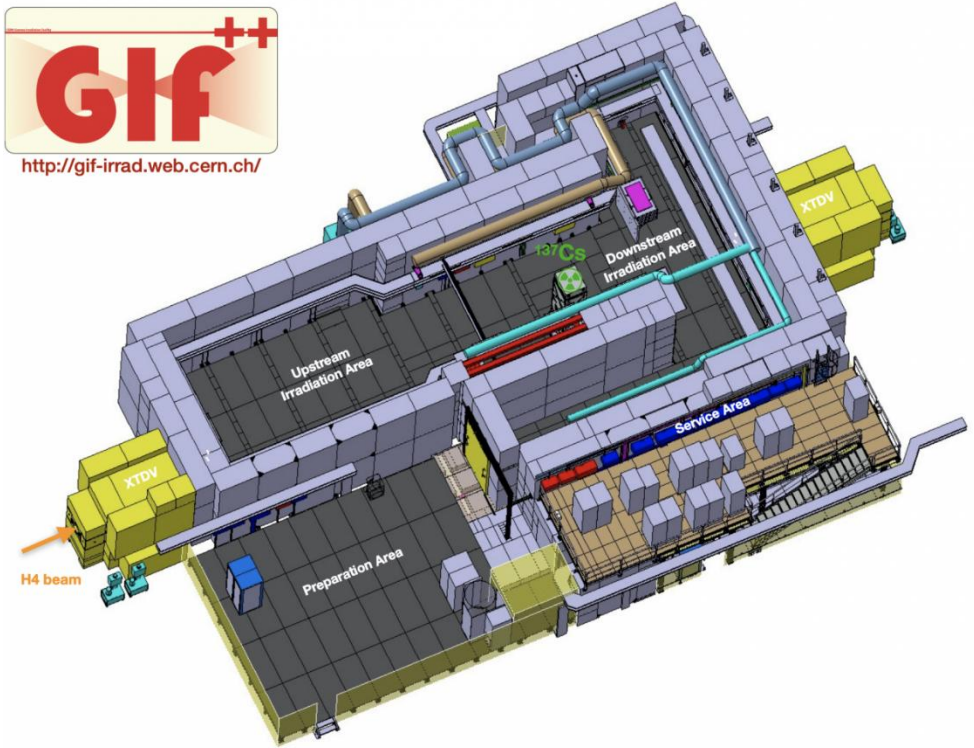
A measurement system consists of:
- laser
- receiver
- controller

pressure test



long term storage

Aging



Temur Enik on behalf of STRAW
TRACKER TEAM

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 ..)