



# Planning for the Proton Radius Measurement



Apparatus for Meson and Baryon  
Experimental Research

2 February 2024

# Proton charge radius: slope of $G_E^p$ at small $Q^2$

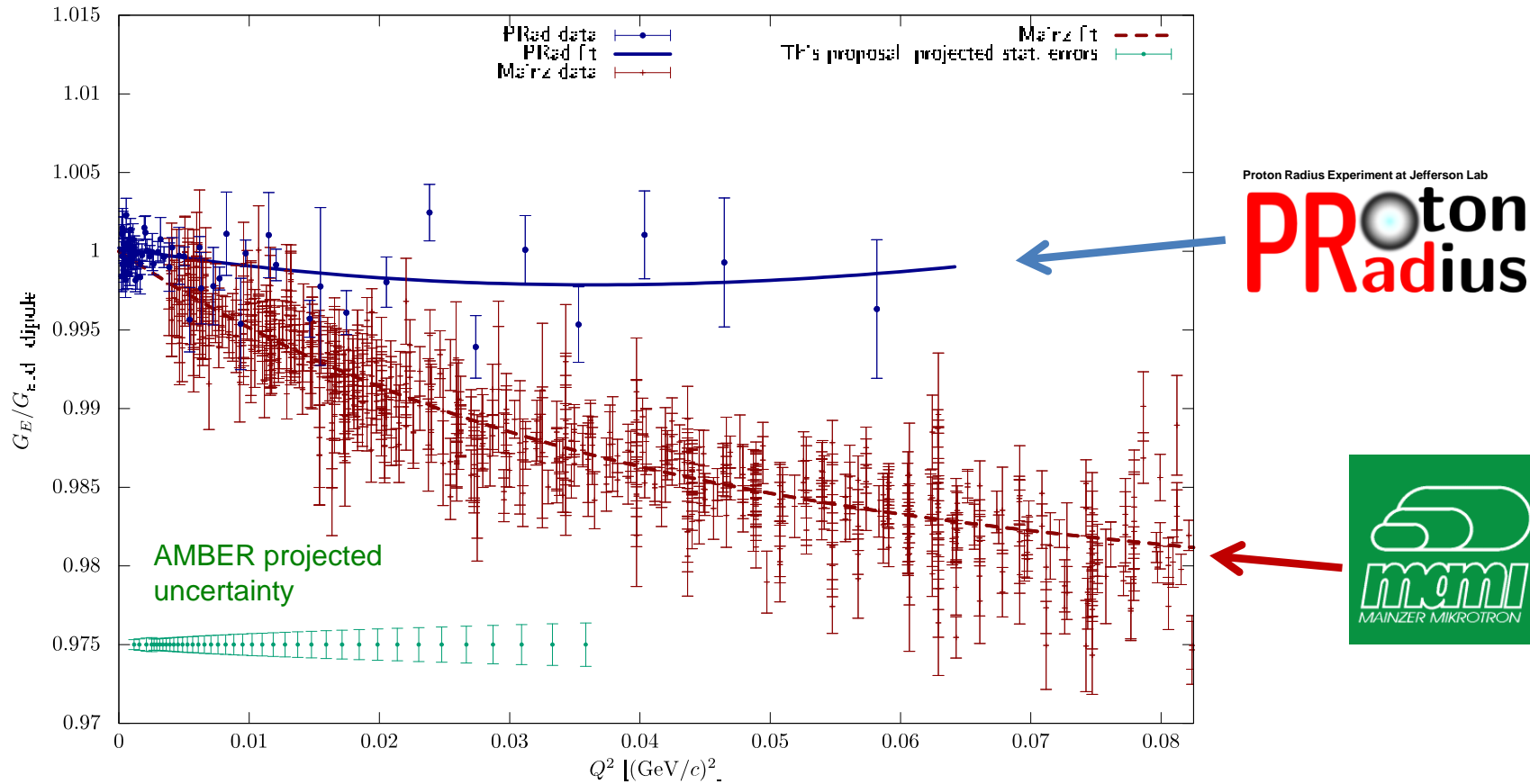
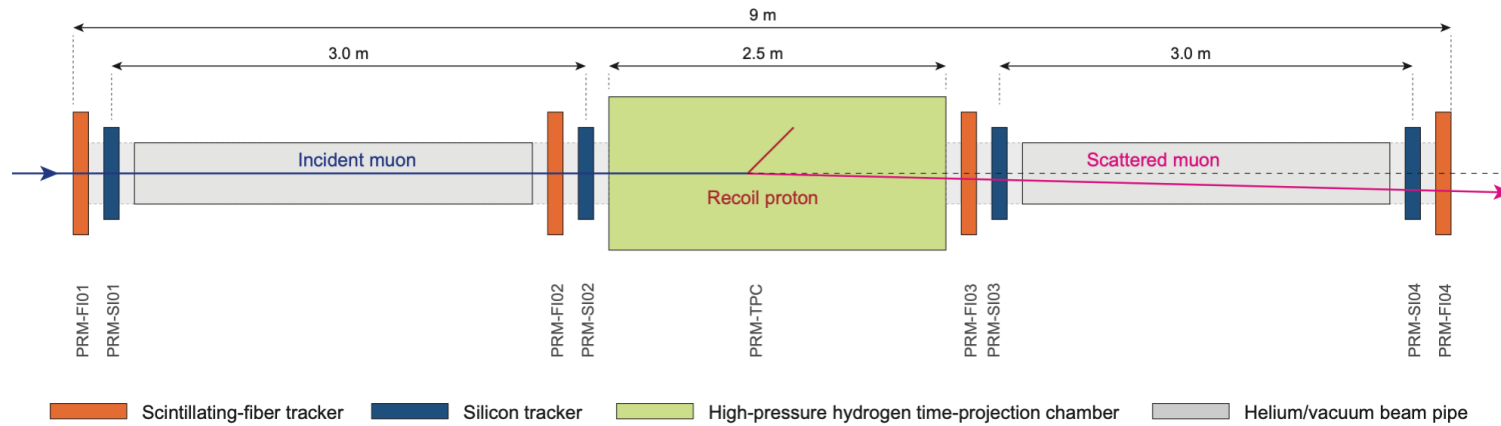
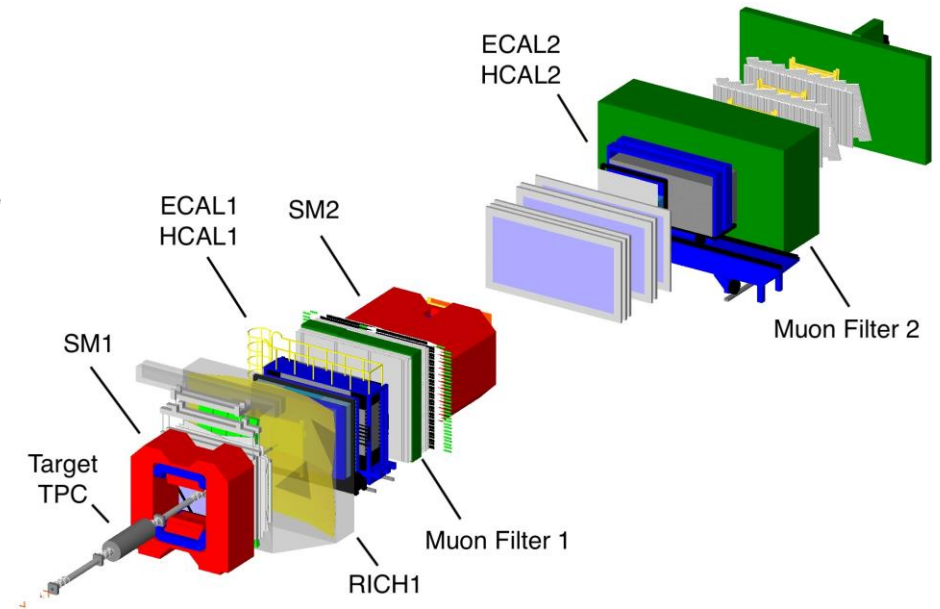


figure: J. Bernauer

# Idea of the AMBER PRM



- 100 GeV **muon** beam
- Active-target TPC with high-pressure H<sub>2</sub>
- high-precision tracking and spectrometer for muon reconstruction
- goal: 70 million elastic scattering events in  $10^{-3} < Q^2 < 4 \cdot 10^{-2} \text{ GeV}^2$
- Precision on the proton radius  $\sim 0.01 \text{ fm}$



**2018:** First measurement of hydrogen TPC in high-energy muon beam

**2021:** First test run with IKAR TPC and already existing tracking detectors from COMPASS → *correlation between proton energy and muon scattering angle*

**2023:** Test run with new free-running DAQ (IKAR TPC, new tracking detector prototypes)

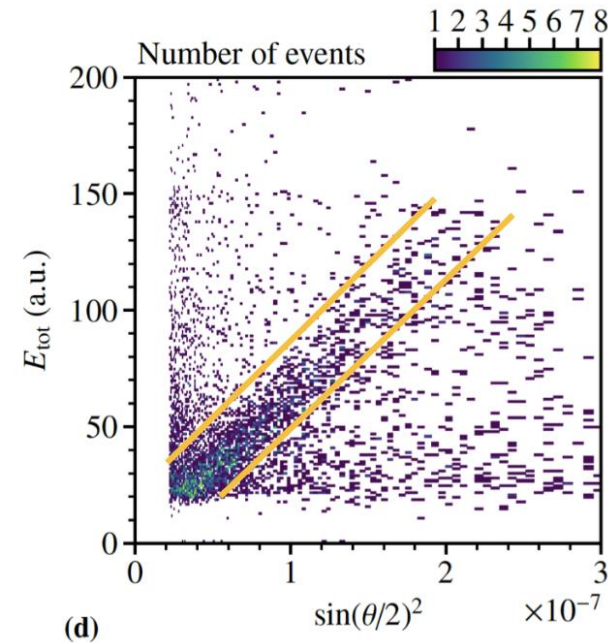
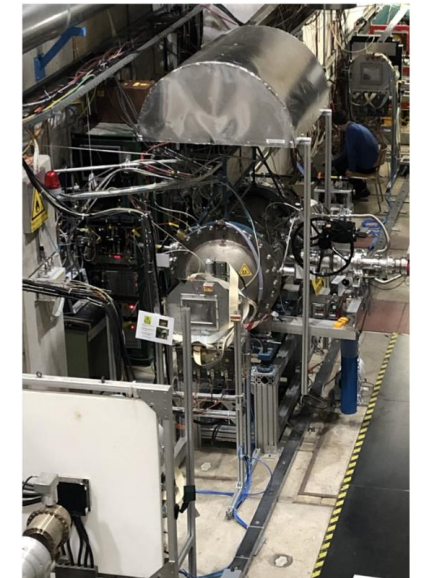
**2024:** Test run with IKAR/new TPC and UTS prototypes

**2025:** Physics run with new TPC and final UTS

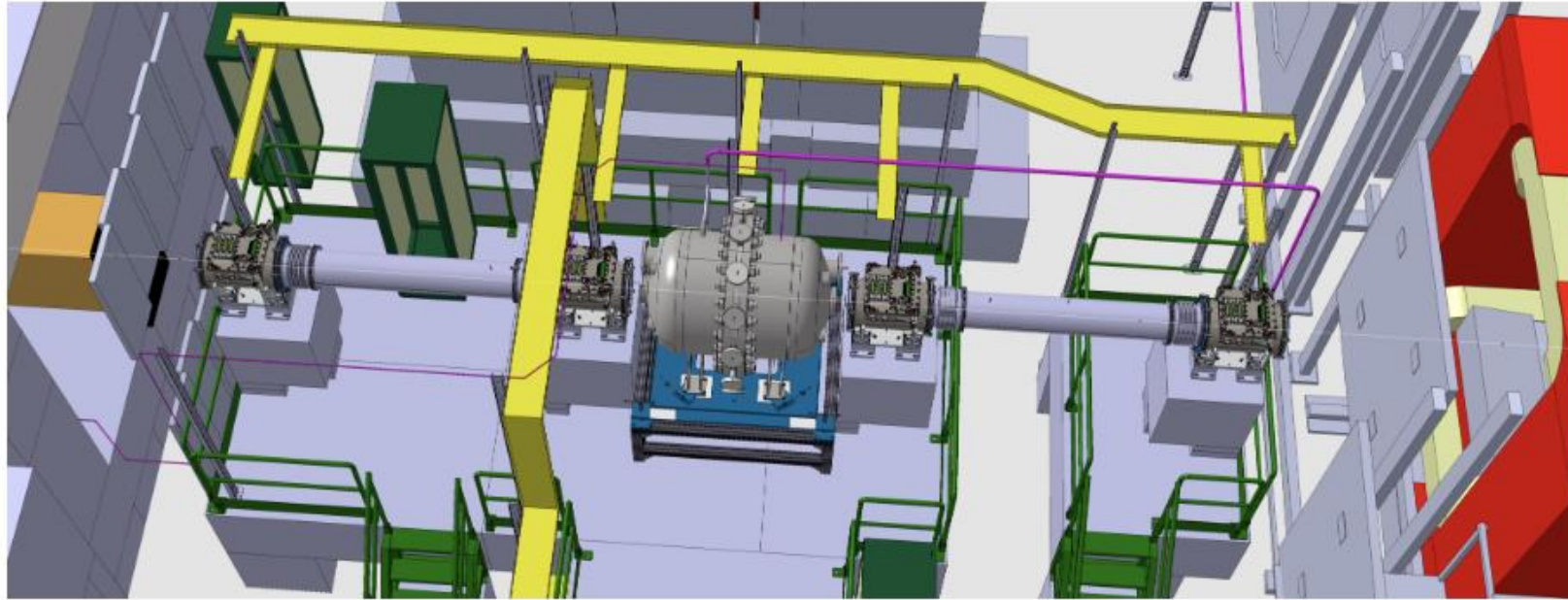
2018



2021

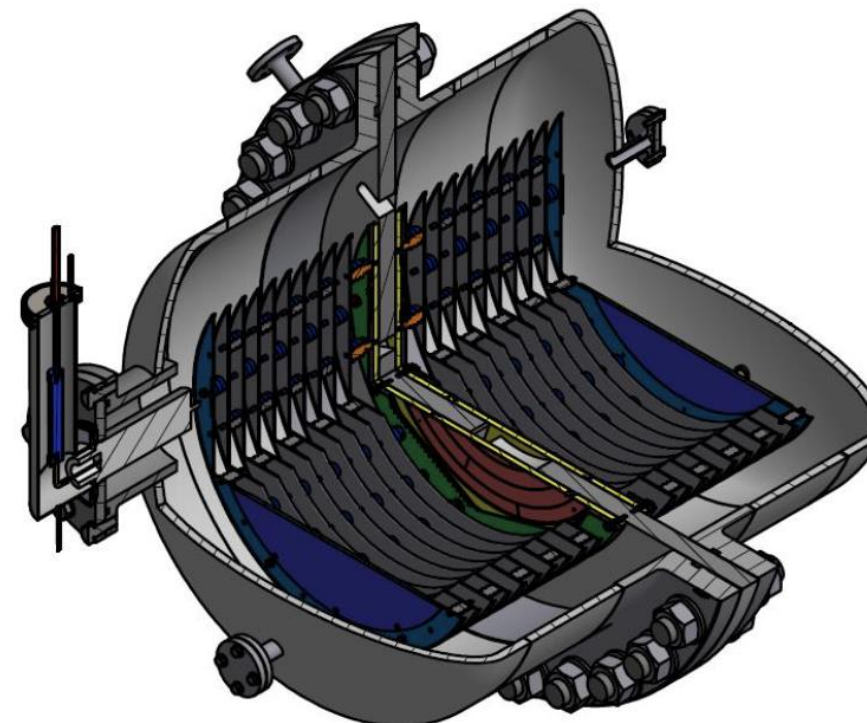
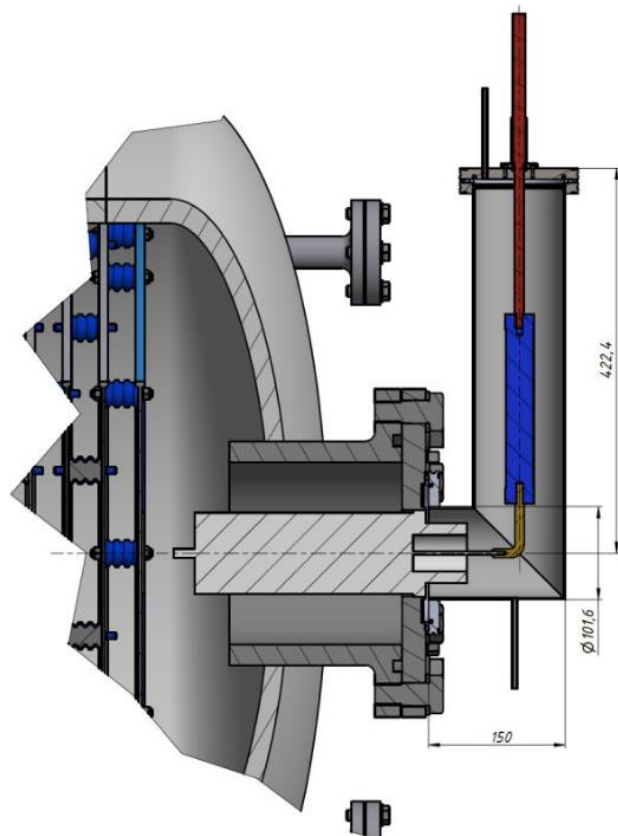


Figures: C. Dreisbach, PhD Thesis (2022)



- Meeting with external company for ATEX cabinet → Need exact list of devices going into cabinet!
- Meeting with David Jaillet to define needs of gas installation for this year.
- He beam pipes needed? → no He gas-system but beam pipes should be produced.
- EP-DT has safety concerns for the work of control PLC → Want involvement of EP-DT-Gas → dedicated meeting on 31.01.2024 → waiting for replay!
- Meeting with external ATEX consultant company on 29.11.2023 → Leak rate and wind speed around TPC main factors → goal has to be safe zone. → Oleg K. tried to get leak rate values from company → no success → Discussion is on-going if dedicated leak test would be sufficient. (waiting for replay of company) → would mean delay for ATEX classification.

# Active-Target Time Projection Chamber

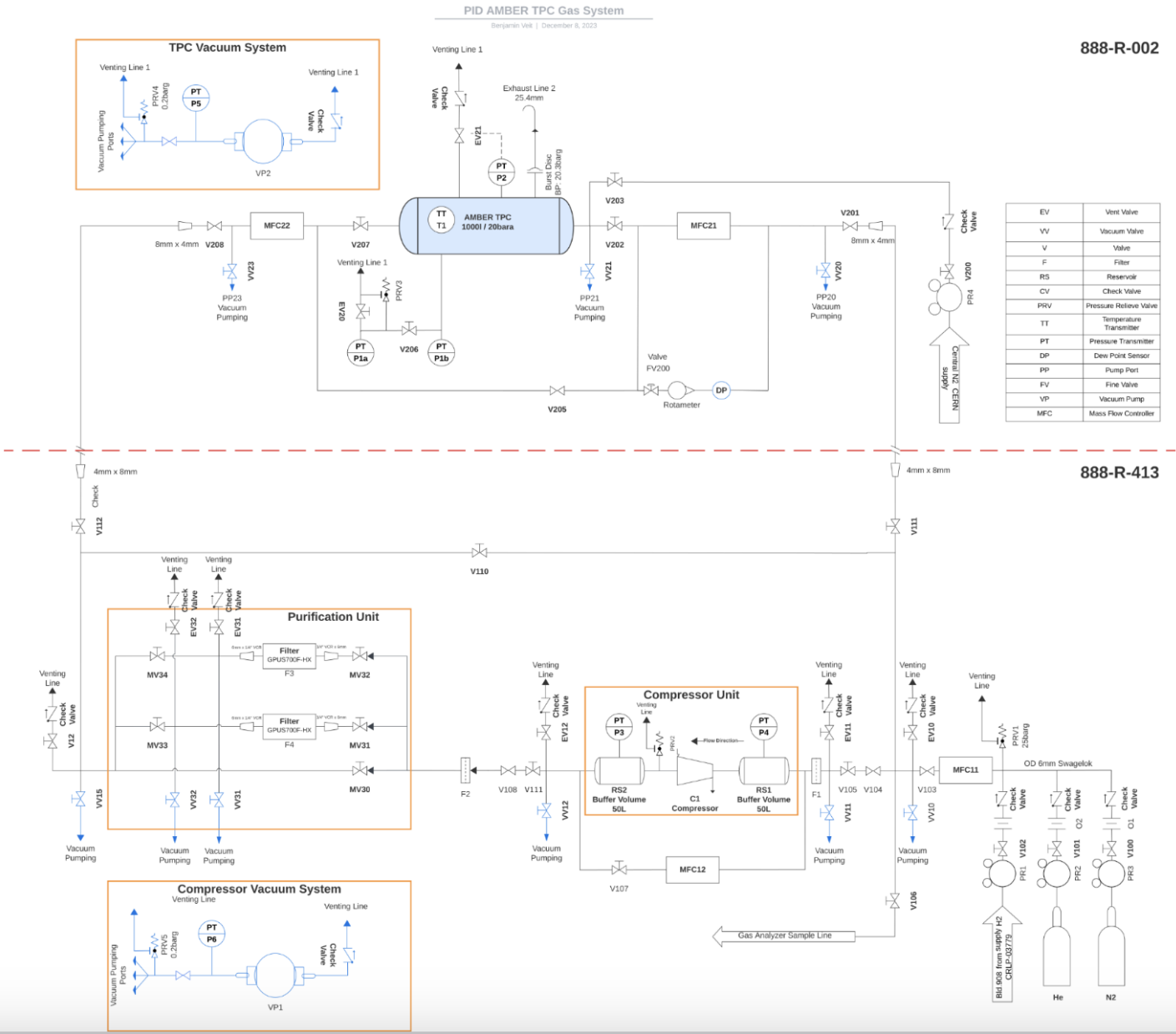


slide by Oleg  
Kiselev (GSI) TB  
report

design by Marat  
Vznuzdaev, PNPI

- Meeting with CERN safety group in November 2023
- Feedthrough from Hositrad, testing made at MPV Darmstadt is basically approved
- Oil-filled design of the protection cylinder is basically approved, details need to be verified
- **Status November 2023**

# TPC circulation gas system



work of Aleksandr Vasilev, PNPI

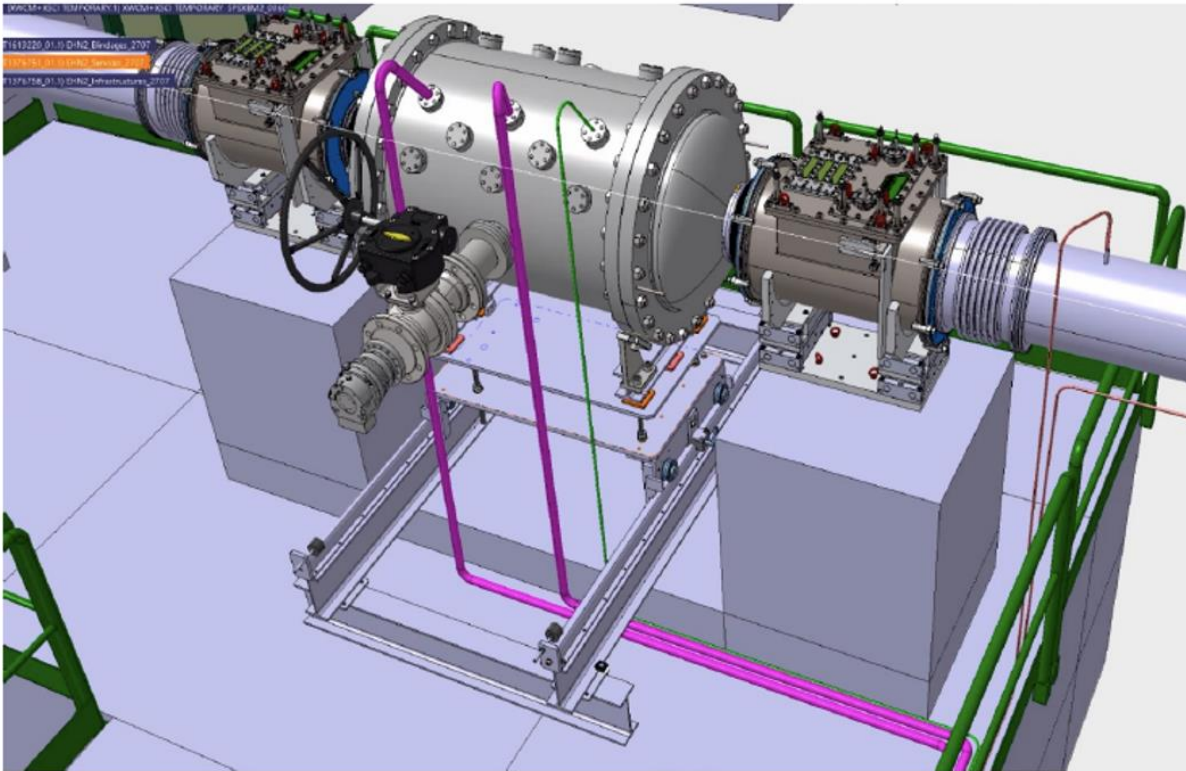


Fig. 29: Sketch of the foreseen IKAR TPC preparations in the target area sandwiched between two UTS. Hydrogen lines are indicated in purple.

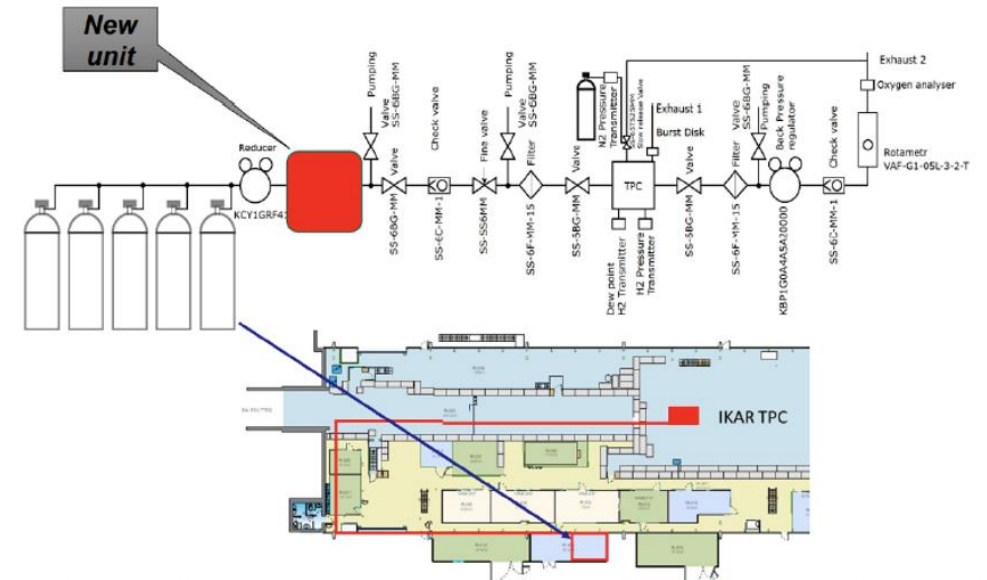
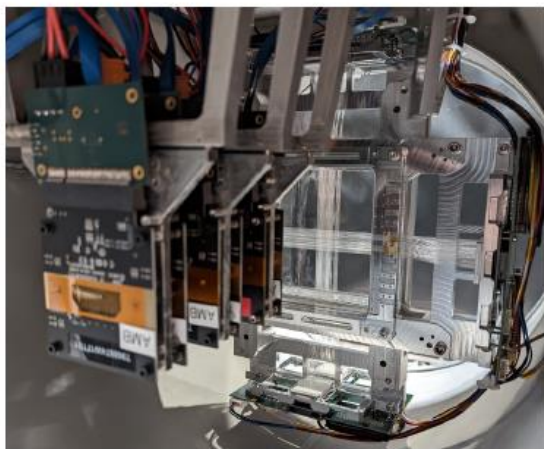


Fig. 30: Sketch of the foreseen IKAR gas system and installation in EHN2. The gas lines are indicated in red together with the new purification unit.



# Unified Tracking Station



beam test 2022

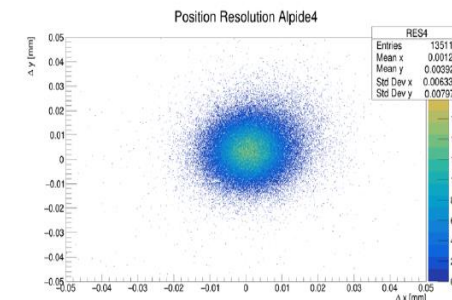
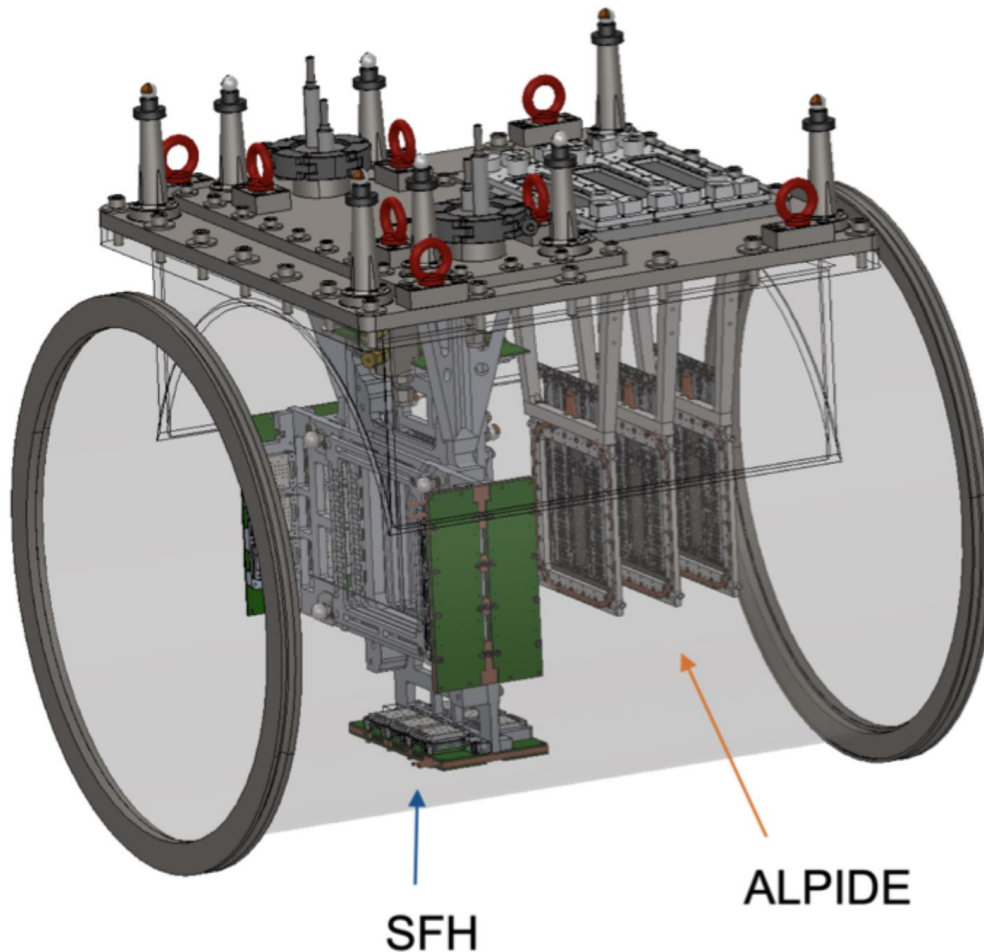


Fig. 34: Position resolution of one ALPIDE detector using tracks measured by the other 5 detectors.

ALPIDE position resolution  $\sim 6 \mu\text{m}$  (beam test 2022)

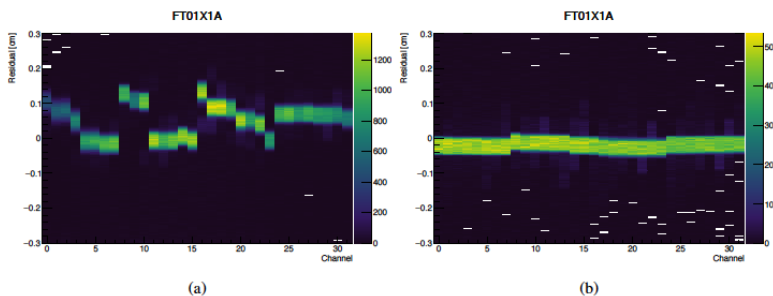


Fig. 36: Panel (a) shows the alignment of individual fibers for the X1A plane during the 2022 beam test, with large fiber-to-fiber variations clearly visible. Panel (b) shows an improved version of the same plane tested in 2023. [11]

## TPC

- the new main TPC has been built
- currently in safety testing as the Danish enterprise
- transport first to GSI, then to CERN in May
- June – August: Setup of the new gas system and operation of the new TPC in September
- fallback if new TPC does not get ready: test of gas system with IKAR
- we need the experts from PNPI at CERN in this time



## Unified Tracking Stations

- Scintillating Fiber Telescope
  - test of new readout electronics in the beginning of the run (April/May)
  - provide one full detector for the 5-week beam time Aug 26 – Sep 26
- Silicon Pixel Detectors (ALPIDEs)
  - testing of the new flex PCBs ongoing
  - sufficiently many ALPIDEs available to equip all stations



## New streaming data acquisition system FriDAQ

- last needed hardware components will become available in the next weeks
- system will be ready for the PRM run from August on



# Beam Time Request for 2024



We ask for 2-5 weeks of beam time from Aug 26 – Sep 26  
for testing the main new components of the PRM setup



# Backup

