

Telescope system for the characterization and qualification of the monolithic active pixel sensors

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Outline

- Motivation
- Setup design
- Overview of the setup
- Cooling system
- Runs at electron beam
- Digital calorimeter
- Summary

Motivation

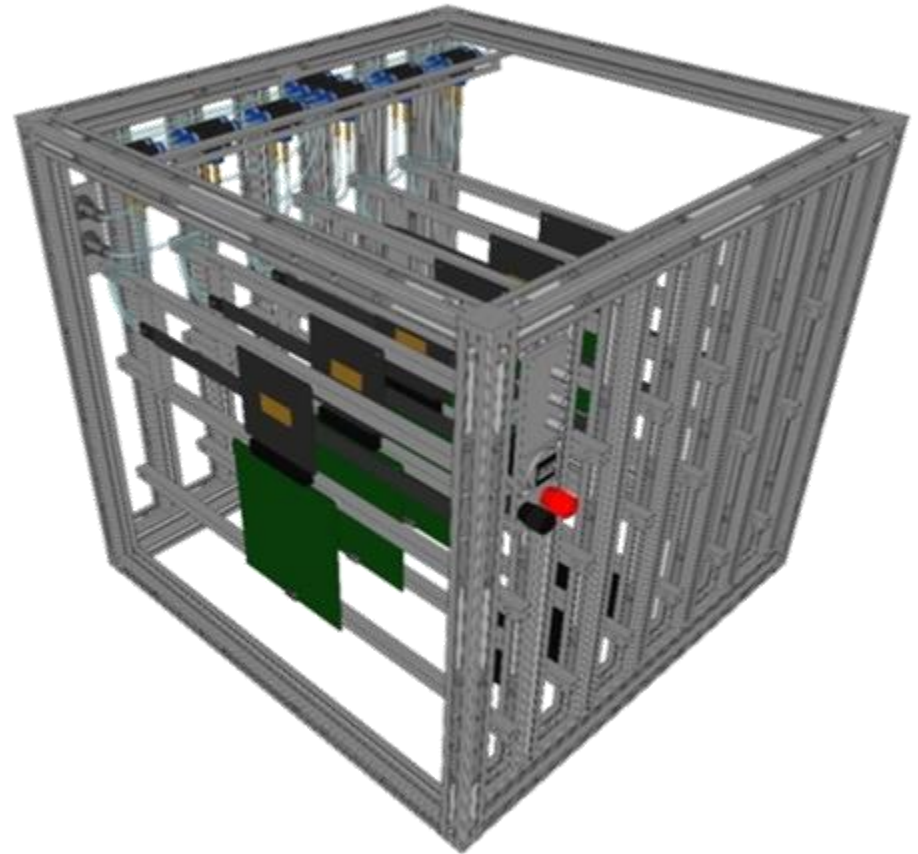
Development of MAPS-based telescope system

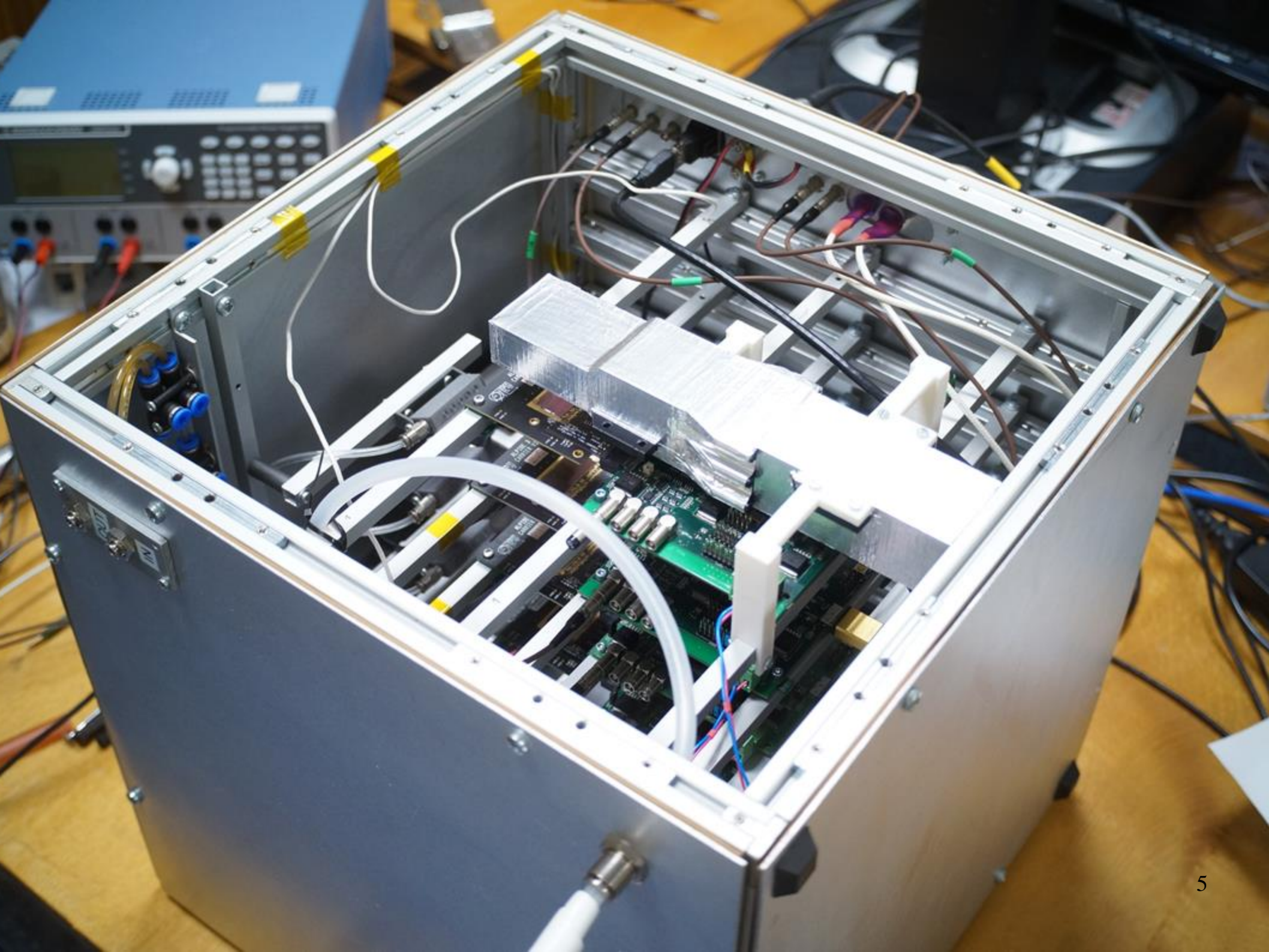
The setup was designed to characterization and qualification of the monolithic active pixel sensors (for the Inner Tracking System of MPD experiment) and can operate in different scenarios:

- Beam tests
- Tracking
- Calorimetry

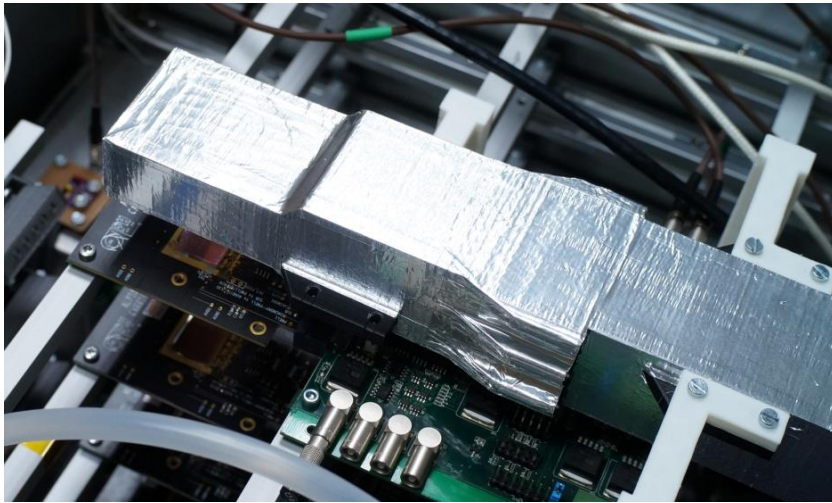
Design considerations

- Mechanical holders for up to 6 ALPIDE (ALice Pixel DEtector) detectors with its DAQs
- Non-transparent outer walls (to keep sensors away from light)
- Thin input and output windows for the beam tests
- Communication panel on the outer wall with necessary plugs and sockets
- Cooling system
- Digital Calorimeter

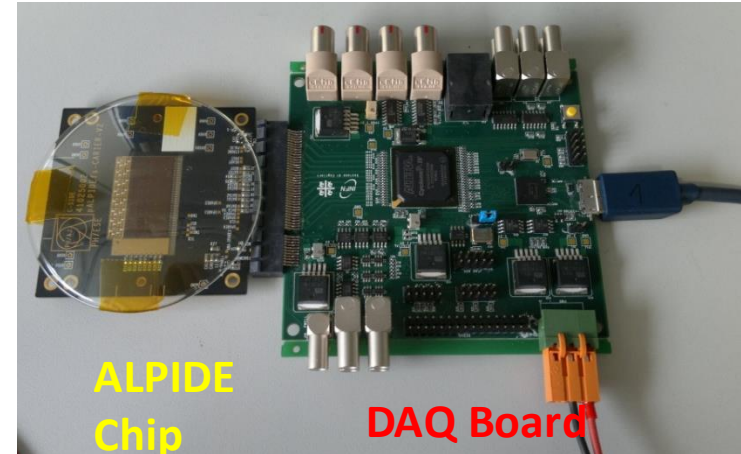
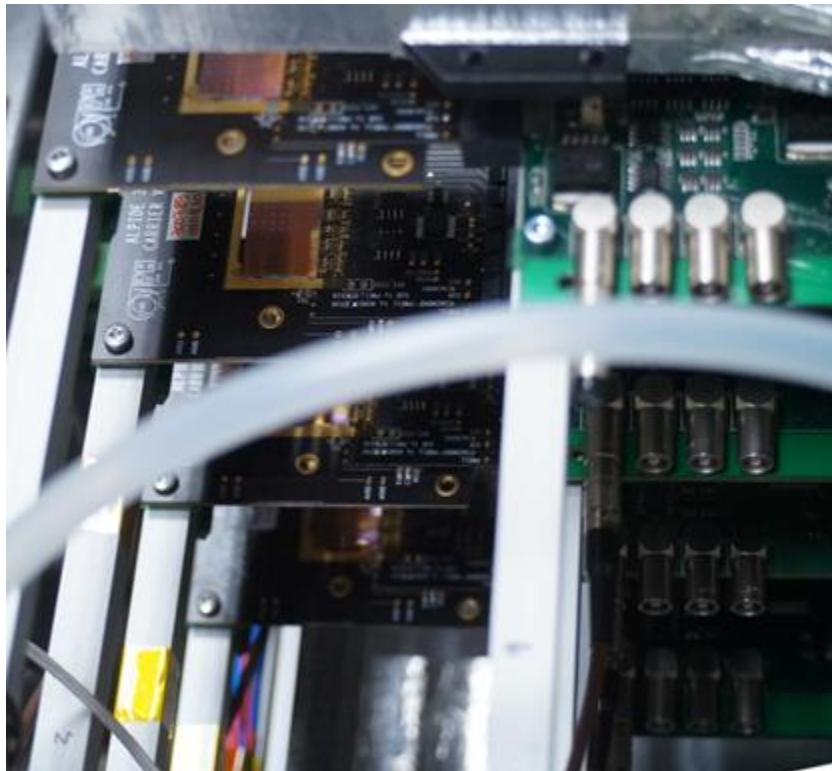




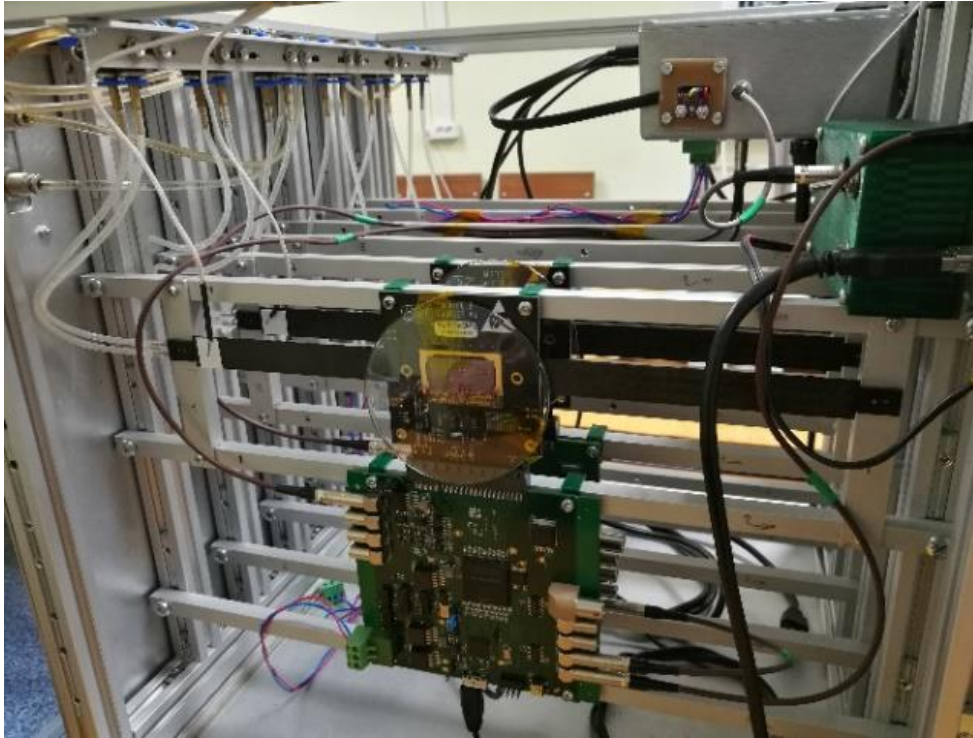
Modules - Telescope



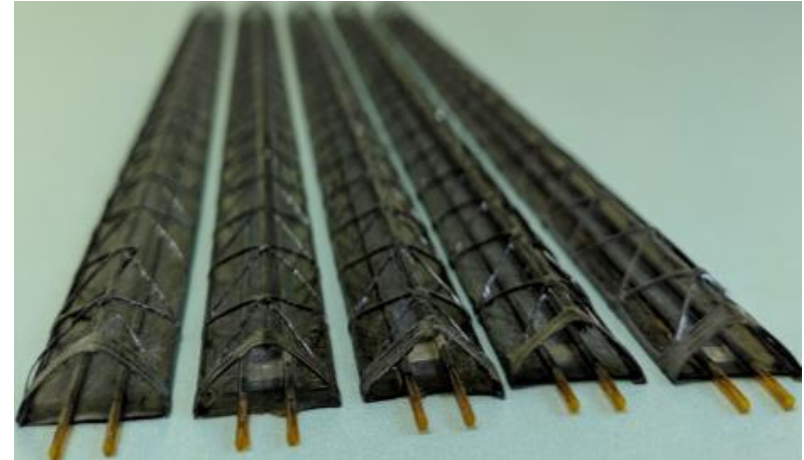
- 4 ALPIDE detectors with DAQ boards, mounted on aluminium profile, adjustable axis
- Two scintillations (trigger)
- Battery-based power supply for back bias: separate circuits to avoid interference.



Cooling system



Support structures with tubes for liquid cooling

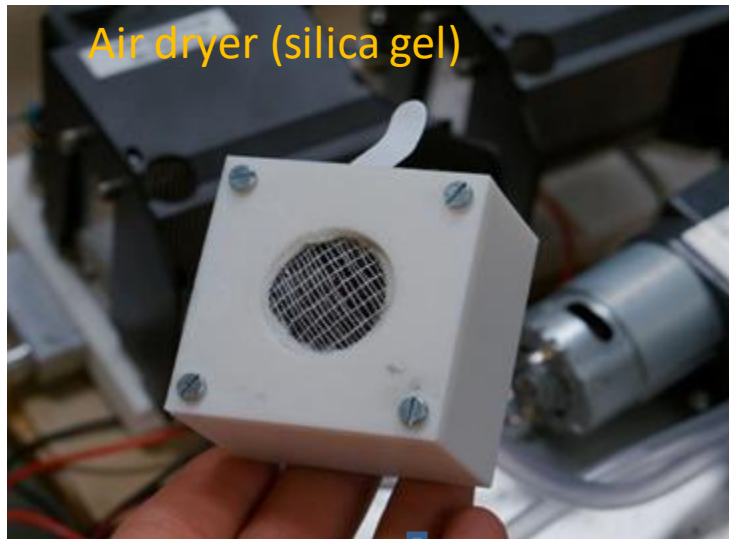


Support structures previously developed for ALICE Inner Tracking System by SPbSU

1st version of the cooling system — non-freeze liquid (chiller)

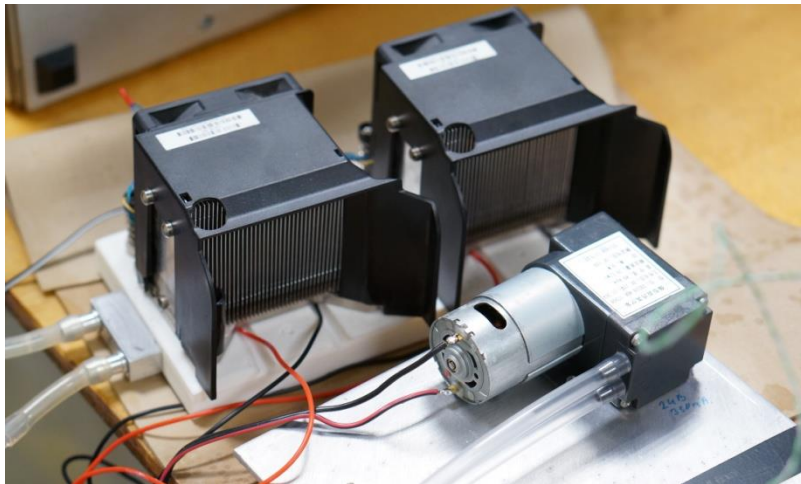
- excess material => undesirable scattering (shown at beam tests)

Cooling system – 2nd version



air cooling system (cold air «showers»):
no additional material on the beam path

Thermoelectric cooler and compressor



Manifold

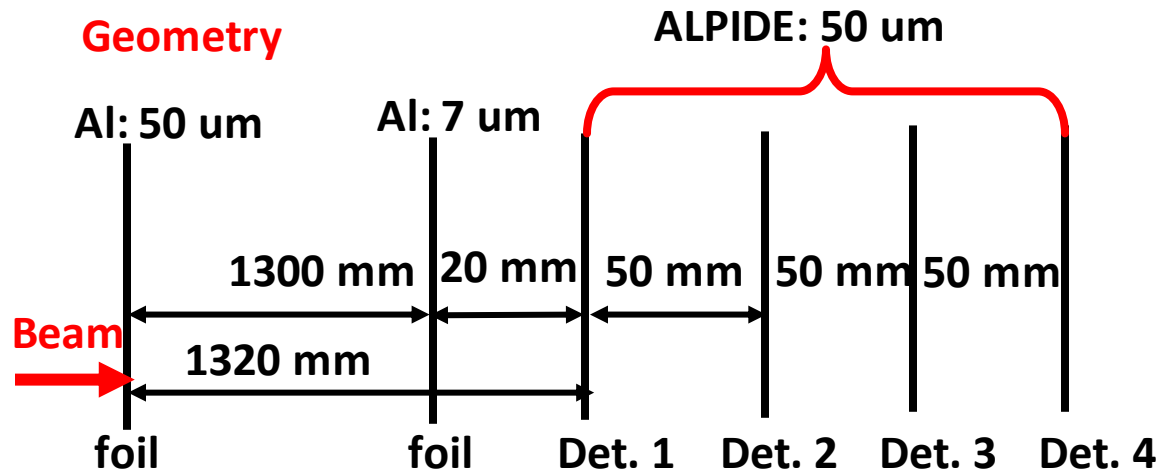


Air cooling system allows us to keep detector temperature (measured with on-chip temp. sensor) at optimal values for such detector (23-25 C)
Otherwise, detector may heat up to 40 C during operation.

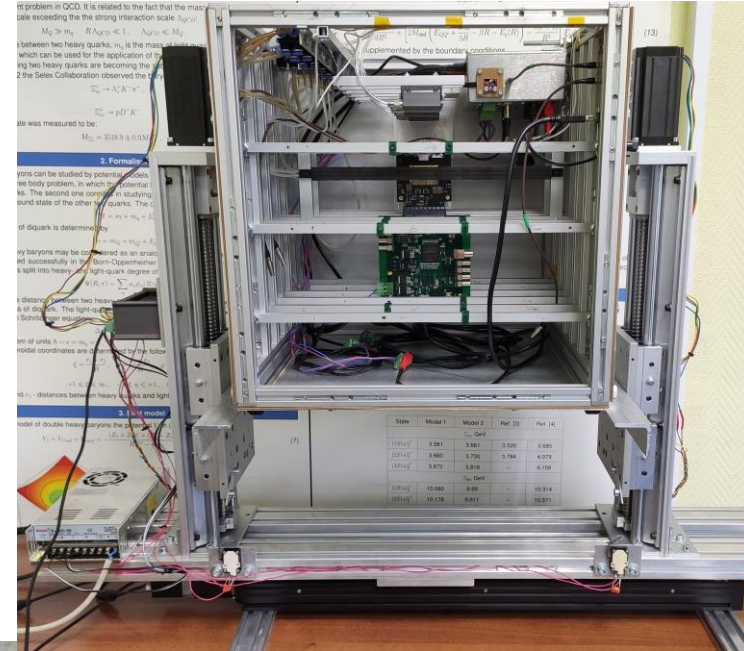
Beam tests

Beam tests in JINR
November 2018 (run 1)
April 2019 (run 2)

Accelerator: LINAC-200
Beam: electrons ~ **50-60 MeV**
electrons ~ **150 MeV**



GEANT 4 calculation of the doses on the detectors

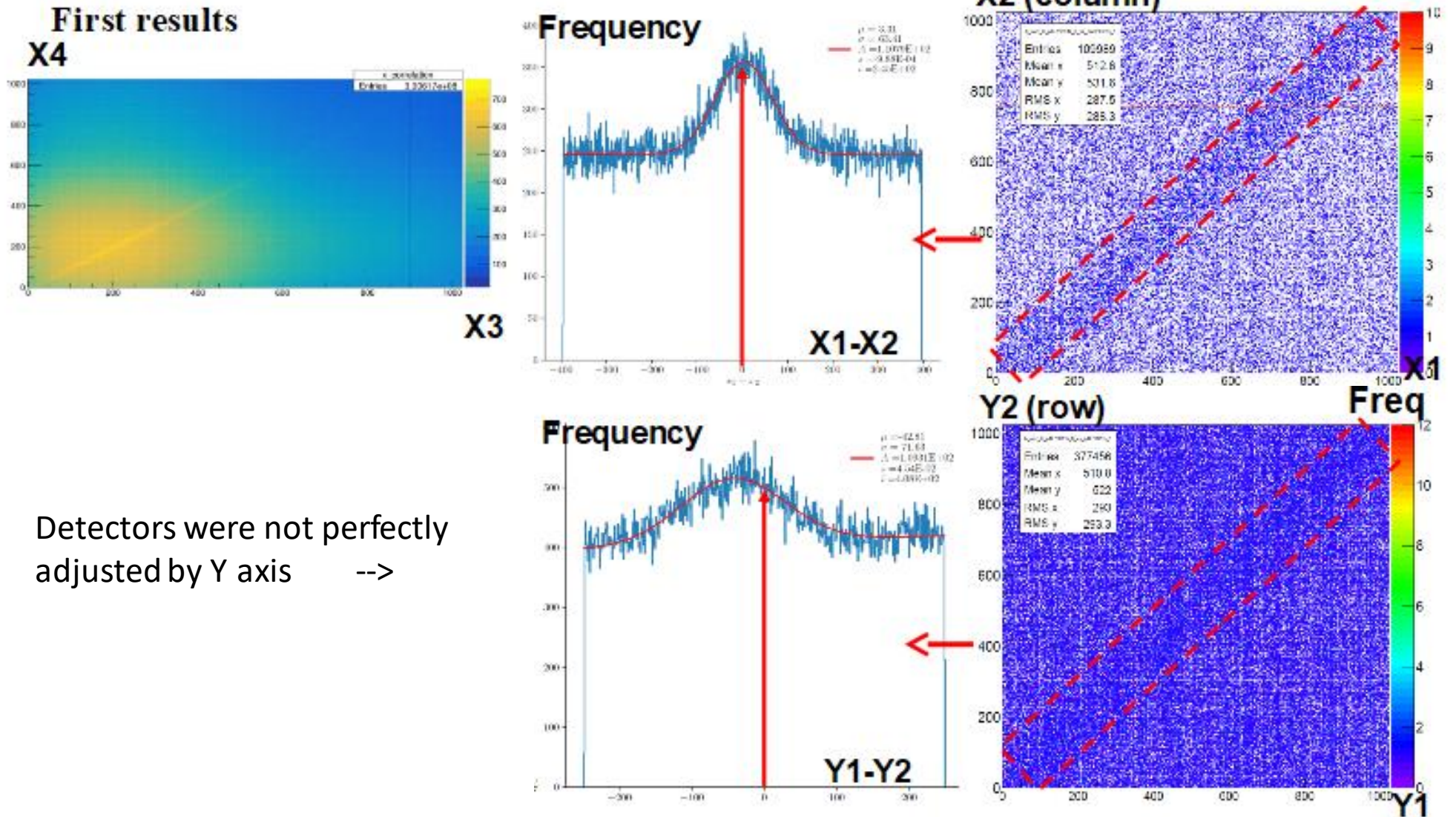


Cooling (water, air),
Two scintillators for the trigger,
Precise X-Y movement
(3 synchronized moving stage)

Beam tests

Beam tests in JINR

Correlations of pixel clusters between the detector planes:

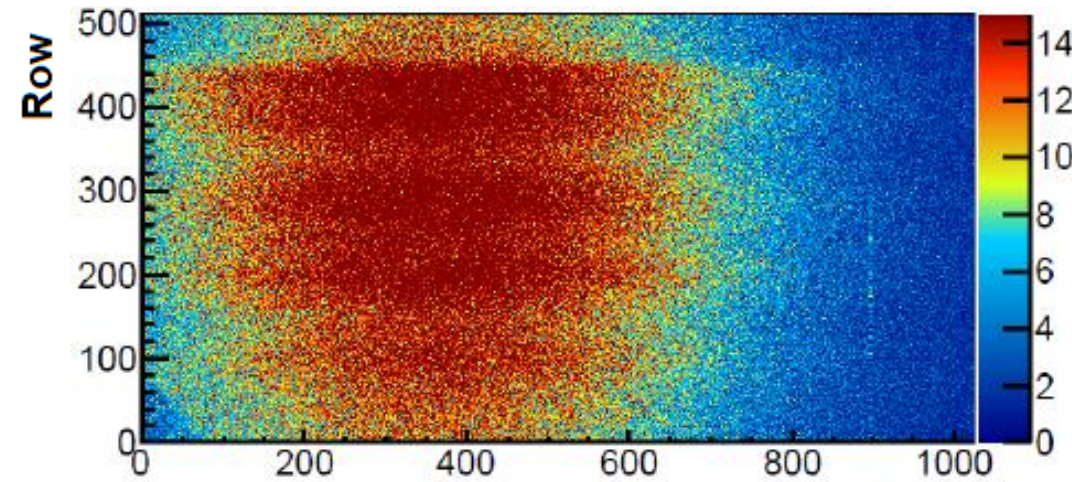


Detectors were not perfectly adjusted by Y axis -->

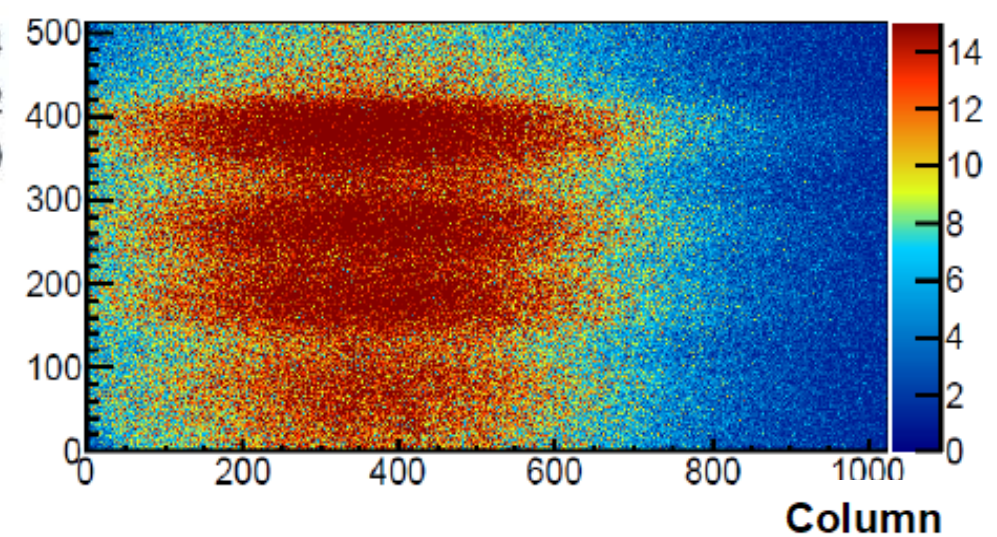
Gate on correlation

Beam tests

Cluster hits (Det. 3)



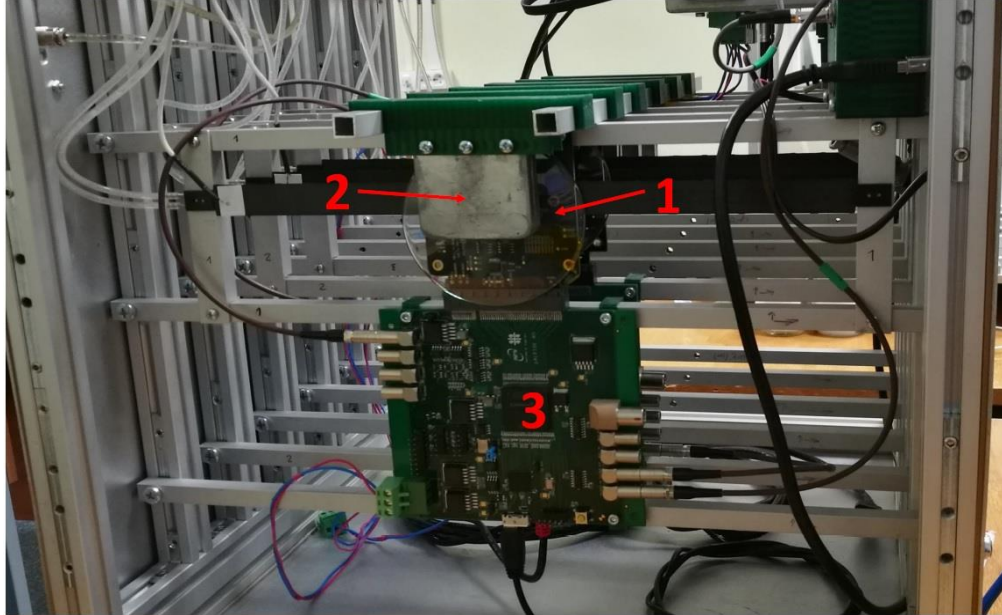
Cluster hits (Det. 4)



After that water cooling system was replaced with air cooling system

Further plans: beam tests with air cooling

Digital calorimeter

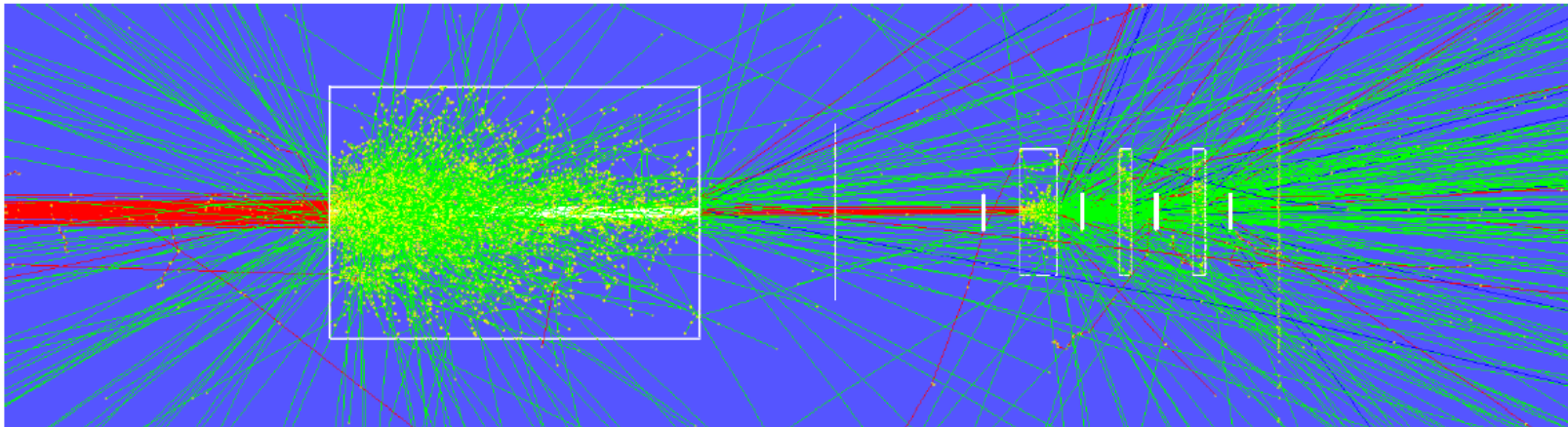


Calorimeter based on MAPS (1)

Lead absorbers (2)

DAQ Board(3)

GEANT4 simulations are performed,
Calorimeter will be tested at 50-200
MeV electron beam



Summary

The setup was constructed and applied for characterization and qualification of the monolithic active pixel sensors:

- Four ALPIDE detectors + 2 additional slots available
- XY stage with remote control
- Two beam tests
- Now we are using this set-up for tracking with cosmic rays

Further plans

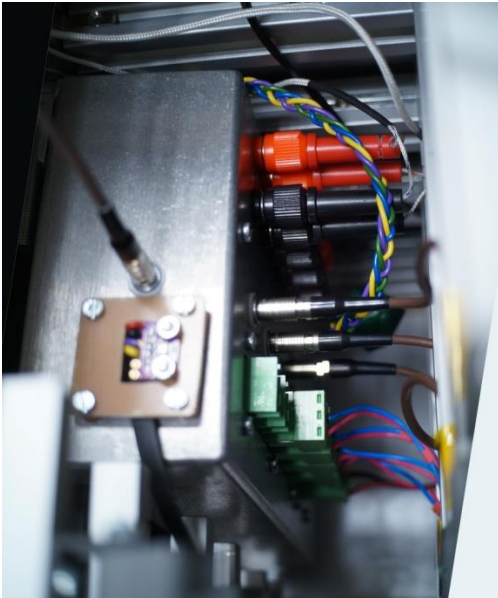
- 1. Modernization of Experimental set-up for new beam measurements at JINR
- 2. Studies of the ALPIDE characteristics using electron beams (LINAC-200) and NUCLOTRON beams in JINR (Tracking, Digital Calorimeter)
- 3. Studies of the ALPIDE characteristics at Petersburg Nuclear Physics Institute (Gatchina) 1 GeV protons primary beam. Secondary pions 750 MeV/c (Tracking)
- 4. Studies of the ALPIDE characteristics at the Ioffe Physical-Technical Institute of the Russian Academy of Sciences Cyclotron: heavy ions up to 6 MeV/u, from 1p up to Ar (Radiation hardness)

Thank you for your attention!



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Backup slides



Power distribution panel
Connection panel for temperature sensors
Inner temp. & humidity sensor

Scintillation detectors for triggering
(second one installed beyond chips)

