CZECH PARTICIPATION AT FACILITY

FOR ANTIPROTON AND ION RESEARCH (FAIR)

Commissioning of the electromagnetic calorimeter ECAL of the HADES experiment

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Development and Education

MINISTRY OF EDUCATION,
YOUTH AND SPORTS

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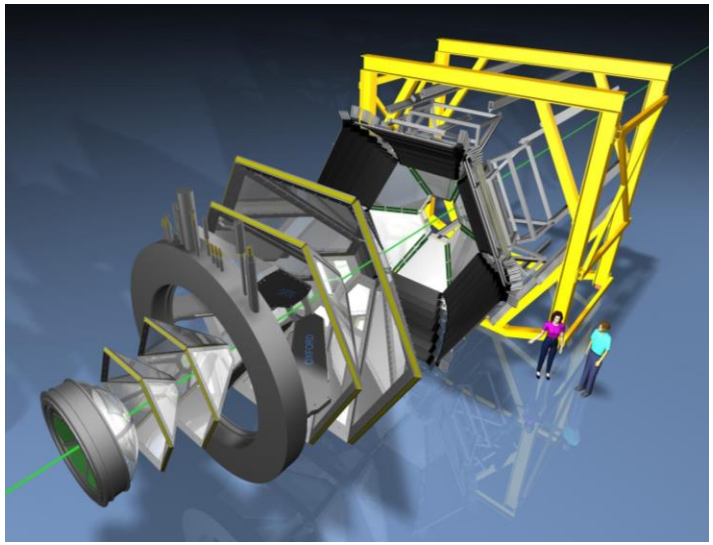
- ECAL@HADES – brief introduction & motivation
- Commissioning of the ECAL workflow & experience
- Dealing with issues – development never ends

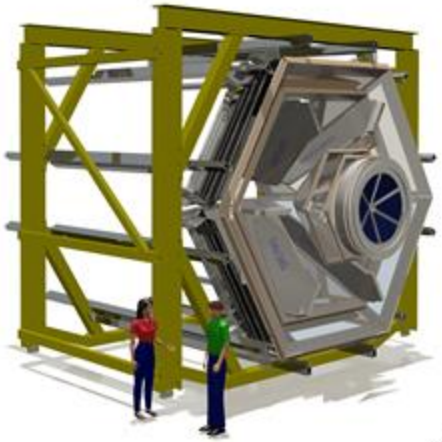
High Acceptance Di-Electron Spectrometer

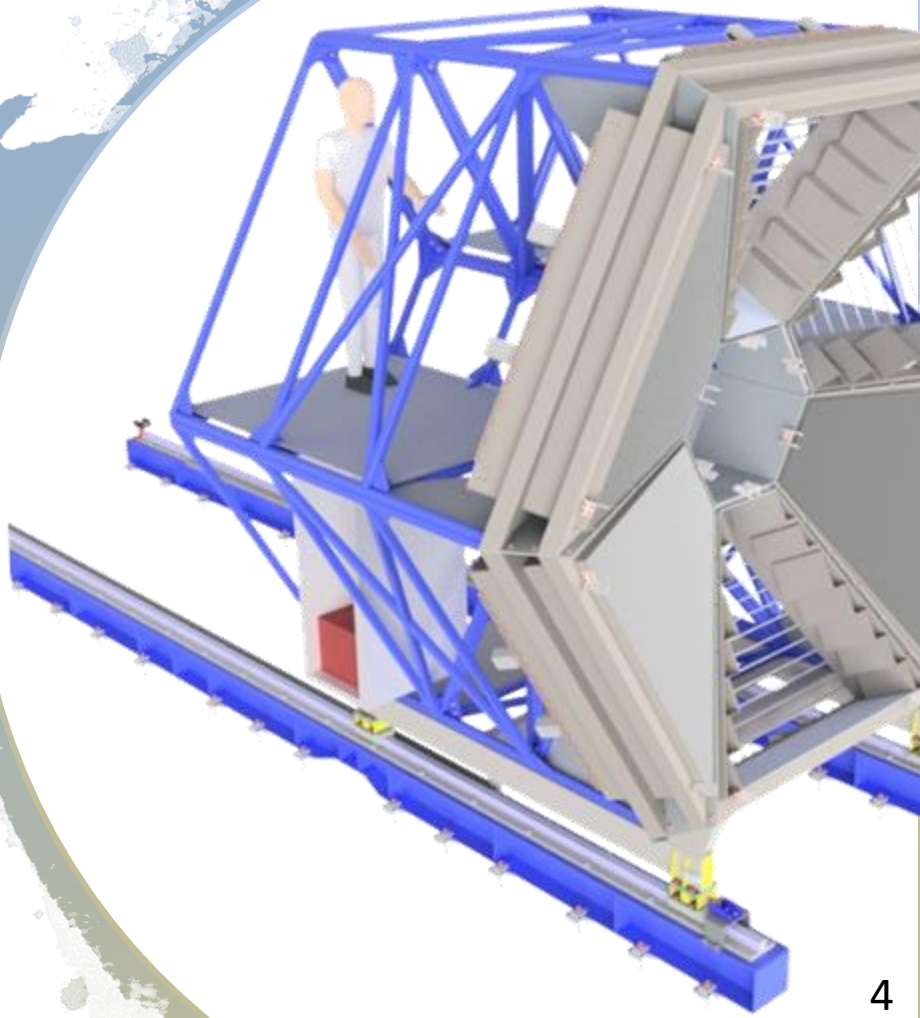


HADES strategy:
Systematic di-electron and strangeness measurements in NN, AA, pA, πN and πA collisions

- Beams provided by SIS18: π, p, ions
- Full azimuthal coverage
- Hadron and lepton identification
- e^+e^- pair acceptance 0.35
- **Mass resolution 2 % (ρ/ω region)**
- ~ 80.000 channels
- now: **up to 50 kHz event rate (400 Mbyte/s peak data rate)**

- **Stage I (2002 - 2008)**
  - Limited granularity of time-of-flight system → light collision systems
- **Stage II (2012 - 2015)**
  - Heavy collision-systems
  - π-induced reactions
- **Stage III (2018 - …)**
  - π,p,A -induced reactions at FAIR Phase-0



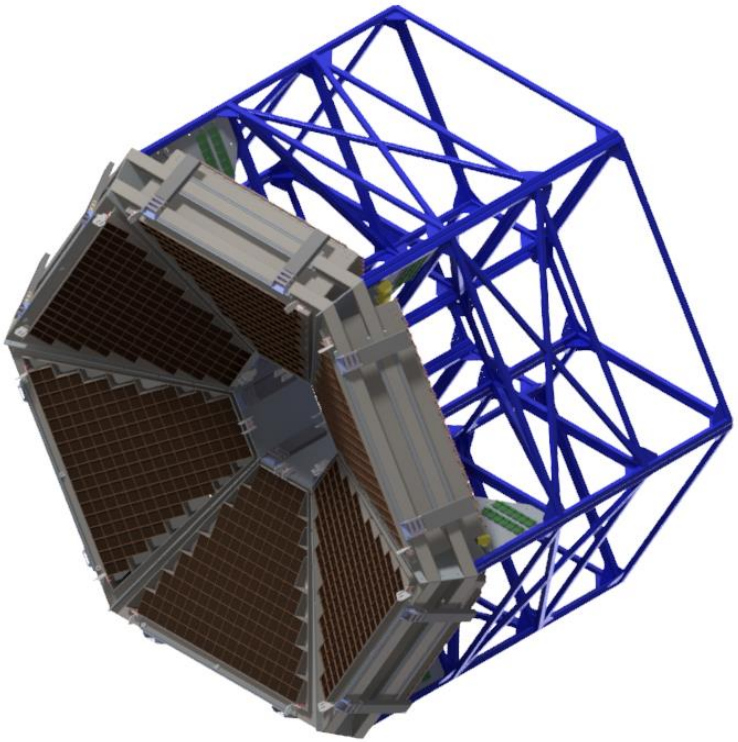


ECAL@HADES

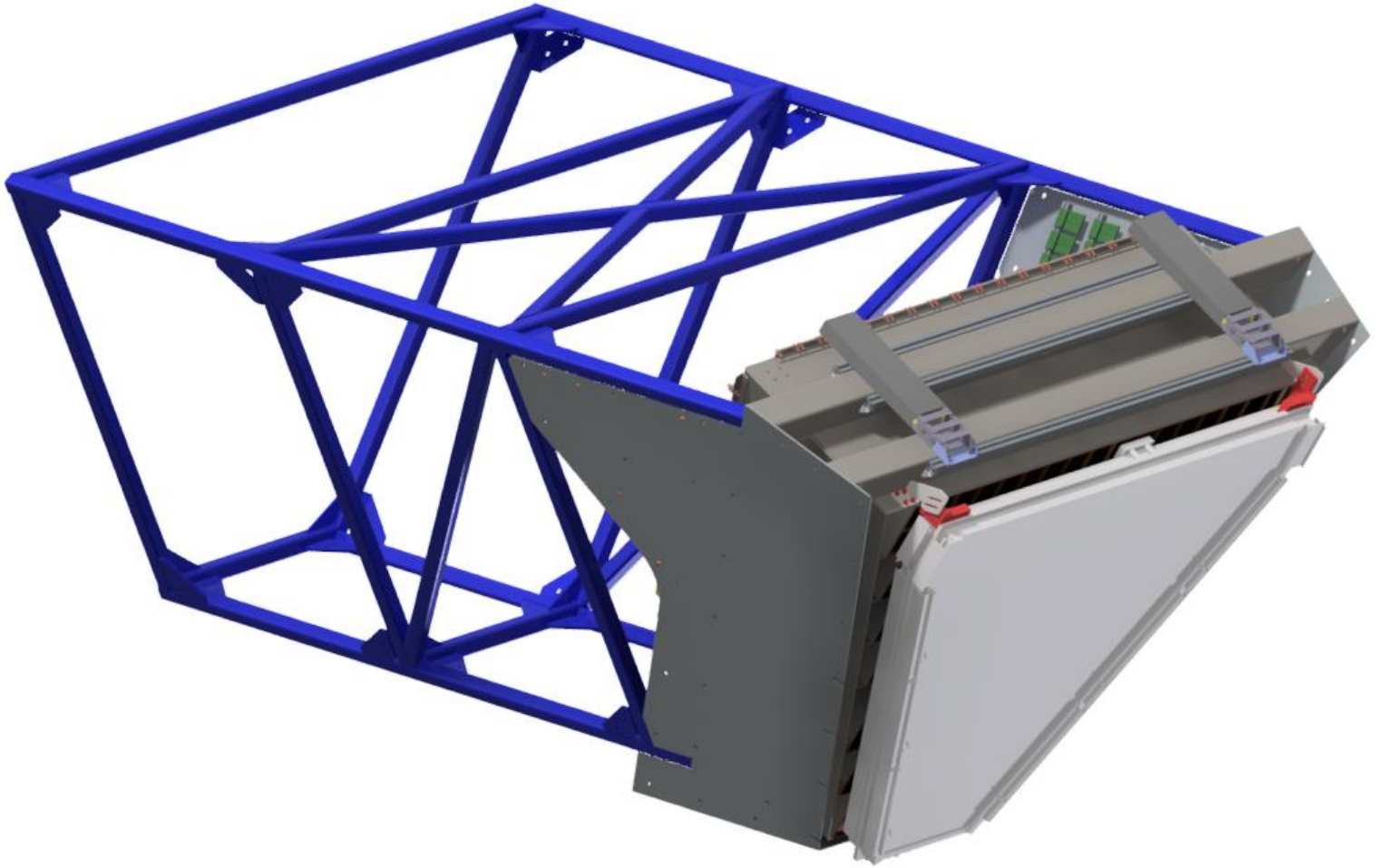
ECAL – basic structure

What is ECAL?

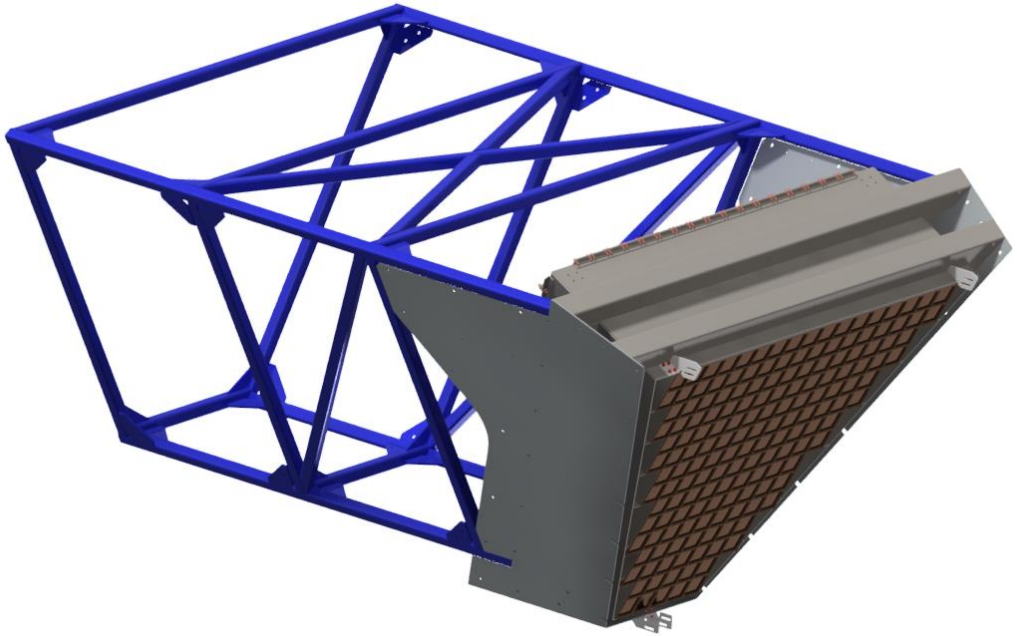
- Surprisingly: **E**lectromagnetic **CAL**orimeter
- It has the same basic hexagonal structure as HADES with coverage of forward angles between 16° and 45° and almost full azimuthal angle
- Each sector consists of 163 modules
  - Modules are based on lead glass, PMT for readout and optical fiber
  - So far 4 sectors are finished and 5th sector will be assembled this year



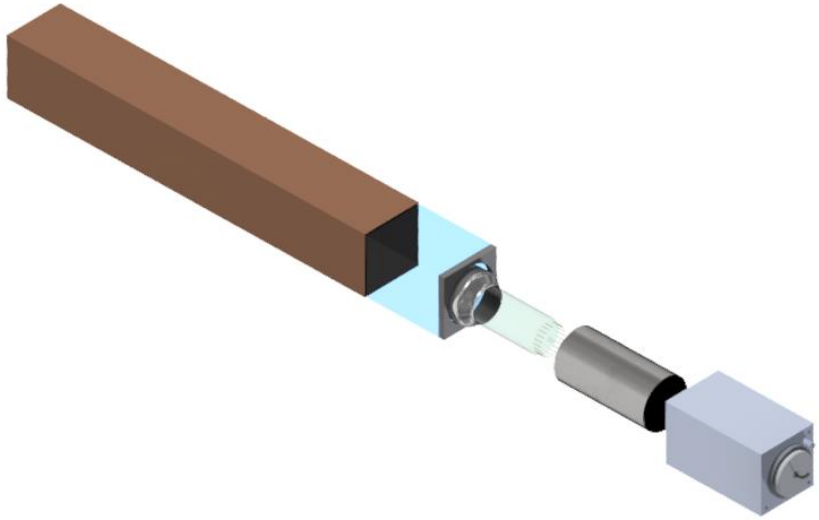
ECAL – sector & modules



ECAL – sector & modules



- Steel-beam structure
- Also holding structure for RPC chamber(s)
- 163 modules in "trapezoidal" arrangement



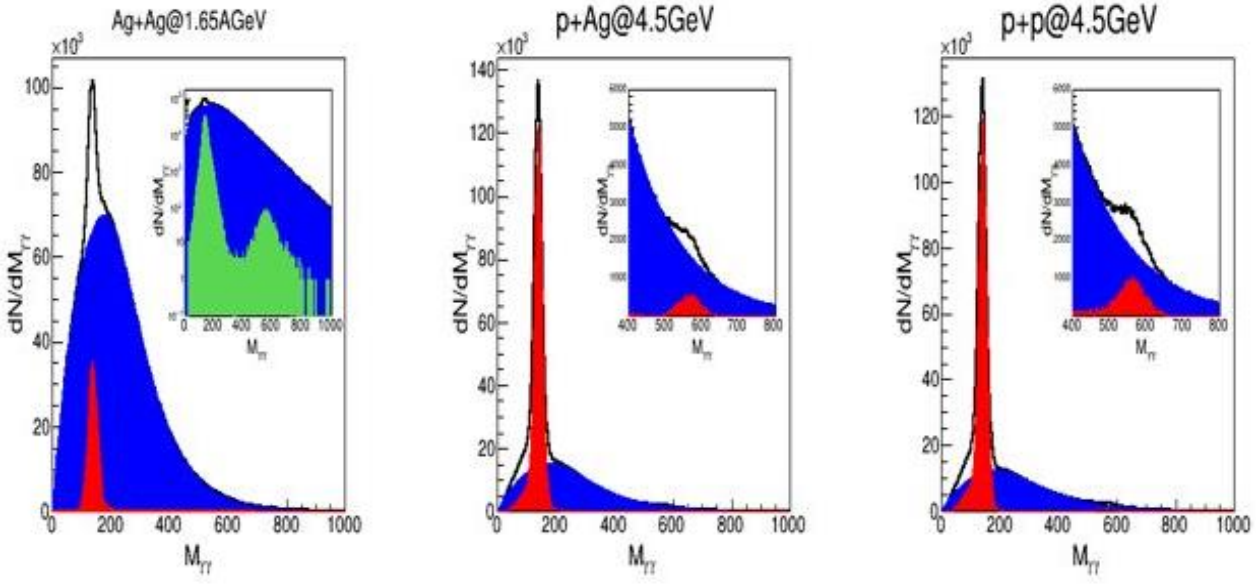
- Bras envelope
- Lead glass – 60% of the mass comes from lead, wrapped in Tyvek paper
- PMT – two versions:
  - 3" Hamamatsu R6091 PMT
  - 1.5" Emmi PMT
- Magnetic shielding - Mumetal
- Aluminium holding structure and housing for a HV divider and opt. fiber

ECAL - motivation

Why do we want it?

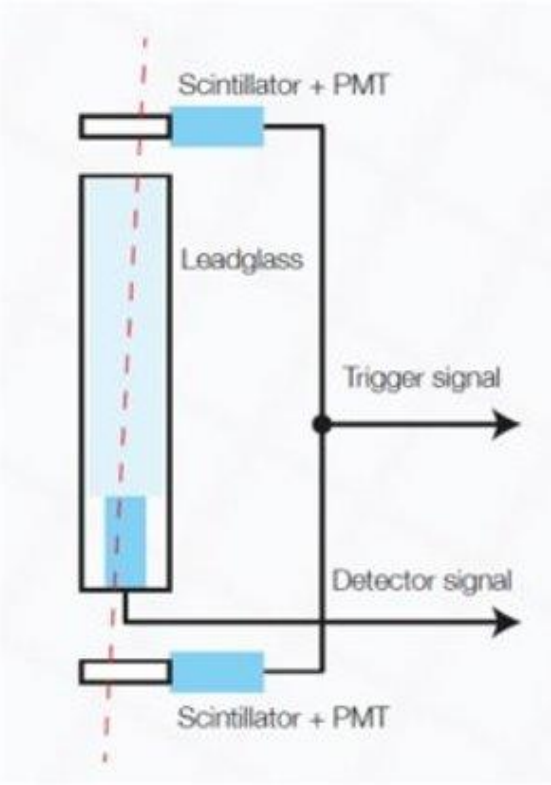
- To open new reaction channels to measurements via measurements of the photons – e.g. neutral mesons, neutral Λ(1405), Σ(1385), and ω. It also provides improved electron pion separation at high momenta.
- Planned resolution ΔE/E=5% for 1 GeV photons

Proposal ECAL performance plots

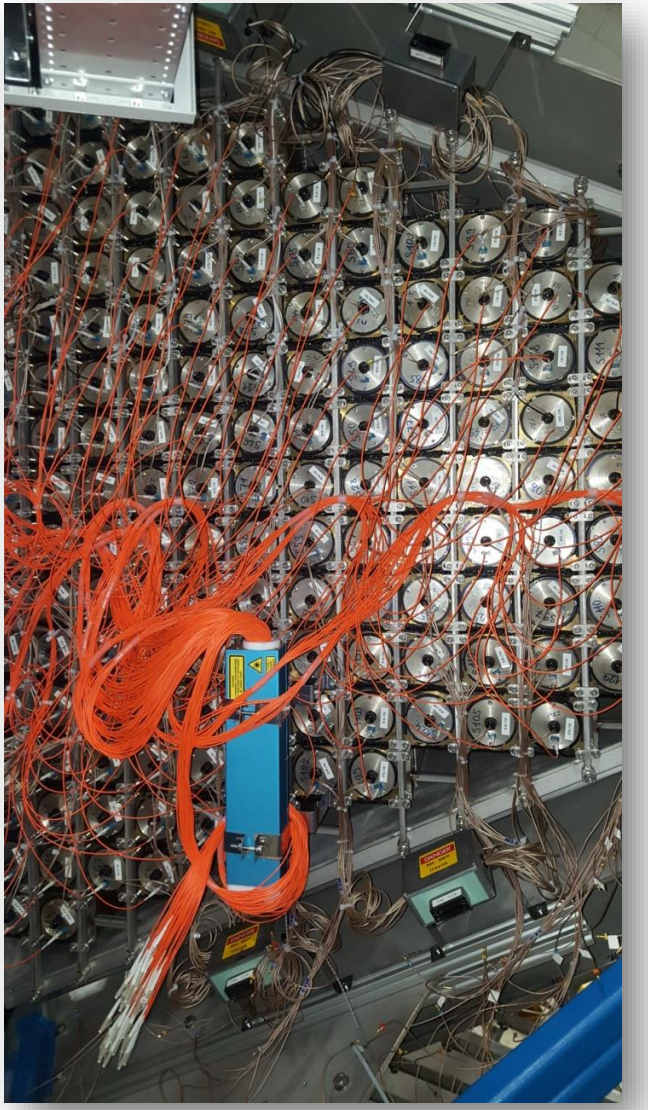


Commissioning of the detector

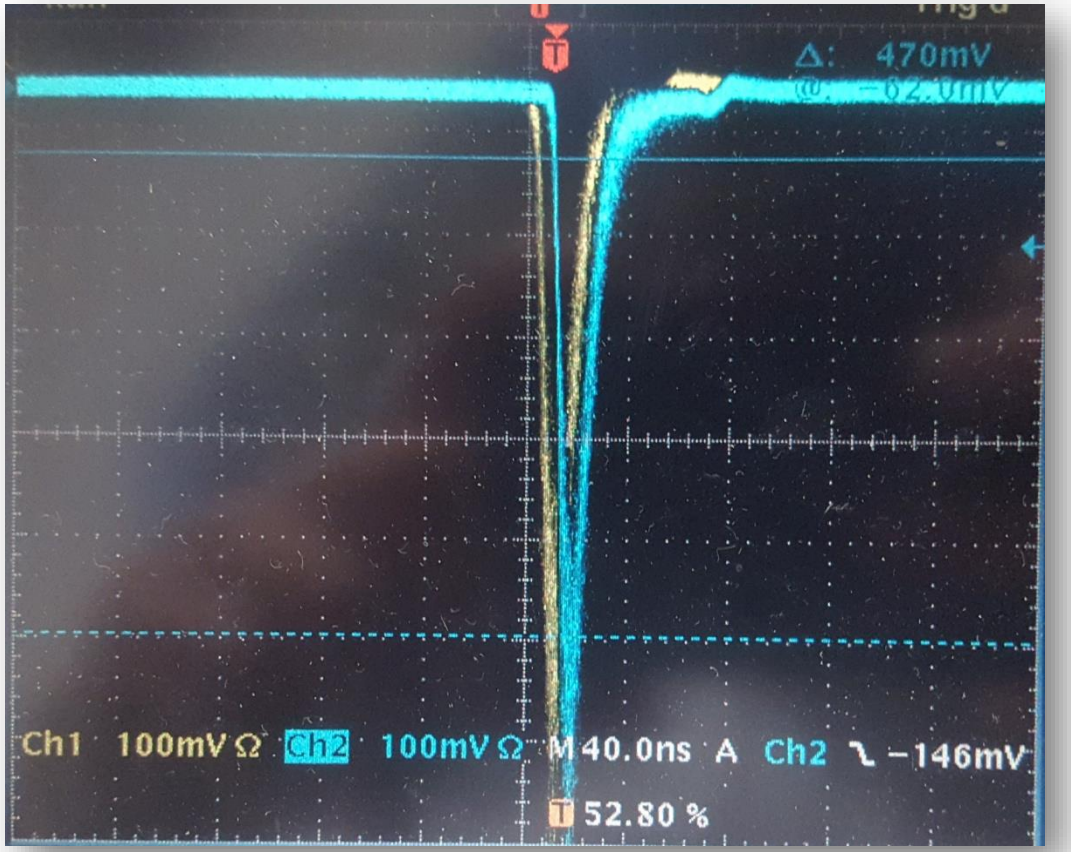
- Four phases:
  - Tests of separate modules in the lab. with cosmics muons using triggering setup
  - On-site measurements using digitizer
  - Cosmics and laser measurements using HADES DAQ
  - Test beam in November 2018



Commissioning - laser monitoring system

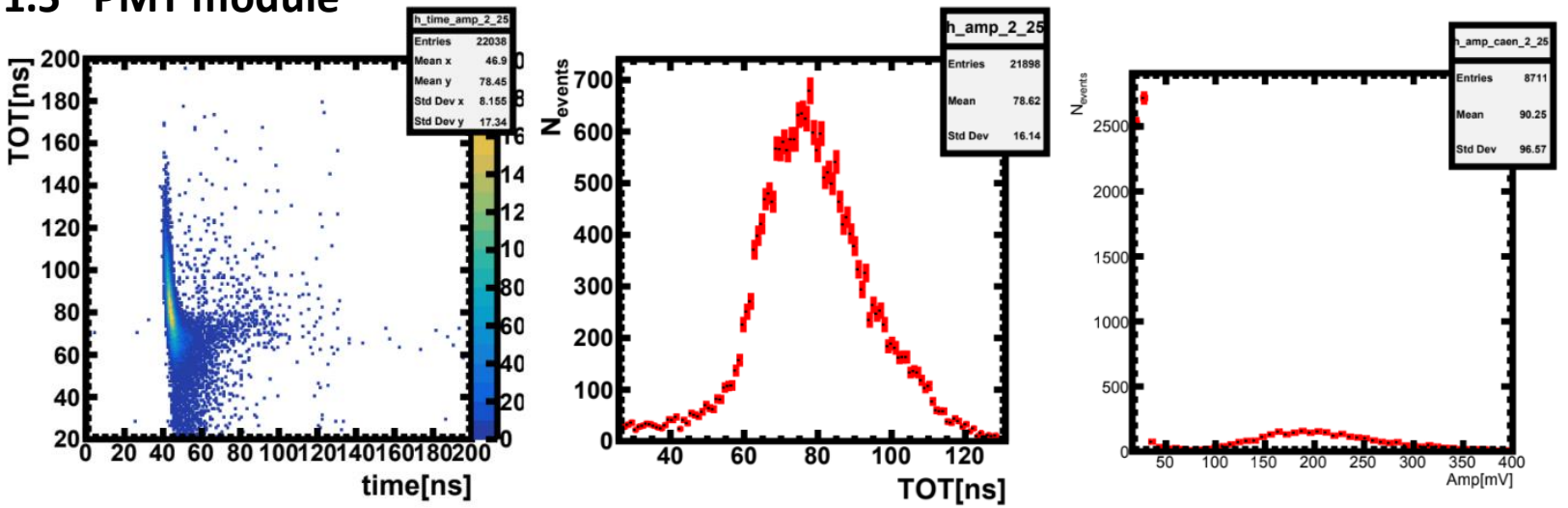


Laser signal from two different modules

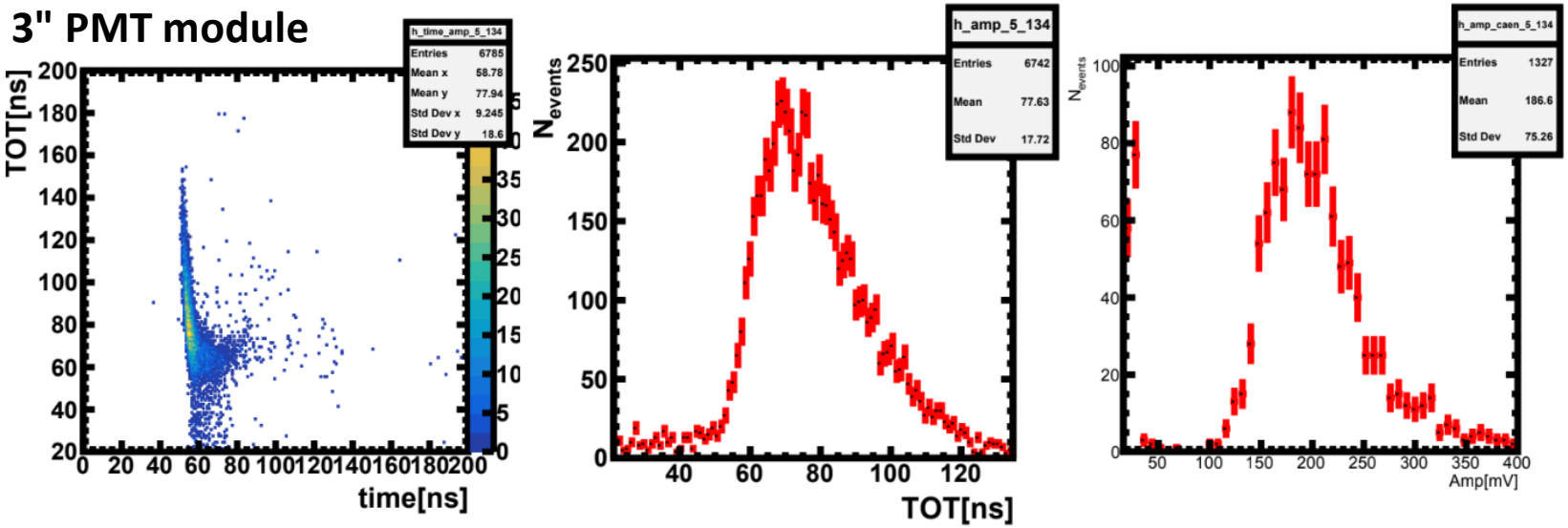


Commissioning - performance of the ECAL

1.5" PMT module



3" PMT module

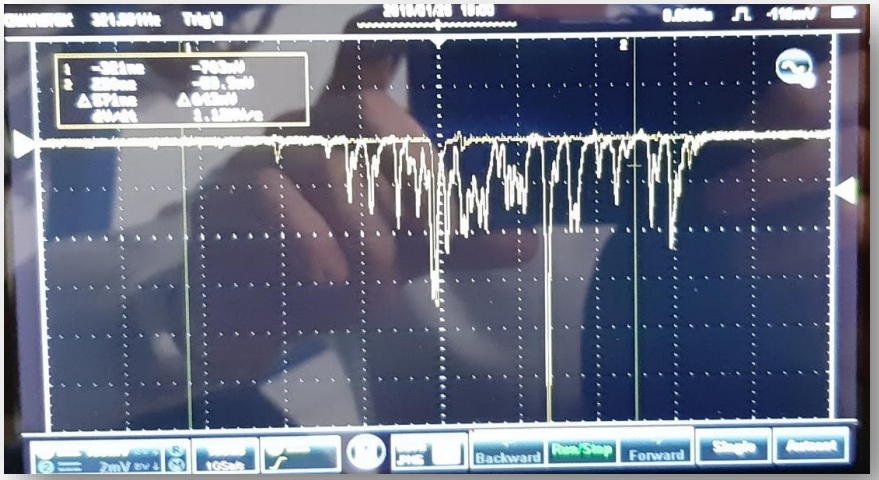


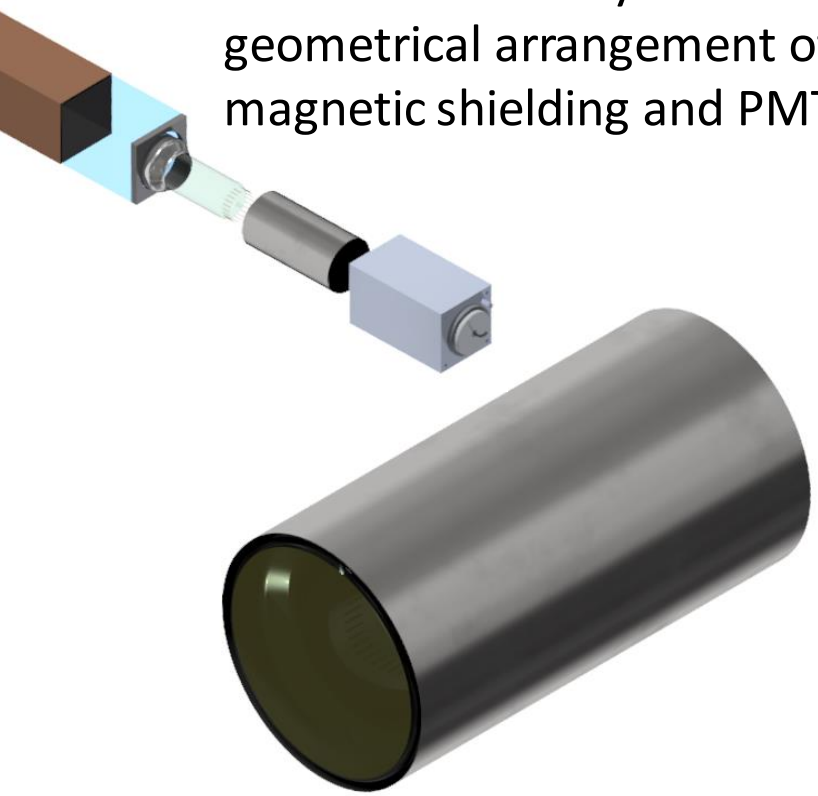
Commissioning – development never ends

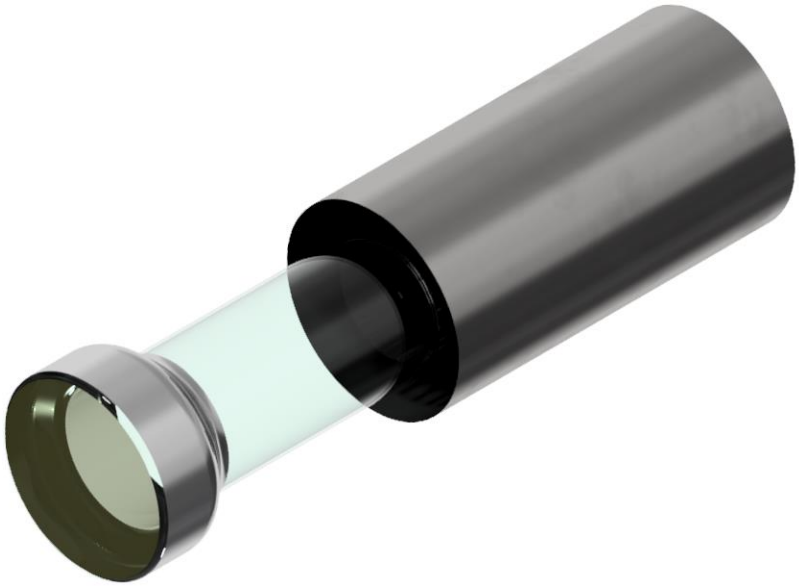
- Commissioning and test beam proved that the detector is fully read out and ready for the experiment which was conducted in March 2019
- Few set-backs were discovered during commissioning
  - Splitted signals – solved by reversing polarity in padiwa amps and using overshoot signal for measurement
  - Uncorrelated high amplitude signals and distorted signals with high rate – solution will be described in more detail

Development of electrostatic shielding

- Uncorrelated high signals and noise were observed during commissioning
- Investigation showed up extreme sensitivity on the geometrical arrangement of the magnetic shielding and PMT

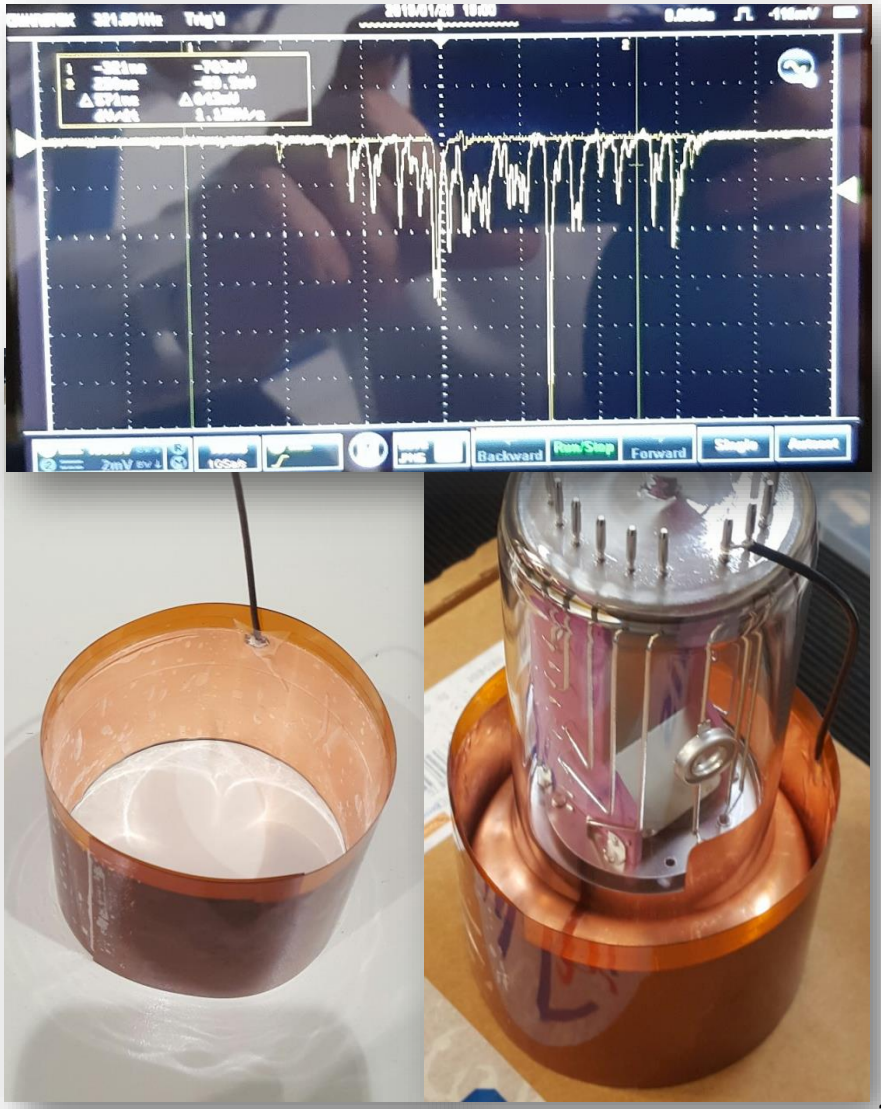






Development of electrostatic shielding

- Uncorrelated high signals and noise were observed during commissioning
- Investigation showed up extreme sensitivity on the geometrical arrangement of the magnetic shielding and PMT
- Partial solution was found in copper shielding around the PMT with the photocathode potential to shield the gradient between the photocathode and the magnetic shielding
- 125 um capton foil is used as electric isolation and holder for the copper foil
- This method was chosen due to possibility of installation without module disassembly.



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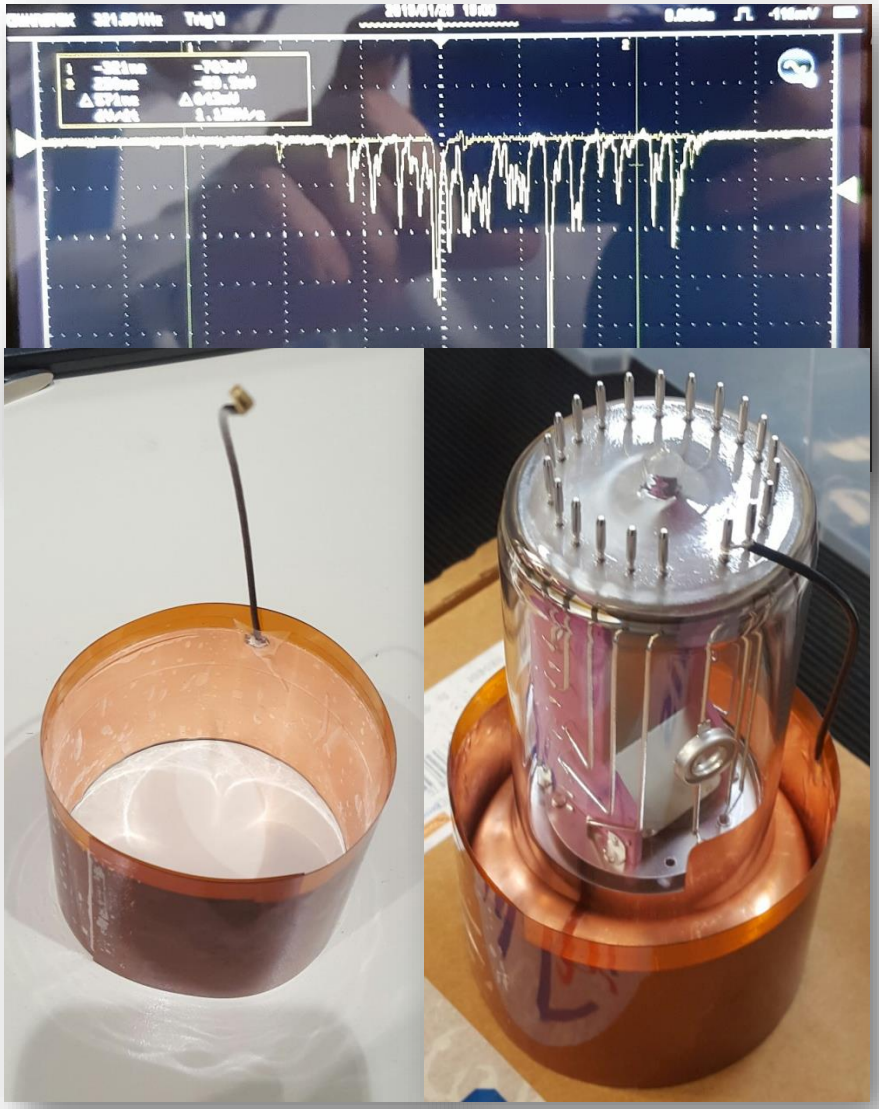


Development of electrostatic shielding – step to the future

- Kapton-copper shielding proved itself to prevent any damage to PMTs due to high potential difference and discharges.
- Still some discharges occur in the treated modules.
- New method based on conductive coating of the PMT was introduced.
- On top of conductive layer, additional protective black layer is added.
- Five modules were fully assembled and shortly tested in lab.
- They were installed in sector 1 and are tested in real conditions with beam and magnetic field.

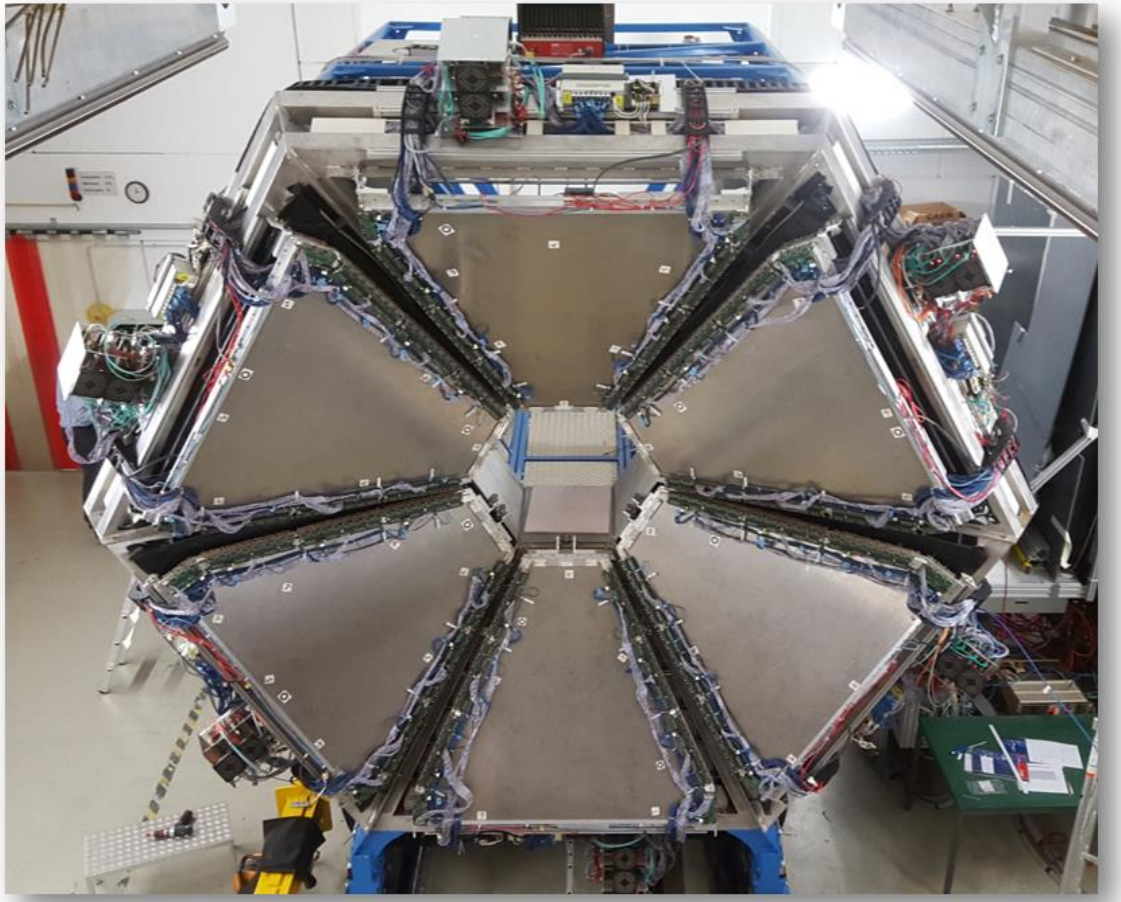
Development of electrostatic shielding - evolution

Prototype

1st iter.

Final state

Thank You for the attention



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