Segmented Cherenkov Electromagnetic Calorimeter (ECAL) of the HADES experiment on SIS18 (GSI)

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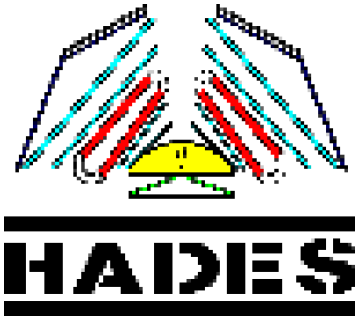
FAIRNESS-2019



Plan:

- HADES experiment
- ECal detector
- First results

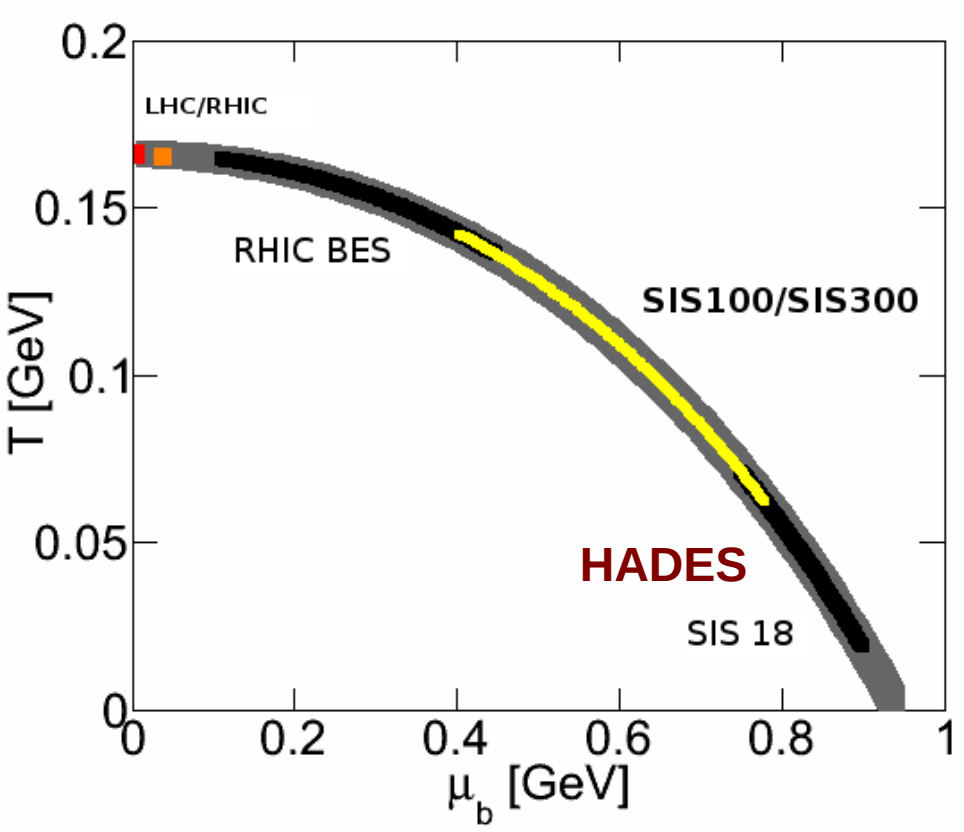
HADES EXPERIMENT

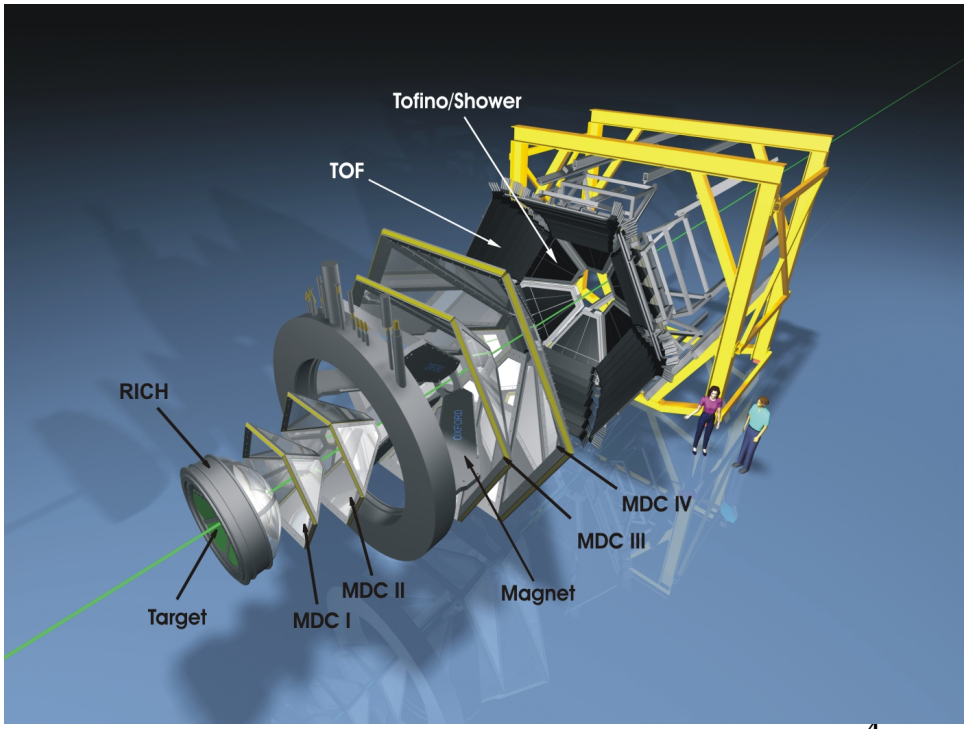
HADES at SIS18

High Acceptance DiElectron Spectrometer operates since September 2001

Explore QCD phase diagram with dilepton spectra

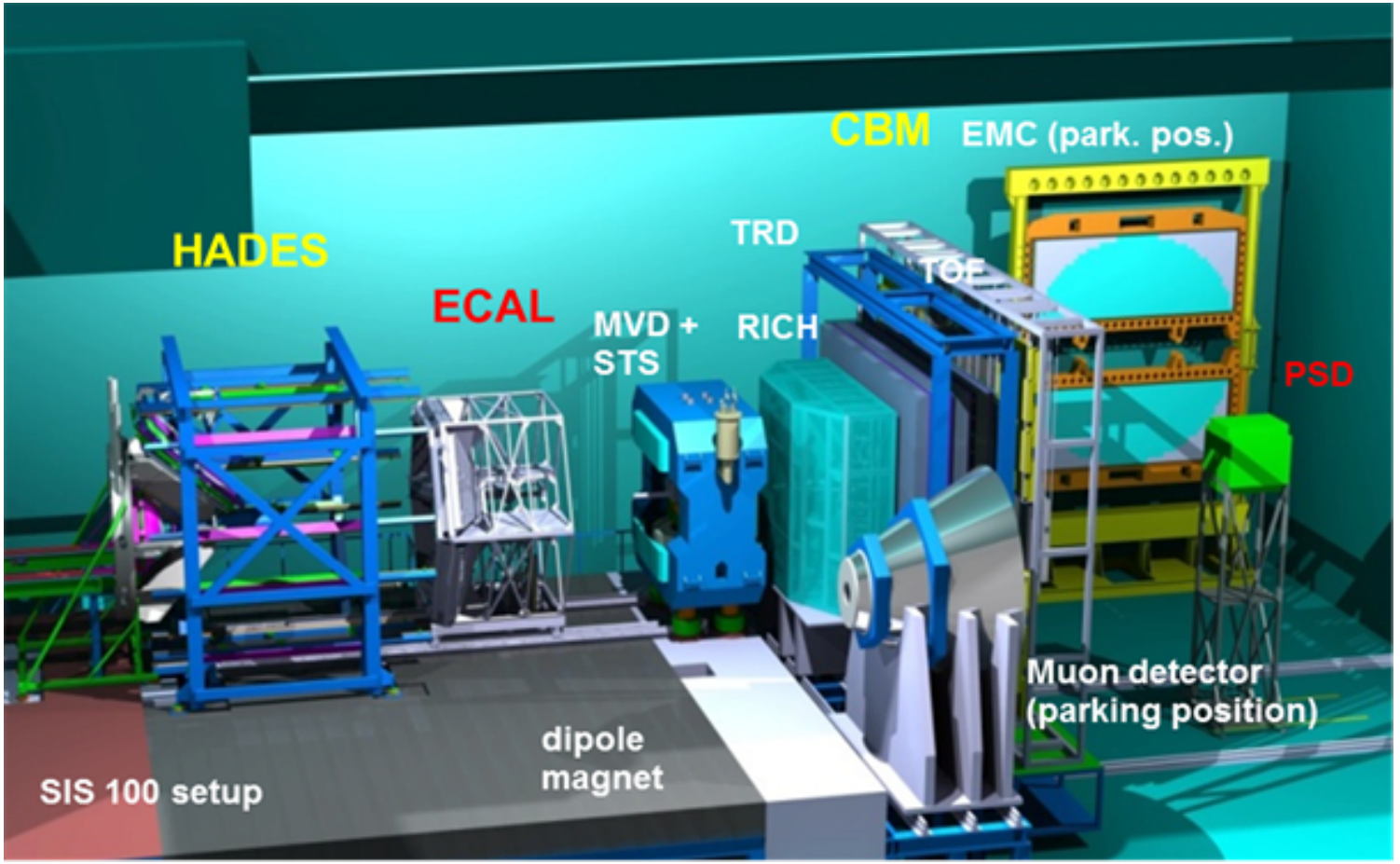
- Beam energies up to 2 AGeV
- pion, proton, deuteron, heavy nuclei beams





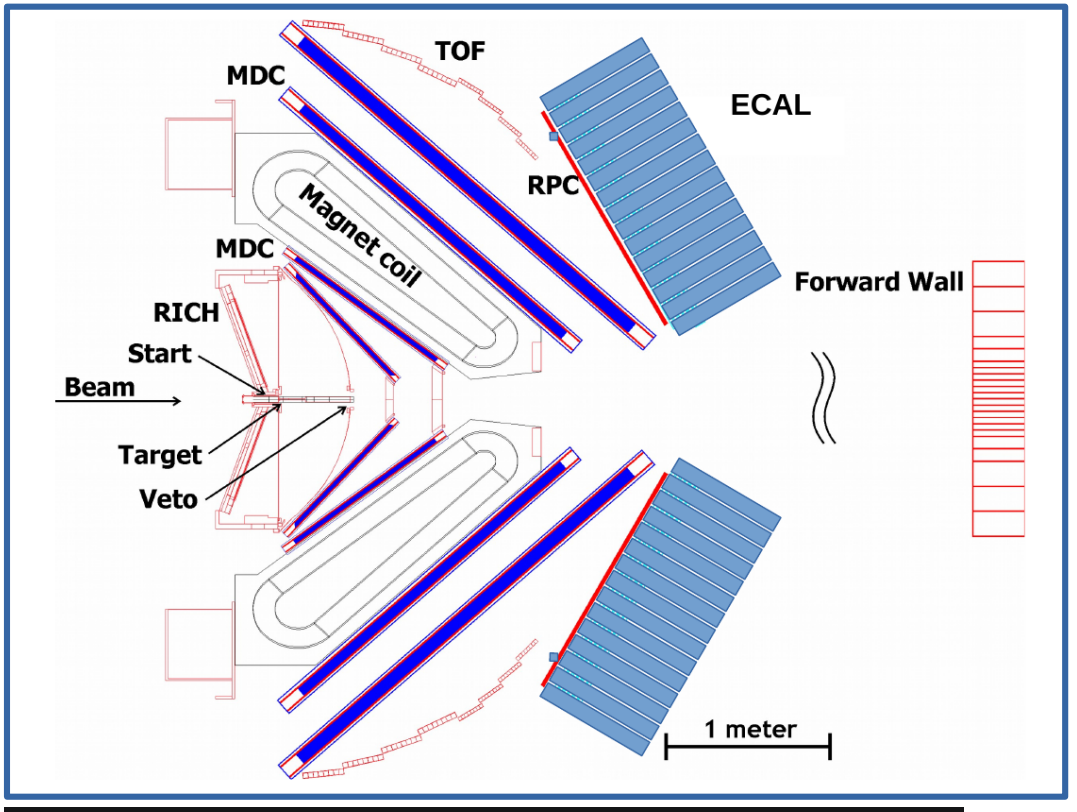
HADES at SIS100

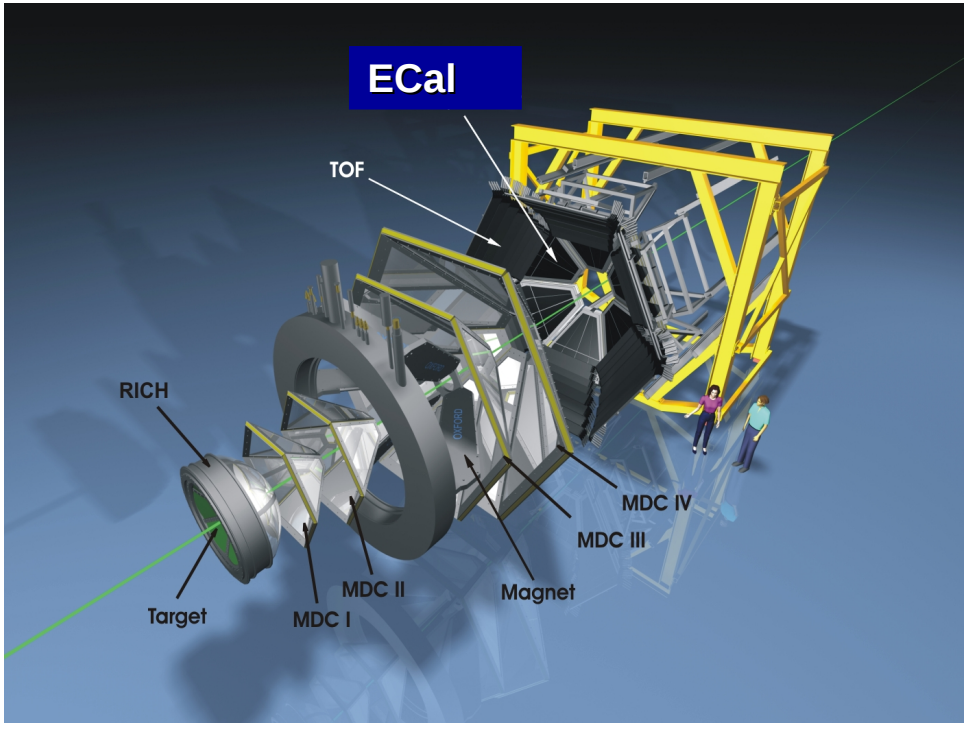
- HADES at SIS100 will operate at 2-12 AGeV



HADES detector

- Start
- RICH
- 4 layers MDC
- Superconducting magnet
- TOF, RPC
- **Electromagnetic calorimeter**
- Forward Wall





ELECTROMAGNETIC CALORIMETER

Why we need the ECal detector

For beam energies between 2-12 AGeV the database for π^0 and η production is not complete → any interpretation of dilepton data depends on models.

π^0 and η ($\gamma\gamma$-decay channel) are measurable with ECal

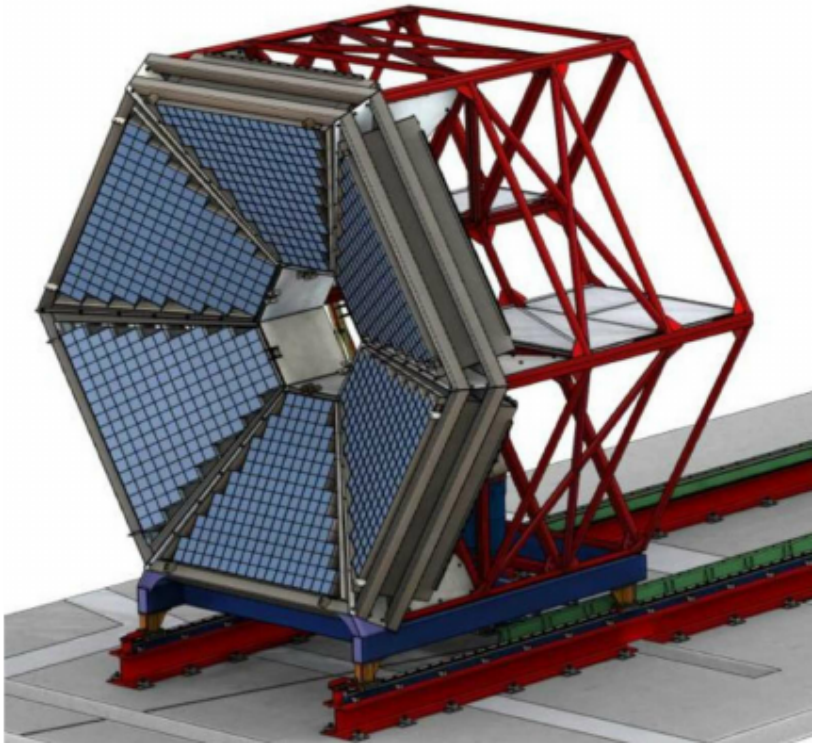
- γ spectroscopy
- Improvement of e/π separation
- π^0 and η yeld by $\gamma\gamma$ invariant mass spectra
- $\Lambda(1405)$ and $\Sigma(1385)$ spectroscopy

Electromagnetic calorimeter

- 978 (6 * 163) modules

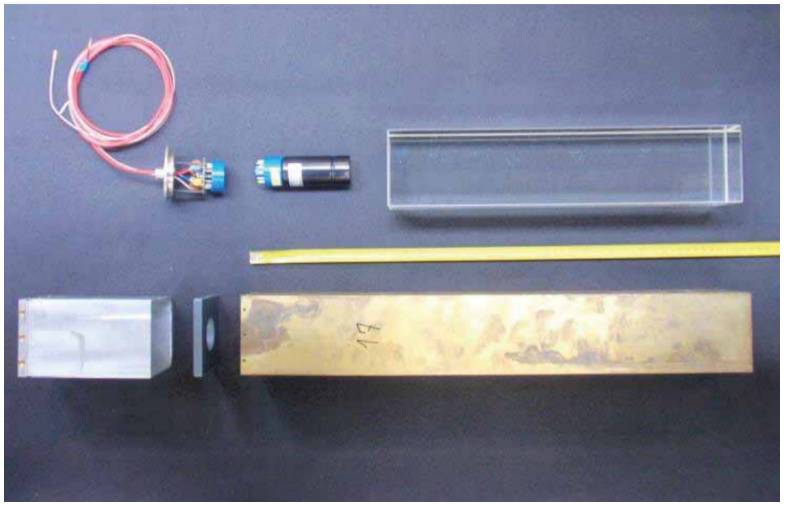
  covering polar angles $12^0 < \theta < 45^0$

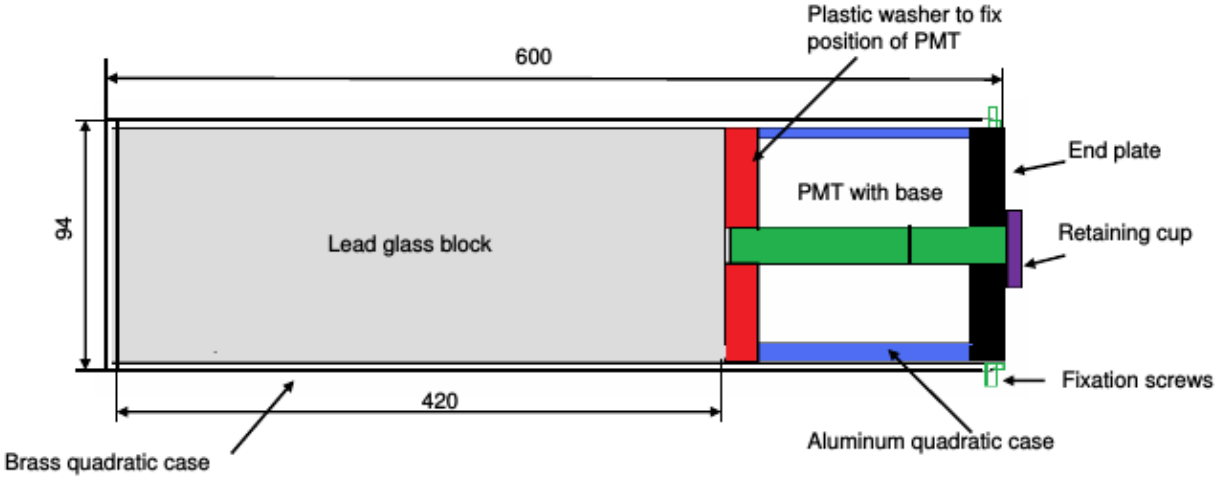
  and full azimuthal angle
- Energy resolution $\frac{5\ \%}{\sqrt{E\,[GeV]}}$



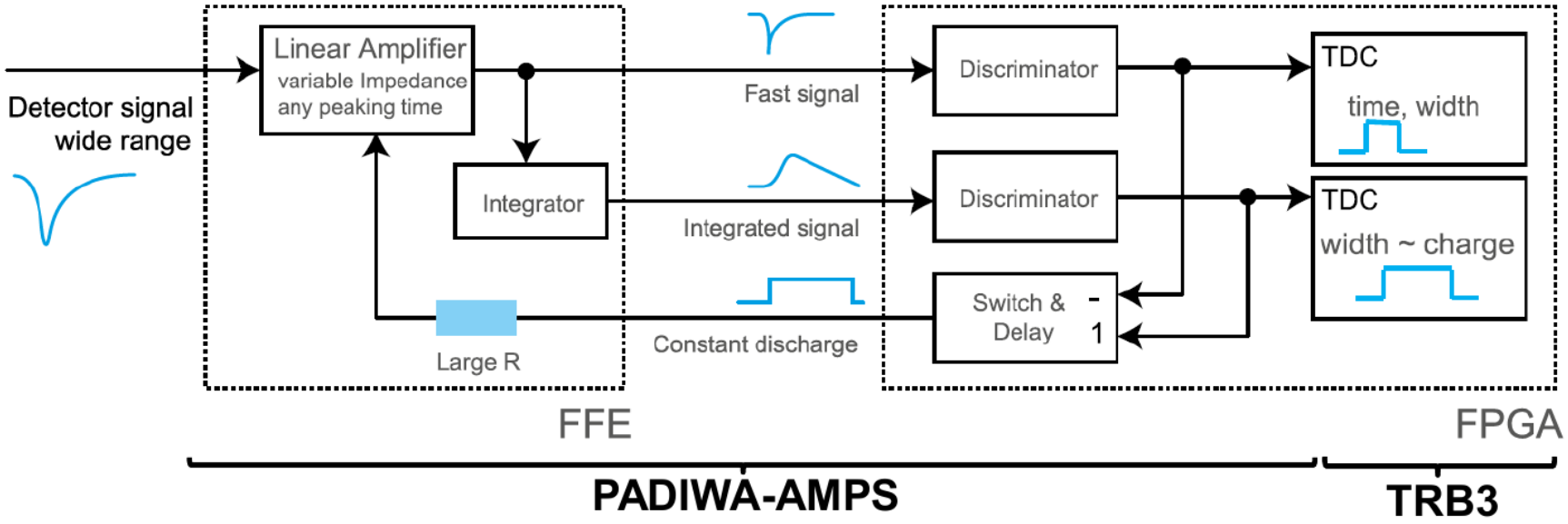
Modules of the ECal (previously used at OPAL experiment)

- Lead glass (CEREN25) radiator covered by Tyvek
- PMTs
  - 1 inch Hamamatsu R8619
  - 1.5 inch EMI 9903KB
  - 3 inch Hamamatsu R6091
- Mechanical support



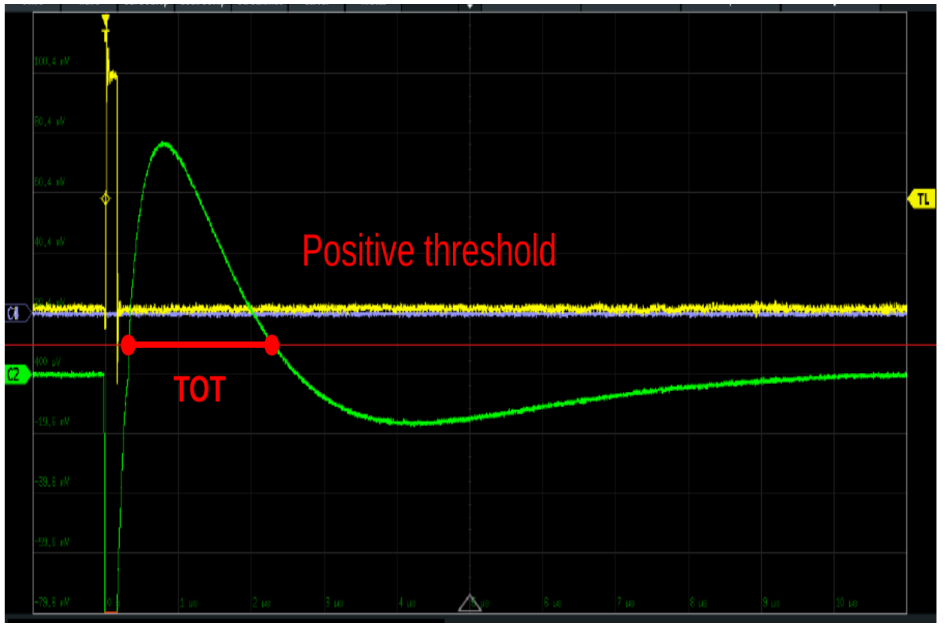


Electronics and readout



Amplitude is measured with

Time over Threshold (TOT) method

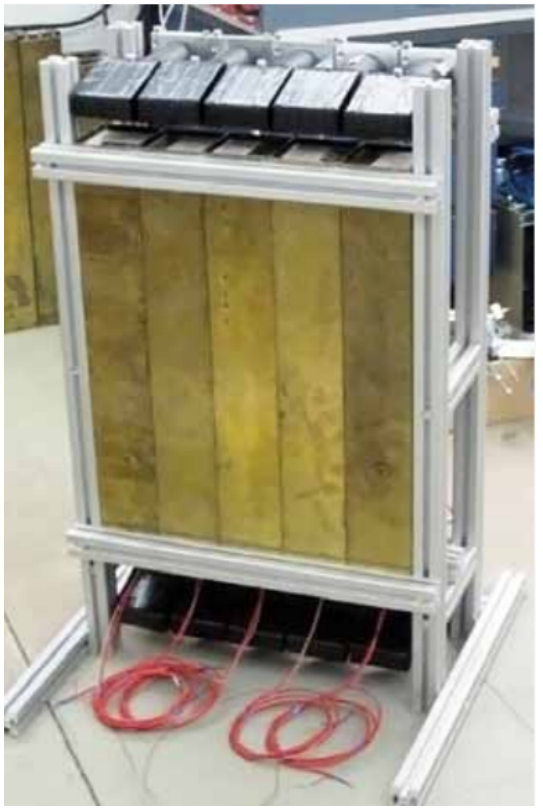


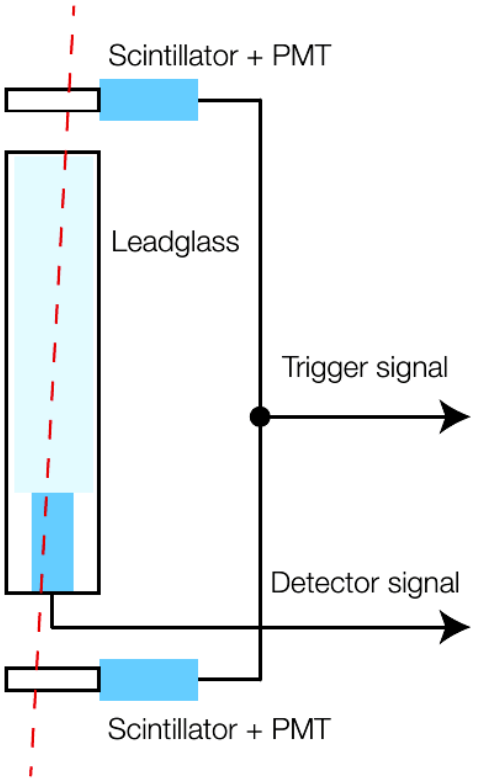
FIRST MEASUREMENTS

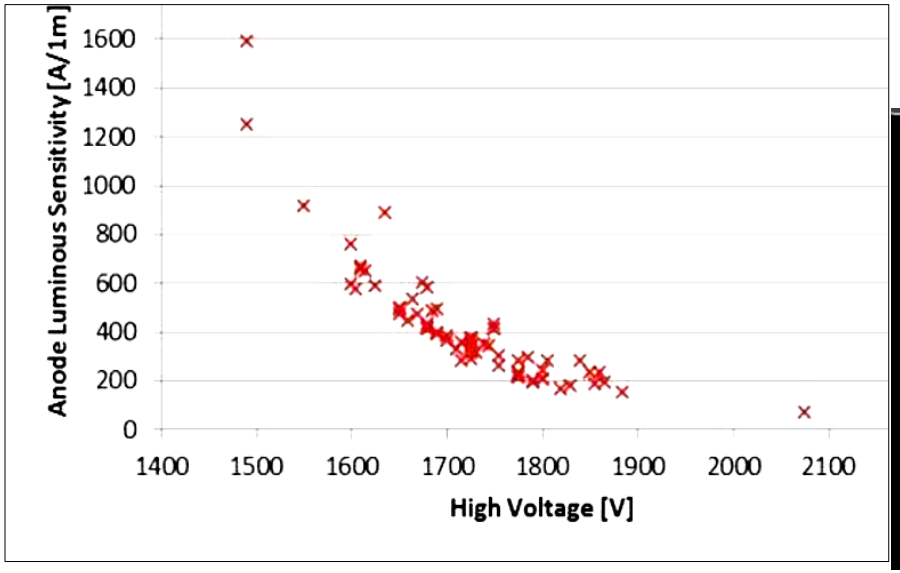
Tests with cosmic muons

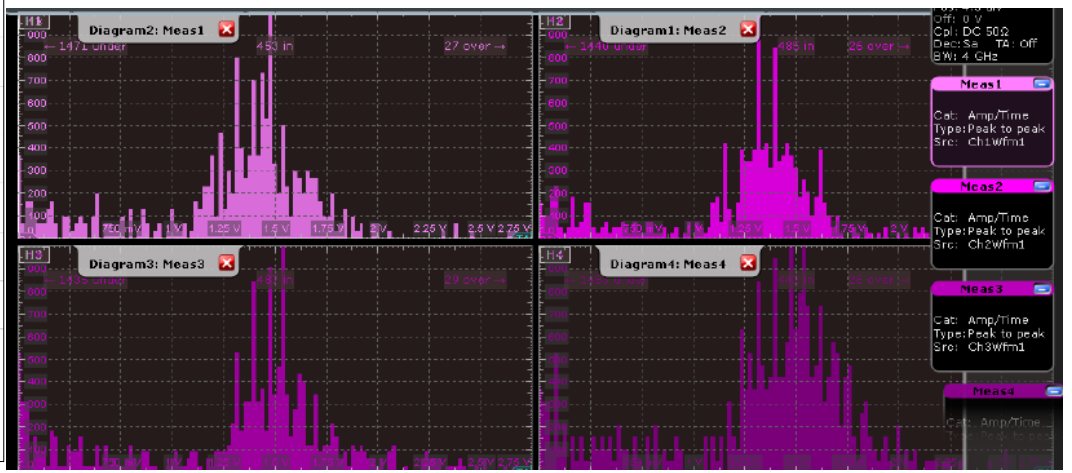
Cosmic muons are MIPs (minimal ionizing particles). For each module HV was set up so that response to MIPs was equal ~1.5 V

Two scintillator detectors connected by coincidence formed a trigger to select only vertical muons.

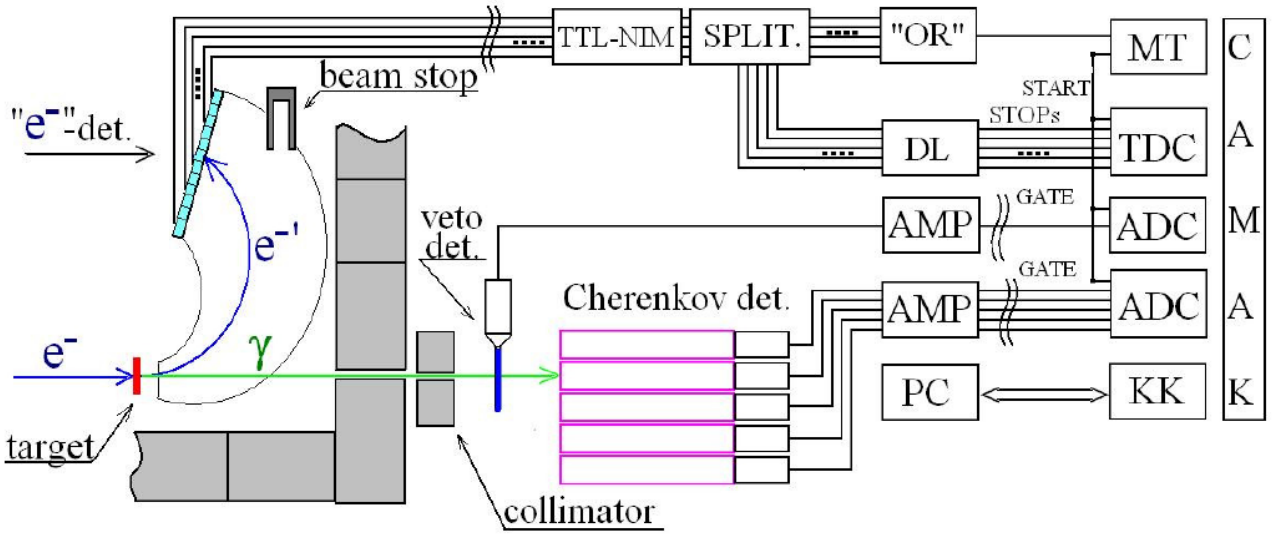




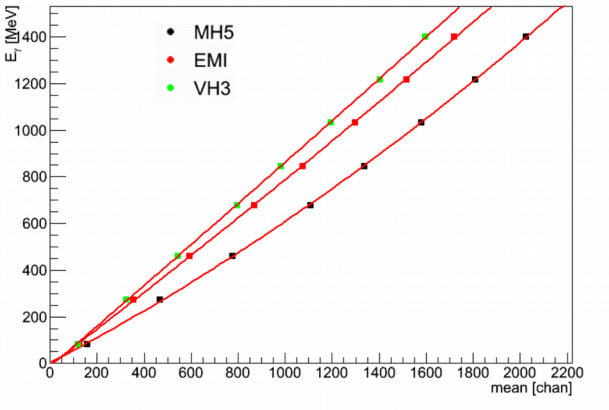




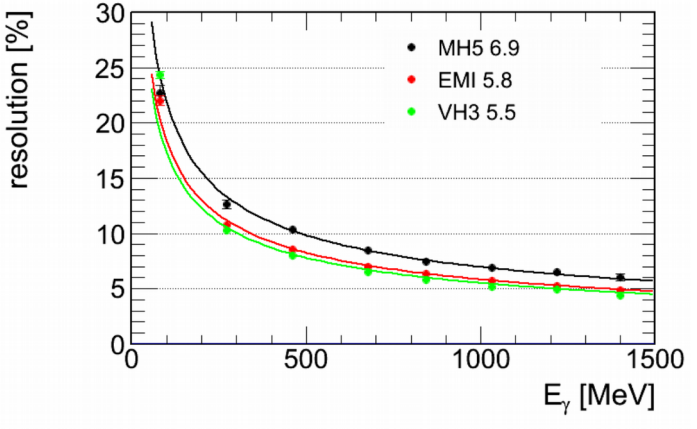
Tests on γ beam at MAMI (Mainz, Germany)



- Linearity check

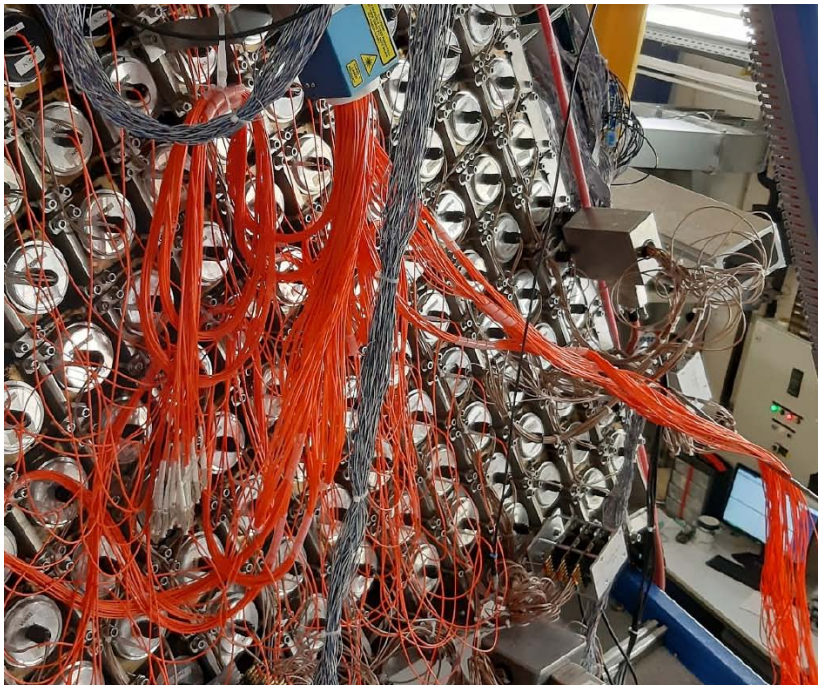


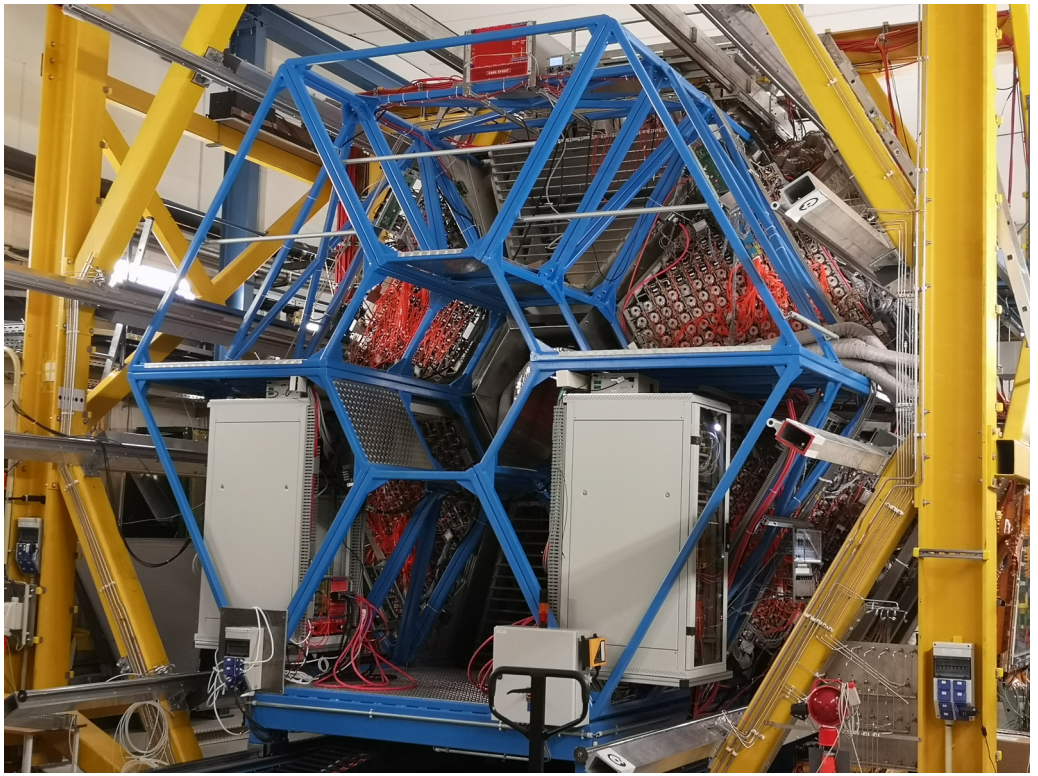
- Energy resolution $\frac{5\ \%}{\sqrt{E\,[GeV]}}$



By November 2018

4 sectors out of 6 were assembled in the experimental hall.

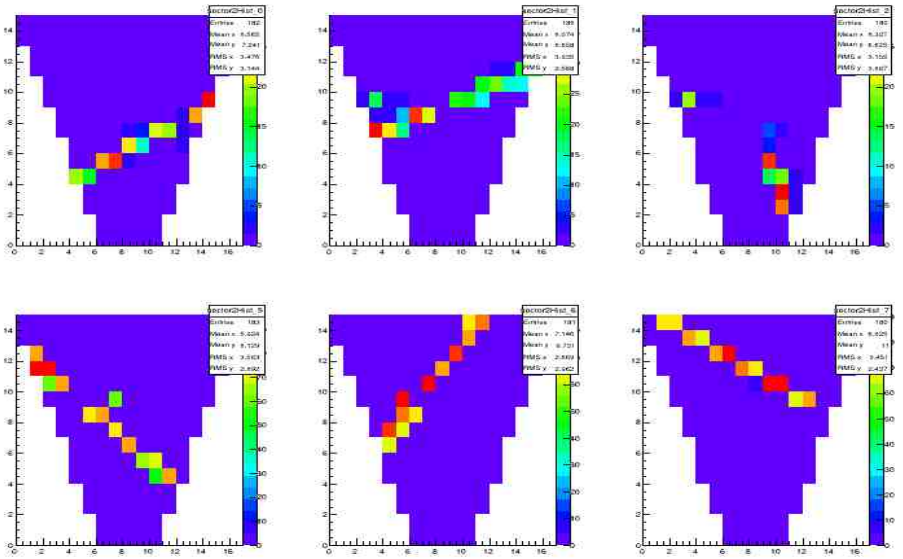


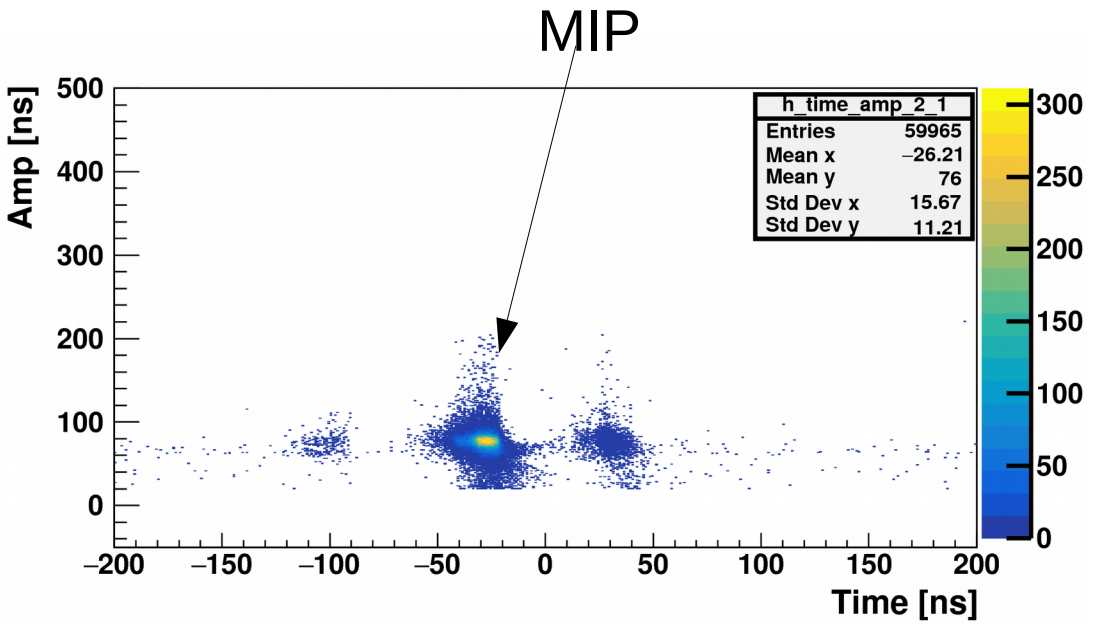


Tests of the assembled modules with cosmic muons

Typical Amplitude-Time distribution.

Used for preliminary amplitude calibration

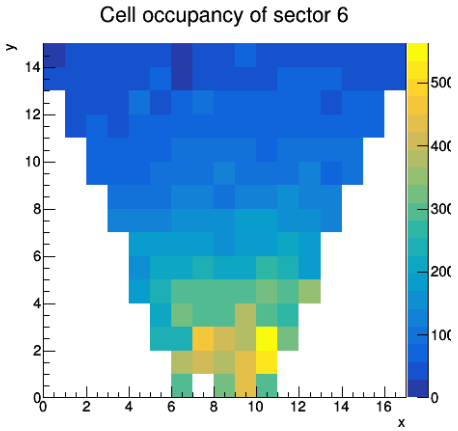


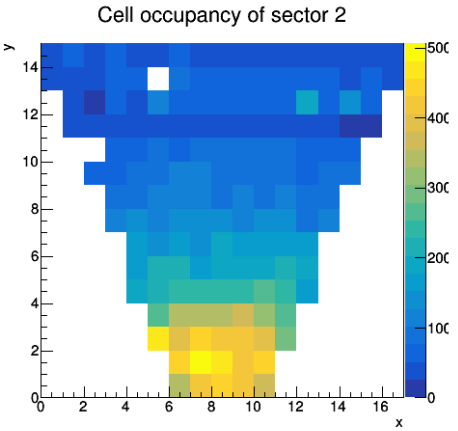


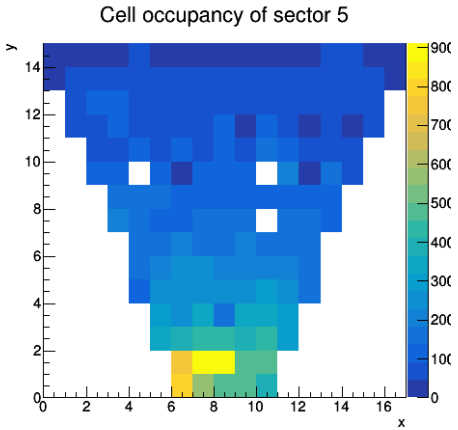
Tests on beam (December 2018)

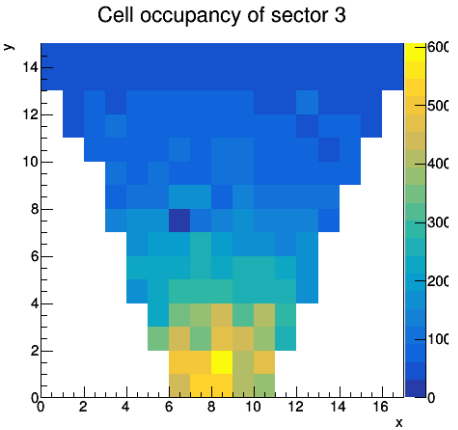
- Ag beam 1.58 AGeV
- Ag fixed target
- No magnetic field → alignment of the detectors
- On-line monitoring:
  - cell occupancy
  - multiplicity
  - time distribution
  - amplitude distribution

Online monitoring

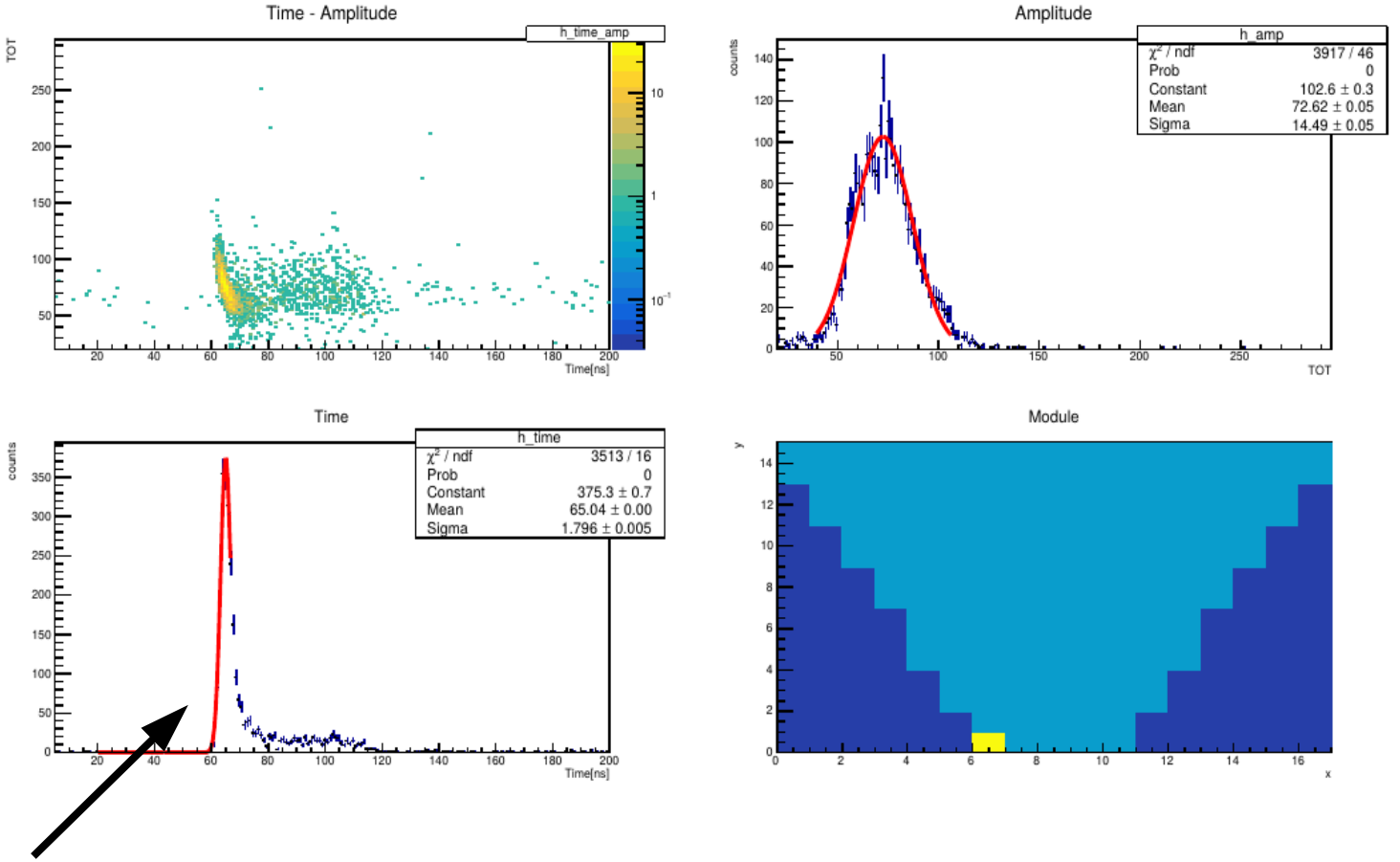






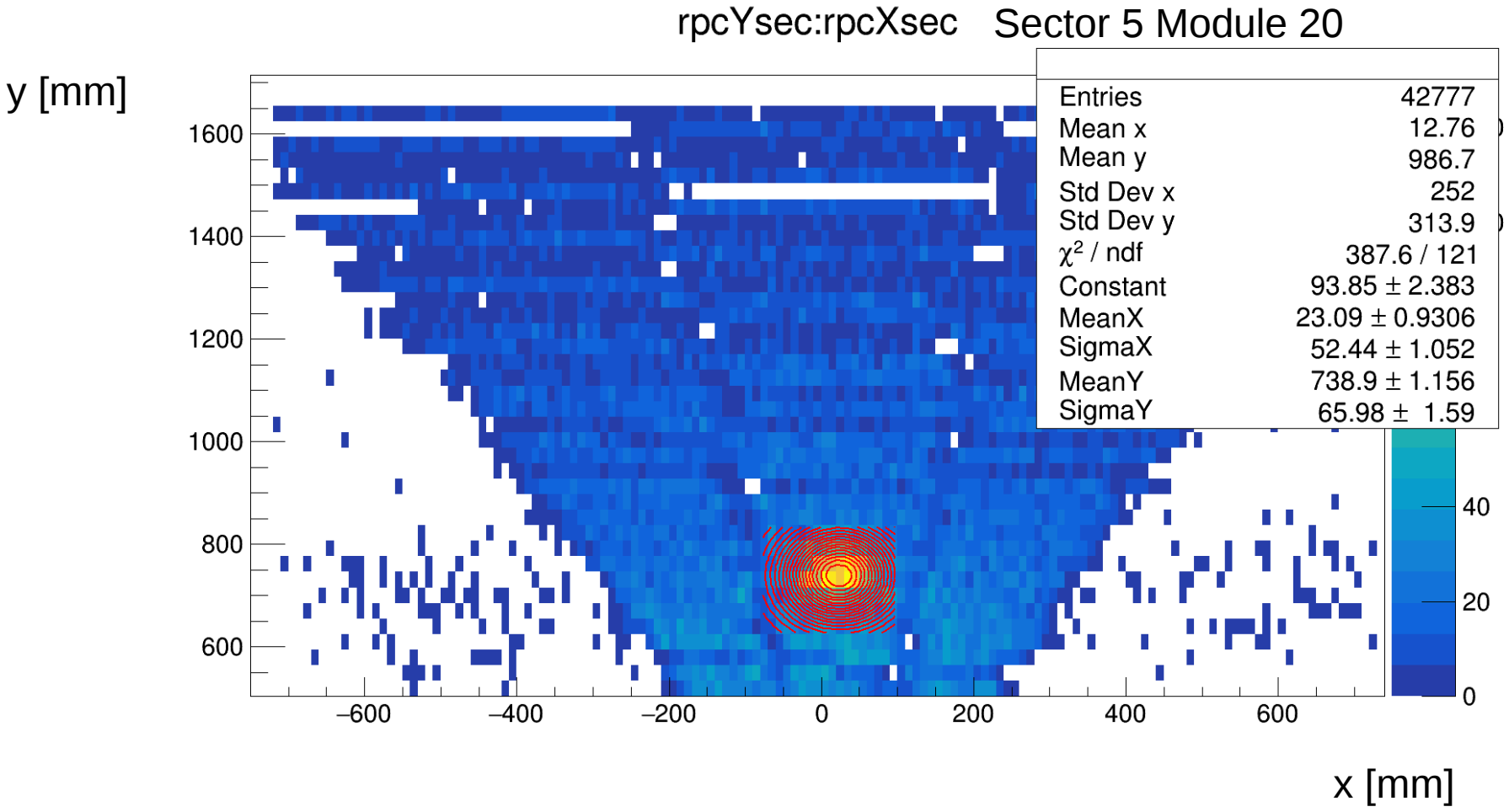


Time calibration of the modules



- Time shift is aligned to match RPC time → assignment of a hit to the track
- Without magnetic field energy of particles is unknown → calibration of amplitude was not possible

RPC to ECal matching



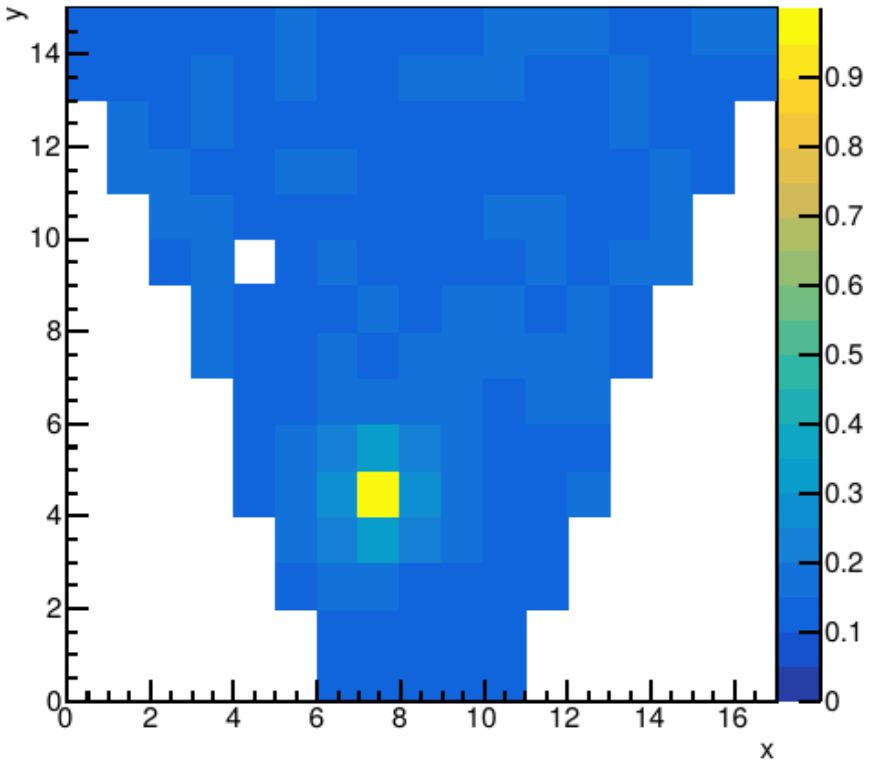
veto on RPC → γ

Tests on beam (March 2019)

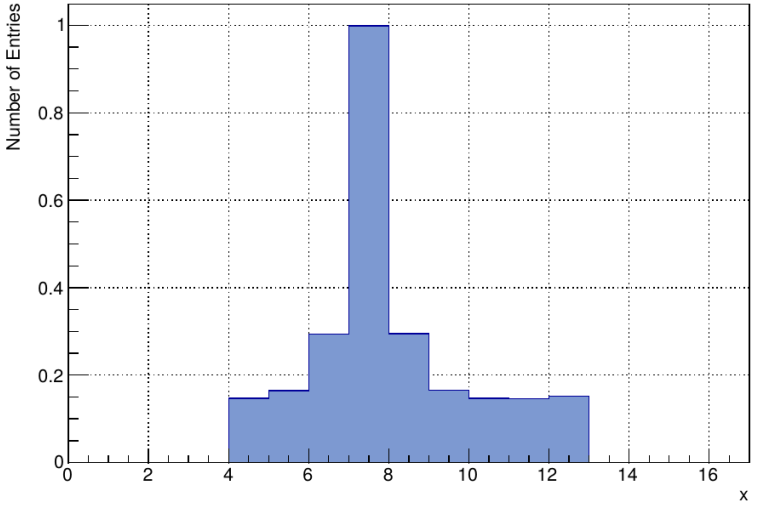
- Ag beam 1.58 AGeV
- Ag fixed target
- Magnetic field On → Amplitude calibration

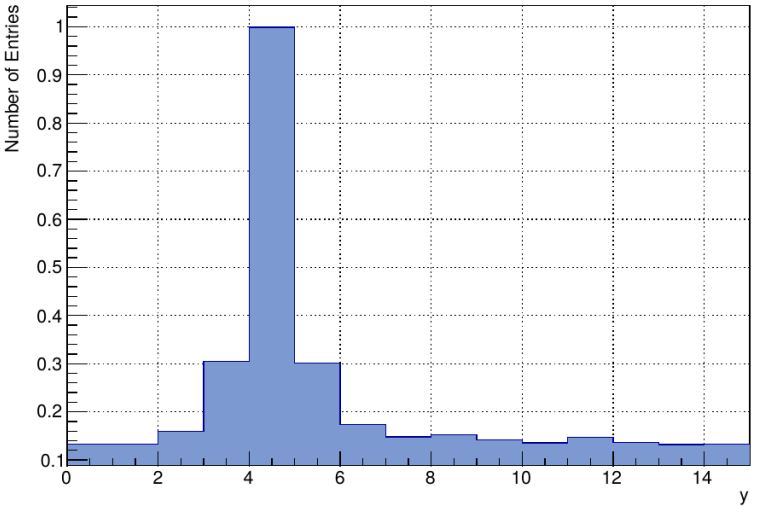
Cluster size

Sector 5 Module 27



Probability to hit neighboring modules if there is a hit in a certain module

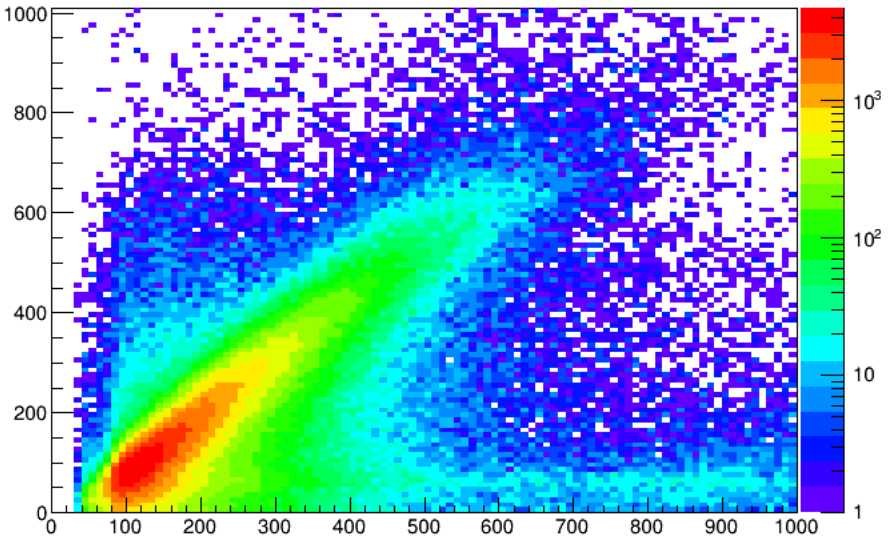




Cluster has 1 - 3 cells width

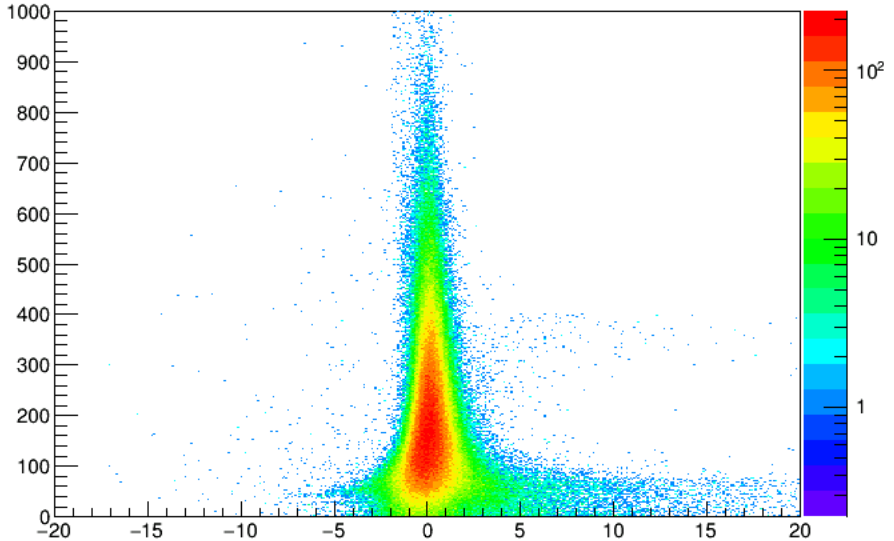
Amplitude & Time calibration on e+

TOT, ns Sector 3



p, MeV/c

TOT, ns Sector 3



$t_{EMC} - t_{RPC}$, ns

A. Prozorov

Conclusion

- the modules were tested one by one on cosmic muons and gamma-beam
- the detector was assembled in experimental cavern
- tests on cosmic muons and on beam
- time calibration is done
- amplitude calibration on e+ is done

Plans:

- calibrate on p, e-, π^+, on events with cluster size >1,
- plot $\gamma\gamma$ invariant mass spectra, search for π^0 yeld
- search for physics …