A Very High Momentum Particle Identification Detector for ALICE

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for the VHMPID proto-collaboration

5th Workshop on High-pt Physics at LHC
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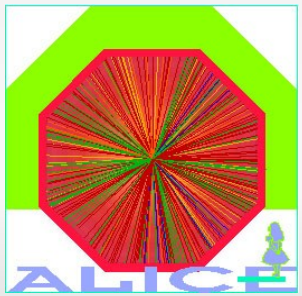

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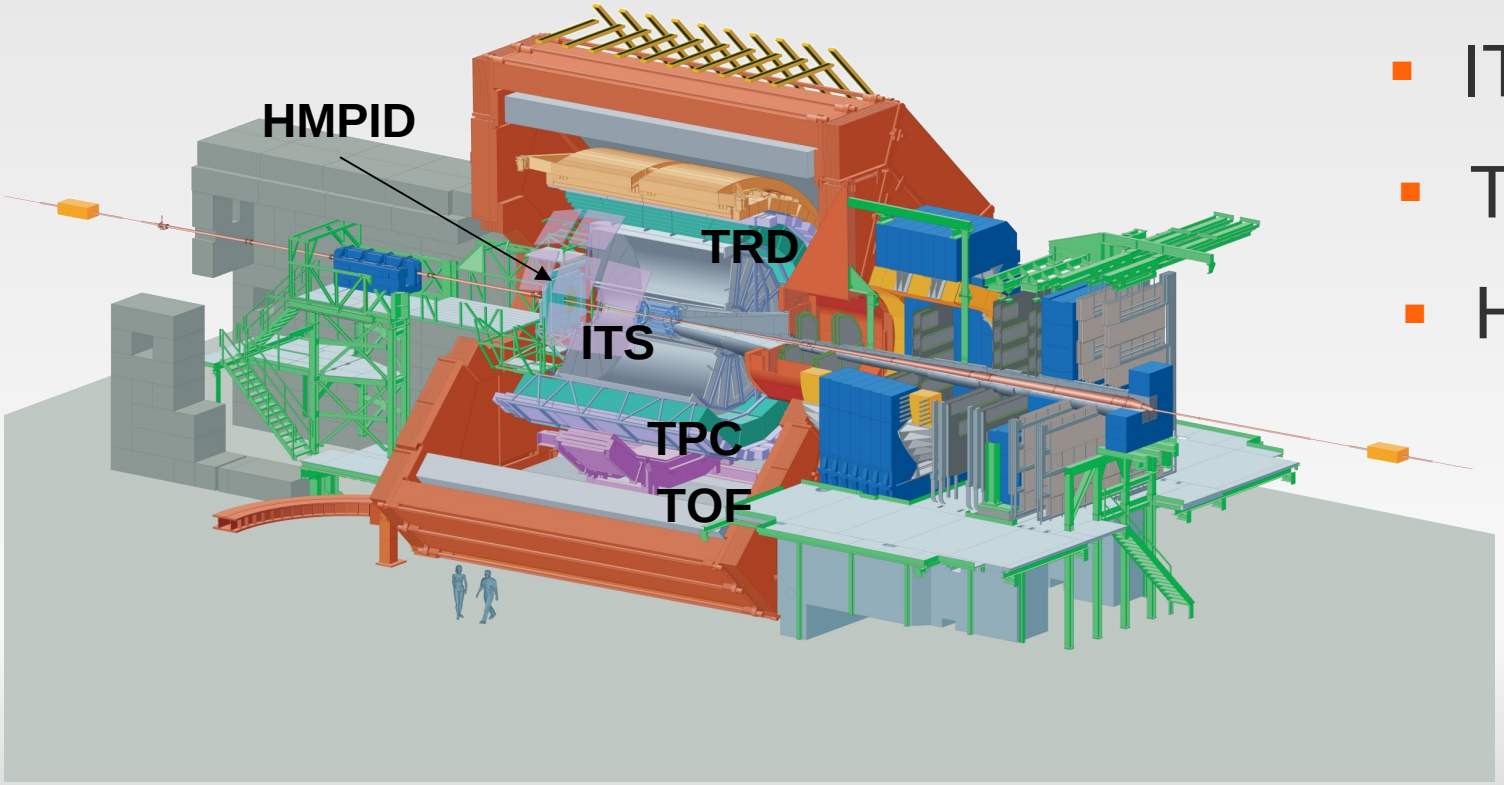
Outline

- Physics motivation
- VHMPID overview
- Detector layout
- Integration in ALICE
- Expected performance
- Triggering
- TGEM detector alternative
- Conclusions

Physics motivation (1)

- The purpose of the ALICE experiment is to identify and study the **quark-gluon plasma (QGP)** in heavy ion collisions at LHC.
- ALICE has a PID capability over a wide range of momentum with different techniques:

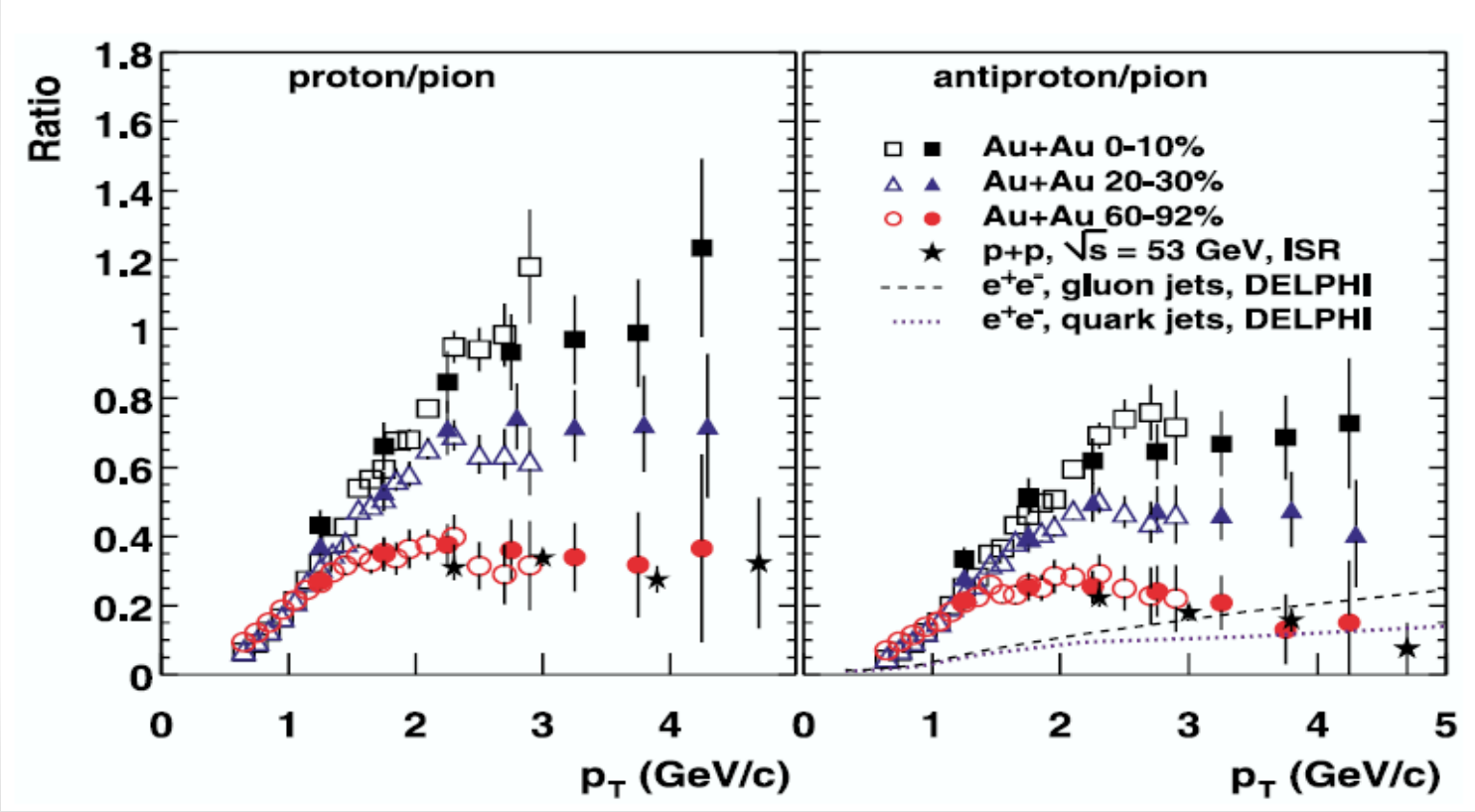


- ITS, TPC: dE/dx
- TOF, TRD
- HMPID: RICH

Physics motivation (2)

Results from **RHIC** have shown the importance of identifying high momentum particles:

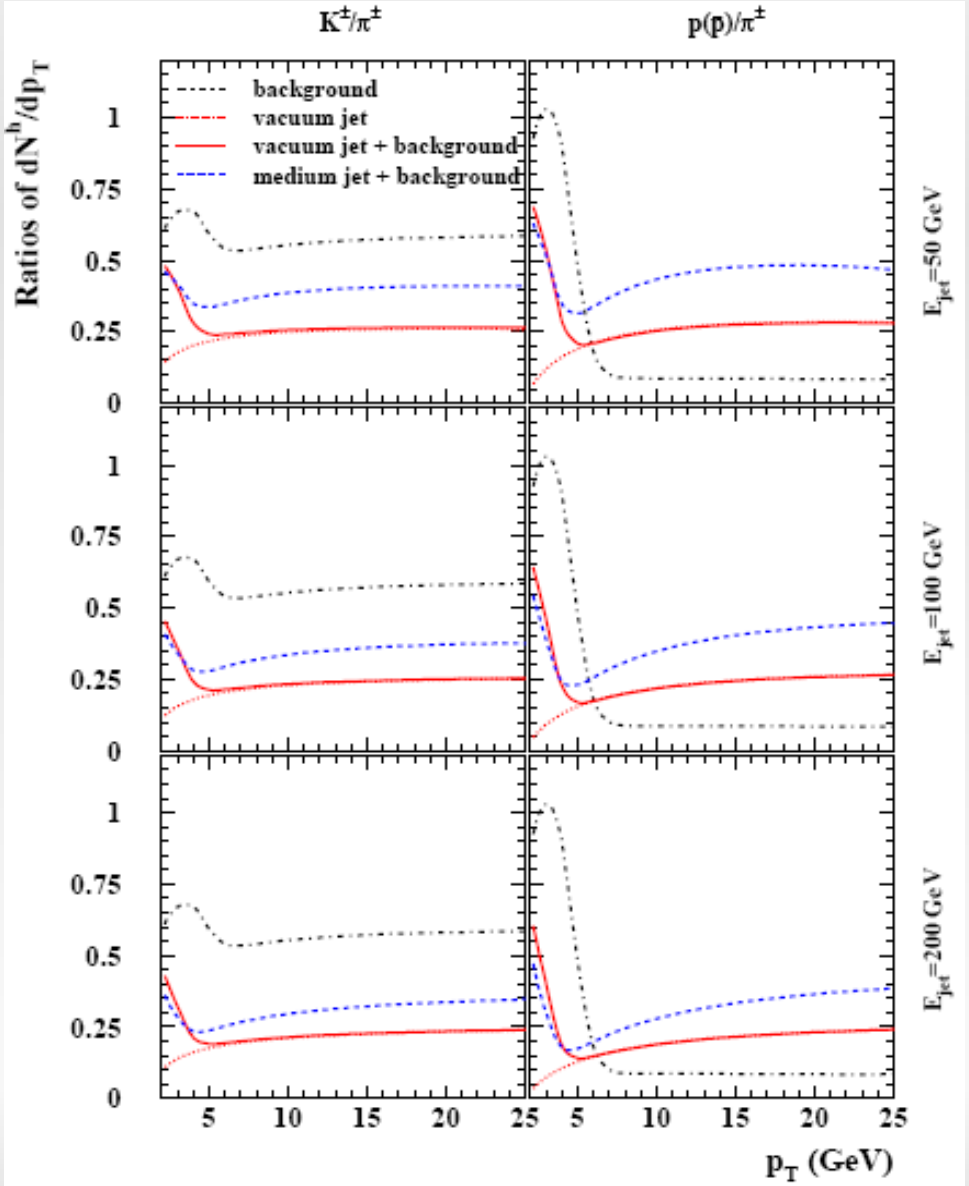
- The **anomalous baryon/meson** ratio observed in the momentum range **2-5 GeV/c** is expected to extend even higher in pt at LHC energies.



Physics motivation (3)

- Jet quenching can leave signatures not only in the longitudinal and transverse jet energy and multiplicity distributions, but also in the hadrochemical composition of the jet fragments.

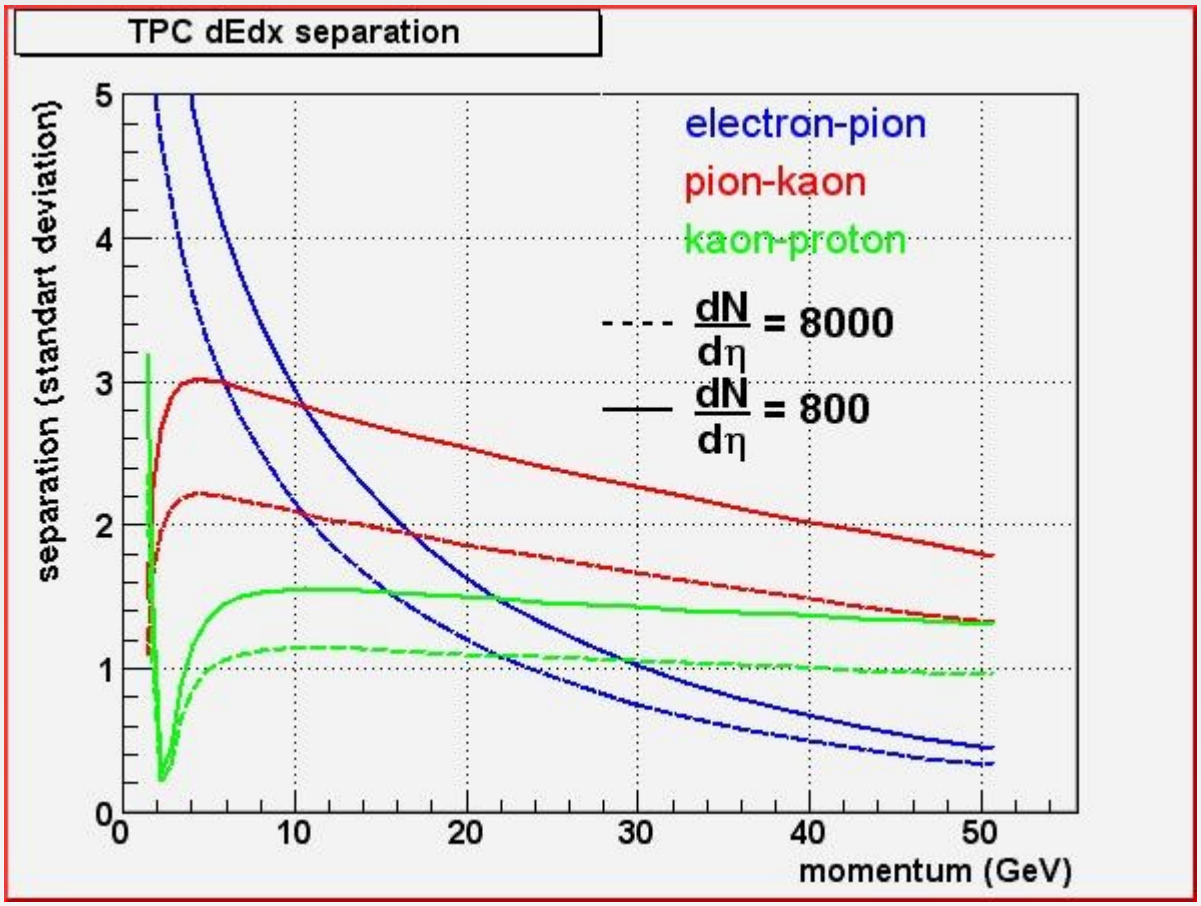
S. Sapeta and U.A. Wiedemann, arXiv:0707.3494 [hep-ph], July 2007.



Physics motivation (4)

- The key issue is to understand the mechanism of hadronization and its influence on the spectra of baryons and mesons.
- **Hadrochemistry** and **PID triggered jet analysis** allow for a detailed insight into the characteristics of the QGP, it is therefore important to be able to identify charged particles on a **track-by-track** basis.

Physics motivation (5)



The TPC performs **statistical PID** in the relativistic region.

Track-by-track PID

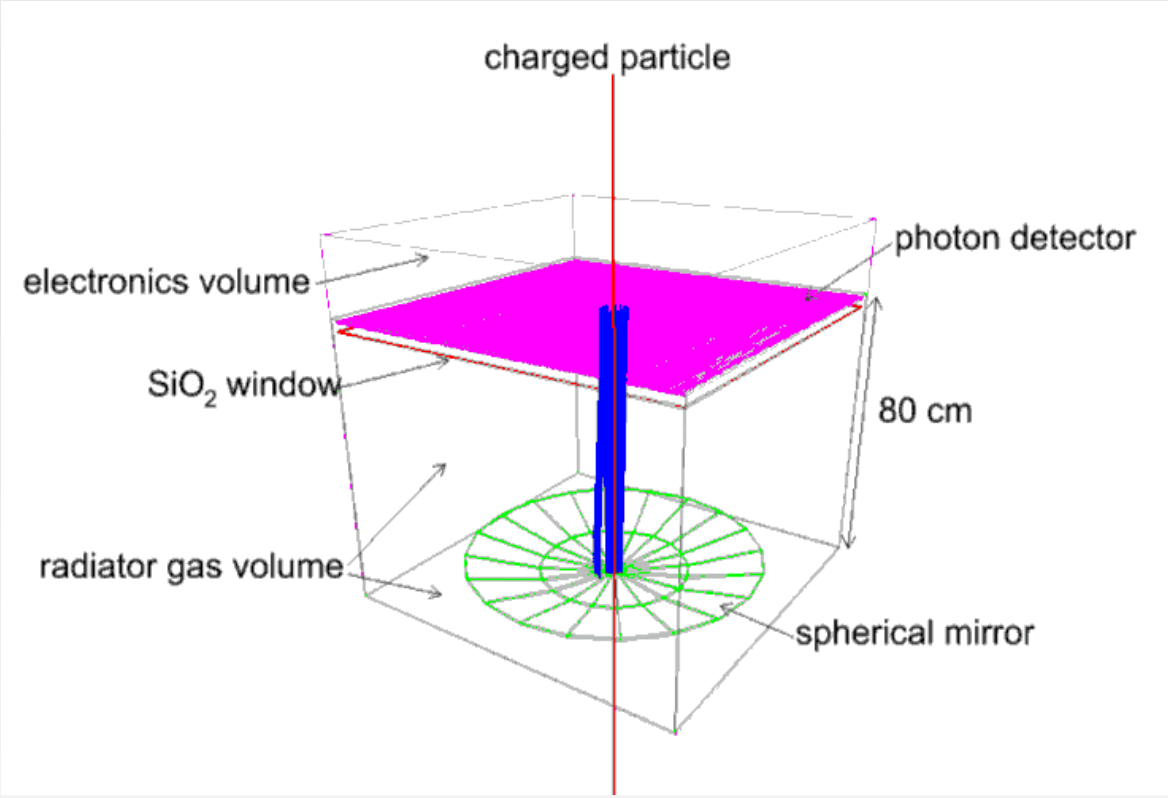
- The topology of events with high pt protons will be distinct from the topology of a jet with a pion leading particle.
- One may study the **conservation of the baryonic number** measuring the p-pbar correlations in the same side jet.
- The **kaon identification** may be also interesting in jet hadrochemistry as shown by Sapeta and Wiedemann.
- The track by track may be also interesting as a benchmark for the statistical identification.

VHMPID overview

Very **H**igh **M**omentum **P**article **I**dentification **D**etector as a proposal for the upgrade of ALICE.

- Track-by-track PID capabilities in the momentum range **10-30 GeV/c**.
- Focus on **physics with ”jets”**.
- State-of-the-art **R**ing **I**maging **Ch**erenkov (**RICH**) detector.

Detector layout

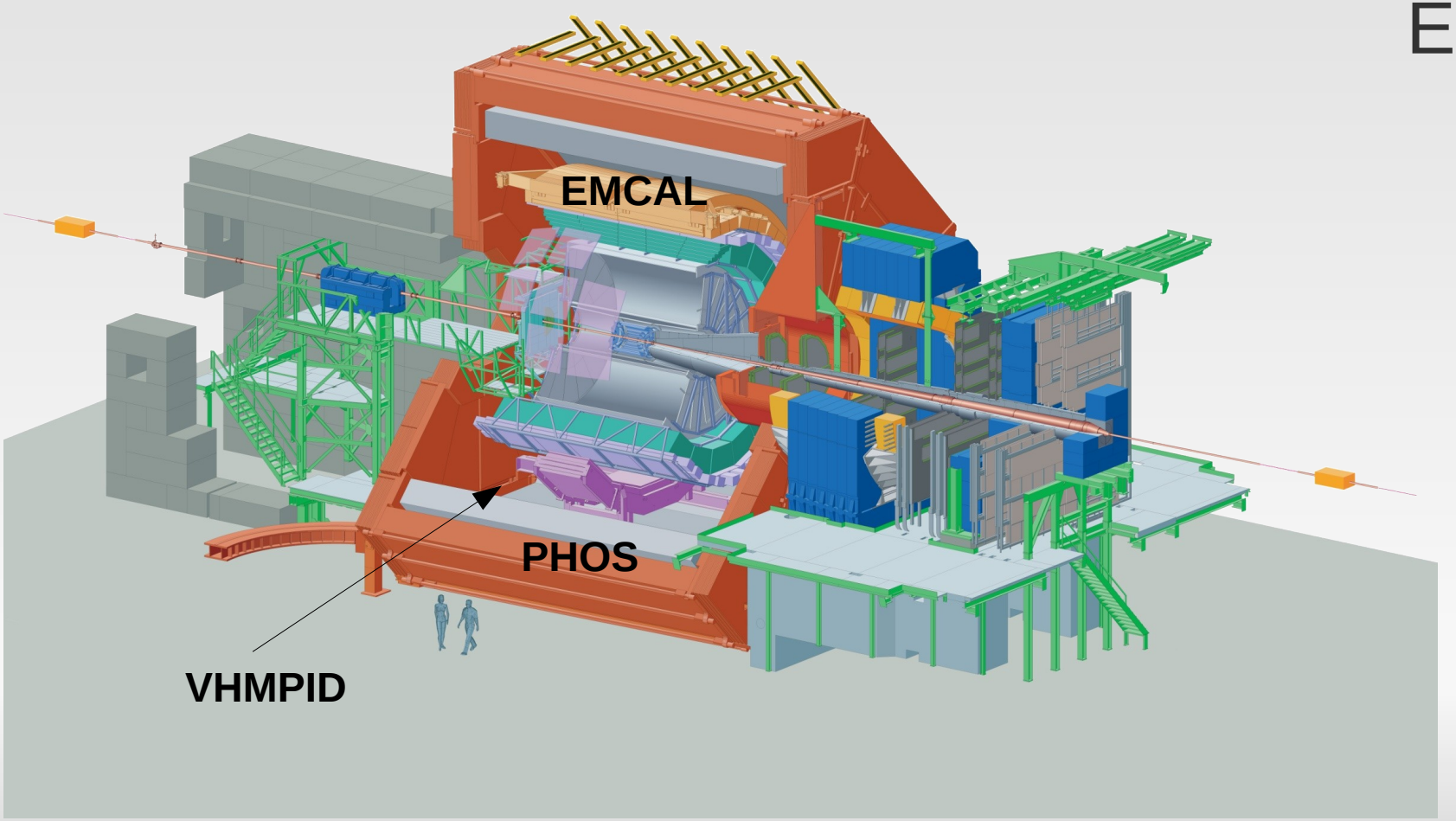


RICH detector

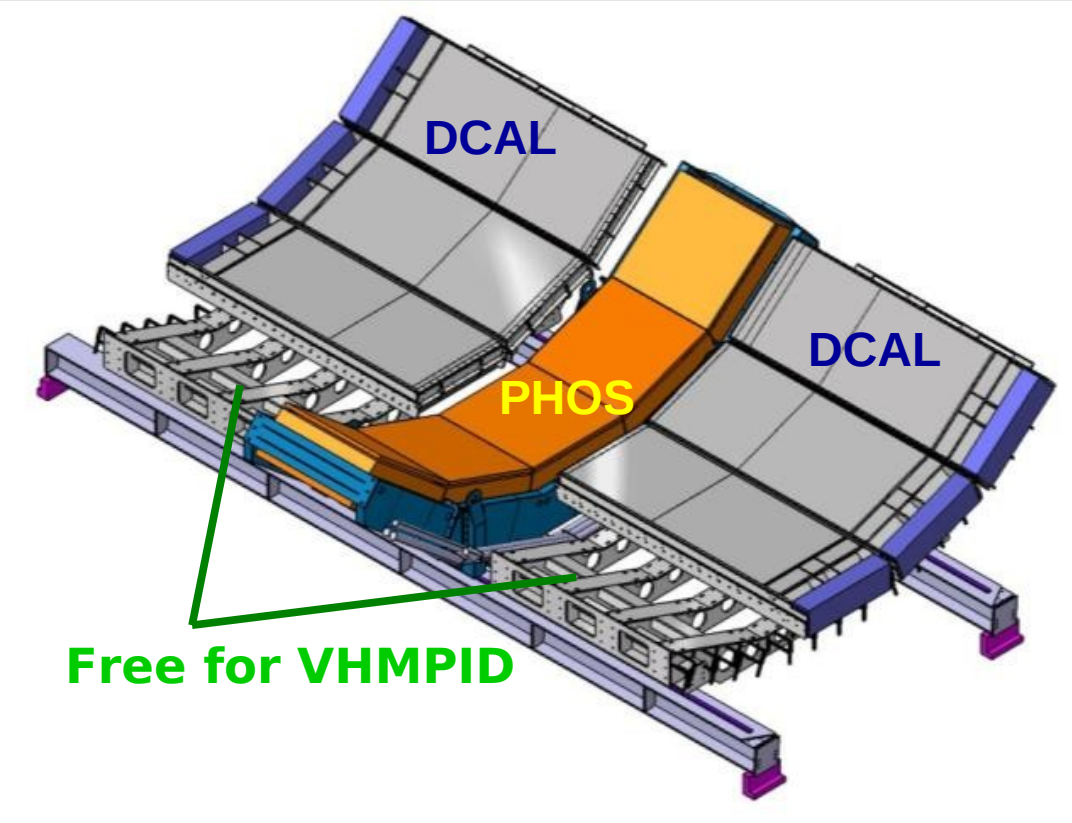
- 80 cm C_4F_{10} radiator (n ≈ 1.0014).
- Spherical focusing mirror.
- CsI coated **MWPC** in CH_4 separated by a SiO_2 (or CaF_2) window.
- Alternative: **CsI-TGEM.**

Integration in ALICE (1)

- Installation of VHMPID modules in **free sectors 11** and **12** next to the PHOS detector and D-CAL extension, opposite in azimuth to the EMCAL.



Integration in ALICE (2)

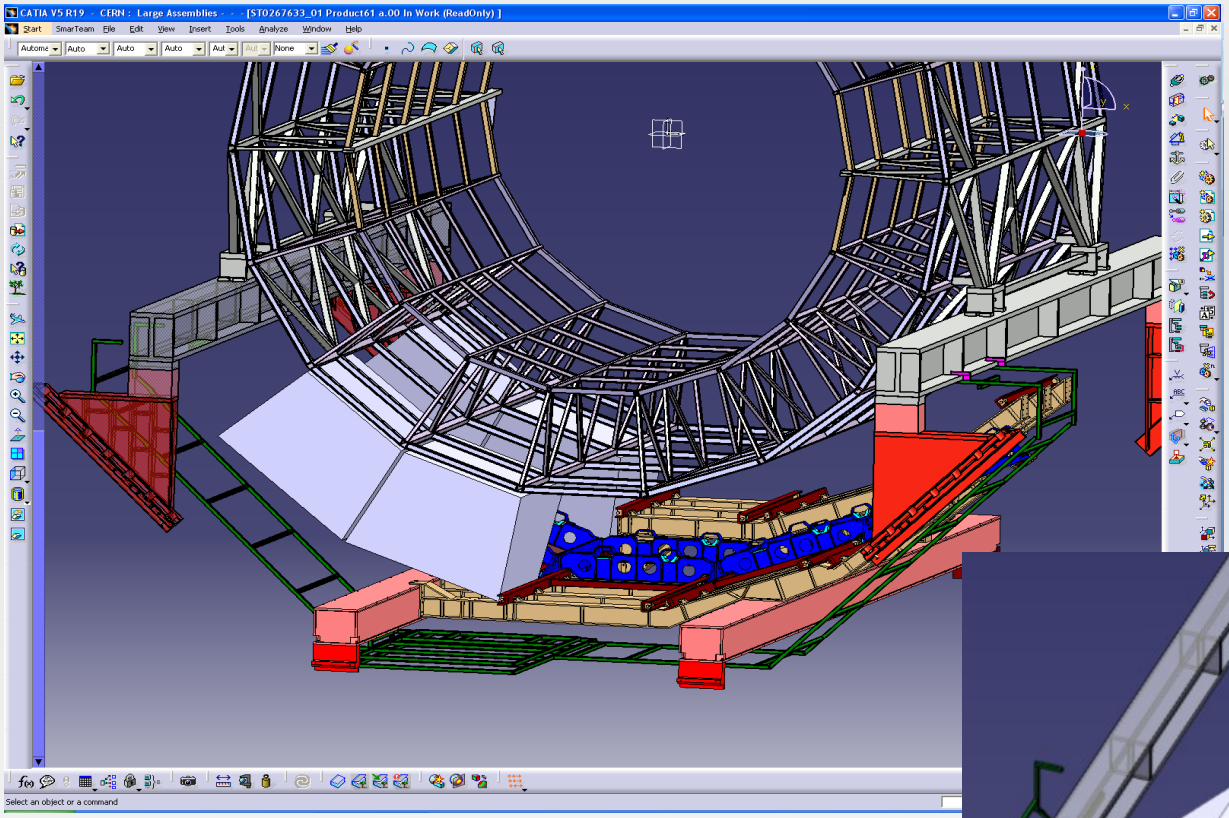


- Available space for **5 ”super modules”** of VHMPID.
- Maximum hight:

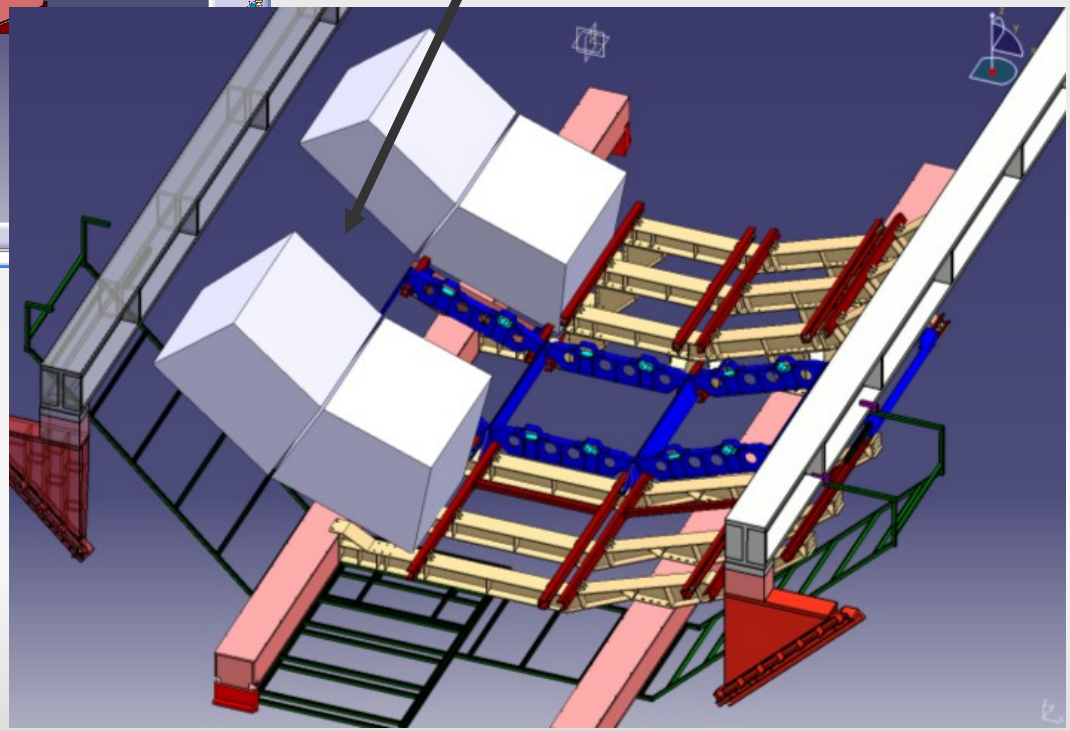
  1300 mm.
- Other dimensions:

  1000 x 1400 mm

Integration in ALICE (3)



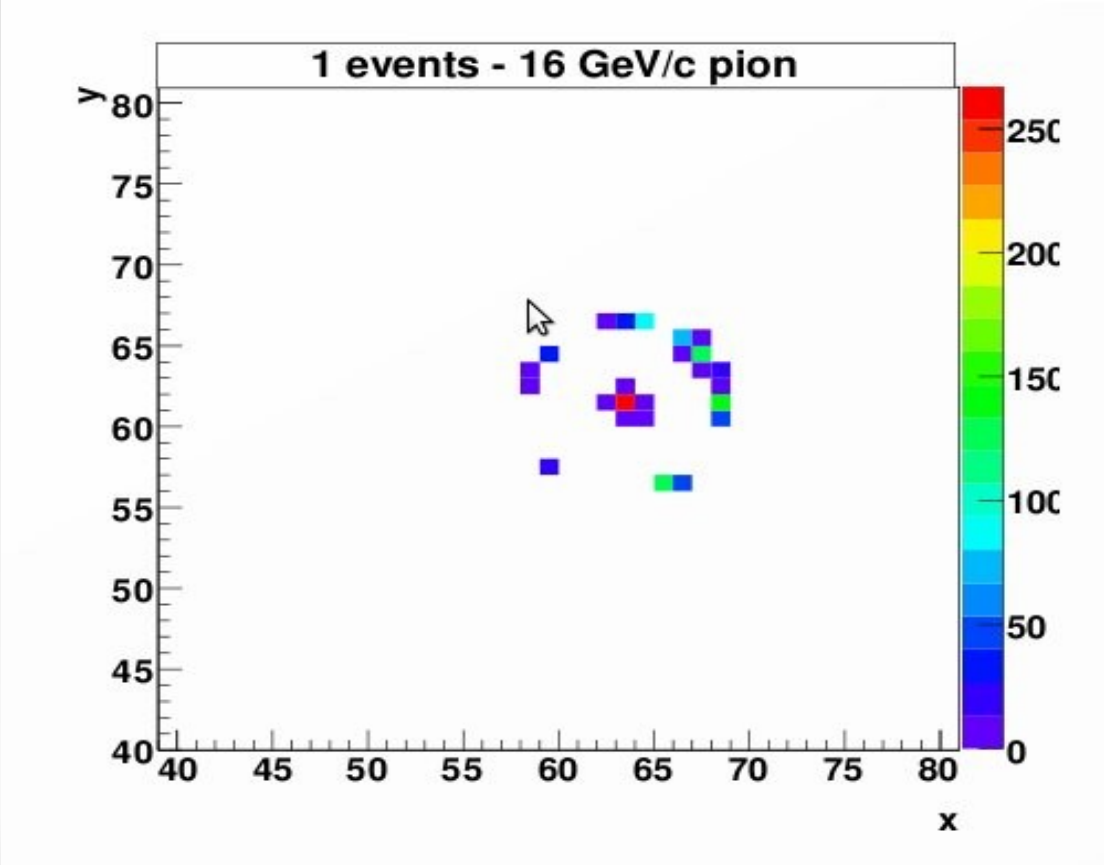
Free slot for prototype
~ ½ supermodule
'module-0'



Acceptance of 12% wrt TPC in $|\eta| < 0.5$ (for the leading particle)

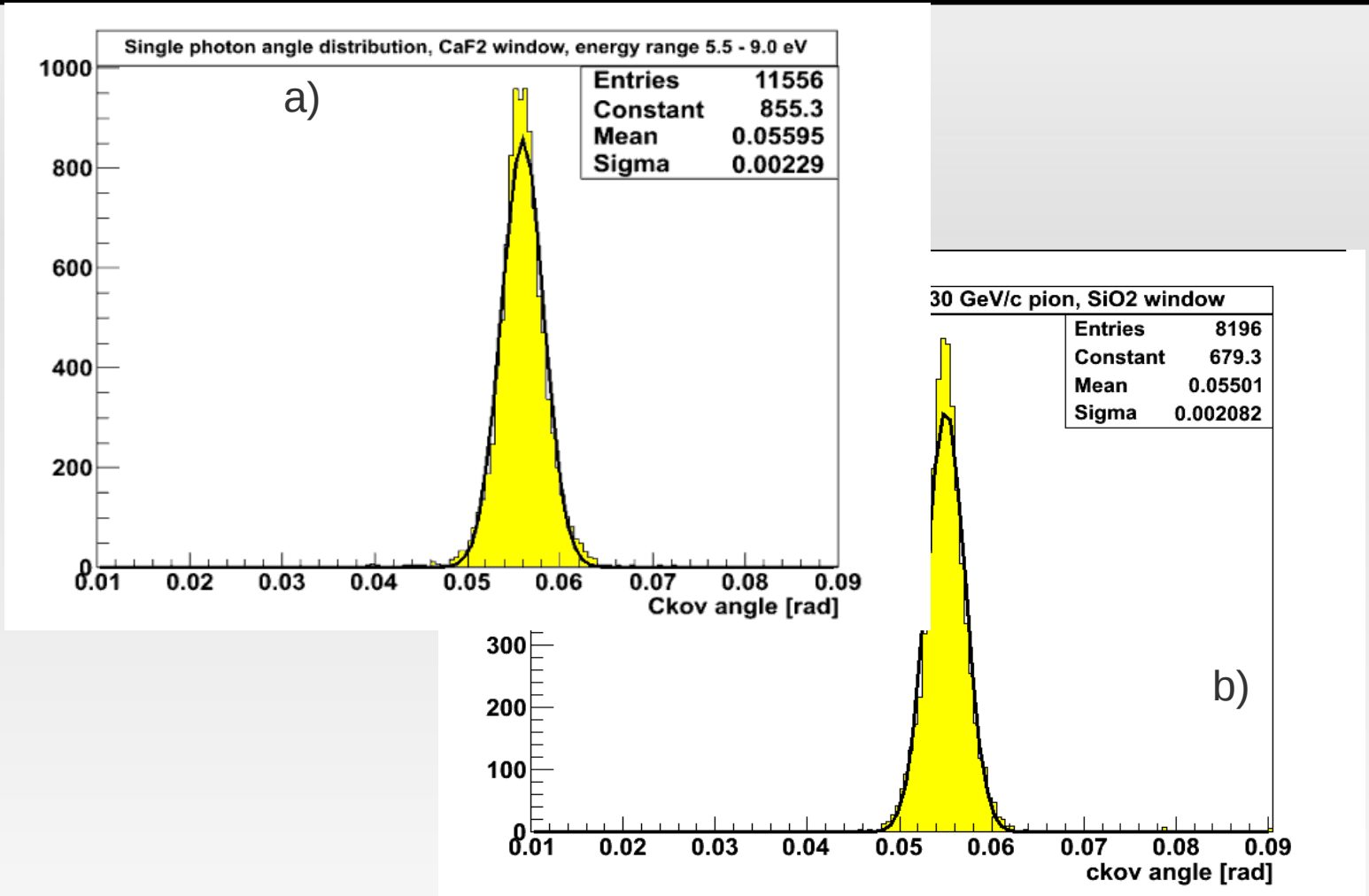
Performance

- The performance and PID capabilities have been studied by means of **Monte Carlo simulations in AliRoot**.



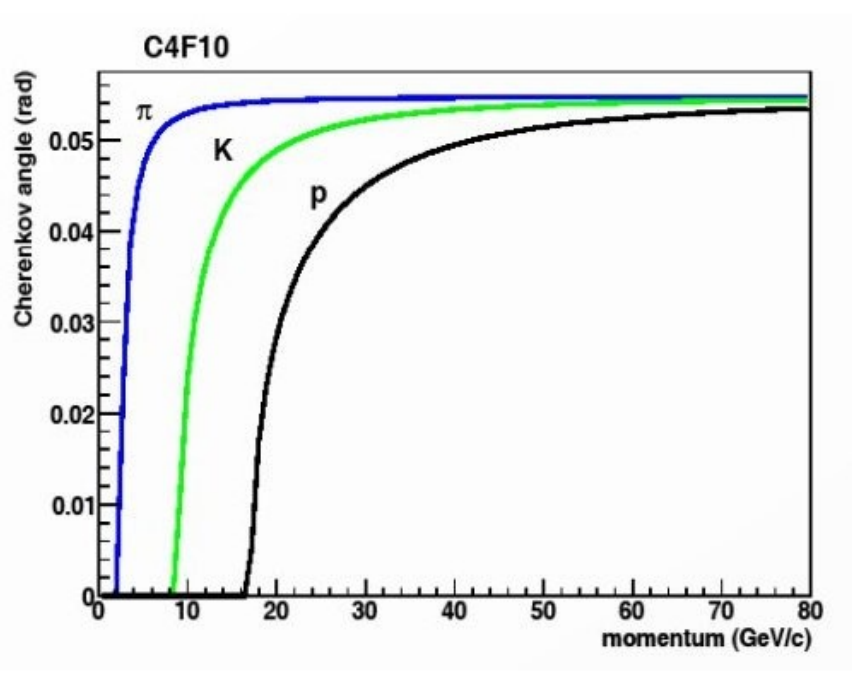
- Cherenkov ring produced by simulation of a single 16 GeV/c pion.

Angle resolution



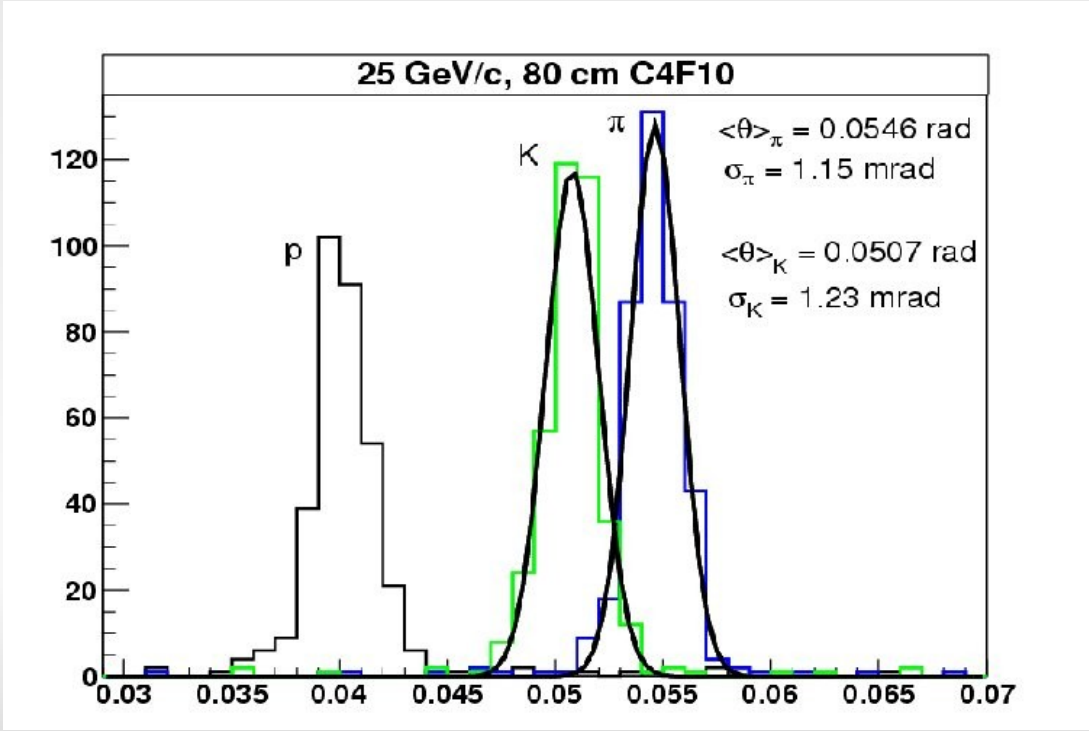
- Reconstructed Cherenkov angle distributions from Monte Carlo simulations for **CaF_2** (a) and **SiO_2** (b) windows.

PID performance

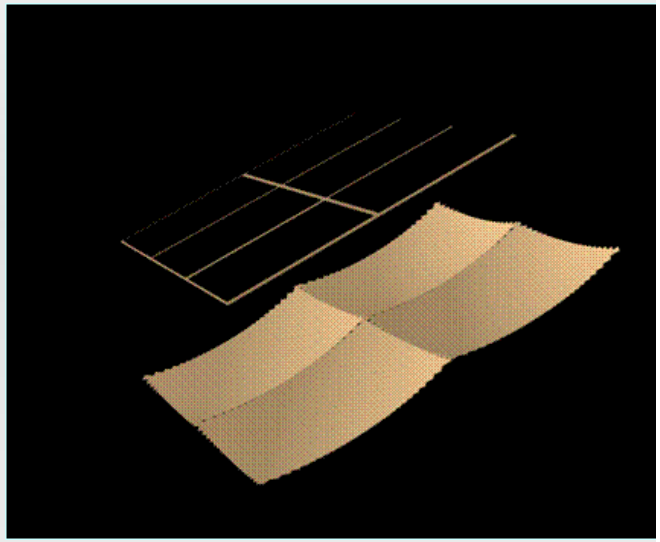


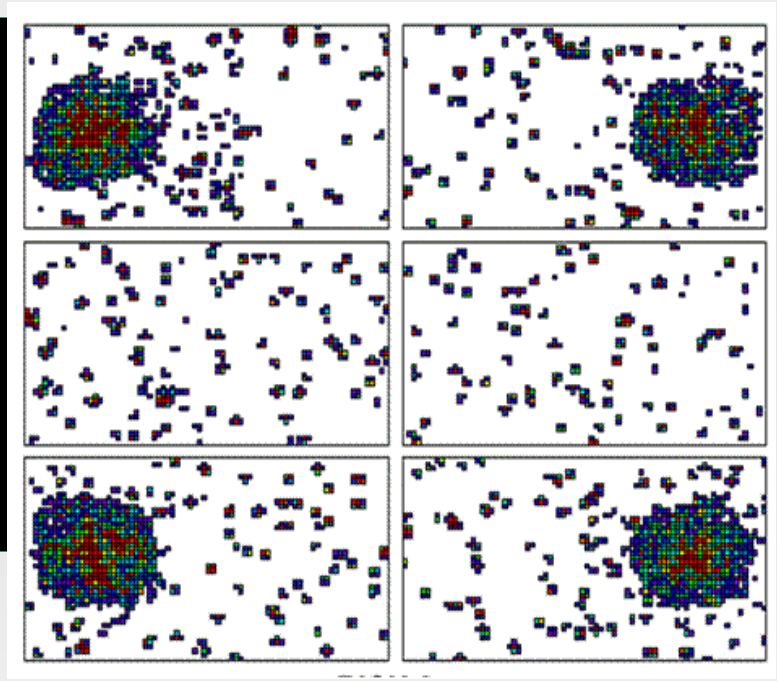
Particle type	Absence of signal [GeV/c]	Presence of signal [GeV/c]
π	-	4-24
K	-	11-24
p	11-18	18-30

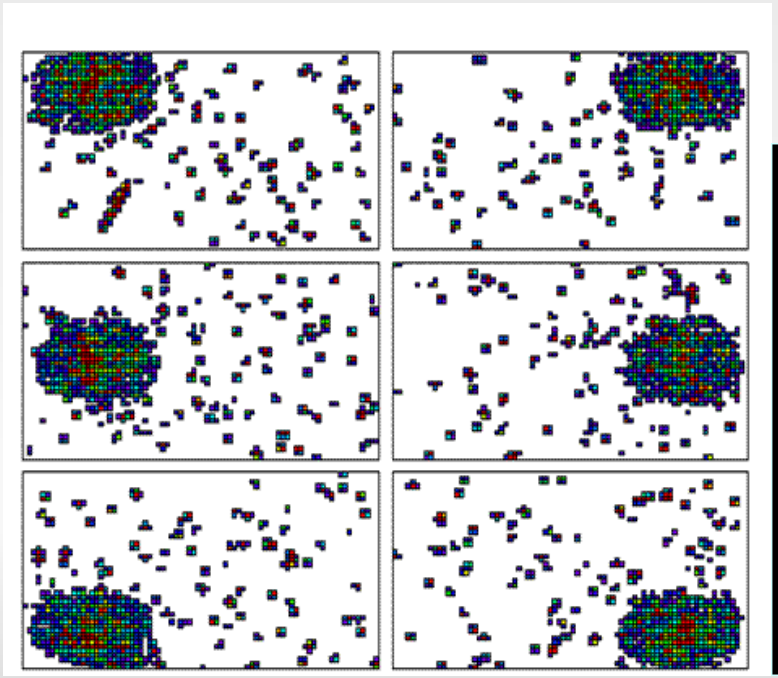
- Cherenkov angle resolution from events with π, K and p at 25 GeV/c.

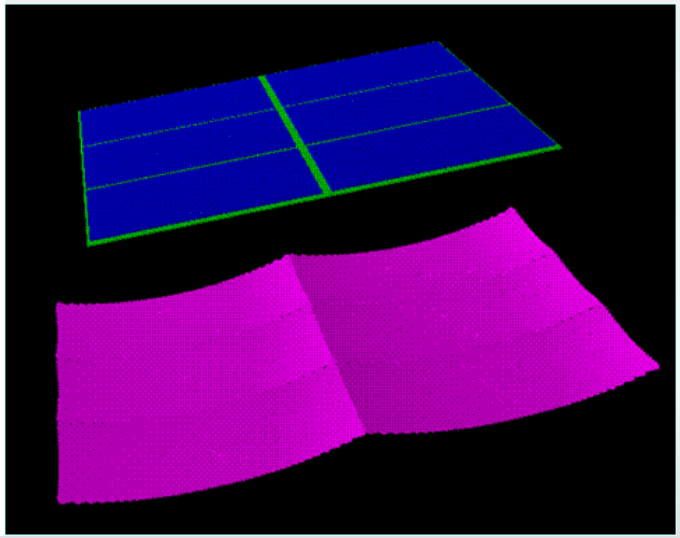


Mirror Configuration









Trigger

VHMPID requires a high-pt trigger to enhance its performance. The possibilities are:

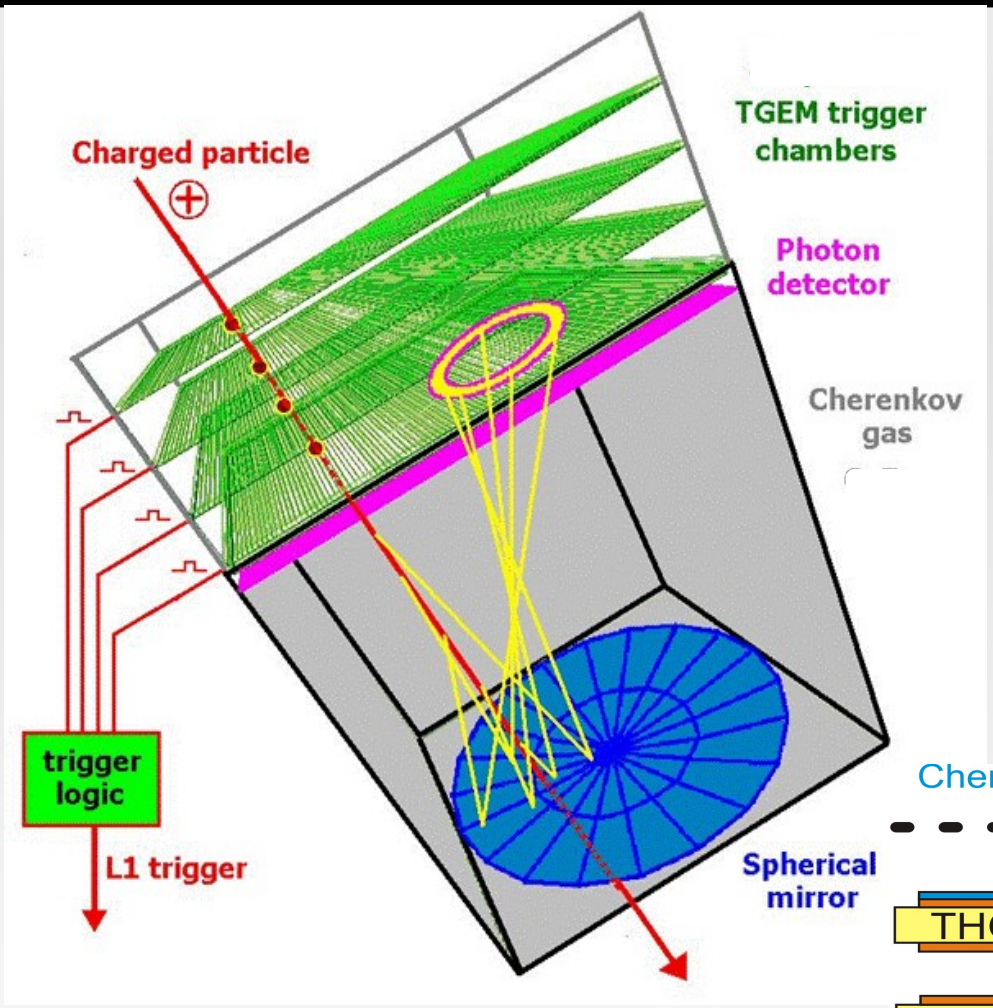
- Dedicated **Hight-pt Trigger Detector (HPTD)**.
- Triggering by TRD.

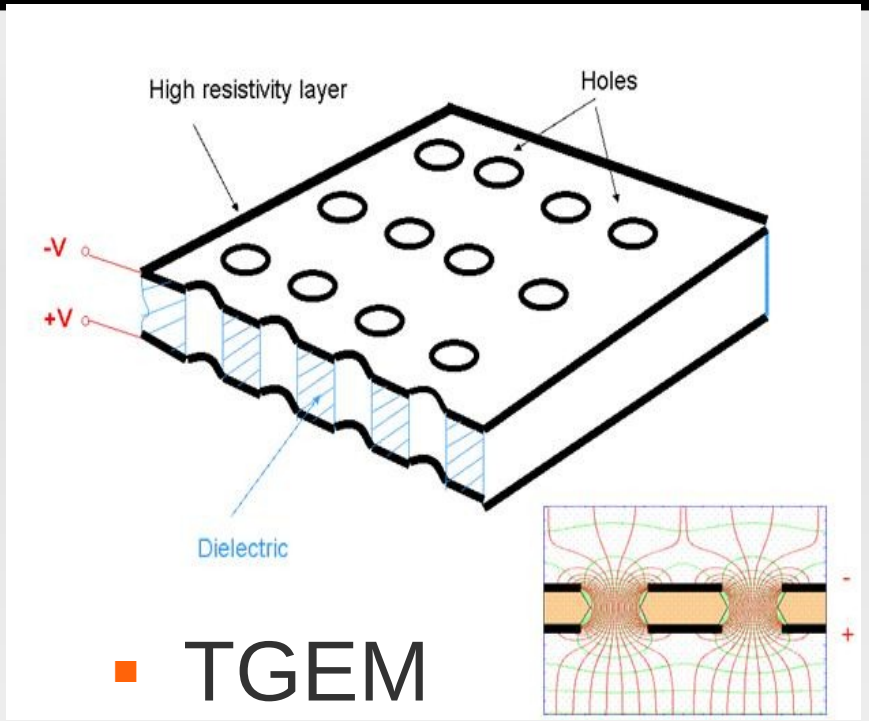
TGEM alternative

- At present the photon detector is planned with the same technology used successfully in the HMPID, i.e. a MWPC with pad cathode with 300nm of evaporated CsI.

- The other alternative under investigation is a photon detector with GEMs.

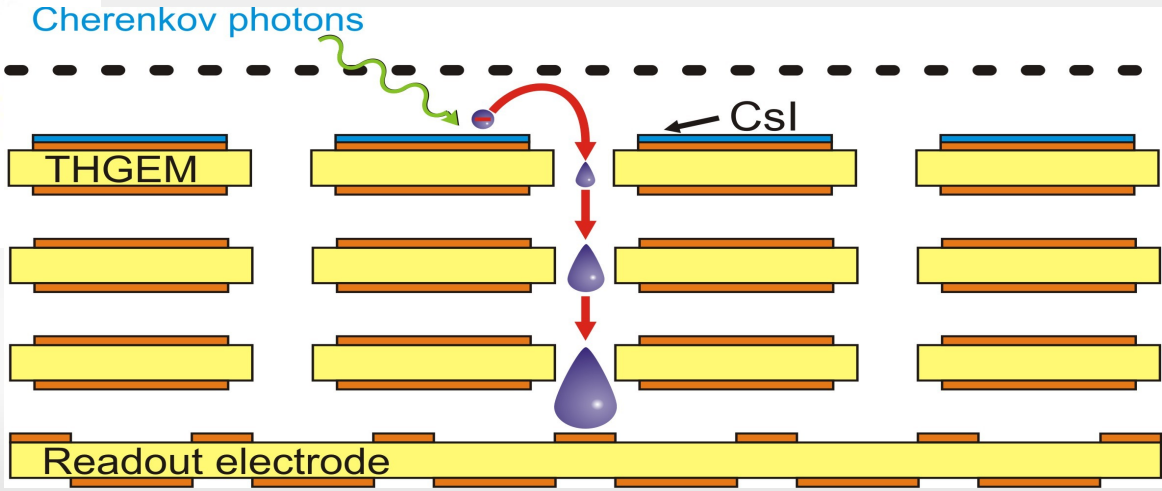
TGEM alternative





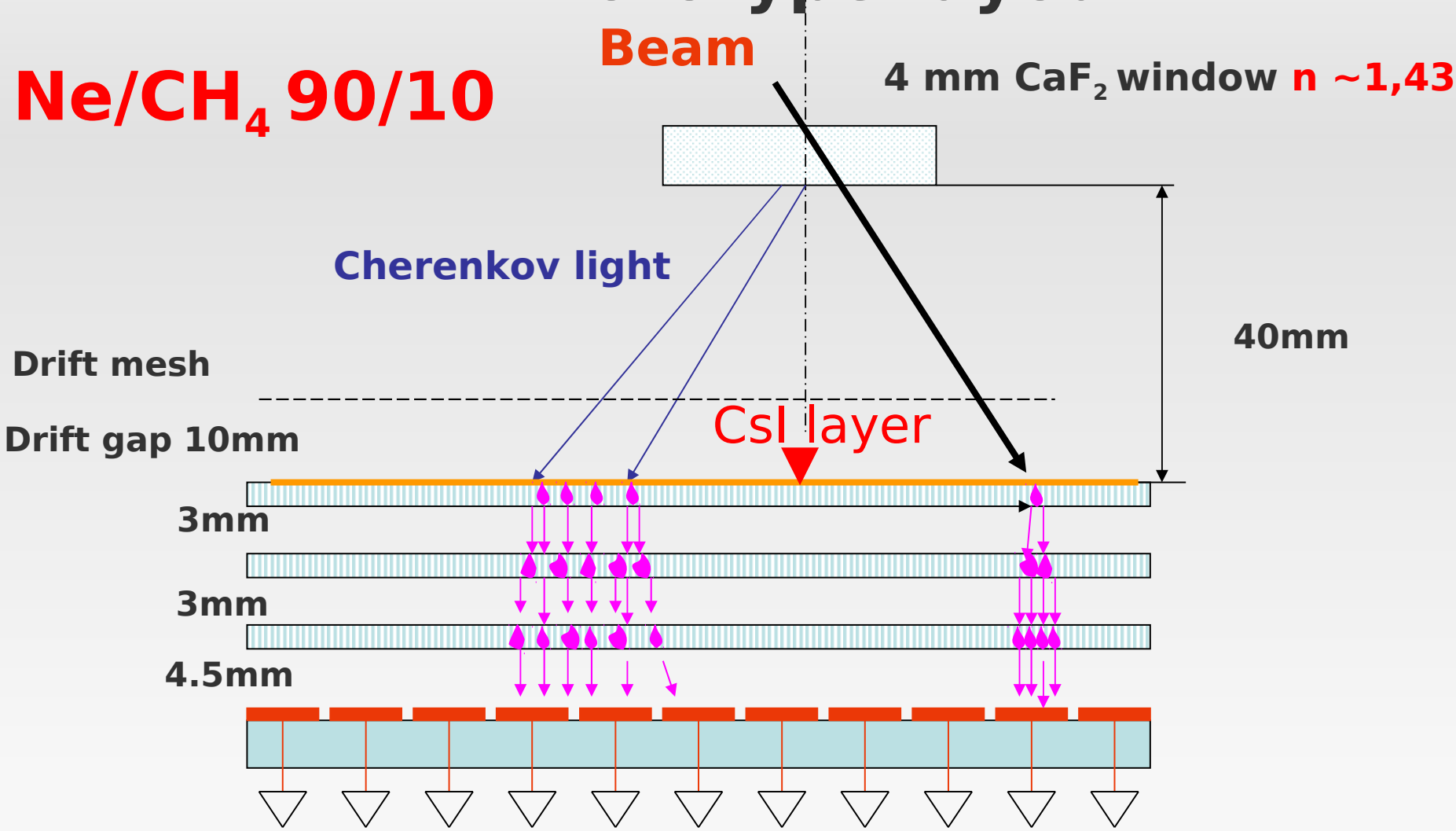
- TGEM

- CsI Triple TGEM



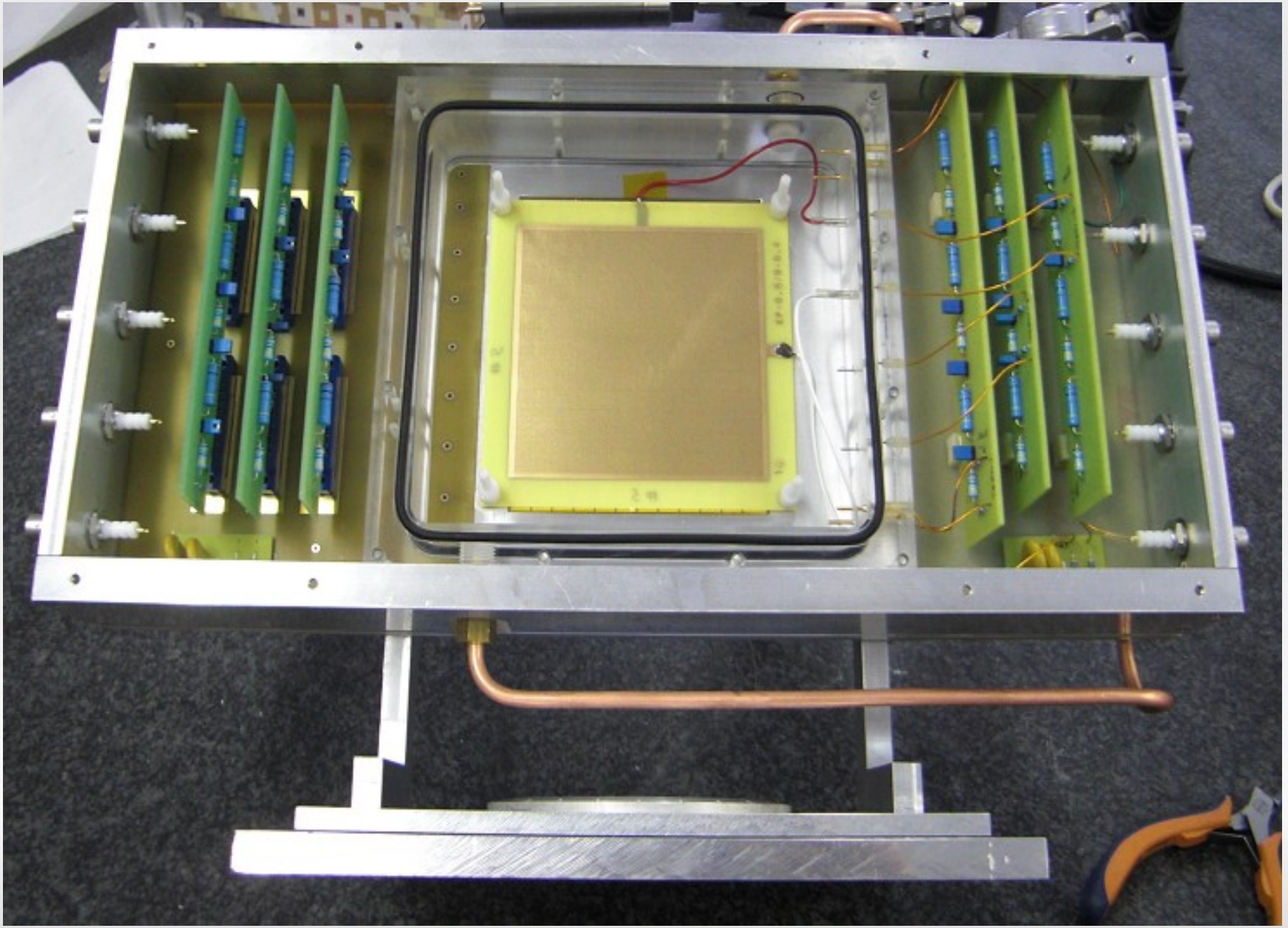
Prototype test (1)

Prototype layout

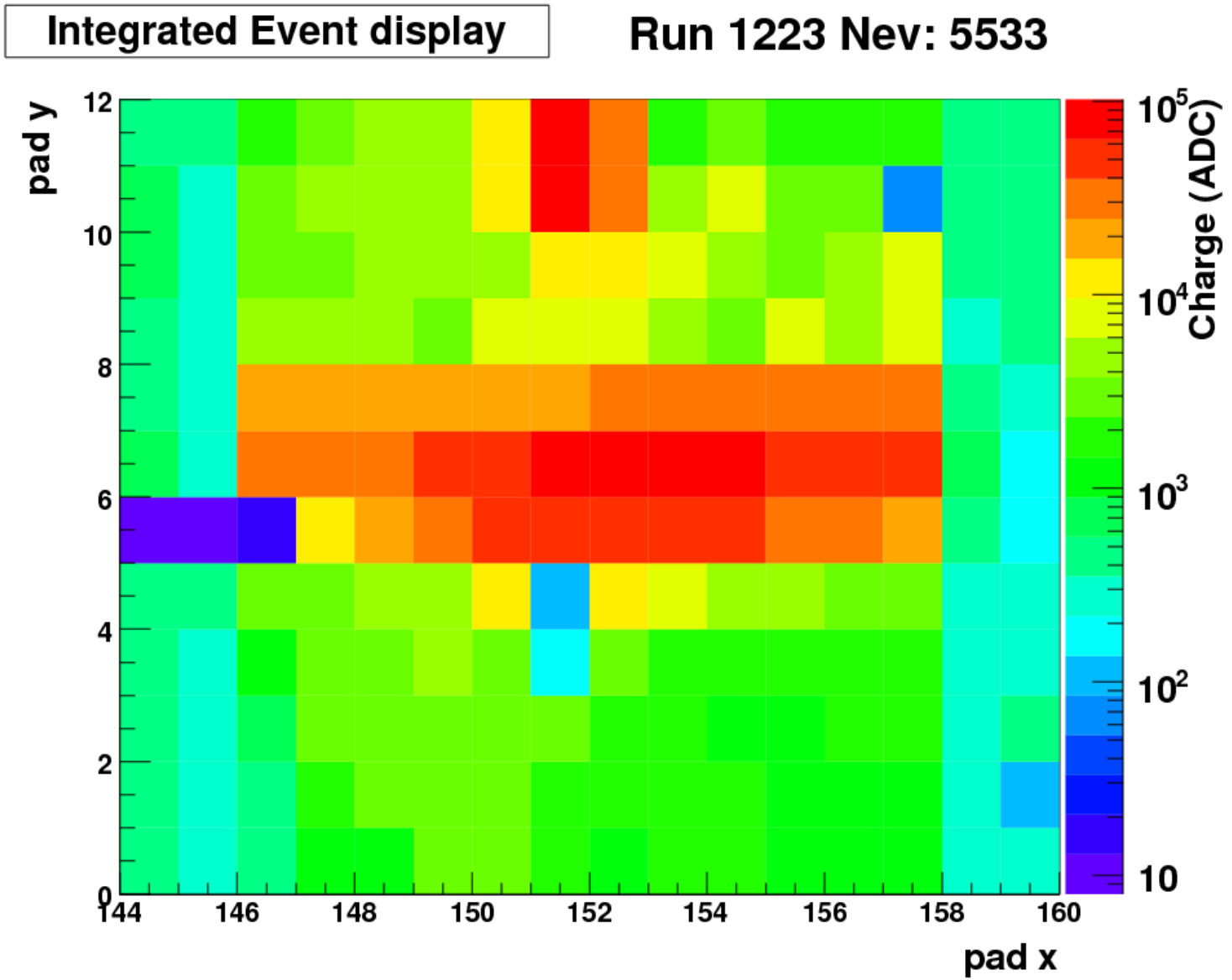


Front end electronics
(Gassiplex + ALICE HMPID R/O + DATE + AMORE)

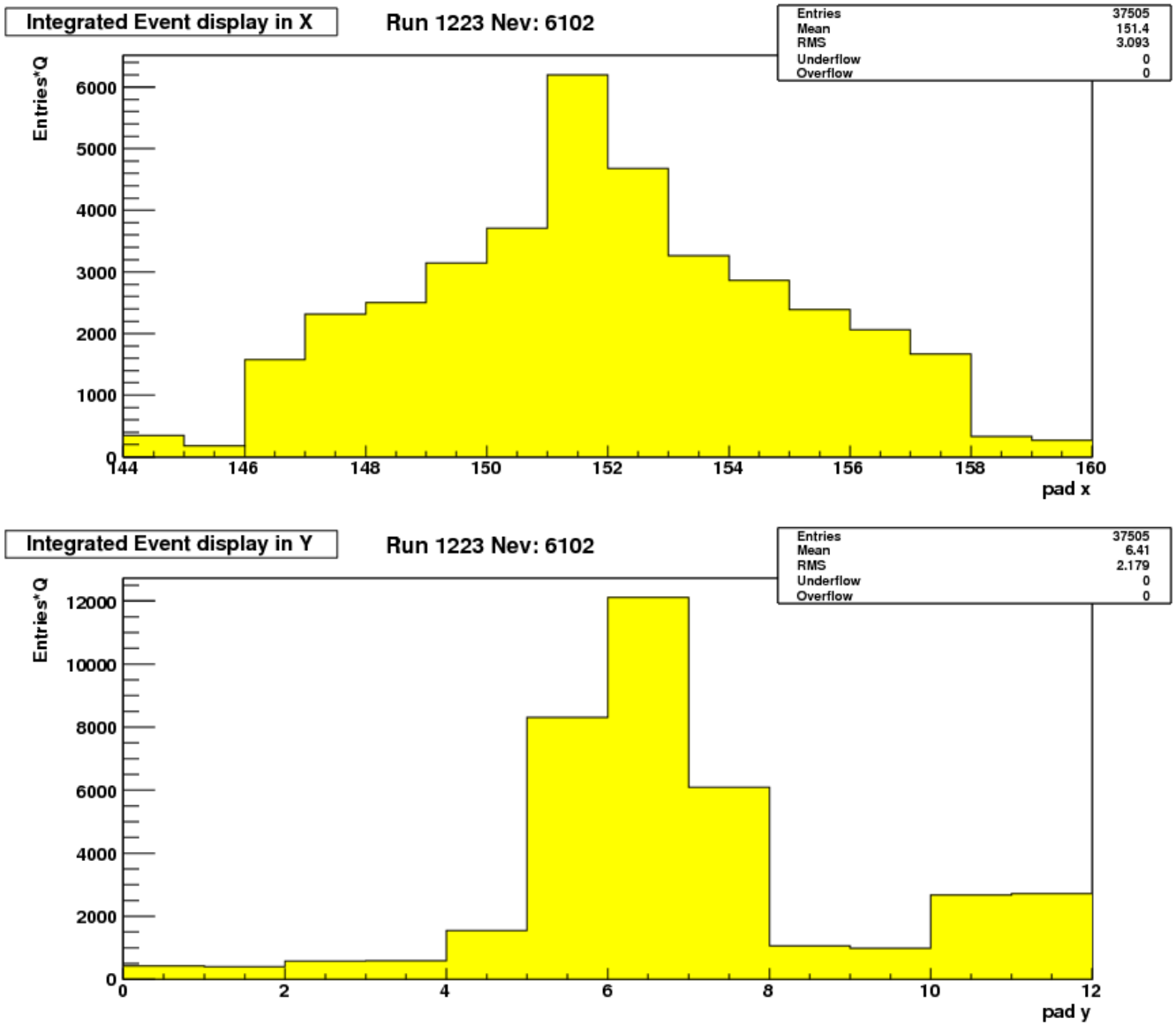
Prototype test (2)



Prototype test (3)



Prototype test (4)



Conclusions

- VHMPID as a possible upgrade for the ALICE experiment is under R&D.
- It will extend the PID in the range 10-30 GeV/c
- With emphasis on jet physics.
- Posibility to install 5 super-modules in sectors 11 and 12 on each side of PHOS.
- Posible construction of a dedicated trigger detector (HPTD).
- Prototype testing with MWPC and TGEM have been done and will continue.