A Very High Momentum Particle Identification Detector for ALICE

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for the VHMPID proto-collaboration

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Outline

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

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.
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.
Very High Momentum Particle Identification Detector 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 Ring Imaging Cherenkov (RICH) detector.
Detector layout

RICH detector

- 80 cm C₄F₁₀ radiator (n ≈ 1.0014).
- Spherical focusing mirror.
- CsI coated MWPC in CH₄ separated by a SiO₂ (or CaF₂) 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 height: 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 |η| < 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.
Reconstructed Cherenkov angle distributions from Monte Carlo simulations for **CaF$_2$** (a) and **SiO$_2$** (b) windows.
PID performance

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

<table>
<thead>
<tr>
<th>Particle type</th>
<th>Absence of signal [GeV/c]</th>
<th>Presence of signal [GeV/c]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\pi$</td>
<td>-</td>
<td>4-24</td>
</tr>
<tr>
<td>$K$</td>
<td>-</td>
<td>11-24</td>
</tr>
<tr>
<td>$p$</td>
<td>11-18</td>
<td>18-30</td>
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Mirror Configuration
VHMPID requires a high-pt trigger to enhance its performance. The possibilities are:

- Dedicated **High-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

- Csl Triple TGEM
Prototype test (1)

Prototype layout

Ne/CH₄ 90/10

Drift mesh

Drift gap 10mm

3mm

3mm

3mm

4.5mm

Csl layer

Cherenkov light

Beam

4 mm CaF₂ window n ~1.43

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.
- Possibility to install 5 super-modules in sectors 11 and 12 on each side of PHOS.
- Possible construction of a dedicated trigger detector (HPTD).
- Prototype testing with MWPC and TGEM have been done and will continue.