High Momentum Particle IDentification (HMPID) in ALICE

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Outline

• Why HMPID?
  – Pre-ALICE RHIC Physics
  – Physics of the HMPID
  – PID in ALICE

• HMPID RICH Detector
  – Concept of Design
  – HMPID Layout

• Cosmic Test Results

• VHMPID Project
  – Motivation
  – Outlook
Why HMPID?

Pre-ALICE RHIC Physics

Jet Quenching

Hard associated particles $\rightarrow$ suppression

Soft associated particles $\rightarrow$ enhancement

$p_T(\text{assoc}) > 2$ GeV/c

$p_T(\text{assoc}) > 0.15$ GeV/c

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Why HMPID?

Pre-ALICE RHIC Physics

High $p_T$ suppression

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Why HMPID?

Pre-ALICE RHIC Physics

Early Universe was a liquid

Quark-gluon blob surprises particle physicists.

by Mark Peplow
news@nature.com

The Universe consisted of a perfect liquid in its first moments, according to results from an atom-smashing experiment.

Scientists at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory on Long Island, New York, have spent five years searching for the quark-gluon plasma that is thought to have filled our Universe in the first microseconds of its existence. Most of them are now convinced they have found it. But, strangely, it seems to be a liquid rather than the expected hot gas.
Why HMPID?

Physics of the HMPID

• Low $p_T$ particle spectra ($< 1$ GeV/c) $\rightarrow$ Temperature of the formed medium, via thermal particle emission

• High $p_T$ particle production $\leftarrow$ hard processes (perturbative QCD)

• Density of the formed medium in AA collisions $\leftarrow$ energy loss of high-energy partons traversing the medium
• Large $E_T$ jet suppression $\rightarrow$ high $p_T$ particle suppression.

• Comparison of high $p_T$ spectra in AA and pp

• Comparison of proton and antiproton spectra $\rightarrow$ quark jets vs. gluon jets [PRL68, 1480] $\rightarrow$ tagging quark vs. gluon jets

• Gluons with more colors lose more energy in a dense medium than quarks $\rightarrow$ suppressing pbar at high $p_T$
Why HMPID?

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Full azimuthal coverage: ITS, TPC, ToF

ITS, TPC up to p \sim 600 \text{ MeV/c}

ToF up to \sim 1.2–1.4 GeV/c

Single-arm detector: HMPID for 1–5 GeV/c

ALICE: the dedicated HI experiment

Solenoid magnet 0.5 T

Central tracking system:
- ITS
- TPC
- TRD
- TOF

Specialized detectors:
- HMPID
- PHOS

Forward detectors:
- PMD
- FMD, T0, V0, ZDC

Cosmic rays trigger

MUON Spectrometer:
- absorbers
- tracking stations
- trigger chambers
- dipole
Why HMPID?

PID in ALICE

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• Ring Imaging Cherenkov (RICH) Detector: Momentum limit = choice of radiator medium
Track-by-track PID
• \( \pi, K, p \) with 1-5 GeV/c: liquid radiator
• Cherenkov photon (\( \lambda \leq 200 \text{ nm} \)) transmittance \( \rightarrow \) \( C_6 F_{14} \)
• Particle density, space, photon absorption etc \( \rightarrow \) ‘proximity focusing’
• Surface, price, CsI photocathode + MWPC
RADIATOR

15 mm liquid C$_6$F$_{14}$, $n \sim 1.2989$ @ 175nm, $(\beta \gamma)_h = 1.21$

PHOTON CONVERTER

Reflective layer of CsI $\text{QE} \sim 25\%$ @ 175 nm.

PHOTOELECTRON DETECTOR

- MWPC with CH$_4$ at atmospheric pressure (4 mm gap) $HV = 2050$ V.
- Analogue pad readout
CsI photo-cathode is segmented in 0.8x0.84 cm pads

Total number of pads per chamber = 161280

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Test HMPID

Cosmic Test Results (G. Volpe, QM09)

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Matching with tracks reconstructed in the TPC
Cosmic Test Results (G. Volpe, QM09)

Run 62022, 1 event, RICH3
• ALICE detectors were designed in the mid-1990’s
• RHIC results → the need for VHMPID
• $10 \text{ GeV/c} < p_T < 25 \text{ GeV/c} →$ the gaseous radiator
• Near-side jet-cone analysis & Away-side jet-cone analysis
HMPID-like photon detector (MWPC + CsI pad cathode)
Readout FEE: GASSIPLEX + DILOGIC (same as HMPID)

- $\text{C}_4\text{F}_{10}$ radiator, 80-100 cm long
- 5 mm Suprasil ($\text{SiO}_2$) window
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