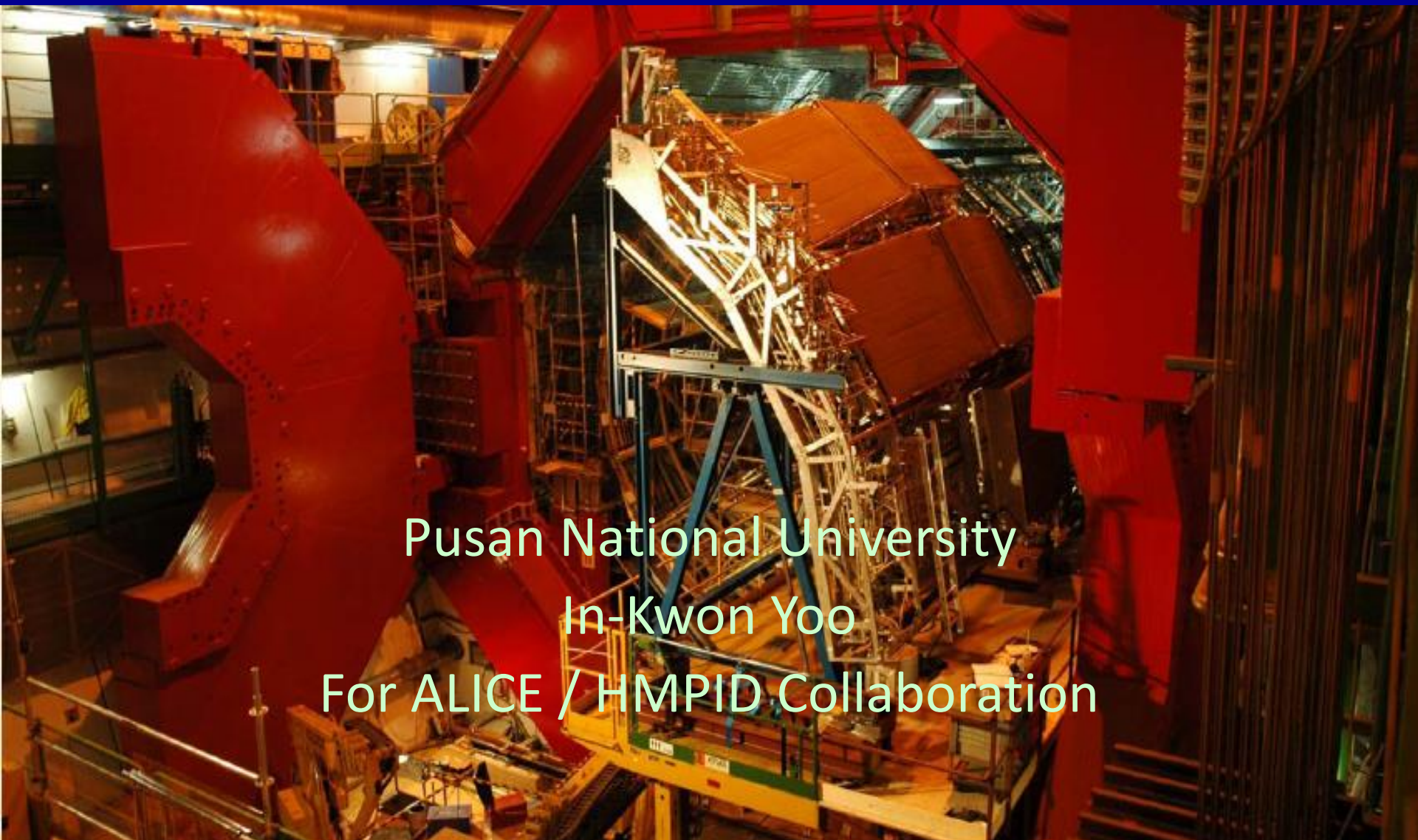
High Momentum Particle IDentification (HMPID) in ALICE



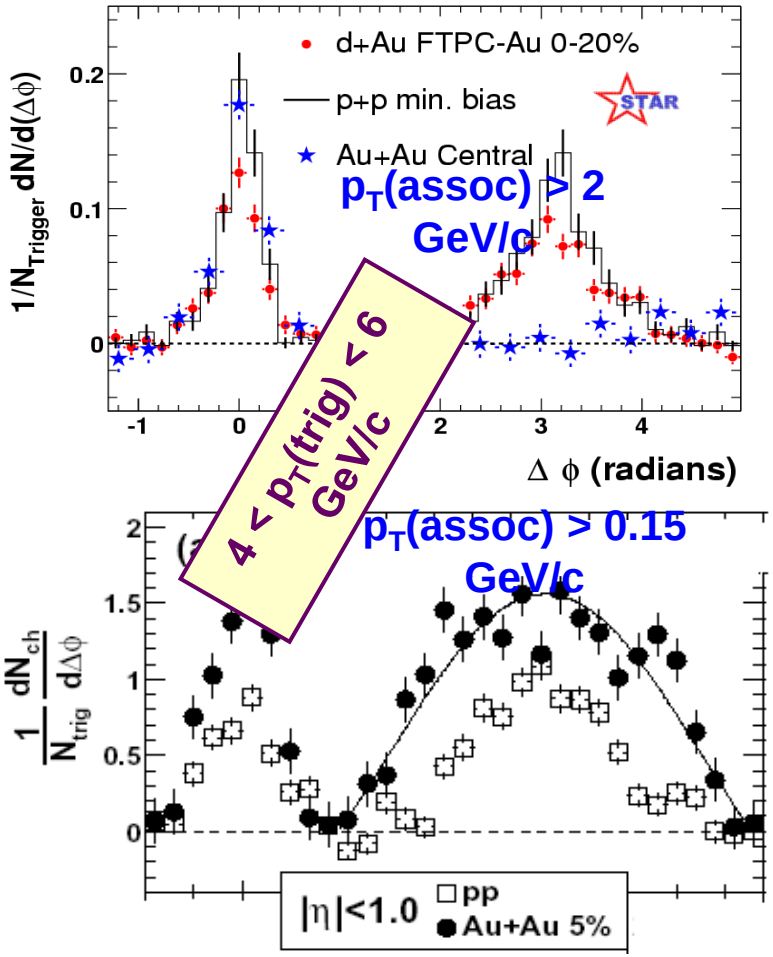
Pusan National University
In-Kwon Yoo
For ALICE / HMPID Collaboration

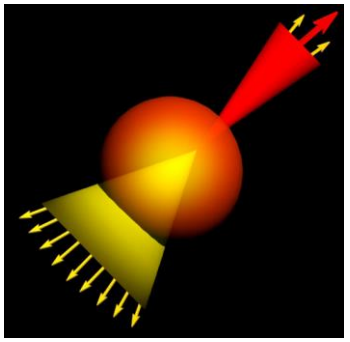
Outline

- 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

Pre-ALICE RHIC Physics

Jet Quenching





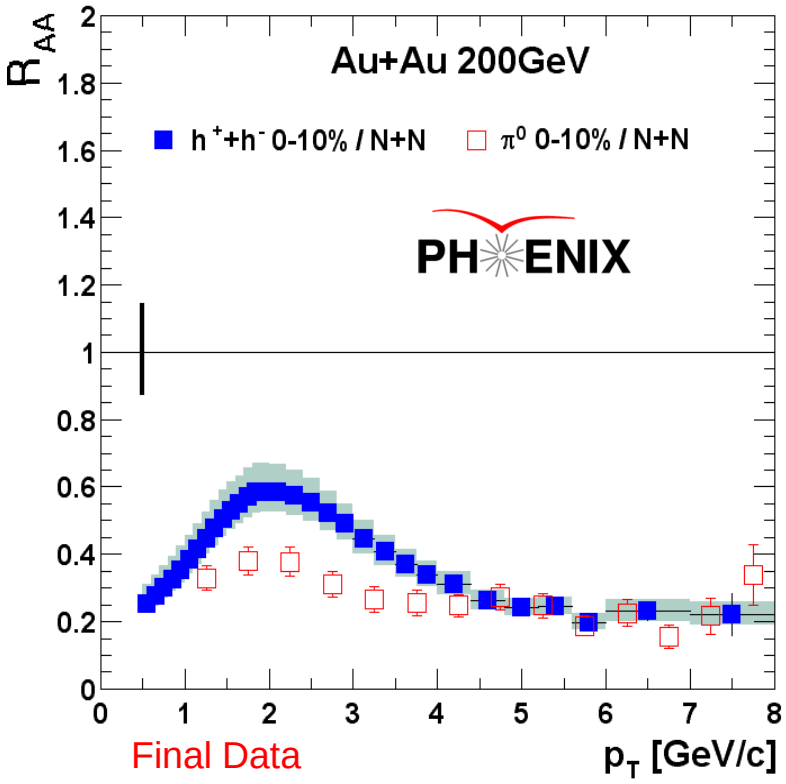
Hard associated particles → suppression

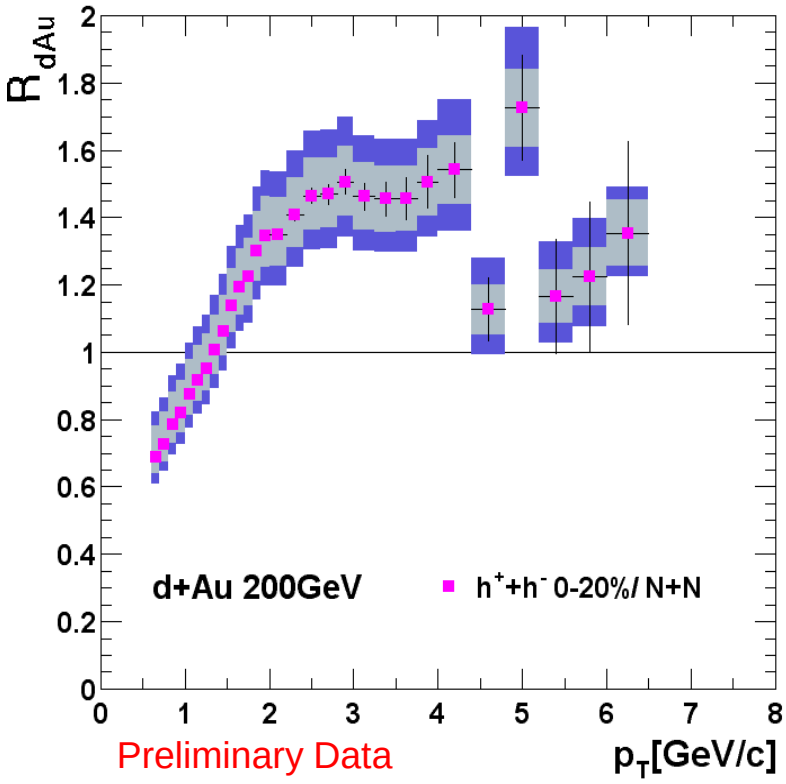
Soft associated particles → enhancement

Why HMPID?

Pre-ALICE RHIC Physics

High p_T suppression





Why HMPID?

Pre-ALICE RHIC Physics

Early Universe was a liquid

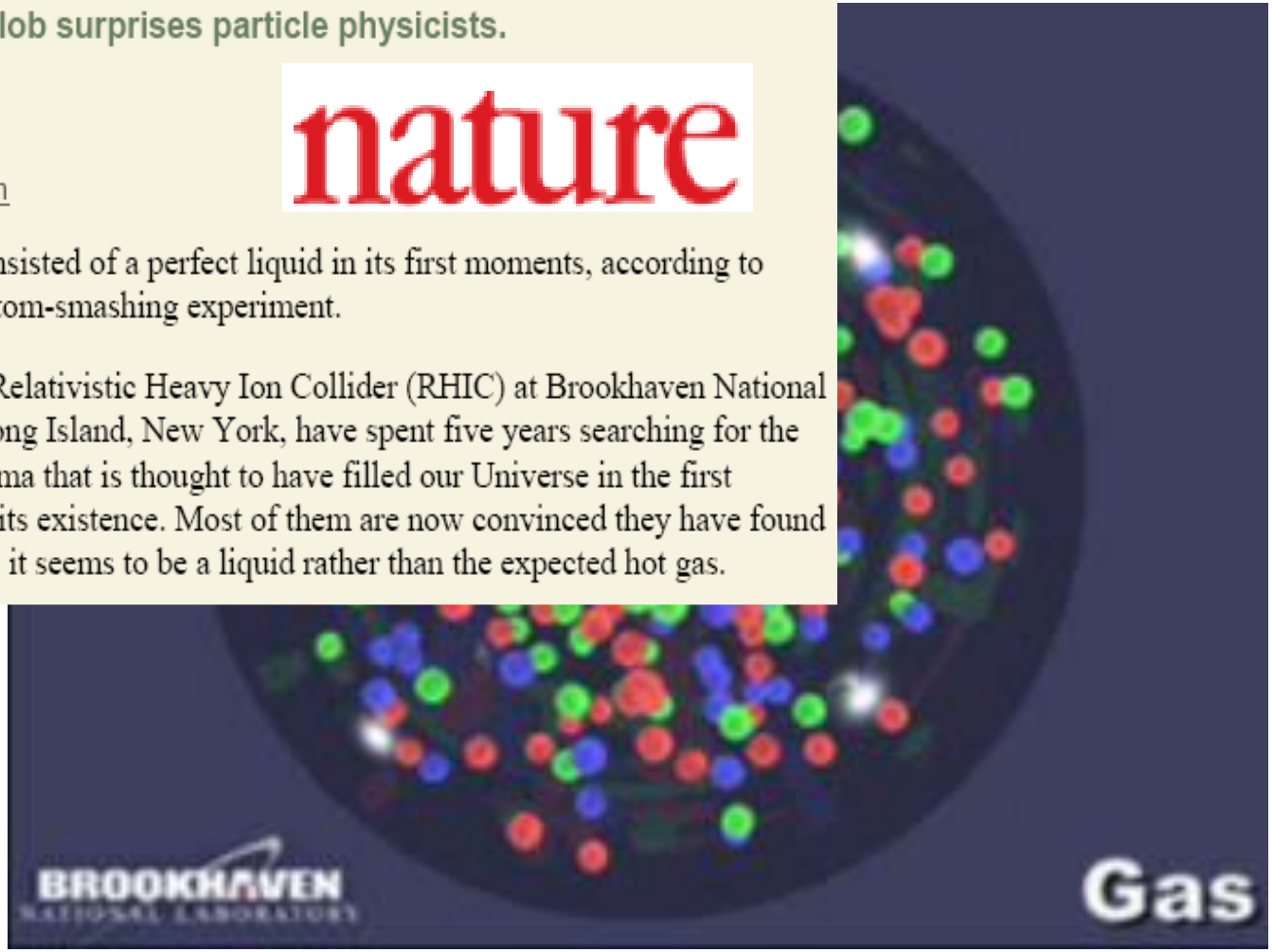
Quark-gluon blob surprises particle physicists.

by Mark Peplow
news@nature.com

nature

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?

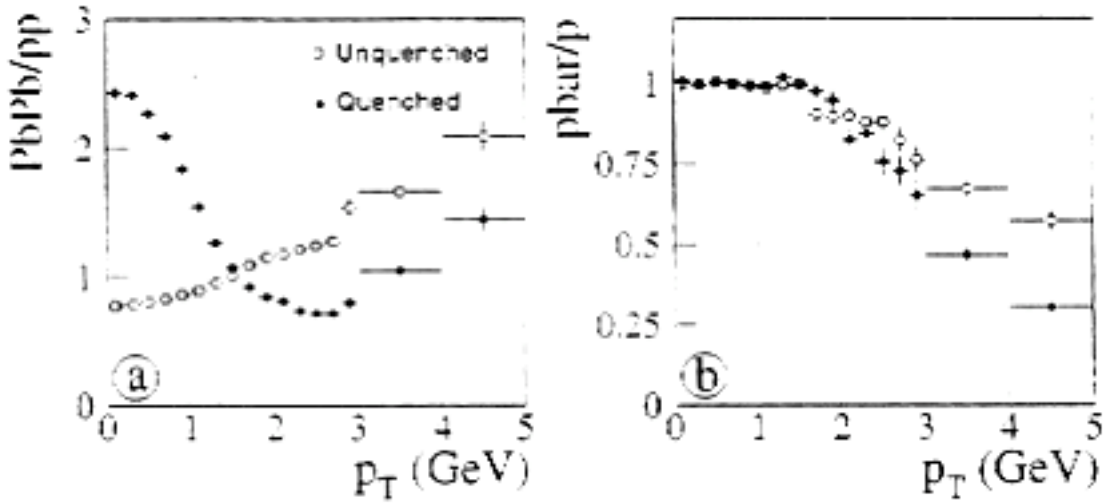
Physics of the HMPID

- Low p_T particle spectra (< 1 GeV/c) → Temperature of the formed medium, via thermal particle emission
- High p_T particle production ← hard processes (perturbative QCD)
- Density of the formed medium in AA collisions ← energy loss of high-energy partons traversing the medium

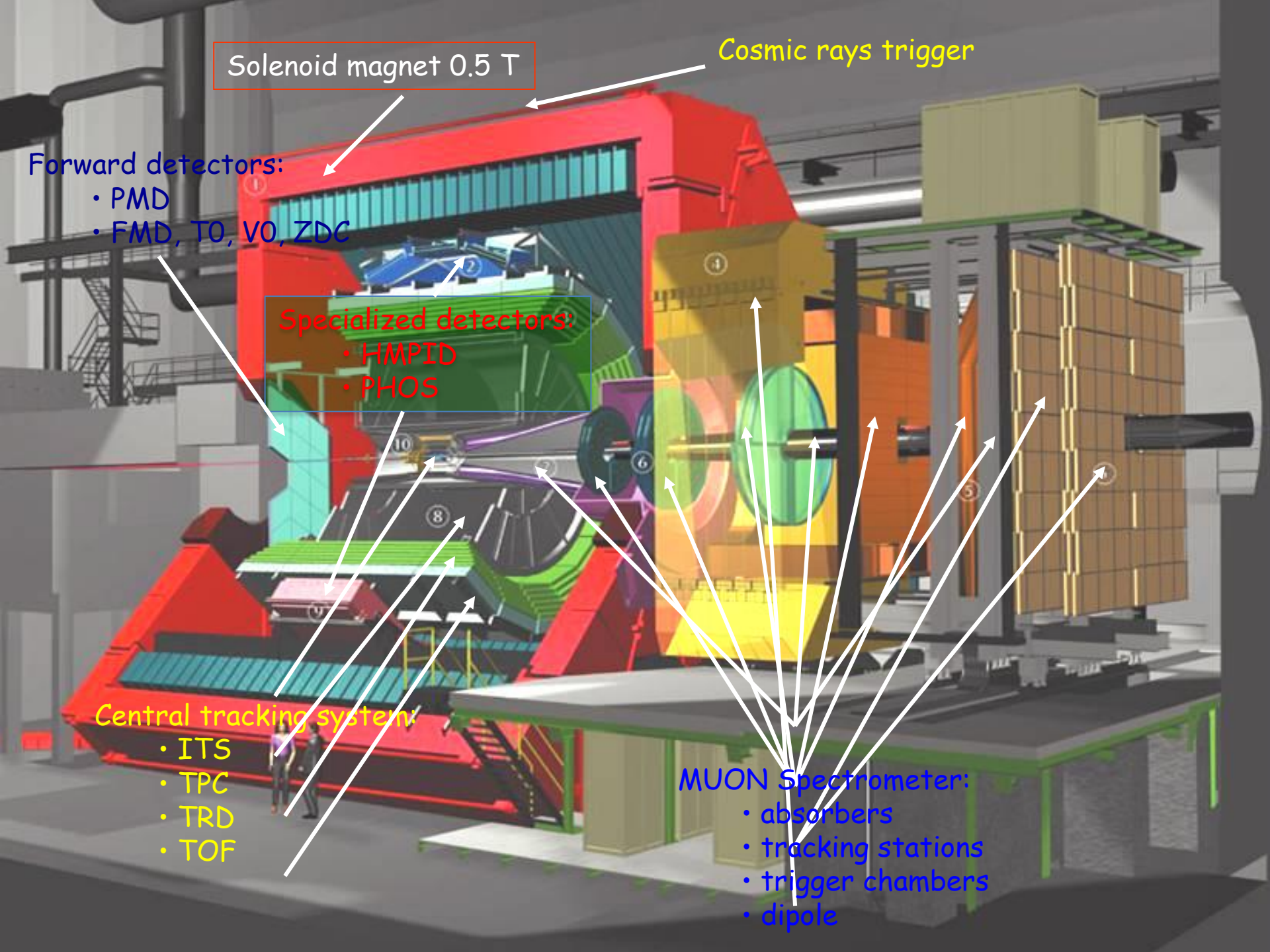
Why HMPID?

Physics of the HMPID

- Large E_T jet suppression → high p_T particle suppression.
- Comparison of high p_T spectra in AA and pp

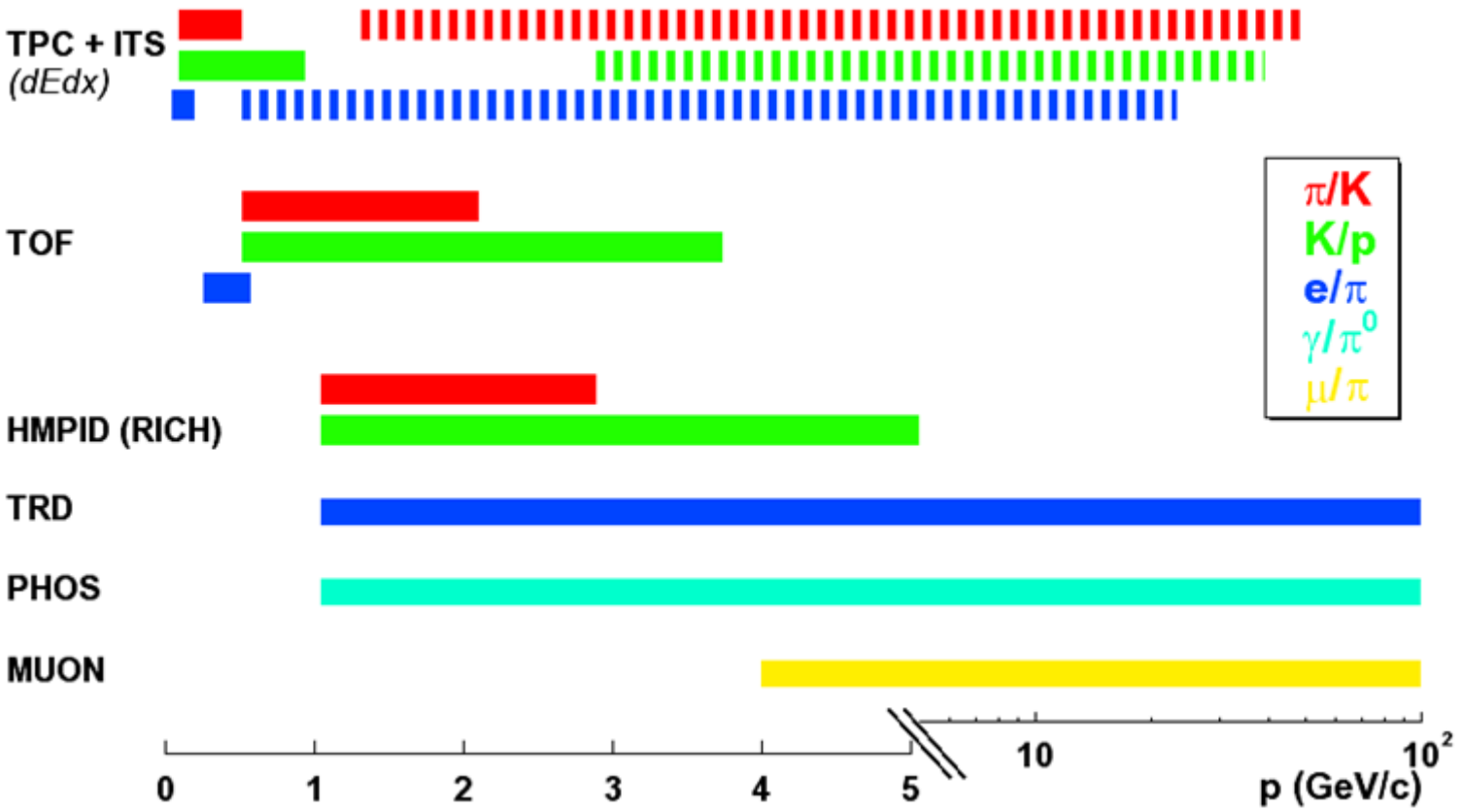


- Comparison of proton and antiproton spectra → quark jets vs. gluon jets [PRL68, 1480] → tagging quark vs. gluon jets
- Gluons with more colors lose more energy in a dense medium than quarks → suppressing pbar at high p_T


Solenoid magnet 0.5 T
Cosmic rays trigger
Forward detectors:
• PMD
• FMD, T0, V0, ZDC
Specialized detectors:
• HMPID
• PHOS
Central tracking system:
• ITS
• TPC
• TRD
• TOF
MUON Spectrometer:
• absorbers
• tracking stations
• trigger chambers
• dipole

Why HMPID?

PID in ALICE



Concept of Design

- Ring Imaging Cherenkov (RICH) Detector :
  Momentum limit = choice of radiator medium
  Track-by-track PID
- π, K, p with 1-5 GeV/c : liquid radiator
- Cherenkov photon ($\lambda \leq 200$ nm) transmittance → C_6F_{14}
- Particle density, space, photon absorbtion etc → 'proximity focusing'
- Surface, price, CsI photocathode + MWPC

HMPID Layout

RADIATOR

15 mm liquid C_6F_{14},
n ~ 1.2989 @ 175nm, $(\beta\gamma)_h$ = 1.21

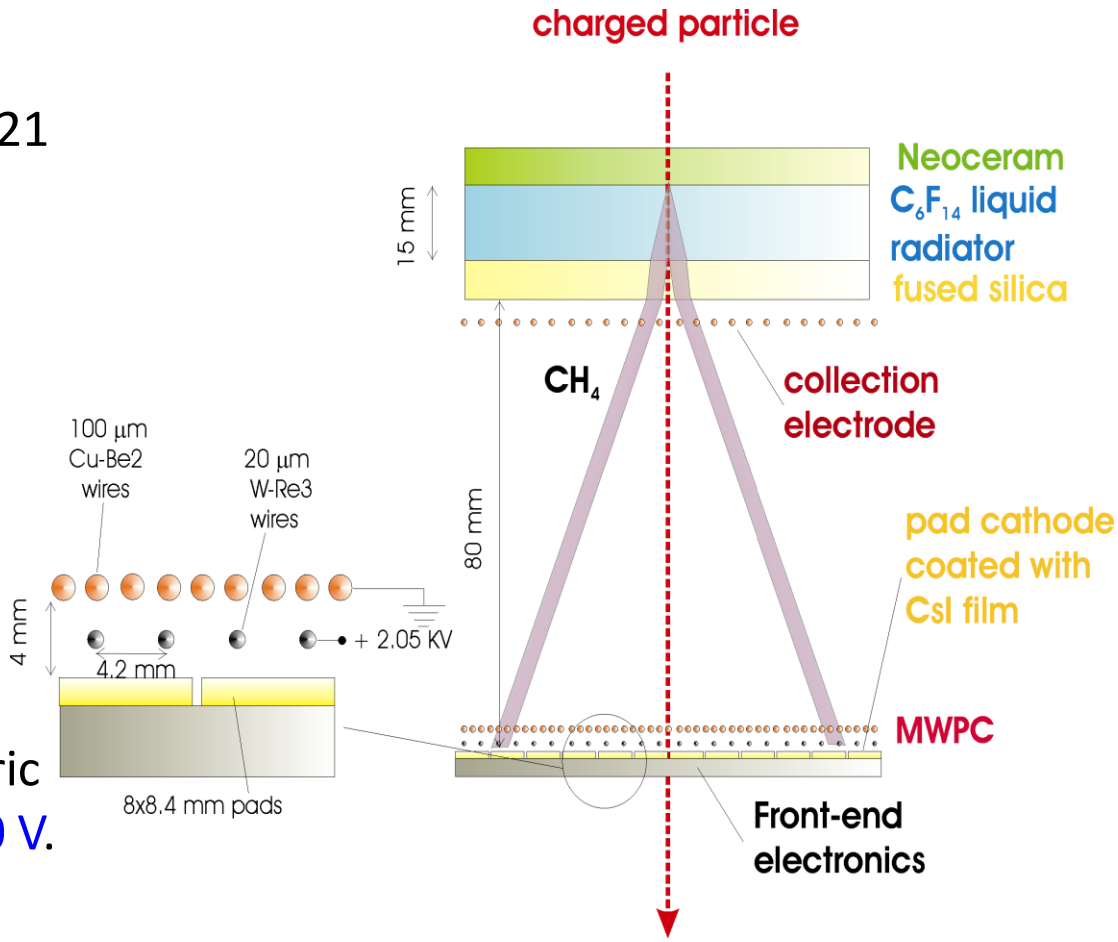
PHOTON CONVERTER

Reflective layer of CsI
QE ~ 25% @ 175 nm.

PHOTOELECTRON DETECTOR

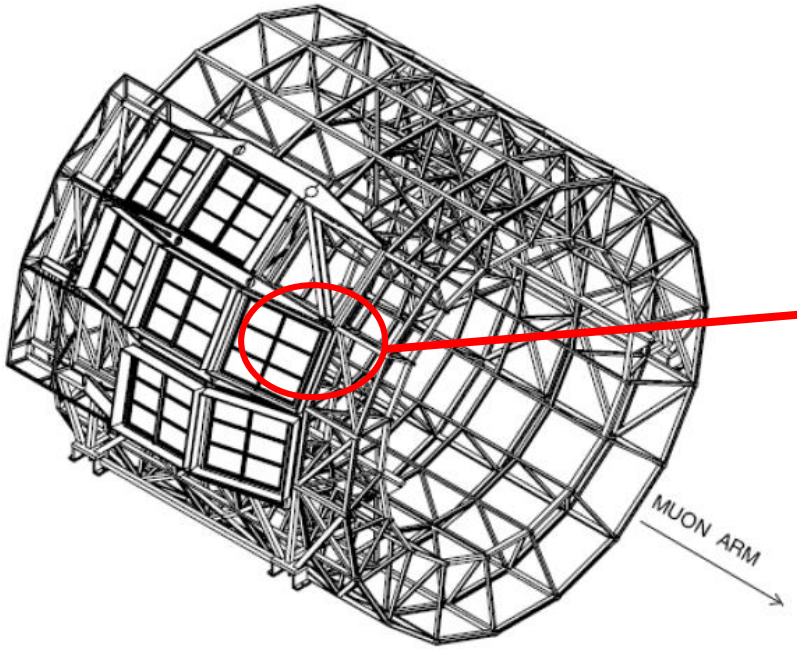
- MWPC with CH_4 at atmospheric pressure (4 mm gap) HV = 2050 V.

- Analogue pad readout

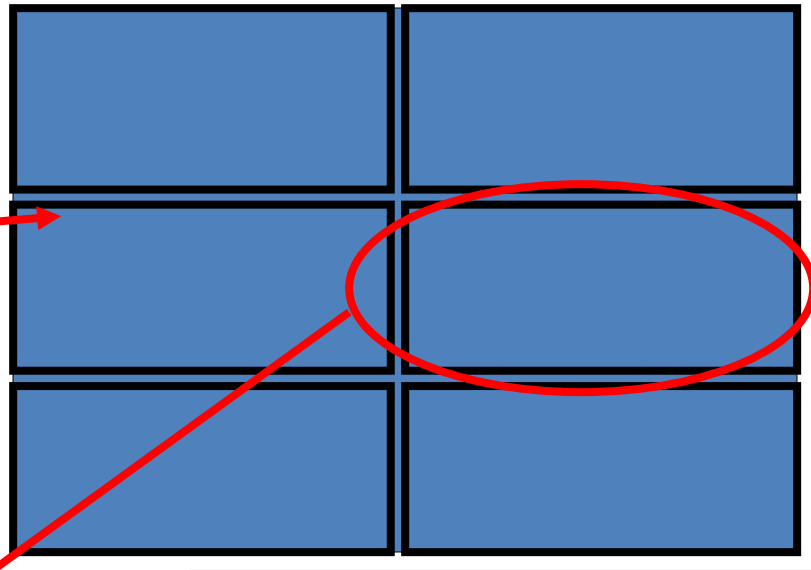


HMPID RICH

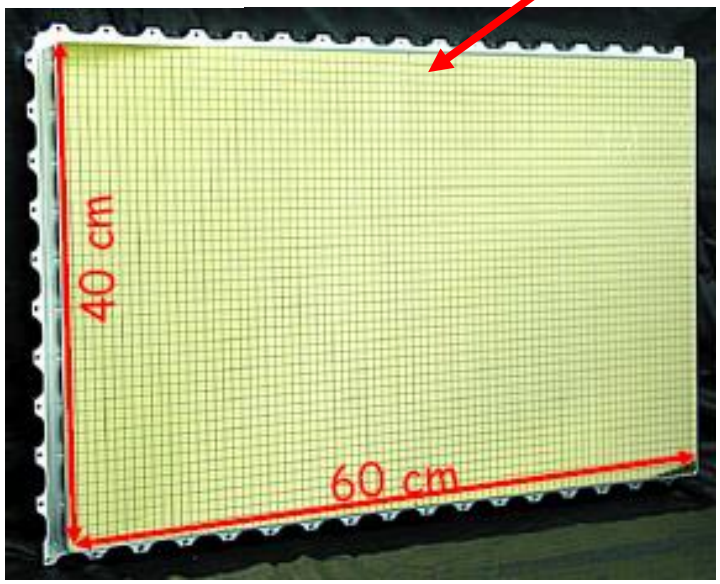
HMPID Layout

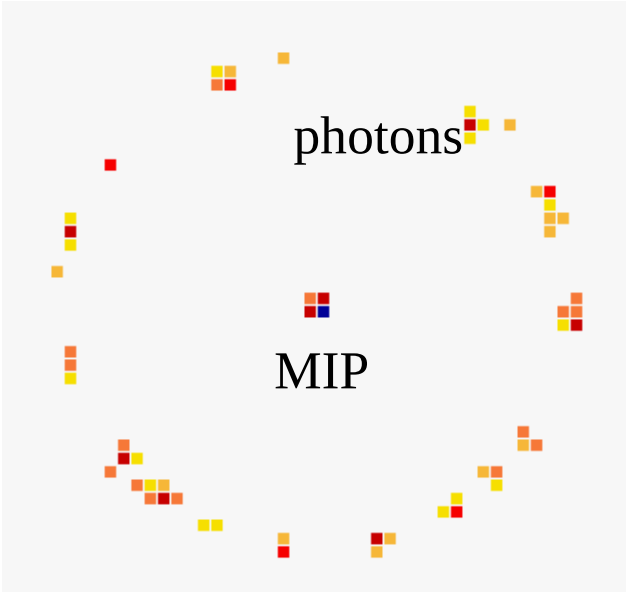


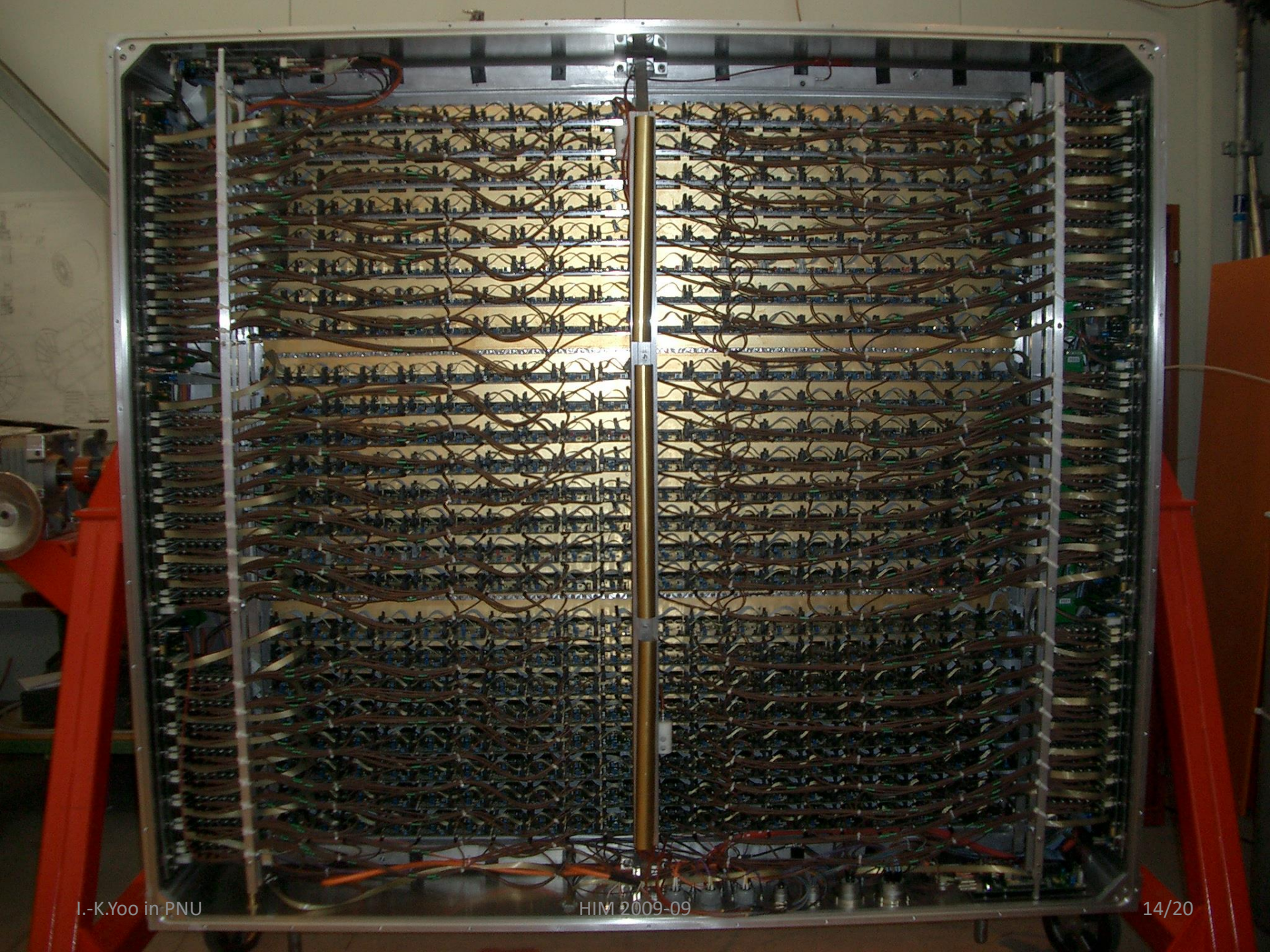
Six photo-cathodes per module



- CsI photo-cathode is segmented in 0.8x0.84 cm pads
- Total number of pads per chamber = 161280





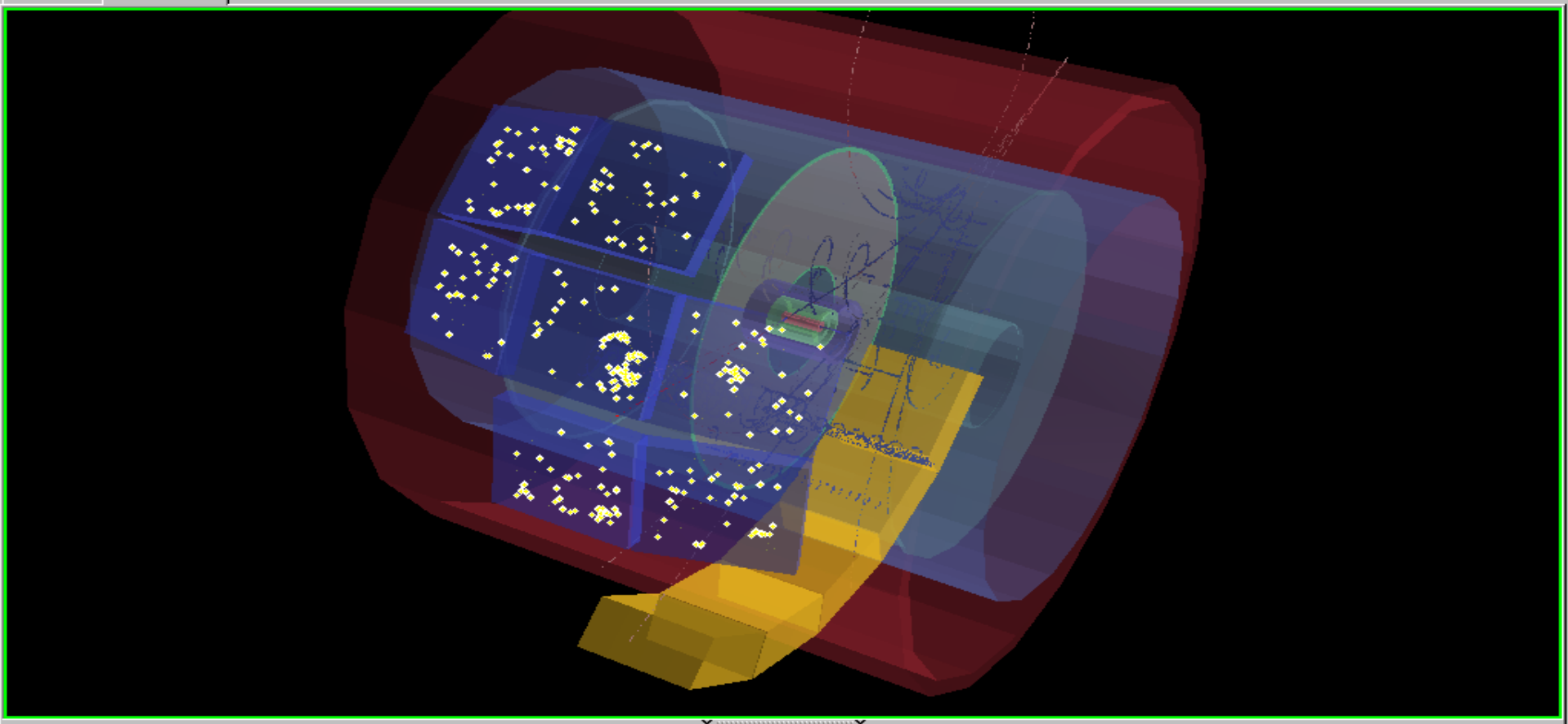


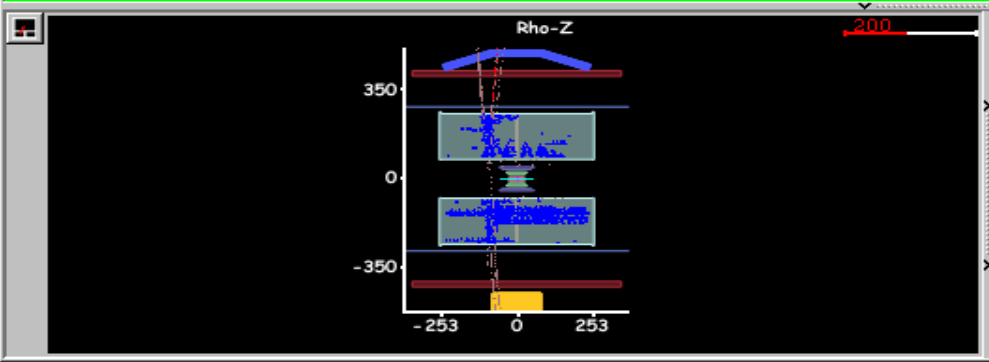
HMPID is installed in the ALICE magnet since September 2006

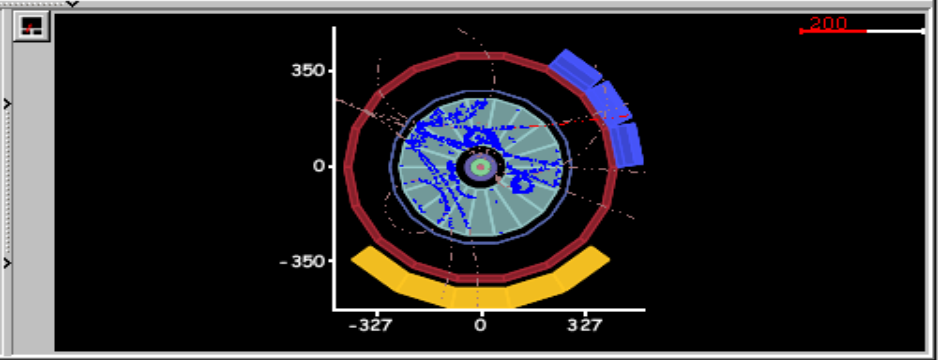
- Since July 2007, fully powered (LV & HV);
- Since July 2007, HMPID is controlled via the Detector Control System;
- Since May 2008 the radiator liquid circulation system is completed;
- HMPID is ready to take data!!

Test HMPID

Cosmic Test Results (G. Volpe, QM09)

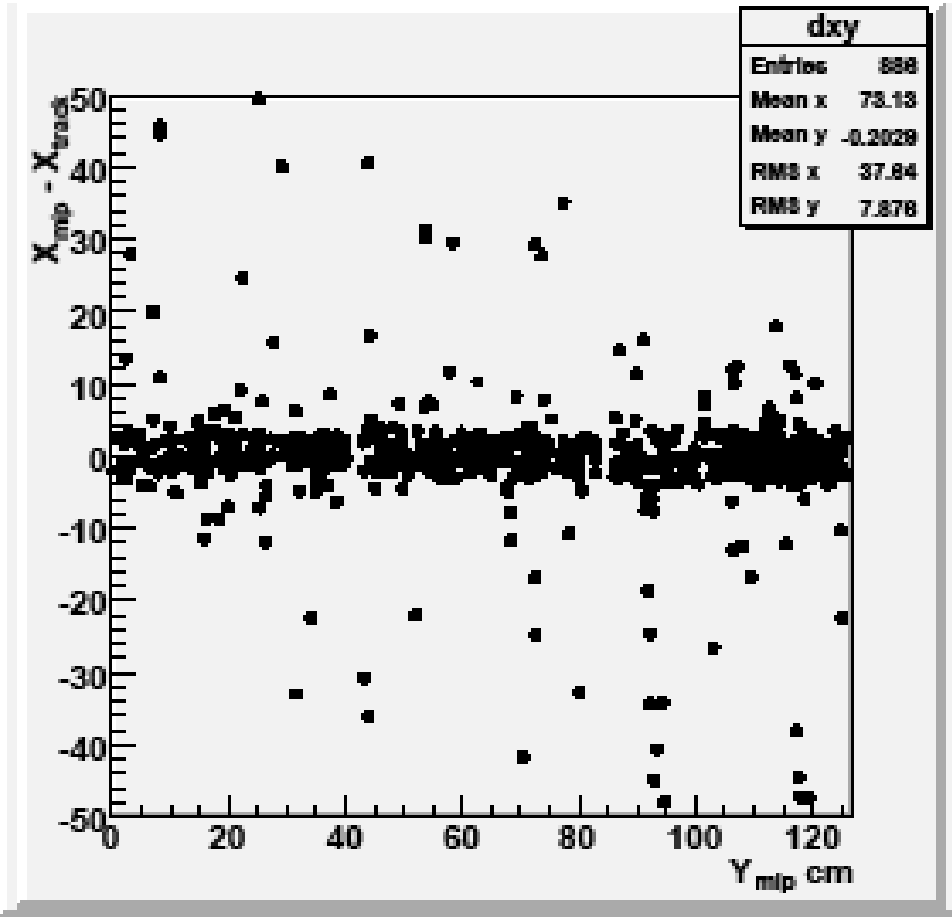


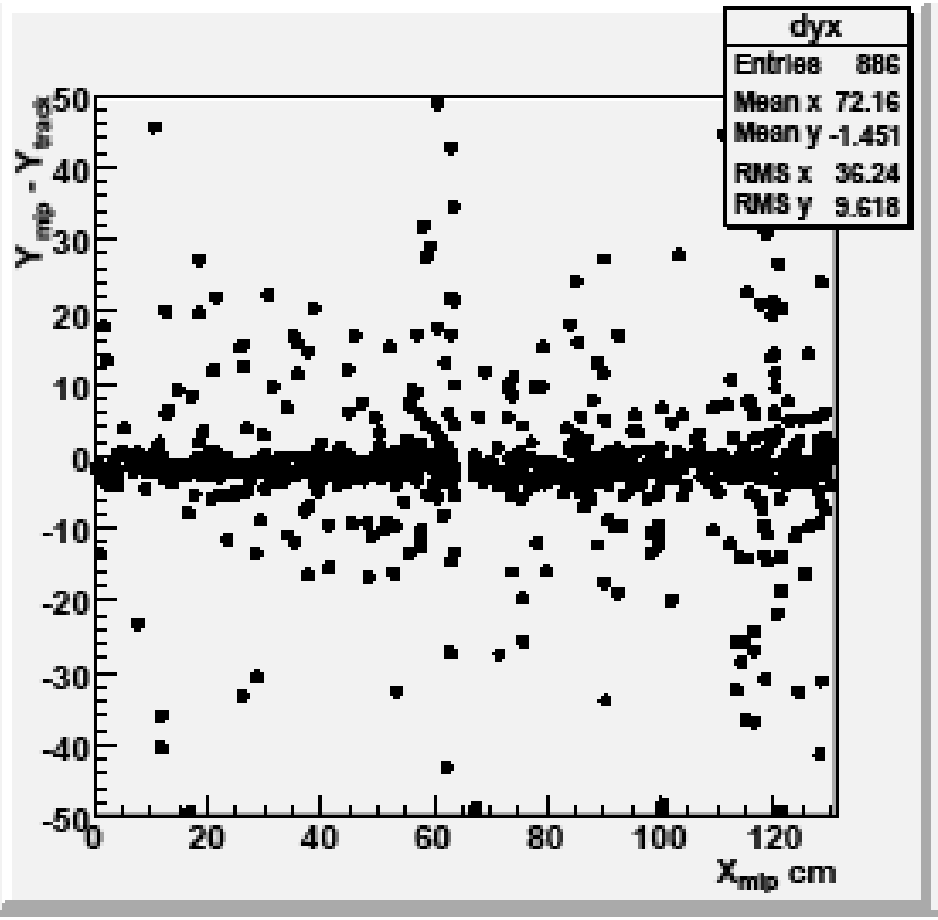




Cosmic Test Results (G. Volpe, QM09)

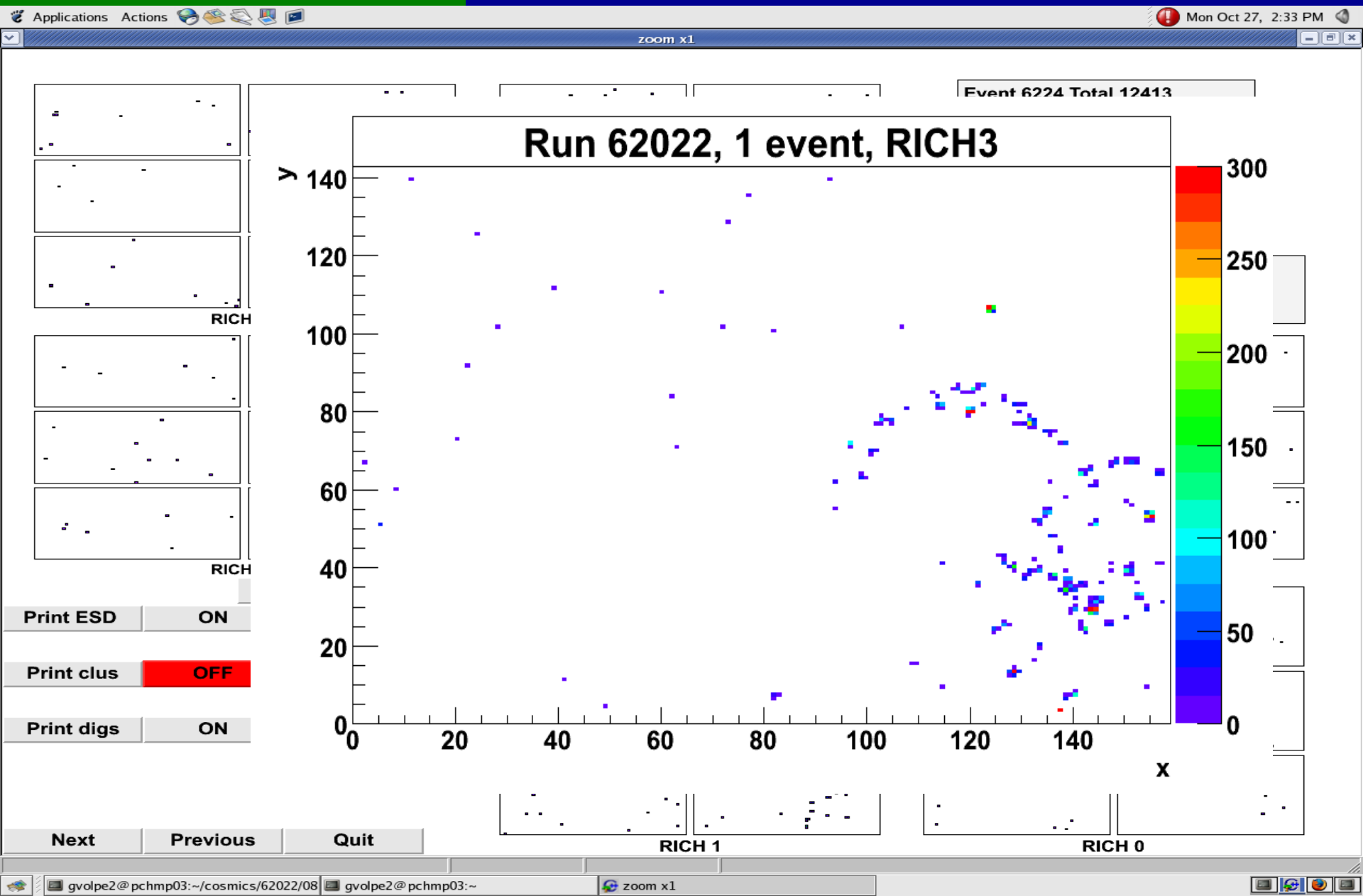
Matching with tracks reconstructed in the TPC



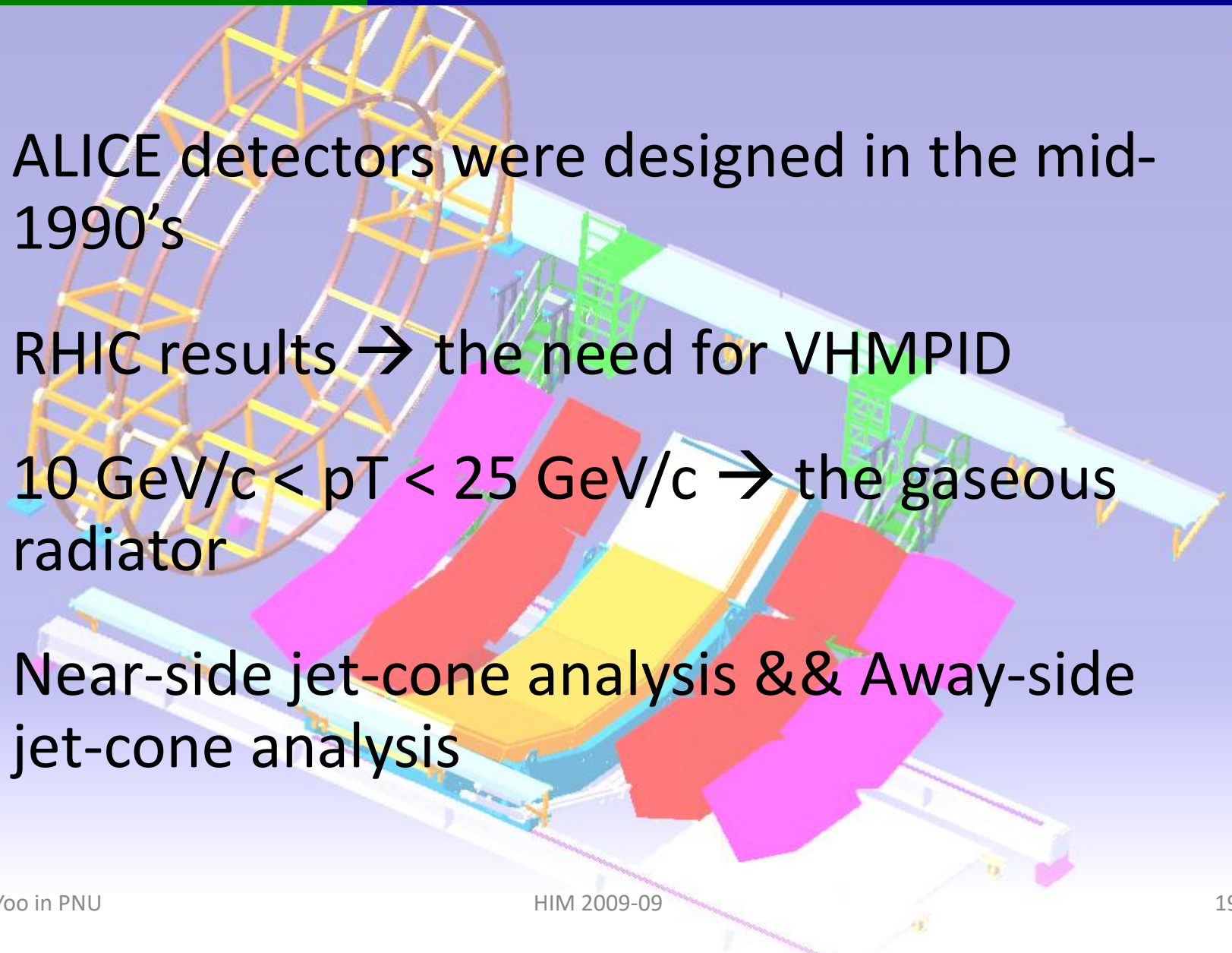


Test HMPID

Cosmic Test Results (G. Volpe, QM09)



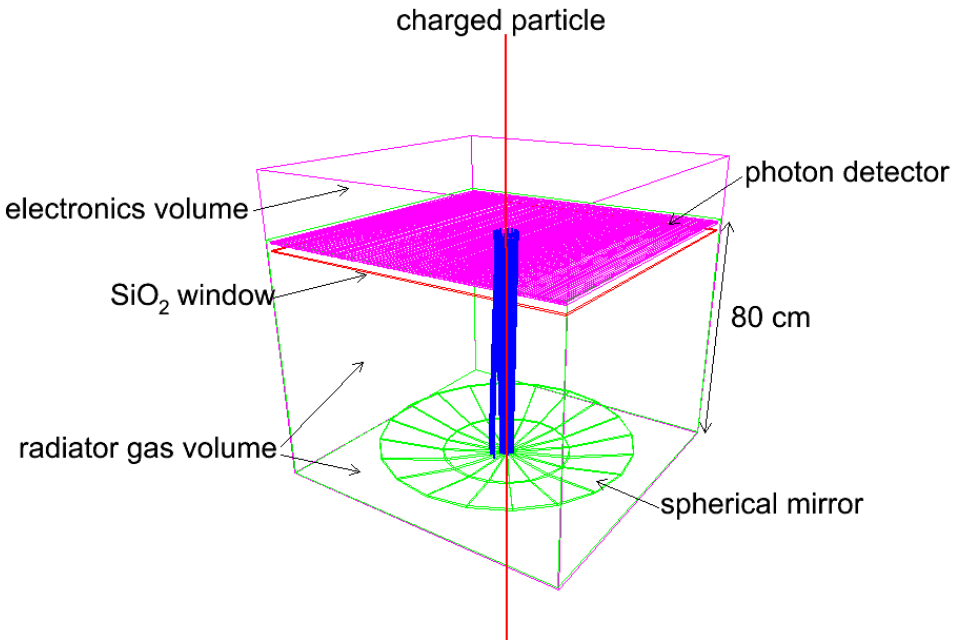
Motivation



- ALICE detectors were designed in the mid-1990's
- RHIC results → the need for VHMPID
- 10 GeV/c < pT < 25 GeV/c → the gaseous radiator
- Near-side jet-cone analysis && Away-side jet-cone analysis

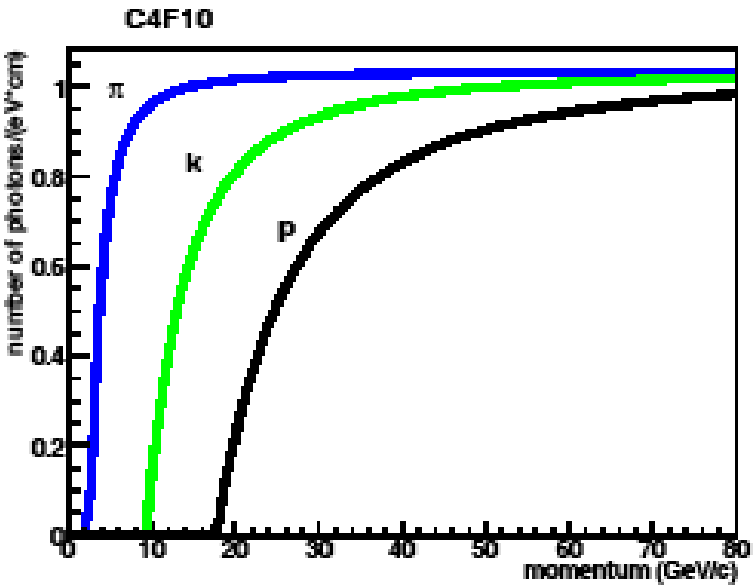
VHMPID Project

Ongoing R&D (A. Di Mauro)



HMPID-like photon detector (MWPC + CsI pad cathode)

Readout FEE: GASSIPLEX + DILOGIC (same as HMPID)



- C_4F_{10} radiator, 80-100 cm long
- 5 mm Suprasil (SiO_2) window

ALICE VHMPID Collaboration

- Instituto de Ciencias Nucleares Universidad Nacional Autonoma de Mexico, Mexico, Mexico : E. Cuautle, A. Ortiz, G. Paic, V. Peskov, P. Podesta, O. Sokolov
- Instituto de Fisica Universidad Nacional Autonoma de Mexico, Mexico, Mexico : R. Alfaro
- Universita' degli Studi di Bari, Dipartimento Interateneo di Fisica "M. Merlin " & INFN Sezione di Bari, Bari, Italy : G. De Cataldo, D. Di Bari, A. Mastroserio, E. Nappi, G. Volpe
- CERN, Geneva, Switzerland : A. Di Mauro, P. Martinengo, D. Perini, F. Piuz
- MTA KFKI RMKI, Research Institute for Particle and Nuclear Physics, Budapest, Hungary : A. Agocs, G.G. Barnaf•oldi, L. Boldizsar, Z. Fodor, E. Futo, G. Hamar, P. Levai, L. Molnar
- E•otv•os University, Budapest, Hungary : D. Varga
- Chicago State University, Chicago, IL, USA : E. Garcia
- Yale University, New Haven, USA : N. Smirnov, J. Harris
- Pusan National University, Pusan, Korea : I.-K.Yoo, J. Yi, C.W. Son

Korea-ALICE Institutions

- Total : 28 Participants (11 PhDs, 7 PhD St., 10 MA St.)
  - Kangnung National University* : 5 PhDs, 4 PhD St., 3 MA St.
  - Pusan National University : 2 PhDs, 1 PhD St., 2 MA St.
  - Sejong University : 2 PhDs, 1 PhD St., 1 MA St.
  - Yonsei University : 2 PhDs, 1 PhD St., 4 MA St.
- Residents at CERN : 5 PhDs, 1 PhD St., 3 MA St.
- Residents at Korea : 6 PhDs, 6 PhD St., 7 MA St.
- 2 PhDs + 1 PhD St. + 1 MA St. increased (17%)

Korea-ALICE Budget

- 2008 Total : 225 kCHF
  - KICOS -> CERN : 215 k
    - common : 50 k (completed)
    - stay at CERN : 109k
    - visitor : 56k
  - local at KNU : 10k

- 2009 Total : 500 M KRW
  - KICOS -> CERN : 410 M
    - stay at CERN : 297 M
    - visitor : 103 M
  - local at PNU : 90 M
    - salary : 54 M
    - local travel : 5 M
    - overhead : 20 M
    - admin. : 11 M

Korea-ALICE Steering Committee

- Steering Committee : 4 Representatives from 4 Institutions
  - Bylaw established
  - assign a new Team Leader : IKYoo
  - assign resident coordinator : Dr. Suh-Urk CHUNG (BNL)
  - budget estimate for 2009
  - M&O-A list : open competition
- http://him.phys.pusan.ac.kr/~alice

Korea-ALICE Activities

- Goal : Discovery and Study on Quark Matter under Extreme Conditions
  - Detector R&D and Operation of ALICE
  - Data Analysis using Grid Computing : Test of theoretical expectations
  - Brainstorming of new physics ideas : HIM
- Kangnung National University
  1. ALICE-ToF R&D, installation and operation
  2. ALICE-EM Calorimeter (Muon Detector) operation
  3. Particle Reconstruction Algorithm Development

Korea-ALICE Activities (contin.)

- Pusan National University
  1. ALICE-HMPID R&D and Operation
  2. Gas System Control System R&D using ALICE-DCS
  3. Charm Production Study (Λ_C/D)
- Sejong University
  1. ALICE Computing GRID Operation
  2. Theoretical Calculation on Hadron Phenomena at LHC (pp and PbPb collisions)
- Yonsei University
  1. ALICE-TRD Installation and Operation
  2. Direct Photon Measurement Study