Status of the ALICE at LHC

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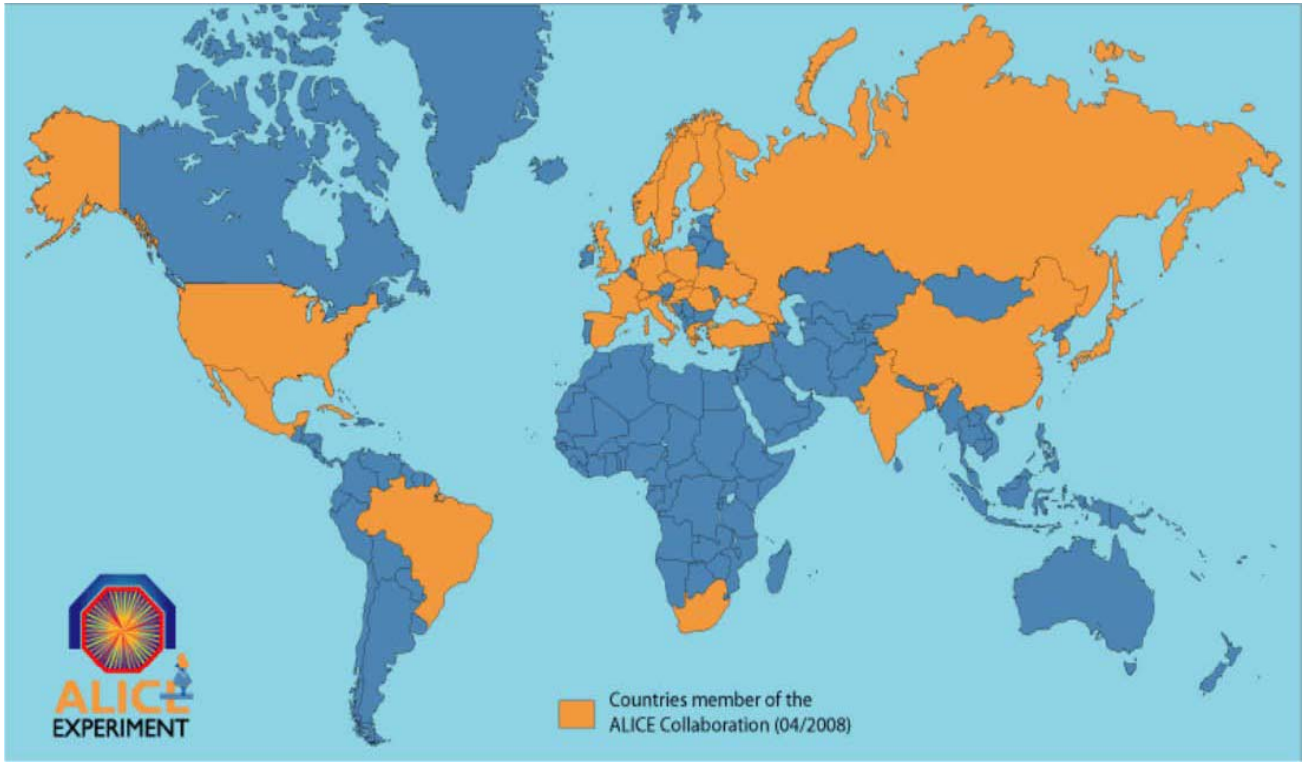
Outline

- ALICE overview
- Status of the ALICE
  - Detector installation
  - Detector performance
- The first physics
- ALICE upgrade program born in Asia
- Summary & questions to address

ALICE@LHC

Dedicated general purpose heavy ion experiment at LHC

The Collaboration



~ 1000 Members (63% -CERN States)

~ 30 Countries

~ 100 Institutes

~ 150 M CHF capital (+ magnet)

The experimental challenges

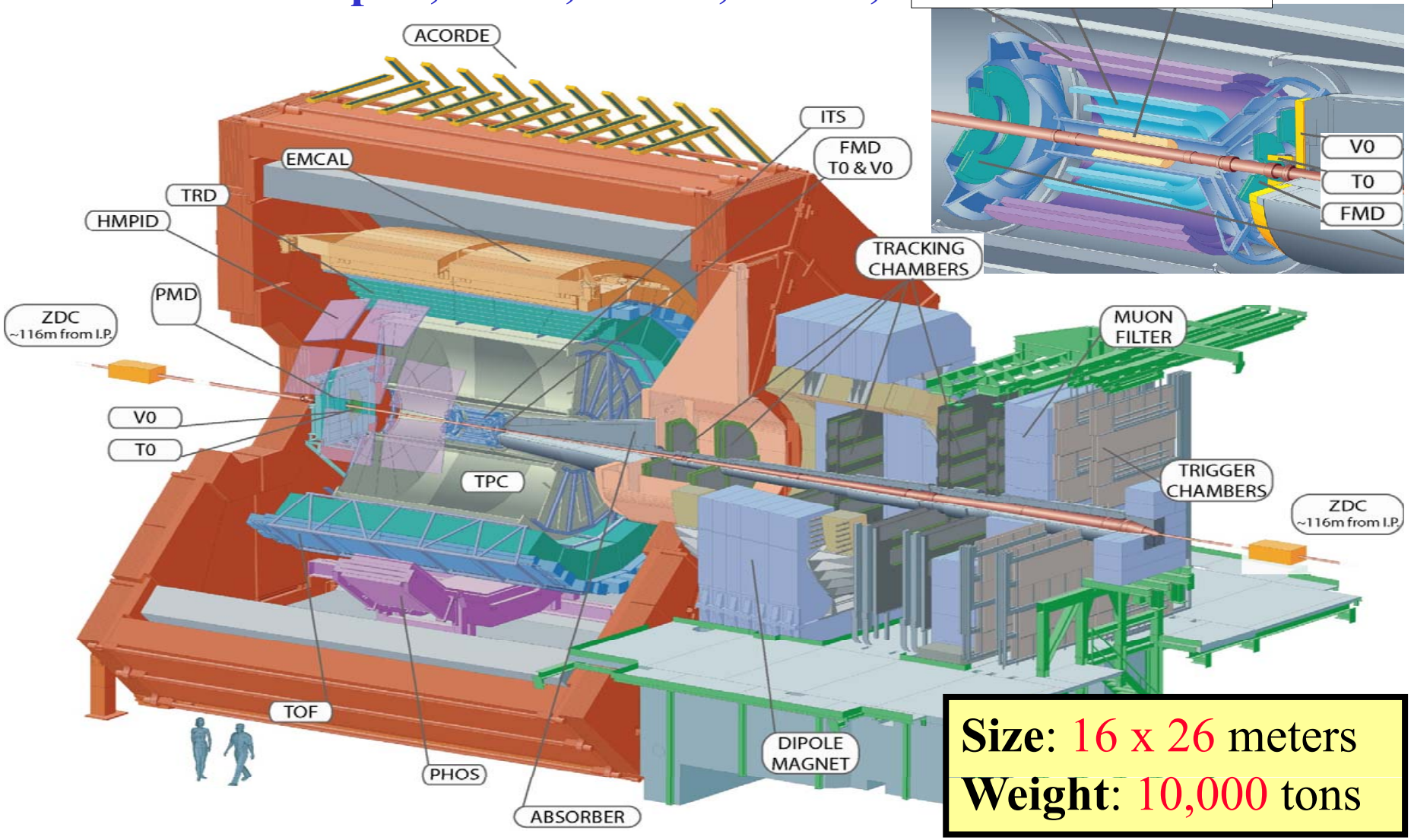
- Extreme particle density (dN_{ch}/dh ~ 2000 – 5000)
  - **500 times compared to pp @ LHC**
- Large dynamic range in p_T:
  - **from very soft (0.1 GeV/*c*) to fairly hard (100 GeV/*c*)**
- Lepton ID, hadron ID, photon detection
- Secondary vertices
- Modest luminosity and interaction rates
  - **10 kHz (Pb-Pb) to 300 kHz (pp) (< 1/1000 of pp@10^{34})**

Experimental solutions

- **dN_{ch}/dh: high granularity, 3D detectors (560 million pixels in the TPC alone, giving 180 space points/track, largest ever: $88m^3$), large distance to vertex (use a VERY large magnet)**
  - **EM Calorimeter: high-density crystals of $PbWO_4$ at 4.6 m**
- **p_t coverage: thin detector, moderate field (low p_t), large lever arm + resolution (large p_t)**
  - **ALICE: < $10\%X_0$ in r < 2.5 m (typical is 50-100%X_0), B= 0.5T, BL^2 ~ like CMS !**
- **PID: use of essentially all known technologies**
  - **dE/dx, Cherenkov & TRD, TOF, calorimeters, muon filter, topological**
- **Rate: allows slow detectors (TPC, SDD), moderate radiation hardness**

The ALICE detector

Asia countries: Japan, India, Korea, China,…



Size: 16 x 26 meters

Weight: 10,000 tons

ALICE 2009 configuration

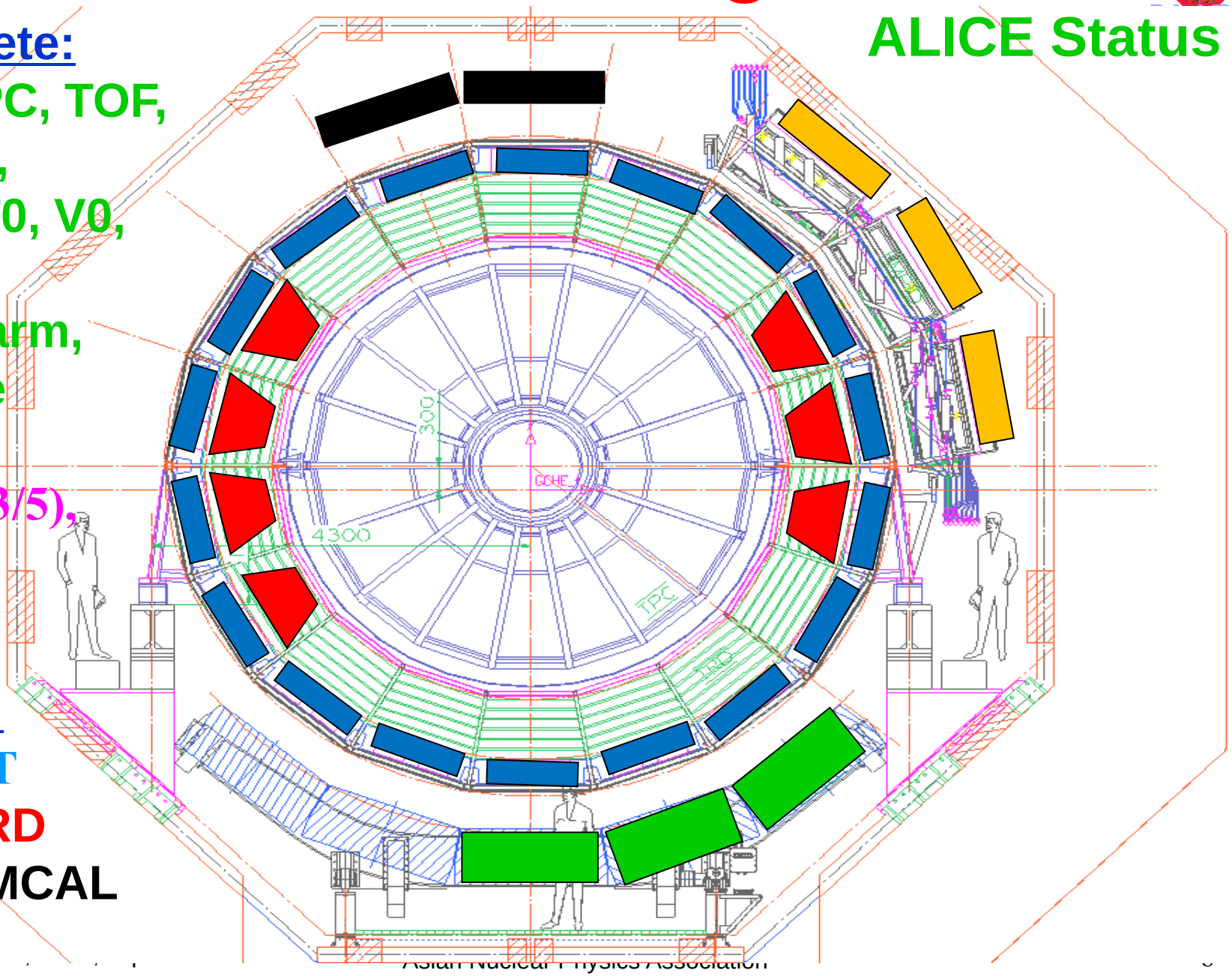
ALICE Status

Complete:

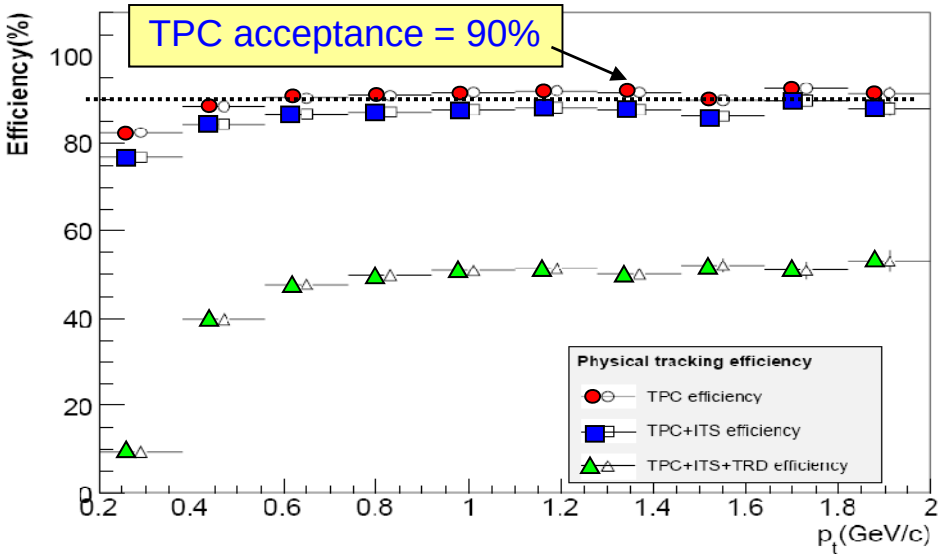
ITS, TPC, TOF,
HMPID,
FMD, T0, V0,
ZDC,
Muon arm,
Acorde
PMD ,
PHOS(3/5),
DAQ

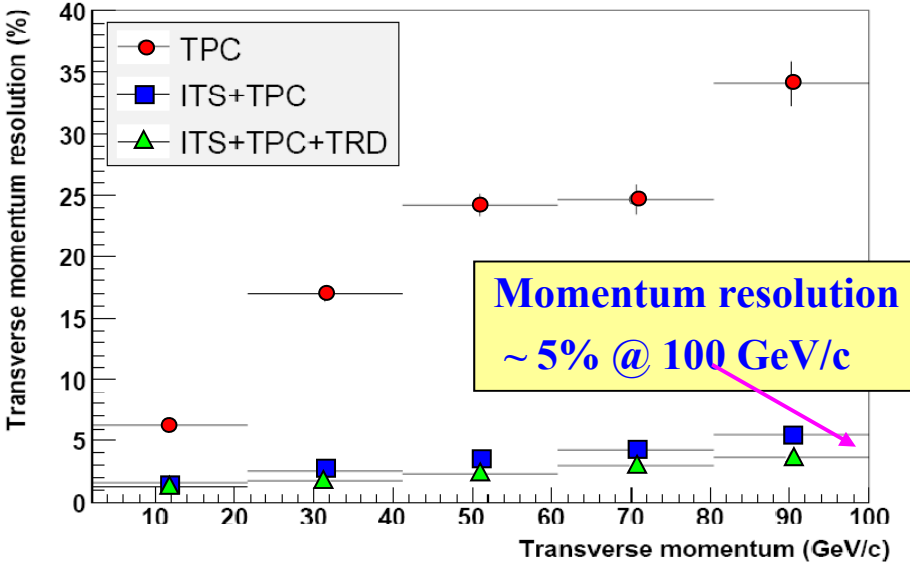
Partial:

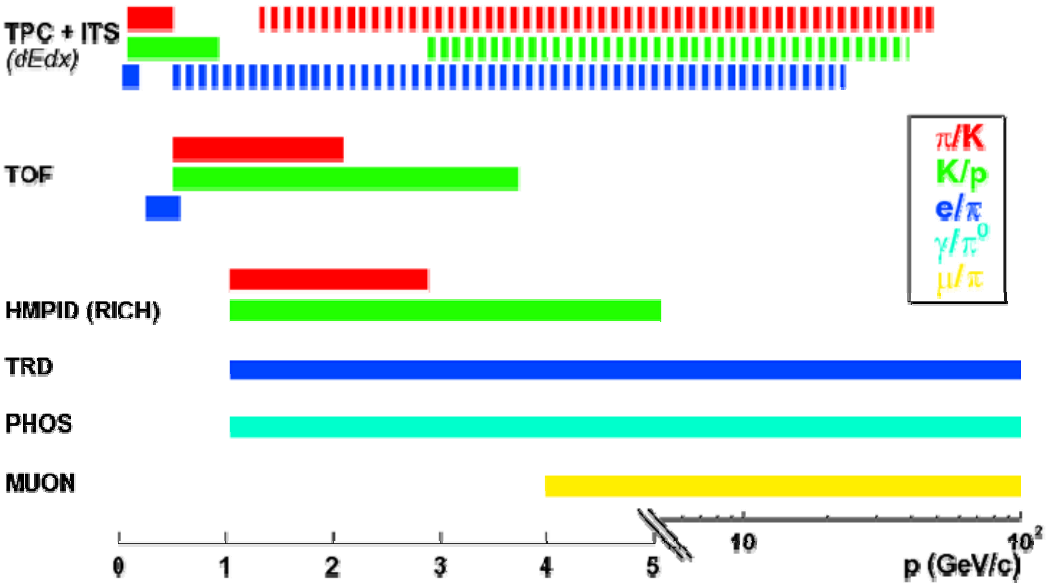
2/3 HLT
7/18 TRD
4/12 EMCAL

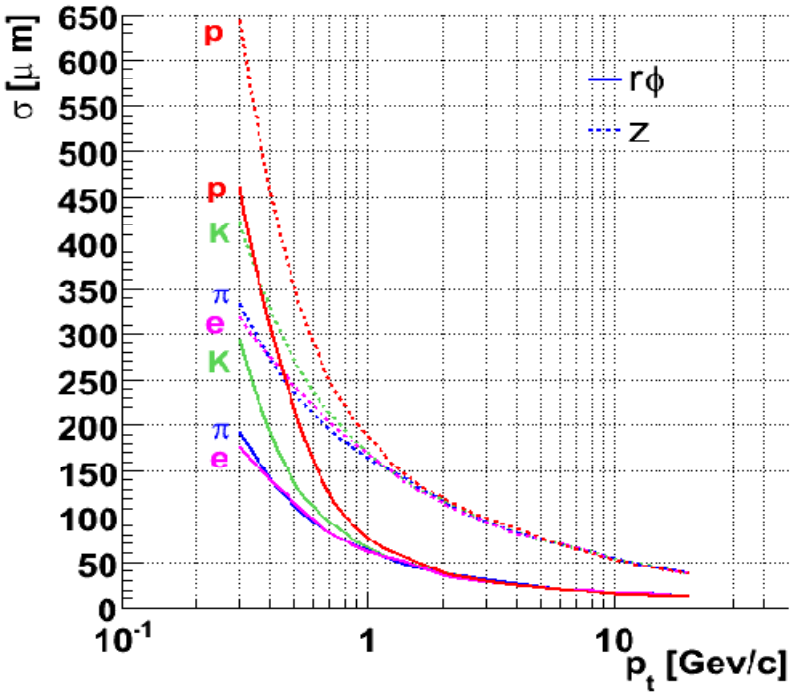


ALICE designed performance



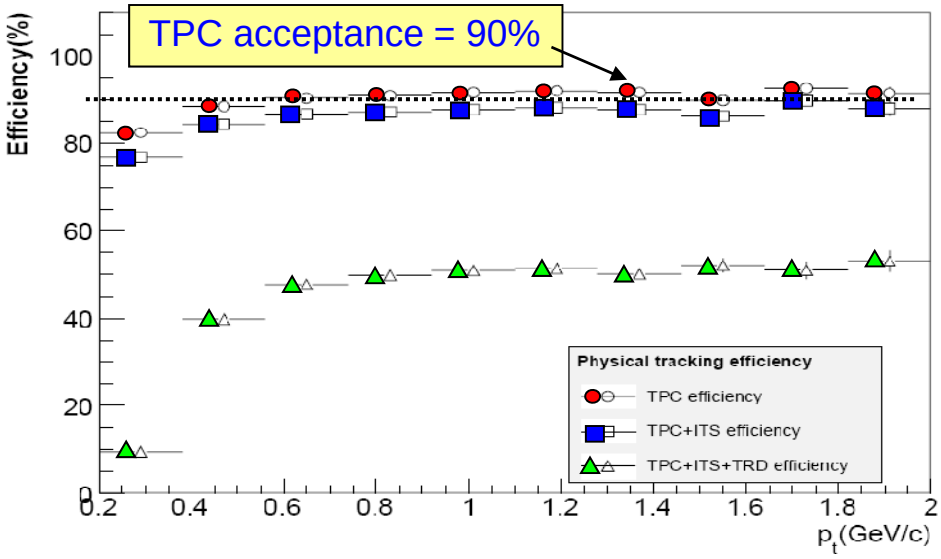


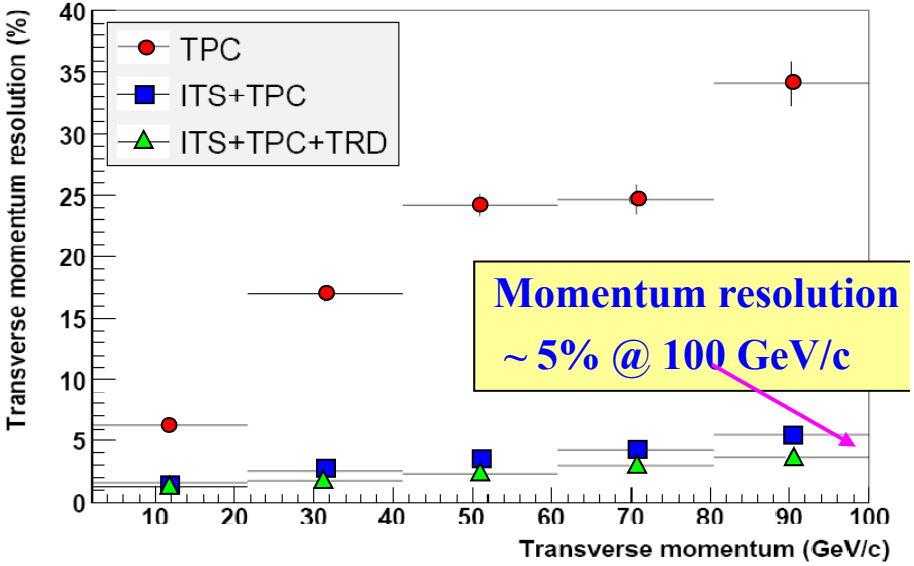


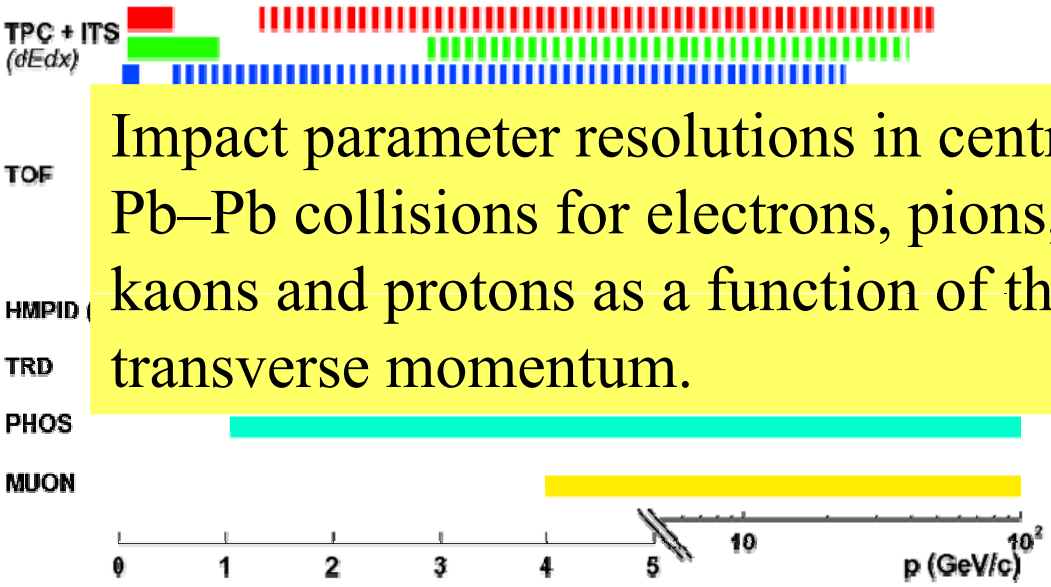


Asian Nuclear Phys

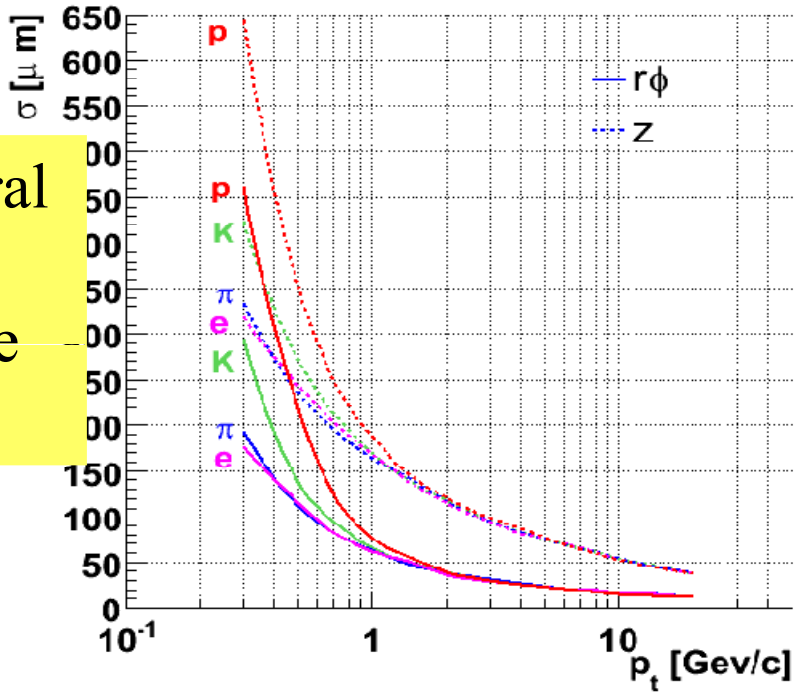
ALICE designed performance





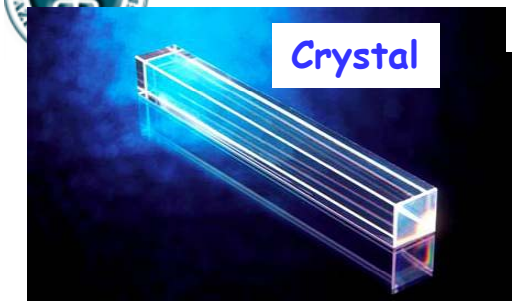


Impact parameter resolutions in central Pb–Pb collisions for electrons, pions, kaons and protons as a function of the transverse momentum.

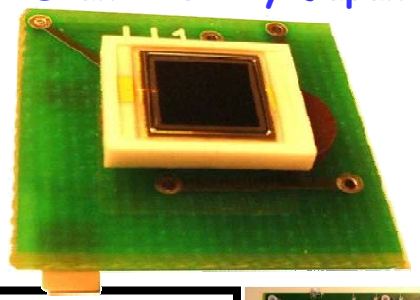


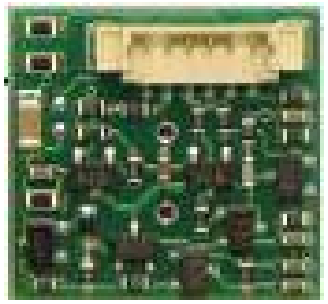
Asian Nuclear Phys

ALICE–PHOton Spectrometer (PHOS)

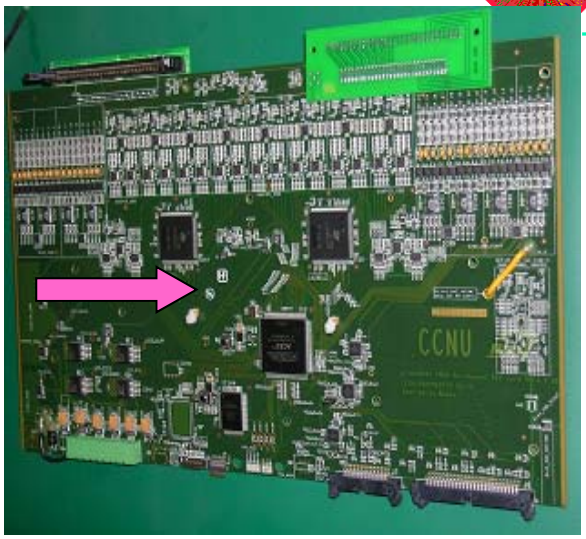


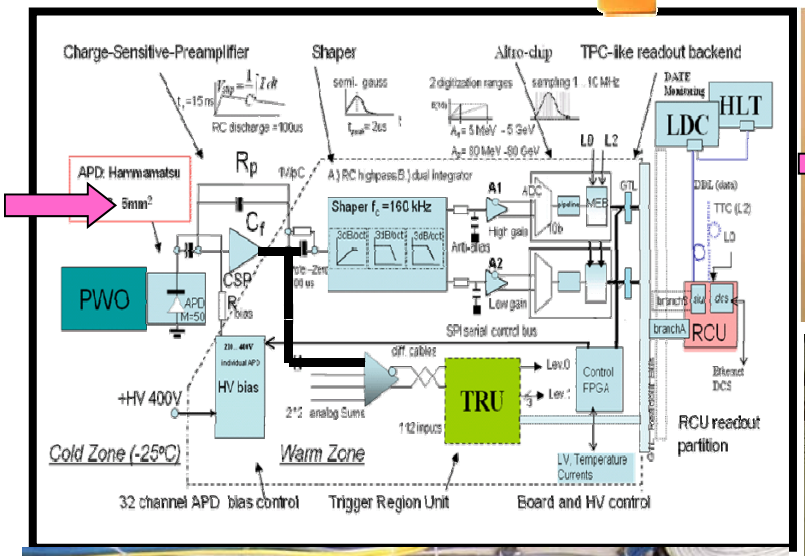
APD and CSP by Japan

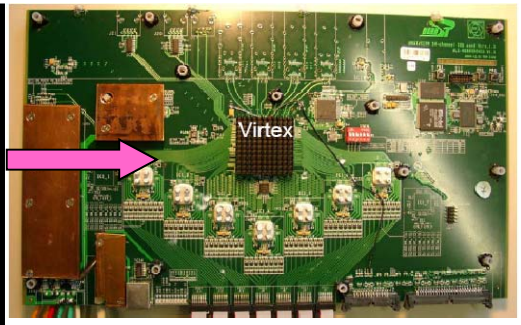


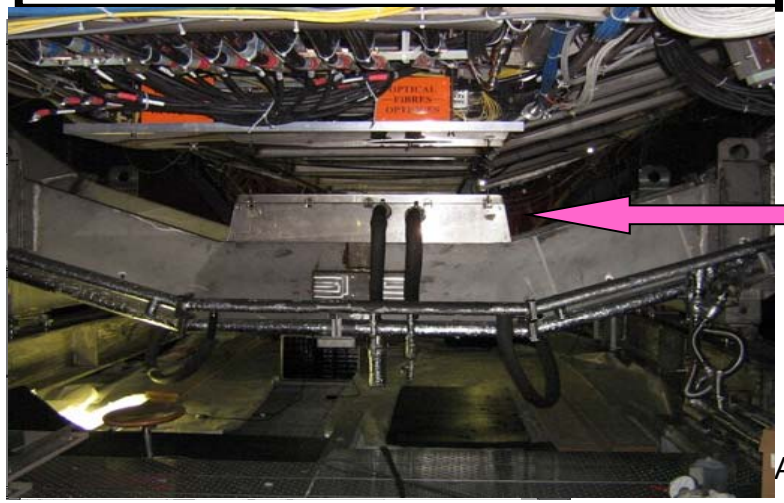


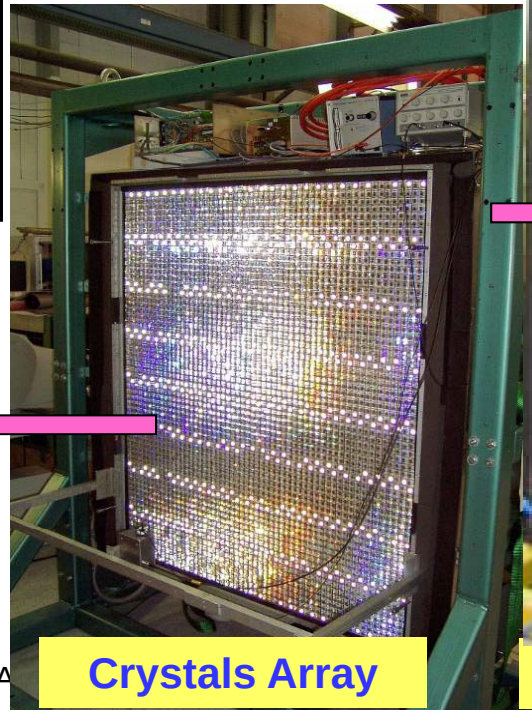
FEE



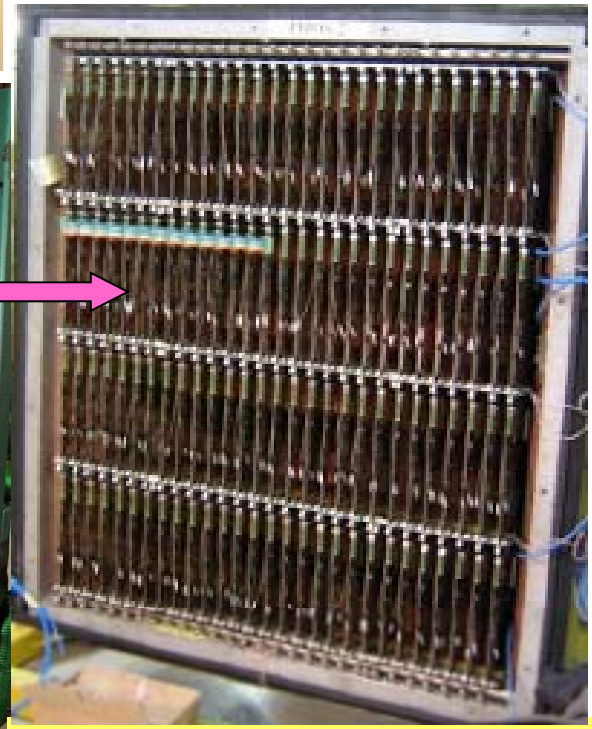






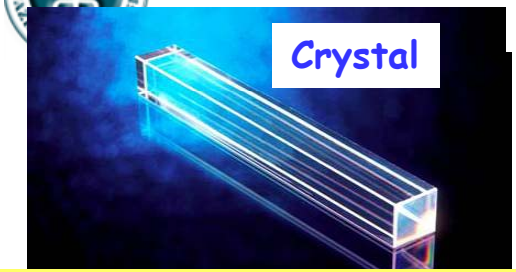


Crystals Array

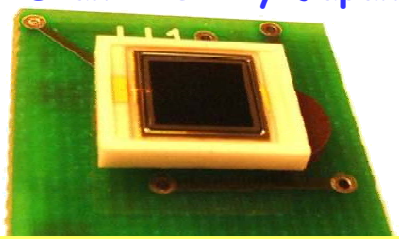


FEE Array

ALICE–PHOton Spectrometer (PHOS)



APD and CSP by Japan



FEE

- **PHOS : High-granularity, high-resolution EM calorimeter**
  - **64x56x5 $PbWO_4$ crystals readout with APD/CSP**
  - **Precise measurement of photons and neutral mesons**
  - $\Delta E/E \sim 3\%/\sqrt{E}$; Mass resolution: $\sigma \sim 4.7$ MeV
  - pt measured from ~100MeV/c to ~100 GeV/c
  - **level-0 and level-1 trigger**
  - **Partial installation 3/5 as of 2009**

  - **Hiroshima, CCNU, CIAE, HUST**

Crystals Array

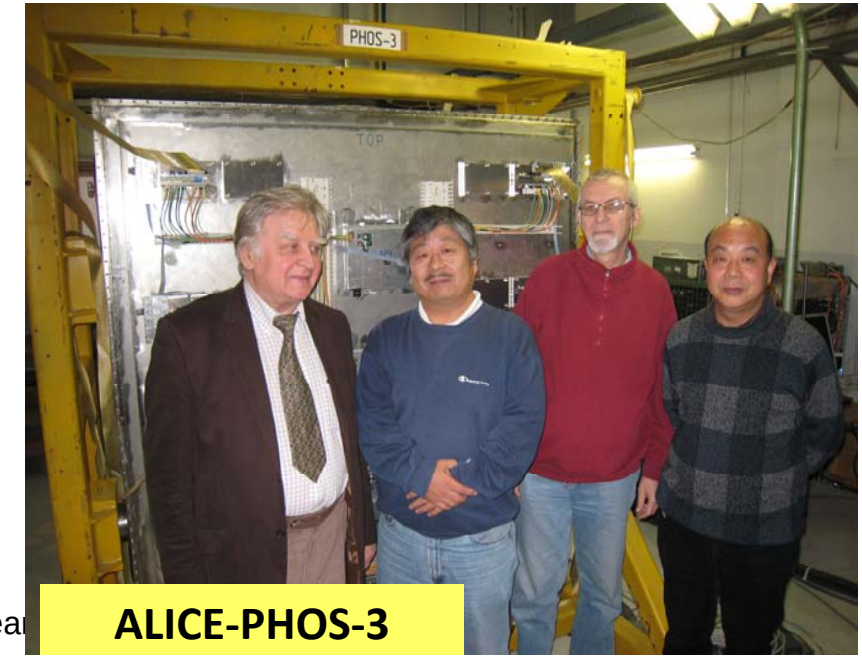
FEE Array

ALICE/PHOS FEE production and test

ccnu Lab.

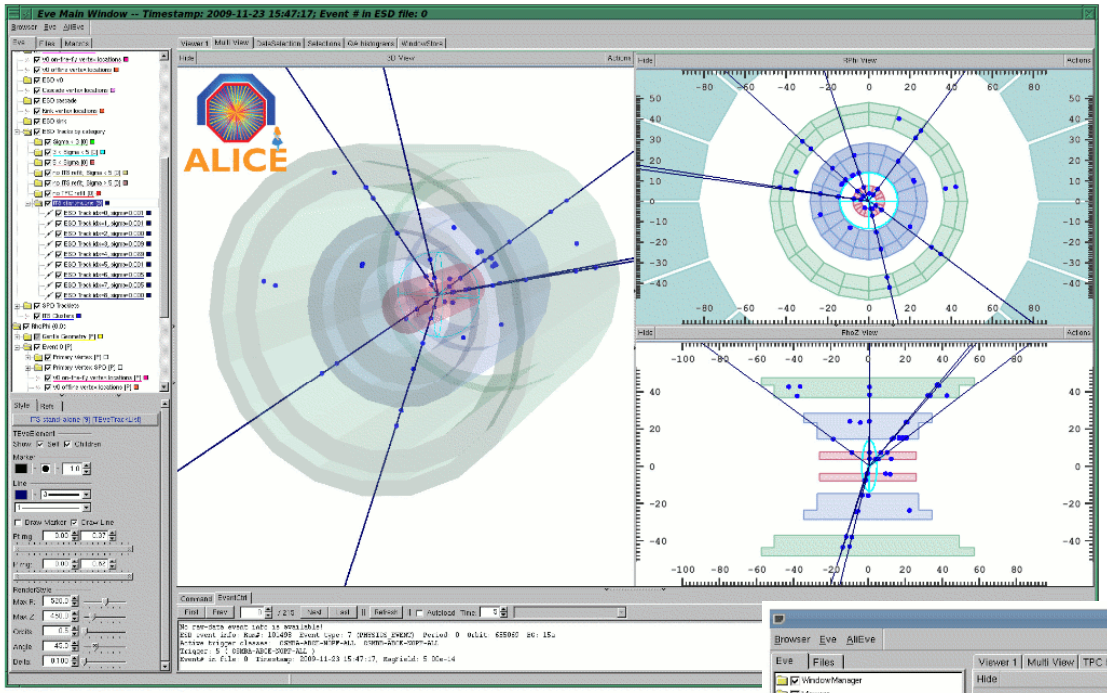
Hiroshima team

CCNU team

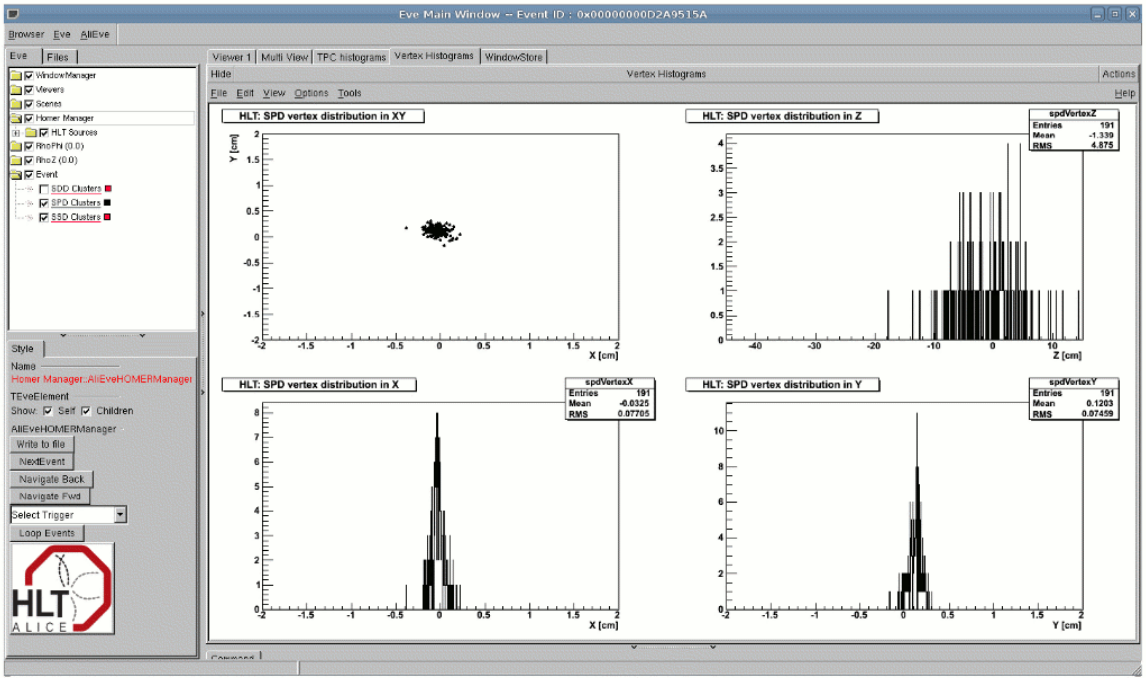


ALICE-PHOS-3

The first collisions



The first collision candidate from event display



Online display of the vertex position reconstructed by HLT

The first physics paper accepted

First proton–proton collisions at the LHC as observed with the ALICE detector: measurement of the charged-particle pseudorapidity density at $\sqrt{s} = 900$ GeV

ALICE collaboration

Abstract. On 23rd November 2009, during the early commissioning of the CERN Large Hadron Collider (LHC), two counter-rotating proton bunches were circulated for the first time concurrently in the machine, at the LHC injection energy of 450 GeV per beam. Although the proton intensity was very low, with only one pilot bunch per beam, and no systematic attempt was made to optimize the collision optics, all LHC experiments reported a number of collision candidates. In the ALICE experiment, the collision region was centred very well in both the longitudinal and transverse directions and 284 events were recorded in coincidence with the two passing proton bunches. The events were immediately reconstructed and analyzed both online and offline. We have used these events to measure the pseudorapidity density of charged primary particles in the central region. In the range $|\eta| < 0.5$, we obtain $\mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta = 3.10 \pm 0.13(stat.) \pm 0.22(syst.)$ for all inelastic interactions, and $\mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta = 3.51 \pm 0.15(stat.) \pm 0.25(syst.)$ for non-single diffractive interactions. These results are consistent with previous measurements in proton–antiproton interactions at the same centre-of-mass energy at the CERN $\mathrm{Sp\bar{p}S}$ collider. They also illustrate the excellent functioning and rapid progress of the LHC accelerator, and of both the hardware and software of the ALICE experiment, in this early start-up phase.

The first physics papers

- Multiplicity density and charged multiplicity distribution
- Mean pt versus multiplicity
- Baryon transportation via p-p bar ratio
- Transverse momentum distribution of charged pion, kaon and proton
- Measurements on resonance such as K_s and Λ
- Neutral pion pt distribution
- Measurement of charm and beauty cross sections down to very low transverse momentum
- ……

Upgrade program born in Asia

1) The earlier collaboration between Asia countries on high energy heavy ion physics, originated from the first Athic 2006 in Yonsei, 2008 in Tsukuba, 2010 to be in Wuhan
2) The first workshop on photon and jet physics with LHC/ALICE in Wuhan in Dec. 3-7, 2008, to discuss the possibility to build Dijet calorimeter
3) This idea was submitted to ALICE by Tsukuba on behalf of Japanese team) and by CCNU on behalf of the Chinese team respectively in March 2009
4) A joined weekly meeting by EVO for DCAL physics since May 2009
5) Formal proposal formed together and submitted to ALICE collaboration in the end of June 2009 together.
6) A general DCAL proposal approved by ALICE in the end of Oct,2009
7) Production plan made by DCAL collaboration (Japan, China, USA, France and Italy) and approved by ALICE in the end of Oct , which should be finished before end of April 2011.
8) The workshop on ALICE upgrade by Asia counties In Nov. 5-7, 2009 was held in Yonsei.
9) Workshop on ALICE analysis strategy by Asia countries to be held in Hiroshima from Jan. 21-23 2010.

Workshop on Photon and Jet with Alice Dec.4-6.2008.CCNU. Wuhan

- Welcome
- program
- Participant
- Venue
- Lodging
- Transport
- Insadong

"The workshop for ALICE upgrades by Asian countries"

November 5-7, 2009

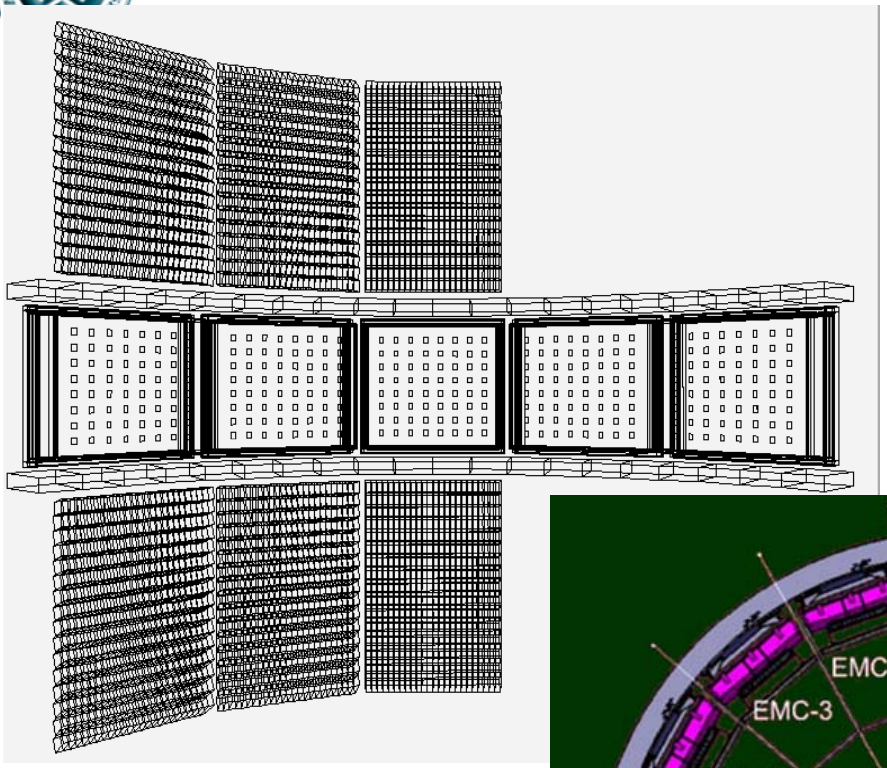
Yonsei University, Seoul, Korea

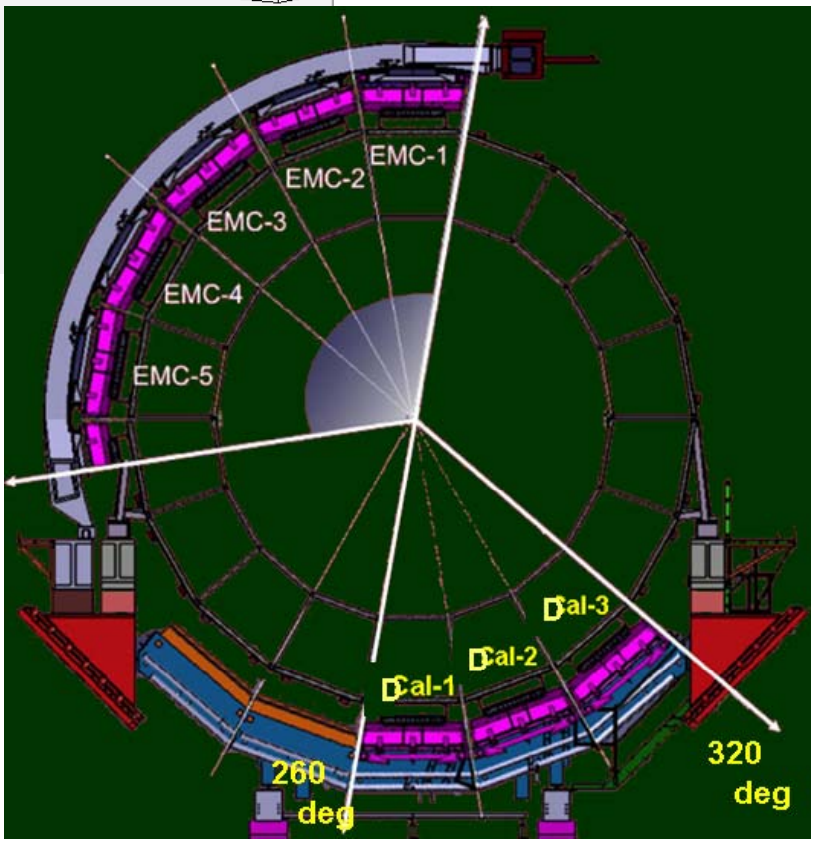
ALICE members from China, Japan, and Korea get together to discuss their current activities as the 1st collision at the Large Hadron Collider is about to occur. Participating members' previous experiences and plans for the future including detector upgrade will be exchanged under free discussion environment with a broad participation including graduate students. This workshop is organized by Yonsei University, Korea and Hiroshima University, Japan.

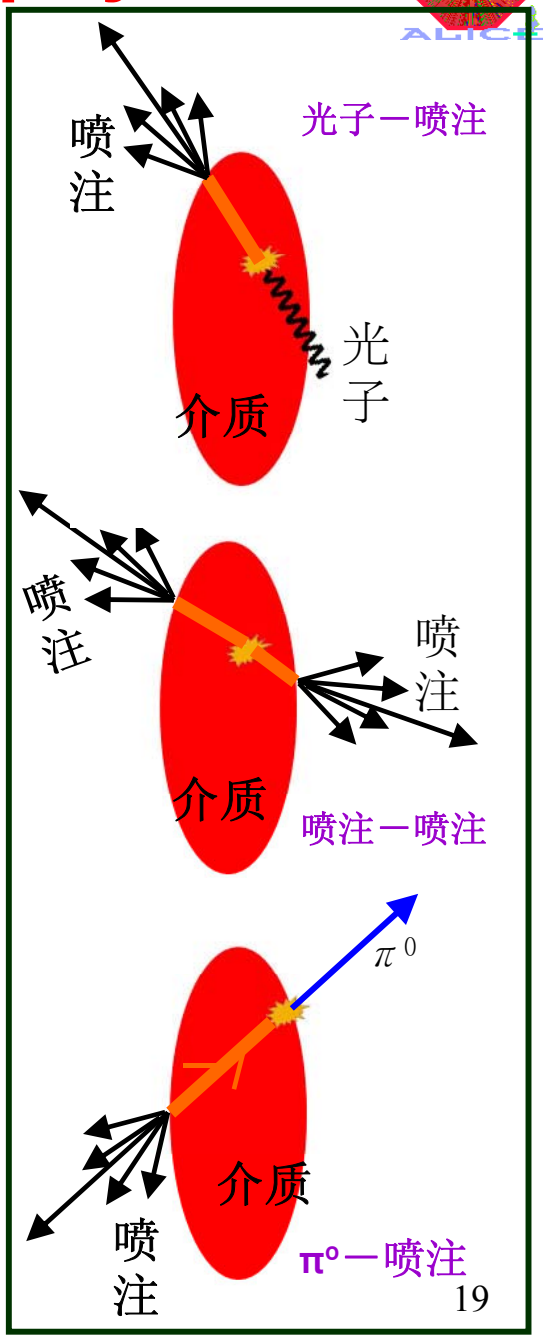
Organizing Committee:

Ju Hwan Kang (Yonsei University)
Youngil Kwon (Yonsei University)
Toru Sugitate (Hiroshima University)
Daicui Zhou (Central China Normal University)

ALICE-DCAL structure and physics

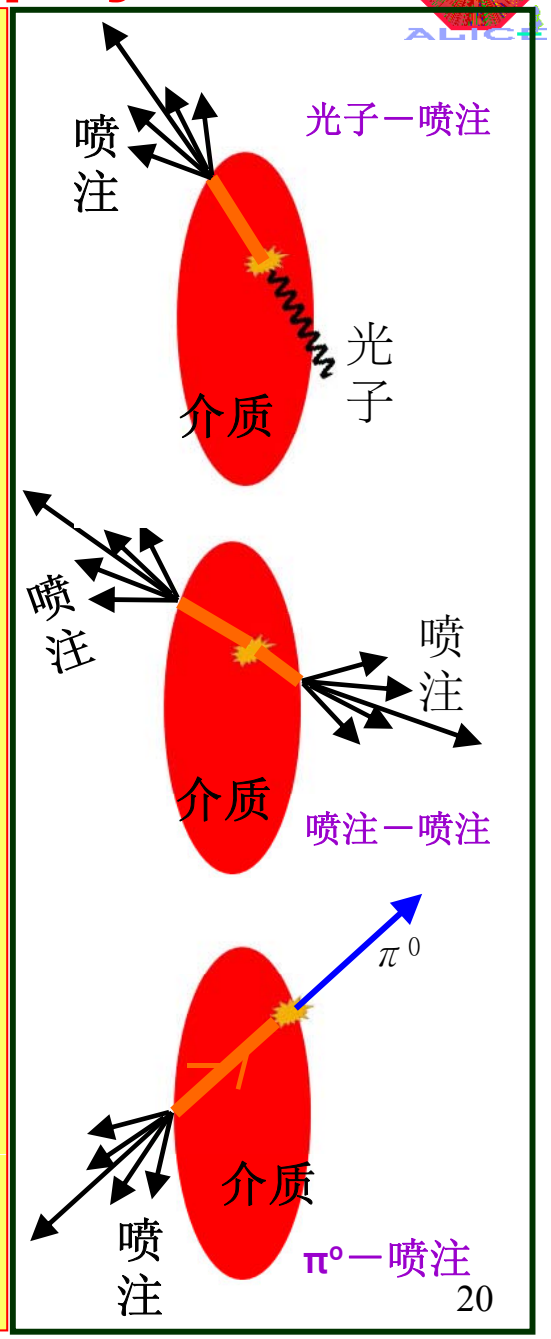






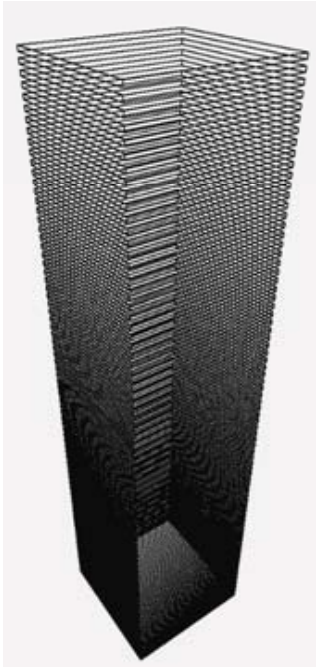
ALICE-DCAL structure and physics

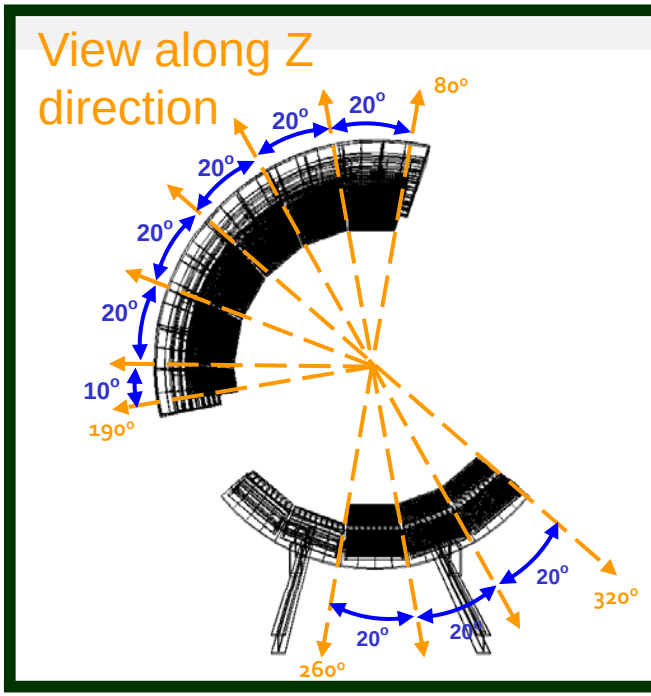
- DCAL denotes "Dijet Calorimeter", to enable significant γ-jet, π0-jet, dijet measurements
- The DCAL and PHOS together provides continuous coverage of 60 degrees in azimuth and $|\eta \leq| < 0.7$
- DCAL will extend significantly the jet quenching measurements enabled by the EMCAL
- DCAL is sued to probe fragmentation function modification in medium by particle Correlation measurement

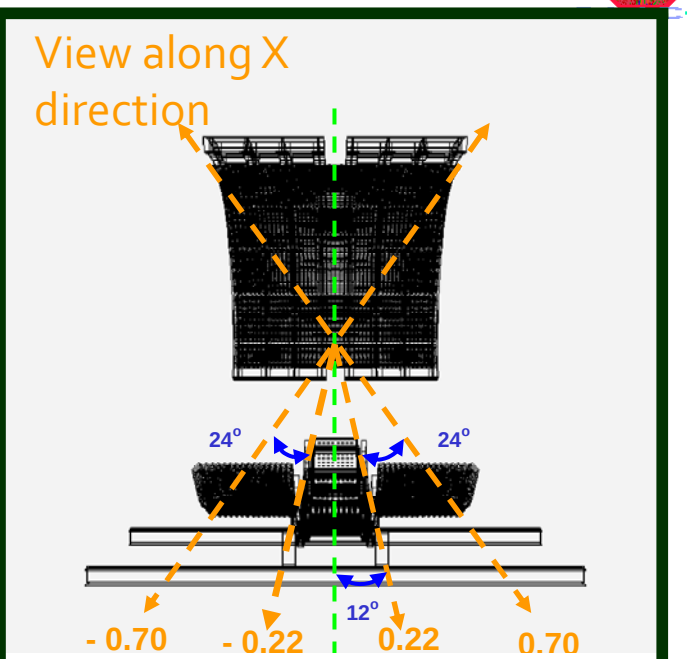


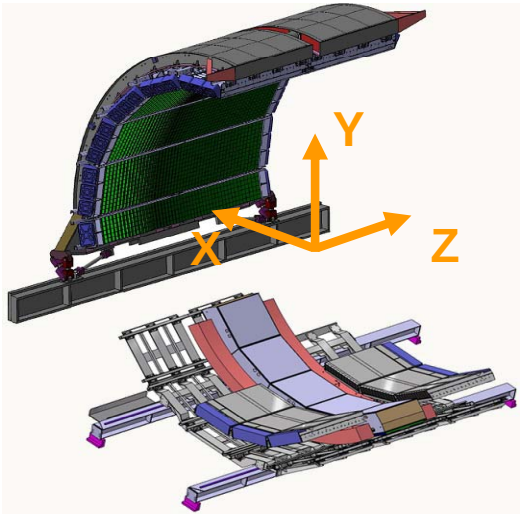
Full Geometry of the EMC system

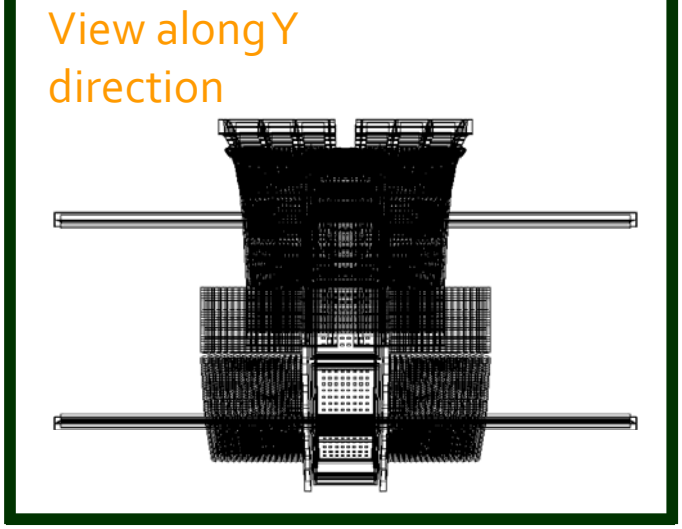
- EMC system created in ALICE software, AliRoot.
- DCal in AliRoot without the cradle
- Module structure





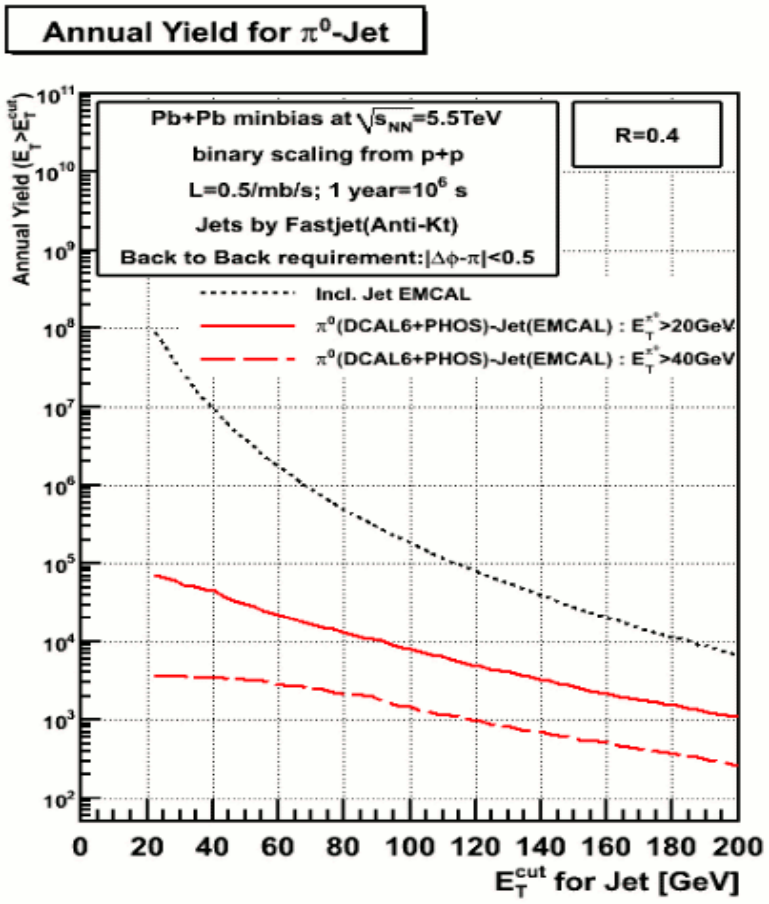


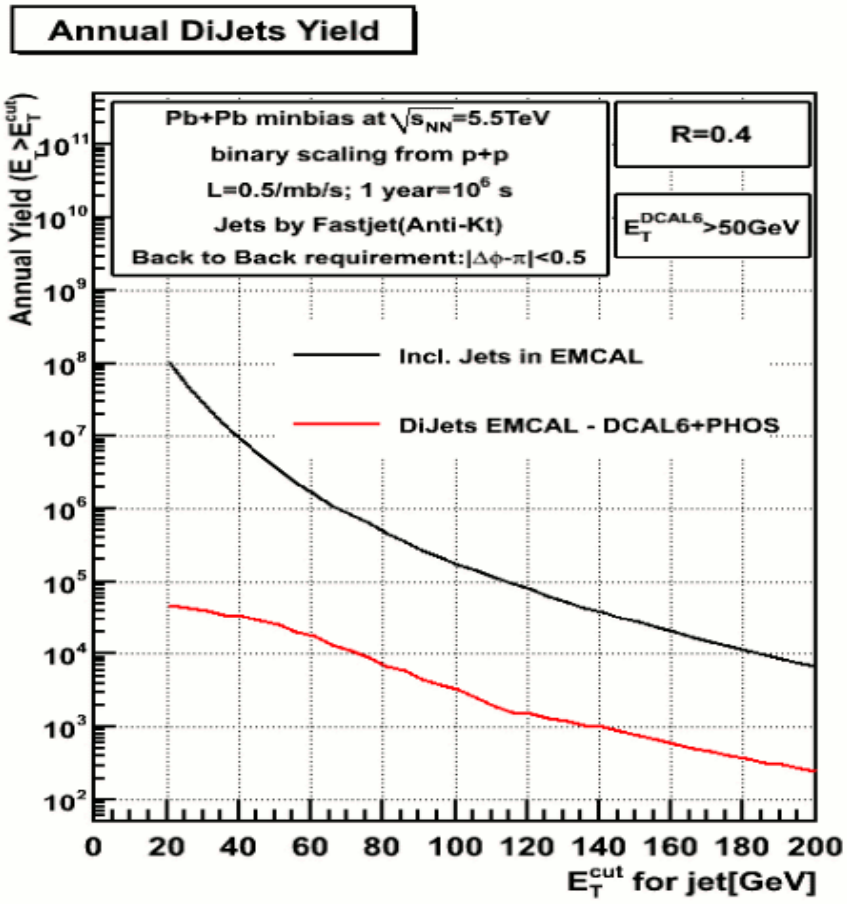




—— Geometry of EMC System

DCAL physics potentials





- **1000 EMCAL jets above 140 GeV given by DCAL jet trigger threshold of 50 GeV per heavy ion running year**

Summary & questions to address

- ALICE is a versatile, general purpose heavy ion detector at LHC
- ALICE is in very good shape and starts to produce physics papers
- ALICE will address general soft physics questions such as:
  - How does the system evolve and thermalize from its initial state? What are the properties of the QGP at LHC energies? Is QCD phase diagram featureless above Tc? Coupling strength vs T? Are there new phenomena?
- ALICE will address physics questions via hard probes:
  - What is the behavior of c-c bar and b-b bar states in medium?
  - Can we understand parton energy loss at a fundamental level? Medium modification? Flavor dependence?
  - Can we understand the hadronization process?

Thanks a lot

Members of ALICE and STAR Wuhan group

ALICE detectors & acceptance

- **Central barrel (-0.9<η<0.9)**
  - 2π in azimuthal tracking and PID (ITS, TPC, TRD, TOF)
  - single arm RICH (HMPID)
  - single arm e.m. cal (PHOS)
  - jet calorimeter (EMCAL)
- **Forward muon arm (-4<η<-2.4)**
  - absorber, dipole magnet, 5 tracking + 2 trigger planes
- **Multiplicity detectors (-3.4<η<5)**
  - including photon counting in PMD
- **Trigger & timing detectors**
  - ZDCxs
  - V0
  - T0