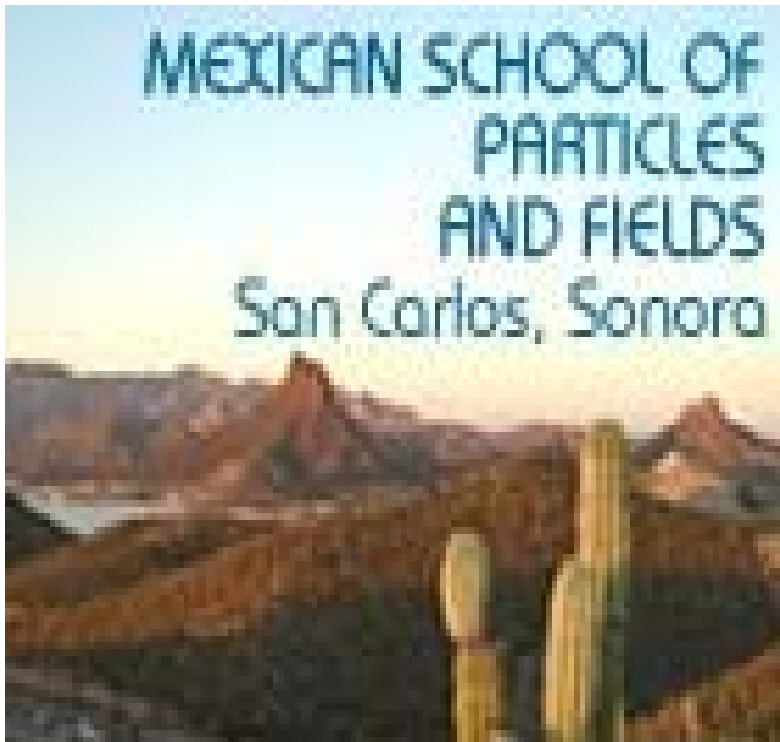


Very High Momentum Particle Identification Detector for ALICE



E. García
Chicago State University

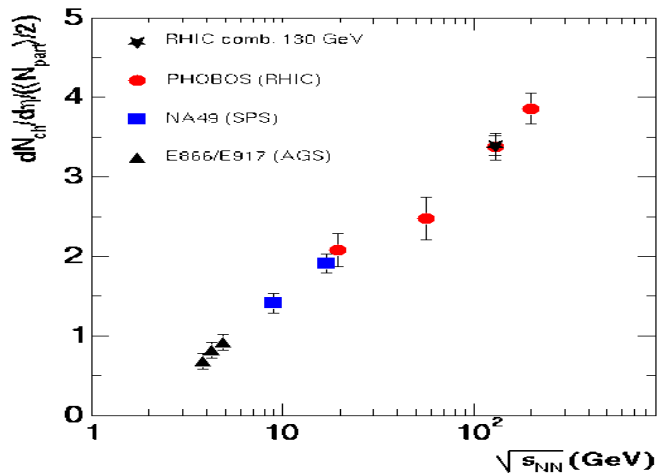
October 2008
Sonora, Mexico

Outline

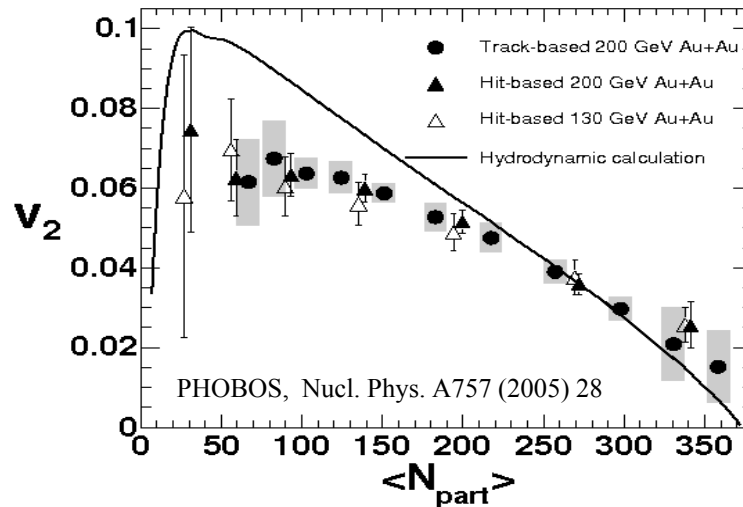
- Background to the **V**ery **H**igh **M**omentum **P**article **I**dentification **D**etector (VHMPID)
- Detector Characteristics and Simulation
- Physics possibilities (work in progress)
- Project Status and Plans

The reference: RHIC

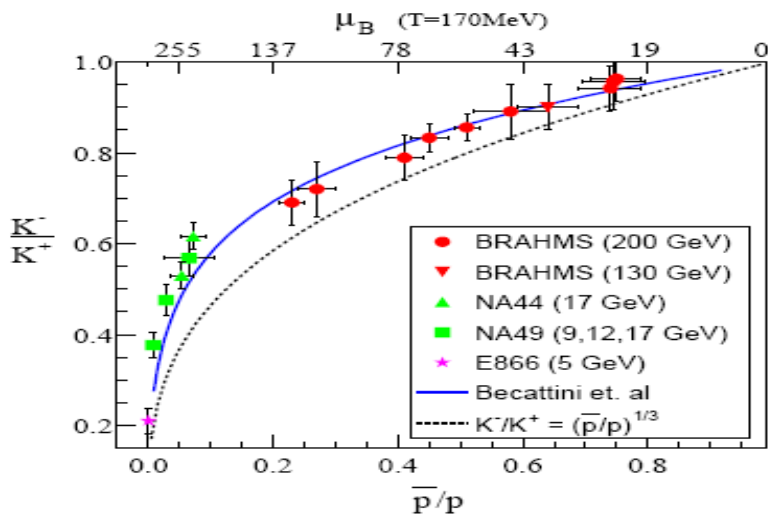
High energy density



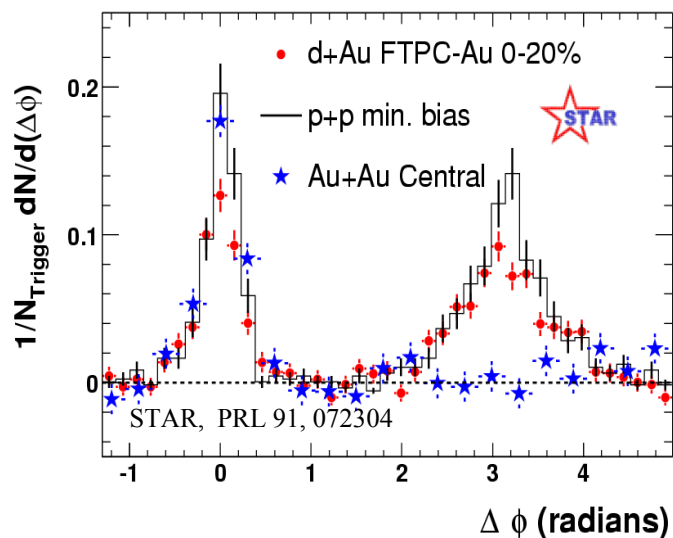
Elliptic Flow



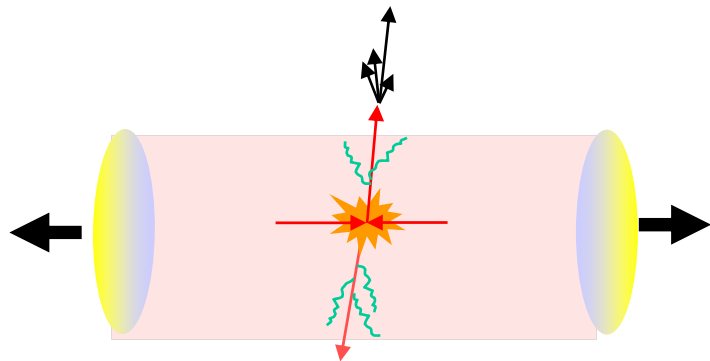
Applicability of thermodynamics



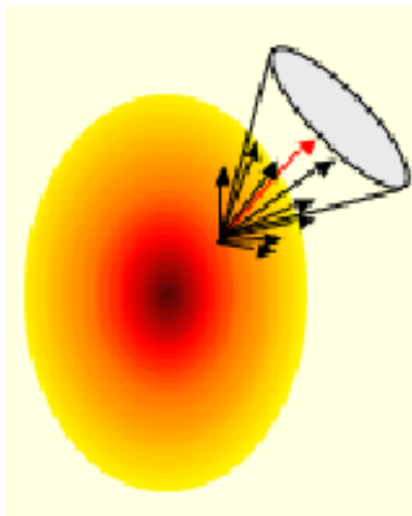
Jet Suppression



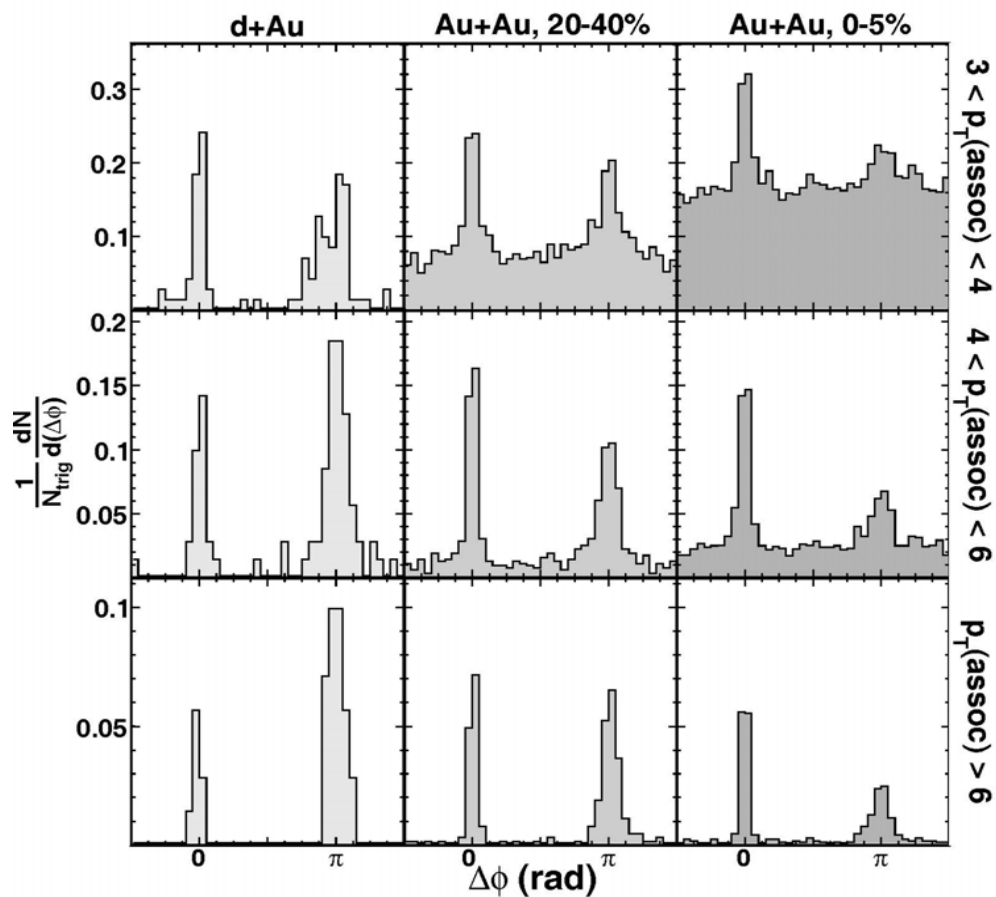
Jet Suppression



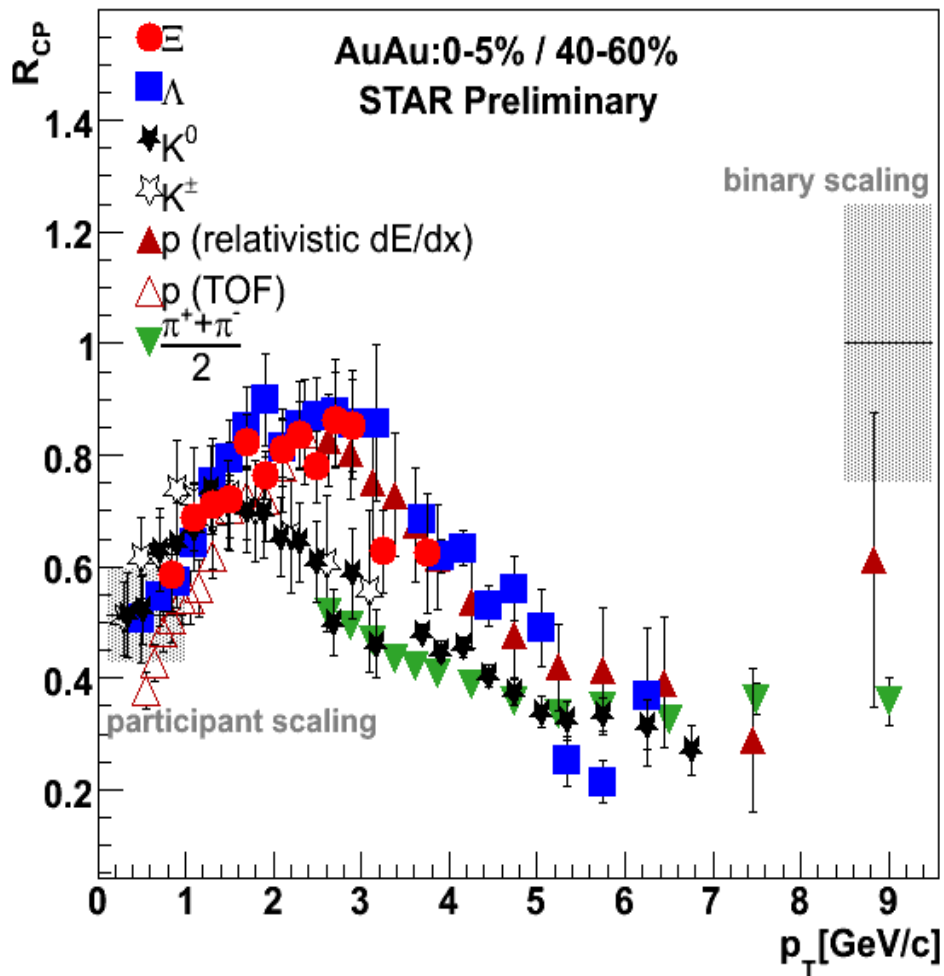
Yield suppression \rightarrow partonic energy loss in medium generated in collision



Jet energy loss deposited in generated medium



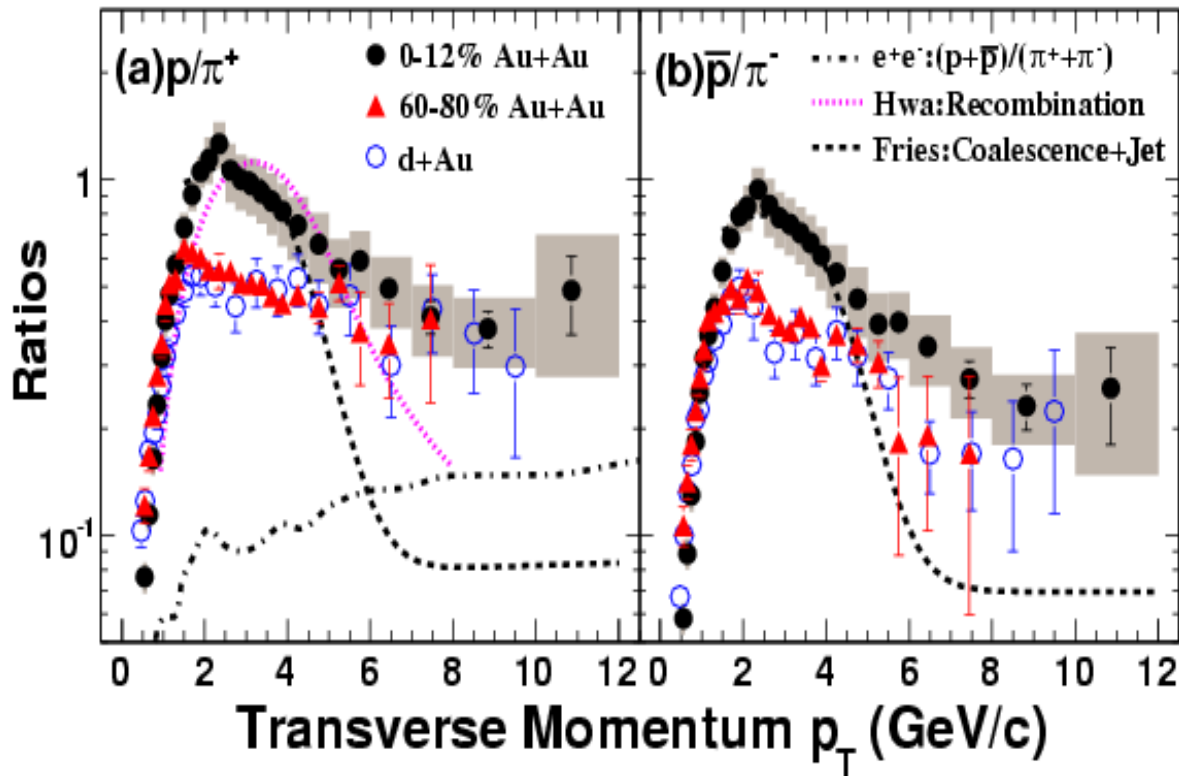
Baryon/Meson Anomaly at intermediate p_T



- R_C is the N_{BIN} scaled central to peripheral yield ratio
- At intermediate p_T baryon to meson splitting independent of the strangeness content
- At high p_T all particles have similar R_{CP} and appear to show similar suppression

Baryon/Meson Puzzle at RHIC

STAR, PRL 97 (152301) 2006

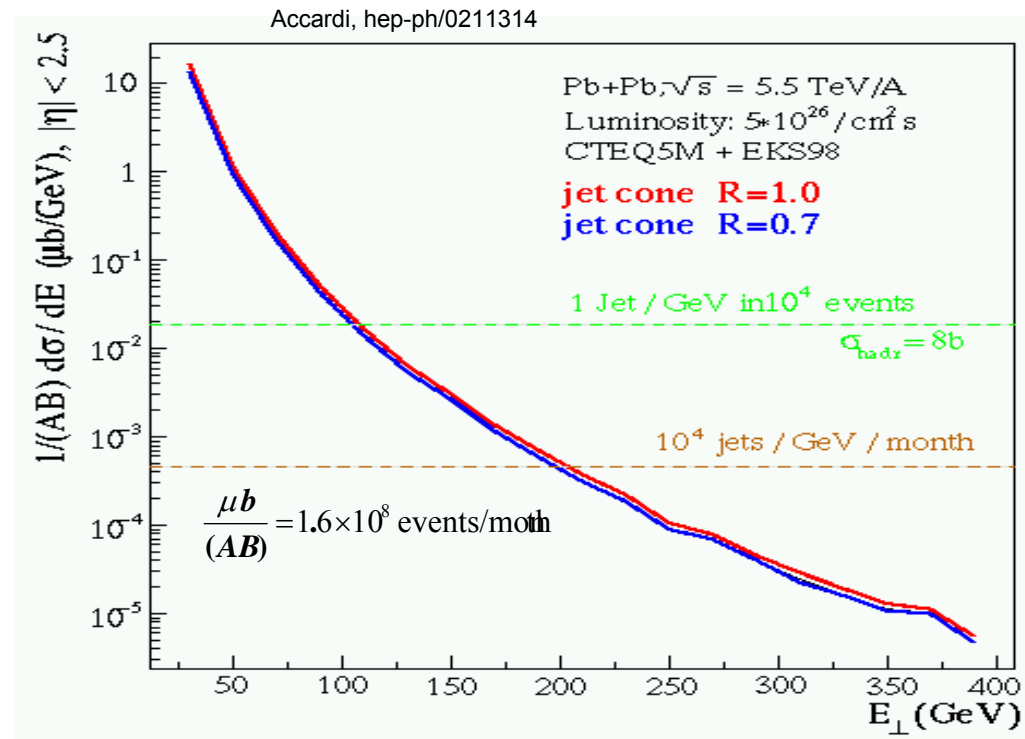
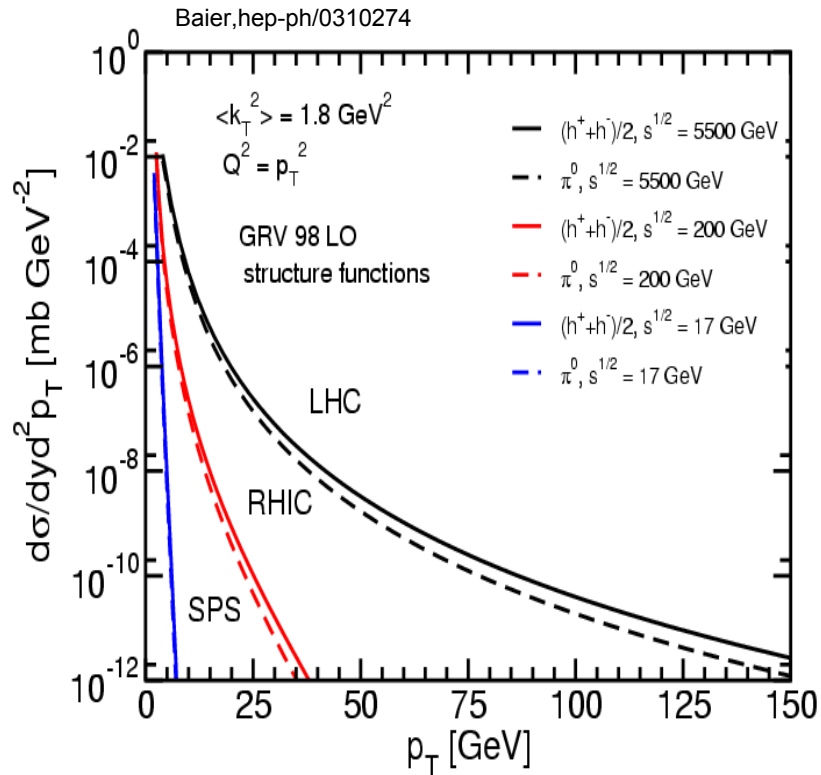


- Large enhancement of baryon to meson ratio in A+A collisions
- Reaches max. at $p_T \sim 3$ GeV/c
- Jet fragmentation not the dominant source of hadronization

p+p: $p/\pi \sim 0.2$
 Au+Au: $p/\pi \sim 1$

- Flow effects?
 Recombination?

From RHIC to LHC

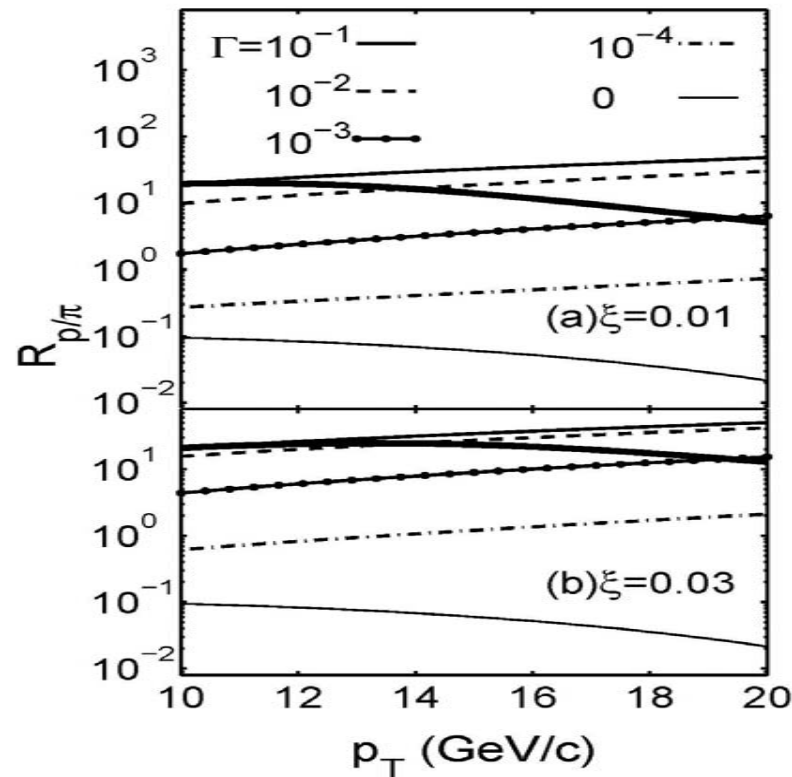
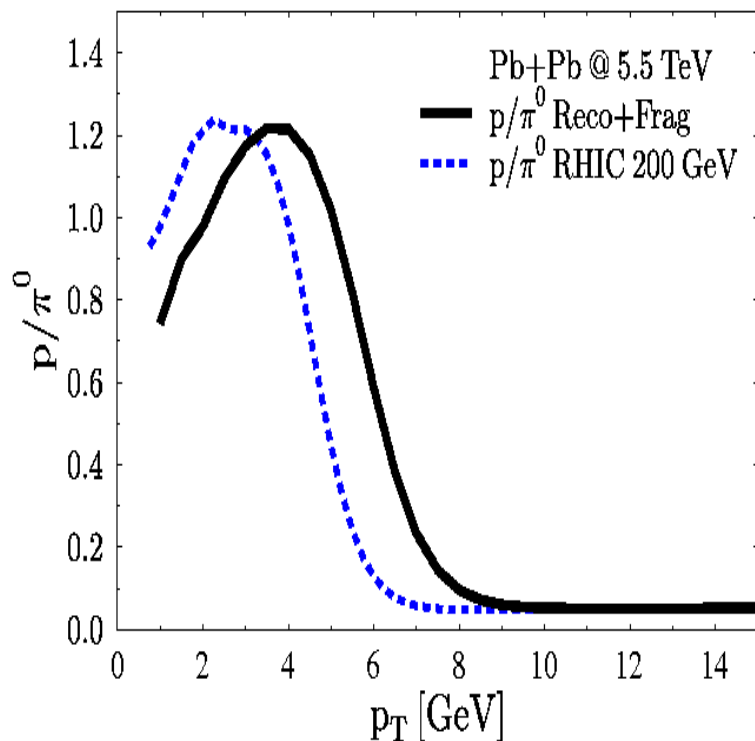


- Factor 28 increase in energy to $\sqrt{s_{\text{NN}}} = 5.5 \text{ TeV}$
- High Luminosity
- Large Cross sections
 - High p_T particles
 - Jets, which are now directly identifiable

Baryon/Meson Ratio at the LHC

R.C. Hwa and C.B. Yang, PRL 97, 042301 (2006)

Fries and Mueller, EJP C34, S279 (2004)



- LHC vs RHIC: amplitude of baryon/meson ratio similar, but pushed to larger p_T .
- Probing baryon/meson differences at the LHC implies particle identification over a large p_T range (10 – 30 GeV/c)

ξ : suppression factor

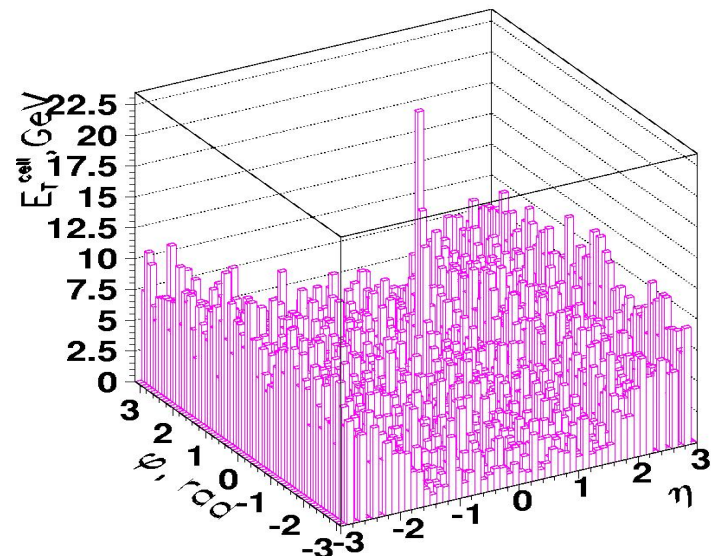
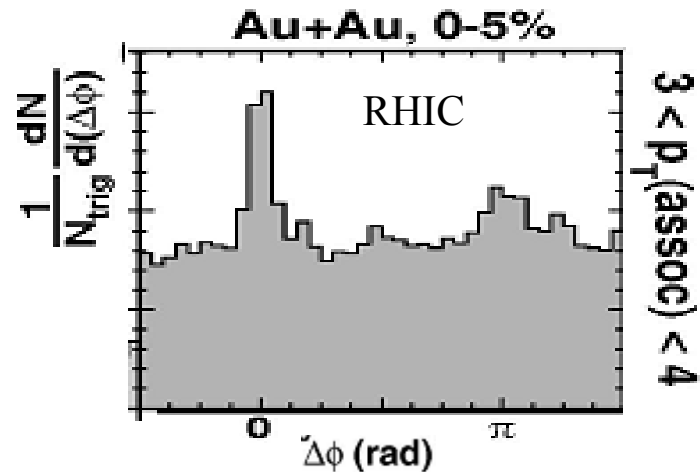
$\xi_{\text{RHIC}} = 0.07$

$\xi_{\text{LHC}} = 0.01-0.03$

Γ : overlap factor of shower partons from neighbouring jets

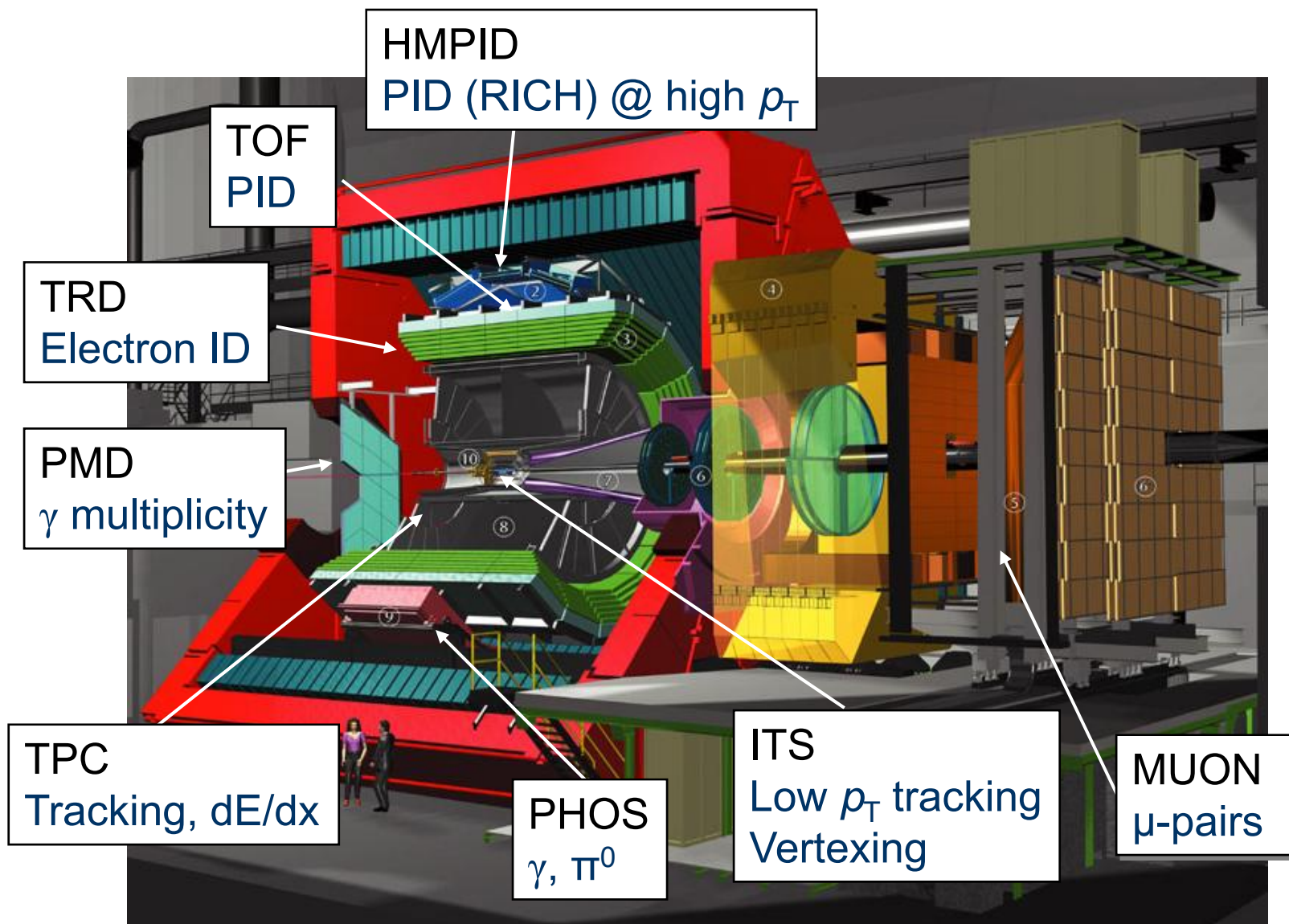
Challenges for Jet Physics at the LHC

- Higher production rates, and the hardening of the spectra may represent a challenge for study of intermediate energy jets.
- It may be difficult to separate the leading hadron and the hadrons from the “radiated” energy.
 - Low *signal to background* in this region maybe a challenge
- The jet correlation studies will require tracking and accurate PID capabilities (track-by-track)



Jet superimposed on 5 TeV Pb + Pb background

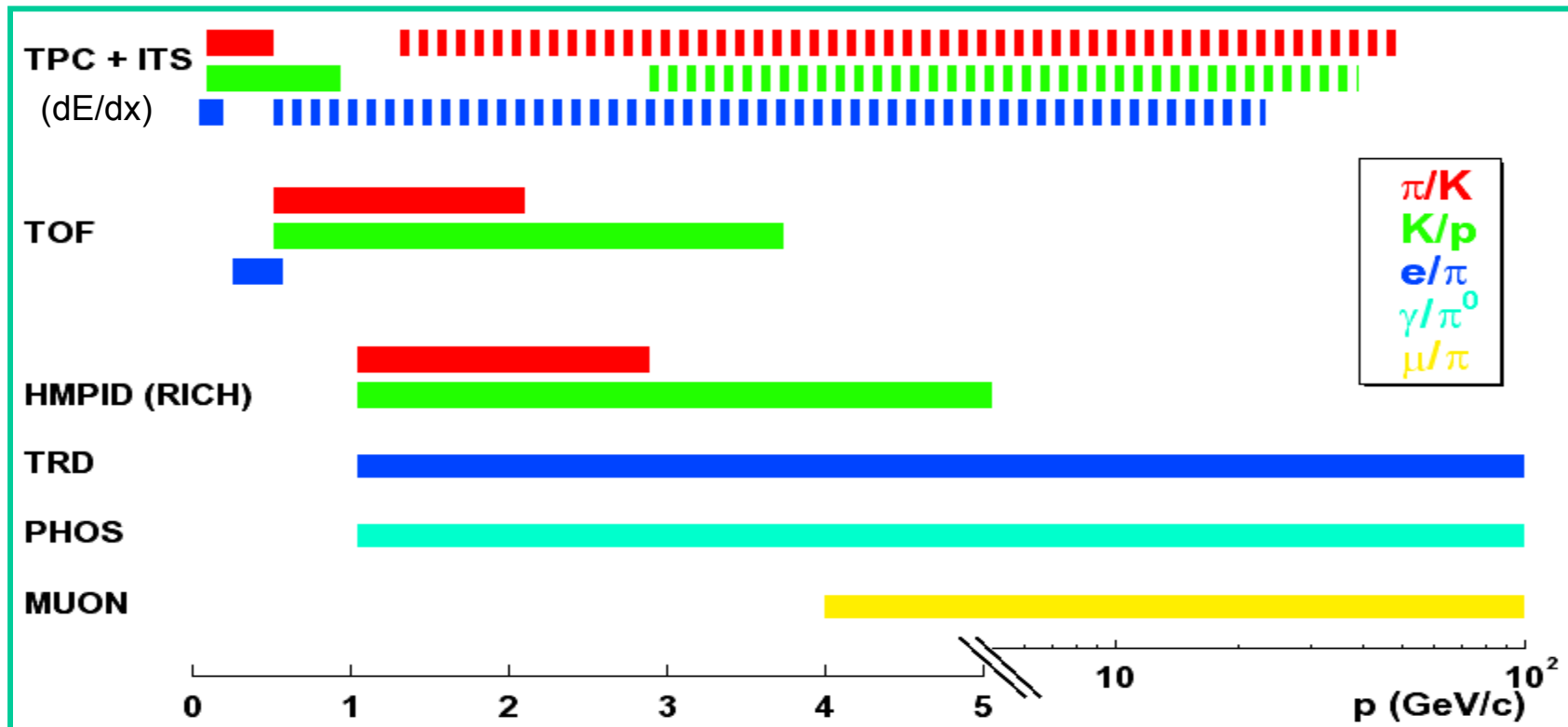
A Large Hadron Collider Experiment - ALICE



ALICE PID

■ separation @ 3σ

▨▨▨ separation @ 2σ



- Existing gap between low and high p_T ALICE for detailed (> 3 s) particle identification.
- Probing the hadronization mechanisms with ALICE suggests an upgrade for track-by-track PID in the momentum range of 10 – 30 GeV/c

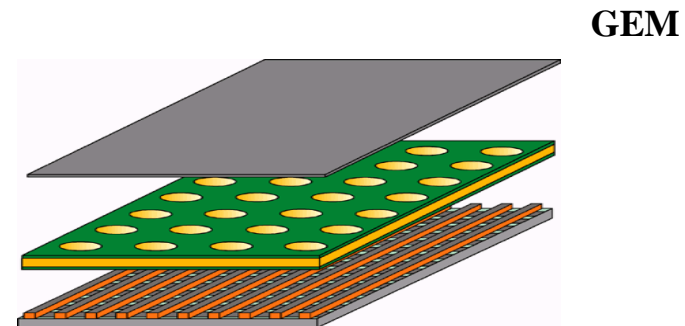
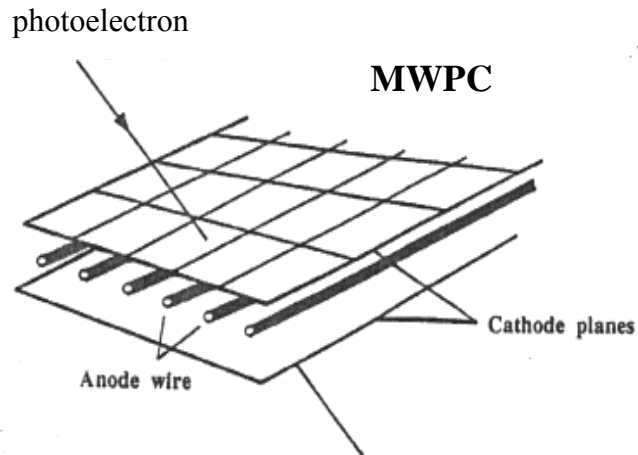
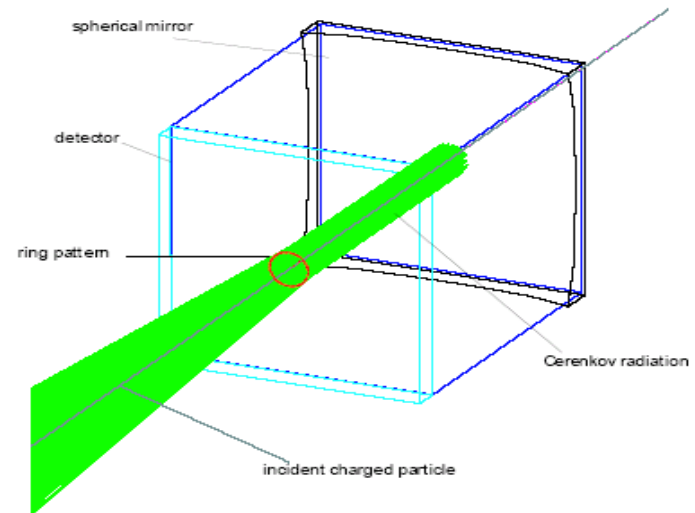
VHMPID

The challenge

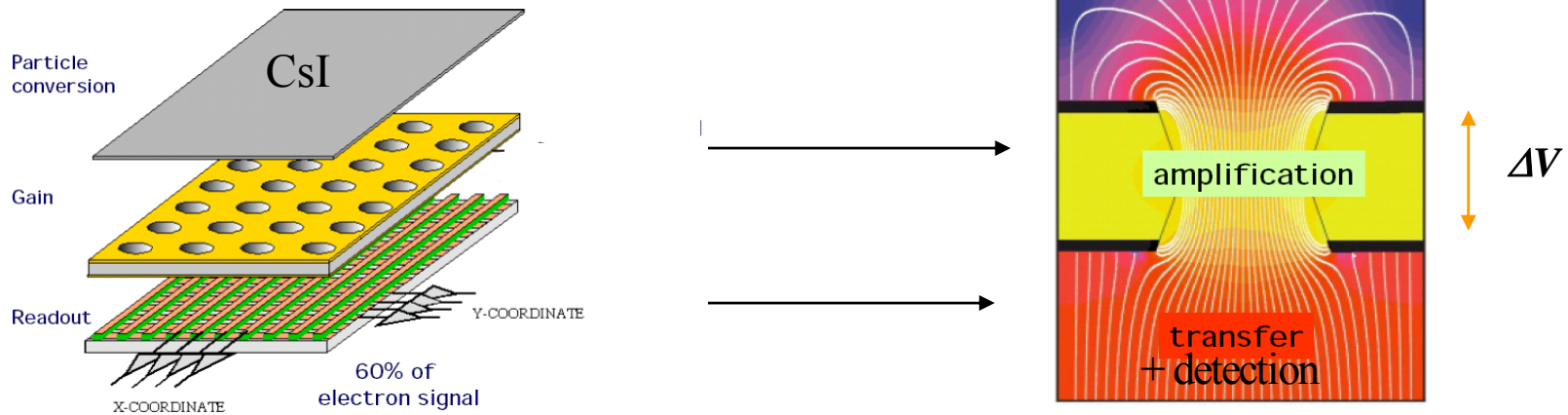
- Relatively small detector covering $\sim 5\%$ of acceptance of ALICE's central barrel
- 0.5 T magnetic field
- PID in the range of 10 – 30 GeV
- Good separation resolution (3s)
- Enough granularity that allows the discrimination of background in a central HI collision

VHMPID Geometry

- C_4F_{10} gas radiator ($n = 1.0014$)
- Large area CsI photon-to-electron converter
- Position sensitive charged particle detector
 - Multi wire proportional chamber (MWPC)
 - Gas electron multiplier (GEM)



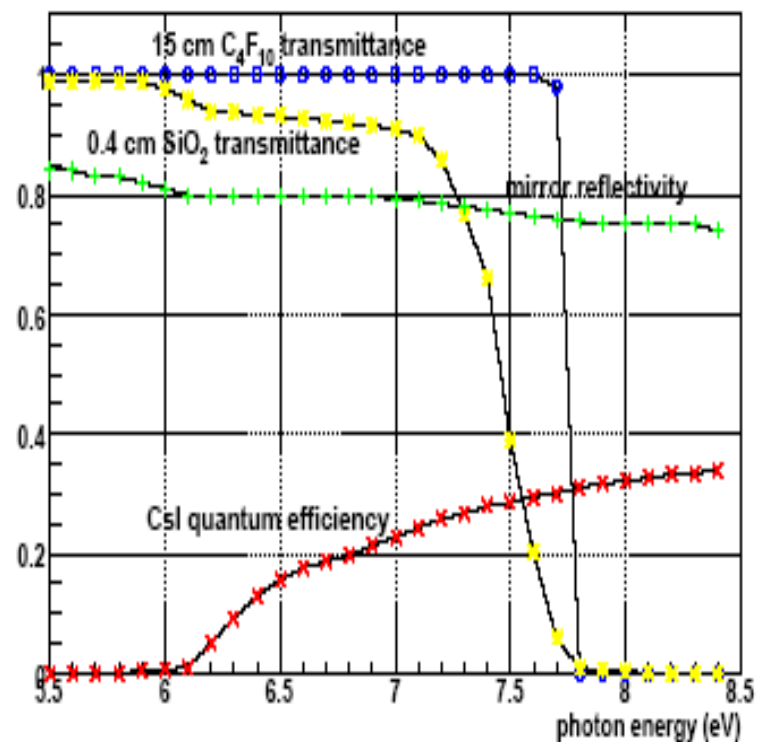
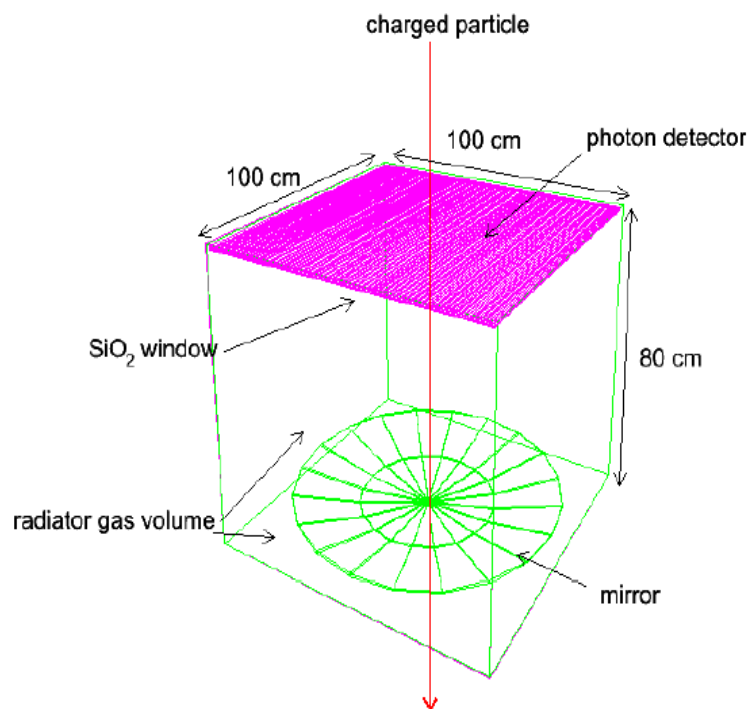
Gas Multiplier Detector



- Alternative to the MWPC
- Composite grid consisting of two metal layers separated by a thin insulator etched with a regular matrix of open channels (holes)
- The metal layers are kept at a suitable difference of potential, allowing the pre-amplification of the charge drift through the channels.
- GEM would improve the efficiency of the VHMPID, given the larger multiplication (gain)
- The sturdiness of the device when compared to a MWPC is also an advantage.

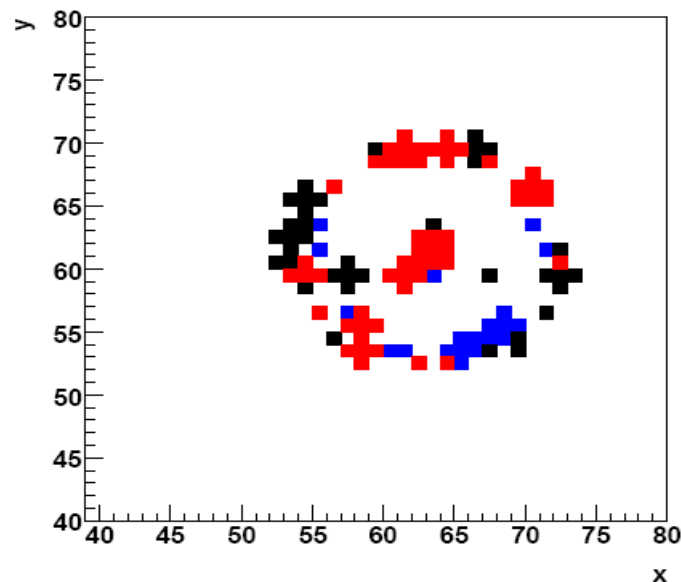
Simulation

- Based on AliRoot - GEANT 4
- The simulations include the CsI quantum efficiency, the gas transmittance and the optical characteristics of the proposed materials.
- They also include the photoelectron conversion and the response of the MWPC



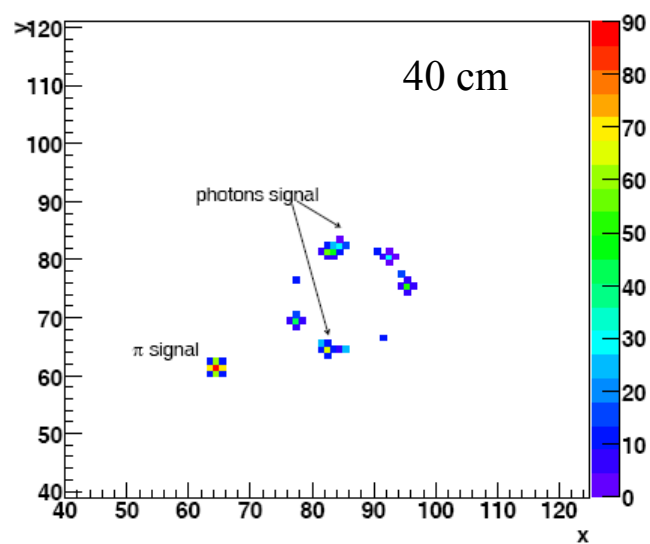
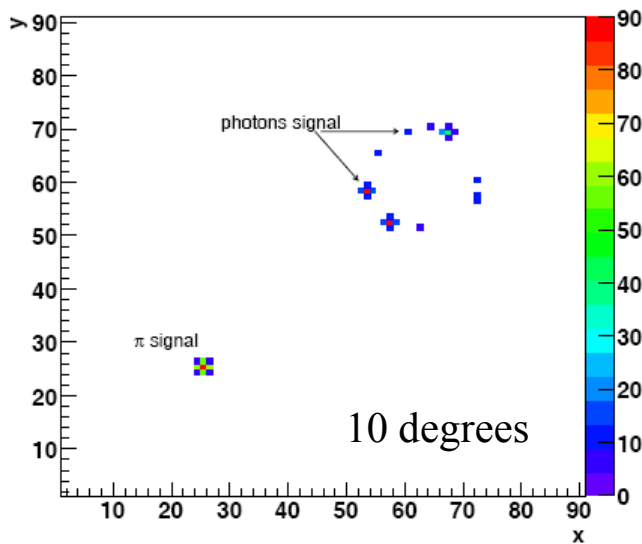
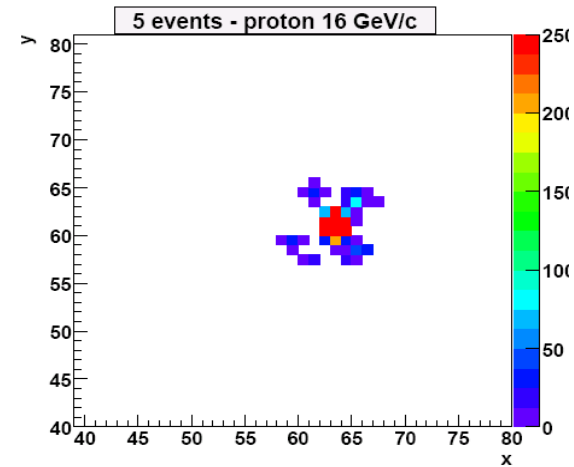
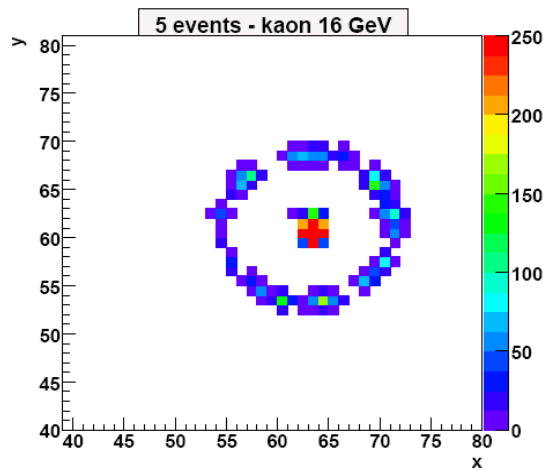
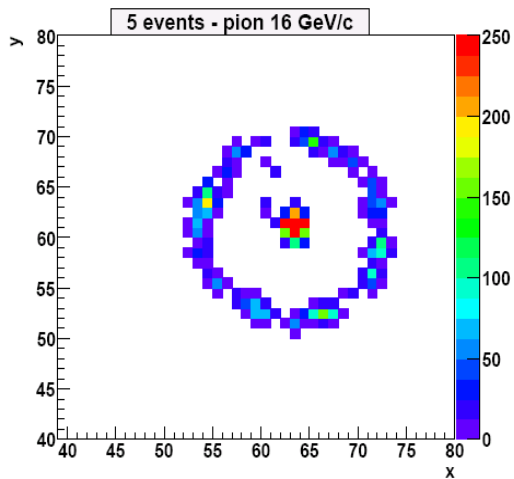
Simulation of Response of MWPC

- The response and pixel size of the MWPC's pads ($8 \times 8 \text{ mm}^2$) was included in the simulation
- The simulation was done with chambers of 122×120 pads corresponding to a surface of about 1 m^2
- Further parameters applied were those that reproduce satisfactorily the ALICE High Momentum Particle Identification Detector (HMPID) experimental results

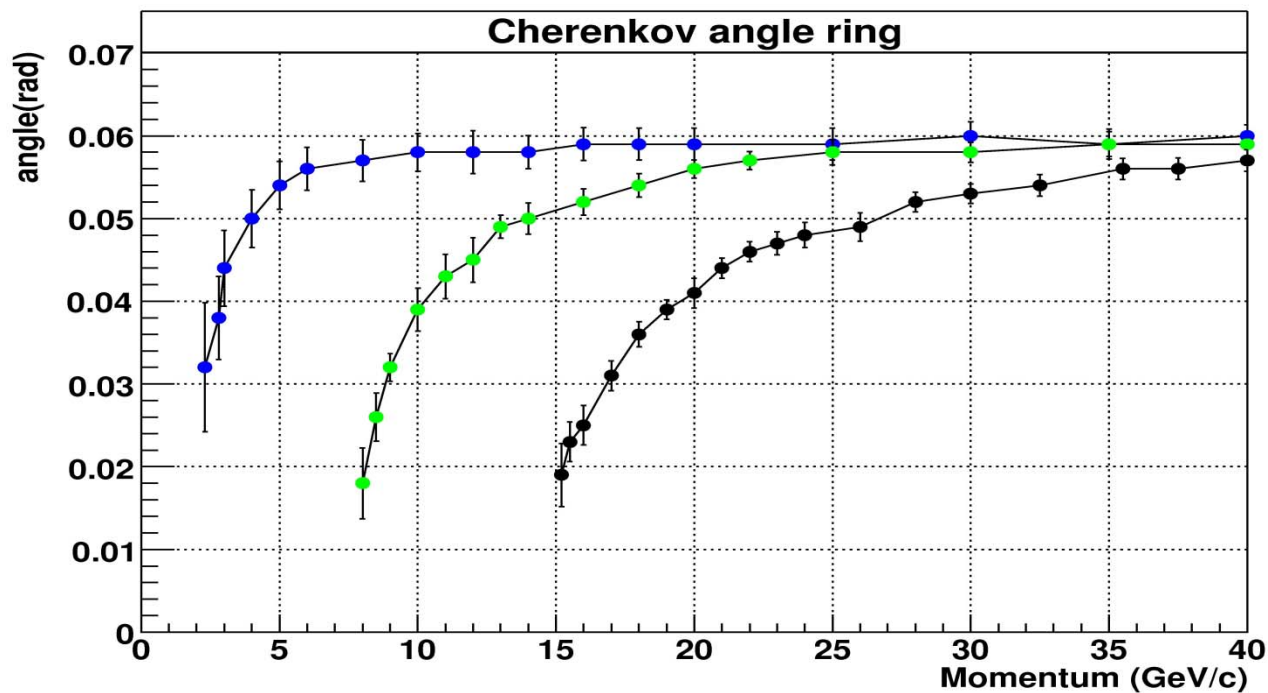


Ring image detected on MWPC. The rings are from one event of one incident $16 \text{ GeV}/c$ pion (black), one kaon (blue) and one proton (red).

Simulations cont.

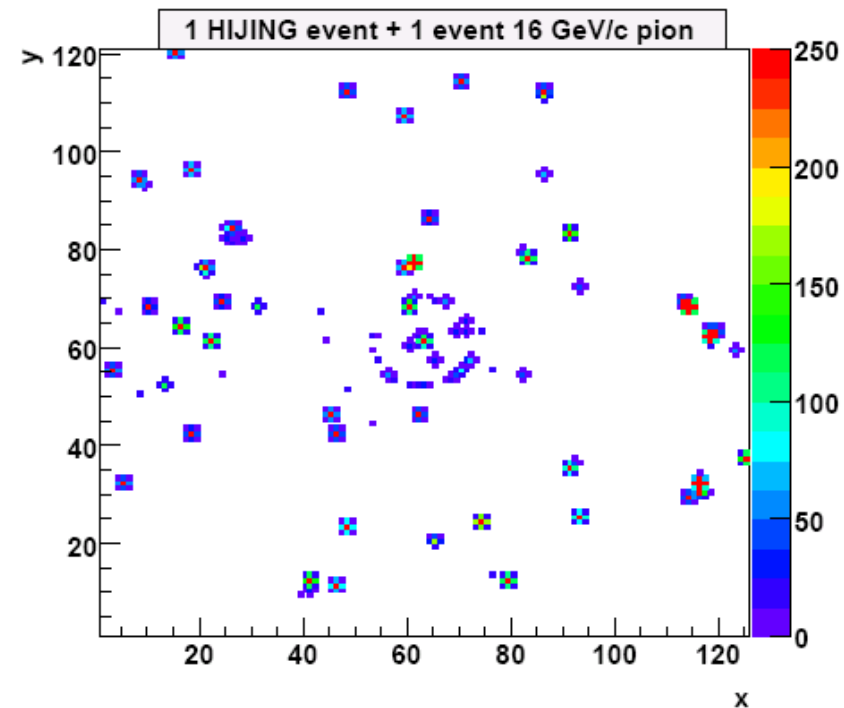
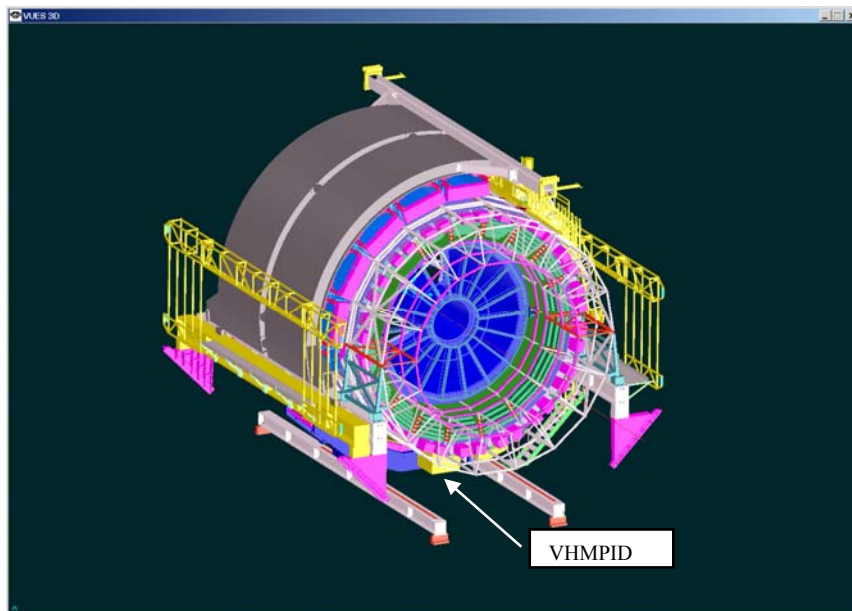


Simulations cont.



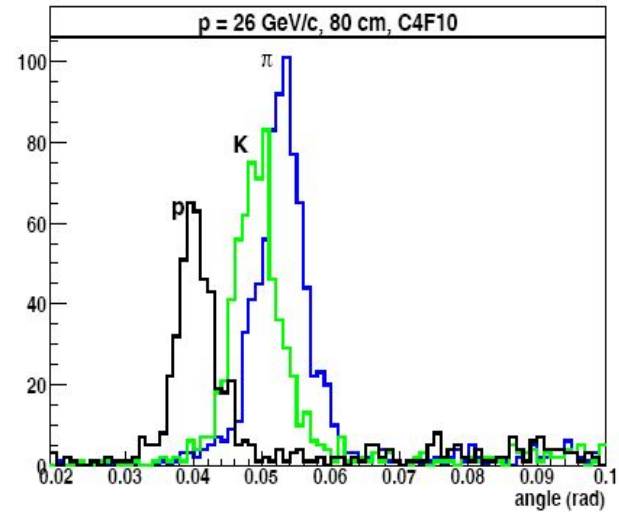
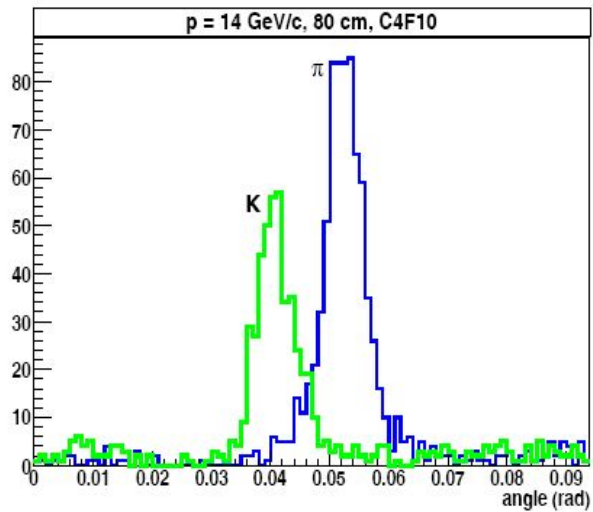
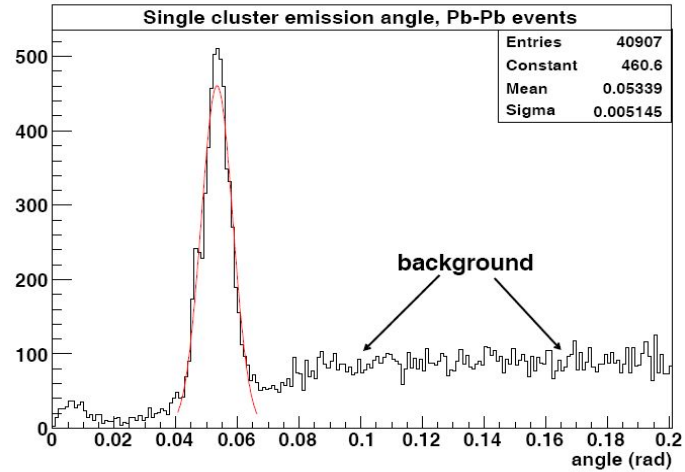
Identification momentum range		
Particle	With signal	Absence of signal
π	3–14 GeV/c	
k	9–14 GeV/c	
p	18–26 GeV/c	9–18 GeV/c

VHMPID Performance in “Beam” conditions



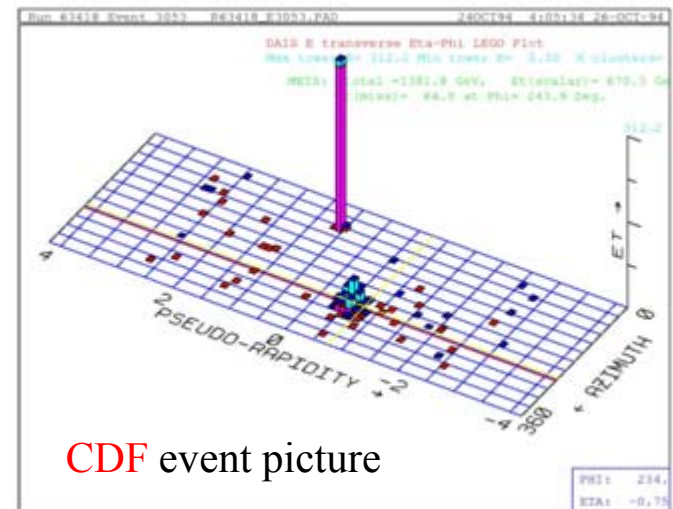
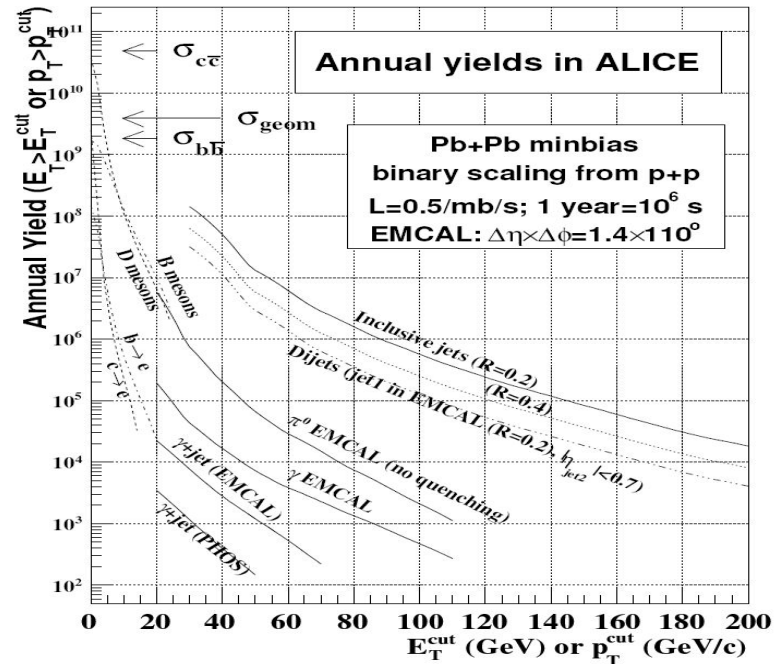
- The VHMPID detector is simulated at its proposed location with the ALICE detector.
- One pion track is embedded in a = 5.5 TeV Pb+Pb HIJING [20] event with a pessimistic charged particle multiplicity $dN_{ch}/dy \sim 4000$ at mid rapidity
- Pion track is clearly detected in the MWPC above the background
- Note that the proposed location of the VHMPID is opposite to the EMCAL

VHMPID Performance within background



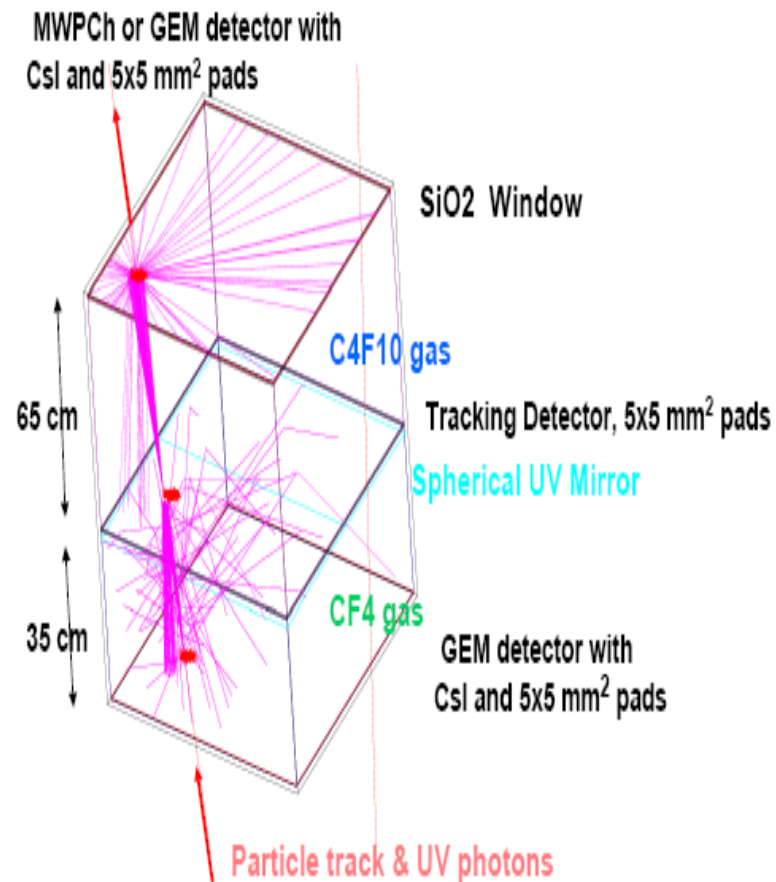
Physics Possibilities (work in progress)

- The proposed location of the VHMPID, opposite to the EMCAL opens the possibility to use both detectors to measure gamma-jet events.
- Triggering with the gammas in the EMCAL
- Measuring the jet composition in the VHMPID
- Study then hadronization, for example: compare the jet multiplicity for proton-leading vs. pion-leading jets



Two Chamber VHMPID

- High p_T trigger possibility: using the "MIP hits" from Cherenkov detectors and the hits from the tracking detector
- Tracks can be reconstructed by reconstructing the hits to a straight line and calculating the distance of close approach (DCA)
- This ("tracking") trigger can be used in a combination with "EMC trigger" specially for p+p and -jet studies.



Project Status

- Finalize simulations (physics studies) by the end of the year
- GEM test planned for this fall
- Finalize design by the end of the year
- Submit letter of intent to ALICE spring 2009
- Start construction of prototype summer 2009