sPHENIX upgrade at mid-rapidity

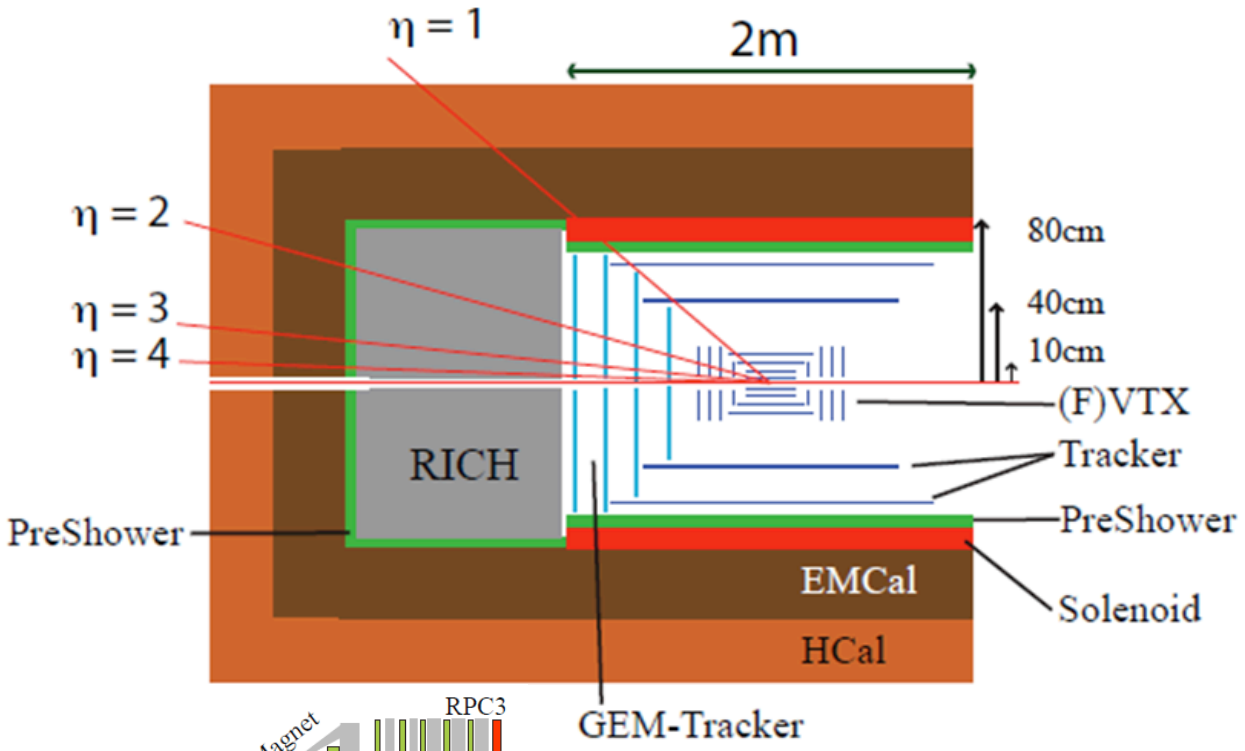
ShinIchi Esumi
Inst. of Physics, Univ. of Tsukuba

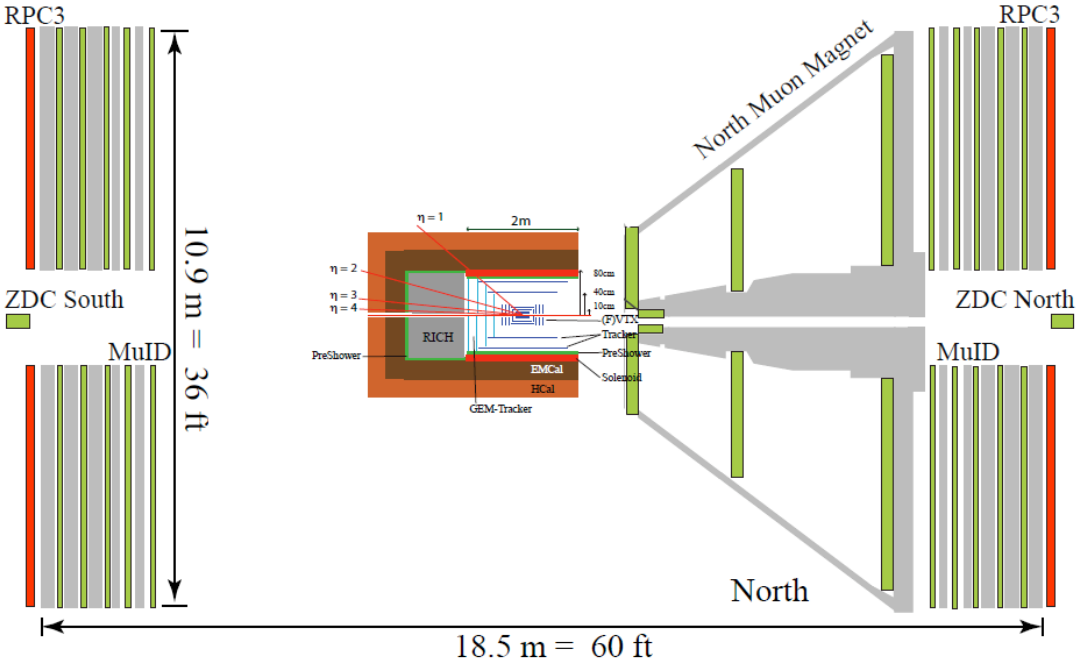
contents :

- Hadrons
- Electrons
- Photons
- Jets

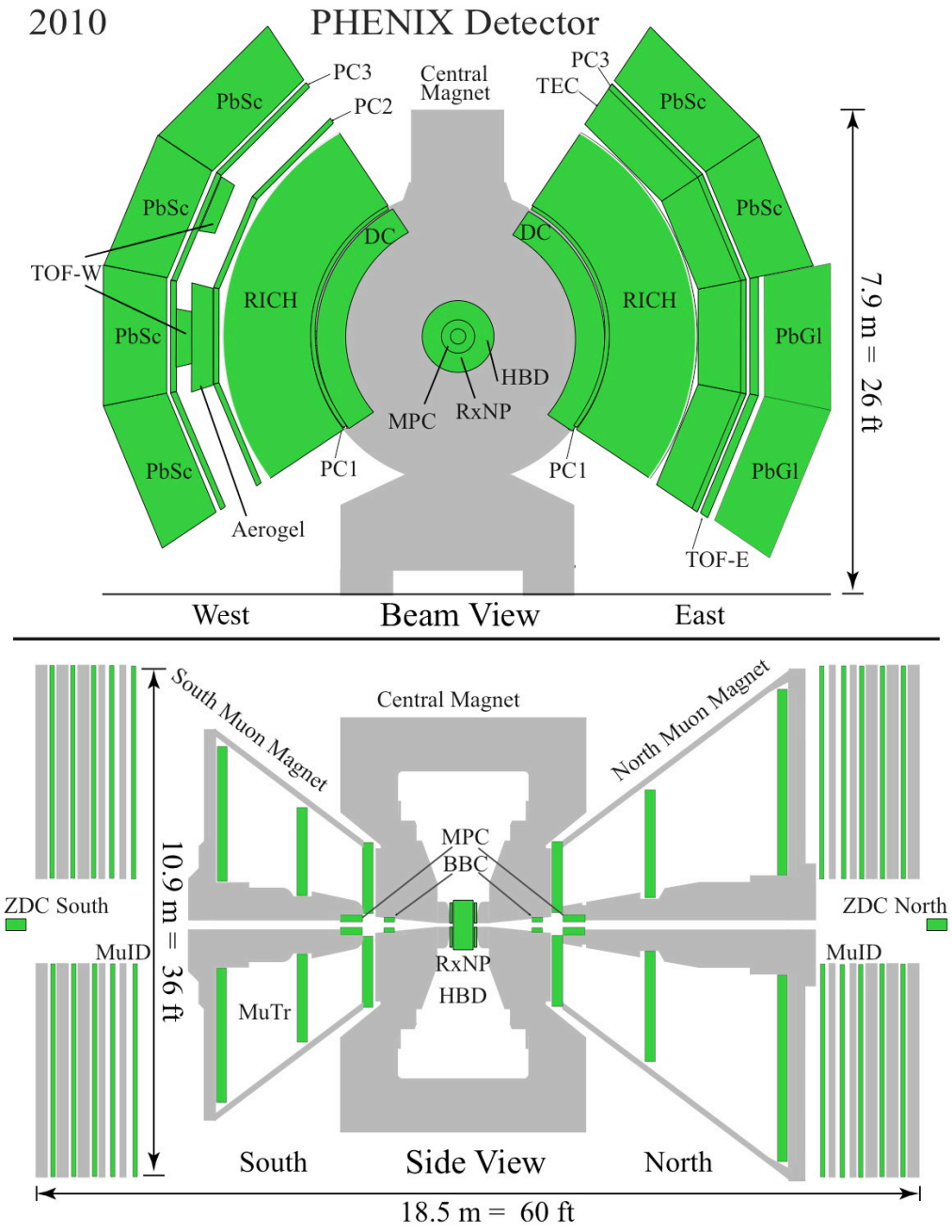
Workshop on :
"Future Directions in High Energy QCD"
20-22/Oct/2011
Nishina Hall, Riken, Japan

sPHENIX & ePHENIX

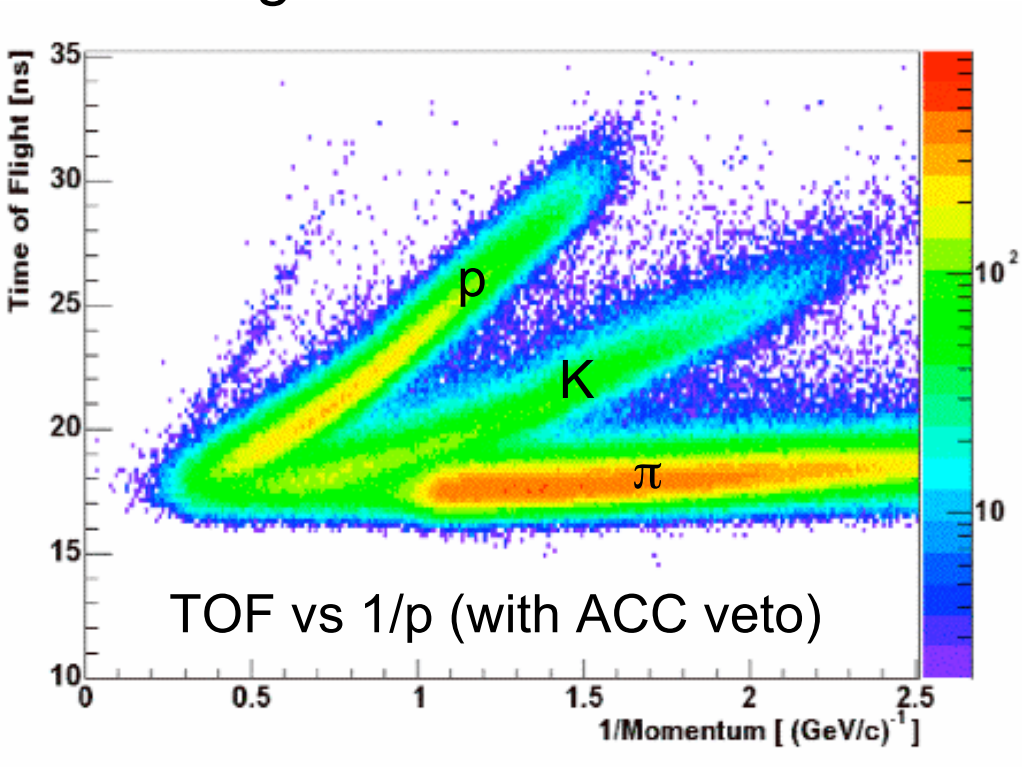




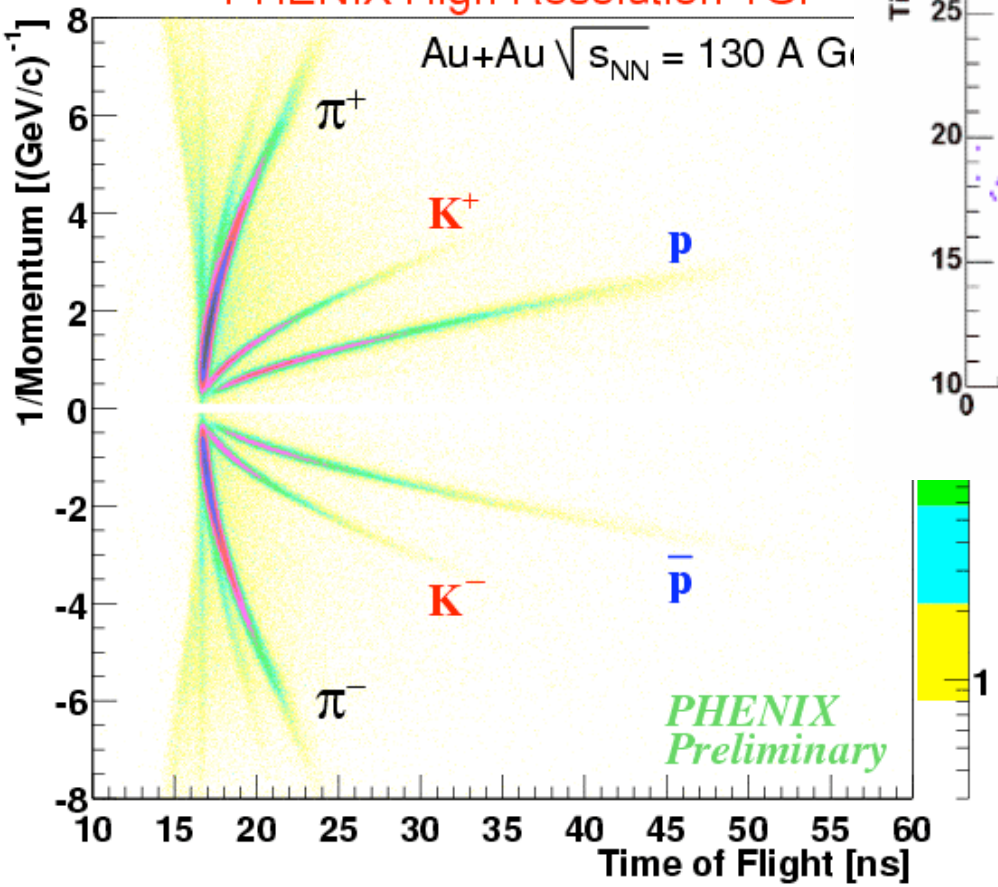
PHENIX


2010
PHENIX Detector
PC3
Central Magnet
PC3
TEC
PbSc
PC2
PbSc
PbSc
PbSc
DC
DC
TOF-W
RICH
RICH
PbSc
PbGl
HBD
MPC
RxNP
PbSc
PC1
PC1
PbGl
Aerogel
TOF-E
7.9 m = 26 ft
West
Beam View
East
South Muon Magnet
Central Magnet
North Muon Magnet
MPC
BBC
ZDC South
ZDC North
MuID
MuID
RxNP
HBD
MuTr
10.9 m = 36 ft
South
Side View
North
18.5 m = 60 ft

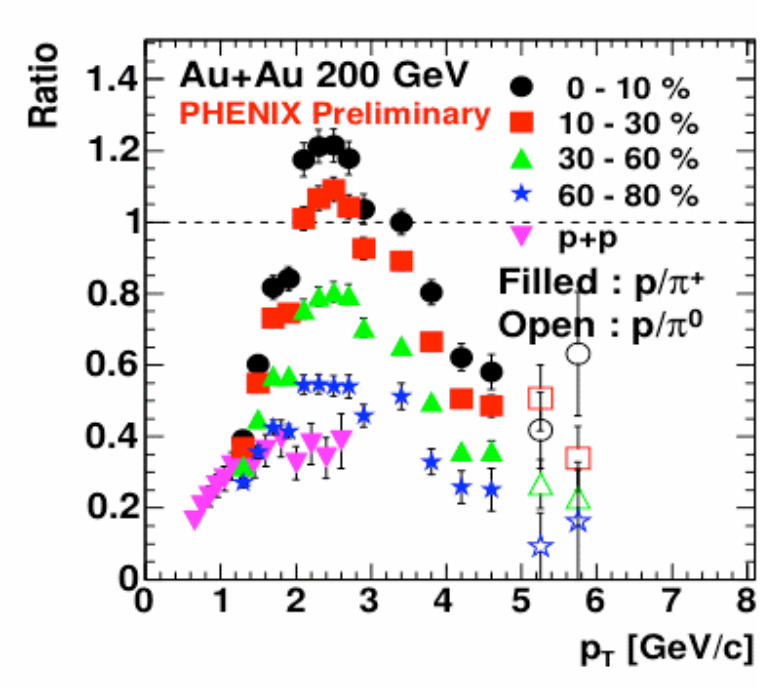
Aerogel Cherenkov Counter

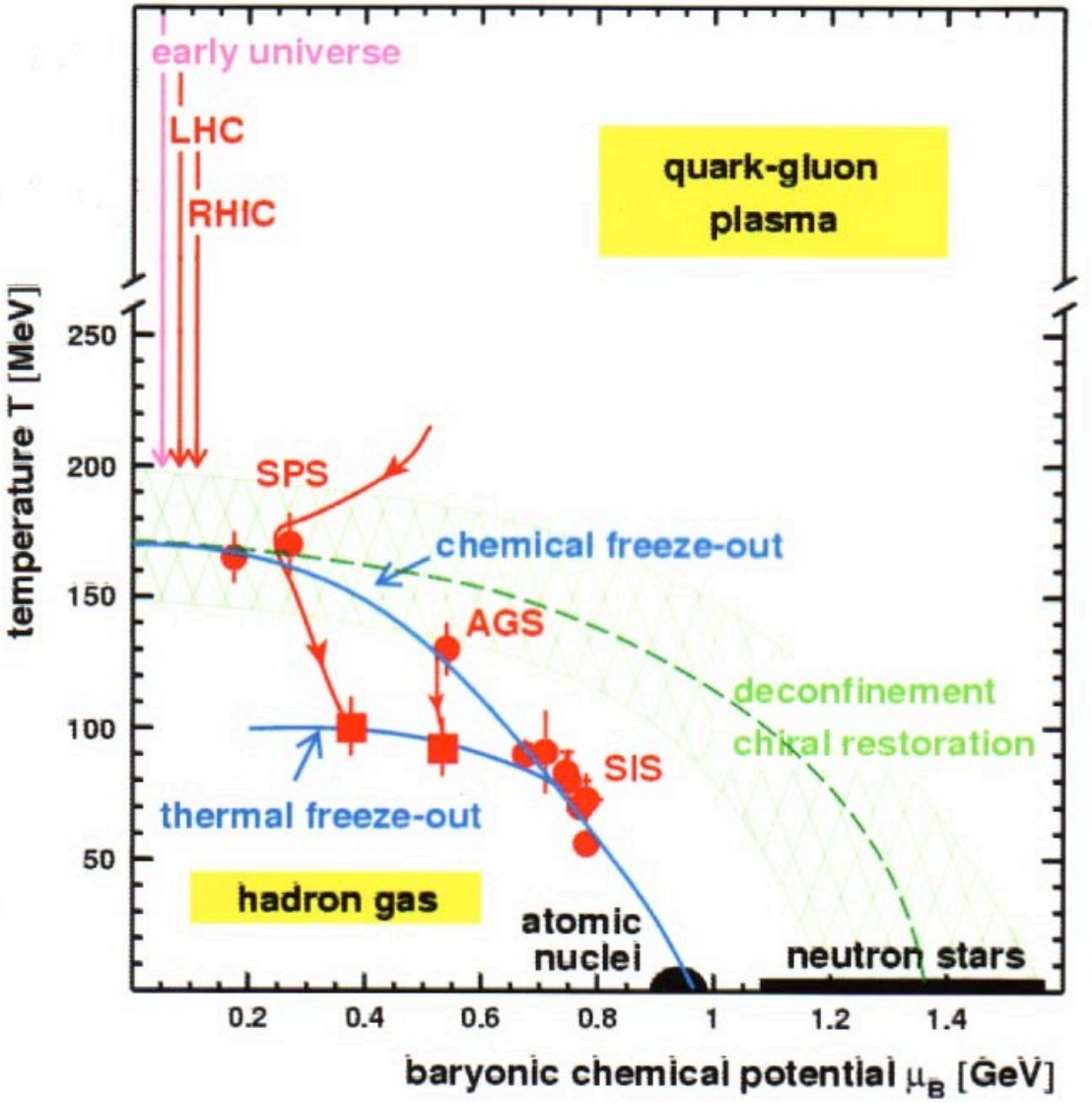


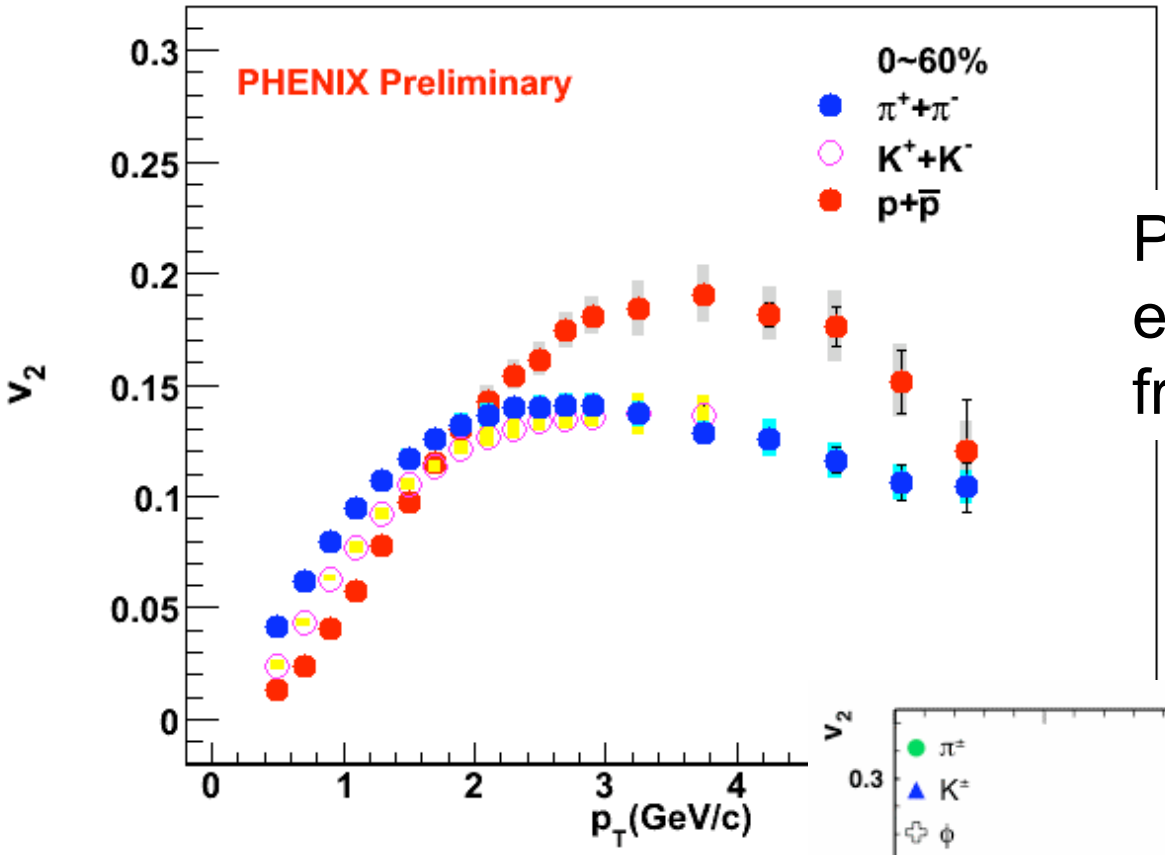
Time of Flight



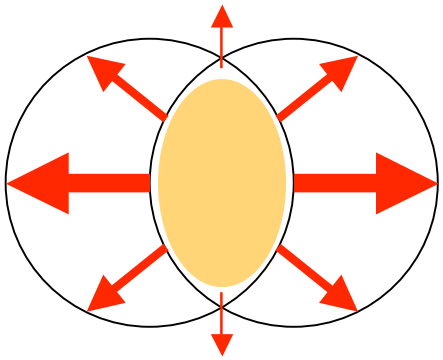
Thermal / chemical freeze-out properties from PIDed spectra and ratios

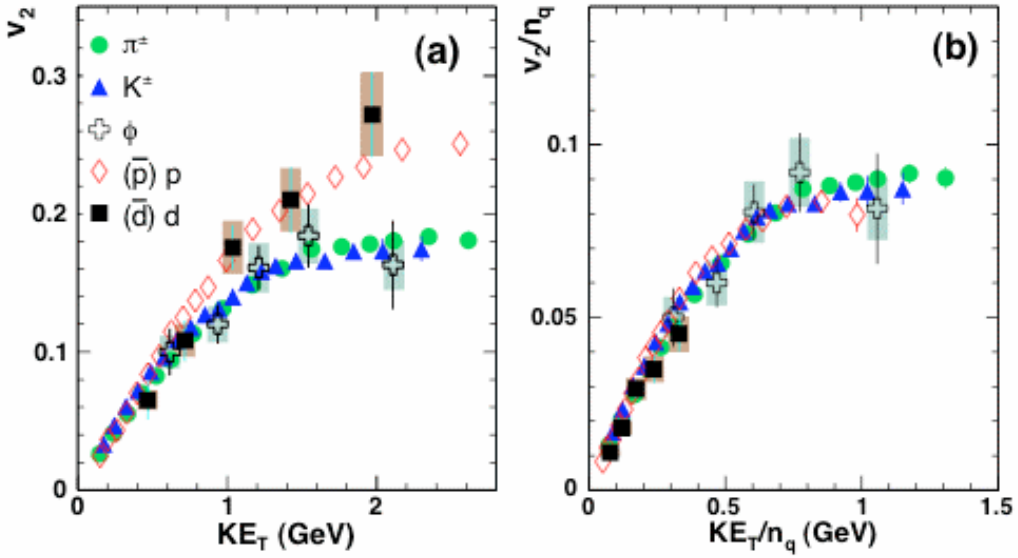




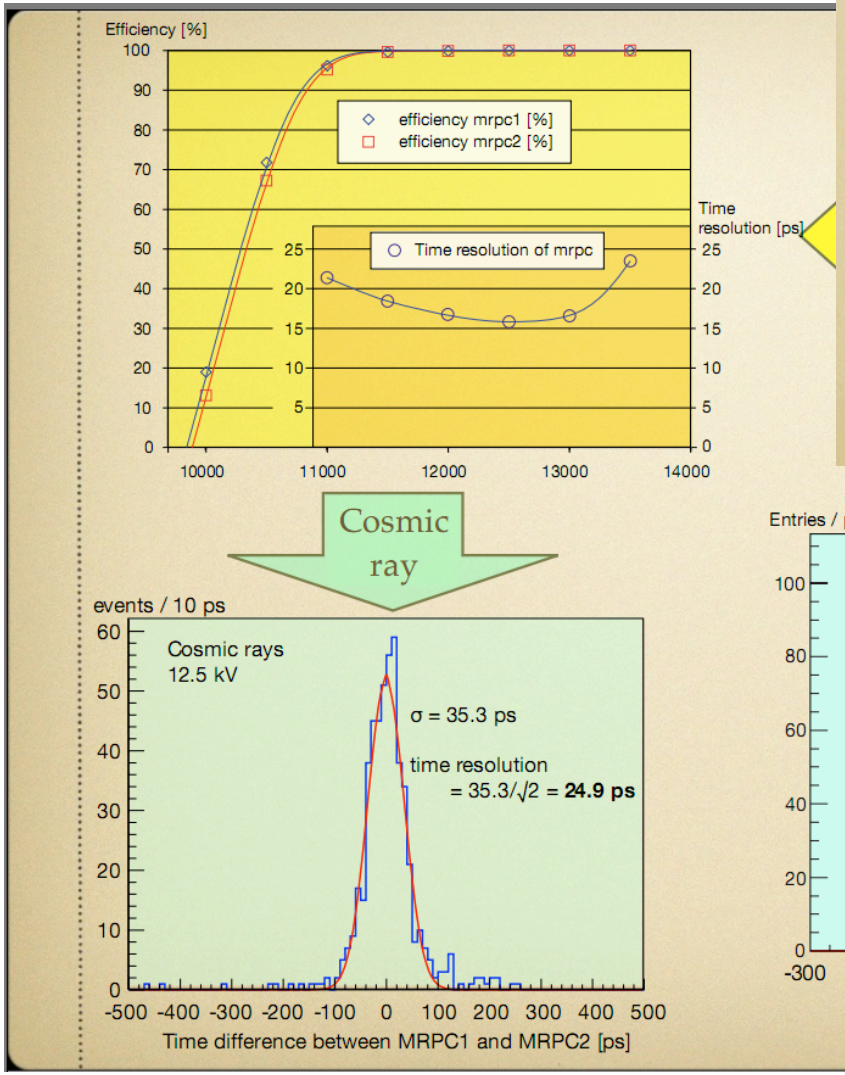


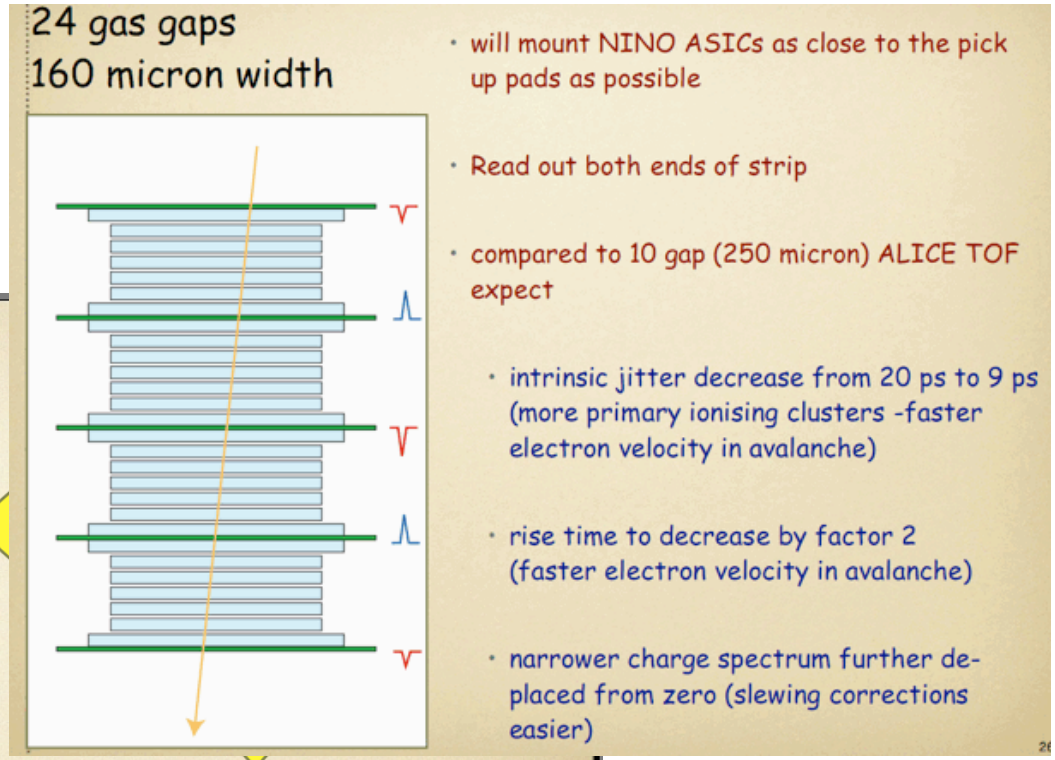
Partonic and hadronic expansion / collectivity from PIDed v_2

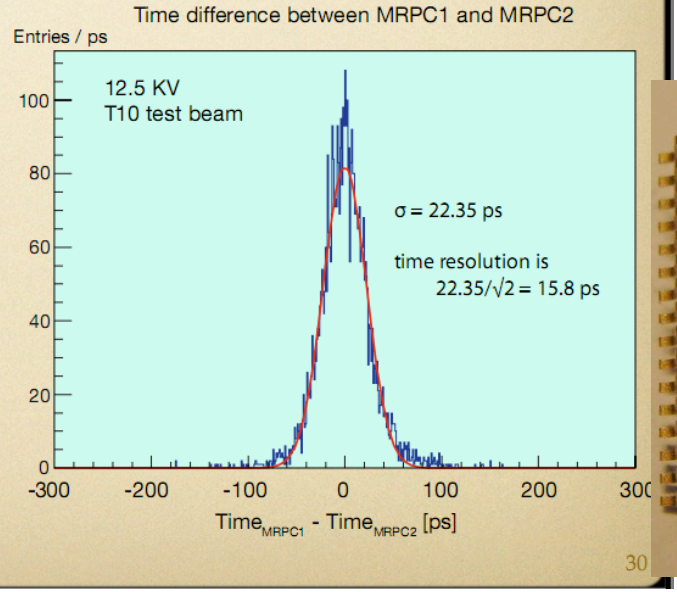




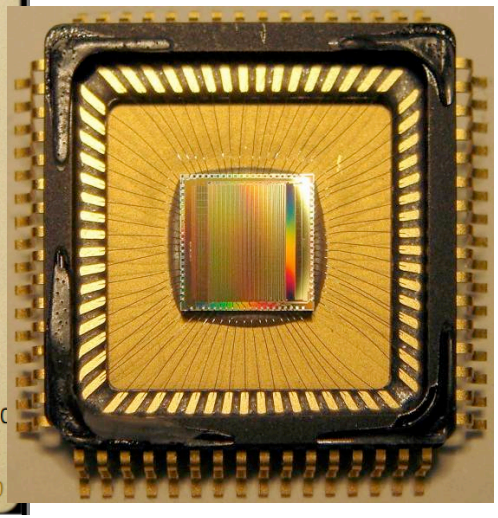
Advanced MRPC



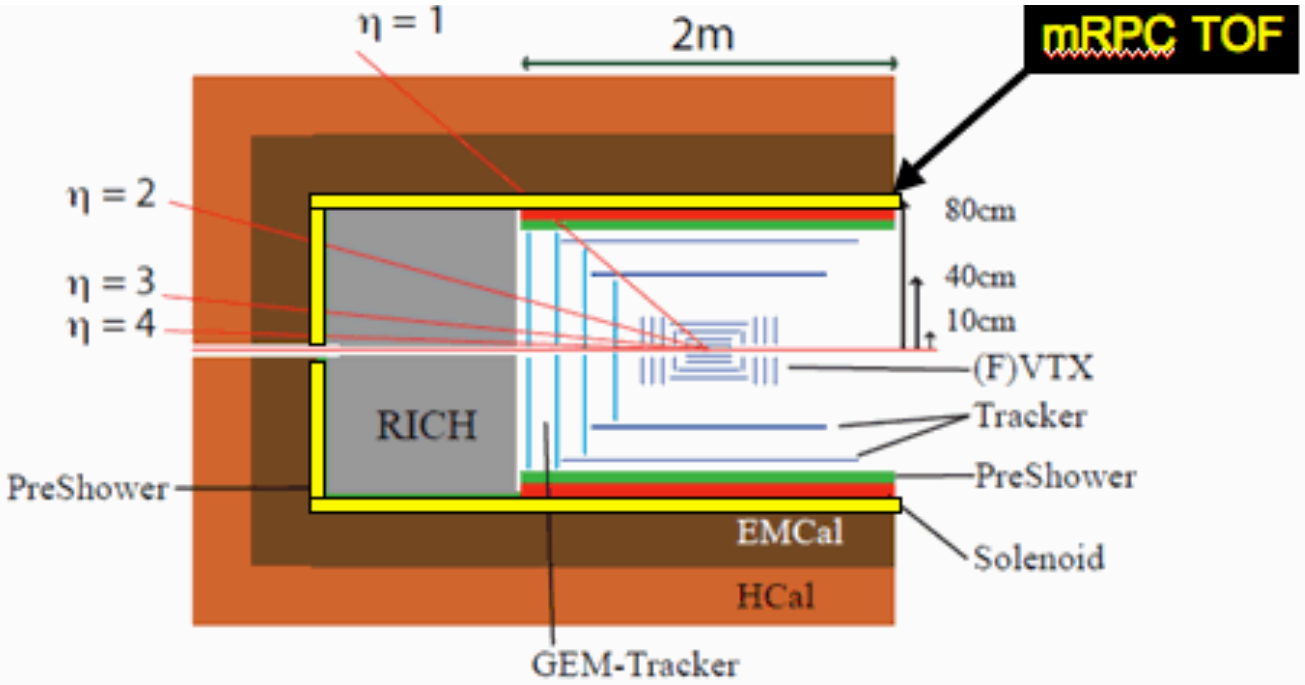




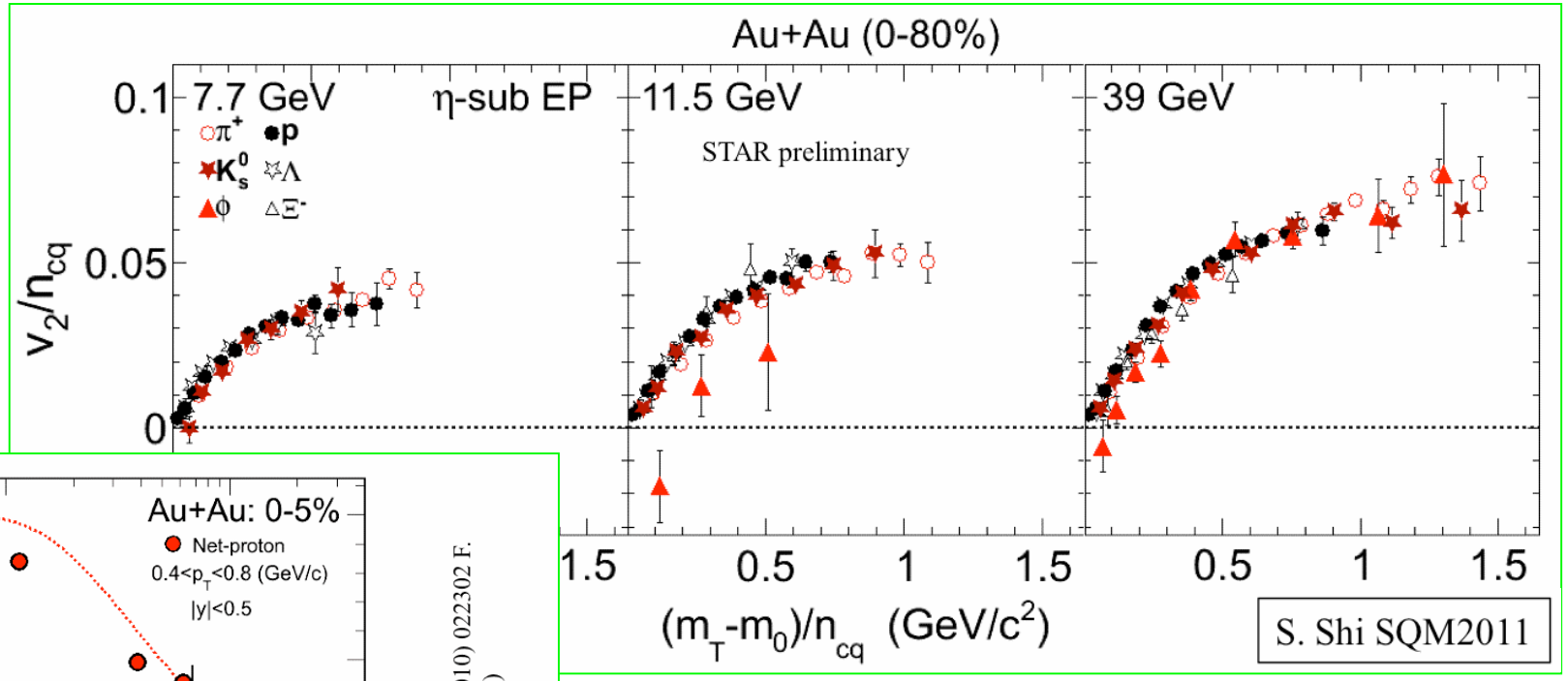
ASICs for fast timing

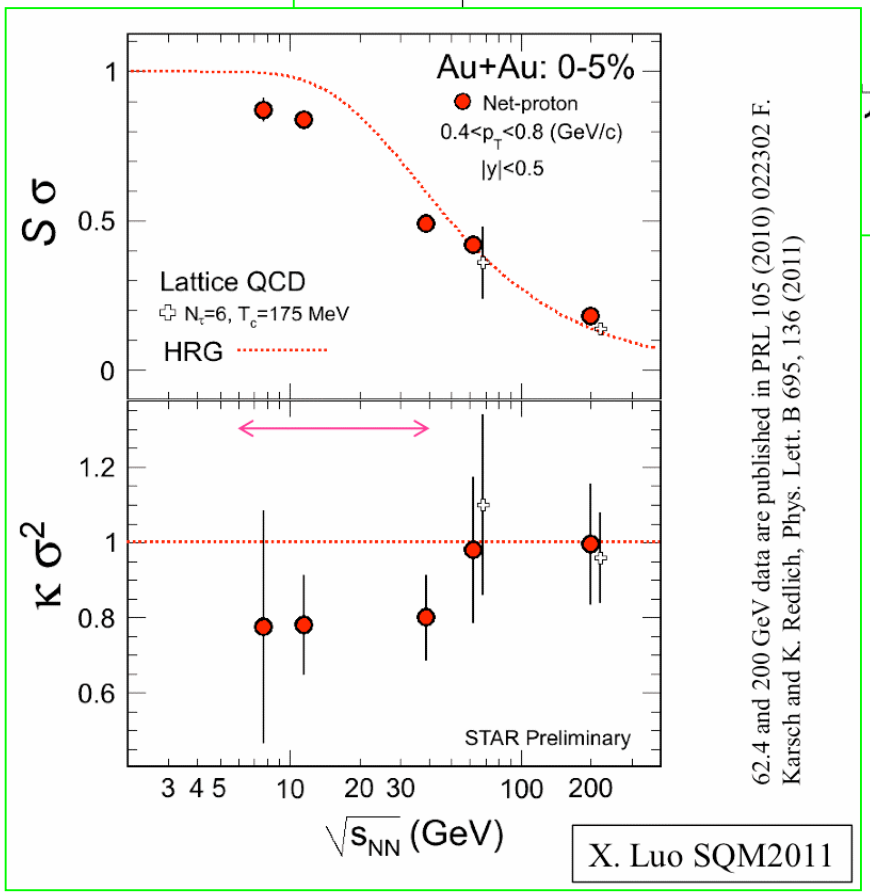


FAST mRPC TOF for PID from Mickey Chiu



•Full coverage hadron PID that works in heavy ion collisions, even at forward rapidities (most other technologies fail at high multiplicities). Very large acceptance.
•Despite small size of sPHENIX, comparable performance to current TOF, but with full acceptance. Performance scales with distance, so larger sPHENIX is better.
•With dE/dx measurement, will have PID from very low to high p_T, and eID down to low p_T (under study what dE/dx would be required).
•Physics: 1. Critical point search/study 2. Onset of deconfinement 3. PID study of jet fragments (what happens to lost energy?) 4. Quantitative tests of 3D hydro 5. Transverse spin studies (IFF⊗Transversity, π/K/p/Λ A_N) 6. Λ spin transfer, etc…

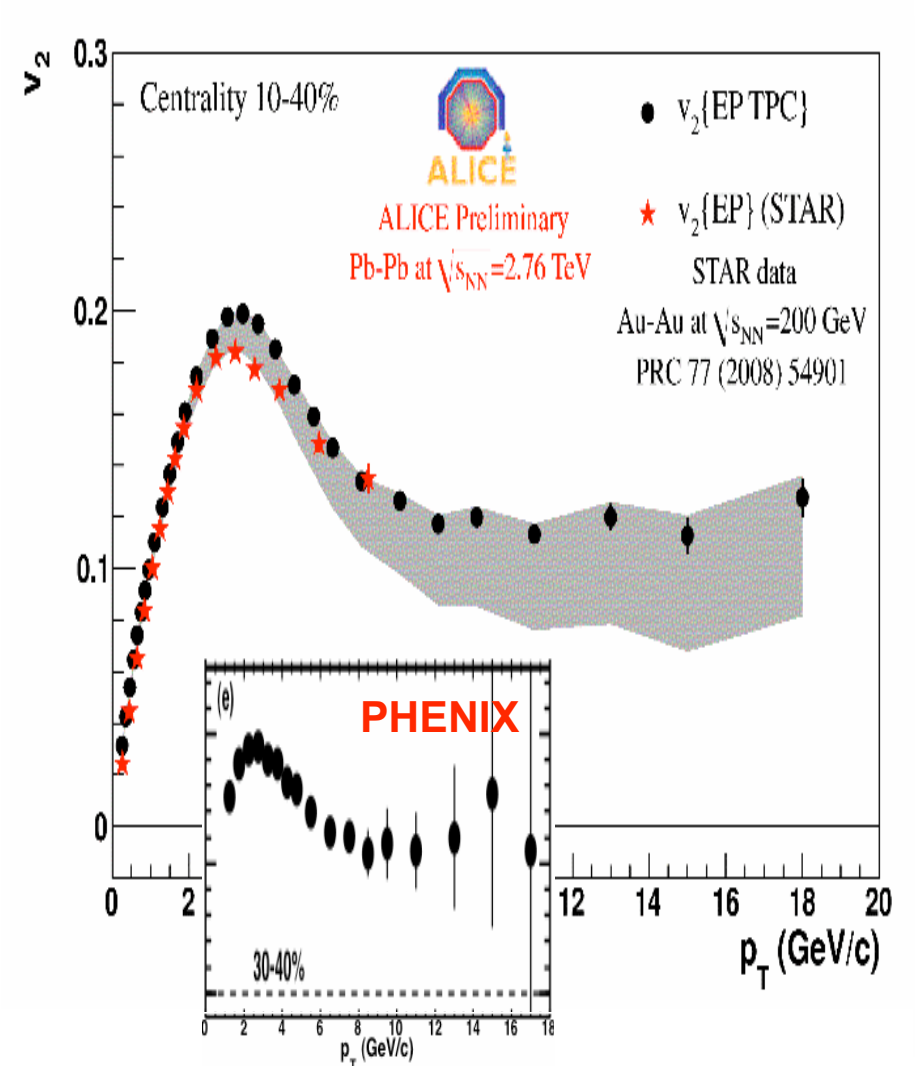


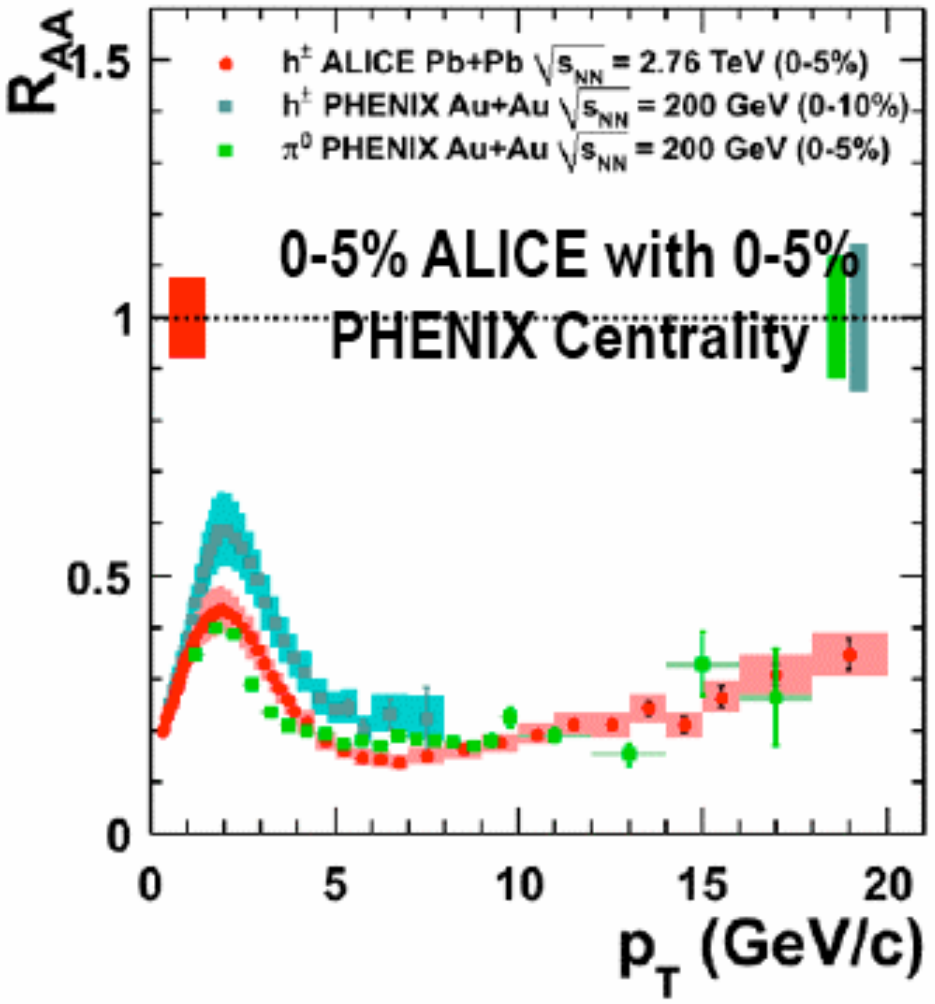


Beam Energy Scan Program from STAR experiment

- net-proton distribution
- n-quark scaling of v_2

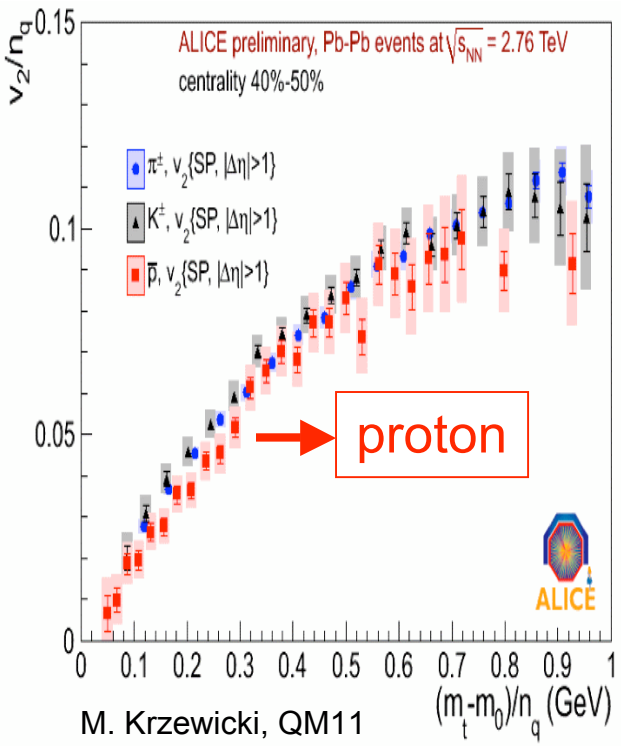
(Amazing) similarity between RHIC and LHC (v_2 and R_{AA})





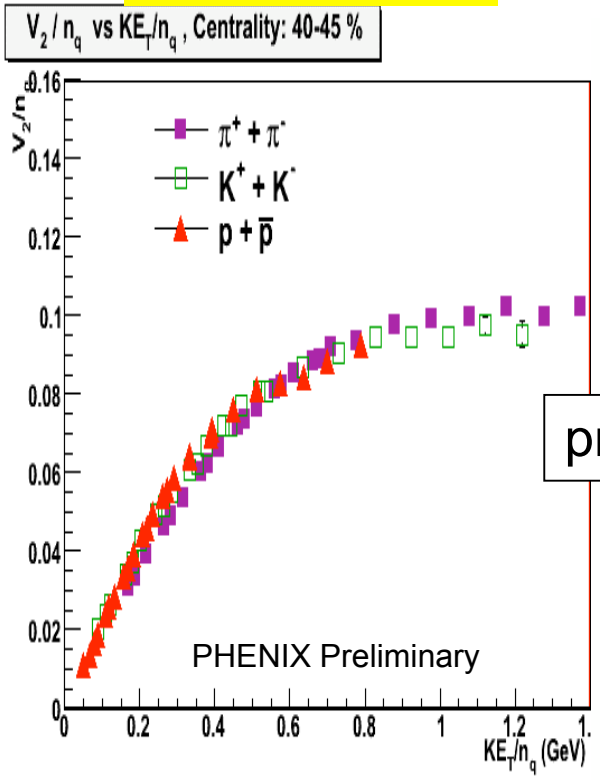
Small deviations in $(m_T-m_0)/n_q$ scaled v_2

Pb+Pb 2.76TeV

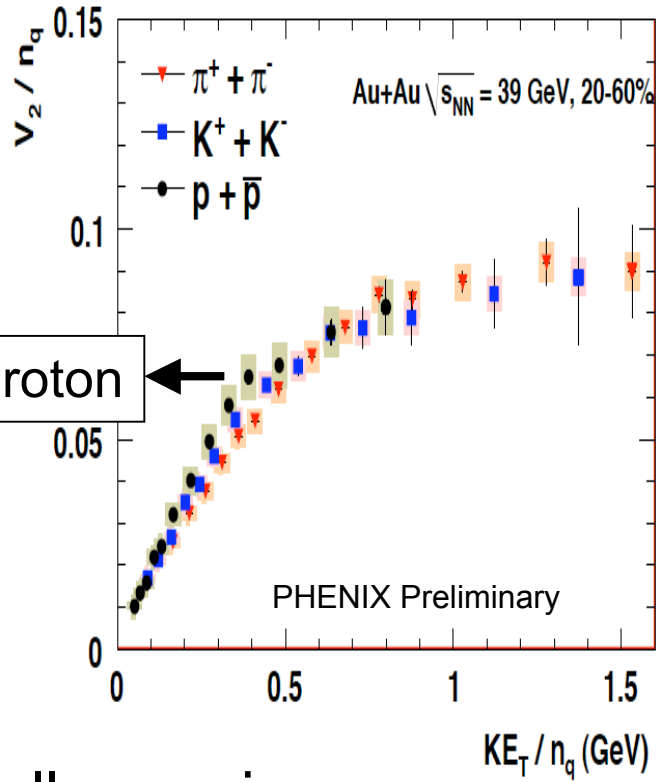


M. Krzewicki, QM11

Au+Au 200GeV

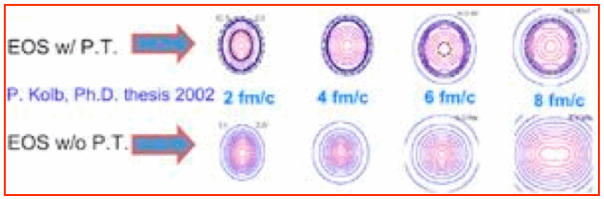


Au+Au 39GeV

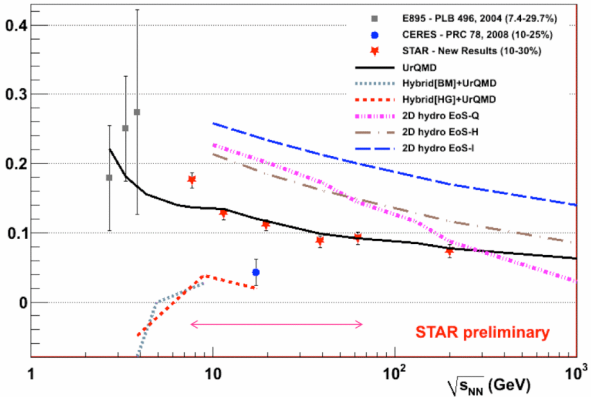


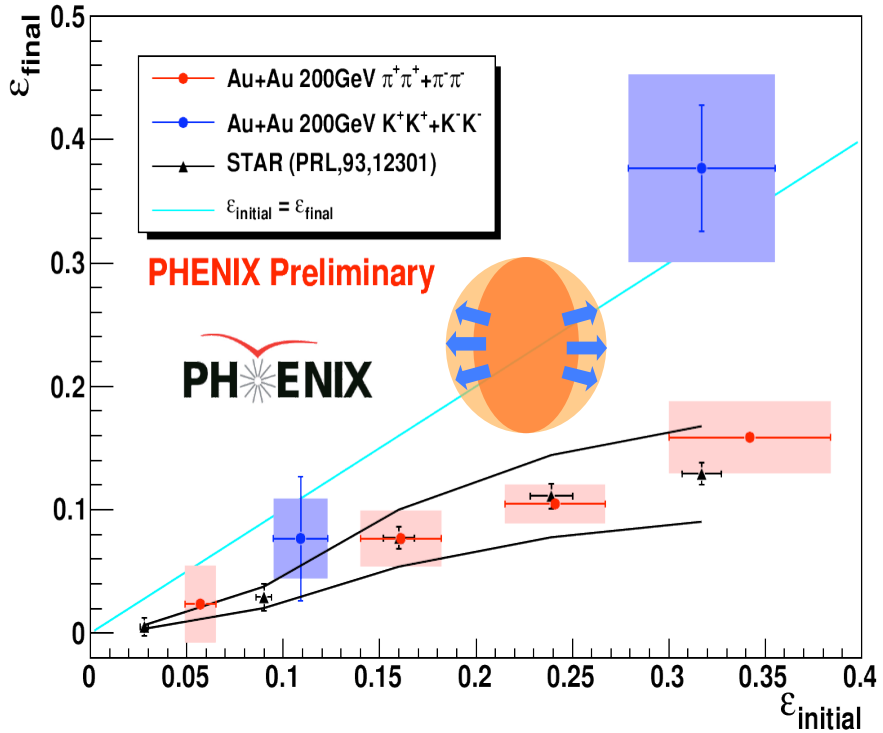
roughly $(m_T-m_0)/n_q$ scaled for all energies
larger p_T shift for heavier particles
radial flow increases with energy

Geometrical source anisotropy via HBT measurement at the end of freeze-out

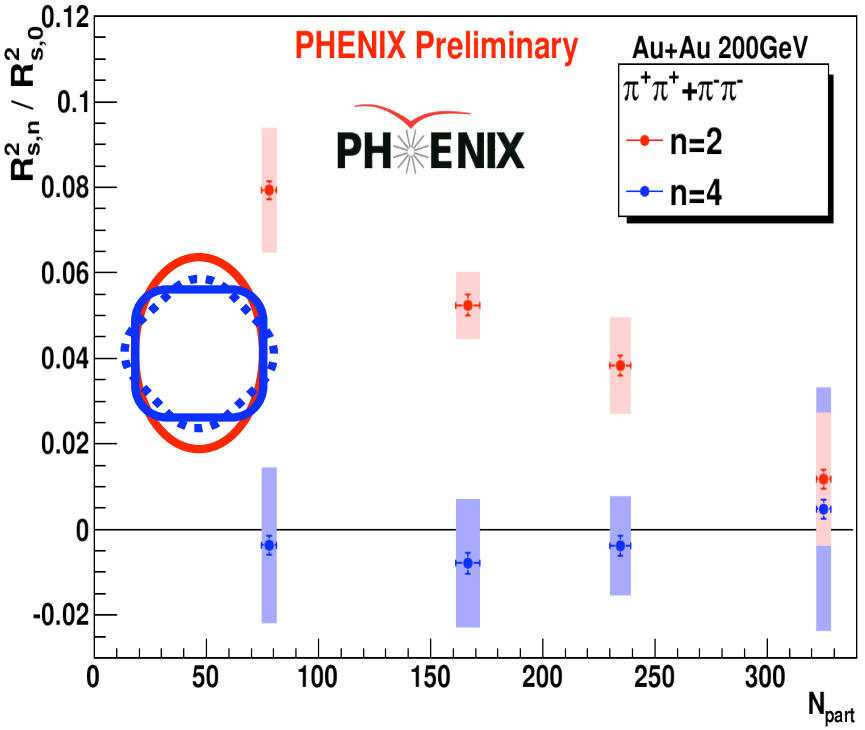


ε_{final}



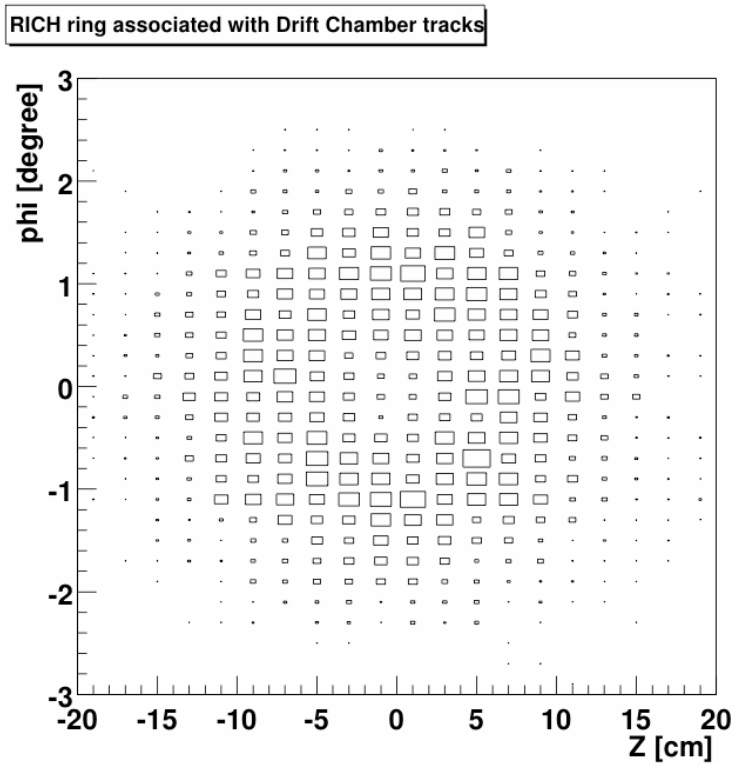


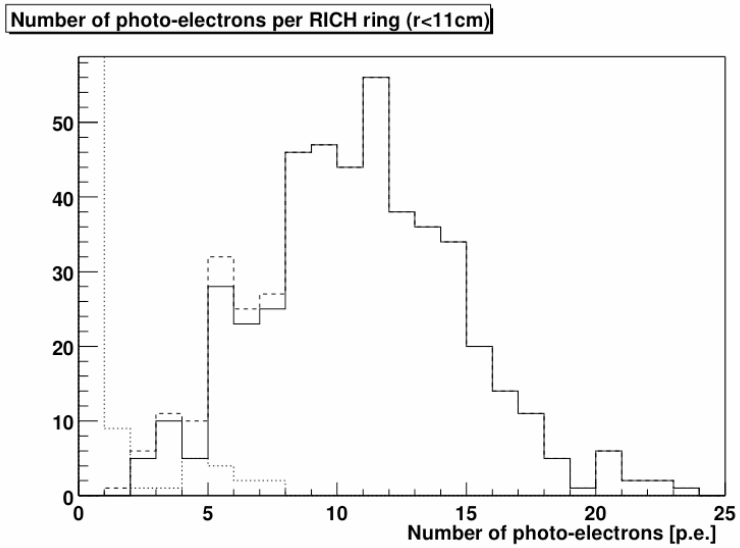
T. Niida, WPCF2011, 20/Sep/2011

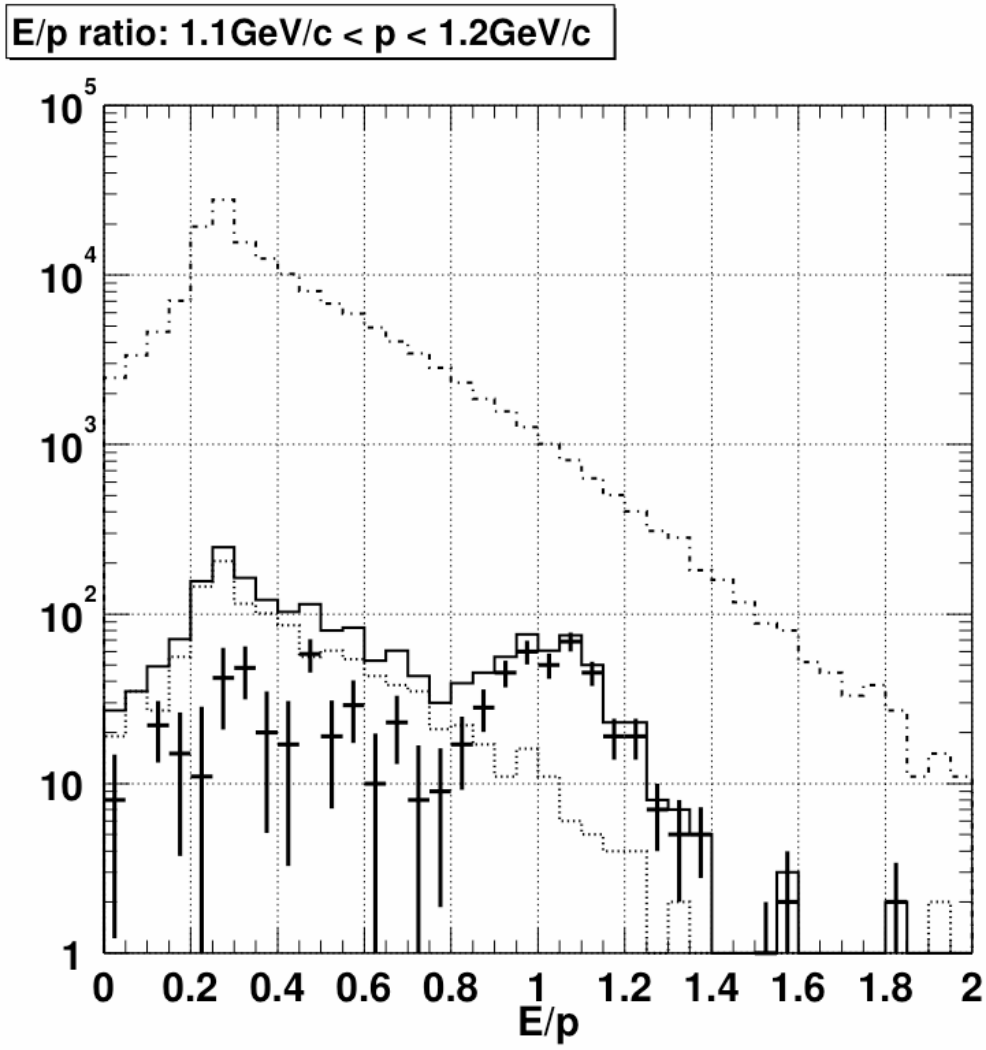


It might be different from the v_2-v_4 relation

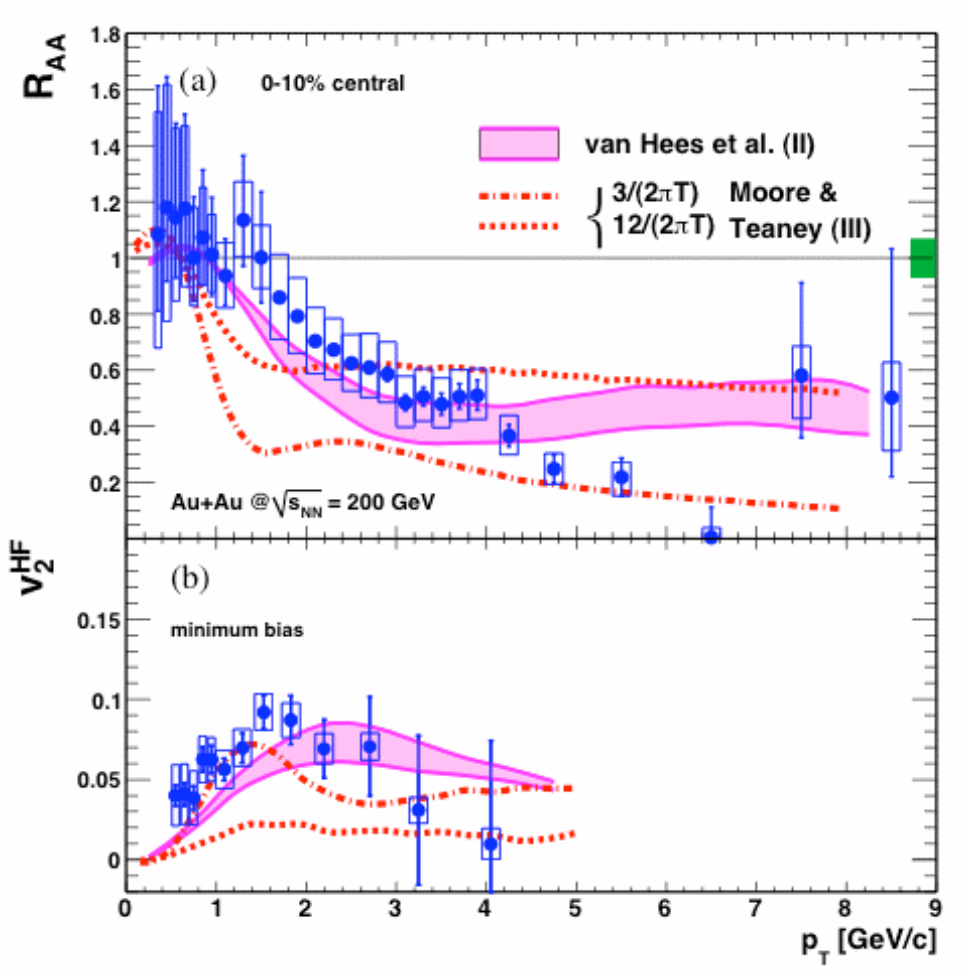
Ring-Imaging Cherenkov Detector



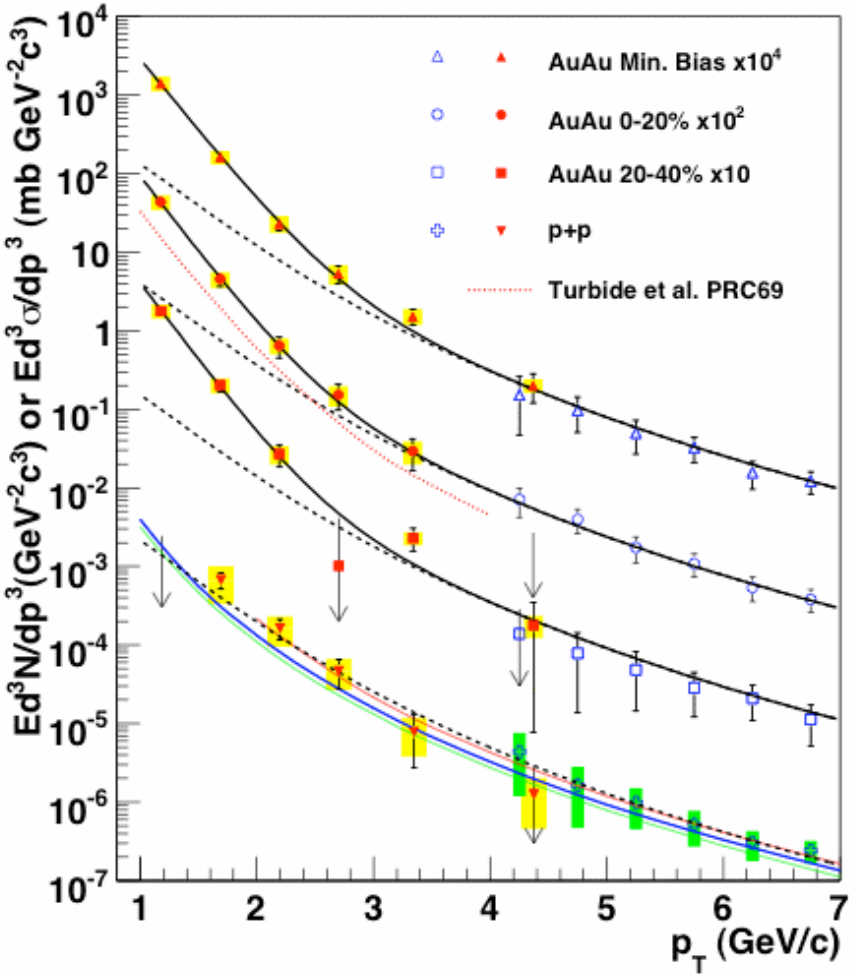


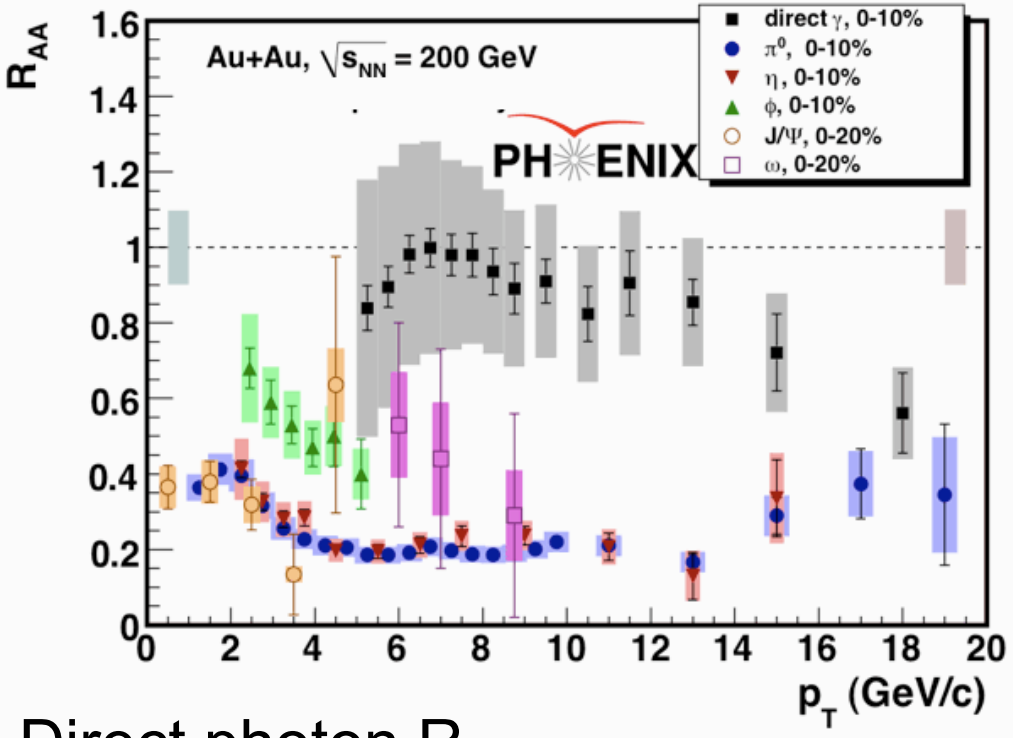


Charm suppression and flow from single electrons

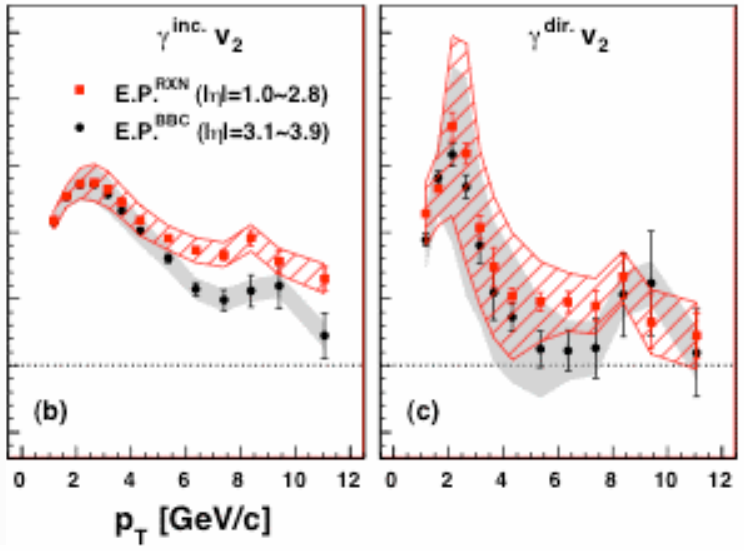


Thermal photon spectra from electron-pairs (γ*)





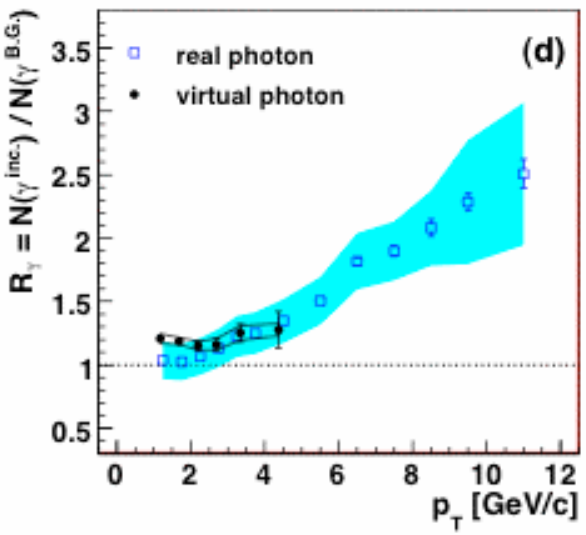
Direct photon v_2

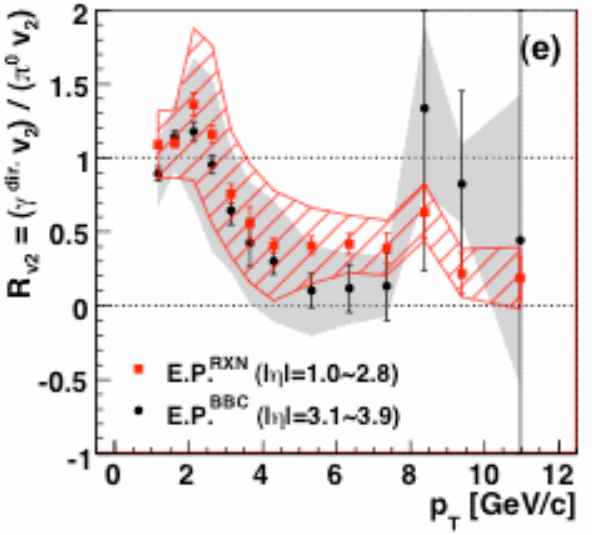


Direct photon R_{AA}

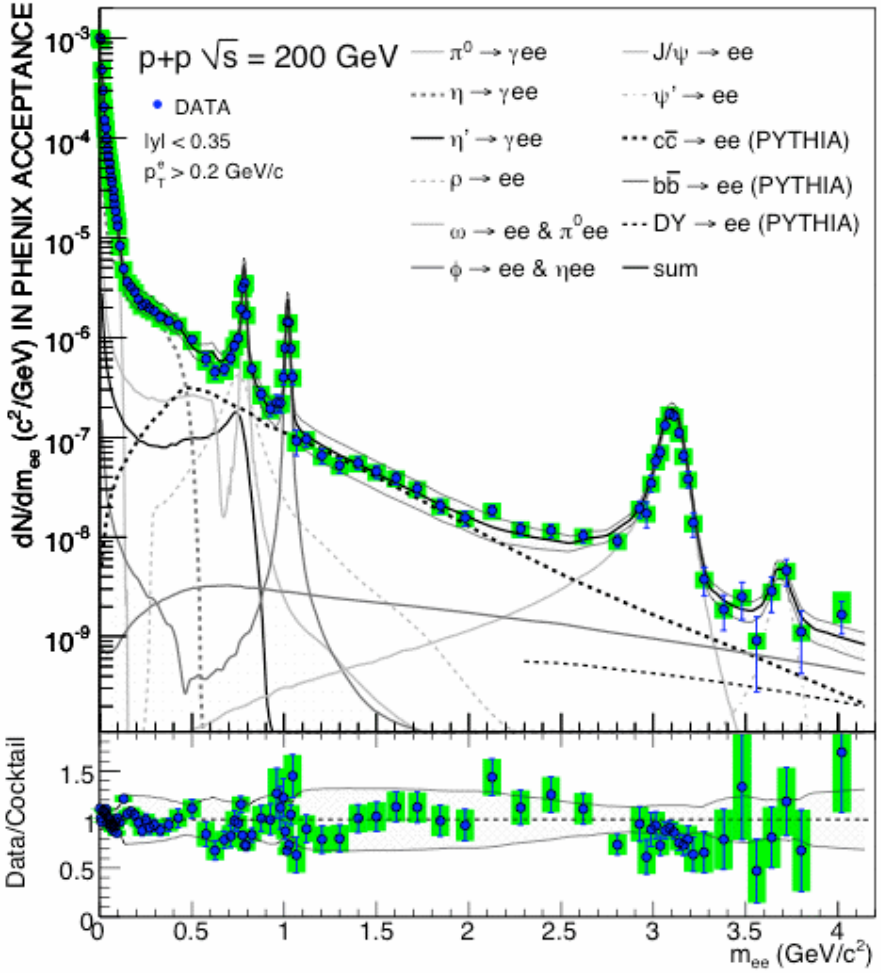
prompt γ dominance :
no suppression and
small v_2 at high p_T

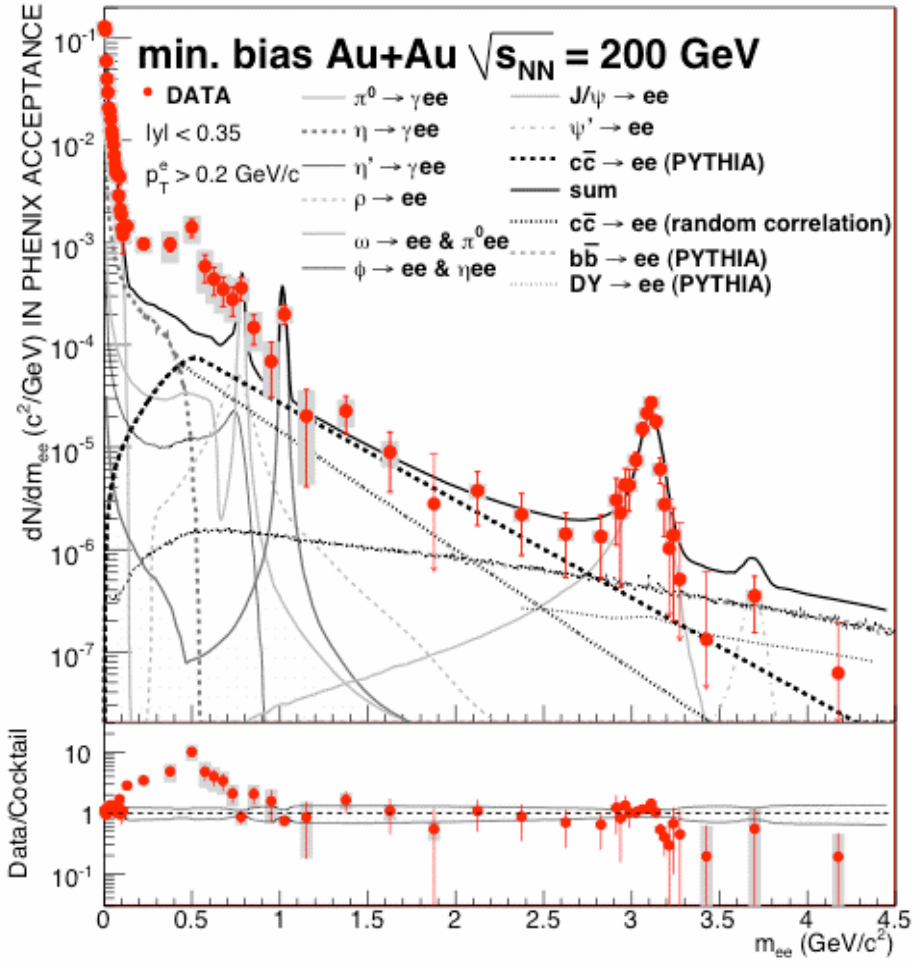
large v_2 for thermal photon
from combined real and
virtual γ measurements



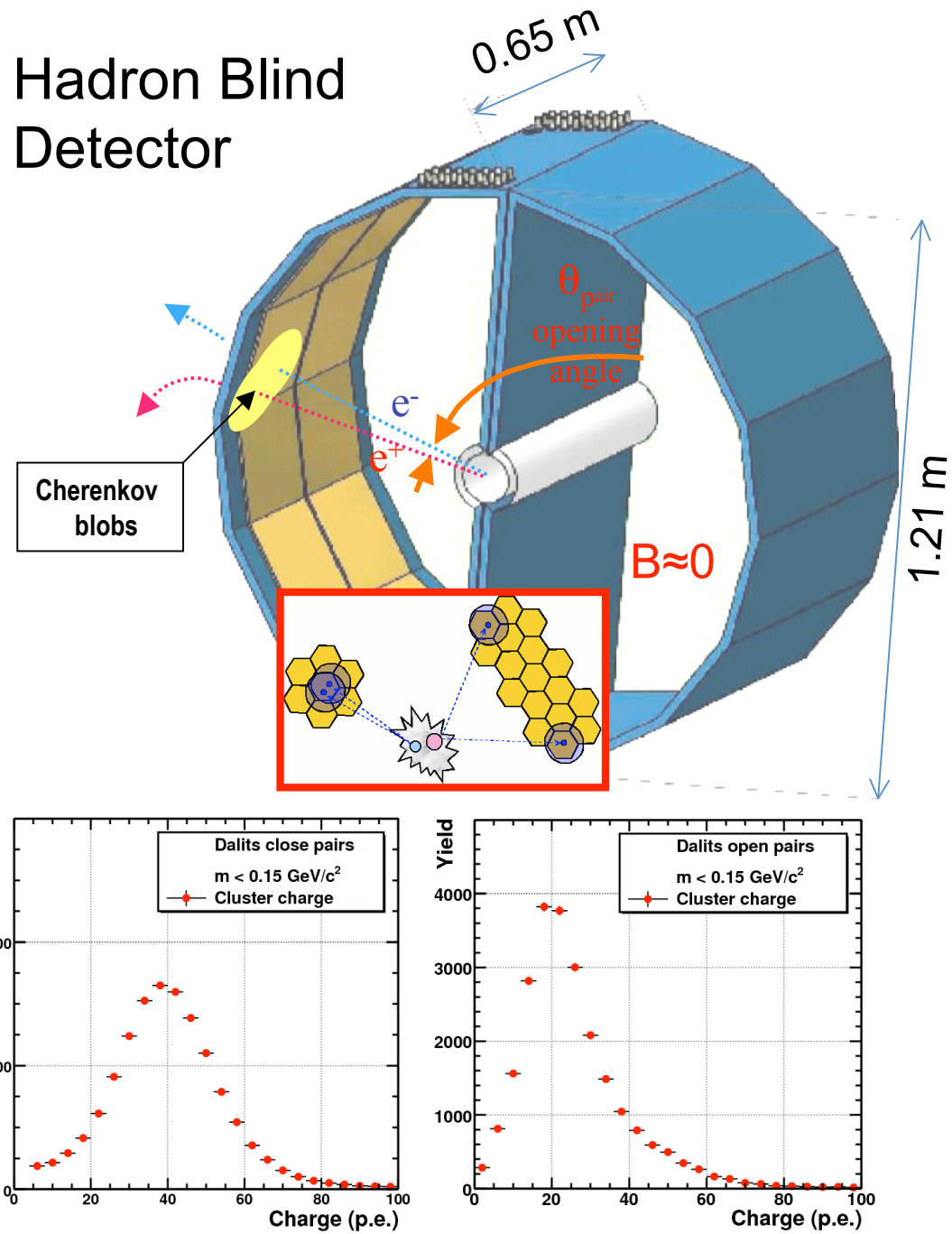


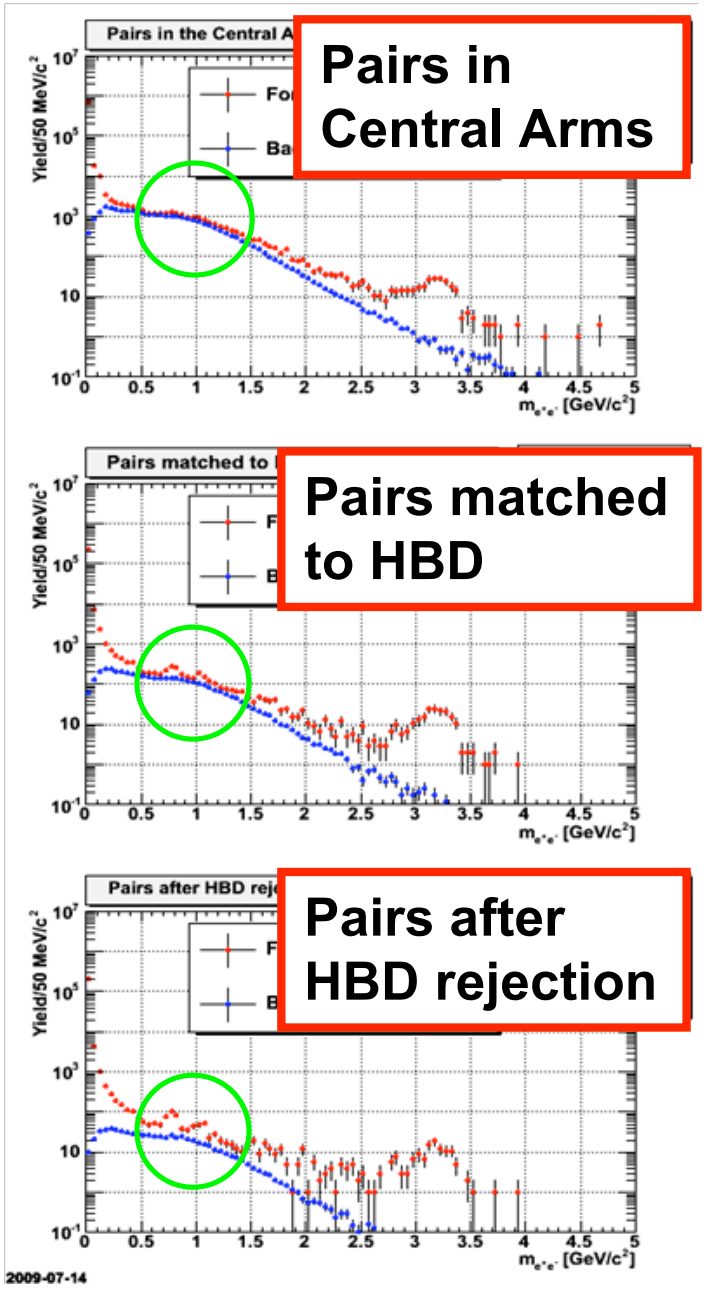
Electron-pair mass spectra in p+p / Au+Au





Hadron Blind Detector



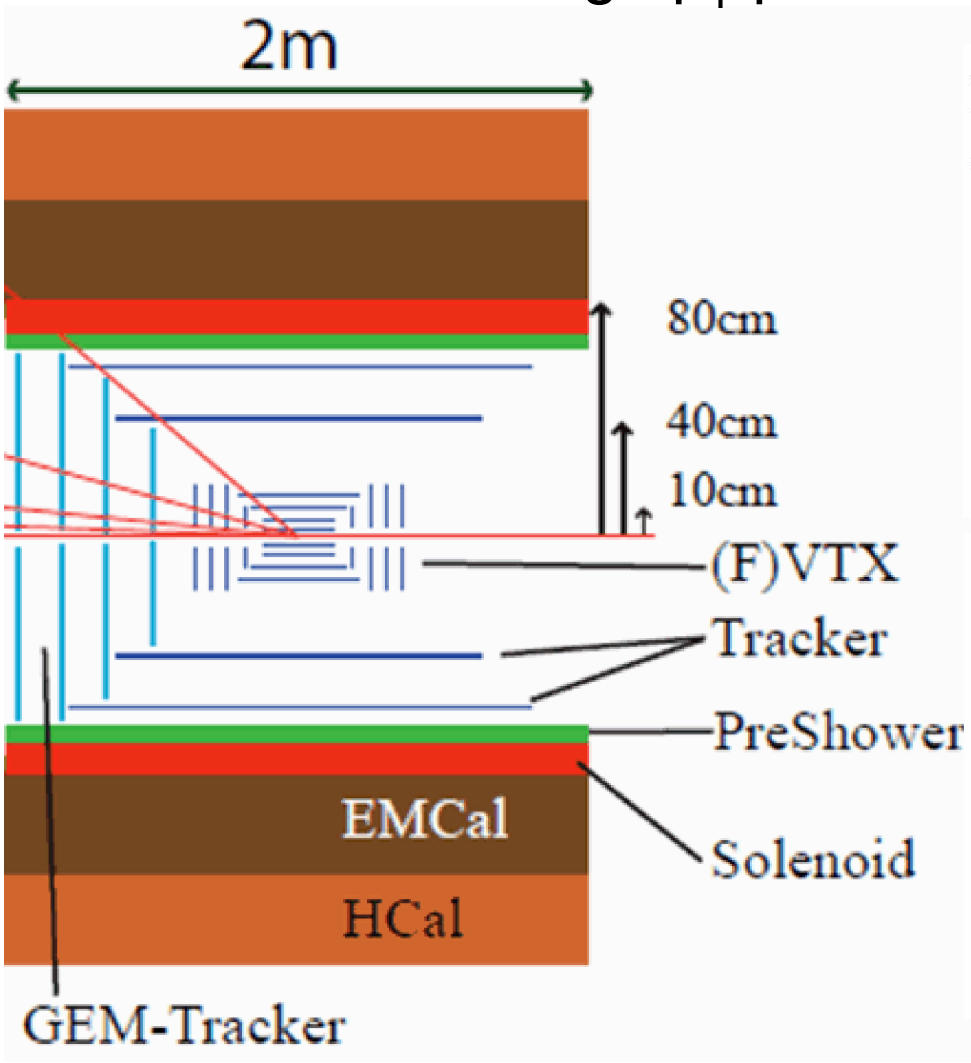


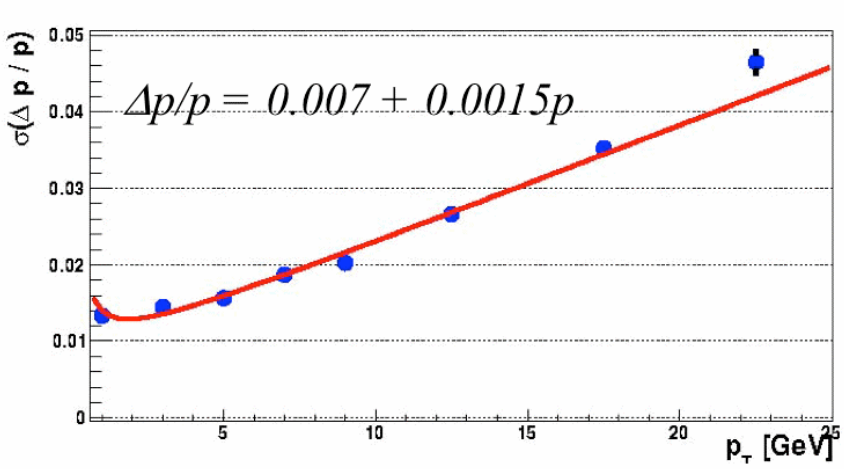
Pairs in Central Arms

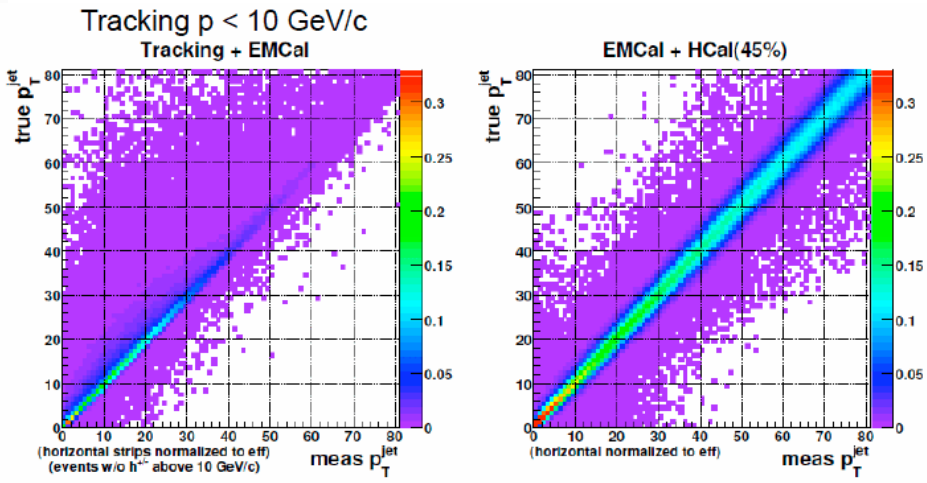
Pairs matched to HBD

Pairs after HBD rejection

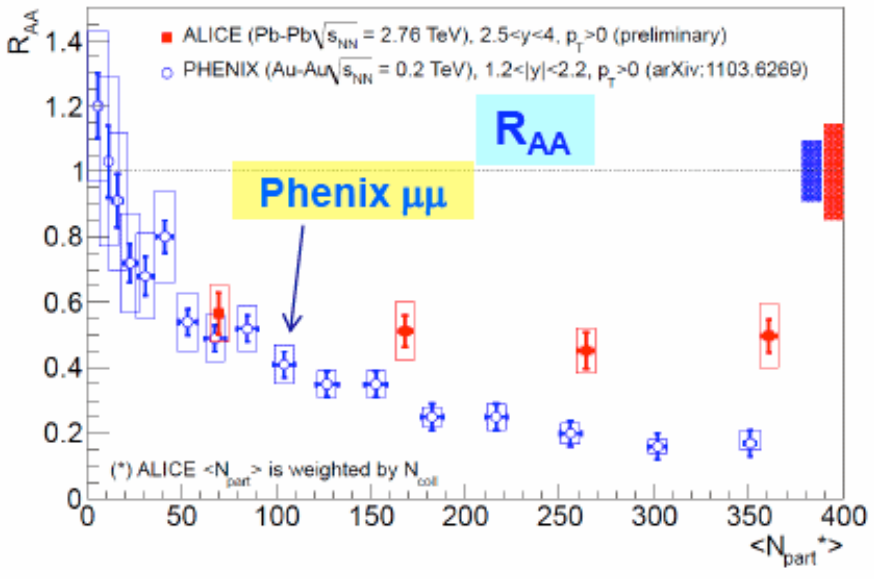
Charged hadrons and jets
High p_T photons and electrons

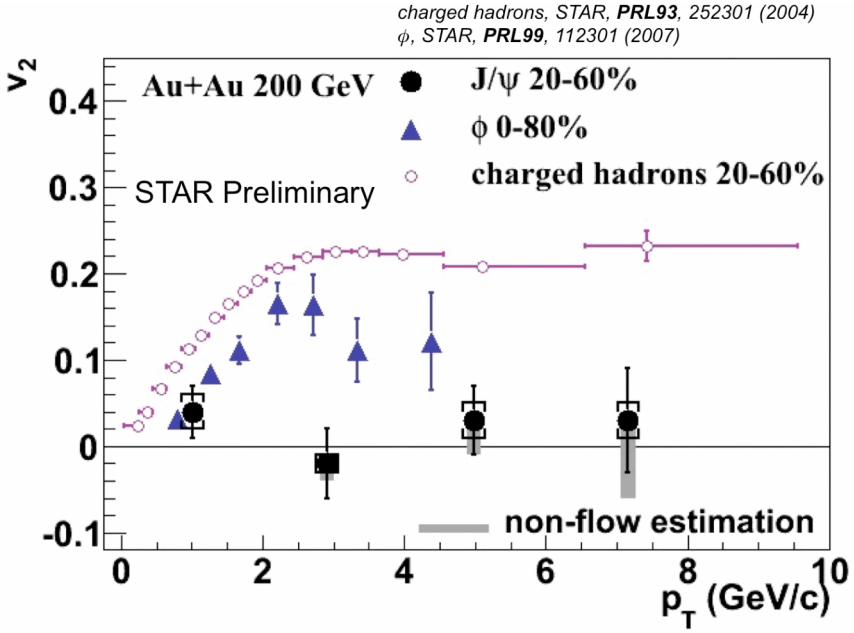


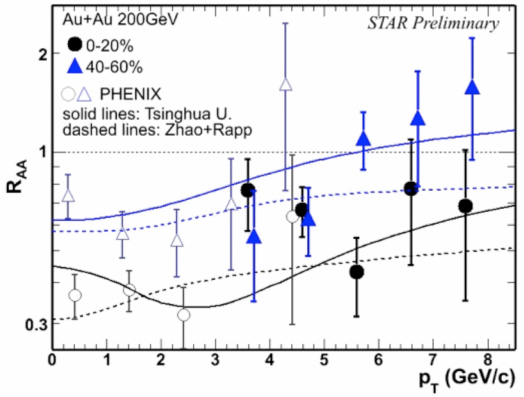




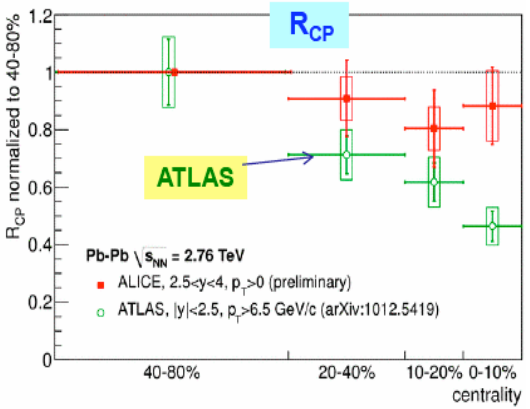
J/Psi R_{AA} and v_2

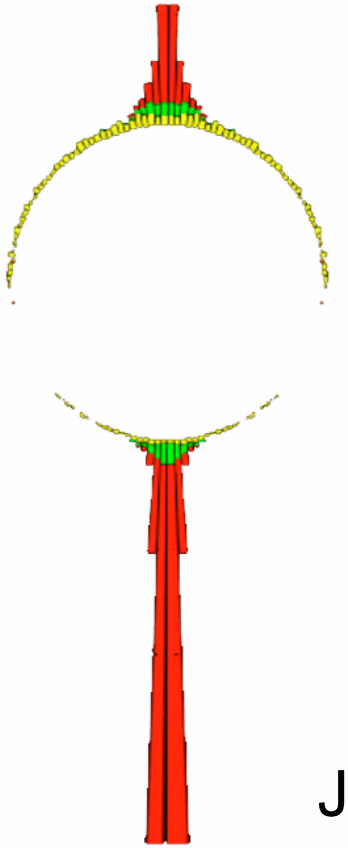


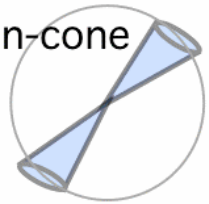


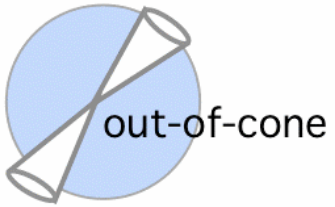


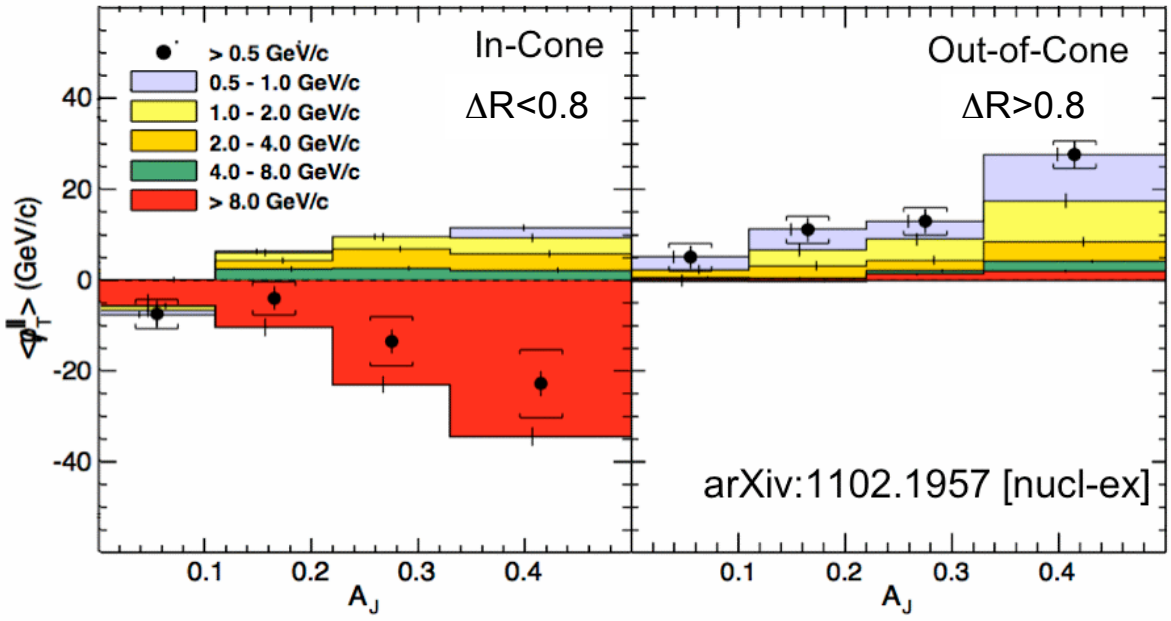
different J/ψ $R_{AA}(p_T)$ dependence between RHIC(↗) and LHC(↘)







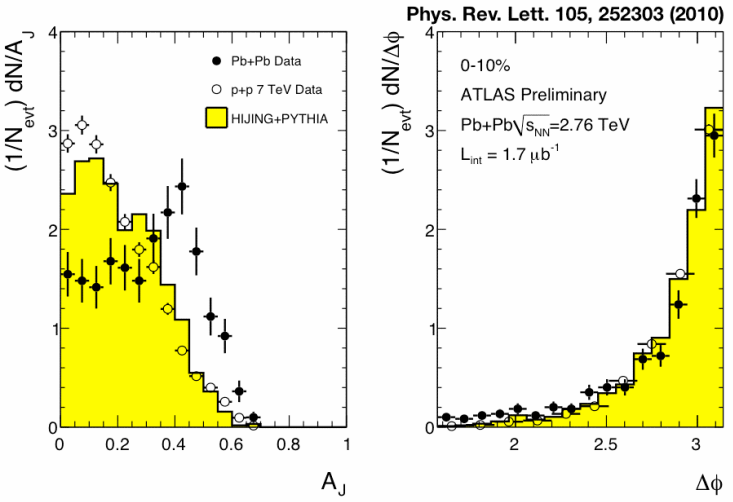




Jet energy asymmetry

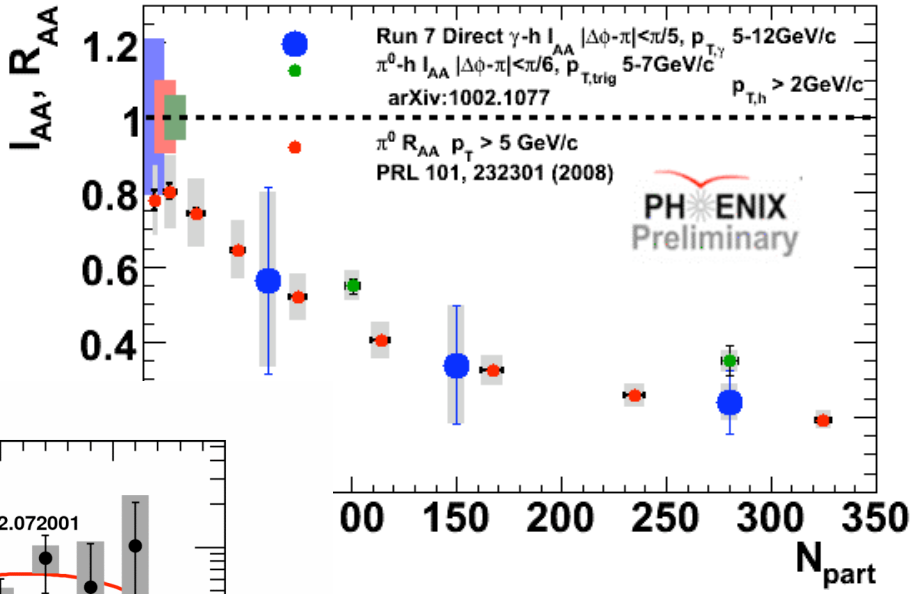
+

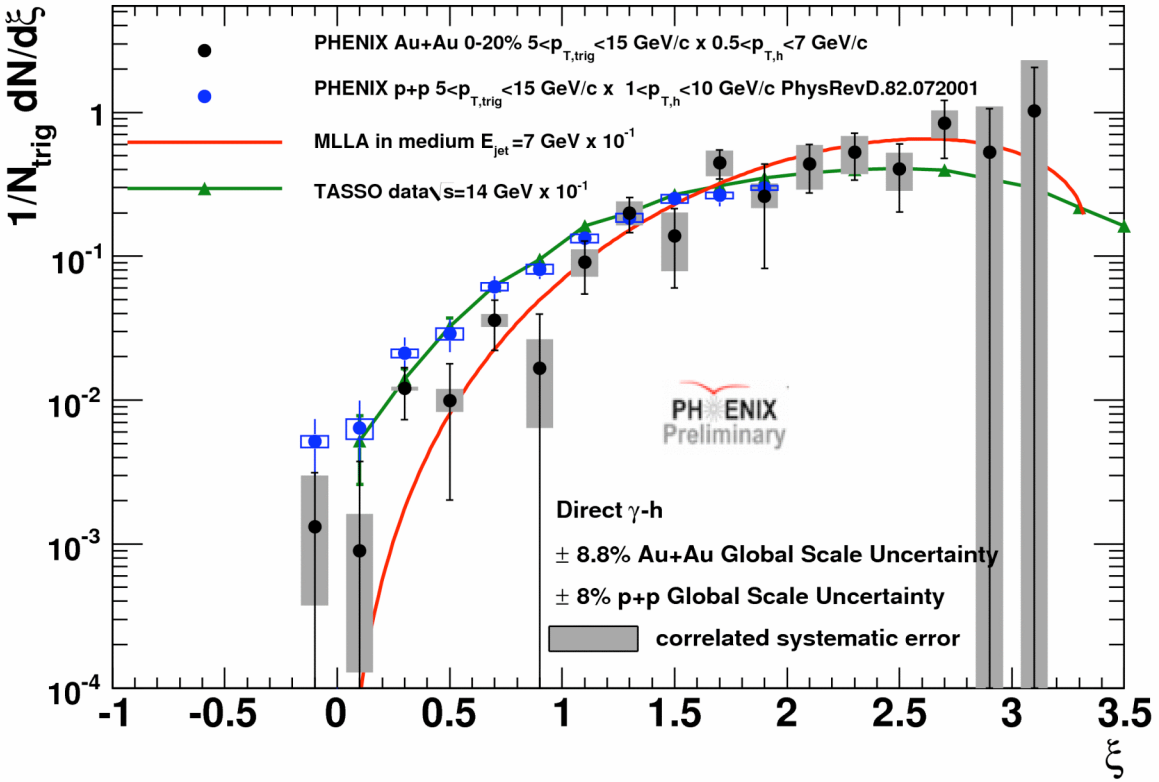
Out-of-Cone radiation

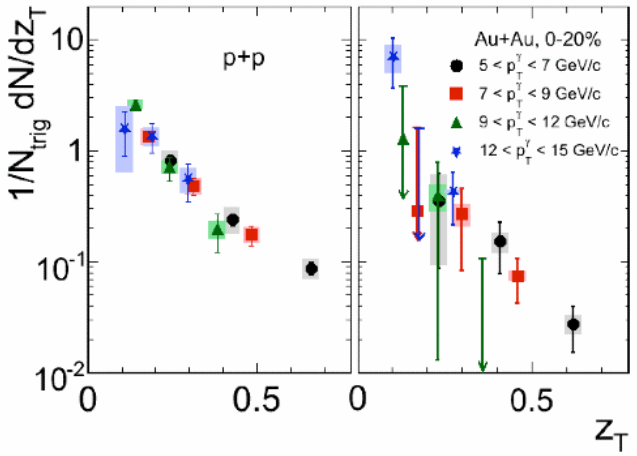


Fragmentation function with direct photon trigger

I_{AA} (p_T^h:2-7GeV/c, p_T^γ:5-12) vs N_{part}

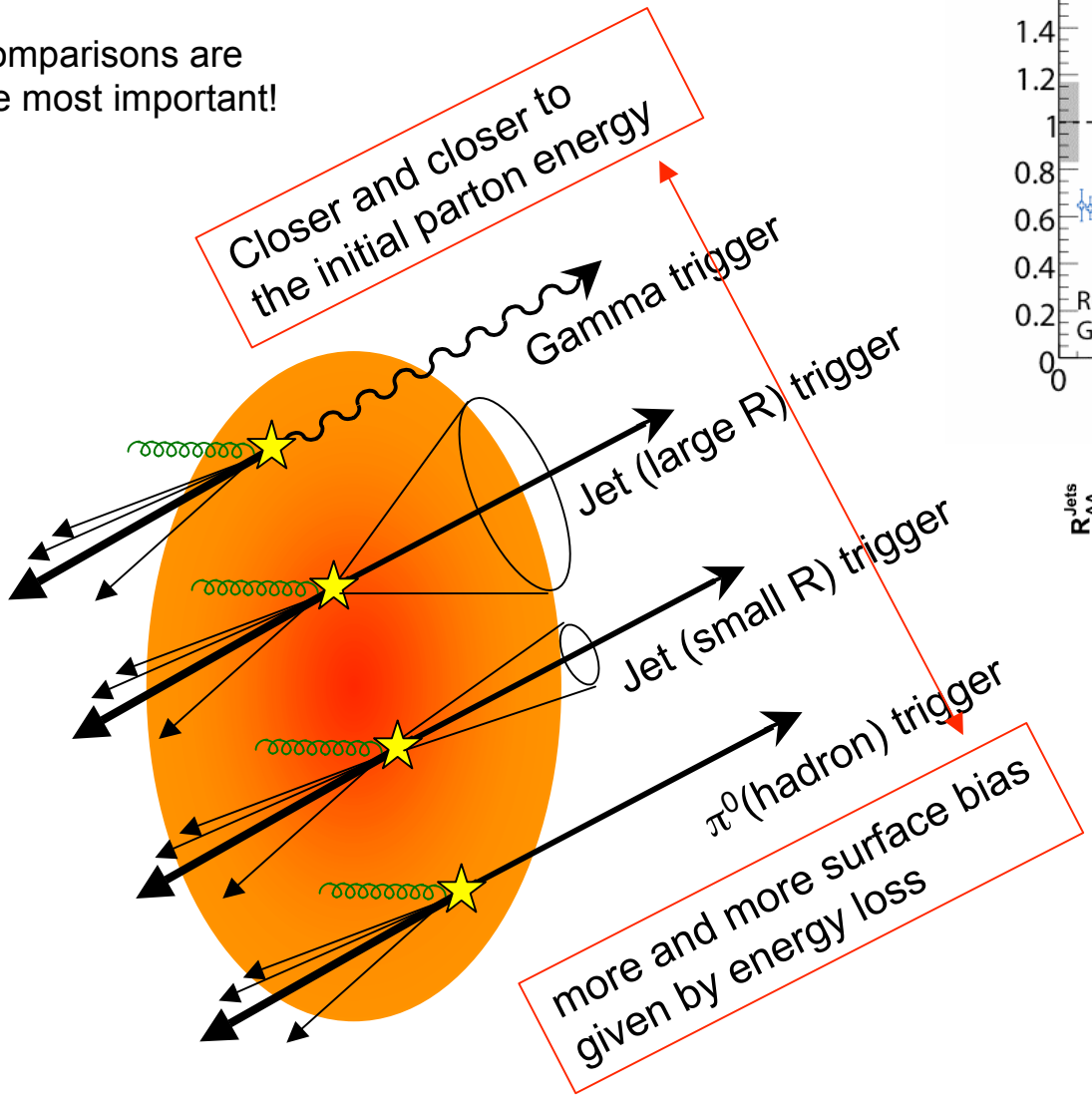




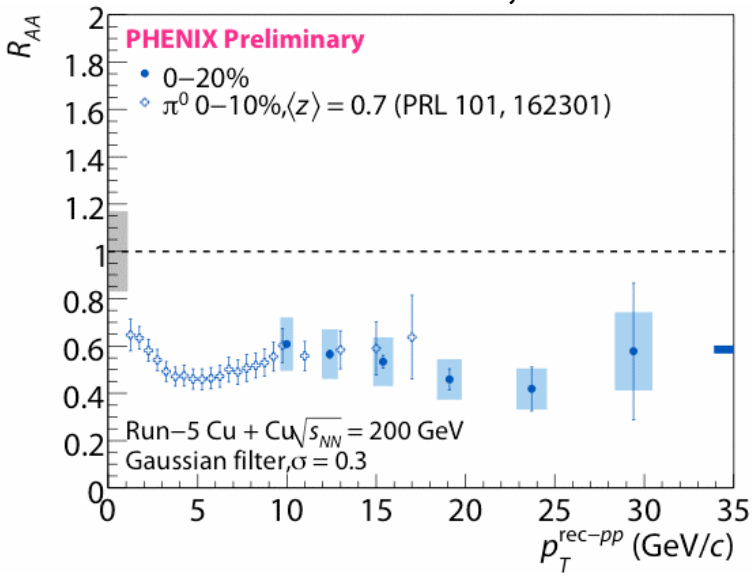


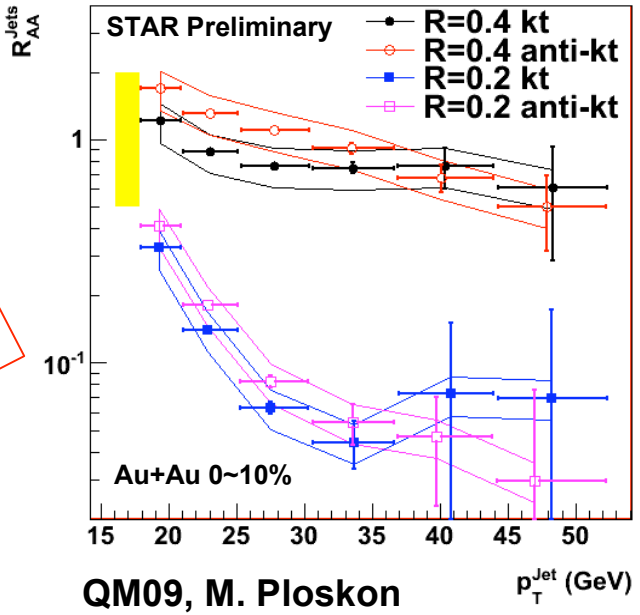
γ,Jet,π^0 - hadron correlation

Comparisons are the most important!

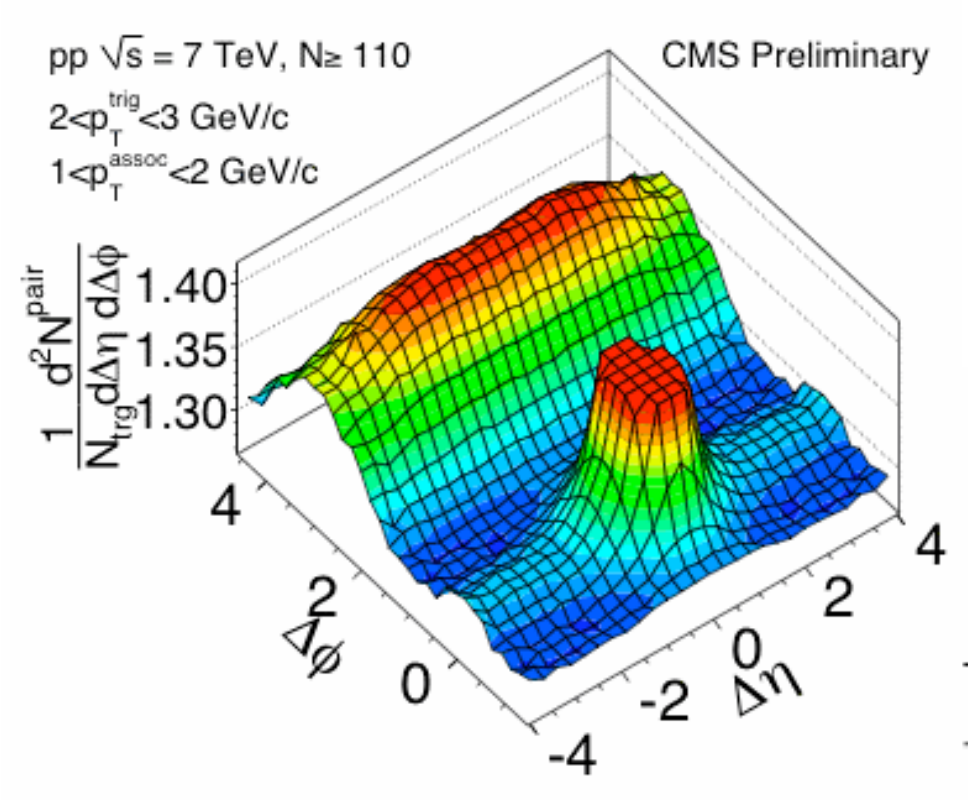


RHIC-AGS'09, Y. S. Lai

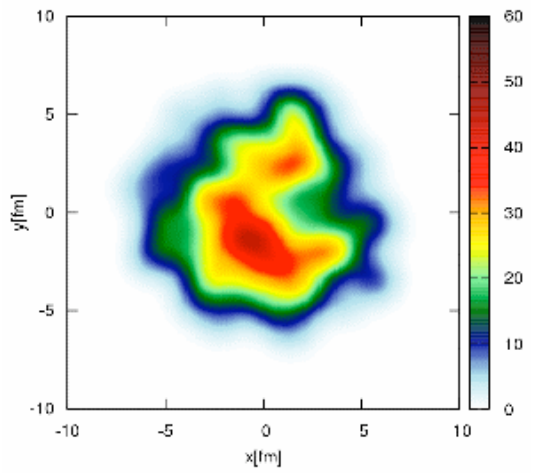


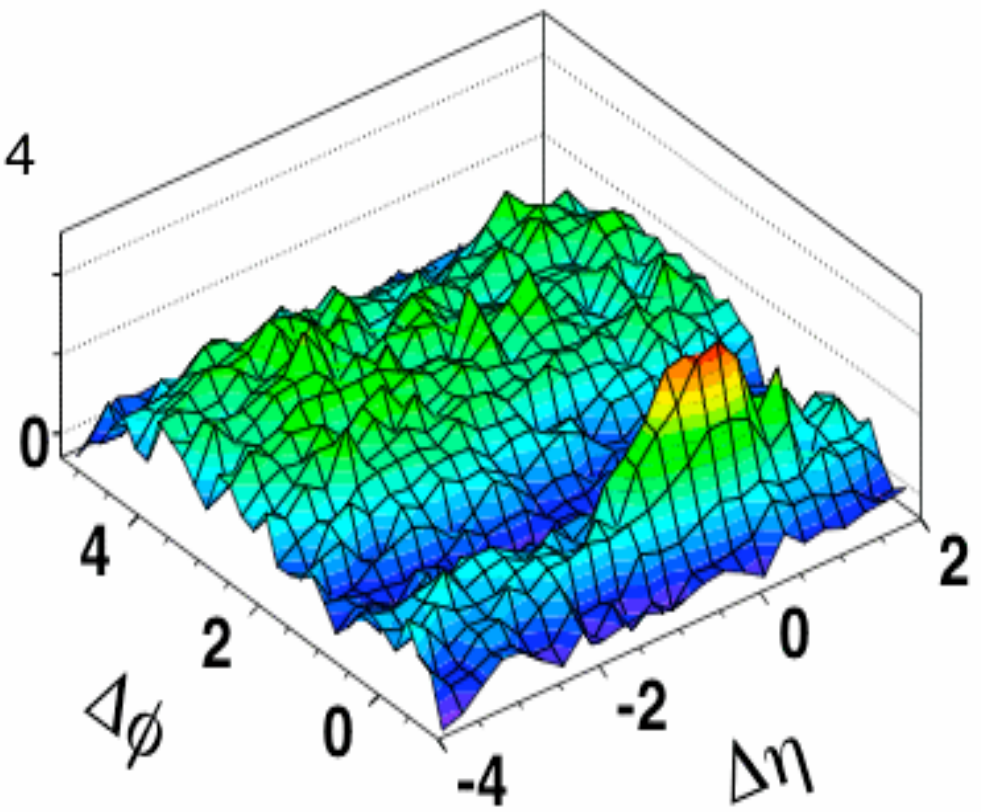


QM09, M. Ploskon



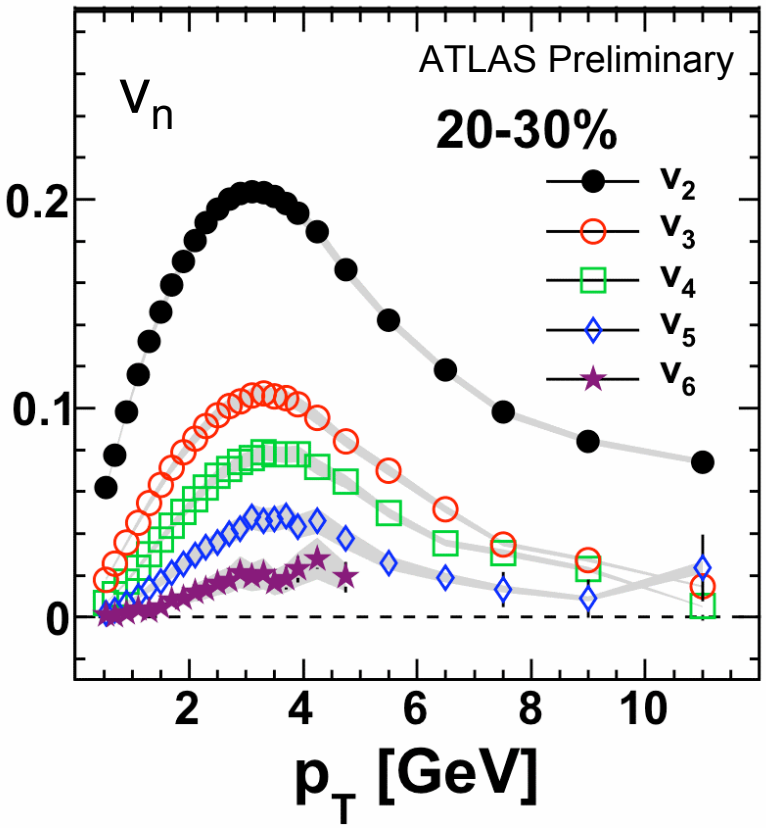
v_2 in p+p ⟷ v_3 in A+A

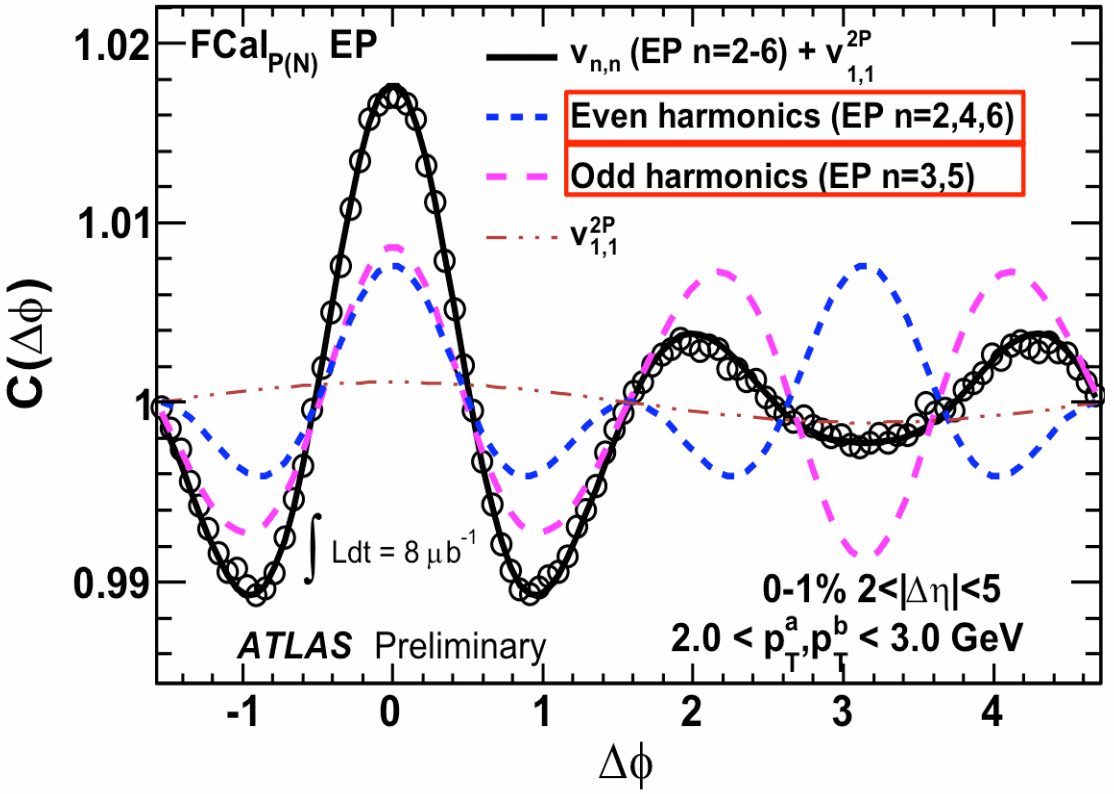


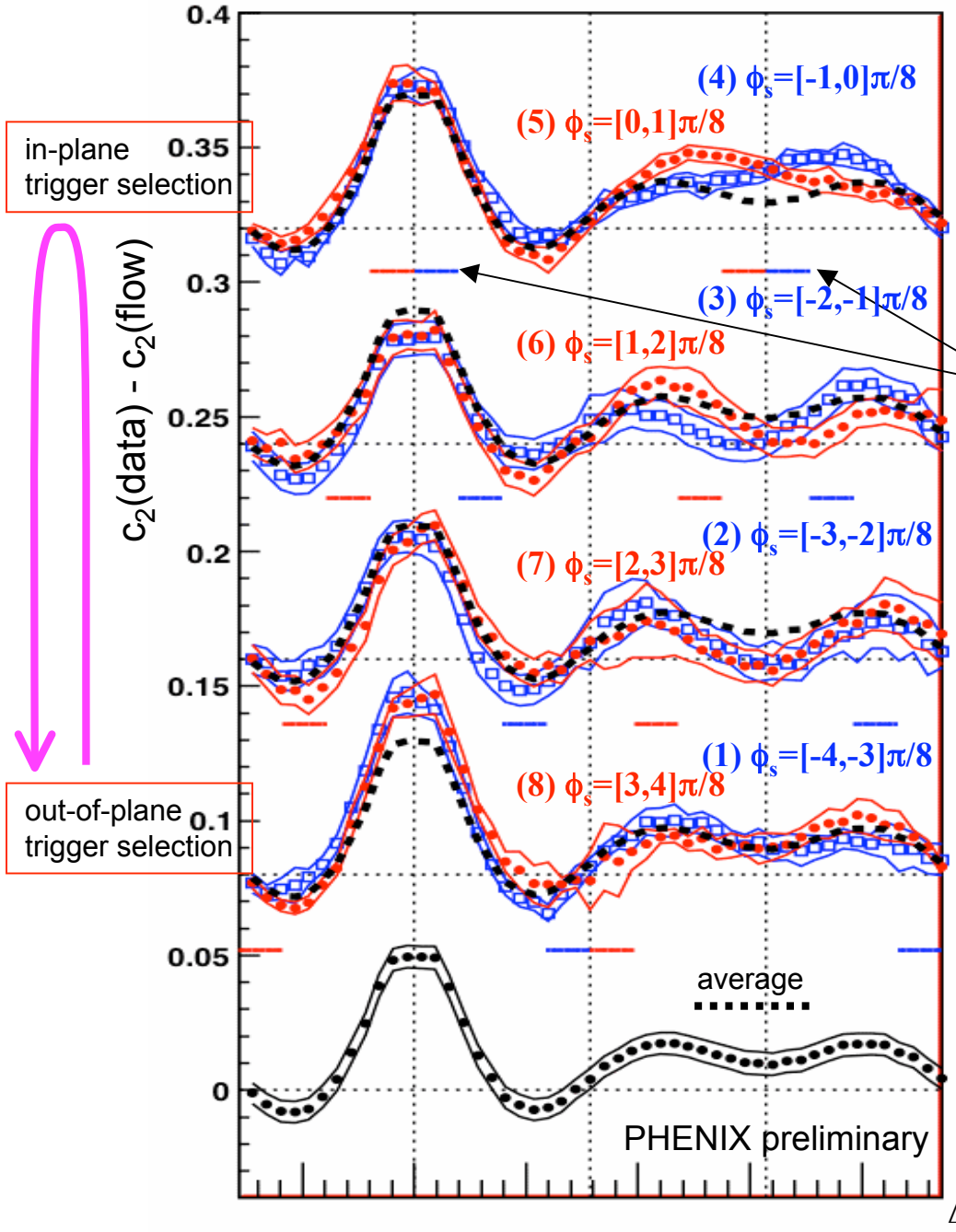


(b) Au+Au 0-30% (PHOBOS)

Higher harmonic event anisotropy and azimuthal correlation





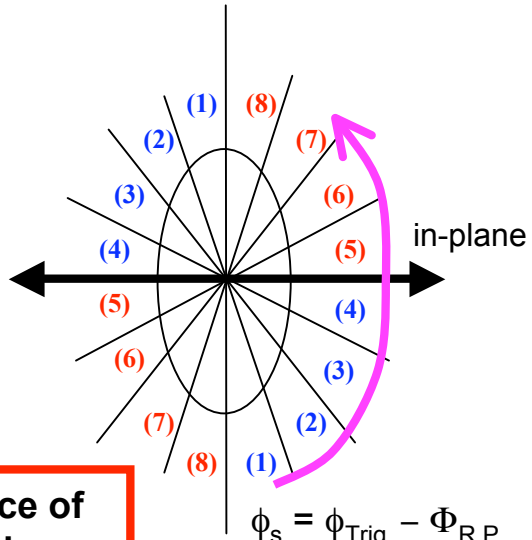


200GeV Au+Au -> h-h (run7)

(p_T^{Trig}=2~4GeV/c, p_T^{Asso}=1~2GeV/c)

mid-central : 20-50%

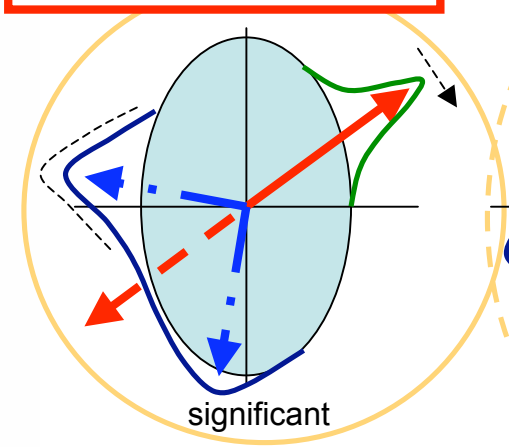
in-plane associate regions

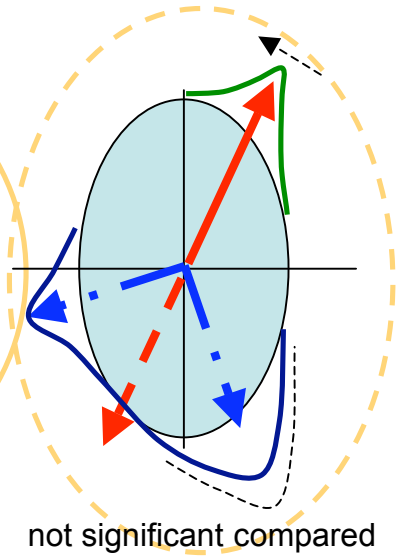


$\phi_s = \phi_{Trig.} - \Phi_{R.P.}$

$[-\pi/2,\pi/2]$

strong preference of associate particle emission towards the in-plane direction



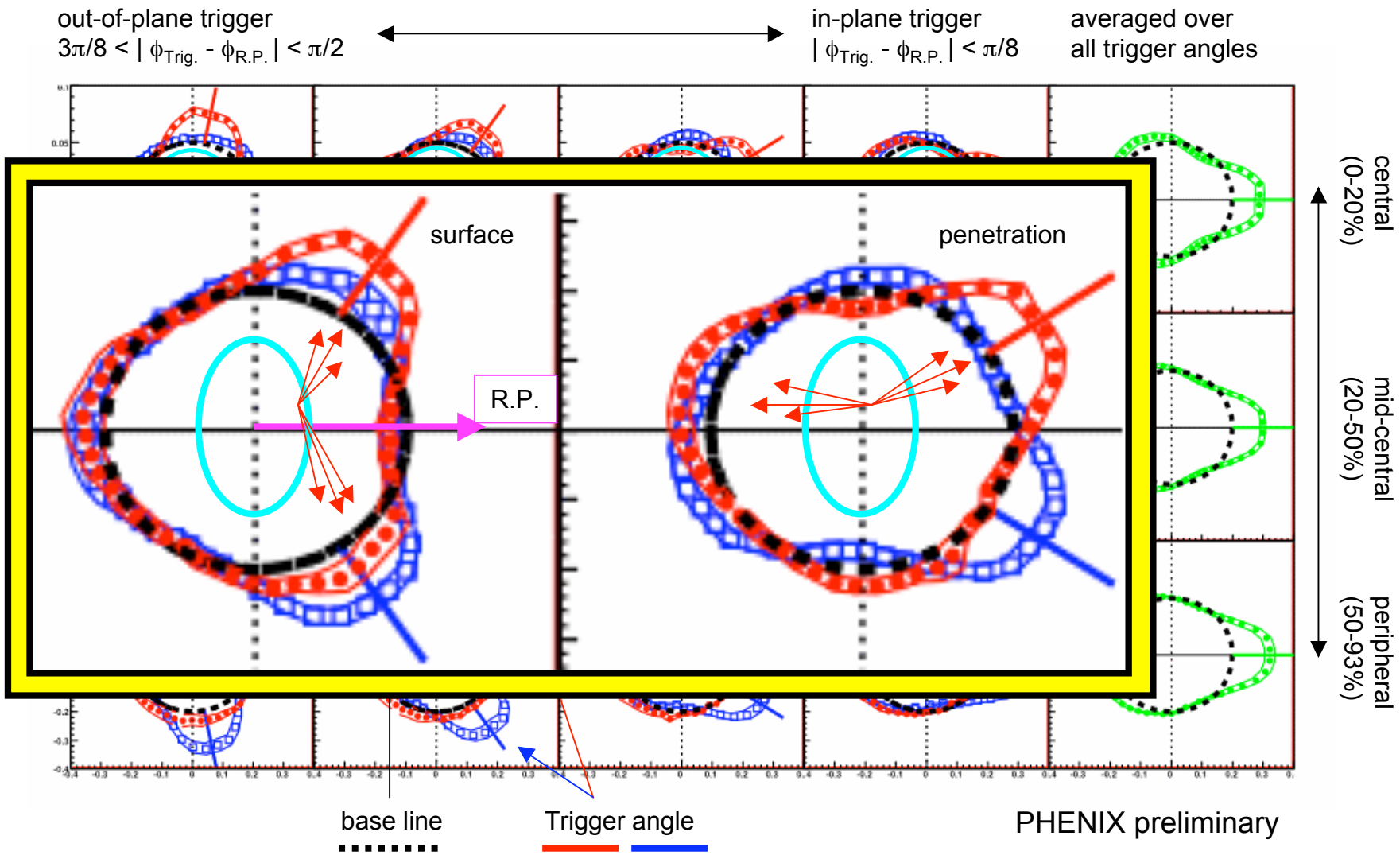


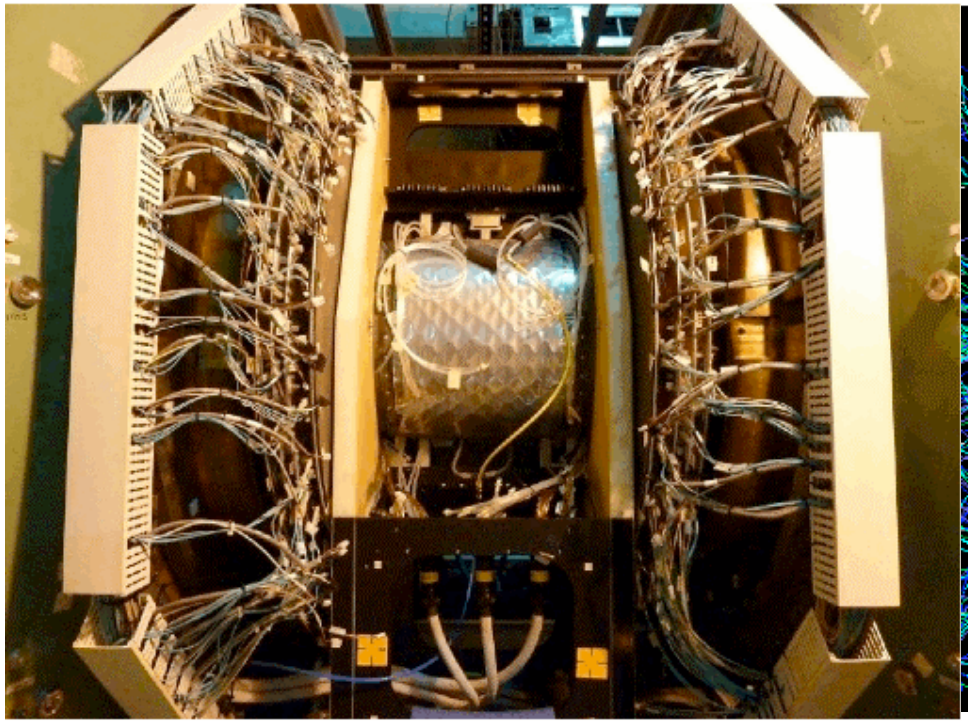
not significant compared with systematic errors

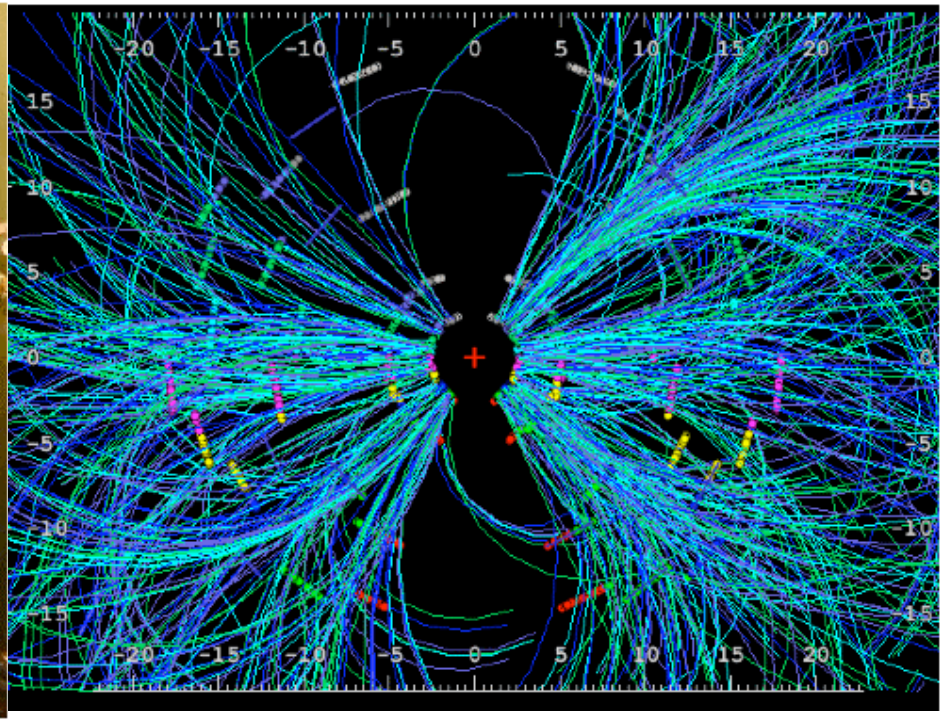
the same data in polar plots (R.P. is x axis)

--- associate distribution for a given trigger direction ---

200GeV Au+Au -> h-h
(p_T^{Trig}=2~4GeV/c, p_T^{Asso}=1~2GeV/c)







heavy-flavor (b/c tagged) electron
identified open heavy-flavor meson
multi-hadron/jet correlations with R.P. / large η^{Trig}
higher harmonic event anisotropy

Summary

- Calorimetric detector for jets, electrons and photons at high p_T
- How about low p_T electrons, photons and identified hadrons?
- What about fluctuation/correlation variables with particle identification using a large acceptance detector…