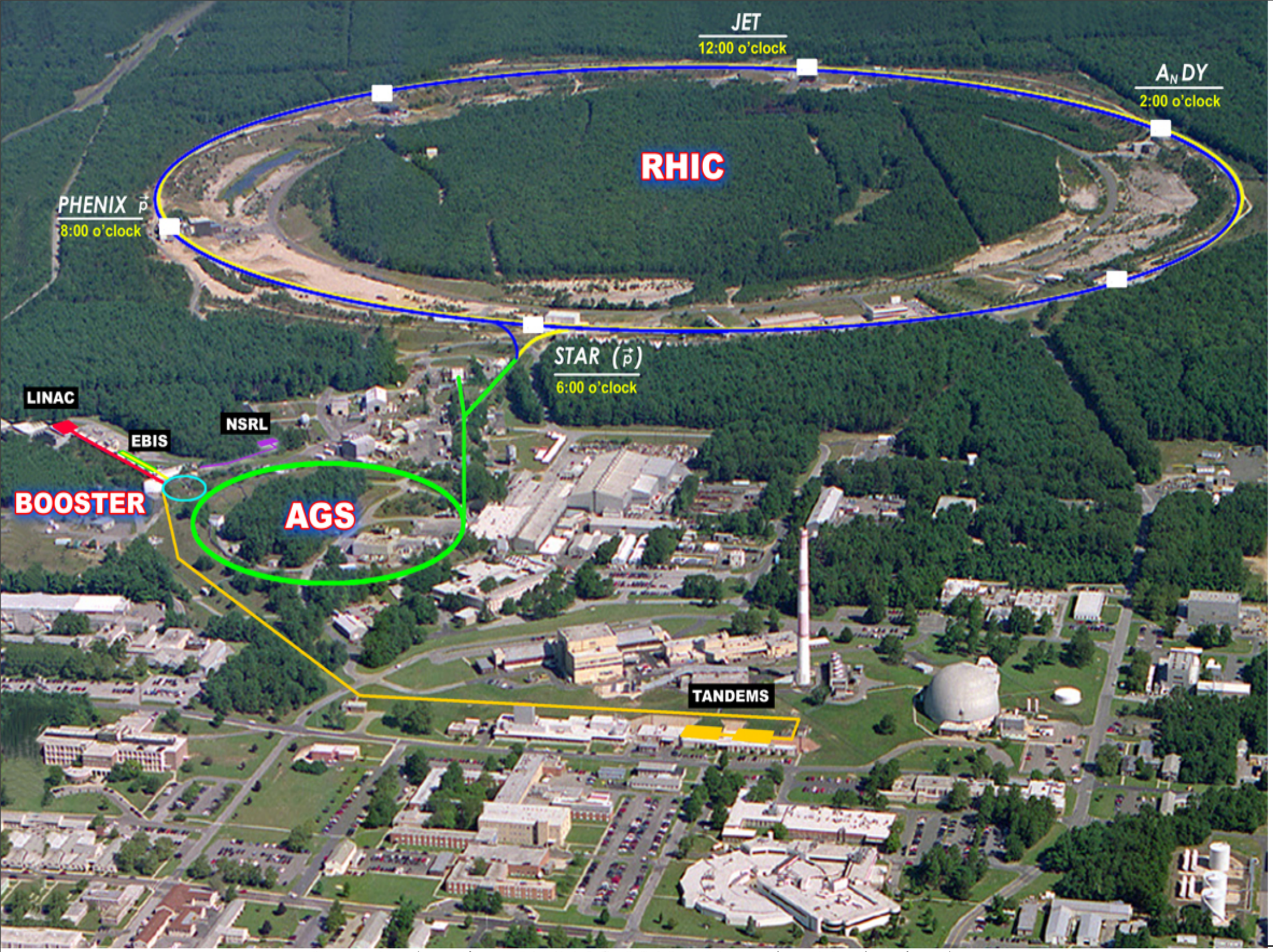
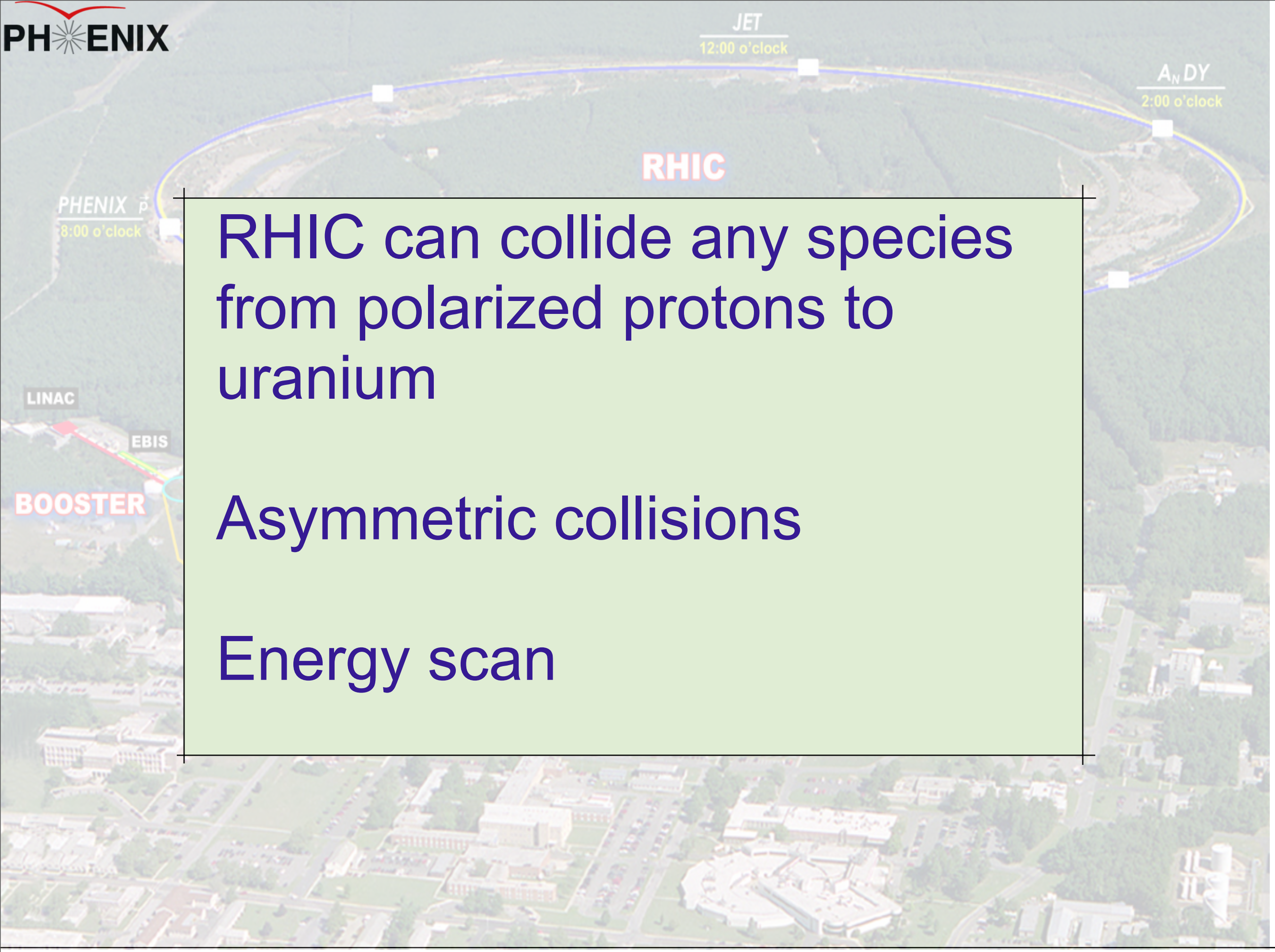
Future of Heavy Quark Measurement at sPHENIX

CESAR LUIZ DA SILVA
MATT DURHAM
LOS ALAMOS NATIONAL LAB
for the PHENIX Collaboration

International Workshop on Heavy Quark Production in Heavy-Ion Collisions
2012 - Utrecht, Netherlands


JET
12:00 o'clock
A_N DY
2:00 o'clock
RHIC
PHENIX $\vec{p}$
8:00 o'clock
STAR ($\vec{p}$)
6:00 o'clock
LINAC
NSRL
EBIS
BOOSTER
AGS
TANDEMS

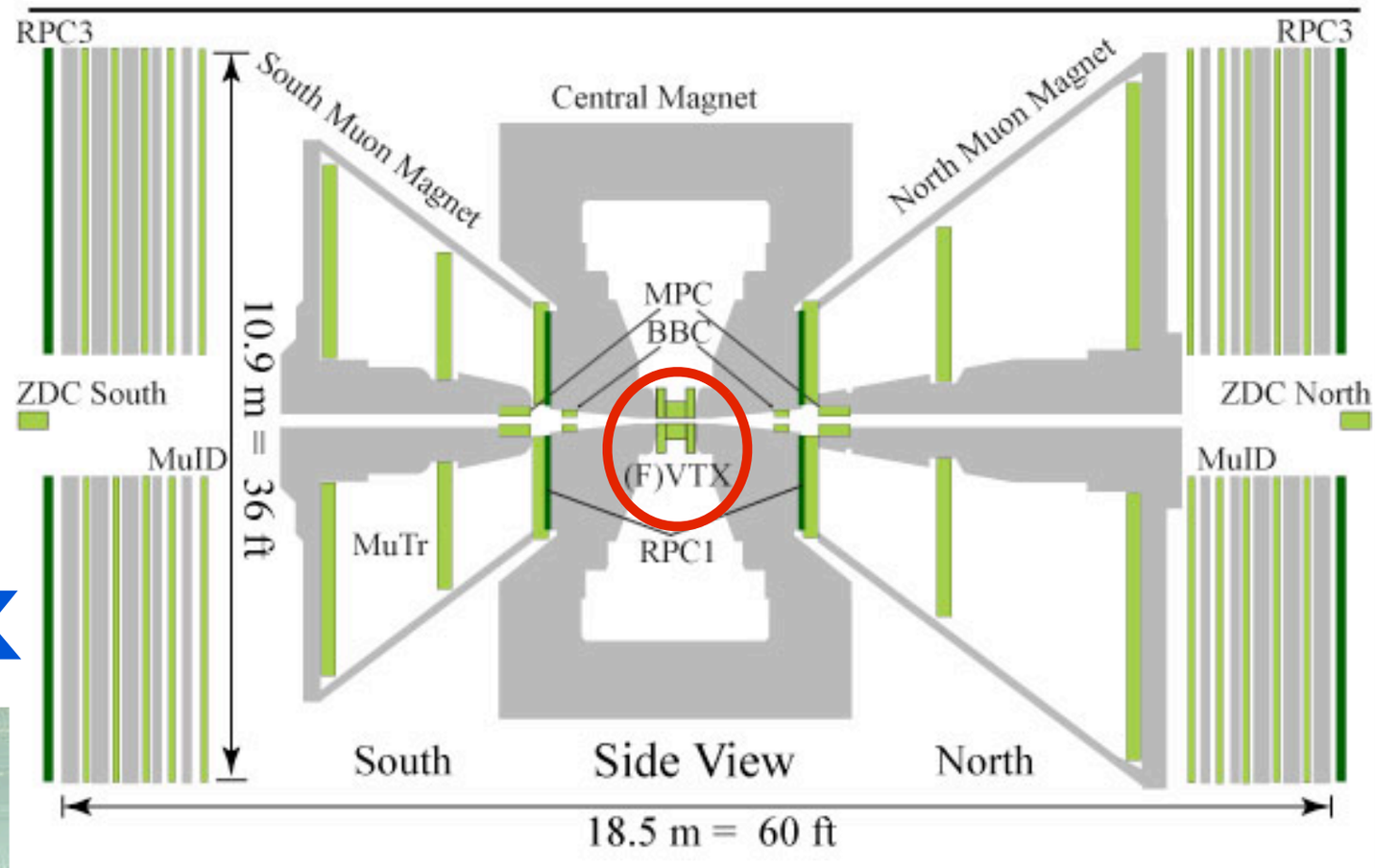


RHIC can collide any species from polarized protons to uranium

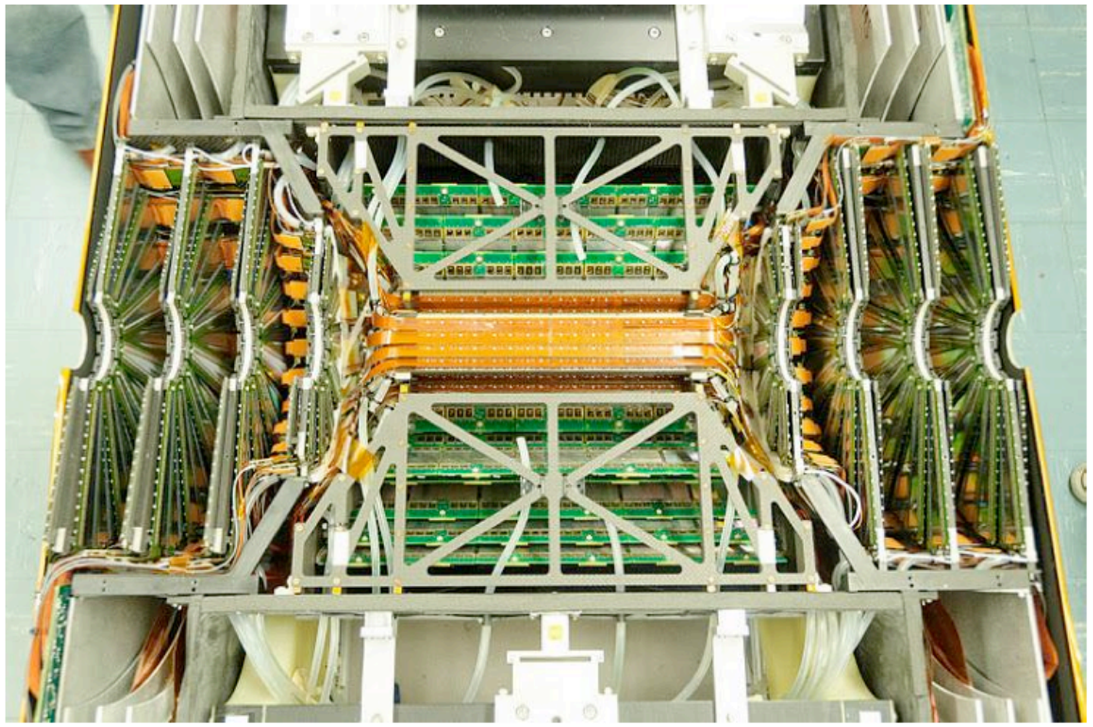
Asymmetric collisions

Energy scan

Vertex Detectors

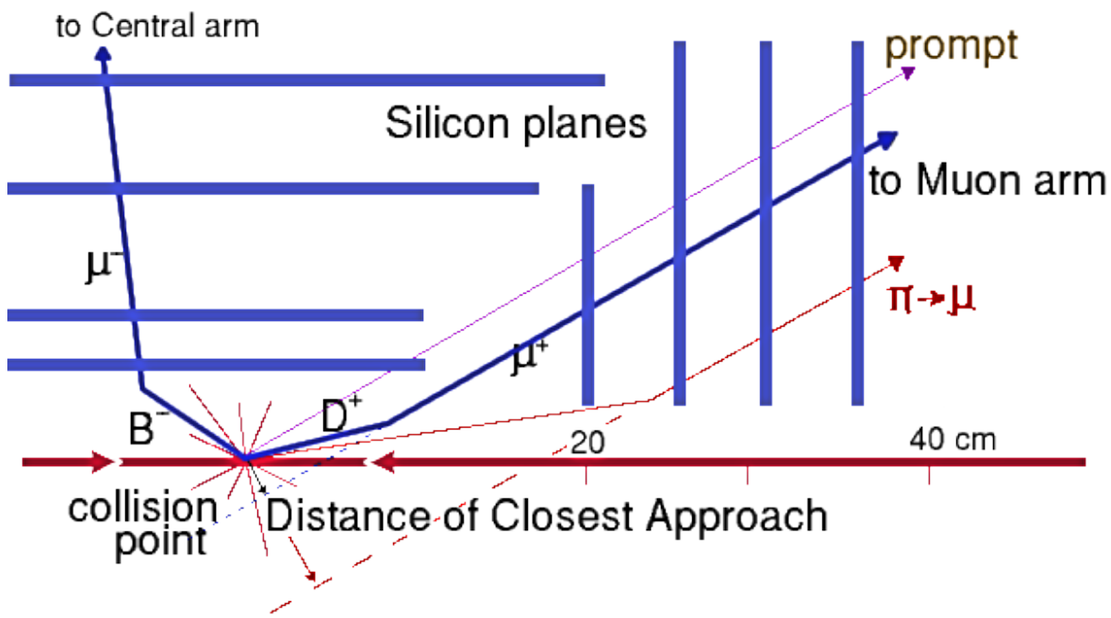


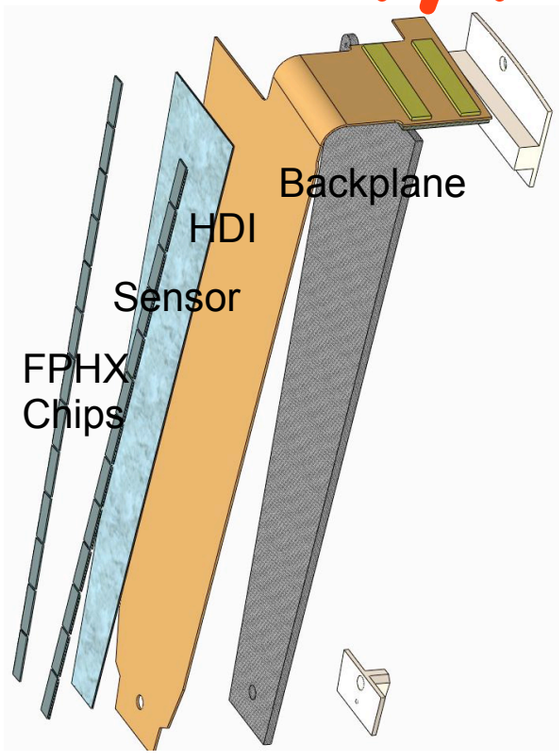
FVTX **VTX** **FVTX**

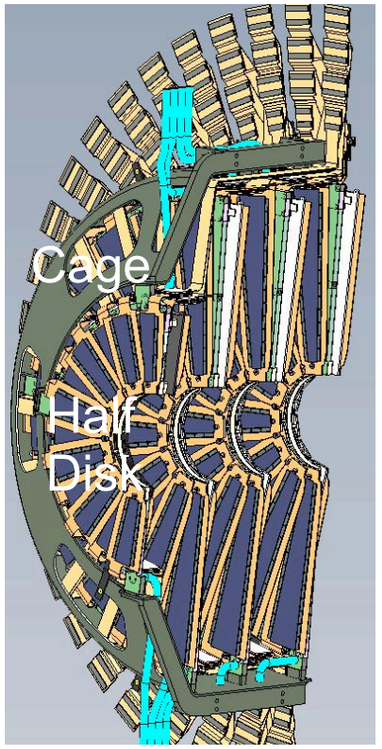


FVTX: muons in 1.2<|y|<2.4

- can measure displaced vertex for c,b separation

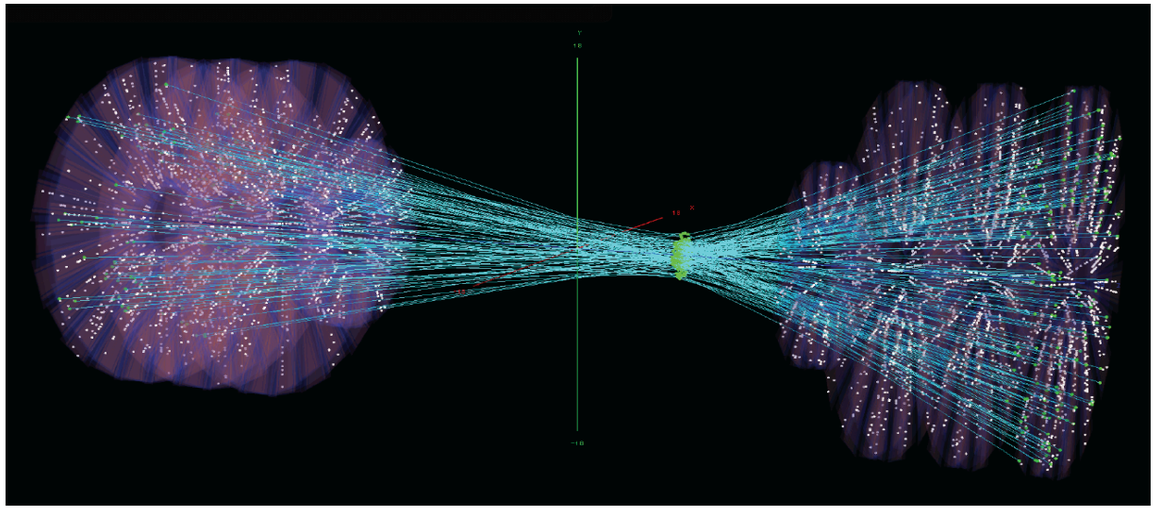






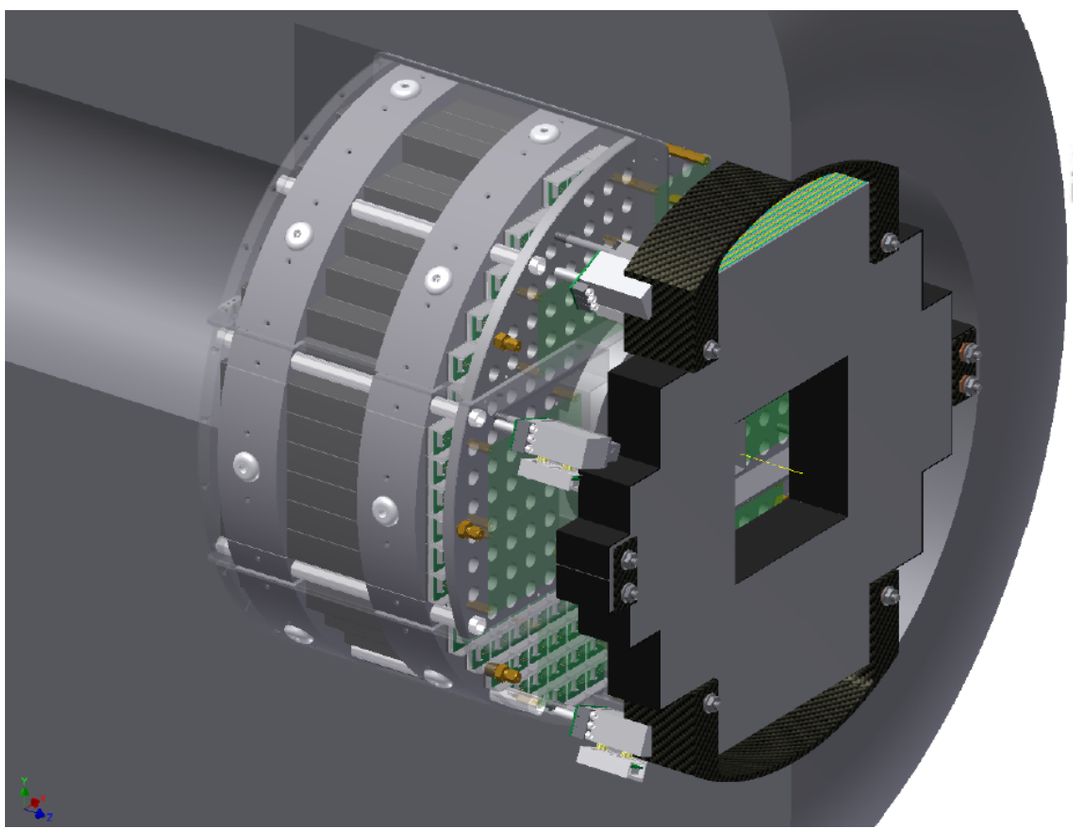
- better determination of dimuon opening angle allowing J/ψ, ψ' separation
- primary vertex, reaction plan and centrality

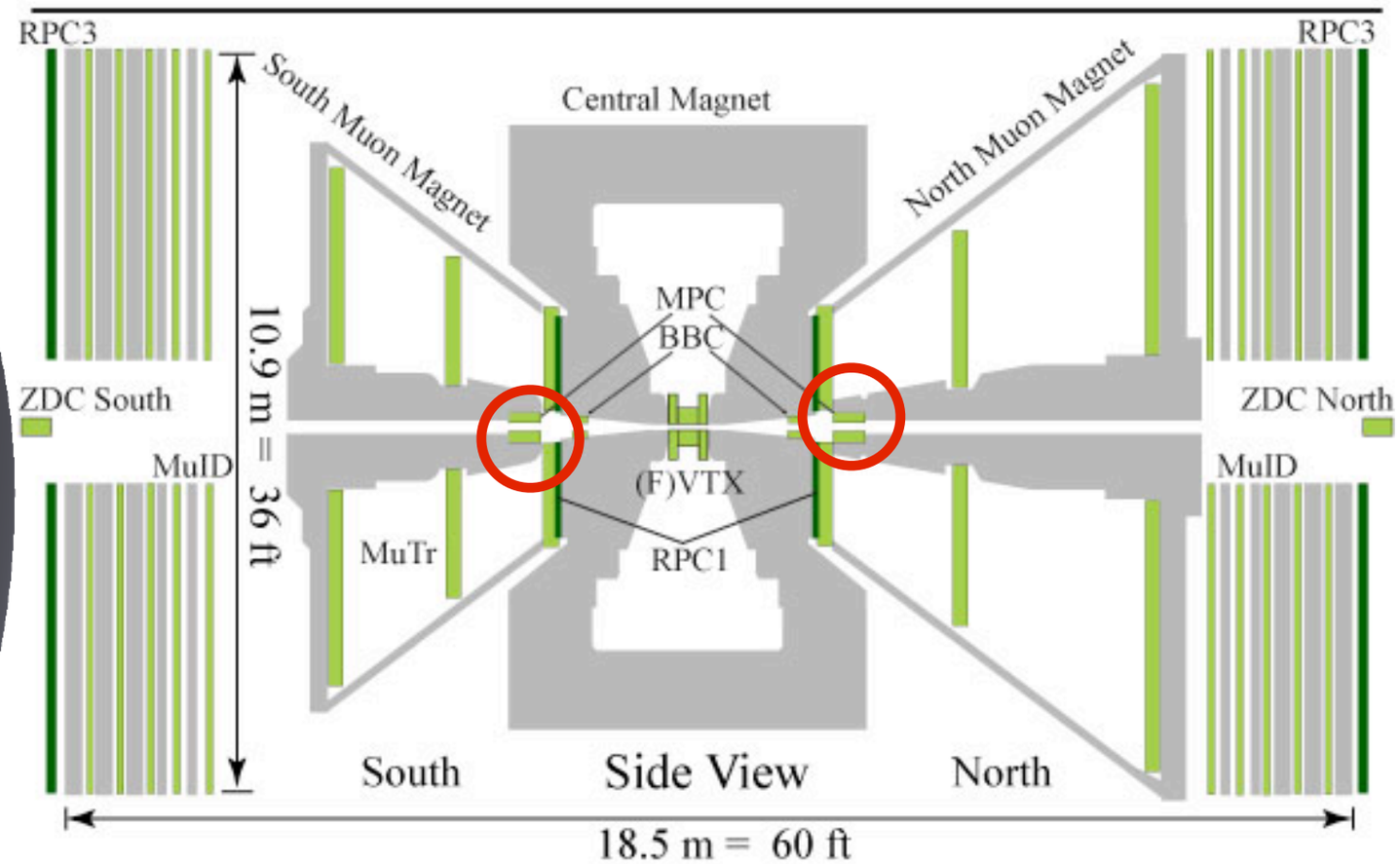
U+U collision



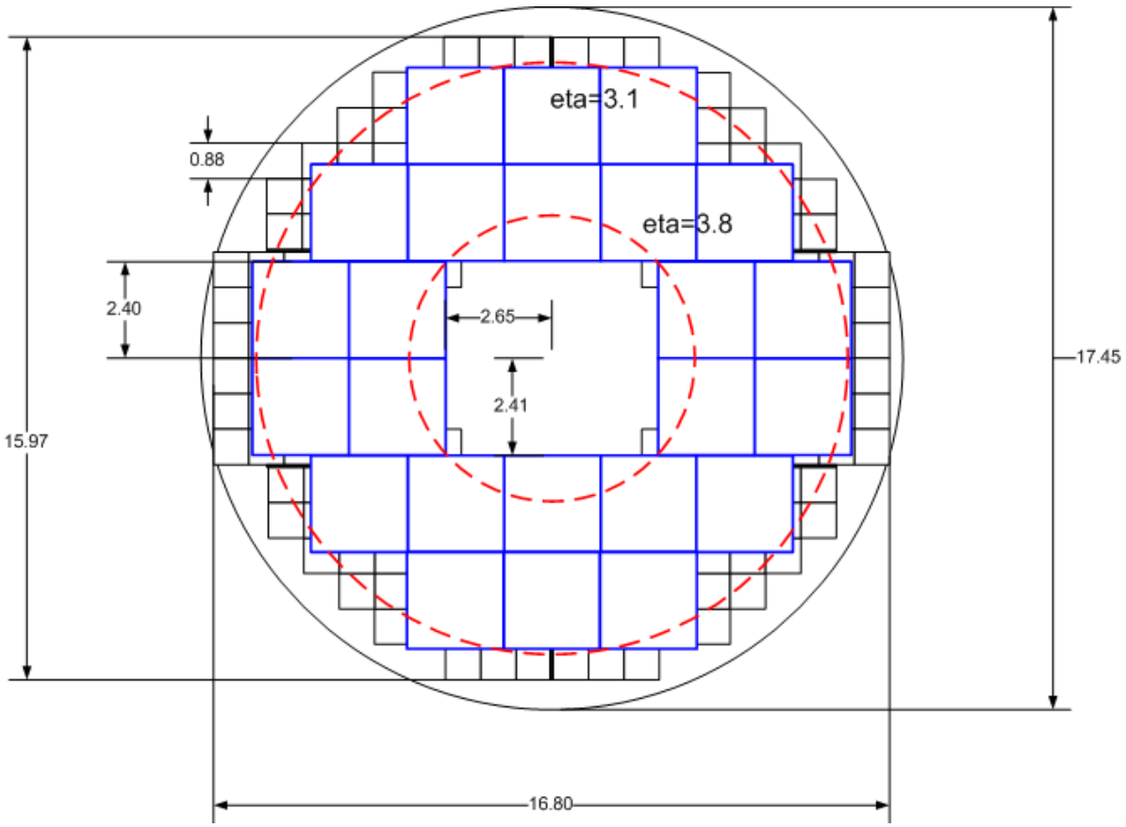
- commissioning during 2012 run
  - 510 GeV p+p, 200GeV U+U, 200GeV Cu+Au
  - data under analysis

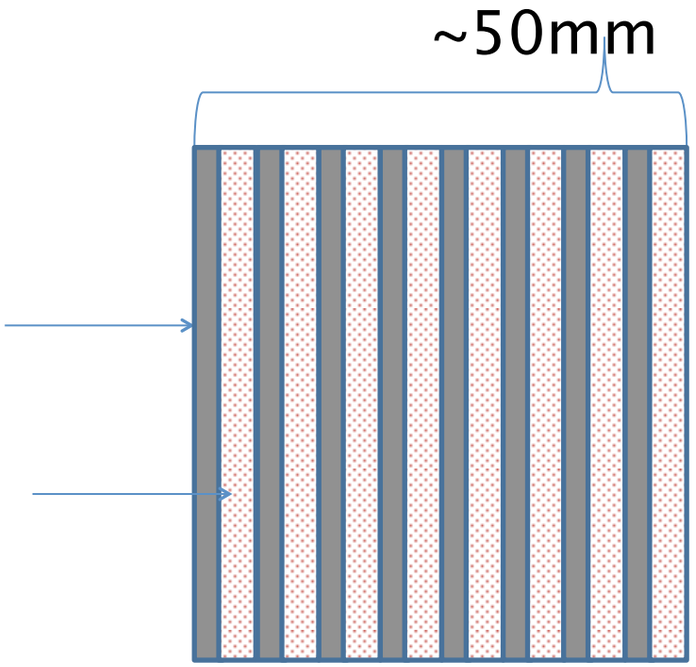
Muon Piston Calorimeter + pre-shower MPC-ex



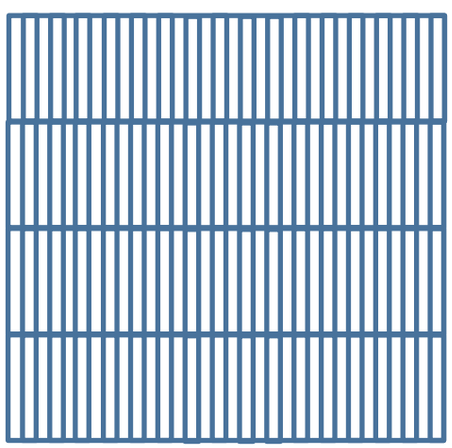


MPC-ex: γ ,e,π^0 in 3.1<|η|<3.8





1.8mm x 15mm
"minipad" silicon sensor



Small-x physics

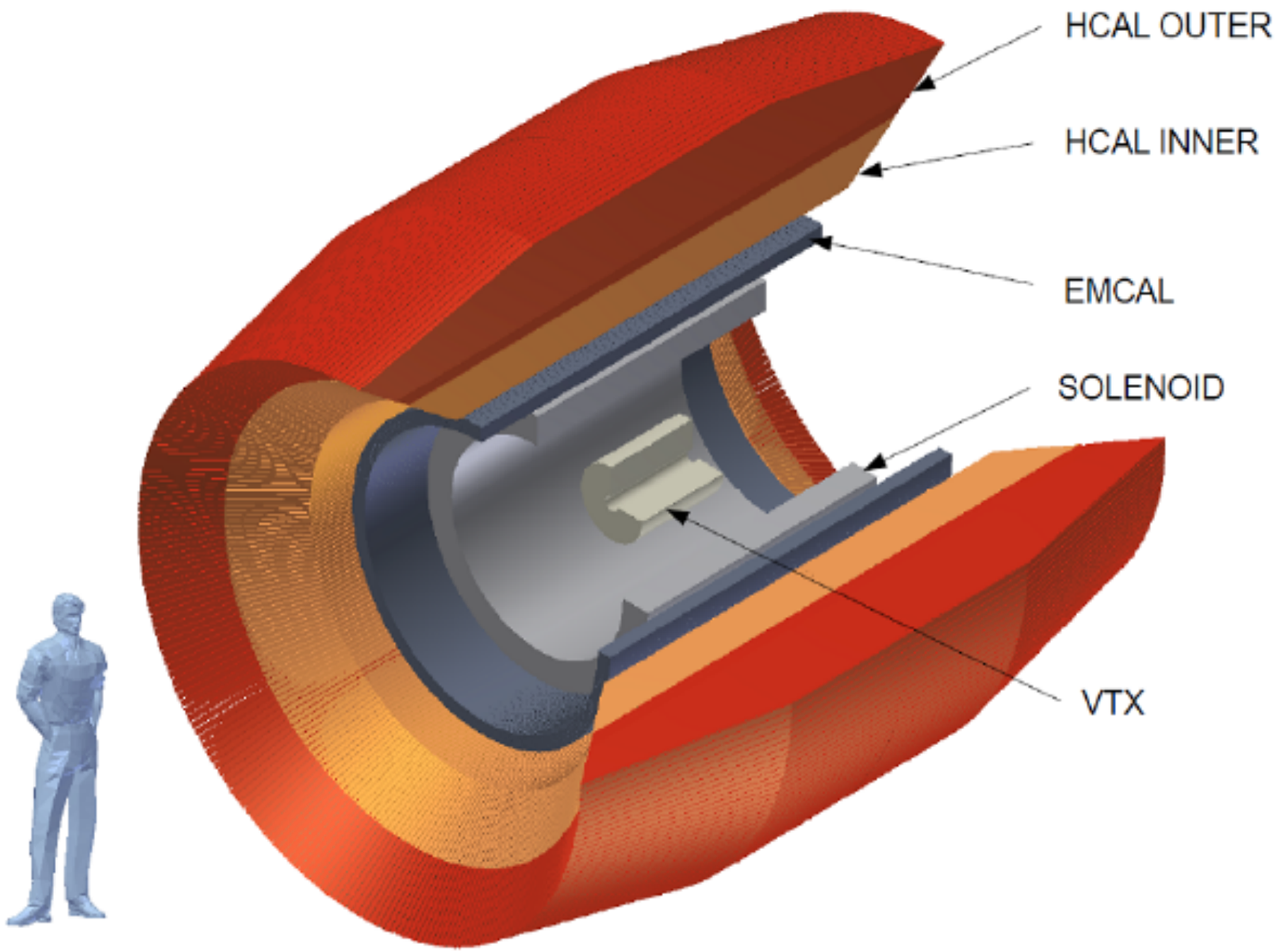
- long range correlations
- gluon saturation
- very forward J/ψ measurement

- can better determine impact parameter in p+A

SPHENIX

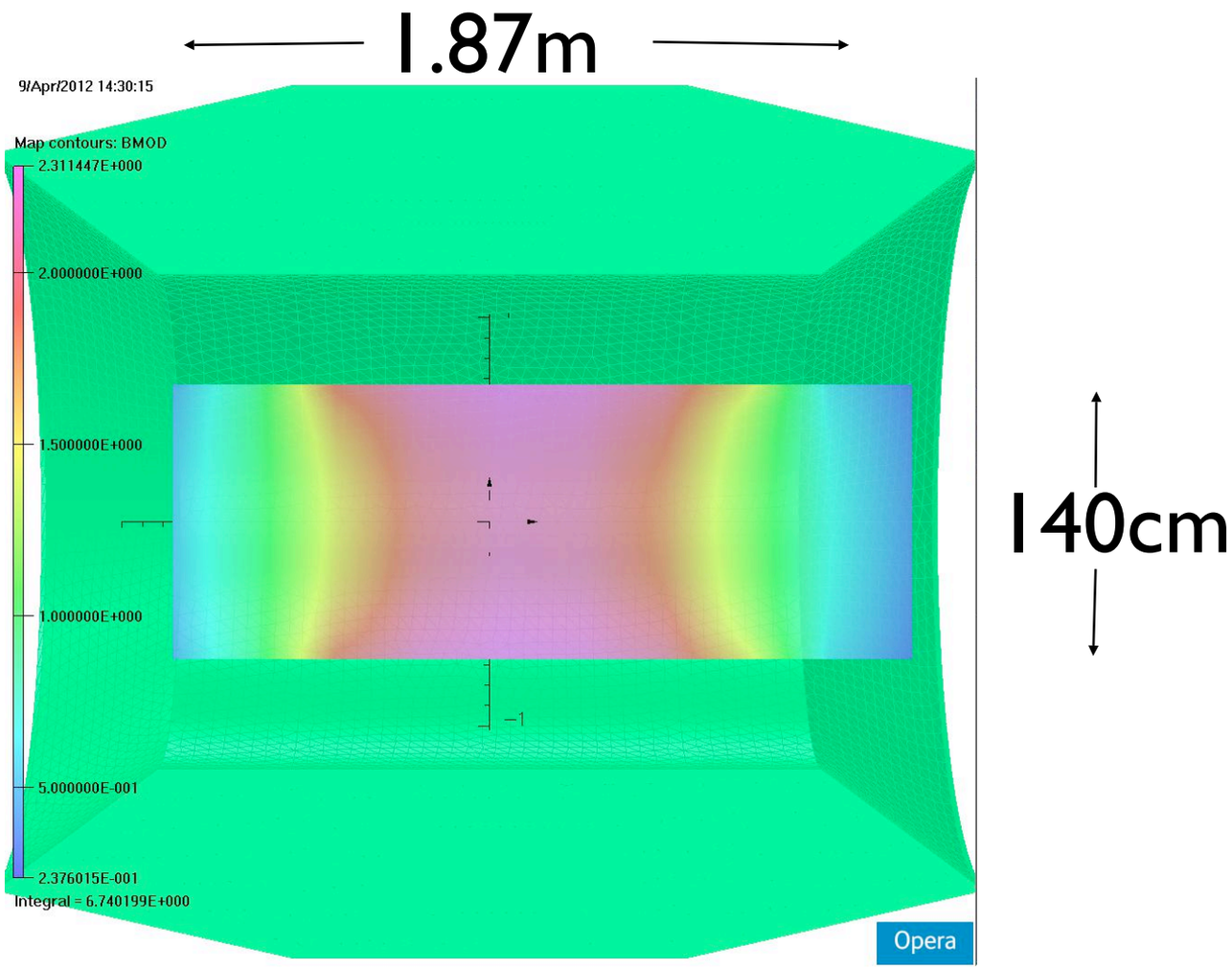
SOLENOIDAL PHENIX

FIRST STAGE



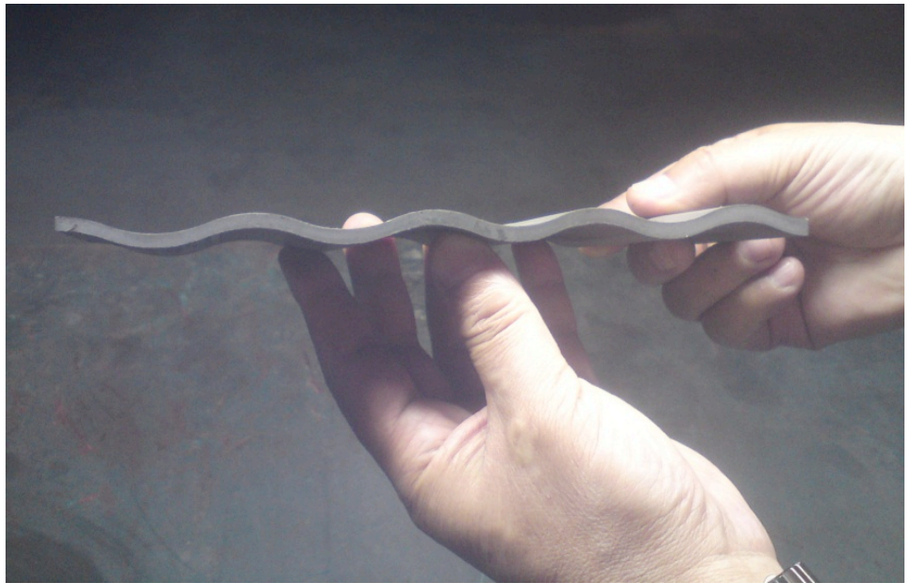
- Full azimuthal coverage in a fiducial region $|\eta|<1$
- focus on jets

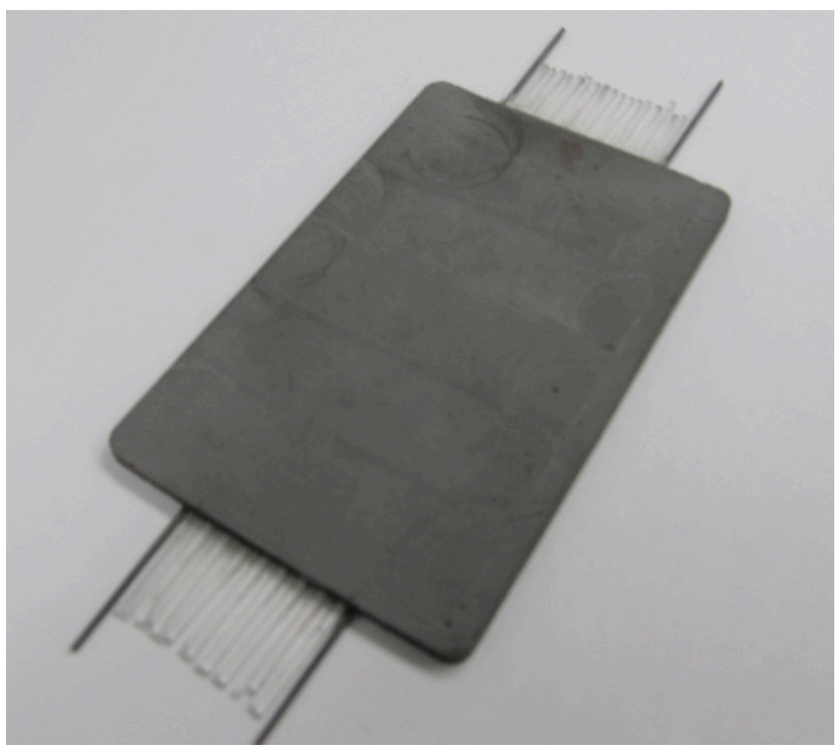
2T Solenoid

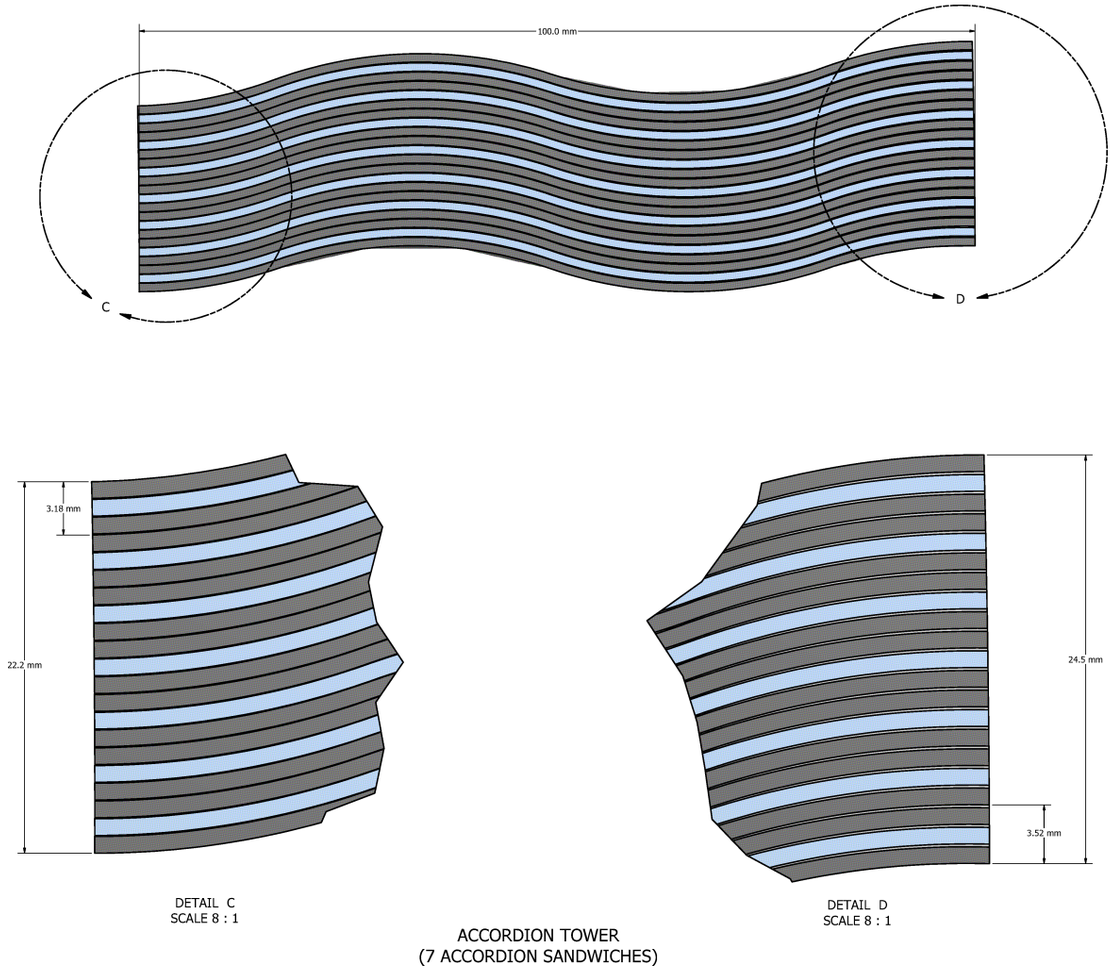


- allow high resolution tracking in a small volume

Electromagnetic calorimeter

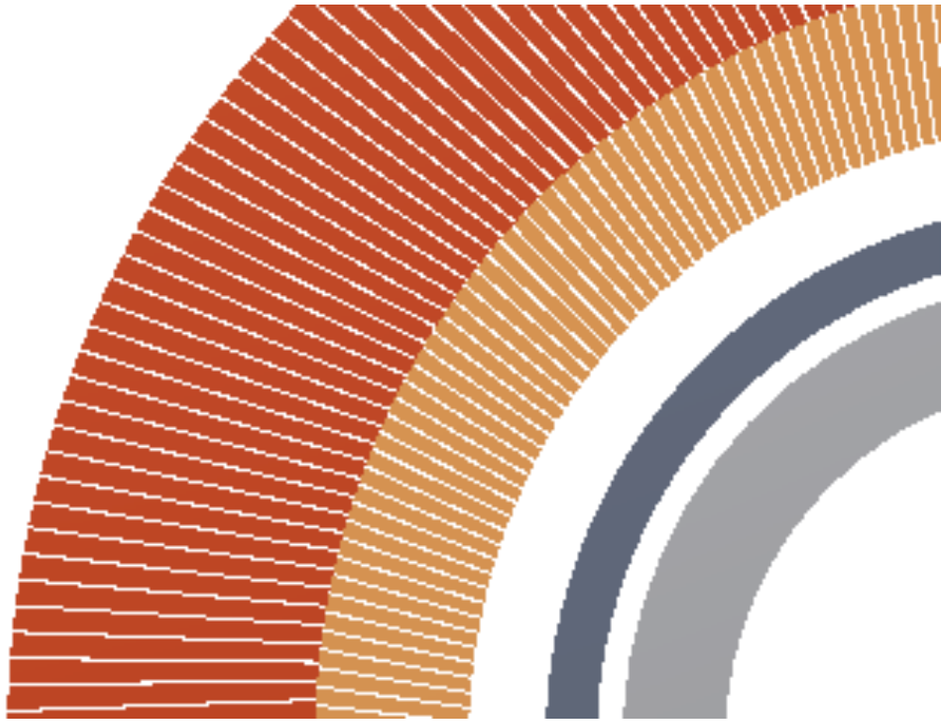


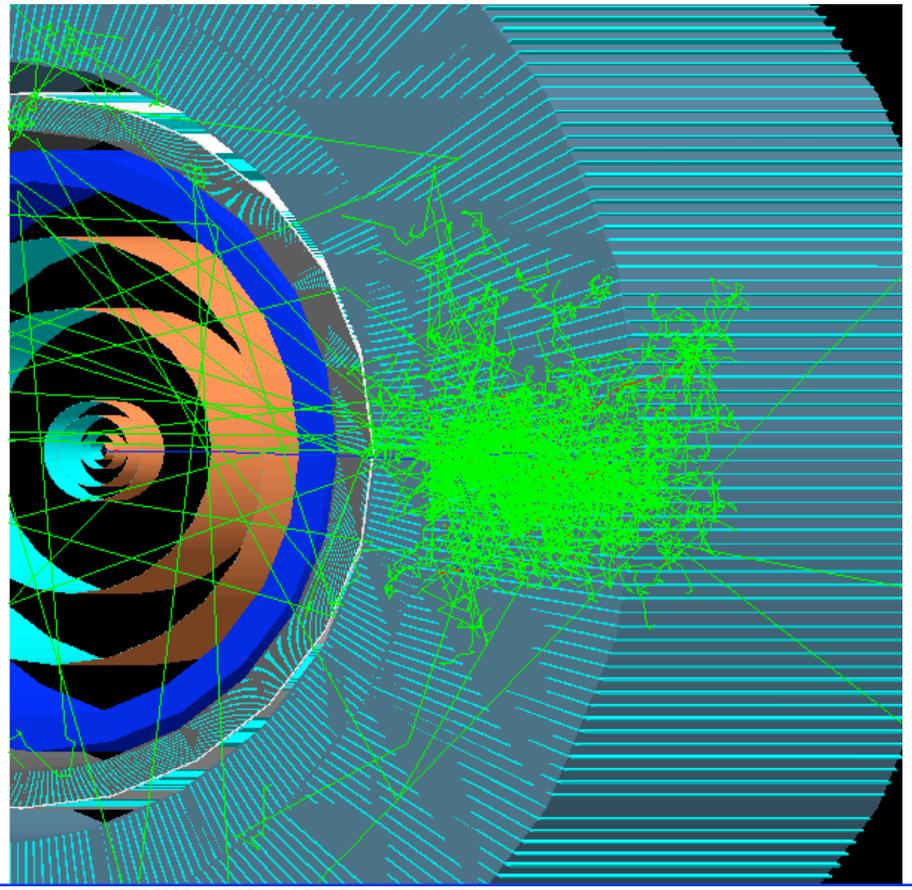




- $\Delta\eta \times \Delta\phi \approx 0.02 \times 0.02$
- $\sigma_E/E \approx 15\%/\sqrt{E}$
- optical accordion
- Tungsten absorber
- Scintillating fiber

Hadronic calorimeter

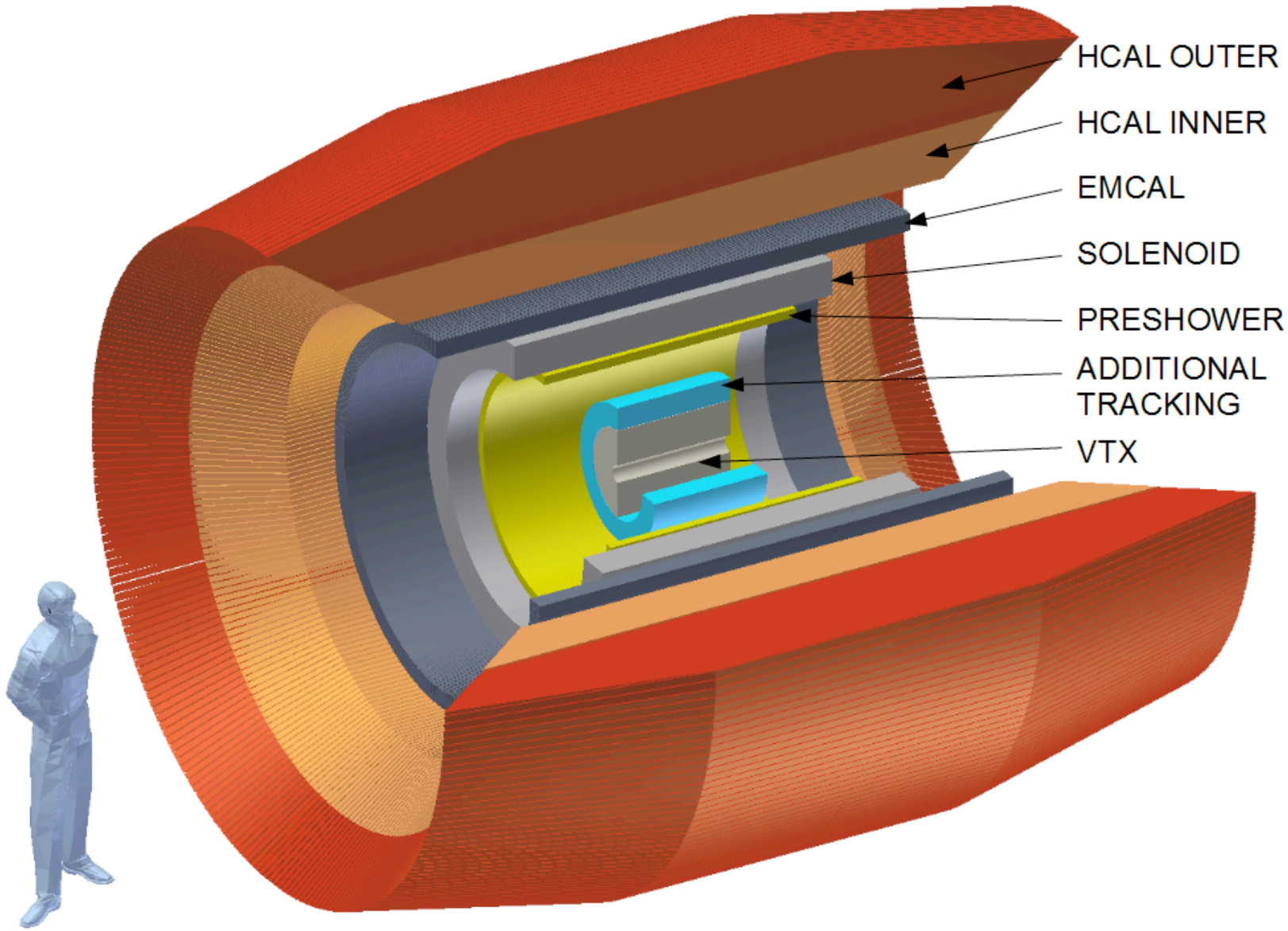




10 GeV/c pion showering in the hadronic calorimeter

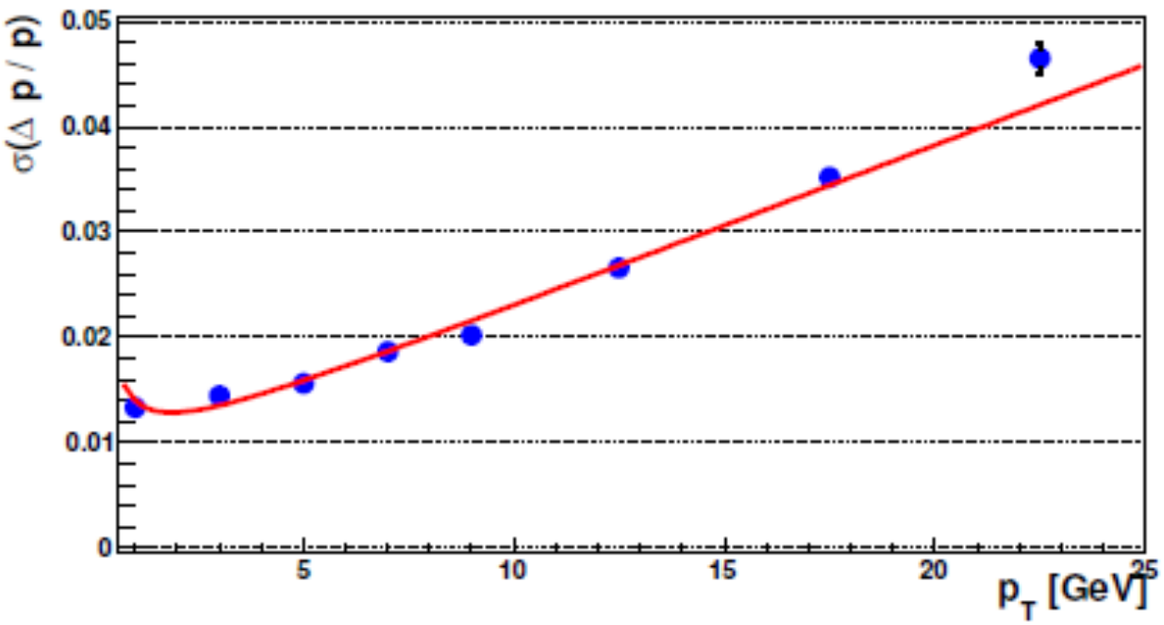
- $\Delta\eta \times \Delta\phi \approx 0.1 \times 0.1$
- $\sigma_E/E \approx 100\%/\sqrt{E}$
- Inner and outer readout
- Fe-Scintillating layers

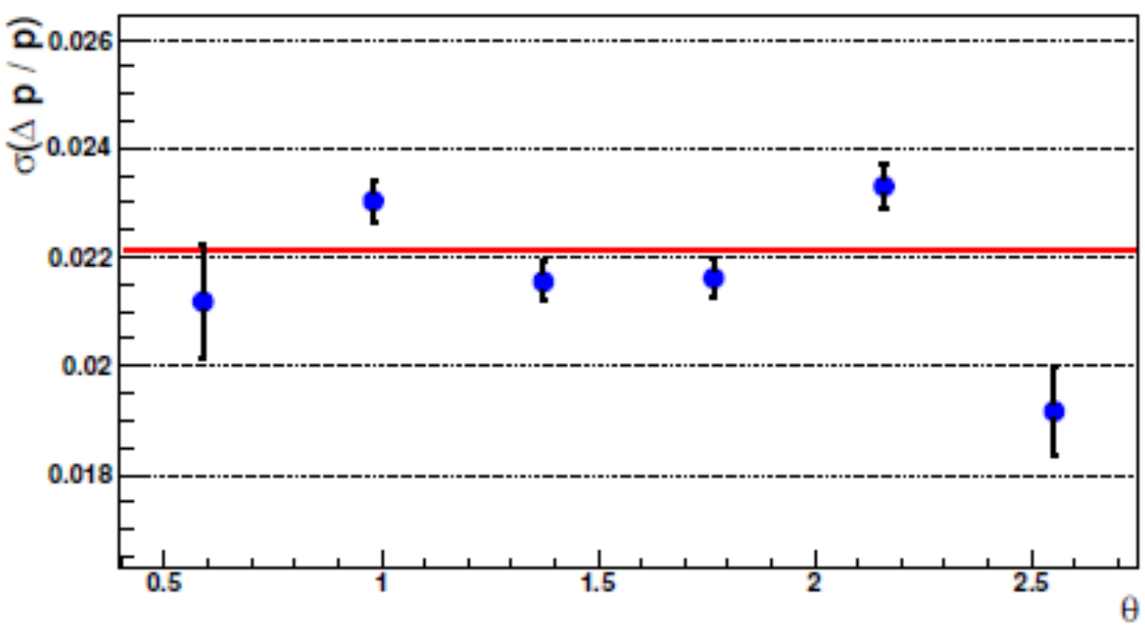
SECOND STAGE



- add at least 2 layers of silicon strips for tracking
- pre-shower allowing electron and photon identification

momentum resolution with additional tracker

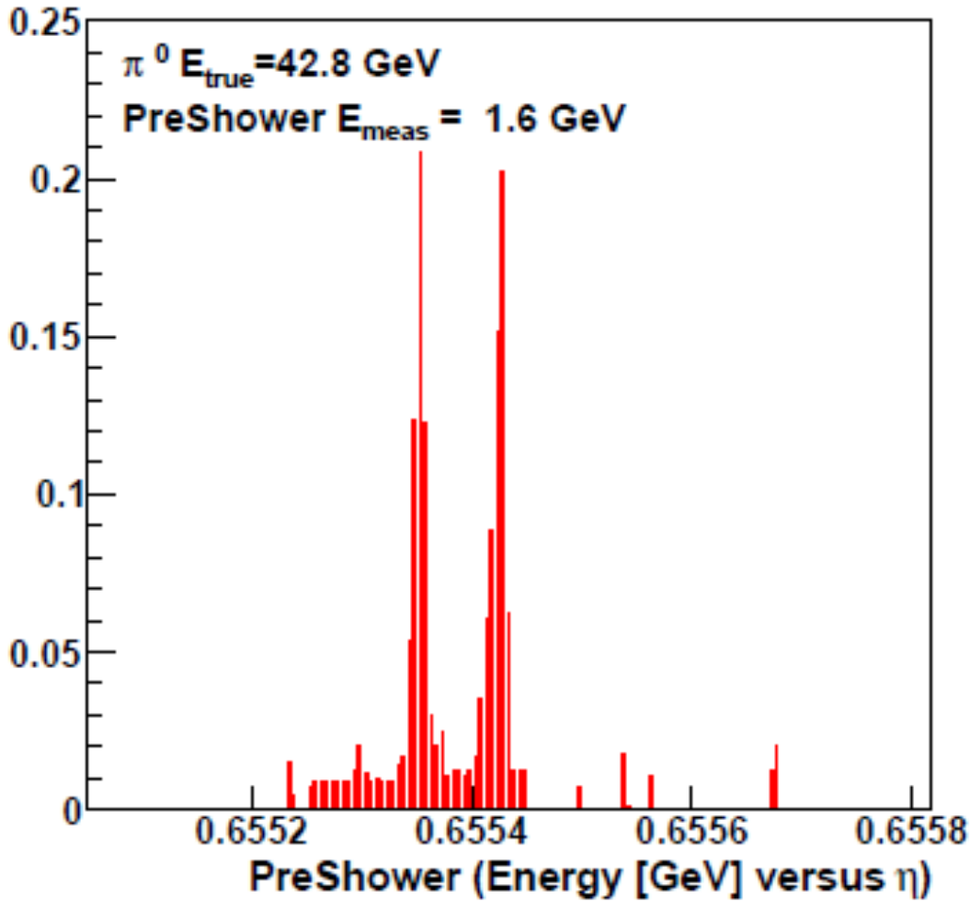


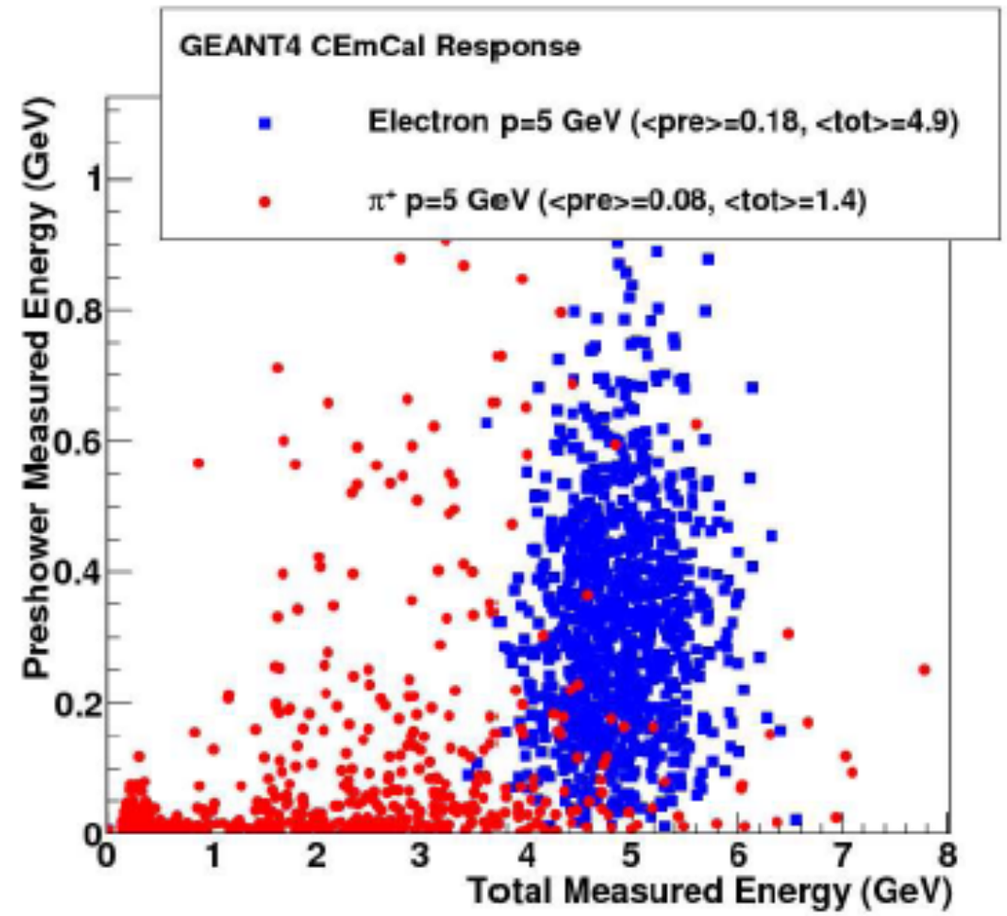


η= 1.2 η= 0 η= −1.2

- Full Geant4 simulation
  - Strip layer at R=40 cm and 60 cm
  - Strip width 80 micron (same as PHENIX VTX)
- $\sigma_p/p \approx 0.7\% + 0.15\% p$ (GeV)
  - Uniform in θ
  - Sufficient to resolve three states of Upsilon

Pre-shower detector

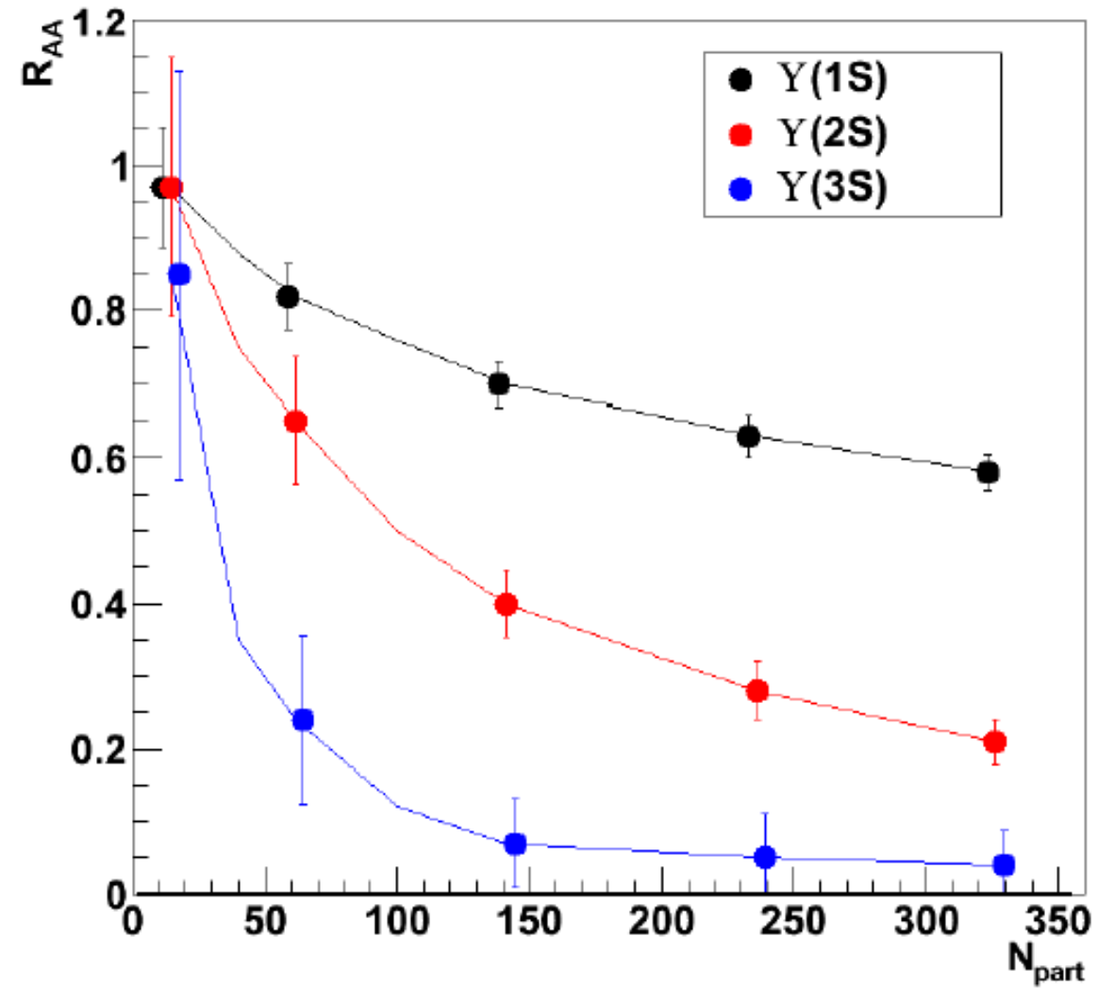




- γ/π^0 separation
  - High pT π^0 RAA up to 40 GeV
  - Direct photon
  - γ–jet correlation

- e/π separation
  - High pT electrons (c, b)
  - Upsilon measurements

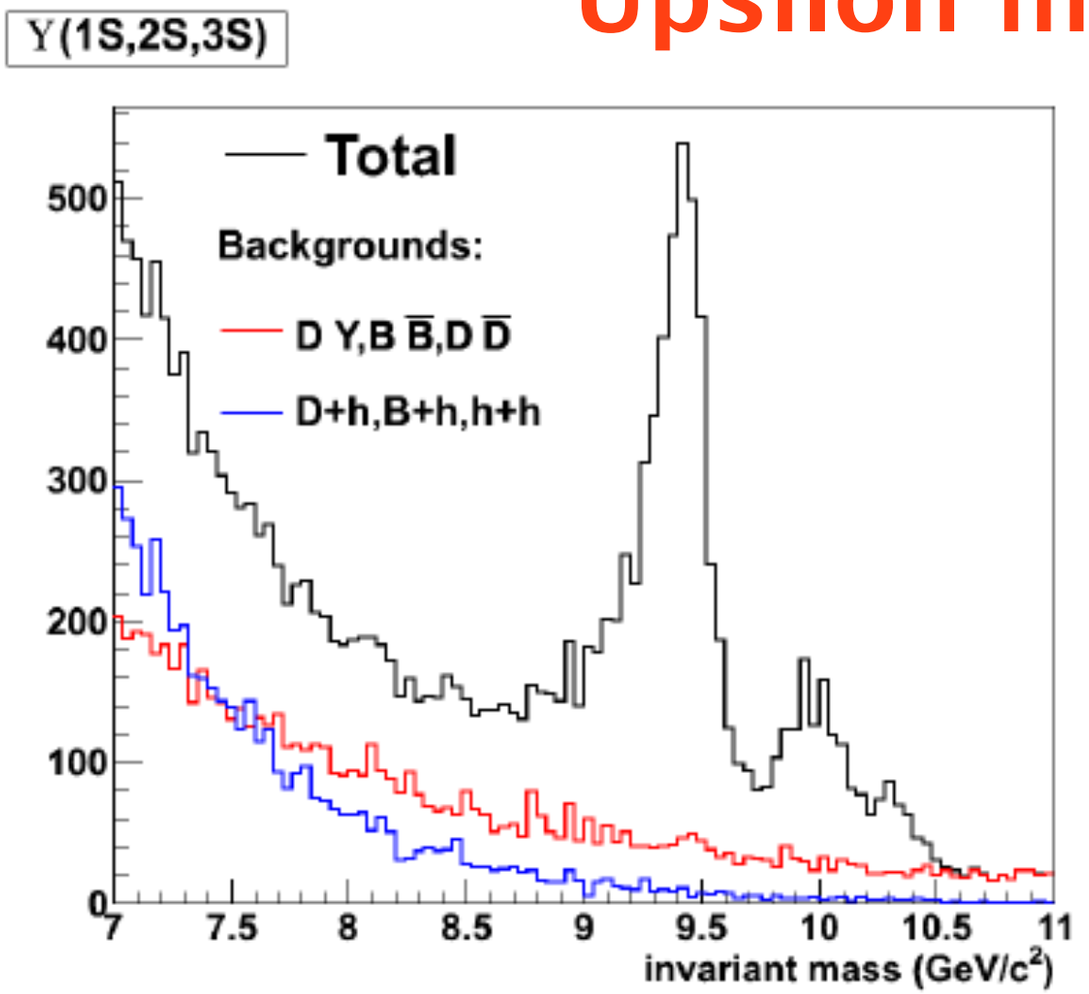
Physics with pre-shower Upsilon measurements

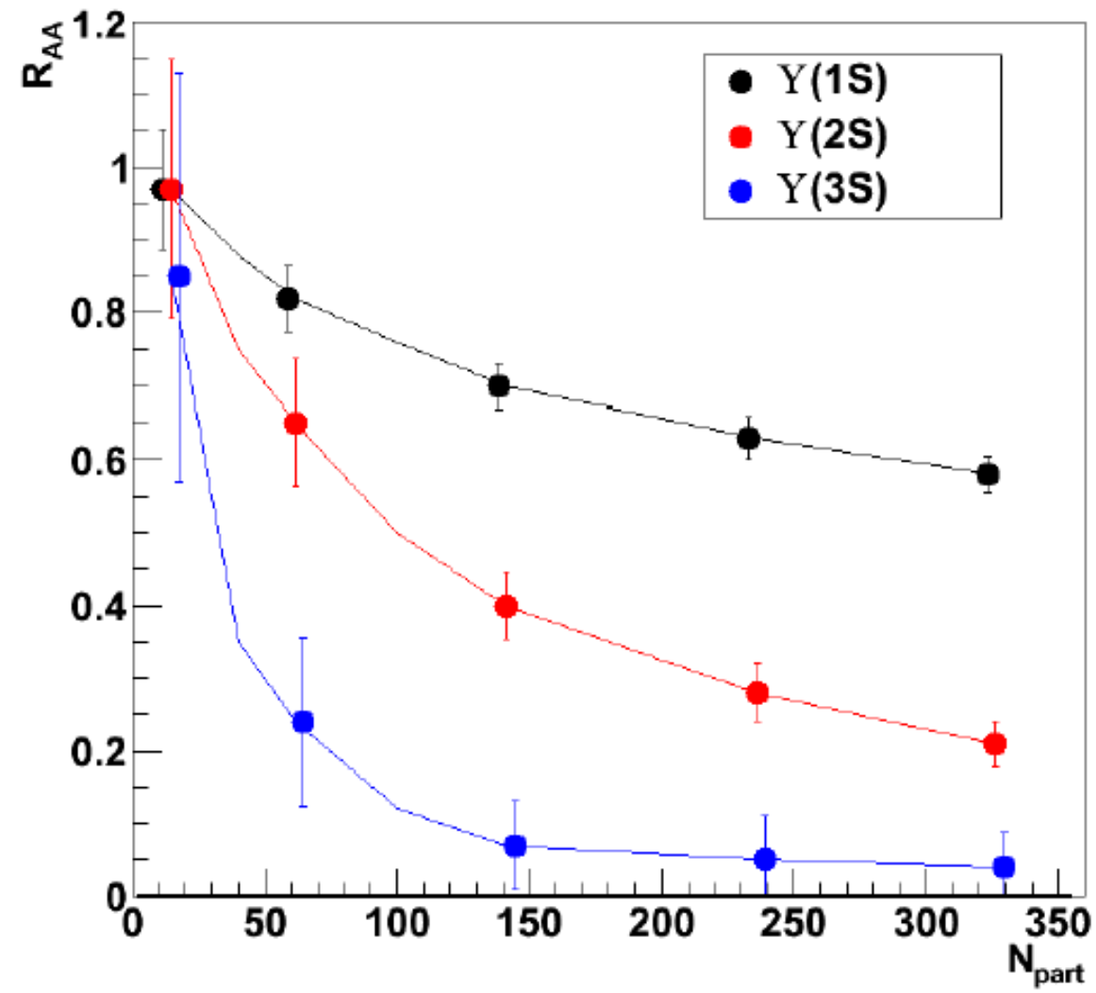


- Clear separation of the three upsilon states
- large acceptance for Upsilons
- similar statistics to LHC

Species	$\int$ L dt	Events	$\langle N_{coll} \rangle$	Υ(1S)	Υ(2S)	Υ(3S)
$p+p$	18 pb^{-1}	756 B	1	805	202	106
Au+Au (MB)		50 B	240.4	12794	3217	1687
Au+Au (0–10%)		5 B	962	5121	1288	675

Physics with pre-shower Upsilon measurements





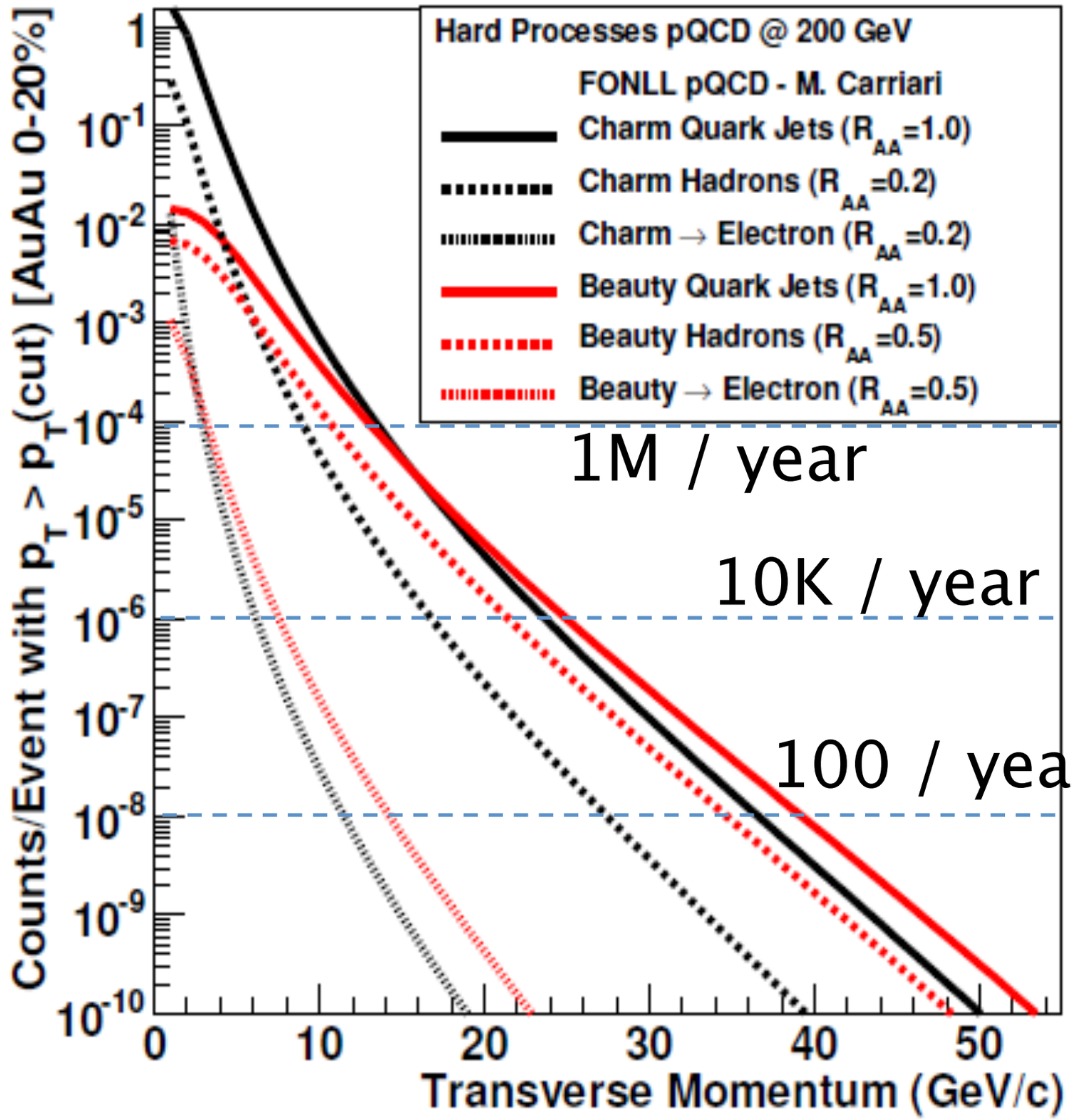
- Clear separation of the three upsilon states
- large acceptance for Upsilons
- similar statistics to LHC

Species	$\int L\,dt$	Events	$\langle N_{coll} \rangle$	Υ(1S)	Υ(2S)	Υ(3S)
$p+p$	18 pb^{-1}	756 B	1	805	202	106
Au+Au (MB)		50 B	240.4	12794	3217	1687
Au+Au (0–10%)		5 B	962	5121	1288	675

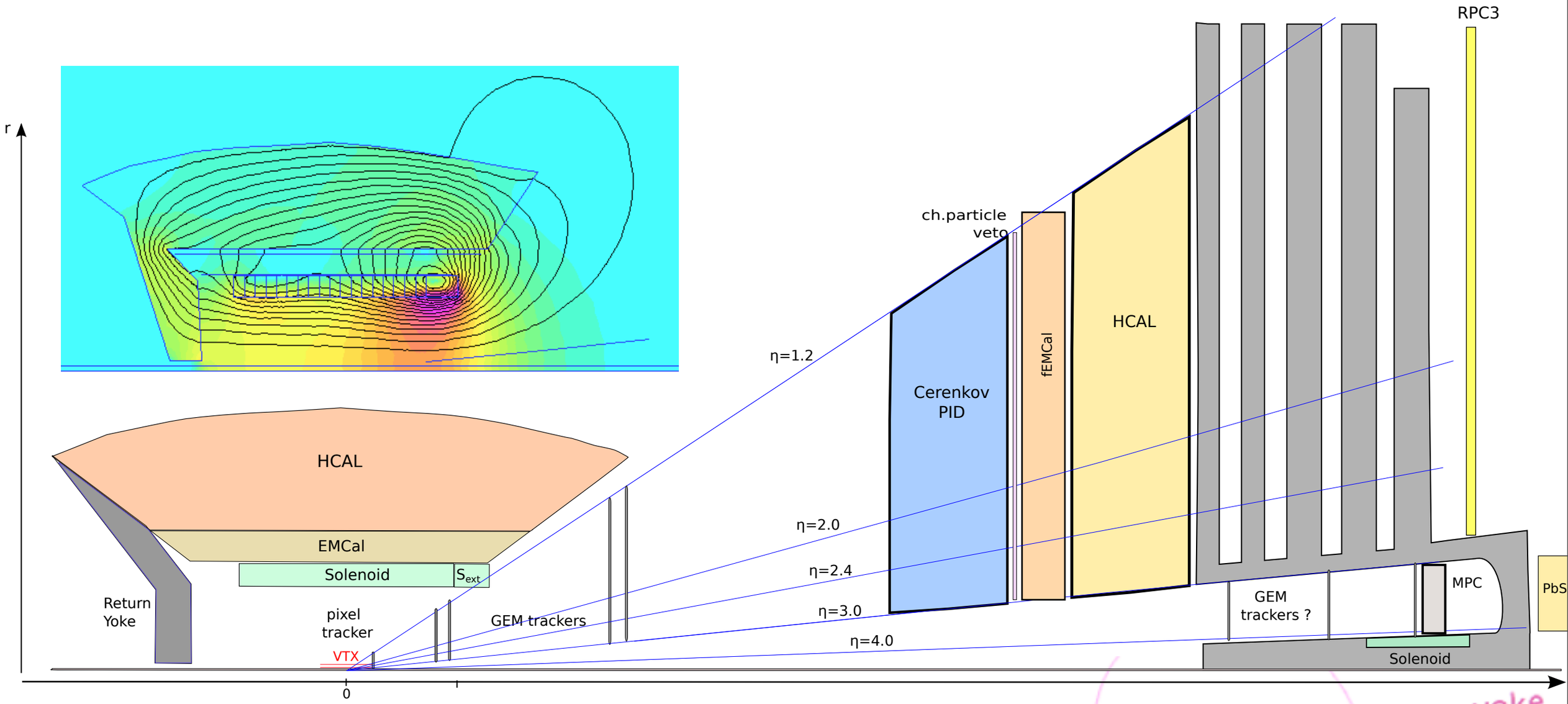
PHENIX

20-week Au+Au RHIC run

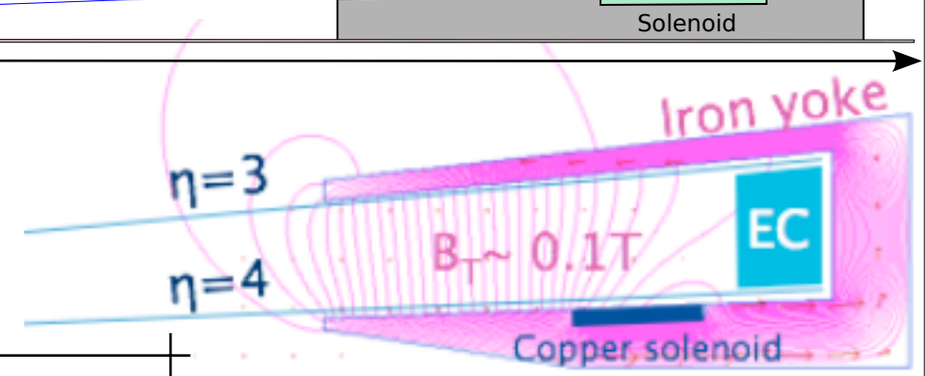
- eID and large acceptance allows
  - HF tagged jets
  - hadron(γ) - HF correlation



sPHENIX forward



a modification in the solenoid design allows tracking for η <3



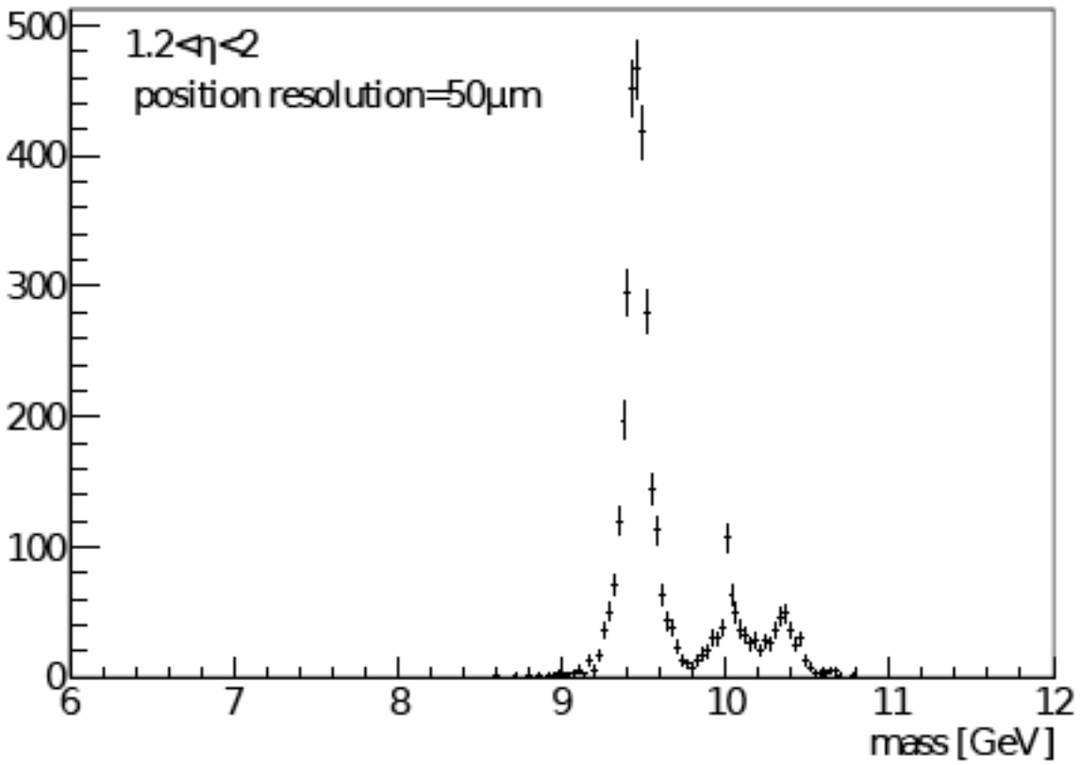
electron, muon, gamma identification and jets for 1.2< η <4

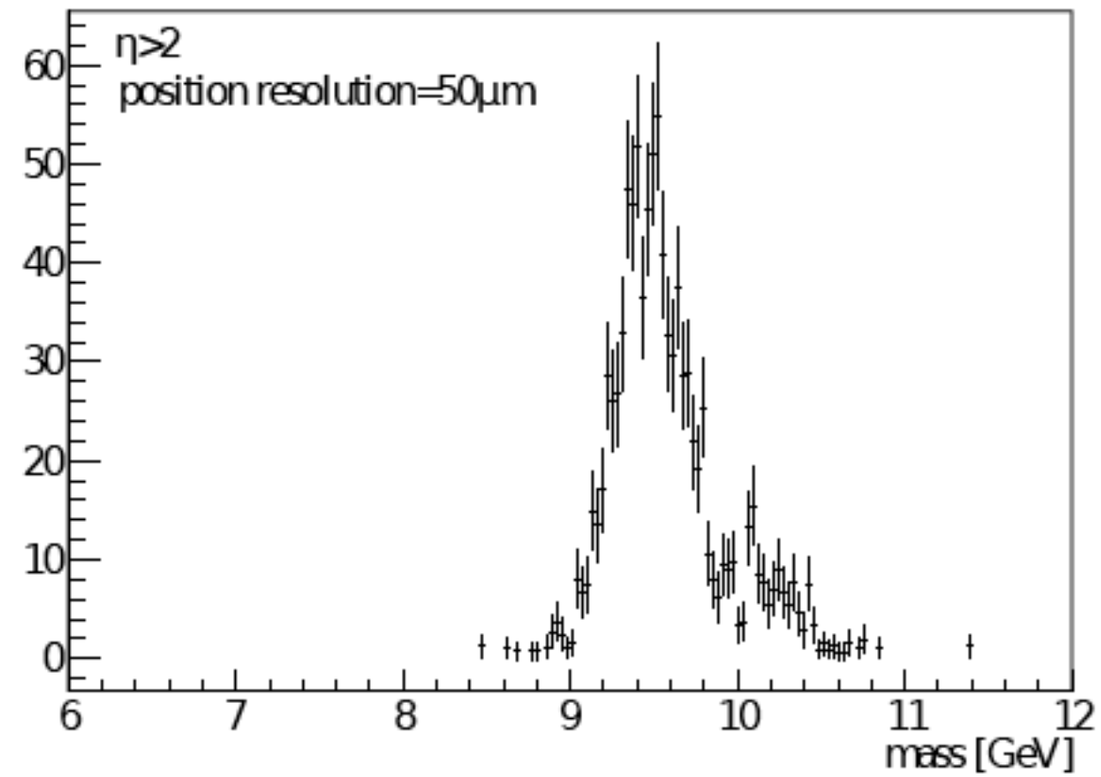
π ,K,p ID for jet chemistry and D identification in p+p and p+A

additional field for very forward physics 3< η <4

Physics with sPHENIX forward

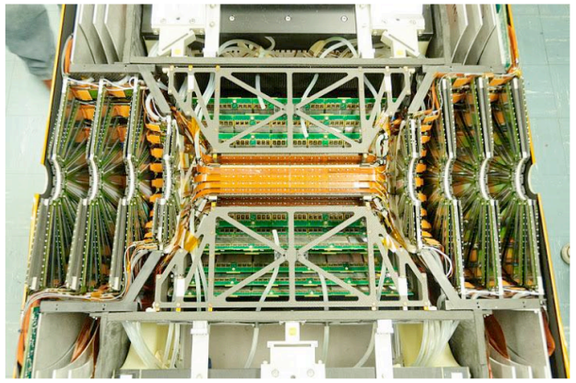
- initial-state in p+A collisions
  - saturation trough HF-γ correlations
  - parton energy-loss with Drell-Yan

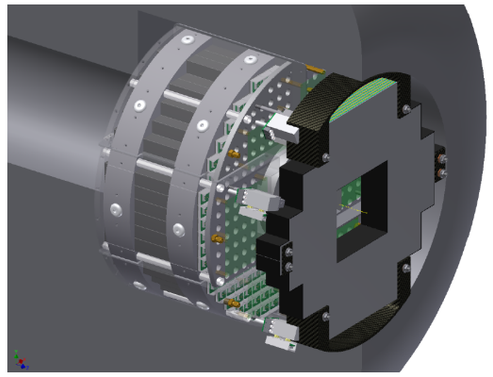


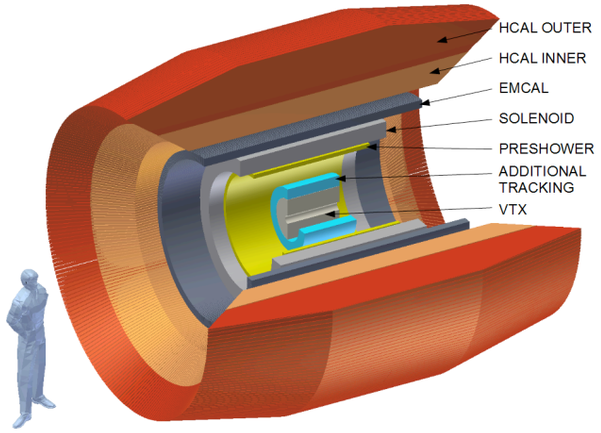


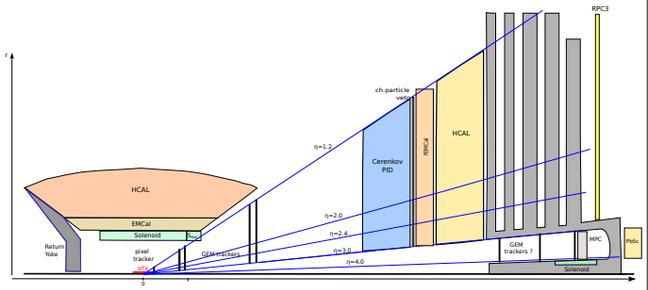
- Heavy Ion collisions up to a limited rapidity (occupancy studies going on)
  - longitudinal expansion
  - variation of energy and net-baryon density

Conclusion









- RHIC can provide enough luminosity and beam variations for the challenging understanding of heavy-ion collisions

- PHENIX is continuing working in detector assembly and studies to extract all the physics RHIC can provide

- heavy flavor physics is in our hearts since the first PHENIX design in early 90s and will continue to be a strong case in our future goals

BACKUP SLIDES

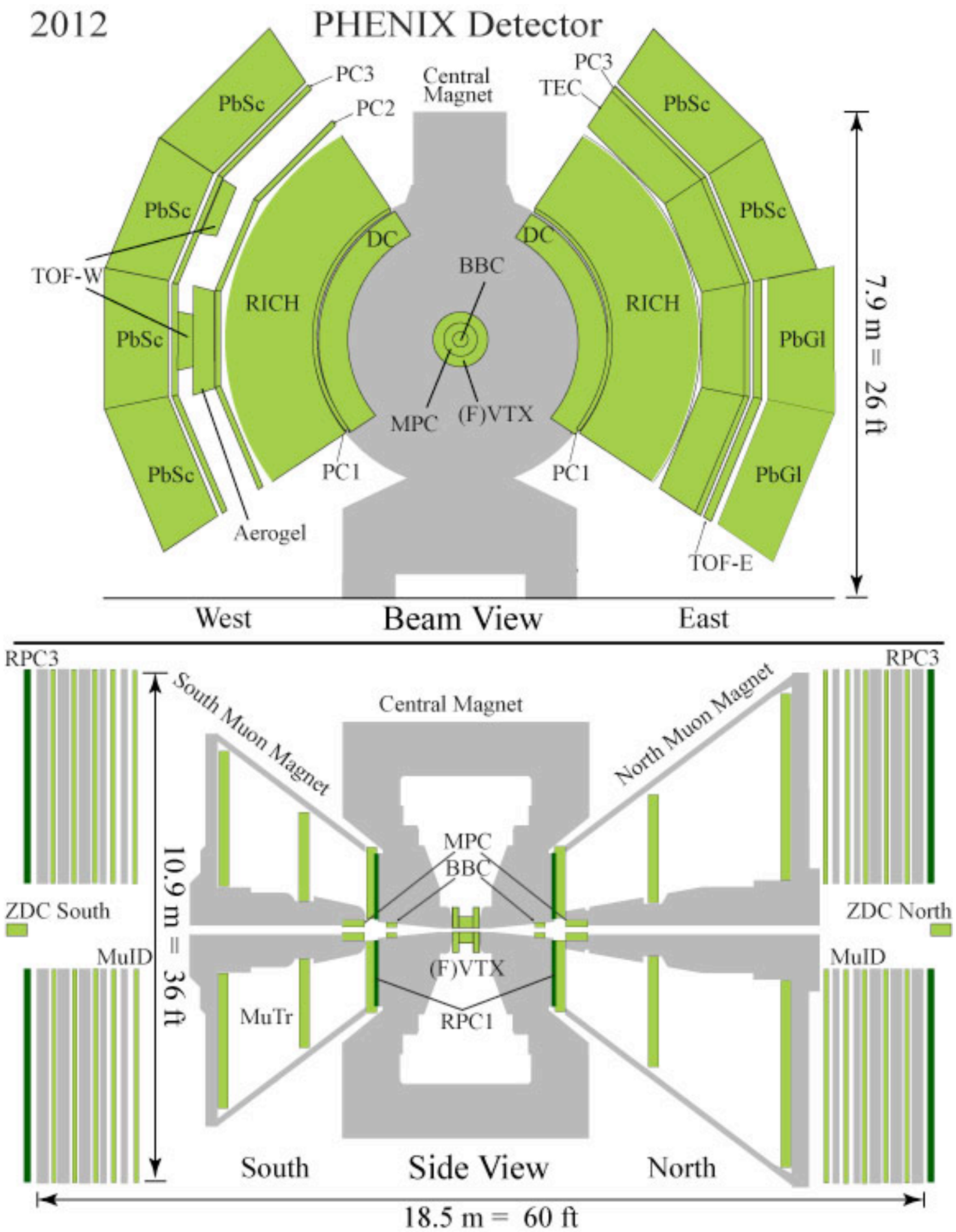
PHENIX

$|y|<0.35$ $\Delta\Phi=2\times\pi/2$

PHENIX can measure quarkonia from zero momentum

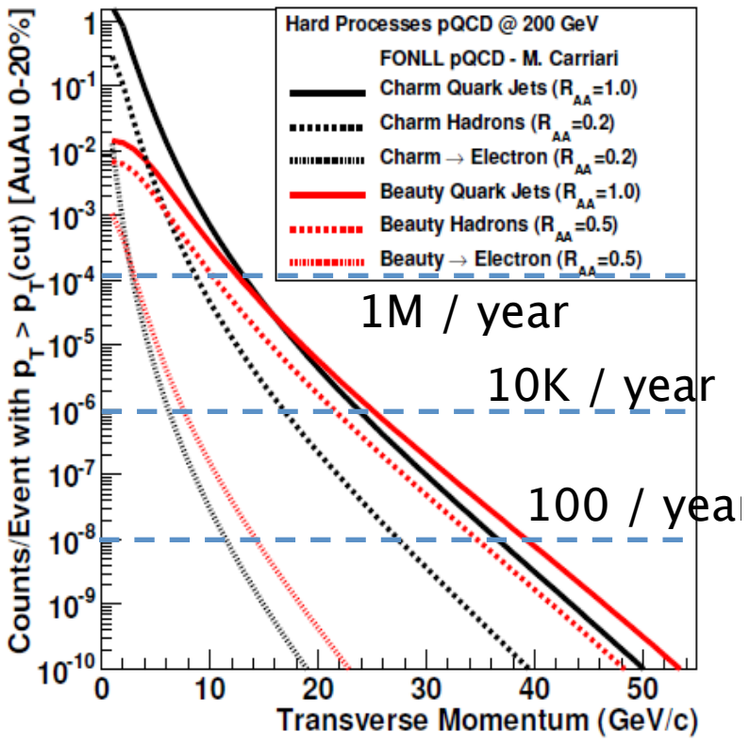
dilepton decays: J/ψ, ψ', Υ
radiative decays: $\chi_c \to e^+e^-\gamma$

$1.2<|y|<2.2$ $\Delta\Phi\approx2\pi$

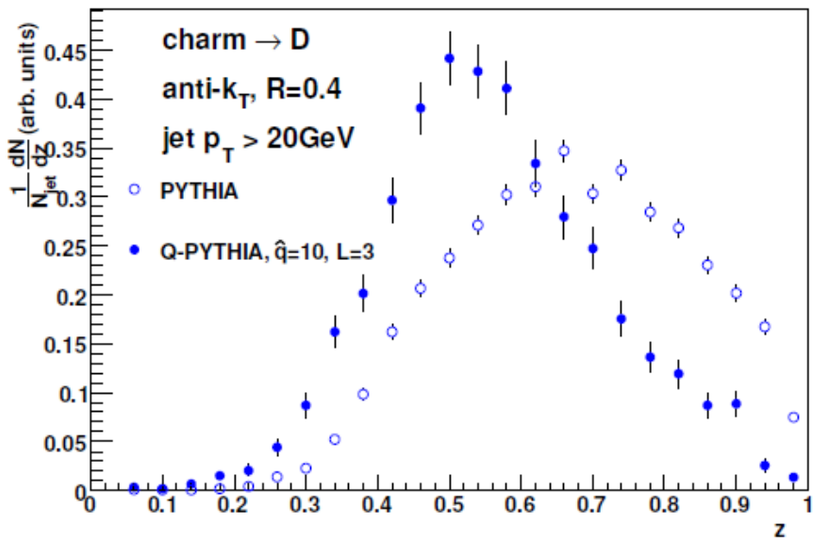


Physics with additional Tracker heavy quark measurements

Rate of b, c jets and b, c hadrons



Charm fragmentation in PYTHIA and Q-PYTHIA (energy loss)



- High statistic measurements of b, c tagged jets
- Study of modified fragmentation of charm

5