Rhicf Simulation

Japan-Korea Phenix Joint Meeting at RIKEN

Junsang Park(Seoul National University)

Nov 27 2014

Out Line

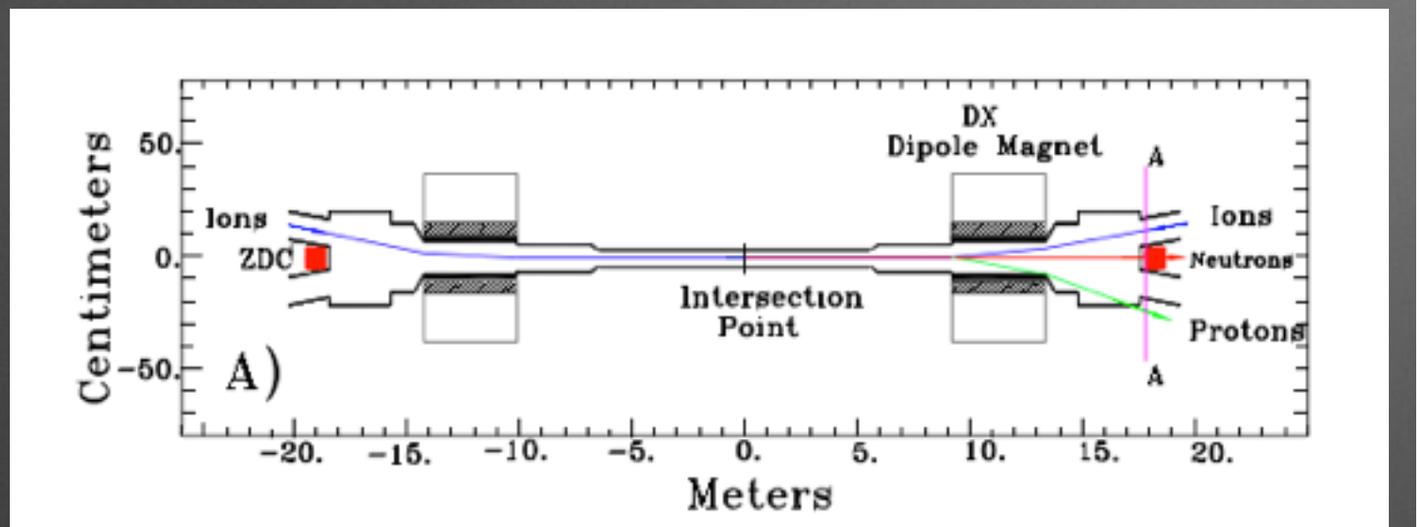
- Overview of Rhicf
  - Observing target
  - Motivation
- Simulation
- Summary and Outlook

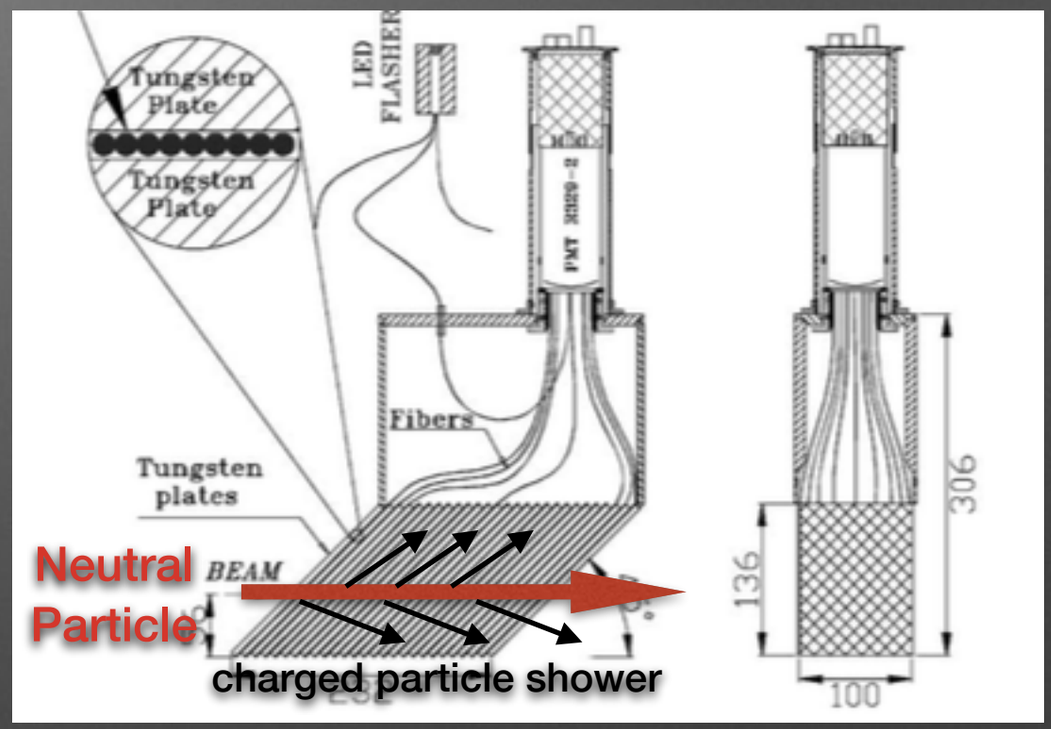
What to observe?

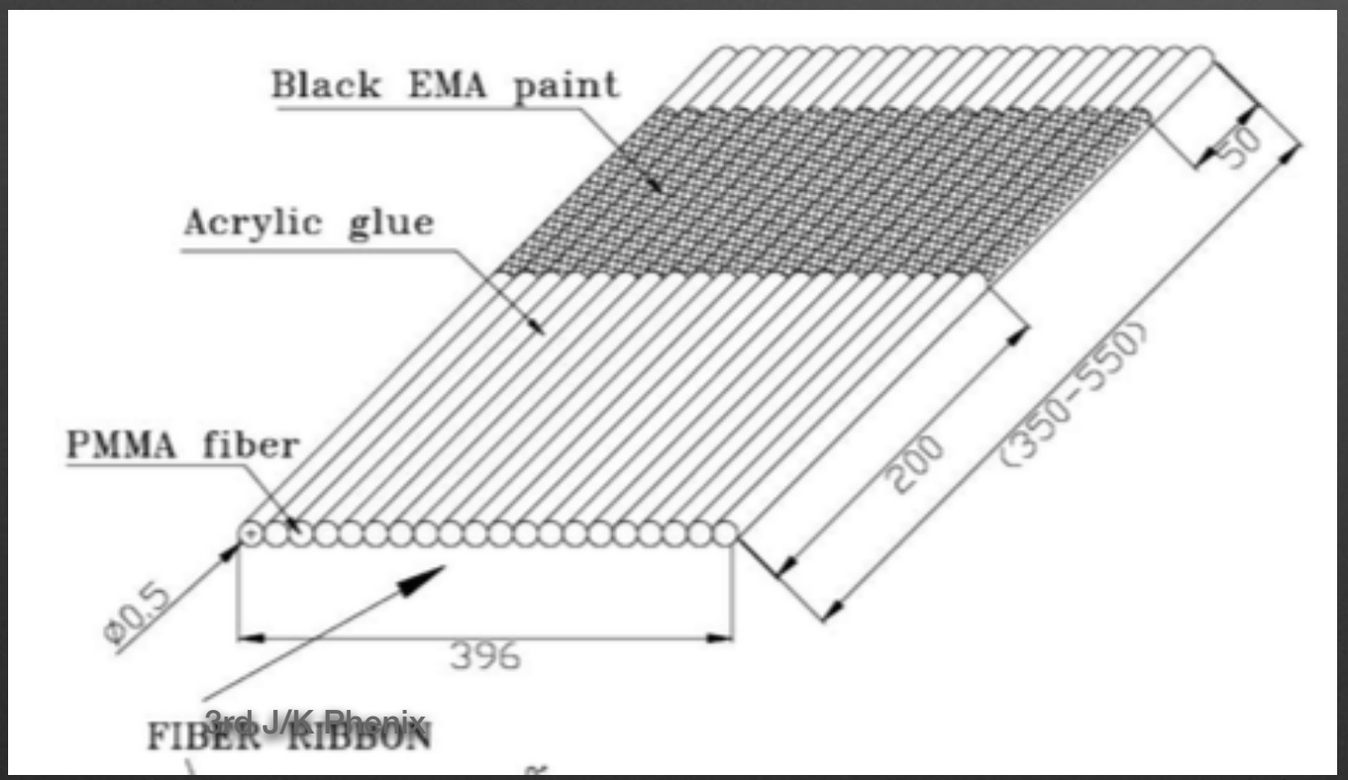
- Rhic+f(forward)
  → Very forward Particle(η>6)
- Neutral Particles(π^0,Neutron,Photon)
- Low Energy(relative to LHC)
  and Low transverse momentum

How to observe?

- Use ZDC and LHCf



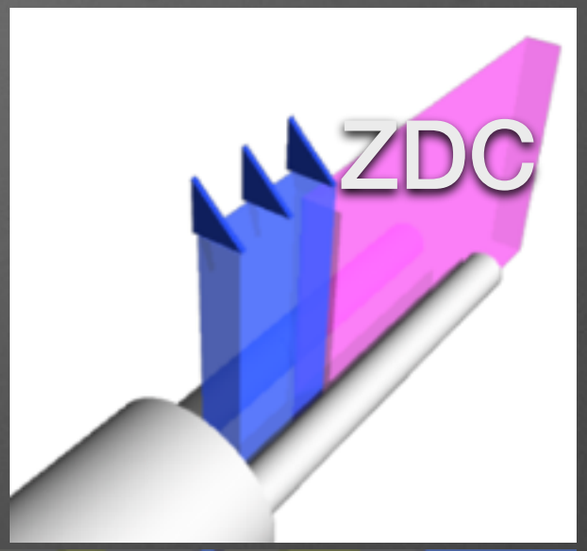


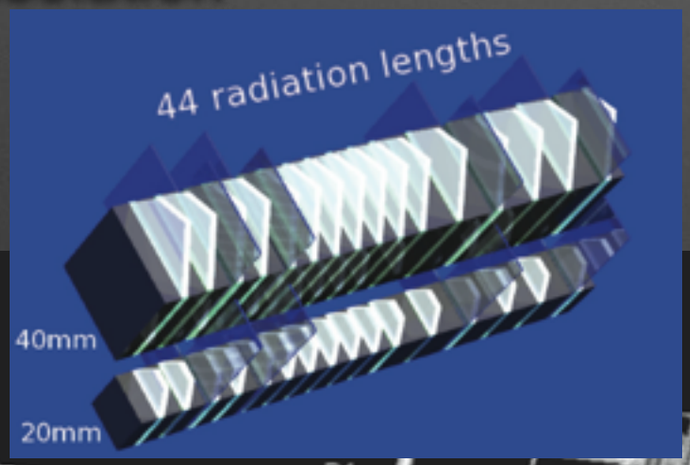


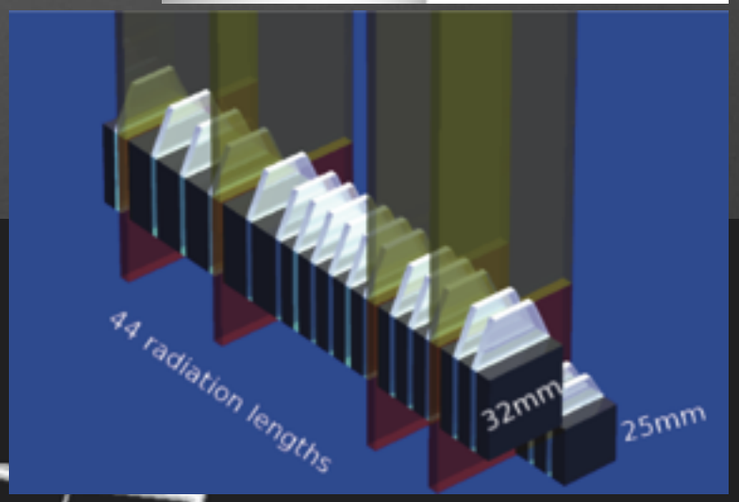
- ZDC collects Cherenkov light created by charged particles
- Deposit energy can be calculated from PMT's signal

LHCf

- Detector for observing forward particle(η>8.4) in LHC (2009~2015)
- Having better position resolution than ZDC
- Use Arm2
- ZDC + LHCf comb make ever best resolution





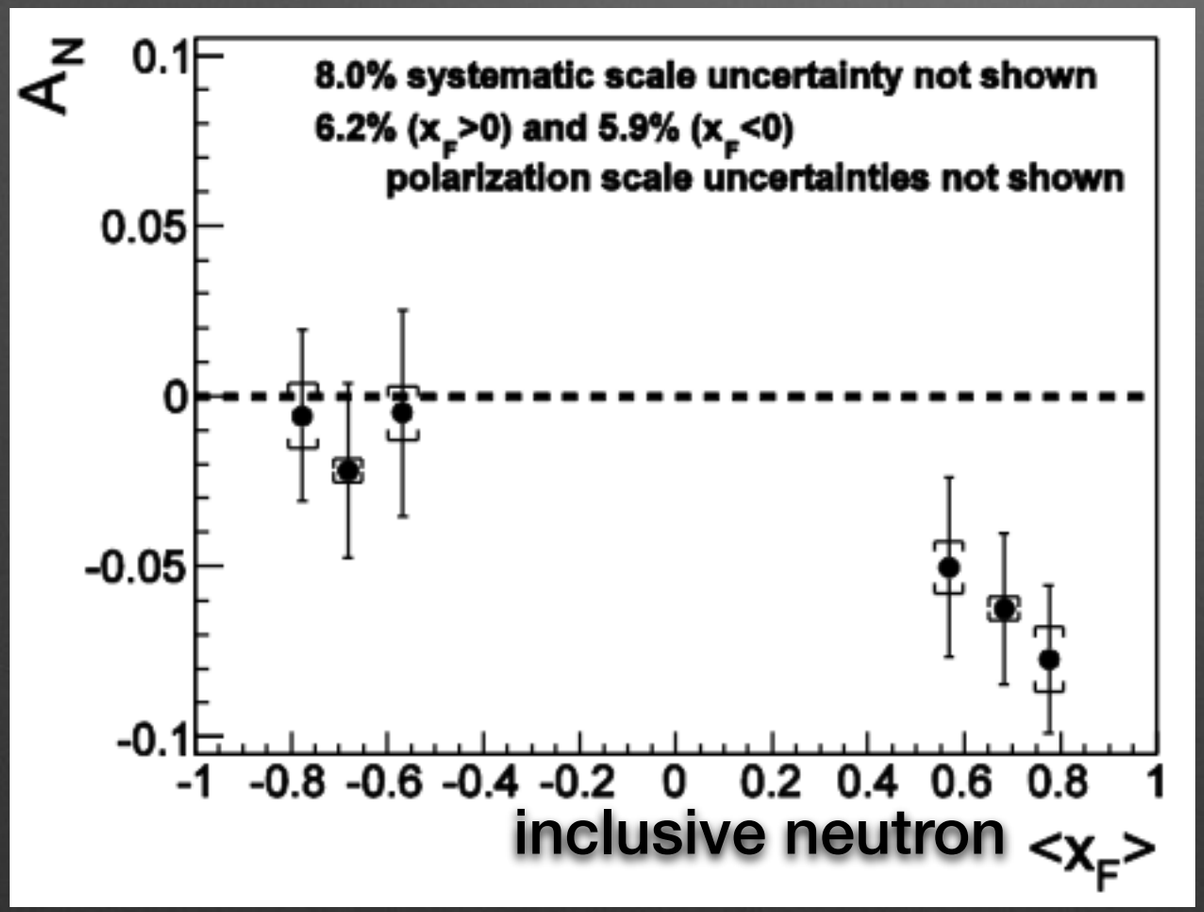


Physics Motivation

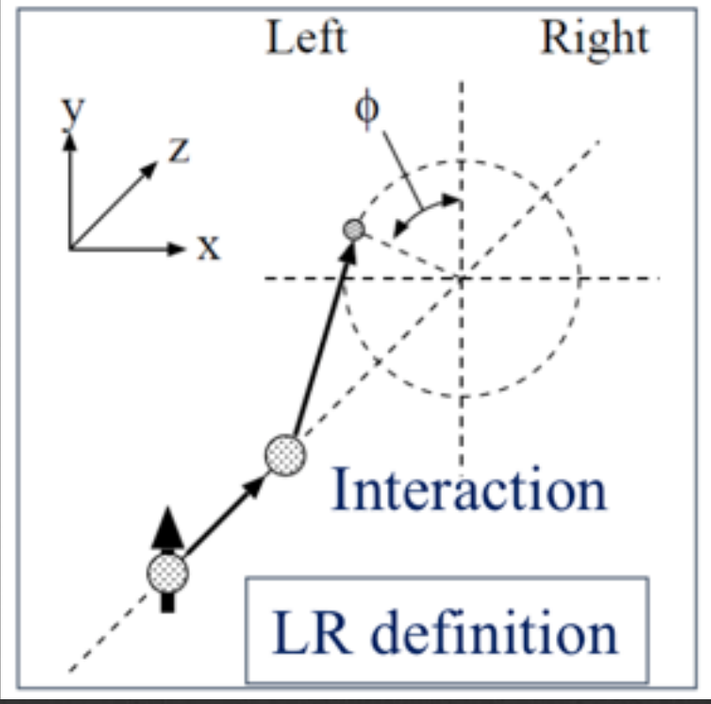
- Spin Physics
  → Forward neutron's A_N
- Verify hadronic interaction model
  → This connects to development of Cosmic Ray Physics

Forward neutron's A_N

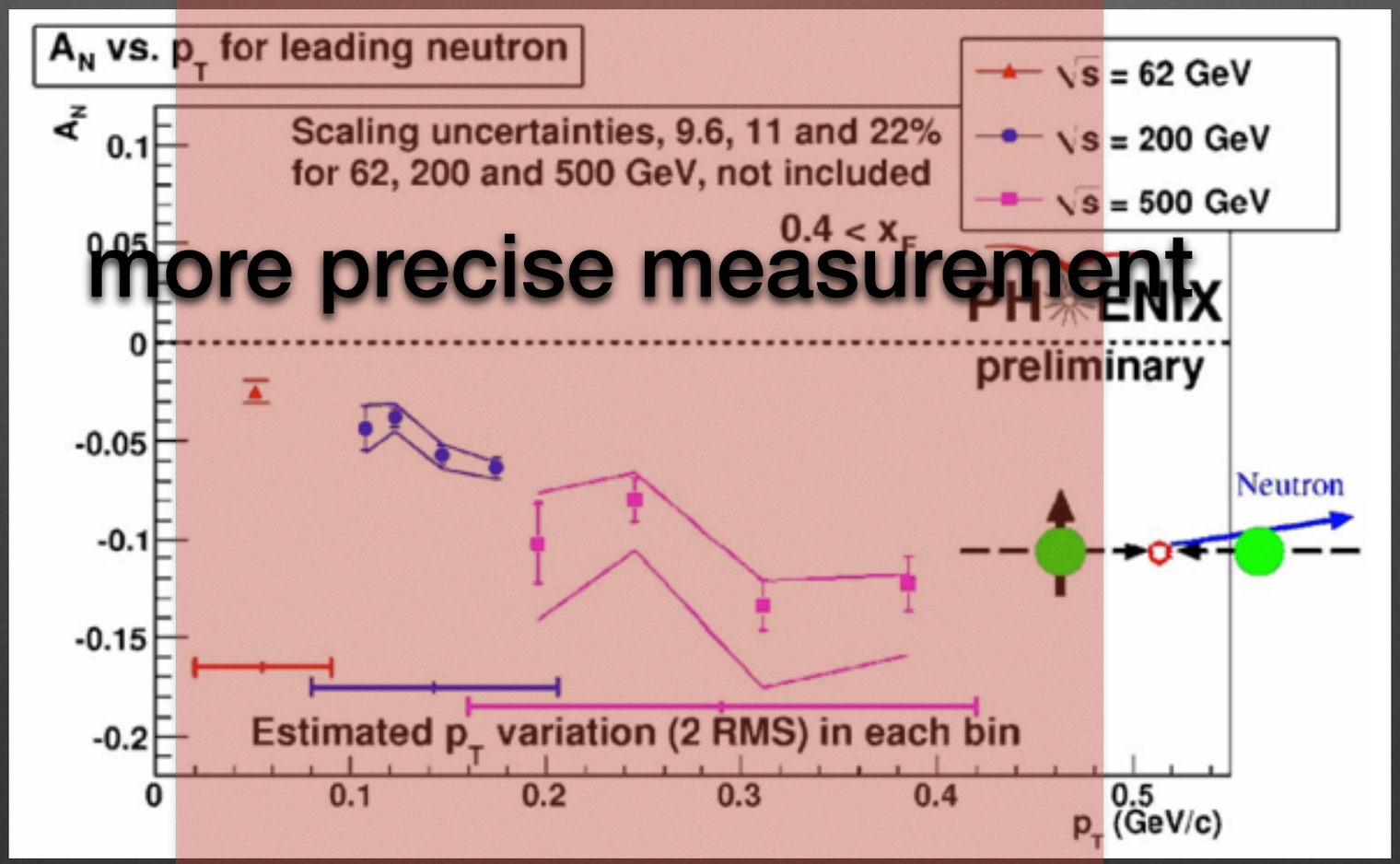
- Run5 data shows relation between X_F and A_N



$$A_N \equiv \frac{d\sigma^{\uparrow} - d\sigma^{\downarrow}}{d\sigma^{\uparrow} + d\sigma^{\downarrow}} = \frac{\sigma_L^{\uparrow} - \sigma_R^{\uparrow}}{\sigma_L^{\uparrow} + \sigma_R^{\uparrow}}$$



- A_N vs $\sqrt{S}$



more precise measurement

Hadronic interaction models

- Theoretical basis
  - pQCD
  - Regge Theory
  - energy conservation
- Phenomenology(Models)
  - hadronization
  - Pomeron interaction
  - etc..

Low P_T region!

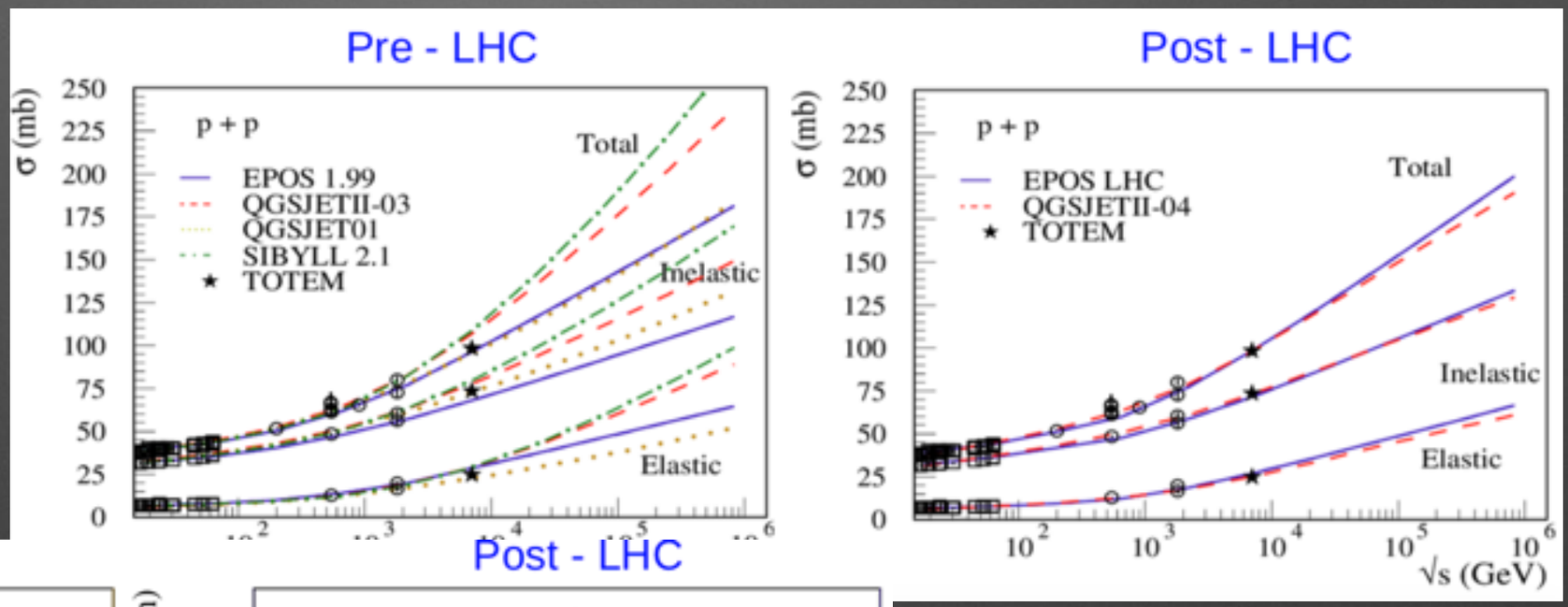
- Tuning parameters with data

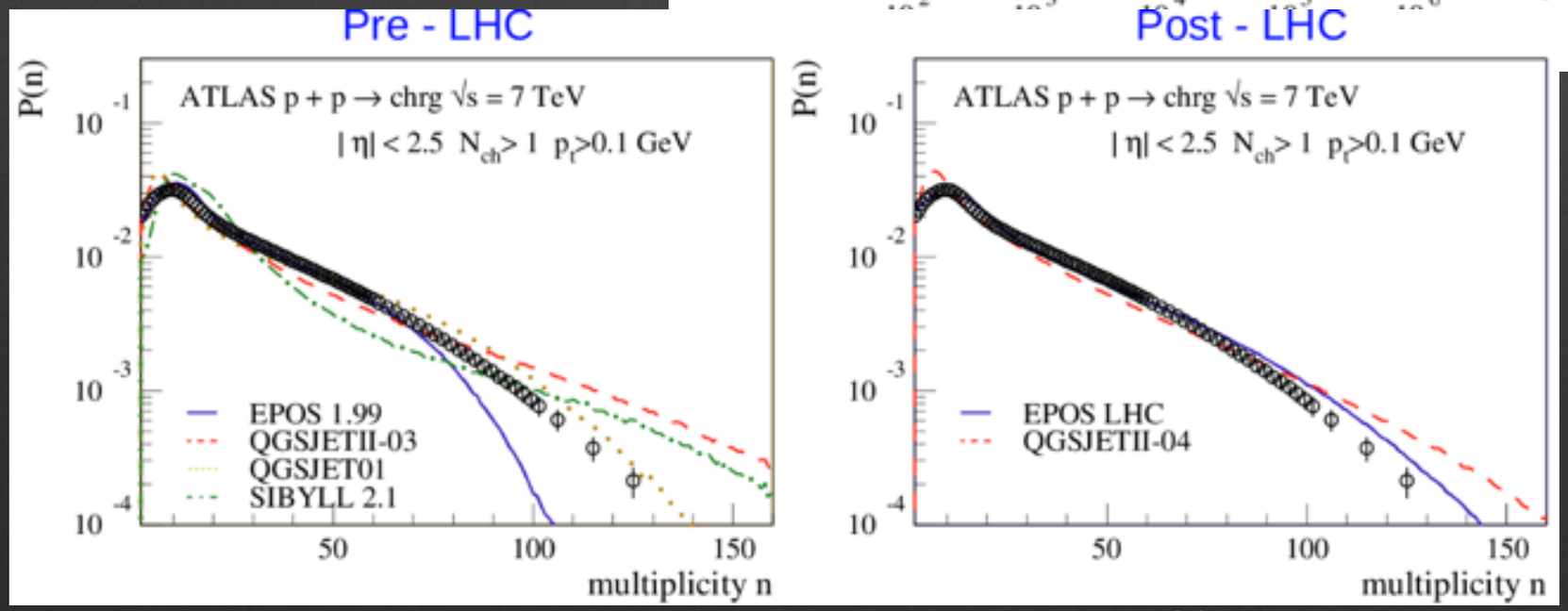
Various Models

- QGSJET series : Regge theory + String dynamics + semi-hadprocess + Pomeron interaction..
- SIBYLL series : mini-jet model + Eikonal approximation
  + Dual parton model + ...
- DPMJET series, EPOS series and so on....

Model verification & tuning

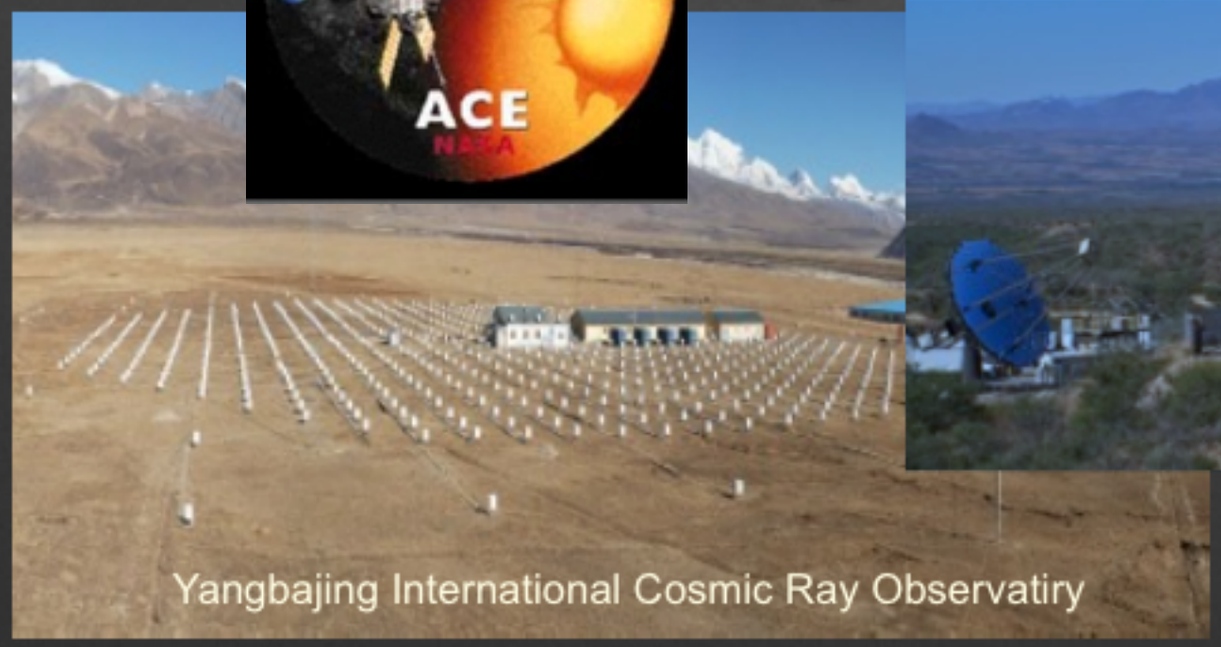
- Verifying or tuning model by experiment data





Why are these models important to Cosmic Ray Physics?

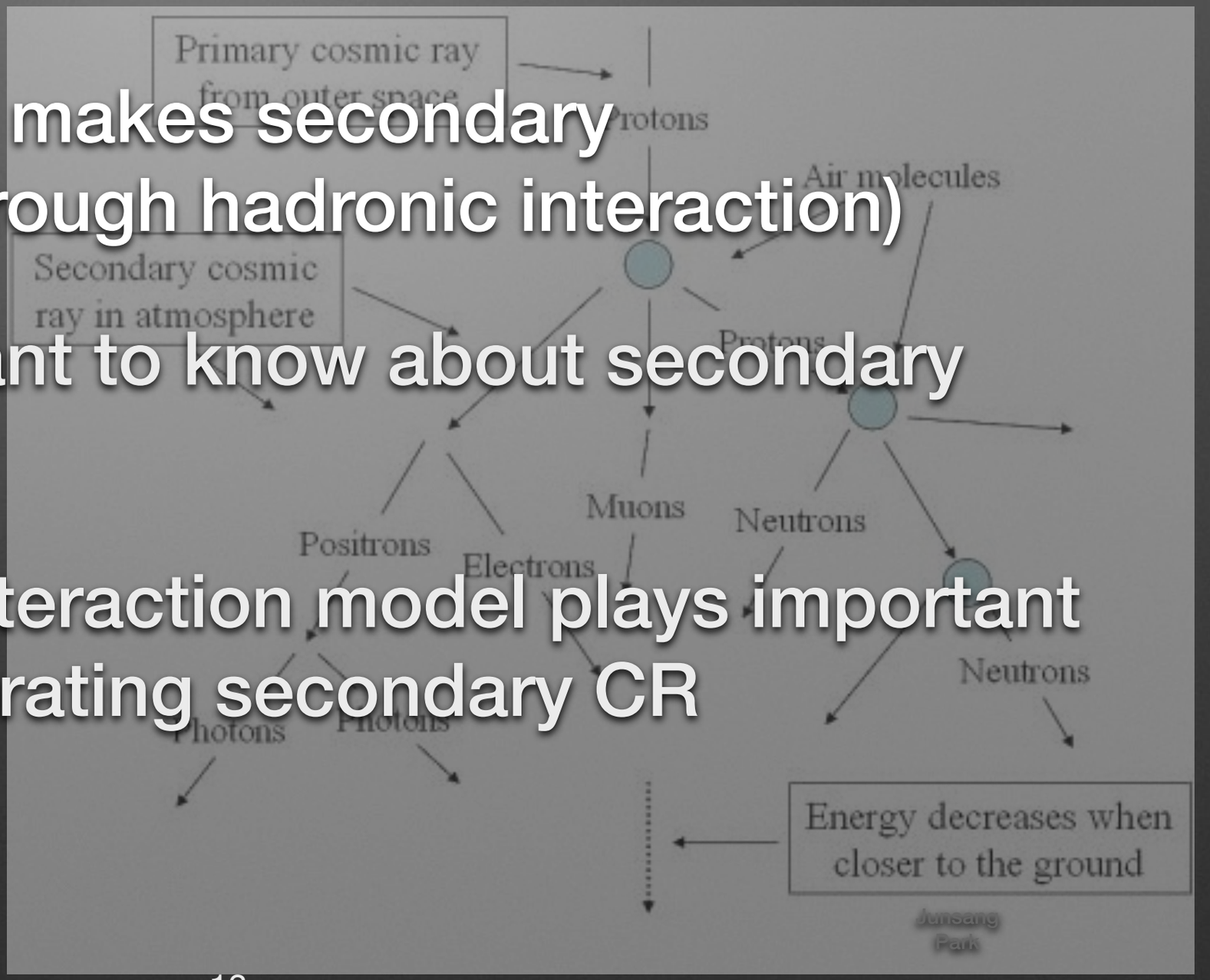
- Observation of CR(cosmic ray)
  - direct method(satellite)→waste space, time and $
  - indirect method(Surface Detector, Radio telescope)


Yangbajing International Cosmic Ray Observatiry


Very Energetic Radiation Telescope Array, Arizona

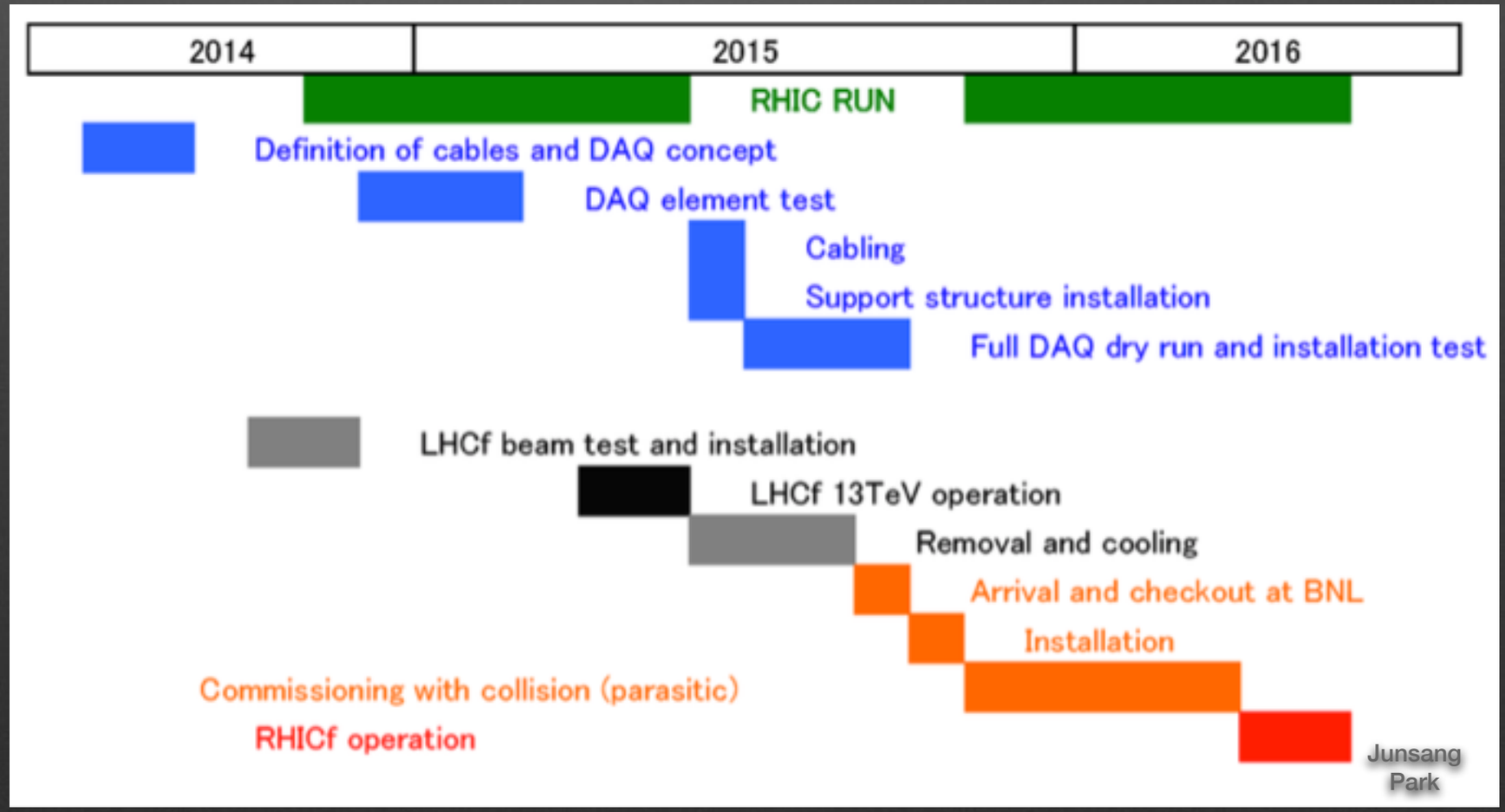
Why are these models important to Cosmic Ray Physics?

- Primary CR makes secondary particles(through hadronic interaction)
- It is important to know about secondary particles
- Hadronic interaction model plays important role in generating secondary CR



Schedules

- 2015 - Run in LHC
- Installation starts from end of 2015
- Mainrun in 2016

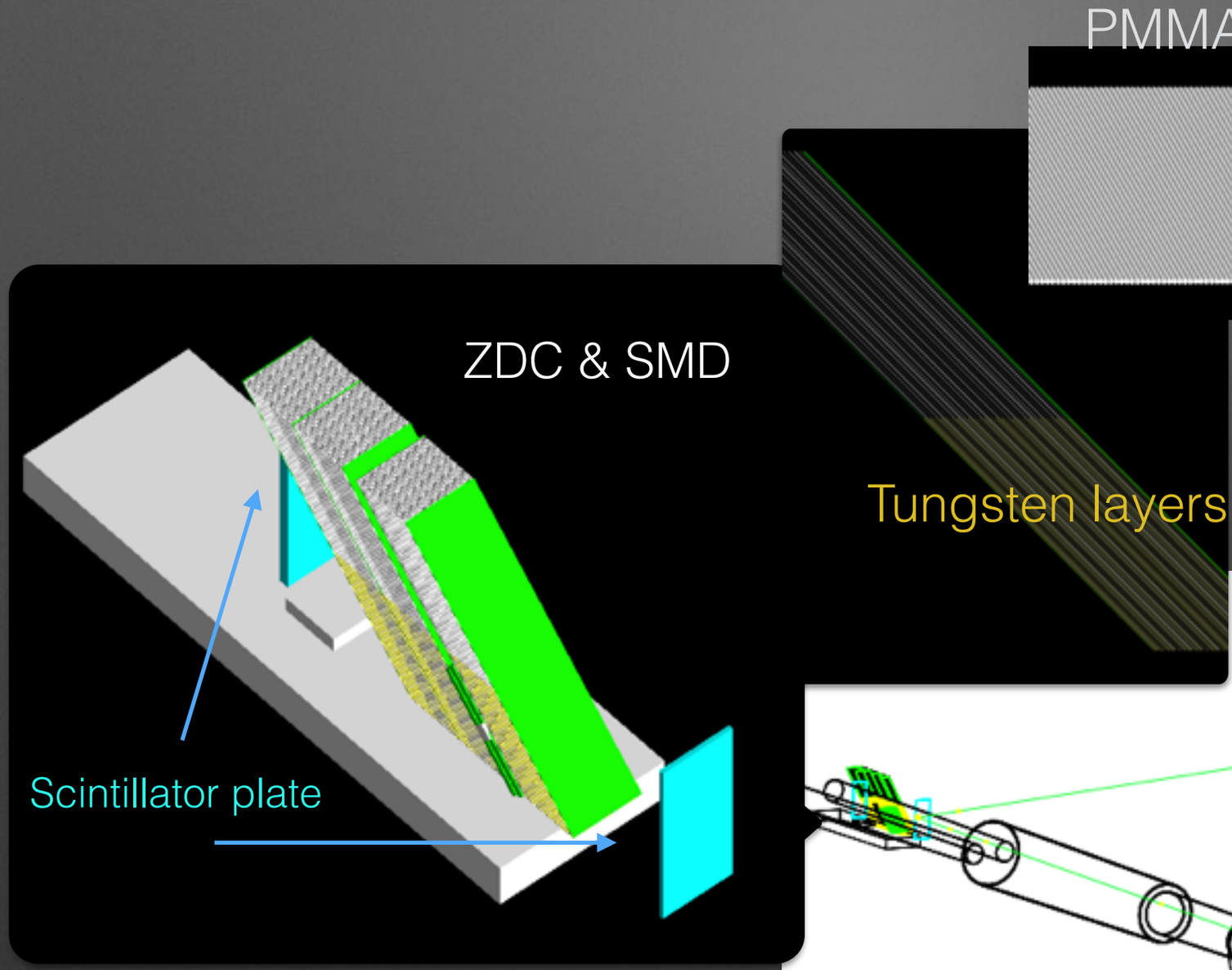


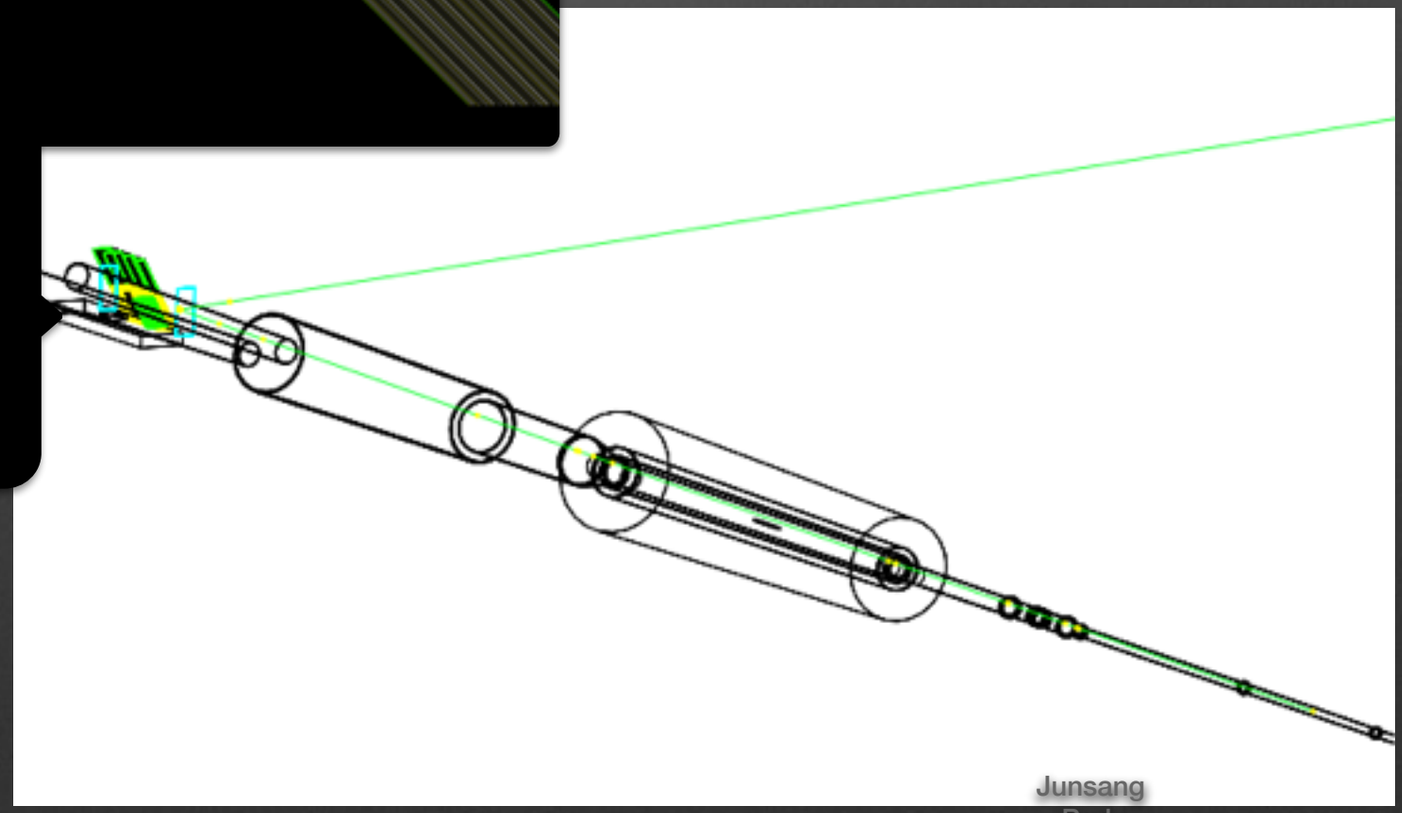
Rhicf summary

- Observe neutral particles with Low energy, small P_T and $\eta>6$
- Data from Rhicf contributes to spin physics, cosmic ray physics and particle physics.
- Operation in 2016

Simulation

- Generally before experiment starts, Need to estimate results of experiment for determination of parameter
  (e.g:structure of detector, matter and so on)
- Use Geant4 simulator for consistency between Phenix detectors and LHCf
  (present code for Phenix is based on geant3)
- geometry code is completed


PMMA tubs layers
ZDC & SMD
Tungsten layers
Scintillator plate



Summary & outlook

- Localpol's geometry code is completed
- ZDC's energy resolution calculation is on going
- Make more proper PhysicsList to Rhicf
- Need to make Multithread activate
- Calculate efficiency, position resolution and energy resolution after implementation of LHCf

Back Up

Definition of Variables

$$x = \frac{p_L}{\sqrt{s}/2} = \frac{2p_L}{\sqrt{s}}$$ Feynman-x

$$y = \ln \frac{E+p_L}{m_T} = \frac{1}{2} \ln \frac{E+p_L}{E-p_L}$$ Rapidity

$$m_T^2 = p_T^2 + m^2$$ Transverse mass squared

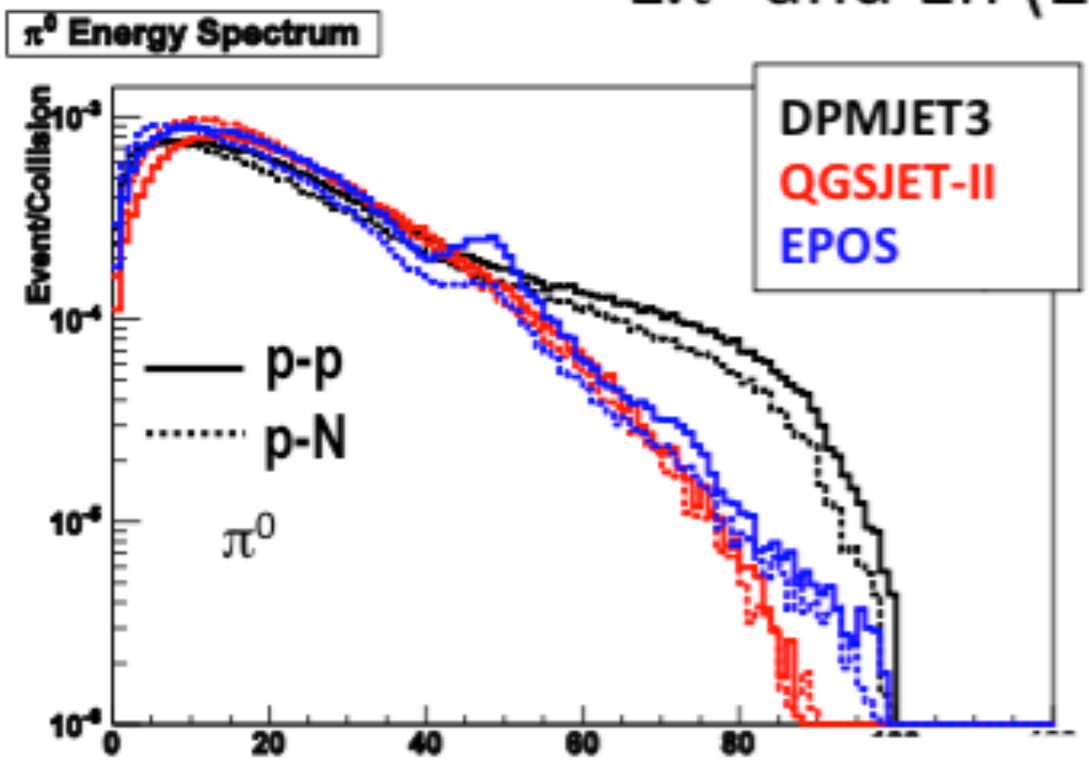
$$d^3p/E = d^2p_T \frac{dp_L}{E} = d^2p_T \, dy$$ Phase space element

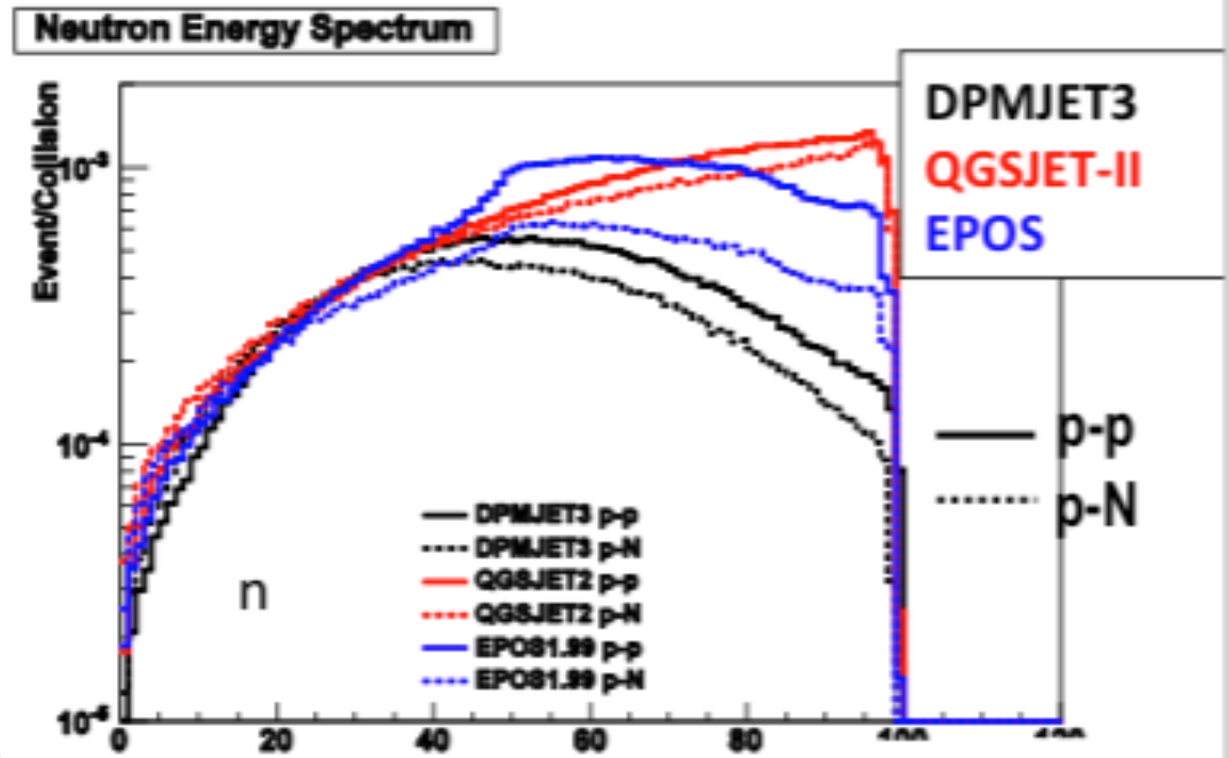
$$\eta \equiv y_{m=0} = -\ln \tan(\theta/2)$$ Pseudorapidity

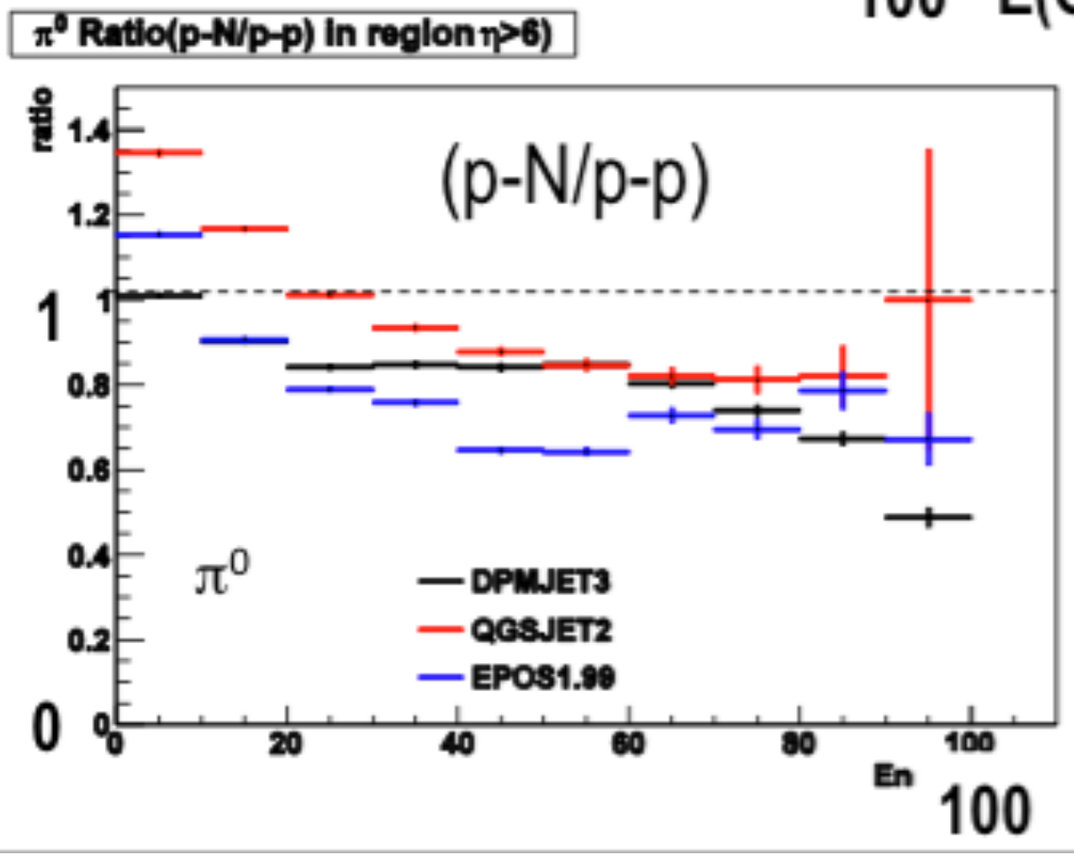
$$p_L = m_T \sinh y$$
$$E = m_T \cosh y$$

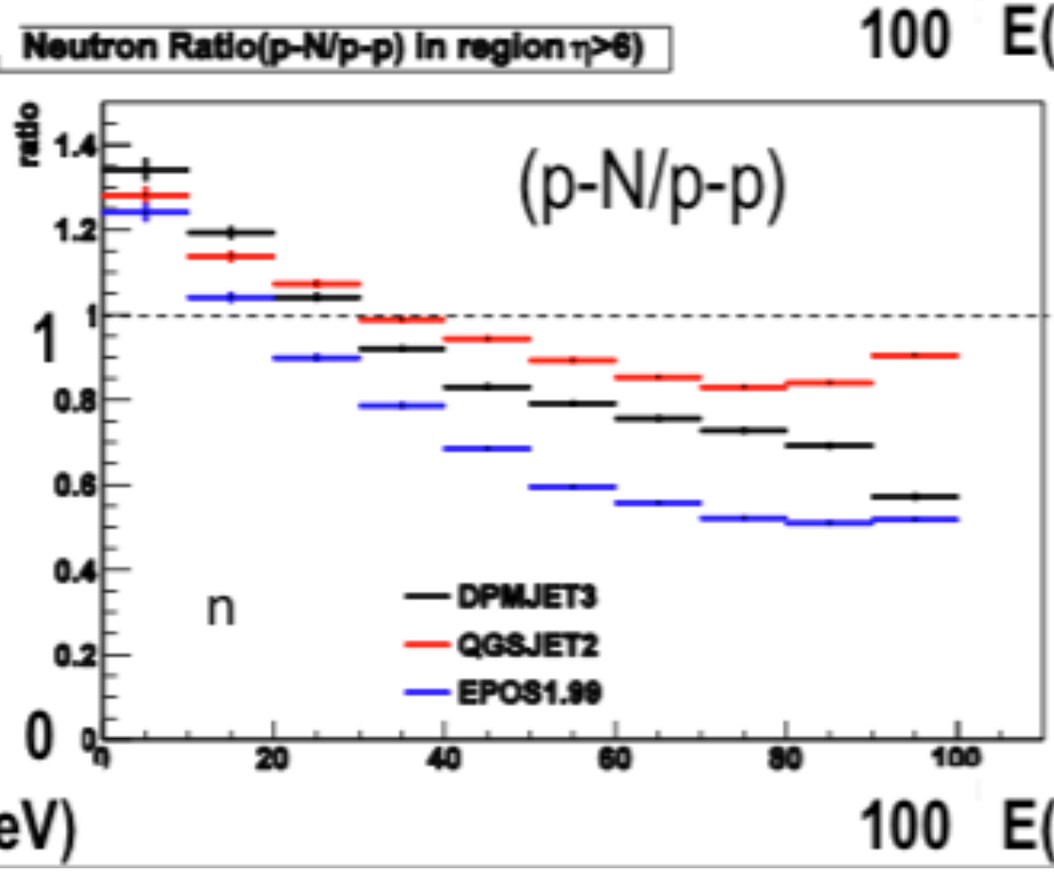
Transportation in geant4

Eπ^0 and En (200 GeV p-p / p-N)

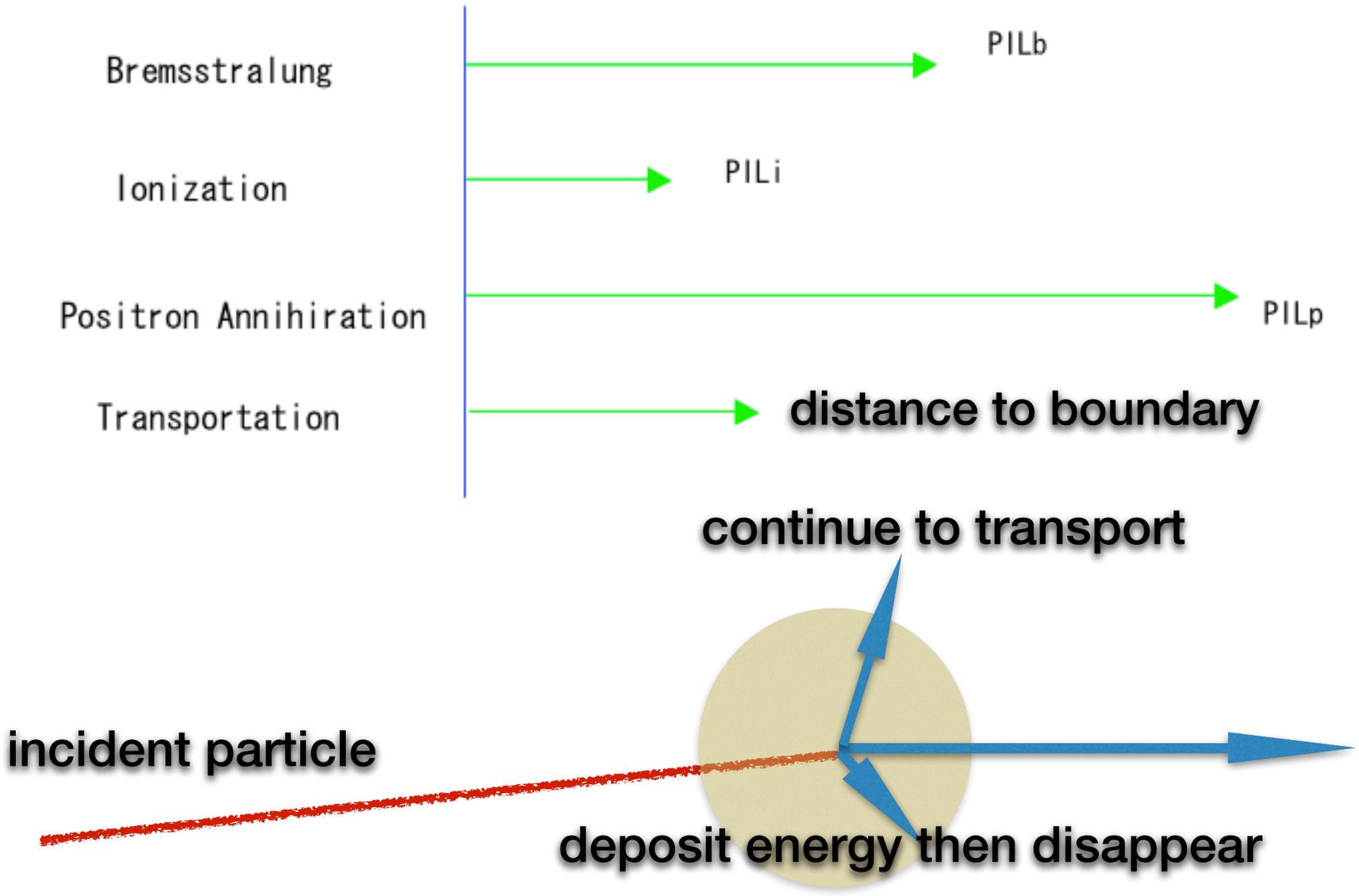








conversion NLL to distance



Hadronic interaction models

Old generation : QGSJET01 SIBYLL 2.1 DPMJET 2.55 VENUS (<1999)

All Glauber based

But differences in hard, remnants, diffraction …

semi-hard

soft

NEXUS 3.97

Attempt to get everything described in a consistent way (energy sharing)

New generation : (QGSJET II-03) (DPMJET III) (EPOS 1.99) (2005-2012)

LHC tuned : **QGSJET II-04** **EPOS LHC** (2013-)

Theory ++ :

-Loop diagrams

-rho0 resonance

-optimized for CR

Phenomenology ++ :

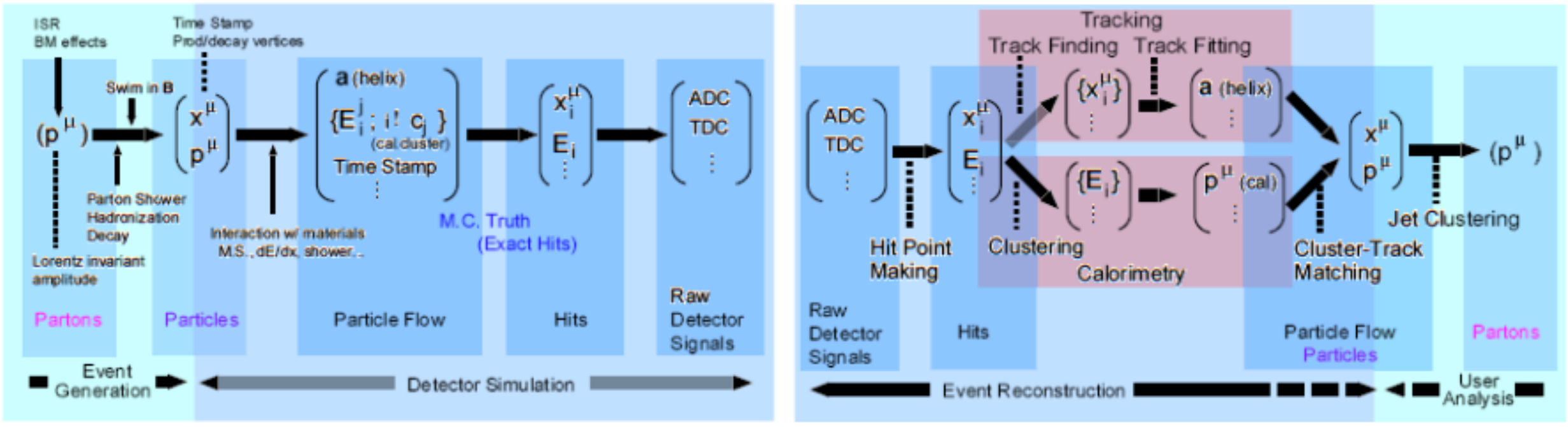
-Nuclear effect

-High density effect (QGP)

-all type of data studied

Only model used in HEP (SPS, RHIC, LHC)

Flow of simulation



QuickSim (LCLIB)

skipping...

JLCSIM (Geant3)

skipping...

JUPITER&Satellites (Geant4)