THE CMS HEAVY ION PROGRAM

A. D. Panagiotou

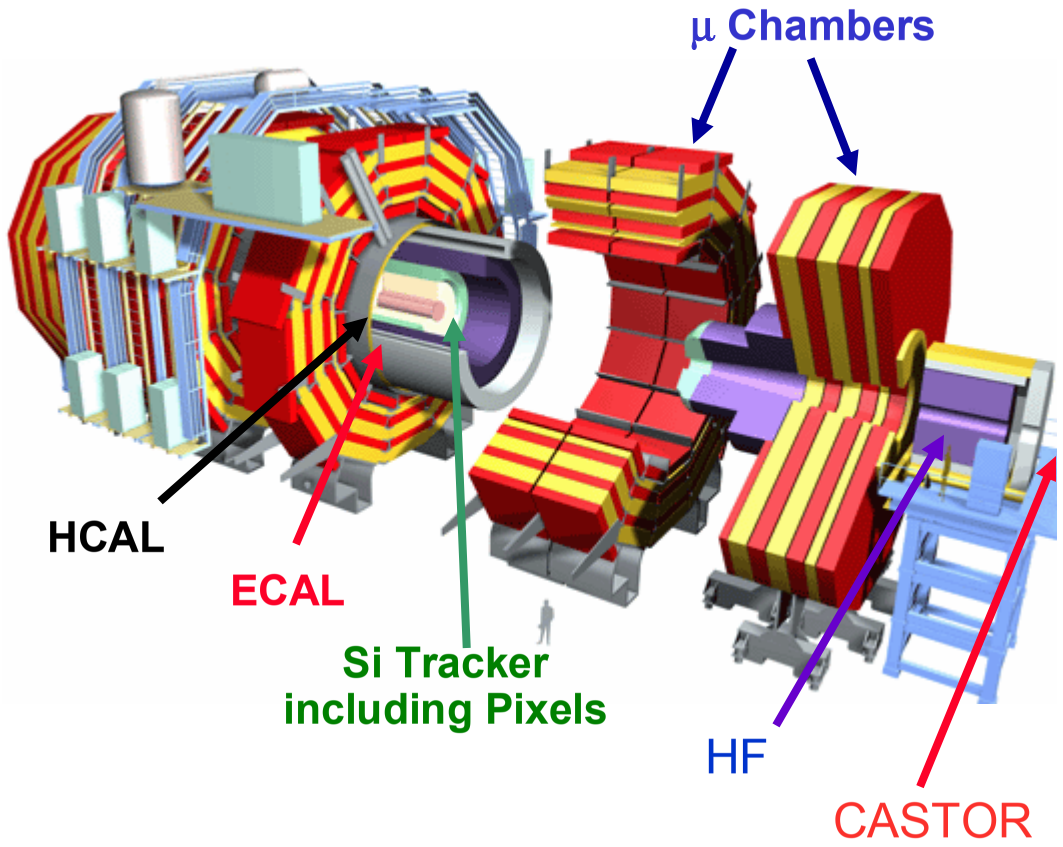
University of Athens

CMS as a Detector for Heavy Ion Physics

- **Fine Grained High Resolution Calorimeter**
  - Hermetic coverage up to $|\eta|<5$
  - $|\eta|<6.6$ using CASTOR
  - Zero Degree Calorimeter (proposed)
- **Tracking μ from Z^0, J/ψ, Υ**
  - Wide rapidity range $|\eta|<2.4$
  - σ_m ~50 MeV at Υ
- **Silicon Tracker**
  - Good efficiency and low fake rate for $p_T > 1$ GeV
  - Excellent momentum resolution $\Delta p/p \sim 1\%$ for $p_T<25$ GeV and higher

Fully functional at highest expected multiplicities
Detailed studies at ~3000-5000 and cross-checks at 7000-8000

- **DAQ and Trigger**
  - High rate capability for AA, pA, pp
  - High Level Trigger capable of full reconstruction of most HI events in real time



CMS as a Heavy Ion Experiment

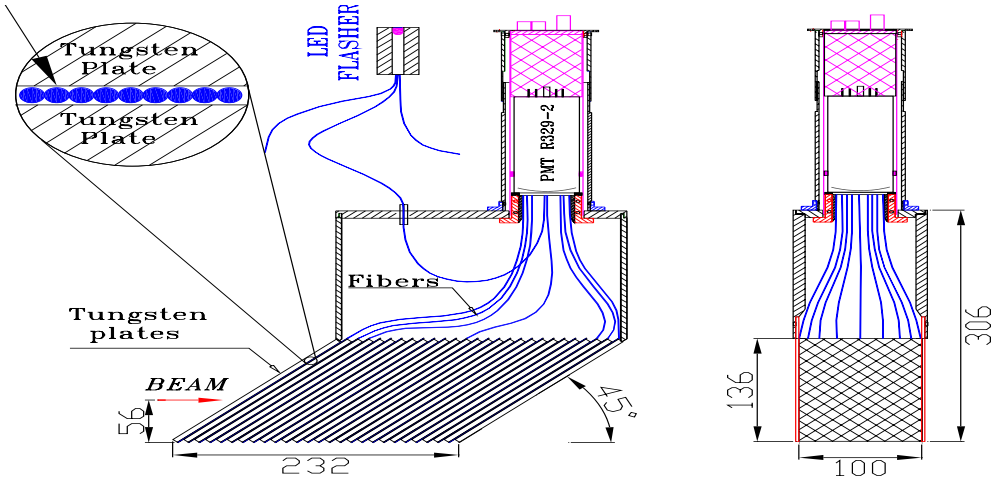
- **Excellent detector for high p_T probes:**
  - **High rates and large cross sections**
    - **quarkonia (J/ψ ,Υ) and heavy quarks (bb)**
    - **high p_T jets**
    - **high energy photons**
    - **Z^0**
  - **Correlations**
    - **jet-γ**
    - **jet-Z^0**
    - **multijets**

- **Global event characterization**
  - **Energy flow to very forward region**
  - **Charged particle multiplicity**
  - **Centrality**
  - **Azimuthal asymmetry**

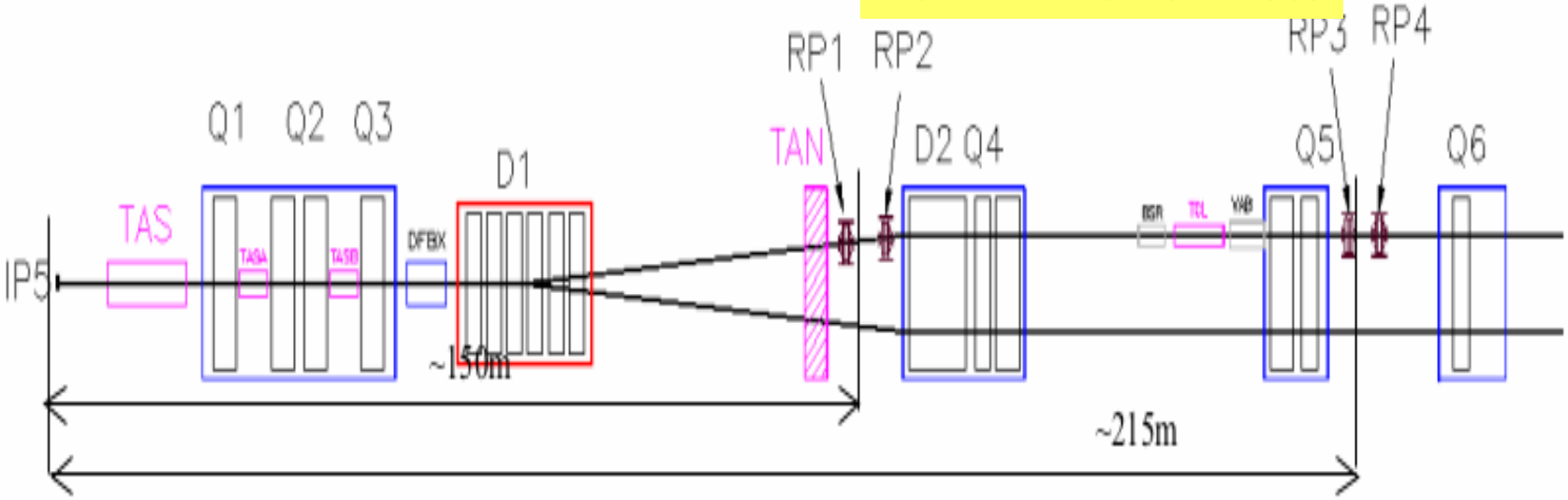
- **CMS can use highest luminosities available at LHC both in AA and pA modes**

CMS Very Forward Region
CASTOR, TOTEM and ZDC

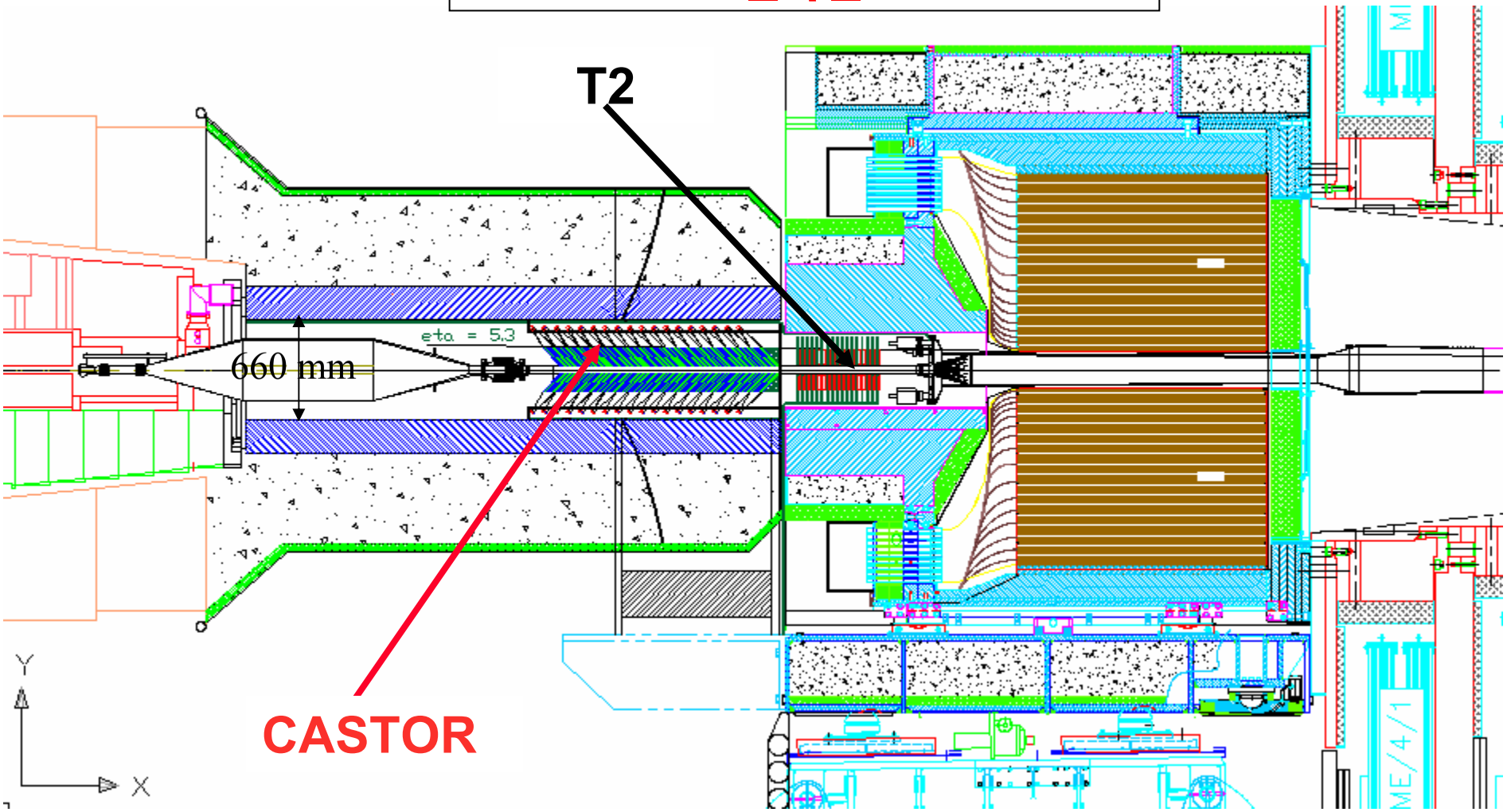
ZDC



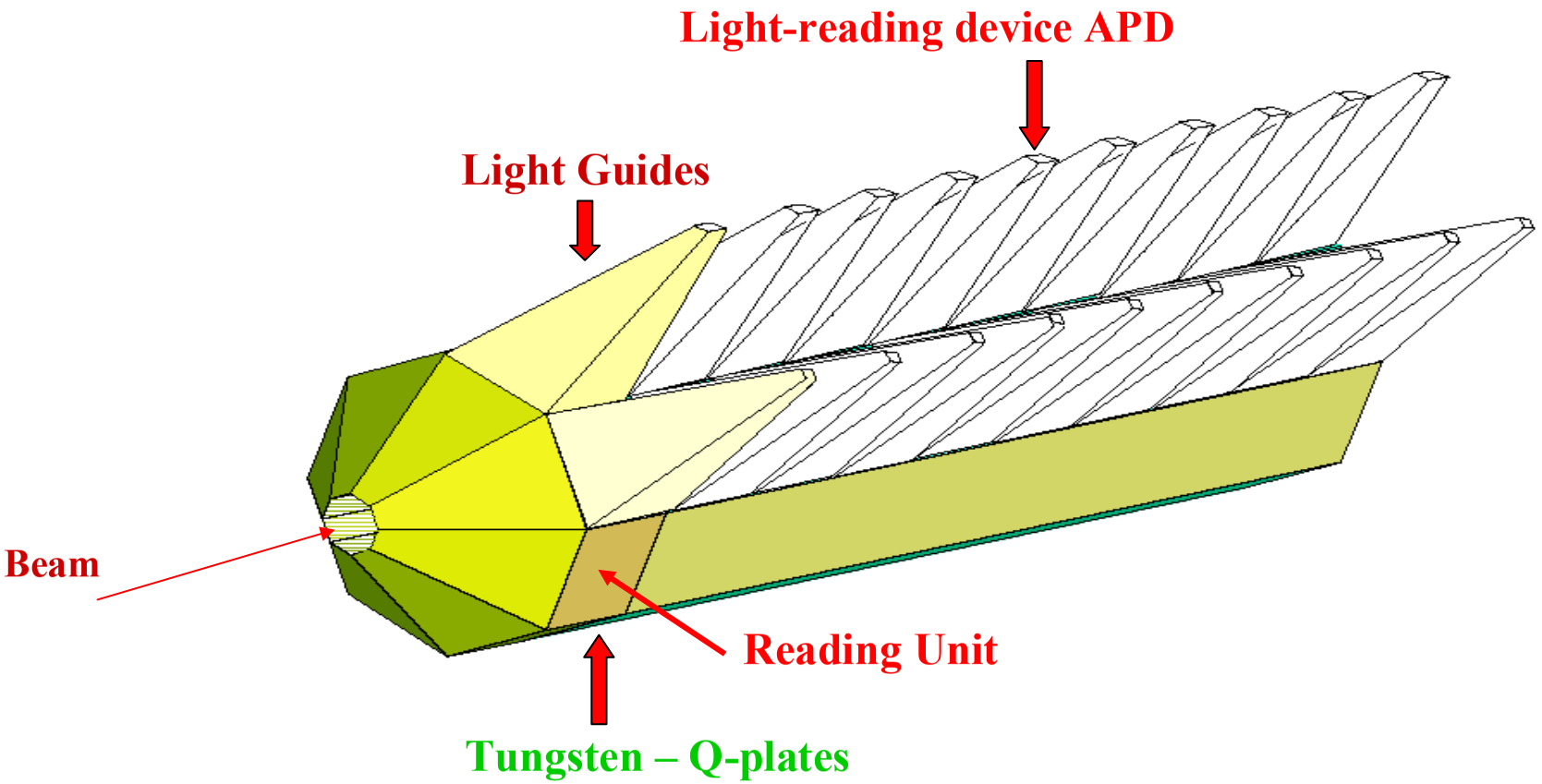
TOTEM: Roman Pots



Castor + T2 acceptance
$5.2 \leq \eta \leq 6.6$



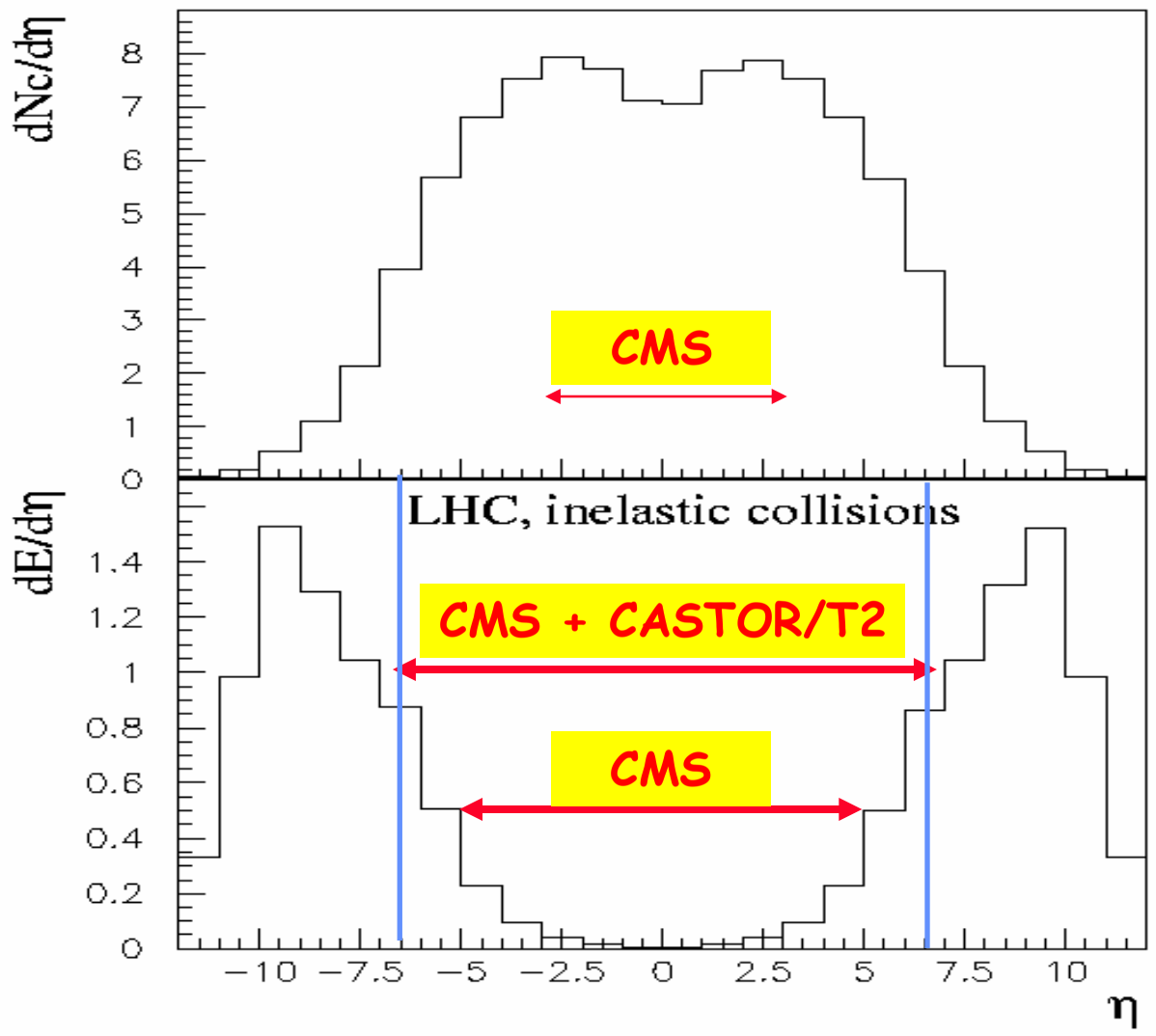
CASTOR Calorimeter



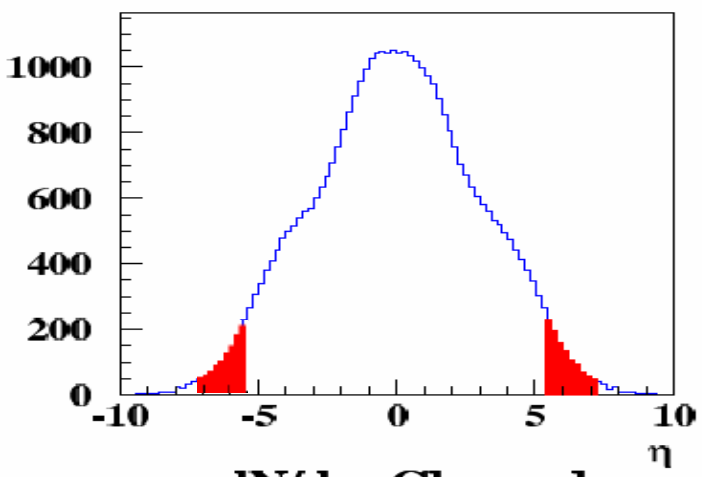
- Hermetic coverage to $|\eta| \leq 6.5$
- Zero Degree Energy
- Physics:
  - Centrality
  - Limiting Fragmentation
  - Peripheral and ultra-peripheral collisions
  - Low-x, Color-Glass Condensates
  - DCC, Centauros, Strangelets

ACCEPTANCES: Multiplicity - Energy

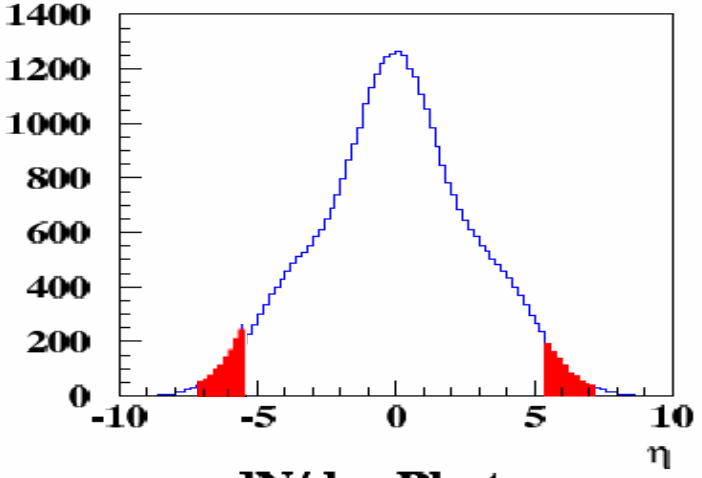
H
CASTOR
A
L



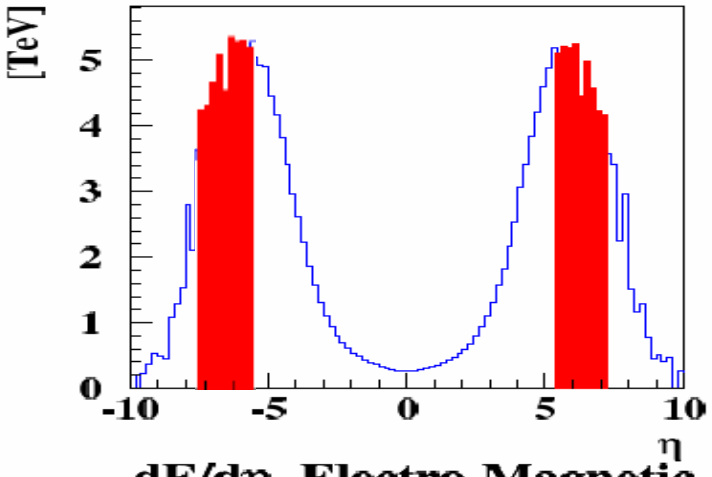
Acceptance of the CASTOR detector



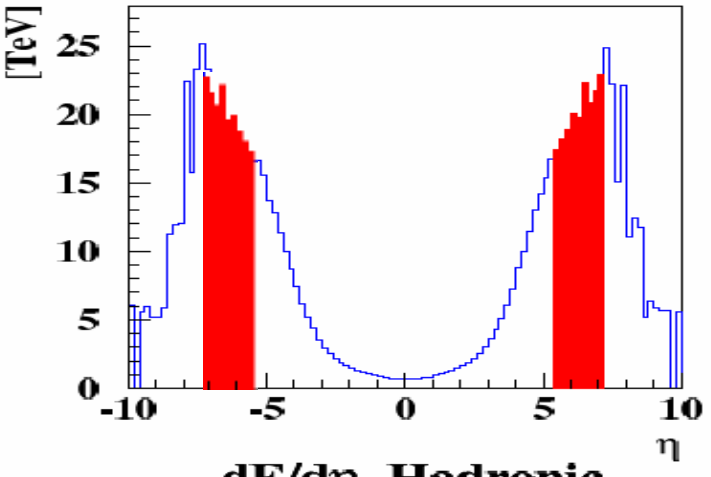
dN/dη, Charged



dN/dη, Photons

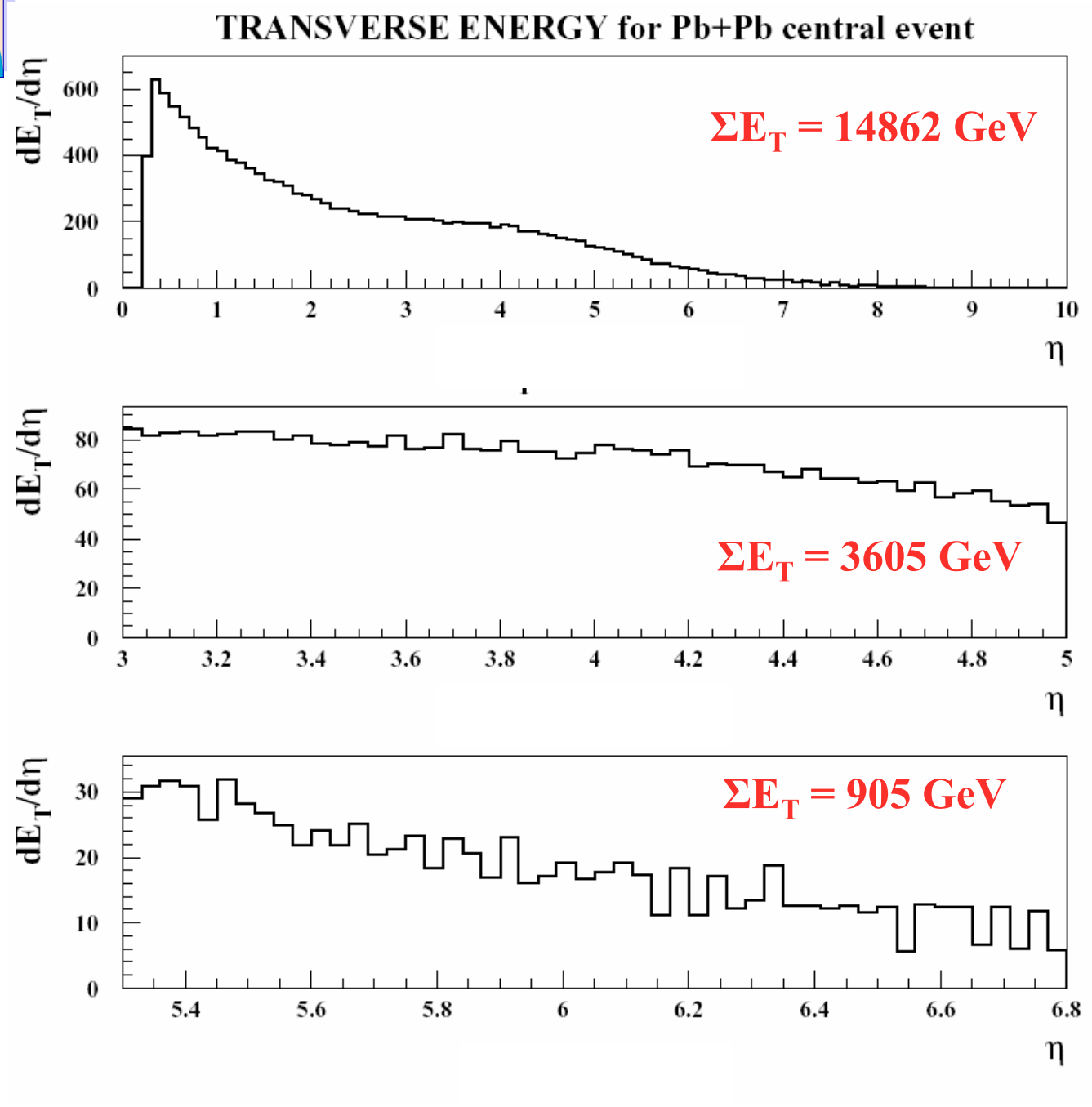


dE/dη, Electro-Magnetic



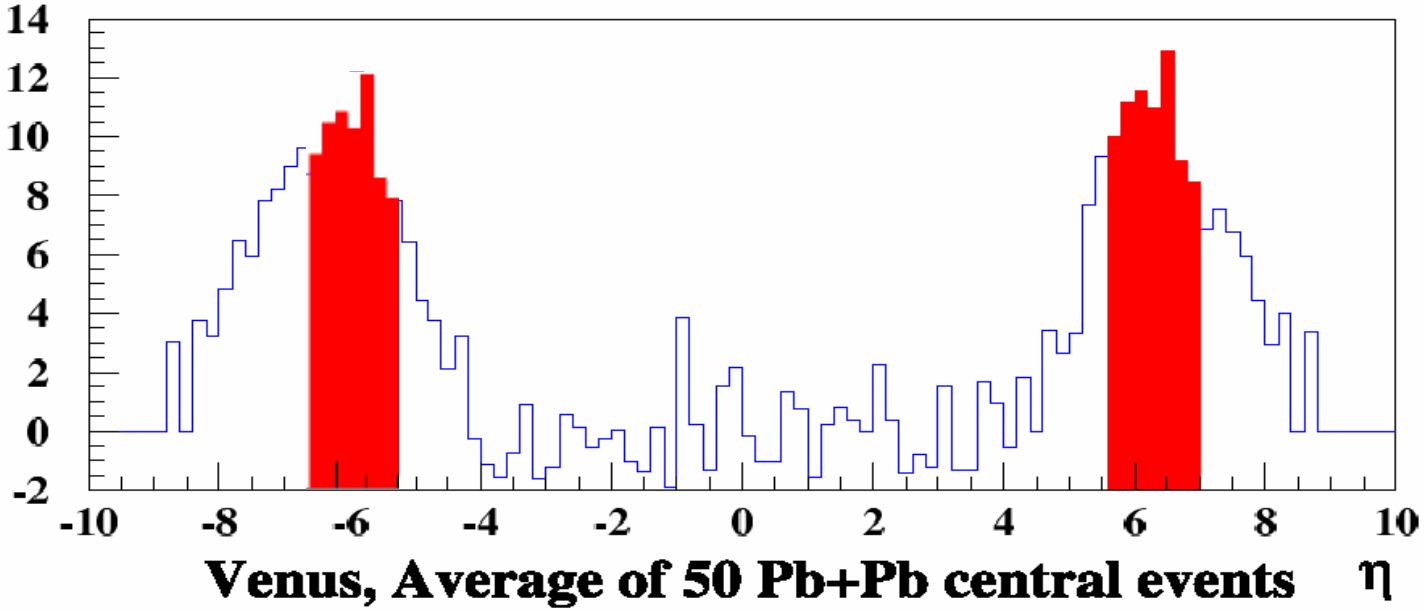
dE/dη, Hadronic

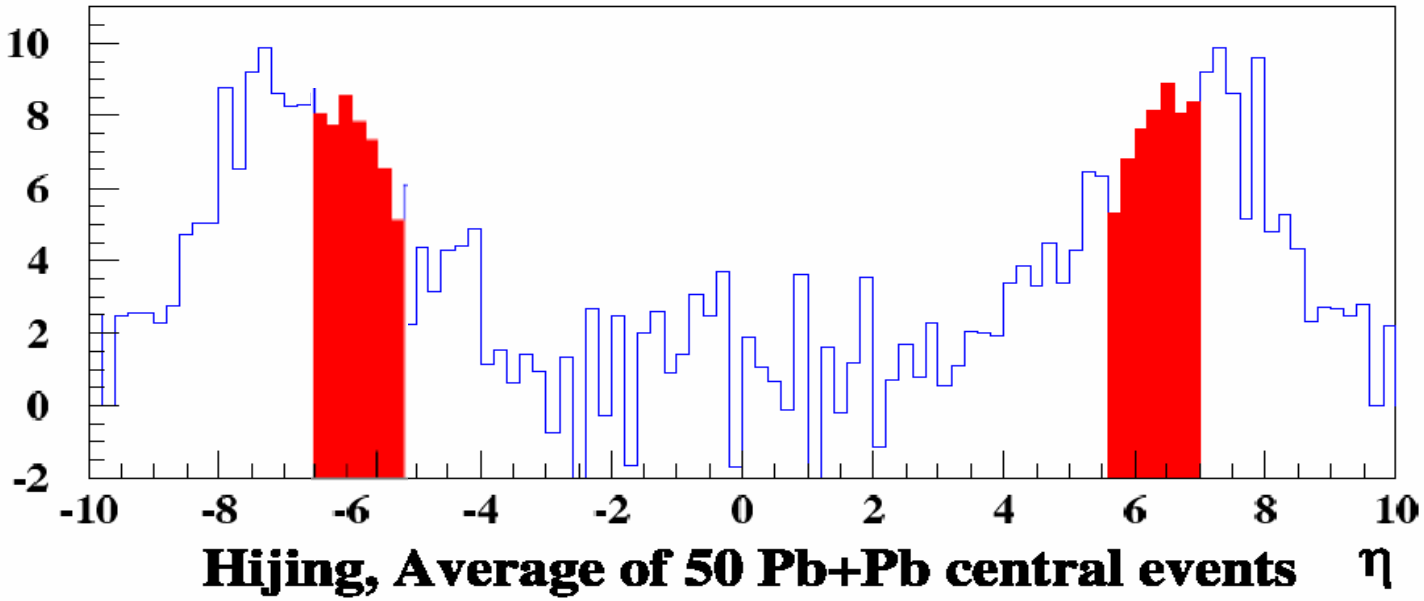
(Average of 50 Hijing Pb+Pb central events)


TRANSVERSE ENERGY for Pb+Pb central event
dE_T/dη
ΣE_T = 14862 GeV
η
dE_T/dη
ΣE_T = 3605 GeV
η
dE_T/dη
ΣE_T = 905 GeV
η

Net Baryon Number at the LHC

In Red the CASTOR Acceptance



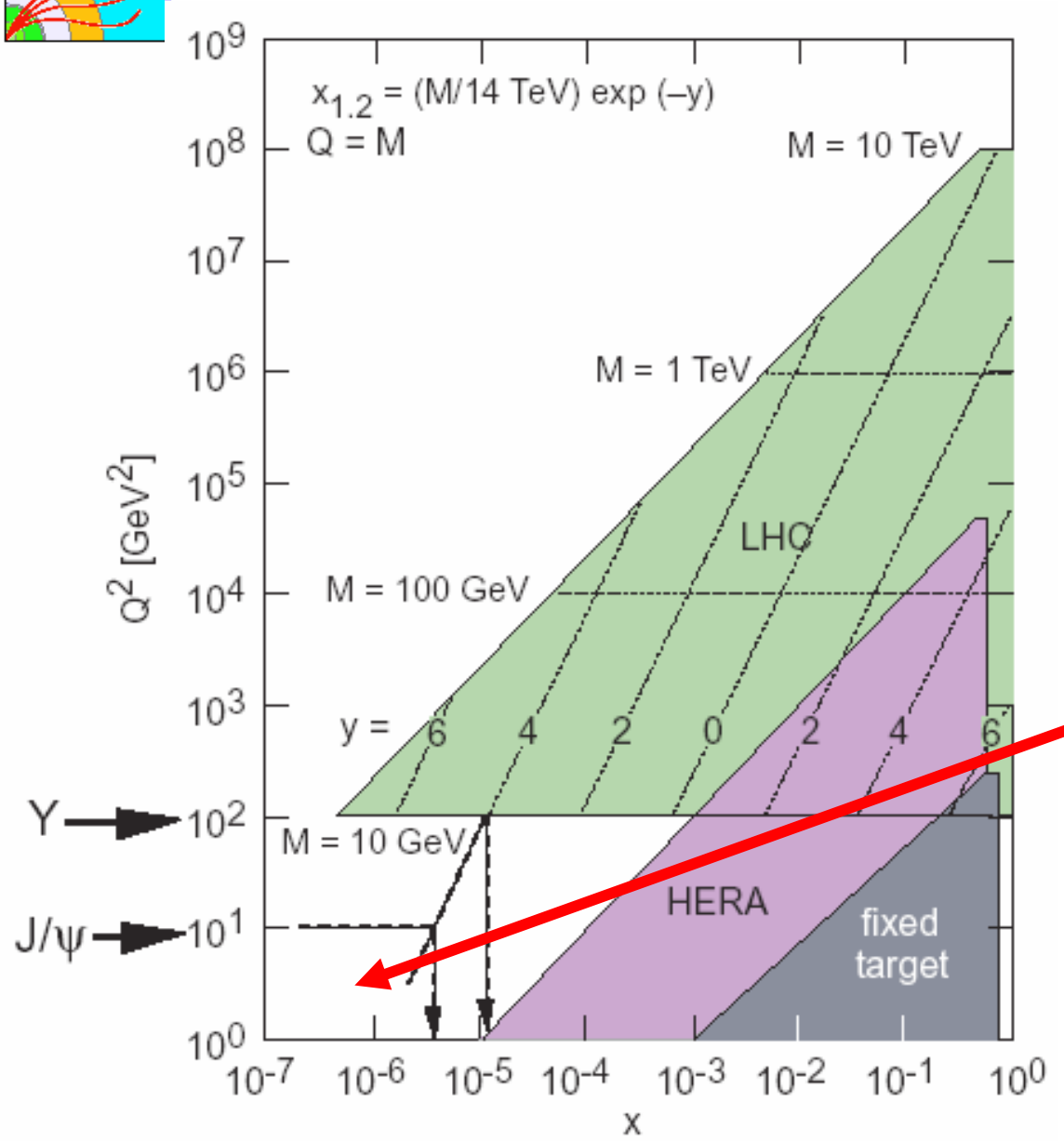


Peak of baryon distribution (BRAHMS)

$\eta \sim \eta_{beam} - 2.4$

~ 6.3

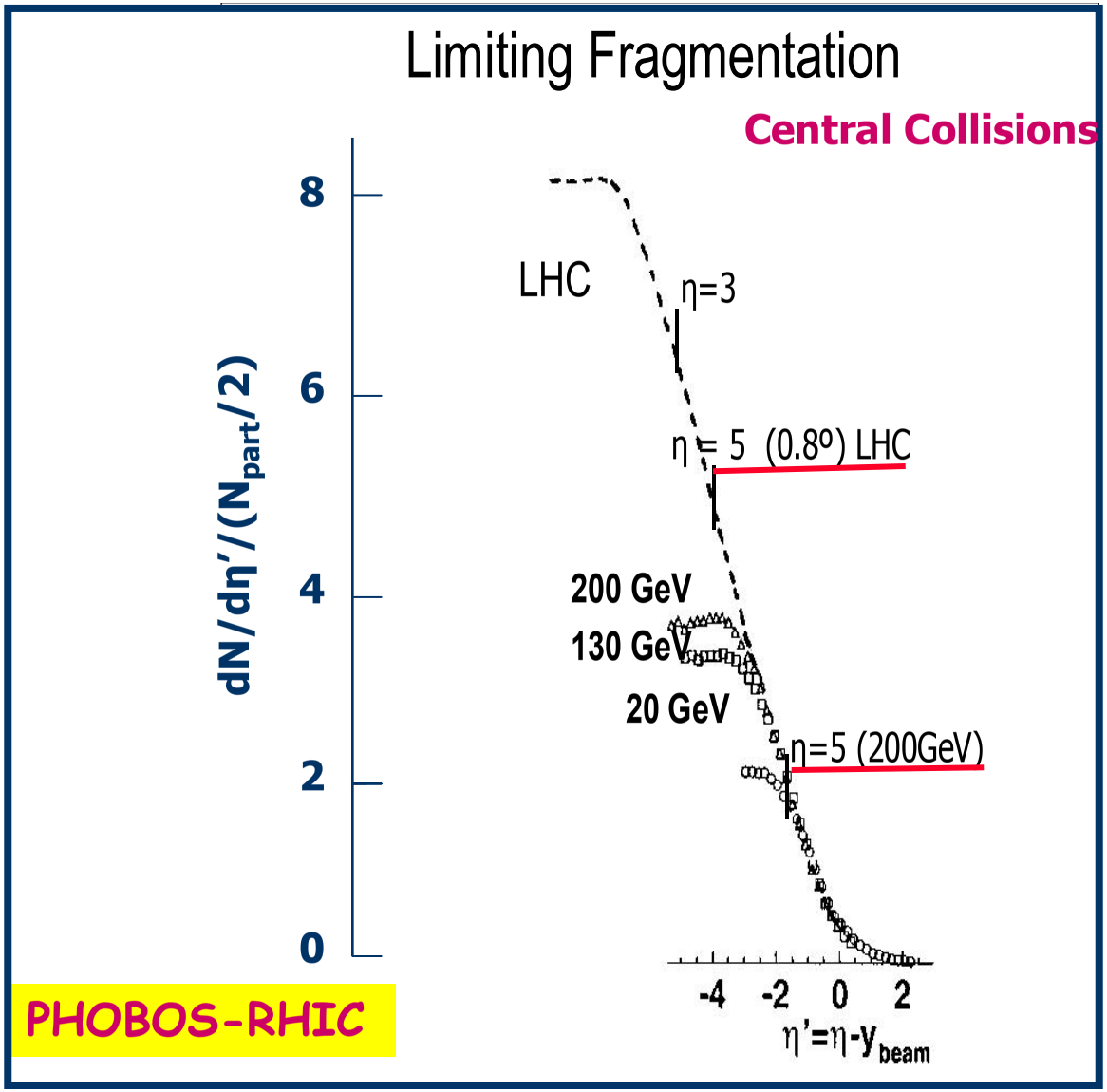
Low-x at the LHC



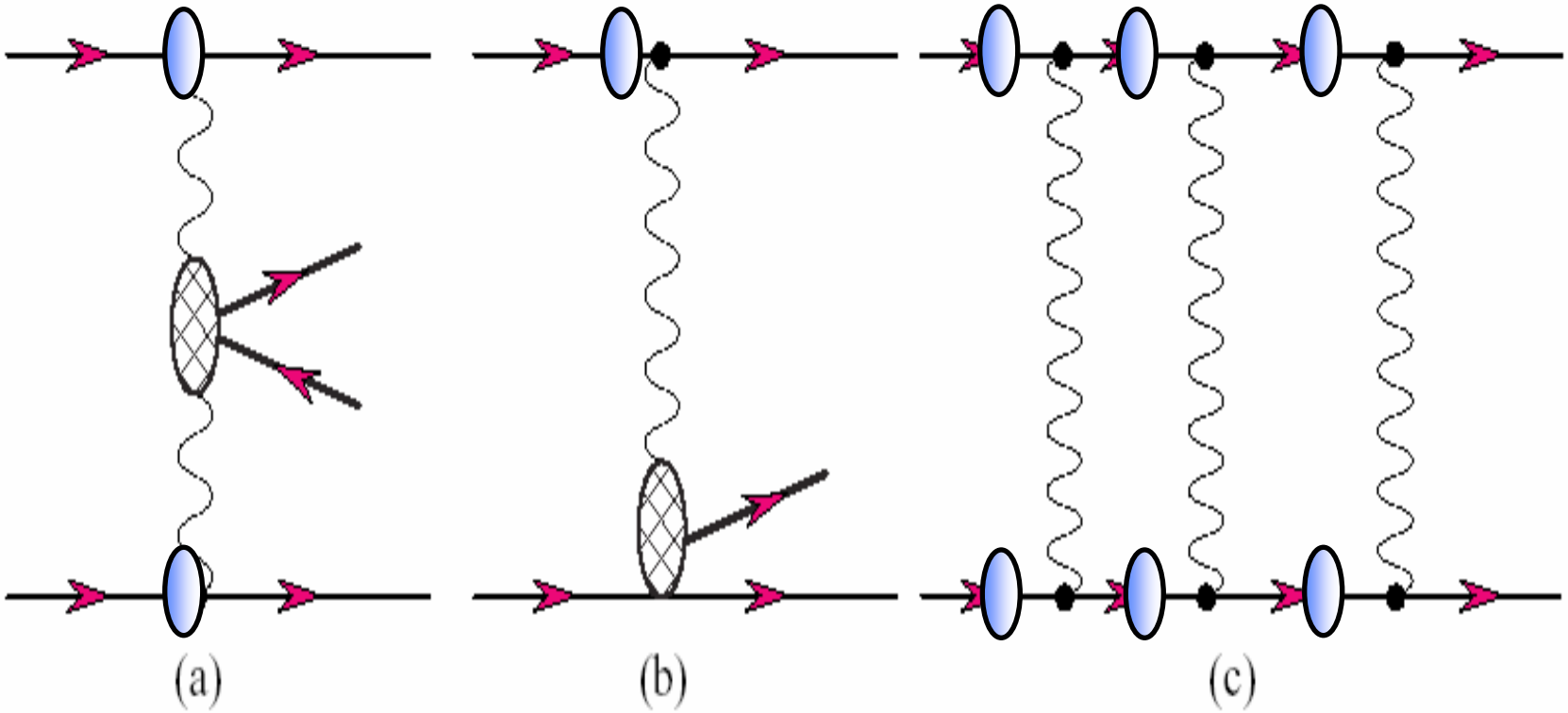
For rapidities below 5 and masses below 10 GeV

⇒ x down to 10^{-6}-10^{-7}

Limiting Fragmentation

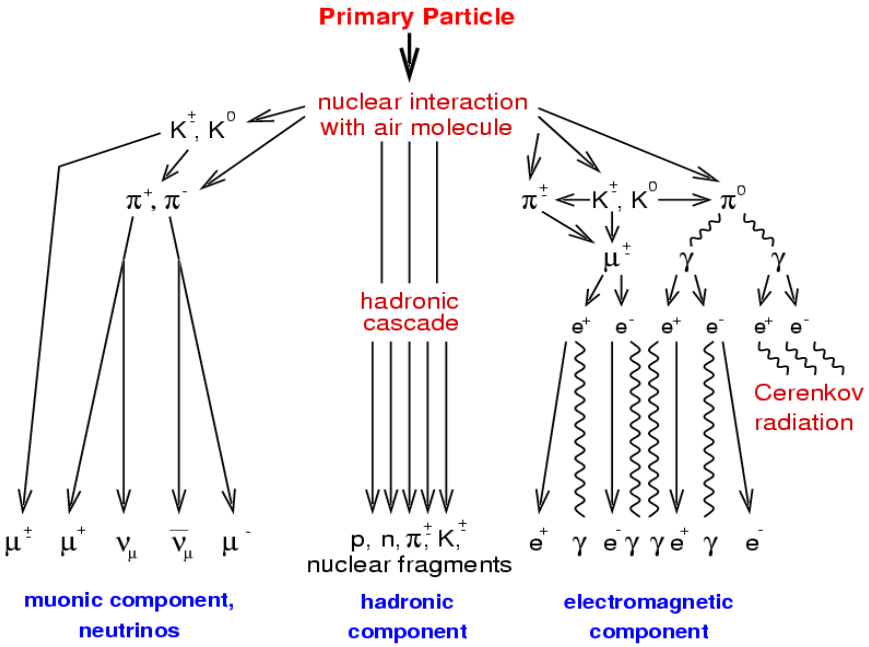


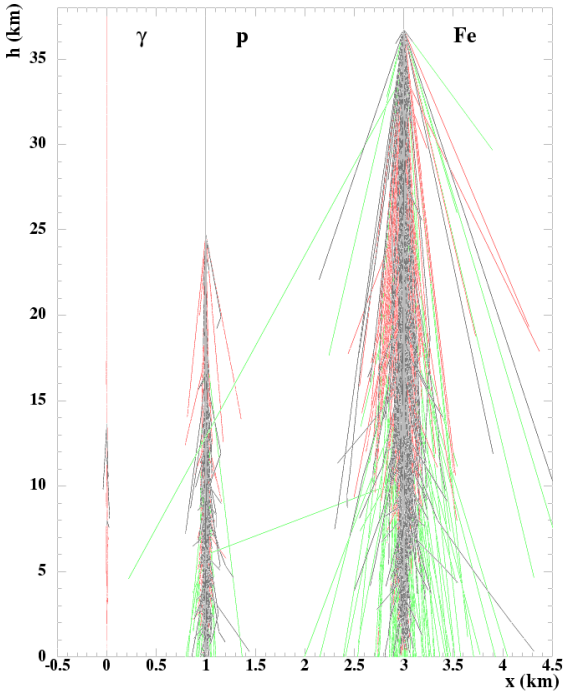
Photon Interactions



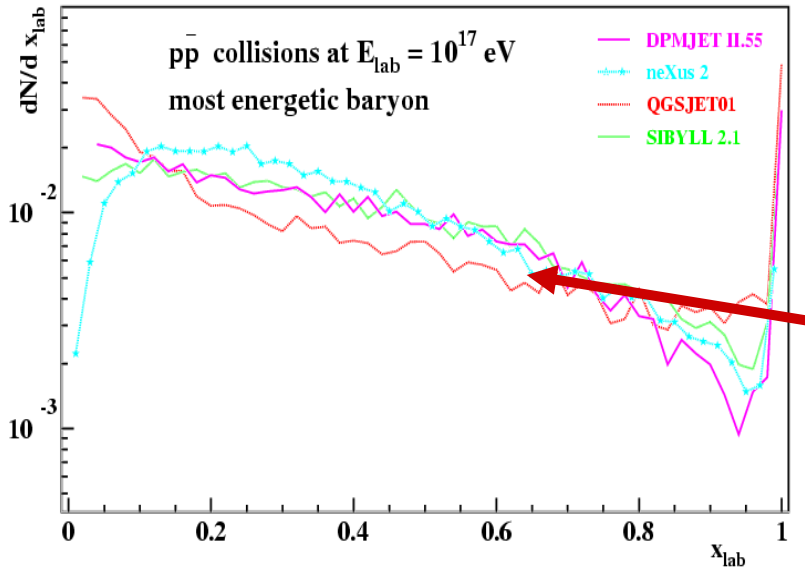
Due to the strong electromagnetic fields relativistic heavy ions are a strong source of quasireal photons. These can be used for photon-photon (a), and photon-nucleus (b) collisions, where even higher order processes, with more than one photon exchange, are possible (c)

High Energy Cosmic Rays





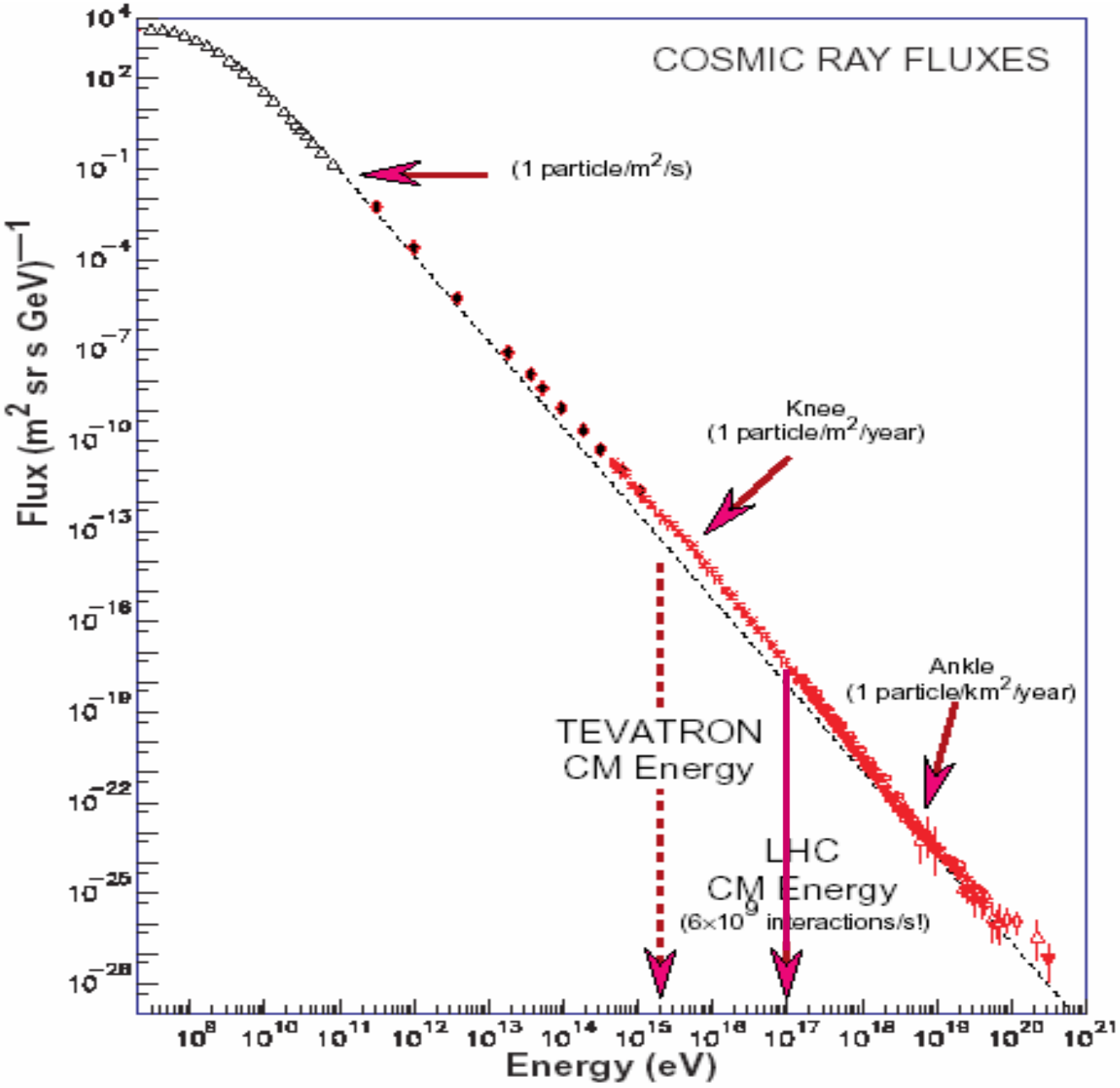
Cosmic ray showers: Dynamics of the high energy particle spectrum is crucial

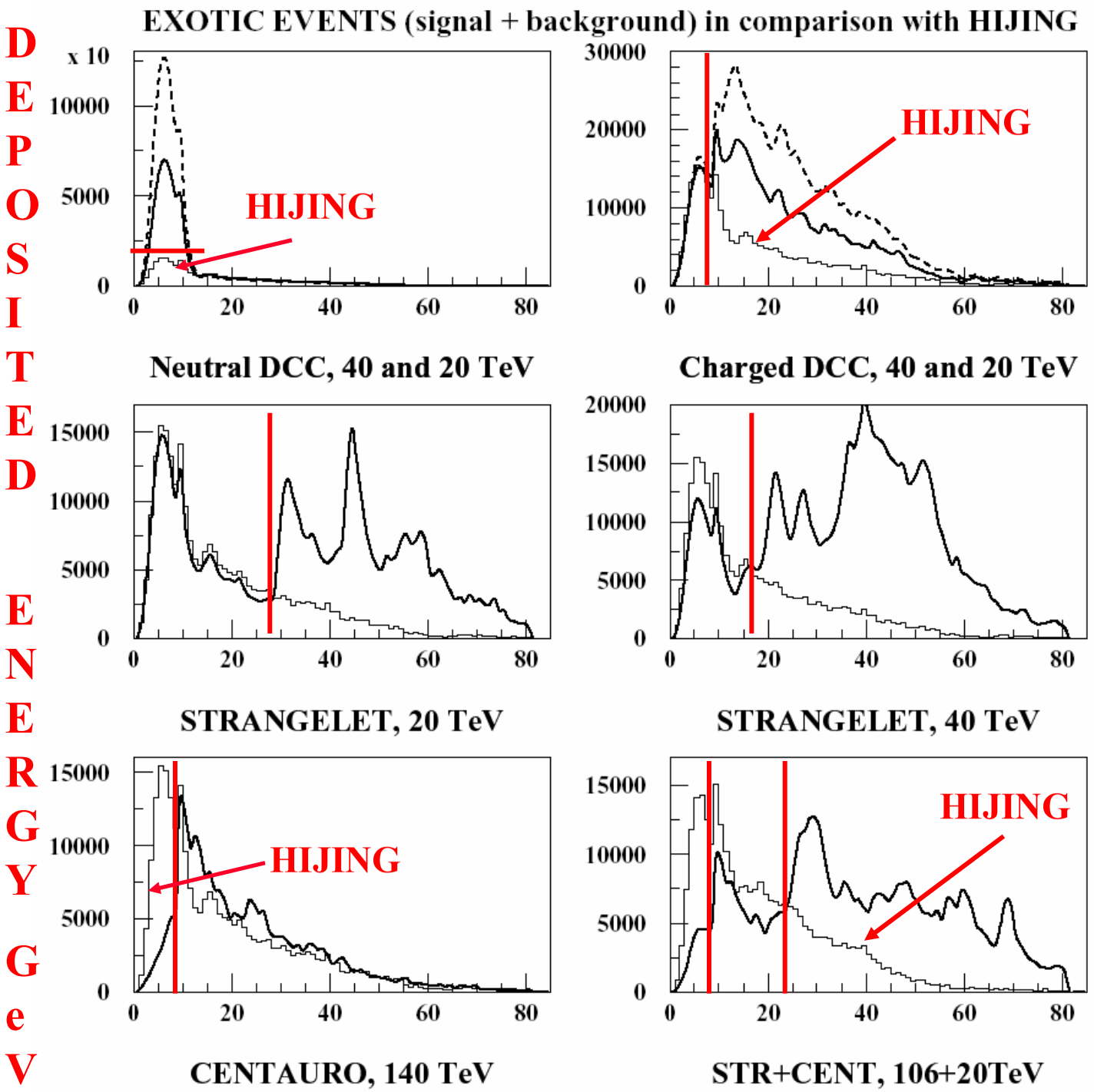


Interpreting cosmic ray data depends on hadronic simulation programs.
Forward region poorly known/constrained.
Models differ by factor 2 or more.
Need forward particle/energy measurements

Forward energy flow for Cosmic Rays

H
CASTOR
A
L




EXOTIC EVENTS (signal + background) in comparison with HIJING
DEPOSITED ENERGY GeV
x 10
HIJING
Neutral DCC, 40 and 20 TeV
HIJING
Charged DCC, 40 and 20 TeV
STRANGELET, 20 TeV
STRANGELET, 40 TeV
HIJING
CENTAURO, 140 TeV
HIJING
STR+CENT, 106+20TeV