Underlying Event Studies with CASTOR in the CMS experiment

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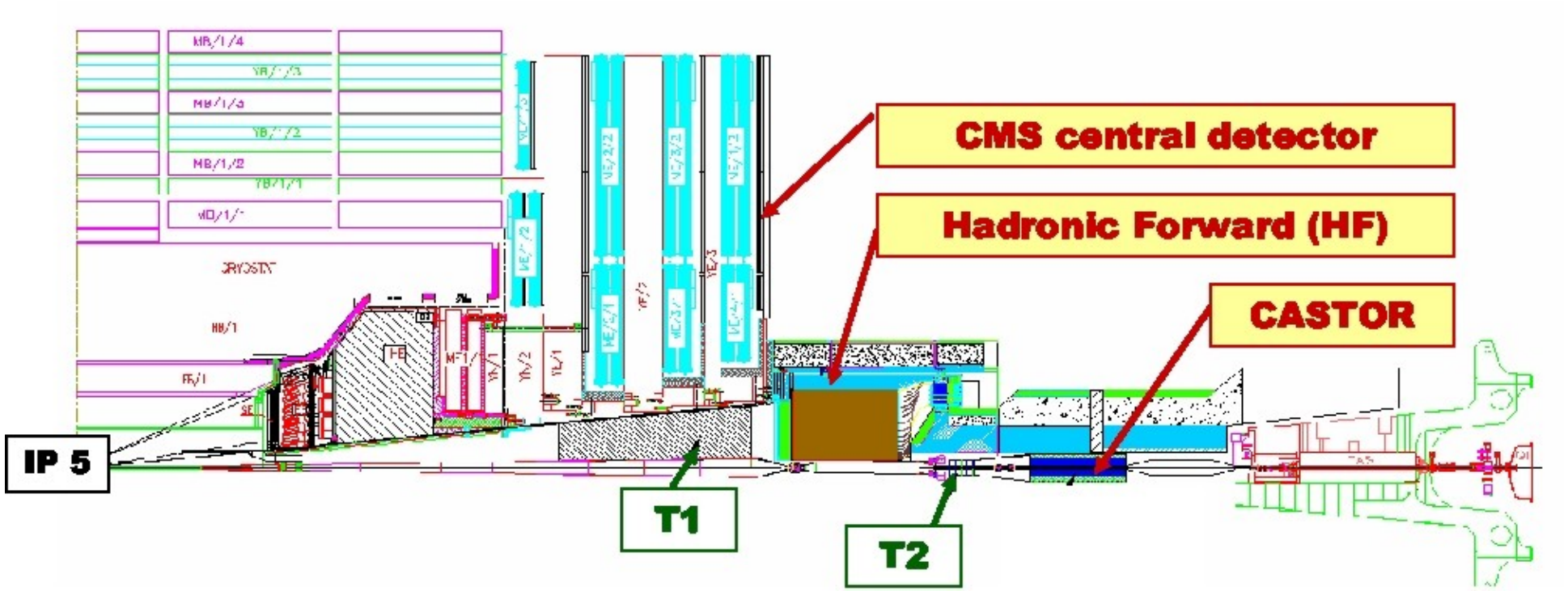
HERA LHC workshop
27. Mai 2008

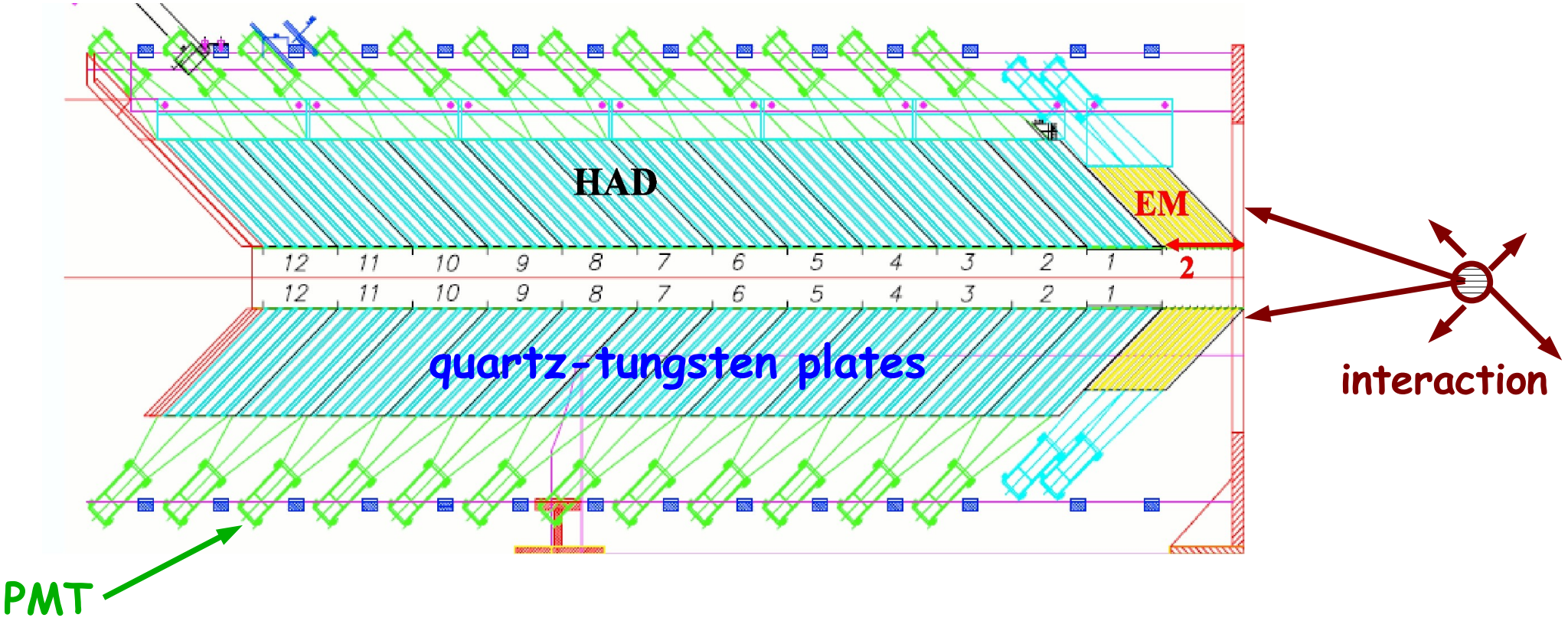
- CASTOR detector
- Particle multiplicities and energy flow
- Jet profiles

CASTOR in CMS



- CASTOR coverage: $5.2<\eta<6.6$

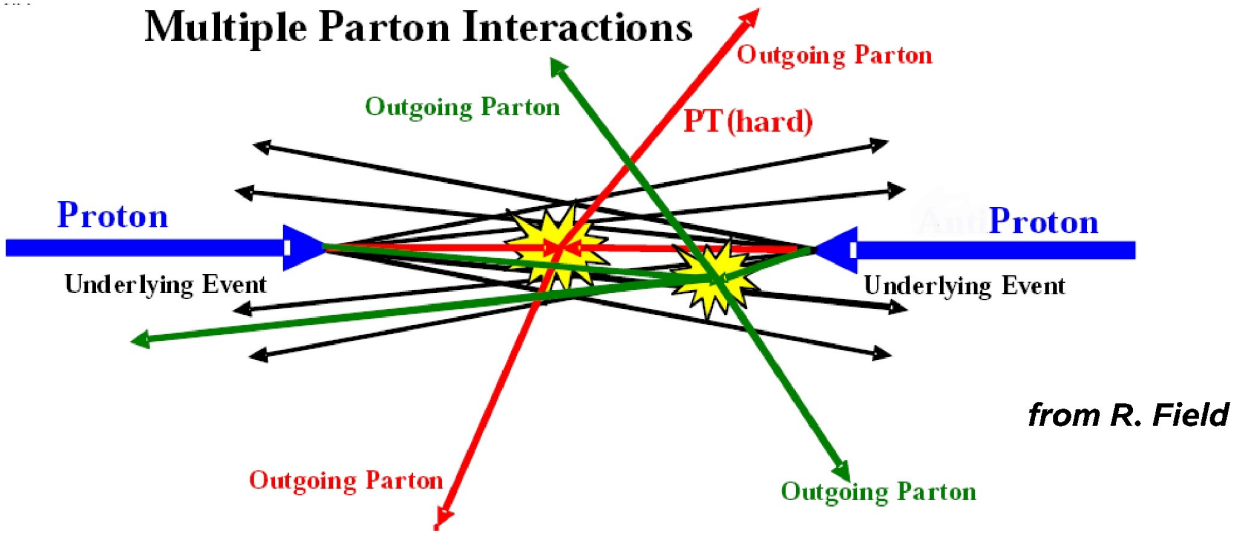
CASTOR



- Sampling Cherenkov calorimeter: absorber tungsten plates & active medium quartz plates
- radial: 16 Φ sectors, longitudinal: 2EM+12HAD sectors

Multi Parton Interactions

- Multi parton interactions(MI) and underlying event(UE):



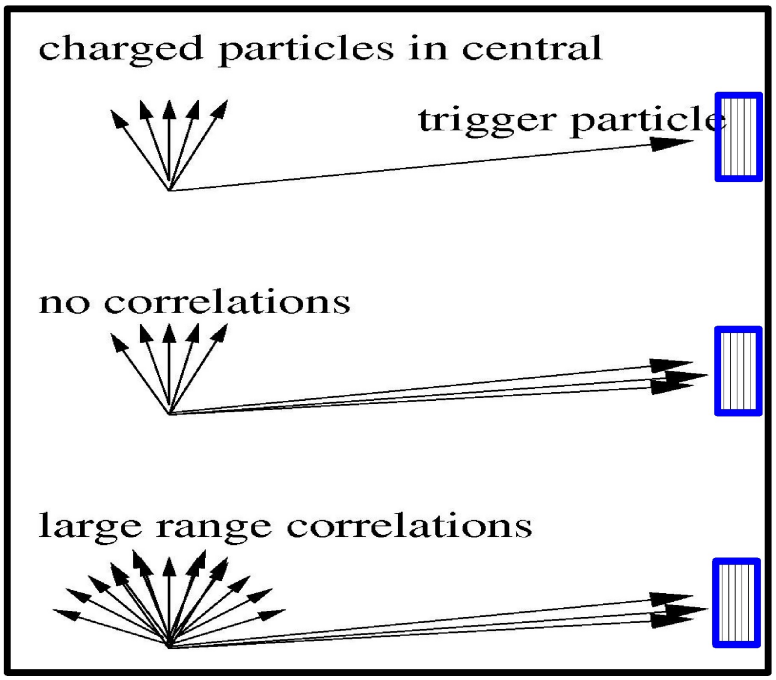
- **UE:** soft interactions with low Pt
  --> important for jet analysis (additional energy offset)

- **MI:** more hard interactions
  --> background for important physics channels (i.e. Higgs production)

==> MI & UE crucial for all precision measurements

Multi Parton Interactions & CASTOR

- At Tevatron UE tuned only to central eta region
- with CASTOR we can look what happens in forward direction
  - Span the energy flow measurement over large rapidity range 0<eta<6.6
  - Use energy deposit in CASTOR to study long range correlations (already observed at HERA & UA5)



Information

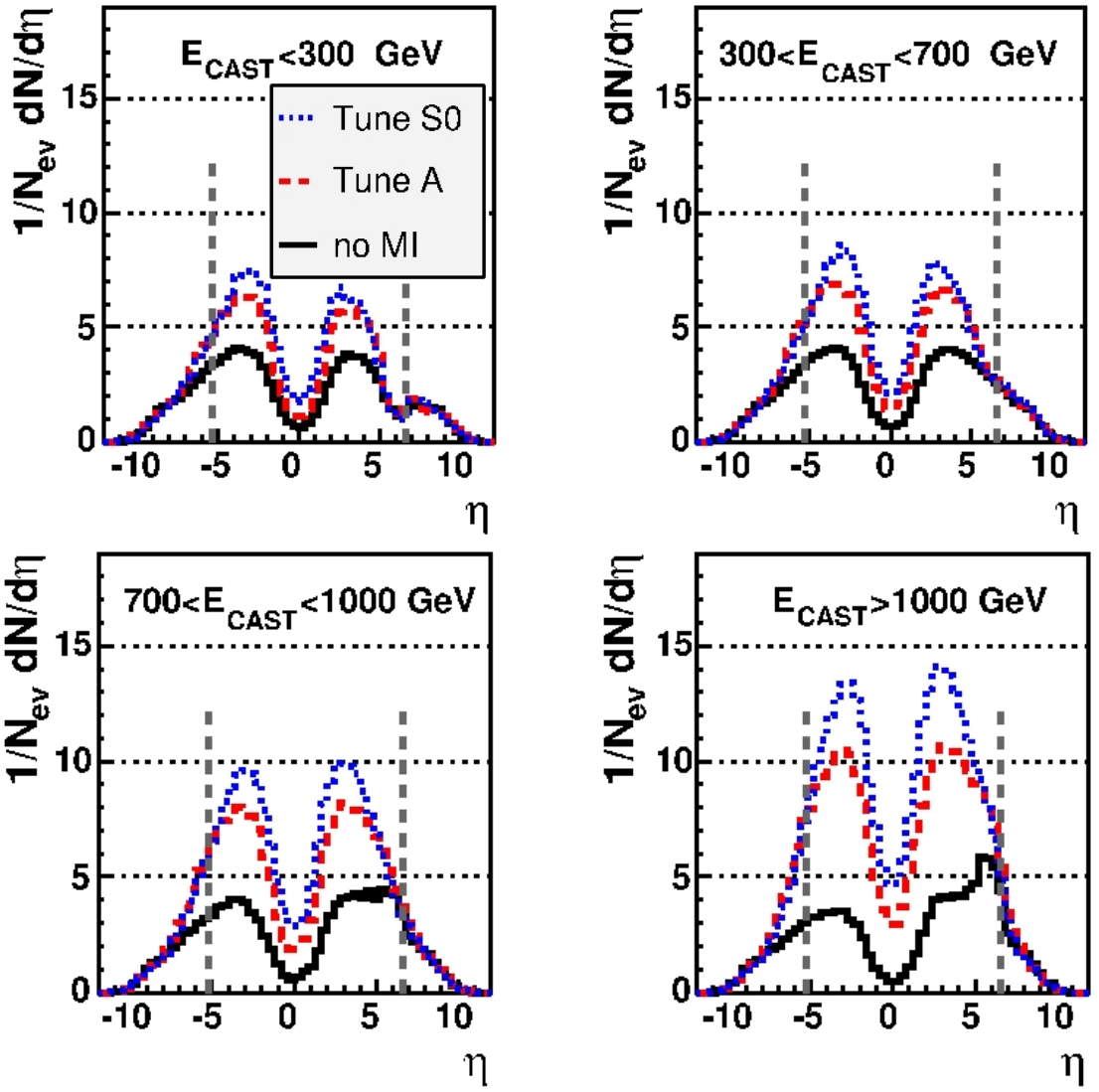
- All studies done on generator level only
- Generator: PYTHIA 6.4.14
- Hard QCD processes (MSEL=1)
- Multi parton interaction tunes:
  - Rick-Field's CDF tune A (tuneA)
  - Sandhoff-Skands tune 0 (tuneS0)
  - MI switched off

Long Range Correlations

$E_{CAST} = \Sigma E_{part}$, $5.2 < \eta_{part} < 6.6$

Charged particle multiplicities (E_{part}>1GeV)

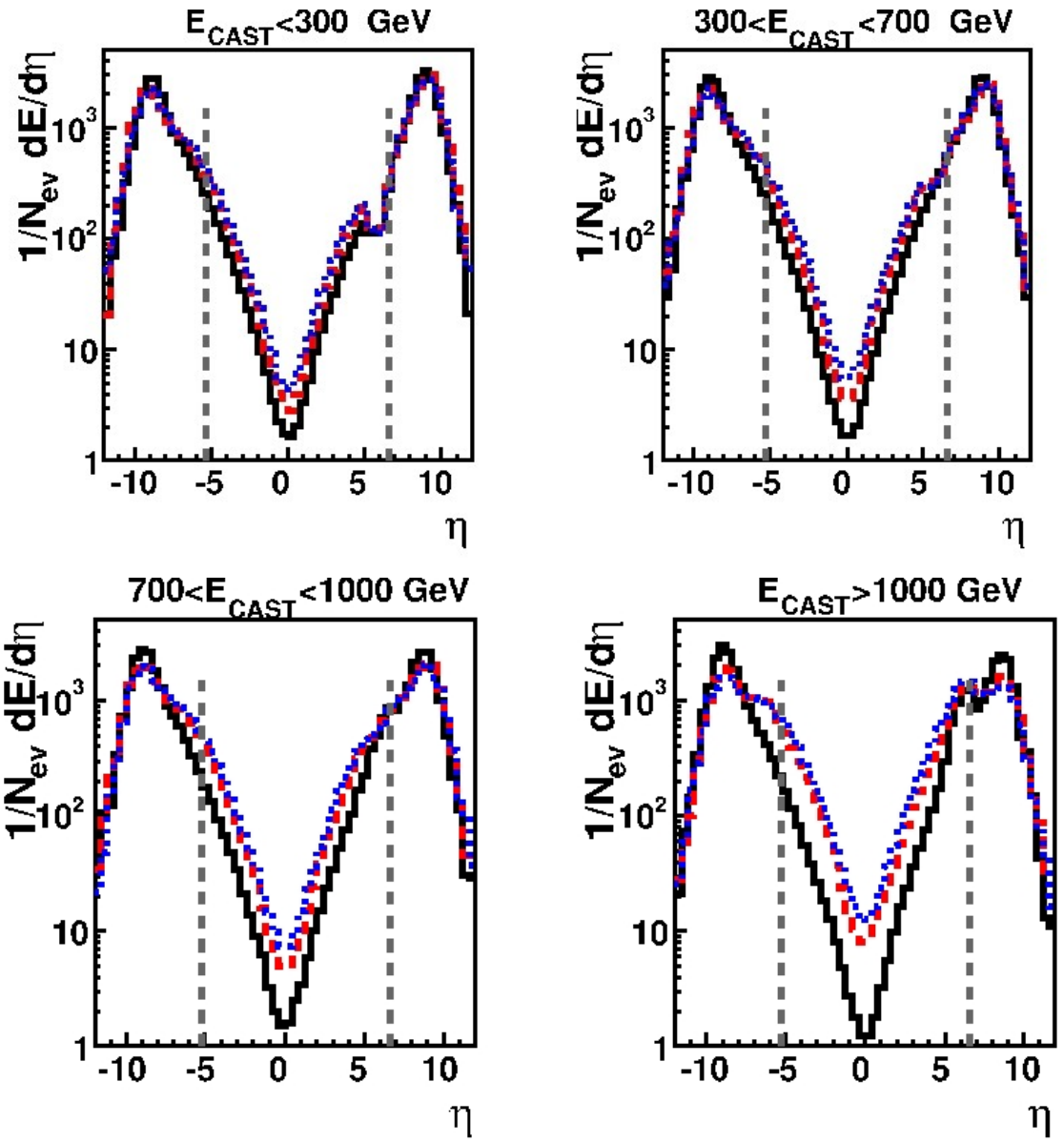
- **Without MI:**
  no correlations
- **With MI:**
  large trigger E in Castor --> high particle multiplicities in central region
- **Triggering on CASTOR enhances differences between various UE tunes**
- Smearing the particle energies in η_{Castor} (TB07 resolution) almost doesn't change the results



Long Range Correlations

- **Without MI:**
  no correlations
- **With MI:**
  large trigger E in Castor
  larger E deposit in the central region

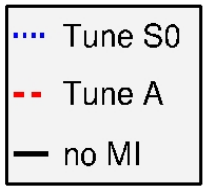
Particle energy flow (E_{part}>1GeV)

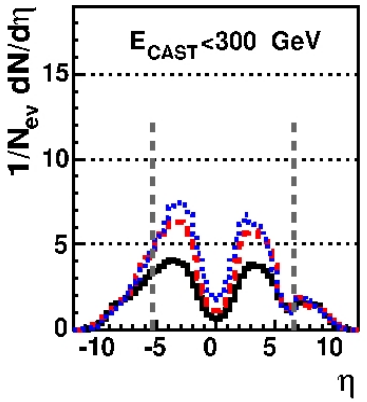


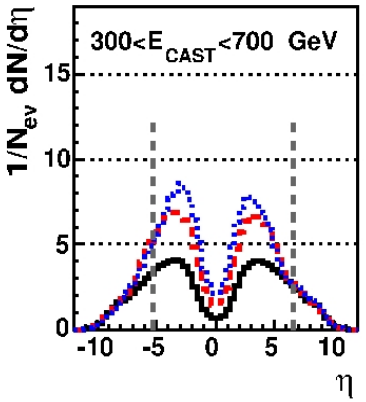
Is UE the Same for all Processes?

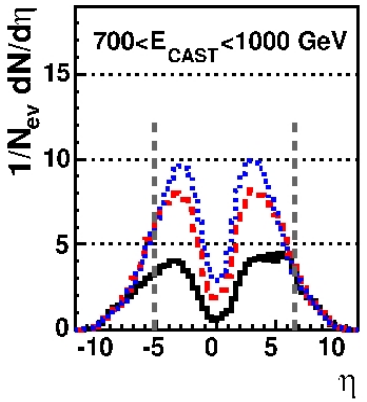
Charged particle multiplicities (E_{part}>1GeV)

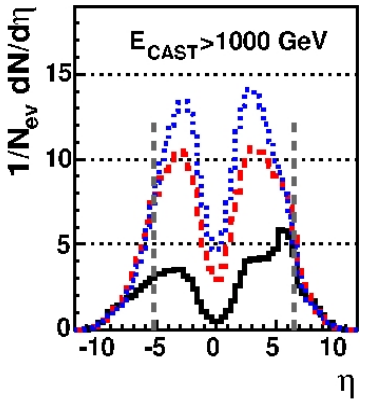
QCD:



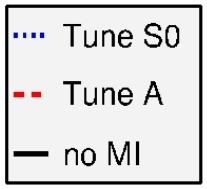


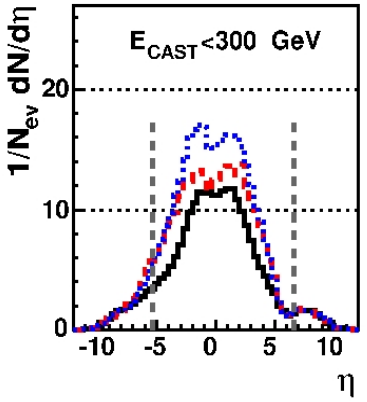


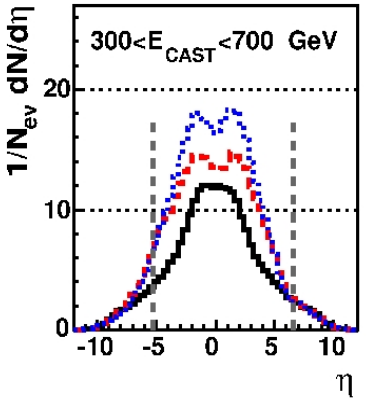


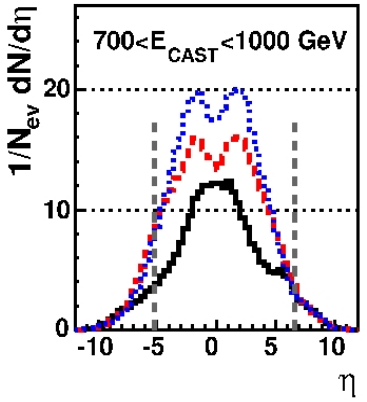


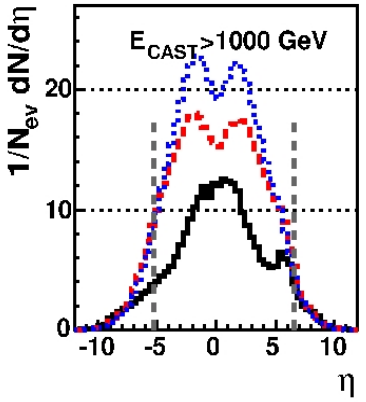
top:





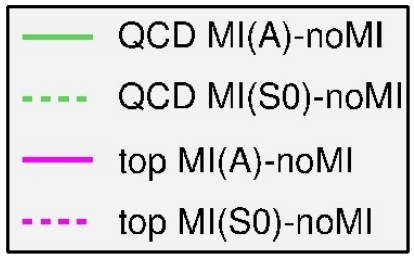






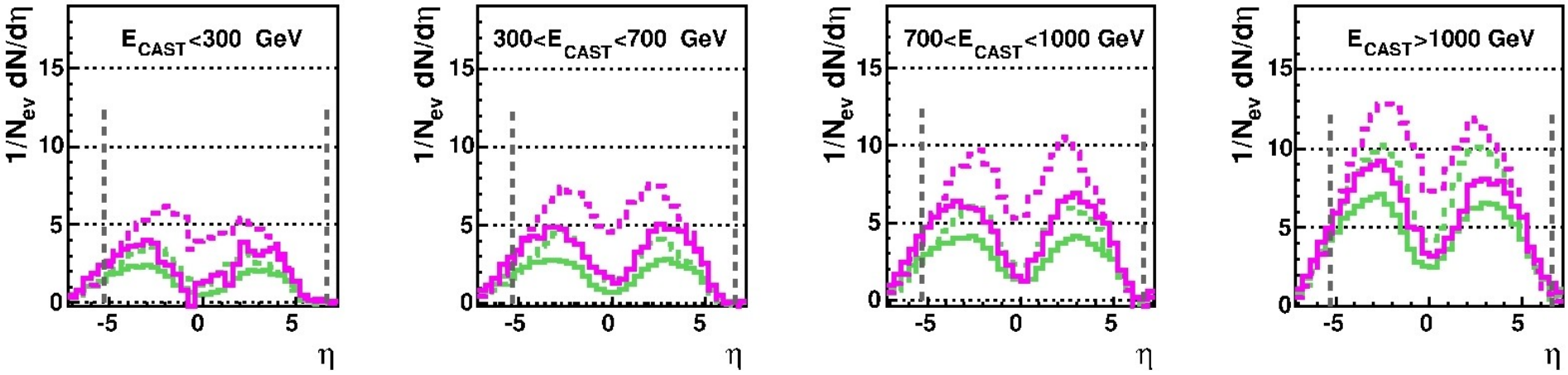
UE MinBias <--> Top

MI - noMI:



Charged particle multiplicities due to UE

(E_{part}>1GeV): N(UE)= N(MI) -N(no MI)



- **In top production much more underlying event activity than in normal QCD processes!**

  (the energy flow plots lead to the same conclusions like particle multiplicities)

UE in harder collisions

- UE depends on the collision centrality:
  - Soft collisions --> less UE activity
  - Hard collisions --> more UE activity

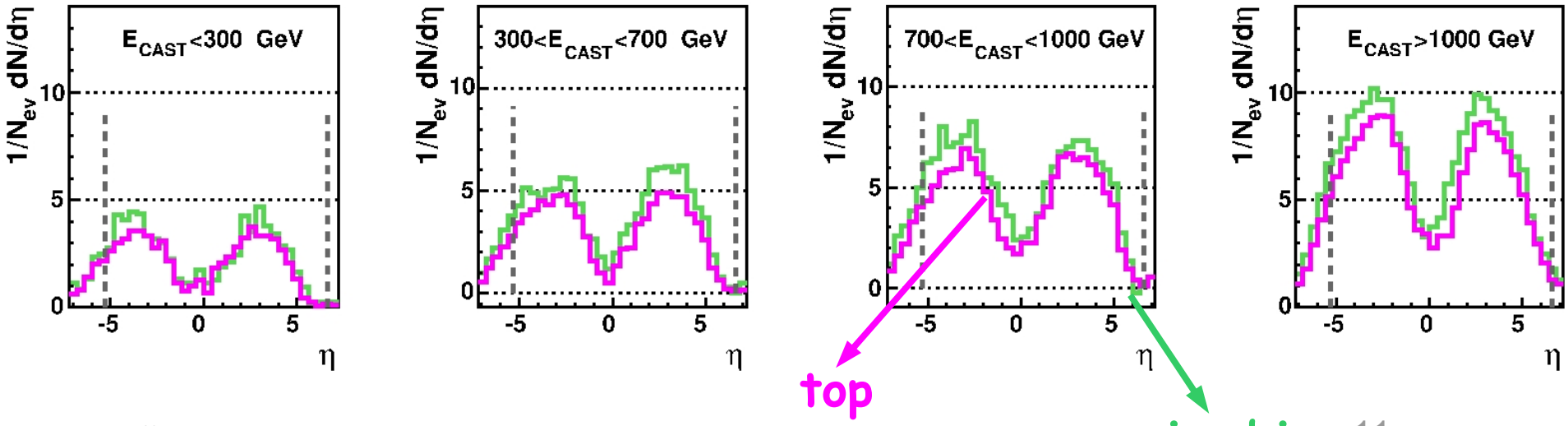
MI - noMI:

QCD MI(A)-noMI

top MI(A)-noMI

- When demanding hard Et(jet)> 40GeV in central region |η|<2.5, differences between UE inl QCD and in top processes almost disappear

Charged particle multiplicities due to UE (MI tune A, E_{part}>1GeV)

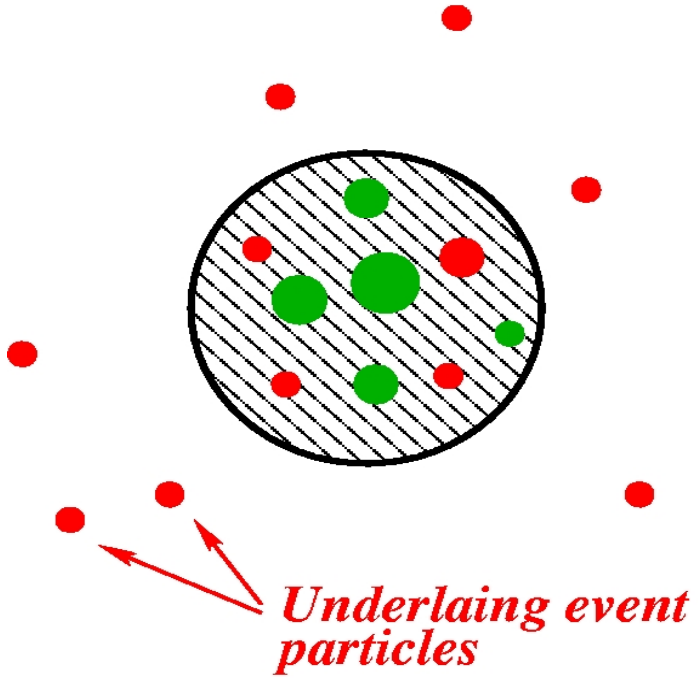


Jet Measurement and UE

- Particles from UE contribute to jet energy measurement:

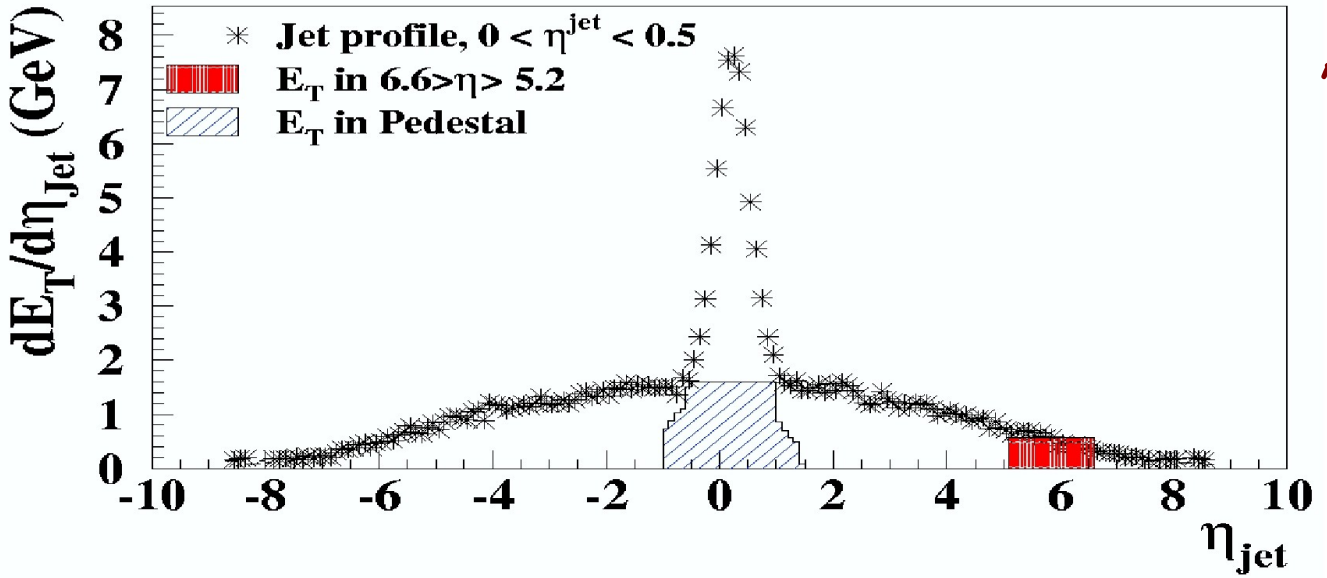
$$Et(jet)_{measured} = Et(jet) + pedestal$$

- Jet profiles can be used to determine the jet pedestal due to UE

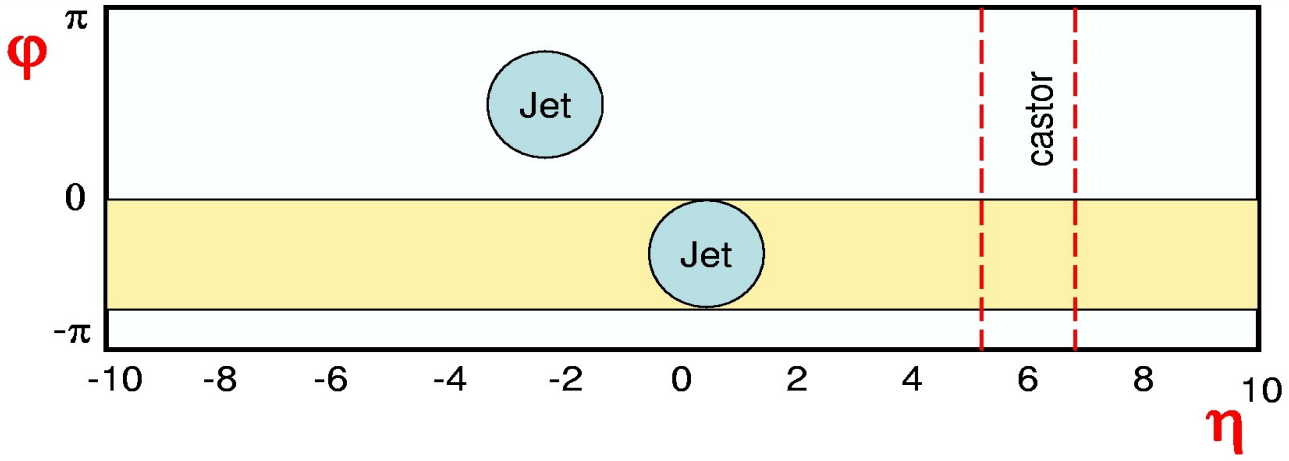


Jet Profiles

- measurements in CASTOR (and HF) may help to determine pedestal shape and so to get "true" Et(jet)



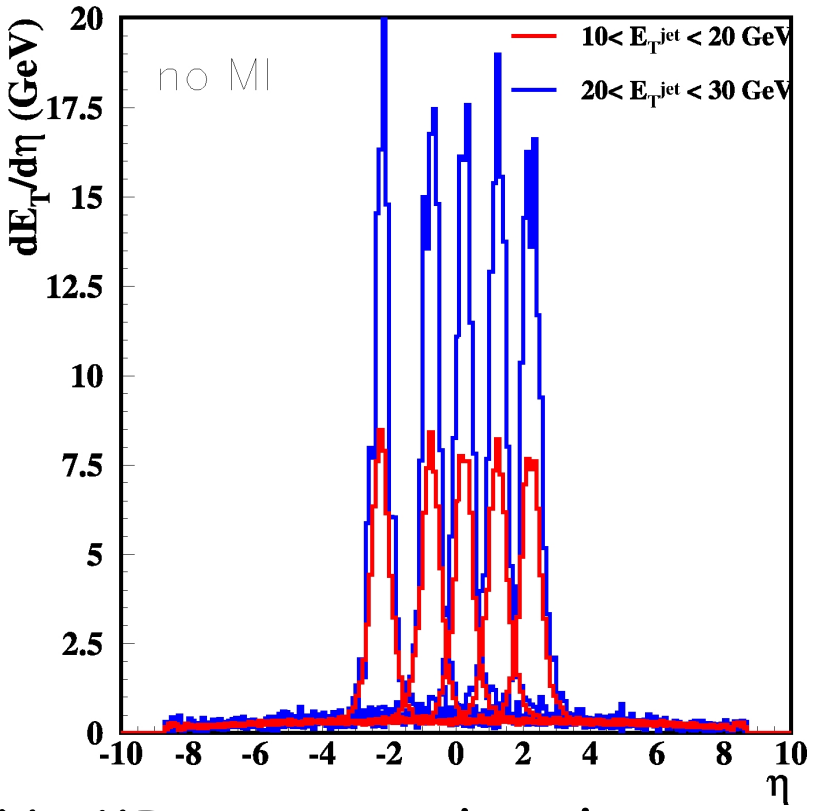
A. Bunyatyan

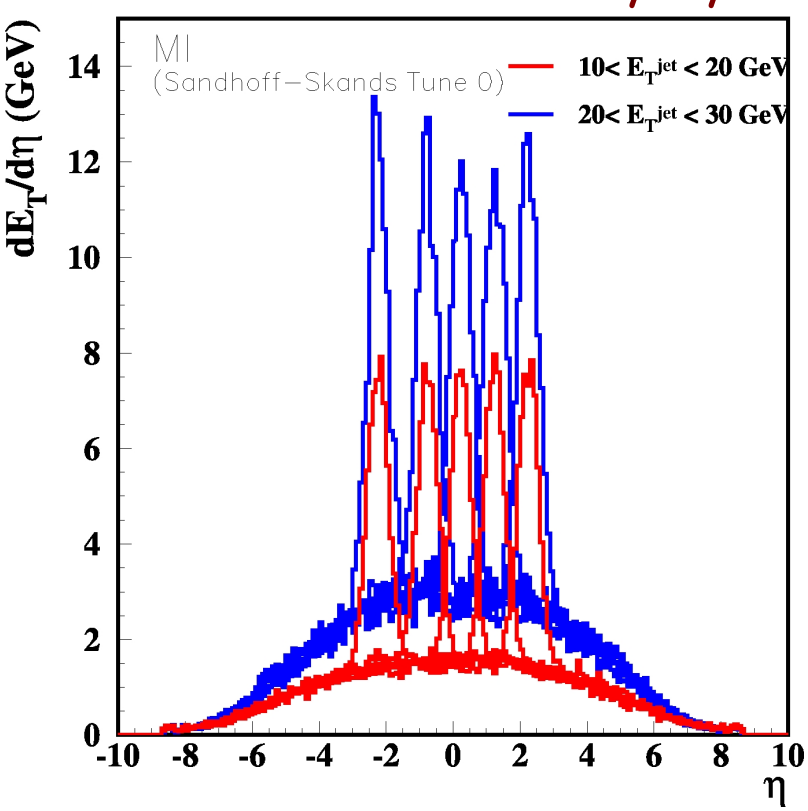


Jet Profiles

Eta Jet profile, different eta(jet) regions

A. Bunyatyan

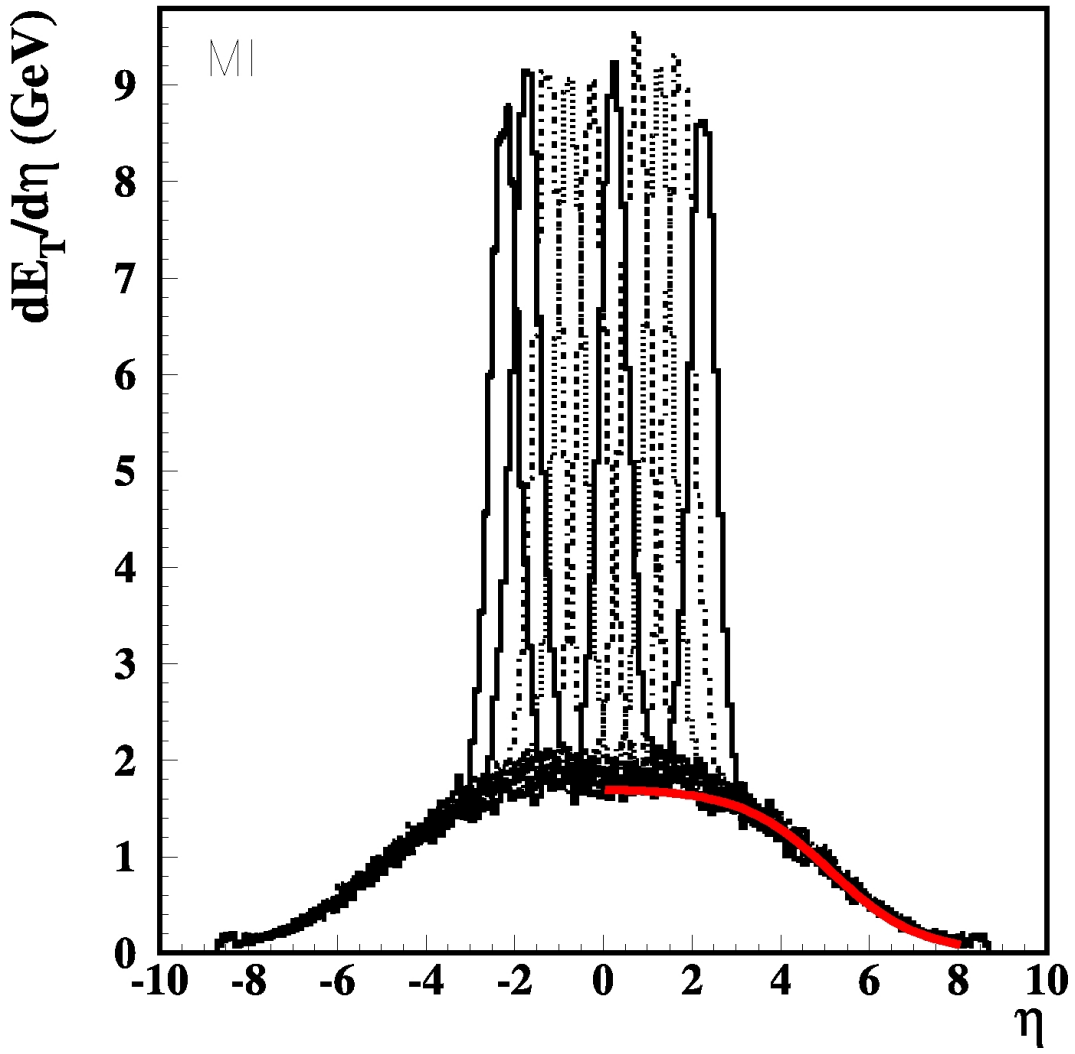




- No MI --> no pedestal
- MI --> pedestal independent on eta(jet), which depends from the MI tune and collision hardness

Extracting Pedestal

A. Bunyatyan



- Try to fit jet pedestal with a simple 2 parameter function

$$f(\eta) = \frac{A}{1 + B \cdot e^{|\eta|-4}}$$

- in fact A and B are correlated ==> even with central + Castor measurement only we may already perform the fit

Summary

- For UE study is information from forward eta region essential
- With Castor we can distinguish better between various MI tunes scenarios (long range correlations,...)
- Measuring jet profiles up to eta 6.6 allows to determine the jet pedestals and thus obtain "true" Et(jet)

Backup

Pedestals: various MI tunes

Result of the fit for different MI options