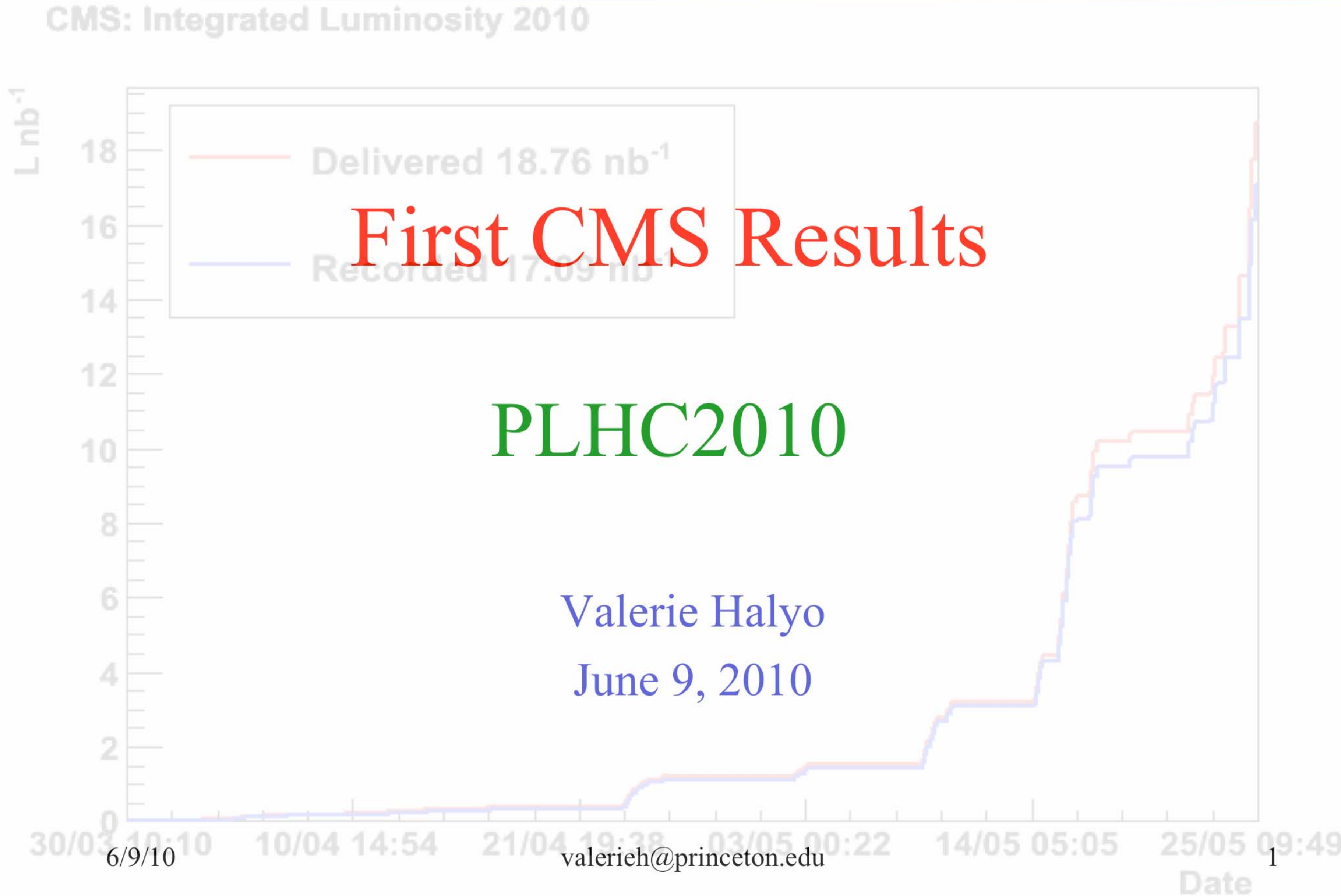
First CMS Results

PLHC2010

Valerie Halyo

June 9, 2010



Physics from all CMS data

Cosmic Ray Runs:

- MTCC 06' (25M mu's) + CRAFT 08' (270M mu's)

=> World most precise measurement charge ratio of atmospheric muons.

Beam Collisions:

- $\sqrt{s}$=900 GeV @ LHC injection energy
  - First LHC collisions December 2009 (~15 $\mu b^{-1}/10\mu b^{-1}$)
- $\sqrt{s}$=2.36 TeV
  - Delivered/recoreded ~1.2$\mu b^{-1}/0.4\mu b^{-1}$
- $\sqrt{s}$=7 TeV
  - 30 March 2010 – continues.. ~20nb^{-1}

} Detailed Bottom – Up Physics Analysis approach to guaranty readiness for searches BSM

Bottom – Up Analysis Approach

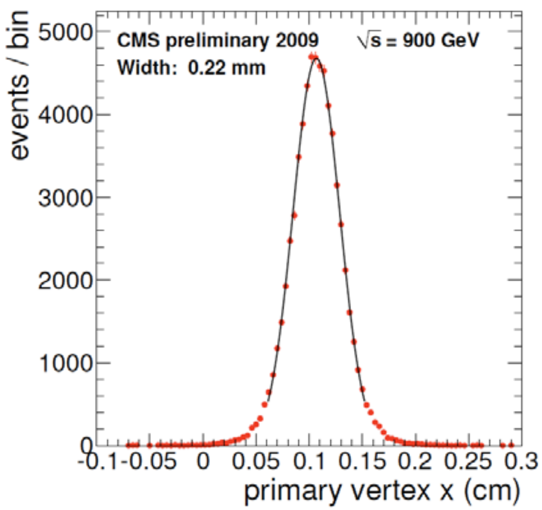
- Class I: (Single Particle properties MB +UE)
  - Understanding mechanism for hadron production and relative role of soft and hard contribution at the highest collision energy
  - Important for high Luminosity runs with pileup (rare signal will be embedded on ~20MB events)
  - Single Diffractive events + Energy flow

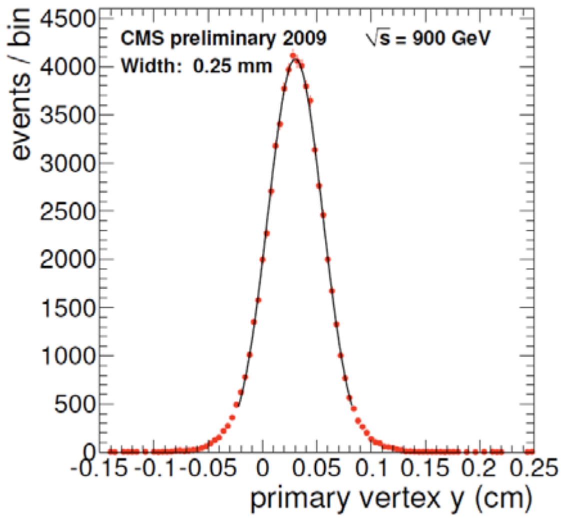
- Class |II: Correlations between particles
  - Two particle correlation
  - Bose Einstein Correlation
  - Studies are also based reference for PbPb collisions

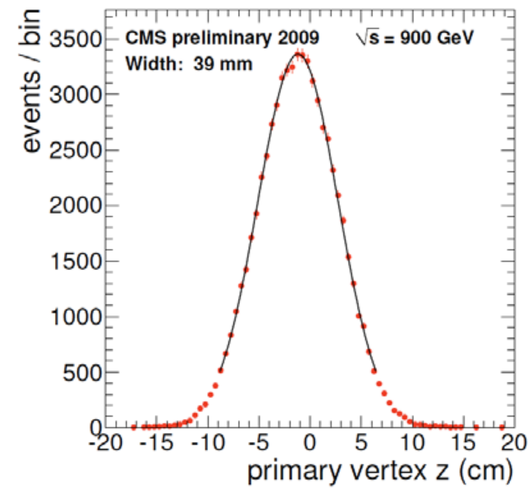
- Class III: Studying objects (Jet properties+dijet spectra etc..) and higher level studies => the plans and prospect for what is expected to come up……

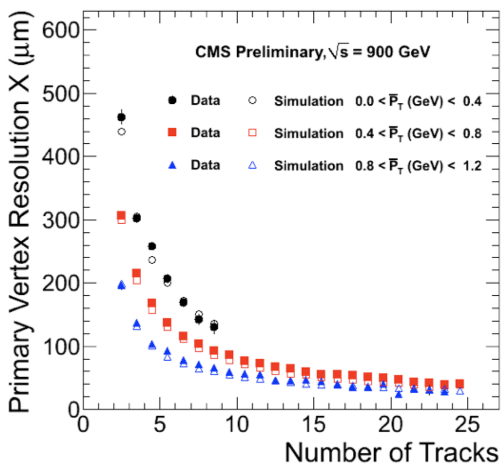
Tracker: Primary Vertex resolution

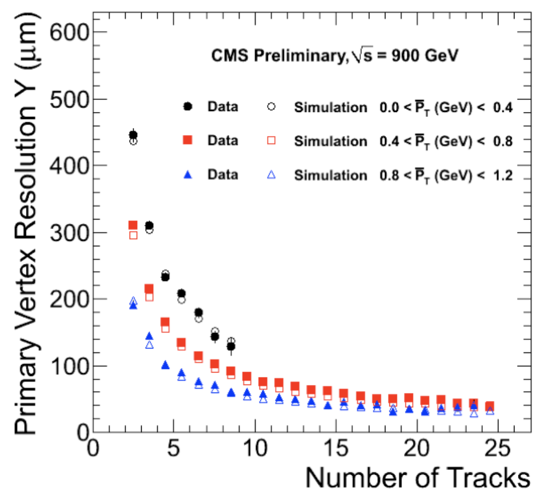
CMS-PAS-TRK-10-001

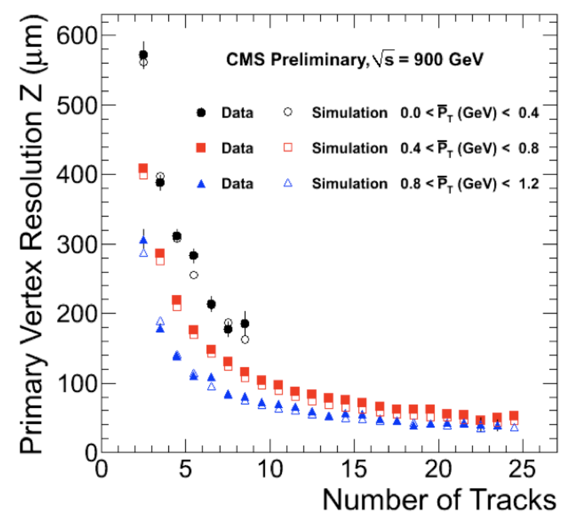








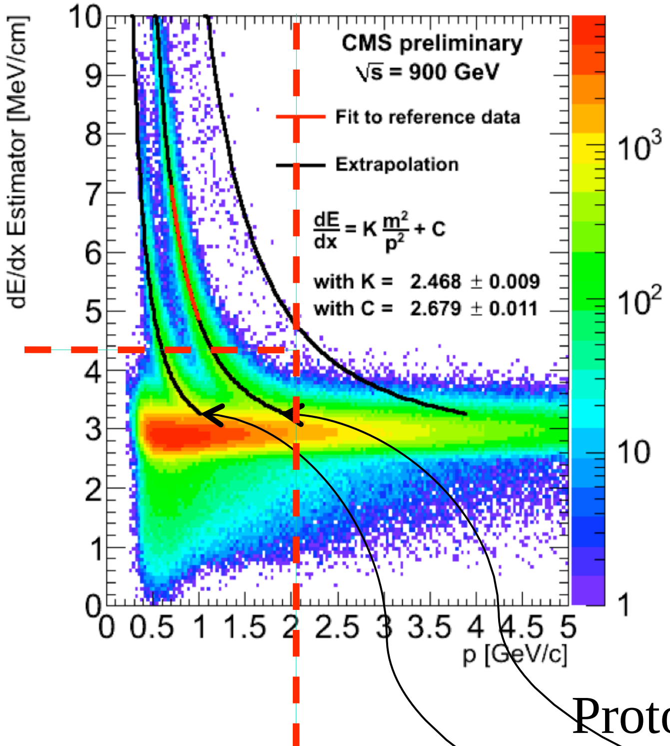




valerieh@princeton.edu

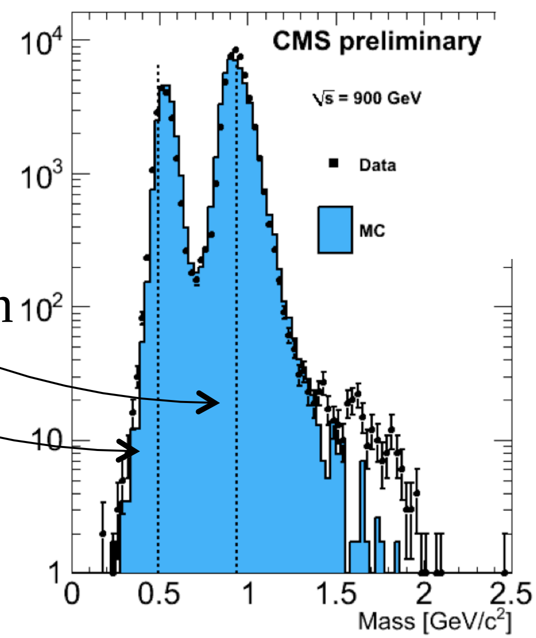
Tracker: Particle ID with dE/dx

Data

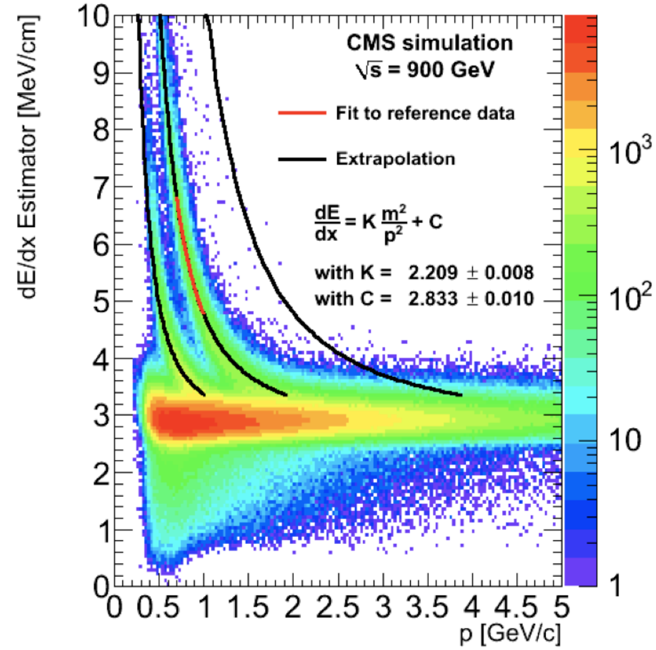


Mass of candidate can be obtained by

$$\frac{dE}{dx} = K\frac{m^2}{p^2} + C\,.$$



Simulation



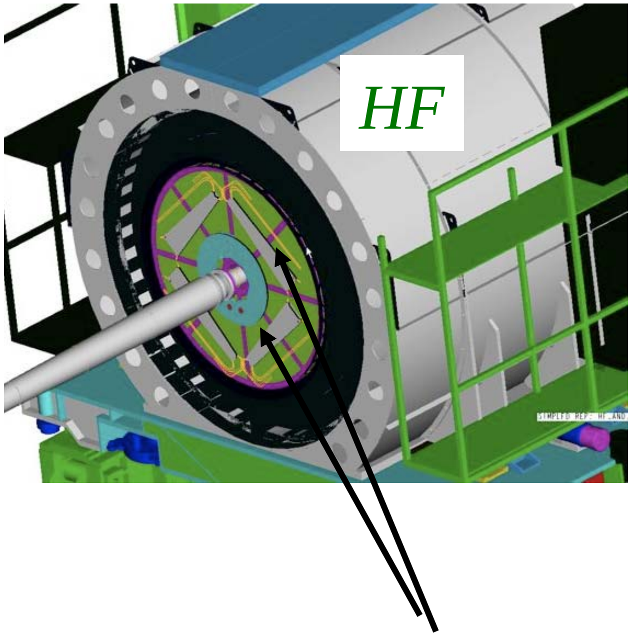
The resulting mass spectrum by inverting The estimator equation

$\sigma(P_t)/P_t \sim 0.7\%$ @ 1GeV

Min Bias Event Selection (Class I+II)

Online Trigger Selection:

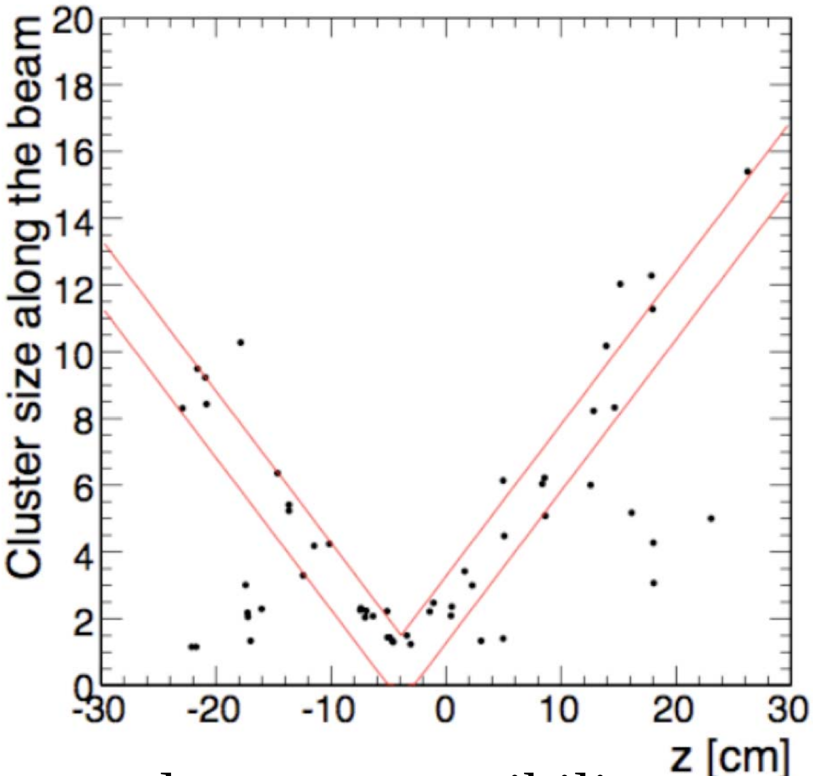
Any hit in the **B**eam **S**cintillator **C**ounters (**BSC**) AND a filled bunch passing the **B**eam **P**ickups **T**iming e**X**periment (**BPTX**)



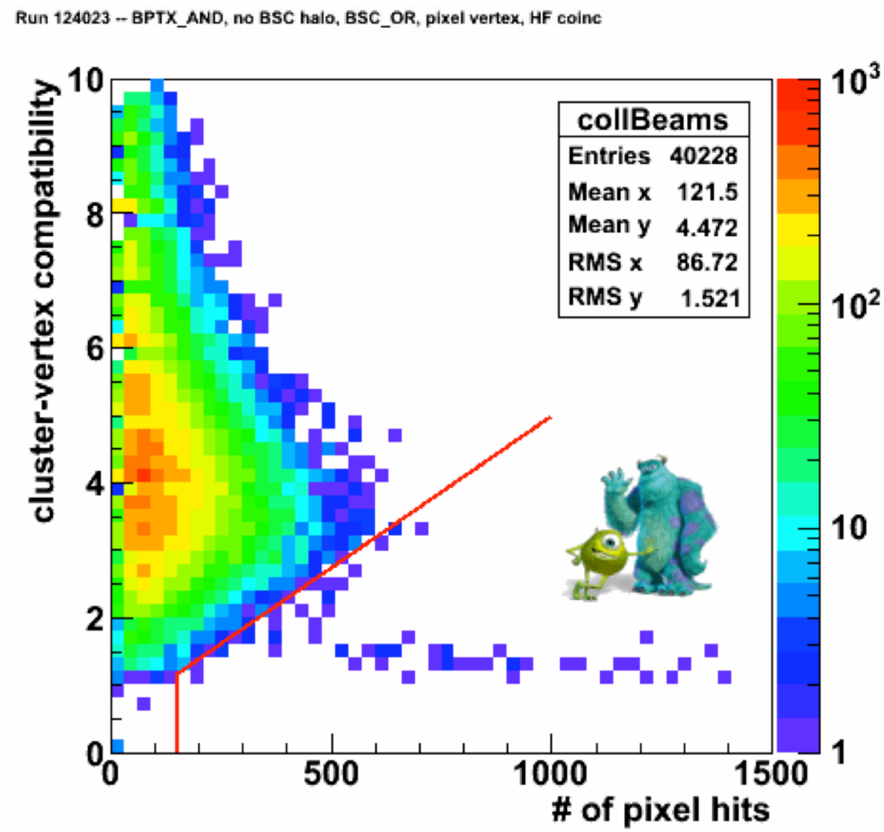
Offline event selection:

- >3 GeV total energy on both sides in the Forward Calorimeter (HF $2.9 < |\eta| < 5.2$)
- BPTX coincidence
- Beam Halo rejection (BSC)
- Dedicated beam background rejection
- Collision vertex

Rejecting Beam- Background Events



Vertex-cluster compatibility: Ratio of num clusters in the V shape and num clusters in the V-shape offset by 10 cm



Beam-scraping/gas events have a lot of pixel hits but ill-defined vertex

Class I: Single Particle Properties

- Transverse momentum and pseudorapidity distributions of charged particles at 7TeV (0.9TeV + 2.36TeV **JHEP02 (2010) 041), (7TeV paper accepted by PRL)**
- Observation of diffraction at 0.9TeV and 2.36TGeV **(CMS PAS FWD-10-001)**
- Measurement of the Underlying Event Activity at 0.9TeV **(CMS PAS QCD-10-001)**

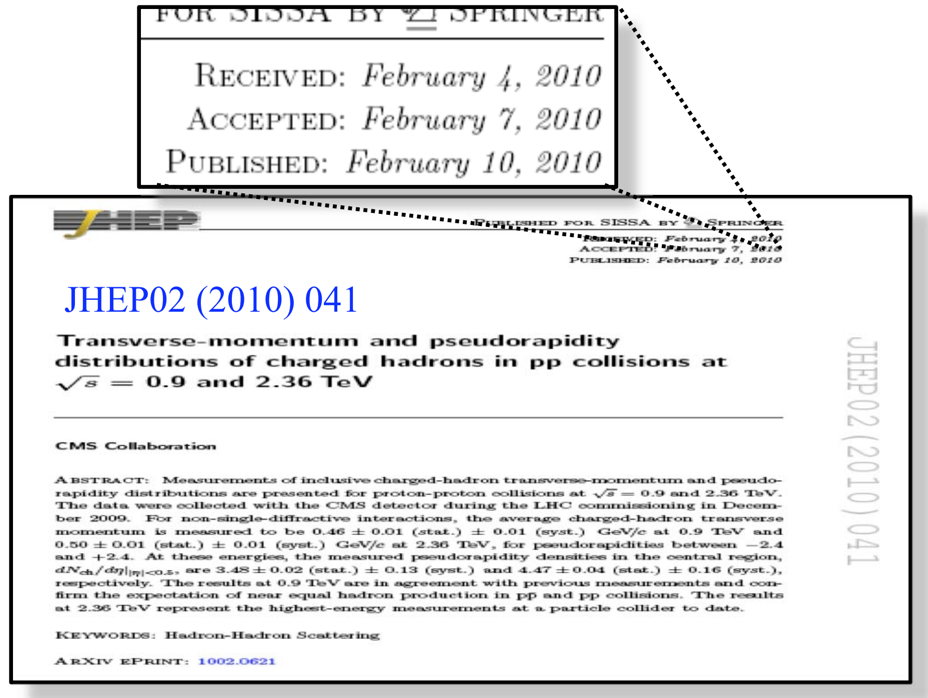
First Collisions at 7TeV

- Few minutes following March 30 2010 7 TeV collisions the first preliminary dN/dη results were ready

- The 7 TeV publication on dN/dη uses 1.1 μb^{-1} of data

[CMS PAS QCD-10-006, arXiv: 1005.3299] accepted by PRL

First Results from 2009 Collision data at 0.9TeV and 2.36TeV data published



FOR SISSA BY SPRINGER

RECEIVED: *February 4, 2010*
ACCEPTED: *February 7, 2010*
PUBLISHED: *February 10, 2010*

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JHEP02 (2010) 041

Transverse-momentum and pseudorapidity distributions of charged hadrons in pp collisions at $\sqrt{s}$ = 0.9 and 2.36 TeV

CMS Collaboration

ABSTRACT: Measurements of inclusive charged-hadron transverse-momentum and pseudorapidity distributions are presented for proton-proton collisions at $\sqrt{s} = 0.9$ and 2.36 TeV. The data were collected with the CMS detector during the LHC commissioning in December 2009. For non-single-diffractive interactions, the average charged-hadron transverse momentum is measured to be 0.46 ± 0.01 (stat.) ± 0.01 (syst.) GeV/c at 0.9 TeV and 0.50 ± 0.01 (stat.) ± 0.01 (syst.) GeV/c at 2.36 TeV, for pseudorapidities between −2.4 and +2.4. At these energies, the measured pseudorapidity densities in the central region, $dN_{ch}/d\eta|_{|\eta|<0.5}$, are 3.48 ± 0.02 (stat.) ± 0.13 (syst.) and 4.47 ± 0.04 (stat.) ± 0.16 (syst.), respectively. The results at 0.9 TeV are in agreement with previous measurements and confirm the expectation of near equal hadron production in p$\bar{p}$ and pp collisions. The results at 2.36 TeV represent the highest-energy measurements at a particle collider to date.

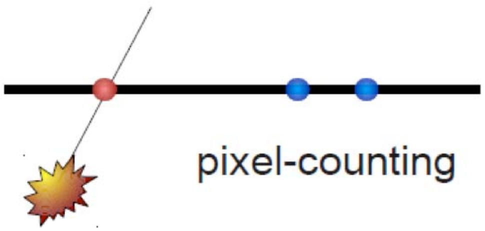
KEYWORDS: Hadron-Hadron Scattering

ARXIV EPRINT: 1002.0621

JHEP02(2010)041

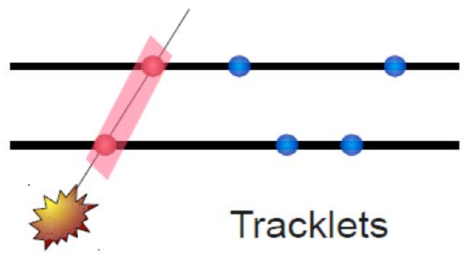
Three Methods for measuring $dN_{ch}/d\eta$

Pixel detector: *53.3cm long, 3 layers with radii: 4.4, 7.3, 10.2 cm*



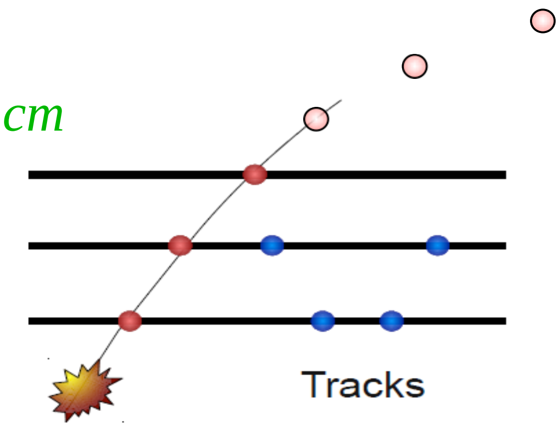
p_T > 30 MeV/c

Clusters per layer
$|\eta|<2$
3 measurements of $dN/d\eta$
Immune to mis-alignment
Simplest method
Requires noise-free detector



p_T > 75 MeV/c

2 of 3 pixel layers
$|\eta|<2$
3 measurements of $dN/d\eta$
Sensitive to mis-alignment



Over 50% Efficient for p_T > 0.1, 0.2, 0.3 GeV/c for π, K, p

Full tracks (pixel and strips)
$|\eta|<2.4$
$dN/d\eta$ and dN/dp_T
Sensitive to mis-alignment
Most complex

Results: Pt distribution at 7TeV 1/3

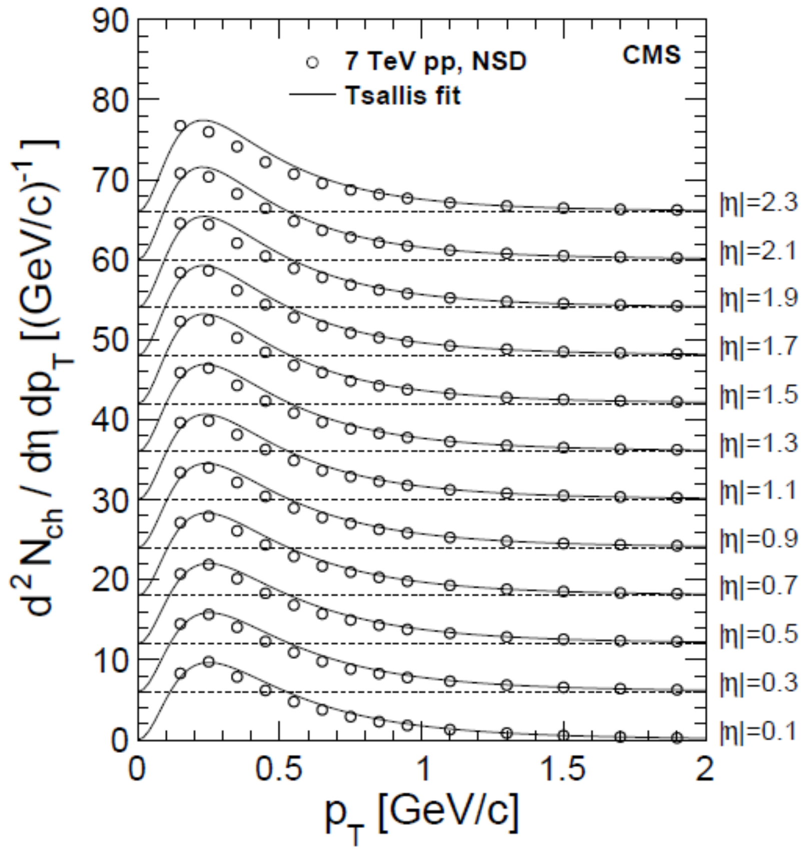
- Measured down to 150 MeV
- Fit with the Tsallis-function:

$$E\frac{d^3N_{ch}}{dp^3} = \frac{1}{2\pi p_T}\frac{E}{p}\frac{d^2N_{ch}}{d\eta dp_T} = C(n,T,m)\frac{dN_{ch}}{dy}\left(1+\frac{E_T}{nT}\right)^{-n}$$

Behavior of the function:

- Exponential at low p_T ~BBR
- Power-law at high p_T ~Hard parton-parton collision

<p_T> = 545 ±5(stat) ±15(syst) MeV/c



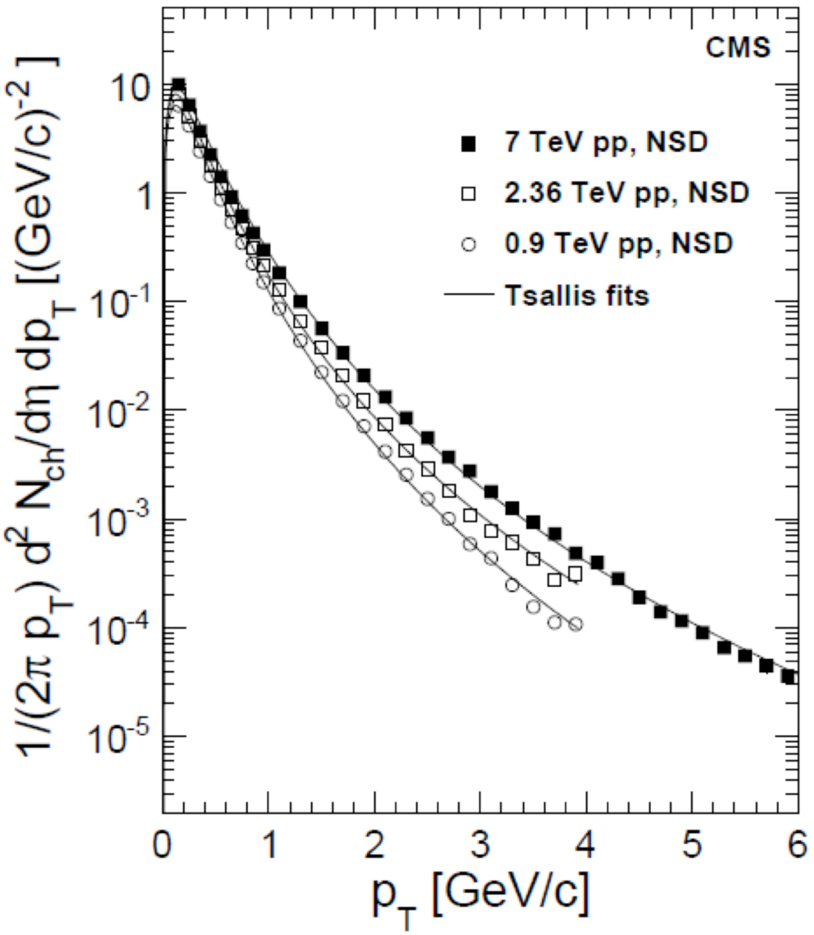
Differential yield of charged hadrons in the range |η|<2.4 in 0.2 η bins. η bins are shifted by six units vertically.

Results: Pt Distribution at 7TeV 2/3

- The transverse-momentum distribution of charged hadron was measured up to 6 GeV/c.

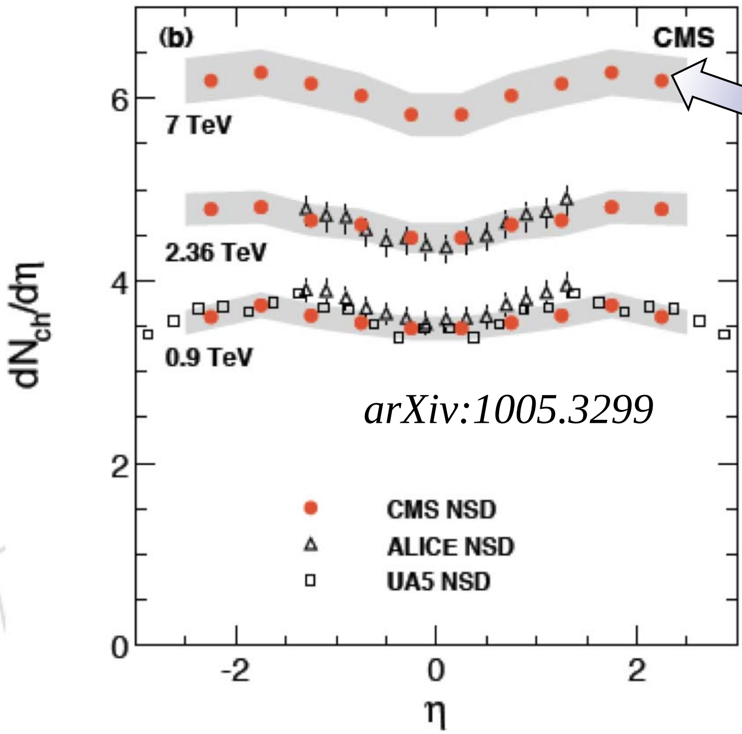
- Well described by the Tsallis function combining a low-p_T exponential with a high-p_T tail

- With increasing energy, the p_T-spectrum gets "harder" (as expected)



Measured yield of charged hadrons for $|\eta| < 2.4$, fit with the Tsallis function.

Results: dN/dη 3/3



First published dN/dη distribution at 7 TeV

dN/dη (|η|<0.5) = **5.78** ± 0.01(stat) ± 0.23(syst)

Increase from 0.9 TeV → 7 TeV:

(66.1 ± 1.0(stat) ± 4.2(syst))%

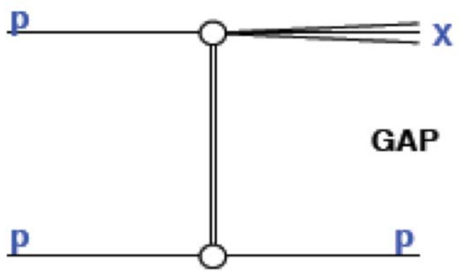
$dN_{ch}/d\eta$ distributions averaged over the cluster counting, tracklet and global track methods and symmetrized in η. The shaded band represents systematic uncertainties.

Observation of diffractive Events

PAS FWD-10-001

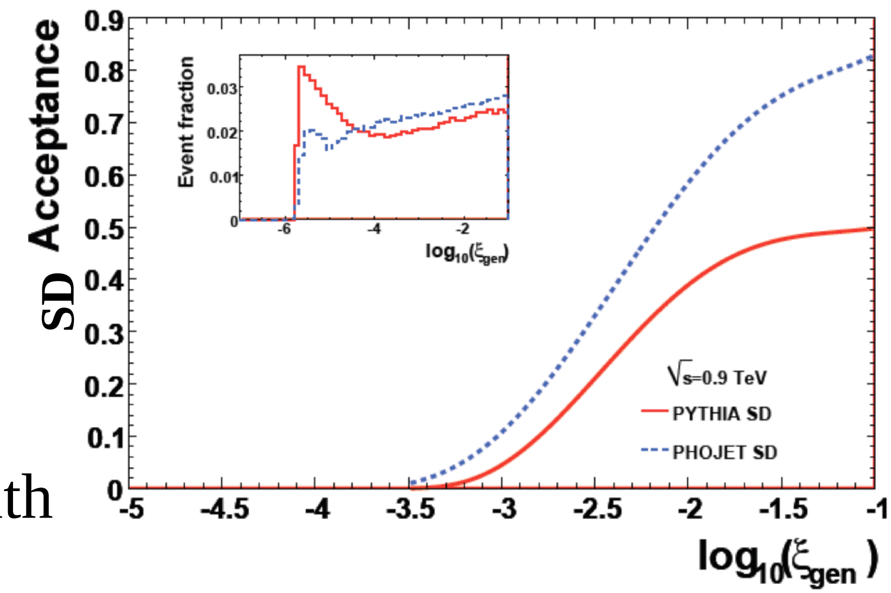
0.9Tev, 2.36TeV

Colorless exchange with the vacuum quantum numbers → final states separated in rapidity



ξ = Mx/s: The fractional energy loss of the scattered proton

- Acceptance for single diffractive events is high enough to clearly observe them at LHC
- The acceptance is clearly model-dependent (event multiplicity and topology)
- The CMS calorimeters are used with coverage of -5<η<5



Result: Observation of SD events 1/2

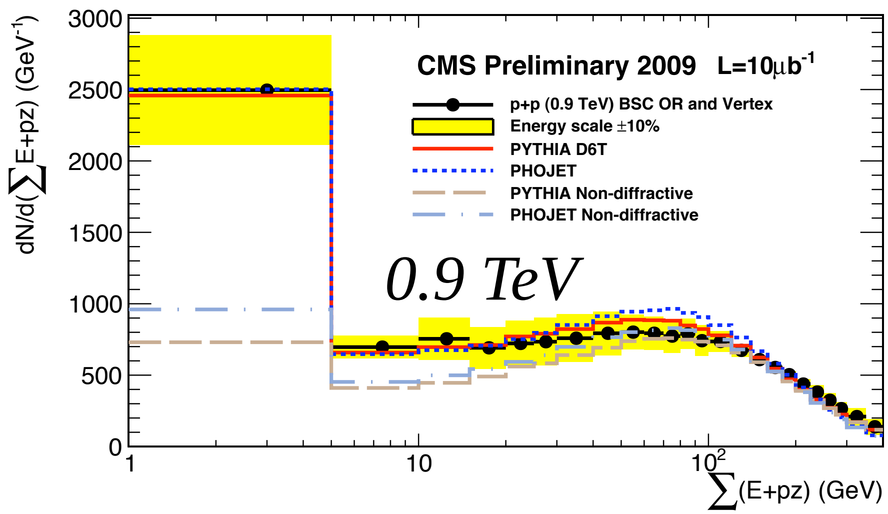
Variable used: $(E+p_z) = E(1+\cos\theta) = (p_T e^{\eta})$

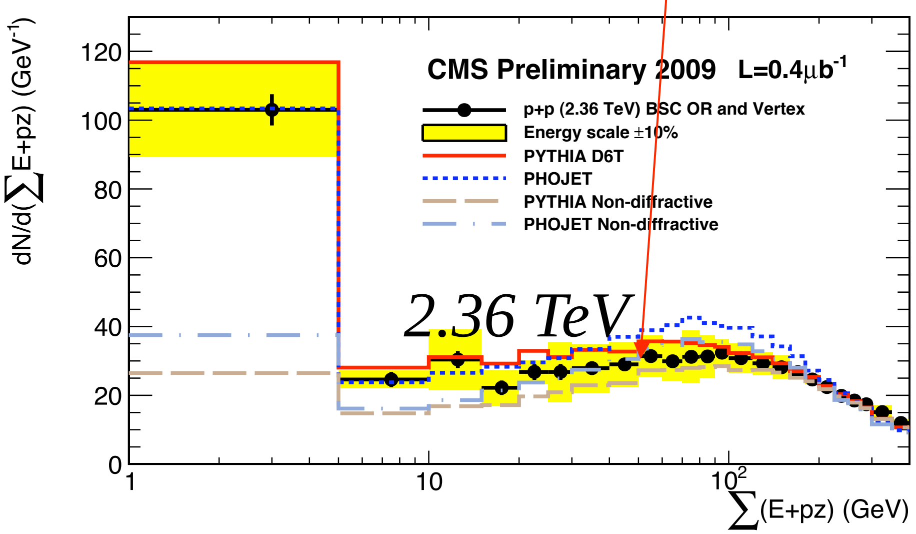
The sum runs over the full calorimeter acceptance

Events below 5 GeV are mainly SD type:

almost no forward energy on the +z side

PYTHIA describes the ND part better than PHOJET



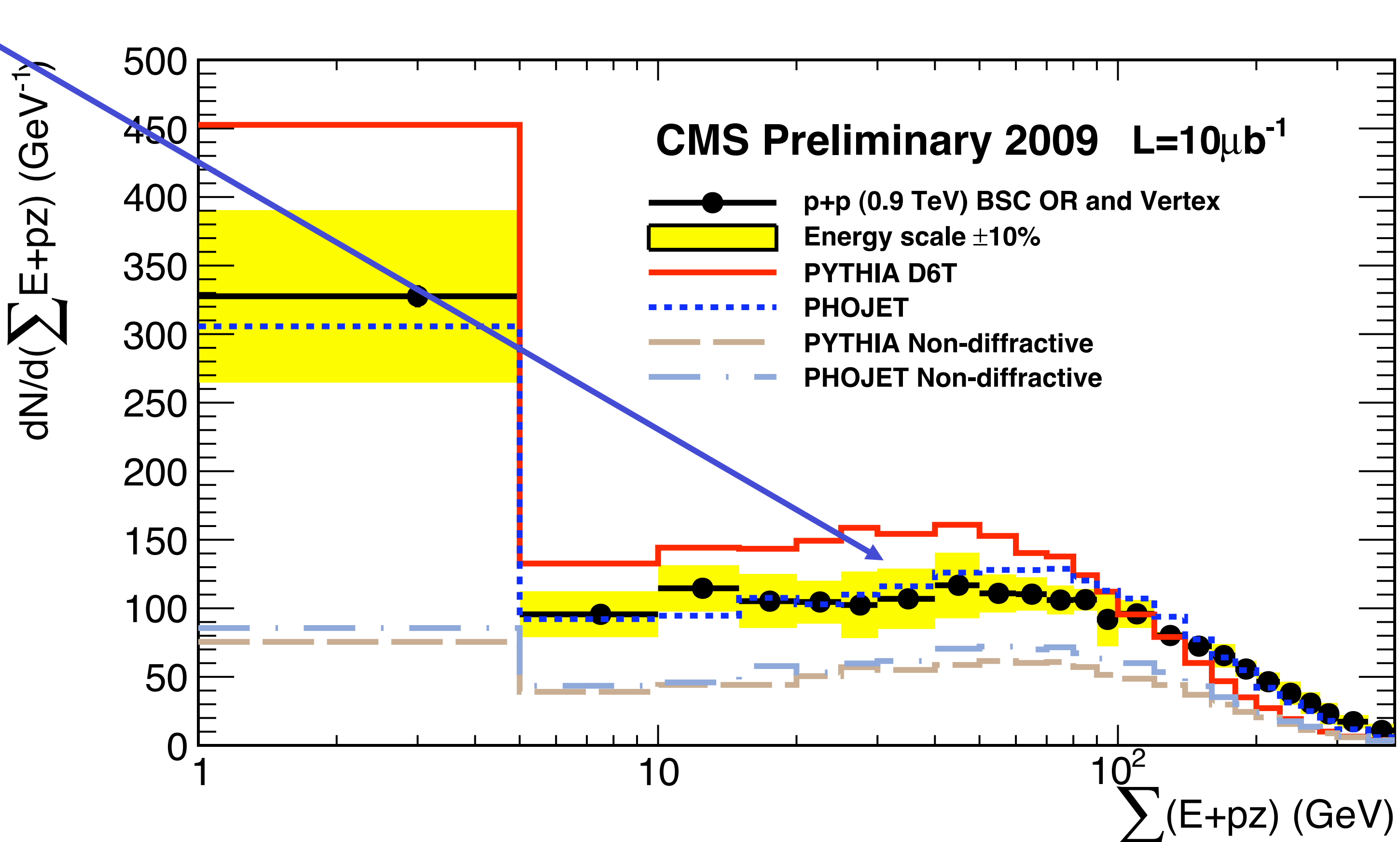


Results: Observation of SD events 2/2

Enhancing SD events:

E_{HF-}<8 GeV was required (LRG over HF-)

PHOJET agrees better with the data (for high-mass SD)

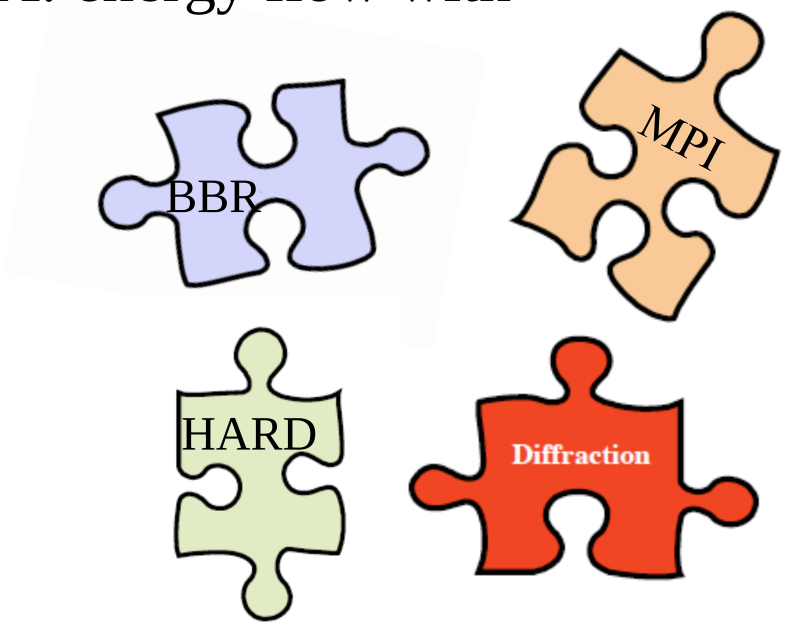


To Summarize

- Pythia describes fairly well the ND component
- Phojet describes the diffractive part fairly well
- Similar results at 7TeV to appear soon

Coming Up:

- Results to compare with HERA: energy flow with additional hard QCD scale
- Analysis of forward jet
- …

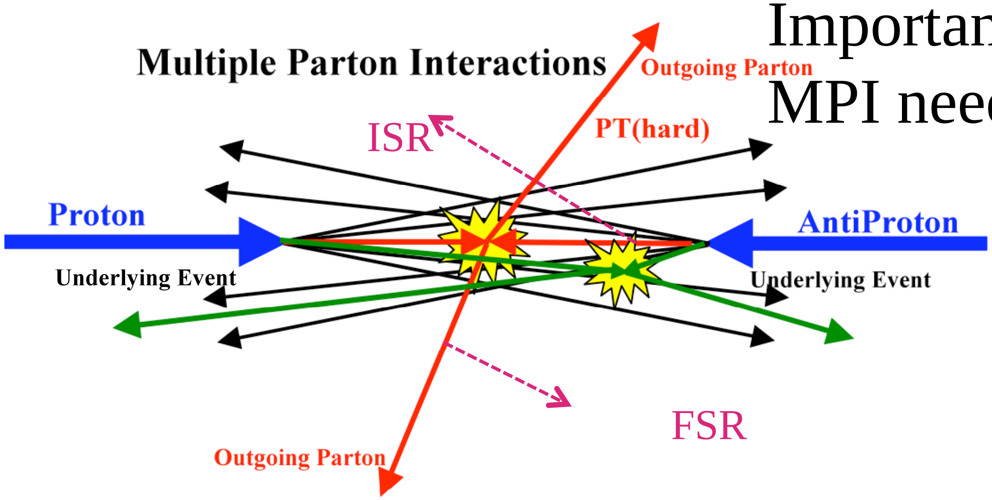


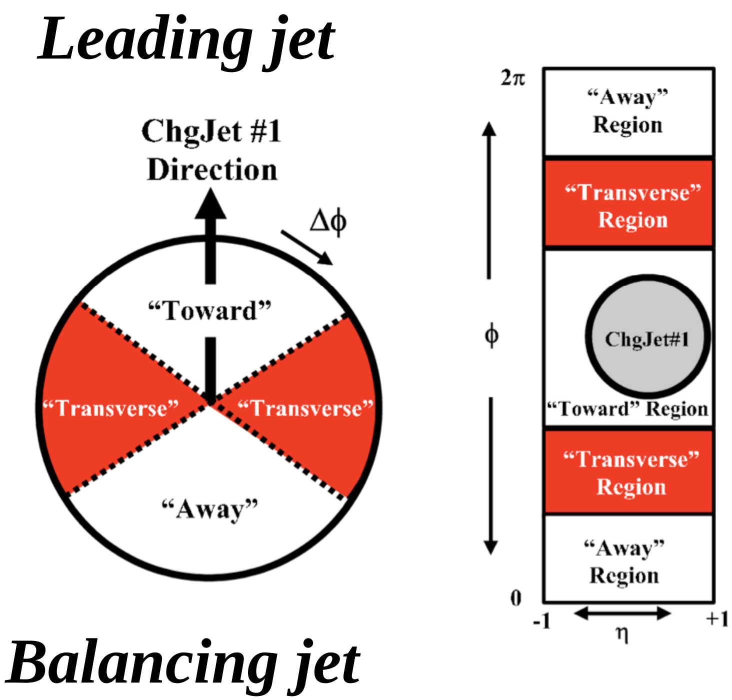
valerieh@princeton.edu

The Underlying Event for √s =900GeV

CMS PAS QCD-10-001

Understand Soft non pertubative regime
Important High pile up
MPI needed to explain distributions



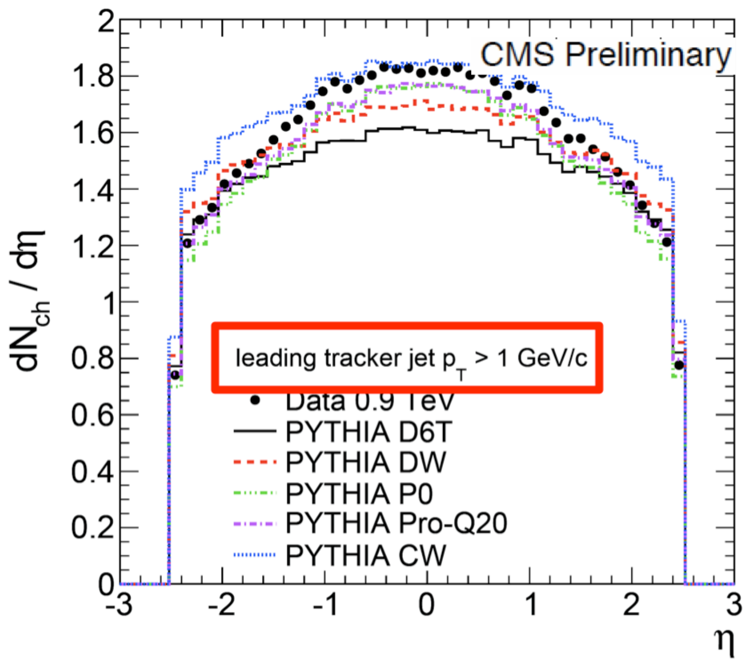


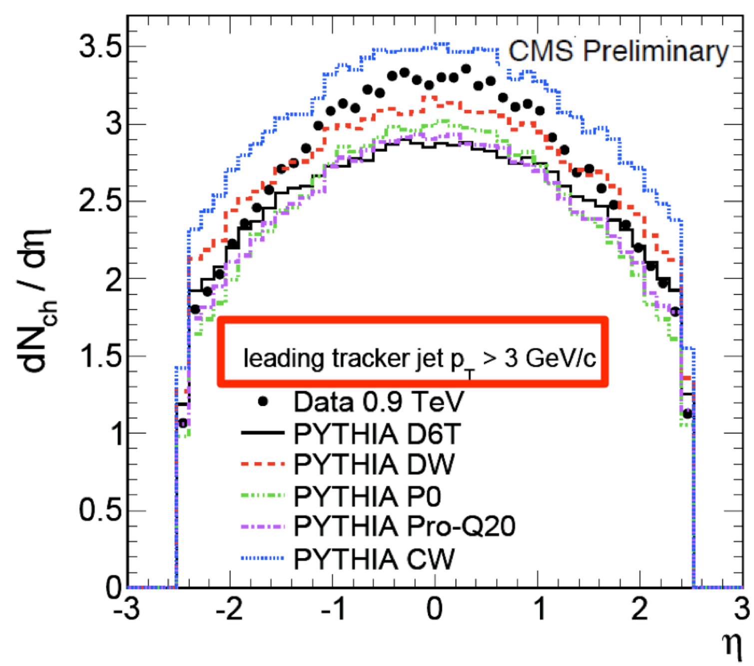
Measurement possibility:
Charged particle density and pT and Pt Sum distribution in transverse region of leading jet of charged particles

Charged Particle Density

Average multiplicity per unit psoeudorapidity

Higher minimum pT ==> higher densities



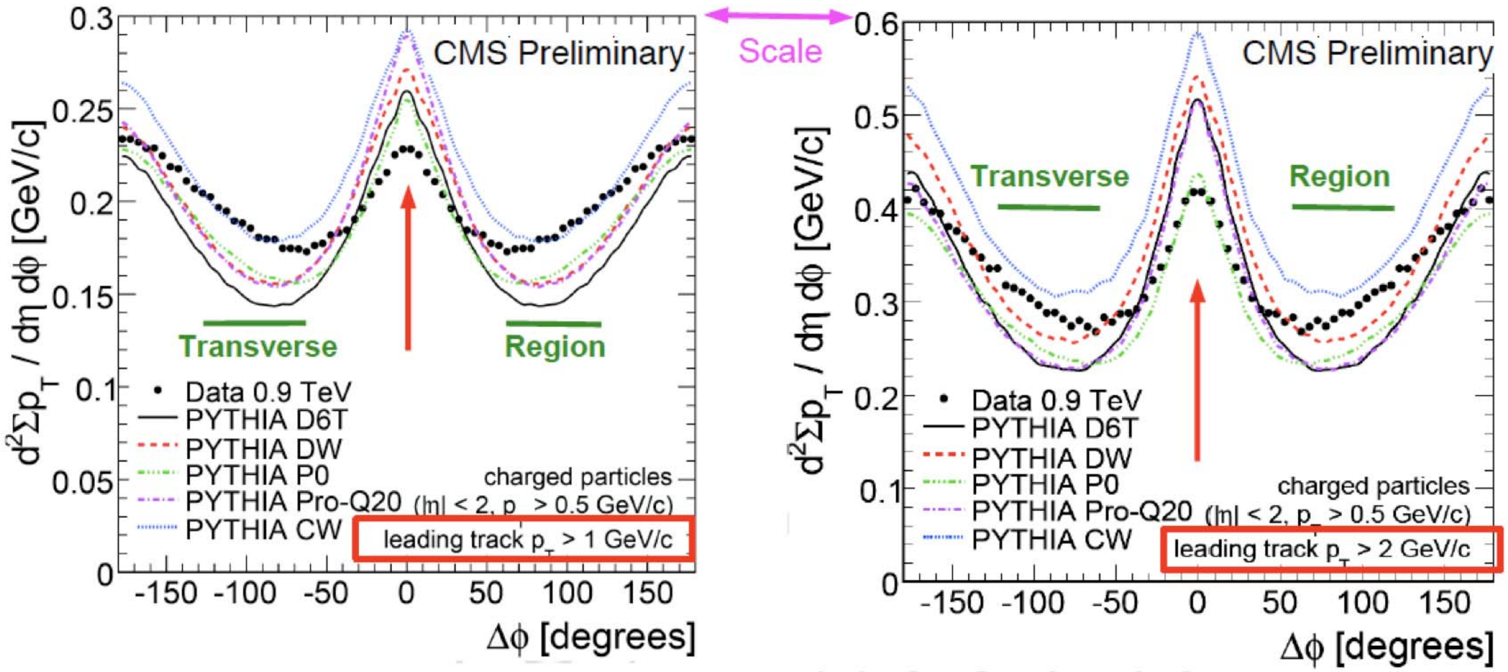


All tracks with Pt> 0.5GeV ! Not only transverse region,

Distribution in Δφ

Sum pT density versus azimuthal angle with respect to leading object

Leading track or jet not included!



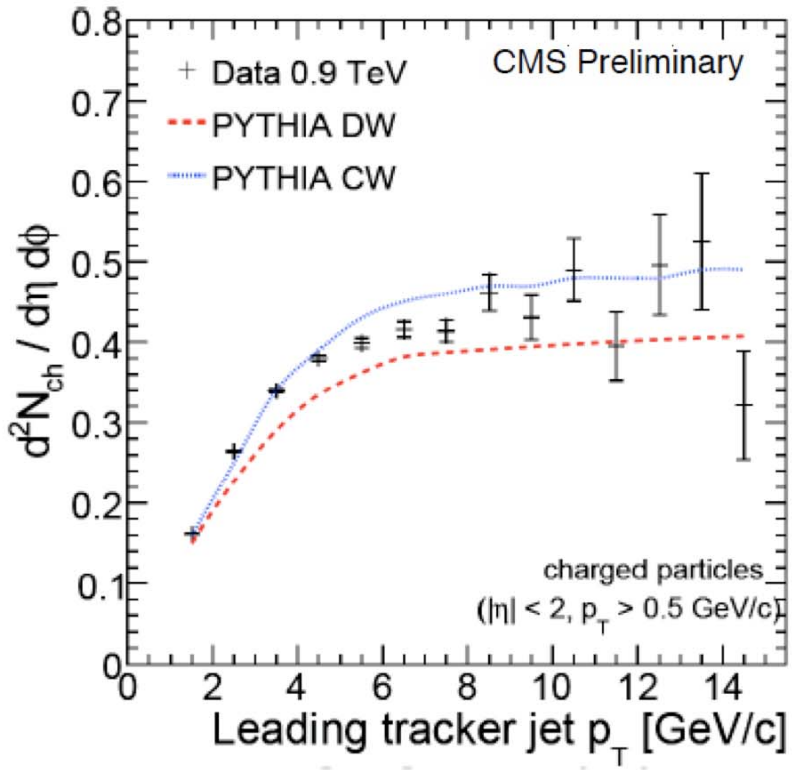
Perugia-0 (P0) good along the leading track direction.

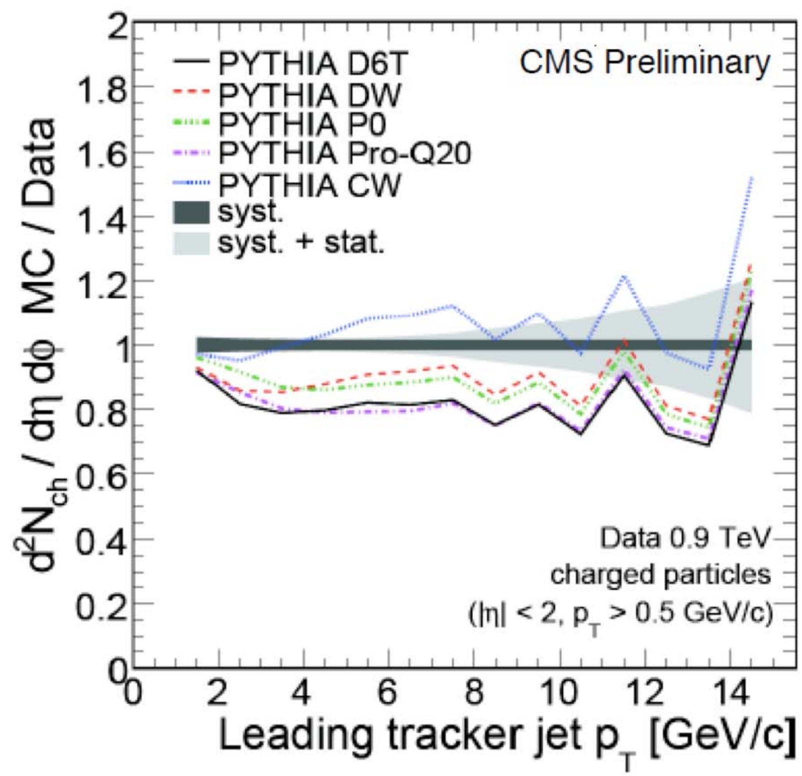
•DW and CW better in the transverse region.

•Other tunes too low in transverse region

Compatibility of Model with Data 1/4

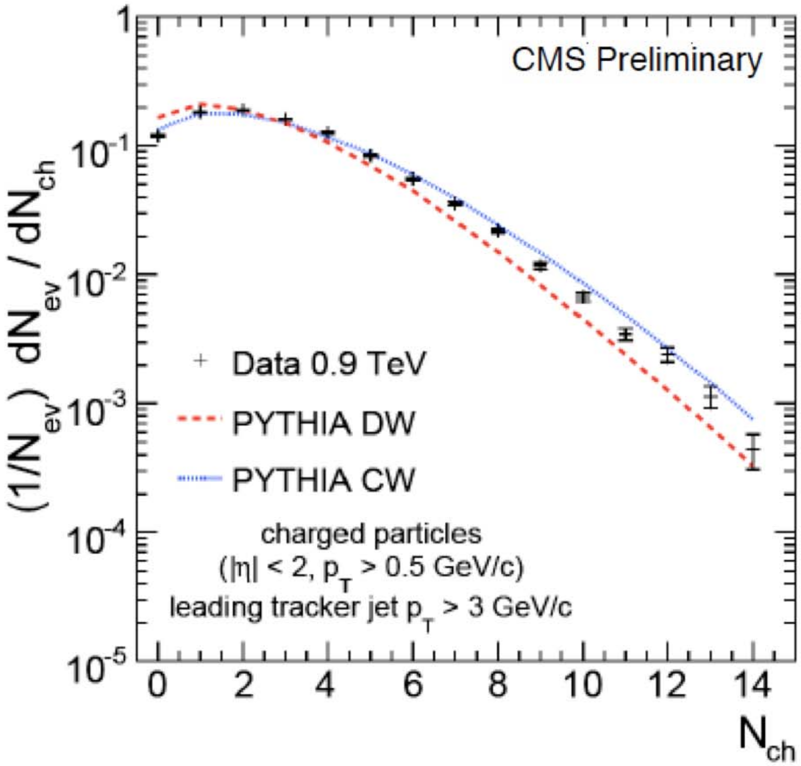
Charged particle density in **transverse region** versus event pT scale

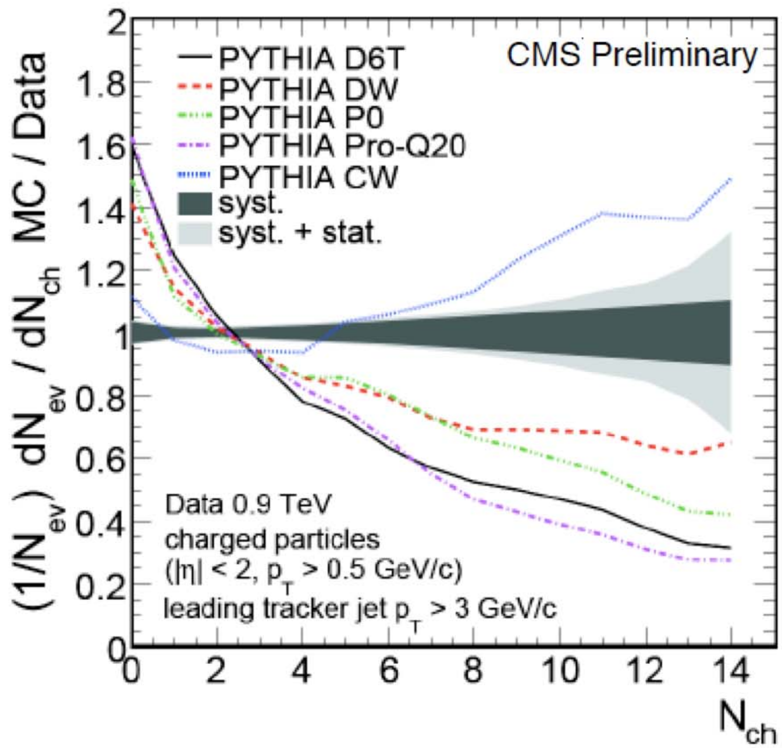




Compatibility of Model with Data 2/4

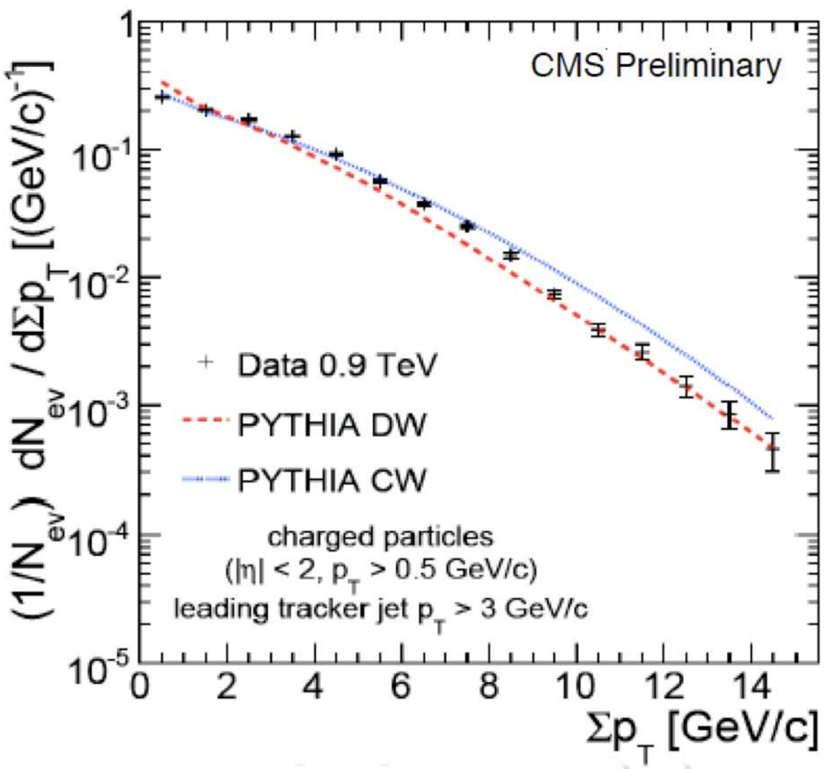
Multiplicity of charged particles in transverse region

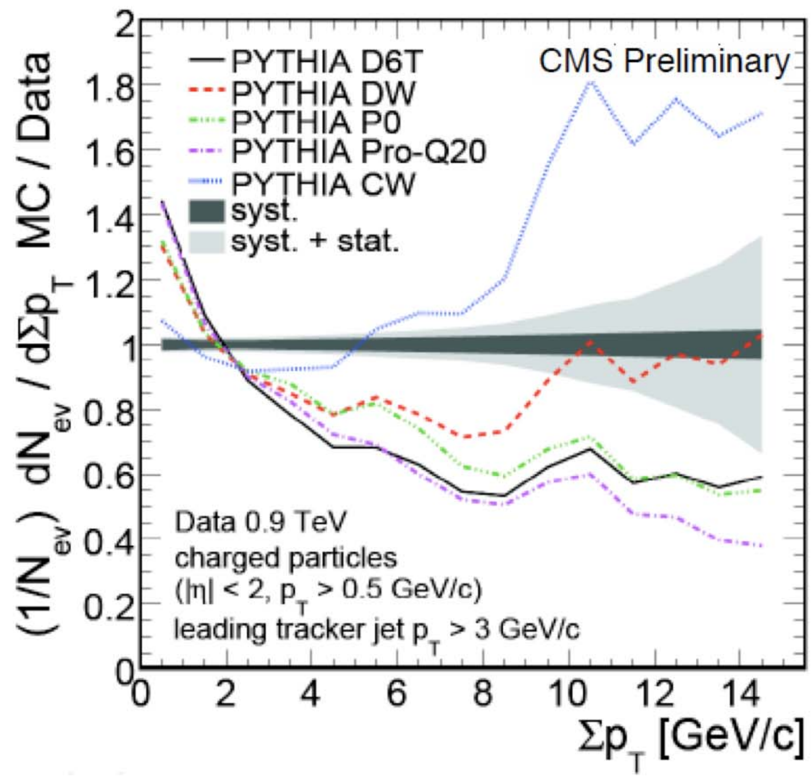




Compatibility of Model with Data 3/4

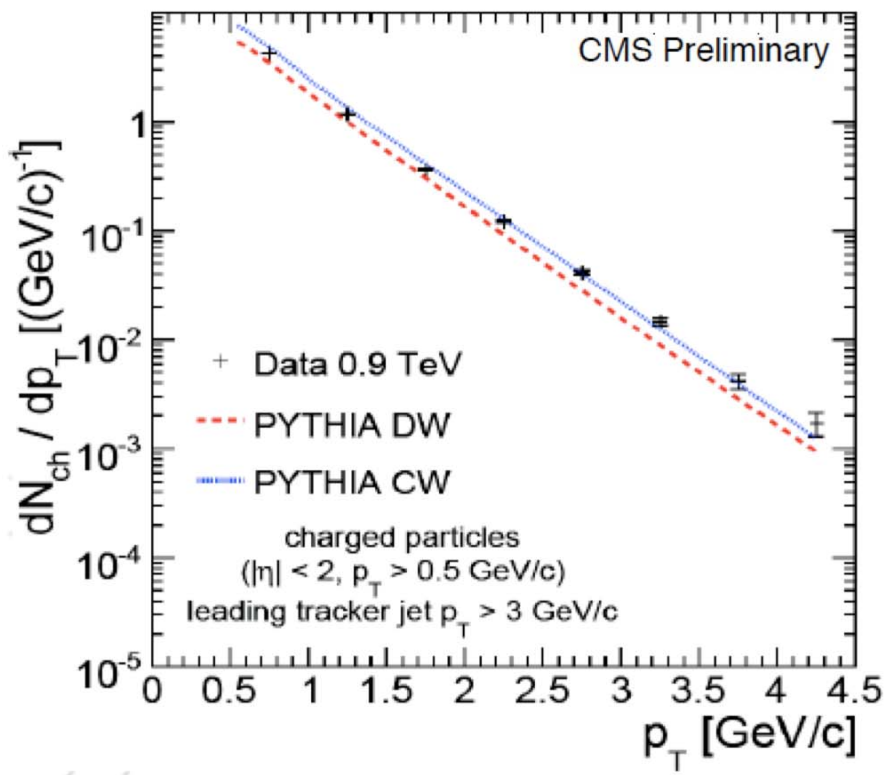
Sum pT distribution of charged particles in transverse region

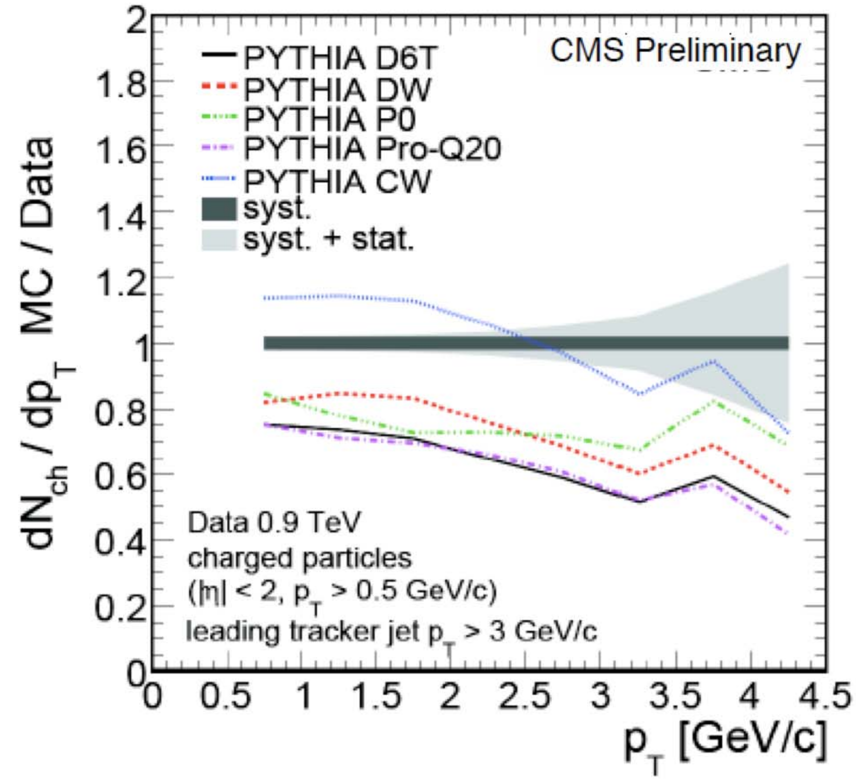




Compatibility of Model with Data 4/4

PT distribution of charged particles in transverse region





Which Tune to use ? Outlook

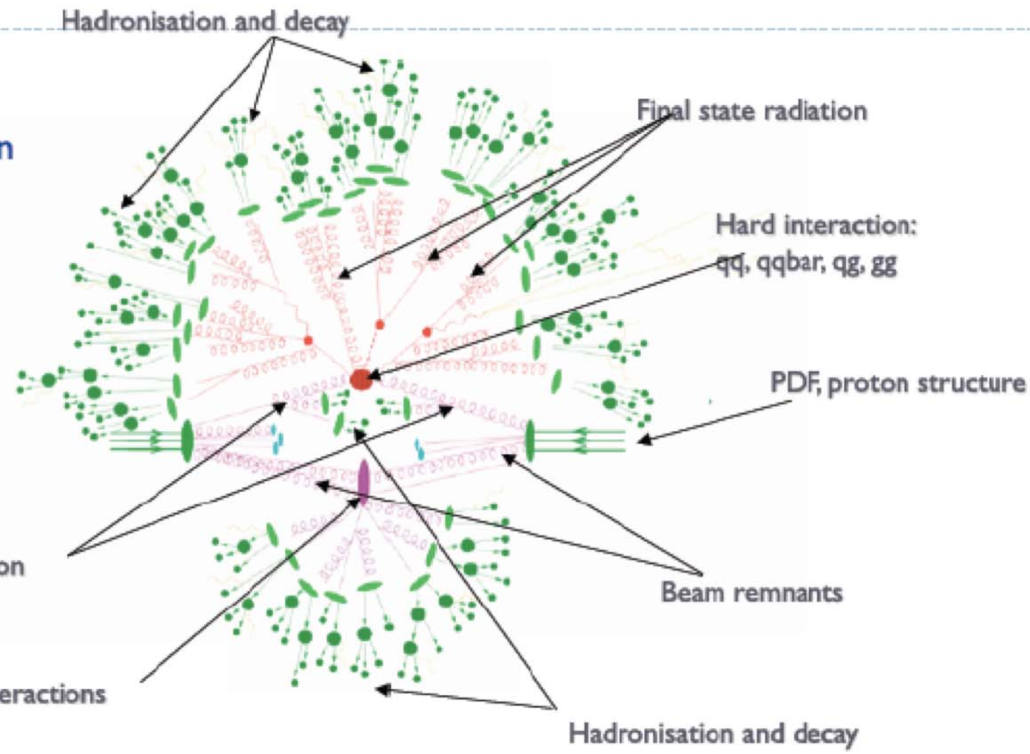
- For the 900 GeV the predictions were ~10% low and can be tuned easily to agree with the 900GeV /7TeV and Tevatron. (see X1(Rick Field, TuneAMBT1 from Atlas.
- The measurements exhibit a preference for higher values of the energy dependence, i.e. $\varepsilon = 0.25$ (as in tune DW) or 0.30 (as in tune CW) and over $\varepsilon = 0.16$ (original Atlas tune)
- Lower values of 0.16 as in tune D6T are disfavored
- The analysis on 7 TeV data as well as corrections for detector effects are ongoing hopefully by ICHEP
- An investigation of the UE with the new jet area/median approach is in progress
- The goal is to produce corrected data for all center of mass
- To test the UE modeling is universal: for example for Z boson

Class II – Correlations in Data

- Inclusive Two Particle Correlations
  - **[CMS PAS QCD-10-002]**
- Bose-Einstein correlations
  - **[CMS-QCD-10-003 ; CERN-PH-EP-2010-010, arXiv: 1005.3294.]**

Motivation : Inclusive Two particle Correlation

The MC description of LHC events is tremendously complex



Shed light on the
the underlying particle production mechanism
since it probes
the connections among various pieces produced in a hadronic collision

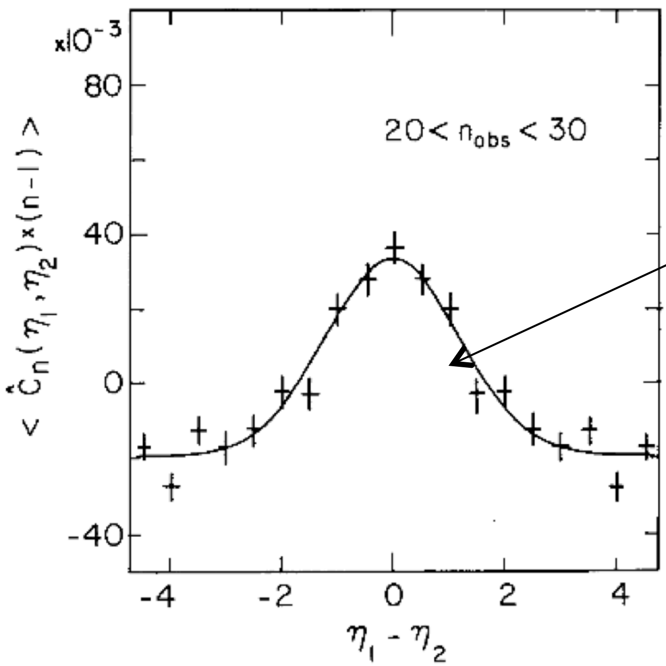
This is a schematization to be able to cut down the problem in pieces and model them in a different way. The "pieces" are correlated !

MCnet workshop

Inclusive Two Particle Correlation

UA5: ppbar 540GeV

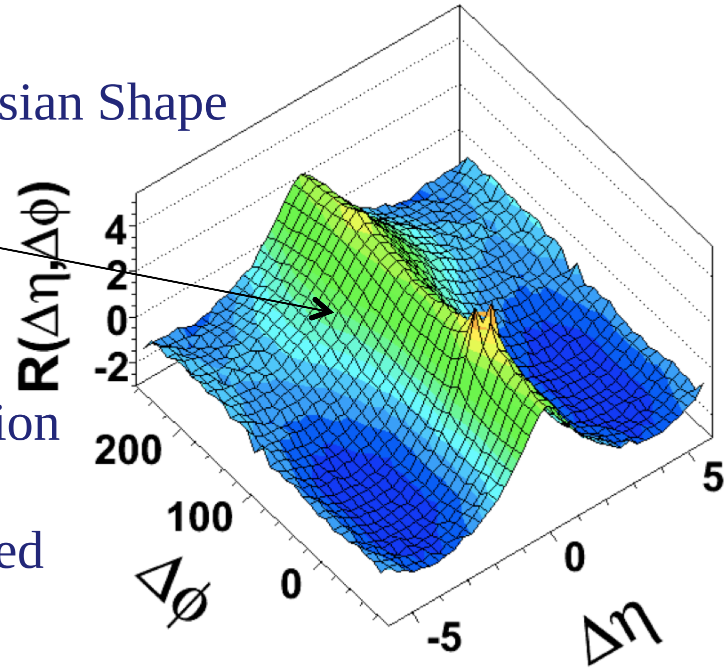
PHOBOS pp 200GeV



Observe Gaussian Shape in relative η

➡called short range correlation

ICM is assumed



UA5: Phys.Lett.B123:361,1983

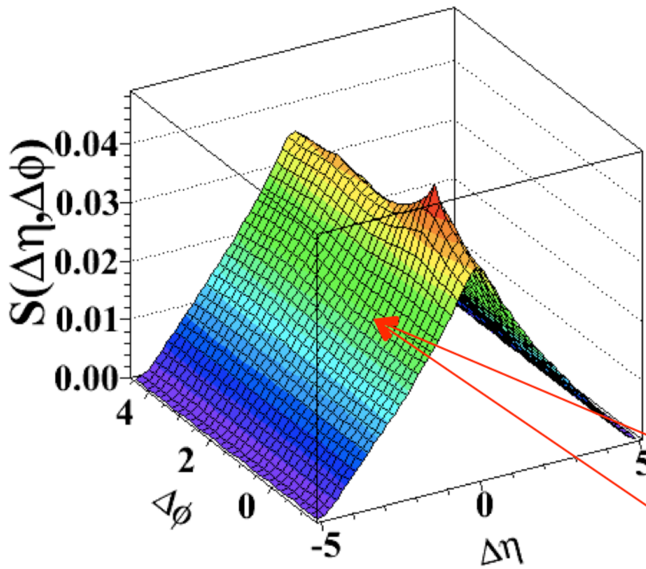
Phys. Rev. C75, 054913 (2007)

- *Phys. Rev. C81, 024904 (2010) (heavy ion)*

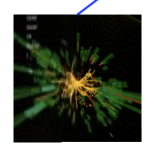
Property of the underlying particle production mechanism

Analysis Method

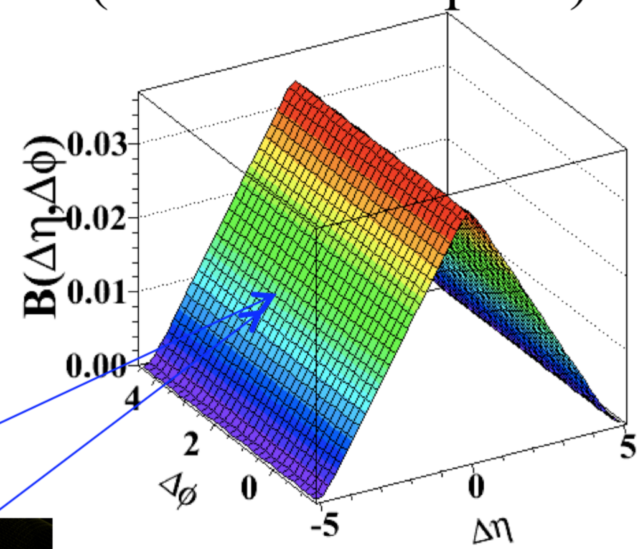
Signal distribution:
(correlated+uncorrelated pairs)



Aim: measure size and width of the cluster



Background distribution:
(uncorrelated pairs)



Density of pairs:

$$S_N(\Delta\eta,\Delta\phi) = \frac{1}{N(N-1)}\frac{d^2N^{\text{signal}}}{d\Delta\eta d\Delta\phi}$$

$$\Delta\eta = \eta_1 - \eta_2,$$
$$\Delta\varphi = \varphi_1 - \varphi_2$$

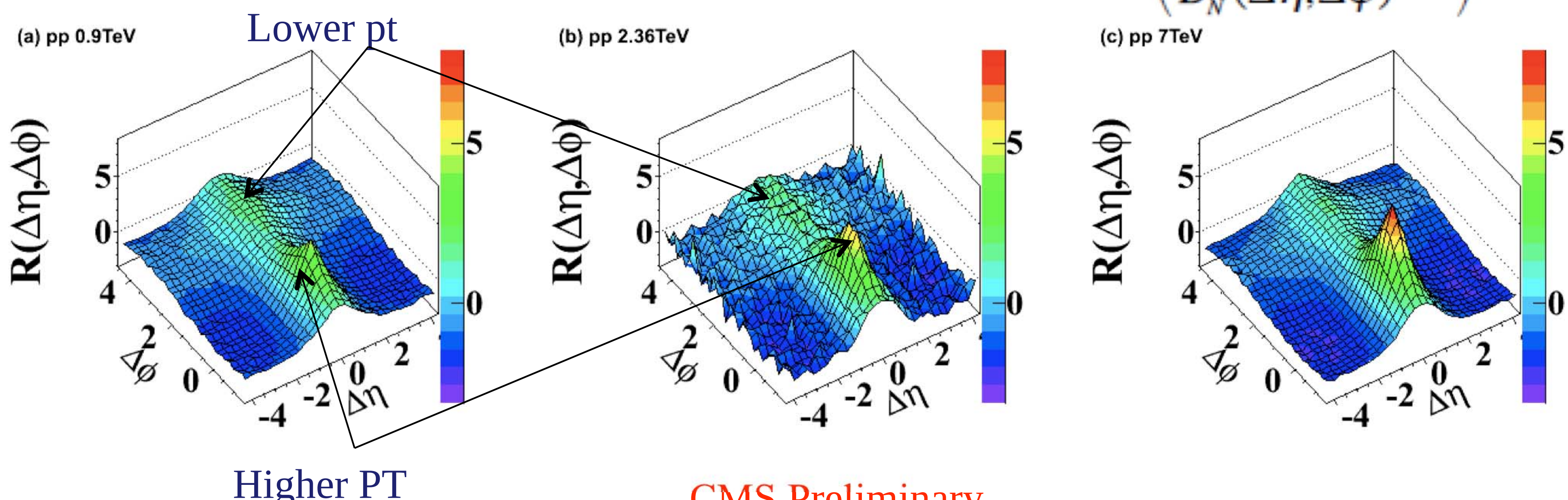
$$B_N(\Delta\eta,\Delta\phi) = \frac{1}{N^2}\frac{d^2N^{\text{mixed}}}{d\Delta\eta d\Delta\phi}$$

Mix events with similar vertex and multiplicity

Two Particle Correlation Function

Final results of data in 2D

$$R(\Delta\eta,\Delta\varphi) = \left\langle (N-1)\left(\frac{S_N(\Delta\eta,\Delta\varphi)}{B_N(\Delta\eta,\Delta\varphi)} - 1\right)\right\rangle_{evt}$$



CMS Preliminary
PAS QCD-10-02

$|\eta|<2.4$
$p_T>0.1$GeV/c

Qualitative features:

- Gaussian-like in Δη, broader at larger Δφ.
- Near-side peak (small Δη and Δφ) enhanced at higher energy

Quantify clustering properties with data

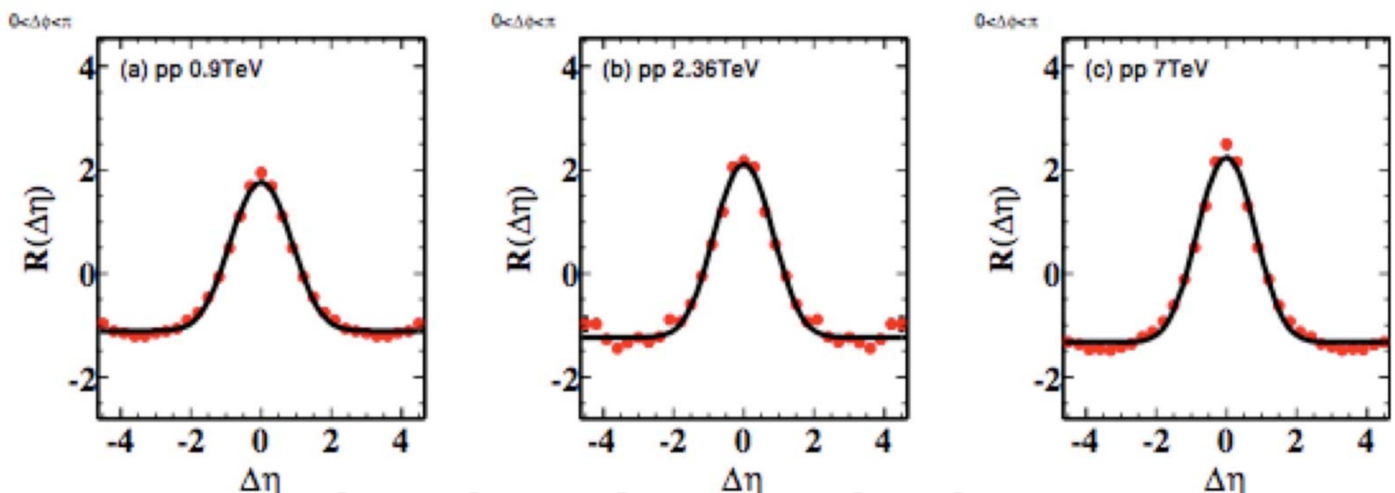
- Cluster parameterization:

K. Eggert et al.,
Nucl. Phys. B 86:201, 1975

$$R(\Delta\eta) = (K_{eff} - 1)\left[\frac{\Gamma(\Delta\eta)}{B(\Delta\eta)} - 1\right] \quad \Gamma(\Delta\eta) \propto \exp\left(-\frac{(\Delta\eta)^2}{4\delta^2}\right)$$

Effective Cluster Size

Cluster Width

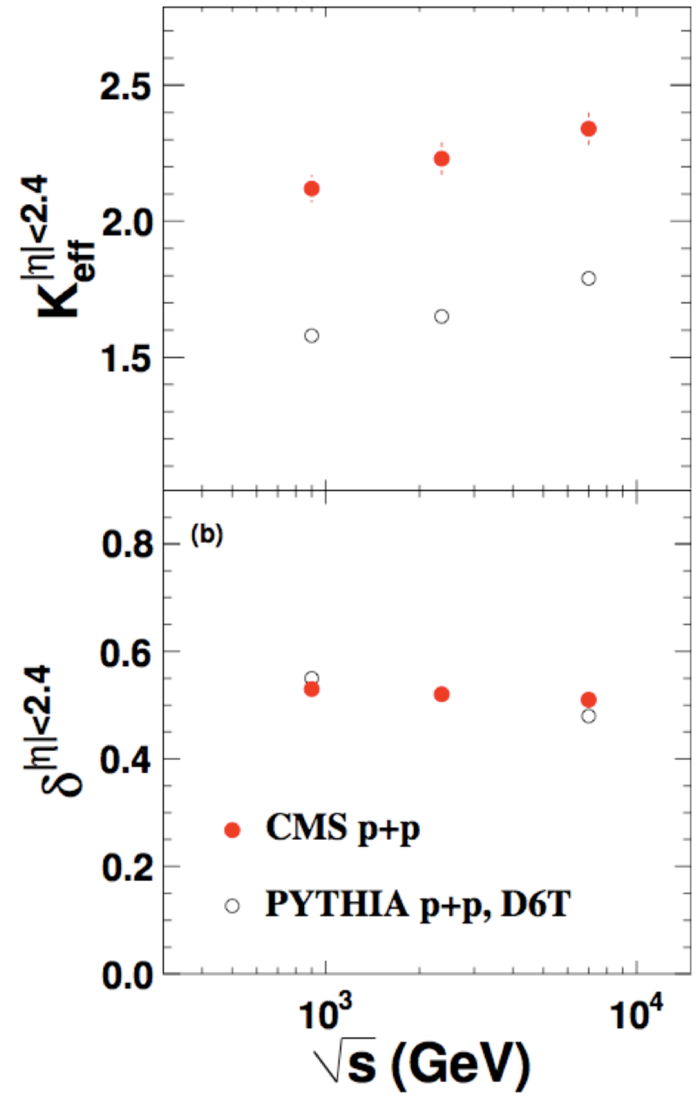


On average, every 2-3 charged particles are produced in a correlated fashion like a cluster.

Results

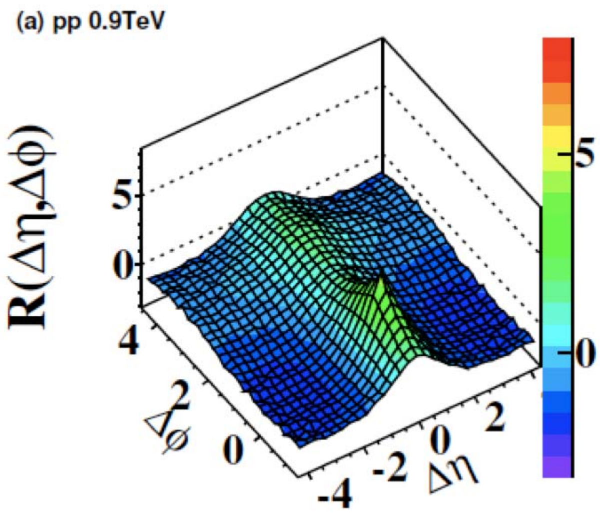
Energy dependence of cluster properties

$|\eta|<2.4$
$p_T>0.1GeV/c$



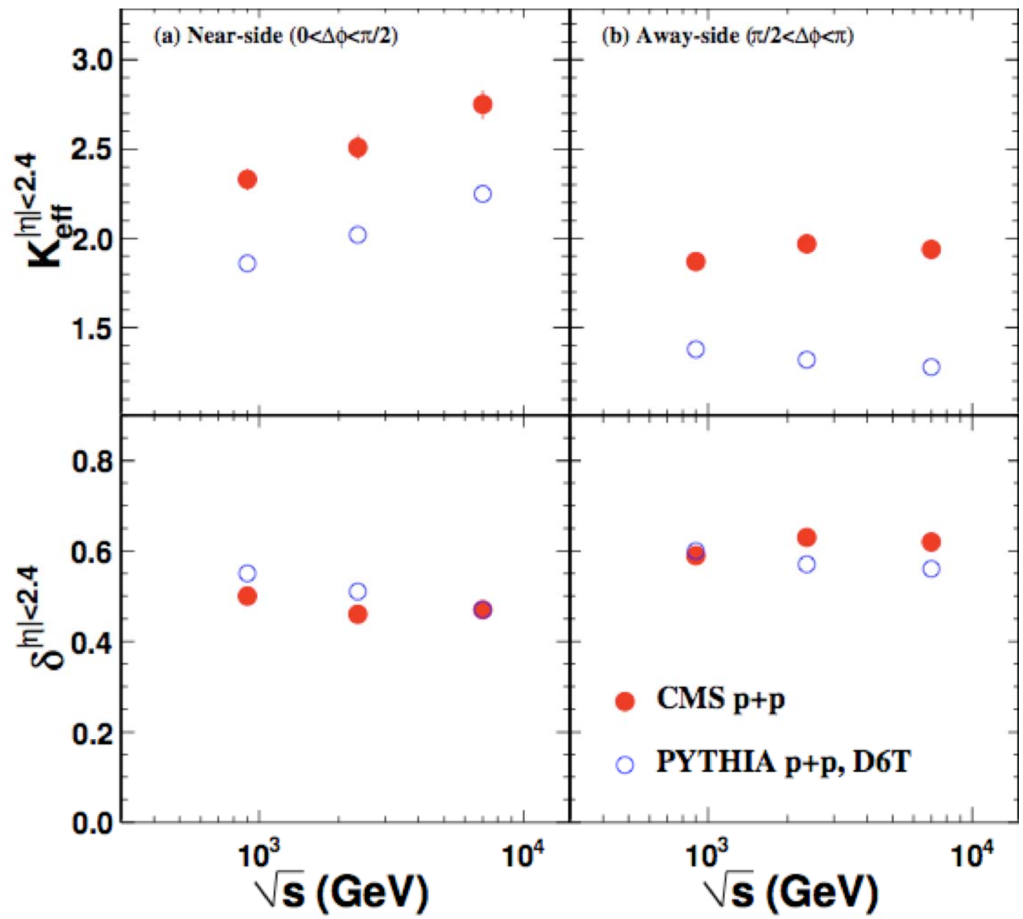
Near and away-side correlations

Average in sub-regions of Δφ



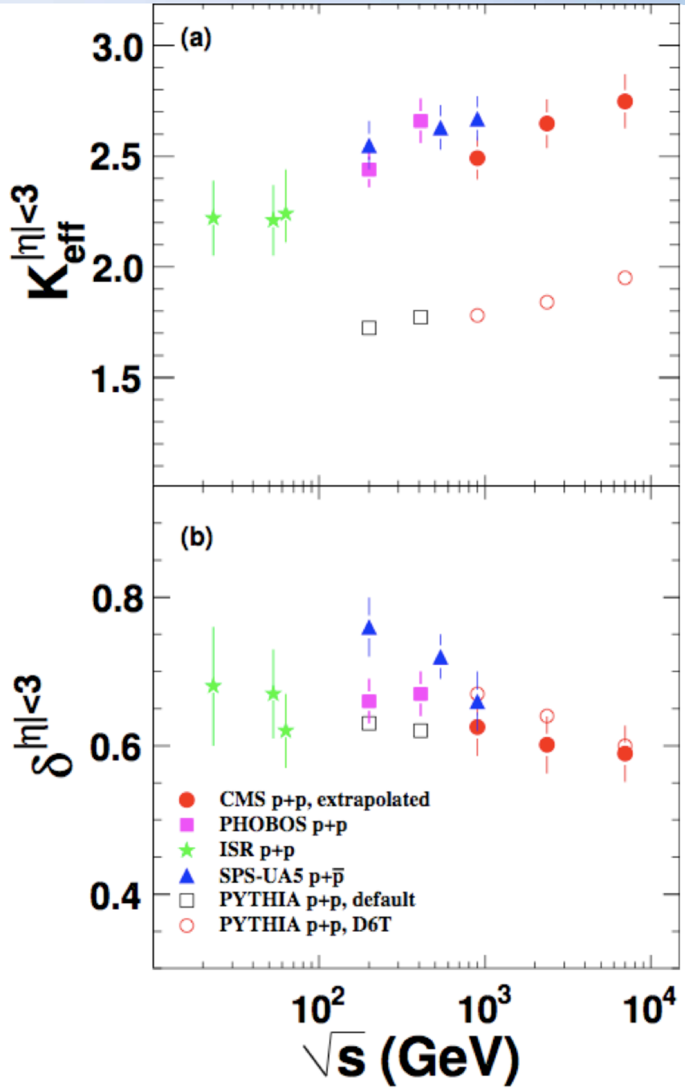
$|\eta|<2.4$

$p_T>0.1 GeV/c$



Energy dependence of cluster properties

Extrapolate to:
$|\eta|<3.0$
pT ~ 0 GeV/c



Error bars:
Systematic +
extrapolation errors

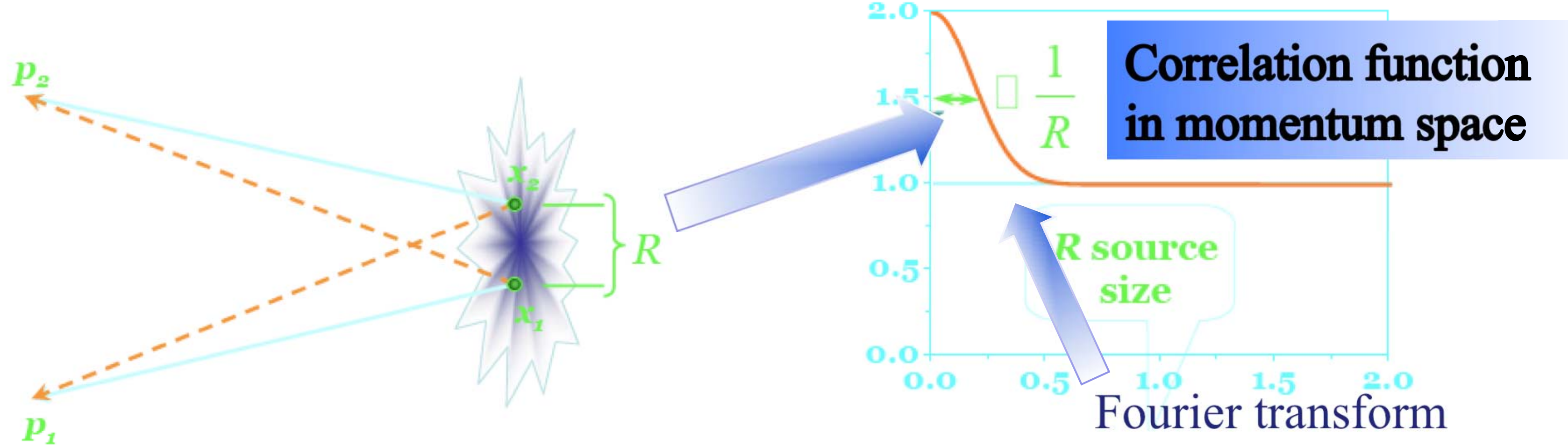
BEC in HEP

CMS-QCD-10-003 ; CERN-PH-EP-2010-010

Space time structure of particle emission can be studied via BEC

During high-energy collisions, bosons are created at small distance in a "fireball"

Their wave functions overlap, and the Bose-Einstein statistics changes their dynamics



Fourier transform of the emission region

arXiv:1005.3294

This is essentially the only way to measure the size of a source at the Fermi scale

Is it New

This is **not** a new phenomenon:

1. Measured for the first time in HEP by Goldhaber *et al.*

G.G.L.P.[1] Phys. Rev. 120 (1960), 300

2. Since then, many measurements with different detectors and different initial states (e+e-, pp, pp, pNand nmN).

But

We have new high energies to explore and a powerful detector to do study with

G. **G**oldhaber, S. **G**oldhaber, W. **L**ee, and A. **P**ais (**GGLP**)[1]

Bose-Einstein Correlations

Theoretically, we need to study the ratio between the joint probability of emission of a pair of bosons, and the individual probabilities

$$R = \frac{P(p_1, p_2)}{P(p_1)P(p_2)}$$

Experimentally, we have to produce the distributions of a "proximity" quantity in the data and in a reference sample (**Coulomb corrected**)

$$R = \frac{dN/dQ}{dN/dQ_{ref}}$$

To measure the proximity between 2 particles, we chose the difference of 4-momentum (assuming all pions):

$$Q = \sqrt{-(p_1 - p_2)^2} = \sqrt{m_{inv}^2 - 4m_\pi^2}$$

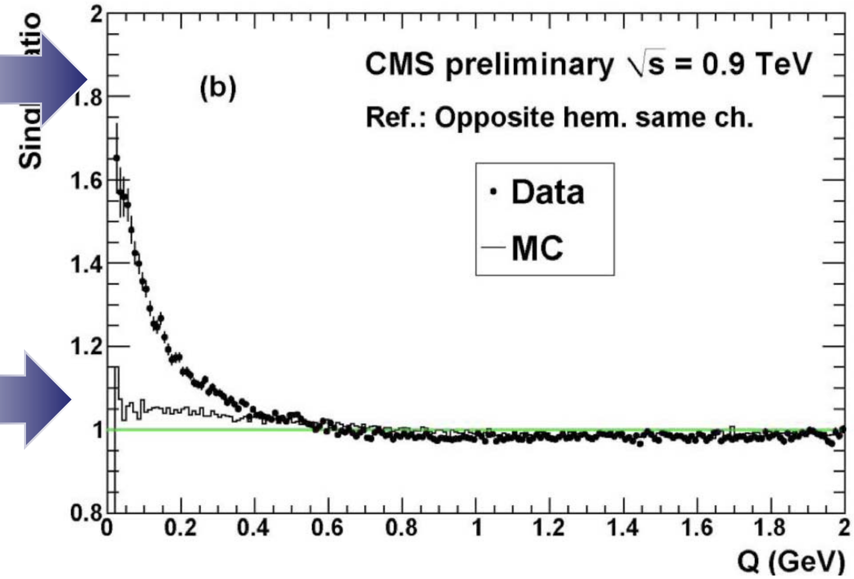
To calculate R:

1. Take all (charged) tracks.
2. Construct Q.
3. Repeat for the reference sample.

Evidence of the Effect

The enhancement at Q=0 shows the expected correlations

Correlations MC is essentially flat (no BEC in the simulations)

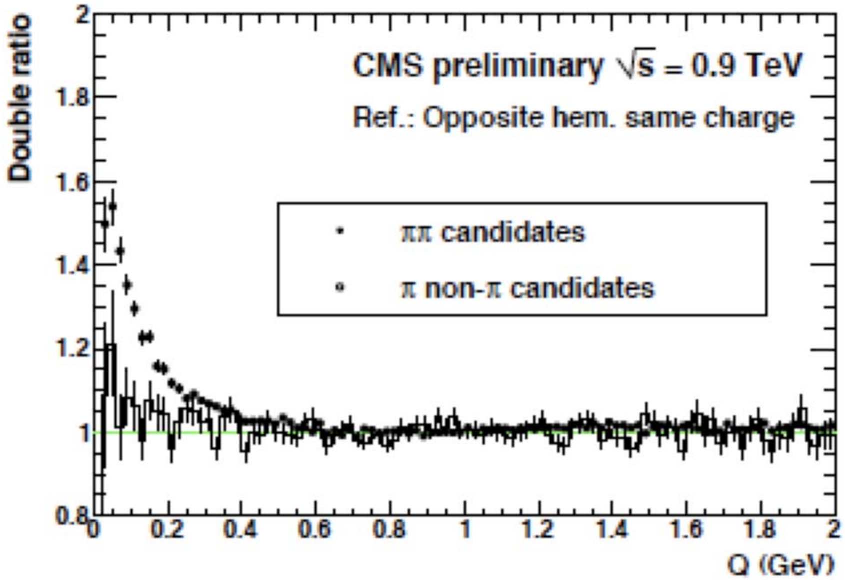


Double Ratio

To reduce the bias due to the construction of the reference samples, a double ratio R is defined:

$$\mathcal{R} = R/R_{MC} = \left(\frac{dN/dQ}{dN/dQ_{ref}}\right) / \left(\frac{dN/dQ_{MC}}{dN/dQ_{MC,ref}}\right),$$

where Q_{MC} and $Q_{MC,ref}$ refer to the Q distributions from the default simulation, which does not include a modeling of Bose–Einstein correlations



Parameterization

To perform the fit of the double-ratio spectra, the following function Was used:

$$R(Q) = C[1 + \lambda\Omega(Qr)](1 + \delta Q)$$

Where **λ** measures the strength of BEC for incoherent boson emission from independent sources, **δ** accounts for long-distance correlations, and **C** is a normalization factor.

In a static model of particle emission, the Ω(Qr) function is the **Fourier transform of the emission region,** whose effective size is measured by r. We chose the following parameterizations*:*

$$\Omega(Qr) = exp(-Qr)$$

Reference samples

We used 7 reference samples, mainly taken from literature:

1. **Opposite charge** pairs;
2. **Opposite charge** pairs where one track has its **three-momentum inverted**;
3. **Same-charge** pairs where one track has its **three-momentum inverted ;**
4. **“Rotated”** pairs: same charge with one track inverted in the transverse plane;
5. Event mixing 1: every pair has one track from one event, the other from the **following selected event;**
6. Event mixing 2: as above, but events are paired such that they have **similar distribution of dNtracks/dη;**
7. Event mixing 3: as above, but events are paired such that they have **similar total invariant mass of charged tracks;**

None of these reference samples is “golden” → We used all of them for our analysis

Results

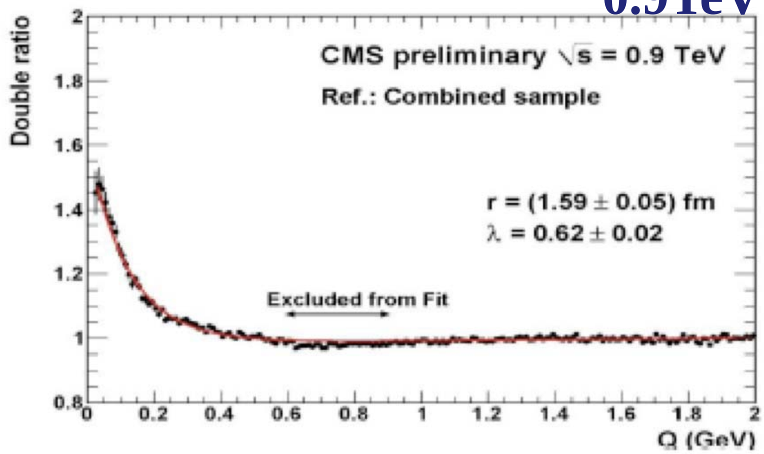
Combined Reference Sample

In order to provide a single value,

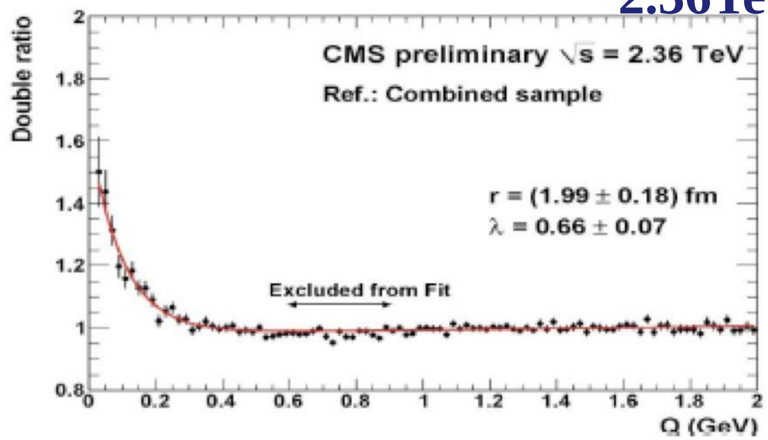
$$\Re^{avg} = \frac{dN/dQ}{dN/dQ_{MC}} \frac{\sum_{i=1}^{m} dN/dQ^{i}_{MC}}{\sum_{i=1}^{m} dN/dQ^{i}}$$

Then we performed the fit for both sets of data:

0.9TeV



2.36TeV



Results

No reference sample is perfect, and none can be discarded

r.m.s.of fit results (±7% for λ, ±12% for r)

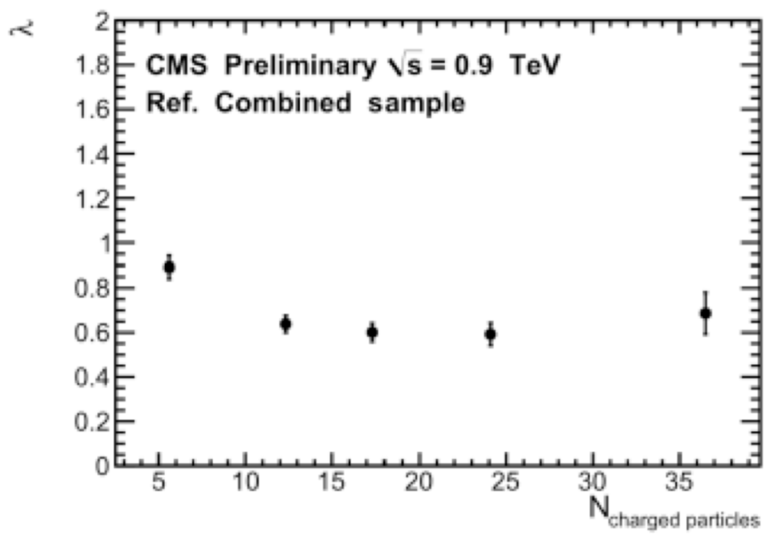
Correct Coulomb effects (±15%)

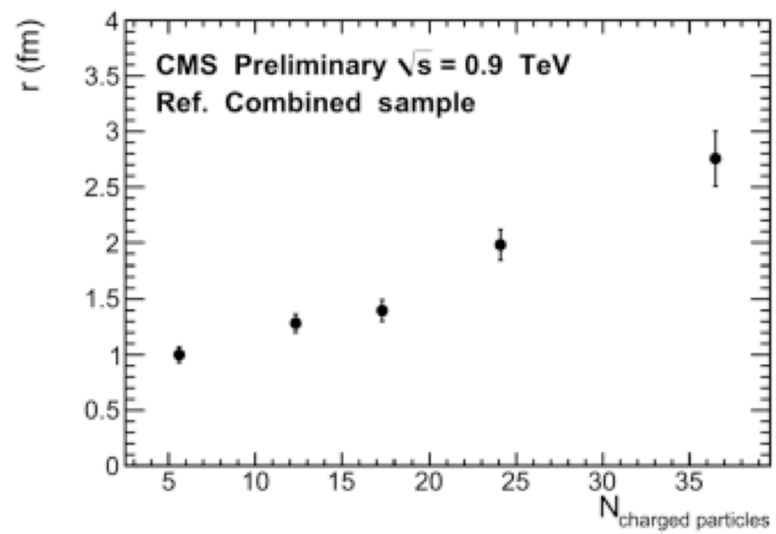
(±2.8% for λ, ±0.8% for r)

Data @ 900 GeV:
$r = 1.59 \pm 0.05_{stat.} \pm 0.19_{syst.}$ fm; $\lambda = 0.625 \pm 0.021_{stat.} \pm 0.046_{syst.}$
Data @ 2.36 TeV:
$r = 1.99 \pm 0.18_{stat.} \pm 0.24_{syst.}$ fm; $\lambda = 0.663 \pm 0.073_{stat.} \pm 0.048_{syst.}$

Dependence on Event Topology

Significant dependence of the r parameter with the charged-particle multiplicity in the event for **all reference samples**





These results confirm previous experiments results in a wide range of energies and initial states

CMS-MUO-10-00

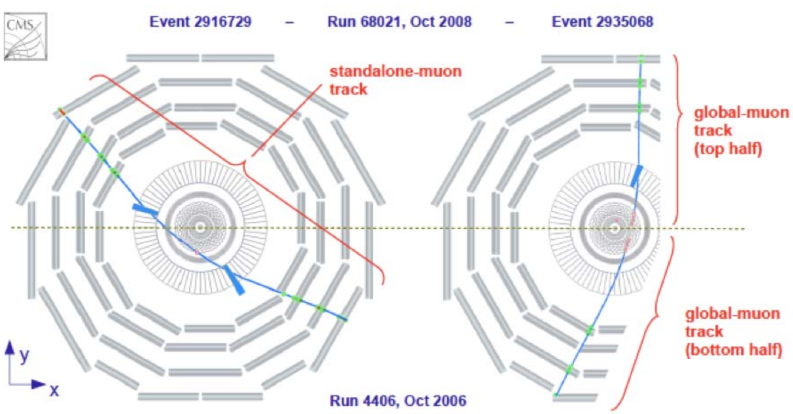
Flux ratio of positive to negative muons in cosmic rays measured as a function of the muon momentum

Combining:

295M mu's in MTCC 06' and CRAFT 08'

Using

Two muon reconstructions algorithm



EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

CERN-PH-EP-2010-011
2010/05/31

CMS-MUO-10-001

arXiv:1005.5332v1 [hep-ex] 28 May 2010

Measurement of the charge ratio of atmospheric muons with the CMS detector

The CMS Collaboration*

Abstract

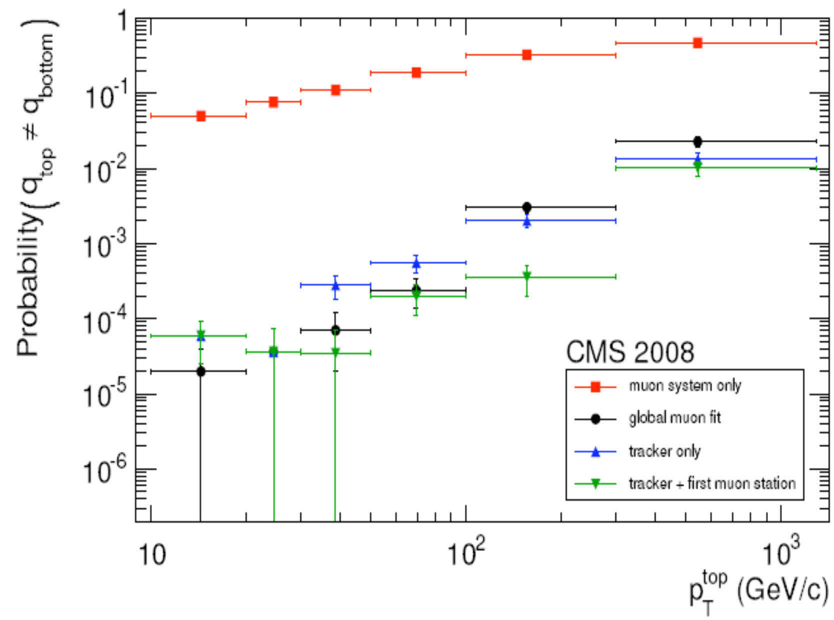
We present a measurement of the ratio of positive to negative muon fluxes from cosmic ray interactions in the atmosphere, using data collected by the CMS detector both at ground level and in the underground experimental cavern at the CERN LHC. Muons were detected in the momentum range from 5 GeV/c to 1 TeV/c. The surface flux ratio is measured to be 1.2766 ± 0.0032 (stat.) ± 0.0032 (syst.), independent of the muon momentum, below 100 GeV/c. This is the most precise measurement to date. At higher momenta the data are consistent with an increase of the charge ratio, in agreement with cosmic ray shower models and compatible with previous measurements by deep-underground experiments.

Submitted to Physics Letters B

arXiv:1005.5332

Muon Performance

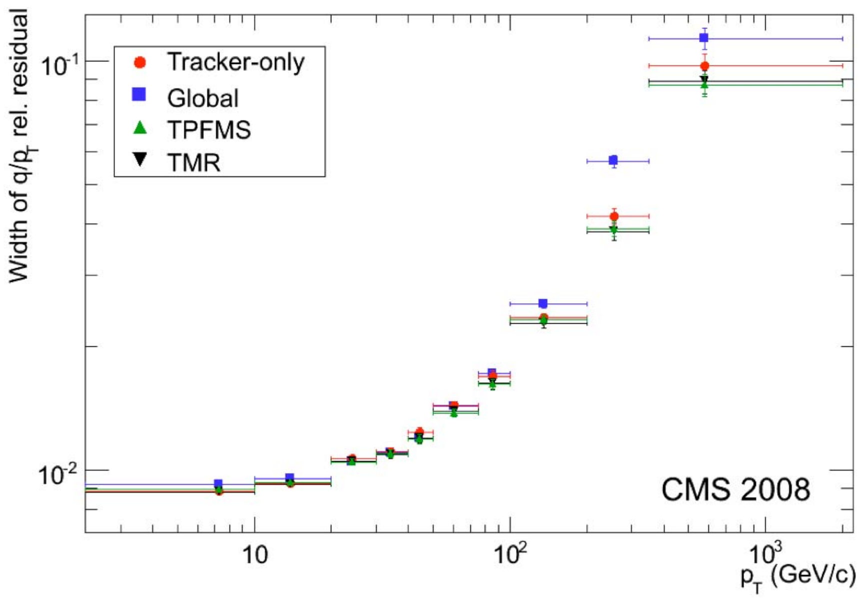
Charge miss assignment



< 0.01% at 10GeV

~1% at 500GeV

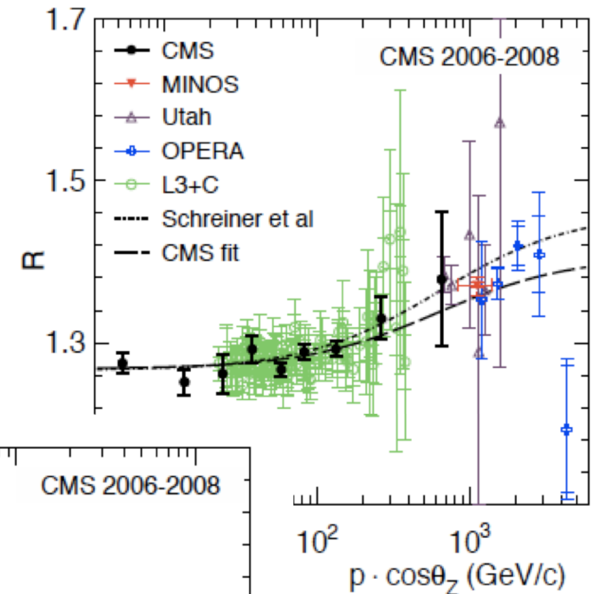
Momentum resolution



<1% at 10GeV

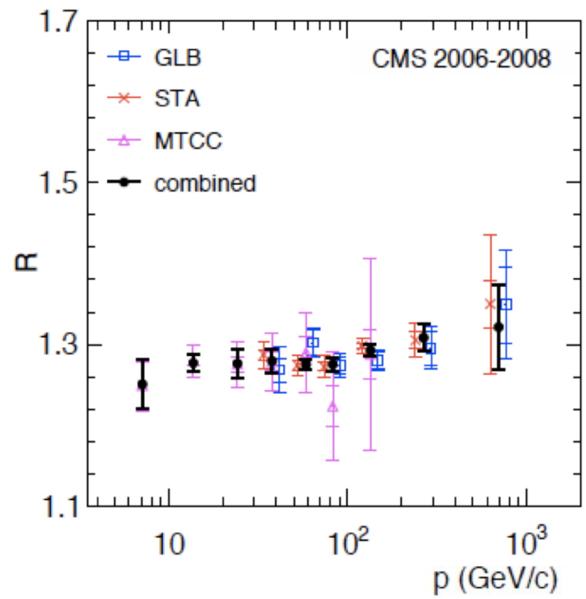
Results

- 2006 data was reanalyzed fixing the B field (20% of the filed in the return Yoke was missing)
- CRAFT included all the detector and added large statistic



Main improvements:

- Momentum range was extended to 850GeV
- The precision increased by a factor of ~ 3



Muon Charge ratio:

$$1.2766 \pm 0.0032\,(\text{stat.}) \pm 0.0032\,(\text{syst.})$$

What is Coming Next ?

QCD: What is Coming Next ?

An investigation of the UE with the new jet area/median approach (*"The Catchment Area of Jets"*, *JHEP04(2008)005* *M. Cacciari et al.*

- A uniform grid of extremely soft "ghost particles" is clustered with the physical input particles

- Number of ghosts in a jet determines its area

- Requires a fast infrared & collinear safe jet algorithm Such as Cambridge-Aachen, kT, anti-kT

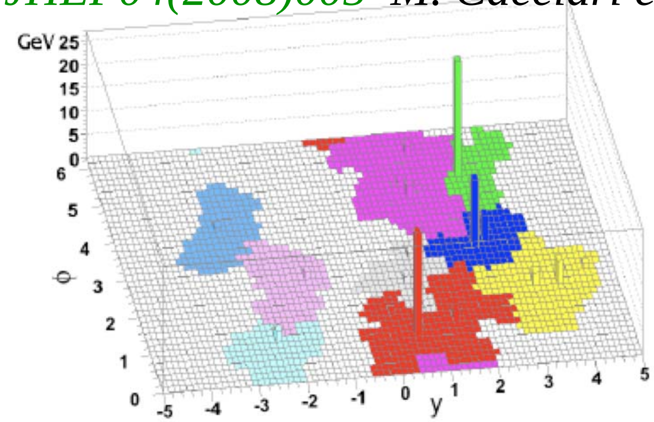


Figure 4: Active area for the same event as in figure 3, once again clustered with the k_t algorithm and $R = 1$. Only the ... own.

Adjusted observable:

$$\rho' = \underset{j \in physical\ jets}{median}\left[\left\{\frac{p_{T,j}}{A_j}\right\}\right] * C$$

$$C = \frac{\Sigma_j A_j}{A_{tot}}$$

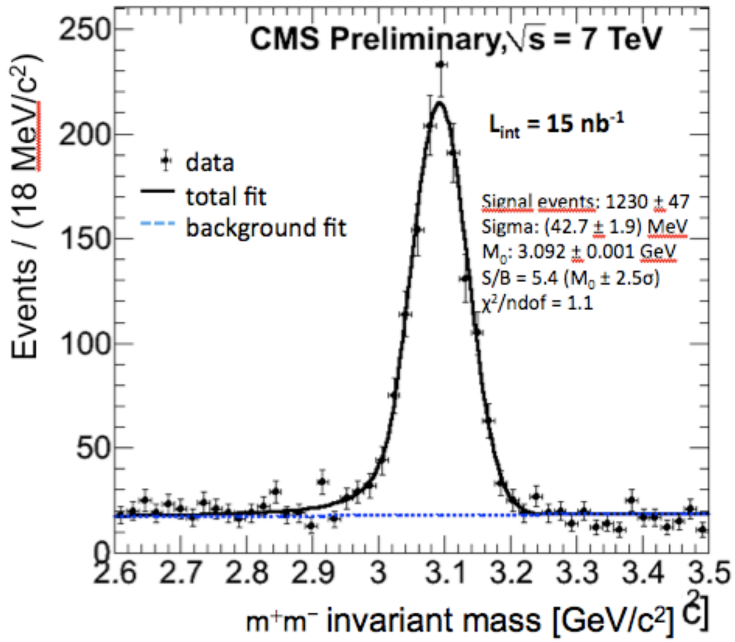
takes into account only physical jets

Advantage : study the full phase space

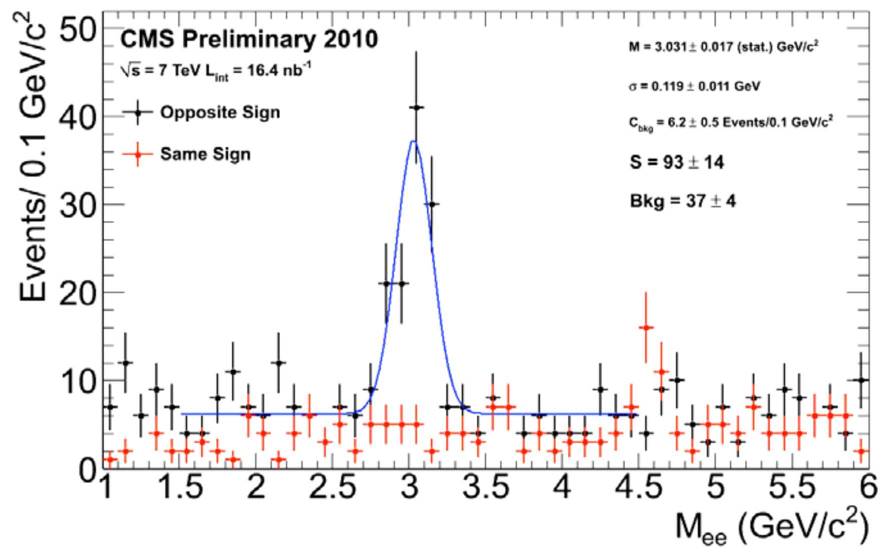
QCD Analysis Working Group

- Particle Level:
  - Underlying Event with Jet Area at 900 GeV
  - Charged particle multiplicities at sqrt(s)=0.9, 2.36 and 7 TeV
  - Spectra of identified hadrons in pp collisions at sqrt(s) = 0.9, 2.36 and 7 TeV
  - Charged hadron transverse momentum spectra
- Jets:
  - Inclusive Pt Sepctra, 3Jet/2Jet Ratio, Transverse structure and momentum distribution, Azimuthal Decorrelations and Angular Distributions
- Di Jets:
  - Mass Spectra, Production Ratio
- Photons:
  - Isolated Photon Cross Section , Photon + N Jet Cross Section

B-Physics Analysis Group

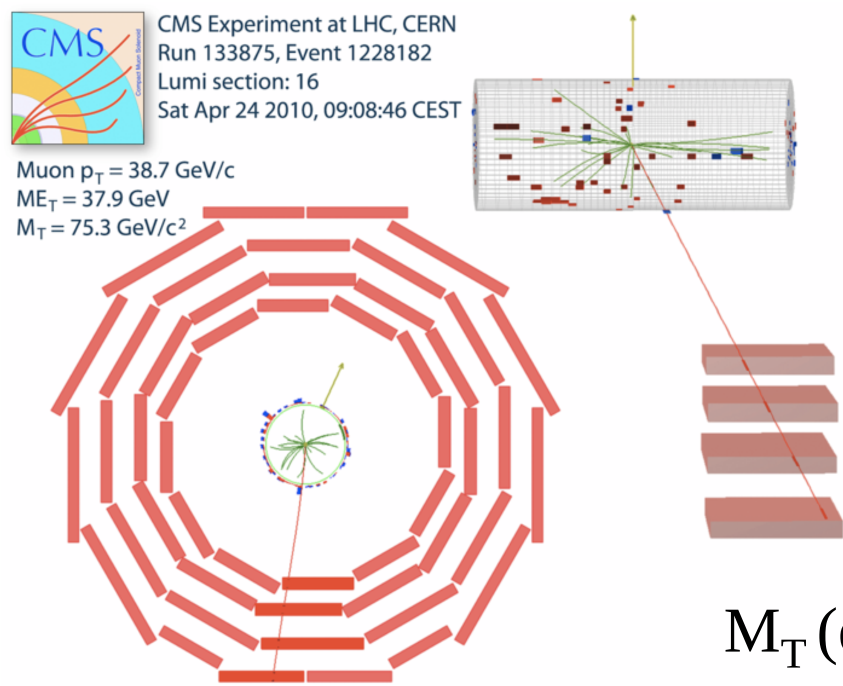


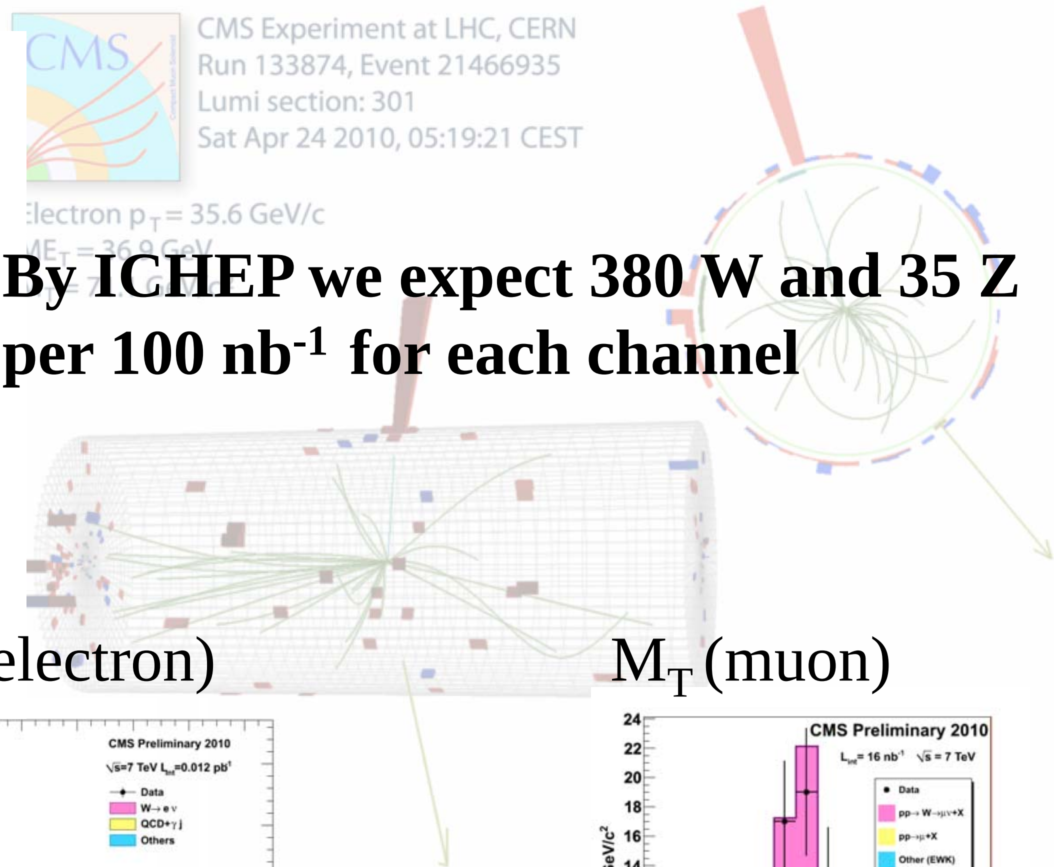
Feasible with O(0.1 pb-1): Measurement of the differential J/Ψ (μμ) and ϒ(μμ) cross-section in few pT bins.
pT -integrated prompt-non prompt Jpsi separation may be possible



Feasible with O(1 pb-1):
Measurement of prompt-non prompt J/Ψ (μμ) and ϒ(μμ) cross-sections differential in pT , possibly in rapidity

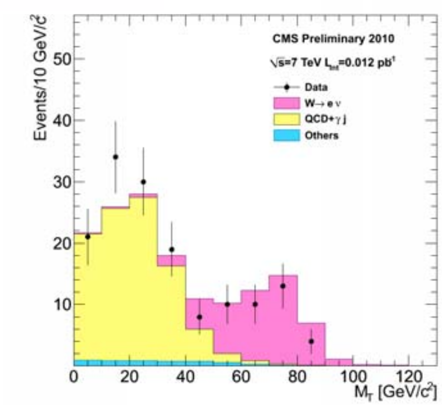
EWK Analysis Group





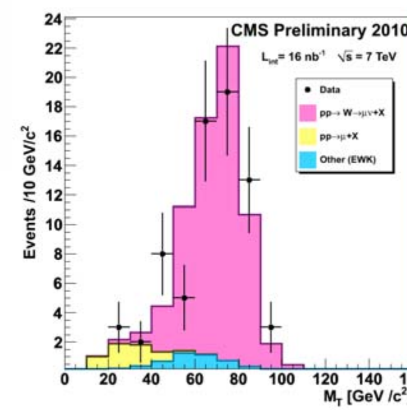
By ICHEP we expect 380 W and 35 Z per 100 nb^{-1} for each channel

M_T (electron)



$M_T > 50$ GeV

M_T (muon)



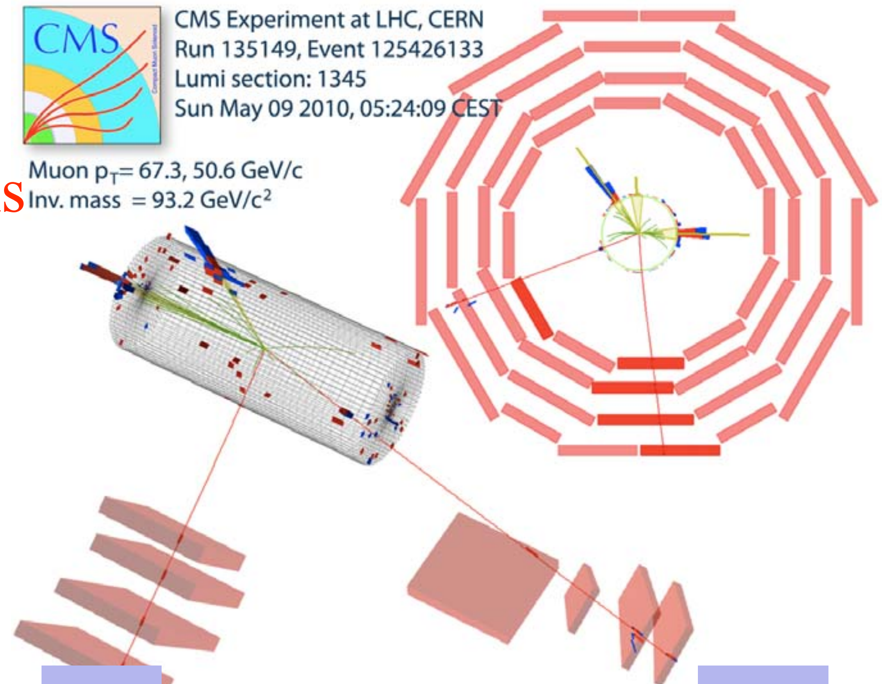
EWK Analysis Group $1pb^{-1}$

Expect: 3800W,in each channel

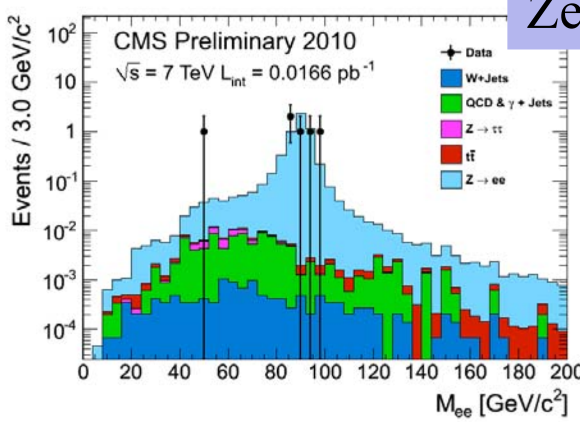
- Measurement of W & Z cross sections
- W^+/W^-cross section ratio
- Z/W cross section ratio

….

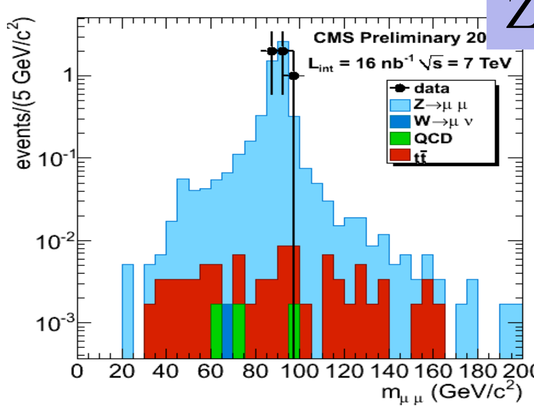
- q_T distribution for Z
- Z rapidity distributio
- W charge asymmetry
- W polarization
- ……..



Zee



Zμμ



Summary

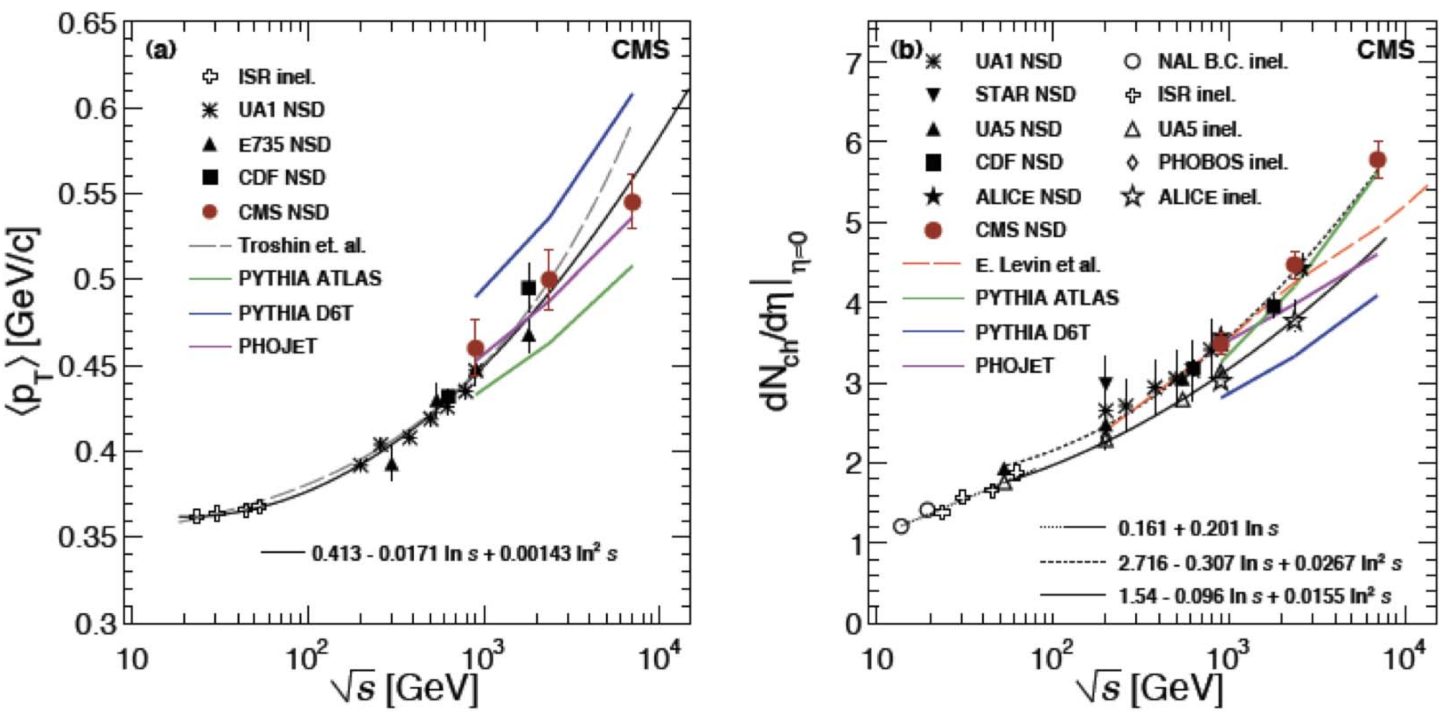
Excellent detector performance yield first public results and many new results are about to be released

to be continued ….

I would like to thank:
Michele Arneodo, Kevin Burkett, Rick Field, Hannes Jung, Wei Li, Martijn Mulders, Klaus Rabbertz, Gabor Veres, for useful discussions and for helping me preparing this talk.

BACKUP

dN/dη: Comparison to Other Exp



dN/dη: Systematic Uncertainties

Source	Pixel Counting [%]	Tracklet [%]	Tracking [%]
Correction on event selection	3.5	3.5	3.5 (1.0)
Acceptance uncertainty	1.0	1.0	1.0
Pixel hit efficiency	0.5	1.0	0.3
Pixel cluster splitting	1.0	0.4	0.2
Tracklet and cluster selection	3.0	0.5	-
Efficiency of the reconstruction	-	1.9	2.0
Correction of looper hits	2.0	1.0	-
Correction of secondary particles	2.0	1.0	1.0
Misalignment, different scenarios	-	1.0	0.1
Random hits from beam halo	1.0	0.2	0.1
Multiple track counting	-	-	0.1
Fake track rate	-	-	0.5
p_T extrapolation	0.2	0.3	0.5
Total, excl. common uncertainties	4.4	2.9	2.4
Total, incl. common uncert. of 3.6%	5.7	4.6	4.3 (2.8)

MC Tunes

Tune A

- DW, DWT, D6, D6T are PYTHIA 6.2 tunes (Q2-ordered parton showers, old MPI mpodel) from Rick Field studies of the UE at the Tevatron (i.e. CDF tunes). They were extrapolated to 900 GeV and 7 TeV (i.e. they are predictions).

Tune CW

- It is a slight change of DW (Rick Field) in order to produce more activity in the "transverse" region at 900 GeV.

PYTHIA

- Perugia 0 (i.e. P0) is a 6.4 tune (pT-ordered parton shower, new MPI model) from Peter Skands.

Tune Pro-Q20 is a PYTHIA 6.2 tunes

- (Q2-ordered parton showers, old MPI mpodel) which came from the MC-Net group (Hendric Hoeth) using the "Professor" tuning package (automated tuning fitting Mostely the Tevatron data).

Two Particle Correlation Systematics

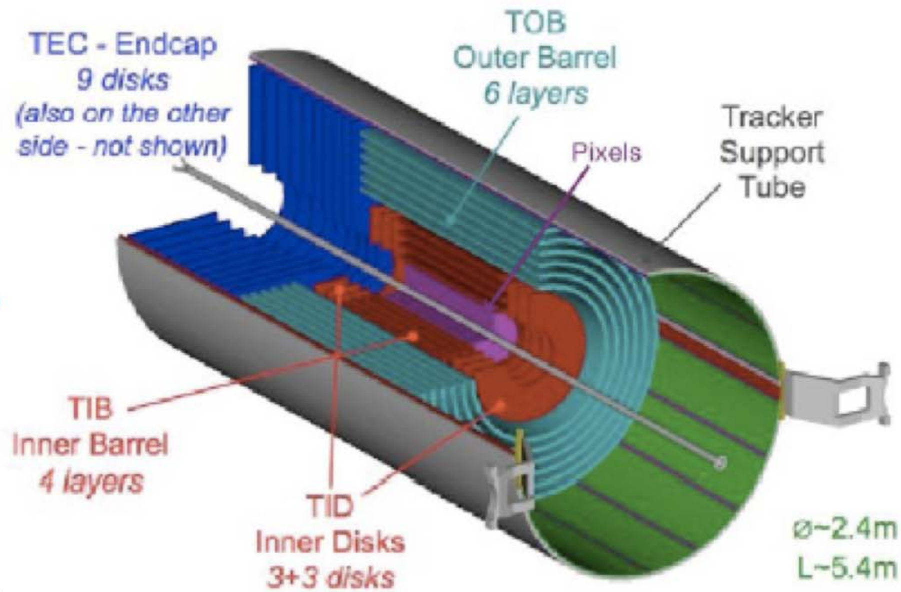
Table 1: Summary of systematic uncertainties.

	Systematic uncertainties [%]	
Source	α	δ
Correction on event selection efficiency	2.6	2.8
Correction on tracking/acceptance efficiency and fake rate	1.3	1.4
Track quality cuts	1.2	1.0
Model dependence on the corrections	2.6	1.3
Total systematic uncertainties	4.1	3.5

DRAFT

CMS Silicon Tracker

- ***Pixel***:
  - ~1 m^2 of Si sensors;
  - 66M channels, 1440 modules;
  - 3 barrel layers (*R*=4, 7, 11 cm), 2 endcap disks;
- ***Strips***:
  - ~198 m^2 of Si sensors;
  - 9.6M channels, 15148 modules
  - 10 barrel layers, 9+3 endcap wheels per side;
  - $|\eta| < 2.5$.



From simulation studies

•Tracking efficiency > 99% (μ), > 90% (hadrons)

•Resolution: Δp/p~ 1-2% (@100 GeV, $|\eta| < 1.6$)

BEC Addition Cuts

A track was used if:

1. $p_T > 200$ MeV (to cross all 3 layers of ***pixel*** detectors);
2. $|\eta| < 2.4$;
3. $N_{dof} > 5$ and $\chi^2/N_{dof} < 5.0$;
4. $|d_{xy}| < 0.15$ cm and $R_{innermost} < 20$ cm.

$0.02\text{GeV} < Q < 2\text{ GeV}$

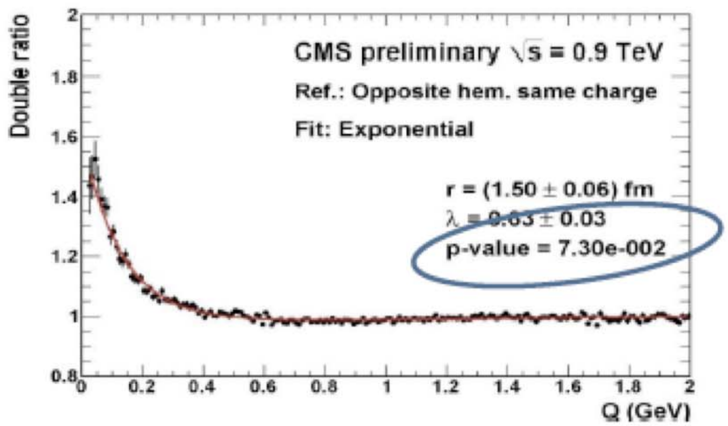
Avoid not well-separated or duplicated tracks

Allows to check a good matching data –ref. sample0.02

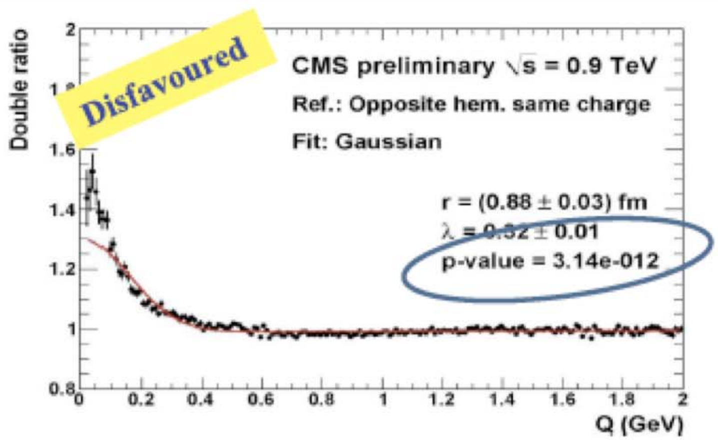
Different Parameterizations

We tested: exponential, Gaussian, Levy,
and those described by Kozlov and Biyajima

$\Omega(Qr) = exp(-Qr)$ – ***Exponential***



$\Omega(Qr) = exp(-Q^2r^2)$ – ***Gaussian***



All functions with the Gaussian form have to be ruled out:
the others give equally good results