Soft physics: propects and discussion

1. Yields and Spectra: models, mechanisms and extrapolations
2. Baryon and meson: particle identification and measurements
2. Underlying event definitions and related observables

then discussion...

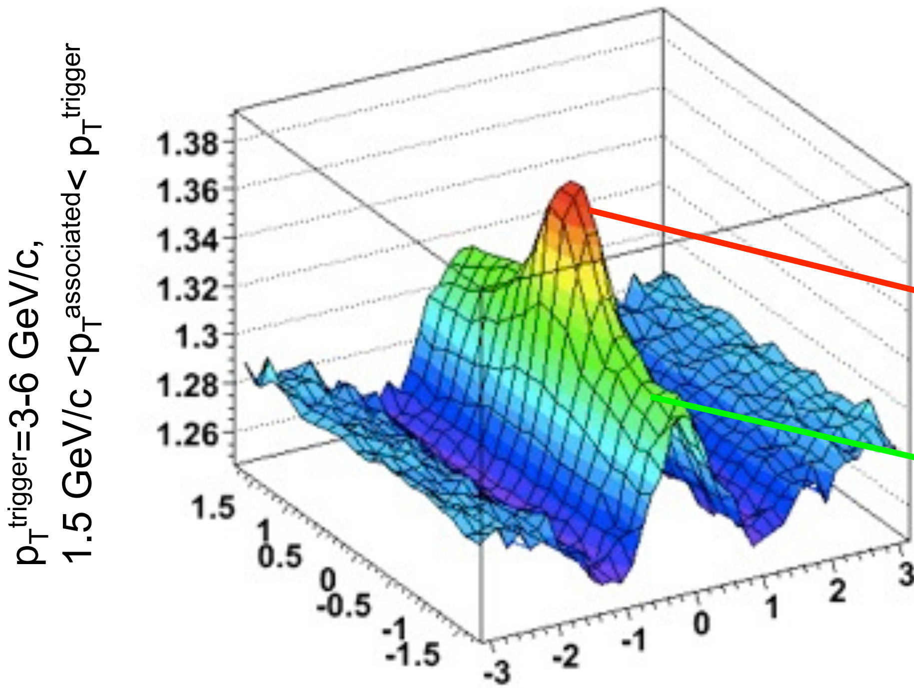
Boris HIPPOLYTE (IPHC - Université de STRASBOURG)

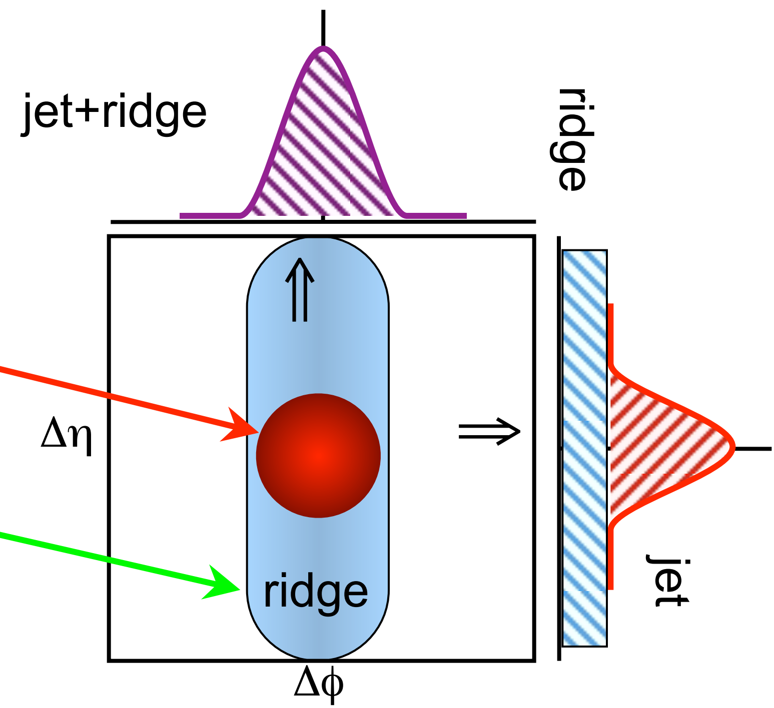
Particle production and correlation from EPOS

Presentation from K. Werner

Great success of EPOS using Gribov-Regge based formalism:

⇨ reproduction of large sets of experimental data: spectra, ratio, flow;
⇨ long eta range correlations should come for free;
⇨ first experimental measurements (vs. multiplicity!) in pp will be important.

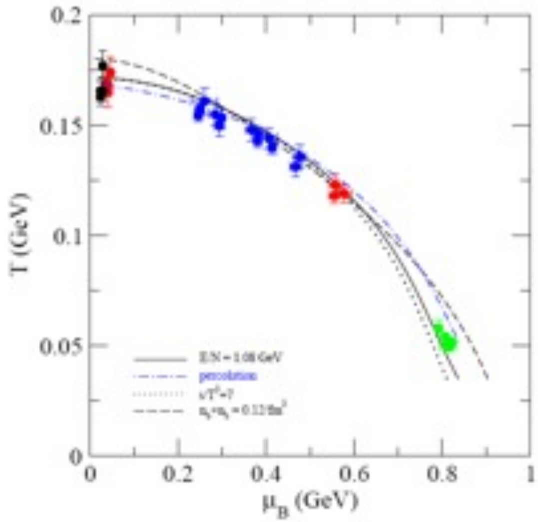


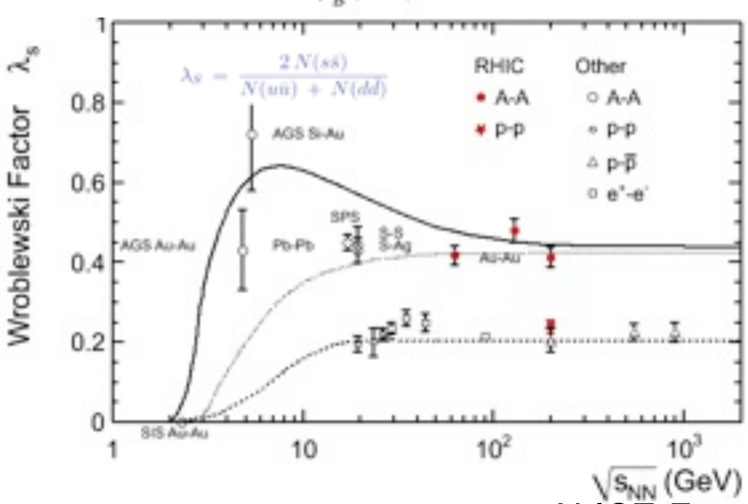


Strange particle production and Statistical Description

Freeze-out description

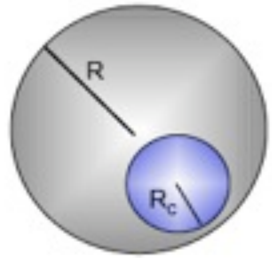
J.Cleymans, H.Oeschler, K.Redlich, S.Wheaton, Phys.Rev.C73 (2006)



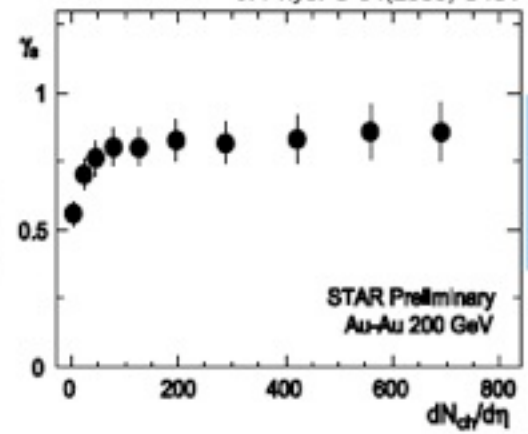


Presentation from H. Oeschler and I. Kraus

suppression beyond canonical expectation



J. Phys. G 31(2005) S101



deviations: strangeness understauration factor γ_S

B. Abelev et al. (STAR Collaboration) Phys. Rev. C 75 064901 (2007)

	Canonical Value
T	0.1680 ± 0.0081 GeV
B	2.000 (fixed)
Q	2.000 e (fixed)
γ_S	0.548 ± 0.052
radius	3.83 ± 1.15 fm

TABLE XI: Comparison of a canonical fit to the STAR feed-down corrected ratios from $p+p$ collisions at $\sqrt{s}$=200 GeV. The χ^2/ndf of the fit was 4.14 / 6 = 0.69. See text for further details.

Multi-strange particle production

Presentation from A. Maire

Tsallis Statistical description:
Exponential (low p_T)+Power law (high p_T)+Blast-wave

$$\frac{d^2N}{2\pi m_T dm_T dy} \propto \left(1 + \frac{q-1}{T} m_T\right)^{-1/(q-1)}$$

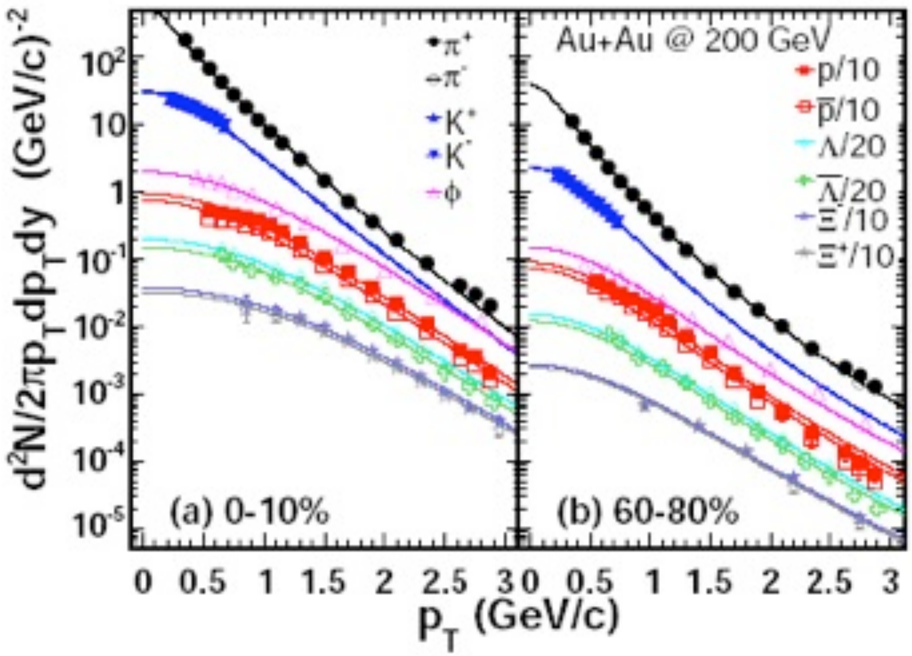
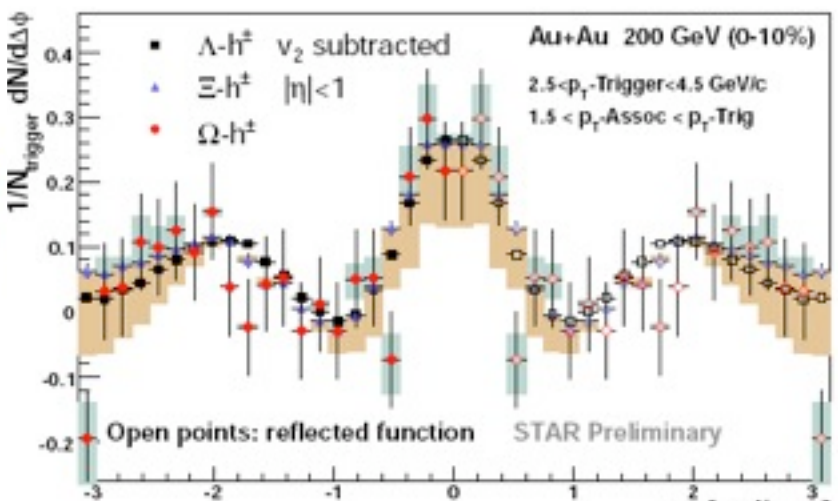


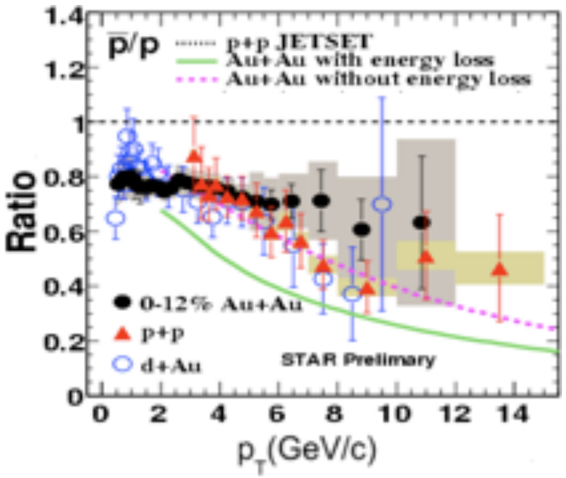
FIG. 1: (Color Online) Identified particle transverse momentum spectra in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV in0-10% central (a) and in peripheral 60-80% collisions (b). The symbols represent experiment data points. The solid curves represent the TBW fit.

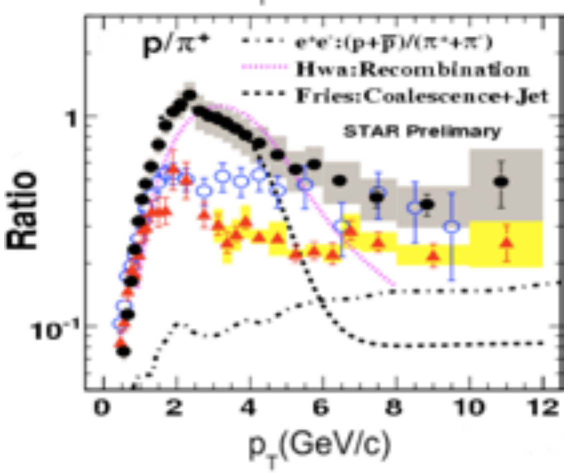
- Coalescence or fragmentation ?
- Tool : azimuthal correlation studies



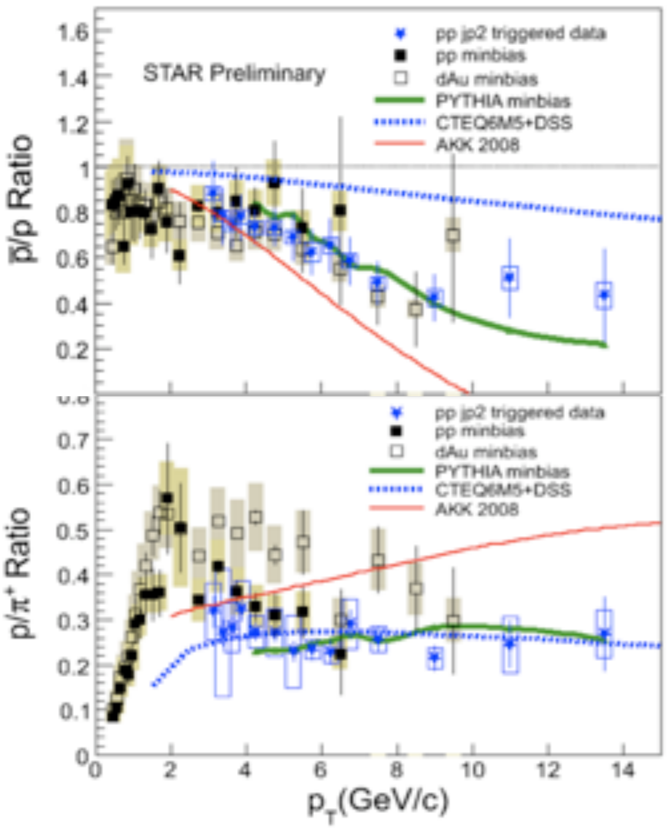
Baryon / Meson ratios at RHIC and HERA

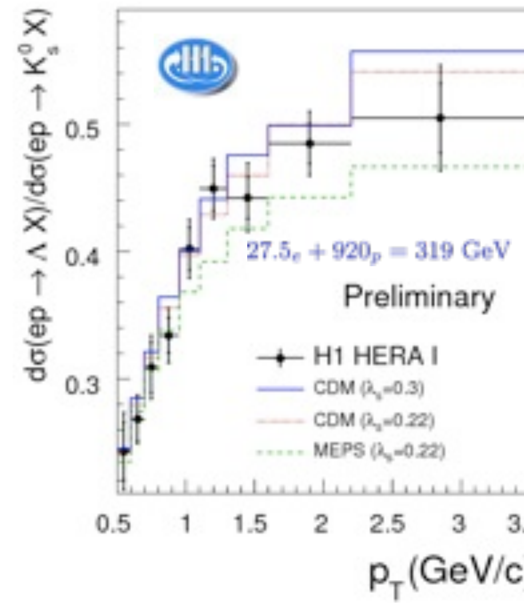
Probing baryon/meson differences at LHC energies implies PID over a large p_T range.





Studying p+p and e+p production for understanding the specificities of A+A





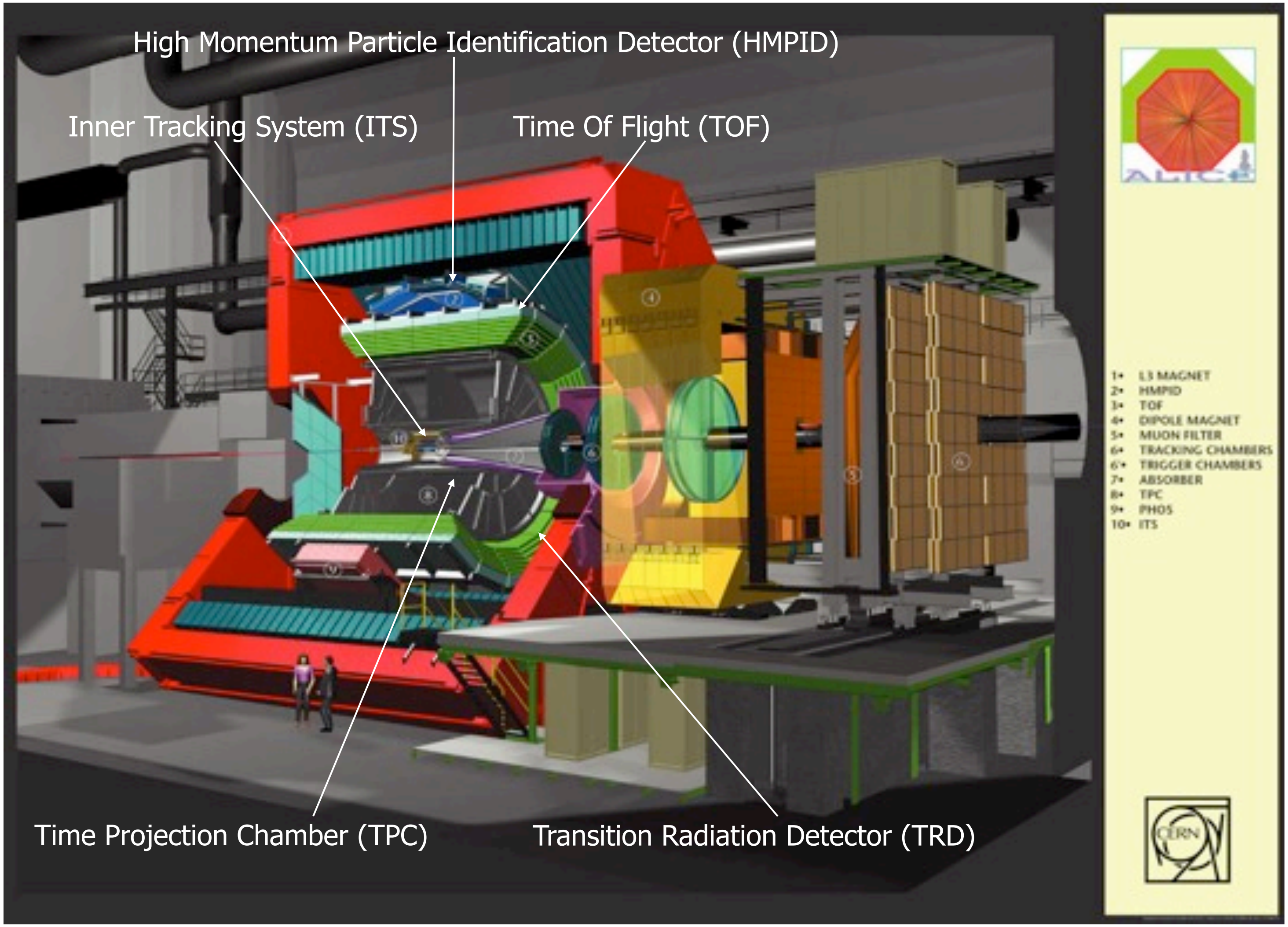
Anna Falkiewicz (H1) DIS08

Yichun Xu (STAR) HQ08: nucl-ex arXiv:0901.0692

As already studied at RHIC, first step for investigating recombination and coalescence mechanisms

ALICE experiment at the LHC

Slide from I. Belikov’s presentation



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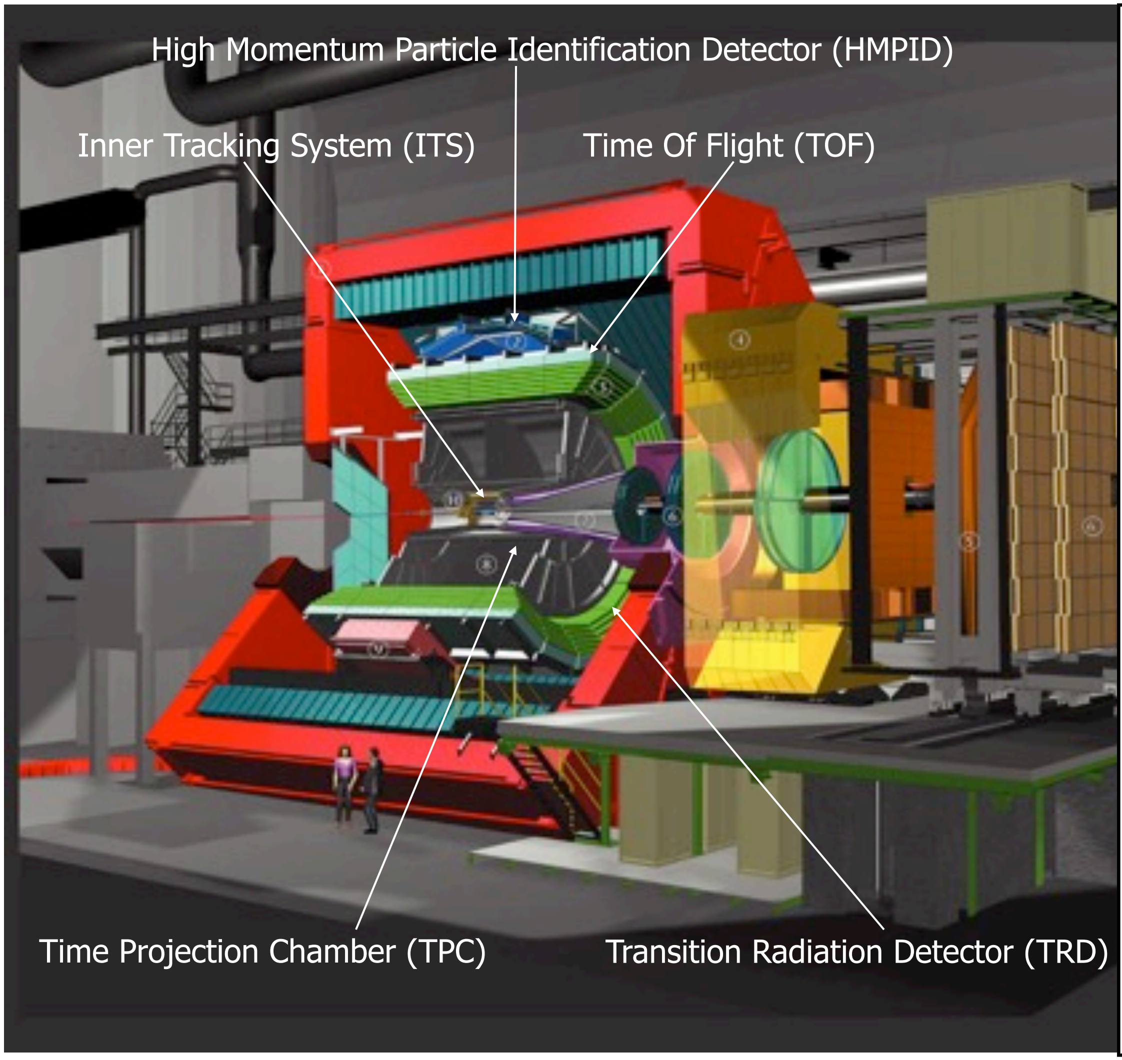


TPC ($-0.9<\eta<0.9$) tracking efficiency:
~80% for Pt<0.2 GeV/c
(limited by decays),
~90% for Pt>1 GeV/c
(limited by dead zones),
for > 10000 tracks in the TPC.

Momentum resolution (B=0.5 T):
~1% at Pt=1 GeV/c,
~5% at Pt=100 GeV/c (ITS+TPC+…).

Precise secondary vertexing
better than 100 μm (ITS).

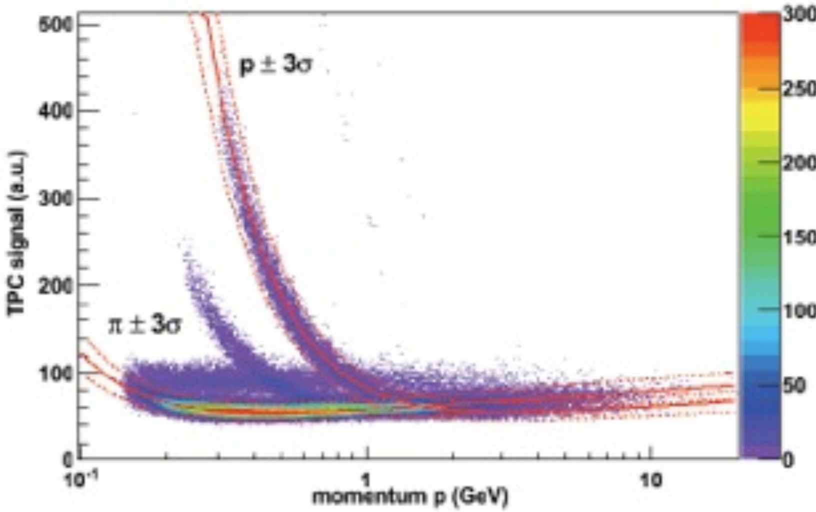
Excellent charged PID capability:
from P~0.1 GeV/c upto a few GeV/c,
(upto a few tens GeV/c, TPC rel. rise),
electrons in TRD, P>1GeV/c
(ITS+TPC+TRD+TOF+HMPID+…).

Single-strange particle production

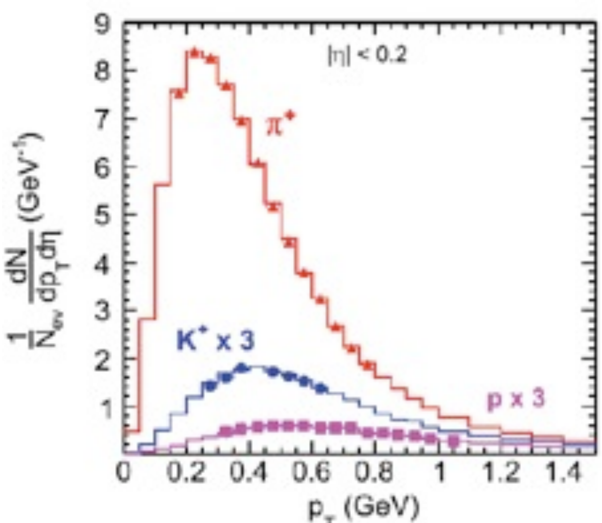
PID in large region transverse momenta available with 3M events recorded by ALICE

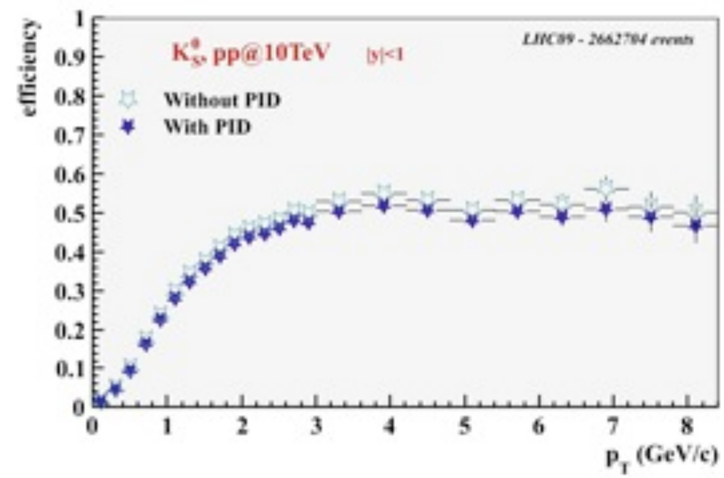
Reconstruction efficiency:

Presentations from A.Kalweit and H. Ricaud



	With PID	*Without PID*
K^0_S	12.8 % 13.6 %	13.8 % 14.6 %
Λ	8.5 % 9.9 %	9.2 % 10.7 %
Λ	7.1 % 8.4 %	7.7 % 9.0 %





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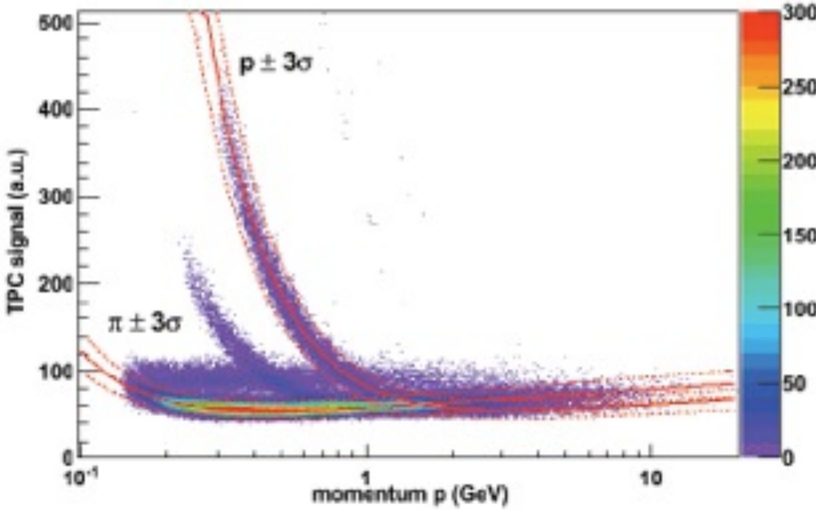

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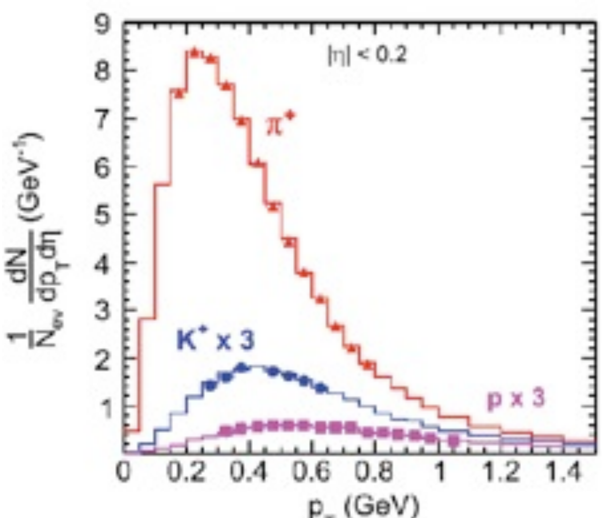

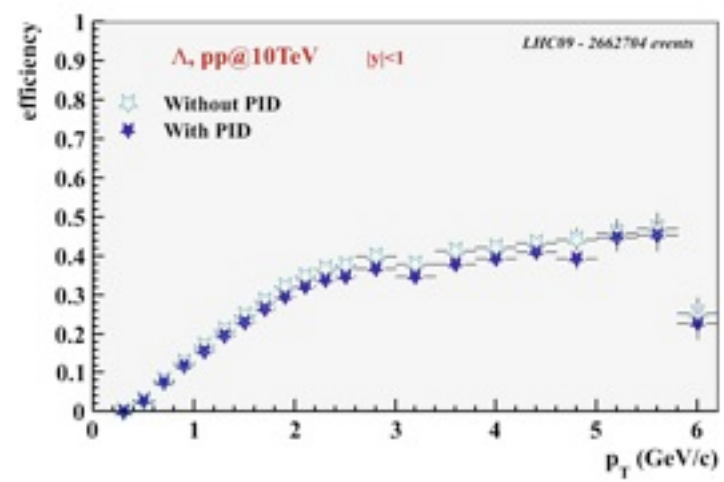

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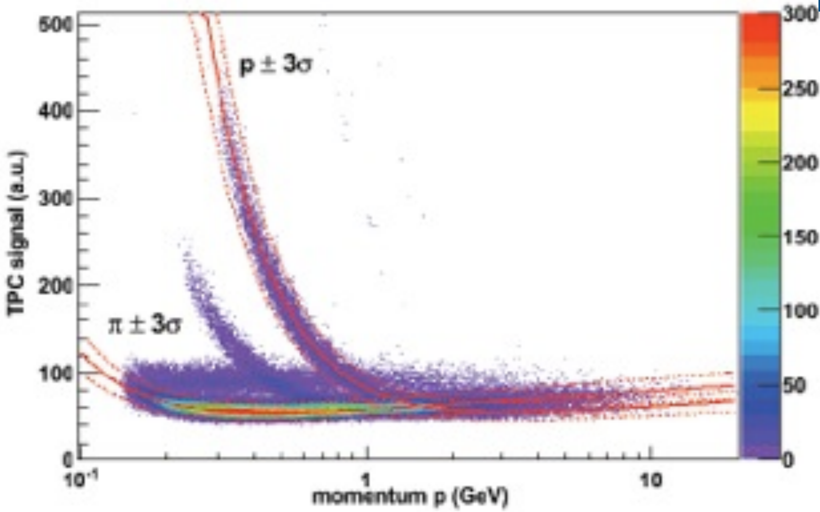

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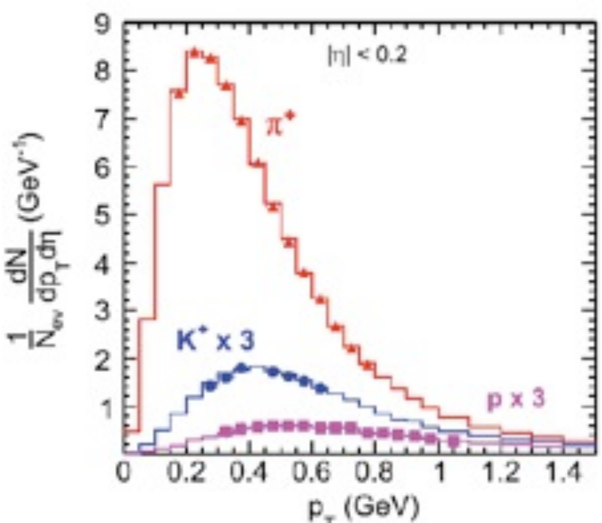
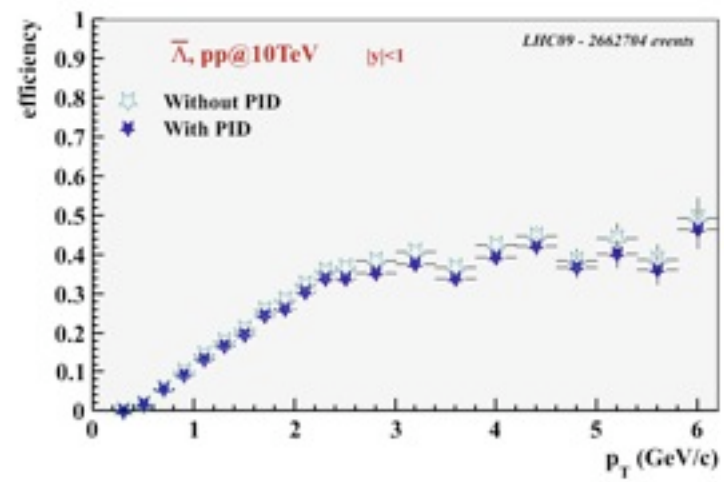
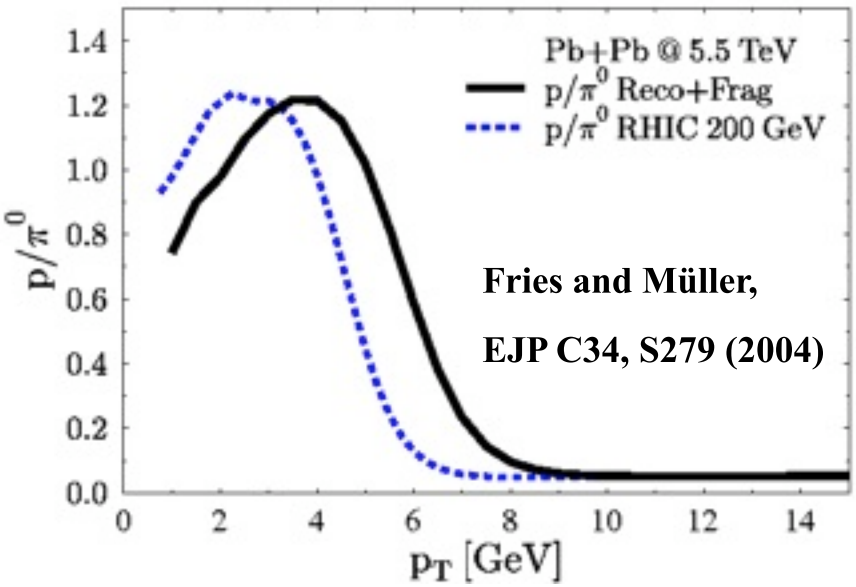




Baryon / Meson ratios at LHC energies

Probing baryon/meson differences at LHC energies implies PID over a large p_T range.

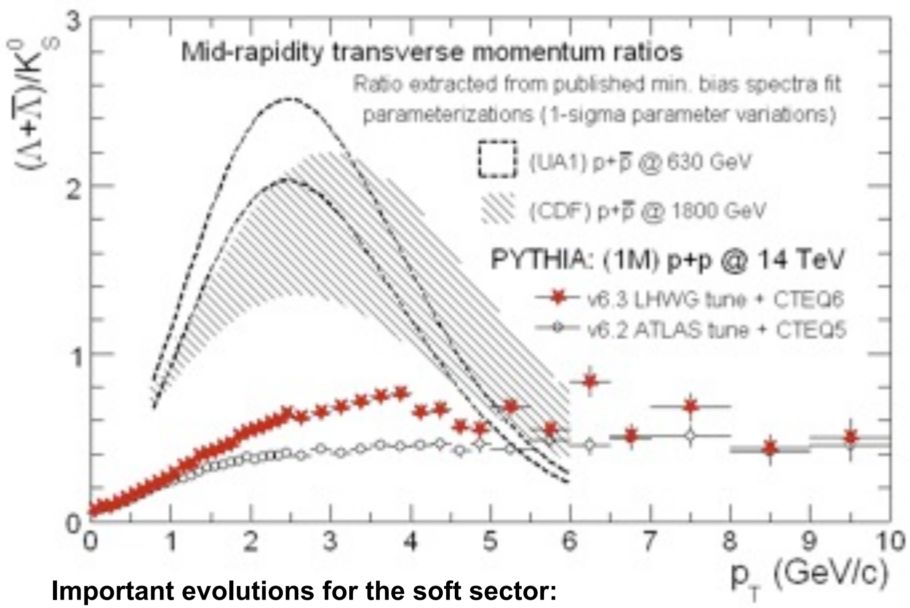
Calculation implies assumption on transverse radial flow extrapolation



Amplitude for mixed ratio predicted to be the same at LHC than for RHIC but the turnover and limit are shifted to higher p_T

But first LHC data will be <u>elementary collisions</u>
⇨ check magnitude of this behaviour then invoke coalescence mechanisms if needed.

PYTHIA Configuration from preprint hep-ph/0604120



Important evolutions for the soft sector:

PYTHIA: **v6.2** ⇨ **v6.3** New multiple interaction (N.M.I) treatment (part.-part. interactions and i/fsr)

PDF: **CTEQ5** ⇨ **CTEQ6** Gluon distribution function (visible at low Q^2)

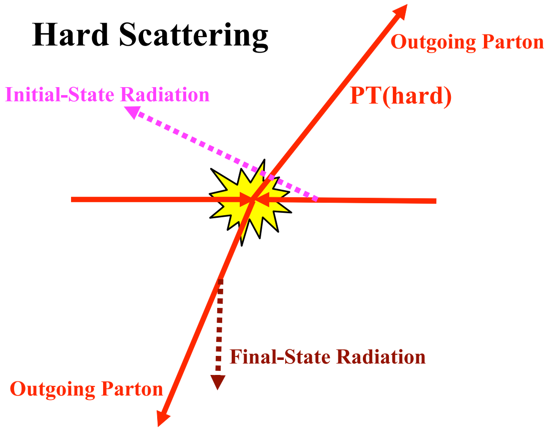
Missing a factor of ~2 wrt RHIC ⇨ UA1 ⇨ CDF extrapolations
⇨ investigation of NLO contribution, baryon creation mechanisms (diquark to popcorn scenario or gluonic baryon junctions).

Multi-parton dynamics in p+p at LHC energies

Soft component in p+p collision: multiple parton interactions

Described in I. Kraus' presentation

Hard parton scattering is one part of the story



Significant differences for production rates and ratios between "min. bias" and "u.e.";
⇨ important for e.g. understanding baryon/meson ratio, deconvoluting R_{AA}...
⇨ angular studies may include leading charged particle and/or full jet reconstruction.

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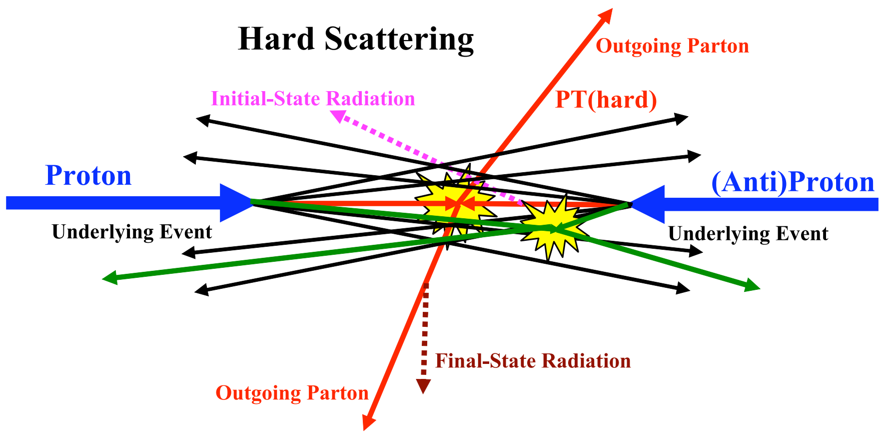

R.Field: «The "underlying event" consists of the "beam-beam remnants" and from particles arising from soft or semi-soft multiple parton interactions (MPI).»

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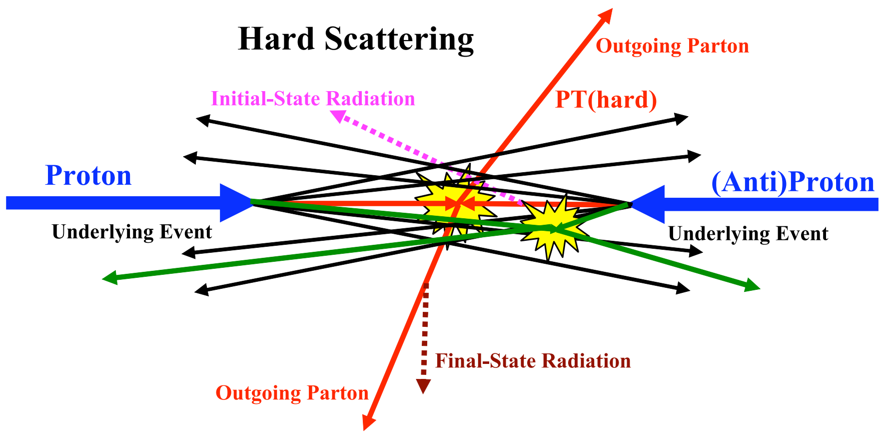

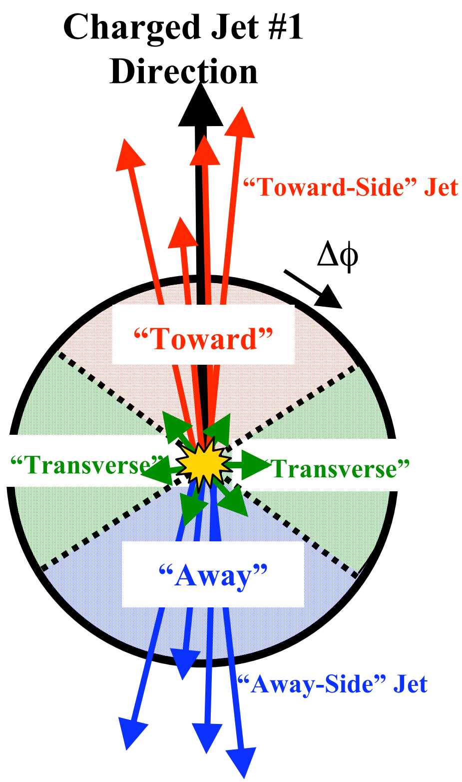

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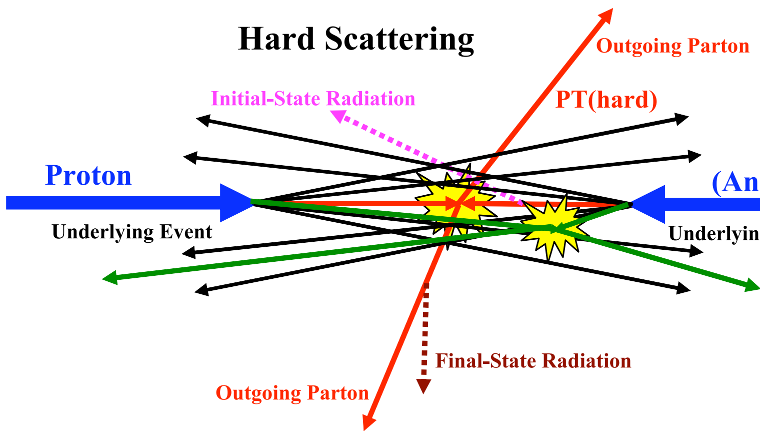

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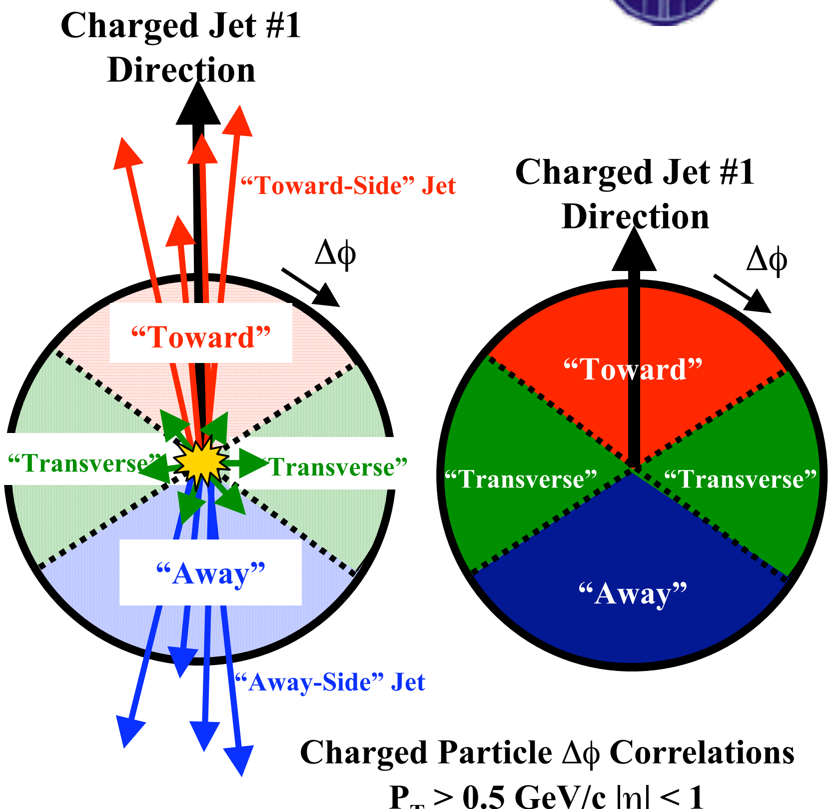

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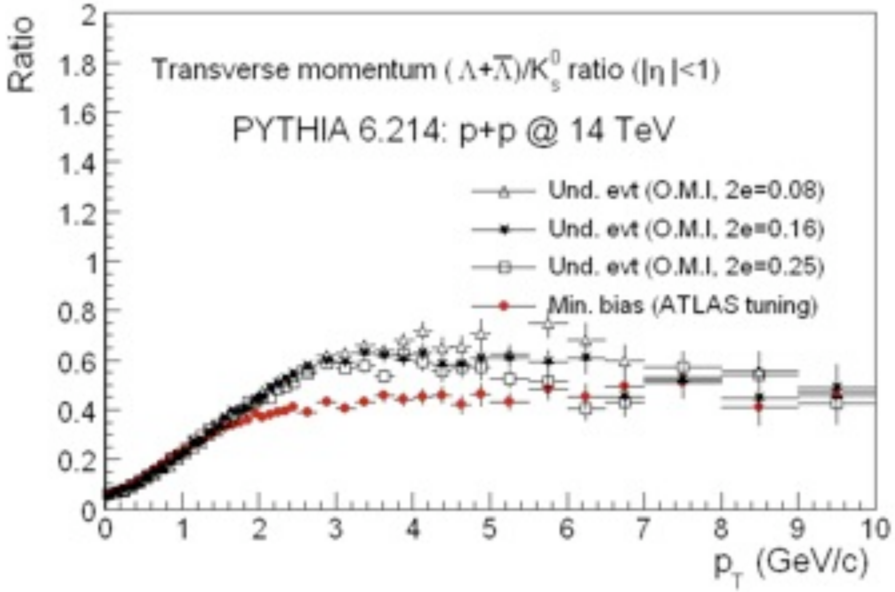
Predictions for B/M p_T ratio: p+p @ 14 TeV

Differences between min. bias and underlying event description

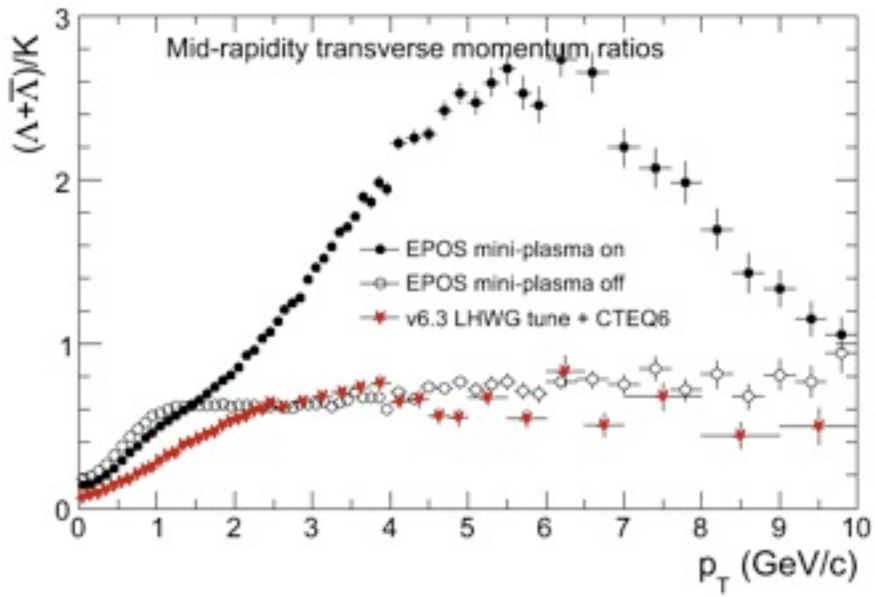


Checking uncertainty for parameters energy dependence:
PYTHIA authors' suggestions : **2ε~0.08** ⇨ **0.25**

Comparison between standard LHC extrapolation and underlying event description

Little **light/strange** flavour dependence in this region

Underlying event description **needed/enough** for production of hadrons in intermediate p_T region ?



Predictions from EPOS can lead to higher ratios

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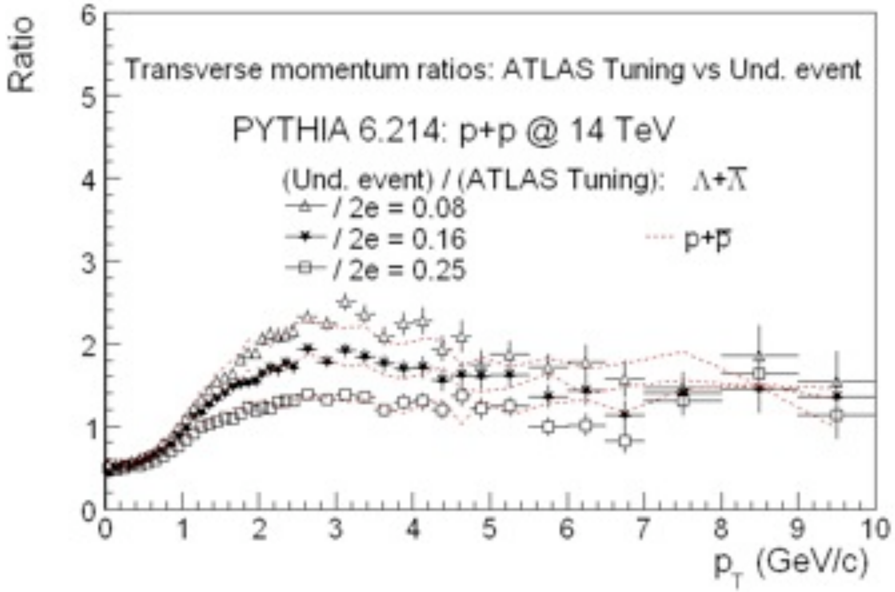

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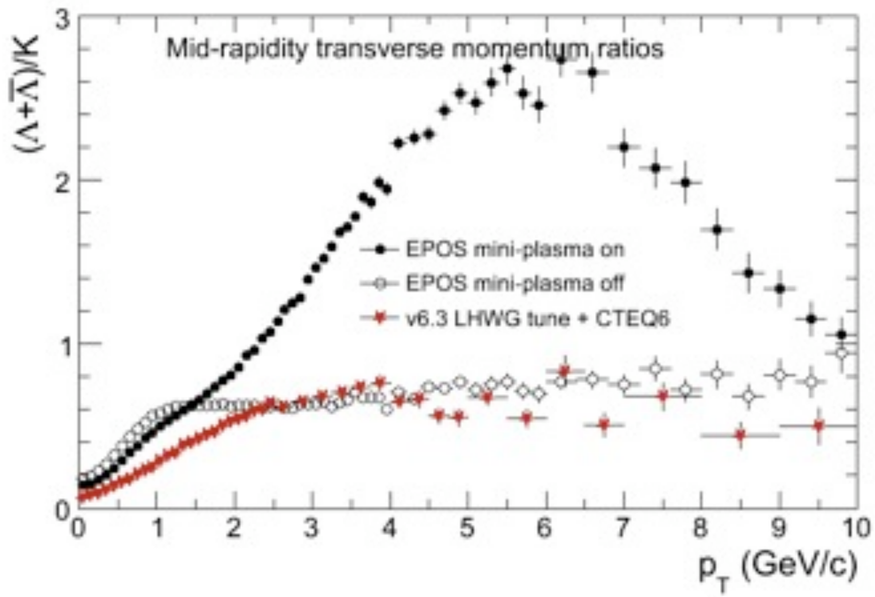

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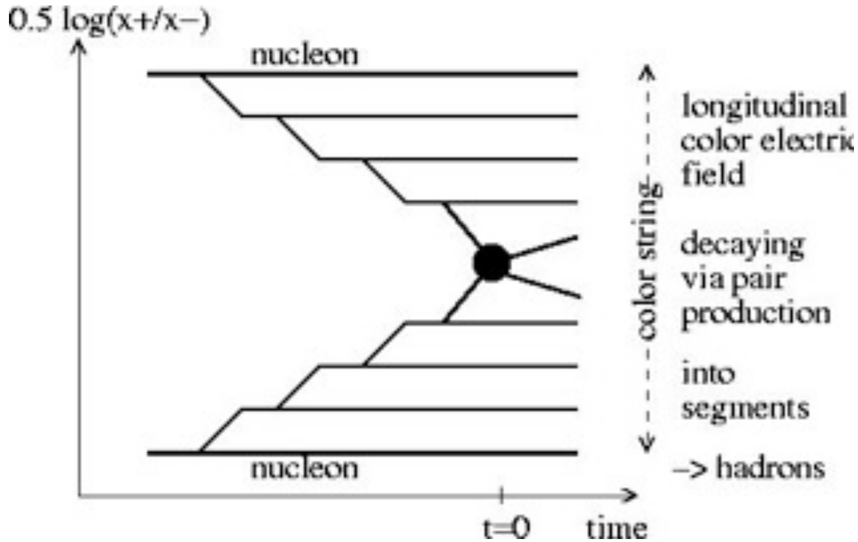
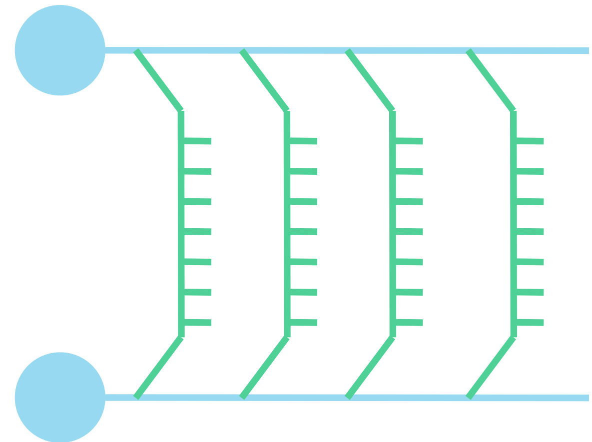
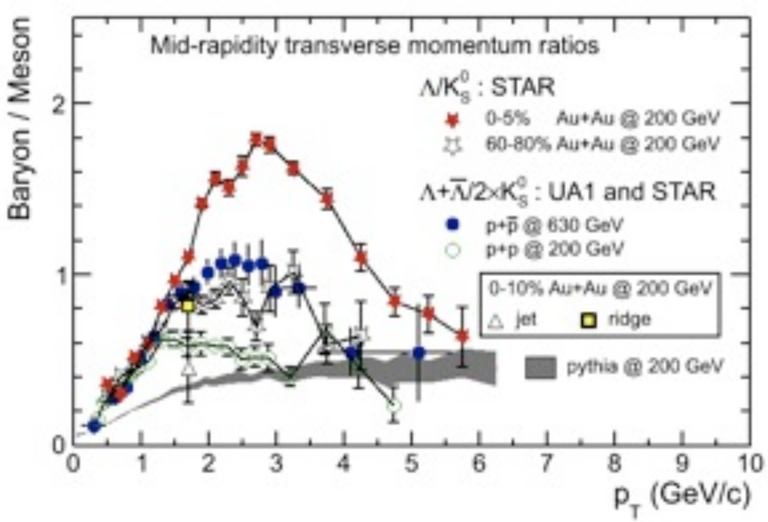
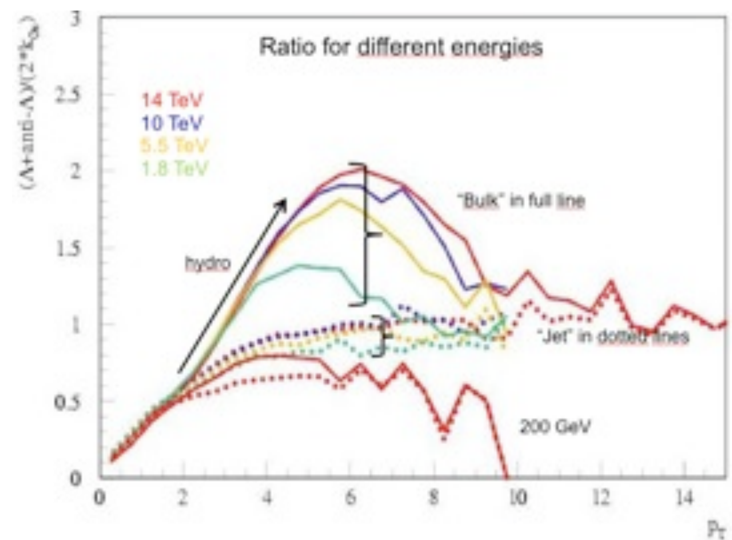
Slide from S. Porteboeuf's presentation





Multiple interaction based on exchange of parton ladders
Existing **light/strange** flavour dependence in this region

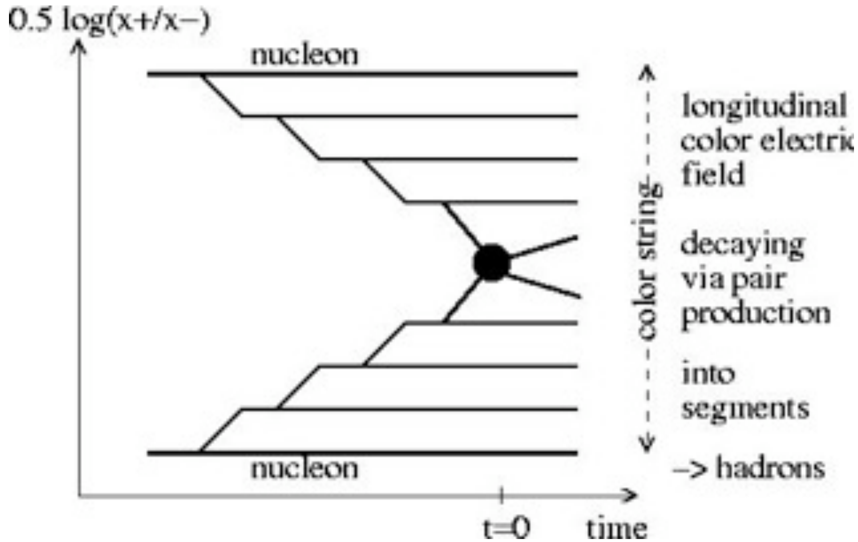


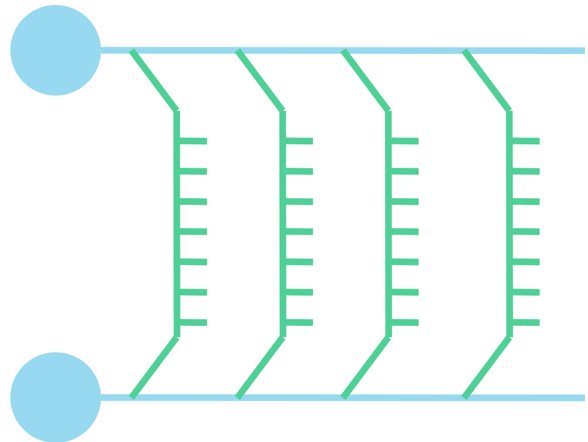


for EPOS at 14 TeV: collectivity and jet contributions

Predictions for B/M p_T ratio: p+p @ 14 TeV

Slide from S. Porteboeuf's presentation





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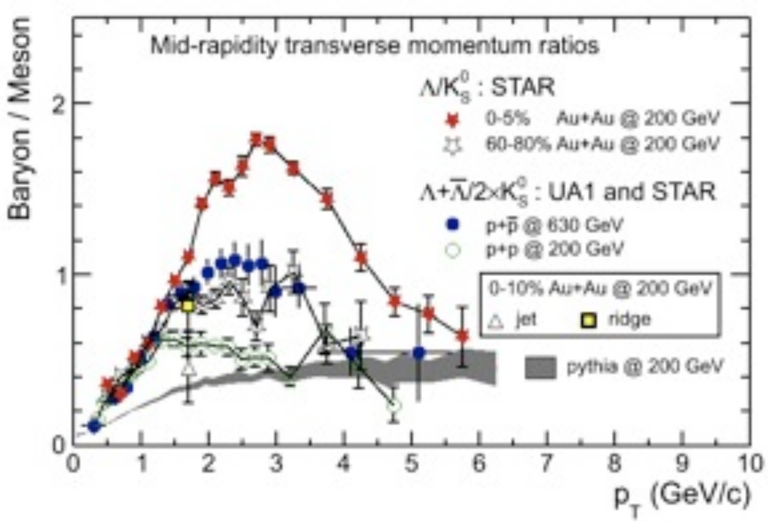
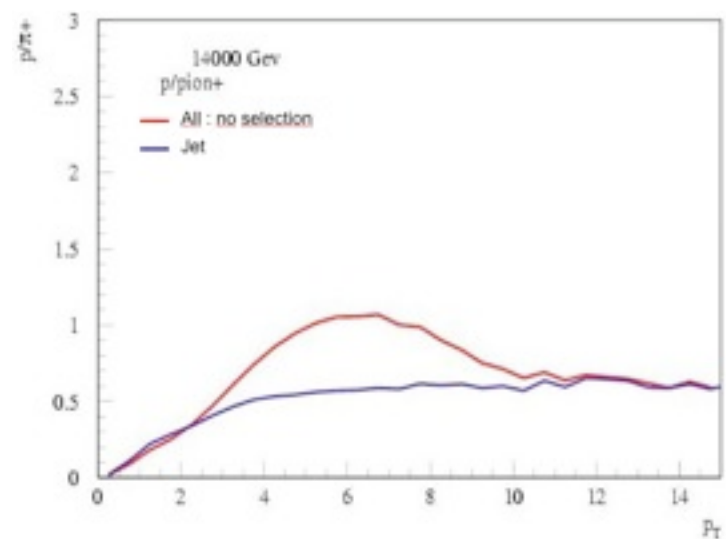


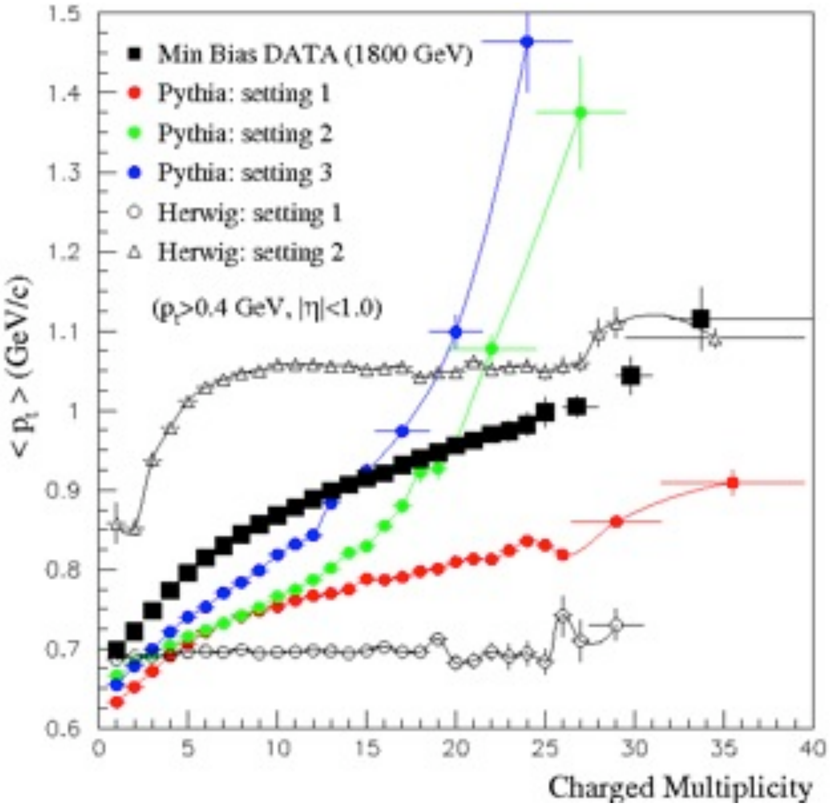


for EPOS at 14 TeV: collectivity and jet contributions

Multiple Parton Interaction: Progress with CDF data

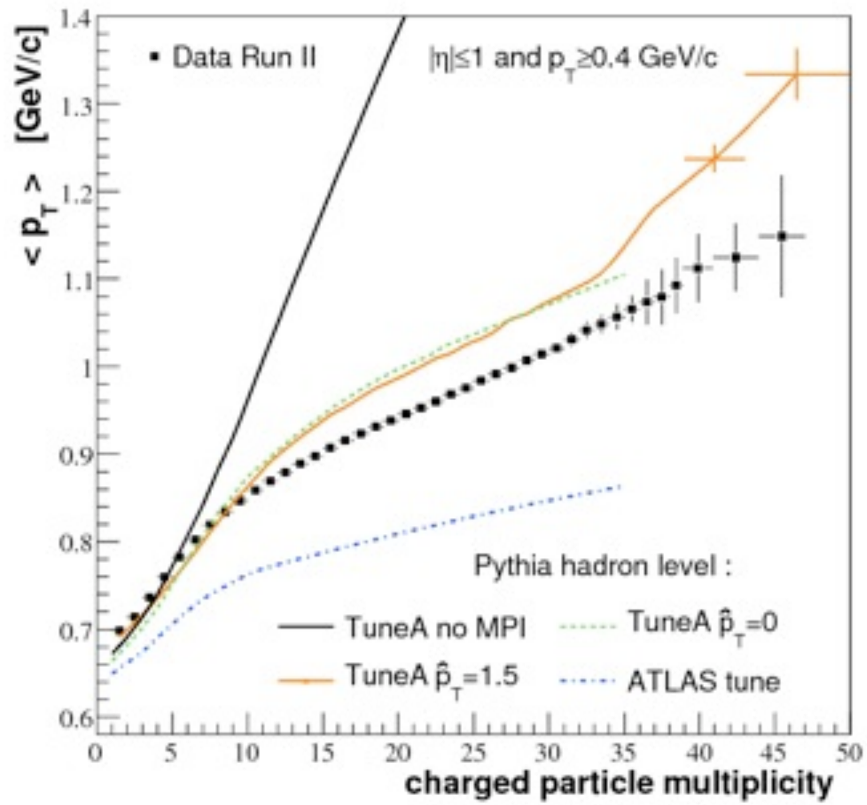
Min. Bias CDF data for p̄+p @ 1800 GeV (Run I) and p̄+p @ 1960 GeV (Run II)

Shown already in K. Werner's presentation



D. Acosta et al. (CDF Collaboration), Phys. Rev. D 65, 072005 **(2002).**

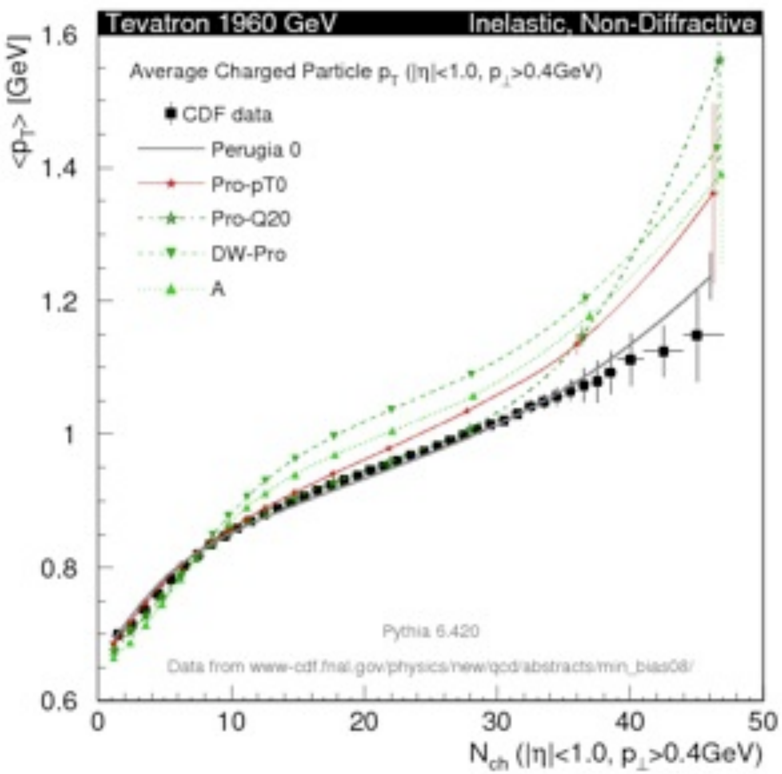
Shown already in I. Kraus' presentation

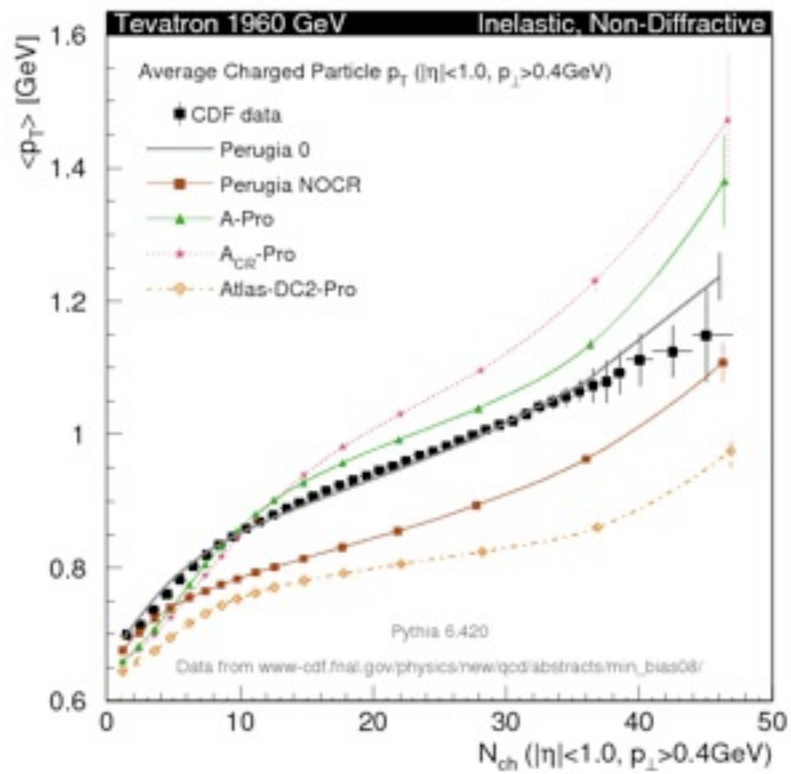


T. Aaltonen et al. (CDF Collaboration), hep-ex 0904.1098 **(avril 2009).**

Progress with using PYTHIA descriptions

Peter Skands proceedings at the 1st International Workshop on Multiple Partonic Interactions at the LHC, Perugia, Italy, Oct 2008





Comparisons to the CDF Run II measurement of the average track p_T as a function of track multiplicity in min-bias pbarp collisions. Left: a representative selection of models. Right: the impact of varying models of color (re-)connections on this distribution.

Discussions

Measurement of Particle Production and Inclusive Differential Cross Sections in pbarp Collisions at $\sqrt{s}$ = 1.96 TeV

T. Aaltonen et al. (CDF Collaboration), hep-ex0904.1098 (avril 2009).

VII. CONCLUSIONS

Minimum-bias collisions are a mixture of hard processes (perturbative QCD) and soft processes (nonperturbative QCD) and, therefore, are very difficult to simulate. They contain soft beam-beam remnants, hard QCD 2-to-2 parton-parton scattering, and **multiple parton interactions** (soft and hard). **To simulate such collisions correctly, the appropriate combination of all the processes involved must be known.**

This paper provides a set of high precision measurements of the final state in minimum-bias interactions and compares them to the best available MC model. The following observations may be made:

– The former **power-law modeling of the particle p_T spectrum is not compatible with the high momentum tail ($p_T \geq$ 10 GeV/c) observed in data**. The change of slope confirms that **the MB spectrum is modeled by the mixing of soft and hard interactions**.

This distribution may be seen as an indirect measurement of such compositeness. The continuity of the p_T spectrum and of the $C_{\langle p_T \rangle \text{ vs. } N_{ch}}$ dependence, and the absence of threshold effects on such a large scale, indicate that there is **no clear separation of hard and soft processes other than an arbitrary experimental choice**. The more recent tunings of the pythia MC generator (Tune A) reproduce the inclusive charged particle p_T distribution in data within 10% up to $p_T \simeq$ 20 GeV/c but the prediction lies below the data at high p_T . This may mean that the tune does not have exactly the right fraction of hard 2-to-2 parton-parton scattering and, also, that **there is more energy from soft processes in the data than predicted.**

– The $\sum E_T$ cross section represents the first attempt to measure the neutral particle activity in MB at CDF. The **MC generator tuned to reproduce charged particle production does not closely reproduce the shape of the distribution**. This might be related to the observation that there is **an excess of energy in the underlying event in high transverse momentum jet production** over the prediction of pythia Tune A.

– Among the observables in MB collisions, the dependence of the **charged-particle momentum on the event multiplicity** seems to be one of the most sensitive variables to the relative contributions by several components of MB interactions. This correlation is reproduced fairly well only with pythia Tune A: the mechanism of **multiple parton interactions (with strong final-state correlations among them)** has been shown to be very useful in order to reproduce high multiplicity final states with the correct particle transverse momenta. In fact, **the data very much disfavor models without MPI**, and put strong constraints on multiple-parton interaction models.

The results presented here can be used to **improve QCD Monte Carlo models for minimum-bias collisions** and further our **understanding of multiple parton interactions.**