Soft QCD WG Summary

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QCD@LHC 2011

St Andrews – Scotland – 8/26/2011

Contributions

Common Soft/Hard QCD Session I

14:15 Parton Showers and Multiple Parton Interactions (Zoltan Nagy)

14:45 Discussion

14:55 The universality of Monte Carlo tunes (Rick Field)

15:25 Discussion

15:35 Double Parton Scattering Theory (Jonathan Gaunt)

16:05 Coffee/Tea break

16:30 Soft physics corrections to Jets (Mrinal Dasgupta)

17:00 Discussion

17:10 Color flow in hard scattering processes (Simone Marzani)

17:40 Discussion

Soft QCD Session III

14:00 Soft QCD results from LHCb (Andrea Contu (University of Oxford))

14:30 ATLAS MC Tuning effort (A. Buckley)

15:00 CMS MC Tunning effort (Rick Field (University of Florida))

15:30 PYTHIA MC Status (Richard Corke)

16:00 Coffee/Tea break

16:30 HERWIG MC Status (Christian Roehr)

17:00 Discussion on MC and Tuning

Soft QCD Session II

14:30 Soft QCD and Correlations results from ALICE (Klaus Reygers)

15:00 Correlations at the LHC (Craig Buttar)

15:30 Minireview on models for diffractive excitations and the Lund cascade model DIPSY (Gosta Gustafson)

16:15 Coffee/Tea break

16:30 Forward and Diffractive reslts from CMS and ATLAS (Benoit Roland)

17:00 Discussion on Future of Soft QCD/Correlations

Thanks to all speakers and apologize for not covering everything

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Christian Roehr)

sion on MC and Tuning

We will rather go through some topics that leaded to discussions and for which further work is needed

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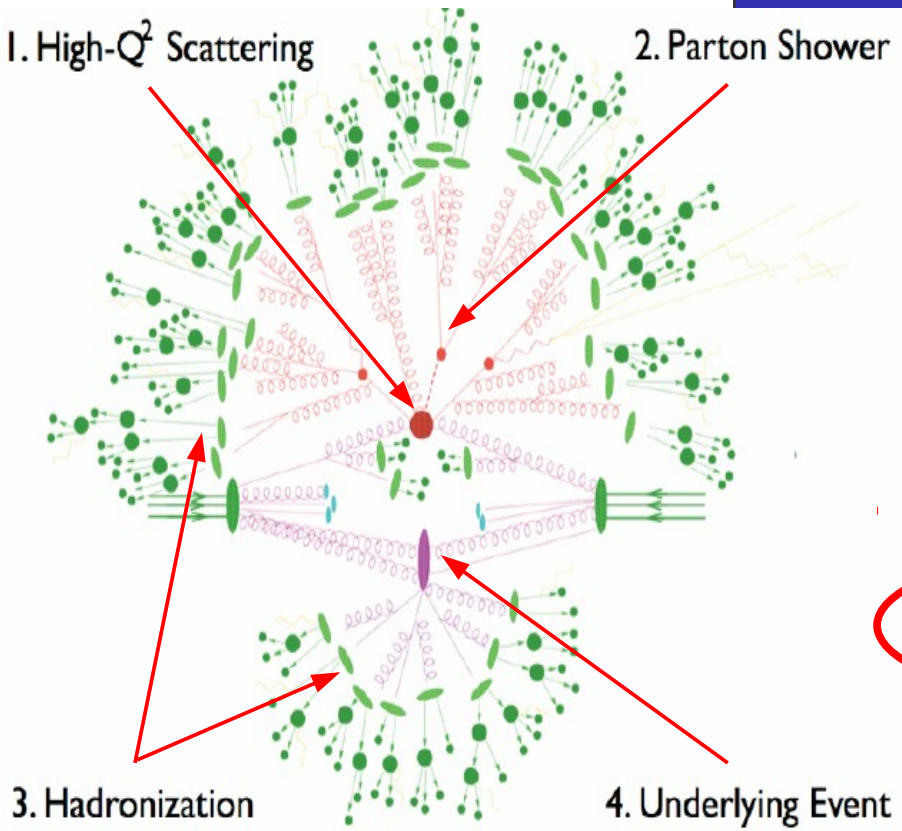
Scope of "Soft QCD WG"

The majority of the pp collisions are soft
→ no hard parton scattering → no "perturbative" predictions
→ need to model them phenomenologically

Hard vs soft physics

to jets

Mrinal Dasgupta



Have to consider a plethora of effects. A loose classification can be

- Hard QCD corrections : Perturbative calculations, soft gluon resummation, parton showers.
- Soft corrections : everything else (hadronisation, underlying event etc)

Hadronisation has a natural scale Λ_{QCD}. For scales larger than this a perturbative approach can be used. Scale of UE is larger but an open question.

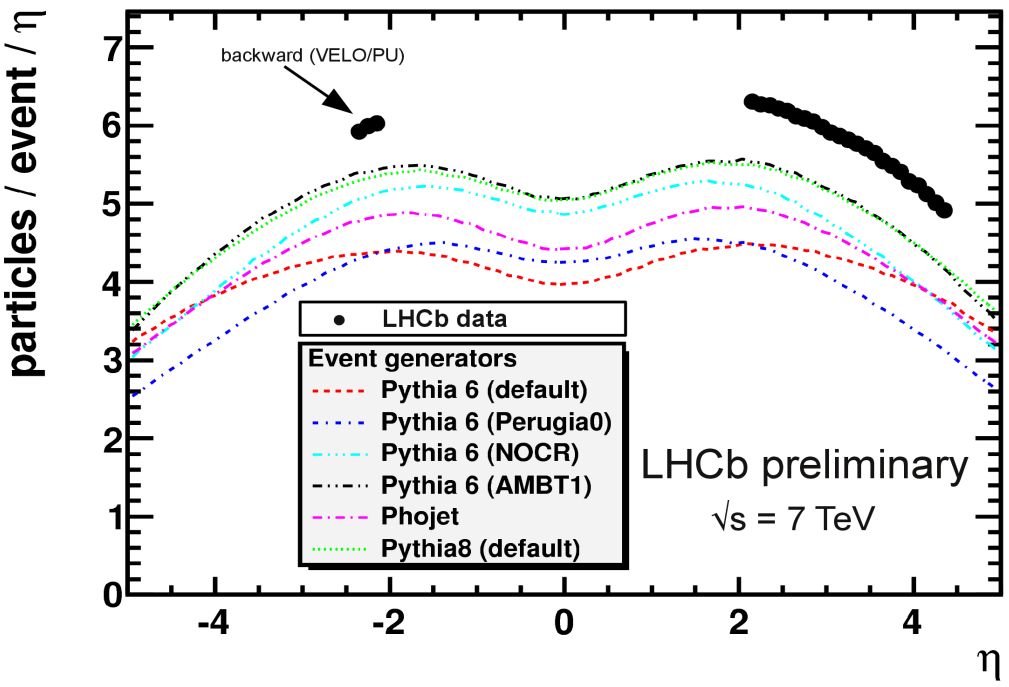
How well can we disentangle the various contributions? Do they have different dependence on various experimental parameters: e.g jet flavour, radius, p_t etc?

Can we come up with measurements addressing this ?

LHC Results: MinBias and UE

Plenty of results from ATLAS/CMS (see plenary talks) and ALICE/LHCb:

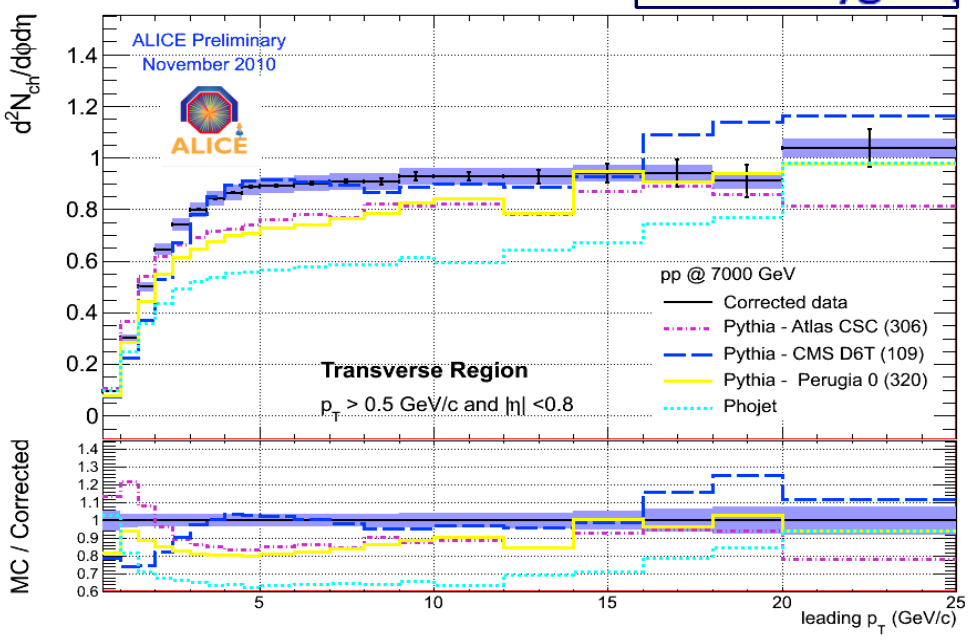
Andrea Contu



Publish "corrected" data in HEPData/Rivet

* Only corrected results useful for comparison to theory/models
* Rivet default in ATLAS/CMS for new standard model analysis approval
  What about LHCb/ALICE results ?
* From preliminary to papers, it takes time (careful further cross-checks performed)

Klaus Reygers



Compare data to other MC e.g. different hadronization models, ...

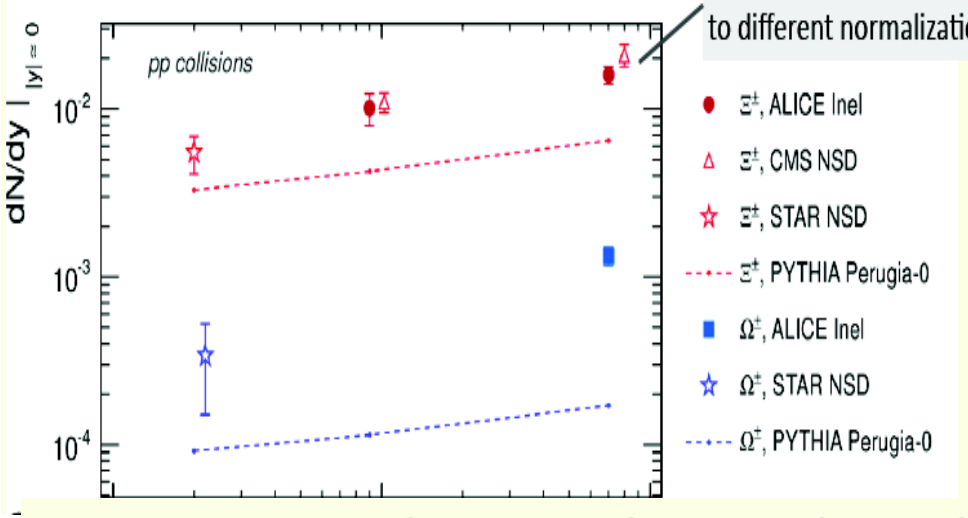
* Solved via Rivet (but slow) !
* Best would be if experiments do it directly

Study particle flavour in UE

* Ongoing in some experiments ….

LHC Results: Identified Particles

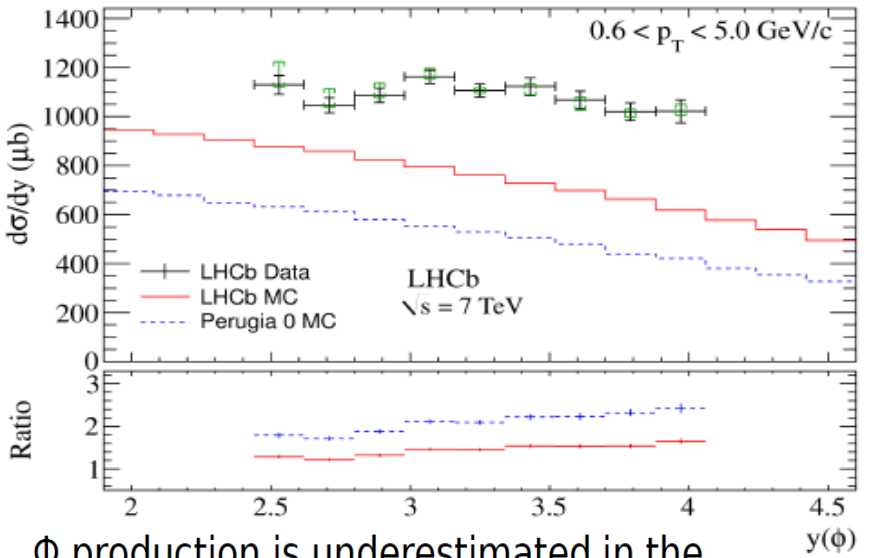
Multi-strange Hadrons (II): Klaus Reygers



- Hyperons: Large discrepancy between data and Pythia

Inclusive Φ Cross Section

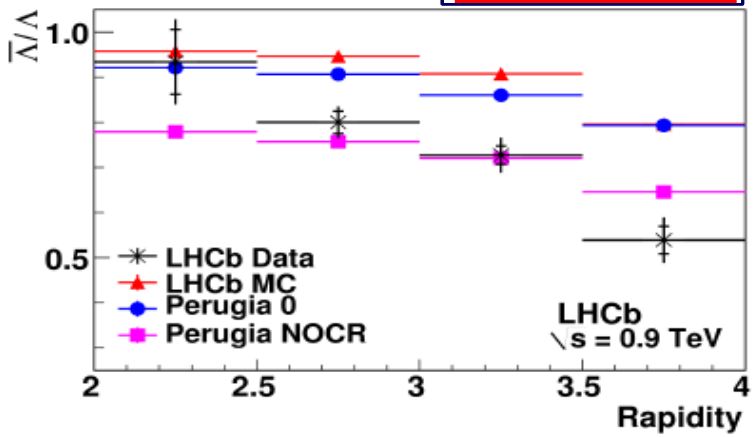
Andrea Contu



Φ production is underestimated in the measured kinematic range by both tunings

$\bar{\Lambda}/\Lambda$ Results

Andrea Contu



Baryon transport higher than predicted by LHCb MC

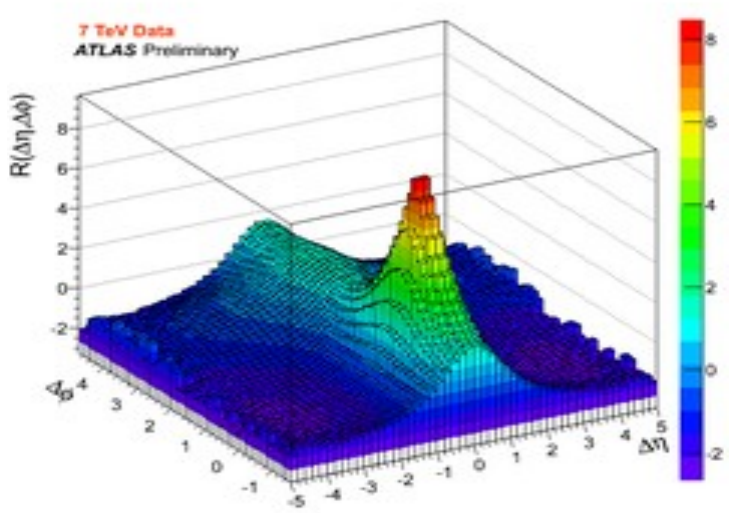
Other measurements to be performed to understand these effects:

* Lambda / Lambda_bar ratios at central rapidity from CMS/ATLAS/ALICE
* Correlations for identified particles: Kaons, Lambdas, …

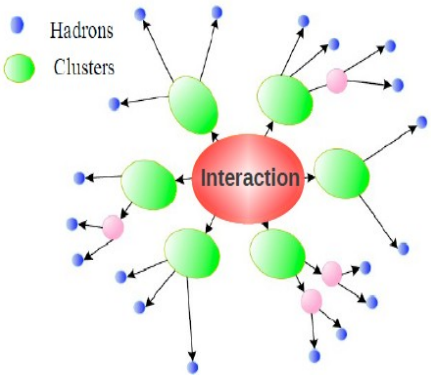
LHC Results: Correlations

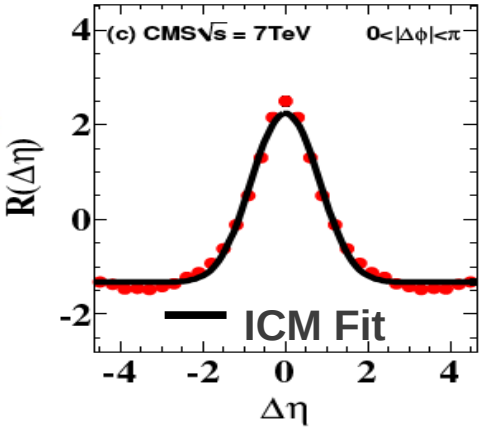
Craig Buttar

Two-particles correlation in Δη and Δϕ

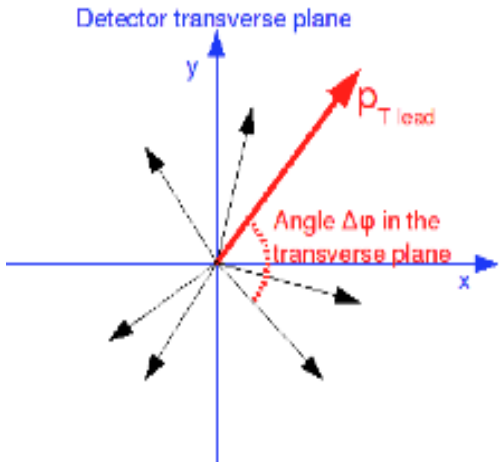


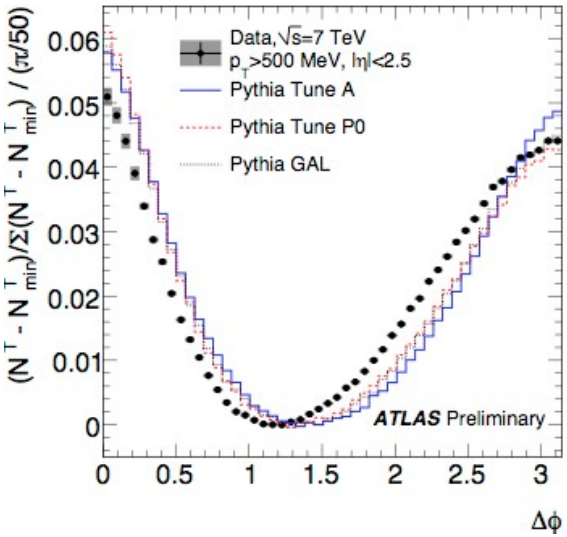
- Short range correlations in Δη can be characterized by 2 parameters:
  - cluster size K → # correlated particles
  - cluster width δ → Δη correlation size





Δϕ Correlations (cresp)





Correlations (vs) MC tuning:
→ Identify parameters to vary to discriminate between component: e.g. pT cut to remove soft contribution, include hard scale, …
→ Study of forward-backward correlations to probe MPI (dominant at large Δη)

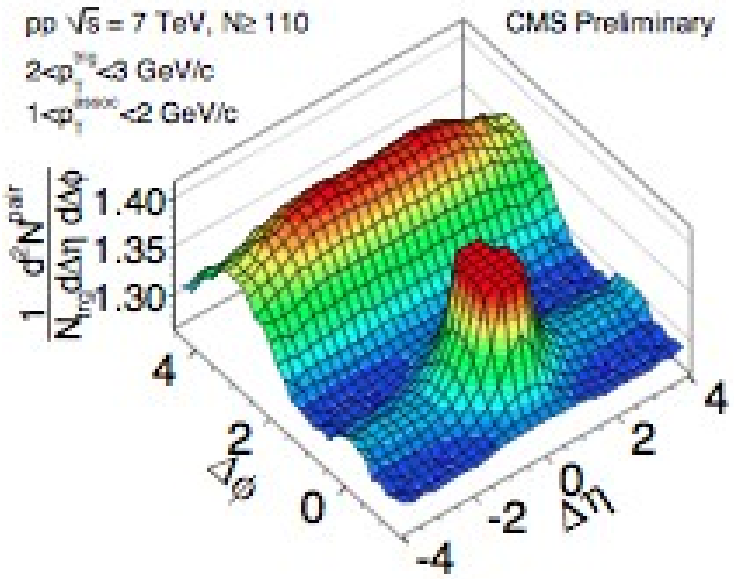
Cluster model fit:
→ Do we have to use another functional form

LHC Results: High Multiplicity Events

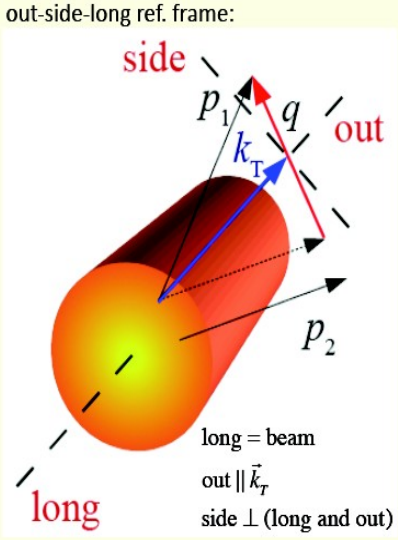
Klaus Reygers

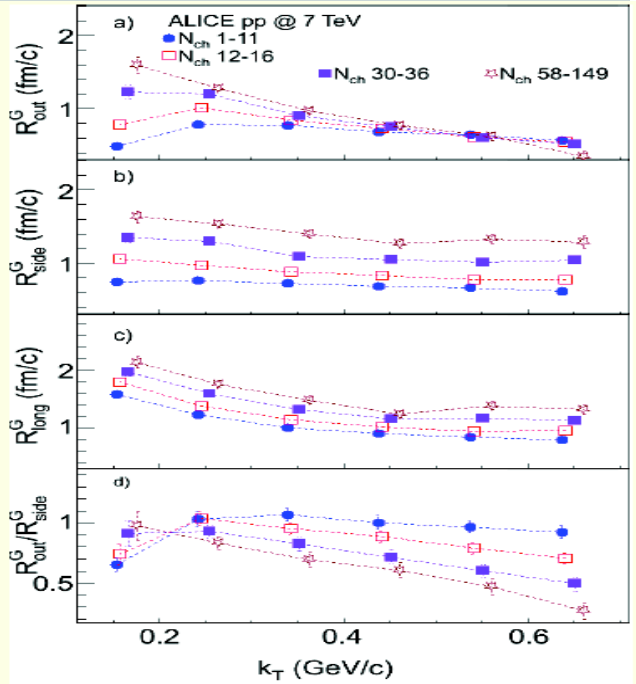
→ Observation of a Long-Range, Near-Side angular correlations at high multiplicity in pp events at intermediate p_T (Ridge at $\Delta\phi \sim 0$)

Craig Buttar



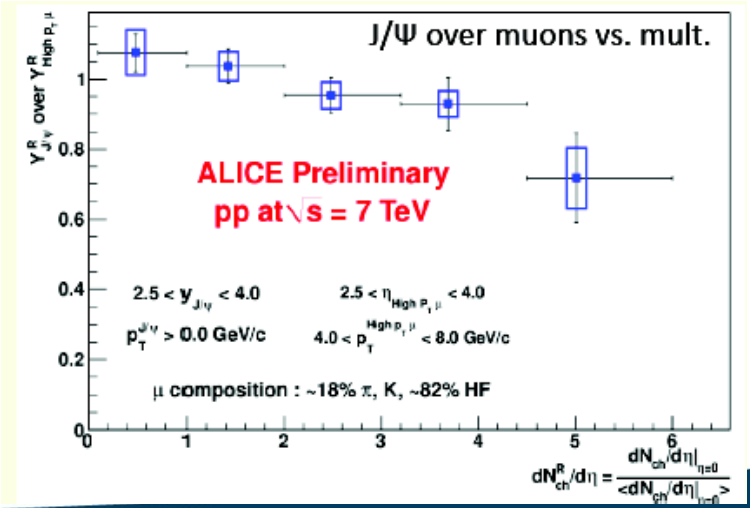
Bose-Einstein Correlations of Identical Pions





Klaus Reygers

J/Ψ Yield as a Function of Charged-Particle Multiplicity



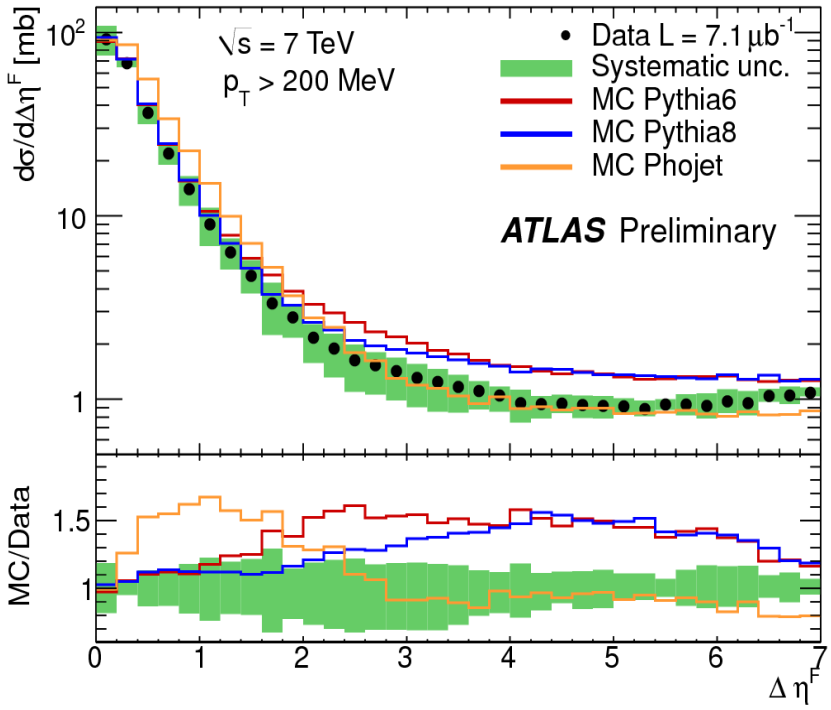
High Multiplicity events studies to do:

* Redo ALICE analysis (BEC, J/Psi, …) in CMS and ATLAS if possible
* s/u ratio (vs) multiplicity
* particle flavour composition (in jets) vs multiplicity
* properties of jets (constituent, brodening, …) vs multiplicity

LHC Results: Forward and Diffraction

Rapidity Gap Cross Section

Benoît Roland



Cross Sections for Inelastic p+p Collisions, and Single-Diffractive and Double-Diffractive Dissociation

Klaus Reygers

SD x-section extrapolated by MC !

√s (TeV)	σ_{inel} (mb)	$\sigma_{SD}/\sigma_{inel}$	$\sigma_{DD(\Delta\eta>3)}/\sigma_{inel}$
0.9	no v. d. Meer scan	0.202 ± 0.034	0.113 ± 0.029
2.76	62.1 ± 1.6 ± 4.3	0.187 ± 0.054	0.125 ± 0.052
7	72.7 ± 1.1 ± 5.1	0.201 ± 0.039	0.122 ± 0.036

Diffraction – how to make the most useful measurements?

- Measuring a 'diffractive cross-section', by subtracting the non-diffractive events, has been the previous typical approach, e.g. at the Tevatron.
  - This is not really in keeping with the current ATLAS/ALICE/CMS approach to measuring well defined final states without MC model dependence.
- Ideally, each experiment could define a *hadron-level* definition of the measurement that **does not** involve subtracting PYTHIA ND events?
  - ATLAS has already attempted this in one soft diffractive measurement:
    - measuring the inelastic cross-section as a function of a forward rapidity gap size, rather than attempting to measure soft single diffraction.
    - Defining the forward rapidity gap at hadron level in terms of particle p_T and η.
  - Can this idea be extended to hard diffraction measurements?
  - Data could be compared outside of the experiments to new models.....

Monte-Carlo tuning and Model building

PYTHIA 8 STATUS

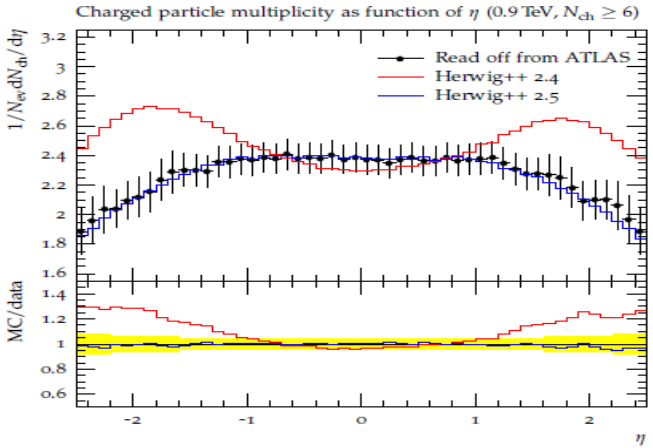
Richard Corke

- Focus of new development; many new features not found in PYTHIA 6.4
  - Fully interleaved $p_\perp$-ordered MPI/ISR/FSR evolution
  - Richer mix of underlying-event processes (γ, J/ψ, DY, ...)
  - Can select two hard interactions in the same event
  - Hard diffractive component (S. Navin)
  - τ lepton polarisation in production and decay (P. Ilten)
  - Updated decay data and LO PDF sets (T. Kasemets)

Underlying Event and Soft Inclusive Events in Herwig++

Christian Röhr

- statistical colour reconnection improves description of MinBias at 7 TeV

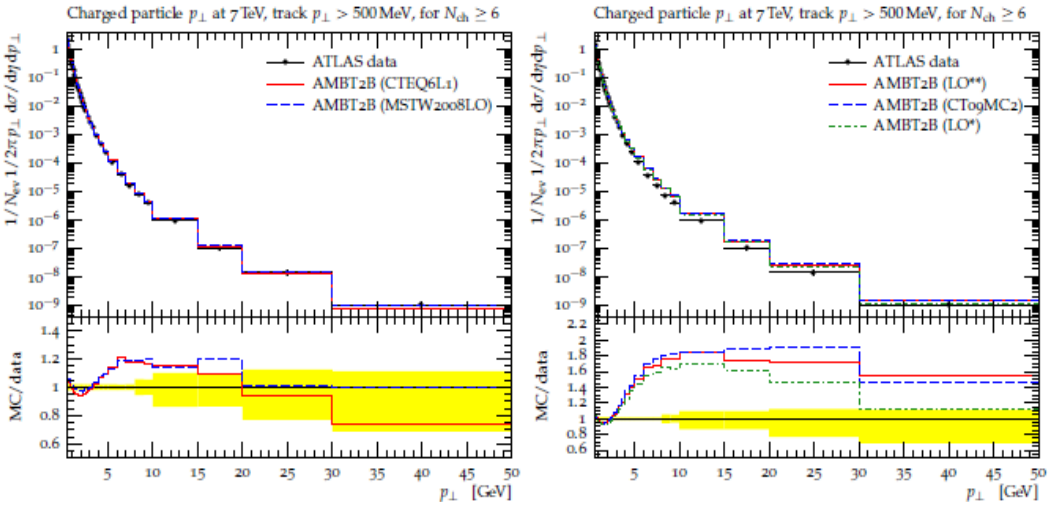


red: no CR, tuned to Tevatron
blue: with CR + tuned to LHC

Developments in (ATLAS) MC generator tuning

Andy Buckley

- Tuning was historically done manually and very ad hoc. Improvement with the original DELPHI PROFESSOR system – reanimated as the Python-based Professor system.



- Interesting feature observed re. features in MPI-dominated plots when modified LO PDFs are used. Similar untuneable features seen for LO*, LO**, and CT09MC2.
- Eigentunes

  Correlated $\Delta\chi^2 = 1$ parameter variations,

+ Status of MC tunes in CMS (Rick Field)
+ Energy dependent Herwig++ tunes (C. Röhr)

Monte-Carlo tuning and Model building

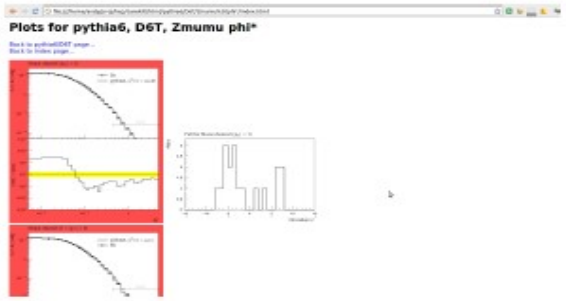
Should we maintain so many tunes of PYTHIA 6&8, HERWIG(JIMMY/++), Sherpa ... ?

A. Buckley

Tune killing

- Les Houches project: quantitatively compare tunes and generators on a set of agreed data.
- Direct comparison on a wide range of physics is itself very useful.
- Info on underperforming tunes can be used to either advocate discarding them or starting work on a replacement.
- It's just a way of gathering relevant information to guide decision making on which tunes to use.

No-one has to follow the recommendations, although if you insist on keeping an evidently broken tune, people may laugh at you.



Answer: No, we should stop using discarded ones for good reason !

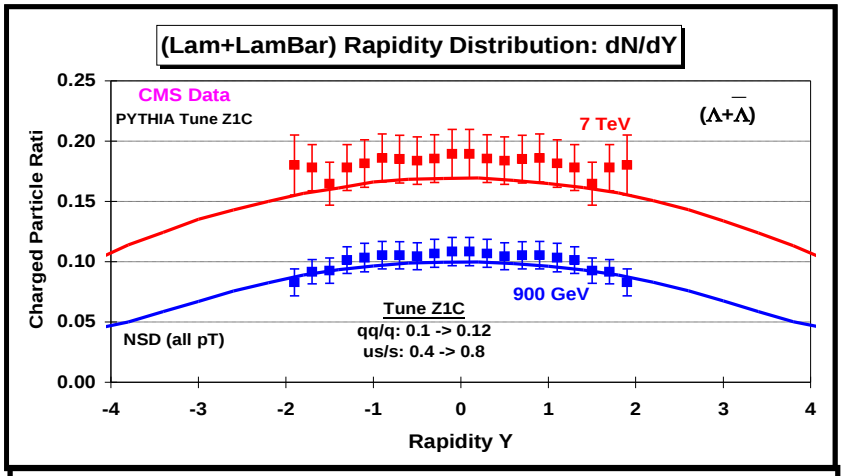
Monte-Carlo tuning and Model building

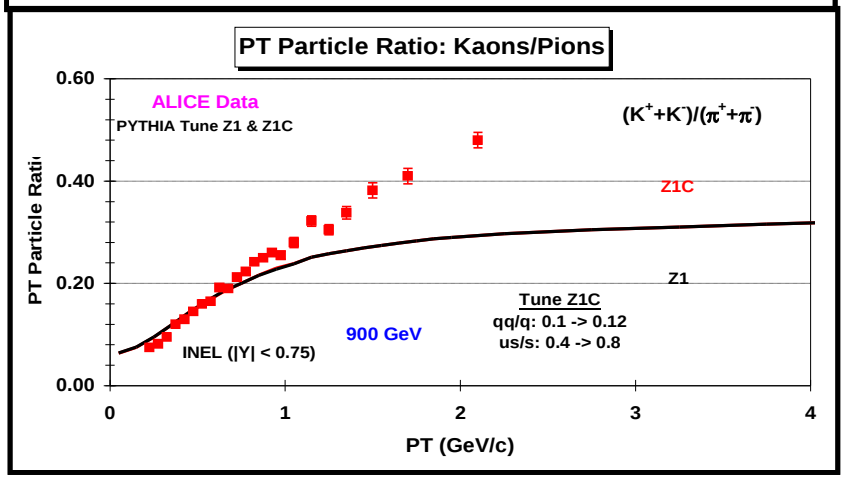
Why should we produce new tunes based on LHC data ?

Answer 1: To be able to describe pile-up at LHC and do searches

Answer 2: Identify places where the MC are failing (and maybe try to develop/test/use other/better models)

R. Field





- Not too hard to get the overall yields of baryons and strange particles roughly right at 900 GeV and 7 TeV.
- **PT Distributions:** PYTHIA does not describe correctly the p_T distributions of heavy particles

  None of the fragmentation parameters I have looked at changes the p_T distributions.
- **Herwig++ & Sherpa:** Before making any conclusions about fragmentation one must check the predictions of Herwig++ and Sherpa carefully!