WG2: Multi-jet final states and energy flows

Sessions:

• Underlying Events and Minimum Bias

• Parton Shower and Matrix Elements matching

• Multi-jet topologies and multi-scale QCD

• Rapidity gaps and survival probabilities

• Common session with the Diffraction group

Session 1 Underlying Events and Minimum Bias

Co-ordinate comparisons of data with models: Pythia, Phojet, Herwig

•Need to be able to use pythia for γp to test LHC tunings at HERA

•B-mesons in min bias events

•Agree standard set of plots and basic data to compare

Study the effect of underlying event on some favourite LHC channels

•Higgs in WH, VBF

•Two pt-cut implementation in Jimmy, can now used for underlying event

Connection to saturation, underlying event in DIS

Session 2 Parton Showers and Matrix Elements matching

A lot of theoretical activity in this area, MC@NLO, HERWIG
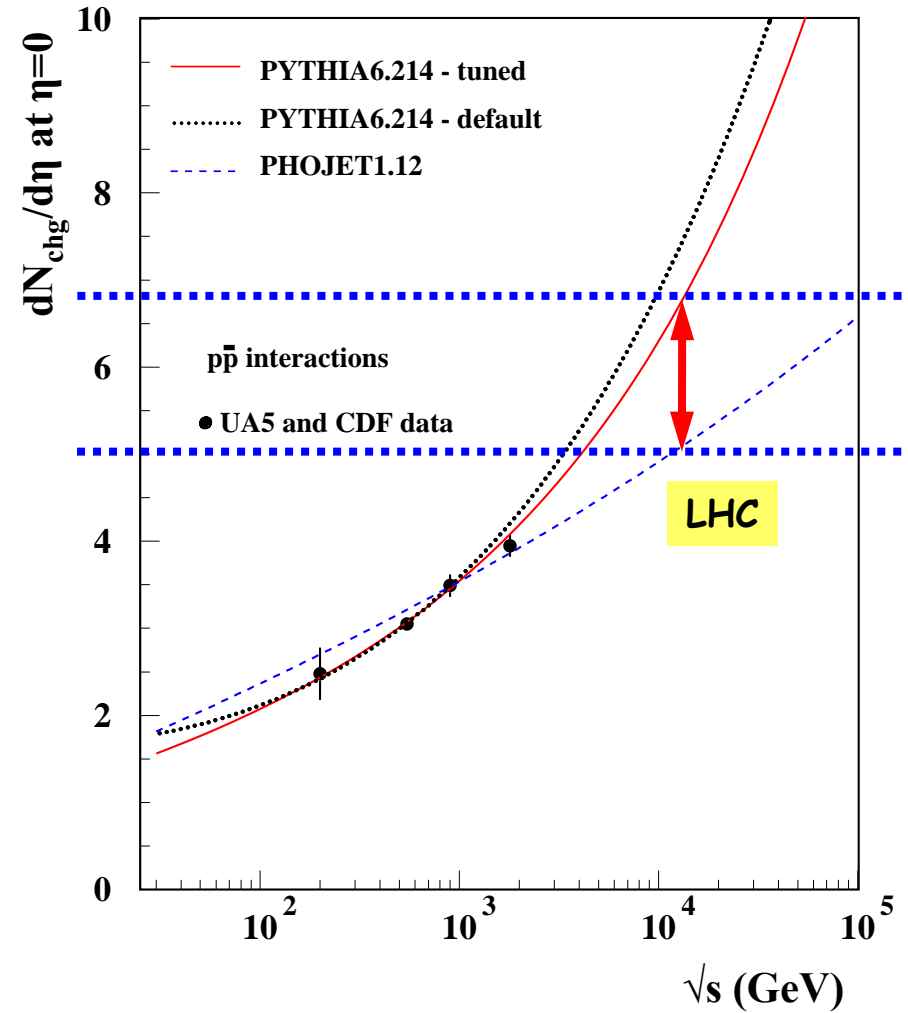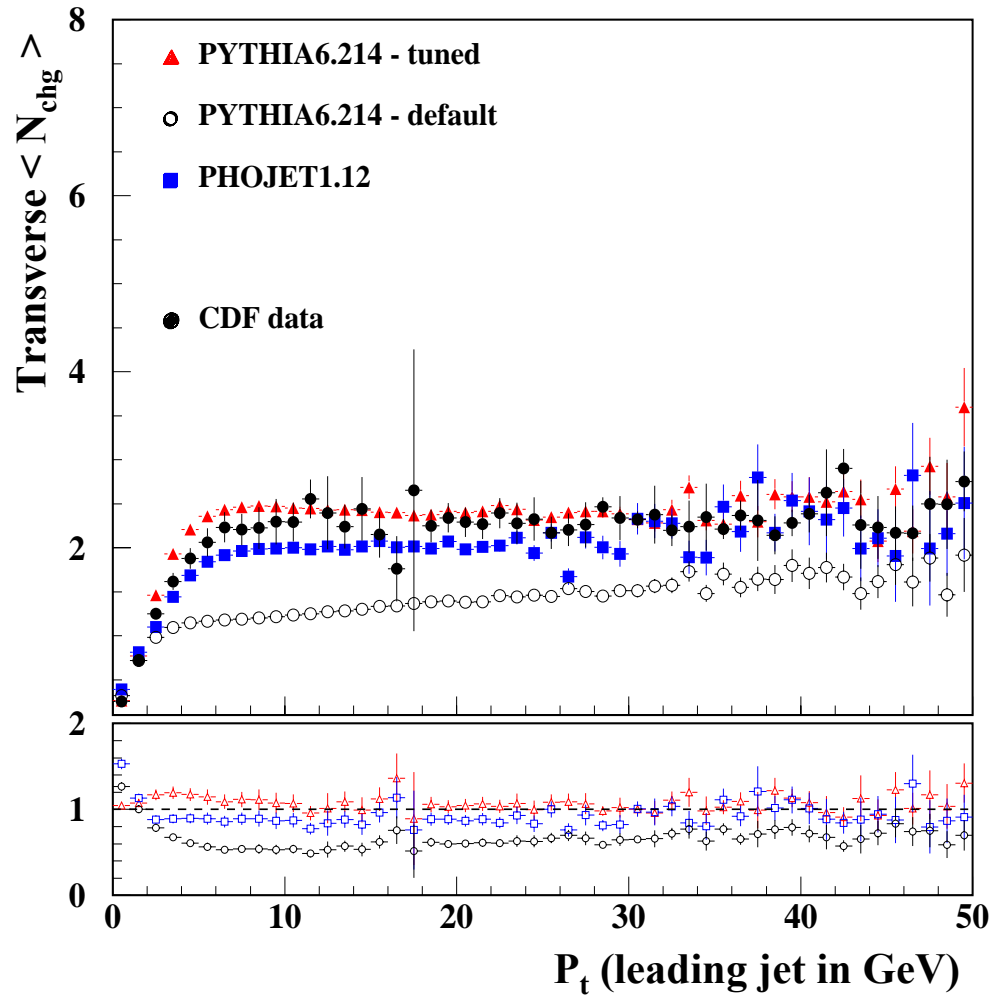
however mainly for pp.

So a plea for theorists to apply this also to HERA data

so that models can be benchmarked at HERA

•MC@NLO@HERA will be looked at
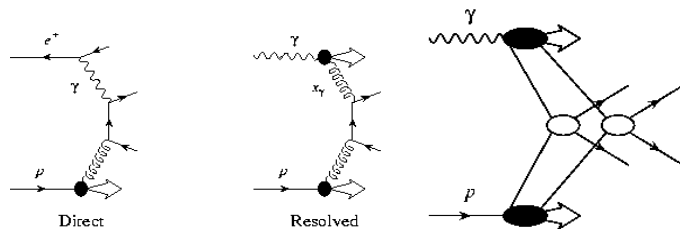
PYTHIA vs PHOJET

Moraes

- PYTHIA models favour $\ln^2(s)$;
- PHOJET suggests a $\ln(s)$ dependence.
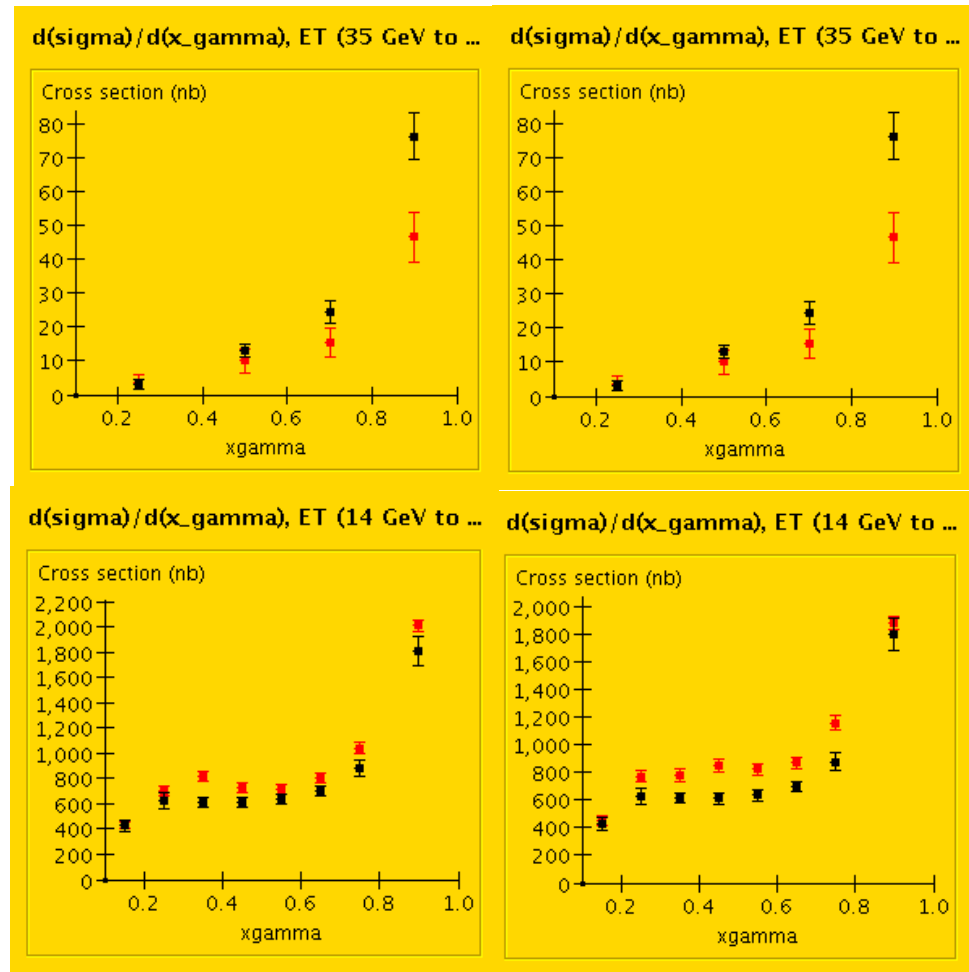
Jetweb comparison
Preliminary

ZEUS precision di-jet
Photoproduction data

	$d\sigma/dx_\gamma \chi^2/DF$	
Jet ET-range	Defaul t	AM tune
35-90	1.4	3.1
25-35	6.8	2.0
17-25	0.9	1.0
14-17	4.0	7.5

Direct Resolved

Default Pythia   Tuned Pythia

d(sigma)/d(x_gamma), ET (35 GeV to ...

d(sigma)/d(x_gamma), ET (14 GeV to ...

Increasing sensitivity to
Underlying event

Moraes

Session 3: Multi-jet topologies and multi-scale QCD

Theoretical effort to solve technical issues

- Non-global logs, quarks in cascade, BFKL@NLO

Measurements already made at HERA- azimuthal jet correlations, forward jets

- What measurements can be made at day-1 LHC to benchmark models ?

- Look at application to LHC processes, particularly forward jets in WW-fusion

- Jet defns of forward jets, experience from HERA→LHC

Session 4: **Rapidity gaps and survival probabilities**

Forward protons/neutrons at HERA, information on re-scattering

- How does this go into models ?

Study of Azimutal Correlations beteen two hardest jets

Q^2

$\gamma*$

$\Delta\phi^*$

κ^2_T

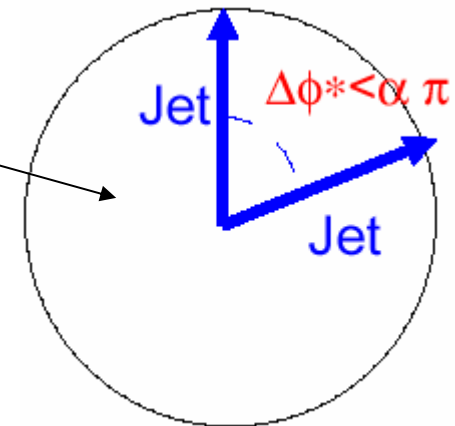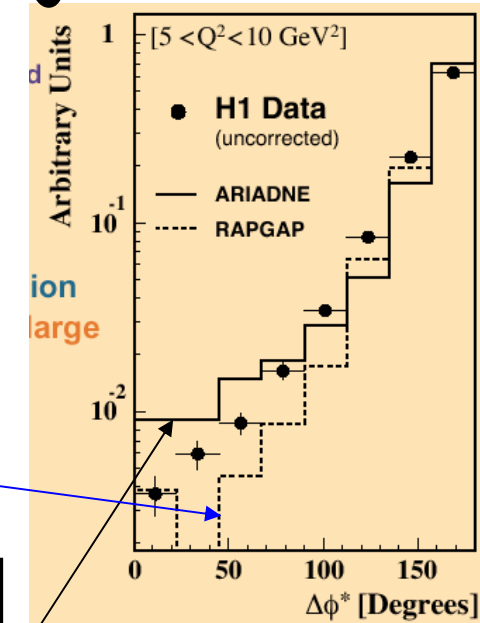DGLAP: $g(x, \kappa^2_T, Q^2) \rightarrow g(x, Q^2)$
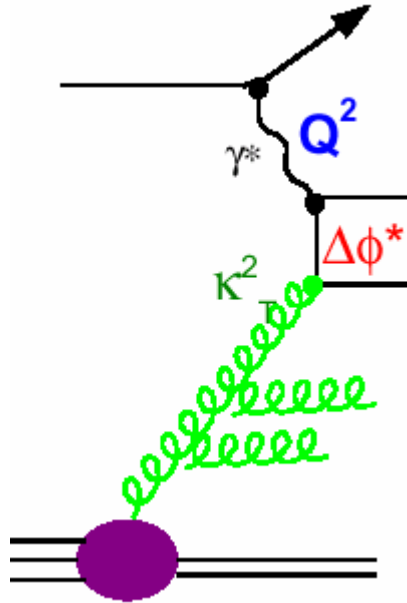
$$\rightarrow \kappa^2_t \approx 0$$

LO: $\Delta\phi^* = \pi$

HE (e.g. PS): $\Delta\phi^* \neq \pi$

NON-DGLAP e.g. ARIADNE

$$\kappa^2_t \neq 0 \rightarrow \Delta\phi^* \neq \pi$$

[5 < Q² < 10 GeV²]

● H1 Data (uncorrected)

—— ARIADNE

---- RAPGAP

Arbitrary Units

$\Delta\phi^*$ [Degrees]

Jet $\Delta\phi* < \alpha \pi$ Jet

Turnau

Inclusive jet production – foward region

H1 Inclusive Jets
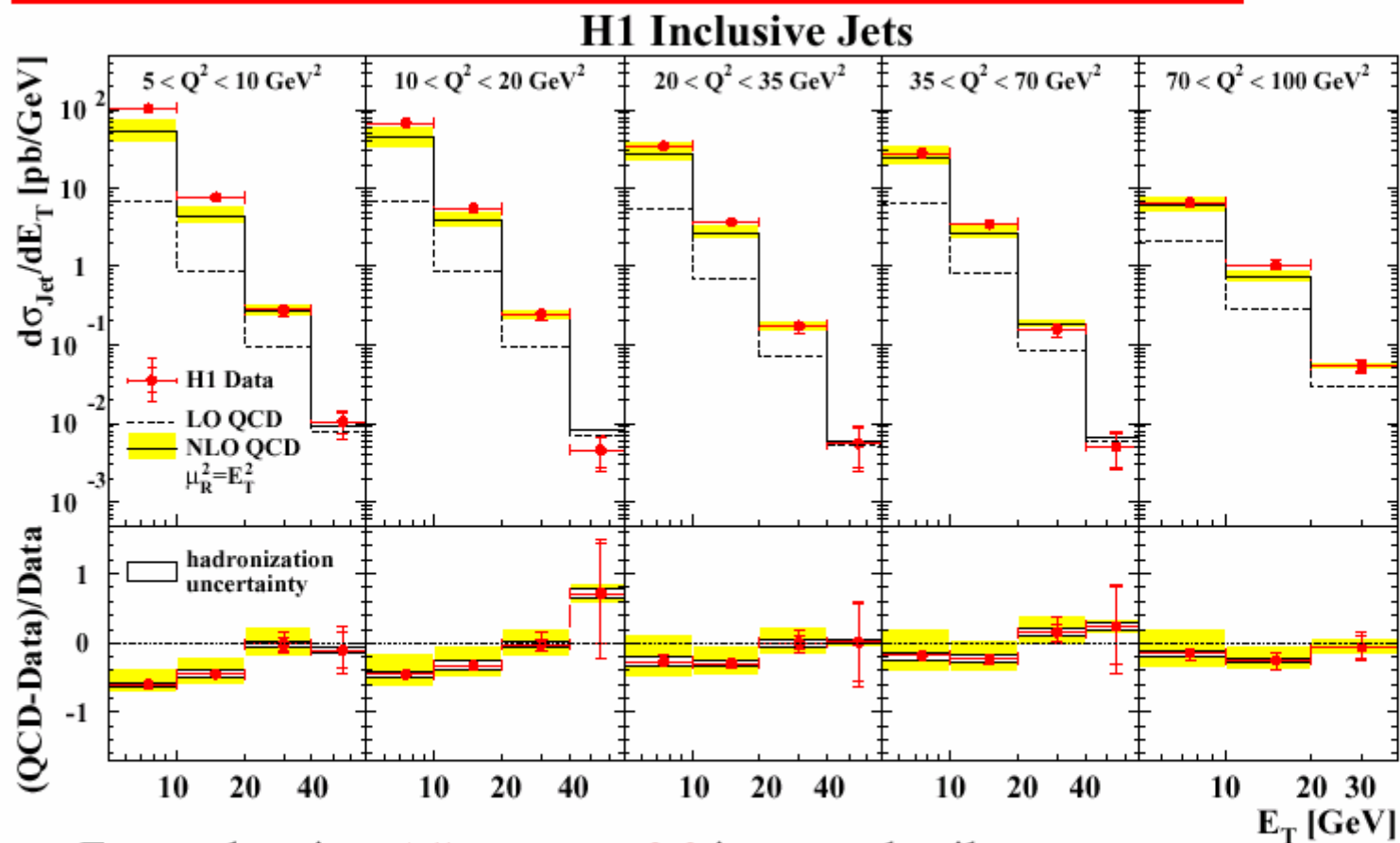
- Forward region, $1.5 < \eta_{lab} < 2.8$ in more detail.
- Discrepancy between data and NLO large at low Q^2 and low E_T.
  ⮕ Improved calculations are needed; Contributions proton PDF's? virtual photon structure? alternative evolution schemes (CCFM, BFKL)?

Turnau

Major Experimental Issues

- Major experimental issues addressed with a full detector simulation (Geant3)

- Tagging forward jets:
  - Efficiencies critical
  - Full simulation used
  - Double tag efficiency ~50%

- Central jet veto:
  - Pile up effects introduce fake central jets
    - Effect small at low luminosity
    - Serious concern at high luminosity
  - Very sensitive to underlying effect
    - Detailed studies underway

Mellado
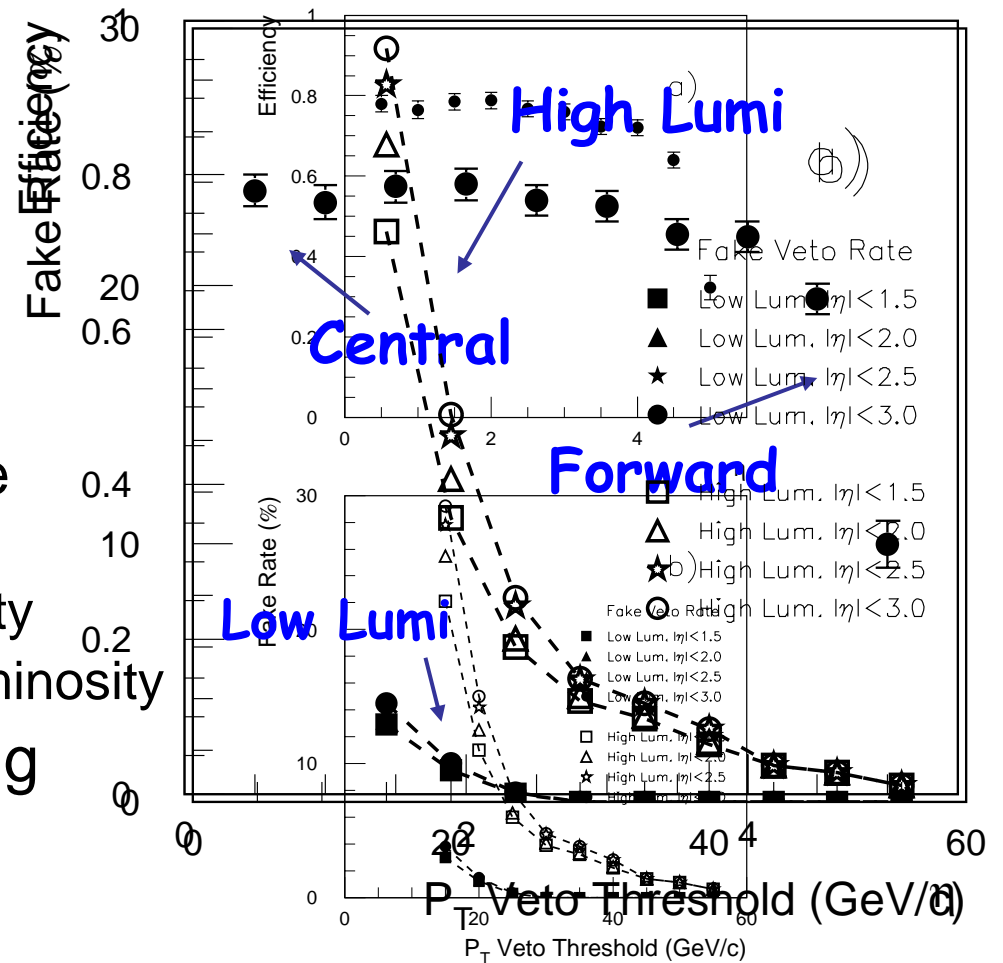
Clear areas where HERA physics is crucial for LHC studies:

Both theoretically and experimentally

Personal list….

• minimum bias and the underlying event

• forward jets

• defining measurements to be made on day-1 for LHC

We look forward to productive work over the next year !