Click to add title

Jeppe R. Andersen

Closing thoughts based on some of the talks, with a few provocative statements to get the discussion going

Jeppe R. Andersen

MC: Push for greater pert. control

POWHEG is the word! (NLO + PS)

Emanuele Re

POWHEG is a powerful method, and it is an implementation.

The POWHEG method

[Nason, JHEP 0411:040,2004]

- POWHEG is a method to merge NLO calculations with Parton Showers:

NLO	PS
✓ reduced scale dependence	✓ Sudakov suppression in collinear regions
✓ better description of high-p_T tails	✓ parton → hadron corrections not needed

- In a nutshell, the method can be summarized by the following *master* formula:

$$d\sigma_{POW} = \bar{B}(\Phi_n)\, d\Phi_n \left\{ \Delta(\Phi_n; k_T^{\min}) + \Delta(\Phi_n; k_T) \frac{R(\Phi_n, \Phi_r)}{B(\Phi_n)} d\Phi_r \right\}$$

where

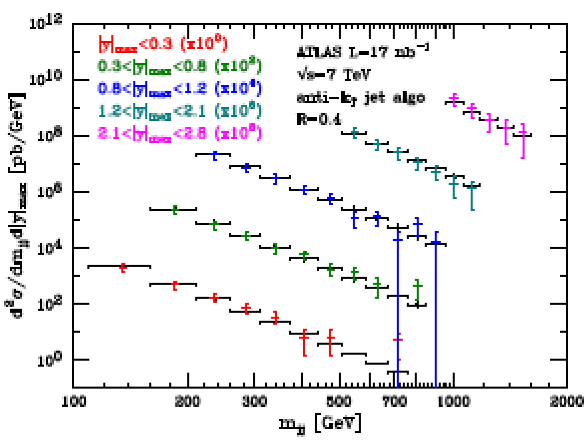
$$\bar{B}(\Phi_n) = B(\Phi_n) + V(\Phi_n) + \int [R(\Phi_{n+1}) - C(\Phi_{n+1})]\, d\Phi_r$$

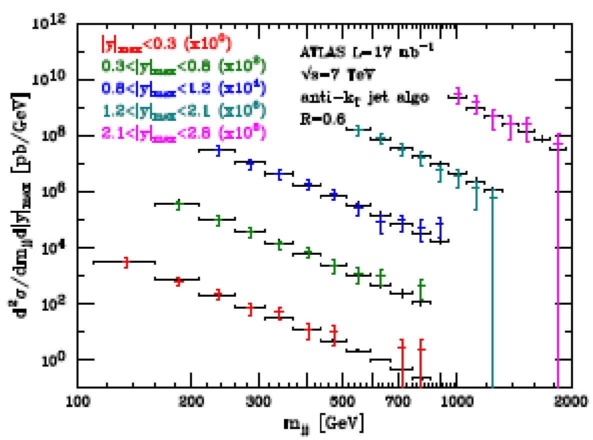
$$\Delta(\Phi_n; k_T) = \exp\left\{ - \int \frac{R(\Phi_n, \Phi_r')}{B(\Phi_n)} \theta(k_T' - k_T)\, d\Phi_r' \right\}$$

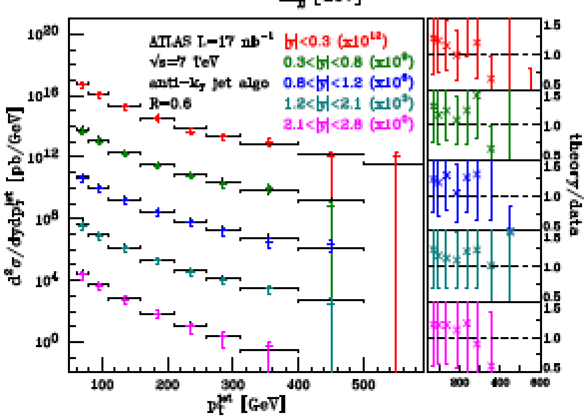
and to avoid double-counting the subsequent emissions are p_T-*vetoed*.

Dijets

[2/3]







- 5M weighted events, $k_{T,cut} = 1$ GeV, $F(p_T) = \left(\frac{p_T^2}{p_T^2 + (200)^2}\right)^3$, folded integration.
- when comparing with first ATLAS data [Eur.Phys.J.C71:1512(2011)], we found good agreement.
- instead, as shown yesterday, with more recent data sizeable disagreement, especially in m_{jj} with R=0.6.
- Problem is currently under study.

Matching of parton shower to NLO (one virtual plus one real correction) is clearly theoretically attractive.

Probably still some details in the implementation to be cleared up.

MC: Push for greater pert. control

POWHEG is the word! (NLO + PS)

MANCHESTER 1824

Herwig++ POWHEGs

Shipping with the current release HW++ 2.5

- hh → γ / Z / W / H / ZH / WH [KH, Richardson, Tully]
- hh → WW / ZZ / WZ [KH]
- H → Q $\bar{Q}$ [Richardson, Winn]
- Spin correlations in decays [also for real emissions]
- QCD coherence via Nason's truncated shower idea

M Seymour

MANCHESTER 1824

POWHEG Validation with Herwig++ and Pythia8

Kiran Joshi, Andy Pilkington, Mike Seymour

University of Manchester

14/04/2011 Kiran Joshi 1

MANCHESTER 1824

The University of Manchester

POWHEG validation conclusion

- Internal/external Powheg should be ~identical
- By default they are as different as Pythia
- Still haven't identified all differences

The POWHEG method has also been implemented by the Herwig++ authors. They are investigating differences in results compared to the implementation by POWHEG authors.

MC: Push for greater pert. control

POWHEG is the word! (NLO + PS)

F. Siegert

Sherpa features

- POWHEG matching for NLO + parton shower
- MENLOPS for POWHEG + CKKW
- Cluster hadronisation model
- Multiple parton interactions

What is MENLOPS?

Hamilton, Nason (2010), Höche, Krauss, Schönherr, FS (2010)

Motivation

- POWHEG:
  - NLO accuracy for inclusive observables
  - LO accuracy for "+1 jet"
  - shower approximation for "+2, 3, ... jets"
- Can one do better especially for the high multiplicities?
- We already know how to get LO accuracy for "+1, 2, 3, 4, 5 jets": CKKW-like ME+PS merging
- Combination of ME+PS and POWHEG: MENLOPS
  - NLO accuracy for inclusive observables
  - LO accuracy for observables sensitive to the first n jets (with n up to ≈ 5, depending on the process)

Availability

- First public availability in Sherpa 1.2.3
- Possible for all processes which are available in Sherpa's POWHEG

The POWHEG method is also implemented in SHERPA.

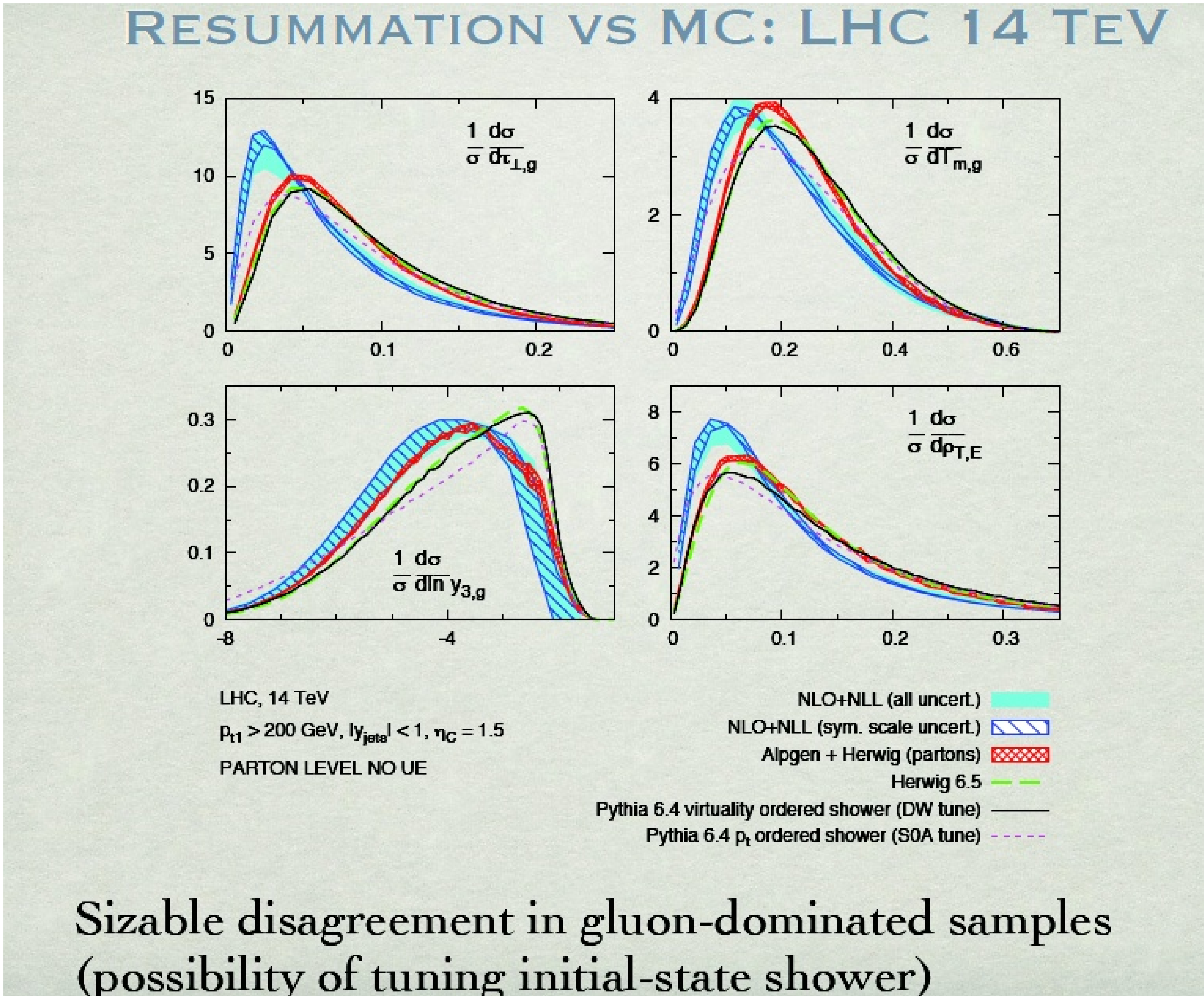
SHERPA also implements a method for matching the parton shower to both NLO and high multiplicity tree-level (MENLOPS).

Checking the MC description

- Hard, perturbative corrections (extra jets)
- Shower domain (shower profiles and large ratios of transverse momenta)
- Underlying event, multiple interactions,...

Would like to check each component independently. Will discuss first a possibility for checking the shower, then observables sensitive to the description of additional hard emissions.

Analytic resm. to check shower?



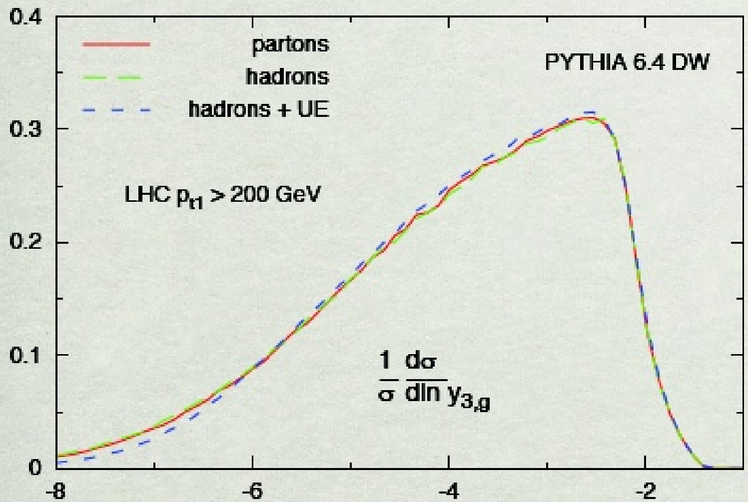
A. Banfi

Analytic resm. to check shower?

A. Banfi

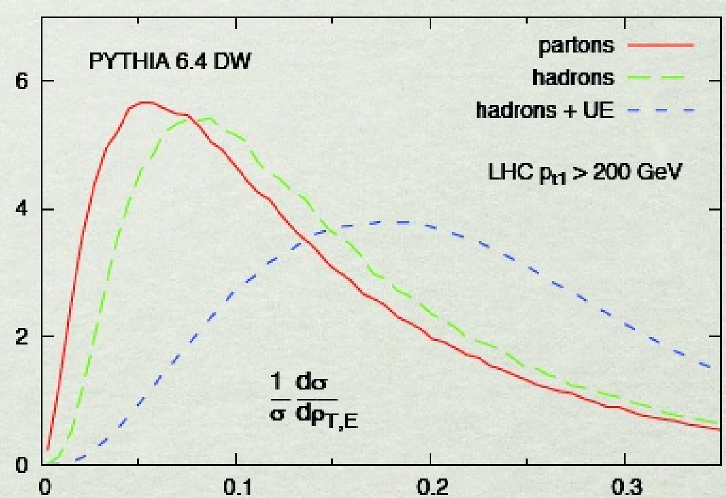
Sensitivity to NP effects

Three-jet fractions are hardly affected by hadronisation and underlying event



- PT predictions can be directly compared to data
- Suitable for tunings of parton shower parameters

Event-shape distributions are heavily distorted by NP effects (hadronisation + UE)



- Comparison to parton level MC for parton shower tests
- Suitable for tests and tunings of models for UE

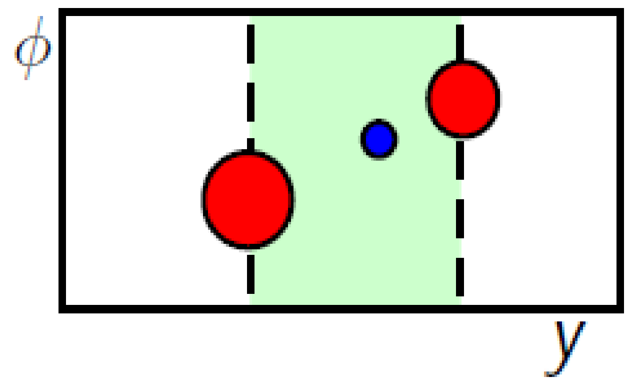
Checking Hard Corrections

Dijet Production with Jet Veto

BROOKHAVEN NATIONAL LABORATORY

Michael Begel

- Measure the hard radiation in the rapidity interval between two jets:
  - sensitive to BFKL dynamics
  - sensitive to wide-angle soft-gluon radiation
  - color-singlet exchange
- This measurement also probes theory predictions and experimental techniques relevant for VBF Higgs searches.



this is different than the traditional "rap gap" measurement focused solely on color-singlet exchange

Boundary Conditions

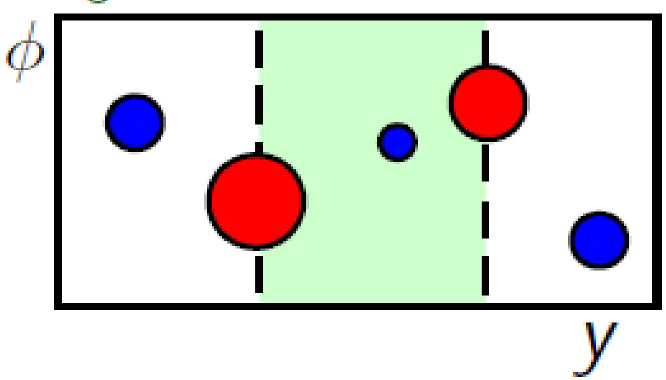
Event Selection:

- anti-k_T jets with $R = 0.6$
- boundary jets require $p_T > 20$ GeV and $|y| < 4.5$
- $\langle p_T \rangle$ of boundary jets > 50 GeV
- veto jet $p_T > 20$ GeV
- single interaction-vertex events

Selection A

boundary jets have highest p_T

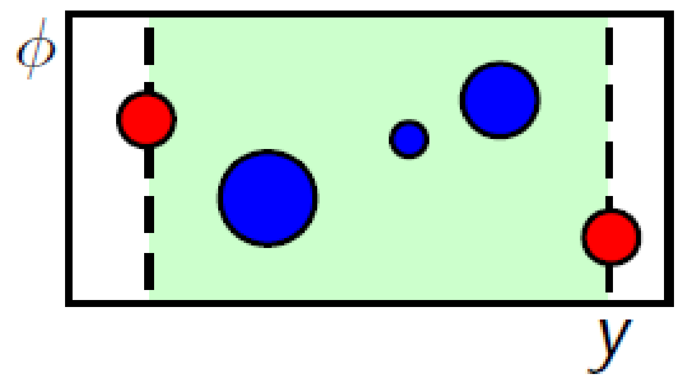
increased sensitivity to wide-angle soft-gluon radiation



Selection B

boundary jets have most forward y

increased sensitivity to BFKL dynamics



Observables (in $\langle p_T \rangle$ and Δy):

- Mean Jet Multiplicity: between boundary jets
- Gap Fraction: fraction of events without jet in gap

Boundary Conditions

Event Selection:

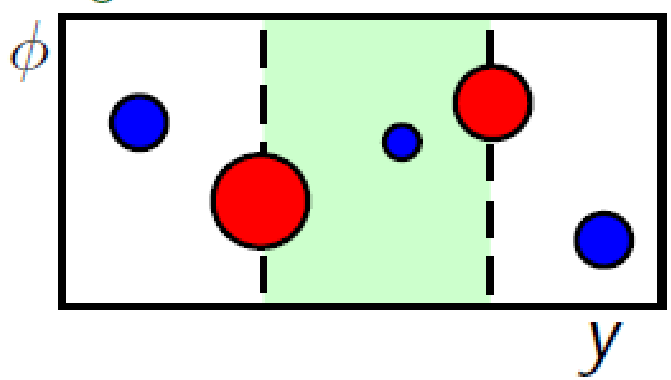
- anti-k_T jets with $R = 0.6$
- boundary jets require $p_T > 20$ GeV and $|y| < 4.5$
- $\langle p_T \rangle$ of boundary jets > 50 GeV
- veto jet $p_T > 20$ GeV
- single interaction-vertex events

Selection A

boundary jets have highest p_T

increased sensitivity to wide-an … ics

soft-gluon radiation



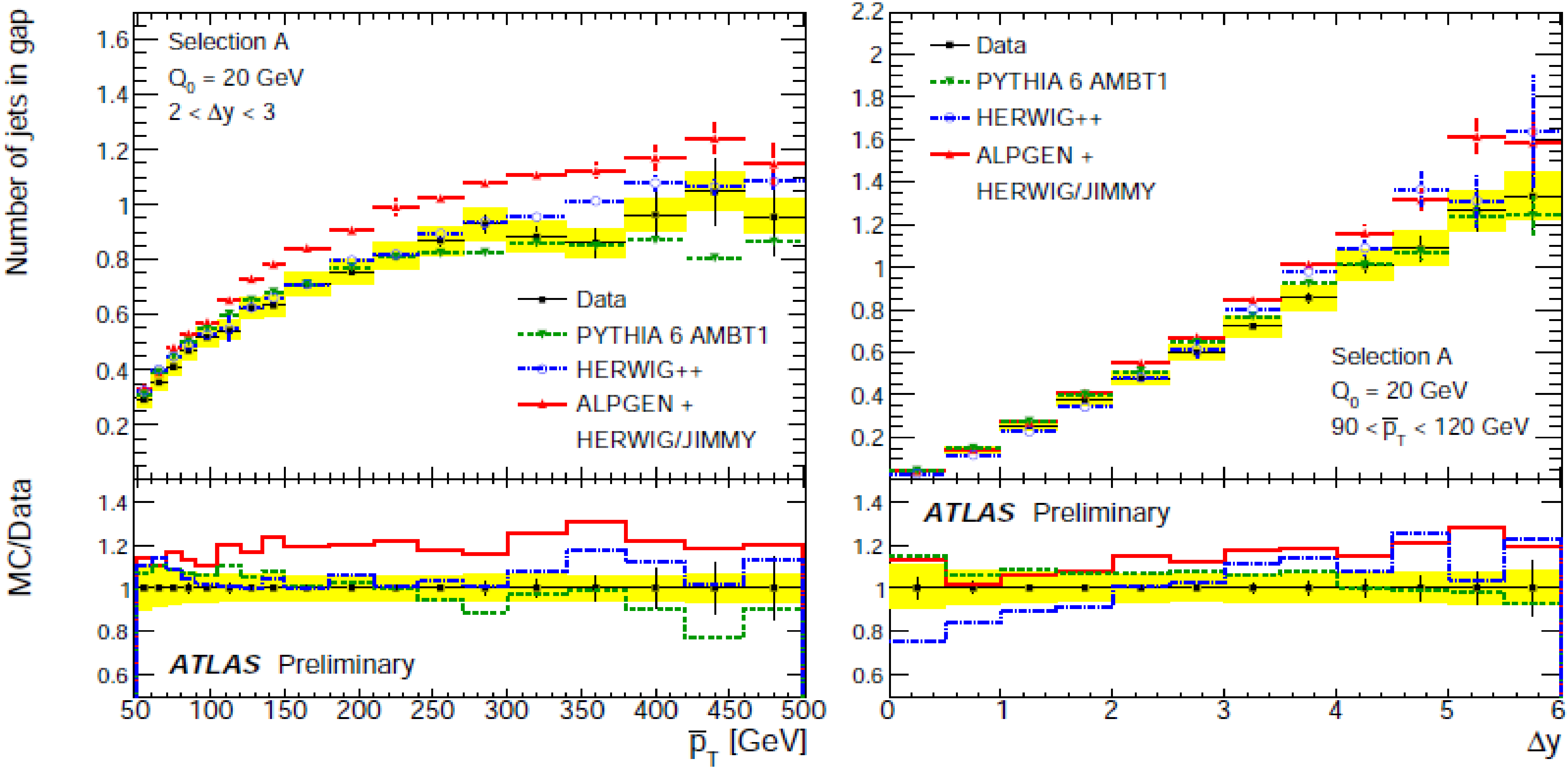
Selection A and B is not just a question of the definition of the rapidity difference. The cut on the average jet pt of most forward/backward jet (selection B) selects events with one very hard forward and a soft backward jet. The large range of transverse scales improves the approximations of the shower. Particularly true for large <pt>. Expectations: Large <pt>: Shower is good. Small <pt> (or rather, jets of similar pt) and large y: Shower not so good.

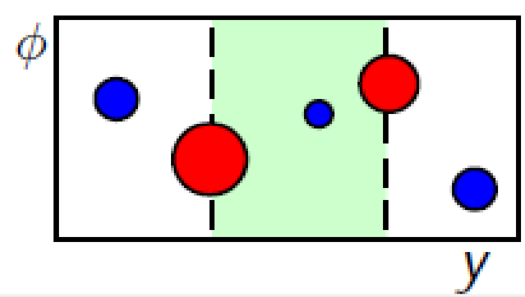
Observables (in $\langle p_T \rangle$ and Δy):

- Mean Jet Multiplicity: betwe
- Gap Fraction: fraction of events without jet in gap

Jet Multiplicity

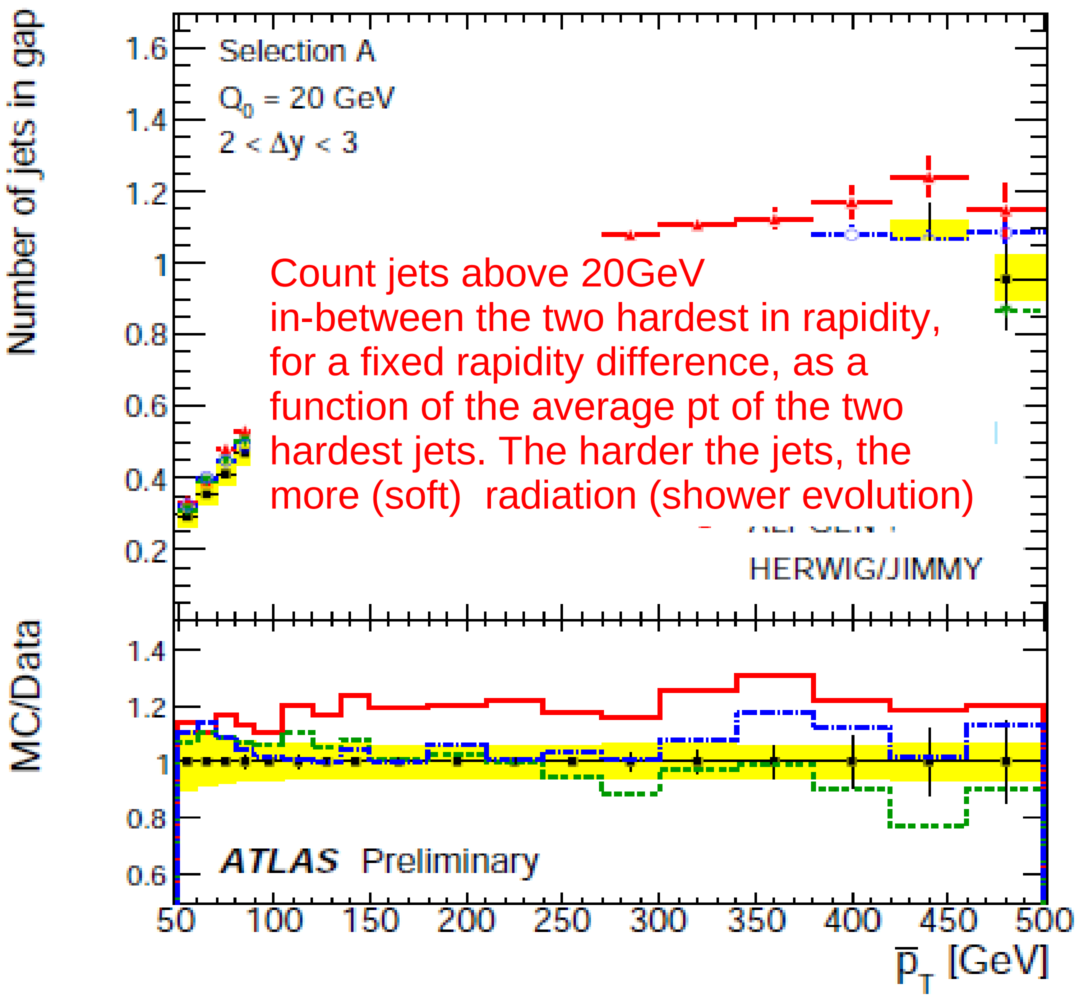
BROOKHAVEN NATIONAL LABORATORY



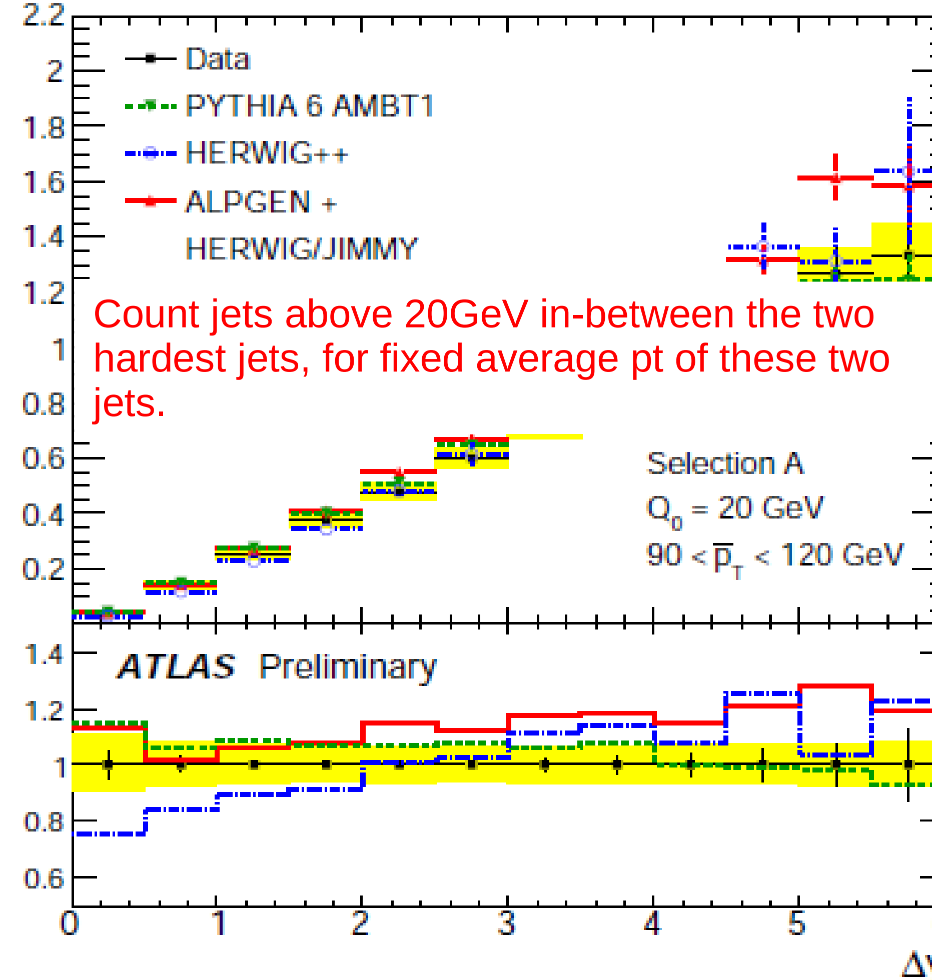


ATLAS-CONF-2011-038

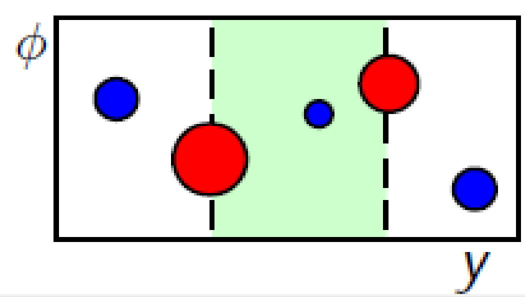
Jet Multiplicity



Count jets above 20GeV in-between the two hardest in rapidity, for a fixed rapidity difference, as a function of the average pt of the two hardest jets. The harder the jets, the more (soft) radiation (shower evolution)

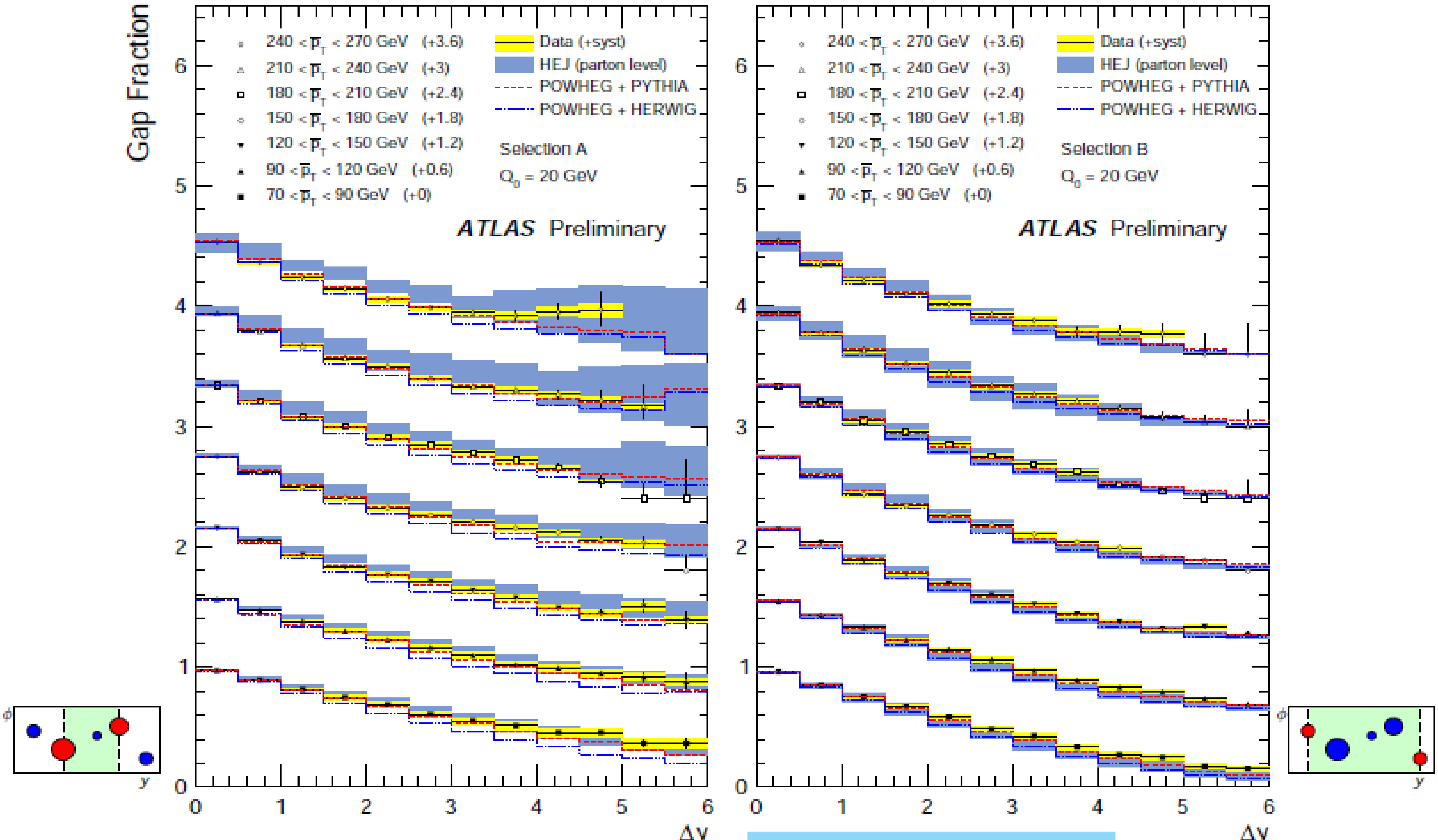


Count jets above 20GeV in-between the two hardest jets, for fixed average pt of these two jets.



ATLAS-CONF-2011-038

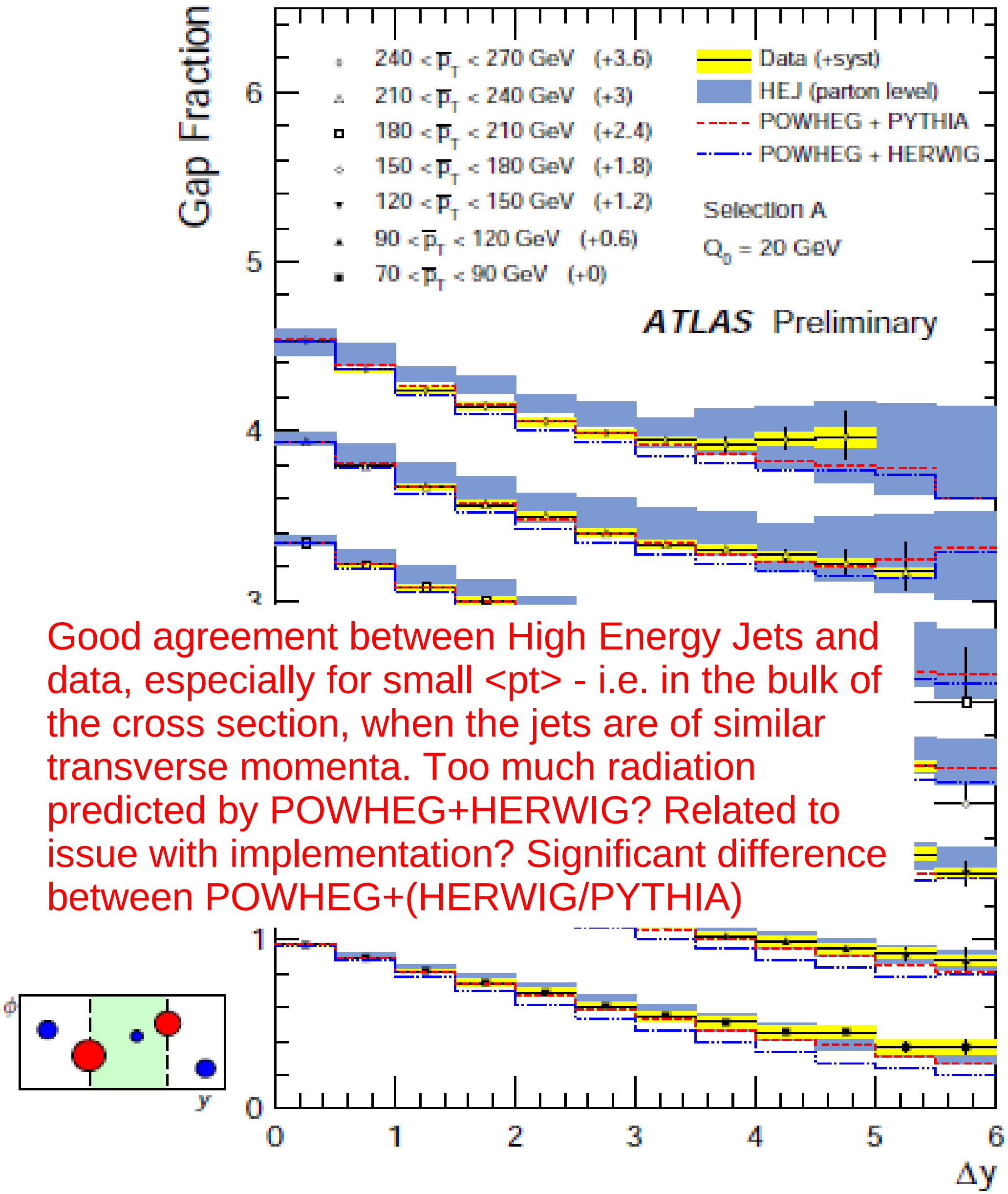
Gap Fraction



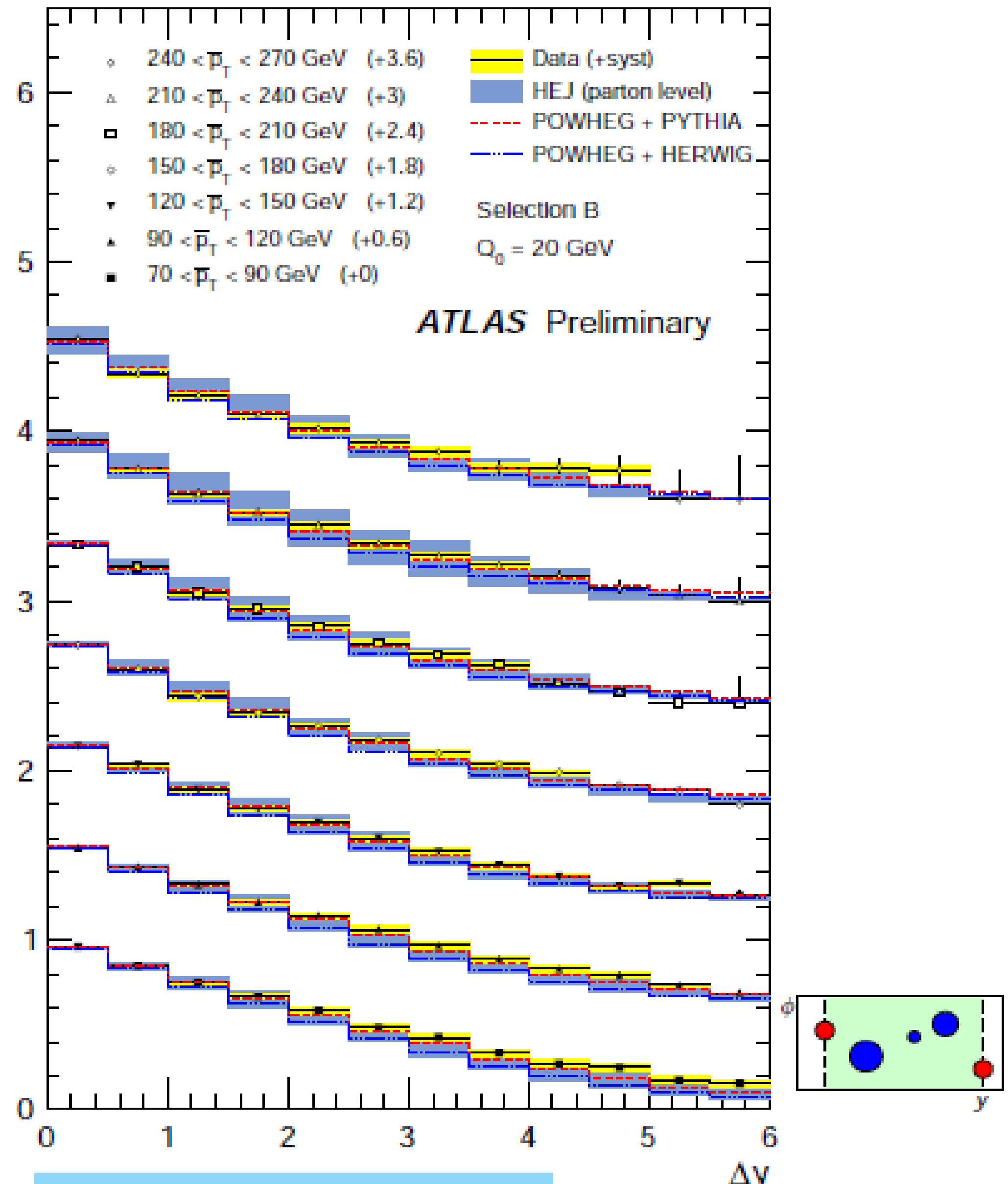
ATLAS-CONF-2011-038

Gap Fraction

BROOKHAVEN NATIONAL LABORATORY

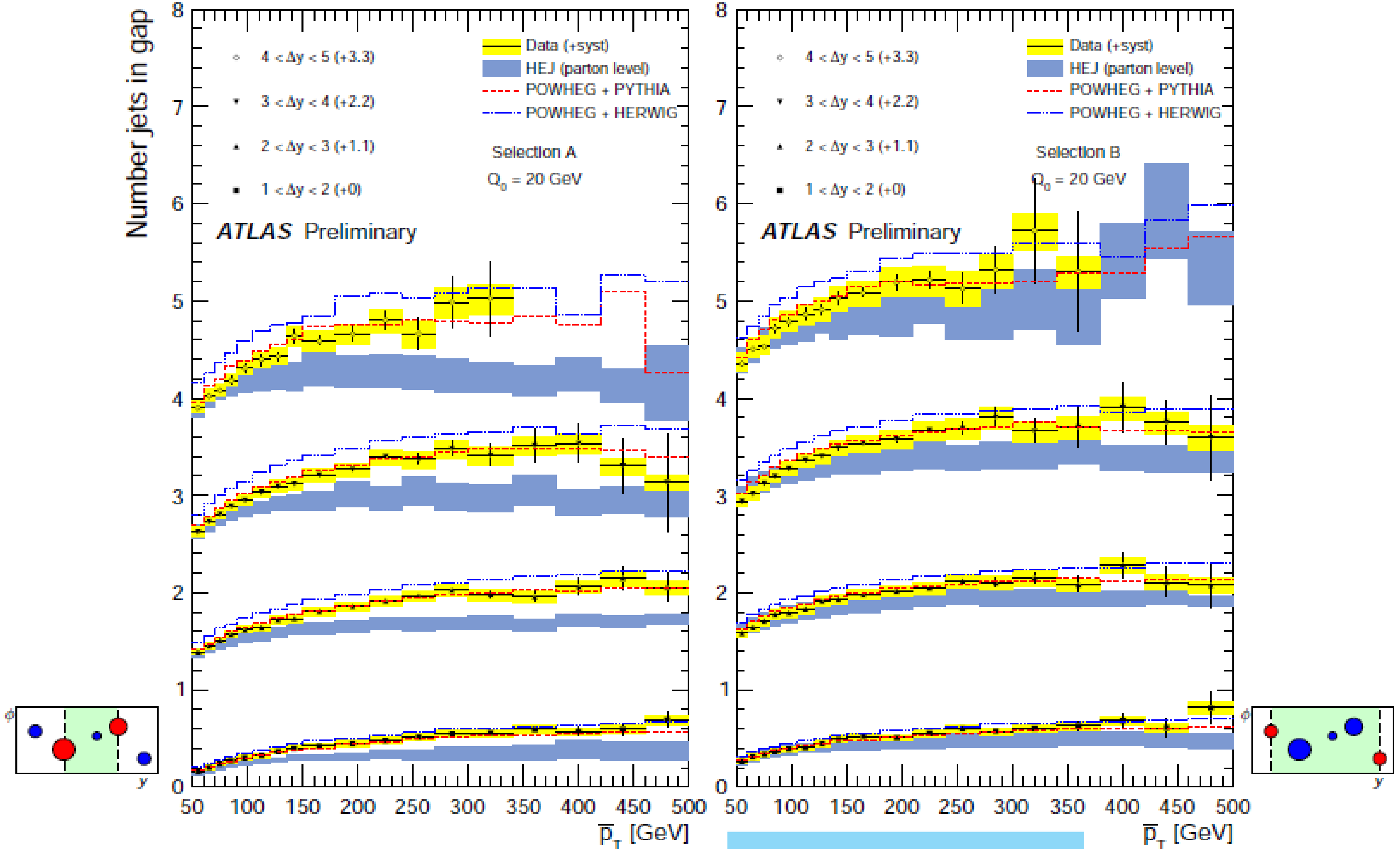


Good agreement between High Energy Jets and data, especially for small <pt> - i.e. in the bulk of the cross section, when the jets are of similar transverse momenta. Too much radiation predicted by POWHEG+HERWIG? Related to issue with implementation? Significant difference between POWHEG+(HERWIG/PYTHIA)



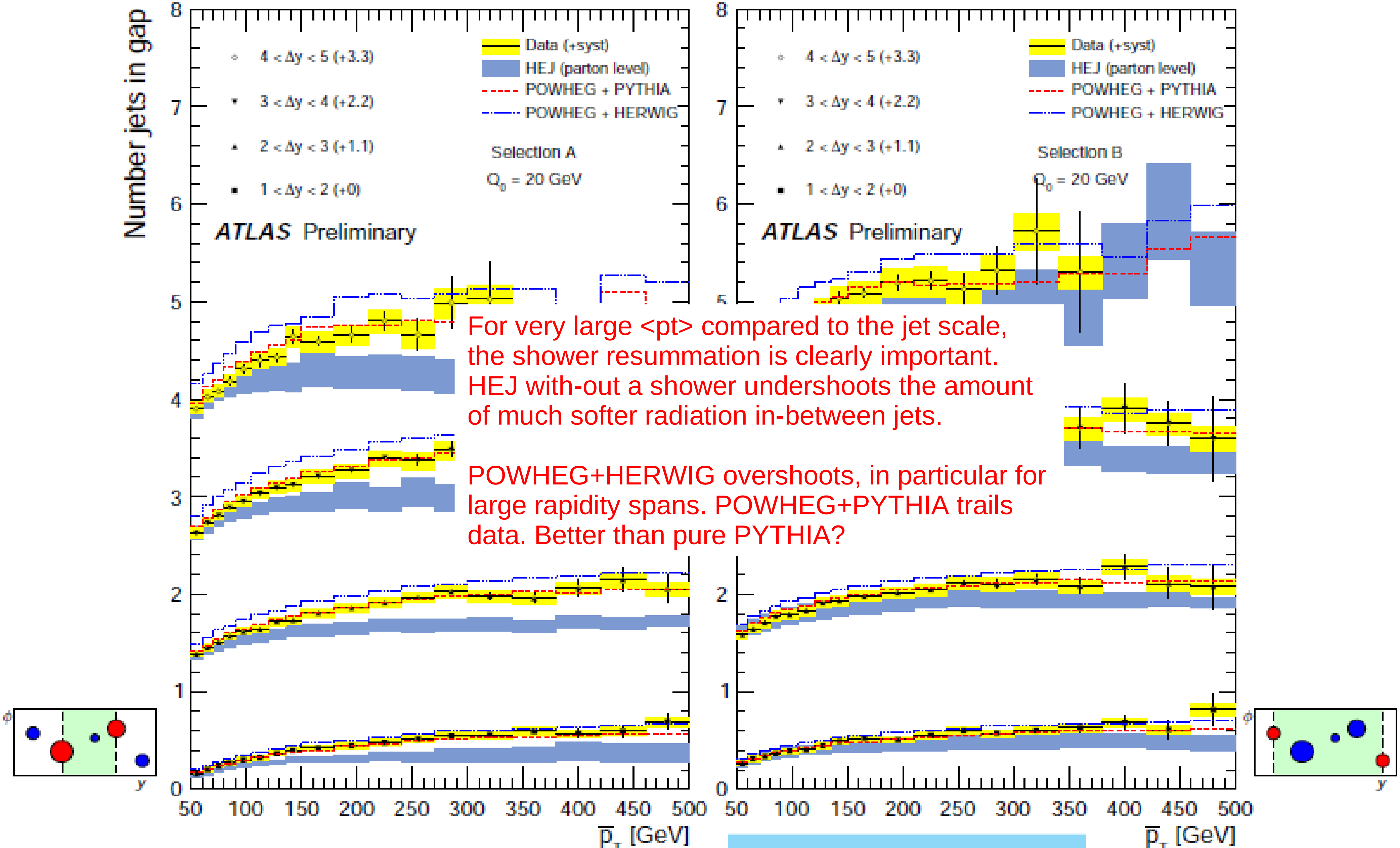
ATLAS-CONF-2011-038

Jet Multiplicity



ATLAS-CONF-2011-038

Jet Multiplicity

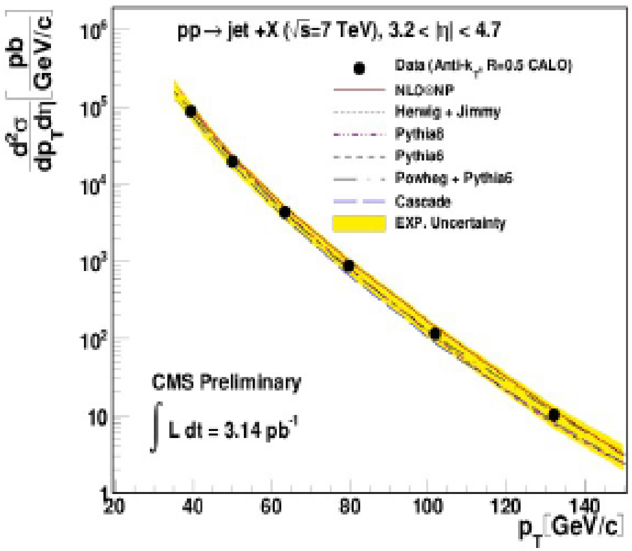


For very large <pt> compared to the jet scale, the shower resummation is clearly important. HEJ with-out a shower undershoots the amount of much softer radiation in-between jets.

POWHEG+HERWIG overshoots, in particular for large rapidity spans. POWHEG+PYTHIA trails data. Better than pure PYTHIA?

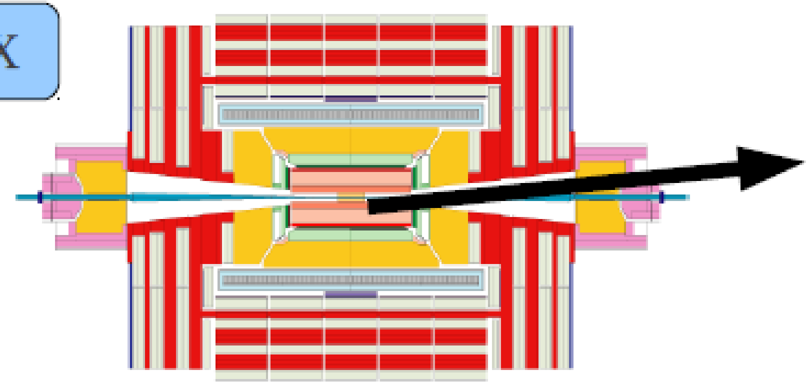
ATLAS-CONF-2011-038

Inclusive Forward Jet Cross Section

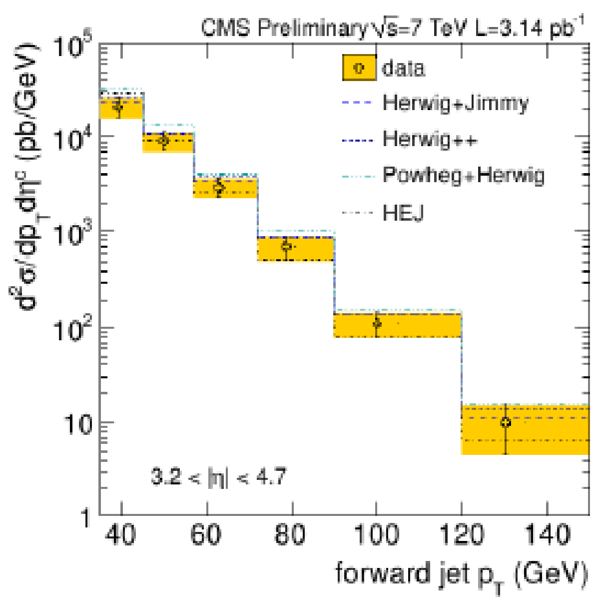


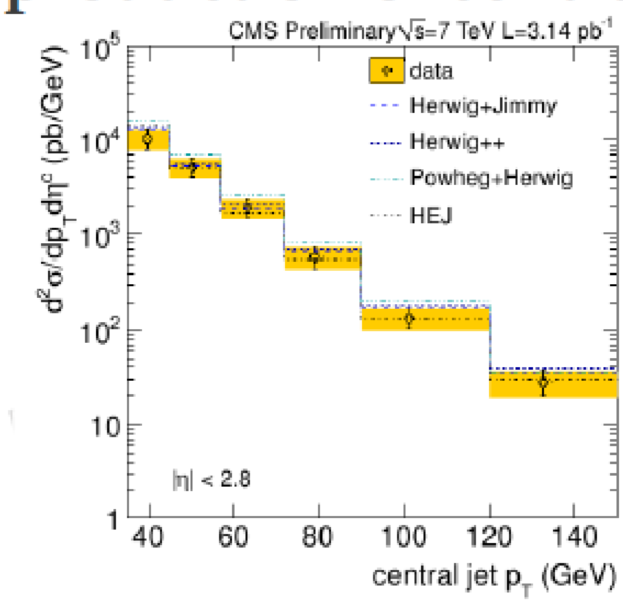
CMS PAS FWD-10-003

$pp \rightarrow$ jet+ X



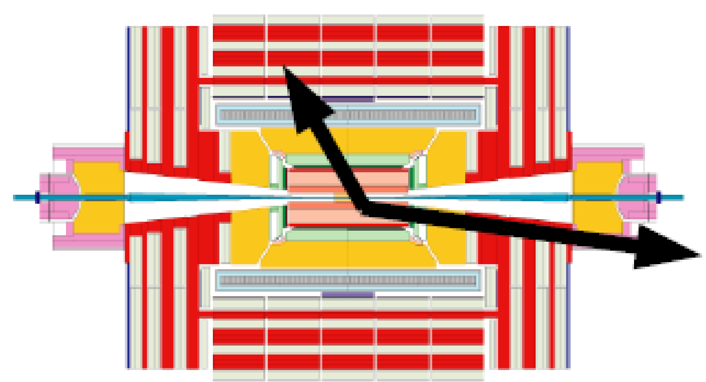
Simultaneous production of central and forward jets



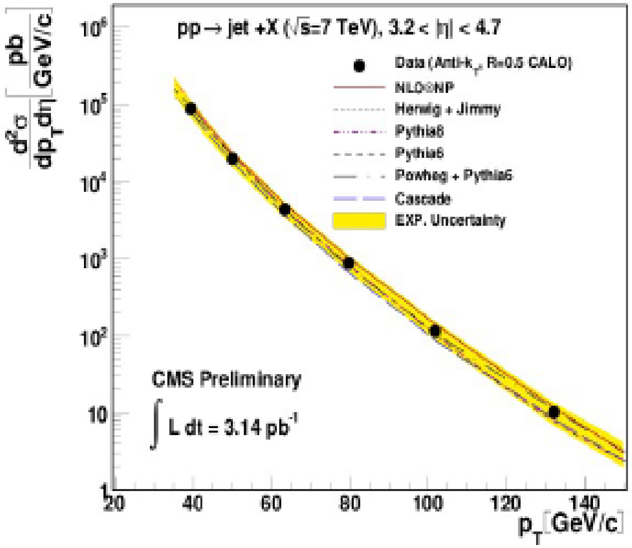


CMS PAS FWD-10-006

$pp \rightarrow$ jet+ jet

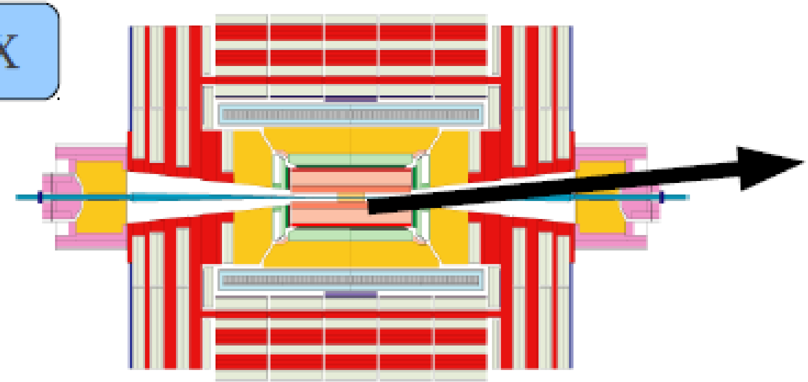


Inclusive Forward Jet Cross Section

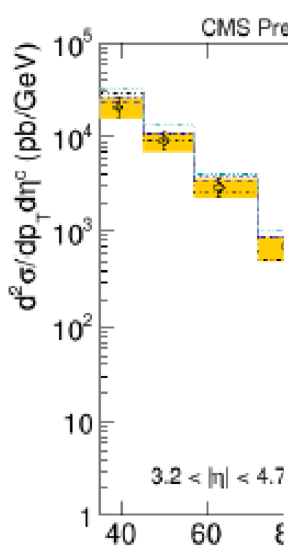


CMS PAS FWD-10-003

$pp \rightarrow jet + X$



Simultaneous production of central and forward jets

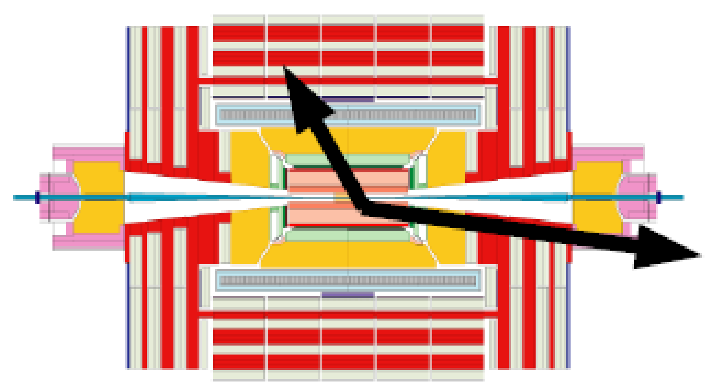


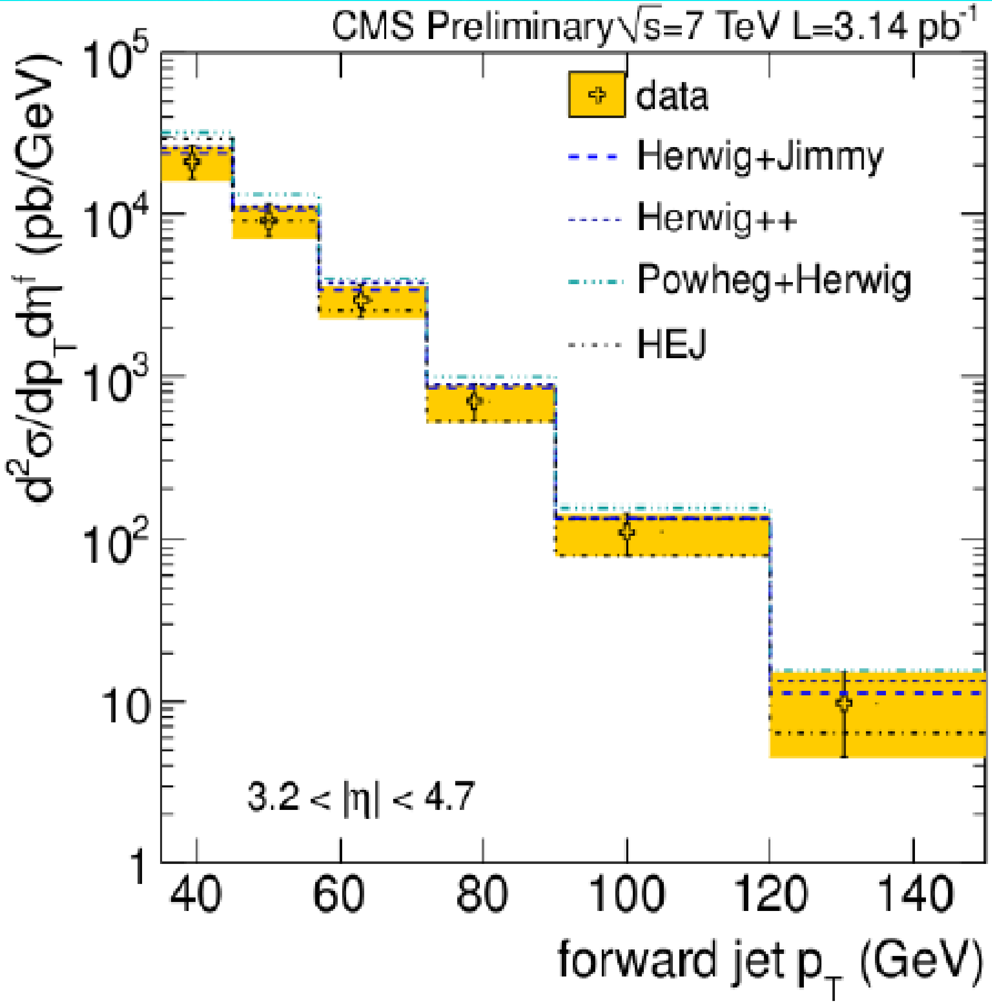
CMS measurement of the pt-spectrum in a dijet sample, requiring a central, and a forward jet, both above 35GeV. The difference in the pt-spectrum of the (hardest) central and the (hardest) forward jet is obviously due to radiation beyond the partonic 2->2 process.

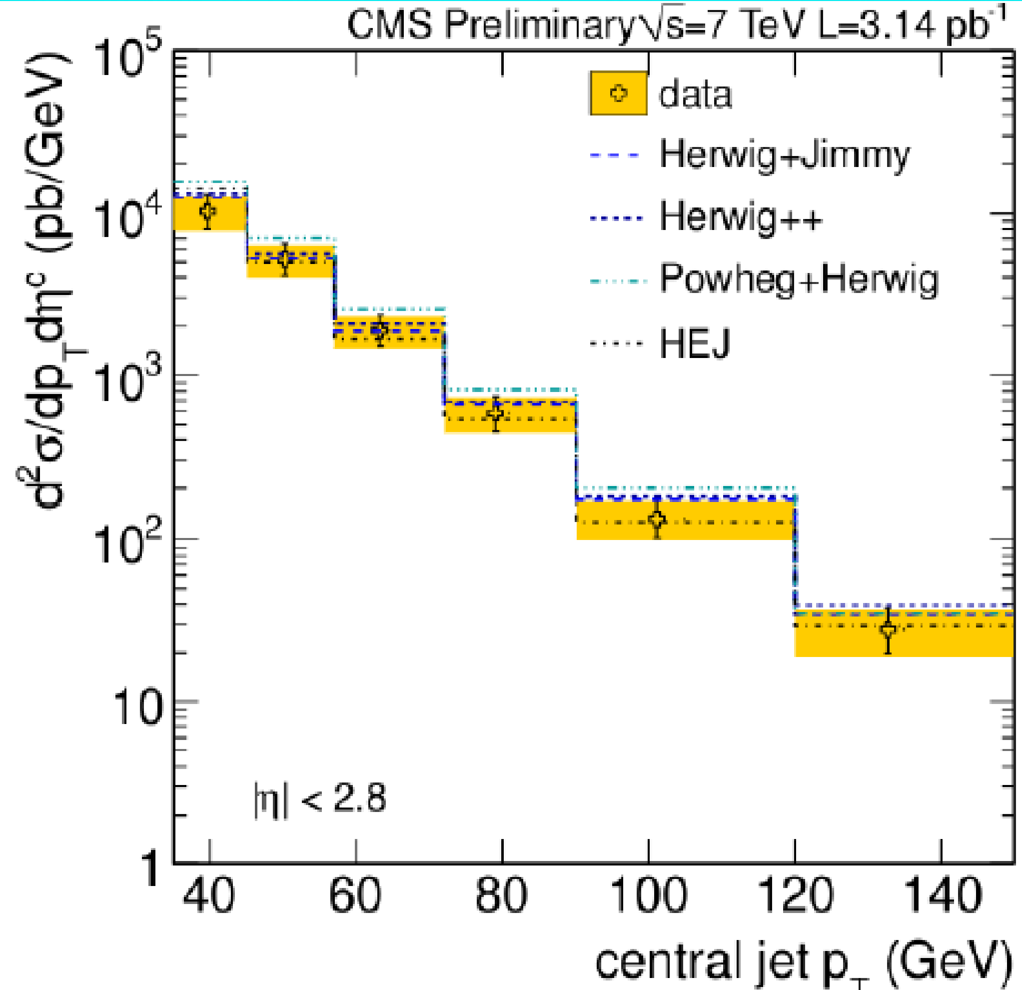
Presented at DIS2011

CMS PAS FWD-10-006

$pp \rightarrow jet + jet$







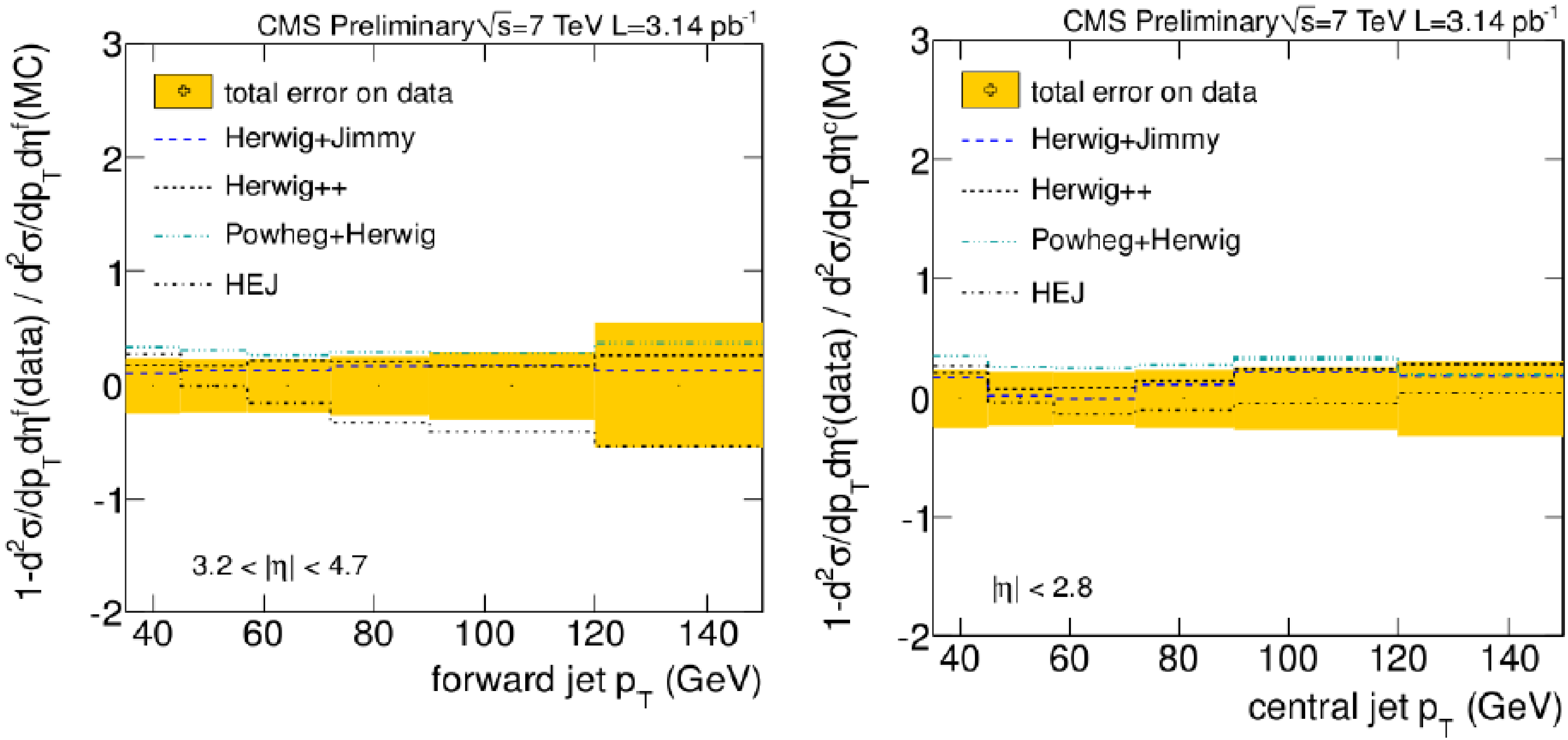
$$\frac{d\sigma}{dp_T d\eta} = \frac{C_{unfold} \cdot N_{jets}}{L \cdot \Delta p_T \Delta \eta}$$

Comparison to various hadron-level theoretical predictions

Some differences in p_T spectra due to the request of simultaneous production of a jet in the forward region and one in the central region

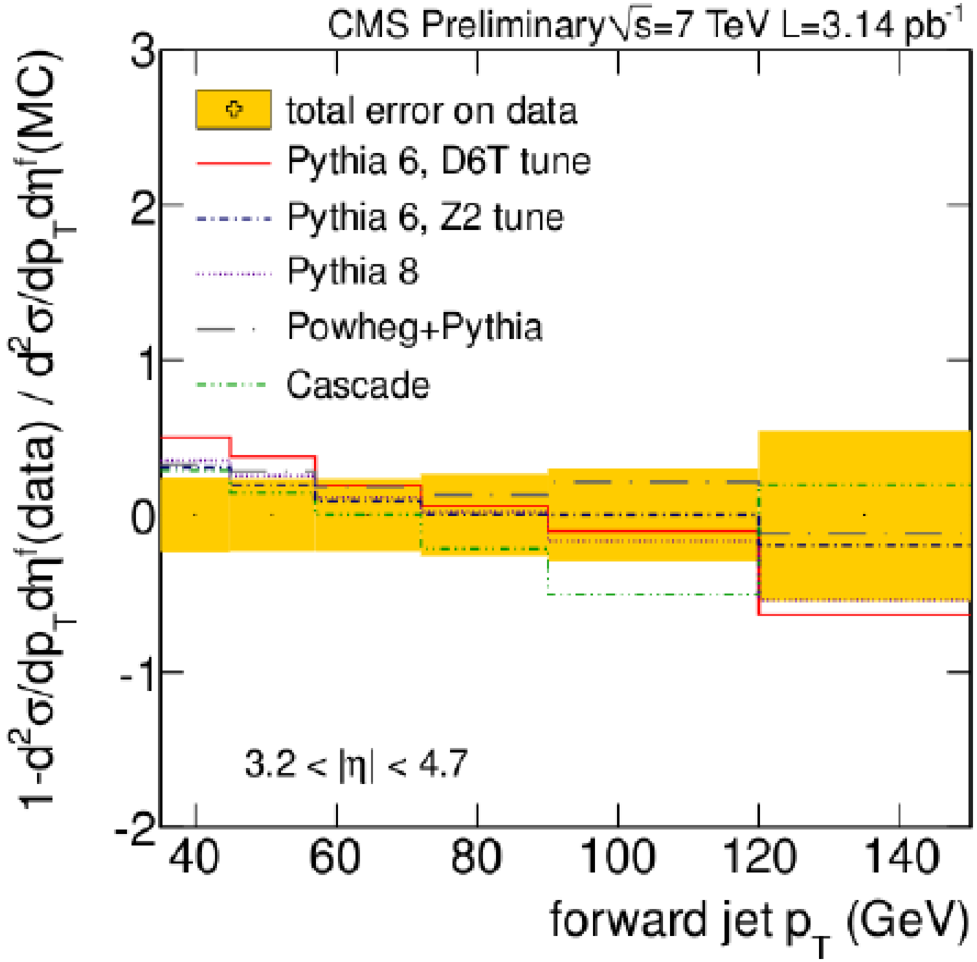
The results (2)

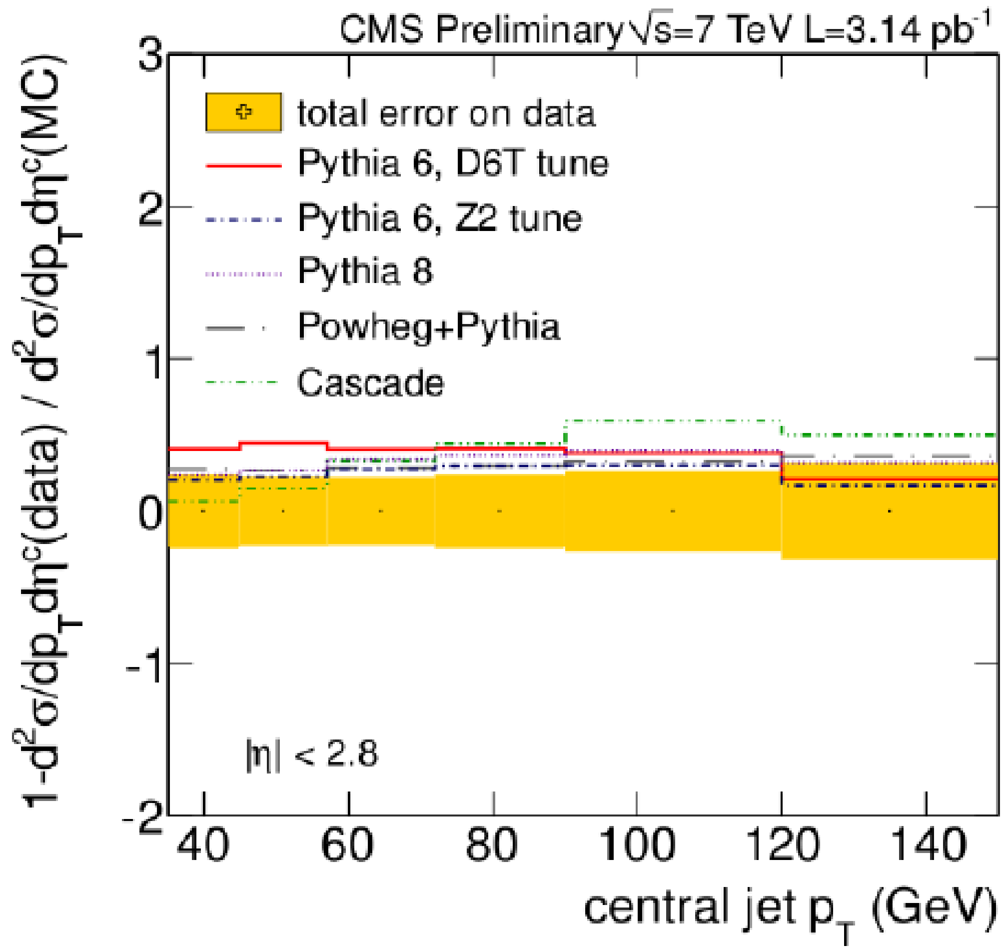
Comparison to various hadron-level theoretical predictions
1 - ratio between measured cross section and MC



Good MC simulations

- Herwig+Jimmy
- Herwig++
- Powheg+Herwig
- HEJ



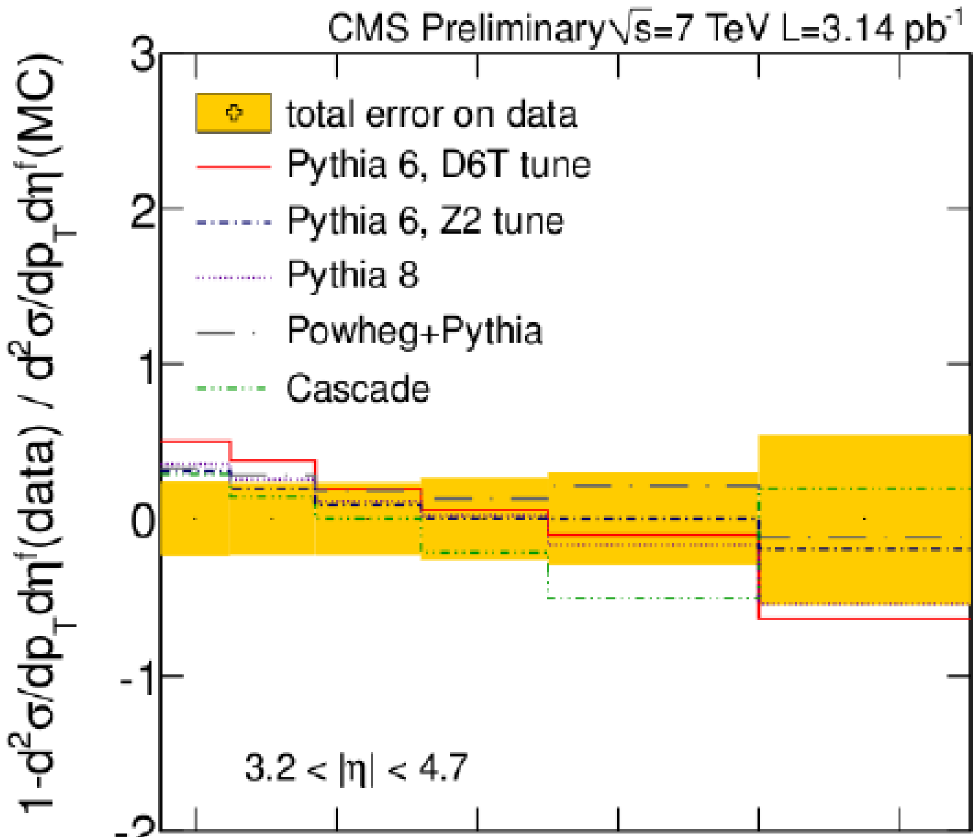


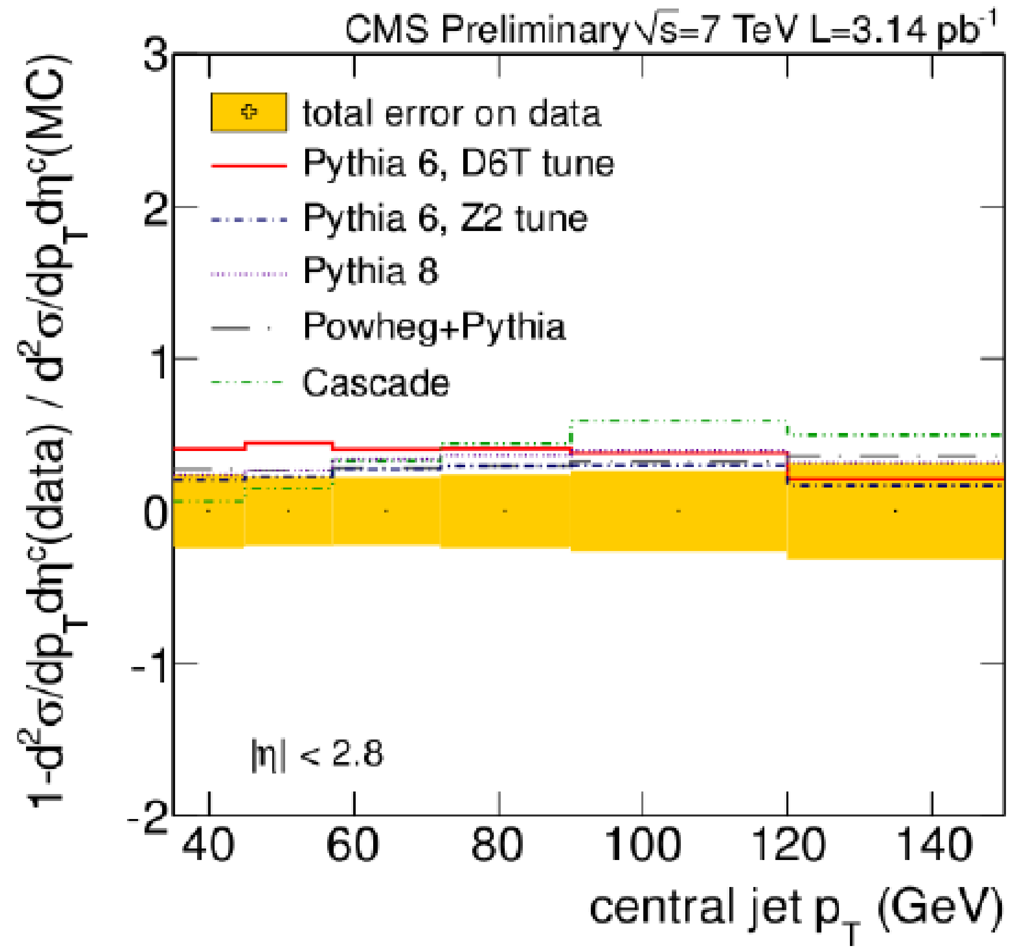
Not fair MC simulations
- Pythia
- Powheg+Pythia
- Cascade

→ Forward: low p_T jets

→ Central: normalization

The results (3)





Pythia seems to predict too steep a pt-spectrum for the forward jets. Large difference between POWHEG+(HERWIG/PYTHIA) a little surprising. Due to modelling of non-perturbative effects (i.e. where the POWHEG matching does not help, at least not until a re-tune has been performed)?

ons

Forward: low p_T jets

Central: normalization