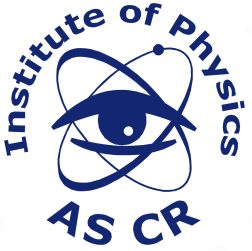

Herwig and Pythia modelling in diffractive dijets

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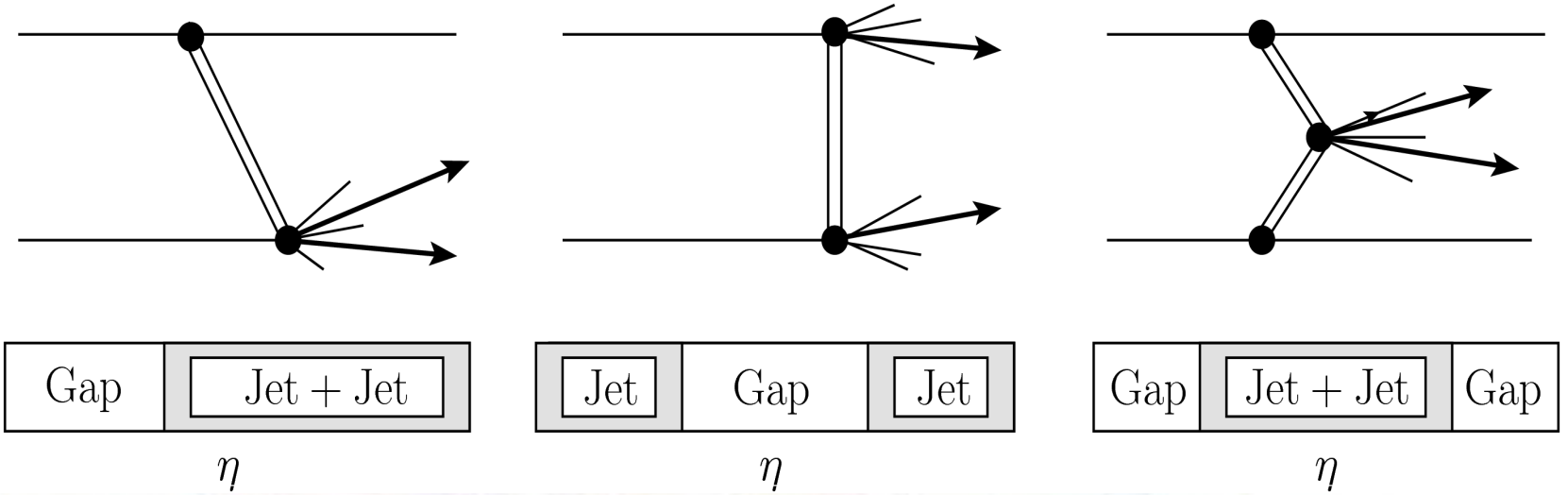
Workshop on QCD and diffraction at the LHC

Diffractive dijets



Single diffraction (SD)

Double diffraction (DD)

Central dijet production

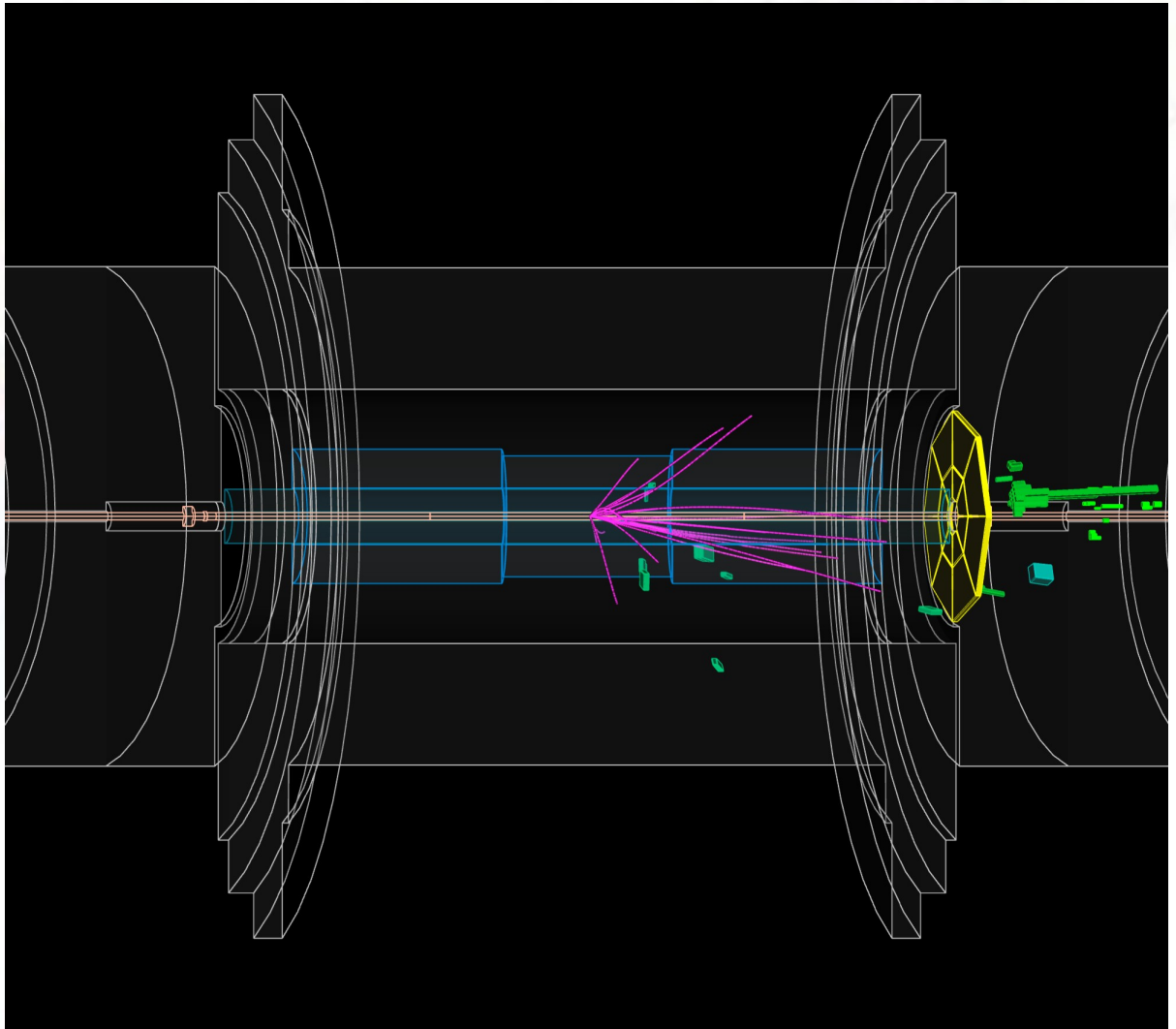
- typical signature – no hadronic activity in large areas of η

  → **rapidity gaps**

- low pile-up required

Gap reconstruction and visualisation

- forward rapidity gap ($\Delta\eta_F$) = a bigger distance from the edge of the detector to the closest cluster or track with p_T>200 MeV

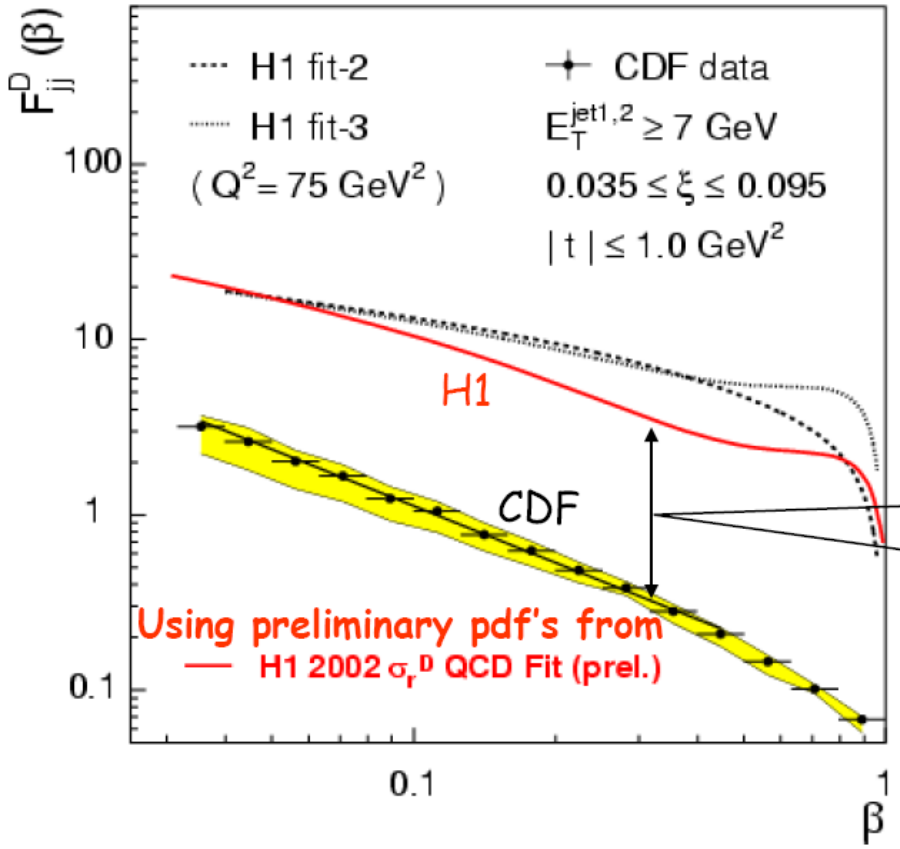


Motivation

Run I

Diffractive Structure Function

Breakdown of QCD factorization



$$\bar{p}p \rightarrow \bar{p} + \text{dijet} + X$$

same suppression
as in soft diffraction
➔ Rapidity gap probability

momentum fraction
of parton in Pomeron

Goals and motivations

- The aim is to study hard single diffraction in di-jet events of 7TeV LHC data
- Main motivation – measurements of diffractive structure function **dPDF** and gap survival probability (S^2) in pp collisions (KMR prediction for 7TeV is 5-7%)
- In this talk – study of gap spectra on generator level of Herwig++ and Pythia 6 Monte Carlos as a preparation for request of an official ATLAS MC production
- Working team – Institute of Physics (ASCR in Prague)

Vlastimil Kůs, Marek Taševský, Oldřich Kepka

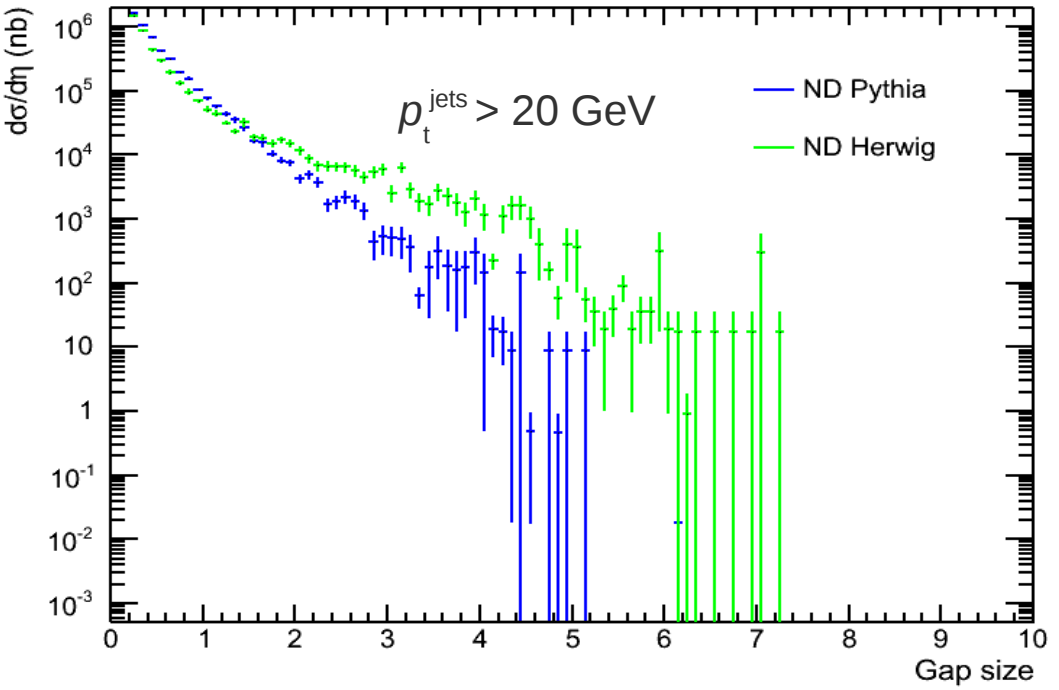
MC truth studies

- Truth studies of Pythia 6, Herwig++ and Pomwig based on private production
  (Herwig++ … update UE-EE-3 Tune, version 2.5.1)
- Event selection – dijet events, $p_T^{jets} > 20$ GeV
  (jet reconstruction algorithm – FastJet 3.0.0)
- Gap definition – largest gap (with no stable truth particle with p_T>200 MeV) to the edge of detector
- Significant **discrepancies** especially between ND Herwig and Pythia observed!
  - ND Herwig provides much slower gap spectrum fall

Probable explanation:
difference in hadronisation models

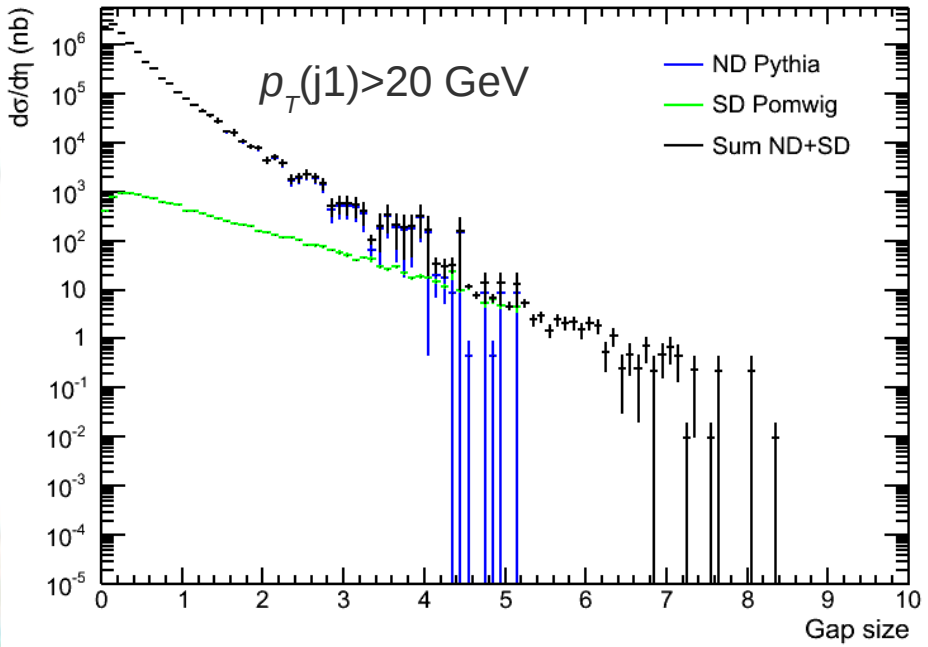
Herwig++: *clustering hadr.* (smaller p_T/multiplicities in fwd region)

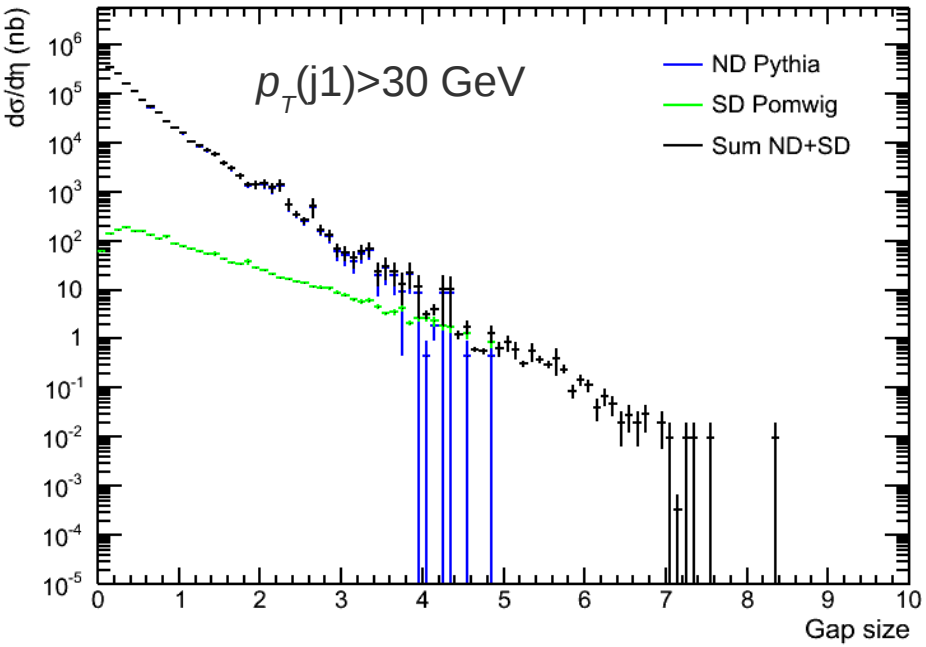
Pythia: *string hadronization*



Gap spectra

Truth level





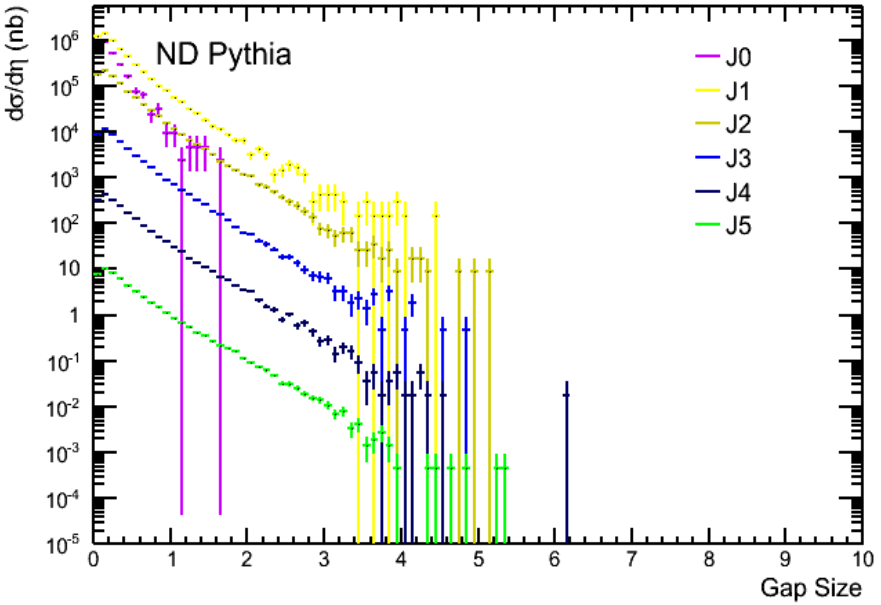
Plots **include** KMR prediction of S^2 (gap survival probability) for CMS energy 7 TeV proton-proton collisions … $\boldsymbol{S^2 = 6\ \%}$

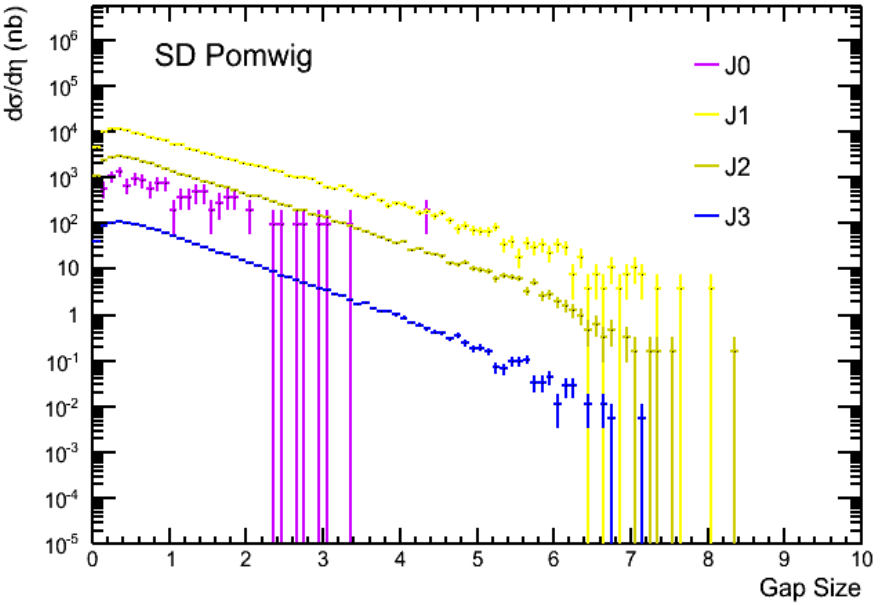
Significant gap spectra fall with increasing p_T cut, no plateau observed due to the presence of hard dijet system.

By using 20 GeV jet cut we gain about one order of magnitude in σ compared to 30 GeV cut. Not possible to go below 20 GeV – no JES available.

Gap spectra for separate Jx samples

Truth level





Cut: p_T(j1) > 20 GeV

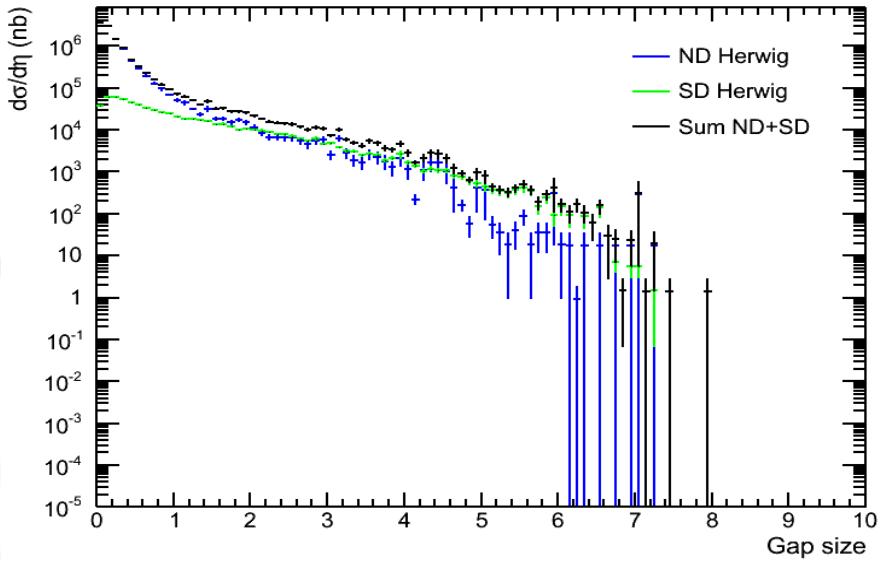
SD Pomwig: S^2 = 6 % factor not included

A need for millions of events for each J0, J1 and J2 samples.

J0 … 8 – 17 GeV
J1 … 17 – 35 GeV
J2 … 35 – 70 GeV
J3 … 70 – 140 GeV

ND and SD Herwig++ events

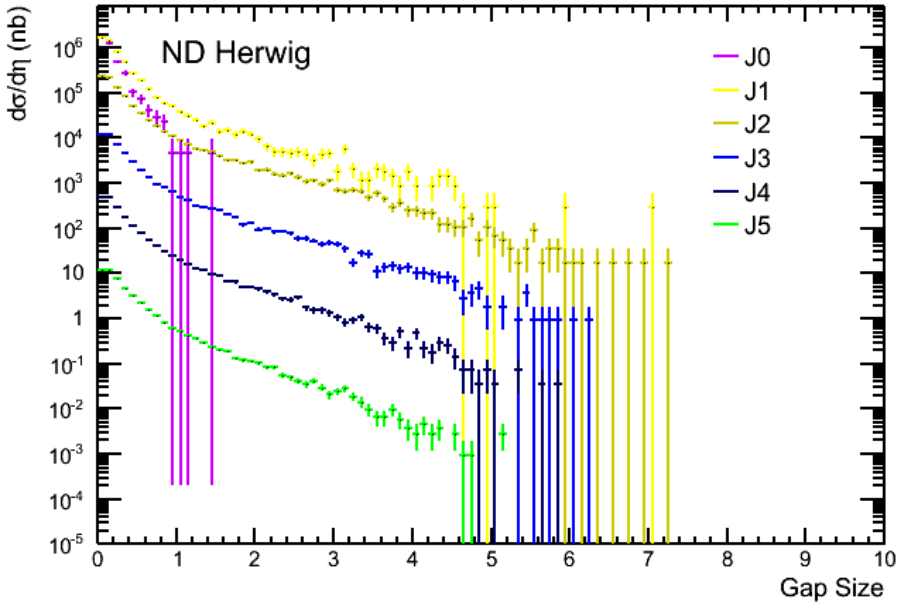
Truth level

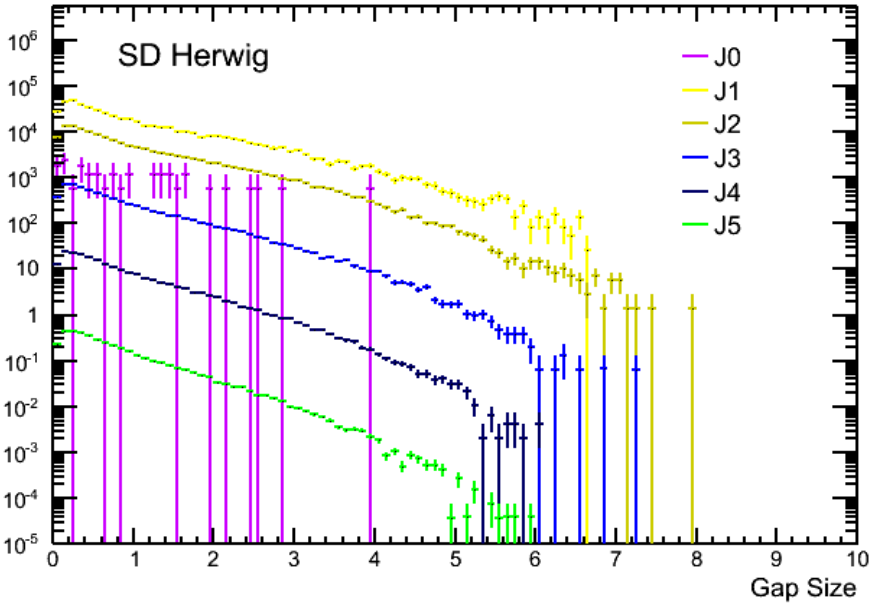


All plots for p_T^{jet}> 20 GeV,

S^2 factor **not** applied

Herwig++ results give significantly different predictions that would make SD practically unobservable.





Gap spectrum - summary

Truth level

Cross-sections (nb) for $\Delta\eta_{gap}$**>3** and p_T^{jet}>20GeV, S^2 = 0.06

	J0	J1	J2	J3
ND Pythia	0	131	22.6	1.4
SD Pomwig	29	643	104	2.5
SD Pomwig * S^2	1.7	38.6	6.2	0.15

In total … SD / ND = 0.3

Cross-sections (nb) for $\Delta\eta_{gap}$**>4** and p_T^{jet}>20GeV, S^2 = 0.06

	J0	J1	J2	J3
ND Pythia	0	14.6	3.5	0.2
SD Pomwig	14.8	208	27.5	0.5
SD Pomwig * S^2	0.9	12.5	1.6	0.03

In total … SD / ND = 0.8

SD/ND ratio expected < 1 also for data => a need for additional selection cut to suppress ND dijets and preserve good yields of SD (x_{Bj}, ...)

Summary

- Millions of ND events needed to explore (with reasonable precision) gap spectrum contribution of ND events on a tail (range 4-6 in $\Delta\eta_F$)
- Significantly different predictions of gap spectra between ND Herwig++ and ND Pythia 6 due to different hadronisation models; ND Herwig++ goes ~ 2 values in $\Delta\eta_F$ to higher gaps

  => another motivation for performing these measurements
- In order to achieve observation of hard SD, one needs to study gaps at least above 4 => SD/ND ratio with inclusion of KMR's S^2 prediction (6%) is **SD/ND~0.8** => additional cut(s) to get ND suppresion needed (x_{Bj}, ...)

B A C K U P

Truth gaps: all particles vs p_T>200MeV particles