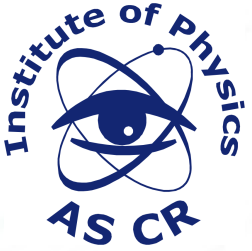

Rapidity gaps in diffractive dijet events at ATLAS

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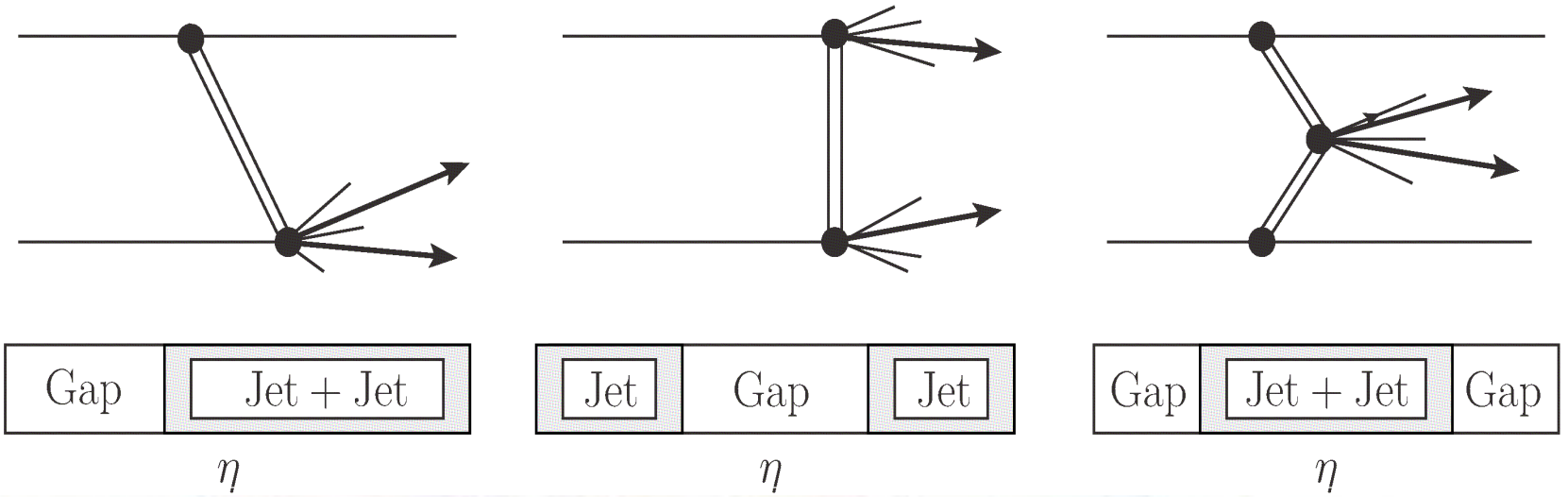
1st March 2012

Diffraction workshop in Trento

Overview

- Introduction to the topic
- Monte Carlo studies of hard single diffractive di-jets
- Status of 2010 data analysis
- Summary

Diffractive dijets



Single diffraction (SD)

Double diffraction (DD)

Central dijet production

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

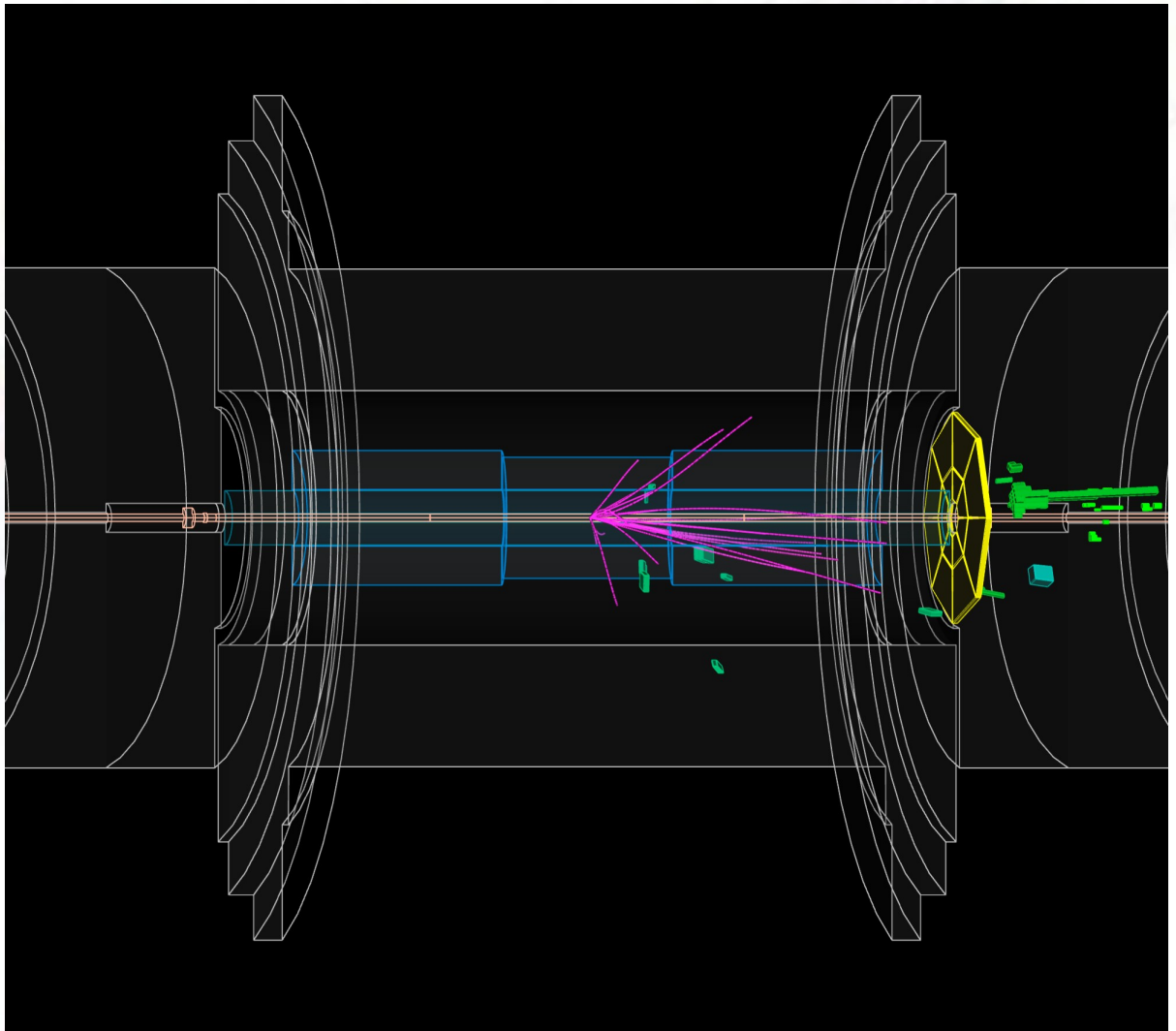
  → **<u>rapidity gaps</u>**

- low pile-up required
- ATLAS – problematic coverage of forward region

  (only calorimeter, $|\eta| < 5$)

Gap reconstruction and visualisation

- forward rapidity gap ($\Delta\eta_F$) = a bigger distance from the edge of the detector (η=4.9) to the closest cluster or track with p_T>200 MeV

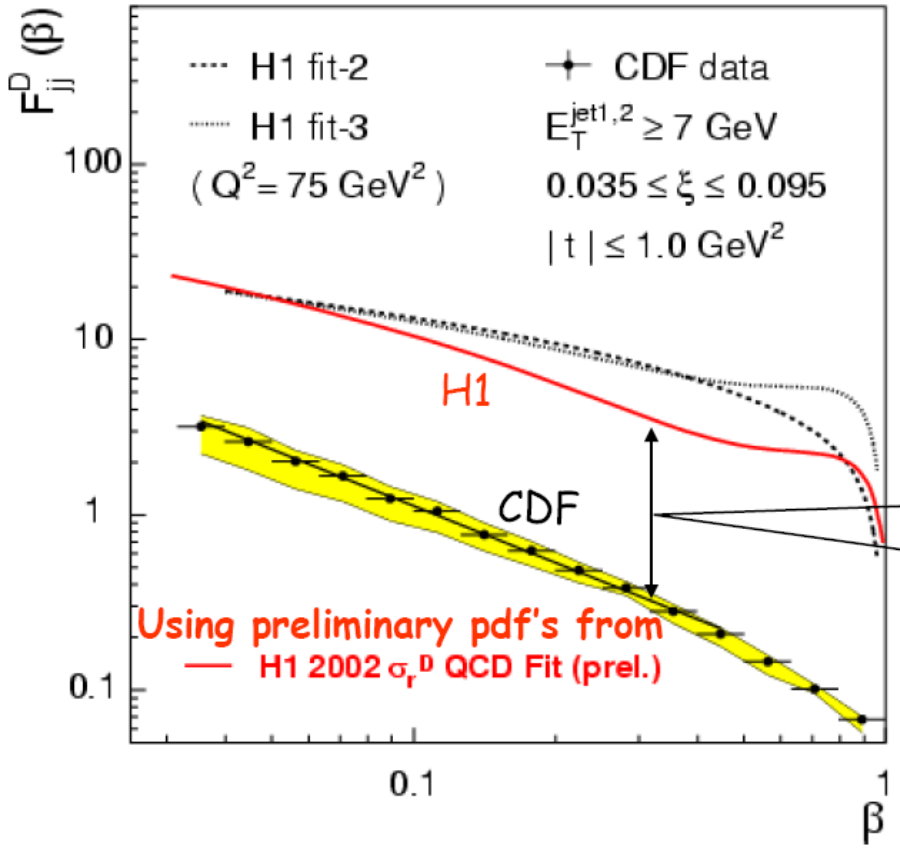


Motivation

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
  - to study hard single diffraction in di-jet events of 7 TeV LHC data
- Main motivation
  - measurements of diffractive structure function **dPDF**
  - **gap survival probability** (S^2) in *pp* collisions (KMR prediction for 7TeV is **5-7%**)
- Working team – Institute of Physics (ASCR in Prague)

  Vlastimil Kůs, Marek Taševský, Oldřich Kepka

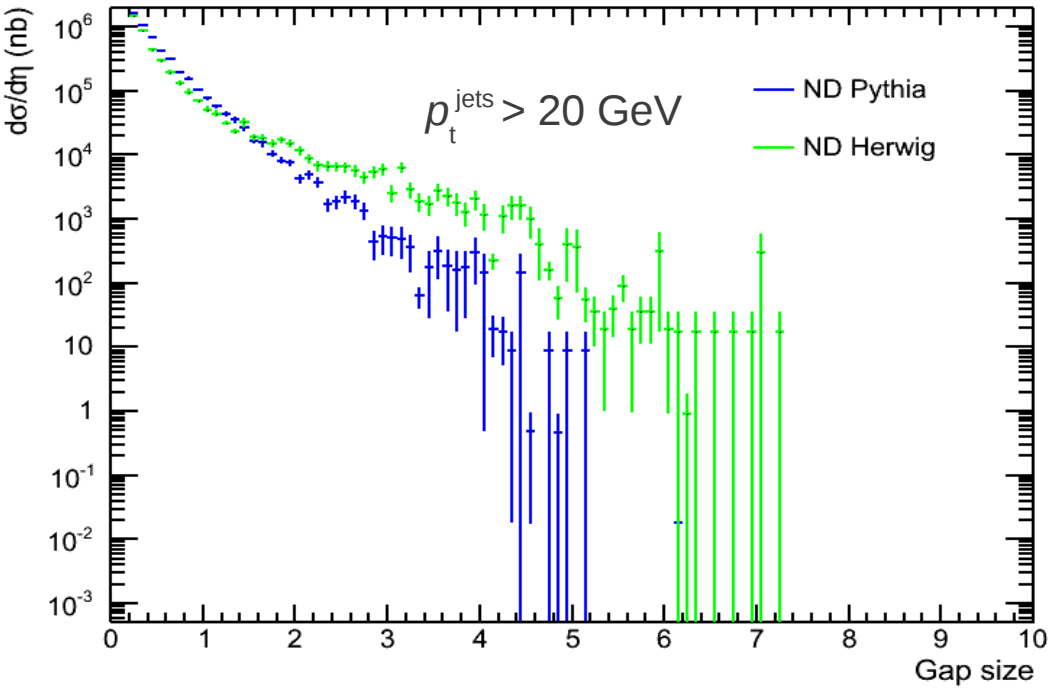
MC truth studies

- 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 in η (with no stable truth particle with p_T>200 MeV) to the edge of detector (|η|<4.9)**
- Significant differences between ND Herwig and Pythia observed
  - ND Herwig provides much slower gap spectrum fall

Probable explanation:
difference in hadronisation models

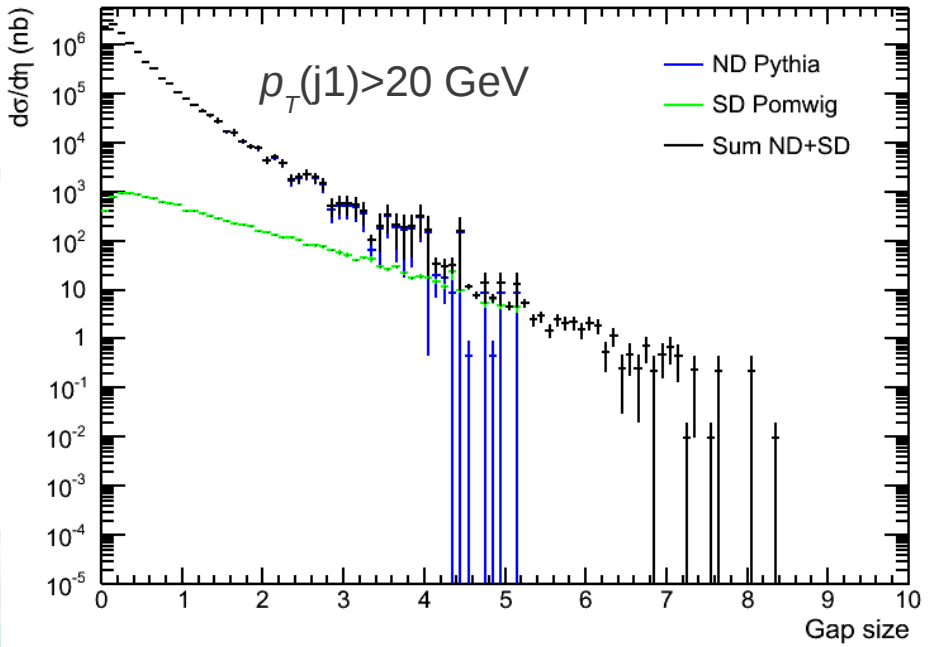
Herwig++: *clustering hadr.* (smaller p_T/multiplicities in fwd region)

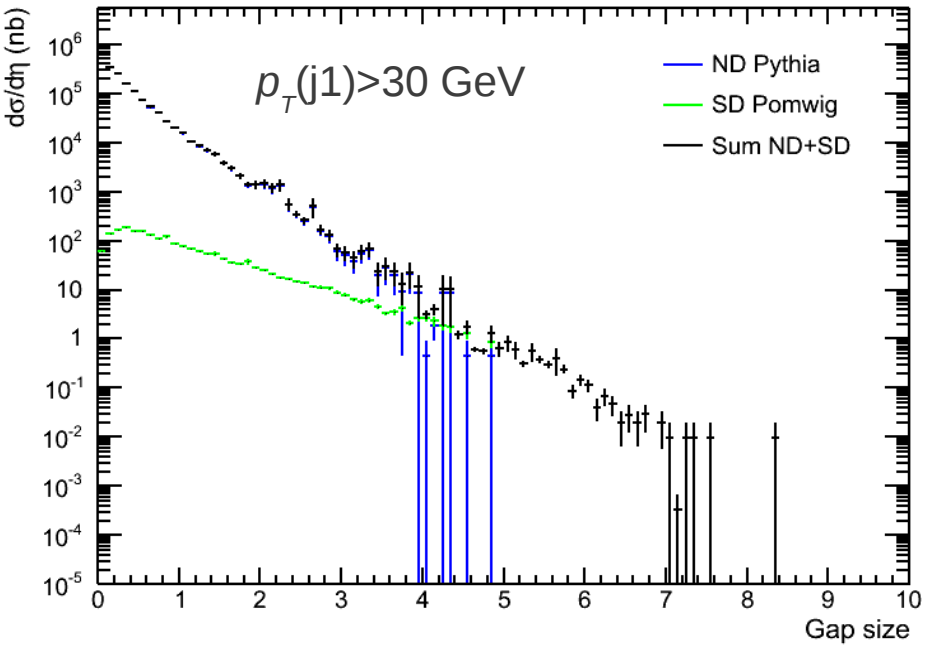
Pythia: *string hadronization*



Gap spectra

Generator level





Plots **include KMR prediction of S^2** (gap survival probability) for CMS energy 7 TeV proton-proton collisions … **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 spectrum - summary

Generator 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 even worse for data => a need for additional selection cut to suppress ND dijets and preserve good yields of SD (x_{Bj}, ...)

Current work – data 2010

- Understanding of the 2010 data specific issues (triggers, calibrations, etc.)
- Reproducing 2010 inclusive dijet production x-sec measurement

  ATL-COM-PHYS-2011-738: "*Measurement of inclusive jet and dijet production in pp collisions at 7 TeV using ATLAS detector*"

  (many thanks to Chris Meyer for his help in this respect)

  This x-sec measurement as a function of the inv. mass successfully reproduced! We can go on to the next point ...
- Finally – building up SD gap analysis on this basis

Event selection

- Selection cuts

  GRL, #PV(5trk)>=1, p_T^{j1}>30GeV, p_T^{j2}>20GeV

- Trigger scheme (ATL-COM-PHYS-2011-738)
  - at least one jet triggered (and being on 99% eff. plateau)

p_T [GeV]	Run>152777	Periods A-C	Periods D-F (minus E1-4)	Periods G-I
$20 < p_T \leq 42.5$	L1_MBTS_1	L1_MBTS_1	L1_MBTS_1	EF_mbMbts_1_eff
$42.5 < p_T \leq 70$	L1_MBTS_1	L1_J5	L1_J5	EF_j20_jetNoEF
$70 < p_T \leq 97.5$	L1_MBTS_1	L1_J15	L1_J15	EF_j35_jetNoEF
$97.5 < p_T \leq 152.5$	L1_MBTS_1	L1_J30	L1_J30	EF_j50_jetNoEF
$152.5 < p_T \leq 197.5$	L1_MBTS_1	L1_J55	L1_J55	EF_j75_jetNoEF
$197.5 < p_T \leq 217.5$	L1_MBTS_1	L1_J55	L1_J55	EF_j95_jetNoEF
$217.5 < p_T$	L1_MBTS_1	L1_J55	L1_J55	EF_L1J95_NoAlg

Central region: |y| < 3.1

p_T [GeV]	Periods A-C	Periods E-F (minus E1-4)	Periods G-I
$20 < p_T \leq 42.5$	L1_MBTS_1	L1_MBTS_1	EF_mbMbts_1_eff
$42.5 < p_T \leq 62.5$	L1_MBTS_1	L1_FJ10	EF_mbMbts_1_eff
$62.5 < p_T \leq 72.5$	L1_MBTS_1	L1_FJ10	EF_fj30_jetNoEF
$72.5 < p_T \leq 95$	L1_MBTS_1	L1_FJ30	EF_fj30_jetNoEF
$95 < p_T \leq 160$	L1_MBTS_1	L1_FJ30	EF_fj50_jetNoEF
$160 < p_T$	L1_MBTS_1	L1_FJ30	EF_fj75_jetNoEF

Transition region: 3.1 < |y| < 3.6

p_T [GeV]	Periods A-E4	Periods E5-F	Periods G-I
$20 < p_T \leq 42.5$	L1_MBTS_1	L1_FJ10	EF_mbMbts_1_eff
$42.5 < p_T \leq 50$	L1_MBTS_1	L1_FJ10	EF_fj30_jetNoEF
$50 < p_T \leq 67.5$	L1_MBTS_1	L1_FJ30	EF_fj30_jetNoEF
$67.5 < p_T \leq 100$	L1_MBTS_1	L1_FJ30	EF_fj50_jetNoEF
$100 < p_T$	L1_MBTS_1	L1_FJ30	EF_fj75_jetNoEF

Forward region: 3.6 < |y| < 4.4

- Prescales
  - in later 2010 data, lower p_T jet triggers suppressed (prescaled) to allow higher statistics for harder jets
  - handled by normalizing histos to effective luminosities of triggers in given areas (iLumiCalc tool)

Summary

- hard SD dijets in MC simulations - gaps 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}, …)
- diffractive plateau in our MC events not present due to the presence of hard di-jet system
- currently working on measurements of diffractive dijets