Rapidity Gaps in Photoproduction

ZEUS Collaboration Meeting

Warsaw

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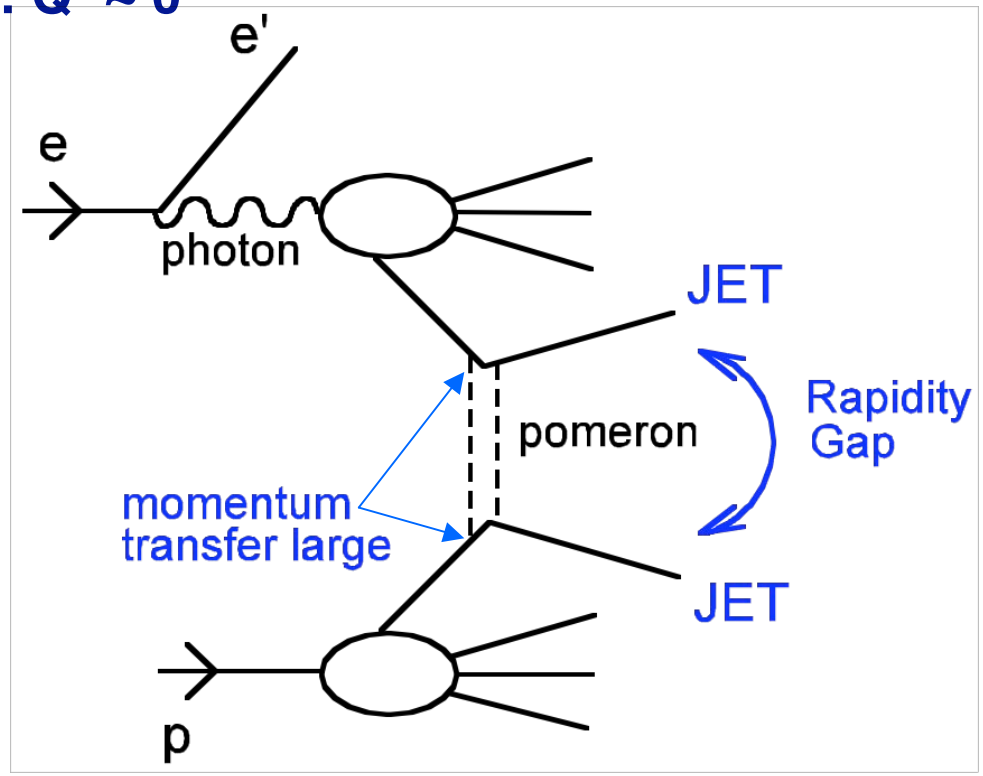
Outline

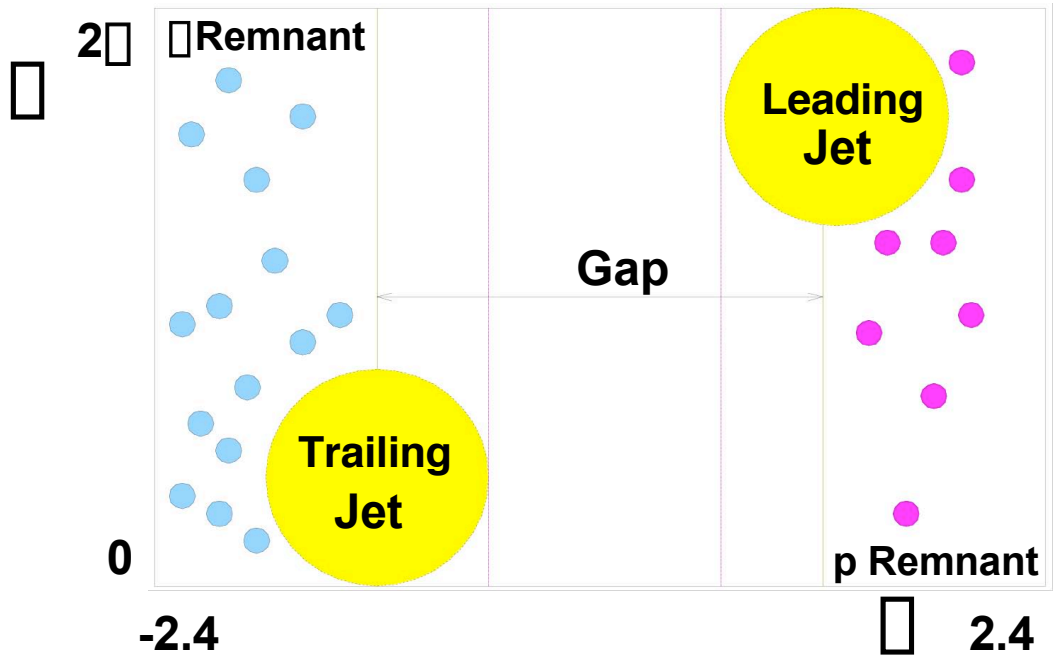
- Introduction
- Comparisons to MC and between analyses
- Cross Sections and Gap Fractions
- HERWIG Study
- Summary

Motivation

- Use pQCD to study a diffractive (soft) process
- Hard Diffractive Photoproduction
  - Hard: High E_T Jets
  - Diffractive: Gap Between jets
  - Photoproduction: $Q^2 \sim 0$



Topology of Rapidity Gaps



- Jets found using k_T inclusive algorithm
- Distance between jet centers:
- E_T^{Gap} = Sum of E_T of jets between leading and trailing jets
- Gap Event: $E_T^{Gap} < E_T^{Cut}$
- Gap may indicate color singlet exchange

The Gap Fraction

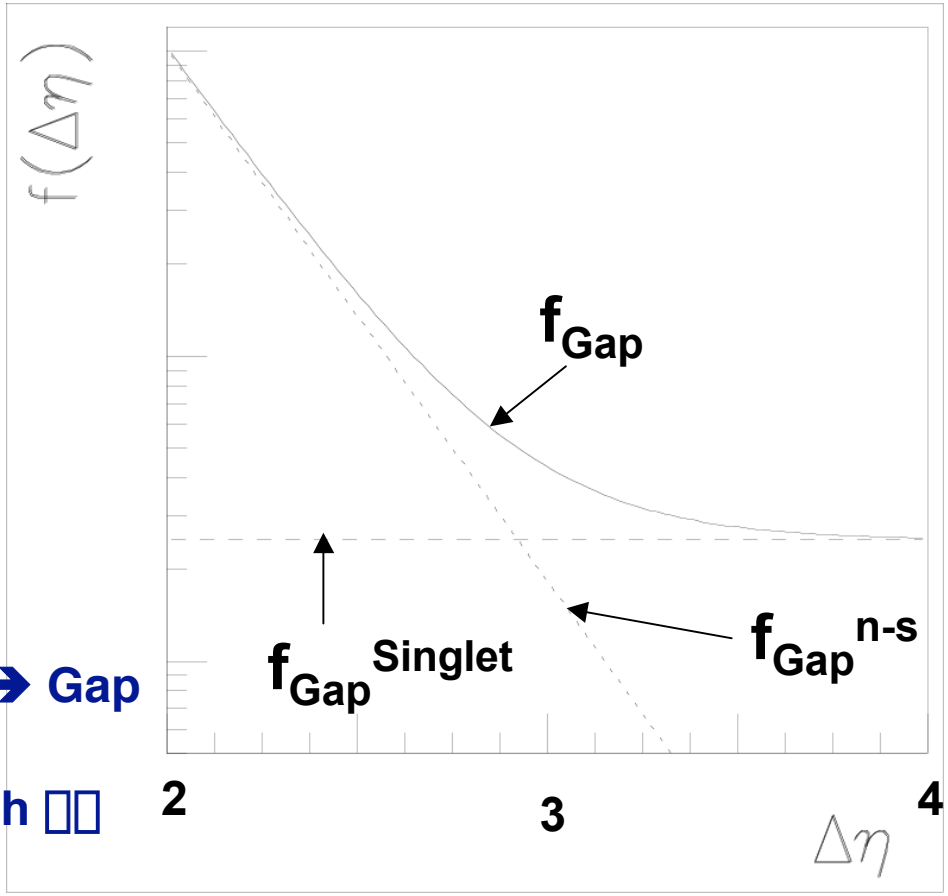
Dijet Events with Rapidity Gap ($E_T^{Gap} < E_T^{Cut}$)

All Dijet Events

$$f(\Delta\eta) = \frac{d\sigma_{Gap}/d\Delta\eta}{d\sigma/d\Delta\eta}$$

Expectation for Behavior of Gap Fraction (J.D. Bjorken, V.Del Durca, W.-K. Tung)

$$\sigma_{Gap} = \sigma_{gap}^{Singlet} + \sigma_{gap}^{Non\text{-}Singlet}$$

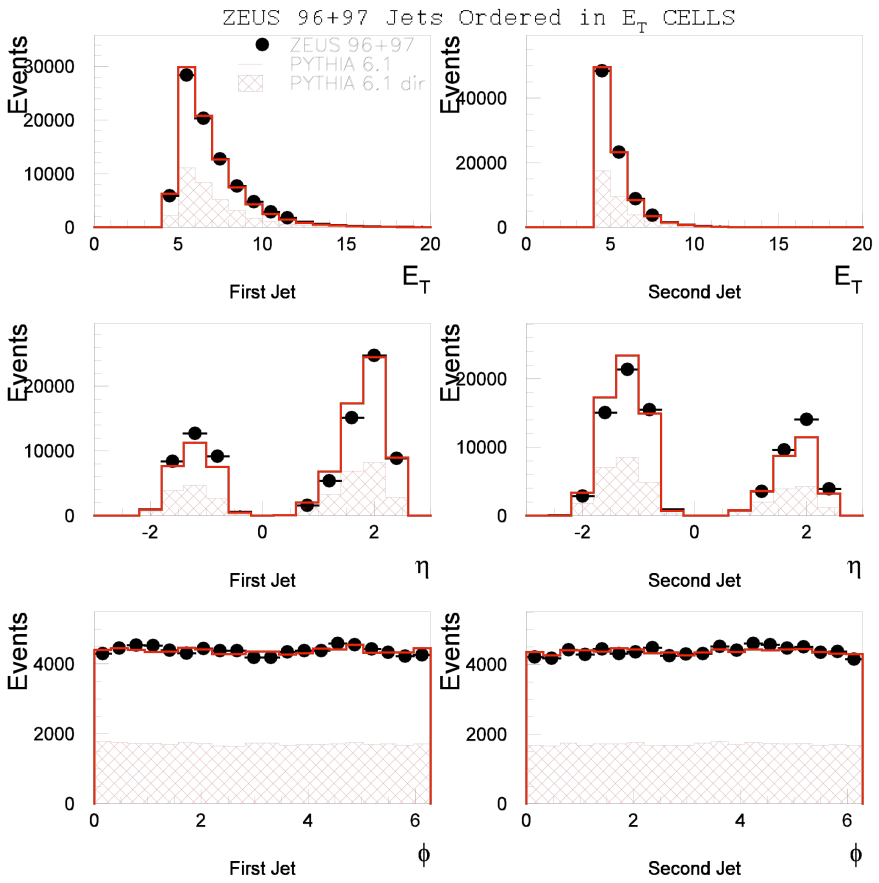


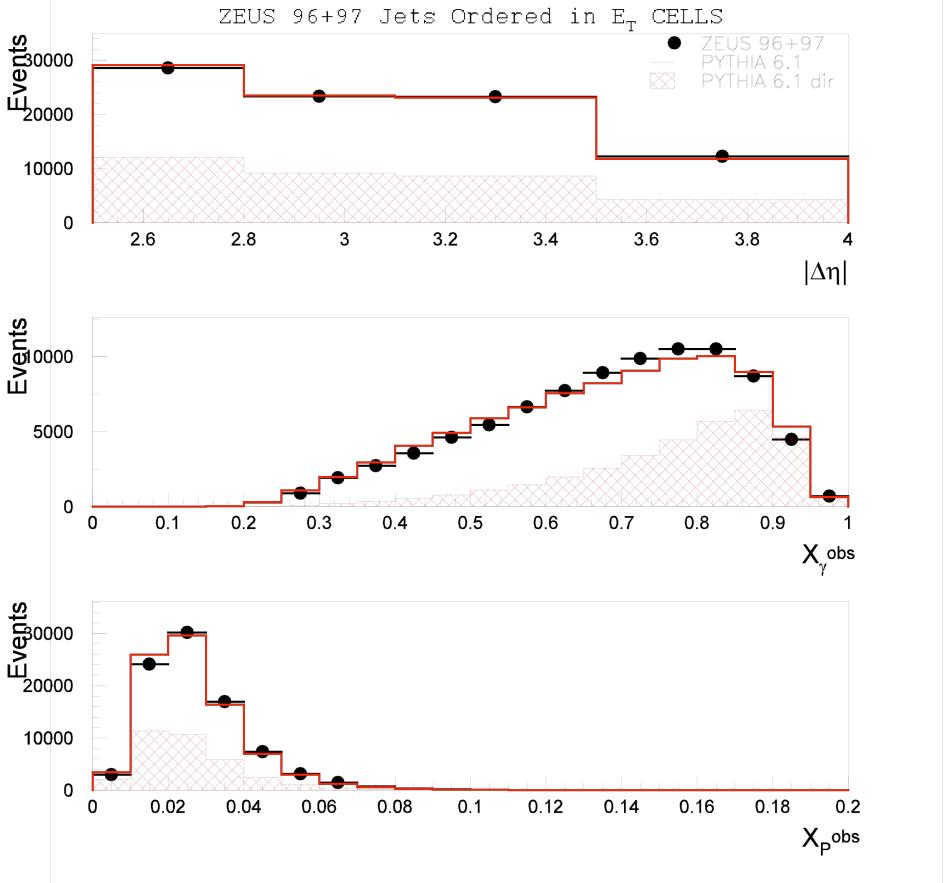
- **Singlet**
  - f(Δη) constant in Δη
- **Non-Singlet**
  - Particle production fluctuations ➔ Gap
  - Non diffractive exchange
  - f(Δη) decreases exponentially with Δη

Event Selection

- 96-97 Reprocessed Data
- HPP Trigger
  - FLT Slot 42
  - SLT HiEt I/II/III
  - TLT HPP14 (DST bit 77)
- Offline Cleaning Cuts
  - $|z_{vtx}| < 40$ cm
  - No Sinistra95 e^+ with
    - $P_e > 0.9$, $E_e > 5$ GeV, $y_e < 0.85$
  - $0.2 < y_{jb} < 0.85$
- Jet Selection
  - $|\eta^{1,2}| < 2.4$
  - $(1/2)*|\eta^1 + \eta^2| < 0.75$
  - $2.5 < |\eta^1 - \eta^2| < 4.0$
  - $E_T^{1,2} > 4.8, 4.0$ GeV (Cells)
  - $E_T^{1,2} > 5.1, 4.25$ GeV (Zufos)
  - $E_T^{1,2} > 6.0, 5.0$ GeV (Had)
- Gap Sample
  - $E_T^{GAP} < E_T^{CUT}$
  - $E_T^{CUT} = 0.5, 1.0, 1.5, 2.0$ (Had)
  - $E_T^{CUT} = 0.6, 1.2, 1.8, 2.4$ (Detector)
- PYTHIA 6.1
  - Direct, Resolved (MPI)
  - PDF(p): GRV-LO
  - PDF(γ): WHIT 2

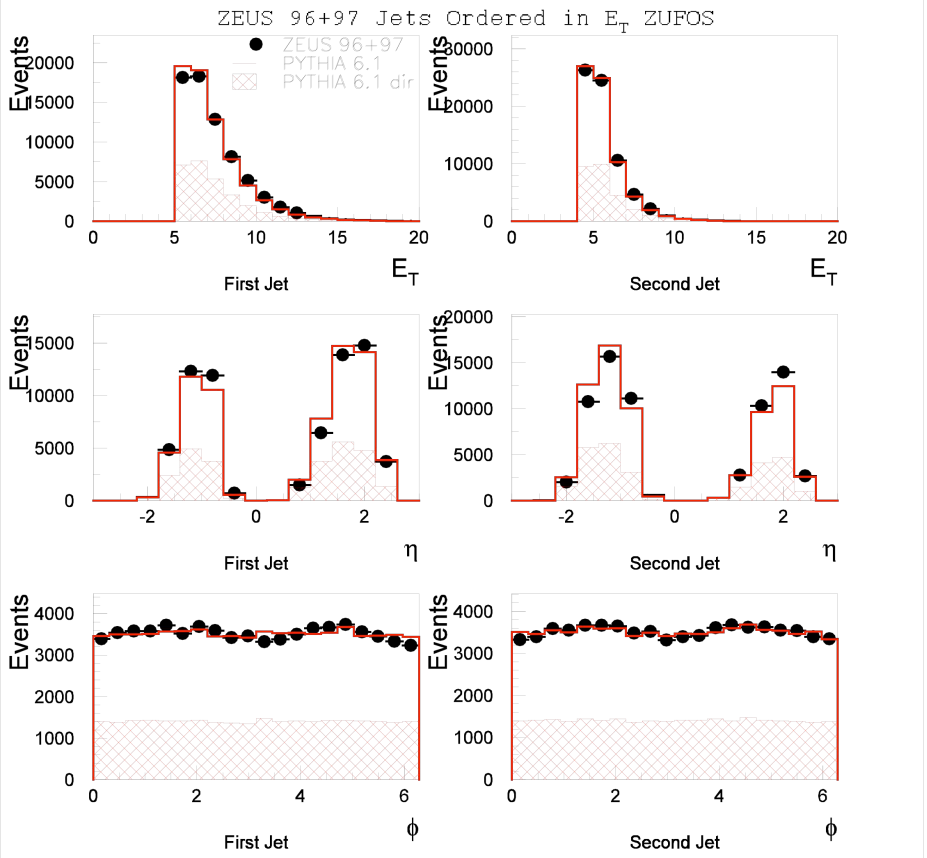
Kinematic Quantities
Jets reconstructed using Cells

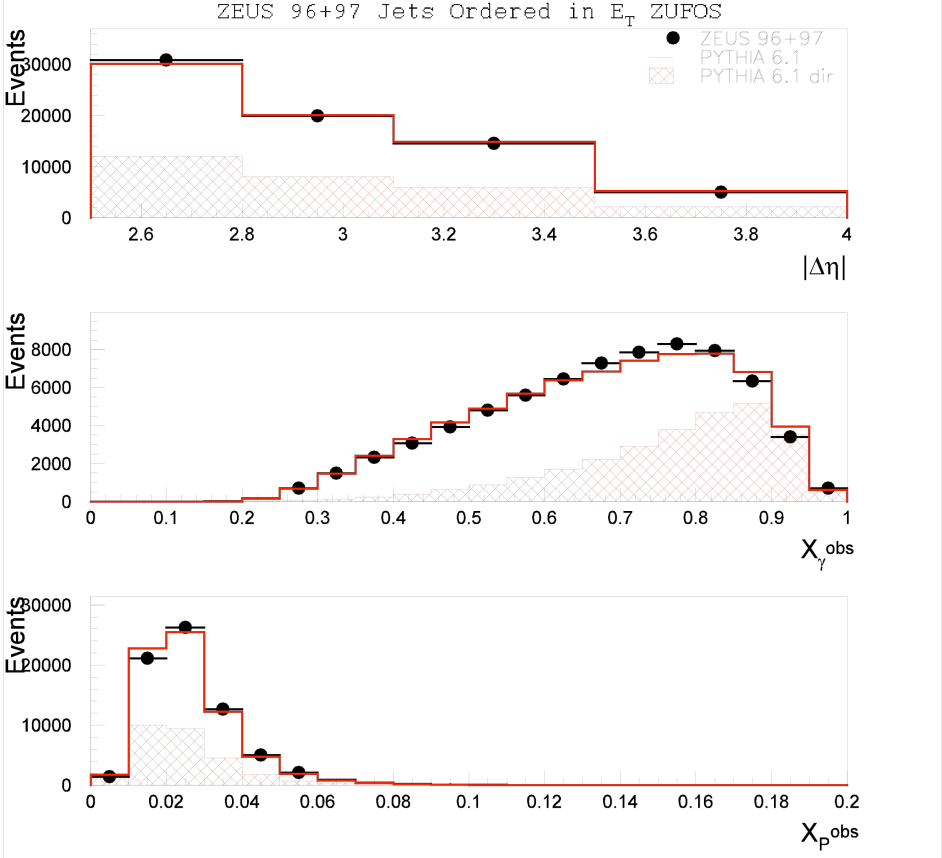




Currently using 37% Direct and 63% Resolved

Kinematic Quantities
Jets Reconstructed using ZUFOS



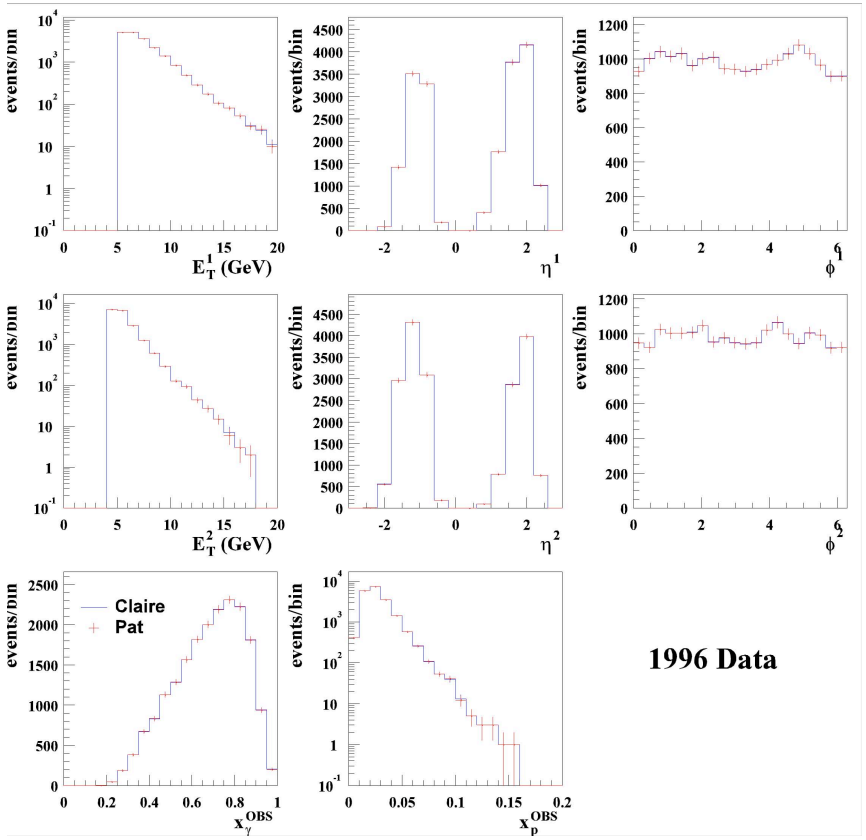


Currently using 37% Direct and 63% Resolved

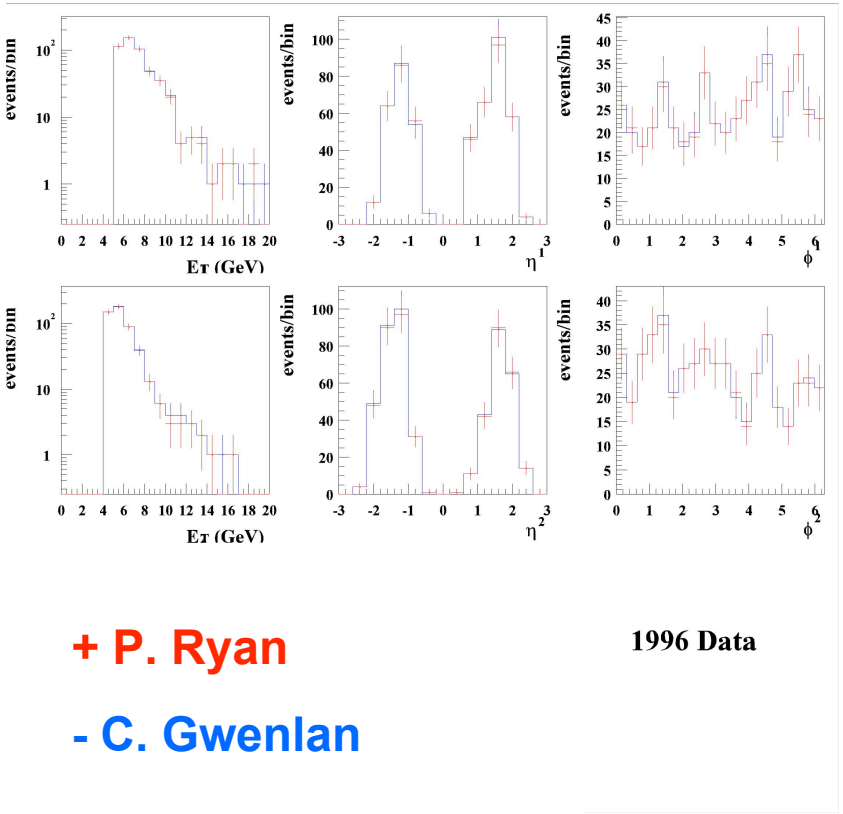
Equally good agreement between Data and MC for Cells and ZUFOS

Comparison between Analyses Data

Inclusive Sample
All Dijet Events



Gap Sample
Dijet Events with Rapidity Gap



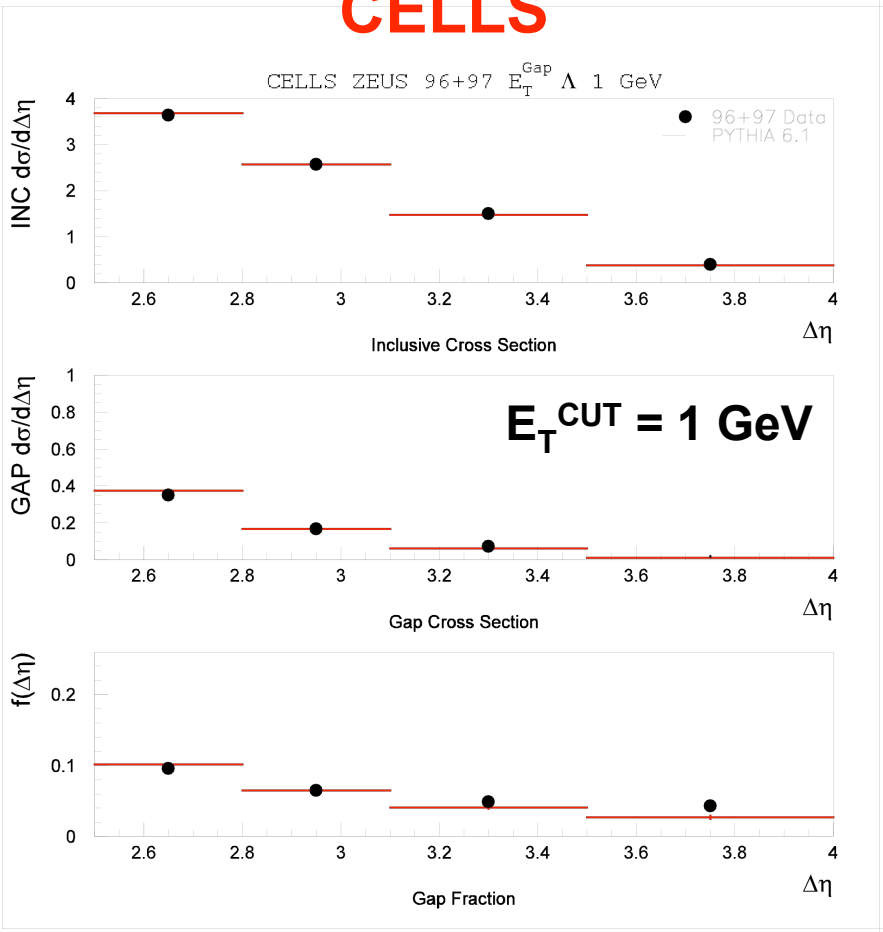
+ P. Ryan

- C. Gwenlan

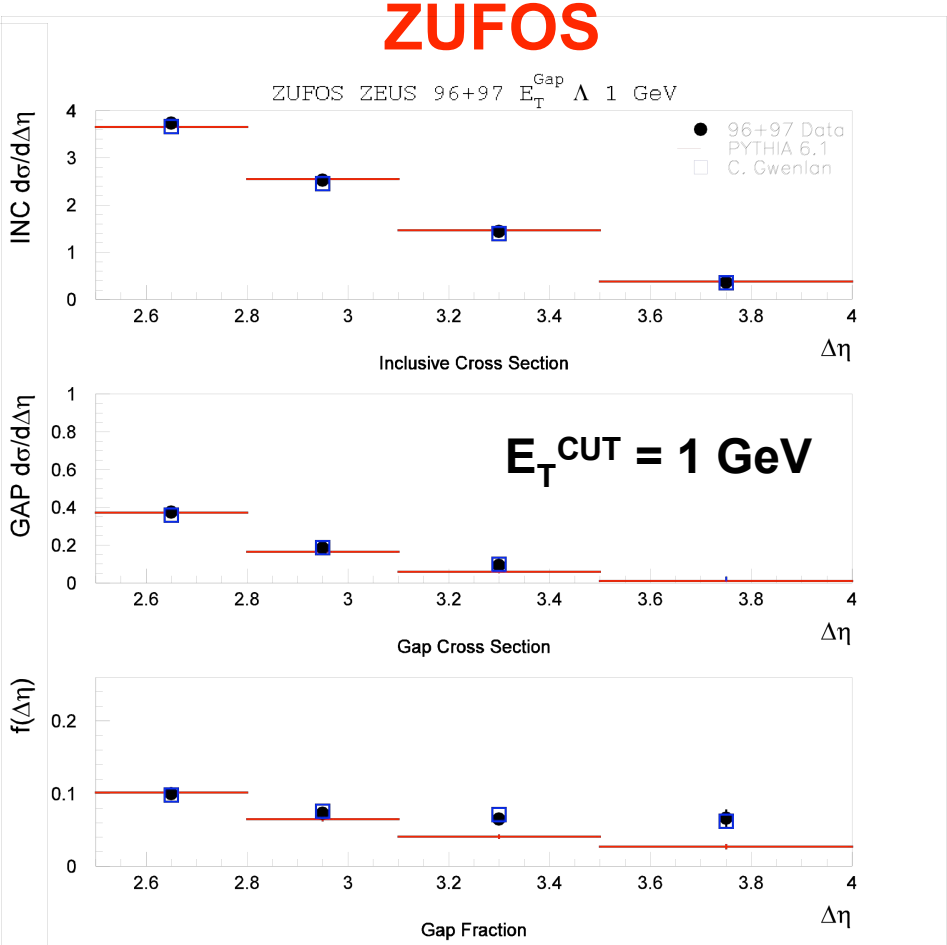
Excellent agreement between the analyses

Comparison between Analyses Corrected Cross Section (PYTHIA)

CELLS



ZUFOS



P. Ryan: Reprocessed MC without color singlet exchange

C. Gwenlan: Unreprocessed MC with color singlet exchange

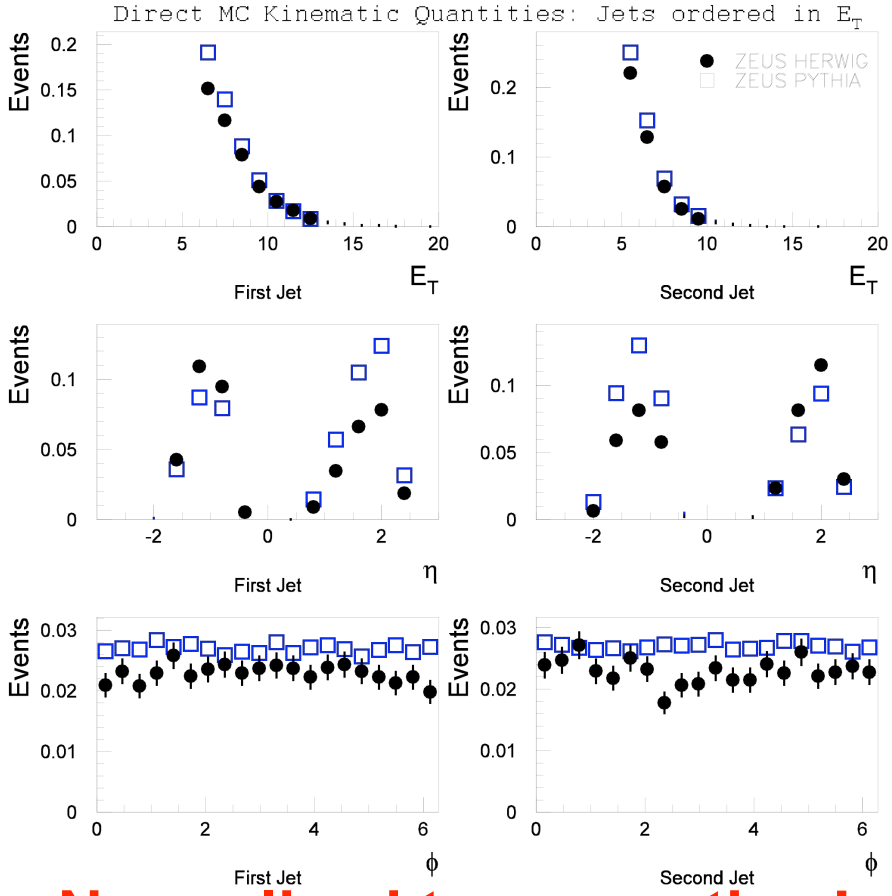
HERWIG

- **Last collaboration meeting**
  - **In previous studies, HERWIG (5.9 stand-alone) and PYTHIA 6.1 disagree**

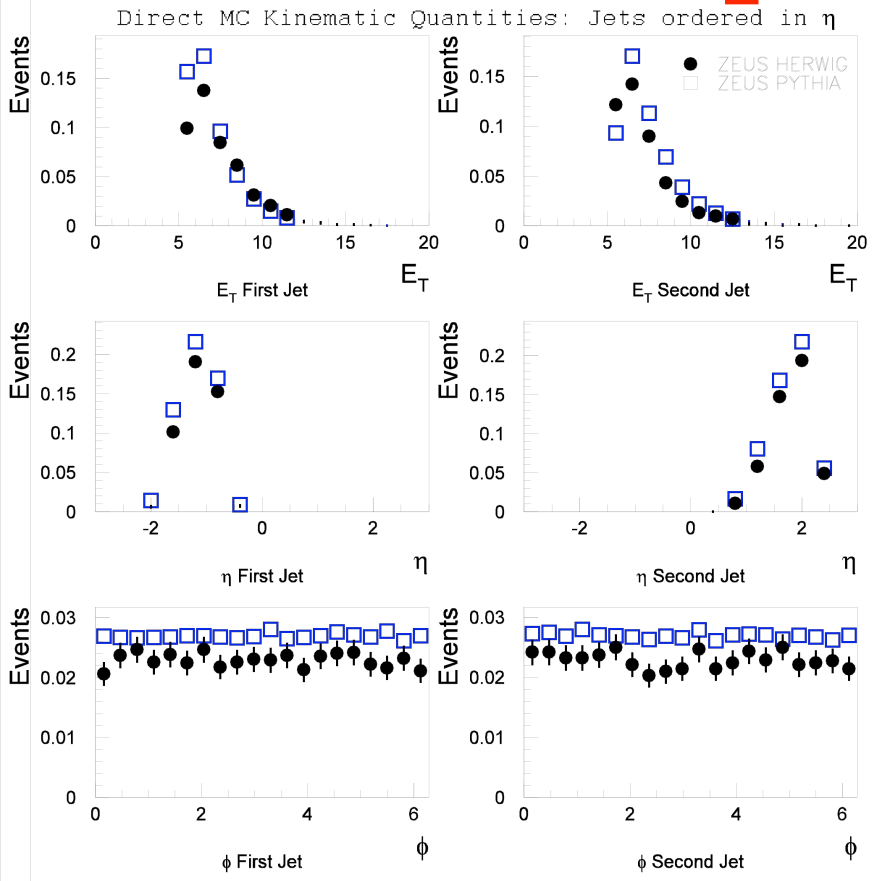
- **This collaboration meeting**
  - **New HERWIG 6.1 using ZEUS-Amadeus**
  - **Separately generated LO-Dir and LO-Res (with MPI)**
  - **PDFs**
    - Proton: GRV-LO
    - Photon: WHIT 2

HERWIG 6.1 vs. PYTHIA 6.1

Jets ordered in E_T



Jets ordered in η

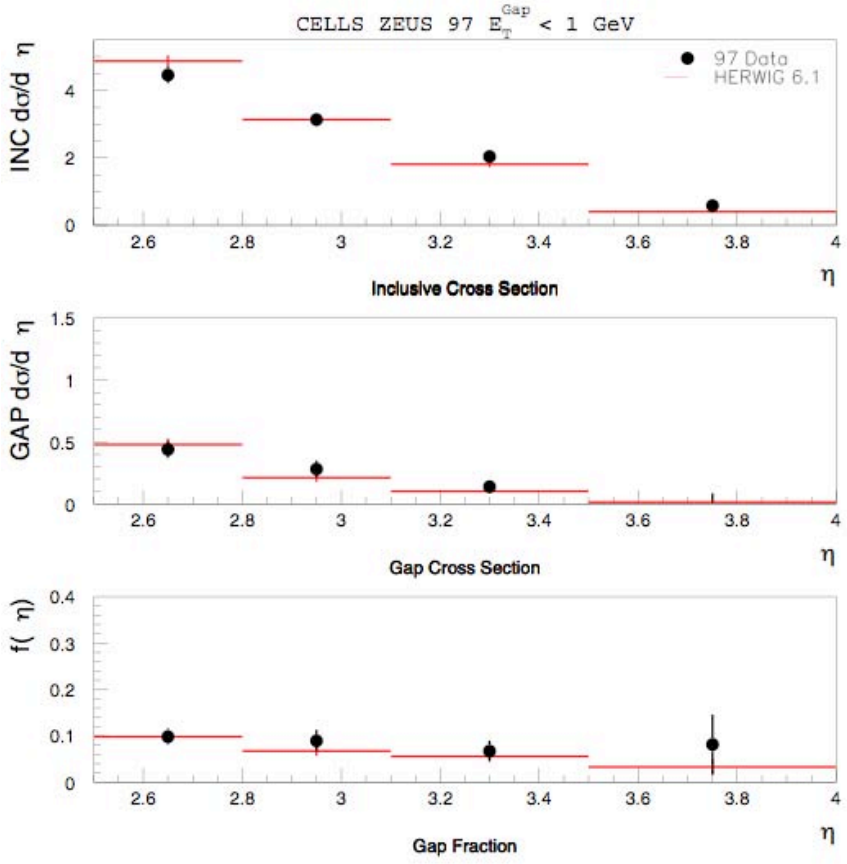


Normalized to respective Luminosities

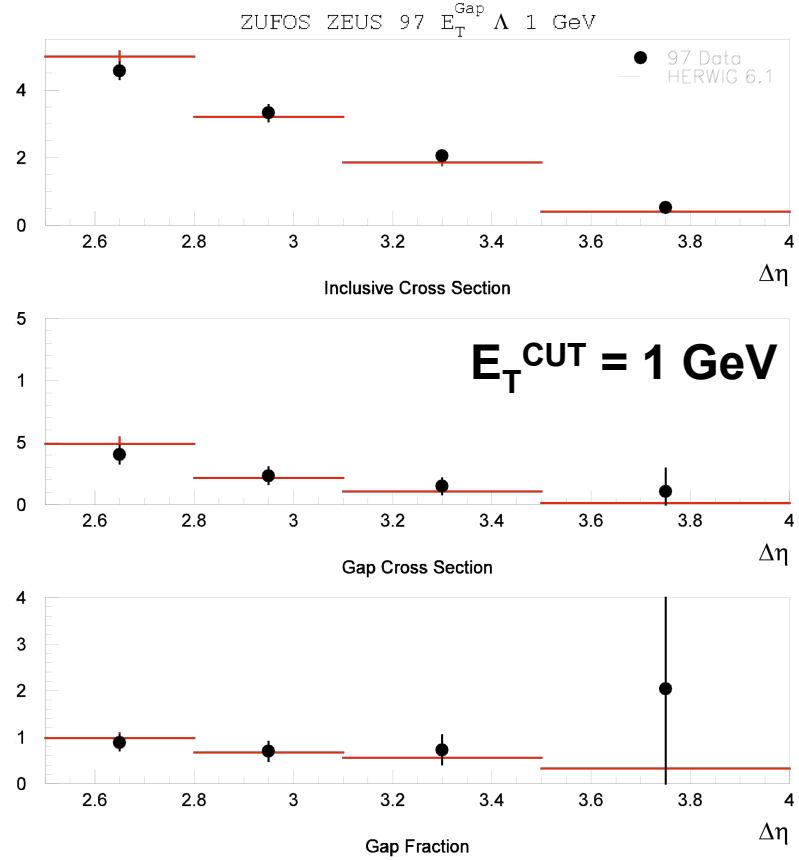
Absolute cross section of PYTHIA larger than HERWIG

Corrected Cross Sections HERWIG 6.1

CELLS



ZUFOS

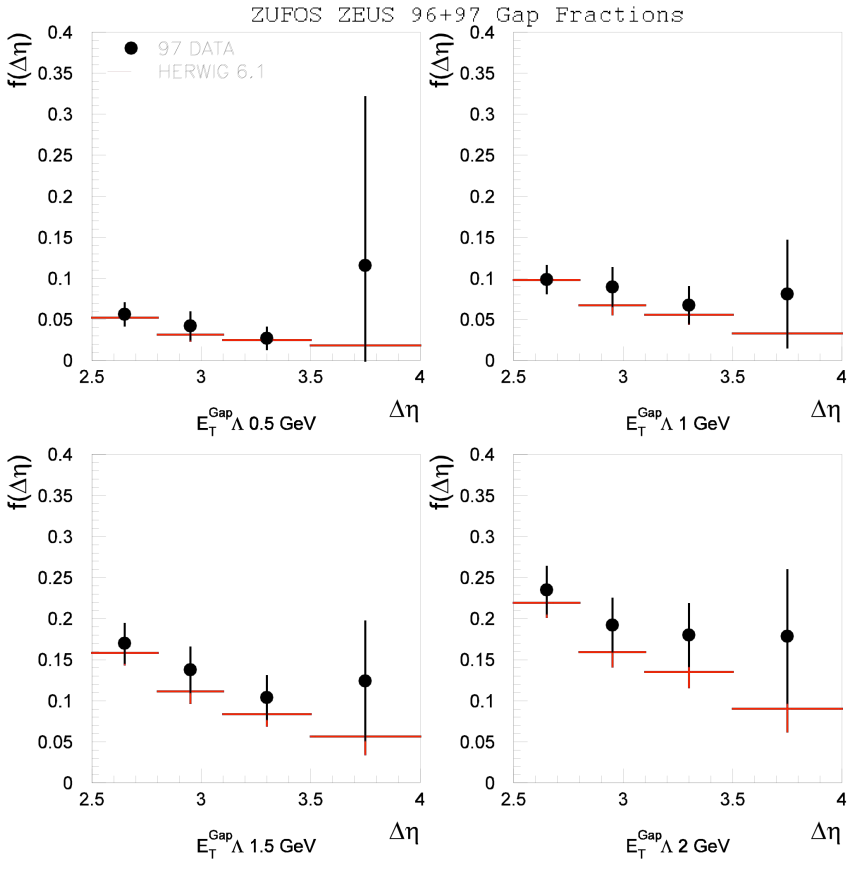


HERWIG describes shape of data reasonably well

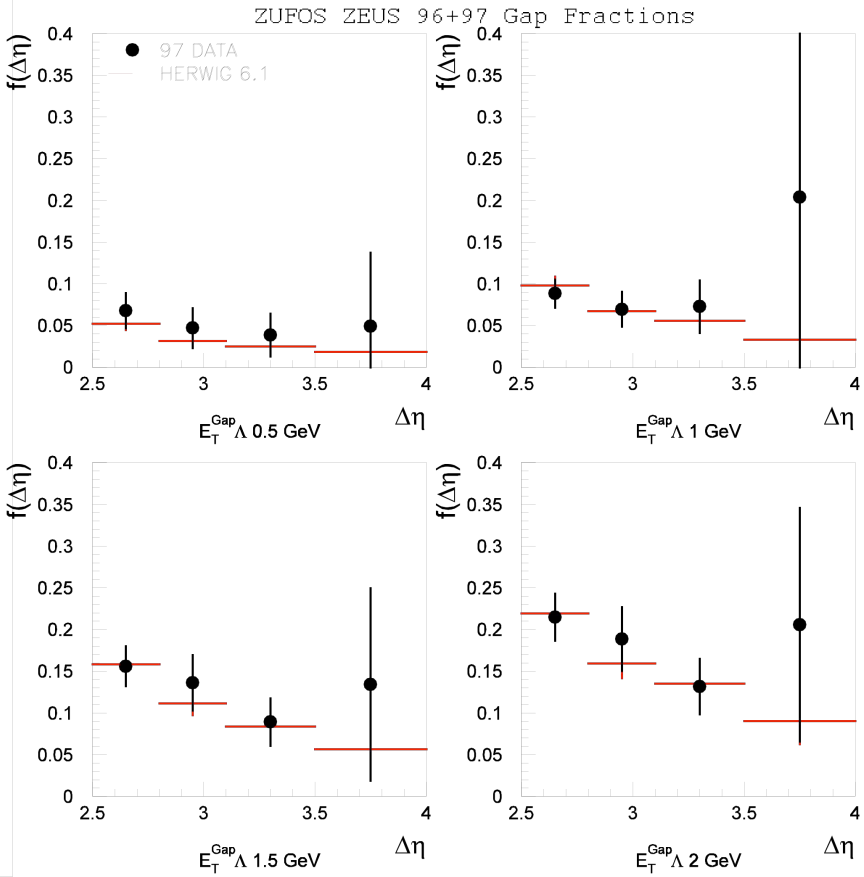
Low MC Statistics, especially in highest □□ bin

Gap Fractions HERWIG 6.1

CELLS



ZUFOS



HERWIG 6.1 does not include color singlet exchange

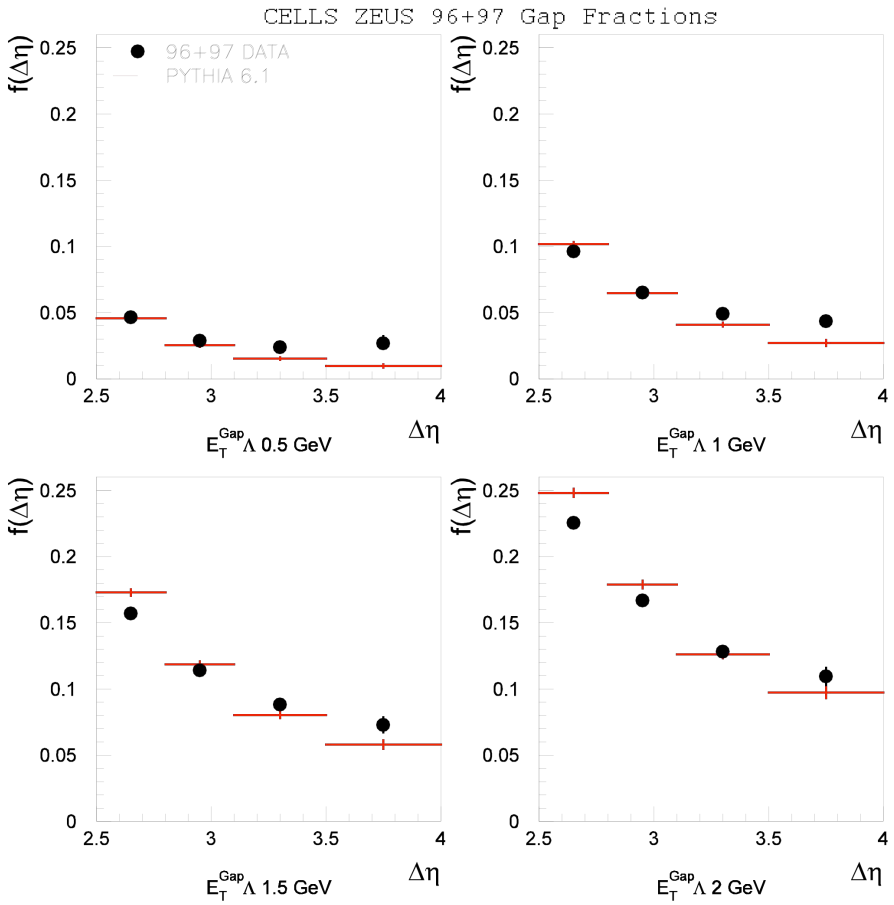
Low MC statistics, especially in highest □□ bin

Summary

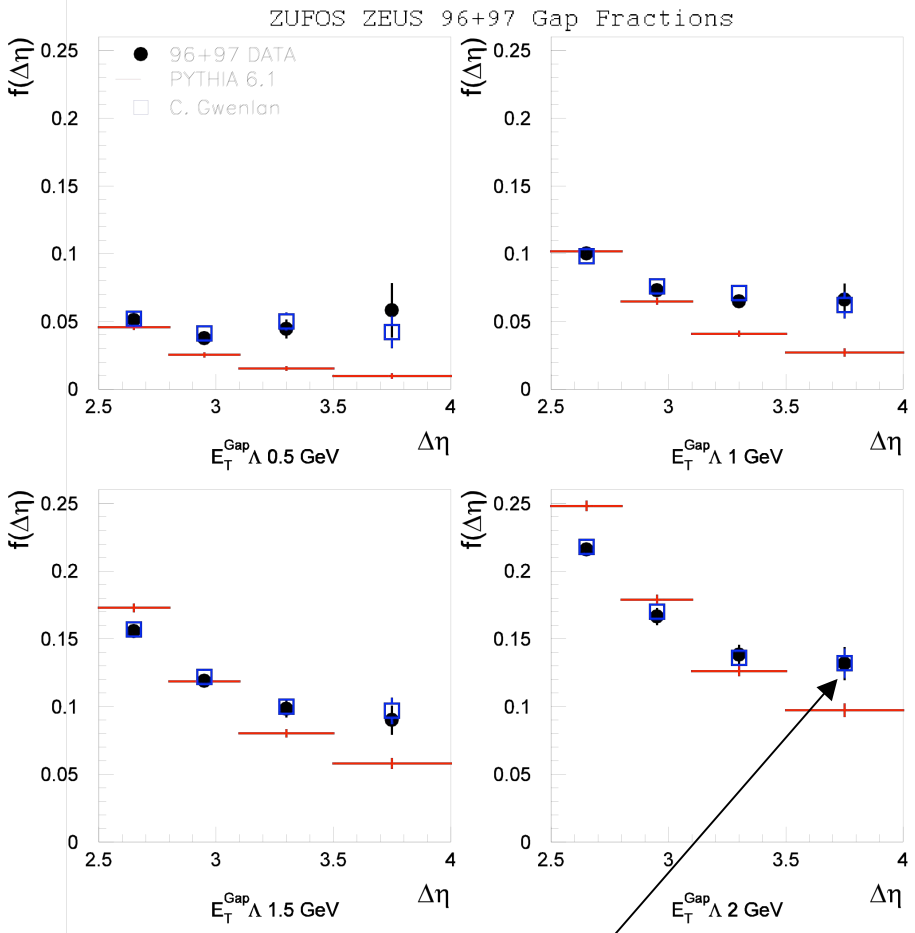
- **Conclusions**
  - **Good agreement between analyses of P. Ryan & C. Gwenlan for cross sections and gap fractions**
  - **Cross Sections differ for PYTHIA and HERWIG**
- **Plans**
  - **Use MC with color singlet exchange**
  - **Study differences between PYTHIA and HERWIG**
    - More statistics needed for HERWIG
  - **Include larger data sample (98-2000 Data)**
    - Can go to higher jet E_T
    - Less sensitivity to underlying event models
  - **Paper to be written soon**

Comparison between Analyses Gap Fraction

CELLS



ZUFOS



PYTHIA 6.1 does not include color singlet exchange

Excess of data in highest □□ bin possible evidence of color singlet exchange