# Dijet $\Delta\Phi$ and Parton-Shower Matching

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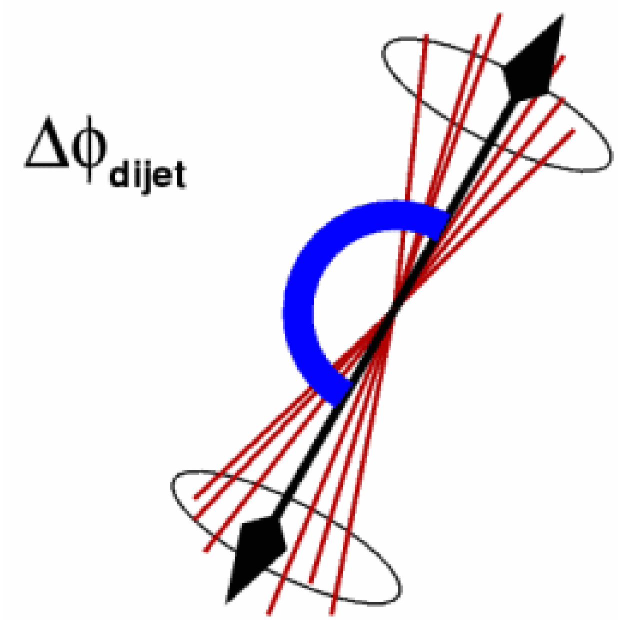
# What is $\Delta\Phi$? Why is $\Delta\Phi$ of interest?

- $\Delta\Phi$ is the azimuthal opening angle between the two leading jets
- $\Delta\Phi$ distribution is sensitive to a wide spectrum of radiation effects
  - ➔ Back-to-back production of two jets gives $\Delta\Phi=\pi$
  - ➔ Soft radiation: $\Delta\Phi \sim \pi$
  - ➔ Hard radiation: $\Delta\Phi < \pi$
  - ➔ At least 4 jet configurations for $\Delta\Phi < 2\pi/3$ (3-jet "Mercedes")
- Ideal testing ground for matching procedures to combine MC samples with different jet multiplicities



# Experimental Motivation

- Observable: $\Delta\Phi$ distribution between the two leading jets normalized by the integrated dijet cross section

$$\frac{1}{\sigma_{\text{dijet}}} \cdot \frac{d\sigma_{\text{dijet}}}{d\Delta\Phi}$$

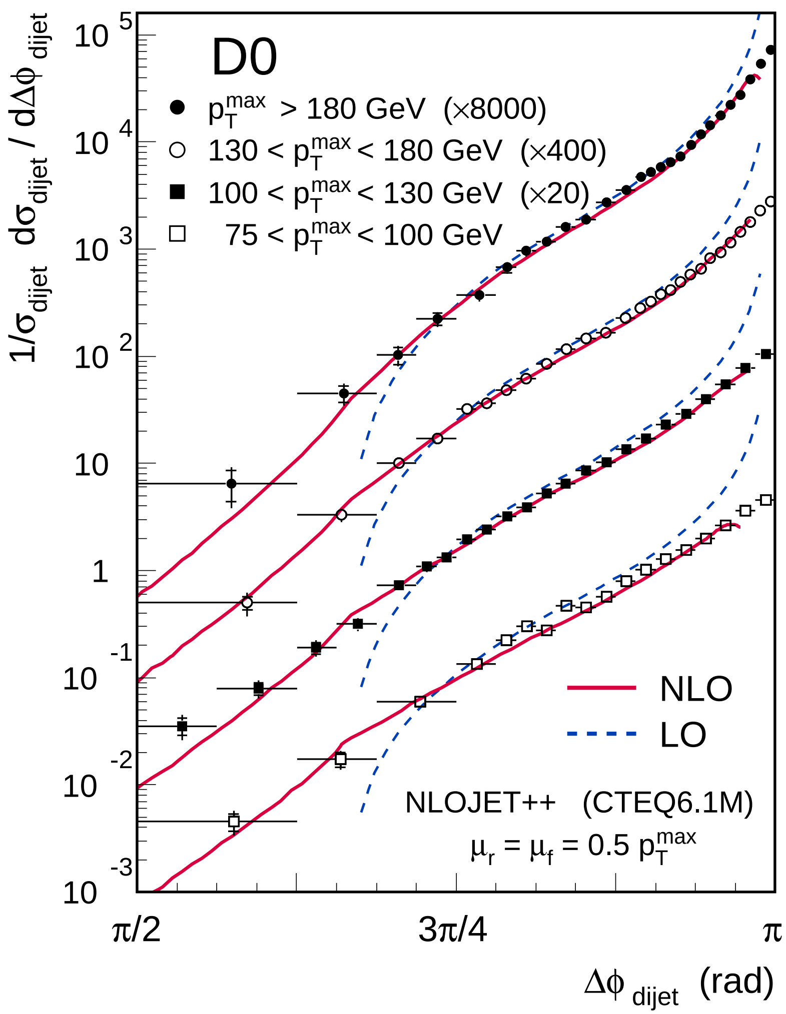
- Advantages:
  - ➔ $\Delta\Phi$ is a simple variable, uses only the two leading jets
  - ➔ No need to reconstruct any other jets!
  - ➔ Jet direction is well measured
  - ➔ Reduced sensitivity to jet energy scale

- Data analysis:
  - ➔ Central jets $|y| < 0.5$
  - ➔ Second-leading $p_T > 40$ GeV
  - ➔ Leading jet $p_T$ bin thresholds:
    - ❖ 75, 100, 130, 180 GeV

- More details in M. Wobisch talk yesterday

- Results submitted to PRL yesterday
  - ➔ hep-ex/0409040

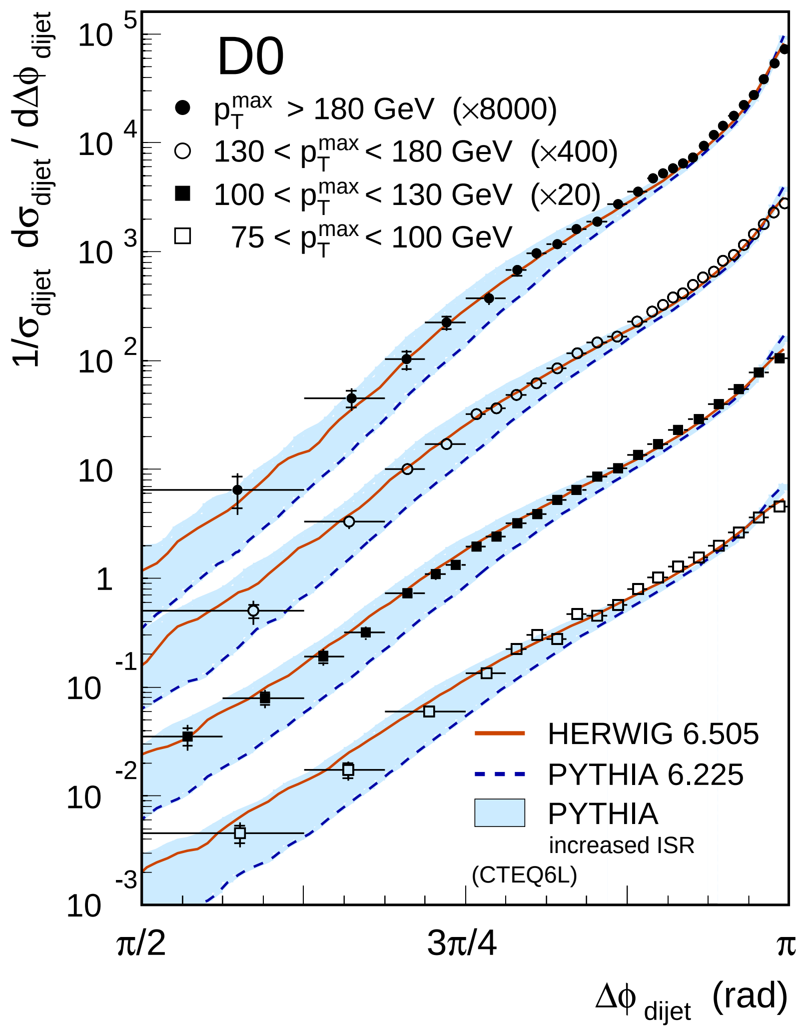
# ΔΦ: Comparison to Fixed-Order pQCD




- Leading order (dashed blue curve) – clear limitations
  - ➔ Divergence at ΔΦ = π (need soft processes)
  - ➔ No phase-space at ΔΦ<2π/3 (only three partons)
- Next-to-leading order (red curve)
  - ➔ Good description over the whole range, except in extreme ΔΦ regions

# ΔΦ: Comparison to Parton-Shower MCs

- Testing the radiation process:
  - ➔ 3rd and 4th jets from parton showers
- HERWIG
  - ➔ Good overall description!
- PYTHIA
  - ➔ Default: very different shape
  - ➔ Sensitivity to ISR
    - ❖ Bands: variation of PARP(67)=1.0-4.0
  - ➔ Not sensitive to soft/FSR params
    - ❖ See Markus' talk
  - ➔ Best value: PARP(67)=2.5
  - ➔ Base for the next round of TeV/universal tuning
    - ❖ "Tune A-prime"



# Multi-parton Samples from Alpgen

- We use Alpgen to generate separate samples of exclusive 1…6 parton multiplicities
  - ➔ Then process events through PYTHIA to generate parton showers (and full-event aspects if desired)

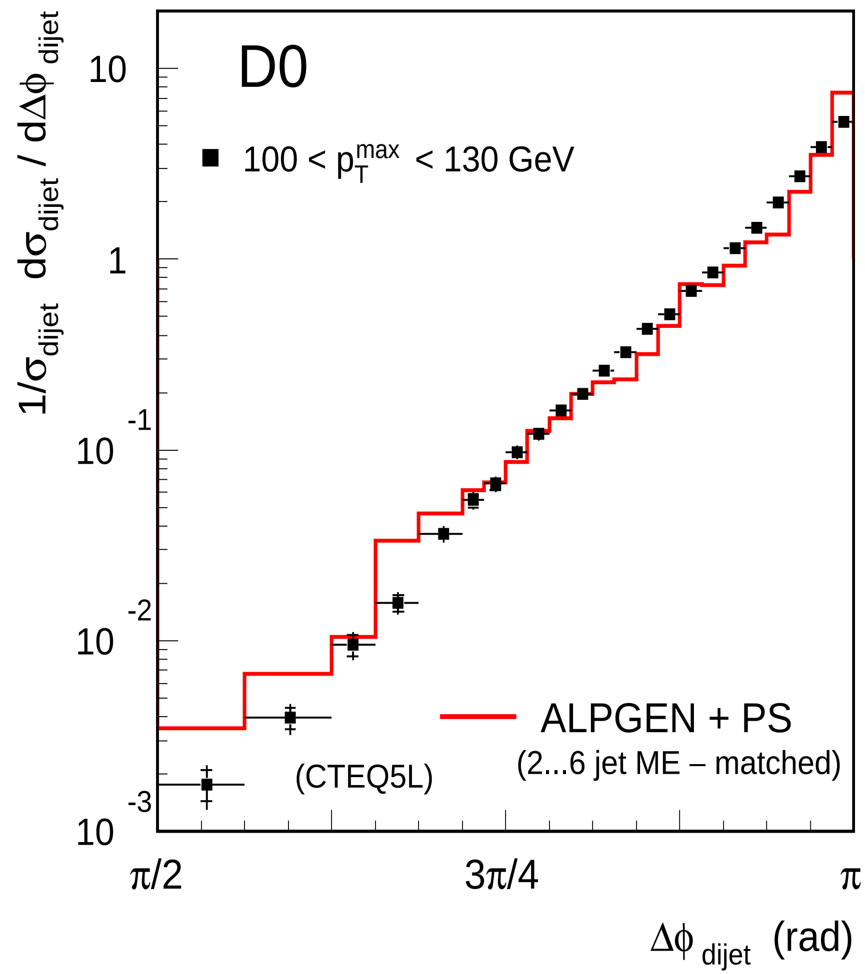
- Matching between contributions from Matrix Element and Parton Shower jets is required to
  - ➔ Eliminate dependence of physical cross-section on generator-level cuts
  - ➔ Eliminate double counting of congurations where jets arise from both the higher-order parton-level calculation and from hard emission during shower evolution

# MLM Matching Prescription

- Generate parton-level conguration for a given multiplicity bin with cuts $p_T > p_{T\,min}$ and $R > R_{min}$
- Perform jet showering using HERWIG or PYTHIA
- Process showered event before hadronization with a jet algorithm
- Match partons and parton-shower jets a jet can only be matched to a single parton
  - ➔ Exclusive: Every parton matched to a jet with $N_{jet} = N_{parton}$
  - ➔ Inclusive: All partons matched to jets
- Combine exclusive event samples (constant luminosity) to obtain an inclusive sample containing events with all multiplicities
  - ➔ $X+N_{jet} = X+0j_{exc} + X+1j_{exc} + \ldots + X+5j_{exc} + X+6j_{inc}$
  - ➔ Here, X=none, but cases when X=W or X=Z are of great interest

# ΔΦ: First comparison to MLM-matched Alpgen

- Data are fully corrected for experimental effects
- ALPGEN tree-level production for 2 ➔ 2, 3,..., 6 partons
- Use PYTHIA parton showers for matching
  - ➔ implemented in F77 by M. Begel
- Reasonable agreement over whole ΔΦ range – scanning a broad range of jet multiplicities
  - ➔ Helps build confidence in matching application for W/Z+jets
  - ➔ Comparison to CKKW will be of great interest



# Conclusions

- ALPGEN + MLM matching describe the $\Delta\Phi$ distributions fairly well –

  as do NLO pQCD, HERWIG, and re-tuned PYTHIA

- Same techniques are being used in DØ for generating W+jets and Z+jets samples for top and Higgs studies

- There is a clear area of common interest between QCD, Top/EW and perhaps Higgs working groups –

  should we form an "interdisciplinary" subgroup?