Inclusive dijet final states at DØ

Zdenek Hubacek

Czech Technical University in Prague
(on behalf of DØ Collaboration)

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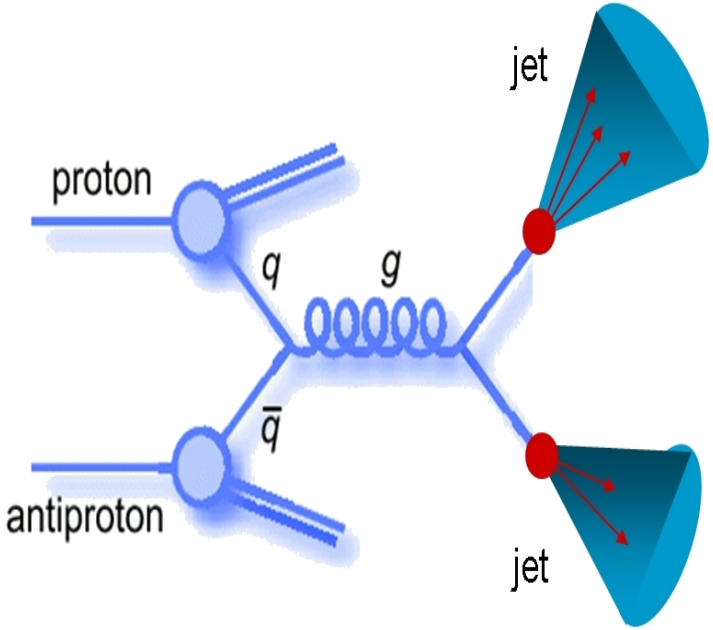
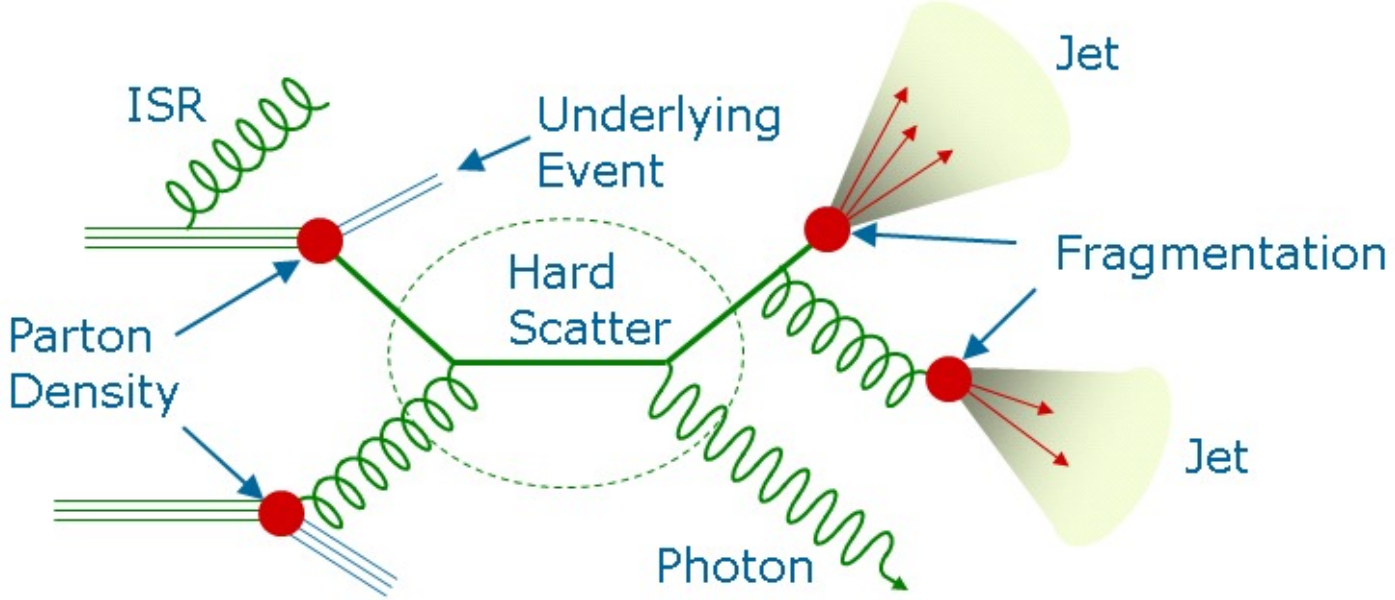
Outline

- **Dijet Final State**
- **DØ Experiment**
- **DØ Dijet Measurements**
  - Dijet $\Delta\phi$
  - Dijet χ
  - Dijet invariant mass
- **Conclusions**

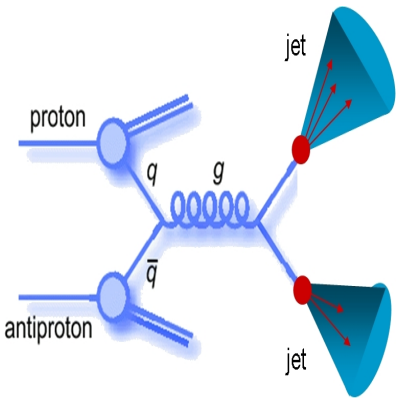


Motivation - General QCD Measurement

- Test of perturbative QCD (LO/NLO calculations, PDFs, α_S)
- Constrain of PDFs (high Q^2, medium to high x)
- Background to other SM processes or to new physics (SUSY, 4th generation, extra dimensions, ...)

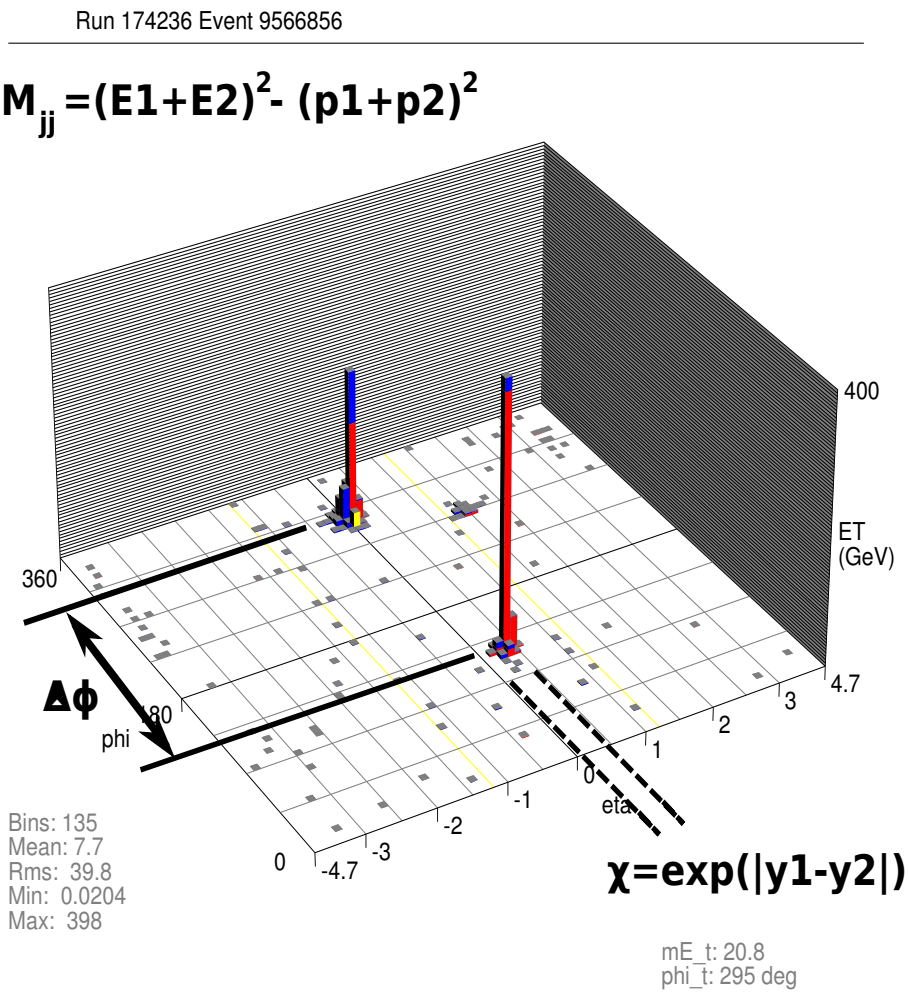


Dijet System

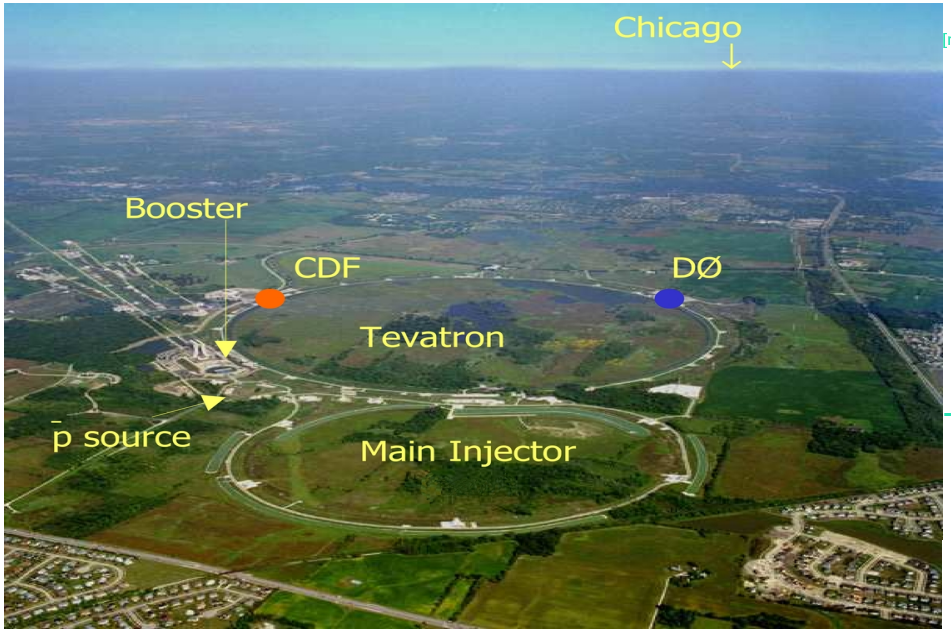


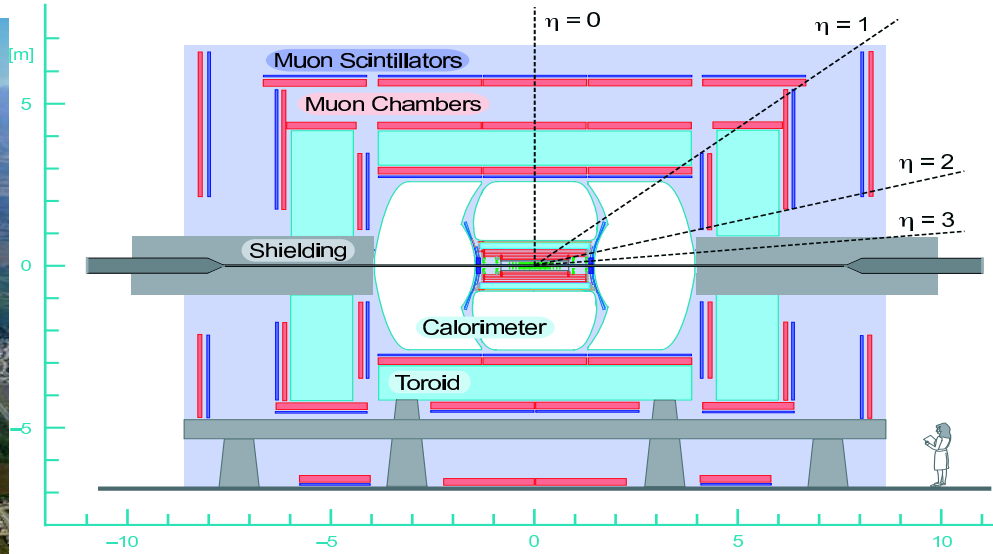
- Dijet invariant mass
- Angular variables - $\chi, \Delta\phi$

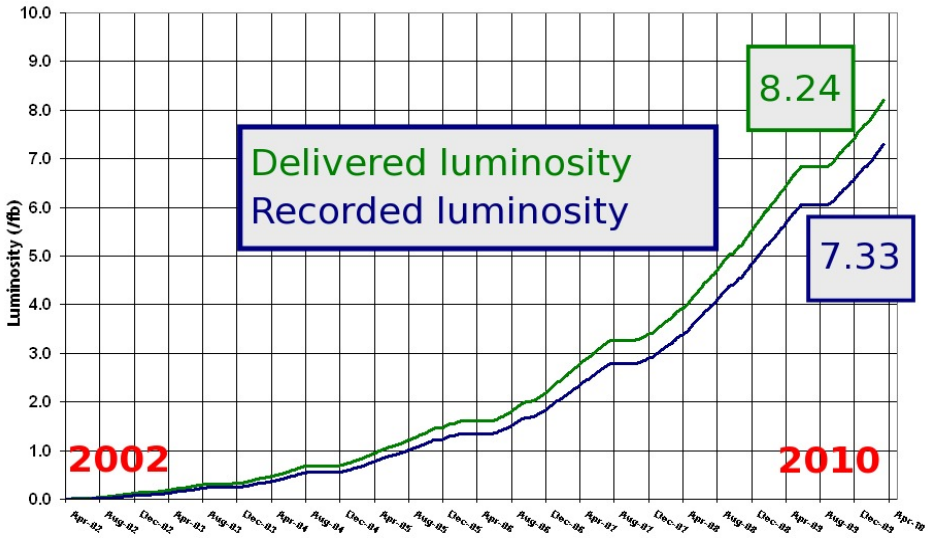
Real dijet event display:



Tevatron and DØ Experiment Overview







- $\sqrt{s} = 1.96\mathrm{TeV}$
- Peak luminosity $4.0 \cdot 10^{32}\mathrm{cm}^{-2}\mathrm{s}^{-1}$
- Integrated luminosity $> 7\mathrm{fb}^{-1}$

DØ Jet Algorithm and Jet Energy Scale

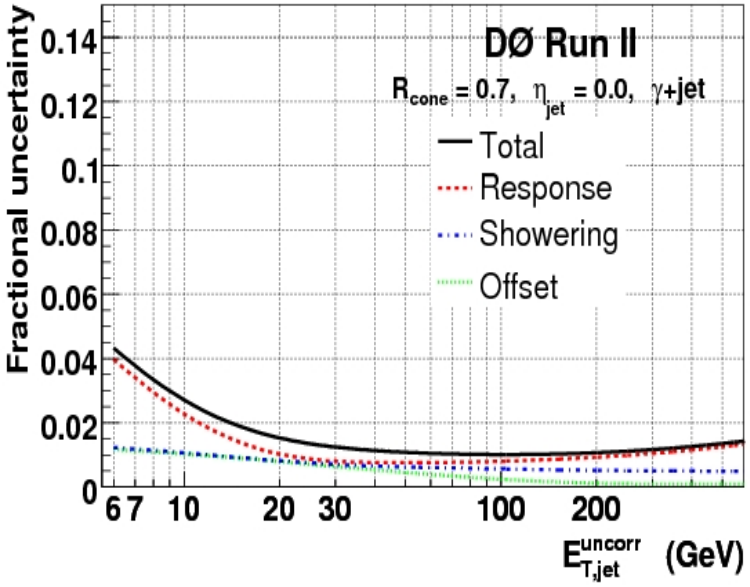
Jet algorithm:

- Cone class algorithm
- $R_{\text{cone}} = \sqrt{(\Delta y)^2 + (\Delta\phi)^2} = 0.7$
- 4-vector scheme - p_T instead of E_T, y instead of η
- Midpoints
- Split-merge fraction 50%
- Min jet p_T 6 GeV

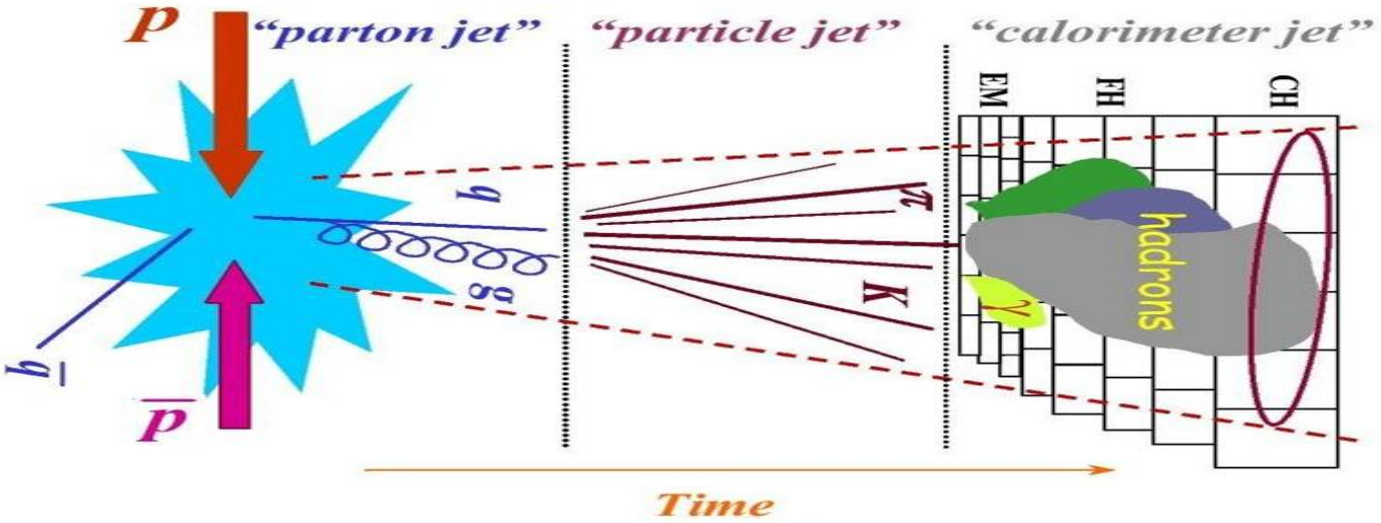
Jet energy scale:

$$E^{\text{corr}} = \frac{E^{\text{meas}} - O}{R \cdot S}$$

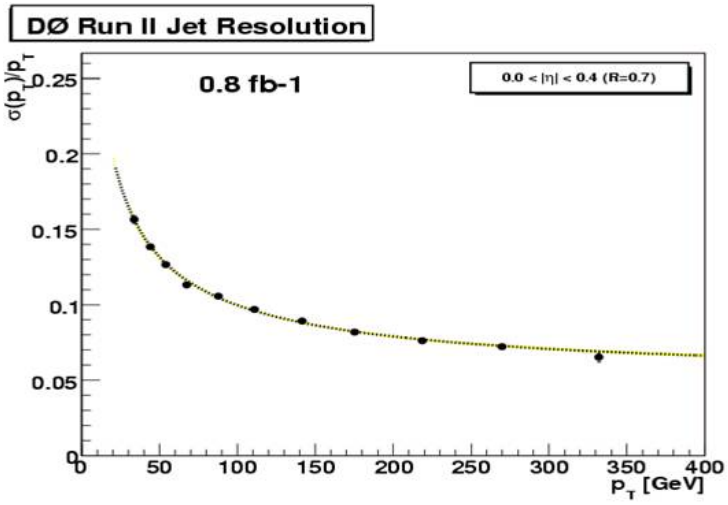
- Offset (O)
- Response (R)
- Showering (S)



Experimental Measurement



Jet p_T resolution:

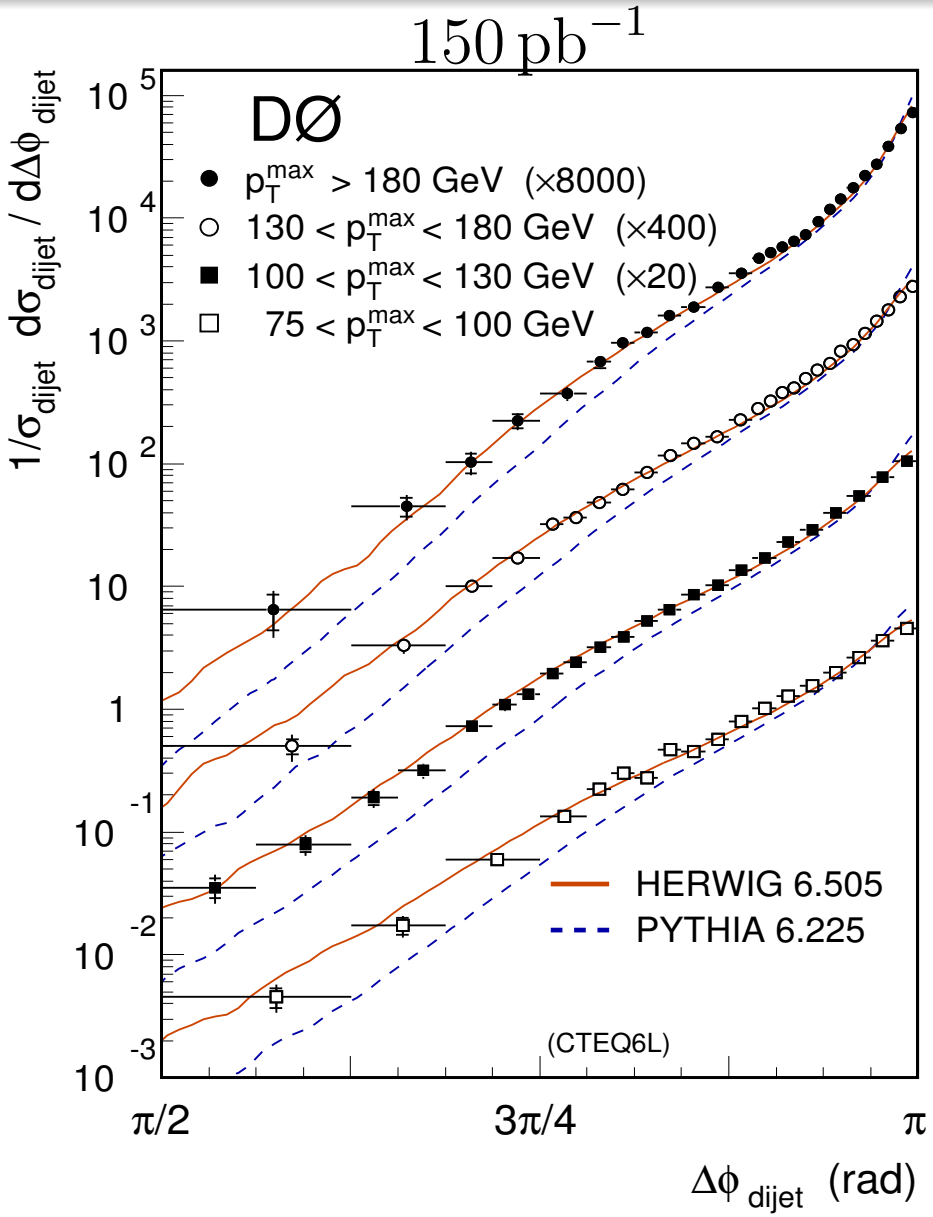


Typical experimental correction (dijet mass measurement):
Central rapidity $|y| < 0.8$: $\pm 2\%$
Forward:
$0.8 < |y| < 1.6$: 0.5% (low mass) – 22% (high mass)
$1.6 < |y| < 2.4$: 1% – 11%

Dijet Azimuthal Decorrelations

- Measure $\Delta\phi$ between the two leading jets
- Dijet production in lowest order pQCD - jets have equal p_{T} and $\Delta\phi_{\mathrm{dijet}} = \pi$
- Additional radiation causes azimuthal decorrelations
- $\Delta\phi$ sensitive to higher order QCD radiation without measuring additional jets
- Sensitivity of MC parton shower models $\rightarrow$ new MC tunes

PRL 94, 221901(2005)



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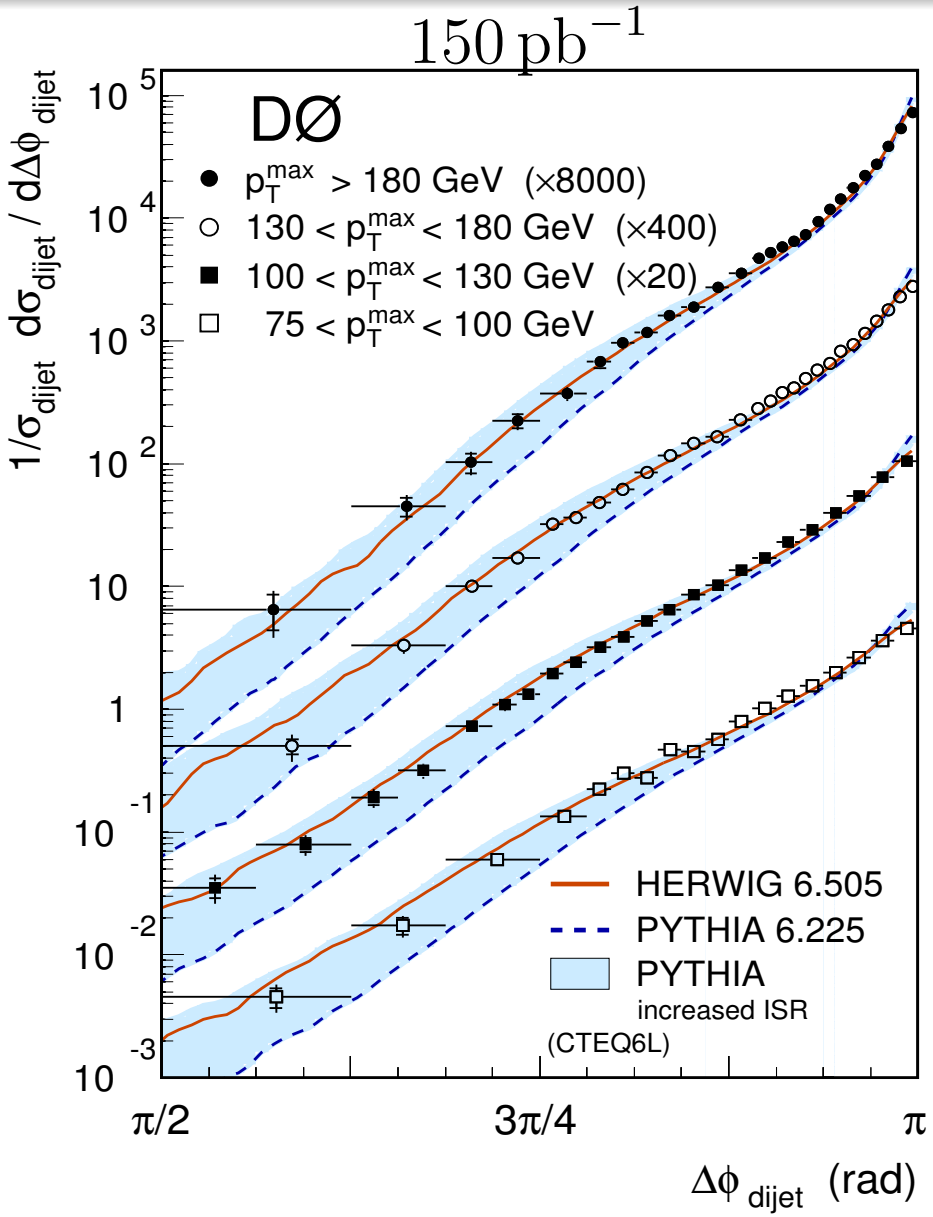
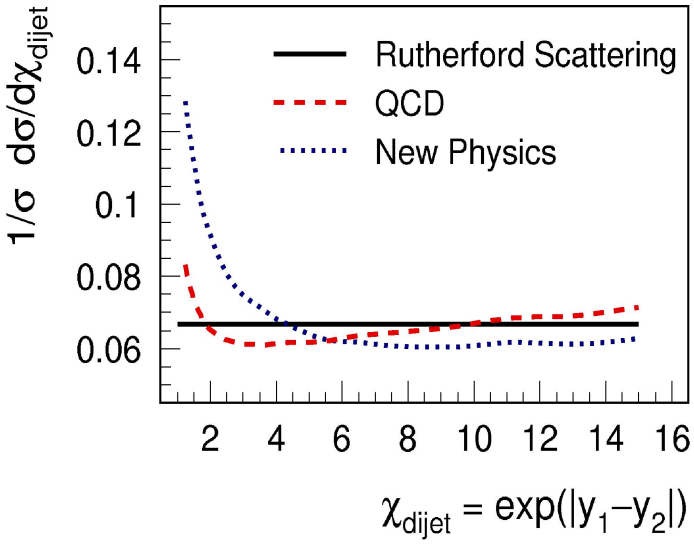
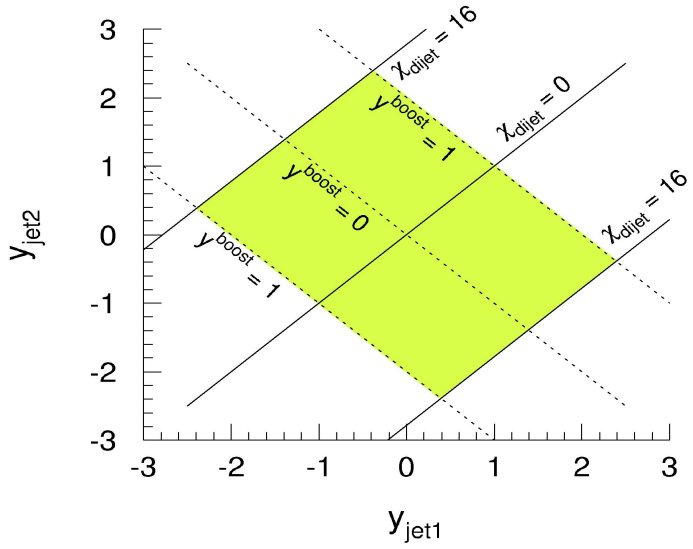


Dijet Angular Distribution - dijet χ





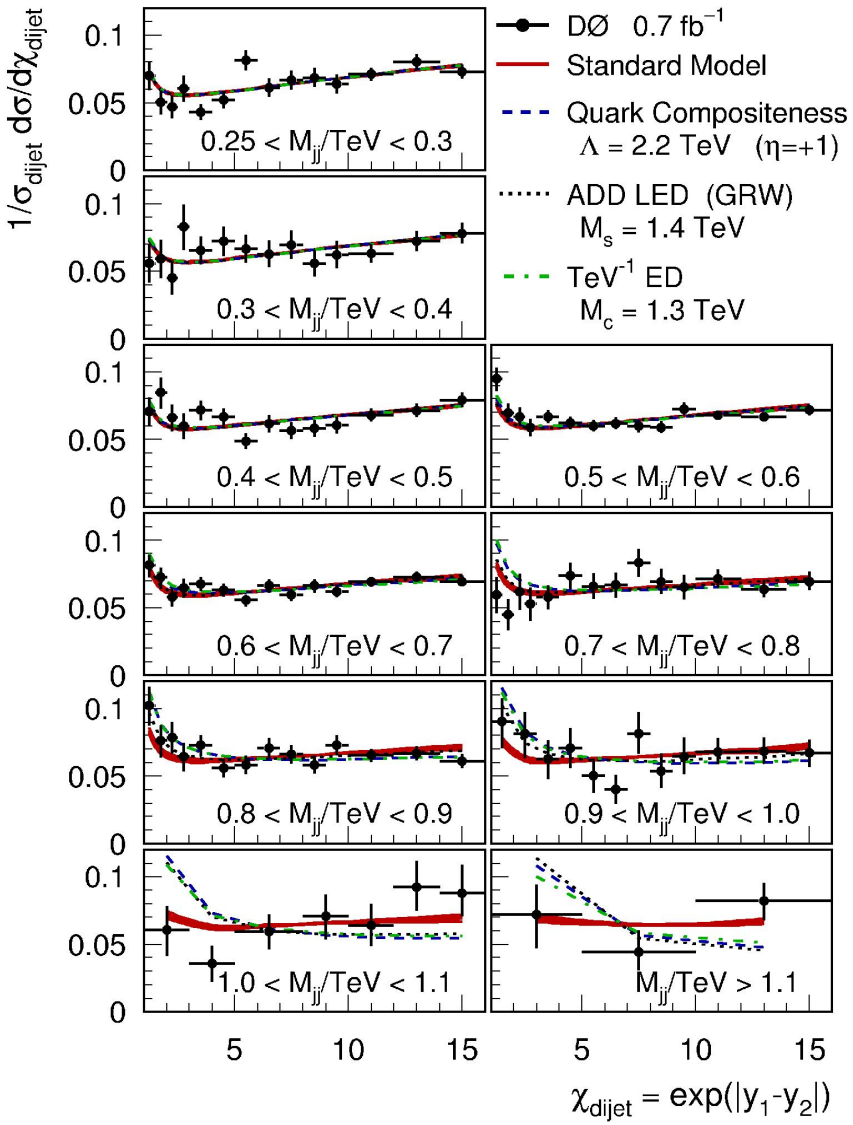
- Measure $\chi = \exp(|y_1 - y_2|)$ in 10 regions of dijet invariant mass $M_{JJ} > 0.25\,\mathrm{TeV}$ for events with $|y_{\mathrm{jet}}| < 2.4$ and $\chi < 16$ using $0.7\,\mathrm{fb}^{-1}$ data
- Compared with NLO pQCD + non-pert. corrections
- Used to set limits on new physics models

Dijet Angular Distribution ($\chi = \exp(|y_1 - y_2|)$)

Best limits on new physics:

- Quark compositeness
- ADD Large extra dimensions
- TeV^{-1} extra dimensions

PRL 103, 191803 (2009)



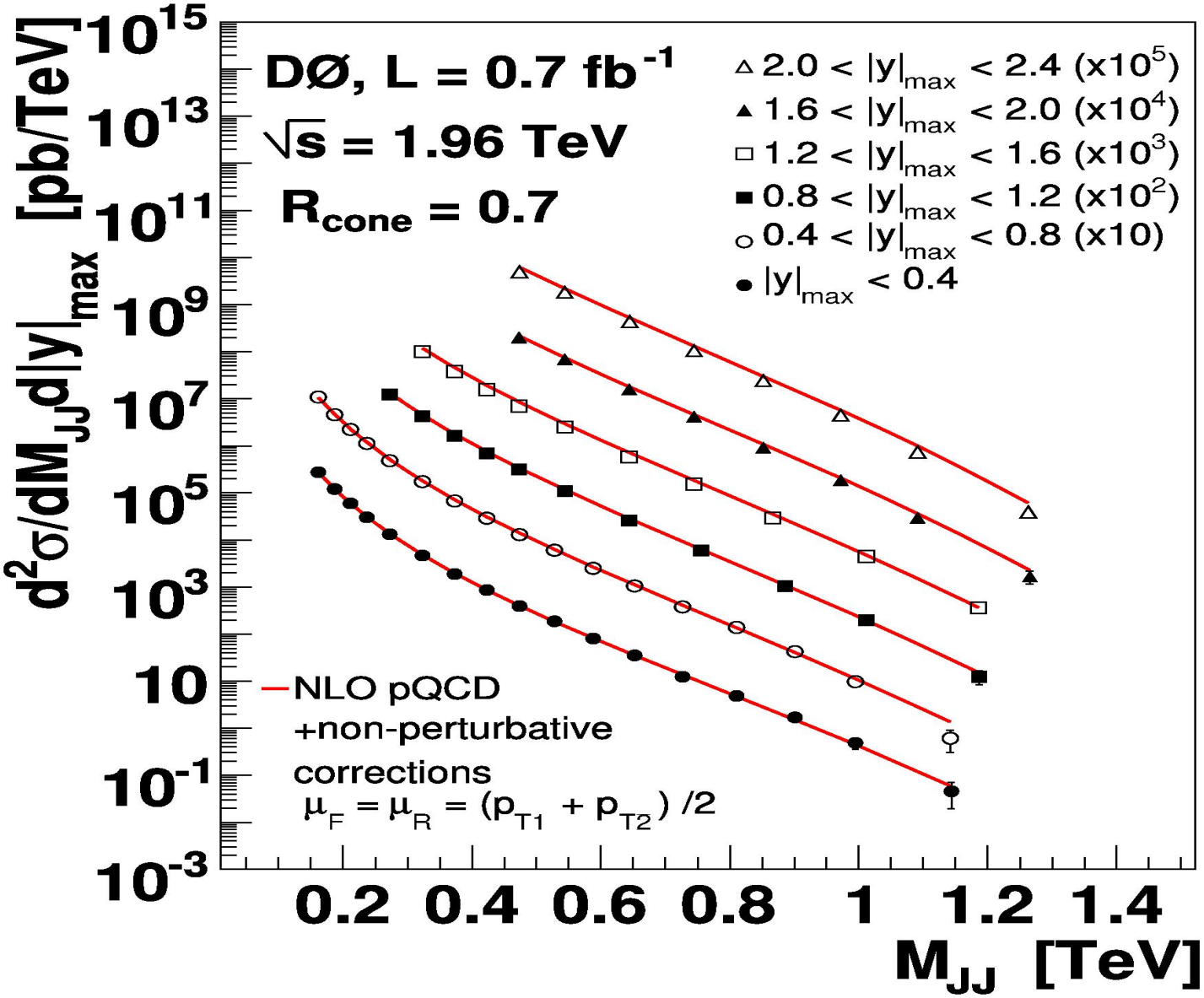
Dijet Mass

Event selection:

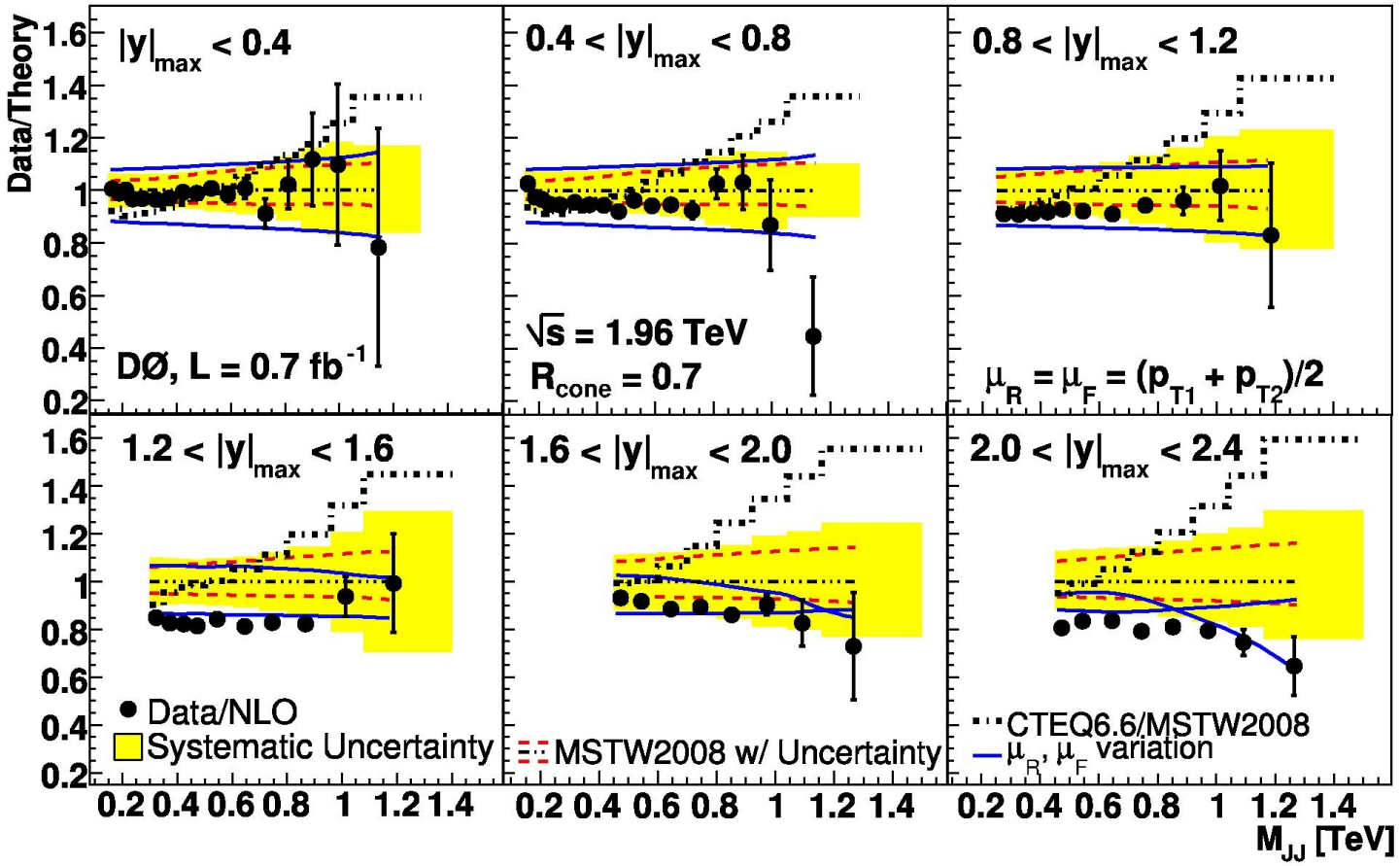
- $0.7\,\mathrm{fb}^{-1}$ - well understood dataset
- At least 2 jets, $p_T > 40\,\mathrm{GeV}$
- 6 rapidity bins according to the most forward jet from $|y|_{\mathrm{max}} < 0.4$ to $2.0 < |y|_{\mathrm{max}} < 2.4$

arXiv: 1002.4594 (submitted to PLB)

Dijet Mass


DØ, L = 0.7 fb^{-1}
$\sqrt{s}$ = 1.96 TeV
R_{cone} = 0.7
2.0 < $|y|_{max}$ < 2.4 (x10^5)
1.6 < $|y|_{max}$ < 2.0 (x10^4)
1.2 < $|y|_{max}$ < 1.6 (x10^3)
0.8 < $|y|_{max}$ < 1.2 (x10^2)
0.4 < $|y|_{max}$ < 0.8 (x10)
$|y|_{max}$ < 0.4
NLO pQCD
+non-perturbative
corrections
$\mu_F = \mu_R = (p_{T1} + p_{T2})/2$
$d^2\sigma/dM_{JJ}d|y|_{max}$ [pb/TeV]
M_{JJ} [TeV]

Dijet Mass Comparison With Theory



- Note that MSTW2008 uses RunII data in PDF fits
- Good agreement in the central region
- $40 - 60\%$ difference between MSTW2008 and CTEQ6.6

Summary & Conclusions

- Dijet system extensivelly studied at DØ RunII
- Measurements benefit from precise jet energy scale calibration which reduces the experimental errors
- Good agreement found with pQCD, dijet χ measurement is used for setting limits on new models beyond the Standard Model
- Another dijet result (evidence for exclusive dijets) presented in Small-x session

Back-up slides

Dijet χ Limits on New Physics

TABLE I: Expected and observed 95% C.L. limits in units of TeV on various new physics (NP) models for different Bayesian priors, and for the $\Delta\chi^2$ criterion.

	Prior flat in NP Lagrang.		Prior flat in NP x-section		$\Delta\chi^2 = 3.84$ criterion	
Model (parameter)	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.
Quark comp. (Λ)						
$\eta = +1$	2.91	3.06	2.76	2.84	2.80	2.92
$\eta = -1$	2.97	3.06	2.75	2.82	2.82	2.96
TeV^{-1} ED (M_C)	1.73	1.67	1.60	1.55	1.66	1.59
ADD LED (M_S)						
GRW	1.53	1.67	1.47	1.59	1.49	1.66
HLZ $n = 3$	1.81	1.98	1.75	1.89	1.77	1.97
HLZ $n = 4$	1.53	1.67	1.47	1.59	1.49	1.66
HLZ $n = 5$	1.38	1.51	1.33	1.43	1.35	1.50
HLZ $n = 6$	1.28	1.40	1.24	1.34	1.25	1.39
HLZ $n = 7$	1.21	1.33	1.17	1.26	1.19	1.32