QCD Fits of Hadronic Final State Observables: From HERA to LHC

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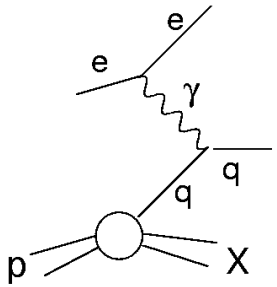
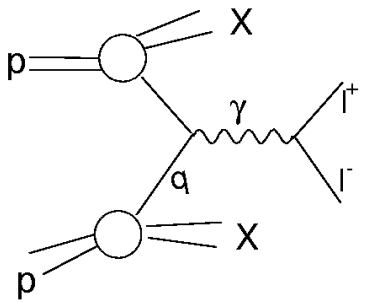
- Aim of the Project
- Recap: “fast NLO”
- 3/2-jet ratio: exploring sensitivity to strong coupling

Aim of the Project

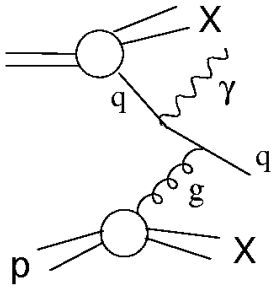
DIS



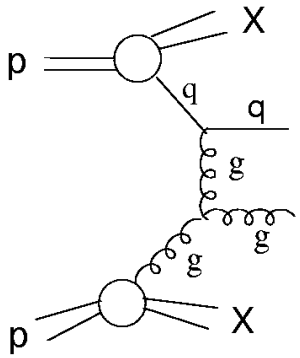
Drell-Yan



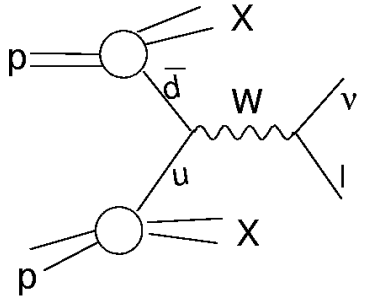
Prompt-Photon



Jet in pp



W-production



Learn how to run NLO codes and study sensitivity of basic SM processes at LHC to parton densities and strong coupling

Set-up grid for coefficient functions using NLO programs → can be easily shared

See what combination gives best sensitivity to constraint

PDF & strong coupling && luminosity

investigate theoretical uncertainties

(clever choice of observables Et, eta, asymmetries, ratios etc.)

investigate experiment uncertainties (detector calibration/alignment etc.)

Perturbative Cross-section Formula and "fast NLO " Technique

…to be determined by experiment
→ Fit parameters

$$\sigma = \sum_{i,n} \alpha_s^2(\mu_r^2) \int_0^1 d\xi \, c_{i,n}(x_{BJ}/\xi) \, f_{i/p}(\xi, \mu_r^2)$$

Perturbatively calculable coefficients
For incl. DIS: analytically known
For jets: need computation via NLO MC program:
- defined via jet algorithm
- within detector acceptance
calculation takes typically 1 day of CPU time
→ can not be included in global PDf-fit

„fast NLO" turns convolution in product:

$$\sigma \approx \sum_{i,n} \alpha_s^2(\mu_r^2) \; f_{i/p}(\xi_i) \int_0^1 d\xi \, c_{i,n}(x_{BJ}/\xi) \, E_i(\xi)$$

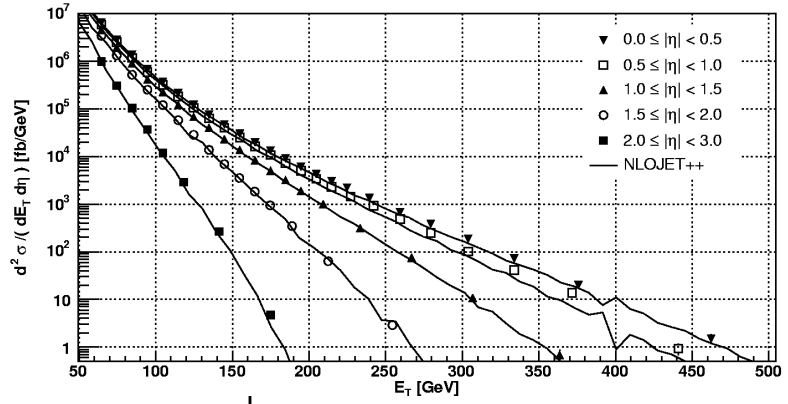
with $f_{i/p} = \sum_i f_{i/p}(\xi_i) \; E^{(i)}(\xi)$

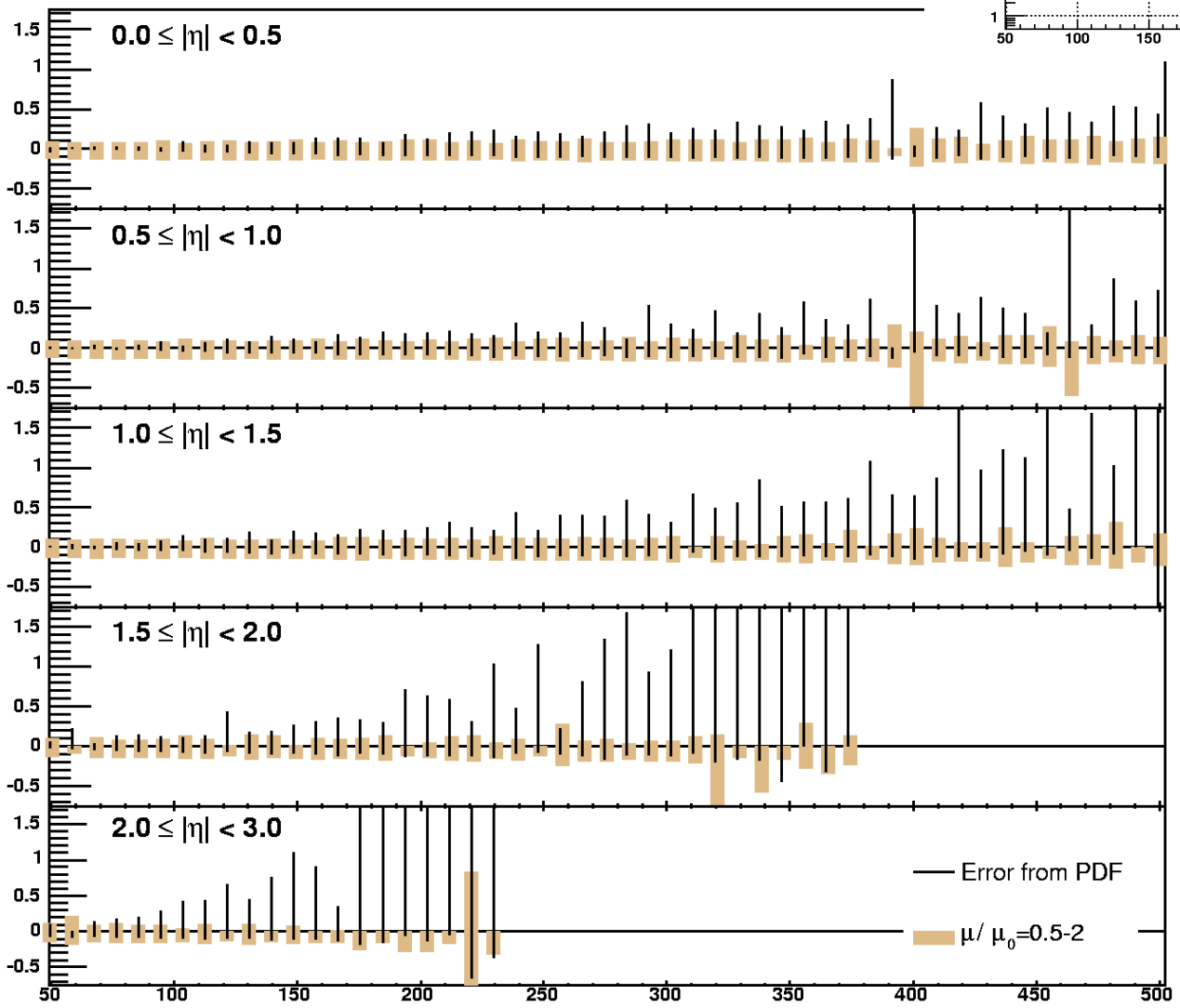
E can be:
Triangles, delta-function,
Polynoms
or ….

This example works in x-space
Can also be done in N-space,
via Mellin-Moments (very elegant!)

Inclusive Jet cross-section at TEVATRON

$d\sigma / dE_T$





-Learned how to run NLOJET++ for pp (very fast)

-PDF error only for gluon at high-x (CTEQ6: PDF-set: 15 default: 0)

-Sensitivity to gluon at high-x very large present uncertainty (50-100%)

3/2 Jet Ratio at TEVATRON

Idea:

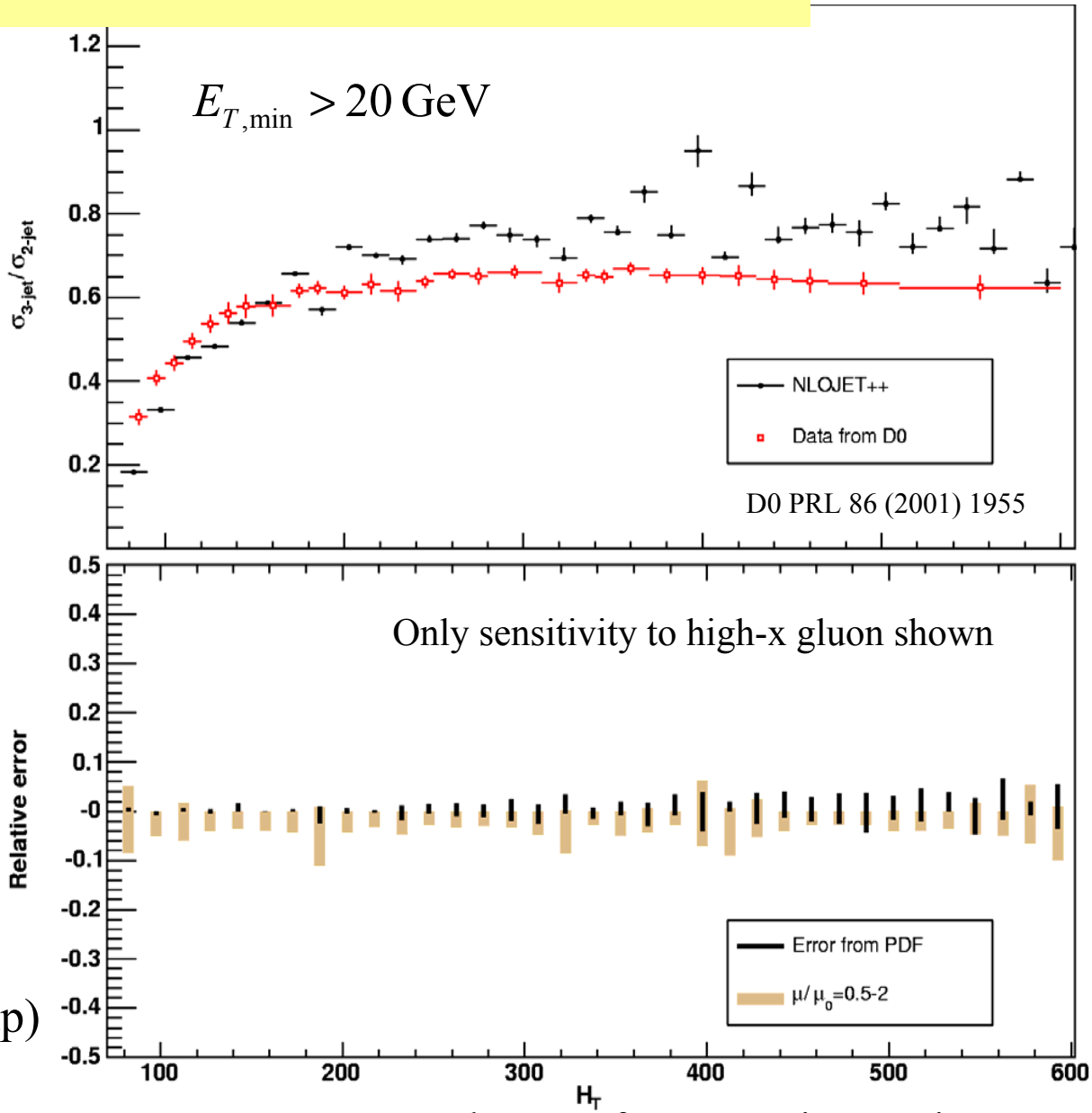
$$\frac{d\sigma_{3-jet}}{d\sigma_{2-jet}} = \frac{\alpha_s^3 \int \ldots dx_1\, dx_2}{\alpha_s^2 \int \ldots dx_1\, dx_2} = \alpha_s$$

PDF uncertainty cancel

PDF ~ scale uncertain.

- Residual uncertainty:
  5-10%
-Data not so well described
  - low E_T ?
  - scale choice ?
  - had corr ?
  - multiple interactions ?

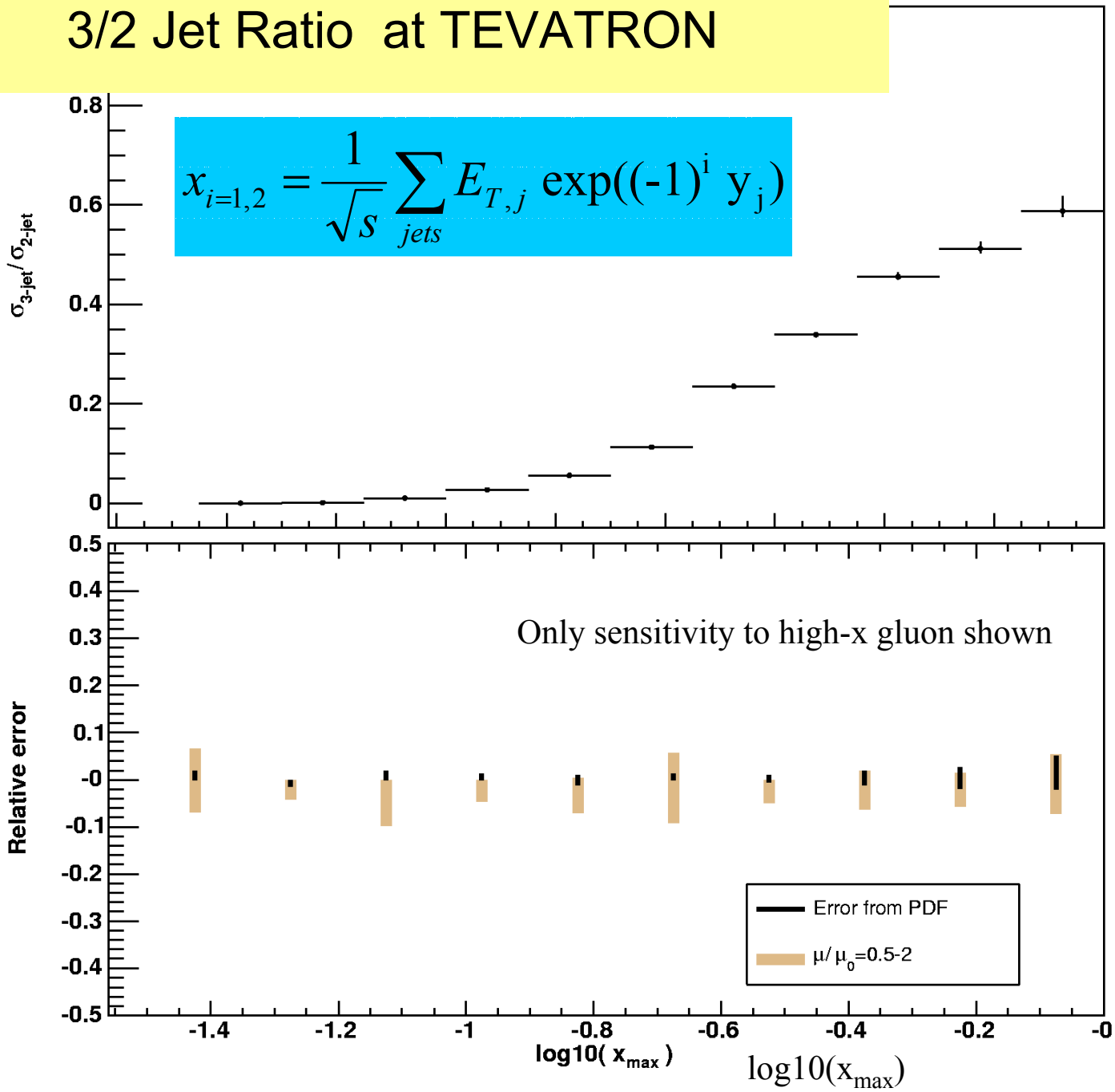
…will be investigated
In the next future
(in collab. with SHERPA group)



H_T scalar sum of transverse jet energies

3/2 Jet Ratio at TEVATRON

$$x_{i=1,2} = \frac{1}{\sqrt{s}} \sum_{jets} E_{T,j} \exp((-1)^i y_j)$$

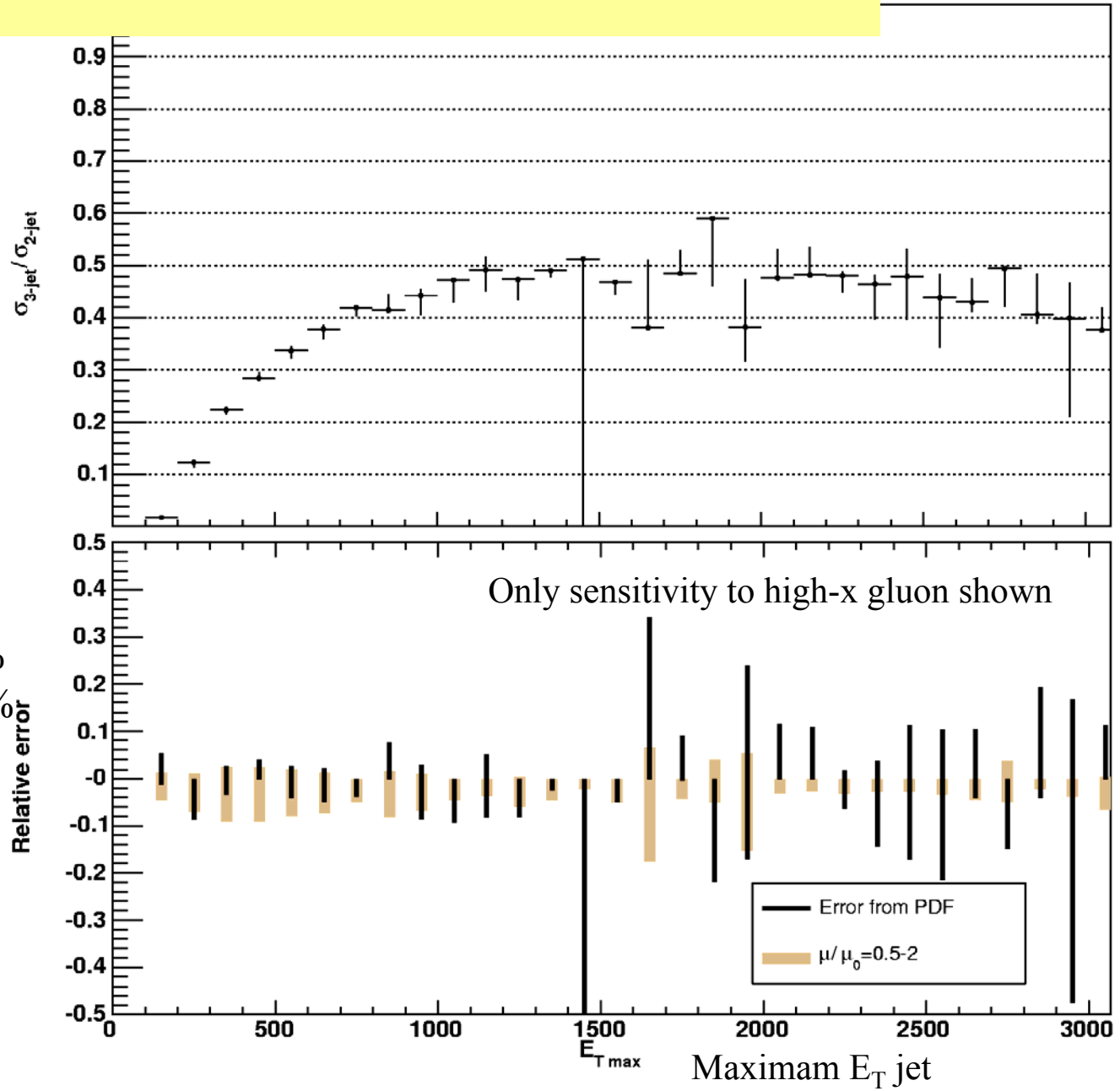


Total uncertainty
5-10%
PDF uncertainty
smaller
scale uncertainty !

3/2 Jet Ratio at LHC

Lack of statistics !
Computing time for these plots few days …needs one long run with „fast NLO“ and then full determination of uncertainties is easy

Looks promising:
Scale uncertaint. ~5-10%
Pdf uncertaint ~10-20%



3/2 Jet Ratio at LHC

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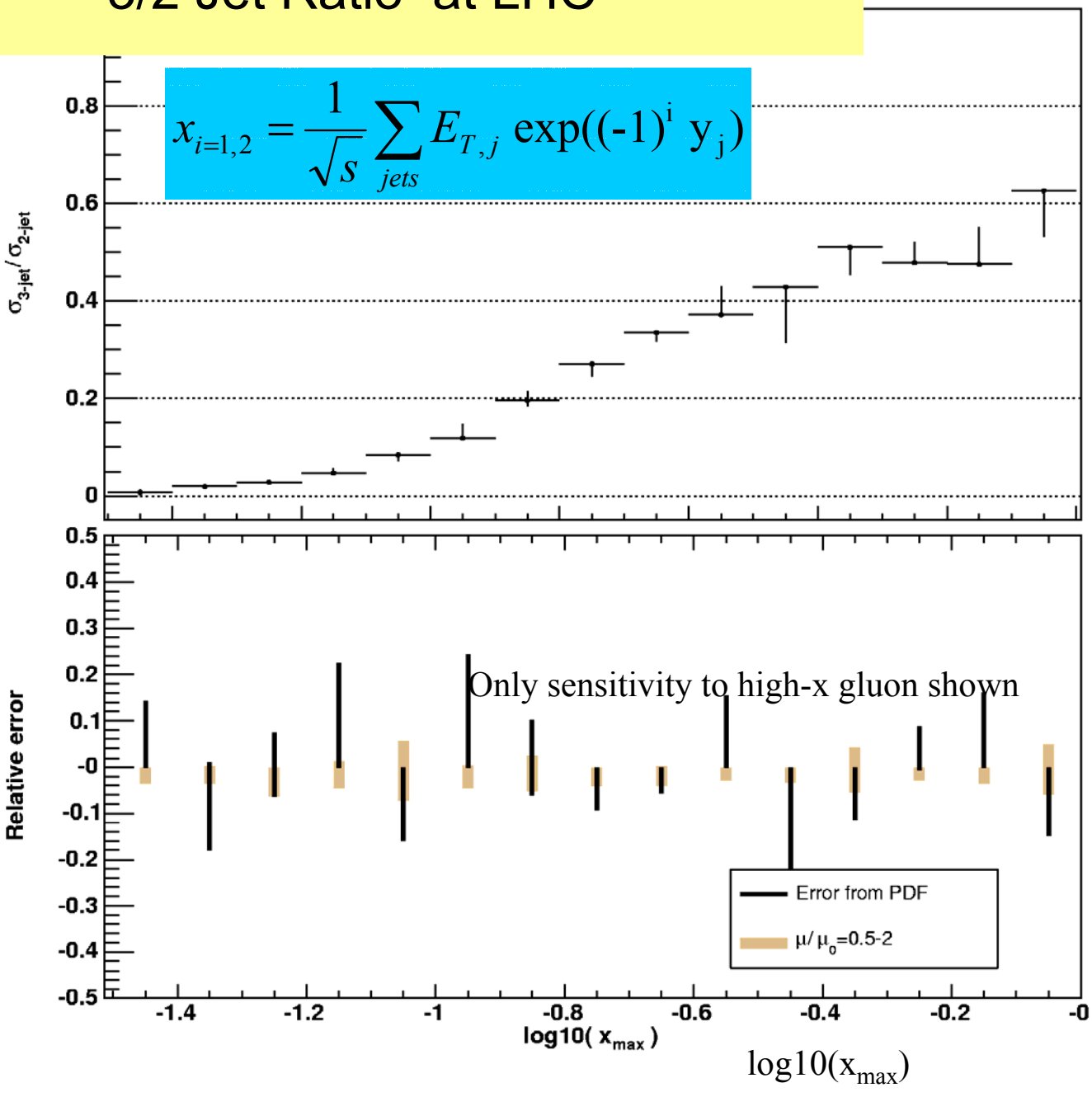

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Conclusion and Prospects

- Far behind original working plan
  (I work 99.9% on calibration strategies for ATLAS)
- Learned how to run NLOJET++,
  Z. Nagy promised help on remaining questions
- 3/2-jet ratio seems to be promising for measuring the
  strong coupling at LHC and TEVATRON, since
  uncertainties cancel
  (measure x for several fix Et to get „running“)
- This could be the observable „fixing“ the strong coupling in
  in a global fit to LHC data
- Next steps: work on the set-up of „fast NLO“ grid
  - to determine full uncertainties with good accuracy
  - to provide it to global „fitters“ like Mandy
- More people are interested and welcome to cover all processes
  (may needs a working enviroment to come to full steam ?)