HZTOOL and Monte Carlo validation

outline:

- introduction
- examples:
  - tuning of MC parameters: ARIADNE CDM with new pdfs
  - comparison with NLO calculations
- routines:
  - examples for existing routines
  - missing routines, wishlist

hztool homepage:
http://hepforge.cedar.ac.uk/hztool/

Tancredis old hztool page:
http://www.desy.de/~carli/hztool.html

more information on CEDAR and future hztool developments in following talk by Jon Butterworth

HZTOOL - Introduction

experimental data ⟷ MC predictions, theory calculations

- calculate and compare MC predictions with experimental data
- easy access to published data to use it for
  - data – theory (MC event generators, NLO) comparison
  - MC development
  - parameter tuning
  - studies for future measurements
  - MC validation : MC for LHC ↔ HERA data
- H1, ZEUS (... and other experiments)
  idea: all published analysis available as hztool routine

published analysis → HZTOOL routine → comparison to any model

original idea: workshop on Future Physics at HERA, J. Bromley et al., Hamburg 1995/96
N. Brook et al., for many years maintained by Tancredi Carli
currently maintained by Jon Butterworth, Hannes Jung, Emiliy Nurse and Ben Waugh
hztool@cedar.ac.uk

HZTOOL - library

- generic fortran library
- common interface for MC generators
- also available for NLO programs :

  NLOLib (T.Schoerner-Sadenius,K.Rabbertz)

  MC@NLO (S.Frixione, B.Webber)

  - example: comparison of jet measurements with NLO pred.
  - MC@NLO HERWIG-like output --> hztool
    can be compared with Tevatron results
- producing data and MC prediction histograms,
  kumacs for plotting results
- fortran / hbook / paw
  tools (jet algorithms and boosts,...)
- how to use : hztool tutorial by Hannes Jung,
  talk at HERA LHC workshop, MC and tools WG, DESY, June 2 2004

ARIADNE parameter tuning

Example:

Albert Knutsson, Leif Jönsson

tuning of CDM parameters in ARIADNE using H1 data

similar to previous tuning [reference]
with new pdfs (CTEQ6L instead of GRV94)

data sets

- η spectra in hcms of charged particles [DESY-96-215, HZ96215]
- inclusive transverse energy flow $1/N\ dE_T^*/d\eta^*$ as fct. of x,Q^2 [HZ99091]
- dijet cross section as fct. of E_T and η of most fwd jet [DESY-00-145]

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smallest averaged (over data sets) $\chi 2$ for different parameter sets

- stat. & syst. errors, no correlation effects
- lowest $\chi 2$ with 2 different parameter sets: choose one closer to old tunes

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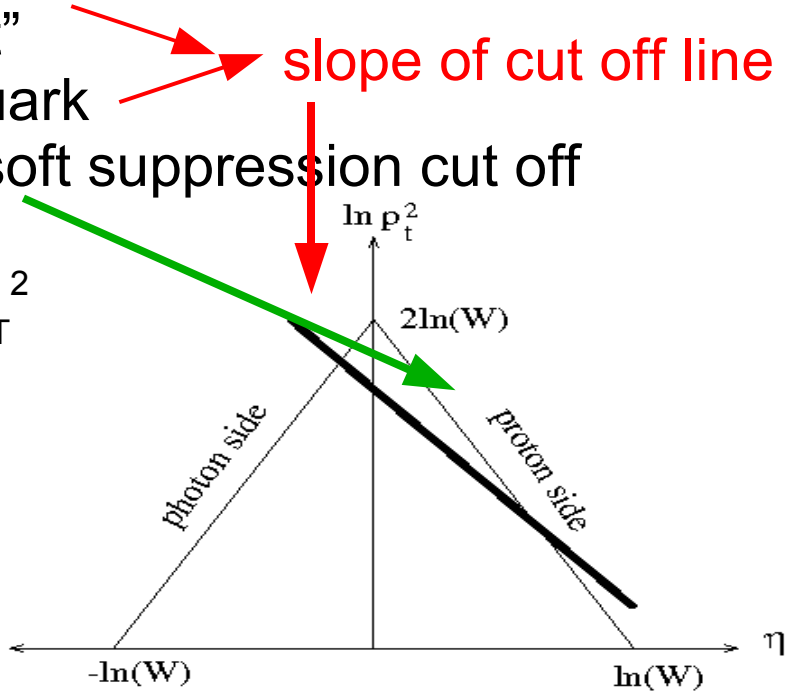
parameters

- PARA(10) "dimensionality of proton remnant"
- PARA(15) soft suppression for the struck quark
- PARA(25) probability of emissions outside soft suppression cut off above the thick line
- PARA(27) square root of mean primordial k_T^2



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new tuning results

PARA	NEW	OLD	def.
10	1.2	1.2	1.0
15	1.0	1.0	1.0
25	1.2	1.5	2.0
27	0.9	0.6	0.6

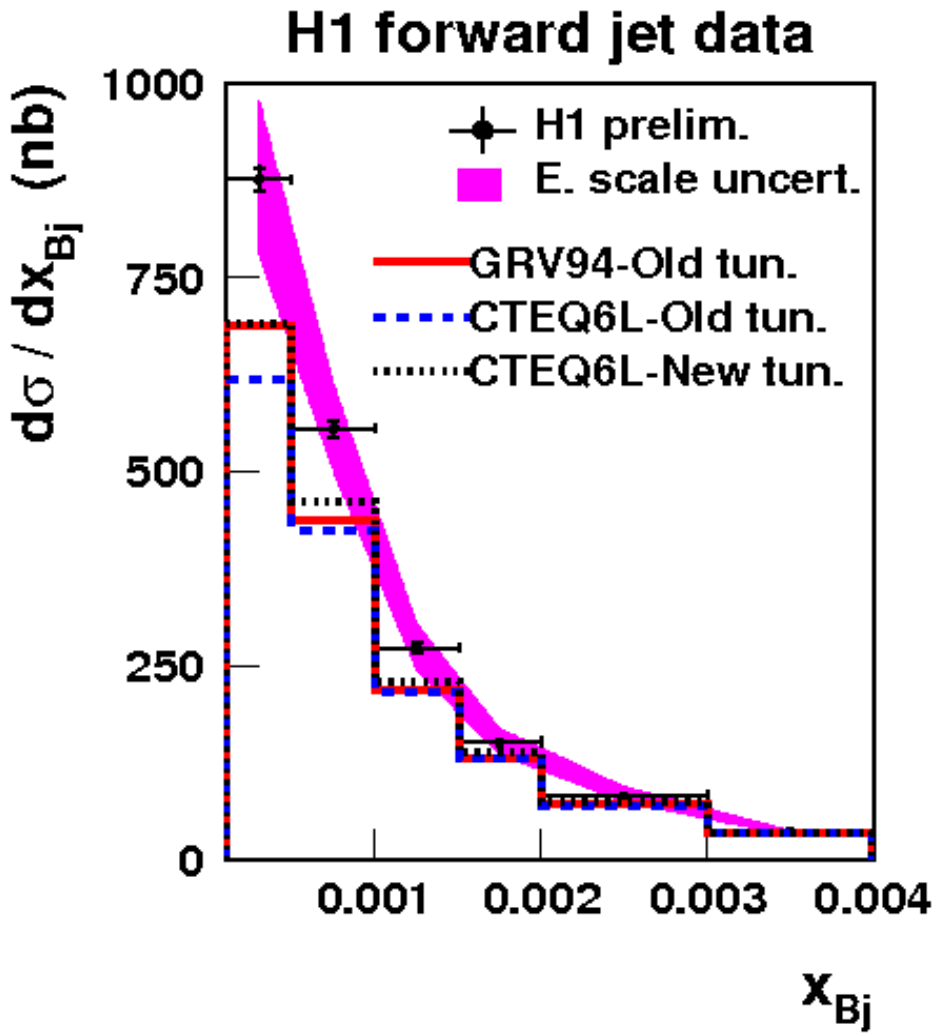
ARIADNE parameter tuning

Comparison of new tunes, old tunes and data Albert Knutsson, Leif Jönsson

forward jet cross section (not used for tuning) compared with old tunes, old pdf
new tunes, new pdf
old tunes, new pdf

- old and new tunes give similar predictions (old/new pdfs, resp.)

- old parameters with new pdfs different prediction, data less well described



comparison with NLO calculations

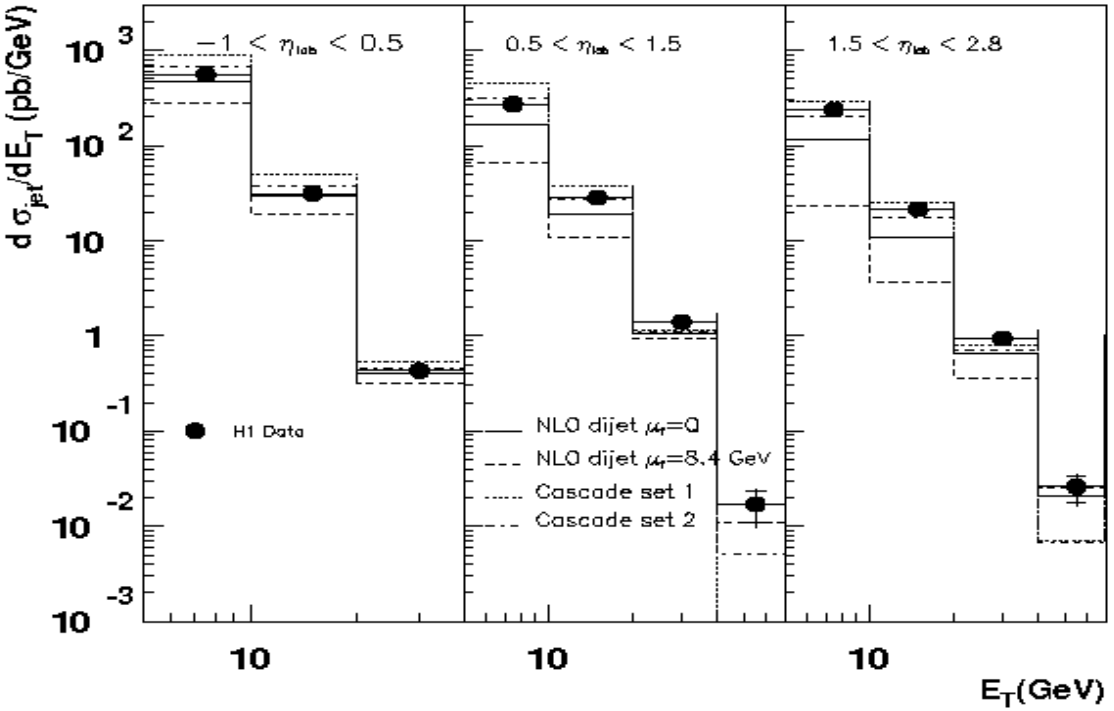
Example: Jet Measurements in DIS

Jets at high pt / high Q2: NLO QCD (DGLAP): excellent agreement
but: other regions of phase space less well described
comparison of several jet measurements with NLO calculations (DISENT)
from small x phenomenology: summary and status, Dec 2003

Inclusive Jet cross section at low Q2 (hep-ex/0206029, DESY-02-079, HZ02079)

- E_T dependence in bins of η:

  good agreement in bwd,
  discrepancies in fwd region



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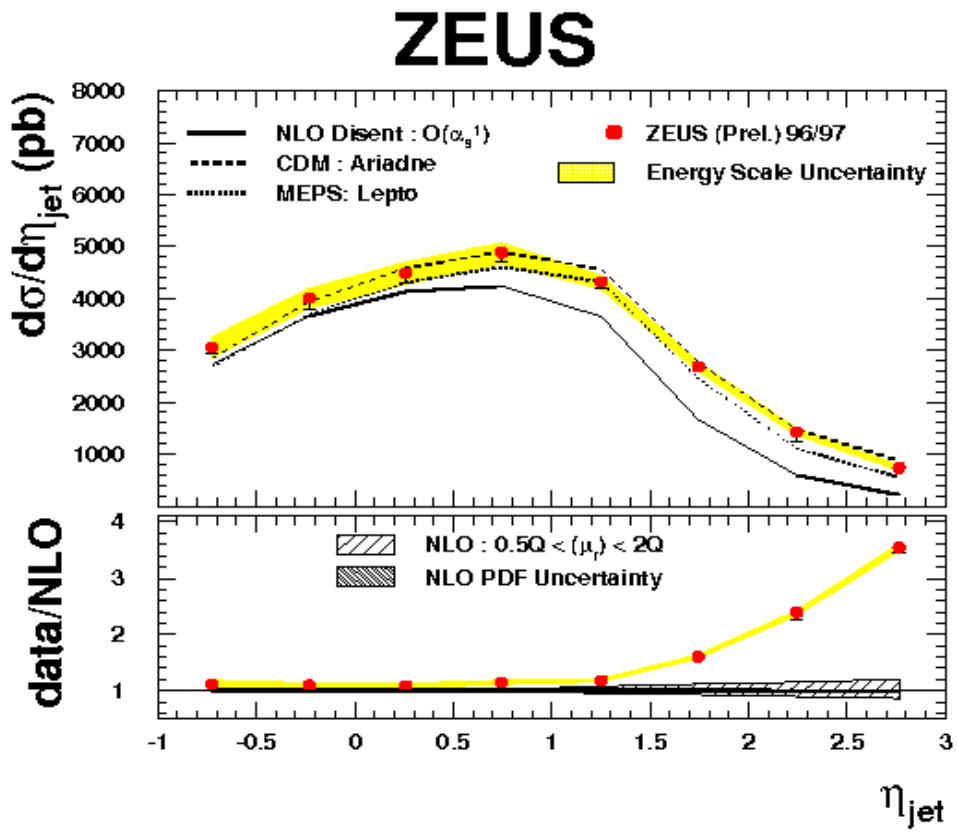
Inclusive Jet cross section at low Q^2

- E_T dependence in bins of η:
  good agreement in bwd,
  discrepancies in fwd region

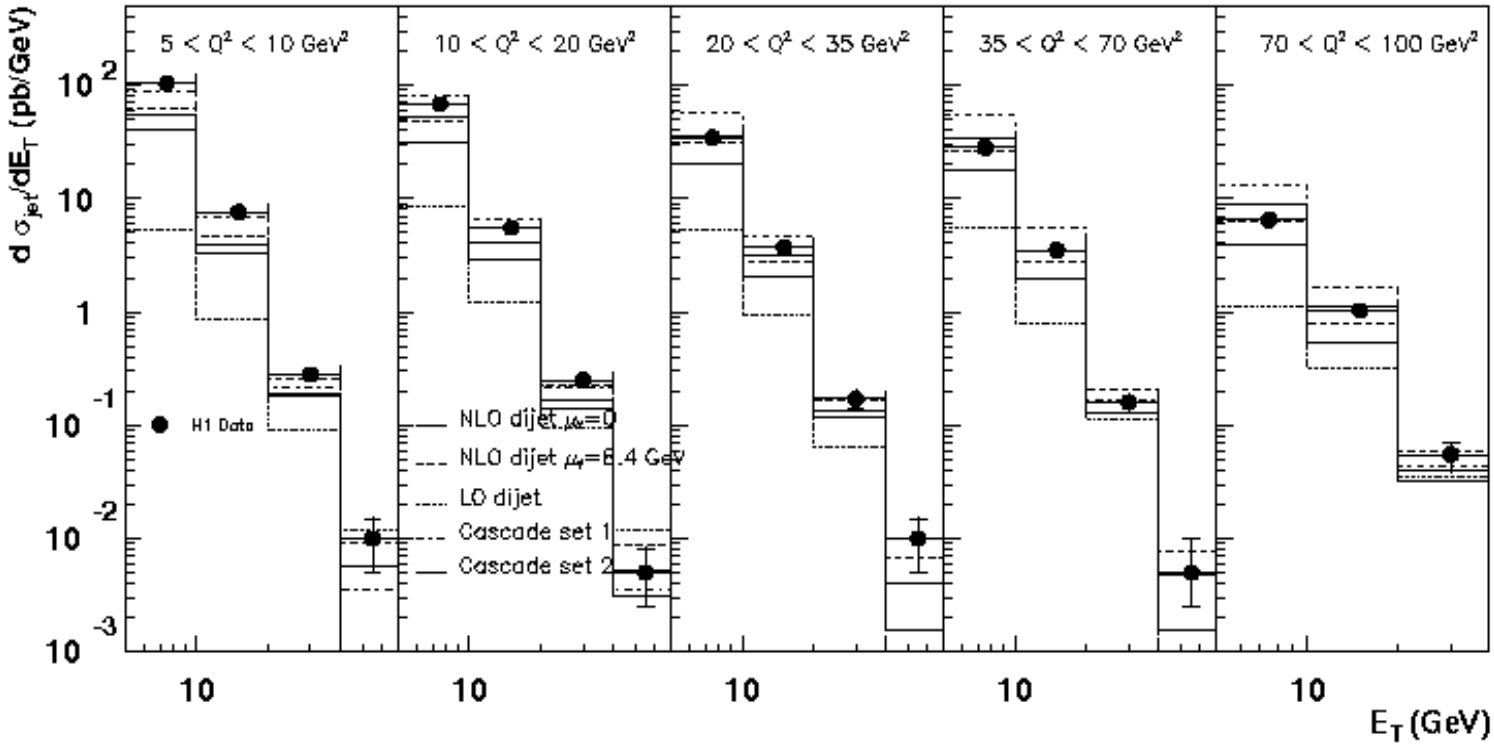
ZEUS: inclusive jet cross section
worse NLO description at large η



comparison with NLO calculations

Example: Jet Measurements in DIS
Inclusive Jet cross section at low Q^2 (hep-ex/0310019, DESY-03-160, HZ03160)

- Q^2 dependence in most fwd η bin:
  discrepancies most significant at low Q^2
  large NLO/LO corrections and high scale sensitivity: NNLO needed!



comparison with NLO calculations

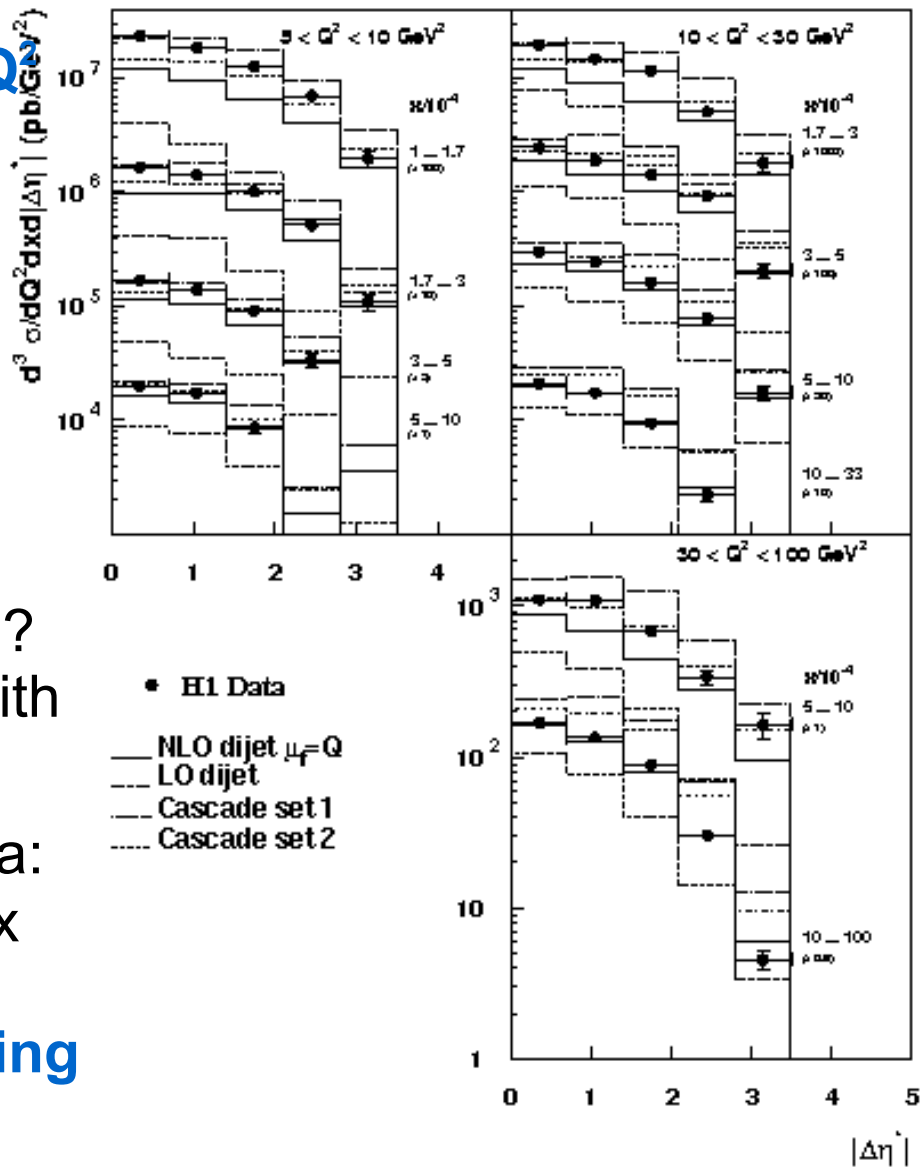
Example: Jet Measurements in DIS
Inclusive Di-Jet cross section at low Q^2

- triple diff. xs: Q^2,x,$|\Delta\eta^*|$

NLO ($\mu_F=Q^2$) below data, (μ_F=70 GeV^2) better description at low x

Summary of jet-NLO comparison

- inclusive jets in DIS: NLO starts to fail the more forward jets are, while scale dependence of NLO increases: NNLO !?
- NLO-dijets: good job down to x=10-4 with μ_F=70 GeV^2, $\mu_F=Q^2$ gives worse descr.
- largest differences between NLO & data: at low Q^2, low x



comparisons like this can be done using HZTOOL and NLOLib

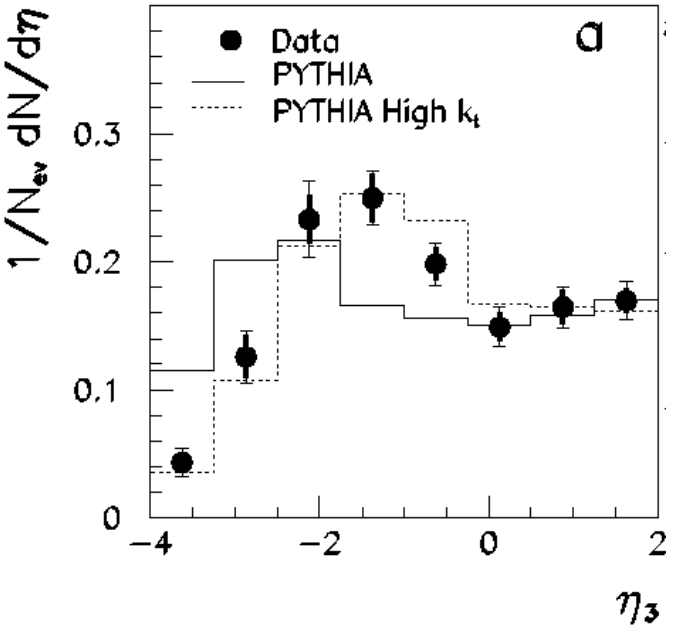
HZTOOL - routines

efforts made in previous HERA LHC meetings - available routines*:

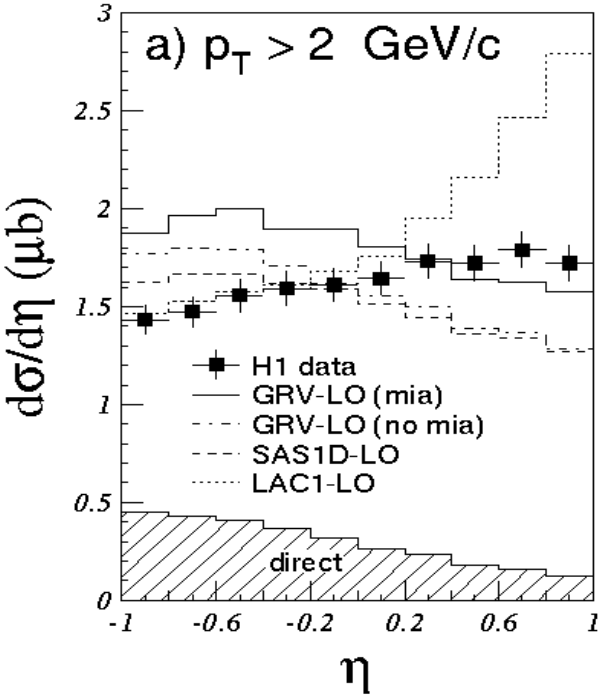
multiple interactions:

HZH9505001, ZEUS, *Study of the Photon remnant in resolved photoproduction at HERA*
HZH9810020, H1, *Charged Particle Cross Sections in Photoproduction and Extraction of the Gluon Density in the Photon*
HZH0006017, H1, *Inclusive Photoproduction of Neutral Pions in the Photon Hemisphere at HERA*
HZH0302034, H1, *Measurement of inclusive jet cross sections in photoproduction at HERA*

HZH9505001



HZH9810020



*HZHxxxxxxx=hep-ex/xxxxxxxx

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heavy flavors:

HZH0108047, H1, *D* Meson Production in Deep-Inelastic Diffractive Interactions at HERA*
HZH0312057, ZEUS, *Beauty photoproduction measured using decays into muons in dijet events in ep collisions at $\sqrt{s}$=318 GeV*
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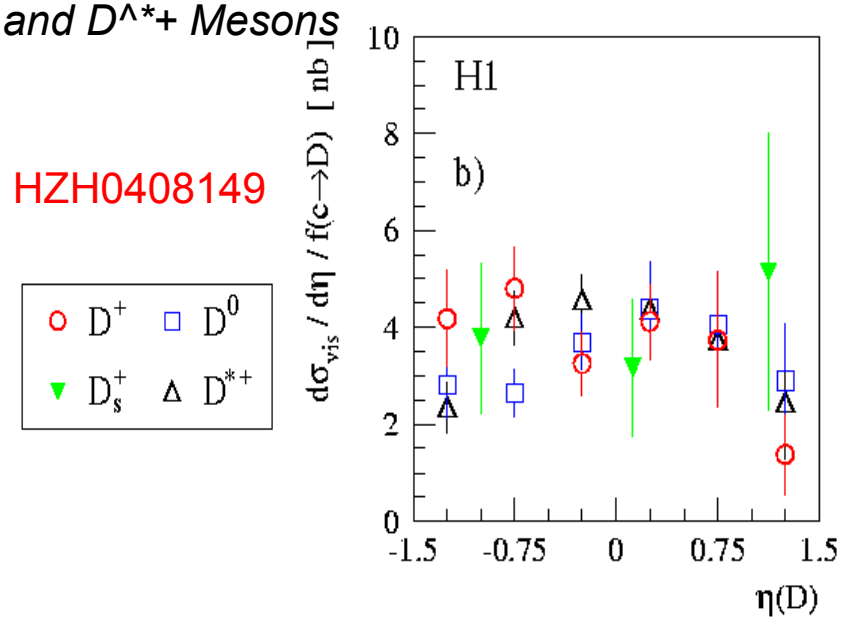

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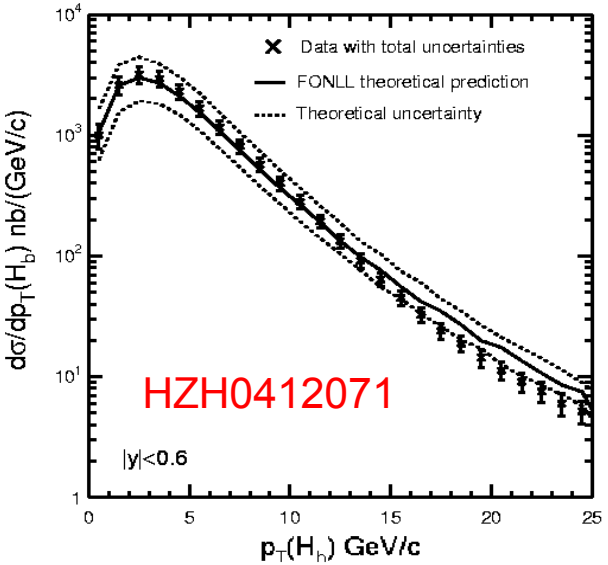

Tevatron results: (full list http://hepforge.cedar.ac.uk/hztool/bugtrack/wiki/TevRoutines)

HZH9905024, D0, *The b-bbar Production Cross Section and Angular Correlations in p-pbar Collisions at sqrt(s) = 1.8 TeV*
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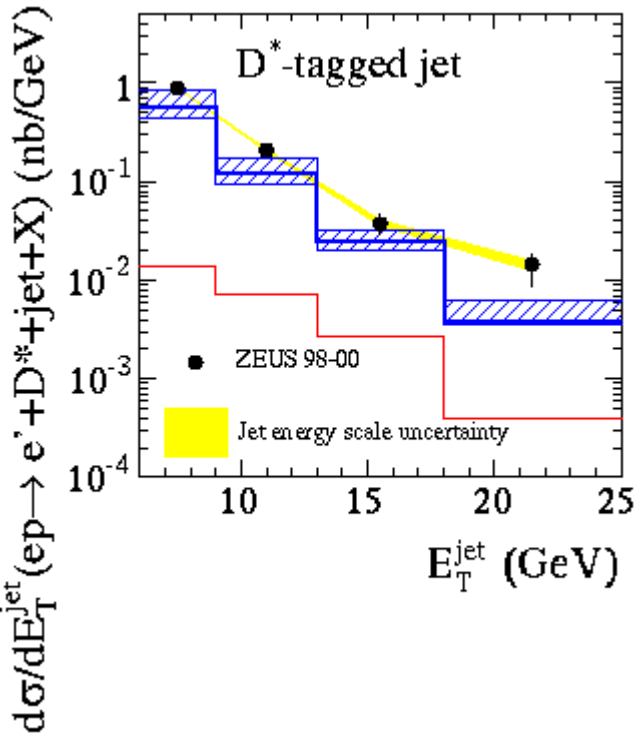
thanks to J.M.Butterworth, B.M.Waugh, S.Lausberg, V.Lendermann, D.Beneckenstein, K.Lohwasser, A.Buniatian, P.D.Thompson, O.Gutsche, A.W.Jung, H.Jung, K.Peters

Future routines: new analyses / wishlist for new routines

Heavy flavors:

DESY-05-147, ZEUS, *Measurement of Charm Fragmentation Ratios and Fractions in Photoproduction at HERA*
DESY-05-132, ZEUS, *Inclusive Jet Cross Sections and Dijet Correlations in D* Photoproduction at HERA*
DESY-05-071, ZEUS, *Measurement of Inelastic J/psi Production in Deep Inelastic Scattering at HERA*



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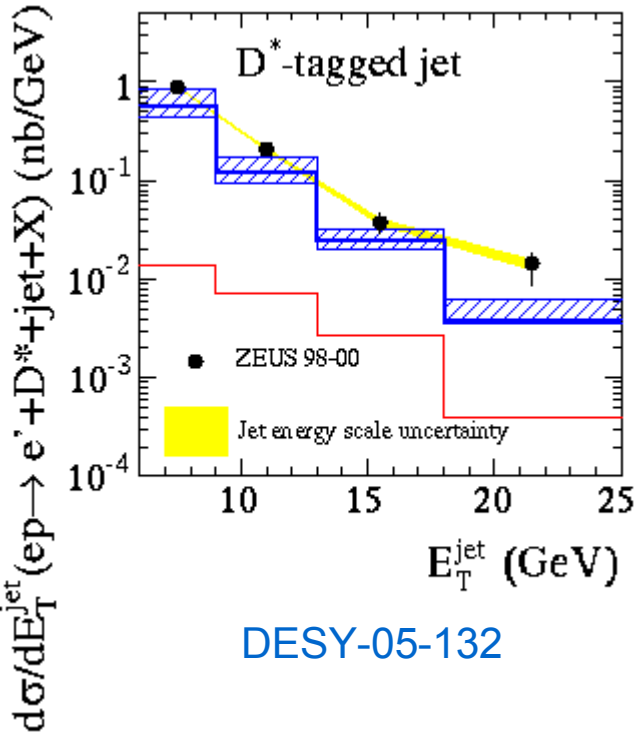
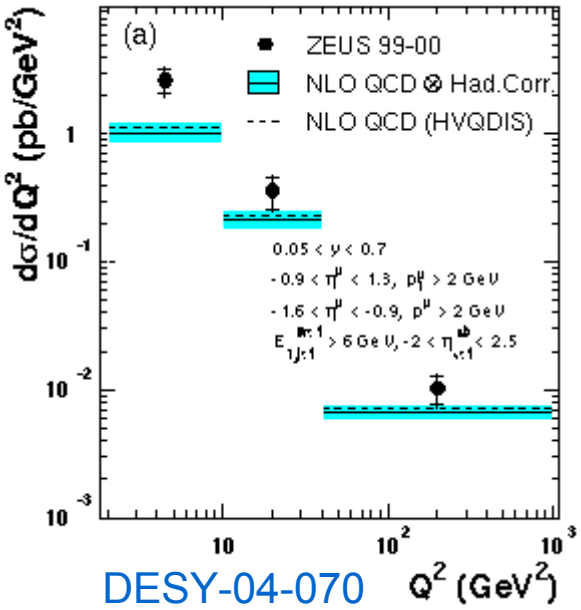


DESY-05-132



DESY-04-070

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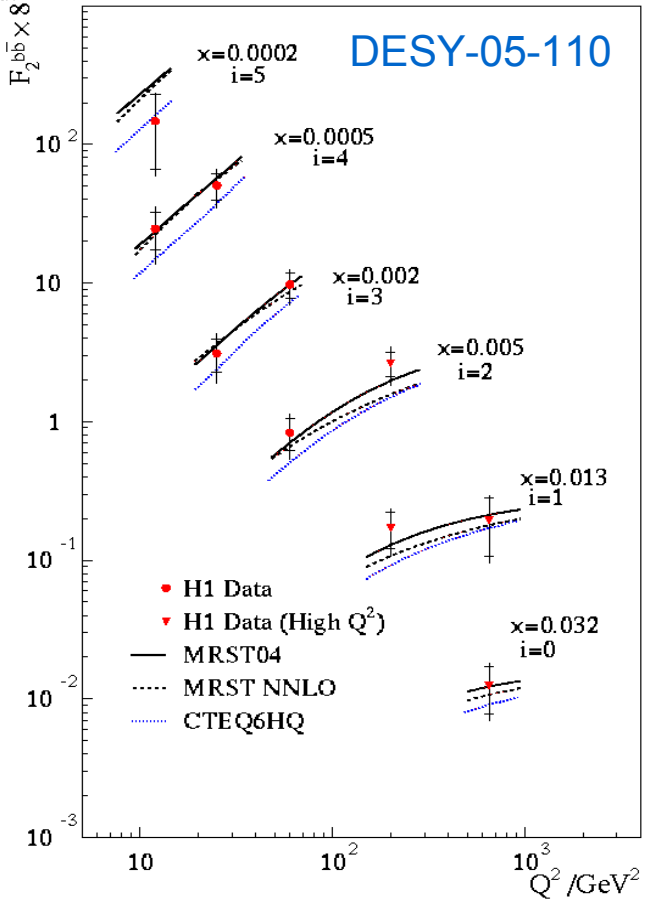
DESY-06-039, H1, *Measurement of Charm and Beauty Dijet Cross Sections in Photoproduction at HERA using the H1 Vertex Detector*

DESY-05-110, H1, *Measurement of F_2^{c\bar{c}} and F_2^{b\bar{b}} at Low Q^2 and x using the H1 Vertex Detector at HERA* (hep-ex/0507081)

DESY-05-040, H1, *Measurement of Charm and Beauty Photoproduction at HERA using D* mu Correlations (hep-ex/0503038)*

DESY-04-209, H1, *Measurement of F_2^{c\bar{c}} and F_2^{b\bar{b}} at High Q^2 using the H1 Vertex Detector at HERA (hep-ex/0411046)*



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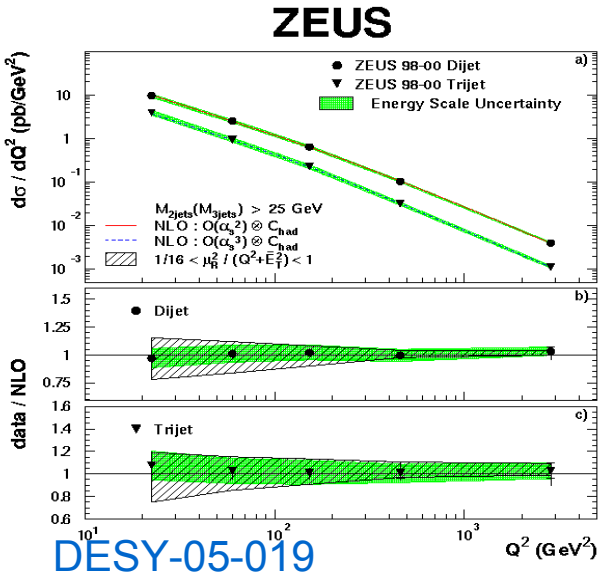
sensitive to gluon density !

HZTOOL - routines

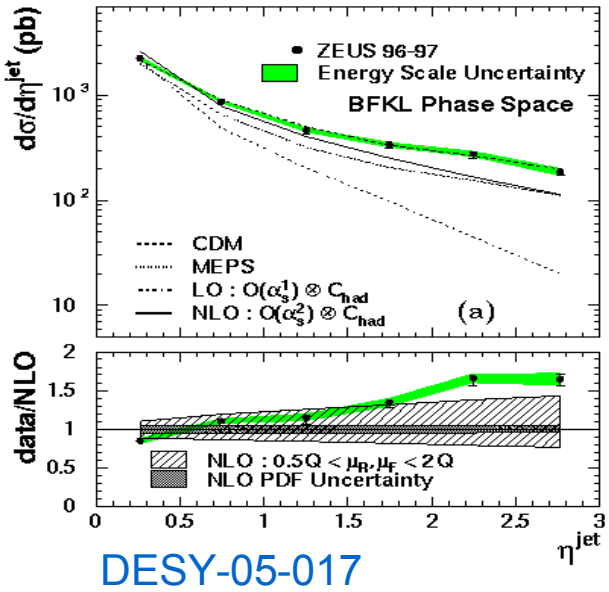
Future routines: new analyses / wishlist for new routines

Jets: many routines exist already, some new analyses not yet final

DESY-05-019, ZEUS, *Multijet Production in Neutral Current Deep Inelastic Scattering at HERA and Determination of Alpha_s*
DESY-05-017, ZEUS, *Forward Jet Production in Deep Inelastic ep Scattering and low-x Parton Dynamics at HERA*
DESY-04-072, ZEUS, *Substructure dependence of jet cross sections at HERA and determination of Alpha_s*
DESY-03-055, ZEUS, *Jet production in charged current deep inelastic e+p scattering at HERA*



DESY-05-019



DESY-05-017

Summary

- hztool is (still) a useful tool for MC/theory data comparison, MC studies and MC validation
- many routines there – dont we want more?
- hztool runs with MC generators, MC@NLO, NLOLIB
- part of HepForge projects --> next talk by Jon Butterworth on cedar and hztool