

HERA AND THE LHC

A workshop on the implications of HERA for LHC physics

March 2004 - Jan 2005

Parton density functions

Multijet final states
and energy flow

Heavy quark

Diffraction

Monte Carlo tools



Startup Meeting
March 26-27 2004

CERN, Geneva
Midterm Meeting
October 2004

Final Meeting
Jan 2005
DESY, Hamburg

Organizing Committee:

A. De Roeck (CERN), J. Stuke (DESY),
M. Dittus (CERN), J. Stuke (DESY),
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Advisory Committee:

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Introduction to the HERA/LHC Workshop

A. De Roeck & H. Jung (co-chair)

- Introduction to the first meeting
- Goals of the workshop
- ep and pp collisions
- Organization/timescale

...Origin of the Workshop



CERN Workshop on Monte Carlo tools for the LHC

July 7 – Aug 1 2003

Organizing Committee :

N. Brook, A. de Roeck, F. Gianotti, E.W.N. Glover, I. Hinchliffe, S. Jadach, F. Krauss, M. Mangano, A. Morsch, F. Paige,
W. Pokorski, A. Presland, A. Ribon, P. Richardson, E. Richter-Was, P. Skands, B. Webber

Secretariat: jeanne.rostant@cern.ch

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<http://mlm.home.cern.ch/mlm/mcwshop03/mcwshop.h>

Programme:

1. **Opening day overviews:** [Programme and transparencies](#)
2. **Academic Training lectures on MC tools for the LHC, by Mike Seymour:** [Transparencies](#)
3. **Matrix element generators:** [Programme and transparencies](#)
4. **N(N)LO tools:** [Programme and transparencies](#)
5. **Tools for electroweak physics:** [Programme and transparencies](#)
6. **Parton Distribution Functions:** [Programme and transparencies](#)
7. **MC's for new physics:** [Programme and transparencies](#)
8. **Heavy quark and tau decay packages:** [Programme and transparencies](#)
9. **Minimum bias, Underlying event, and MC tunings:** [Programme and transparencies](#)
10. **Tools for Heavy Ion Physics:** [Programme and transparencies](#)
11. **CLHEP and related tools:** [Programme and transparencies](#)
12. **Herwig++, Pythia7, Sherpa:** [Programme and transparencies](#)



Turned out to be a good experience
After this workshop: discussion started to try to do more

Workshop Aims

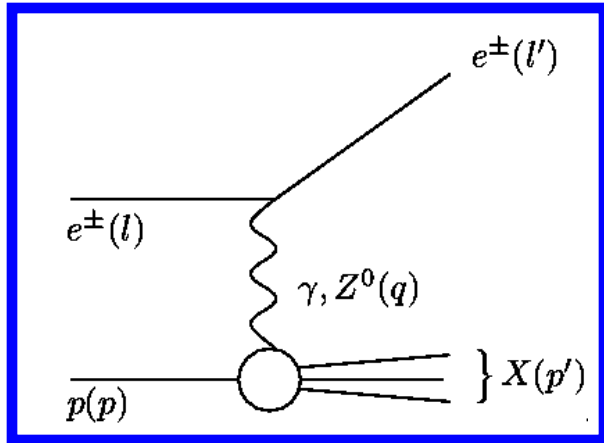
- To identify and prioritize those measurements to be made at HERA which have an impact on the physics reach of the LHC.
- To encourage and stimulate transfer of knowledge between the HERA and LHC communities and establish an ongoing interaction.
- To encourage and stimulate theory and phenomenological efforts related to the above goals.
- To examine and improve theoretical and experimental tools related to the above goals.
- To increase the quantitative understanding of the implication of HERA measurements on LHC physics.

⇒ Five Working Groups

- Parton density functions
- Multi-jet final states
- Heavy quarks (charm and beauty)
- Diffraction
- MC-tools

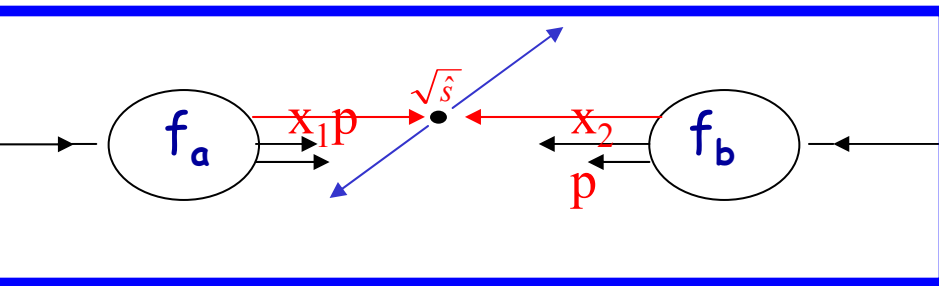
ep and pp colliders

ep collisions (HERA)



- * Ideal tool to study the structure of hadrons via deep inelastic scattering (structure functions/parton densities)
- * Can use the photon as a pointlike or hadronic particle through its virtuality
- * Main contributions are in the area of QCD: Small- x , diffraction, saturation, high densities, jets...
- * Tests of new approaches/QCD

pp collisions (LHC)

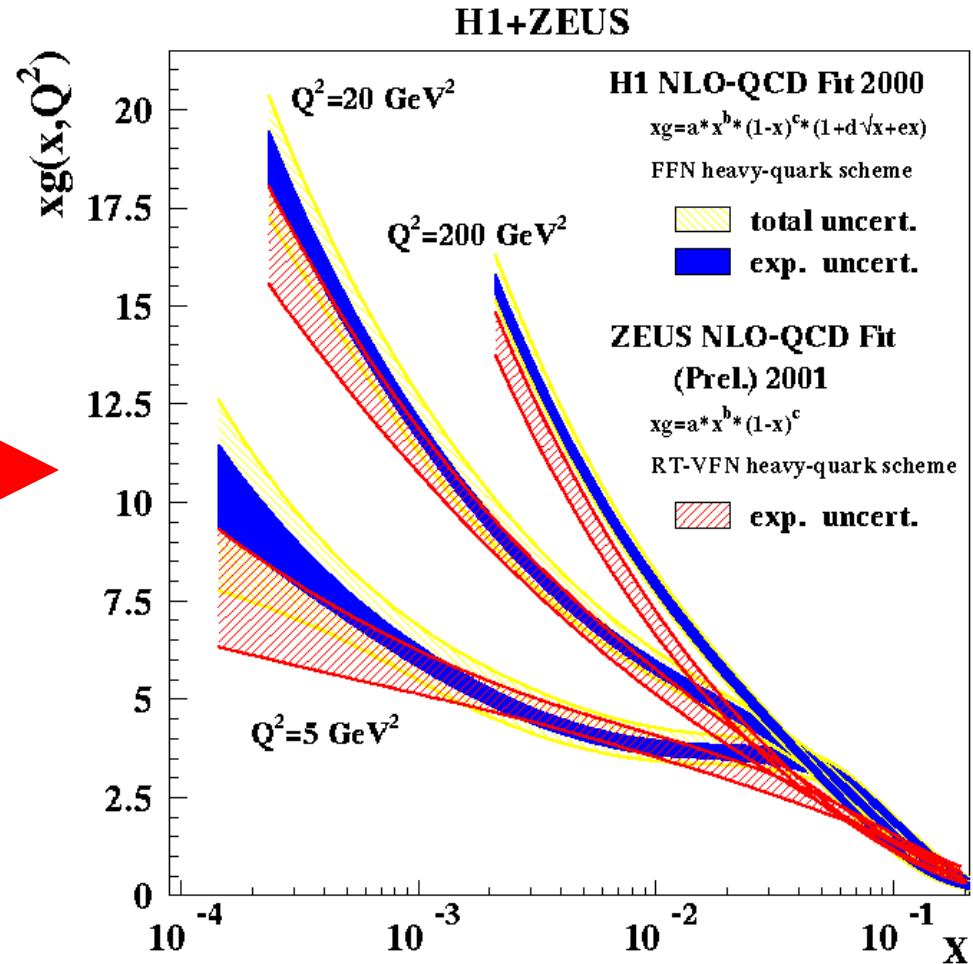
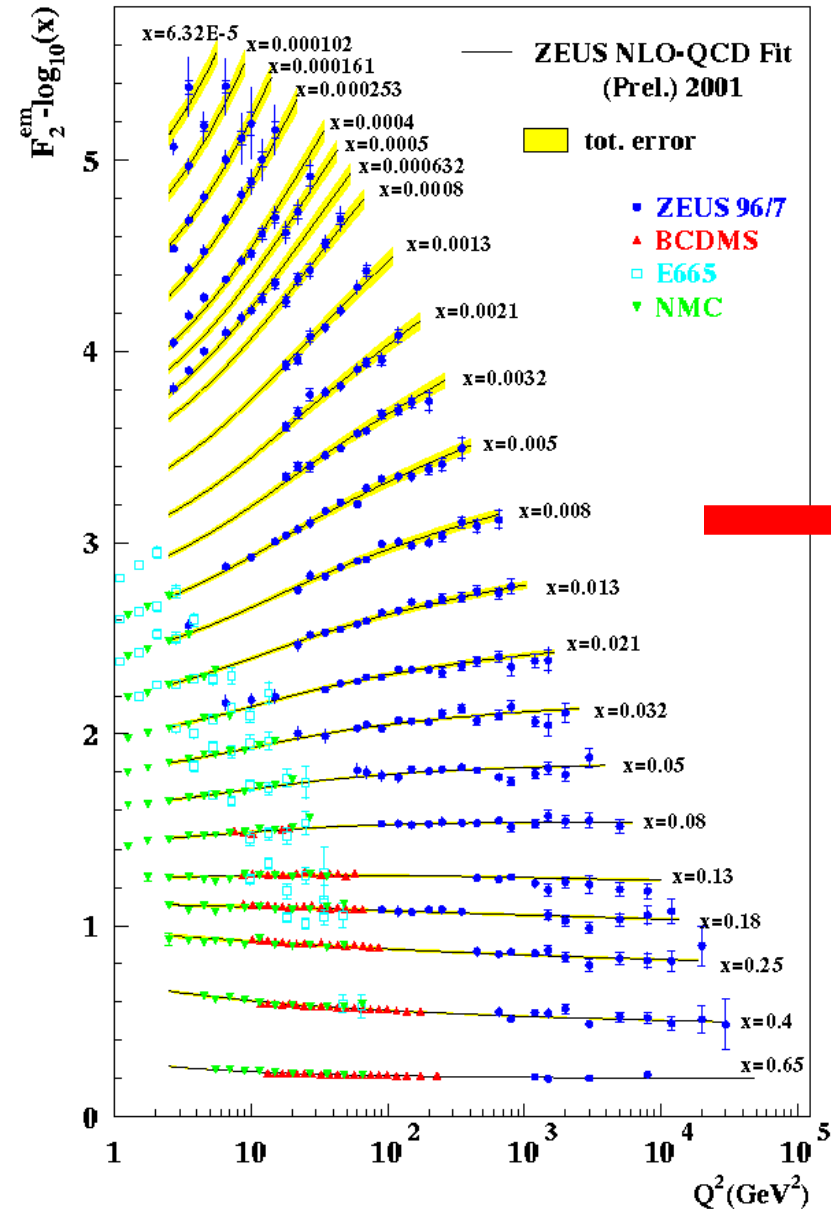


x = momentum fraction of quark in proton

$$\sigma = \sum_{a,b} \int dx_a dx_b f_a(x_a, Q^2) f_b(x_b, Q^2) \hat{\sigma}_{ab}(x_a, x_b)$$

- * Highest energies reachable
- * Can reach highest masses for new particles production
- * Precision often limited by knowledge of quark/gluon structure of proton
- * QCD effects need to be controlled to the best of our knowledge

Structure of the proton at HERA

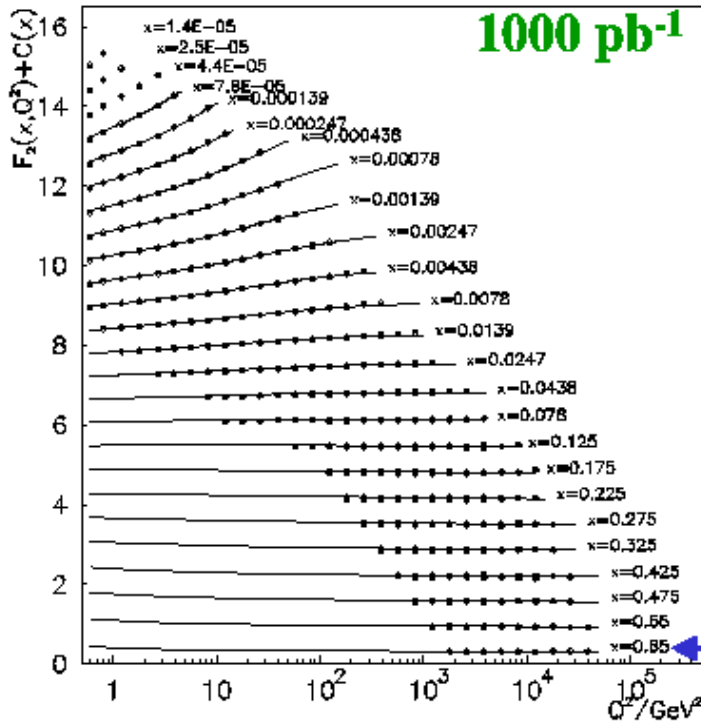


Proton structure known to a few % in a large area of x and Q^2

HERA-II, now starting

The promise..

- The Structure Function F_2



High Precision F_2

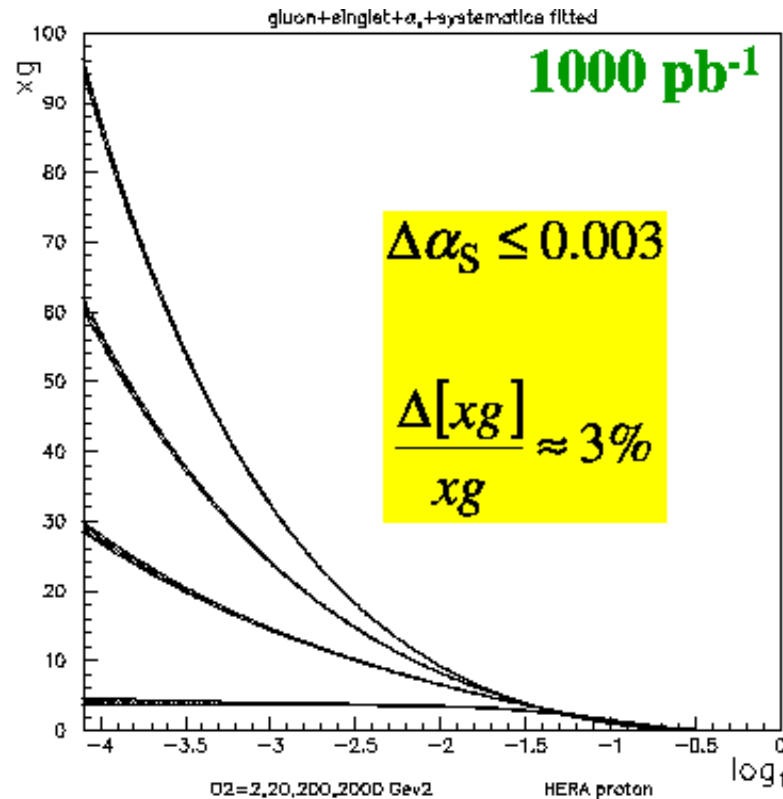
Large x, Q^2 range



α_s and xg

$x = 0.65$

$Q^2 = 4 \times 10^4$



High precision at large Q^2 , precise determination of the gluon distribution, flavour separation (via CC), $u(x)/d(x)$ for $x \rightarrow 1, \dots$

...but there is much more

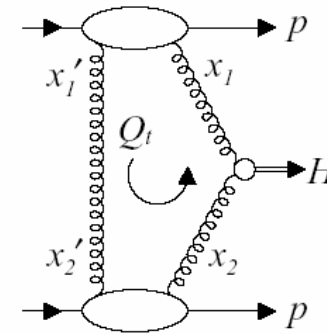
- Heavy quarks in the proton distributions
- Multi-jet topologies, mini-jets and multiple scale QCD
- Underlying event, multiple interactions
- Parton shower/ME matching in LO and NLO
- Saturation and high density QCD
- Kt factorization and low-x effects, e.g affects Higgs production
- Forward physics BFKL/CCFM
- Rapidity gap survival probabilities
- Diffractive structure functions and (non) factorization
- Diffractive phenomena, e.g Higgs production
- NLOLIB: library for NLO programs
- HZTOOL and JETWEB: Generator validation and tuning
- Experimenting: e.g. forward detectors, roman pot stations.
- Study of gluon density via F_L , charm & jet production
- eA scattering, polarized scattering (would need HERA-III)
- ...

Low-x and diffraction the LHC

Access to low x
(down to 10^{-6} - 10^{-7})

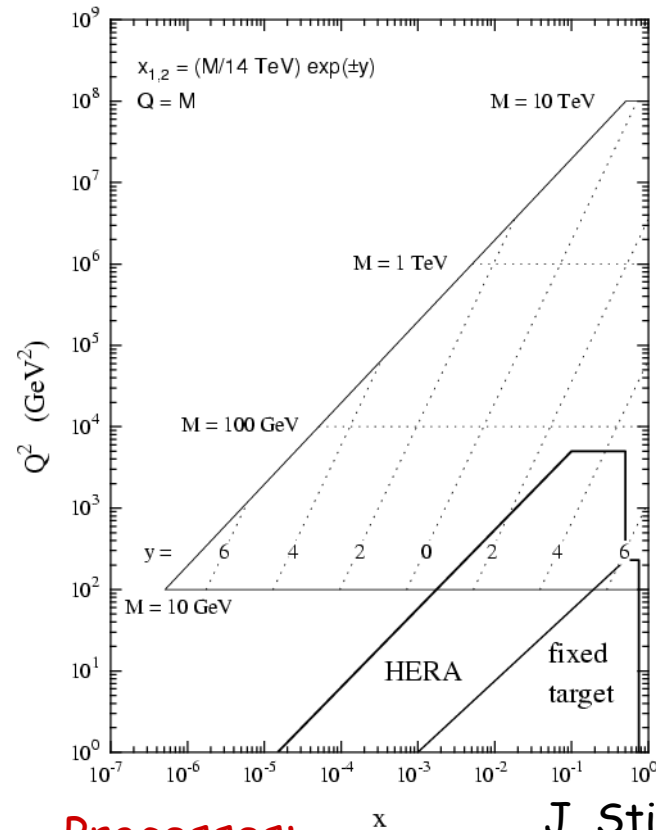
Study of diffractive phenomena
CMS, TOTEM,...

⇒ Diffractive structure, rapidity gap phenomena, diffractive Higgs production...



Diffractive, parton saturation, γp , final state studies, multi-jet studies, heavy flavour studies.

⇒ Part of the LHC physics program



Processes:

- Drell-Yan
- Prompt photon production
- Jet production
- W production

J. Stirling

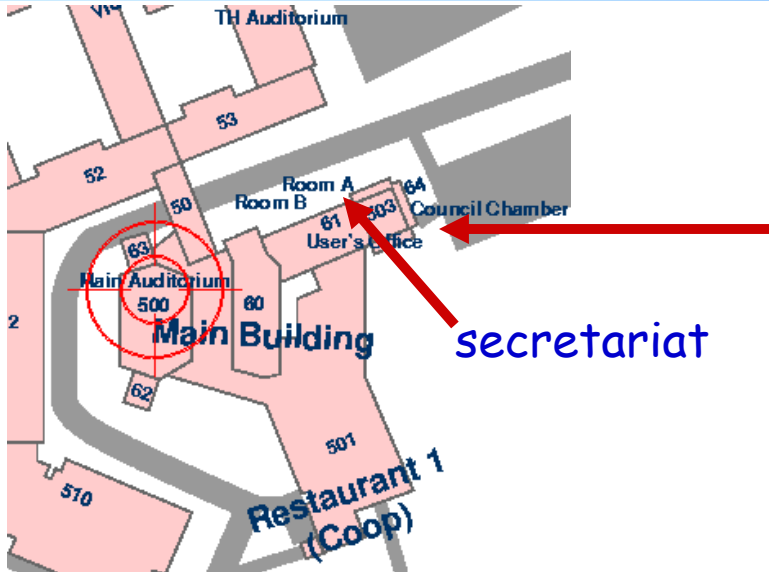
- Opportunities to join the experiments
- Some of these topics need additional detectors

Organization

First meeting:	26-27 March CERN
Intermediate meeting:	(proposal) 3-7 May/ DESY
Second meeting:	11-13 October CERN
Intermediate meeting:	(proposal) 15-19 November/ venue??
Final meeting:	January 2005 DESY

- Goals for this meeting
 - Discuss problems
 - Set priorities
 - Form study groups
- Long term goal
 - List of measurements to be performed at HERA
 - Quantify impact on LHC measurements
 - Development of the tools
- Proceedings
 - Summary reports of the working groups
 - Individual contributions
 - Printed + electronically

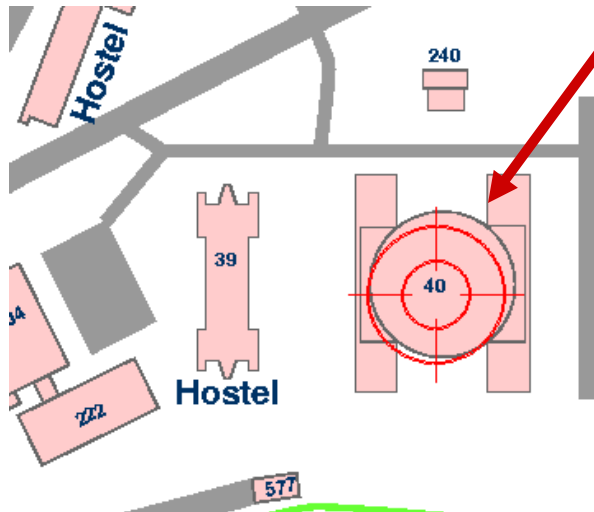
Practical information



Plenary meetings in either
Main auditorium or
Council Chamber (this afternoon only)

Note Council chamber has 180 seats

Parallel sessions are in Building 40



Practical questions
Secretary: D. Denise in Room A
or 40-5-B01

Registered participants: please
pick up your badge

Have a good workshop