ZEUS Experiment Status Report

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Alexandria, VA

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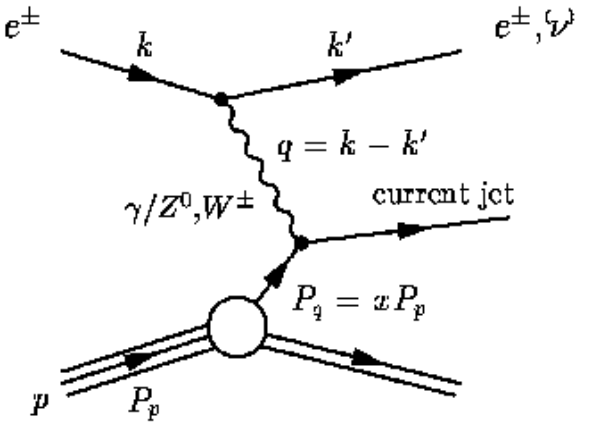
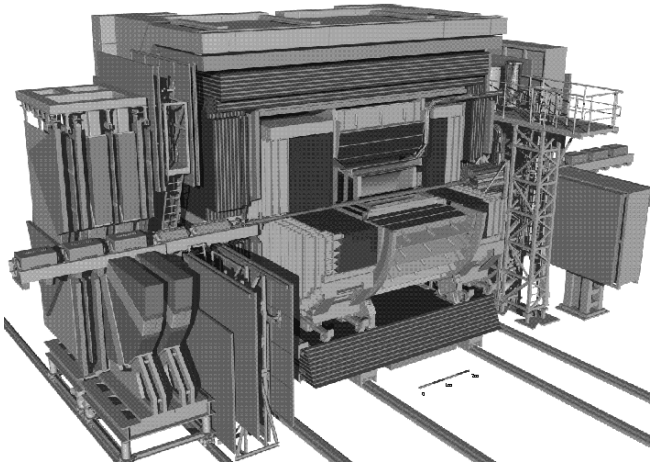
Introduction

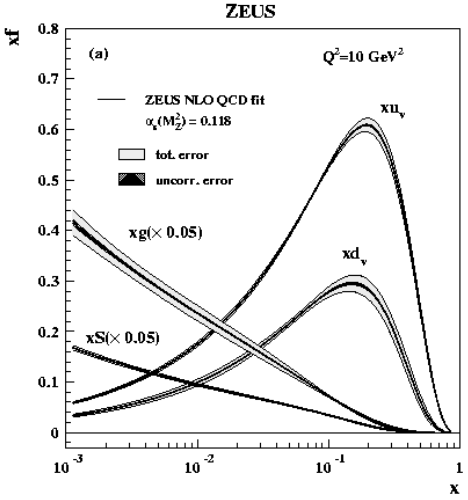
- HERA ep collider in Hamburg, Germany had its first collisions in 1991. Experiments, ZEUS and H1.
- ZEUS: a collaboration of 50 institutes, 350 physicists.
- HERA I: 1992-2000 27.5 GeV e on 820-920 GeV p: 200 pb^{-1} delivered to ZEUS.
- Shutdown for HERA II: Upgrade Goals: ×5 increase in luminosity. Polarization for lepton beam .
- Currently starting up for HERA II
- HERA II scheduled to end January 1, 2007. Goal: 1000 pb^{-1}



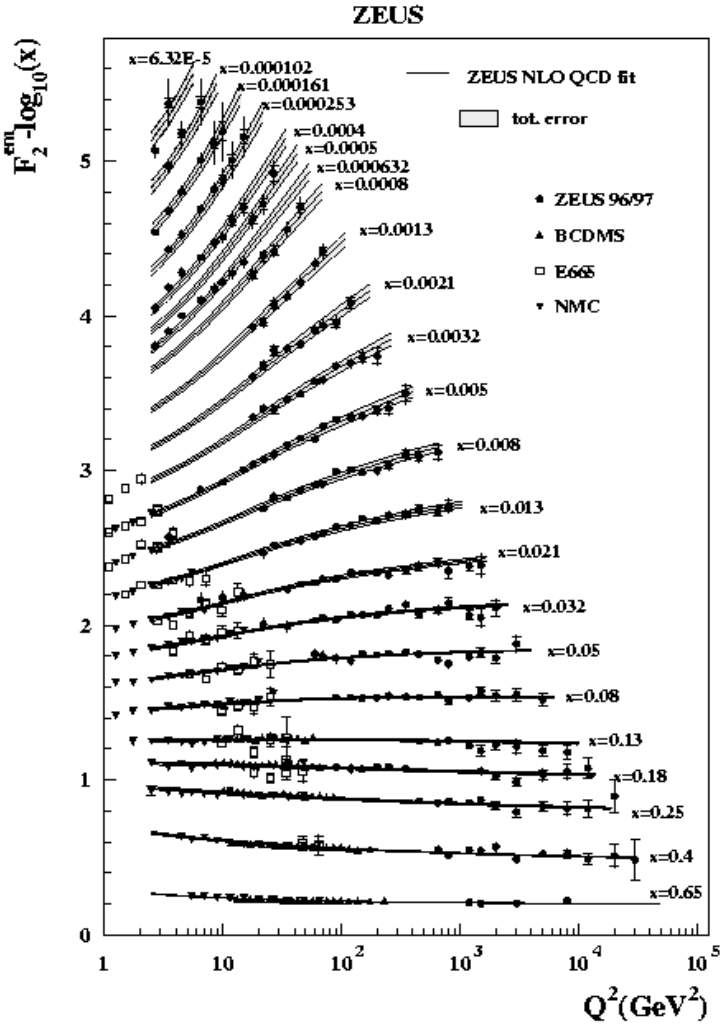


HERA I physics

- HERA I has extended the proton structure measurements by 3 orders of magnitude in x and Q^2.
- The data are precision measurements (2-3% uncertainty).
- Extraction of parton densities with quantitative uncertainties and correlations.



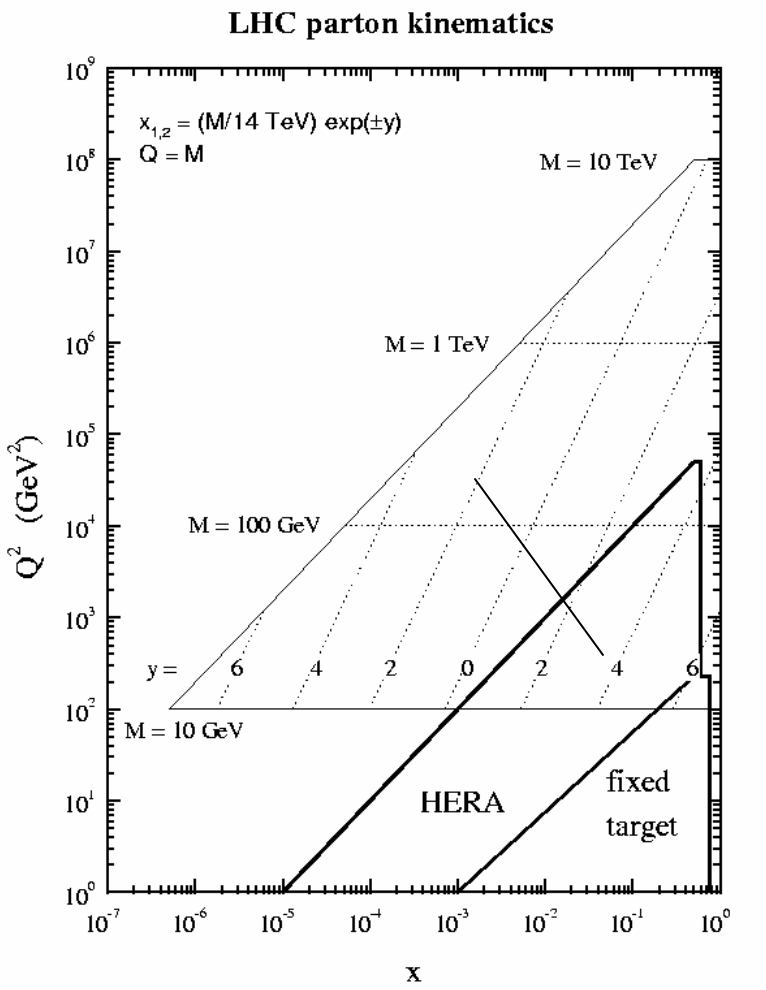
Why do we care?



HERA I physics

- Best quantitative test of QCD.
- Precision extraction of α_s.
- Need the information for the LHC and the Tevatron.

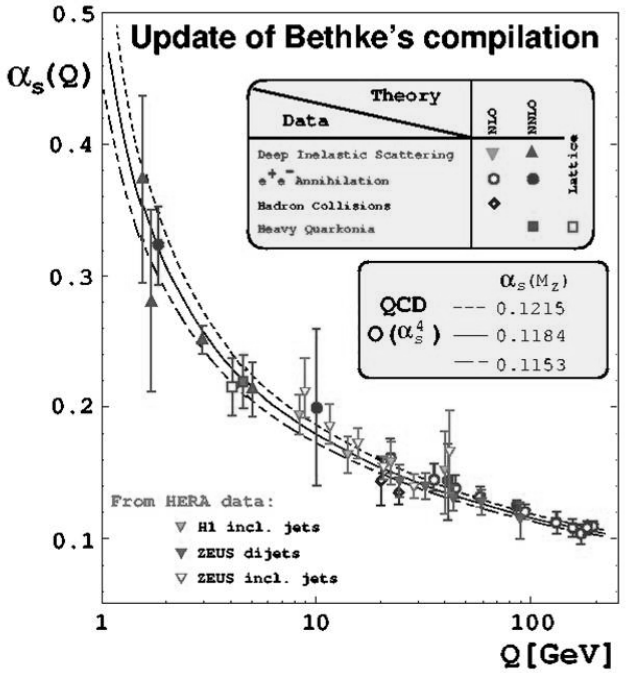
(You need to understand your beam particles if you want to find something new!)

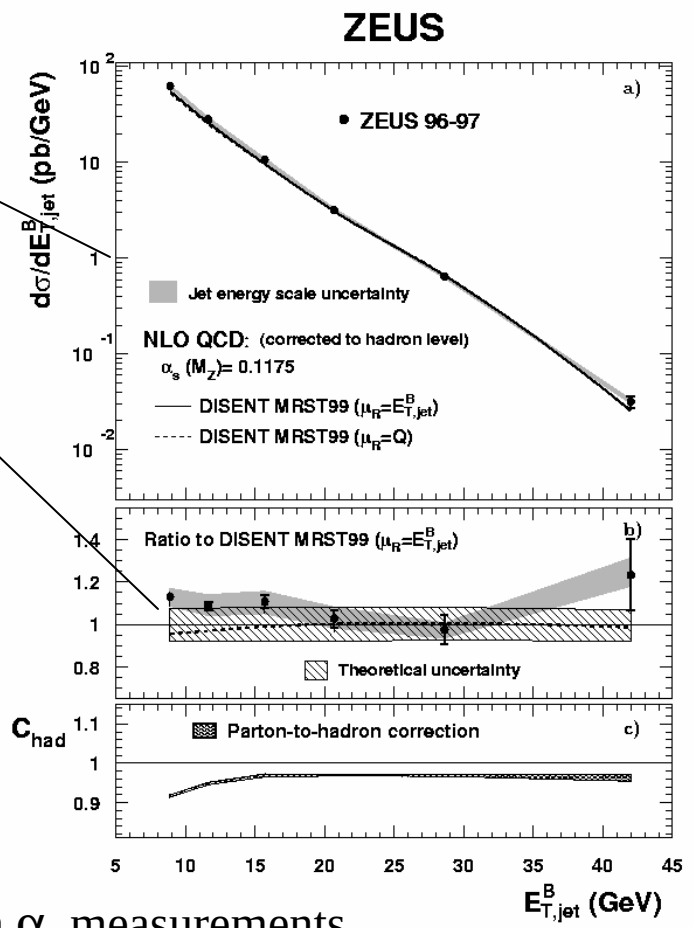


HERA I physics

- Precision jet physics:
- 1% uncertainty in jet energy scale

  5% uncertainty in jet cross-sections

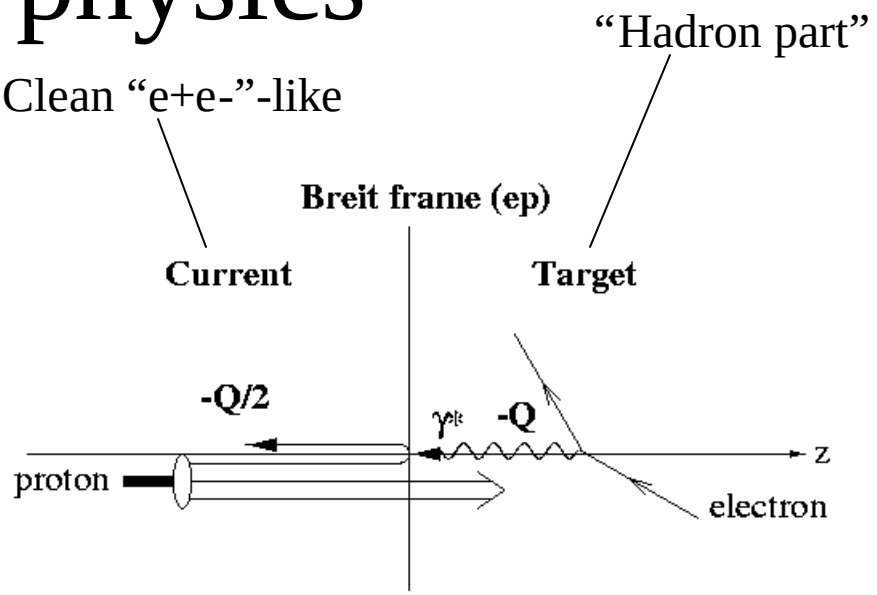




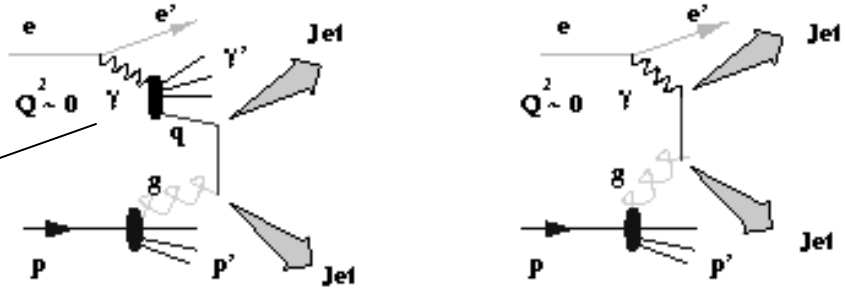
Precision α_s measurements

HERA I physics

- HERA is a precision tool for dissecting the proton.
- Precision pQCD in the current frame. (Reference)
- Hadronic environment in the target hemisphere
- Hadronic environment in resolved photoproduction.



Photon is a hadron

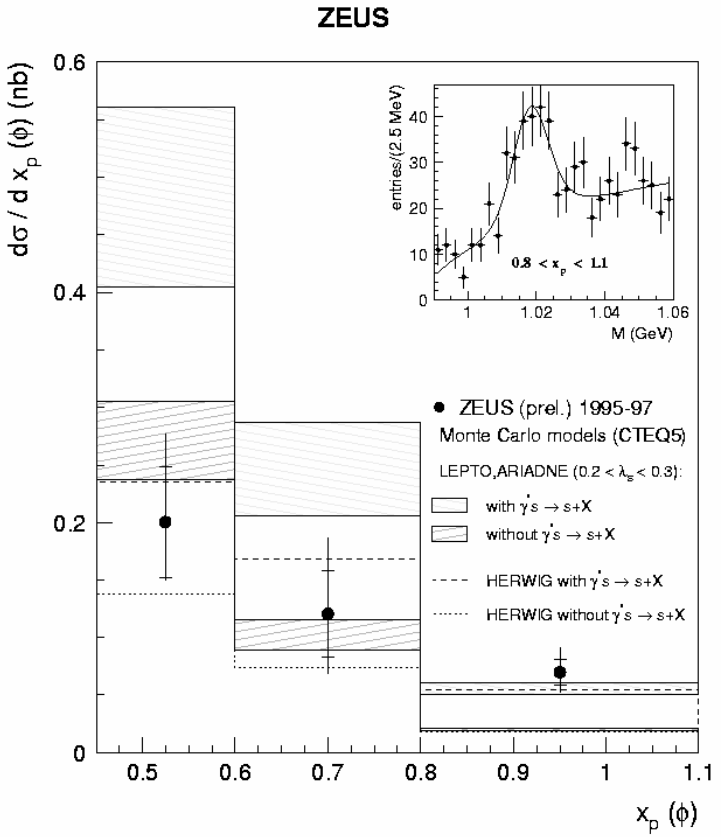


Ideal for gathering hadronic information

HERA I physics

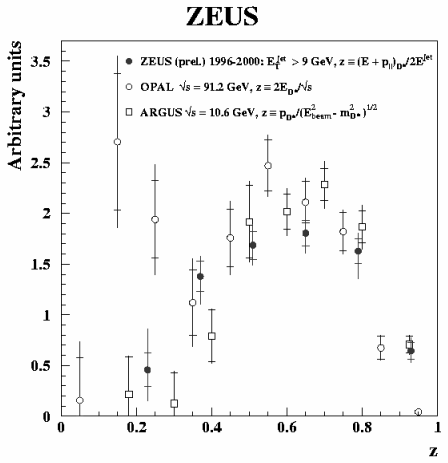
For example:

- Inclusive ϕ production in DIS
- Strangeness suppression factor in current and target regions.
- Strange Sea quarks in the proton.



Another example:

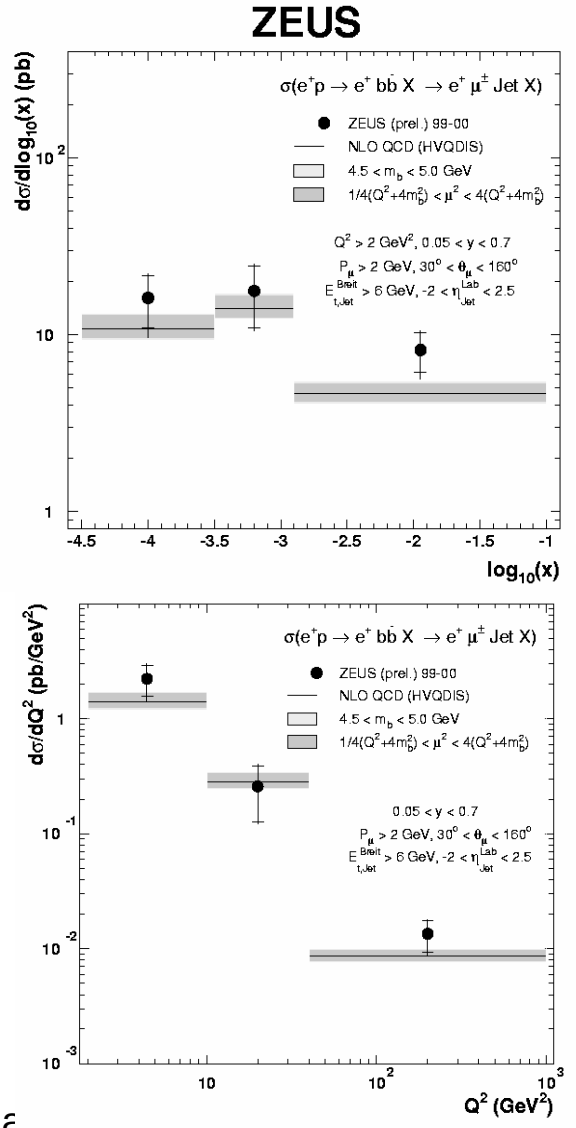
- Charm fragmentation in hadronic events:



Information needed for LHC

HERA I physics

- Beauty cross-section in DIS: a first differential measurement.
- Agrees with NLO QCD.
- Photoproduction (i.e. production in hadronic collisions) also agree with NLO QCD.
- Important to understand b-production process in QCD.
- Important in application: e.g. understanding the use of b-tagging for searches at LHC.



HERA I physics

Many other topics ——— Relates to:

- Diffraction, low x, in DIS ——— • Diffractive Higgs at LHC. Non-DGLAP evolution. Saturation.
- Prompt photons→intrinsic k_T in the proton. ——— • W mass at the Tevatron.
- Charm production ——— • Sensitivity to medium x gluons
- Underlying events, Multiparton interactions ——— • Background at LHC, Tevatron
- …

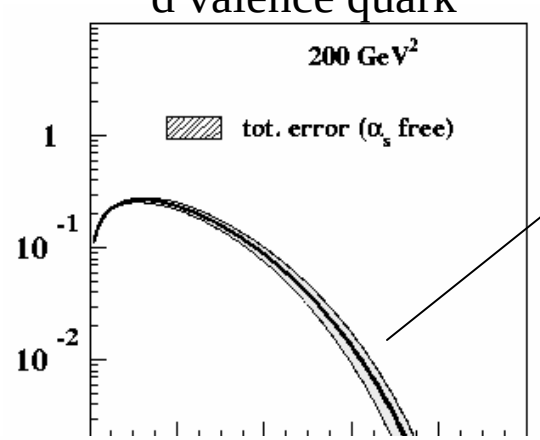
HERA : The ideal QCD machine. HERA I Results show qualitatively new level of understanding in structure functions and jet physics.

HERA I results are indispensable information for future hadron collider physics!

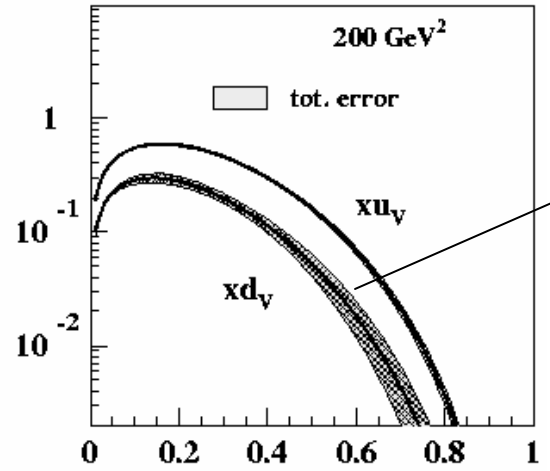
HERA II physics

- Structure function measurements: high x partons
- Currently determined by the fixed target (low Q^2) measurements.
- Measurements using HERA I data instead gives similar precision.
- Future measurements from HERA II statistics will directly translate to precision!

d valence quark



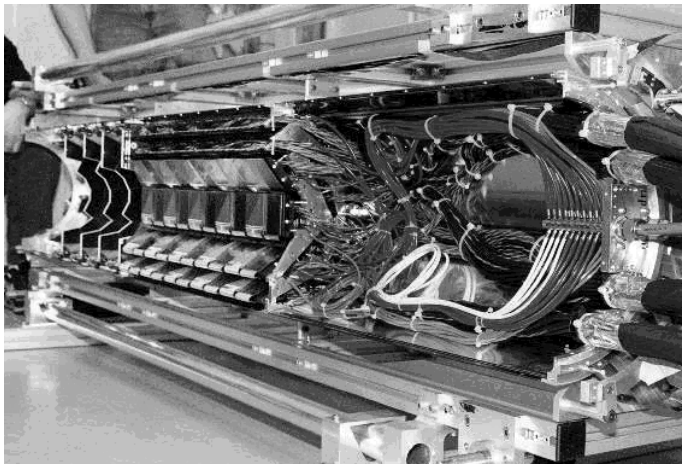
Systematics dominates

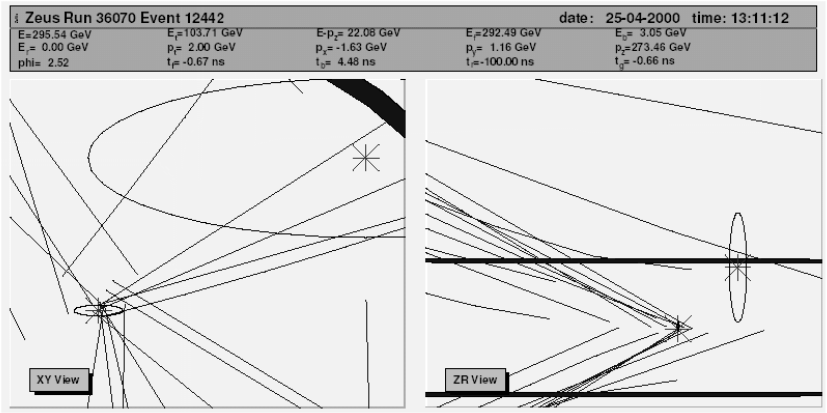


Statistics dominates

HERA II physics

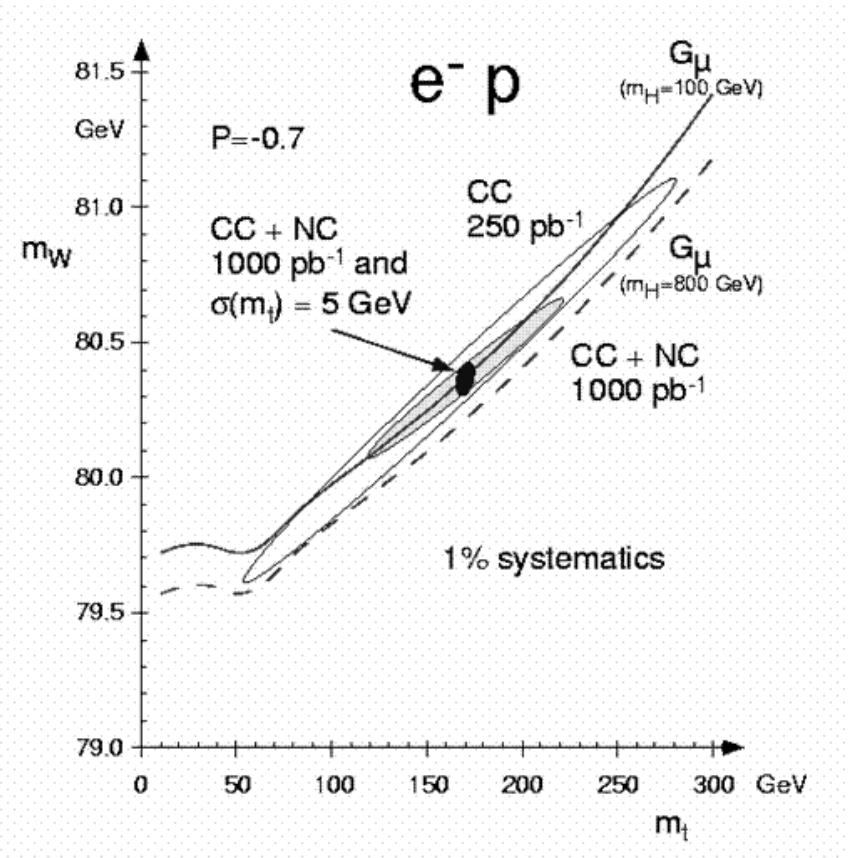
- Heavy Quark physics: new microvertex and forward tracking detectors in ZEUS
- Detached vertices will increase tagging efficiency by more than an order of magnitude.
- The new detectors will increase the kinematic reach of heavy quark measurement.
- Improve precision
- Access new information: e.g. medium x gluon (c.f. Tevatron high E_T jets).





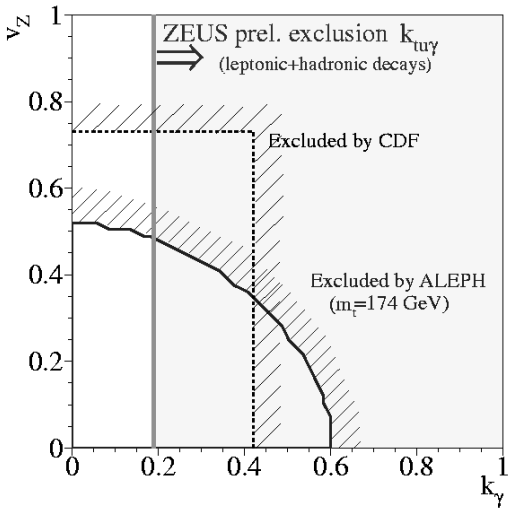
HERA II physics

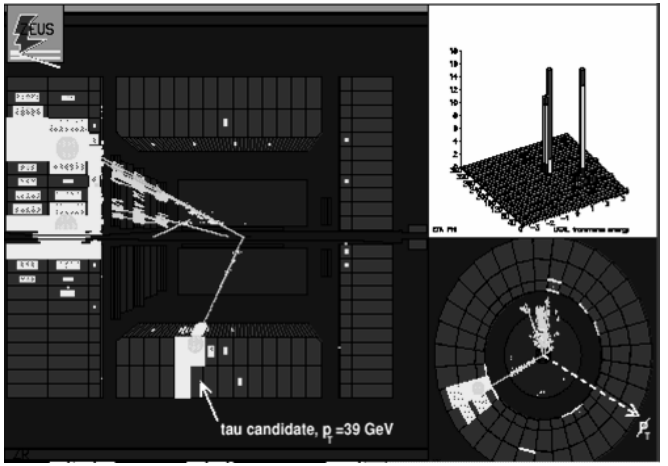
- High luminosity and polarization of the lepton beam will allow electroweak studies:
- An example: polarized cross-section measurements will pin down EW parameters→combined with a top mass measurement from Tevatron or LHC→ constrain W-mass to ~50 MeV.
- Many other studies: e.g. NC coupling of light quarks, anomolous WWγ coupling, limits on right handed W.



HERA II physics

- Searches: there are still windows of discovery at HERA: e.g. single top production limits.
- Some intriguing events exist in HERA I sample.
- Isolated τ's with missing P_T P_T>25 GeV 0.12 events expected from SM. 2 events observed.
- Keep looking! Surprise are supposed to happen in unexpected places!

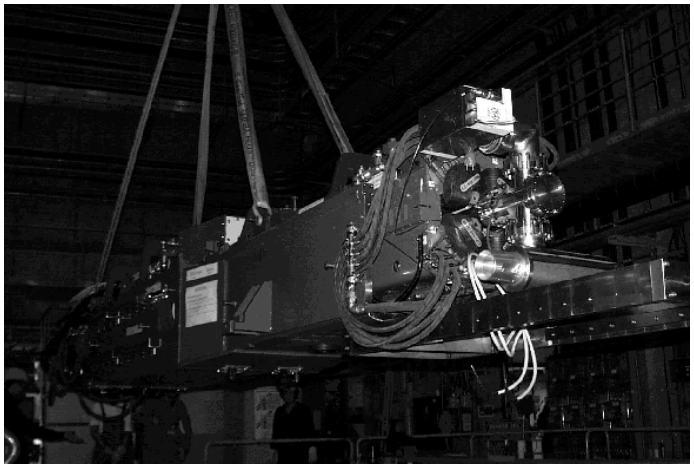


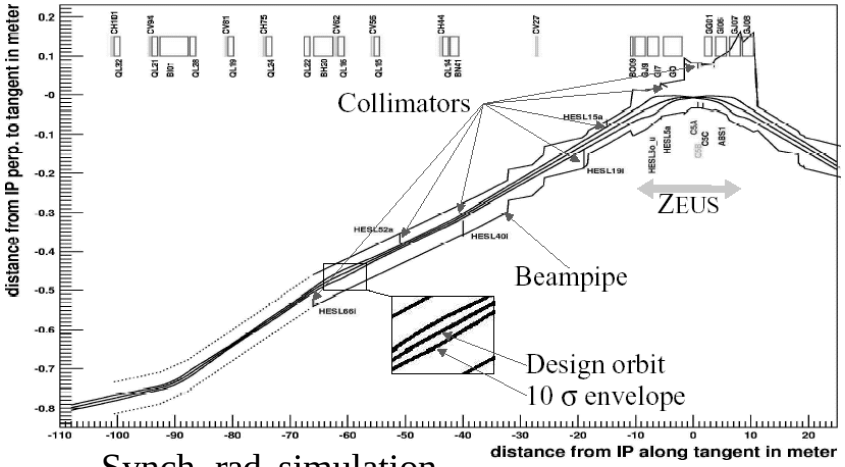


Current Status: HERA

- Sept. 2000: end of HERA I
- Summer 2001: close detector HERA II commissioning starts
- October 2001: first ep collisions
- November 2001: HERA achieves design specific luminosity : 1.8×10^{30} $cm^{-2}s^{-1}mA^{-2}$
- Background and reliability problems . Additional synchrotron shields installed, aperture limitations fixed.
- May 2002: Reliability improved Systematic studies of background
- Now: Background largely understood. Planning for shutdown to fix the problems.

Final focusing magnet being installed in ZEUS

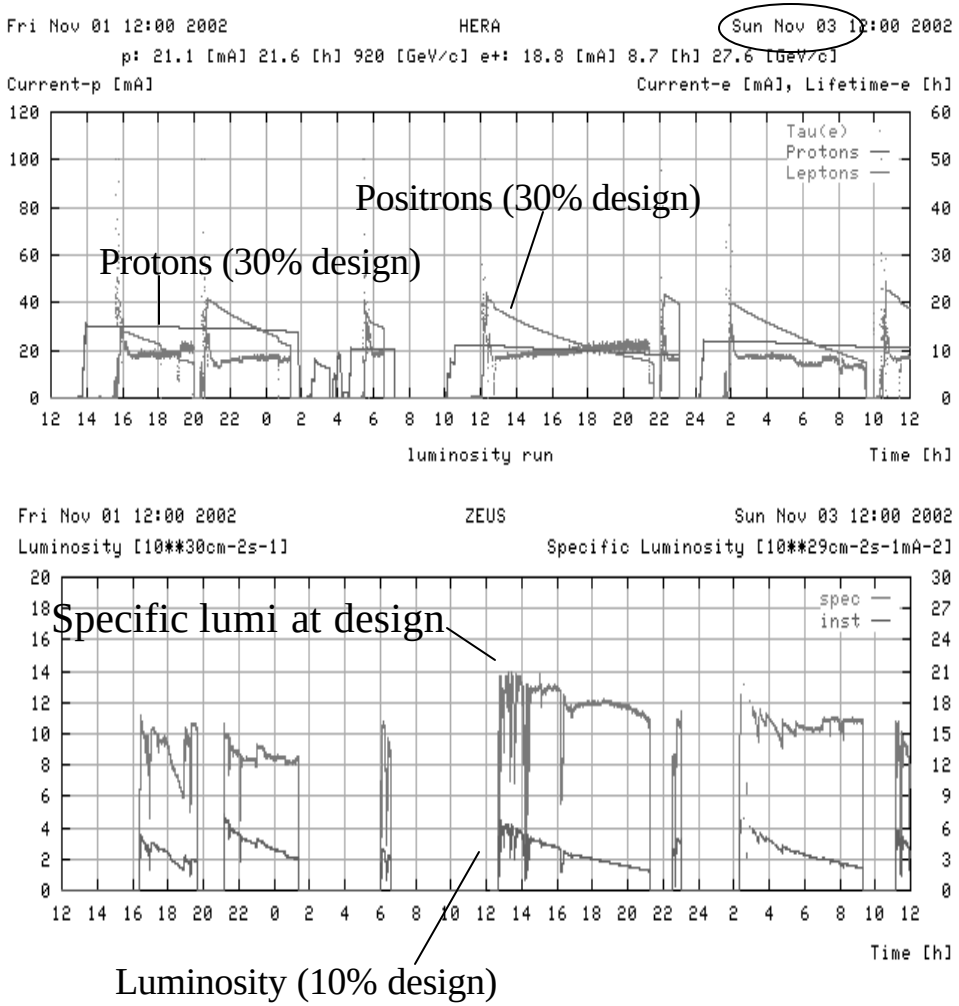




Synch. rad. simulation

Current Status: HERA

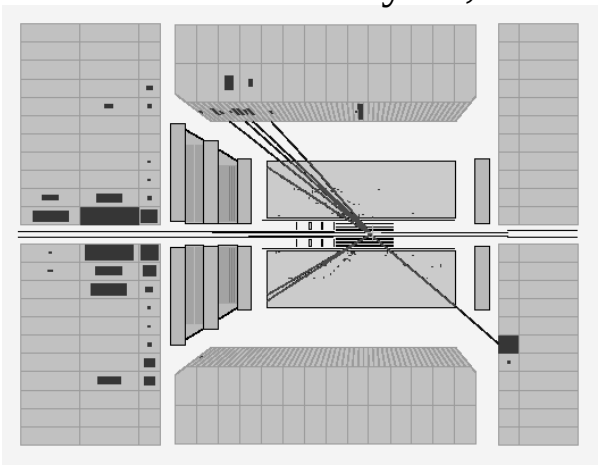
- Synchrotron radiation problem understood –technical solution being worked out (Mods ready by March.)
- Electron-beamgas background also understood. Will be able to reduce to a sufficient level.
- Proton-beamgas background largely understood, but needs further studies.
- Currently HERA being operated at reduced current but in a data taking mode. Bakeout and further studies.
- 4-months shutdown in March to put in redesigned synchrotron shields.



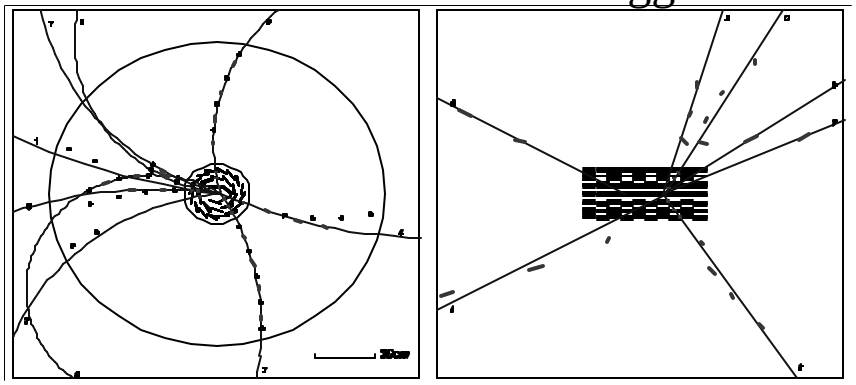
Current Status: ZEUS

- Old detector components are working well.
- Central Tracking Detector (CTD) current limit is the main problem due to the background—however the CTD has a lot of headroom. Will reduce gain by factor 2 without seriously compromising performance.
- Microvertex detector is working well. MVD is also in the second level trigger—working well.
- Ready to take data efficiently when background problems solved after March shutdown.

July 24, 2002



Trigger tracks



HERA in the HEP community

- HERA is the only HEP collider operating in Europe now, and will be the only one until the LHC turns on.
- HERA provided and still provides young physicists with strong experience in:

  -Operation of a high-crossing rate (100 ns b.c.) hadron experiment (many ex-ZEUS people in Tevatron, LHC)

  -Physics analyses: one of the few operating collider experiments. Many topics directly connected to LHC. (c.f. http://jetweb.hep.ucl.ac.uk/)

US role in ZEUS

- US make up ~10 % of the ZEUS collaboration.
- Many hardware responsibilities: barrel calorimeter, calorimeter trigger, “fast clear”, presamplers, straw tube tracker electronics, luminosity monitor, global tracking trigger, small angle tracking detector.
- Strong physics contributions: ~30 PhD’s awarded.
- Strong leadership roles:
  Physics chairs: J. Whitmore (PSU), M.Derrick (ANL)
  Physics coordinators: J. Repond(ANL), D.Krakauer(ANL), S. Paganis(Colunbia), C.Foudas(Wisconsin), N.Brummer(OSU), P.Saull(PSU), B.Straub(Yale), C.Ginsburg(OSU)… many more
  Deputy Spokespersons: J. Whitmore, A. Caldwell(Columbia), RY
  Spokespersons: A. Caldwell, RY (from Jan. 2003)

US role in ZEUS

- The current cost of US participation in ZEUS is small.
- Nevertheless, there are (understandable) pressures at many levels to take priority away from ZEUS. Very often this takes the form of personnel. i.e. leaving post-docs or retiring staff not being replaced.
- This has resulted in thinning of the US ZEUS ranks to a point beyond which I believe is wise.
- In some cases, the coverage of our hardware responsibilities is barely adequate.
- Given the benefit of the ZEUS program, I believe it deserves stronger support from the funding agencies and the HEP leadership.

Conclusions

- HERA in general, and the ZEUS experiment, in particular, are making important contributions to HEP. –Both as pure knowledge, and also as stepping stones to LHC.
- HERA II (2002-2007) will be a valuable resource for HEP.
  --Training ground for young physicists
  --Analyses geared toward applications in LHC
- US is a vital part of ZEUS.
- US ZEUS effort deserves, and needs, support.
  I believe there is a case for a modest increase in the effort.