EW probes of the QCD media -
an experimentalist’s perspective

Mieczyslaw Witold Krasny
LPNHE, University Paris VI et VII

Krakow, 6th Dec 2016
EW probes of QCD media

Light cone variables (Bjorken, Brodsky, Hoyer, ....)

\[ q^+ = (q^0 + q^3) \sqrt{2} \]
\[ q^- = (q^0 - q^3) / \sqrt{2} \]
\[ x = Q^2 / 2mq^0 \]
\[ y = q^0 / E_e \]

- **transverse distances:**
  \[ r_t \sim 1/Q \sqrt{(1 - y)} \]

- **longitudinal distances:**
  \[ r_+ \sim \sqrt{2} / mxy \]

... probed on the light-cone \( r_+ = ct \) with the dispersion \[ r_+ \sim 1 / \sqrt{2} q^0 \]
Status before HERA

1. Partonic structure of hadrons
2. Establishing scaling violations
3. QCD as experimentally verified SU(3) theory of strong interactions (abelian vs. non-abelian, gluon spin, etc…)
4. Filtering leading from higher twist processes (SLAC E140)
5. Spin structure of protons
6. PDFs (from B-spine and histogram form to functional forms)

Beginning of the 90-ties:

HERA looks at low x scattering in the perturbative QCD regime
The preparatory steps for the low-x measurements at HERA

1. Detector upgrade(s) (*HERA experiments were not optimized to addressed the low x physics*)
2. Adequate measurement techniques (*Brussels, Paris, Saclay (BPS) group*)
3. Experimental control of radiative corrections (*DESY radiative correction group*)
4. Low-x specific QCD analysis tools (*invitation to Krzysztof Golec-Biernat to join the effort*)
1991 – the H1 detector upgrade proposal: precision measurements in the low x region

Deep inelastic physics requirements for the H1 upgrade in the backward region.

Low-x → significant energy loss and low angle scattering
Memorandum to the Hermes collaboration:

HERMES, a precision experiment to study low x physics at HERA?

M.W. Krasny
DAPNIA - SPP, Centre d’Etudes de Saclay
F-91191 Gif-sur-Yvette Cedex (France).

Abstract: In the course of the 1991 HERA workshop it became evident that the low x physics is one of the most exciting subjects to study at HERA. Study of high density parton system in the kinematical domain controled by the perturbative QCD may give us a new insight into the nature of strong interactions. The two existing Hera experiments H1 and ZEUS will soon provide a first glimpse into the low x domain. It has to be stressed however that both of them have been optimized for the high x (high Q^2) rather then for the low x physics. Therefore, if an onset of a new phenomena is observed, a dedicated low x experiment has to follow. In general, such an experiment has to resemble an open geometry fixed target experiment rather then a collider experiment in order to optimize the measurement of low x events, where electrons are scattered from ”almost” stationary partons. A cost effective solution, in my opinion, would be to modify the existing proposal of the HERMES group such that their experiment would work both in the fixed target mode (spin physics) and in the collider mode (low x physics). In this note a physics potential of such a solution is discussed.
HERA specificity - measurement techniques in presence of a large EM radiative corrections

We want to measure $\frac{d\sigma}{dx dQ^2}$ at a given $(x, Q^2)$

The knowledge of $\frac{d\sigma}{dx dQ^2}$ over the full $x' > x$ is required, in particular in the region marked by the lines corresponding to collinear singularities

We want to measure $\frac{d\sigma}{dx dQ^2}$ at a given $(x, Q^2)$

Figure 4. The topology of the $(x, Q^2)$ domains contributing to the radiative differential cross section. See text for further explanations.
Krzysztof’s task

Recombination effects in the structure function evolution at low $x$. Can they be observed at HERA?

K. Golec-Biernat $^{a}$, M.W. Krasny $^{b}$, S. Riess $^{c}$

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Could HERA provide an evidence for the partonic saturation (recombination) effects in the $Q^2$-evolution of partonic densities (independently of the assumed form of partonic distributions at fixed $Q_0^2$ scale)?

What measurements, detector and machine upgrades are necessary to achieve the requisite precision?
\[ Q^2 \frac{\partial}{\partial Q^2} \left[ xg(x, Q^2) \right] = P_{gg} \otimes g + P_{gq} \otimes q_s \]

\[ - \frac{81 \alpha_s^2(Q^2)}{16 R^2 Q^2} \theta(x_0 - x) \int_x^{x_0} \frac{dz}{z} \left[ zg(z, Q^2) \right]^2 \] (1)

\[ Q^2 \frac{\partial}{\partial Q^2} \left[ xq_s(x, Q^2) \right] = P_{qg} \otimes g + P_{qq} \otimes q_s \]

\[ - \frac{27 \alpha_s^2(Q^2)}{160 R^2 Q^2} \theta(x_0 - x) \left[ xg(x, Q^2) \right]^2 \]

\[ + \frac{\alpha_s(Q^2)}{\pi Q^2} \theta(x_0 - x) \int_x^{x_0} dz \left[ \frac{x}{z} \gamma(\frac{x}{z}) G_H(z, Q^2) \right]. \] (2)

where \( q_s(x, Q^2) \) and \( g(x, Q^2) \) denote the sea quark and gluon distributions, respectively, and \( G_H \) satisfies

\[ Q^2 \frac{\partial}{\partial Q^2} \left[ xG_H(x, Q^2) \right] = - \frac{81 \alpha_s^2(Q^2)}{16 R^2} \theta(x_0 - x) \int_x^{x_0} \frac{dz}{z} \left[ zg(z, Q^2) \right]^2. \] (3)


J. Kwieciński, A.D. Martin, W.J. Stirling and R.G. Roberts
D 42 (1990) 3645.

Fig. 2. The \( F_2 \) logarithmic slopes \( \frac{\partial F_2}{\partial \log(Q^2)} \) as a function of \( x \). The open points represent the values calculated for the \( R_{\infty} \) data set in the domain of \( \theta_e > 7.5^\circ \) (a) and \( \theta_e > 3^\circ \) (b), and the values calculated for the \( R_3 \) data set in the domain of \( \theta_e > 3^\circ \) (c). The solid, dashed and dotted lines are derived from the results of the \( R = \infty \), 5, 3 GeV\(^2\) fits, respectively.
1. Quantitative arguments for extending the measurement of the scattered electron down to lower angles (feedback on the H1 detector upgrade)

2. Importance of independent constrain on the gluon distribution coming from a precision measurement of $F_L(x, Q^2)$ (feedback on the SPACAL front-end electronic design and on the HERA machine operation modes)

3. Importance of an extension of the HERA research programme: storage and collisions of heavy and light ion beams with electrons (gain the $A^{1/3}$ factor in the transverse-plane density of partons)
The basic experimental question which remained to be answered in 1992:

(conditioning the subsequent phenomenological development of low x physics)

how fast parton density rises in the low-x region?
1992 - Two independent ...and competing data analyses

Analysis by the ELAN group led by M. Klein and A. De Roeck, (published in Phys. Lett. B299, January 1993) indicated “almost flat” (MRS D0-type) partonic densities for $x \to 0$ (a fraction of the collected data).

Analyse by the BPS group (presented for the first time to the H1 collaboration in December 1992) suggested a strong (MRS D-like) rise of partonic densities for $x \to 0$ (full collected data).
Final verdict announced at the Durham workshop 21-26/03,1993 by Albert DeRoeck:

MRS D- like rise of partonic densities at low x

Result considered as important by the QCD community…

Max Klein honoured by Germany and the UK
Max Klein of the University of Liverpool has been awarded the Max Born Medal and prize of the German Physical Society and the UK’s Institute of Physics, for "fundamental experimental contributions to reveal the structure of the proton through deep-inelastic scattering". In particular, as a member of the H1 collaboration at the HERA electron–proton collider at DESY, he played a decisive role in the discovery in the 1990s of a surprisingly large gluon component within the proton.

A De Roeck

Journal of Physics G: Nuclear and Particle Physics, Volume 19, Number 10
Towards a proposal of a QCD-optimized research program at DESY (1993-1998)

• Final design of the SPACAL electronics to access the high y region by H1: e.g. for the precision measurement of $F_L(x, Q^2)$

• Proposal of the HERA upgrade (nuclear beams and accelerator upgrade discussions at the Paris DIS workshop in 1995 and the HERA 1996 workshop)

• Towards a joint European (DESY, GSI, NUPECC) QCD research program and its specialized facility at DESY (Seeheim meeting 1997)
The role of nuclear beams for the on-going HERA program (1996 surprise):

1. Study of the large density partonic systems. Search for nonlinear QCD phenomena.

2. Unique means of verifying how universal is the concept of Pomeron. Answer to the question: "Does Pomeron have an unique structure independent of the process in which it is created?"

3. Filtering out soft from hard processes (which "interplay" in the ep scattering). Establishing a list of ep processes where perturbative QCD must survive quantitative checks.

4. Nucleus - the best invented so far femtovertex detector to study the space-time structure of strong interactions.

5. eA scattering \rightarrow luminous jet scattering

M.W.K, DESY, 1996 HERA workshop

Slide shown at the closing session of the 1996 HERA workshop presenting the highlights of the nuclear option of the HERA future programme…
Memorandum

To: B. Wiik, A. Wagner, DESY
From: M.W. Krasny, LPNHE - Paris

...selected two points of the memorandum to DESY directors:

- to build an "A-tunable" ion injector system and collide at HERA electrons with nuclei. The ePb collisions would have the world record center-of-mass energy (if realized before RHIC becomes operational) and, apart from several merits which I tried to explain in my summary talk of the HERA workshop, would provide the largest effective luminosity for photon-photon interactions in the intermediate W range. It is worth noticing that several physicists became interested in the nuclear option for HERA after introducing to the program of the Paris HERA workshop, back in 1995, a parallel session on nuclei and that this physics received some attention during the DESY workshop this year.

- to design a dedicated experiment for HERA for the "low Q^2 (Q^2 \leq 100 \text{ GeV}^2)" domain optimized both for the ep and eA interactions. Let me note, as an example, that neither the upgraded H1 experiment nor the ZEUS experiment will be able to measure structure functions, in particular \sigma_L/\sigma_T, with the precision comparable to that of SLAC experiments of 70-ties, despite the energies and angles of the scattered electrons are, in this Q^2 range, similar. Such a detector would have to measure the energies and angles of particles produced over the large domain of \eta, covering in particular the proton (nucleus) fragmentation region, which still remains a "terra incognita". It should use large \beta rather than small \beta optics because the physics advocated here requires modest luminosities and high detection quality of particles emitted at small angles. I failed, back in 1991, to persuade the spokesman of the HERMES experiment that the first component of such an experiment could be the HERMES electron spectrometer used in the colliding beam mode.

DEUTSCHES ELEKTRONEN-SYNCHROTRON (DESY)
Hamburg, 11.07.1996

Dr. M.W. Krasny
Universities Paris 6 +7
LPNHE
4, Place Jussieu, Tour 33
F-75252 Paris Cedex 05

Dear Dr. Krasny,

Thank you very much for your contribution to the HERA workshop and for your remarks to the HERA programme.

I agree with you that HERA will make a solid contribution to strong interaction physics and that colliding electrons with nuclei may open up new vistas and should be explored further. Indeed we want to do this in collaboraton with GSI and I hope that you will be able to participate and contribute to this work. In order to carry out a programme in this direction there must be a well reasoned physics programme, a strong support including funds from the community, and GSI must be interested in a collaboration.

I'm not so sure that I agree with your comments concerning the luminosity frontier - at least I would feel somewhat uneasy if we neglected this frontier.

With my best wishes

Björn H. Wiik

August 19, 1996
A world-wide support for the initiative (an example):

Professor Bjorn Wiikk, Director
DESY
Notkestrasse 85
D-22607 Hamburg
Germany

Dear Bjorn:

We write to you concerning the future physics program at HERA. The two-volume report “Future Physics at HERA” has given a remarkably thorough presentation of the possibilities that lie ahead. In surveying that report we have been struck by the fact that one particular proposal, having nuclear beams in HERA, builds on the most impressive results of the present HERA program and extends the range and scope of these experiments in a very significant way...

...We urge you to give the most careful consideration to the electron-ion option, and do hope that it may become a reality.

With our best regards,

James Bjorken
SLAC

Stanley Brodsky
SLAC

Alfred Mueller
Columbia Univ.

Larry McLerran
Theoretical
The context of the 1997 Seeheim meeting

- Parallel to the HERA operation the European nuclear physics community (NuPECC) has been searching for the next nuclear facility capable study the physics of strongly interacting matter with electron probes
- GSI has been developing the ENC project
- NuPECC (in particular FRANCE) has been developing the concept of a high luminosity fixed target electron accelerator for a CEBAF-like programme
- DESY has just proven -- contrary to initial expectations -- its capacity to address strong interaction physics with HERA
- The main question was if (and how) these three projects could be combined into a joint European projects having as an ultimate goal a facility to address the strong interaction physics in terms of quark and gluon degrees of freedom
Joint DESY/GSI/NuPECC workshop
March 3/4 1997
Luftansa - Zentrum, Seeheim near Darmstadt (Germany)

Monday, March 3:
9:00 - 9:15 Welcome
V. Matag

Chair: W. Weise
9:15 - 10:00 Electron - Nucleon/Nucleus scattering
in the 21. Century
A. Mueller
10:00 - 10:15 Discussion
10:15 - 10:45 Nuclear Physics with HERMES
K. Rith
10:45 - 11:00 Discussion
11:00 - 11:30 Coffee

Chair: G. Middelkoop
11:30 - 12:00 The physics program of COMPASS
F. Bradamante
12:00 - 12:15 Discussion
12:15 - 13:00 Electron-Nucleus Collisions at HERA (theory)
M. Strikman
13:00 - 14:00 Lunch
14:00 - 14:45 Electron-Nucleus Collisions at HERA (experiment)
W. Krasny

Chair: B. Schloch
15:00 - 15:45 Physics with an e-N/A facility at GSI (theory)
A. Schäfer
15:45 - 16:30 Physics with a e-N/A facility at GSI (experiment)
D. v.Harrach
16:30 - 17:15 Discussion: Electron-Nucleon/Nucleus Collisions at GSI
16:45 - 17:15 Coffee

Chair: B. Frois
17:15 - 18:00 Physics with ELFE/DESY (theory)
P. Hoyer
18:00 - 18:45 Physics with ELFE/DESY (experiment)
J.M. Laget
18:45 - 19:00 Discussion: Electron-Nucleon/Nucleus Collisions at ELFE

F. Willeke

Beam Parameters (based on present lattice):

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Momentum</td>
<td>$P_1 = 6.724 \times 10^{14}$ GeV $^{-1}$</td>
</tr>
<tr>
<td>Energy</td>
<td>$E_1 = 6.724 \times 10^{14}$ GeV</td>
</tr>
<tr>
<td>Energy per Nucleon</td>
<td>$E_{n} = 213.274$ GeV</td>
</tr>
<tr>
<td>Emittance</td>
<td>$e_0 = 4.656 \times 10^{-11}$ mm</td>
</tr>
<tr>
<td>e_1</td>
<td>$e_1 = 1.161$ mm</td>
</tr>
<tr>
<td>$\beta_{x}$</td>
<td>$\beta_x = 0.40$ m</td>
</tr>
<tr>
<td>$\beta_{y}$</td>
<td>$\beta_y = 0.20$ m</td>
</tr>
<tr>
<td>Beam Size</td>
<td>$\sigma_{x} = 176.364 \pm 16 \mu m$</td>
</tr>
<tr>
<td></td>
<td>$\sigma_{y} = 41.731 \pm 16 \mu m$</td>
</tr>
<tr>
<td></td>
<td>$\sigma_{x} = 173.285 \pm 16 \mu m$</td>
</tr>
<tr>
<td></td>
<td>$\sigma_{y} = 41.833 \pm 16 \mu m$</td>
</tr>
<tr>
<td>Number of partbunch</td>
<td>$N_{x} = 5 \times 10^{7}$</td>
</tr>
<tr>
<td></td>
<td>$N_{y} = 3.7 \times 10^{7}$</td>
</tr>
<tr>
<td>Beam Current</td>
<td>$I_x = 5.385$ mA</td>
</tr>
<tr>
<td></td>
<td>$I_y = 55.16$ mA</td>
</tr>
<tr>
<td>Beam-Beam Tuneshift</td>
<td>$\Delta \omega_{x} = 7.86 \times 10^{-9}$</td>
</tr>
<tr>
<td></td>
<td>$\Delta \omega_{y} = 1.98 \times 10^{-9}$</td>
</tr>
<tr>
<td>Effective Beam Size</td>
<td>$\sigma_{x} = 242.949 \mu m$</td>
</tr>
<tr>
<td></td>
<td>$\sigma_{y} = 59.069 \mu m$</td>
</tr>
<tr>
<td>Luminosity</td>
<td>$L_x = 1.91 \times 10^{28}$ sec$^{-1}$ cm$^{-2}$</td>
</tr>
<tr>
<td></td>
<td>$L_y = 3.97 \times 10^{28}$ sec$^{-1}$ cm$^{-2}$</td>
</tr>
</tbody>
</table>

$L_x = 2.10^{28}$ cm$^{-2}$ s$^{-1}$
New upgraded HERA Luminosity.
The main problem to reach a requisite luminosity at HERA (existing already for protons but significantly more severe for ions) to execute the GSI, ELFE and HERA experimental programs:

The emittance blow up in the chain of HERA injectors: Intra-beam scattering and slow ramping time

GSI interested in construction of the pre-injector chain for DESY: the estimated cost 25 MDM (e.g. a ~2% of the cost the high luminosity CERN-LHC upgrade)
How to merge the three proposals into a QCD research facility?

A sketch of an "experimentalist's dream" set-up for precision studies of strong interactions - totally unrealistic?!

... one component already exists...
My main intransigent points:

- The DESY QCD programme must include a development of **high intensity sources** of both isoscalar ions (including deuterium) and the highest Z ions, and **their low emittance pre-injector(s)**

- One of its detectors for must have a **full $4\pi$ acceptance** (allowing to detect all the fragments of the nucleus)

- The “HERA leg” of this programme requires a factor of $O(100)$ increase of the collider luminosity:
  - **statistics:** $F_2^c$, $F_2^b$, $F_L$, EW, multidimensional studies
  - **systematics:** drastic reduction of syst. errors (e.g. $x$ and $Q^2$) scans at fixed theta as a function of $(E_n, E_e)$

- RHIC was expected to start in 2000 and the LHC in 2006 — the DESY QCD program -- capable to provide a vital input for the interpretation of the RHIC and the LHC data -- **must start before (or soon after) RHIC and LHC became operational**
Example: The proposed future HERA QCD programme and the Krzysztof’s and Mark’s saturation model

1. Test of $z$-independence of

2. Test of validity of $r$-rescaling formula for various thickness targets

3. Test of the assumed form of factorisation by varying the gluon density for a fixed virtual photon wave function and fixed $x$

4. Test of applicability of the proposed ansatz for peripheral collisions: (“nuclear versus nucleon Pomerons”)

5. …
Two important problems at DESY:

• difficult to reconcile between TESLA – and and a joint QCD facility at DESY → B.Wiik strategy

• The lepto-quark an supersymmetry “ghosts” at HERA – strong political push by the H1 and ZEUS spokesman, physics coordinators and, finally, of the H1 and ZEUS collaboration members for the small $\beta^*$ magnet-insert programme (despite the experimental evidence, provided by the “Generic Searches” group -- based in Paris -- that the claimed BSM signals are fake)

(efficient censorship of any discussions/presentation at DESY of both the results of the “generic searches group” and of the joint DESY/GSI/NUPECC QCD initiative)
1999 – the end of a dream of the European QCD Facility at DESY

- B. Wiik’s unfortunate accident --
  TESLA project loses its momentum and is finally abandoned

- An unsuccessful trial of the nuclear option for HERA revival (1999 HERA workshop)

- GSI works towards a local FAIR PROJECT (low energy), ELFE (e.g French) groups join the CEBAF program

- The electron-ion concept moves to US (thanks to a strong commitment to this project by Peter Paul – the BNL director)

- … and finally -- closing the HEP program at DESY couple of years later
The US reincarnation (end extension) of the project

- The first presentation of the BNL option of the eA collider at the MORIOND 1999 conference
- the project baptised eRHIC, gets its momentum in the US following the BNL (1999), Yale (2000), and Snowmass (2001) workshops
- The first White Paper in 2002 …but NSAC decides to finance FRIF
- Since then the e-A Collider designs have been greatly refined.
- The project became EIC -- two labs want to host it: TJNF and BNL
- A CHANCE TO FINANCE THIS PROJECT FOLLOWING THE 2016 LONG TERM NSAC PLAN???
Perspectives of electron-nucleus scattering at RHIC

Preliminary studies (Peggs, Trbojevic 1999) show that it is possible to collide heavy ions with positrons at RHIC. Two scenarios are to be considered:

- positrons circulating in one of the two existing rings
- electrons circulating in a purpose built room temperature ring in the RHIC tunnel

providing luminosities for e.g. eAu collisions of:

- \( L \approx 1.0 \times 10^{27} \text{cm}^{-2}\text{s}^{-1} \) at the positron energy of 10 GeV and the nucleus energy of 100A GeV - for the first scenario
- \( L = 3.7 \times 10^{29} \text{cm}^{-2}\text{s}^{-1} \) - for the second scenario

The limit of the luminosity in the first scenario is determined by the maximal heat load of 1 Watt/m of dipole bend, due to the synchrotron radiation
New initiatives

1. 2005 – Proposal of a special collision mode at the LHC of electrons with protons and light ions (electrons accelerated and stored in LHC “on the shoulders” of heavy ions and colliding in the ATLAS and CMS collision points).
3. 2012 – “Exploring confinement” initiative (MWK) with a new electron-proton(ion) collider in the CERN SPS tunnel (playing also a role of a LHC-precision experimental support programme).
The ep(eA) collider in the SPS tunnel – an optimal facility to study the confinement phenomena

The proton(ion) ring

The electron ring

2.45 GeV ERLs
(no bypasses necessary)

6 vertically stacked recirculation passes in the arcs: 5.5, 10.4, 15.3, 20.2, 25.1, 30.0 GeV

$E_{CM}(ep/eA) = 14-230$ GeV

(covers the energy range of eRHIC, MEIC and ENC@FAIR, overlap with PIE@LHC)

The SPS tunnel

The UA1 cavern
The experimental programme to study QCD media with EW probes is not yet finalized (a link to Krzysztof’s Santa Claus gift) leaving the validity of many models (e.g. the saturation models) as an open question.

If there is any use of recalling the past it is to try to avoid obvious errors which (the DESY case) led to closing of an experimental program in HEP in a big international laboratory.

This lesson is worth considering while formulating the European Strategy in HEP.

The large scale project such as FCC, CLIC, requiring substantial investments, must be backed up by the complementary “low cost” accelerator projects opening new research domains.

Their recognition and founding must be assured to reduce the risk that the accelerator based HEP is not extinct if large scale projects are not financed in the future (the TESLA lesson).
The Gamma Factory Initiative

E.G. Bessonov, Lebedev Physical Institute, Moscow, Russia; D. Budker†, Helmholtz Institute, Johannes Gutenberg University, Mainz, Germany; K. Cassou, K. Dupraz, A. Mariens, F. Zomer, LAL Orsay, France; P. Czodrowski, Department of Physics, University of Alberta, Edmonton, Canada; O. Dadoun, M. W. Krasny*, LPNHE, University Paris VI et VII and CNRS-IN2P3, Paris, France; M. Kowalska, A. Petenko, CERN, Geneva, Switzerland; W. Placzek, Jagellonian University, Krakow, Poland; Y. K. Wu, FEL Laboratory, Duke University, Durham, USA; M. S. Zolotorev†, Center for Beam Physics, LBNL, Berkeley, USA.

† Initiative supporter
* Contact person: e-mail: krasny@lpnhe.in2p3.fr

Presented at the PBC Workshop, September 2016

by

Mieczyslaw Witold Krasny
LPNHE, Pierre et Marie Curie University – Paris

...for the executive summary see: e-Print: arXiv:1511.07794 [hep-ex]
Extra transparencies
QCD media – length scales

**Length scales of strong interactions**

- Partons
- "Constituent quark" radius
- Nucleon radius
- Pion wavelength
- Nuclear radius

**QCD**

- Asymptotic freedom, (perturbative QCD)
- Instantons? (higher twists)
- Confinement (lattice QCD)
- Effective nucleon-nucleon interactions

**Required resolving power**

**Nuclear medium:**

1) Filtering of various distance scales involved in a given process

2) Femto-detector (1.4 fm resolution) for partonic processes --

**Leptonic probes:**

- Fine-tuning of space-time resolution
Existing and Future Facilities:
TJNAF, EIC and LHeC

1. Partonic structure of nuclei, validity of pert. QCD
2. Longitudinal distances confined to nucleon size
3. Large distance coherent partonic processes
Physics goals of luminosity upgrade (Workshop future physics of HERA, Hamburg 96)

1000 pb⁻¹ HERA with polarised (P=0.7) electrons and positron competitive with LEP and Tevatron???
...and the reality in 2000 - before restarting the HERA program with the mini beta inserts
Dear Witek: I would be happy to come over after the end of January, when we have the last town meeting, or even better, after the final "reconciliation meeting" which takes place at the end of March. After that meeting, the priorities are set for the next decade.

At the Hadron Physics Town meeting, the working group voted in a recommendation that eRHIC should be the next construction program and that vigorous development program should be started immediately with the goal of a realistic proposal before five years. Considering that we have to work out the electron cooling and detector details, 3 years is about as fast as we can move toward a full-scale proposal. But it looks like an electron ion Collider will happen. There was a lot of excitement about it at the Town Meeting.

Thanks for your continuing help.

Peter Paul
Physics with lepton-ion colliders

towards a dedicated facility for a generic research in QCD

Detector Issues of Lepton-Hadron Colliders

Snowmass workshop on the future of high energy physics

Mieczysław Witold Krasny

LPNHE - Paris
The first design of the « Bj's dream » $4\pi$ detector and its corresponding IR optics capable to measure all the particles produced in ep (eA) collision

Electron beam for LHC

Mieczyslaw Witold Krasny

LPNIHE, Université Pierre et Marie Curie, 4 Pl. Jussieu, Tour 33, RDC, 75025 Paris, France

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Available online 22 December 2004

Abstract

A method of delivering a small energy spread electron beam to the LHC interaction points is proposed. In this method, heavy ions are used as carriers of projectile electrons. Acceleration, storage and collision-stability aspects of such a hybrid beam is discussed and a new beam-cooling method is presented. This discussion is followed by a proposal of the Parasitic Ion–Electron collider at LHC (PIE@LHC). The PIE@LHC provides an opportunity, for the present LHC detectors, to enlarge the scope of their research program by including the program of electron–proton and electron–nucleus collisions with minor machine and detector investments.

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Exploring confinement

Mieczyslaw Witold Krasny
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Abstract

This note is an extended version of the contribution to the CERN Council Open Symposium on European Strategy for Particle Physics. It discusses an experimental programme to explore the QCD confinement phenomena at CERN with a new electron-proton and electron-nucleus collider using the existing SPS beams (optionally also the future SPL and PS proton and ions beams) and the polarised electron beam in the range of 5 to 20 GeV from a newly built Energy Recovery Linac.
The measurement of the W mass at the LHC: shortcuts revisited

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Abstract

The claim that the W mass will be measured at the LHC with a precision of $\mathcal{O}(10)$ MeV is critically reviewed. It is argued that in order to achieve such precision, a considerably better knowledge of the $u$, $d$, $s$, $c$, and $b$ structure functions of the proton than available today is needed. This will permit to assess with adequate precision the production characteristics of the W and Z bosons in the proton–proton collisions at the LHC, and their effect on the $p_T$ spectra of charged leptons from W and Z decays. An experimental programme is suggested that will deliver the missing information. The core of this programme is a dedicated muon scattering experiment at the CERN SPS, with simultaneous measurements on hydrogen and deuterium targets.