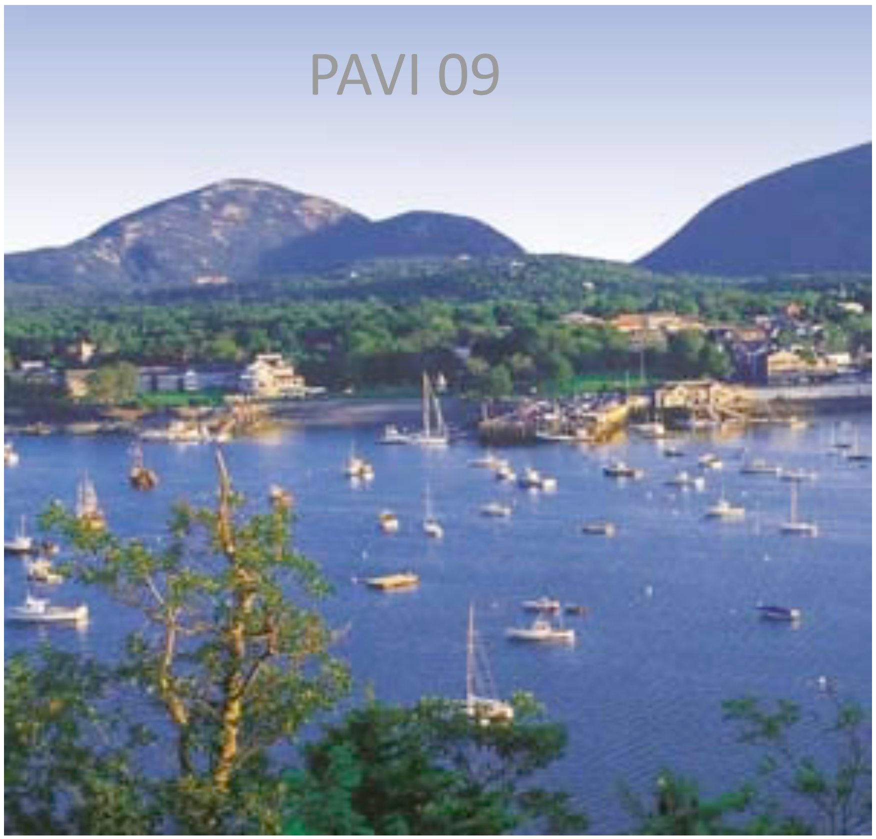
The Electron Ion Collider

Physics Opportunities & Accelerator Challenges

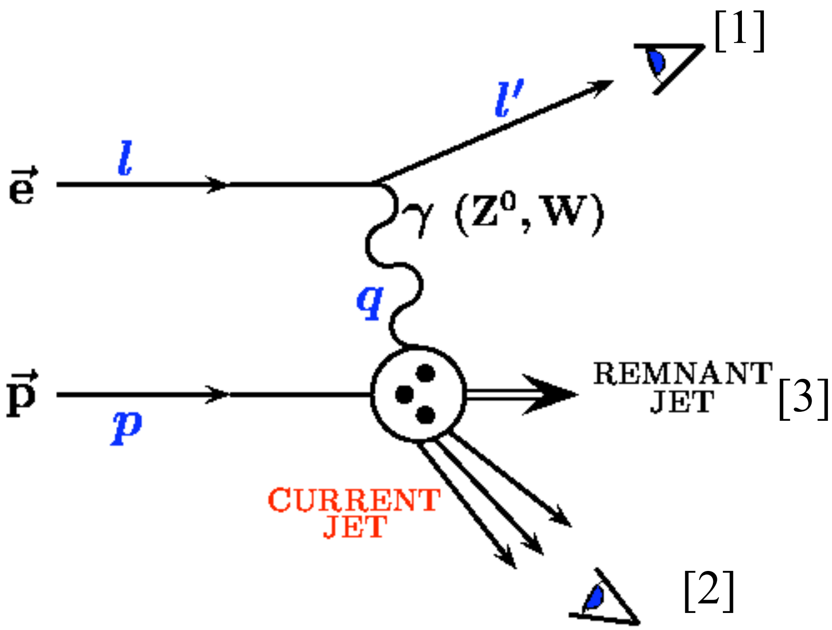


- Physics Motivation for EIC
  - Gluons in QCD, nucleon (spin)
- Designs under consideration
- Physics impact within & beyond QCD
- Issues of Realization….

Abhay Deshpande
Stony Brook University &
RIKEN BNL Research Center

4th International Workshop:
From Parity Violation to Hadronic Structure & More
College of the Atlantic, Bar Harbor, Maine, USA

Deep Inelastic Scattering



$$Q^2 = -q^2 = sxy$$

$$x = \frac{Q^2}{2p\cdot q}$$

$$y = \frac{p\cdot q}{p\cdot l}$$

$$s = 4E_e E_p$$

$$W = (q + p)^2$$

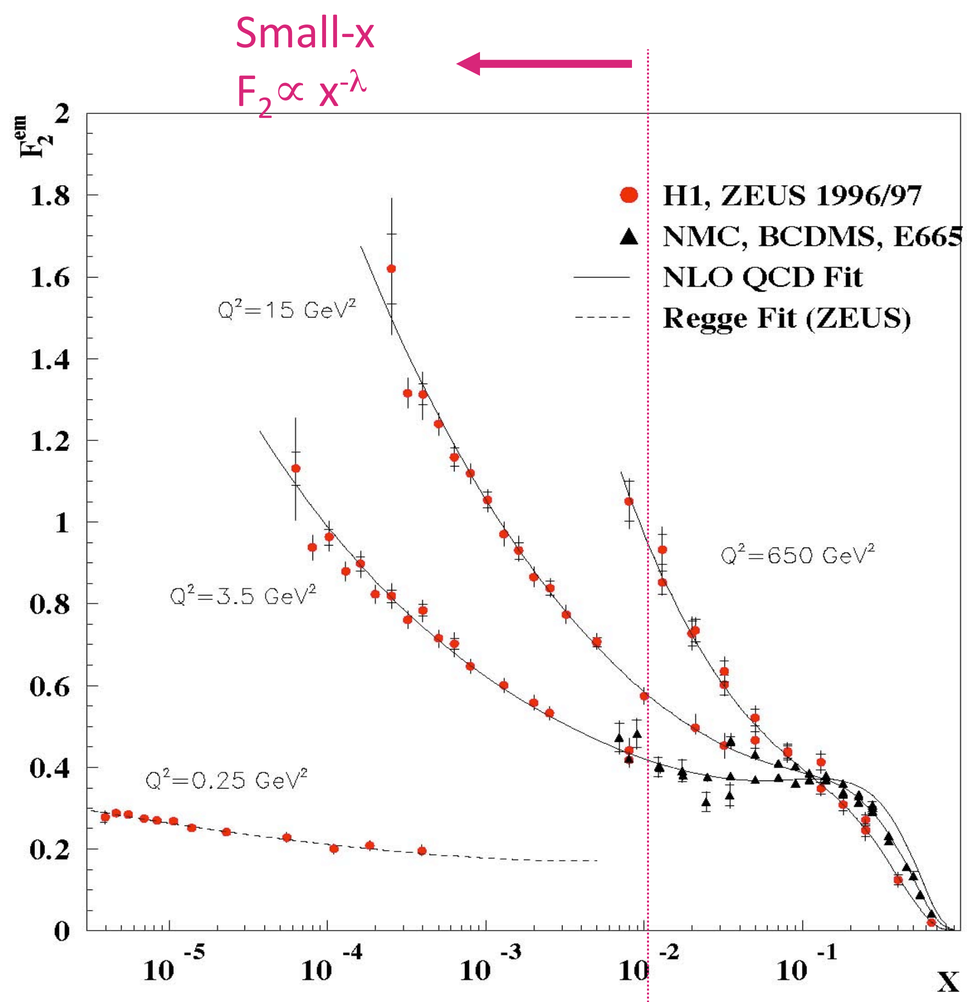
- Definition: Inclusive [1], semi-inclusive [1,3], exclusive [1,2,3]
- Luminosity requirements lowest [1] → highest [1,2,3]
- Exclusive measurements put demanding requirements on the detector design and its integration with the machine lattice

Nucleon Structure

Most of what what we know about the nucleon structure in the recent times has come from studies at HERA using H1 and ZEUS Detectors

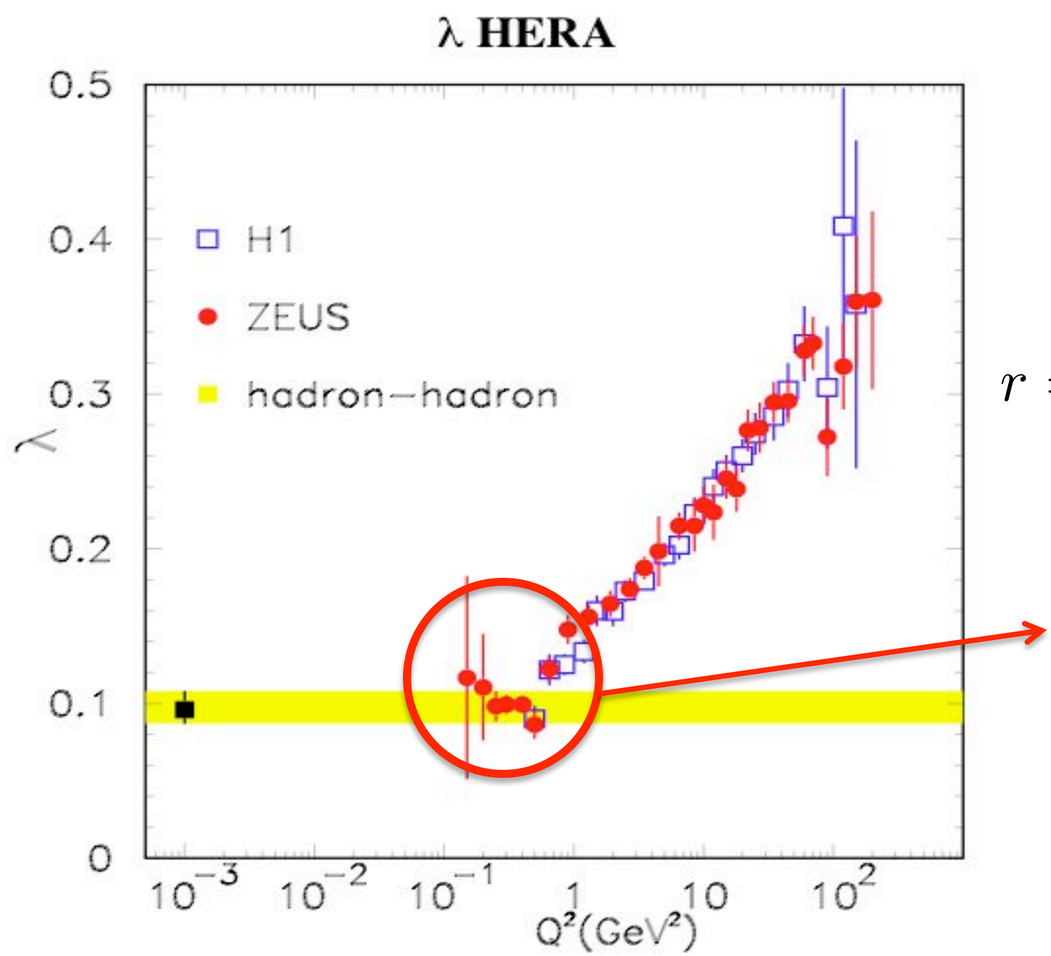
Discovery at HERA: Rise at small x

- Rise of parton densities (and of F_2) with decreasing x is strongly dependent on Q^2. Implies very large density of partons in protons when probed at high energy



The small x rise….

$$F_2 = C(Q^2)x^{-\lambda} \qquad x < 0.01$$



- Below Q^2=0.5 GeV^2 observe same x (energy) dependence as observed in hadronic interactions

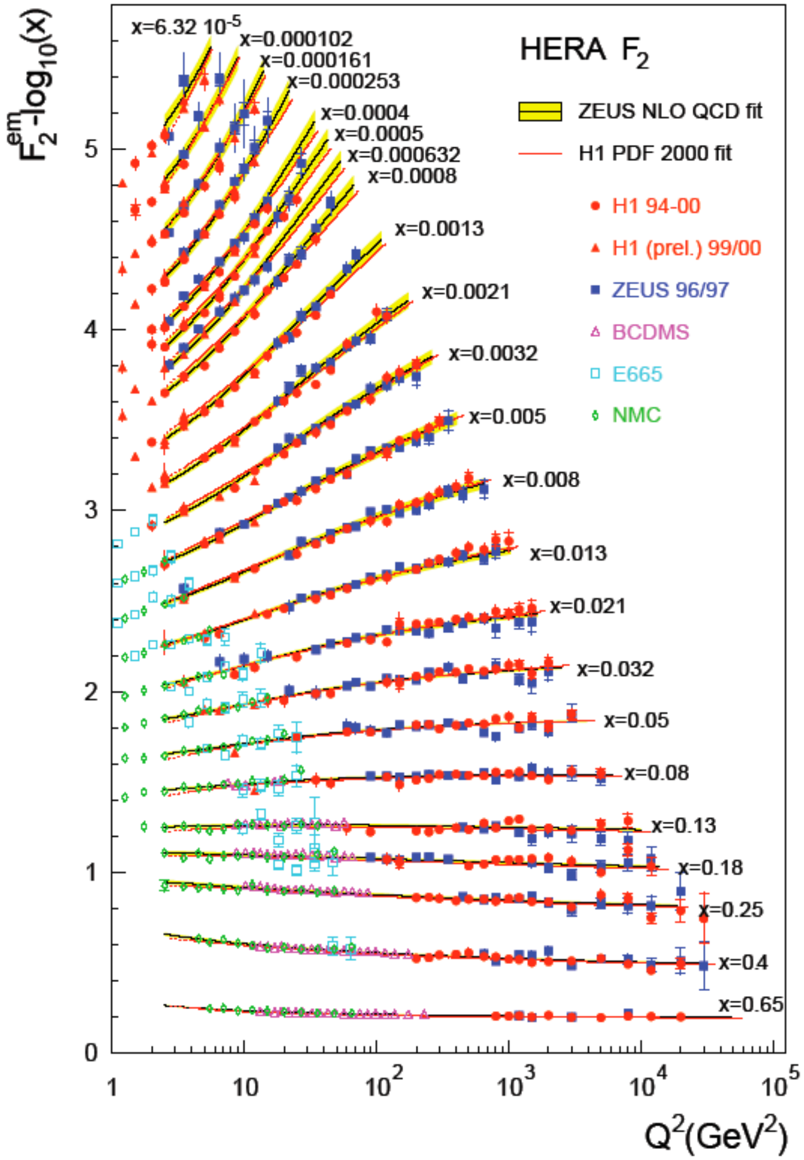
$$r = \frac{hc}{2\pi Q} \approx 2 \text{ fm} \quad \text{for Q} = 1 \text{ GeV}$$

- Small angle e scattering
- A smooth transition?
- Behavior the same for nuclei?
- Anything to do with understanding confinement?

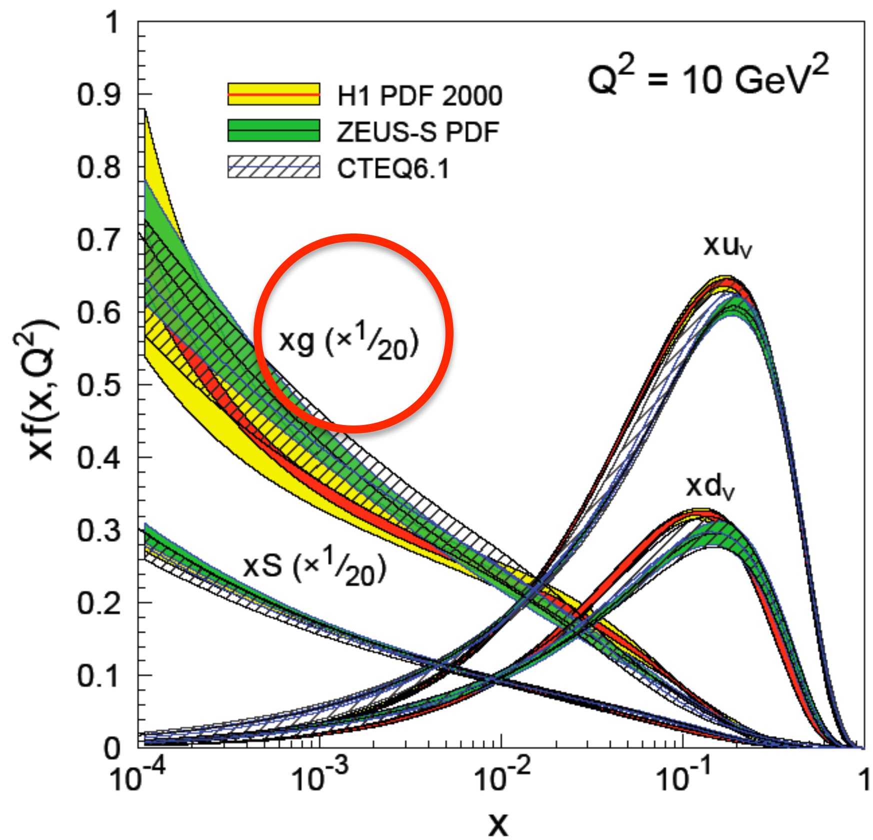
Need to study glue at the highest density.

Why?

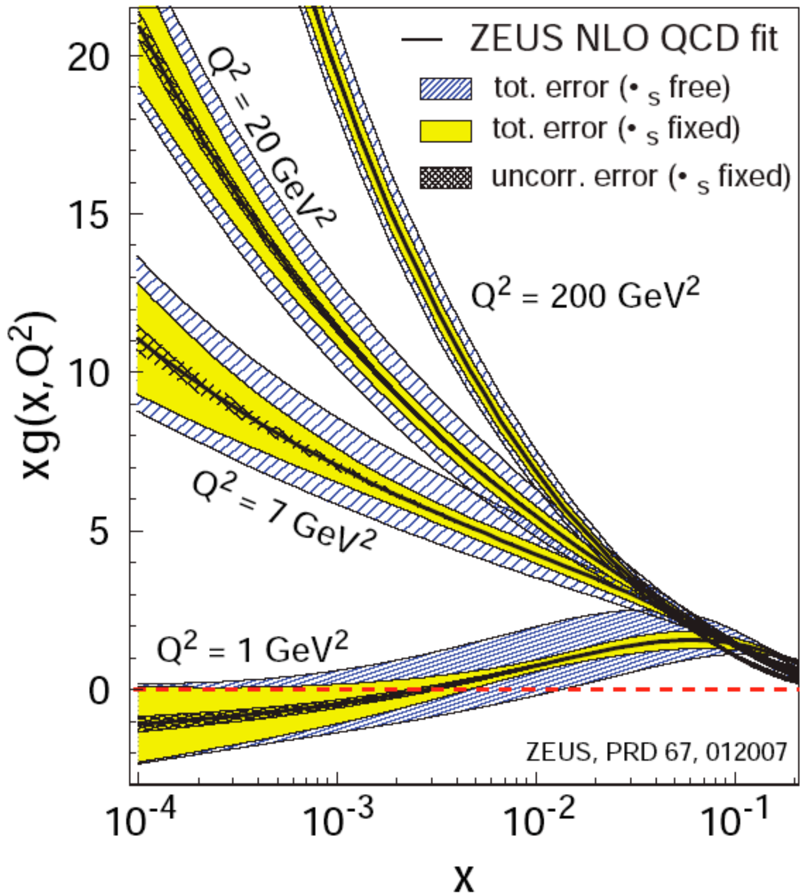
Measurements of Glue at HERA

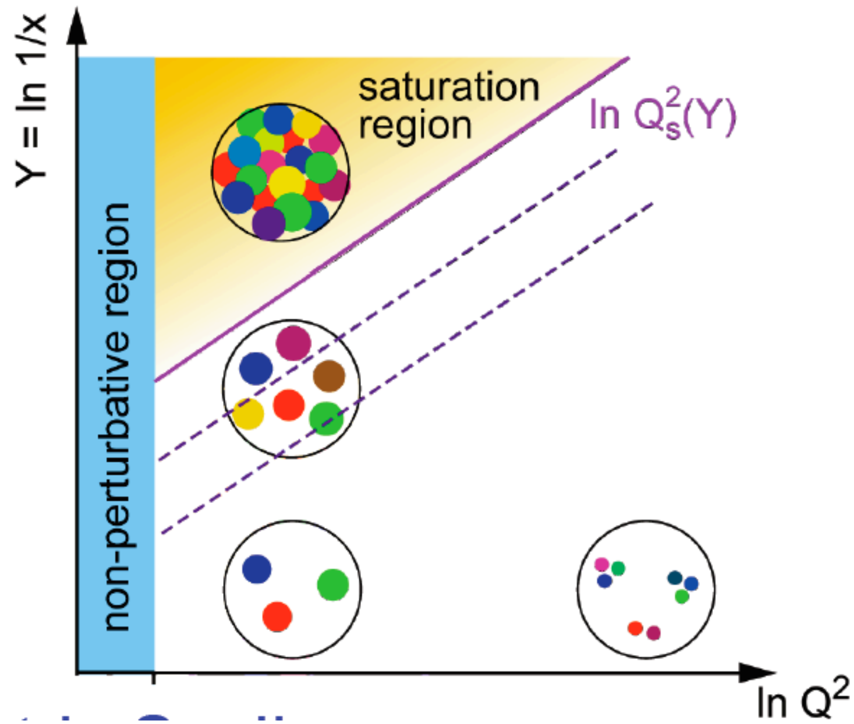


- Scaling violations of $F_2(x,Q^2)$
- NLO pQCD analyses: fits with LINEAR DGLAP equations



Gluons still not well understood!





- Rise at high Q^2, low x
  - Infinite rise, infinite cross section?
  - Is this due to use of **linear** DGLAP?
  - Direct consequence to high energy hadron cross sections
- Negative g(x) at low Q^2?

- What is the effect of including **non-linear** effects in DGLAP equation?
  - BK, JIMWLK
- A possible scenario: Color Glass Condensate
- Charactristic scale $Q_s(x,A)$
- Experiment with high densities of gluons → Nuclei!

How well do we understand the nucleon spin?

If you think you understand hadronic reactions, try to explain them with spin

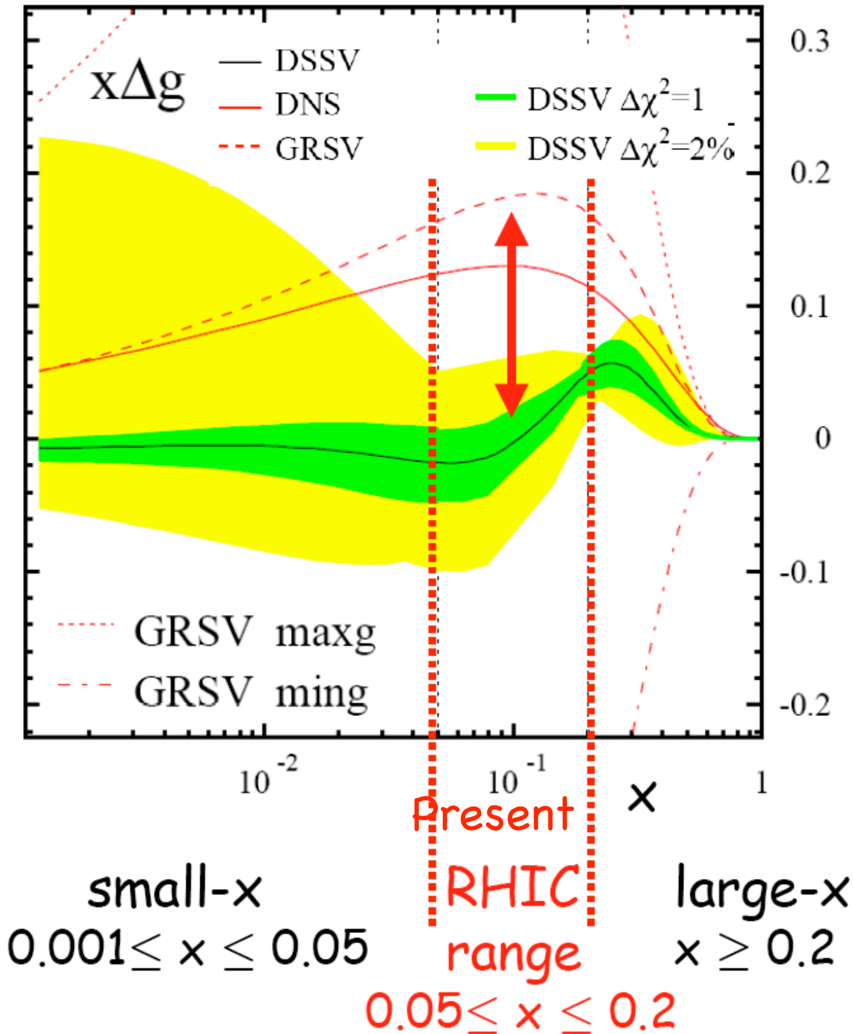
Experiments with spin have managed to kill more theories and models than any other single variable used in experiments

Nucleon Spin ~~Crisis~~ Puzzle

$$\frac{1}{2} = \frac{1}{2}\Delta\Sigma + L_Q + \Delta G + L_G$$

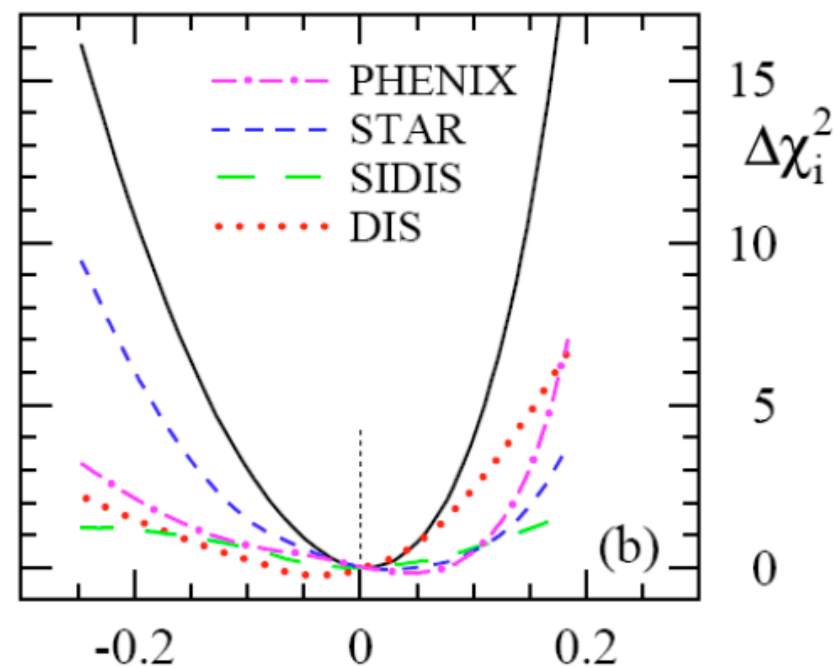
- We know how to measure $\Delta\Sigma$ and ΔG precisely using pQCD in a <u>model independent</u> way
  - ½ ($\Delta\Sigma$) ~ 0.12 : From fixed target pol. DIS experiments
  - RHIC-Spin: ΔG *not large* as anticipated in the 1990s, but *measurements incomplete, precision at low x?*
- Measurement of orbital angular momenta: L_Q (L_G?)
  - Through **GPDs:** 3D tomographic images of the proton
  - Significant model dependence … in getting OAMs
  - A lot to learn from the 6 GeV and the 12 GeV Jlab program & an ongoing theoretical development

$\Delta G(x)$ @ Q^2=10 GeV^2



De Florian, Sassot, Stratmann & Vogelsang

- **Global analysis: DIS, SIDIS, RHIC-Spin**
- **Uncertainly on ΔG large at low x**

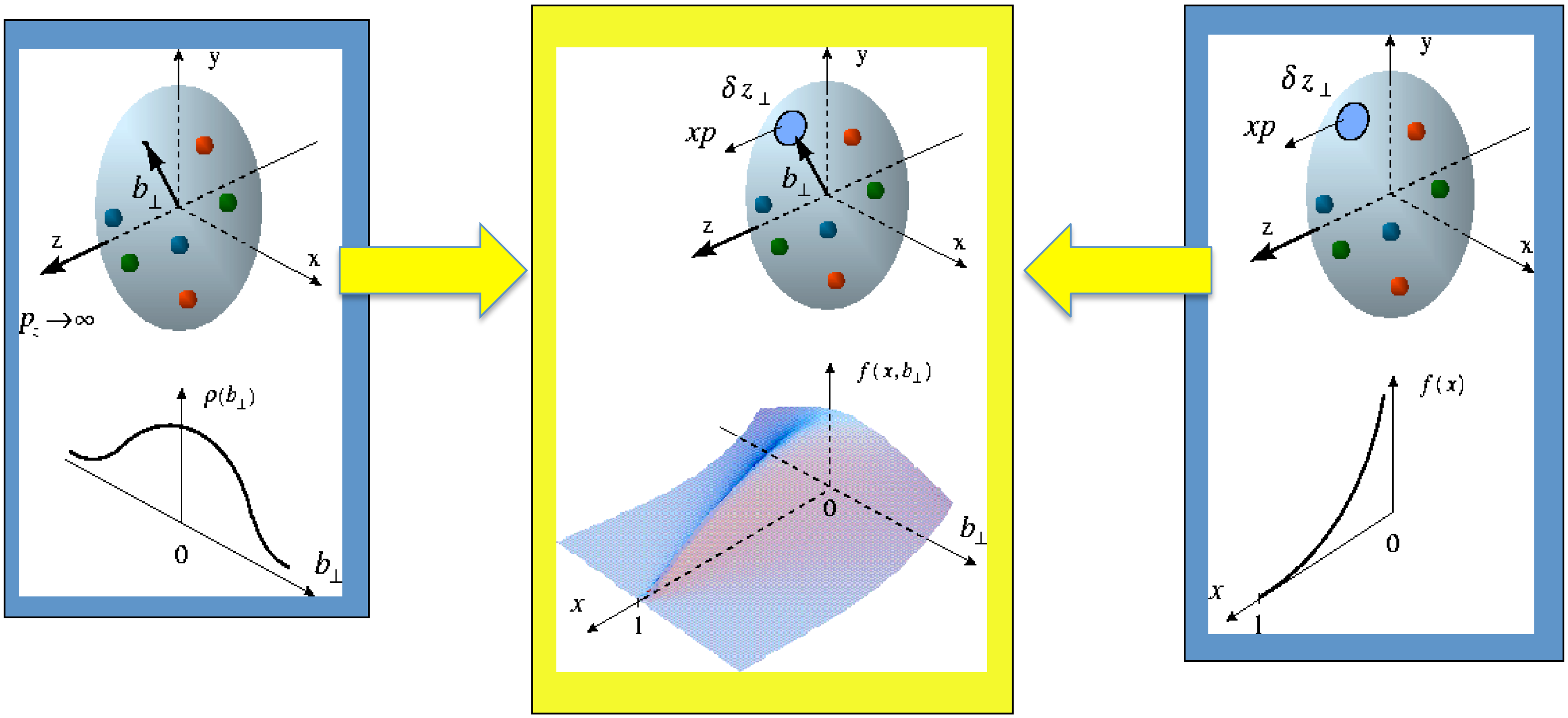


$$\delta g \equiv \int_{0.05}^{0.2} \Delta g(x, 10\,\mathrm{GeV}^2)dx$$

Beyond form factors and quark distributions

Generalized Parton Distributions

X. Ji, D. Mueller, A. Radyushkin (1994-1997)



Proton form factors, transverse charge & current densities

Correlated quark momentum and helicity distributions in transverse space - GPDs

Structure functions, quark longitudinal momentum & helicity distributions

The Proposal

A high energy, high luminosity (polarized) ep and eA collider and a suitably designed detector will address these and such fundamental questions in QCD

The EIC proposals

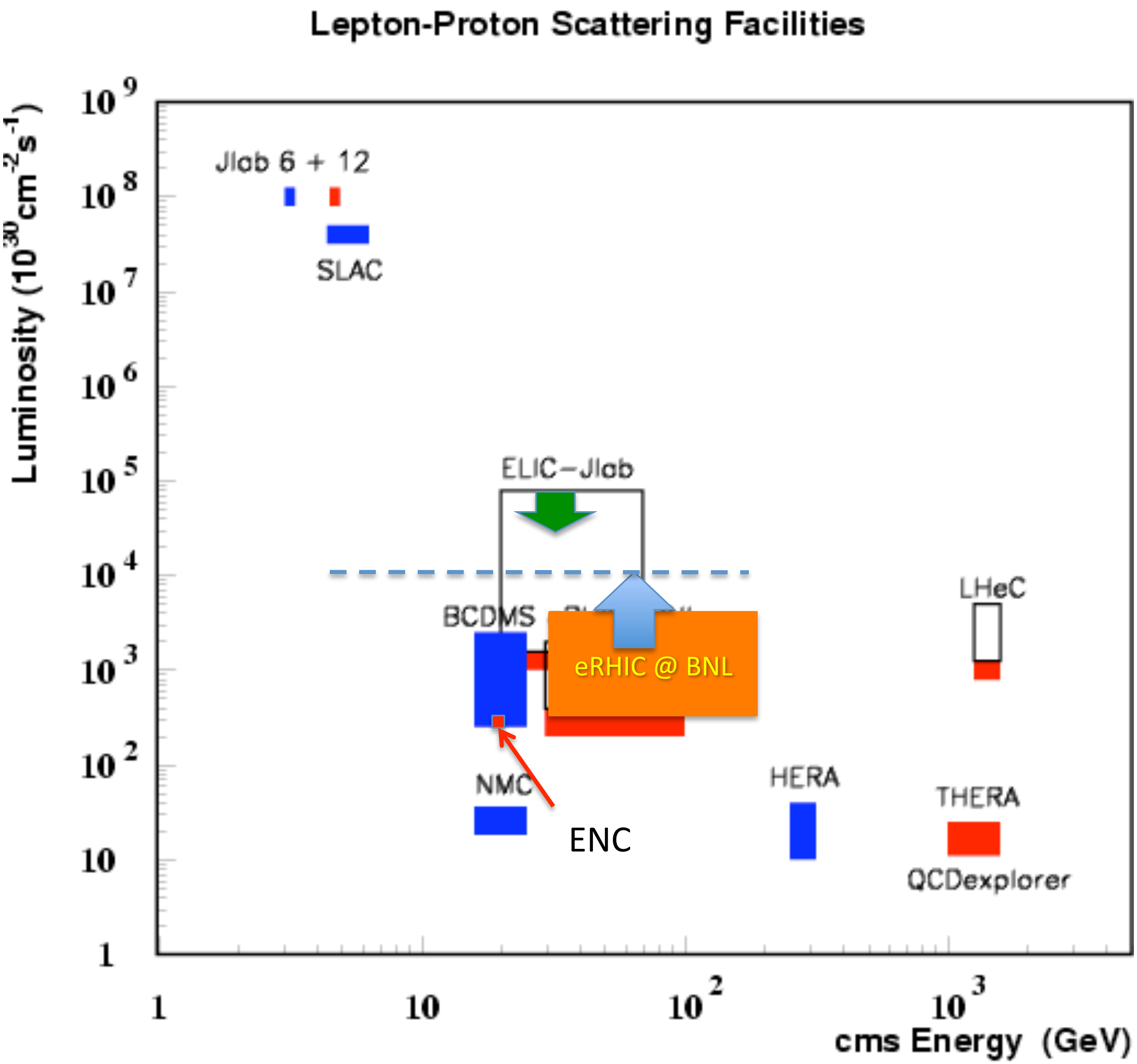
(All based around existing facilities)

- European Nucleon Collider ENC@GSI (~1 yr old)
  - CM Energy 14 GeV, Luminosity: few x 10^{32} $cm^{-2}s^{-1}$
- Large Hadron electron Collider LHeC (~ 2 yr old)
  - CM Energy 1.4 TeV, Luminosity: 10^{33} $cm^{-2}s^{-1}$

Europe

- ELectron Ion Collier ELIC @Jlab (~5 yr old)
- *e*RHIC @ BNL (~10+ yr old)
- CM Energy (both): About 30-100 GeV
- Luminosity: few x 10^{32-34} $cm^{-2}s^{-1}$
  - Staged realization : low to high luminosity

US


Lepton-Proton Scattering Facilities
Luminosity (10^30 cm^-2 s^-1)
cms Energy (GeV)
Jlab 6 + 12
SLAC
ELIC−Jlab
BCDMS
eRHIC @ BNL
LHeC
NMC
ENC
HERA
THERA
QCDexplorer
1
10
10^2
10^3
10^4
10^5
10^6
10^7
10^8
10^9

The European proposals

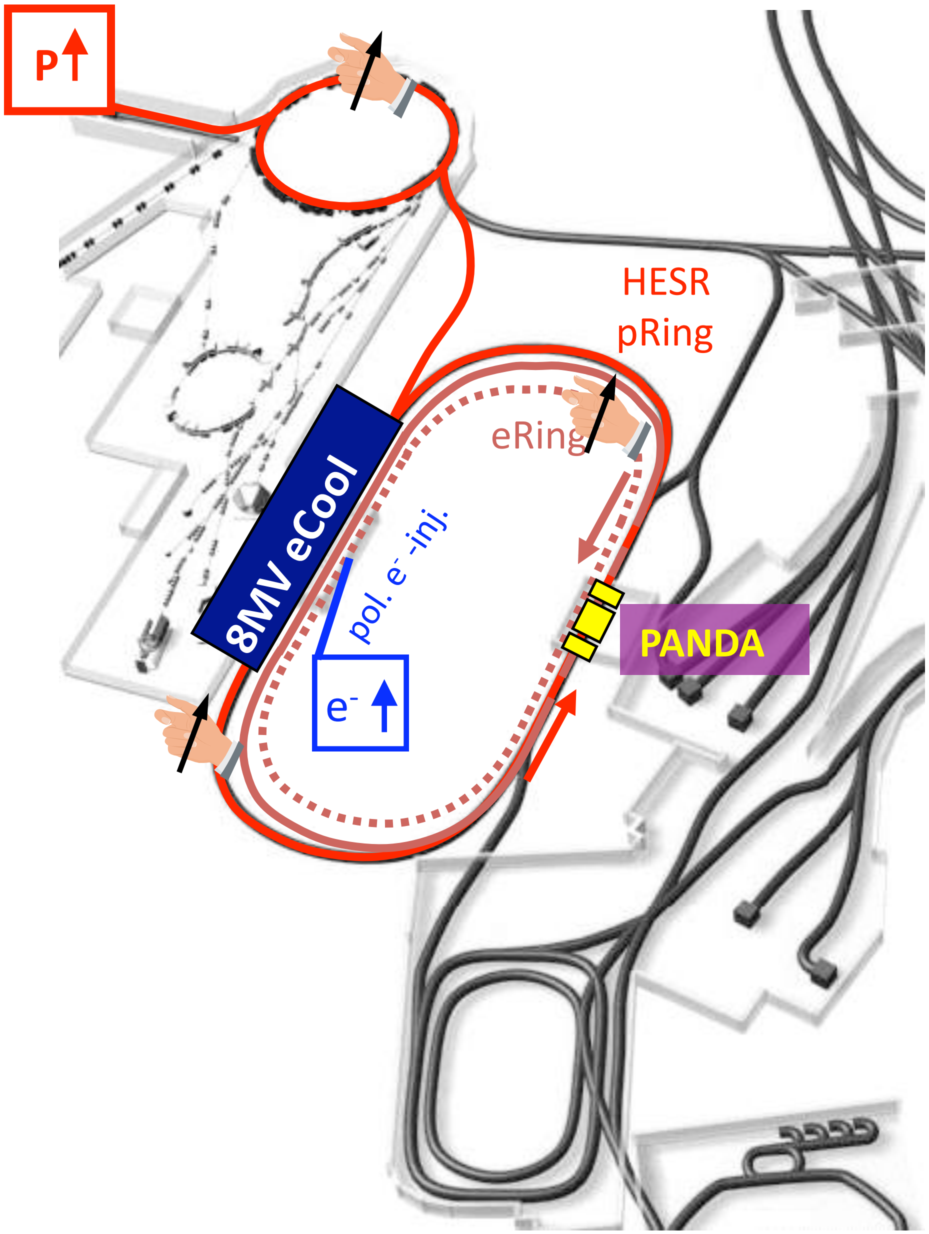
ENC @ GSI/FAIR

LHeC at CERN

ENC @ GSI & its Physics

- Center of mass ~14 GeV
  - 3.3 GeV electrons and 15 GeV protons
  - Polarization in both beams
  - Deuteron polarization possible
  - Center of mass intended to be between HERMES at DESY and COMPASS at CERN
- Intended focus on *mid-high-x in a collider geometry*
  - *Transverse* Momentum Distributions (TMDs)
  - Generalized Parton Distributions (GPDs)
    - Deeply virtual compton scattering (DVCS)
    - Deeply virtua Vector Meson production measurements
- **Low x IMPORTANT but impractical (cost/facility)**

ENC@FAIR (ii)



Proposal 08/2008

•L > 10^{32} 1/cm^{2}s

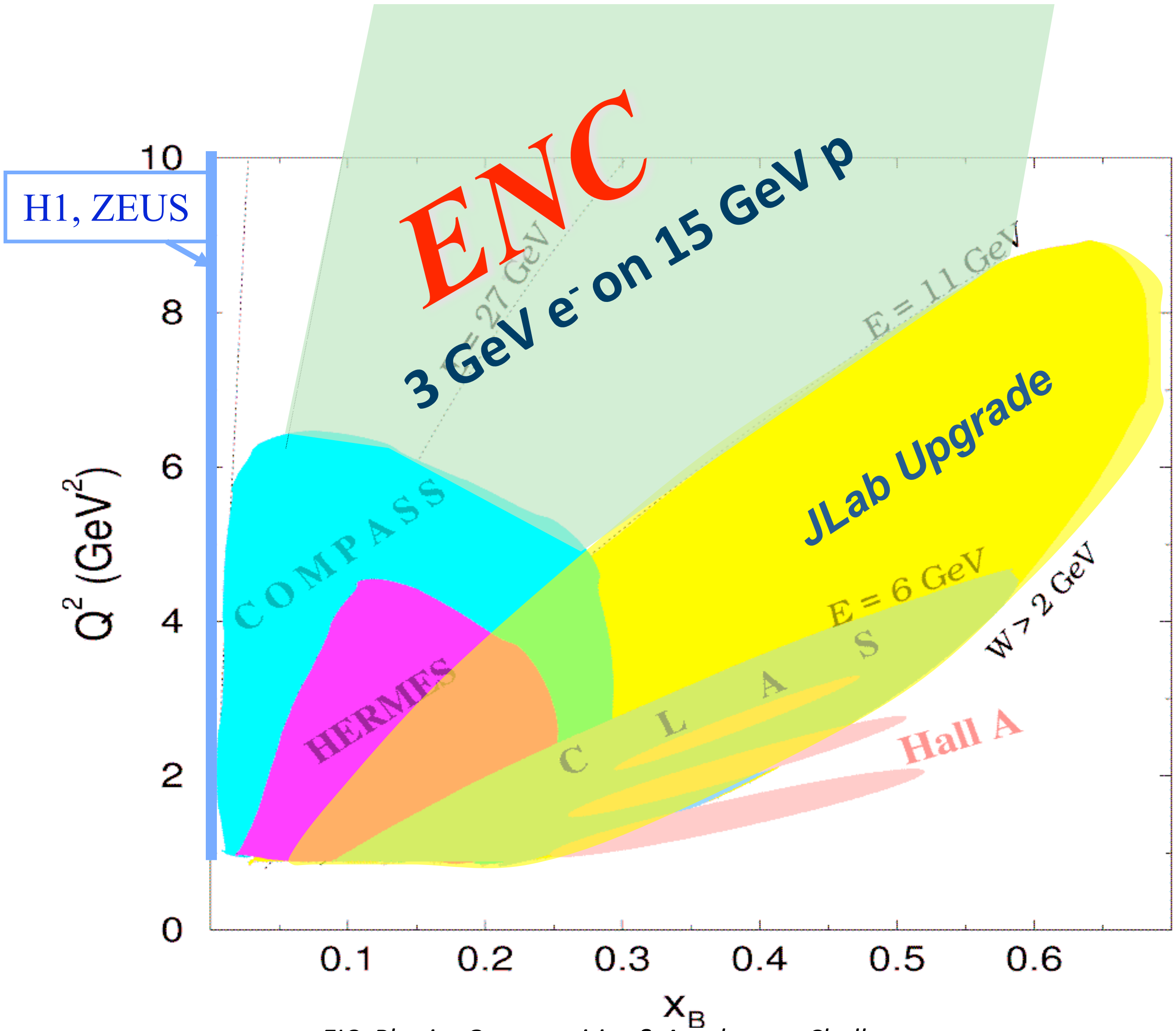
•$s^{1/2}$ > 10GeV
(3.3GeV e^- ↔ 15GeV p)

•**polarised** e^- (> 80%)
polarised p / d (> 80%)
(transversal + longitudinal)

•Use the PANDA detector

•Common effort of
German Universities
(Bonn, Mainz, Dortmund)
plus collaboration with
Research Centres
FZJ, DESY, GSI, ...
+
US EIC Collaboration....

ENC w.r.t. existing/approved fixed target facilities

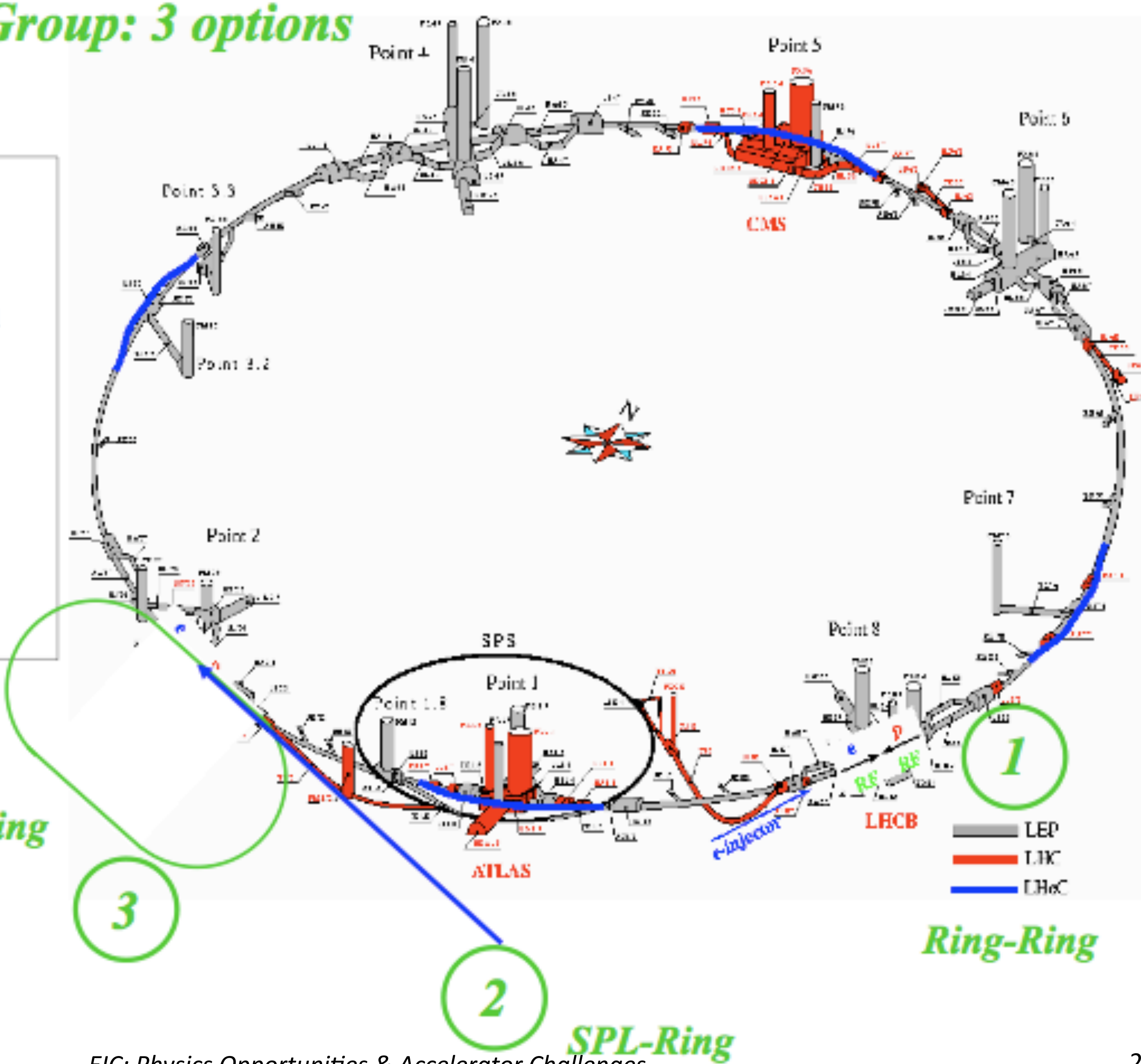


All transparencies from B.Holzer, CERN DIS2009 Madrid

LHeC Study Group: 3 options

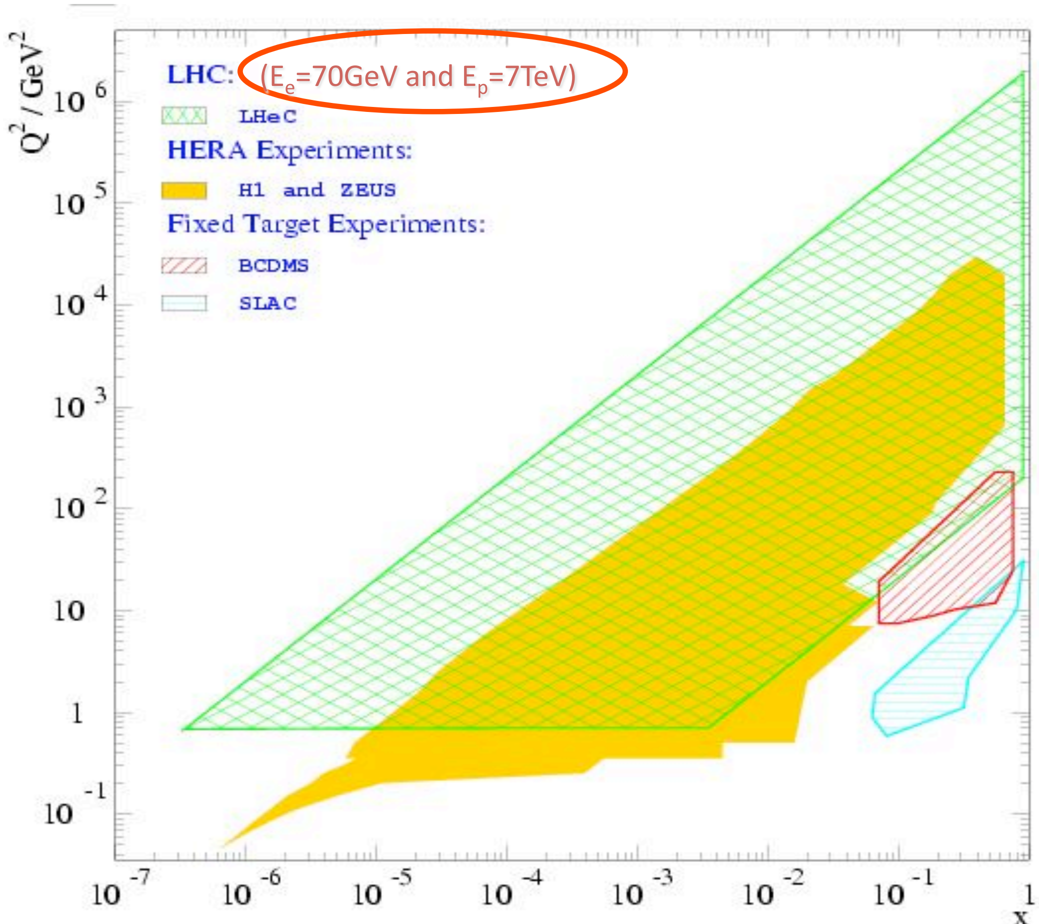
Accelerator Design [RR and LR]
Oliver Bruening (CERN),
John Dainton (CI/Liverpool)
Interaction Region and Fwd/Bwd
Bernhard Holzer (CERN),
Uwe Schneeekloth (DESY),
Pierre van Mechelen (Antwerpen)
Detector Design
Peter Kostka (DESY),
Rainer Wallny (UCLA),
Alessandro Polini (Bologna)

... and many colleagues



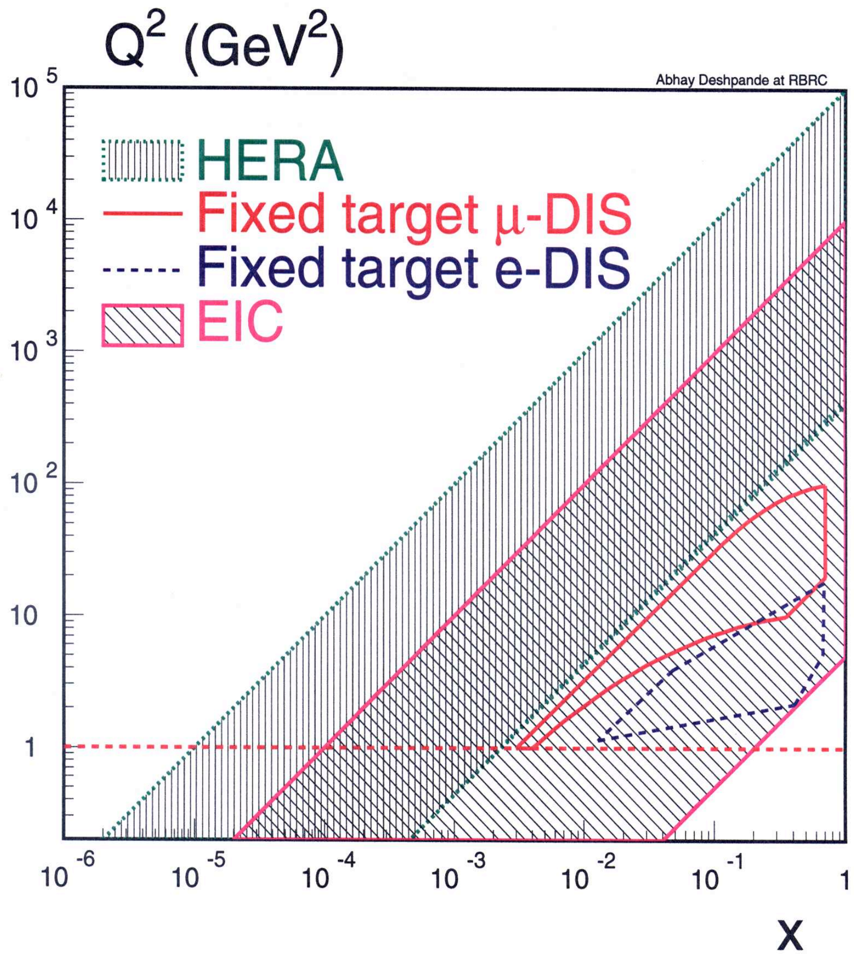
LHeC with protons

- 70-140 GeV e beam collides with 7 TeV proton beam
- Max CM: ~1.4 TeV
- Physics Scope:
  - QCD at low x, high gluon density in both protons and in nuclei
  - Possible physics beyond SM: high x, Q^2
  - http://www.lhec.org.uk
- No plans for polarization in protons/hadron beams



The US EIC proposals

EIC in the US: Basic Parameters

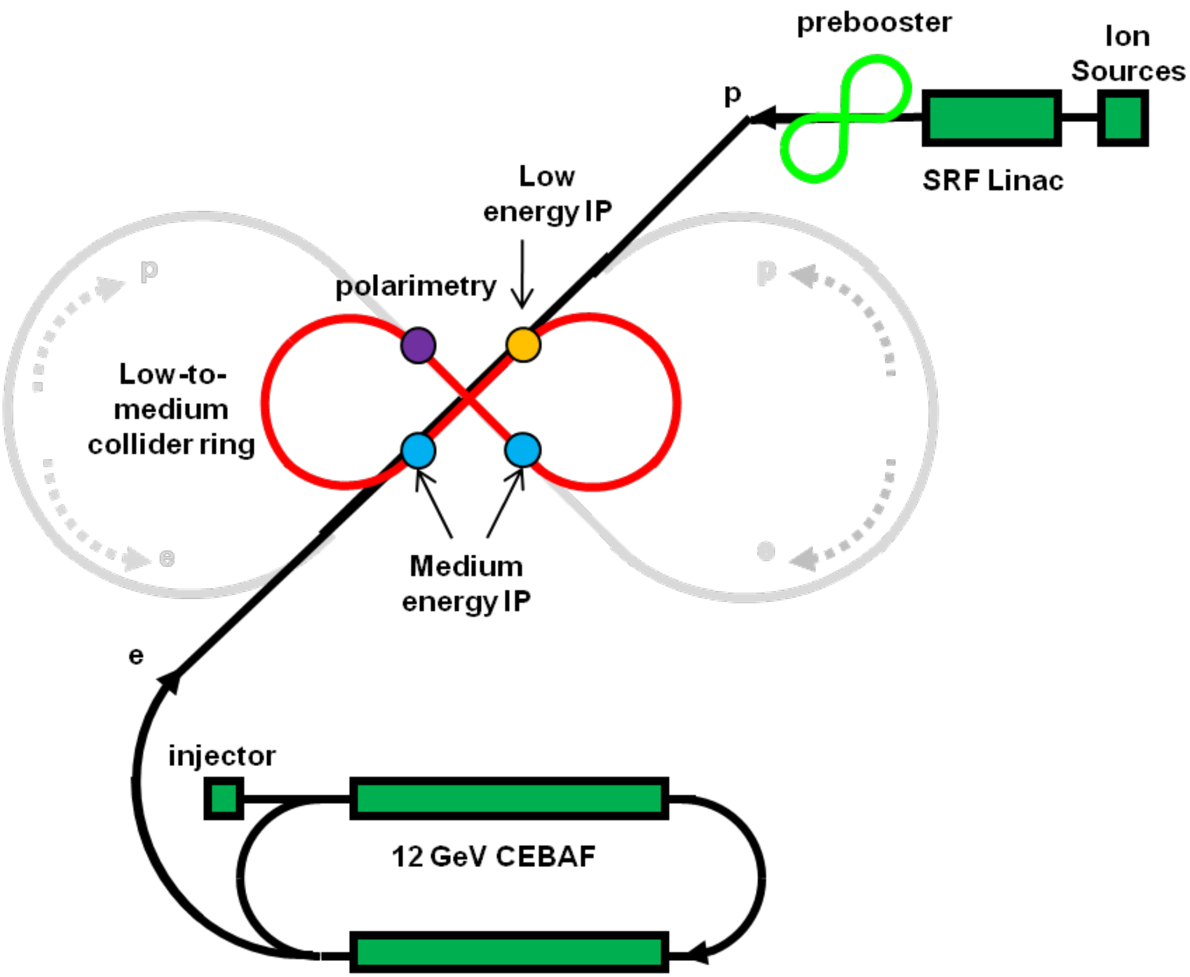


- E_e=10 GeV (5-20 GeV variable)
- E_p=250 GeV (50-250 GeV Variable)
- Sqrt(S_{ep}) = 30-100 GeV
- X_{min} = 10^{-4} ; Q^2_{max}= 10^4 GeV
- Beam polarization ~ 70% for e,p
- Luminosity L_{ep} = 10^{33-34} $cm^{-2}s^{-1}$
- Aimed Integrated luminosity:
  - 50 fb^{-1} in 10 yrs (100 x HERA)
  - Possible with 10^{33} $cm^{-2}s^{-1}$

Nuclei:

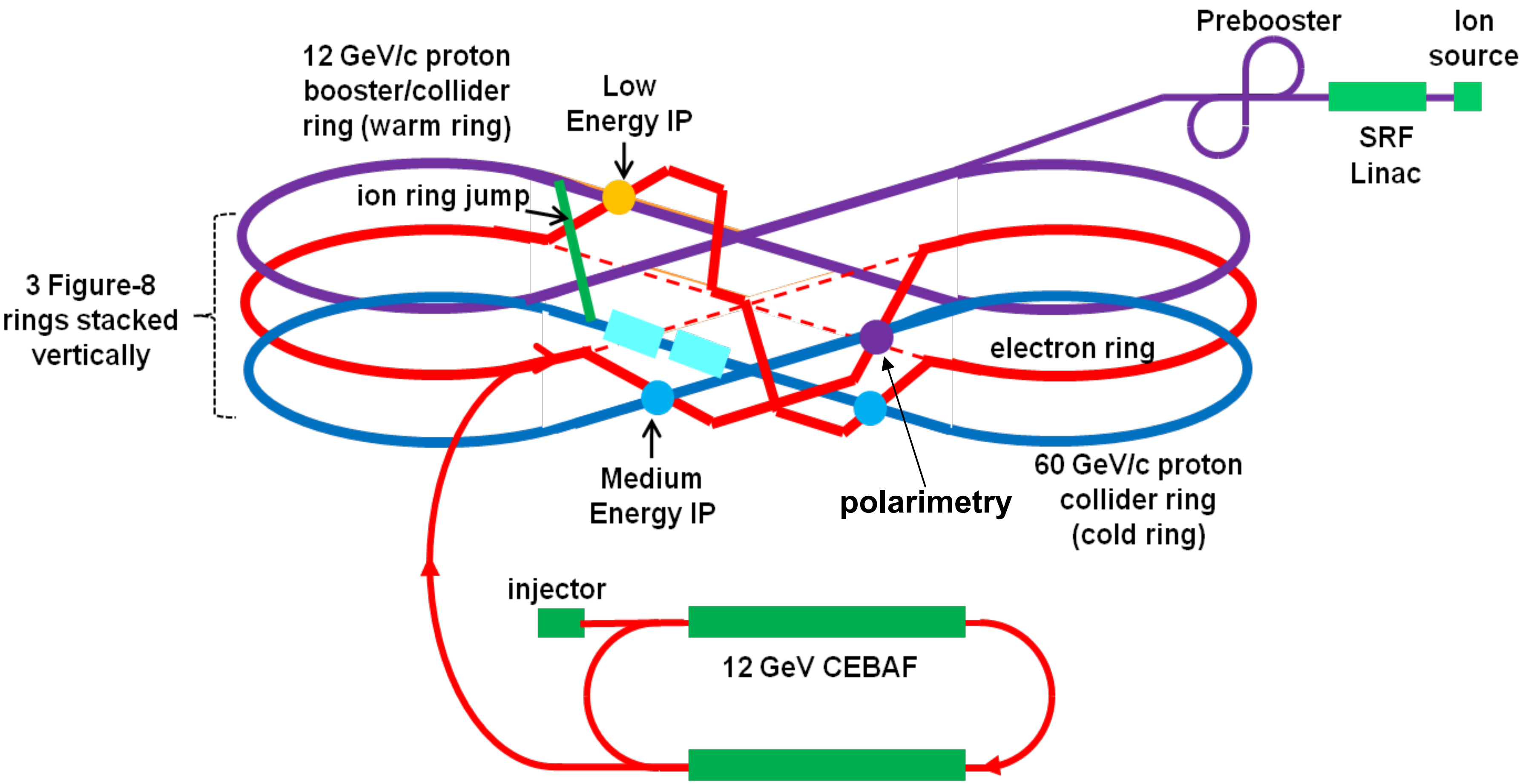
- **p->U; E_A=20-100 GeV**
- **Sqrt(S_{eA}) = 12-63 GeV**
- **L_{eA}/N = 10^{33} $cm^{-2}s^{-1}$**

Low & Medium Energy ELIC



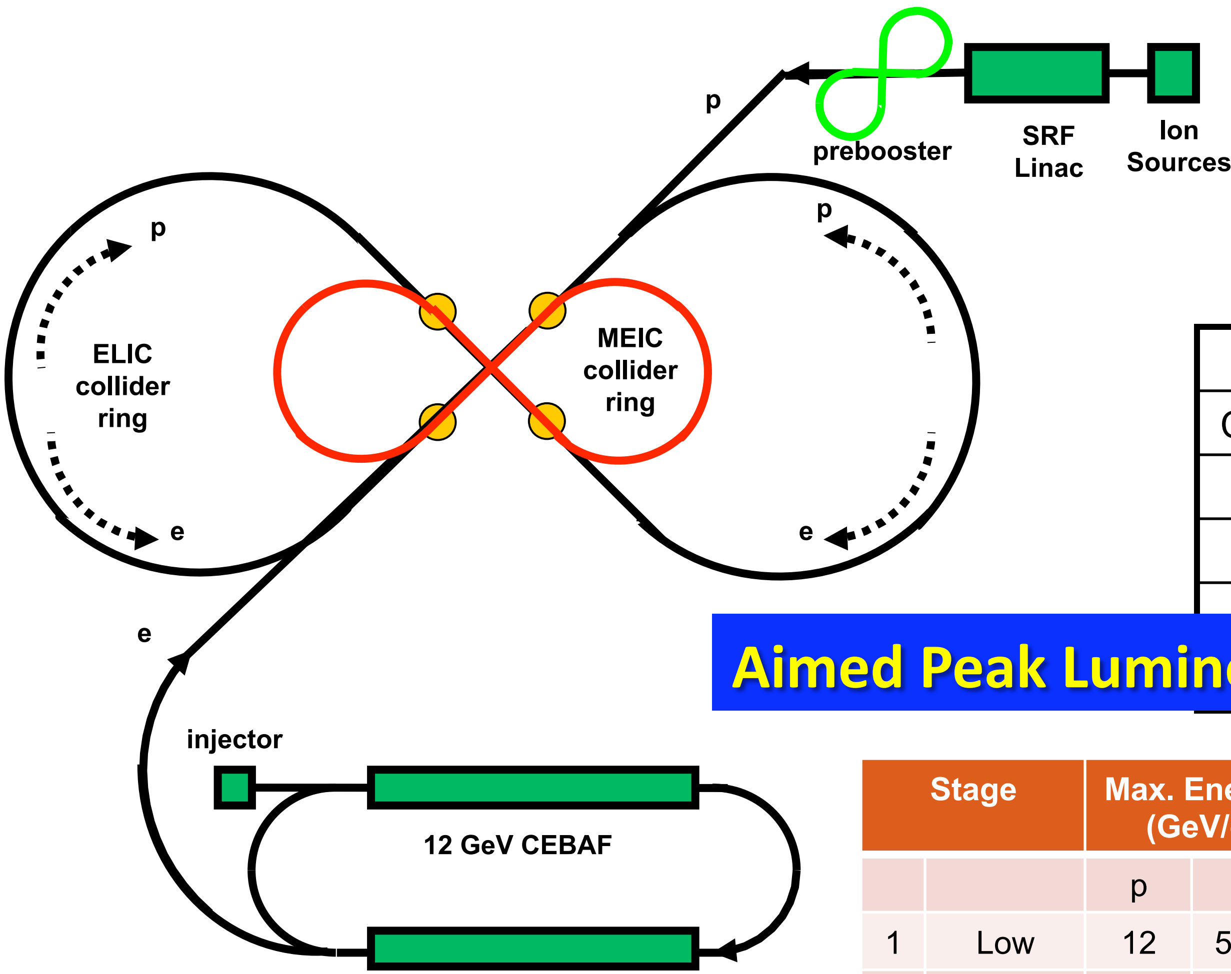
- Staged realization
- Stage 1 & 2
  - CM 12-50 GeV
  - *Realization 2020+*
- Final ELIC
  - CM 100 GeV
  - ***Realization 2020++ if still relevant***

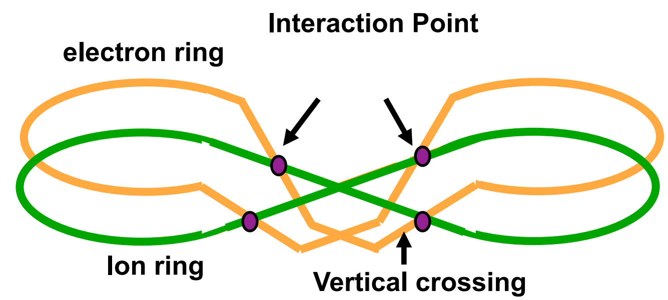
ELIC @ Jlab Low/Medium Energy



Aim Peak Luminosity: 1-10 x 10^{33} cm^{-2} s^{-1}

ELIC at High Energy & Staging



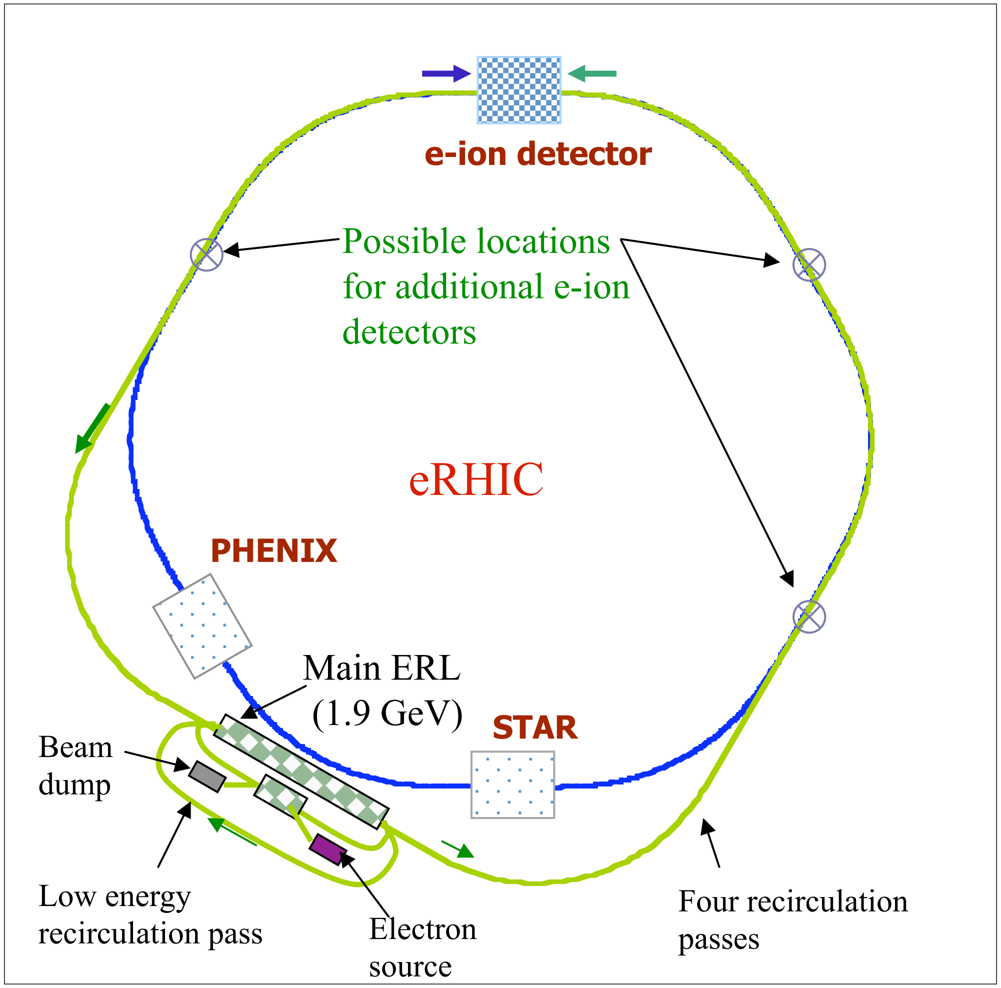


		Small	Large
Circumference	m	1800	2500
Radius	m	140	180
Width	m	280	360
Length	m	695	920

Aimed Peak Luminosity: 4-6 x 10^{34} cm^{-2} s^{-1}

Stage		Max. Energy (GeV/c)		Ring Size (M)		Ring Type		IP #
		p	e	p	e	p	e	
1	Low	12	5 (11)	630	630	Warm	Warm	1
	Medium	60	5 (11)	630	630	Cold	Warm	2
2	Medium	60	10	600	1800	Cold	Warm	4
3	High	250	10	1800	1800	Cold	Warm	4

ERL-based eRHIC Design (Circa 2008)



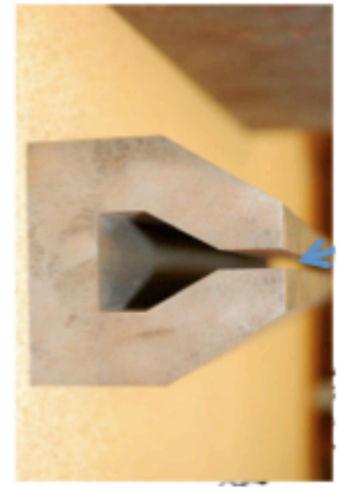
- 10 GeV electron design energy. Possible upgrade to 20 GeV by doubling main linac length.
- 5 recirculation passes (4 of them in the RHIC tunnel)
- Multiple electron-hadron interaction points (IPs) and detectors;
- Full polarization transparency at all energies for the electron beam;
- Ability to take full advantage of transverse cooling of the hadron beams;
- Possible options to include polarized positrons: compact storage ring

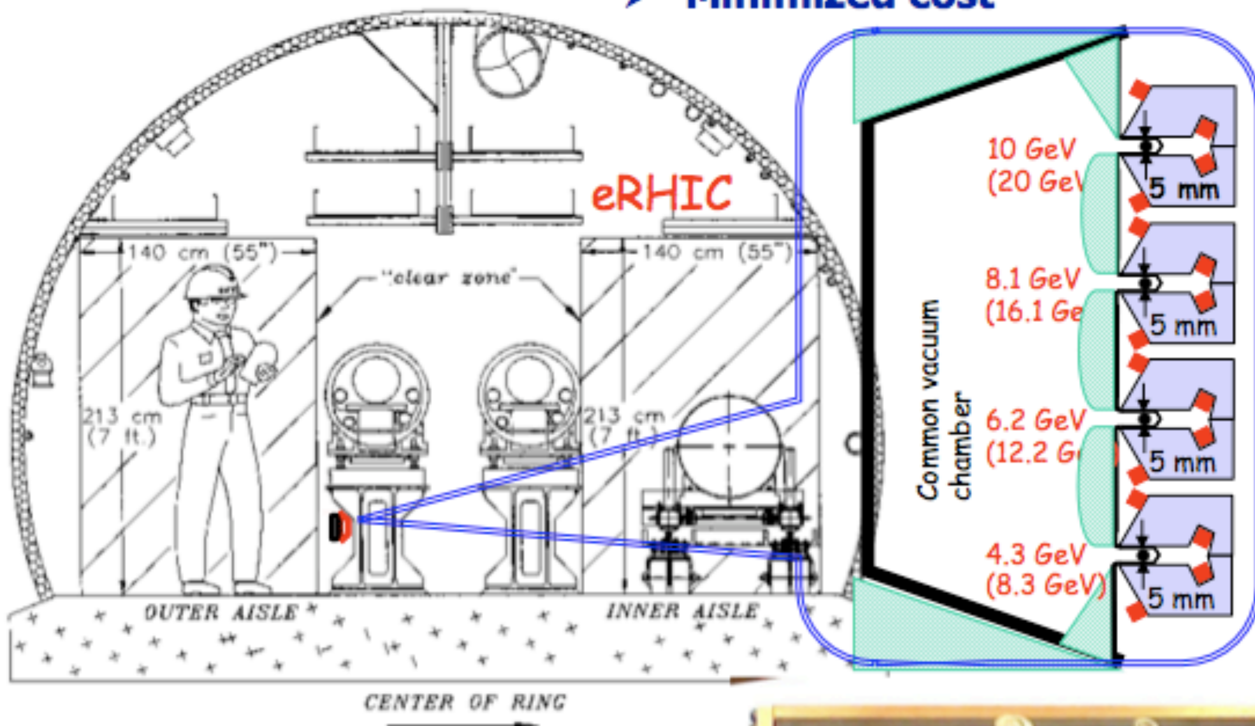
Can reach L ~ $10^{33\text{-}34}$ cm^{-2} sec^{-1}

A staged approach with significantly reduced initial cost possible

Four recirculation passes:

- **Separate recirculation loops**
- **Small aperture magnets**
- **Low current, low power consumption**
- **Minimized cost**





Prototype magnets are already built
(V. N. Litvinenko)

2009 RHIC & AGS Annual Users' Meeting June 1-5 2009 13

Staged Realization…

Early Collisions: 2015-2020

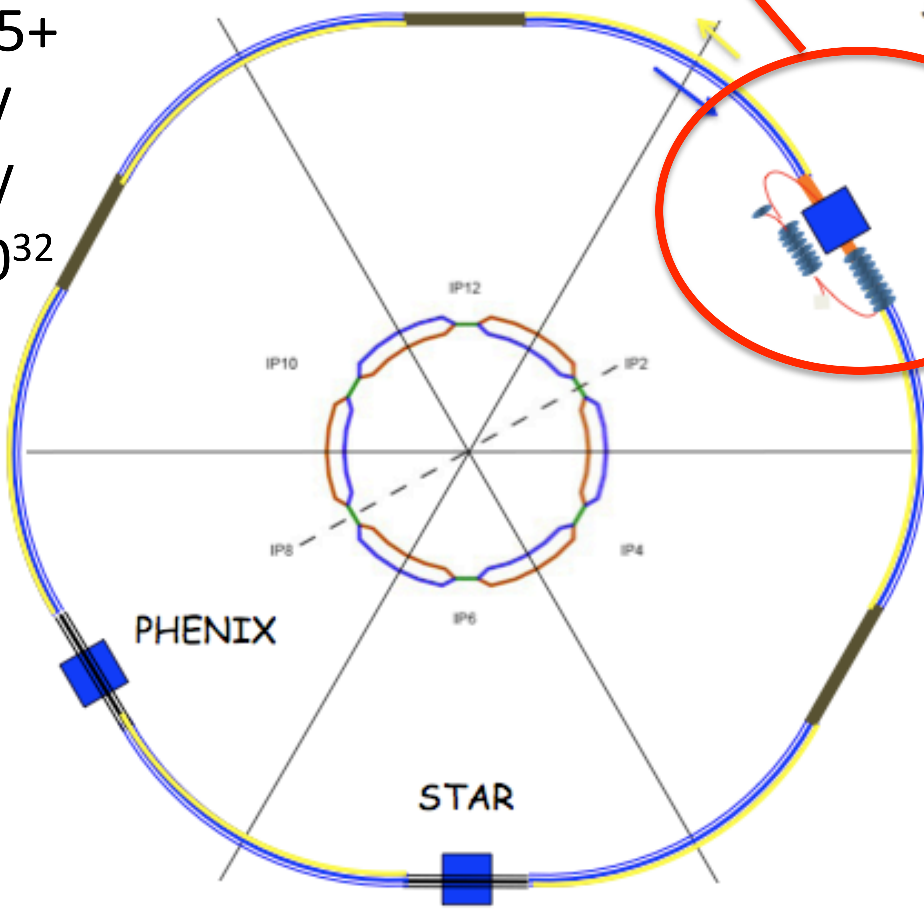
Low cost… < 250M?

All instrumentation re-used in final eRHIC

4 GeV e x 250 GeV p MeRHIC
with ERL inside RHIC tunnel

Realizable 2015+
E_p=50-250 GeV
E_A=20-100 GeV
Lumi ~ few x10^{32}

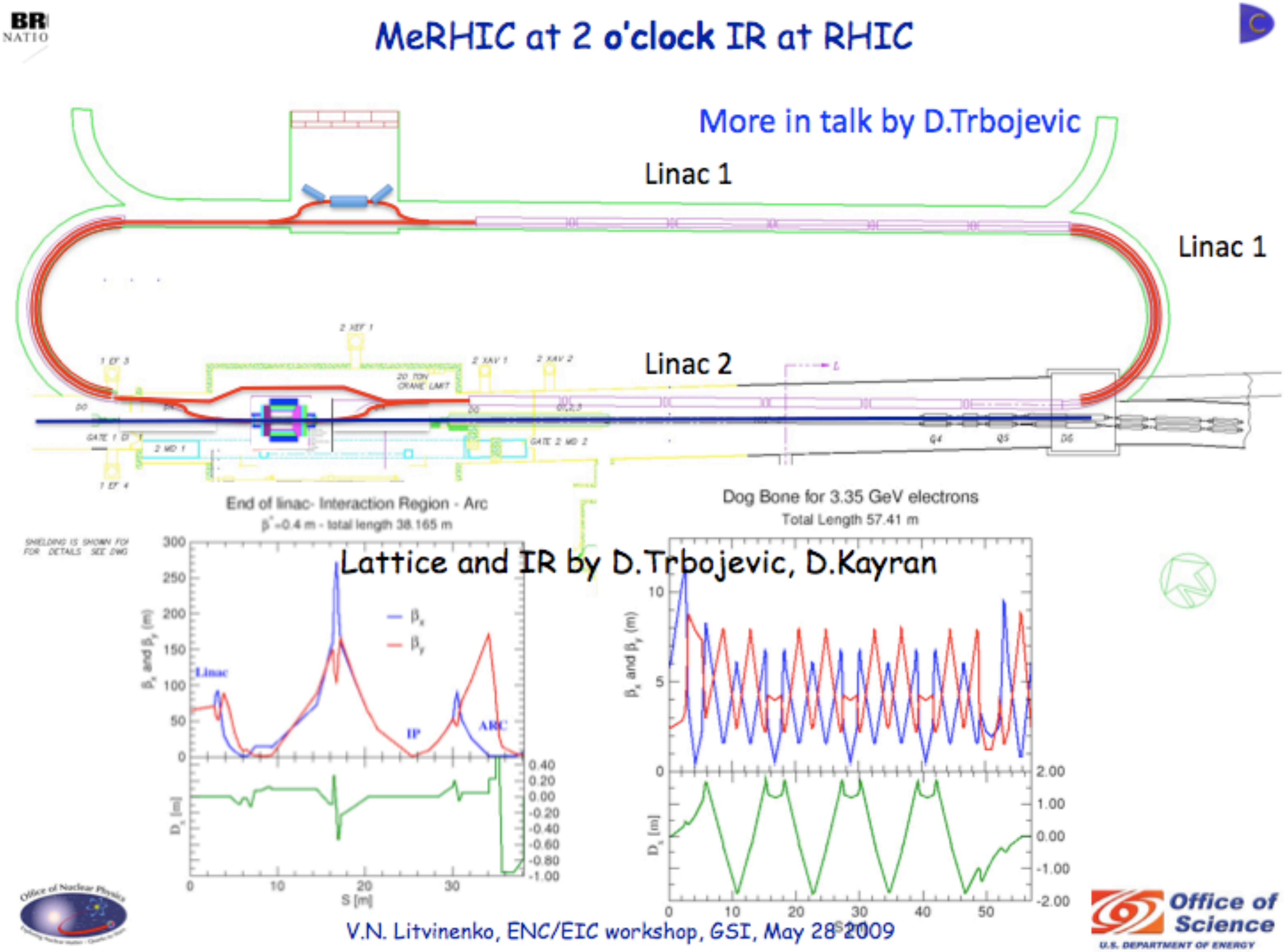
2 x 60 m SRF linac
3 passes, 1.3 GeV/pass



5 (6) vertically separated passes

19

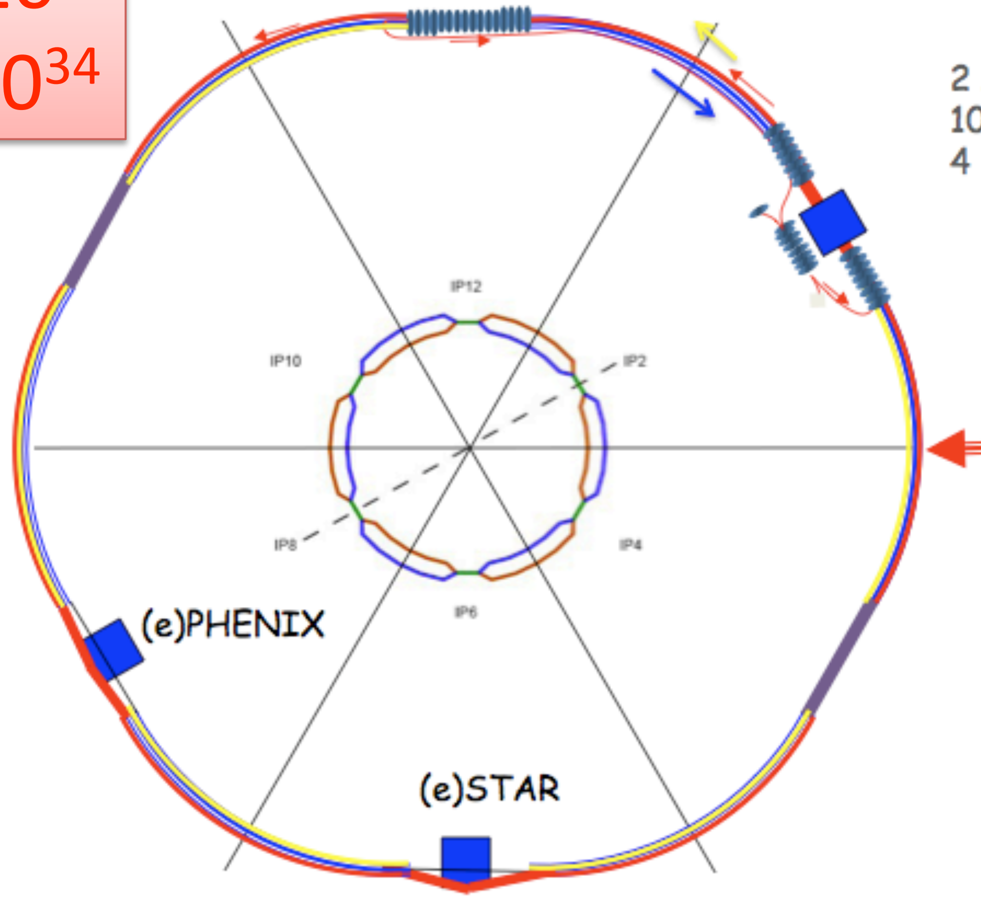
V.N. Litvinenko, DIS 2009, Madrid, April 28 2009


MeRHIC at 2 o'clock IR at RHIC
More in talk by D.Trbojevic
Linac 1
Linac 1
Linac 2
End of linac- Interaction Region - Arc
β*=0.4 m - total length 38.165 m
Dog Bone for 3.35 GeV electrons
Total Length 57.41 m
Lattice and IR by D.Trbojevic, D.Kayran
Linac
IP
ARC
S [m]
Office of Science
U.S. DEPARTMENT OF ENERGY
V.N. Litvinenko, ENC/EIC workshop, GSI, May 28 2009

20 (10 & 30) GeV e x 325 GeV p eRHIC with ERL inside RHIC tunnel

Beyond 2020

Lumi > = ~10^{34}



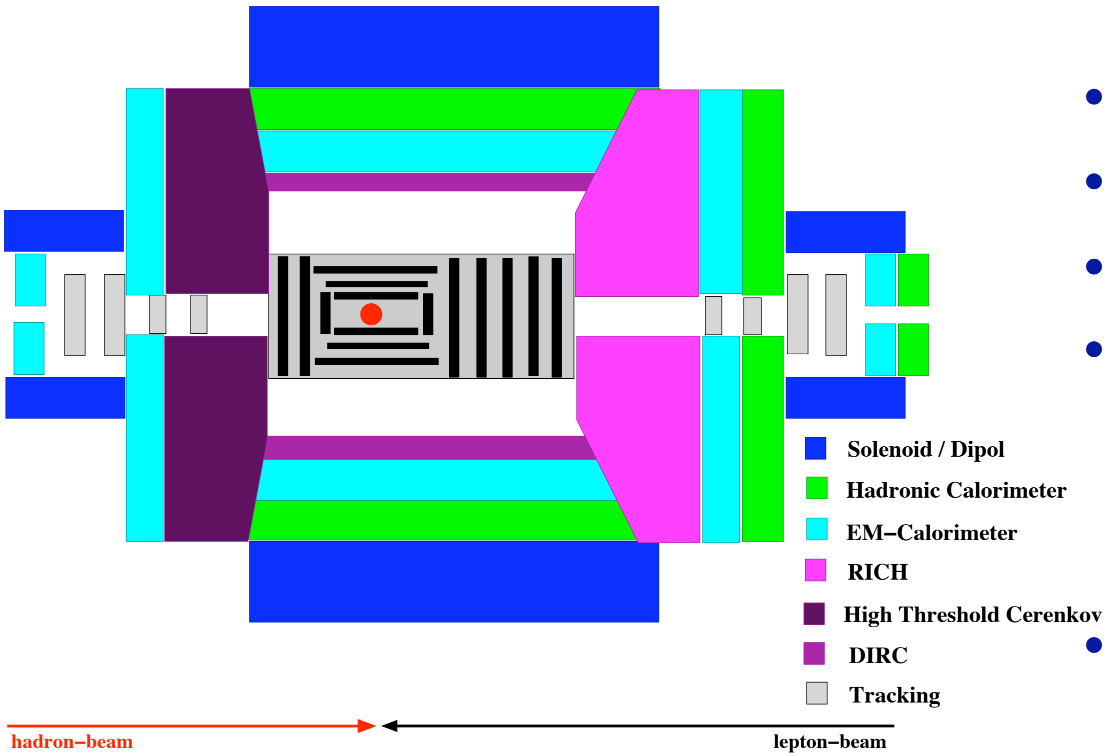
2 x 200 m SRF linac
10 (12.5) MeV/m
4 (5) GeV per pass

5 (6) vertically separated passes

20

V.N. Litvinenko, ENC/EIC workshop, GSI, May 28 2009

Detector Idea/Challenges



- Design based on experience at HERA, Belle-Babar
- Integrated with the accelerator lattice
- Polarimetry planned locally

- Calorimetry (EM & Hadronic)
- Particle ID (RICH, TRD ….)
- Tracking (central & forward)
- Magnets
  - Central Solenoid
  - Forward dipole

- Tracking, calorimetry for very forward physics (low x, and low Q^2)
  - Diffraction
- Particle ID, spectrometer using beam elements
- Radiation hard, resistence

EIC Data & its impact

Type [1]: Inclusive DIS: L_{ep} ~ 2 fb^{-1}

Type [1,3]: Semi-Inclusive DIS: L_{ep} ~ 4-10 fb^{-1}

Type [1,2,3]: Exclusive DIS: L_{ep} ~ > 10 fb^{-1}

Detector requirements & its integration with machine lattice most demanding for the Exclusive Measurements

Type [1]: Inclusive DIS

Luminosity Requirement: ~ 2 fb^{-1}

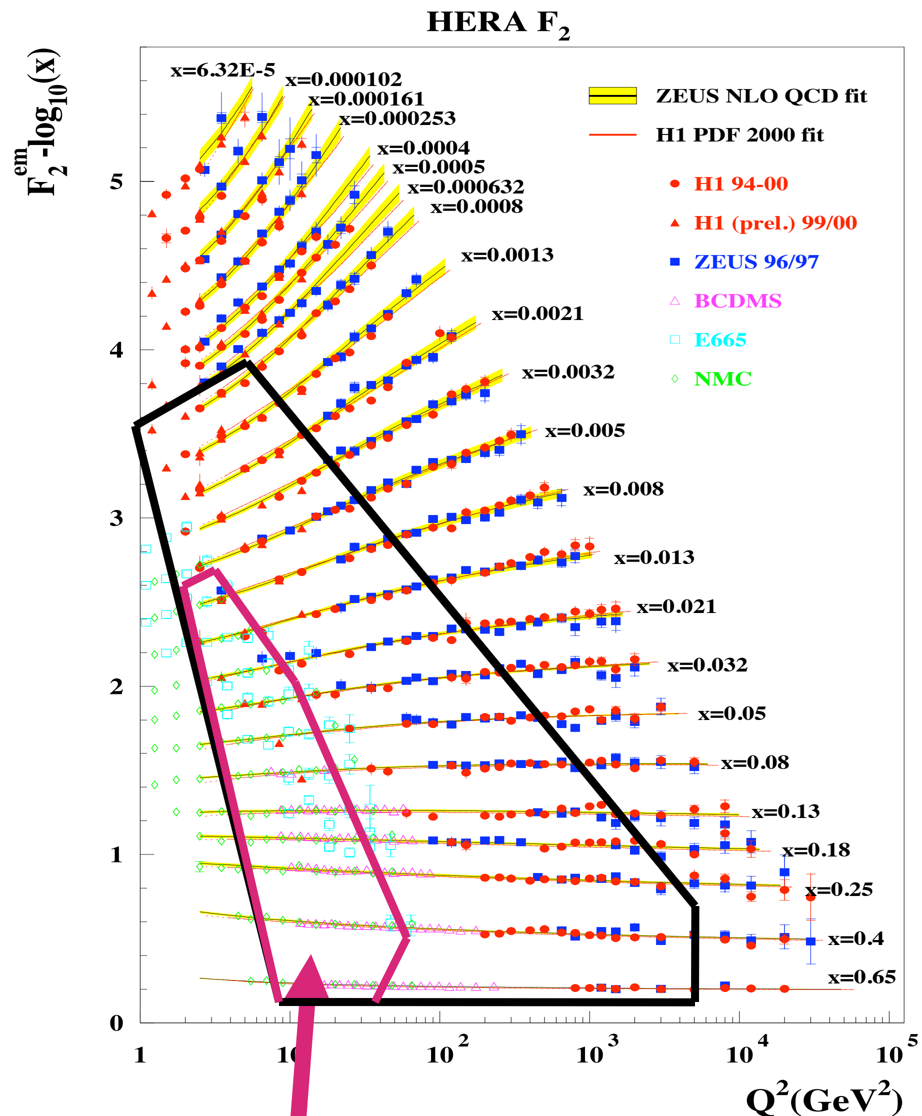
Good EM calorimetry

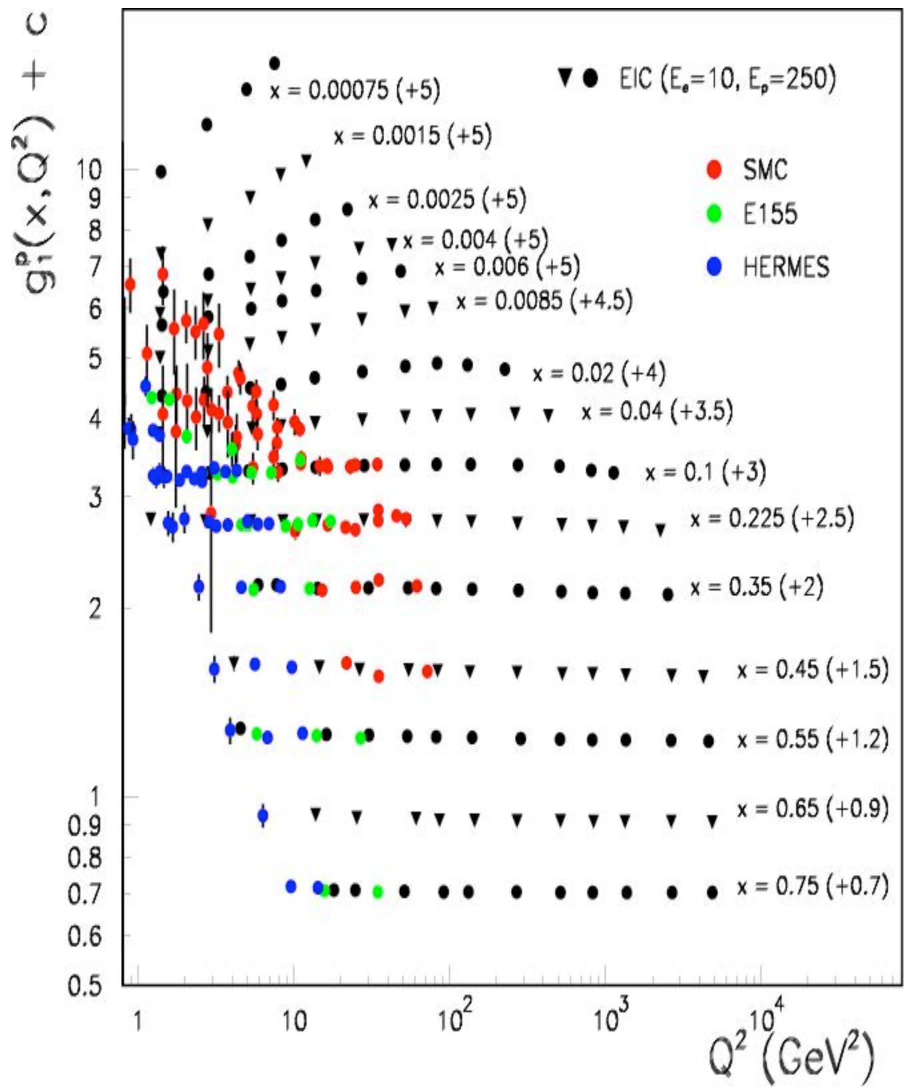
Recall: 10^{33} $cm^{-2}s^{-1}$ → 5 fb^{-1} in 10 weeks

With 70% detector & 70% machine efficiency

World Data on F_2^p

World Data on g_1^p

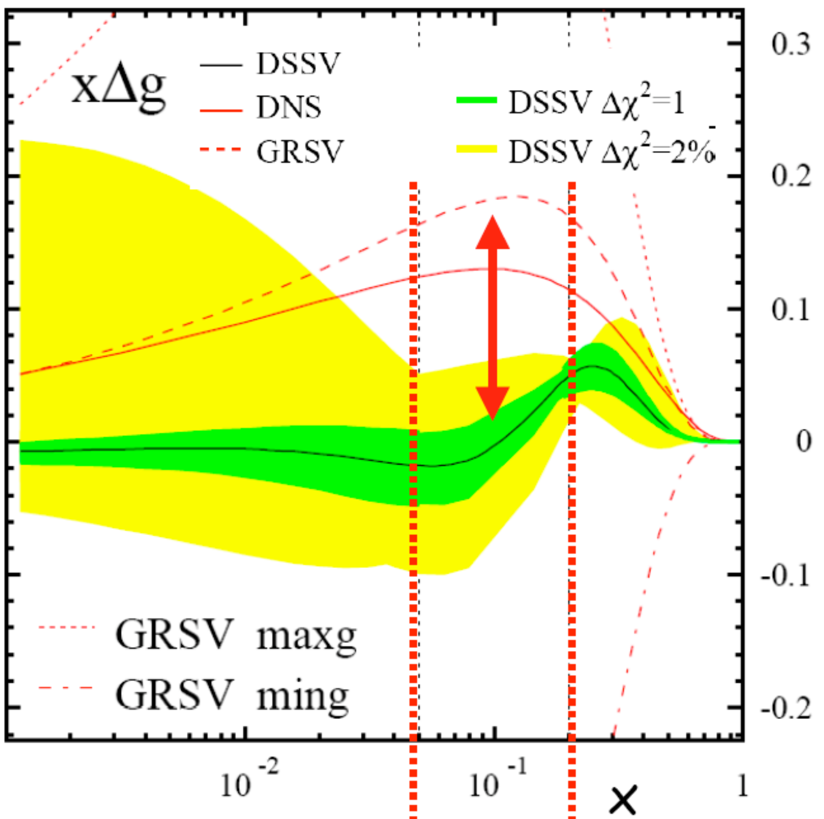




Region of existing g_1^p data

An makes it possible!

Precision measurement of ΔG

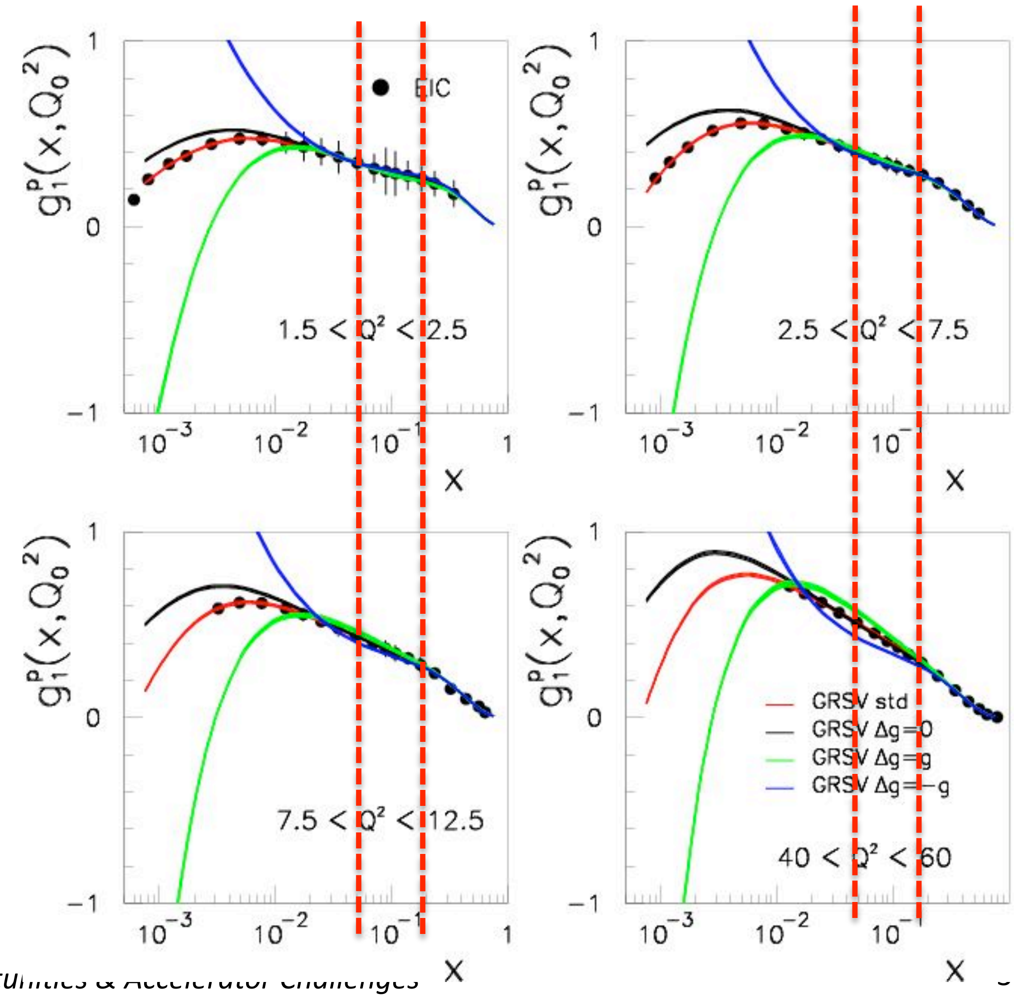


small-x
$0.001 \leq x \leq 0.05$

RHIC range
$0.05 \leq x \leq 0.2$

large-x
$x \geq 0.2$

- Different $g_1(x,Q^2)$ curves for different ΔG values



Type [1,3]: Semi-Inclusive DIS

Luminosity Requirement: ~ 4-10 fb^{-1}

Good EM calorimetry

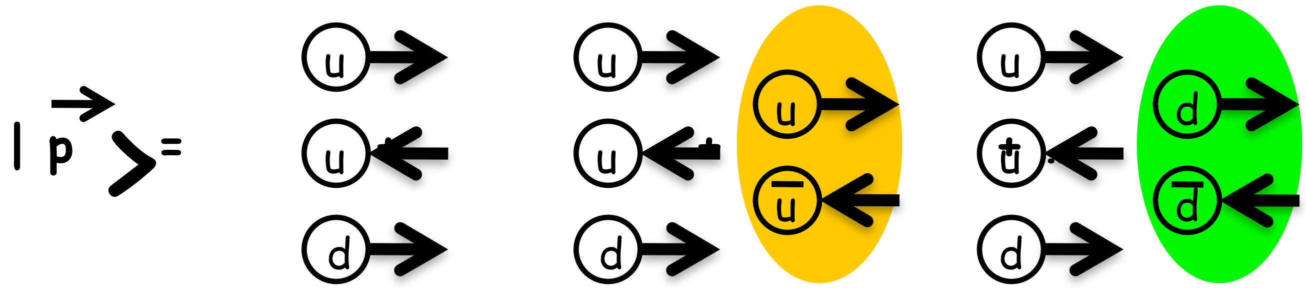
Good particle ID

Recall: 10^{33} $cm^{-2}s^{-1}$ → 5 fb^{-1} in 10 weeks

With 70% detector & 70% machine efficiency

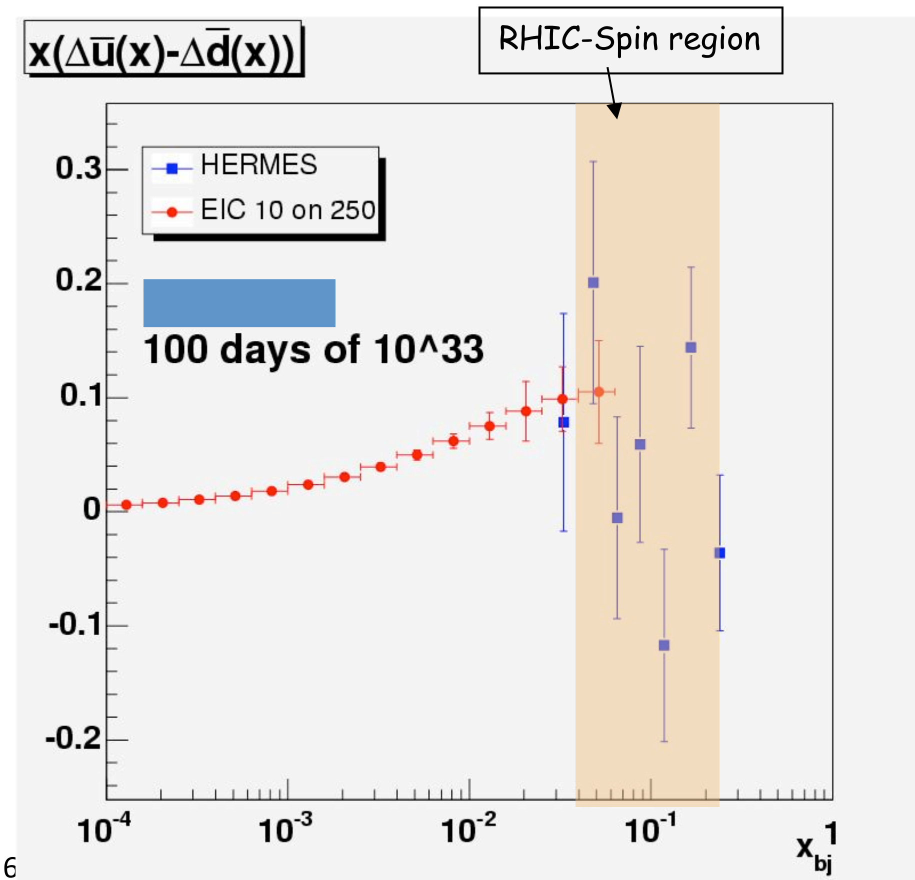
Precisely image the sea quarks

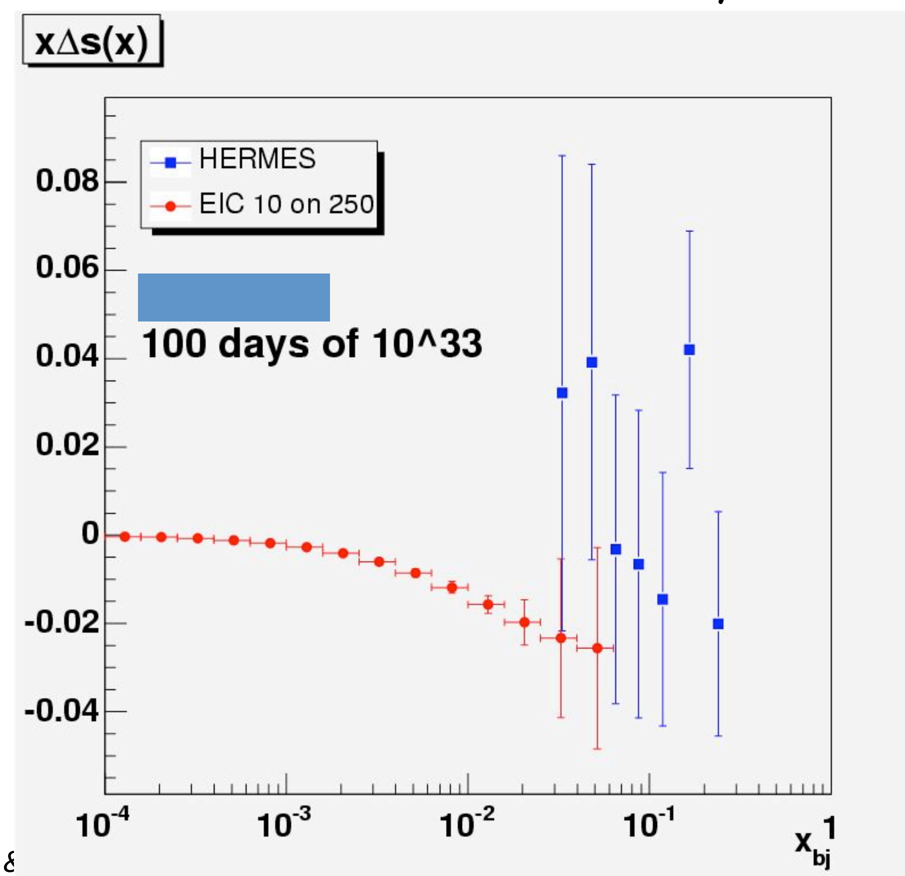
Spin-Flavor Decomposition of the Light Quark Sea



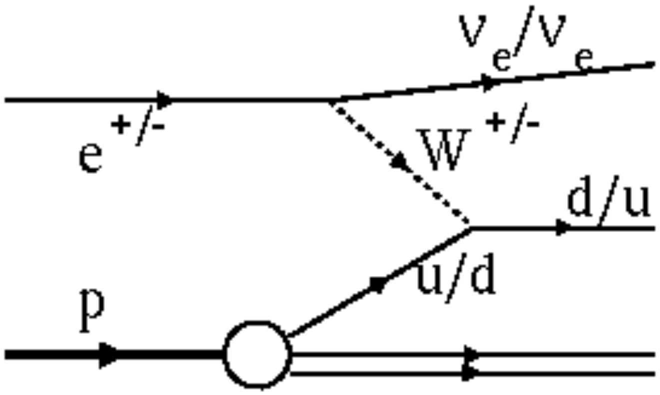
Many models predict

$\Delta\bar{u} > 0$, $\Delta\bar{d} < 0$





Parity Violating Structure Function g_5



$$\frac{d^2\sigma}{dx dQ^2} \sim \{a[F_1 - \lambda b F_3] + \delta[a g_5 - \lambda^2 b g_1]\} \frac{1}{(Q^2 + M_W^2)^2}$$

where

$a = 2(y^2 - 2y + 2)$; $b = y(2 - y)$; $\lambda = \pm 1$ for $e^{\pm}$

$\delta = \pm 1$ for $\uparrow\downarrow$ and $\uparrow\uparrow$ spin orientations

- Experimental signature is a huge asymmetry in detector (neutrino)
- Unique measurement
- Unpolarized xF_3 measurements at HERA in progress
- Will access polarization of heavy quarks/anti-quarks

$$A_{cc}^{W^+} = \frac{-2bg_1 + ag_5}{aF_1 - bF_3} \qquad A_{cc}^{W^-} = \frac{+2bg_1 + ag_5}{aF_1 + bF_3}$$

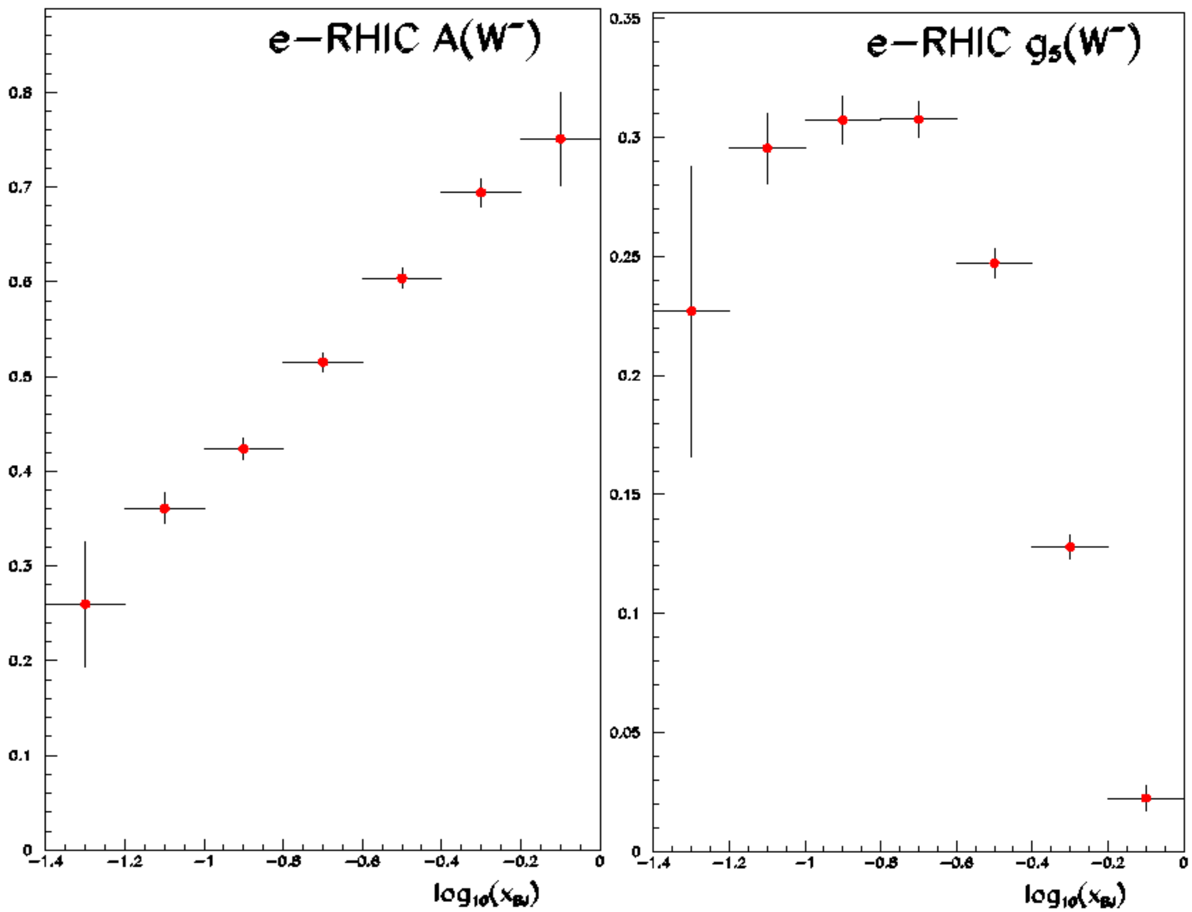
For eRHIC kinematics $a \gg b$

$\Rightarrow g_5$ dominates $\rightarrow$ Extract g_5

$$g_5^{W^-} = \Delta u + \Delta c - \Delta \bar{d} - \Delta \bar{s}$$
$$g_5^{W^+} = \Delta d + \Delta s - \Delta \bar{u} - \Delta \bar{c}$$

Need electron and positron beams in the EIC

Measurement Accuracy PV g_5 at eRHIC



Assumes:

1. Input GS Pol. PDFs
2. xF_3 measured by then
3. 4 fb^{-1} luminosity

Positrons & Electrons in EIC

➔ $g_5(+)$ & $g_5(-)$

>> One reason for keeping the option of positrons in eRHIC

>> For LINAC-Ring, enormous effort on intense enough positron source R&D needed.

Type [1,2,3]: Exclusive DIS

Luminosity Requirement: ~ >10 fb^{-1}

Good EM, Hadron calorimetry

Good particle ID

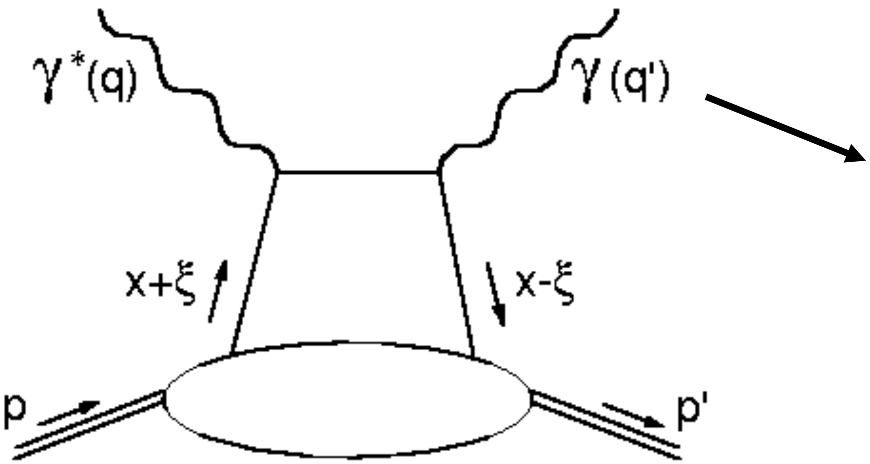
4π coverage of detector

Operation in high rate environments

Recall: 10^{33} $cm^{-2}s^{-1}$ → 5 fb^{-1} in 10 weeks

With 70% detector & 70% machine efficiency

DVCS/Vector Meson Production



- Hard Exclusive DIS process
- γ (default) but also vector mesons possible
- Remove a parton & put another back in!

- Access to Generalized Parton Distributions with theoretically clean connections to partonic **orbital angular momentum**!

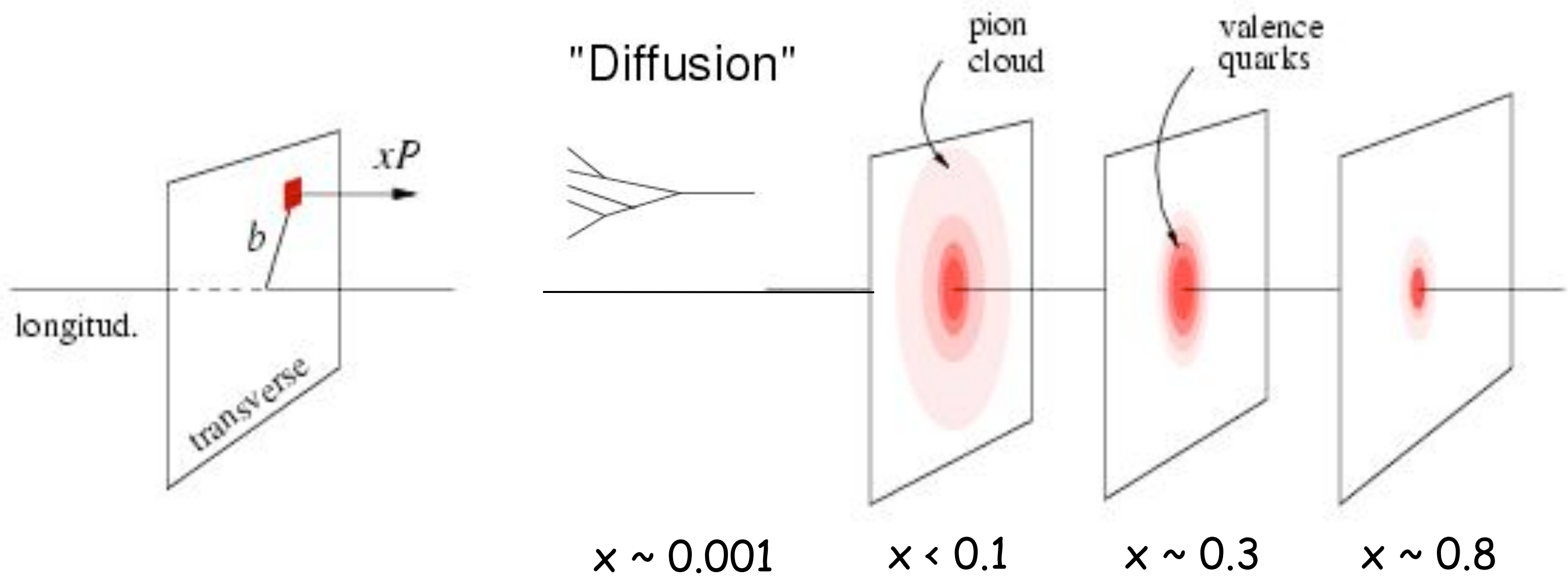
$$\int x dx [H(x, t, \xi) + E(x, t, \xi)] = 2J_{quark} = \Sigma + 2L_q$$

$\xi \to 0$, t: $0 \dashrightarrow -Q^2$

Experimental effort just beginning…To fully explore this physics **beam Charge asymmetries need** to be measured… **=> Luminosity Hungry Measurement**

GPDs and transverse parton imaging

Fourier transform in momentum transfer

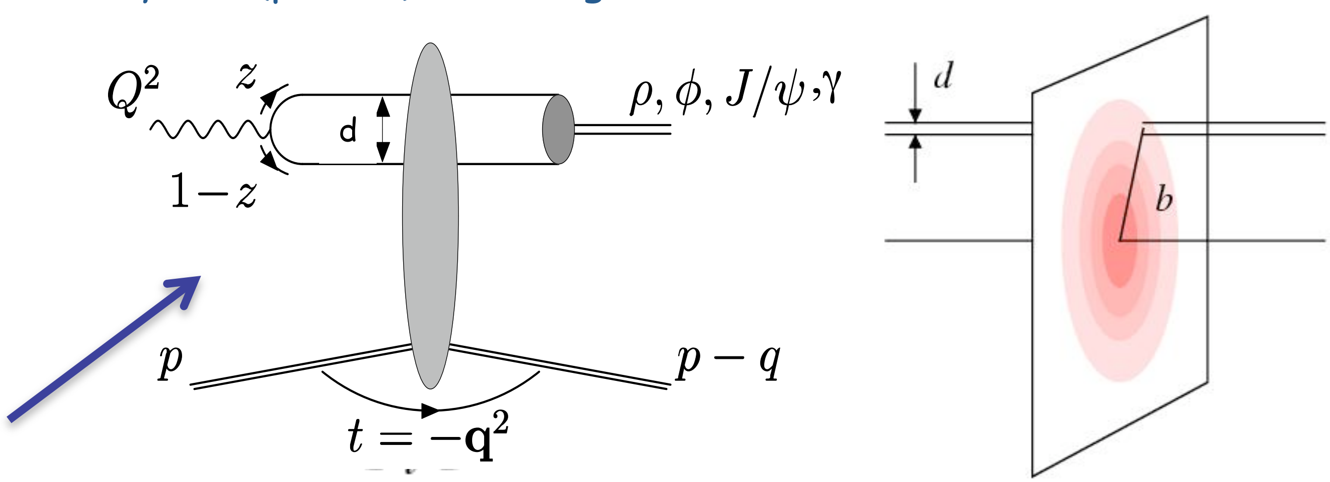


gives transverse size of quark (parton) with longitud. momentum fraction *x*

EIC:

1) x < 0.1: gluons!

2) ξ ~ 0 → the "take out" and "put back" gluons act coherently.

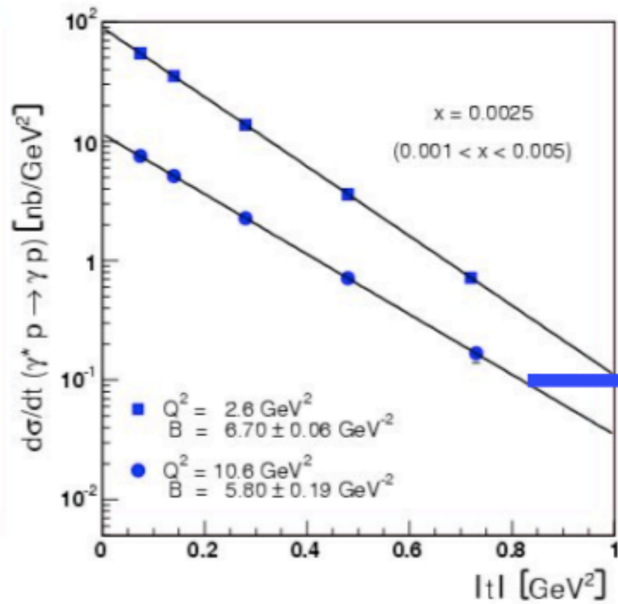


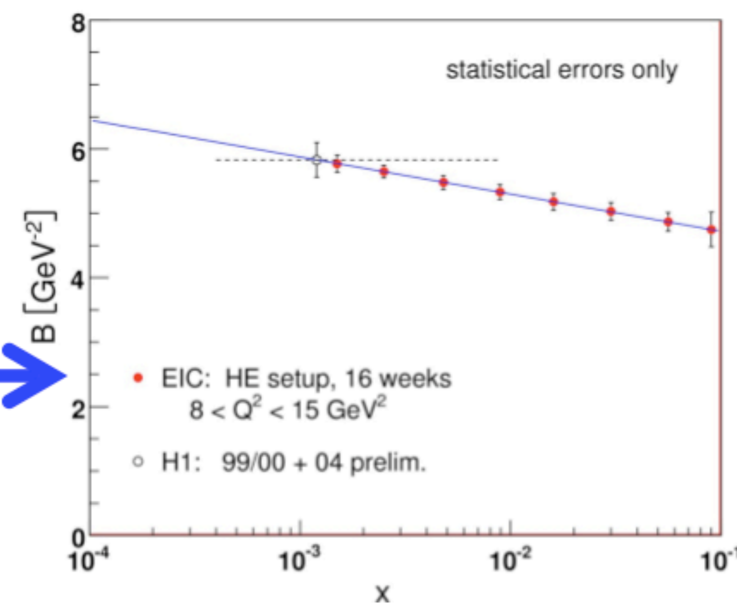
GPDs & Transverse Gluon Imaging

DVCS/DVVM Measurements require

- A wide x-range 0.001 < x < 0.1 (lower the x larger the glue)
- A large Q^2 & wide range: 10-20 GeV^2 for clear interpretation
- Sufficient luminosity to study Q^2, W^2 & t dependence of cross section

EIC Simulations for 10 x 250 eRHIC design with real RHIC Lattice @ $L_{ep}=10^{33}$ $cm^{-2}s^{-1}$





Precision measurements in QCD and beyond

Demanding luminosity & beam polarimetry

Fundamental Measurement in QCD:

One example there could be others

Bjorken Spin Sum Rule

(BjSR, 1966)

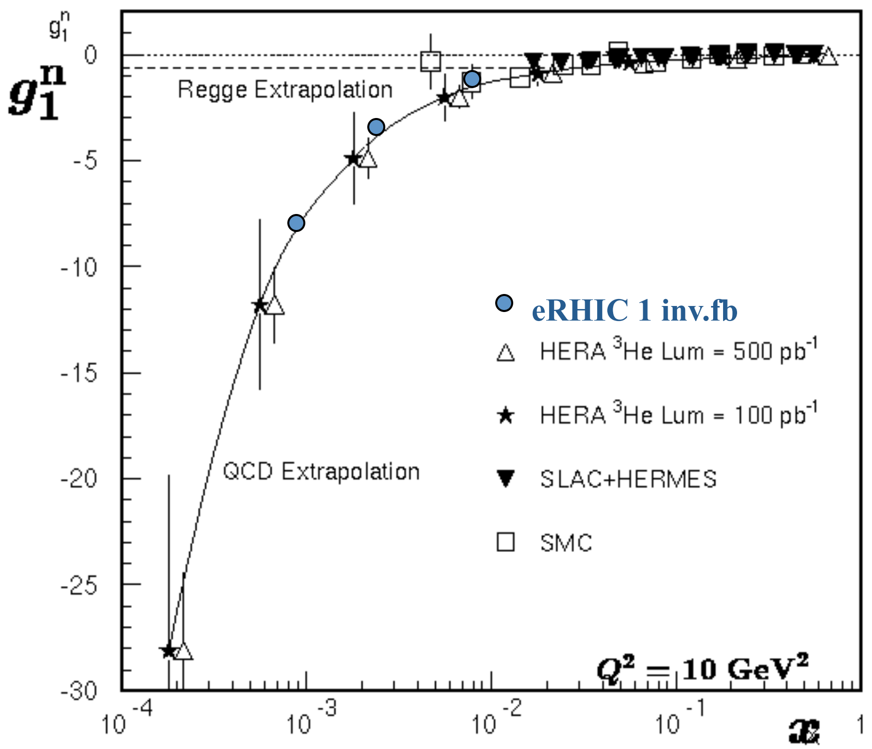
A paper of historical importance to our field.

Left hand side is purely QCD, right hand side is a combination of an electro-weak constant and QCD corrections, which are calculable to a higher order than any other QCD quantity!

("g-2" of QCD?)

$$\int_0^1 \left[g_1^p(x,Q^2) - g_1^n(x,Q^2) \right] dx = \frac{1}{6} \left[\frac{g_A}{g_V} \right]_{n \to p} \left[1 - \frac{\alpha_s(Q^2)}{\pi} + \mathcal{O}(\alpha_s^2) \right] + \mathcal{O}\left(\frac{1}{Q^2} \right)$$

Spin Structure of Neutron at Low x



A huge effort at high x at Jlab!

At EIC/eRHIC

- With polarized He^{+3} to be stored and accelerated
- ~ 2 months of data at EIC allows the measurement shown on left

At EIC/ELIC (Jlab)

- Plan to have polarized deuterons in their ring
- Also aimed at measuring neutron spin structure function

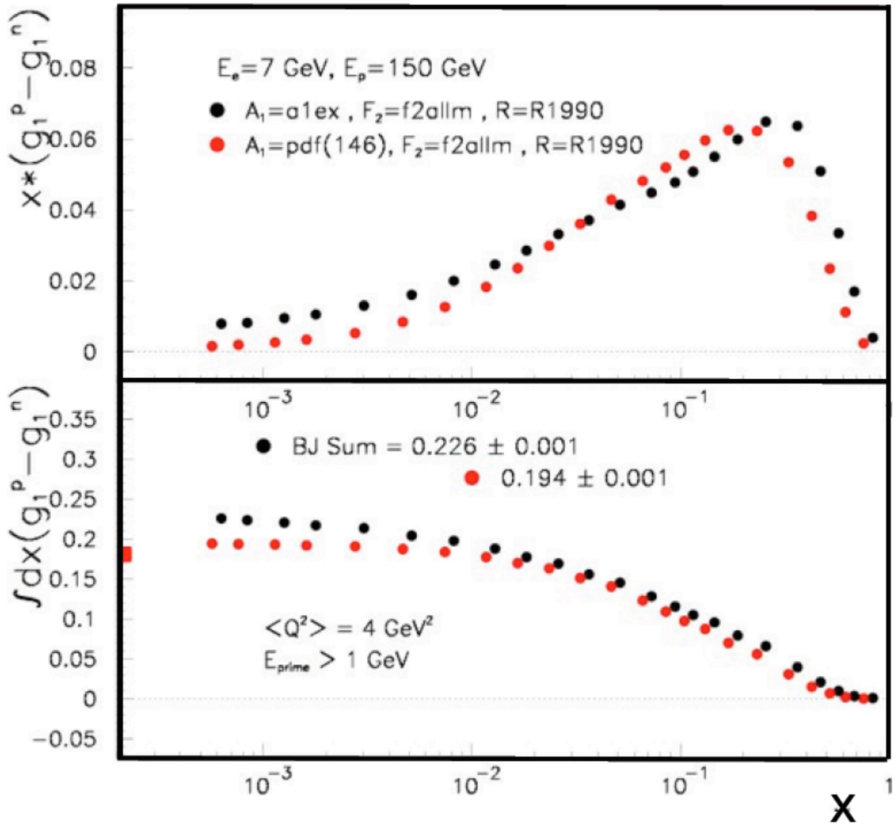
Nuclear corrections need to be revisited(?)

Helium beams **can be stored & manipulated** in RHIC with **existing magnets**
Intense polarized He^{+3} and D sources & polarimetry (for high energy beams) need to be developed.

$$\int_0^1 \left[g_1^p(x,Q^2) - g_1^n(x,Q^2)\right] dx = \frac{1}{6}\left[\frac{g_A}{g_V}\right]_{n\to p}\left[1 - \frac{\alpha_s(Q^2)}{\pi} + \mathcal{O}(\alpha_s^2)\right] + \mathcal{O}\left(\frac{1}{Q^2}\right)$$

Status Bj sum rule measurement:

- Experimental measurement uncertainty ~8%
- Low x extrapolation uncertainty ~10%
- QCD corrections are known to ~$[\alpha_S(Q^2)]^4$



Aim to measure with 1-2% absolute accuracy with the EIC

Severe demand on proton and helium or deuteron beam polarimetry

Confirm Bj sum rule: get the best possible value of the strong interaction constant α_S

Some measurements considered so far for the EIC:

- Push the luminosity requirements > 10^{34} $cm^{-2}s^{-1}$
  - Recall that although lower in luminosity than fixed target experiments, the collider is at (high) 100 GeV in CM Energy
- Push the polarimetry and beam quality requirements to the extreme:
  - (dPol/Pol) ~ 1%
  - Ultra low beam divergence for DVCS/Diffraction…

Why not consider using this machine for precision EW-Physics measurements?

Topics under consideration*:

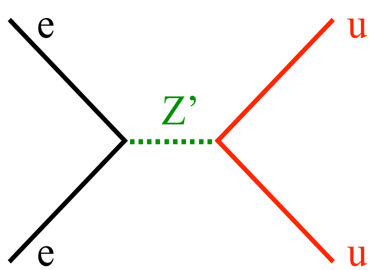
- High energy collisions of polarized electrons and protons and nuclei afford a unique opportunity to study electro-weak deep inelastic scattering
  – Significant contributions from W and Z bosons which have different couplings with quarks and anti-quarks
  – Polarized protons, nuclei (are there nuclear modifications?)
- Parity violating DIS: a probe of beyond TeV scale physics
  – Measurements complimentary (higher Q^2) than the PV DIS 12 GeV at Jlab
- New window for physics beyond SM? $e^- + p \rightarrow \tau^- + X$
  – Lepton flavor violation searches?

*Initiated through discussions with: M. R. Musolf, K. Kumar
Being pursued by: W. Marciano, K. Kumar, M. Savastio, W. Vogelsang, AD

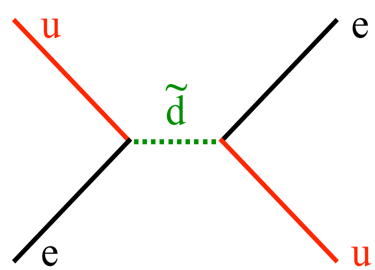
Very Preliminary Parity Violation Study (studied EIC 150 x 10 GeV, e-d scattering)

Measurement of Weinberg angle at a different scale

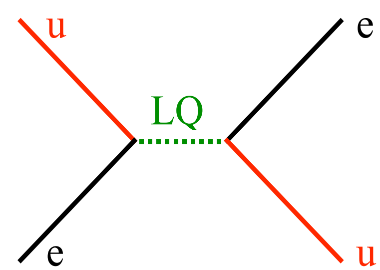
E_6 Z' Based Extensions



RPV SUSY Extensions



Leptoquarks

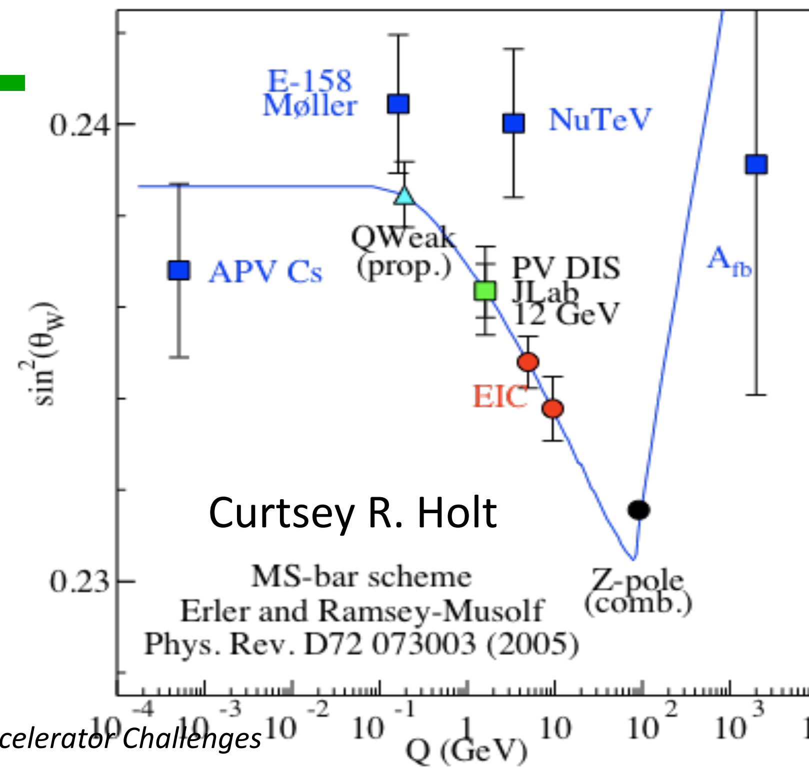


Due to finite Y

$$\left.\frac{\delta \sin^2\theta_W}{\sin^2\theta_W}\right|_{Y=0.46} \approx \frac{1}{2}\left(\frac{\delta A_d}{A_d}\right)$$

$$A_d \approx 2.9 \times 10^{-4}$$

Assumed 10^{35} /cm^2/s, 10 weeks &
100% machine and detector efficiency
Sub 0.5% polarimetry



Study of Glue facilitated by e-**A**?

- An e-p collider at high energy: HERA (1992-2006)
  - No unambiguous evidence of non-linear QCD effects

- eA at the EIC: will probes interactions over distances L ~$1/(2m_N x)$
  - For L > $2R_A$ ~$A^{(1/3)}$ probe interacts coherently with all nucleons in the nucleus
    - Hence nuclear enhancement

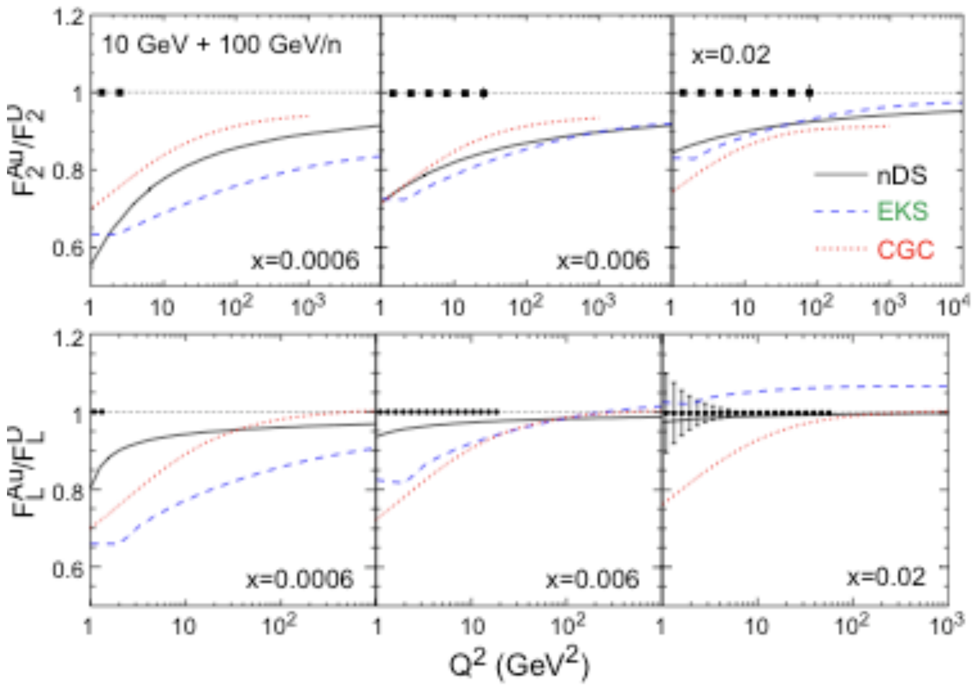
$$(Q_s^A)^2 \approx cQ_0^2 \left[\frac{A}{x}\right]^{1/3}$$

Kowalsky & Teany PRD 68:114005 ==> b & x dependence of Q_s from diffractive and exclusive measurements at HERA

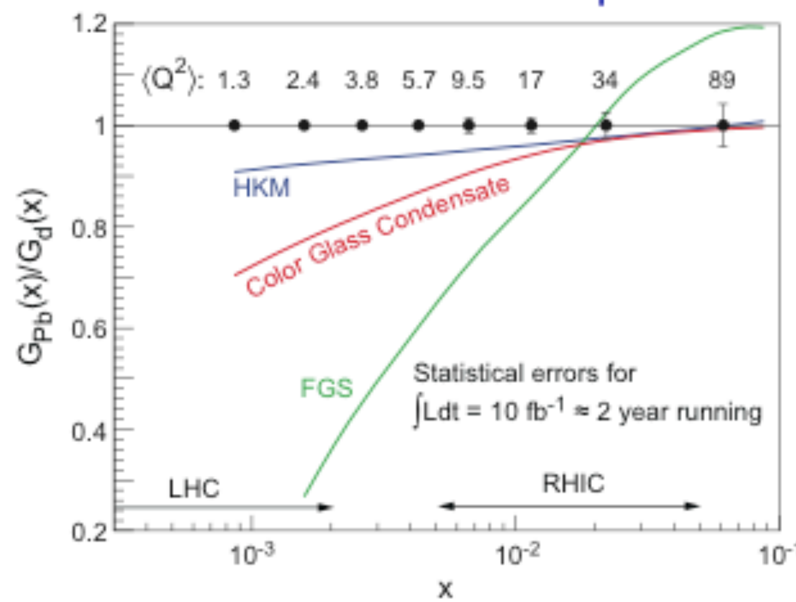
  - Enhancement of Q_s with A ==> non-linear QCD regime at significantly higher x (I.e. lower CM) in A than in a proton!
  - This enhancement is crucial for making the case for i.e. selecting proper values for beam energies and nuclei for eA@RHIC

Early e-A simulations

Simulations to demonstrate the quality of EIC measurements



Folded with EIC acceptance



$F_L \sim \alpha_s\, G(x,Q^2)$ requires $\sqrt{s}$ scan, $Q^2/xs = y$

Assume:

L = 3.8 10^{33} cm^{-2} s^{-1} (100x Hera)

T = 10 weeks

duty cycle: 50%

L ~ 1/A (approx)

$\int L dt$ = 11 fb^{-1}

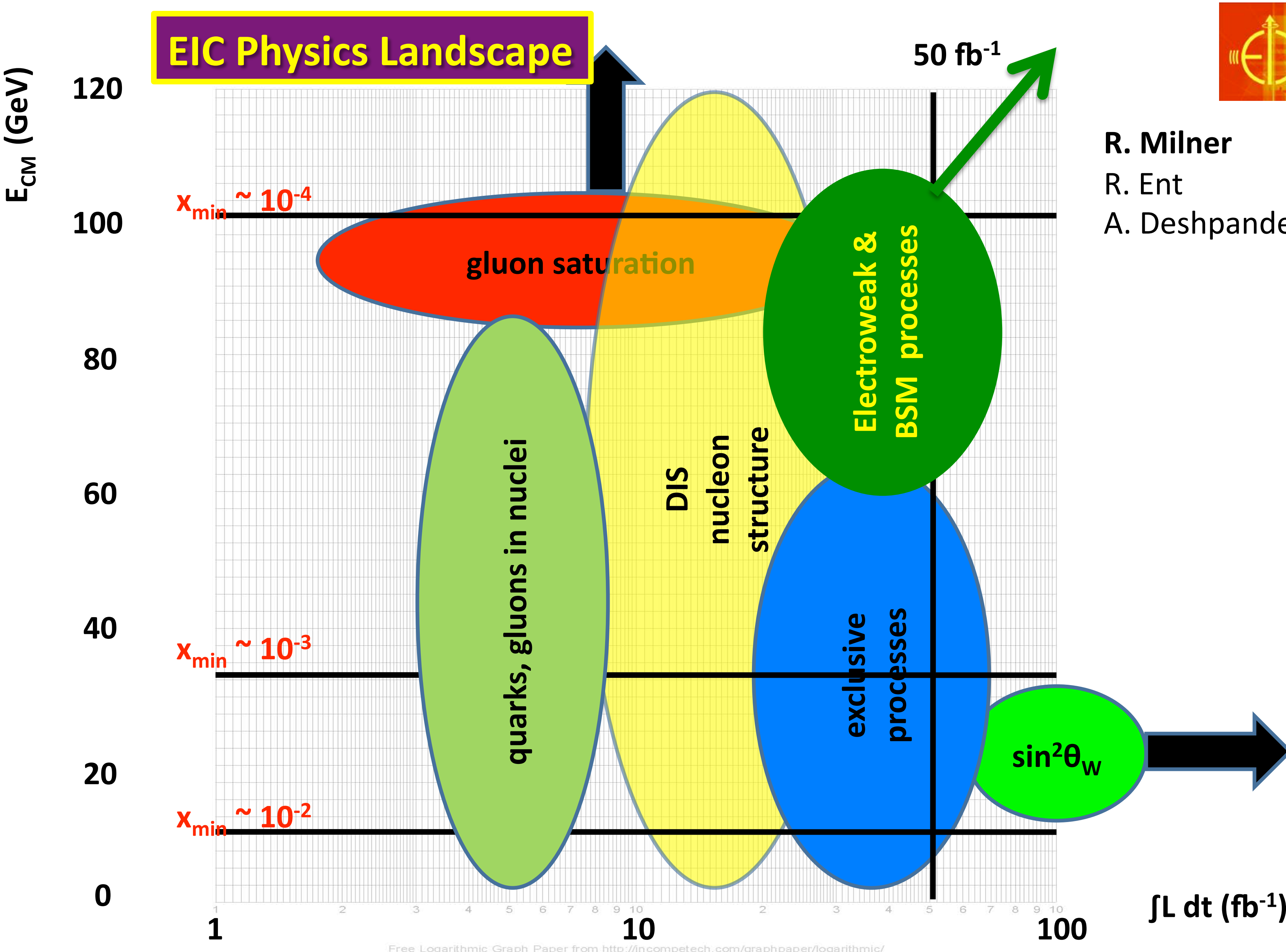
Plots above:

$\int \mathcal{L}dt$ = 4/A fb^{-1} (10+100) GeV

= 4/A fb^{-1} (10+50) GeV

= 2/A fb^{-1} (5+50) GeV

statistical error only



R. Milner
R. Ent
A. Deshpande

Summary

- EIC has been embraced by the US and European community as the right machine to explore the next QCD frontier: See NSAC2007 Long Range Plan
- The EIC Physics community is gearing up for the approval of the project in NSAC 2012 Long Range Planning Exercise

- Realization
  - Simulation studies to finalize the machine and detector design have begun, within a year-or-so this needs to be accomplished
  - Detector R&D funding now becoming available
  - Collaboration is forming:
    - http://eicc.mit.edu/ or http://www.bnl.gov/eic

- Studies associated with parity violation, precision EW physics and possibilities of searches Beyond SM are now being explored. Your interest, help and input is crucial!

EIC in the NSAC 2007

" An electron ion collider (EIC) with polarized beam has been embraced by the US nuclear science community as embodying the vision of reaching the next QCD frontier. The EIC would provide unique capabilities for the study of QCD well beyond those available at existing facilities world wide and complementary to those planned for the next generation of accelerators in Europe and Asia. In support of this new direction: *We recommend the allocation of resources to develop accelerator and detector technology necessary to lay the foundation for a polarized electron ion collider. The EIC would explore new QCD frontier of strong color fields in nuclei and precisely image the gluons in the proton."*

The EIC WG/Collaboration

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** Collaboration Contact Persons

- Collaboration Meetings: ~2/year
- http://web.mit.edu/eicc
- Working Groups & steering committee
  - Physics: e-p, e-A
  - Detector, IR, Accelerator
- Regular meetings to be initiated to finalize physics, machine and detector design and finally the proposal for EIC
- International Advisory Committee: (Appointed by LDs)
  - J. Bartels (DESY), A. Caldwell (MPI Munich), A. De Roeck (CERN), W. Henning (ANL, Chair), D. Herzog (UIUC), X. Ji (Maryland) , R. Klanner (Hamburg), A. Mueller (Columbia), K. Oide (KEK), N. Saito (JPARC), U. Wienands (SLAC)

Realization

- NSAC 2012 Long Range Plan, target date for project “approval” for “construction”
  - Requires a compelling physics case consistent with detector, IR and machine design, costed and well-articulated
  - Staging option well developed and path to full EIC understood & well defined

- Expansion of collaboration
  - Significant growth needed. Connections to other physics interests within the US Nuclear Science community identified and understood
    - EW/PV physics presently being explored: Your input ESSENTIAL
  - International collaboration extremely important
    - Join early and get involved in the defining of the physics and the details of the facility!

EICAC Report: Summary

- Matrix of Science, Design and Cost
  - EIC Stage 1 and the full EIC
- Identify a few most compelling "golden physics" measurements
  - e-p (with polarization) and e-p/e-A physics for the wider physics community
- Dedicated working group activities towards the golden measurements
  - Physics, accelerator, detector studies in detail
- Develop detailed resource loaded schedule
  - Timeline, technical developments and staged realization
- Strive for a timeline with data taking earlier than 2020
- Develop a common accelerator development R&D plan
- Develop and present a common plan for R&D, deliverables, and the resource needs by the next EICAC meeting