trieste_italia
october 10_16 2004

spin 2004
16th international spin physics symposium

FUTURE FACILITIES

Abhay Deshpande
SUNY Stony Brook
&
RIKEN BNL Research Center

Prof. Abdus Salam & ICTP

- Prof. Abdus Salam holds a special place in the minds of all scientists originating in the developing countries

- ICTP gives opportunities to visiting scientists from these and other countries to experience the thrill and the excitement of world class research. Some times the ONLY opportunity to be productive at that level, have the tools and people to discuss things!

- A special personal thanks to the SPIN2004 Organizers for inviting me to give this talk!

My View of This Talk

- **Spin2004 : great presentations of new data, theories, ideas…**

- My task: **Predict the Future!**
- A very wise man once said:
  - “**PREDICTIONS ARE VERY DIFFICULT…… ESPECIALLY, WHEN THEY ARE ABOUT THE FUTURE!**”
  - I will not try this

- **Great wisdom of Spin2004 Organizing Committees:**

  This talk is scheduled **after** the conference summaries. That presumably means if things do really go wrong in future, as long as I don’t write a proceeding, there will be nothing to hold me accountable!

Spin Surprises…

- Stern & Gerlach (1921) Space quantization associated with direction
- Goudschmidt & Ulhenbeck (1926): Atomic fine structure & electron spin magnetic moment
- Stern (1933) Proton anomalous magnetic moment 2.79 μ_N
- Kusch(1947) Electron anomalous magnetic moment 1.00119μ_0
- Prescott et al., Yale-SLAC Collaboration (1978), EW interference in polarized e-d DIS, parity non-conservation in EW physics

- **European Muon Collaboration (1988/9)** Longitudinal Double Spin Measurements led to the **Spin Crisis/Puzzle**
  - Series of SLAC, CERN and DESY fixed target experiments

- Transverse spin asymmetries: FNAL E704, AGS pp scattering, HERMES (1990s), RHIC Spin (2001) (single spin neutron production, pion production at 200 GeV Sqrt(S))

- Recent Jlab experiments explore the proton shape and orbital angular momentum

"Nucleon Spin"

Extremely interesting to explore by itself

&

High potential for returns towards understanding fundamental physics when manipulated innovatively

Talk Overview

- Open/Unanswered questions of today and what answers are expected in this decade?

- What will they be toward the end of this decade?

- **Future Facilities motivated by**
  - **Open Physics Questions**
  - **What we have learnt from the past decade**

Experiment Families & Relations

- **First Generation DIS Experiments:**
  - E80, E130 at SLAC, EMC at CERN
- **Second Generation DIS Experiments:**
  - E142, E143, E154/55 at SLAC, SMC at CERN, *HERMES at DESY*
- **Third Generation Experiments (Current):**
  - *HERMES at DESY*, COMPASS at CERN, CBAF at Jlab and RHIC Spin at BNL
- **Fourth Generation Experiments:**
  - **e-RHIC at BNL, New York**
  - **Electron-Light-Ion-Collider (ELIC) at Jlab, Virginia**
  - **You already heard about in SPIN2004: GSI Future Spin Experiments, Neutrino DIS facility, 12 GeV upgrade at the Jlab, J-PARC in Japan**
  - **Forgotten: HERA-III at DESY, TESLA*HERA at DESY and ELFE in Europe**

Understanding Nucleon Spin

time

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

1st & 2nd Generation

3rd Generation(?)

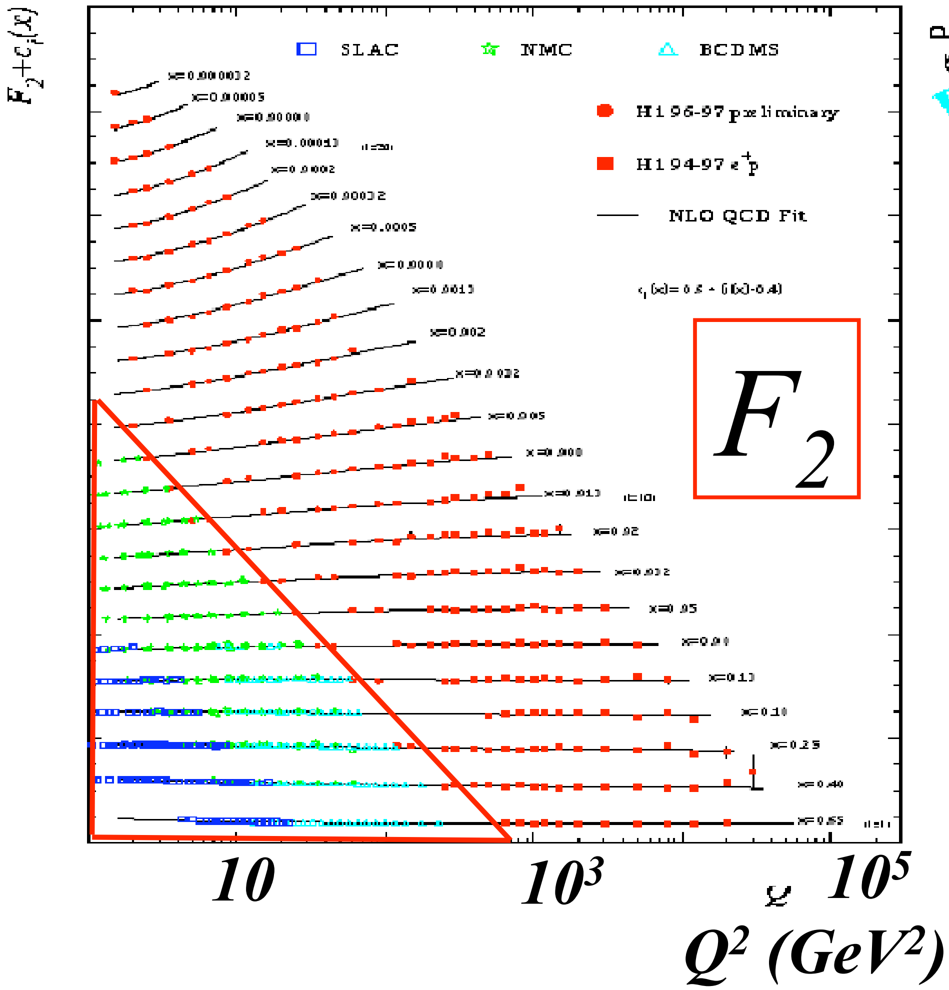
4th Generation(?)

Transverse spin

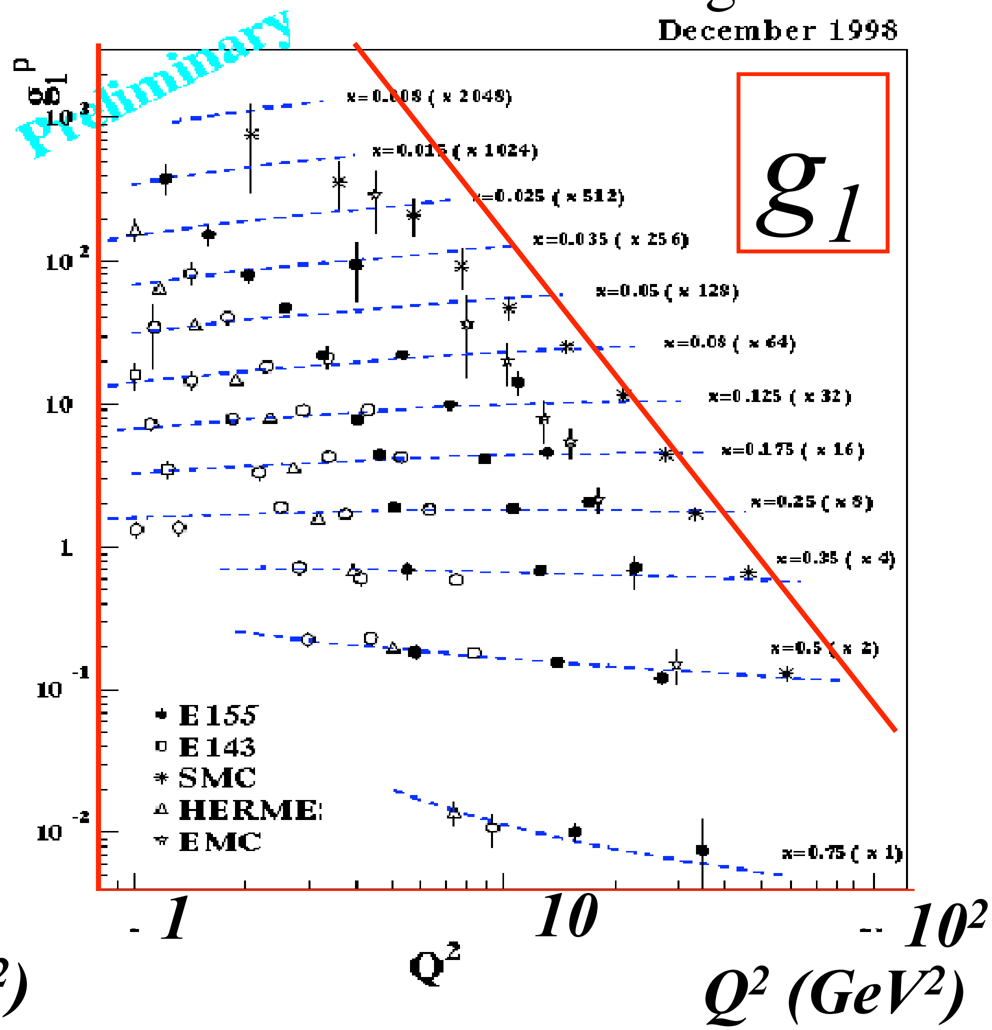
?th Generation

Our Knowledge of Structure Functions

HERA Collider Un-polarized



Polarized DIS fixed target



Large amount of polarized DIS data since 1998… but not in NEW kinematic region!

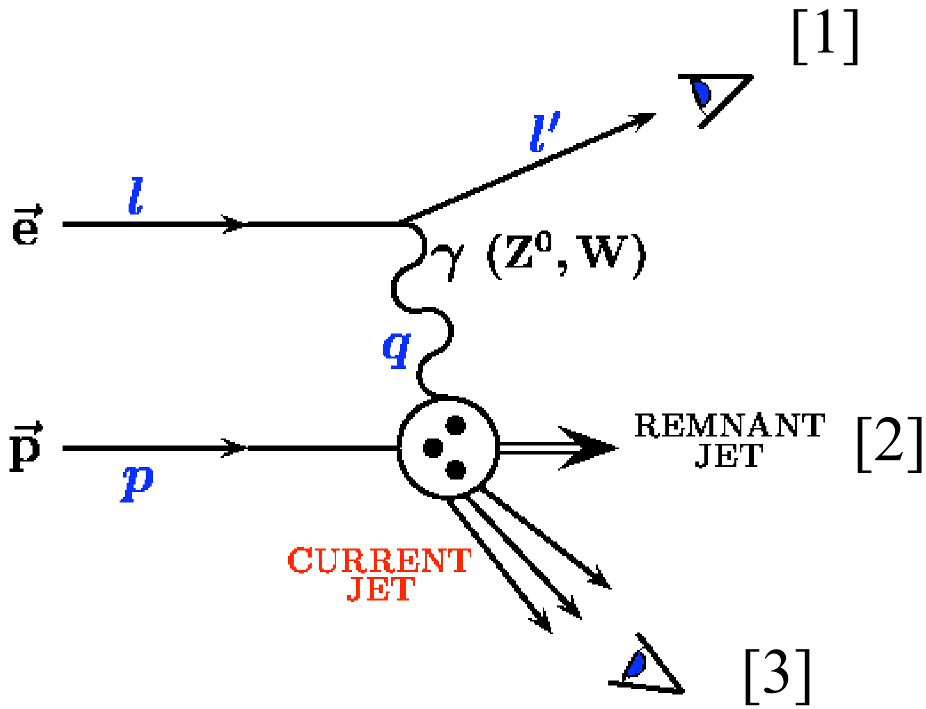
Why Collider In Future?

- Polarized DIS in past only in fixed target mode (gain in : dilution factor)
- Collider geometry--> distinct advantages (HERA Experience)

Fixed target   Collider

- Higher Center of Mass energies reachable
- Better angular resolution between beam and target fragments
  - Better separation of electromagnetic probe
  - Recognition of rapidity gap events (diffractive physics at HERA)
  - Better measurement of nuclear fragments
- **Tricky issues**: **integration of interaction region and detector**

Deep Inelastic Scattering



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

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

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

$$s = 4E_e E_p$$

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

- Observe scattered electron [1] inclusive measurement
- Observe [1] + current jet [2] semi-inclusive measurement
- Observe [1] + [2] + remnant jet [3] exclusive measurement
- Luminosity requirements goes up as we go from [1] --> [2] --> [3]
- **Exclusive measurements put demanding requirement on detectors, interaction region and their integration**

Prospects of HERA-III

- **Work-Shops1995-1999**
- **Polarized DIS:** Excellent Scientific Case
  - WS led by A. De Roeck (CERN), Prof. V. W. Hughes (Yale)
  - Accelerator: led by D. Barber (DESY) and Prof. A. Krisch (Michigan) et al.
  - Two Large Detector Existed (ZEUS and H1)
  - Large collaborations to run them existed, about to form internal Working Groups, New University Groups about to join….
- **Un-Polarized DIS e-A (heavy ions):** Excellent Scientific Case
  - WS led by W. Krasny (Paris IV), M. Strikmann(PSU), T. Greenshaw and others
  - Acceleration issues looked in to F. Willeke et al. (easier than polarized protons)
  - Other issues similar (as above)
- **Polarized Fixed Target HERA-N: (Polarized P_{HERA} on fixed target in HERA ring)**
  - Led by W.D.Novak et al.
  - Easiest to do, use HERA-B detector or a new detector

- **Directorate decided to explore a completely NEW DIRECTION:**
  - the next generation LINEAR Collider

- **An excellent program with existing detectors and collaboration did not realize!**

The Proposals

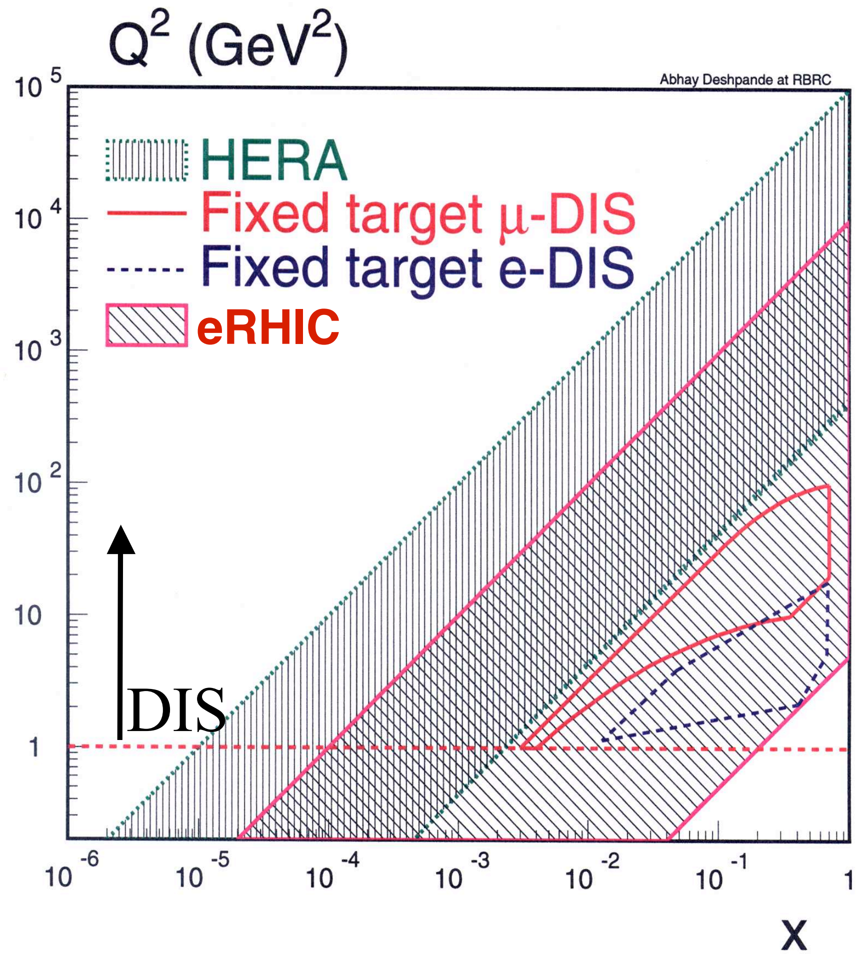
eRHIC at BNL

A high energy, high intensity polarized electron/positron beam facility at BNL to colliding with the existing heavy ion and polarized proton beam would significantly enhance RHIC's ability to probe **fundamental and universal aspects of QCD**

Jlab Upgrade II: CEBAFII/ELIC

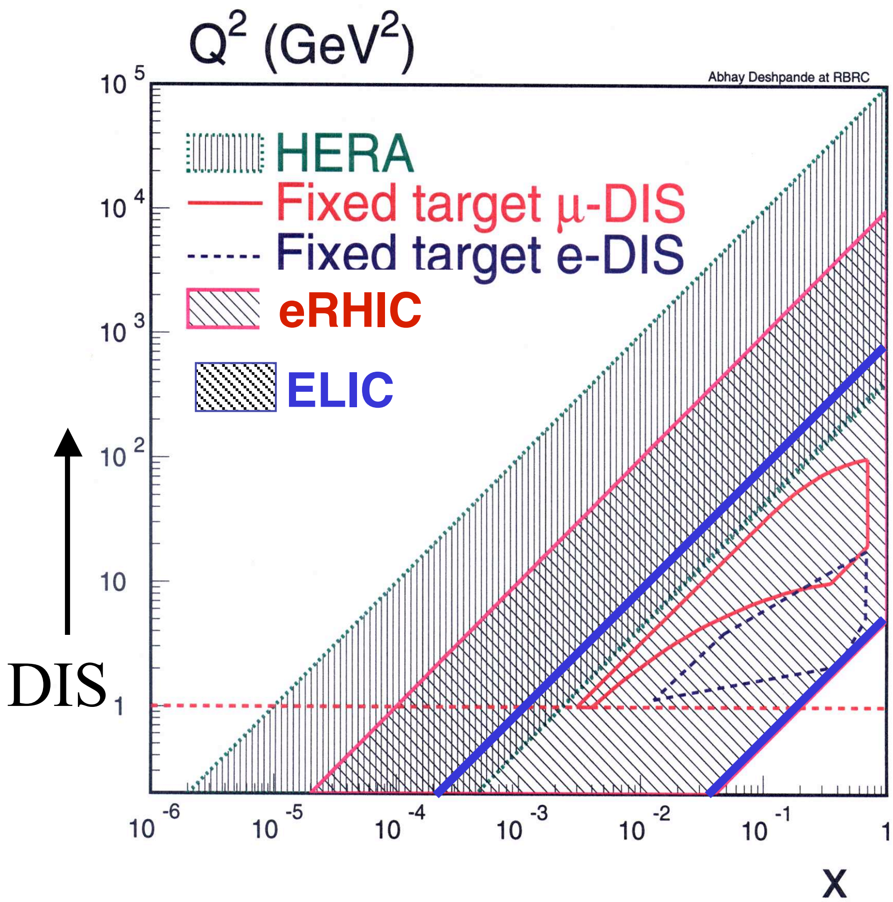
An electron-light-ion collider or/and a 25 GeV fixed target facility at Jlab will address the question of **precision measurements of nucleon spin**, including the issues related to generalized parton distributions with its large luminosity. The collider and fixed target facility will cover complementary kinematic regions.

eRHIC vs. Other DIS Facilities



- **New kinematic region**
- E_e = 10 GeV (~5-12 GeV variable)
- E_p = 250 GeV (~50-250 GeV variable)
- E_A= 100 GeV
- **Sqrt[S_{ep}] = 30-100 GeV**
- Kinematic reach of eRHIC:
  - X = 10^{-4} --> 0.7 (Q^2 > 1 GeV^2)
  - Q^2 = 0 --> 10^4 GeV^2
- Polarization of e,p and light ion beams at least ~ 70% or better
- Heavy ions of ALL species at RHIC
  - High gluonic densities
- High Luminosity:
  - **L(ep) ~10^{33-34} cm^{-2} sec^{-1}**

ELIC vs. Other DIS Facilities



- **Physics of Exclusive measurements**

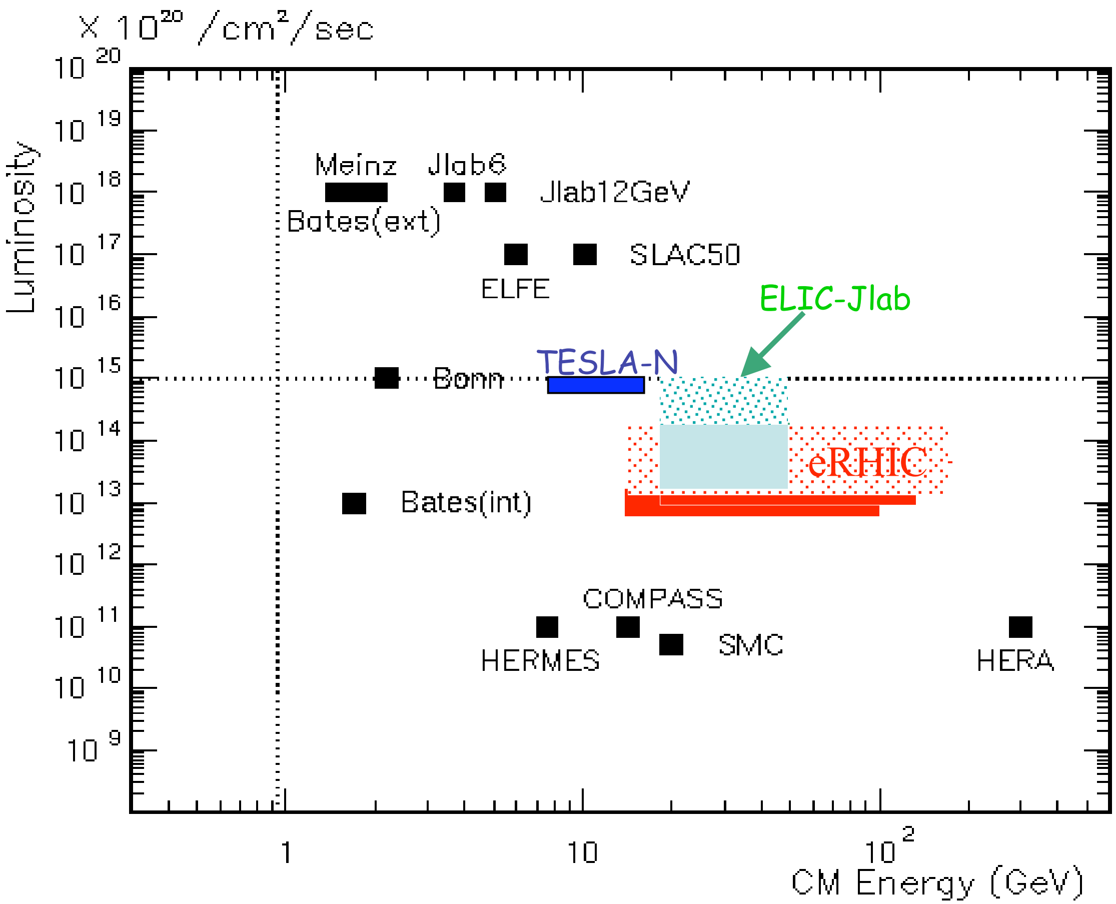
- Ee = 3-7 GeV
- Ep = 30-100 (150) GeV
- **Sqrt[S_ep] = 20-45 (65) GeV**

- Kinematic reach of ELIC
  - X = 10^{-3} --> 0.8 ($Q^2 > 1$ GeV^2)
  - Q^2 = 0 --> 10^3 GeV^2

- Polarization of e, p & light ion beams ~ 70%

- **High luminosity:**
  - **L_(ep) ~$10^{33\text{-}35}$ cm^{-2} sec^{-1}**
  - **Staged increase in luminosity**

CM vs. Luminosity



- **eRHIC**
  - Variable beam energy
  - P-U ion beams
  - Light ion poalrization
  - Large luminosity
- **ELIC**
  - Variable beam energy
  - Light ion polarization
  - Huge luminosity

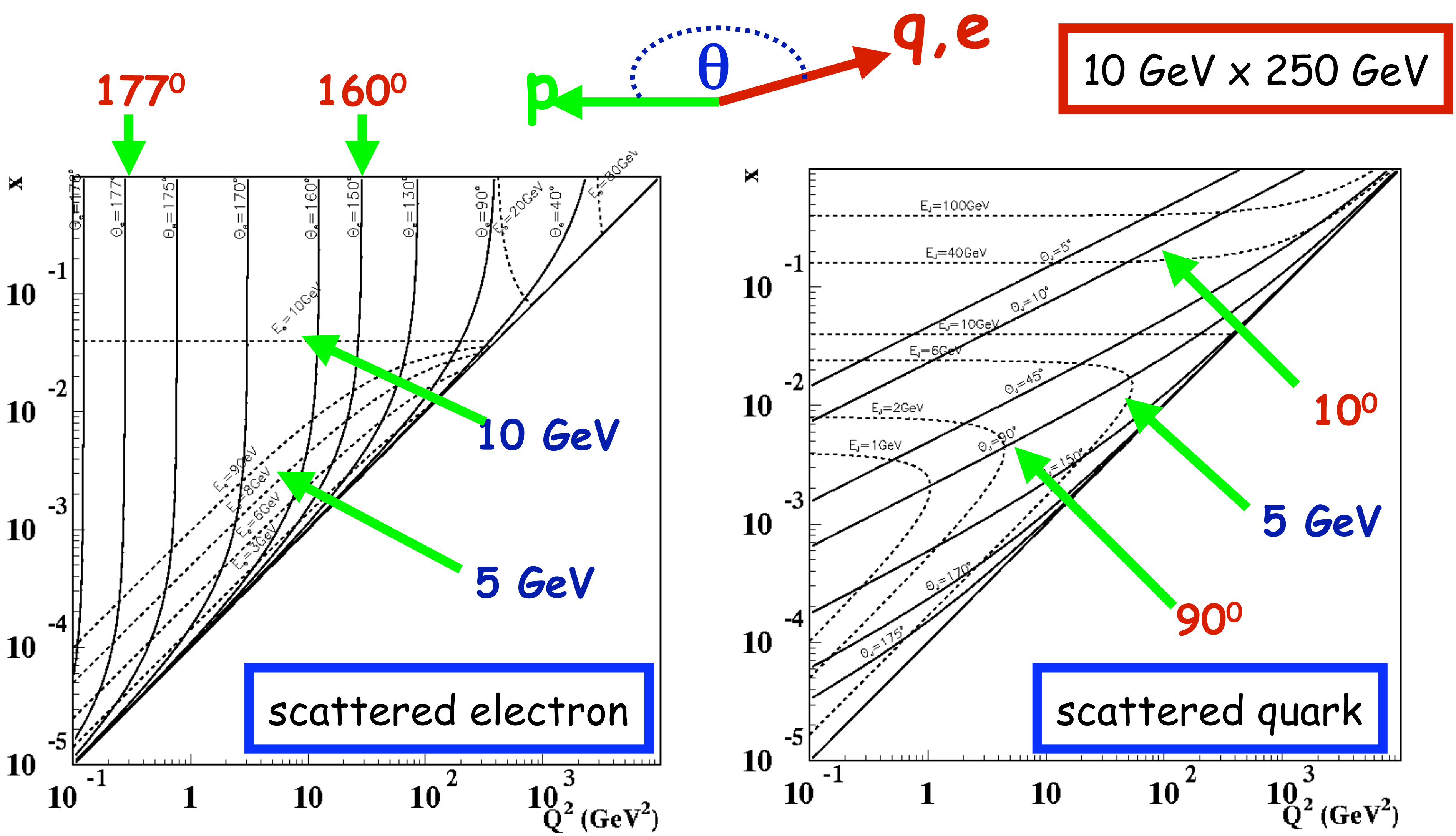
A Detector for eRHIC
A 4π Detector

- Scattered electrons to measure kinematics of DIS
- Scattered electrons at small (~zero degrees) to tag photo production
- Central hadronic final state for kinematics, jet measurements, quark flavor tagging, fragmentation studies, particle ID
- Central hard photon and particle/vector detection (DVCS)
- ~Zero angle photon measurement to control radiative corrections and in e-A physics to tag nuclear de-excitations
- Missing E_T for neutrino final states (W decays)
- Forward tagging for 1) nuclear fragments, 2) diffractive physics

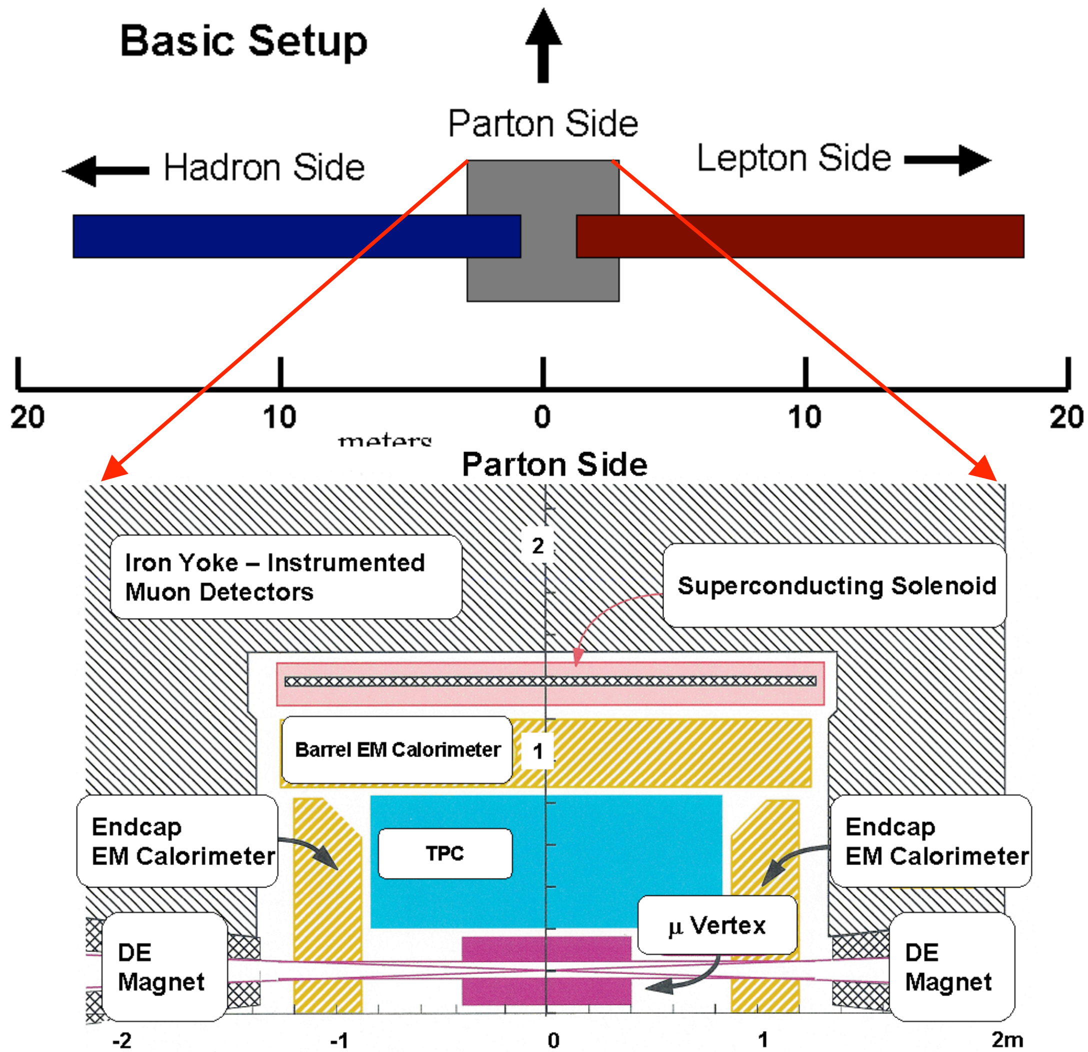
- ***Lot of experience from HERA… use it!***
  - What was good about HERA detectors?
  - What was bad? How/What can we improve?

- eRHIC will provide: 1) Variable beam energies 2) different hadronic species, some of them polarization, 3) high luminosity

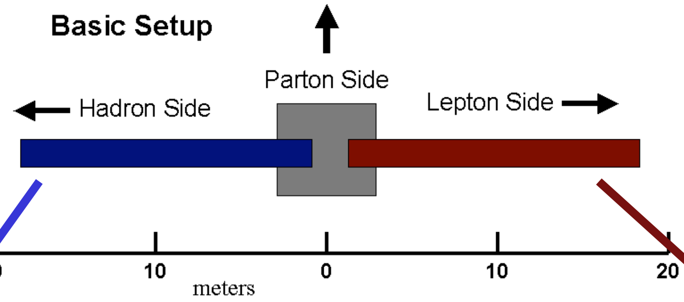
Where do electrons and quarks go?

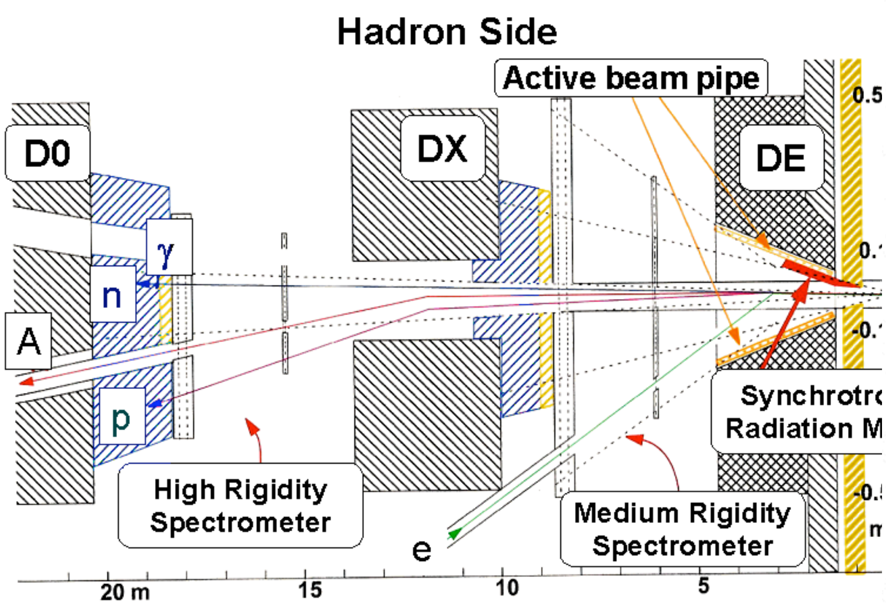


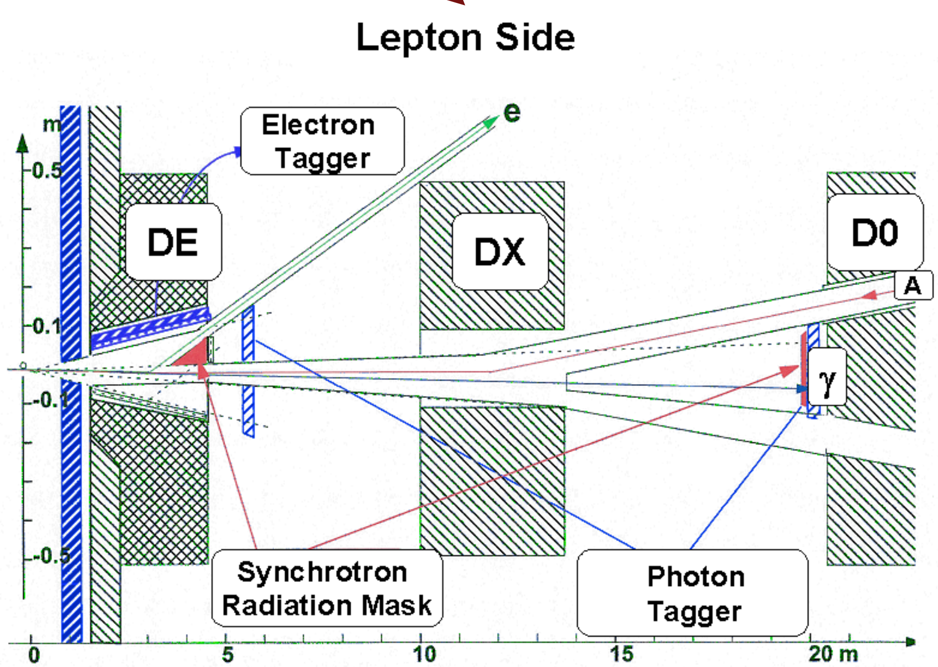
Detector Design….



Detector Design ….

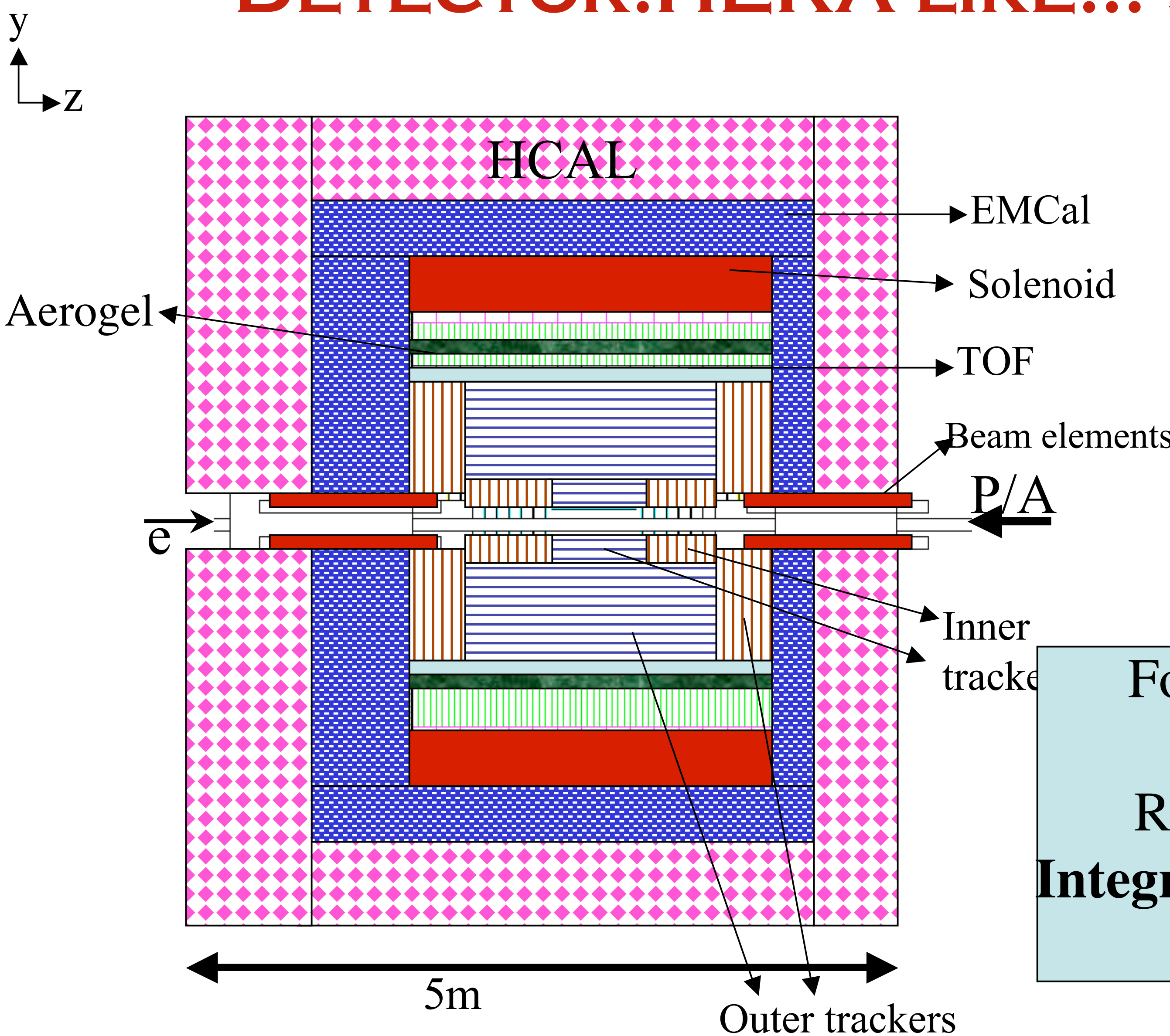






B. Surrow, N. Smirnov, A. D.

Detector:HERA like…+ PID



(Not to scale)

A HERA like Detector with dedicated PID:
>>Time of flight
>>Aerogel Ckov

AND

Forward detectors including Roman Pots etc…
Integrated in to the beam Elements!

Scientific Frontiers Open to eRHIC

- **Nucleon structure, role of quarks and gluons in the nucleons**
  - Un-polarized quark and gluon distributions, confinement in nucleons
  - Polarized quark and gluon distributions **(LOWEST POSSIBLE X)**
  - Correlations between partons
    - Exclusive processes--> Generalized Parton Distributions
  - Understanding confinement with low x/lowQ^2 measurements
- **Meson Structure:**
  - Goldstone bosons and play a fundamental role in QCD
- **Nuclear Structure, role of partons in nuclei**
  - Confinement in nuclei through comparison e-p/e-A scattering
- **Hadronization in nucleons and nuclei & effect of nuclear media**
  - How do knocked off partons evolve in to colorless hadrons
- **Partonic matter under extreme conditions**
  - For various A, compare e-p/e-A

Scientific Frontiers Open to ELIC

- **Nucleon structure, role of quarks and gluons in the nucleons**
  - Polarized quark and gluon distributions
  - Correlations between partons
    - **Exclusive processes--> Generalized Parton Distributions**
  - Understanding confinement with low x/lowQ^2 measurements
- **Meson Structure:**
  - Goldstone bosons and play a fundamental role in QCD

Polarized DIS at eRHIC

- Spin structure functions g_1 (p,n) at **low x**, high precision [1]
  -- g_1(p-n): Bjorken Spin sum rule 1-2% accuracy
- **Polarized gluon distribution function $\Delta G(x,Q^2)$*** [1]
  -- at least three different experimental methods
- Precision measurement of α_S(Q2) from g_1 scaling violations [1]
- Spin structure of the photon from photo-production [1]
- Electroweak s. f. g_5 via virtual **$W^{+/-}$ production* (heavy quarks)** [1,2]
- Deeply Virtual Compton Scattering (DVCS), exclusive VM production [1] [1,2]
  >> Generalized Parton Distributions (GPDs) [3]
- **Transversity: Single and Double Spin Measurements*** [1]
- Drell-Hern-Gerasimov spin sum rule test at high ν [1]
- Flavor separation of PDFs through semi-inclusive DIS [1]
- Target/Current fragmentation studies [2,3]
- … *and many more ……*

***Also being pursued at RHIC Spin Now.**

[1] --> inclusive, [2]--> semi-inclusive

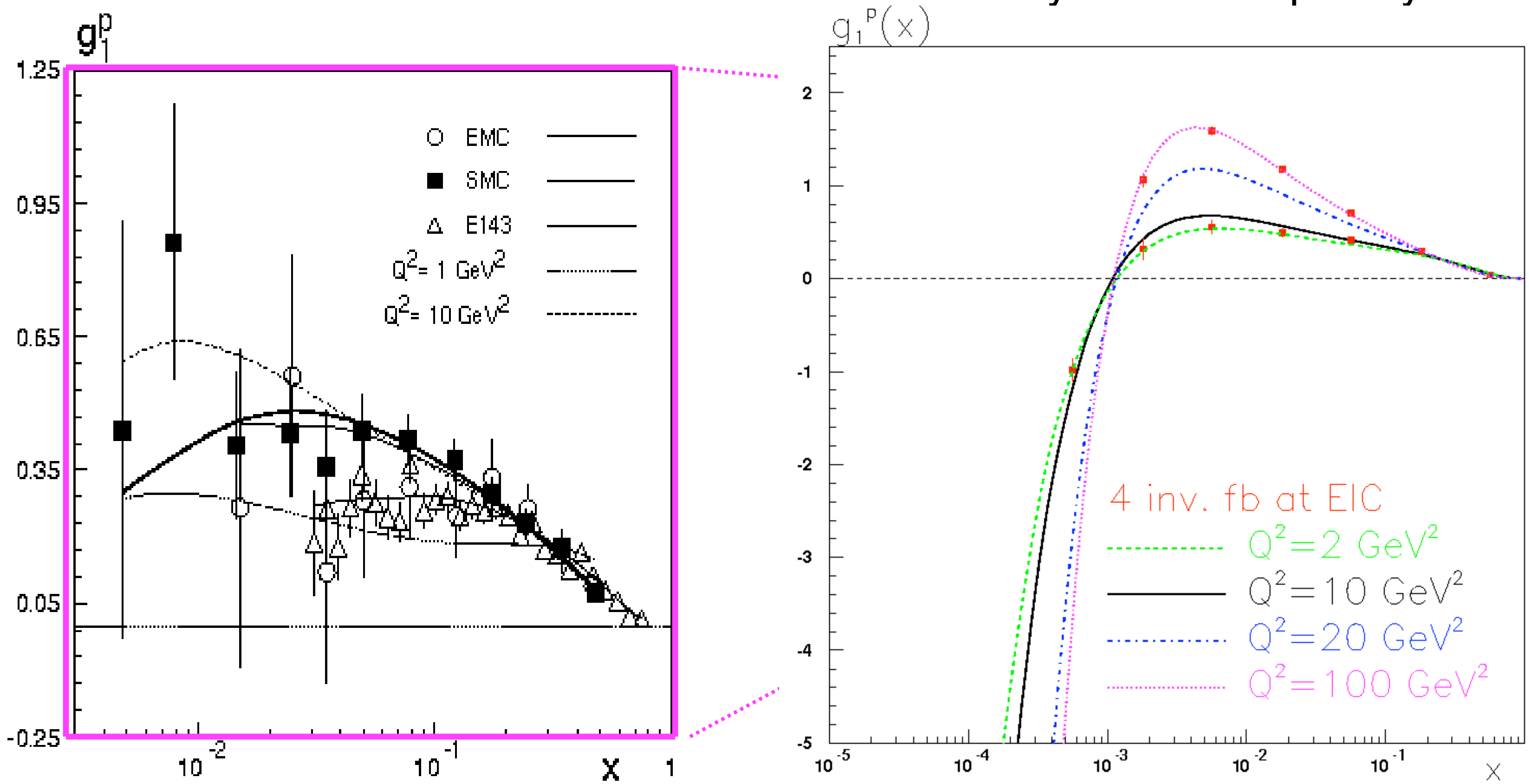
[3] --> exclusive measurements

Luminosity Requirement

Low x Proton Spin Structure

Fixed target experiments
1989 – 1999 Data

eRHIC 250 x 10 GeV
Luminosity = ~85 inv. pb/day



Studies included statistical error & detector smearing to confirm that asymmetries are measurable. No present or future approved experiment will be able to make this measurement

$\Rightarrow$ Bjorken sumrule $\int_0^1 dx(g_1^p - g_1^n)(x, Q^2)$ ~ 1-2% precision at eRHIC

Bj Sum Rule & Determination of α_s

$\alpha_s(M_Z)$ has been determined from Bj spin sum rule by:

1. J. Ellis & M. Karliner, Phys. Lett. B341, 387 (1995)
2. G. Altarelli et al., Nucl. Phys. B496, 337 (1997)
3. B. Adeva et al. SMC Collaboration, Phys. Rev. D58 (1998) 112002

Values range from 0.114-119 with uncertainties:

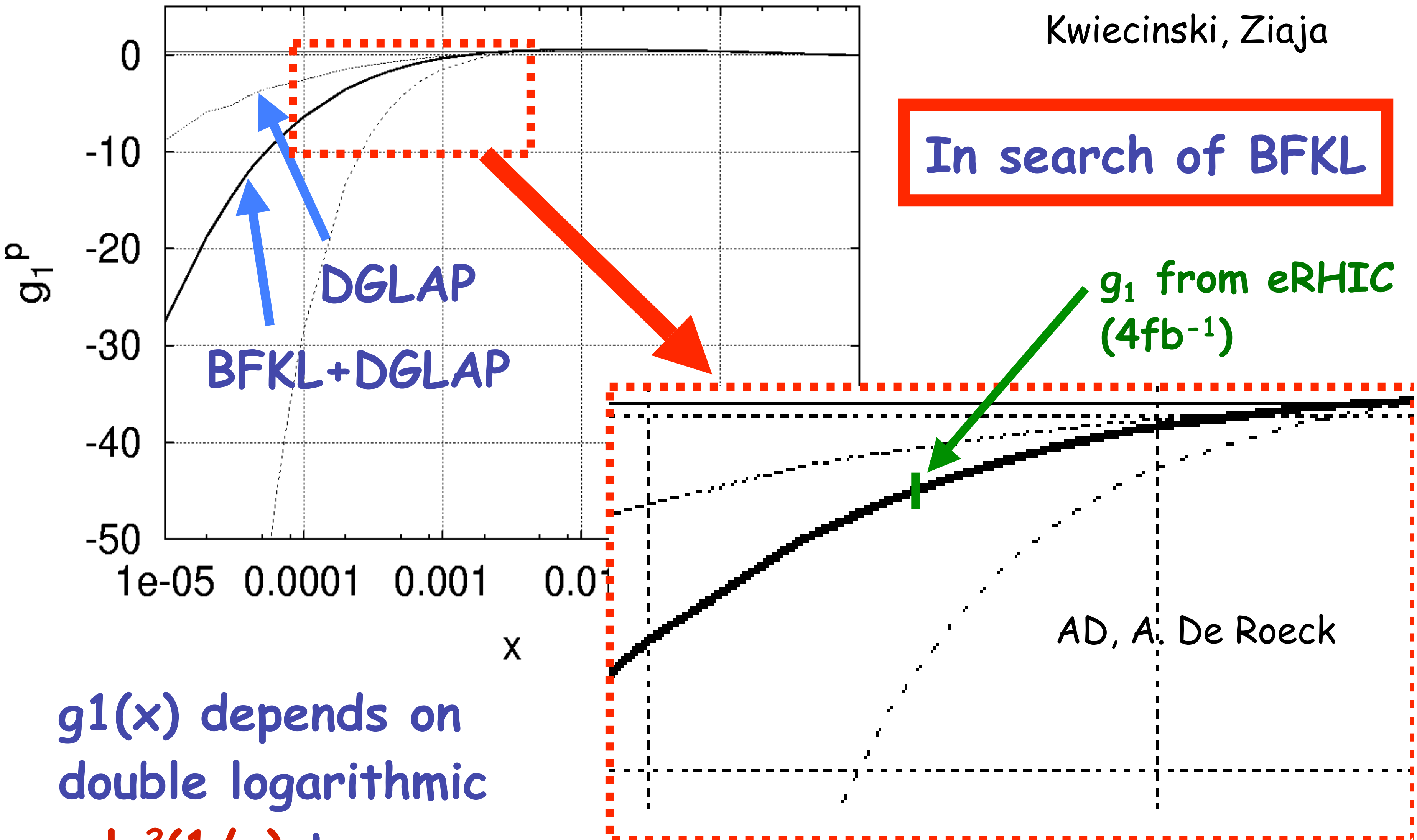
+/- 0.004 (experimental)

+/- 0.010 (theory/ low x extrapolation)

Particle Data Book (2002), Extended version:

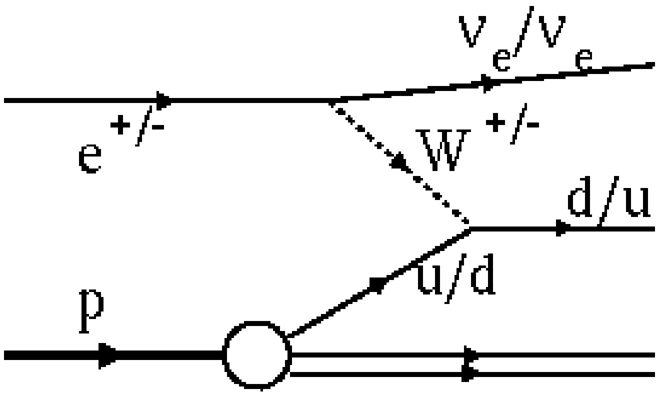
"Theoretically, this sum rule is better for determining α_s because perturbative QCD result is known to higher order ($o(\alpha_s^4)$), and these terms are important at low Q^2……… **Should data at lower x become available**, so that the low x extrapolation is more tightly constrained, the ***Bj sum rule method could give the best determination of α_s***"

Low-x measurements



g1(x) depends on double logarithmic $\alpha_s \ln^2(1/x)$ terms

Parity Violating Structure Function g_5



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

where

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

$\delta = \pm 1$ 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 heavy quark distribution in polarized DIS

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

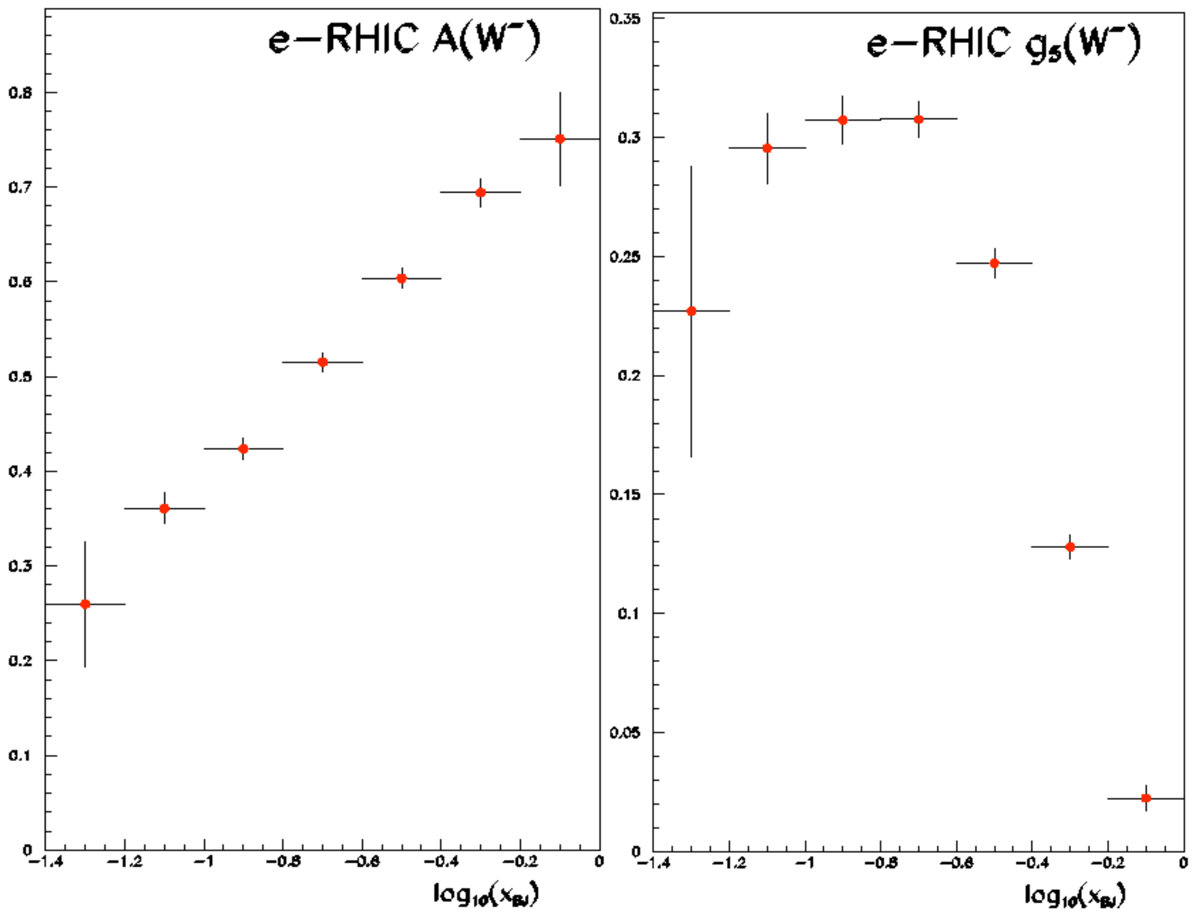
For eRHIC kinematics $a \gg b$

$\Longrightarrow g_5$ dominates $\rightarrow$ Extract g_5

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

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

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 eRHIC → $g_5(+)$

>> reason for keeping the option of positrons in eRHIC

Fits of $g_1(x,Q^2)$+jets

J. Lichtenstadt
AD, A.D.R.,V. H., G.R.

Constrain better the shape and the first moment

ΔG determined from the Scaling violations of g1

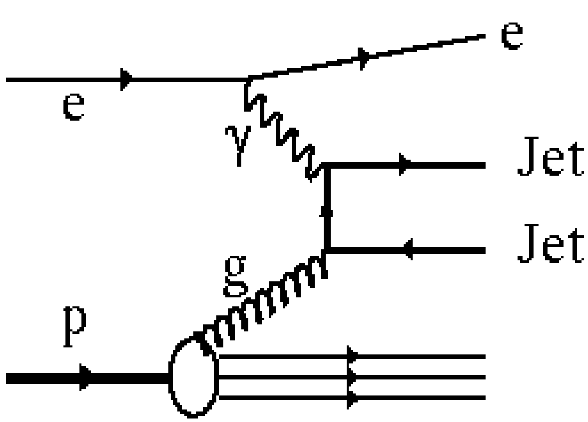
SMC Published 1998: First Moment of $\Delta G(x)$

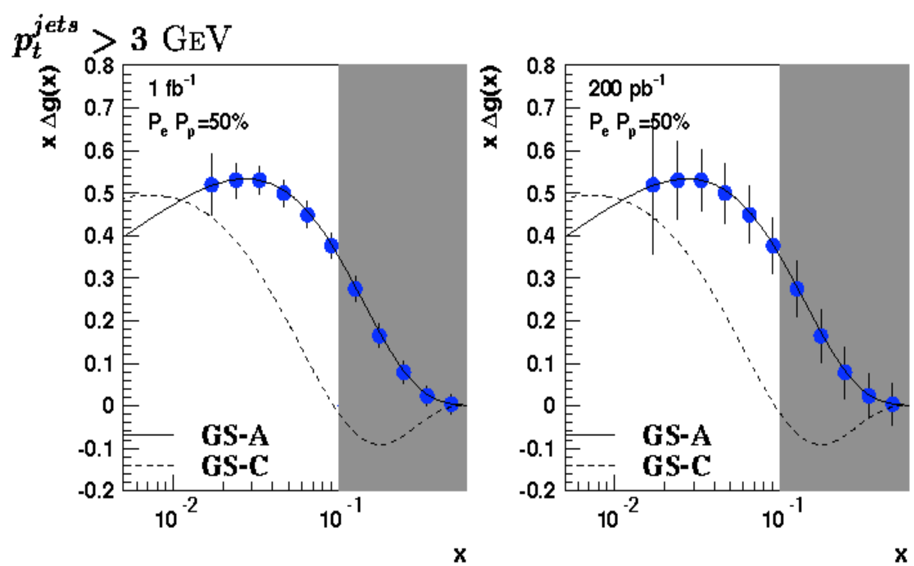
$\int \Delta G(x)dx =$ 1.0 +/- 1.0 (stat) +/- 0.4 (exp.syst) +/- 1.4 (theory)

-- one week eRHIC reduces statistical & theory errors by ~5

-- low x --> strong coupling, functional form at low -x, renorm. & fact. scales

Di-Jet at eRHIC:

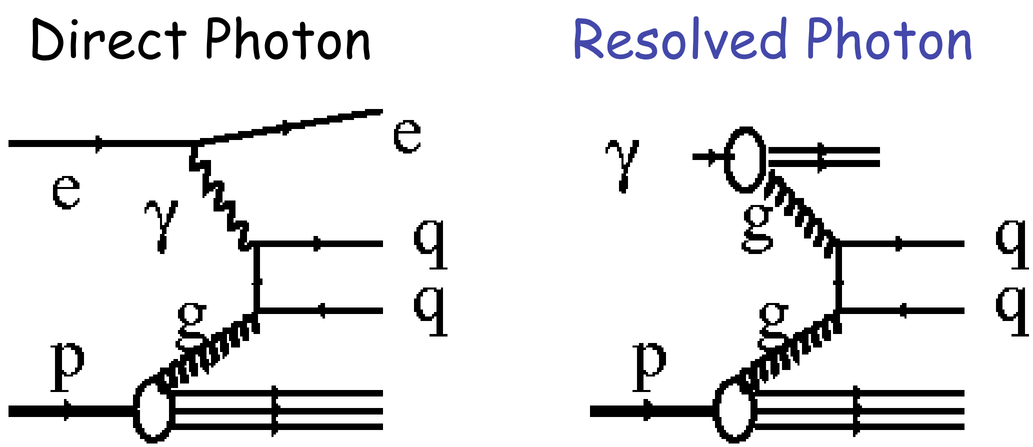


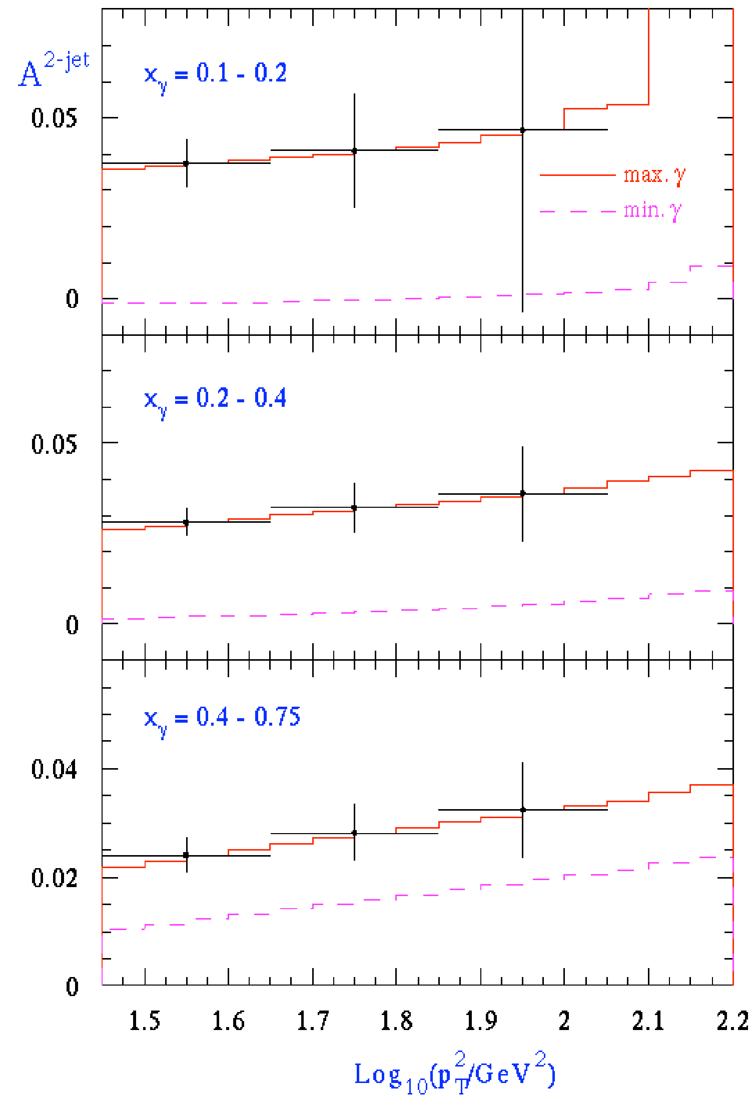


M. Stratmann, W. Vogelsang

Polarized PDFs of Photons

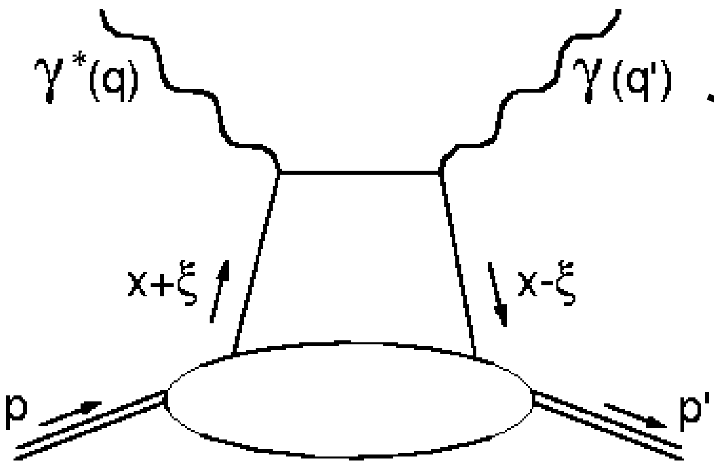
- Photo-production studies with single and di-jet





- Photon Gluon Fusion or Gluon Gluon Fusion (Photon resolves in to its partonic contents)
- Resolved photon asymmetries result in measurements of spin structure of the photon
- 1 fb-1 (~3 weeks) data, ZEUS acceptance: ample data to explore the QCD/spin structure of the photon

DVCS/Vector Meson Production



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

➔ Microsurgery of Baryons!

•Claim: Possible access to skewed or off forward PDFs?
Polarized structure: Access to quark orbital angular momentum?

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

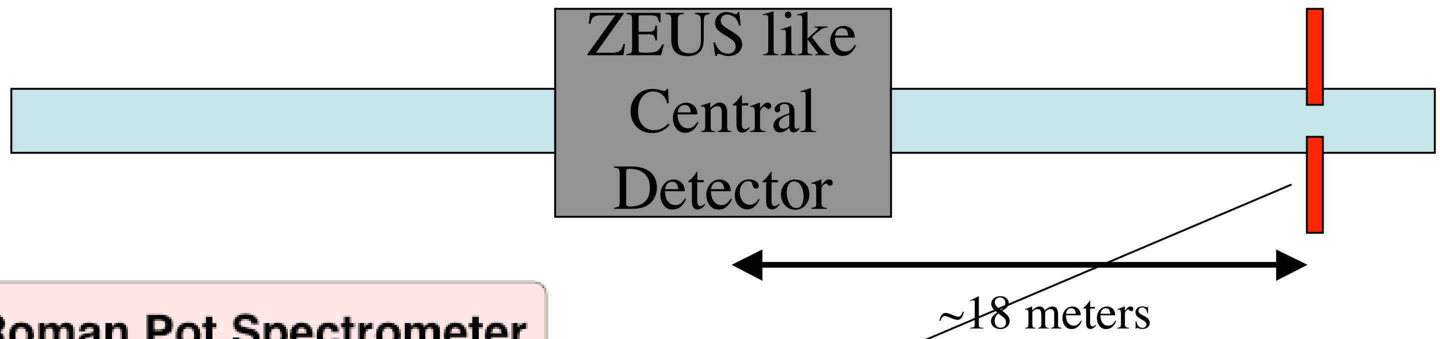
$t \to 0$, $\xi \to 0$

On going theoretical debate… experimental effort just beginning…

--A. Sandacz, AD

A. Sandacz,AD

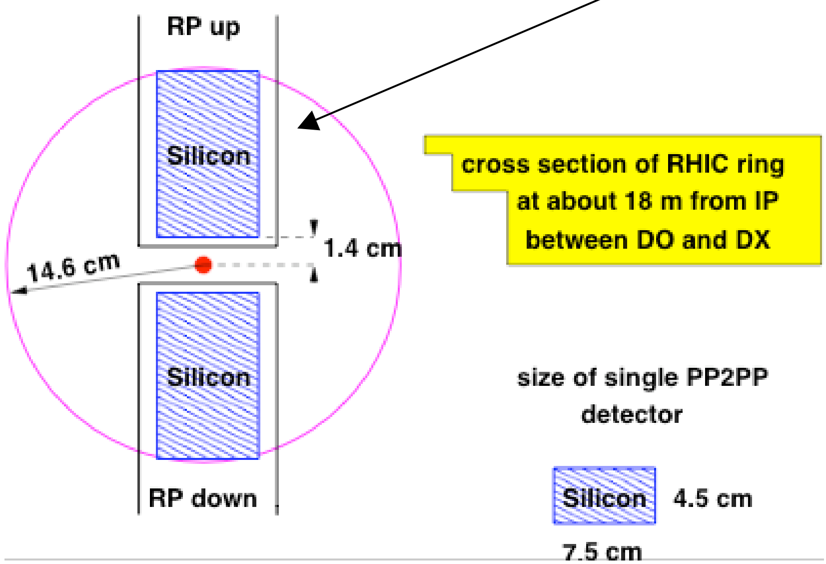
Roman Pots for eRHIC



Roman Pot Spectrometer

$$ep \rightarrow e'p\gamma$$

Generate DVCS events with Frankfurt et al. PRD58 (1998)



For Deeply Virtual Compton Scattering:

- Central tracker
  (for scattered e')
- Central and forward EMCal
  (for scattered e' and γ)
- Roman Pots a la PP2PP@RHIC
  (for scattered p)

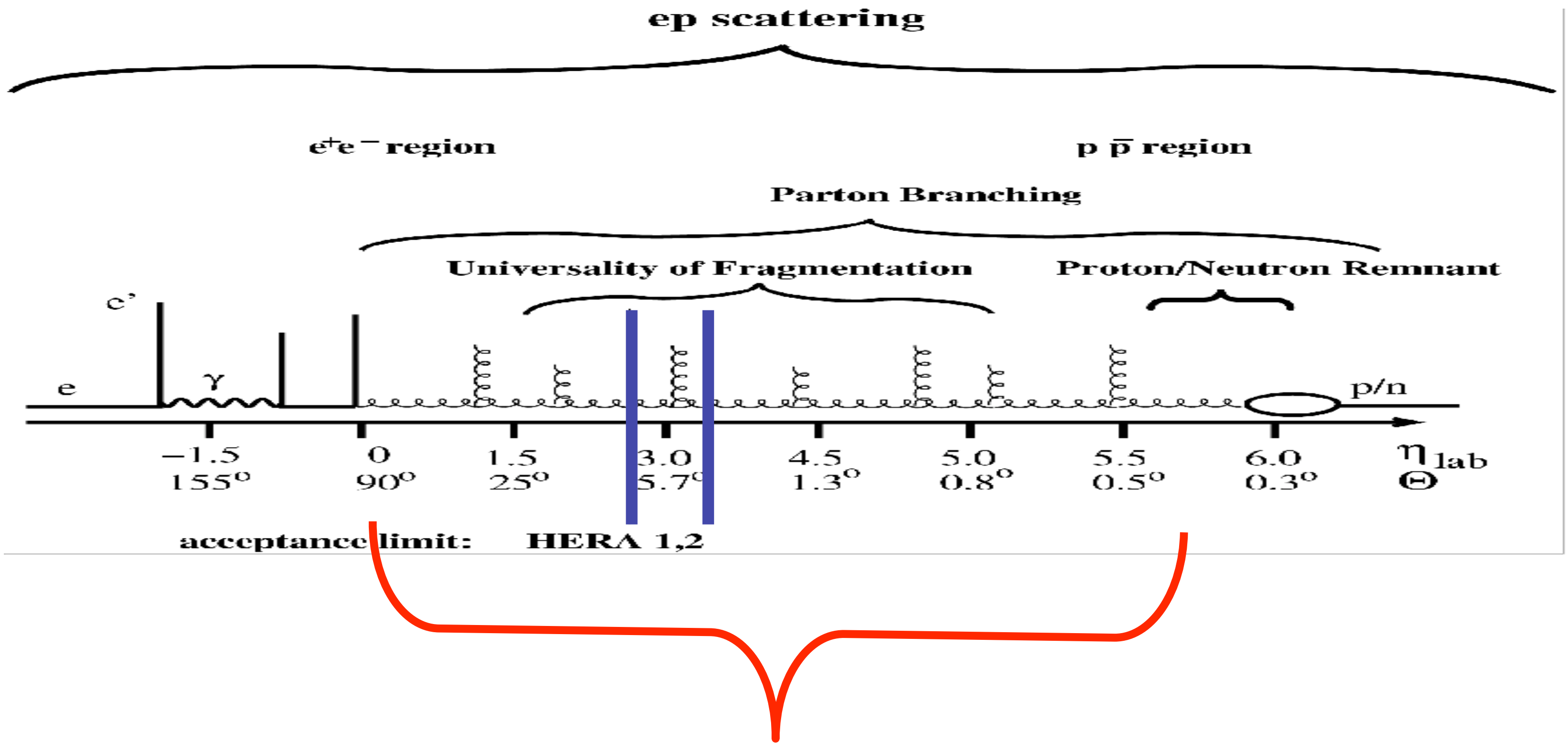
Recent interest in eRHIC from HERA

- Latest from HERA-III: probably no prospects for any Phyiscs beyond 2007
- Physics of strong interaction, main motivation for HERA-III
  - **Understanding the radiation processes in QCD at small and large distances:**
    - Small distance scales: explores parton splitting (DGLAP, BFKL, CCFM…)
    - Large distance scales: transition from pQCD to non-pQCD regime
- Needs specially designed detector to look in to very very forward directions, unprecedented so far at HERA

- Early indications are that eRHIC energies would be sufficient to study this physics… if a specially designed detector is installed in eRHIC

- Effort led by A. Caldwell, I. Abt et al. From Munich plan to submit a LoI

A DETAILED STUDY OF RADIATION IN QCD: FORWARD JETS



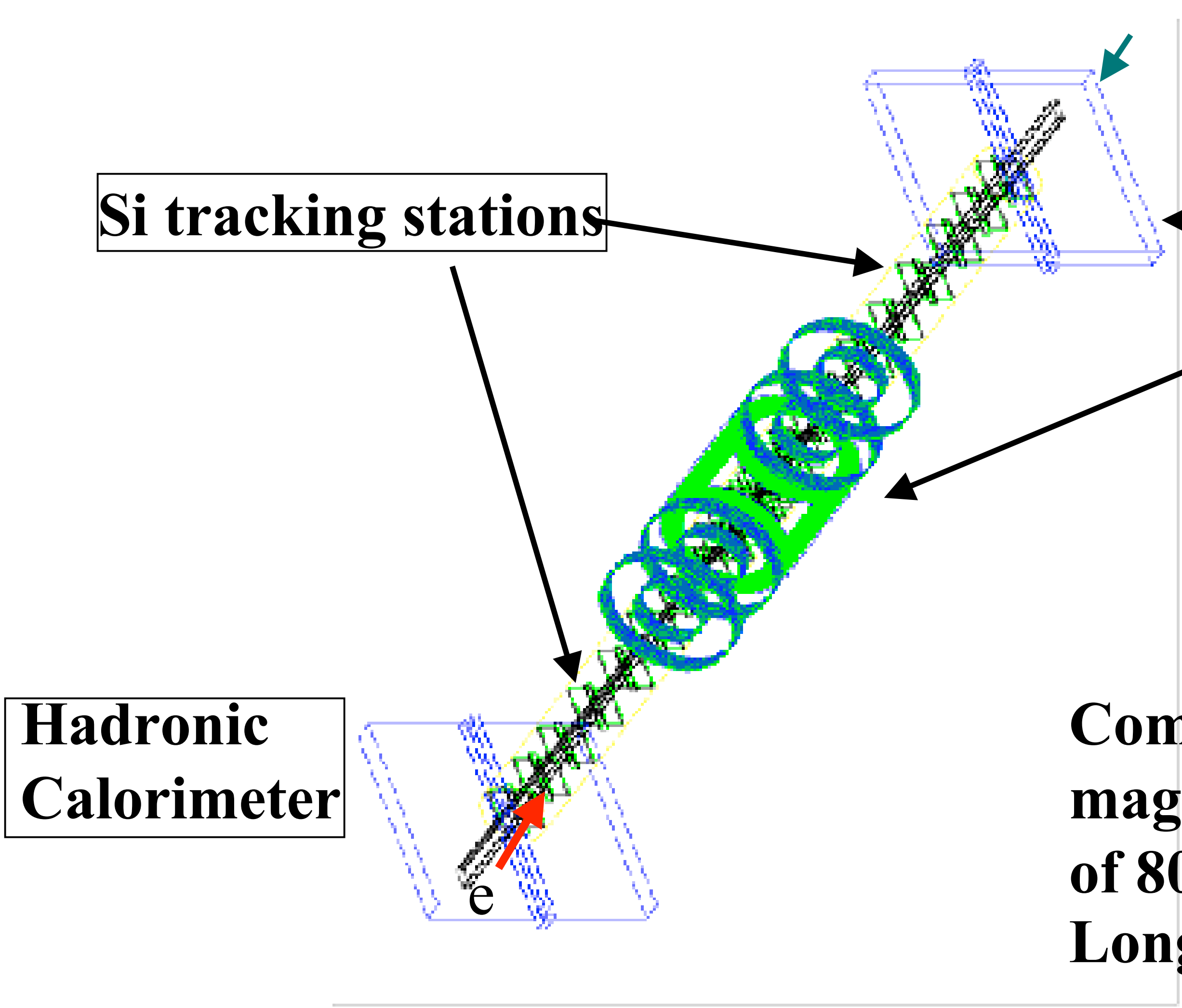
Investigate this region

Large effects are expected in
Forward jet cross sections at high rapidities (also for forward particle production (strange, charm, …)

A. Caldwell et al.

A new detector to study strong interaction physics

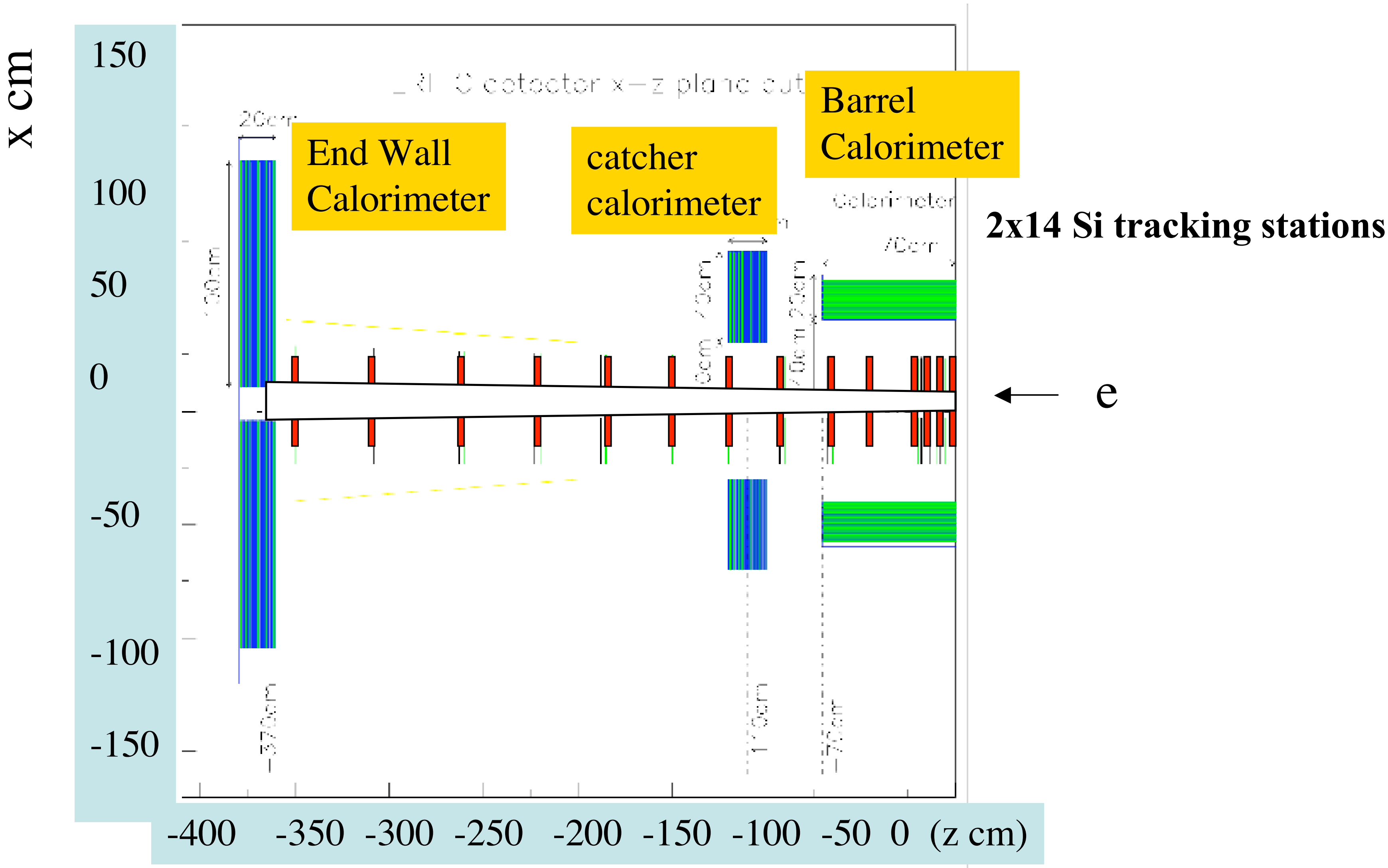
A. Caldwell et al.



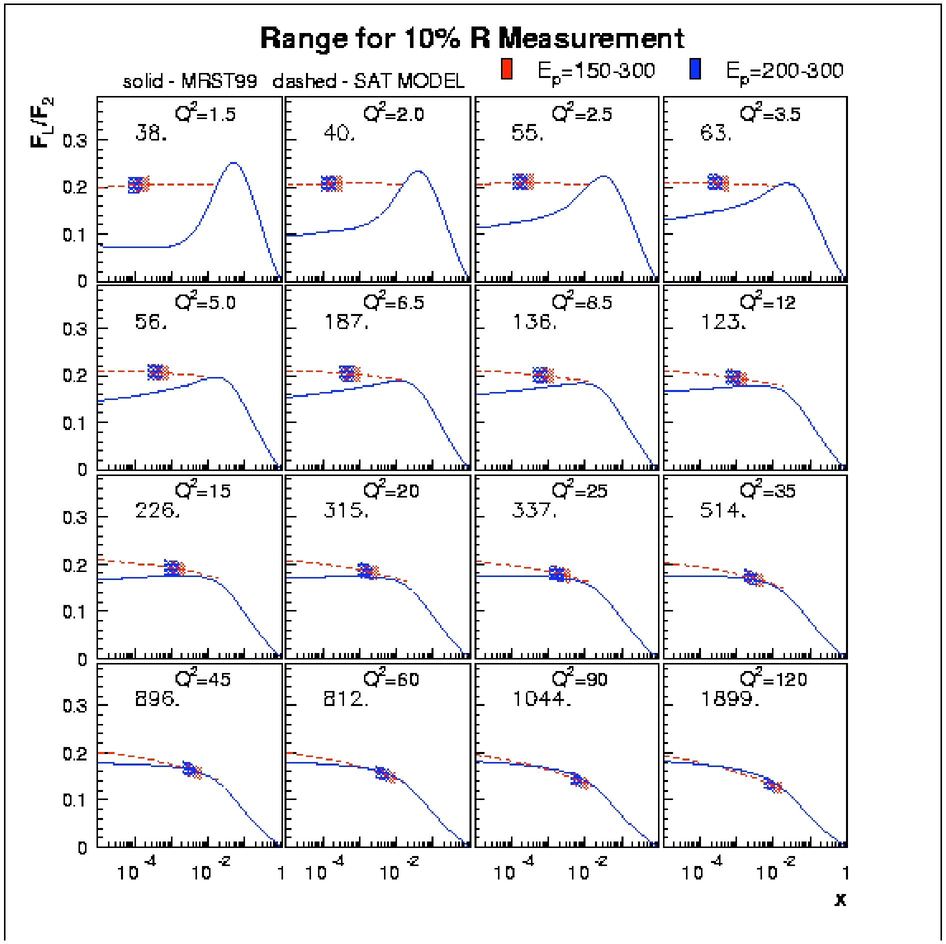
Compact – fits in dipole magnet with inner radius of 80 cm.
Long - |z|≤5 m

A. Caldwell et al.

Low x Detector studies for eRHIC



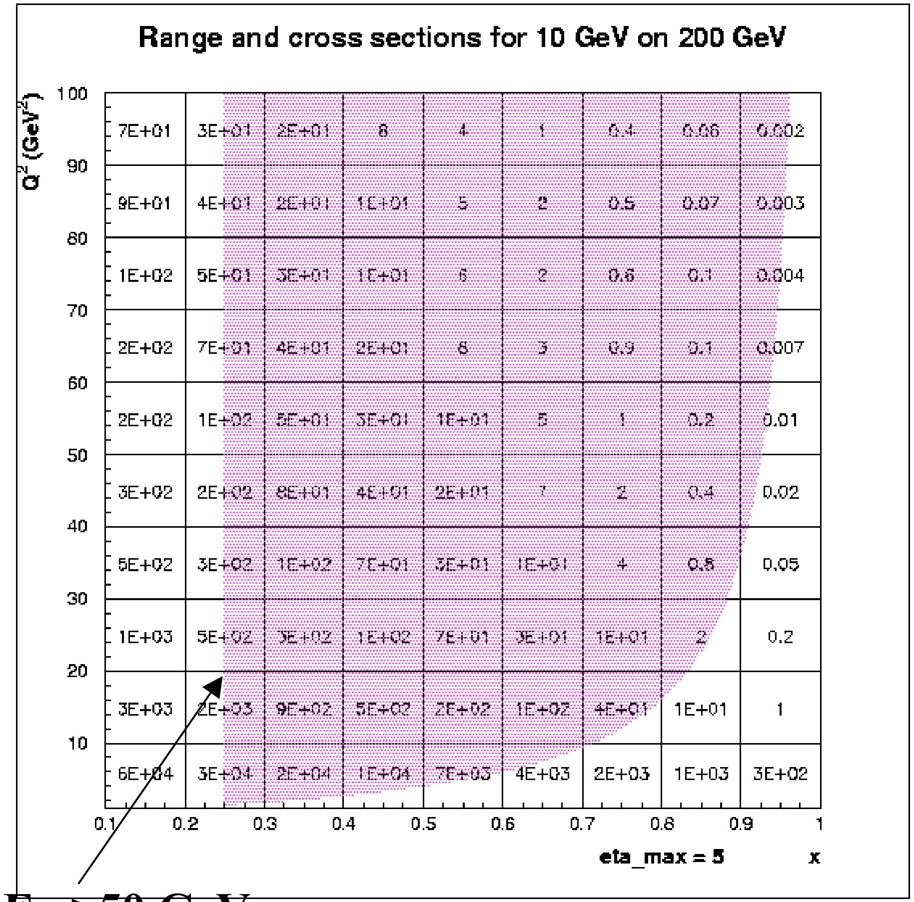
F_L/F_2 vs. x for different Q^2



High x measurement

W^2>5 GeV^2

Cross sections in pb



Q^2 \ x	0.1–0.2	0.2–0.3	0.3–0.4	0.4–0.5	0.5–0.6	0.6–0.7	0.7–0.8	0.8–0.9	0.9–1
90–100	7E+01	3E+01	2E+01	8	4	1	0.4	0.06	0.002
80–90	9E+01	4E+01	2E+01	1E+01	5	2	0.5	0.07	0.003
70–80	1E+02	5E+01	3E+01	1E+01	6	2	0.6	0.1	0.004
60–70	2E+02	7E+01	4E+01	2E+01	8	3	0.9	0.1	0.007
50–60	2E+02	1E+02	5E+01	3E+01	1E+01	5	1	0.2	0.01
40–50	3E+02	2E+02	8E+01	4E+01	2E+01	7	2	0.4	0.02
30–40	5E+02	3E+02	1E+02	7E+01	3E+01	1E+01	4	0.5	0.05
20–30	1E+03	5E+02	3E+02	1E+02	7E+01	3E+01	1E+01	2	0.2
10–20	3E+03	2E+03	9E+02	5E+02	2E+02	1E+02	4E+01	1E+01	1
0–10	6E+04	3E+04	2E+04	1E+04	7E+03	4E+03	2E+03	1E+03	3E+02

Highlights of e-A Physics at eRHIC

- Study of e-A physics in Collider mode for the first time
- QCD in a different environment

- Clarify & reinforce physics studied so far in fixed target e-A & μ-A experiments including target fragmentation

  QCD in: $x > [1/(2m_N R_N)] \sim 0.1$ (high x)

  QCD in: $[1/(2m_N R_A)] < x < [1/(2m_N R_N)] \sim 0.1$ (medium x)

  Quark/Gluon shadowing

  Nuclear medium dependence of hadronization

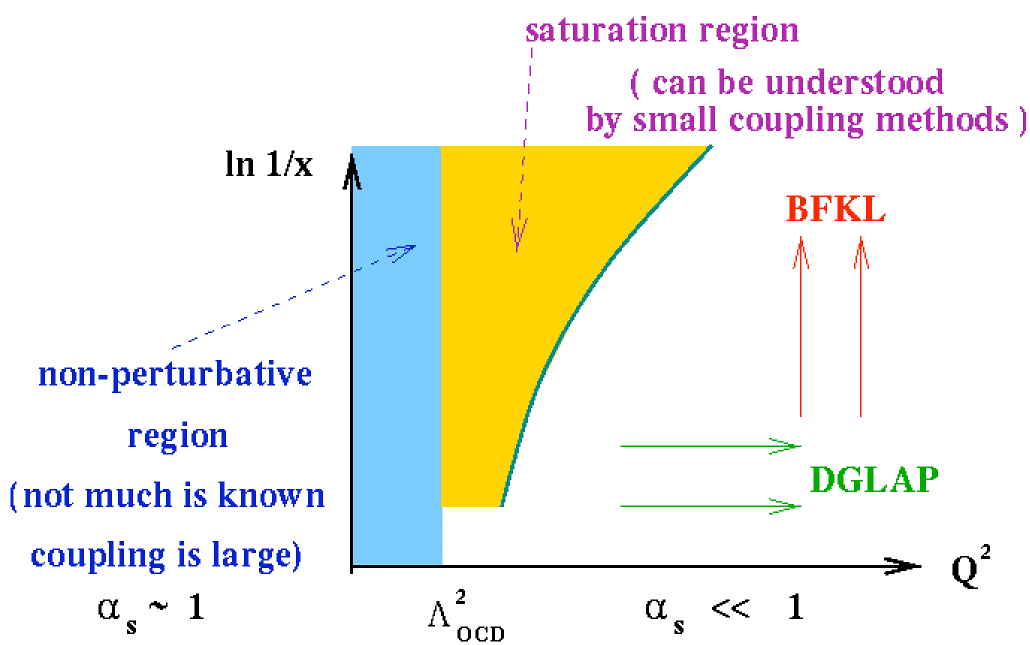
- …. And extend in to a very low x region to explore:

  saturation effects or high density partonic matter also called the Color Glass Condensate (CGC)

  QCD in: $x < [1/(2m_N R_A)] \sim 0.01$ (low x)

Already hints of exciting physics in this from: HERA, RHIC d-A; if true, eRHIC will do a precision measurements in this regime

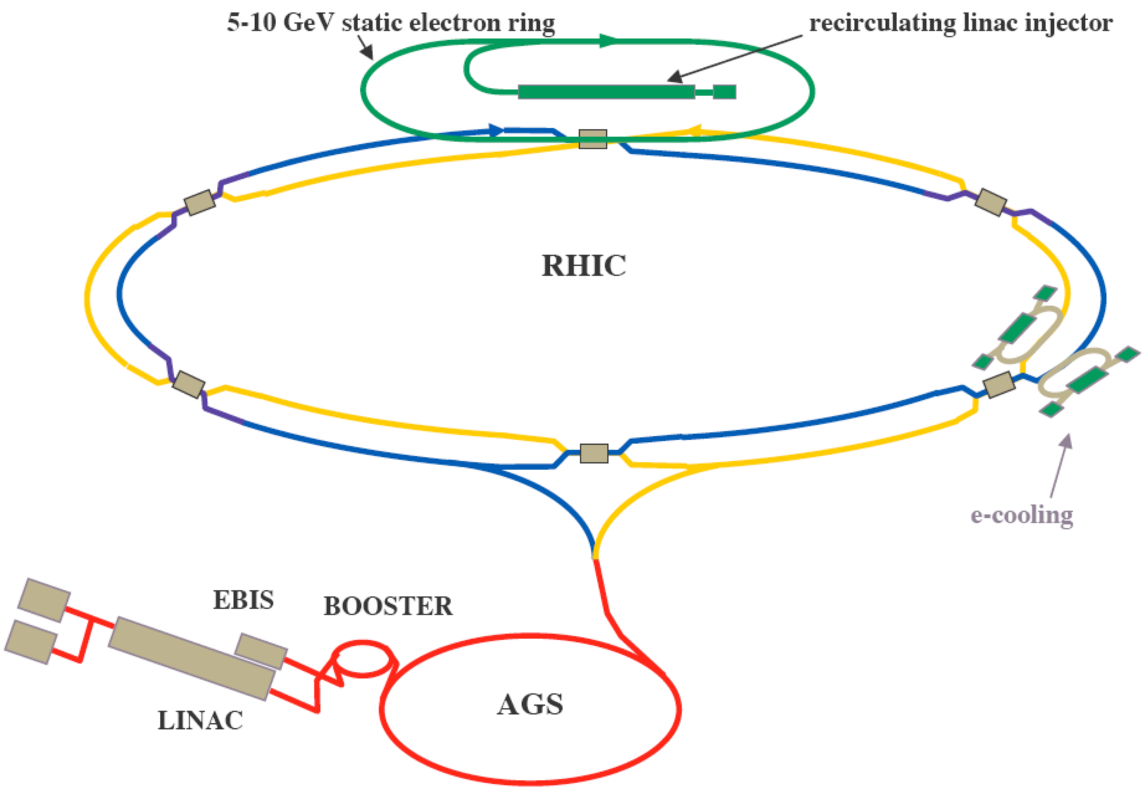
The Saturation Region…



- As parton densities grow, standard pQCD break down.
- Even though coupling is weak, physics may be non-perturbative due to high field strengths generated by large number of partons.
- A new state of matter???

An e-A collider/detector experiment with high luminosity and capability to have different species of nuclei in the same detector would be ideal… ➔ Low x --> Need the eRHIC at BNL

The eRHIC Ring-Ring Lay Out

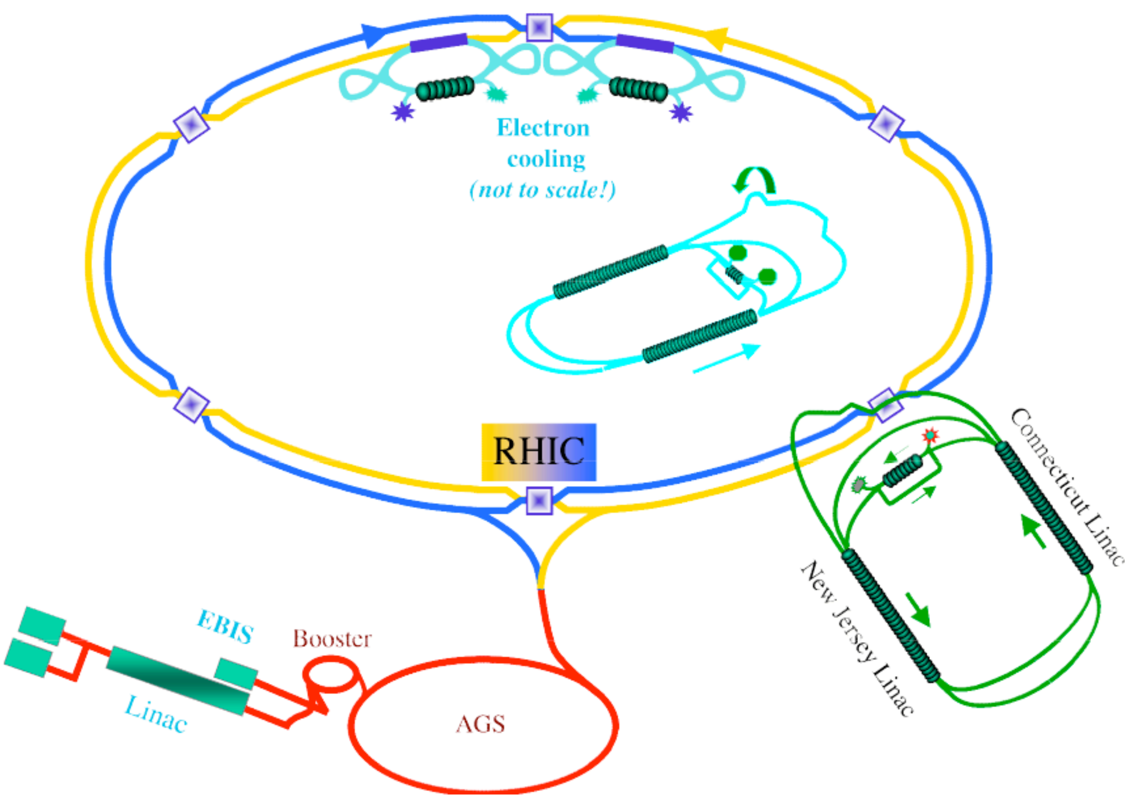


- Full energy injection
- Polarized e- source & unpolarized e+ --> (polarization via synchrotron radiation)
- 10 GeV main design but up to 5 GeV reduction possible with **minimal polarization loss**
- Fill in bunch spacing 35ns
- See eRHIC ZDR for more details

Plus Points: Both positrons/electrons positrons…..
Most advanced in technical feasibility

Minus Points: Multiple detectors or/and Interaction Regions?

eRHIC: Linac-Ring Option



Features:

- Up to L(ep) ~10^{34} $cm^{-2}sec^{-1}$
- Polarization transparency at all energies
- Multiple IRs and detectors
  - 1 low 1 high lumi/pol
- Long element free regions (+/- 5-7 m)

- Full range of CM Energies without loss of polarization & luminosities
- Future upgrades to 20 GeV straightforward

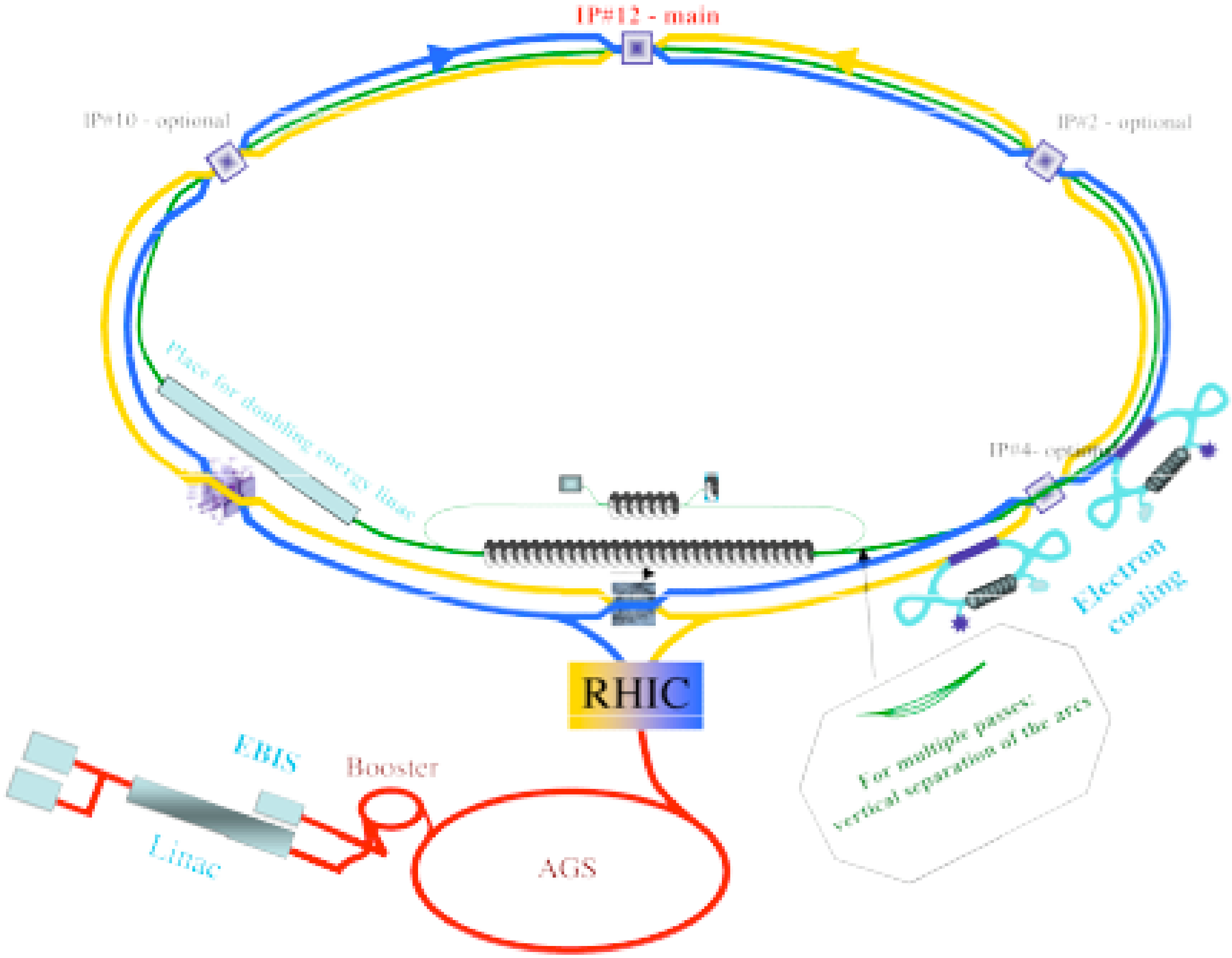
Limitations:

Positron beams not possible

Physics implications?

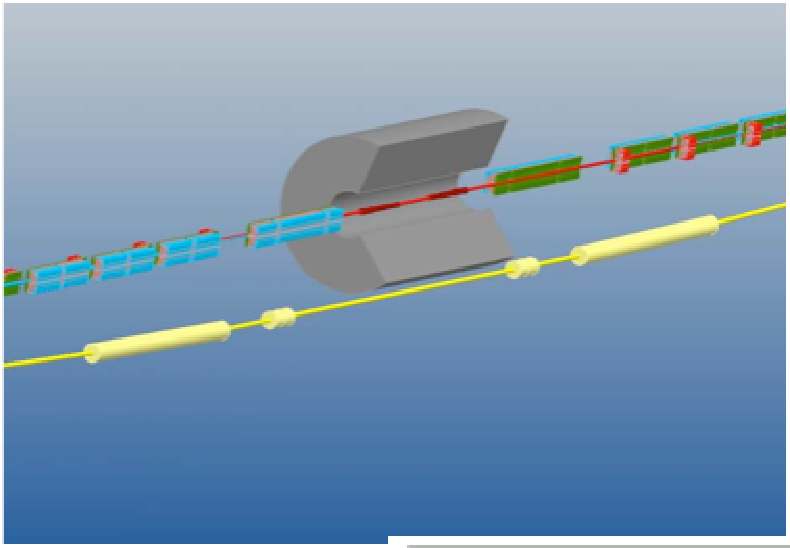
Time to get on mass shell longer

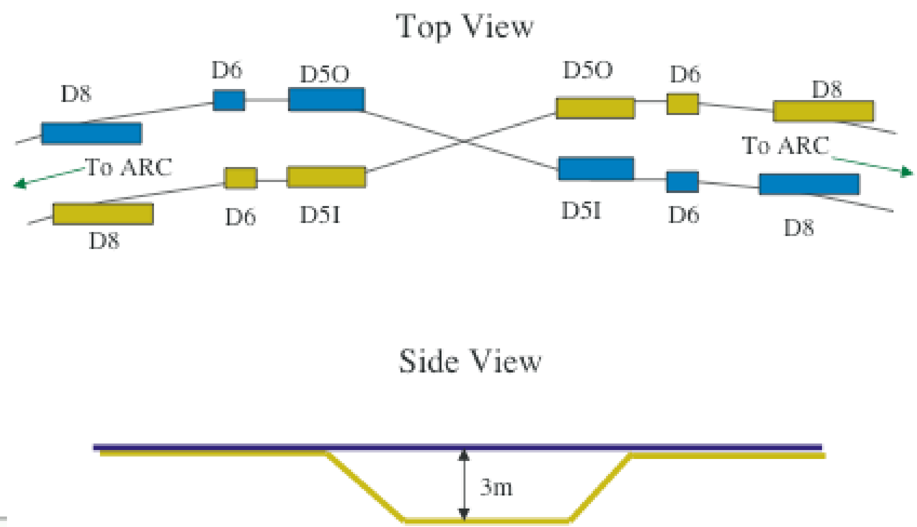
eRHIC Linac-Ring

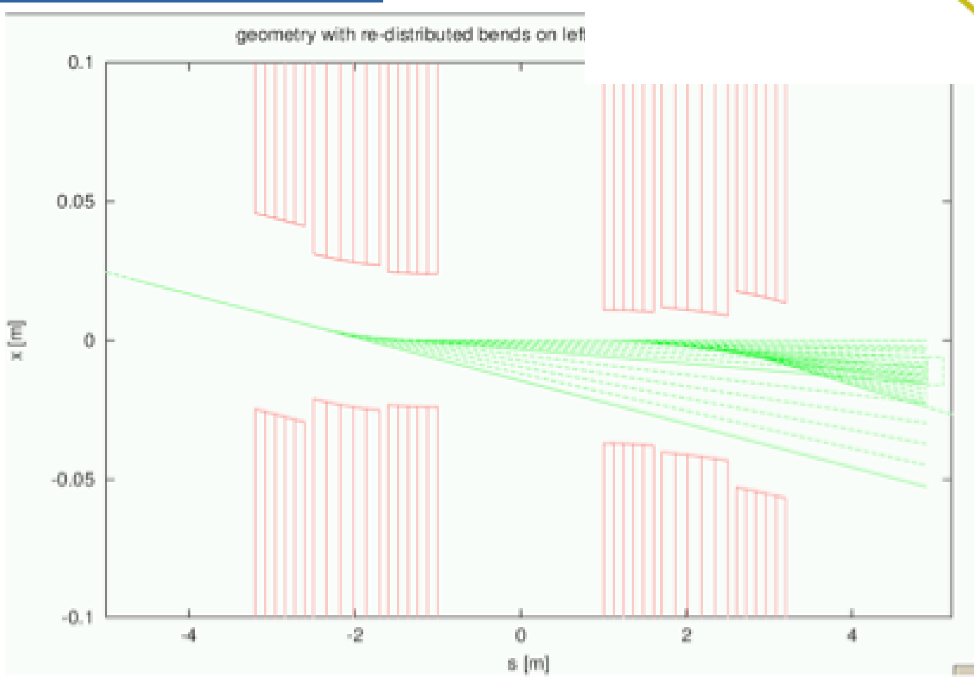


Up to 4 Irs
Up to 20 GeV
Electron beams

IR, Synchrotron Radiation, other Hadron Beam Modification







eRHIC:
Zeroth
Design
Report
April 04

R. Ent & L. Meminga

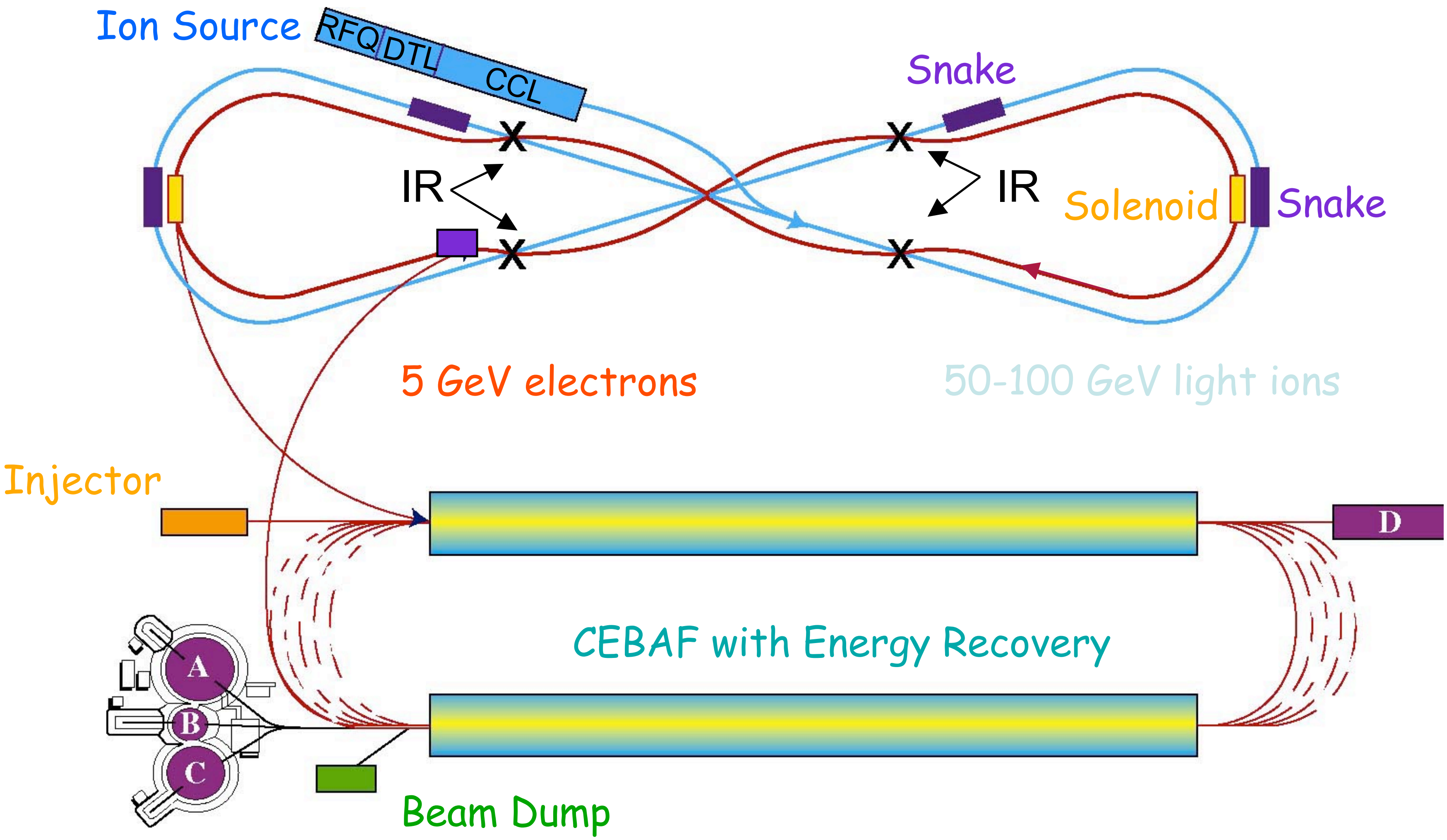
Elic at Jlab

- **A linac-ring collider design (additional circulator ring)**
- Flexible CM Energy: 20-65 for e-p, Ee = 3-7 GeV on Ep = 30-150 GeV
- **Linac:**
  - CEBAF is used for the one-pass acceleration of electrons
  - Energy Recovery is used for rf power savings and beam dump requirements
- **Ring:**
  - Figure 8 storage ring for ions for flexible spin manipulations of all ion species of interest: proton, deuterons and He3
  - Unpolarized beams of up to Calcium
  - Circulator ring for the electrons may be used for high current polarized photo-injector requirements
- Luminosity up to a **few x 10^{34} cm^{-2} sec^{-1}** per interaction region

- **Four interaction regions**

L. Merminga

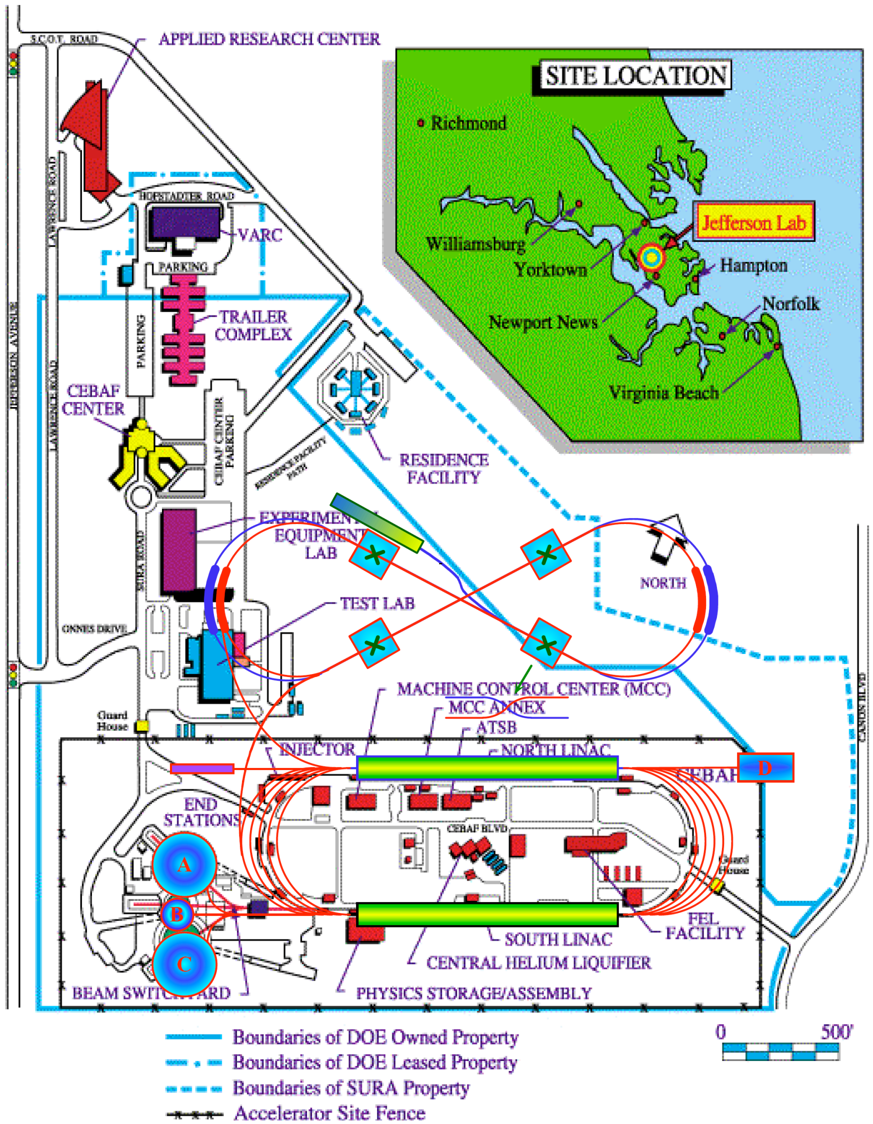
JLAB UPGRADE II: ELIC LAYOUT



One accelerating & one decelerating pass through CEBAF

Elic on Jlab Site
A Perspective

R. Ent



- Use existing CEBAF
- Build new hadron ring: ~1.2 km
- Bunch (collision) spacing ~660 ps --> 2 ns
- 2.5 A e-current
- electron cooling of ions
- Use crab crossings technique

R. Ent, Jlab

ELIC at Jlab

- ELIC parameters are based and guided by the a completely new ring with a promise high spin and luminosity preservation.

- EIC2004 Meeting (ELIC+eRHIC Joint Meeting at Jlab April2004)
  - Uli Winands (SLAC, Summary of Acceleration Session)
  - **"Parameters for accelerator have been pushed to a new territory.."**
    - **The parameters: β, I_b, ring shape, crab crossing efficiency**
  - **"ELIC proposes some very elegant and innovative features worth further investigation"**

L. Merminga

JLAB/ELIC Aggressive R& D Launched

- **Conceptual development:**
  - Circulator ring → to reduce the high current polarized photo-injector and ERL requirement
  - Highest luminosity limits

- **Analysis and simulations:**
  - electron cooling and short bunches
  - beam-beam physics
  - energy recovery linac physics

- **Experimental research effort:**
  - CEBAF-ERL to address ERL issues in large scale systems
  - JLAB FEL (10mA), Cornell/JLAB Prototypes (100 mA), BNL Cooling Prototype (100mA) to address high current ERL issues.

eRHIC Status & Design Ideas

- 2001 LRP: NSAC enthusiastically supported R&D and stated its would be the next major for nuclear physics (after 12 GeV Jlab upgrade)
- 2003 NSAC subcommittee's high recommendation
  - **Level 1 for physics, and level 2 for readiness**
- ***2003 One of the 28 "must-do" projects in the next 20 yrs of the DoE list***
- BNL Management Requested a Zeroth Design Report (ZDR)
  - What can be done with minimal R&D and shortest time scale?
    - **eRHIC: Ring-Ring design (presently: "main design line")**
  - Identify parameters for enhanced machine parameters with identified R&D topics toward significant luminosity enhancement
    - **eRHIC: Ring-Ring design enhancement**
    - **eRHIC: Linac-Ring design**
  - BNL-MIT-Budker-DESY collaboration: ZDR ready April 2004
  - Includes a preliminary but realistic cost estimates
  - Review planned in near future
- **Development on both projects ring-ring & linac-ring will continue in future until the time to make the decisions to freeze technology and design option**

http://www.bnl.gov/eic

Many involved…. But more needed & Welcome!

- **eRHIC steering committee:**
  - A. Caldwell (Munich,MPI), A. Deshpande (SBU), R. Ent (Jlab), G. Garvey (LANL),R. Holt (Argonne), E. Hughes (Caltech), K. Imai (Kyoto), R. Milner (MIT), P. Paul (SBU), J.C.Peng (UIUC), S. Vigdor (Indiana)
- **The eRHIC Accelerator Group**: BNL, MIT/Bates, DESY, PNPI
  - Accelerator ZDR: Ed. V. Ptitsyn (BNL), M. Farkondeh (MIT/Bates)

    and ~40 other collaborators… from MIT, BNL, DESY,Jlab, and PNPI
- **Monte Carlo Simulation & Detector Group** (meets every 3-4 months)
  - A. Bruell (Jlab), A.D.(Stony Brook), R. Ent (Jlab), E. Kinney (Colorado), N. Makins (UIUC), C. Montag (BNL), E. Sichtermann(LBL), B. Surrow (MIT)
    - (also pursue studies for ELIC at Jlab (lower sqrt(s) higher luminosity))
  - AND " eRHIC Collaboration:" ~100 or so people who contributed to the Whitepaper 2001/2
- **Supportive Theorists**:
  - L. McLerran (BNL), R. Venugopalan (BNL), W. Vogelsang (BNL), D. Kharzeev (BNL), M. Stratmann (Regensburg), M. Strikmann(PSU), X. Ji (Maryland), S.Kretzer (BNL), M. Diehl (DESY), and many others!

Concluding Thoughts (I)

- E-RHIC promises to be a truly next generation collider & experiment facility
  - Detector ideas dictated by the physics are developing
  - Over the next couple of years, the focus will be to refine them and come up with a "conceptual design"
  - Many technical challenges, but none deemed unsolvable
  - Critical Importance: integration of detector + interaction region
  - Technically driven begin construction date: earliest 2010/12

- ELIC is even more ambitious in terms of its parameters:
  - A great set of accelerator minds are leading this effort, although it is expected that this will take longer time scale to achieve
  - Physics to be pursued with this collider is being explored now
  - Technically driven construction beginning date: not determined

- ***To fully realize the fruits of these ideas:***
  -- Need keep on a **fast path towards realization**
  -- Critical for the present DIS/Spin NON-RHIC experiments to have something tangible to proceed in a realistic time scale
  -- **We do not want to explore "how late" is "too late"!**
  -- **Next Step 1:** NSAC 2005/6 long range plan approval

Concluding thoughts (II)

- The case for a future ep/eA collider is very strong already and is being continuously improved
- eRHIC at BNL, **ZDR is now ready**; will seek approval from NSAC in the next LRP (2005-2006) and prepare the CD0
  - **Advanced accelerator designs** integrating IR and Detector issues will be ready by that time after a few more iterations with detector design
- ELIC design will solidify in the next few years and a dedicated R&D program will lead and decide the details of luminosity and interaction region issues
- **We hope that the DIS collider seeking communities joins forces now to realize the chance of these future collider(s) for QCD studies**

http://www.bnl.gov/eic --> register email eic/news servers

Thank You