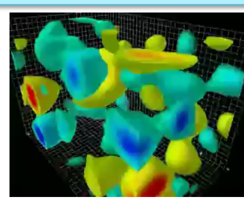
The Electron Ion Collider: Why? How? When?

Precision study & understanding the role of gluons (& sea quarks) in QCD

http://arxiv.org/pdf/1108.1713v2

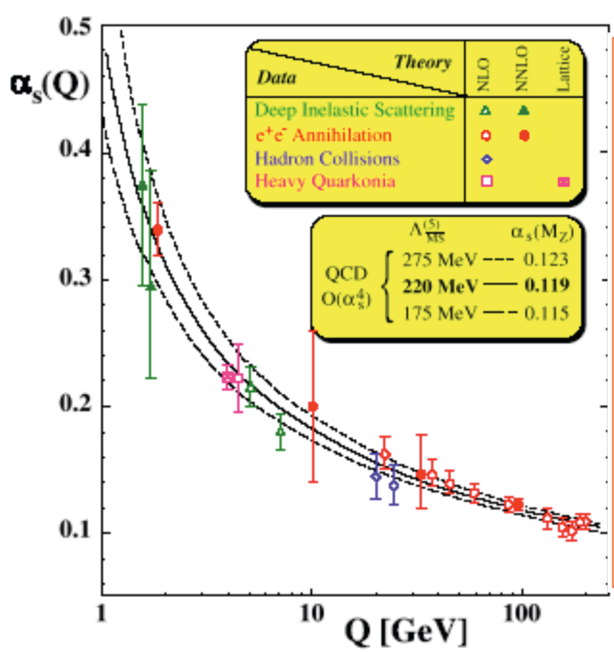


Abhay Deshpande

January 30, 2012

CPTEIC Workshop @ STIαS, Stellenbosch, South Africa

What distinguishes QCD from QED?



Asymptotic Freedom ⇔ antiscreening

$$\text{QCD: } \frac{\partial \alpha_s(Q^2)}{\partial \ln Q^2} = \beta(\alpha_s) < 0$$

Compare

$$\text{QED: } \frac{\partial \alpha_{EM}(Q^2)}{\partial \ln Q^2} = \beta(\alpha_{EM}) > 0$$

D.Gross, F.Willczek, Phys.Rev.Lett 30, (1973)
H.Politzer, Phys.Rev.Lett. 30, (1973)

2004 Nobel Prize in Physics

QCD: The SM of Strong Interactions

2004 For the discovery of asymptotic freedom in QCD

"Folks, we need to stop "testing" QCD

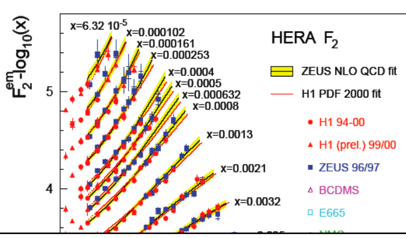
and start understanding it"

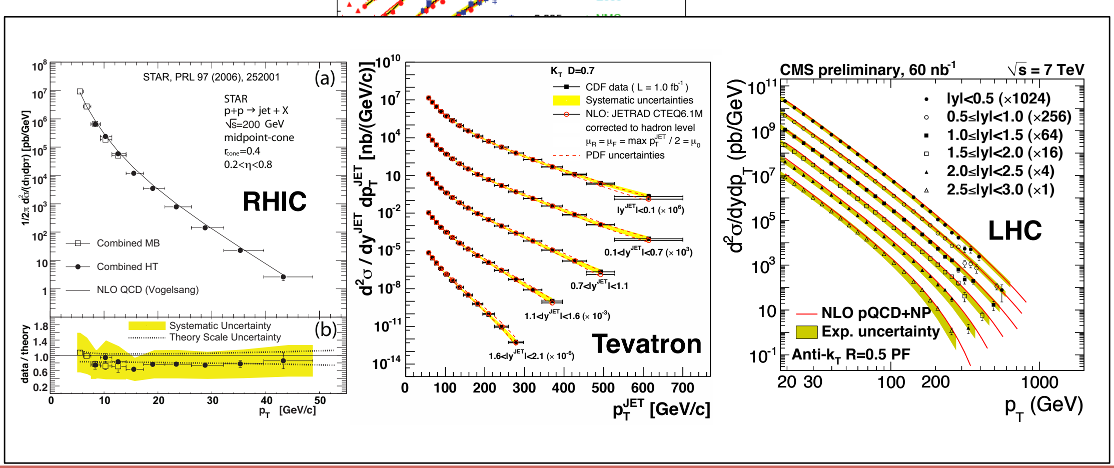
Yuri Dokshitzer

1998, ICHEP Vancouver, BC , Conference Summary Talk

Success of pQCD at High Q: Jet Cross section

- Input:
  - $F_2(x,Q^2)$ … RA
  - Next to I … QCD



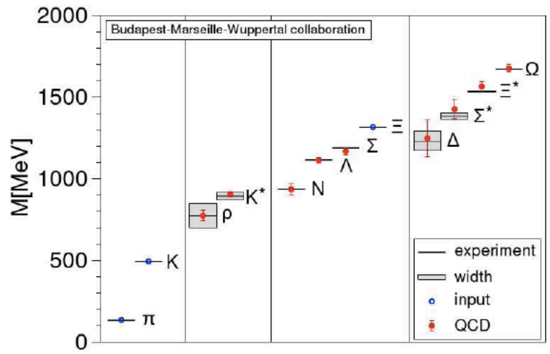


QCD definitely correct

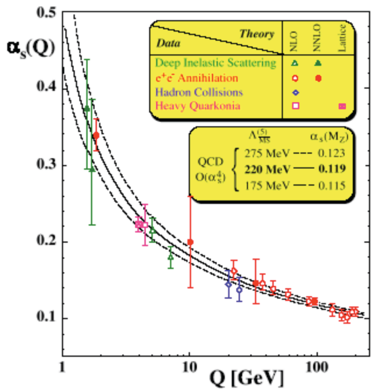
Lattice QCD

- Starting from QCD lagrangian → Static properties of hadrons: hadron mass spectrum

BUT, No guidance on partonic dynamics



Durr et al '08



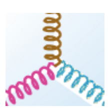
Perturbative QCD

- Calculations possible when ***coupling is small, at high Q***

BUT, problematic at low Q → fast rise of $\alpha_S(Q)$

Generation of Mass – Gluons in QCD

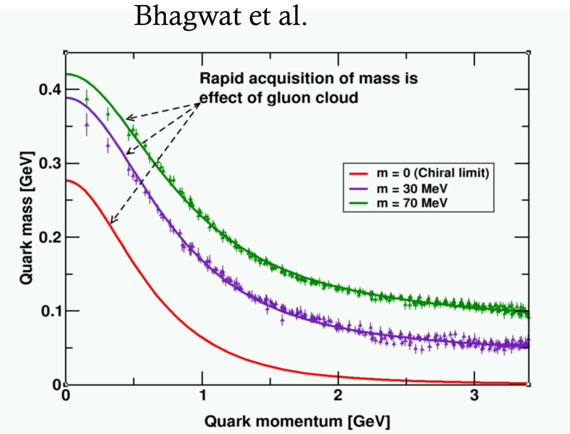
- Protons and neutrons form most of the mass of the **visible universe**
- 99% of the nucleon mass is due to **self generated gluon fields**
  - **Similarity** between p, n mass indicates that **gluonic interactions are identical** & overwhelmingly important



- Lattice QCD supports this

Higgs Mechanism, often credited with mass generation, is of no consequence

Bhagwat et al.



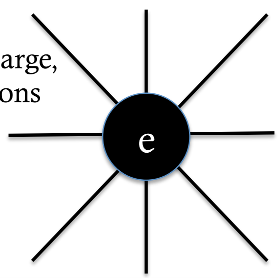
Gluon self-interaction in QCD

Dynamical generation & self-regulation of hadron masses

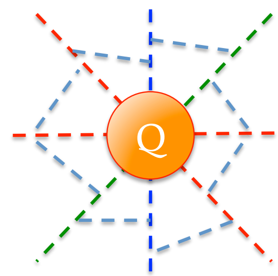
F. Wilczek in "Origin of Mass"

Its enhanced coupling to soft radiation… means that a 'bare" color charge, inserted in to empty space will start to surround itself with a cloud of virtual color gluons. These color gluon fields themselves carry color charge, so they are sources of additional soft radiation. The result is a self-catalyzing enhancement that leads to a ***runaway growth****. A small color charge, in isolation builds up a big color thundercloud….****theoretically the energy of the quark in isolation is infinite… having only a finite amount of energy to work with, nature always finds a way to short cut the ultimate thundercloud"***

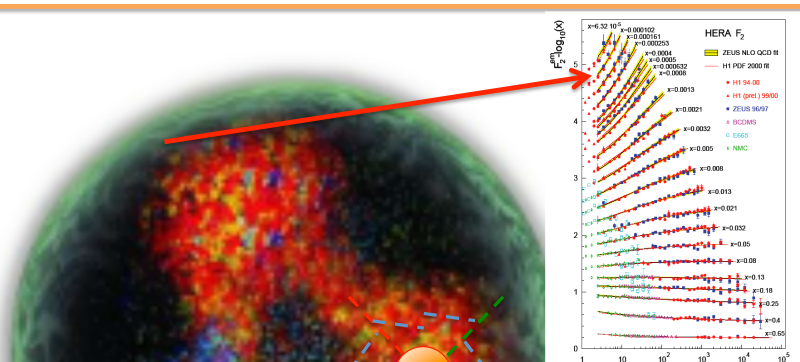
Electric charge,
lines: photons



Color charge
gluons



What limits the "thundercloud"?



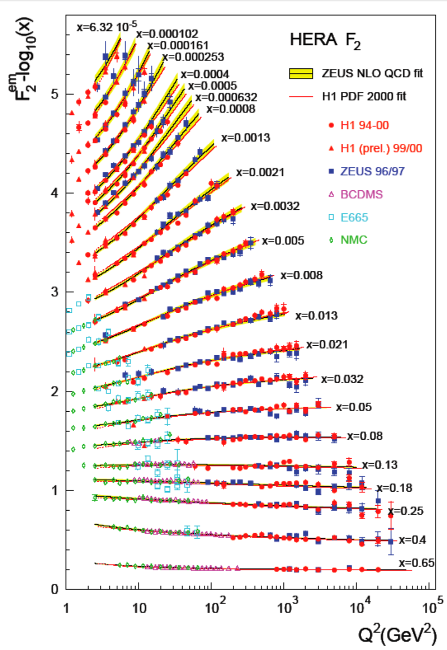
- Partial cancellation of quark-color-charge in color neutral finite size of the hadron (confinement) is responsible, ***but***
- **Saturation of gluon densities due to gg→ g (gluon recombination) must also play a critical role regulating the hadron mass**

Need to experimentally explore and study ***many body dynamics***
a) regions of ***quark-hadron transition*** and
b) non-linear QCD regions of extreme ***high gluon density***

What is the role of gluons at high energy?

HOW WELL DO WE UNDERSTAND GLUONS?

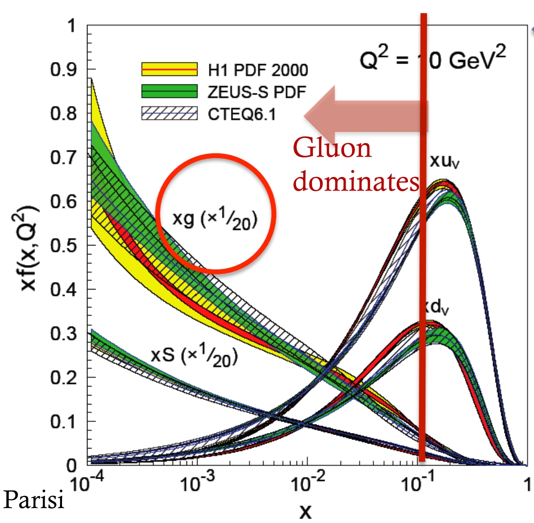
Measurement of Glue at HERA



- Scaling violations of $F_2(x,Q^2)$

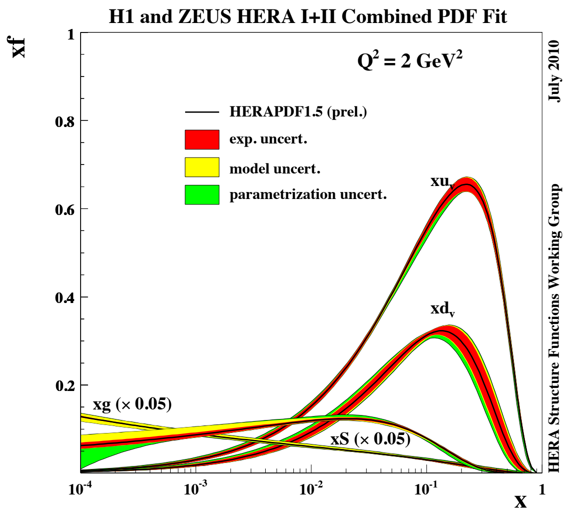
$$\frac{\partial F_2(x,Q^2)}{\partial \ln Q^2} \propto G(x,Q^2)$$

- NLO pQCD analyses: fits with **linear** DGLAP* equations

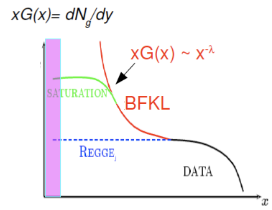


*Dokshitzer, Gribov, Lipatov, Altarelli, Parisi

Gluon distribution at low-x understood?



- Indefinite rise: Infinite high energy hadron cross section?
  - Could this be an **artifact** of using of **linear** DGLAP in gluon extraction?

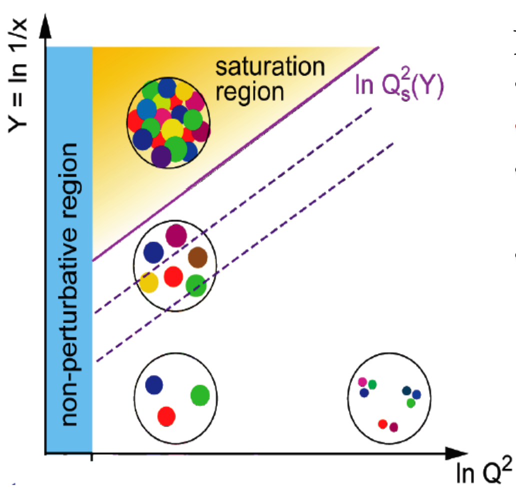


- How would we find out?

No higher energy e-p collider than HERA! → other than "LHeC"
OR
→ Nuclei: naturally enhance the densities of partonic matter
Why not use Nuclear DIS at high energy?

Physics at Low x & Color Glass Condensate

See Ann. Rev. Nucl Part (60) 2010 F. Gelis et al., , arXiv:1002.0333)



Method of including **non-linear** effects
- McLerran & Venugopalan
- Small coupling, high gluon densities
- BK/JMWLK equations lead to a Saturation Scale $Q_S(Y)$
- Wave function: Color Glass Condensate in infinite momentum frame

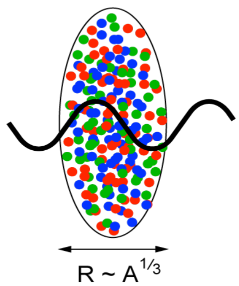
Infinite Momentum Frame (IMF)
- BFKL (linear QCD) gluon splitting functions → higher gluon density
- BK (non linear) recombination of gluons → restricts gluon density

At Q_S gluon emission balances the recombination

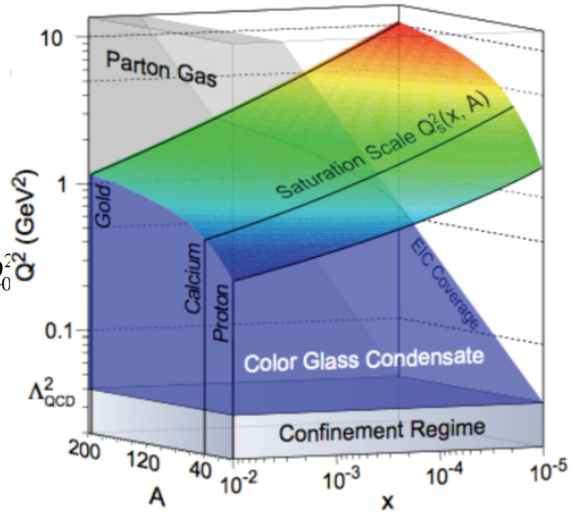
How to reach the high gluon density regions?

More powerful e-p collider
CME~ 1-2 TeV instead of HERA's 300 GeV

Alternatively,
Probe the nucleons in ***NUCLEI*** coherently…. $(Q_s^A)^2 \approx cQ_0^2 A^{1/3}$

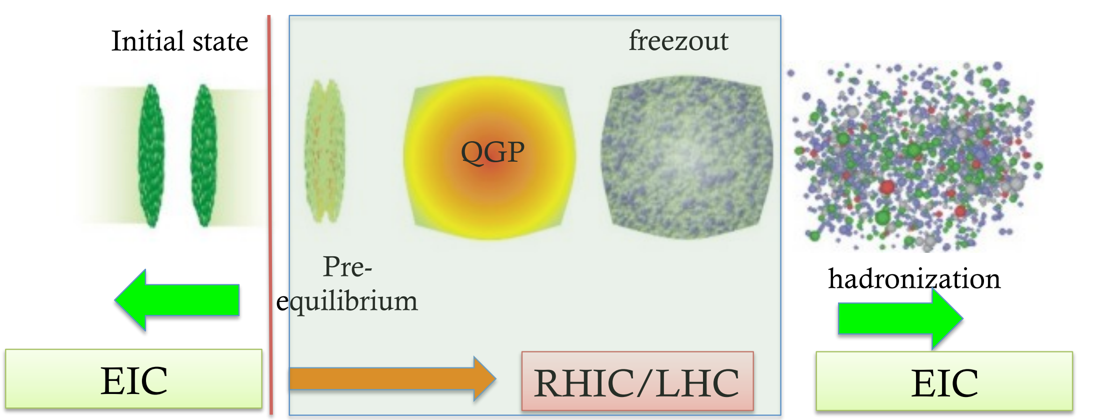


$L \sim (2m_N x)^{-1} > 2 R_A \sim A^{1/3}$



Enhancement of Q_S with A, not energy

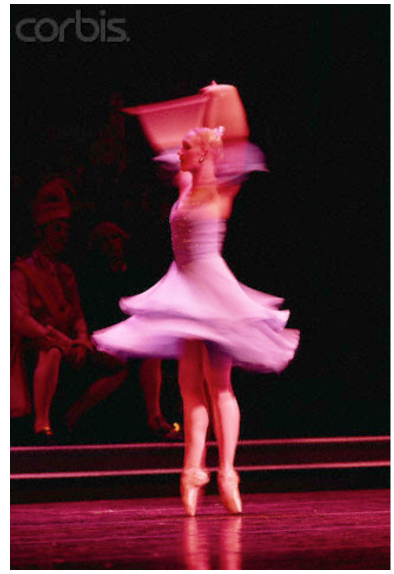
EIC and RHIC/LHC (Heavy Ion)



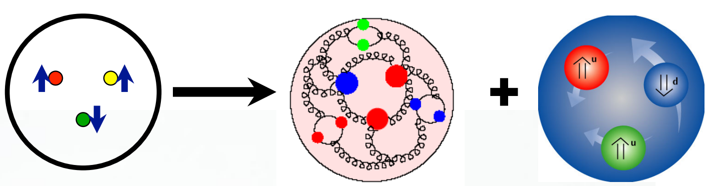
A decadal plan is being launched to characterize the "QGP"
To understand "QGP" fully, we need to understand:
The initial state i.e. the nucleus & hadronization
Deeper Connection: many body interactions of parton in QCD

UNDERSTANDING NUCLEON SPIN:

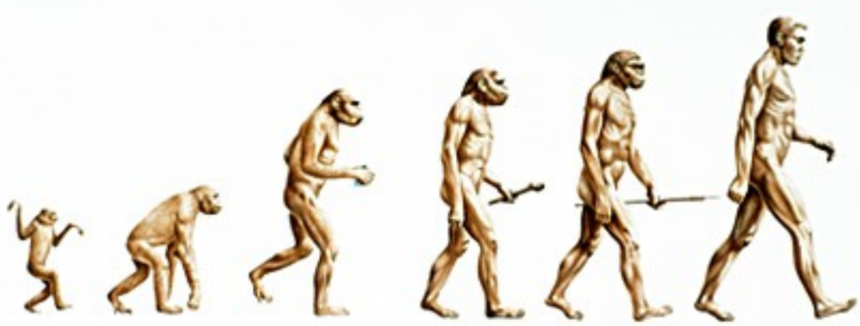
WHAT ROLE DO GLUONS PLAY?

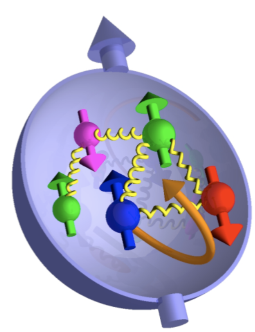


Evolution: Our Understanding of Nucleon Spin



1980s 1990/2000s



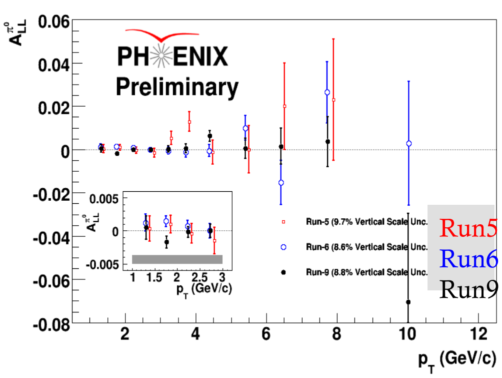


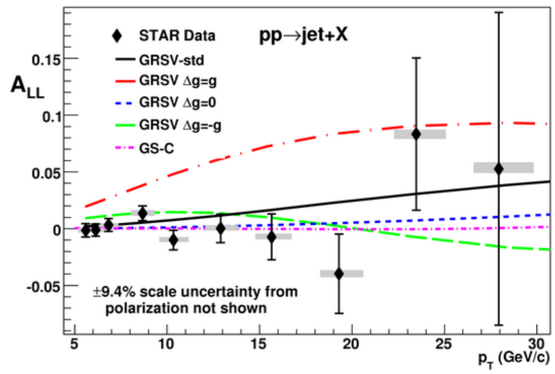
We have come a long way, but do we understand nucleon spin?

Status of "Nucleon Spin ~~Crisis~~ Puzzle"

$$\frac{1}{2} = \frac{1}{2}\Delta\Sigma + L_q + \Delta g + L_g$$

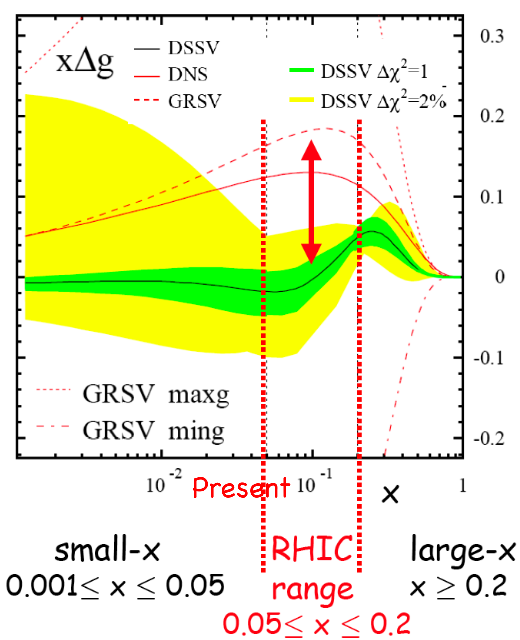
- We know how to determine ΔΣ and Δg precisely: data+pQCD
  - ½ (ΔΣ) ~ 0.15 : From fixed target pol. DIS experiments
  - RHIC-Spin: Δg *not large* as anticipated in the 1990s, but *measurements & precision needed at low & high x*





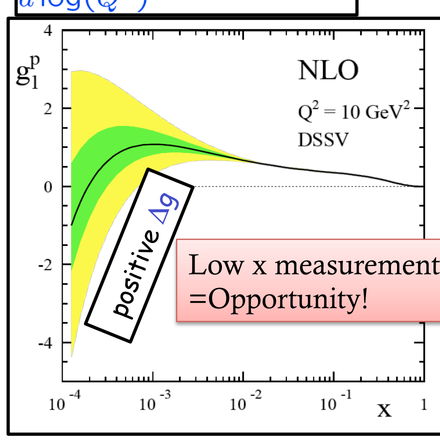
Δg(x) @ Q²=10 GeV²

de Florian, Sassot, Stratmann & Vogelsang



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

$$\frac{dg_1}{d\log(Q^2)} \propto -\Delta g(x, Q^2)$$



Status of "Nucleon Spin ~~Crisis~~ Puzzle"

$$\frac{1}{2} = \boxed{J_q} + J_g = \boxed{\frac{1}{2}\Delta\Sigma + L_q} + \Delta g + L_g$$

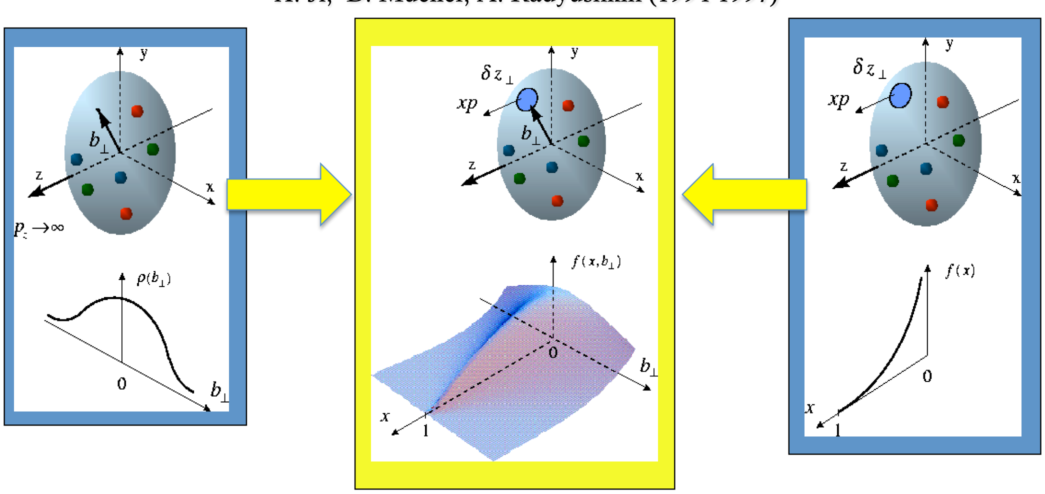
- We know how to measure ΔΣ and ΔG precisely using pQCD
  - ½ (ΔΣ) ~ 0.15 : From fixed target pol. DIS experiments
  - RHIC-Spin: ΔG *not large* as anticipated in the 1990s, but *measurements & precision needed at low & high x*
- Generalized Parton Distributions: H,E,E',H' → Connection to partonic OAM
  - Quark GPDs → J_q: 12GeV@JLab & COMPASS@CERN
  - Gluons @ low x → J_g → will need the future EIC!
- (2+1)D tomographic image of the proton…. Transverse Mom. Distributions
  - **2: x,y position and +1:momentum in z direction**

Towards Full understanding of transverse and longitudinal hadron structure including spin!

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

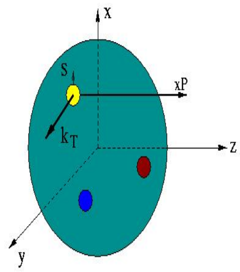
Structure functions, quark longitudinal momentum & helicity distributions

Unified View of Nucleon Structure

6D Dist.

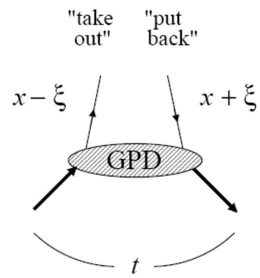
$W_p^u(x,k_T,\boldsymbol{r})$ Wigner distributions

$d^3\boldsymbol{r}$ $\quad$ $d^2k_T\, dr_z$



TMD PDFs
$f_1^u(x,k_T)$, .. $h_1^u(x,k_T)$

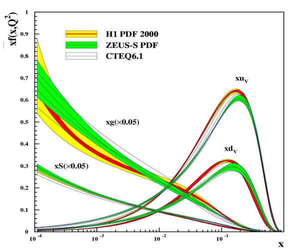
GPDs/IPDs



3D imaging

d^2k_T $\quad$ d^2r_T

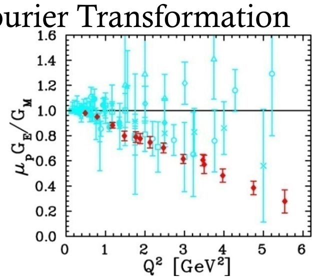
dx &
Fourier Transformation



PDFs
$f_1^u(x)$, .. $h_1^u(x)$

1D

Form Factors
$G_E(Q^2)$, $G_M(Q^2)$



Do we really "understand" QCD?

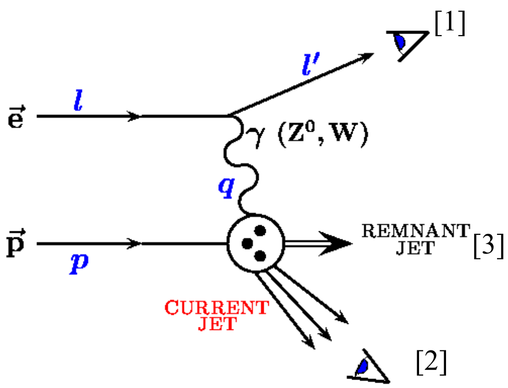
While there is no reason to doubt QCD, our level of understanding of QCD remains extremely unsatisfactory: both at low & high energy

- Can we explain basic properties of hadrons such as mass and spin from the QCD degrees of freedom at low energy?
- What ***are*** the effective degrees of freedom at high energy?
- How do these degrees of freedom interact with each other and with other hard probes?
- What can we learn from them about confinement & universal features of the theory of QCD?

After ~20+ yrs of experimental & theoretical progress, we are only *beginning to understand* the many body dynamics of QCD

The Proposal:

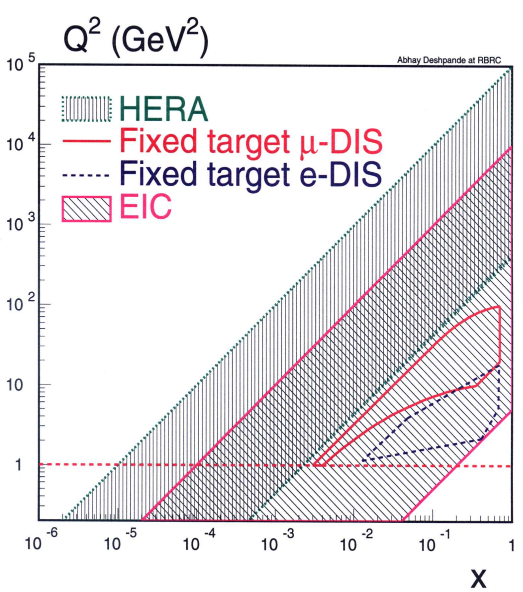
Future DIS experiment at an Electron Ion Collider: A high energy, high luminosity (polarized) *ep* and eA collider and a suitably designed detector



Measurements:
[1] → Inclusive
[1] and [2] **or** [3] →Semi-Inclusiv
[1] and [2] **and** [3] →Exclusive

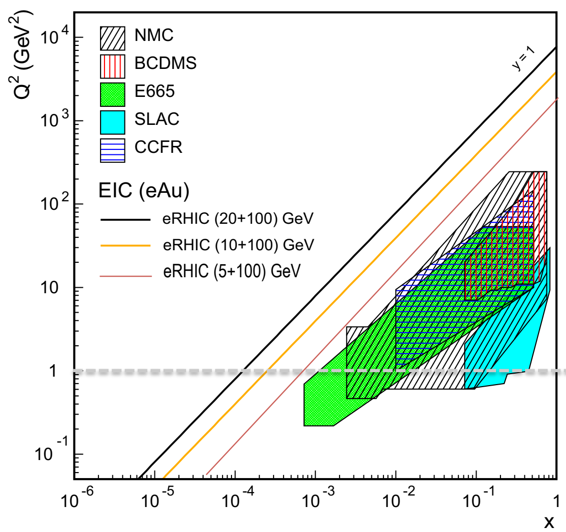
Inclusive → Exclusive
Low → High Luminosity
Demanding Detector capabilities

EIC : Basic Parameters (e-p)



- E_e=10 GeV (5-30 GeV variable)
- E_p=250 GeV (50-275 GeV Variable)
- Sqrt(S_{ep}) = 100 (30-180) GeV
- x_{min} ~ 10^{-4}; Q^2_{max}~ 10^4 GeV
- Polarization ~ 70%: e,p, D/^{3}He
- Luminosity L_{ep} = $10^{33\text{-}34}$ cm^{-2}s^{-1}
- Minimum Integrated luminosity:
  - 50 fb^{-1} in 10 yrs (100 x HERA)
  - Possible with 10^{33} cm^{-2}s^{-1}
  - Recent projections *much higher*

EIC : Basic Parameters (e-A)



- E_e=10 GeV (5-30 GeV variable)
- E_A=100 GeV (20-110 GeV Variable)
- $Sqrt(S_{eA})$ = 63 (20-115) GeV
- x_{min} ~10^{-4} ;
- Q^2_{max} ~ 8 x10^3 GeV

Nuclei:

- Proton → Uranium
- $L_{eA}/N = 10^{33\text{-}34}\ cm^{-2}s^{-1}$

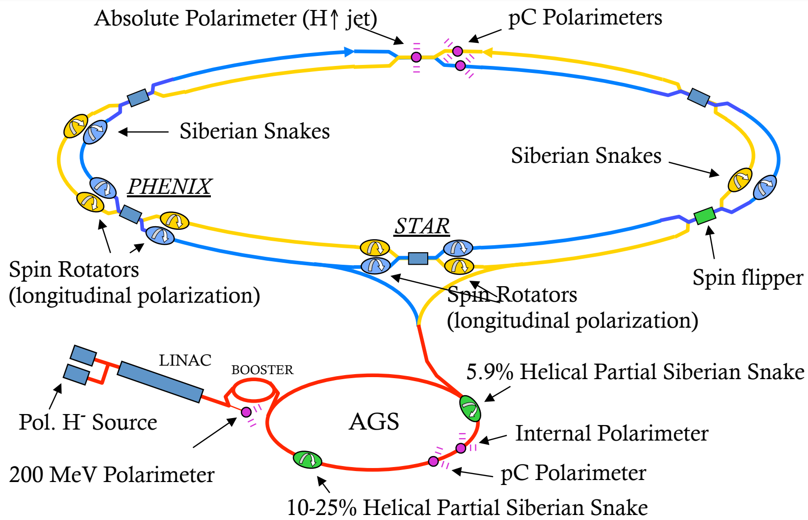
Machine Designs

eRHIC at Brookhaven National Laboratory
using the existing RHIC complex

ELIC at Jefferson Laboratory using the
Upgraded 12GeV CEBAF

Both planned to be STAGED

RHIC as a Polarized Proton Collider

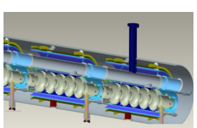


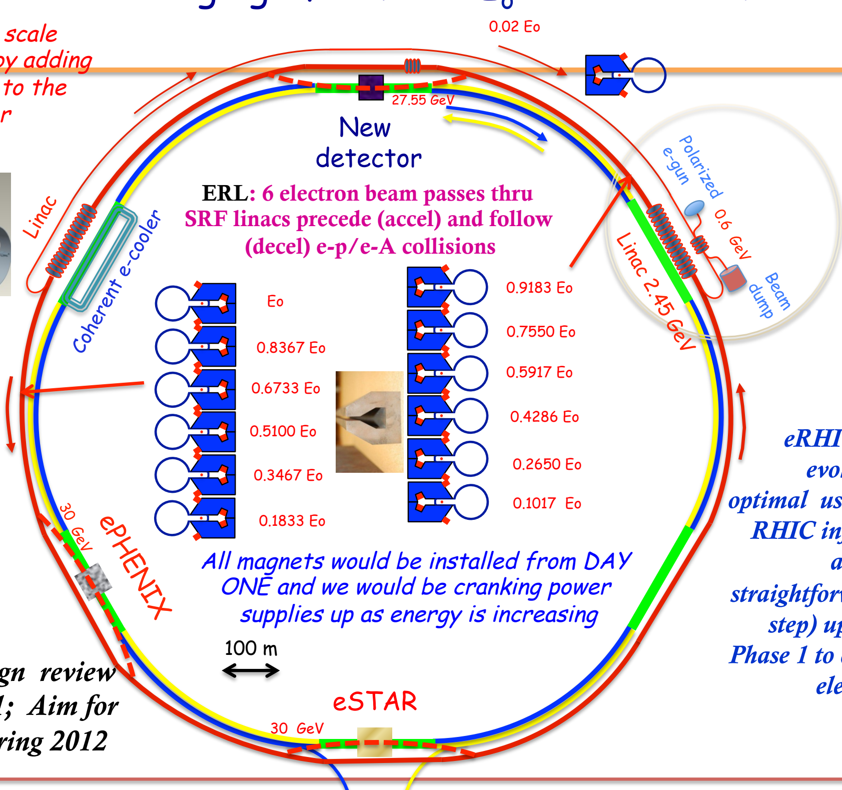
Without Siberian snakes: $\nu_{sp} = G\gamma = 1.79$ E/m → ~1000 depolarizing resonances
With Siberian snakes (local 180° spin rotators): $\nu_{sp} = ½$ → no first order resonance
Two partial Siberian snakes (11° and 27° spin rotators) in AGS

Staging of eRHIC: E_o : 5 -> 30 GeV

All energies scale proportionally by adding SRF cavities to the injector

E/Eo
0.0200
0.1017
0.1833
0.2650
0.3467
0.4283
0.5100
0.5917
0.6733
0.7550
0.8367
0.9183
1.0000



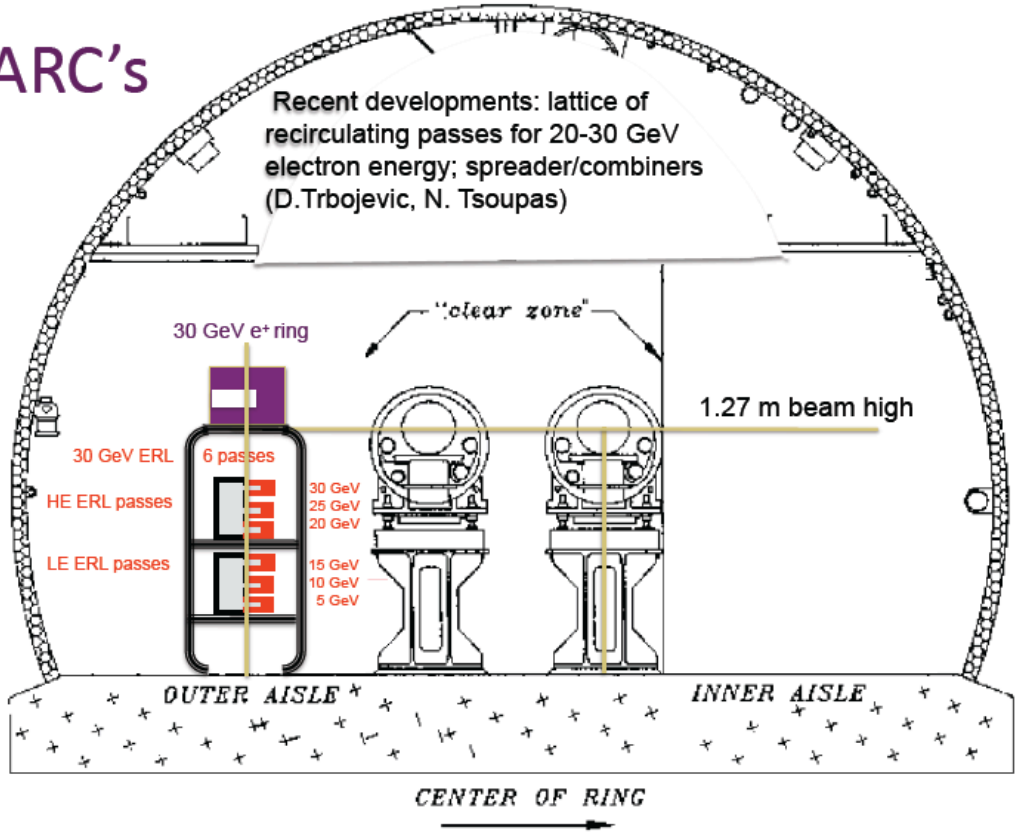


V. Litvinenko

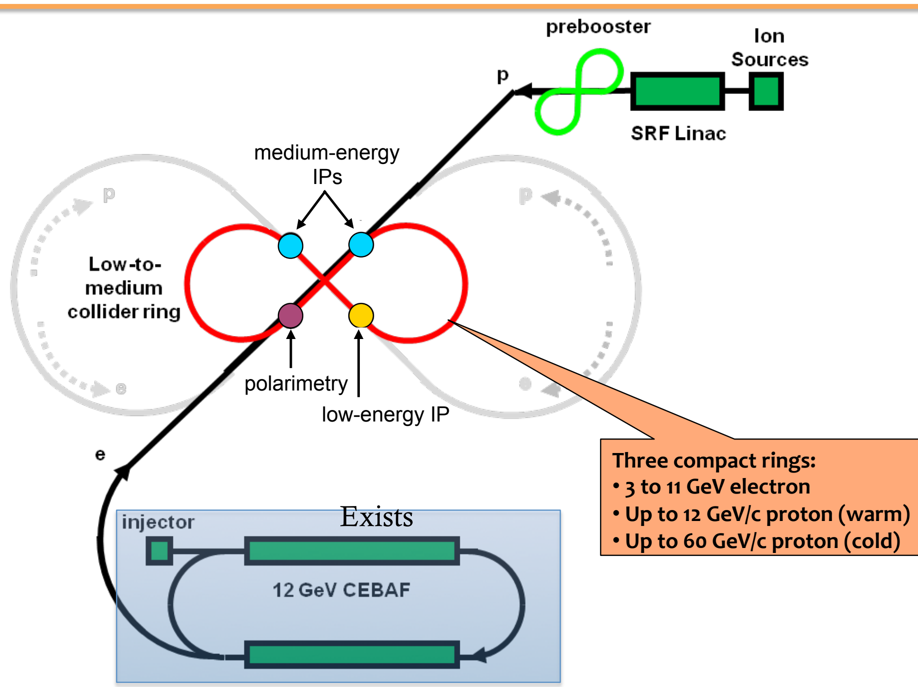
Technical design review Aug. 1-3, 2011; Aim for cost review Spring 2012

eRHIC design has evolved to make optimal use of existing RHIC infrastructure, and to permit straightforward (multi-step) upgrades from Phase 1 to eventual full electron energy

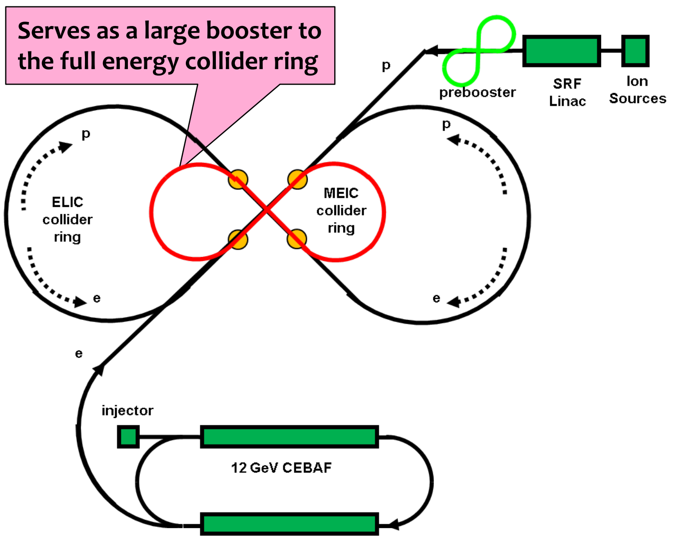
ARC's

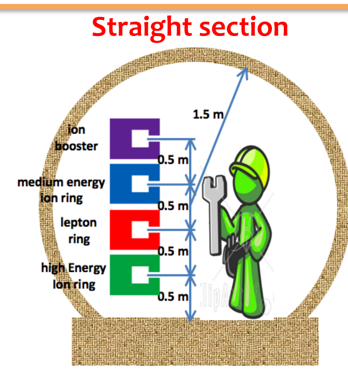


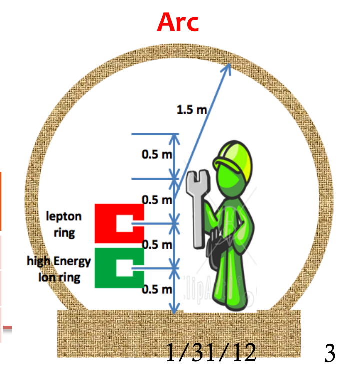
MEIC: Medium Energy EIC



ELIC: High Energy & Staging





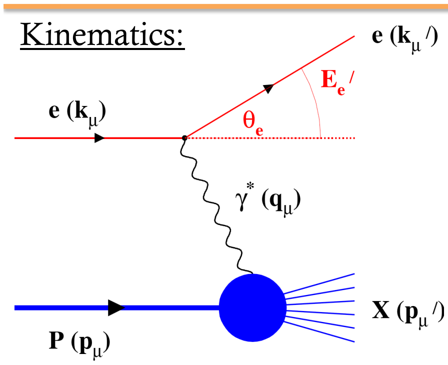


Hutton

Stage	Max. Energy (GeV/c)		Ring Size (m)	Ring Type		IP #
	p	e		p	e	
Medium	96	11	1000	Cold	Warm	3
High	250	20	2500	Cold	Warm	4

Deep Inelastic Scattering

Kinematics:



$$Q^2 = -q^2 = -(k_\mu - k'_\mu)^2$$

Measure of resolution power

$$Q^2 = 2E_e E'_e(1 - \cos\Theta_{e'})$$

$$y = \frac{pq}{pk} = 1 - \frac{E'_e}{E_e}\cos^2\left(\frac{\theta'_e}{2}\right)$$

Measure of inelasticity

$$x = \frac{Q^2}{2pq} = \frac{Q^2}{sy}$$

Measure of momentum fraction of struck quark

Hadron :

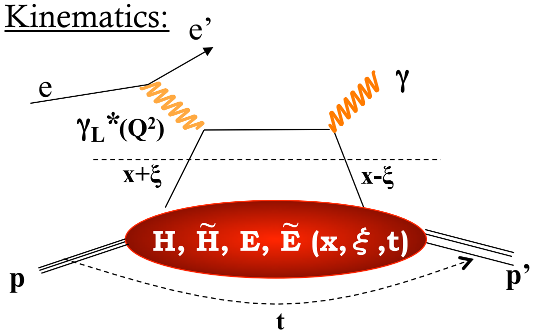
$$z = \frac{E_h}{\nu};\ p_t^{\text{with respect to }\gamma}$$

Inclusive events:
e+p/A → e'+X
detect only the scattered lepton in the detector

Semi-inclusive events:
e+p/A → e'+h(π,K,p,jet)+X
detect the scattered lepton in coincidence with identified hadrons/jets in the detector

Deep Inelastic Scattering

Kinematics:



$$Q^2 = -q^2 = -(k_\mu - k'_\mu)^2$$

Measure of resolution power

$$Q^2 = 2E_e E'_e(1-\cos\Theta_{e'})$$

$$y = \frac{pq}{pk} = 1 - \frac{E'_e}{E_e}\cos^2\left(\frac{\theta'_e}{2}\right)$$

Measure of inelasticity

$$x_B = \frac{Q^2}{2pq} = \frac{Q^2}{sy}$$

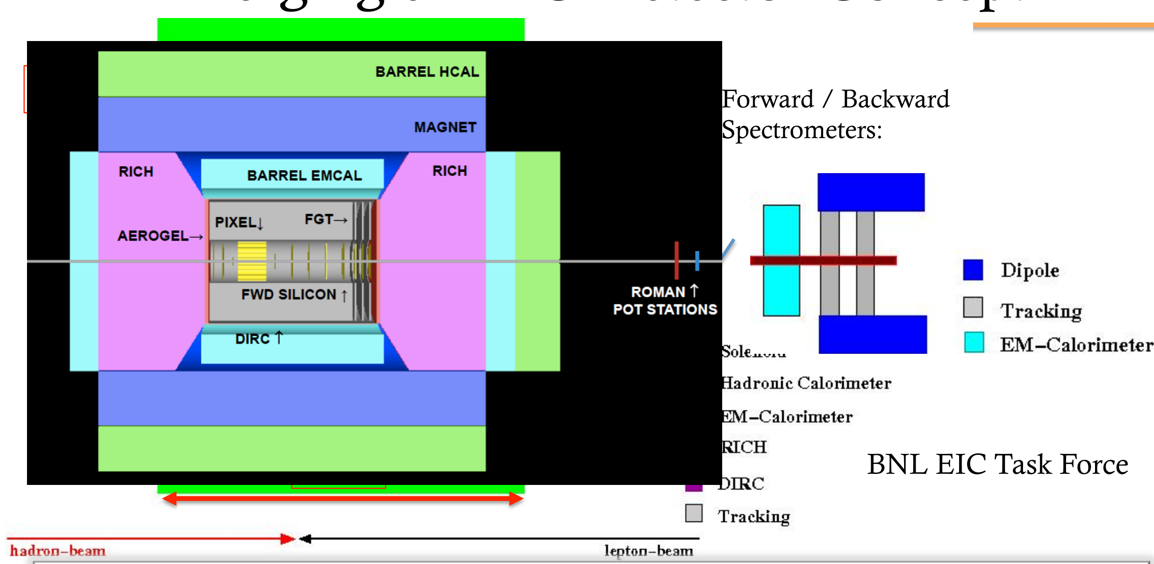
Measure of momentum fraction of struck quark

$$t = (p-p')^2, \xi = \frac{x_B}{2-x_B}$$

Exclusive events:
e + **(p/A)** → e'+ **(p'/A')**+ γ / J/ψ / ρ / ϕ
detect **all** event products in the detector

Special sub-event category rapidity gap events
e + **(p/A)** → e' + γ / J/ψ / ρ / ϕ / jet
Don't detect **(p'/A') in final state**

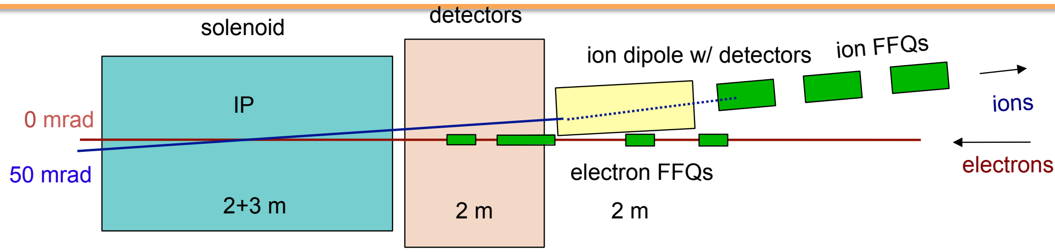
Emerging eRHIC Detector Concept

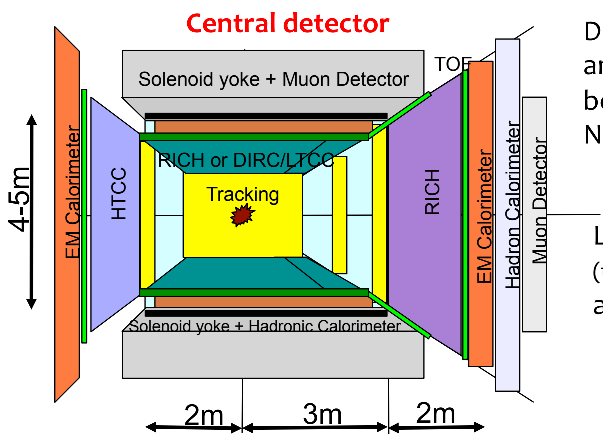


BNL EIC Task Force

high acceptance -5 < η < 5 central detector
good PID and vertex resolution (< 5μm)
tracking and calorimeter coverage the same → good momentum resolution, lepton PID
low material density → minimal multiple scattering and brems-strahlung
very forward electron and proton detection → maybe dipole spectrometers

Detector & IR Design: ELIC





Detect particles with angles down to 0.5° before ion FFQs. Need 1-2 Tm dipole.

Detect particles with angles below 0.5° beyond ion FFQs and in arcs.

Very-forward detector

Large dipole bend @ 20 meter from IP

(to correct the 50 mr ion horizontal crossing angle)

allows for **very-small angle detection (<0.3°)**

JLab EIC WG

A set of meetings on the Physics of EIC: 1999-2010

http://web.mit.edu/eicc/Meetings.html

A series of Users Workshops at Jefferson Lab in 2010:

Users Workshops Organizer by the Users of Jeff Lab:

httpp://michael.tunl.duke.edu/workshop

httpp://www.physics.rutgers.edu/np/2010rueic-home.html

http://www.phy.anl.gov/mep/EIC-NUC2010/

https://eic.jlab.org/wiki/index.php/Electroweak_Working_Group

An International Group met at the INT September – December 2010 to define: The Science of EIC "Golden Measurements"

Institute of Nuclear Theory (INT) at U. of Washington: Sep-Nov 2010

Organizers: D. Boer, M. Diehl, R. Milner, R. Venugopalan, W. Vogelsang

See the INT WebPage for details of all studies:

http://www.int.washington.edu/PROGRAMS/10-3/

INT Workshop Write-up: http://arxiv.org/abs/1108.1713v2

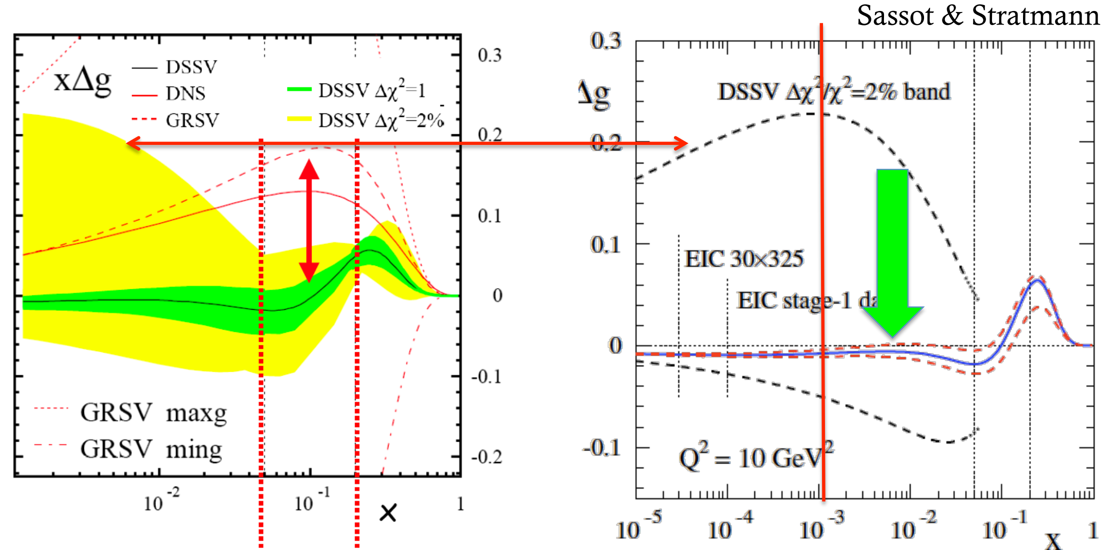
Science of EIC:
Precise Investigations of the "Glue & Sea Quarks"

- Precision measurements of Sea Quarks and Gluon's Spin via inclusive and semi-inclusive DIS including EW probes of the hadron structure
- Measurement of (gluon) GPDs & TMDs: via semi-inclusive and exclusive DIS **(nucleons and nuclei) → wide range in x and Q^2**
  - 3D momentum and position (correlations) of the nucleon/nuclei → Possibly leading to orbital angular momentum in nucleons
- Study of extreme high gluon densities via inclusive and sem-inclusive DIS off a wide range of nuclei and energies

- High energy, beam polarization, and a full acceptance detector: why not explore precision electroweak physics and EW (spin) structure functions

Nucleon Spin: Precision measurement of ΔG

Sassot & Stratmann



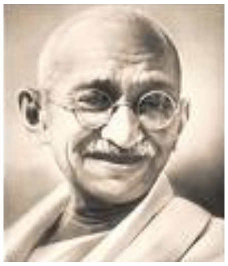
small-x
$0.001 \leq x \leq 0.05$

RHIC range
$0.05 \leq x \leq 0.2$

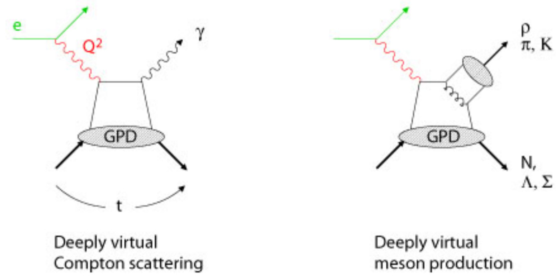
large-x
$x \geq 0.2$

Yellow band (left) reduces to the band shown with **red dashed line** (right)

GPDs → Orbital Angular Momenta?



Nonviolent collisions:



$$\text{Nucleon Spin} = \frac{1}{2} = J_{\text{quark}} + J_{\text{gluons}}$$

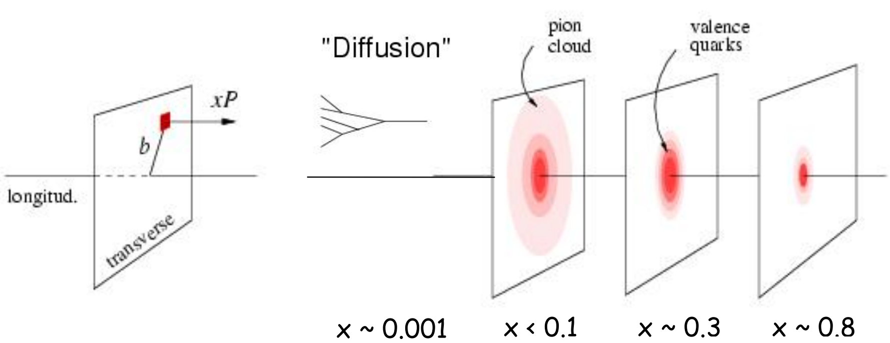
$$J_q = \frac{1}{2}\Delta\Sigma + L_q \qquad GPDs : H, E, \tilde{H}, \tilde{E}$$

$$J_q = \frac{1}{2}\int_0^1 xdx\,[H(x,t,\zeta) + E(x,t,\zeta)]$$

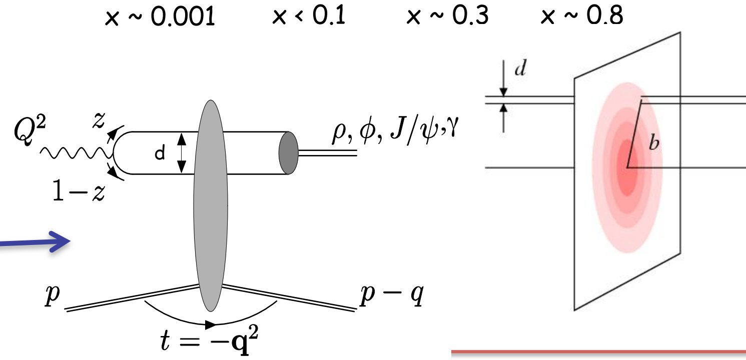
Similar expression for gluon J_g total spin contribution through DVVM
Needs measurements over a wide range in each of the variables
Simulations and eRHIC impact studies: underway in BNL Task Force

Transverse Parton Imaging & GPDs

Fourier transform of momentum transfer



EIC:
1) x < 0.1: gluons!
2) ξ ~ 0 → the "take out" and "put back" gluons act coherently.



Measurement of Gluons at Low x

- **Diffractive cross section**
- $F_2(x,Q^2)$ and its **scaling violations** of Nucleons & Nuclei
- Structure function $F_L(x,Q^2)$

$$\frac{d^2\sigma^{eh\rightarrow eX}}{dxdQ^2} = \frac{4\pi\alpha_{em}^2}{xQ^4}\left[\left(1 - y + \frac{y^2}{2}\right)F_2(x,Q^2) - \frac{y^2}{2}F_L(x,Q^2)\right]$$

Quarks and anti-quarks

Gluon momentum distribution

$$Q^2 = Sxy$$

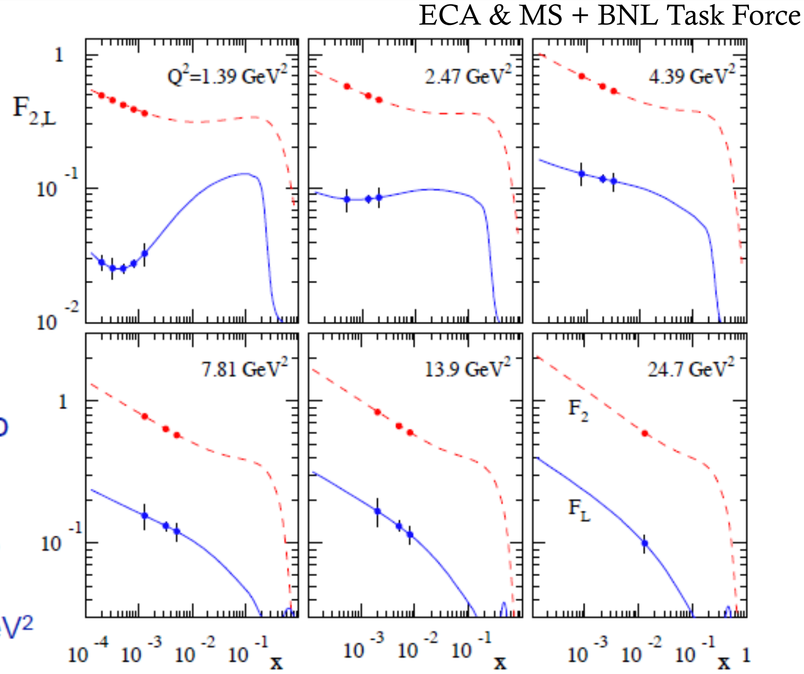
– Needs **change of beam energies** to directly measure F_L

$F_{2,L}$ sensitivity studies

ECA & MS + BNL Task Force

$F_{2,L}$ extracted from pseudo-data generated for 1 month running at 3 eRHIC energies
- 5+100 GeV
- 5+250 GeV
- 5+325 GeV

Data points added to theoretical expectations from ABKM09 PDF set to visualize stat. errors
- valid for $Q^2 > 2.5$ GeV^2



How does e-A really help?

Nuclear Oomph Factor: $$(Q_s^A)^2 \approx c\, Q_0^2 \left(\frac{A}{x}\right)^{1/3}$$

EIC Beam Energy (GeV)	√s (GeV)	low-x reach compared to HERA (e+p equivalent)
2+100	28	4
10+100	63	18
20+100	89	36
20+130	102	50
30+130	125	71

eached at significantly lower
p

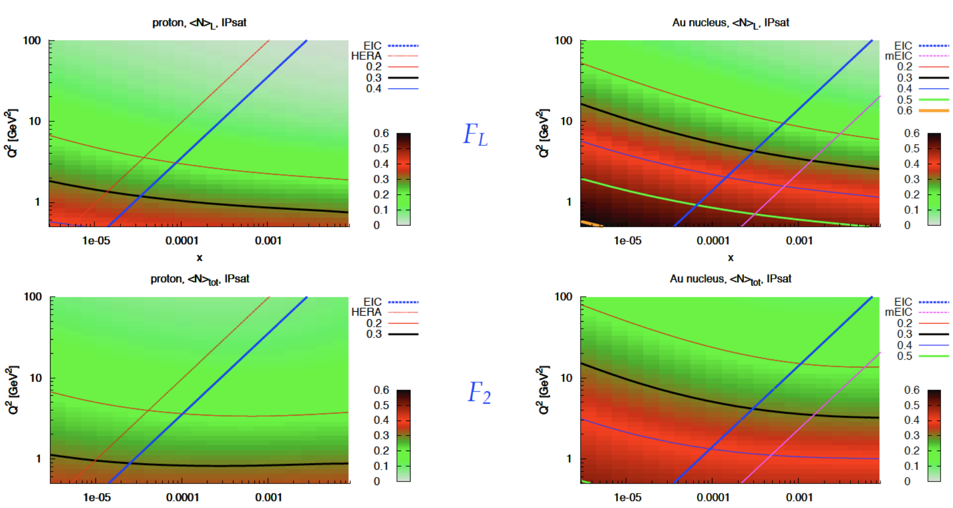
tead of extending x, Q reach
increase Q_s

~ *sx*: EIC factor 27 behind
(10+100 GeV)

$$Q_s^2(Hera) = Q_s^2(EIC) \rightarrow Q_0^2\, x_{Hera}^{-1/3} = c\ Q_0^2\ A^{1/3}\ x_{EIC}^{-1/3}$$
$$x_{EIC} = x_{Hera} \cdot c^3 A$$
$$c^3 A = 0.5^3 \cdot 197 \approx 25$$

PROTON NUCEUS

Small x and saturation



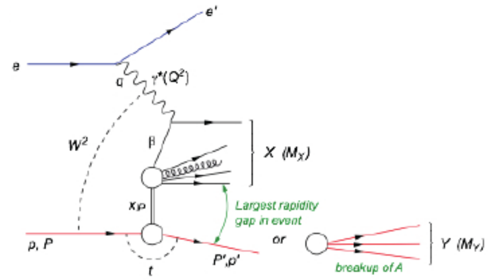
plots: T. Lappi

- EIC: E_p = 300 GeV, E_A = 130 GeV/nucleon, E_e = 30 GeV
- mEIC: E_A = 130 GeV/nucleon, E_e = 5 GeV
- always cut $y < 0.9$

MORE RED THE BETTER!

Diffraction: A robust signature for CGC

- Diffraction ➔ in the final state, the proton remains intact
- Pomeron exchange: → low-x issue
- Surprise: **~14%** of the time, the proton remain intact. Completely unanticipated, astonishing phenomena

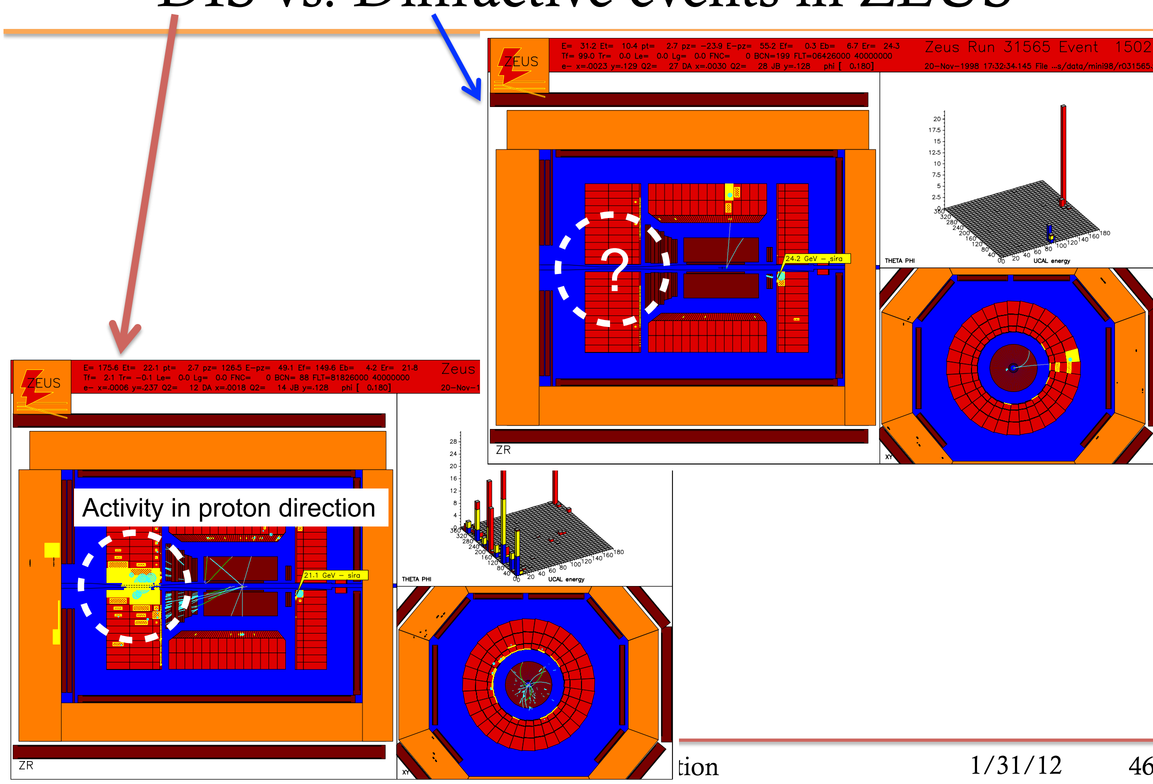


- CGC attempts to give quantitative description
  - CGC predicts in e-A, DIFFRACTION: **14% → 30%-40%**
  - Needs to be experimentally verified…

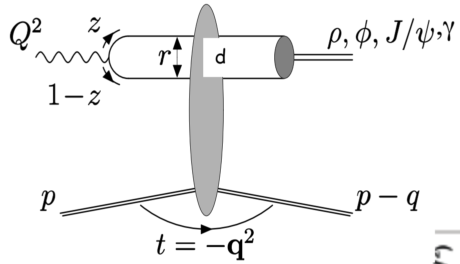
Requires tagging of the nucleus:
Can it be successfully done?
- ➢ Low angle
- ➢ Low binding energy of the nucleon
- ➢ Prone to break-up

Experimental simulation studies
In progress

DIS vs. Diffractive events in ZEUS



Diffractive vector meson production in eA



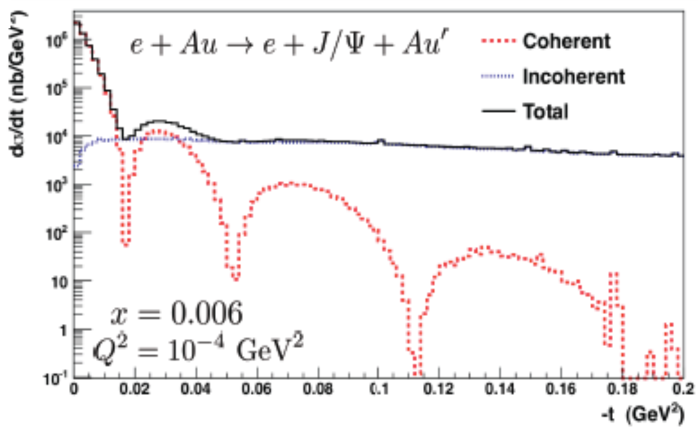
Precise transverse imaging of the gluons in protons & nuclei

Later, how low x dynamics modifies this transverse gluon distribution

Toll and Ullrich (2011)

Exclusive coherent (at small t) and incoherent (intermediate t) Diffraction

Experimental challenges being Studied.



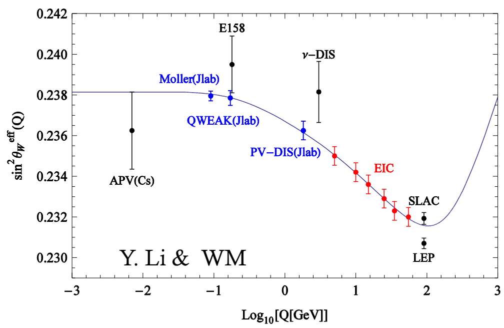
Electroweak & beyond….(?)

BNL LDRD: Deshpande, Marciano, Kumar & Vogelsang

- High energy collisions of polarized electrons and protons and nuclei afford a unique opportunity to study electro-weak deep inelastic scattering
  - **Electroweak structure functions (including spin)**
  - Significant contributions from W and Z bosons which have different couplings with ***quarks and anti-quarks***
- **Parity violating DIS**: a probe of beyond TeV scale physics
  - Measurements at higher Q^2 than the PV DIS 12 GeV at Jlab
  - Precision measurement of $Sin^2\Theta_W$
- **New window for physics beyond SM?**
  - Lepton flavor violation search $e^- + p \rightarrow \tau^- + X$

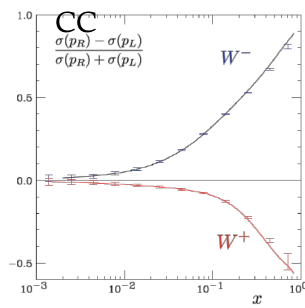
arXiv: 006.5063v1 [hep-ph]
M. Gonderinger et al.

EW Physics Highlights

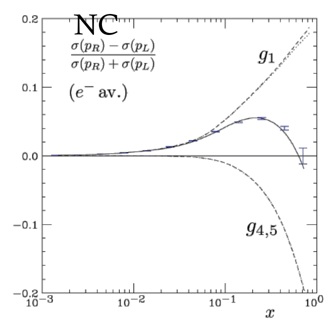


Deviations from the curve may hint at existence of BSM scenarios including: Lepto-Quarks, RPV SUSY extensions, E_6/Z' based extensions of the SM

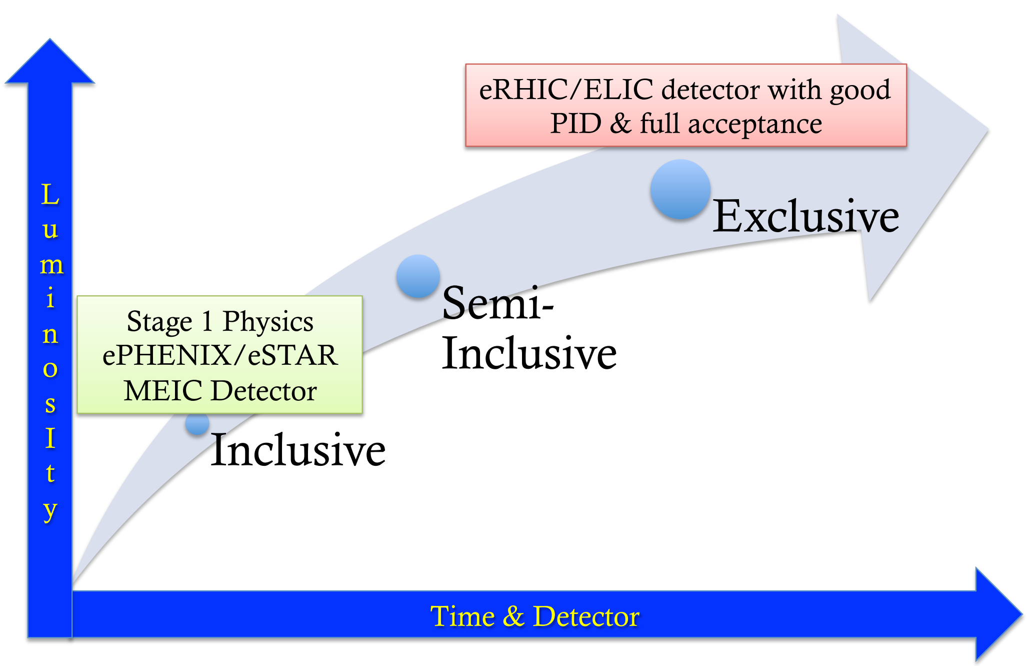
Electroweak CC and NC structure functions: access to spin properties of quarks and anti-quarks over a wide x, Q^2 range.



FR, SR, ST,, KK, WV & AD



EIC Luminosity vs. Time (Detector)



EIC Project status and plans

- A “collaboration” of highly motivated people:
  - EIC Collaboration **Web Page: http://web.mit.edu/eicc/**
  - 100+ dedicated physicists from 20+ institutes
  - Task Forces at BNL (Aschenauer & Ullrich) and at Jefferson Laboratory (Ent)
  - Steering Committee (co-ordinators/contacts persons: Milner & AD)
- **EIC International Advisory Committee** formed by the BNL & Jlab Management to steer this project to realization: ***W. Henning (ANL/RIKEN, Chair)***, *J. Bartels (DESY),A. Caldwell (MPI, Munich) A. De Roeck (CERN), R. Gerig (ANL), D. Hetrzog (U of W), X. Ji (Maryland), R. Klanner (Hamburg), A. Mueller (Columbia), S. Nagaitsev (FNAL), N. Saito (J-PARC), Robert Tribble (Texas A&M), U. Wienands (SLAC), V. Shiltev (FNAL)*

A White for NSAC Long Range Plan 2012/2013 to be produced by early 2012

Writing Group: E; Aschenauer, M. Diehl, H. Gao, A. Hutton, T. Horn, K. Kumar, Y. Kovchegov, M. Ramsey-Musolf, T. Roser, F. Sabatie, E. Sichtermann, T. Ullrich, W. Vogelsang, F. Yuan

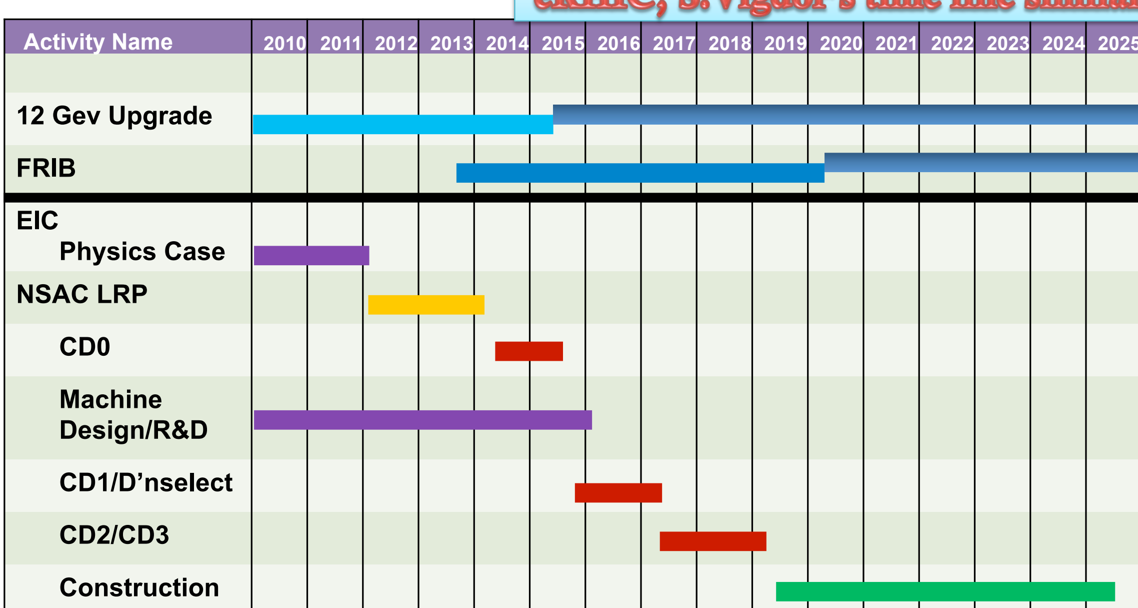
Senior Advisors: A. Mueller, R. Holt

Co-Chairs/Editors: A. Deshpande, J. Qiu, Z.E. Meziani

H. Montgomery, Jeff. Laboratory Director

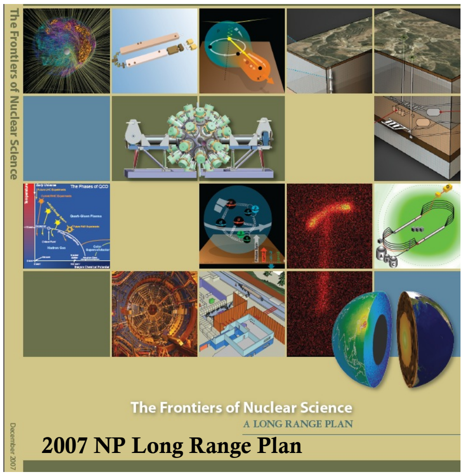
EIC Realization Possible Time Line

eRHIC, S.Vigdor’s time line similar



Construction Schedule Highly Site Dependent

EIC: Status in US NP & Path Forward



- “An EIC with polarized beams has been embraced by the US nuclear science community as embodying the vision for reaching the next QCD frontier”
- EIC was not ready for construction in 2007, hence no recommendation
- Highest priority for accelerator and detector R&D

Approval in the next LRP (2012/2013/?) needs: articulation of the science case for a broad NP community

Summary

The science case for EIC is strong. Best possible articulation of it for the wider NP audience (and beyond) is now being developed.

Science Case for EIC: → “Understand QCD” via

“Precision study of the role of gluons & sea quarks in QCD”

For this the EIC, with its parameters & flexibility, will be superior to any other existing or future planned QCD facilities in the world

The EIC Enthusiasts & the BNL+Jlab managements are moving ***(together)*** towards its realization: ***Milestone: NSAC approval 2013***

- Machine R&D, detector discussions, simulation studies towards making the final case including detailed detector design & cost: underway…