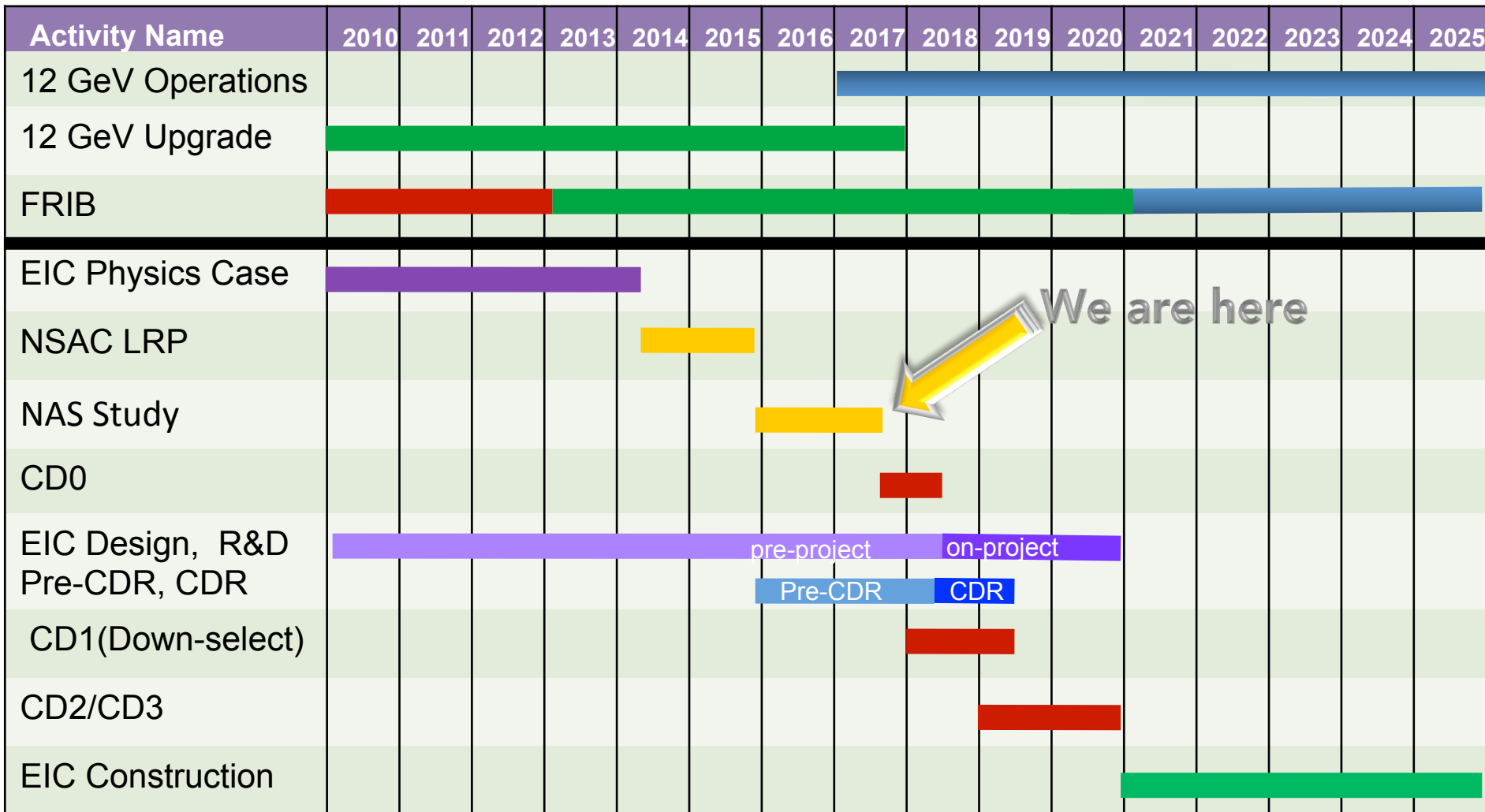


OPPORTUNITA' DI EIC PER I GRUPPI ITALIANI

Contalbrigo Marco
INFN Ferrara

Incontro sulle opportunita' del progetto EIC
Aprile 28, 2017 - Phone Conference

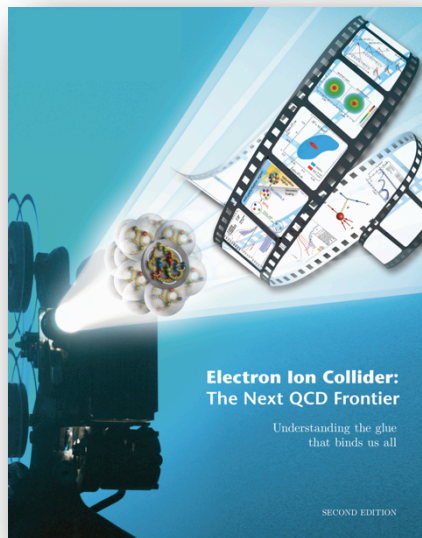
EIC Timeline



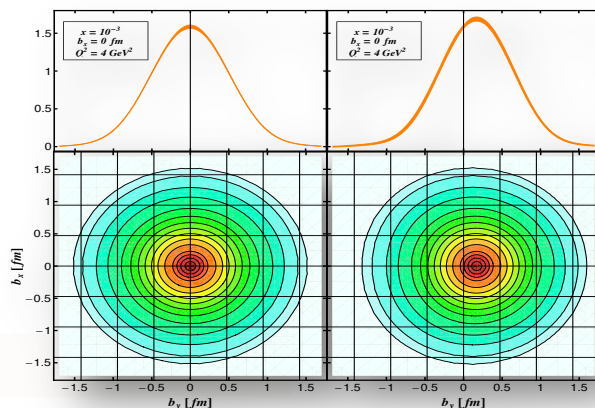
**CD0 = DOE "Mission Need" statement; CD1 = design choice and site selection (VA/NY)
 CD2/CD3 = establish project baseline cost and schedule**

The Electron Ion Collider

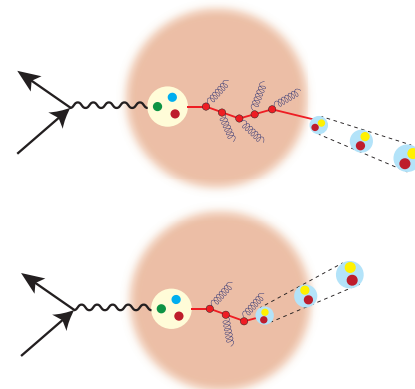
Accardi et al., Eur. Phys. J. A (2016) 52: 268 arXiv: 1212.1701.v3



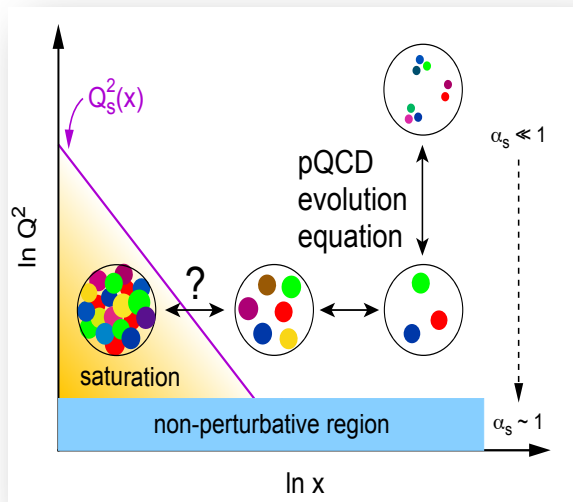
3D Imaging of Nucleon Structure



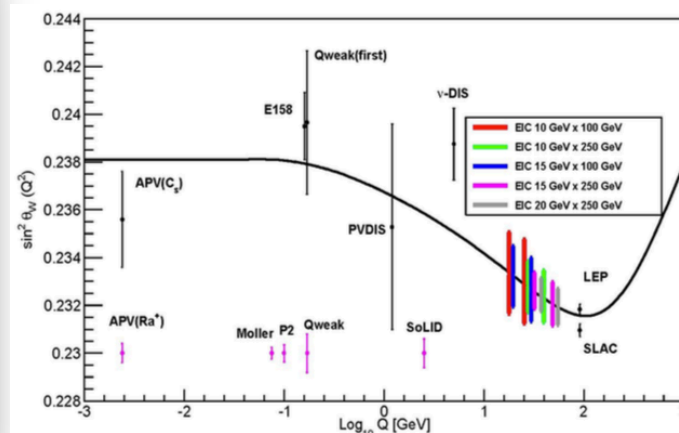
Hadronization in cold QCD matter



Gluon Saturation



EW Physics, BSM



EIC Parameters

Key parameters:
Energy, Luminosity, Polarization

For e-N collisions:

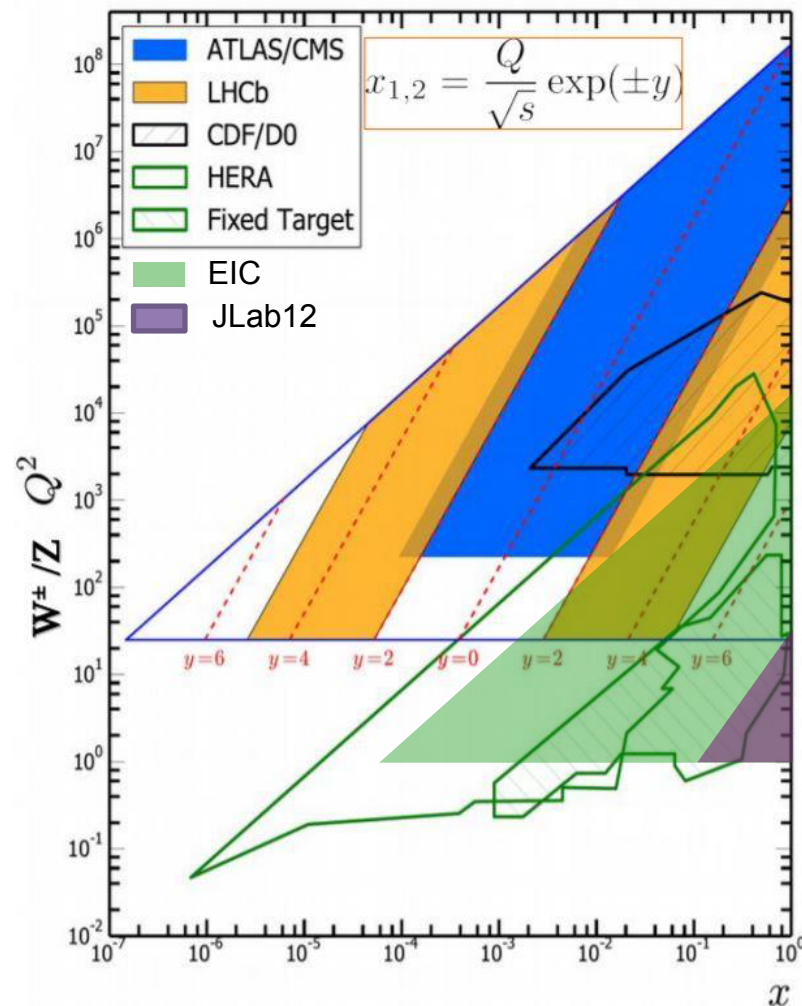
- ✓ Polarized beams: e, p, d/³He
- ✓ $E_e = 5-10$ (20) GeV
- ✓ Luminosity $L_{ep} \sim 10^{33-34} \text{ cm}^{-2} \text{ sec}^{-1}$
- ✓ 20-100 (140) GeV Variable C.M.

For e-A collisions:

- ✓ Wide range in nuclei up to A above 200 (Au, Pb)
- ✓ Luminosity per nucleon same as e-p
- ✓ Variable center of mass energy

**World's first
Polarized e-N & e-A collider**

LHC 13 TeV Kinematics

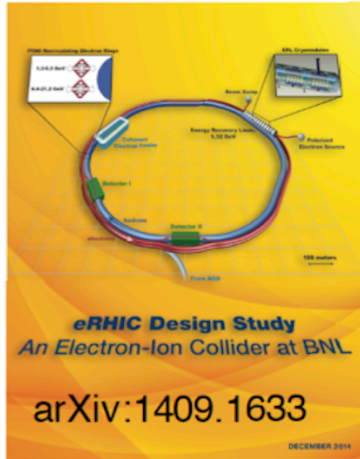


EIC Distinct from (the past) HERA

- Luminosity 100-1000 times that of HERA
 - Enable 3D tomography of gluons and sea quarks in protons
- Polarized protons and light nuclear beams
 - Critical to all spin physics related studies, including precise knowledge of gluon's spin & angular momentum contributions from partons to the nucleon's spin
- Nuclear beams of all A ($p \rightarrow U$)
 - To study gluon density at saturation scale and to search for coherent effects like the color glass condensate and test its universality
- Center mass variability with minimal loss of luminosity
 - Critical to study onset of interesting QCD phenomena
- Detector & IR designs mindful of “Lessons learned from HERA”
 - No bends in e-beam, maximal forward acceptance....

The EIC Options

Two options of realization with various technological challenges

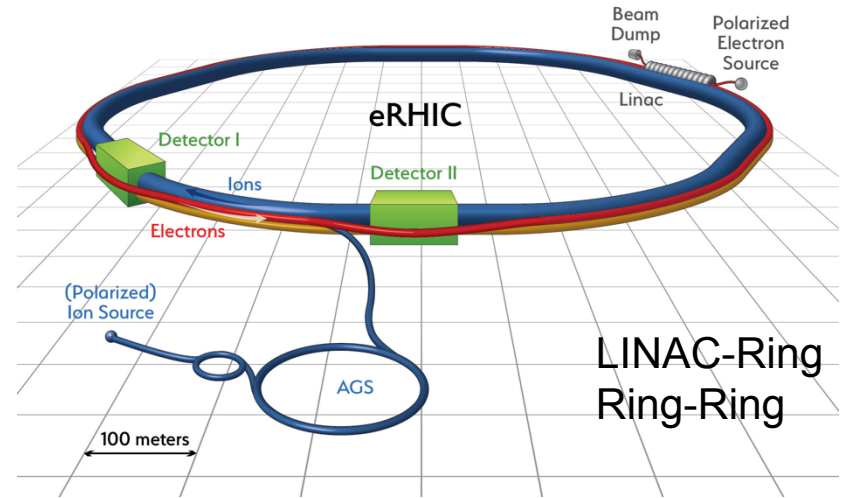


arXiv:1409.1633

Energy range:
e-: 15-20 GeV
p : 100-250 GeV

1.3 GeV ERL

eRHIC



LINAC-Ring
Ring-Ring

Both designs use DOE's significant investments in infrastructure

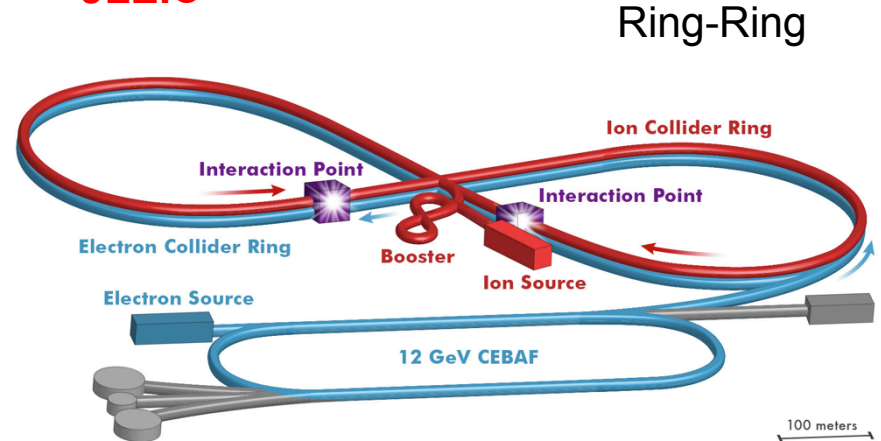


arXiv:1504.07961

Energy range:
e-: 3-10 GeV
p : 20-100 GeV

Figure-8 ring to preserve polarization

JLEIC

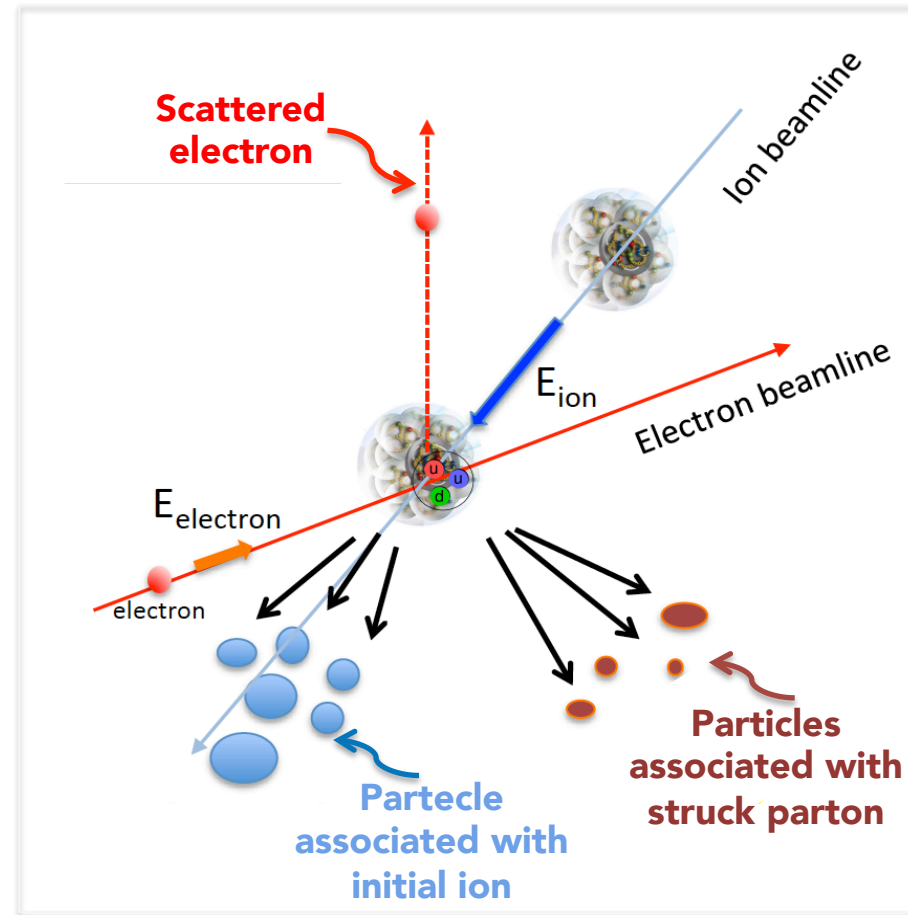


Ring-Ring

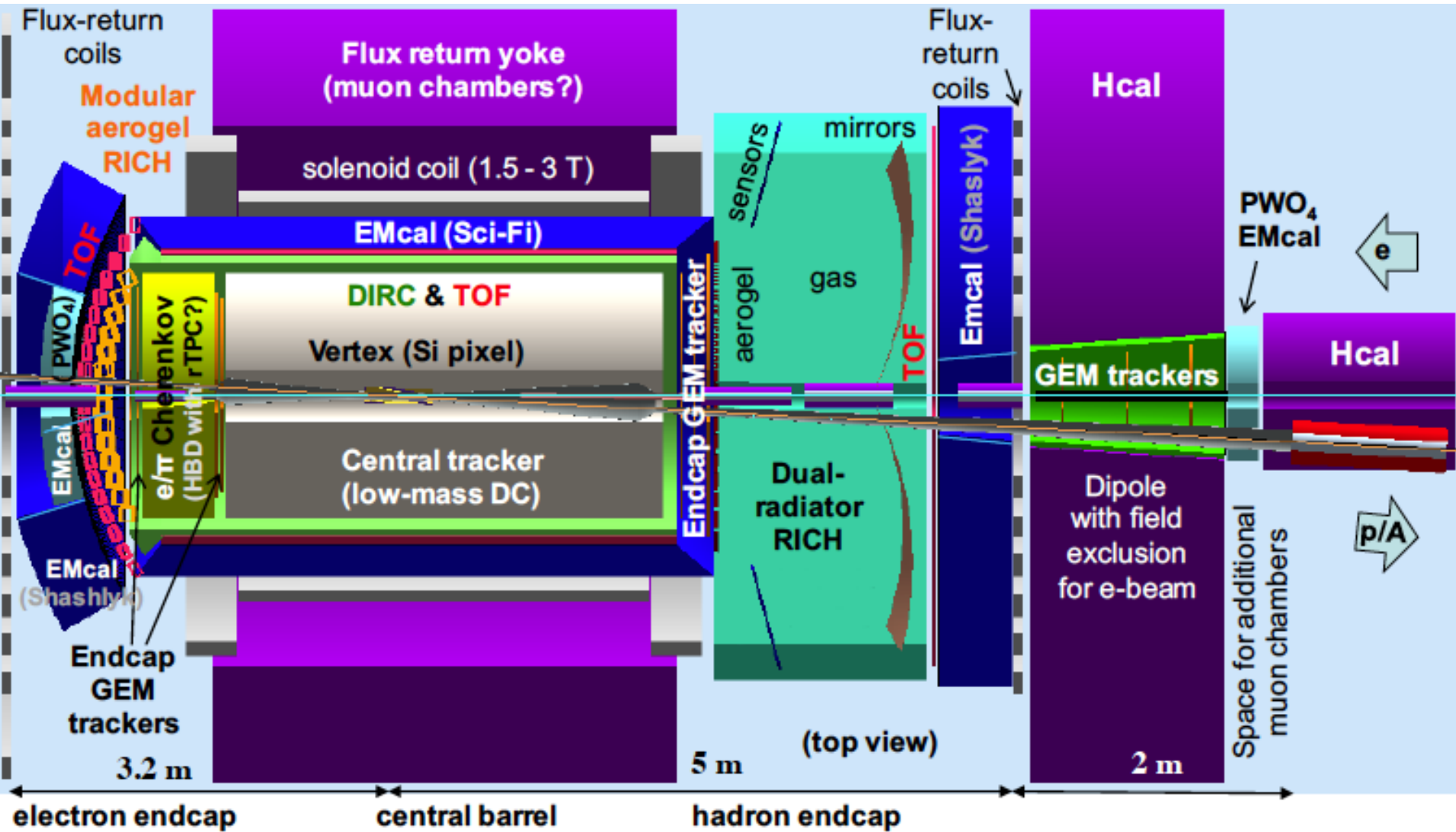
EIC Detector Challenges

Specific requirements to move beyond the longitudinal description

- Resolve partons in nucleons
 - ➔ high beam energies and luminosities
 Q^2 up to **$\sim 1000 \text{ GeV}^2$**
- Need to resolve quantities (k_t , b_t) of the order **a few hundred MeV** in the proton
Correlated quantities, multi-D analyses
 - ➔ High Granularity, wide dynamic range
- Need to detect **all types of remnants** to seek for correlations:
 - scattered electron
 - particles associated with initial ion
 - particles associated with struck parton
- ➔ Large acceptance, Forward particle detection, Excellent PID



Current JLEIC Concept

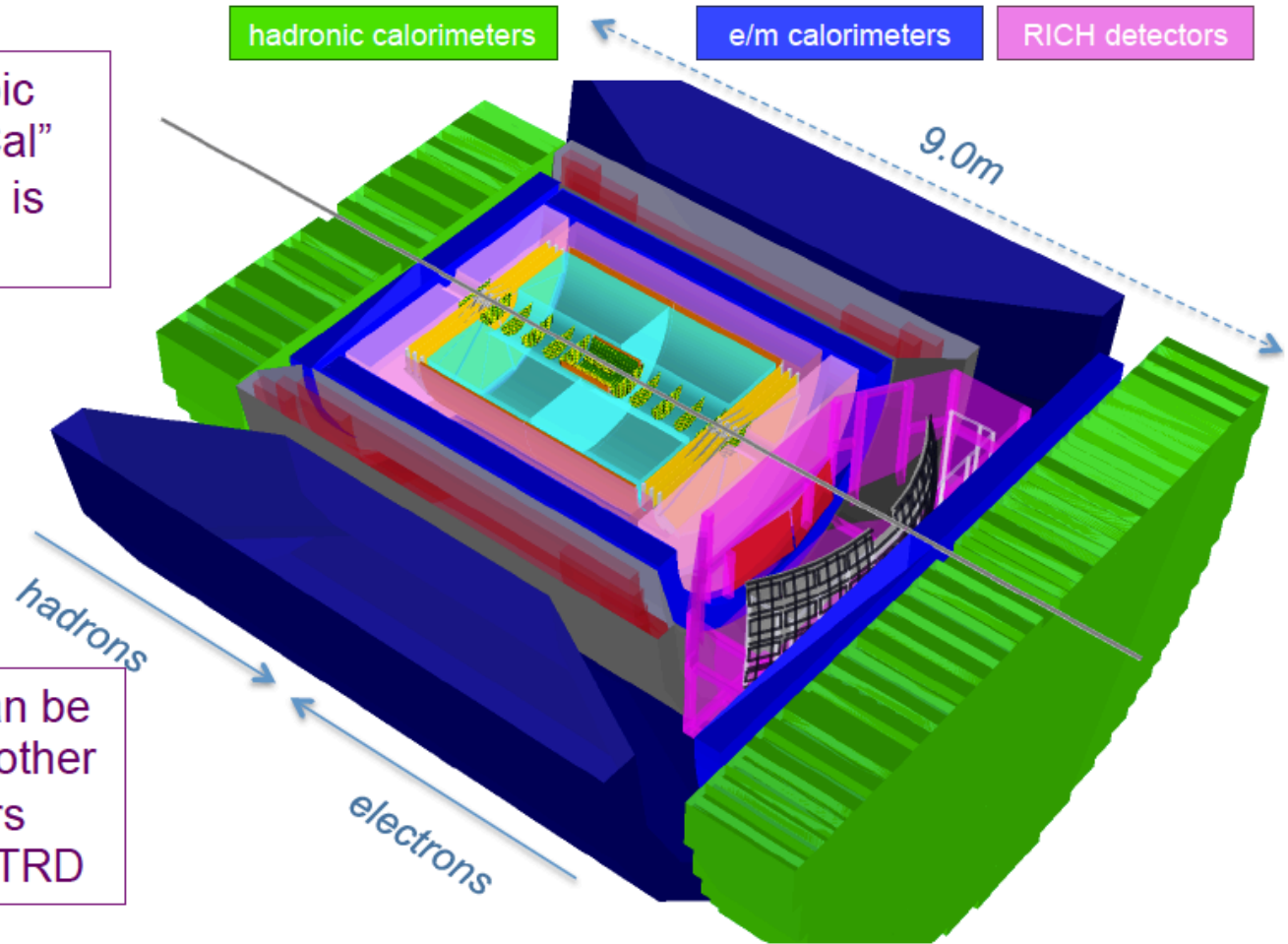


Reference eRHIC Layout

Synergy with (or influence by) sPHENIX development

A detailed microscopic simulation of “e/p+HCal” electron identification is in progress

If needed, the setup can be appended at $\eta < -1$ by other electron ID detectors like preshower and/or TRD



silicon trackers

TPC

GEM trackers

Micromegas barrels

3T solenoid cryostat

magnet yoke


The Detector R&D Program

Detector R&D program ~1.3 \$ M/year in FY17

- Still focus on generic technology advance
Not yet targeted on specific solutions
- Open to foreign Institutions: Abroad expertise is very welcomed
- Flexible support: Funds for hardware and personnel
- Post-doc positions (3 years maximum) to promote career progresses
- Summer meeting: review reports and call for new proposals
Last Meeting held in July 6-7, ANL
- Winter meeting: progress report
FY17 Mid-term review on January 26-27, BNL

EIC Detector R&D Web Page

https://wiki.bnl.gov/conferences/index.php/EIC_R%25D



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eic r&d

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- Advisory Committee
- Meetings
- Proposals
- Travel to BNL

meetings

- RSC Meeting forward upgrades
- EIC Detector R&D Simulation

workshops

- INT Workshop: Studies of 3D Structure of Nucleon
- RHIC DY
- RHIC DY Agenda
- DIS-2011
- DIS-Program

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EIC R%D

Generic Detector R&D for an Electron Ion Collider

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Introduction

In January 2011 Brookhaven National Laboratory, in association with Jefferson Lab and the DOE Office of Nuclear Physics, announced a generic detector R&D program to address the scientific requirements for measurements at a future Electron Ion Collider (EIC). The primary goals of this program are to develop detector concepts and technologies that have particular importance for experiments in an EIC environment, and to help ensure that the techniques and resources for implementing these technologies are well established within the EIC user community.

This program is supported through R&D funds provided to BNL by the DOE Office of Nuclear Physics. It is not intended to be specific to any proposed EIC site, and is open to all segments of the EIC community. Proposals should be aimed at optimizing detection capability to enhance the scientific reach of polarized electron-proton and electron-ion collisions up to center-of-mass energies of 50-200 GeV and e-p equivalent luminosities up to a few times $10^{34} \text{ cm}^{-2}\text{s}^{-1}$. Funded proposals will be selected on the basis of peer review by a standing EIC Detector Advisory Committee consisting of internationally recognized experts in detector technology and collider physics. This committee meets approximately twice per year, to hear and evaluate new proposals, and to monitor progress of ongoing projects. The program will be administered by the BNL Physics Department.


This program is funded at an annual level of \$1.0M - \$1.5M, subject to availability of funds from DOE NP.

Next Meeting

The next meeting of the EIC Detector R&D Committee will take place at JLab on July 13 and 14, 2017. More details will be provided as we move closer to the meeting.

Advisory Committee Meetings

EIC Detector R&D Advisory Committee



bnl conferences

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EIC-Detector-Proposals



2017:
Progress Reports submitted for the January 2017 meeting can be found [here](#) 



2016:
Progress Reports and Proposals submitted for the July 2016 meeting can be found [here](#) 
Progress Reports submitted for the January 2016 meeting can be found [here](#) 

2015:
Progress Reports and Proposals submitted for the July 2015 meeting can be found [here](#) 
Progress Reports submitted for the January 2015 meeting can be found [here](#) 

2014:
Proposals and Progress Reports submitted for the July 2014 meeting can be found [here](#) 

2013:
Proposals and Progress Reports submitted December 2013/January 2014 can be found [here](#) 
Proposals and Progress Reports submitted May 2013 can be found [here](#) 

2012:
New Proposals submitted November 2012 can be found [here](#) 
New Proposals submitted April 2012 can be found [here](#) 

2011:
New Proposals submitted November 2011 can be found [here](#) 
New Proposals submitted April 2011 can be found [here](#) 

EIC Detector R&D Proposal Guidelines

1 What R&D Projects Qualify for Funding?

For proposals to qualify for funding, they need to include a well-articulated motivation for their research, both in terms of advancement of technology and improvement in physics reach. The proposed project must address what physics program at an EIC it will enable and why the technologies to be studied have a particular importance for experiments in an EIC environment.

The focus of this R&D program is generic R&D or directed R&D. Generic R&D in this context refers to concept-independent research, developing a new technology or advancing an existing technology to such a level that it will satisfy the requirements of an EIC. Directed R&D refers to research and development of an area that has been identified as an area where current state-of-the-art is not able to meet the EIC physics requirements or where a technology is completely missing or unaffordable. In the past funding cycles, it was noticed that some of the existing proposals are moving more in the direction of pre-construction engineering & design (PED). This falls outside the scope of this program. When a concept has demonstrated proof-of-principle and has reached a level of maturity where scaling by a factor of a few is involved, this research has reached a level of maturity where it has satisfied the goals of the R&D program, can be moved out of this program and be easily revived once calls for concept detectors are issued and *project* R&D funding can be obtained.

The Detector R&D Program

Program manager: Thomas Ullrich (BNL)

Standing Advisory Committee:

Marcel Demarteau* (Argonne)

Carl Haber (LBNL)

Peter Krizan (Ljubljana)

Ian Shipsey (Purdue)

Rick Van Berg (UPenn)

Jerry Va'vra (SLAC)

Glenn Young (JLab)

*chair



FY2017 Funding Period

- Record participation
 - ▶ 17 proposals
 - ▶ 8 new proposals
 - ▶ eRD12 successfully completed

EIC Detector R&D Activities

Report of the 11th Meeting held on 6-7 July, 2016

- ✓ eRD3: Fast and lightweight EIC integrated tracking system (barrel MM, fwd GEM)
- ✓ eRD6: Tracking Consortium for the EIC (TPC, fwd GEM)
- ✓ eRD3/eRD6 Targeted R&D

INFN-Trieste: Thick GEM and MM for tracking and PID (MPGD)

- ✓ eRD14: Integrated particle identification for a future EIC (barrel DIRC, fwd RICH, TOF)

INFN-Roma1: Dual RICH

INFN-Ferrara: MA-PMT readout electronics

- ✓ eRD1: Calorimetry for the EIC (PbWO_4 , Sampling W powder ScFi)
- ✓ eRD2: Magnetic Field Cloaking Device (YBCO layers)
- ✓ eRD12: Polarimetry, Luminosity and low Q2 tagger for the EIC into the IR (done)
- ✓ eRD15: Compton Polarimetry
- ✓ eRD16: MAPS for the EIC (Vertex tracker)
- ✓ eRD17: DPMJETHybrid 2.0

New Detector R&D Proposals (2016)

Report of the 11th Meeting held on 6-7 July, 2016

- ✓ Detailed Simulations of Machine Background Sources and the Impact to Detector Oper.
- ✓ Developing Analysis Tools and Techniques for the EIC

INFN - Trieste

- ✓ Performance characteristics of the SiD detector for deep inelastic events at the EIC
- ✓ Precision Central Silicon Tracking & Vertexing for the EIC
- ✓ Developing Imaging Hadron Calorimetry
- ✓ Realizing Radiation Tolerant Magnetic Immune Radiation Detector Readout Using Optical Phase-modulation-based Electro-optical Coupling
- ✓ Precision Timing at the Electron Ion Collider
- ✓ Monolithic Fast Timing Silicon Detectors

The Detector R&D Program

R&D program to provide **seed funding for promising research ideas**

Focus more on the research aspects rather than the development aspect.

The research proposal should crisply articulate the R&D program with achievable **milestones for key performance parameters**.

The proposal should clearly indicate **how the EIC science will benefit** from the R&D and what physics channels will be enabled by the research proposal.

Focus on EIC needs:

- Moderate rate and background

- Polarisation control

- 4π acceptance, forward detection...

Join a consortium

Propose **stand-alone suitable own technology or innovative idea**

The Detector R&D Program

Sent message about this meeting to (and got reply by person in blue)

- **eRD1 – Calorimetry:** [Huan Zhong Huang huang@physics.ucla.edu](mailto:huang@physics.ucla.edu)
[Craig Woody woody@bnl.gov](mailto:woody@bnl.gov)

“We are certainly open to some collaborative effort”
Focusing on readout and SiPM studies

- **eRD14 - PID:** [Pawel Nadel-Turonski turonski@gmail.com](mailto:turonski@gmail.com)
[Yordanka Ilieva jordanka@jlab.org](mailto:jordanka@jlab.org)

“It would be great to have a continued and expanded Italian participation in eRD14!”
Focus on dual RICH, modular RICH, sensor in high magnetic field, (TOF ?)

- **eRD16 - Silicon tracking:** [Ernst Sichtermann epsichtermann@lbl.gov](mailto:epsichtermann@lbl.gov)
[Barbara Jacak BVJacak@lbl.gov](mailto:BVJacak@lbl.gov)

“EIC will of course need new collaborators. I am certainly interested to learn more about you and your colleagues interests.”
This is starting, of course focused on silicon tracking.

The Detector R&D Program

Are there missing topics ?

- **zero degree calorimeters**

diffraction, quasi-real photon

- **muon detectors**

lepton flavor violation processes, lepto-quark

- ...

Report updates reviewed in January 26-27 2017
eRD2 successfully completed

INFN Meeting with BNL Director
Rome, 11 May 2017

Next meeting of the EIC Detector R&D Committee
JLab, 13-14 July 2017

User Group Meeting
Trieste, 18-22 July 2017

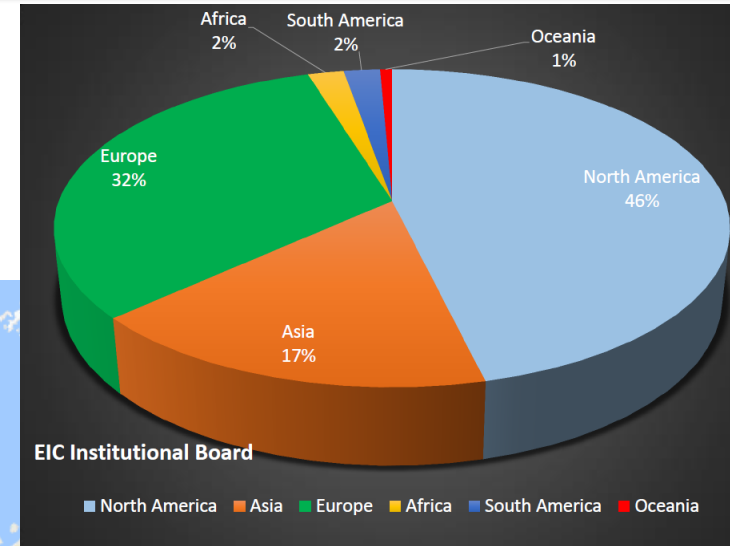
New proposal submission deadline expected at
the beginning of June 2017

EIC User Group: EICUG.ORG

670 collaborators, 28 countries, 150 institutions... (December, 2016)

(no students included as of yet)

IB Chair: Christine Aidala (University of Michigan)



Good opportunity to stay tuned (still informal joining procedure)