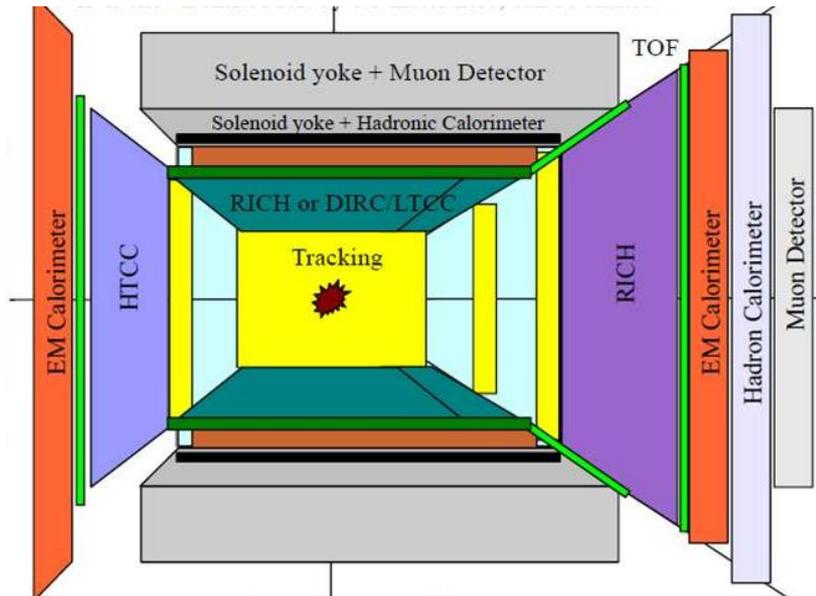
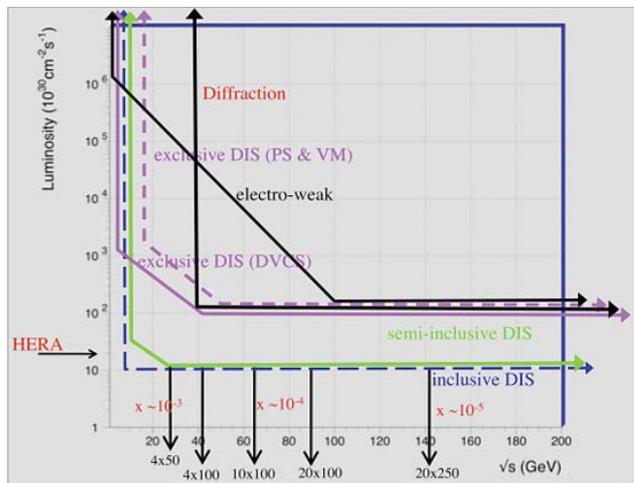
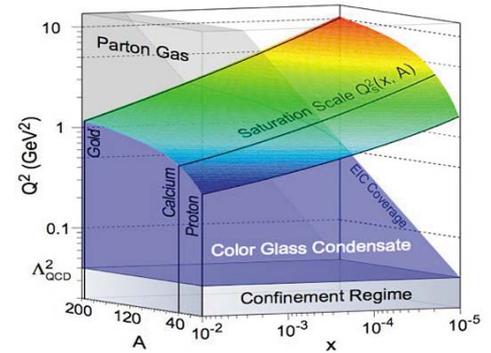
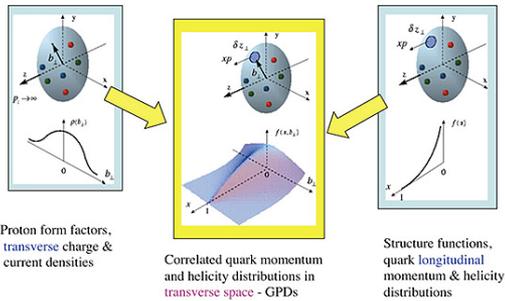


# Generic Detector R&D for an Electron Ion Collider

## RHIC & AGS Annual Users Meeting

T. Ludlam, June 2011



# The national discussion for a U.S. Electron Ion Collider

Machine designs being developed independently at BNL (eRHIC) and at JLab (ELIC/MEIC)  
Converging on similar performance parameters. See this week's workshop talks.

## INT workshop on EIC science, September – November 2010

Detailed theoretical study of the science case, with focus on key experiments.  
Will produce a 500-page “Yellow Book”, due within a few weeks.

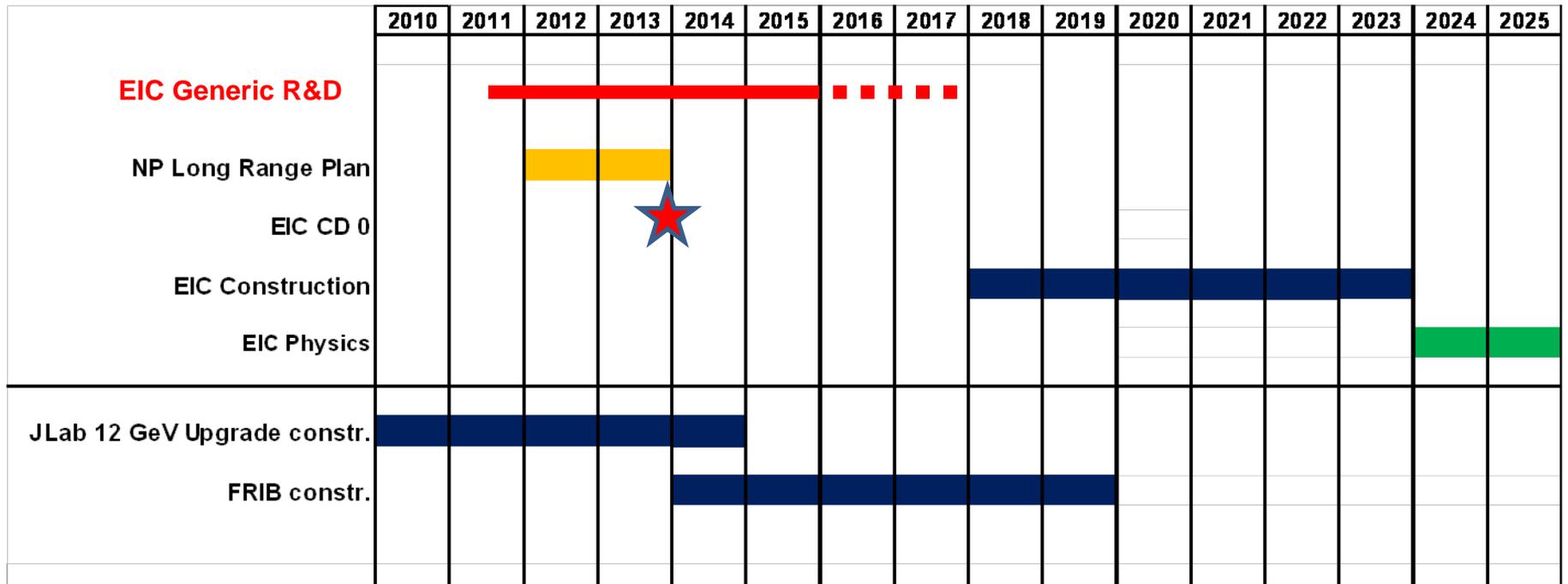
## Preparing for Nuclear Physics Long Range Plan meetings ~2012-2013

A “white paper” will outline the EIC science case, key experiments, and performance goals.  
Steering committee has been appointed by Brookhaven and JLab :  
Primary editors: A. Deshpande, Z. Mezziani, J. Qiu

**Will there be a strong, united user community for EIC?  
Detector design and development is an important component.**

# A Rough Timeline

## EIC and other NP construction projects



# Plans for EIC Generic Detector R&D

Establish a peer reviewed program of R&D to enable EIC experiments

- ❑ Develop detector concepts and technologies that have particular importance for experiments in an EIC environment.
- ❑ Help ensure that the techniques and resources for implementing these technologies are well established within the EIC user community.
- ❑ Endorsed by DOE, BNL, and JLab; Managed at BNL

Support community-wide development efforts:

*New concepts and technologies*

*Adaptations of existing technology*

*New design and simulation tools*

*New computing/analysis techniques*

Funding provided by DOE Office of Nuclear Physics through RHIC program operations budget:

\$0.5M committed in FY 2011

Expect ~\$1-1.5M per year thereafter for ~5 years.

**Proposals are solicited from all segments of the EIC community.**

# EIC Detector R&D Advisory Committee

Meet ~twice per year to....

- Hear public presentations of new proposals, and progress on approved projects
- Evaluate the merits of proposals, and the performance of on-going projects
- Make funding recommendations and provide overall guidance for the program

The committee met May 9-10, 2011 to kick off the program and evaluate the first round of proposals. New proposals and progress reports will be presented at subsequent meetings.

Website: [https://wiki.bnl.gov/conferences/index.php/EIC\\_R%25D](https://wiki.bnl.gov/conferences/index.php/EIC_R%25D)



**Advisory Committee members: (Ian Shipsey, Chair)**

Marcel Demarteau (Argonne)

Rick Van Berg (Penn)

Howard Wieman (LBNL)

Robert Klanner (Hamburg)

Jerry Va'vra (SLAC)

Ian Shipsey (Purdue)

Glenn Young (JLab)

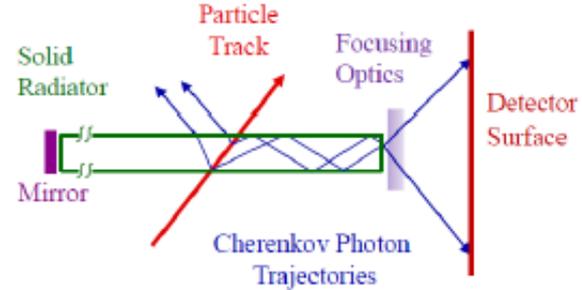
# Initial Proposals, presented at May meeting

The proposals are posted on-line at <https://wiki.bnl.gov/conferences/index.php/Proposals-April2011>

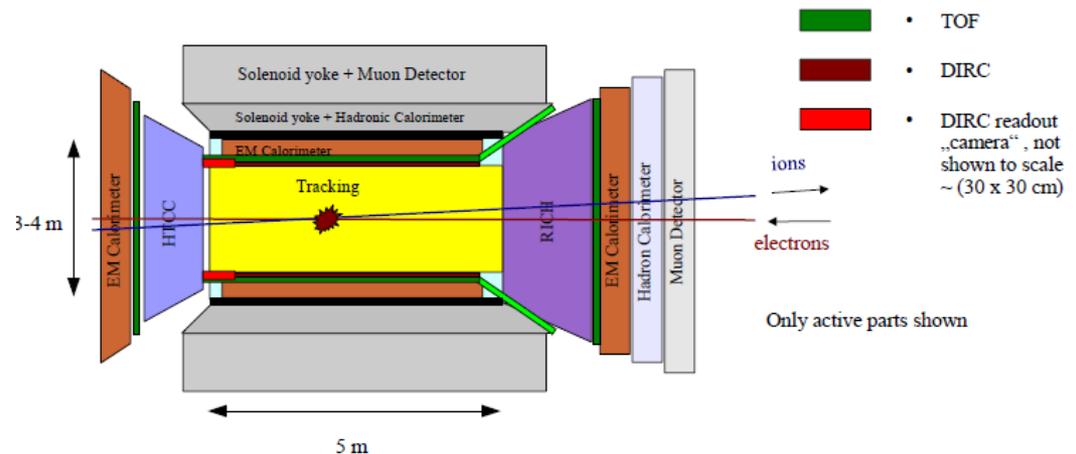
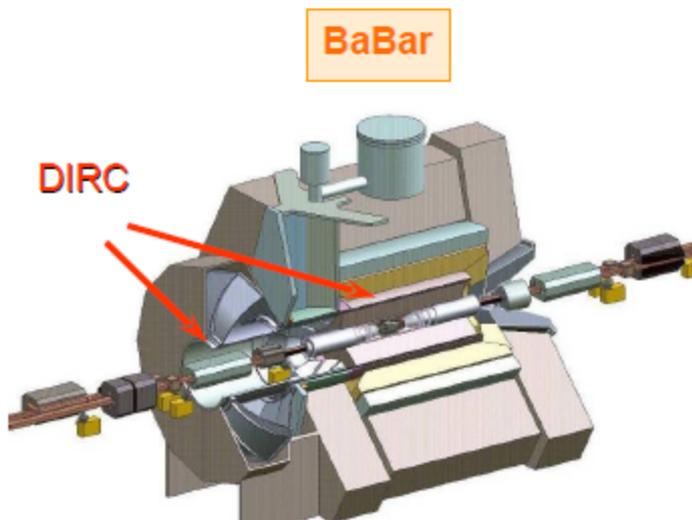
<b>Prop. No.</b>	<b>Title</b>	<b>Presenter</b>	<b>Institutions</b>
1	Development of a new detector technology for fiber sampling calorimeters for EIC and STAR	Oleg Tsai (UCLA)	UCLA, Texas A&M, Penn State Univ.
2	Front end readout module for detector data acquisition and trigger system	Chris Cuevas (JLab)	Jefferson Lab
3	DIRC-based PID for the EIC Central Detector	Pawel Nadel-Turonski (JLab)	Catholic Univ. of America, Old Dominion Univ., JLab, GSI (Darmstadt)
4	Liquid scintillator calorimetry for the Electron Ion Collider	Justin Frantz (Ohio Univ.)	Ohio University
5	Proposal to test improved radiation tolerant silicon photomultipliers	Carl Zorn (JLab)	Jefferson Lab
6	Letter of Intent for detector R&D towards an EIC detector	Tom Hemmick (Stony Brook)	BNL, Florida Inst. Of Technology, Iowa State Univ., LBNL, LANL, MIT, RIKEN-BNL Res. Cntr., Stony Brook Univ., Univ. Virginia, Yale Univ.

# Prop. #3: Adapting the DIRC principle for particle i.d. at EIC

- Charged particle traversing radiator with refractive index  $n$  with  $\beta = v/c > 1/n$  emits Cherenkov photons on cone with half opening angle  $\cos \theta_c = 1/\beta n(\lambda)$ .



- For  $n > \sqrt{2}$  some photons are always **totally internally reflected** for  $\beta \approx 1$  tracks.
- Radiator and light guide: bar made from **Synthetic Fused Silica**
- DIRC is intrinsically a **3-D device**, measuring:  $x$ ,  $y$ , and  $time$  of Cherenkov photons, defining  $\theta_c$ ,  $\phi_c$ ,  $t_{\text{propagation}}$  of each photon.



T. Horn<sup>1</sup>, C. Hyde<sup>2</sup>, P. Nadel-Turonski<sup>3,\*</sup>,  
K. Peters<sup>4</sup>, C. Schwarz<sup>4</sup>, J. Schwiening<sup>4</sup>.

1) The Catholic University of America, Washington, DC 20064

2) Old Dominion University, Norfolk, VA 23529

3) Jefferson Lab, Newport News, VA 23606

4) GSI, 63291 Darmstadt, Germany

## R&D goals

### 1. Demonstrate feasibility of using a DIRC in hermetic EIC detector

- Compact readout “camera” (expansion volume + sensors)
- Operation in magnetic field up to 2-4 T

### 2. Investigate possibility of pushing state-of-the-art performance

- Extend  $3\sigma$   $\pi/K$  separation beyond 4 GeV/c, maybe as high as 6 GeV/c
- Also improve  $e/\pi$ ,  $\pi/K$ , and  $K/p$  separation

### 3. Study integration of the DIRC with other detector systems

- Supplementary gas Cherenkov?
- Backgrounds
- Integration with solenoid, tracking, calorimeter, etc

## Prop. #6: A Letter of Intent requesting “seed money” for a large R&D collaboration

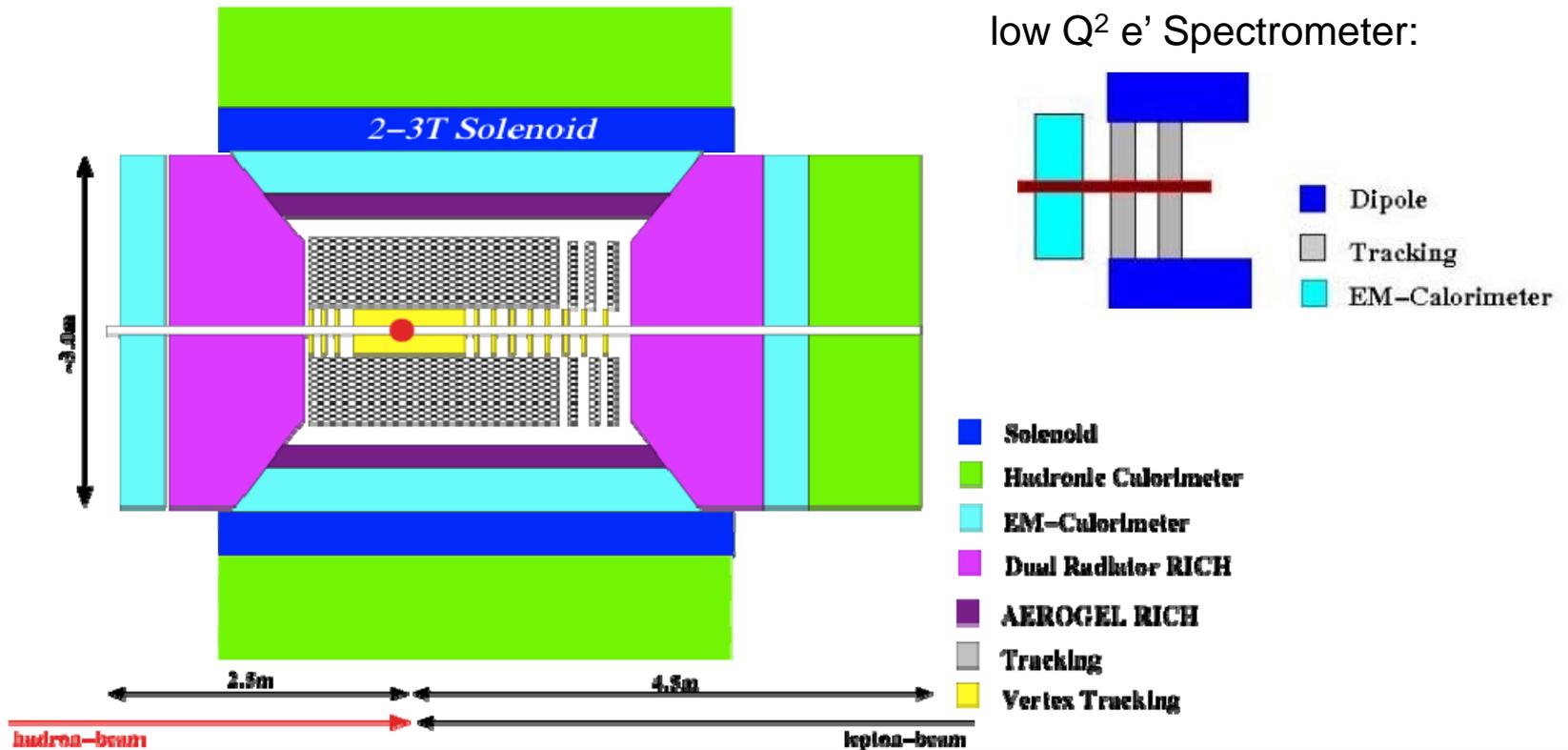
- Brookhaven National Laboratory
- Florida Institute of Technology
- Iowa State University
- Lawrence Berkeley National Laboratory
- Massachusetts Institute of Technology
- Riken Research Center at BNL
- Stony Brook University
- University of Virginia
- Yale University

Build on existing expertise and infrastructure for:

- Fast drift, low mass TPC
- GEM technology
- CsI photocathodes
- ASIC development
- Silicon strip/pixel systems

Develop detector technologies to address key requirements identified by recent studies of EIC physics, *driven by simulations...*

## Emerging detector concept....



high acceptance  $-5 < \eta < 5$  central detector  
 good PID and vertex resolution ( $< 5\mu\text{m}$ )  
 tracking and calorimeter coverage the same  $\rightarrow$  good momentum resolution, lepton PID  
 low material density  $\rightarrow$  minimal multiple scattering and brems-strahlung  
 very forward electron and proton detection  $\rightarrow$  dipole spectrometers

# Committee Actions & Recommendations

The Report is posted on the website

Extensive commentary and guidance on all 6 proposals;

Four approved for FY 2011 funding

## Strongly encouraged simulation studies

- “to maximize acceptance and efficiency for each golden measurement while minimizing machine backgrounds, and backgrounds from other physics processes”.
- Models of machine backgrounds “urgently needed” to predict radiation dose and charged and neutral particle fluence in the detector.

## Importance of the formation of consortia of universities and national labs:

- Much work needs to be done on each class of detector technique to identify appropriate technologies through simulation, prototyping, etc.
- Such consortia are the first step toward building scientific collaborations that can successfully mount EIC experiments.

**Other important areas in need of R&D, not yet seen in proposals:**

- Luminosity and polarization measurements
- tagging detectors and calorimeters downstream in both hadron and electron directions
- Low-mass precision vertex measurement

**The Committee will meet again in the fall, to hear new and updated proposals, and progress reports from the funded projects.**

**The funded projects will provide quarterly progress reports, which will be reviewed by the Committee members.**

# Next (FY 2012) Call for Proposals

## FY 2012 Call for Proposals

### Generic Detector R&D for an Electron Ion Collider

In January 2011 Brookhaven National Laboratory 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 100-200 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 is administered by the BNL Physics Department.

The website for this R&D program is at: [https://wiki.bnl.gov/conferences/index.php/EIC\\_R%25D](https://wiki.bnl.gov/conferences/index.php/EIC_R%25D)

Funding for this program began in FY 2011, at a level of approximately \$0.5M, and will rise to an annual level of \$1.0M - \$1.5M, subject to availability of funds from DOE NP.

Initial proposals were presented at the inaugural meeting of the Detector Advisory Committee on May 9-10, 2011. The next meeting of this committee is planned for the fall of 2011. *Proposals to be considered at this meeting should be received at BNL by October 15, 2011.*