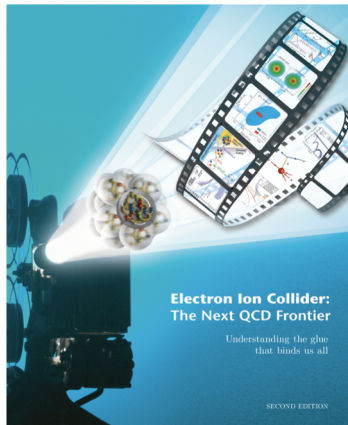


# Update on Electron Ion Collider

by

Douglas W. Higinbotham

# October Review of EIC Designs



1212.1701.v3  
A. Accardi et al  
Eur. Phys. J. A, 52 9(2016)

## For e-N collisions at the EIC:

- ✓ Polarized beams: e, p, d/<sup>3</sup>He
- ✓ e beam 5-10(20) GeV
- ✓ Luminosity  $L_{ep} \sim 10^{33-34} \text{ cm}^{-2}\text{sec}^{-1}$
- ✓ 100-1000 times HERA
- ✓ 20-100 (140) GeV Variable CoM

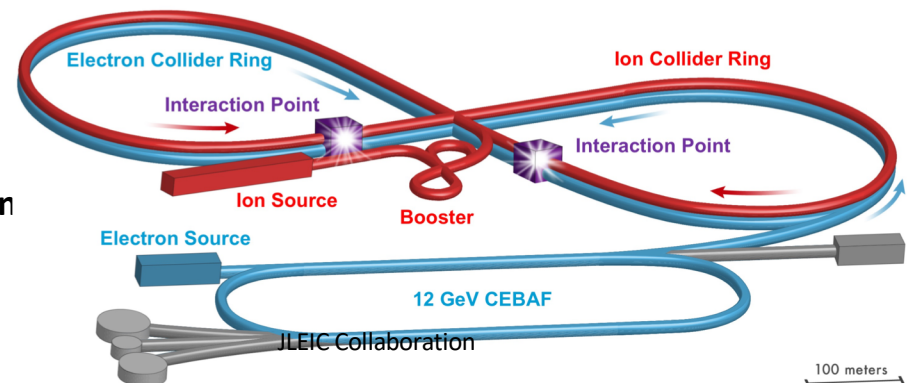
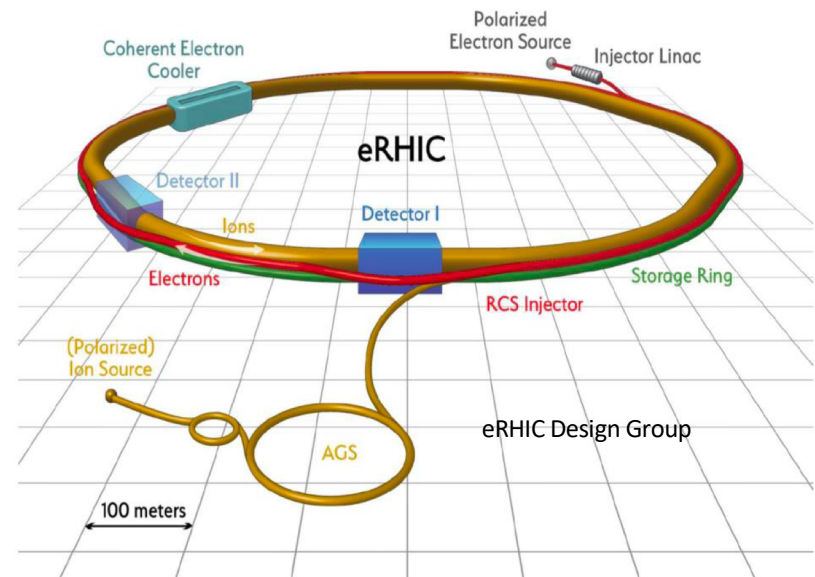
## For e-A collisions at the EIC:

- ✓ Wide range in nuclei
- ✓ Luminosity per nucleon same as e-p
- ✓ Variable center of mass energy

## World's first

**Polarized electron-proton/light ion  
and electron-Nucleus collider**

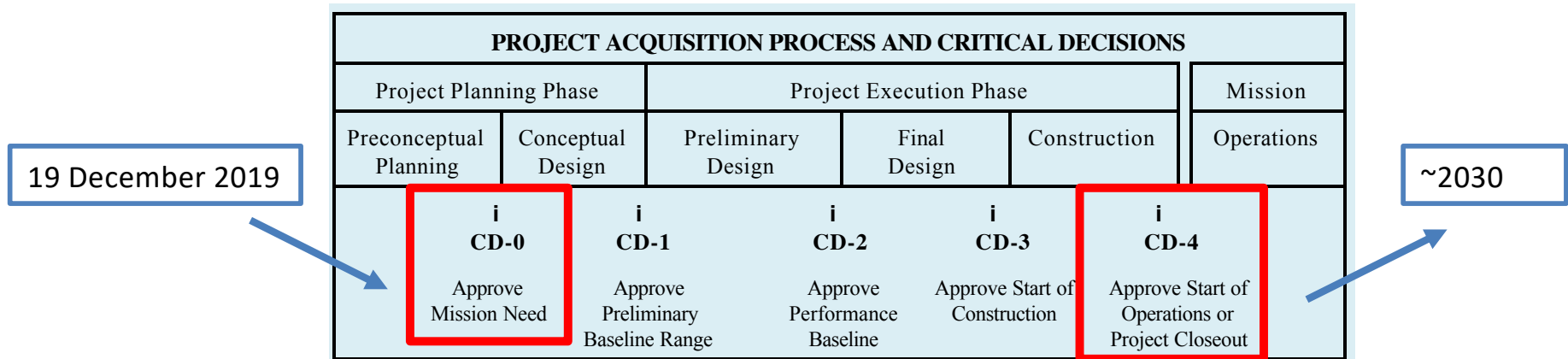
**Both designs use DOE's significant investment  
in infrastructure**



pCDR's are not publicly available, but white paper is available <https://arxiv.org/abs/1212.1701>

and a collection of docs: [http://www.eicug.org/web/sites/default/files/YR\\_References\\_v8.pdf](http://www.eicug.org/web/sites/default/files/YR_References_v8.pdf)

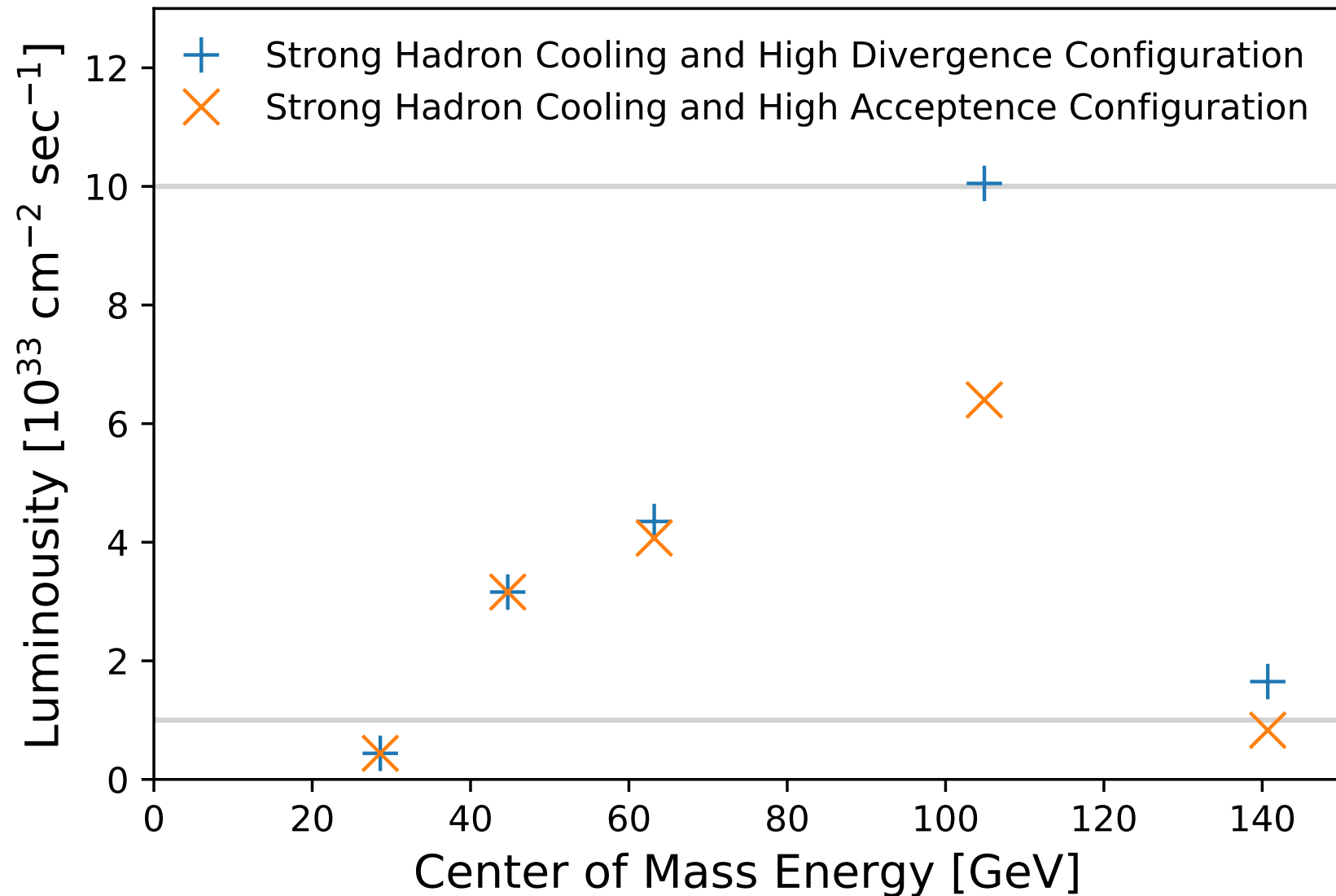
# Critical Decision Process



CD-0	CD-1	CD-2	CD-3	CD-4
Actions Authorized by Critical Decision Approval				
<ul style="list-style-type: none"> <li>Proceed with conceptual design using program funds</li> <li>Request PED funding</li> </ul>	<ul style="list-style-type: none"> <li>Allow expenditure of PED funds for design</li> </ul>	<ul style="list-style-type: none"> <li>Establish baseline budget for construction</li> <li>Continue design</li> <li>Request construction funding</li> </ul>	<ul style="list-style-type: none"> <li>Approve expenditure of funds for construction</li> </ul>	<ul style="list-style-type: none"> <li>Allow start of operations or project closeout</li> </ul>

PED: Project Engineering & Design

# Expected Electron Proton EIC Luminosity



With electron energies from 5 to 18 GeV and proton energies 41 to 275 GeV.

# Yellow Report

- Kick-off Meeting @ MIT
  - <https://www.jlab.org/indico/event/348/>
- Physics Conveners:
  - [Adrian Dumitru](#) (Baruch)
  - [Olga Evdokimov](#) (University of Illinois at Chicago)
  - [Andreas Metz](#) (Temple)
  - [Carlos Muñoz Camacho](#) (Orsay)
- Detector Conveners:
  - [Ken Barish](#) (UC Riverside)
  - [Tanja Horn](#) (CUA)
  - [Peter Jones](#) (Birmingham)
  - [Silvia Dalla Torre](#) (Trieste)
  - [Markus Diefenthaler](#), ex-officio (JLab)

# Foreseen Yellow Report Physics topics

*White Paper & NAS measurements*

## 1. Global properties and parton structure of hadrons

- a. Spin structure of proton & neutron (spin sum rule, helicity distributions, transversity)
- b. Mass of the nucleon and mesons
- c. Multi-parton correlations (structure function  $g_2$ )
- d. (Inclusive) diffraction

## 2. Multi-dimensional imaging of hadrons

- a. GPDs and 3D-imaging (includes also Ji's sum rule, pressure and shear distributions)
- b. TMDs and 3D-imaging
- c. Wigner functions (includes, in particular, orbital angular momentum)
- d. Form factors and 2D-imaging in position space

### 3. The Nucleus: A Laboratory for QCD

- a. High parton densities and Saturation
- b. Diffraction
- c. Particle propagation through matter, energy loss
- d. Collective effects (shadowing, anti-shadowing, ridge effect, other emergent phenomena)
- e. Special opportunities with jets and heavy quarks
- f. Short-range correlations, origin of nuclear force
- g. Structure of light (polarized) nuclei

### 4. Understanding hadronization

- a. Hadronization in the nuclear environment
- b. Hadronization in the vacuum
- c. Particle production for identified hadron species
- d. Production mechanism for quarkonia and exotic states
- e. Spectroscopy

## 5. Connections with other fields

- a. Electro-weak physics (e.g. scale dependence of Weinberg angle)
- b. Neutrino physics
- c. Cosmic-ray / astro-particle physics
- d. BSM physics (e.g. lepton flavor violation)
- e. Other connections to pp/pA/AA
- f. Lattice QCD

And of course new ideas are always welcome!

# Physics topics linked to processes & measurements

White Paper & NAS measurements

Processes→ ↓ Topics	Inclusive	Semi-Inclusive	Jets, Heavy Flavor	Exclusive	Diffraction, Forward Tagging
Global properties and parton structure	<i>Incl. SF</i>	$h, hh$	$j, Q$	<i>excl. <math>J/\psi, \gamma</math></i>	Incl. diffr., tagged DIS on pol. D/He
Imaging		$h$	$j, jj, j+h, Q+Qbar, [QQbar]$	<i>Excl-DIS: DVCS, DVMP (<math>J/\psi, \gamma, \rho^0, \phi, \pi^+, K, \rho^+, K^*...</math>), Elastic scattering</i>	
Nucleus	<i>Incl. SF</i>	$h, hh$	$j, jj, Q, [QQbar]$	<i>coh. VM, jj, h, hh</i>	<i>Diffr. SF, incoh. VM, jj, h, hh</i> D/He FF, nucl. fragments
Hadronization		$h, hh, j+h$	$j, Q$		
Other fields		CC DIS, $\gamma$ -A total X-sec		$\gamma$ -A elast. X-sec	$\gamma$ -A diffr. X-sec

# Physics Working Group Sub-conveners

- Inclusive

- Theory: Nobuo Sato (JLab)

- Experiment: Renee Fatemi (Kentucky), Barak Schmookler (Stony Brook)

- h SIDIS

- Theory: Bowen Xiao (CCNU, China), Alexey Vladimirov (Regensburg)

- Experiment: Anselm Vossen (Duke), Ralf Seidl (RIKEN), Justin Stevens (W&M)

- Jets, heavy quarks

- Theory: Ivan Vitev (LANL), Frank Petriello (Argonne & Northwestern U.)

- Experiment: Ernst Sichtermann (LBL), Brian Page (BNL), Leticia Mendez (ORNL)

- Exclusive

- Theory: Tuomas Lappi (Jyvaskyla), Barbara Pasquini (Pavia)

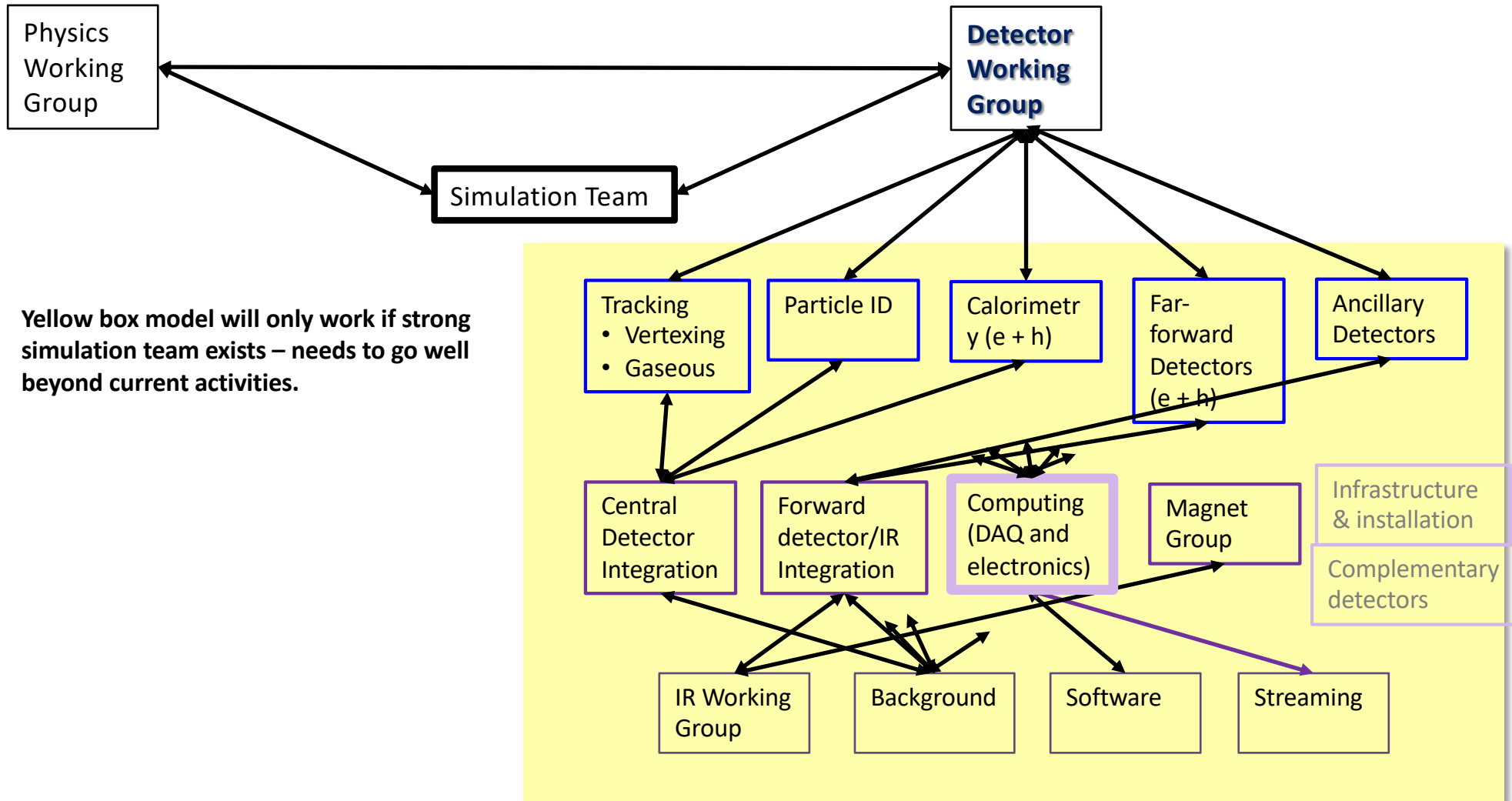
- Experiment: Raphaël Dupré (Orsay), Salvatore Fazio (BNL), Daria Sokhan (Glasgow)

- Diffractive & Tagging

- Theory: Wim Cosyn (Florida), Anna Stasto (PSU)

- Experiment: Or Hen (MIT), Douglas Higinbotham (JLab), Spencer Klein (LBNL)

# Organogram



# Detector Working Group Sub-conveners

- **Tracking (including vertexing)**, Conveners: [Kondo Gnanvo](#) (UVA), [Leo Greiner](#) (LBNL), [Annalisa Mastroserio](#) (INFN)
- **Particle ID**, Conveners: [Tom Hemmick](#) (SBU), [Patrizia Rossi](#) (JLab)
- **Calorimetry (EM and Hadronic)**, Conveners: [Vladimir Berdnikov](#) (CUA), [Eugene Chudakov](#) (JLab)
- **Far-Forward Detectors**, Conveners: [Alexander Jentsch](#) (BNL), [Michael Murray](#) (Kansas)
- **DAQ/Electronics**, Conveners: [Andrea Celentano](#) (INFN), [Damien Neyret](#) (CEA Saclay)
- **Polarimetry/Ancillary Detectors**, Conveners: [Elke Aschenauer](#), [Dave Gaskell](#)
- **Central Detector/Integration & Magnet**, Conveners: [Alexander Kiselev](#) (BNL), TBA
- **Forward Detector/IR Integration**, Convener: [Yulia Furletova](#) (JLab)
- **Infrastructure and Installation**, Convener: TBA
- **Detector Complementarity**, Conveners: [Elke Aschenauer](#) (BNL), TBA
- **Simulations**, Convener: [Markus Diefenthaler](#) (JLAB)

See <http://www.eicug.org/web/content/yr-detector-working-group> for updates.

# EIC Software Working Group

<https://software.eicug.org/>  
<https://eic.gitlab.io/documents/quickstart/>

**The software group has used Docker to make installation very easy!**

Install Docker

Install EIC Software via Docker (includes GEANT4, ROOT, Python, ... )

Launch the tutorial and start running the software

# Summary

- October 2019 Review of JLEIC and eRHIC Designs
- December 2019 Yellow Report Kick-Off / CD0 Signed
- January 2020 DOE Announces BNL Chosen As Site For Future EIC
- **Yellow Report Efforts Underway Now**
  - Design Choices That Are Being Made That Will Effect Many In This Room
  - Please consider getting involved In a Synergistic Activity
    - Your Physics Knowledge
    - Your Detector Knowledge
  - Feel free to contact a subconvenier or just ask me if you are interesting in contributing
- JLab will continue as a *major* contributor to the EIC project
  - Working on accelerator physics (e.g. luminosity & polarization)
  - Working on our physics and ensuring best possible acceptances / detectors
- **Very exciting times both for JLab 12 GeV & the EIC !**