



The Galileo Galilei Institute For Theoretical Physics

Centro Nazionale di Studi Avanzati dell'Istituto Nazionale di Fisica Nucleare

Arcetri, Firenze

Bound states in strongly coupled systems
Mar, 12 2018 - Mar, 16 2018



EIC: The Electron Ion Collider project

M. Battaglieri
INFN - GE
Italy

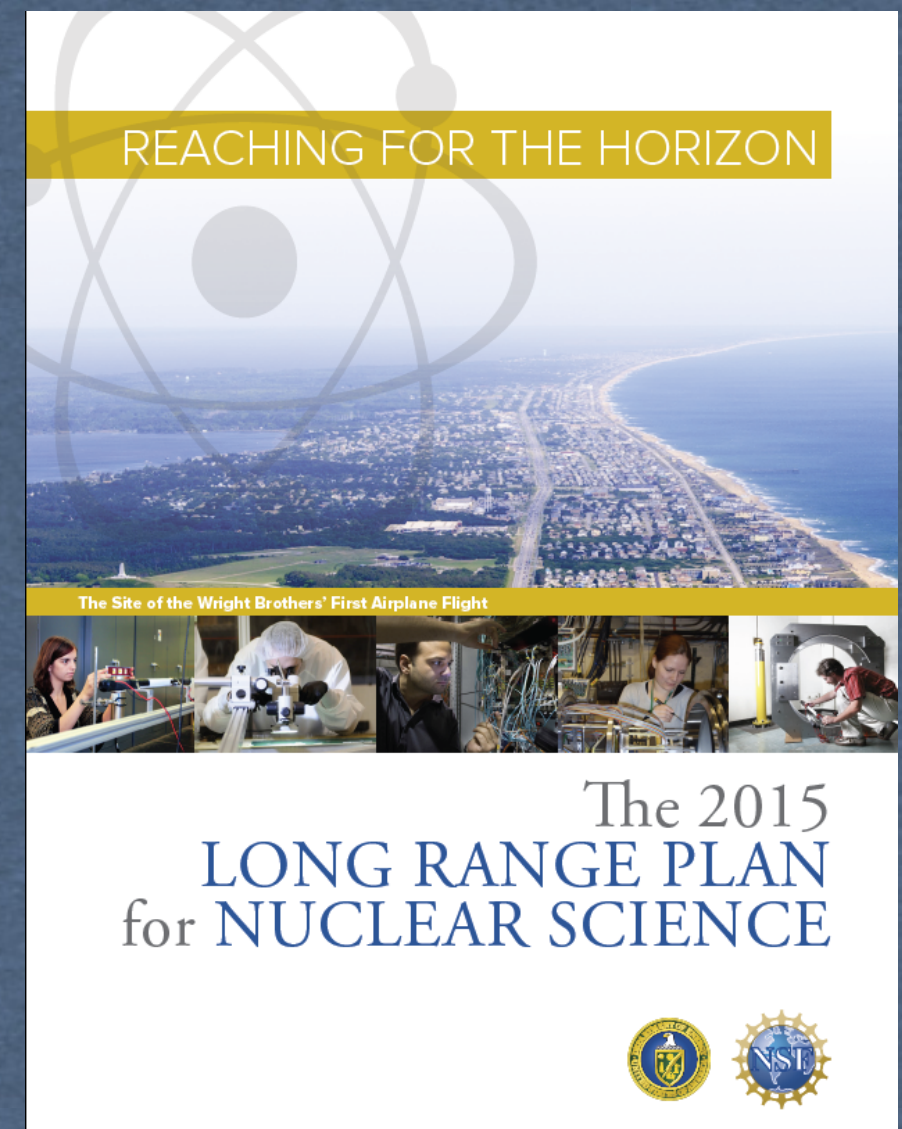


The 2015 Long Range Plan for Nuclear Science

Nuclear Science Advisory Committee (NSAC) and American Physics Society – Division of Nuclear Physics (APS-DNP) partnered to tap the full intellectual capital of the U.S. nuclear science community in identifying exciting, compelling, science opportunities

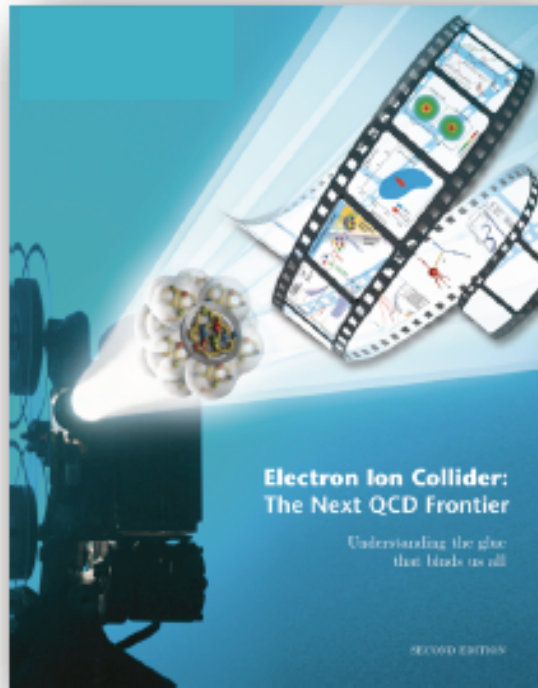
Recommendations:

- The progress achieved under the guidance of the 2007 Long Range Plan has reinforced U.S. world leadership in nuclear science. The highest priority in this 2015 Plan is to capitalize on the investments made.
- The observation of neutrinoless double beta decay in nuclei would...have profound implications.. We recommend the timely development and deployment of a U.S.-led ton-scale neutrinoless double beta decay experiment.
- **Gluons...generate nearly all of the visible mass in the universe. Despite their importance, fundamental questions remain....These can only be answered with a powerful new electron ion collider (EIC). We recommend a high-energy high-luminosity polarized EIC as the highest priority for new facility construction following the completion of FRIB.**
- We recommend increasing investment in small-scale and midscale projects and initiatives that enable forefront research at universities and laboratories.

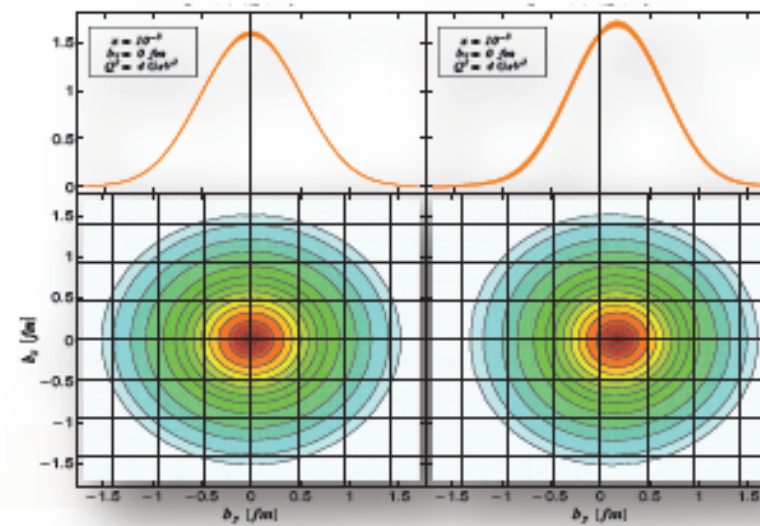


The EIC physics (so far ...)

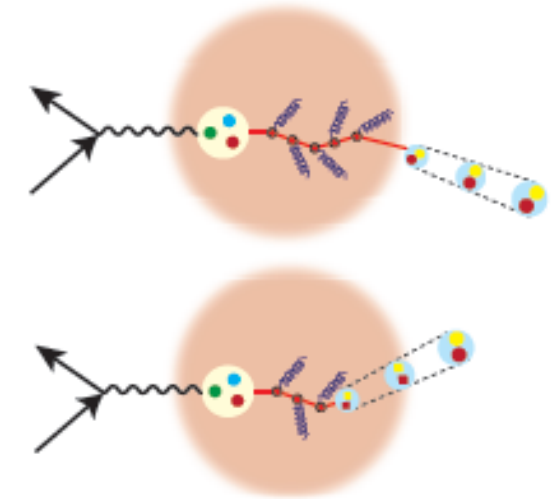
Accardi et al., Eur. Phys. J. A (2016) 52: 268 arXiv: 1212.1701.v3



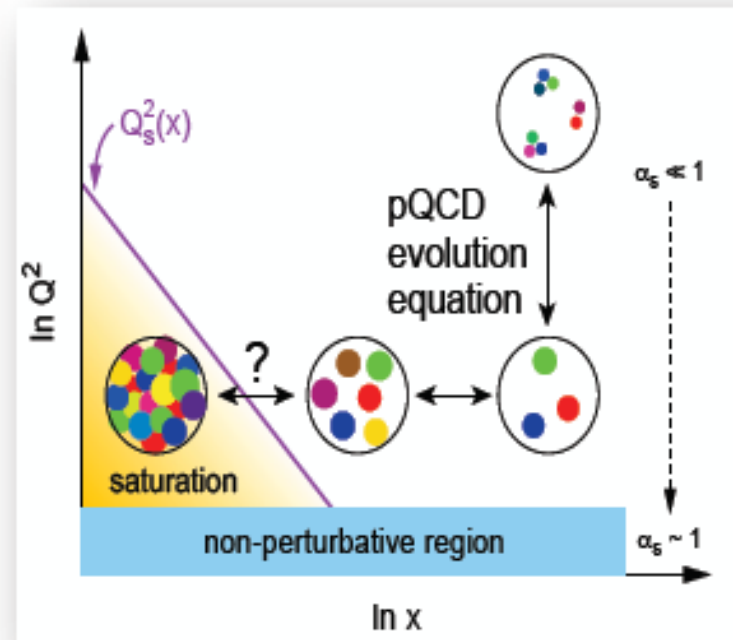
3D Imaging of Nucleon Structure



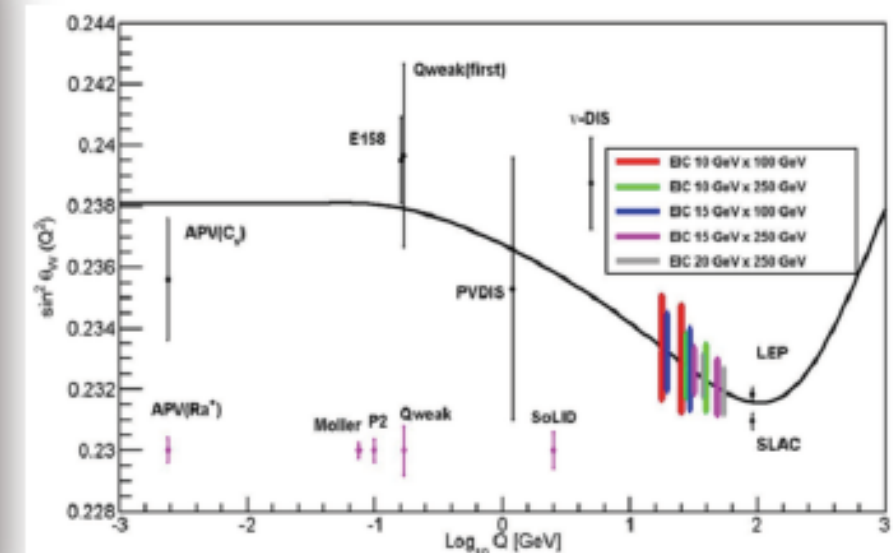
Hadronization in cold QCD matter



Gluon Saturation



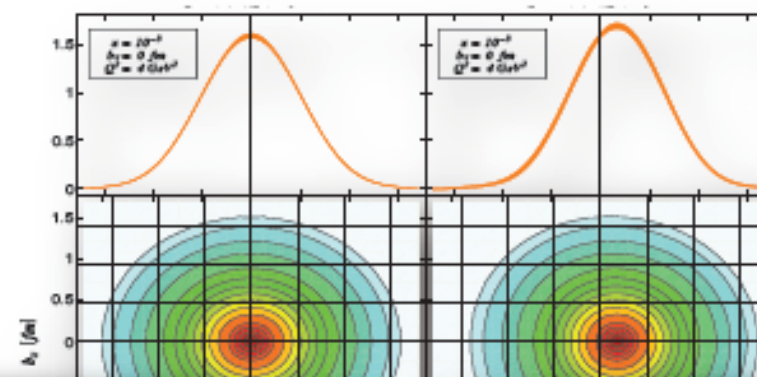
EW Physics



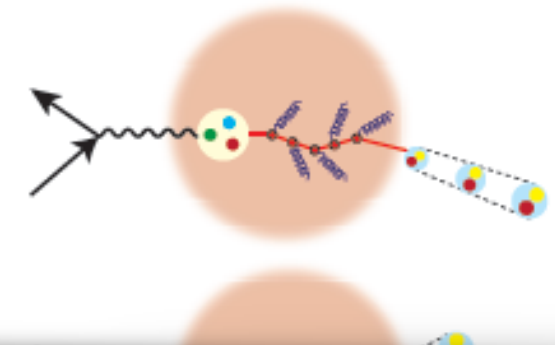
The EIC physics (so far ...)

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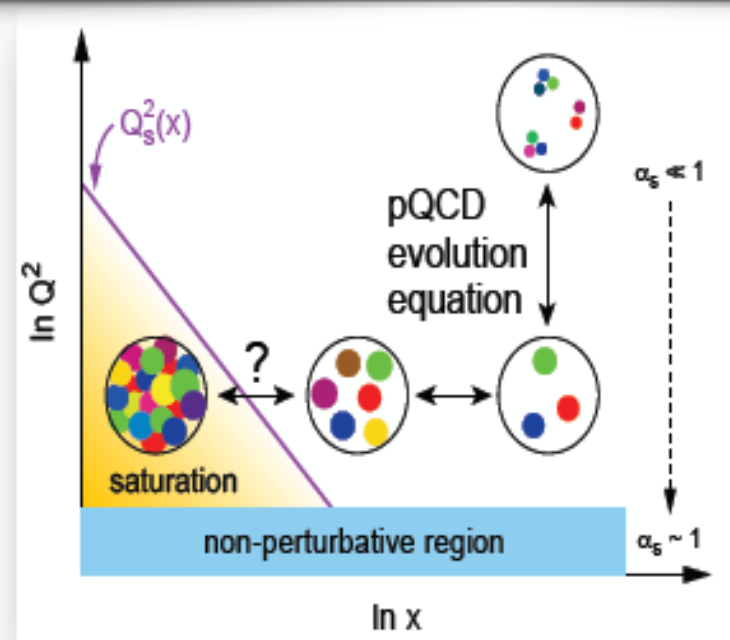
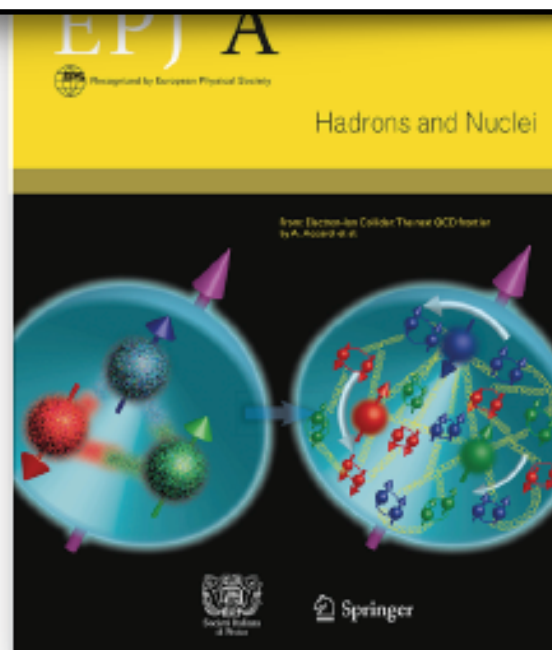
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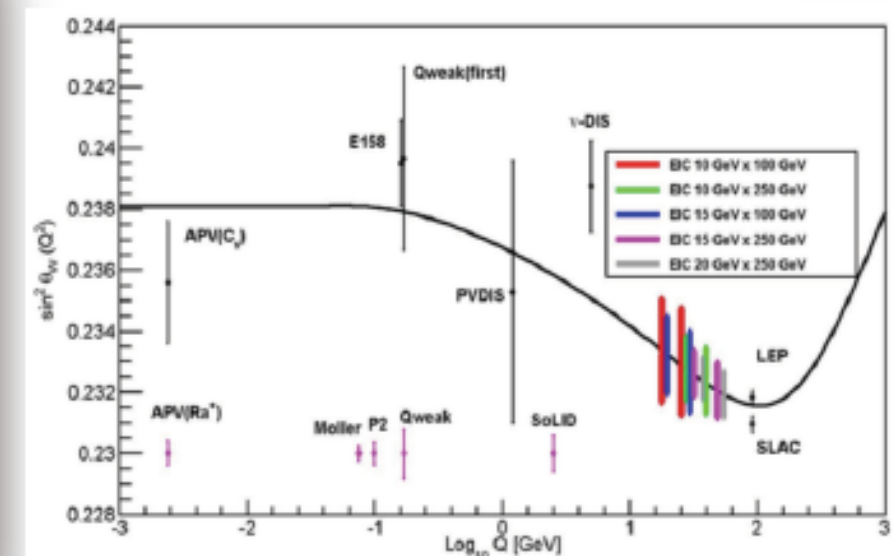
Hadronization in cold QCD matter



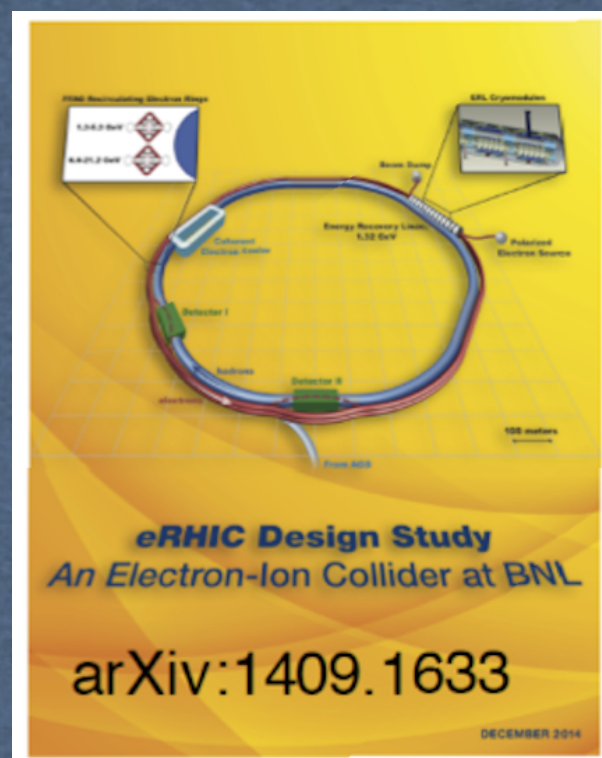
No spectroscopy program (yet)!



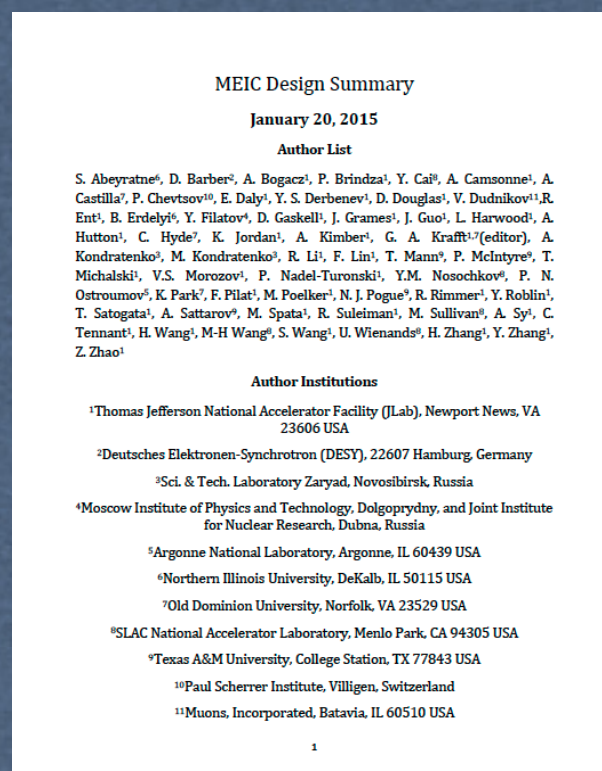
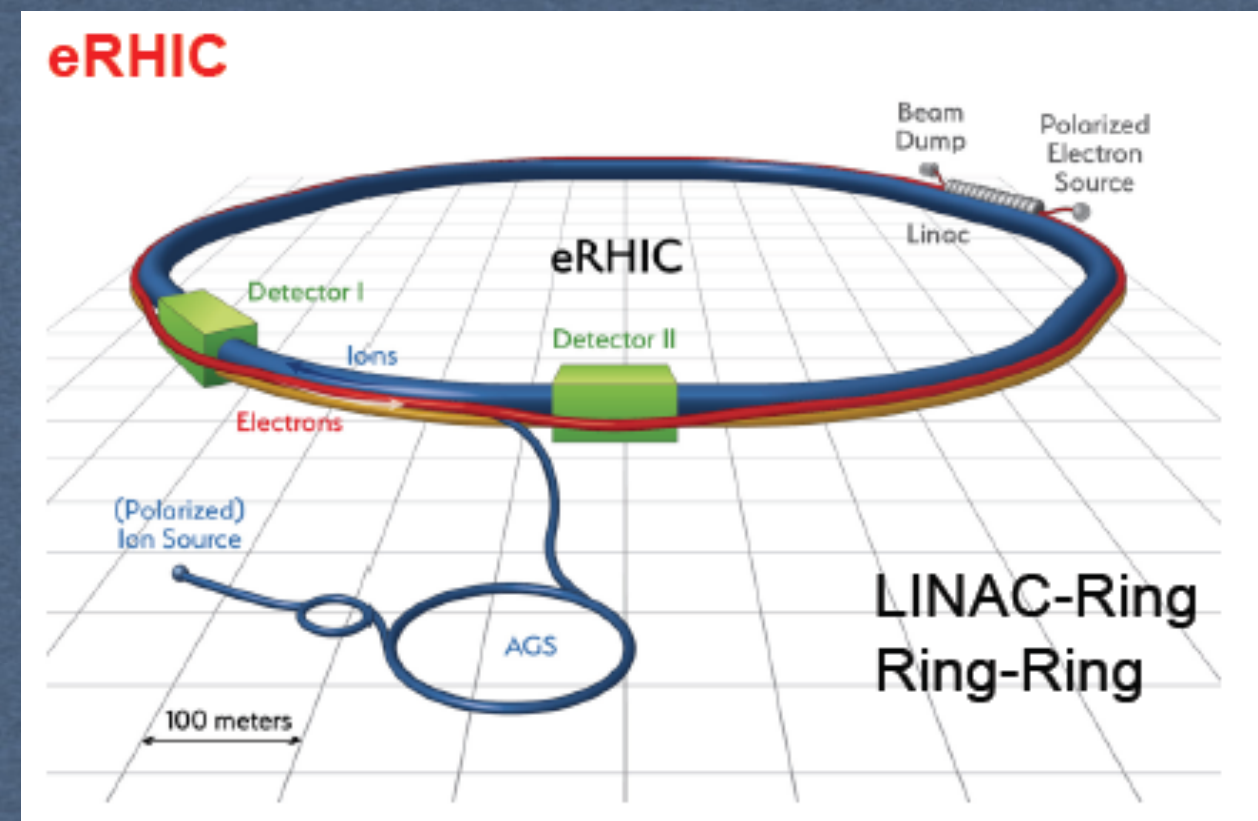
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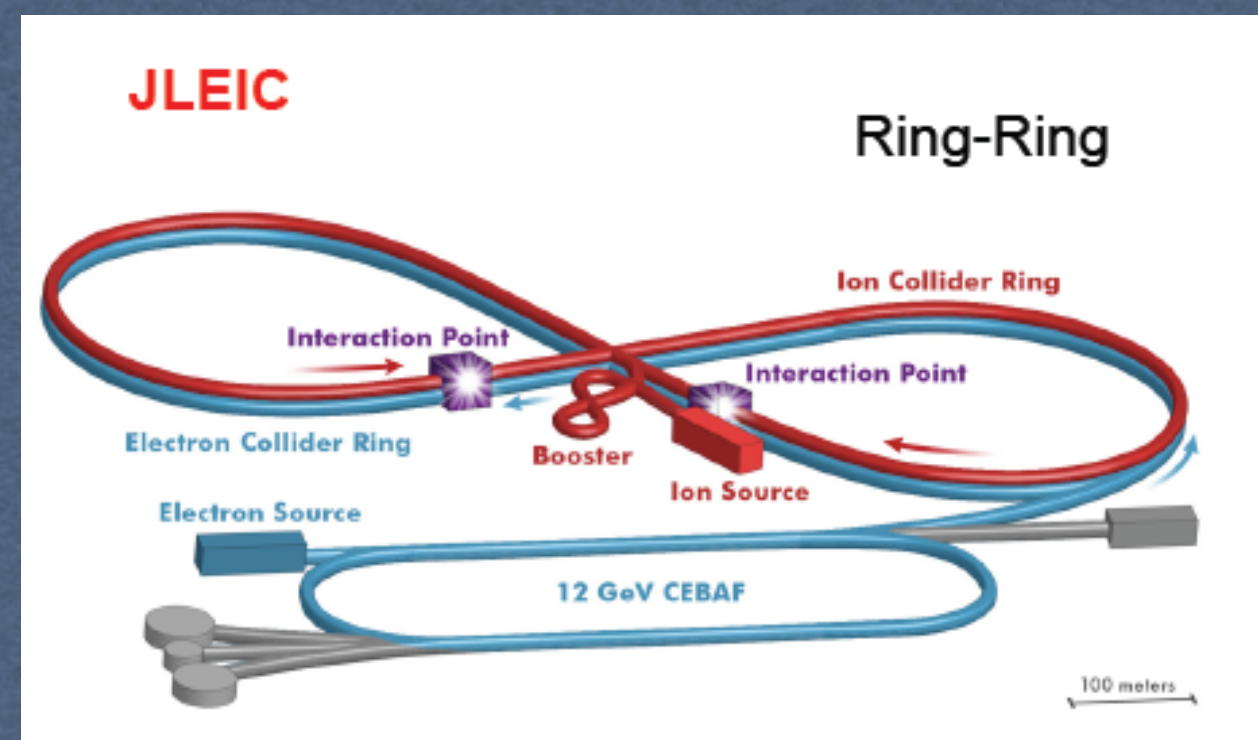
Options for EIC



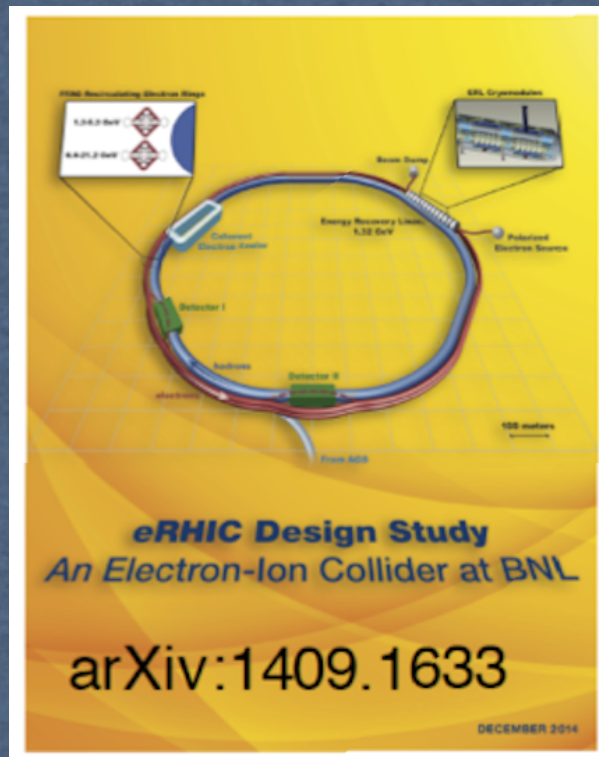
eRHIC
 arXiv:1409.1633
 Energy range:
 e-: 15-20 GeV
 p: 100-250 GeV
 W: 40-120 GeV



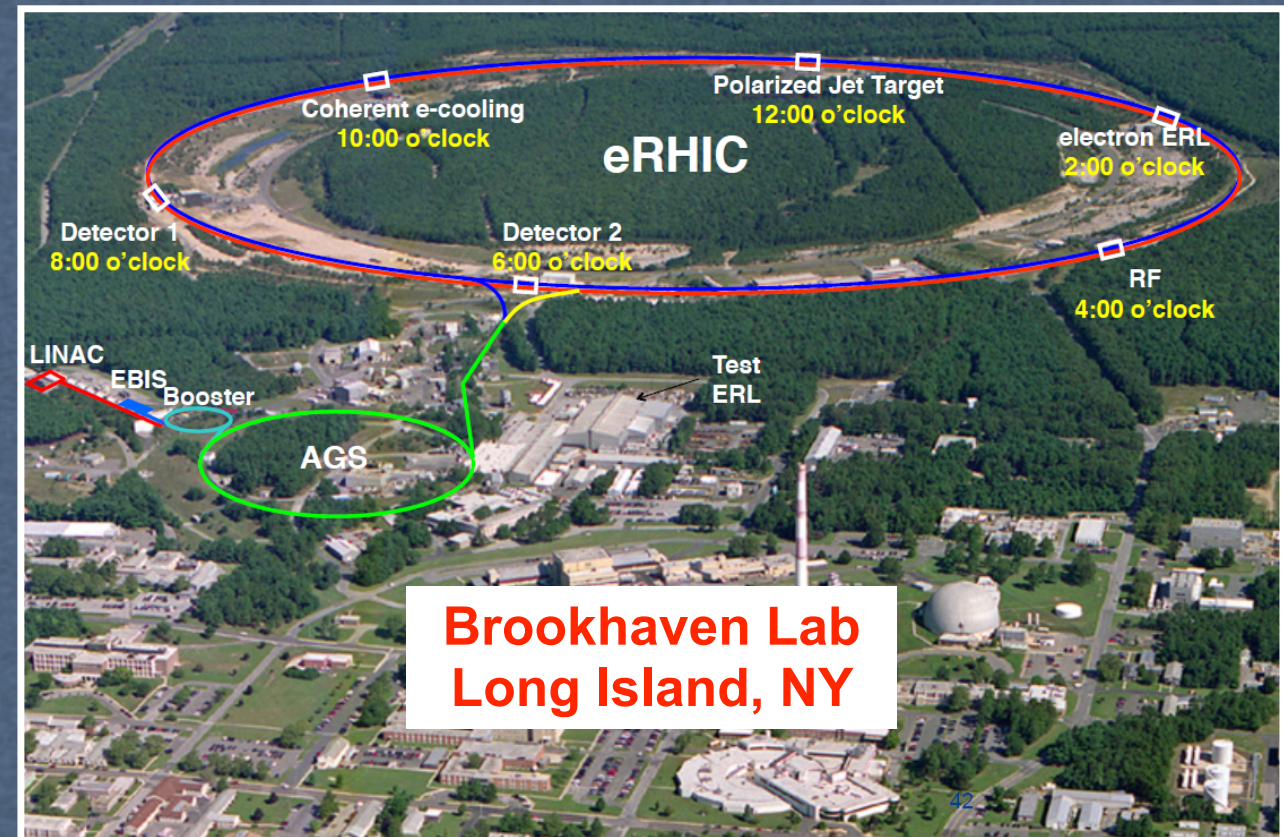
JLEIC
 arXiv:1504.07961
 Energy range:
 e-: 3-10 GeV
 p : 20-100 GeV
 W: 20-100 GeV



Options for EIC



eRHIC
arXiv:1409.1633
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MEIC Design Summary

January 20, 2015

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Author Institutions

¹Thomas Jefferson National Accelerator Facility (JLab), Newport News, VA 23606 USA

²Deutsches Elektronen-Synchrotron (DESY), 22607 Hamburg, Germany

³Sci. & Tech. Laboratory Zaryad, Novosibirsk, Russia

⁴Moscow Institute of Physics and Technology, Dolgoprudny, and Joint Institute for Nuclear Research, Dubna, Russia

⁵Argonne National Laboratory, Argonne, IL 60439 USA

⁶Northern Illinois University, DeKalb, IL 50115 USA

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⁹Texas A&M University, College Station, TX 77843 USA

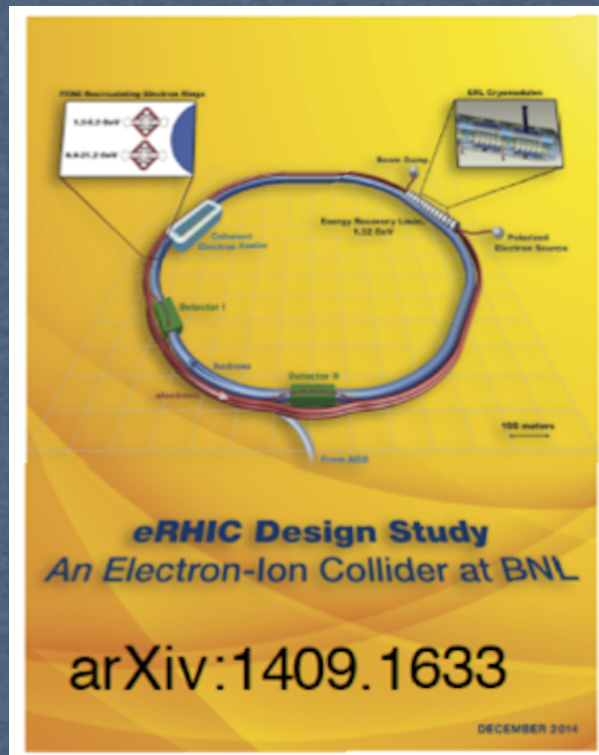
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¹¹Muons, Incorporated, Batavia, IL 60510 USA

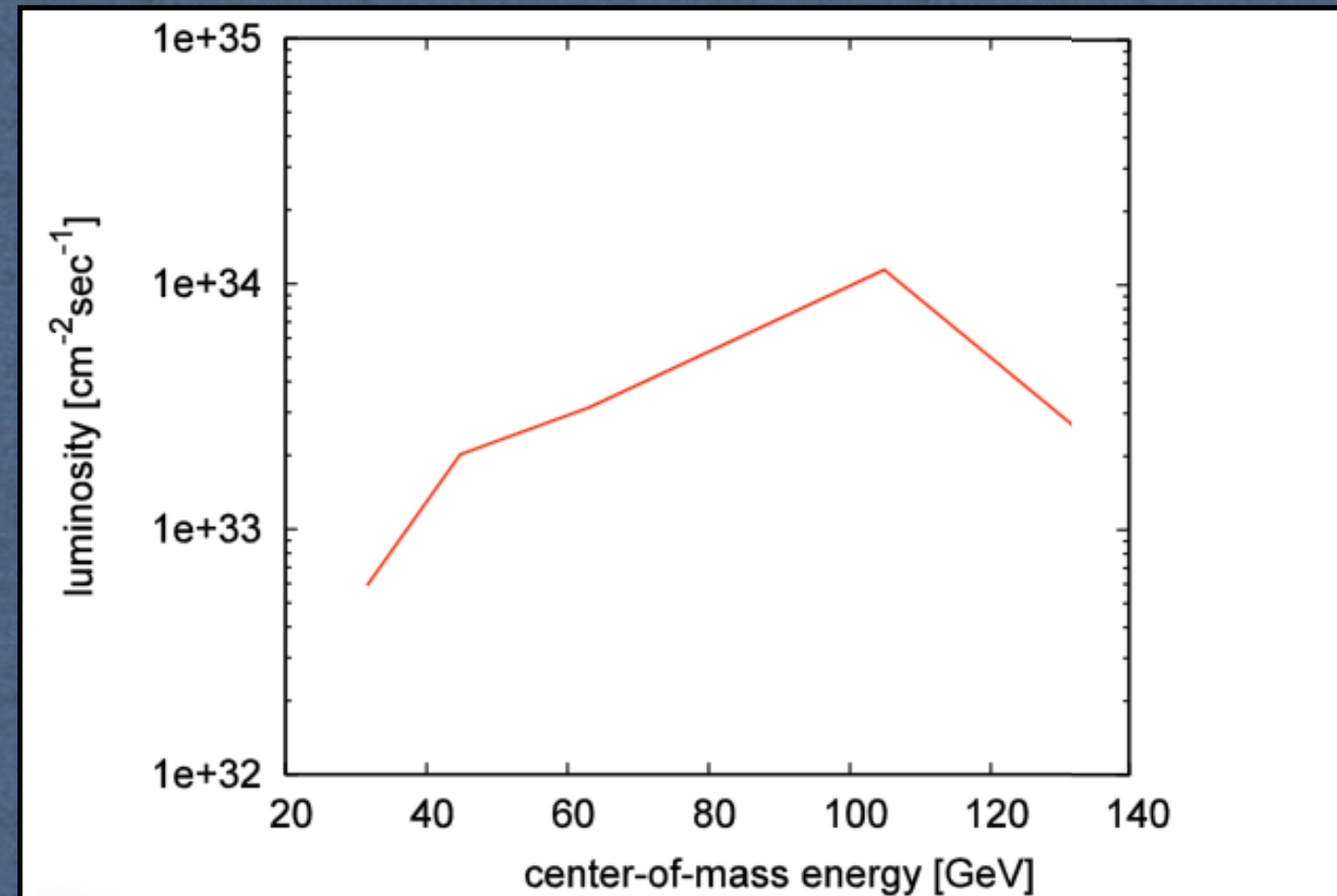
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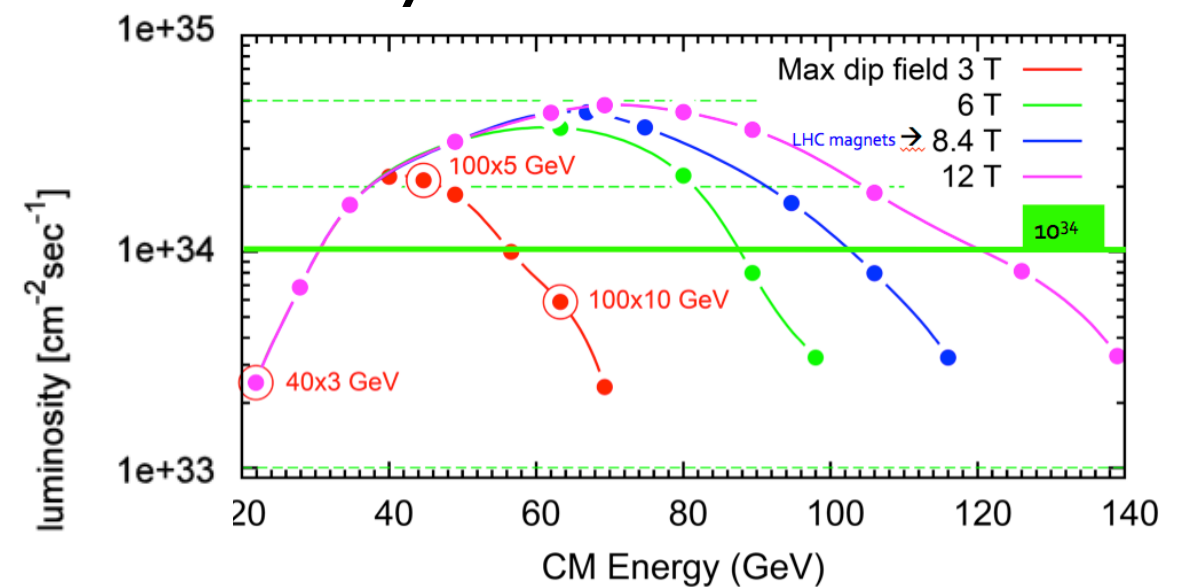
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Luminosity vs. center-of-mass energy



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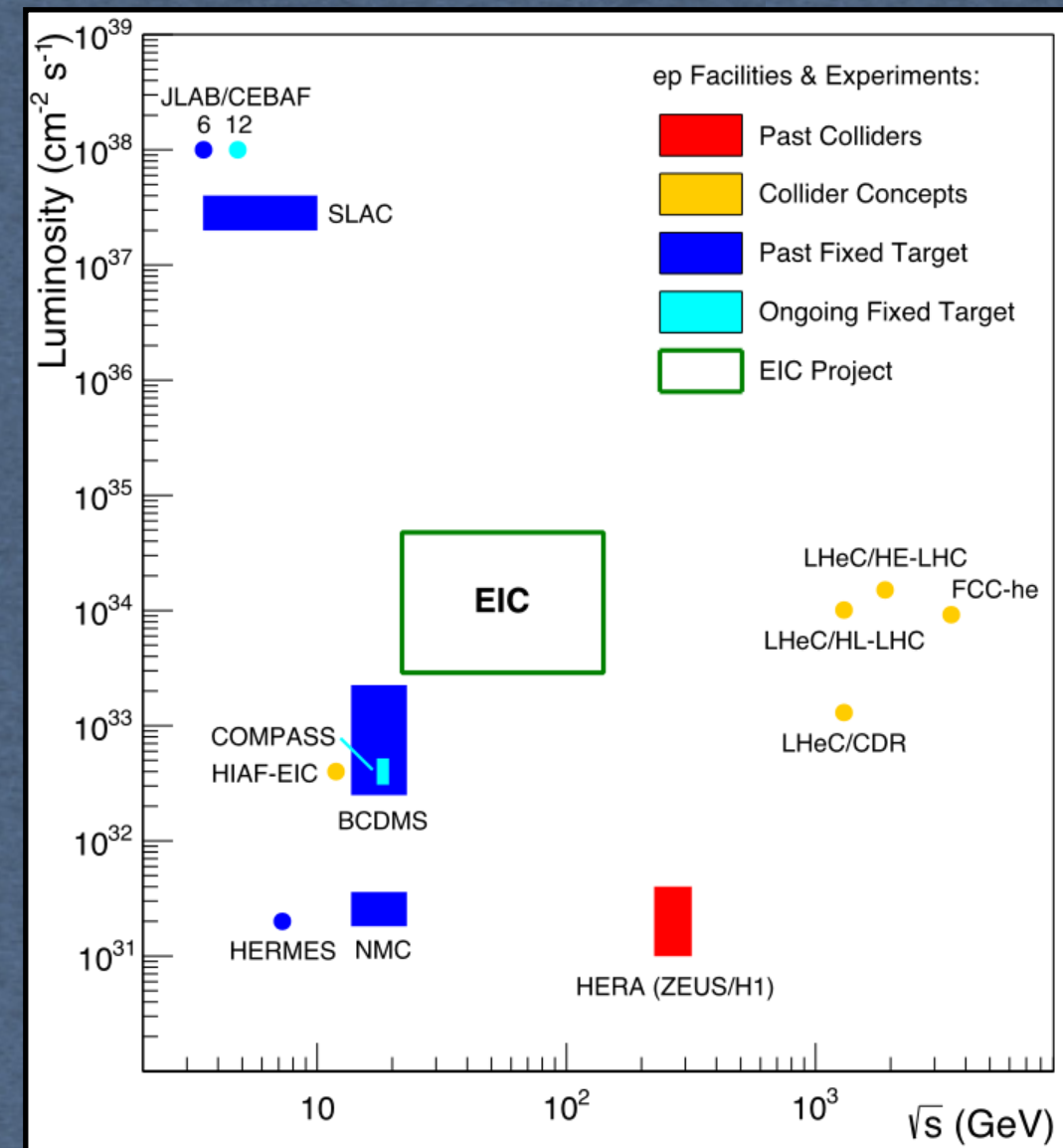
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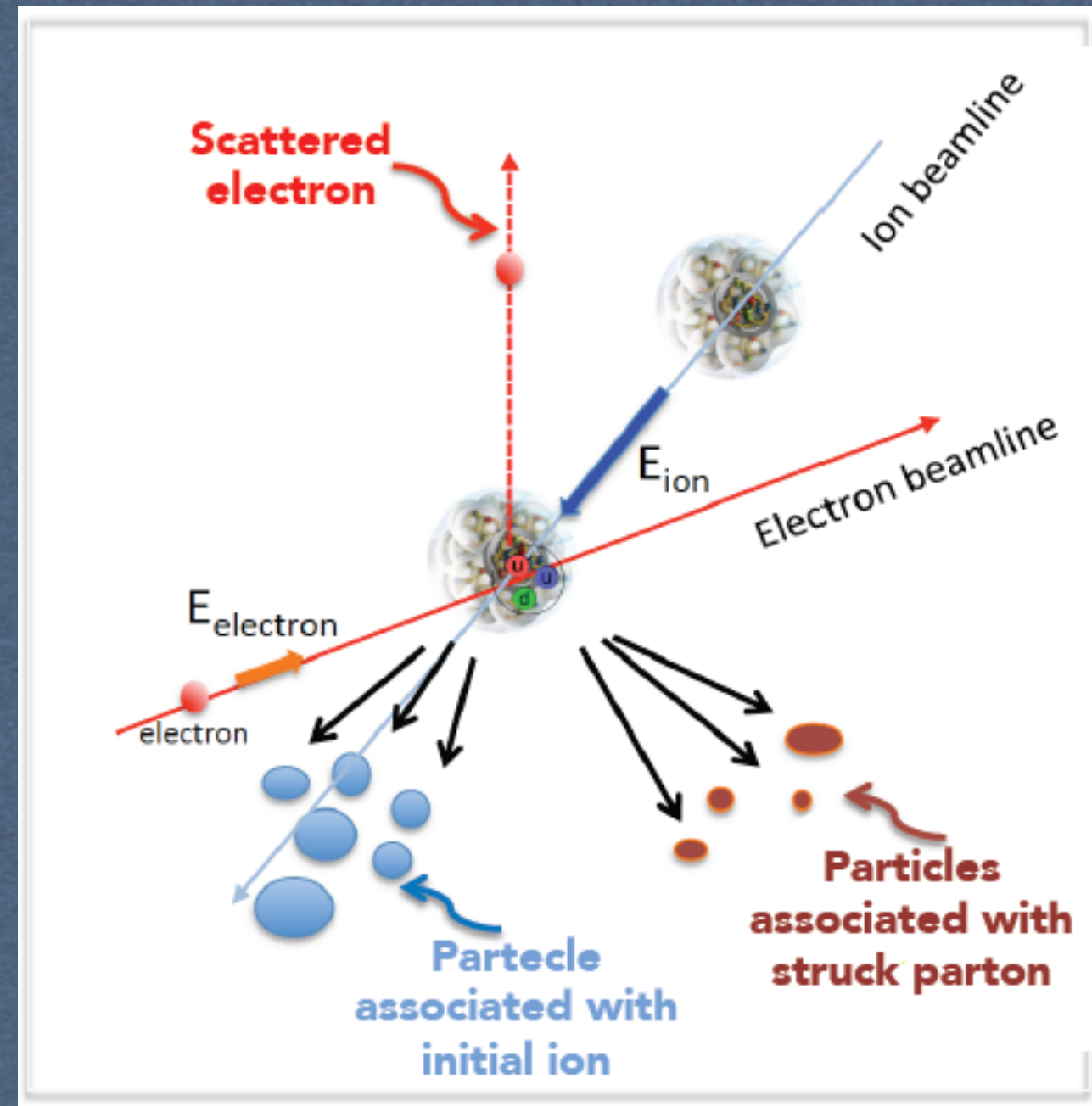
EIC and the other facilities

- **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 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....

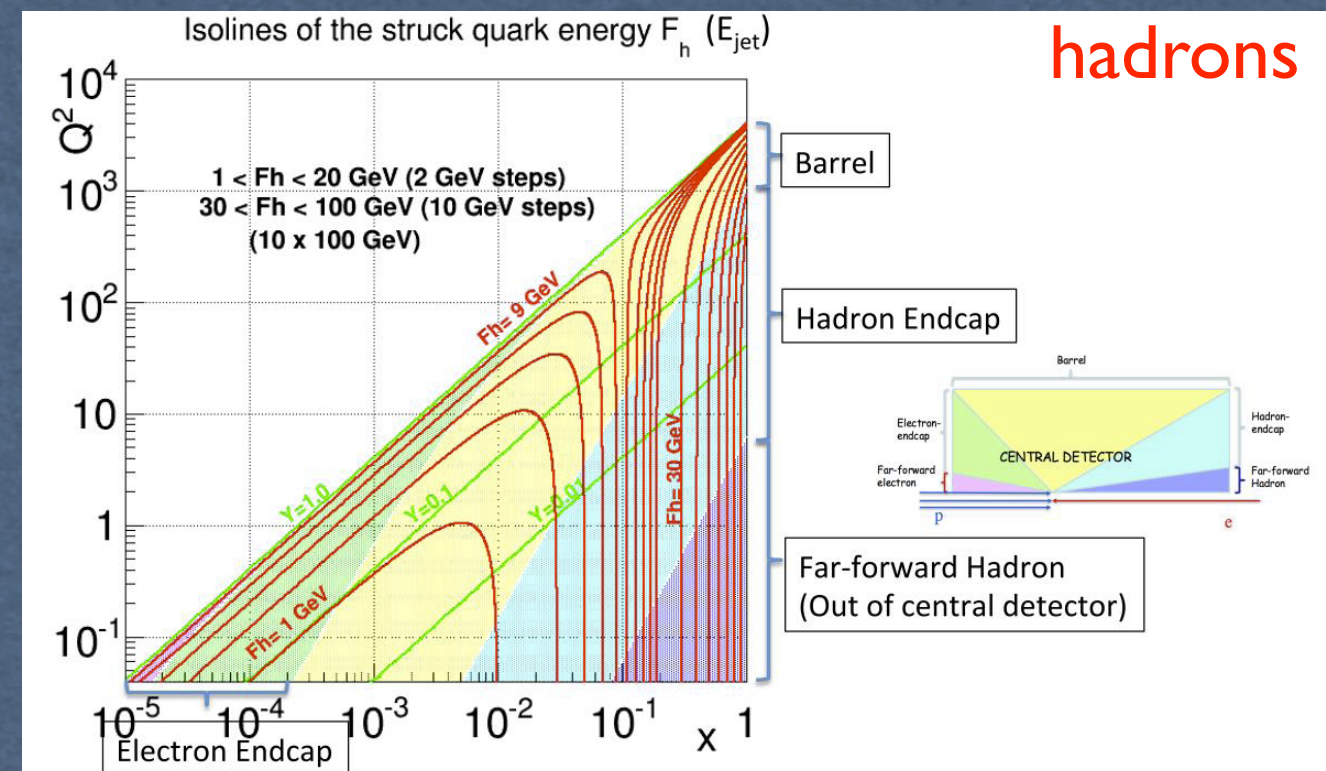
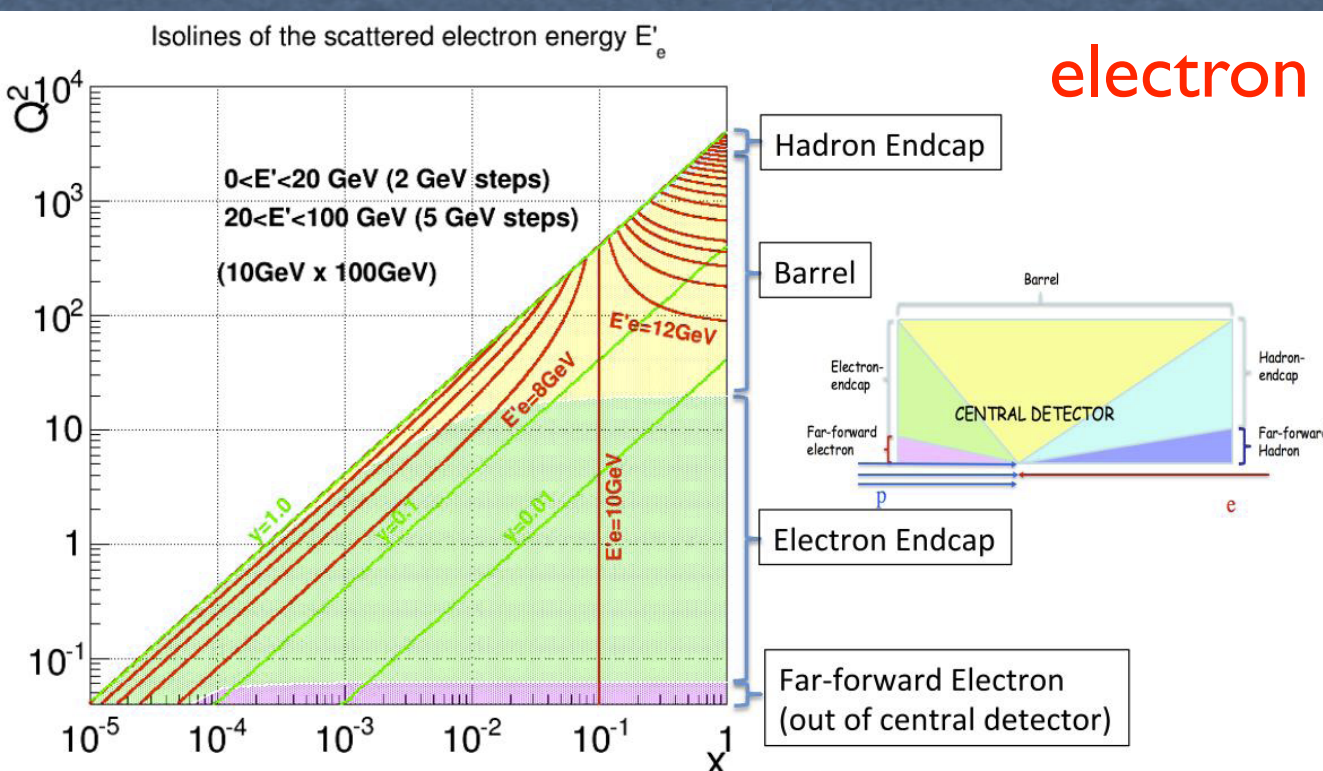
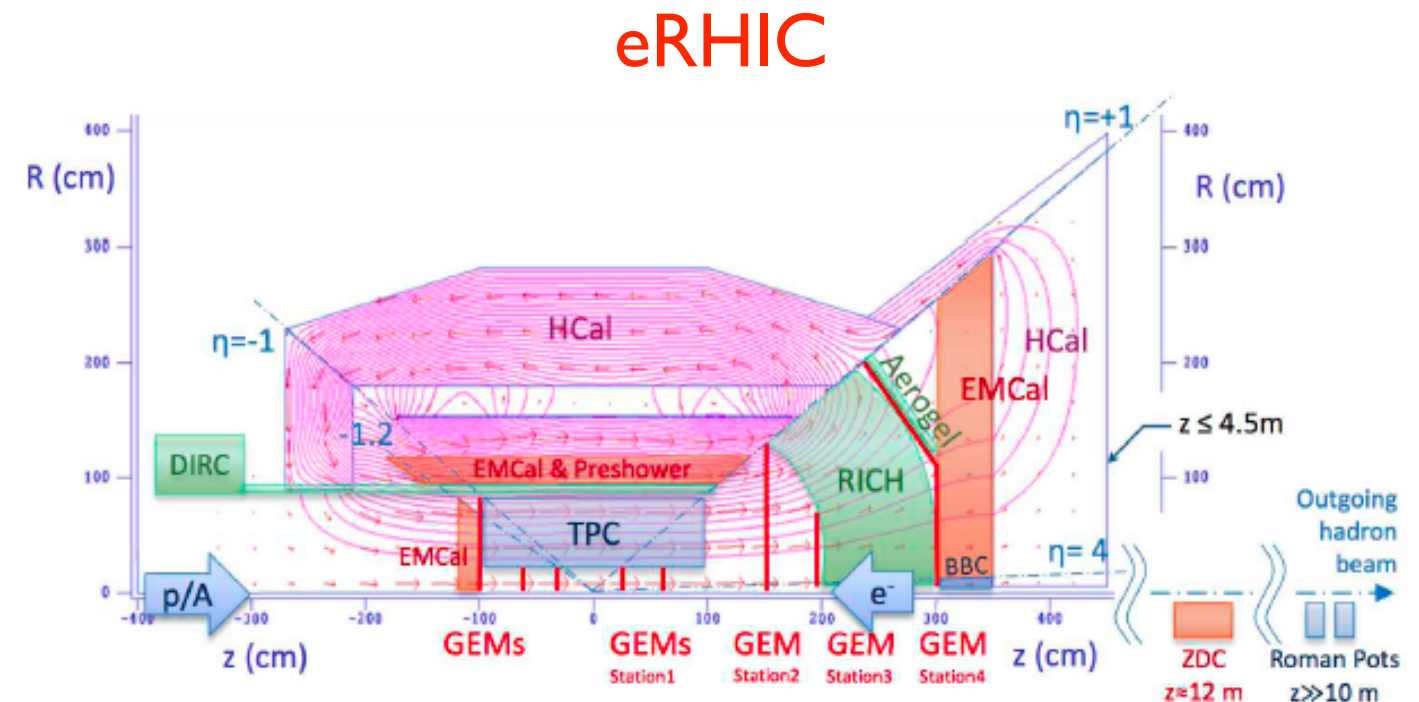
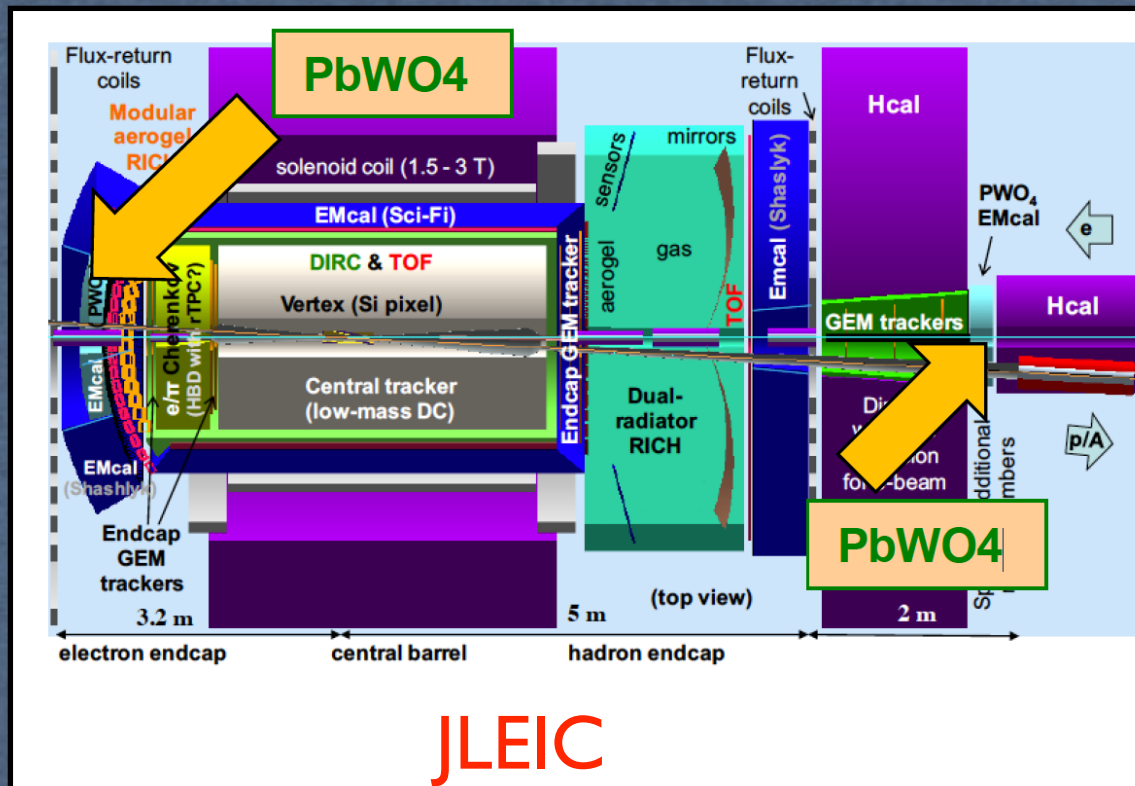


EIC detectors challenge

- 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-dim 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



EIC detectors

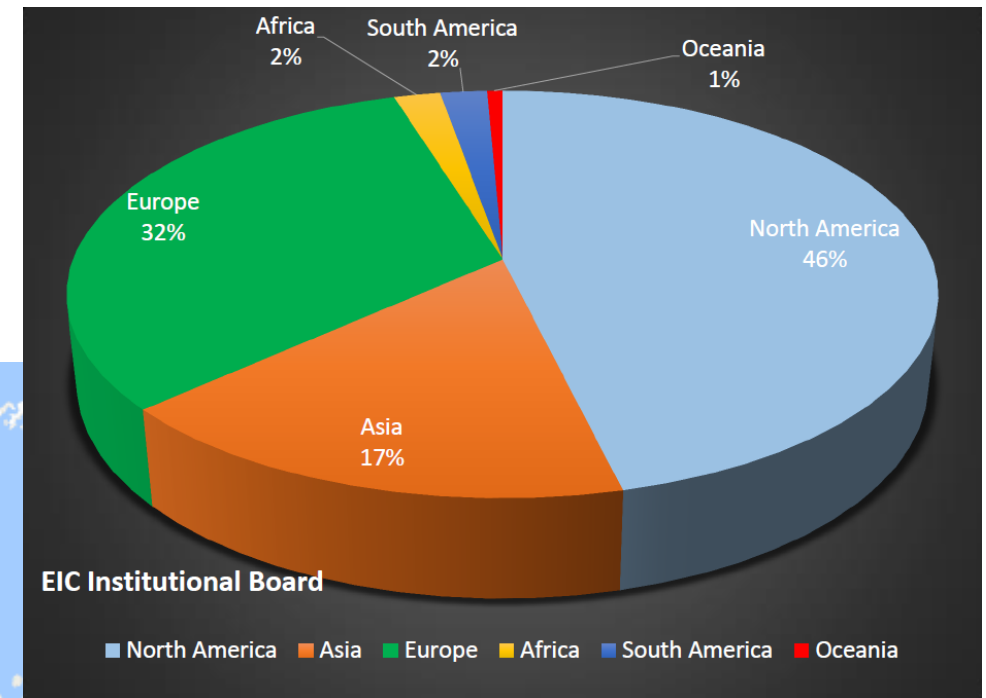


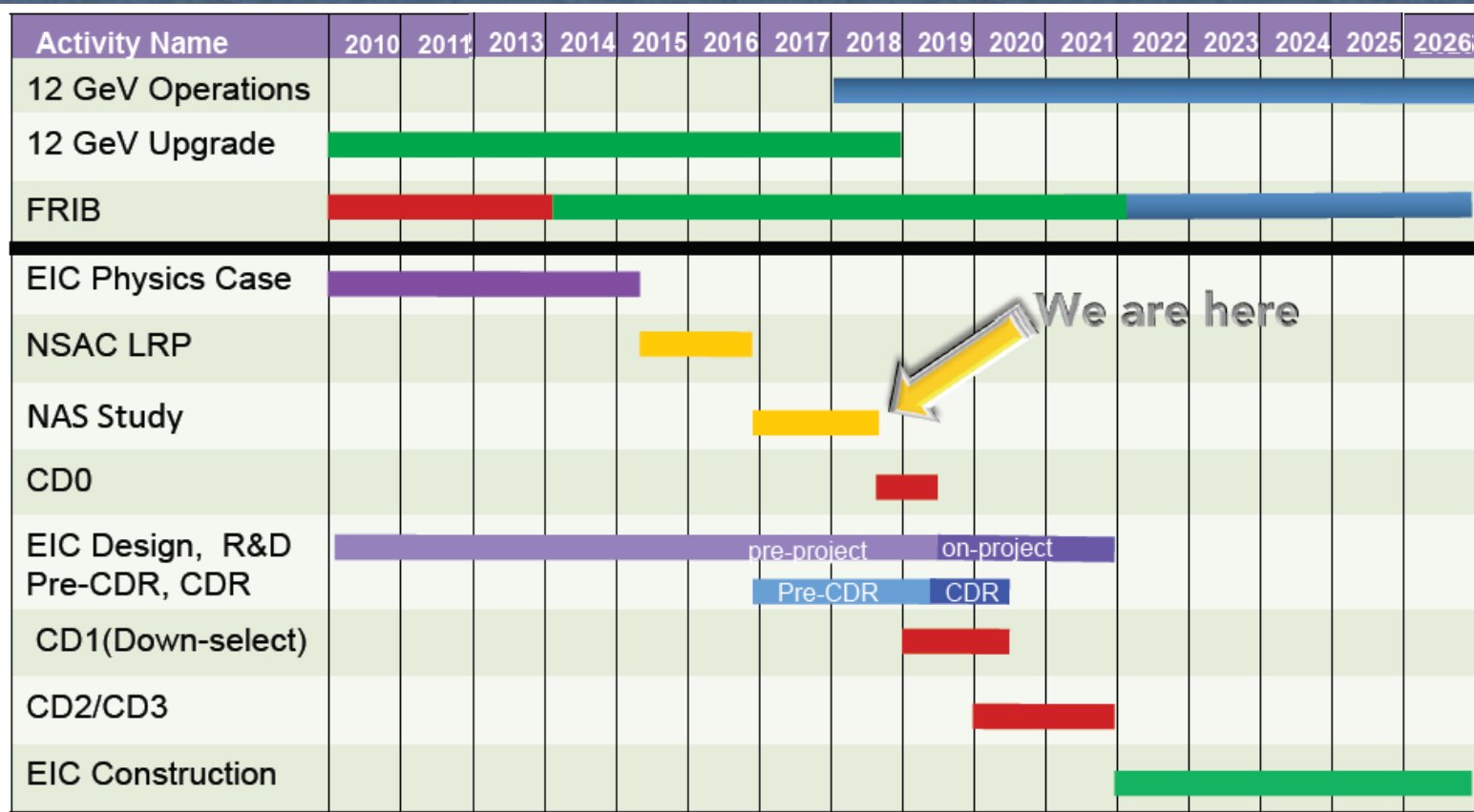
Worldwide interest in EIC physics

The EIC Users Group: EICUG.ORG

(no students included as of yet)

734 collaborators, 29 countries, 167 institutions...
(February 24, 2018)





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

EIC timeline

* 2015 EIC in the NSAC long range plan priorities list

* 2016 DOE charge to National Academy of Science (NSAC meeting - March 2016)

The committee will assess the scientific justification for a US domestic electron ion collider facility, taking in to account current international plans and existing domestic facility infrastructure. In preparing its report, the committee will address the role that such a facility could play in the future of nuclear physics, considering the field broadly, but placing emphasis on its potential scientific impact on quantum chromodynamics.

* ~2018 Resolution in few weeks/months

* ~2020/21 CDRs ready and CD0

It is time to propose a spectroscopy program for EIC!

- So far detectors just sketched (eRHIC vs JLEIC)
- They will be finalised for the CDR (site-dependent)
- We have a chance to propose a spectroscopy program at EIC to be included un the next EIC - Physics Book
- "The spectroscopy program at EIC and future accelerators" Dec 19-21 2018 ECT* workshop

