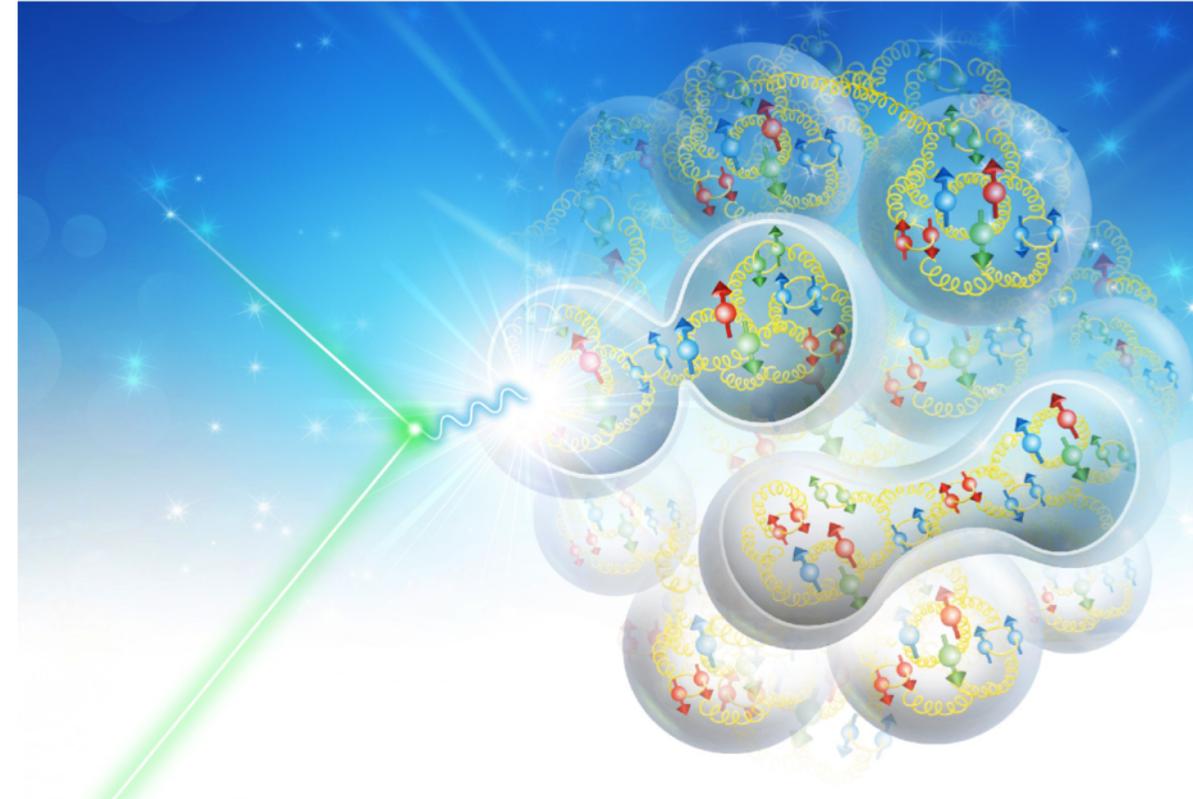


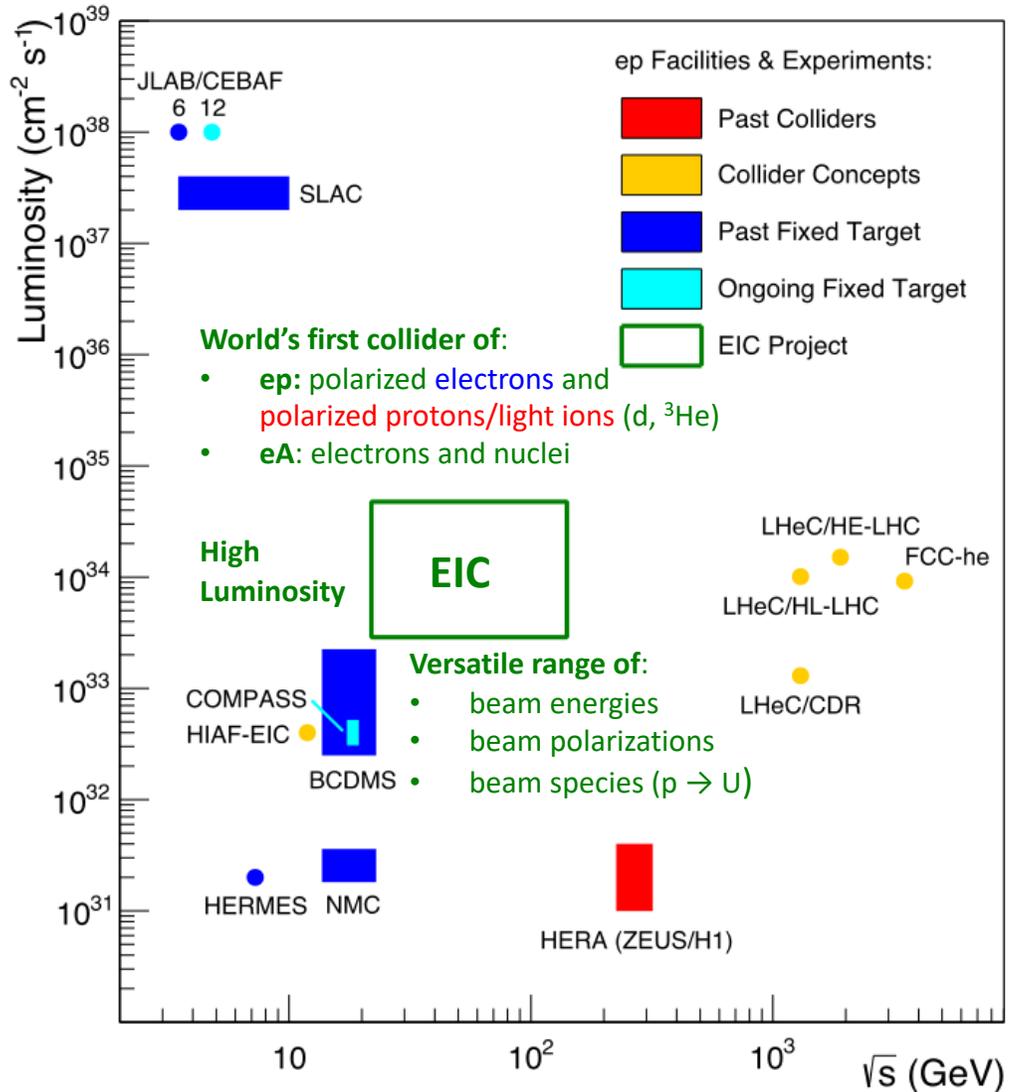
Open and new requirements: Electron-Ion Collider

The **Electron-Ion Collider** is **highest priority for new construction** for the U.S. Nuclear Physics program. The proposed frontier accelerator facility will enable us to embark on a **precision study of the nucleon and the nucleus at the scale of sea quarks and gluons**, over all of the kinematic range that are relevant.

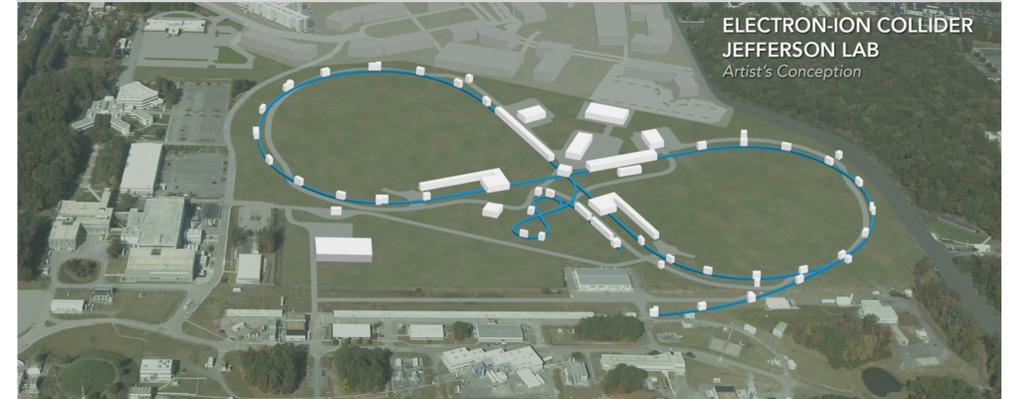
Markus Diefenthaler (EIC Center, EICUG)



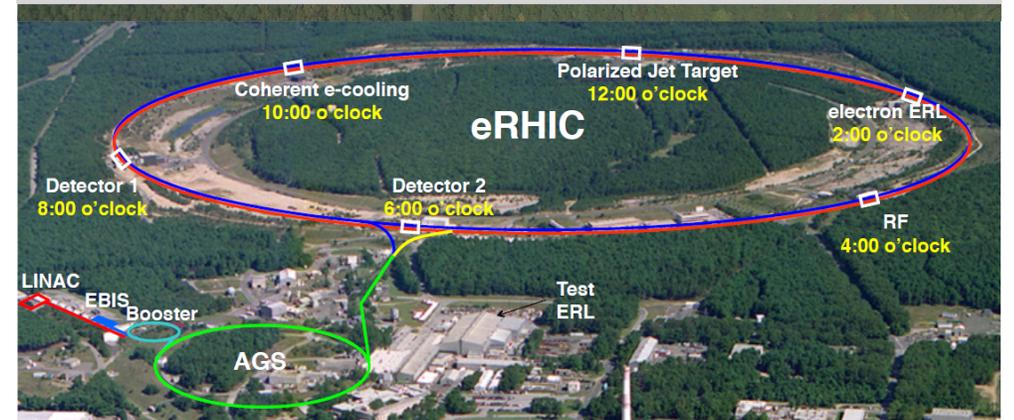
The **Electron-Ion** Collider: Frontier accelerator facility in the U.S.



Highest priority for new construction
for the U.S. Nuclear Physics program

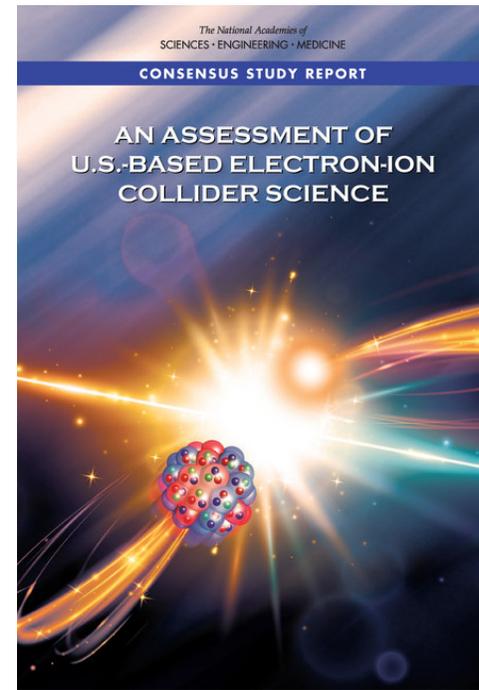
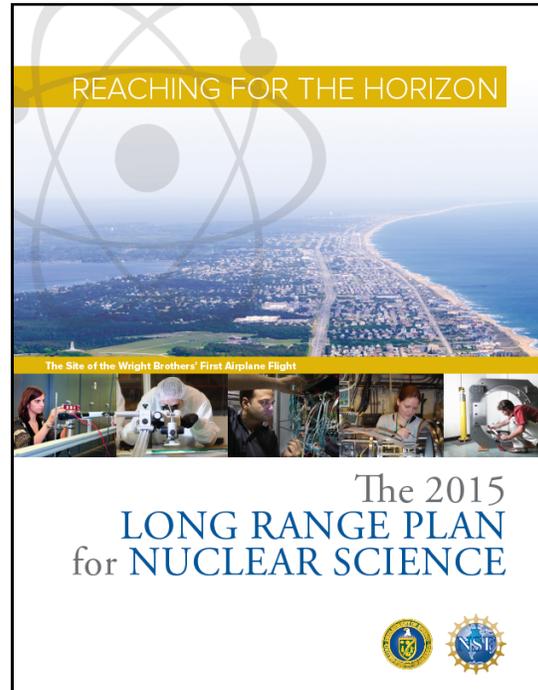
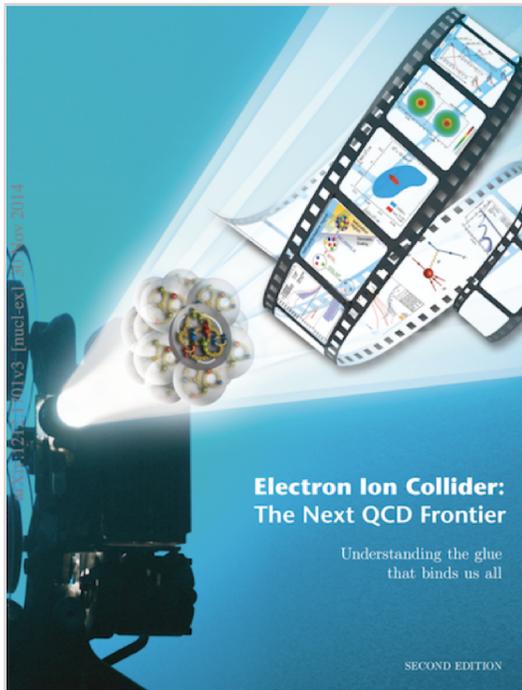


Proposal by Jefferson Lab



Proposal by Brookhaven Lab

Why an Electron-Ion Collider?



Right tool

- to precisely **image quarks and gluons** and their interactions
- to explore the new **QCD frontier of strong color fields in nuclei**
- to understand **how matter at its most fundamental level is made.**

Understanding of nuclear matter is **transformational**, perhaps in an even more dramatic way than how the understanding of the atomic and molecular structure of matter led to new frontiers, new sciences and new technologies.

EIC detector simulations

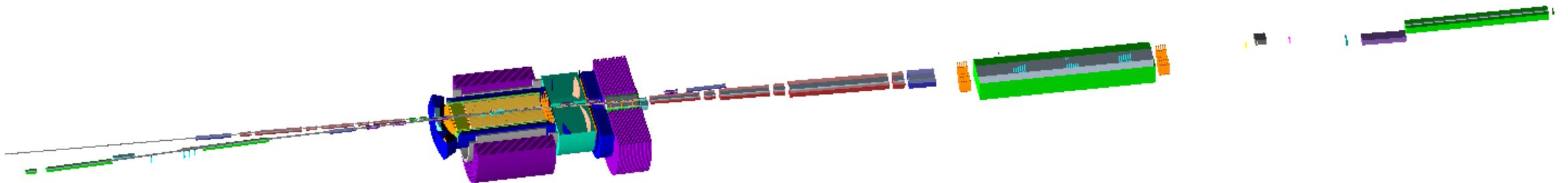
EIC

- energy range is different from LHC
- validation, tuning and extension including test beam studies

collaboration with Geant4 Collaboration

- **liaison** Makoto Asai (SLAC), since 2016
- knowledge transfer (e.g., sub-event parallelism or tessellated solids)
- coordinate input for Geant4 validation based on EIC physics list maintained by SLAC Geant4 group

Geant4 simulation of JLEIC IR and detector region (80m)



Detector Simulation R&D

- containers and tutorials for EIC detector simulations
- full simulations in Geant4
- fast simulations in Geant4?
 - For factor 2-10, technologies already exist (e.g. gflash or biasing in G4)
 - More needed? If so, how to develop technologies?

Improved photo-nuclear and electro-nuclear reactions in Geant4

Low Energy Hadronic Physics Detailed talk by Dennis Wright

Status

- **High-energy physics** Photo-nuclear and electro-nuclear reactions implemented for simulating high-energy interactions in calorimeters. Relatively simple models were implemented (to speed up simulations) which produced good average behavior.
- **Nuclear Physics** Detailed modeling of photo-nuclear and electro-nuclear reactions required at energies of 15 GeV and below:
 - JLAB 12 GeV Science program with photon and electron beams
 - EIC detector and physics simulations related to forward collision products

Requests

- Electro-nuclear models rely on Weizsacker-Williams approximation. Not sufficient for high-intensity and high precision electron scattering. The full, off-shell electron scattering vertex must be implemented for nucleons within the nuclear target.
- Bertini cascade has been shown to overproduce protons and neutrons in the form of a *knee* near the kinematic endpoints of reactions at 4.5 GeV. This appears to be unphysical and needs to be addressed.
- **Improvements** directly applicable at high-energy colliders:
 - detailed simulations of ultra-peripheral reactions
 - detailed simulations for reactions with low-energy fission products
 - further understanding for environmental and cosmic backgrounds for fundamental symmetry experiments

Summary

Markus Diefenthaler

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Electron-Ion Collider project

- A new frontier in Nuclear Physics

Geant4 for EIC

- EIC detector and physics simulations rely on Geant4
- **Collaboration with Geant4 Collaborations**
 - maintain EIC physics lists
 - knowledge transfer (e.g., sub-event parallelism or tessellated solids)
 - **request** improved photo-nuclear and electro-nuclear reactions

