

# Electron Ion Collider for High Energy Physics

Swagato Mukherjee



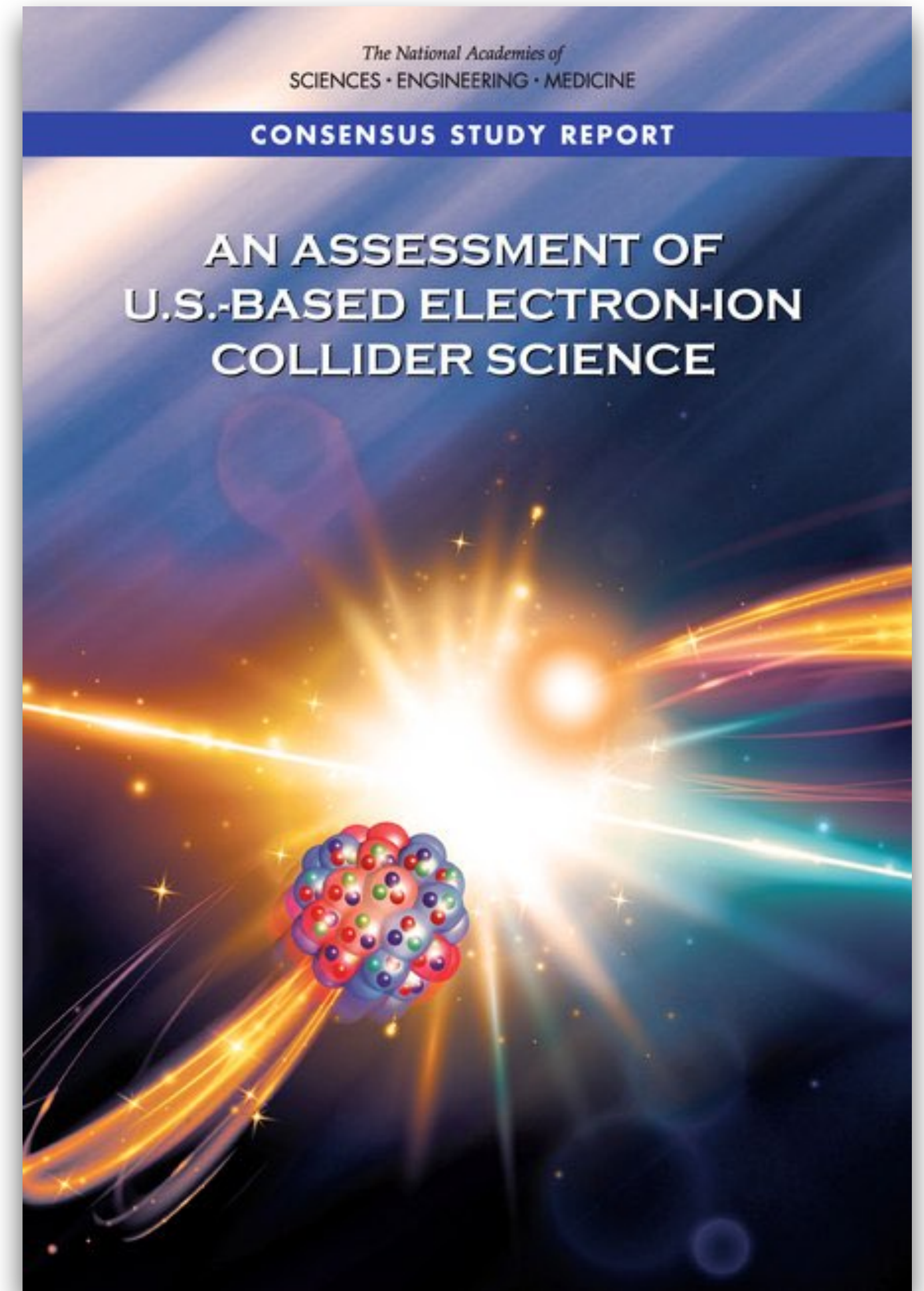
Brookhaven National Laboratory, January 2022

3 profound questions:

- ▶ how does the mass of the nucleon arise ?
- ▶ how does the spin of the nucleon arise ?
- ▶ what are the emergent properties of dense systems of gluons ?

answer:

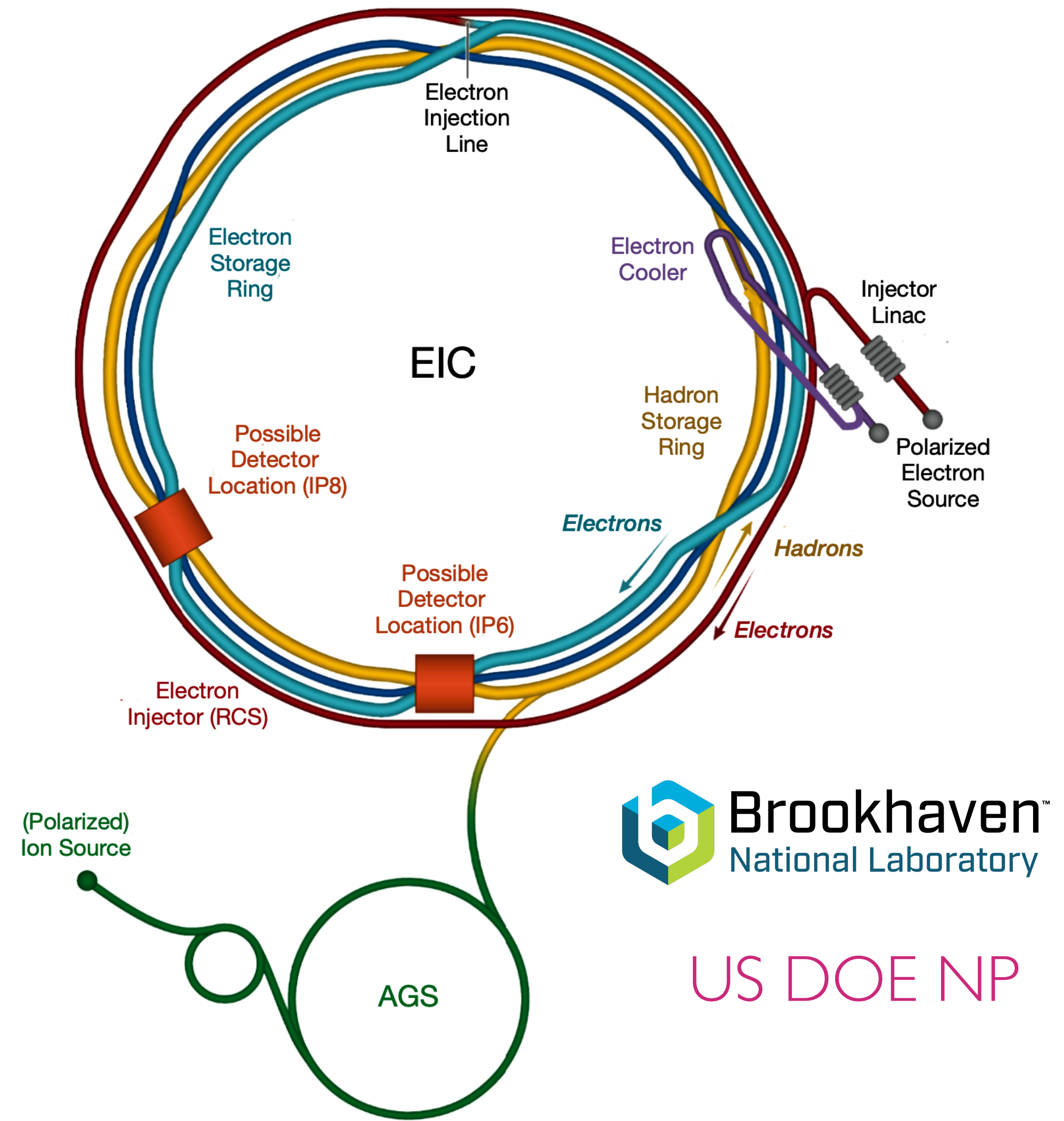
an electron ion collider (EIC) with highly polarized beams of electrons and ions, with sufficiently high luminosity and sufficient, and variable, center-of-mass energy



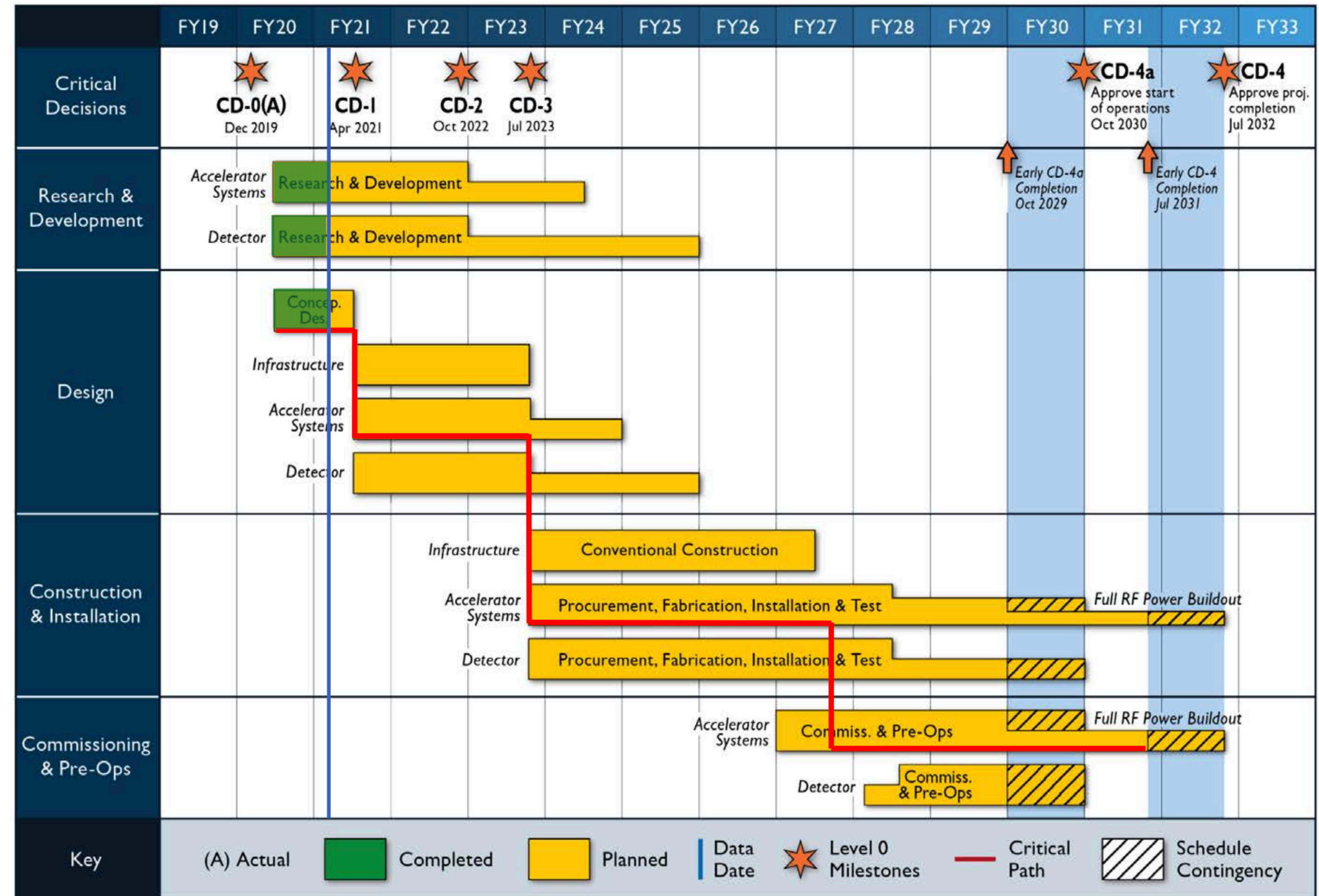


# The EIC

- ▶ polarized ( $\sim 70\%$ ) e & p beams
- ▶ Ion beams: d to Au / Pb / U
- ▶ e+p cm energies: 20–100 GeV, upgradable to 140 GeV
- ▶ e+p luminosity:  $10^{33} - 10^{34}/\text{cm}^2/\text{s}$
- ▶ possibility of more than one interaction region
- ▶ large detector acceptance and good background conditions



- ▶ project baseline (CD-2) ~ 2 yr
- ▶ construction start ~ 3 yr
- ▶ science ~ 10 yr





# EIC — an ultimate QCD machine: engagement opportunities for high energy physics ?

- ▶ energy frontier:

- ▶ EF04: EW Physics: EW Precision Physics and constraining new physics

- ▶ EF05: QCD and strong interactions: Precision QCD

- ▶ EF06: QCD and strong interactions: Hadronic structure and forward QCD

- ▶ EF07: QCD and strong interactions: Heavy Ions

- ▶ instrumentation frontier

- ▶ accelerator frontier



# EIC opportunities for Snowmass

25-29 January 2021

Online

US/Eastern timezone

## Overview

[Call for Abstracts](#)

[Timetable](#)

[Contribution List](#)

[Participant List](#)

[Remote Connection \(via ZOOM\)](#)

## Contact

✉ [cfns\\_contact@stonybrook.edu](mailto:cfns_contact@stonybrook.edu)

✉ [ciprian.gal@stonybrook.edu](mailto:ciprian.gal@stonybrook.edu)

✉ [swagato@bnl.gov](mailto:swagato@bnl.gov)

✉ [Yen-Jie.Lee@cern.ch](mailto:Yen-Jie.Lee@cern.ch)

The goal of this workshop is to summarize and document Electron Ion Collider (EIC) related science that have been discussed within the SnowMass2021 process so far. An updated and expanded version of this document based on the future discussions will eventually become the summary of the EIC related contributions to SnowMass2021.

**Due to the COVID-19 virus, we will hold the workshop online using Zoom. Link:**

<https://mit.zoom.us/j/96805844190?pwd=cGg5eWVYTetlQ0hEWWsrR3N0Q09YUT09>

**This event is part of the CFNS workshop/ad-hoc meeting series. See the [CFNS conferences](#) page for other events.**

**Program Committee:** Yulia Furletova, Ciprian Gal, Claire Gwenlan, Salvatore Fazio, Timothy Hobbs, Alexey Prokudin, Alessandro Vicini, Miguel Arratia, Zhong-Bo Kang, Stefan Prestel, Ivan Vitev, Xin Dong, Stephen Sekula, Tuomas Lappi, Soeren Schlichting, Renaud Boussarie, Bjoern Schenke,

**Advisory Committee:** Michael Begel, Stefan Hoeche, Michael Schmitt, Huey-Wen Lin, Pavel Nadolsky, Christophe Royon



**Starts** 25 Jan 2021, 10:00

**Ends** 29 Jan 2021, 16:00

US/Eastern



Online



[Abhay Deshpande](#)

[Ciprian Gal](#)

[Swagato Mukherjee](#)

[Yen-Jie Lee](#)

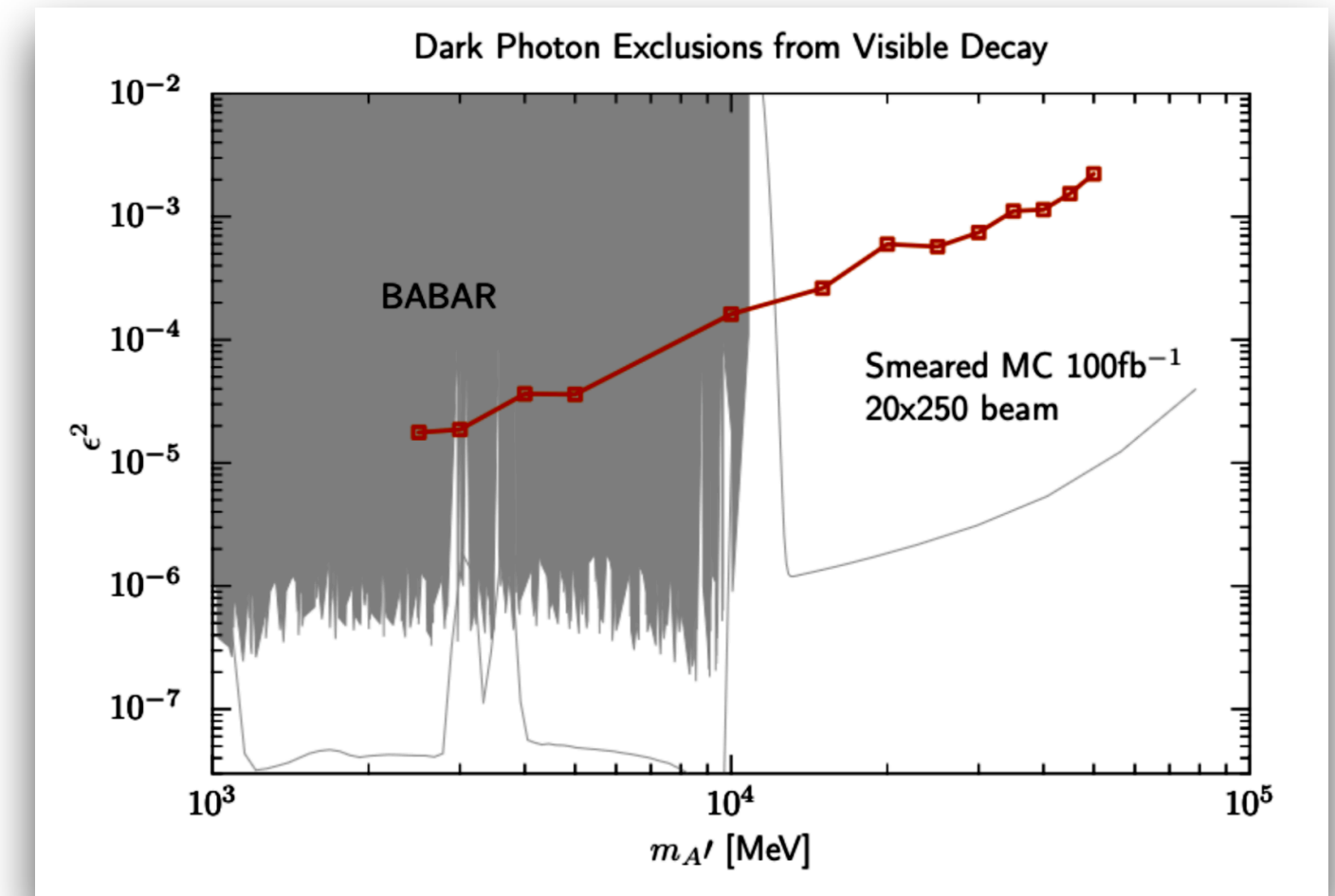
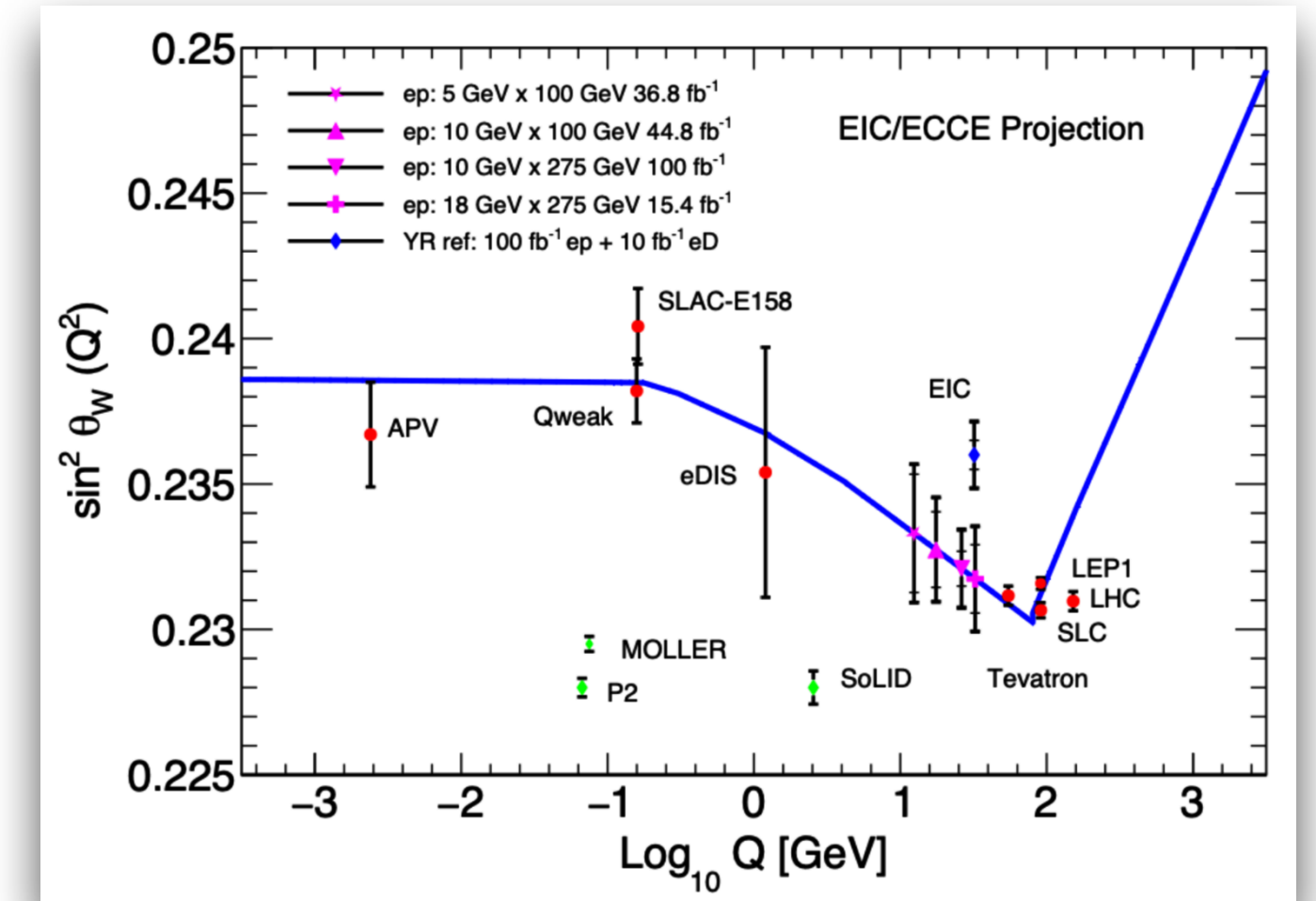
# identified opportunities / synergies

## ■ QCD:

- ▶ multi-dimensional hadron structure
- ▶ jet physics
- ▶ heavy flavor physics
- ▶ gluons at small- $x$  and saturation

## ■ beyond standard model & precision electroweak physics:

- ▶ neutral current coupling
- ▶ Parity violation asymmetries
- ▶ weak mixing angle
- ▶ complementarity of EIC & LHC for SMEFT framework
- ▶ charged lepton flavor violation
- ▶ testing charged current chiral structure
- ▶ heavy photon
- ▶ Lorentz- and CPT-violating effects



preparation of a single “EIC for HEP” report across all EF topical groups are in progress