Overview

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Electron Ion Collider – EIC at BNL

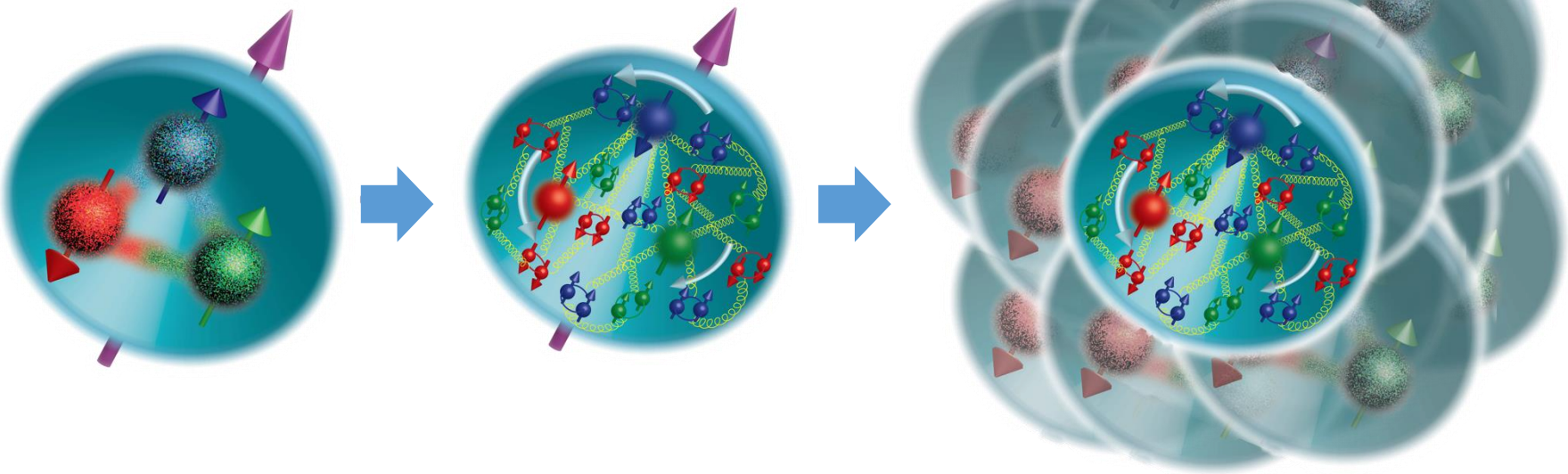
BROOKHAVEN NATIONAL LABORATORY

EIC will provide a complete view of the nucleus

The Proton in 1975

The Proton in 2015

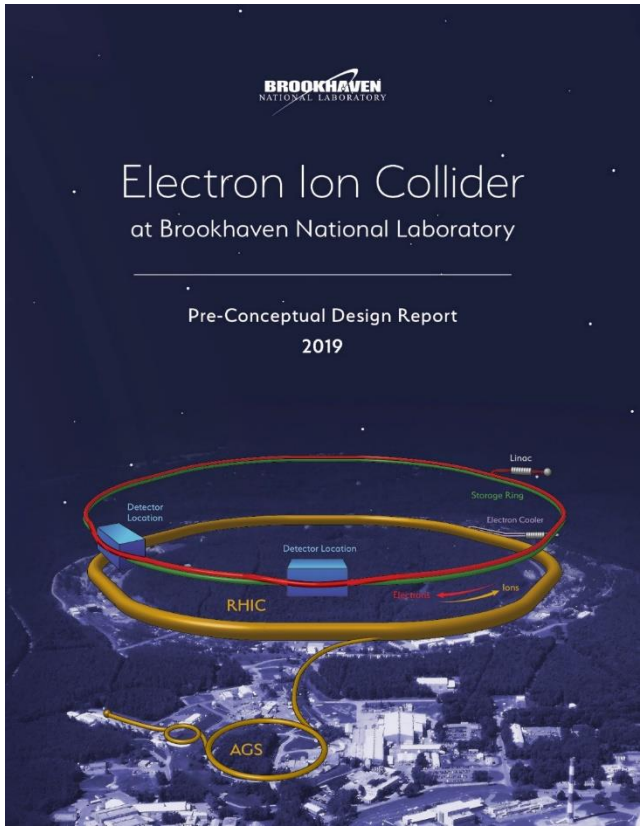
Proton in a nucleus



The goal of the EIC is to provide us with an understanding of the internal structure of the proton and more complex atomic nuclei that is comparable to our knowledge of the electronic structure of atoms.

An Electron Ion Collider at BNL

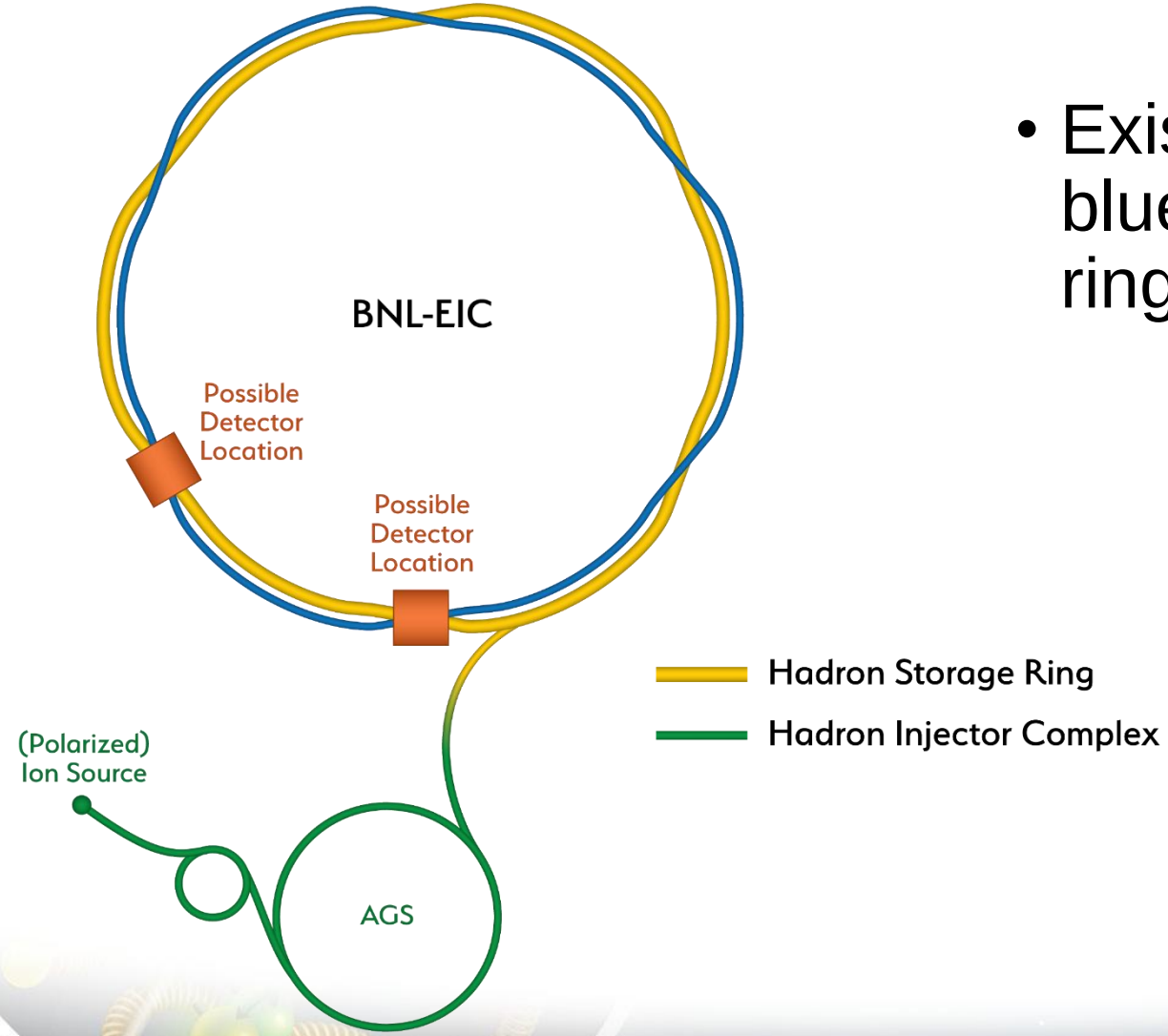
- Design detailed in our pre-Conceptual Design Report
- Independent Cost Review – “the design is mature for pre-CD-0”
- CD-1 is achievable in 2020
- Repurposing RHIC eliminates risk of building a new hadron beam facility—the most complex part of the EIC



EIC Design at BNL

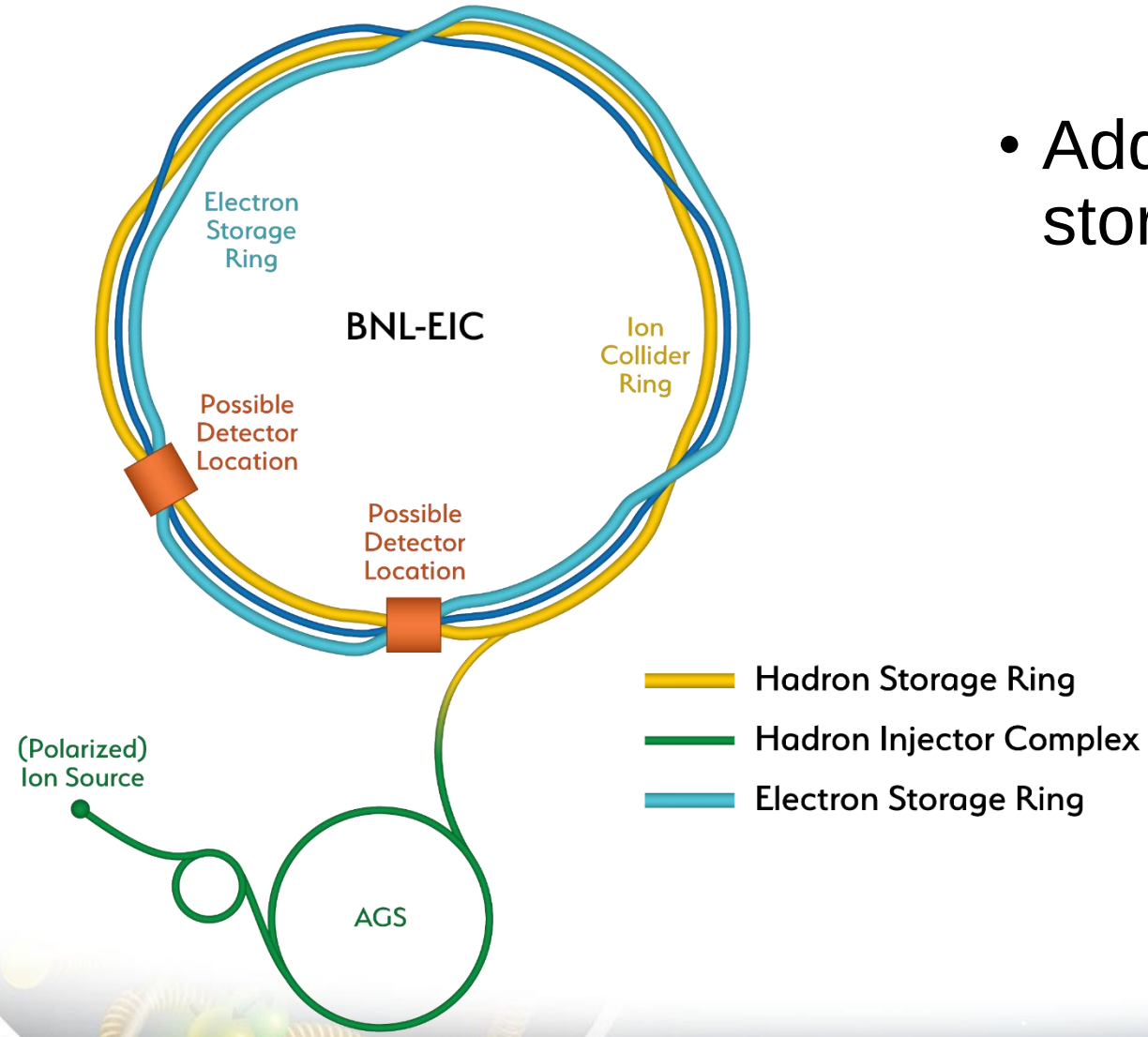
- **Meets all required machine parameters without the need of a future energy upgrade**
  - NSAC requirements to carry out the science are included in base design
- **Is cost effective – repurposes RHIC**
  - RHIC complex in excellent condition
  - Accelerator at peak performance
  - Satisfies hadron beam requirements for EIC
- **Is low-risk**
  - Proven accelerator science and technology
- **Requires minimal new civil construction**
  - Only utilities, utility buildings, and access roads needed
- **Is flexible**
  - Can optimize luminosity for the science
  - Staging possible with physics running

How RHIC is transformed into an EIC



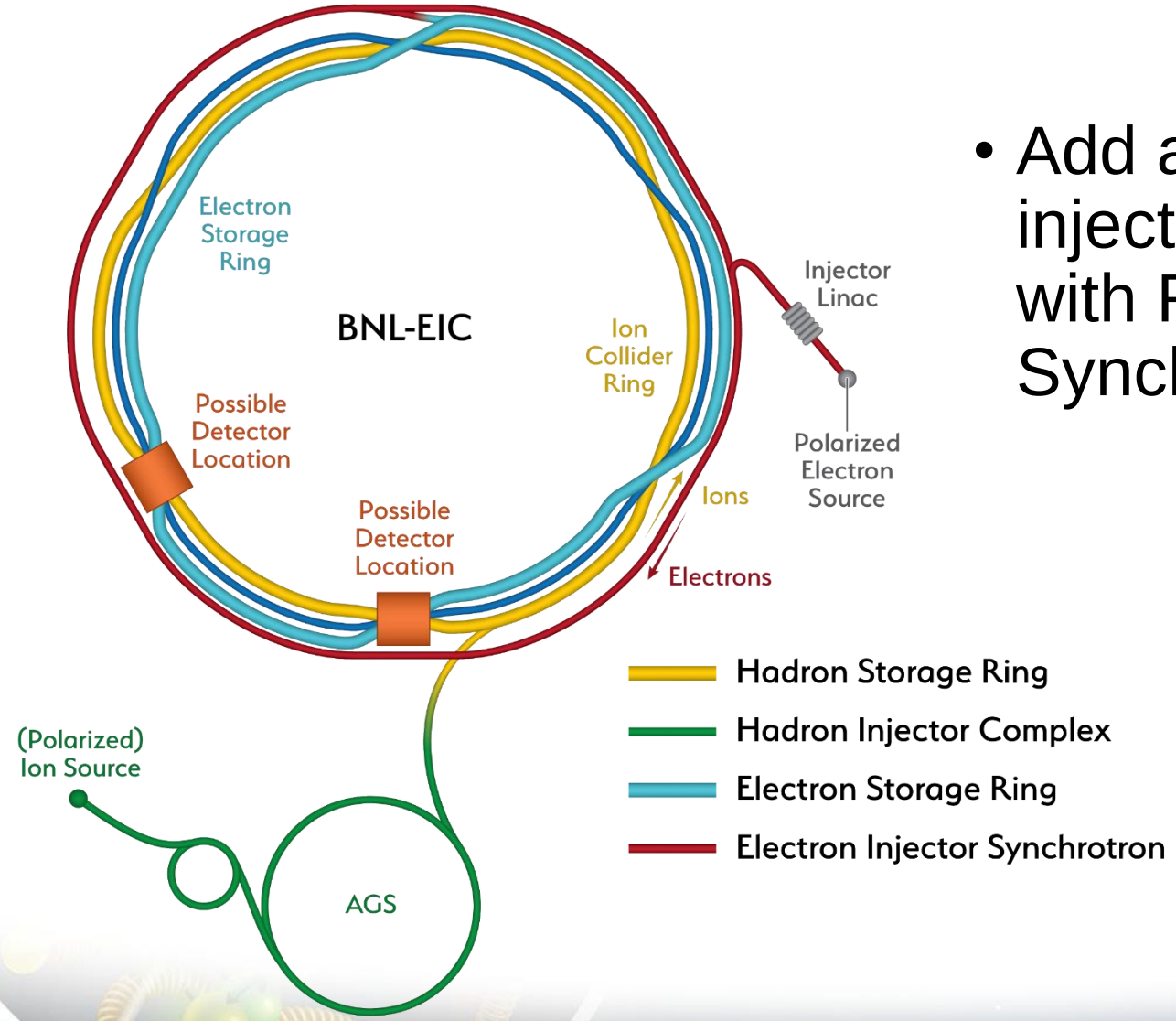
- Existing RHIC with blue and yellow rings

How RHIC is transformed into an EIC



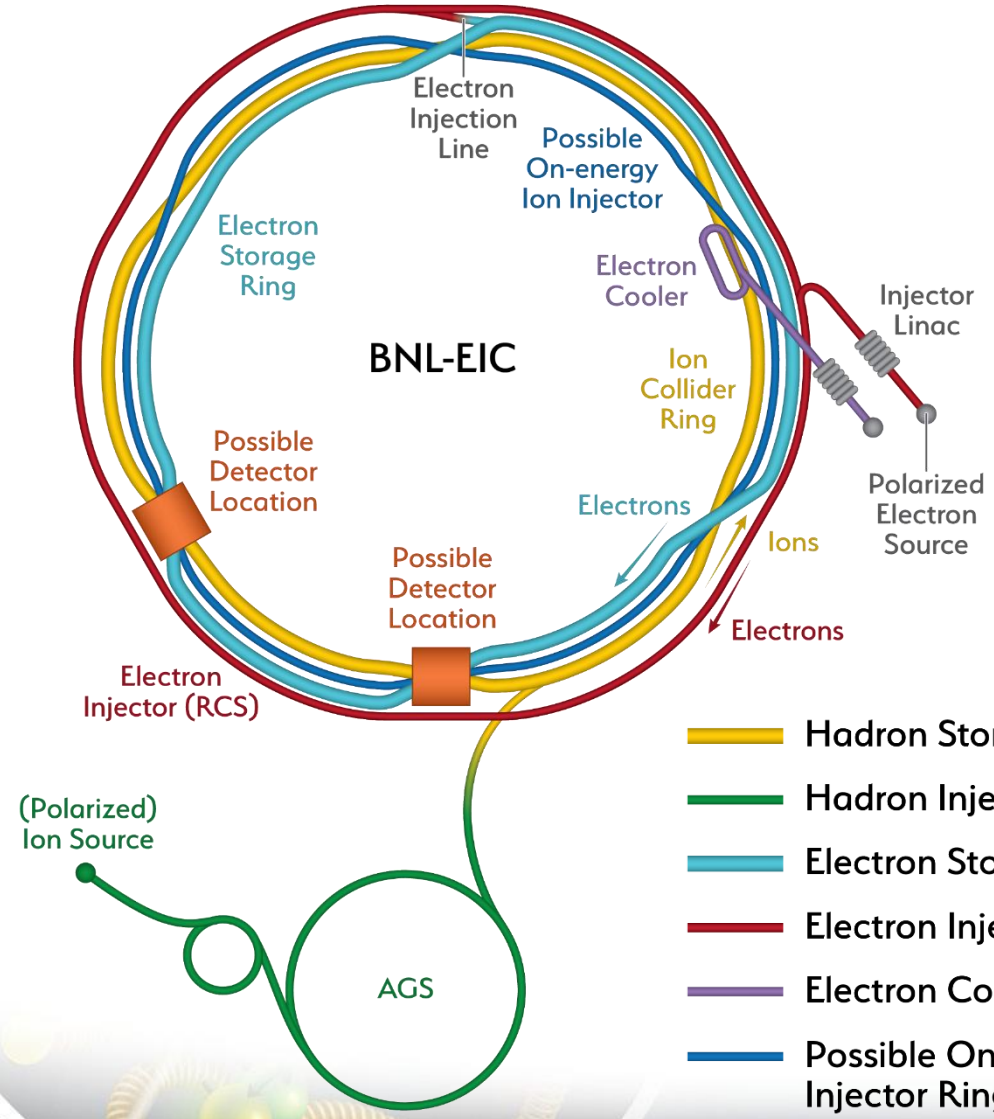
- Add electron storage ring

How RHIC is transformed into an EIC



- Add an electron injector complex with Rapid Cycling Synchrotron

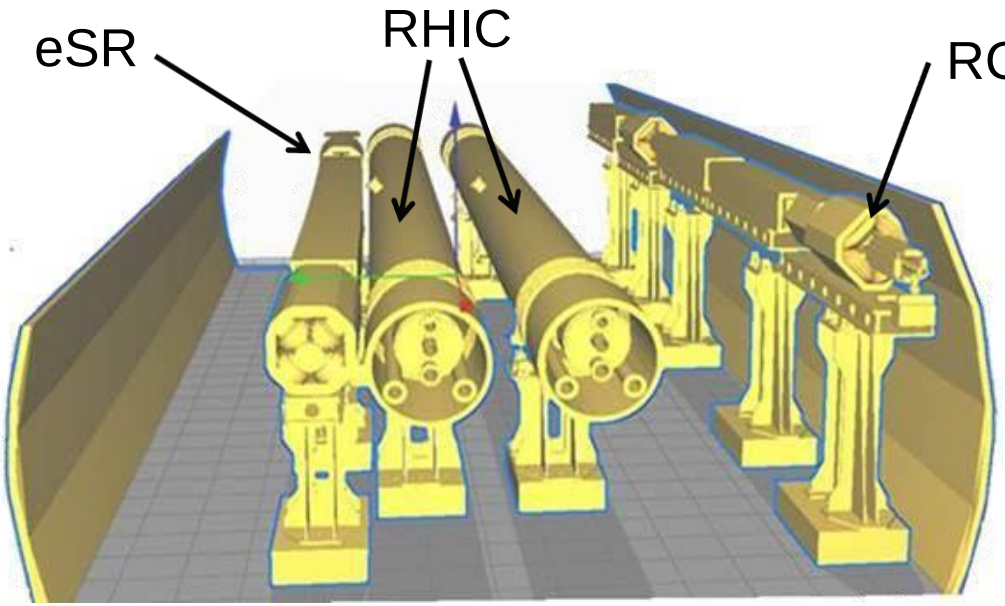
How RHIC is transformed into an EIC



- Strong hadron cooling completes the facility
- Alternate solution also shown using RHIC blue ring

Major additions fit in RHIC tunnel

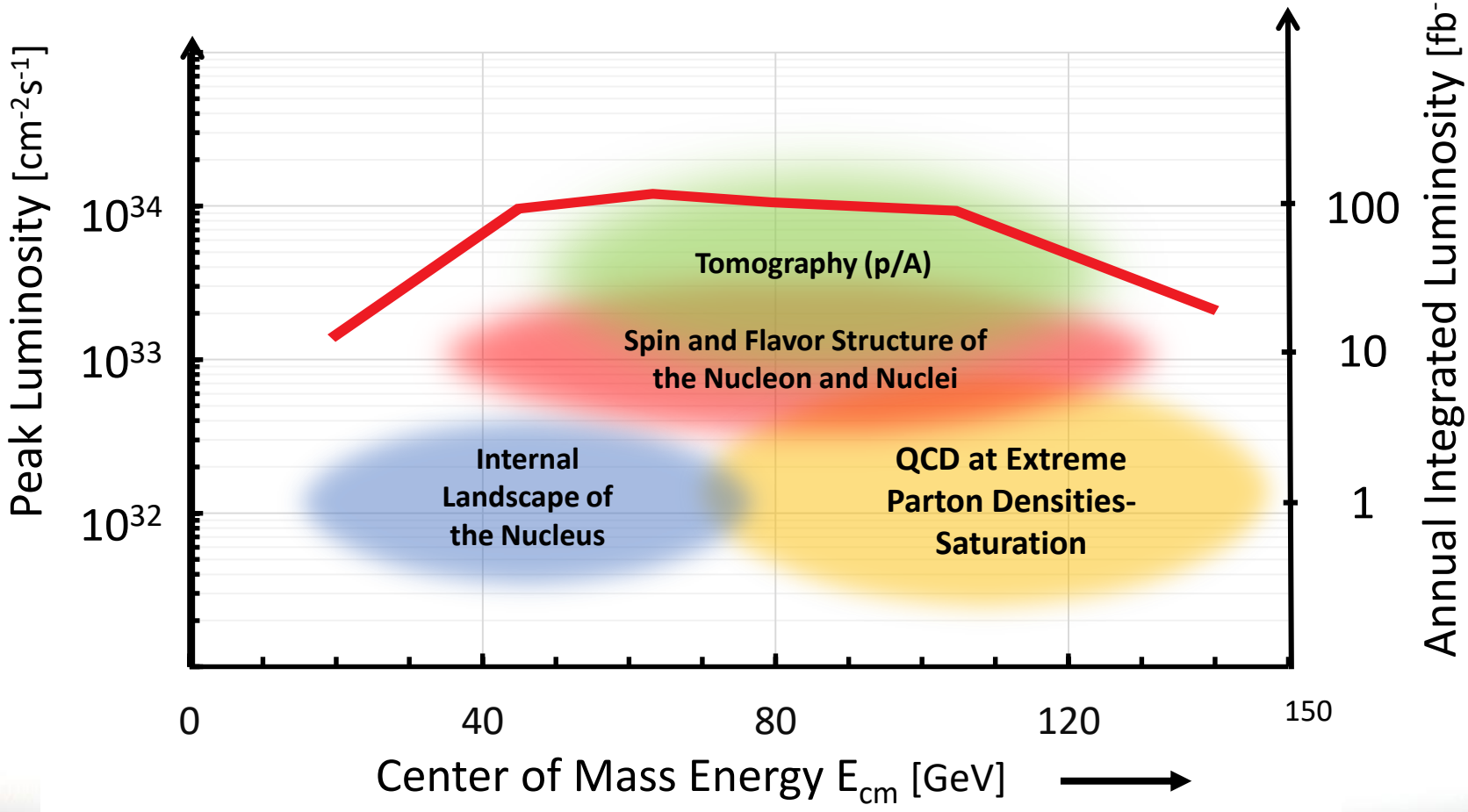
- Rapid Cycling Synchrotron (RCS) for electrons and Electron Storage Ring (eSR) fit into the existing RHIC tunnel
- Two detector halls available for interaction regions and detectors; one was included in independent cost review



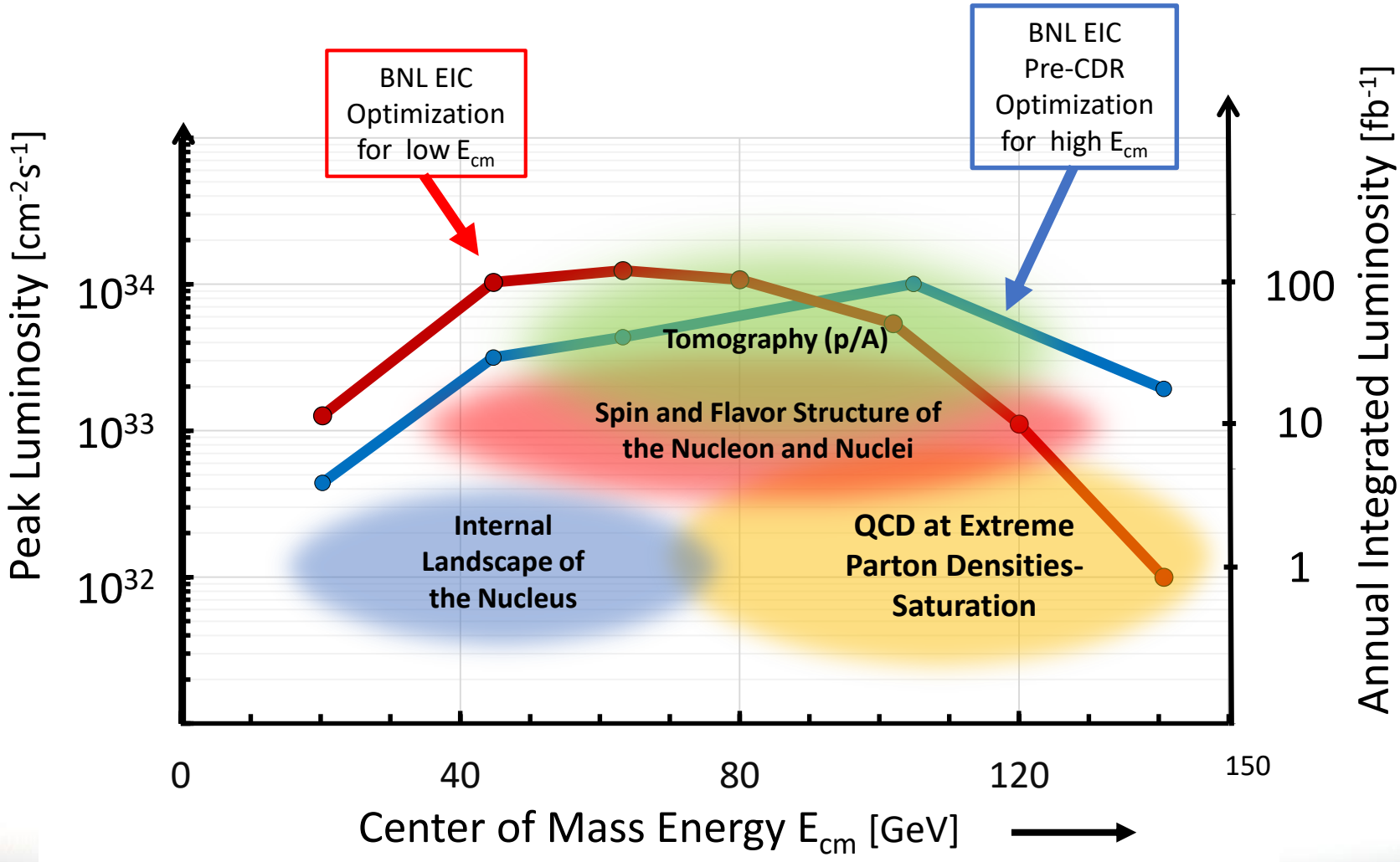
EIC covers the full science range

Collider capability envelope

- Based on design choice of 10 MW synchrotron radiation

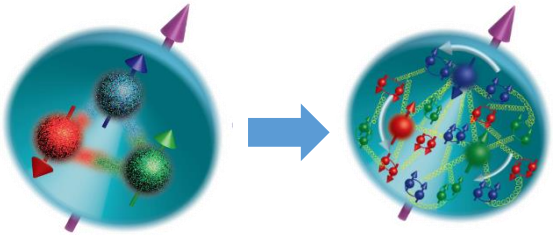


Interaction region and detector options

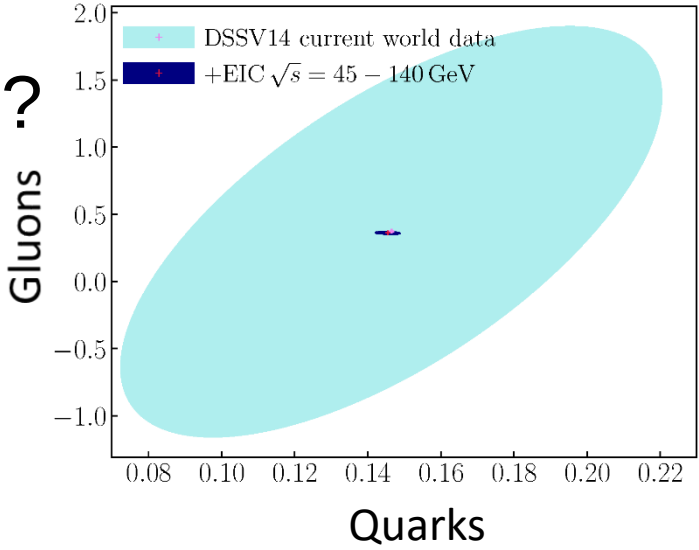


NAS and NSAC science questions

- How does the proton get its spin?

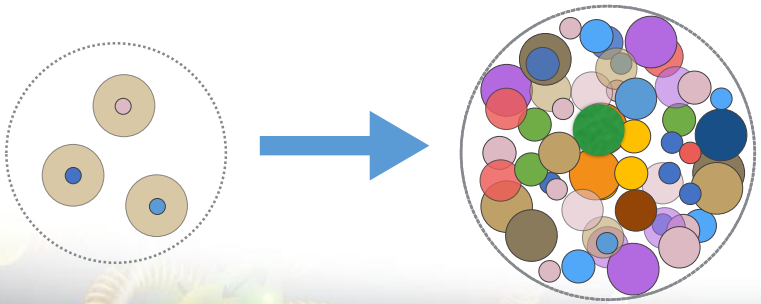


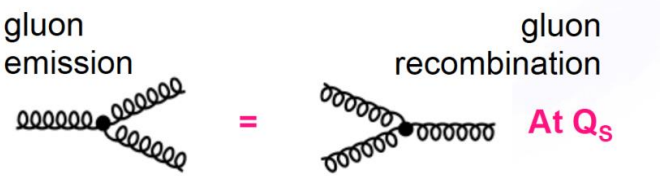
High E_{CM} for low momentum fraction '*x*'



- What is the nature of dense gluon matter?

Low energy ***High energy***





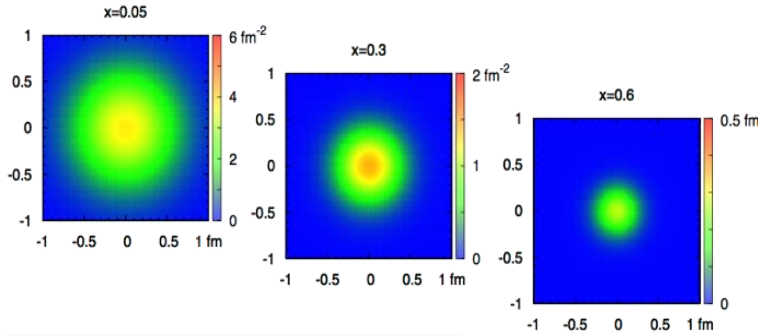
Onset scales with $(A/x)^{1/3}$

NAS and NSAC science questions

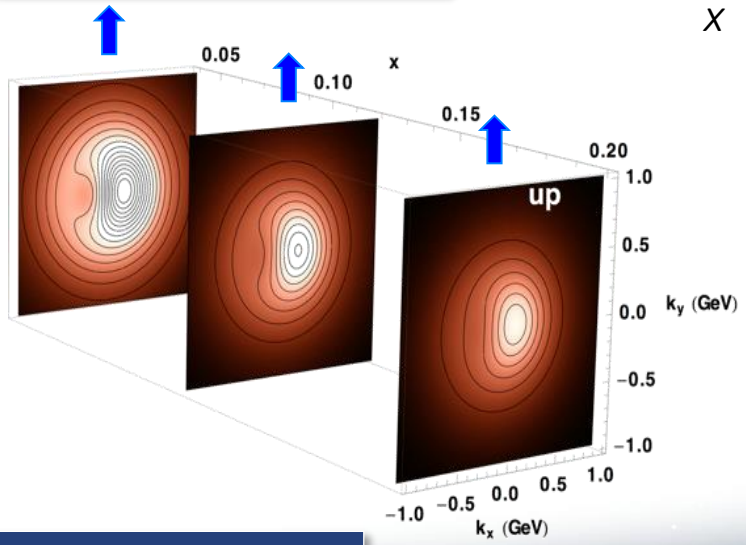
- How does the proton get its mass?
  - Requires detailed understanding of QCD dynamics
- How do quarks and gluons form nucleons and nuclei?

The EIC will answer these questions!

Spatial images



Momentum space images



Tomographic Imaging

A Solid Foundation for EIC

- **Comprehensive accelerator science and engineering**
  - Hadron expertise at RHIC
  - Electron expertise at NSLS-II
- **Outstanding experimental group**
  - Co-developed EIC science program
  - Major contributions to the measurement of gluon spin
  - Integrated into collider and detector design
- **World-leading theory group**
  - Developed gluon saturation concept
  - Leaders in Lattice QCD
- **Joint Stony Brook/BNL Center for Frontiers in Nuclear Science**
  - Post-docs, students, visiting leaders, and summer school
  - Director Abhay Deshpande – is the EIC Science Director

Strong Support for EIC

- Computational Science Initiative
  - Scientific Data and Computing Center
    - Manages data for RHIC, LHC-ATLAS, Belle-II, and more
    - Moving to new data center in 2022
    - Among the top five scientific data archives in the world
  - Developing machine-learning algorithms and exascale capability
- Instrumentation and Superconducting Magnet Divisions
  - Vast expertise in detector development
  - Unique capabilities for engineering and constructing complicated magnets
- Workforce Development
  - BNL internship program – a focus on diversity
  - BNL/Stony Brook Center for Accelerator Science and Education, training accelerator scientists and engineers

Applying accelerator S&T to societal issues

- Health and medicine
  - Accelerator-based medical isotope production
  - New isotopes to treat cancer
  - Understanding effects of long space flight
- Accelerator applications
  - New accelerator concepts for medicine
  - Accelerators in industry – semiconductor manufacturing, sterilization, manufacturing and wear studies
  - Accelerators for nuclear transmutation
- National security
  - Detectors for scanning and screening at ports of entry
  - Proton radiography for stockpile stewardship

EIC at BNL

- World-leading accelerator science and engineering
- Best-in-class nuclear physics program
- Decades of experience in collider physics
- Superior EIC design
- Full discovery potential from Day 1
- International facility attracting world's best and brightest