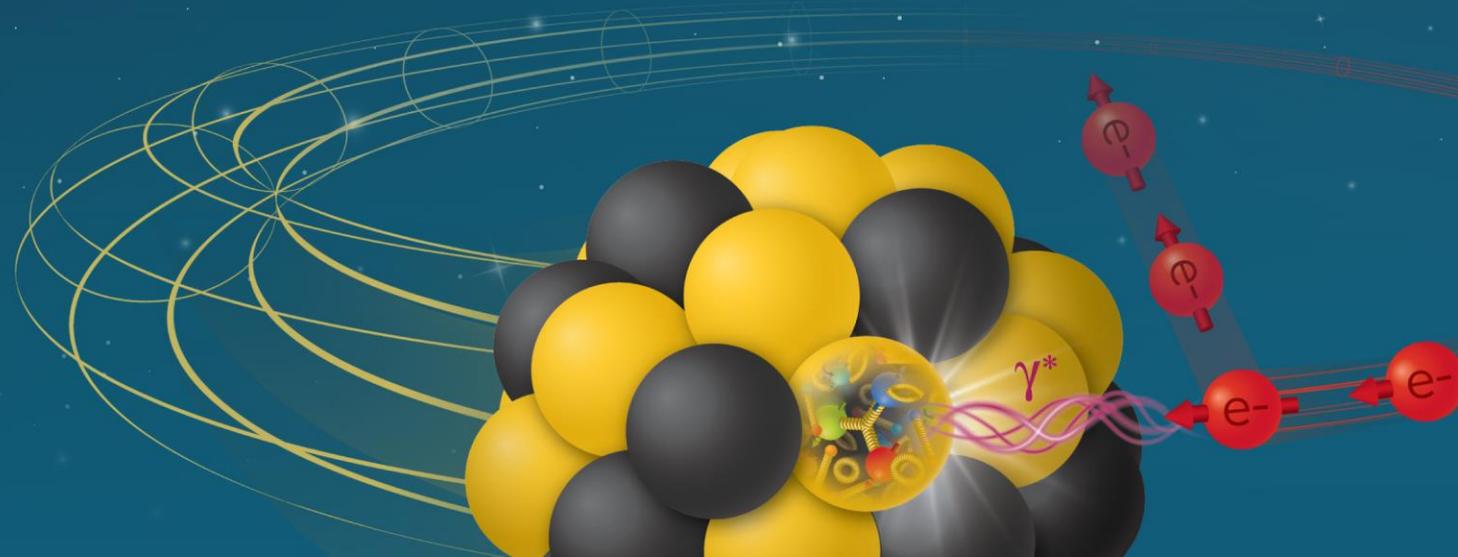


Electron Ion Collider Accelerator Collaboration: status and opportunities

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EIC Technical Director

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IPAC 2025

Electron-Ion Collider



Compelling EIC Science Case



How do quarks, gluons, and orbital angular momentum contribute to proton spin?

Spin is a fundamental property of matter.

All elementary particles, but the Higgs, carry spin. Spin cannot be explained by a static picture, rather the interplay between the properties and interactions of quarks and gluons inside the proton.



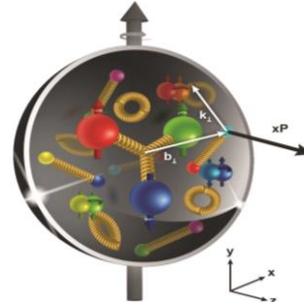
Does the mass of visible matter emerge from quark-gluon interactions?

Atom: Binding/Mass = 0.00000001

Nucleus: Binding/Mass = 0.01

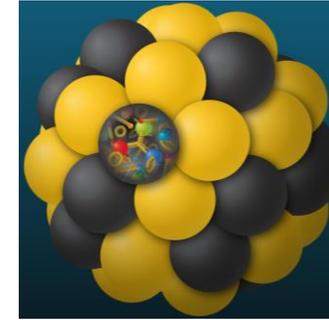
Proton: Binding/Mass = 100

The EIC will determine an important term contributing to the proton mass, the so-called quantum chromodynamics (QCD) trace anomaly.



How can we understand QCD dynamics and the relation to confinement?

EIC will image quarks and gluons in 3D in space and momentum inside the nucleon and nuclei and uncover how the nucleon properties emerge from quarks and gluons and their interactions.

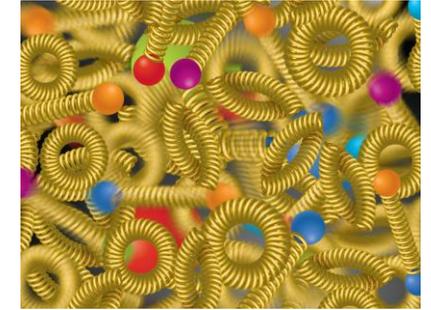


How do quark-gluon interactions create nuclear binding?

Is the structure of a free and bound nucleon the same?

How do quarks and gluons, interact with a nuclear medium?

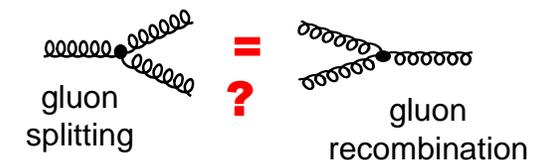
How do the confined hadronic states emerge from these quarks and gluons?



Does gluon density in nuclei saturate at high energy?

How many gluons can fit in a proton?

How does a dense nuclear environment affect the quarks and gluons, their correlations and interactions?

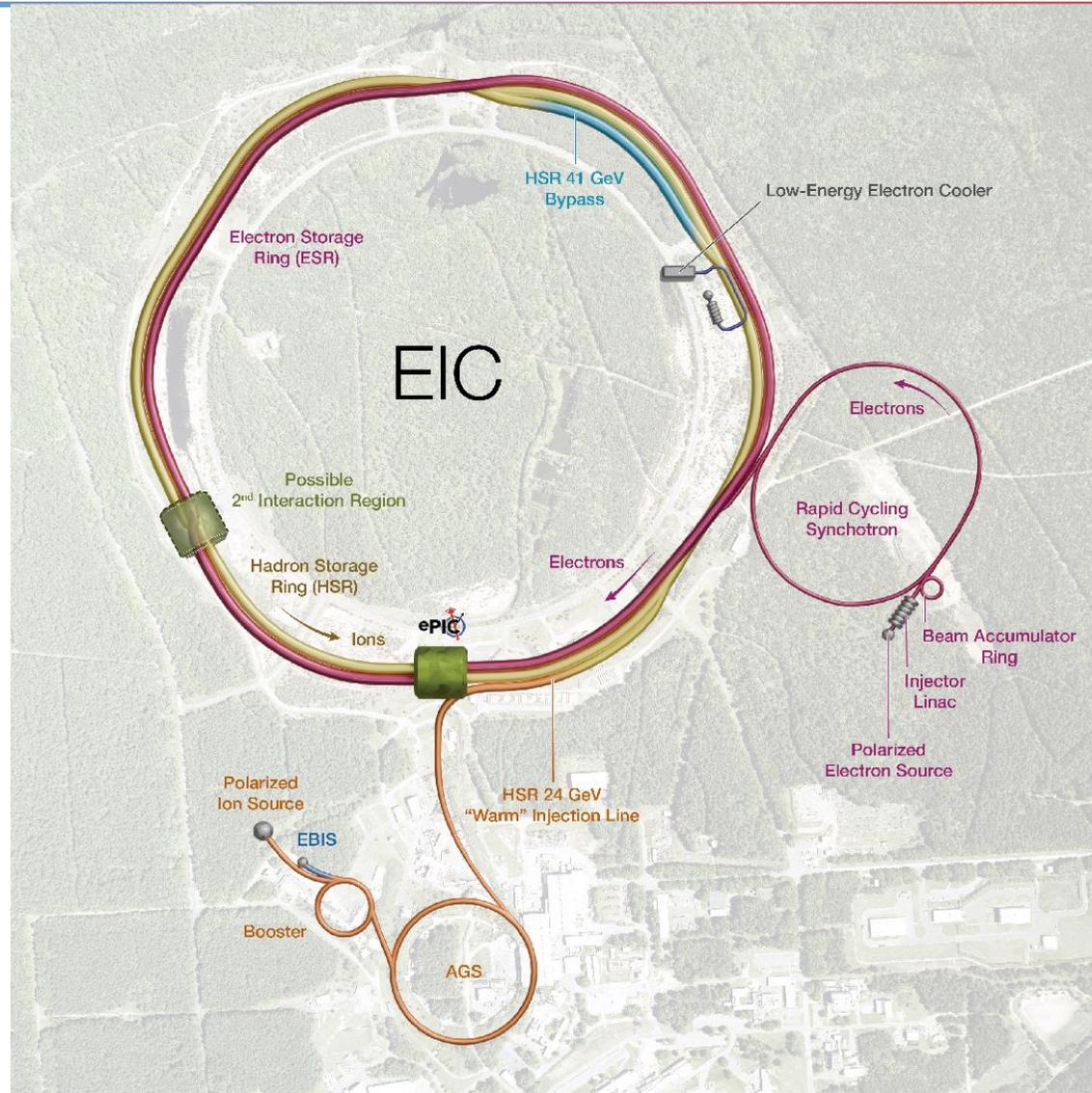


EIC at BNL

Timeline for planning purposes:
Mid-2026 → 2035

We will have several sub-projects:

- Collider rings
- IR
- Detector
- Electron Injector
- Global systems



Strong Support from Partners & Collaborators

- **New York State** committed **\$100M** toward construction of EIC buildings and infrastructure.
- **EIC Accelerator Collaboration** kicked off at IPAC'24 with over 150 participants expressing interest in contributing to the global EIC effort.
- **UK** announced £58 million (**\$75M**) for the EIC.

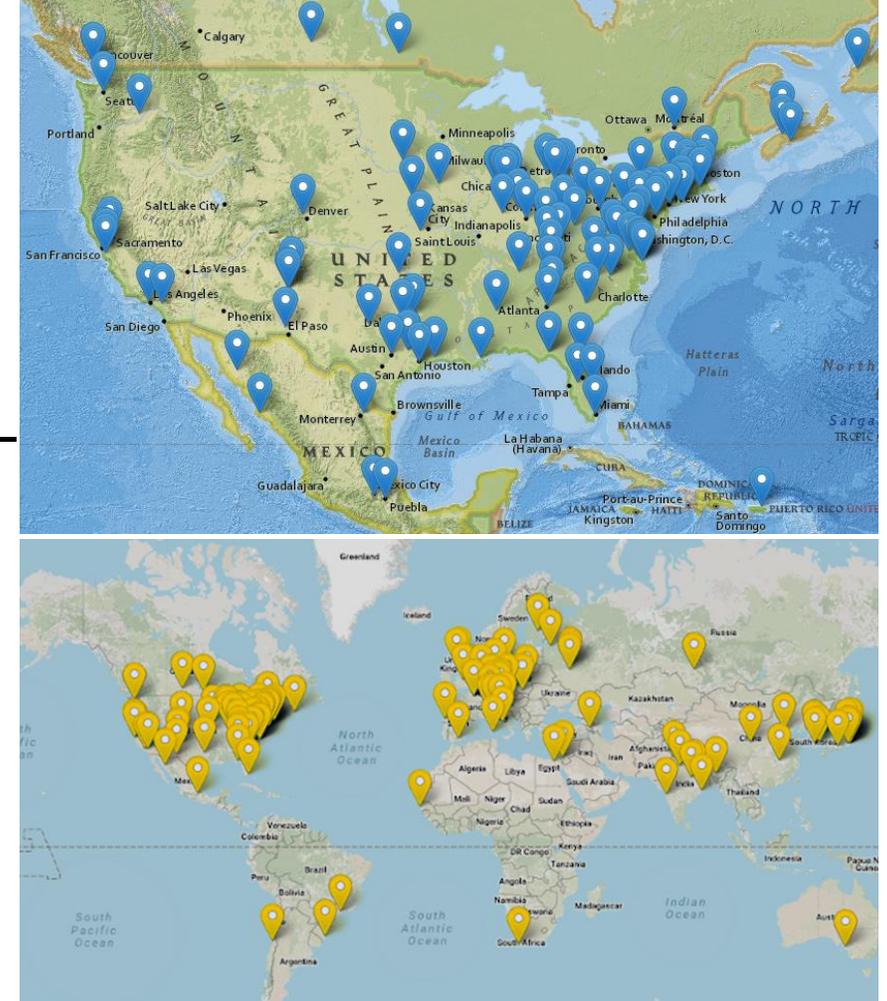


- **EIC Resource Review Board** Meetings in Rome in May 2024 and at BNL in Oct. 2024. Strong participation from **Canada, Czech Republic, France, India, Israel, Italy, Japan, Poland, South Korea, United Kingdom, and Taiwan**. Next meeting to be held in Prague in June 2025.

In-kind contribution goals represent ~30% of the Detector and ~5% of the Accelerator

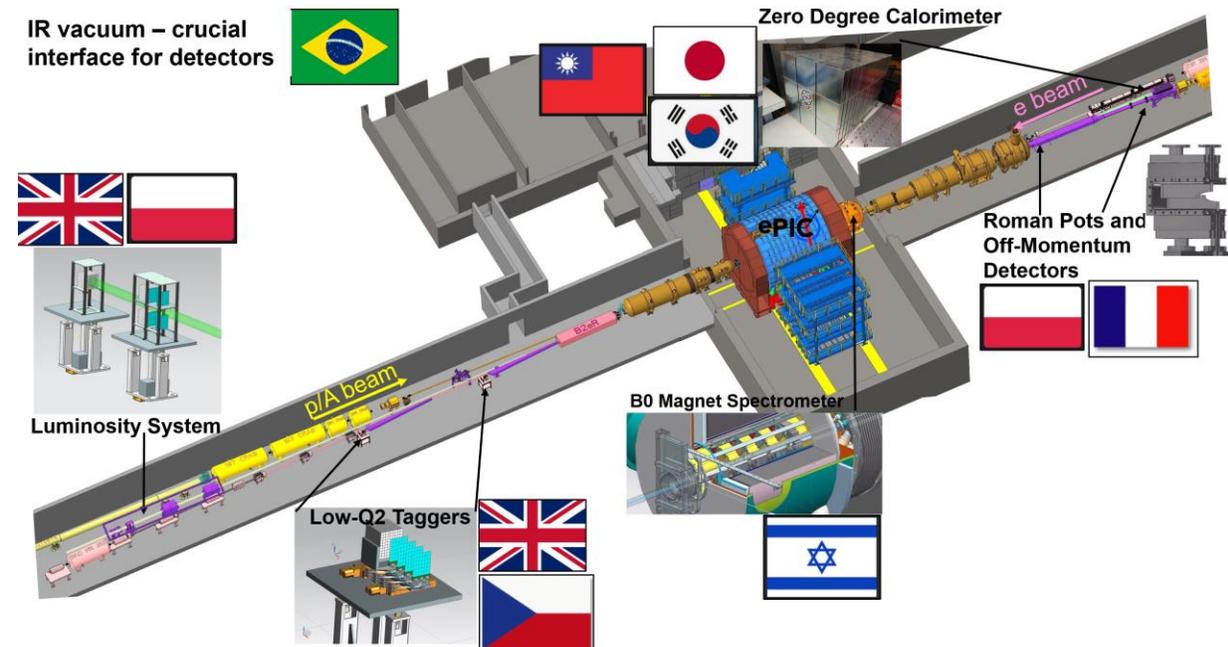
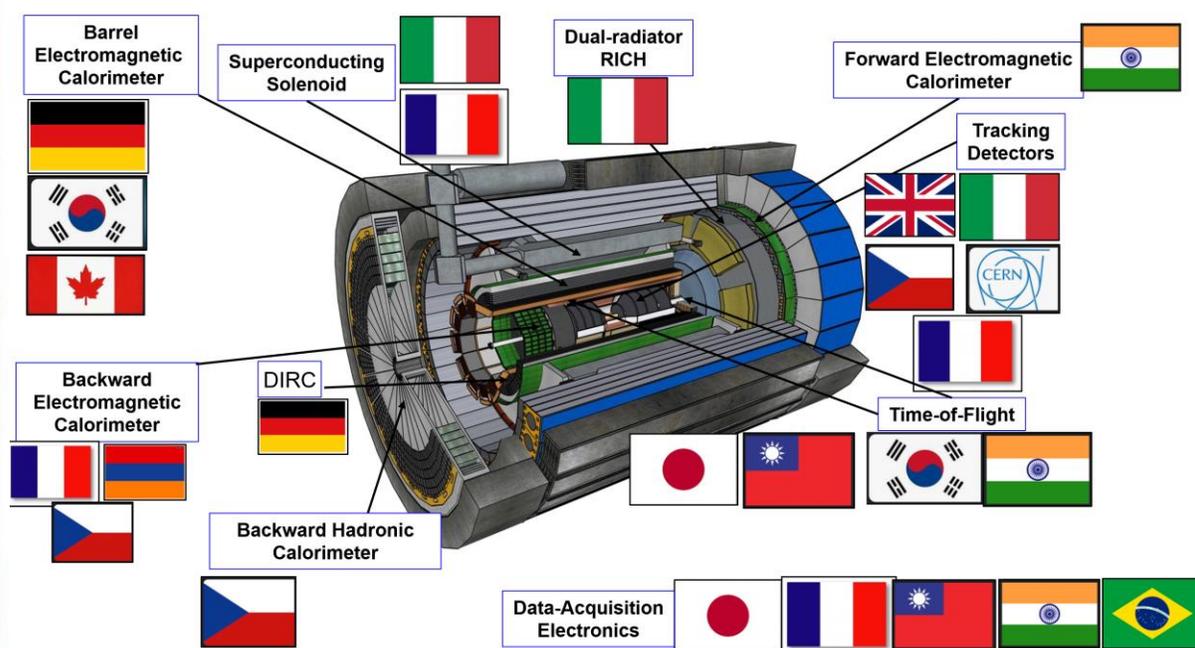
The EIC Users Group – a vibrant community

- Nine national labs and 99 U.S. universities and institutions, as well as 139 international partners, will participate in the EIC.
- The EIC Users Group has been growing rapidly—more than 1,400 scientists from more than 296 institutions in 40 countries around the world.
- www.eicug.org



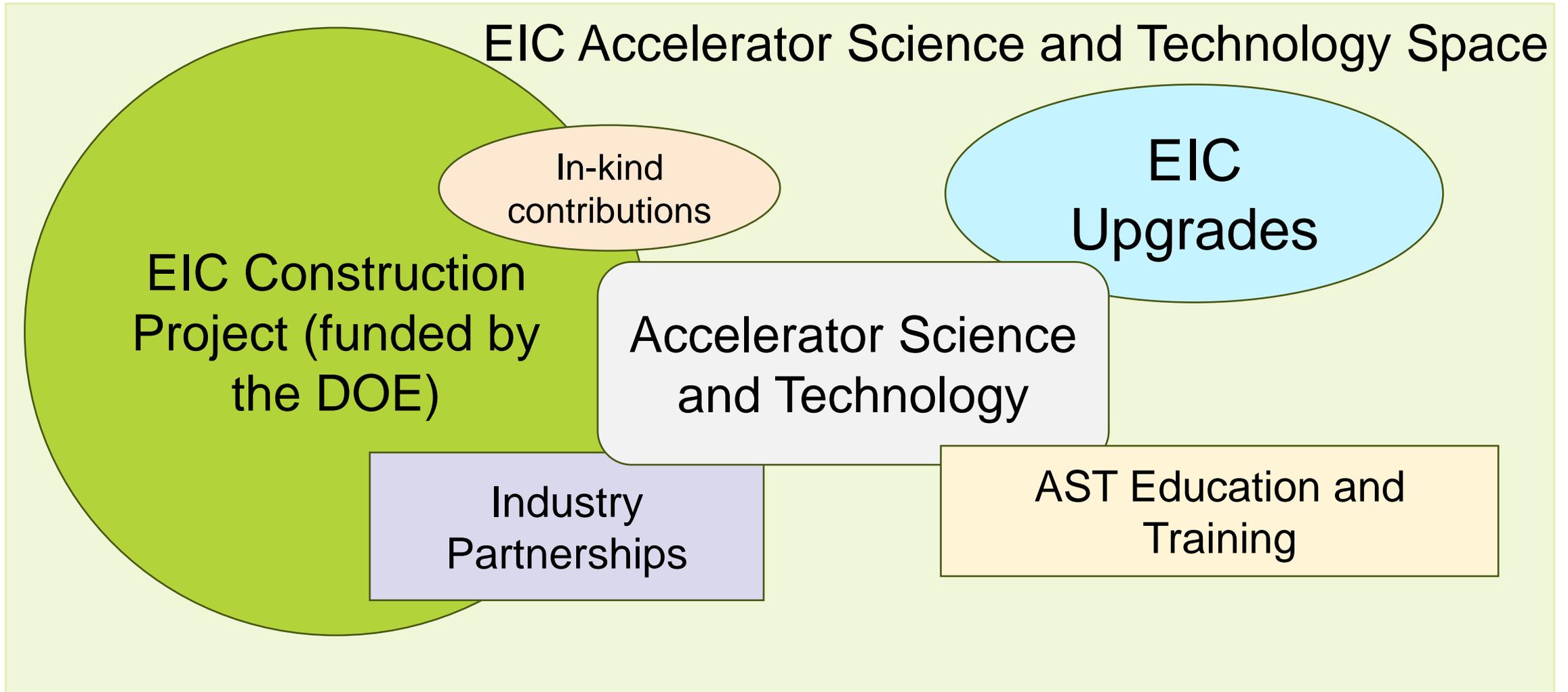
Overview of IKC for the ePIC Detector

- Italy and France IKCs for the Detector Solenoid magnet, procurement and design respectively.
- UK, Italy, France, Korea, Canada, and Japan have identified scope for IKCs in several Detector areas.
- Other IKCs are being discussed with India, Israel, Taiwan and potentially others could follow.



Can we organize the EIC Accelerator Collaboration in a similar manner?

EIC Accelerator Collaboration?



Funding

- US Nat Labs and universities
 - On-project and off-project – different approaches
 - LDRDs, DOE ECA grants, FOAs
- Non-US partners
- CERN
- Industrial partners

- Every case is going to be unique. Every conversation should start with science and technology impacts, not with funding.

EIC Accelerator Collaboration

- EIC Accelerator Collaboration missions:
 - Provide a discussion forum and a collaboration vehicle for the EIC accelerator-related working groups and topics;
 - Identify and create opportunities for US institutions to contribute to the EIC construction project;
 - Identify and create opportunities for In-Kind contributions to the EIC project and to future upgrades;
 - Identify and develop future EIC facility upgrades;
 - Identify and provide accelerator research and development topics and opportunities;
 - Communicate to EIC stakeholders on behalf of the accelerator R&D community;
 - Communicate to various long-range planning panels.
- The EIC Accelerator Collaboration will enhance the long-term evolution and performance of the EIC, and should also help us construct the EIC more efficiently.

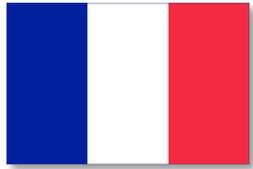
EIC Accelerator Collaboration Kick-off meeting



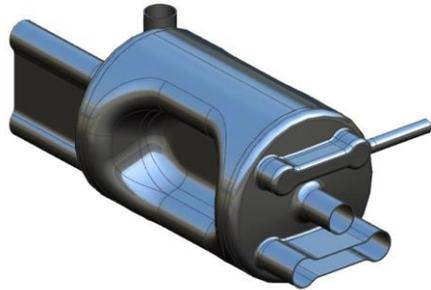
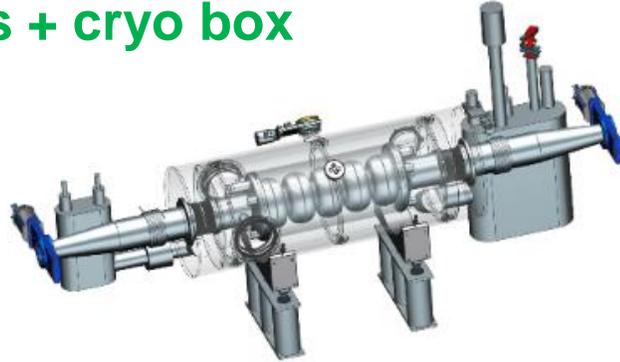
Since IPAC'24

1. Launched 3 Working Groups, working on an 'EIC industry forum'
2. Launched a new web site: www.eicac.org
3. Launched a common indico site for all EICAC WGs on indico.global
4. Contributed to the European Strategy update
5. New co-chair: Carsten → Tatiana

Overview of Accelerator IKC under discussions



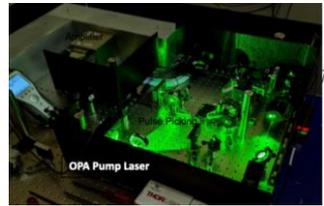
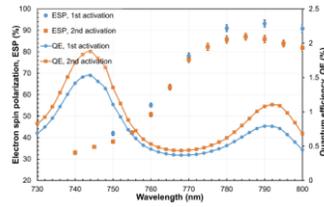
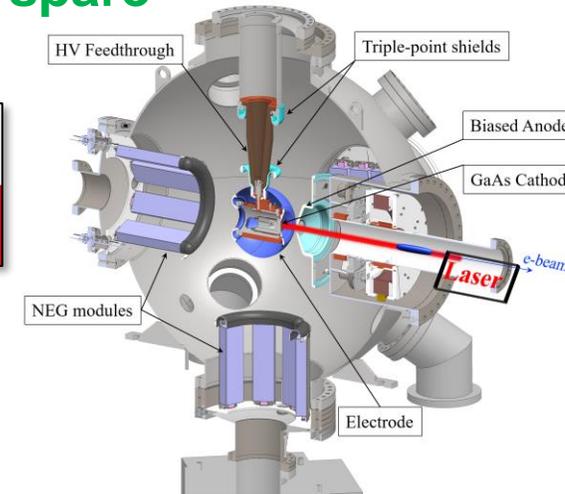
591 MHz 5-cell CM for RCS,
2 CMs + cryo box



394 MHz Crab CMs,



Laser for the Electron Source of EIC,
1 + 1 hot spare



Be beam pipe, 200 MHz NC cavities, FLUKA, ...



Potential collaboration opportunities

- EIC – Future Colliders Forum: many topics
- Polarized electron source (PSI)
- UK interests

Other potential IKC opportunities

- SC spin rotators (high-field solenoids)

Quantity	Magnet Type	Pole Tip Field (T)	Inner Radius [mm]
2	Spin Rotator - Long	8.5	50
2	Spin Rotator - Short	8.5	50
2	Spin Rotator - Long	8.5	50
2	Spin Rotator - Short	8.5	50

- ESR swap-out injection kickers

- High-power water-cooled strip-line
- Qty: 8 + 2 spares

- ESR kicker pulsers:

- 25-30 kV, 10 ns FW, 1 Hz

- HSR transverse instability dampers at injection (25 GeV)

- Diagnostics (various items)

- RCS beam-based alignment during ramp (polarization preservation)

- Controls (EPICS based and RHIC legacy)

- Collimation systems

What is still 'at play' in the EIC Design and Construction?

- Understanding of beam-beam interactions ($\xi_e=0.1$, $\xi_p=0.015$)
- Full understanding of a 25-mrad crossing angle, compensated by crab cavities
- Highly polarized electron and hadron beams, including novel polarized He3+ beams
- Spin matched electron ring beam optics at 5 GeV, 10 GeV, 18 GeV
- Hadron cooling at collisions to maintain hadron beam brightness
- Dynamic aperture optimizations

- Maintaining an option for the 2nd IR
- Swap-out injection
- Design and fabrication of IR SC 2K magnets
- Design and fabrication of SCRF cavities and cryomodules
- Cu-clad and aC coated Beam screens
- Modern control system and instrumentation

Science

Technology

New working groups

- Hadron beam cooling
 - COOL25 workshop at Stony Brook, Oct 27-31, 2025
- 2nd IR
- FCC-EIC forum
- Collimation and machine protection
- EIC upgrades
- Optics
- Collective effects