Transnational Access for EIC@BNL

E.C. Aschenauer[1], S. Dalla Torre[2], **R. Dupre**[3], R. Montgomery[4], and T. Ullrich[1]

[1]Brookhaven National Laboratory, Upton, NY, United States

[2]INFN, Sezione di Trieste, Trieste, Italy

[3]Univ. Paris-Saclay, CNRS, IJCLab, Orsay, France

[4]School of Physics & Astronomy, University of Glasgow, Scotland, UK

Town Meeting, Hadron Physics in Horizon Europe

July 1st – 3rd, 2025, Nantes

Electron-Ion Collider

The EIC Facility

What is the EIC:

A high luminosity (10^{33} – 10^{34} $cm^{-2}s^{-1}$) polarized electron proton / ion collider with $\sqrt{s_{ep}}$ = 28 – 140 GeV

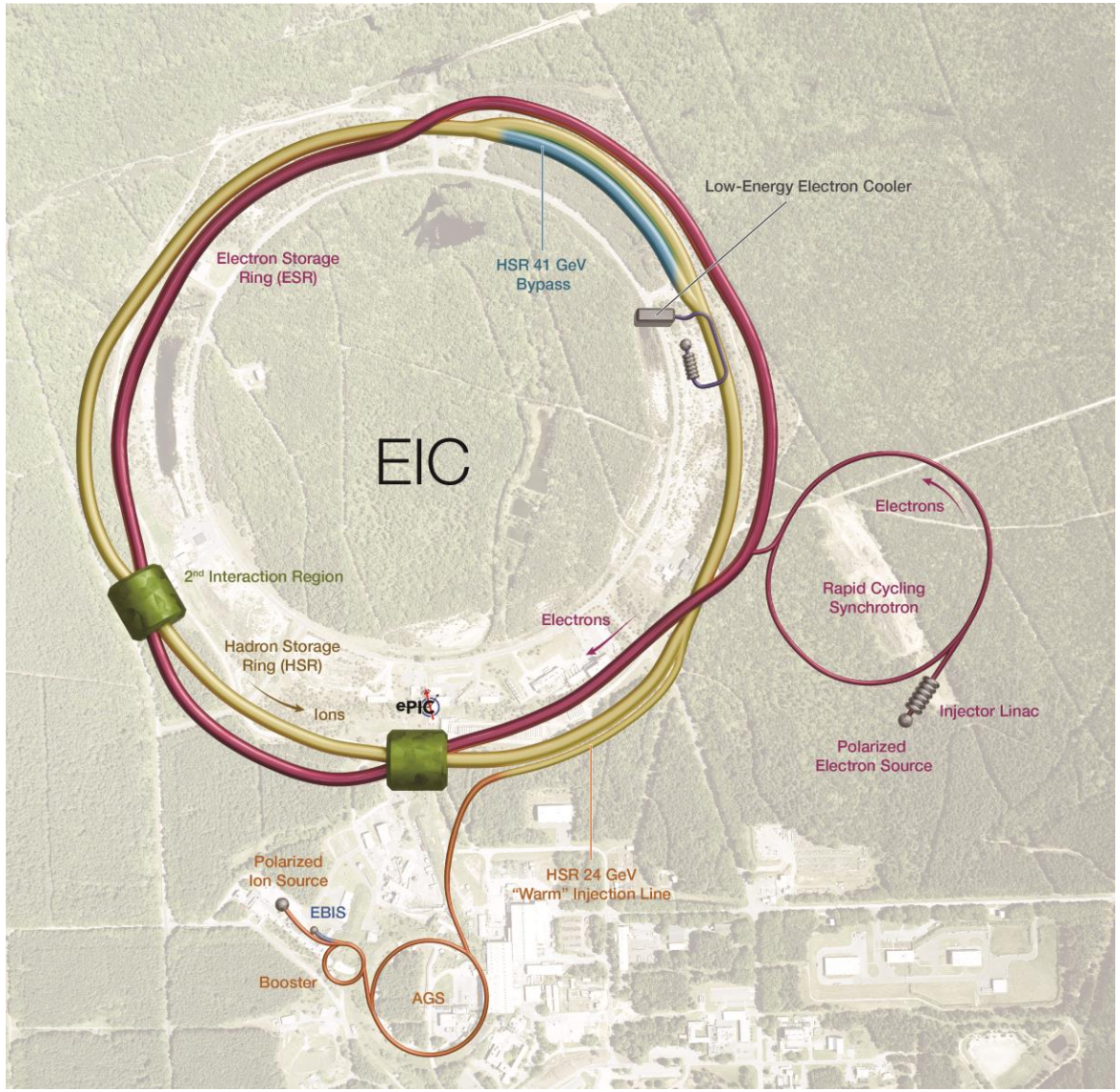
What is special:

EIC is the ONLY new collider in foreseeable future.
Allows to remain at frontier of Accelerator S&T.

factor 100 to 1000 higher luminosity as HERA
both electrons and protons / light nuclei polarized,
nuclear beams: d to U
Fixed Target Facilities i.e.:
at minimum > 2 decades increase in kinematic coverage in x and Q^2

State of the art general purpose collider detector

Provides a possibility for a 2nd Interaction-Region and Detector



EIC Science Pillars

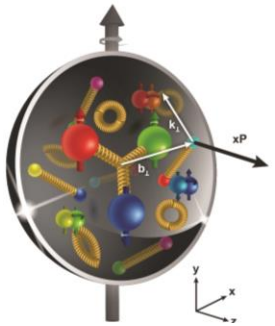
The EIC will unravel the different contribution from the quarks, gluons and orbital angular momentum

SPIN is one of the fundamental properties of matter.
All elementary particles, but the Higgs carry spin.
Spin cannot be explained by a static picture of the proton
It is the interplay between the intrinsic properties and interactions of quarks and gluons

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

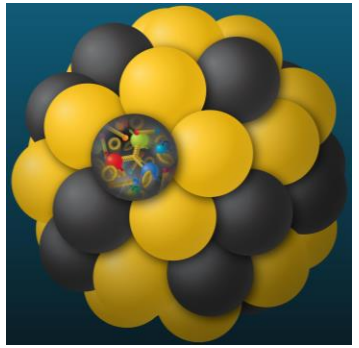
For the proton the EIC will determine an important term contributing to the proton mass, the so-called “QCD trace anomaly



How can we understand QCD dynamics?
What is the relation to Confinement

How are the quarks and gluon distributed in space and momentum inside the nucleon & nuclei?

How do the nucleon properties emerge from them and their interactions?

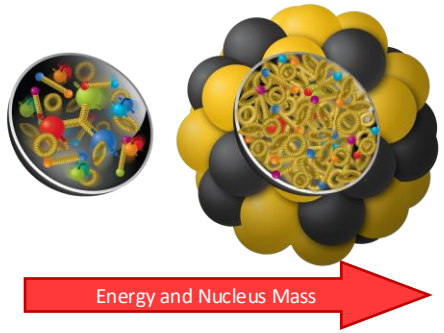


How do the confined hadronic states emerge from quarks and gluons?

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

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

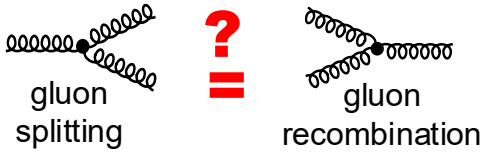
How do the quark-gluon interactions create nuclear binding?



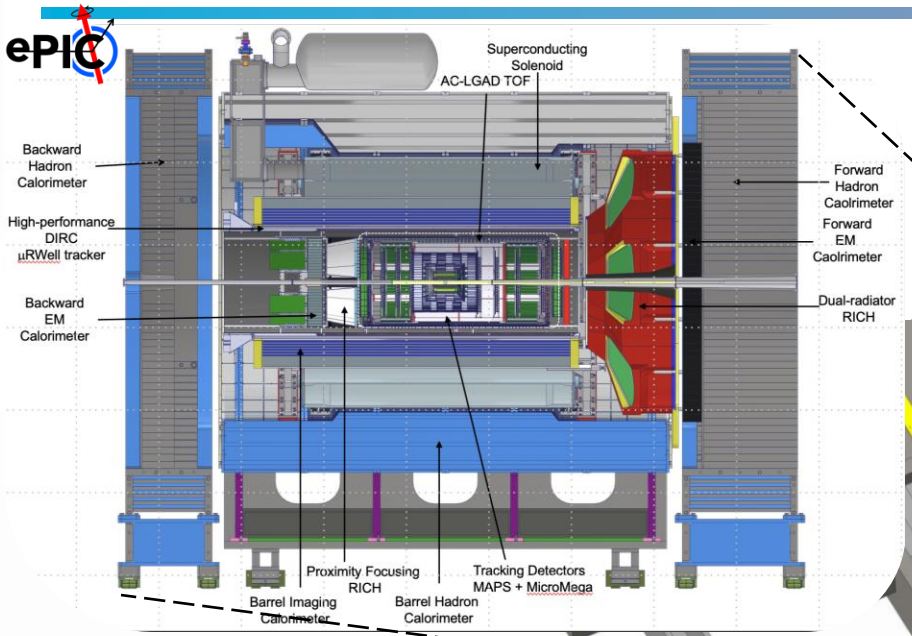
What happens to the gluon density in nuclei? Does it saturate at high energy?

How many gluons can fit in a proton?

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



ePIC – EIC General-Purpose Detector



p/A beam

electron beam

ePIC:

26 subsystems over ± 40 m
to measure particle momenta, energy and particle type

- 3 electromagnetic calorimeters
- 3 hadronic calorimeters
- Silicon and Multi-pattern gas detectors
- 3 RICH detector (pfRICH, DIRC, dRICH)+ time-of-flight
- 7 Auxillary detectors (Si + HCal + ECals)
- electron and hadron polarimetry

→ **8 world first technologies**

Highest scientific flexibility

→ fully streaming readout electronics and data acquisition

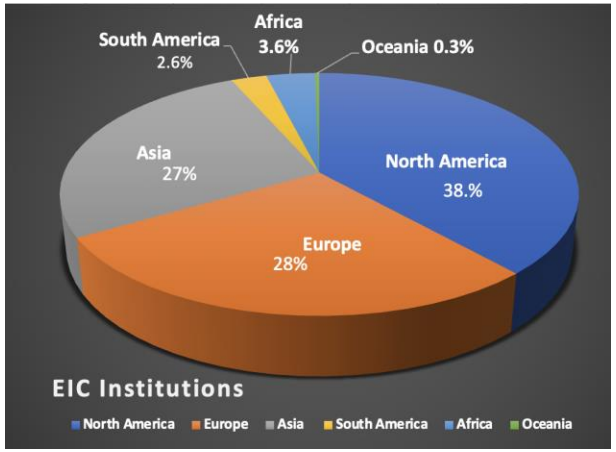
→ integration AI/ML capabilities from the start

World-Wide Interest in EIC and ePIC

The EIC Users Group: EICUG.ORG

Formed 2016: 400 Users → Now

1550 collaborators, 41 countries, 305 institutions



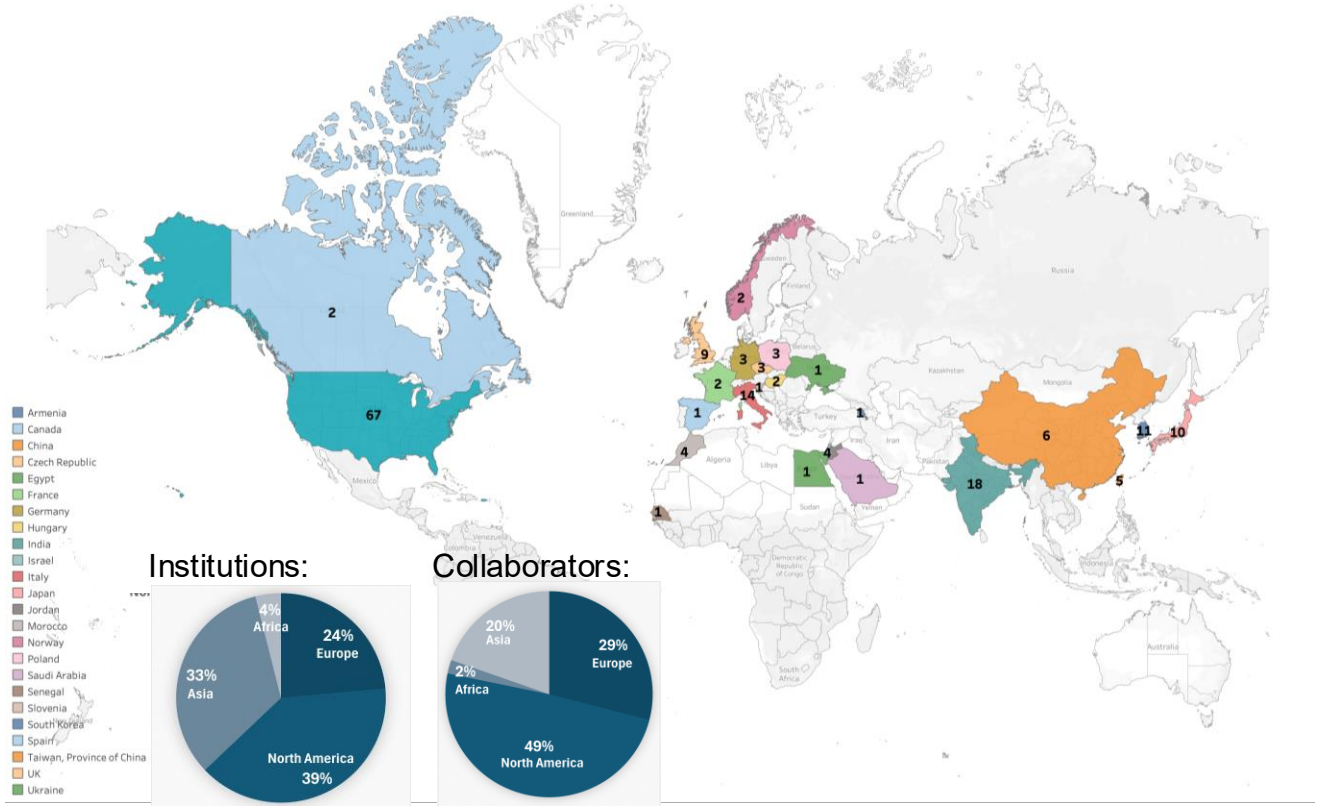
Location of Institutions

ePIC Collaboration

https://www.epic-eic.org

Formed in 2022 → Now

~1031collaborators, 25 countries, 180 institutions



EIC science has worldwide endorsement

(UK/STFC Infrastructure grant, Canada Long-Range Plan, NSAC Long-Range Plan, India MegaScience Vision Plan, NuPECC recommendation, …).

European Central Detector Interest & In-Kind

Total In-kind contribution goal: 30% of the Detector

Barrel Electromagnetic Calorimeter

Karlsruhe Institute of Technology

Superconducting Solenoid

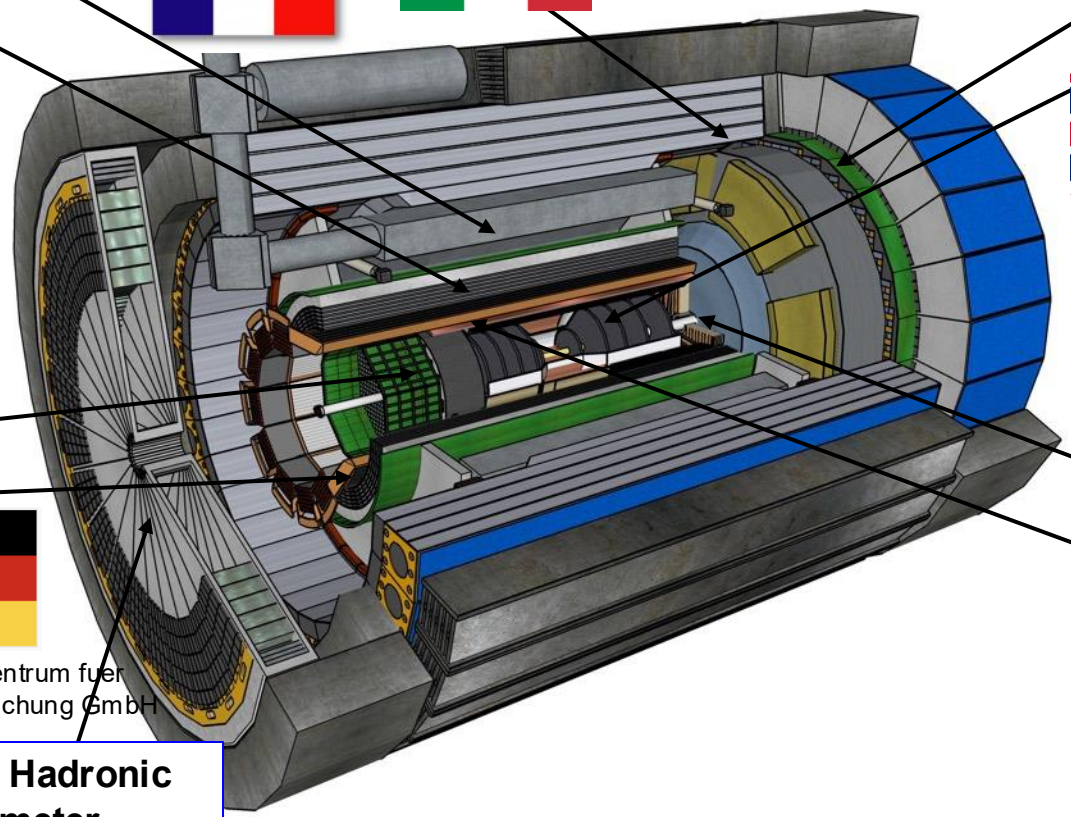
Dual-radiator RICH

INFN Sezione di Bologna
Università di Bologna
INFN Sezione di Ferrara,
Università di Ferrara
INFN Sezione di Trieste
Universita di Trieste

Forward Electromagnetic Calorimeter

Tracking Detectors

University of Birmingham,
Daresbury Laboratory,
INFN Sezione di Bari,
Università di Bari,
Università di Foggia,
INFN Sezione di Padova,
Università di Padova,
INFN Sezione di Pavia,
INFN Sezione di Trieste,
Universita di Trieste,
Czech Technical University in Prague,
Rutherford Appleton Laboratory
University of Liverpool,
CEA-Saclay,
Seoul National University,
INFN Sezione di Roma Tor Vergata,
Universita di Roma Tor Vergata



Backward Electromagnetic Calorimeter

IJClab (Orsay)
A. Alikhanian National Laboratory, Armenia,
Charles University (CUNI), Prague

DIRC

GSI Helmholtzzentrum fuer Schwerionenforschung GmbH

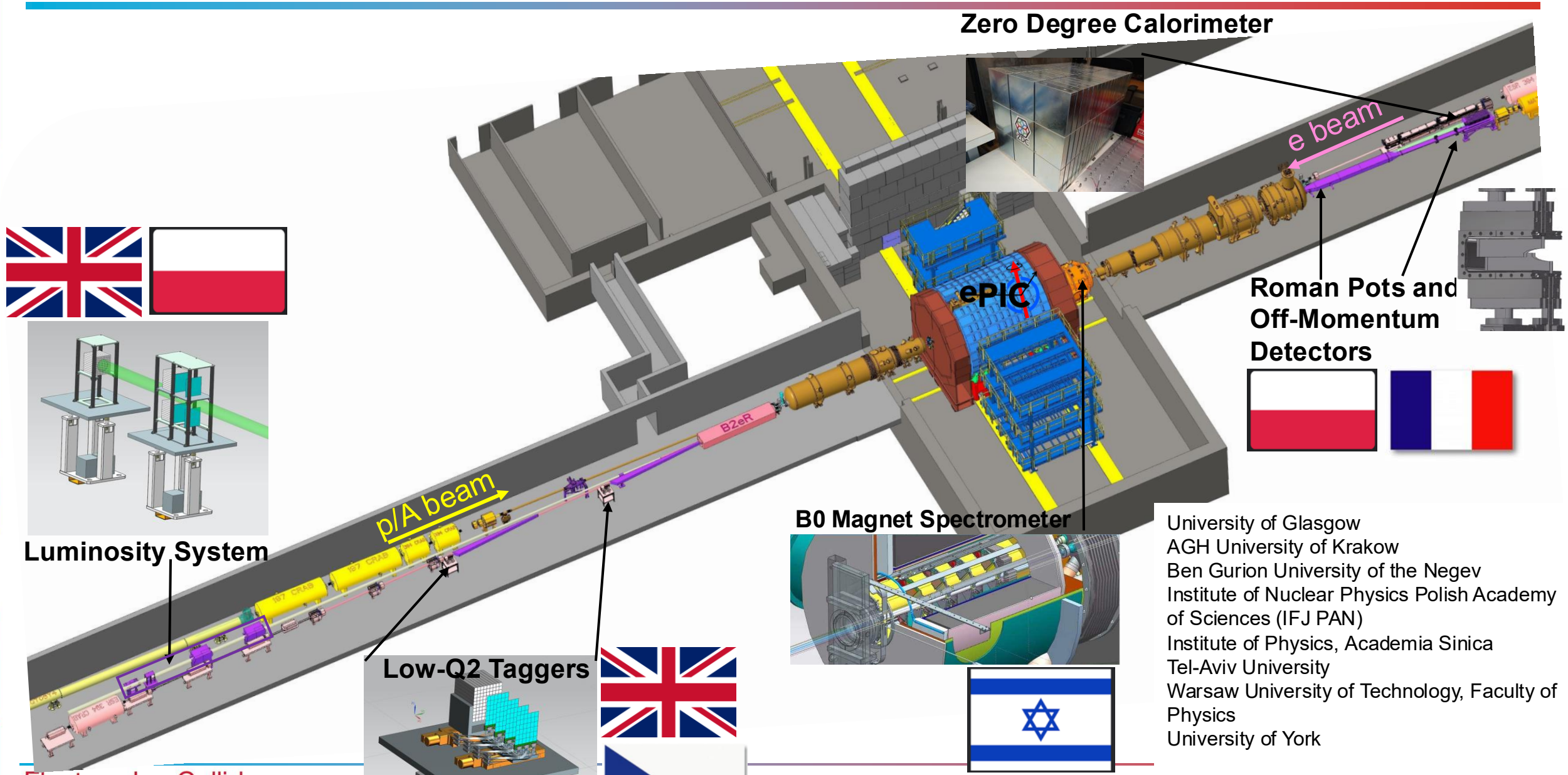
Time-of-Flight

Backward Hadronic Calorimeter

Czech Technical University in Prague,
NPI The Czech Academy of Sciences

Data-Acquisition Electronics

European Far-Forward/Far-Backward Detectors Interest & In-kind



University of Glasgow
AGH University of Krakow
Ben Gurion University of the Negev
Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN)
Institute of Physics, Academia Sinica
Tel-Aviv University
Warsaw University of Technology, Faculty of Physics
University of York

International Governance: Resource Review Board (RRB) Meetings

DOE and the host labs promoting the EIC as a facility “fully international in character.”

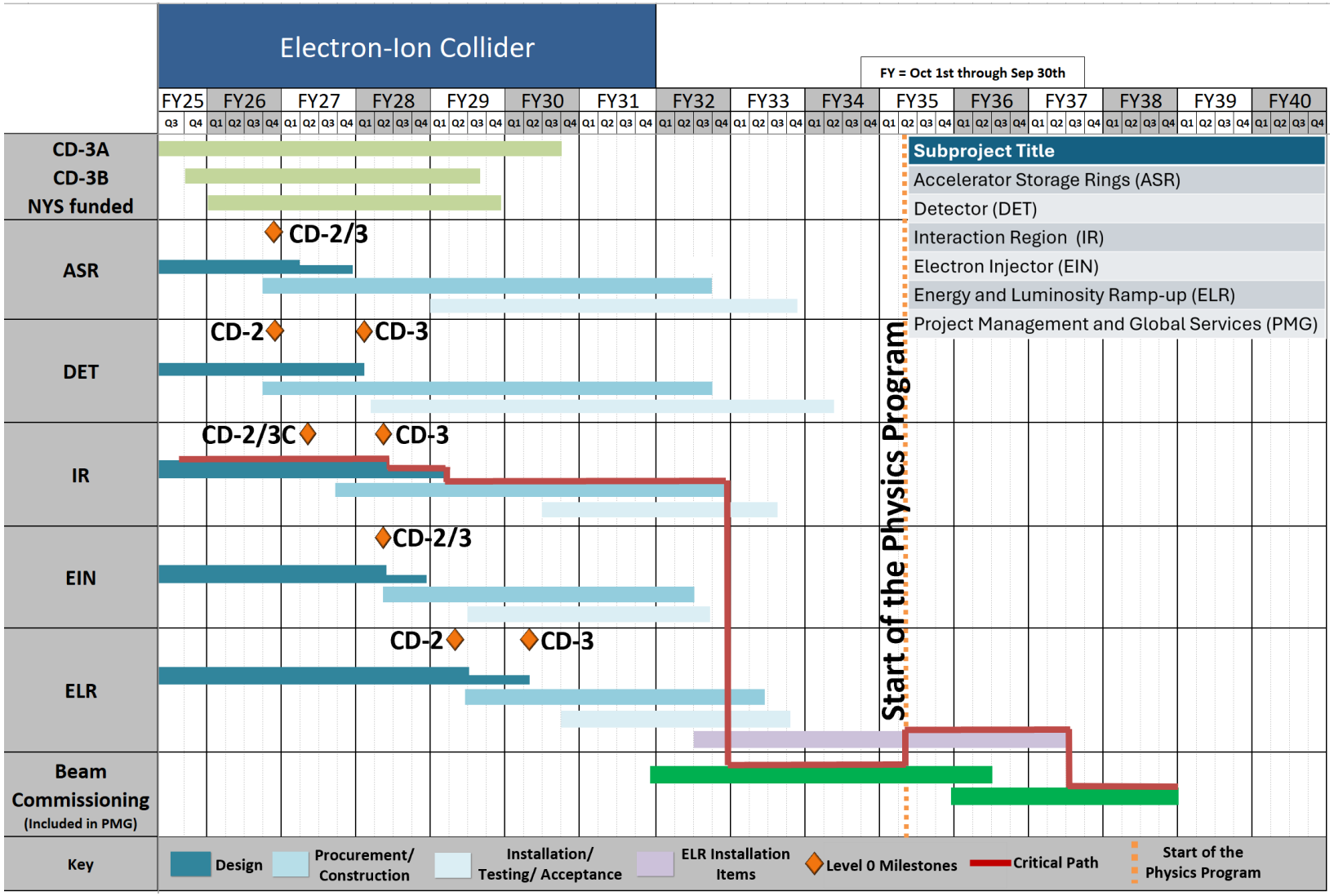
Initial RRB Co-Chairs:
Haiyan Gao (BNL) (Now: Abhay Deshpande)
Diego Bettoni (INFN) – (Tenure ends at next RRB)
David Dean as JLab CRO is ex-officio

https://www.bnl.gov/eic-rrbmeeting/
1st RRB meeting on April 3-4, 2023 at Stony Brook University.
2nd RRB meeting on December 7 + 8 at Catholic University of America.
3rd RRB meeting on May 6 + 7 hosted by INFN/Italy in Rome
4th RRB meeting on November 7+8 2024 at BNL
5th RRB meeting on June 5+6 2025 in Prague
Future: 6th RRB meeting on November 4+5 2025 at BNL

- The EIC-RRB provides coordination among the different funding partners during both the detector development and construction phase of the project and during the operations of the experiments that follow
- The EIC-RRB shall provide oversight of resources utilized for detector construction and planning, which is the ePIC detector in the EIC project scope
- The EIC-RRB will function as the body that reaches agreement on scope entailed in common projects, as appropriate, which shall be funded by members of the EIC-RRB

Strong international participation included: Armenia, Brazil, Canada, CERN, Czech Rep., France, India, Israel, Italy, Morocco, Japan, Poland, South Korea, Senegal, South Africa, Taiwan, UK

EIC Schedule:



Critical Dates for ePIC:

- CD-2 Baseline scope and cost and schedule of EIC: Q4 FY26
- CD-3 – Start of Construction: Q1 FY28
- Start of ePIC assembly: Q2 FY30
- Start of non-beam commissioning: Q2 FY233
- Start of beam commissioning: Q2 FY34
- Start of Science: Q2 FY35

Why Transnational Access for EIC@BNL

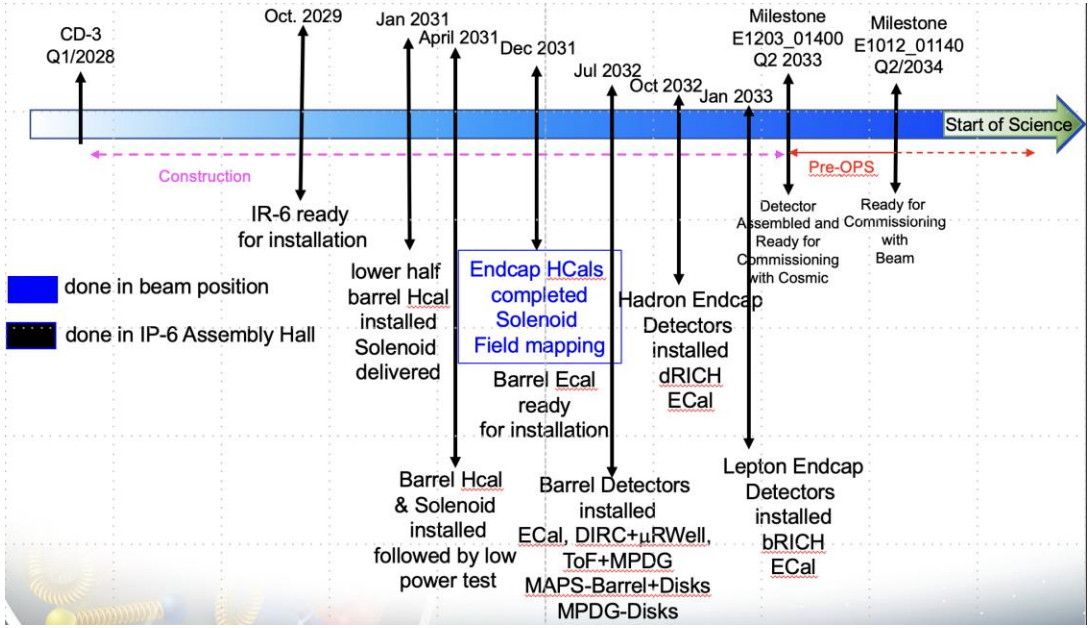
- Proposal period covers the construction and assembly phase of ePIC subsystems
  - detector subsystems need to be assembled at BNL and them mounted together to form ePIC
- BNL provides unique test facilities critical for detector subsystem tests
  - NSLS high brilliant synchrotron radiation facility
  - TANDEM accelerating a wide variety of ion species https://www.bnl.gov/tandem/about.php
  - NSRL Beams of all ions from protons to thorium, ranging in energy from 50 MeV to 1500 MeV
  - Irradiation sources https://www.bnl.gov/instrumentation/facilities/irradiation-facility.php
  - Large open bore 2T solenoid for magnetic field sensitivity tests
  - Large amount of Laboratories, Clean Rooms and High-bay areas
  - User Center for Functional Nanomaterials https://www.bnl.gov/cfn/
- European Users:
  - ePIC has 30% European Collaborators → ~ 300 ePIC members
  - We assume a minimum of 30 people per year to be at BNL for at least a month
  - In 2025 the per diem per day is $86 / day and housing is $138 per night for a 1-bedroom apartment and for students there a $69 per night dorm rooms available.
- We estimate at the high of the construction phase to have at least 30 people for a minimum of a month at BNL. Therefore, we are estimating a cost of $810 k for the 4 years of this proposal period (2026 to 2039).


QUESTIONS


BACK UP

Schedule

- The schedule is driven by:
  - **To hold the date for the CD-2 IPR of June 2026**
  - To keep the (inter)national user community engaged and limit the danger to lose groups
  - all subdetectors need to be more or less ready at the same time to be assembled to ePIC



- The schedule drivers are:
  - Superconducting Solenoid → CD-3A item
  - Silicon Sensors (MAPS, AC-LGAD & ASTROPIX)
  - ASIC long time frames only one ASIC designed from scratch all others are modifications to existing ASICS
  - Items with long production times, single vendor and complex assembly → CD-3A & CD-3B
  - International agreements driving in-kind and MAPS design (agreement with CERN)