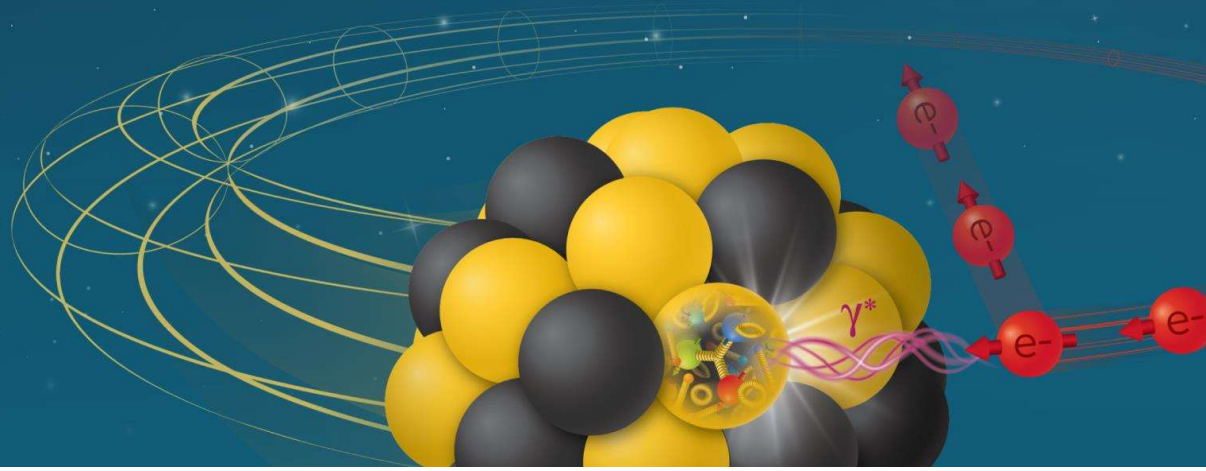
Brookhaven National Laboratory

Jefferson Lab

U.S. DEPARTMENT OF ENERGY

The EIC - a collider to unravel the mysteries of visible matter

Dr. Elke-Caroline Aschenauer
Co-Associated Director, EIC Experimental Program

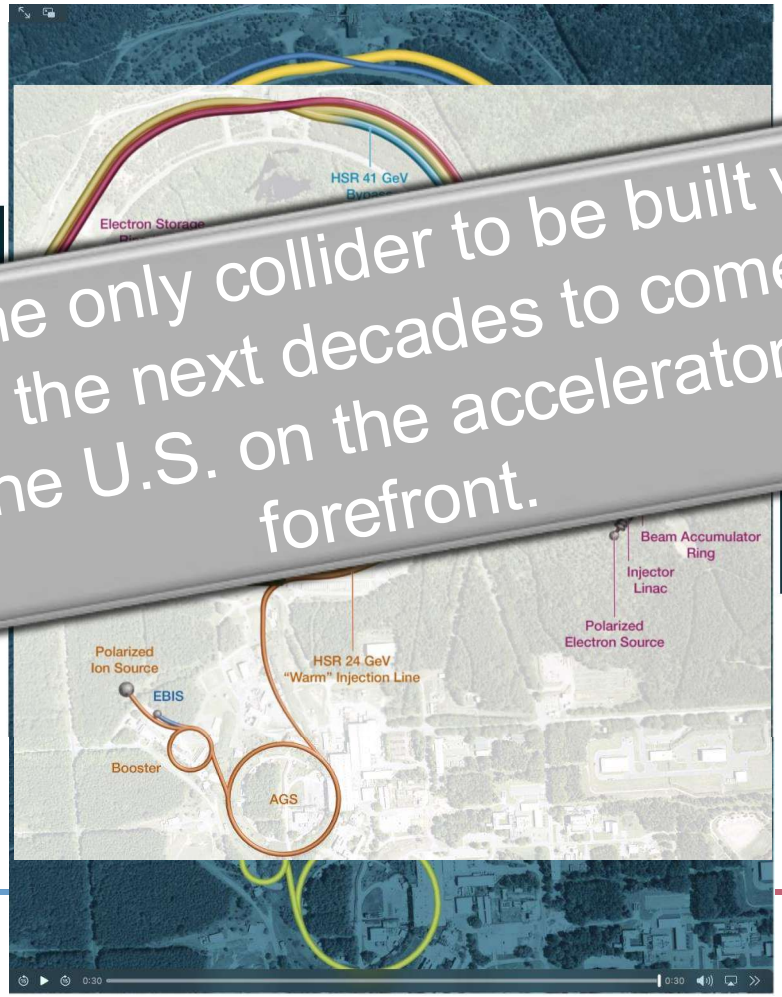


Electron-Ion Collider

What is the Electron-Ion Collider

The transformation of BNL's Relativistic Ion Collider (RHIC) to the Electron Ion Collider (EIC)

RHIC NOW

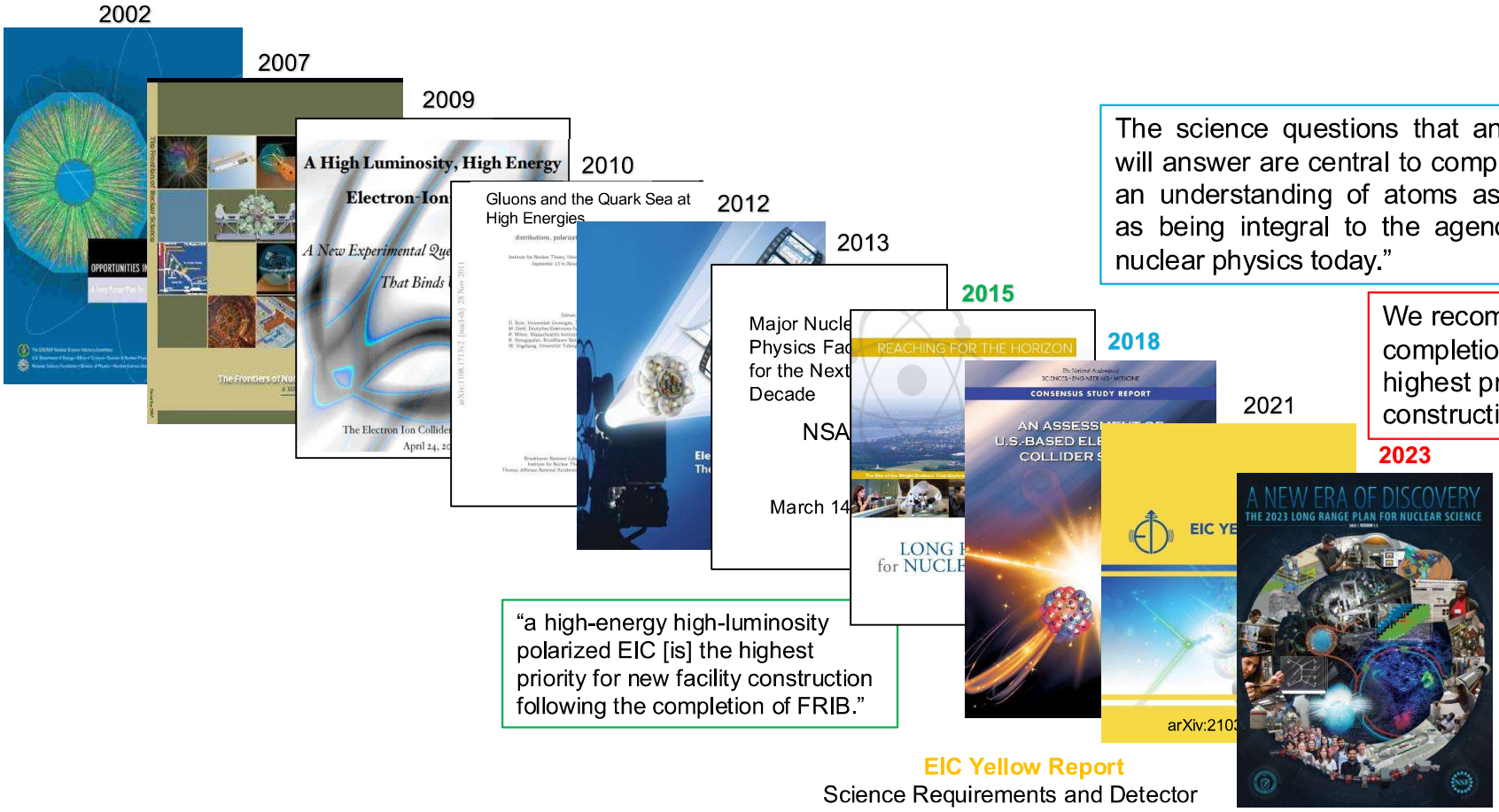


The EIC is the only collider to be built world-wide for the next decades to come!
It will keep the U.S. on the accelerator technology forefront.

Colliding
protons with protons
or
Ions with Ions (Au + Au)

Colliding
electrons with protons
or Ions (Au)

The Scientific Foundation for an EIC was Built Over Two Decades



The science questions that an EIC will answer are central to completing an understanding of atoms as well as being integral to the agenda of nuclear physics today."

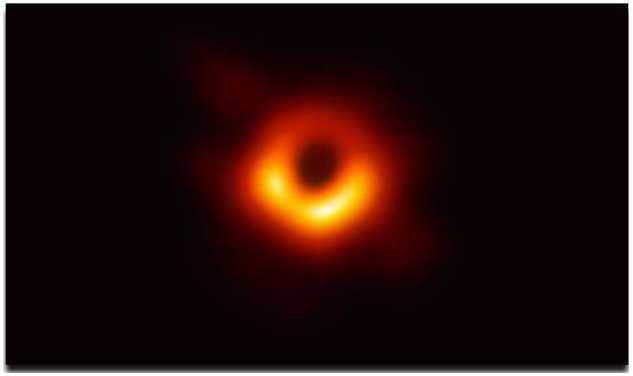
We recommend the expeditious completion of the EIC as the highest priority for facility construction.

"a high-energy high-luminosity polarized EIC [is] the highest priority for new facility construction following the completion of FRIB."

EIC Yellow Report
Science Requirements and Detector Concepts for the EIC – Drives the requirements of EIC detectors

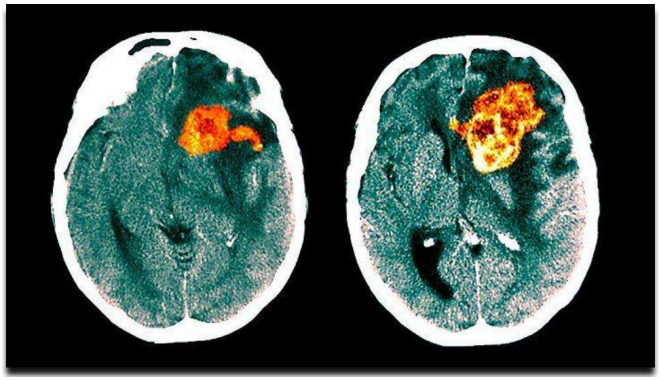
Seeing is believing – the power of imaging

38 billion km (~10^{12}m)



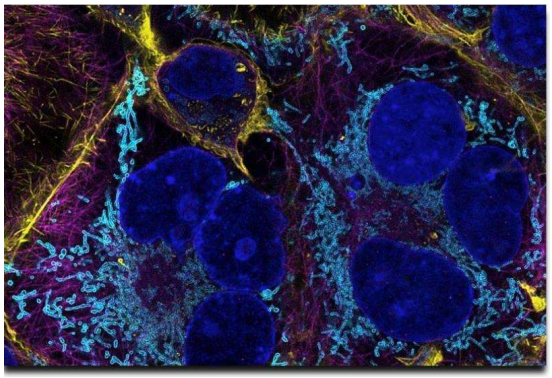
First-ever image of a black hole - *Event Horizon Telescope*

a few centimeter (~10^{-2} m)



CT scan sequence of a patient with a *glioblastoma*.

10-100 nanometer (~10^{-9} m)



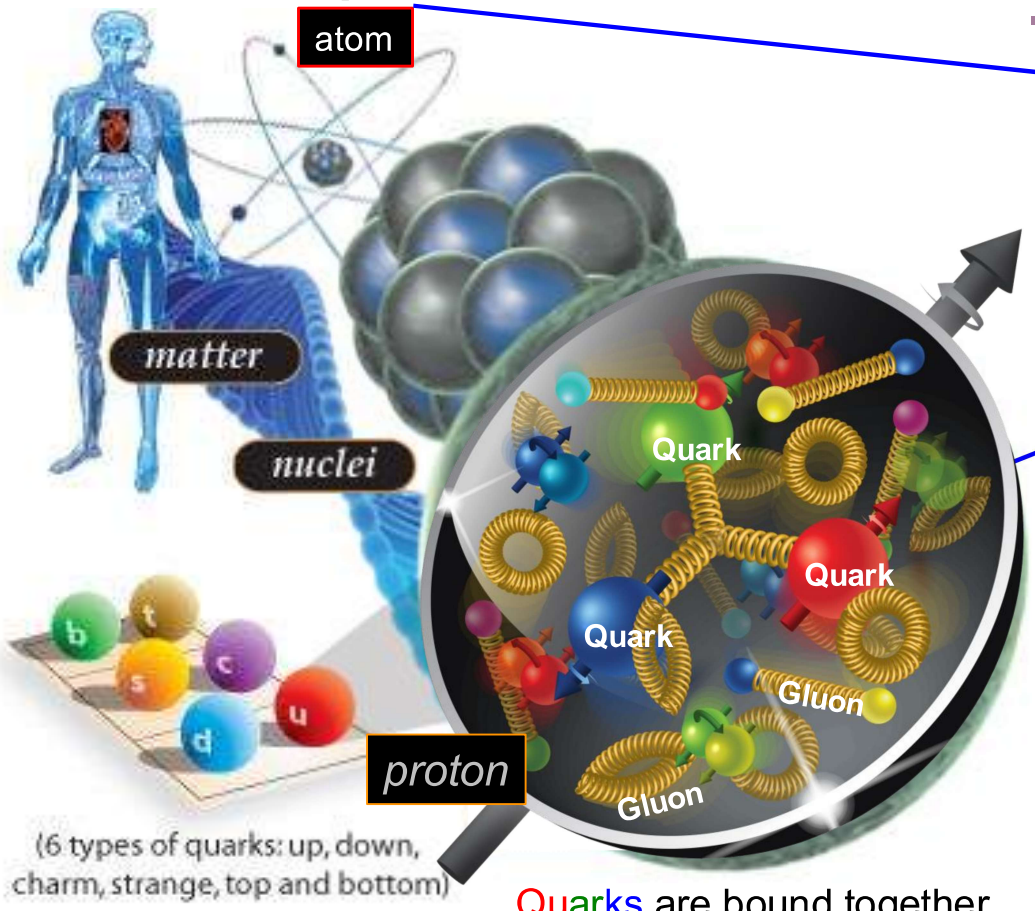
3D images of myelin - the insulation coating our nerve fibres

Astronomical scale → Microscopic scale

Imaging: one of the most convincing scientific methods to understand our nature!

EIC: "Imaging" the fundamental structure of matter

What composes visible matter



Quarks are bound together by gluons to form nucleons

if you look through a higher and higher resolution microscope you discover a femto Universe

size scale

3.2 10^{-15} feet = 1 femto m (fm)

Big Question:

can we understand how the visible matter is formed from the smallest elementary building blocks quarks and gluons

All elementary building blocks can be characterized by their mass, spin and charge

EIC Science Pillars

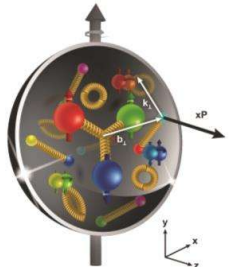
The EIC will unravel the different contribution from the quarks, gluons and orbital angular momentum

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

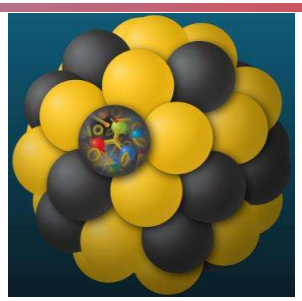
For the proton the EIC will determine an important term contributing to the proton mass, the so-called "QCD trace anomaly



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?

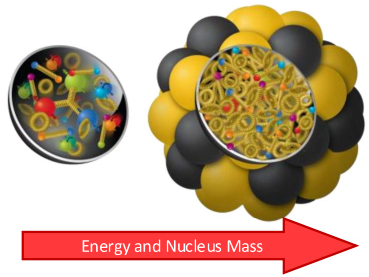


How do the confined hadronic states emerge from quarks and gluons?

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

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

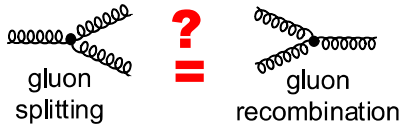
How do the quark-gluon interactions create nuclear binding?



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?



The spin of the proton

Proton spins are used to image the structure and function of the human body using the technique of *magnetic resonance imaging.*

Nobel Prize 2003:
Paul C. Lauterbur & Sir Peter Mansfield
for discovery concerning magnetic resonance imaging

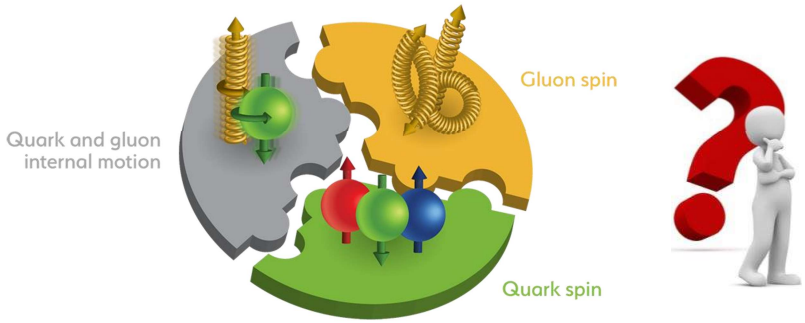
Spin – one of the fundamental properties of

How does the **nucleon spin originate** from its **quark** constituents and their dynamics?

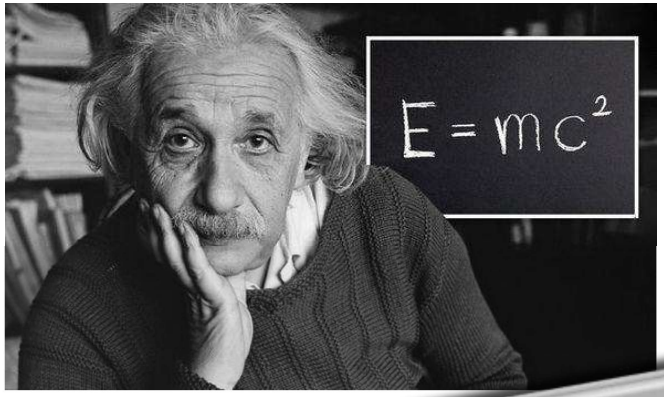
The EIC can resolve this mystery

Proton spin is not the sum of the three valence-quark spins like charge.

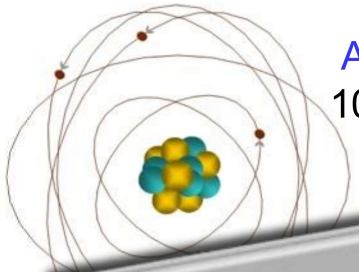
What makes up the spin of the proton?



The Mystery about Visible Matter

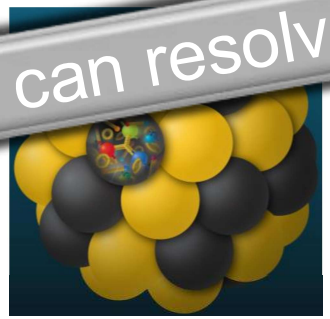


Does the mass of visible matter arise from the energy of the strong force between quarks and gluons?



Atom
10^{-10}m

The EIC can resolve this mystery



10^{-14}m

Protons
10^{-16}m

Iron atom
Ionization Energy = 7.9 eV/electron
Energy/Mass = 0.00000001

Iron nucleus
Binding Energy = 8.8 MeV/nucleon
Energy/Mass = 0.01

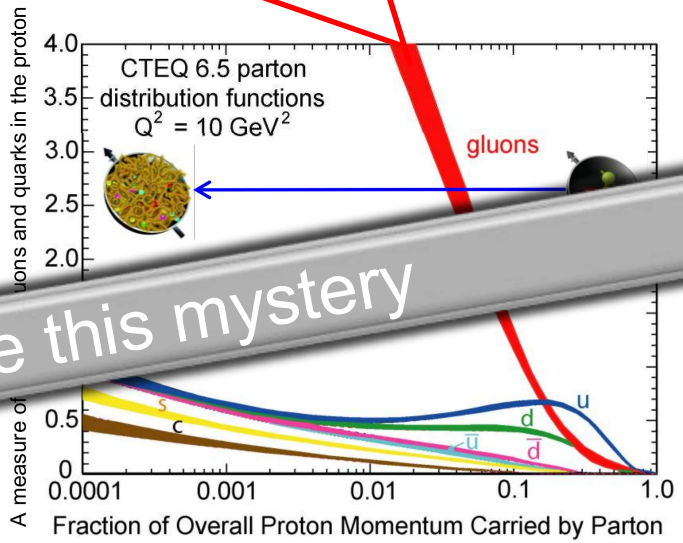
Set of 56 protons/neutrons
Binding Energy = 310 MeV/quark*
Energy/Mass = 100

**Binding Energy = ∞/gluon*

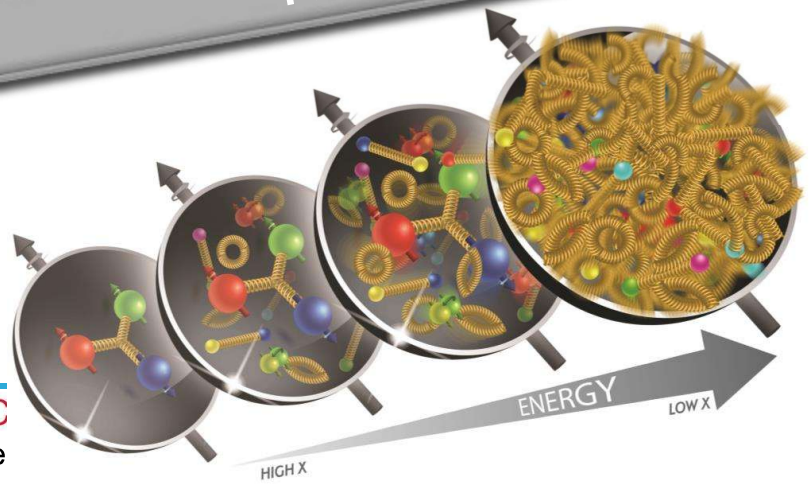
How many gluons fit in a proton?

Is the proton a runaway popcorn machine?

?



The EIC can resolve this mystery



The EIC
will tell us the growth gets tamed
and if gluons saturate into a new state of matter:
Color Glass Condensate

What do we need to built

EIC Design Overview

- **Hadron Storage Ring (RHIC Rings) 40, 100-275 GeV**
  - Based on **existing, well maintained, well performing RHIC**
  - Superconducting magnets (existing)
  - 1160 bunches, 1A beam current (3x RHIC)
  - Bright vertical beam emittance 1.5 nm (“flat beams”)
  - Cooling at injection and later upgrade → high energy cooler

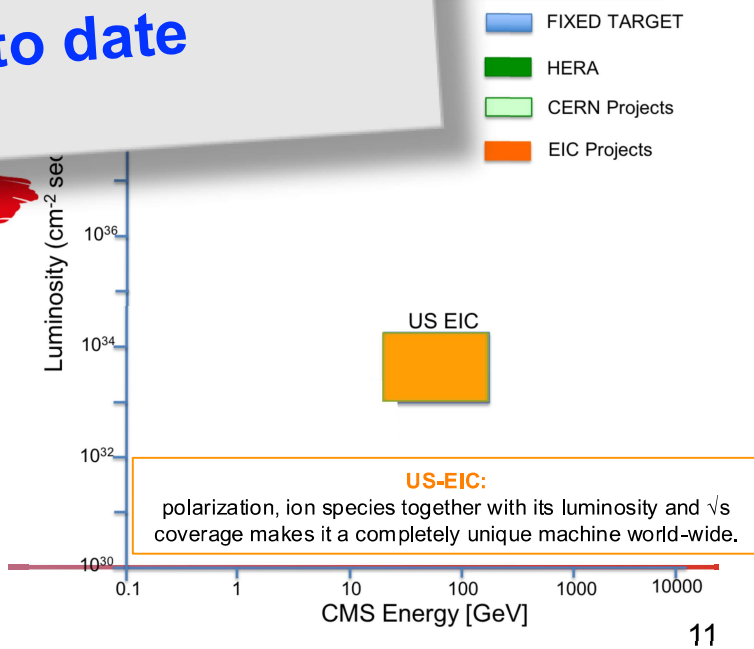
- **Electron Storage Ring 5–18 GeV**
  - L
  - N
  - S
    hi

All the Novelties make EIC the most challenging and complex collider project to date

- **High c** **(80 %) electron source**

- **Electron Pre-Injector (750 MeV linac)**
- **Electron rapid cycling synchrotron, 1Hz, 0.75 -> 18 GeV**
  - Spin transparent due to high quasi-periodicity

- **High luminosity Interaction Region(s)**
  - Large bore superconducting final focusing magnets
  - 25 mrad crossing angle with crab cavities
  - Spin Rotators (longitudinal spin)
  - Forward hadron instrumentation
  - Bunch Crossing ~ 10.2 ns/98.5 MHz



Electron Guns for EIC – World Records

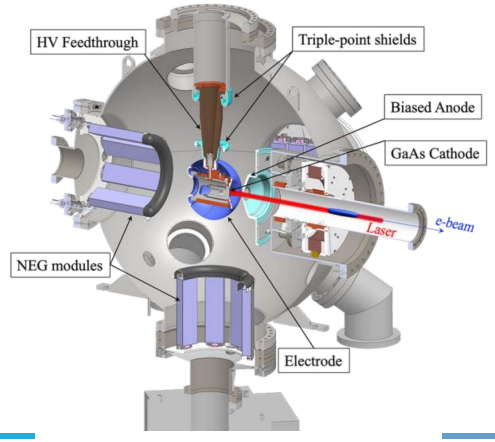
Very successful BNL – SBU Collaboration

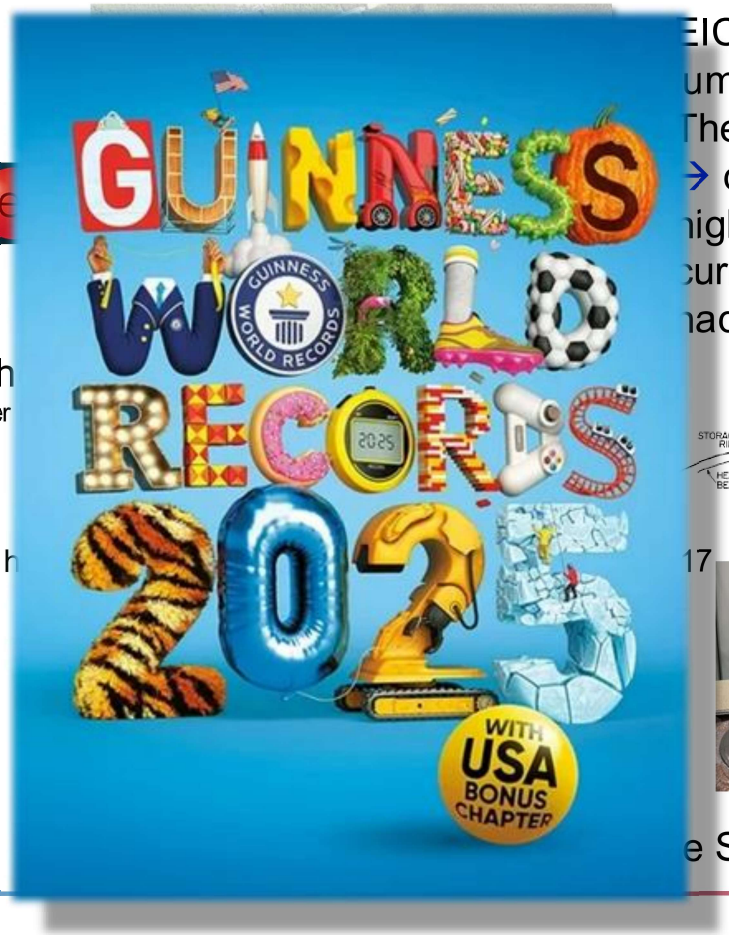
EIC sciences requires polarized electrons

→ designed and build the world's highest-voltage and highest-intensity polarized electron gun

→ accelerated electrons from 0 to 80% of speed of light in 2 inch

Equal to a car going from 0 to 500 million miles per two ten-billionths of a second

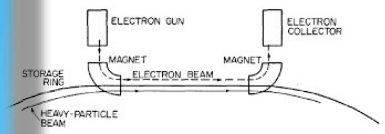


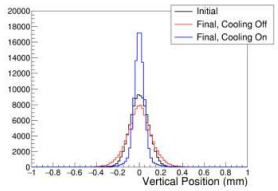


EIC sciences requires very high luminosities in collisions

The next World Records

→ development of the world's even higher-voltage and very-high-average-current electron gun to cool the EIC hadron beam





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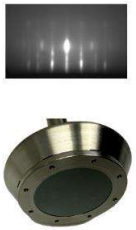


e SBU PhD student involved in research

Electron-I One SBU PhD thesis

The Trick to get high Luminosity and low Background

Requirements for high luminosity and low beam induced background

- bring magnets that focus the beams as close to the collision point as possible
- don't bend beams strongly before the collision point

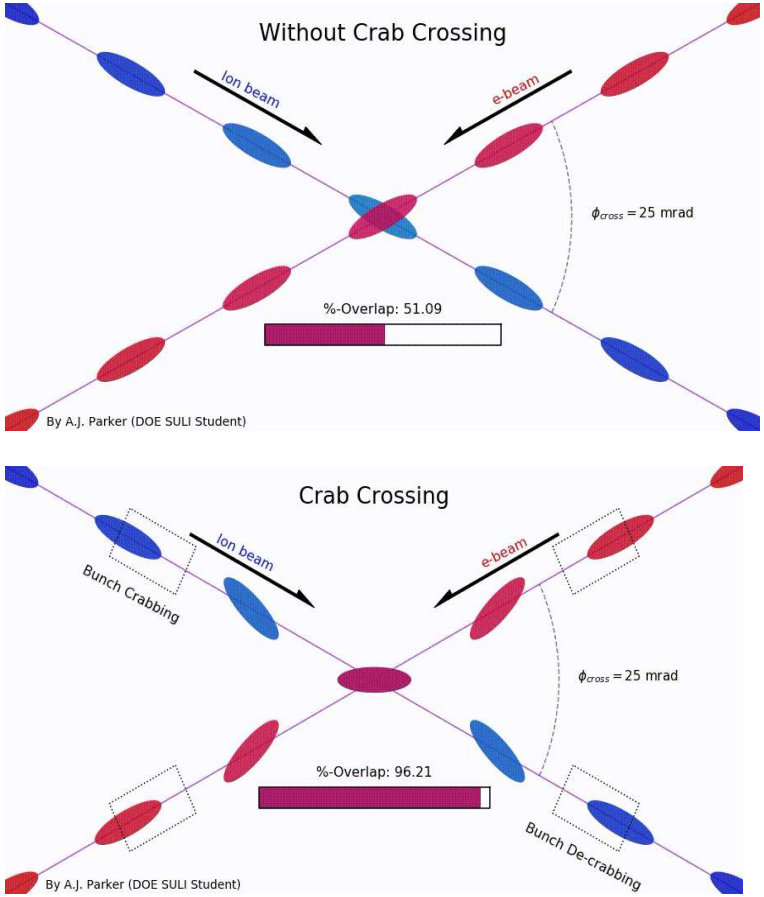
→ **collide both beams under an angle**

But significant loss of luminosity
as beam bunches do not fully overlap

Solution: Crab crossing

- Head-on collision geometry is restored by rotating the bunches before colliding ("crab crossing")

Completely new concept for a collider



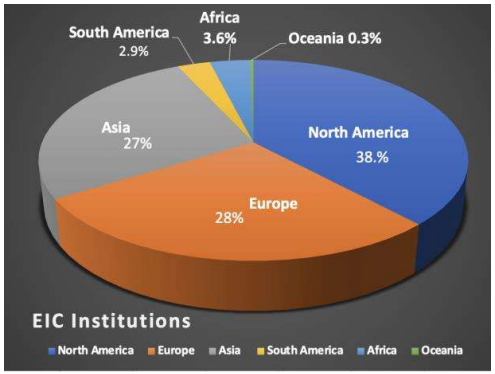
luminosity is a measure of how effectively beams of particles are packed and focused for collisions, indicating the rate at which collisions occur.

World-Wide Interest in EIC and ePIC

The EIC Users Group: EICUG.ORG

Formed 2016: 400 Users → Now

1558 collaborators, 41 countries, 307 institutions



Location of Institutions

ePIC Collaboration

https://www.epic-eic.org

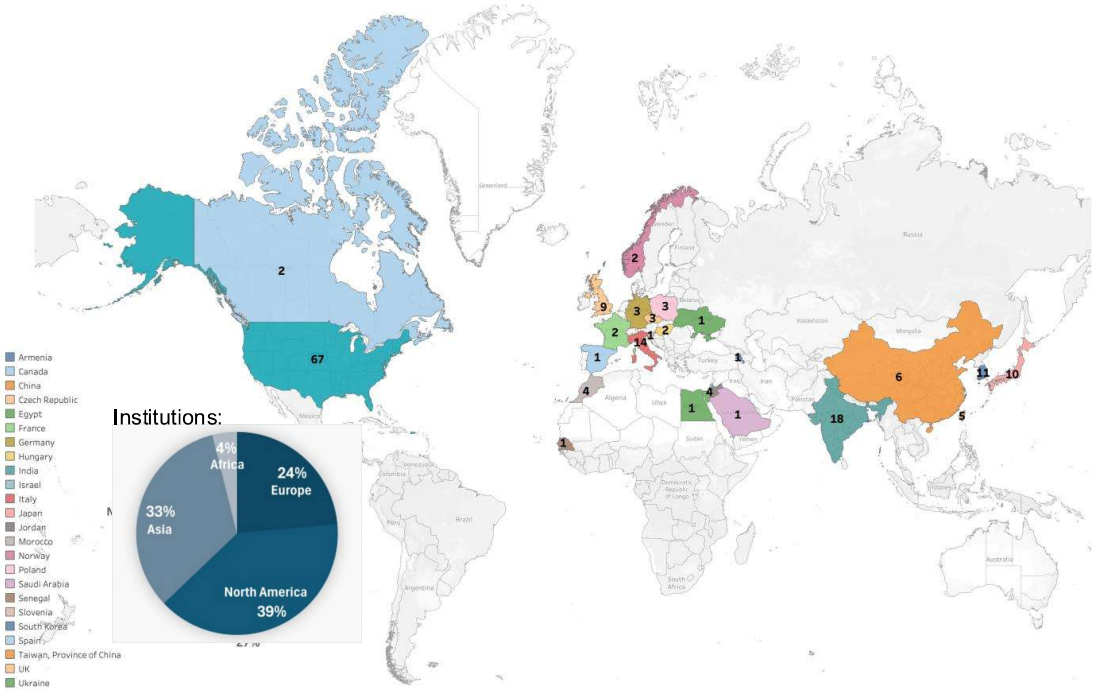
Formed in 2022 → Now

~1050 collaborators, 25 countries, 180 institutions

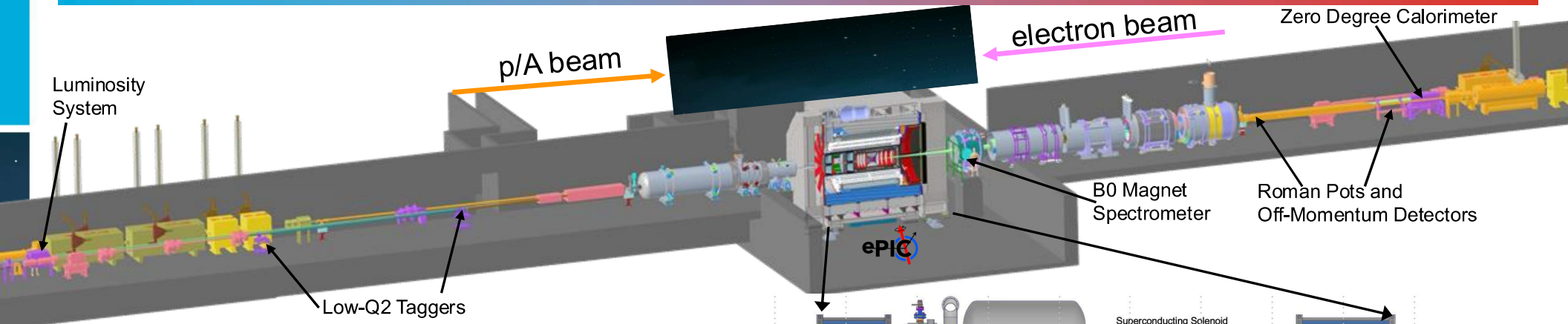
US: 8 National Labs + 59 Universities

In-kind contribution from international partners:

30% of the Detector → ~$100M



ePIC – The EIC State-of-the-Art General-Purpose Detector



ePIC:

26 subsystems over ± 40 m

to measure particle momenta, energy and particle type

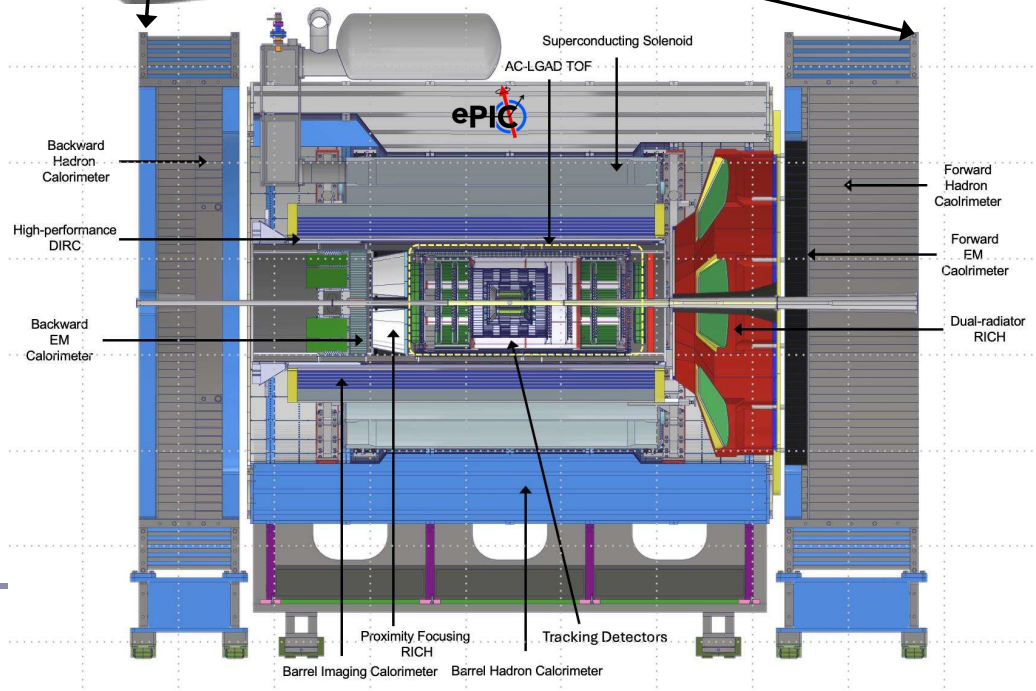
Needs: tracking, particle identification, EM and hadronic calorimetry over an extremely wide acceptance

8 world first technologies

Highest scientific flexibility

→ fully streaming readout electronics and data acquisition

→ integration AI/ML capabilities from the start

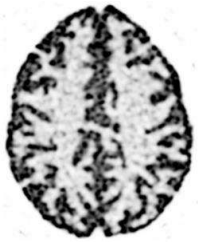


ePIC a State-of-the-Art General-Purpose Detector

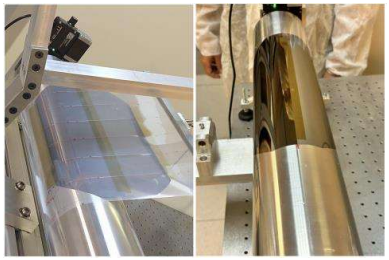
Technology Highlights:

LAPPDs: New photon sensor development → Combining Timing and Photon detection Potential Factor 5 improvement in resolution in Time-of-Flight Positron Emission Tomography (PET)

Current state of the art PET scanner



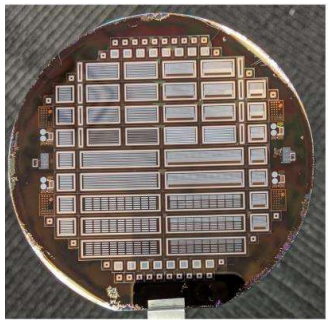
Utilizing new EIC Photon sensors



Monolithic Active Pixel Sensor → world's thinnest most flexible Si-Pixel detector
Development in synergy ALICE ITS3 MOSAIX sensor (65 nm), small pixels (~18 μm) and power consumption (<20 mW/cm^2)

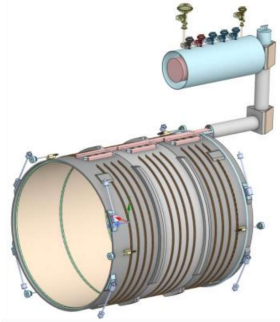
High resolution, radiation hard Tracker with basically no material

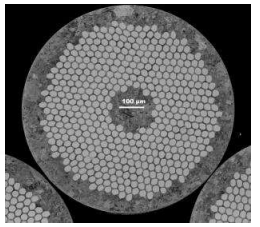
Critical Technology for the next generation high energy colliders.



AC-LGAD (AC-coupled Low Gain Avalanche Diodes)
Si-detector measuring particles in 4d
→ position and time
→ combining momentum measurement with determining the particle type
Precision:
Time 30ps, Position 10 μm and only 30 μm thick

Critical Technology for the next generation high energy colliders.



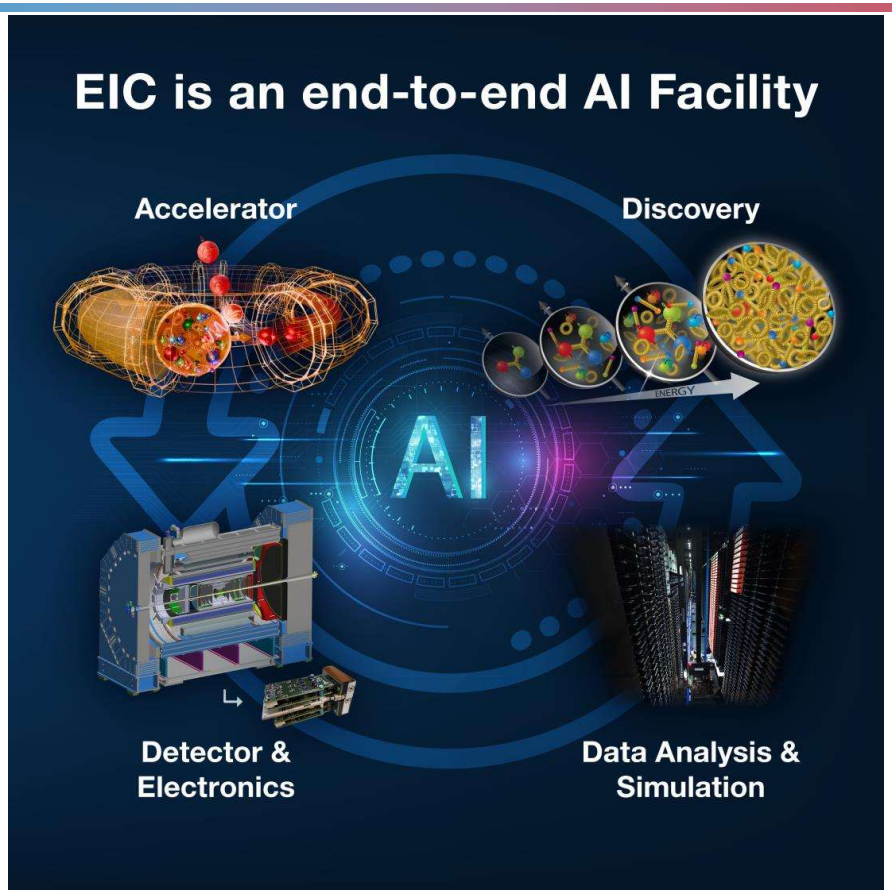


New 2T superconducting Solenoid
→ First Large Bore size (2.4m) since 20+ years
→ Conductor: Rutherford Cable Nb-Ti strands with Copper core

Critical to keep expertise to build large Solenoids for collider experiments
Synergy with CERN Superconducting Magnet Workshop
https://indico.cern.ch/event/1162992/

Integrating AI

Generate digital twins of the collider and detector to increase operational efficiency through early failure detection and improved operation with higher signal purity



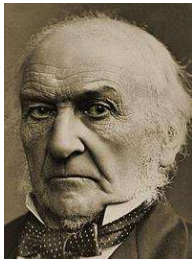
Interplay between theory and experiment through AI/ML applications.
Integrating AI/ML within a streaming readout data processing environment, prompting a convergence between offline and online analyses.

creating a single ecosystem with the accelerator, detector, computing and science

Why should we care?

Michael Faraday
(1791-1867)

VS.



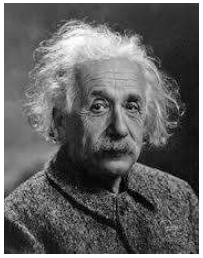
William E. Gladstone
(1809–1898)

Faraday's reply to William Gladstone, then British Chancellor of the Exchequer (minister of finance), when asked of the practical value of electricity (1850)

"One day sir, you may tax it."

http://en.wikiquote.org/wiki/Michael_Faraday, as quoted in *The Harvest of a Quiet Eye : A Selection of Scientific Quotations* (1977), p. 56

Fundamental research



A. Einstein
"Laws of Special and General Relativity"

Spin of the proton

Training of the next generation of science and technology leaders

Applied research

GPS

Design of quantum computers

that will play a crucial role developing new methods in medical diagnosis and treatment

Who is building the EIC

Human Resources Specialists

We need you all

Food Services
Public Relations Professionals
Local LI Businesses
Engineers
Designers
Technicians
Administrative Professionals
Carpenters
Plumbers
Scientists
Vacuum Experts
Interns
Magnet Experts
Painters
Architects
Accountants
Computing Experts
Information Technology Experts
Procurement Specialists
Students
Project Controls Experts
Construction Companies / Workers

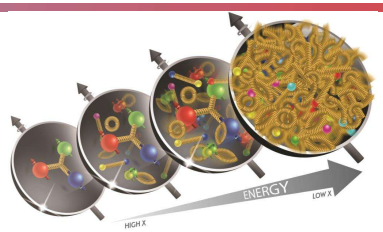
Jobs:
https://jobs.bnl.gov/search-jobs/eic?orgIds=3437&kt=1


QUESTIONS

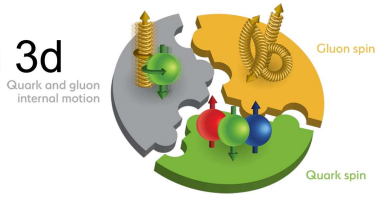

BACK UP

Accelerator Performance for EIC Science

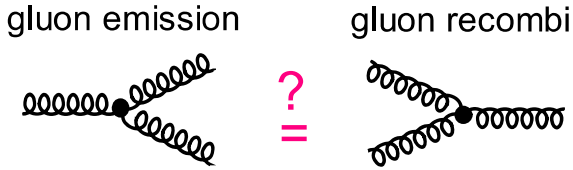
- map the out nucleon and nuclei structure from high to low x
  - ➢ span center-of-mass energy √s: 30 – 140 GeV



- access to spin structure of nucleons and nuclei
- Spin vehicle to access the spatial and momentum structure of the nucleon in 3d
- quark – gluon structure of light nuclei
  - ➢ polarized electron and hadron (p, He-3) beams

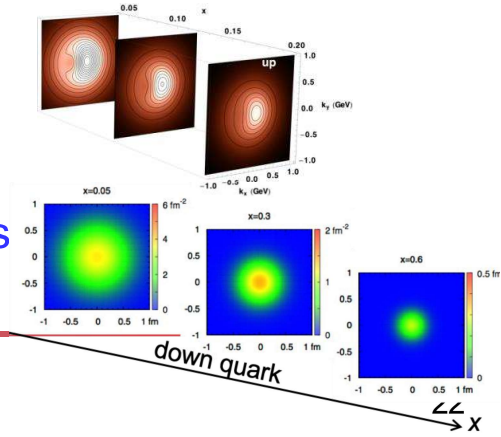


- accessing the highest gluon densities → saturation
- How quarks and gluons interact with a nuclear medium
  - ➢ nuclear beams: d to Pb at √s: 30 – 90 GeV



- mapping the access to rare probes, i.e. Ws and BSM Physics
  - ➢ high luminosity: $10^{33\text{-}34}$ $cm^{-2}s^{-1}$

- spatial and momentum structure of nucleons and nuclei in 3d
  - ➢ high luminosity: $10^{33\text{-}34}$ $cm^{-2}s^{-1}$
  - ➢ large acceptance in p_T (0.2 – 1.3 GeV) through forward focusing IR magnets



Resource Review Board (RRB) Meetings

DOE and the host labs promote the EIC as a facility "fully international in character."

Initial RRB Co-Chairs:

Haiyan Gao (BNL) (Now: Abhay Deshpande)

Diego Bettoni (INFN) – (Will now become Franck Sabatie)

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

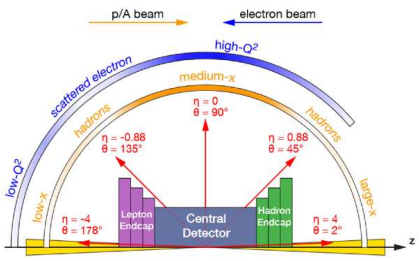
7th RRB meeting to be hosted by Japan

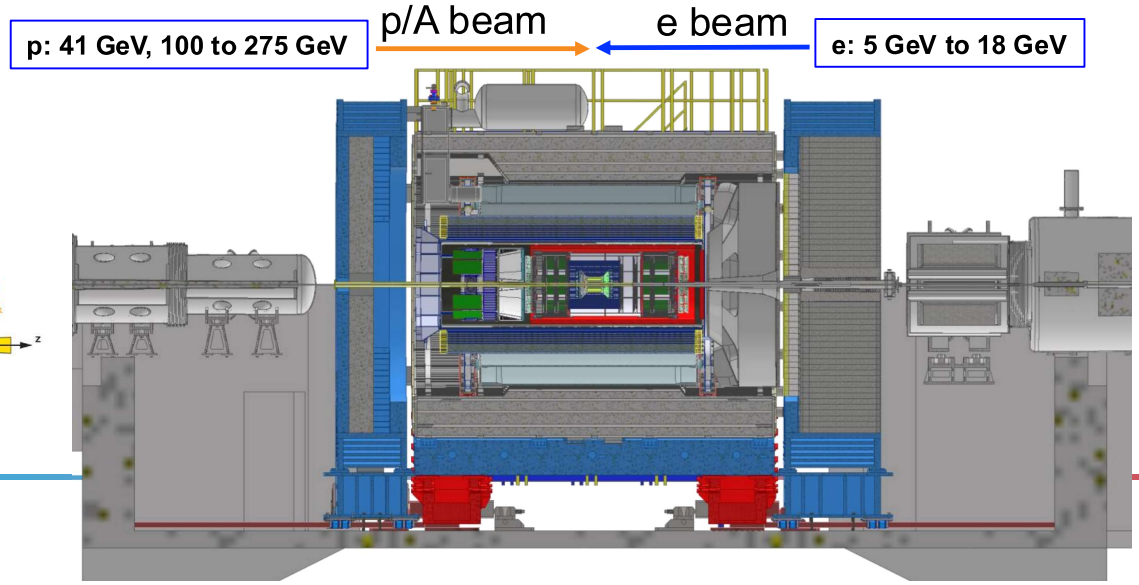
- The EIC-RRB provides coordination among the different funding partners during both the detector development and construction phase of the project and during the operations of the experiments that follow
- The EIC-RRB shall provide oversight of resources utilized for detector construction and planning, 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

Why is ePIC Unique

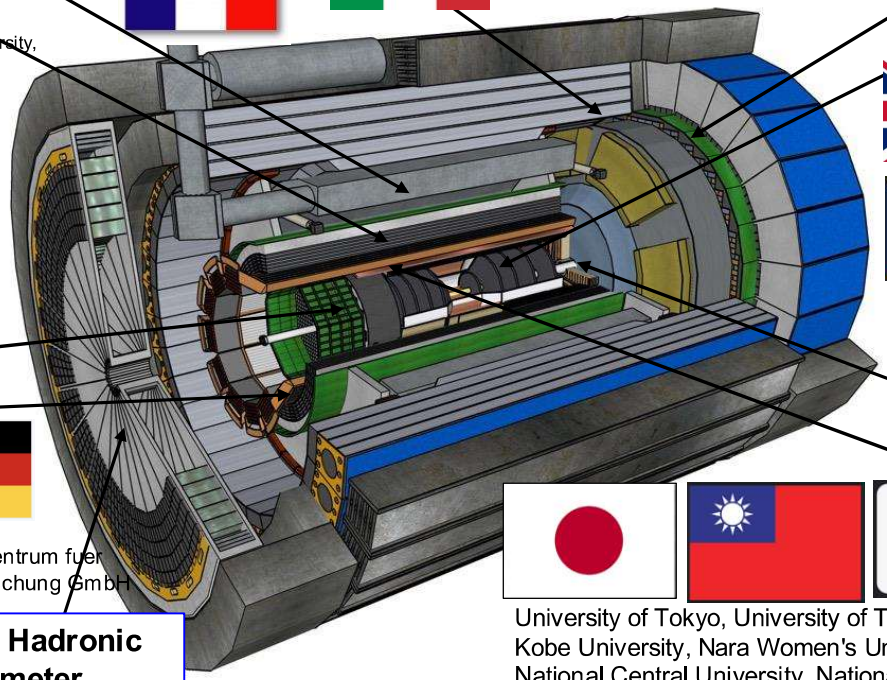
- Asymmetric beam energies
  - requires an asymmetric detector with electron and hadron endcap → 9.5 meter
  - tracking, particle identification, EM and hadronic calorimetry functionality in all directions, covering equal rapidity area: (2° to 178°) (see backup slide 24 – 27)
  - low mass detectors critical for precise scattered electron reconstruction → new tracking technologies
  - PID detectors: π, K, P detection 100 MeV to 50 GeV
    → single photon detection as part of RICH detectors
- Highly Polarized Beams: 70%
  - requires high precision electron and hadron polarimetry
- Momentum resolution for EIC science
  - requires a large bore (⌀ 2.84 m) 2T magnet
- very compact Detector, Integration will be key





Central Detector Non-DOE Interest & In-Kind

In-kind contribution goal: 30% of the Detector



Barrel Electromagnetic Calorimeter

Karlsruhe Institute of Technology

Yonsei University,
Gangneung-Wonju National University,
Hanyang University
Jeonbuk National University
Korea University
Kyungpook National University
University of Seoul
Pusan National University
Sungkyunkwan University
Sejong University
Hanyang University
Yonsei University

University of Regina
University of Manitoba

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

Backward Hadronic Calorimeter

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

Time-of-Flight

University of Tokyo, University of Tsukuba, Hiroshima University
Kobe University, Nara Women's University, Nihon University, Shinshu University
National Central University, National Cheng Kung University
National Taiwan University, National Tsing Hua University

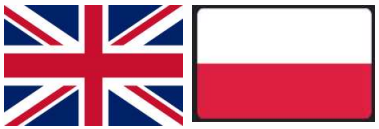
Data-Acquisition Electronics

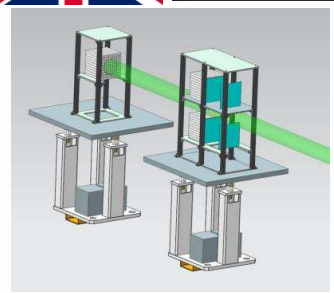
Far-Forward/Far-Backward Detectors Non-DOE Interest & In-kind

IR vacuum – crucial interface for detectors

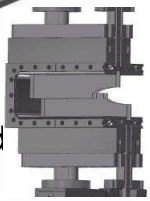
Zero Degree Calorimeter

e beam





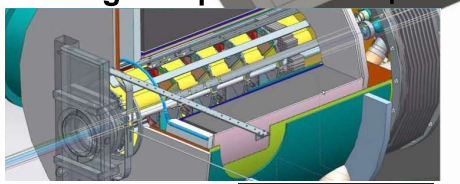
ePIC



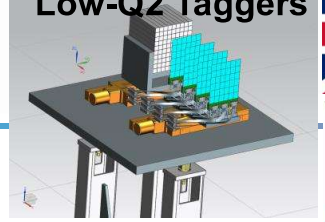
Roman Pots and Off-Momentum Detectors

Luminosity System

B0 Magnet Spectrometer

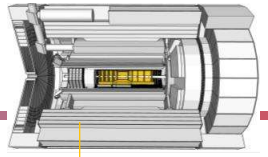


Low-Q2 Taggers

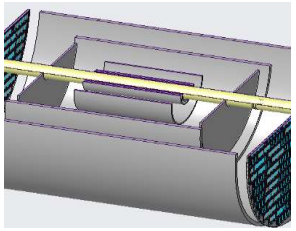


RIKEN Nishina Center
University of Glasgow
AGH University of Krakow
Ben Gurion University of the Negev
Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN)
Institute of Physics, Academia Sinica
Tel-Aviv University
Warsaw University of Technology, Faculty of Physics
University of York

ePIC Tracking Detectors



μVertex Tracker



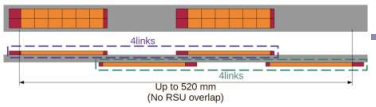
Excellent momentum 0.05%pT⊕0.5% and spatial resolution 20μm/pT⊕ 5μm

Displaced vertex reconstruction

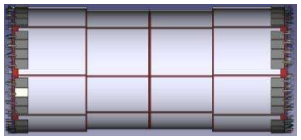
Monolithic Active Pixel Sensor → ALICE ITS3 MOSAIX sensor (65 nm) small pixels (~18 μm) and power consumption (<20 mW/cm^2)

Barrel Tracker

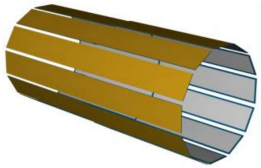
EIC Large Area Sensor (LAS), modification of ITS3 sensor with 5 or 6 RSU forming staves as the basic building elements for the Outer Barrel



Outer Barrel MPGD Tracker



MicroMegas Tracker



μRWELL Tracker

Main Function

Provide redundancy and pattern recognition for tracking

Tracking close to hpDIRC detector to improve angular and space point resolution. Redundancy and pattern recognition for tracking

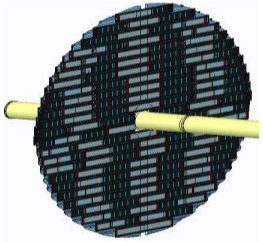
Proven Technology

Cylindrical resistive Micromegas technology Used: ATLAS NSW, CLAS12, SPHENIX, MINOS& T2K TPC

world's first at ePIC

24 planar Thin-gap & double amplification (GEM & μRWELL) modules & 2D-strip readout

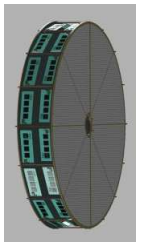
EndcapTracker



MAPS Disks

Excellent momentum 0.05 (0.10)% pT⊕1.0 (2.0)% and spatial resolution 30μm/pT⊕ (20 – 40) μm

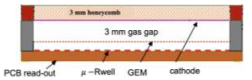
EIC Large Area Sensor (LAS), staves as the basic building elements for the MAPS disks



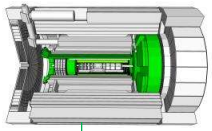
μRWELL Disks

Provide redundancy and pattern recognition for tracking

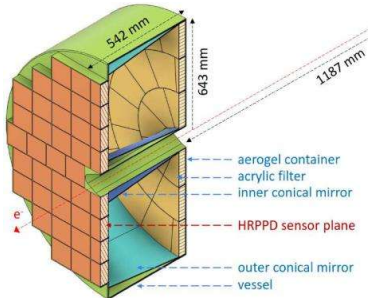
GEM- μRwell hybrid configuration with increased gain



ePIC Particle Identification Detector

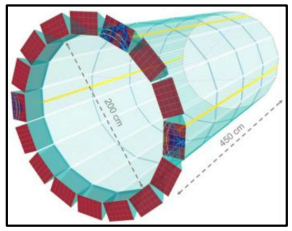


Backward RICH



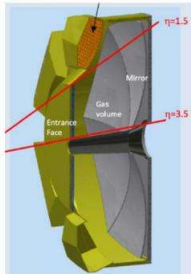
- e, π, K, p separation
→ π/K 3σ sep. up to 9 GeV/c and 10-20 ps timing → ToF

Barrel DIRC



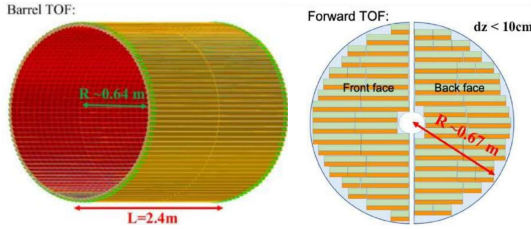
- e, π, K, p separation
→ π/K 3σ sep. at 6 GeV/c

Forward RICH



- e, π, K, p separation
→ π/K 3σ sep. up to 50 GeV/c

Time-of-Flight (Barrel, Forward)



- e, π, K, p separation through 20-35 ps ToF

Barrel: $0.15 < p_T < 1.5$ GeV/c

Forward: $0.15 < p_T < 2.5$ GeV/c

- Accurate space point for tracking

Main Function

Proven Technology

Classical single volume proximity focusing aerogel RICH with long proximity gap (~30 cm)

High Performance DIRC
- Quartz bar radiator
  → Reuse of BaBAR DIRC bars
- light detection with MCP-PMTs
- Fully focused

Dual Radiator RICH
- Aerogel and C_2F_6 gas
- Spherical Mirrors (6 Azimuthal Sectors)
- Photon-Sensors tiled on spheres

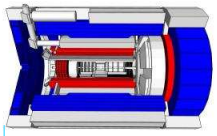
world's first at ePIC

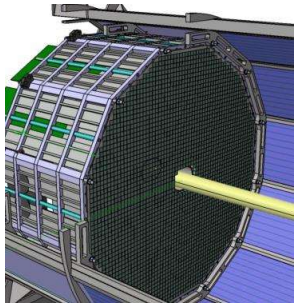
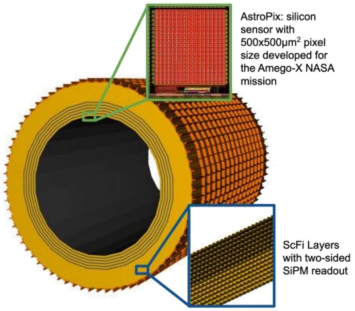
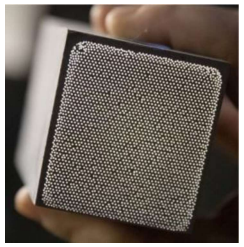
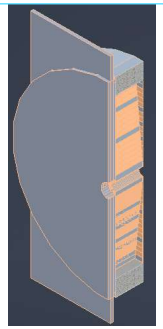
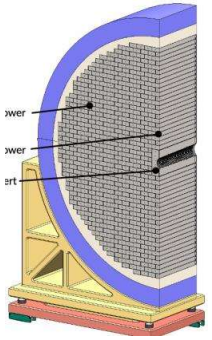
Photonsensors:
HRPPDs for Time-of-Flight

First use of SiPMs as Photonsensors in a RICH

First time use of AC-LGAD (Low Gain Avalanche Detector) in collider detector

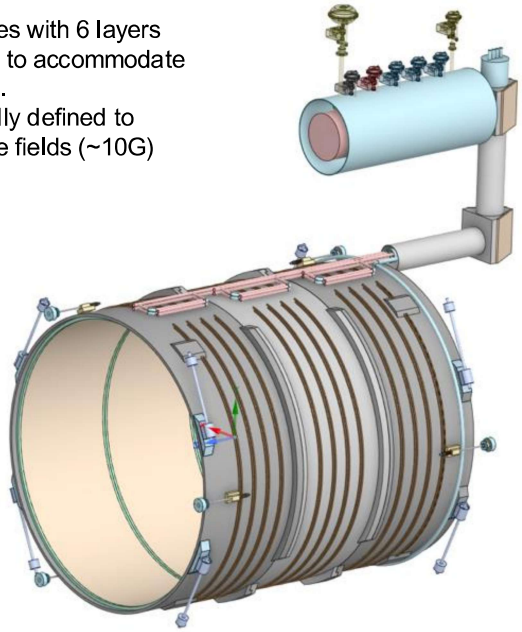
ePIC Calorimetry



Backward ECal	Barrel ECal	Forward ECal	Backward HCal	Barrel HCal	Forward HCal
					
Main Function					
scattered lepton detection → very high-precision	scattered lepton and γ detection, hadronic final state characterization	lepton and γ detection, hadronic final state characterization → π^0, γ separation	muon and neutral detection → improved jet Energy reconstruction	muon and neutral detection → improved jet Energy reconstruction	particle-flow measurements
Proven Technology					
PbWO4 – crystals → long lead procurement	Pb/SciFi sampling part using SiPMs combined with imaging section (6 layers) interleaving Pb/SciFi with ASTROPIX	Tungsten-powder + SciFi SPACAL design Developed through EIC R&D and applied successfully in sPHENIX	Steel + Scintillator SiPM-on-tile	Steel + Scintillator design re-used from sPHENIX	longitudinal segmented Steel + Scintillator SiPM-on-tile Pioneered by CALICE analog HCal High resolution insert next to beam-pipe
		world's first at ePIC			
SiPM as Photonsensors	Use of ASTROPIX in Calorimetry				first-time full-size CALICE like calorimeter in collider experiment

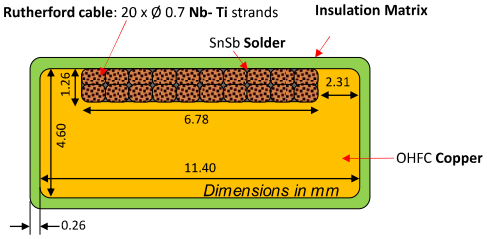
ePIC: MARCO Magnet

Coil is divided in 3 modules with 6 layers each. This is done mainly to accommodate possible conductor length.
Flux return steel layout fully defined to minimize forces and fringe fields (~10G)



B_0	1.5 T	1.7 T	2.0 T	Units
Current	2942	3335	3924	A
T_{op}	4.7	4.7	4.7	K
B_{peak}	2.00	2.27	2.67	T
Temp. margin	3.06	2.82	2.45	K
Load line margin	59.6	54.2	46.1	%
I / Ic(T,B_{peak})	17.9	22.1	29.3	%

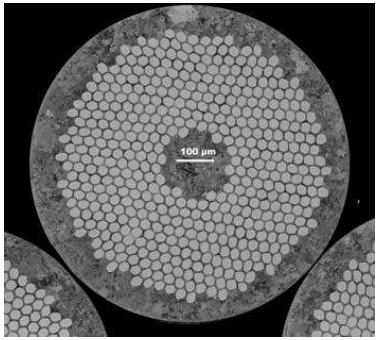
Robust and safe operating parameters



Mechanical: 2D and 3D mechanical analysis done on the overall magnet assembly, coils, mandrel and tie-rods: All stresses and displacements are well within the acceptable limits.

Cryogenic: Redundant cooling system is used to ensure that thermosiphon works properly

6.10.07 Magnet – strands that are sent from Luvata to Twente for sample tests, the filaments are beautifully arranged and tests confirmed specifications – These were the final quality assurance tests before starting the long-lead procurement for conductor.

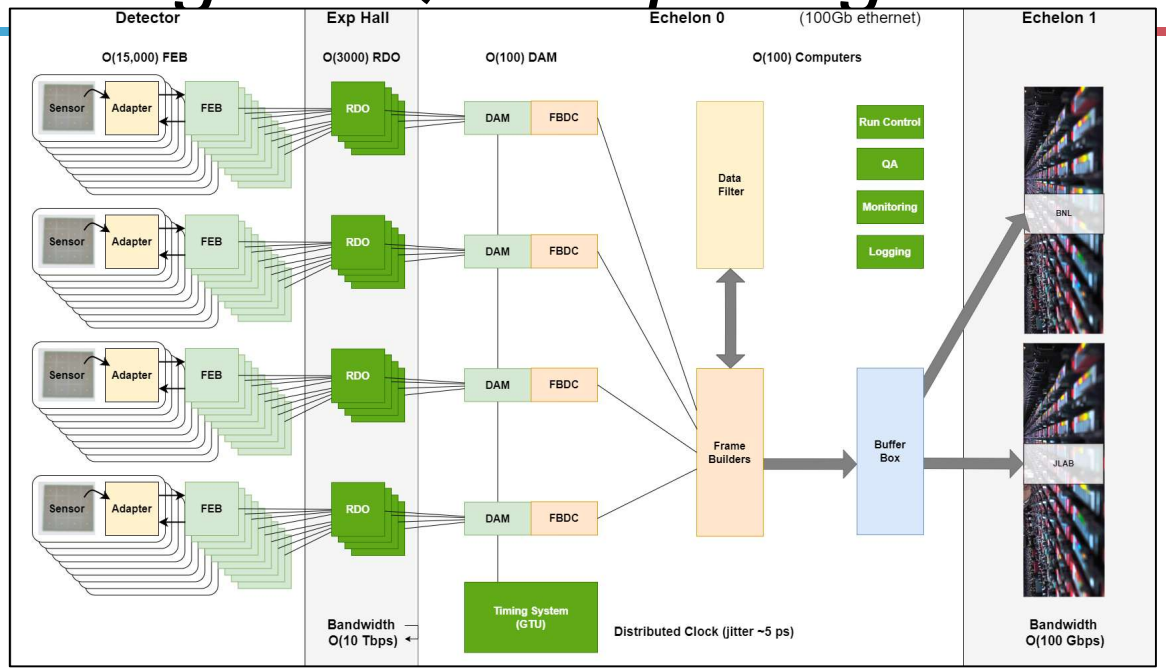


Magnet Status:
All documentation for the biding process ready
- Magnet Design Report
- Magnet Specification Document
- Magnet Acceptance Plan
- Inspection, Test Plan (ITP)
- Statement of Work – Have the draft from the RFI (Request For Information) of Spring 2023. Need to further edit to the tender package.
- All documents shared with INFN and CEA/Saclay
- INFN working on tender package for submission this Summer

Conductor Status:
- Order of conductor samples is in place with Luvata
- Conductor is similar to conductor used for 11.7 T MRI magnet at CEA, Saclay
- First samples received, pass visual (electron microscope) inspection
- Sent to test facility (U Twente) for sample qualification; passed specifications
- Technical specifications and Statement of Work ready
- Technical Production Readiness Review ready
- RFP released
- Vendor submitted bid; procurement worked with vendor on revised bid.
- Collecting last documentation from vendor to submit to TJ Site Office approval

EIC Streaming DAQ/Computing Architecture

- Bunch Crossing ~10.2 ns/98.5 MHz
- Interaction Rate ~ 2 us/500 kHz
- Low occupancy



DAQ

Definition of streaming is "No L0 trigger"

- All data is zero suppressed by the front end electronics
- No system wide deadtime in normal operation
- Collaboration should have the full ability to make data selection cuts on the widest possible criteria
  - Flexible event selection, data selection and background characterization
- But subject to an overall throughput budget of ~100Gb/sec

ePIC Streaming will include

- Capabilities for hardware and firmware based triggering
- Capability for flow control
- Zero suppression & aggregation within data packets

Greater sensitivity to noise than triggered system

Greater sensitivity to backgrounds than triggered system

Computing

Definition of streaming is "Process data as it arrives"

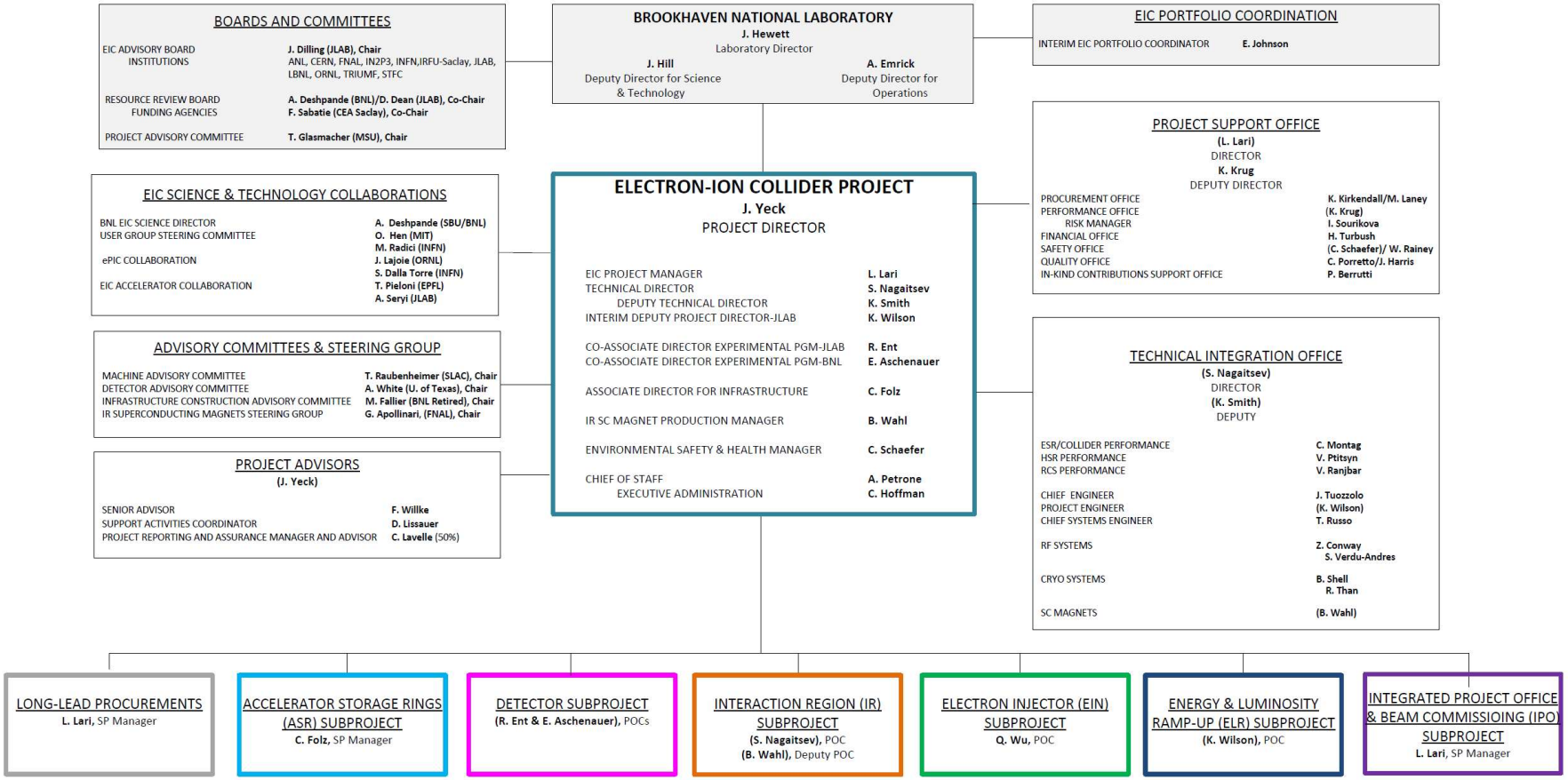
- Fast Analysis (~3 weeks not months or years) using automation of calibration & reconstruction.

Requires some overlap between DAQ/computing

- Automation of calibrations
  - Mapping calibration dependencies
  - Mapping application of calibrations
  - Mapping evolution of calibrations
- QA and monitoring can make use of full offline structure
- Consistent schemes and language for data/metadata
- Event selection / tagging / and accounting

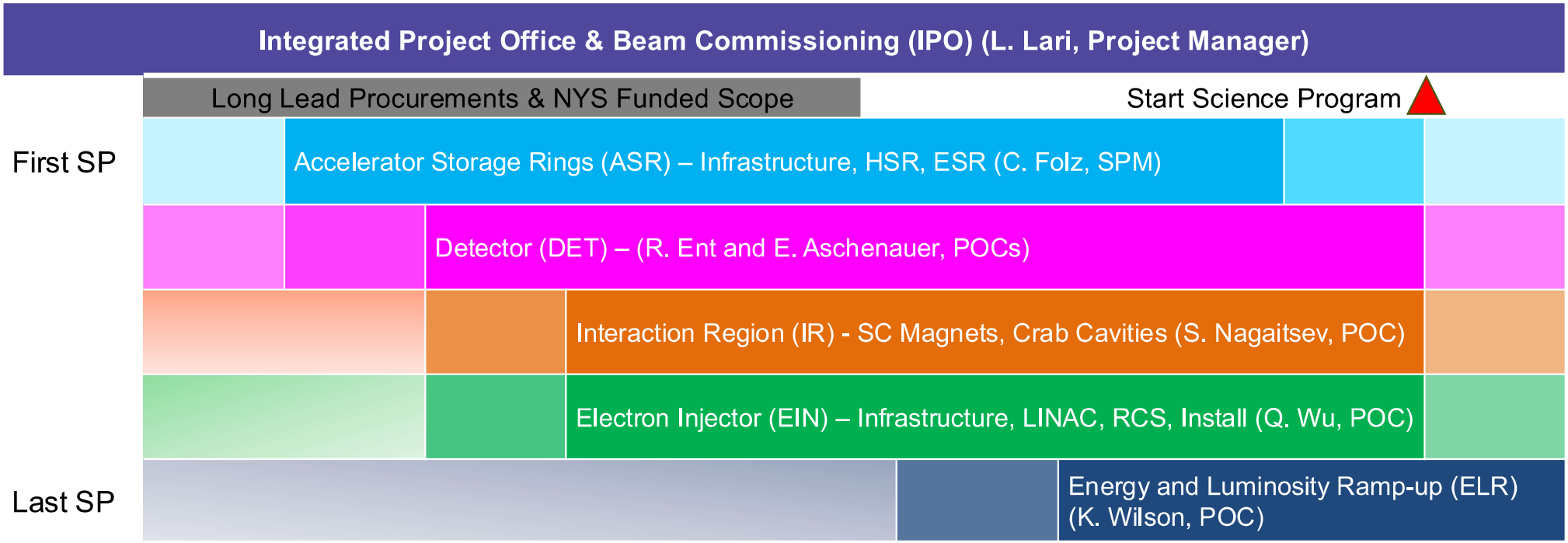
EIC Project Organization

Notes:
1-BNL is the EIC host lab.
2-The BNL and JLab project organization integrates the BNL/JLab project team and reflects JLab expertise in key areas including SRF and Cryogenics.
3- The high-level project organization chart is focused on how we deliver the project and does not necessarily reflect all WBS levels, changes in institutional roles or reporting lines at BNL, JLab, or our partners.

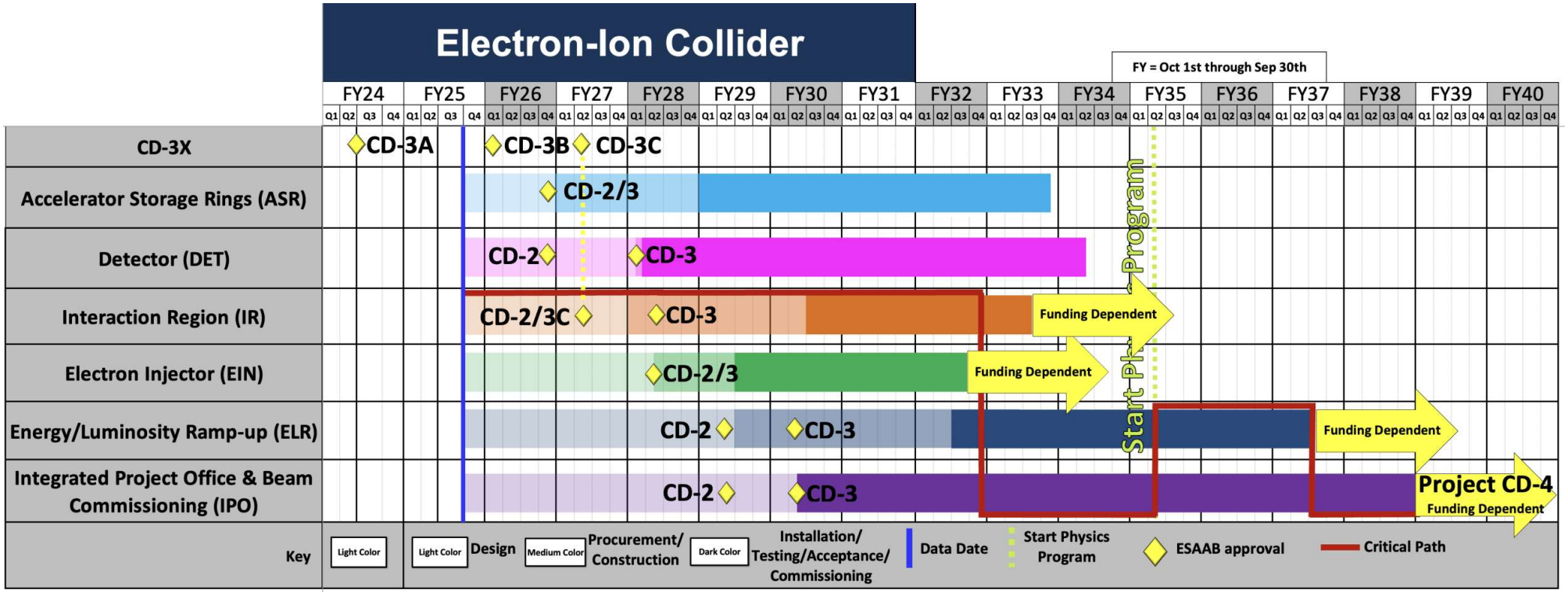


Project Delivery Strategy

Deliver the full EIC facility scope using subprojects and the phased implementation of the EIC project scope. The strategy enables the start of the EIC construction when the first subproject is ready and the start of the EIC science program during collider commissioning, concurrent with the final subproject equipment installation. Line-Item Construction Project includes the full scope required to meet EIC facility performance requirements.



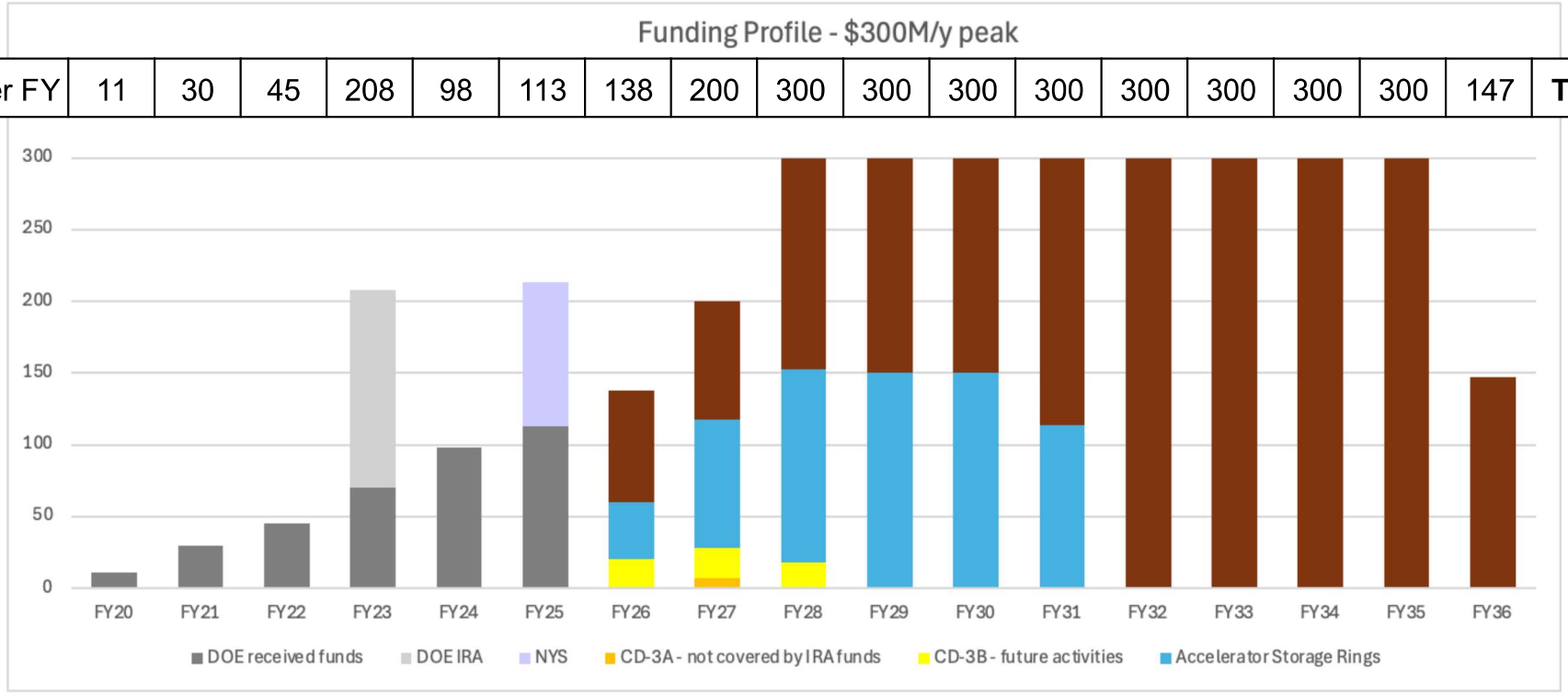
High Level Schedule



Effect of the $300M/y peak funding profile on the schedule

Possible Funding Profile

Total Per FY	11	30	45	208	98	113	138	200	300	300	300	300	300	300	300	300	147	**TOT 3390**



A technically driven schedule would require more than $450M in peak years.