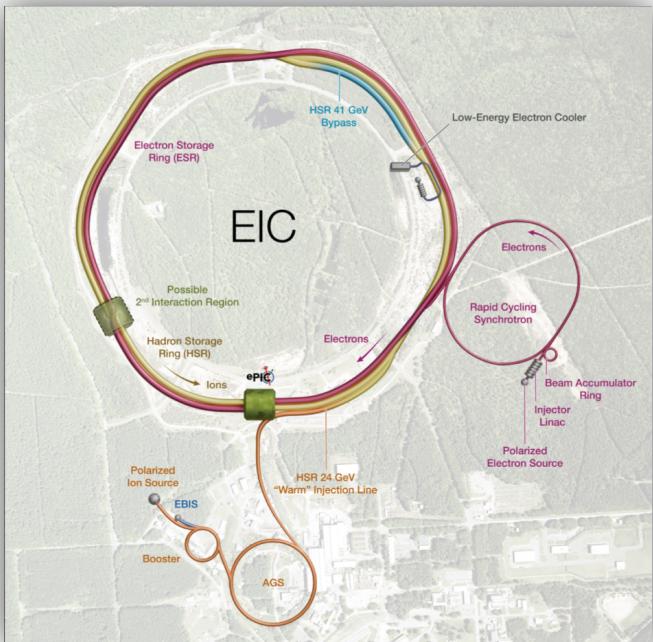
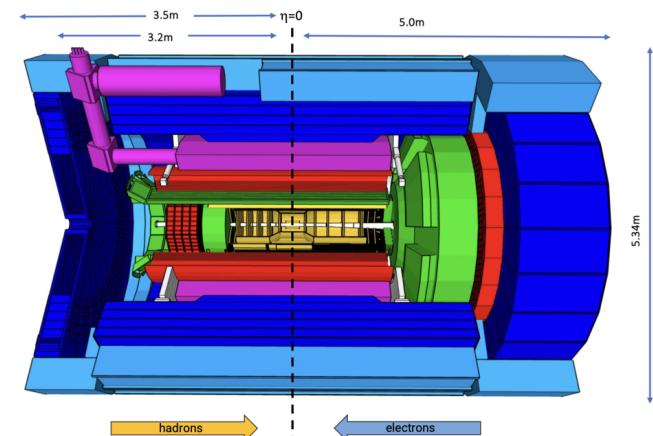


The Electron-Ion Collider – UKRI Infrastructure Fund project



Daria Sokhan

University of Glasgow



UNIVERSITY OF
BIRMINGHAM



Brunel
University
London



University
of Glasgow



Lancaster
University



UNIVERSITY OF
LIVERPOOL



UNIVERSITY OF
OXFORD



UNIVERSITY
of York



Science and
Technology
Facilities Council

Daresbury Laboratory
Rutherford Appleton Laboratory

Electron-Ion Collider

World's first polarized electron - proton / light ion and electron - nucleus collider.

- Widely variable CoM energy: 30 - 140 GeV
- High luminosity $L_{ep} \sim 10^{33-34} \text{ cm}^{-2}\text{s}^{-1}$
- Wide range of nuclei up to Uranium

Starting construction at Brookhaven National Lab in 2026.

Unique facility to:

- image the proton,
- search for gluon saturation,
- shed light on the generation of mass of > 99% of the visible universe.

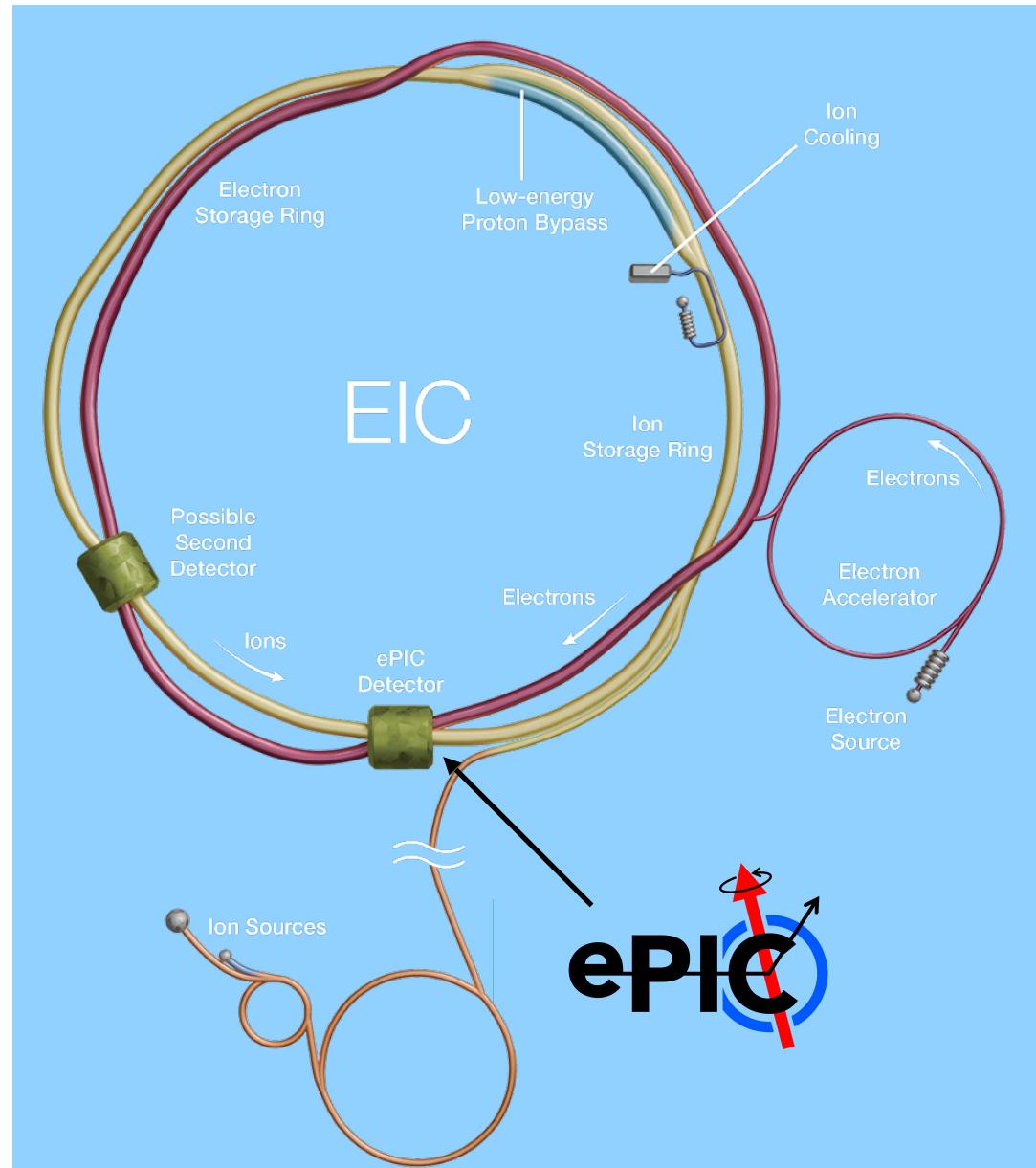
US project:

Initial Total Project Cost = \$2.4B incl. contingency

Currently in R&D and design phase

Expect construction start in 2026.

Expect start of physics programme: 2035.

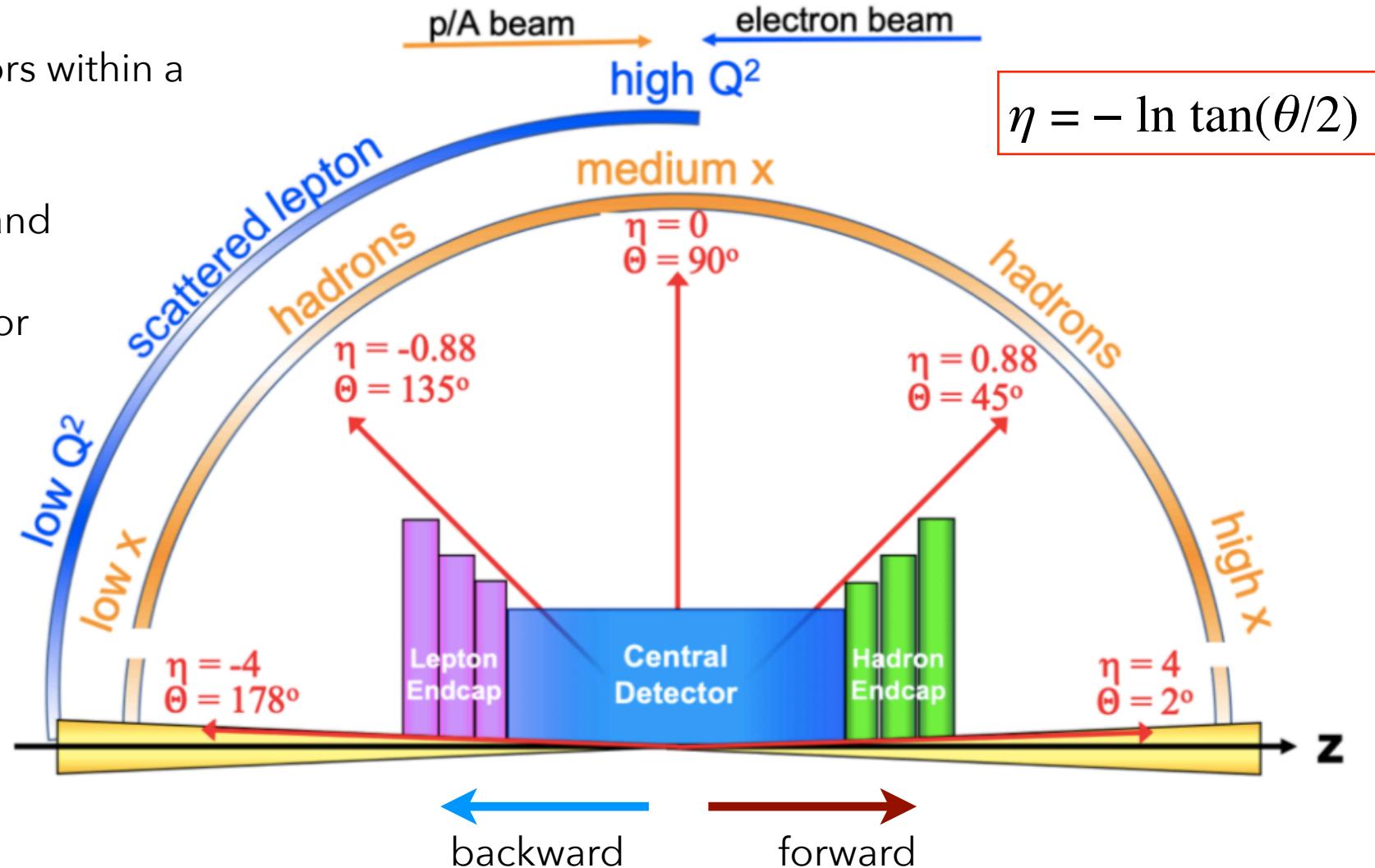


Detector configuration

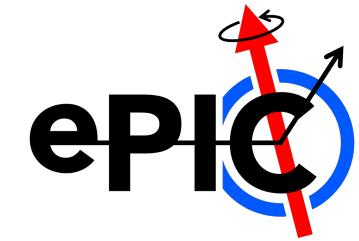
Very asymmetric beams

Hermetic detectors within a central solenoid

Very far-forward and far-backward instrumentation for lowest scattering angles.



EIC-UK Full Infrastructure Project



Hadronic Calorimeters (HCAL)

Solenoidal Magnet

E/M Calorimeters (ECal)

Time-of.Flight (ToF), DIRC, RICH detectors

MPGD trackers

MAPS tracker

WP1 – Silicon Tracker

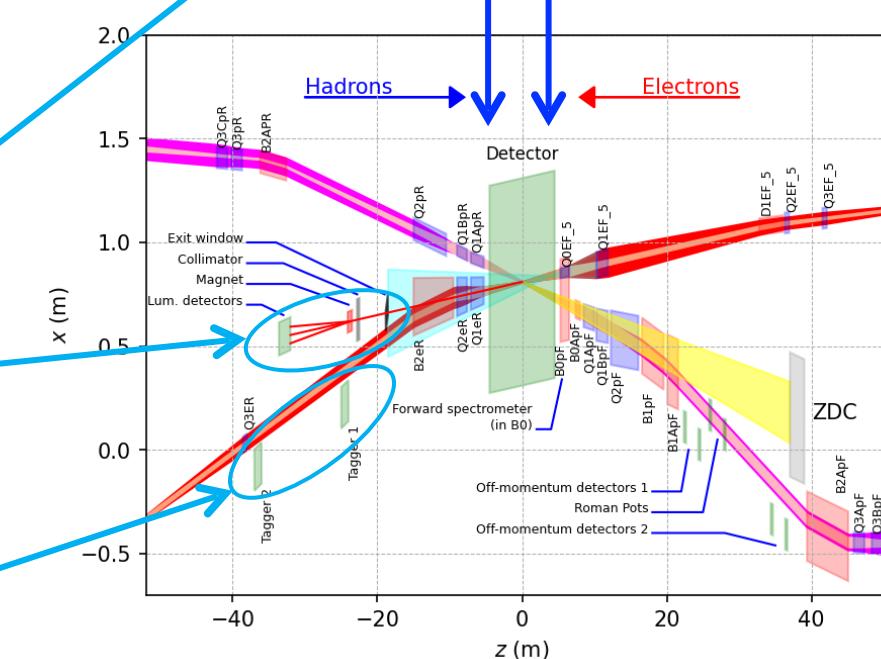
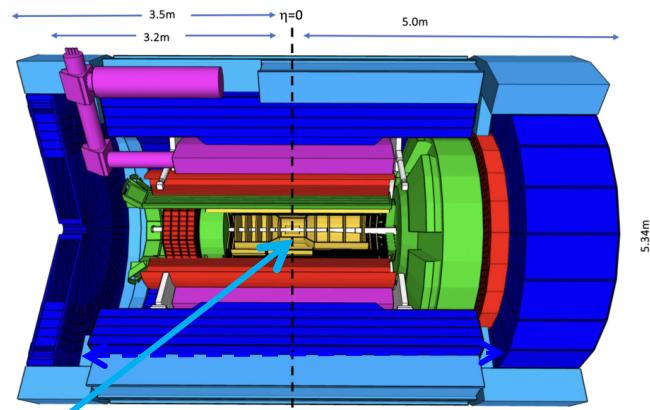
Birmingham, Brunel, Liverpool, Oxford,
Daresbury Laboratory, Rutherford Appleton Laboratory

WP3 – Luminosity Monitor

York

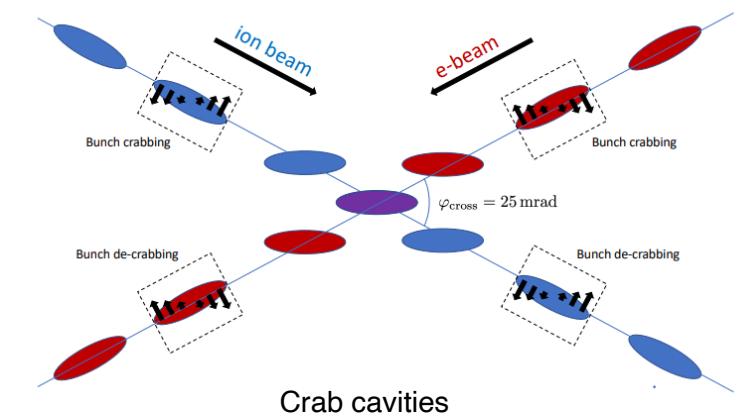
WP2 – Electron Tagger

Glasgow

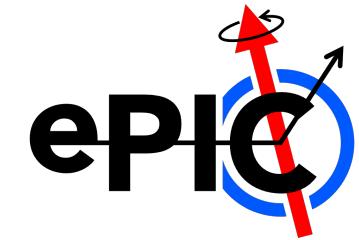


WP4 – Accelerator

Lancaster, Daresbury Laboratory



UK Project Overview



■ UKRI Infrastructure Preliminary Activity

EIC Detector R&D awarded £2.97m

Duration 2.5 years (Oct 2021 – Mar 2024)

Funded institutes:

Birmingham, Brunel, Glasgow, Lancaster, Liverpool, York,
STFC/DL, STFC/RAL

Work packages (lead institute):

[WP1 – MAPS \(Birmingham\)](#)

- Silicon tracking and vertex reconstruction in the central detector

[WP2 – Timepix \(Glasgow\)](#)

- High-rate tracking of scattered electrons in the far-backward detector region

[WP3 – Polarimetry \(York\)](#)

- Developing new technology to measure recoil nucleon polarisation; also leading the design of the luminosity monitoring system

■ UKRI Full Infrastructure Project

Total request £58.8m, 100% fEC, incl. contingency.

Duration 7+1.75 years (Jul 2025 – Mar 2034)

Work packages:

[WP1 – Silicon Tracker](#)

[WP2 – Electron Tagger](#)

[WP3 – Luminosity Monitor](#)

[WP4 – Accelerator \(New\)](#)

[WP5 – Project Management](#)

Note: Plan to pursue [Polarimetry](#) as a detector upgrade via US EIC Generic R&D program

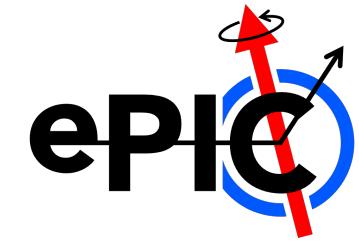
Submitted to UKRI on [24th of July 2023](#)

Funding announced on [27th of March 2024](#)

Proposal institutes:

Birmingham, Brunel, Glasgow, Lancaster, Liverpool, **Oxford**,
York, STFC/DL, STFC/RAL

New UK Project Management Team – from July 2025



Principal Investigator

Daria Sokhan
University of Glasgow

Deputy Principal Investigator

Marcello Borri
Daresbury

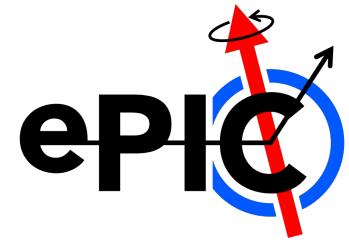
Project Manager

Paul Aden
Daresbury

Three-year term, started 1st July 2025

Big thanks to Peter Jones (Birmingham) who led the project from inception!

UK EIC Collaboration



Institute Board representatives:

Birmingham	- Paul Newman
Brunel	- Liliana Teodorescu
Glasgow	- Daria Sokhan
Lancaster	- Graeme Burt
Liverpool	- Marielle Chartier
Oxford	- Todd Huffman
York	- Dan Watts
DL TD	- Marcello Borri
RAL PPD	- Fergus Wilson
RAL TD	- Iain Sedgwick

Work Package leaders:

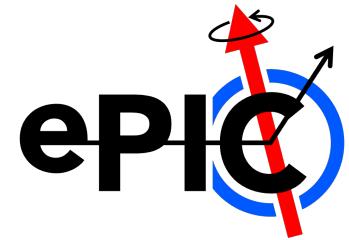
WP1	- Iain Sedgwick
WP1	- Georg Viehhauser
WP2	- Ken Livingston
WP3	- Nick Zachariou
WP4	- Nik Templeton



Daresbury Laboratory
Rutherford Appleton Laboratory

Thank you to Paul Newman (Birmingham) and Dave Ireland (Glasgow) for creation of the IB and for running of the first EIC-UK elections.

WP1 – Silicon Tracker – Project overview



ePIC SVT Detector Subsystem Collaboration

ePIC SVT DSC Leader: Ernst Sichtermann (LBNL)

ePIC SVT DCS co-Technical Coordinator: [Laura Gonella \(Birmingham → INFN Trieste\)](#)

ePIC SVT DSC co-Technical Coordinator: [Georg Viehhauser \(Oxford\)](#)

- WP1.1 Sensor Design

[Iain Sedgwick \(RAL\)](#), Joao De Melo (BNL)

- WP1.2 Sensor Characterisation

Ivan Amos Cali (MIT), Lukas Tomasek (CTU Prague)

- WP1.3 Electrical Interfaces

[Marcello Borri \(Daresbury\)](#), Zheyu Ye (LBNL)

- WP1.4 Layers and Disks

Nikki Apadula (LBNL), Domenico Elia (INFN), [Georg Viehhauser \(Oxford\)](#)

- WP1.5 Readout and Powering

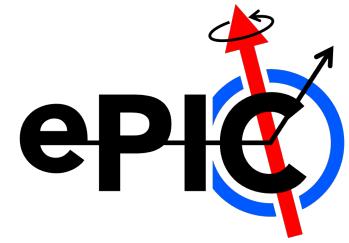
[James Glover \(Birmingham\)](#), Jo Schambach (ORNL)

- WP1.6 Global Mechanics and Integration

Andy Jung (Purdue), Eric Andreseen (LBNL)

UK WP1 – Silicon Tracker coordinated by
[Georg Viehhauser \(Oxford\)](#) and [Iain Sedgwick \(RAL\)](#)

WP1 – Silicon Tracker – Sensors



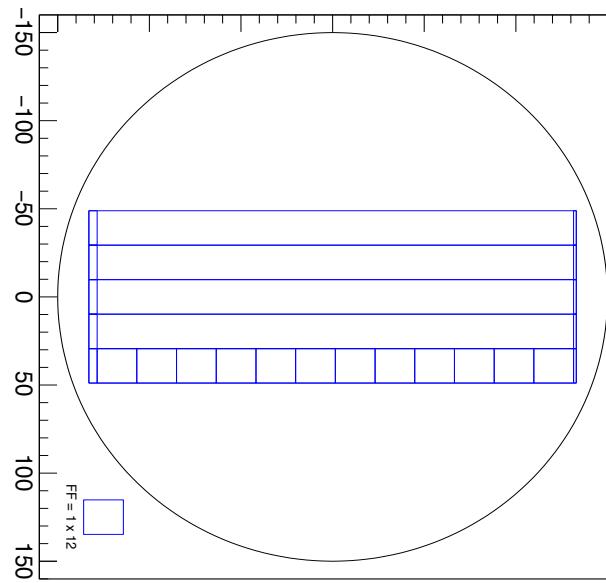
The ALICE ITS3 MOSAIX (MAPS) sensors are being modified for use within the EIC Outer Barrel.

Main design changes: size and readout (Ancillary ASIC).

Design led, in the UK, by RAL.

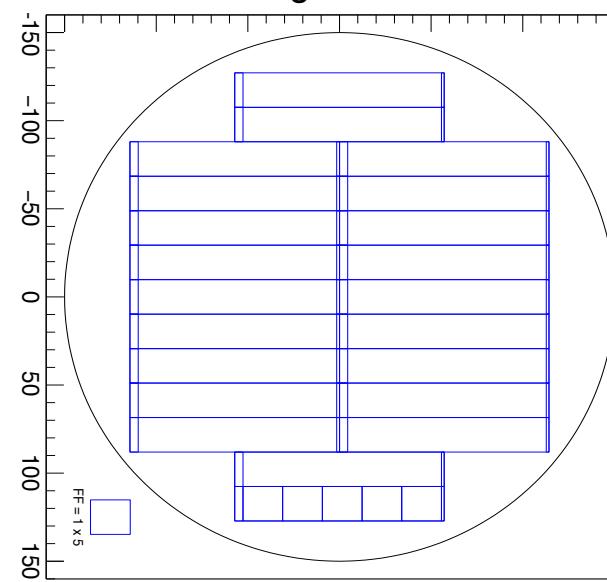
Awaiting CERN-BNL (DOE) agreement on sharing the MOSAIX blueprint to enable design modifications.

ITS3 – Wafer Scale Sensor



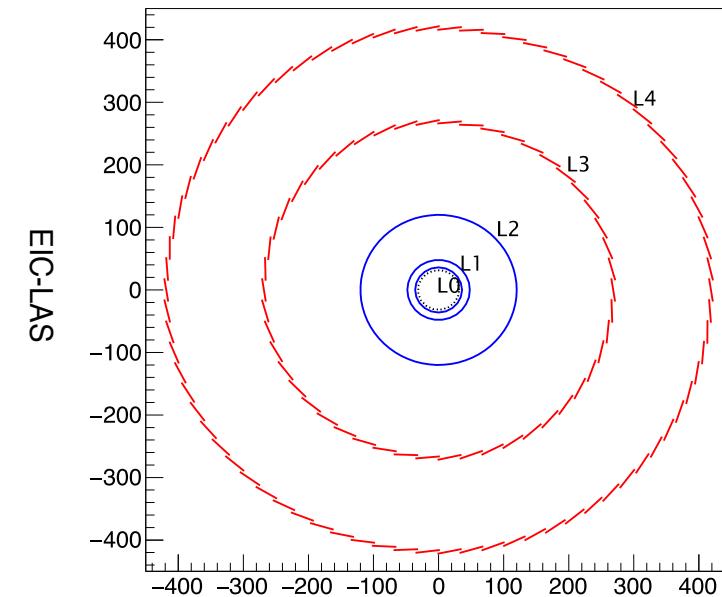
Total 60 RSUs

EIC – Large Area Sensor

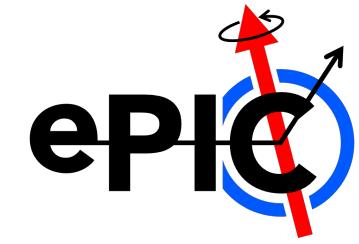


Total 110 RSUs

Outer Barrel Stave Layout



WP1 – Silicon Tracker – Staves for the sensors in the barrel



Total 60 RSUs

Total 110 RSUs

L4 Stave Conceptual Design (length approx. 840 mm)

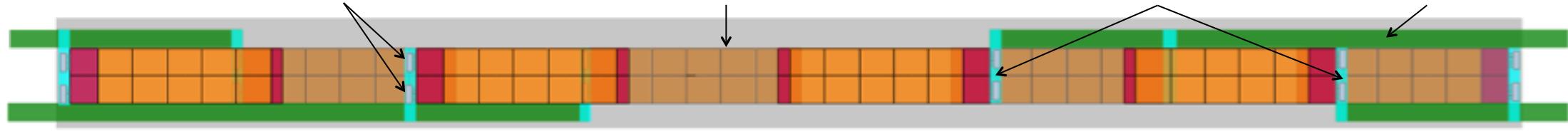
(drawing not to scale)

Ancillary ASICS

Carbon fibre skin

Bridge FPC

Main FPC

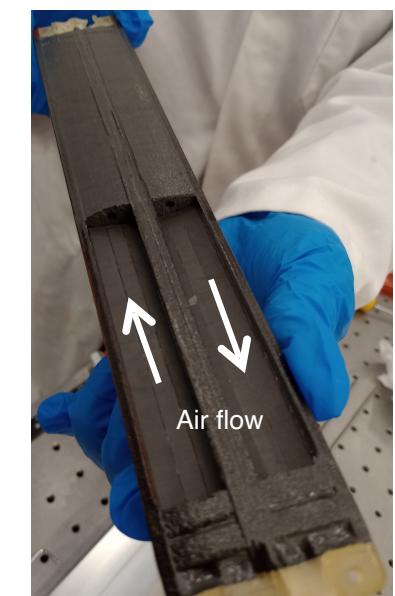
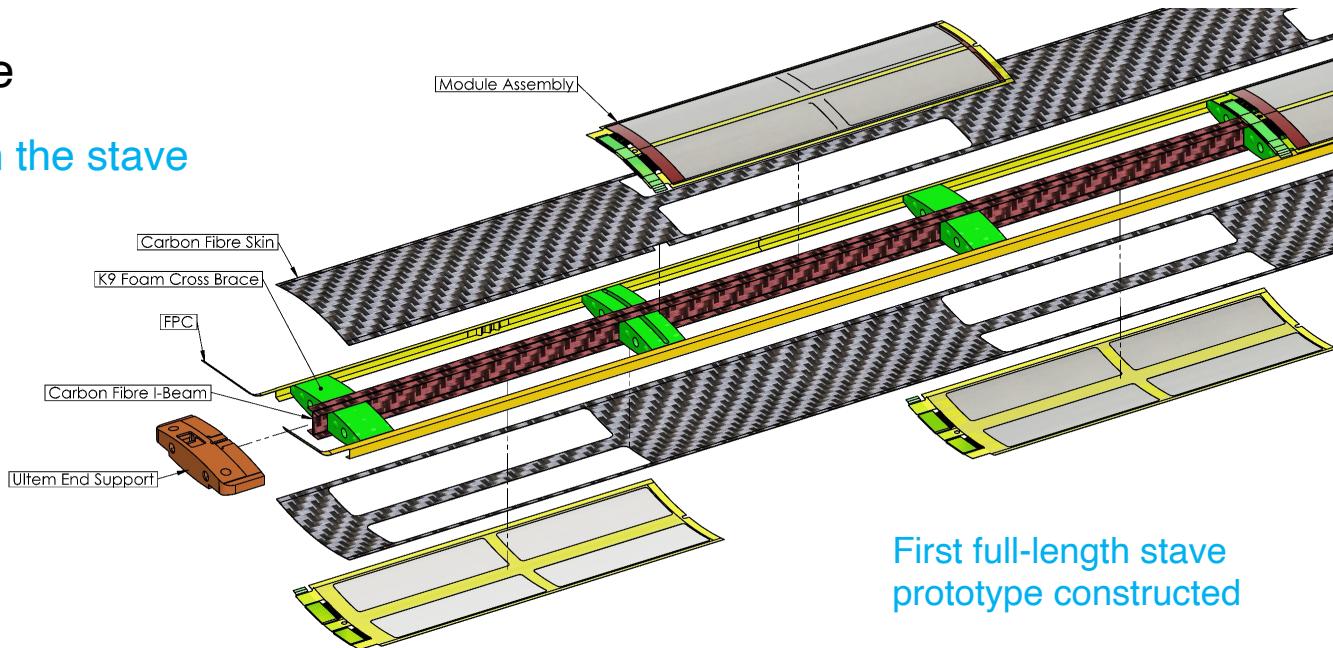


Top Sensor

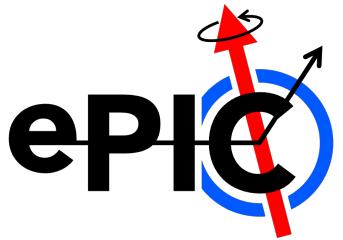
Bottom Sensor

▪ Stave Structure

Air cooling within the stave

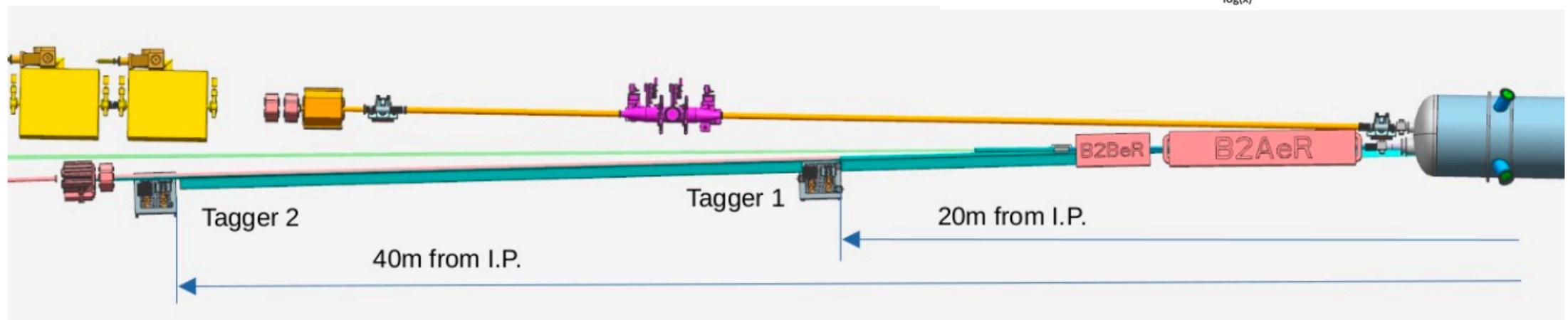
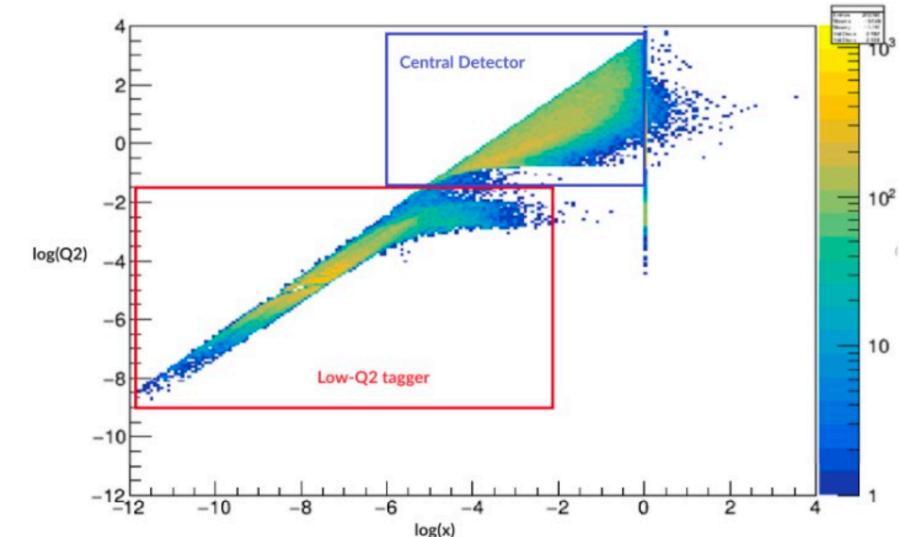
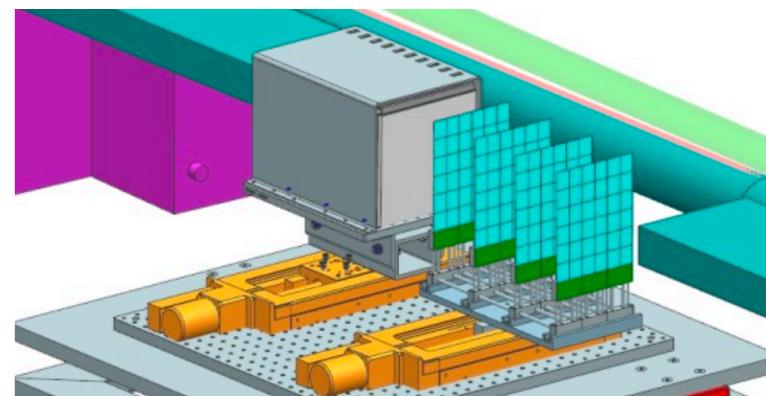


WP2 – Electron Tagger

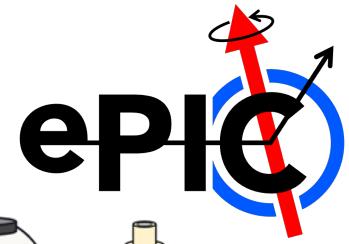


- Tagger design with Timepix4 tracker

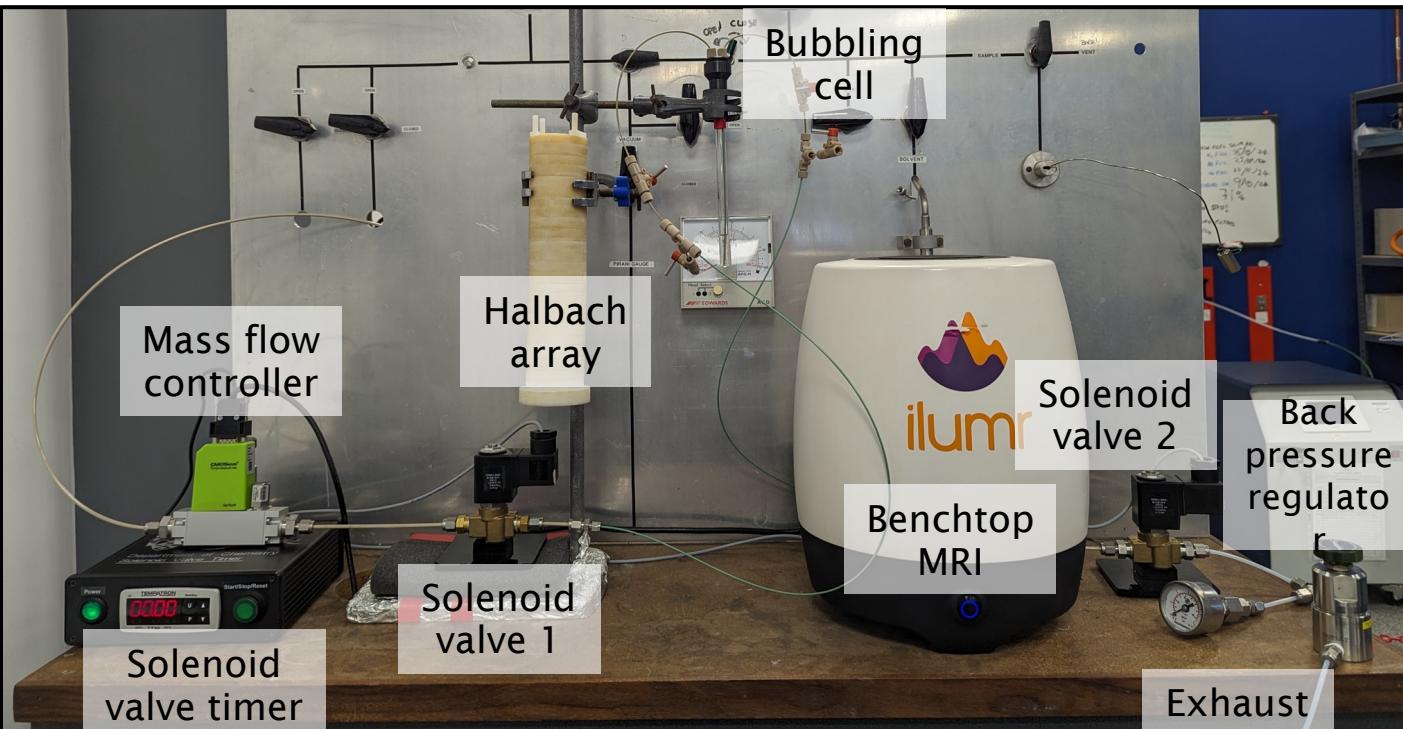
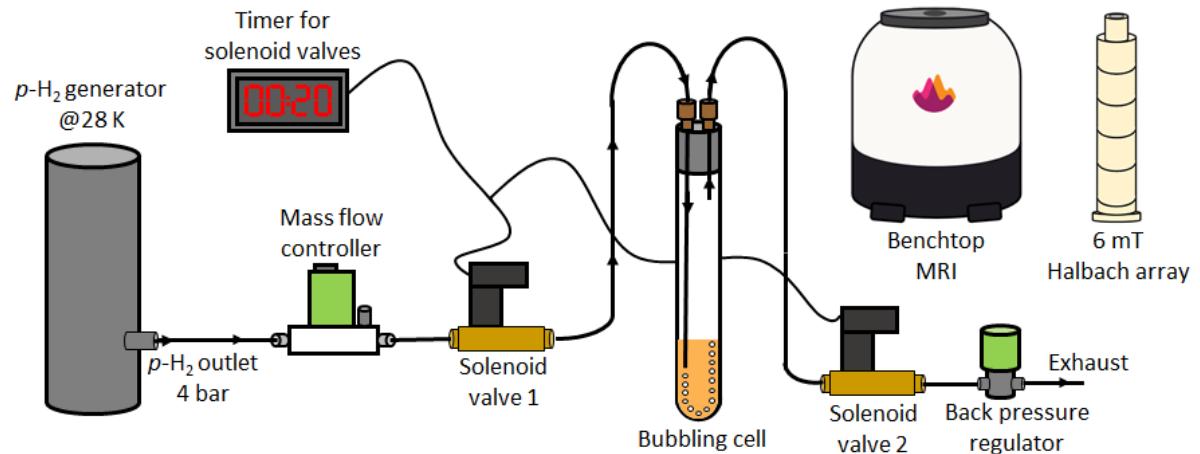
Taggers very close to outgoing e^- beam line: increase Q^2 acceptance, allow quasi real ($Q^2 \sim 0$) physics
Extremely high data rate determines choice of sensor



WP3 – Polarimetry



Chemical Hyper-polarisation method



Equipment:

- Resonint Ilumr benchtop MRI.
- Sensirion SFC5500-2slm mass flow controller.
- Festo solenoid valves.
- Swagelock back pressure regulator.
- Fittings are a mixture of Ibex HPLC fittings and Swagelock.
- Bubbling cell is custom made in-house.
- $p\text{-H}_2$ is 99%+ purity generated at 28 K and supplied at 4.3 bar.

WP3 – Polarimetry

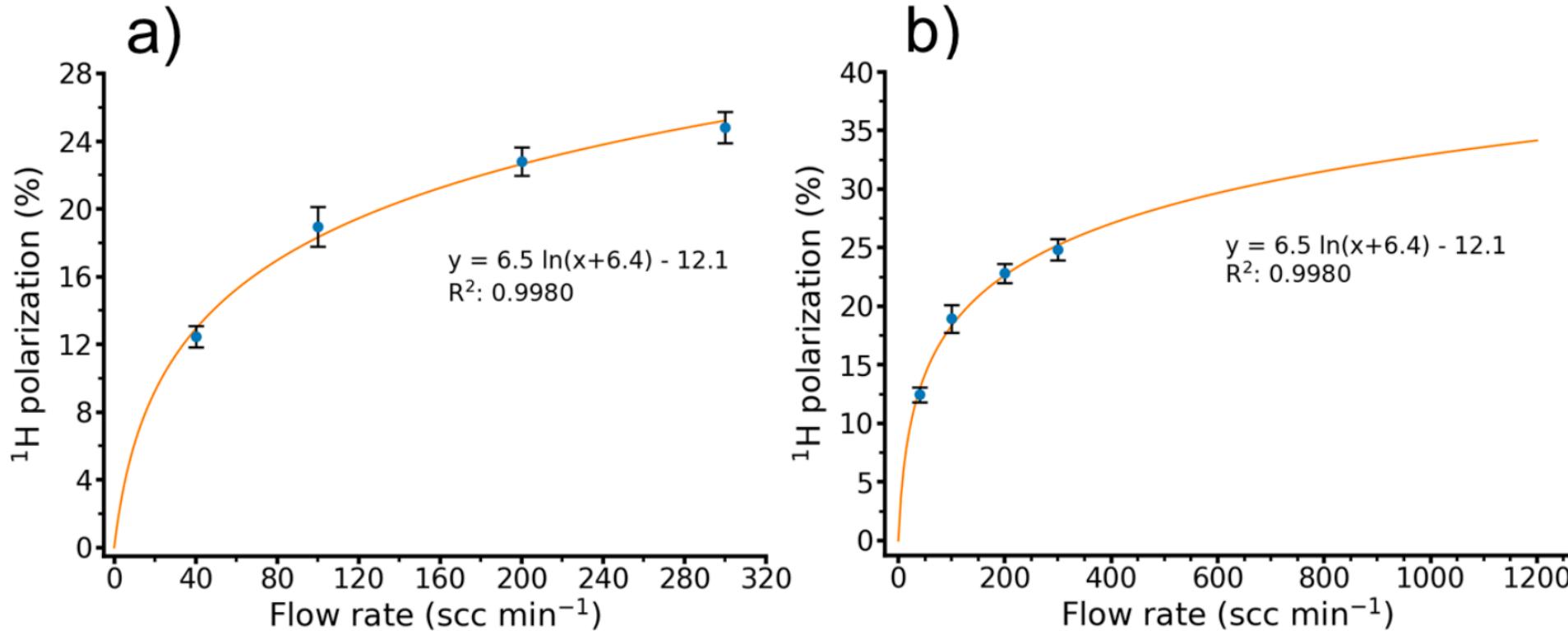
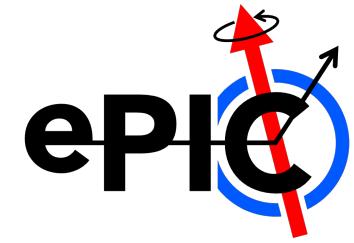


Figure 5.11 - Polarization levels with varying flow rates for the sample at 5.5 bar with a logarithmic fitting. a) shows the range 0-300 scc min^{-1} and b) shows the range 0-1200 scc min^{-1} .

WP3 – Luminosity Monitor



■ Physics requirements

Determination of the **absolute luminosity** to **1%** level

Determination of the **relative luminosity** to **10^{-4}** level

Rates **10^3** higher than previous facilities

■ Technology choice

W-powder and epoxy infused with a bundle of scintillating fibers

Meets all requirements

Dimensions **$18 \times 18 \times 18 \text{ cm}^3$**

Radiation length $\sim 8 \text{ mm}$

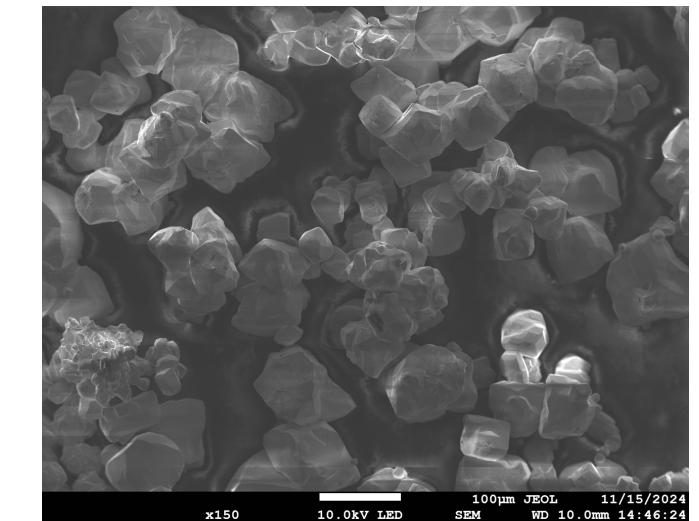
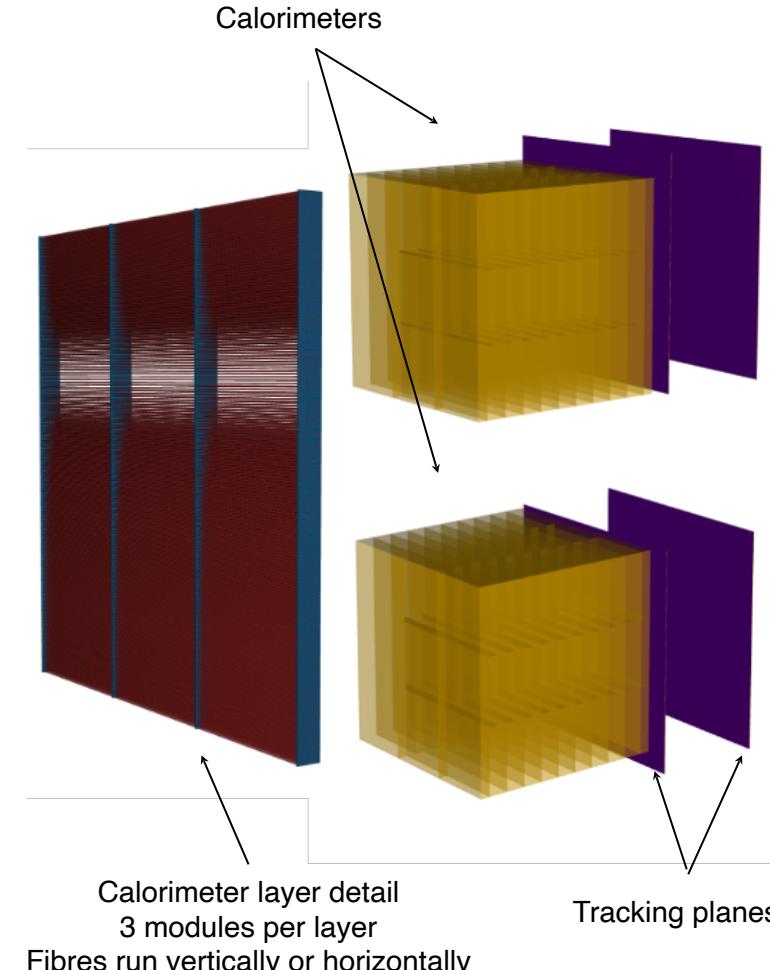
20 layers $\rightarrow 23 X_0$

Scintillating Fibre 0.5 mm diameter
(Kuraray or Luxium – samples for tests)

W-SciFi ratio = 4:1

Density **10.95 g/cm³**

Pair spectrometer



Scanning Electron Microscope image showing uniformity of W-powder grains

WP4 – Accelerator

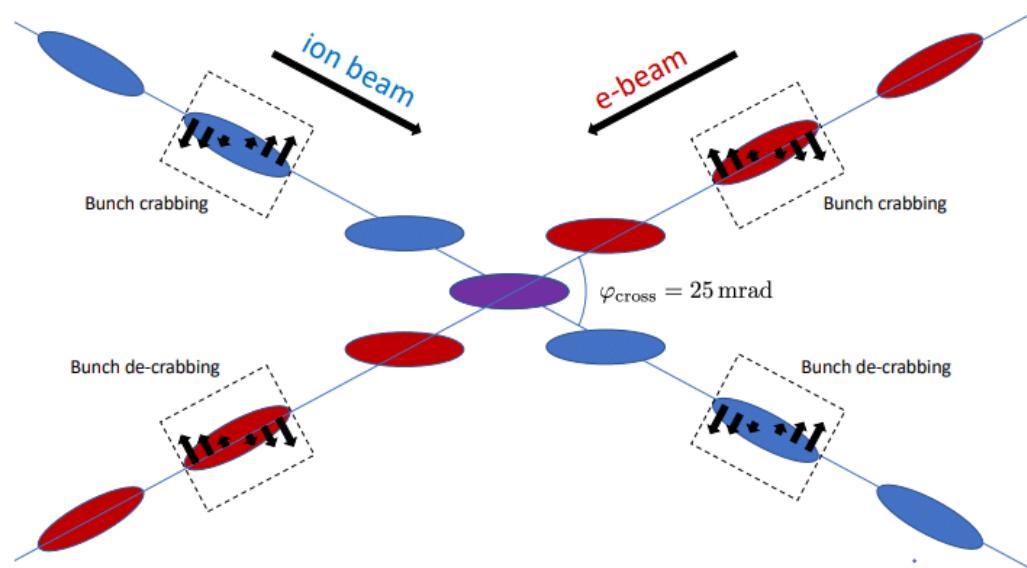
- Superconducting radiofrequency systems

Builds on experience from [HL-LHC](#), [ESS](#) and [PIP-II](#)

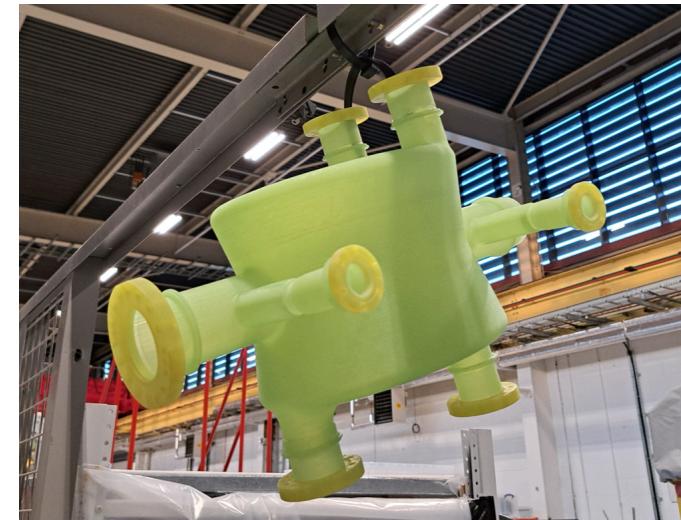
Original scope: cavity design and cryomodules for the [ERL](#) hadron beam cooler

New scope: cavity design and cryomodules for the beam [crabbing system](#)

In collaboration with [BNL](#), [JLab](#) and [TRIUMF](#)



HL-LHC cryomodule at Daresbury Laboratory



3D printed model of a crab cavity

New Scope – 394 MHz Radio Frequency Dipole

- 7-year project Starting Apr26

Design & Development

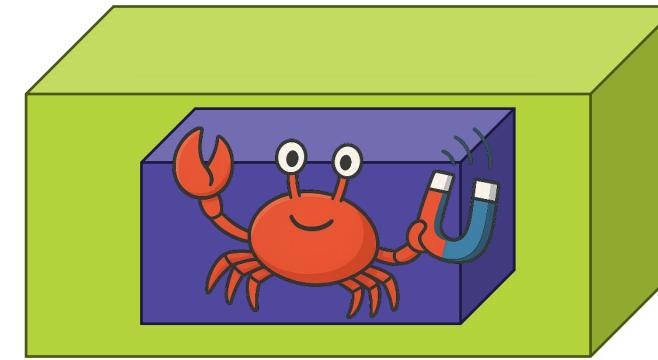
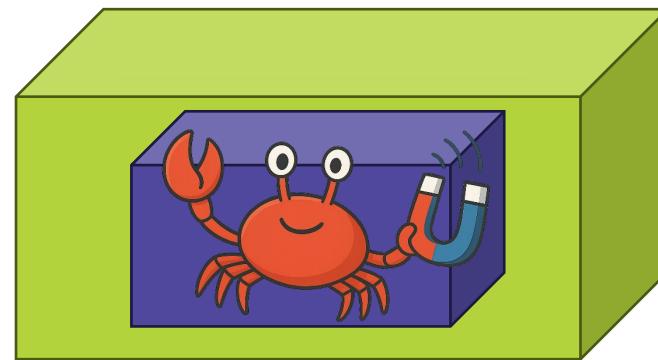
Procurement

Delivery

- 2x 394 MHz Crab Cavity Cryomodules

EIC Requirement

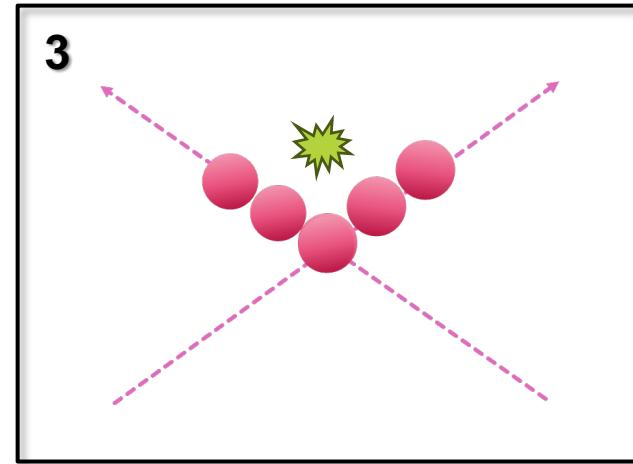
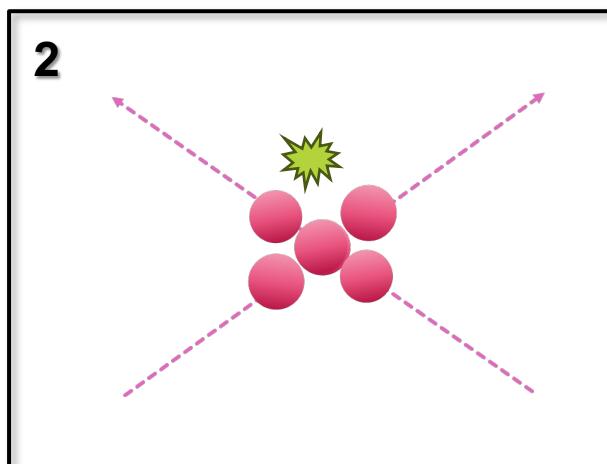
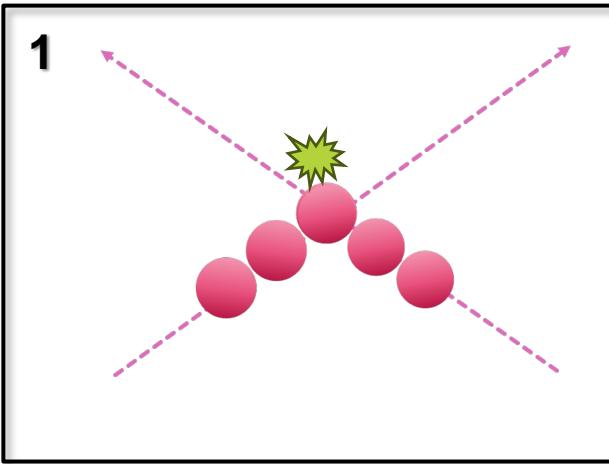
Two single-cavity cryomodules for the electron storage ring – before & after the interaction region



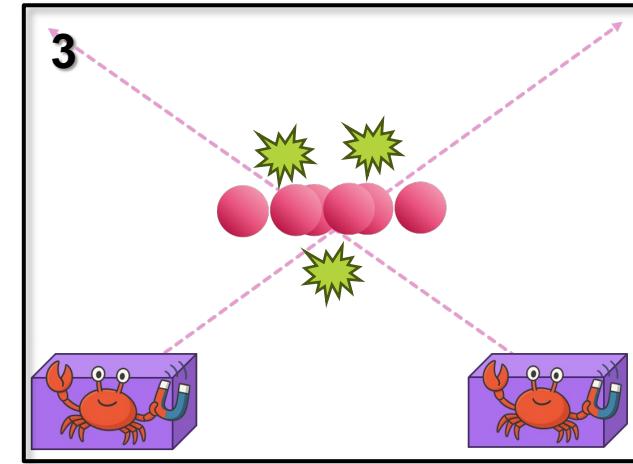
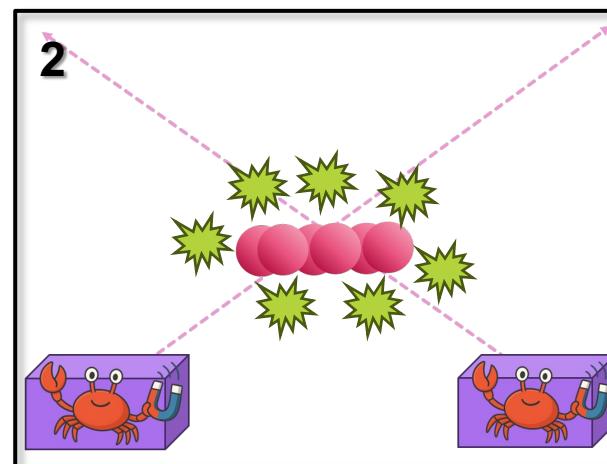
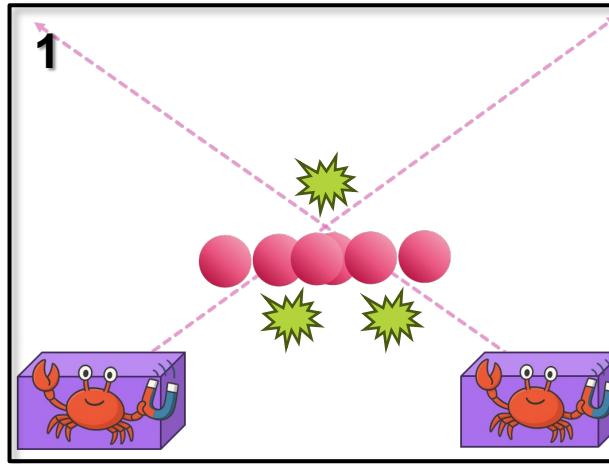
Why EIC needs Crab Cavities

FOR
DUMMIES

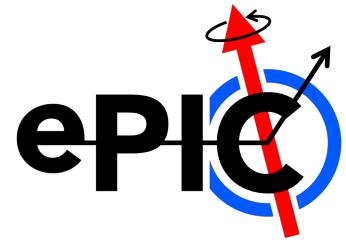
No Crabs



Crabs

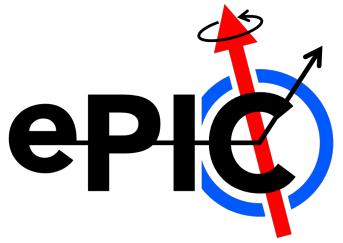


UKRI Full Infrastructure Project



- Submitted proposal in **July 2023** for **£58.8m fEC** incl. contingency, duration **7 + 1.75 years (Jul 2025 - Mar 2034)**.
- UKRI funding announcement in **March 2024**: funding would start in **FY26/27 (Apr 2026 at earliest)**.
- STFC tentatively agreed with UKRI Infrastructure to advance funding in FY25/26.
- Reprofiled **£58.8m cost to STFC (£64.1m fEC)** incl. contingency, duration **8.25 + 1.75 years (Apr 2025 - Mar 2035)**.
- STFC clarified that grants to HEIs would be at **80% fEC** (apart from equipment/exceptions); indexation at **2.48%**.
- The project underwent a Full Business Case approval process; approved by UKRI ExCo in **December 2024**.
- WP4 (Accelerators) – Project Peer Review scheduled for **March 2026**.
- Budget in **FY25/26** was limited to **£2.8m** – but the **Spending Reviews** happened and this was not granted: we're still waiting for the **UKRI Infrastructure Fund** announcement (expected early January 2026).
- UKRI have advanced us, at risk, **£500k for FY25/26** to tide us over to the full project start.

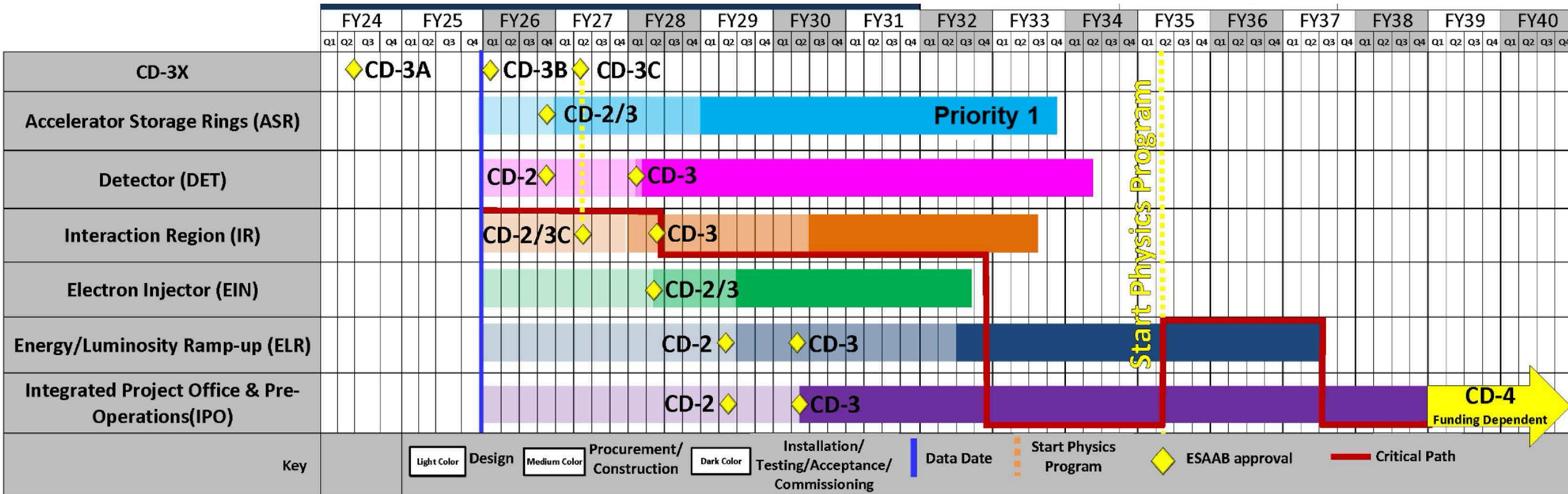
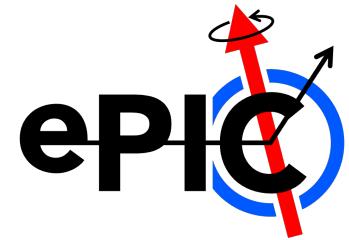
EIC Subprojects



- EIC Project split into **five Subprojects**, which follow decoupled paths through the Critical Decisions:

Integrated Project Office & Beam Commissioning (IPO) (L. Lari, Project Manager)				
	Long Lead Procurements & NYS Funded Scope			Start Science Program 
First SP		Accelerator Storage Rings (ASR) – Infrastructure, HSR, ESR (C. Folz, SPM)		
		Detector (DET) – (R. Ent and E. Aschenauer, POCs)		
		Interaction Region (IR) - SC Magnets, Crab Cavities (S. Nagaitsev, POC)		
		Electron Injector (EIN) – Infrastructure, LINAC, RCS, Install (Q. Wu, SPM)		
Last SP				Energy and Luminosity Ramp-up (ELR) (K. Wilson, POC)

EIC Project Schedule: new (tentative) schedule (Nov 2025)



US Fiscal Year starts 1st October of the year before.

Critical Decision (CD) Milestones

CD-0 Approve Mission Need

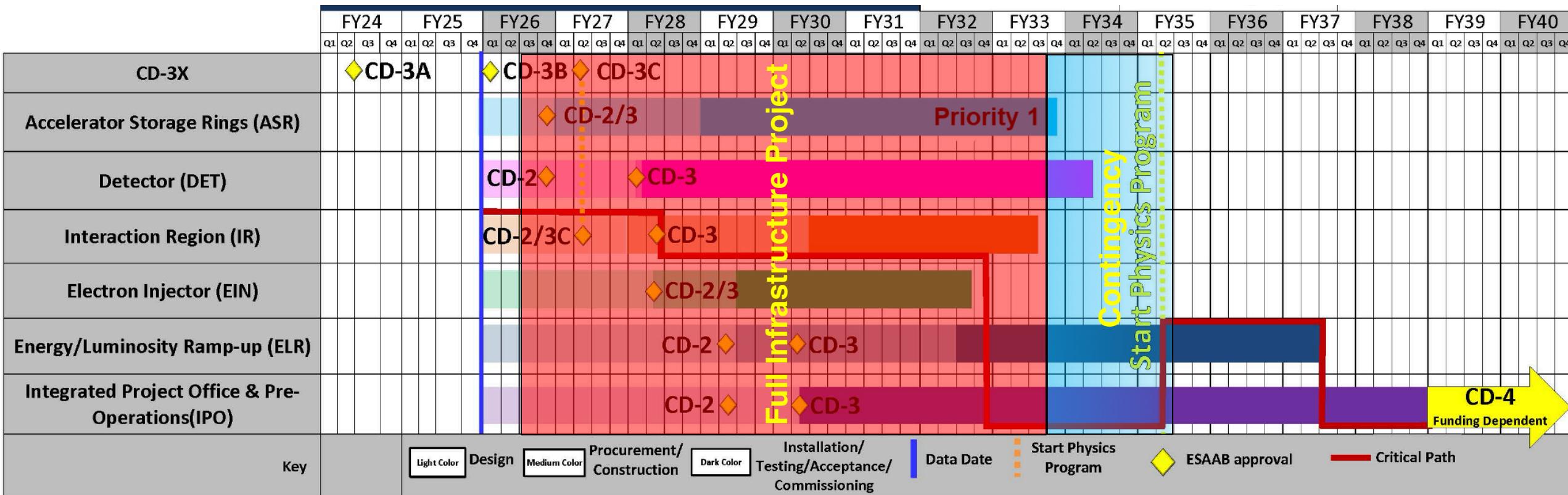
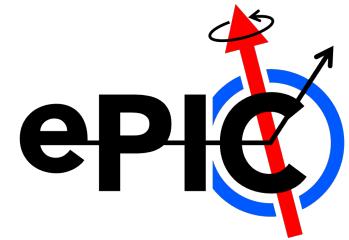
CD-1 Approve Cost Range

CD-2 Approve Baseline Performance

CD-3 Approve Start Construction

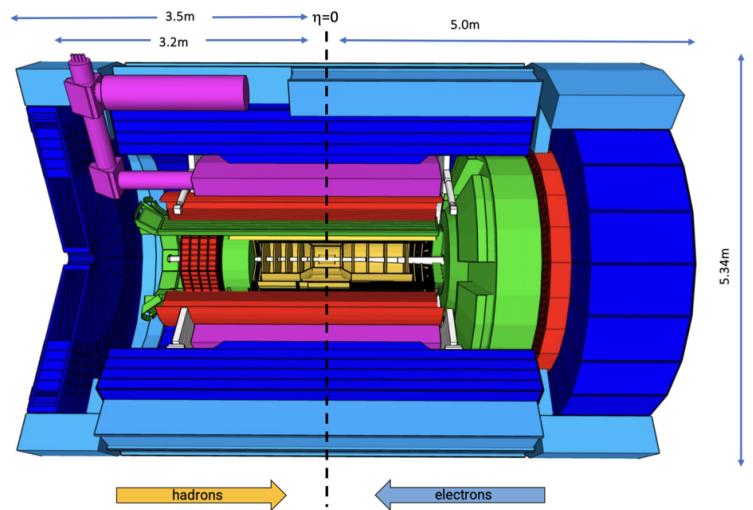
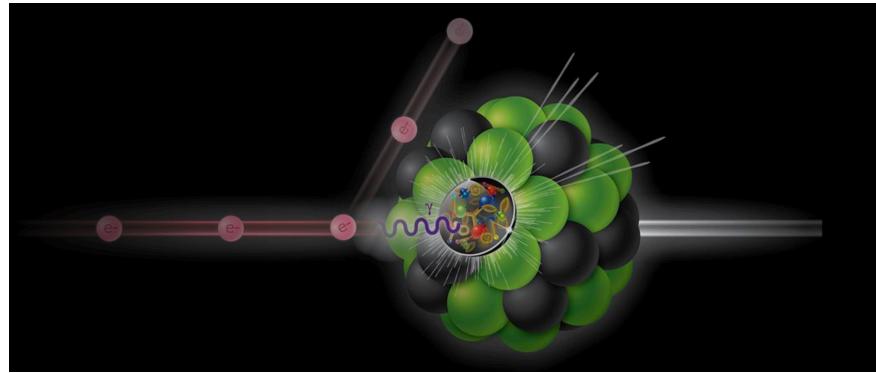
CD-4 Approve Project Completion

EIC Project Schedule: new (tentative) schedule (Nov 2025)

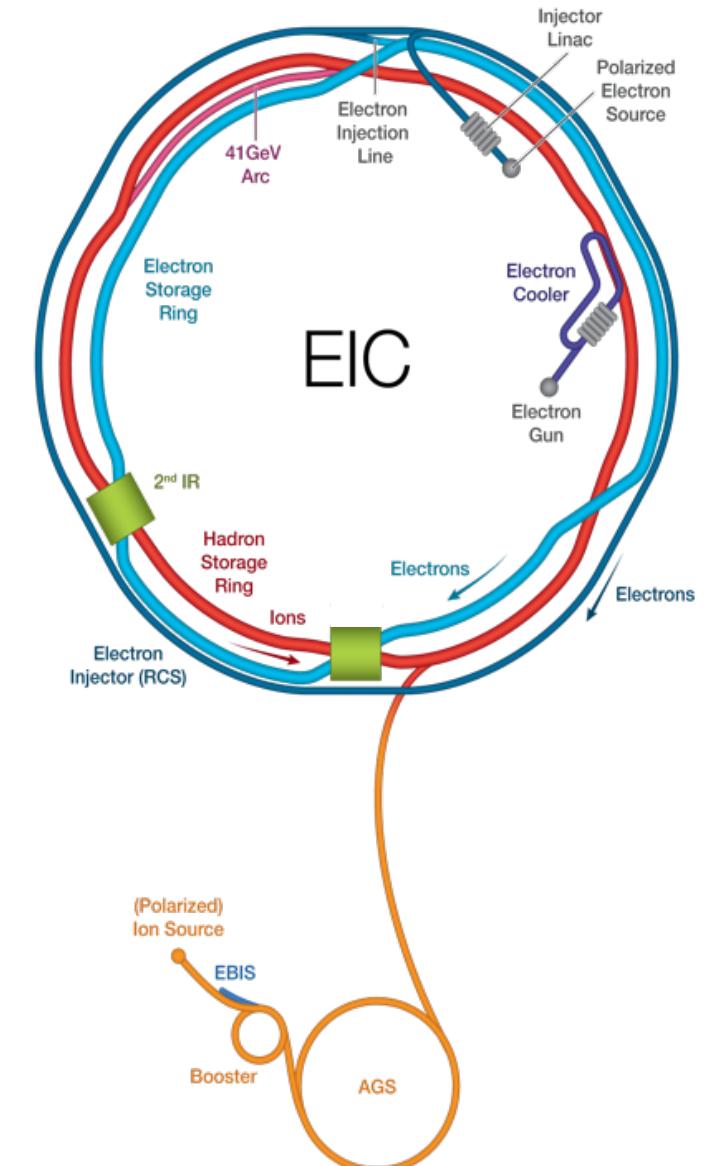
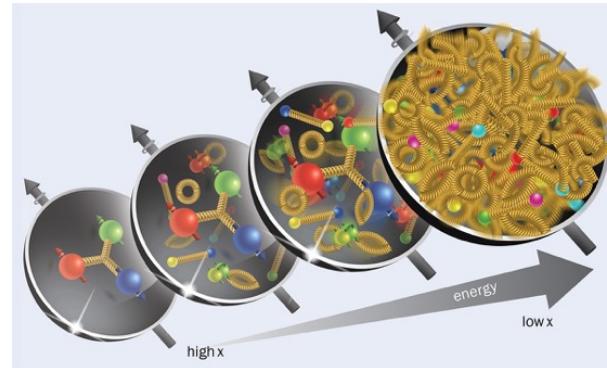
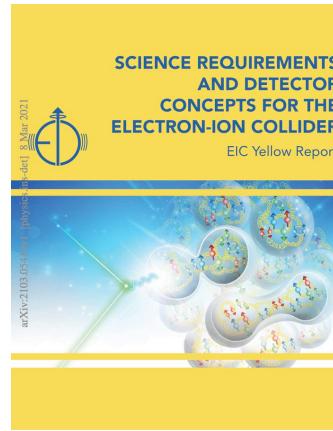


US Fiscal Year starts 1st October of the year before.

- Critical Decision (CD) Milestones
- CD-0 Approve Mission Need
- CD-1 Approve Cost Range
- CD-2 Approve Baseline Performance**
- CD-3 Approve Start Construction**
- CD-4 Approve Project Completion

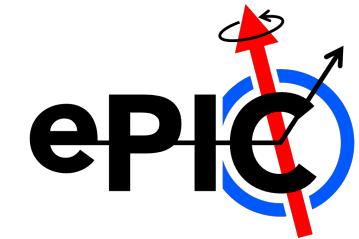


Thank you!
Any questions?



Back up

WP3 – Luminosity Monitor (YRK)



▪ Luminosity Monitoring Strategy

Measure BH bremsstrahlung photons

Based on experience with ZEUS at HERA

Two detector subsystems: a direct photon detector (PD) and a pair spectrometer (PS)

PD sees **~20 photons per bunch crossing** in e-p collisions; must be shielded from SR fan; photon flux based on energy measurement; determines required energy resolution

PS sees **~1% of the BH photons** through conversion; sits outside the acceptance of the SR fan of the electron beam; systematics due to the limited acceptance

SR heat load on lumi system windows established, easily manageable

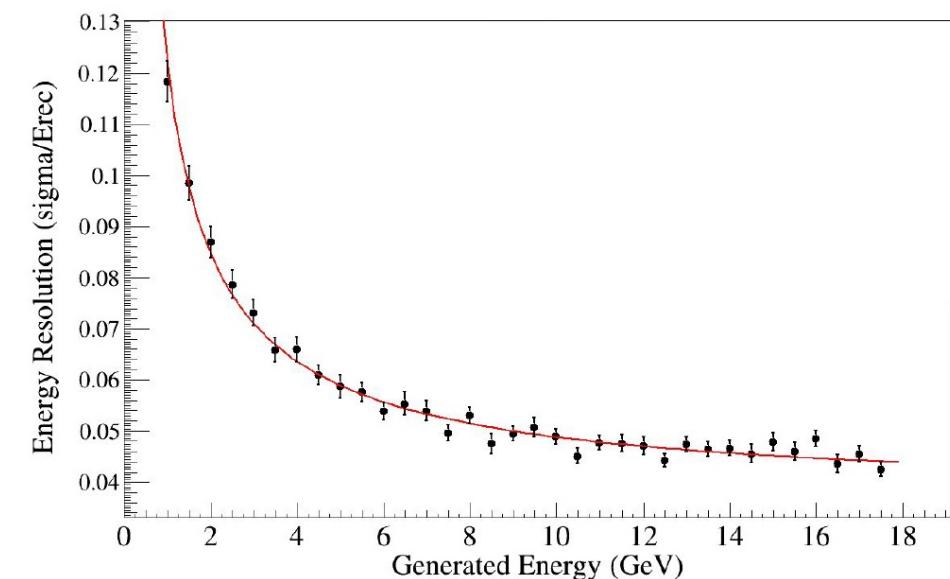
Same calorimeter design will be used for PS, and the PD in low luminosity runs

▪ Calorimeter Performance

Yellow Report design specifies **15%** for the stochastic term:

$$\frac{\sigma_E}{E} \approx \frac{0.15}{\sqrt{E}}$$

Latest design **4:1 W-to-SciFi ratio** achieves an energy resolution **< 5%** for **$E > 9 \text{ GeV}$** , consistent with the design specification



EIC Project Schedule (June 2025)



NOTE: US Financial Years (FY) = Oct-Sep

Critical Decision (CD) Milestones

- CD-0 Approve Mission Need
- CD-1 Approve Cost Range
- CD-2 Approve Baseline Performance**
- CD-3 Approve Start Construction**
- CD-4 Approve Project Completion

Upcoming Project Milestones

PDR (pre-TDR) – Sep 2025

CD-2 – Sept 2026

TDR – Sep 2026

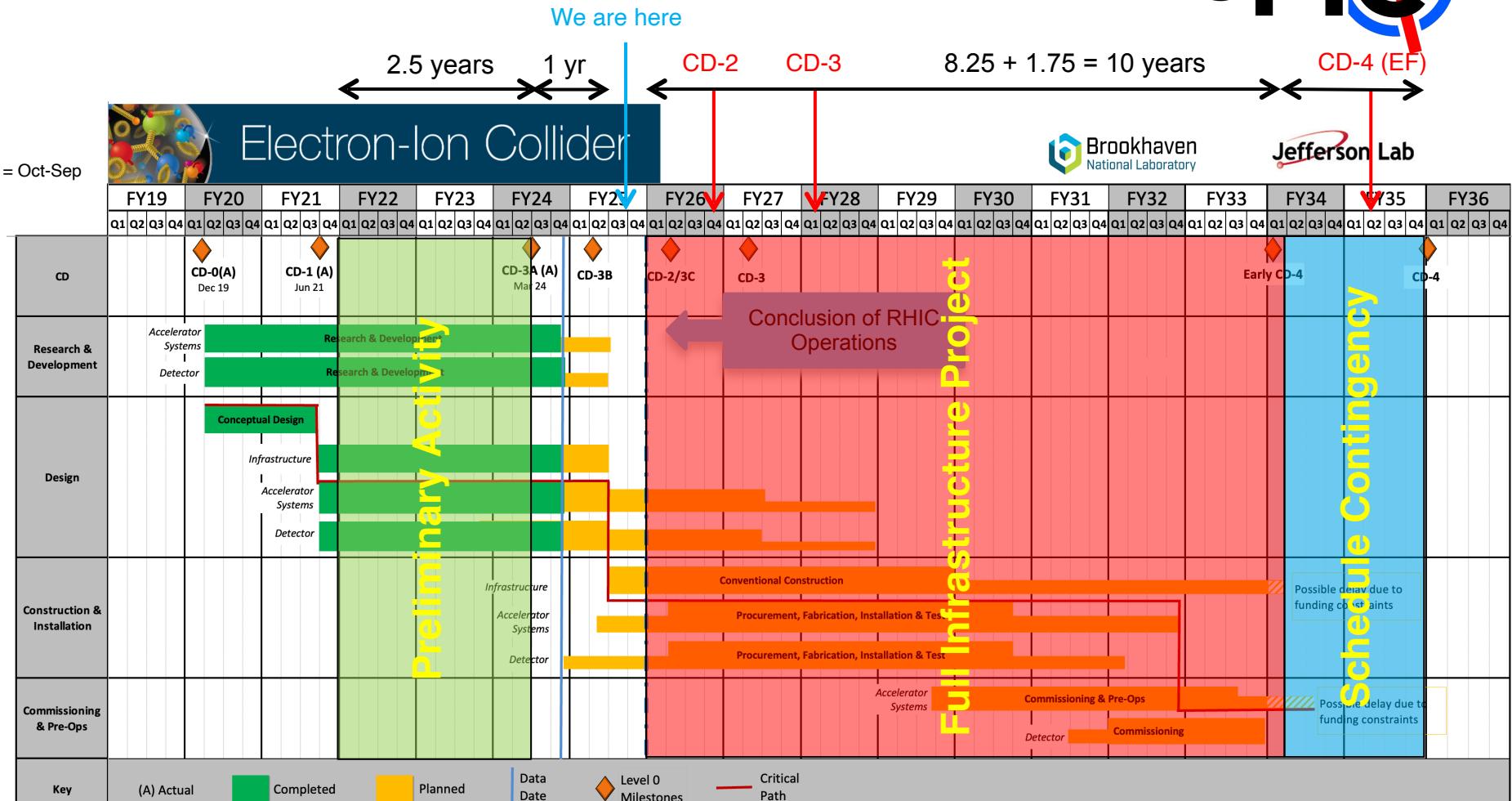
CD-3 – Dec 2027

CD-4(EF) – Jan 2035

CD-4 – 2037?

Difference between **CD-4(EF)** and **CD-4**
is US schedule contingency

(EF = Early Finish)



Phasing the delivery of the accelerator allows science programme to start at CD-4 (EF)

UK-EIC Detector R&D Project
UK-EIC Detector Construction Project

Latest (unofficial) EIC project schedule – CD dates still under discussion
Reflects uncertainty in level of FY25 funding and current plans to phase the delivery of the accelerator

