EIC Full Infrastructure Project

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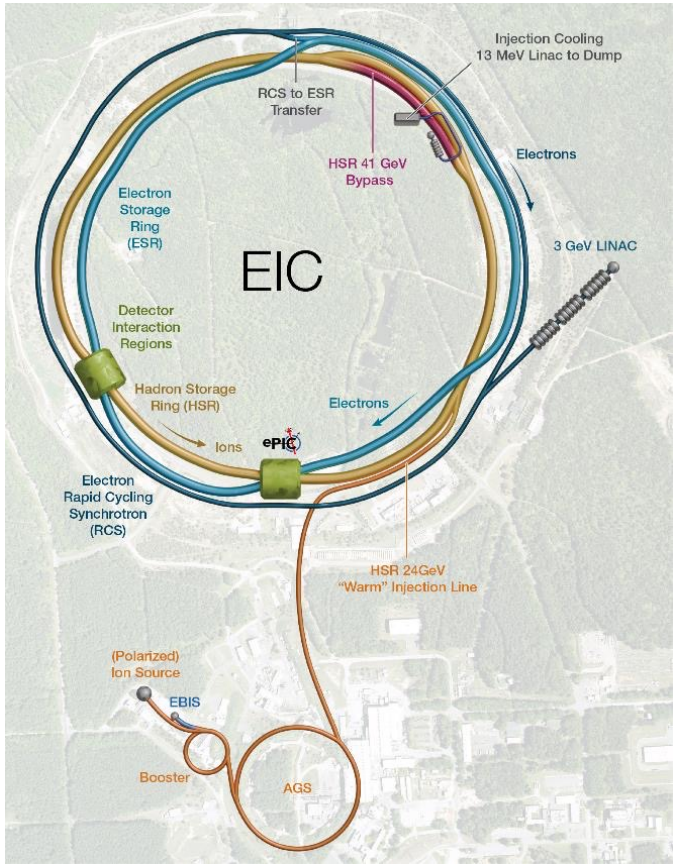


Daresbury Laboratory
Rutherford Appleton Laboratory

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

  Request £58.8m fEC including contingency

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

  Proposal institutes:
  Birmingham, Brunel, Glasgow, Lancaster, Liverpool, Oxford, York, STFC/DL, STFC/RAL

  Work packages:
  WP1 – Silicon Tracker
  WP2 – Electron Tagger
  WP3 – Luminosity Monitor
  WP4 – Accelerator (New)
  WP5 – Project Management

  Submitted to UKRI on 24th of July 2023
  Funding announced on 27th of March 2024

  Note: Plan to pursue Polarimetry as possible upgrade

- Bridging Support

  Awarded £300k (NM) plus £642k (underspend) plus £242k (WA) to 31st of March 2025

EIC-UK Full Infrastructure Project

Hadronic Calorimeters (HCAL)

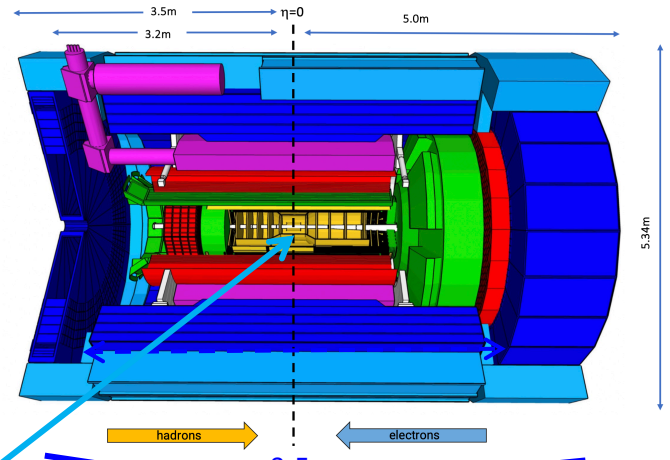
Solenoidal Magnet

E/M Calorimeters (ECal)

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

MPGD trackers

MAPS tracker



WP1 – Silicon Tracker

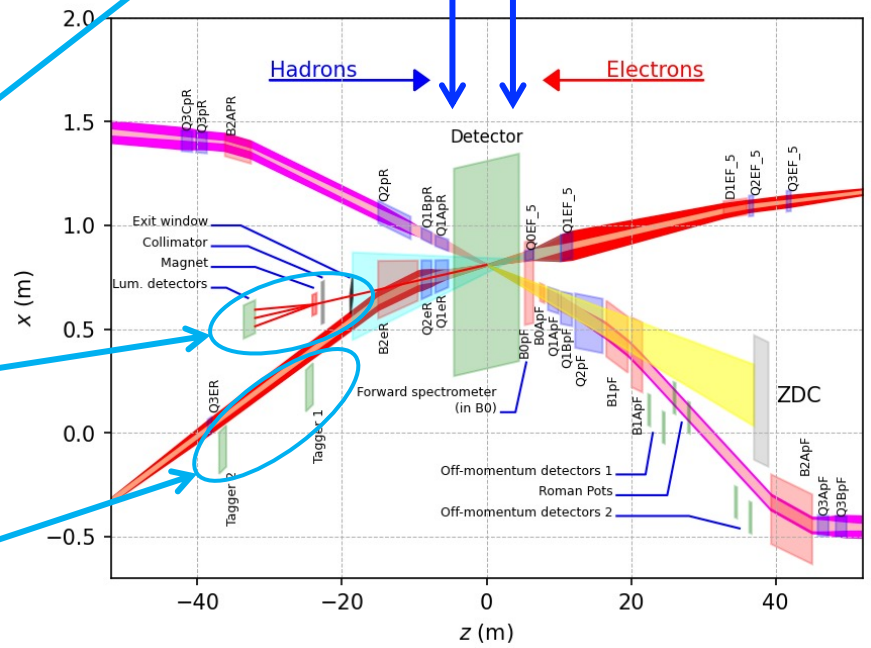
Birmingham, Brunel, Liverpool, Oxford, Daresbury Laboratory, Rutherford Appleton Laboratory

WP3 – Luminosity Monitor

York

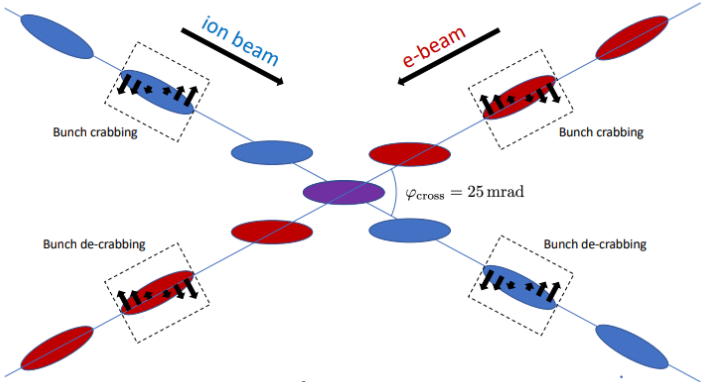
WP2 – Electron Tagger

Glasgow



WP4 – Accelerator

Lancaster, Daresbury Laboratory



Crab cavities

Infrastructure Funding – Budget, Profile, Contingency

- Original UKRI IF bid

  UKRI approved budget £58.8m fEC (including £16m contingency)

  Baseline project duration: 7 years (1 July 2025 to 31 June 2032)

  Contingency adds: 1.75 years (1 July 2032 to 31 March 2034)

  UKRI announced that funding for Wave 3 projects would start in FY26/27

  Funding profile shifted later by 1 year (1 July 2026 to 31 March 2035) including schedule contingency

- Reprofiling

  STFC asked us to reprofile so that grants could start on 1 April 2025

  Note: there was only 9 months of funding in FY25/26 in the original bid

  Involves adding 1.25 years, so the new baseline project duration is 8.25 years (1 April 2025 to 31 June 2033)

  Also had to accommodate an increase in STFC lab staff costs awarded after the proposal was submitted

- Budget Constraints

  Budget in FY25/26 is limited to £2.8m

  Made possible by STFC managing its portfolio of Infrastructure Projects

  The reprofiled budget cannot exceed the submitted budget (shifted by 1 year) in any year

  Funding to HEIs will be at 80% fEC (apart from equipment/exceptions); indexation at 2.48%

Infrastructure Funding – Reprofiled project costs

- Work package costs

Pre-award → Protoyping → Construction → Installation & Commissioning

	Cost £k (1 decimal place)										
	25/26	26/27	27/28	28/29	29/30	30/31	31/32	32/33	33/34	34/35	
Total for WP1	2003.5	2657.5	4591.0	5999.8	4078.3	3717.5	2799.6	1445.2	374.9	0.0	27.7
Original profile for WP1		2616.8	4515.5	5870.9	5730.1	3663.2	3106.9	1836.4	518.8	0.0	27.9
Total for WP2	307.2	481.9	1200.1	1336.2	528.1	453.1	322.7	319.6	60.7	0.0	5.0
Original profile for WP2		492.6	985.8	958.3	952.1	610.8	485.4	438.4	100.1	0.0	5.0
Total for WP3	314.2	443.4	484.2	472.5	261.9	269.3	275.4	274.8	0	0	2.8
Original profile for WP3		200	588.1	732.45	271.6	252.6	272.9	277.1	92.8	0	2.7
Total for WP4	0.0	371.6	818.8	2387.8	1635.8	410.1	0.0	0.0	0.0	0.0	5.6
Original profile for WP4		371.6	818.8	2387.8	1635.8	410.1	0.0	0.0	0.0	0.0	5.6
Total for WP5	176.8	209.1	214.7	220.1	225.7	231.4	237.3	243.2	62.3	0.0	1.8
Original profile for WP5		160.8	219.8	226.1	232.7	239.4	246.4	253.6	63.2	0.0	1.6

← Reprofiled – 80% fEC to HEIs

← Original – 100% fEC

- Cost summary

Lower contingency in FY26/27 to FY28/29 to stay within original profile

Cost summary	Cost £k (1 decimal place)										£m
	25/26	26/27	27/28	28/29	29/30	30/31	31/32	32/33	33/34	34/35	
Contingency ORIGINAL		412.3	1010.3	2131.5	2031.5	1484.0	1780.5	1559.2	2850.3	2724.5	16.0
Total (UKRI IF contribution) ORIGINAL		4254.2	8138.2	12307.1	10853.8	6660.1	5892.1	4364.7	3625.2	2724.5	58.8
Baseline Project Costs NEW PROFILE	2801.6	4163.6	7308.7	10416.4	6729.7	5081.4	3635.1	2282.8	497.9	0.0	42.9
Contingency NEW PROFILE		90.6	829.5	1890.7	2031.5	1484.0	1780.5	1559.2	2850.3	2724.5	15.2
Total (UKRI IF contribution) NEW PROFILE	2801.6	4254.2	8138.2	12307.1	8761.2	6565.4	5415.6	3842.0	3348.2	2724.5	58.2

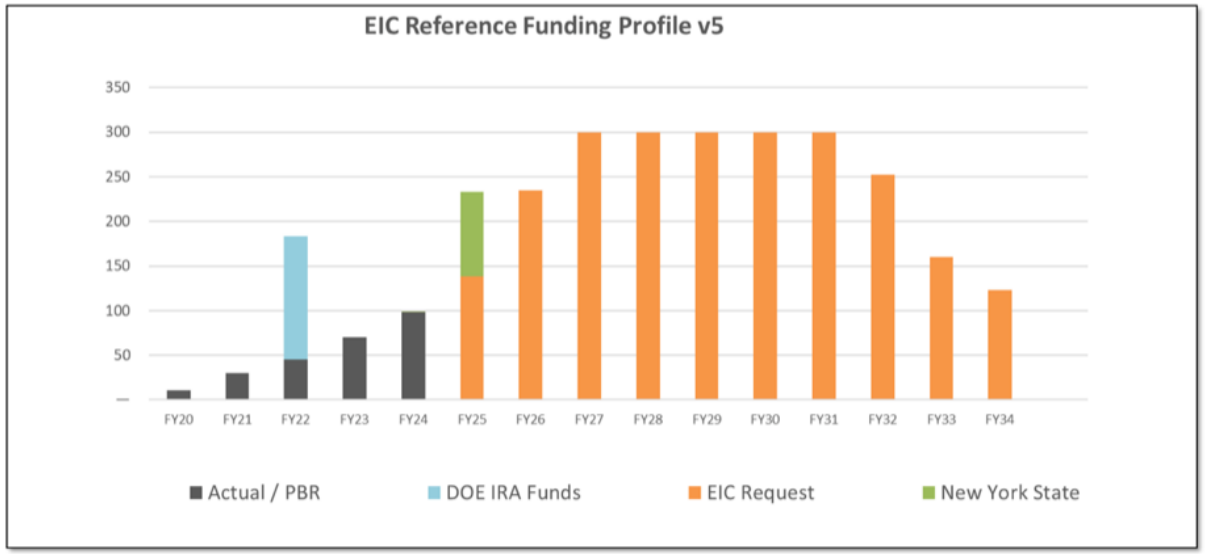
← Includes contingency

← £0.6m under budget
Add to contingency
Contingency = £15.8m

EIC Project Funding

- CD-1 Approval June 2021
  Cost Range $1.7B-$2.8B
- FY21
  Project Request $43M
  Actual $30M
- FY22
  Project Request $100M
  Actual $44.8M – Ramp-up slowed due to funding constraints
  Inflation Reduction Act (IRA) $138.24M
- FY23
  Project Request $90M
  Actual $70M
- FY24
  Project Request $181M
  Actual $98M
- FY25
  Project Request $150M (minimum) – $219M (maximum)
  President' Budget Request $113M, House Mark $128M, and Senate Mark $138M
  Continuing Resolution $98M

Cumulative Project Funding to Date ($490M) • DOE = $390M, including $138M Inflation Reduction Act. • New York State = $100M.	**Assumed Peak Annual Funding $300M per year**



EIC Project Schedule

- Schedule is largely driven by the Accelerator

  Existing constraints (tunnel, hadron source, infrastructure), broad energy range, asymmetric collisions, radial orbit offsets, high beam currents and polarization for both beams, crab cavities, strong hadron cooling (SHC)

  Proposal to phase the delivery of the accelerator to allow science programme to start by 2035 (latest)

- Phase I Proposal:

  HSR: no SHC, add injection cooler, no 41-GeV bypass → US requested change of scope for the Accelerator WP

  ESR: 5-10 GeV, 7 nC max (means fewer RF cavities and amps); maybe no crabs

  RCS: operates with a 7 nC (single bunch), 3 → 5 or 10 GeV ramps at 1 Hz

- Phase II Proposal:

  HSR: add SHC, add 41-GeV bypass

  ESR: add RF cavities and power to operate at 28 nC and 18 GeV; add crabs

  RCS: upgraded to 28 nC and 3 → 18 GeV ramps (at 1 Hz);

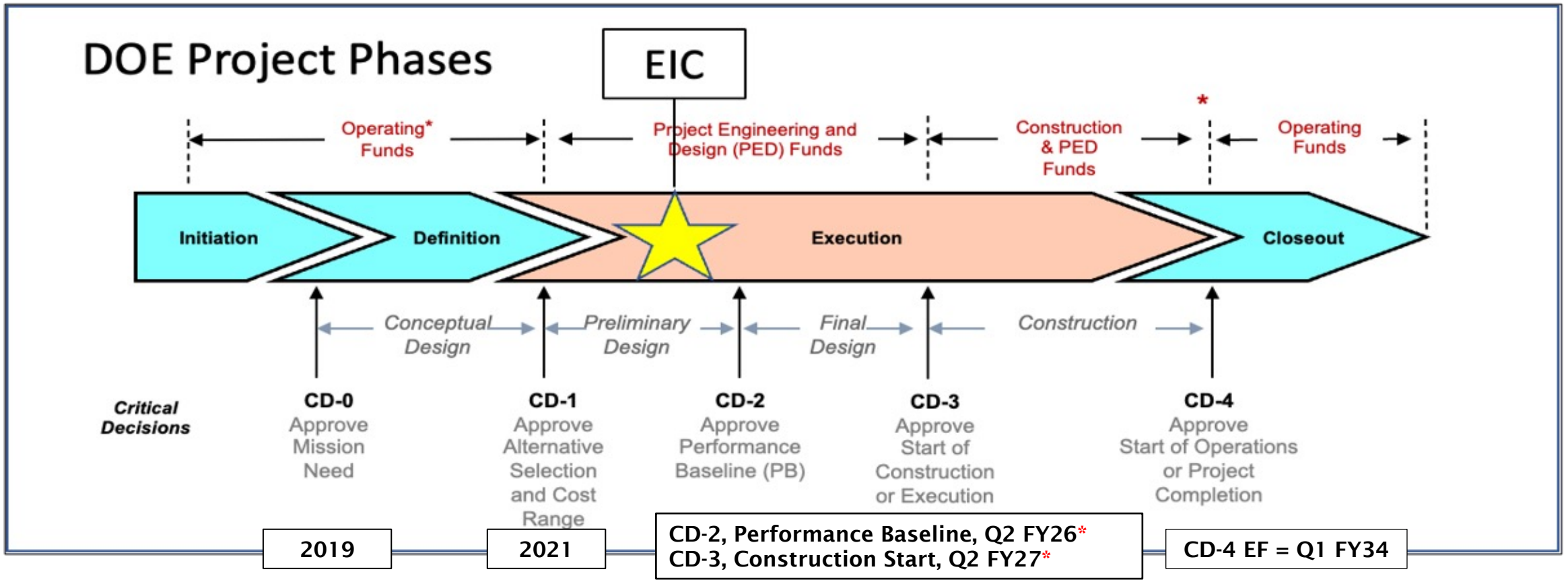
- Change in baseline since Nov 2023 DOE review (independent of phasing):

  Add injection cooler for hadrons

  Replace a 400 MeV NC commercial linac with a 3 GeV SRF (1.3 GHz) linac as injector to the RCS

DOE Project Phases – Critical Decisions

- EIC Project Status and Plans

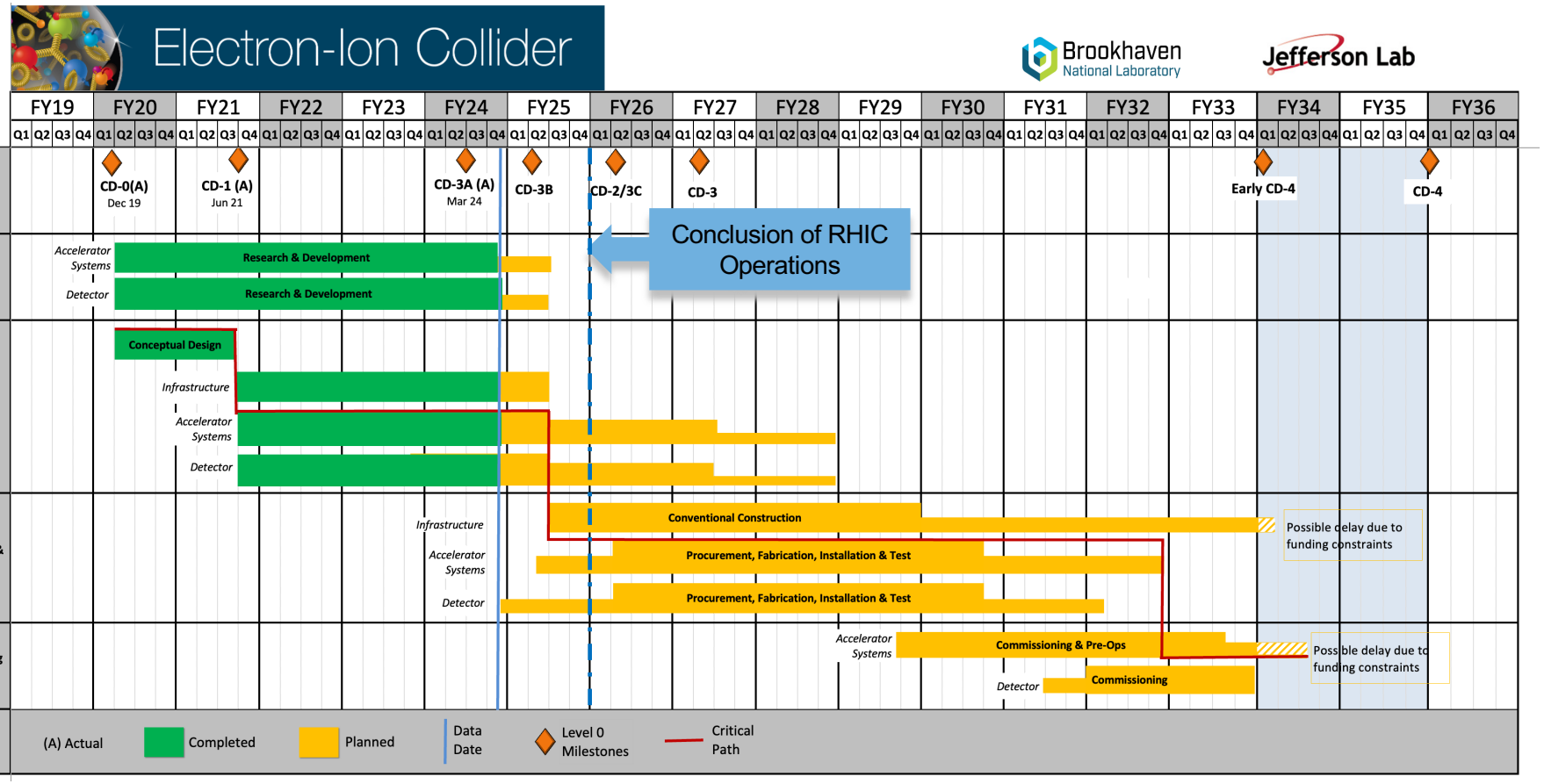


CD-3A, LLP, approved March 2024. Enabled by use of DOE Inflation Reduction Act funding
CD-3B, LLP, approval planned for March 2025
CD-2, Project Performance Baseline, requires mature design and a secure funding profile

*** FY25/FY26 funding will impact CD-2 & CD-3 dates**

EIC Project Schedule

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

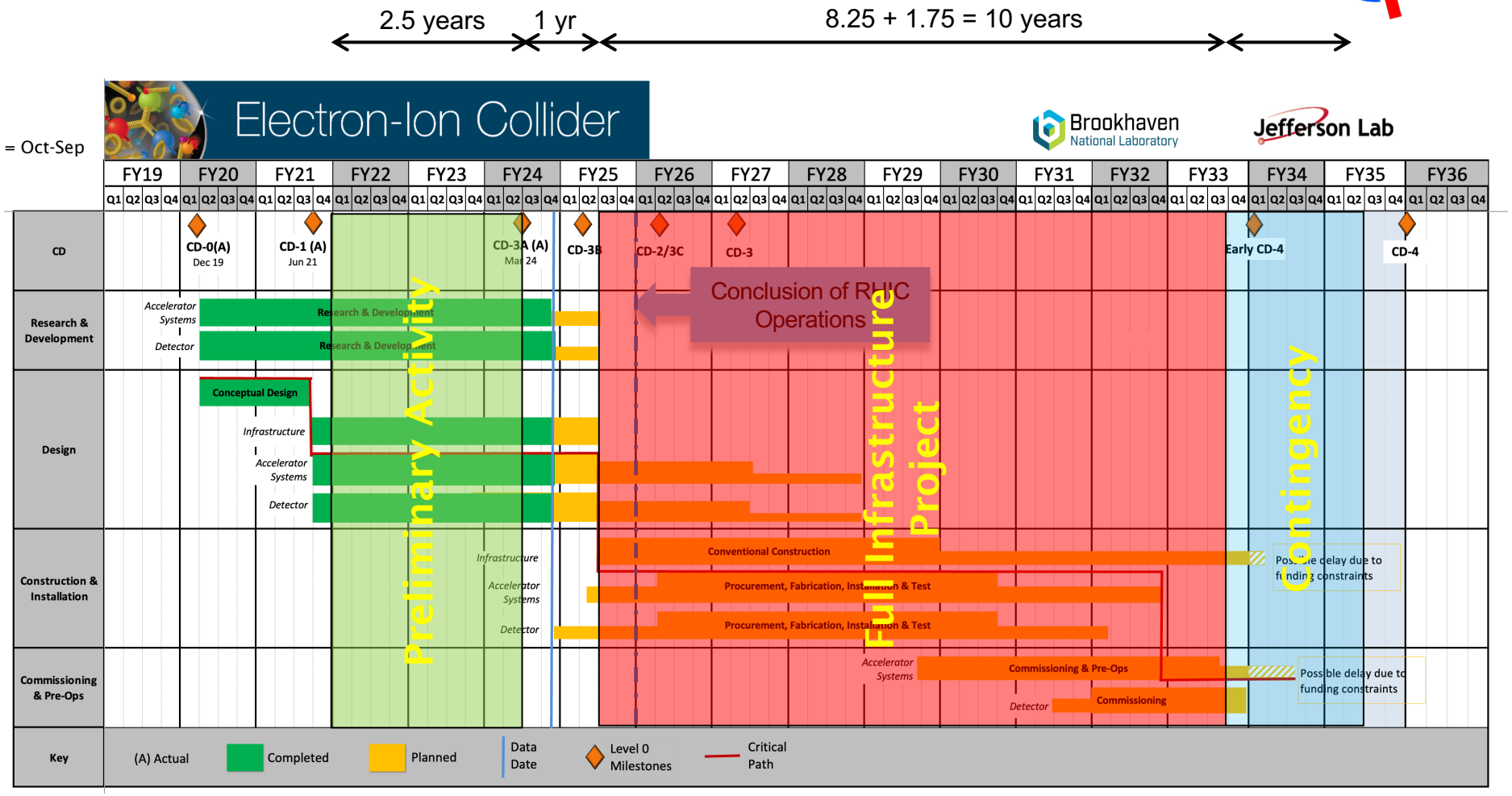
Pre-TDR – Sep 2025
CD-2 – Dec 2025 (9 months delay)
TDR – Sep 2026
CD-3 – Dec 2026 (21 months delay)
CD-4(EF) – Oct 2033
CD-4 – Oct 2035 (12 months delay)
Difference between CD-4(EF) and CD-4 is US schedule contingency

(EF = Early Finish)

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

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

EIC Project Schedule



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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

EIC-UK Project Schedule

- Version 3.2

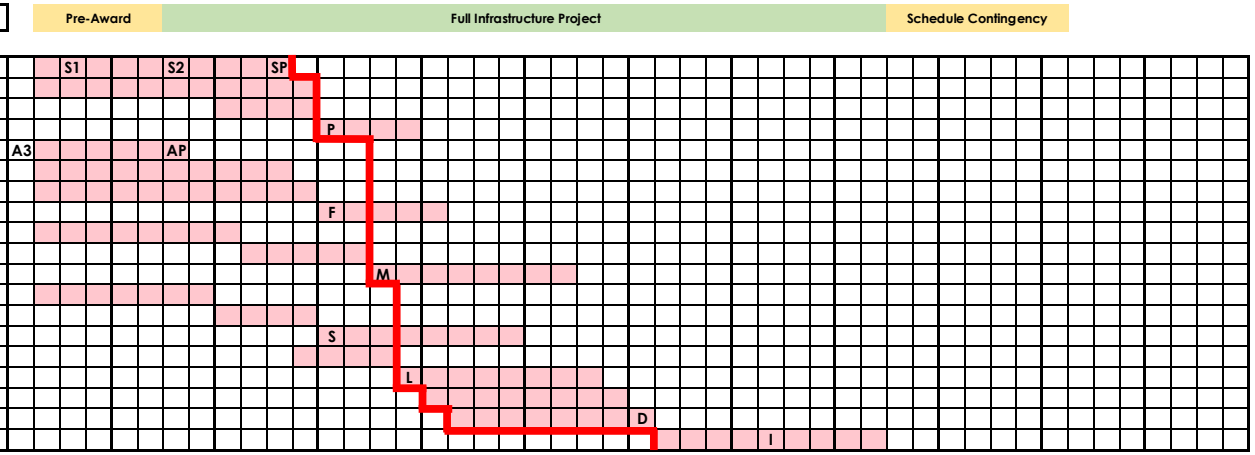
Gantt chart: EIC Full Infrastructure Project

Version: 3.2
Author: Peter Jones (p.g.jones@bham.ac.uk)

In the current (unofficial) schedule CD-2 and CD-3 have been split (again)
CD-2 is delayed by 9 months anticipated in the Full Infrastructure proposal
CD-3 is delayed by 12 months compared to the proposal
CD-4 (EF) and CD-4 also slip by 12 months
Barrel detectors installed: earliest June 2031, latest June 2032

Starting date:	01/04/2025	Year	2025				2026				2027				2028				2029				2030				2031				2032				2033				2034				2035				2036			
Year:	2025	Q		2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Quarter:	2	nQ		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
		CD milestone					2				3																											4e								4				

ID	Task	Start Time	End Time	Duration Q
	WP1 - Silicon Tracker			
1	Sensor Design	01/04/2025	30/09/2027	10
2	Sensor Characterisation	01/04/2025	31/12/2027	11
3	Sensor Pre-Production Testing, site setup and qualification	01/01/2027	31/12/2027	4
4	Sensor Production Testing (QC/QA) incl. wafer probing	01/01/2028	31/12/2028	4
5	AncASIC Design	01/04/2025	01/08/2026	6
6	AncASIC Testing	01/04/2025	30/09/2027	10
7	Flexible Printed Circuits – Design and Testing	01/04/2025	31/12/2027	11
8	Flexible Printed Circuits – Production and Testing	01/01/2028	31/03/2029	5
9	Modules - Prototypes	01/04/2025	31/03/2027	8
10	Modules - Preproduction, site setup and qualification	01/04/2027	30/06/2028	5
11	Modules - Production	01/07/2028	30/06/2030	8
12	Staves - Prototypes	01/04/2025	31/12/2026	7
13	Staves - Preproduction, site setup and qualification	01/01/2027	31/12/2027	4
14	Staves - Production	01/01/2028	31/12/2029	8
15	Staves - Loading, site setup and qualification	01/10/2027	30/09/2028	4
16	Staves - Loading	01/10/2028	30/09/2030	8
17	Staves - Testing	01/01/2029	31/12/2030	8
18	Shipment to BNL	01/04/2029	31/03/2031	8
19	Installaton and Commissioning at BNL	01/04/2031	30/06/2033	9



Past ("FY24") EIC Critical Decision Plan

CD-0/Site Selection	December 2019 ✓
CD-1	June 2021 ✓
CD-3A	March 2024 ✓
CD-3B	**October 2024**
CD-2/3	**April 2025**
early CD-4	October 2032
CD-4	**October 2034**

Updated Project Schedule:
based on the actual appropriated FY24 funding ($98M), and uncertain FY25 budget scenarios
President's Budget ~$113M,
House ~$128M,
Senate ~$138M,
Original assumption >$150M

Updated EIC Critical Decision Plan

CD-0/Site Selection	December 2019 ✓
CD-1	June 2021 ✓
CD-3A	March 2024 ✓
CD-3B Review	**January 2025**
CD-2/3C Review	December 2025
CD-3 Review	December 2026
early CD-4	October 2033
CD-4	October 2035

Provisional

S1 = EIC-LAS Version 1 submission (**M1.2A**)
S2 = EIC-LAS Version 2 submission (**M1.3A**)
SP = EIC-LAS Production Version submission (**M1.3B**)
P = Start of Production Sensor testing (**M1.4**)
A3 = AncASIC (final) MPW submission (**M1.5C**)
AP = Order Production AncASIC (**M1.5D**)
F = Start of FPC production (**M1.6**)
M = Start of Module production (**M1.7B**)
S = Start of Stave production (**M1.8B**)
L = Start of Stave loading (**M1.8C**)
D = Final delivery to BNL (**D1**)
I = Barrel detectors installed (ePIC schedule) (**M0.4**)

Red line = critical path

EIC Project Schedule

- Preparations for CD-2 and CD-3 (presented by Jim Yeck at 4th RRB meeting last week)

  In addition to the phased delivery of the accelerator, there is now discussion around defining subprojects

  EIC is a single integrated line-item project with several subprojects

  Each subproject should have well-defined deliverables

  Each subproject should have clean interfaces with other subprojects

  A subset of the subprojects will enable the start of the EIC early science programme

  Each subproject will have its own CD-2 and CD-3 review

- Potential EIC Subprojects (example)

  >>> Phase I <<<

  1st subproject – hadron storage ring modifications, new electron storage ring, infrastructure

  2nd subproject – ePIC detector

  3rd subproject – electron injector systems, interaction region, and infrastructure

  >>> Phase II <<<

  4th subproject – RF power, additional beam cooling

Timetable for UKRI Full Infrastructure Project (1/2)

- Business Case Timeline

  30 September – 2 October: Gateway 3 Review ✓

  21 October: Reviewed by UKRI Investment Advisory Working Group ✓

  End October/early November: Engage with DSIT keyholders ✓

  >>> 19 November: Goes before UKRI Executive Committee to ratify Business Case <<<

  20 November: Formal submission to DSIT Investment Committee

  3 December: Business Case goes before DSIT Investment Committee

- Review by the Projects Peer Review Panel (PPRP)

  13 September: Case for support submitted ✓

  17 October: PPRP Review at RAL ✓

- Grant submission and award

  31 March 2025: Bridging Support ends

  1 April 2025: Full Infrastructure Project starts

  Grant submission via TFS (unlike JeS only one submission by lead RO)

Timetable for UKRI Full Infrastructure Project (2/2)

- Grant funding mechanism

  STFC are proposing to award as two grants: one for the detector WPs and another for the accelerator WP

  Both to be managed under one project

  Majority of the funding to be awarded to Birmingham as lead RO

  STFC lab staff effort to be funded by direct transfer

  Collaboration agreements to be set up between Birmingham and the other collaborating institutes

  >>> Needed anyway to allocate working allowance <<<

  Main advantage: gives the project increased flexibility to redirect underspends

  Main disadvantage: increased project management overhead for the project

- Challenges

  There are lots of details that need to be worked out …

  Collaboration have asked STFC for a clear timetable for agreeing the terms of the award

  All the partner institutes need to be on board and Birmingham needs to understand its role and liabilities

Next steps

- Act on recommendations from DSIT and PPRP reviews and EIC Project Board

  Increased Project Management effort and admin support at Birmingham to manage funding

  Recommendations for PMP on procedures for change control and risk management

  Recommendations to OsC for monitoring risks and impact

  Recommendations to Collaboration for UK NP, PP community outreach – growing the UK EIC community

- Grant submission via TFS

  Need to understand grant award terms and conditions

  Discussion with the finance offices of collaboration institutes

  Probable submission at the end of January (TBC)

- Agreements between STFC and BNL/JLab

  iCRADAs = international Collaborative Research And Development Agreements (legally binding)

  PPDs = Project Planning Documents – detailed cost, schedule, milestones and deliverables (one per detector)

  Silicon Tracker – iCRADA with BNL

  Electron Tagger and Luminosity Monitor – iCRADA with JLab

Summary

Collaboration continues to make good progress

All detector work packages are now in the prototyping phase

US Project schedule has slipped, but now more realistic

Phasing the delivery of the accelerator is designed to ensure that operations start by 2035

Delay to UKRI Full Infrastructure Funding has kept UK schedule in step with the US

Reprofiling the Full Infrastructure Award will enable grants to start on 1 April 2025

Currently awaiting approval by DIST Investment Committee

Main concern is with the timeframe for setting up the new grant / collaboration agreements

Collaboration has asked STFC to clarify the terms of the grant

Scope of accelerator WP to be defined by early 2025

Will require a separate review and grant award