ePIC Collaboration Mtg. Discussion / highlights

Barbara, Ernst, John, Nikki, Shujie

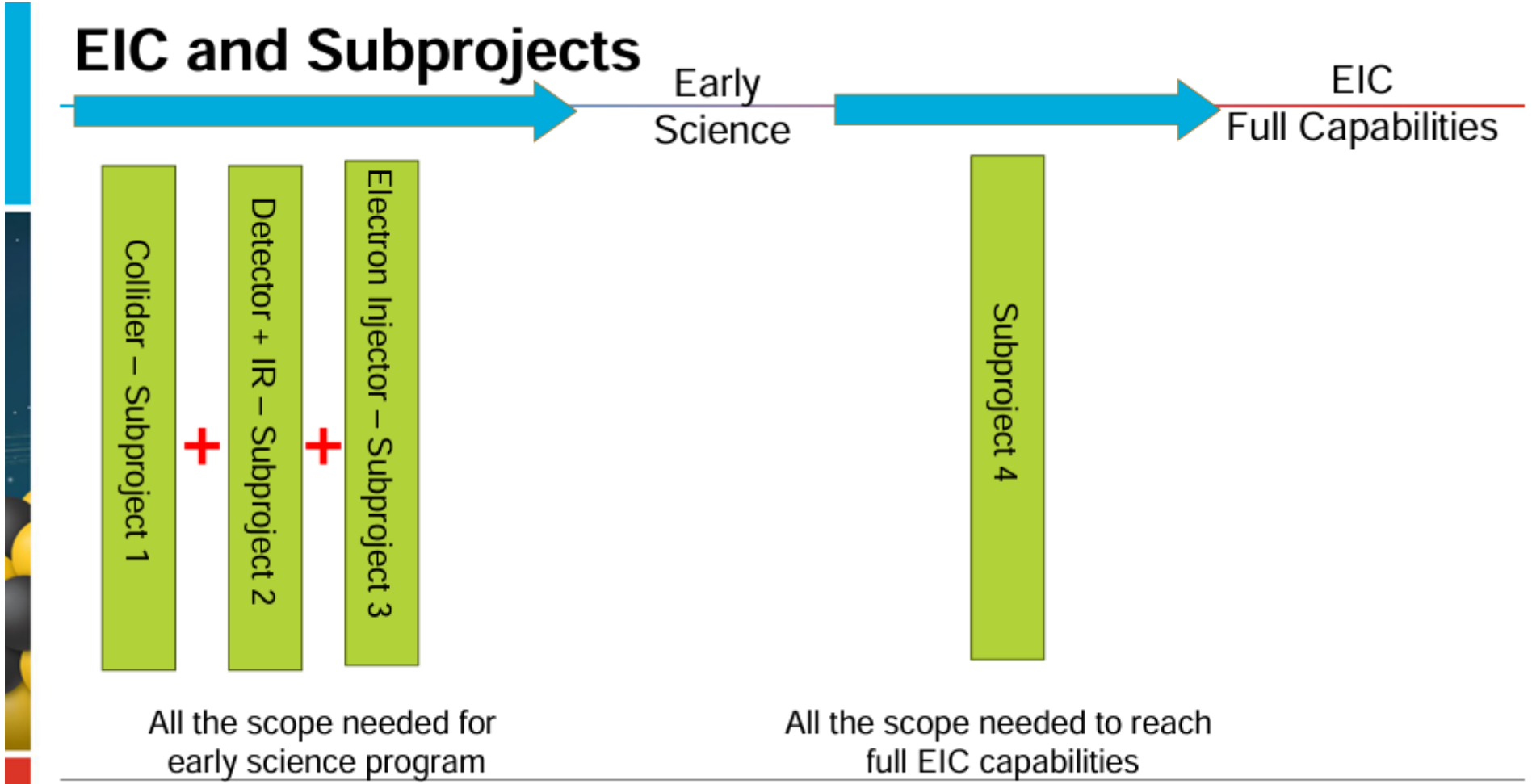
- Summaries / highlights are not a substitute for participation,
- Preparing a summary / selecting highlights can be a way of engaging even when participating was not practical,
- Not where we are today though; instead, you will be exposed to my (ES) heavy-handed selections and bias(-es) in the slides that follow,
- Full agenda at: https://agenda.infn.it/event/43344/

Machine – Nagaitsev, Monday

Key Takeaway Messages

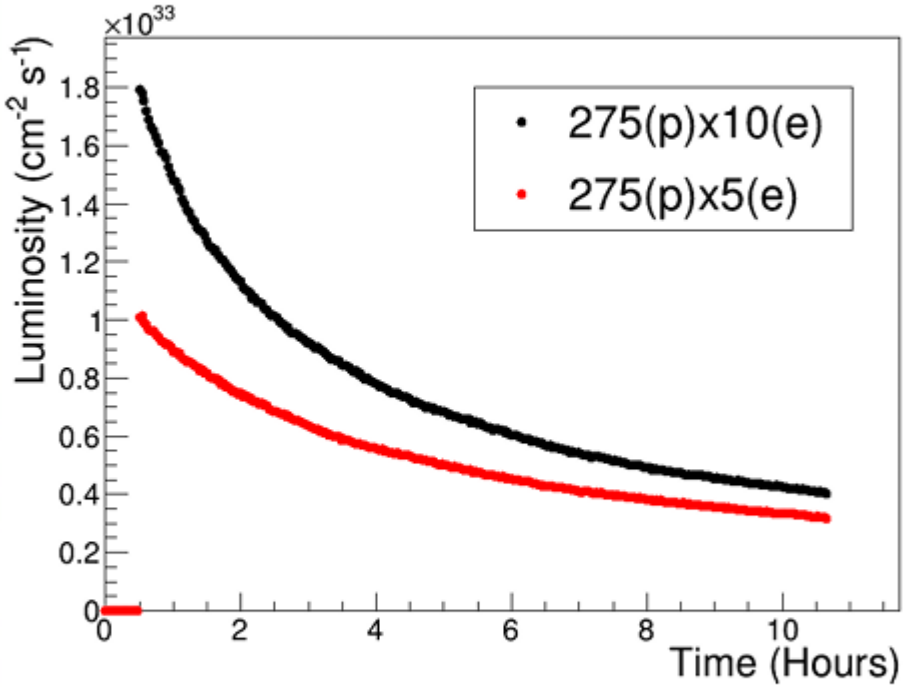
- In 2024, the project made several key EIC design decisions. They will lead to formal Project Scope changes after the Technical Change Control Board (TCCB) and the CCB processes.
  1. Reuse the entire Yellow RHIC ring, delay the 41-GeV bypass (a Blue RHIC arc).
  2. Implement a new room-temperature Hadron Storage Ring (HSR) injection line.
  3. Drop Strong Hadron Cooling (SHC), add Low-Energy Cooling (LEC).
  4. Move the Rapid Cycling Synchrotron (RCS) out of the collider tunnel.
  5. Delay the 28 nC/bunch and the 18 GeV capability implementation (ESR and RCS).
- These design decisions resolve uncertainties, challenges, and risks to EIC performance, safety, and future operation and maintenance.
- Today, there are no more technical scope uncertainties related to the EIC performance and Key Performance Parameters (KPPs).
  - There are of course remaining risks, which we will continue to mitigate and properly manage.
- We understand what we need to build to deliver EIC!

Machine – Nagaitsev, Monday



Machine – Nagaitsev, Monday

Projected e-p Luminosities for the Proposed Scope



First 30 mins. are taken by filling the ESR and turning on detector.

- 7 nC electron bunch charge (reduced from 28 nC)
- Nominal 11 nC proton bunch charge for 275x10 (as in CDR)
  - Reduced 5.5 nC proton bunches for 275x5
- Constant proton beam IP divergencies are maintained throughout the store. by gradual increase of proton IP beta-functions as the beam emittance increases.
- The electron IP beta-functions are adjusted accordingly to match electron and proton transverse beam size.
- Compare to HERA peak luminosity of $5x10^{31}cm^{-2}sec^{-1}$

Machine – Nagaitsev, Monday

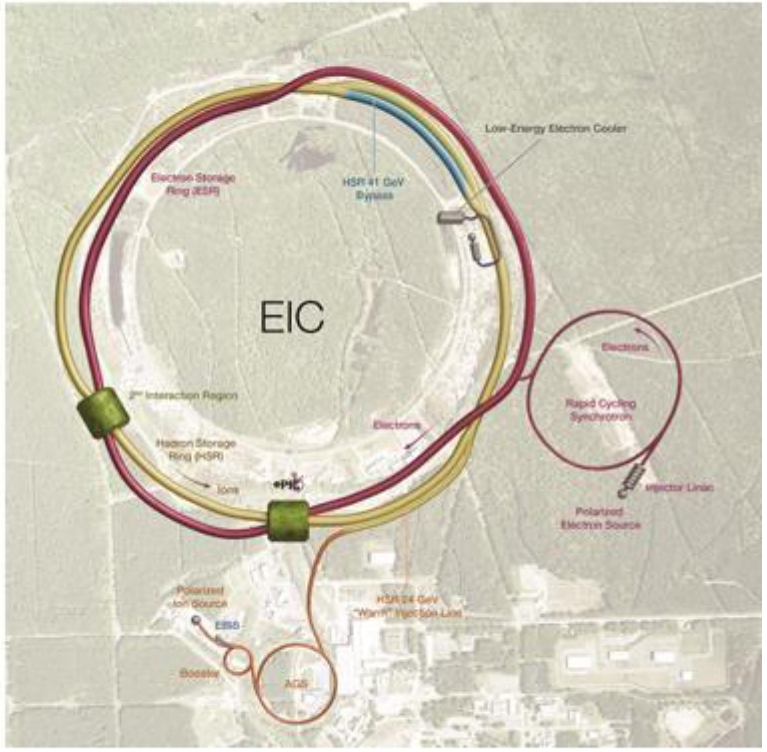
Present EIC Concept (2025)

Ultimate EIC Performance Parameters:

- High Luminosity: L= 10^{33} – 10^{34}cm^{-2}sec^{-1}
- Highly Polarized Beams: 70%
- Large Center of Mass Energy Range: Ecm = 28 – 140 GeV
- Large Ion Species Range: protons – Uranium
- Large Detector Forward Acceptance and Low-Background Conditions
- Possibility to Implement a Second Interaction Region (IR)

Accelerator Status in a glance:

- ✓ Polarized ion/proton source
- ✓ Ion injection and initial acceleration systems – Linac (200 MeV), Booster (1.5 GeV), AGS (25 GeV)
- UPGRADE Hadron Storage Ring (40-275 GeV) – HSR
- NEW Electron Pre-Injector (750 MeV linac) – EPI
- NEW Electron Rapid Cycling Synchrotron (0.75 GeV – top energy) – RCS
- NEW Electron Storage Ring (5 GeV – 18 GeV) – ESR
- NEW Interaction Region(s) – IR
- NEW Hadron Injection Cooling System



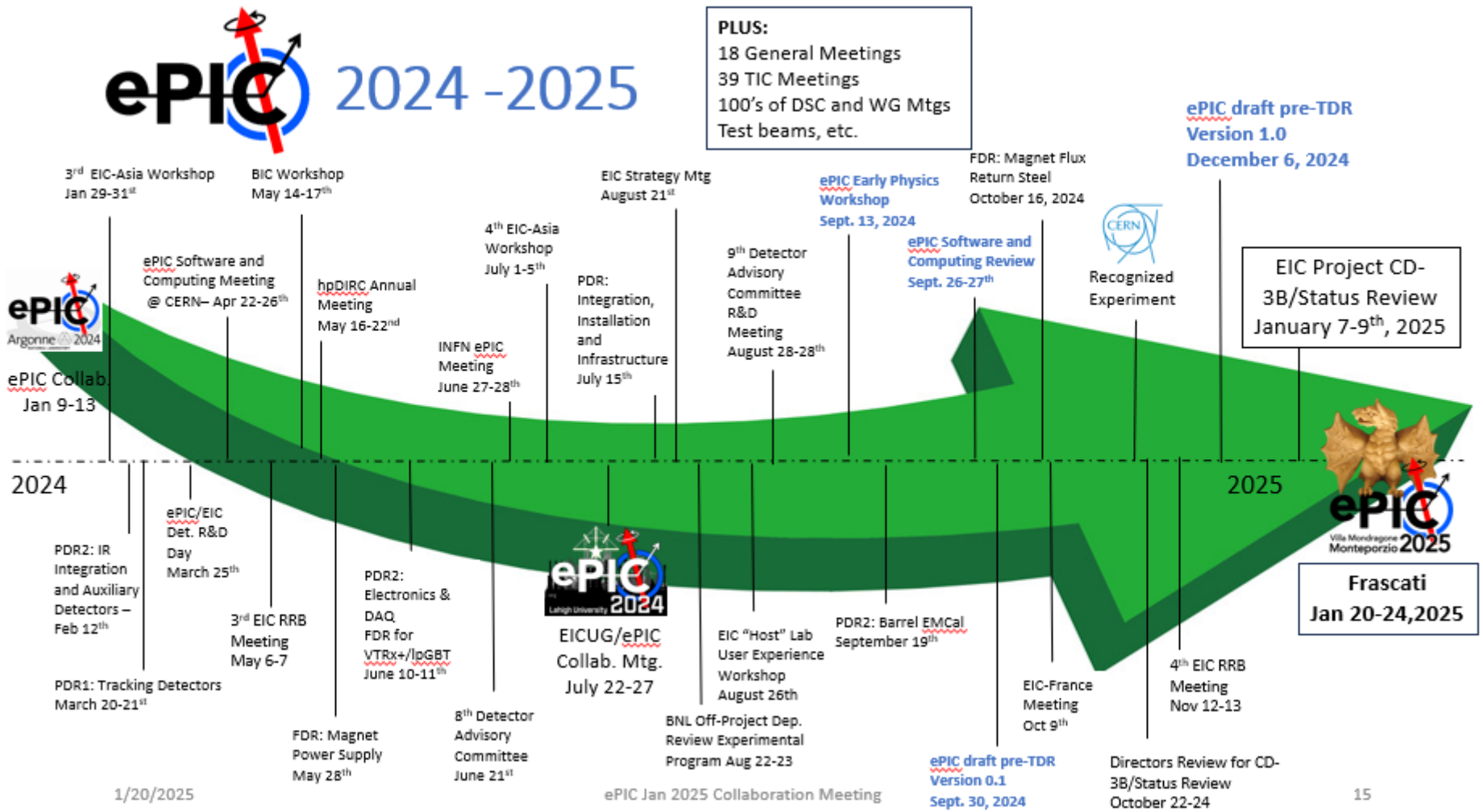
Machine – Nagaitsev, Monday

Summary of Proposed Major Design Changes

1. Reuse all Yellow ring, delay the 41-GeV bypass (savings: $)
2. Implement a new room-temperature HSR injection line (savings: $)
3. Drop SHC, add LEC (savings: $$)
4. Move RCS out of the collider tunnel (in progress)

5. Delay 28 nC/bunch and 18 GeV capability implementation

Collaboration – Lajoie, Monday



Collaboration (TC) – Dalla Torre, Monday

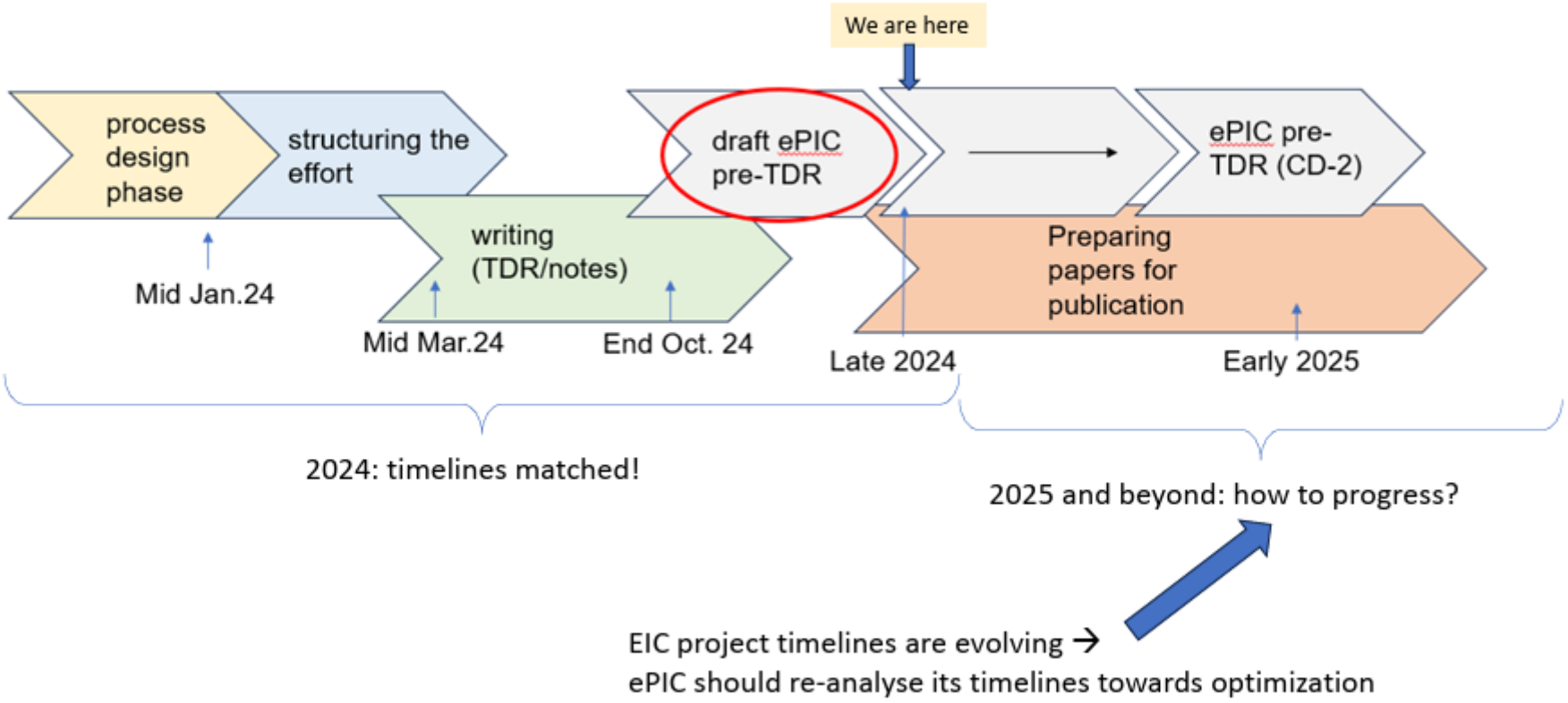
ePIC in the preTDR process in 2024

Reminder

- Domain of ePIC contributions:
  - *Chapter 2 "Physics Goals and Requirements"*
  - *Chapter 8 "Experimental Systems"*
- Enthusiastic contribution by the DSCs for chapter 8
- ePIC planning: with priority to preTDR, prepare in parallel 3 publications on high-rank scientific journals, reshaping the preTDR material and focusing on
  - The ePIC Detector *(from chapter 8)*
  - The ePIC detector performance for EIC physics scope *(from chapter 2)*
  - The ePIC software and computing model *(from dedicated subsection in chapter 8)*
- *PROCESS TIMELINES:*

Collaboration (TC) – Dalla Torre, Monday

ePIC in the preTDR process, about timelines



Collaboration (TC) – Dalla Torre, Monday

ePIC in the preTDR process beyond 2024

- Guiding considerations :
  - It is interest of ePIC to progress as quickly as possible to CD2 and CD3:
    - To preserve the present momentum and, possibly, to increase it;
    - To ensure the in-kind from international institutions;
    - To facilitate the flux of financial resources.
    - The project is reorganizing its activity by forming a set of subprojects and, correspondingly, its timelines; in this context, being "ready" is a key ingredient to be part of earlier approval

- A tentative realistic calendar *(this can change with the prioritization exercise at this meeting):*
  - final preTDR within 2025, namely :
    - final text from DSCs by June 2025
    - text polishing and homogenized by an **editorial panel** by September 2025
    - 2 parallel reviews (internal and external) in October and November 2025
    - December 2025: the **editorial panel** finalizes the text thanks to the review input
      - An extended "reading section" can be added to this finalization process
  - *The goal is to be ready for a detector CD-2 as early as 2026*
  - TDR following in 2026 towards CD3

Collaboration (TC) – Dalla Torre, Monday

ePIC in the preTDR process beyond 2024, more

- Interplay between chapter 2 and chapter 8
  - Clear detector requirements have to come from chapter 2
    - This requirement is identified as a must for a consistent preTDR

- Papers accompanying the ePIC preTDR effort
  - From the discussion at the TIC meeting on January 13th, 2025:
    - This can be appropriate for the detector paper
    - For the physics paper waiting for the most advanced stuydies of TDR can be more appropriate
    - Of course, all this is matter of discussion at this ePIC meeting

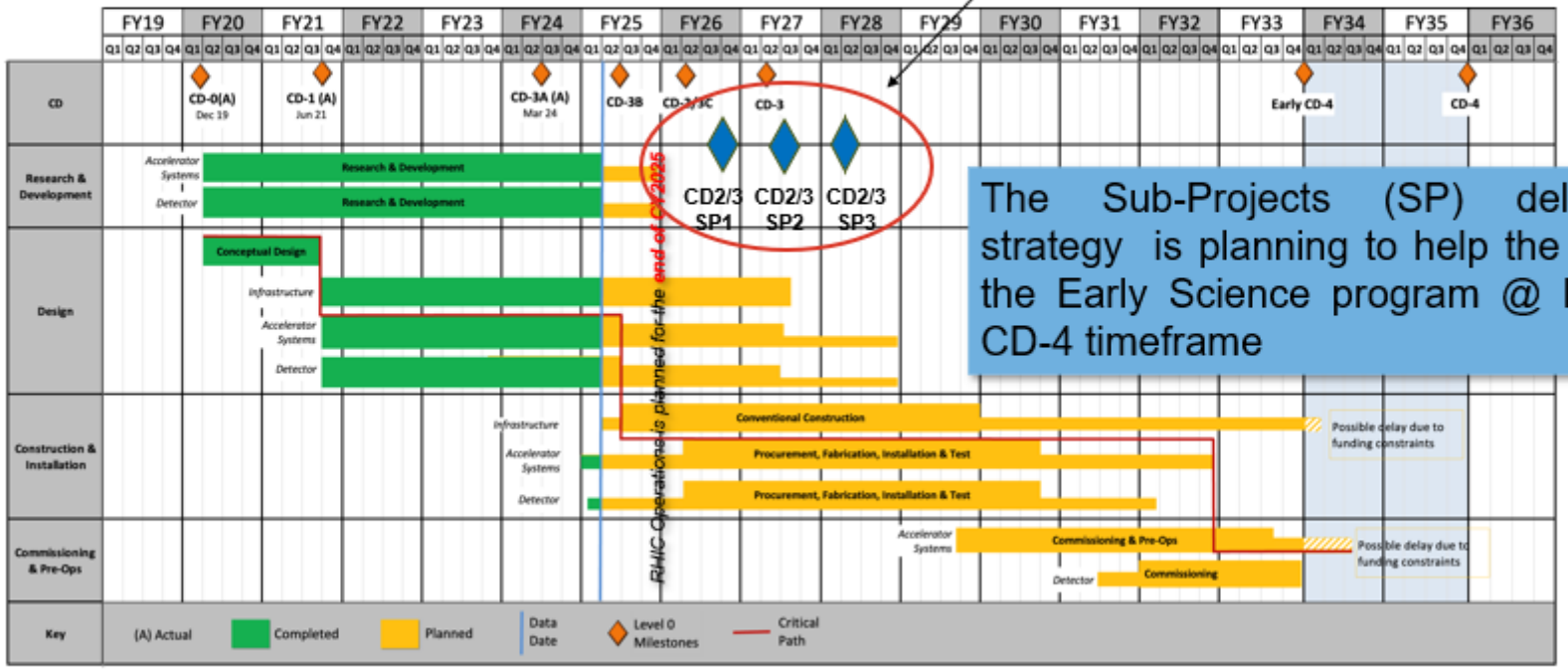
Project – Aschenauer, Monday

Schedule

From L. Lari CD-3B Plenary Presentation

Notional – project plan to be defined and reviewed in 2025

Under finalization; Mostly Technically Driven after FY2027

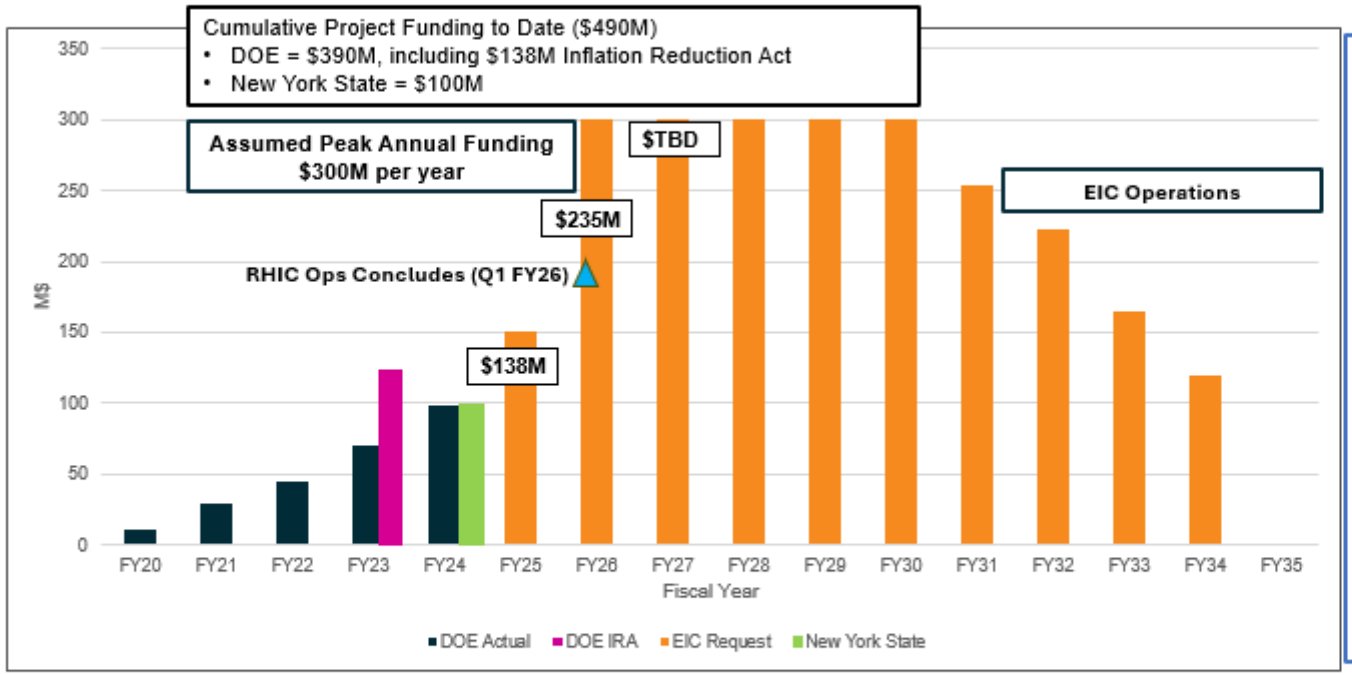


The Sub-Projects (SP) delivery strategy is planning to help the start the Early Science program @ Early CD-4 timeframe

Since CD-1, the critical path is on the Accelerator systems.

Project – Aschenauer, Monday

EIC Project Funding Plans (Version 4.2 → V5)



FY2025 Funding TBD

EIC Plan:	$150M
DOE Request:	$113M
House:	$128M
Senate:	$138M
CR:	$98M

FY2026 Funding TBD

- RHIC operations conclude end of 2025.
- EIC project transitions to construction.
- Reduced RHIC operations funding maintains the injector complex and the removal/repurposing of equipment.

EIC Proposed Annual Funding Plan, Version 4.2, Prior to FY2025 PBR ($M)

FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	Total
11	30	183	70	98	150	300	300	300	300	300	254	222	165	120	2,803

Project – Aschenauer, Monday

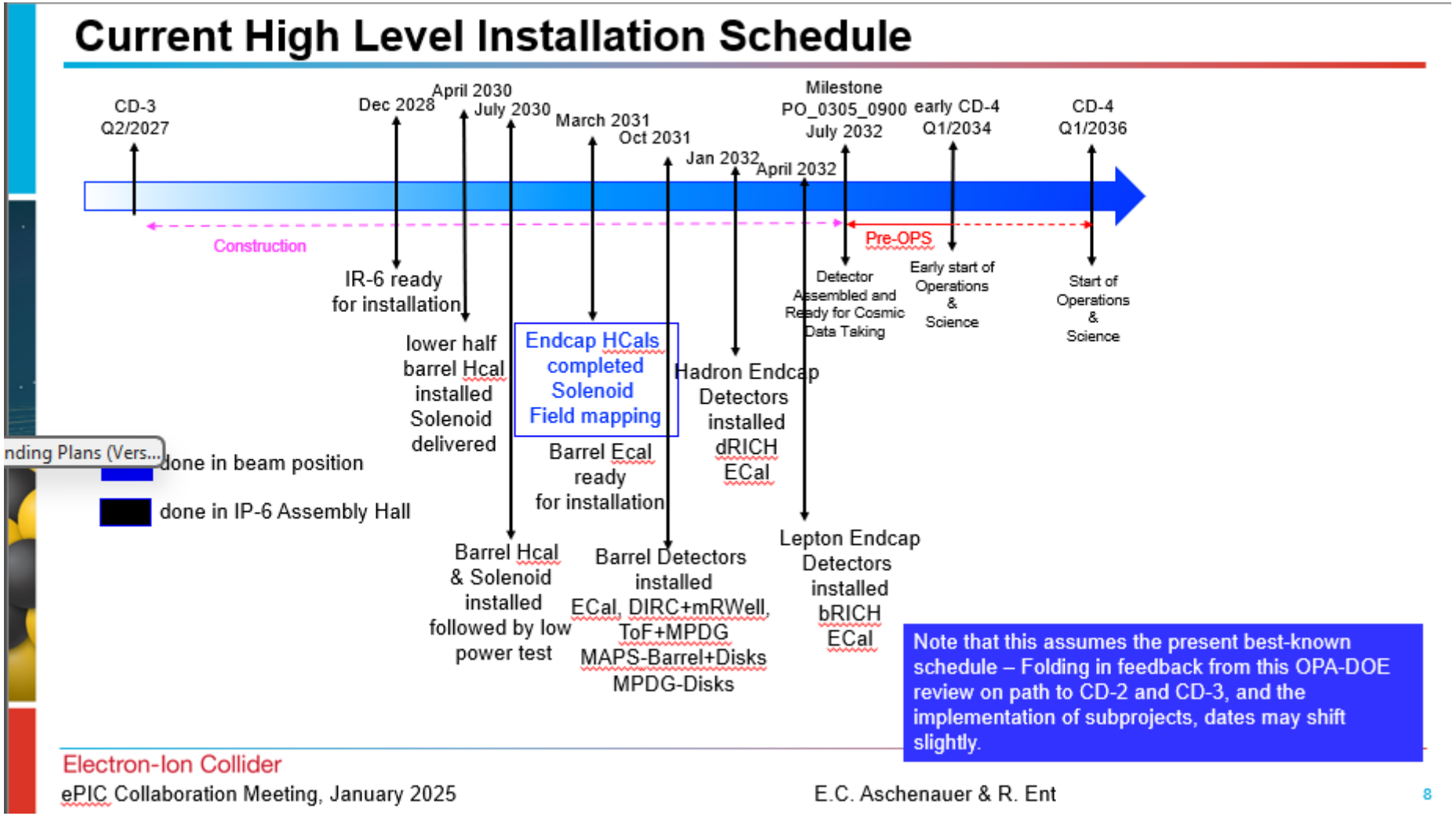
Critical Assumptions for Installation

- RHIC stops operation September 30th 2025
- R&R at IP-6 and IP-8 is done consistent with the installation schedule of the detector
- IR-6 is ready for installation by December 2028 → beneficial occupancy
- The ePIC detector is fully assembled by July 2032 (P6 Milestone PO_0305_0900 Detector Assembled and Ready for Cosmic Data Taking (Replacing early finish CD4a for Detector)), the original date for early finish CD-4A

R&R at IR-6	R&R at IR-8

• The STAR detector deconstruction needs to be **fully** finalized by July 2027
  ○ This is critical to have time to refurbish the STAR cradle and platforms for the reuse for EIC. The refurbishment is estimated to take 1.5 years.
  ○ The current plan is to reuse the STAR flux return steel
  ○ An estimate exist → the process needs to be started latest in October 2025. More details have been presented in the R&R review.
  ○ Assuming a start of **October 1st 2025**, it will take 6 month to have access to the IR through the assembly hall
Finished April 1st 2026
	• The sPHENIX detector deconstruction needs to be **fully** finalized by July 2027
	  ○ This is critical to have time to refurbish the Barrel HCal for the reuse for EIC. The refurbishment is estimated to take 1.5 years with one team redoing the work done constructing the HCal.
	  ○ Time estimates to deconstruct sPHENIX have been presented in the R&R review
	• The remains of the muon wall need to be removed. This will take time and effort, but it can happen in parallel to the work to deconstruct sPHENIX, estimates have been presented in the R&R review

Project – Aschenauer, Monday



Project – Aschenauer, Monday

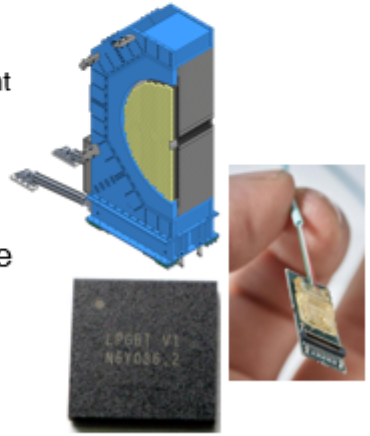
Long-Lead Procurement CD-3B Scope

Continuation of CD-3A Scope

- WBS 6.10.05: Lead Tungstate Crystals for the Detector Backward EM Calorimeter
  - 1000 pieces next step to complete the 3000 needed
- WBS 6.10.05: Scintillating Fibers for the Detector Barrel and Forward EM Calorimeters
  - 2nd phase of 4 phases → 1264 km and 1065 km, respectively out of the 4900 km and 3000 km
- WBS 6.10.06: Steel Plates, machining, coating and welding of the Towers for the Detector Forward Hadronic Calorimeter
  - the next 200 units out of the 1066 total 8M towers

New Items:

- WBS 6.10.07: Detector Solenoid Magnet Power Supply
  - Required for operation of the magnet at its design field which is required for the magnet acceptance
  - Reduces schedule risk due to competing project schedules → installation accelerator vs. experimental equipment
- WBS 6.10.10: Flux Return Steel for the Electron and Hadron Endcap Structures
  - 50% of needed magnet steel → first phase hadron endcap flux return steel
  - Required for operation of the magnet at its design field which is required for the magnet acceptance
- WBS 6.10.08/09: VTRx+/lpGBT for MAPS tracker, dRICH and other subsystems to ensure homogenization
  - Includes 5500 Versatile Link Plus Transceivers (VTRx+) and 1500 Low Power GigaBit Transceivers (lpGBT)
  - Take advantage from the planned production run by CERN, reduces cost and schedule risks as the alternative would be to develop a new design with new electronic components



Project – Aschenauer, Monday

Recent EIC DOE OPA CD-3B LLP Review

SC4: Detector

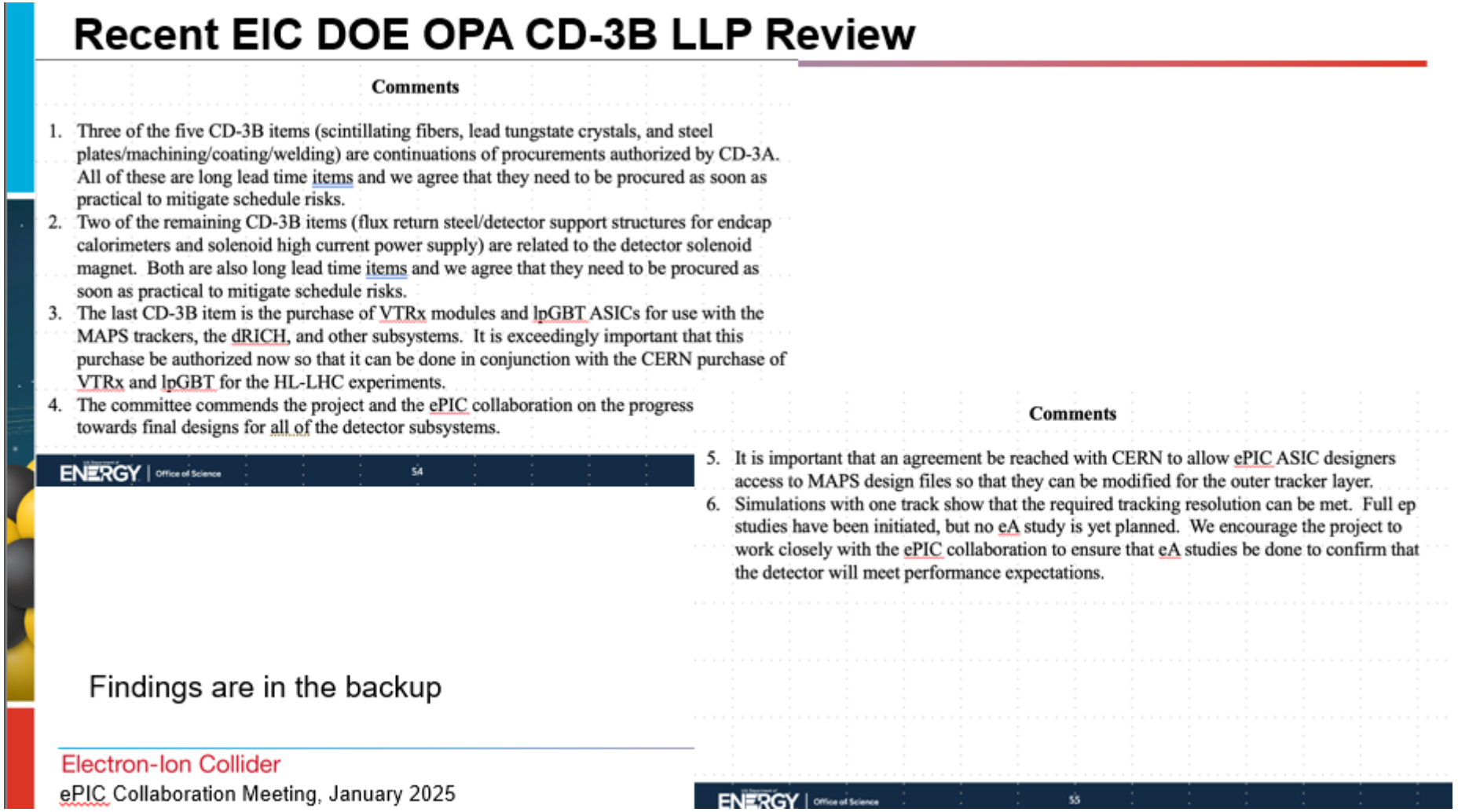
David Christian, FNAL; Claude Pruneau, Wayne St. U.

1. Is the project team effectively executing the work, including the long-lead procurements authorized by CD-3A? YES. Is the project positioned to complete CD-3A scope within the established schedule and cost baseline? YES. Are technical issues appropriately and proactively being addressed? YES.

2. Are R&D and design efforts yielding sufficiently advanced designs and mitigating technical risks? YES. Are the proposed CD-3B long-lead procurements appropriate and do they support project risk mitigation? YES. Have the proposed CD-3B long-lead procurements attained final design? YES.

6. Has the project satisfactorily addressed recommendations from previous DOE SC reviews? YES.

Project – Aschenauer, Monday



Recent EIC DOE OPA CD-3B LLP Review

Comments

1. Three of the five CD-3B items (scintillating fibers, lead tungstate crystals, and steel plates/machining/coating/welding) are continuations of procurements authorized by CD-3A. All of these are long lead time items and we agree that they need to be procured as soon as practical to mitigate schedule risks.
2. Two of the remaining CD-3B items (flux return steel/detector support structures for endcap calorimeters and solenoid high current power supply) are related to the detector solenoid magnet. Both are also long lead time items and we agree that they need to be procured as soon as practical to mitigate schedule risks.
3. The last CD-3B item is the purchase of VTRx modules and lpGBT ASICs for use with the MAPS trackers, the dRICH, and other subsystems. It is exceedingly important that this purchase be authorized now so that it can be done in conjunction with the CERN purchase of VTRx and lpGBT for the HL-LHC experiments.
4. The committee commends the project and the ePIC collaboration on the progress towards final designs for all of the detector subsystems.

ENERGY | Office of Science 54

Findings are in the backup

Electron-Ion Collider

ePIC Collaboration Meeting, January 2025

Comments

5. It is important that an agreement be reached with CERN to allow ePIC ASIC designers access to MAPS design files so that they can be modified for the outer tracker layer.
6. Simulations with one track show that the required tracking resolution can be met. Full ep studies have been initiated, but no eA study is yet planned. We encourage the project to work closely with the ePIC collaboration to ensure that eA studies be done to confirm that the detector will meet performance expectations.

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Project – Aschenauer, Monday

EIC Project CD-2 Planning

CD-2 Project Planning Objectives and Constraints:

- Scope required for the DOE Project Key Performance Parameters (KPPs)
- Develop plans for the execution of the portfolio of "off-project" scope
- EIC Project total cost less than $3B (working to optimize scope within this objective)
- DOE annual project funding not to exceed $300M per year
- EIC construction start following the conclusion of RHIC operations
- Start Early Science Program when electron-ion collisions begin!

The constraints result in a longer construction schedule and "dark period" than desirable. This can be partially mitigated by constructing EIC in two stages:

Early Science:	Electron-ion collisions with the ePIC detector
Mission Need:	Additional project scope required to meet the Mission Need

One integrated project delivery plan for the EIC aligned with annual funding constraints.

Project – Aschenauer, Monday

Preparation for CD-2 and CD-3 w/ Subprojects

Requirements

- EIC is a single, integrated line-item project.
- Subprojects will have well-defined deliverables and interfaces.
- Completed subprojects will enable the start of the EIC "early science program."
- Annual funding profile for the subprojects must be consistent with DOE guidance.

Potential EIC Subprojects:

Subproject 1: Hadron storage ring modifications, electron storage ring, and infrastructure
Subproject 2: IR integration, IR superconducting magnets, ePIC detector
Subproject 3: Electron injector systems and related infrastructure

Start Science Program

Subproject 4: RF power, 41 GeV by-pass, 18 GeV capability

Project – Aschenauer, Monday

Detector Reviews planned for 2025

Preliminary Design Reviews (60% design maturity equivalent, called PDR, PDR2 or PDR3, pending the subsystem)

- PDR2: MPGD Tracking Detectors (6.10.03.02) – **Summer 2025** – exact timing linked to progress on first engineering test articles
- PDR2: Silicon Tracking Detectors (6.10.03.01) – Fall 2025 – After early results of ITS3 ER2
- PDR2: Cherenkov-based Particle Identification Detectors (6.10.04; pfRICH, hpDIRC, dRICH) – **early March 2025**
- PDR2: AC-LGAD-based Particle Identification Detectors (6.10.04; BTOF, FTOF, common systems) – Fall 2025
- PDR3: Barrel EM Cal (6.10.05.02) – ~August 2025
- PDR2: Backward HCAL (6.10.06.01) – ~September 2025
- PDR: Magnet Cryogenics and infrastructure (6.10.07) – September/October 2025
- PDR3: Electronics/DAQ-computing (6.10.08. 6.10.09.01) – **Late August 2025** – this does not include slow controls
- PDR: DAQ-Slow Controls (6.10.09.02) – November/December 2025 – Later to ensure integration DAQ in the collider common platform
- PDR: Integration, Infrastructure and Installation (6.10.10) – September/October – everything outside GST, includes cradle, HCAL, etc.
- PDR: Integration, Infrastructure and Installation (6.10.10) – November/December 2025 – everything inside GST
- PDR3: IR Integration and Auxiliary Detectors (6.10.11) – November/December 2025 – includes 6.10.14 lumi detector
- PDR2: Polarimetry (6.10.014) – September/October 2025

Final Design Reviews (FDR):

- FDR: Backward & Forward EM Calorimetry, Barrel & Forward HCAL (6.10.05.01; 6.10.05.03; 6.10.06.02; 6.10.06.03) – **May 2025**

Project Reviews:

- ✓ OPA CD-3B Review – January 7-9, 2025
- OPA Project Status Review – Summer 2025 (~6 months after CD-3B Review)

Other Meetings:

- Detector R&D Day hosted by ePIC and EIC Project: **~April 2025**
- DAC Meeting – **Spring 2025** – Comprehensive look to design status and readiness for CD-2. Plan for 3-4 separate days to split topics.
- 5th RRB Meeting: June 5-6, 2025 – Prague, Czech
- ePIC Software & Computing review by host labs: ~April 2025 for status check?

Project – Aschenauer, Monday

Impact of recent Accelerator Changes on ePIC

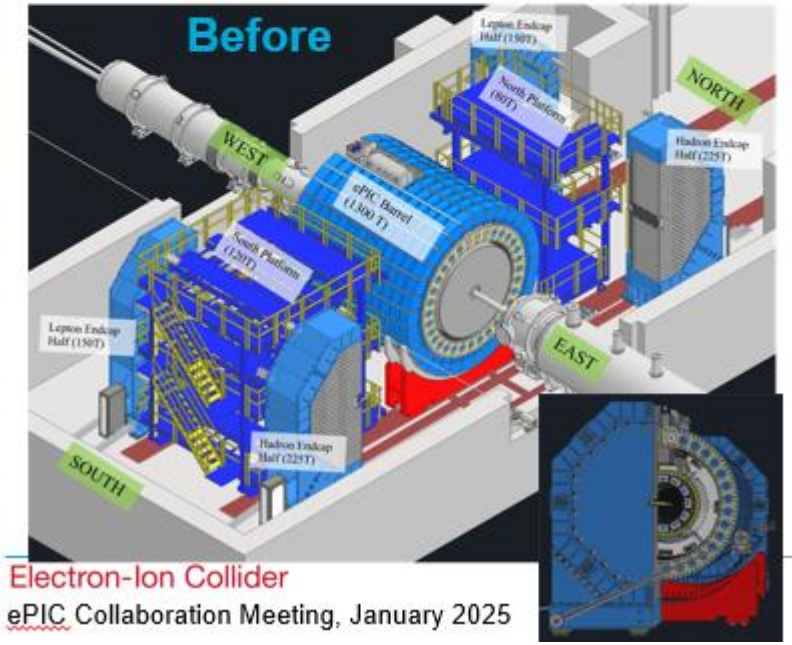
RCS is moved out of the EIC tunnel → significantly simplified constrains

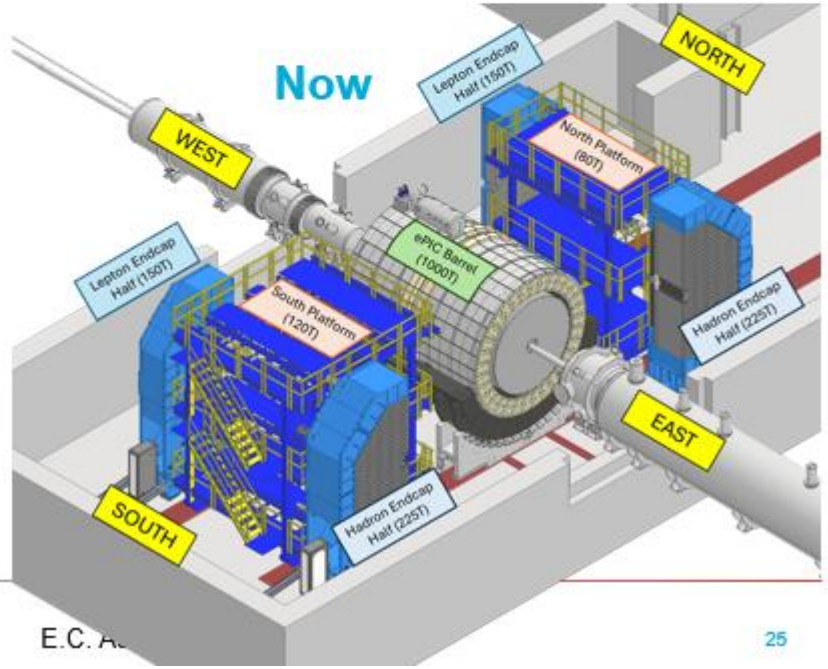
Original constrains by the RCS: Fringe field along ePIC < 10 Gauss

→ required additional flux return steel around Barrel HCal → significant weight increase → floor strengthening required?

→ flux return around Barrel HCal not needed anymore

- outer radius limit of ePIC to 3.4 m removed
- no changes to endcap design as they are driven by the fringe field requirement of IR magnets and forces on ePIC magnet
- no need to break RCS vacuum anymore if endcaps are opened → faster access
- now large fraction of Barrel HCal is serviceable





SVT Workfest – Sedgwick, Tuesday

AncASIC Performance

Overall Power Consumption

EIC-LAS, AncASIC and Total Power (mW)	MODE 0										
	Typ				Max				Total		
	EIC-LAS	AncASIC			EIC-LAS	AncASIC			Min	Nom	Max
		Min	Nom	Max		Min	Nom	Max			
Global Digital	701	131	210	238	1088	193	341	394	832	911	1482
Global Analog	224	61	71	83	360	88	111	147	285	295	507
Services	53	28	32	44	80	18	41	66	81	85	146
Serialiser	246	47	115	128	369	37	172	246	293	361	615
Total	1224	267	428	493	1897	336	665	853	1491	1652	2750
AncASIC Power Fraction		21.81%	34.97%	40.28%		17.71%	35.06%	44.97%			

N.B. FPC traces add another 200mW

Prev values: 1702 2581

Science and Technology Facilities Council

SVT Workfest – Close-out, Friday

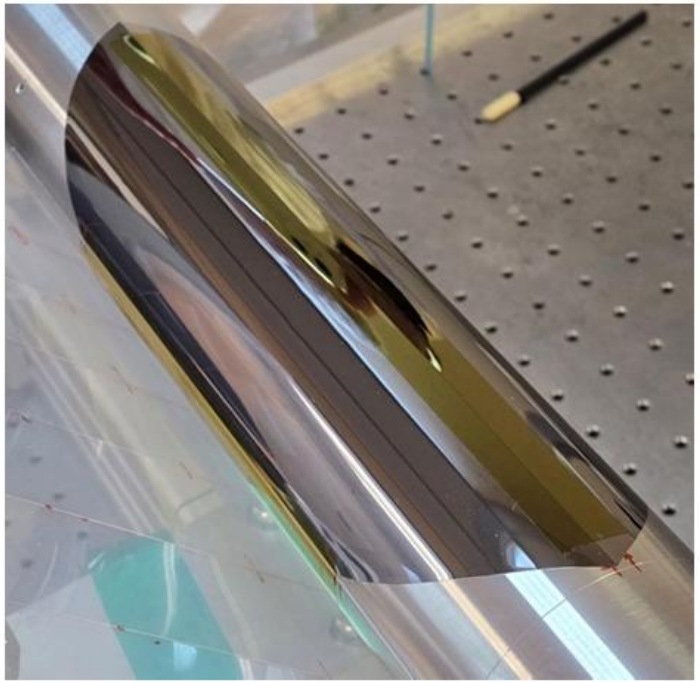
Chip temperature specifications

	LEC	RSU	REC	AncASIC
Maximum temperature [°C]	65	40	N/S	80
Maximum temperature variation [°C]	10	1 over 3 mm 10 over full length	N/S	10

- Joao will investigate the variation of power with temperature
- If no objection will import to standalone TDR document for specification of thermal management

SVT Workfest – Camerlingo, Tuesday

Results of the last half-layer bending trial



It proceeded smoothly

No significant cuspid was observed

SVT Workfest – Li / ES, Friday

Where are we?

In the ePIC software stack:

- performance metrics from real-seeded tracks (i.e. track finding and reconstruction),
- performance metrics on single-tracks and on DIS-events

SVT Workfest – Li / ES, Friday

Where are we not or not yet?

In the ePIC software stack:

- No demonstration yet of performance with DIS events + backgrounds + detector noise,
- Detector description is still far from complete,
- (No rapid-feedback loop between design and simulation),

SVT Workfest – Li / ES, Friday

What do we need?

Demonstration of sufficiency of the ePIC tracking system for DIS + background + noise events

Hit rates at the sensor level are increasingly critical

More advanced detector description, including an updated services model,

…

That is,

Concerted effort, i.e. find additional dedicated effort / person-power,

? – “Hackathon” e.g. adjacent to an upcoming ACTSNP workshop (May 14-16, 2025 in Berkeley)
-- SVT in-person workshop in June/July 2025 timeframe in the Long Island area

Early Science – Zurita, Wednesday

Theory: Opportunities for first EIC physics

P. Zurita

ePIC collaboration meeting
Jan. 20-24, 2025

Early Science – Zurita, Wednesday

25/26

- Despite not having the fully polarised collider nor the integrated luminosity envisioned in the YR, the first years of the EIC are very promising.
- It will be possible to use early first data to improve on observables that we are familiar with (plus contributions from other experiments before EIC starts).
- Even without all nuclear species and “low” luminosity, many observables are absolutely new and exciting.
- Careful and realistic studies are the next step.
- I would not rule out anything that is not 100% impossible for now.
- Ru vs. Cu? Choose Ru!

26/26

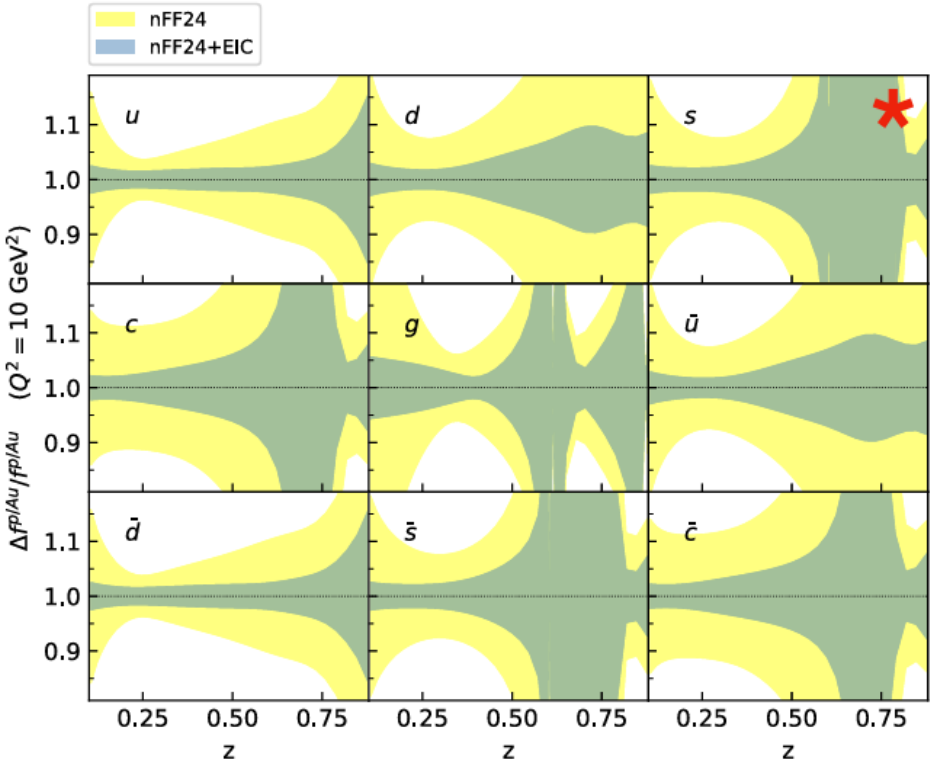
We have come a long way from the YR, but we have a lot more to do.

Early Science – Zurita, Wednesday

SIDIS in e+A and nFFs (for light mesons)

Hadron formation in-medium for low energies (suppression at HERMES and JLAB)

Hadron formation outside the medium for EIC?



- New (global) extraction of nFFs.

nFF24 by M. Doradau, R.T. Martinez, R. Sassot, M. Stratmann, 2411.08222 [hep-ph]

- JLAB Fe data poorly described (w.r.t. Pb)

Collaboration Council Mtg. – Thursday

Spokesperson Election Report
Helen Caines

Committee: John Arrington, Ken Barish, Helen Caines (Chair), Domenico Elia, Maria Stefaniak

1/22/2025

Collaboration Council Mtg. – Thursday

Election Details

- EC made email calls to whole collaboration seeking nominees starting Fall 2024
- All nominees (> 20) were contacted
- John Lajoie accepted nomination with Silvia Dalla Torre as Deputy
  - Our charter allows for a second term
  - Many other nominees expressed interest in running in the future, but decide not to stand this time due as thought timing was not optimal
- Although only one candidate will still proceed with election started during CC meeting towards end of February
  - A quorum of at least 2/3 of the voting Council members is required for a valid vote
  - Spokesperson elected by simple majority (>50%) of CC votes cast
- Special thanks to anyone who took the time to make nominations

Closing (plenary) session – Friday

Next EICUG/ePIC Collaboration Meeting

- Jefferson Lab, Newport News, VA
- Joint meeting with the EICUG/ePIC Collaboration
  - Planning a more integrated meeting
- Week of July 14th
- More information to follow soon

Thank you, Douglas Higinbotham, for making the July option at JLab concrete!

Closing (plenary) session – Friday

TDR and Early Science

- Chapter 2 needs to grow into polished document with a coherent text
  - **Priority:** ch.2 must provide clear requirements set by the science
  - **Priority:** assign internal and external reviewers to guide us though the process
- Define an Early Science case for ePIC
  - Use Early Science studies a focus for efforts in analysis and engagement with theory
  - Keep/improve communications with theorists and the project
  - Final product should be a published ePIC paper
  - **Priority:** define a clear and achievable roadmap to the final product

Closing (plenary) session – Friday

High-level analysis priorities for 2025

In view of these considerations, the following list highlights out high-level priorities for 2025

- **Priority 1:** Increase Analysis engagement —> Need to include analysis "module" attached to SCC landing page so people can go from learning to make histograms to real analysis
- **Priority 2:** Increase realism for physics observables —> Multiple issues - need more "physics objects", need PID/eID
  - Work with SCC to develop a boundary between what is in the data model and what is under analysis macros/scripts
- **Priority 3:** Efficiently connect tasks with workforce – improve onboarding
- **Priority 4:** Determine the "best" observables for the early science case and what is needed for impactful measurements
- **Priority 5:** Develop a results validation scheme for talks/reviews/documentation