

# EIC Computing and Software Joint Institute Status Report



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Review of ePIC Computing and Software.  
September 26-27, 2024

## Outline

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- This talk particularly addresses aspects of the EIC Computing and Software Joint Institute (ECSJI) since previous review
  
- Outline
  - ECSJI scope
  - ECSJI and ePIC collaboration / EIC project coordination and integration
  - EIC Resource Review Board meeting (May 6-7, 2024)
    - RRB recommendations
  - EIC International Computing Organization Status
  - ECSJI plans on SW&C integration
    - EIC off-project dependencies review at BNL (August 21-22, 2024)

## EIC Computing and Software Joint Institute

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- Brookhaven National Laboratory (**BNL**) and Thomas Jefferson National Accelerator Facility (**JLab**), as Electron-Ion Collider host labs, have established a collaborative entity, the **EIC Computing and Software Joint Institute (ECSJI)**.
  - This joint institute is designed to support the computing and software needs and activities of the EIC.
    - ECSJI mandate ([link](#))
  - The Institute was established in FY24
- ECSJI will leverage **complementary expertise at the two labs** and provide needed visibility to the respective lab management and stakeholders.
  - *The advantages of such a structure also include increased reliability and availability of resources for the ePIC collaboration and other future collaborations.*
- The success of the EIC, an international scientific endeavor, will benefit from contributions from international partners towards its computing effort.
- To facilitate efficient coordination, the Institute will administer the EIC International Computing Organization (EICO), which will include all the contributors to the EIC computing effort.

## ESCJI : Scope

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### **The Institute will provide for EIC computing and software matters:**

- 1) A single entity to interface with the EIC project, accelerator scientists, the ePIC collaboration, theoreticians, and future collaborators.
- 2) Execution of host lab technical computing responsibilities ([link](#)).
- 3) Maintenance of service level agreements and statements of work outlining the host labs' contribution to the ePIC collaboration concerning computing resources, services, and personnel assigned to work on ePIC computing and software deliverables.
- 4) A coordinating body for interacting with international partners, providing computing resources as in-kind contributions, including:
  - Assessing resources.
  - Managing the agreements with the sites delivering resources (including service levels).
  - Facilitating and assessing the delivery against the agreements.

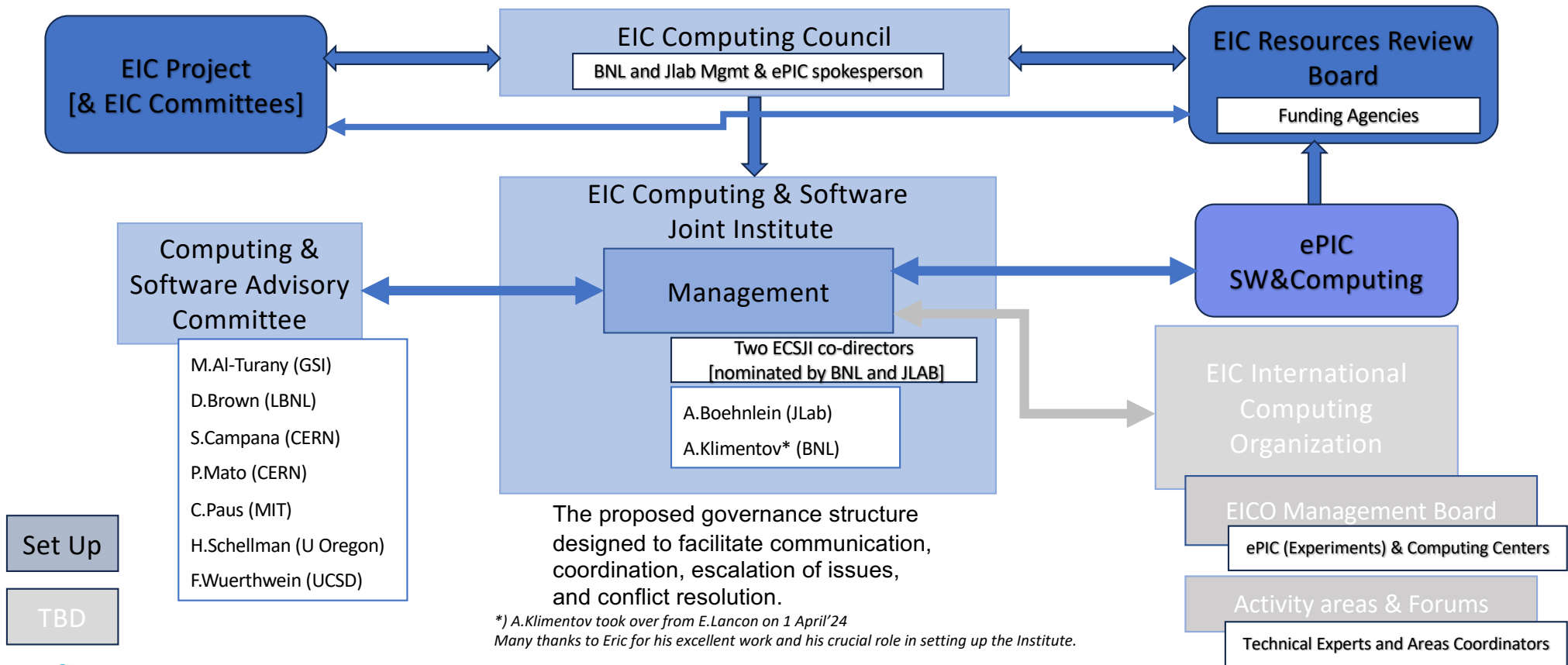
*The scope may evolve over time and the organization of the institute as well*

## ECSJI / EIC / ePIC Coordination and Integration

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- ECSJI. The Institute has two co-directors, each is nominated by one Lab
  - The co-directors are currently Amber Boehnlein (JLab) and Alexei Klimentov (BNL)
    - *A.Klimentov took over from E.Lancon on 1 April'24*
      - *Many thanks to Eric for his excellent work and his crucial role in setting up the Institute.*
- ECSJI co-directors have regular meetings with host labs management
  - To discuss how Computing and Software activities (personpower and resources) are supported by Labs
- ECSJI co-directors have regular meetings with ePIC (spokesperson and deputy, SW&C coordinator) and EIC Management (Co-Associate Directors for the EIC Experimental Program)
  - Typically, bi-weekly – address host Labs < == > ePIC and host Labs < == > EIC project issues
- ECSJI co-director(s) have been invited to participate in ePIC/EIC topical meetings
  - Collaborative tools development for the experiment and EIC project
  - ePIC data streaming model
  - AI/ML for EIC
  - Positive SW developments and coordination between ePIC SW&C and ECSJI*
- Two reviews with ECSJI & ePIC/EIC talks about SW&Computing for ePIC and EIC
  - EIC RRB May 6-7, 2024 (AB&AK, MD)
  - EIC off-project review August 21-22, 2024 (AK&TW)

# EIC Computing Organization & Governance



Set Up

TBD

## EIC RRB Meeting, May 6-7, 2024

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### Findings (ECSJI, Computing and SW)

- BNL and JLAB established the EIC Computing and Software Joint Institute (ECSJI) in 2023.
- The ECSJI will administer the EIC International Computing Organization (EICO), which will include all the contributors to the EIC computing efforts.
- The proposed EIC Computing Organization and Governance organization chart were presented. This includes a Computing Council (ECC), Institute Management, Computing and Software Advisory Committee (ECSAC), and the International Computing Organization (EICO).
- The ePIC Streaming Computing Model is the primary document for preparing agreements with international partners.
- External partners will be included in drafting the EICO charter. Discussions with WLCG are in progress.
- The first version of the ePIC Streaming Computing Model will be reviewed by the ECSJI Computing and Advisory Committee in Fall 2024. Discussions are ongoing with international partners including Italy, Canada and UK.

## EIC RRB Meeting, May 6-7, 2024. Cont'd

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### Action Items (ECSJI, Computing and SW)

- Echelon 1 is funded by DOE-NP; Echelon 2 & 3 are extraordinary and IKC. Develop mechanism to determine needs and what the pledges will be.
- International Funding agencies will look into their existing computing infrastructure and its alignment with EIC Echelon 2.
- RRB develops its vision for EIC computing and governance.
- Clarify the relationships with the RRB, EICO, and ECSJI.
- Establish EICO by next RRB.
- Review of ePIC computing model will be scheduled by next fall before the next RRB.
- Further development of an overall governance structure (RRB, ECSJI, computing, experiment, EIC project).

4<sup>th</sup> RRB Meeting will be held in the USA at Brookhaven National Laboratory on November 12-13, 2024



## EICO : progress and plans

- Principal Investigator(s) and/or funding partner contact(s) involved in the EIC and ongoing Resource Review Board meetings have been contacted in June - August.
  1. If you are interested in being a partner in providing computing resources for the EIC, we would like you to nominate a computing contact.
  2. These computing contacts would work with Amber Boehnlein and Alexei Klimentov to gather and distil input on how we can best integrate funding partners into the ePIC computing model, and to develop a strategy on how best to integrate computing and detector contributions for oversight by an RRB.
- EICO Kick-off meeting : ~week 41 or 42
  - Topics (PoC have asked us to address so far)
    - ePIC computing model
    - the expected resource requirements and the expected share per country
      - starting from simulation and design activities through to eventual running
    - event sizes and memory profiles

1. **Canada** - **Wouter Deconinck** (Manitoba)
2. Czech - no response yet
3. **France** (IN2P3 & IRFU) – primary scientists (Carlos Munoz Camacho and Francesco Bossu) are investigating but **may only name person beyond August meeting**
4. India - no response yet
5. Israel - no response yet
6. **Italy** – for next months they want to start with **Andrea Bressan** (Trieste) who is the INFN-ePIC computing coordinator and with **Domenico Elia** (Bari) who is the incoming EIC-Italy primary scientist and a member of the top INFN steering committee on computing (chaired by Giampaolo Carlino).
7. **Japan** - **Taku Gunji** (Tokyo)
8. Korea - no response yet
9. **Taiwan** - **Eric Yen** from Academia Sinica Grid Center (ASGC)
10. **UK** – interested in ePIC computing, **one ePIC contact** (for now use **Peter Jones** (Birmingham)) and **one GridPP contact** (**Roger Jones** (Lancaster)). Have had preparatory meetings including Jon Hays (IRIS), Pete Clarke and Dave Britton (GridPP) and Roger Jones (Lancaster, GridPP/ATLAS rep.).

## EIC off-project dependencies review at BNL, August 21-22, 2024

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- EIC computing\* session
  - Host Labs responsibilities
  - EIC Computing and Software Joint Institute scope and progress report
  - Echelon0 computing and networking options (with SW&C and DAQ input) [\[link\]](#)
  - ePIC computing model : Echelon1 and networking requirements [\[link\]](#)
  - Possible schedule for I&I during construction and commissioning phases [\[link\]](#), for Science Phase [\[link\]](#)
  - Available Computing Resources
    - Opportunistic resources continue to provide most of the processing resources in FY24
  - Actions required
- Some recommendations
  - Consider a programmatic management model of these dependencies with roles and responsibilities reporting directly to the lab director.
  - Do a risk analysis and develop mitigation strategy for each dependency.
  - The project needs to provide key milestones for the off-project dependencies. Dependencies should also provide key milestones to be tracked inside the project schedule.
  - Revisit the organization structure of the ePIC project to strengthen the relationship between on-project, off-project and the Lab managements.
  - The EIC Host Labs should organize a Director's review of the EIC Project, including all Off Project Dependencies by Spring 2025.

*\*Echelon0 is funded by EIC project, Echelon1 - off-project dependencies*

## Conclusion

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- ESCJI has executed its responsibilities successfully and working closely with the ePIC collaboration and the EIC project
  - Preliminary Computing and Software plans have been presented to the BNL EIC off-project dependencies review
- Limited SW&C budget (with no dedicated funding) represents a persistent challenge
  - DOE NP statement on Echelon1 funding is a positive step and important at this stage of the project
  - The allocation of dedicated funds for early computing and software prototyping at both laboratories will be beneficial for the ePIC and EIC project.
- I&I will be a challenging effort for both Labs and preliminary plans for SW&C will be developed (also to be coordinated with ePIC DAQ and SW&C teams)
- The EICO kick-off meeting is planned for October, the initial list of topics for International Partners is ready (prepared by ESCJI and EIC), and it will be discussed with ePIC management after this review
  - The aim is to report EICO status at the next RRB meeting

# Backup Slides

# The EIC Computing and Software Joint Institute was created fall of 2023

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## The EIC Computing and Software Joint Institute (ECSJI)

Brookhaven National Laboratory (BNL) and Thomas Jefferson National Accelerator Facility (JLab), as EIC host Labs, are creating a joint structure, the EIC Computing and Software Joint Institute (ECSJI), incorporating parts of BNL and JLab facilities to support the EIC and computing and software needs and activities. ECSJI will leverage complementary expertise at the two Labs and provide needed visibility to the respective Lab management and stakeholders. The advantages of such a structure also include increased reliability and availability of resources for the ePIC collaboration.

The success of the EIC, an international scientific endeavor, will benefit from contributions from international partners towards its computing effort. To facilitate efficient coordination, the institute will administer the EIC International Computing Organization (EICO), which will include all the contributors to the computing effort.

### Scope of the EIC Computing and Software Joint Institute

*This institute will provide for EIC computing and software matters:*

- 1) A single entity to interface with the EIC project and the ePIC collaboration,
- 2) Maintains Service Level Agreements and statements of work outlining the host labs' contribution to the ePIC collaboration concerning computing resources, services, and personnel assigned to work on ePIC computing and software deliverables,
- 3) A coordinating body for interacting with international partners providing computing resources as in-kind contributions. This includes assessing resources, managing the MOUs with the sites delivering resources (including service levels), and facilitating and assessing the delivery against the MOUs,
- 4) Execution of host Lab responsibilities as detailed below.

### Organization & Governance

The institute aims at providing efficient support to the EIC while acknowledging the differences in the organization at the two Labs. The proposed governance model ensures that the EIC experiment(s) are well supported in matters of computing and software, the institutes' performance is monitored, and reporting is clearly defined.

#### The Institute Management

- **Composition:** the management will comprise two co-Directors; each is nominated by one Lab. The co-directors are currently Eric Lancon (BNL) and Amber Boehnlein (JLab).
- **Reporting:** the institute's management will report jointly to the two host Lab management.
- **Duties and accountability:**
  - The management will be responsible for organizing the institute to deliver on the responsibilities defined above.
  - The management will maintain a multi-year operation plan for the host Labs, providing matrixed staff members to support the activities.
  - The management will provide a yearly report to the host Lab's management.

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## Responsibilities

### The Host Lab's Responsibilities

*The primary technical responsibilities of host Labs include and are not limited to the following:*

- Oversight for ePIC software and computing designs and execution to provide assurance functions for the host Labs and DOE,
- Provisioning and operating standard infrastructure solutions consistent with supported Lab infrastructures and with community best practices,
- Support for the EICO,
- Interface for local resources and policies at the respective Labs,
- On-going computing operations in support of the accelerator and detectors design and construction,
- Operational Support Functions for:
  - Experimental data curation,
  - First-pass processing,
  - Data analysis,
  - Support of collaboration(s) and users,
  - Accelerator and detector simulations.

### ePIC Collaboration Responsibilities

*The ePIC collaboration responsibilities include and are not limited to the following:*

- Developing and documenting a cost-effective computing model tailored to the experiment's needs, with the concurrence of the host Labs,
- Developing and maintaining multi-year resource plans,
- Report ePIC status in computing and software to the EIC-RRB,
- Identifying with input from the host Labs, a Computing and Software coordinator who serves as Point of Contact to ECSJI,
- Developments of Software Algorithms,
- Production operations.

Haiyan Gao  
Associate Laboratory Director  
Brookhaven National Laboratory

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Haiyan Gao  
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David J. Dean  
Deputy Director for Science  
Jefferson Lab

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Dean  
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# The primary technical responsibilities of host Labs

Oversight for ePIC software and computing designs and execution to provide assurance functions for the host labs and DOE.

Provisioning and operating standard infrastructure solutions consistent with supported lab infrastructures and community best practices.

Support for the EIC International Computing Organization.

Interface for local resources and policies at the respective labs.

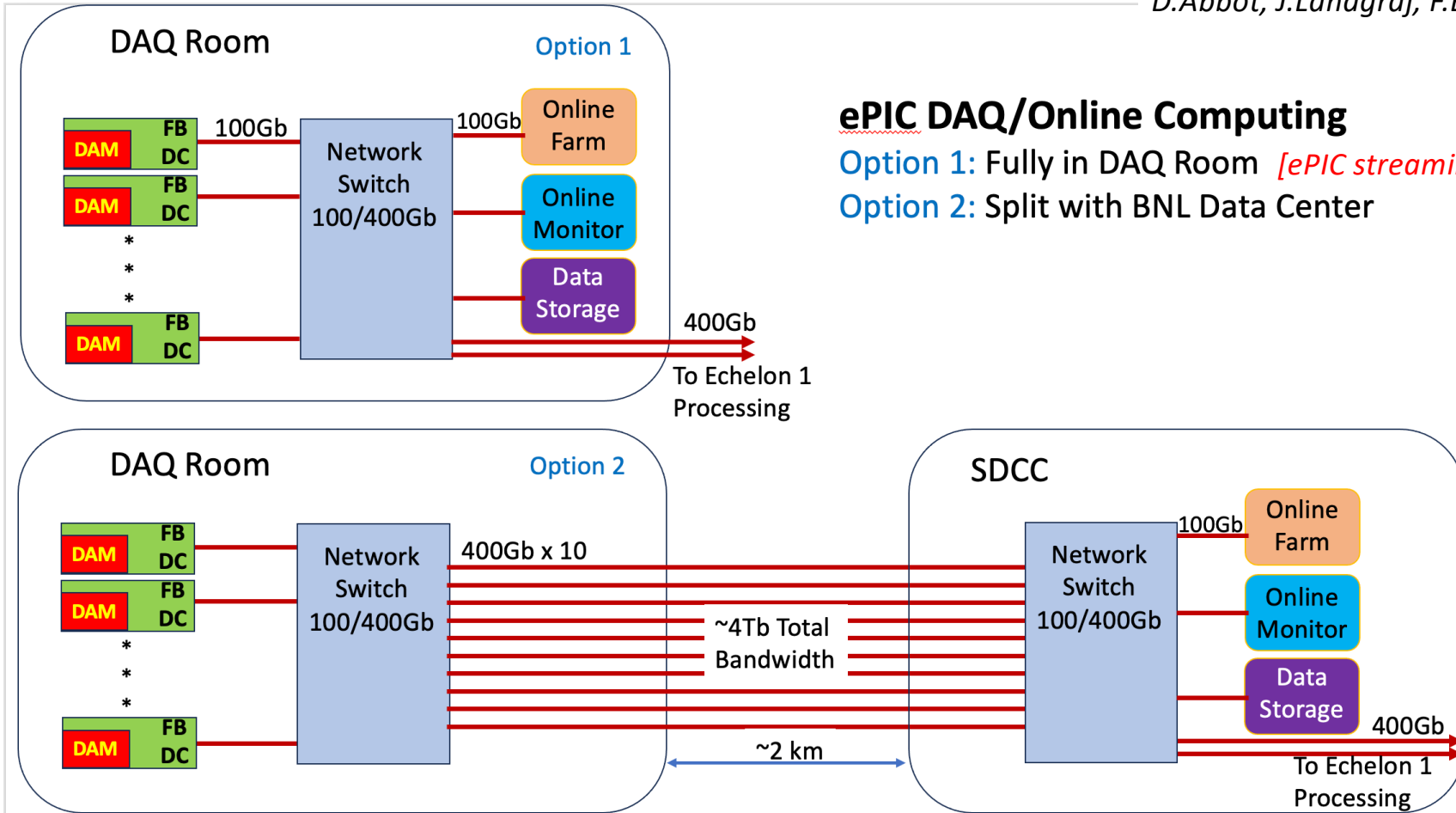
On-going computing operations in support of the accelerator and detector design and construction.

Operational support functions for:

- ✓ Experimental data curation.
- ✓ First-pass processing.
- ✓ Data analysis.
- ✓ Support of collaboration(s) and users.
- ✓ Accelerator and detector simulations .

# Echelon 0 Computing Options

Plans for DAQ/Electronics  
Integration/Testing/Installation and  
needs for Off-Project Support  
D.Abbot, J.Landgraf, F.Barbosa



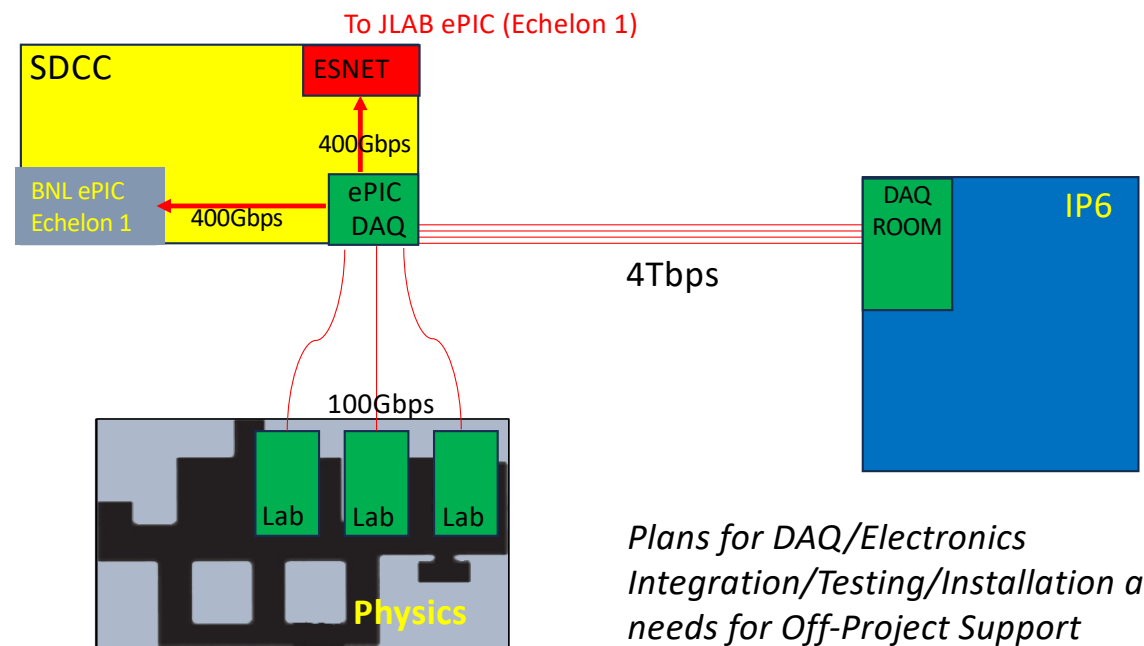
## ePIC DAQ/Online Computing

Option 1: Fully in DAQ Room [ePIC streaming model]

Option 2: Split with BNL Data Center

# Network Infrastructure

- ePIC DAQ and Computing require network connectivity at BNL between resources in IP6, SDCC and development labs that is bandwidth guaranteed and minimizes routing.
- Early DAQ & Electronics development will be in Labs (Physics).
- Initial computing needs for development would best be placed in a central location (SDCC, 5-6 racks total).
- As construction and installation ramps up at IP-6 additional Echelon 0 computing resources can be placed in both sites.
- For production running it is important to have **equal and transparent network access** from SDCC to both Echelon 1 sites (BNL and JLAB)



*Plans for DAQ/Electronics Integration/Testing/Installation and needs for Off-Project Support  
D.Abbot, J.Landgraf, F.Barbosa*



# ePIC Computing Requirements for Echelon1. Networking

Networking	egress [Gbps]	ingress [Gbps]
RAW data (immediate ~17% of total)	17	
RAW data (contingency)	50	
Monitoring, H&S data, E0/E1/E2 status	1	1

*All numbers from ePIC “The streaming computing model” note and do not include Monte-Carlo data [at least 30% should be added]*

ePIC network requirements do not include:

- Networking infrastructure at BNL
  - Data transfer between counting house and computing center
  - Data transfer between counting house and “buffers”
- ingress doesn’t include data transfer (derived data) from Echelon2 to Echelon1
- egress doesn’t include raw data transfer to Echelon2 and derived data transfer from Echelon1 to Echelon2
- Users traffic is not included
- BNL < – > JLab WAN connectivity performance is not addressed

## Open questions :

1. What is the required uptime for connectivity from the counting house to the 725 data center and to JLAB

*The current fibre infrastructure within the EIC/RHIC ring doesn't include fibre redundancy to/from the counting house. Also, these current projects don't address the fibre infrastructure and cabling from the counting houses to Building 725.*

2. Bldg.515 and Bldg.725 network infrastructure

1. Bldg 515 (old data center) network infrastructure will be EoL in FY26 and it doesn’t support high data rate
  1. The 515 Spine can connect compute top of rack switches at ~40Gbps where in 725 we can support 400Gbps+ to each compute rack.

# ePIC Computing Requirements for Echelon1. Storage

Storage	Disk transient [PB]	Disk permanent [PB/year]	Tape [PB/year]
RAW and derived data	11	20	220

*All numbers from ePIC “The streaming computing model” note and do not include Monte-Carlo data [at least 30% should be added]. All numbers for nominal luminosity.*

ePIC storage requirements do not include :

- storage for intermediate data buffering
- storage for end user analysis and for users
- storage for tape buffer
- *The scale of compute resources is not estimated yet, but 220PB/year is comparable with ATLAS annual data volume for LHC Run3 and require  $O(3000kHS23)$  for the first year and 15% increase per year*

*US ATLAS approach to have 10% margin for storage and 20% for Compute*

**Services : data management, WF management, databases are not included**

**Tape** (assuming ‘data carousel’ – active data exchange between disk and tape)

- 1 LTO10 tape library (8,000 slots) can hold 240PB. LTO10 is GA in 1Q25.
- To meet 50Gb/sec (6.5GB/sec) , we should prepare 2 disk arrayys (\$105K each) as HPSS internal cache and 28 LTO10 drives (400MB/sec per drive).
- The tape library with 28 LTO drives should cost about \$450K. Tape medium cost is about \$3 per TB.

*We don’t see problems on Data Carousel with HPSS for ePIC at nominal luminosity.*

# Computing and Networking Schedule. Construction and Commissioning Phase

	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32
EIC schedule								c c c c
DAQ schedule		t	d	h	f		μ	
<u>Networking&amp;Tests</u>	Ω	Test 515 725		Test IP6 725		β	λ	α
SDCC Bldg.725		6 DAQ racks		DAQ+ racks	DAQ storage		Production ready	
Bldg.515	Check/Decide & (no)update infrastructure							
compute		2000 jobs slots		5000 jobs slots		Procurement and Installation : 30% of FY34 nominal	Production ready	
storage		2PB		5PB		Procurement and Installation : 25% of FY34 nominal	Production ready	
archive (tape)				5PB		Procurement and Installation : 25% of FY34 nominal	Production ready	
services		Early development & prototype		HW procurement & installation	commi ss'ng		Production ready	

## EIC timeline:

- c : commissioning run

## DAQ timeline :





- t : DAQ test set up
- h:DAQ full hardware and timing chain
- d : DAQ readout detector in test stand
- f : full DAQ chain
- μ : DAQ ready for cosmics

## Networking & tests timeline :

- Ω : collect and evaluate requirements for EIC/RHIC LAN
- β : BNL LAN Data Challenge
- λ : Echelon0/Echelon1 Data Challenge
- α:Full Dress Rehearsal
  - DAQ → <Echelon 0> → Echelon1/..

*This is an early assessment and will be discussed and updated after the ePIC Computing model review in September 2024  
The procurement schedule, WAN testing and data challenges are also subject to discussion and agreement with JLab.*

# Computing and Networking Schedule. Science Phase

	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	
EIC schedule		10% nominal luminosity						Nominal luminosity	
compute	Procurement & Installation 20% of FY39				Procurement & Installation 75% of FY39	Procurement & Installation 120% of FY39		Pledge resources +15% / year	
storage	Procurement & Installation 20% of FY39				Procurement & Installation 75% of FY39	Procurement & Installation 110% of FY39		Pledge resources +15% / year	
archive (tape)	Procurement & Installation 25% of FY39				Procurement & Installation 75% of FY39	Procurement & Installation 120% of FY39		Pledge resources +15% / year	
<u>Networking&amp;Tests</u>	DC 33	ESnet case study : EIC				DC38			

*This is an early assessment and will be discussed and updated after the ePIC Computing model review in September 2024  
The procurement schedule, WAN testing and data challenges (DC) are also subject to discussion and agreement between host Labs*

## Glossary and Abbreviations

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- AHM – All Hands Meeting
- AI4EIC --- Artificial Intelligence for the Electron Ion Collider
- ECC - EIC Computing Council
- EICO – EIC International Computing Organization
- ESCJI – EIC Software and Computing Joint Institute
- I&I – installation and integration
- IKC – in-kind contribution
- SLA – Service Level Agreement
- WLCG – World LHC Computing Grid