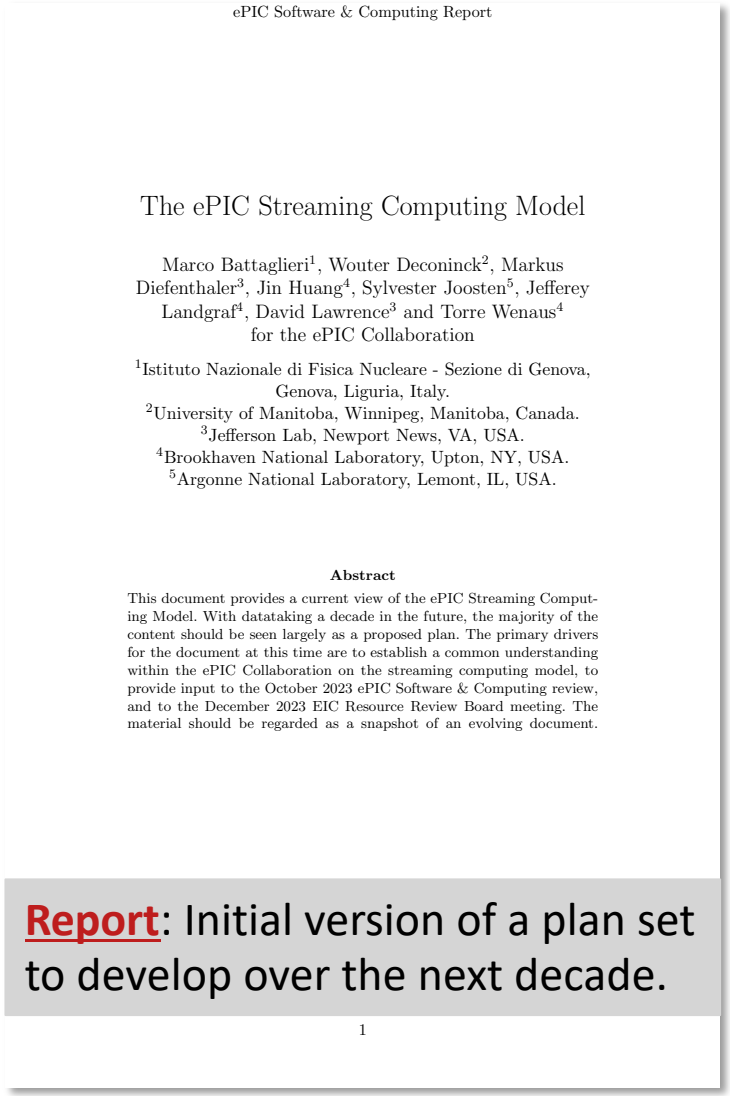
Compute Resource Estimates

ePIC Streaming Computing Model



ePIC Software & Computing Report

The ePIC Streaming Computing Model

Marco Battaglieri[1], Wouter Deconinck[2], Markus Diefenthaler[3], Jin Huang[4], Sylvester Joosten[5], Jefferey Landgraf[4], David Lawrence[3] and Torre Wenaus[4]
for the ePIC Collaboration

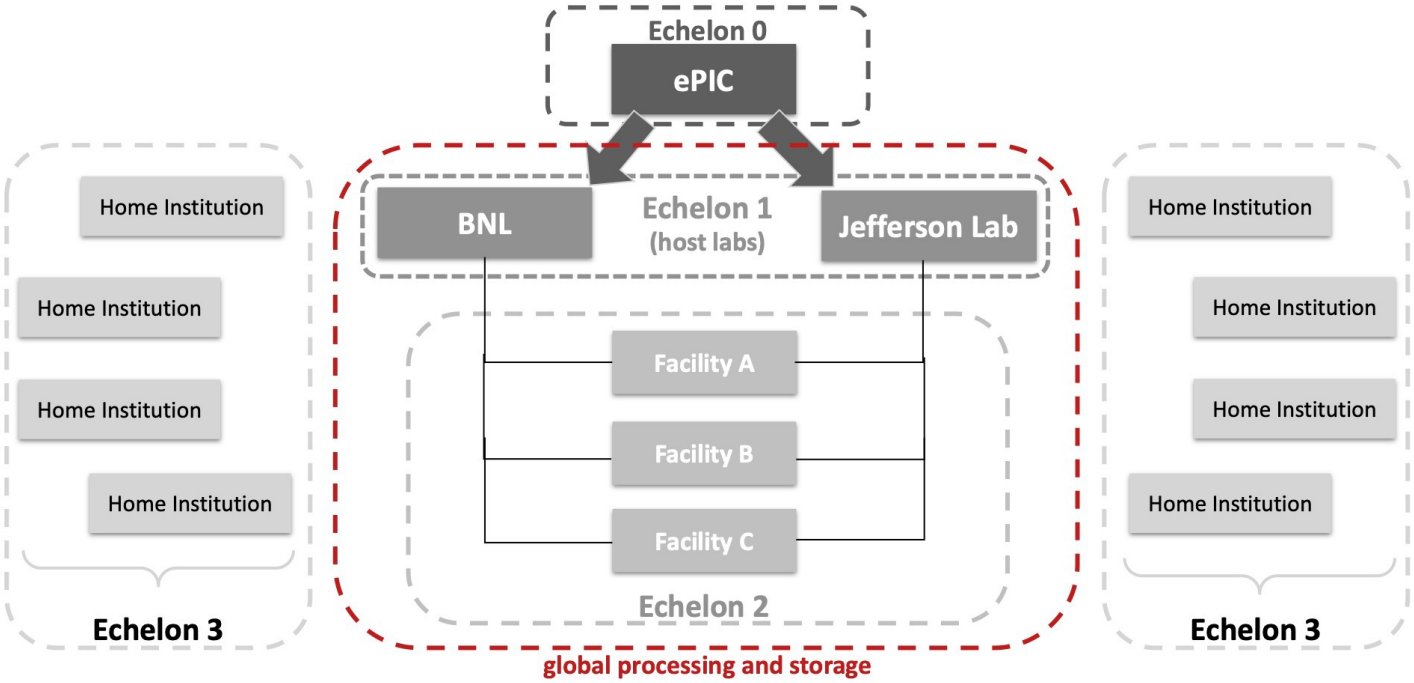
[1]Istituto Nazionale di Fisica Nucleare - Sezione di Genova, Genova, Liguria, Italy.
[2]University of Manitoba, Winnipeg, Manitoba, Canada.
[3]Jefferson Lab, Newport News, VA, USA.
[4]Brookhaven National Laboratory, Upton, NY, USA.
[5]Argonne National Laboratory, Lemont, IL, USA.

Abstract

This document provides a current view of the ePIC Streaming Computing Model. With datataking a decade in the future, the majority of the content should be seen largely as a proposed plan. The primary drivers for the document at this time are to establish a common understanding within the ePIC Collaboration on the streaming computing model, to provide input to the October 2023 ePIC Software & Computing review, and to the December 2023 EIC Resource Review Board meeting. The material should be regarded as a snapshot of an evolving document.

1

Report: Initial version of a plan set to develop over the next decade.



Echelon 0: ePIC experiment.

Echelon 1: Crucial and innovative partnership between host labs.

Echelon 2: Global contributions.

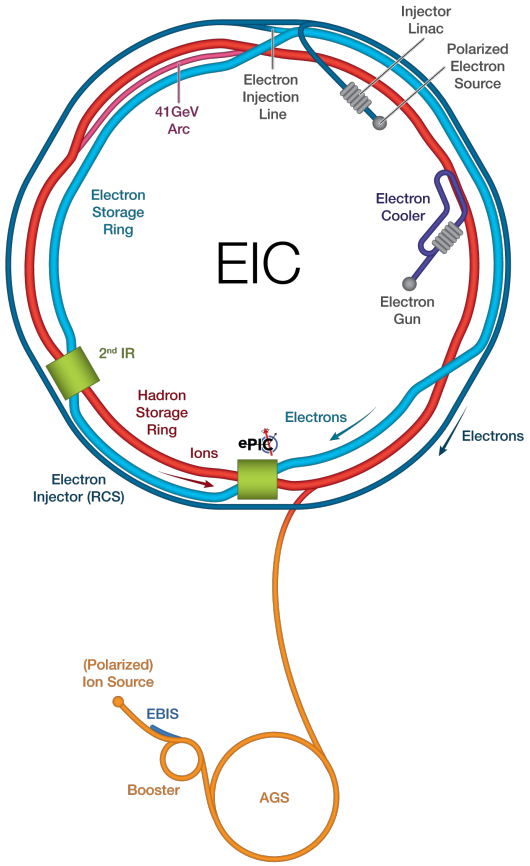
Echelon 3: Full support of the analysis community.

Towards a Quantitative Computing Model

Use Case	Echelon 0	Echelon 1	Echelon 2	Echelon 3
Streaming Data Storage and Monitoring	✓	✓		
Alignment and Calibration		✓	✓	
Prompt Reconstruction		✓		
First Full Reconstruction		✓	✓	
Reprocessing		✓	✓	
Simulation		✓	✓	
Physics Analysis		✓	✓	✓
AI Modeling and Digital Twin		✓	✓	

ToDo: Estimate compute resources for each use case.

The EIC and Event Rates



- **Versatile machine**: versatile range of beam polarizations, beam species, center of mass energies.

- **High luminosity** up to L = 10^{34} cm^{-2} s^{-1} = 10 kHz/µb.
  - The e-p cross section at peak luminosity is about 50 µb. This corresponds to a signal event rate of about 500 kHZ.

- The **bunch frequency** will be **98.5MHz**, which corresponds to a **bunch spacing** of about **10ns**.
  - For e-p collisions at peak luminosity, there will be in average 200 bunches or about 2µs between collisions (98.5MHz / 500 kHz).

Rate Estimates from MC

Details on rate estimates are available on the **Wiki pages of the background task force**:

E_e x E_p [GeV x GeV]	5 x 41	5 x 100	10 x 100	10 x 275	18 x 275
Signal Rates					
e-p cross section [µb]	28	35	41	50	54
e-p rates [kHZ]	12.5	129	184	500	83
Background Rates					
e-beam gas rates [kHZ]	2182.0	2826.4	3177.3	3177.3	316.9
p-beam gas rates [kHZ]	12.2	22	31.0	32.9	22.5

Bounds for signal and background event numbers, assuming running 60% up-time for ½ year = 9,460,800 s:

E_e x E_p [GeV x GeV]	Signal Events	Background Events
18 x 275	0.79×10^{12}	3.21×10^{12}
10 x 275	4.73×10^{12}	30.38×10^{12}

Rate Estimates from Streaming DAQ

The StreamingDAQ experts plan with:

- **Data rate of in average 100 Gbit/s**,
  - Based on rate estimates from MC (previous slide),
  - 10 Gbit/s for detector noise + 100 kbit/s per collision

Bounds for data rates:

E_e x E_p [GeV x GeV]	Signal Events	Background Events	Data Rate
18 x 275	0.79×10^{12}	3.21×10^{12}	52.2 Gbit/s
10 x 275	4.73×10^{12}	30.38×10^{12}	381.0 Git/s

- **Event size of in average 100 kbit**, including signal and background apart from detector noise,
  - Assuming that detector noise can be substantially reduced in early stages of processing.
  - Event sizes will be larger during commissioning and early data taking due to lower detector thresholds (400 kbit)
- **Running 60% up-time for ½ year = 9,460,800 s**:
  - Data rate of in average 100 Gbit/s results in 9.46×10^{12} events per year.

Compute Resource Estimates

https://docs.google.com/spreadsheets/d/1ApjIriu44DymP_i2T5O3W5_QgkXhVeinE6VRBZDHwSU/edit?gid=0#gid=0