DIS e-Tagger with ML

Ming Liu
Los Alamos National Lab

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ePIC Analysis Coordination Meeting
https://indico.bnl.gov/event/20344/

Intelligent Experiments Through Real-Time AI:
Fast Data Processing and Autonomous Detector Control for sPHENIX and Future EIC detectors

Department of Energy Announces $16 Million for Research on Artificial Intelligence and Machine Learning For Autonomous Optimization And Control Of Accelerators And Detectors

Announcement Number: *DE-FOA-0002785 Artificial Intelligence and Machine Learning for Autonomous Optimization and Control of Accelerators and Detectors* *List Posted:* *8/17/2023*

Selection for award negotiations is not a commitment by DOE to issue an award or provide funding.

Principal Investigator	Title	Institution	City	State	9-digit zip code
Liu, Ming Xiong	Intelligent Experiments Through Real-time AI: Fast Data Processing and Autonomous Detector Control for sPHENIX and Future EIC detectors	LANL	Los Alamos	NM	87545-0001
Roland, Gunther (Co-PI)	*same as above- Collaboration*	Massachusetts Institute of Technology	Cambridge	MA	02139-4307
Yu, Dantong (Co-PI)	*same as above- Collaboration*	New Jersey Institute of Technology	Newark	NJ	07102-1982
Tran, Nhan (Co-PI)	*same as above- Collaboration*	FNAL	Batavia	IL	60510-5011
Hao, Cong	*same as above- Collaboration*	*Georgia Institute of Technology*	Atlanta	GA	30332-0420
Schambach, Jo	*same as above- Collaboration*	ORNL	Oak Ridge	TN	37831-6374

Study for EIC: e-Tagger, HF-Tagger

arXiv:2209.02580v1 [physics.ins-det] 6 Sep 2022

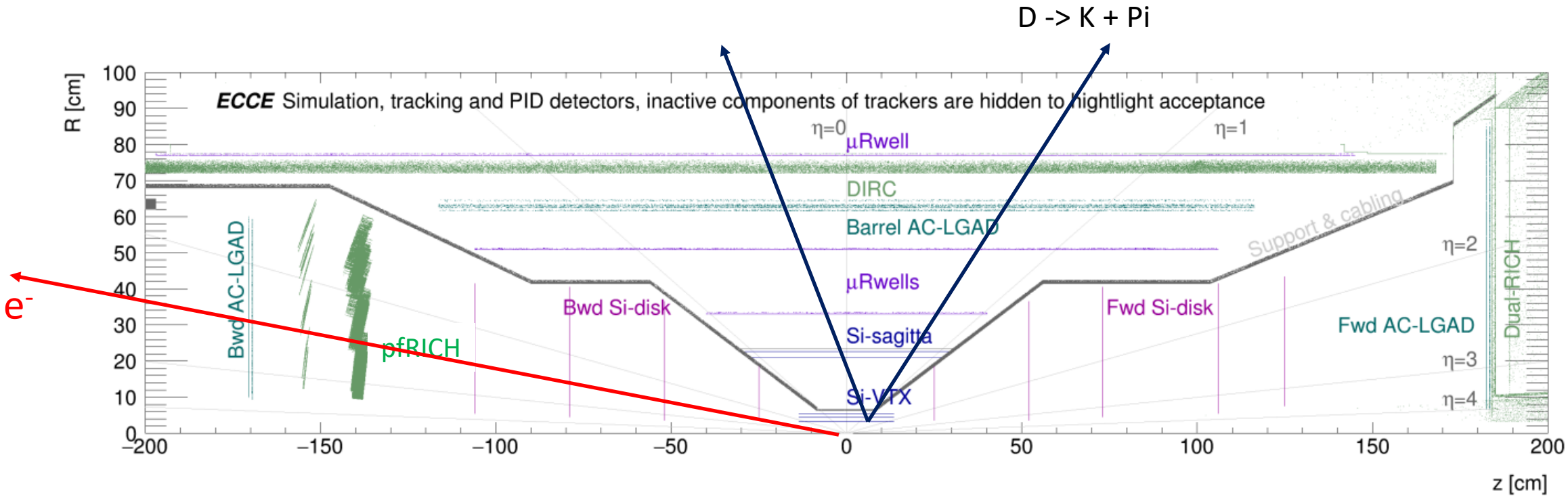
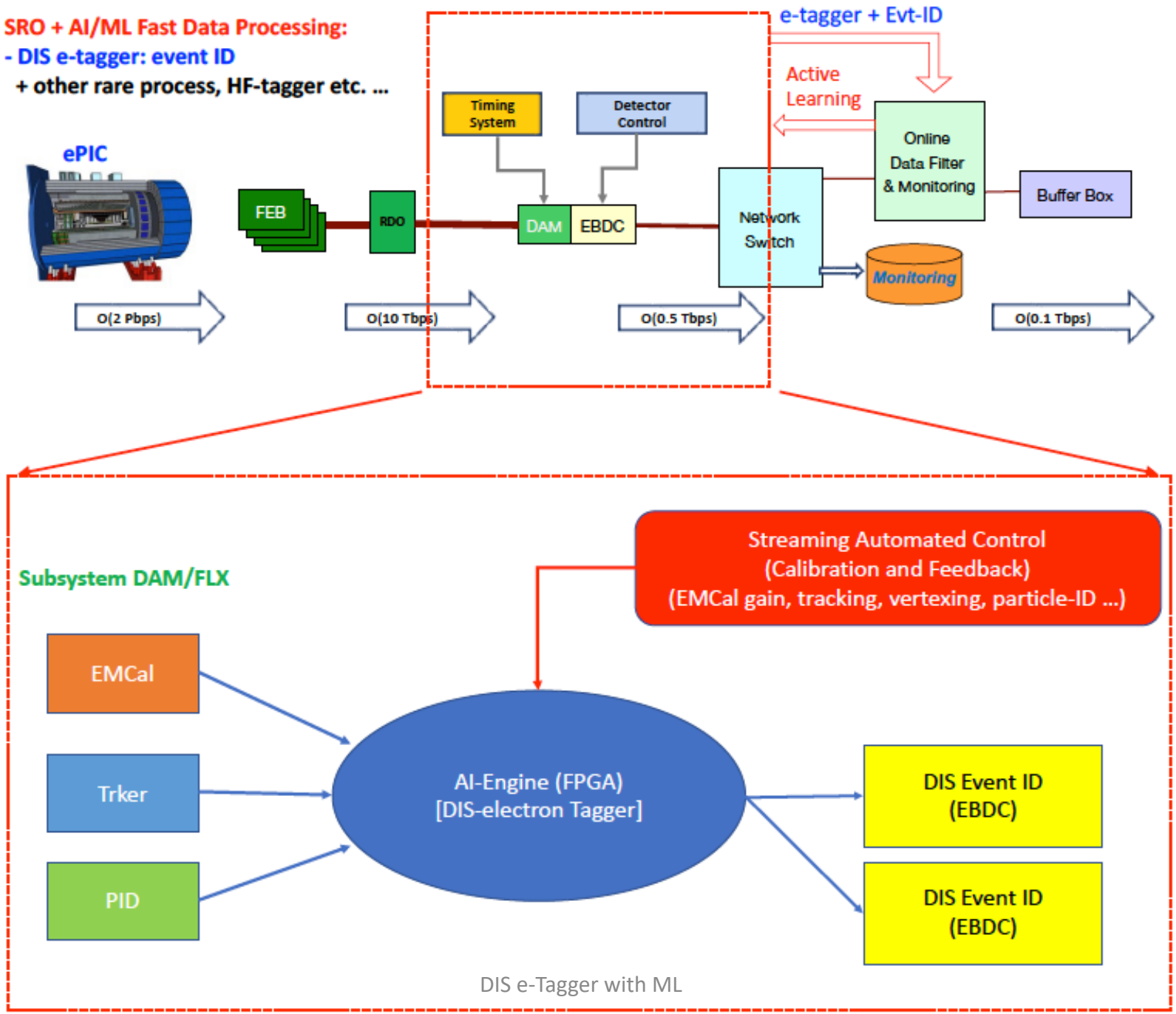
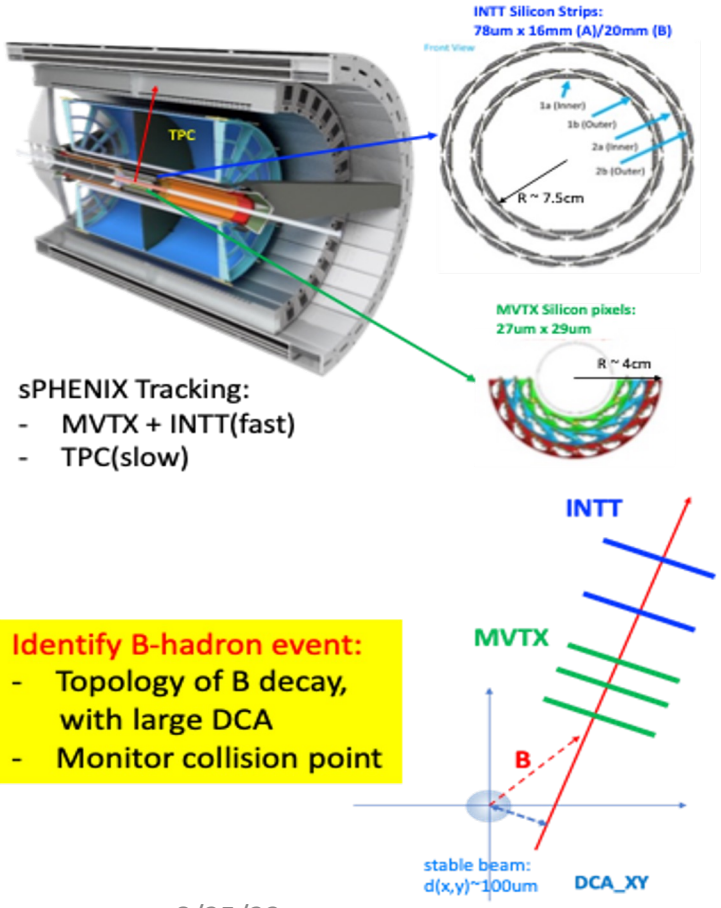


Figure 6: Schematic view of the ECCE tracker, including silicon, μRWELL, AC-LGAD, DIRC, mRICH and dRICH detector systems. **Need better version of this image.**


SRO + AI/ML Fast Data Processing:
- DIS e-tagger: event ID
+ other rare process, HF-tagger etc. …
ePIC
FEB
RDO
Timing System
Detector Control
DAM
EBDC
Network Switch
e-tagger + Evt-ID
Active Learning
Online Data Filter & Monitoring
Buffer Box
Monitoring
O(2 Pbps)
O(10 Tbps)
O(0.5 Tbps)
O(0.1 Tbps)
Subsystem DAM/FLX
Streaming Automated Control
(Calibration and Feedback)
(EMCal gain, tracking, vertexing, particle-ID …)
EMCal
Trker
PID
AI-Engine (FPGA)
[DIS-electron Tagger]
DIS Event ID
(EBDC)
DIS Event ID
(EBDC)

AI/ML R&D: from sPHENIX to EIC

Selective streaming real-time AI and autonomous detector control:
Deliver a demonstrator for p+p and p+A running for sPHENIX - generalizable for applications in experiments at the EIC



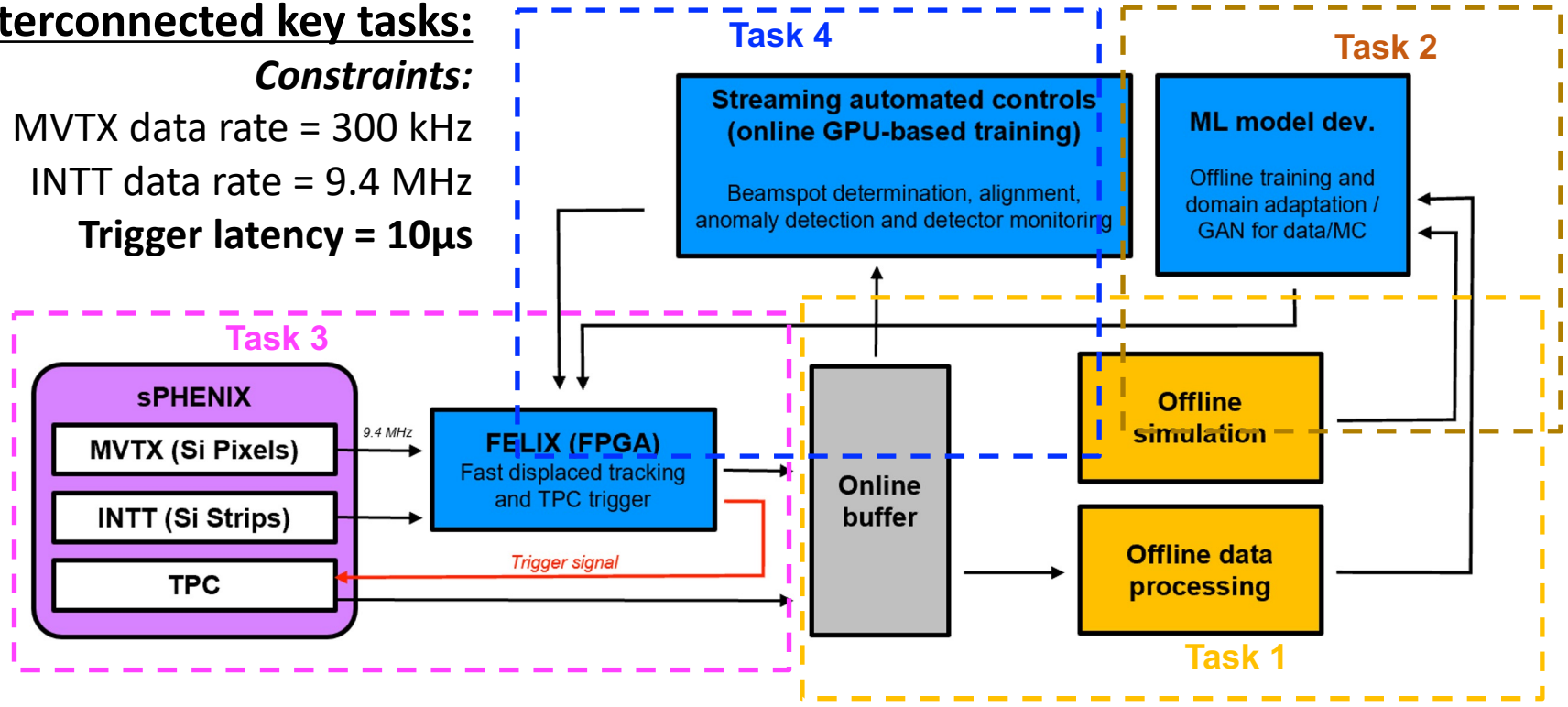
4 interconnected key tasks:

Constraints:

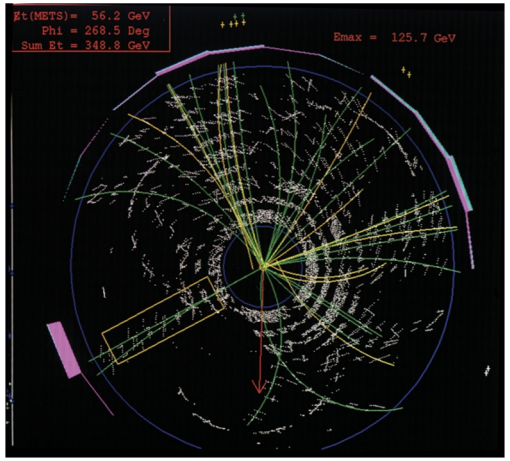
MVTX data rate = 300 kHz

INTT data rate = 9.4 MHz

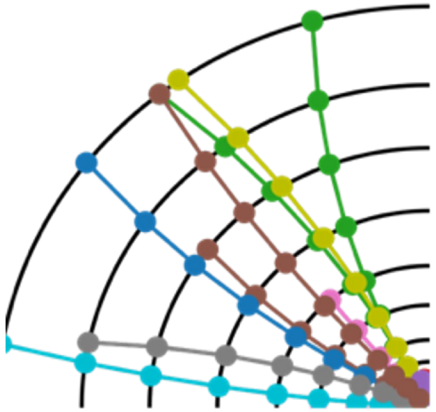
Trigger latency = 10μs

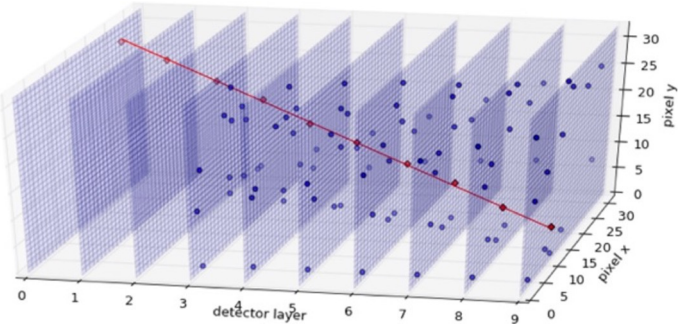


sPHENIX HF AI Trigger Pipeline



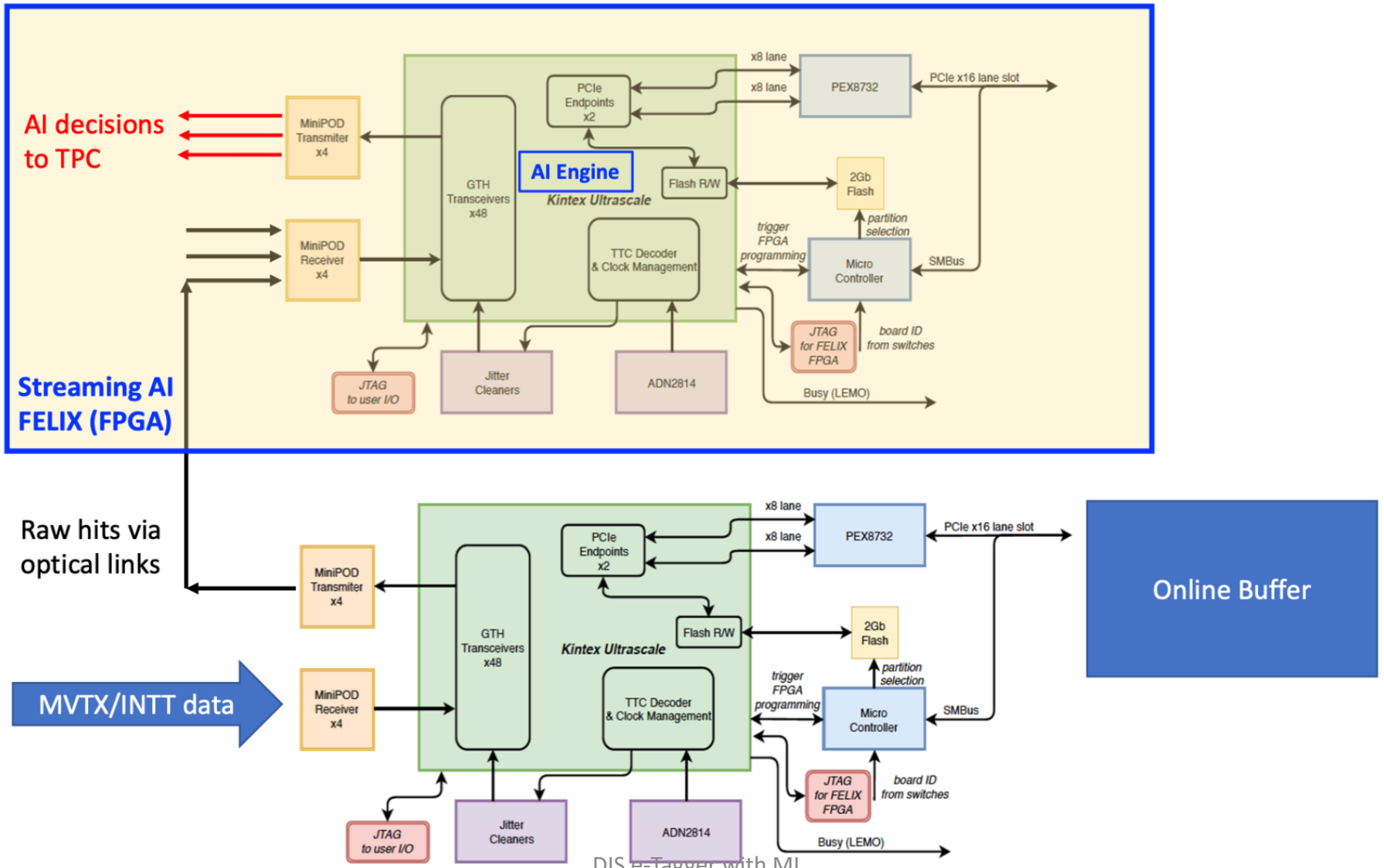
1. **Fetch events from event buffer to Processing**
2. **Data Pre-processing Clustering**
3. **Tracking + Outlier hits Removal**
4. **Triggering**
5. **Triggers on TPC**



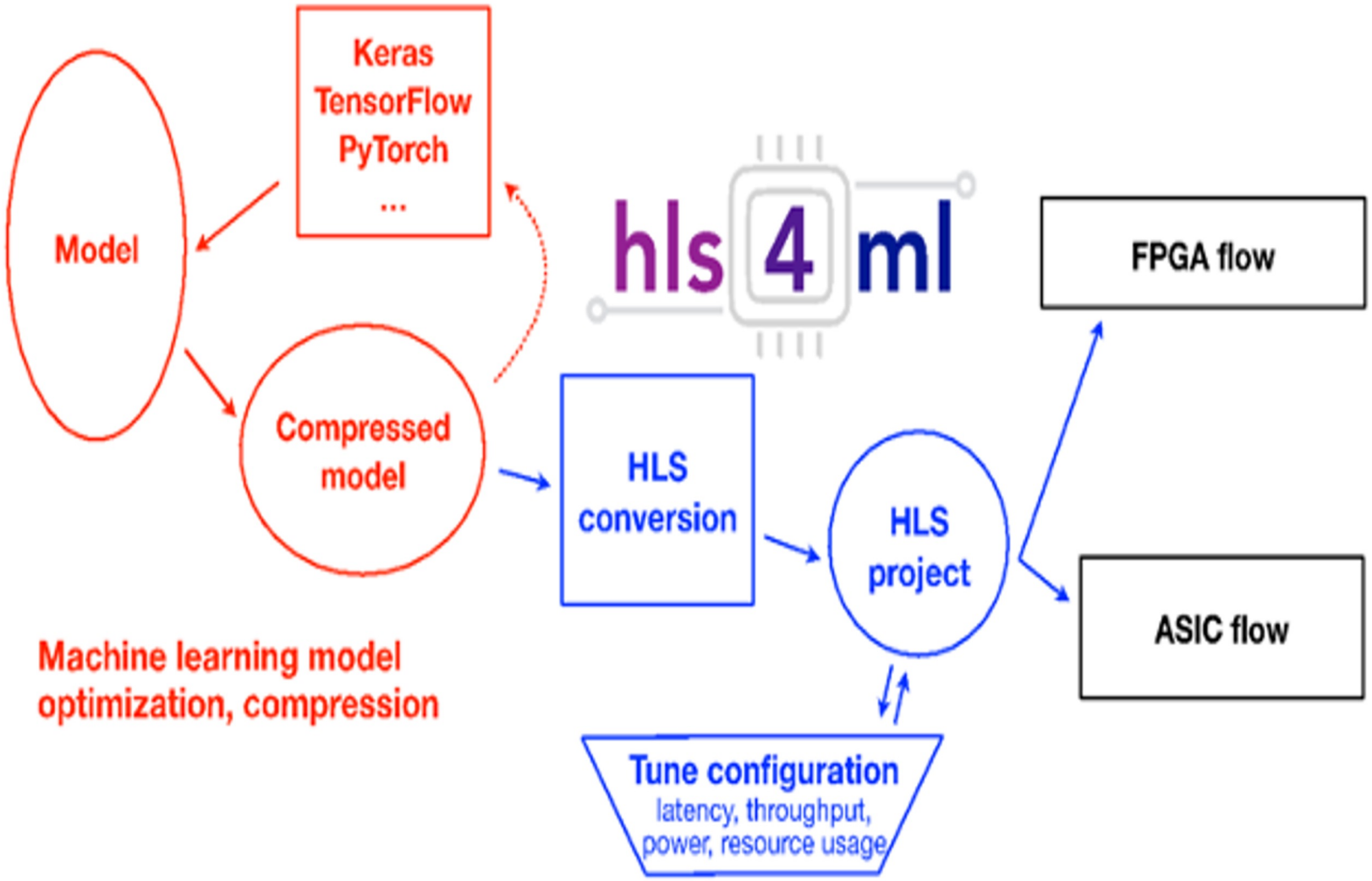


Hardware Implementation

- FELIX 711, 712 for sPHENIX
- FELIX 812 for EIC



Technical Approaches



Primary focus:
achieving low latency, real-time processing of data, and deployment of algorithms with high efficiency

Plan for EIC … FY24 – FY25

Besides the sPHENIX AI/ML work, expect ~50% effort on EIC R&D

- ePIC detector and physics simulations
  - HF & Jet taggers, based on sPHENIX work
    - Tracking, HCal …
  - DIS e-tagger
    - Tracking, EMCal, PID …
- Develop EIC AI-based SRO/e-Tagger demonstrator
  - FELIX 712/sPHENIX, 812/EIC in hand
- EIC/ePIC TDR …

Invite students/postdocs/staff to join our effort!