

EIC User Group & ePIC Joint Collaboration Meeting

14–18 Jul 2025
Thomas Jefferson National Accelerator Facility

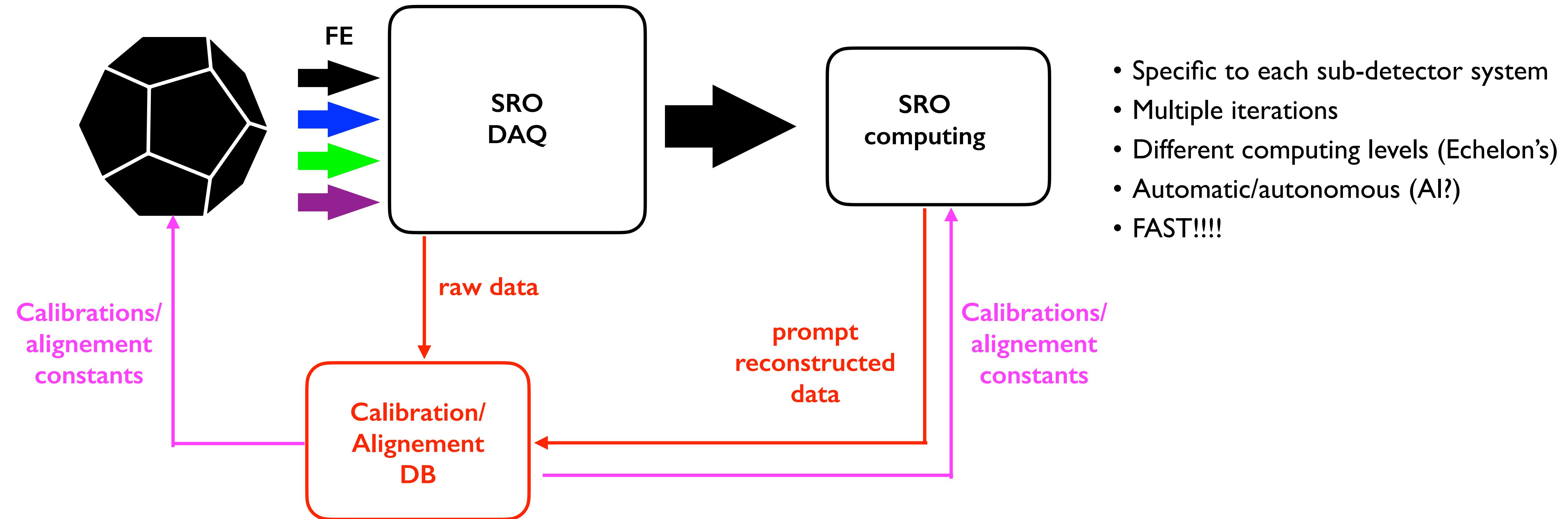
ePIC Streaming Computing Model WG ePIC Calibration and Alignment Workflow Overview and Requirements

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Alignment/Calibrations

- **ePICS SRO DAQ** aims for a rapid turnaround from data to full calibrated/reconstructed data
- **Data reconstruction time scale driven by calibrations (2-3 weeks max)**



Defining calibrations and alignment procedures is essential and urgent!
Everybody agrees but

Alignment/Calibrations

Questions to be answered

- Needs to define calibration requirements from each sub-detector
 - how much data is needed?
 - when often?
 - how/where to apply corrections to data?
- Correction should be autonomous (AI/ML algorithms as a second iteration or from the start?)
- At which level (Echelon 0 and/or Echelon 1 or 2)
- Calibration and simulation framework

• Implementation

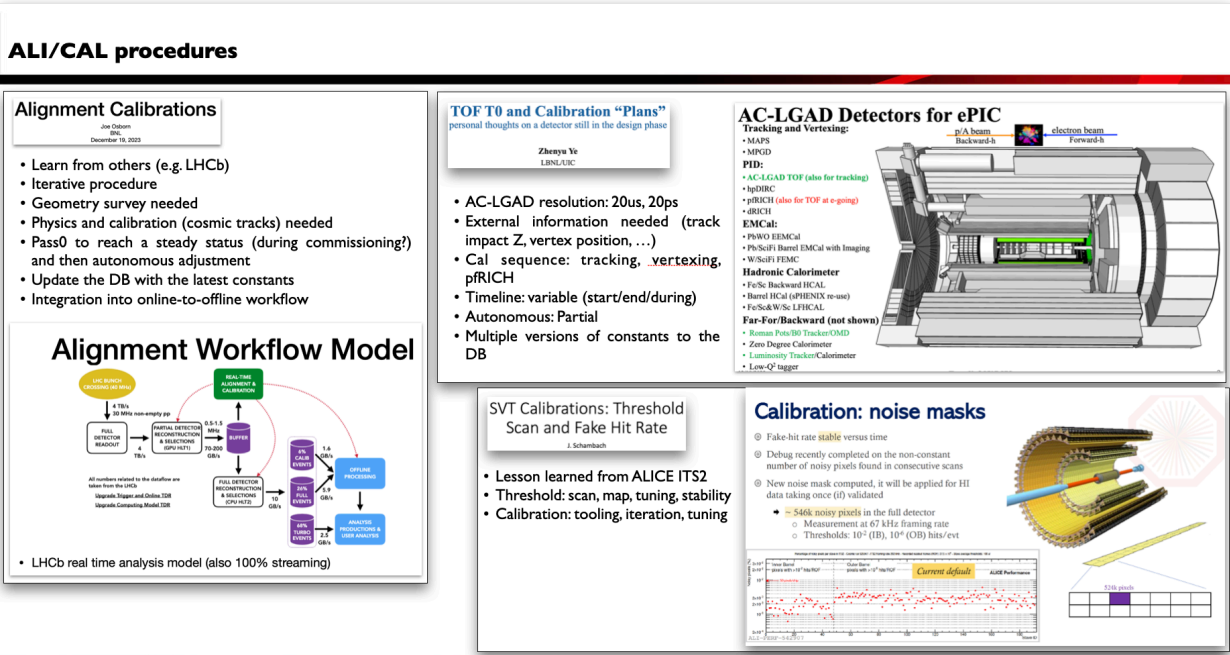
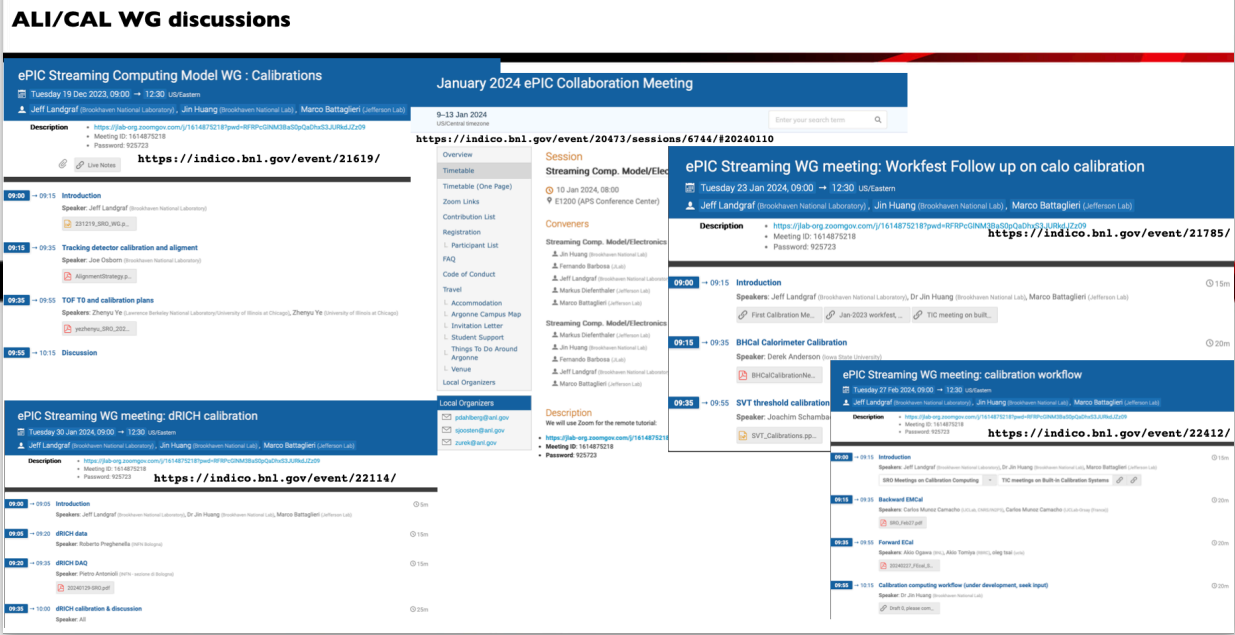
- how to implement an iterative procedure in (semi) real-time (some detectors may need info from others)
- Are calibration parameters biasing the data set we will write on disk?
- Are calibration procedures background-aware and how to reliably estimate that bg?
- Identify required Infrastructures (e.g monitoring tools)
 - ASIC level: e.g. 0 suppression
 - DAQ level: eg. clustering
 - SRO level: final physics extraction: how it propagates back to the FE?
- Identify dependencies from other subsystems
- Identify calibration procedures requiring dedicated runs and calibrations that could be extracted by production run streams
- Is an RND-trigger (fully unbiased) data stream in parallel to the production run stream?
- Alignment may require special procedures that need to be considered upfront
- Tracking too

Is it NOT premature, even if,

- Detectors are still being designed
- Procedures require feedback from real implementation (far away!)
- WG assumption
 - A lot of work can/should be done in advance to understand details of alignment and calibration procedures
- Strategy
 - A (living/updated) survey of different subsystem procedures
 - Engage sub-detector leaders to develop a shared workflow

Alignement/Calibrations

- Several WG meeting last years focused on calibration procedure of subsystems summarised in Jin’s table available here
- Prepare a short intro about the current scheme of ePIC SRO and implications for calibration/alignment procedures to distribute to link persons
- Prepare a template to gather the updated information and complete/update Jin’s table



Subsystem	Region	Pre-physics operation calibrations (Cosmic, no-beam calibration, commissioning)	Task	Human intervention ?	Data Needed	Dependency	T0 + 12hr	T0 + 24hr	T0 + 36hr	T0 + 48hr	T0 + 60hr	T0 + 72hr	T0 + 84hr	T0 + 96hr	Monitoring	Computing resource	Post-reconstruction calibrations (applied at analysis stages)	Comment	Subsystem
MAPS	Barrel+Disk	Threshold Scan / ALICE=20min Fake rate scan/noisy pixel masking	(See Alignment)															TIC meeting: https://indico.bnl.gov/event/21648/	MAPS
MPGD	Barrel+Disk	?	?																MPGD
bTOF, eTOF (ac-Igad)	Barrel/Forward	Bias voltage determination ASIC baseline, noise, threshold Clock sync Time walk calibration	Gain calibration TDC bin width determination Clock offset calibration Hit position dependency (intrinsic and c-by-c)	QA	High p tracks ~1hr of production data?	Tracking, pRICH	Data Acc. Depend	Depend	Processing	Processing								SRO meeting https://indico.bnl.gov/event/21619/	bTOF, eTOF (ac-Igad)
Central Detector Tracker Alignment			Initial alignment	Alignment Check/Update (if needed)	QA	Production data		Processing										SRO meeting https://indico.bnl.gov/event/21619/	Central Detector Tracker Alignment
pRICH	Backward	Thresholds (noise dependent), dynamic range adjustments, timing offsets, synchronization Initial alignment	Alignment Check/Update (if needed) Time dependencies (Aerogel transparency, mirror reflectivity, Gas pressure)	?	Production data		Data Acc.	Processing										TIC meeting: https://indico.bnl.gov/event/21648/	pRICH
DIRC	Barrel	Laser data?	?	?														TIC meeting: https://indico.bnl.gov/event/21648/	DIRC
dRICH	Forward	Bunch timing offset scan Threshold scan Noise masking	Track based alignment	?	High p tracks ~1hr of production data?	Tracking	Data Acc. Depend	Processing	Processing									SRO meeting: https://indico.bnl.gov/event/22114/	dRICH
bEMC	Backward	Cosmic and LED for the initial gain balancing	DIS Electron Pi0->gg events energy scale	QA	DIS electron Pi0 di-photon resonance ~1 day of production data	Tracking	Data Acc. Depend	Data Acc.	Processing	Processing					LED		SRO meeting: https://indico.bnl.gov/event/22412/ Carlos: aiming 1% precision Planning for LED flash during production run, processing	bEMC	
AstroPix	Barrel		SiPM gain		?													TIC meeting: https://indico.bnl.gov/event/21648/	AstroPix
ScifiPb	Barrel		Pi0, eta->gg events energy scale				Data Acc.	Data Acc.	Processing	Processing								TIC meeting: https://indico.bnl.gov/event/21648/	ScifiPb
fEMC	Forward	IV Scan	Second iteration pi0 (if needed)	QA	Pi0 di-photon resonance ~1 day of production data		Data Acc.	Data Acc.	Processing	Processing					LED		High energy cluster non-linearity SRO meeting: https://indico.bnl.gov/event/22412/ Need pi0 filtered data for automated calibration AI driven calibration?	fEMC	
bHCAL	Backward	LED	?															TIC meeting: https://indico.bnl.gov/event/21648/	bHCAL
cHCAL	Barrel	MIP calibration Gain calibration	(See hadronic e-scale calib)															SRO meeting: https://indico.bnl.gov/event/21785/	cHCAL
fHCAL	Forward																		fHCAL
fHCAL insert	Forward																		fHCAL insert
Hadronic energy scale calibration			?	Set full calo stack energy scale for hadronic shower and jets	?	High energy hadronic showers and jets	Tracking h-PID	Data Acc. Depend	Data Acc. Depend	Data Acc. Depend	?	?	?	?	?		Final energy scale calibration (if needed)	Comments from Oleg during SRO meeting: https://indico.bnl.gov/event/22079/	Hadronic energy scale calibration
low Q2 Tagger	Far Backward	Alignment?																TIC meeting: https://indico.bnl.gov/event/22079/	low Q2 Tagger
low Q2 Tagger (CAL)	Far Backward																	TIC meeting: https://indico.bnl.gov/event/22079/	low Q2 Tagger (CAL)
Pair Spec Tracker	Far Backward																	TIC meeting: https://indico.bnl.gov/event/22079/	Pair Spec Tracker
Par Spec Cal	Far Backward																	TIC meeting: https://indico.bnl.gov/event/22079/	Par Spec Cal
Direct Photon Cal	Far Backward																	TIC meeting: https://indico.bnl.gov/event/22079/	Direct Photon Cal
B0 Tracking	Far Forward	Survey alignment/Cosmic	Alignment check		MIP		Processing											SRO/FF meeting https://indico.bnl.gov/event/22676/	B0 Tracking
B0 PbWO4	Far Forward	Survey alignment/Cosmic	SiPM gain		MIP/Gamma/Electrons		Processing								LED			SRO/FF meeting https://indico.bnl.gov/event/22676/	B0 PbWO4
Roman (Pots)	Far Forward					Acc. BPM Potential use of vertex of central detector	Data Acc. Depend	Processing										SRO/FF meeting https://indico.bnl.gov/event/22676/	Roman (Pots)
Off Momentum	Far Forward	laser/survey alignment Low lumi running	beam position monitors/fill by fill correction		MIP rate distribution in RP		Data Acc. Depend	Processing										SRO/FF meeting https://indico.bnl.gov/event/22676/	Off Momentum
ZDC PbWO4	Far Forward	Survey alignment, timing delay	SiPM/APD gain, timing	QA	Photon		Processing								LED			SRO/FF meeting https://indico.bnl.gov/event/22676/	ZDC PbWO4
ZDC Sampling	Far Forward	Survey alignment, timing delay	SiPM gain	QA	Single neutron		Processing								LED			SRO/FF meeting https://indico.bnl.gov/event/22676/	ZDC Sampling

https://docs.google.com/spreadsheets/u/1/d/e/2PACX-IvRkJT9ODHAjqJhR_nb2GxPgYvHEcawklMgC-u_Fi67shZXdMitENF4ashAbD8dlvS6TwHqXG3UtZvhY/pubhtml

Today's discussion

Streaming Computing R&... Prof. Shinsu...	ePIC Calibration and Align... Marco Batta...
Discussion	ePIC Alignment and Calibr... Carlos Muno...
ePIC Calibration and Align... Marco Batta...	ePIC Alignment and Calibr... Dr Joe Osborn
ePIC Alignment and Calibr... Carlos Muno...	Autonomous Alignment a... Torri Jeske
ePIC Alignment and Calibr... Dr Joe Osborn	Discussion
Autonomous Alignment a... Torri Jeske	Coffee Break
Discussion	Streaming Orchestr... Maxim P...
Coffee Break	Discussion
Streaming Orchestr... Maxim P...	JANA2 Updates for ... Nathan Brei
Discussion	Discussion
JANA2 Updates for ... Nathan Brei	Streaming Reconstr... Dr Takuy...
Discussion	Discussion
Streaming Reconstr... Dr Takuy...	
Discussion	

- Introduction
- Use case: backward EM Calorimeter (Carlos Munoz Camacho)
- Use Case: tracking (Joe Osborn)
- Autonomous Alignment and Calibration Workflows (Torri Jeske)

Expected outcome of this meeting

- Resume the SRO WG interest in calibration/alignment of ePIC sub detectors
- Learn from use cases on how to generalise the survey and extend it to all subdetectors
- Discuss how to engage subdetectors in C&A work plan (from now!)
- Discuss further ideas on alternative C&A procedures/requirements