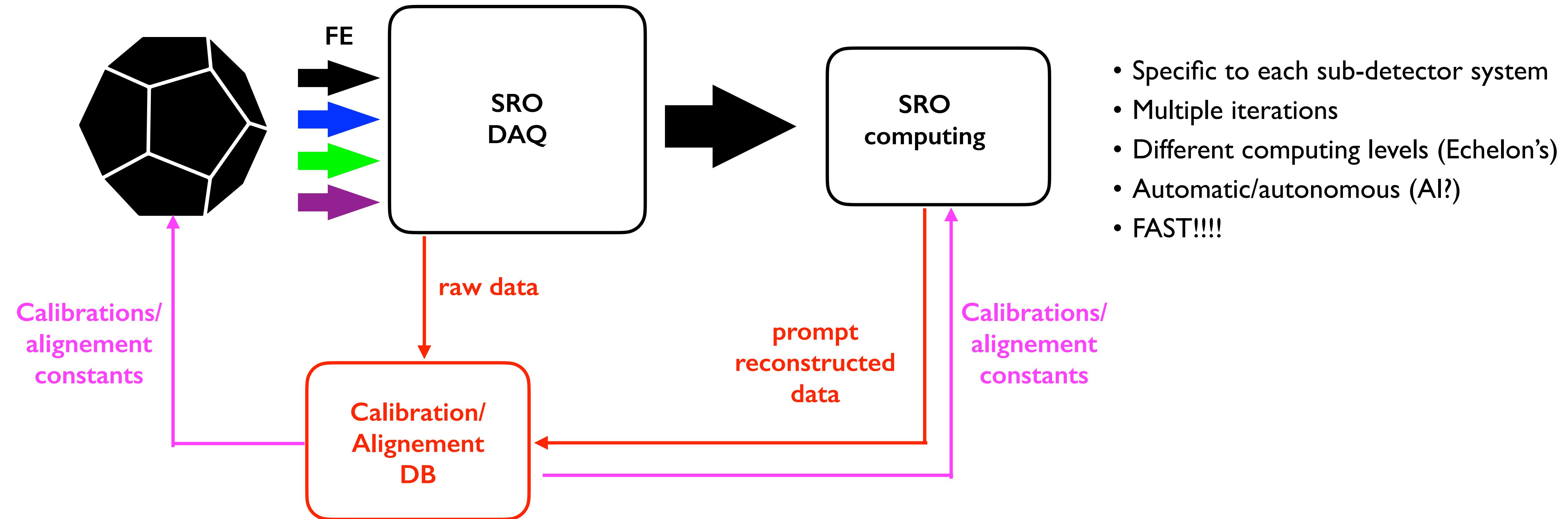


Alignment/Calibrations

- **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)**



- Specific to each sub-detector system
- Multiple iterations
- Different computing levels (Echelon's)
- Automatic/autonomous (AI?)
- FAST!!!!

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:

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

ALI/CAL WG discussions

ePIC Streaming Computing Model WG - Calibrations

January 2024 ePIC Collaboration Meeting

https://indico.bnl.gov/event/21619/

https://indico.bnl.gov/event/20473/sessions/6744/20240110

ePIC Streaming WG meeting: Workfest Follow up on calo calibration

https://indico.bnl.gov/event/21785/

https://indico.bnl.gov/event/22412/

ALI/CAL procedures

Alignment Calibrations

- Learn from others (e.g. LHCb)
- Iterative procedure
- Geometry survey needed
- Physics and calibration (cosmic tracks) needed
- Pass0 to reach a steady status (during commissioning) and then autonomous adjustment
- Update the DB with the latest constants
- Integration into online-to-offline workflow

Alignment Workflow Model

TOF T0 and Calibration "Plans"

AC-LGAD Detectors for ePIC

SVT Calibrations: Threshold Scan and Fake Hit Rate

Calibration: noise masks

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, pfRICH	Data Acc. Depend	Dependen	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	Prodcution data		Processing											SRO meeting https://indico.bnl.gov/event/21619/	Central Detector Tracker Alignme
pfRICH	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)	?	Prodcution data		Data Acc.	Processing										TIC meeting: https://indico.bnl.gov/event/21648/	pfRICH
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 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, processi	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						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 hadroinc 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

Work plan of Alignment and Calibration SRO taskforce (Taku and Marco)

- Build on Jin's table
- Contact ePIC leadership (John and Silvia) and sub-detector project leaders to define a link person responsible for calibration/alignment
- 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
- Start a new round of presentation at Tuesday meeting (2-3 subgroups per meeting with 2-3 slides each)
- Reserve a slot during July ePIC Coll meeting (*workfest*) with all link person present and discuss together
 - outcome of the survey
 - strategy for future actions
 - possible implementation of alternative procedures (e.g. autonomous calibrations using AI or modern techniques)
- ...