Event Builder Status

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CLAS Collaboration Meeting

November 13, 2018

Overview

- "Event Builder" is the last CLAS12 service run, after all detectors
- Retrieves/analyzes event-based quantities, e.g. helicity state
- Geometrically associates detector responses into particles
- Defines event start time, and does a basic particle identification
- Writes all info for physics analysis into DSTs (REC* banks)
- Documentation: https://clasweb.jlab.org/wiki/index.php/CLAS12_EventBuilder

EBAnalyzer.java	switch default, unassigned pid quality to 99	5 days ago
EBEngine.java	Merge pull request #255 from JeffersonLab/vg-optimize	4 days ago
EBHBEngine.java	Merge pull request #255 from JeffersonLab/vg-optimize	4 days ago
EBMatching.java	cherenkov matching fixes	8 days ago
EBTBEngine.java	Merge pull request #255 from JeffersonLab/vg-optimize	4 days ago
EBio.java	disable scaler readout	5 days ago
EventBuilder.java	particle-htcc combos for looser matching requirements	5 days ago

EBCCDBConstants.java	Merge branch 'development' into ebdev-mrg	4 months ago
EBCCDBEnum.java	Merge branch 'development' into ebdev-mrg	4 months ago
EBConstants.java	EBConstants: cleanup	3 months ago
EBRadioFrequency.java	eb cleanup: move rf to rec instead of service	3 months ago
EBScalers.java	eb: cleanup unused imports	8 days ago
EBUtil.java	eb: cleanup unused imports	8 days ago
SamplingFractions.java	eb: move sampling fractions to dedicated class, add pid- and sector-d...	5 months ago

Creating Particles

Charged Particles

- associate detector responses with tracks, based on DOCA

Neutral Particles

- identify remaining trackless ECAL/CND hits as neutrals, assume straight trajectory, and associate with other detectors' unmatched
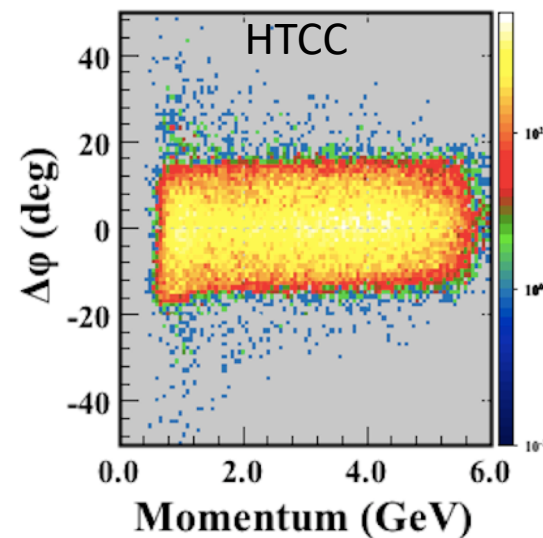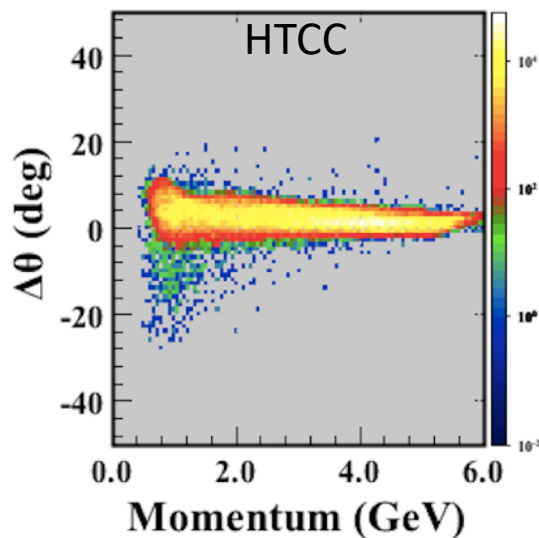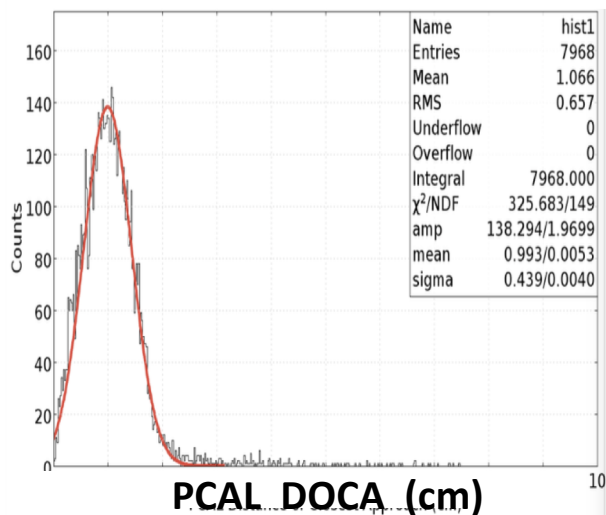
Currently loose, flat detector-dependent cuts, with minimum-DOCA hit chosen and only one response allowed per detector layer per particle.

Timing information is currently ignored at the stage.

Event Start Time

Choose "Trigger Particle"

- highest energy e^- else e^+, if one exists
- else highest momentum track with an FTOF hit, assumed a π
- else Forward Tagger
  - *** not implemented in EB, yet ***
  - must be mutually exclusive events, else would need a separate/"duplicate" particle bank

Construct its vertex time

- based on path length, mass, momentum

Use nearest RF bunch to assign start time

- Correction for non-zero z-vertex is still disabled
  - especially important for CTOF
  - ideally requires DC-CVT to be aligned w.r.t. each other, else using one's z-vertex degrades the other's TOF timing resolution

66 ps resolution consistent with FTOF1B design

Engineering Run

124.25 ns is the default start time of all GEMC events
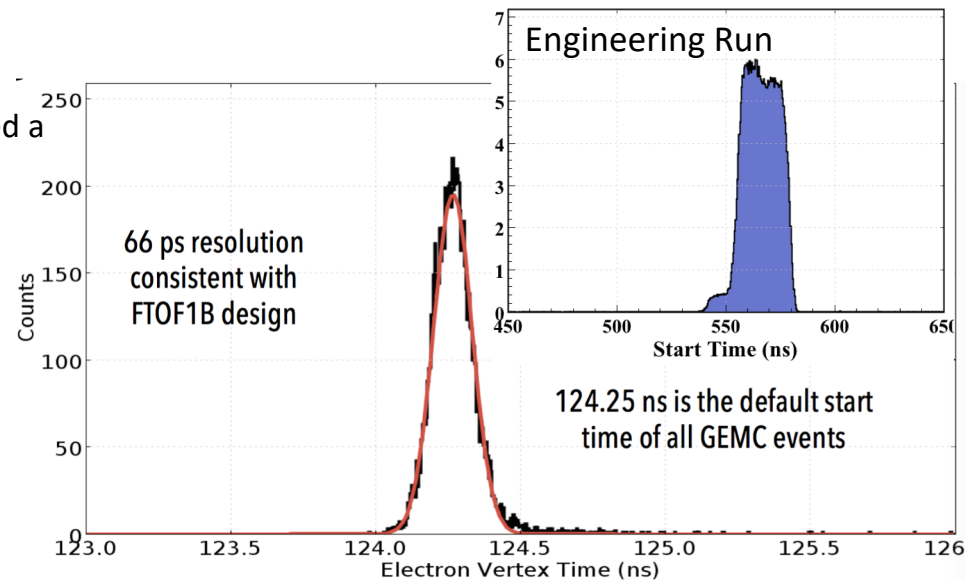
Lepton and Neutral Identification

e⁻e⁺ in Forward Detectors

- Charged Track ECAL, HTCC, and FTOF hits
  - PCAL > 60 MeV
  - HTCC #phe > 2

- ECAL sampling fraction
  - $\pm 5\sigma$ sampling fraction parameterized in momentum
  - REC::Particle.chi2pid is N_σ from nominal, so tightening the critera can be done with simple cut on chi2pid

Neutrals

- Forward Detector
  - ECAL clusters unassociated with a track
    - seeds with PCAL first and matches to EC Inner/Outer
    - then seeds with EC Inner, and finally EC Outer
  - Also associates them with unmatched FTOF (currently unused)
  - γ
    - ECAL $\beta > 0.9$
    - Energy calculated from ECAL and sampling fraction parameterized in momentum
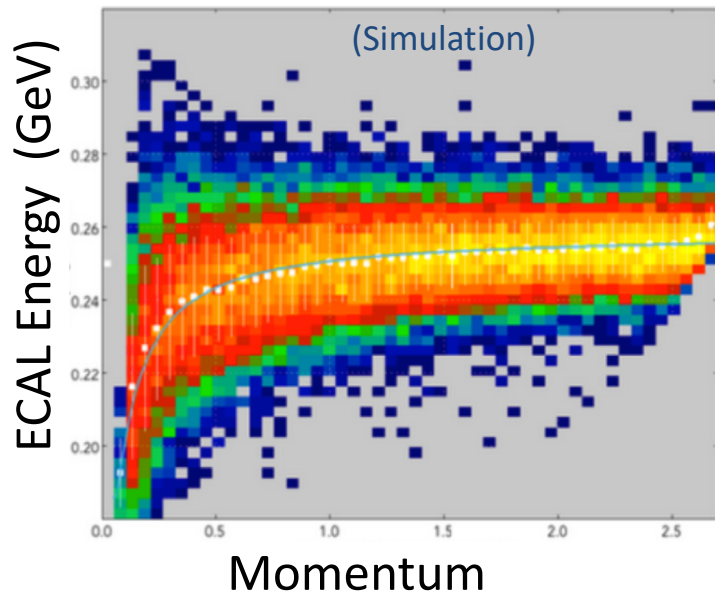 - neutron
    - $\beta < 0.9$
    - Energy calculated from β assuming neutron mass

- Central Detector
  - CND clusters unassociated with a track assigned as neutrals
  - Also associates them with unmatched CTOF (currently unused)
  - neutron
    - $\beta < 0.9$
    - Energy calculated from β assuming neutron mass

Forward Tagger

- e⁻
  - Matched calorimeter and hodoscope clusters
  - No charge separation, assumed negative
- γ
  - Calorimeter cluster unmatched to hodoscope
- Energies based on calorimeter

Charged Hadron Identification

If a track fails e⁻/e⁺ identification, assume it's a charged hadron and assign its identity based on minimizing the time difference between event start time t_0 and vertex time.

$$\Delta t_i = t_0 - \left[t_{FTOF} - \frac{L}{\beta_i(p)} \right], \quad i = \pi/K/p/d/...$$

- If no TOF info, pid=0
- Vetoes from Cerenkov
  - #photoelectrons greater than 2 and below kaon threshold → reassign to π
- REC::Particle.chi2pid is a signed N_σ from nominal timing, based on σ per FTOF-paddle, so tightening the requirements can be done with a simple cut on chi2pid

- Can be extended to more sophisticated scheme, e.g. multi-dimensional likelihood

- Will need updating from RICH

Plots are 10.6 GeV @ 5nA, require e⁻ for start time, and black curves are Δβ/Δt=0
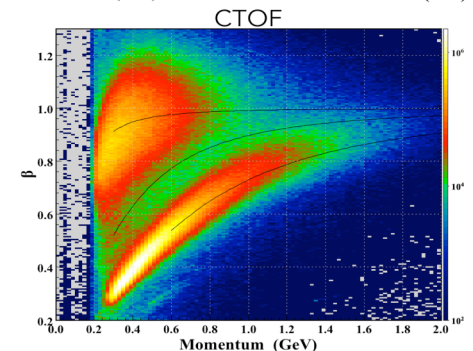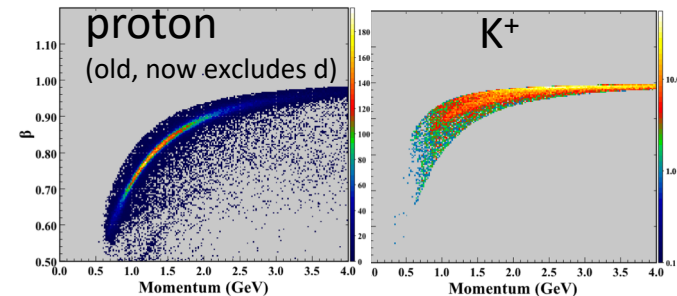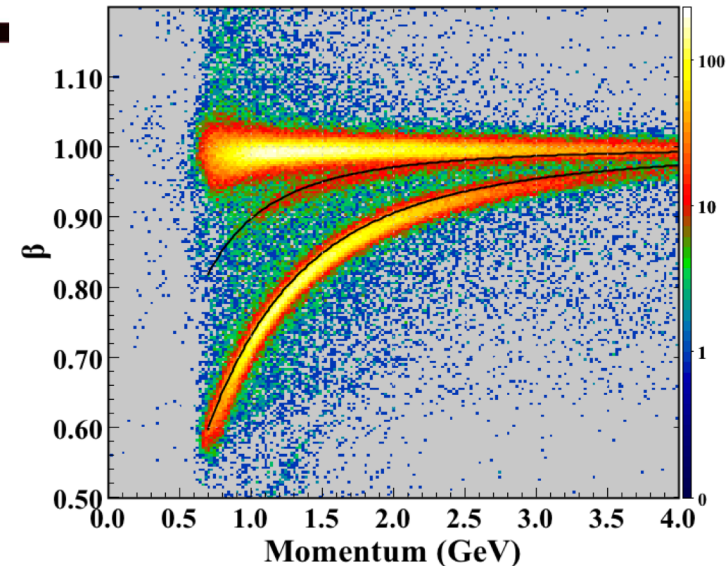
DSTs

High level HIPO banks for physics analyses

- Names are prefixed by "REC", in `EVENT.json`
  - https://github.com/JeffersonLab/clas12-offline-software/blob/master/etc/bankdefs/hipo/EVENT.json
- REC::* is based on time-based tracking, RECHB::* on hit-based
- We keep only REC banks in standard physics analysis workflow, and drop all lower level info
  - Also keep RUN::* and RAW::scaler banks

The main examples:
- **REC::Event**
  - run/event #, event time, trigger bits, helicity, etc
- `REC::Particle`
  - pid, charge, momentum, etc
- `REC::`"ResponseType"
  - e.g. `Calorimeter`, `Scintillator`, `Cherenkov`, `Track`
  - hit/cluster energies, positions, times, shapes
  - Only contains responses associated with particles
    - with pointer to `REC::Particle and` corresponding clusters/hits in lower-level detector banks

Documentation:

https://clasweb.jlab.org/wiki/index.php/CLAS12_DSTs

Validation Tests

To check software progress, MC-based
- `clas12-offline-software/validation`
- test gemc files automatically downloaded from webserver
  - kept in sync with latest gemc version
- decoded, reconstructed, analyzed to perform
  - data sanity checks
  - yields, efficiency / misidentification
- A few are included in automatic Travis build tests

2-particle test events
- electron plus another, in different sectors
  - e⁻ : **1-9 GeV**
  - other (hadron/photon): **1-4.5 GeV**
- `Clas12FastMC` at generator level to ensure expected trajectories intersect all relevant detectors
  - i.e. account for B-fields, acceptance
  - very useful tool, needs to be extended to CD/FT

Index of /clas12offline/distribution/coatjava/validation_files/eb

Name	Last modified	Size	Description
Parent Directory		-	
4a.2.2-fid-r10-10K/	16-Apr-2018 07:31	-	
4a.2.2-fid-r10/	10-Mar-2018 16:08	-	
4a.2.2-fid-r11/	10-Mar-2018 15:59	-	
4a.2.3-fid-r10-100/	10-Jun-2018 12:11	-	
4a.2.3-fid-r10/	20-Apr-2018 16:27	-	
4a.2.3-fid-r11/	20-Apr-2018 15:54	-	
4a.2.4-fid-r10-100/	28-Aug-2018 13:52	-	
4a.2.4-fid-r10/	28-Aug-2018 10:10	-	
4a.2.5-fid-r11-100/	06-Nov-2018 21:03	-	
4a.2.5-fid-r11/	06-Nov-2018 19:38	-	

File	Date	Size
electronFTgamma.evio.gz	20-Apr-2018 16:27	2.9M
electronFTpion.evio.gz	20-Apr-2018 16:27	4.4M
electrongamma.evio.gz	20-Apr-2018 16:27	3.7M
electrongammaC.evio.gz	20-Apr-2018 16:27	3.0M
electrongammaFT.evio.gz	20-Apr-2018 16:27	4.5M
electronkaon.evio.gz	20-Apr-2018 16:27	4.9M
electronkaonC.evio.gz	20-Apr-2018 16:27	3.7M
electronneutron.evio.gz	20-Apr-2018 16:27	3.4M
electronneutronC.evio.gz	20-Apr-2018 16:27	3.0M
electronpion.evio.gz	20-Apr-2018 16:27	5.1M
electronpionC.evio.gz	20-Apr-2018 16:27	3.8M
electronproton.evio.gz	20-Apr-2018 16:27	4.7M
electronprotonC.evio.gz	20-Apr-2018 16:27	3.5M

Forward Detectors		MC Truth					
		e	π	K	p	γ	n
P I D (%)	e	98					
	π		89	17	<1		
	K		5	72	<1		
	p		3	5	95		
	γ					93	30*
	n					3	65

*A rough efficiency based on 1K events for each, averaged over given kinematics, used to help track software development. For e / hadrons, demoninator requires a track; any other detector/reconstruction inefficiencies, kaon decay, track-matching, etc, are absorbed. Empty cell means <<1%. *Cut currently at β=0.9 (2 GeV).*

Documentation

- https://clasweb.jlab.org/wiki/index.php/CLAS12_DSTs

- https://clasweb.jlab.org/wiki/index.php/CLAS12_EventBuilder

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Please check it out when you have questions/concerns about DST format and Event Builder, and give feedback! Many questions I've received about EB and DSTs were already answered there!

Summary

Updates since July

- HTCC-track matching updated
  - loosened according to MC
  - now doing all combinatorics
  - bugfix on unintended cluster sharing between close tracks
- ECAL neutrals had missing seed cluster association
- bugfix on FT response indexing (when >1 FT particle)

- accommodate FTOF CCDB resolution units change (previously being corrected in trains)
- Addressed clock rollover for beam charge, but needs to be done pre- or post-processing, e.g. trains

- Fixed some NaN's in banks (e.g. unphysical beta)
- Fixed a couple other bugs that weren't having any effect … yet
- Prep to sort particles, needs final testing
- cleanup/restructuring
  - FT moved to standard class hierarchy
  - remove various duplicate/deprecated code

TODO

- Turn on z-vertex correction to start time after alignment
- Incorporate RICH
- FT-based start time?
- Investigate adding timing coincidence requirements to geometric matching
- Investigate alternative/better identification schemes
- Move specialized FT banks to standard REC::Cal/Sci
- Add halfwave plate position to CCDB and include in helicity state
- …