Event Builder Status

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CLAS Collaboration Meeting

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Overview

- EventBuilder is generally the last CLAS12 service run, after all detectors' reconstructions
- Retrieves and analyzes event-based quantities
  - e.g. RF, heliticy state, beam-charge, live-time
- Geometrically associates detector responses into particles
- Defines event start time
- Performs particle identification
- Writes all info for physics analysis into DSTs (REC* HIPO banks)

clas12-offline-software / reconstruction / eb / src / main / java / org / jlab / service / eb /

|		
baltzell Merge branch 'development' into ebdev-mrg		Latest commit 74c1d80 4 days ago
..		
EBAnalyzer.java	EBAnalyzer: cnd neutron/photon updates	15 days ago
EBEngine.java	Merge branch 'development' into ebdev-mrg	4 days ago
EBHBEngine.java	FT and Tracks Bank	11 months ago
EBMatching.java	EBMatching: set path on cnd seed	15 days ago
EBRadioFrequency.java	EB: added jitter correction to RF time based on event timestamp	2 months ago
EBTBEngine.java	eb: propagate TBT::TBCovMat to REC::CovMat, make REC::CovMat format a...	3 months ago
EBio.java	EBScalers: remove getters and return data from read for multithreading	5 days ago
EventBuilder.java	eb+cnd: Rongs neutron beta cut, more ccdb, set pid test limits	17 days ago

Geometric Matching, Creating Particles

- Charged particles: associate detector responses with tracks based on geometric matching via DOCA between track and response
  - Currently loose, flat detector-dependent cuts, with minimum-DOCA hit chosen (single response allowed per detector layer)
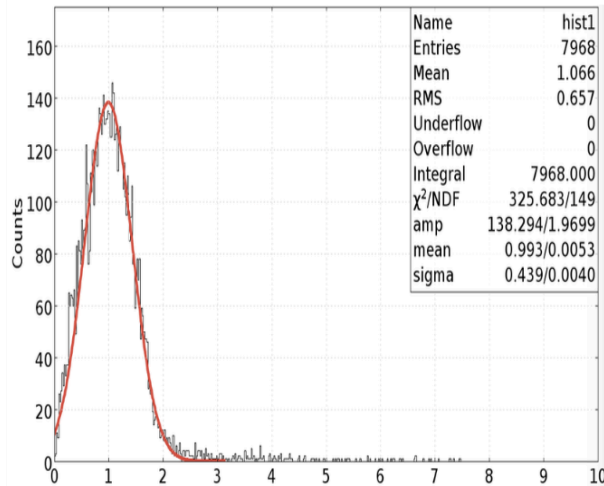
PCAL DOCA (cm)
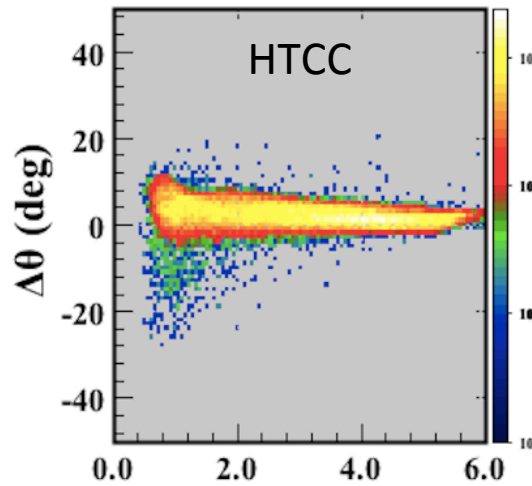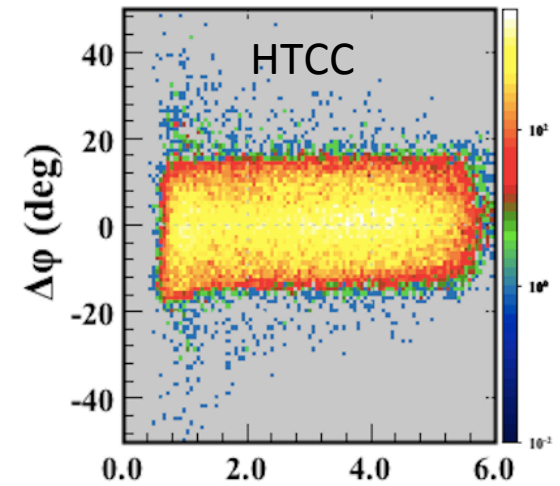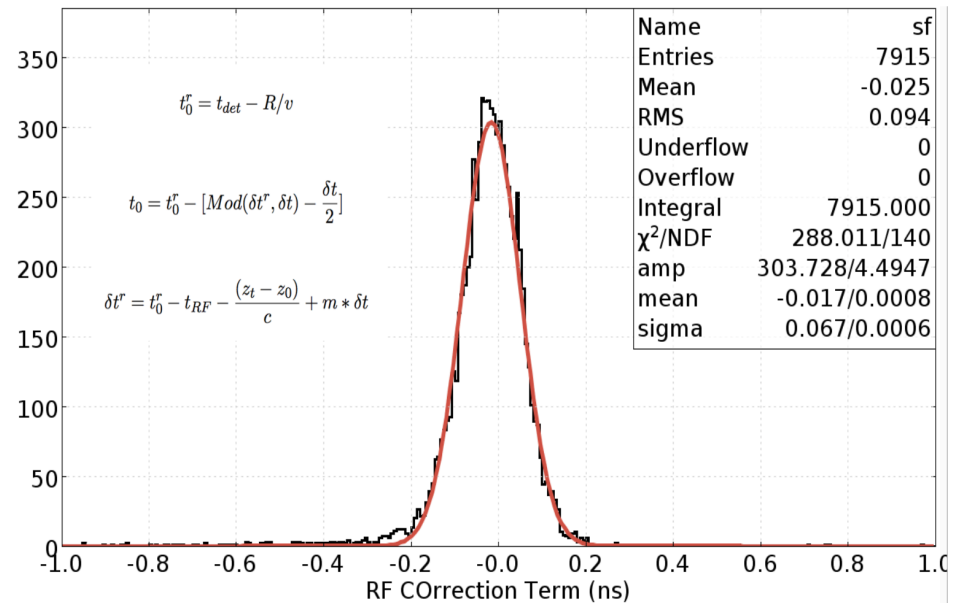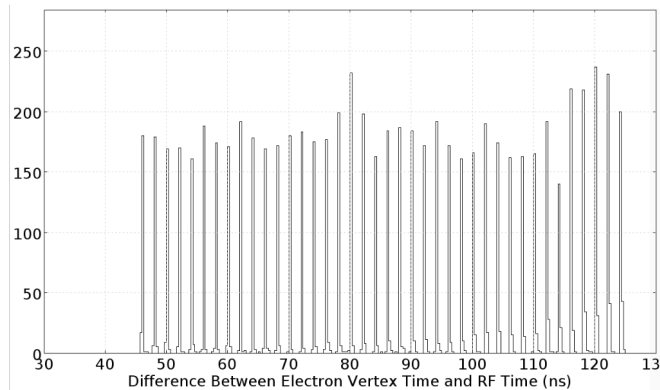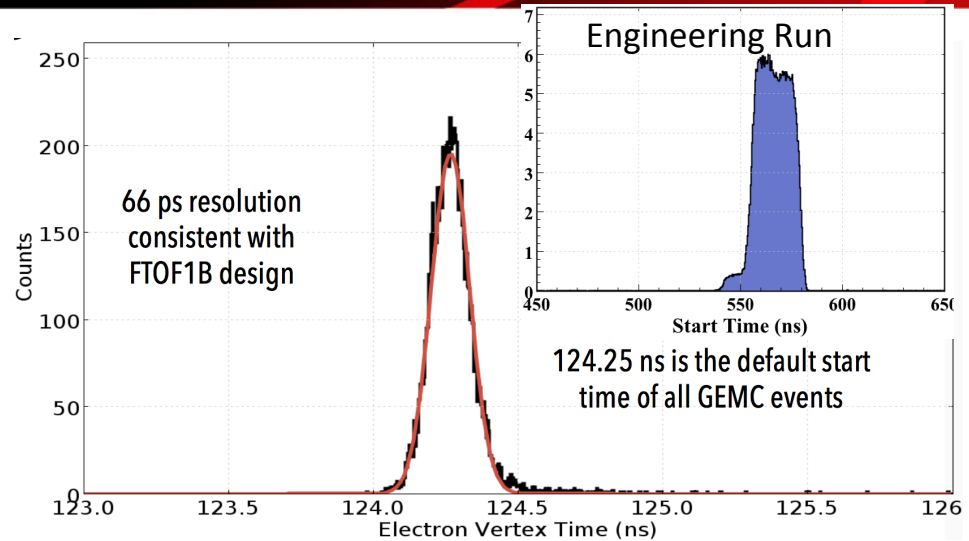
- Identify trackless ECAL (CND) hits as neutrals, assume straight trajectory, and associate with other detectors' unmatched hits based on geometric matching

- Matching quality (normalized distance) reported in output

ForwardTagger matching is currently just imported from its dedicated recon service

Event Start Time

- Choose "Trigger Particle"
  - highest energy electron if one exists
  - else positron
  - else highest momentum track with an FTOF hit
    - assumed a π
  - else Forward Tagger
    - *** not yet implemented, under study by FT group
    - needs to be mutually exclusive events
- Construct particle's vertex time and calibrated RF TDC signal to identify start time as nearest RF bunch time at vertex

66 ps resolution consistent with FTOF1B design

Engineering Run

124.25 ns is the default start time of all GEMC events

Electron Vertex Time (ns)

Start Time (ns)

Difference Between Electron Vertex Time and RF Time (ns)

$$t_0^r = t_{det} - R/v$$

$$t_0 = t_0^r - [Mod(\delta t^r, \delta t) - \frac{\delta t}{2}]$$

$$\delta t^r = t_0^r - t_{RF} - \frac{(z_t - z_0)}{c} + m * \delta t$$

Name	sf
Entries	7915
Mean	-0.025
RMS	0.094
Underflow	0
Overflow	0
Integral	7915.000
χ^2/NDF	288.011/140
amp	303.728/4.4947
mean	-0.017/0.0008
sigma	0.067/0.0006

RF COrrection Term (ns)

U.S. DEPARTMENT OF ENERGY   JSA   Jefferson Lab

Lepton and Neutral Identification

e⁻e⁺ in Forward Detectors

– Charged Track matched to ECAL, HTCC, and FTOF hits

– ECAL sampling fraction
   • *±5σ 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

– *PCAL > 60 MeV

– HTCC nphe > 2

– FTOF hit

– *Improved based on feedback from collaboration analyzers*

(Simulation)

ECAL Energy (GeV) vs Momentum (GeV)
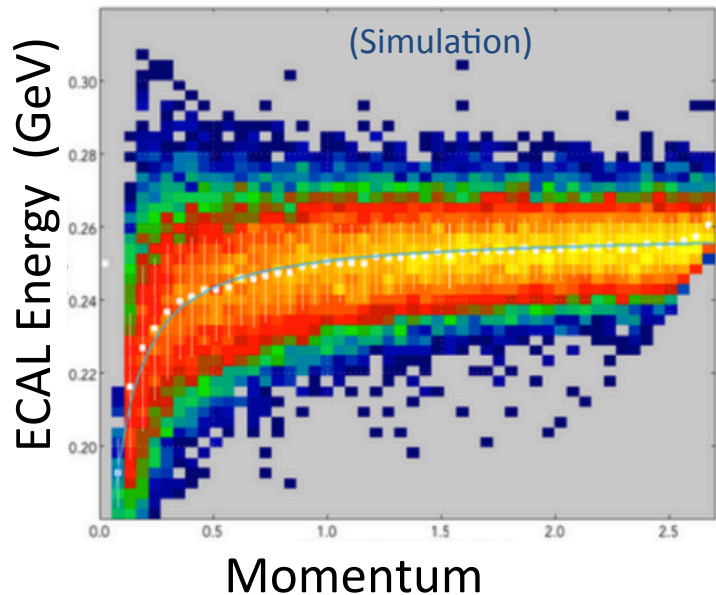
Neutrals *(after start time is determined)*

– 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
   • γ
      – ECAL β>0.9
      – Energy calculated from ECAL and sampling fraction parameterized in momentum
   • neutron
      – β<0.9
      – Energy calculated from β assuming neutron mass
   • FTOF-veto experimented with, currently not used

– Central Detector
   • * Based on work from Orsay group
   • CND clusters unassociated with a track assigned as neutrals
   • Also associates them with unmatched CTOF
   • neutron
      – β<0.9
      – Energy calculated from β assuming neutron mass
   • CTOF-veto under study, easily available in analysis

Forward Tagger

– e⁻
   • Matched calorimeter and hodoscope clusters
   • No charge separation, assumed negative

– γ
   • Calorimeter cluster unmatched to hodoscope
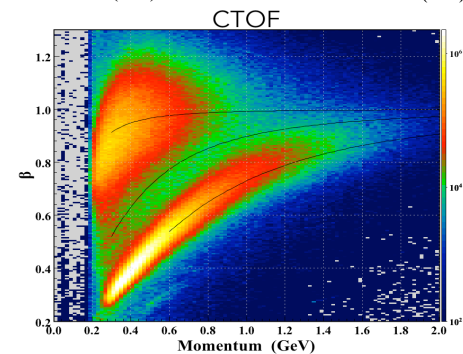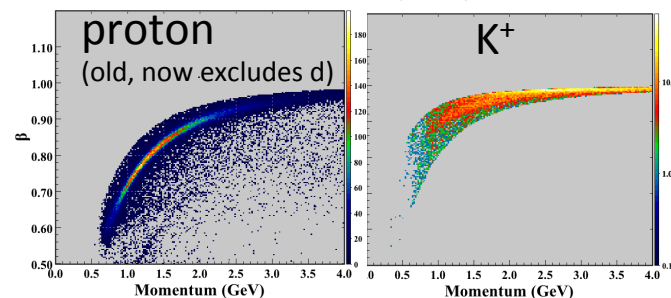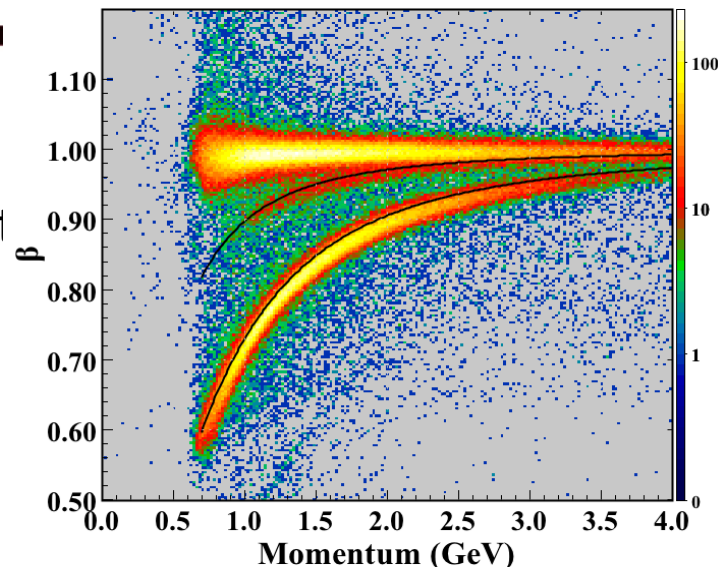
– Energies based on calorimeter

Charged Hadron Identification

- If a track fails electron identification, assume it's a charged hadron and assign it's 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
- Note, Event Builder doesn't implement timing calibrations/corrections!
- Vetoes from Cerenkov
  - e.g. kaon hypothesis gives best timing, but hit in LTCC and below kaon threshold → reassign to π
- REC::Particle.chi2pid is signed N_σ from nominal, with sigma per FTOF-paddle, so just 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 for analysis, and drop all lower level info, resulting in "DSTs"
    - 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
  - Now included in automatic Travis build tests

- 2-particle test events
  - FD: electron plus another, in different sectors
    - e⁻ : **1-9 GeV**
    - other (hadron/photon): **1-4.5 GeV**
    - away from detector edges (ϕ/θ)
  - Now includes CD and FT
  - `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

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/	10-Jul-2018 08:57	-	
4a.2.4-fid-r10/	10-Jul-2018 08:57	-	

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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

Apache/2.2.3 (Red Hat) Server at clasweb.jlab.org Port 80

Forward Detectors	MC Truth				
	e	π	K	p	γn
P I D (%) — e	99				
π		89	16	3	
K		5	68		
p		3	6	94	
γn					>90*

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%.

Documentation

- https://clasweb.jlab.org/wiki/index.php/CLAS12_DSTs
- https://clasweb.jlab.org/wiki/index.php/CLAS12_EventBuilder

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5 Non-DST Detector Banks

Please check it out when you have questions/concerns about DST format and Event Builder, and give feedback!

Summary

Status

– Almost all machinery in place, couple missing pieces pending feedback from detector experts/reconstruction →

– Particle Identification
  • simple cut-based logic and algorithm with single PID assignment
  • FD/CD/FT developed and well-tested

– Validation/testing "suite" in use
  • checking yields, efficiencies/ misidentification, data sanity checks
  • some run automatically in Travis (via github)
  • for tractable software development, proven useful for catching bugs

TODO

– Start time based on Forward Tagger if otherwise unavailable

– Incorporate RICH reconstruction into p/K/pi assignment

– Incorporate FT banks in more standard REC::"Response" scheme

– Assess optimization of DSTs

– Improving documentation …

– Improved PID schemes, input from collaboration