Event Builder Status

N. Baltzell

CLAS Collaboration Meeting

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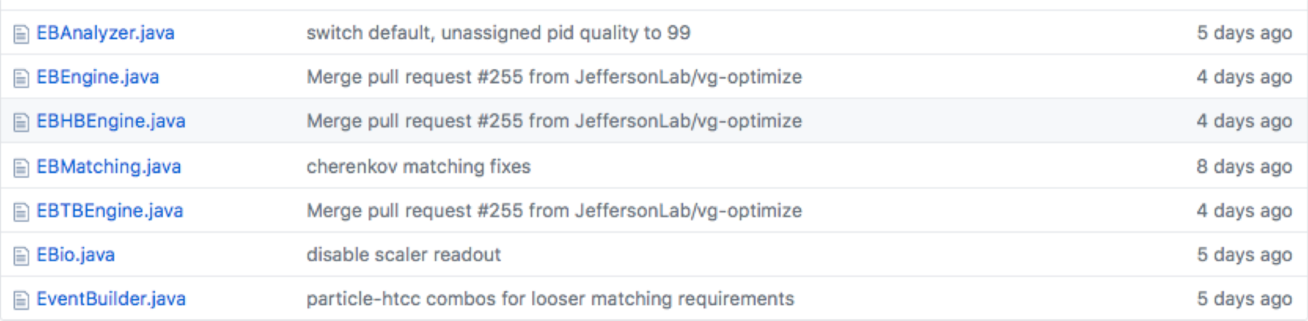
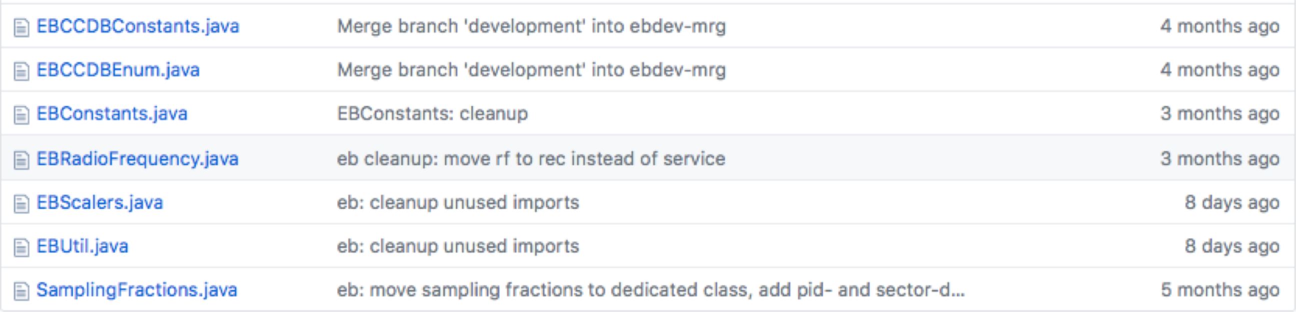
Overview

- “Event Builder” is the last CLAS12 service run, after all detectors
- Geometrically associates detector responses into particles
- Defines event start time, and does a basic particle identification
- Retrieves/analyzes various event-based quantities, e.g. helicity state
- 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

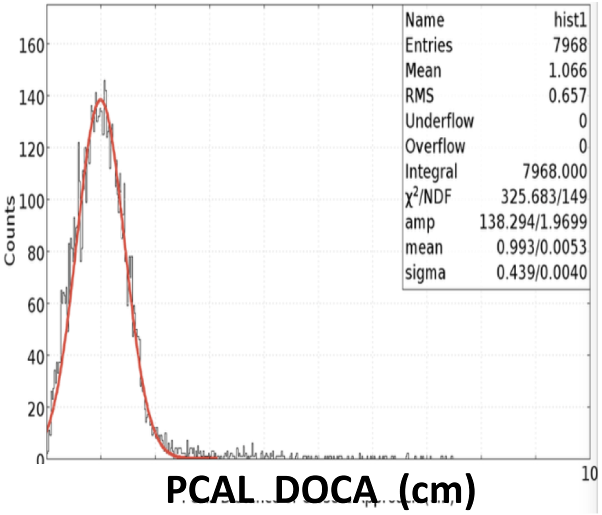
Creating Particles

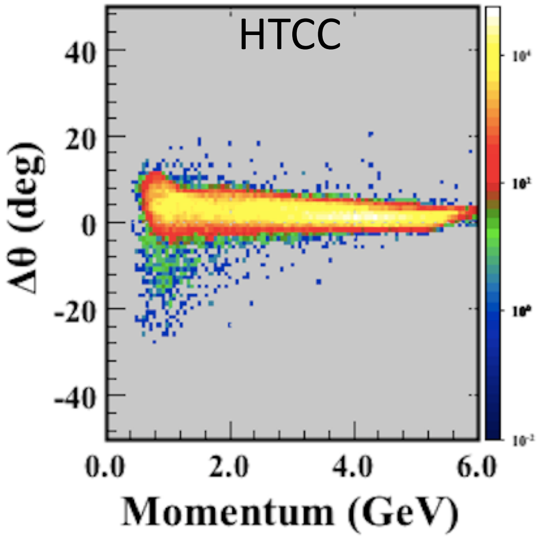
Charged Particles

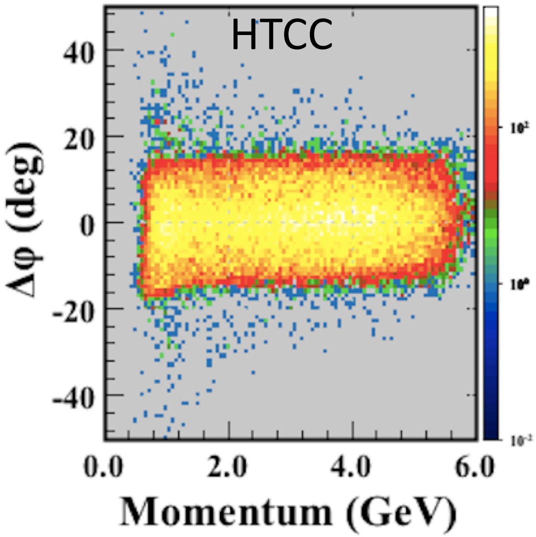
- associate detector responses with tracks, geometrically, based on DOCA

Neutral Particles

- identify remaining trackless ECAL/CND hits as neutrals, assume straight trajectory, and associate with other detectors' unmatched, geometrically, based on DOCA







Currently loose, flat detector-dependent cuts, with minimum-DOCA hit chosen.

NEW! Many-to-one, track-to-hit relationships in coatjava-6+. This plays a minor role with real particles hitting the same TOF paddle, and a significant role for accommodating ghost tracks.

Timing information is currently ignored at this 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
- Forward Tagger (***NEW!***)
  - Uses "shadow" banks, RECFT::Particle and RECFT::Event, just appending, when appropriate (i.e. no electron in FD), with new RECFT::Particle based on start time from FT, based on algorithm from FT analyzers
  - Take electron clusters in FT, and compare with all combos of tracks in FD and mass hypotheses, and that with the closest timing match (within half a beam bucket) is taken as the FT electron for start time

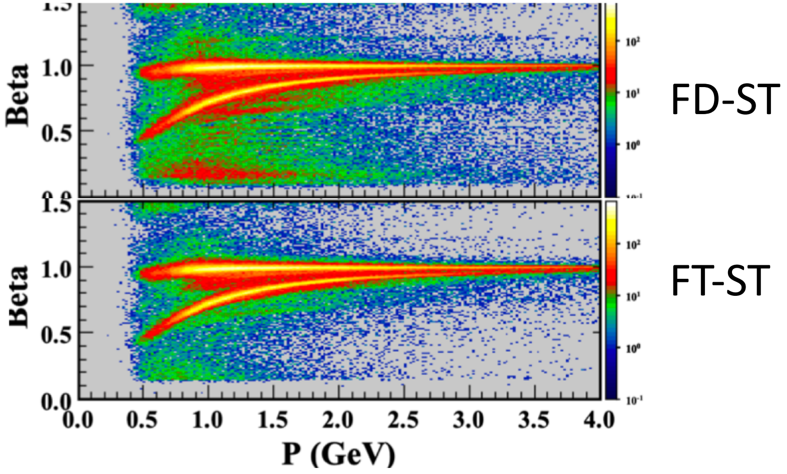
Construct its vertex time

- based on path length, mass, momentum

Use nearest RF bunch to assign start time

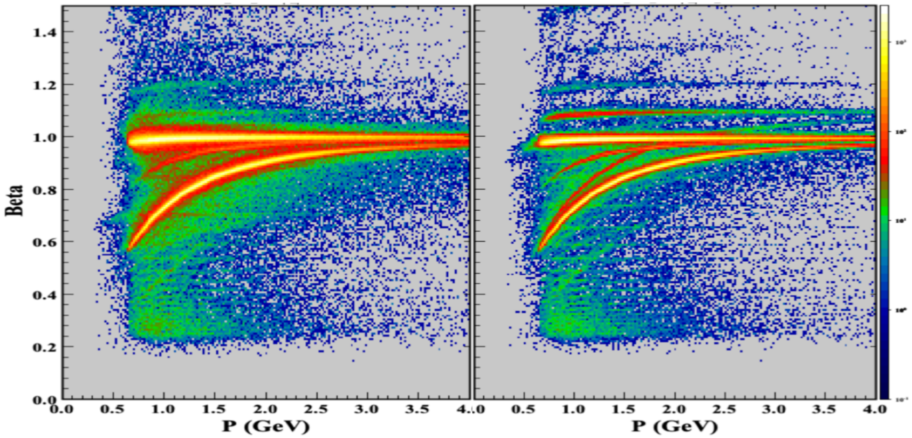
- Correction for non-zero z-vertex is ***imminent***
  - especially important for CTOF
  - *looks like we'll first use per-track z-vertex correctio due to unknown systematics (single z-vertex correction like CLAS6 doesn't provide improvement*

Events with e- in FT



No Z-vertex correction

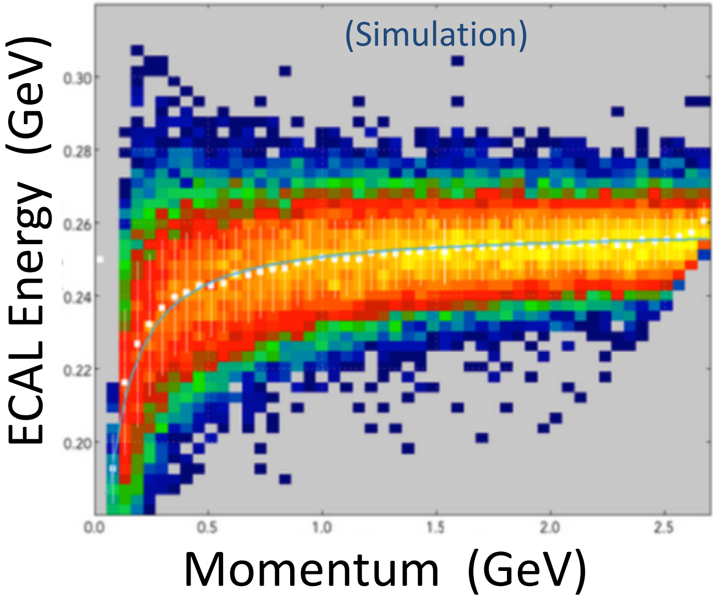
With per-track Z-vertex correction



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
  - ±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
  - ***Sampling fraction in CCDB needs to be updated based on final calibration***



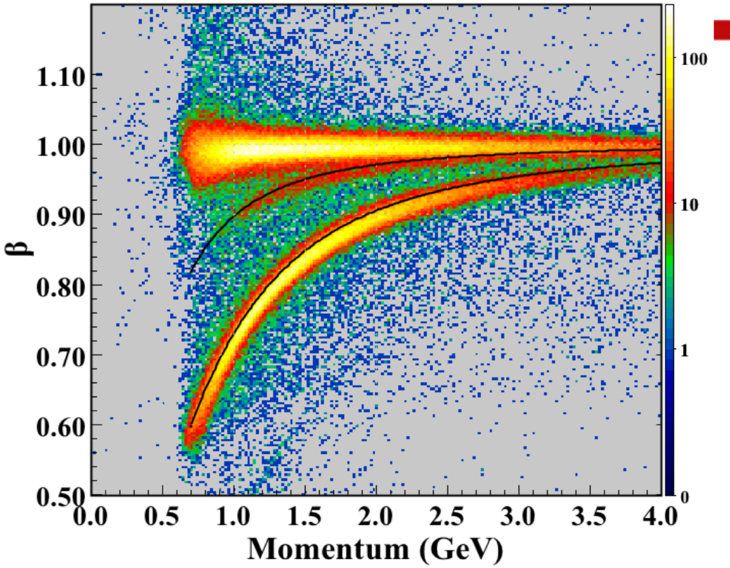
Neutrals

- 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 β>0.9,
    - Energy calculated from ECAL and sampling fraction parameterized in momentum
    - ***Sampling fraction in CCDB needs to be updated based on final calibration***
  - neutron
    - β<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
    - β<0.9
    - Energy calculated from β assuming neutron mass

Forward Tagger

- e^-: matched calorimeter and hodoscope clusters
- γ: calorimeter cluster unmatched to hodoscope
- Energies based on calorimeter

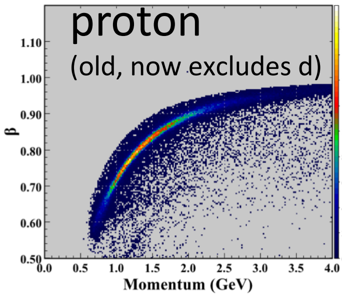
Charged Hadron Identification

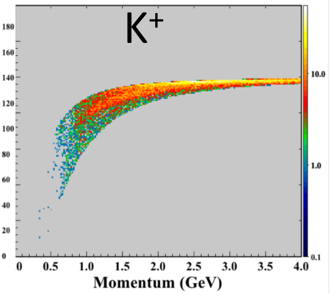


If a track fails e^-/e^+ identification, assume it's a charged hadron and assign its identity based on minimizing the time difference between event start time t_0 and vertex time.

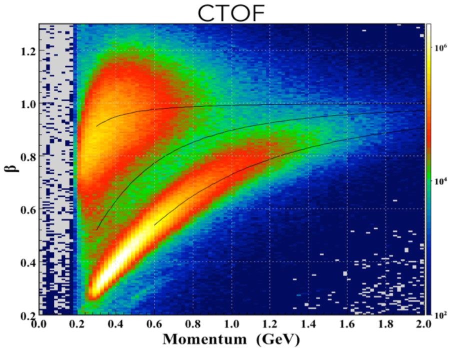
$$\Delta t_i = t_0 - \left[t_{FTOF} - \frac{L}{\beta_i(p)}\right], \quad i = \pi/K/p/d/\ldots$$

- 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 (or a signed-χ) 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, ML …



- ***Will need updating from RICH, and maybe BAND***

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

DSTs (1)

High level HIPO banks for physics analyses

- Most DST bank names are prefixed by “REC”, in `event.json`
  - https://github.com/JeffersonLab/clas12-offline-software/blob/master/etc/bankdefs/hipo4/event.json
  - `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
    - contains `pindex` link to its particle
    - *Note, this only contains responses associated with particles*

- Also keep RUN::*, RAW::scaler banks, RAW::epics, and some helicity banks

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

DSTs (2)

NEW BANK CHANGES AS OF HIPO4/coatjava6

Cleanup

- ~~REC::Cherenkov.theta/phi~~
  - use x/y/z
- ~~REC::Event.RUN/NEVENT/TYPE~~
  - use RUN::config instead
- ~~REC::Track.*nomm*~~

Additions

- RECFT::Particle
  - For FT-based start time and resulting hadron identification
  - ”Shadow” bank; same row-ordering as REC::Particle, and only contains REC::Particle quantities that are start-time-dependent
- HEL::online
  - Online delay-corrected helicity
- HIPO4, Tag=1 banks
  - HEL::flip
    - Only filled on flips, during serial decoding, for offline delay correction
  - RAW::epics
  - RUN::scaler
    - Calibrated beam charge
- Plus some other minor additions

Modifications

- REC::Particle.status
  - Now negative if it’s the start-time particle, to accommodate RECFT::Particle without reordering
- REC::Traj
  - Switched from single detId to standard detector/layer conventions like other DST banks
- REC::Event
  - Bring naming conventions more consistent with everything else, drop old CLAS6 shorthands, some still unused
  - NGPG → topology
  - EvCAT→ category
  - STTime → startTime
  - BCG→ beamCharge
  - Ptime → procTime
  - Helic → helicity and helicityRaw

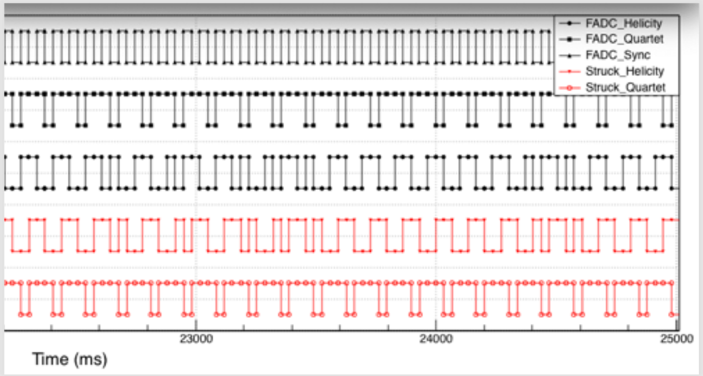
See documentation and release notes:

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

https://github.com/JeffersonLab/clas12-offline-software/releases/tag/6b.1.0

Helicity

- We have multiple readouts of the helicity state, in multiple types of hardware, for redundancy and cross-checking, as well as an online delay-correction as of 2019
- Direct Reporting
  - Spring 2018 only
  - easy, just read the FADC state from `REC::Event.helicity`
- Delayed Reporting
  - Fall 2018
    - Only offline correction possible
      - we tracked state changes during decoding and registered them in `HEL::flip` banks (Tag=1 for direct access in any file)
      - post-processing is required to validate and analyze the sequence
  - Spring 2019 and later
    - Online correction available in every event in `HEL::online`, can be cross-checked with offline version
- Note, in all instances we store both HWP-corrected and raw helicity for validation
  - and convention was finalized at +1/-1/0, for positive/negative/UDF
- Analysis software written in coatjava to read Tag=1, `HEL::flip` banks, on-the-fly during analysis and provide event-based helicity
- Validation performed, comparing the online and offline corrections and the different readouts, across ~100 file and a few runs
  - checked out good
  - despite some missing low-state readouts in FADCs that are correctable and occaisonal pileup in the scaler readout

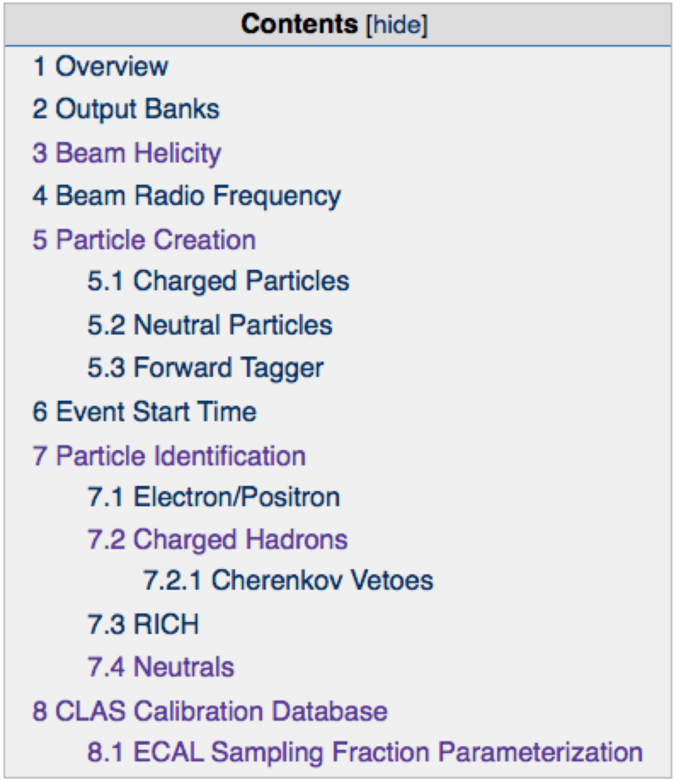


TODO: offline delayed helicity

- Validate and finalize the offline-correction
  - Initial testing on ~100 files showed no issues, all sequences complete, and online/offline in agreement
  - Recently processed RG-A/K data showed some new gaps due to DAQ-busy to address
  - Software already adjusted to accommodate and correct for gaps, testing in progress
- Post-processing to populate the `REC::Event.helicity` variable for easy event-by-event access for non-coatjava analyses

Documentation

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



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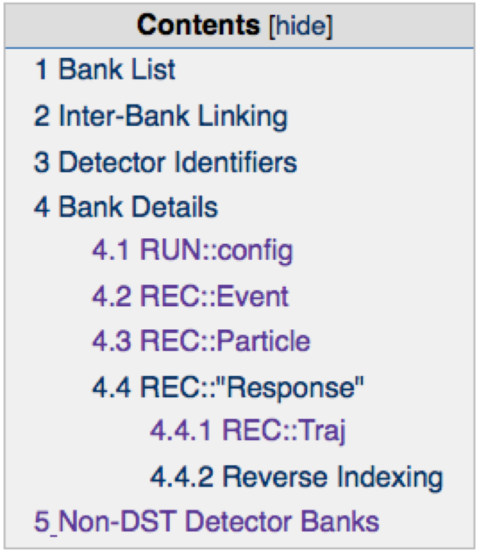

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5 Non-DST Detector Banks

Please check it out when you have questions/concerns about DST format and Event Builder, and give feedback! ***Almost all questions we've received about EB and DSTs were already answered there, else updated!***

Summary

Updates since March Meeting

- FT-based start time
  - available and used for particle identification in RECFT::Particle and RECFT::Event banks
- Many-to-one track-to-hit relationship
  - ghost tracks and real hit-sharing
- Online and offline delayed helicity corrections
- Use of tag=1 HIPO4 events for non-physics events
  - Scalers, helicity, EPICS

TODO

- Finalize and post-process offline delayed helicity correction
  - Careful treatment of gaps
- Finalize z-vertex correction to start time
  - Currently requires a per-track correction to be effective
- Switch to trajectory banks for path lengths
  - Along with all other reconstruction services and calibration suites!
- Future
  - possible track-hit matching improvements, e.g. timing
  - alternative/better identification schemes
  - Incorporate RICH, and now BAND, pending input from detector groups

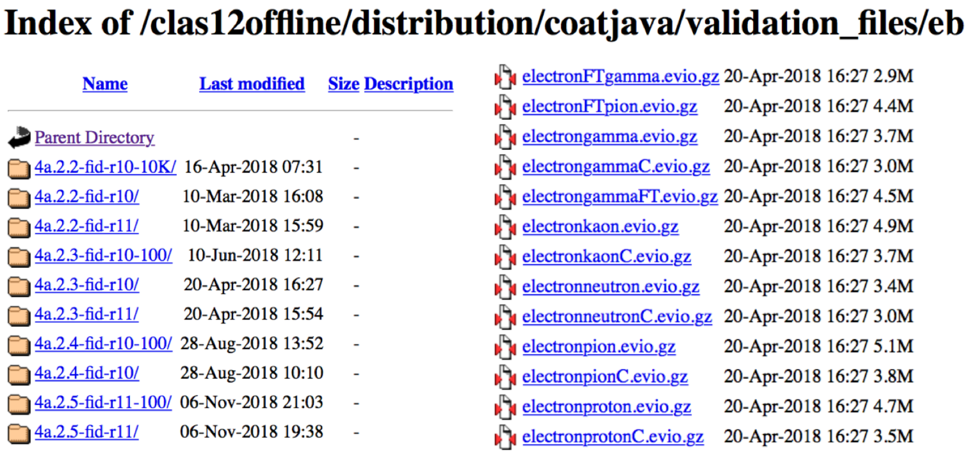
Validation Tests

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
  - ***this has proven extremely useful, despite the occasional maintenance overhead***

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

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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
PID (%)	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).*