Hall B:User Software Contributions

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Internal Software Review
Jefferson Lab
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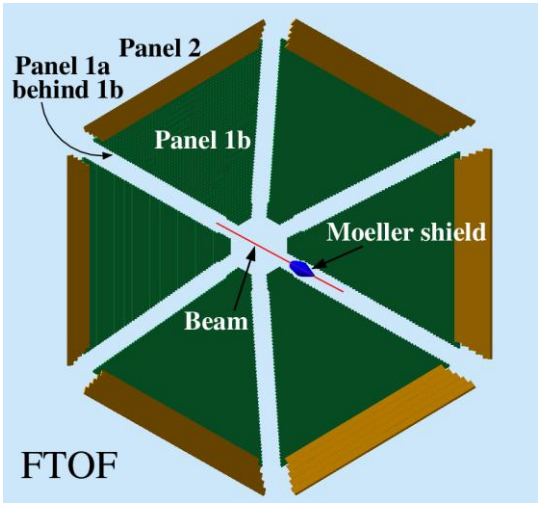
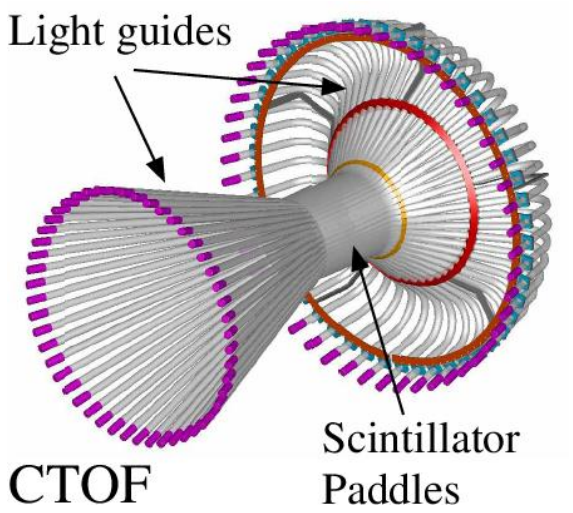
Goals and Outline

- Committee Charge - 1.c
  - Are users engaged at a sufficient level to demonstrate usability and readiness from a user's perspective?
  - Has the CLAS Collaboration identified appropriate mechanisms to support utilization of the software by the entire collaboration?
  - Is the level of user documentation appropriate for this point in time?
- Outline of talk
  - Example of user software development:
    - TOF reconstruction software
    - detectors, methods, results, and status.
  - User experience: developers, projects, workflow.
  - Connection with committee charge.

TOF Reconstruction

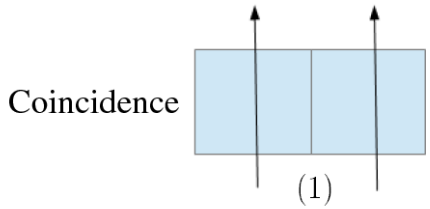
- Forward Time-of-Flight (FTOF)
  - 6 sectors, double-sided PMT readout.
  - Paddles: Panel 1a - 23, Panel 1b - 62, Panel 2 – 5.
- Central Time-of-Flight (CTOF)
  - 48 paddles, double-sided PMT readout.
  - form hermetic barrel around target.
- Outputs
  - Times (T_L, T_R from TDCs)
  - Positions (y_{hit} from $T_L - T_R$)
  - Hit times (T_{hit} from $(T_L + T_R)/2$)
  - Deposited energy (E_{dep} from ADCs)

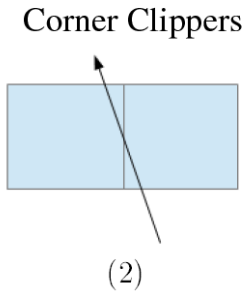


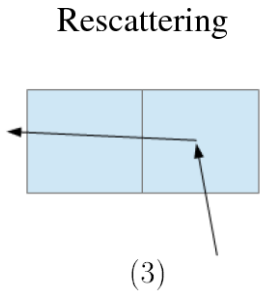


TOF Reconstruction Methods

- Single TOF paddles and clusters
  - adjacent hits grouped based on cuts on Δy_{hit} and ΔT_{hit}.
- TDC Time (T_L, T_R)
  - Apply time walk corrections and calibration.
- Position (y_{hit})
  - Use T_L-T_R to get y_{hit} relative to paddle center.
  - Clusters - energy-weighted average.
- Deposited Energy (E_{dep})
  - Apply ADC calibration and $E_{dep} = \sqrt{E_L \cdot E_R} \cdot e^{y_{hit}}$
  - Clusters – sum E_{dep}'s
- Hit time (T_{hit})
  - Average T_L, T_R
  - Clusters - energy-weighted average vs. earliest hit.

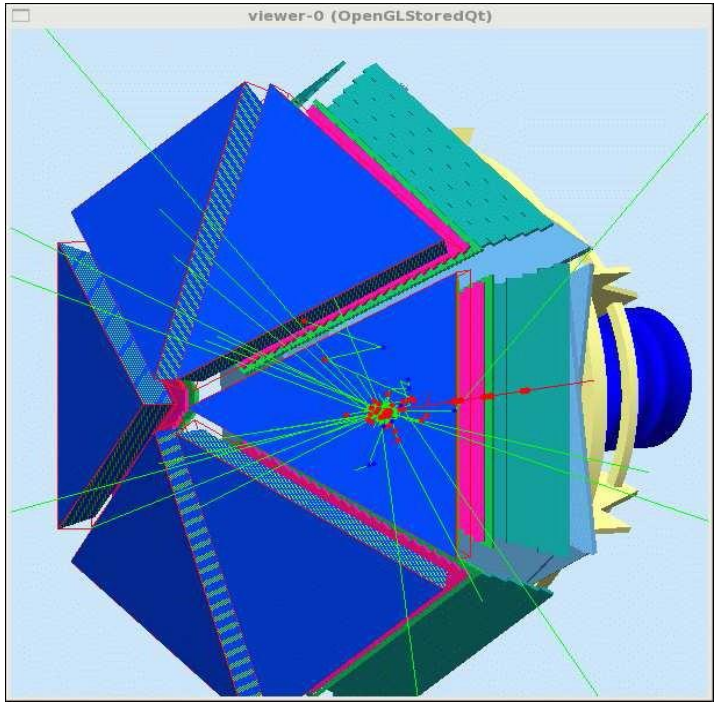






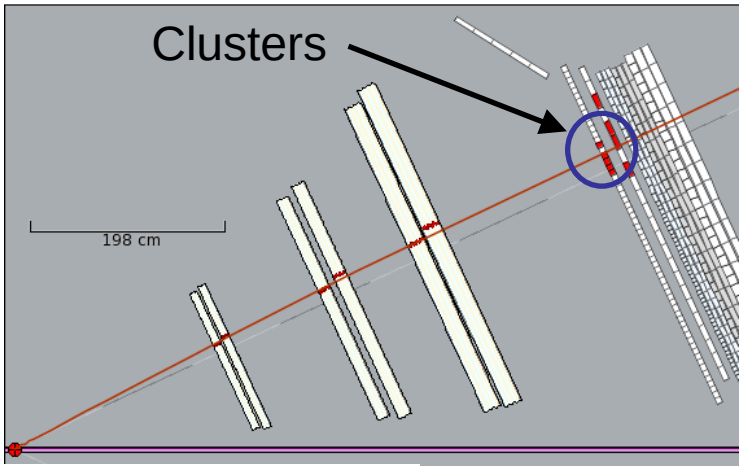
Code Validation

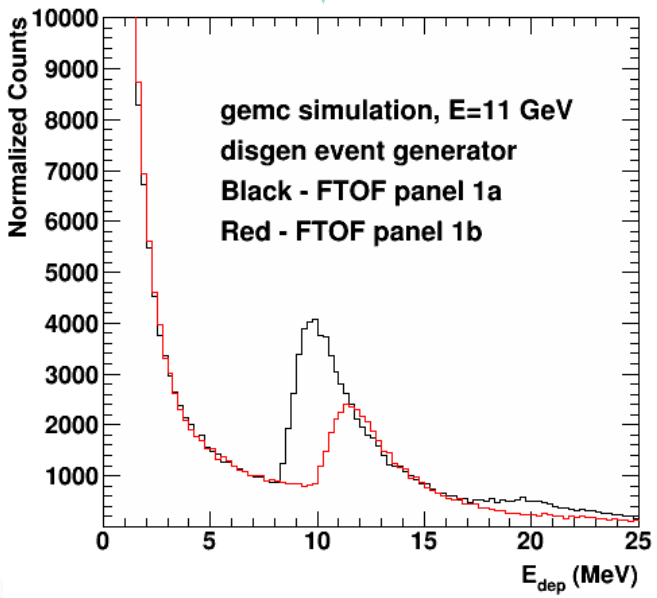
- Simulation is primary testing tool of TOF reconstruction code.
- CLAS12 Simulation – *gemc*
- Simulations done on Richmond cluster and copied to JLab.
  - Accessible, well-documented, bug reporting, website.
  - JLab staff member (M. Ungaro).
- Event generation
  - disgen – proton DIS
    - Range of final states and momenta.
    - Local
  - QUEEG – quasielastic scattering from deuterium
    - Local, under svn.
    - CLAS-NOTE 2014-008.

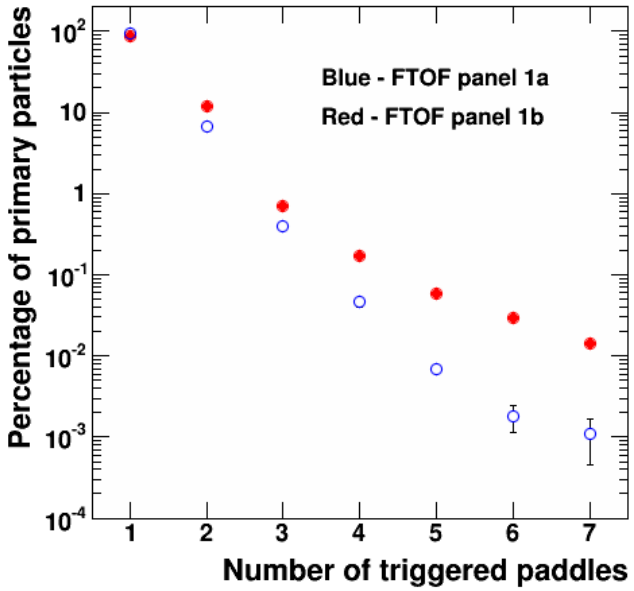


FTOF Standalone Reconstruction Results

- Validated in stress tests.
- Time difference with gemc.
- Measured N_{adj} dependence.
- Optimized clustering parameters.
- E_{dep}.
- CLAS12-NOTE 2014-003.







TOF Status

- CLAS12 generation 1 TOF reconstruction completed
  - Standalone versions for FTOF and CTOF.
  - Working as a service in analysis chain.
  - Validated in stress test.
  - Documentation: CLAS12-NOTE 2014-003.
- Updated to new clas-io libraries, bank definitions.
- New test version for event builder development.
- First version of code to match drift chamber track from hit-based tracking with FTOF hit.
- Geometry package in use.
- Streamlined code.

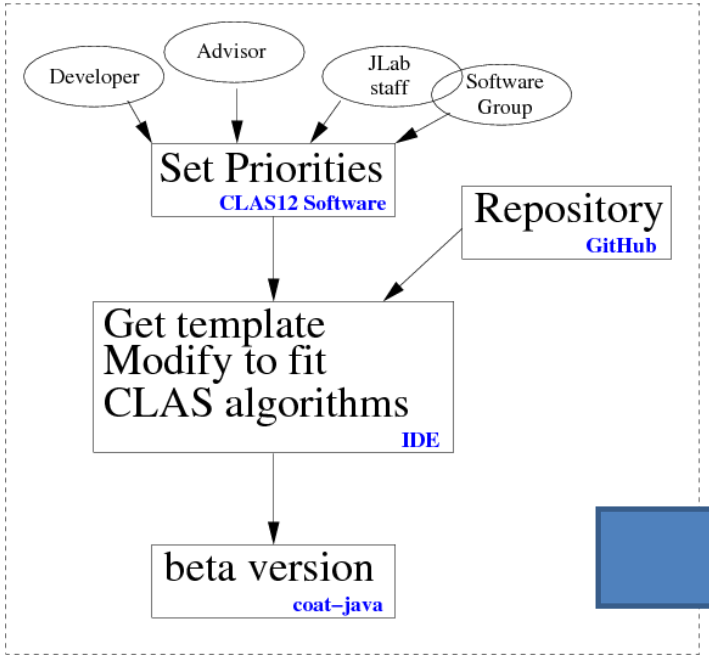
People and Projects

- Developer categories: A – environment programmers, B – service developers, C – physics-only users
- Time-of-flight reconstruction
  - Alex Colvill: Surrey master's student, gen1 TOF developer
  - G.P.Gilfoyle: Richmond
  - E.Golovach, Moscow State
    - periodic visitor to JLab from Moscow State
    - Working on DC-FTOF track matching.
- Forward Tagger Reconstruction
  - Raffaella DeVita INFN (Genova)
- ced12 development
  - Dave Heddle (CNU)
- Central Neutron Detector reconstruction
  - Daria Sokhan (Glasgow)
- PCAL reconstruction
  - Mike Wood (Canisius)
- Validation suite and BST calibration
  - Justin Ruger (CNU)

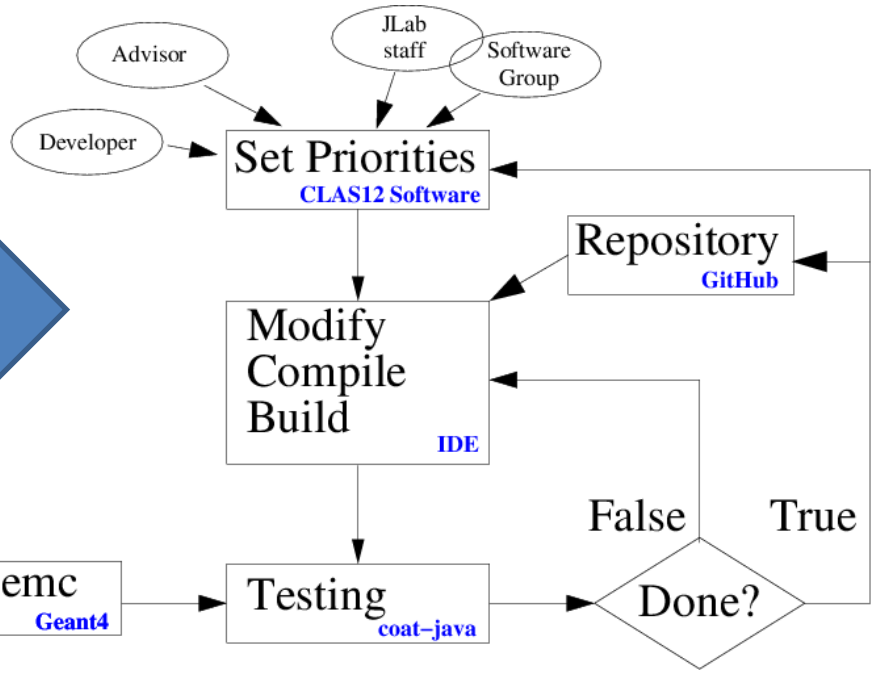
All project use the CLAS12 Common tools: ClaRA, coatjava, gemc, ced12,…

User Workflow

Getting Started



Development Cycle



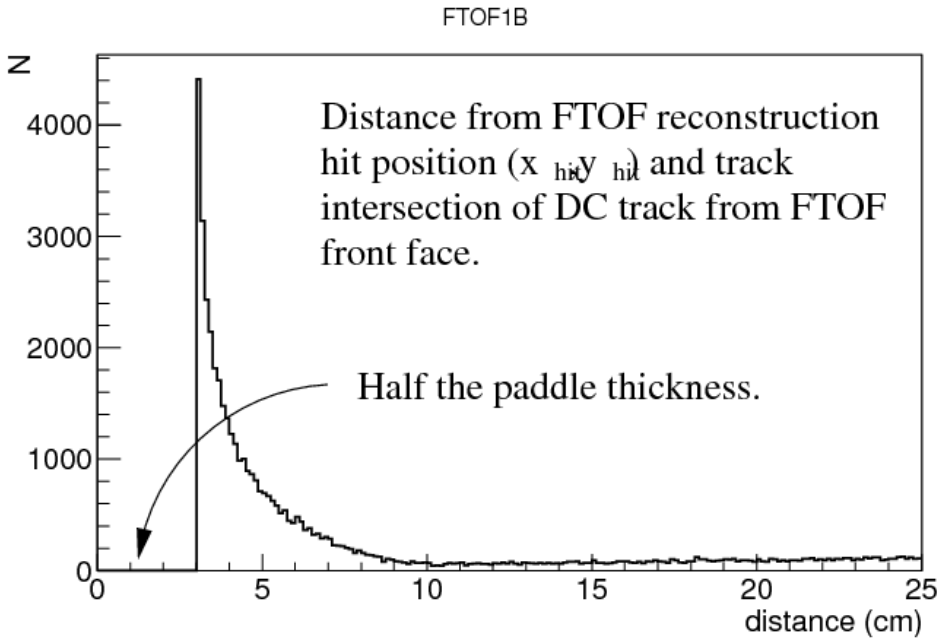
Connection to Charge

- Are users engaged at a sufficient level to demonstrate usability and readiness from a user's perspective?
  - Gilfoyle (Richmond), Golovach (Moscow State) and their students have been able to make significant contributions to the time-of-flight reconstruction package.
  - More CLAS collaborators using common tools (six projects now).
  - Time spent on-site is crucial for start-up.
- Has the CLAS Collaboration identified appropriate mechanisms to support utilization of the software by the entire collaborations?
  - For TOF project the common tools are far enough along for off-site users to make contributions.
  - Simulations with gemc and analysis in the ClaRA framework are ongoing at Richmond, MSU, and spreading to other CLAS Collaboration groups.
- Is the level of user documentation appropriate for this point in time?
  - Lots of material for FTOF, but should be localized (CLAS12 wiki?).
  - Starting to centralize documentation, tutorials, etc.
  - Bug reporting, access to JLab staff for support is crucial to get software working offsite.

Additional Slides

Track Matching with Drift Chambers

- Match drift chamber track with FTOF hit.
- Hit-based tracking results are used now.
- DC track is propagated from last DC plane to front face of FTOF panel (**B**=0) using geometry service tools.
- FTOF returns (x_{hit},y_{hit},z_{hit}) where x_{hit}, z_{hit} are in the center of the paddle.
- Consider only single paddle clusters.
- First results:



Energy-weighted T_{hit} vs. Earliest T_{hit}

- Cluster hit times have been calculated as the energy-weighted sum of the paddle hit times.
- We also considered taking the earliest T_{hit} among the paddles of each cluster.