Hall B: User Software Contributions

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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.

- **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 $\Delta y_{hit}$ and $\Delta T_{hit}$.

- 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.
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 $N_{\text{adj}}$ dependence.
- Optimized clustering parameters.
- $E_{\text{dep}}$.
- CLAS12-NOTE 2014-003.

![Image of Clusters](image)

**Graph 1:**
- gmem simulation, $E=11$ GeV
disgen event generator
Black - FTOF panel 1a
Red - FTOF panel 1b

**Graph 2:**
- Percentage of primary particles
- Number of triggered paddles
- Blue - FTOF panel 1a
- Red - FTOF panel 1b

![Graphs](image)
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

Set Priorities

Repository

Modify to fit CLAS algorithms

beta version

cocot-davinci

Development Cycle

Set Priorities

Modify Compile Build

Teste

gemc

Software Group

JLab staff

Advisor

Developer

Repository

GitHub

False True

Done?
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:

![Graph showing track matching results.](image)
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.