CLAS12 software status and plans

March 2, 2021

Agenda

Tuesday

10:45 — **Software status and plans**
Speaker: Raffaella De Vita (INFN - Genova)

11:05 — **Computing updates**
Speaker: Nathan Baltzell (Jefferson Lab)

11:20 — **ECAL clustering studies**
Speaker: Cole Smith (JLAB)

11:40 — **Simulation update**
Speaker: Maurizio Ungaro (Jefferson Lab)

12:00 — **Truth-matching**
Speaker: Rafayel Paremuzyan (University of New Hampshire)

12:20 — **CALCOM status and plans**
Speaker: Daniel Carman (JLab)

12:45 — **Discussion**

Friday

09:45 — **CLAS12 CVT Status**
Speaker: Veronique Ziegler (Jefferson Lab)

10:10 — **AI Assisted Tracking**
Speaker: Gagik Gavalian (Jefferson Lab)

10:35 — **Level-3 Trigger with AI**
Speaker: Richard Tyson (University of Glasgow)

Main topics:

- Recent developments and preparation for pass2
- Computing
- Support to analysis

…plus a few communications

Latest software release

New software release in support of RG-F data processing and calibration

- New EVIO library addressing recent issue in reading RG-F data
- Reconstruction updates for RTPC
- New COAT::config bank for data preservation

See Nathan's talk for next release plans

https://github.com/JeffersonLab/clas12-offline-software/releases

Latest release

🏷 6.6.0

○ 304cfb9

Compare ▾

COATJAVA release 6.6.0

🟣 baltzell released this 16 days ago · 5 commits to development since this release

Compatible with GEMC 4.4.1

- common-tools
  - minimize RCDB queries by sharing/caching across all services
  - evio 6.1 -> 6.2
    - addresses issues with reading recent BONuS EVIO data
    - requires dependency updates to keep consistent EVIO version
      - jnp-hipo 1.1 -> 2.0
      - jnp-hipo4 4.0 -> 4.1
  - magfield cleanup
- reconstruction
  - bugfix on RF-based event start-time, effective for tracks *very* far from the target
  - add latest truth-matching engine, pending HIPO output from GEMC
  - updates to BONuS reconstruction, including:
    - bugfix for out-of-bounds array limits
    - ignoring events with huge RTPC hit counts to avoid memory issues
- convert CI tests from Travis to github actions
- add `COAT::config` bank, with software versions, for data preservation

Commits since 6.5.13

Pass2 preparations

- Pass2 tasks status information available in O365 spreadsheet
  - Status column added
  - See https://jeffersonlab-my.sharepoint.com/:x:/g/personal/devita_jlab_org/EWEMPtgyNrpGizPqPvuJFNoB1M2eBG7RyEk9MIOvqsqJzQ?e=hLp49y

| Category	Task	Description	Priority (1-4) 1=high, 4=low	Manpower Core	Manpower Support	Status
			*needs further information		italic: not identified yet	
Software	Add new e/pi separation cuts in EB	Implement additional ECAL cuts to improve e/pi separation (iss605)	1	0.01(NB)		Complete
Software	Use event vertex in direction calculation for FT	Define angles of particles in FT based on vertex of FD particle. Requires discussion on moving FT particle building to EB and swimming to vertex (iss604)	1	0.01(NB)+0.02(RDV)		Study completed
Software	Resolve DC intrasector z-vertex dependence	Investigate and resolve the observed phi dependence of the vertex z coordinate (a "smile" in MC (iss603)	1	?(VZ)+?(RDV)		In progress
Software	Resolve DC covariance matrix issues	Validate the FD tracking covariance matrix in the TSC frame, transform it to the lab frame and tune it using MC (iss607)	1	?(VZ)	0.1	In progress
Software	Complete restructuring of CVT	- Implement new generic KF / - Implement straight track reconstruction for beam data and cosmic / - Remove/understand biases in reconstructed 3-momentum, vertex and residuals / - Implement shifts and rotations for BMT to support alignment / - Implement eloss and multiple scattering in KF / - Optimize seeding and rejection of out of time hits / - Implement Lorentz angle correction for SVT / - Port the covariance matrix to the lab; validate and tune the matrix elements	1	done / done / 0.05(VZ) / 0.025(RDV)+0.025(VG) / 0.02(VZ)+0.05(YG) / 0.02(VZ)+0.05(YG) / 0.02(VZ) / 0.02(VZ)	0.2	In progress
Software	Complete RICH reconstruction	Finalize reconstruction for both direct and indirect light, assess resolution and efficiency	1	?	?	Waiting on alignment
Software	Incorporate RICH into EB	Depends on the previous row (Complete RICH rconstruction)	1	?(NB)		Postponed
Software	CND clustering and neutral veto refinement	Update of clustering and veto algorithm based on ongoing studies	1	0.01(NB)	0.025	In progress
Software	Complete RTPC reconstruction	Relevant for RG-F	1	?	?	In progress
Software	Complete FMT tracking	Relevant for RG-F	1	?	?	In progress
Software	Incorporate AI-assisted tracking for DC	Integrate and validate AI-assisted tracking (iss608)	1*	0.05(GG)+0.05(RDV)+0.025(VZ)	0.1+0.1+...	Complete
Software	Save TB tracks with no beta	Assume a beta (pion?) for those that don't have non-DC timing information (iss621). May require some optimization on beta cuts	1*	0.02(SS)		In progress
Software	FTT reconstruction	Complete FTT reconstruction	2	0.05(RDV)	0.05	In progress
Software	Implement ECAL clustering sharing	Algorithm is known, pending implementation (iss601)	2*	0.02(NB)+0.02(LCS)	0.05	In progress
Software	Revisit geometric track-hit matching criteria in EB	Optimize cut values for non-LTCC based on geometrical residuals	2		0.05	In progress
Software	Revisit geometric track-hit matching criteria in EB	Optimize cut values for LTCC	2	0.025(NB)	0.05	In progress
Software	Status tables	Use CCDB status tables in reconstruction to knock out dead/malfunction detector components. Particularly relevant for MC, but unclear how relevant it is for real data's pass2.	2	0.02(RDV)+0.01(LCS)		In progress
Software	Use combined FTOF 1A and 1B timing in EB	Implement combined use of 1A and 1B time in PID. Pending improvement estimate and definition of implementation strategy	2*	0.025(NB)	0.1	Waiting on in-layer clustering
Software	Use HTCC timing in EB matching	Use HTCC cluster time in matching tracks to clusters in EB (iss602). It will require updates of HTCC calibration. Requires dedicated study.	2*	0.025(NB)+0.025(NM)	0.05	Waiting on HTCC recalibration
Software	Use energy deposition in charged hadron PID	Use information on energy loss in TOF, CND and ECAL to improve charged hadron PID. Depends on actual study and algorithm development	2*	?(NB)+?(SS)	0.1	Study in progress

- Software tasks also tracked via GitHub issues and milestones
  - See https://github.com/JeffersonLab/clas12-offline-software/milestone/3

Pass2

No due date   29% complete

🕐 19 Open   ✓ 8 Closed

- ⊙ **Implement ECAL cluster sharing**
  #601 opened on Oct 6, 2020 by baltzell
- ⊙ **Use HTCC timing in EB matching**
  #602 opened on Oct 6, 2020 by baltzell
- ⊙ **Resolve DC intrasector z-vertex dependence**
  #603 opened on Oct 6, 2020 by baltzell
- ⊙ **Use event vertex in direction calculation for FT particles**
  #604 opened on Oct 6, 2020 by baltzell
- ⊙ **Add new e/pi separation cuts in EB**
  #605 opened on Oct 6, 2020 by baltzell
- ⊙ **Use FTOF clustering**
  #606 opened on Oct 6, 2020 by baltzell
- ⊙ **Resolve DC covariance matrix issues**
  #607 opened on Oct 6, 2020 by baltzell
- ⊙ **Incorporate AI-assisted tracking for DC**
  #608 opened on Oct 6, 2020 by baltzell

CVT

- Advanced restructuring of reconstruction code:
  - Most distortions observed with old code understood and resolved, few remaining anomalies being debugged
  - New geometry package and layer removal functionality to support alignment
  - Support for beam and cosmic data
  - Eloss and multiple-scattering

- In progress/to do:
  - Further debugging of cosmic data fitting
  - Complete switch to new geometry package for BMT
  - Check chi2 and covariance matrix
  - Improve seeding/efficiency with high background
  - Switch to jnp matrix library to improve speed
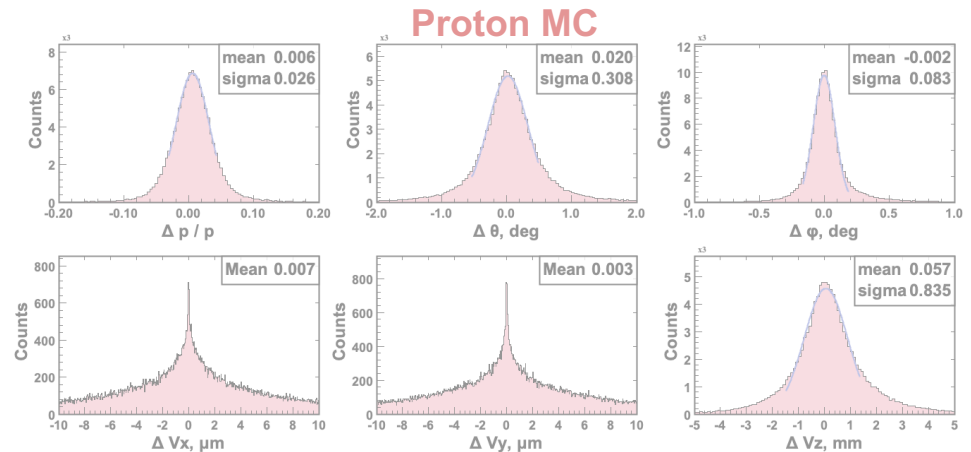
See Veronique's talk on Friday
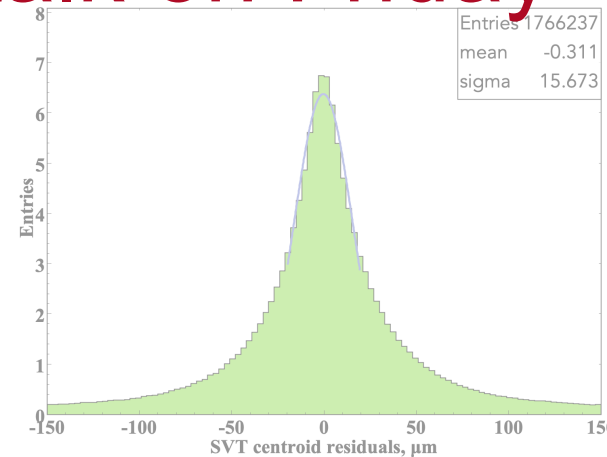
Forward tracking

- *AI-assisted tracking:*
  - *See Gagik's presentation on Friday*

- Intra-sector phi dependence of z vertex
  - Observed in MC
  - Issue tracked back to torus field: either map interpolation or inconsistency between digitization and reconstruction
  - Further checks ongoing

- Covariance matrix
  - Transformation from local to global frame implemented
  - Comparison of matrix diagonal element versus MC resolution indicates (pulls) further tuning is necessary
  - Matrix initialization values checked
  - Debugging of matrix transport and filtering in KF

- Save TB tracks with no beta
  - Done

π- at p=4GeV, θ=20°, z=-3 cm, no solenoid
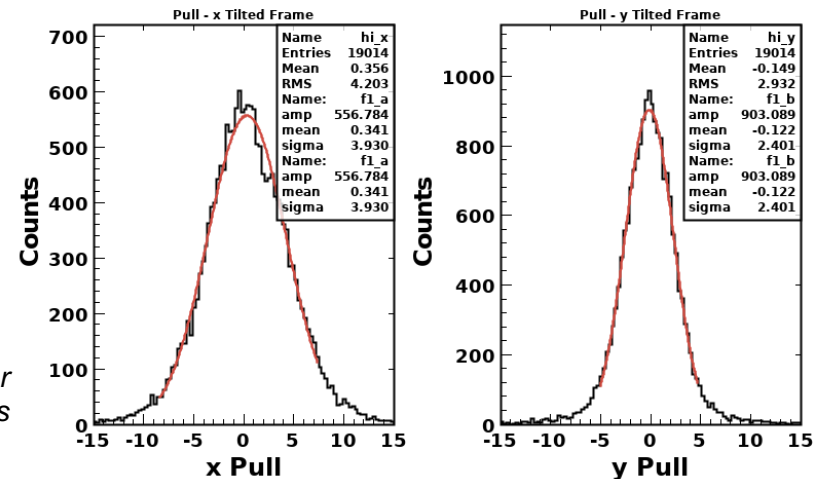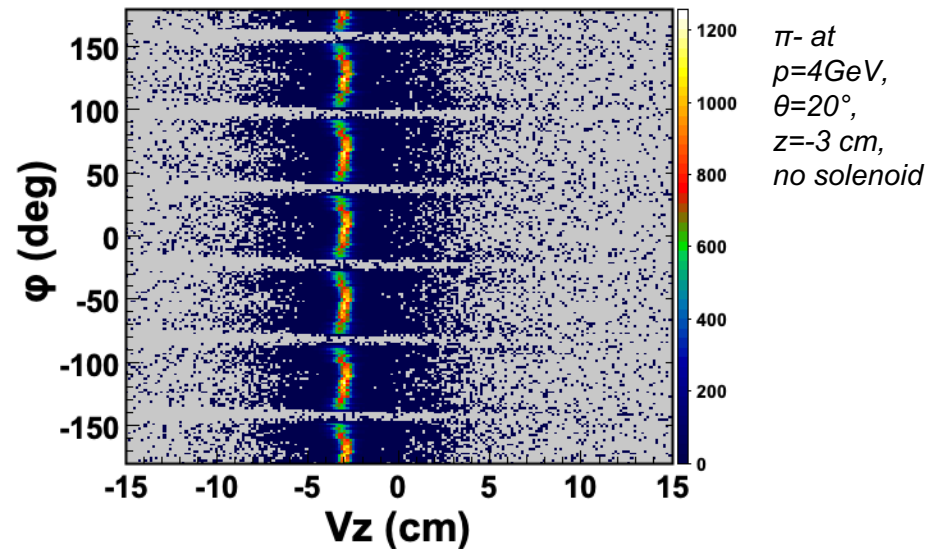
x/y pull for simulations

ECAL updates

- Started as "Implement energy sharing for overlapping clusters"

- Particularly relevant for pi0 reconstruction given small angle between decay photons. Significant impact on DVCS analyses

- Found potential issue with artificial clusters arising from multiple peaks (fluctuations?)

- Refinement of peak finding algorithm necessary

- More work than expected, in progress
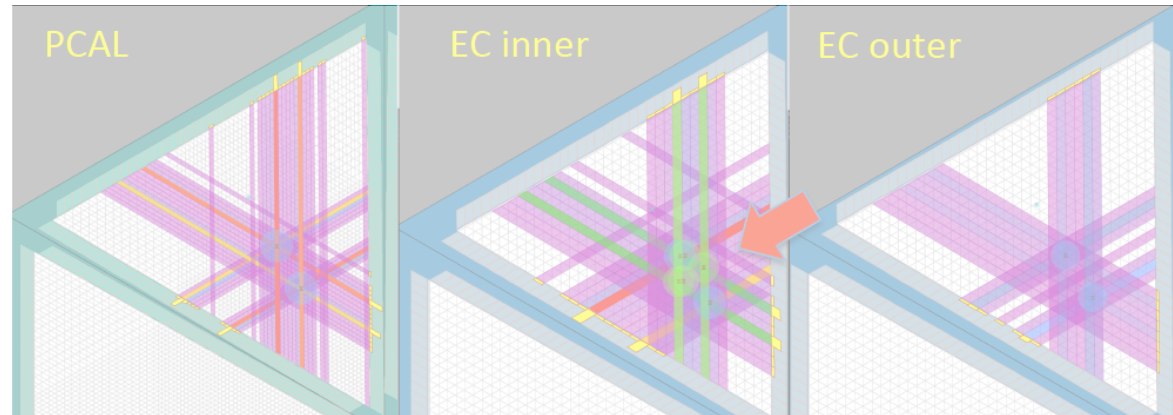

See upcoming talk by Cole
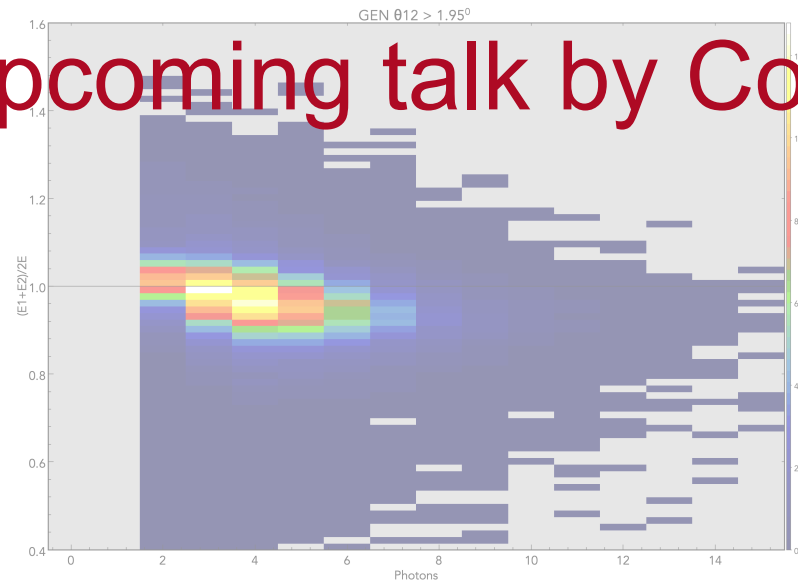
$\pi^0 \to \gamma\gamma$ simulation: Unphysical clusters (PC, ECi, ECo > 2) increase the photon yield and corrupt the energy reconstruction by 3-5%

FTOF clustering

- In-layer clustering:
  - Cluster of neighboring paddles for corner-clippers tracks
  - Algorithm implemented in reconstruction and tested
    - Relevant improvement of energy reconstruction in 1B
    - Moderate (1-4%) improvement of timing in 1B
    - No benefit for 1A due to splash-back from PCAL
  - Further tuning of hit matching parameters needed and test on panel 2
  - Mostly analysis work and DB constant updates
  - See https://clasweb.jlab.org/wiki/images/b/b5/FTOF_Cluster_Software_Feb_25_2020.pdf

- Multi-layer clustering (1A+1B):
  - First studies indicate limited benefit
 - Work in progress to converge over the next two months

Panel 1B Clusters
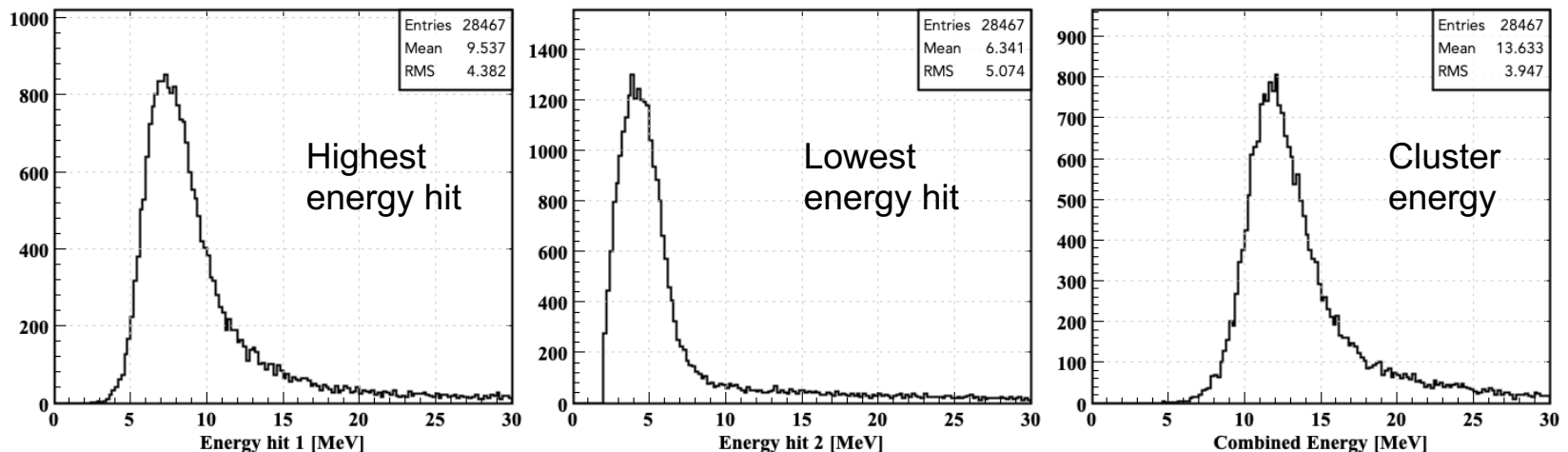
FT updates

- Use event vertex or target position in definition of z vertex of FT particles
  - Study completed and strategy defined
    - Use target position in reconstruction
    - Leave further corrections based on other tracks vertices (topology dependent) to analysis
  - Minimal software changes to be done
  - See https://clasweb.jlab.org/wiki/images/3/36/20210128_ftvertex.pdf

- Tracker reconstruction:
  - First version completed and tested on simulations
  - Test on data in progress
    - Issues with translation table found
    - Alignment and detector performance evaluation next
  - See https://clasweb.jlab.org/wiki/images/1/1f/FTT_tracking_update_210128.pdf

Tracker resolution from MC for detector 1 and 2
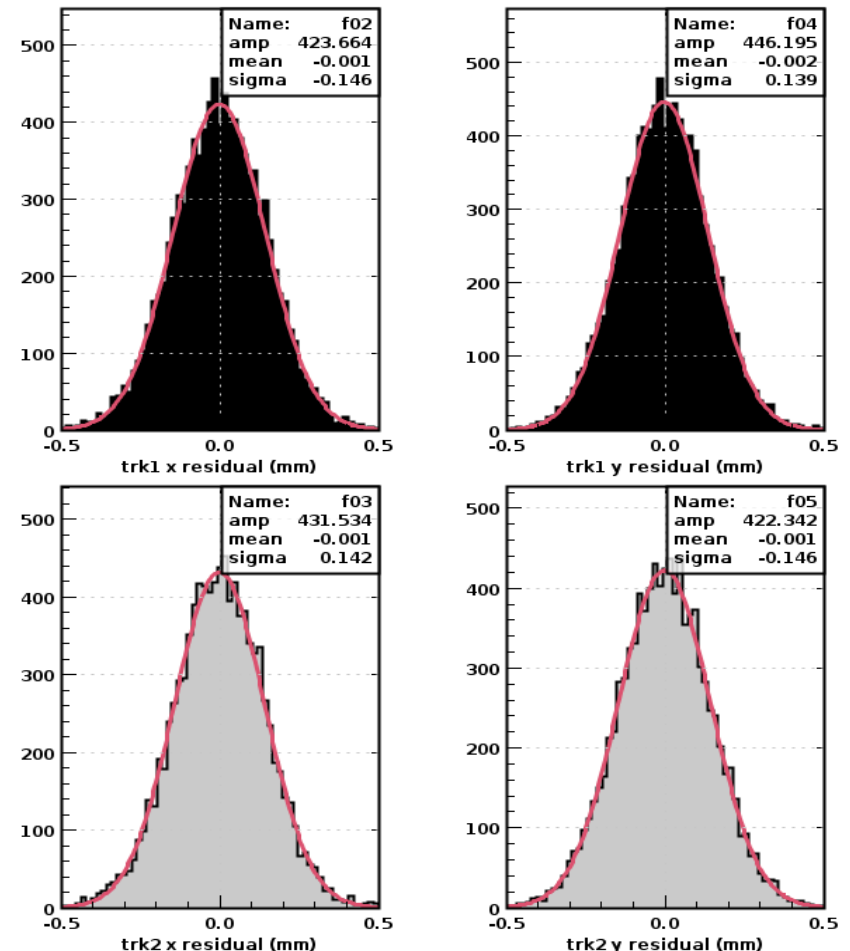
EB updates

- New e/pi separation cuts
  - Use correlation between ECinner and PCAL energy deposition
  - Implementation complete

- Updated RF correction in event start time
  - Unique choice of beam bucket for the event while maintaining particle-dependent vz correction
  - Relevant for tracks originating far away from the target
  - Implementation complete (see https://clasweb.jlab.org/wiki/images/6/6d/Baltzell-rf-20210204.pdf)

- Tuning of track-hit matching cuts
  - Study in progress

- Use of dE/dx in scintillators for hadron id
  - Study in progress

PCALECIN
Simulated positrons

Pre-Start-Time-Fix

Post-Start-Time-Fix
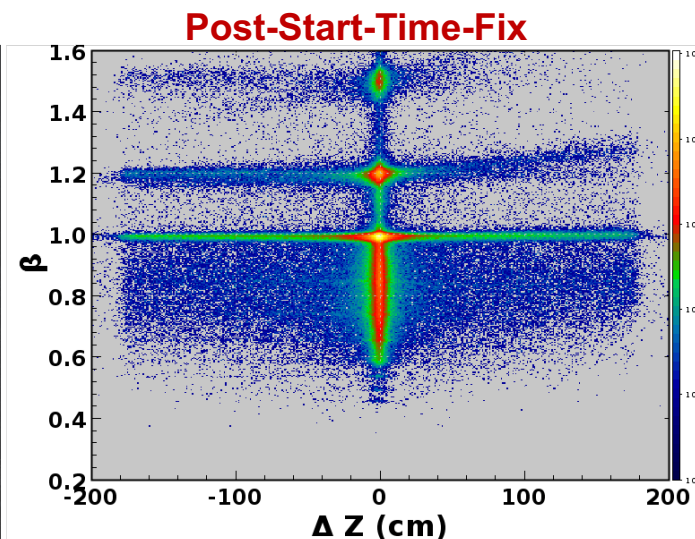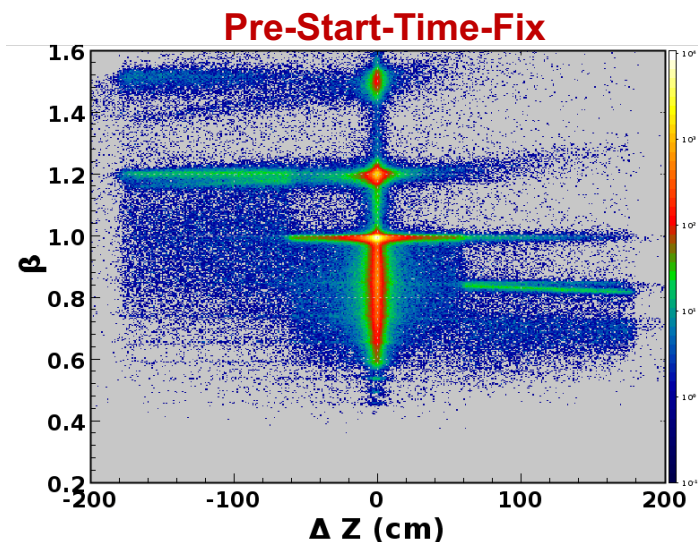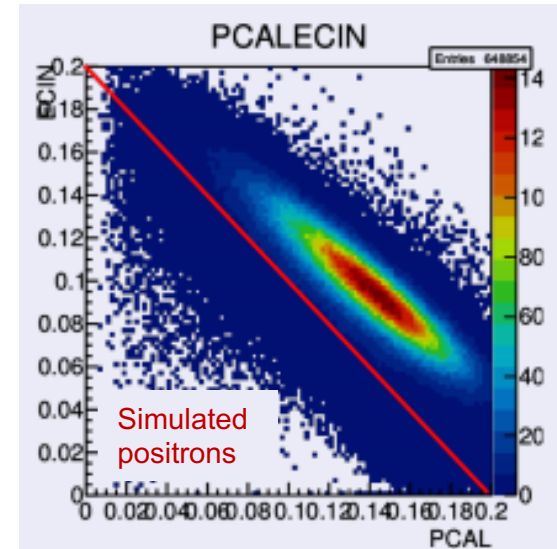
Field map

- Test of new torus field maps:
  - 2020 map based on modified coil geometry in the upstream corner
  - 2021 map based on full survey of individual coils

- Comparison with 2018 map (identical coil shapes based on "average" survey) shows significant improvement of elastic peak position for both 2020 and 2021 maps, with 2021 being slightly better
  - See https://clasweb.jlab.org/wiki/index.php/Clas12_software_meetings_2021#February_18.2C_2021

- Further tests with finer map grid in progress

(*) for all maps, coil positions are fit to the field map measurements

Elastic peak studies from RG-K 6.5 GeV data
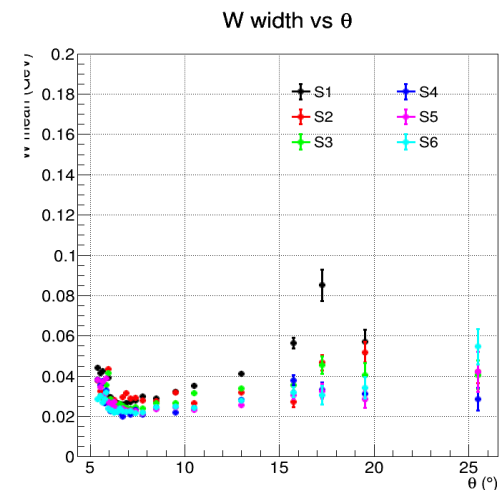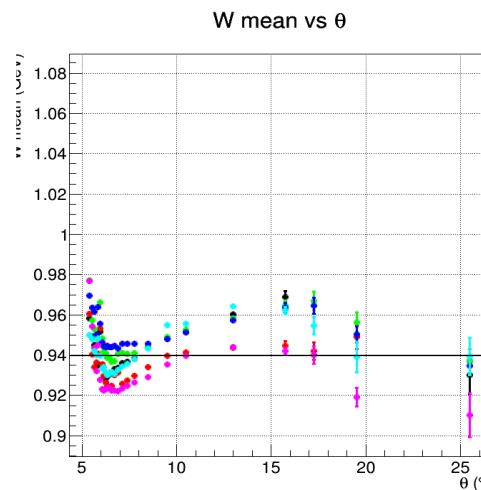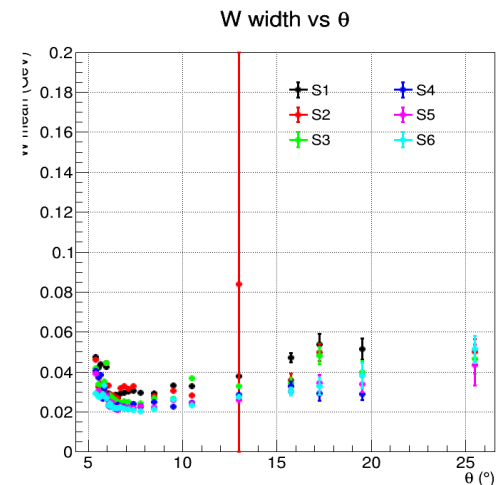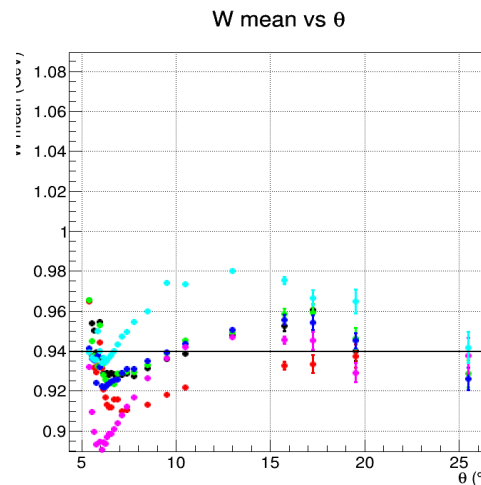
Other tasks and summary

- CND:
  - Improvements to clustering algorithm under study:
    - Energy sorting of hits
    - Use of independent matching cuts in x,y,z,t

- FMT:
  - Reconstruction now uses alignment constants
  - Debugging in progress

- LTCC:
  - Implement cluster timing to be started

- RICH:
  - Finalization of reconstruction algorithms for direct and indirect light still waiting for completion of mirror alignment
  - Integration in EB postponed

- RTPC:
  - Work in progress

- Miscellaneous:
  - Use status tables to rejects hits in malfunctioning detector elements in progress

See Daniel's presentation for updates on calibration tasks

See backup slides for more information on some tasks

Pass2 preparation summary

- Significant progress toward pass2
  - Several task already completed or close to completion
  - Many in progress
  - A few to be started or postponed
  - Good response to service work task offer

- Most software tasks on track for completion by end of March, few will likely extend beyond that, some depends on ongoing studies

- Timeline for completion of alignment tasks still uncertain due to first time exploration

Support to analysis

- Simulations at OSG and GEMC updates
  - See Maurizio's presentation today

- Truth-matching
  - See Rafayel's presentation today

- Analysis tools
  - See Derek's update on clas12root at the software meeting on 2/18 (see https://clasweb.jlab.org/wiki/index.php/File:Clas12Root1.7.pdf)

New in CLAS12ROOT

Version 1.7:   https://github.com/jeffersonlab/clas12root

- Access to RCDB and CCDB
- Application of clasqaDB
- RTPC included as possible central tracker
- Add SetEntries function to clas12reader, particleDraw, BankDraw
- Add C12Ref function to HipoChain

- Use submodules for data bases, this version is tagged with
  - ccdb v1.06.07
  - rcdb v0.06.00
  - clasqaDB v1.0.0
  - lz4 v1.9.2

- Add mcmatch class and automate particle truth matching
- Add scintextras as part of scintillator

- For FTBased, protect ftbparticle against queries when no entries, new getters which return FTBased if requested, normal if not
  - p→getStatus()
 - p->getChi2Pid()
  - p->getVt()
  - p->Beta()

Computing resources and disk space

- See Nathan's presentation for computing updates

- Use of /work disk:
  - Precious resource for long-term storage
  - Used to store software and small data files
  - Not optimized for heavy I/O (better using /volatile)
  - Permanent, i.e. it is user responsibility to remove old files

Work disk allocations (Total ~150 TB)
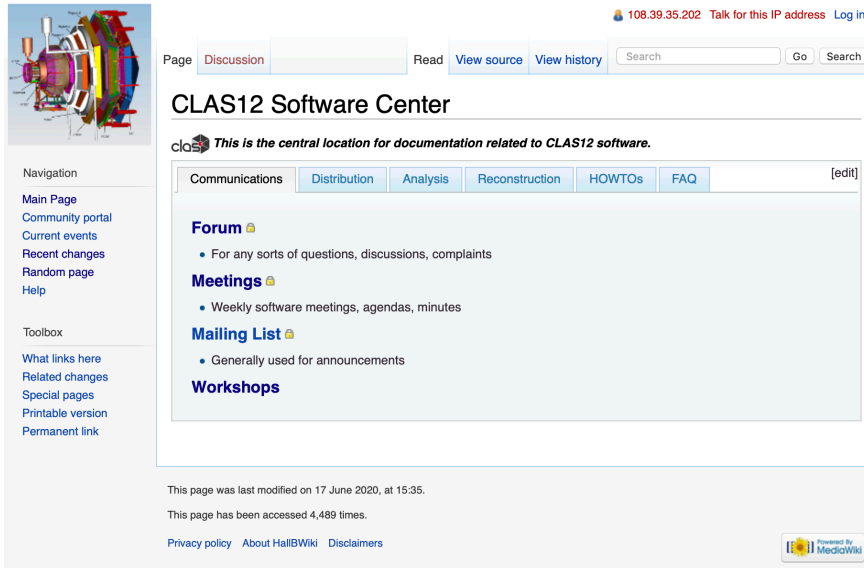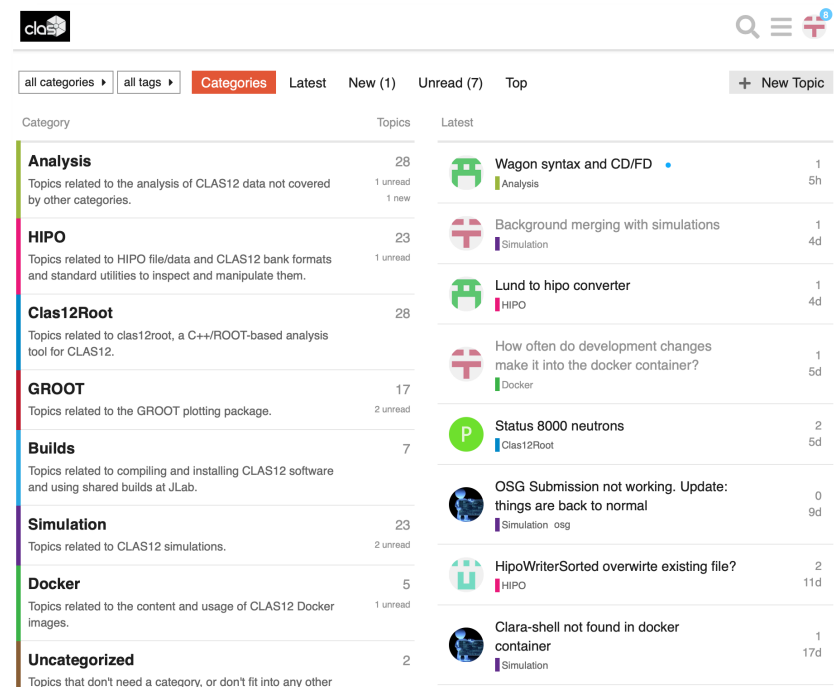
Current usage:
- **Clas: 88%**
- **Clas12: 90%**

general
17%

clas
24%

clas12
59%
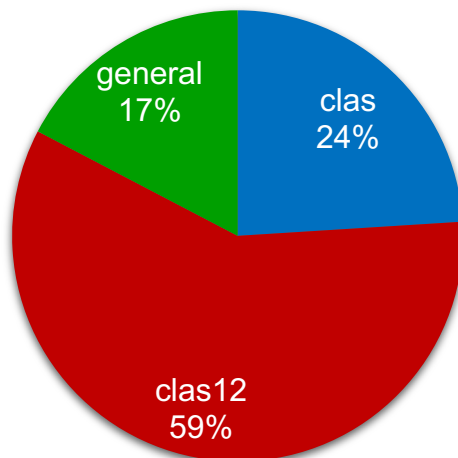
Monitoring:
- https://scicomp.jlab.org/scicomp/#/work
- See FAQ tab of software center wiki

Documentation

Centralized software wiki:
https://clasweb.jlab.org/wiki/index.php/CLAS12_Software_Center

Discourse forum for software related questions and communications

Backup

CND clustering

Old clustering

- Clustering performed on energy-unsorted list of hits
  - The cluster seed is most likely to be artificial depending on the hit the algorithm starts from

- The measure used to cluster hits considers resolutions in x, y, z and t, combining all the 4 dimensions together
  - Two hits could really be far away in one dimension, but the difference is compensated in the sum over all the four dimensions
  - The measure was at the limit

- Road to improvement:
  - Used single-particle MC simulations (neutrons and protons) to study the distribution of Delta X, Y, Z and t between hits from same particle
  - This was mainly inspired by what has been done for the TOFs

New clustering

- Improved clustering algorithm: look for seed hits first then cluster hits around seed hit
  - Position and time of cluster are determined by the seed hit

- Change the measure used for clustering: evaluate independently a cut on the difference for hits in each of the 4 dimensions x, y, z and t
  - Cut values are optimized independently for each dimension using single-particle MC

- A preliminary estimation of performance has been evaluated on data
  - Some of the cuts were very loose, mainly Delta t
  - A slight reduction in number of identified particle is observed w.r.t. the old clustering
    - Old clustering had very tight measure, remnants of some clusters would be clustered as separate particles

- Will reoptimise cut values and redo test to disentangle the sources of changes/improvements

Alignment tasks

- CVT:
  - First SVT alignment parameters based on manual adjustments give promising results
  - Currently being extended to BMT-C detectors
  - Full KF-based alignment being developed in parallel
  - Parallel studies using millipede

- DC:
  - Explore possible improvements to DC alignment, i.e. study the effect of systematic shifts to the stereo angle
  - "Effective" ministagger
  - Could be started after completion of field map tests
  - Note: collaborator currently repeating the DC alignment procedure to become familiar with the code

- FMT:
  - First alignment of RG-F 3-layer detector completed, results under evaluation

- FTT:
  - Alignment started

- RICH:
  - In progress