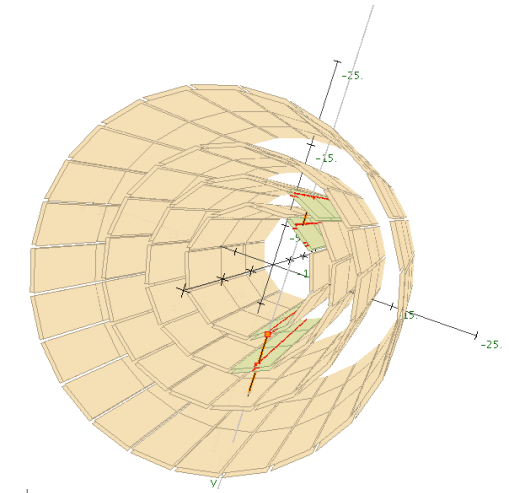
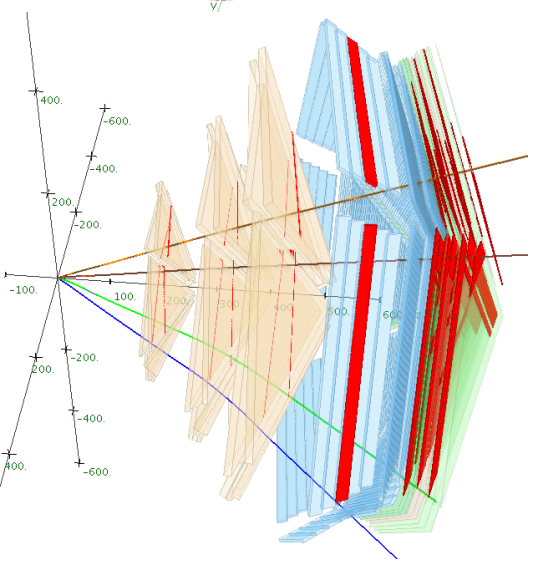
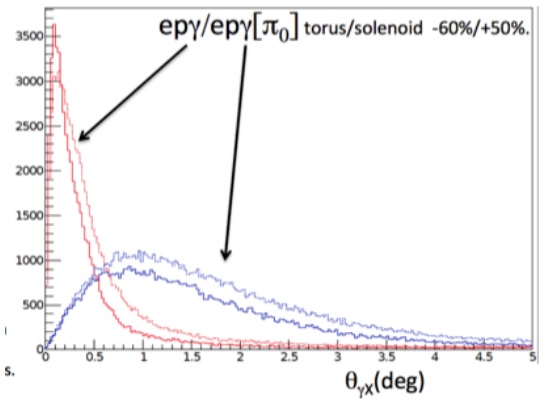






CLAS12 Event Reconstruction Status

Veronique Ziegler
Jefferson Laboratory

CLAS12 Collaboration Meeting
February 24, 2016

Overview

- Advances in reconstruction, validation & event display
- Framework advances
- Database management

Simulation & Reconstruction

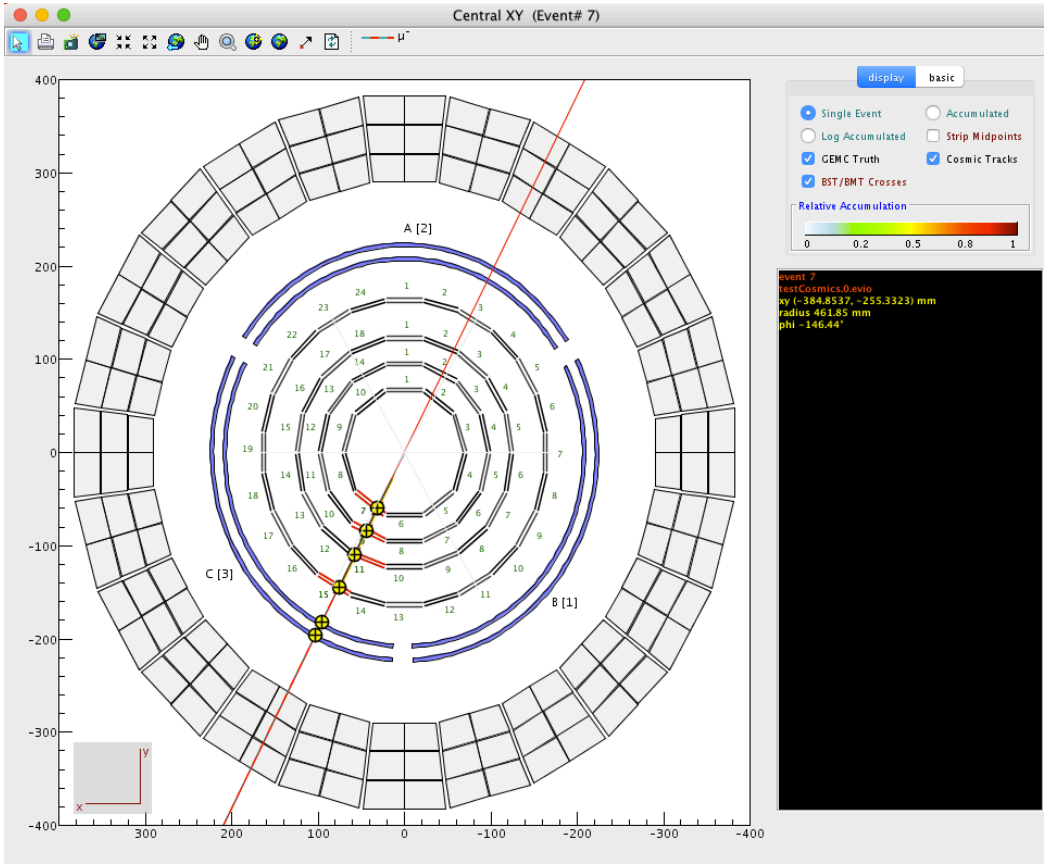
- Parallel development of reconstruction and simulation
  - gemc digitization ←→ reco. de-digitization, gemc validation using reconstruction & visualization tools (ced)
  - Geant-4 simulation and Event Generator developed for *CLAS12 luminosity upgrade studies* (W. Armstrong [ANL]) (c.f. First CLAS12 Experiment Workshop presentation)

- gemc version 2.3 **(M. Ungaro)**
  - parameters from CCDB
  - added production cut for all system
  - added cosmic ray model
  - added sampling of voltage every <bunch> ns (FADC mode 1)
  - added "trigger window" display and output
  - digitization of EC, FTOF using calib. constants from DB →proper neutral reconstruction
  - 1 region barrel micromegas included in CVT
  - code fixes (HTCC, DC)

Advances in reconstruction & validation

- Central Tracker Code Development (SVT + BMT)
- SVT reconstruction code validation
- SVT alignment studies
- DC Cosmic data analysis
- Forward tracking validation
- HTCC simulation & reconstruction
- FTOF reconstruction
- EC reconstruction
- RICH development (geometry)

MicroMegas Simulation & Reconstruction



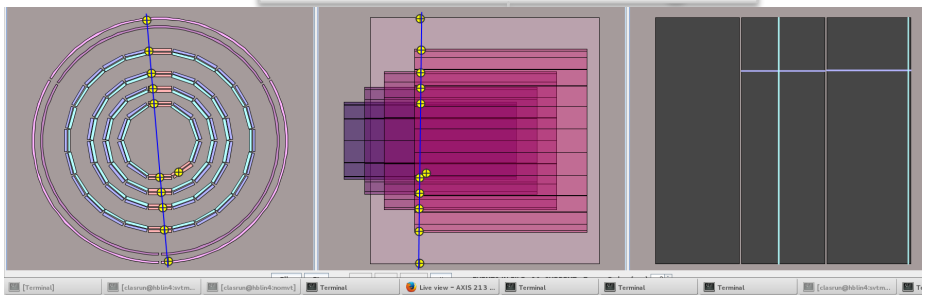
- region 3 BMT is in GEMC
  - Current version of geometry implemented
  - Producing samples to check digitization and input to reconstruction
- reconstruction package
  - New Central Vertex Tracker (CVT) package to reconstruct track going through SVT + BMT
  - Hit reconstruction (correction for Lorentz angle for Z detectors)
  - Clustering
  - Cross finding
  - Linking algorithm to match SVT to BMT
  - New fitting algorithm to take into account BMT C & Z detector cluster position information
  - Validation on cosmics & simulated events

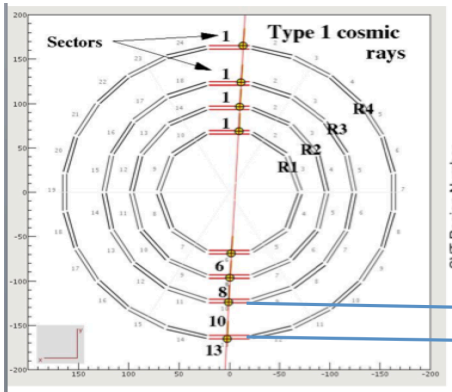
Central Tracking Validation Studies

Monitoring and Data Validation

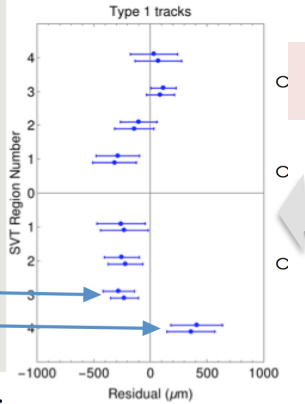
- Online cosmic track reconstruction monitoring of SVT and MVT using ET
- Validation Suite
  - Added MC truth histograms
  - Added helical tracks
  - Optimizing channel testing
  - Working on the tracker map, component and object views

Online Monitoring





Each region has two layers.

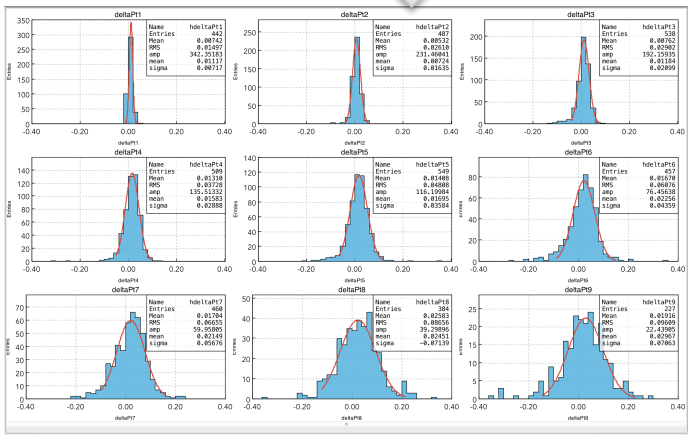


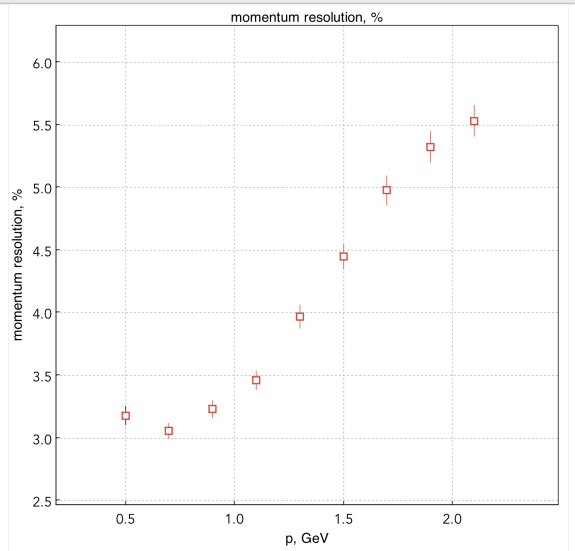
J. Gilfoyle

Alignment Studies

Y. Gotra

Reco. Validation
(4 crosses – type 1 tracks)



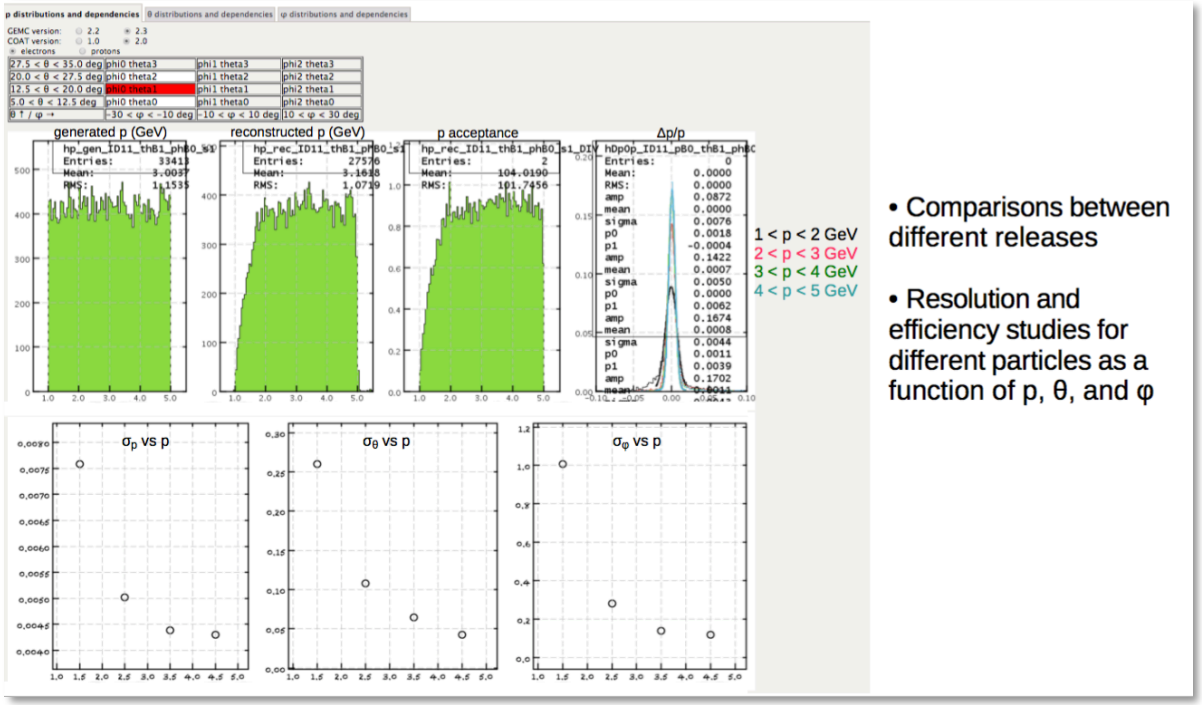


Forward Tracking Validation Studies

Validation

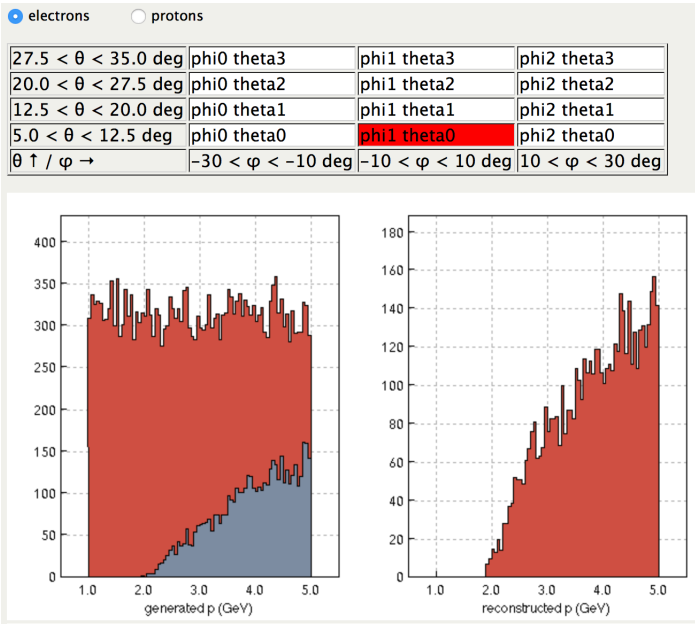
- Validation of GEMC, reconstruction software and coatjava analysis tools
- fastMC development (include resolutions)
- Documentation, tutorials, and user support

N. Harrison

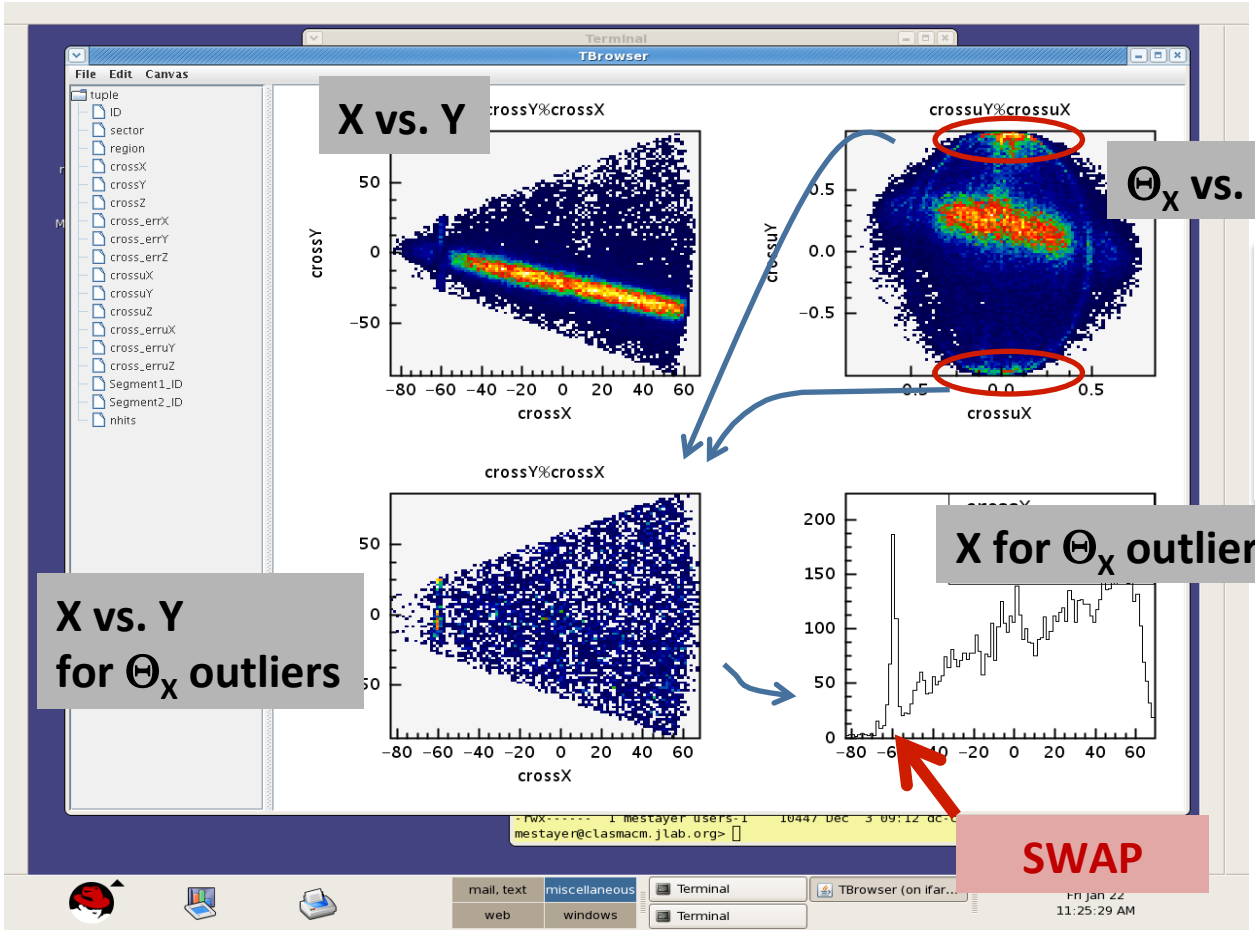


- Comparisons between different releases
- Resolution and efficiency studies for different particles as a function of p, θ, and φ

- Use **FastMC** to obtain acceptance and tracking efficiency as a fcn of p, θ, ϕ



DC12: Finding Malfunctions from DC-Rec Output

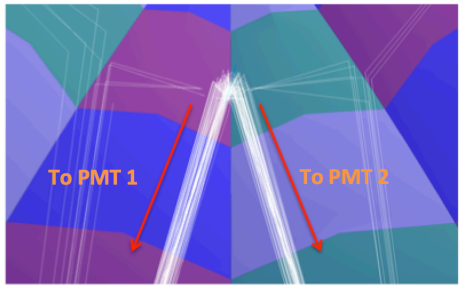


(M. Mestayer, O. Cortez, K. Adhikari)

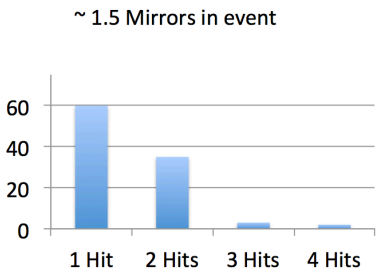
HTCC Reconstruction

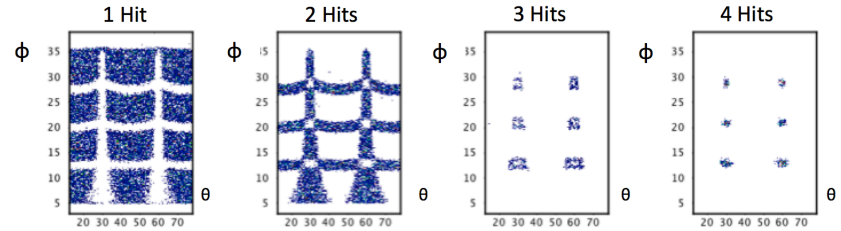
N. Markov (UConn)

Reconstruction: clusters



Cerenkov radiation from single electron splits between two mirrors and is collected by different PMTs



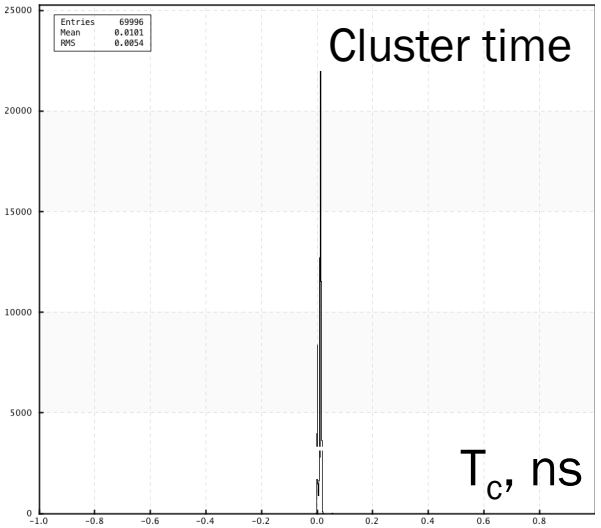


Calculation of the time of the cluster at the target

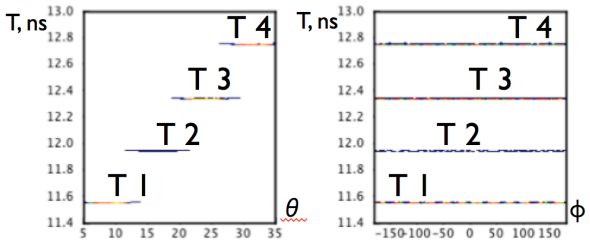
$$T_c = \frac{\sum_i^n (T_i - T_s) * NPE_i}{\sum_i^n NPE_i}$$

T_s is calculated from HTCC geometry

T_i measured from experiment

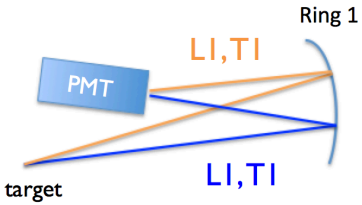


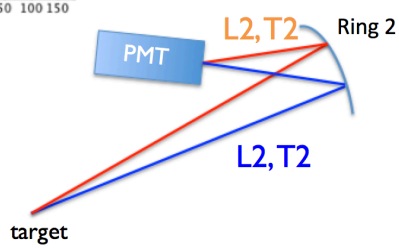
Reconstruction: clusters, timing



Time is fixed within a given ring

Every T_i corresponds to mirror number *i*





◆ Signal digitization in ***gemc*** (underway)

➔ reconstruction with a quasi-real signal

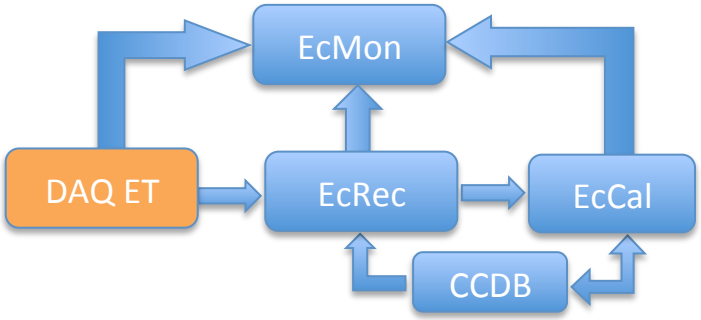
EC Software

C. Smith

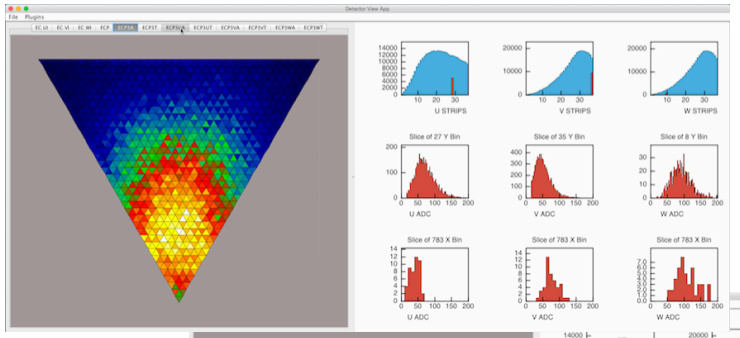
EcMon: Monitors raw, reconstructed and calibrated data (realtime rates, time-lines, detector maps, etc.)

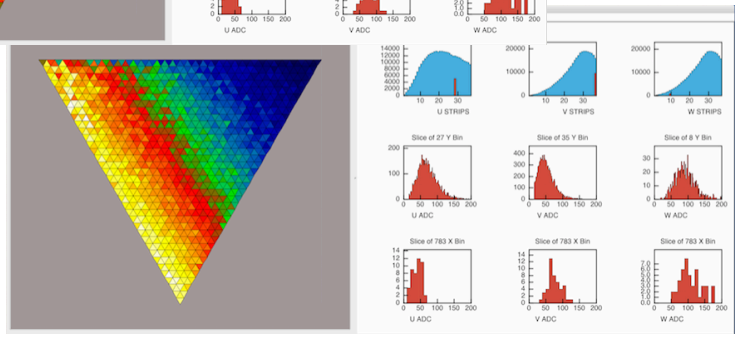
EcRec: Offline/online energy cluster reconstruction package will be used to select events for calibration.

EcCal: Performs calibration procedures and displays intermediate results (PMT gains, attenuation lengths, timing offsets and other constants.)



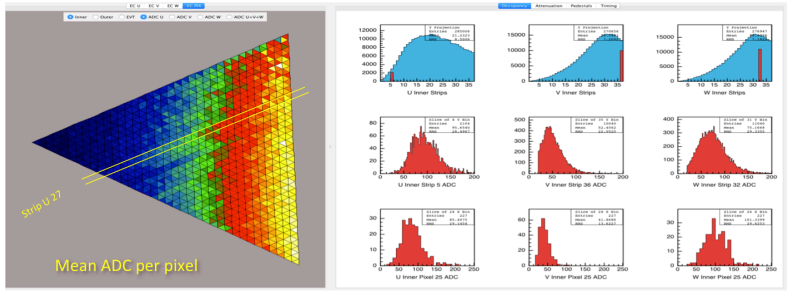
EcMon: Number of events per pixel





EcMon: Average ADC per pixel

Attenuation Fits



Progress:

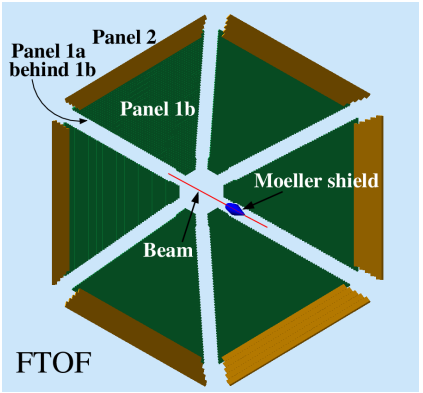
- **DAQ / EcMon** connection now works.
- **EcCal** development in coatjava framework
- **EcRec** upgrade:
  1. Introduction of calibration constants from CCDB.
  2. Re-entry points in code for attenuation correction and iteration of reconstruction.
  3. Indexing to allow identification of strips in clusters, peaks (for iteration, calibration).
  4. Configuration parameters (thresholds, peak/cluster/iteration options, etc.)
  5. Methods for handling two-cluster identification with shared energy in peaks (for pi-zeros).

TOF Reconstruction

E. Golovach [MSU] , G. Gilfoyle [U. Richmond]

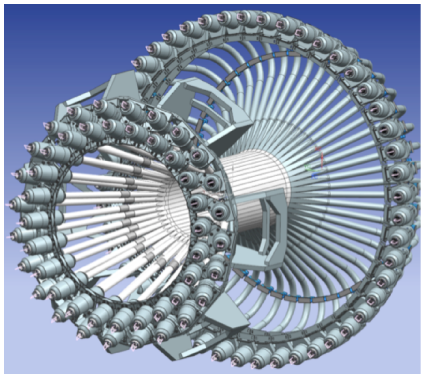
Forward Time-of-Flight (FTOF)

- 6 sectors, double-sided PMT readout
- Paddles:
  - Panel 1a - 23, 15-cm wide, 70-130 ps timing requirement
  - Panel 1b - 62, 6-cm wide, 40-100 ps timing requirement
  - Panel 2 – 5, 15-cm wide, 140-165 ps timing requirement



Central Time-of-Flight (CTOF)

- 48 paddles, double-sided PMT readout
- form hermetic barrel around target
- 60-ps timing resolution requirement

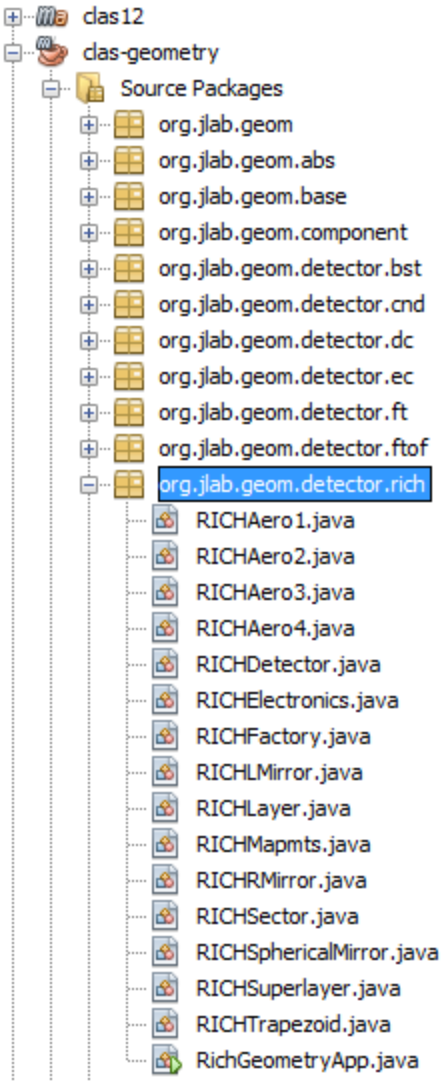


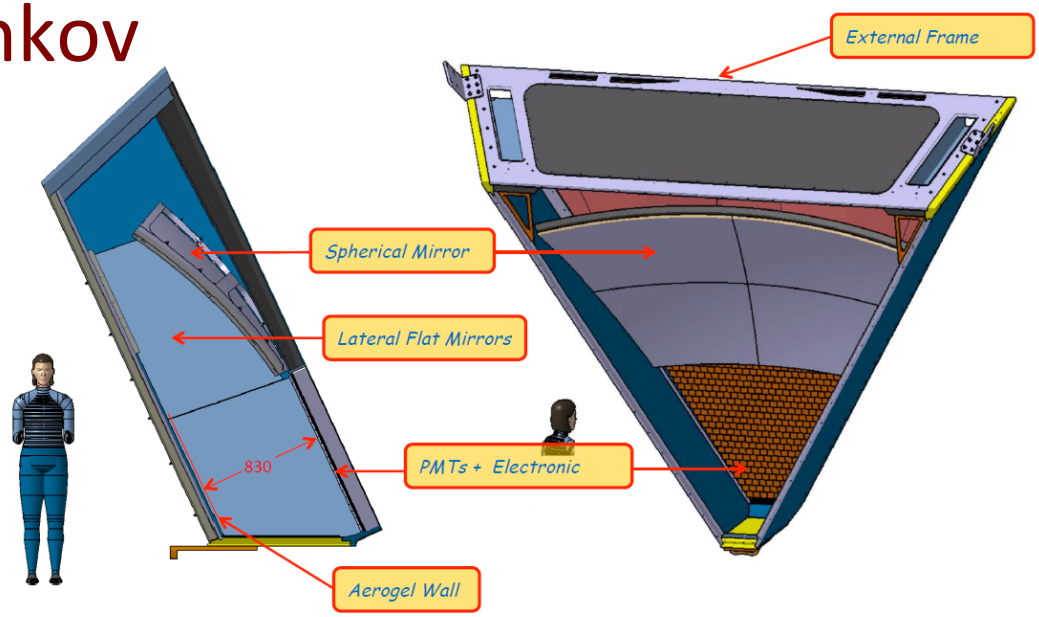
STATUS

- First version of standalone TOF reconstruction code ported to coatjava
- Results of DC reconstruction used to extrapolate track to FTOF panels
- Geometry obtained from Java package for FTOF reconstruction and gemc
- Updated to latest versions of Common Tools
- Validation studies on going

The Ring Imaging CHerenkov (RICH)

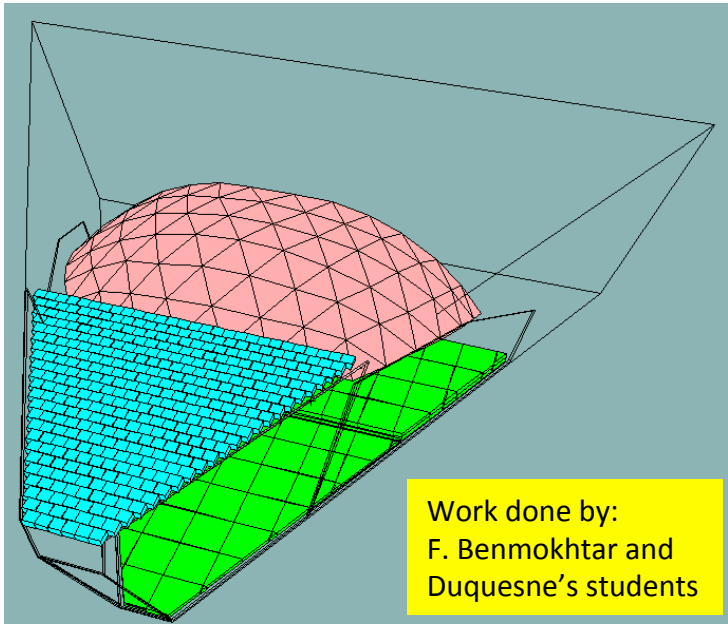
Addition of the RICH to CLAS12 Geometry





- MAPMTs
- Aerogel tiles
- planar mirrors
- Lateral Mirrors
- Electronic panel
- Spherical Mirror
- Doing some final dimension checks and adjustments.

Rotatable, zoomable, translatable and option to choose an mapmt



Work done by:
F. Benmokhtar and Duquesne's students

Framework Advances

G. Gavalian

- Data Input/Output
  - standard XML driven format for reading GEMC banks
  - raw data decoder for raw and fitted pulse modes
  - tools for reading fADC tables and translation tables
  - standard interface for reading files, attaches to ET-ring

```
<evio_dictionary>
    <bank name="DC" tag="1300" info="Simulated DC Hit Information">
        <section name="true" tag="1301" num="0" info="Digitized information">
            <column name="pid"     num="1"  type="int32"   info="ID of the first particle entering the sensitive volume"/>
            <column name="mpid"    num="2"  type="int32"   info="ID of the mother of the first particle entering the sensitive volume"/>
            <column name="tid"     num="3"  type="int32"   info="Track ID of the first particle entering the sensitive volume"/>
            <column name="mtid"    num="4"  type="int32"   info="Track ID of the mother of the first particle entering the sensitive volume"/>
            <column name="otid"    num="5"  type="int32"   info="Track ID of the original track that generated the first particle entering the sensitive volume"/>
            <column name="trackE"  num="6"  type="float64" info="Energy of the track"/>
            <column name="totEdep" num="7"  type="float64" info="Total Energy Deposited"/>
            <column name="avgX"    num="8"  type="float64" info="Average X position in global reference system"/>
            <column name="avgY"    num="9"  type="float64" info="Average Y position in global reference system"/>
            <column name="avgZ"    num="10" type="float64" info="Average Z position in global reference system"/>
            <column name="avgLx"   num="11" type="float64" info="Average X position in local reference system"/>
            <column name="avgLy"   num="12" type="float64" info="Average Y position in local reference system"/>
            <column name="avgLz"   num="13" type="float64" info="Average Z position in local reference system"/>
            <column name="px"      num="14" type="float64" info="x component of momentum of the particle entering the sensitive volume"/>
            <column name="py"      num="15" type="float64" info="y component of momentum of the particle entering the sensitive volume"/>
            <column name="pz"      num="16" type="float64" info="z component of momentum of the particle entering the sensitive volume"/>
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            <column name="vy"      num="18" type="float64" info="y component of primary vertex of the particle entering the sensitive volume"/>
            <column name="vz"      num="19" type="float64" info="z component of primary vertex of the particle entering the sensitive volume"/>
            <column name="mvx"     num="20" type="float64" info="x component of primary vertex of the mother of the particle entering the sensitive volume"/>
            <column name="mvy"     num="21" type="float64" info="y component of primary vertex of the mother of the particle entering the sensitive volume"/>
            <column name="mvz"     num="22" type="float64" info="z component of primary vertex of the mother of the particle entering the sensitive volume"/>
            <column name="avgT"    num="23" type="float64" info="Average time"/>
            <column name="hitn"    num="99" type="int32"   info="Hit1 Number"/>
        </section>
        <section name="dgtz" tag="1302" num="0" info="uploading the hit definition">
            <column name="sector"     num="1" type="int32" info="sector number"/>
            <column name="superlayer" num="2" type="int32" info="layer number"/>
            <column name="layer"      num="3" type="int32" info="view"/>
            <column name="wire"       num="4" type="int32" info="strip number"/>
            <column name="LR"         num="5" type="int32" info="Left/Right: -1 (right) if the track is between beam and the closest wire"/>
            <column name="doca"       num="6" type="float64" info="2D distance between closest track step to the wire hit"/>
            <column name="sdoca"      num="7" type="float64" info="smeared doca"/>
            <column name="time"       num="8" type="float64" info="doca/drif velocity in each region 53,26,36 um/ns"/>
            <column name="stime"      num="9" type="float64" info="sdoca/drift velocity in each region"/>
            <column name="tdc"        num="10" type="int32" info="tdc"/>
            <column name="hitn"       num="99" type="int32" info="hit number"/>
        </section>
    </bank>
```

- Calibration Framework
  - unified interface for reading ccdb constants and standardization of calibration tables
  - GUI interface for for data processing and event calibration & monitoring

- Calibration Constants tables are standardized.

SECTOR	LAYER	COMPONENT	CA	CB
1	2	3	0.1	0.2
1	2	4	0.2	0.2
1	2	5	0.3	0.2
1	2	6	0.4	0.2

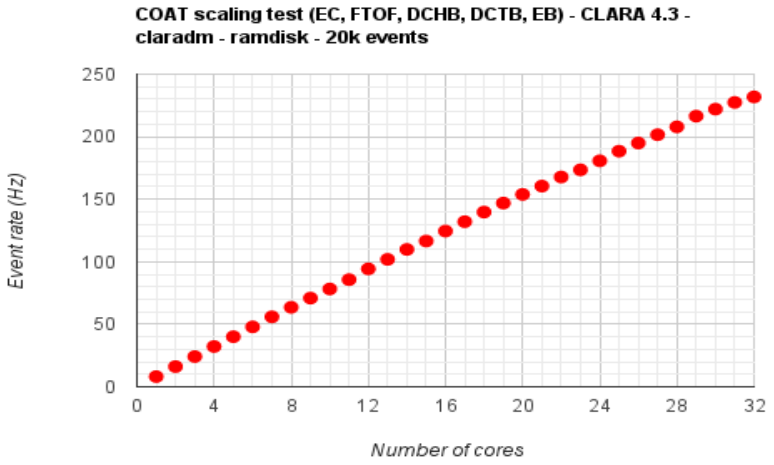
- FADC parameters table is standardized

CRATE	SLOT	CHANNEL	NSA	NSB
18	2	3	65	72
18	2	4	67	74
18	2	5	64	73
18	2	6	65	76

Framework Advances (cnt.)

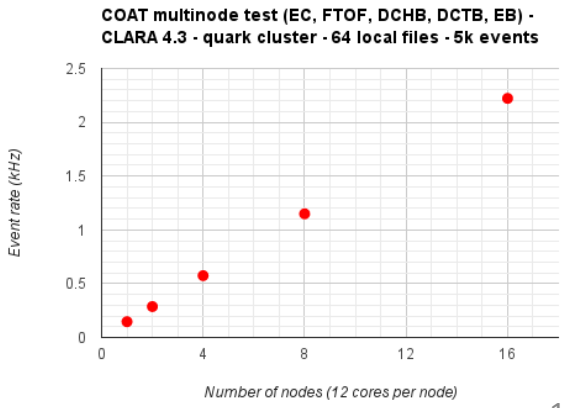
Sebastian Mancilla
CCTVal, UTFSM Chile

- Reconstruction
  - Initialization of run conditions and constants
  - Modular reconstruction framework (ClaRA-based) compatible with ClaRA 4.3
- Plotting Package
  - Histogramming & plotting emulating ROOT API
  - LateX formatting
  - Improved fitting algorithms (MINUIT lib)
- Geometry
  - package provides geometry for DC, FTOF, EC, FT, SVT, CND
  - Detector representation shapes
  - Detector component tracker for Fast-MC



✓ **CLARA 4.3**

- CLARA switched from using cMsg to xMsg (version 4)
- easy transfer from 2.2 interface to 4.3
- tests run on CLARADM machine show 250 Hz event reconstruction



CLAS12 Calibration Constants

H. Avakian, B. McKinnon

Unique storage of CLAS12 calibration constants is the mysql database ccdb (calibration constants database)

https://clasweb.jlab.org/wiki/index.php/CLAS12_Constants_Database

Policy:

- use the same set of constants in GEANT simulation (gemc) reconstruction (coatjava), calibration software
- *lock* the constant set during the "production"

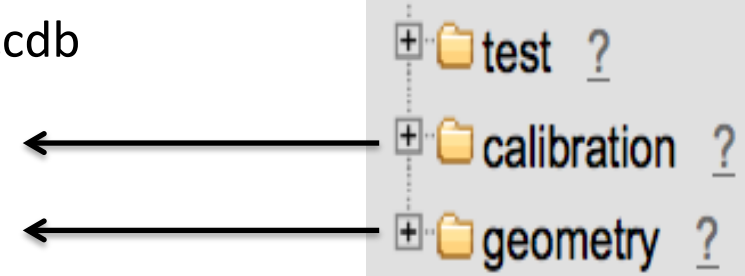
Basic Information about the CLAS12 Constants Database

mysql server host:	clasdb.jlab.org
user:	clas12reader
database:	clas12
web viewer:	https://clasweb.jlab.org/ccdb

Structure of clas12 db:

calibration constants

geometry parameters



Recent Changes to *ced*

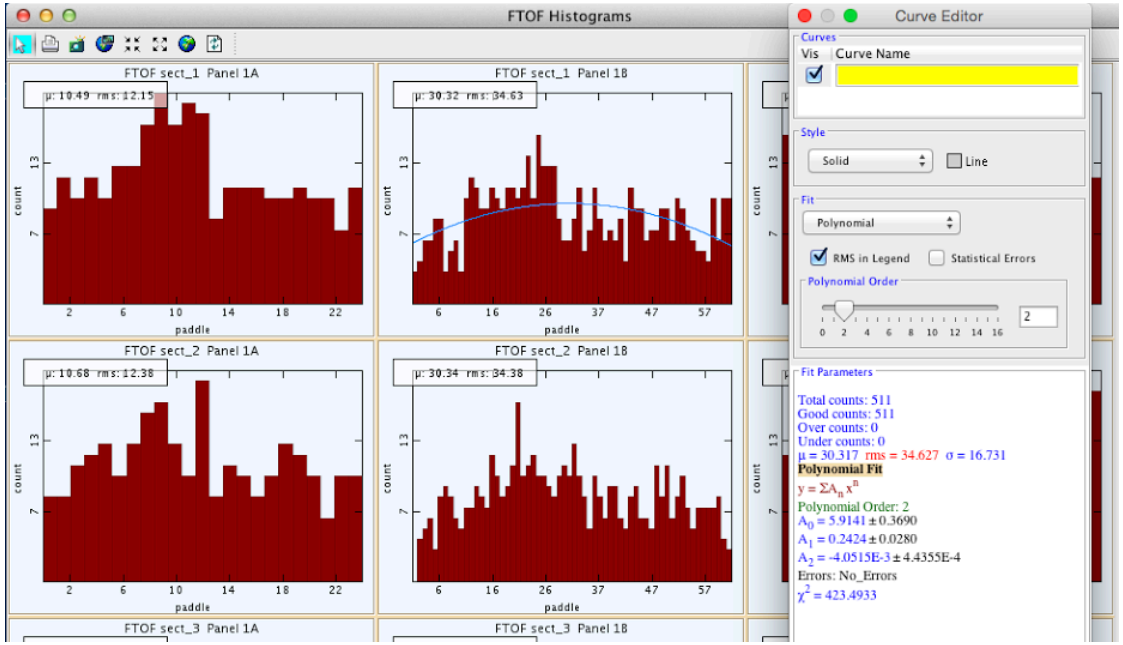
D. Heddle

1. **Stand-alone deployment**

   https://userweb.jlab.org/~heddle/ced/builds/

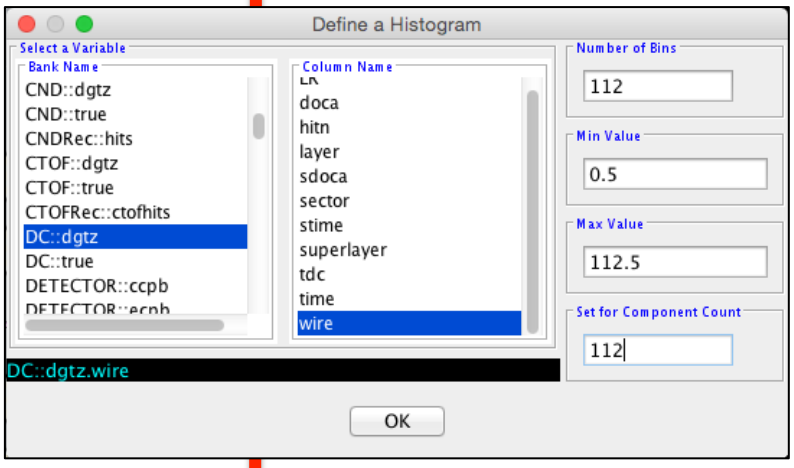
   Extract and double-click on *ced.jar*

2. **Built it Histograms.** Through accumulation, component level occupancy histograms for DC, BST, FTOF, PCAL, EC, (more to come)

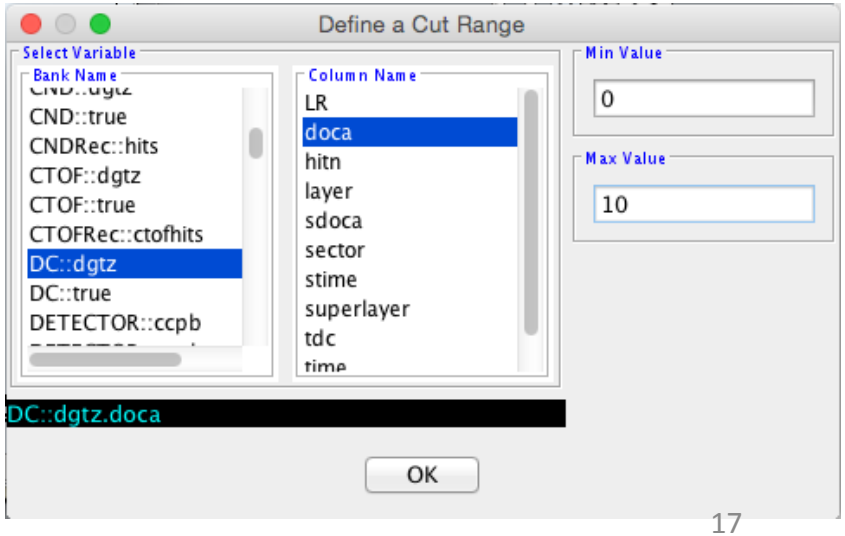


3) **Plot "anything".** 1D/2D Histograms and scatter plots can be created from any *evio* column (e.g., DC:dgtz.wire) or any defined expression (e.g., atan2(dcy, dcx)). Cuts can be defined and applied. Example shown is a 1D histogram.

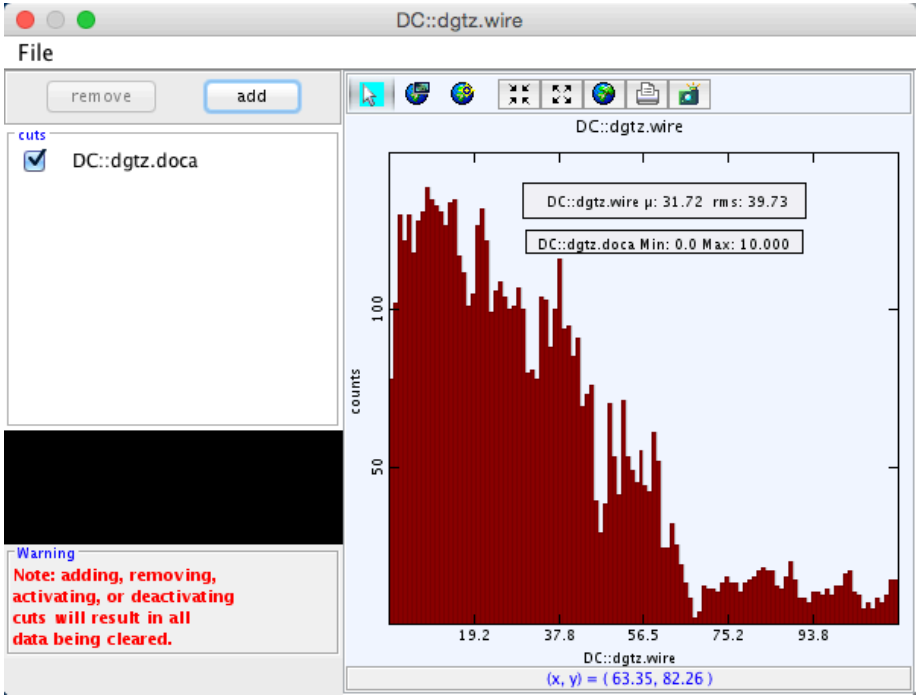
Step 1: pick the column



Step 2 (optional): create and apply one or more cuts



Step 3: Accumulate to fill the histogram



Concluding Remarks

- Next release (coatjava-2.3) to include
  - Improved de-digitization of TOF and CAL systems, HTCC reconstruction
  - PID using more realistic detector responses
  - new Central Tracking code (under validation)
  - framework to do fiducial cuts and analysis
  - ✧ Target release timescale: end of March
  - ✧ gemc-2.3 to be released by that time ➔ consistency between simulation and reconstruction
- coatjava-2.3 release should be used for proposals
- ClaRA validation
  - reconstruction rate on 4-tracks events was 6.3 ms/event on 32 cores Haswell machines in multithreaded mode with ClaRA-4.2.
  - benchmarks performed with ClaRA-4.3 using the Richmond cluster show linear scaling with number of nodes.

Concluding Remarks

- Very High Priority Tasks
  - Translation tables definitions
  - Status Tables (malfunctions…) definitions and creation
  - Calib & Cst Tables definition and creation
  - Calib. Database API to read and write data
  - Completing missing digitization in simulation (TOFs, Micromegas, DC[Time-to-dist]) & missing reconstruction components (LTCC, MM, CND)

Need these in place when we start KPP

Need this in place to complete the reconstruction

- High Priority Tasks
  - Completing the geometry package (gemc volumes, missing detectors) & include misalignment + survey numbers in geometry passed to the reconstruction
  - Alignment
  - Monitoring & Analysis framework development*

Need this in place for reconstruction to be accurate

* Unified framework already shown to be successfully used

  - Investigating and selecting DST data format
  - Documentation