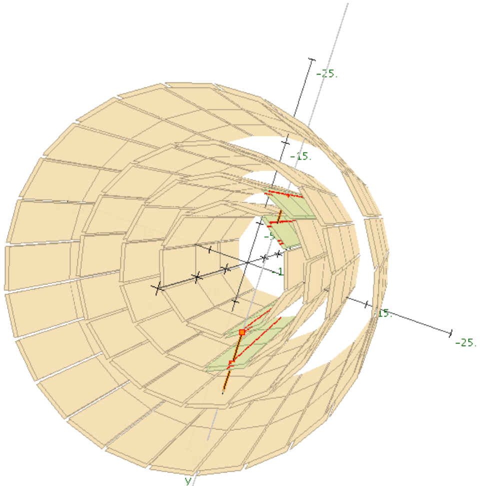
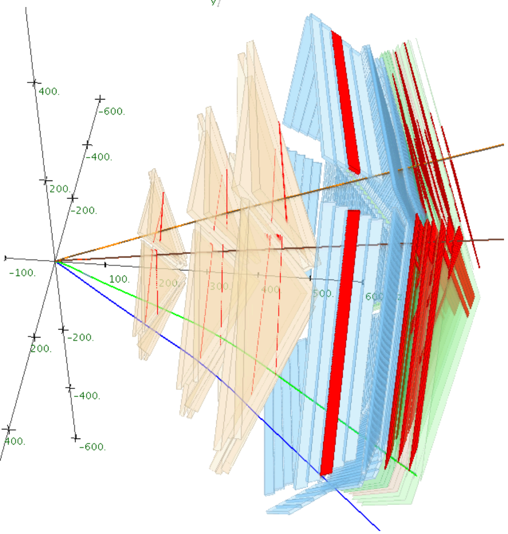
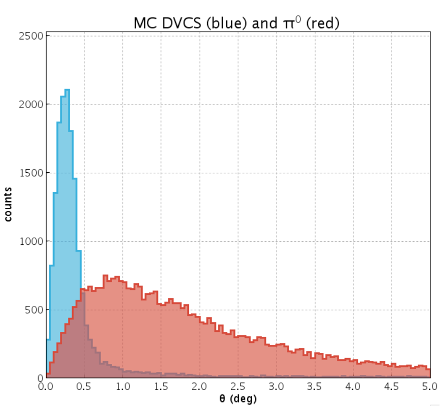






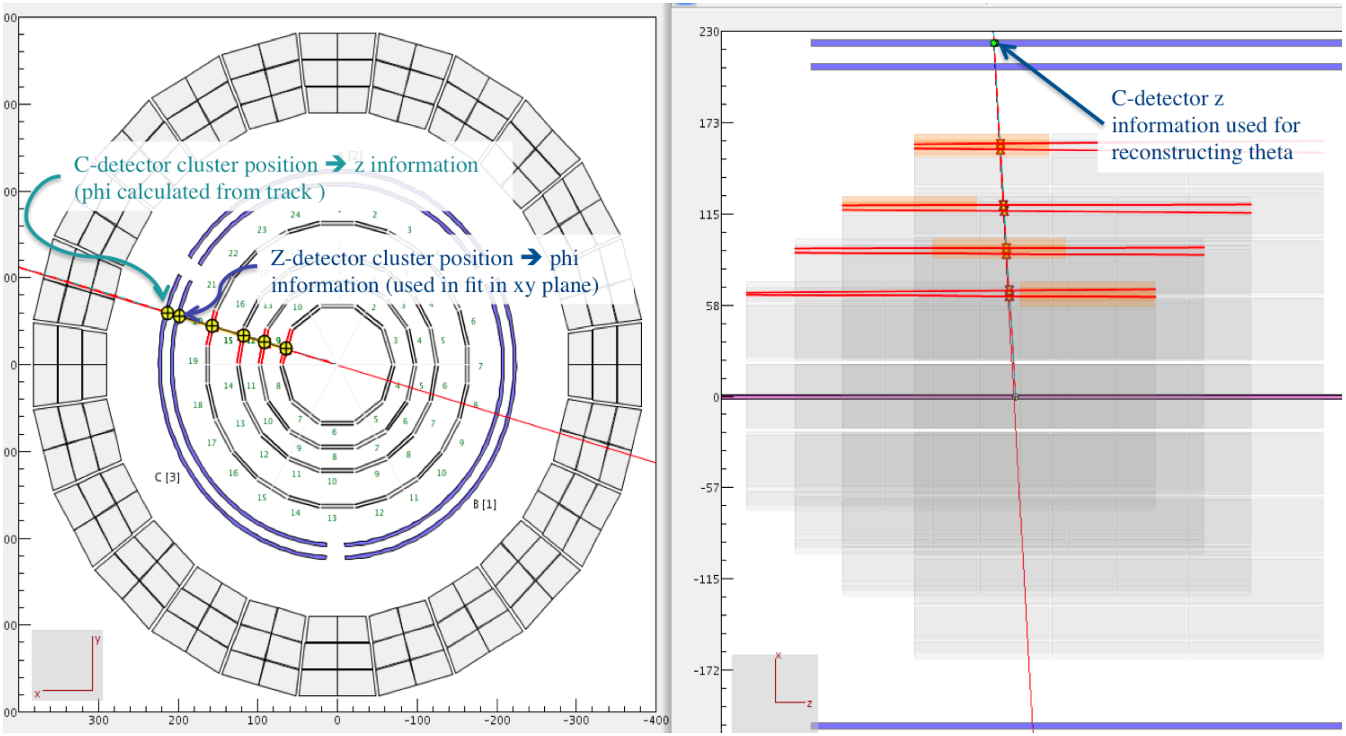
CLAS12 Event Reconstruction Status

Veronique Ziegler
Jefferson Laboratory

CLAS12 Collaboration Meeting
June 16, 2016

Central Vertex Tracker Reconstruction

- New package clasrec-CVT contains algorithms to reconstruct events using combined system BMT+SVT
  - Raw data translation for both systems
  - new algorithms to use BMT cluster positions
- Used in On- and Offline Monitoring



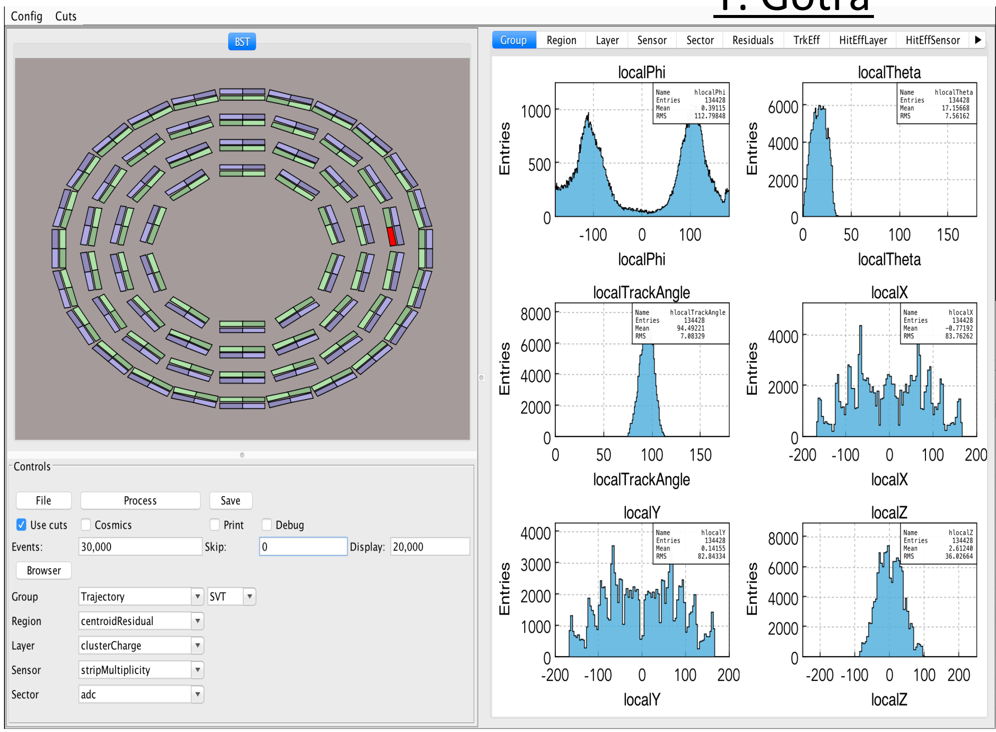
CVT Offline Monitoring and Validation

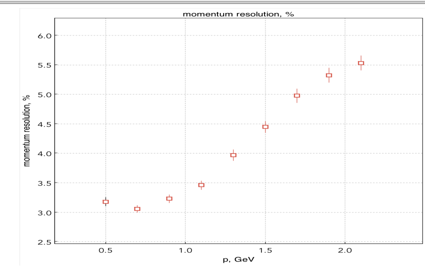
Y. Gotra

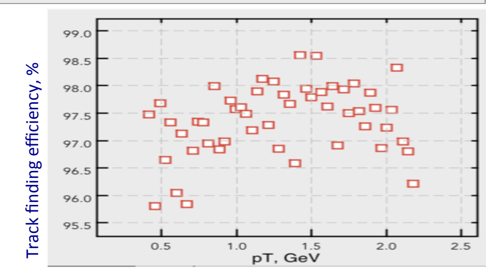
CVT Validation suite
- Histogram selection menus added
- MVT histograms added
- Cut selection menu implemented
- Event skimming added
- Unbiased centroid residuals added
- Efficiencies and resolutions implemented
- Hipo and root output format

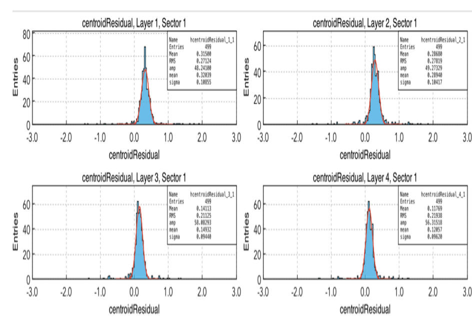
Validations performed
- Reconstruction release validation v0.1 - v0.6
- Single track reconstruction
  - Geantinos, muons, pions
  - Straight (0T) and helical tracks
- Gemc 2.3
- Geometric acceptance
- Discriminator thresholds
- Resolutions (momentum, angular)
- Efficiencies (track finding, hit finding)
- Occupancies

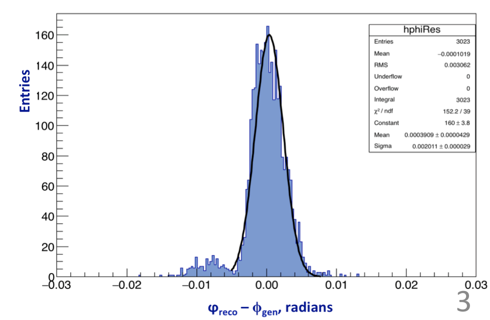
Work in progress
- Misaligned geometry
- Multiple tracks
- Electronic noise
- Local reconstruction
- Lorentz angle
- Documentation







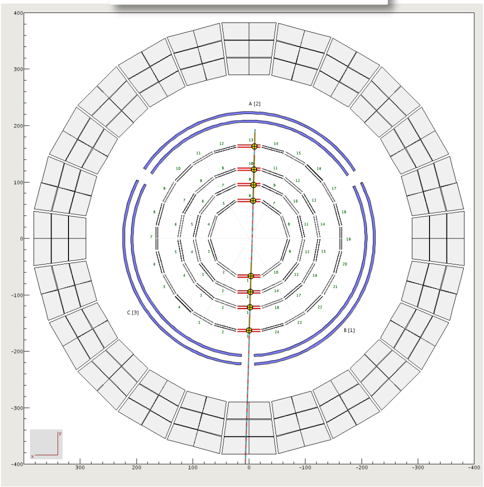




Alignment of the SVT using Millepede

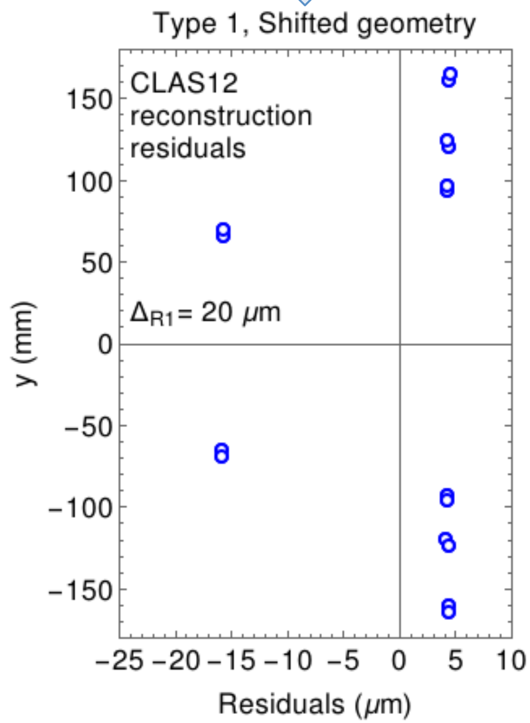
J. Gilfoyle

Type 1 track

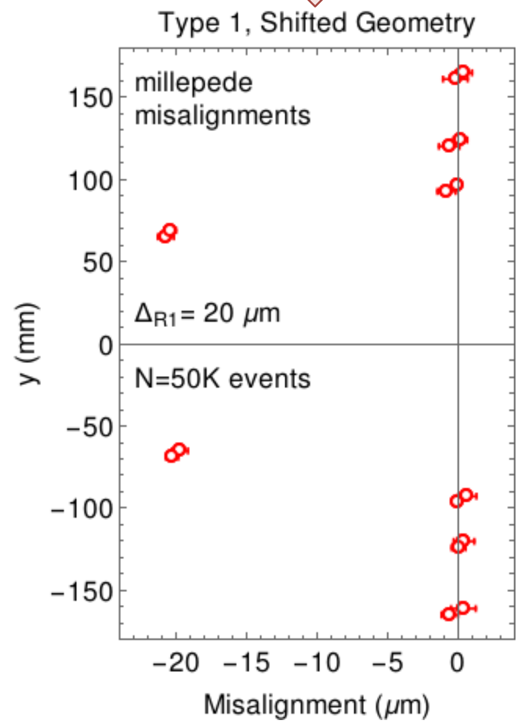


shift barrel R1 by 20 microns

Reconstruction of events generated with geometry shifted In GEMC



Misalignment results obtained from Millepede



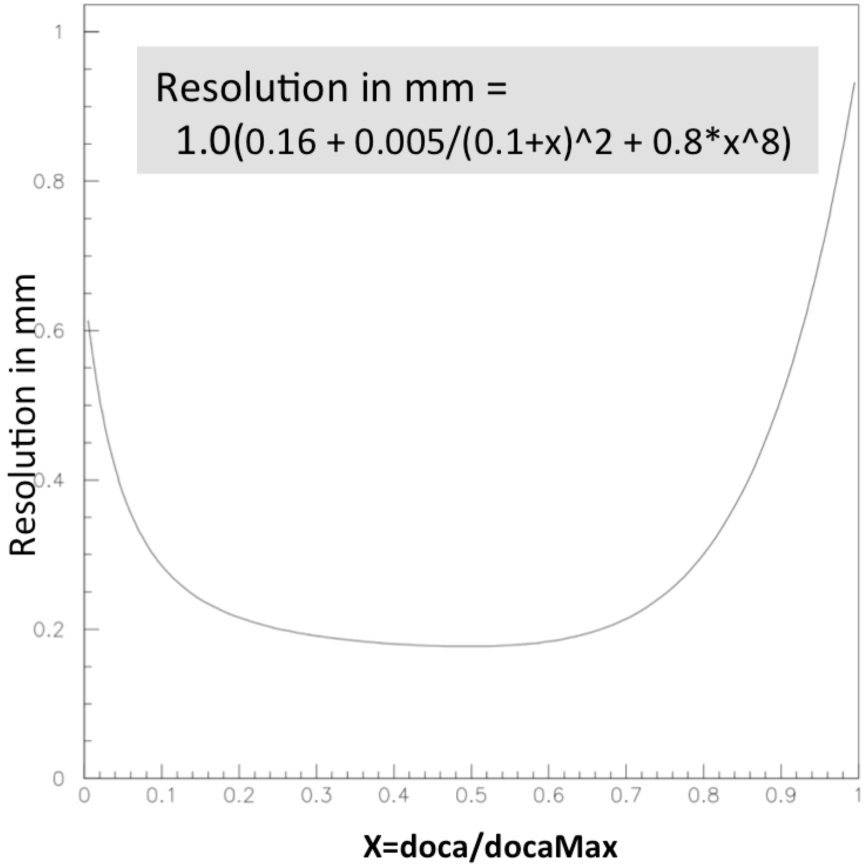
* Geometry implementation in Java framework & validation ongoing (P. Davis [U. Surrey])

DC MC Tuning

Simulation of doca resolution

$$scale\left(P_1 + \frac{P_2}{(P_3 + x)^2} + P_4\, x^8\right)$$

- Functional form: M. Mestayer & K. Adhikari
- GEMC implementation: M. Ungaro

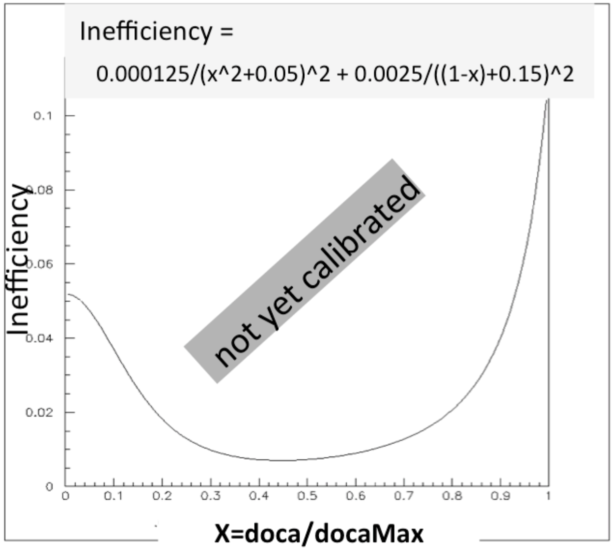


- used to smear docas in GEMC
- used in reconstruction in measurement error in Kalman Gain calculation

DC MC Tuning

Simulation of intrinsic wire inefficiencies

- Three sources of inefficiency:
  - Intrinsic (applies to all wires) – cells don't always fire,
  - Equipment malfunction-related (applies to specifc wires),
  - Background-related (unavoidable knock-on electrons)
- Improved digitization in GEMC
  - parameters added to CCDB: SQlite
  - intrinsic inefficiency (distance dependent) is added in GEMC



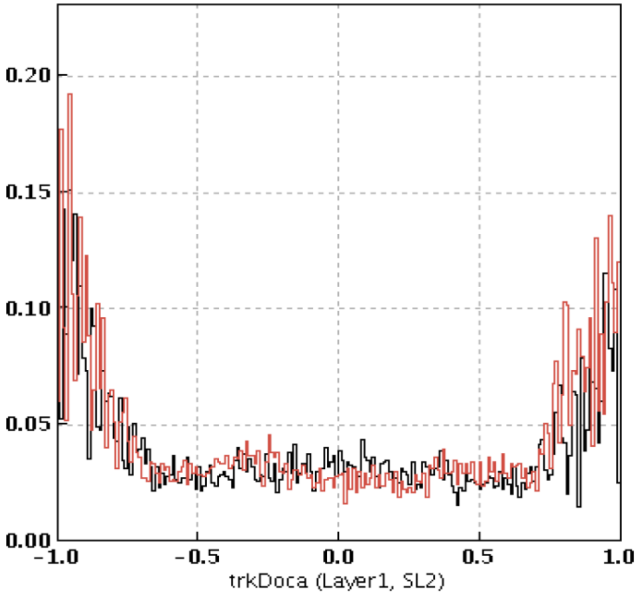
The intrinsic inefficiency function:

$$f(X) = scale\left(\frac{P_1}{(X^2+P_2)^2} + \frac{P_3}{((1-X)+P_4)^2}\right)$$

where X = doca/docaMax & docaMax = 2 d_{layer}

<u>M. Mestayer & K. Adhikari</u>

- Studied distance dependence of layer inefficiency for cosmic data
  - Except of layer 4 in SL1, inefficiency is about 3 to 4 %
  - Layer 4 in SL1 has high inefficiency (about 12%) which seems to be due to voltage issues in some of the channels.
  - Corrections for equipment status (dead channels) not applied yet
  - Time-to-distance function not calibrated yet. (Linear function being used in reconstruction).
- Corresponding study on GEMC data yet to be done.

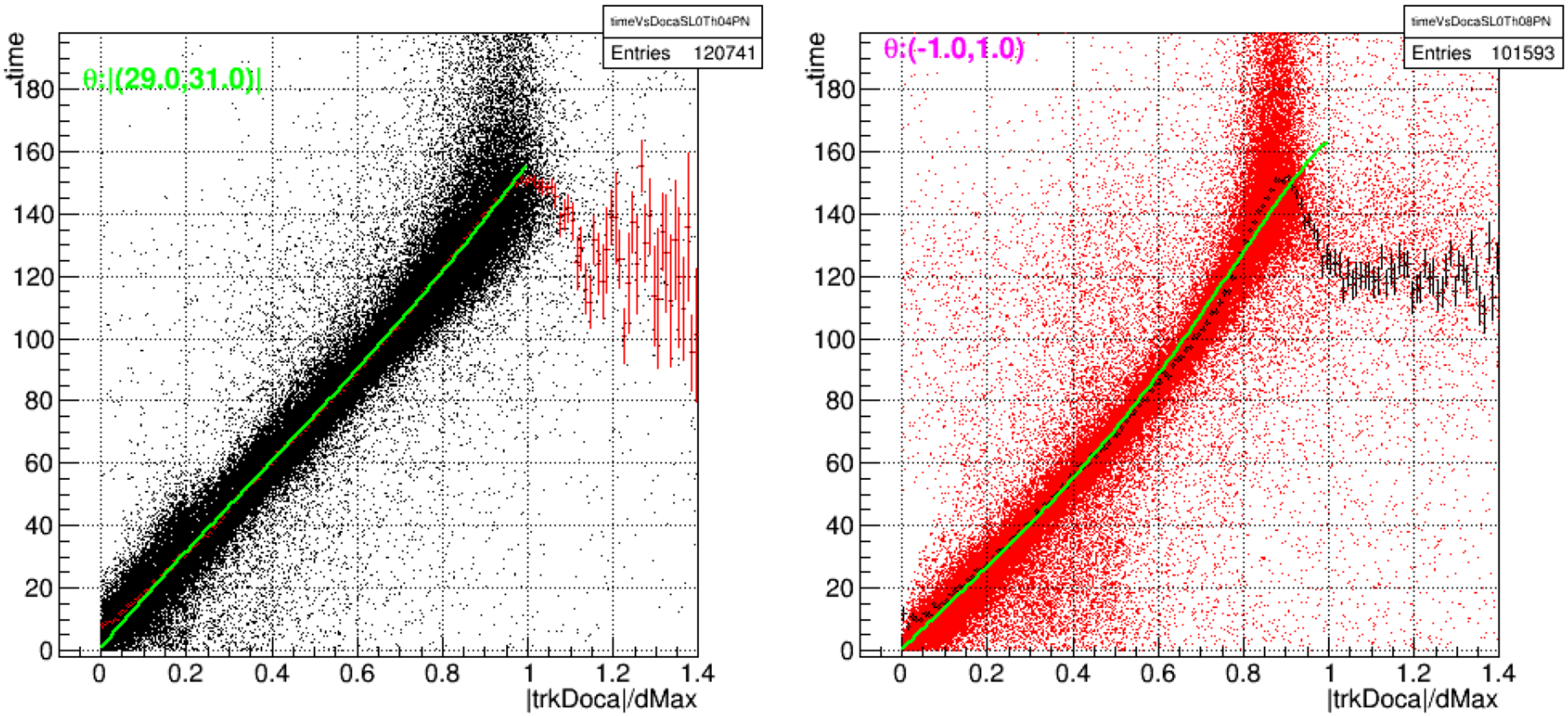


Time-to-distance parameterization

Starting equation for 30 degree tracks:

K. Adhikari

$$time = \frac{x}{v0} + a\left(\frac{x}{dMax}\right)^{n} + a'\left(\frac{x}{dMax}\right)^{m}$$



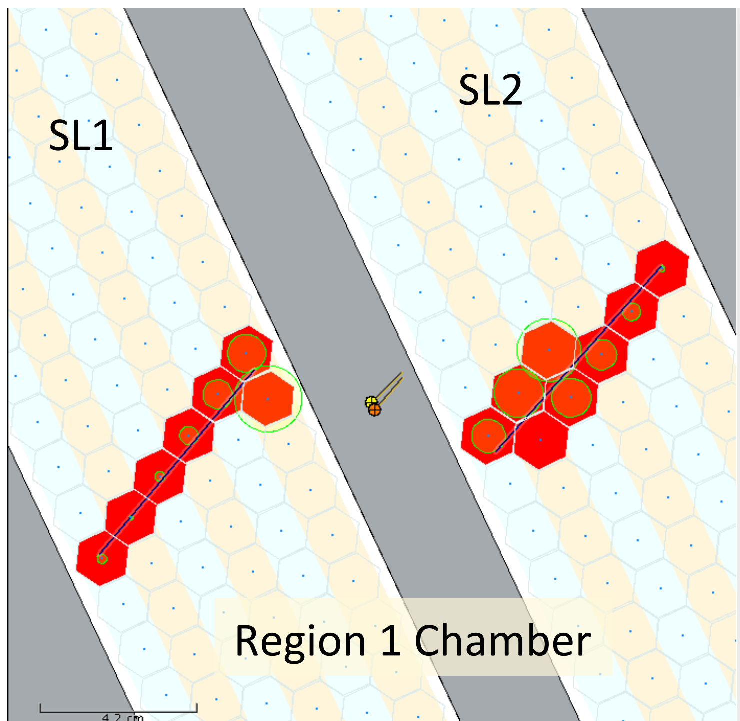
Very preliminary fits on 30 degree & 0 degree tracks respectively

Distance-to-time Computation

$$time = \frac{x}{v0} + a\left(\frac{x}{dMax}\right)^{n} + a'\left(\frac{x}{dMax}\right)^{m}$$

Fills arrays for each region, 2 values of local angle (0 & 30 °) and multiple values of B field

Tri-dimentional interpolation method



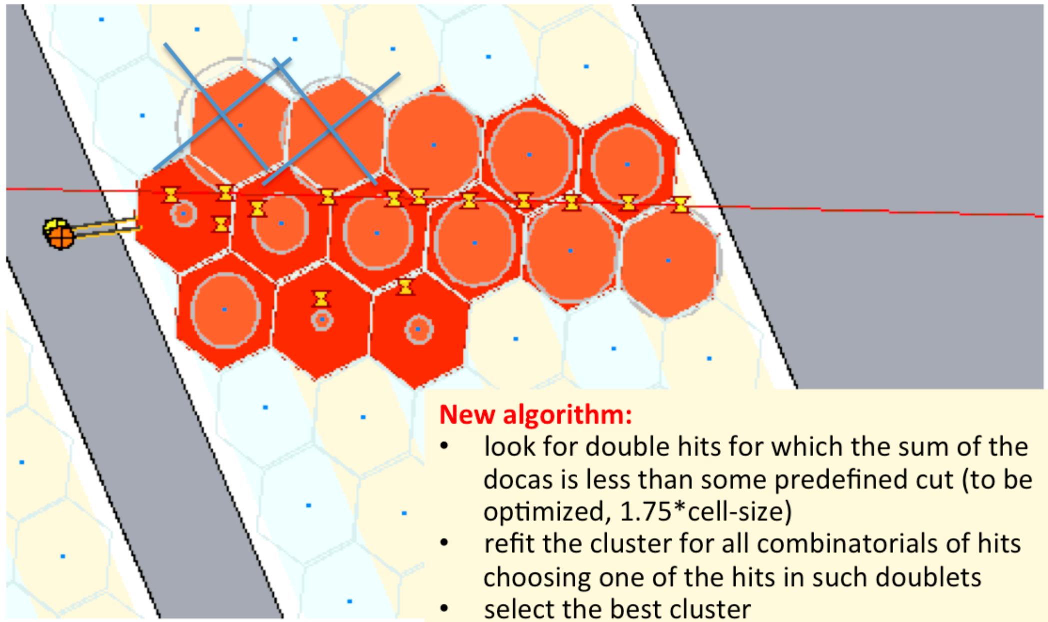
Cosmic data sample

New DC Algorithms

Noise Rejection

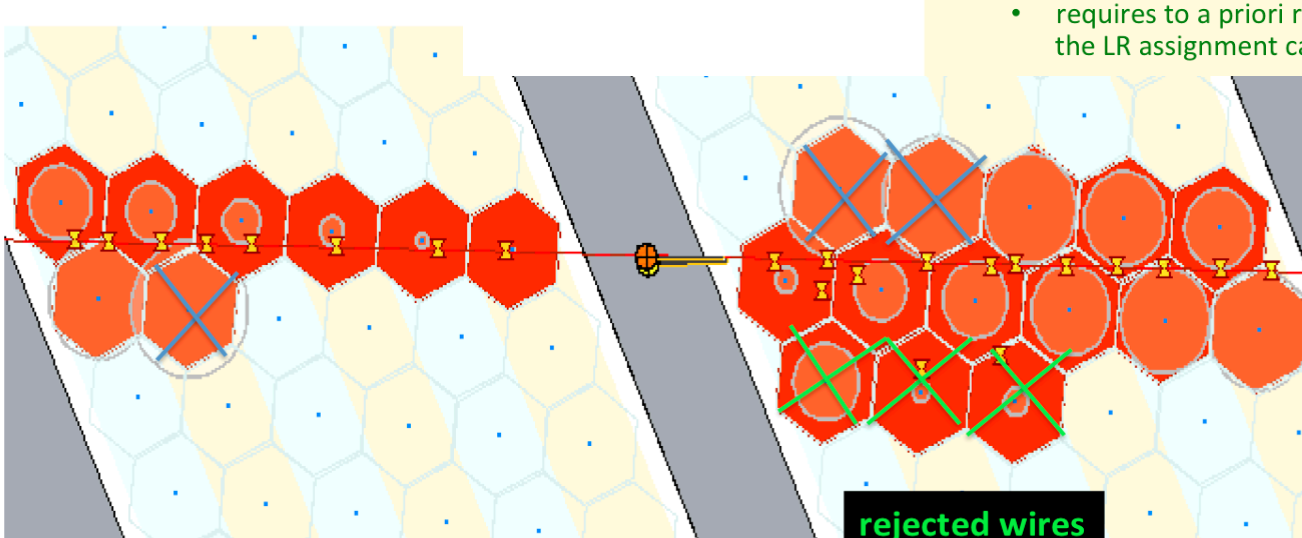
inefficient wires

MC sample
4.5 GeV e- @ $\phi = 0^o$, $\theta = 10^o$



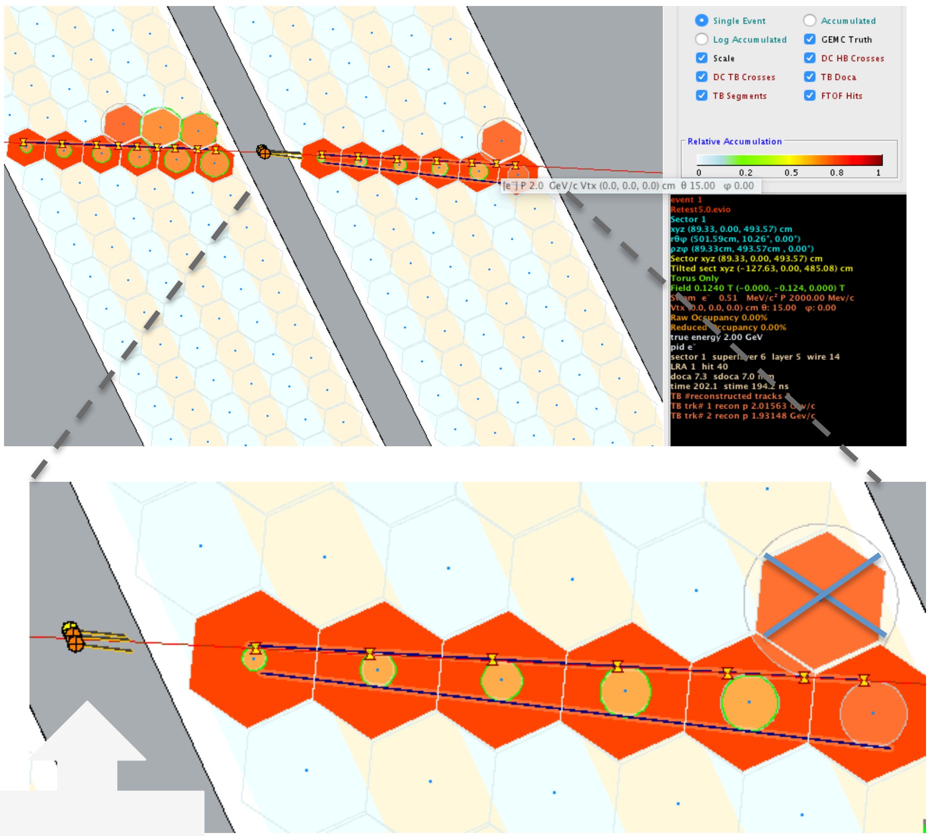
New algorithm:

- look for double hits for which the sum of the docas is less than some predefined cut (to be optimized, 1.75*cell-size)
- refit the cluster for all combinatorials of hits choosing one of the hits in such doublets
- select the best cluster
  - requires to a priori redo hit-based fits as the LR assignment can be wrong



New DC Algorithms

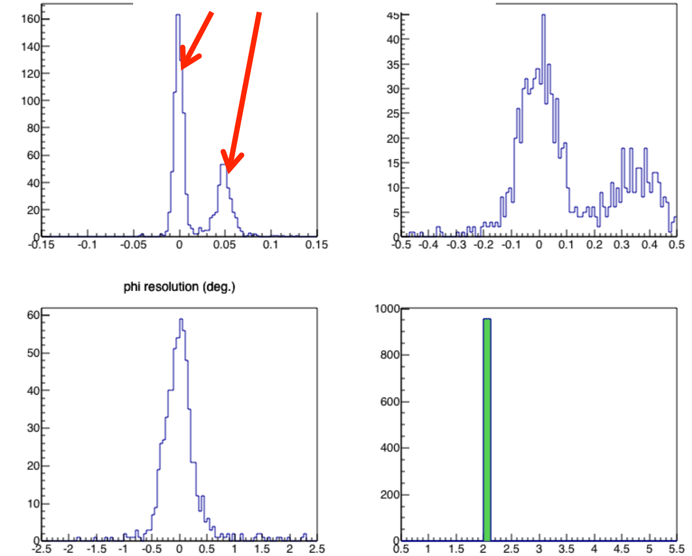
Track finding



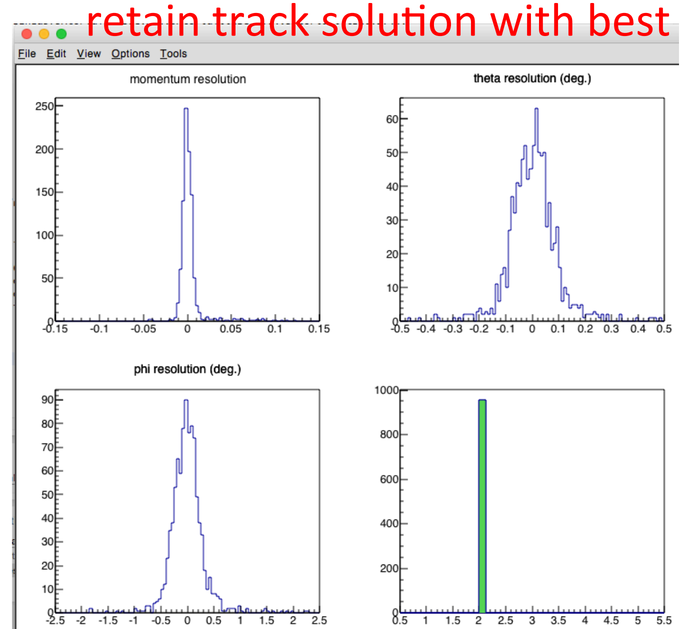
2 crosses → only 1 yields well reco. track

Allowing both segments and picking the *correct* one

2 track solutions



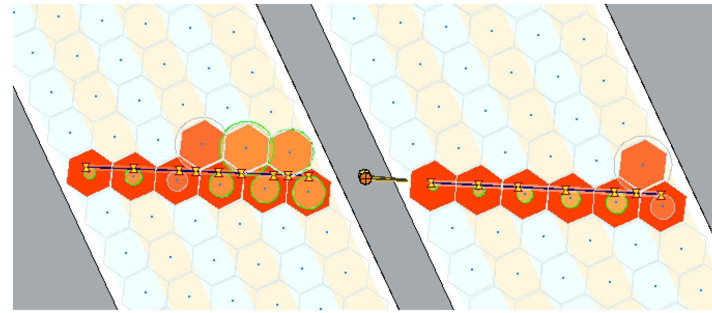
retain track solution with best chi^2



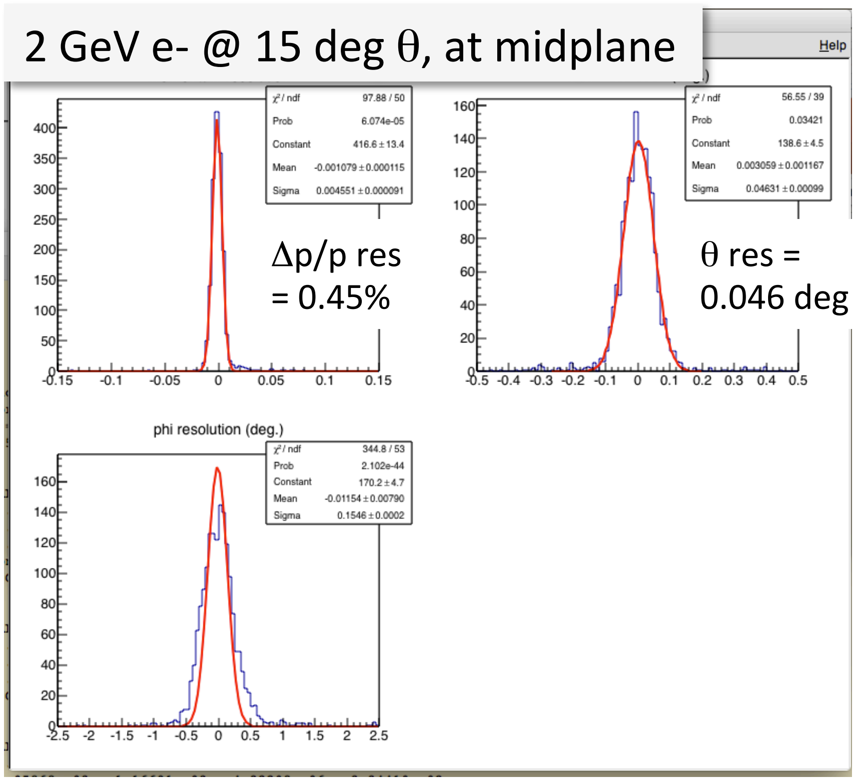
New DC Algorithms

Hit-Based Track fitting

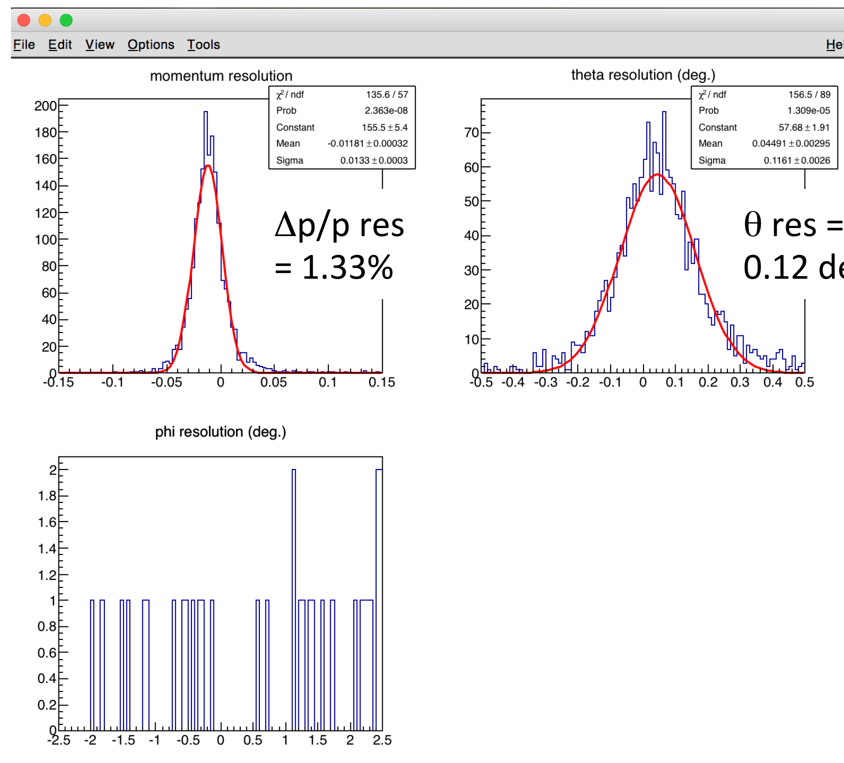
- Test: and run KF using <u>segment fit values </u>at measurement plane with times set times to zero → *kinda* worked (except for phi)
- in parallel: development of dictionary & Neural Net (D. Heddle [CNU], M. Catelli [CNU student], L. Lorenti [CNU student])



2 GeV e- @ 15 deg θ, at midplane



Time-based



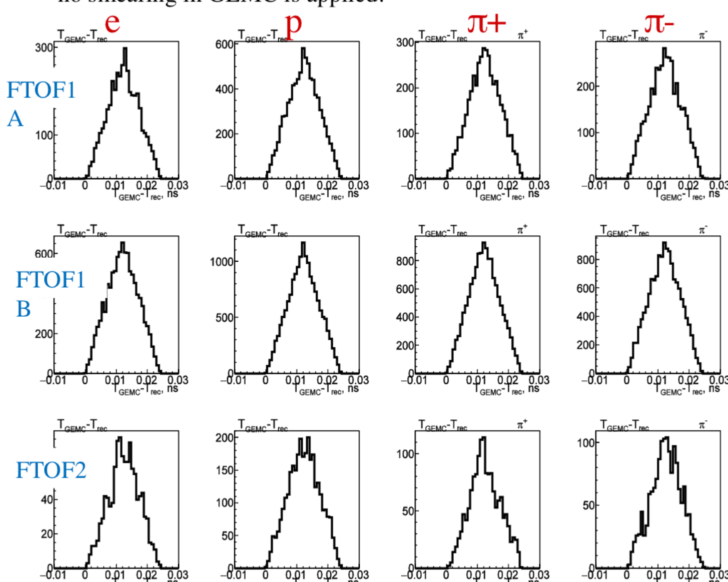
Hit-based

TOF Software Update

- Reconstruction code (Java) written for combined system CTOF+FTOF
- Algorithms based on status word describing hit TDC and ADC values [1: OK, 0: not OK, i.e. FTOF word = ADCL_stat TDCL_stat ADCR_stat TDCR_stat]
  - Done on a case by case basis → order of steps matters
    - missing ADCL,R - or TDCL,R, missing one ADC & one TDC → use tracking info
- Clustering and panel 1a,1b matching
  - corrected time using combined panel information (better than 1b alone)

- Ongoing validations
  (E. Golovach [Moskow U.])

FTOF hit time (T), hit position along the scintillator paddle (X) and deposited energy (E) are reconstructed within the accuracy determined by the truncation of the digitized ADC and TDC, if no smearing in GEMC is applied.



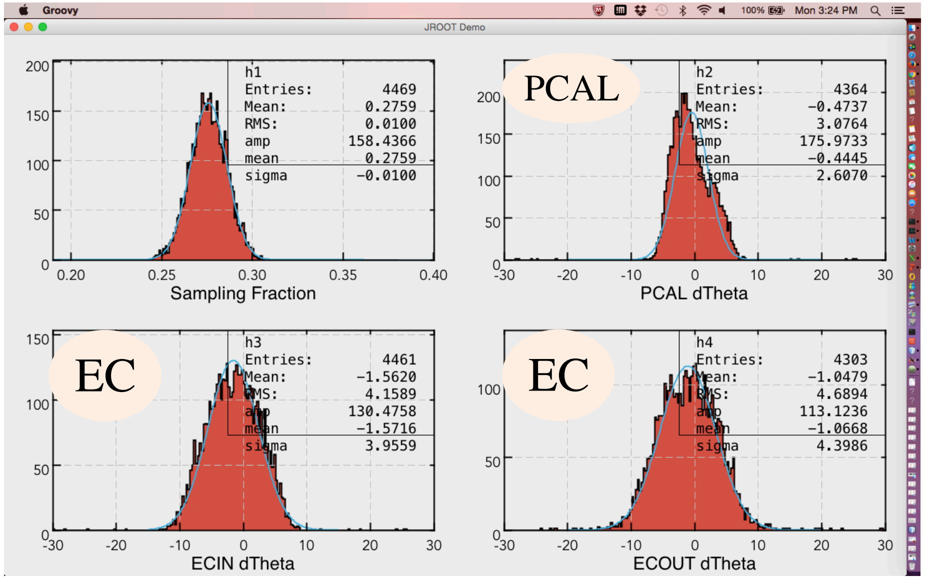
- Good agreement between simulation and reconstructed data
- Energy correspondingly good
- Algorithm for clusterization being developed and validated
  - combine timing from panel 1a and 1b to give better hit time resolution

* systematic shift due to digitization

EC+ PCAL Reconstruction Validation

Realistic detector responses from calibration data in MC

6 GeV photon simulated with GEMC



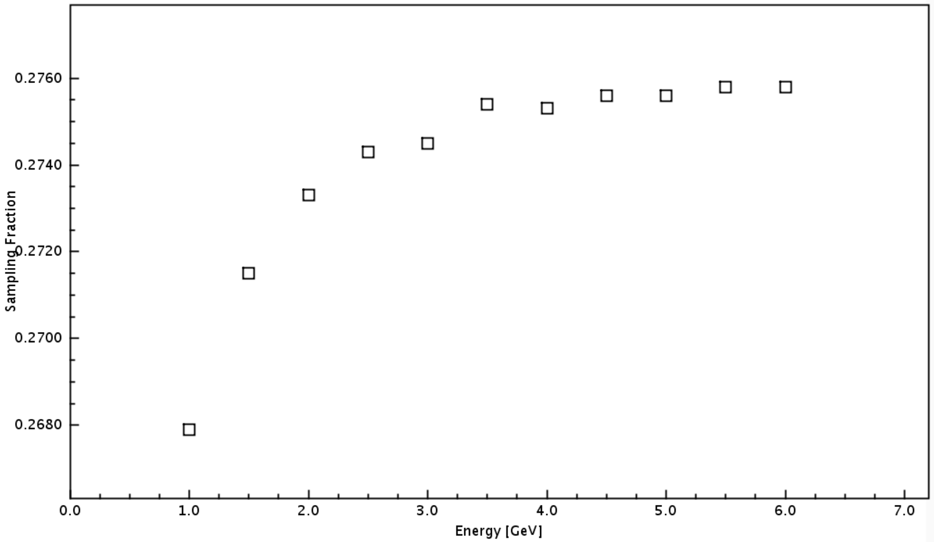
(units = mrad)

~96% efficiency from 1 to 6 GeV

J. Newton (ODU)

- Good agreement between simulation and reconstructed data for EC & PCAL
  - geometry agreement between GEMC and reconstructed validated for EC

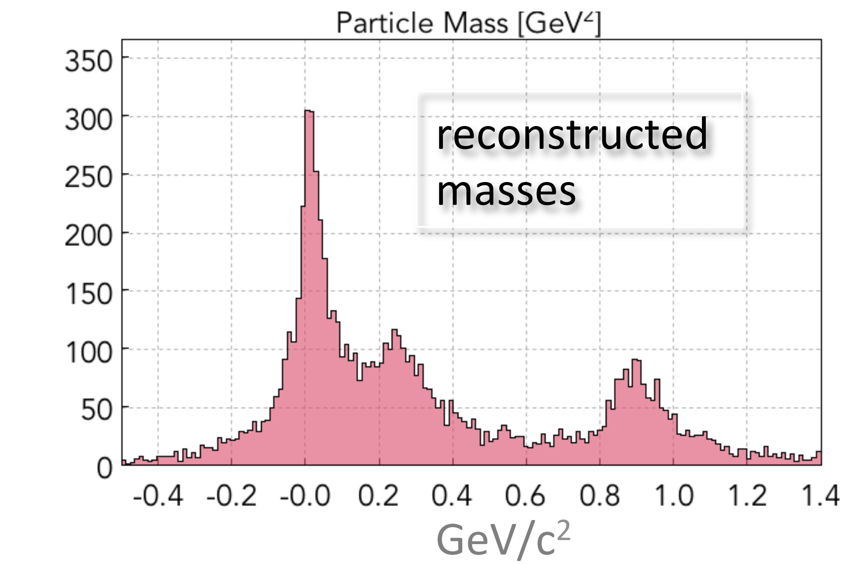
Sampling fraction as a function of energy

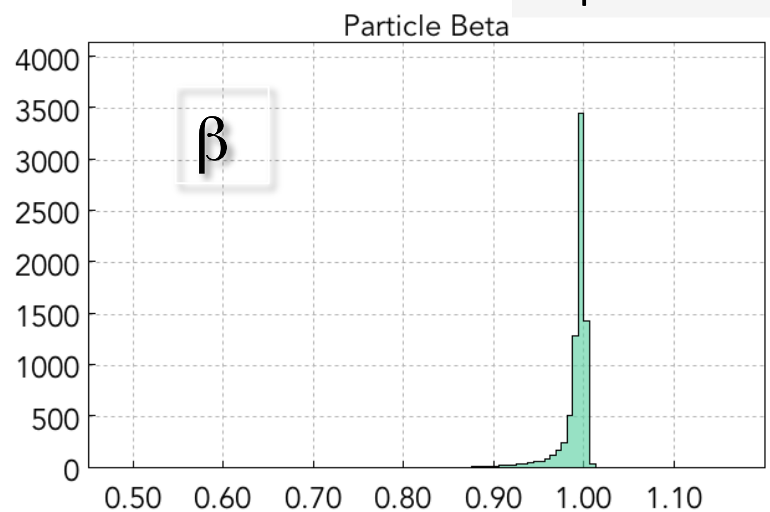


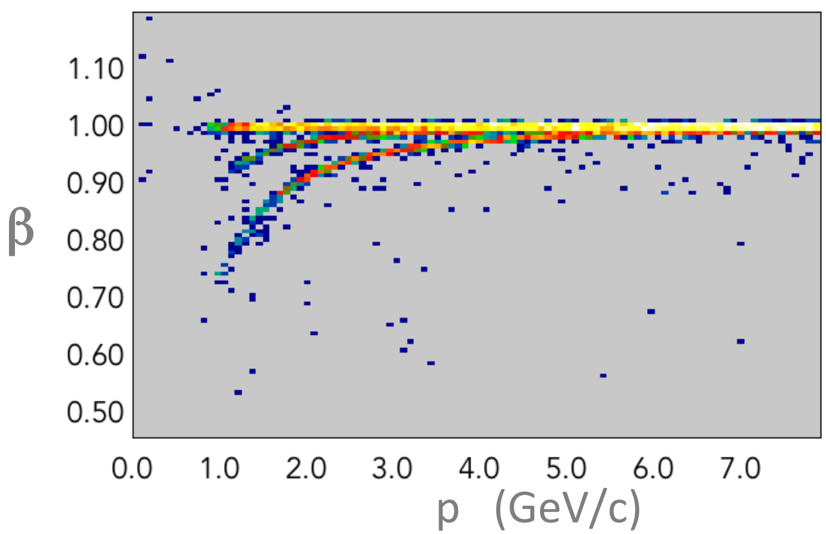
Event Builder: PID

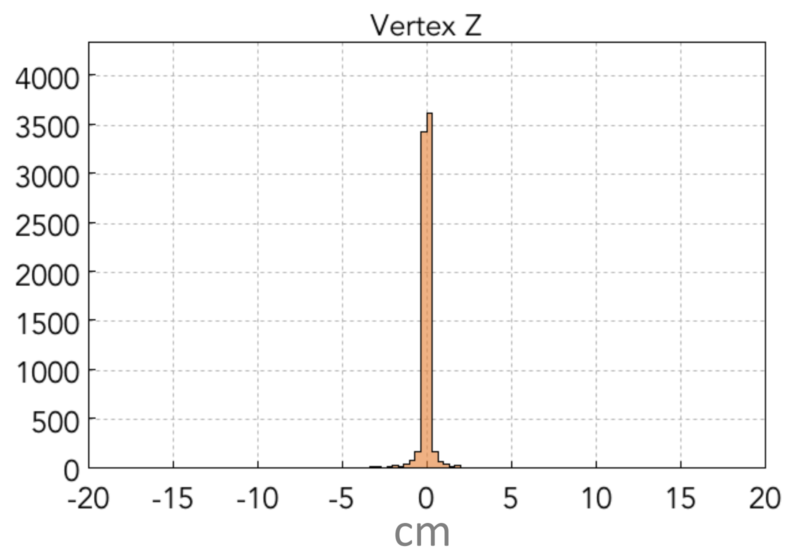
G. Gavalian

e p K^+ π^- sample



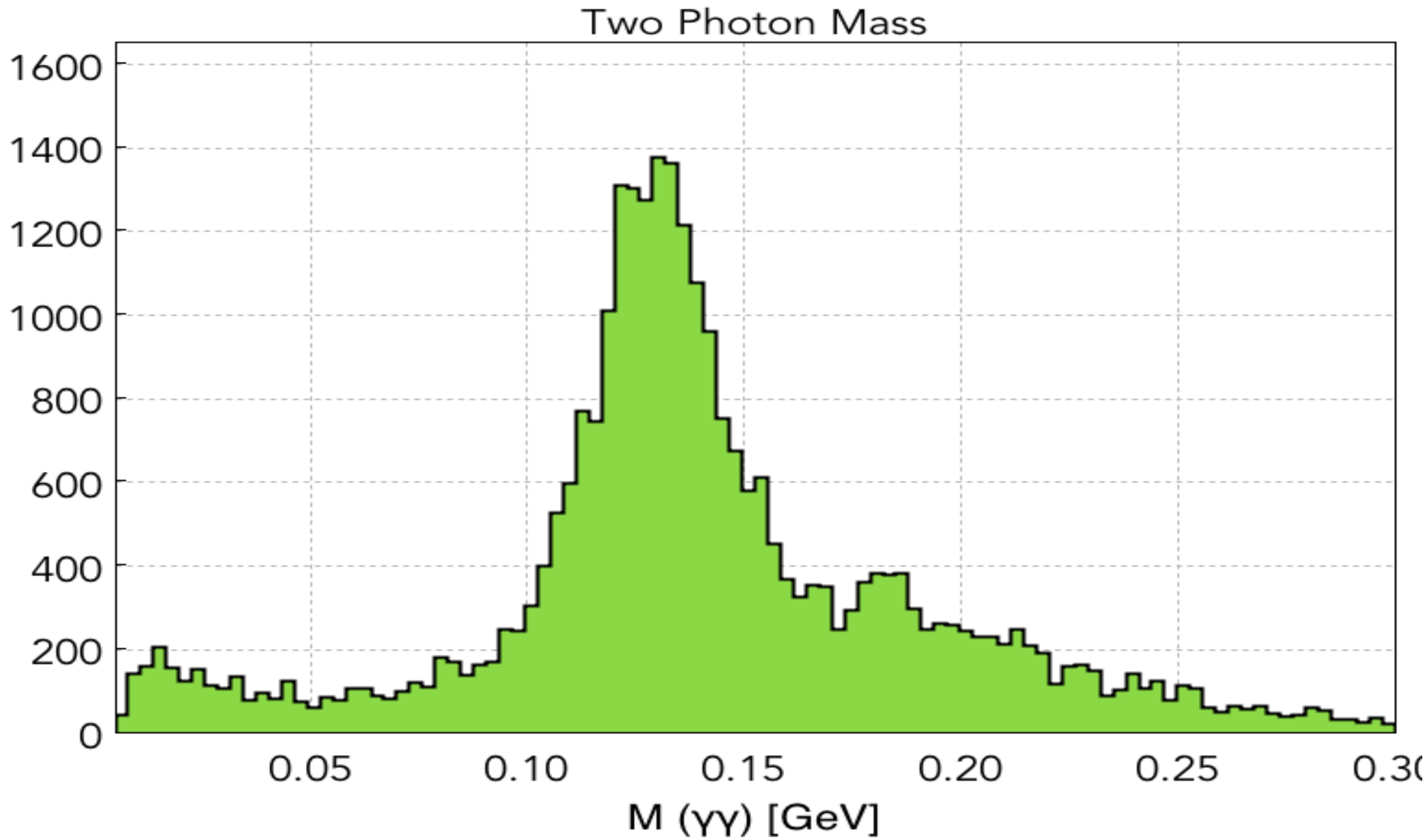






Event Builder: Neutrals Reconstruction

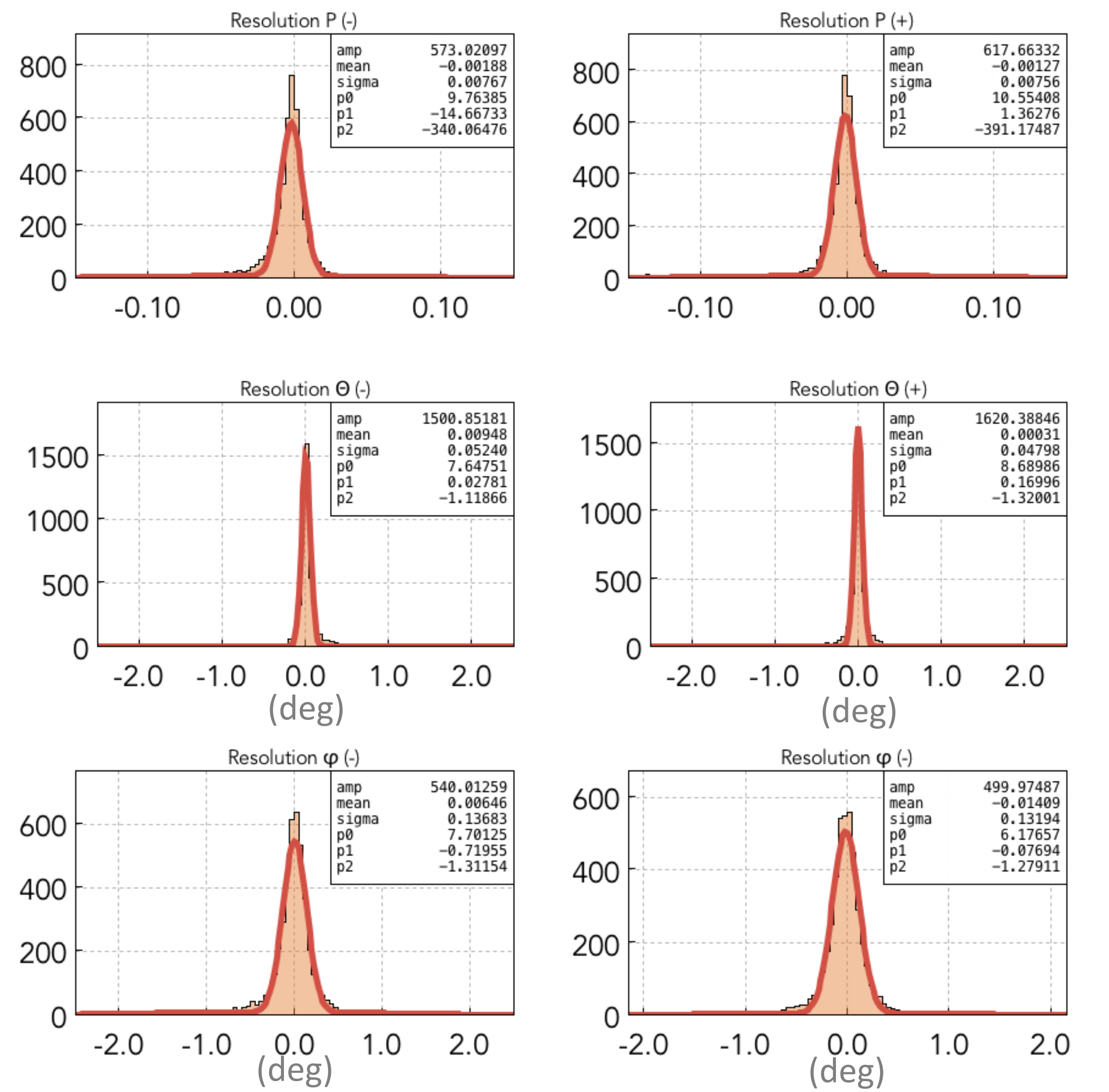
e p → e p π^0 sample



Event Monitoring: Tracking Resolutions

G. Gavalian

e p $K^+ \pi^-$ sample



negative tracks

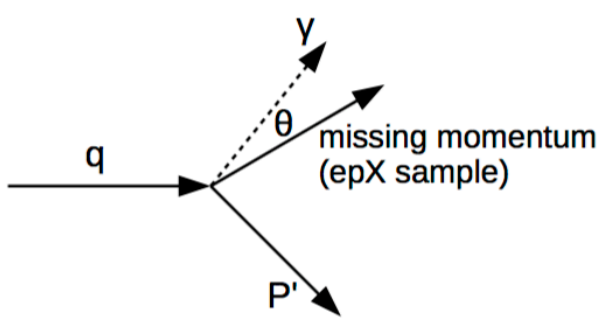
positive tracks

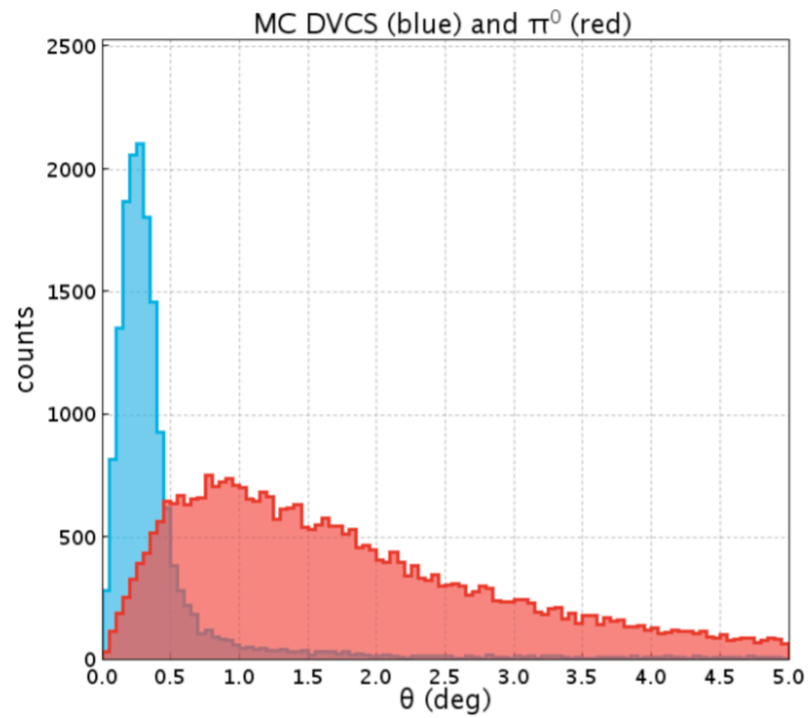
Analysis example running full available reconstruction chain

N. Harrison

- CLAS12 analyses are done with groovy scripts. This method ties well with the coatjava framework and provides standard tools for reading EVIO files and reconstructed banks.

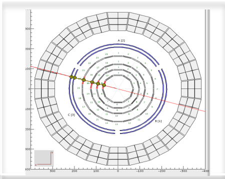
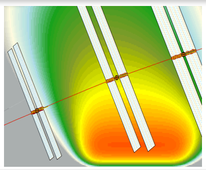
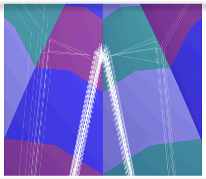
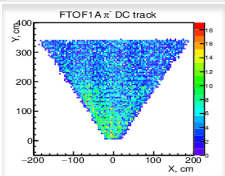
- For example, the DVCS and π^0 data files just produced can be used to study π^0 contamination ($\pi^0 \rightarrow \gamma\gamma$) in DVCS. To run the sample analysis code, do:
  /group/clas12/packages/coatjava-2.4/bin/run-groovy theta_gX.groovy file1.evio file2.evio …
  where the files are the DVCS and π^0 cooked files.

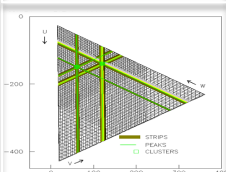


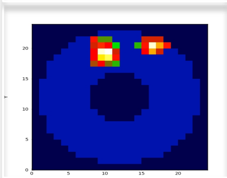
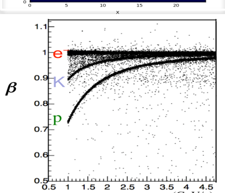


- demo shown during First Experiment Workshop 06/14/16

Coatjava-2.4 Release Available



Central Tracking: : new reconstruction package for combined system 4 double-layers SVT + 1 double-layer BMT.

- CVT → helical tracks reconstruction
- CVTCosmics → straight tracks (cosmics) reconstruction

Forward Tracking : improved noise rejection and segment finding algorithms.

- DCHB → hit-based tracking
- DCTB → time-based tracking ➔ track parameters used for matching to FTOF & EB

PID: HTCC reconstruction included in full reconstruction chain (e- ID). Clustering and timing validated on MC. Improved GEMC simulation of HTCC mirror reflectance.

- HTCC → runs HTCC reconstruction

PID: TOFs: new reconstruction package for combined system CTOF+FTOF. Calibration constants from database.

- FTOFRec → FTOF reconstruction (hits & clusters [only hit info used in EB])
- CTOFRec → CTOF reconstruction

PID: EC/PCAL: implementation of attenuation correction. MC parameters tuned to match calibration data. Calibration constants from database.

- ECREC → runs EC and PCAL reconstruction

PID: FT: FT-Calorimeter & FT-Hodoscope services available for low angle γ & e- reconstruction. Improved clustering algorithms.

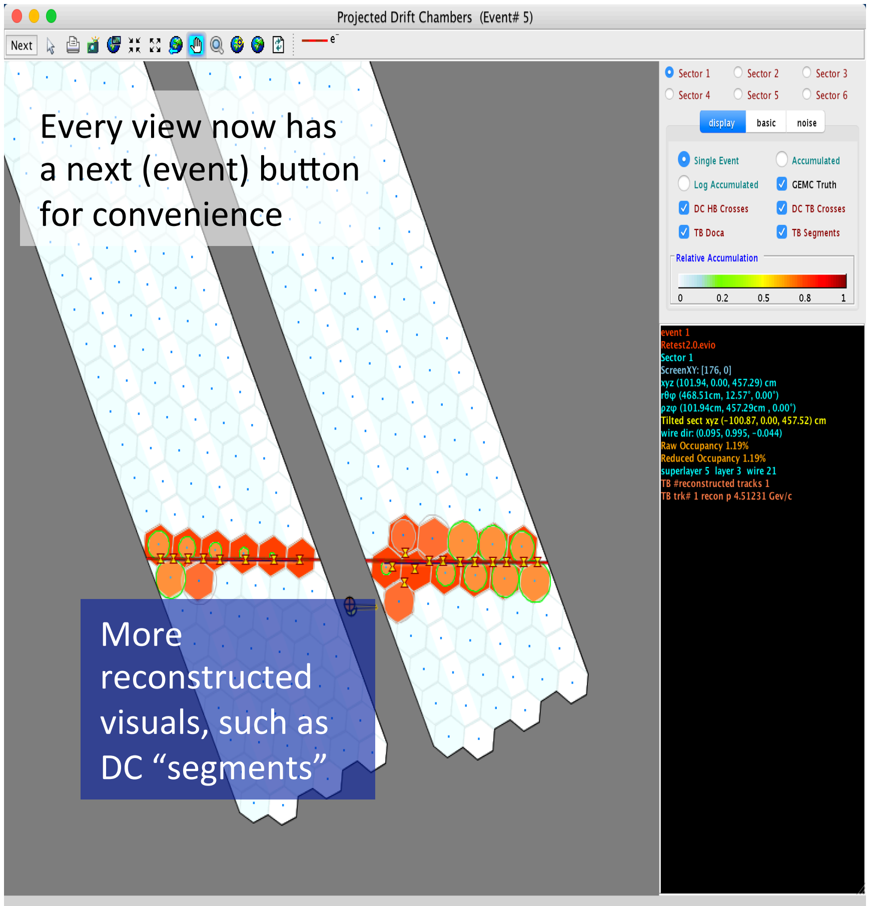
- FTCAL → Forward Tagger calorimeter reconstruction
- FTHODO → Forward Tagger hodoscope reconstruction
- FTMATCH → Forward Tagger matching between CAL and HODO

Event Builder: links services together, uses detector responses and tracking information to assign PID

- EB → runs the event builder (added at the end of the service chain by default)

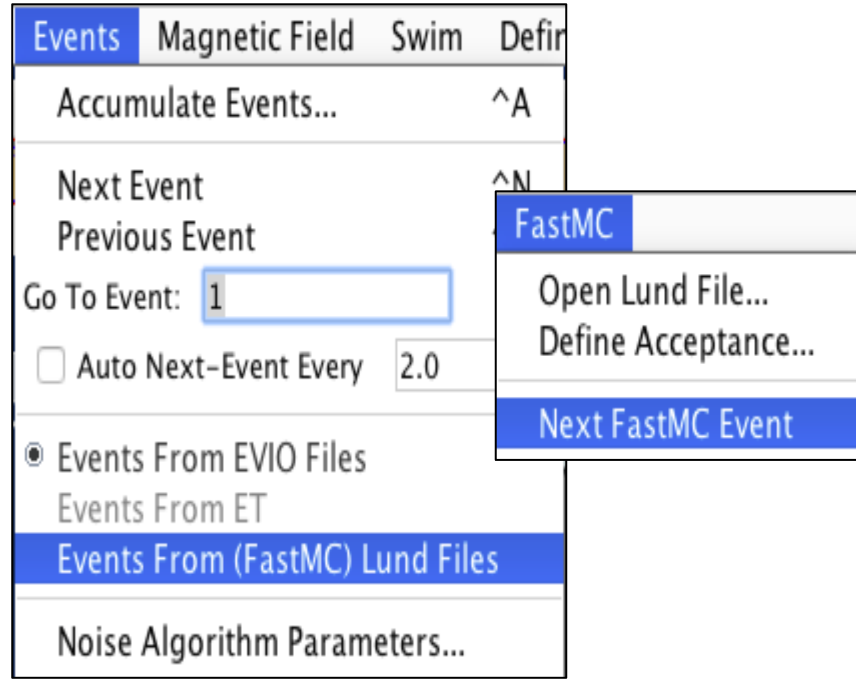
ced new features

(D. Heddle)



New "Projected Drift Chambers" view. Instead of the entire detector projected onto a constant ϕ plane, each superlayer is projected onto a plane perpendicular to its wires. This reduces distortion and makes visualization of tracks and segments wrt DOCAs more accurate and, consequently, more useful.

Coming soon, full integration with FASTMC, dictionary building, machine learning



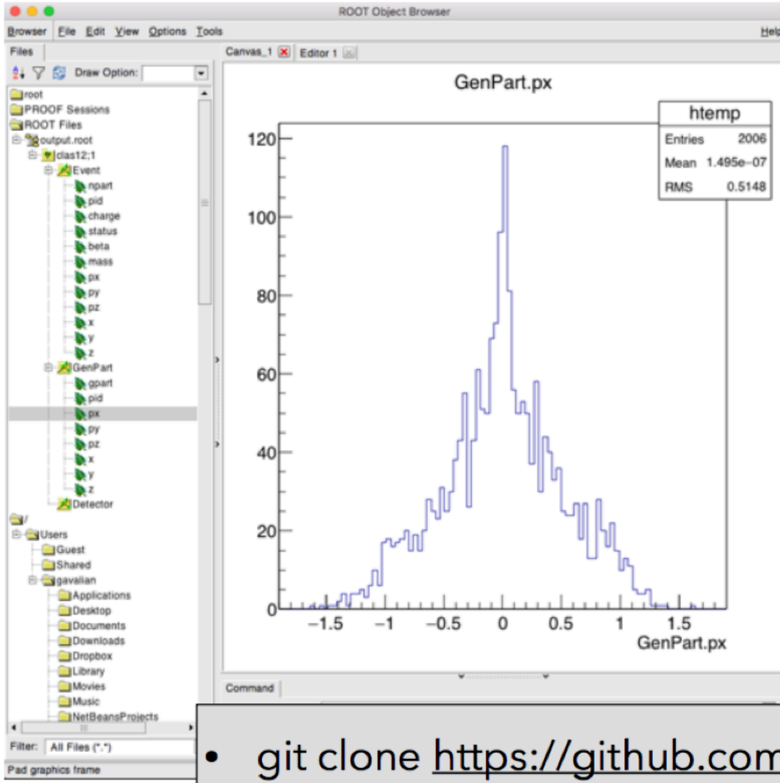
You can now choose "Lund Files" as the source of events. *ced* will read the file and swim the particles. It will then ask *coatjava* libraries to determine what was hit, and then it will display the hits.

Over the next month, we will use the DC hits to build a dictionary and (independently) to train a neural net. We will then test the resolution and speed of using these machine-learning products as 0^{th} pass track fitters.

New Common Tools

G. Gavalian

ROOT converter



- output to ROOT tree
- flat NT10 structures
- includes generated particles
- reconstructed particles
- combined detector responses

- git clone https://github.com/gavalian/evioRoot
- cd evioRoot
- scons
- ./bin/evio2root   badfile.evio   goodfile.root

Common Tools

G. Gavalian

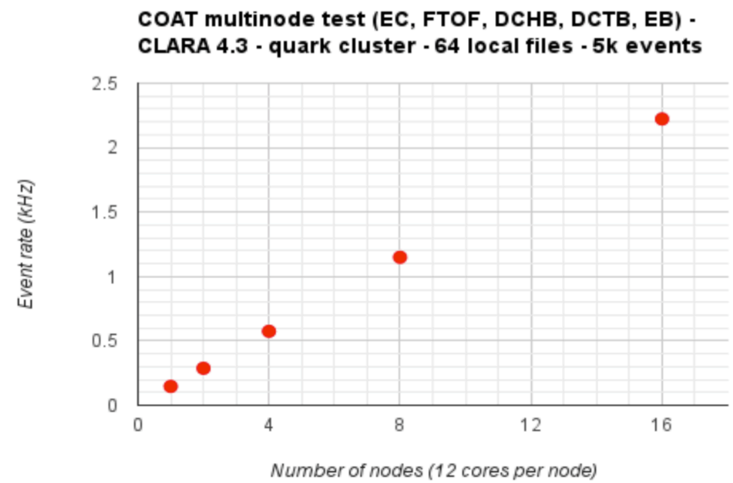
Data Formats and Preservation

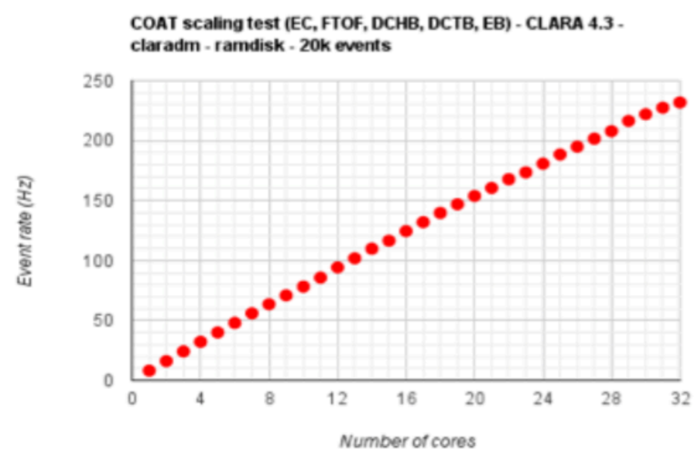
- Transition to reading translation tables from DB is underway.
- ADC pulse parameters are being read from database.
- Raw bank decoders implemented for all detectors. Transitional data structures are implemented (HIPO) for data compression. Work is being done to optimize bank structures to save space.

Migration to CLARA 4.3

- CLARA 4.3 switch from cMsg to xMsg → zeroMQ* socket◆ libs
- ongoing scaling tests on clara-dm machine and Richmond cluster using forward detector reconstruction service chain (most of compute intensive portion of the reconstruction chain)
- Modular reconstruction service composition (reconstruction plugins)

S. Mancilla





* high-performance asynchronous messaging library for applications.

◆ sockets allow applications to communicate using standard mechanisms built into network hardware and operating systems.

Summary

- **GEMC 2.4** and **coatjava 2.4** released
  - GEMC 2.4 version code updates
    - linear interpolation, field properties, cosmic event-gen
    - material change options (material name, volume)
    - electronic Noise
  - ongoing validations with cosmics & simulated events
  - coatjava release includes Central, Forward and FT systems and loads constants from ccdb
  - many common tools upgrades (i.e. plotting package -- shown during calibration talk)
  - several ced new features
- This release should be used for proposals
  - use drupal forum to report issues
    - works like hypernews: searchable
    - https://clasweb.jlab.org/drupal/forum