CLAS12 Offline Software Tools

G.Gavalian (Jlab)
CLAS Collaboration Meeting (June 15, 2016)
Overview

- **Data Formats:**
  - RAW data decoding from EVIO.
  - Reconstruction output banks in EVIO.
  - Reconstruction output convertor to ROOT (coming soon).
  - Data preservation format (HIPO), compression and fast random access.
    - Fast indexing and error recovery
    - Used to produce small data samples (and DSTSs)

- **Calibration Framework:**
  - Powerful 2D detector visualization framework.
  - Data analysis library for plotting, fitting (most of the plots in presentations today).
  - Interface to constants database, and translation tables.
  - Pulse fitting toolkit (database aware).
  - Automated calibration constants visualization and analysis.

- **Reconstruction:**
  - Modular reconstruction framework (CLARA based)
  - Event Builder for full event reconstruction
  - ROOT convertor for particle ID and physics analysis
Data Input/Output

✓ **Raw DAQ Data**
  - standard CCDB tables for pulse parameters (NSA, NSB, TET).
  - standard tables for Translation Tables (CCDB).
  - tools for reading FADC tables and Translation tables.
  - visualization and constrain highlighting.
  - simple interface to interact with data (independent of the source)

✓ **Raw Detector Pulse viewer**
  - interface for pulse FADC visualization
  - fitting for FADC pulse (integration)

✓ **Event Decoder**
  - decoder for compact data structures
  - pedestal subtraction/pulse fitter
  - creating reconstruction detector banks
Geometry & Calibration Tools

✓ **Standard Detector Geometry Package Implements:**
  - Forward Time of Flight
  - Electromagnetic Calorimeter
  - Forward Tagger
  - Drift Chambers
  - Silicon Vertex Tracker
  - Central Neutron Detector

✓ **Geometry Tools and Utilities:**
  - Drawing package for 2D detector representation
  - 3D shapes for CED-3D viewer
  - Detector component tracker for Fast Monte-Carlo

✓ **Calibration UI:**
  - new UI for developing Calibration code
  - data stream implementation for EVIO files and ET-ring
  - reasonable drawing and fitting package
Geometry 3D in CED
Calibration Examples (SVT)
Calibration Examples (SVT) (Y. Gotra)
CND Calibration (G. Murdoch)
FTOF Calibration (L. Clark)

Work completed / in progress
- Conversion of calibration algorithms to COATJAVA framework for high voltage, attenuation length, effective velocity, timewalk, paddle to paddle offsets
- Script generation for high voltage adjustments
- Output file of calibration constants for transfer to calibration database
- Summary graphs of calibration values
- FTOF calibration GUI

Work planned
- Conversion of calibration algorithms for RF offsets and counter status
- Full functionality within GUI for each calibration area
- Testing
Data Visualization (EC) (C. Smith)

Current Features
- Common framework for PCAL and EC.
- Pixels dynamically generated from geometry database.
- Mouse-over navigation of detector elements.
- Live updating of detector response and calibration results.

Monitoring
- Occupancy: strips, pixels, fADC and TDC data.
- fADC data: pulse shape, noise, fitter settings.
- Single event: visualize hits and showers.
- Pedestals: event-by-event, noisy channels.

Calibration
- GUI isolates single pixel cosmic muon hits (Dalitz).
- Optimization of pixel selection (statistics, geometry).
- Fits to pixel data: PMT gains and light attenuation.
- Validation using GEMC simulations.

Further Development
- Incorporate EPICS data (scalers and HV) for status monitoring.
- Energy cluster reconstruction and trigger debugging support.
- Energy calibration using physics data (e-, pi-zero and MIP pions).
- Timing calibration (offsets, time-walk).
- EC, PCAL relative alignment using cosmic muon pixel events.
Calibration EC
Calibration & Monitoring (FTCAL) (E. Fanchini)

- **Modular software:** project organized in subroutines (app) to be re-used
- **Runs:** online and offline data analysis
- **Selections:** Tabs and buttons to select analysis and variables to display
- **Comparison:** distributions compared with a reference or an offline run
- **Summary panel:** window displaying channel distributions and fits

- **Refit panel:** user function fit optimization
- **Outputs:** output files for offline analysis (txt, hipo)
Reconstruction CLARA 4.3

✓ **xMsg CLARA service bug**
  - general purpose public subscribe MPI
  - utilizes zeroMQ socket libraries
  - Sockets that carry messages across various transports
    - In-process
    - Inter-process
    - TCP
    - Multicast
  - Sockets can be connected N-to-N with patterns
    - Fan-out
    - Pub-sub
    - Task distribution
    - Request-reply
  - Java, C++, Python bindings

✓ **Reconstruction Framework**
  - reconstruction framework reads GEMC generation parameters.
  - modular, runs as separate services.

✓ **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
COAT multinode test (EC, FTOF, DCHB, DCTB, EB) - CLARA 4.3 - quark cluster - 64 local files - 5k events

Event rate (kHz)

Number of nodes (12 cores per node)
ROOT (migration to comfort zone)

- 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
### Particle Index

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### FTOF

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Live Demo
Summary

• **Calibration:**
  • Unified framework for calibration seems to work for everyone.
  • All detector systems are using unified tools (visualization and analysis).
  • More work has to be done to unify data analysis

• **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.

• **Reconstruction:**
  • Reconstruction release 2.4 is ready to use.
  • Includes all detectors (Forward, Central and FTCAL)
  • CLARA Sand-Box available for CLAS12 reconstruction

• **Future Developments:**
  • Conversion from EVIO to ROOT for final reconstruction files.
Analysis Software Framework