GlueX discussion

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Outline

- **Recent activities**
  - Deploy the software on the IHEP farm
  - Get familiar with the Glue-X BCAL detector and software

- **Plans**

Software deployment

- **Deployed the Glue-X offline software to CernVM-FS on the IHEP farm.**
  - Version: 2.33
  - Traditional build method (the container way is not compatible with the farm currently)

- **To upgrade the software and copy the new MC generation soon**

GlueX calorimetry is to detect and to measure photons from the decays of π^0's and η's and other radiative decays of secondary hadrons. The detector measures the energies and positions of the showers made by photons, as well as the timing of the hits. It also provides the timing of the hits caused by charged hadrons, allowing for time-of-flight particle identification.

The GlueX detector

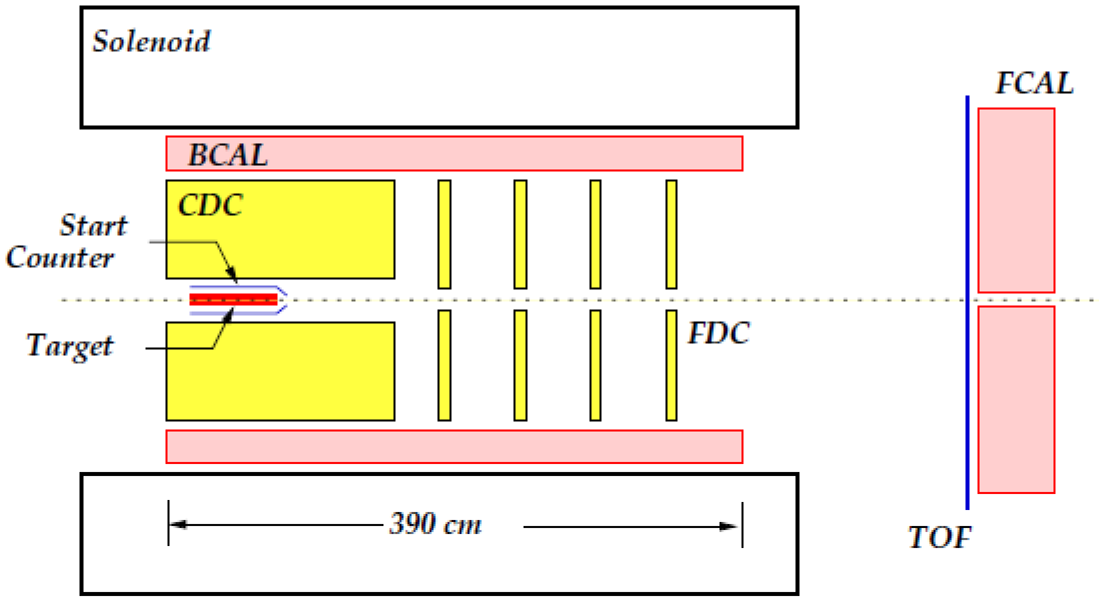


Figure 1: Sketch of GlueX detector. The main systems of the detector are the Start Counter [4], the Central Drift Chamber (CDC) [5] the Forward Drift Chamber (FDC) [6], a scintillator-based Time of Flight (TOF) wall and a lead-glass Forward Calorimeter (FCAL) [7]. The Barrel Calorimeter (BCAL) is sandwiched between the drift chambers and the inner radius of the solenoid. (Color online)

BCAL

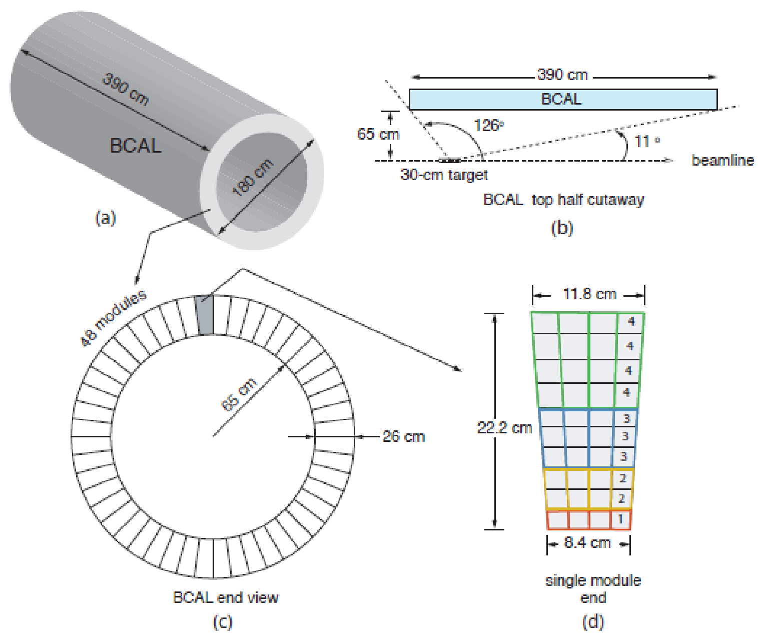


Figure 2: Sketch of the Barrel Calorimeter and readout. (a) A three-dimensional rendering of the BCAL; (b) top-half cutaway (partial side view) of a BCAL module showing its polar angle coverage and location with respect to the GlueX LH_2 target; (c) end view of the BCAL depicting all 48 azimuthal modules and (d) wedge-shaped end view of a single module showing the location of light guides and sensors as well as the 1:2:3:4 readout summing scheme, described in Section 4. More details can be found in the text. (Color online)

- The calorimeter is made of consecutive layers of ~4m long lead sheet and scintillator fibers (SF) acting as passive and active materials
- Weight fractions (Pb:SF:Glue)
  - 86.1:10.5:3.4
- 48 modules with inner radius of 65 cm
- The polar angle coverage and location W.R.T. the target is shown in the figure
- Fiber selection
  - Kuraray SCSF-78MJ double-clad, blue-green fibers

Readout

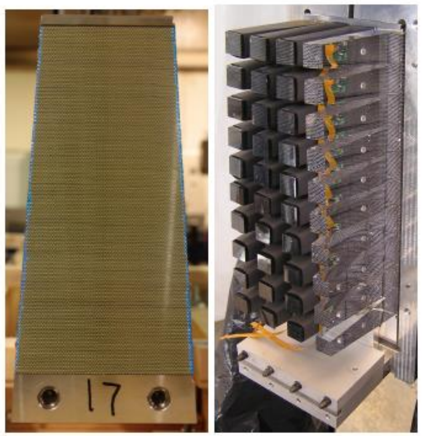


Figure 3: Left) Photo of the machined end of the lead-scintillator matrix. Individual fibers can be seen between the lead corrugated sheets. The matrix lies between the the thin Al plate on top and the thick Al base plate at the bottom. Right) Arrangement of light guides glued to the face of the matrix. Three columns are already covered with black covers. Visible are LED boards showing through the last column as well as the location of the side pockets for the LEDs. (Color online)

Column 1	Column 2	Column 3	Column 4
4	4	4	4
3	3	3	3
2	2	2	2
1	1	1	1
4	4	4	4
3	3	3	3
2	2	2	2
1	1	1	1
3	3	4	4
1	1	2	2

Figure 5: Bias distribution shown for the SiPMs in the 1:2:3:4 summing readout configuration for one end of one module. The numbers indicate the bias line feeding each SiPM and the summing groups are indicated by the thick lines. By powering a single bias line and pulsing one column, it is possible to select a specific SiPM within a summing group.

- The matrix lies between the thin Al plate on the top (8 mm) and the thick Al base plate at the bottom (31.75 mm)
- Light guides are glued to the face of the matrix
- There are 4 columns and 10 rows of light guides
- Light is then delivered to the silicon photomultiplier (SiPM) light detectors. The selection of SiPMs was driven by their insensitivity to magnetic fields
- The outputs of each array are summed by columns in a 1:2:3:4 scheme, which reduce 40 SiPMs down to 16 signals

Raw data processing

- **Raw FACD and TDC are collected**
- **Combining Raw Data**
  - The raw ADC and TDC data from individual channels are combined to produce calibrated energy, time and position values for reconstructed showers
  - Raw data are combined into “points”
    - The time difference is used to determine the z position
    - The time sum determines the time of energy deposition
    - The energy of a point is the sum of the energy from the ends corrected for attenuation along the scintillating fibers
  - These points are combined into “clusters” of points that collect all the energy deposited by a single particle incident in the BCAL
  - Once the clusters are determined, a nonlinear energy correction is applied to convert them into “showers”

Shower Reconstruction

- **Find the ‘seed’ cell that has the highest energy (> 15 MeV)**
- **Cells with deposited energy that are in geometrical proximity to the cluster seed are added to the cluster iteratively**
- **Find the next highest energy cell from the remaining cells and form a new cluster and the procedure is iterated**
- **Check that each cell was placed in its most appropriate cluster. Merge clusters that are very close together into a single cluster**
- **Combine the information from these cells to form “showers”**
  - Energy: sum of all of the energy deposited in each of the cells
  - Time: energy-square-weighted average of all the cell times
  - Distance from the target center & polar angle: energy-square-weighted averages
  - Phi: energy-weighted average
- **The shower information is used to reconstruct a particle’s four-vector to be used for physics analyses**

Calibration

- **Procedure**
  - Remove hardware time offsets in the ADCs and TDCs.
  - Correct TDC times for time-walk using ADC information
  - The positions of the hits, z , are calibrated using a sample of pion-enriched negatively charged tracks
  - The point times are calibrated by projecting the time sum of the two ends back to the target
  - The attenuation within the scintillating fibers and the ratio of the gains between each end of a BCAL cell are then extracted by comparing the size of the signal at each end with the z position, calculated from the time difference
  - The overall gain for each BCAL cell is then determined in an iterative procedure by minimizing the width of the reconstructed pi0 invariant mass distribution from its 2gamma decay

JANA: Data Factories

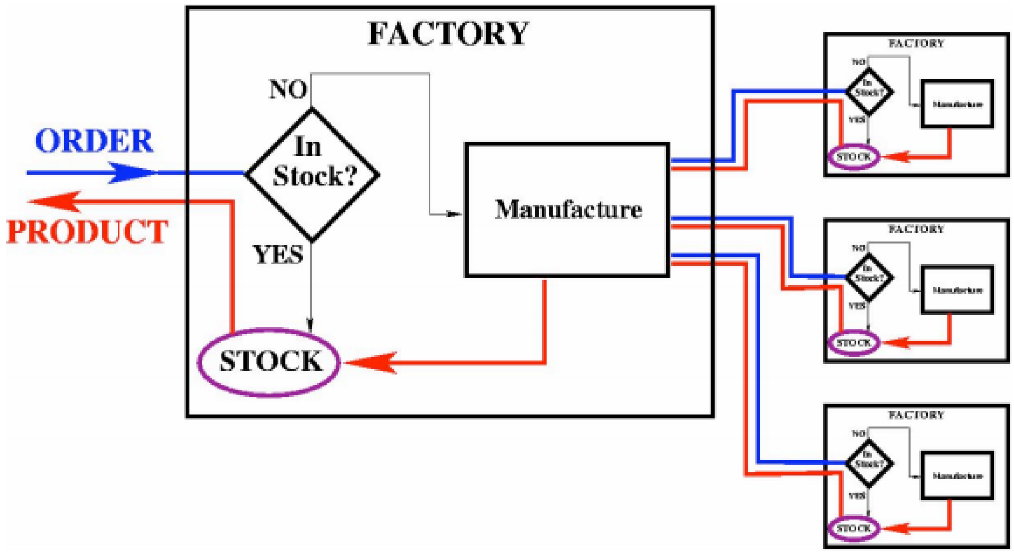
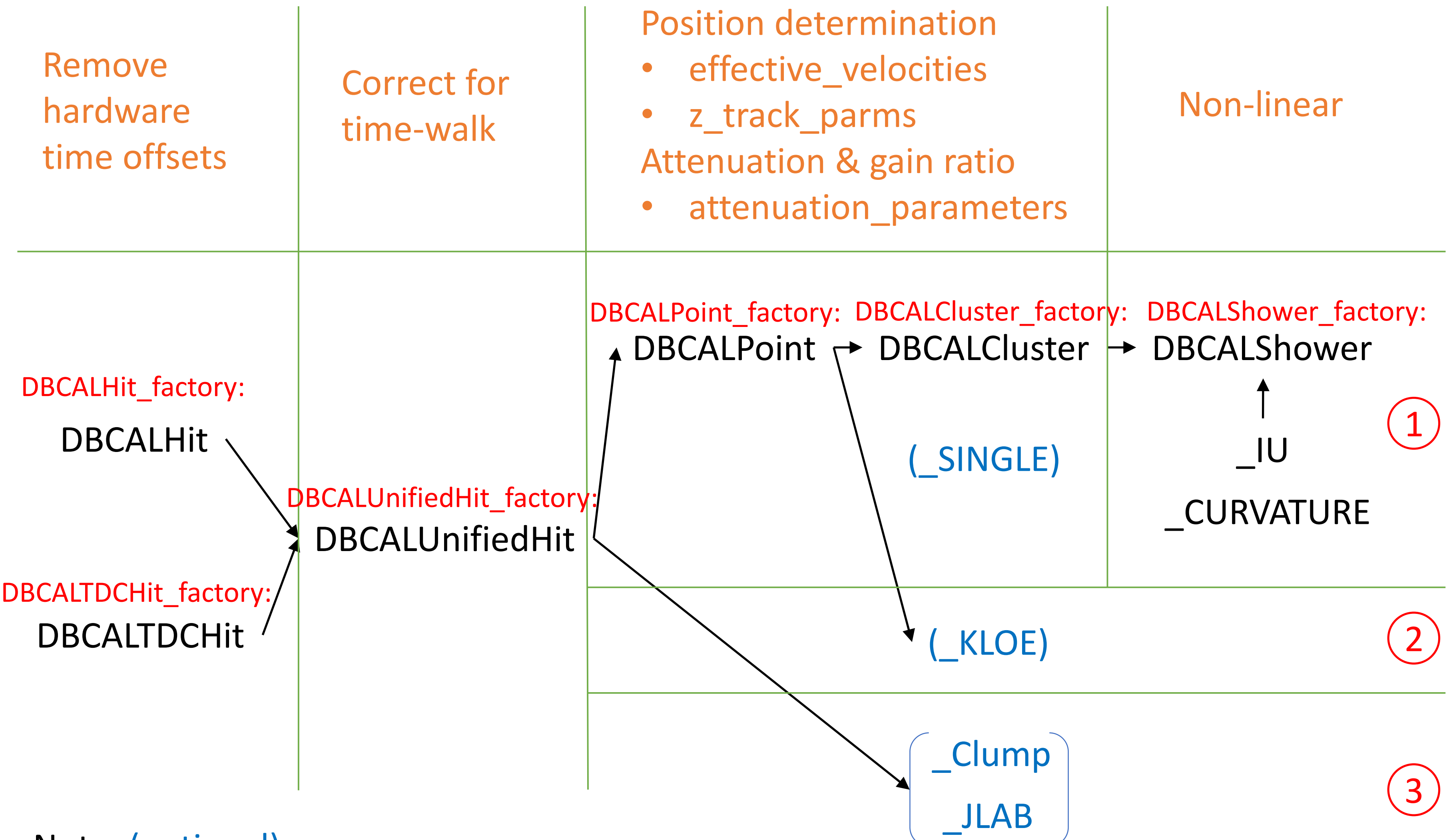


Figure 1: Factory flowchart. Requests for data can be thought of like orders to a factory. The factory must either "manufacture" the data, or retrieve it "from stock".

1. Manufacture of data is only done "on demand" so CPU cycles are not wasted doing reconstructed values that are never used.
2. Objects are "recycled" in that subsequent requests to the same factory are just given pointers to the objects created in the first request.

The reconstruction procedure



Note: (optional)

Plans

- **I have been looking at the minutes of the recent calorimeter meetings. Since this year, action items mainly include:**
  - Calibration for the new data set
  - Performance checks for the new data
  - Tracking matching to FCAL
  - Separation of photons and neutrons in BCAL
  - Create non-linearity corrections for MC for gain adjustment
  - Develop standard fiducial volume cuts for the calorimeters
- **In my understanding, the software framework of calorimeter is almost complete. But there is still room to improve the performance.**

Plans (II)

- **Our initial goal is**
  - to improve the data/MC consistency in order to decrease the systematics in physics analysis.
  - More specifically, we plan to check and improve the consistence of error matrices for the neutron showers between data and MC.
  - Low-level calibration or high-level correction may be applied if necessary

- **We need more input from the calorimeter group to let us know the current status and also if there is any other work of high priority that we can participate**