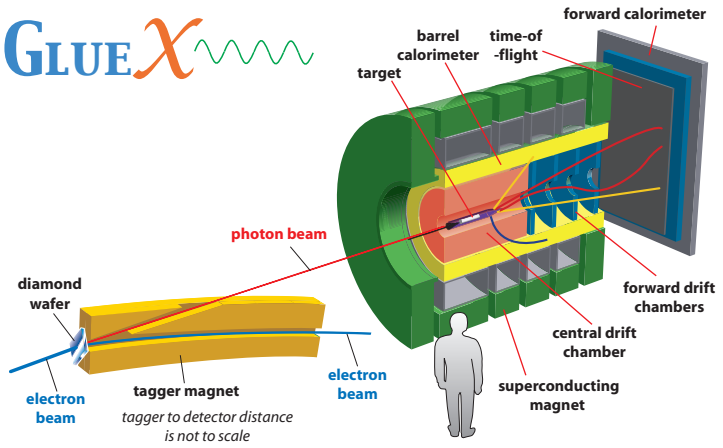
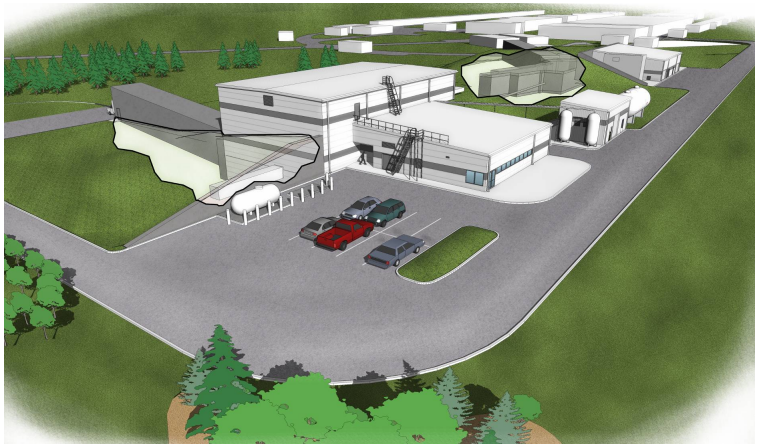
12-GeV Software Review

The GlueX Collaboration GlueX/Hall-D

Curtis A. Meyer, Spokesperson



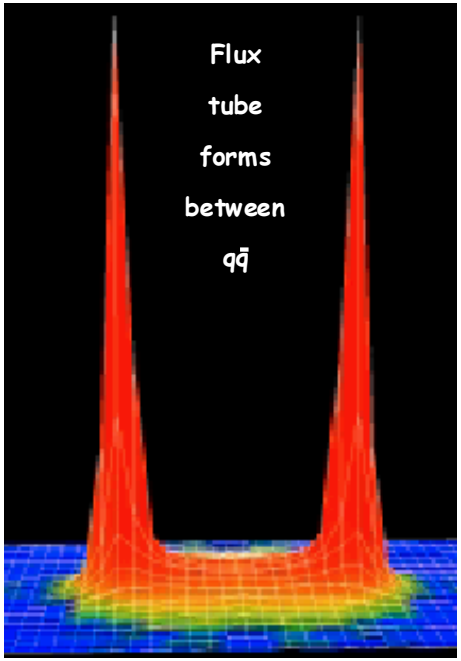


Athens University, Arizona State University, Carlton University, Carnegie Mellon University, Catholic University, Christopher Newport University, University of Connecticut, Florida International University, Florida State University, University of Glasgow, Indiana University, Jefferson Lab, University of Massachusetts Amherst, Massachusetts Institute of Technology, MEPHI, University of North Carolina A&T, University of North Carolina Wilmington, Old Dominion University, Oxford University, University of Pittsburgh, University T`ecnica Federico Santa Mari'a and University of Regina.

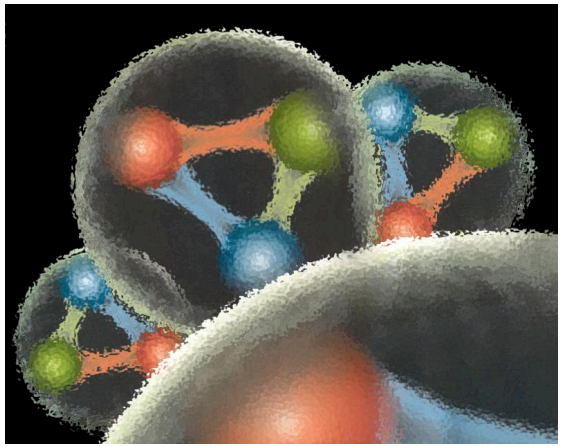
Outline

- **GlueX Experimental Overview**
  - *Curtis A. Meyer, GlueX Spokesperson*
  - The Physics of GlueX/Hall-D.
  - Management of GlueX/Hall-D.
  - Data-analysis.
  - Remaining Offline Tasks.

- **Hall D Software Overview**
  - *Mark Ito, Offline Coordinator*



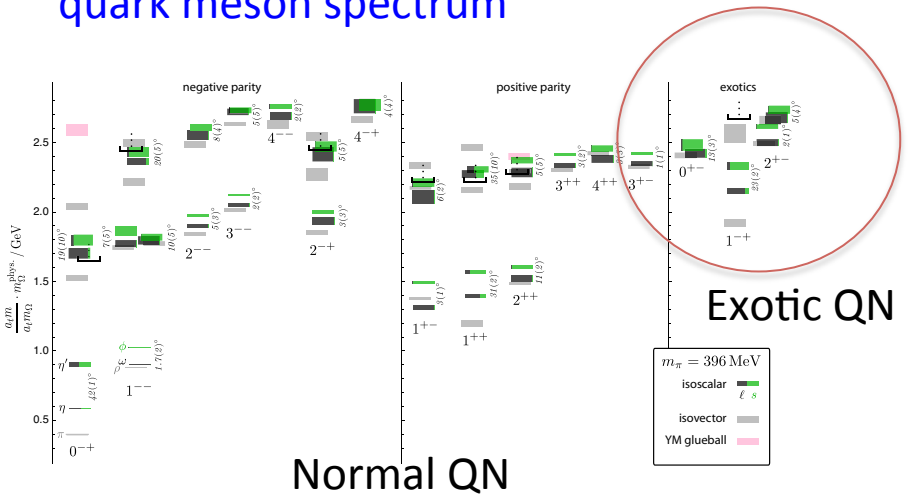
Quantum Chromo Dynamics

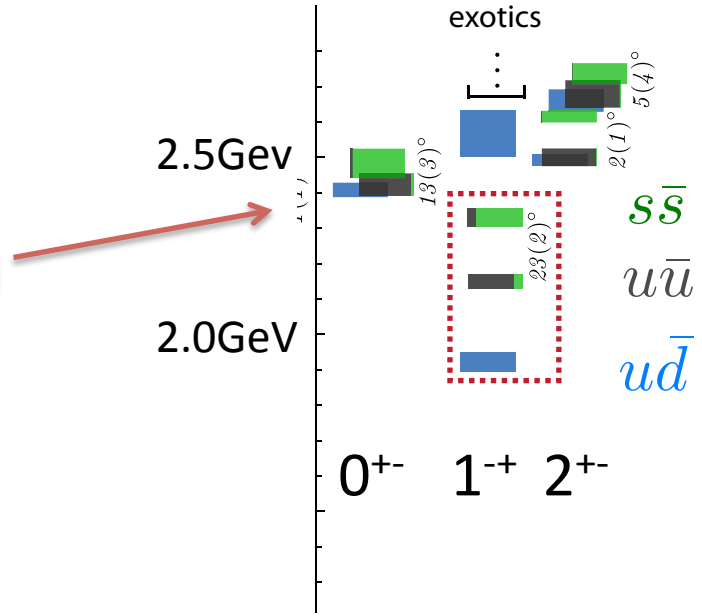


QCD describes the interactions of quarks and gluons and should predict the spectrum of bound-state baryons (qqq) and mesons ($q\bar{q}$).

There should also be mesons in which the gluonic field contributes directly to the J^{PC} quantum numbers of the states --- hybrid mesons. Some are expected to have ``exotic'' quantum numbers.

Lattice QCD calculation of the light-quark meson spectrum

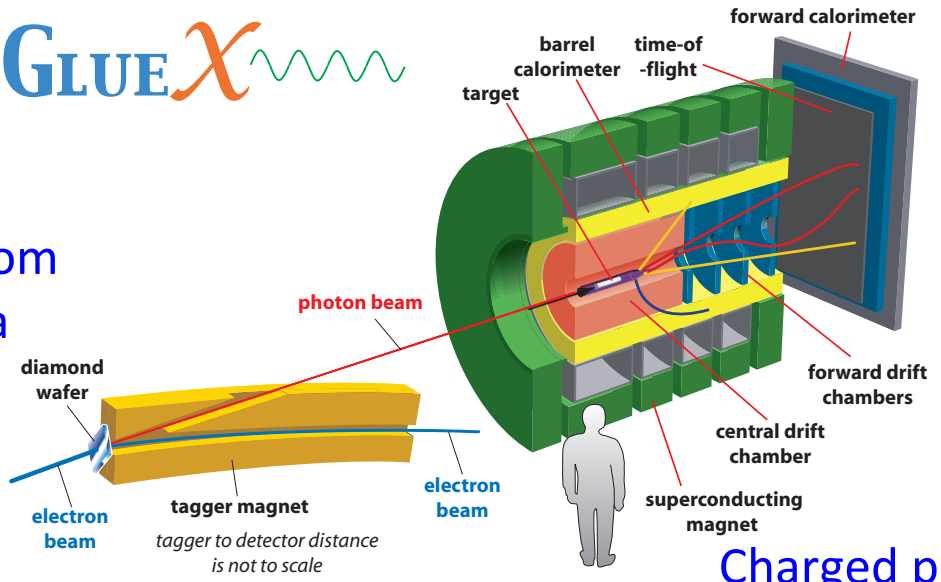




Several nonets predicted

Physics in GlueX

8-9 GeV Linearly polarized photons from 12 GeV electrons in a thin diamond wafer



Charged particle tracking + timing and photon detection in a 2.2T magnetic field.

$$\gamma p \to X(J^{PC})(p,n)$$
$$\pi_1(1^{-+}) \to \rho\pi \to \pi\pi\pi$$
$$h_0(0^{+-}), \pi_1(1^{-+}), h_2(2^{+-})$$
$$\to b_1\pi \to \omega\pi\pi \to 5\pi$$

$\pi^+\pi^-\pi^0 p$
$\pi^+\pi^+\pi^- n$
$\pi^+\pi^-\pi^+\pi^-\pi^0 p$
$\pi^0\pi^0\pi^0\eta p$

Fully reconstruct final states

- All of these channels have been studied in Monte Carlo during the last three years to look at acceptance.
- These studies have been used to ``stress'' our offline reconstruction software.

Amplitude Analysis

Describe the the process of producing a particular final state as a set of possible amplitudes : $\mathcal{A}_j(\gamma p \to p\pi^+\pi^-\pi^0)$

E.g. $\mathcal{A}_1(\gamma p \to pX_i \to \rho^+\pi^- \to p\pi^+\pi^-\pi^0)$

Build a total amplitude by coherently summing all the individual amplitudes. This total amplitude yields a probability that the given sum describes a particular event ``k''.

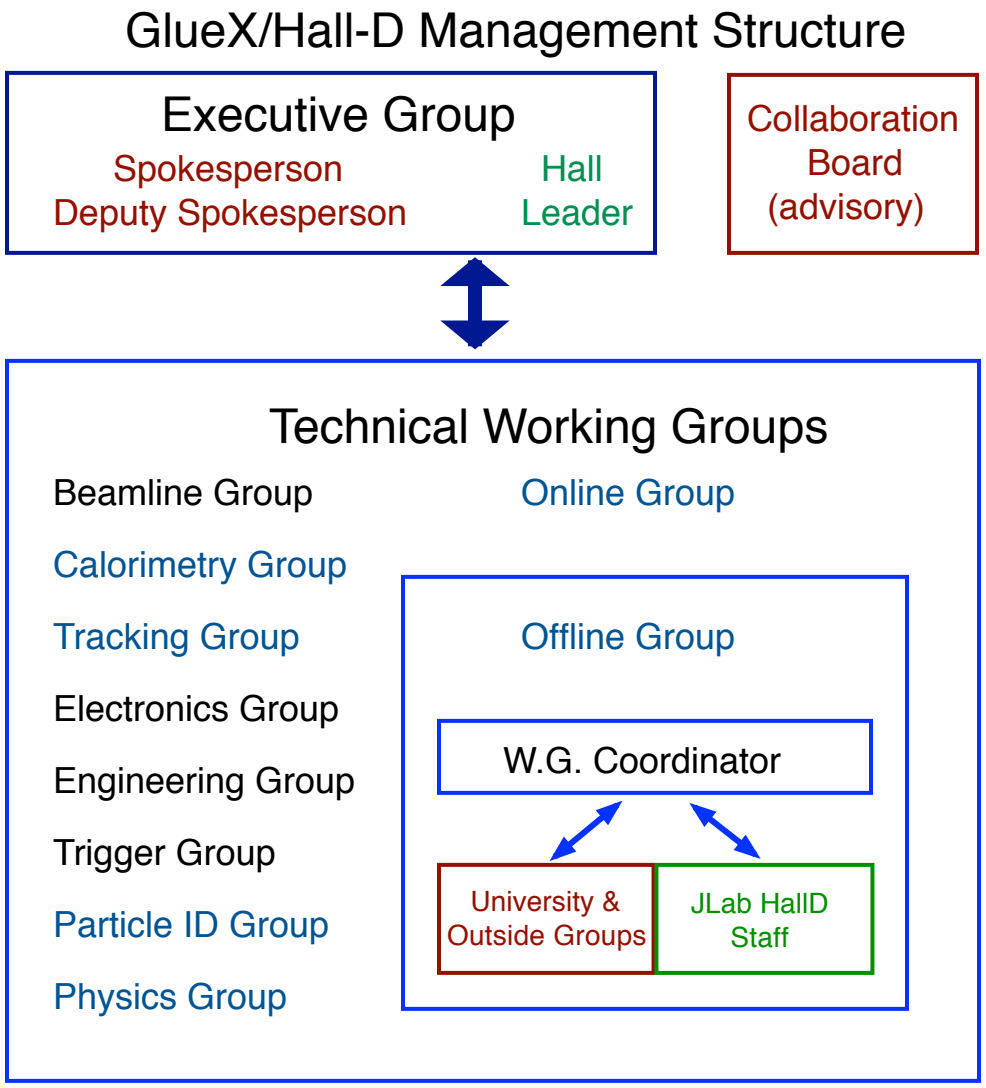
$\mathcal{N}$ is a normalization factor and $P(e_k) = \frac{1}{\mathcal{N}}|\sum_j a_j \mathcal{A}_j(e_k)|^2$

a_j are complex coefficients.

Form the likelihood and then minimize the natural log of it with respect to the a_j . This is a CPU-intensive problem that we have found scales very well on graphical processor units (**GPUs**). To do this requires the four-vectors of all events plus a comparable Monte Carlo data sample to do the normalization.

$$\ln \mathcal{L} = \sum_k \ln P(e_k)$$

Management



Meetings:

- Groups meet every 2 weeks via video conference.
- Groups report every 2 weeks in collaboration-wide video conference.
- Collaboration meetings every 4 months (JLab).

Participation:

- At least one member of the E.G. attends nearly every bi-weekly W.G. meeting.
- The E.G. will step in to redirect W.G. activities when needed. Most recent in Offline group refocused the effort on resolving issues found when the Physics group started to seriously stress the software.

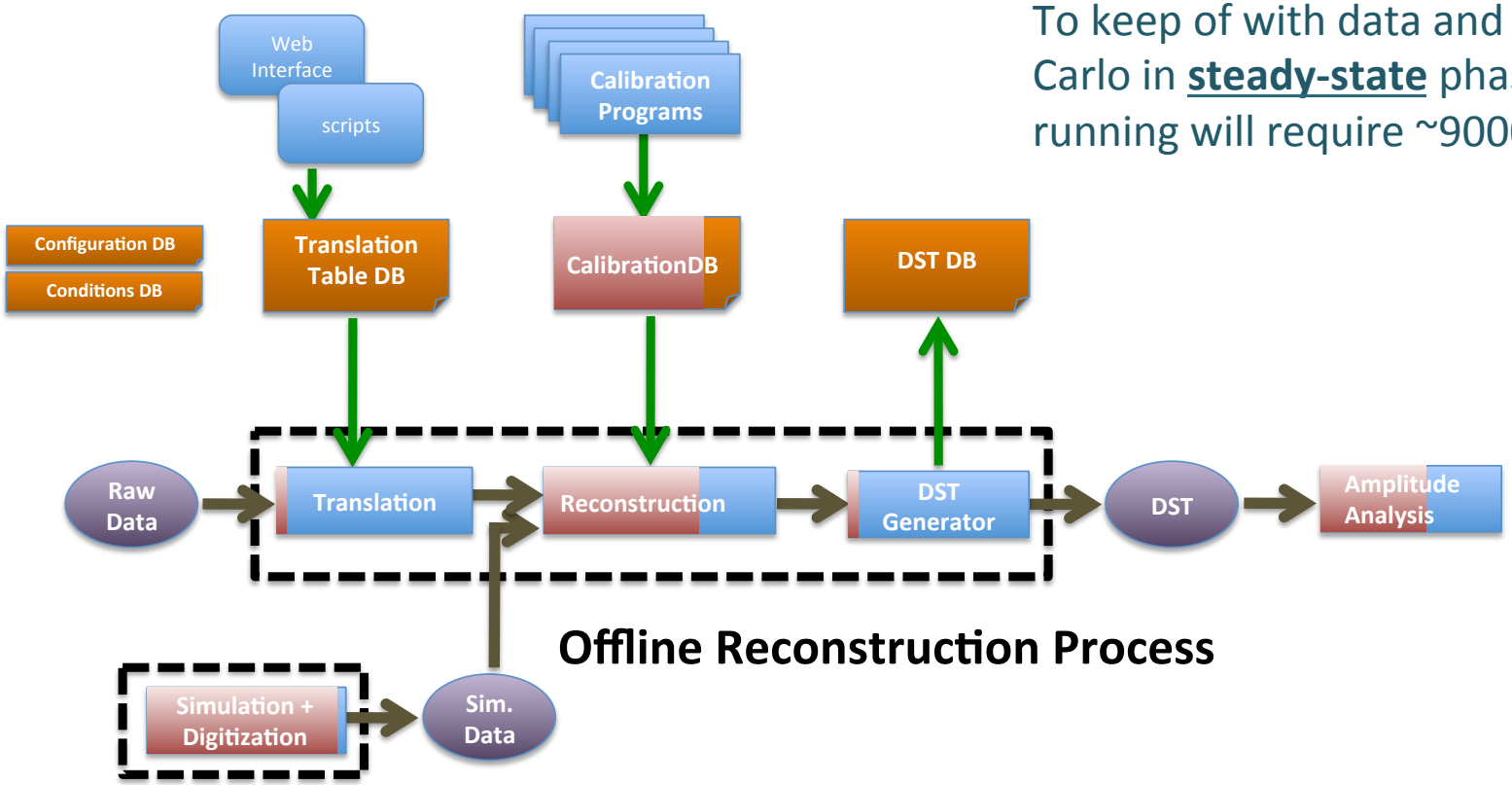
Activities:

- Reconstruction software is nominally handled in the Offline group. DAQ issues are handled in the Online group.
- Calibration issues are handled in the relevant W.G.s.
- Focused efforts are often shifted into the relevant W.G. until resolved.
- Organize tutorials and workshops on software use.

GlueX Reconstruction

Raw-event size ~ 15Kbytes

Phased Running:			Event Rates		Data Volume		Yearly Data Storage	
	photons	year	E_e	Raw	DST	Raw	DST	Raw	DST
I	10^6 γ/s	2014	10GeV	2kHz	0.1kHz	30 MB/s	1.5MB/s	0.1 PB	0.1 PB
II	10^7 γ/s	2015	11GeV	20kHz	1. kHz	300 MB/s	15MB/s	0.8 PB	0.2 PB
III	10^7 γ/s	2016	12GeV	20kHz	2. kHz	300 MB/s	30MB/s	1.6 PB	0.3 PB



Offline Reconstruction Process

To keep of with data and Monte Carlo in **steady-state** phase III running will require ~9000 cores.

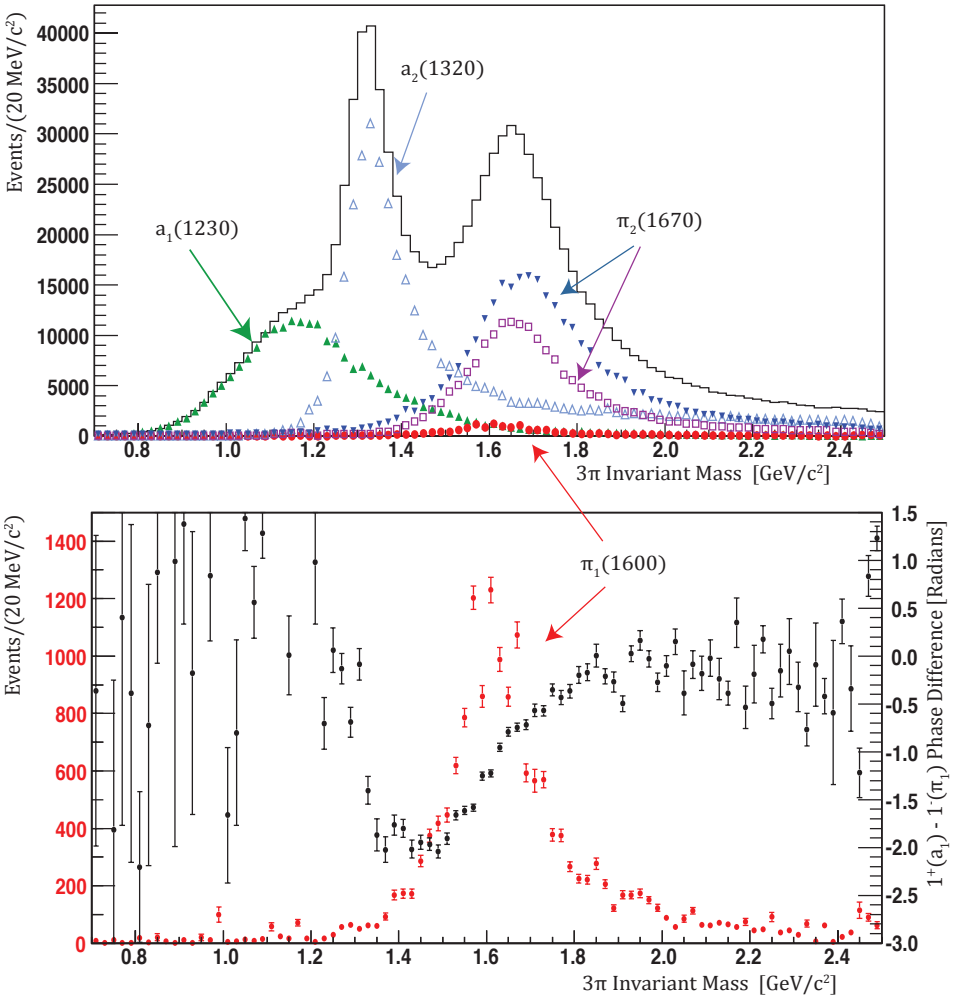
Brown indicate fraction complete, not all tasks are the same size.

Amplitude Analysis Data Challenge

- Analysis **completed in mid 2011** and represents ~3.5 hours of phase-3 beam.
- Includes full hadronic rate, EM backgrounds and physics signal.
- Full GEANT3 simulation run on Open Science Grid (GlueX organization).
- Full reconstruction using GlueX/ Hall-D offline software.
- Physics analysis developed to isolate events, led to 30% background.

- Full amplitude analysis of physics events only was performed on graphical processor units.
- 1%-level exotic QN partial wave extracted from these events.

$$\gamma p \rightarrow n\pi^+\pi^+\pi^- \qquad \sigma_{3\pi} = 10\mu b \qquad \sigma_{tot} = 120\mu b$$



Offline Task to Complete

We will present a detailed description of what needs to be done as well as how this will be accomplished with available manpower (next part of this talk).

- **Setup our calibration and alignment procedures and codes.**
  - Our software and hardware is mature enough that this task can be started.
  - Work is now part of the relevant working group activities.
  - This has been done with prototypes, but needs to be developed for the full detectors within the Hall-D offline and database frameworks.

1st ver. 6/13
Fin. ver. 6/14

- **Define the overall DST and mini-DST formats with input from physics.**
  - Work is underway based on our first data challenge.

8/12

- **Continue to refine and improve our reconstruction code.**
  - Work is underway based on our first data challenge and significant input from physics WG.
- **Move to the next level of data challenge.**
  - Full exercise of system with ~days and then ~weeks of simulated data.

day 12/12
week 9/13

- **Deal with legacy code such as Geant3 and Xerces 2.8**

*While we believe our current estimates are accurate, they are estimates. We expect to work closely with the JLab computer center as we continue to move forward and their continued support and quick response to **issues that will come** up is crucial to the success of physics analysis.*