Response to the issues raised in the GlueX Detector Review

GlueX-doc-524 (draft version 2)

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Abstract

A brief abstract of the note that will be placed on the search sites to allow searching the document

1 Introduction

The GlueX Detector review was held at Jefferson Lab in October of 2004. In the report of the committee, a number of issues were brought up by the committee. This document is a summary of work that has been carried out by the collaboration in addressing those issues.

2 Overall Comments

The following issues were raised as overall comments by the committee. While not all of them can be fully addressed by GlueX alone, significant progress has been made in addressing them.

The collaboration urgently needs to take a global perspective in making design choices. Most critically, this implies that they should start as soon as possible using full GEANT MC with (a) real detector material (structural material, electronics, cables, etc) in place, (b) primary hit generation, (c) *reasonable representations of noise levels (occupancy) in detectors, and (d) event reconstruction and analysis, in order to assess combined performance of all detectors. This analysis should include both signal and hadronic background. Some of the GEANT infrastructure appears to exist but it has not propagated to the detector designers, and pattern recognition and reconstruction software need yet to be written. Even rudimentary versions of a complete simulation will be helpful.*

Since the detector review, priority has been placed on the GEANT simulation by the software group. The simulation itself has been made more accurate and the current focus is on getting event reconstruction software written and in place to be able to carry out studies of the detector. It is anticipated that such a goal will be able to be met by the fall of 2005.

The Collaboration needs to develop a global perspective also in technology choices so that as much as possible common solutions can be adopted. Where differences are necessary to achieve performance goals or cost minimization, the choices should be clearly justified.

Work is proceeding in this direction with various aspects of the detectors. The tracking chambers anticipate using the same gas systems, preamps, FADC's and high-voltage controls. The readout for the barrel calorimeters will be used in the up-stream veto and quite possibly in parts of the tagging system.

The open issue of downstream PID (threshold Cherenkov? DIRC? other?) is crucial to resolve soon. The Collaboration intends to do so by early spring 2005, but at present the DIRC option is the only one obviously on the table. In view of the considerable technical, cost, and schedule risk that a DIRC would involve, the Collaboration needs to develop at least one viable alternative so that they c an make a genuine decision between options in order to avoid a Hobson's choice. The Collaboration should also study the impact of having no Cherenkov device downstream. If the outcome of the study confirms the need for such a device, the Collaboration should either be actively trying to revive the threshold Cherenkov option or should explicitly drop it; keeping a non-viable option on the table distorts decision making.

Shortly after the detector review, the collaboration set up a task force to look very carefully at the particle identification issue. This group created several working groups to look at several different PID possibilities (including no down stream PID). Each group reported its findings in a series of meetings, and these led to a consensus on the PID system. Some of this work is documented in internal notes [3],[2].

- The option with no PID was shown to significantly compromise the strangeness physics program in GlueX.
- With regard to the DIRC option, the collaboration would be able to tap into significant technical expertise at SLAC. It may also be possible to acquire some fraction of the current BaBar DIRC after BaBar ends in 2009. Both the compact design of the DIRC, coupled with its excellent match to the physics needs of the collaboration lead us to believe that if assistance from SLAC is available, then this is the best design for the experiment.
- It was concluded that a viable gas Cerenkov option existed, but its physics performance was inferior to the DIRC option.

Tracking is not yet optimized. The Collaboration should explore ways to reduce the inner radius of the CDC and provide good z measurements at low radius. This will reduce the p_T threshold for tracking, improve vertex reconstruction, and K_S and Λ identification. It is not clear that the start counter is needed, and currently it occupies real estate that tracking might better use.

Detailed simulations were carried out with both additional layers and relocation of the stereo layers in the CDC [1]. This work led to several more optimized wire configurations. However, the inner-most radius is not so much driven by the physics, but rather by the background rates in the innermost layers of the CDC. Our current understanding of these rates indicate that the innermost CDC layers are about as close to the beam line as they can be.

Current manpower levels are somewhat marginal. While sufficient for developing the main aspects of individual subsystems, the present staffing level is not sufficient to permit critical intersystem and global issues to be addressed.

In particular there is the problem of the missing overall simulation, discussed in item 1, above. Even a single additional full-time person, for instance a post-doc, on each of the major subsystems could have a large impact.

The GlueX collaboration clearly recognizes the man power issues and have been in discussion with the JLab management about ways for the lab to start building up the people needed to support the GlueX effort.

Overall technical coordination is essential and the Collaboration or the Laboratory should appoint a Project Manager and give him or her sufficient authority to act decisively. A management structure is in place within the collaboration, and some formalities such as MOUs, leadership assignments for subsystems, and a system of regular teleconferences do exist. Nevertheless the system is largely informal, and mechanisms for resolving or enforcing global or inter-system issues are essentially absent. A more robust structure with a clear Project Manager will be critical for progress beyond this point.

The collaboration concurs on this point and is awaiting action by the lab management.

Several individual subsystems showed schedules and milestones, but a fully integrated plan remains rather sketchy at this point. One clear starting task for a Project Manager would be to establish the schedule and plan, with milestones and a well-identified critical path.

3 Overview of subsystem status

Perform a Monte Carlo simulation of the tagging system with particular attention to background in the tagging counters caused by high-energy electrons.

Evaluate the benefits of covering part of the central region of the calorimeter with higher granularity, rad-hard detectors, e.g. lead tungstate crystals. A solution similar to that used in the PRIMEX experiment is clearly proof that this can be done. Although work still needs to be done on the region that where two different types of crystals abut each other. There is also some R&D work being done with Pb-scintillator used in the barrel calorimeter as it has very similar radiation length to Pb-glass. Initial studies that were carried out in low energy beams at TRIUMF are inconclusive, mostly due to too low of beam energy.

Develop a good understanding of the light output budget of the calorimeter and evaluate the impact of different readout schemes on the energy and timing resolution of the calorimeter. There is still significant R& D work related to the SiPM's going on in this area.

Make sure that the start counter has an essential role for triggering or event analysis. If it does not, then remove it; if it does, then look into a substantial reduction of the scintillator thickness. After careful consideration of the start counter, the collaboration believes that a very simple and inexpensive design will be able to carry out the the role of helping to identify the beam bunch of the primary electron during the initial phases of the experiment. It has also been shown that unless the start counter has both an $r\phi$ resolution better than a few hundred microns and can provide reasonably accurate z information that it is not useful in track reconstruction.

Study the physics impact of upgrading the UPV to provide real shower energy and position information. The impact appears to be additional electronics cost to handle the readout.

For the CDC:

1. *Explore ways to obtain z information at the lowest radii possible in the CDC.*
2. *Explore ways to extend tracking into the volume presently occupied by the Start Counter.*
3. *Investigate designs that reduce the end-plate material of the CDC as much as possible.*

4. *Study dE/dx resolution in prototypes soon to determine actual capability of the straw system.*

All of these studies have been or are being carried out, and design changes to the CDC have been implemented to address them.

For the FDC:

1. *Explore the possible physics advantage and design implications of obtaining dE/dx information from the FDC.*

2. *Use a fully integrated GEANT based Monte Carlo with pattern recognition to optimize the spacing of the FDC planes.*

3. *Demonstrate that the isochrones of the present design provide adequate spatial resolution, or consider design modifications to improve drift properties.*

The dE/dx studies have been carried out and a GlueX note has been produced study the PID possibilities for the FDC [4]. Design work is proceeding that will include dE/dx capabilities in this system. Working is presently ongoing to develop a fully integrated GEANT Monte Carlo to study the FDC design. Work on a small-scale prototype of the FDC chambers has shown that resolutions of $200\,\mu m$ can be achieved with the planned cathode readout [5].

Integration and Milestones:

1. *The Laboratory should move rapidly to confirm the Hall-D Coordinator and ensure the Coordinator is invested with broad authority and provided with sufficient supporting manpower to act decisively in all aspects of GlueX development, construction, integration, and commissioning.*

2. *The Hall-D Coordinator, when formalized, should bring standard management tools such as WBS or ganization fully into play and use these to drive the progress of the project.*

4 Summary

The recommendations from the review committee can be divided into two categories. Those items over which the collaboration has direct control and those items which require action on the part of Jefferson Lab to complete. All of the items over which the collaboration has control have been or are currently being addressed, and have led to an improved detector system. The issues of additional manpower at Jefferson Lab are currently being discussed with the Jefferson Lab management, and while it is very difficult for the collaboration alone to tackle those issues, we concur that they are very important.

References

[1] Curtis A. Meyer, *A Study of Vertex Resolution in GlueX*, GlueX-doc 338, November 2004.

[2] Matt Bellis, Curtis A. Meyer, *Kinematic Fitting Studies in GlueX using HDFast*, GlueX-doc 414, December 2004.

[3] Ryan Mitchell, *Identifying $K^*\overline{K}^*$ Events with different Cerenkov options*, GlueX-doc 419, Dec 2004.

[4] Daniel S. Carman, *Forward Drift Chamber – Particle Identification Via dE/dX*, GlueX-doc 417, May 2005.

[5] D.S. Carman and S. Taylor, *FDC prototype studies*, GlueX-doc-453, 2005.