Memorandum of Understanding between the GlueX Collaboration, Jefferson Lab and Indiana University

13 May, 2004
Draft Version 3

1 Introduction

This Memorandum of Understanding (MOU) outlines the activities and responsibilities of the Indiana University (IU) IU within the Jefferson Lab (JLab) GlueX collaboration. It describes the commitments of all three parties to the successful completion of the GlueX experiment and is subject to regular review and updating by all three parties. The manpower commitment and deliverables described in this document are contingent on continued funding of the IU group.

The goal of the GlueX experiment is a mapping of the spectrum of gluonic excitations with the ultimate objective being a quantitative understanding of the nature of confinement in QCD. To achieve this goal a hermetic detector, the GlueX spectrometer, optimized for amplitude analysis, will be constructed in a new experimental hall (HALL D). A tagger facility will produce $9GeV$ linearly polarized photons via coherent bremsstrahlung radiation of $12GeV$ electrons through a diamond wafer. To achieve $12GeV$ photons CEBAF will be upgraded to $12GeV$ with additional cryomodules, modified arcs and an additional arc. Critical Decision 0 (CD-0) for the upgrade and GlueX was awarded by the Department of Energy (DOE) in April, 2004. The GlueX collaboration was formed in 1998. The fourth and most recent version of the GlueX Design Report was issued in 2002. The project has been reviewed externally and by the JLab PAC. The GlueX management has been in place since 2000 with a Spokesman, Deputy-spokesman, HALL D group leader and an elected Collaboration Board.

This MOU does not constitute a contractual obligation on the part of any collaborating GlueX institution or JLab. No contractual obligations shall arise except pursuant to appropriate written authorizations by each party. All foregoing work is subject to the appropriate written contractual agreement of the parties.

2 Institutional Commitments to GlueX

2.1 Commitments to GlueX R&D

The Indiana University group is carrying out R&D associated with the time-of-flight (TOF), the lead glass electromagnetic detector (LGD), magnetic shielding and electronics: flash ADC's and Cockcroft-Walton (CW) PMT bases. In addition the IU group is working with physicists from the Institute for High Energy Physics (IHEP) in Protvino on aspects of TOF and LGD as well as preliminary designs of the threshold Cerenkov counter and with the group from the University of Regina on aspects of the barrel calorimeter. The Indiana University group has also been discussing the possibility of collaborating with physicists from the University of Guanajuato in León, Mexico on the testing of PMT bases and other electronics.

R&D for the TOF has been completed following tests with cosmic rays and beam tests at IHEP in Protvino. Results have been presented at conferences and two publications. Work is underway at IU on evaluating the 3000 lead glass blocks and PMTs for the LGD which had been used in the E852 experiment at Brookhaven Lab. The glass is being checked for any radiation damage and curing techniques using UV light sources are being studied. Effect of aging of PMT's is also being studied. Upon completion of these studies a paper will be prepared. Magnetic shielding tests have been carried out using a Helmholtz coil arrangement with spacing of 50 cm and a central field of 200 G. A paper summarizing results has been submitted for publication. Several FADC prototype boards have been produced and are now being tested at JLab and at the University of Delaware. A robotic electronics assemble facility (Spark Station) has been installed at IU and is being used for the assembly of 100 prototype Cockcroft-Walton PMT bases. These bases will be tested in a wall of 100 PMT's for the purpose of studying long-term stability. Physicists from the University of Guanajuato may participate in this testing.

The Indiana University group plans to complete the construction of 100 CW PMT bases within 9 months as well as completing the testing of all the lead glass blocks and PMT's for the LGD within 12 months.

In addition to this, the superconducting solenoid to be used in the GlueX experiment is being refurbished at the Indiana University Cyclotron Facility (IUCF). This work is being carried out under a separate MOU between Jefferson Lab and Indiana University.

2.2 Hardware Deliverables for GlueX

An approximate timeline for the construction of the LGD, TOF and electronics is shown in Figure 1. The schedule is contingent on funding.

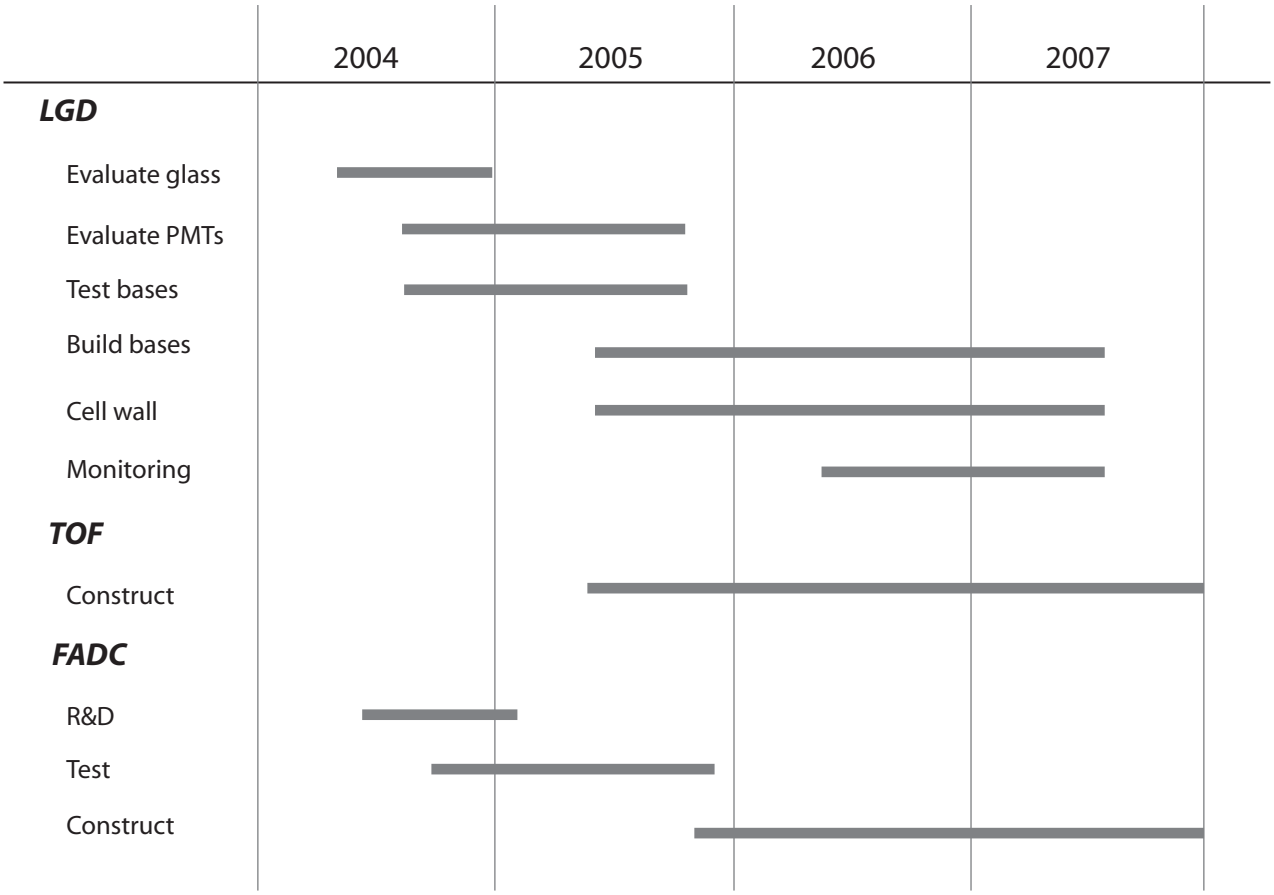

Figure 1: Approximate timeline for construction of the LGD, TOF and electronics.

2.3 Software Deliverables and Support for GlueX

The Indiana University group has been involved in Monte Carlo studies needed to optimize the detector design with the goal of doing an amplitude analysis. In particular the Indiana University group has concentrated on the TOF, LGD and working with the IHEP group on the Cerenkov counter. The Indiana University group continues to work as well on simulations of PMT pulses to optimize the FADC design.

2.4 Support for Running The GlueX Experiment

During the running of the experiment the Indiana University group will participate in commissioning the detector, provide manpower needed for data-taking, provide available expertise to diagnose and repair problems with the subsystems that fall under the responsibility of the Indiana University group and also provide manpower to evaluate data in real time.

2.5 Support for Analysis of GlueX Data

The Indiana University group is working with others in the GlueX collaboration and the CLEO-c collaboration on establishing a center (PAMS – Physics Analysis for Meson Spectroscopy) to develop the tools needed to carry out an amplitude analysis of large data sets. The tools include GRID-based data handling, function minimization on parallel processors and visualization. To that end the group is analyzing a multi-terabyte data set on the final states $\pi^-\pi^-\pi^+$ and $\pi^-\pi^-0\pi^0$ – a final state of fundamental importance for the GlueX given its relevance for exotic hybrid meson searches.

2.6 Theoretical Support to GlueX

Part of the PAMS project will be regular meetings and workshops which are focused on specific topics. In particular, these can be divided into phenomenology of PWA, the software tools for PWA and visualization, and implementation of the GRID framework. While it is clear that all of these need to be coordinated, it will be important to have focused meetings in each of these areas. It is also clear that this list will evolve over the lifetime of the proposal. We anticipate holding 1-2 workshops per year, each of which would be focused on a particular aspect of the project.

The Indiana University group is also involved in the development of the phenomenology through the activities of the Nuclear Theory Center.

2.7 Collaboration Responsibilities

Alex Dzierba is the Spokesperson for the GlueX collaboration and Adam Szczepaniak is a member of the Collaboration Board. The IU group fully supports this effort and any other efforts deemed necessary by the collaboration.

3 Funding and Infrastructure

3.1 Indiana University

The Indiana University group will provide funds associated with support of personnel and travel to carry out the tasks outlined in this MOU.

The Indiana University group will request funding from the Department of Energy and from Jefferson Lab to carry out work beyond the scope covered by this MOU. In addition the Indiana University group will also seek funds from the National Science Foundation (NSF) along with other institutions for a Physics Analysis Center. The Indiana University group will also work with the group from IHEP to secure additional joint funds from the Civilian Research and Development Fund (CRDF) and the International Science and

Technology Center (ISTC). The group will also work with collaborators from Canada and Mexico to seek funds specifically focusing on joint scientific collaborations among scientists from the Canada, Mexico and the IUS.

The Indiana University group maintains a fully equipped shop and a full time technician, (Eric Scott). These will be available to carry out the fabrication work covered by this MOU. Indiana University will also provide many of the smaller components needed for the fabrication as part of their normal operating budget.

The Indiana University group controls lab space necessary to both build hardware and perform tests of the resulting equipment. This space exists and is assigned to the IU group involved in GlueX. In addition, the IU group has or will obtain sufficient electronics, test equipment and infrastructure top carry out all needed tests on both the prototype and the final TOF and LGD.

The Indiana University group will provide written time lines for the completion of various phases of the project and written reports on the outcome of each of these various phases.

3.2 The GlueX Collaboration

The construction of the final TOF, LGD, CW PMT bases and FADCs will be contingent on securing additional funds from outside sources specifically for this project. The GlueX collaboration will develop a global plan for the timely funding and construction of all elements of the GlueX detector. The collaboration as a whole will seek funds to build all parts of the detector in a coordinated fashion.

3.3 Jefferson Lab

- JLab will retain ownership of all deliverables as specified under individual contracts and MOUs.
- JLab is responsible for all engineering aspects of GlueX and all aspects of the detector integration that require legal and certified engineer approval.
- JLab assumes all legal liabilities related to IU provided and installed equipment while located on JLab property.
- JLab will provide reasonable assistance to the IU group to assure smooth flow of information regarding DOE procedures and protocols as they affect the funding of the work agreed between JLab and Indiana University.

- JLab will provide physical space to IU personnel and for their equipment to facilitate their work on GlueX. The IU group will convey such requirements to JLab with reasonable advance notice in the spirit of good relations and sound planning.
- Official contact between the IU group and JLab will be through the HALL D project management office and its JLab appointed staff.

4 Personal

1. The contact person for the Indiana University group is Alex Dzierba.
2. The following personnel are included in the IU GlueX group:

Person	**Positions**	**Percent of Research Effort**
Alex Dzierba	Professor	100%
Geoffrey Fox[1]	Professor	20%
Matt Shepherd [2]	Assistant Professor	50%
Adam Szczepaniak[3]	Associate Professor	60%
Scott Teige	Senior Scientist	100%
Ryan Mitchell	Post Doc	100%
Maciej Swat	Post Doc	100%
Paul Smith	Electronics Engineer	100%
Eric Scott	Technician	100%
Debbie Hamm	Hourly	100%

[1] Geoffrey Fox is Professor of Computer Science and Physics. He is also the Director of the Community Grids Lab of the Pervasive Technology Laboratories at Indiana University. Geoffrey participates in the GlueX GRID planning and the phenomenology and associated analysis for GlueX.

[2] Matt Shepherd will be joining the faculty in May of 2005 after completing his Ph.D. at Cornell. He plans to spend at least 50% of his time on GlueX.

[3] Adam Szczepaniak is the Director of the Indiana University Nuclear Theory Center.

In addition the Indiana University group will involve three to four undergraduates a year devoted to GlueX-related research.

The percentages refer to the approximate percentage of research time to be spent by the person on all GlueX activities during FY2004–FY2006 time period. These commitments will be updated as the project matures.

5 Special Considerations

1 The GlueX collaboration will have final responsibility for the acceptance of all deliverables and retains the right, to terminate or renegotiate this MOU if the technical requirements, performance, physical specifications, time schedules and costs cannot be met by the Indiana University group.

2 The GlueX collaboration retains the right to assign additional manpower and/or additional groups to this project if it is deemed that this is necessary for timely and within budget completion of the project.

3 The continuation of this agreement is dependent on the approval for continuing funding for all parties in the MOU.

4 This agreement may be amended as necessary.

5 The Indiana University group, the GlueX Collaboration management and the JLab management of GlueX agree to commit themselves on a collegial, open and effective working relationship for the benefit of the project.

SIGNATURE PAGE

Prof. Alex Dzierba Contact Person Indiana University	Date
Prof. Alex Dzierba Spokesperson GlueX Collaboration	Date
Dr. Elton Smith JLab HALL D Group Leader Jefferson Lab	Date