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

May 3, 2004

Draft version 2

1. Introduction

This Memorandum of Understanding (MOU) outlines the activities and responsibilities of the University of Regina (UofR) Group within the Jefferson Lab (JLab) and the 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 UofR 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 9*GeV* linearly polarized photons via coherent bremsstrahlung radiation of 12*GeV* electrons through a diamond wafer. To achieve 9 *GeV* photons, CEBAF will be upgraded to 12*GeV* with additional cryomodules, modified arcs and an additional arc. Critical Decision 0 (CD-0) for the upgrade and for GlueX was awarded by the Department of Energy (DOE) in April of 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. The UofR Commitments to GlueX

2.1 Commitments to GlueX R&D

The UofR group has assumed the commitment and responsibility to complete the R&D phases of hardware and software tasks to such a state that firm decisions can be made toward funding decisions and subsequent construction and physics phases of the GlueX project.

By the end of 2004, the UofR group will complete the construction of a full-scale prototype element module (Mod. 1) of the neutral and charged particle barrel calorimeter (BCAL) and its initial testing with cosmic ray particles (muons). These tests will establish the timing resolution of the BCAL and its readout system. The latter will be selected among several available options based on timing, energy resolution, resistance to high magnetic fields and cost. Before the end of 2005, all testing with charged particles, under beam conditions, as well testing with tagged photons will be completed with the optimal read out. The accelerator facilities for these tests are those of Serpukhov and Hall-B at JLab and, as such, these timelines are subject to approval and scheduling by the two respective labs.

The UofR group will undertake detailed computer simulations of the BCAL performance. For this, a computer system will be utilized as a test bed for performing these simulations in a time efficient manner using commercially available hardware. The system will be developed in such a way that secure access to the system is made available to GlueX members so they can run simulations as well. Database tools will be developed to allow coordination of the main simulation runs made by the various GlueX members.

2.1.1 Hardware Deliverables for GlueX R&D

The deliverables for the hardware R&D are: the complete documentation of the techniques learned for the construction of BCAL, the establishment of its operating parameters and overall performance and a realistic budget estimate for the construction. Part of the required hardware infrastructure to complete Mod.1 is being developed with all the structural requirements to satisfy the bigger task of completing the whole BCAL, and all this hardware constitutes parts of the deliverables.

2.1.2 Software Deliverables for GlueX R&D

The deliverables will be a report on the optimization of the BCAL design based on the simulation results, as well as a computer system design, simulation program design, remote access strategy, detailed-usage and user-friendly instruction set, and recommendations for further work needed to lead to a fully functioning system.

2.2 Hardware Deliverables for GlueX Construction

Upon completion of the final design of the BCAL, including the exact length required for hermiticity and the necessary thickness to contain the electromagnetic showers, the UofR group will undertake the responsibility of building the BCAL to the specifications and performance requirements dictated by the experimental demands on the physics analysis. This responsibility extends to the physical detector itself (BCAL) and its read-out system, namely the light collection and amplification system and electronics. The mounting hardware that will secure the BCAL within the solenoid magnet will constitute part of the detector, as delivered, however, the design of such mounting hardware is not part of this MOU and will be determined by other members of the Hall-D Collaboration and JLab engineers. Also, all required hardware to couple the interior of BCAL to every other detector system in GlueX will be considered part of the BCAL, however, the design of such mounting hardware is not part of this MOU.

Since the selection of the read-out system has not been finalized as this MOU is being written, the cabling and electronic units and channels required have not been determined yet. Once the read-out system is finalized, all electronics and cables associated with the read-out system leading to an analog signal to be processed by the common GlueX data acquisition electronic units will be also part of the deliverables. Ordinary signal cables and H.V. cables (if any) from the read-out electronics to the rest of the common electronic racks in GlueX are not part of this MOU.

2.2.1 Hardware Construction Timeline

The construction of the BCAL is time and labour consuming. Even though much of the infrastructure to build the BCAL (now the design calls for 48 modules) exists for the construction of Mod. 1, full-scale production will require significantly enhanced infrastructure that reduces the need for human labour and speeds up the process. A number of machines will be needed that will be custom made (one of) for this task. As the infrastructure is now for Mod.1, it takes approximately one month of effort per module. Thus for 48 modules, and assuming there are no delays of any nature in supply and construction, nearly four years will be required for the construction of the modules alone. With the use of two parallel construction lines (two press/frames) and some automation in the processing of the lead sheet and the SciFi strands, this can be reduced to approximately 2.5 years. The timeline scenario below is based on such a production plan:

Timetable is based from start of construction	
+ 0 to 12 months	• *Procure machines to support handling of Pb and SciFi.* • *Procure a second press/frame to build a second module in parallel.* • *Negotiate and arrange for a multi-year procurement of Pb and SciFi with respective suppliers.* • *Negotiate and arrange for a multi-year procurement of read-out elements and associated electronics.* • *Start production of modules using infrastructure from R&D.*
+ 12 to 24 months	• *Construct modules and machine them as they are processed.* • *Assemble the read-out system and its electronics.*
+ 24 to 36 months	• *Complete construction of modules and read-out.* • *Mount modules within the solenoid.* • *Couple SciFi to read-out in situ.*
+ 36 to 48 months	• *Complete the BCAL assembly in Hall-D.* • *Complete the calibration of each BCAL element with beam.* • *BCAL becomes operational.*

2.3 Software Deliverables and Support for GlueX

The UofR group will provide support and will contribute to several aspects of software for GlueX. A communications and meta-queuing manager web-based portal, MC simulations of physics processes to understand the response of the detector and its connection to the PWA will be the main contributions of the UofR.

2.4 Support for Running The GlueX Experiment

The UofR group will provide manpower support as a member of GlueX, in general, and as the group responsible for the operation of the BCAL and its components in particular, as well as software support for the elements the group has assumed responsibility for. The overall support will reflect efforts by faculty members, research scientists, post-doctoral fellows and graduate students.

2.5 Support for Analysis of GlueX Data

The UofR group has considerable computing resources and these resources will be made available to the Collaboration for PWA and simulations. The group will, in consultation with the Collaboration, assume certain reaction channels to perform PWA within the overall GlueX effort.

2.6 Theoretical Support to GlueX

The UofR is the Canadian center for Lattice Gauge Theory with one faculty member, graduate students and post doctoral fellows utilizing Canada's largest computer cluster for Lattice calculations and the intention is to extend such calculations to exotic hybrid mesons. The LGT group leader is Randy Lewis.

2.7 Collaboration Responsibilities

The UofR group with five faculty members (as of July 1, 2004) will participate in all aspects of Collaboration management. As this is written, one member is the Collaboration Board Chair while two other members have assumed leading roles in hardware and software groups. Such activity will continue and group members will attend Collaboration meetings, Working Group meetings and will host such meetings at the UofR. The participation in all such GlueX and Collaboration activities will be active and continuous. The group members will let their names stand for election to positions as defined in the Collaboration Management Plan.

3. Funding and Infrastructure

3.1 The UofR

The UofR group will provide funds associated with support of personnel and travel to carry out the tasks outlined in this MOU. The source of such funding is NSERC and UofR institutional funding in support of the Prairie Particle Physics Institute at Regina.

The UofR group is currently funded by NSERC; the GlueX project, specifically, has been endorsed as an Institute for Particle Physics (IPP) project by IPP in Canada. The group is also an IPP Institutional Member because of GlueX. As such, and as long progress on GlueX is satisfactory and the project continues to be supported by DOE, the level of funding by NSERC is expected to cover the group's travel, post-doctoral and student obligations. Although opportunities for major equipment grants in support of GlueX exist, no such commitments can be made a priori and funding for the construction of BCAL and its associated equipment is a DOE responsibility.

Machine and electronics shops facilities are limited at the UofR and can support primarily design and prototype construction, as has been the case with most of the tasks associated with the R&D phase. Partnership with the Centre for Subatomic Research (CSR) at the University of Alberta (UofA) has alleviated most of the restrictions on space and personnel at the UofR. As such, among UofR and CSR,

there is adequate infrastructure and technical expertise to complete the BCAL construction.

The UofR 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 as defined in task-specific MOU's and contracts.

3.2 The GlueX Collaboration

The construction of the BCAL and its associated read-out and other components necessary for the successful completion of this detector subsystem will be contingent on adequate funding from outside sources, other than NSERC and UofR which are considered internal sources for the purpose of this MOU. The Hall-D Collaboration, as the body managing the GlueX project, will develop a global plan for the timely and adequate funding for the construction of all elements of the GlueX project such that the experiment can be declared as completed and ready to take data.

3.3 Jefferson Lab

- JLab will retain ownership of all deliverables, as specified under individual contracts and MOU's.
- JLab is responsible for all the engineering aspects of GlueX and all aspects of detector integration that require legal and certified engineer approval.
- JLab assumes all legal liabilities related to UofR provided and installed equipment while located on JLab property.
- JLab will provide all reasonable assistance to the UofR group to assure smooth flow of information regarding DOE procedures and protocols as they affect the funding of the work agreed between JLab and the UofR.
- JLab will provide physical space to UofR personnel and to their equipment to facilitate their work on GlueX. The UofR group will convey such requirements to JLab in a reasonably advance time fashion in a spirit of good relations and sound planning.
- Official contact between the UofR group and JLab will be the Hall-D project management office and its JLab appointed staff.

4. Personnel

1. The contact person for the UofR group is George J. Lolos

2. The following personnel is included in the UofR GlueX group:

Person	Position	Fraction of Research Effort
Mauricio Barbi	Assis. Professor	75%
Edward J. Brash	Assoc. Professor	50%
Garth M. Huber	Professor	25%
George J. Lolos	Professor	80%
Zisis Papandreou	Professor	80%
Vitaly Kovaltchouk	Res. Ass.	100%
Danny Kolybaba	Machinist	20%
Keith Wolbaum	Electronics Tech.	15%
Unnamed	Graduate Student	100%

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 Hall-D 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 and physical specifications, time schedules and costs cannot be met by the UofR group.
2. The Hall-D Collaboration retains the right to assign additional manpower and/or additional groups to this project if it is deemed that such action is necessary for the 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 to this MOU.
4. This agreement may be amended as necessary.
5. The UofR group, the Hall-D Collaboration management and the JLab management of GlueX agree and commit themselves on a collegial, open and effective working relationship for the benefit of the project.