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

27 April, 2004
Draft Version 1

1 Introduction

This Memorandum of Understanding (MOU) outlines the activities and responsibilities of the Ohio University (OU) group 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 OU group, on continued standing of the GlueX collaboration, and on appropriate R&D support from JLab and the GlueX management.

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. 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 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, as well as 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 main system for charged particle track reconstruction between the target region and the downstream detector systems of GlueX is a set of detectors known as the Forward Drift Chambers (FDCs). The FDCs are envisioned to include four separate sets of disk-shaped planar drift chambers to measure the momenta of all charged particles emerging from the target at angles of up to 30° relative to the photon beam line. At their present level of design, each of the basic detector packages, as shown in Fig. 1, contains six planes of parallel wires, each sandwiched between two planes of cathode strips. The signals in the wires and the cathode strips should allow for the reconstruction of a 3-D space point at the position of each wire plane with a resolution of roughly 200 μm.

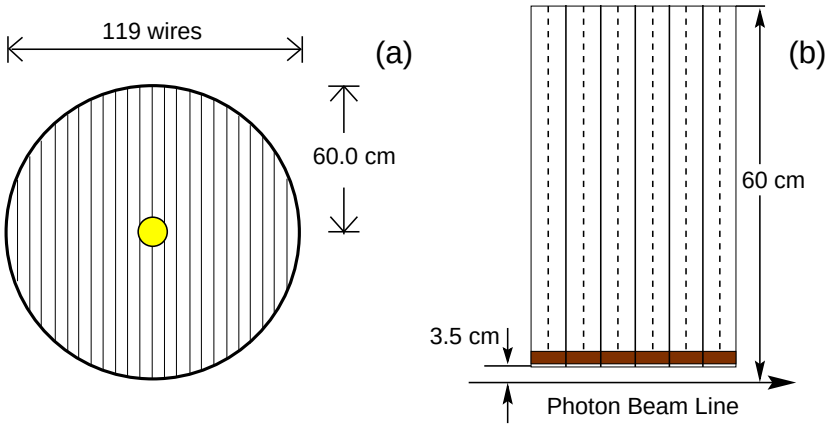

Figure 1: Schematic views from the front (a) and side (b) of a single FDC package (as currently envisioned in the GlueX Design Report). In (a) the wires are schematically indicated as the vertical lines. In (b) a side view of the upper half of an FDC package is shown with the wire planes indicated as the dashed lines.

The primary development issues that must be addressed before the final system design can proceed are factors affecting the intrinsic resolution of the chambers, along with the mechanical and electronics layout. The goal is to construct a tracking detector that meets the required design specifications and has a long life time, a uniform and predictable response, a high efficiency, and is serviceable in case of component failure.

The OU group within the GlueX collaboration has assumed responsibility for the development of the FDC system. As there is very little practical experience with cathode strip chambers at JLab or within the GlueX collaboration, the initial R&D work related to the FDC system development will concentrate on the construction and study of prototype chambers. We foresee at the present time the need for the development and testing of at *least* two

prototypes, one focussing on general chamber electrode optimization and a second focussing primarily on mechanical design issues and on-chamber electronics layout. The work will also include the design of the final full-scale FDC detector package. An essential and significant aspect of the design work will include development and study of Monte Carlo of the GlueX detector system focussing on the properties of the FDC system that will enable us to meet or exceed the required design specifications.

The design and development of the first FDC prototype – `FDC-1` – (to study the optimal electrode configuration) has been ongoing since the summer of 2003. By the middle of 2005, the OU group expects to have completed a full study of this prototype. A complete test plan has been written by the OU group detailing the work that will be done on the prototype `FDC-1` (entered as GlueX Note 62). A rough time line for the completion of the work divided into individual tasks is shown in Fig. 2.

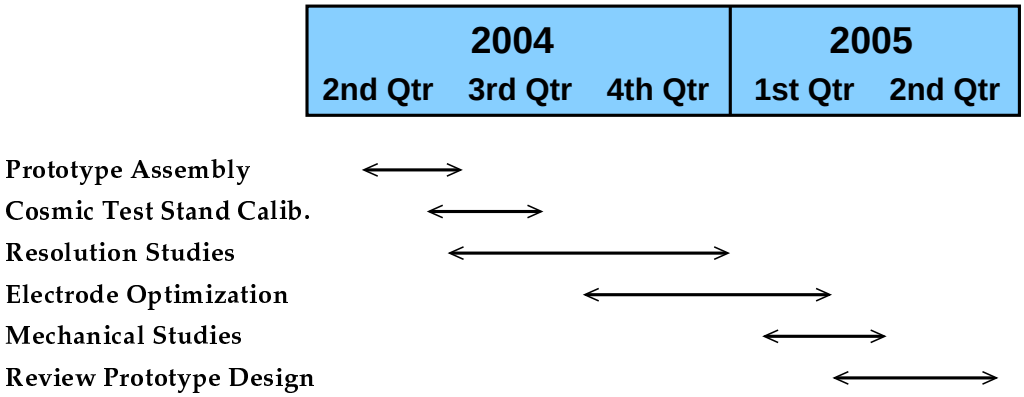

Figure 2: A time line showing the tasks necessary to complete the R&D work on the forward drift chamber prototype chamber `FDC-1`.

Based on both this work and continued Monte Carlo studies of both the detector and the physics, the OU group will work to design the next FDC prototype system, `FDC-2`. One of the primary purposes of the second prototype will be to test mechanical support designs for the full-scale chamber cathode planes and wire planes, which is necessary to avoid electrostatic instabilities and non-uniformities that are known to affect resolution. `FDC-2` will most likely represent a full scale multi-plane design of a least one-half of a full FDC package. This will be essential to allow us to also focus on the design of the FDC circuit boards.

The time line for the development of the `FDC-2` prototype is somewhat speculative at this point. Its development and its specific purposes are contingent in part on lessons learned and questions raised from the `FDC-1` prototype chamber. However it is reasonable to expect its development to proceed in earnest by the middle of 2005.

During the course of the next two years, we expect to fully understand the design requirements for the full FDC system. We should also have decided upon and documented all design decisions relevant for the final chamber design.

2.2 Hardware Deliverables for GlueX

Upon completion of the final design for the GlueX FDC chambers, the Ohio University group will plan to take on the responsibility of procuring components and of building the FDC chambers. This responsibility includes the detector itself, the electronics that mount directly on the detector, the cables to take the signals to the data acquisition electronics, and all elements of subsystem integration.

The time line for the design and construction of the FDC packages is very speculative although there is presently every expectation that it can initially proceed before the end of calendar year 2005. Beyond the issues associated with understanding the design, the time line is also contingent on funding and manpower. A rough outline of the required tasks and a *very* preliminary time line is contained in Fig. 3. This time line will begin upon completion of the studies of the FDC prototype chambers, estimated to be at some point in calendar year 2006.

The current scope of this work does not include the high voltage control and monitoring system, nor the final gas mixing and control system. The most efficient use of resources in this regard would be to have a common high voltage system for the entire experiment and common controls and hardware for all gaseous detectors in the experiment. The work also does not include design of the on-chamber preamplifiers or voltage regulators, nor does it include any development of TDCs or ADCs, both of which are expected to be designed by other subgroups within the GlueX collaboration.

2.3 Software Deliverables and Support for GlueX

The OU group will work with the developing GlueX Data Acquisition Group to provide support for the development of the tracking software related to the FDC system. It will also work on the development of the fast Monte Carlo simulation and the full GEANT Monte Carlo, especially those components related to the FDC system.

2.4 Support for Running The GlueX Experiment

2.5 Support for Analysis of GlueX Data

2.6 Theoretical Support to GlueX

2.7 Collaboration Responsibilities

Task	Year 1	Year 2	Year 3
♦ **Design:**			
Mechanical design of chambers	******		
Design of circuit boards	******		
♦ **Procurement:**			
Chamber frames	******		
Circuit boards	******		
Wire	******		
On–chamber electronics	******		
♦ **Acceptance checks:**			
Machined parts		****	
Circuit boards		****	
Electronics		****	
♦ **Construction:**			
Construction setup		********	
Chamber stringing		******	
Chamber construction		******	
Installation of electronics		***	
Sighting and measurement			***
♦ **Chamber tests:**			
Resolution studies			********
Cross–talk studies			********
Efficiency studies			********
Magnetic field studies			********
Wire deadening schemes			********
Noise immunity studies			********
Alignment and positioning studies			********

Figure 3: A *very* preliminary task list and time line for the design, construction, and commissioning of the forward drift chamber for the GlueX experiment. This time line will begin after completion of the prototype chamber studies.

3 Funding and Infrastructure

3.1 Ohio University

The Ohio University group will provide funds associated with support of personnel and travel to carry out the tasks outlined in this MOU. The Ohio University group will request funding from the National Science Foundation and from Jefferson Laboratory to carry out work beyond the scope covered by this MOU.

The Ohio University group has access to a fully-equipped on-campus machine shop. This can be made available to carry out a portion of the fabrication work covered by this MOU. The OU group may also be able to provide some of the smaller components needed for the fabrication as part of its normal operating budget, contingent on availability of funds.

The Ohio 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 Forward Drift Chamber packages 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 all Ohio Universityprovided and installed equipment while located on JLab property.
- JLab will provide reasonable assistance to the OU group to assure smooth flow of information regarding DOE procedures and protocols as they affect the funding of the work agreed between JLab and Ohio University.

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

4 Personnel

1. The contact person for the Ohio University group is Daniel S. Carman.
2. The following personnel are included in the OU GlueX group:

Person	**Positions**	**% of Research Effort**
Daniel S. Carman	Associate Professor	35%
Simon Taylor	Research Associate	80%
Rafael Yarulin	Graduate Student	30%

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 Ohio 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 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 Ohio 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. Daniel S. Carman
Contact Person
Ohio University

Date

_____ _____

Prof. Alex Dzierba
Spokesperson
GlueX Collaboration

Date

_____ _____

Dr. Elton Smith
JLab HALL D Group Leader
Jefferson Lab

Date