Attachment OPS to the
Memorandum of Understanding (LIGO-M050377-00-M)
between the
University of Wisconsin-Milwaukee Group (UWM)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
August 15, 2005

This Attachment OPS to the Memorandum of Understanding LIGO-M050377-00-M defines the role of the University of Wisconsin-Milwaukee Group (UWM) as a Member of the LIGO Scientific Collaboration (LSC) in the areas of detector commissioning, detector characterization, and operations in support of the initial LIGO interferometers. The period of performance for the activities in this Attachment is from August 15, 2005 to August 15, 2006.

1. Together, the LIGO Laboratory and the LIGO Scientific Collaboration (LSC) are responsible for implementing and exploiting the initial LIGO detector through its science data runs. LSC groups are encouraged to contribute to the commissioning, characterization, and operation of the LIGO detectors, as members of working groups established by the LIGO Laboratory and the LSC.

2. During the period August 15, 2005 to August 15, 2006, the members of UWM Group will participate in the initial LIGO detector research program in the following areas:

a) Detector Characterization

(i) *Strain Calibration:* Siemens will continue to support the time-domain calibration code. He will continue to produce and document new versions of the time domain calibration code and new S4 calibrated data sets as the official calibration model evolves. He will run the time-domain calibration code under the on-line system during S5 and support the production of calibrated S5 data sets as better calibration models are made available. Siemens will continue to work as part of the LSC Calibration Team in strain data generation, artifact identification, etc

b) LIGO Operations

(i) *Cluster Computing Systems:* Allen and Wiseman will continue to lead this effort. With assistance from others in the group they will finish the specifications, bidding, ordering and installation of the new Nemo cluster (approximately 400 dual-CPU nodes). As this process is underway, the UWM group will continue to maintain and operate the UWM/LSC Data Analysis Facility (296 node Medusa cluster). When the new Nemo cluster is operating reliably, the old Medusa cluster may be decommissioned or turned into a general purpose grid computing resource. The UWM group will continue to provide access to its computing facilities with high availability and in a user friendly manner. Access will be granted by the LSC Computing Committee.

c) LSC Operations

(i) *Data Analysis Software Working Group:* Brady will continue to chair this working group of the LSC whose charge is to coordinate software development activities for data analysis in the LSC. Activities in the group also include planning and specification development. Active software projects include (a) Data Monitoring Tool (DMT), (b) GLUE, (c) LSC Algorithm Library (LAL), (d) LAL Applications (LALAPPS), (e) LIGO Data Analysis System (LDAS), (f) Lightweight Data Replicator (LDR), (g) LIGO-tools, (h) LSC Data Grid Client/Server bundle, (i) Matlab Applications (MatApps), and (j) Online Analysis System (Onasys). Brady will continue to oversee the software development effort with the goal of developing a fully functional environment for gravitational wave data analysis. A major component of the activity is planning and development of tools for the on-line analysis environment which is needed as the instruments transition to long-duration stable operation. The successful deployment of the prototype during S4 will be followed by deployment of an improved system during S5.

(ii) *LAL/LALApps/PyLAL Software:* Creighton will continue to serve as the LAL software librarian. The librarian will oversee the maintenance of LAL, the incorporation of packages added by groups in the LSC, and the publication of releases of LAL at timely intervals. The librarian will also participate in the integration of LAL with other software through the DASWG. Allen, Brady, Cannon, Creighton, Fairhurst, Messaritaki, Ray-Majumder, Siemens and Woods will continue to contribute to the development of LAL as major contributors to the general LAL infrastructure as well as specific packages for inspiral, pulsar, and burst searches.

(iii) *Lighweight Data Replicator:* Koranda, assisted by Brian Moe, will continue design, development, and deployment of the Lightweight Data Replicator (LDR), a package for high-speed, robust replication of LIGO data products to UWM and other LIGO/LSC Tier-2/3 sites.

(iv) *Grid Computing:* The UWM group will continue development of grid computing applications for LIGO data analysis. The group will contribute to enhancements and architectural design of GLUE and related packages to allow deployment and execution of LSC workflows across computing Grids. Anderson will finish implementing the LSC Certificate Authority and will continue to take on high-priority grid computing related projects as the need arises. Kevin Flasch will continue to serve as liaison/help for deployment and running of LDR (see below). The UWM Group will continue to develop and enable the LSC Data Grid Client/Server bundle; Junwei Cao (MIT) has recently assumed responsibility for releases.

(v) *LSCSOFT Software Repository:* The UWM group will maintain releases of underlying libraries for a variety of operating systems. These software repositories now serve as the reference installation for the major computing facilities of LIGO.

(vi) *Software & Computing Committees:* Anderson will serve on the LSC Computing Committee as an LSC member at large. Brady will serve on the LSC Computing Committee in his role as LSC Software Coordinator; Creighton will serve on the LSC Computing Committee as the UWM representative; Koranda will participates in LSC Computing Committee meetings as an ex-officio expert on

Grid Computing. Creighton continues to serve on the Software Change Control Board.

(vii) *Other Committees:* Creighton will serve as on the LSC detection committee on behalf of the inspiral group. In his capacity of coordinating analysis efforts, Wiseman also participates in the efforts of the LSC detection committee. Allen will serve on the LSC/LIGO restructuring committee. Allen, Brady, and Wiseman will all serve on the LSC Executive Committee. Allen, Brady and Papa will serve on the MOU committee.

3. Resource Sharing: The LIGO Laboratory will contribute resources including allocation of appropriate scientific and engineering personnel, research facilities and funding in support of the effort in Item No. 2, as indicated below.

   a) Research accommodations for UWM group members while on LIGO research assignment at any LIGO Laboratory site,
   b) Access to LIGO data through established LSC channels in support of this work.

4. Coordination and Reporting – UWM Group will perform this research within the structures established by the LIGO Laboratory and the LSC where appropriate. In particular activities described in Item 2a) will be carried out in coordination with the LSC Calibration team and the LSC Detector Characterization Working Group . Item 2b) will be carried out in coordination with the LSC Computing Committee, and Item 2c) will be carried out in coordination with the LSC Spokesperson and LIGO Lab Director. Coordination will include keeping the contacts informed of activities and plans, reporting to the group at meetings and telecons, and through technical documents submitted to the LIGO Document Control Center.

   In addition, an annual report will be submitted with the update to this Attachment, giving a summary status on research by topic as indicated in Item No. 2, including progress against the milestones if any, significant accomplishments such as new insights/discoveries or publications, issues of concern if any, and an indication of invested time. This Attachment will be updated at least annually with a plan of activities for the succeeding on-year period. These documents will be due one month before the close of the period of performance under this Attachment.

5. All computer code delivered to the LSC under this Attachment must be developed in consultation with the LSC Data Analysis Software Working Group (DASWG) and archived, documented and reviewed as determined by that group.

Approved:

Barry Barish LIGO Laboratory Director	Bruce Allen UWM Principal Investigator
Peter Saulson LSC Spokesperson	Keith Riles LSC Detector Characterization Leader
Gabriella Gonzalez Calibration Team Leader	