Attachment DAT to the
Memorandum of Understanding (LIGO- M050270-00-M)
between the
Pennsylvania State University Relativity Group (PSURG)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
August 15, 2005

This Attachment DAT to the Memorandum of Understanding LIGO-M050270-00-M defines the role of the Pennsylvania State University Relativity Group (PSURG) as a Member of the LIGO Scientific Collaboration (LSC), in particular, its activities in data analysis 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 are responsible for implementing and exploiting the initial LIGO detector through its science data runs. The LSC has organized the data analysis effort into search groups which coordinate the analyses, perform detailed reviews, and prepare publications on behalf of the collaboration. LSC groups are encouraged to participate in one or more of these groups. MOU Attachments define the contributions of each participating group to the data analysis groups.

2. During the period August 15, 2005 to August 15, 2006, the members of PSURG Group will participate in the analysis of initial LIGO data in the following areas:

a) Burst sources

1. Block-Normal implementation: Finn, Desai, McNabb, Stuver, Summerscales and Thorne will analyze S5 data using the Block-Normal pipeline and a distributional analysis for burst events. They will complete the analysis of S4 data using the Block-Normal pipeline to derive Bayesian upper limits. They will provide technical documentation of the S4 and S5 analyses for reviewers.

2. Block-Normal methods paper: Finn, Desai, McNabb, Stuver, Summerscales, and Thorne will complete the manuscript describing the statistical underpinnings of the Block-Normal changepoint analysis and submit it for publication.

3. Near-realtime analysis: Finn, Desai, McNabb, Stuver, Summerscales and Thorne will run their existing Block-Normal pipeline in near-realtime on S5 data, which will provide initial results for the S5 Block-Normal analysis.

4. Summerscales Dissertation: Summerscales will continue on her main Ph.D. dissertation project. For this project she will continue working with the supernova simulations group headed by Adam Burrows at the University of Arizona. She will insert

supernova waveforms into LIGO noise and will determine how well the method of maximum entropy is able to reconstruct signals from the data for various signal strengths. This will indicate which parts of the core-collapse evolution LIGO will be able to detect and give information on.

5. Stuver Dissertation: Stuver will continue her Ph.D. thesis research by undertaking a comparative study of the performance of burst event trigger generators (ETG's) on simulated signals of different types with the goal of determining the strengths of each type of trigger generator, the degree of (in)dependence of the triggers generated by each, and whether ETGs are more sensitive to time-domain or frequency-domain features of signals.

6. MATLAB simulation engine: Stuver will continue to maintain the MATLAB based GravEn simulation engine which can simulate all sky sources with both polarizations and projected onto specific detector antenna patterns and coincidence between detectors. Stuver will also add functionality to GravEn to convert GPS time to local sidereal time to allow the sky to move properly over the detectors and maintain the project web page.

7. BurstMDC package: Thorne and Stuver will complete the grid-based BurstMDC software package for acclerated production of Mock Data Challenge (MDC) burst simulations for the S4 and S5 burst analyses. This will include technical documentation and ongoing support to the Burst Group.

8. External-trigger burst analysis: Finn and Thorne will work on a Block Normal-based analysis of LIGO data for long-duration (1 second) bursts to extend the parameter space coverage of the externally-triggered LIGO burst data analysis.

9. Interaction with SWIFT: Thorne will provide liaison between LIGO and the SWIFT gamma-ray burst telescope team regarding joint data analysis efforts. This will take advantage of the location of the SWIFT Mission Operations Center at Penn State.

10. Astrophysical Interpretation: Finn and McNabb will develop general methods for interpreting burst analysis results in an astrophysical context. This work will be documented in a set of technical reports and, where appropriate, publications.

11. Waveform recovery: Finn, Summerscales, and other students and postdocs, will implement a maximum entropy based module for examining coincident burst events and identifying whether their is a common, underlying waveform that is responsible for them.

b) Inspiral sources

1. Template bank for precessing binaries: Owen and Yunes will finish debugging the parameter space metric code for arbitrary modulation strength and insert it into LAL. The current LAL code, which uses the strong modulation approximation, will be upgraded to use the new metric. The draft manuscript on the calculation of the metric will be finished and submitted for publication, including an explanation of the strong modulation approximation used in the existing code.

c) Periodic sources

1. Astrophysical guidance for searches: Owen, with Ian Jones (GEO600 MoU), will continue to inform the PULgroup's decisions on parameter limits for S4 and S5 searches. For instance, the minimum spindown age of an all-sky search can be dramatically lengthened (and the computational cost reduced) by taking into account the distribution in age and space of nearby supernova remnants, and the frequency range of such a search is influenced by the maximum ellipticity of a neutron star.

2. Einstein@Home: Owen, with the AEI group (GEO600 MoU), will update the calculations and code for dividing the parameter space of future searches into manageable work units as needed for upcoming searches.

Ramsunder will work with the UWM group to continue PSU's support an Einstein@Home mirror.

3. N-dimensional template banks: Owen, with Ian Jones and the AEI group (GEO600 MoU), will provide flexible algorithms and code for producing templates in more than two dimensions as will be needed for upcoming searches for periodic sources. This will be based on Owen's group's 3-dimensional LAL code for precessing binary template banks.

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 PSURG 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 – PSURG 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 within the LSC Burst Search Group, Item 2b) will be carried out within the LSC Inspiral Search Group, and Item 2c) will be carried out within the LSC Pulsar Search Group. Coordination will include keeping the Group leaders 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	Lee Samuel Finn PSURG Principal Investigator
Peter Saulson LSC Spokesperson	Erik Katsavounidis LSC Burst Search Group Leader
Albert Lazzarini LIGO Laboratory Data and Computing Group Leader	Patrick Brady LSC Inspiral Search Group Leader
Mike Landry LSC Pulsar Search Group Leader	