Attachment DAT to the

Memorandum of Understanding (LIGO-M 000125 -00-M)

between the

Carleton College Relativity Group (CCRG)

and the

Laser Interferometer Gravitational Wave Observatory (LIGO)

August 15, 2006

This Attachment DAT to the Memorandum of Understanding LIGO-M 000125 -00-M defines the role of the Carleton College Relativity Group 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, 2006 to August 15, 2007.

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. 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, 2006 to August 15, 2007, the members of CCRG will participate in the analysis of initial LIGO data in the following areas:

a) Binary Inspirals

Members of the CCRG will study instrumental disturbances (glitches) with the intent of developing vetoes and data quality flags for the binary inspiral searches. The PI and Carleton student Hans Bantilan will further develop their generic glitch finding algorithm, graph tool. This veto-glitch work will also be coordinated with the LSC glitch group, and the LSC Detector Characterization group. Efforts will be made to understand the physical mechanisms that generate the detected glitch events.

The CCRG will continue to develop and apply their Markov chain Monte Carlo (MCMC) parameter estimation codes as part of the the inspiral search. Currently the CCRG has developed a single interferometer 2.0 post-Newtonian (PN) stationary phase frequency domain 5-parameter MCMC, a single interferometer 3.5 PN phase and 2.5 PN amplitude time domain 6-parameter MCMC, and a multiple interferometer 3.5 PN phase and 2.5 PN amplitude time domain 9-parameter MCMC. All of these parameter estimation programs will be used on candidate events, and hardware injections in the LIGO data. The CCRG will work on better incorporating these inspiral parameter estimation programs into the binary inspiral search and detection pipelines.

b) Bursts

The multiple interferometer coherent parameter estimation MCMC program also has been modified to include burst templates. Currently the CCRG is testing Gaussian and Sine-Gaussian templates. Work for the CCRG this year will include the expansion of this code to include physical super-novae templates. The CCRG will also collaborate with burst group members on developing an appropriate application for the coherent burst parameter estimation code as part of the burst search and detection pipeline.

c) Stochastic

Christensen will continue to serve on the LSC Stochastic Review Committee, and will execute all of the tasks required.

d) Continous

The CCRG will continue to collaborate with the LSC researchers at Glasgow University of the development and application of the MCMC parameter estimation code for pulsar searches. We will apply our code to events that may come out of the search pipelines.

The CCRG will calculate the coherence between the LIGO interferometers' output, and PEMs. These results will be used to try and determine if signals observed by pulsar searches might be caused by environmental noise. This work will also be coordinated through the LSC Detector Characterization Group.

e) Other Contributions

Detector Characterization Group –

The CCRG will calculate the coherence between the LIGO interferometers' output, and PEMs. This work will be coordinated through the LSC Detector Characterization Group. The CCRG will attempt to identify and determine the cause of noise lines in the LIGO data.

Glitch Working Group – The CCRG will conduct research on identifying and characterizing glitches that appear in the LIGO interferometer output data. Specific attention will be given to identifying the cause of events that appear as triggers in the the LSC binary inspiral search pipeline. Inspiral vetoes will be developed. This work will be coordinated with both the LSC Glitch Working Group, and the LSC Inspiral Group.

The CCRG will also continue to work on the development of a generic glitch finding algorithm, currently called graph tool. This tool will be applied to interferometer and PEM channels at times coincident with events in the interferometers' gravity wave channel.

The joint LIGO – Virgo Working Group – The CCRG will continue to be actively involved in the LIGO-Virgo Working Group. There will be a number of tasks within this working group that CCRG expects to contribute.

Christensen will coordinate data quality information from LIGO and Virgo when they begin the process of examining each others data. Information on how the data was studied, and how vetoes and data quality flags were developed, will be communicated to both LIGO and Virgo.

The CCRG will continue to collaborate with Virgo researchers on the development of an extreme mass ratio binary inspiral detection pipeline. The CCRG's coherent time domain 3.5 PN phase 2.5 PN amplitude MCMC code will be part of this search routine.

The CCRG will contribute to any other tasks that may come before the LIGO-Virgo working group.

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 **CCRG** 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.

c) Not Applicable

4. Coordination and Reporting -

   CCRG 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 Inspiral Search Group, Item 2b) will be carried out within the LSC Burst Search Group, Item 2c) will be carried out within the LSC Stochastic Search Group and Item 2d) will be carried out within the LSC Continuous Waves search Group. This includes 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:

Jay Marx
LIGO Laboratory Director

Nelson Christensen
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Peter R. Saulson

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