

Attachment DAT to the
Memorandum of Understanding (LIGO-M050292-00-M)
between the
Caltech Relativity Theory Group (CaRT)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
August 15, 2005

This Attachment DAT to the Memorandum of Understanding LIGO-M050292-00-M defines the role of the Caltech Relativity Theory Group (CaRT) 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 CaRT Group will participate in the analysis of initial LIGO data in the following areas. *For background and details on most of these projects, see current and past CaRT Progress Reports and past MOUs.*
 - a) *Binary Inspirals* –
 - i) Non-spinning (BCV1) templates for BH-BH binaries in S2 and later searches:** Pan and Vallisneri, with Buonanno [UMd] and Chen [AEI-GEO], will continue their contribution to the implementation of BCV1-template searches for S3 and following runs, working in particular on template placement strategies with the Cardiff group.
 - ii) Spinning BCV2 templates for NS-BH and BH-BH binaries:** Pan and Vallisneri, with Buonanno and Chen, will continue their contribution to the implementation of BCV2-template searches for future runs, collaborating with the Inspiral Upper Limits Group and in particular with the Cardiff group.
 - iii) Quasi-Physical (PBCV) templates for NS-NS, NS-BH and BH-BH binaries:** Pan and Vallisneri, with Buonanno and Chen, will continue their study of the expected accuracies of parameter estimation for the quasi-physical template binaries, focusing on Monte Carlo simulations as well as the Fisher Matrix. This study will update previous work for parameter estimation in spinning binaries (NS-NS, NS-BH, and BH-BH), which includes spins only as constant terms in the waveform phasing.
 - iv) Extreme Mass Ratio Inspirals (EMRI's):** Fang and Thorne will continue their scoping of the ability of LIGO to extract science from EMRI waves. Duncan Brown [a

part-time member of CaRT who appears on the LIGO Lab-Caltech MOU] and others will develop a template family for EMRI searches with initial LIGO.

b) *Pulsars* --

i) LALBarycenter LAL Routines: Cutler [who is moving from AEI-GEO to CaRT] plans some improvements to the LALBarycenter LAL routines, which he wrote some time ago. These routines currently barycenter the data to within around 2-3 microsec; the improvements should decrease this error by about a factor of 2. Also, with Rejean Dupuis [a part-time member of CaRT who appears on the LIGO Lab-Caltech MOU], Cutler intends to document some tests of LALBarycenter based on comparisons to TEMPO. And Cutler intends to finish a 30-page document explaining how LALBarycenter works.

ii) Detector-Network Search Routines for Pulsars: With B. Schutz [AEI-GEO], Cutler recently wrote a paper (gr-qc/0504011) explaining how to generalize the F-statistic for gravitational-wave pulsars (the optimal frequentist detection statistic) to a network of detectors and/or to multiple sources. Along with Reinhard Prix and Iraj Gholami [AEI postdoc and grad student, respectively], Cutler intends to develop detector-network search routines for gravitational-wave pulsars, based on this generalized F-statistic, within the LIGO Software Library (with the goal of ultimately implementing them with [Einstein@Home](#)).

iii) Hierarchical Search Routines for Pulsars: With B. Krishnan and I. Gholami, Cutler recently completed a paper on optimized, multi-stage, hierarchical searches for gravitational-wave pulsars. Cutler and those co-authors will adapt that study to the Einstein@Home context.

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 CaRT 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 – CaRT 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 Inspiral Search Group, Item 2b) 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:

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