LIGO-M070226-00

Attachment DAT to the Memorandum of Understanding LIGO-M970077-00 between the German/British Collaboration (GEO 600) for the Detection of Gravitational Waves (GEO600) and the Laser Interferometer Gravitational Wave Observatory (LIGO)

For The Period August 15, 2007 - August 14, 2008

This Attachment DAT to the Memorandum of Understanding LIGO-M970077-00 defines the role of the German/British Collaboration (GEO 600) for the Detection of Gravitational Waves (GEO600) as a Member of the LIGO Scientific Collaboration (LSC). In particular, it addresses data analysis activitites in support of the initial LIGO interferometers. The period of performance for the activities in this Attachment is from August 15, 2007 - August 14, 2008.

1. Collaboration

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 analysis, review, and publication on behalf of the collaboration. LSC groups are encouraged to participate in one or more of these groups.
MOU Attachment DAT defines the contributions of each participating group to the data analysis development groups.

2. Participation

During the period August 15, 2007 - August 14, 2008, the members of GEO600 will participate in the analysis of initial LIGO data in the following areas:

a. Binary Inspirals

Cardiff University:

1. S5 CBC search: Complete the low-mass and high-mass CBC searches [Cokelaer, Robinson, and Sathyaprakash].

2. Co-ordinate the effort to get the second year of S5 data analyzed for low-mass compact binaries, using the automated ihope script currently under development [Fairhurst].

3. Coincidence with Gamma-ray bursts: Dietz will run the pipeline implemented for GRG 070201 to search for inspiral coincidences with all the GRBs that occurred during the S5 run [Dietz, Sutton].

4. Development of the IMR search: The next steps involve taking the waveforms developed for the blind injection test and making them available to inspiral/burst/ringdown pipelines to test our sensitivity. Also, work with others to add the ability to use numerical relativity simulations as injections into our pipelines [Fairhurst to co-lead with Laura Cadonati].

5. Implementation of the inspiral null stream test [Fairhurst, Harry, Sutton].

6. Spinning BBH Search: Complete the comparison of the spinning BBH search using BCV templates with SPA templates [Van Den Broeck].

7. Amplitude corrections: Implement the amplitude corrected waveforms for searches and parameter estimation [McKechan, Sathyaprakash, Van Den Broeck].

8. Improved background/foreground separation: Investigate neural networks as a means to identify foregrounds from backgrounds [Robinson, Sathyaprakash, Sengupta (now in Caltech), Sajeeth Philip (visitor to Cardiff)].

9. Parameter estimation: Investigation into parameter estimation using the inspiral, merger and ringdown parts of the waveform [Jones, Sathyaprakash, Van Den Broeck].

10. Parameter estimation of spinning binary black hole waveforms in LIGO and Virgo data [Cokelaer, Fairhurst, Sathyaprakash, Van Den Broeck].

11. Better understand the effect of 1st-order corrections to the GW response on specific searches at higher frequency (e.g., directed searches for pulsars), and how this is connected to the relationship between the Michelson and Fabry-Perot responses of an interferometer [Grishchuk and Romano].

Albert Einstein Institute:

Inspiral searches:
- continue work on developing template banks that incorporate information from numerical relativity simulations
- Inject numerical and hybrid (numerical-PN) waveforms as a benchmark for the current inspiral search pipeline

Birmingham CBC Group (J Veitch & A Vecchio):

We plan to complete the exploratory phase of the development of a Bayesian evidence-based approach to model selection to be applied on triggers produced by a search pipeline. Our work will concentrate primarily on including realistic waveforms and on exploring how the method performs on real data. Once this stage

is complete we will begin the development of a pipeline (starting from triggers), that can work on single or multiple data streams and can be included as one of the stages of the end-to-end analysis pipeline to search for coalescing binaries. Initially, the development will concentrate on non-spinning objects but will be constructed in a sufficient modular fashion to include in the more distant future also spinning black holes.

In collaboration with NUGWAG (Northwestern University) - van der Sluys, Mandel & Kalogera - and CCRG (Carleton College) - Christensen - we will complete the exploratory study of a MCMC code for parameter estimation of spinning binaries to act on triggers produced by the relevant search pipeline (at present, we envisage two LSC method papers to report results on the algorithm). We will then start the development of codes for MCMC parameter estimation to be included as part of an end-to-end pipeline . Our effort, besides code development starting from our existing software, will concentrate on including realistic waveforms and on characterizing the performance of the algorithm on real data, running on software/hardware injections.

b. Bursts

Cardiff University:

1. Search for gravitational-wave bursts associated with S5 GRBs:
- GRBs during Nov 2005 - May 2007 (LIGO, LIGO-GEO networks)
- GRBs during May 2007 - end of S5 (LIGO-GEO-Virgo)
Prepare S5 GRB search results for review and publication.

2. Coherent analysis pipeline infrastructure development: incorporating K. Cannon's fast correlator algorithm into X-Pipeline for all-sky burst searches (with Cannon, A. Searle), incorporating ring-down model for triggered Bayesian search (with Glasgow)

Albert Einstein Institute:

Burst searches:
- characterization and control of GEO600 data during astrowatch
- contribution to network analyses

c. Stochastic

Albert Einstein Institute:
Stochastic searches:
- development of joint LSC-Virgo searches

Birmingham SB Group (C.N. Colacino, E L Robinson and A Vecchio):

We will complete and submit a method paper (at present in advanced stage of preparation) on a Bayesian analysis approach to search for stochastic backgrounds of arbitrary spectrum using two interferometers. Building on the existing pipeline

for isotropic signals, we will then develop a pipeline that uses this new approach and begin processing S5 data with the goal of ultimately producing science results for a broad range of stochastic background spectra.
We will continue our contribution within the LIGO-VIRGO analysis effort to bring a pipeline to the stage of carrying out a science analysis for isotropic stochastic backgrounds in the frequency range above 800 Hz using also VIRGO data recorded in the last part of S5.

d. Continuous

University of Glasgow:

1. Publish both the Crab and general targeted pulsar upper limits results from S5

2. We will develop a fully covariant timing model for the pulsar parameters. Currently we take a worst case upper limit for these uncertainties and therefore needlessly exclude some otherwise good targets.

3. We will include glitch models within our investigations.

4. We will extend our ring-down search method [Clark et al. 2007] to be a waveform consistency test for the ongoing all-sky search for ring-downs from black holes. There is currently no such test for the black hole ring-down search, so the inclusion of such a test will reduce the number of false alarms, thereby increasing the sensitivity of the search.

5. Environmental noise can have distinct waveform signatures in the data. The ring-down search method [Clark et al. 2007] allows for the inclusion of noise transients to be included in the detection statistic. We will use instrumental glitch classification to identify noise transients.

Albert Einstein Institute:
CW searches: continue support of all activities mentioned above, plus post-processing and follow-up of S5 candidates, targeted analysis in interesting parameter-space regions, optimization of computing resources for different astrophysical targets, studies of source populations and expected rates.

Birmingham CW Group (D Kasprzyk, A Vecchio & J Veitch):
We will complete the validation of the Fstat pipeline for a search targeted at accreting msec X-ray pulsars and carry out the relevant analysis using S5 data. This work is done in close collaboration with C. Messenger (Glasgow/AEI), and has the dual purpose of producing science results (together with the “side-band” search) and contribute to a cross-validation and efficiency comparison of (part of) a new search method (”side-band” search) that has been proposed for LMXBs.

e. Other Contributions

Cardiff University:
Hardware/Support [Gerald Davies]

1. Maintain and operate the explorer and coma clusters.

2. Keep up to date GEO raw data and LIGO S5 strain data at Cardiff.

3. Help in the selection of the hardware/OS for the University's 2048-node new cluster (about 10-20 percent of this devoted to the use of LSC data analysis).

4. Purchase and install a new data archive for LIGO data to replace mini.astro.cf.ac.uk .

Committee memberships and main activities:

1. Steve Fairhurst
- Member of the Calibration Review Committee, involved in S4 h(t) and S5 calibration reviews
- "Inspiral Code Librarian" for 6 months starting in September 07

2. B.S. Sathyaprakash
- Member of the CW Review Committee
- Member of the LSC Council
- Member of the GEO Executive Committee

3. Patrick Sutton
- LSC Burst Review Committee (GRB070201 burst search review)
- LSC Presentations and Publications Committee (drafting updated publications policy, review of LSC Amaldi presentations, editor for paper reviews)

Albert Einstein Institute:

Hardware: - purchase and installation of large compute cluster at AEI Hannover, and data storage servers.

Birmingham (D Stops):

We will continue the support of our 210 CPU Beowulf cluster (Tsunami) and make it available to the LSC for data analysis exploratory work and production analyses

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 GEO600 group members while on LIGO research assignment at any LIGO Laboratory site.

Not Applicable

b. Access to LIGO data through established LSC channels in support of this work.

Not Applicable

4. Coordination and Reporting

GEO600 will perform research within the structures established by the LIGO Laboratory and the LSC where appropriate.
In particular, with reference to activities described above:

2a will be carried out within the LSC Inspiral Search Group.

2b will be carried out within the LSC Burst Search Group.

2c will be carried out within the LSC Stochastic Search Group.

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 one-year period. These documents will be due one month before the close of the period of performance under this Attachment.

5. Computer Code

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.

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Karsten Danzmann
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GEO600

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