

## LSC Six-Month Progress Report

**Organization** Pennsylvania State University Relativity Group (PSURG)

**Report Date** February 10, 2005

### Data Analysis

a) Consistent with decisions made with the Burst Group, the BlockNormal analysis pipeline has been used to analyze S3 data only as playground in preparation for S4 data analysis.

The planning for the BlockNormal-based analysis of the S4 data was completed. The goal is to perform the analysis in a "near-online" pipeline. A grid-based pipeline has been developed to do this analysis on a daily basis during the S4 science run.

Stuver continues to use the SLOPE ETG in the MATLAB environment for her thesis research and SLOPE may also be used in the S4 analysis.

b) Participation in the LIGO/TAMA analysis exercise was completed.

c) The documentation of the BlockNormal analysis pipeline was updated and responses provided to queries from the review committee. This led to the development of several techniques to check the performance of the data conditioning, which will be used during the S4 analysis. The initial review of this pipeline was completed by the committee.

d) Matched filtering search for precessing binaries: Owen and Alberto Vecchio (University of Birmingham, GEO600 MOU), in order to deal with numerical problems in the parameter space metric at small values of the modulation parameter, derived a new formalism for computing the metric. This led to a rewrite of the manuscript, whose method can now be applied also to pulsar searches (the  $F$ -statistic) and LISA searches.

e) Template bank code for precessing binaries: Minor debugging while being tested in the pipeline by the Cardiff group (GEO600 MOU).

f) Generic template bank code: No progress during this reporting period.

g) Sky area search for periodic sources: Owen and Ian Jones (GEO600 MOU) developed analytical approximations to correct numerical problems in the grid placement near the equator for short integration times.

h) Upper limits on neutron star ellipticity: Owen submitted a paper to Phys. Rev. Lett. providing astrophysical justification for why the LIGO upper limits on known pulsars are becoming interesting. The paper is not on arXiv pending referee reports, but is available on the periodic source group's S2 investigation page. An early version of Owen's notes for the paper was written as Technical Document T040192-00-Z. The highest predicted ellipticities are comparable to the S2 upper limits, but come from an equation of state that is not widely believed (although not ruled out). An exotic but believable equation of state might lead to maximum ellipticities at the

edge of detectability for known pulsars with one year of data at design sensitivity. This makes a scientific case that it is worth pursuing small (factor two) improvements over design sensitivity if Advanced LIGO is delayed.

i) Summerscales has investigated methods for extracting the signals present in data from multiple detectors. She is testing a method used in radio astronomy called Maximum Entropy and will be comparing it with simple filtering approaches.

j) Stuver has further refined her thesis topic to answer the following questions:

- i) What characteristics of the LIGO data cause the strongest triggers in each ETG?
- ii) Is it the frequency domain or the time domain characteristics of a signal that induces a trigger in each ETG?

Work on the first question is in progress and about 50% complete. Some infrastructure for beginning work on the second question is complete and awaits results from the first question to proceed.

k) Stuver continues to maintain the MATLAB based GravEn simulation engine. A project page has been developed at <http://gravity.psu.edu/~stuver/graven/>.

l) Finn has served on the GWIC Statistical Methods Sub-committee

### **Detector Characterization and Data Studies**

a) Desai and Finn have been using medNoiseChar tools for studying the stationarity of LIGO detector noise in S3. Results have been posted on the web for use by the collaboration and will be documented in a technical document.

b) Due to the delay in the launch of the Swift telescope, Thorne did not have any active liaison duties during this period. He has joined the LSC External Trigger working group to help develop a near-online pipeline for use during S4 for which Swift will provide many of the external triggers.

### **Other Work**

a) Desai and Finn have been studying veto analysis with S3 data using Block-Normal. They have developed a strategy for judging the effectiveness of a veto channel, based on maximizing its figure of merit, as outlined in T030181-00. This will be used in near-online analysis of S4 data.

b) Thorne developed an automated tool for finding narrow spectral lines in the LIGO data. This was intended to automate development of Kalman filters for BlockNormal pipeline data-conditioning. This tool was also used to correlate many of these lines in the S2 and S3 data as harmonics of low-frequency (~37 Hz) fundamentals. These fundamentals were found to be at slightly different frequencies for each IFO, and to drift slightly over time. Results have been posted for both S3 and E11 runs.

### **PSU Tier 2 Center and LIGO Data Analysis Computing**

- a) No one has been hired to support the development of DMT.
- b) The PSU tier 2 center is on line and running analysis jobs from around the collaboration.
- c) McNabb, and Ramsunder have represented PSU at the various iVDGL meetings.

### **Administration**

- a) Finn has served on the LSC executive committee.
- b) Finn has served as the GWIC executive secretary. The updates to the GWIC web site have been completed.
- c) Finn has represented LIGO on the joint LIGO/TAMA analysis team.
- d) Finn has represented the PSU tier 2 center on the LSC Comp COORD Comm.
- e) Finn has continued to serve on the LSC Detection Committee.
- f) Finn has supervised and participated in the work described in this Attachment associated with Kissel, Lin, McNabb, Stuver, Summerscales, Thorne, and Zaleski. Owen has supervised and participated in the work with Whitbeck and Essinger-Hileman.

### **Operations Support**

There were no expert science monitor shifts to be staffed.

### **Collaboration Software Infrastructure**

- a) McNabb has acted as the DASWG MatApps project librarian.
- b) Support has been provided for the MATLAB software package (Channel) which greatly simplifies rapid access to LIGO frame data maintained in Lightweight Data Repository (LDR) archives. This package has recently been extended to support integration with LSCdataFind.
- c) Ashley, McNabb, Summerscales and Thorne provided a large portion of the training during the three-day 'boot camp' which followed the August 2004 LSC Meeting. Numerous web pages were created to provide step-by-step instruction both during and after these sessions. Topics included MATLAB setup, signal analysis with MATLAB, compiling MATLAB for grid analysis, the MATLAB Channel tool for frame data access, and accessing and using LSC 'Grid' computers.