

LIGO M020136-A-M

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Date: Tue, 12 Mar 2002 08:05:30 -0800
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Subject: Transition to Scientific Running
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Our prior memorandum (LIGO M010216-A-M) of August 2001, appended below, laid out the strategy for transition from commissioning to scientific operations, and interleaving these operational modes. In this memo, we define the progression of early scientific running in additional detail and create a basis for planning the important data analysis and interferometer commissioning and development work between the scientific running periods.

We have just completed a very successful E7 engineering run, as called for in the attached memo. Analysis of the data from this run and further interferometer commissioning and modification, at least partially based upon the E7 experience, is underway. We have carried out a set of "lessons learned" discussions in the Laboratory Executive Committee meetings, and a discussion with the LSC Executive Committee. The LSC has also held an important teleconference to expose the status of the data analysis effort with the E7 data. The E7 run also involved coincidence running with the GEO 600 interferometer and the Allegro bar detector. We have consulted with our partners in these efforts, as well, regarding accomplishments and the perspective for the future. These have all been quite constructive and the scientific, technical and operational issues have been examined and priorities that guide the next steps have been discussed.

Our overarching mission is to accomplish the scientific reach planned for the LIGO interferometer system and to exploit the system, with the LSC, to accomplish the science. Given this priority, we structure the next steps in the program around the progression of scientific running periods and the scientific reach for each of these periods. The development of the data analysis and detector systems, and the conduct of the scientific data analysis will then be guided by these science runs.

Our plan for the next steps includes:

Following the E7 Engineering Run -

1. The March LSC meeting should be the point at which we reach consensus on the sensitivity and noise curves from E7, as called for in the memo below. This consensus should help us benchmark E7 and set the mark for the S1 run as we laid out in the earlier memo.
2. By the end of May, the analysis working groups should be able to complete much of the targeted data analysis tasks, as we called for in the memo below.

The Upper Limits Runs S1 and S2 -

3. Given the lessons learned from E7, the remaining high priority interferometer installation and rework tasks, and the goal to initiate science running described below, we will schedule the S1 run to begin at 8:00 am Pacific time on Saturday, June 29 and to be completed at 8:00 Pacific on Monday, July 15. This run will be the joint responsibility of the Laboratory and the LSC. The sensitivity goal is a two site coincidence with 3 interferometers running and the achieved scientific reach (volume searched x observation time in coincidence) should be an order of magnitude

better than achieved in the E7 run. At least one interferometer at each site should be operated in the full recycled configuration.

4. The S2 run will have a goal of at least an order of magnitude improvement in scientific reach (volume searched x observation time in coincidence) beyond S1 and should follow successful completion of analysis of the S1 data. Considering the estimated time to carry out the data analysis of the S1 data, and the interferometer commissioning and development tasks, we will schedule the next science run to begin at 8:00 am Pacific Friday November 22, 2002 with completion at 8:00 on Monday, January 6, 2003.

These two runs will complete the upper limit running and the orientation for the LIGO running experience. We believe that this should lead to a broad set of new publishable limits, well beyond what has been previously published.

Extended LIGO Search Runs

5. Installation of the additional seismic filtering at LLO will be scheduled to follow the completion of the S2 run. A plan for the major additional interferometer commissioning, modifications and rework is under development with the goal of supporting the next major science run after S2 in the middle period of 2003. This significant shutdown period will be intended to achieve readiness for an extended science run with a significant step in sensitivity.

6. The S3 run will mark the beginning of true search running, representing a step beyond setting upper limits on selected gravitational wave searches. S3 will be intended to accomplish a real search for gravitational waves with significant astrophysical significance. We expect to schedule S3 to commence about June 27, 2003 and this run will be planned for several months duration.

7. During 2003 and 2004, we will plan to run in this search mode for at least 50% of the calendar time, followed by the planned one year integrated LIGO science run at design sensitivity. This science run will be completed prior to proposed major interferometer replacements.

With this framework, we will now develop a more detailed set of merit figures for setting goals for these runs. These planned runs will now be used to structure the detailed LIGO program plan for LDAS development, detector modeling and diagnosis, interferometer commissioning, modification and revision. This program planning will provide a clear structure for the work involved in interleaving interferometer development and improvement with progressively more ambitious science running.

To: LIGO Executive Committee

From: Barry Barish and Gary Sanders

LIGO Commissioning and Transition to Scientific Running (LIGO M010216-A-M)

During the past 18 months, LIGO installation has been essentially completed and commissioning of subsystems and complete interferometers has been initiated. We have achieved first lock in the Hanford 2k interferometer, operated the Livingston 4K in recombined mode, carried out several successful engineering runs, encountered and overcome several technical issues and at least one instance of force majeure. It was very encouraging to observe the reestablishment of lock in the fully recycled mode of the 2k following the extensive rework necessitated by the earthquake and the planned replacement of the suspension optical sensors. Early running of the Hanford 4k mode cleaner with the new sensors, digital controls and higher power is another very

positive indication that our commissioning is progressing. Nevertheless, we have a great deal of work ahead in completing the commissioning of the three interferometers and initiating scientific observation.

The plan we established last year called for a coincidence run this year as a significant milestone, for the use of engineering run data to exercise the complete analysis pipeline from acquired data to a calculated upper limit, and for initiating committed scientific running in 2002 interleaved with progressive noise and availability studies. We defined this strategy recognizing that once the interferometers operated in stable configurations for significant blocks of time, scientific data collection and analysis and the detector characterization that is part of this process would be of critical importance to bringing the interferometers to full scientific utility. The strategy requires that interferometer commissioning should evolve from fully focused on technical issues to balanced data and detector studies as part of the smooth progression to science.

As part of this strategy, the Laboratory and the LSC have organized the data analysis working groups and the upper limits groups with the goal of initiating the scientific analysis team efforts. Proposed physics goals have served as foci for the activities of these groups. The groups have already carried out successful Mock Data Challenge activities. Our plan has been to initiate the prototype data analysis with the upper limits groups using engineering run two-site coincidence data this year.

This memo provides additional definition to this commissioning and early science program for the next year. We list below several goals and the major planning milestones around which we should structure the details of the program.

The major goals of this program are:

1. Bring the LIGO interferometers, and our data acquisition and analysis capability rapidly to the ability to collect and analyze coincidence data to address the scientific goals of LIGO. Advance both the interferometer commissioning and the commissioning of our analysis capability in a mutually balanced manner.
2. Emphasize the goal of initiating the scientific running in 2002, with the subsequent scientific running interleaved with instrumental sensitivity studies until the instrumental limits are achieved.

We define Engineering runs (E) as data taking runs that are primarily motivated by the Laboratory detector improvement program and not by scientific goals leading to publications. Science runs (S) are intended to produce a data product for the LSC with scientific goals and resulting in publications.

With this background, we define the following major program milestones:

1. The LIGO Laboratory will carry out the E7 run before the end of the year. We anticipate that the run will take place during December and will be scheduled for two full weeks. The run is an engineering run and will be the responsibility of the LIGO Laboratory. The precise schedule for the run will be defined by the commissioning directors and the observatory heads, Stan, Rai, Dennis, Fred and Mark. The Laboratory will operate at least one interferometer at each observatory with the earnest goal to operate all 3 instruments. At least one operating interferometer should be in full recycled configuration so that the interferometer data is representative of a complete configuration. The goal is to achieve significant individual periods of locked coincidence data and a total locked duration that is significant. Sensitivity of the interferometers will not be guaranteed except that it will be the result of our best effort. While the E7 run is the responsibility of the Laboratory, participation in all of the run activities is open to the LSC members in the LIGO I working groups. The data collected will be available to all of the upper limits groups. The analysis goal is to produce sensitivity curves and information on noise by the end of February and full execution of the analysis to demonstrate our ability to do an end-to-

end analysis by the end of April. If the E7 data run is not successful in producing data capable of accomplishing the run period goals, the Laboratory will repeat the E7 run in January 2002.

2. The S1 run will be held in May 2002. The prime purpose for this run is to carry out the first scientific searches. This run will be the joint responsibility of the Laboratory and the LSC. The sensitivity goal is a two site coincidence with 3 interferometers running and the achieved scientific reach (volume searched x observation time in coincidence) should be an order of magnitude better than achieved in the E7 run. At least one interferometer at each site should be operated in the full recycled configuration.

3. Between the E7 run and the S1 run, the commissioning teams are to have priority with the interferometers. Any data provided will be collected for instrument characterization purposes.

4. In order to accomplish the goals of the E7 and S1 runs, decisions will be required on scheduling implementation of digital controls for suspensions, coil driver augmentation in LLO, tidal servos, common mode servos, etc. The details of these implementations will be defined by Stan, Dennis, Rai, Fred, and Mark representing the commissioning and observatory management, consistent with the goals and milestones above.

5. The S2 run will be scheduled with at least an order of magnitude improvement in scientific reach (volume searched x observation time in coincidence) beyond S1 and following successful completion of analysis of the S1 data. We anticipate future interleaving of E and S runs with significantly improved scientific reach will continue until design sensitivity and reliability are obtained and an extended science run is motivated.

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