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To: Tom Carruthers <tcarruth@nsf.gov>, Beverly Berger <bberger@nsf.gov>

From: Phil Lindquist <lindquist\_p@ligo.caltech.edu>

Subject: Large Facilities Projects Monthly Report (End of March 2008)

Cc: "Phil Lindquist" <lindquist\_p@ligo.caltech.edu>,

Jay Marx <marx\_j@ligo.caltech.edu>,

"Stan Whitcomb \ (E-mail\)" <whitcomb\_s@ligo.caltech.edu>,

Linda Turner <turner@ligo.caltech.edu>,

"Thomas B. Lucatorto" <toml@nist.gov>, dcc@ligo.caltech.edu,

Albert Lazzarini <lazz@ligo.caltech.edu>,

Dave Beckett <beckett@ligo.caltech.edu>,

Dave Reitze <reitze@phys.ufl.edu>

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Subject: **LIGO End of March 2008 Highlights**

Reference: **LIGO-M080043-00-P**

### **LIGO Scientific Collaboration (LSC)**

The LSC-Virgo meeting was held in Pasadena on the Caltech campus March 15-20, with an agenda that spanned instrument science and data analysis. Over 250 LSC and Virgo members attended the meeting (the largest attendance to date). Highlights of the meeting included progress reports on the Enhanced LIGO upgrade, an update on Advanced LIGO and the anticipated approval of the project by the National Science Board in late March, progress on Virgo+, and a number of data analysis results from all of the search groups - burst, continuous wave (CW), inspiral, and stochastic. Mature drafts of several papers from the CW group were also presented. During the Council meeting, we admitted a new member to the LSC, Selim Shahriar of Northwestern University. We also approved a change to the nominating process for LSC leadership positions, as well as some changes to the bylaws.

This was the first meeting to allow remote participation using the EVO collaboration network, and a follow up survey indicates that as many as 30-35 LSC-Virgo members participated from their home institutions at various times. The Remote Participation Committee is only three months old, but its efforts, along with those of the local computing and audio-visual staff, did a great deal to improve the quality of the LSC-Virgo meetings for those joining remotely.

The LSC Education and Public Outreach working group held a face-to-face meeting in Pasadena. Discussions were held on submitting an LSC outreach presentation for the AAS meeting in St. Louis at the end of May (our proposal has been accepted). We also made plans for the World Festival of Science 2009, and staged a discussion on "Communicating Research to Public Audiences."

There was a satellite Coating Workshop with a large attendance of LSC and Virgo members as well as scientists from other optics communities and industry. Judging by the large attendance and enthusiasm during the presentations, the meeting was a success.

The date and venue of the next LSC-Virgo meeting have been set. It will take place at the l'Université Paris-Sud 11 in Orsay on June 11-12. This meeting will cover only data analysis. Face-to-face meetings will be

scheduled June 9-10.

## **Publications**

The Burst group GRB paper, "Search for gravitational waves associated with 39 gamma-ray bursts using data from the second, third, and fourth LIGO runs," has been published in Phys. Rev. D - Phys. Rev. D 77 (2008) 062004.

## **Education and Outreach**

### Livingston Outreach

#### Student Programs

The LIGO Science Education Center (SEC) hosted 14 school visits this month with a total attendance of 507: 243 high school students, 138 middle school students, and 126 elementary students.

All available SEC school field trip days for the school year have been scheduled. We have placed schools on a "cancellation standby list" and urged them to consider requesting a Fall field trip date next year to avoid our crowded Spring calendar.

#### Teacher Programs

- We conducted one off-site teacher Professional Development (PD) program. This was for an MSP (Math/Science Partnership) project in Monroe, LA, about 200 miles north and west of the observatory. Twenty middle school teachers attended.
- We conducted one on-site teacher PD program for an MSP project from the Baton Rouge area. Thirty third and fourth grade teachers and administrators attended.
- We experienced increasing pre-service teacher docents participation during our school visits. We conducted two docent training days.

#### Education Research

- Tulane University's research in student interactions during exhibit play continued this month at the SEC with video data collection events during most of the school visits.

#### Public Outreach

- We conducted four public tours of the LIGO and LIGO SEC facilities. In addition, a member of the SEC staff and one observatory staff physicist joined the LSC education and public outreach (EPO) working group.

### Hanford Outreach

The Hanford Observatory hosted a public event on March 8, "LIGO Inside and Out." The "Out" portion was handled by Michael Landry who hosted a showing of the NOVA episode "Death Star," and then updated the audience on the connections between LIGO and recent Gamma Ray Burst findings, including the February 1, 2007, GRB from the direction of M31. To provide guests a glimpse of the "Inside," Fred Raab went into the primary vacuum equipment area with camera operator Cyrus Reed and grip Evan Goetz. Fred provided a tour of the LVEA while the camera feed was piped to the auditorium and

moderated by Michael. Guests in the auditorium were able to ask Fred questions along the way. Walking tours, exhibit play, and hands-on astronomy activities rounded out the day's agenda. Roughly 130 visitors participated, some from as far as Portland. Engineer Richard McCarthy implemented the video feed.

## **Enhanced LIGO**

The installation of Enhanced LIGO achieved several milestones this month. We integrated the Livingston output mode cleaner cavity to its double suspension system and installed the assembly into the new output vacuum system atop the active seismic isolation system (ISI) installed last period. We began commissioning the integrated DC readout by locking the new output cavity onto a beam from the dark port.

The remainder of the Livingston four-kilometer interferometer was realigned with the upgraded input optics and has been relocked using the original readout (for now, maintained in parallel with the new DC readout). Commissioning and noise diagnostics are in progress. At the Livingston Observatory we also tested the higher-power CO<sub>2</sub>-laser thermal compensation system (TCS) required for high-power operation; although basic operation was successfully demonstrated, work continues to improve the projected heating profile.

Meanwhile we installed the first of the 35W lasers on the four-kilometer interferometer at Hanford and powered it up. The laser passed standalone performance tests, and we are installing the remaining optics and aligning them to deliver the beam to the interferometer injection point.

The Hanford four-kilometer interferometer output internal seismic isolation (ISI) system is nearly complete, with all major components except sensors installed and aligned. Sensor pods have passed performance tests at Livingston and are en route to Hanford for integration.

Finally, after internal science and engineering review, LIGO elected to replace NdFeB permanent magnets on the four-kilometer end test masses with SmCo magnets to mitigate a source of nonlinear Barkhausen noise which limited performance during the last science run. At this writing the end test mass in one of the Hanford arms has been retrofitted and returned to service, and the end test mass in the other arm has been removed and is being processed.

## **Advanced LIGO**

Please refer to the to the work reported above in the context of the enhancements to initial LIGO for many of the subsystems -- suspensions, seismic isolation, lasers, and sensing and control. Much of the activity this month focused on formal elements of the development program, with reviews starting, underway, or concluding in Interferometer sensing and control, seismic isolation, core optics, input optics, and systems.

Some of the efforts of the suspensions and seismic isolation teams were focused on preparations for moving the quadruple suspension and seismic isolation into the LASTI vacuum system. Some anomalies in the pointing of the suspension were investigated, finally considered to be benign, but leading to some side effort on understanding hysteresis in the upper suspension wires.

We completed a preliminary review of the Advanced LIGO Timing system, on which Columbia University is a close collaborator. We also continued prototyping Advanced LIGO data acquisition systems. In particular, a new graphical-interface system for creating real-time acquisition and control software has been used quite successfully for a range of applications, moving us away from reliance on the small number of real-time programmers available.

A focus meeting on coatings during the LSC-Virgo meeting at Caltech permitted us to firm up our model

for the coating to be used for the Advanced LIGO test masses. We will pursue an optimized version of the present coating, but reaffirmed that the "doped" coating that has now been directly characterized for thermal noise would be satisfactory.

Preparations for the start of the project continued pending receipt of funding from the NSF.