GONG

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From time to time, GONG has the occasion to take advantage of a unique, nonhelioseismic opportunity, and the Mercury transit of 7 May 2003 was one such opportunity. Cliff Toner spearheaded the transit observations, and Jean Goodrich and Chirag Shroff successfully captured the real-time images seen by three of GONG's instruments (Learmonth, Udaipur, and El Teide). The images were relayed to the NSO/GONG Web pages, which Ruth Kneale and Caroline Barban prepared for the event. The site had over 250,000 hits during the event, and Dave Dooling captured the hoopla in a National Solar Observatory (NSO) press release.

Timing and triangulating such transits allowed 18th century astronomers to make some of the earliest accurate measurements of the Earth-Sun distance, long before the advent of radar or space probes. Today's ability to observe the events in near real time via the Web led Michele Gerbaldi (Institut d'Astrophysique in Paris, Maitre de Conferences at the University of Paris-Sud, Orsay) to propose the unique educational effort of linking GONG observations with the 18th century transit expeditions to stimulate student interest in the science and math. The real-time link from GONG to Professor Gerbaldi's classroom and the world transmitted flawlessly. Development of an educational CD-ROM planned around the entire event is in the works, and should be available on the Web as well. Cliff Toner has been working on the data to further refine our knowledge of the angular orientation of the network (see figure 1).

Next year's meeting, GONG 2004/SoHO 14, is being organized by Yale University and will be held 12–16 July 2004 in New Haven, CT. For more information, contact Sarbani Basu at *sogo04@astro.yale.edu*.

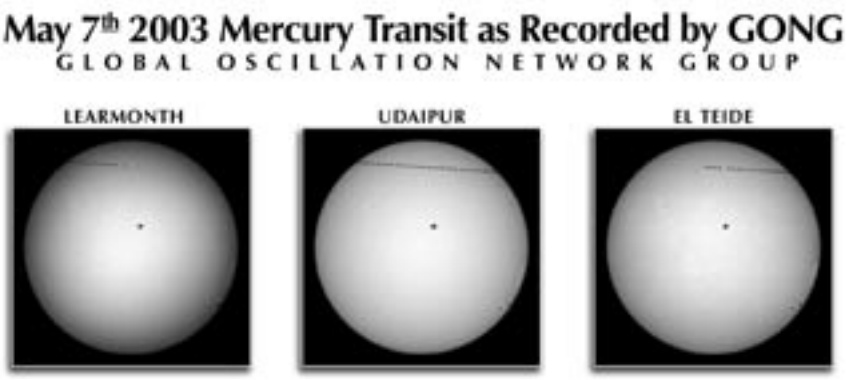

Figure 1. The transit of Mercury on 7 May 2003 was visible at three GONG sites. The transit was in progress when the El Tiede instrument began observing, Udaipur saw the entire transit, and Learmonth collected about 3.5 hours of the event before the Sun set. Included here is an excerpt from the press release, "Mercury Transit 2003: GONG Network Records Transit of Mercury; Ready for Venus," which is available, along with images and other transit sites and educational links, at gong.nso.edu/mercury_transit03/: "GONG's global network of telescopes captured and relayed images of the transit of Mercury across the face of the Sun on May 7, providing people worldwide with a safe, front-row view of the event. 'The network worked extremely well with clear skies at all three sites, and the data transmission back to Tucson was great!' said Dr. John Leibacher. 'We transmitted just one image from each site every 15 minutes, and a few were missed, but it looks like we'll have very close to 100% when the dust has settled.' . . . Dr. Cliff Toner said, 'Success with the Mercury transit sets the stage for next year's Venus transit, which will allow more accurate calculations because Venus is farther than Mercury from the Sun.'" The data will be used to verify the absolute angular orientation and image scale for these three instruments. It may also be useful in estimating the upper limits of our image distortion.

Operations

The GONG prototype instrument at the University of Arizona (UA) farm had originally been envisioned as a "ground simulator" for devising solutions to field problems, the development of new technologies, and also as a spare western-US site at a longitude between Cerro Tololo and Big Bear. Due to aging components, failures in the field systems have resulted in the prototype instrument being compromised. Since the development of the GONG+ instrument, it has been used to provide emergency spares for actual field systems and, as a result, it has lost much of its usefulness as a prototype and engineering site for the testing and certification of fixes and modifications, as well as a test bed for any possible new capabilities. George Luis has joined the GONG team to address reestablishing the GONG farm engineering site to a full-up working system. George has been working as an electrical engineer for SOLIS, and we are very happy to have him on the team. In addition to restoring

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the engineering site and working with the operations team, George will lead the planning of an additional shelter/instrument at the GONG farm that will serve as a field-swappable spare to address many of the issues in the transition to long-term continuous operations.

In the second quarter of 2003, two preventive maintenance trips took place. The first was to Cerro Tololo in May. Most of the work was routine except for the replacement of the Lyot Filter/Michelson Interferometer assembly. As we reported in the March 2003 *Newsletter*, the ADP elements in the Udaipur instrument's filter assembly have reacted with moisture in the air, bonded to the neighboring calcite elements, and turned cloudy at the interface. As a result, the filters at all of the sites will be rebuilt and replaced to prevent future failure.

The second site, El Teide, was visited in June. The interferometer was replaced, and the Uninterruptable Power Supply (which was failing to sustain the instrument during power dropouts) was repaired. At the end of March, a replacement CPU board and a DLT drive for the on-site SUN workstation arrived in Udaipur. The new items were quickly installed and, instead of halting approximately once per day and requiring a power-cycle reboot, the workstation began operating normally. This problem did not stop data collection, but did compromise our ability to monitor the instrument.

A major improvement at the Udaipur instrument was the implementation of an ISDN connection to Tucson. At present, this is the network's only special-purpose connection, as it is relatively expensive and our typical present usage requires only a modest bandwidth. The ISDN connection has greatly improved our day-to-day monitoring of the system. There continues to be some variation in the output of one of the four camera channels at Udaipur. The output variation has been known for some time, but has not been particularly detrimental. Unfortunately, this has changed over the last few months and the output data is no longer stable. The remedy will be to replace the camera when the instrument comes back up after the monsoon. The instrument has also failed to guide for extended periods of the day. This could be related to a parameter (which can be affected by particularly hazy atmospheric conditions) that assists the guider to lock onto the Sun. At the same time, the utility power and the GONG generator were not operating properly, so the site was taken off line for about two weeks. By then, the arrival of monsoon weather precluded further analysis of the guider performance. A maintenance team will be visiting India in October.

Figure 2. George Luis (left) and Sudhir Gupta are taking a closer look at the GONG light-feed. George has recently joined the GONG team to reestablish the GONG farm engineering site to a full-up working system. Sudhir, from the Udaipur Solar Observatory, was in Tucson participating in an intensive, hands-on training program for maintaining and trouble-shooting the GONG instrument.

During the last week of April and the first two weeks of May, the Learmonth, Udaipur, and El Teide instruments were switched from the normal observing mode into a calibration mode to determine the camera rotator orientations for the Mercury transit on May 7. Ideally, this would require sacrificing one day of observations at each of the three sites. However, because of undesirable weather and intermittent problems with the calibration observations, more time was required to get the needed data. Fortunately, all of the test measurements were made and the transit images were obtained at all three sites (see figure 1).

Data Management and Analysis

We would like to welcome two new members to the GONG staff: Irene Gonzalez-Hernandez and Shukur Kholikov. Shukur joins us from the Ulugh Beg Astronomical Institute in Tashkent, Uzbekistan and will be in charge of the time-distance and acoustic holography portions of the GONG pipeline. Irene has returned to helioseismology after an interlude as a programmer in a London financial

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institution. She will take over the ring-diagram pipeline, which Thierry Corbard installed. In addition, Anna Malanushenko has returned as a summer student and is continuing to work on farside imaging with Charlie Lindsey.

During the past quarter, the DMAC produced month-long (36-day) velocity time series and power spectra for GONG months 75 and 76 (ending 1 November 2002), with fill factors of 0.77 and 0.86, respectively. The Data Storage and Distribution System (DSDS) distributed 300 gigabytes in response to 26 data requests.

The ring-diagram and image-merging portions of the GONG++ pipeline have been undergoing improvements in the area of interpolation and restoration. Thanks to the Local Helioseismology Comparison (LoHCo) team activities, differences were found between ring-diagram results using GONG data processed through the Arizona (NSO/GONG) pipeline and GONG data processed through the California (Stanford) pipeline. The differences were in the number of modes fitted, the apparent frequency gradient across the disk, and artifacts in the ring diagrams.

Irene Gonzalez-Hernandez, Cliff Toner, John Bolding, Rachel Howe, and Rudi Komm tested several combinations of image restoration, as well as *sinc*, Fourier, and spline interpolation in both the image merge and the remapping and tracking modules. They found that the most consistent and best results were obtained using nonrestored, *sinc*-interpolated, merged images, and by using the spline interpolator in the remapping stage. We are thus adopting this combination as the initial standard GONG ring-diagram processing. We will, however, continue to investigate and develop fitting methods that can exploit the increased information content of the restored merged images. The completion of this testing means that we will be able to begin producing flow maps on a regular basis.

The SoHO/MDI group at Stanford University hosted the second LoHCo Group workshop on April 30. The workshop materials can be found on the Web at *gong.nso.edu/lohco/* along with the poster presented at the AAS Solar Physics Division meeting in June. Doug Braun at Colorado Research Associates hosted the third workshop in Boulder, CO, July 28–30. The LoHCo group has made good progress on the comparisons between data sets (GONG, MDI, and Mt. Wilson) and between the ring-diagram and time-distance methods.

Using the *V-I* multispectral fitting method that she developed, Caroline Barban has obtained intriguing pictures of the physical amplitudes and phases of the solar background components. The quantities are not at all random and have very clear signatures as a function of temporal frequency, but little dependence on degree. This implies once again that the source of the oscillations is near the surface. The detailed shapes of the curves will be used to constrain physical models of the excitation.

One remaining baseline processing issue is the full implementation of the high-time-coverage magnetogram capability. The current magnetograph modulator suffers from a rather slow switching time, which compromises the ability of the instrument to produce a reliable zero-flux point. Richard Clark has been working with Jack Harvey on the correction of the GONG+ magnetogram zero error. The accurate determination of the zero-point is important for two scientific uses. The first is the study of magnetic field changes associated with flares for which a zero error of 1 gauss is sufficient. The second is the study of slow-changing, large-scale fields used to infer the coronal magnetic field for which the zero error greater than 0.1 gauss is likely to be detrimental. The former has been achieved but the latter has proven to be very difficult. Although the continuous magnetograms are considered a by-product of the helioseismic data collection and processing system, their community value continues to rise, and therefore it is important to continue to investigate this issue. The limiting factor appears to be the noise level of the calibration magnetogram obtained at the start of the day.

At this point, it appears that further improvement can only be accomplished by modifying the instrument itself. Since this would take some time, a two-pronged approach has been established: GONG will make the once-an-hour magnetograms available to the community with the understanding that the zero-point is within 1 gauss, and upon request, once-a-minute magnetograms with the 1 gauss zero uncertainty will be prepared for selected time periods. Efforts to determine the zero-point to a tolerance of 0.1 gauss will resume at a later date as a research project. Richard has returned his focus to the automated rejection of bad images during the calibration process. He is running a suite of tests on a large amount of incoming data and will compare the results with those of Greg Ladd's visual inspection procedure, but we look forward to the automation very soon.