GONG Newsletter

Number 26 | The Global Oscillation Network Group | October, 1995

The GONG network is completely deployed and operational, and the DMAC has network data available for you!!!

It took 16 months of hard work from the first groundbreaking, at Learmonth, to the last camera alignment, at Udaipur, to complete the deployment of the network; not to mention the decade of design, development, and production that preceded it. Thank you, dear reader, for your patient support while the Project has been working to achieve this, and thank you to the Project staff and all of our collaborators and hosts around the world for all of their effort on behalf of *GONG*. Now is the time for you to get actively involved and help us all work with the data to pursue the exciting scientific investigations that are becoming possible.

The deployment sequence was chosen to achieve a three-site network, with roughly 120° separation at the earliest possible moment, in order to get data into the hands of the members — to start working with it to help understand the performance as rapidly as possible. The duty cycle for the first *GONG* month of three stations was a quite respectable 70%, and the data have been pushed all the way through the *DMAC* pipeline. All of the data products — including our first–cut frequencies — are now available through the *DSDS*. (See the boxes on page 10 and page 11.) If you do not already have an account with the *DSDS*, the simplest way to set one up is through our *WWW* server (`http://helios.tuc.noao.edu`).

While the Project team is still working on a long list of improvements to many aspects of the processing, we encourage you to get your investigations underway. At the same time, please appreciate the challenges associated with understanding the characteristics of such a complicated system, and initiating a number of complex processing tasks — such as merging imaged data — that have never been undertaken before.

The Science Teams are shifting into high gear, and they are scheduling working sessions to work toward three near-term goals for the presentation of their work: *i)* a summary presentation at the Winter meeting of the American Astronomical Society in mid-January, *ii)* a special issue of the journal "Science" to be submitted in February, and *iii)* a joint meeting with the *AAS* and its Solar Physics Division in June 1996. These "opportunities" are discussed starting on page 18.

John Leibacher

Deployment

Deployment is behind us at last. It took about 10 months from the very beginning to the very end when Frank Hill and the Red Team departed from New Delhi in early October. There were many anxious moments (many more of those than real problems), many successes, and many good times along the way. The short version of the story is this: all of the stations arrived where we intended them to go, none were damaged beyond repair, and they were all working when we left. Now, the rest of the story.

The activity officially began in Tucson last December when the Teide station was lifted by crane onto the back of a flat bed truck, beginning its personal odyssey to the Canary Islands.

What is Inside

The stories it could tell, if only it could talk! There was the day that one end of the external cable raceway and the doorknob were crushed beyond recognition at the hands of some nameless stevedore somewhere between Los Angeles, California and Santa Cruz de Tenerife. Then there was the day or days during that same period when salt water flooded over the station, corroding every lock and hinge that hadn't already been crushed, almost (if not completely) beyond use. This, however, was hardly sufficient to discourage either Frank Hill and the rest of *GONG*'s Red Team, or the truly excellent *IAC* staff at El Teide. The cable raceway was rebuilt by the observatory shops, the doorknob was replaced, and judicious application of bolt cutters, oil, clean water, and paint rendered the shelter indistinguishable from the condition it was in when it left the Arizona desert. The instrument itself went back together just like the manuals said it would, and the first data was obtained on February 17. The installation process took six weeks, which was exactly what had been scheduled. Special thanks go out to Pere Pallé, Jesús Patrón, Otilia de la Rosa, Antonio Pimienta, and many others at the *IAC* who helped us make our first deployment a success.

Next stop: Learmonth, Western Australia. Ed Stover and Rob Hubbard, the vanguard of the Blue Team, left Tucson on March 15, and caught up with the shelter in Learmonth on March 20. To our surprise the shelter was in *exactly* the same condition as the El Teide station. The cable raceway was crushed to the same unrecognizable pulp in exactly the same place, as was the doorknob. Were we dealing with the same evil stevedore, singling out the *GONG* project for this special attention, or were we missing something fundamental? While in Australia, Duane Miller, the blue team's instrument maker, saw a brief image on local television that provided us with the answer. The piece of equipment which is used world wide to move standard shipping containers around ports has a hydraulic ram that conflicts in several places with some of the modifications we had made to the container to make it into a *GONG* instrument shelter. Although we had asked for special handling, our "big white box" just looked too much like a standard shipping container, and was routinely being treated as such.

When the balance of the Blue team arrived in Learmonth, Master Sergeant Coffman, a member of the United States Air Force contingent at the observatory, gave us our official "in brief." The message was simple: drive on the left, pedestrians *don't* have the right of way, and almost everything that crawls or swims is deadly. If we would just keep our hands in our pockets and not leave our rooms, we would be safe. Coming from rattlesnake country, we were not so easily frightened. We did adopt the temporary site password *deathadder*, however, just as a reminder of our mortality. The bite of this particular serpent renders its victim dead within about 30 minutes in most cases. In the final analysis, the only death adder we saw was a dead death adder. (Self-inflicted wound?) The people and the critters alike were wonderful to us, and we had the second *GONG* network site up and running when the last of the team returned home on April 28. Here the acknowledgements have to include John Kennewell, Alex Liu, Major Jeff Carson, Jenny House, and the rest of the Australian and *USAF* observatory staff.

No rest for the wicked, however. After three weeks at home to get to know our families again, the Blue team was back in the air, preparing to install the Mauna Loa station. By now we had learned what pieces of the station should be removed prior to shipping, and the Mauna Loa station arrived in Hilo in far better condition than the first two. Most of the team left together this time, arriving in Hilo

Calendar

Event	*Date*	*Location and Contact*
The Solar Cycles: Perspectives and Future Research	April 1 - 4, 1996	Hermosillo (Mexico) Antonio Sanchez-Ibarra (antonio@fisica.uson.mx)
IRIS Team Meeting	April 1 - 4, 1996	Nice (France) Eric Fossat (fossat@ayalga.unice.fr)
GONG First Results Workshop	June 12 - 15, 1996	Madison (Wisconsin) John Leibacher (jleibacher@noao.edu)
Helioseismology 1996 Western Pacific Geophysics Meeting	July 23 - 27, 1996	Brisbane (Australia) David Cole and John Leibacher (david@ips.oz.au, jleibacher@noao.edu)
Heliosismology status and asteroseismology prospects IAU Symposium 181	September 30 - October 3, 1996	Nice (France) Gabrielle Berthomieu (astro96@rameau.obs-nice.fr)

on May 22. We had come to participate in a deployment in a tropical paradise, but instead we found ourselves — within a very few hours of making landfall — up at an altitude of 11,000 feet on a desolate volcano in the rain and fog. Every day we commuted two hours from Hilo to Mauna Loa Observatory, and two more hours home at day's end. We called our work site Mars, because it was slightly more colorful (though no less lifeless) than the moon. Our offerings to Pele, the goddess of the volcano, forestalled the next major eruption of Mauna Loa at least long enough for us to complete the task at hand. As proof that we do learn from our experiences, this deployment was completed in only four weeks. And just in case anyone out there is feeling too sorry for the Blue Team, Hilo may not be the greatest place in the world to look for beaches, but we found out where to drive to places that are. We actually suffered very little during our stay on the Big Island. Our heart-felt thanks in this case go out to Charlie Garcia, Eric Yasukawa, Darryl Koon, Russ Schnell and Judy Pereira for making this one a lot of fun.

Next came Cerro Tololo and a chance for the Red Team to try their hand for the second time. The activity began with the departure of Frank and most of the others on June 24. Once again, the support afforded our team by the local staff was nothing short of amazing. The shelter had arrived in excellent condition this time, and assembly proceeded very smoothly. Even the weather cooperated, yielding up almost summer-like conditions some days in the midst of the Chilean winter. It was reported that an unnamed instrument maker associated with the Red Team contingent lay prostrate on the ground for an extended period one day in an attempt to lure condors, but this cannot be confirmed. Nor can we categorically deny that his bunk mates staked him there. The end result was that the fourth *GONG* network site was left to the *CTIO* staff and the condors on July 22, another four-week installation. All kinds of thanks go out to Oscar Sáa, Ricardo Venegas, and all of the great people working at our sister observatory in the Chilean Andes.

The last hurrah for the Blue Team was Big Bear Observatory in southern California. Our adventure began on July 24. We had had more than enough of airplanes and transoceanic flights by this time, so the team just loaded up our gear, piled into two cars in Tucson, and headed west on Interstate 10. Although we were faced with eight hours of some of the hottest interstate driving anywhere in the *US* (it was 50˚C when we stopped for lunch in Blyth, California), the cool, clean air and spectacular scenery awaiting us at Big Bear Lake made it well worth the little bit of effort to get there. The shelter, too, had no boat rides to contend with, traveling the same interstate that we did about a day behind us. We saw it go by the window of the cafe at which we were enjoying a leisurely breakfast after a morning of shoveling sand in preparation for its arrival. No paint job this time. The shelter looked — not surprisingly — just like it had when it left Tucson a day earlier. What a fine place to work! The locals complained of the oppressive heat (it got up to almost 30˚C one day), but those of us used to the desert in July and August in Tucson could hardly relate to their complaints. We had the instrument up and running in about three weeks, but several of us remained a few extra days to train the Big Bear staff in the operation of the instrument, and to breath just a little more pine-scented air. We grudgingly returned home on August 18, ending our deployment adventures. Many thanks for help and fond memories go out to Bill Marquette, Jeff Nenow, John Varsik, Karen Carlson, Randy Fear, and Melinda Hope. It was the perfect ending for us.

The final test of the Red Team began with the Udaipur deployment on August 27. The Udaipur Solar Observatory staff at their new facility just outside of Udaipur already had the shelter and generator roughly in position when the team arrived. There were some delays initially, as two

The El Teide Station at the Instituto Astrofisico des Canarias site there, with the vulcano of the same name in the background, was the first GONG station to come online on March 2.

large install kits sent to India by air freight ultimately lagged behind the instrument shipment. The team and the *USO* staff did a great job of "getting along without" until the gear showed up about half way through the deployment.

Although frustrating, these delays did allow the team to take a day off to explore the countryside and do some site seeing. They visited a beautiful Jain Temple near Udaipur, where one of our number was confronted by an angry monkey. During what seemed like an innocent photo opportunity, the primate dropped down from its perch and assumed a fighting stance reminiscent of an antagonist skilled in the martial arts. Sang Nguyen — himself having earned a black belt in Tae Kwon Do — instinctively adopted a threatening posture of his own which so intimidated the ape that it opted to stand down and live to fight another day. Many skills are needed on a well rounded *GONG* install team.

Other than colds and flu that most likely accompanied the team all the way from Tucson, the balance of the deployment went smoothly. On October 3, that instrument came on line, and the network was complete. As always, there are many folks to thank, but we should certainly name Arvind Bhatnagar, Ashok Ambastha, Sushant Tripathy, Sudhir Gupta, Naresh Jain, Raj Mal Jain, and the team's driver, Chaman Lal Tak.

If we learned anything from our globe trotting experiences, it would include the following:

- The only thing one can be sure about if ships are involved is that they will arrive late, and the people in country will know about it before we do.
- Any *GONG* deployment team member is by nature and training more dangerous to his or her colleagues than any indigenous insects, reptiles, or sea creatures.
- The weather will always be good until it needs to be.
- When the going gets tough, trust the local people. They'll know what to do!

Rob Hubbard

The Learmonth station at the Learmonth Solar Observatory of the IPS Radio and Space Services in Exmouth, Western Australia became operational on April 28. The SEON radio telescope can be seen in the background.

Instrumentation

Where is the best place to put the focus? (Part II)

In the last Newsletter we discussed the issue of how to focus the *GONG* instruments to best avoid problems with spatial aliasing. The article ended with the words "Stand by …". This is a further report about the issue.

All imaging helioseismology instruments have to deal with spatial aliasing. Unlike the well studied problem of spectral contamination by temporal gaps and crosstalk with modes of nearby ℓ and m values, there has been little study of spatial aliasing and its effects in helioseismology. Stated simply, discretely sampled images of the Sun can produce a result in which a high-ℓ spherical harmonic may mimic a low-ℓ harmonic if the image is undersampled. The result is that different modes may appear at the same place in an oscillation spectrum.

The usual way of avoiding the problem is to either use a large number of pixels and/or a small aperture telescope such that the highest spatial frequencies present in the image are below one-half the sampling frequency (known as the Nyquist frequency). For CCD arrays of a few hundred pixels on a side, this means a telescope aperture of less than one cm. Such small apertures have been used with a few moderate ℓ helioseismology observations, but more typically a somewhat larger aperture is used because of the needs for accurate guiding and greater light flux to obtain high signal-to-noise ratio measurements. There is also a natural desire to try to observe modes with ℓ values as close as possible to the Nyquist frequency. These pressures to violate the sampling theorem lead to the spatial aliasing problem.

As explained in the last Newsletter, the *GONG* instrument was designed to attenuate high spatial frequencies in the image of the Sun before it is

The Mauna Loa Station was commissioned on June 15. The instruments of *NOAA*'s Climate Monitoring and Diagnostic Laboratory can be seen in the background. The *GONG* station is being operated in collaboration with *NCAR*'s High Altitude Observatory site there.

sampled by the *CCD* detector. The attenuation is done by a combination of a small amount of spherical aberration and a larger amount of defocus. Atmospheric seeing also attenuates high spatial frequencies. When it is in focus, the *GONG* instrument violates the sampling theorem. The result is spatial aliasing. It is possible to defocus the instrument enough to satisfy the sampling theorem fairly well but the penalty is significant attenuation of modes with ℓ below the Nyquist frequency.

Also as explained in the last Newsletter, the initial plan for the *GONG* instruments was to defocus enough to attenuate $\ell = 250$ modes by about a factor of six. With the current CCD cameras used by *GONG*, this amount of defocus attenuates spectral features of moderate ℓ relative to the instrumental background noise level more than is desirable.

We have evaluated the options of staying with this focus, going to an in-focus setting, and an intermediate focus setting. Many competing factors interact to make the choice difficult. The goal is to keep the solar background noise and *p* modes above the instrument noise level up to the Nyquist frequency while attenuating these features to a level smaller than the instrumental level above the Nyquist frequency. This will not eliminate spatial aliases completely because long integrations will reveal narrow spectral aliases against the smooth spectral background. For the record, the amount of defocus chosen is 1% of the camera lens focal length which operates at f/25. This choice increases the ratio of the response of the system at $\ell = 100$ to its alias at $\ell \sim 600$ by more than two orders of magnitude in power compared to an in–focus system.

Since most other helioseismology imaging instruments also suffer from spatial aliasing, it is time to explicitly deal with it in the production and analysis of *p*-mode spectra. This is an interesting challenge. There are several characteristics of the aliases that may allow them to be "dealiased". For example, one might produce two spectra from the same data, one favoring the disk center where aliasing is strong and one favoring away from disk center where aliasing is weak. The difference should allow aliases to be distinguished from non-aliased features.

Cliff Toner has made significant progress in establishing where the spatial aliases fall in the *m*-ν spectra, and we are optimistic about our prospects for dealing with the artifacts until a higher resolution camera becomes available.

Jack Harvey

Timing of Helioseismic Observations

It may seem to be a simple thing to decide how to time helioseismic observations. For the *GONG* observations, it was decided long ago to synchronize the observations at all the sites and to integrate observations for exactly one minute. The main issue remaining is when to start the one-minute integration periods. Why not start on minute ticks? When we refer to time casually, we mean the time used in everyday activities. This is Coordinated Universal Time (*UTC*) plus some number of hours appropriate for the time zone of the user. *UTC* is widely available and is maintained to about 1 millisecond synchronization among various countries. Although *UTC* has the same rate as atomic time, the varying rotation of the Earth requires that sometimes leap seconds be added or subtracted to *UTC* at the end of June or December. Having a minute of 59 or 61 seconds duration every once in a while can be an observational and instrumental nuisance.

A better observational time system is international atomic time (*TAI*) which does not have leap seconds and is the current *SI* time standard. During 1995, *UTC* minute ticks are 29 seconds later than *TAI* minute ticks. The Global Positioning System (*GPS*) distributes time via 24 satellites that is synchronized to *TAI* to an accuracy better than a microsecond. Each

GONG site has a *GPS* receiver to obtain *GPS* time. *GPS* time started at midnight on 5 January 1980 with a delay of 19 seconds relative to *TAI* (*i.e.* in synchronization with *UTC* on that date). Thus, a solution to when to start *GONG* minute-long integrations is simply to use *GPS* minute ticks.

Things get more complicated when we want to coordinate observations made by different projects. In particular, it seems to be a good idea to try to take both *GONG* and *SOI* data in synchronization. The *SOHO* spacecraft will be five light seconds closer to the Sun than the Earth. Therefore, *GONG* should start its one-minute integrations five seconds later than *SOI*. *TAI* will be available on the *SOHO* spacecraft and it is planned to center *SOI* observations on *TAI* minute ticks. Thus, for a one-minute observation, *SOI* will start 30 seconds after a *TAI* minute tick and *GONG* should start 5 seconds later, or 35 seconds after the *TAI* minute tick. Since the *GPS* tick is 19 seconds after the *TAI* tick, this means that *GONG* should start 16 seconds after the *GPS* tick.

This complicated situation can be summarized as a progression of events:

- 0 sec - *TAI* minute tick (simultaneous on *SOHO* and Earth)
- 19 sec - *GPS* minute tick
- 29 sec - *UTC* minute tick (until 1996 January 1)
- 30 sec - *SOI* start of one minute observation
- 35 sec - *GONG* start of one minute observation

This scheme for taking *GONG* data started on April 11, 1995.

There are several subtle issues of timing. For example, as Earth moves toward and away from the Sun during the year, the observed frequency and phase of a coherent oscillation of the Sun will vary by a small amount. Also, an oscillation seen at the limb is seen about 2.3 seconds later than the same oscillation at disk center due to the increased light travel time. As the Sun's brightness waxes and wanes during a day at a *GONG* site, the intensity-weighted center time of a one-minute integration will vary slightly in such a way as to make the observations seem to be taken a bit faster than one per minute. This later effect on frequencies is small, of the order of a part in 200000. It can shift the velocity zero point by up to 2 m/s for observations made when the brightness is rapidly changing.

For those interested in matters of time, the Astronomical Almanac is recommended. The latest information about leap seconds can be found on the World Wide Web at *URL* `http://maia.usno.navy.mil`. This *URL* also points to other sources of excruciating detail about time and related matters. A discussion about synchronizing *GONG* and *SOI* is found in *SOI* Technical Note 24 by Bogart, Bush and Harvey.

There is a second, less critical issue of synchronization between different helioseismology projects. This has to do with the length and start times of reduction periods. In the *GONG* project, data products such as ℓ-ν diagrams are generated on daily and roughly monthly bases. The *GONG* day is 24 hours long. It starts with the first one-minute integration that falls entirely within a new *GPS* day. In other words, the first observation of a *GONG* day is the one that starts at 00:00:16 *GPS* time or (in 1995) 00:00:06 UTC.

Users of *DSDS* ancillary and quality assurance products (not time series of velocity images) should be aware that daily products from single sites are stored using the local date in the name rather than *GPS* date. This is to avoid the problem that some sites experience two *GPS* dates during an observing day. Users of ancillary items in individual image headers should check with the project to determine what time the particular item was measured within a one minute interval.

The *GONG* 'month' is 36 *GONG* days. The project will reduce a 'month' of data every half 'month'. The first *GONG* Month started on May 7, 1995.

Jack Harvey

The Cerro Tololo station — dwarfed by the nighttime telescopes of the Cerro Tololo Interamerican Observatory and the Chilean Andes — came online on July 20.

Operations

Just a few short months ago all six *GONG* instruments and the tools needed to deploy them were lined up out at the integration site in Tucson, awaiting trucks, boats and airplanes to carry them to their destinations around the world. Now we're a network. All six sites have been deployed, and the old prototype has been moved from the Rincon Vista site to the Farm, where it has been upgraded to production standard. That station is also operational.

The significant organizational changes that have resulted from this change in our lives are outlined starting on page 17. In summary, there is now a group of people within the project whose primary job it is to operate and maintain the network.

The highest priority of the new Network Operations group is keeping the data flowing. As one might expect, the most critical people in this regard are the dedicated folks working with us at the host sites. We have provided them with remote status boards, usually located in an area at the host site where the technical people spend most of their daylight hours. For example, at Big Bear, the status terminal is located in one of the offices in the dome, while in Learmonth, it's located in the radio (*RSTN*) building. What the local folks see is a video simulation of green, yellow and red lights indicating the status of the instrument. Green means the instrument is operational and all monitored parameters are within operating limits; yellow means a parameter has become marginal, but the bits are still flowing (or could if the Sun were out); red means that the site is no longer operational. The display also shows an intensity image derived from the digital data and updated every minute, and a magnetogram derived from the most recent hourly observation. A graphical user interface allows the on-site personnel to enquire as to the state of about 100 monitored instrument and weather parameters, and generally determine the exact source of trouble should problems arise.

What we have noticed so far in nearly six months of operating instruments in the field is just how good the people at our host sites are. We have had very few serious problems so far, and in many cases the scientists and technicians at the site have been able to fix things without our help at all! But when serious problems arise, the first step is to contact the *GONG* Network Operations Duty Responder (know locally as the "Duty Dude"). That is an individual within the Network Operations group whose job it is to monitor the Internet, the phone, and fax machine for trouble and service requests. Only two of our sites are not currently on the Internet, and they expect to be soon. Thus, electronic mail has proved to be the best way to contact us and get the group here working on the problem.

So what does the traffic from the sites look like so far? A review of the activity over the last 30 days looks something like this:

Issue	*Service Requests*
Routine Correspondence	6
Tape problems	4
Modem problems	2
Network Connections	2
Computer hung	1
Image Display	1
Shelter Thermostat	1

The "Routine Correspondence" items include things like shortages of supplies, and other notes and comments on the routine operation of the instrument. We have had some problems with the modems at two of the sites, requiring in both cases some intervention by local experts. The so called "Network Connections" problems involve failure of the local-area network at two of the sites, which temporarily kept us from obtaining status and operations traffic over the Internet. (The modems are the fall back in this situation.) The "Hung Computer" was the *SPARC* station (not actually part of the data path), and was fixed with a reboot; the cause is still unknown.

The biggest problem is data taping, and this one-month score card somewhat understates the problems that we

The Big Bear station in the San Bernardino mountains of southern California, with the Big Bear Solar Observatory in the background, came online on August 17.

have been having with tapes and tape drives. Two of the service requests during the last month relate to Exabyte tape drives that had to be replaced at two different sites with new units shipped from Tucson. Prior to this, we have had a number of other problems with these and other drives, requiring operator intervention in most cases. These were also caused by tape drive hardware problems or media errors. Fortunately each site has four of these drives in service, and two more available as additional backups. For this reason, we have lost only about six hours of data from a single site as a result of these various failures since the first station came on line in March. Still, we're sure that the Exabytes are the biggest source of frustration for the on-site personnel, to say nothing of the operations group here! We are anxious to have a look at our data-taping software to see if we can't make it more robust to hardware failure, and see if we cannot take better advantage of the redundancy that we have at our disposal at each site.

In addition to this sort of "passive" support of the *GONG* network (that is, sitting by and waiting for the phone to ring), we also have some active procedures in place. Every morning (Tucson time) someone remotely connects to each station, looks at the status, and reads any messages sent to us by our hosts, or by the operating software. Next, we download the last 24 operating hours of instrumental engineering parameters. These minute-by-minute values, such as power supply voltages and motor currents, are analyzed daily back in Tucson for unusual behavior, and become part of a data base allowing longer-term analysis for trends and signs of fatigue and imminent failure.

Keep an eye on this column in future *GONG* Newsletters to see what works, what doesn't, and what we're doing to fix it. So far, we are very pleased with the reliability of the stations over all. Our goal is to bury you in excellent data!

Rob Hubbard

The Udiapur station at the Physical Research Laboratory's Udaipur Solar Observatory, which came online on 3 October completing the network, is watched over by a Hindu temple in the background.

Data System

Data Management and Analysis Center

During the past six months, the *DMAC* successfully integrated the algorithms for refining the limb geometry and extracting *MTF*s and for merging multi-site data using a *MTF*-derived weighting scheme into the data reduction pipeline. The *DMAC* reduced network data acquired by six deployed network instruments (including the prototype in Tucson), test data acquired to verify the successful installation of six instruments, and test data acquired as construction of the observing instruments was completed at the University of Arizona farm site before the units were disassembled for shipment. The project also generated data products from the first *GONG* month (36 days) of network data that was acquired by the three-site mini-network of Teide, Learmonth, and the Big Bear station in Tucson. This included month time series, power spectra, and mode frequency information that were made available to the participants in the inversion workshop that was held in Boulder.

With the onset of network operations, the data reduction activity in the *DMAC* has increased dramatically. For example, the number of site days calibrated per calendar month has increased from 25 in February to 152 in August. The upstream data reduction stages that perform site-dependent processing (*VMICAL*, *GEOMPIPE*, *DNSPIPE*, and *AVER*) have ramped-up more quickly than anticipated. Except for *AVER*, these reduction stages have been maintaining backlogs of about 50 site-days.

A key technical hurdle for merging multi-site image was the precise determination of the orientation of the cameras in the observing stations. A procedure developed and implemented by the instrument team successfully satisfied this requirement. This information was integrated into the data reduction software that registers the velocity images into heliographic

Next Meeting of Inversion Team in Tucson in December

The Inversion Team is planning to have an extended working session in Tucson during an interval starting about Wednesday December 6, 1995 and ending on about Tuesday December, 19. We are hoping to have the greatest overlap of team members during the middle of that interval, from about December 10 to 17, but recognize that various individual schedules may favor coming earlier or leaving later. The primary objective is to have close interaction among the inversion team members and resident *GONG* project experts in discussing the scientific interferences for differential rotation and mean structure that can be drawn from both the multi-station and full network data that has become available by then. A number of inversion team members are typically in twice-weekly contact by workstation conferencing to discuss progress related to frequency fitting and inversion of the resulting data sets, and on developments related to the joint inversion workbench. If anyone would like to join in those conferencing sessions, please inquire of either Sylvain Korzennik or Mike Thompson for details on how to participate. Further, all *GONG* members are most welcome to join in the general activities of the inversion team, and to join also in the Tucson working session if their time and interests permit. More details about the December working session, with opportunities to work actively on the *GONG* data using the inversion workbench tools on a suite of workstations and x-terminals, will be available from either Douglas Gough or Juri Toomre (inversion team co-leaders) at least by 10 November. (Prior to that Toomre will be on travel in India.)

coordinates.

In general, merging the mode coefficient time series from multiple observing sites has proven to be less problematic than anticipated. By the end of the exercise that merged the first *GONG* month, this data reduction stage was operating routinely. At this writing, all available data through July 30 has been merged.

The *DSDS* is moving the user interface for the catalog query and data product request functions from *CURSES* to *HTML*. This development was released for testing and was discussed with the *DMAC* Users' Committee at the recent meeting in Boulder.

The *DSDS* also recently conducted a survey of its users regarding various technical aspects of using the projects facility for accessing data products. The *DSDS* received 25 responses from the 64 *GONG* members to whom the survey was emailed.

With the ramp-up of network operations, the frequency and volume of data requests has also increased. Eleven data distributions totaling 9.7 *GB* were made in July and six distributions totaling 19.2 *GB* were made in August. This compares to zero distributions in February and two distributions totaling 101 *MB* in March.

The *DMAC* Users' Committee met at *HAO* in Boulder on August 14. Dave Hathaway's report on the meeting appears elsewhere in this newsletter. The meeting focussed on the first *GONG* month data products and the ramp-up of network operations.

Marguerite Rodriguez who had been working as a *DSDS* operator left Tucson in March, but we were fortunate to be able to quickly fill the vacancy with Robert Perry. Rob operates the *DSDS*, performs various system administrative tasks, and develops and supports database applications. In August, Tatia DeKeyser joined the project. Tatia operates the data reduction stage that refines the geometry of the solar images and extracts the *MTF*.

Jim Pintar

Data Management and Analysis Center (DMAC) Readiness Review

An expanded *DMAC* Users Committee met in Tucson on March 16th for a readiness review of the *DMAC* facilities and pipeline software. The review committee consisted of Tim Brown, David Hathaway (chair), Todd Hoeksema, and Steve Tomczyk. (Sylvain Korzennik and Mike Thompson were unable to attend.)

The *GONG* staff members presented reports on the current status of the *GONG* pipeline software as well as the status of the *DMAC* itself. The committee listened to these reports, asked questions for clarification, and provided a list of recommendations. This report consists of a brief overview of the presentations along with the recommendations themselves.

DMAC Overview: Jim Pintar gave an overview of the *DMAC*. This facility is designed to develop and support the data reduction and analysis software for reducing the *GONG* field data to produce the Data Products. The facility also supports the *GONG* community's access to and use of these Data Products. The *DMAC* is composed of several subsystems: the

Off-site Copy Facility (*OCF*), the Data Storage and Distribution System (*DSDS*), the Field Tape Reader (*FTR*), and the data reduction pipeline with its own subsystems. The facility currently includes 17 workstations (mostly Sun *SPARC* machines running *SUNOS* 4.1.3 or *SOLARIS* 2.4 but also including two *DEC5000*s, a *DEC3100*, and an *RS6000*) with 120 *GB* of disk space, 32 Exabyte tape drives, and a Exabyte Cartridge Library with a capacity for 10,000 cartridges. There are currently 12 full-time employees with plans for four additions as the network is deployed. Each data processing step must be capable of processing ten site-days of data per day in order to keep cadence with the flow of data from the six-site network. This assumes that data is not processed on weekends, holidays, and vacation days.

Off-site Copy and Storage Facilities (*OCF*/*OSF*): Jean Goodrich reported on the *OCF*/*OSF*. The *OCF* produces duplicate copies of all archived data products and stores them in the *OSF* located in the basement of the Kitt Peak Vacuum Telescope building. This activity does not require continuous operator attention and can be run as a background activity. One outstanding issue concerns finding a reliable method for testing the cartridge quality.

Data Storage and Distribution System (*DSDS*): Wendy Erdwurm and Marguerite Rodriguez described the *DSDS*. The *DSDS* does the cataloging and archival storage of the data products, supports the data reduction pipeline, and provides the user interface for data product queries and requests. This system is the central hub for the *DMAC*. It consists of two *SPARC10/51s* and a *SPARC20/61* (the community's User Machine helios) running *SOLARIS* 2.4 with *ORACLE* as the database management tool. *GONG* member accounts are provided on helios to enable members to query the *GONG* data product database and to order *GONG* data products. The data products are distributed via network or tape with the network distributed products being placed in the users space on helios. An anonymous ftp area is also maintained on helios for standard datasets and a *WWW* interface is planned. On-line storage is currently one *GB*. Each of the two *DSDS* operators can currently process 20 new data tapes per hour, make ten on- line transfers per hour, and produce two three-*GB* data distributions per day. Future user demand for both disk space and data distribution are still somewhat uncertain.

Field Tape Reader (*FTR*): Dave Armet described the *FTR*. This system is the interface between the data acquisition sites and the *DMAC*. Data tapes are received from the *GONG* field stations, copied to disk, written to tape for pipeline analysis, and data characteristics from the headers are plotted. The original field tapes are then stored in the *OCF*. Two one-week field tapes can be processed per day with the current system.

Data Pipeline Processing Steps

Calibration (*VMICAL*): Dave Armet also described the pipeline calibration step *VMICAL*. This step takes data tapes from the *FTR* and produces calibrated velocity (*V*), modulation (*M*), and intensity (*I*) images that are then written to tape. These images are also viewed on screen and bad images are noted by the operator and flagged as such. Single image gaps are filled by interpolation and *VMI* images taken from the magnetograms are rescaled to match the standard *VMI* images. Currently four to five site-days of data can be processed each day by two operators.

Hankel Geometry (*GEOMPIPE*): Jean Goodrich described the *GEOMPIPE* pipeline procedure. This procedure takes *VMI* images from *VMICAL* and produces a more accurate measure of the image geometry along with a measurement of the image modulation transfer function (*MTF*). The *MTF* is then used in the merging step further down the pipeline. *GEOMPIPE* performs a flat field correction to the intensity images, calculates the optimum geometry and updates the geometry header parameters, and calculates the *MTF* for the intensity images. Current performance on a *SPARC* 10 allows for the reduction of one site-day in three hours. Nearly half of this processing time is associated with reading data from tape and then writing it back to tape afterward.

Site-day Mode Coefficients (*DNSPIPE*): Ed Anderson outlined the *DNSPIPE* pipeline step. This step takes calibrated velocity images from *VMICAL* and *GEOMPIPE* and

GONG Merged Velocity Mode Frequencies Available

The *GONG DMAC* announces the first *GONG* Velocity Merged Mode Frequencies are available for distribution. There is a table for each ***l***-degree, 0-250. Each table will be distributed as a compressed text file. The set of tables is 75 MB, compressed, 376 MB uncompressed. The entire set of tables can be ordered as as online distribution. The *DSDS* will assist any *GONG* member with repackaging the set of compressed files for optimum remote transfer to his/her home institution. To transfer the 251 files using ftp, invoke ftp with the flag to turn off interactive prompting during multiple file transfers. Within the ftp protocol, set the transfer type to binary and execute the mget command. Tape distributions are always available. If you have any questions or encounter any problems after receiving a mode frequency distribution, please contact, the *DSDS* operators, Wendy Erdwurm, (520)-318-8371, Rob Perry, (520)-318-8523, or via e-mail to dsds_operators@noao.edu.

Query: Order GONG DATA via WWW

The *DSDS* announces the release of an *HTML* (HyperText Markup Language) version of *mqry* and *mdata*. It provides *GONG* members the capability to query and order *GONG* data via the World Wide Web. The URL for the system is *http://helios.tuc.noao.edu/gong_query.html*.

The *DSDS* has created, in each member's home directory on helios, the user, group writable directory, *www*. All files required as inputs to, or created as outputs by, the *WWW* server software reside in this directory. A new chapter, *Data Query and Distribution via WWW*, has been added to the *DSDS* User's Guide.

produces a time series of spherical harmonic coefficients and an ℓ-ν diagram for each site-day. The velocity images are remapped to heliographic coordinates, filtered to remove the low frequency velocity signal, apodized, and then projected onto spherical harmonics. Gaps in the spherical harmonic coefficient time series are filled and then power spectra and ℓ-ν diagrams are produced. One operator using a *SPARC* 20 can process ten site-days per 8-hour working day.

Multi-site Merge (*MERGE*): Winifred Williams described the multi-site merging process *MERGE*. This process takes the individual site-day time series along with the image MTFs to produce a merged network-day time series of mode coefficients. The merging process calculates weights from the MTFs and produces a weighted mean of the individual site coefficients for the network coefficient. This process takes about one work-day on a *SPARC* 20 to produce a network-day time series.

Month Products (Time Series, Power Series, Frequencies) (*MTS*, *MPS*, *PEAKFIND*): Ed Anderson described the pipeline procedures for the *GONG* month products. These steps start with the network-day coefficient time series from the *MERGE* process. Every 18 days a 36 day *GONG* month time series (*MTS*) of the coefficients is produced. Power spectra (*MPS*) of these time series are calculated and the frequencies of the individual modes are found (*PEAKFIND*). These three procedures must be completed in 18 days to keep cadence with the network. It currently takes about 2.3 days to produce the time-series, 3.1 days to produce the power spectra, and about nine days to find the peak frequencies. The *PEAKFIND* algorithm is still evolving. The additional complexity of future processes may override any increases in efficiency that might save processing time on this step.

Four-minute Cadence Time Averaged Images (*AVER*): Jim Pintar described the procedures (*AVER*) for producing the time-averaged images for the low frequency modes and the nearly steady flow components. These procedures take *VMI* images from *VMICAL*/*GEOMPIPE* and apply a 17-minute temporal average to remove the *p*-mode oscillations. This new time series of images is then resampled at four minute intervals. In addition, the velocity images have the signal due to the observer's motion removed and a detrended velocity image with solar rotation removed is also produced. Currently this step requires one day to process eight site-days.

Findings and Recommendations

The review committee was delighted to find that all the necessary pieces for the *GONG* pipeline now exist in working form. Considering some of the gloomy predictions of several years ago and the uncertainties related to some processes, amazing progress has been made. The committee was particularly happy to see the image geometry (*GEOMPIPE*) and merging (*MERGE*) sections up and running. The calibration procedures (*VMICAL*) also seem to be well in hand. We were all impressed with the attention to detail shown by the *GONG* staff members in each of the task areas. We found that all of the data processing steps now operate at a cadence close to that needed for operating the six-site network. We did find some need for improvements and offer the following recommendations.

1. The *GONG* project should make an initial one-time effort to push a three-site network month (36 days at ~80%) through the entire pipeline at the earliest reasonable time. This would exercise the *DMAC*; provide an important test of the pipeline from end-to-end; and put real data in the hands of the *GONG* community for analyses that might reveal unforeseen problems. After digesting the results of these analyses, *GONG* should focus on getting the software into final form.
2. *GONG* should continue hardware/software improvements to ultimately get the processing steps done in half the time needed to maintain cadence with the network. Many steps seem to be uncomfortably close to being right on cadence. This will make the inevitable need for reprocessing data very difficult to undertake. Since several steps seem to be I/O bound, hardware upgrades may go a long way toward reaching this goal.
3. The time, both human and machine, consumed in I/O is a significant part of many processing steps. Substantial savings, at least on the input side, could be realized if the verification of output tapes were in some cases separated from the analysis pipeline and data were made available to the following pipeline element on disk. We urge the project to evaluate this possibility.
4. Pipeline steps *VMICAL* and *GEOMPIPE* should be combined.

GEOMPIPE takes *VMI* images from *VMICAL* and outputs *VMI* images with additional header information on the image geometry. Combining the two would eliminate one I/O cycle. Other steps should be evaluated for similar savings.

5. The *MERGE* step is particularly I/O bound. We recommend investigating adding disk or tape drives to alleviate this problem.
6. The image characterization method should be improved. The current procedures merely flag images as good or bad. Since an informed judgement is being made to reject images, it would be helpful to record why, perhaps by simply making a selection from a standard list of reasons, so that others who might want to keep such images have some means of identifying them. It would also be good to document what criteria are used in rejecting images, what characteristics are used to decide whether an ℓ-ν diagram is good or bad, and to develop some level of standardization among the evaluators.
7. It would be desirable to have more data available on-line. We suggest that *GONG* keep track of what datasets are most requested and then provide more disk space for keeping some of these on-line.
8. *GONG* should survey the community to better determine what software and data will be requested and in what volume. This should include ascertaining how much employee time will be needed to support the *GRASP* software and provide help to the community in its usage. Volunteers from the community might be enlisted to help with this last point and in establishing and maintaining a library of contributed software.
9. *GONG* should "cross-train" individuals so that at least two people are capable of running each section of the pipeline. The pipeline should not come to a stand still when a crucial staff member is unavailable.
10. *GONG* should strive to make their computing environment more uniform. The pipeline elements currently run on several different makes of machine under several different operating systems using different shells and environmental variables. It is crucial that data be processed with documented and known software. We are concerned that this could be a source of problems.

Dave Hathaway

GONG '95 - Asilomar Proceedings

Advance copies of the Proceedings arrived on October 3 via airmail. Thanks and congratulations to Bruce Battrick, Todd Hoeksema, and Margie Stehle for their expeditious handling of the editing and publication. The rest should be following along soon.

10th DMAC Users Committee Meeting

The *DMAC* Users Committee (*DUC*) met at the *GONG DMAC* in Tucson on Friday March 17, 1995 following the *DMAC* Readiness Review. In attendance were committee members Brown, Hathaway (Chair), Hoeksema, and *GONG* representatives Anderson, Erdwurm, Hill, Leibacher, Pintar, and Toner. Korzennik and Thompson were unable to attend but Tomczyk sat in for part of the discussions.

Hill presented the status of *GONG*. Comparisons between instruments, both at common sites and at multiple sites, have been performed. The Big Bear instrument results have been compared with those from the Teide, Udaipur, and Learmonth instruments while all were at the farm site. Comparing time series for mode coefficients shows good agreement. The Big Bear instrument results have also been compared with results from the Teide instrument after the latter was deployed at its site in the Canary Islands. There was also good agreement between these results. The residual differences are attributed to camera errors: offsets in camera angle and in the position of the axis of rotation. Current plans are to use drift scans to better determine the orientation. These comparisons also reveal velocity scale factor differences from instrument to instrument. Additional efforts may be needed to produce more uniform results. (Hill's responsibility.)

Erdwurm described the recent progress on the *DSDS*. Work is underway to produce a *WWW* interface to the *DSDS* that would be similar in function to the present menu system. This would allow easy access to the *DSDS* from a wide variety of platforms and systems. Information on Data Events will also be more readily available under both systems. (Erdwurm's responsibility.)

Hill discussed the *GONG*/*SOI* comparison. This exercise was meant to test the *GONG* data processing algorithms and software by pushing data through these two (almost) independent pipelines. *SOI* data is not available but the *SOI* project should be ready to analyze *GONG* data within the next few months. Meanwhile, the analysis of the artificial data string is in progress. (Hill's responsibility.)

Toner reported on the defocusing experiments. Spatial aliasing from the high ℓ modes was noticed in previous analysis of *GONG* data. Although some scientific information is contained in this signal, the *DUC* suggested that the signal be removed to produce a cleaner spectrum. Toner found that defocusing the instruments can remove the aliasing but it also reduces the amplitude of the $\ell = 250$ modes by a factor of about 5. Defocusing also introduces noise at the limb which shows up as streaks at constant ν in an ℓ-ν diagram. Further testing is in order. (Toner's responsibility.)

Toner also reported on the image restoration procedures. The image *MTF* is determined from the intensity images and then used in a deconvolution routine to produce clean intensity images that are then used to produce *VMI* images. The process is still too slow to become a part of the pipeline but might be done elsewhere for interested *GONG* members. Additional work is needed to determine the low-ℓ response of this procedure. (Toner's responsibility.)

Anderson described his work on the peak bagging procedure *PEAKFIND*. This procedure fits a Lorentzian on a linear background to each peak to determine the frequency and width of the peak. Testing is underway with artificial data. Additional work is needed to characterize errors and for handling asymmetric peaks. Schou's *a*-coefficient code is due to be imported and tested as well. (Anderson's responsibility.)

Anderson also reported the 16 *vs.* 32 bit data storage. The images are well represented by 16 bits. The 16 bit time series shows only very small differences from the 32 bit time series. The *DUC* recommends storing data as 16 bit *FITS* files with *BZERO*=0 and *BSCALE* set at 6 to 10 standard deviations above the signal in the time series so that outlying points don't go off scale. (Anderson's responsibility.)

Pintar presented the current status of the Low Frequency/Nearly Steady Flow pipeline. This pipeline conveys 17-minute Gaussian-weighted averages of the *VMI* images at 4-minute intervals. Outstanding problems with this data include the presence of gradients and zero offsets that vary with time. Improvements in the calibration procedures may alleviate these problems. At the moment the variations are well fit by linear trends that can be removed from the data. (Pintar's responsibility.)

The next *DUC* Meeting is set for Thursday, August 17, 1995 in Boulder, Colorado. Brown and Hoeksema will be completing their terms on the committee and will be replaced by Tomczyk and Schou.

David Hathaway

11th DMAC Users Committee Meeting

The *DMAC* Users Committee (*DUC*) met at *HAO* in Boulder on Monday August 14, 1995. In attendance were: committee members Hathaway (Chair), Korzennik, Schou, Tomczyk, and Thompson, *GONG* representatives Anderson, Erdwurm, Hill, Leibacher, Pintar, and Toner, and *GONG* community members Brown, Gilman, Gough, and Toomre.

Pintar presented the current status of *GONG*. The site installations have gone better than expected with five of the six sites deployed at the time of the meeting. A new strategy for aligning the telescopes to geographic north has been developed. It relies on the proven technique of letting the image of the Sun drift to establish an east-west line in the focal plane. This function then defines the locus of the drifting limb, and it is fit with a model that allows the east-west direction to be accurately determined. The *DMAC* is now quite busy processing data from the first *GONG* month. Data requests to the *DSDS* are increasing and some activities of the Offsite Copy Facility have been taken up by the *DSDS* as well. The Field Tape reader is keeping up with the current data flow. However, the pipeline processing is experiencing backlogs which are expected to grow to be as much as 6 months long on some data products. The only staff change since the last meeting was hiring Rob Perry to replace Marguerite Rodriguez. At least two people are now capable of running any of the processing steps as was suggested by the *DMAC* review (with the exception of *PEAKFIND*, which is run by Anderson only, and *AVER*, which is run by Pintar only).

Hill described some of the results from the processing of the first *GONG* month of data. This first month included data from three sites (Learmonth, Teide, and Tucson) with about 75% coverage for 95/05/07 through 95/06/11. The sidelobes at 1/day are less than about 1%. Several problems have been identified in the data. The power spectra show problems at $\ell = 0$-3 that have been attributed to changes in the ephemeris velocity from one image to the next that are not accounted for in the backward time differencing. There may also be some problems due to camera nonlinearities. Other artifacts are attributed to A/B cache problems (images on the even minutes are loaded in one image cache while images on the odd minutes are loaded in the second image cache). There may also be an "alternate row problem" within the camera. The problem that received the most attention was related to the measured frequencies of the modes. Below $\ell = 150$ the spatial sidelobes are well defined and each one is fit to determine mode frequencies. Above $\ell = 150$ the spatial sidelobes begin to merge and a different process is required. An apparent consequence of this appears in the frequency differences between the zonal modes and the tesseral modes. Below $\ell = 150$ these splittings show one behavior. Above $\ell = 150$ they show a different behavior. Another area of concern is the asymmetries in the peaks. The asymmetries found in this first month of *GONG* data were different from those found in South Pole data from 1994.

A Virtual Helioseismological World

In order to improve communication amongst Team Members, the Inversion Team has put in place several mechanisms for network conferencing over the Internet.

A first tool, called helioMOO, (aka 'a virtual helioseismological world', or should it be helioSeisMOO?), is an Object Oriented MUD, based on on Xerox Parc's public domain LambdaMOO server. It was inspired by the AstroVR project, and is currently running at CfA, where I maintain it.

This server allows people to enter a virtual space with rooms (and other objects) that can be explored. The main feature used by the Inversion Team is its chatting capability, that allows people that are in the same "room" to talk to each other over the net. Bi-weekly, one-hour long meetings are carried out in the Inversion Team Chat room. Logs of each meeting are kept and posted on the Web.

More information on helioMOO can be found at the URL:

http://www-sgk.harvard.edu:1080/~sylvain/helioMOO/

or via anonymous ftp at:

cfa-ftp.harvard.edu:/pub/sylvain/helioMOO

Related to the helioMOO, a public image exchange repository is available at *CfA* for incoming files, while a second one for outgoing files is also in place. These are on the anonymous ftp site *cfa-ftp.harvard.edu* under */incoming/sylvain/helioMOO/images* and */outgoing/sylvain/helioMOO/images* respectively. By adding the URLs

file://cfa-ftp.harvard.edu/incoming/sylvain/helioMOO/images/

and

file://cfa-ftp.harvard.edu/outgoing/sylvain/helioMOO/images/

to your Web browser hot list (or by following the hyperlinks in place at *http://www-sgk.harvard.edu:1080/~sylvain/helioMOO/*) you can exchange and view documents using your Web browser, and/or anonymous ftp.

Finally, in order to provide an interactive tool to view and annotate plots, I wrote an X-based whiteboard program, called *xwb*. The programs — available for SUN, SGI and Linux platforms — allow several users to interactively draw and annotate an image. This tool is still being developed, but a beta version is available via anonymous ftp in:

cfa-ftp.harvard.edu:pub/sylvain/xwb/

or at URL:

file://cfa-ftp.harvard.edu/pub/sylvain/xwb/

Sylvain G. Korzennik

Hill also described the results of the tests on the data merging process from the first month of data. Some noise is evident at low-ℓ but it is diminished when images with "clouds" are removed from the data stream. Even without employing a "cloud killer" the 36-day run looks good with no evidence of site-to-site transition problems. Further assessments of the merging process should be undertaken. (Hill & Toner's responsibility.)

Erdwurm described the progress on the *DSDS*. The recent survey indicated that about 40% of the users connect to the *DSDS via PC*s or *MAC*s. Some of these users experience compatibility problems that need to be addressed. Several responses indicated the need for data distribution *via DAT* tapes. The *DUC* recommended purchasing one of the newer units. A *WWW* interface to the *DSDS* has been developed. Members of the *DUC* liked the interface but had some problems and suggestions. A reply or response feature should be added to send problem reports to Erdwurm. Graphics bitmaps should be added to show the product availability at much finer increments than daily. Links to the *GONG* homepage and documentation should be added. The *DUC* agreed that the input history could be omitted and that the limit of 10 hits lists was sufficient (but should be monitored). (Erdwurm's responsibility.)

The project's support for the *GRASP* software was discussed. Only a handful of people outside the project are using it at this time. Discussion of any expanded support or future releases was delayed until the next *DUC* meeting.

Hill discussed the *GONG*/*SOI* comparison. *GONG* data from 94/10/30 was processed through the *SOI* pipeline. The low frequency end of the spectrum was somewhat better due to the deterministic detrending used by *SOI* which does include ephemeris motion. Streaks through the k-ω diagram at 1/hour frequencies were found and attributed to the magnetogram acquisition. Linear interpolation diminished but did not eradicate these features. Further comparisons of time series and frequencies are needed. (Hill's responsibility.)

Toner reported on the defocusing experiments. Aliasing from modes with $\ell > 250$ indicated the need for some defocusing of the instruments. Earlier experiments had over-adjusted for this problem. Current procedures place the imaged plane 0.065" from the nominal focus. This removes most of the aliased signal while reducing the amplitudes at $\ell = 250$ to ½ their original values. Some aliasing remains and the longitude-latitude range had to be reduced to ±54˚ from the previous ±60˚. This compromise solution was accepted by the *DUC* while noting that the optimum solution would be to switch to a 1024^2 square pixel *CCD* without defocusing.

Toner also reported on the image restoration procedures. These procedures take the *MTF* from the Hankle transform in *GEOMPIPE* and then restore the three intensity images to ultimately make restored *VMI* images. The advantage this has, over using the *MTF* to simply adjust the spectral coefficients, is that it includes the m-dependent variations. The procedures require about 19 seconds of compute time to restore the *VMI* images but they do produce a much more uniform image series. The *DUC* supports a trial using the first *GONG* month of data to determine the usefulness of employing these procedures as part of the pipeline processing. The *DUC* also supported keeping *GEOMPIPE* and *VMICAL* separated until these tests are completed. (Toner's responsibility.)

The *DUC* had further discussions on the peak bagging procedures. Although no immediate solutions were identified, the committee suggested that Anderson and Schou collaborate on an effort to identify possible solutions. (Anderson's and Schou's responsibility.)

Anderson reported that no further progress was made on the 16 bit data storage problems. The *DUC* had recommended storing data as 16 bit *FITS* files with *BZERO* = 0 and *BSCALE* set at 6 to 10 standard deviations of the signal so that outlying points don't go off scale. Currently *BZERO* and *BSCALE* are not fixed. (Anderson's responsibility.)

Pintar described the current status of the *AVER* data products. A set of merged and detrended velocity images

DRAT Workshop

GONG's Data Reduction and Analysis Team (*DRAT*) will have a working meeting in Tucson, November 13-15 at *NSO*. The purpose of the meeting is to review the early results from the network, address outstanding data reduction problems and analyze the quality of the results for the first publication of results. We will, insofar as possible, produce a draft of the first publication. Five of the six sites are now operational. The sixth is being installed at Udiapur in September. There is a month of 3-site data already processed; there should be at least another month of data, based on a greater number of sites, processed and available by this meeting. The most important reduction issues at this time are spatial aliasing, a small discontinuity in frequency splittings at $l = 150$ where the peak-finding algorithm changes, low-l noise stemming from the ephemeris correction and camera non-linearity, amplitude attenuation as a function of m, and the "A-B cache problem." While some of these issues may be settled before the meeting, others are likely to crop up. The current plan calls for *DRAT* to report the standard *GONG* results, compare them to earlier work and to produce an error analysis of those results in a special series of articles in a May issue of *Science*. That error analysis is expected to encompass a validation of the instrument, the calibration and the pipeline reduction and a noise analysis of the instrument and reduction process. The *DRAT* article must be in a relatively finished form by February 1996. This three day workshop will be the main opportunity for *DRAT* to fulfill its primary function. The first half day will consist of presentations on the status of the data reduction and current issues. Attendees will then identify tasks to be done and break up into working groups to address those action items. There will be occasional gatherings to report progress and a final session to assemble results and to set schedules and work assignments for the following four months. Please indicate your intention to participate by sending the following information to *stebbins@jila.colorado.edu*: name, email address, address, phone, fax. If you are unable to attend this workshop, but wish to participate in this critical *DRAT* activity, please respond and so note. Authorship on these *GONG* papers is determined by participation.

Tuck Stebbins

is available on `helios.tuc.noao.edu` in `/usr/users/pintar/mr/mrvda/` for the first *GONG* month. The magnetograms should also be available.

Harvey and Toussaint are investigating changes to the calibration procedures to remove camera nonlinearities and to smooth the calibration images. This should better decouple the *VMI* images and should reduce noise introduced by the calibration into the oscillation images. An investigation of the temporal stability of the calibration images indicated that day-to-day changes do occur in some instances and that, at best, a set of calibration images can only be used within a 11-day interval centered on the day the calibration sequence was recorded.

A pipeline error analysis was discussed. A formal error analysis has not been undertaken but would be extremely useful (although quite time consuming). Hill outlined the procedure and identified some of the sources of error. The *DUC* felt that any large efforts in this direction were unnecessary as long as the errors were in line with those expected from simple analyses. The systematic errors such as the spatial aliasing are probably more important to understand.

A final topic was the plan for future publications and the publication policy. Leibacher indicated that there would be a special session at the January *AAS* meeting in San Antonio with presentations (probably) by Leibacher and Toomre. A series of articles are scheduled for a May/June issue of Science that would have to be prepared by April 1996. This would include an overview of the project and team reports on early results. The early results would then be presented at the June *AAS*/*SPD* meeting in Madison, Wisconsin and published as referred journal articles at about that time. Until the publication of the Science articles there will be an embargo on articles using network data.

The final item of business was to prioritize some of the *GONG DMAC* efforts. The *DUC* felt that the highest

Mode Frequencies for GONG Month 1

A first pass has been made at mode fitting on individual *m*-spectra, as well as *m*-averaged spectra. It is expected that revisions to this table will be made in the next few months as the *PEAKFIND* procedures are refined.

Total Number of Modes fit (including spatial leaks):	4,736,571
Total Number of Modes available:	1,048,713
Number of modes judged to be a good fit:	571,291

The following parameters are included: Radial order, Degree, Azimuthal order, Primary target or spatial leak, Fit frequency, Frequency error, Fit FWHM, *Positive FWHM error bar, Negative FWHM error bar, Fit power spectrum amplitude, Positive peak power error bar, Negative peak power error bar, Mode amplitude, Positive mode amplitude error bar, Negative mode amplitude error bar, Background power at mode frequency, Background power error at mode frequency, Background slope at mode frequency, Background slope error at mode frequency, Merit function value, Number of iterations taken to reach solution, Initial guess for mode frequency, Initial guess for mode width, Good or bad fit.*

The following criteria were used for determining whether a fit was considered good or bad. The criteria were chosen to be fairly certain that the obvious bad fits were marked as such at the expense of possibly excluding some good fits as well.

1) *All fits to modes with frequencies above 5000 μHz were considered bad. This is due to problems fitting blended profiles where the spatial leaks are not resolved. The number of modes fit with frequencies ≤ 5000 μHz is 768,672 Thus, 26% of these fits were considered suspect by the remaining criteria.*
2) *All fits to modes whose FWHM exceeded $5. \times FWHM_{guess}$ were considered bad.*
3) *All fits to modes whose power was less than the background were marked bad.*
4) *All fits where the fitted frequency was greater than a FWHM away from the initial guess frequency were considered bad.*
5) *All fits where the merit function was greater than 1.5 were considered bad.*
6) *All fits where the frequency error bar was greater than half the fitted FWHM or greater than 5 μHz were considered bad.*

Ed Anderson

priority was to put Anderson to work on the peak bagging problems. In parallel with this, Toner should test his image restoration procedures on the first month of data. The third priority was to continue to plow through the incoming data.

The next *DUC* Meeting is set for early December in Tucson in conjunction with the inversions team meeting.

David Hathaway

Steady Flows Team Meeting and Publications

GONG plans to publish results for early *GONG* data in a series of articles in *Science* next March/April. We will be responsible for writing the paper on results concerning the nearly steady surface flows. I would like to propose that some of us meet in Tucson in early December to workout some of the details of this paper. The *GONG* Inversions team is meeting there at that time and the *DMAC* Users Committee will also be meeting there. Please let me know if this works for any of you. I will be writing again in the near future with more details.

David Hathaway

Project Management

Without a doubt the last few months have been the most intense, and exciting, of any the project has experienced to date. Beginning with the December shipment of the first station from the Tucson Farm to Tenerife, until the present, when we have just completed the Udaipur deployment, we have been running at full speed.

Our annual budget struggle was resolved favorably in February with a $2.6M figure for *FY* 95. This has been adequate to allow us to deploy the field stations at a rate of about one every six weeks, since the first station arrived on Tenerife in January. It should be borne in mind that, since then, we have been simultaneously completing the integration and testing of the remaining stations, completing site land preparations, deploying stations, and operating them as they came on line. This has been an interesting management challenge since the deployments have necessarily meant that we were carrying on these many tasks with half or more of our instrument staff thousands of miles away from home base.

Nevertheless, Frank Hill and Rob Hubbard, the on-site deployment-team leaders, oversaw the successful completion of all of the installations, ahead of schedule and under budget. Together with the deployment teams and those who stayed at home, they accomplished many other instrument tasks as well.

Among these other tasks has been the development and implementation of the network operations activities. Rob Hubbard, who has served as the Assistant Project Manager during the development and deployment phases of the project has now been named as Network Operations Manager. As such, Rob will be responsible for overseeing the day-to-day operations of the field network. The operations group has established an effective program to access each instrument daily to retrieve and examine health and welfare status files, and to rapidly respond and interact with our hosts' staffs that look after the instruments in the field.

Jim Pintar and his *DMAC* crew have been as busy as any of the rest. They provided the significantly increased data processing throughput required to certify the stations in test at the Farm, to do the same for the remote stations as they were certified on site, and to then continue to process the data from the field stations as they progressively came on line. The climax of this activity was the production of the first merged data sets from the mini-network consisting of the first three sites to come on line, El Teide on Tenerife, Learmonth Western Australia, and the Big Bear station temporarily operating in Tucson.

A sadder activity has been saying goodbye to some old friends. As the project has essentially completed its original development mission and has been making the transition to a network of operational observatories, a number of people on the instrument team have had their work come to an end. In the past few months, Mark Trueblood has joined the U.S. Gemini Project as its Project Engineer, Bret Goodrich has also joined Gemini, Bob Hartlmeier has retired, Don Farris, Arden Petri, and Dee Stover have taken positions in other *NOAO* programs, Jerry Gonzales, Jeff Vernon, and Tom Bajerski have all left *NOAO* for other employment. Their contributions to the *GONG* program have been essential and we wish them every success.

On the other hand, the *DMAC*'s real work is just beginning. This has meant the addition of two staff positions and plans for one or two more over the next few months. More detailed reports on these various activities will be found starting on page 8.

As usual, our *FY* 1996 budget is unclear. Our original request included funds to vigorously pursue a new development program to produce a 1024 × 1024 square-pixel camera that might be installed as a retrofit into the existing field stations to produce even higher quality data. However, this request was rejected in favor of a more modest one which included little more than the basic funding required to operate and maintain the network and data management facilities. Nevertheless, it amounts to some $2.1M, and if this figure survives the Federal process, and the network is blessed with relatively trouble-free operation, we may be able to at least begin a modest exploration of the new camera concept. All in all, we are looking forward to our first year of "normal" operations with great anticipation.

Jim Kennedy

Science

Presentations and Publications

The initial phase of the scientific investigation has developed virtually as discussed at this year's Annual Meeting in Asilomar. In order to get data into the hands of the members to start working with it to help understand the performance as rapidly as possible — and to pursue the teams' scientific objectives — the deployment sequence was chosen to achieve a three-site network, with roughly 120˚ separation at the earliest possible moment. The duty cycle for the first *GONG* month of three stations was a quite respectable 70%, and the data have now been pushed all the way through the *DMAC* pipeline. All of the data products - including our first cut frequencies - are now available through the *DSDS*. If you do not already have an account with the *DSDS*, the simplest way to set one up is through our *WWW* server. While you are browsing there, please do check out the scientific programs.

With the availability of preliminary network data, the Teams' activities are now shifting into high gear as they work toward four presentations of their work:

1) a special session at the January, 1996 *AAS* meeting in San Antonio, Texas where two overview talks will be presented, to keep the broader astronomical community appraised of the highlights of *GONG*'s initial performance and results,
2) a series of articles are scheduled for a special issue of the journal *Science* in the May-June 1996 timeframe, that will have to be prepared by March-April. These will include an overview of the project and team articles on early results. **This will be the first publication of GONG results**. *Science* is a refereed journal, with a *very* broad circulation, and it is a tremendous opportunity to be invited to avail ourselves of this forum. It means a lot of work as well.
3) the *AAS* and its Solar Physics Division have invited us to hold *GONG* '96 in conjunction with their joint meetings in Madison, Wisconsin in June 1996. The Teams will present their collaborative results in a special joint session with the entire society, to be followed by Team meetings.
4) the Teams will publish their work in refereed journals following the *GONG* '96 meeting.

To help the coordinated analysis along, we are establishing facilities here in Tucson to support extended working sessions of a dozen or so investigators at a time, with workstations, *etc*…, in close contact with the project staff. If you haven't heard from your Team leader, don't hesitate to get in contact with them. The Network and the *DMAC* are up and running. It's time to join the fun!

An important aspect of the invitation from *Science* to dedicate a special issue to the first results from *GONG* is that in fact this be the first publication. There will be no publications prior to this time. The *GONG* Publication Policy calls for a subsequent, more substantial — in terms of the amount of data, work, and presentation — team publication prior to individual publications.

Individual investigators are reminded that their continued membership is based upon

1) providing a brief report on the status of their investigations every six months, for sharing among the other members,
2) submitting for notification to the other members of the appropriate team oral presentations, seminars, ...
3) submitting for review by the Project and the cognizant Team all publications utilizing *GONG* data.

Recall that the presentation and publication clearance forms are available on the *WWW*.

John Leibacher

Low Frequency Team Meeting

Many of you probably know that a publication of the early GONG results will be submitted to *Science* next March. It is expected that the results of each teams' work will be presented at next summer's AAS meeting. The detection of low frequency modes is the responsibility of our team and it would be highly desirable to participate in the first GONG publication.

I'm writing this note for two purposes:

First, to see if there's any interest in getting together as a team, perhaps adjacent to the Steady Flows Team meeting, to discuss our progress and develop an outline for our team's contribution to the GONG initial results publication.

As I understand it the Flows team will meet in Tucson sometime in mid November or early December. Feel free to propose and alternate site/time if you like.

- If we had such a meeting in mid November, would you come?

Second, to encourage you to take a look at the initial GONG low & slow time series and to share your thoughts, impressions, and results with the rest of the team.

- Has anyone found anything interesting or disturbing the the data?

Please use the GONGLow@solar.stanford.edu alias to communicate with the entire team.

Todd Hoeksema

Science article outlines

Data Reduction and Analysis

1. Purpose
To describe the initial GONG data products and demonstrate their reliability.
2. Theme
This is unique data.
3. Contents
a) Describe main results.
  (i) ℓ, ν diagram
  (ii) Line profiles: compare to "best previous" data.
  (iii) Frequencies, linewidths: compare to "best previous" data.
b) Error analysis.
  (i) Validation of instrument, calibration, analysis.
    - Artificial data.
    - Comparison with other results (accuracy).
    - Comparison between different time strings (precision).
  (ii) Noise analysis.
    - Instrument and calibration - systematic and random noise (e.g. photon)
    - Reduction - systematic effects like peak-finding and random numerical noise
    - Solar noise
c) Others
  (i) Low frequency limit? or "Low Frequency" Paper
  (ii) Low & Slow Pipe Results
  (iii) Diode as Σ low ℓ

Tuck Stebbins

Radial Structure of the Sun determined from GONG Data

Introduction
Brief history plus motherhood statements about physics, direct and indirect inferences, neutrino flux, material redistribution, globular clusters and cosmology.
Acknowledgement that knowing the structure is not very interesting except to the extent that it teaches us physics and astronomy.
Modelling the solar interior
The physics of what goes into the model, and the justification or lack of. The concept of a reference model.
Seismic inferences
Relation between structure and oscillation data; what we might learn directly and what must require additional assumptions before a statement can be made.
Inversion techniques
Brief summary of at least one technique, and demonstration of its efficacy using artificial data with GONG noise estimates and, of course, the GONG data state.
Emphasize that frequency differences no(??) causes 3-4 figures to be discarded.
Sound-speed variation
Presentation of the basic *p*-mode primary inference from c^2-ρ inversions for c^2. Core speculations perhaps hinted at here. Acknowledgement of structural issues concerning the base of the convection zone.
Equation of State (in convection zone)
Testing EQS, helium abundance.
The surface layer
What little knowledge we can succeed in gleaning about the upper convective boundary layer, *etc*…
Speculations, conclusions, and a look into the future
Perhaps we should await for some GONG data before we write this section.

Douglas Gough

1996 Western Pacific Geophysics Meeting

July 23 - 27, 1996 Brisbane (Australia)

Session SP01: Helioseismology

The *GONG*, *IRIS*, *BISON*, and *TON* networks of ground-based helioseismology instruments and the SoHO spacecraft's *SOI-MDI*, *VIRGO*, and *GOLF* experiments will be providing a tremendous injection of new data about the internal structure and dynamics of the Sun. This special session will provide the forum for the discussion of these new results, and for their confrontation with theory. **ABSTRACT DEADLINE: March 15, 1996** Conveners: D. Cole, IPS - Radio and Space Services, PO Box 1548, Chatswood NSW 2057, Australia, tel: +61 2 414 8334, e-mail: david@ips.oz.au and J. Leibacher, National Solar Observatory, P O Box 26732, Tucson AZ 85726, USA, tel: +1 520 318 8305, e-mail: jleibacher@noao.edu.

Internal Rotation and Asphericity of the Sun

Introduction
Brief history. Importance of angular momentum in astrophysics (stellar); spindown, instabilities, *etc*… The great suprise of 1984. So-called dynamos (*i.e.* numerical simulations.)
Seismic diagnostics
Integral constraints, inversion procedures and test on artificial data. 2-D, problems with overcoming sidelobes. Poor *a priori* 'knowledge', unlike(?) structure inversion. Emphasize differences in accuracy of result of structures. In that respect there is an analogy with structural inversion at the current state of progress. Artificial-data inversions to demonstrate degree of reliability
Presentation of Ω(r,θ) - not a title
- What we can say about it, and how it relates to previous results.
- Influence of annihilator on shapes of contours, and why it looks sensitive.
- Lack of apparent shear layer within the convection zone that was previously troubled by diurnal sidelobes.
- Shear layer at base of convection zone, and its torque.

- Dynamics of deep interior, if possible. (Probably not)

Asphericity

- Asphericity of surface layers and its relation to mean
- Brightness temperature measurements.
- Shape of base of convection zone.
- Putative magnetic fields, as an indirect inference

Discussion

Dynamics - relation between asphericity and Ω variations, if possible (unlikely with such a short data set) Statement of how things should improve with time. Temporal variations, in particular with regard to upper reflection layer. Implications relating Ω contours and magnetic field lines, if possible, and relation (if there is any hint from the data) between rotation of core and the helium-abundance variation inferred from the structural variations.

Douglas Gough

Energetics of Solar Oscillations: Amplitudes, Line Shapes and Phase Relation

- Energetics of Solar Oscillations
- Solar Oscillations - Amplitudes, line shapes and phase relation
- Time dependence of mode amplitudes
- Line widths as a function of ℓ and ν
- Line asymmetrics as a function of ℓ and ν
- Relationship between physical variable and GONG observables
- Activity effects on phase relations

Roger Ulrich

Magnetic Effects

Large Scale Internal Magnetic Field

- Toroidal magnetic fields inside the Sun (*Goode*)
- Physics of the solar cycle (*Kosovichev*)
- Global magnetic fields in the Sun's deep interior (*Thompson*)

Effect of Magnetic Fields on P-modes (*Forward Problem* **)**

- P-mode propagation in active regions (*Brown*)
- P-mode interaction with magnetic fields (*Penn*)
- Amplitude and phase changes in oscillation signals correlated with magnetic fields (*Ulrich*)

Local Area Helioseismology of Magnetic Field Regions (*Inverse Problem* **)**

- Active Region Seismology - Focusing on higher-ℓ and cross comparing with Stokes polarimeter data (*Bogdan*)
- P-mode scattering from sunspots and subsurface magnetic fields (*Braun*)
- First cut at time-distance seismology (*Duvall*)

Phil Goode

Low Frequency Solar Oscillation Modes

- Probing the Deep Interior of the Sun with Low Frequency Modes
- Description of the GONG Low-Frequency Pipeline
- Merging Methods for Low-Frequency Data
- Upper Limits of Low Frequency Oscillation Amplitudes
- Effects of Solar Noise Sources and Instrumental Errors
- Plans for Further Analysis and Progress

Todd Hoeksema

Nearly Steady Magnetic Fields and Flows

Rotation Profile (Doppler)

- Are higher order terms needed to represent it:
  A + B $\cos^2$ Lat + C $\cos^4$ Lat + ?
- What are the North-South asymmetrics?
  (Are odd powers of cos (Lat) needed?)
- Can the torsional oscillation signal be seen in a short (3-6 mo.) time series?
- Does the rotation vary on a short (3-6 mo.) time scale?
- Are the spatial or temporal time variations associated with magnetic structure

Meridional Circulation Profile (Doppler)

- What is the strength and direction of the meridional flow?
- Is there evidence for additional latitudinal structure (sources or sinks at mid-latitudes)?
- Is there evidence for temporal variations?
- Are the structure or temporal changes associated with changes in the rotation profile?
- What does this tell us about convection zone dynamics?

Convection Limb Shift

- What is the structure of the quiet Sun limb shift?
- How does the limb shift change as a function of magnetic field strength?
- What does this tell us about the solar granulation?

Non-Axisymmetric Motions (Doppler)

- What are the lifetimes of supergranules and how do they evolve?
- What is the spectrum of the photospheric convective velocities out to ℓ = 250?
- How strong are the radial flows in supergranules?
- How much vorticity is associated with supergranules?
- How does the ratio of radial/horizontal flow speed vary with cell size?
- Are Giant Cells evident in the Doppler velocities?
- What is the structure of flows in active regions?
- What does this tell us about the MHD of active regions?

Correlation Tracking of Supergranules

- Do supergranules move with velocities? Different from the photospheric gases?

- Do the velocity differences vary systematically with cell size?
- What does this tell us about the subsurface flows?
- Are active region flows or giant cells detectable with this technique?

Dave Hathaway

Theses

Congratulations to Said Loudagh for his thesis entitled "Traitement du Signal du Reseau IRIS de Sismologie Solaire: Du signal brut à la rotation du coeur solaire." (Signal Processing of the IRIS Network for Solar Seismology: From the raw signal to the rotation of the core) which he received from the Université de Nice.

Recent Preprints in Helio- and Astero-seismology

The titles included here are preprints which have been sent, as a courtesy, to members of the *GONG* project staff. They are listed for the convenience of *Newsletter* readers. Please contact the author(s) for additional information. If you would like your preprint titles to be included in future *Newsletters*, send a copy of your preprints to one of the *GONG* staff. If you would prefer that your preprint titles do not appear in the *GONG Newsletter*, please indicate that when you send any of us a copy. Otherwise, we shall share it!

Antia, H.M.: "Effects of Surface Layers on Helioseismic Inversions"

Antia, H.M.: "Nonasymptotic Helioseismic Inversion: Iterated Seismic Solar Model"

Appourchaux, T.A., Toutain, T., Telljohann, U., Jiménez, A., Rabello-Soares, M.C., Andersen, B.N., and Jones, A.R.: "Frequencies and Splittings of Low-Degree Solar *p* Modes: Results of the Luminosity Oscillations Imager"

Audard, N., Kjeldsen, H., and Frandsen, S.: "Analysis of the Asteroseismological Data of Six δ Scuti Stars in the Open Cluster NGC 6134"

Audard, N., Provost, J., and Christensen-Dalsgaard, J.: "Seismological Effects of Convective-Core Overshooting in Stars of Intermediate Mass"

Bahcall, J.N., Krastev, P.I., and Leung, C.N.: "Solar Neutrinos and the Principle of Equivalence"

Banerjee, D., Hasan, S.S., and Christensen-Dalsgaard, J.: "The Influence of a Vertical Magnetic Field on Oscillations in an Isothermal Stratified Atmosphere II"

Basu, S., and Antia, H.M.: "Helium Abundance in the Solar Envelope"

Basu, S., Thompson, M.J., Christensen-Dalsgaard, J., and Hernández, F.P.: "A Self-Consistent Approach to Filtering out Near-Surface Uncertainties from Helioseismic Inversions"

Bogdan, T.J., Hindman, B.W., Cally, P.S., and Charbonneau, P.: "Absorption of *p*-Modes by Slender Magnetic Flux Tubes and *p*-Mode Lifetimes"

Bogdan, T.J., and Cally, P.S.: "Jacket-Modes: Solar Acoustic Oscillations Confined to Regions Surrounding Sunspots and Plage"

Braun, D.C.: "Scattering of *p*-Modes by Sunspots. I. Observations"

Chaboyer, B., Demarque, P., Guenther, D.B., and Pinsonneault, M.H.: "Rotation, Diffusion, and Overshoot in the Sun: Effects on the Oscillation Frequencies and the Neutrino Flux"

Chaboyer, B., Demarque, P., and Pinsonneault, M.H.: "Stellar Models with Microscopic Diffusion and Rotational Mixing I: Application to the Sun"

Christensen-Dalsgaard, J., Schou, J., Thompson, M.J., and Toomre, J.: "The Potential For Resolving Jets and Shearing Flows with the GONG Helioseismic Dataset"

Christensen-Dalsgaard, J., Monteiro, M.J.P.F.G., and Thompson, M.J.: "Helioseismic Estimation of Convective Overshoot in the Sun"

Christensen-Dalsgaard, J., Larsen, R.M., Schou, J., and Thompson, M.J.: "Optimally Localized Kernels for 2D Helioseismic Inversion"

Christensen-Dalsgaard, J., and Thompson, M.J.: "SOLA Inversions for the Radial Structure of the Sun"

Christensen-Dalsgaard, J. et al.: "Near-Surface Effects in Modelling Oscillations of η Boo"

Christensen-Dalsgaard, J., and Reiter, J.: "A Comparison of Precise Solar Models with Simplified Physics"

Christensen-Dalsgaard, J., and Petersen, J.O.: "Pulsation Models of the Double-Mode Cepheids in the Large Magellanic Cloud"

Christensen-Dalsgaard, J., Bedding, T.R., and Kjeldsen, H.: "Modelling Solar-Like Oscillations in η Boo"

Christensen-Dalsgaard, J.: "Effects of Opacity on Stellar Oscillations"

Christensen-Dalsgaard, J., and Mullan, D.J.: "Accurate Frequencies of Polytropic Models"

Christensen-Dalsgaard, J., Schou, J., Thompson, M.J., Toomre, J.: "Hunting for Azimuthal Jets and Shearing Flows in the Solar Convection System"

Espagnet, O., Muller, R., Roudier, T., Mein, P., Mein, N., and Malherbe, J.M.: "Spatial Relations Between the 5-minute Oscillations and Granulation Patterns"

Fan, Y., Braun, D.C., and Chou, D.Y.: "Scattering of *p*-Modes by Sunspots. II. Calculations of Phase Shifts from a Phenomenological Model"

Frandsen, S. and Viskum, M.: "Asteroseismology in Open Clusters"

Houdek, G., Balmforth, N.J., and Christensen-Dalsgaard, J.: "Amplitude Ratios and Phase Shifts in the Solar Atmosphere"

Houdek, G., Rogl, J., Balmforth, Neil J., and Christensen-Dalsgaard, J.: "Excitation of Solarlike Oscillations in Main-Sequence Stars"

Monteiro, M.J.P.F.G., Christensen-Dalsgaard, J., and Thompson, M.J.: "Helioseismic Constraints on Theories of Convection"

Monteiro, M.J.P.F.G., Christensen-Dalsgaard, J., and Thompson, M.J.: "Seismic Properties of the Sun's Superadiabatic Layer I. Theoretical Modelling and Parameterization of the Uncertainties"

Musielak, Z.E., and Moore, R.L.: "Klein-Gordon Equation and the Local Critical Frequency for Alfven Waves Propagating in an Isothermal Atmosphere"

Petersen, J.E., Christensen-Dalsgaard, J.: "Models of the Double-Mode Cepheids in the Large Magellanic Cloud"

Rogers, F.J., Swenson, F.J. and Iglesias, C.A.: "OPAL Equation of State Tables for Astrophysical Applications"

Rosenthal, C.S., and Christensen-Dalsgaard, J.: "The Interfacial *f* Mode in a Spherical Solar Model"

Rosenthal, C.S., Christensen-Dalsgaard, J., Nordlund, Å., and Trampedach, R.: "Convective Perturbations to Solar Oscillations: The *f* Mode"

Rosenthal, C.S., Christensen-Dalsgaard, J., Houdek, G., Monteiro, M.J.P.F.G., Nordlund, Å., and Trampedach, R.: "Seismology of the Solar Surface Regions"

Rouse, C.A.: "Calculation of Stellar Structure. IV. Results Using a Detailed Energy Generation Subroutine"

Schou, J., Christensen-Dalsgaard, J., and Thompson, M.J.: "Some Aspects of Helioseismic Time-Series Analysis"

Tomczyk, S., Schou, J., and Thompson, M.J.: "Measurement of the Rotation in the Deep Solar Interior"

Tripathy, S.C., and Christensen-Dalsgaard, J.: "The Effect of Opacity Modifications on Solar Structure and Oscillations"

The *GONG Newsletter* is intended to keep the community abreast of news and progress relating to the *GONG* project and other activities within the field of helioseismology. The current mailing list for the *Newsletter* includes about 400 individuals who have expressed an interest in these topics. We welcome contributions from anyone wishing to disseminate information of general interest to this community. Contributors to this issue include Wendy Erdwurm, Phil Goode, Douglas Gough, Jack Harvey, David Hathaway, Todd Hoeksema, Rob Hubbard, Jim Kennedy, Sylvain Korzennik, Jim Pintar, Tuck Stebbins, Juri Toomre, and Roger Ulrich.

John Leibacher
GONG Project Director, Editor

Mailing address: National Solar Observatory
P.O. Box 26732
Tucson, Arizona 85726-6732
USA

Electronic Mail: Internet ≡ jleibacher@noao.edu
NSI-DECnet ≡ 5355::jleibacher

Phone: +1 520 318-8305

Anyone on the *GONG* project staff can be reached via electronic mail by substituting their first initial and last name for *jleibacher* in the above electronic mail addresses.

The Project is on the World Wide Web at the URL *helios.tuc.noao.edu*