GWIC Meeting Report: 22-23 April 1998

B. Barish & L. S. Finn

INTRODUCTION

This report describes discussion and actions taken at the GWIC meeting of 22-23 April 1998.

lists the attending GWIC members, Table 2 lists the invited observers, and Table 3 summarizes the meeting agenda. GWIC met jointly with the LIGO Program Advisory Committee on 23 April.

Table 1. Listed below are the GWIC members in attendance at the 22-23 April 1998 GWIC meeting. Absent was Massimo Cerdonio, representing the AURIGA Project. Dr. Robin Stebbins represented the LISA Project in place of Dr. Peter Bender.

ACIGA	John Sandeman
ALLEGRO	William O. Hamilton
GEO 600	Karsten Danzmann
	Jim Hough
GRAIL	P. W. Van Amersfoort
LIGO	Barry Barish
	Gary Sanders
LISA	Robin Stebbins
NIOBE	David Blair
Rome Detector Group	Guido Pizzella
TAMA	Yoshihide Kozai
	Masa-Katsu Fujimoto
VIRGO	Alain Brillet
	Adalberto Giazotto
Acting Secretary	Lee Samuel Finn

MEETING COORDINATION AND PLANNING STATUS REPORTS

MEETING COORDINATION

One of GWIC's goals is the coordination of international meetings and the elimination of redundant meetings. Several GWIC members reiterated that meeting coordination remains a critical issue. Highlighting the current lack of coordination was a hastily called meeting in Germany going on at the same time as this meeting.

There was a brief discussion of how GWIC might assist in the coordination of meetings. One suggestion was that GWIC maintain, on its web pages, a list or registry of planned conference related to gravitational-wave detection.

Table 2. Listed below are the invited observers and presenters attending the GWIC meeting of 22-23 April 1998.

Journalist	Marcia Bartusiak
National Science Foundation	David Berley
	Richard Isaacson
KES	Harold Collins
Institute for Cosmic Ray	
Research, University of Tokyo	Kazuaki Kuroda
GRAIL	Peter de Witt Huberts
LIGO	GariLynn Billingsley
	Mark Coles
	Albert Lazzarini
	Sydney Meshkov
	Stan Whitcomb
LIGO/LSC	Rainer Weiss

Table 3. 22-23 April 1998 GWIC Meeting Agenda. GWIC met in conjunction with the LIGO Program Advisory Committee on 23 April.

22 April		
8:00 AM		Meet in hotel lobby for transportation to LIGO/Livingston
9:00 AM – 9:15 AM	M. Coles	Introduction and orientation
9:15 AM - 10:30 AM		LIGO/Livingston site tour
10:30 AM - 10:45 PM	S. Finn	Meeting planning
10:30 AM - 11:10 AM	S. Meshkov	Amaldi Meeting Status Report
11:10 AM - 11:40 PM	S. Finn	Gravitational-Wave Data Analysis
		Workshop Planning Report
11:40 PM - 12:00 PM	S. Meshkov	Aspen/Moriond Meeting Status Report
12:00 PM - 12:15 PM	M.-K. Fujimoto	Announcement: Second TAMA Workshop on Interferometric Gravitational-Wave Detectors
12:15 PM - 1:30 PM		Lunch
1:30 PM - 2:00 PM	R. Stebbins	GRAVITAS: Gravitational-wave international association
2:00 PM - 3:15 PM	W. O. Hamilton	Cryogenic Resonant Detectors: Program status and future plans
3:15 PM - 3:30 PM	K. Kuroda	Large Scale Cryogenic Gravitational-Wave Telescope
3:30 PM - 4:00 PM	R. Stebbins	LISA: The Laser Interferometer in Space
4:00 PM - 4:15 PM	B. Barish	GWIC Composition
4:15 PM - 5:00 PM	B. Barish	GWIC Governance
6:30 PM		Reception and dinner
23 April 1998		
8:00 AM		Meet in hotel lobby for transportation to LIGO/Livingston
9:15 AM - 9:30 AM	B. Barish	Introduction & orientation
9:30 AM - 9:50 AM	S. Whitcomb	Sapphire test mass collaboration status report
9:50 AM - 10:10 AM	A. Lazzarini	FRAME Data Format collaboration status report
10:10 AM - 10:30 AM	G. Billingsley	Optical metrology collaboration status report
10:30 AM - 11:00 AM	K. Danzmann	GEO/VIRGO collaboration status report
11:30 AM - 12:30 PM	R. Weiss	Joint GWIC/PAC Discussion on collaborative data analysis
12:30 PM - 2:30 PM	B. Barish/W. Frazier	Structuring LIGO as an international collaboration
2:30 PM - 4:00 PM		Tour CB&I Beam Tube Factory
4:30 PM - 6:30 PM		Tour ALLEGRO detector
6:30 PM		Joint GWIC/PAC dinner

AMALDI `99 STATUS REPORT

At its November `97 Paris meeting, GWIC decided to sponsor a biennial international meeting focused exclusively on gravitational-wave detection. Discussions with the sponsors of the Edoardo Amaldi Meeting made it possible for GWIC to adopt the Amaldi Meeting for this role.

The next Amaldi Meeting – the first to be sponsored by GWIC – will be hosted by LIGO in early summer, 1999, and held on the Caltech campus. Dr. Sydney Meshkov was asked to assemble and chair the organizing committee. Dr. Meshkov reviewed for GWIC progress toward the organization of the conference.

Size. This meeting will be the principal meeting of the international gravitational-wave detection community; consequently, attendance is anticipated to include most of the community. Plans are for between 250 and 300 attendees.

Dates. Plans are for a five-day meeting program. Other conferences in the Pasadena area restrict the availability of hotel accommodations. Adequate accommodations are available in hotels nearby the Caltech campus on two sets of dates in the early and mid-summer 1999: 21-25 June and 12-16 July. Several GWIC members expressed preference for the 12-16 July dates, as more compatible with teaching schedules in Europe and Australia.

Accommodations. A range of accommodations are available, from low-cost (US$50) motels to more expensive (US$100-132) hotels. A limited number of very low-cost (US$25) dormitory rooms on the Caltech campus are available for graduate students.

Meeting rooms and other facilities. All scientific sessions will be held on the Caltech campus. Plenary sessions will be held in Baxter Lecture Hall, which seats 296. Baxter is available on the proposed meeting dates and has been reserved for the conference. Four other meeting rooms, for parallel sessions or other uses, are also available in Baxter Hall: the largest of these seats 60. East Bridge Hall also has a large lecture room (220 seats) available.

Public Outreach. Dr. Meshkov recommends that the meeting sponsor a widely advertised public lecture on gravitational-wave detection to coincide with the meeting. Kip Thorne has agreed to give such a lecture and arrangements are being made to find a suitable campus venue for this activity.

Social program. Four social activities are planned for meeting participants:

1. a welcome reception, coinciding with registration on the night before the first conference session, to be held in the Athenaeum Rathskellar (on campus);
2. a cocktail party, with food, to be held after the first day's meetings at Dabney Gardens (on campus);
3. a half-day visit, scheduled for the meetings mid-point, to the recently opened J. Paul Getty Art Museum;
4. a reception and banquet, to be held on the final night of the conference at the Caltech Athenaeum.

Conference Proceedings. The decision on a conference proceedings was referred to GWIC; the plans presented did not include a proceedings, except that the estimated budget showed the approximate incremental cost of producing and distributing a proceedings. A consensus was quickly reached that a proceedings should be produced. There was considerable sentiment that electronic publication - either by CD-ROM or on the web as HTML or PDF documents - should be investigated as an alternative to paper publication. Dr. Meshkov will investigate both electronic and paper publication of a conference proceedings.

Budget. The preliminary budget for the meeting, including a contingency, is US$95,000 (US$108,000 with a paper conference proceedings). (The budget details are available in the Amaldi Meeting Presentation Transparencies, which can be found on the GWIC web site.) It was proposed that the budget be met through a conference registration fee (US$250), a National Science Foundation grant (US$22,500), and a contribution from the Caltech Physics, Math and Astronomy Division (US$10,000).

Program and Advisory Committees. An international advisory committee and a smaller organizing committee have been appointed. Some GWIC members observed that international advisory committees are often a fiction: members are appointed, but never consulted. GWIC urged that the international advisory committee be consulted on the conference organization (though in an advisory role).

GRAVITATIONAL-WAVE DATA ANALYSIS WORKSHOP `98 STATUS REPORT

History. GWDAW'98 is the third in a series of annual workshops focusing exclusively on data analysis for gravitational-wave detectors. The first two workshops were held in Boston (December 1996) and Orsay (November 1997). This year's workshop will be held on 19-21 November 1998 at The Pennsylvania State University, in State College, Pennsylvania.

Format. GWDAW'96 was organized as a 3-day workshop. Invited speakers were asked comment briefly (<20m) on outstanding problems in particular areas of data analysis relevant for gravitational-wave detection. Time was reserved following each speaker's remarks for open and extended discussion among the attendees on the general subject of the comments. The ratio of discussion time to presentation time was approximately 2:1. No formal proceedings were produced, although transparencies were copied and made available informally to interested participants.

GWDAW'97 was organized as a traditional conference, with a full schedule of 30m to 1h presentations on work completed or underway. Each talk was followed by 5-10m of questions. A formal conference proceedings is being produced.

GWDAW'98 will return to the Boston workshop formula of short presentations, highlighting outstanding problems, followed by extended, moderated discussion among the attendees.

Budget. GWDAW'96 had no registration fee. GWDAW'98 charged a registration fee of approximately US$80, which included lunches and a copy of the conference proceedings. GWDAW'98 will charge a US$20 registration fee, to be applied to the cost of refreshments. A banquet for workshop participants will be held on the final night of the workshop; banquet tickets (US$25) are separate and in addition to workshop registration. Registration and banquet tickets will be reduced for graduate students. No formal conference proceedings are planned; however, it is expected that transparencies will be collected and made available over the web.

Attendance. GWDAW'96 had approximately 95 participants; GWDAW'97 had slightly more. In order to preserve an atmosphere conducive to group discussion, GWDAW'98 will be strictly limited to less than 130 participants on a first-come, first-served basis.

Organizing Committee. The GWDAW'98 scientific program advisory committee is chaired by Sam Finn (who also chaired the GWDAW'96 organizing committee). Each collaboration represented on GWIC will be invited to nominate one person to the committee; in addition, the theory community will be represented on the committee by Professors B. Allen, B. Schutz, and K. Thorne.

Discussion. There was general agreement that the workshop format is preferred for GWDAW'98. GWIC members made three recommendations:

1. While the open discussion plan of the Boston meeting was successful with an attendance of approximately 95, it is not clear that a similar format will work with an attendance of 130. Finn was urged to consider limiting the attendance to a number closer to the total attendance of the Boston meeting.
2. In response to a question from Finn, several GWIC members indicated that the intersection between data analysis and instrument diagnostics is critical and would be an appropriate theme for GWDAW'98.
3. While the timescale of the LISA mission is much longer than that for ground-based detectors, LISA has some quite difficult data analysis problems that would benefit from immediate attention. Devoting time to some of these problems at GWDAW'98 would raise their profile, to the advantage of the project.

The GWDAW meetings have focused on preparations for data analysis. GWIC asked about the anticipated future of this meeting series. Finn responded with his own view that, as operations drew near, the focus of GWDAW meetings would turn more toward testing and performance assessment of the data analysis systems in the context of the actual detector hardware and data streams. This would continue through instrument commissioning. Once scientific operations began, however, the need for an annual workshop of this kind would evaporate. There may develop other reasons for data analysis workshops; however, these would likely be highly focused meetings, convened ad hoc to deal with the kind of immediate technical questions that arise at irregular intervals.

ASPEN/MORIOND `99 STATUS REPORT

The Aspen Center for Physics has hosted a January workshop on gravitational wave detectors and detection since 1995. The sponsors of the January Moriond meetings have for the last several years held sessions on the same subject at competing times. To avoid competition, the organizers of the Aspen and Moriond meetings have agreed to hold only a single winter workshop on gravitational-waves and their detection. Aspen will be the principal home for this winter workshop; however, every third year the workshop will be held as part of the Moriond meeting. The first meeting of this merged series will be held as part of the 1999 Moriond meeting.

Merging these two meeting series requires changes in the winter workshop format and logistics during the years it is held in Moriond. The Aspen Workshops have been week-long, focused exclusively on gravitational-wave detectors and detection issues, with attendance limited to less than approximately 70 participants. The meeting format and size has meant that it is generally attended by experts, and the presentations and discussions have reflected that audience. The Moriond meetings, while generally larger, have a more diverse program and attendance; consequently, the number of attendees from the gravitational-wave detection community will be limited to a smaller number than is customary at Aspen. Commensurate with the more diverse Moriond program and attendance, the gravitational-wave detectors and detection component of the Moriond meeting will last only a fraction of a week and cannot have the same intense focus that is possible at Aspen. Finally, while most participants attend the Aspen Workshop for the full week program, it is possible to attend for only part of the program and pay only for the days of accommodation required. The logistics of the Moriond meeting preclude that possibility: accommodations can be purchased only for the entire week of meetings, regardless of how many days a participant is actually in residence.

TAMA SPONSORED MEETINGS

Prof. Fujimoto announced two meetings sponsored by the TAMA project. The ``Second TAMA Workshop on Interferometric Gravitational-Wave Detectors'' will be held somewhere in the Tokyo area during the autumn of 1999, and ``New Eyes in the 21st Century: Black Holes and Gravitational Waves'' will be held 28 June - 1 July 1999 at the Yukawa Institute for Theoretical Physics in Kyoto. The primary focus of Second TAMA Workshop will be on technical problems common to interferometric gravitational wave detectors, common formats for data recording, and methods and prospects for data analysis carried out jointly by different detector projects. The primary focus of the ``New Eyes'' meeting is on problems in theoretical and observational astrophysics and relativity that gravitational-wave observations can shed light on.

GRAVITAS: GRAVITATIONAL-WAVE INTERNATIONAL ASSOCIATION

Dr. R. Stebbins gave an informational presentation to GWIC on the need for a ``user's group'' serving the international gravitational-wave detection community.

One role of the proposed user group would be to function for the several different gravitational-wave detector projects in the same way that a laboratory user group functions for the several different scientific collaborations that use its facilities. A second role of the proposed user group would be to coordinate and provide an avenue through which the international community of gravitational-wave researchers could act as an advocate for gravitational-wave research.

GWIC is an international organization of large gravitational-wave detector laboratories. In the same way that the interests and perspectives of a user group are often different from those of a scientific collaboration or laboratory, so the interests and perspectives of the international community of gravitational-wave researchers may differ from those of the gravitational-wave project and laboratory managements. While each project has its own mechanisms for discussing internally the direction of the field and the project's research, there is not currently any forum for holding similar discussion between the scientists of different projects. An international user group would provide a venue for discussions of exactly this kind.

The proposed international user group would also act as an advocacy body for gravitational-wave related research. GWIC also has advocacy of gravitational-wave research as a goal; however, as an organization of laboratories its voice is that of the laboratory management, not the member scientists. As a result, while it can forcefully express the self-interest of the community of large gravitational-wave detector projects, it cannot represent international support of the research community for its member laboratories or for gravitational-wave research generally. The proposed international user group, on the other hand, unaffiliated with any particular project or collaboration, can provide an independent voice in support of gravitational-wave research.

Finally, consistent with its role as an advocacy body for gravitational-wave research, GRAVITAS would provide information services such as community news and meeting calendars, public outreach, and, on request, provide the labor for organizing meetings or workshops.

Rather than form an entirely new organization, Stebbins proposed that the current LIGO Research Community reformulate itself as this international gravitational-wave community. This reformulation would involve changes to both the LRC's name and its structure as a LIGO-centric organization. Much of that evolution has already occurred naturally: the LRC Executive Committee, which governs the organization, has international representation (two members are GEO 600 Collaboration members); additionally, the LRC membership is approximately half international. Finally, much of the role that the LRC played for the LIGO Project is now played by the recently formed LIGO Science Collaboration.

Some GWIC members were concerned that the transformation of the LRC from a LIGO-centric organization to an international one would be difficult to effect, in which case it would be better to form a new organization and let the LRC dissolve. There was no consensus in GWIC on this point, however.

CRYOGENIC ACOUSTIC DETECTORS

GWIC heard a report on the status of current and planned cryogenic acoustic gravitational-wave detectors. Five ``bar'' detectors are currently funded to operate and take data (ALLEGRO, AURIGA, EXPLORER, NAUTILUS, and NIOBE). Research and development aimed at improved performance is funded for four of these (AURIGA, EXPLORER, NAUTILUS, and NIOBE). In addition, two different research and development projects for a next generation ``spherical'' detector are proposed or funded (GRAIL and SFERA).

Collaboration between the cryogenic acoustic detector groups generally involves extended visits by group personnel between the different projects, exchange of post-docs and graduate students, and collaborative data analysis activities.

ALLEGRO

The ALLEGRO detector is currently operating with an approximate sensitivity of 2x10-21/Hz1/2 at its resonant frequencies. Current activity is focused on data analysis and understanding why SQUID performance on the instrument does not meet SQUID performance on a table-top.

AURIGA

The AURIGA detector is currently operating at a peak spectral sensitivity of approximately 5x10-22/ Hz1/2 on resonance. Current activity is focused on collaborative data analysis with ALLEGRO, EXPLORER, NAUTILUS and NIOBE.

EXPLORER, NAUTILUS AND SFERA

The Rome Group is currently operating two bar-geometry detectors: EXPLORER and NAUTILUS. The sensitivity of these two detectors is better than 1x10-21/Hz1/2 in an approximately 0.5 Hz bandwidth about the resonant frequencies of 907 Hz and 923.5 Hz (EXPLORER) and 907 Hz and 923.75 Hz (NAUTILUS). The current focus of activity at these detectors is data taking and analysis. Data analysis activities involve collaboration with AURIGA and international collaboration with the NIOBE and ALLEGRO detector groups.

In addition to these operating detectors, the Rome Group was funded in July 1997 to pursue research and development for SFERA, a proposed 100 ton spherical-geometry cryogenic acoustic detector. Operating at 20 mK, SFERA would have a target strain sensitivity of 5x10-24/Hz1/2 in a bandwidth of 50 Hz about 790 Hz. The funded SFERA R&D activity includes the construction of a 10 ton CuAl prototype spherical detector operating at 4 K. The prototype would be sensitive to gravitational radiation near 1.7 KHz, with a second harmonic at 3.2 KHz. SFERA R&D activities related to materials, fabrication and cosmic ray background are being carried out in collaboration with the GRAIL project.

GRAIL

Note: GWIC has been informed by the GRAIL Project that, despite strong and favorable review by an international expert evaluation committee, the GRAIL R&D proposal was rejected by the Dutch pure research funding agency in favor of extending more conventional, on-going work.

GRAIL is a proposed cryogenic acoustic detector, consisting of a 110 ton copper-alloy spherical geometry acoustic resonator operated at a temperature of approximately 10 mK. The sensitivity goal of the proposed detector is a strain sensitivity of better than 10-21/Hz1/2 over a greater than 100 Hz bandwidth about a frequency of approximately 650 Hz. The GRAIL Collaboration involves six different groups at five different institutions in the Netherlands: Amsterdam University, Eindhoven University, Leiden University, NIKHEF, and Twente University.

GRAIL has recently emerged from a three year pilot study and received strong, favorable reviews for further research and development on critical issues identified in the pilot study. Assuming a successful conclusion to this R&D effort, antenna construction could begin in 2000, with completion and commissioning in 2002 and operations commencing in 2003.

NIOBE

The NIOBE detector is currently funded for a three year (1998-2001) program of technology enhancements. The focus of this program is on improving the cooling, transducer (in collaboration with GRAIL) and associated signal amplifier. The ultimate goal is a noise temperature of less than 1mK (corresponding to a strain noise power spectral density of a few times 10-21/Hz1/2) in a 90 Hz bandwidth about the resonant frequency.

In addition to the hardware enhancement program, data analysis is a continuing priority of the NIOBE group, with special focus on improved discrimination against excess detector noise. Coincident data analysis is being carried out in collaboration with the Rome Group (EXPLORER and NAUTILUS detectors); additionally, the Indian Inter-University Center for Astronomy and Astrophysics (IUCAA) is collaborating with NIOBE on data analysis for CW (e.g., pulsar) sources.

DISCUSSION

The ALLEGRO group submitted in 1996 a proposal to the US National Science Foundation for the construction of an advanced, spherical-geometry cryogenic acoustic detector. This proposal was declined by the Foundation. Simultaneously, a National Science Foundation Special Emphasis Panel on Gravitational Physics, convened as a regular part of the triennial NSF external review process, made the following recommendation:

> *It is important that [ALLEGRO] be funded at an appropriate level to ensure its continued operation, with emphasis on maximizing coincident `on-air' time with detectors in Europe and Australia. This support should continue until the sensitivity of the LSU detector is surpassed. However, in light of the heavy commitment of resources to the LIGO program, the Panel recommends that initiatives for major improvements of existing detectors or development of new generation acoustic detectors should not be undertaken.*

The NSF decision to not fund the spherical detector proposal made by the ALLEGRO group, together with the recommendation quoted above from the Special Emphasis Panel, has had a significant international impact. GWIC appointed a sub-committee (D. Blair, A. Brillet, and W. O. Hamilton) to draft a statement in support of the acoustic cryogenic detector effort. The committee reported back the following statement, which was adopted by the GWIC project members:

> GWIC heard presentations from the resonant detector groups in the U.S., Italy, Australia, and the Netherlands. The bar detectors are operating continuously and reliably with good sensitivity. The operating detectors are exchanging data with the intention of searching for burst sources by detecting coincidences. The proposed spherical resonant detectors represent a major opportunity.
>
> 1. The proposed spherical detectors are complementary to the interferometers, and offer the possibility of being more sensitive at higher frequencies.
> 2. The spherical detectors are sensitive to any polarization and are omni-directional. They offer the possibility of locating the direction of a source
> 3. A detection, at a moderate signal-to-noise ratio, will be greatly enhanced by coincidence in several detectors, including interferometers.
> 4. A detection will be much more definitive if it is observed on detectors based on completely different technologies. Improvement of the existing bar detectors both increases the chance of detecting gravity waves from nearby sources, and also enables the development of improved technologies for the spherical detectors.
>
> We conclude that research on spherical detectors can be of large value to the future of the field.

LARGE SCALE CRYOGENIC GRAVITATIONAL WAVE TELESCOPE

GWIC heard a report by Dr. K. Kuroda on LCGT: a proposed cryogenic mirror interferometric gravitational-wave detector. The proposed detector would have a 3 Km baseline, operate with 100 W of input IR laser power (recycling gain of 50, finesse of 100, 40% efficiency), and with mirrors cooled to 20K. The target sensitivity is one neutron star coalescence per year with signal-to-noise 10 at a distance of 60 Mpc.

LISA: LASER INTERFEROMETER IN SPACE

LISA is an approved cornerstone project in the European Space Agency Horizon 2000+ program. Within the context of this program, LISA is regarded as a fundamental physics mission, even though its science has a more immediate relevance to astronomy and astrophysics than that of the ground based detectors. Within ESA, LISA oversight is the responsibility of the Fundamental Physics Advisory Group (FPAG).

While LISA is approved as a cornerstone mission, weak funding of ESA has caused all of the Horizon 2000+ cornerstone projects to be drawn out. As a result, there is no guaranteed flight date for LISA within the next two decades. That could change if NASA were to agree to work jointly with ESA on LISA, or NASA were to adopt LISA as its own project. The latter is unlikely; however, the former is a real possibility.

Over the last several years there has been a significant increase in interest on the part of both NASA and the US astronomical community in a space-based gravitational-wave mission. The catalyst for this increased interest has been the discovery of large black holes in the centers of many galaxies and the recognition that LISA could detect the radiation originating from the formation of these black holes, or other, related black hole interactions, to large redshifts.

As a result of this new interest, NASA is currently evaluating LISA as a candidate mission within its Structure and Evolution of the Universe (SEU) program. As part of this evaluation process, a LISA pre-project office has been created at the Jet Propulsion Laboratory (JPL); additionally, a LISA Mission Definition has been appointed to gauge the interest of the US science community and advise NASA on the proposed mission's scientific payoff and technical challenges.

The ESA FPAG has advised ESA to proceed with an industrial study, based on the current LISA payload definition and design. The FPAG has also advised ESA that this study should be carried-out in close collaboration with NASA's own studies of the LISA project, and that ESA should explore the feasibility of a collaborative ESA/NASA mission with a launch in the 2008-2010 time frame.

GWIC COMPOSITION

B. Barish noted that GWIC is currently composed of representatives from the major gravitational-wave detection projects. This is consistent with its goal of promoting international cooperation in the planning, construction and operation of these projects, and in providing a forum where the laboratory directors can regularly meet to discuss and plan jointly the operations of their laboratories and the associated experimental programs. GWIC has several other goals, however: in particular, promoting the development of gravitational-wave detection as an astronomical tool, organizing and sponsoring regular, world-inclusive meetings and workshops in gravitational-wave science, and representing the gravitational-wave detection community internationally. These additional goals set it apart from other, parallel organizations that exist in other fields and suggest that the committee might better serve these goals with a small number of additional appointments drawn from the astrophysics and theoretical relativity communities.

Four particular arguments were raised in favor of adding standing member(s) to GWIC drawn from the theoretical relativity and astrophysics community:

1. They can provide valuable advice and perspective during the planning and organization of scientific conferences;
2. Representatives of these communities do not have the same institutional interests that the lab directors, who form the mainstay of GWIC's membership, have; thus, they will be seen by the wider community as speaking less from institutional self-interest;
3. They can provide valuable advice and assistance in originating and framing GWIC Statements arguing for projects and resources;
4. They can provide a liaison to important communities that have not been well integrated into the detection efforts.

GWIC did not reach a consensus on including standing members drawn from either the astrophysics or (theoretical) relativity community on GWIC; consequently, the question was deferred for further discussion at a later meeting.

GWIC GOVERNANCE

GWIC established its charter at the November 1997 Paris meeting. At that meeting, Barish agreed to act as temporary chairperson until such time as a permanent governance structure and preliminary by-laws were established. Discussion of GWIC governance and by-laws were the final agenda item for the first day's meeting.

After some preliminary discussion, GWIC quickly recognized it needed a strong chairperson who could address funding agencies and other international scientific organizations as the organization's spokesperson. Both rotating and elected chairs were considered before the consensus settled on a chair elected by secret ballot. The chairperson’s natural term was recognized to be of the same duration interval between GWIC’s large international meeting (i.e., two years).

The issue of GWIC representation arose: do GWIC members represent the detector projects, the agencies that fund the projects, or their home institutions? GWIC quickly decided that it is an organization of detector projects and not individuals, collaborating institutions, funding agencies or governments, and that this would be made clear in the by-laws.

The frequency of GWIC meetings was also discussed. At least initially, while GWIC establishes itself, it was agreed that meetings would continue with a frequency of once every six months; however, it was also agreed that the final goal would be one regular meeting a year.

GWIC appointed a sub-committee (G. Sanders, A. Giazotto, P. de Witt Huberts) to sift through the discussion and report back with a detailed, written proposal on 23 April. On 23 April the sub-committee reported back with a recommeded statement covering governance and by-laws, which was adopted with only minor modifications after a short discussion:

1) Governance: GWIC is governed by a Chairperson, who may also appoint a secretary to assist in the work of the committee.
   - The chairperson is elected by secret ballot from among GWIC members;
   - The chairperson serves a two year term;
   - The chairperson can speak for GWIC with appropriate consultation;
   - The chairperson can call extraordinary meetings;
   - The chairperson can appoint subcommittees to study particular issues;
   - The chairperson can represent GWIC to agencies with consultation as needed.
2) Membership: GWIC consists of representatives of all gravitational-wave detector projects (laser interferometers, resonant mass detectors, space-based gravitational-wave detectors). Members represent the projects and not the member institutions, funding agencies, governments or other organizations.
3) Observers: The GWIC chairperson may invite observers to GWIC meetings as needed. Observers will typically include appropriate representatives of funding agencies, government officials, theorists, other scholars and members of the science journalism community.
4) Meeting Frequency: GWIC will meet at least once annually. In alternate years, the meeting will be held coincident with or adjacent to the Amaldi Meeting; in other years, the meeting will rotate between member project sites or held in conjunction with other, international meetings that are not associated with any one project.
5) Report: A report will be issued by the GWIC Chair following each meeting.

After discussion, B. Barish was elected GWIC chair for a two year term, effective immediately.

INTERNATIONAL COLLABORATION AMONG INTERFEROMETER PROJECTS

There exist several formal collaborations between the interferometric gravitational-wave detector projects. GWIC heard status reports on these collaborative activities, which are summarized in this section.

SAPPHIRE TEST MASS COLLABORATION

Thermal noise originating in the cavity and end mirrors determines the sensitivity of projected interferometric detectors in the most sensitive part of their bandwidth.

Enhancements aimed at either increasing the sensitivity in this bandwidth or increasing the detector bandwidth toward lower frequencies require reducing this noise contribution first. This is ultimately a materials problem that requires replacing the currently planned fused silica interferometer substrates with new materials that have higher resonant frequency, higher on-resonance Q, and greater mass.

The choice of acceptable materials is severely restricted by other requirements, originating in the use of test masses as optical components.

Attention is currently focused on sapphire. An international collaboration, involving several of the interferometer projects as well as industrial partners, is currently investigating whether sapphire can be fabricated to meet simultaneously all of the requirements necessary to improve the sensitivity of enhanced interferometric detectors in the critical mid to low-frequency regime. The partners in this collaboration and their particular responsibilities are summarized below:

- Optical surface quality: LIGO, ACIGA, CSIRO and General Optics;
- Bulk optical properties (homogeneity and birefringence): ACIGA, Virgo and LIGO;
- Thermal distortion and lensing: Virgo, Stanford/GALILEO, LIGO;
- Thermal noise: ACIGA, Virgo, LIGO;
- Producibility and cost: LIGO, Crystal Systems, Shanghai Institute of Optics and Fine Mechanics.

OPTICAL METROLOGY COLLABORATION

The interferometric gravitational wave detectors currently under construction place severe constraints on the bulk and surface optical quality of the test masses. Not all of these constraints can be posed in the specification language used for the selection and manufacture of the optical materials; additionally, testing that the delivered optical components meet the required constraints has required the development of new and improved optical metrology techniques. The problems of converting requirements to specifications and characterizing delivered optical components have been the subject of an international collaboration involving LIGO, Virgo and several industrial partners. The partners in this collaboration and their particular responsibilities are summarized below:

- Material development and specification: Virgo/Orsay, LIGO
- Surface optical properties characterization:
    - Wavefront distortion: Virgo/ESPCI
    - Surface roughness: Virgo/ESPCI, Virgo/IPN, Virgo/Lyon, CSIRO, General Optics, REO
- Bulk optical properties characterization:
    - Absorption: Virgo/ESPCI, Virgo/Orsay
    - Birefringence: Virgo/ESPCI

FRAME DATA FORMAT COLLABORATION

Broadband gravitational-wave detectors generate large volumes of data. The ability to effectively manipulate and use that data requires careful attention to the definitions of the recorded data channels, their logical organization (for recording and retrieval) and their physical organization on the recording medium. Additionally, data sharing and collaborative data analysis among several different projects can be facilitated if common definitions and standards are adopted for data expression, organization, and input/output.

Virgo and LIGO have opted to work together to define and implement a common physical and logical organization for recorded data - referred to as the Frame - as well as certain common definitions and standards for data acquisition and recording. The Frame exists currently as a specification with a C-language function library implementation. The specification and implementation have evolved as a result of continual testing, primarily using data recorded at the LIGO 40m prototype. The Frame specification is now regarded as stable and a major effort to define a Frame Application Programmer Interface (API) and an implementation in C++ is underway.

Use of the Frame is not restricted to LIGO and Virgo: TAMA 300 has identified the Frame standard for its data acquisition system, and GEO 600 has decided to archive its data in the Frame format.

COLLABORATIVE DATA ANALYSIS

GWIC and the LIGO Program Advisory Committee (PAC) together discussed aspects of collaborative data analysis and strategies for announcing the first direct detection of gravitational waves. The discussion was initiated by R. Weiss, who proposed for discussion minimal criteria for gravitational-wave detection and a strategy for announcement of a first detection.

The Weiss proposal for detection requires that the putative signal be consistent within all operating detectors and inconsistent with all environmental monitors and ancillary detector channels. Self-consistency among the operating detectors means that, within acceptable statistical variation,

- the signal amplitude or spectrum should scale appropriately given the relative sensitivity and orientation of the several detectors, and
- the putative source and the signal arrival time should be consistent with the signal origin on the sky and the relative separation of the several detectors.

The Weiss proposal for an announcement strategy involves two papers, submitted simultaneously. The first of these papers is authored by the group(s) that initially identify the signal: it involves details of their analysis. The second, companion paper is authored by all other detector groups whose detectors are operating at time of the signal detection: it discusses the statistical significance of the detection in light of observations made in these other detectors.

There was general agreement on the scientific merit of the proposal for detection; however, there was general disagreement on whether the detection proposal or the announcement strategy could be made to work. In particular, even in well-established fields there is no history of intra- or international cooperation at anything approaching the proposed level.

STRUCTURING LIGO AS AN INTERNATIONAL COLLABORATION

At the November 1997 GWIC meeting, several projects raised a question regarding Memoranda of Understanding between themselves and the LIGO Project. Memorandum of Understanding (MOU) are the official avenue for formal cooperative arrangements with the LIGO Project. These MOUs have generally involved language requiring the participants to abide by the US National Science Foundation (NSF) rules regarding intellectual property rights. This requirement has sometimes led to difficulties in negotiating inter-project MOUs acceptable to the funding agencies of non-US governments. B. Barish indicated that he understood these conditions to be National Science Foundation requirements. D. Berley, the NSF representative observing at the Paris Meeting, agreed to investigate whether adherence to these terms and conditions was necessary when one party was not a recipient of NSF funds.

At this meeting, D. Berley reported back that, when no money is exchanged, the NSF does not place any requirement on agreements, such as the LIGO Memoranda of Understanding, between universities, projects or individuals. The situation is more complex when a sub-contract is involved, in which case certain rights follow the sub-contract while others remain with the grantee institution. B. Barish indicated that he would bring this to the attention of the Caltech legal office.