GWIC Meeting Summary

Sydney, 8 July 2007

David McClelland, David Blair	ACIGA
Warren Johnson	ALLEGRO
Massimo Cerdonio	AURIGA
Eugenio Coccia	EXPLORER/NAUTILUS
Karsten Danzmann, Jim Hough	GEO 600
Jay Marx, Dave Reitze, Albert Lazzarini	LIGO
Tuck Stebbins, Bernard Schutz	LISA
Kimio Tsubono, Kazuaki Kuroda	TAMA/LCGT
Benoit Mours, Adalberto Giazotto	Virgo
Cliff Will	Theory Community/GRG Society
Peter Saulson	Report on Collaboration
Alberto Lobo	LISA Symposium
Odylio D. Aguiar, Szabi Marka	2009 Amaldi Bids
Stan Whitcomb	GWIC Executive Secretary

Minutes

1. Chair's Remarks

1.1. Welcomes and Introductions

1.1.1. Massimo Cerdonio, GWIC Chair, welcomed one new member to the GWIC Dave Reitze, the new Spokesperson of the LIGO Scientific Collaboration, who replaces Peter Saulson as one of the LIGO representatives. He also welcomed Stan Whitcomb as the new Executive Secretary, replacing Sam Finn who had asked to step down. It was also noted that Warren Johnson was representing ALLEGRO in place of Bill Hamilton, and that Kazuaki Kuroda was substituting for Masa-Katsu Fujimoto.

1.1.2. Massimo welcomed invited visitors Odylio D. Aguiar, David Blair, Alberto Lobo, Szabi Marka, and Peter Saulson.

1.2. Massimo briefly reviewed the history of GWIC and its position within the world physics community. GWIC was founded in 1997, ten years ago. Massimo noted that Sam Finn had served as Executive Secretary since the formation, and expressed his personal appreciation for Sam's help in establishing and nurturing GWIC, a sentiment widely supported around the table.

Formally, GWIC is a sub-panel of PaNAGIC, which is itself a Working Group under IUPAP. Currently three members of GWIC also serve on PaNAGIC (Cerdonio, Coccia and Fujimoto). Two years ago, PaNAGIC agreed that the chair of GWIC would be invited to become a member of PaNAGIC. Our relationship to IUPAP and PaNAGIC also serves as a formal link to the International Society for General Relativity and Gravitation (GRG) which is an Affiliated Commission of IUPAP.

GWIC will report on its activities to PaNAGIC at the PaNAGIC's next meeting (held at the TAUP conference in Japan in mid-September). With the recent progress toward bringing about international collaboration and the other activities, the GWIC report should be well-received. PaNAGIC must make a presentation to IUPAP in 2008 to renew its mandate from IUPAP, and the GWIC activities should be a large part of their case for renewal.

1.3. Massimo then reviewed the agenda (reproduced in Appendix A), highlighting the important discussions on raising the visibility of GWIC, the selection of a new chair, and the selection of the venue for Amaldi 8 as particularly important agenda items.

2. Report on GWIC Thesis Prize

2.1. Administrative arrangements
Stan Whitcomb reported on the efforts to fund and manage the Thesis Prize. After some discussion, the International Society of General Relativity and Gravitation agreed to hold and manage an endowment for the GWIC prize, as they do for the FORTH Foundation and its Basilis Xanthopoulos Prize. A private

donor was identified and $21k was secured ($1000 for the first year prize and the remainder to serve as the endowment) and transferred to the GRG Society. As an aside, this arrangement was made possible because of the connections between the two organization through IUPAP and PaNAGIC.

2.2. Competition for 2006

Stan reported on the selection of the 2006 winner, to be awarded later at the Amaldi7/GR18 meeting. Eight nominations were received. The eight nominations spanned 4 countries and four of the projects represented in GWIC, including three ground-based projects and LISA. The selection committee was very impressed with the high quality of the theses.

2.3. Plans for 2007

The competition got a later-than-ideal start this year since the administrative arrangements took longer than expected. This year the plan is to announce the competition earlier than last year and to announce it more broadly than last year. It was proposed, and agreed to by the GWIC membership, to ask for four volunteers from the current committee to serve again next year, and to seek four new members to fill out the committee. This will give some continuity and establish a rotation so that the responsibility gets shared. The 2007 Prize will be awarded at the LISA Symposium in Barcelona.

3. Report from Projects

3.1. ALLEGRO:

NSF has declined to continue funding ALLEGRO, so it was mothballed in April of 2006.

It was run, as a skeleton operation (me and one grad student) for most of S5, from mid-November 2005 to mid-April 2006. Significant automation of most operations, including the data analysis, was accomplished in this period.

The analysis of that data for S5 is essentially complete, and it will be submitted to IGEC-2 for coincidence analysis. The rms noise of 3e-22 strain/Hz was close to the expected value, between AURIGA and NAUTILUS-EXPLORER. Non-Gaussian noise was small, and the duty factor was 98%.

It could be restarted in about 2 months, at a cost of 8-10 $K/month, to cover the period while LIGO and VIRGO are off for upgrade and commissioning. Jay Marx suggested that NSF could be approached for such funding.

3.2. AURIGA/DUAL:

AURIGA will be running essentially continuously, on time > 95%, through 2008 and until enhanced LIGO/Virgo will be in operation with a spectral sensitivity h ~ 2 x 10^-21/rHz @ 930 Hz and an useful bandwidth of > 100 Hz bandwidth (defined as h < 10^-20/rHz); an "astrowatch", hopefully as part of a global network but in any case possible also as standalone, will be active during this period for externally triggered events, as Supernovae, SGR flares, GRBs, etc. the IGEC 2 run has been completed and a paper is under review with PRD; a

semicoherent method, tested successfully using 1 day of C7 Virgo data, is the one strongly preferred for further searches; to this end, data taken after the end of IGEC 2 until May 17th 2007 have been validated and prepared for further joint searches with the other bars and, if requested, with ifos.

DUAL R&D has completed half of its 3y program, as approved by INFN; much encouraging progress has been made in crucial areas as i) demonstration of the "back-action reduction" effect, characteristic of the Dual concept ii) demonstration of the Folded Fabry-Perot cavity for the read-out iii) studies down to to 2 K of mechanical Q and thermal properties of relevant materials as pure Si, C/Sic (as of ESA procedure), Mo iv) mechanical Q of bonding on pure Si.

3.3. EXPLORER/NAUTILUS:

The detectors are running continuously with 95% duty cycle, with a spectral sensitivity h ~ 1 x 10^-21/rHz @ 915 Hz and an useful bandwidth of > 50 Hz (defined as h < 10^-20/rHz).

NAUTILUS will run through 2008 and 2009; EXPLORER will run through 2008, while its operation in 2009 is not sure. Data during these periods will be available for analysis IGEC-like or in "astrowatch" mode, also using coherent methods. Three components of our data analysis team can work on bars-ifo data analysis.

Part of the ROG Collaboration (the Roma Tor Vergata Group) is participating in VIRGO since July 2006.

3.4. GEO

No report

3.5. LIGO:

The current science run (S5) is progressing extremely well with the range of the 4 km interferometers now typically over 15 Mpc (all sky average for an inspiraling pair of 1.4 Mo neutron stars) and 7 Mpc for the 2 km interferometer. One year of 2-site coincidence data has been logged and in the fall of 2007 1 year of 3-interferometer coincident data will be logged. The S5 run is expected to end in late 2007.

Following the signing of the MU between the LIGO and Virgo collaborations, joint LIGO-Virgo science running, data analysis and operations planning commenced with the beginning of the 1st Virgo science run (VSR1) on May 18, 2007.

The enhanced LIGO program that has as its goal to double the sensitivity of LIGO's 4 km interferometers is making good progress with hardware being ordered or fabricated. The installation of components is on schedule to begin following the S5 run and the next science run (S6) with enhanced sensitivity is expected to begin in 2009.

The Advanced LIGO Project is on track to begin construction in US FY2008. Progress in technical development and design activities are consistent with this schedule. A very successful review by the NSF was held in June 2007 with the review committee endorsing the project's readiness to begin construction at the beginning of FY2008. Appropriation of funding at the full requested FY2008 funding level of $32.75M is being considered by the US Congress. This funding has been included in the Appropriations bill being considered by both houses of Congress and the probability is very high that this funding will be approved.

The LIGO Scientific Collaboration is producing results of astrophysical interest that are being presented at conferences and being published.

3.6. LISA:

3.6.1. United States/NASA:

No report.

3.6.2. Europe/ESA:

LISA and LISA Pathfinder continue to make progress in the ESA system. LISA Pathfinder (LPF) has passed all the relevant technical readiness milestones to date, and is on track for an anticipated launch in 2010. Earlier this year ESA's Science Program Committee (SPC) approved a budget for LPF that includes a contingency that is expected to be sufficient for the completion of the project. The LPF team produced a document on LPF science, pointing out that there are some scientific questions that LPF addresses, besides technology development.

LISA is the subject of a design study being performed by Astrium Germany. This study has looked at many different design options and made trade-offs. It will soon produce costings. ESA conducted a review of the management of its science program, in view of the need to make a call for proposals for Cosmic Vision. The result was a further delay in the anticipated launch date for LISA but also an increase in the resources that will be made available to it. In ESA's present schedule LISA's earliest launch date is 2018, and it might be held back until 2022. The decision about which of these two "slots" for large missions will be allocated to LISA will be made in 2011, after digesting LPF results. The cost envelope for LISA will, however, now be around 600 MEuros, increased from the last "official" allocation of 200 MEuros.

3.7. TAMA/LCGT/CLIO/DECIGO:

TAMA300.
Installation of the new seismic attenuation systems (SAS) in the both arms has been completed. TAMA300 was successfully locked in a power-recycled Fabry-Perot Michelson configuration with the SAS. After the final tuning, TAMA operation will restart in this summer, in the hope of joining S5 and the international network of observation.

As for the funding for TAMA, the proposal for enhancement of TAMA300 by introducing an RSE configuration and a higher laser power was not approved by the government. NAOJ (National Astronomical Observatory, Japan) is providing minimum support to continue the current upgrade of TAMA300.

LCGT
LCGT applied third trial to get funding (FY2008). Design of LCGT has been reviewed in 2005 by the external review panel by the Institute of Cosmic Ray Research and it was evaluated by the Science Board of the Ministry of Education. The Academic Science Council of Japan expressed a demand to the Japanese government to make a framework accepting large science project such as LCGT. However, the government is still slow to manage to open the window. In this year, the University of Tokyo is still willing to submit our LCGT request to the Ministry of Education, Sports, Culture, Science and Technology in this July. After this month, the Ministry of Education evaluates and selects budget requests to the Ministry of Finance by this August. If LCGT is submitted to the Ministry of Finance, the Science Panel of Japan will review, the chairman of which is the prime minister, where the discussion will be done by only 1 page description of the projects. However, at present the possibility of the submission to the ministry of Finance is quite low. So far, we had been stressing the first detection of GW to get funding. This means that the disapproval in this year terminates LCGT due to the possible delay of its construction. However, the review panel of ICRR (held in the last October) summarized its report this April and raises the importance of the detector with good sensitivity comparable with the advanced LIGO to be build in other places than US and Europe. By this recommendation, we are thinking to resubmit the request for the next year budget request (FY 2009).

CLIO
CLIO is under commissioning to attain the design sensitivity at room temperature. Cryogenic system has been tested and confirmed its performance without producing any harmful mechanical vibration into the suspension system. Original design of heat transfer of the cryogenic shield duct has turned out to be wrong and corrected by installing new radiation baffles inside the 5m-long radiation shields. After attaining the design sensitivity at room temperature, it is cooled down to prove the reduction of thermal noise.

DECIGO
DECIGO-pathfinder (DPF) working group has been formally approved by space science/engineer committee in JAXA/ISAS as one of the working groups for missions using small spacecrafts. We will submit application for the R&D funding for DPF. There are now 140 members in the DECIGO working group. We have been establishing science obtained by DECIGO and requirement of DECIGO with more details.

The budget request for performing R&D for DECIGO and building DPF we submitted last year was rejected. We plan to submit a budget request only for R&D this year.

3.8. Virgo:

The first Virgo Science Run started on May 18th with a good sensitivity for the low and high frequency (few hundred Hz) bands. For the mid range frequency the LIGO detectors are still better. The BNS horizon (averaged) reach up to 4Mpc. Duty cycle for science mode is above 80%.

At the end of VSR1 (late September) a commissioning period a several months will take place to improve the sensitivity in the low and mid frequency range. Then, the different parts of the Virgo+ upgrade will be installed in 2008. This will be followed by a global commissioning in order to start the second Virgo Science Run (VSR2) around mid 2009.

Advanced Virgo is also in preparation. Request to the funding agencies will be made at the end of the year. First expenditure is expected for 2009

3.9. ACIGA:

No report.

3.10. Spheres/miniGRAIL:

SCHENBERG
We had the first detector cryogenic run last year with three initial parametric transducers. They worked ok pretty much all the time, even at room temperature, with no vacuum in the chamber and with the microwave carrier sent out of the cavity electrical resonance. The cryogenic run lasted for about 12 days around 5K. We took 120 hours (5 days) of data. We are still analyzing this data (and the data we have been taken later, at room temperature), not looking for waves, of course, but trying to find out about the problems of our system in order to fix them. Our funds are ok for the next four years.

The next things we plan to do:
- to solve the circuitry problems (at room temperature);
- to use a special transducer for calibration;
- to make circuit cabling/wiring for at least a set of six transducers (perhaps eight);
- to test the three-mode transducers (with silicon membranes);
- to test different superconducting cavities;
- to use sapphire oscillators at 77 K;
- to develop a ultra-high sensitivity non-resonant “nano”-transducer.

4. Selection of New GWIC Chairman

GWIC met in executive session to select a new chairperson, Jim Hough. Massimo transferred the gavel to Jim who conducted the rest of the meeting.

5. Reports on GWIC activities:

5.1. Toward a Global Network (Saulson)

Peter Saulson reported on progress toward international collaboration since the last GWIC meeting--his presentation is attached in Appendix C. He reported

briefly on two major developments since the last GWIC meeting. First, the remaining active members of the earlier IGEC collaboration had renewed this effort in IGEC-2. They have analyzed one year of data, with improvements in sensitivity and in the coincidence methodology. A paper is in publication.

Second, a very significant development in international collaboration is the final signing of an agreement between the LIGO Scientific Collaboration (which includes GEO and ACIGA) and Virgo. This agreement calls for all data from the two projects collected starting May 18, 2007 to be analyzed and published jointly. It also calls for joint meetings and for joint R&D on future detectors. Peter emphasized that a cornerstone of this agreement was that it be open to the participation of other projects, whenever their inclusion adds scientific value, and that an appropriate voice in the governance of the enlarged collaboration be given to new projects.

This development has important repercussions for existing and future collaborations between the LSC and/or Virgo and other projects. Existing MoU's with other projects will be carried out using pre-May 2007 data only. Any future data analysis activities will necessarily involve both LIGO and Virgo data. This lead to a discussion of the structure of future collaborative efforts: would they involve multi-party agreements or a interlocking set of bi-party agreements? No final decision was reached, but the importance of GWIC in helping to navigate these issues was recognized.

5.2. Beyond Advanced LIGO and Advanced Virgo (Hough)

Jim Hough made a presentation on R&D plans aimed at future interferometers beyond Advanced LIGO and Advanced Virgo. (This presentation is attached as Appendix C.) Two meetings have been held to discuss these plans and to ensure that the various initiatives are exposed throughout the community.

The most important new initiative is a Europe-wide Design Study Proposal submitted under the FP7 framework. This is a three year study. It would not include any experimental research, but rather would focus on a conceptual design. The proposers represent both Virgo and GEO, and they welcome the participation of others from the world community. Jim estimated that the proposal had less than a 50% probability of funding (however after the meeting we have learned that this proposal will be funded).

There was also a discussion of a set of roadmapping exercises that are underway in Europe. There are two separate groups creating roadmaps relevant to GWIC, to cover the next 10-20 years. Astronet is preparing a roadmap for major astronomical facilities; ASPERA is preparing a roadmap for astro-particle physics. The two organizations do not seem to have a clear idea about where GW facilities fit. For example, LIGO was asked to provide information on its status to Astronet, but Virgo and GEO were not. Instead they have been collaborating on preparing planning material for ASPERA. LISA appears to clearly belong to Astronet. This discussion provided the lead-in to the next discussion.

6. Increasing the role of GWIC in promoting international projects (Cerdonio)

   Massimo introduced this topic by expressing the wish that GWIC could play a more influential role in promoting and advocating for international projects. The potential for organizations like GWIC to exert such influence has been demonstrated this past year by ICFA (also a sub-unit of IUPAP, in a very analogous position to GWIC), through its role in guiding the course for the International Linear Collider.

   There was considerable discussion of what might raise the ability of GWIC to help positively influence activities in the field. Questions about the composition, the meeting frequency, and many others were raised. The conclusion was that there is no need to change GWIC's structure. There is a need to increase the visibility of GWIC both within and outside our community; more communication to the community and an improved website can help. More importantly, producing a vision for the future, that the GW community adopts and supports and which can be read and understood by those outside the community will go a long way to achieving this goal.

   Action Item: Jay Marx was appointed as the chair of a GWIC committee charged with producing a roadmap for the field for the next 30 years. Jim Hough will work with Jay to fill out the remainder of the committee and to draft the formal charge.

7. Presentation of Scientific Case for AIGO (David Blair)

   David Blair made a presentation on the status of AIGO. This presentation is attached as Appendix D.

8. Meeting Reports:

   8.1. Amaldi7 Meeting

   David McClelland reported on the Amaldi7/GR18 meeting. The major disappointment has been the attendance, approximately 490 paid attendees, compared with an expected number of 650. This has negatively impacted the services that can be provided because of the reduced revenues. David indicated that his subjective impression was that the Amaldi attendance was more or less in line with expectations, and that the majority of the lower attendance was from the GRG community. He described the plans for the proceedings, which will have the "premier papers" published in CQG, and the remaining papers in Journal of Physics Conference Proceedings Series.

   8.2. LISA Symposium:

   Alberto Lobo reported on the preparation and plans for the LISA Symposium to be held in Barcelona June 16-20, 2008. (His brief presentation is attached in Appendix E.) In general, GWIC was pleased with the arrangements and encouraged the organizers to continue with their plans.

   The question of how much time the organizing committee should be urged to devote to ground-based detection status and results was discussed. There is a delicate balance between the long-term benefits that come from encouraging

participation of the ground-based community in the LISA Symposium and the immediate needs of the LISA community to have sufficient time to cover all of their material. The suggestion was made that the scientific organizers try to give ~1/4 of the session time to ground-based talks, and that the ground-based projects encourage sufficient attendance to warrant this allotment of time. A rough estimate for the Amaldi7 program indicated that it had about 3/4 allocated to ground-based and 1/4 allocated to space-based detection and astrophysics.

The largest discussion centered on the issue of Proceedings. Lobo had approached CQG about publishing the proceedings, but was told that they had already committed to the maximum number of proceedings that they intend to publish for 2008. Instead, the JOP Conference Series was offered. The majority of the GWIC members felt that CQG was far preferable, since younger scientists benefit from the higher visibility of CQG and get relatively little credit in career advancement from the Conference Series. Lobo was encouraged to try CQG again, and to enlist the aid of the GW people on the CQG Editorial Board to lobby on his behalf.

8.3. GWDAW:

GWDAW12 will be held 18-21 December 2007 at MIT. There was some discussion about the role of the GWDAW series, given the two largest participant groups (LSC and Virgo) already have four joint meetings per year with substantial data analysis content. It was pointed out that GWDAW has a strong loyal following. Others argued that we should be placing a greater emphasis on interactions with the broader astronomy and physics communities.

8.4. GWADW:

Albert Lazzarini reported to the group on the status of the GW Advanced Detector Workshop (commonly known as the Aspen meeting). Syd Meshkov and Albert had prepared a proposal to the Aspen Center for Physics to hold GWADW there in January 2008. Unfortunately, the Center management has changed and they did not accept the proposal—it is believed that they thought our meeting was too small, and that they wanted to concentrate on laregr meetings. Several alternatives were investigated, and as a result, the 2008 GWADW meeting will be held at Elba.

The GWIC discussion centered on the importance of the Aspen series in the development of Advanced Detectors (particularly Advanced LIGO and Advanced Virgo.

8.5. Appointment of Committee to Evaluate Meeting Needs

It became clear in the discussion of the various meetings that there are concerns about whether the existing meetings are the best set to meet the needs of the community. Do we need GWDAW, GWADW and either Amaldi/LISA Symposium every year? Should more of our effort go into meetings that involve others from outside our community (astrophysicists, for example)? Given the large LSC/Virgo collaboration meetings, what are the needs

Action Item: Albert Lazzarini and Karsten Danzmann were charged to lead a review of the existing meetings and to recommend any changes that might improve efficiency and effectiveness.

9. Selection of Venue for Amaldi 8

9.1. Three proposals for hosting the Amaldi 8 meeting in 2009 were received, from National Institute for Space Research (Sao Paolo, Brazil), Columbia University (New York City), and Caltech (Pasadena). Brief written proposal had been prepared by each group proposing to host the meeting and these had been circulated to the GWIC membership prior to the meeting. Brief oral presentations were made by each of the proposing groups, with an emphasis on clarification of any issues with the written proposals.

9.2. In closed session, GWIC selected the Columbia University Proposal (Local Organizing Committee chaired by Szabi Marka). After a brief discussion in open session, GWIC also accepted the dates proposed by the Columbia Local Organizing Committee, June 21-26, 2009.

10. Next GWIC Meeting:

There was a brief discussion of the venue for the next meeting. An initial suggestion that it be held in immediately before the LISA symposium ran into conflict with LISA Science team meetings which occur then. An alternative suggestion was made that it be held adjacent to a LIGO-Virgo Collaboration meeting, since a large number of the GWIC members normally attend these meetings—however, the dates for the LIGO-Virgo meetings have not been finalized yet. No conclusion was reached; the date for the next meeting will be determined via email.

The meeting was then adjourned.

Appendix A

Agenda

9:00am Welcome and introductions
9:05 Report from the chair
including: about actions after last meeting, PaNAGIC, etc
9:20 Report on GWIC Thesis Prize (update by stan)
9:30 Reports from the Projects
very brief, no slides, please tell about project/agency plans and submit a prepared statement for the minutes
10:00 Collaborative R&D projects: review of collaborative activities in technologies and data analysis
coffee break
10:45 Closed session: selection of new Chair
11:00 Towards the "global network" (report by Peter Saulson)
LIGO/VIRGO MoU + refocusing bilateral MoUs (discussion: all)
11:30 Beyond Advanced LIGO/VIRGO: understanding and evaluating the long term possibilities
(Report by Jim Hough)
12:00 Increasing the role of GWIC in promoting international projects
(discussion led by Massimo Cerdonio)
12:30 Presentation of Scientific Case for AIGO (David Blair)
1:00 pm ***working lunch***
2:00 Meetings: Vision and future evolution
Amaldi
LISA Symposium
GWDAW
GWADW ('Aspen')
3:00 Presentations of Amaldi 8 Bids
Brazil
USA (Caltech, Columbia)
3:30 Any other business; date of next meeting
coffee break
4:00 Closed session: Selection of Amaldi 8 site
5:00 Adjourn

Appendix B

Toward an International Network

Peter Saulson

Report to GWIC:
Toward the “global network”

Peter Saulson

Outline

- New collaborative activities
- Openings for the future
  - » General principle: Expansion clause from preamble of the Virgo-LIGO MOU
  - » Bar-ifo discussions
- Is there any ongoing role for bilateral data analysis agreements?
  - » position of the Virgo-LIGO MOU
  - » Scientific merit

New collaborative activities

- IGEC-2 paper
  - » Improved upper limit, coincidence methodology
- MOU between Virgo and LIGO/LSC (incl. GEO)
  - » Approved in early 2007
  - » Data sharing provisions went into effect on 18 May 2007
    - – Virgo joins S5
    - – Data analysis groups are working together, exchanging data
  - » Two joint collaboration meetings have been held already (5 per year are scheduled)

Virgo-LIGO MOU is open to new participants

From the preamble:

"We enter into this agreement in order to lay the groundwork for decades of world-wide collaboration. We intend to carry out the search for gravitational waves in a spirit of teamwork, not competition. Furthermore, we remain open to participation of new partners, whenever additional data can add to the scientific value of the search for gravitational waves. All partners in the collaborative search should have a fair share in the scientific governance of the collaborative work."

Principles of L-V collaboration: basis of adding new projects?

From the Virgo-LIGO MOU:

"… a collaboration between independent projects, not a merger. Each project will maintain its own separate governance."

"There will be no LSC-only or Virgo-only gravitational wave data analyses."

How to link bars and interferometers in the global network?

Discussions have been under way for some time. Several modes of collaboration under discussion.

From the IGEC-2 paper:

"The role of the resonant bar observatory is significative to search for signals occurring whenever the network of the more sensitive interferometric detectors is not fully operative and therefore not able to issue an autonomous detection of a gw candidate."

"IGEC-2 can collaborate with the other observatories to extend the time coverage of current gw surveys and can contribute to the identification of rare gw events."

Role of bars in study of a strong candidate signal?

The IGEC-2 paper continues:

"A joint investigation bar-interferometer could increase the information on the gw candidate, for instance on the signal direction and polarization amplitudes. To take the most from an hybrid bar-interferometer observatory, the data analysis methodology should overcome the intrinsic limitations of a time coincidence search and exploit the phase information of the *h(t)* data streams provided by the different detectors, aiming at the solution of the inverse problem for the wave tensor."

Neither LSC nor Virgo will negotiate new bilateral agreements

"All subsequent collaborative data analysis work with projects other than LIGO or VIRGO will be negotiated by and carried out by the LSC and VIRGO together; prior agreements will remain in force automatically only for data collected earlier."

Action items

- Move bar-interferometer discussions forward to a successful conclusion.
- Keep all channels of discussion open with other potential members of the global network as new projects move forward.
  e.g., Australia, Japan, and perhaps China

GWIC can play a key role as a forum for these discussions.

Appendix C:

Detectors beyond Advanced LIGO and Advanced Virgo

Jim Hough

Sub-group for Future Detectors

Adhikari, Bonaldi, Cerdonio, Danzmann, Gustafson, Hough, Kuroda, Lueck, McClelland, Marin, Marx, Mours, Punturo, Reitze, Rowan, Shoemaker, Strain, Whitcomb, Willke.

Or a subset thereof

Two Meetings to date

- Prelim meeting at LSC/VIRGO TN meeting in Cascina (Winter 2006)
- Follow-up telecon in April to have more concrete interchanges

Telecon Agenda

- Interferometers
  - European Design Study Proposal – Lueck and Punturo
  - Future Research in LIGO – Adhikari & Reitze
  - Future Research in Japan
  - Future Research in Australia – McClelland
  - Update on Dual – Marin/Bonaldi

Design Study Proposal for

E.T.

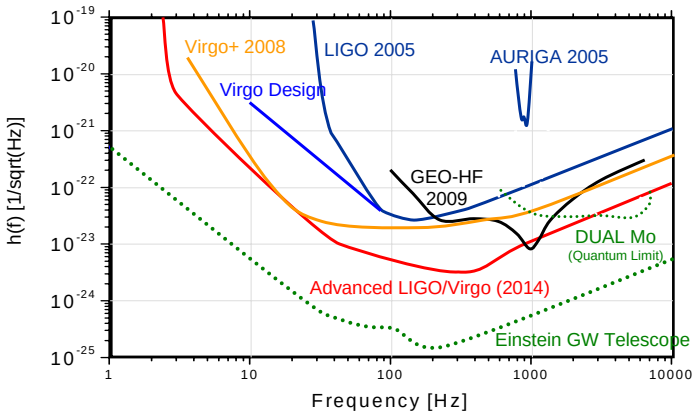
Einstein Gravitational-Wave Telescope

Harald Lück
for the European Gravitational-Wave Community

First call for proposals closing in spring 2007

- For **design studies**, preparatory phase, and support actions
  - ➔design studies: 35 M€
  - ➔Support actions: 28 M€ *(budget 2007-2008)*
- Indicative budget for preparatory phase:
  - ➔34 projects *(budget 2007-2008)*
- Closure: 2nd May 2007
- First contracts to come into force before end 2007

E.T.



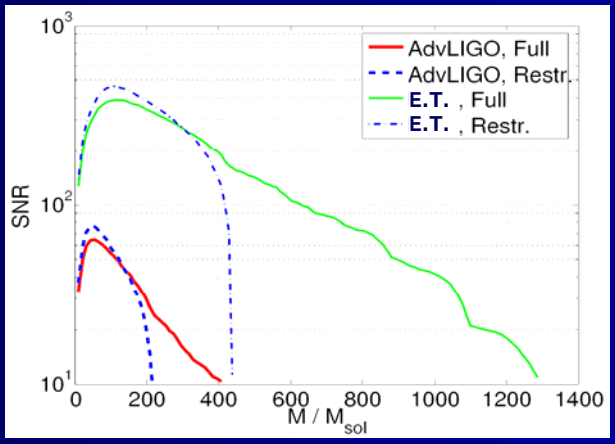
Sources and Science from E.T.
From GW detection to GW astronomy

- **Fundamental Physics**: Test general relativity in the strongly non-linear regime
  - Initial and advanced detectors won't have the sensitivity required to test strong field GR (too low SNR)
  - Most tests are currently quoted in the context of LISA
  - E.T. will have good enough SNR for rare BBH mergers which will enable strong-field test of GR
- **Black hole physics:** Are black holes really *bald?*
  - What is the end state of a gravitational collapse?
- **Cosmology**: Resolve the problem of dark energy
  - Obtain accurate luminosity vs. distance relationship from inspirals at a red-shift $z \sim 1$ from GW/EM observations

Sources and Science from E.T.
From GW detection to GW astronomy

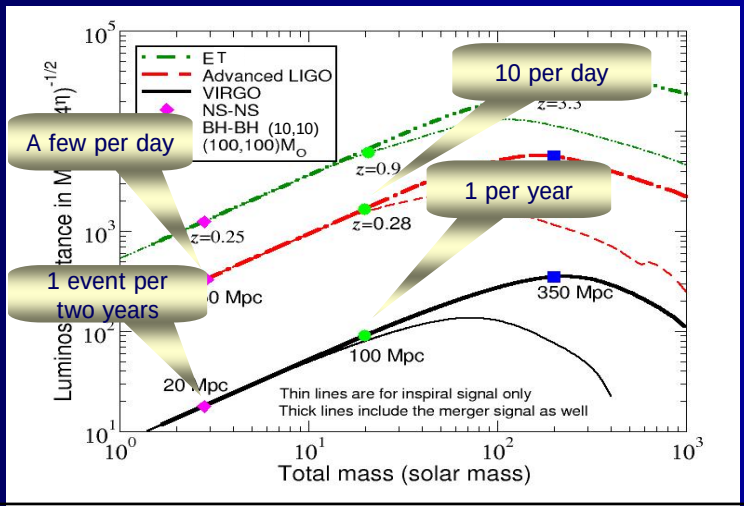
- **Astrophysics:** Take a census of binary neutron stars in the high red-shift Univ.
  - Adv VIRGO/LIGO might just about confirm BNS mergers, possibly provide links to γ-ray bursts
  - E.T. should be able to do much more: see different classes of sources (NS-NS, NS-BH), determine their orientation and resolve the enigma in the variety of γ-ray bursts
- **New Sources and Science:** Detect intermediate mass binary black holes at cosmological distances
  - Higher harmonics that are unimportant in Initial or Advanced detectors highly relevant in E.T.
  - Can see IMBH in higher harmonics

Effect of higher harmonics on SNR in E.T.

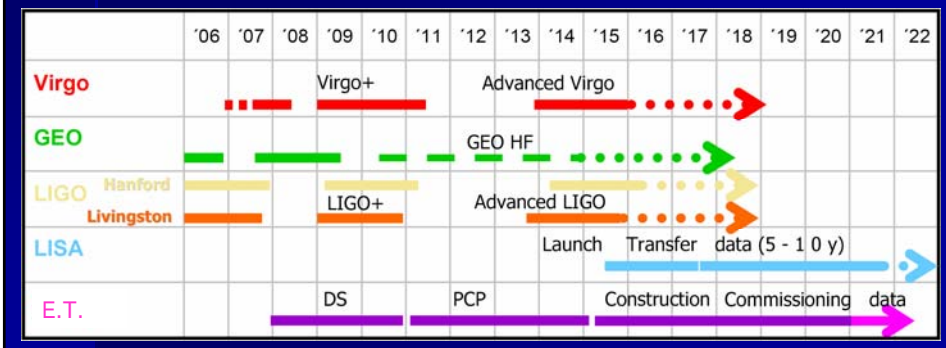


Sources at a distance of 100 Mpc

Binary Inspirals with E.T.



Timelines



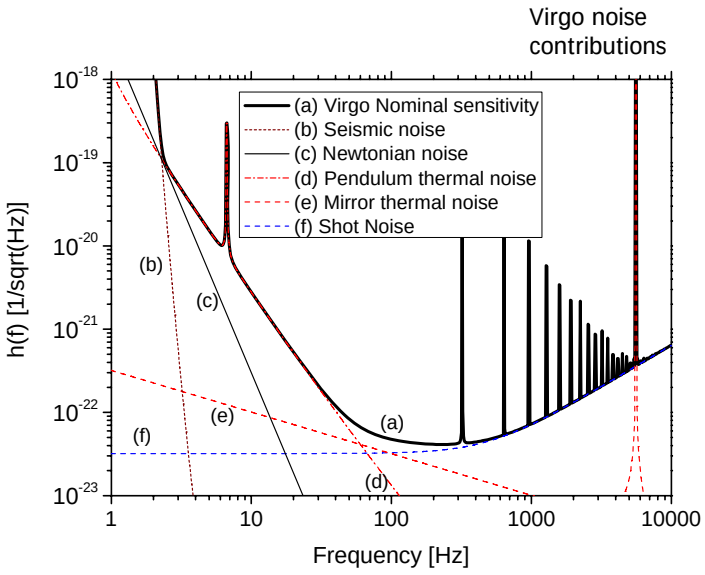
Need for new infrastructure

- Existing facilities subject to high, unshieldable environmental noise levels (seismic, gravity gradient noise)
- Data taking with advanced detectors incompatible with installation of third generation techniques in same envelope (requires long comissioning times)

Baseline Concept

- Underground location
  - Reduce seismic noise
  - Reduce gravity gradient noise
  - Low frequency suspensions
- Cryogenic
- Overall beam tube length ~ 30km
- Possibly different geometry

Typical noise sources



Working Packages

(1) Site and infrastructure
(2) Thermal noise of mirrors and suspensions / cryogenics
(3) Optical configuration
(4) Astrophysics issues
(5) Management

WP1: Site requirements and identification

- Identify strategies to reach a further reduction of the seismic noise effects beyond the second generation detectors expectations.
- Seismic requirements and methods to reach sensitivity
frequencies
- Gravity gradient
- Site selection and

Site Selection

Identify criteria for site selection and evaluation

- Site availability, acquisition risks, legal issues
- Scientific suitability
- Construction suitablility
- Operations suitability
- Construction costs
- Accessibility, travel times and costs
- Environmental dangers (floods, storms, earthquakes etc.)

WP2: Thermal Noise Requirements

Identify strategies to minimize thermal noise of test-masses

- Material Losses @ low temperatures
  Identify materials for:
  - Mirror bulk
  - Mirror coating
  - Mirror suspension wires
- Seismic Attenuation Requirements
  - Suspension seismic attenuation requirements (input from WP1, site selection)
  - Identification of control strategy and optimal mode frequencies
- Preliminary conceptual Design of the overall Cryogenic Suspension
  - Upper suspension stage
    - Active vs. Passive
    - Conceptual design of damping, alignment and optical losses requirements
    - Cryogenic compatibility
  - Last Stage
    - Test mass requirements (geometry and size (input from WG3), mechanical and optical losses req., test mass definition, suspension wire material and size, actuation of the last stage)
- Finalizing Conceptual Design of Cryogenic Suspension

WP3: Topology Identification

- **Evaluation of available and developing technologies** for the suppression of quantum noise.
  Quantify the feasibility and cost of:
  - recycling techniques,
  - using laser sources with larger wavelength
  - use of squeezed light sources
  - constructing interferometers as speed or momentum meters
  - displacement-noise-free interferometry
  - all-reflective interferometry.
- Modelling of **Interferometer Topologies** (= arrangement of optical components)
  Determine quantum noise limited sensitivity of different technologies for similar bounding conditions
- Modelling of **Interferometer Geometries** (= interferometer shape/s)
  Quantify signal extraction and noise reduction capabilities of multiple interferometers in dependence of their relative geometry (co-located, co-linear, etc.)
- **Effects of high Laser Power**
  - Opto-mechanical coupling
  - thermal lensing
  - Parametric instabilities
  - feasibility of all-reflective techniques
- **Cross-Compatibilities**
- **Trade-off analysis**
  - pre-selection of geometry and topology
  - trade-off analysis taking into account WP1 & WP2 results
- Modelling of **Interferometer Configurations** (= parameters, e.g. cavity Finesse)
  - Initial design of optical-readout and control configuration for given topology
  - Quantify technical noise propagation to detector output
  - Iterate optical design

WP4: Astrophysics Issues

- **White paper** Assuming a 1 Hz – 10 kHz frequency range of operation produce a straw man document discussing a minimum and an optimistic science requirement for E.T. Study tunings to low frequency (1-10 Hz), medium frequency (10-100 Hz), high frequency (0.1-1 kHz) and very high frequency (1-10 kHz) sources.
- **Science potential** Consider in detail the potential of such an interferometer to detect different classes of sources.
- **Cosmology** number counts, relationship to star formation rate history, observation of intermediate mass black hole binaries, origin and evolution of super-massive black holes at galactic nuclei, primordial stochastic backgrounds of gravitational waves.
- **Multi-window observation** Explore how to go beyond conventional GW astronomy goal. For example, the scientific benefit of multi-messenger astronomy deploying high energy astrophysics combined with E.T. observations to study accretion disk environments, x-ray binaries, magnetars, glitching radio pulsars, transient x-ray and radio sources, etc.
- **Strong field tests of GR**
- **Input from numerical relativity** Explore how numerical relativity simulations would be helpful in E.T. observations of binary black holes and how observations can be used to guide the simulations.
- **Computing requirements** Estimate the computational resources required for data analysis.

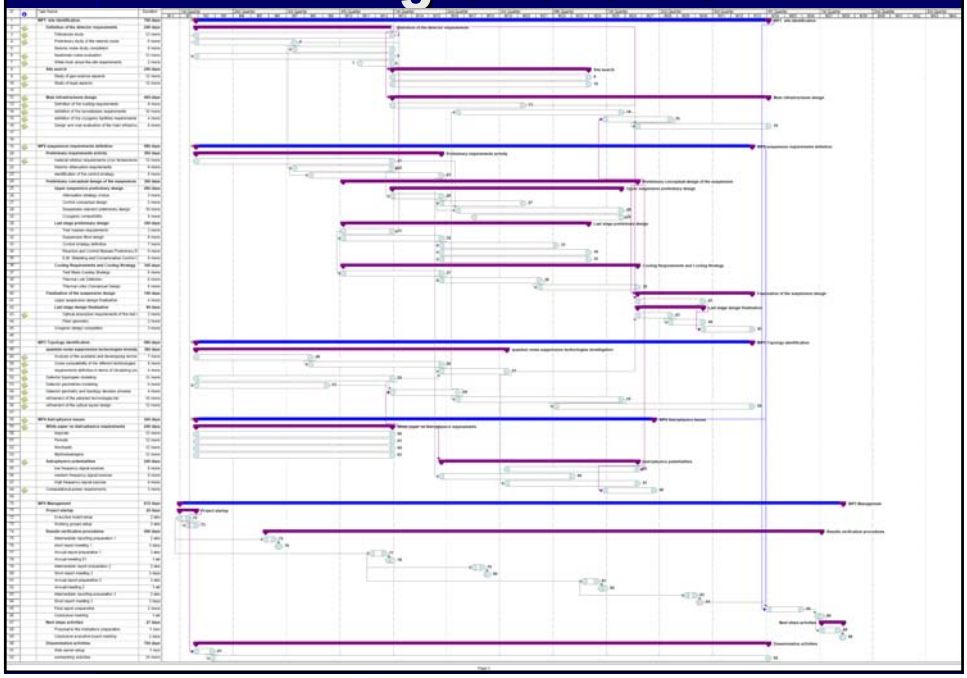
WP5: Management

Science team

- Participation open to all scientists of the GW community willing to contribute to this project through their expertise and networking ability.
- Co-chaired (first 6 months) by GEO spokesperson and by Virgo-EGO Scientific Forum coordinator

The Science Team is to keep continuous contact between the scientists working in the project with the larger GW scientific community and to allocate resources (man power and know-how) available outside the project for all the activities in the project that need external support

Timing of the DS



Participating institutions

Participant no.	Participant organization name	Country
1	European Gravitational Observatory	Italy
2	Istituto Nazionale di Fisica Nucleare	Italy
3	Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V., acting through Max-Planck-Institut für Gravitationsphysik	Germany
4	Centre National de la Recherche Scientifique	France
5	University of Birmingham	United Kingdom
6	University of Glasgow	United Kingdom
7	National Institute for Nuclear Physics and High Energy Physics	The Netherlands
8	Cardiff University	United Kingdom

Proposed EU-Contributions for Design Study: ~ 3.5 M€

Australia 1

- R&D:
  - 1. Squeezing and QND
  - 2. Configurations
  - 3. Suspension point interferometers
  - 4. Thermal Noise - coating free mirrors
  - 5. High power lasers
  - 6. High power instabilities
  - 7. Mechanical systems
  - 8. Alternative wavelengths

Australia 2

- AIGO: 5 km
  - sensitivity similar to AdvLIGO, increased slightly due to 5km baseline
  - 2008-2011: Phase 1 funding for R&D, design study, beamtube construction and international partnerships
  - 2012-2015: Phase 2 interferometer installation
  - 2015+: commissioning
  - budget - Phase 1 ~ $30M
  - Phase 2: TBD
  - Possibility of successful bid - unknown

LSC Research 1

1. Lasers
•Goal: kW class lasers (depends on IFO architecture)
•Approaches

1. Third generation lasers
   Material: Yb:YAG – 1030 nm
   Adv: higher efficiency, lower quantum defect, better thermal management and potentially longer-lived laser diode pumps
   Architecture: slabs and fibers
   slabs: thermal management
   fiber amplifiers: mode quality and distributed gain

2. Adaptive Optics

3. High Power Photodiodes

LSC Research 2

2. Suspensions and Seismic
•Goal: reduce seismic noise below 10 Hz; support heavier TMs; reduced suspension thermal noise
•Approaches

1. improved seismic isolation
   a. silicon flexures
   b. suspensions for sus point interferometry
   c. new bonding methods
   d. cryogenic operation
2. reduction of 'Newtonian' or 'gravity gradient' noise,
   a. simulations
3. reductions in suspension thermal noise.
   a. cryogenic operation
4. reduction of other noise sources
   a. Charging noise

LSC Research 3

- **3. Optics**
- Goal: heavier TMs and new materials, cryogenic cooling, better coatings, reflective geometries (gratings), ancillary optics
- Approaches:
  - 1. TMs (large and cryogenic)
    - a. Sapphire
    - b. Silicon
    - c. Heat removal, contamination control
  - 2. Reflective optics
    - a. High efficiency, large area, grating development
  - 3. Adaptive optics
    - a. Mesa beams
    - b. Measurement and control of TM surface figure
  - 4. Low thermal noise coatings
    - a. Continued coating development and characterization for mirrors
    - b. Microscopic simulations of materials
    - c. Coatings for gratings
  - 5. Ancillary optics development
    - a. Mods and isolators
    - b. High power PD
  - 6. Noise reduction
    - a. Charge mitigation

LSC Research 4

4. Advanced Interferometers

•Goals: higher sensitivity with less light (squeezing, QND), control systems for handling higher laser powers

•Approaches

1. development of optical configurations to operate beyond the standard quantum limit,
   a. “intracavity” readout methods in general, “optical-bars” and “optical-levers” in particular.
   b. investigation of other non-standard approaches to interferometry including, for example, “white-light” cavities.
   c. Modeling and simulations
2. control topologies for managing high power effects
   a. instabilities

LIGO-Lab 1

- Photodetector Development:
  high power RF photodiodes in collaboration with Stanford and higher QE for DC diodes
- Lock Acquisition and Modern Controls:
  deterministic, debuggable, and guided lock acquisition algorithms + adaptive, trainable controls for in-lock noise optimization
- Robust Squeezer:
  development of a high stability squeezer-in-a-box to achieve 6 dB down to 10 Hz.
- Low frequency tilt sensing:
  nrad/rHz level tilt sensors below 1 Hz

LIGO-Lab 2

- Seismic platform interferometers:
  In collaboration with ANU, interferometric stabilization of the suspension point to control differential seismic platform motions.
- Gravity Gradient Noise subtraction:
  Low noise sensors and high fidelity models of gravity gradient noise coupling. In-lock feed forward reduction using SVD or otherwise.
- Coatings....
- Advanced thermal compensation and wavefront 'fixing'
- Interferometer Configurations

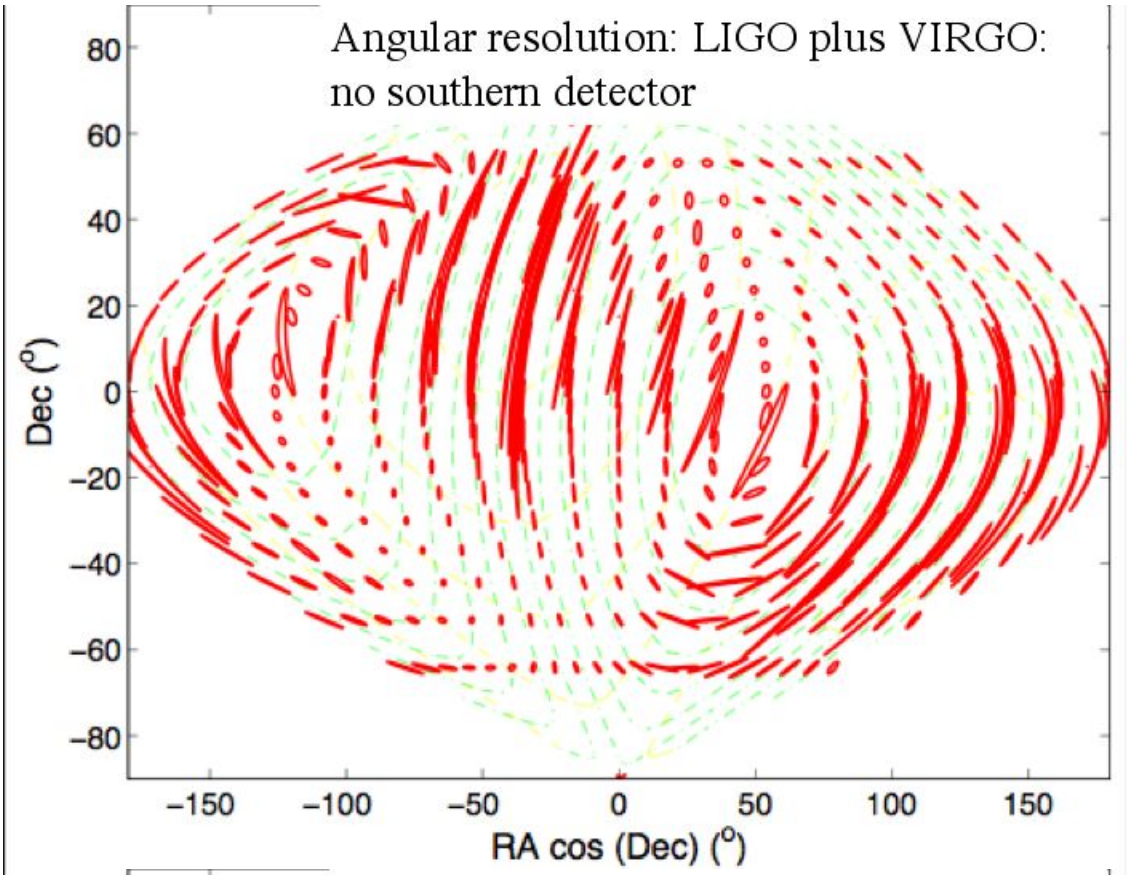
Appendix D:

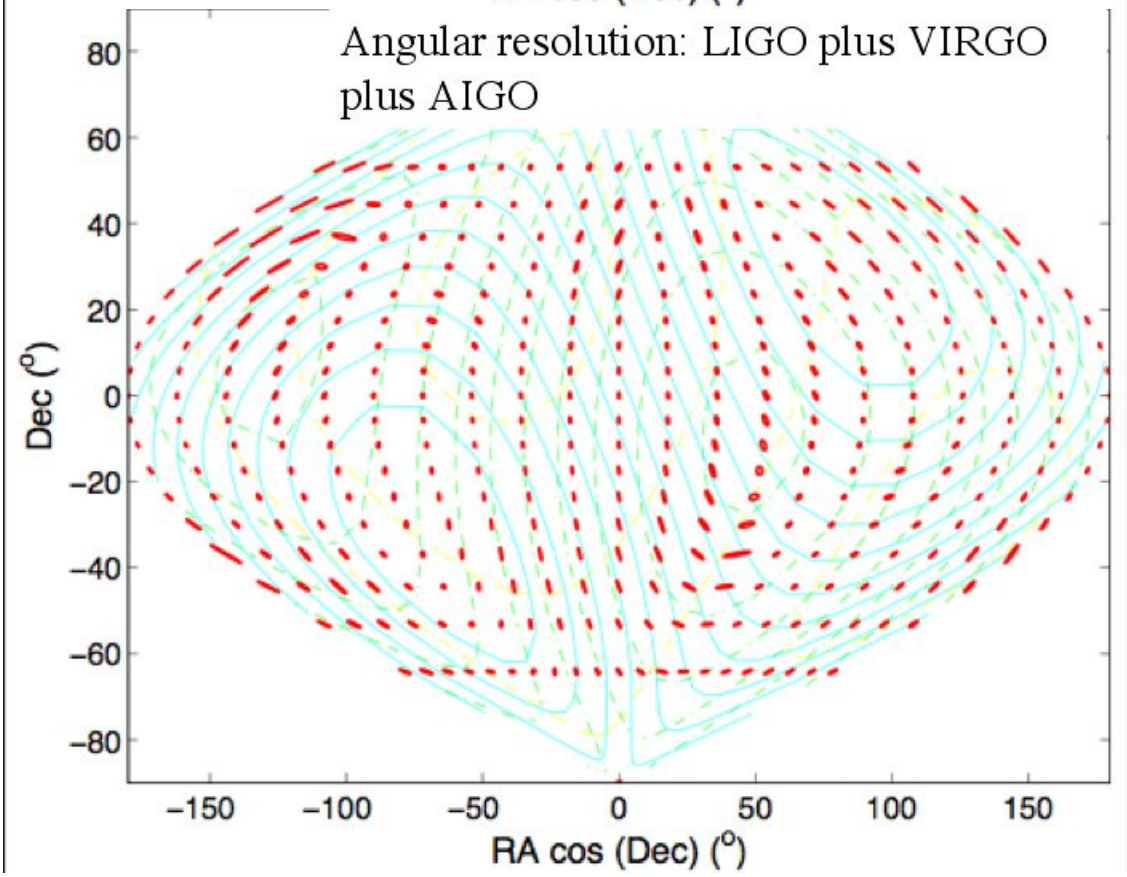
AIGO Status Report

David Blair

AIGO Science Benefits

- AIGO provides major improvement in science capability of all other LIGWDs.
  - Baseline gives beam size reduction
  - Orientation allows dual polarisation distance estimation.
  - Host galaxy identification: >30-fold improvement.
- GW-triggers enabled
  - a) Hubble law tests without optical transient counterparts
  - b) deep exposure large telescope searches for afterglows.
  - c) Black hole science


Angular resolution: LIGO plus VIRGO:
no southern detector
Dec (°)
RA cos (Dec) (°)
80
60
40
20
0
−20
−40
−60
−80
−150
−100
−50
0
50
100
150


Angular resolution: LIGO plus VIRGO
plus AIGO
Dec (°)
RA cos (Dec) (°)
80
60
40
20
0
−20
−40
−60
−80
−150
−100
−50
0
50
100
150

AIGO Recent History

- AIGO proposal submitted to ARC Linkage Program and to Minister for Science under guidance of chief Science Advisor
- Science Advisor resigned 1 month before submission
- ARC Linkage withdrawn for strategic reasons June 2007
- Project redefinition now underway

Advisory Structure

- Funded by UWA
- International Advisory Committee
  - first meeting tomorrow (Chair Weigold)
- National Advisory Committee
  - first meeting next week (Chair Weigold)
- UWA AIGO Committee
  - first meeting Wednesday (Chair Stewart)

Two Funding Opportunities

- ARC Linkage
  - difficulties in satisfying technical guidelines
  - funding formula difficult to satisfy
  - weakness in arm-by-arm construction strategy
  - only alternative: half size now, future extension has science weakness
  - without larger non-ARC contributions unable to budget full interferometer in single application.
- Higher Education Endowment Fund (2009)
  - undefined program

Australian Requirement for International partnership

- Astronomers have just raised $100m on basis of $20m vague international in-kind contributions and promise of international funding for SKA Project
- Australia too timid to embrace risk in science without partnership
- AIGO can happen with international partnership
- AIGO may be impossible without partnership

Small cost large benefit partnership

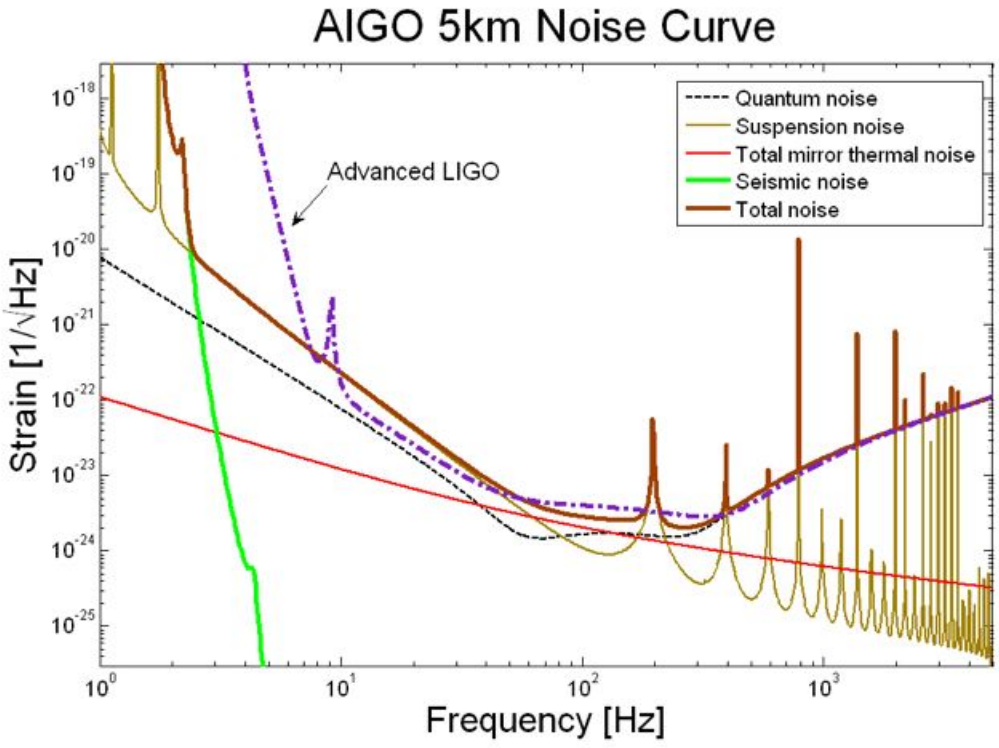
- Contribute spare test masses
  - Non-critical applications where performance does not need state of the art materials: eg pathfinder sapphire ETMs, other test masses for mode cleaners, PR and SR mirrors. (LIGO already provided some for Gingin)
- Control System Software
  - High value, low cost
- Control boards
  - Some already contributed by Virgo
- Personnel after own IFO commissioning completed

Modest Cost Large Benefit Partnership

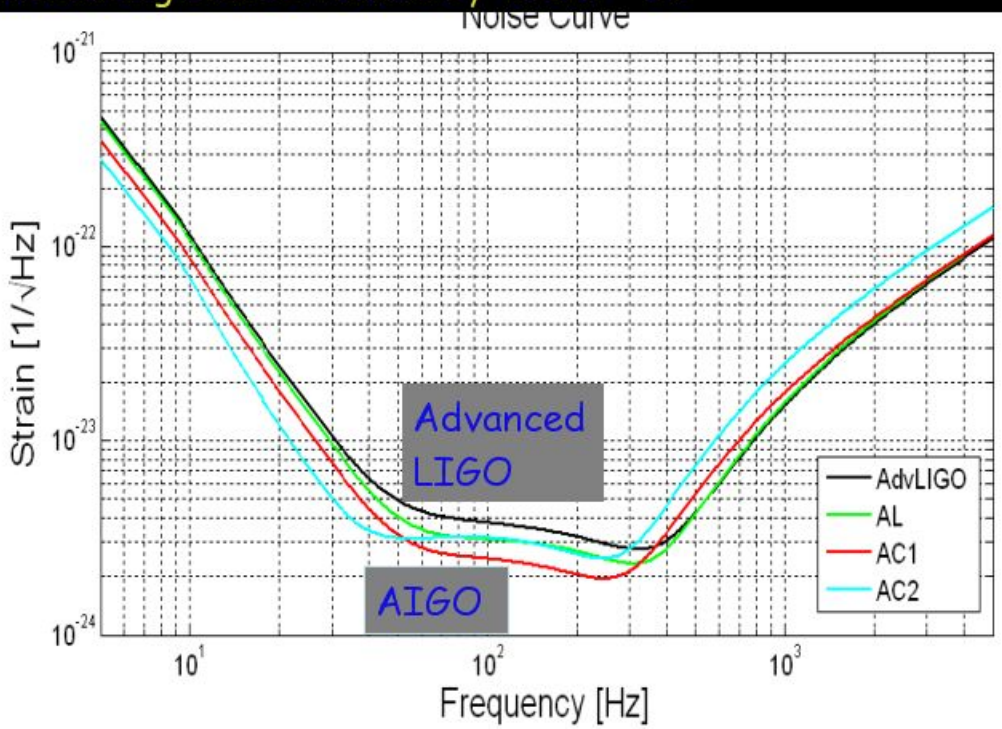
- ACIGA is open to full partnership
- We are not wedded to any particular technology.
- We have assessed AIGO site carefully:
  - best above ground site
  - low wind seismic
  - low local seismic
  - easy access, excellent facilities
  - high stability silica sand
- Partnership would be a low cost way of getting optimum world array in place on an appropriate timescale.

AIGO Proposal: Technical Aspects

- 5km RSE Interferometer, sapphire test masses, stable PR Cavity
- Potential Inspiral range 260Mpc: (double number of sources cw AdvLIGO)
- Designed for low risk of parametric instability
  - extra length allows useful trade-offs
- Niobium modular test mass suspensions
  - Compatible with sapphire, could be replaced with FS in future
- Soft isolation system
- Vacuum
  - Conventional 1.2m design, on-site manufacture
- Most local technology validated and published



5km arm length increases NS inspiral range to 260Mpc
increasing source volume by factor ~1.8



Proposal Validation

- Suspensions: published CQG
- Vacuum: published Int J of Vacuum
- PR Cavity: LSC review, collab with Florida
- Budget : help from GEO
- Low PI Design: many publications.

Proposal assumptions and strategies (needing discussion)

- Access to LSC and VESF collaborations and protocols
- No large data analysis component
- Upfront saving by allowing planned future upgrades
- No saving on basic infrastructure
- Extension and reuse of existing AIGO facility components where applicable.

Ongoing Activity

- Proposal improvement:
  - some components are presented as published papers
  - ACIGA editorial and scientific input
- ACIGA discussions and Advisory meetings
- UWA and WA Government considerations

Appendix E:

LISA Symposium

Alberto Lobo

Barcelona will host LISA #7 in 2008

Alberto Lobo
ICE-CSIC & IEEC

Where we are at this time

- Dates fixed for **16-20 June 2008**
- ***CosmoCaixa*** is confirmed venue:
  - 2 large rooms, for 320 and 220
  - 5-6 more rooms for ~30
  - fully equipped
- Webpage is in place, ready to operate

  `http://www.ice.cat/research/LISA_Symposium`
- 1st circular sent 18 May 2007
- ***Proceedings***:
  - CQG cannot accept
  - JOP Conference Proceedings (IOP) can:
    - ~3000 € to prepare Web available volume
    - Some extra/article for paper support
  - Local University Editors give very cheap conditions

Where we are at this time

- Funding:
  - National Spanish:
    - GREG, 2400 € guaranteed
    - MEC, ~10 000 € basically guaranteed
    - CSIC, ~5000 €, not sure
    - AGAUR, =< 5000 €, not sure
  - International:
    - IUPAP: we were beyond deadline
    - ESA: does not seem very motivated (Oliver)
    - NASA: reluctant as event is not in house?
- Total so far: ~22 000 € –if Spain behaves...
- Needs (depending on services, etc): ~100 000 €
- Registration fee: 200 € to 250 €?
- **Suggestions for other sources are welcome!!**

Two questions for GWIC

1. Who will be the members of the ***SOC***?
   - When will they be nominated?
2. Are there any ***Institutional*** recommendations to the LOC?