



LIGO & the Global GW Effort

Discussion with PAC 23

December 7, 2007

Jay Marx

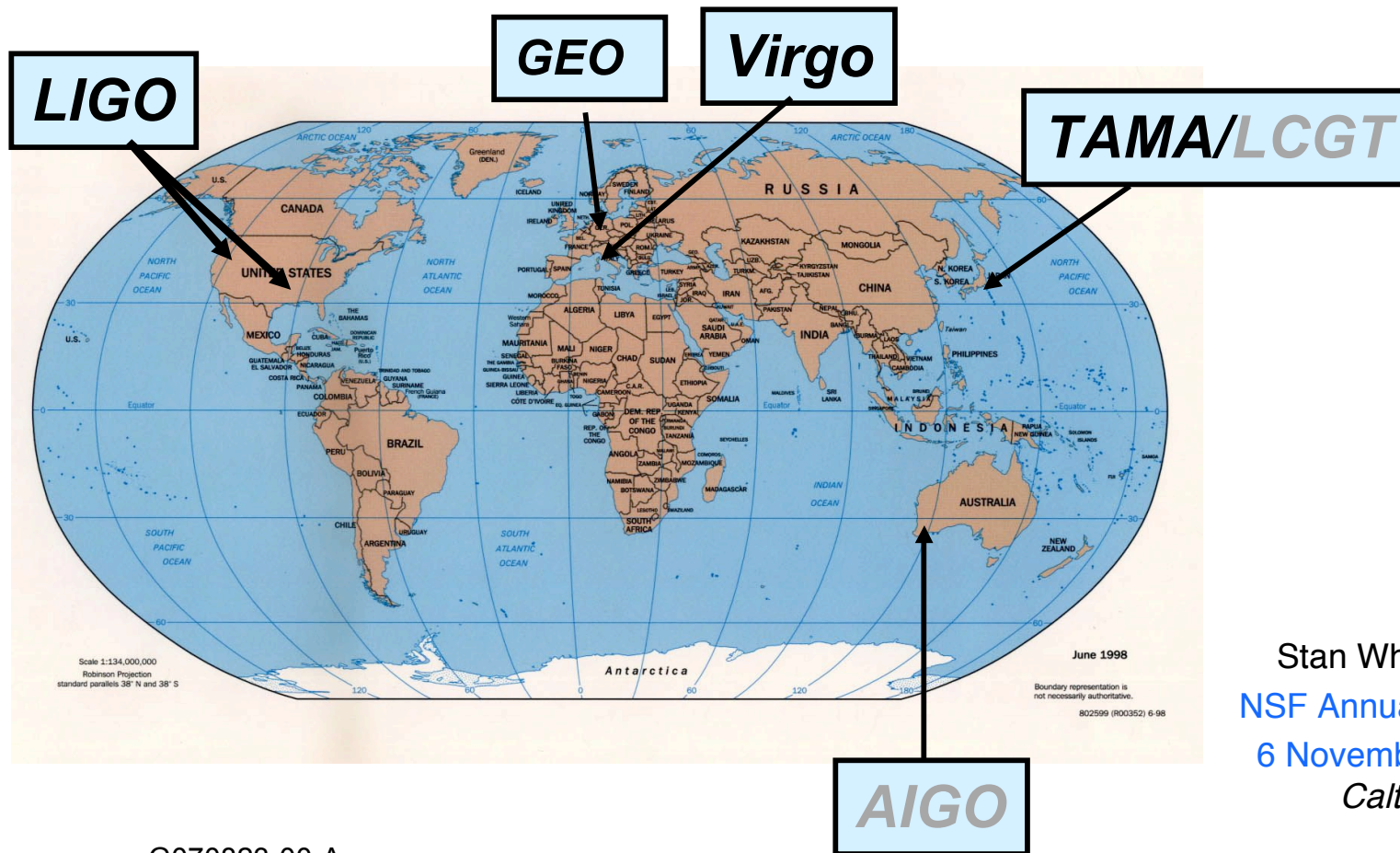


This talk---

- The international gravitational wave scene-
 - » Talk by Stan Whitcomb to recent NSF review of LIGO Lab
- GWIC Roadmap for the gravitational wave field
 - » Talk by Jim Hough (GWIC chair) at recent LIGO/Virgo collaboration meeting
- LIGO involvement in the international scene



LIGO's Role in the Global Scene



Stan Whitcomb
NSF Annual Review
6 November 2007
Caltech



Other Gravitational Wave Projects: **GEO**

- GEO Collaboration
 - » Univ of Glasgow, Cardiff Univ, Albert Einstein Institute, Univ of Birmingham, Rutherford Appleton Lab, Univ of Hannover
 - » GEO as a whole is a member of the LIGO Scientific Collaboration
 - » GEO making a capital contribution to Advanced LIGO
- GEO600
 - » Near Hannover
 - » 600 m arms
 - » No arm cavities
 - » Signal recycling
 - » Fused silica suspensions
- GEO-HF
 - » Proposed up-grade
 - » Pioneer advanced optical techniques





Other Gravitational Wave Projects: Virgo

- Virgo
 - » Italian, French, Dutch collaboration, located near Pisa
 - » Single 3 km interferometer, similar to LIGO in design and specification
 - » Advanced seismic isolation system (“Super-attenuator”)
 - » Operation in coincidence with LIGO since May 2007
- Future Improvements
 - » Virgo+, Advanced Virgo (similar in scope and time to Enhanced LIGO and Advanced LIGO)





Other Gravitational Wave Projects: TAMA and LCGT

- TAMA
 - » University of Tokyo, National Astronomical Observatory of Japan, ...
 - » Located at NAOJ
 - » 300 m arms, optical configuration similar to LIGO
 - » First large interferometric detector to operate/observe
 - » Now coming back on-line after extended commissioning break
- LCGT (Large Cryogenic Gravitational-wave Telescope, proposed)
 - » Promised initial sensitivity similar to AdvLIGO
 - » Underground (Kamioka mine)
 - » Test masses cooled to 20K
 - » Funding turned down 3 times—future is uncertain





Other Gravitational Wave Projects: AIGO

- AIGO (Australian International Gravitational Observatory)
 - » Australian Consortium for Interferometric Gravitational Astronomy- ACIGA(Australian National Univ, Univ of Western Australia, Adelaide Univ...)
 - » ACIGA a full member of the LIGO Scientific Collaboration
 - » 80 m facility located at Gingin (about 100 km from Perth)
 - » Operated as a high power test bed for LIGO
 - » Site expandable to 5 km
 - » Limited opportunities for funding large projects within Australian system — will need international partner(s)





Towards an International Network

- Set of instruments spanning the globe and operating together with data analyzed coherently
 - » All instruments sample the same gravitational wave but from different location
- Scientific benefits of collaboration
 - » Coherent observations with detectors on intercontinental baselines essential for source localization
 - » Improves detection confidence, temporal and sky coverage
 - » Coordinated efforts for problem solving, new developments
- LIGO-Virgo collaboration historic 1st step
 - » All analyses, all observational publications to be joint after signing
 - » Extends to AdvLIGO/AdvVirgo era
 - » MOU explicitly invites other detectors to join when they reach a “useful” sensitivity
 - » Throughout MOU negotiations, kept other projects informed (shared drafts with GEO, TAMA, ACIGA leaders)



Role and importance of LIGO in International GW Community

- LIGO largest detector array, highest sensitivity
 - » Great influence in setting the world GW agenda, and corresponding responsibility!
- LIGO leading establishment of collaborations with other GW projects
 - » Collaboration with LIGO considered the “gold seal” of approval by other projects and funding agencies
- Leadership in establishing a culture of inclusiveness
 - » Growth of the LSC has been a strength for LIGO
 - » Other projects have begun similar “accretions”



International Structures for Fostering Collaboration

- Gravitational Wave International Committee
 - » Founded by Barry Barish in 1997 to provide a forum for GW project leaders to meet and discuss collaboration
 - » Formally a subcommittee of PaNAGIC (IUPAP Working Group)
- GWIC activities
 - » Communication of results/plans among various projects (prevent surprises)
 - » Monitor Astrowatch coverage during Enhanced LIGO/Virgo+ downtime
 - » Annual prize for best Ph.D. thesis in GW physics to promote next generation of GW scientists
 - » Currently preparing a roadmap for the future of GW astrophysics with 30 year time horizon (Marx chair)



3rd Generation facilities in US & Europe

- Goal-- excellent sensitivity down to 1 hz--
 - » Higher mass BH-BH inspirals, much more sensitivity to big bang relic GW, NS-NS inspiral signal can last for minutes, most known pulsars would be in band
 - » Must reduce gravity gradient wall-- go underground
- US-- DUSEL as possible site-
 - LSC beginning to work at low level with DUSEL team to learn what's needed to characterize site
 - May or may not be good site---tbd
- Europe-- Design study for next generation funded--
 - » Einstein Telescope (ET)



European Initiative for 3rd Generation Detectors

Design Study Proposal for

E.T. Einstein Gravitational-Wave Telescope

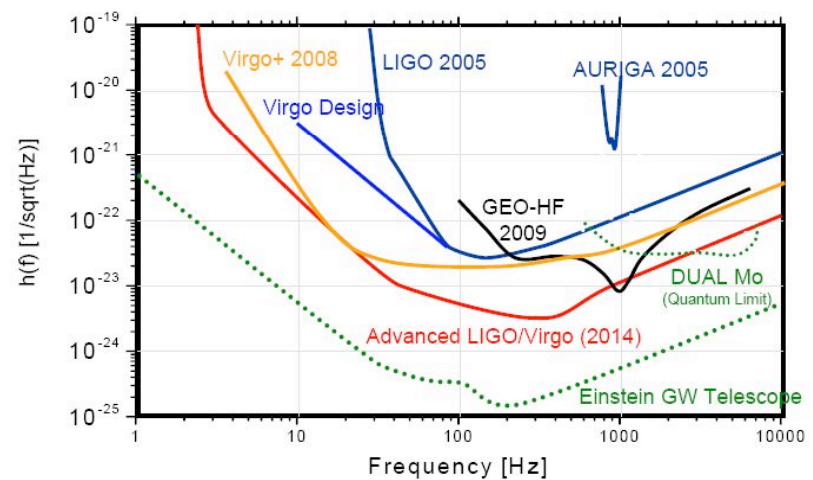
Harald Lück
for the European Gravitational-Wave Community

GEO and Virgo scientists
leading study for next
generation detectors

G070823-00-A

LIGO

E.T.





GWIC Roadmap Exercise

Prof Jim Hough,

University of Glasgow,

Chair, GWIC

Presented at “town meeting” held
during joint LIGO/Virgo
Collaboration meeting

October 2007



Charge to Roadmap Committee

- To develop a roadmap for the field (ground and space based) with a 30- year horizon taking account of known national and regional planned projects [including those nominally in other fields (e.g pulsar timing, CMB etc)].
- To identify relevant science opportunities and the facilities needed to address them in order to optimize the global science in the field.

Report - brief and to the point for scientists from outside of the field and national and international roadmap and priority setting groups.

Timescale: approximately 1 year



Areas for consideration by committee

- The long-term scientific value of the field
- Existing and planned facilities in the perspective of a global network
- Anticipated scientific opportunities utilizing gravitational waves
 - 10 year horizon
 - 20 year horizon
 - 30 year horizon
- Theory and numerical relativity—anticipated developments and impact on the science capabilities of the field
- Impact of technologies



Areas for consideration

- Projected new technologies that will improve capabilities
- Technologies that need development to allow goals to be met
- Global goals for the field—10, 20, 30 year horizon
- Facilities and capabilities needed to reach these goals
- Roadmap to these goals (what should happen when, key decision points)
- Discussion of strategies, politics, etc.



Membership-- drawn from all GW project, world-wide

J. Marx (Chair)- LIGO

K. Danzmann

S. Phinney

K. Kuroda

B. Mours

D. McClelland

S. Rowan

F. Vetrano

S. Vitale

S. Whitcomb

C. Will



Subcommittees to do the work

1---Gravitational Wave Science—general tutorial level

Rowan (chair), Marx +

2--Scientific opportunities in GW science in next few decades

McClelland (chair), Phinney, Will, Mours +

3--Current state of the field

Mours (chair), Danzmann, Kuroda, Vetrano, Will +

4- The future of the field in response to anticipated scientific opportunities—on the ground

Whitcomb (chair), Marx, McClelland, Kuroda, Rowan, Vetrano +

5- The future of the field in response to anticipated scientific opportunities—in space

Danzmann (chair), Vitale, Phinney +

6-- Impact of GW science on other fields

Vitale (chair), Whitcomb, Phinney +

- Will co-opt members from the community
 - “+” on previous slide)
- Will undertake wide consultation in their respective areas



Full Committee

- **Will interact with all funding agencies with a GW portfolio**
- **Will seek input from “wise” people inside and outside the field**



LIGO

Informational talks at Hanover “town meeting”

- **ET design study (H. Lueck/ M. Punturo)**
- **Future LIGO (D. Shoemaker)**
- **Space based GW detectors (K. Danzmann)**
- **Discussion**

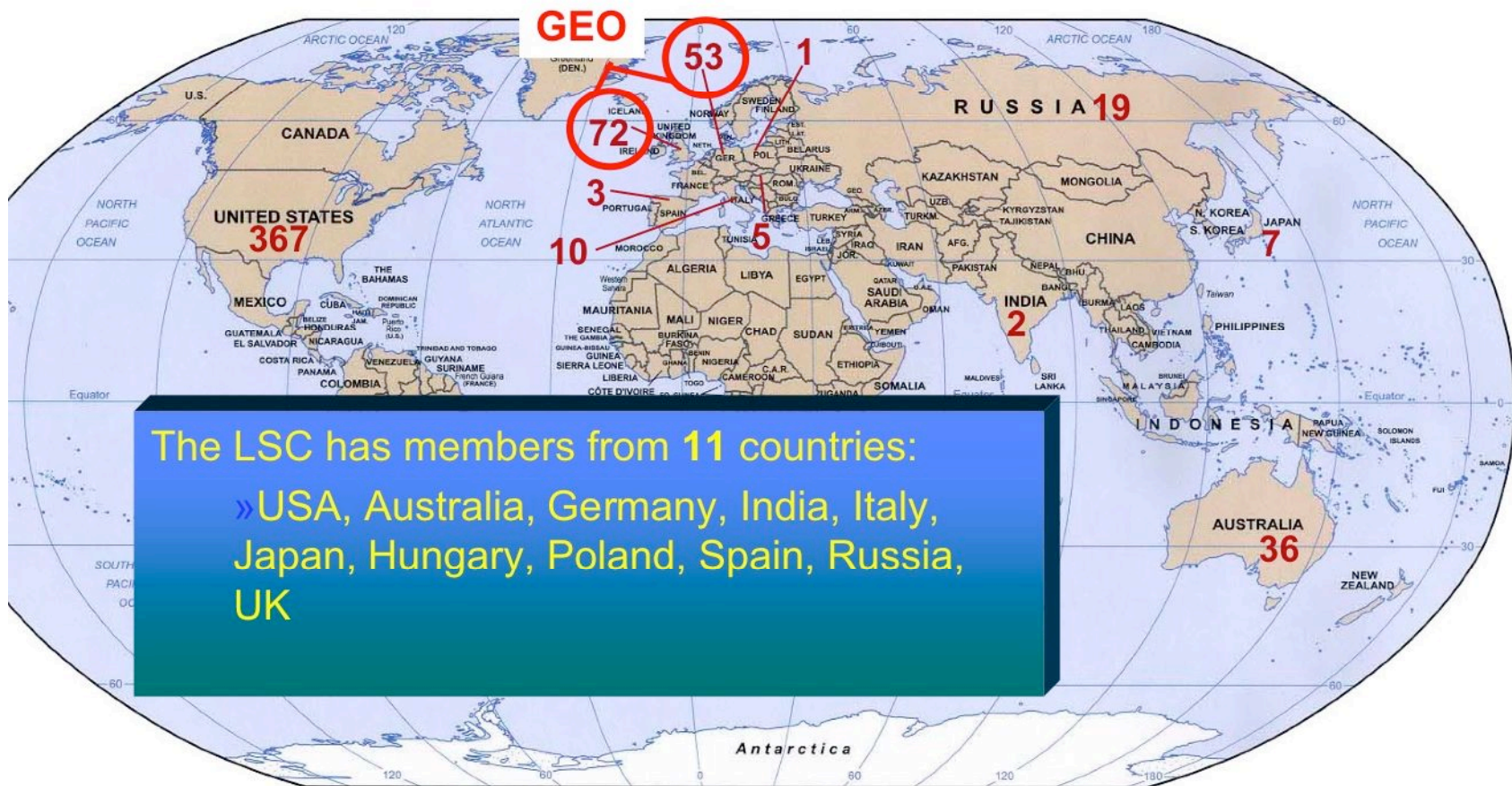


LIGO involvement in the international scene



The LIGO Scientific Collaboration itself is international and so promotes global links and thinking

LSC Geographic Makeup by Country







Summary of major Activities worldwide during next decade or so-

- Generation 1.5 and 2 on the ground-- next ~15 years
 - » E-LIGO and Advanced LIGO-- US site; LSC
 - » Virgo +, Advanced Virgo-- Italian site; Italy, France, Netherlands Collaboration
 - » LCGT-- Japan
 - » AIGO-- Australia
 - » GEO-HF-- German Site; UK, German collaboration
- Generation 3 underground-- sometime mid-late next decade
 - » Europe--Einstein Telescope design study
 - » US-- possibly at DUSEL-- (US Underground Lab)
- Space-based (will not discuss)
 - » LISA Pathfinder-- next few years
 - » LISA-- late next decade
 - » DESIGO-- Japan



LIGO *LIGO involvement with Virgo (incl. Virgo +, Adv. Virgo)*

- Joint data taking and operations planning began May 18, 2007.
- Going very well with joint analysis groups, joint collaboration meetings, frequency joint meetings between LIGO & Virgo leadership
- Virgo + will run with e-LIGO (S7, VSR 2)
- Adv. Virgo and Adv. LIGO will operate concurrently
- LIGO and Virgo will help each other to the extent desired and consistent with commitments--e.g. visits, help with technical issues, etc.



LIGO involvement with Japanese community

- A few TAMA scientists are LSC members
- Support our Japanese colleagues
 - » In seeking funding, based on requests
 - Previous efforts to seek funding for LCGT supported by LIGO with letters and even highlighting LCGT on our website to indicate international support
 - » LCGT seeking funding again
 - Support letter if requested
 - Possible visit to funding agency to indicate importance of LCGT in context of global network and GWIC roadmap
 - » Possible exchange of small number of people if interested and consistent with commitments
- LIGO would welcome discussions of any Japanese interest in participating in Advanced LIGO



LIGO involvement with Australia

- Australian community significant part of LSC through ACIGA
- LIGO involved with R&D effort at 80m facility
- AIGO
 - » Probably too costly for Australia alone
 - » Would need international effort to make it happen
 - » LIGO could provide some help via designs (e.g. AdL control system) and expertise- exchange of a few people consistent with commitments
 - » Jay participating as member of AIGO International Advisory Committee
 - Chair Erich Weigold, a new PAC member
 - Gives him insider's view of LIGO that might inform aspects of AIGO's development



Towards the 3rd Generation

- In Europe--ET Design Study funded ~3M euros over 3 years
 - » Would be good to have LIGO Lab participation in study (at low level)
 - Already LSC involvement through GEO component
- In US- Would need new site--underground
 - e.g. at Deep Underground Science & Engineering Lab (DUSEL)-- design study approved by NSF
 - » Interactions with DUSEL team beginning
 - Driven by LSC, not LIGO Lab
 - Lab's agenda is very full with other major responsibilities for next ~5 years;
 - Cannot commit significant effort, but wants to maintain involvement at the level of a small fraction FTE of interested scientists within lab.
 - Possible proposal for studies to characterize Homestake mine for suitability for Generation 3 facility; submit for S4 solicitation in spring
 - Other relatively low level studies by LSC groups of interferometer configuration and technology R&D



For discussion by PAC

- Is LIGO's engagement in the international community at the right level considering our commitments to e-LIGO and Advanced LIGO?
- What more or less should we do?