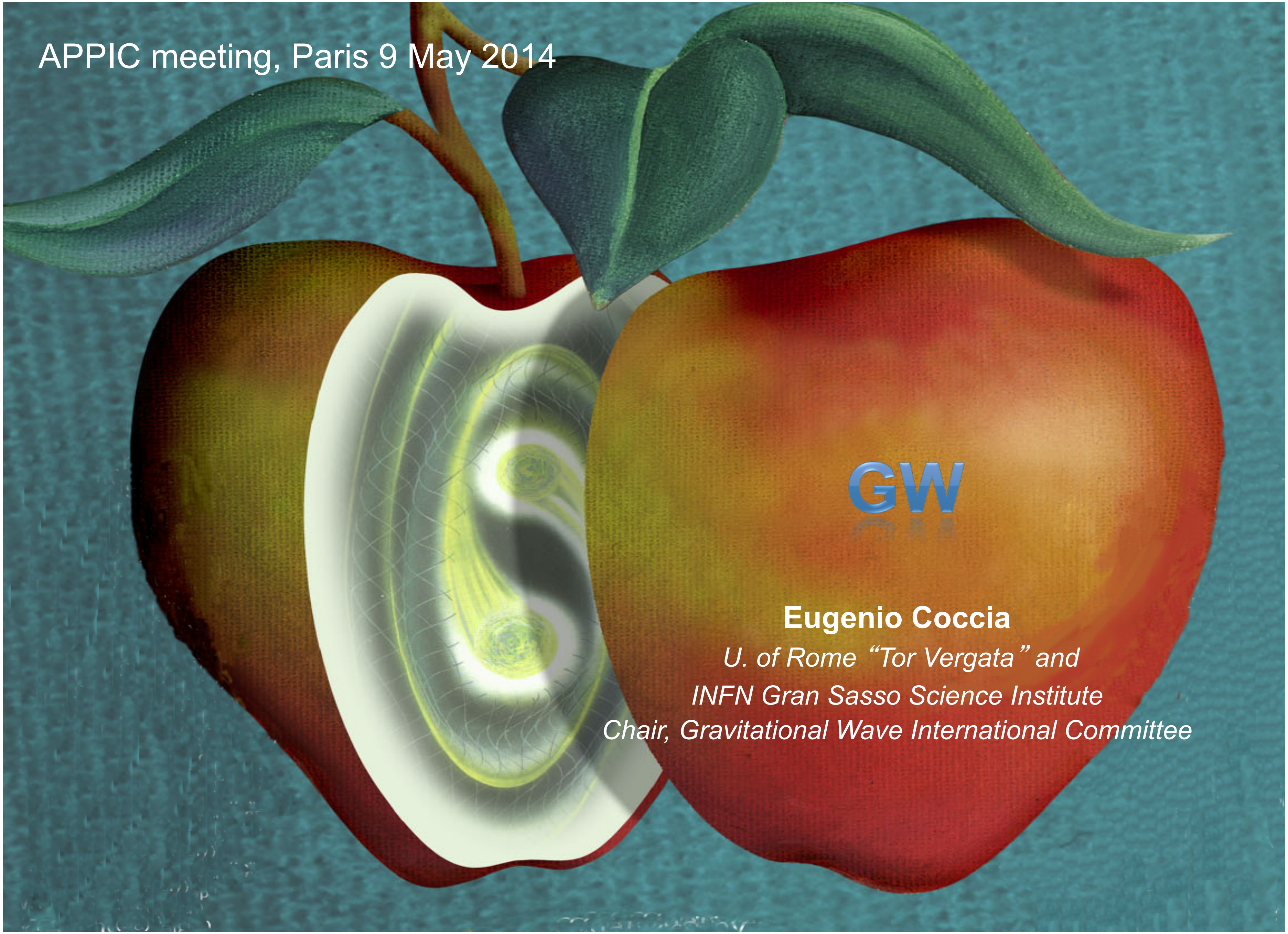
APPIC meeting, Paris 9 May 2014



GW

Eugenio Coccia

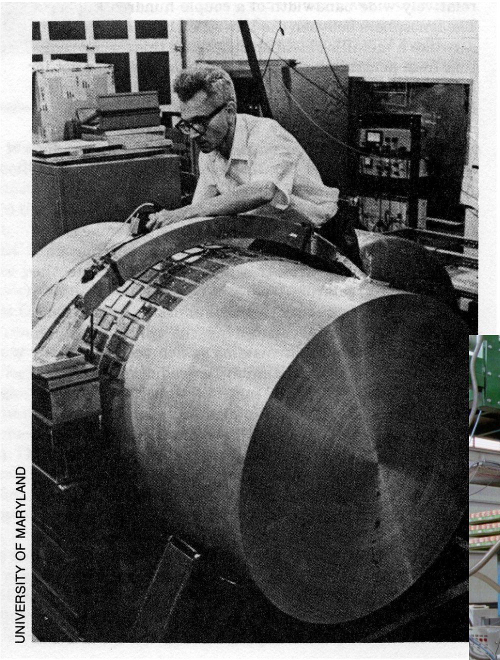
U. of Rome "Tor Vergata" and

INFN Gran Sasso Science Institute

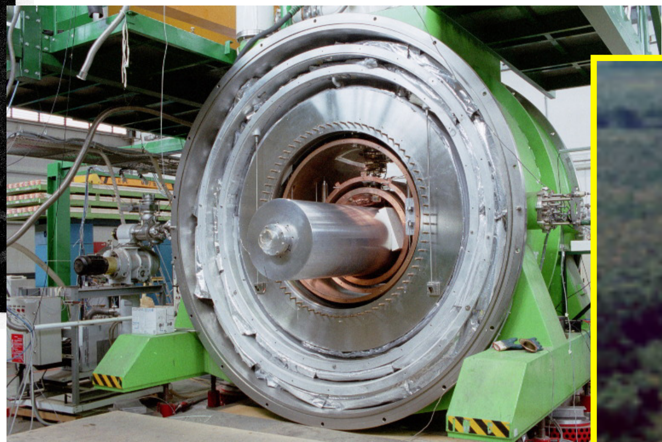
Chair, Gravitational Wave International Committee

Some perspective: 50 years of attempts at detection:

Since the pioneering work of Joseph Weber in the ‘70, the search for Gravitational Waves has never stopped, with an increasing effort of manpower and ingenuity:



60’: Joe Weber pioneering work



90’: Cryogenic Bars

2000’ - : Large Interferometers

1997: GWIC was formed

GWIC
Gravitational Wave International Committee

https://gwic.ligo.org/

Home
News
GWIC Roadmap
Thesis Prizes
Statements
Conferences
GWIC meetings
Reports to IUPAP
Simulation Programs
GWIC By-laws
Members
Related Links

The Gravitational Wave International Committee:

GWIC, the Gravitational Wave International Committee, was formed in 1997 to facilitate international collaboration and cooperation in the construction, operation and use of the major gravitational wave detection facilities world-wide. It is associated with the International Union of Pure and Applied Physics as its Working Group WG.11. Through this association, GWIC is connected with the International Society on General Relativity and Gravitation (IUPAP's Affiliated Commission AC.2), its Commission C19 (Astrophysics), and another Working Group, the AstroParticle Physics International Committee (APPIC).

GWIC's Goals:

- Promote international cooperation in all phases of construction and scientific exploitation of gravitational-wave detectors;
- Coordinate and support long-range planning for new instrument proposals, or proposals for instrument upgrades;
- Promote the development of gravitational-wave detection as an astronomical tool, exploiting especially the potential for multi-messenger astrophysics;
- Organize regular, world-inclusive meetings and workshops for the study of problems related to the development and exploitation of new or enhanced gravitational-wave detectors, and foster research and development of new technology;
- Represent the gravitational-wave detection community internationally, acting as its advocate;
- Provide a forum for project leaders to regularly meet, discuss, and jointly plan the operations and direction of their detectors and experimental gravitational-wave physics generally.

More about GWIC:

GWIC - Ten Years on (PDF) reprinted from Matters of Gravity (Fall 2007),
the newsletter of the Topical Group on Gravitation of the American Physical Society.

- GWIC is now an IUPAP Working group (WG11)

Member Projects and Representatives

Chair

- Eugenio Coccia, University of Rome "Tor Vergata" (GWIC, 2000--, Chair 2011--)

ACIGA

- Peter Veitch, University of Adelaide, 2013--

AURIGA

- Massimo Cerdonio, University of Padua and INFN, 1997--

Einstein Telescope

- Michele Punturo, INFN-Perugia, 2009--

European Pulsar Timing Array (EPTA)

- Michael Kramer, Jodrell Bank Centre for Astrophysics (University of Manchester), 2009--

GEO 600

- Karsten Danzmann, Albert-Einstein-Institut fur Gravitationsphysik and University of Hannover, 1!
- Sheila Rowan, University of Glasgow, 2009--

IndIGO

- Bala Iyer, Raman Research Institute, 2011--

KAGRA (formerly LCGT)

- Yoshio Saito, KEK, 2013--
- Takaaki Kajita, Institute for Cosmic Ray Research, University of Tokyo, 2011--

LIGO, including the LSC

- Dave Reitze, California Institute of Technology and University of Florida, 2007--
- Gabriela Gonzalez, Louisiana State University, 2011--

LISA Community

- Neil Cornish, Montana State University, 2012--
- Bernard Schutz, Albert-Einstein-Institut fur Gravitationphysik, 2001--
- Robin Stebbins, Goddard Space Flight Center, 2001--
- Stefano Vitale, University of Trento, 2001--

NANOGrav

- Frederick Jenet, University of Texas, Brownsville, 2013--

NAUTILUS

- Eugenio Coccia, University of Rome "Tor Vergata", 2000--

Parkes Pulsar Timing Array (PPTA)

- George Hobbs, Australia Telescope National Facility (ATNF), 2013--

Spherical Acoustic Detectors

- Odylio D. Aguiar, Instituto Nacional de Pesquisas Espaciais, Brazil, 2011--

Virgo

- Francesco Fidecaro, University of Pisa, 2007--
- Jean-Yves Vinet, Observatoire de la Côte d'Azur, 2011--

Theory Community

- Clifford Will, University of Florida, 2000--

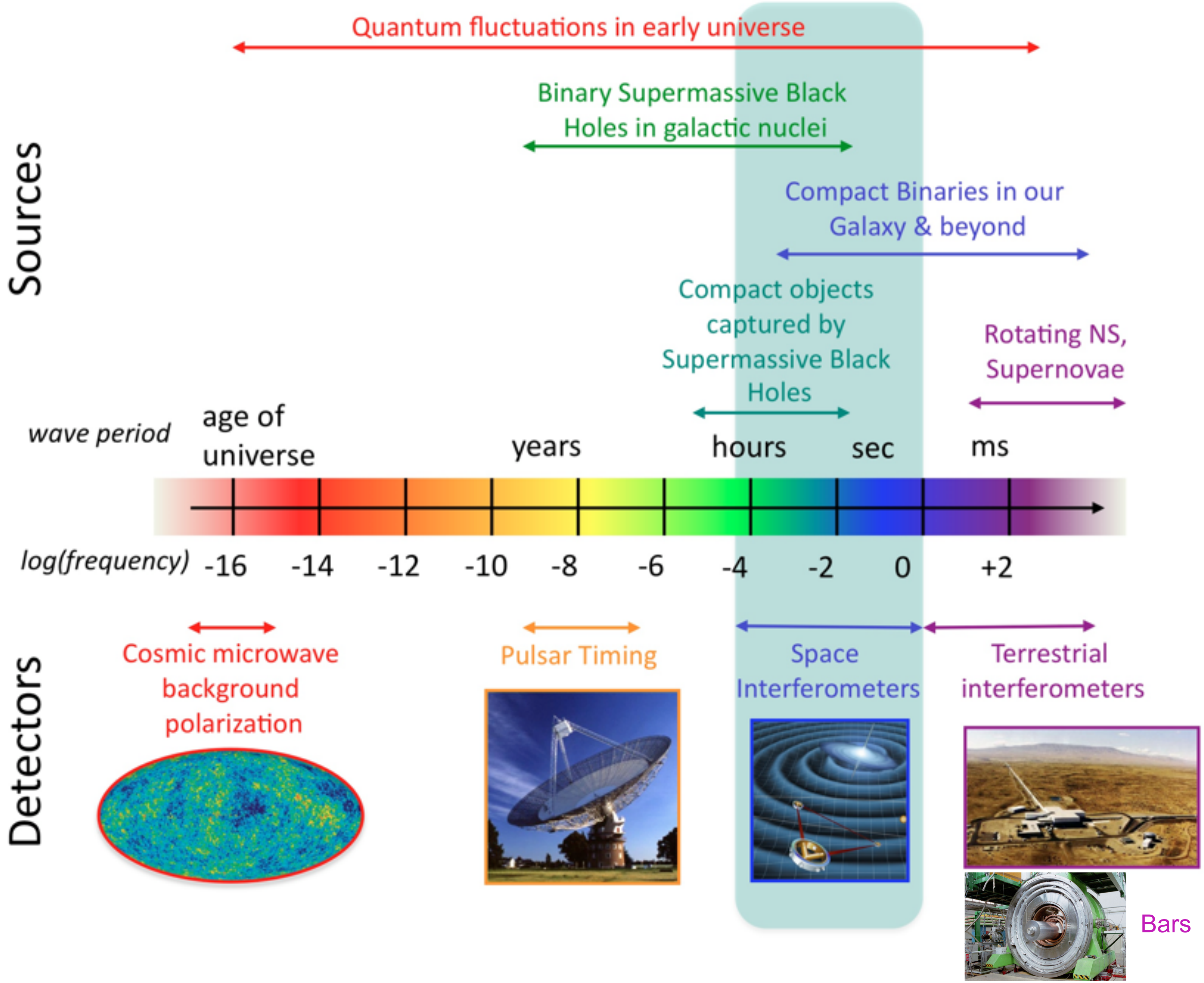
IUPAP Affiliate Commission AC2 (International Commission on General Relativity and Gravitation)

- Beverly Berger, 2013--

Executive Secretary

- Stan Whitcomb, California Institute of Technology, 2007--

The Gravitational Wave Spectrum



Virgo

LSC

Results from Initial Detectors: Some highlights from LIGO and Virgo

Several ~year long science data runs by LIGO and Virgo
Since 2007 all data analyzed jointly

- Limits on GW emission from known ms pulsars
  - Crab pulsar emitting less than 2% of available spin-down energy in gravitational waves
- Limits on compact binary (NS-NS, NS-BH, BH-BH) coalescence rates in our local neighborhood (~20 Mpc)
- Limits on stochastic background in 100 Hz range
  - Limit beats the limit derived from Big Bang nucleosynthesis

LIGO-VIRGO recent papers

All sky search for periodic gravitational waves in the full LIGO S5 science data.
Published in Phys.Rev. D85 022001, 2012.

Directional limits on persistent gravitational waves using LIGO S5 science data.
Phys. Rev. Lett. 107:271102, 2011.

Beating the spin-down limit on gravitational wave emission from the Vela pulsar.
Astrophys. J. 737, 93, 2011

Search for Gravitational Wave Bursts from Six Magnetars.
Astrophys. J. 734, L35, 2011.

Search for gravitational waves from binary black hole inspiral, merger and ringdown.
Phys. Rev. D83:122005, 2011.

Search for GW inspiral signals associated with Gamma-Ray bursts during LIGO's fifth and Virgo's first science run.
Astrophys. J. 715:1453-1461, 2010.

Searches for gravitational waves from known pulsars with S5 LIGO data.
Astrophys. J. 713:671-685, 2010.

Search for GW bursts associated with Gamma-Ray bursts using data from LIGO Science Run 5 and Virgo Science Run 1.
The LIGO and the Virgo Collaborations
Astrophys. J. 715:1438-1452, 2010.

All-sky search for gravitational-wave bursts in the first joint LIGO-GEO-Virgo run.
Phys. Rev. D81, 102001, 2010

Search for Gravitational Waves from Compact Binary Coalescence in LIGO and Virgo Data from S5 and VSR1.
Phys. Rev. D82, 102001, 2010

An upper limit on the stochastic GW background of cosmological origin
Nature 460, 08278, 2009

Constraints on cosmic (super)strings from the LIGO-Virgo gravitational-wave detectors
e-Print: **arXiv:1310.2384** **[gr-qc] |**

First Searches for Optical Counterparts to Gravitational-wave Candidate Events
e-Print: **arXiv:1310.2314**

A directed search for continuous Gravitational Waves from the Galactic Center
e-Print: **arXiv:1309.6221** **[gr-qc] |**

A search for long-lived gravitational-wave transients coincident with long gamma-ray bursts
e-Print: **arXiv:1309.6160** **[astro-ph.HE]**

Gravitational waves from known pulsars: results from the initial detector era
e-Print: **arXiv:1309.4027** **[astro-ph.HE]**

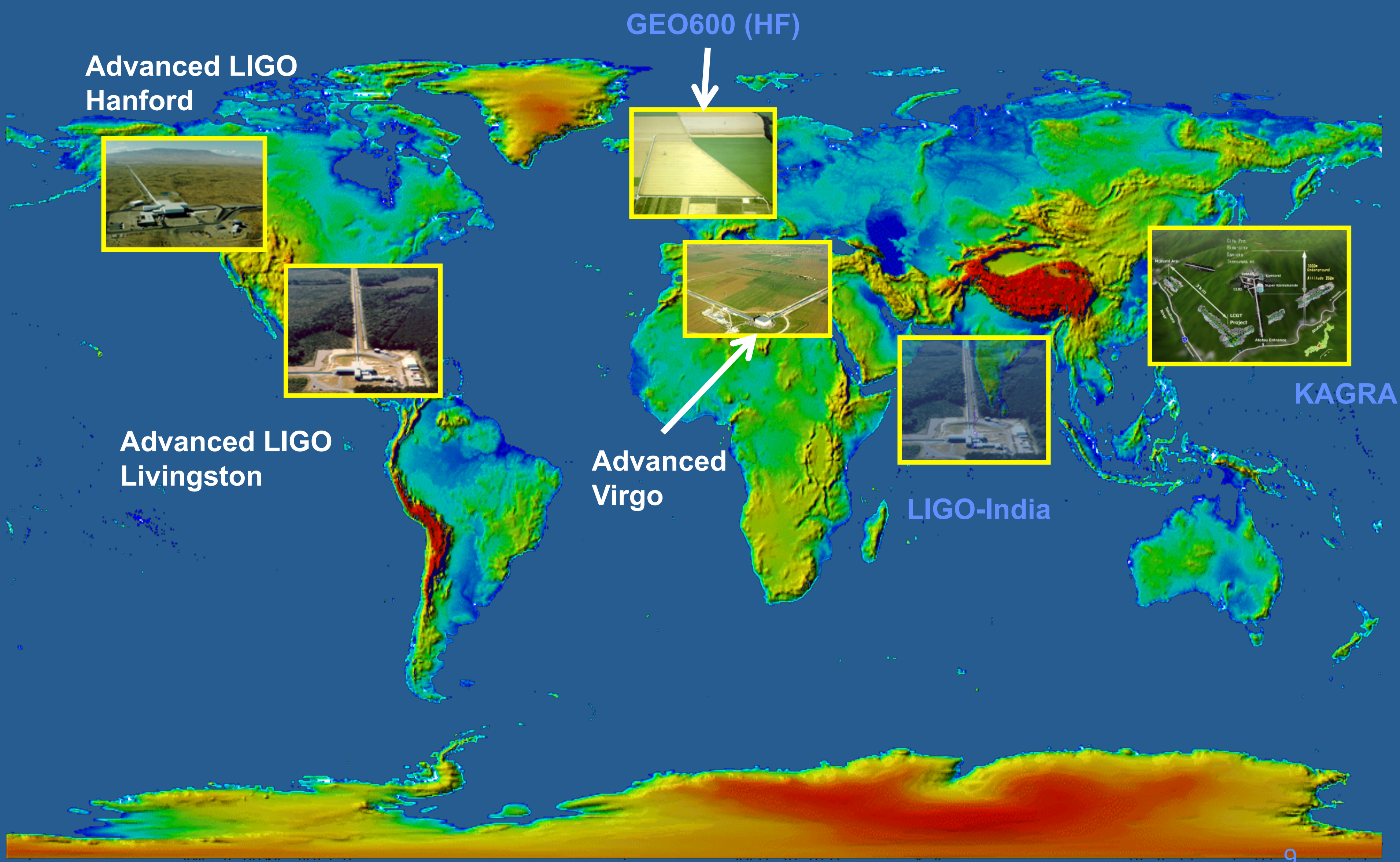
Prospects for Localization of GW Transients by the Advanced LIGO and Advanced Virgo Observatories
e-Print: **arXiv:1304.0670** **[gr-qc]**

Parameter estimation for compact binary coalescence signals with the first generation GW detector network
LIGO and Virgo Collaborations (J. Aasi (Caltech) *et al.*). Apr 5, 2013. 23 pp.
Phys.Rev. D88 (2013) 062001

Search for GW from Binary Black Hole Inspiral, Merger and Ringdown in LIGO-Virgo Data from 2009-2010
Phys.Rev. D87 (2013) 022002

Einstein@Home all-sky search for periodic gravitational waves in LIGO S5 data
Phys.Rev. D87 (2013) 4, 042001

The Advanced GW Detector Network



2nd GENERATION:
DISCOVERY AND ASTRONOMY

2nd generation detectors:

Advanced Virgo, Advanced LIGO

GOAL:

sensitivity 10x better →

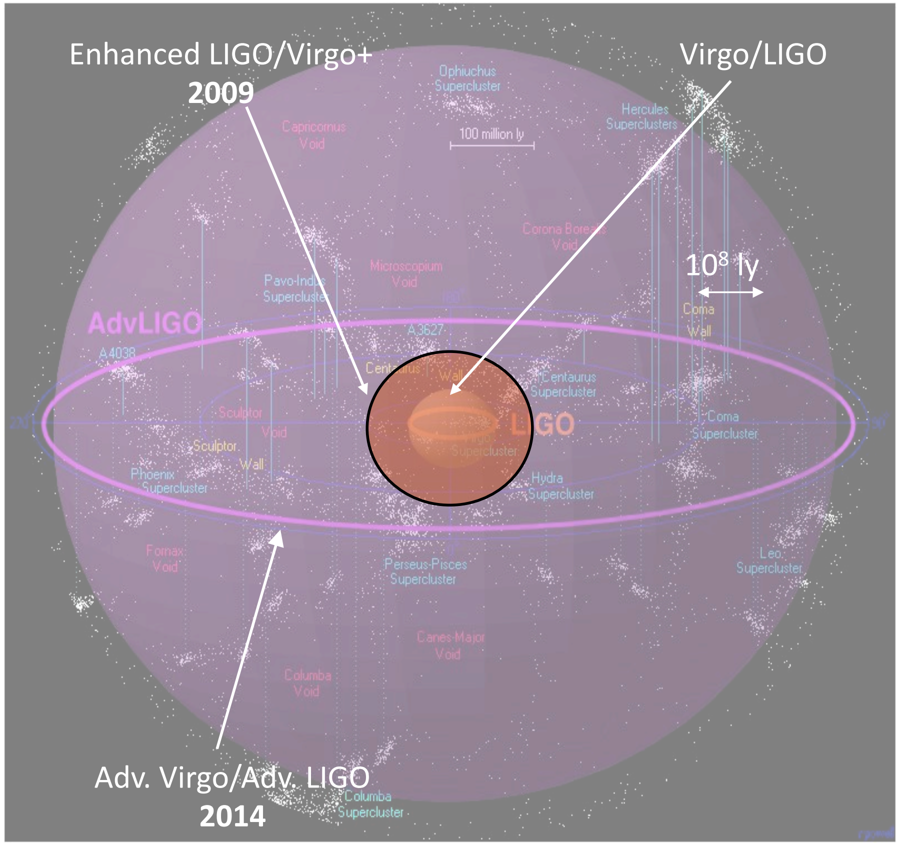
look 10x further →

Detection rate 1000x larger

NS-NS detectable as far as 300 Mpc

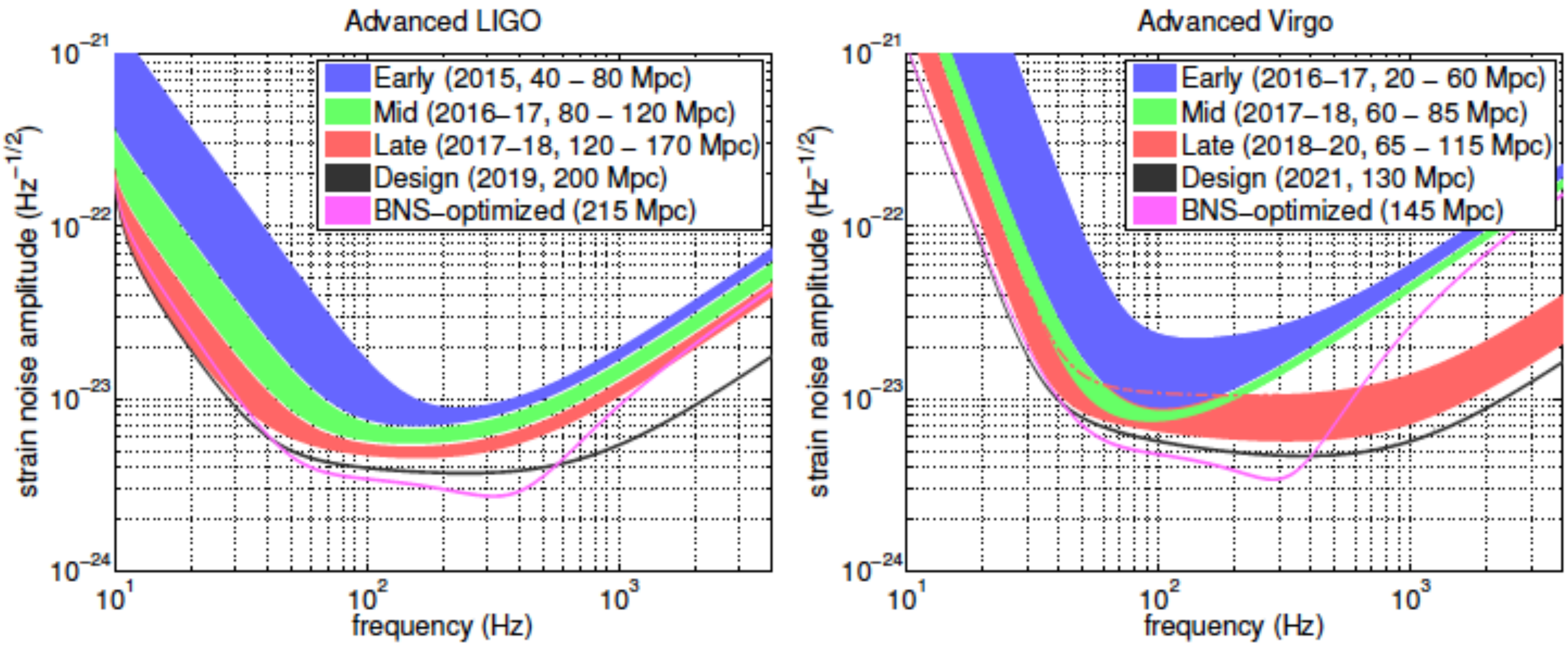
BH-BH detectable at cosmological distances

10s to 100s of events/year expected!

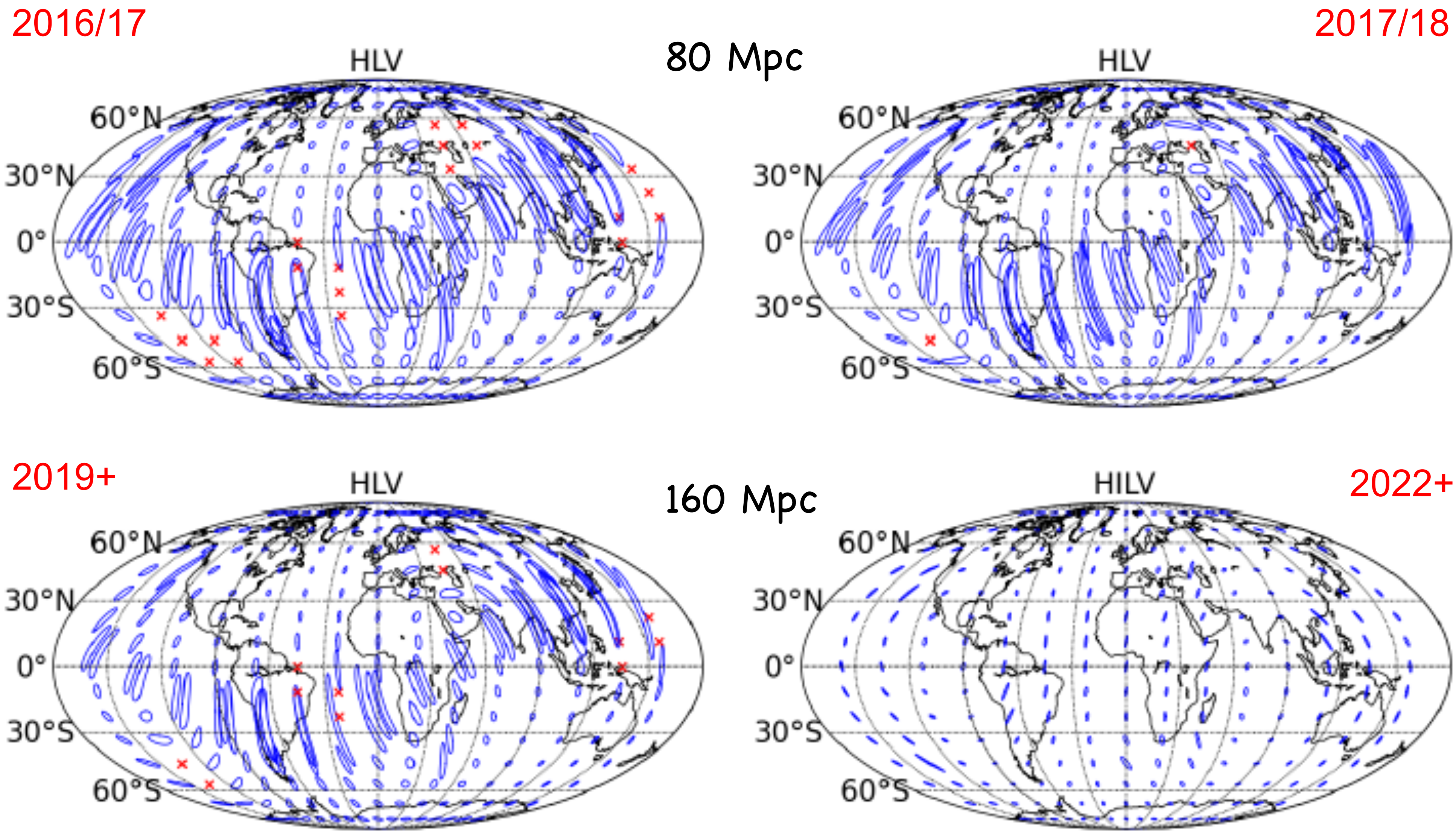


Credit: R.Powell, B.Berger

Plausible scenario
for the operation of the LIGO-Virgo network over the next decade

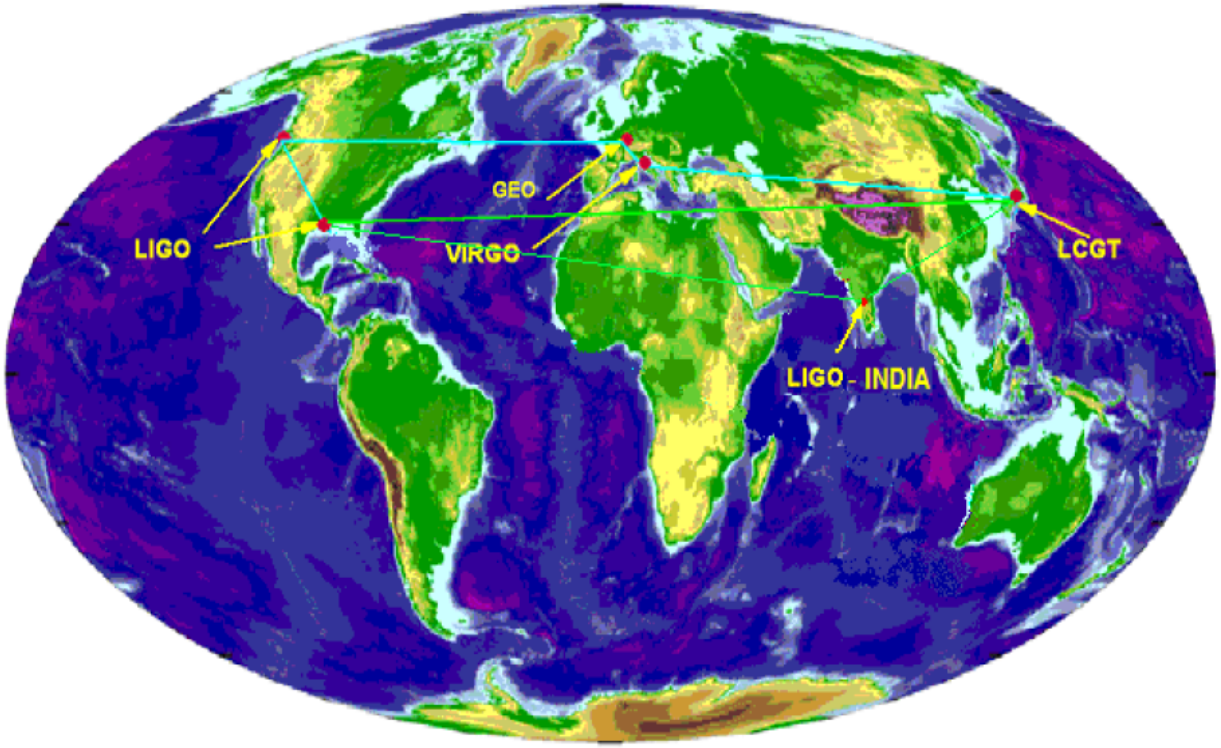


Epoch	Estimated Run Duration	$E_{GW} = 10^{-2} M_{\odot} c^2$ Burst Range (Mpc)		BNS Range (Mpc)		Number of BNS Detections	% BNS Localized within	
		LIGO	Virgo	LIGO	Virgo		$5\,\mathrm{deg}^2$	$20\,\mathrm{deg}^2$
2015	3 months	40 – 60	–	40 – 80	–	0.0004 – 3	–	–
2016–17	6 months	60 – 75	20 – 40	80 – 120	20 – 60	0.006 – 20	2	5 – 12
2017–18	9 months	75 – 90	40 – 50	120 – 170	60 – 85	0.04 – 100	1 – 2	10 – 12
2019+	(per year)	105	40 – 80	200	65 – 130	0.2 – 200	3 – 8	8 – 28
2022+ (India)	(per year)	105	80	200	130	0.4 – 400	17	48



Localization expected for a BNS system

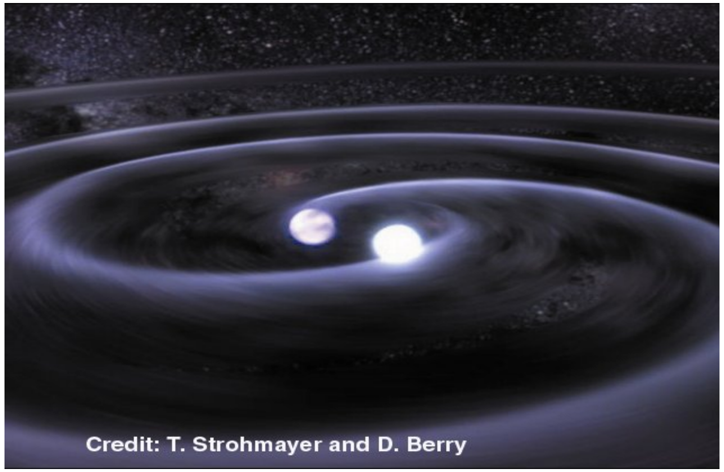
The ellipses show 90% confidence localization areas, and the red crosses show regions of the sky where the signal would not be condently detected.

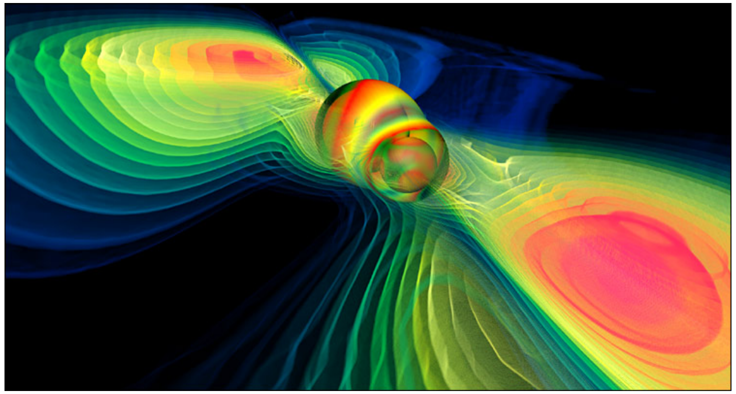


- We are on the threshold of a new era of gravitational wave astrophysics
- First generation detectors have broken new ground in optical sensitivity
  - Initial detectors have proven technique
- Second generation detectors are starting installation
  - Will expand the "Science" (astrophysics) by factor of 1000
- In the next decade, emphasis will be on the *NETWORK*

THE GLOBAL PLAN

- Advanced Detectors (LIGO, VIRGO +) will initiate gravitational wave astronomy through the detection of the most luminous sources - compact binary mergers.
- Third Generation Detectors (ET and others) will expand detection horizons and provide new tools for extending knowledge of fundamental physics, cosmology and relativistic astrophysics.
- Observation of low frequency gravitational wave with LISA/NGO will probe the role of super-massive black holes in galaxy formation and evolution





MoU LSC-Virgo **Purpose of agreement:**

The purpose of this Memorandum of Understanding (MOU) is to establish and define a collaborative relationship between VIRGO on the one hand and the Laser Interferometer Gravitational Wave Observatory (LIGO) on the other hand in the use of the VIRGO, LIGO and GEO detectors based on laser interferometry to measure the distortions of the space between free masses induced by passing gravitational waves.

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.

Among the scientific benefits we hope to achieve from the collaborative search are: better confidence in detection of signals, better duty cycle and sky coverage for searches, and better source position localization and waveform reconstruction. In addition, we believe that the intensified sharing of ideas will also offer additional benefits.

3. This agreement governs cooperative scientific work between VIRGO and LIGO. The terms governing work on data analysis are exclusive; that is, the parties agree that all of the data analysis work that they do will be carried out under the framework of this agreement. The terms governing other forms of collaborative work are not exclusive; they may, in addition, make agreements with other parties that are not governed by this agreement, as long as such agreements do not involve sharing of data.

4. The agreement described herein represents a scientific collaboration between independent projects, not a merger. Each project will maintain its own separate governance. Decisions on issues that bear on collaborative work will be made in discussion among the leadership of the projects, each representing their Collaborations' position as determined according to their own governing structures.

5. Goals for joint data analysis will be proposed by LSC/Virgo collaboration Joint Data Analysis Groups, will be discussed jointly by both Collaborations and will be approved by each Collaboration according to their own governing structures. The specific mechanisms for the coordination of the data analysis activities are described in an Attachment to this MOU.

6. After the data sharing provisions of this agreement go into effect, all subsequent observational data will be open to both collaborations, to be used in the framework of Joint Data Analysis Groups on all gravitational wave analysis topics. All gravitational wave data analysis will be carried out under the umbrella of this agreement between LIGO and VIRGO; there will be no LSC-only or Virgo-only gravitational wave data analyses while this agreement remains in force. (However, each collaboration may use its own environmental data freely, outside the framework of this agreement.)

Nevertheless, the LSC and the Virgo collaboration each reserve the right to maintain independent pipelines to carry out any data analysis problem.

After the data sharing provisions of this agreement go into effect, 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.

Organization of joint data analysis:

11. All data analysis activities will be open to all members of the LSC and Virgo Collaborations, in a spirit of cooperation, open access, full disclosure and full transparency with the goal of best exploiting the full scientific potential of the data.

Data analysis projects and activities will be organized in joint Analysis Groups, comprising members of the LSC and Virgo. Every data analysis project must be affiliated with at least one of the Analysis Groups.

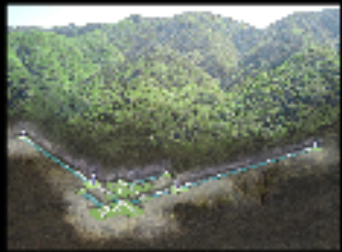
Participation in the Analysis Groups will be open. Instrument experts will be active members of all Analysis Groups and Review Committees, to ensure appropriate use and interpretation of the data.

All data and their interpretation will be held strictly within the membership of the Collaborations until the review processes outlined below are complete and both Collaborations have given their permission for public release. This is to be interpreted that no discussion of results or pre-prints may take place with scientists who are not members of the Collaborations or with members of the media, until the leaderships of the Collaborations have approved the release of the information.

Comprehensive Multimessenger Studies

LIGO Livinston

LCGT



GEO

ET

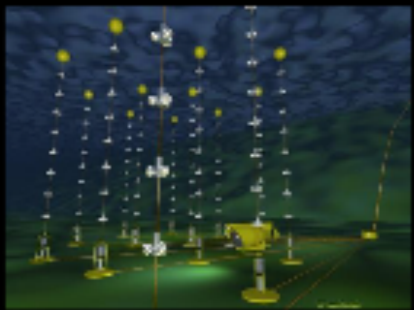
LIGO Hanford

Virgo

LVD

Swift

Antares



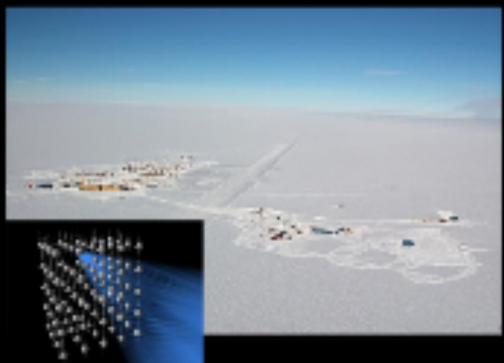
Fermi

QUEST

TAROT

Super-K

IceCube



Arecibo

Green Bank

LOFAR

Open Questions for Multimessenger Observations

- What is the speed of gravitational waves?
  (subluminal or superluminal?)

- Can gravitational wave detectors provide an early warning to electromagnetic observers?
  (to allow the detection of early light curves?)

- What is the precise origin of SGR flares?
  (what is the mechanism for GW and EM emission and how are they correlated?)

- What happens in a core collapse supernova before the light and neutrinos escape?

- Are there electromagnetically hidden populations of GRBs?

- What GRB progenitor models can we confirm or reject?

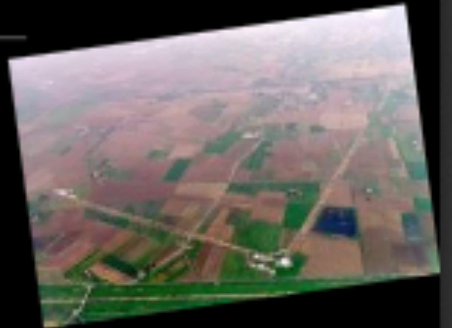
- Is it possible to construct a competitive Hubble diagram based on gravitational wave standard sirens?

Basic Glossary: Multimessenger Approaches

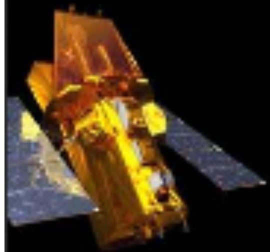
"Multi-messenger astrophysics": connecting different kinds of observations of the same astrophysical event or system

"Looc-Up" strategy:

GW Data — Flow of trigger information → **Telescopes, Satellites or other external entities**



"ExtTrig" strategy:



Telescopes, Satellites or other external entities — Flow of trigger information → **GW** Search

Transient Multimessenger Astrophysics with GWs

- » Gamma-ray transients (GRBs, SGRs)
- » Optical transients
- » Neutrino events
- » Radio transients
- » X-ray transients
- »…

- ➤ Correlation in time
- ➤ Correlation in direction
- ➤ Information on the source properties, host galaxy, distance
- ➤ …

- ✓ Confident detection of GWs.
- ✓ Better background rejection ⇒ Higher sensitivity to GW signals.
- ✓ More information about the source/engine.
- ✓ Measurements made possible through coincident detection.

LSC VIRGO

Soft Gamma Repeater - GW results

PRD, 80, 042001, 2009
CQG, 24, 659, 2007

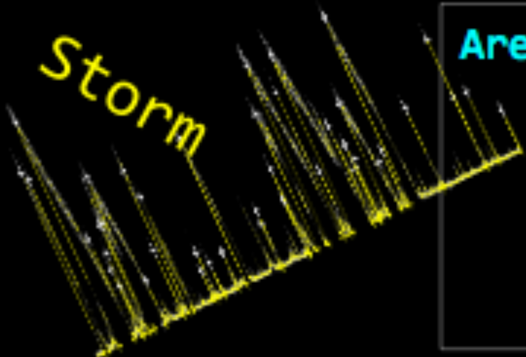
Long-lived quasiperiodic GWs after giant flare ?

- December 2004 giant flare of SGR 1806-20
- Searched for GW signals associated with X-ray QPOs
- GW energy limits are comparable to total EM energy emission -> *Abbott et al., PRD 76, 062003 (2007)*

Are there GW bursts at times of SGR flares ?

- 2004 giant flare plus 188 other flares from SGR 1806-20 and SGR 1900+14 during first calendar year of LIGO S5 run (First search for neutron star *f*-modes ringing down (~1.5-3 kHz, 100ms), also for arbitrary lower-frequency transients…) For certain assumed waveforms, GW energy limits are as low as 3×10^{45}erg, comparable to EM energy emitted in giant flares

-> *Abbott et al., PRL 101, 211102 (2008)*



Are repeated GW bursts associated with multiple flares ?

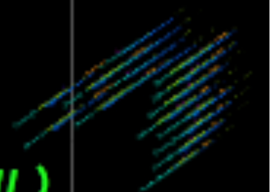
- "Storm" of flares from SGR 1900+14 on 29 March 2006
- "Stack" GW signal power around each EM flare. Gives per-burst energy limits an order of magnitude lower than the individual flare analysis for the storm events

-> *Abbott et al., ApJ 701, L68 (2009)*

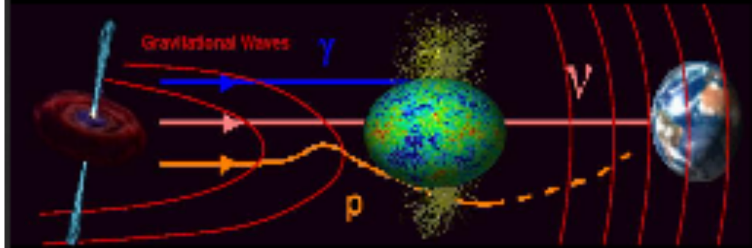
Can we see gravitational waves from newly discovered close-by SGRs ?

- SGR 0501+4516 and SGR 0418+5729 are 5-10x closer than SGR 1806-20 and SGR 1900+14… our GW energy scales as distance²… stay tuned!

-> *Abadie et al., LIGO-P0900192 TBS(ApJL)*



Some GW+HEN source candidates

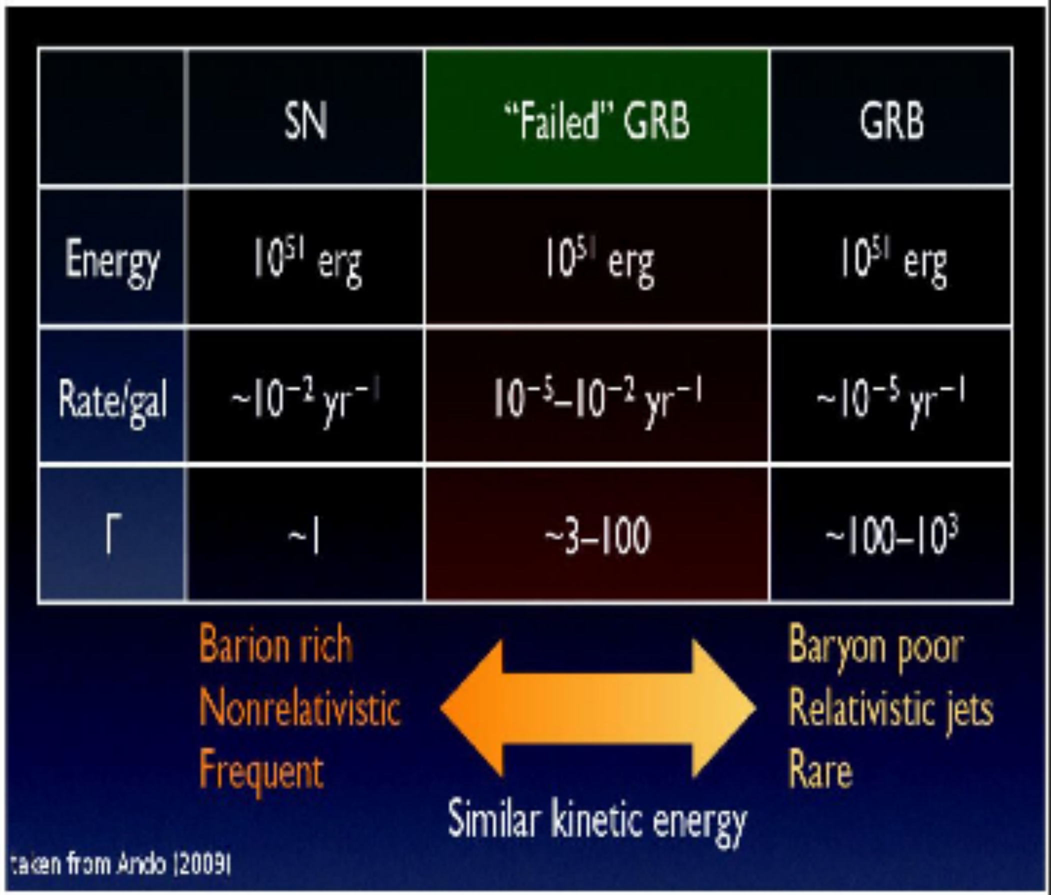


Long GRBs: In the prompt and afterglow phases, high-energy neutrinos (10^5-10^{10} GeV) are expected to be produced by accelerated protons in relativistic shocks (e.g., *Waxman & Bahcall 1997; Vietri 1998; Waxman 2000*).

Short GRBs: HENs can also be emitted during binary mergers (*Nakar 2007; Bloom et al. 2007; Lee & Ramirez-Ruiz 2007*).

Low-Luminosity GRBs: Associated with particularly energetic population of core-collapse supernovae (*Murase et al. 2006; Gupta & Zhang 2007; Wang et al. 2007*). Local event rate can be significantly larger than that of conventional long GRBs (*Liang et al. 2007; Soderberg et al. 2006*).

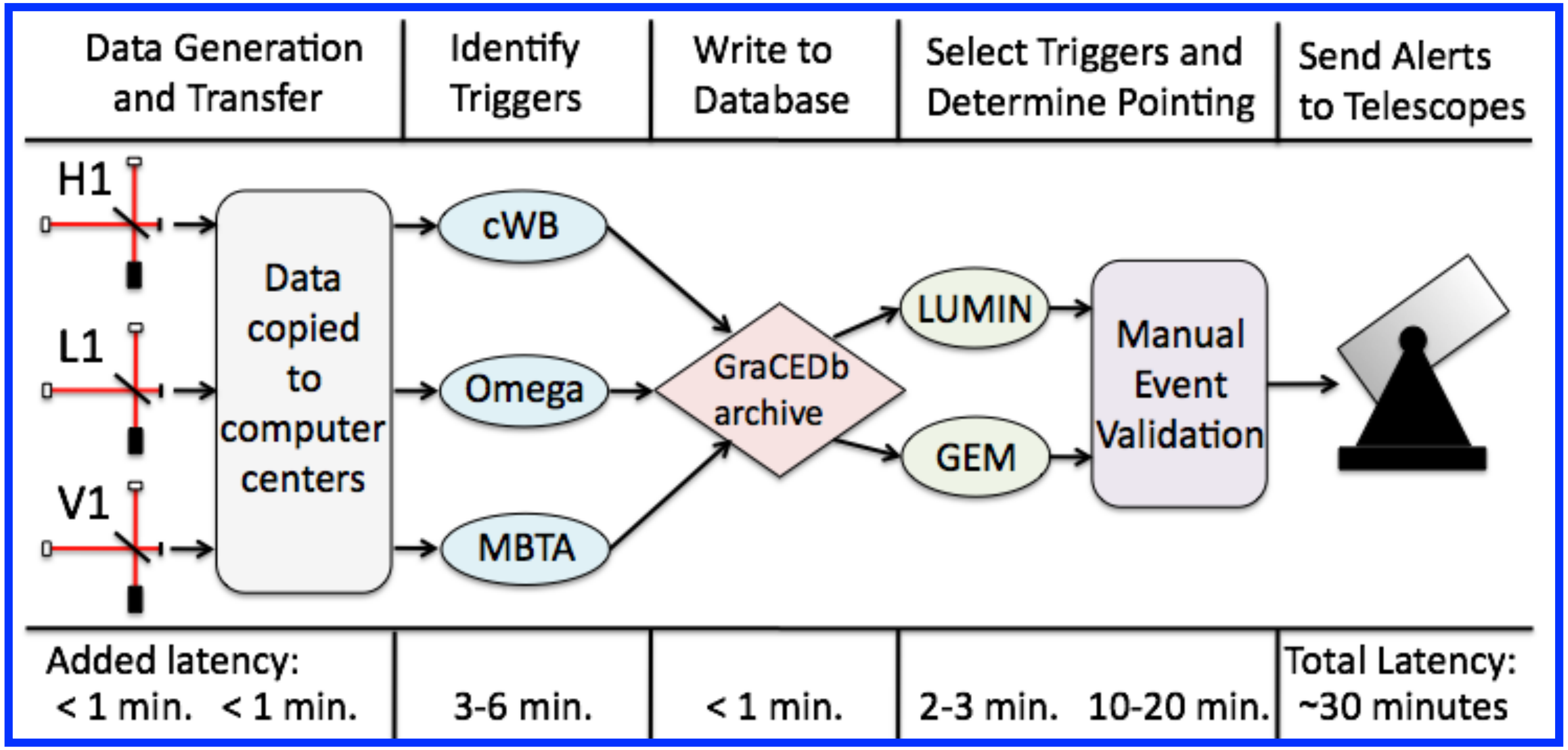
"Choked" GRBs: Plausibly from baryon-rich jets. Optically thick, can be hidden from conventional astronomy, <u>neutrinos and GWs might be able to reveal their properties</u> (*Ando & Beacom (2005), Razzaque et al. 2004; Horiuchi & Ando 2008*).



	SN	"Failed" GRB	GRB
Energy	10^{51} erg	10^{51} erg	10^{51} erg
Rate/gal	$\sim 10^{-2}$ yr^{-1}	10^{-5}–10^{-2} yr^{-1}	$\sim 10^{-5}$ yr^{-1}
Γ	~1	~3–100	~100–10^3

missing link between SN and GRB?

Low Latency EM Follow-Up Program



- Subthreshold candidate GW events sent to partner ~meter class telescopes network
- Target alert rate of 1 per week
- Ran during parts of most recent science runs Dec 2009-Jan 2010 and Sep to Oct 2010
- Images obtained for 8 different events

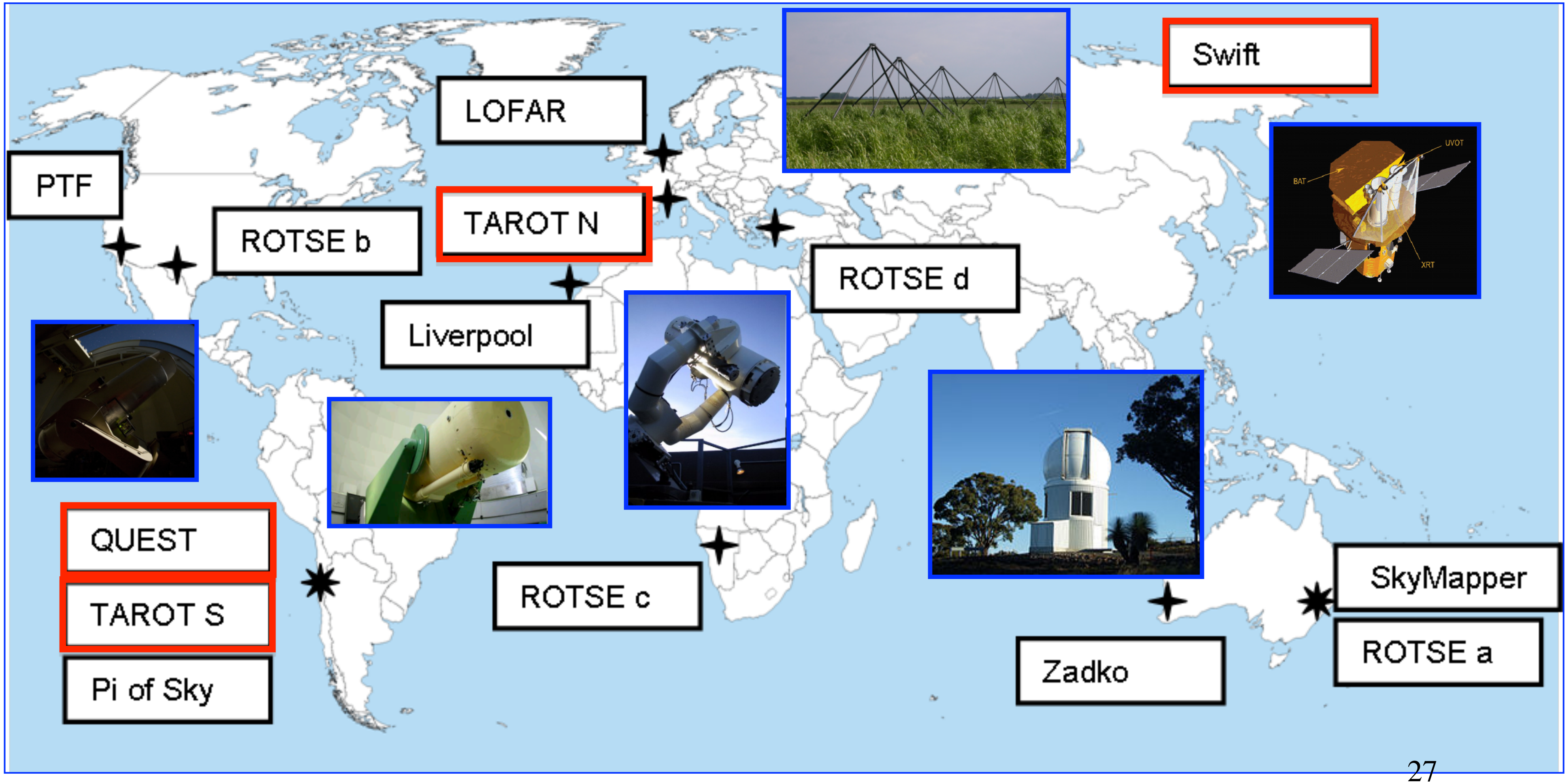
LSC VIRGO

Astronomy & Astrophysics 539 (2012)A124

Astronomy & Astrophysics 541 (2012)A155

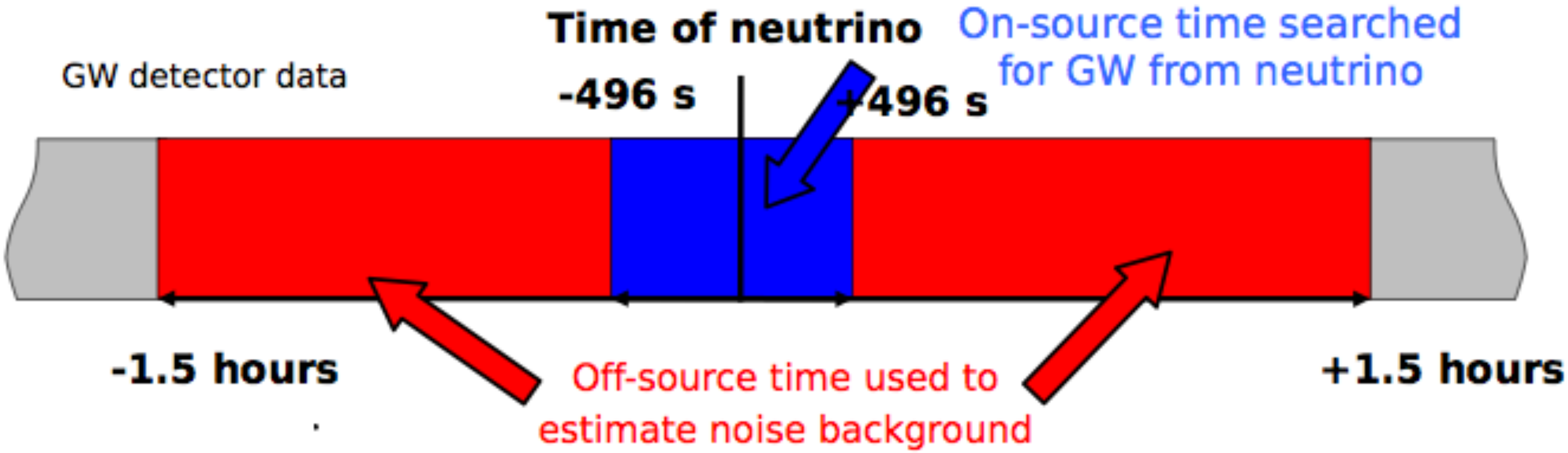
Telescope Network

Used in winter and autumn run   autumn run only



X-Pipeline search (ANTARES)

- Same procedure as bursts GRB search:
  - Each neutrino trigger is processed independently of the others.
  - The data is divided on-source ([-496, +496] s around each neutrino trigger) and off-source (all other data within +/- 1.5 hr of the neutrino + time slides) [arXiv:1101.4669].
  - The on-source data is searched coherently for large-energy events.
  - Event significance estimated by comparing to the off-source data.
  - Detection / upper limit for each neutrino trigger.



https://trac.ligo.caltech.edu/xpipeline/wiki/Documentation http://www.ligo.org/science/GWEMalerts.php.

LSC LIGO Scientific Collaboration VIRGO

news magazine Advanced LIGO science students/teachers/public multimedia partners about

Introduction Popular Articles LSC Scientific Publications Science Summaries Data Releases GW-EM Alerts

IDENTIFICATION AND FOLLOW UP OF ELECTROMAGNETIC COUNTERPARTS OF GRAVITATIONAL WAVE CANDIDATE EVENTS

The LIGO Scientific Collaboration (LSC) and the Virgo Collaboration currently plan to start taking data in 2015, and we expect the sensitivity of the network to improve over time. Gravitational-wave transient candidates will be identified promptly upon acquisition of the data; we aim for distributing information with an initial latency of a few tens of minutes initially, possibly improving later. The LSC and the Virgo Collaboration (LVC) wish to enable multi-messenger observations of astrophysical events by GW detectors along with a wide range of telescopes and instruments of mainstream astronomy.

In 2012, the LVC approved a statement (LSC, Virgo) that broadly outlines LVC policy on releasing GW triggers (partially-validated event candidates). Initially, triggers will be shared promptly only with astronomy partners who have signed an Memorandum of Understanding (MoU) with LVC involving an agreement on deliverables, publication policies, confidentiality, and reporting. After four GW events have been published, further event candidates with high confidence will be shared immediately with the entire astronomy community (and the public), while lower-significance candidates will continue to be shared promptly only with partners who have signed a MoU.

From June to October 2013, we organized rounds of consultations with groups of astronomers that have expressed interest in the GW-EM follow-up program. Thanks to these consultations, we could define the framework and guiding rules for this program that are collected into a standard MoU template.

LSC AND VIRGO POLICY ON RELEASING GRAVITATIONAL WAVE TRIGGERS TO THE PUBLIC IN THE ADVANCED DETECTORS ERA

The LSC and Virgo recognize the great potential benefits of multi-messenger observations, including rapid electromagnetic follow-up observations of GW triggers. Both Collaborations (the LSC and Virgo) will partner with astronomers to carry out an inclusive observing campaign for potentially interesting GW triggers, with MoUs to ensure coordination and confidentiality of the information. They are open to all requests from interested astronomers or astronomy projects which want to become partners through signing an MoU. They encourage colleagues to help set up and organize this effort in an efficient way to guarantee the best science can be done with gravitational wave triggers.

After the published discovery of gravitational waves with data from LSC and/or Virgo detectors, both the LSC and Virgo will begin releasing especially significant triggers promptly to the entire scientific community to enable a wider range of follow-up observations. This will take effect after the Collaborations have published papers (or a paper) about 4 GW events, at which time a detection rate can be reasonably estimated. The releases will be done as promptly as possible, within an hour of the detected transient if feasible. Initially, the released triggers will be those which have an estimated false alarm rate smaller than 1 per 100 years.

Partners who have signed an MoU with the LSC and Virgo will have access to GW triggers with a lower significance threshold and/or lower latency, according to the terms of the MoU, in order to carry out a more systematic joint observing campaign and combined interpretation of the results.

Throughout the Advanced Detectors era, the LSC and Virgo will release appropriate segments of data from operating detectors corresponding to detected gravitational waves presented in LSC/Virgo authored publications, at the time of the publication, including the first claimed detection of gravitational waves.

Open call for partnership for the EM identification and follow-up of GW candidate events

LIGO-M1300550, VIR-0494E-13 — December 12, 2013

LIGO and VIRGO open a call to sign Memoranda of Understanding (MOUs) with astronomers in order to enable a program of electromagnetic (EM) follow-up observations of gravitational-wave (GW) event candidates. While each MOU represents an agreement between LIGO, VIRGO and a single astronomy group, it is an agreement for participation in the program as a whole, which requires sharing information with other partners as well. We have discussed the issues, consulted with astronomers, and settled on a framework for the EM follow-up program that we believe facilitates the science that can be done and will be fair to all participants. The purpose of this document is to provide background on LIGO and VIRGO and outline some of the important details of the GW-EM follow-up program that partners are invited to participate in.

Memorandum of Understanding between

XXXXX and LIGO and VIRGO

regarding follow-up observations of gravitational wave event candidates

This Memorandum of Understanding (MOU) establishes a collaborative effort among the Laser Interferometer Gravitational-Wave Observatory (LIGO) and LIGO Scientific Collaboration (LSC), the European Gravitational Observatory and Virgo Collaboration (EGO/Virgo), and Full-name-of-XXXXX-Collaboration (XXXXX) in order to participate in a program to perform follow-up observations of gravitational wave (GW) candidate events with the sharing of proprietary information (see LIGO-M1300550 and VIR-0494E-13 for an overview).

The purpose of this MOU is to reference the parties involved and their relevant policies; define the appropriate data and information that is to be shared under this arrangement, and its permitted use; and establish how any publications and presentations coming out of this work will be handled. By signing this MOU, the parties agree that they understand the nature of the collaborative work, consider it to be scientifically worthwhile, and will do their best to bring it to successful completion.

Low Energy Neutrinos and Gravitational Waves

- A multi-messenger partner to GWs for core collapse supernovae
- LSC and Virgo are developing search methods especially for the advanced detectors
- For a range of 5 Mpc the supernovae rate becomes about 1/year
- 5 Mpc is on the outside edge of the aLIGO and Super-K ranges, but a weak coincident signal in both may be convincing (especially if there were also an optical signal)
- For a galactic supernova, the neutrino signal will be large, and one would do a standard external trigger search (GRB search) with a tight coincidence window

Neutrinos meet GravitationalWaves: Preparing for the Next Nearby Core-Collapse Supernova

Memorandum of Understanding among the Borexino Collaboration, the IceCube Collaboration, the LVD Collaboration and the LIGO Scientific and VIRGO Collaborations

In proceeding with this work, we propose two phases:

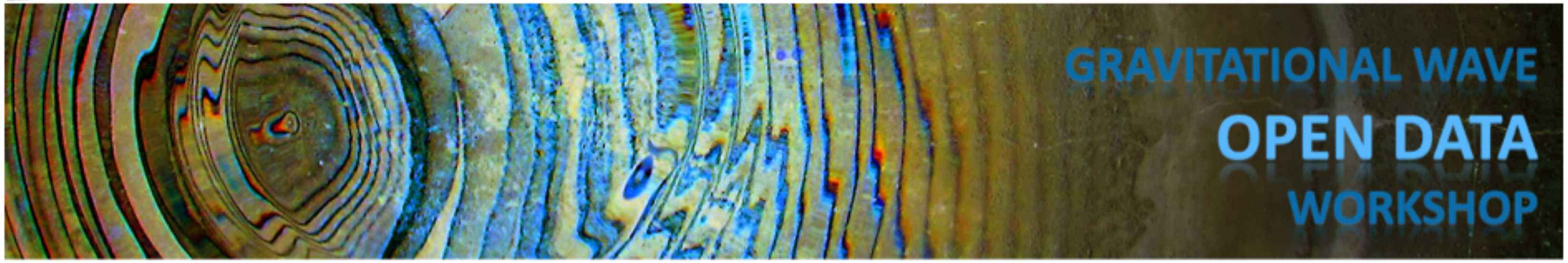
Phase 1 (lasting 1 year and requiring 2 FTE spread over multiple contributors) will focus on the preparation for the, near/sub-threshold scenario. As an exercise, we propose to re-analyze archival data of neutrino andGWdetectors from 2005 to 2010. We will aim for a conservative false alarm rate of 1/1000 years and consider two (or more) neutrino candidate events in 20-second temporal coincidence with significant GW triggers.
The results of this proof-of-principle joint analysis will be presented to the participating collaborations who will decide on the publication of a joint paper.

In Phase 2, (lasting 2 years and spreading 2 FTE spread over multiple contributors) based on the experience gained in Phase 1, we will prepare for joint deep searches and integrate low-latency neutrino and GW triggering through the SuperNova EarlyWarning System (SNEWS) in the advanced GW detector era. We will also prepare for the nearby, high-statistics scenario (2) by developing integrated neutrino and GW parameter estimation approaches that will allow determination of core-collapse supernova physics by combining neutrino and GW information.

The details of data access, working group organization, membership and paper publication will be specified at a later time through a Memorandum of Understanding (MoU) among participants. In general, we expect any data exchanged as part of this effort to be analyzed only for the purpose of carrying out the joint scientific goals outlined in this proposal. No sharing of these data (in raw or derived form) outside the joint working group will be permitted.

LIGO Open Data for Gravitational-Wave Astronomy
2011 October 27-28, LIGO Louisiana

http://www.ligo.caltech.edu/gwodw2011/



OPEN DATA FOR GRAVITATIONAL-WAVE ASTRONOMY

Once gravitational waves are detected in the Advanced LIGO era, after 2014, LIGO will release data to the broader community. This workshop aims to bring together experts from the gravitational wave community with astronomers and open data experts in a two-day workshop to address the question: How should LIGO proceed in releasing gravitational wave data to maximize scientific return?

Why

After the first detections of astrophysical gravitational waves, the challenge will be finding photons from the same source, through a rapid-followup program -- detection of an afterglow will lead to new insight into source astrophysics and fundamental physics. The strain history (GW signal) will be a valuable proving ground for numerical relativity, and lead to further discoveries. In both cases, the more minds and telescopes brought to bear, the more science will be accomplished. This workshop will set the stage for open data in gravitational wave science, and define requirements.

What

The workshop will be a combination of overviews and focus groups: overviews of the science and astronomy of gravitational waves, focus groups to work on specific questions. The result for the attendees will be an appreciation of how gravitational wave astronomy will affect their field, and the result for LIGO will be a path forward to the Open Data Center.

Who

The workshop is open to all who have an interest in the exciting new field of gravitational wave astrophysics: astronomers, gravitational wave experts, those associated with the LIGO, Virgo, GEO or other detectors. We also hope for the wisdom of people who are experts in open data and its challenges, to put the resources where the best science can be achieved.

Where

The workshop will be Thursday and Friday October 27/28 at the LIGO observatory in Livingston, Louisiana. There will be a tour of the high-technology that is Advanced LIGO, as well as a chance to see beautiful New Orleans on Halloween weekend.

SURVEY

We invite all potential users of gravitational wave open data to fill in our survey to allow LIGO to better gauge requirements.

https://docs.google.com/spreadsheet/viewform?formkey=dFJuS1d4UlNiLW9Wdm5OQTJKWFE4ekE6MQ

LIGO Open Data Questionnaire

The LIGO Data Management Plan (https://dcc.ligo.org/cgi-bin/DocDB/RetrieveFile?docid=9967) defines plans for data release by the LIGO Scientific Collaboration (LSC) in the advanced detector era. In the discovery phase (phase 1) these plans foresee limited data releases around detections and around significant non-detections, for example in conjunction with interesting electromagnetic/neutrino observations. In the observational phase (phase 2) a much broader data release is planned, including near-real-time alerts. Furthermore, 24 months after data taking, all LIGO data will become publicly accessible.

The LIGO Data Analysis Council would appreciate your feedback on the following questions, to enable planning for phase 2. Anonymous submission of this form is welcome, however, we will weigh responses with contact information more heavily in our considerations. You need not answer all the questions. You may make just one response to one question. Your input and thought is appreciated.