

# *Gravitational Wave International Committee: roadmap and activity*

Presentation to ET symposium 2018

Sheila Rowan

for the Gravitational Waves International Committee (GWIC)

## ***What is GWIC (Gravitational Wave International Committee)?***

***Body formed in 1997 to facilitate international collaboration and cooperation in the construction, operation and use of the major gravitational wave detection facilities world-wide***

Affiliated with the International Union of Pure and Applied Physics (Working Group (WG.11).)

Current Chair: Sheila Rowan

Executive Secretary: David Shoemaker, Co-secretary: Stan Whitcomb

The membership of GWIC represents all of the world's active gravitational wave projects\*, as well as other relevant communities, covering gravitational wave frequencies from nanohertz to kilohertz.

- **Pulsar timing arrays, covering low-frequency nanohertz GW sources**
- **Space based detectors, covering the micro – mHz band**
- **Ground-based detectors, covering the Hz – kHz band**

Complementary approaches **essential to maximising the scientific potential of the field**

Full membership and more information at: <https://gwic.ligo.org/>

- Examples (only) of GWIC's actions and activities
  - » has a full meeting of the membership at least once annually
  - » convenes the biennial Edoardo Amaldi Conference on Gravitational Waves, sponsored by IUPAP (The members of GWIC serve as the Scientific Organizing Committee)
  - » administers the GWIC thesis prize, Stefan Braccini Thesis Prize
  - » organises focussed workshops on important topics in the field
  - » encouraged and supported members of the gravitational wave community in successfully proposing a new commission in 'Gravitational Wave Astrophysics to the IAU (commission D1)
  - » **created and maintains a global roadmap for the future of the field**
  
- GWIC July 2007, GWIC members voted to initiate the Roadmap and charge a Roadmap committee to carry out the task
  - » **Develop a strategic plan that lays out the excitement of the field, the potential great discoveries and the facilities and resources needed to reach that potential**
    - Ground-based, space-based, including pulsar timing



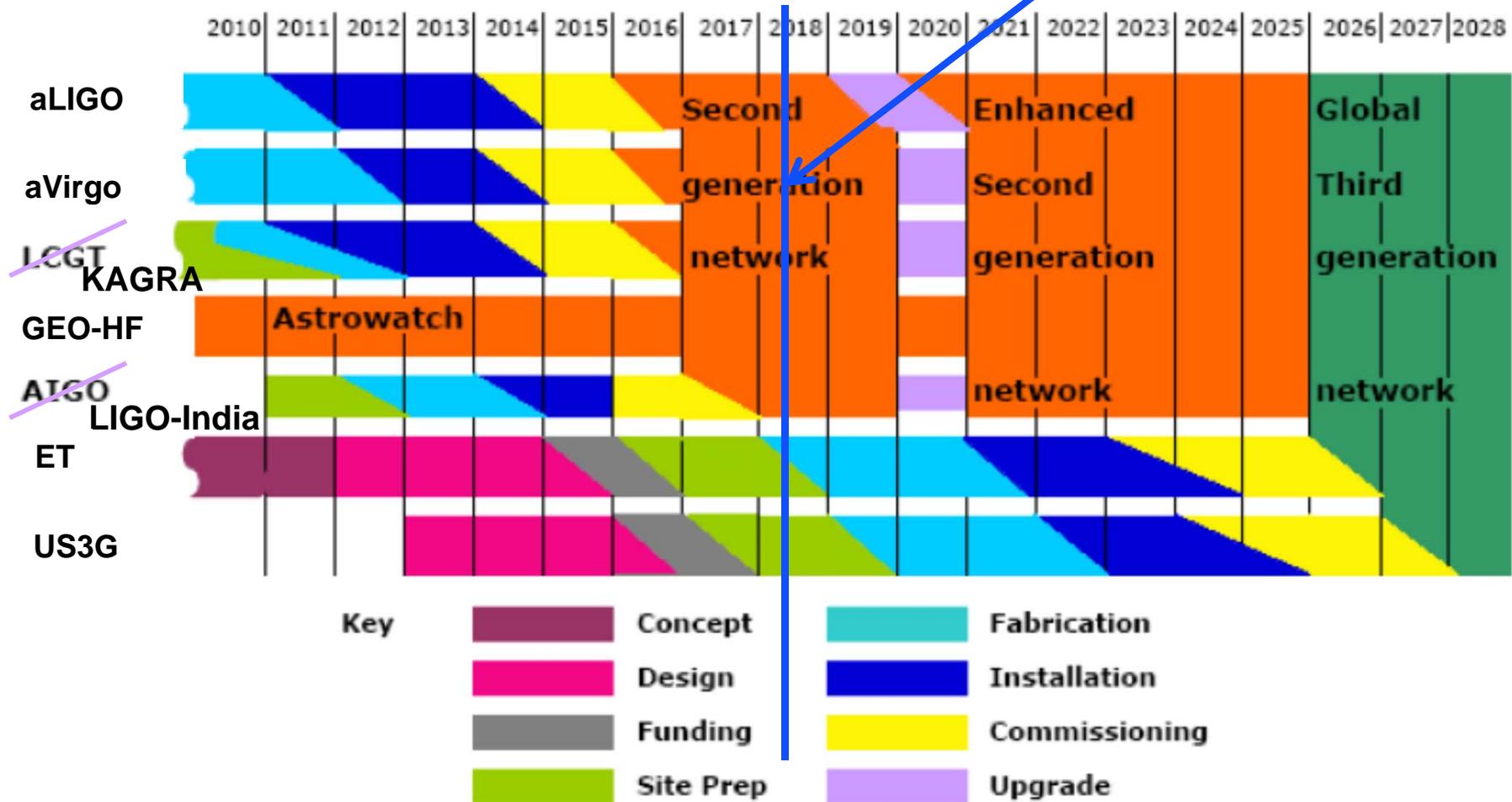
VALENCIA, SPAIN  
JULY 7-12, 2019

**Have publicly available a realistic and coherent science-driven plan**

We are here

Published ~2009

*The global Gravitational Waves roadmap*



## Community status: Ground-based field

### Rapid developments in the field

- » *First Science run ('O1') of Advanced LIGO: Sept 15 – Jan 16*
- » *Second science run ('O2') of aLIGO completed (Dec 16 – Aug 17), joined by aVirgo*
- » *Multiple detections of BBH mergers and spectacular first detection of BNS merger*
- » *Validation of global network approach*
- » *Extra-ordinary wealth of new science*
- » *Multi-messenger approach highlighted in both GW and EM/Particle astro-community planning*

### International planning landscape

- » **Update to Astro-Particle Physics European Consortium (APPEC) roadmap launched in Europe in Jan 2018**

“European Astroparticle Physics Strategy 2017-2026”  
<http://www.appec.org/roadmap/>

- » **Planning for providing input to the next Astronomy Decadal survey in the US**

Ground-based GW astronomy is squarely on their radar  
[http://sites.nationalacademies.org/cs/groups/ssbsite/documents/webpage/ssb\\_182873.pdf](http://sites.nationalacademies.org/cs/groups/ssbsite/documents/webpage/ssb_182873.pdf) (page 7)

- » **Planning for providing input to the next European 'Astronet' Roadmap**

timescales possibly synched to the decadal

- » **Individual national roadmaps?**

## GWIC's role in coordinating 3G detector development

### **GWIC Subcommittee on Third Generation Ground-based Detectors (charged in November 2016)**

#### GWIC 3G subcommittee Purpose and Mission:

With the recent first detections of gravitational waves by LIGO and Virgo, it is both timely and appropriate to begin seriously planning for a network of future gravitational-wave observatories, capable of extending the reach of detections well beyond that currently achievable with second generation instruments.

The GWIC Subcommittee on Third Generation Ground-based Detectors is **tasked with examining the path to a future network of observatories/facilities**

Michele Punturo – ET (co-chair)

David Reitze – LIGO (co-chair)

Stavros Katsanevas– European Gravitational Observatory

Takaaki Kajita - KAGRA

Vicky Kalogera – Northwestern (co-opted)

Harald Lueck, AEI (co-opted)

Jay Marx, LIGO (co-opted)

David McClelland, ACIGA (co-opted)

Sheila Rowan - GWIC Chair

Bangalore Sathyaprakash – Penn State (co-opted)

David Shoemaker – Executive Secretary

*Overall committee meets roughly biweekly;*

***Subcommittees established to work on all of the major charge elements***

Web Site <https://gwic.ligo.org/3Gsubcomm/>

1. **3G Science Case**
2. **R&D Coordination**
3. **Community Networking**
4. **Agency Interfacing**
5. **Investigation of Governance Structures**

## 4. Agency Interfacing and Advocacy Subcommittee

Overseen by GWIC Chair (currently Sheila Rowan)

**Mission:** identify and establish a communication channel with funding agencies who currently or may in the future support ground-based GW detectors; communicate as needed to those agencies officially through GWIC on the scientific needs, desires, and constraints from the communities and 3G projects (collected via 1) – 3) above) structured in a coherent framework; serve as an advocacy group for the communities and 3G projects with the funding agencies.

- Telecons with presentations to GWAC, (Nov 2016, Jan 2018)\*
  - GWAC = informal grouping of international funding agencies supporting GW science (inc. space)
- Presentation at APPEC General Assembly, Barcelona (Dec 2017)

\*GWIC presented the status of community planning along with some recommendations to GWAC for support actions

## 1. Science Case Subcommittee

**Mission:** Commission a study of ground-based gravitational wave science from the global scientific community, investigating potential science vs architecture vs. network configuration vs. cost trade-offs, recognizing and taking into account existing studies for 3G projects (such as ET) as well as science overlap with the larger gravitational-wave spectrum.

### Goals

- Develop a robust science case enabled uniquely by GW observations for the next generation of ground-based detectors
    - articulate the case based on refereed publications
    - influence and impact position papers for national and international studies and surveys
- e.g. APPEC, ESFRI and Astronet roadmaps in Europe, Astro2020 US decadal survey

## *Science Drivers*

- **Seed black holes**
- **Neutron star structure**
- **Compact binaries**
- **Cosmology, early Universe**
- **Supernovae**
- **Multi-messenger observations**
- **Extreme gravity and fundamental physics**
- **Detector networks**

## *Science Case Team*

- An open call to join the 3G SCT Consortium was made in July 2017
- ~ 200 researchers from around the world have joined the consortium
  - » members can join & contribute to as many science working groups as they wish
  - » The 8 working groups each have between 20 to 40 members
- Science case document to be delivered to GWIC by Dec. 2018
  - well defined structure in 02/18, early draft 06/18, mature draft 09/18, final version 12/18
  - **3G-SCT will meet f2f two to three times over the next year**
    - **expect to have one meeting of the entire consortium:**  
**1<sup>st</sup>/2<sup>nd</sup> Oct 2018, hosted by the AEI**

## 2. R&D Coordination Subcommittee

**Mission:** Develop and facilitate coordination mechanisms among the current and future planned and anticipated ground-based GW projects, including identification of common technologies and R&D activities as well as comparison of the specific technical approaches to 3G detectors. Possible support for coordination of 2G observing and 3G construction schedules.

<b>Harald Lueck</b>	<b>(AEI, co-chair)</b>	<b>David McClelland</b>	<b>(ANU, co-chair)</b>
Rana Adhikari	(Caltech, USA)	Anil Prabkhar	(IIT Madras, India)
Masaki Ando	(NAOJ, Japan)	Fulvio Ricci	(INFN Rome, Italy)
Marty Fejer	(Stanford, USA)	Norna Robertson	(Caltech, USA)
Andreas Freise	(Birmingham, UK)	Benno Willke	(AEI, Germany)
Gabriela Gonzalez	(LSU, USA)	Mike Zucker	(MIT, USA)
Gianpetro Cagnoli	(LMA, France)	Matt Evans*	(MIT, USA)
Jan Harms	(GSSI, Italy)	Stefan Hild*	(Glasgow, UK)
Giovanni Losurdo	(Pisa, Italy)	*co-opted from Science Case Team	

Topics allocated,  
teams formed,  
and internal wiki set up.

### Activities:

- review current R&D levels of activity and of collaboration amongst detector groups
- Evaluate subsystem designs and interdependencies
- Identify technology shortfalls

### ***Work Underway***

Topic	Topic coordinators	
Communication with outside	Harald Lück David McClelland	Set up wiki, make sure R&D plans&progress are communicated outside GWIC
Light sources (Lasers + squeezers)	Benno Willke Anil Prabhakar David McClelland	Different $\lambda$ s (1064, 1550, 2100?), different powers, [not interfacing of squeezers]
Coatings	Geppo Cagnoli Marty Fejer	Requires large efforts
Low Frequencies (NN) + site requirements	Jan Harms Stefan Hild	NN subtraction; influence of geology and facility geometry on NN and seism. noise
Simulations & Controls	Andreas Freise Rana Adhikari	Error signal creation, PI, control systems
Facilities & infrastructure	Mike Zucker Fulvio Ricci	Cost saving designs (incl. Op. Costs?) maintain quietness
Cryogenics	Ando Massaki Fulvio Ricci Rana Adhikari	Different cryo regimes (4K, 20K, 124K, 300K)
Suspensions and Isolation	Norna Robertson Gabriela Gonzalez Giovanni Losurdo	Materials, sensing, actuation, coupling (for diff. temperatures)
Core optics	Geppo Cagnoli Marty Fejer	May need 'internal' x-tal growth facilities not to rely on progress of industry
Aux optics	Anil Prabhakar Matt Evans	New $\lambda$ s, lower loss, TCS
Quantum noise + Configurations	Jan Harms Stefan Hild Giovanni Losurdo Andreas Freise	Include FD squeezing,

### **3. Networking Subcommittee**

Overseen by Michele Punturo and Dave Reitze; provides a coordinating function

**Mission:** organize and facilitate links between planned global 3G projects and other relevant scientific communities, including organizing:

- town hall meetings to survey the community
- dedicated sessions in scientific conferences dedicated to GW physics and astronomy
- focused topical workshops within the relevant communities

**Report:** town hall meetings held at various events including:

LVC meetings 2017 (US and Europe)  
Amaldi 2017 (Pasadena)  
ET design workshop, (UK) 2017  
GW Physics and Astronomy Workshop (France) 2017 +...

**Dedicated meetings on future detector planning include:**

DAWN III workshop July '17 (Syracuse)  
ET workshop Jan '18 (Liege)  
ET symposium April '18 (Pisa)  
*DAWN IV/3G workshop upcoming Aug '18 (Amsterdam)*

## 5. Governance Evaluation Subcommittee

**Mission:** By applying knowledge of the diverse structures of the global GW community, propose a sustainable governance model for the management of detector construction and joint working, to support planning of 3rd generation observatories.

Stavros Katsanevas	(Italy, EGO, co-chair)
Jay Marx	(USA, LIGO, co-chair)
Beverly Berger	(USA, LIGO)
Gabriela Gonzalez	(USA, LIGO)
Eugenio Coccia	(Italy, Virgo)
Jim Hough	(UK, GEO)
Stavros Katsanevas	(France, CNRS)
Ajit Kembhavi	(India, LIGO-India)
Frank Linde	(Netherlands, Nikhef)
David McClelland	(Australia, ANU)
Masatake Ohashi	(Japan, KAGRA)
Fulvio Ricci	(Italy, Virgo)
Gary Sanders	(USA, TMT)
Stan Whitcomb	(USA, LIGO)

### Governance Evaluation Approach

- Step 1--- Assemble a knowledgeable group with members from those regions and nations we hope will participate in the development and utilization of the 3<sup>rd</sup> generation array. **COMPLETED**
- Step 2--- Evaluate governance structures of existing large scale, international scientific enterprises. Their strengths, weakness, and relevance to 3G GW. **UNDERWAY**
- Step 3--- Provide evaluations and make recommendations to the GWIC 3G subcommittee

## Governance Evaluation Subcommittee Status

*Examining governance structures for 21  
existing/planned projects/facilities*

Project/ Facility	Concluded evaluation?	Project/ Facility	Concluded evaluation?
ALMA	X	ITER	X
AUGER		KAGRA	
CERN	X	KM <sup>3</sup>	
CTA	X	LHC Experiments	X
DUNE	X	LIGO	X
EGO/VIRGO		LSC/LIGO	
ELI	X	LSST	
ELT	X	SKA	X
ESS	X	SNOLab	X
IceCube	X	TMT	X
ILC	X		

The GES has constituted four members to draft descriptions of options, with an analysis of their respective strengths and weaknesses for the 3rd generation of GW detectors.

Builds on reports prepared by the full GES analyzing governance structures of major international experiments and facilities.

**A draft report should be submitted to the Governance Group’s co-chairs by March 1, 2018 with a final report distributed to the full GES by April 1, 2018.**

Following iteration the GES will produce a final report to the GWIC subcommittee.

- **GWIC:** Welcomes the statement by APPEC European APPEC Roadmap “European Astroparticle Physics Strategy 2017-2026”  
[http://www.appec.org/roadmap\(\)](http://www.appec.org/roadmap())

#### APPEC recommendations:

- *“With its global partners and in consultation with the Gravitational Wave International Committee (GWIC), APPEC will define timelines for upgrades of existing as well as next-generation ground-based interferometers. APPEC strongly supports further actions strengthening the collaboration between gravitational-wave laboratories.*
- *It also strongly supports Europe’s next-generation ground-based interferometer, the Einstein Telescope (ET) project, in developing the required technology and acquiring ESFRI status.*
- *In the field of space-based interferometry, APPEC strongly supports the European LISA proposal.”*

The GWIC 3G subcommittee is 'funding limited' – limited largely to working through telecons and e-mail.

- The Australian Research Council (ARC) has committed approx. AUD 600K to support participation of Australian scientists in global 3G preparatory activities
- **GWIC recommended:** GWAC should consider and identify support mechanisms for the community in its respective regions to participate in the 3G activities which are essential to feed into the major international roadmapping and landscaping exercises
- **GWIC recommended:** GWAC endorse and support a joint Dawn/ET workshop in 2018 to advance coordination of Euro-US community-agency planning
- **GWIC recommended:** GWAC consider playing a role in collaborating with scientists in the study and definition of possible governance schemes in the 3G detector era

## *Time Scales for Completing 3G Subcommittee's Work*

- Subcommittees will work over the next 5 months to assemble their reports to have a preliminary report and set of recommendations by the 2018 GWIC meeting (Chicago, July 2018).
- Preliminary report will be broadly circulated for comment and input among the relevant communities.
- *Interim report not later than December 2018 delivered to relevant communities and GWAC*
- **Goal: Final report mid-2019**

### Summary:

- Set of actions here provide a framework to **enhance 3G profile and accelerate interaction** between international projects and global agencies
- As a community **we need to be well organised to have clear, coherent input** to the variety of upcoming international roadmapping exercises
- Very active global environment for 3G work - **ET can benefit from this and also further stimulate progress** in the global field