



Setting the scene

GWADW, Alyeska, 2018

Sheila Rowan



Photo: Ralph Kristopher

Setting the scene: Ground-based field

Rapid developments in the field (no surprise to you...)



- » *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/>

» Increasing interest from the Particle Physics Community

(currently preparing a PP roadmap in Europe - evidence of reaching out to GW communities)

» 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 (page 7)

» Planning for providing input to the next European ‘Astronet’ Roadmap

Timescales possibly sync'd to the decadal

Near term Advanced detector related activities

- KAGRA and LIGO-India progressing through construction and pre-construction phases
- Advanced detectors currently in a commissioning period before further data ('O3') taking towards end of 2018/start 2019 (tbd).
- Strong scientific rationale for implementing upgrades to the Advanced detectors
- Both aLIGO and Advanced Virgo have relatively mature design concepts for respective near term upgrades

3G ground-based detector development – rapid developments over the last year

GWIC Subcommittee on Third Generation Ground- based Detectors

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

(charged in November 2016, lots of activity since last GWADW in 2017)

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/>

- **3G Science Case**
- **R&D Coordination**
- **Community Networking**
- **Agency Interfacing**
- **Investigation of Governance Structures**

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.

Goal

Develop a robust science case enabled uniquely by GW observations for the next generation of ground-based detectors

Science Case Team

Open call to join the 3G SCT Consortium made in **July 2017**
~ 200 researchers from around the world have joined the consortium

[Update from Sathya at this meeting](#)

3G-SCT f2f meeting planned for 1st/2nd Oct 2018 hosted by the AEI

Science case document to be delivered to **GWIC by Dec. 2018** then period of refinement in discussion with community, agencies etc before finalising.

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.

Co-Chairs:	Harald Lueck (AEI) David McClelland (ANU) Jo van den Brand (Nikhef)		
Rana Adhikari	(Caltech, USA)	Anil Prabhakar	(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 λ 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 λ s, lower loss, TCS
Quantum noise + Configurations	Jan Harms Stefan Hild Giovanni Losurdo Andreas Freise	Include FD squeezing,

Examples of the current positive ‘feedback loops’ in action:

- **Strong support** statement by APPEC European APPEC Roadmap “European Astroparticle Physics Strategy 2017-2026” <http://www.appec.org/roadmap/>

APPEC recommendations published Jan 2018:

- *“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.”*

Community Actions:

- Kick-off meeting of the ET collaboration on the 19-20 of April 2018
 - ET Letter of intent: <http://www.et-gw.eu/index.php/letter-of-intent>
 - 409 signatures as of today

Setting the scene: Space-based detectors - LISA

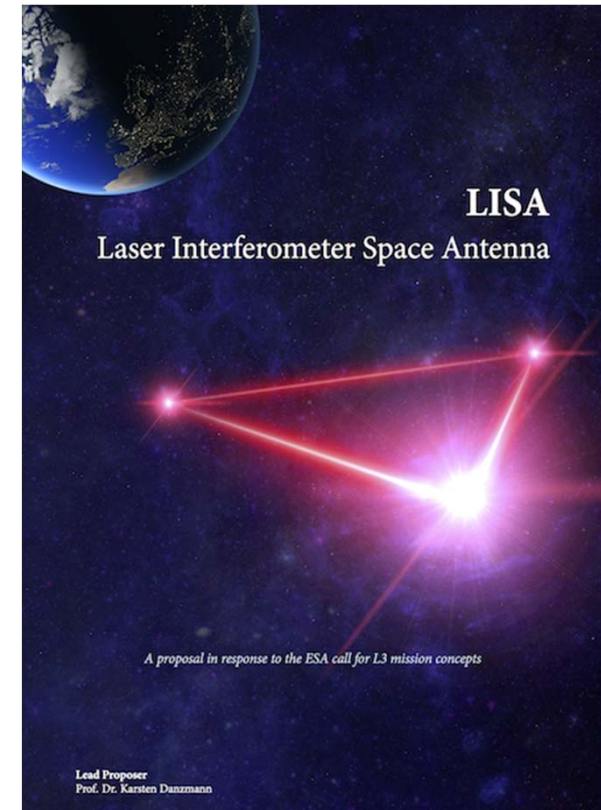
ESA-led project with international partners

- ESA
 - » Selected LISA as 3rd Large-class mission in Cosmic Visions Programme **in June 2017**
 - » Leading **Phase A** activities in collaboration with international partners and European industry
- European National Agencies
 - » Contributing to mission formulation, leveraging experience from LISA Pathfinder
 - » Developing payload technologies and early prototyping of analysis infrastructure
- NASA
 - » Developing technologies for potential contribution to payload and/or platform.
 - » Contributing to mission formulation activities
 - » Supporting US science community to participate in LISA Consortium activities

Preliminary distribution of roles in place to guide formulation activities.

Formal international agreement by mission adoption in early to mid 2020s.

Science strongly complementary with future ground-based observatories₉



We have various visions for our possible future (Voyager/ET/Cosmic Explorer..) working in a multi-messenger, multi-GW wave-band world

- *The spotlight is shining much more brightly than before on our future*
- *Interested parties around the globe are increasingly active (sister communities/funding agencies)*
- *Momentum strongly increased since last GWADW*

Key topics for this meeting:

What are the gaps in our R&D activity?

What needs accelerated?

Where should we be focusing?