SCIENCE CASE FOR 3G

DEVELOPING A GLOBAL VISION FOR NEXT GENERATION OF GRAVITATIONAL-WAVE DETECTORS

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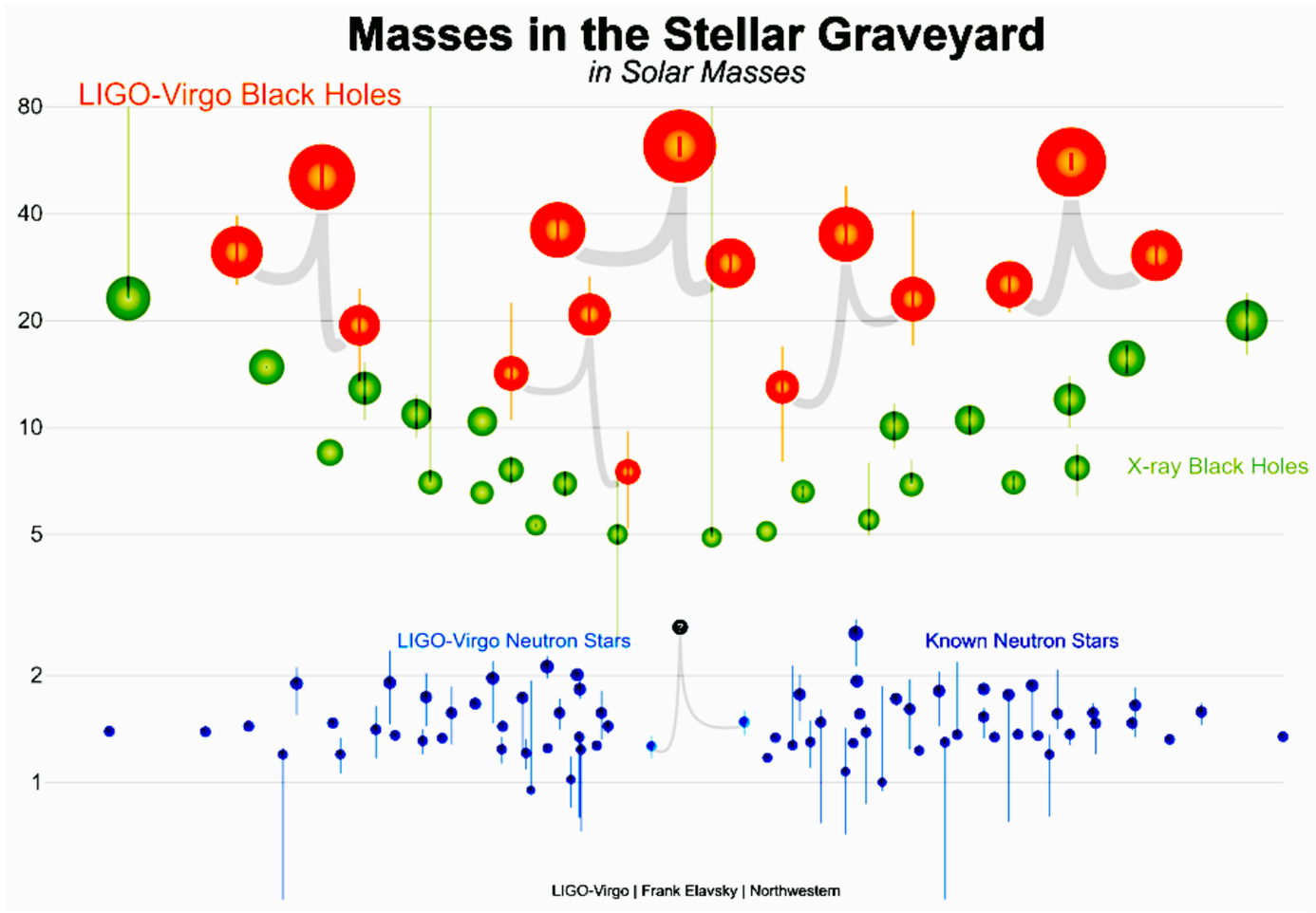
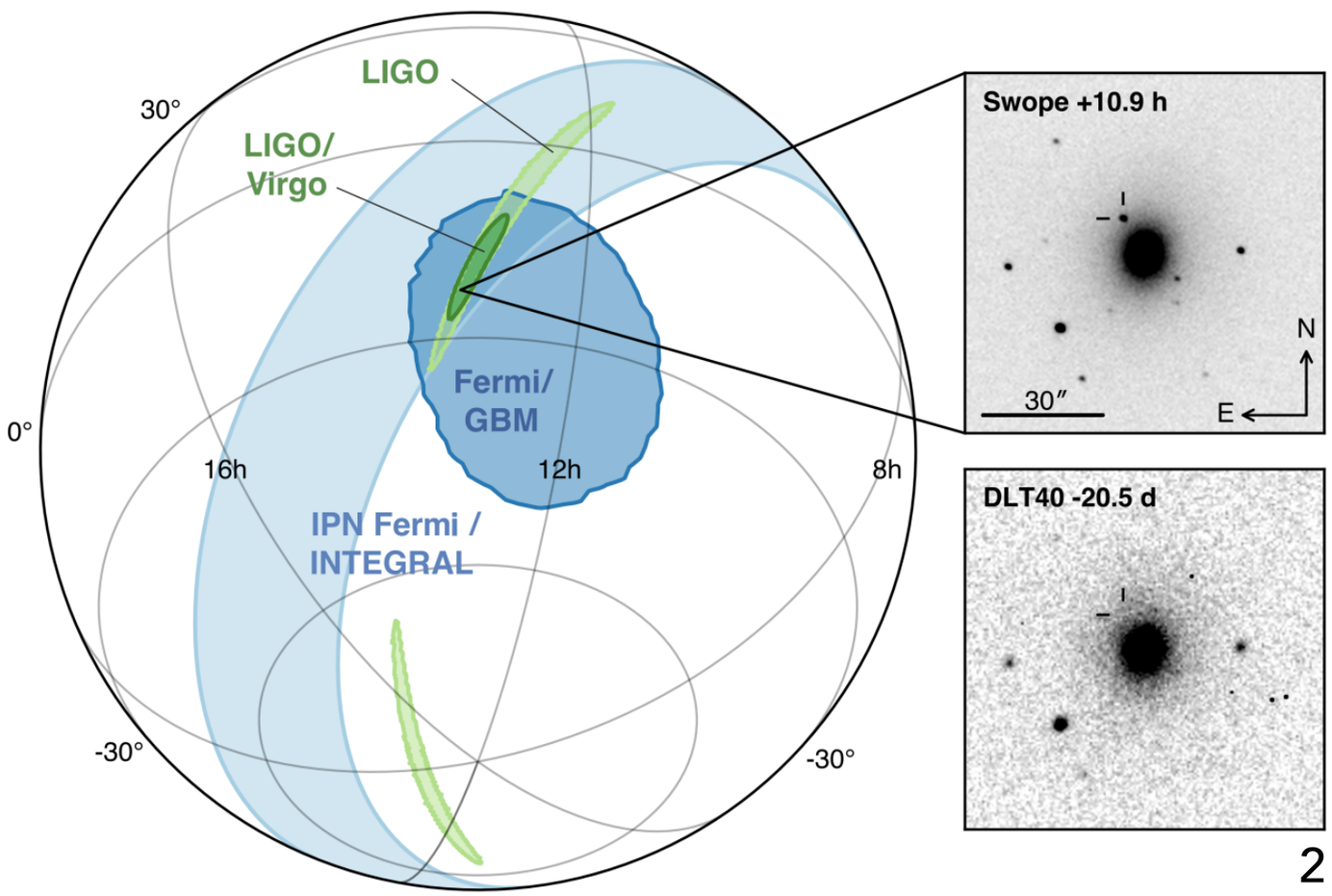
ON BEHALF OF

GWIC 3G COMMITTEE & 3G SCIENCE CASE TEAM (SCT)

CONTEXT

- gravitational wave observations by LIGO and Virgo have ushered in a new era of scientific discovery
- will advance the exploration of extremes of astrophysics and gravity
- solve open questions in fundamental physics and astronomy
- provide insights into most powerful events in the Universe
- boost the impact of multi-messenger astronomy
- likely to reveal new objects and phenomena





WHY 3G, WHY NOW?

- LIGO and Virgo both have facility-imposed limits on sensitivity
  - at most, x 3 improvements in strain sensitivity possible, gravity gradient noise limits sensitivity below 10 Hz
  - there is a compelling case to build detectors that can observe deeper into the cosmos
- LIGO and Virgo took ~ 15 years each for initial and advanced configuration
  - need to act now to have vastly improved sensitivity in ~15 yrs
  - vision to build a facility that's good ~30-40 yrs after construction
  - need to explore/understand funding scenarios in different regions
- to succeed it is critical to have a common/shared global vision
  - articulate for the excellent science we know is possible from a strong platform

GRAVITATIONAL WAVE AGENCIES CORRESPONDENTS (GWAC)

- an informal grouping of funding agencies, initiated by NSF in 2015
  - communication between funding agencies to coordinate existing and new funding opportunities for GW science
  - will work in direct contact with the scientific community
  - membership open to funding or national government agency
  - no financial commitment is required, just the motivation to start a dialogue
- current membership includes
  - ARC, CFI, CNRS, CONACYT, DFG, INFN, NASA, NSF, STFC

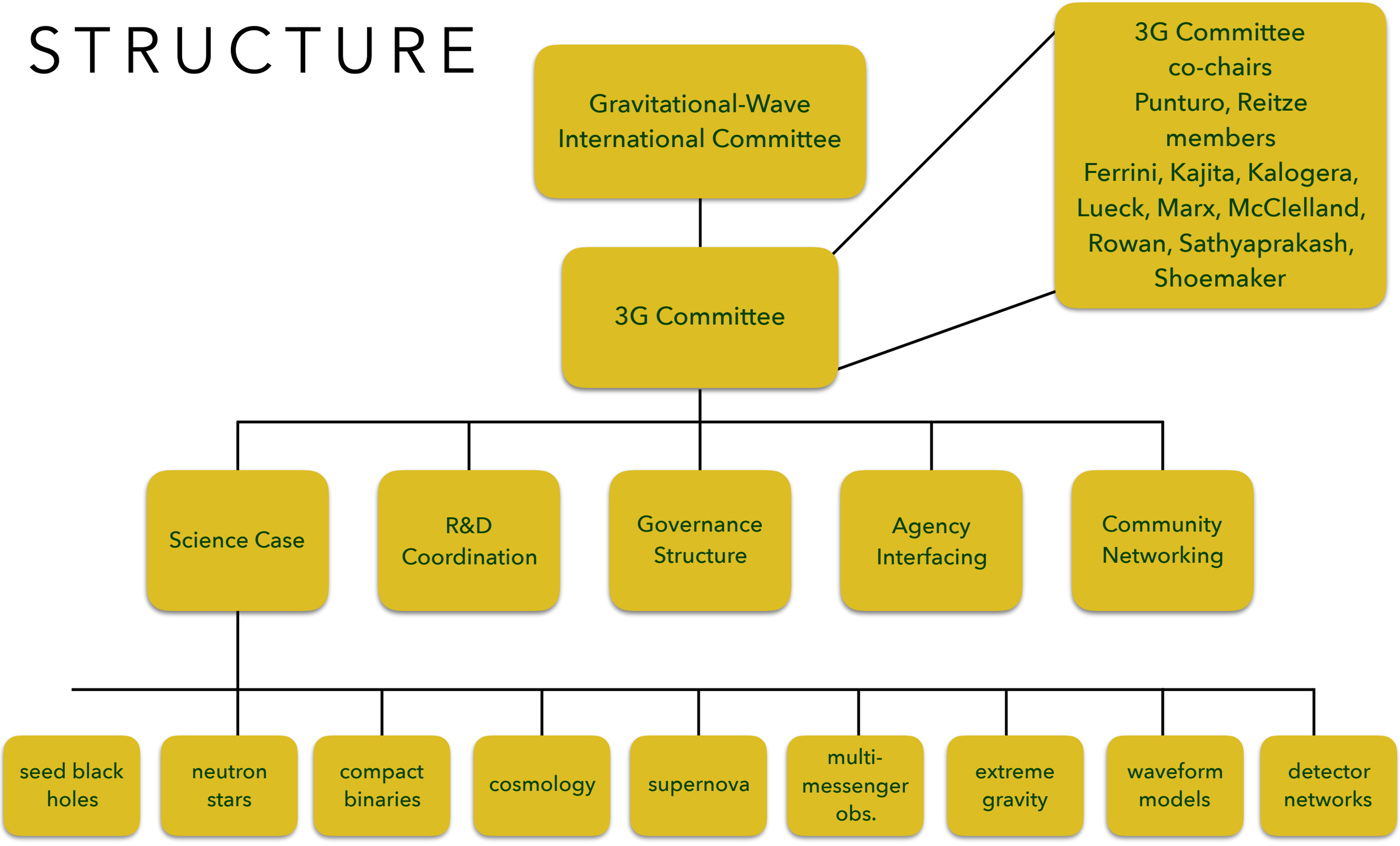
SCOPE

- to fully exploit the GW window we will need new facilities
- GWIC formed a subcommittee to develop a vision for the next generation of ground-based detectors
- one of the charges to the GWIC subcommittee is:
  - *"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, …"*
  - GWIC subcommittee has constituted five 3G subcommittees:
    - (1) Science Case Team (3G-SCT), (2) R&D Coordination, (3) Governance, (4) Agency Interfacing, (5) Community Networking
- the Science Case will be developed by an international consortium of scientists under the leadership of the 3G-SCT (18 members)

GOALS, TIMELINE

- develop a robust science case unique to GW observations for the next generation of ground-based detectors
  - possibly, help with position papers for national and international studies and surveys
    - APPEC and ESFRI roadmaps in Europe, US decadal survey, …
- science case document to be delivered by Dec. 2018
- study will be supported by **nine** working groups
- ~ 150 researchers from around the world have joined the 3G-SCT consortium
  - each WG consists of ~20-40 members
  - WG will have begun bi-weekly TeamSpeak teleconferences

STRUCTURE



for membership of committees see:
https://gwic.ligo.org/3Gsubcomm/

Working Group	**Co-chairs**	**list-address @gw-astronomy.org**
Extreme Gravity	Buonanno, Van Den Broeck	gwic-3g-xg
Neutron Stars	Papa, Reddy, Rosswog	gwic-3g-ns
Compact Binaries	Bailes, Kalogera, Mandel	gwic-3g-binaries
Seed Black Holes	Colpi, Fairhurst	gwic-3g-bh
Supernovae	Bizouard, Burrows	gwic-3g-sn
Cosmology	Mandic, Sathyaprakash	gwic-3g-cosmo
Numerical & Analytical Relativity	Buonanno, Lehner	gwic-3g-nrar
Detector Networks	Evans, Fairhurst, Hild	gwic-3g-net
Multi-Messenger Observations	Bailes, Kasliwal	gwic-3g-mmo

SCIENCE CASE: THE BIG PICTURE

- start with the most compelling science questions in fundamental physics, astrophysics, cosmology, … relevant to GW observations
  - don’t start with sensitivity or network goals or assumptions
  - however, questions shouldn’t require unreasonably greater sensitivity than 3G
    - strain sensitivity a factor 10-30 better than advanced detectors and frequency range from 1 Hz to ~few kHz, are both reasonable
- discuss what infrastructure will be required for answering these questions
  - waveforms, calibration, computational capabilities, analysis techniques, strain sensitivities at specific frequency ranges, detector networks, EM telescopes, LISA, …

SCIENCE CASE: THE DOCUMENT

- executive summary: ~ four pages with high quality images and text
- science case (part of a bigger document but stand alone in content)
  - ~100 pages of text including graphics, tables, illustrations, boxes, …
  - each WG will have between 8-12 pages
  - might organize chapters differently from WG titles
    - decision on structure in the next ~2-3 months
  - expect significant overlap in science questions among some WGs
    - addressed by coordination within the 3G-SCT and cross WG memberships
- will need videos, animations, brochures, postcards, factsheets and other outreach material
  - helpful in community building, public outreach, advocacy

INFRASTRUCTURE

- TeamSpeak for teleconferences zam.mit.edu
- gw-astronomy.org for email lists, consortium and WG membership
- git repository for science case document, wiki pages to record meeting minutes, assignments, to-do lists, projects and outcomes, etc. https://github.com/gwic-3g/