# Progress on action items in the Dawn III report

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# The DAWN III meeting

DAWN-III took place on **July 6-7, 2017** in Syracuse, NY

Talks are available at https://wiki.ligo.org/LSC/LIGOworkshop2017/WebHome

The report: https://dcc.ligo.org/LIGO-P1800037/public

# Highlights on progress from DAWN II → III

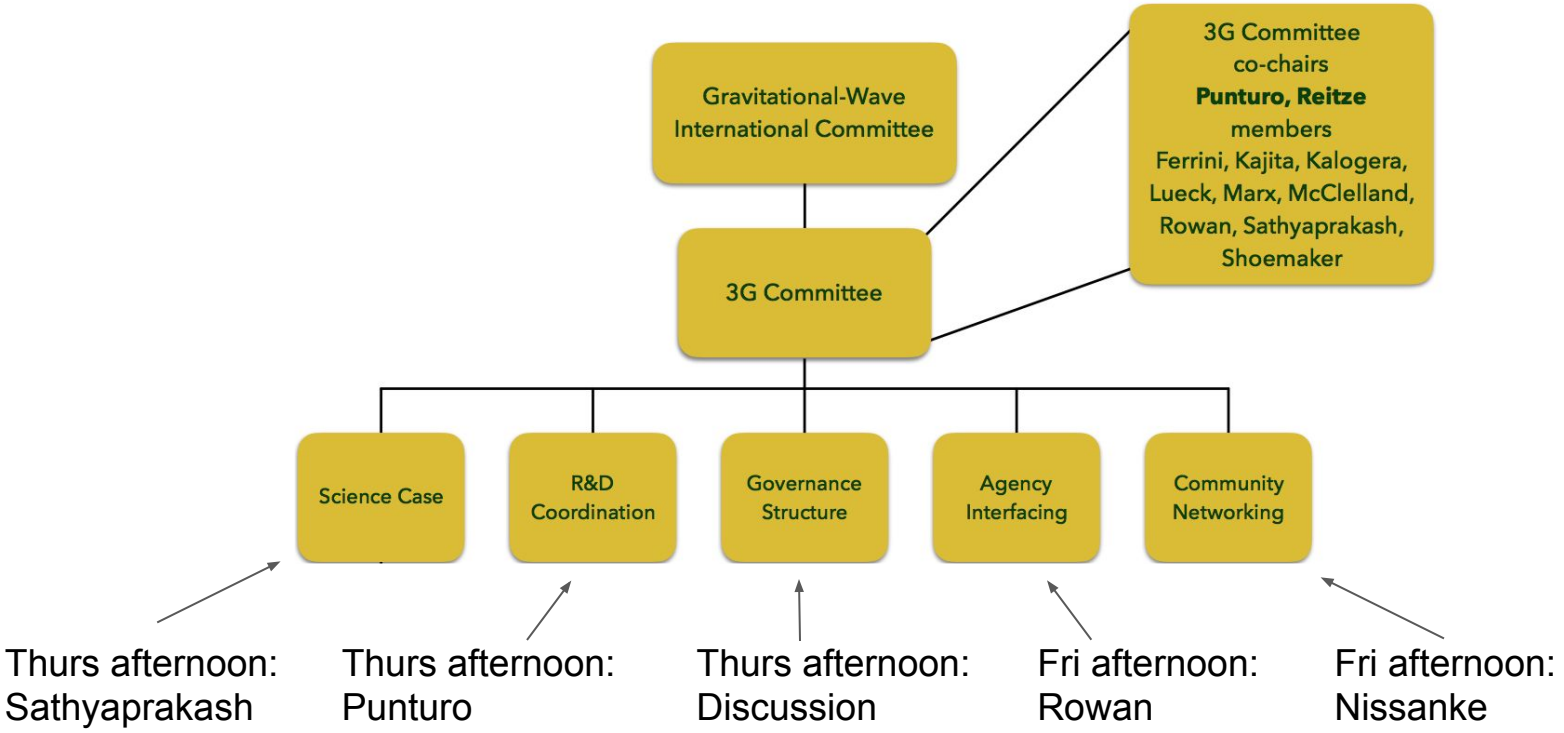
GWIC's leadership in organizing and fostering the 3G studies

GWAC's increasing role in facilitating funding agency communication

Establishment of the Center for Coating Research to organize the US and international research aimed at the LIGO A+ upgrade and beyond

Progress toward implementing frequency-dependent squeezing in time for A+, and the likely UK participation in LIGO A+.

# Perspectives from GWIC at DAWN IV



# What happened since DAWN-III?

- **August 2017 happened!**
  - The network of ground based detector was activated:  Virgo joined LIGO in the second science run O2
    - GW170814 was the first detection of a BBH from a network of 3 detectors
  - GW-EM multimessenger astrophysics was unlocked:  GW170817 was the first detection of gravitational waves from a binary neutron star merger
    - Virgo enabled localization
    - Alerts, followup
  - High rate of events
  - The GW community and its interaction with the broader scientific community has been deeply transformed over the past year - change is happening!

# Progress towards future detectors

**Recommendation**: A+ should be implemented, and the team developing the upgrade concept should submit a proposal as soon as possible.

- LIGO A+ proposal has been recommended for funding by NSF, and one is under review by the STFC in the UK, providing significant in-kind contributions to LIGO A+.
- The Australian OzGrav consortium is exploring ways to participate in A+, and has received funding for A+ squeezing.

# Progress towards future detectors

**Recommendation**: Essential A+ R&D must continue, in order to be ready to inform the A+ final design.

- **Seismic isolation and suspensions:** for either cryogenic silicon or large room-temperature silica mirrors
- **Coatings**: Several options are being explored by the NSF-Moore funded Center for Coating Research (CCR), including ideal glass, stabilized, and nanolayer coatings.
- **Squeezing**:
  - 300m scale filter cavity is now considered the baseline for A+
  - Exploring thermally-controlled adaptive lenses to reduce mode mismatch loss (Caltech)
  - Investigating alternative interferometer topologies (Glasgow, GEO)
  - 2 micron squeezing demonstrated at ANU

# Progress towards future detectors

**Recommendation:** The timelines, ideal sensitivities, and realistic costs of the ultimate instrumentation of existing 2G facilities (e.g., Voyager in the US) must be understood in order to make a credible science case for new 3G facilities.

- We expect this will be an action item from Dawn IV.
- See talk tomorrow morning by McClelland.

# Progress towards future detectors

**Recommendation:** The lifetimes of the present 3- and 4-km installations should be soberly assessed to help in determining timelines for 3G facilities.

From a LIGO lab study:

- The current LIGO facilities are expected to last until the mid-2040s **IF:**
  - i) the vacuum system is refurbished (underway for LIGO sites)
  - ii) funds are found to keep the remainder of the infrastructure from decaying

# Progress towards future detectors

**Recommendation:** An engineering study to establish scaling relations and to identify potential cost reductions should begin as soon as proposed 3G concepts are sufficiently precise to allow it.

- A collaborative proposal to study the science-driven requirements of a 3G network, and perform a cost assessment for long above-ground detectors such as Cosmic Explorer was funded by NSF (MIT, Penn State, Syracuse, CSU Fullerton, Caltech)

# Progress towards future detectors

**Recommendation:** Communication must be maintained among planners of 3G instruments (e.g., ET and CE) to ensure that the gravitational wave community has a common science case, a synergistic plan for the observatories, and a coherent message. The 3G science case is the first priority

- There has been progress in the GWIC 3G subcommittees, especially the Science Case Team
- This Dawn IV meeting is intended to deliver on this recommendation

# Progress towards future detectors

**Recommendation:** In the age of public GW triggers, the recommendation was made to continue MoUs with EM partners who wish to target particular sources or science.

From Laura Cadonati:

- GW170817 seeded lively interactions between GW and EM communities
- O3 will see open public alerts: no more partnership MoUs to receive alerts
- We are open to science-based MoUs on topics of interest. However to date no proposal of collaboration has been seeded either by GW or by EM
- Right now LVC focused on preparing for O3 and handling the expected high rate of GW events

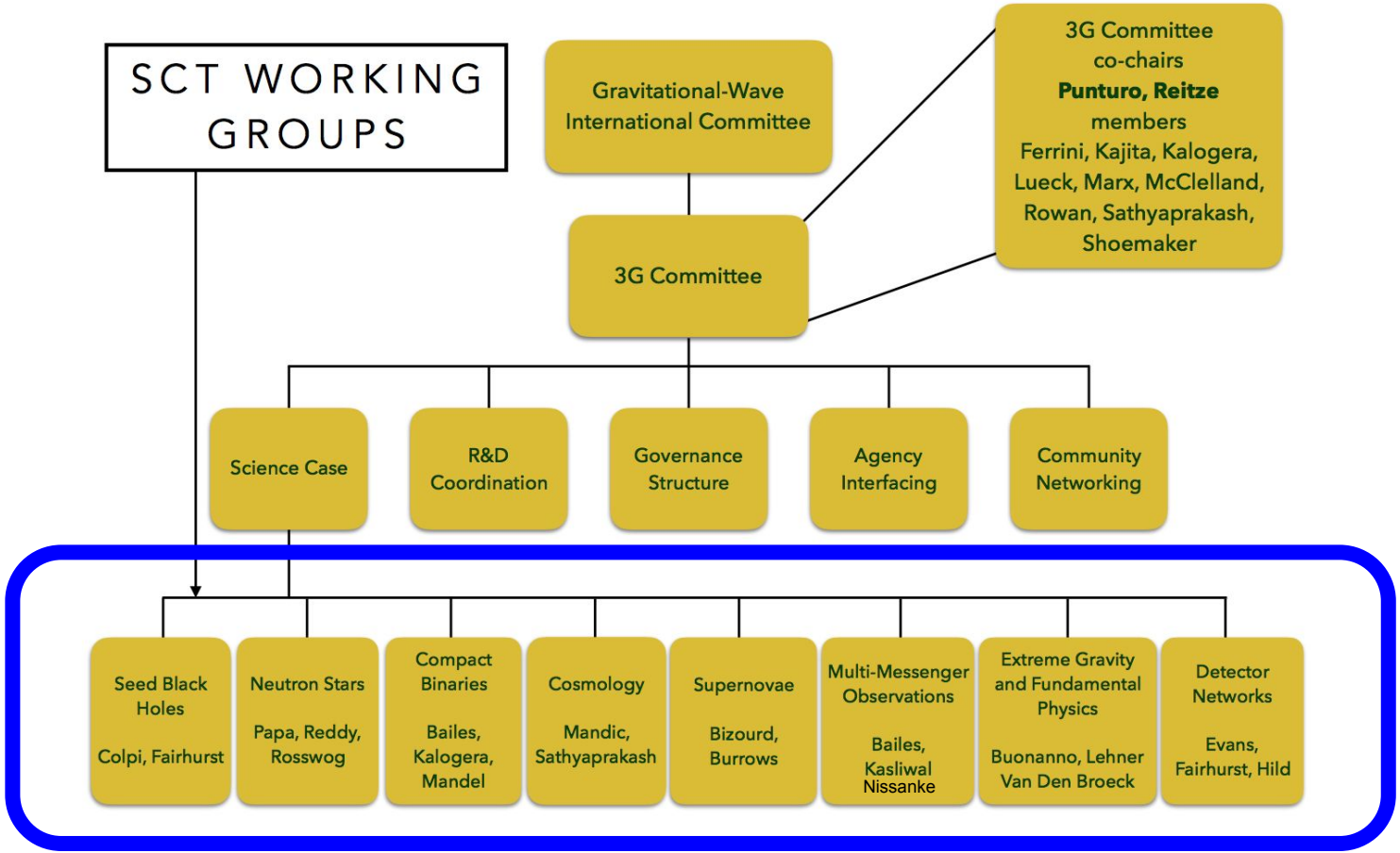
# The 3G science case

The GWIC 3G sub-committee has been charged to deliver a science case document by December 2018

GWIC 3G Science Case Team: an open call to the international community to help develop the science case attracted more than 200 researchers worldwide and still growing.

The science case is being studied by nine working groups, each co-chaired by two or three members of the science case team.

See Sathya’s talk this afternoon


SCT WORKING GROUPS
Gravitational-Wave International Committee
3G Committee co-chairs **Punturo, Reitze** members Ferrini, Kajita, Kalogera, Lueck, Marx, McClelland, Rowan, Sathyaprakash, Shoemaker
3G Committee
Science Case
R&D Coordination
Governance Structure
Agency Interfacing
Community Networking
Seed Black Holes
Colpi, Fairhurst
Neutron Stars
Papa, Reddy, Rosswog
Compact Binaries
Bailes, Kalogera, Mandel
Cosmology
Mandic, Sathyaprakash
Supernovae
Bizourd, Burrows
Multi-Messenger Observations
Bailes, Kasliwal Nissanke
Extreme Gravity and Fundamental Physics
Buonanno, Lehner Van Den Broeck
Detector Networks
Evans, Fairhurst, Hild

# 3G Science Case: Priorities identified at DAWN-3

**Recommendation**: Access to a global network capable of resolving the polarization states of gravitational wave signals is of critical importance for tests of General Relativity.

From Sathya:

- GW170814 demonstrated that the signal's polarization is consistent with GR. We need more than three detectors to test non-GR polarizations. KAGRA and LIGO-India are keenly awaited.
- GW170817 helped constrain the propagation speed, and this helped rule out many alternative theories of gravity.

# 3G Science Case: Priorities Identified at DAWN-3

**Recommendation** The much improved sensitivity of 3G detectors will deliver high-SNR events from which it may be possible to decode the ringdown phase of black holes, to establish whether they are Kerr black holes or something more exotic.

From Sathya:

- We are not there yet, but theoretical efforts are underway to:
  - understand the dynamics of the merged horizon
  - generalize the no hair theorem to BBH systems

# 3G Science Case: Priorities Identified at DAWN-3

**Recommendation** Concomitant with detector improvements, the numerical relativity community should continue to deliver waveforms that cover a greater parameter space than is available today, in particular covering highly spinning, less massive systems, with much longer waveforms, and eccentric systems.

From Sathya:

- NR efforts have been split between BBH and BNS (matter), but NR group are coordinating to increase the parameter space for BBH simulations.

# 3G Science Case: Priorities Identified at DAWN-3

**Recommendation** To access the nuclear equation of state (EOS) under super-nuclear densities attainable in neutron stars and understand how a binary neutron star (BNS) merger might begin to inform the EOS, techniques need to be developed and tested that can derive neutron star radii from the data. This requires further development of codes capable of producing GR waveforms when taking into account matter effects.

From Sathya:

- We are working on improved waveform models, now that we have analyzed GW170817 and reported the first measurement of NS radius. We need to understand the model systematics and include postmerger part of the signal in our analysis and here too some progress has been made within the LVC.

# Detector design figures of merit

There is a continued wish to formulate more target-based performance metrics, for science targets which rely on more than just detection of CBC sources and/or on non-CBC sources.

- Some proposed ideas under investigation
- See talk by Evan Hall tomorrow morning

# Building an international collaboration of 3G efforts

# Governance

**Recommendation:** the community should begin now the process of global planning to ensure community-wide buy-in of the science case and how to support it with a 3G network: what is needed is a global ownership of the design(s), and the implementation plan, including validated cost estimates, plans for risk mitigation, and the overall development schedule.

- This DAWN-4 meeting is a step towards this global planning
- We expect lively discussions in the next 2 days!