Summary of the Town Hall meeting and next steps

David Shoemaker for LSC and Virgo

OpenLVEM Town Hall Meeting
Amsterdam, 13 April 2018

LIGO-G1800782-v1

GOES-8 image produced by M. Jentoft-Nilsen, F. Hasler, D. Chesters (NASA/Goddard) and T. Nielsen (Univ. of Hawaii)

Goals of the Meeting

To share LVC's expectations for how the GW detectors will operate during the O3 run

- And what it implies about expected event rates

To talk about the new direction we are going with the follow-up program for O3 and beyond

- Open Public Alerts: long promised, now will be the norm!
- Philosophy and mechanics of selecting event candidates and sharing information about them
- Preliminary (un-vetted) GCN Notices; GCN Circulars & Notices after vetting

To allow observers to discuss plans for taking advantage of this

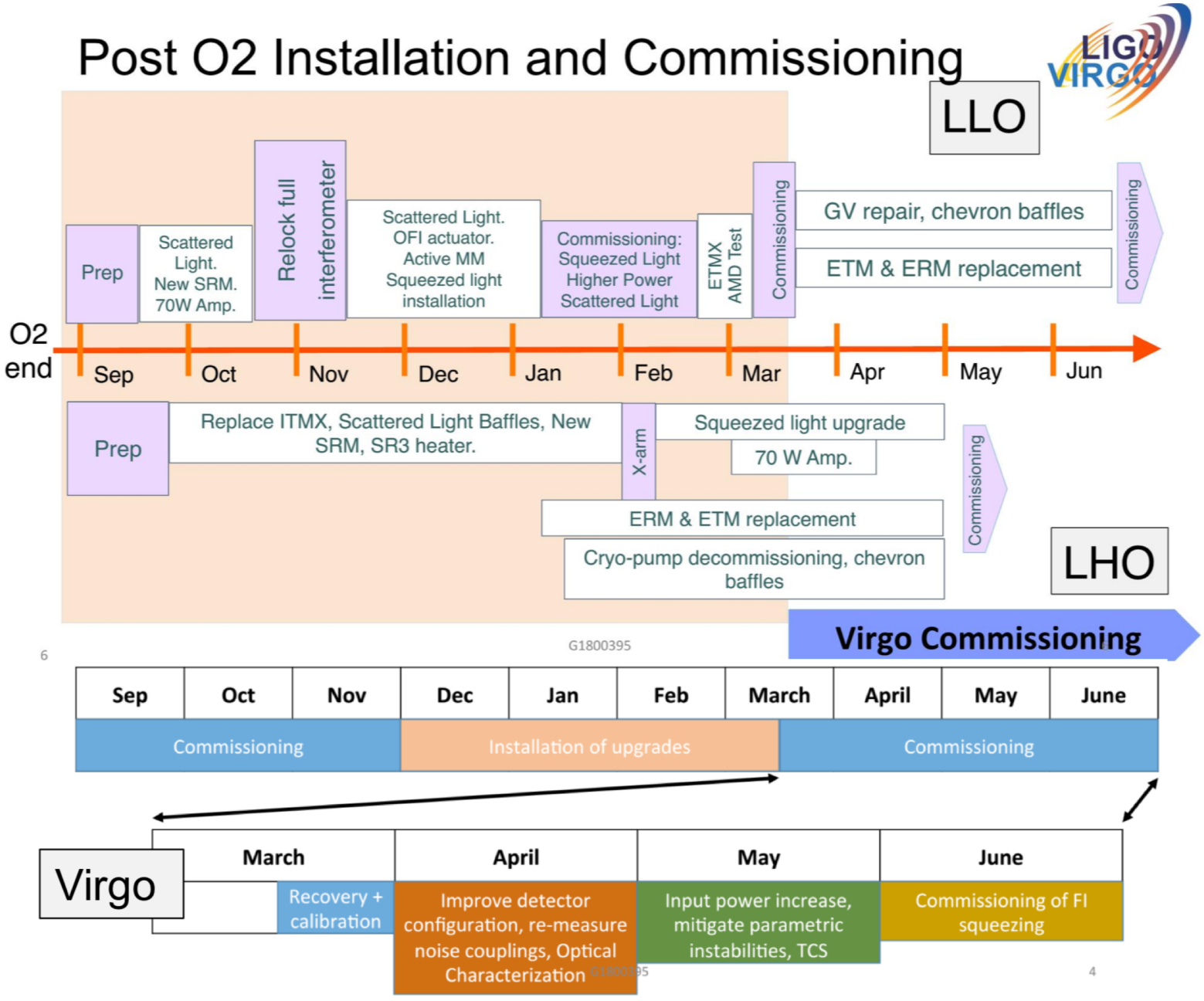
- Acting on low-latency alerts
- Doing science with multi-messenger observations

To discuss whether some science investigations will require more

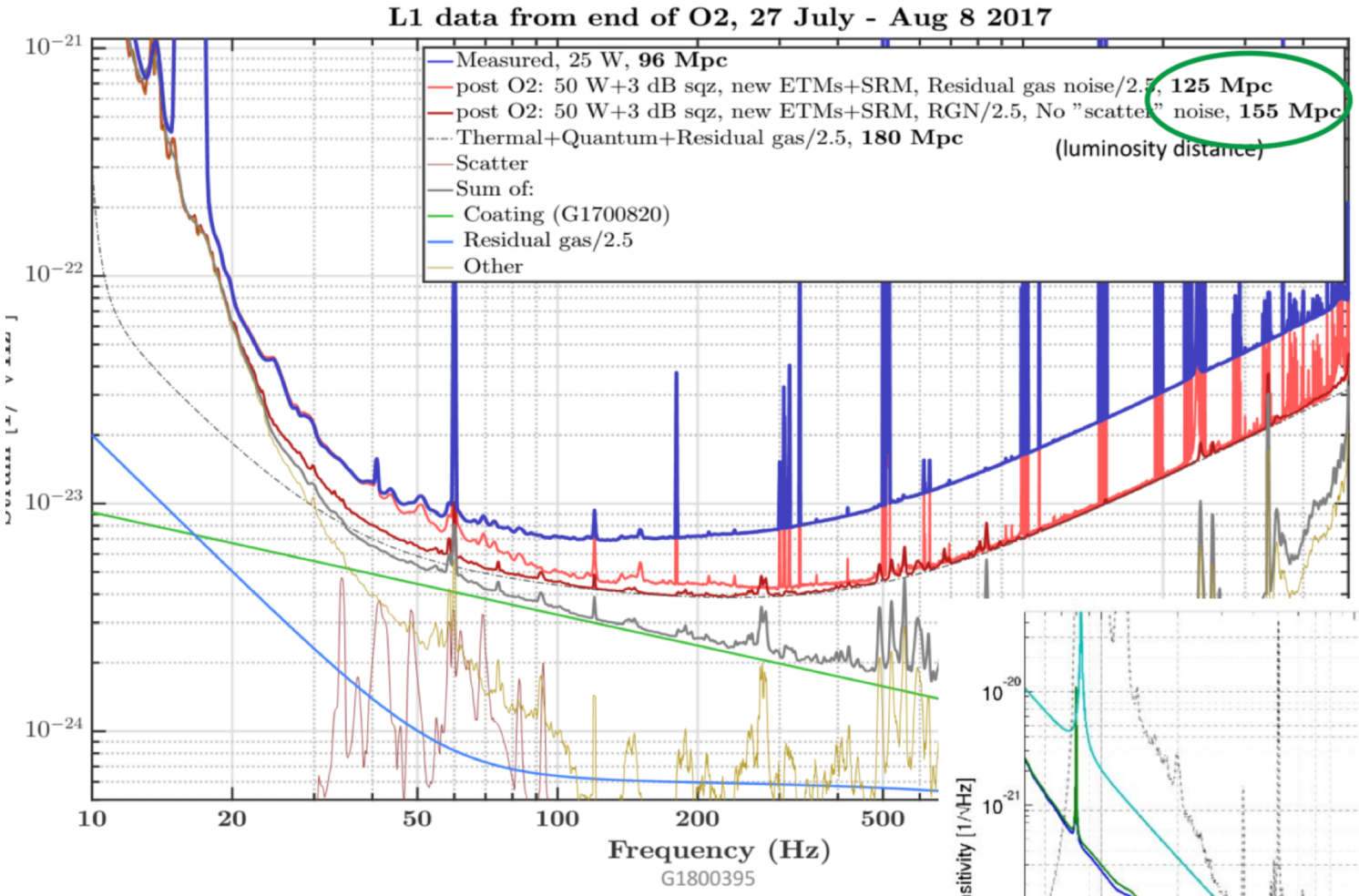
- Active collaboration, joint papers, exchange of additional information, and/or lower-confidence event candidates

LIGO/Virgo instrument status & timeline

Lots of work by Virgo and LIGO to achieve good sensitivity for O3

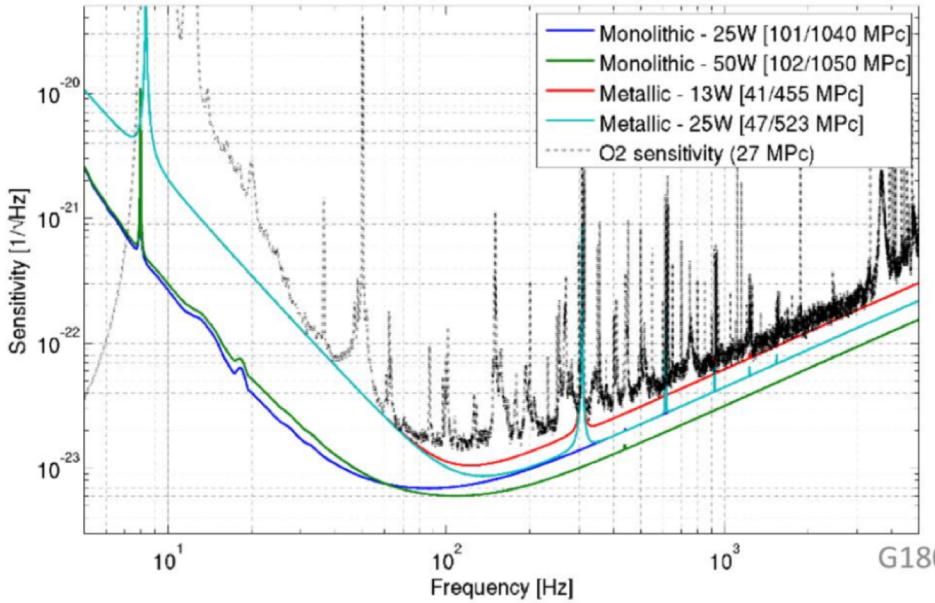


Sensitivity



Good reason to anticipate LIGO BNS range of 120 Mpc, at least

Somewhat greater improvements (vs. O2) for BBH and NS-BH (low f)

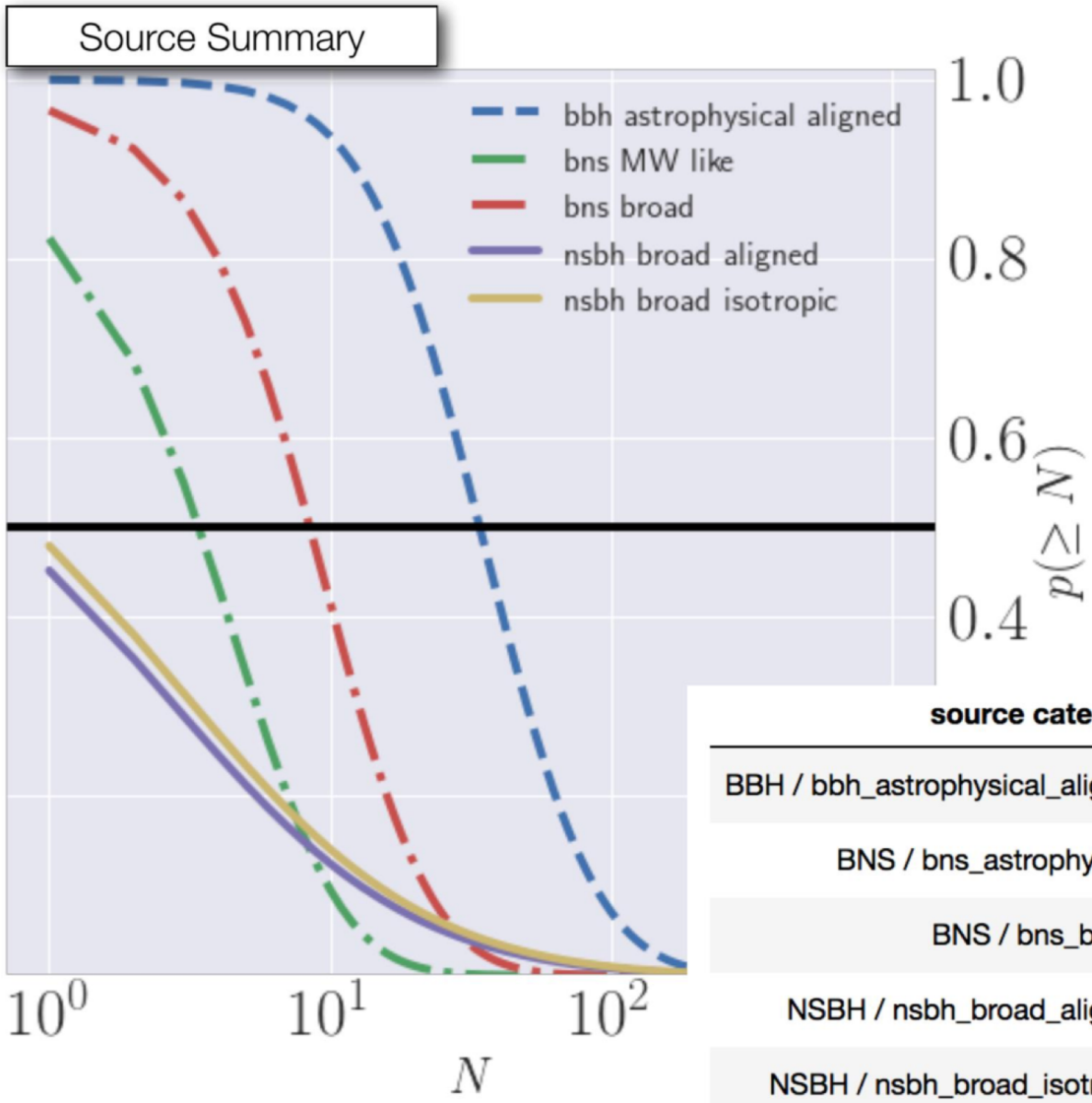


Virgo: aiming for 60–85 Mpc range

Timing

- **Virgo should make significant contributions to detection and localization of events**
- **KAGRA now aims to join near the end of the run, but it's not yet known if their sensitivity will be sufficient to have a scientific impact**
- **Date of beginning O3 run is not fixed; lots of commissioning to to do**
  - **Current expectation: early 2019**
- **Plan to have a one-month engineering run leading into O3 Time for shaking down systems; may issue (open) alerts on best-effort basis Need to be clear about when we may send alerts – status display / API ?**

Rates



There are caveats, but the general picture is:

BBH: at least a few per month, maybe more

BNS: 1–10, possibly up to ~1 per month

NSBH: Could detect one or more during O3, but uncertain. We'll see!

source category	full year VT	N_d
BBH / bbh_astrophysical_aligned	6.8×10^8 Mpc^3 yr	34^{+79}_{-25}
BNS / bns_astrophysical	3.2×10^6 Mpc^3 yr	4^{+9}_{-4}
BNS / bns_broad	7.3×10^6 Mpc^3 yr	9^{+19}_{-7}
NSBH / nsbh_broad_aligned	5.0×10^7 Mpc^3 yr	1^{+24}_{-1}
NSBH / nsbh_broad_isotropic	5.7×10^7 Mpc^3 yr	1^{+28}_{-1}

Rates

- **Those estimates are for 3-detector events; will also have some 2- detector events (and potentially 1-detector, if validated by a counterpart)**
- **Handling these rates will present challenges**
  - Will you still follow up on all the BBHs you can?
  - There will be times with more than one event “in play” – we will need to keep the identities clear
  - Unlikely (not impossible) to get another BNS event as close as GW170817
  - Nearby core-collapse supernova? Better be ready for one
- **Publishing schedule?**
  - Notable individual events will still be published individually, including at least the next few BNS
  - Expect to publish “routine” events periodically in catalog papers; maybe 6-month cadence, but this is under discussion. Could coordinate.
  - Issue: delay in getting parameter results out could negatively impact EM observers publishing about the event

Open Public Alerts

- **LIGO-Virgo alerts in O3 will all be public**
  - We will set CBC FAR threshold to try to get an *overall* purity of 90%
  - We will tell you the FAR so that you can be more selective if you want
  - CBC alerts will include type classification
  - We'll issue an alert for a sufficiently high-confidence GW burst detection
  - We will "promote" a weaker event to a public alert if it is compellingly associated with a multimessenger signal – but may take weeks
  - Alerts will be communicated using (regular) GCN Notices and Circulars, starting with one or more *Preliminary* Notices before vetting
  - → Users should be prepared to handle *Retraction* Notices too
- **LIGO/Virgo are looking forward to seeing the fruits of open alerts**
  - This plan for the program was the result of extended discussions, endorsed by votes of the LSC Council and Virgo Steering Committee

Notes

- Rich real-time Communication is of high value, esp. If we have difficulties with the data. Not asking for more insider information, but anything we can say about the quality and certainty of the data
  - DQ flag planned, but maybe a bit more info behind it
  - A ‘quality factor’ to come with the data
  - Time scales for refined data
- Interest in getting projections for the further future latencies for e.g., sky maps
  - Work underway on speeding up at least the non-human part of the calculations/evaluations. 10^7 waveforms
  - Help offered to work on the calculations/computation
- Interest in understanding the localization potential
  - For 3 and 2 detector detections
  - For different SNRs

Notes

- BHBH are still interesting to look for, and there is interest to have the info as rapidly as possible
  - May want to poll for the intervals which would be best, but understand that the LVC may be limited by personpower
  - Trades needed -- not all triggers can be followed up. Any additional information to be used to select?
    - Models -- e.g., a cut on mass
    - Additional data from LVC -- e.g., high mass or low mass

Notes

- Request for more information on say strongest signals to help choose how to spend telescope time
  - Masses for example
  - Maybe a flag that gives some semi-quantitative information -- classes of masses, e.g., to aid in making triage in observing
  - Want clarification on the NS probability criterion --- 0 or 1, or is it continuous variable? (Pannarale and Ohme 2014)
  - Spin also interesting for observers (although sub-dominant in our waveforms; no ‘smoking guns’ seen to date)
  - Science-specific MoUs are an opportunity to look more deeply at the initial data
  - Also: specific requests make it easier to craft means to release additional information

Notes

- We confirm that there is no need to keep any of the telescope observing data private if triggered by the Open Public Alerts
  - Science-based MoUs could bring in exceptions
- OPA contents will be finalized and put in a public place to allow e.g., automated reading of the alerts
- LVC data become public
  - Upon publication: 1 hr of data used in papers, plot data, full posteriors
  - No longer than 18 months after a 6 month ‘chunk’ -- might be shorter for O3 (e.g., 12 months) if we are ready
- Coordination of EM observers could be useful to ensure that all events get some attention
  - Do astronomers want to create an organization for this? Global ENGRAVE?
  - Asterics Horizon 2020 is pursuing this sort of coordination in Europe
- To discuss: A further meeting (or session at a meeting) to coordinate

Opportunities for science-driven collaboration

We're delivering OPAs and we expect most multi-messenger science investigations to be based on those events

Some investigations may warrant sharing additional events; there are several existing MOUs

Regardless, we may need to collaborate to make best use of OPA events

How does an opportunity get proposed and discussed?

Some boundary conditions firm, others may be rethought

Policy Fundamentals

Objectives must be part of the science program of the LIGO-Virgo Collaborations.

Agreements/collaborations with non-LIGO-Virgo partners should not be “exclusive” for any of the science topics pursued.

Data/information/results privacy to be maintained at all times.

Joint Publications of results upon mutual agreement and with the whole LIGO-Virgo author group.

Collaboration

- **Desire to do all possible science enabled by GW and other observations, and to do it optimally**
- **Desire to get credit for doing / contributing to good science**

versus

- **Effort required to make and fulfill commitments**
- **LVC having to pay attention to many different projects**

LVC is looking for the right balance.

Collaborative Projects

- **BBH to contribute to H_o?**
  - Galaxy surveys focused on areas of interest maybe --- and/or an assessment of the current catalogs
- **Combining EM and GW distance measures**
  - May improve accuracy
- **Inclination via afterglow analysis**
  - Or inform modeling of afterglow with GW
  - The physical systems are complicated!
  - Better GW waveforms and SNR may help; least sensitive detector dominates
- **Localization**
  - Share richer information from LVC modeling
  - Joint modeling projects?
  - KAGRA might join end-O3

Collaborative Projects

- **Subthreshold events**
  - Background grows very very rapidly
  - Requires more modeling to see if there is benefit
  - Rich data sets exist
- **Common working group and tools**
  - Asterics a European path; efforts starting to make a long term and more global endeavor.
  - AMON an possibility
- **Supernovæ**
  - 12 hour cadence EM observation at this time – shorter feasible?
  - Neutrinos a reliable trigger for Galactic SN
  - GW sensitivity probably limited to Galaxy
- **Open Call**
  - LVC to think about what we have heard; invite further input
  - Then define the process

Next steps

- **LVC: Implement new low-latency event handling infrastructure**
- **Testing**
  - Will distribute test Notices, including *Retraction* Notices
- **Engineering runs to be scheduled; updates to EM Community on what to expect and how to participate**
- **Communication, communication, communication**

The Last Page

- **Get in touch with any of us with questions and ideas**
- **Thanks to EM Community for participating**
- **Thanks to Marica and Jo**