Prioritized Search Goals for O1

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The Charge

- **Prepare a list of prioritized scientific goals for GW searches in LIGO/Virgo observing runs, associated to the human and computing resources required for each search.**

- The list should be derived from the astrophysics search plans in consultation with members of the data analysis council (which includes chairs for the data analysis groups, computing, software and detector characterization), to be presented for approval to the LSC Executive Committee and the Virgo Steering Committee.

- Timeline:

  - **LVC meeting August '14 (Stanford): for all searches proposed in O1.**

  - LVC meeting March '15 (Caltech): for all O1/O2/O3 searches in 2016-18.

  - LVC meeting August '15 (Budapest): and periodically as needed but at least annually every August: a revised plan if needed for searches in the following 3 years.

Input Information

For each search:

- Software

- Storage needs (Tb/year)

- **Time averaged number of modern CPU cores** (modern CPU=SandyBridge 2.7 GHz) needed for O1 for development and for **production**

- For some searches: additional resources to bring the significance of a detection to 4-sigma ("*followup mode*")

- How long will the cores be needed for?

- FTE needed and committed (1 FTE=40 hours/week) for dev, run and review

- Expected readiness

A spreadsheet with 95 rows and 27 columns

for details see https://wiki.ligo.org/DAC/Priorities

How will this list be used?

- **We need a realistic estimate of the resources we need for our science. Tying them to "science priorities" will help guide efforts to identify these resources.**

- **The spreadsheet is not meant to be sent to funding agencies as is.**

- However it will be input in the preparation of appropriation requests to funding agencies for computing resources.
    - We will use these lists to assess which searches can be done with existing computing and human resources, dedicating them appropriately, and plan on finding additional, needed resources.

- Schedule initially driven by a request of the US National Science Foundation.
    - October 2014: approval for LIGO Tier 1 resources.
    - January 2015: proposals for additional (shared) resources for O1
    - Fall 2015: approvals for LIGO Tier 1 resources for O2/O3, as well as proposals for significant shared resources

- **But this is not only about NSF**: e.g. Virgo has an end-2014 deadline set by the EGO Council for budget approval (INFN, CNRS)

- **Appropriations take a long time and planning needs to be done in advance**

The process (1)

Starting point: the 4 search groups and DetChar organized their proposed searches and activities that are computing and/or FTE intense in 3 tables:

1. **Minimal** requirements for ADE science: must be on time, must happen.

2. Searches that will boost scientific return in early years, deeper searches for selected classes, or most promising extensions of searched parameter.

3. Searches at higher risk/cost with potentially higher return. Also included are searches that will enhance the science potential of table 1 and 2 searches once the detectors are at design sensitivity.

Some groups also provided detailed ranking within the 3 classes.

The process (2)

The DAC chairs merged the 5 lists into a spreadsheet which was first presented and discusses at the DAC retreat and then revised, following discussions within the search groups and in DAC meetings.

Searches are grouped in blocks, each with a rank number (order within each block is simply alphabetical)

The criteria for ranking were, in order:

1. Discovery potential in O1

2. Maturity / readiness for running in O1

3. Computational cost

Computing and FTE needs are based on the best current understanding. They may be revised by December/January as benchmarking and optimization progress; revisions will be reflected in the March 2015 list, which will also include O2 and O3.

Timeline

- **July 8**: charge from LSC-Virgo Spokespersons to the DAC chairs.

- **July 25**: Search groups and DetChar provided separated list of searches and computing or FTE intense tasks in 3 tables. Some with internal ranking.

- **August 8**: DAC retreat: DAC chairs presented a first proposal for global ranked list to search group chairs, Detchar, DASWG and CompComm chairs, Spokespersons and LIGO Directorate.

- **August 11**: draft list distributed to DAC with requests for additional information, triggering fruitful exchanges in all search groups and teleconferences. Engagement of CompComm and DASWG.

- **August 22**: draft distributed to Council.

Rank 0 (top priority)

- **Fundamental detector characterization tasks that will enable good data to be analyzed.**

  - Online and offline state and veto segment determination (*Guardian, Calib, DMT, ODC, DQSEGDB*), to define which data can be analyzed, and *Omicron* transient-finder code run on h(t) and auxiliary channel for the interface between detector characterization and commissioning.

- **Deep CBC search up to 50 M$_\odot$**

  - Non-spinning searches are chosen at top priority for O1 as they are ready to run now, well understood and tested from past runs, although we expect these will be replaced by aligned spin searches, when ready.

  - Also included is basic offline transient parameter estimation for a detection candidate: if a detection is made, we need to be ready to make a statement about the nature and properties of the source.

Rank 1

- All-sky, deep **Burst** search for short duration GW bursts, up to 2 kHz, with a parameter estimation followup.

- Low latency, non-spinning **CBC** search to rapidly identify CBC detection candidates.

- **Continuous Waves** targeted search for high-value known pulsars.

- **Stochastic** isotropic background search.

- **Detector Characterization** activities that enable these searches (daily summary pages, data quality product evaluation, single IFO CBC candidate production).

Rank 2

- **Targets of opportunity** offline triggered transient searches for GRBs and SNEWS/HEN alerts.

- low latency **Burst** search for prompt identification of burst transients.

- **Continuous waves** all-sky search for isolated pulsars.

- Non-isotropic **stochastic** background search.

- **Detector Characterization** activities that will improve top priority searches (automated line find and track, user-requested time-frequency scans, daily DQ triggers, data server for DQ work, transients on auxiliary channels...)

Rank 3

- Effort towards low-latency sky localization, and the means to send triggers to EM partners.

- Low latency and medium latency GRB-triggered searches.

Together these form the framework that may lead to the discovery of an EM counterpart.

For O1, these are ranked below deep searches, since even if there is a detectable signal (which would be found by offline pipelines), the discovery of an EM counterpart does not seem very likely for O1. Ideally, these should be combined with deep searches. Note this effort is computationally cheap, but still significant in human power.

Rank 4

- This group has CW searches which, even though they may not lead to a detection, could yield interesting astrophysical information, though less so than the high-value pulsar searches (Cas-A, Sco-X1)

- Long transient searches with high false alarm probability (1%) that may serve as a diagnostic for possible biases in the stochastic searches.

NOTE: Ranks 0-4 include the highest priority ("minimal requirements that must happen and must be on time") for all group and detector characterization for O1.

For more, see https://wiki.ligo.org/DAC/Priorities

Next steps

- Some changes expected following the face-2-face meetings here in Stanford; they will be implemented prior to vote by ExecComm and VSC.

- The groups are collecting additional information for each line item:

  - astrophysics search plan, quarterly milestones

  - scientific and technical assumptions behind the requirement calculation

  - de-scoping plan if not all resources are available

  - optimization and benchmarking details

- As appropriation requests are prepared and resource allocation for O1 is drafted, we need to fold in development and production for O2/O3, including revisions based on ongoing benchmarking and simulations.

Extra slides

CBC mapping of the parameter space

- legend to CBC searches as in the spreadsheet - will be presented in the DAC plenary session on Thursday