Virgo and LIGO Detector
Progress towards O3

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LV-EM Town Hall Meeting
March 16 2018
Status of Advanced Virgo

- Time towards O3 shared between commissioning and installation of upgrades:
  - **Commissioning** activities after O2 focused on ITF configuration finalization;
  - Some progress on sensitivity, with overall reduction of glitch rate;
  - **Installation** of upgrades:
    - Monolithic suspensions;
    - High power laser;
    - Frequency independent squeezing source: in collaboration with AEI.

- Longest data stretch: 69 hrs;
- BNS range up to 28 Mpc;
- Science duty cycle: 85%.
Main upgrades: Nov 2017-Mar 2018

• All test masses suspended with fused silica fibers;
• Will boost the low frequency sensitivity.

• On-site measured squeezing: around 10 dB;
• Improves high frequency sensitivity.

• New high power laser amplifier: delivers up to 60 W to the ITF;
• New monolithic pre-mode-cleaner.
Commissioning and upgrades

- General plan of the commissioning (at least up to end of June):
  - First problem solving activities;
  - Increase of input power (mitigate possible Parametric Instabilities);
  - Commission squeezed light source;
- Engineering runs possibly starting from end of April.

<table>
<thead>
<tr>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commissioning</td>
<td>Installation of upgrades</td>
<td>Commissioning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
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<tr>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovery + calibration</td>
<td>Improve detector configuration, re-measure noise couplings, Optical Characterization</td>
<td>Input power increase, mitigate parametric instabilities, TCS</td>
<td>Commissioning of FI squeezing</td>
</tr>
</tbody>
</table>
O3 sensitivity target

- Target BNS range: between 60 and 85 Mpc;
- Upgrades promise a boost of the frequency sensitivity at all frequencies;
- Goal for ITF input power set at 50 W: not much effect on BNS (or BBH) range, improves SNR of last inspiral cycles and merger;
- Commissioning of the full ITF to restart on March 19th;
- Virgo ER plans: starting from end of April (if ITF status allows), one per month, during the weekends;
Scattered Light. 
New SRM.  
70W Amp.

ETM & ERM replacement
Cryo-pump decommissioning, chevron baffles

Sep

70 W Amp.
LLO

GV repair, chevron baffles
ETM & ERM replacement

Prep

Prep

LHO

Replace ITMX, Scattered Light Baffles, New SRM, SR3 heater.

Relock full interferometer
Scattered Light.
OFI actuator.
Active MM Squeezed light installation
Commissioning:
Squeezed Light
Higher Power Scattered Light

Squeezed light upgrade
70 W Amp.

ETMX AMD Test
Commissioning

X-arm

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Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun

Post O2 Installation and Commissioning
70 W Amplifier

Installed Fall 2017 at LLO
Currently providing up to 50
Installed March 2018 at LHO
A point absorber was found on the HR side of H1 ITMX during the May 2017 Vent.

Cleaning was unsuccessful.

Optic replaced in September 2017

Affected ability of H1 to operate at higher power.
Hope to reduce residual gas damping noise by a factor of 2.5

This is a significant noise source at LLO below ~60 Hz
Acoustic Mode Dampers

Passively damp mechanical modes of the Test Mass

Mitigate Parametric Instabilities.
Squeezing down to ~ 70 Hz without any noise re-injected.
Status

• Higher Power: 70 W Amplifier works, now working on stable operation.

• Squeezing: Much work yet to do but early results are very promising.

• Acoustic Mass Dampers: Promising results from test at LLO.

• ETM and ERM Replacement: In progress, ETMY and ERMY at H1 already done.

• Scattered Light: Lots of new baffles to absorb scattered light. This is very much a work in progress.

• Optimistic that we will reach our O3 goal of 120 Mpc BNS range.
Noise Projection

L1 data from end of O2, 27 July - Aug 8 2017

- Measured, 25 W, 96 Mpc
- post O2: 50 W+3 dB sqz, new ETMs+SRM, Residual gas noise/2.5, 125 Mpc
- post O2: 50 W+3 dB sqz, new ETMs+SRM, RGN/2.5, No "scatter" noise, 155 Mpc
- Thermal+Quantum+Residual gas/2.5, 180 Mpc

Scatter
Sum of:
- Coating (G1700820)
- Residual gas/2.5
- Other (luminosity distance)
Engineering Runs

• Virgo: Starting from end of April will attempt to have an ER once per month if instrument status allows.
• LIGO Instruments may join starting in June/July.
• Possibly a longer ER if progress permits.
• Best effort to distribute alerts during this phase.
• Will inform LV-EM mailing list of upcoming short Engineering Runs.
O3

• O3 will be preceded by a month-long Engineering Run.
• Best guess is Engineering Run October/November 2018.
• O3 anticipated to start towards end of 2018 and last for one calendar year.
• Much progress has been made, much remains to be done...

We are Optimistic
Extra Slides
Plans for O4 (2021)

- Install further upgrades:
  - Signal recycling mirror;
  - Input power increase to 125 W;
- Expected range for BNS in the range 100’s Mpc;
Beyond Advanced Virgo: AdV+

- Major upgrade to fully exploit the current infrastructure;
- Two distinct phases:
  - **Phase-I** in time for O4;
  - Installation of frequency dependent squeezing and reduction of low frequency fundamental noise;
  - **Phase-II**, major upgrade with replacement of test masses with heavier ones to reduce thermal noise;
- Expected multi-messenger event rates per year:
  - BNS: 36-540;
  - NSBH: 0.7-1010;
- Proposal submitted to funding agencies.