



# Virgo and LIGO Detector Progress towards O3

*Brian O'Reilly*

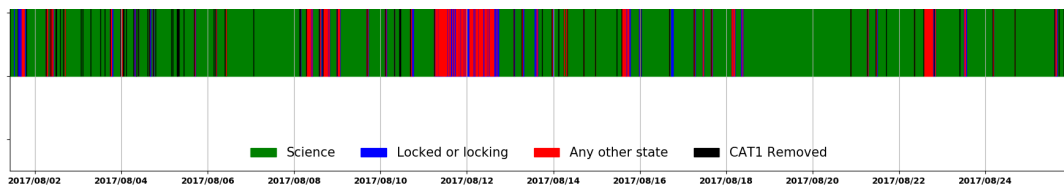
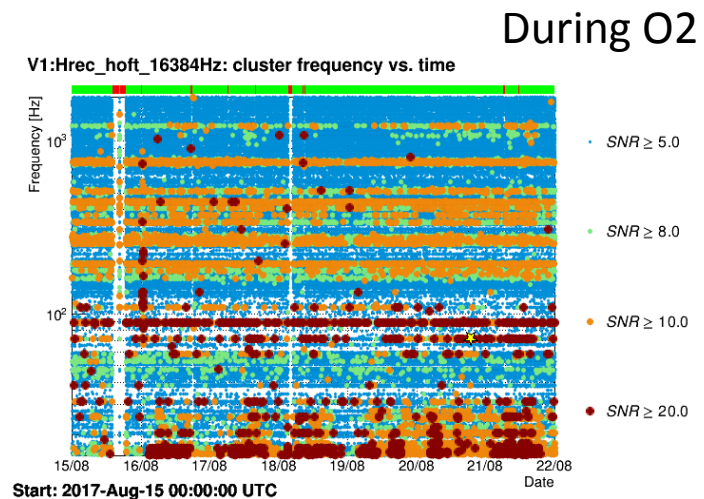
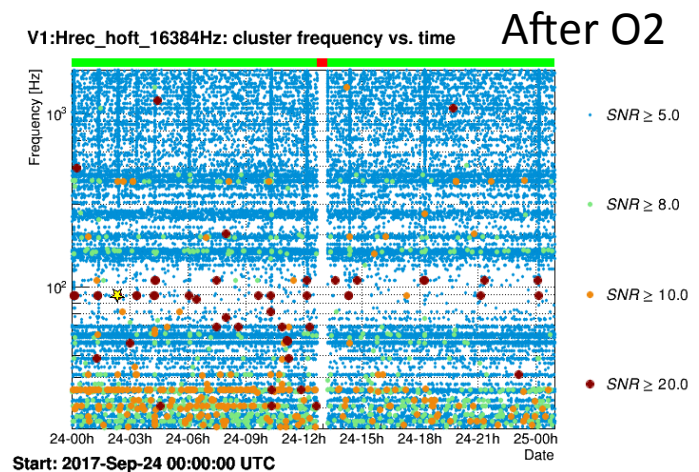
*Alessio Rocchi*

LV-EM Town Hall Meeting

March 16 2018

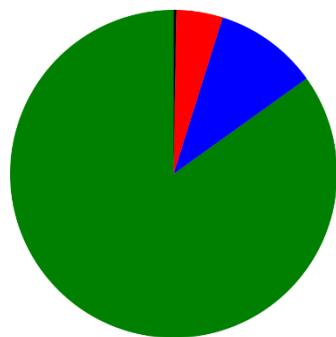
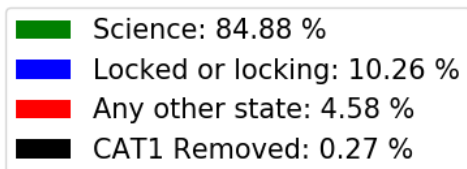
# Status of Advanced Virgo

- 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.



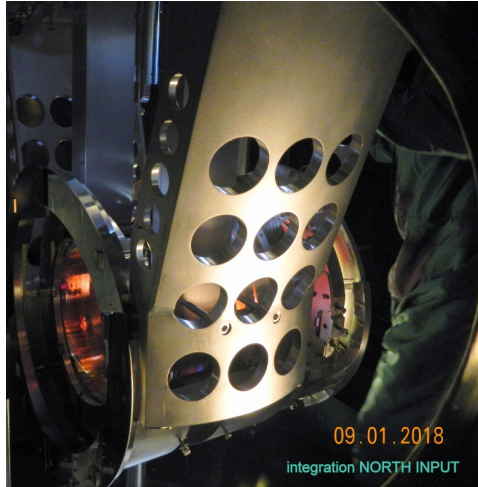
## Advanced Virgo O2 data taking

2017/08/01 10:00:00 UTC -> 2017/08/25 22:00:00 UTC



- Longest data stretch: 69 hrs;
- BNS range up to 28 Mpc;
- Science duty cycle: 85%.

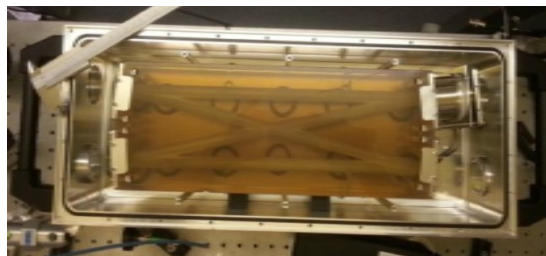
# Main upgrades: Nov 2017-Mar 2018



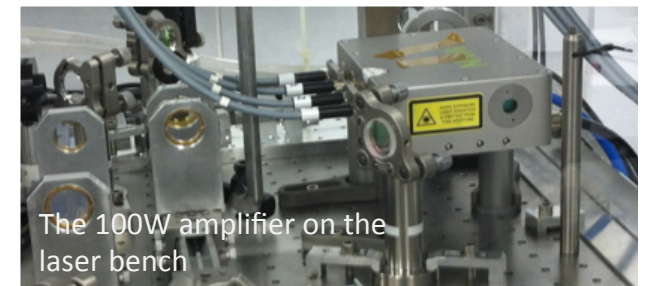
- All test masses suspended with fused silica fibers;
- Will boost the low frequency sensitivity.



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

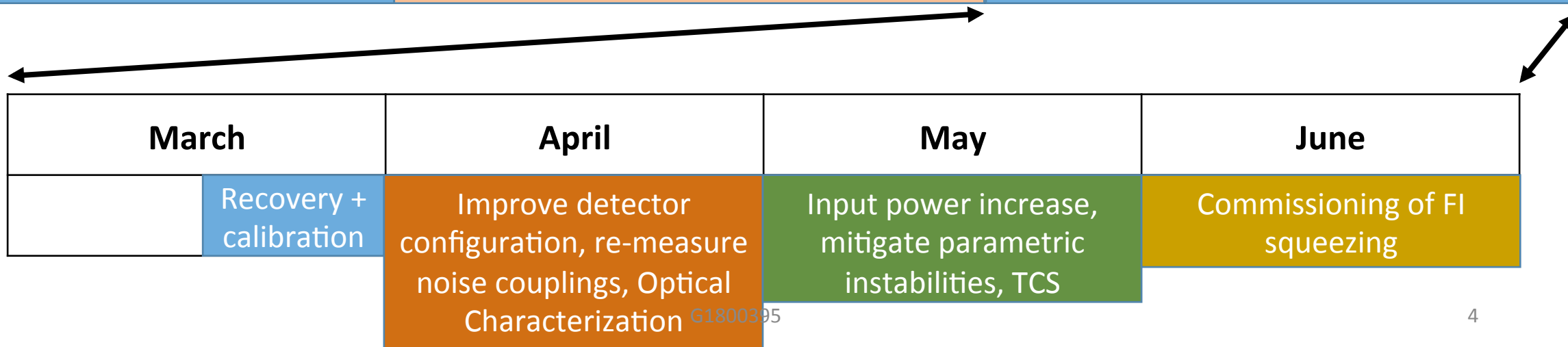
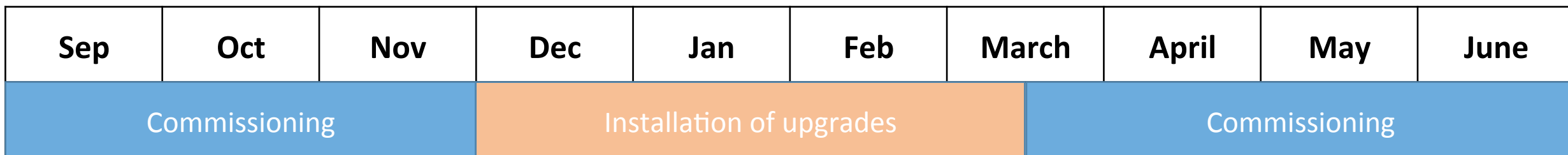


- New high power laser amplifier: delivers up to 60 W to the ITF;
- New monolithic pre-mode-cleaner.



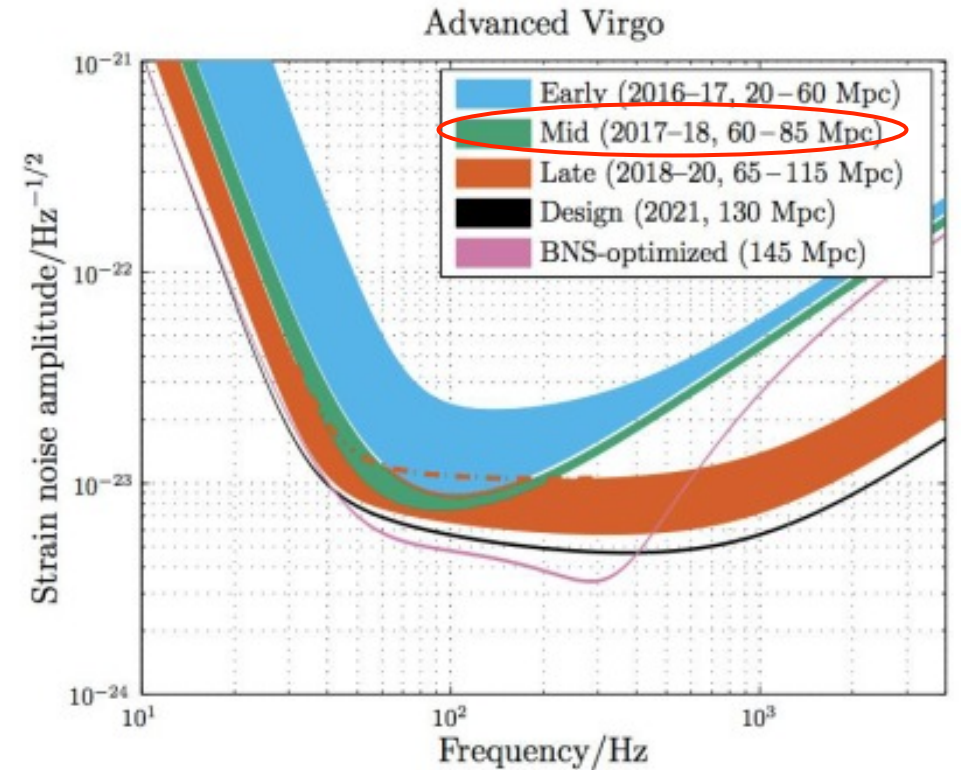
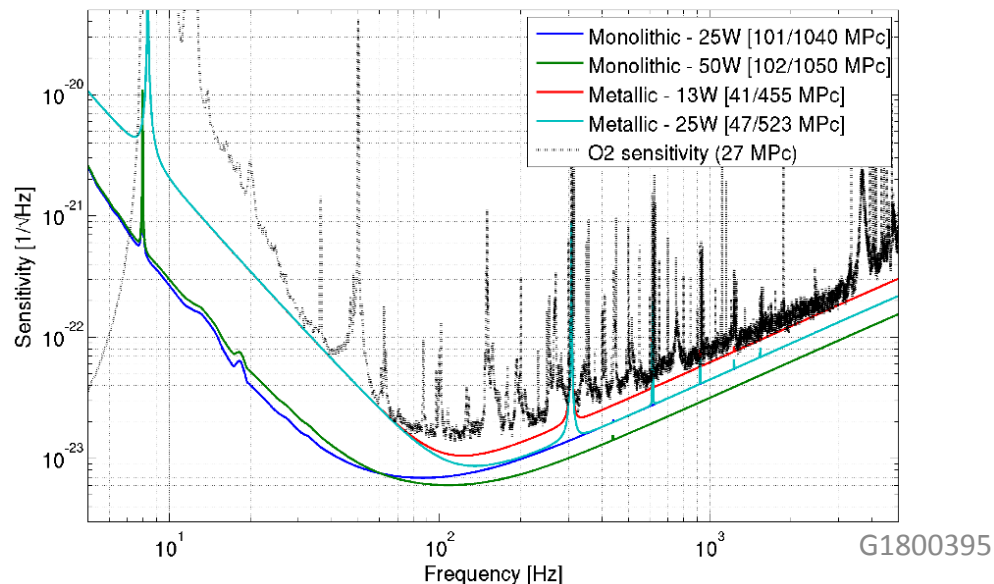
# Commissioning and upgrades

- 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.

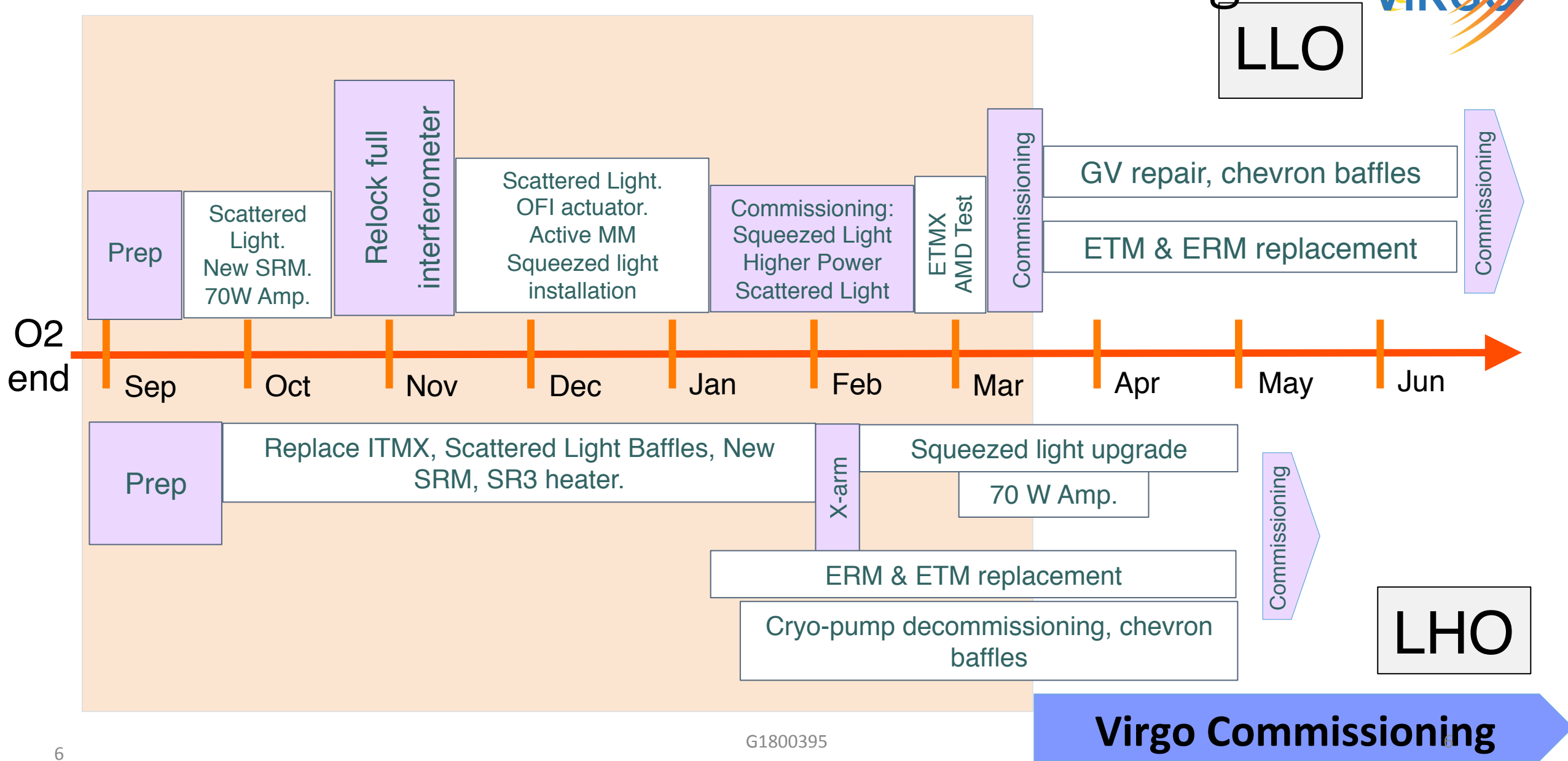


# O3 sensitivity target

- 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 19<sup>th</sup>;
- Virgo ER plans: starting from end of April (if ITF status allows), one per month, during the weekends;



# Post O2 Installation and Commissioning

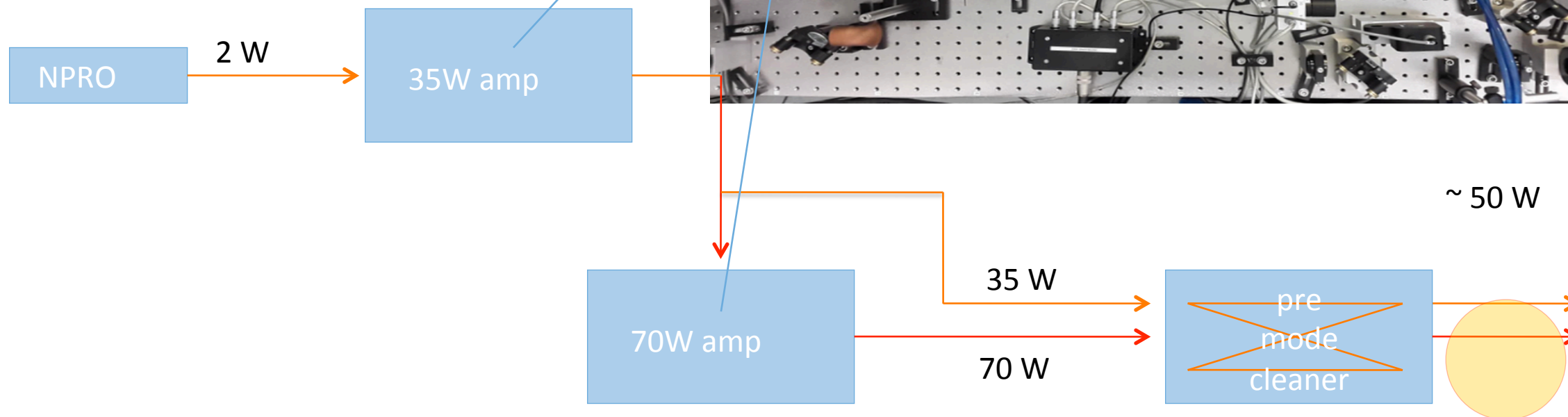
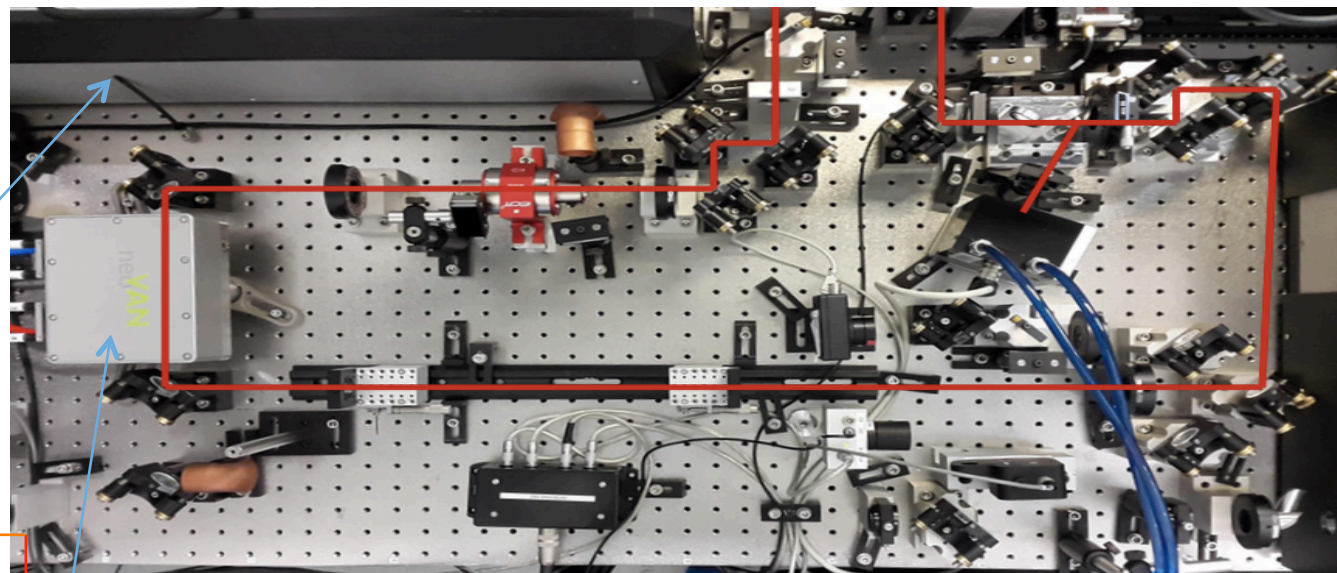


# 70 W Amplifier

Installed Fall 2017 at LLO

Currently providing up to 50

Installed March 2018 at LHO



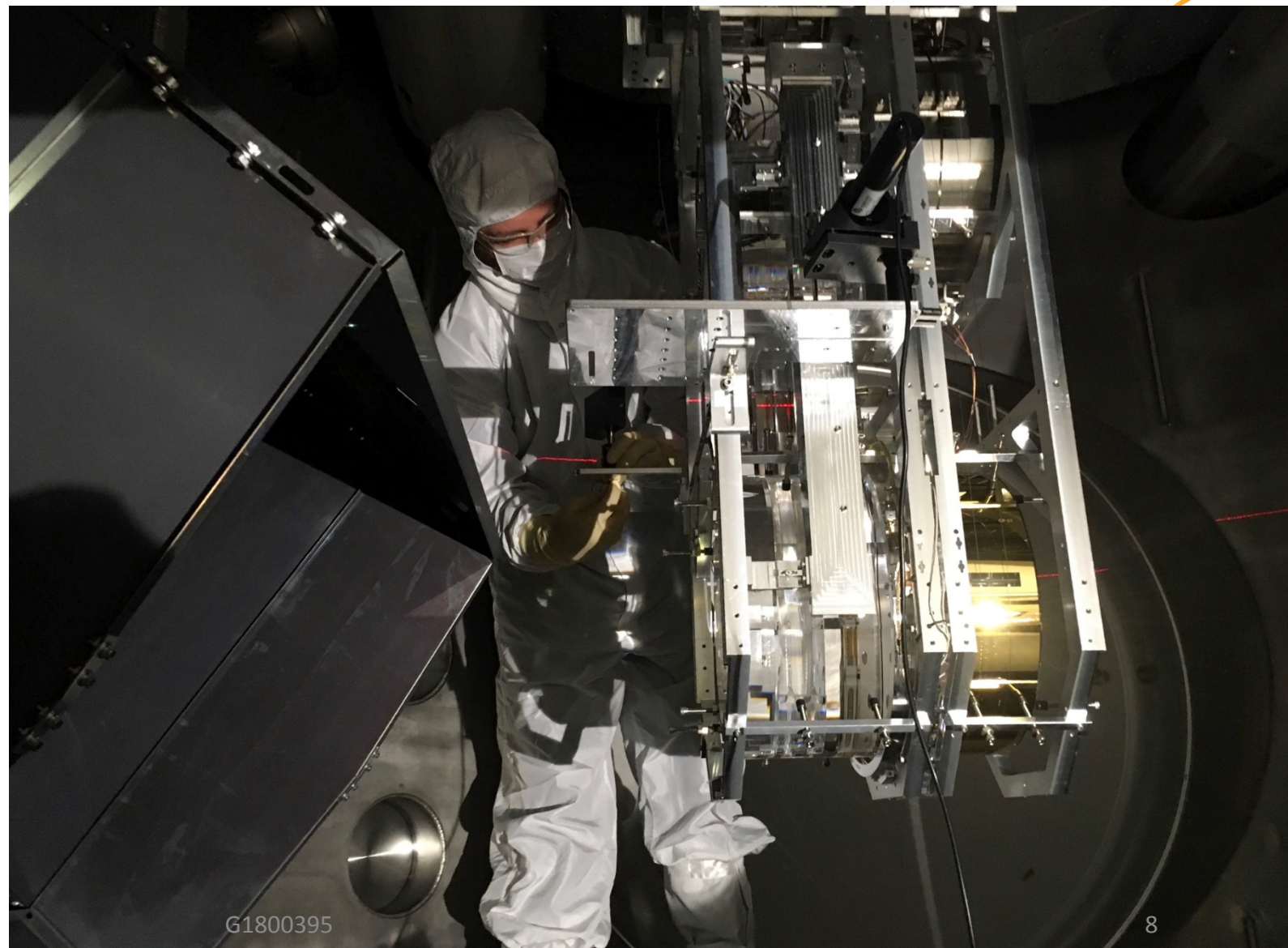
# ITMX Replacement

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.

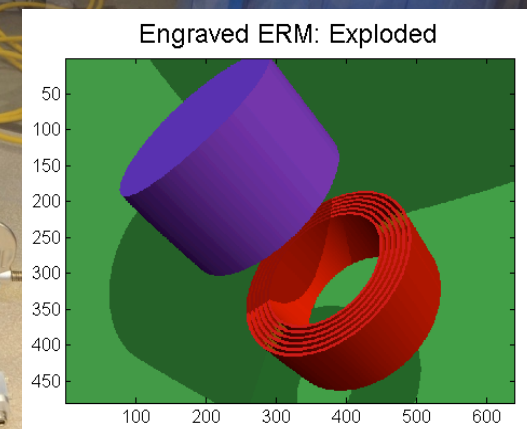
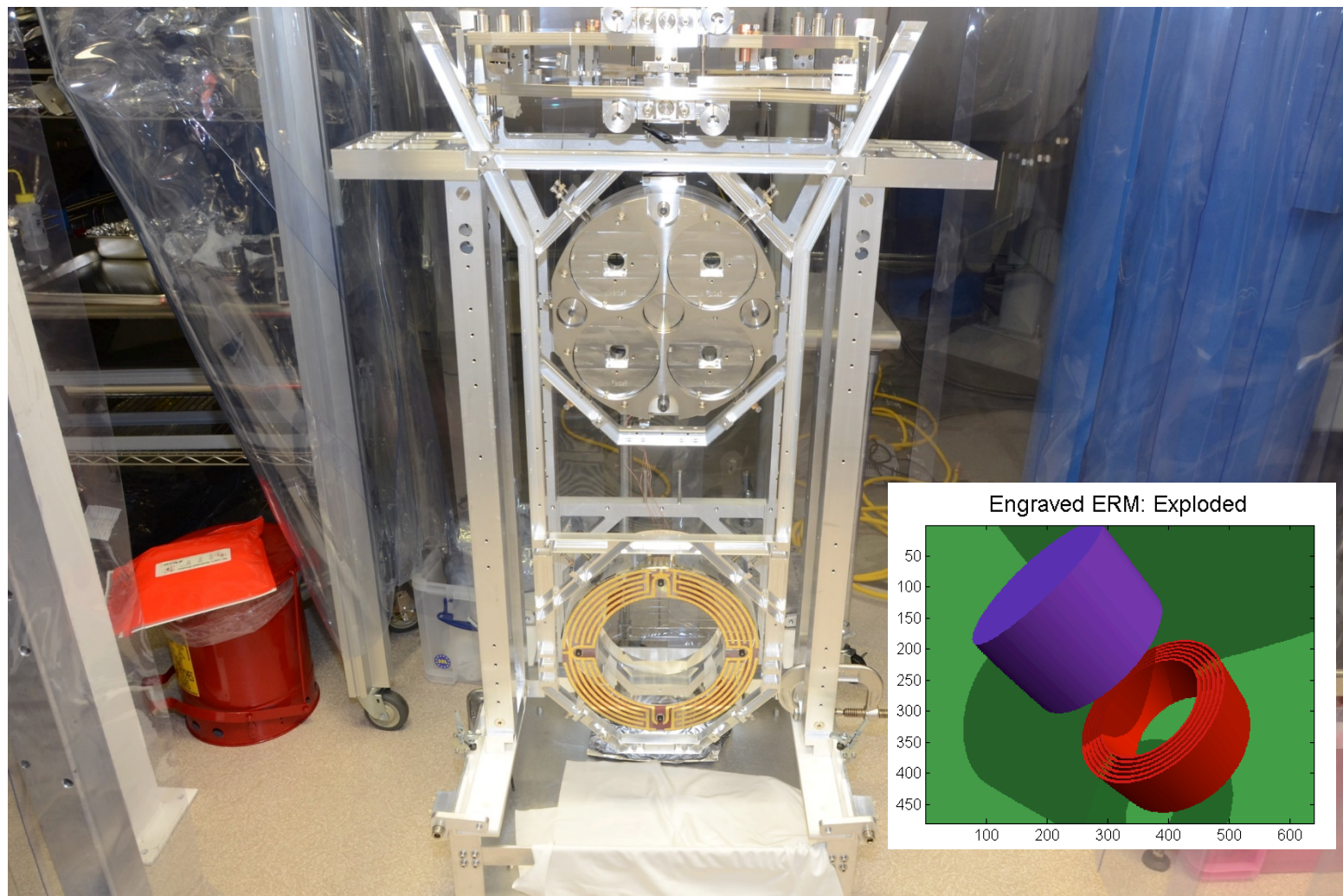




# ERM and ETM Replacement

Hope to reduce residual gas damping noise by a factor of 2.5

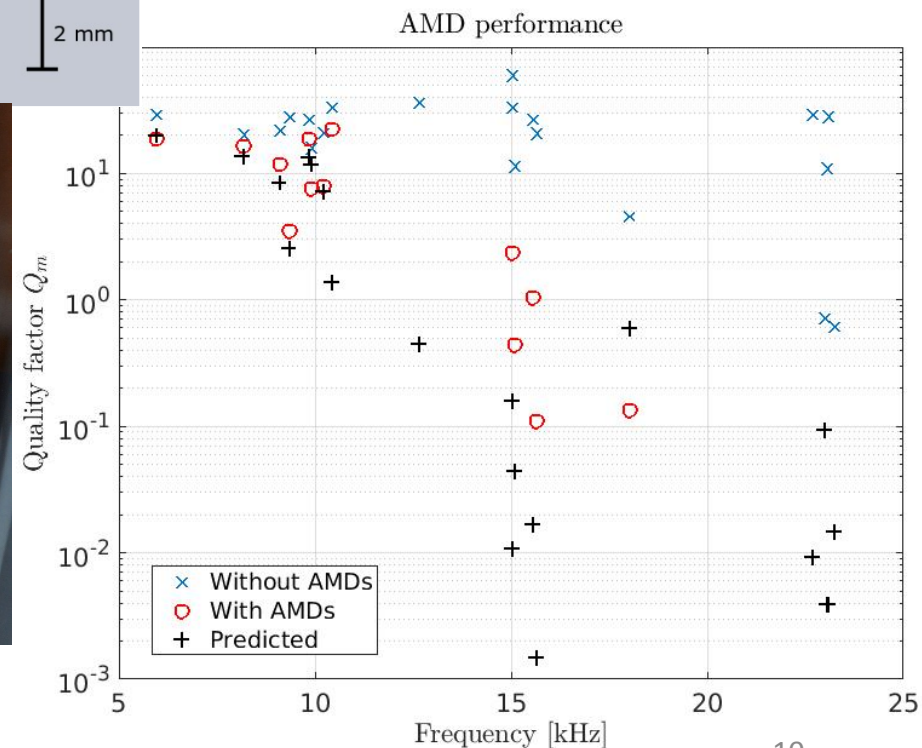
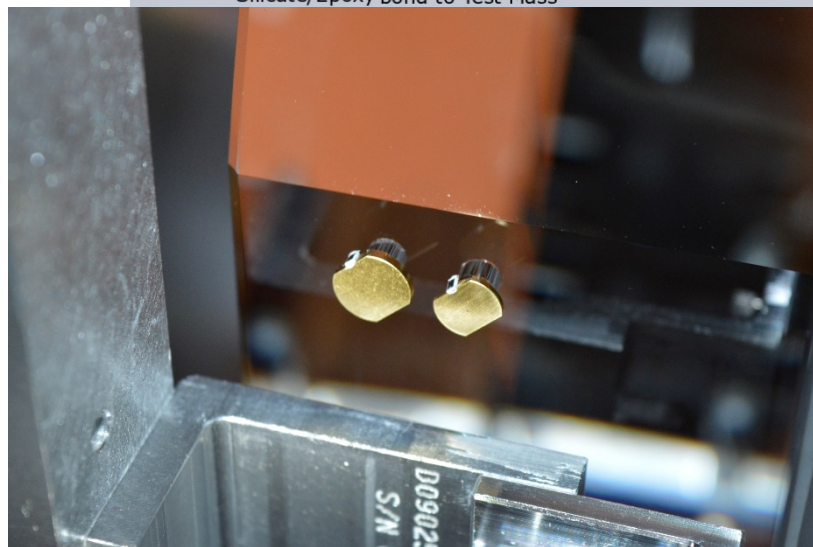
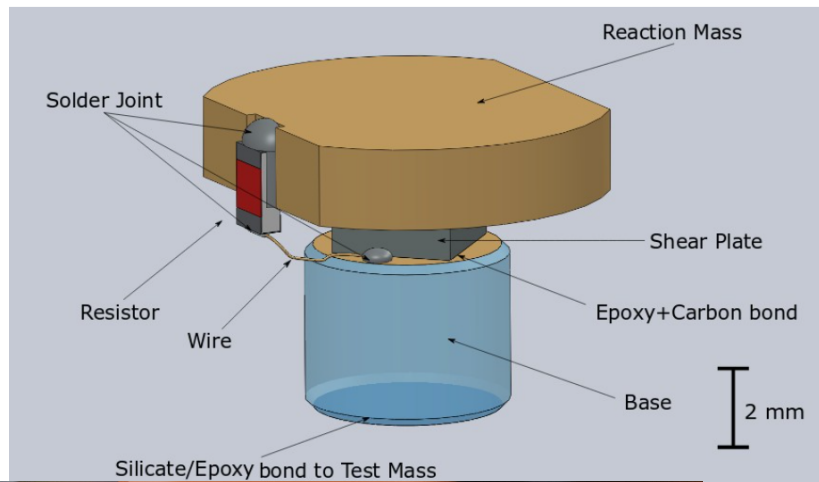
This is a significant noise source at LLO below  $\sim 60$  Hz



# Acoustic Mode Dampers

Passively damp mechanical modes of the Test Mass

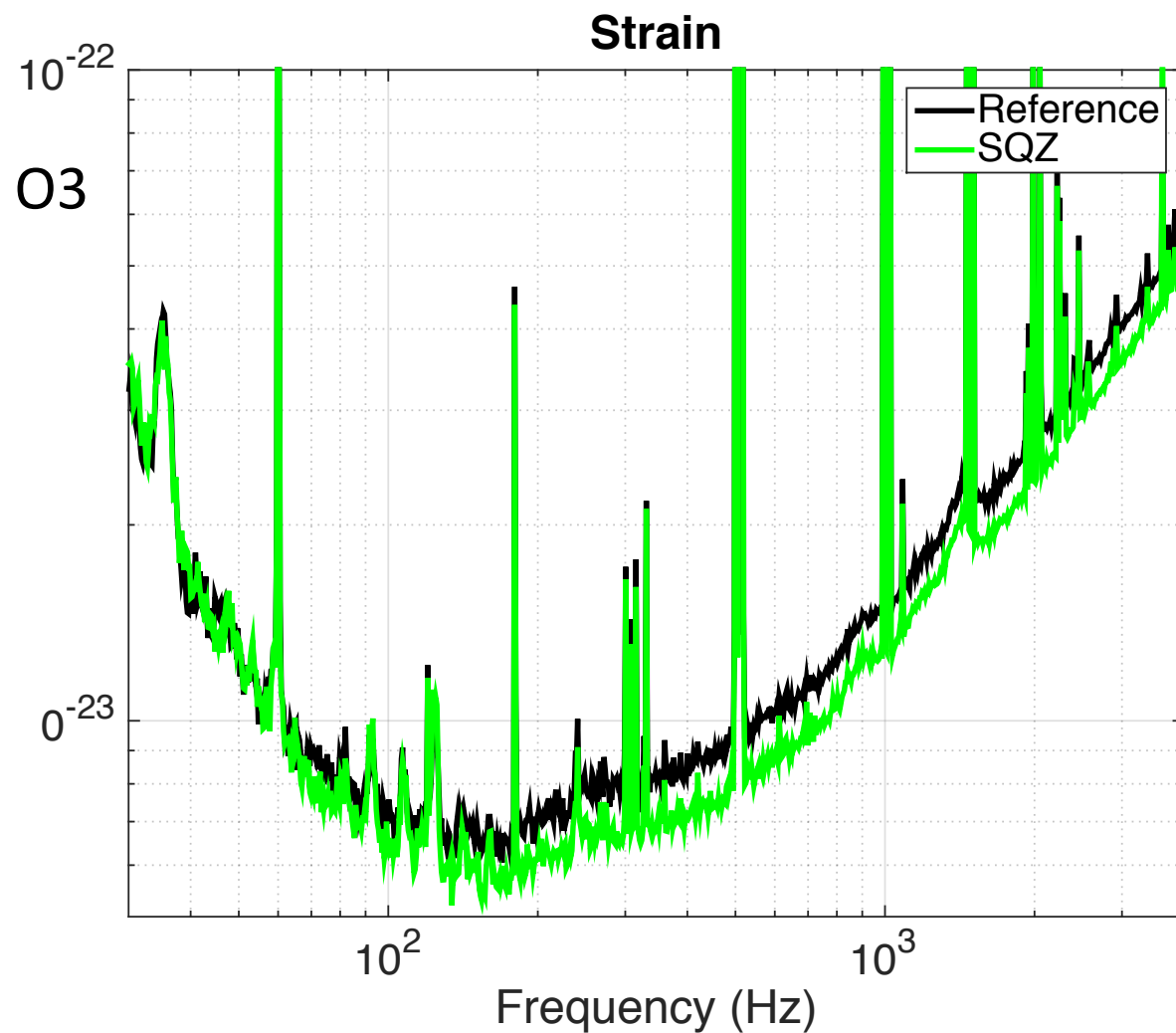
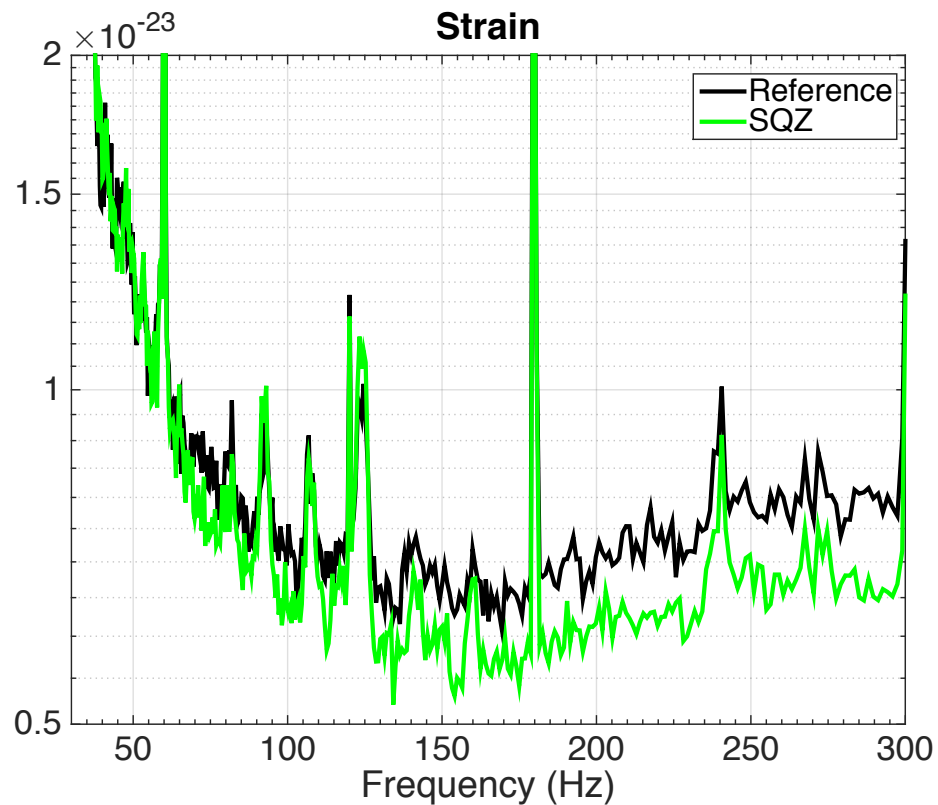
Mitigate Parametric Instabilities.



# Squeezing

First promising test of squeezing injection at LLO:

- ~15% shot noise reduction
- improvement visible down to 70 Hz
- target is 40% shot noise reduction for O3



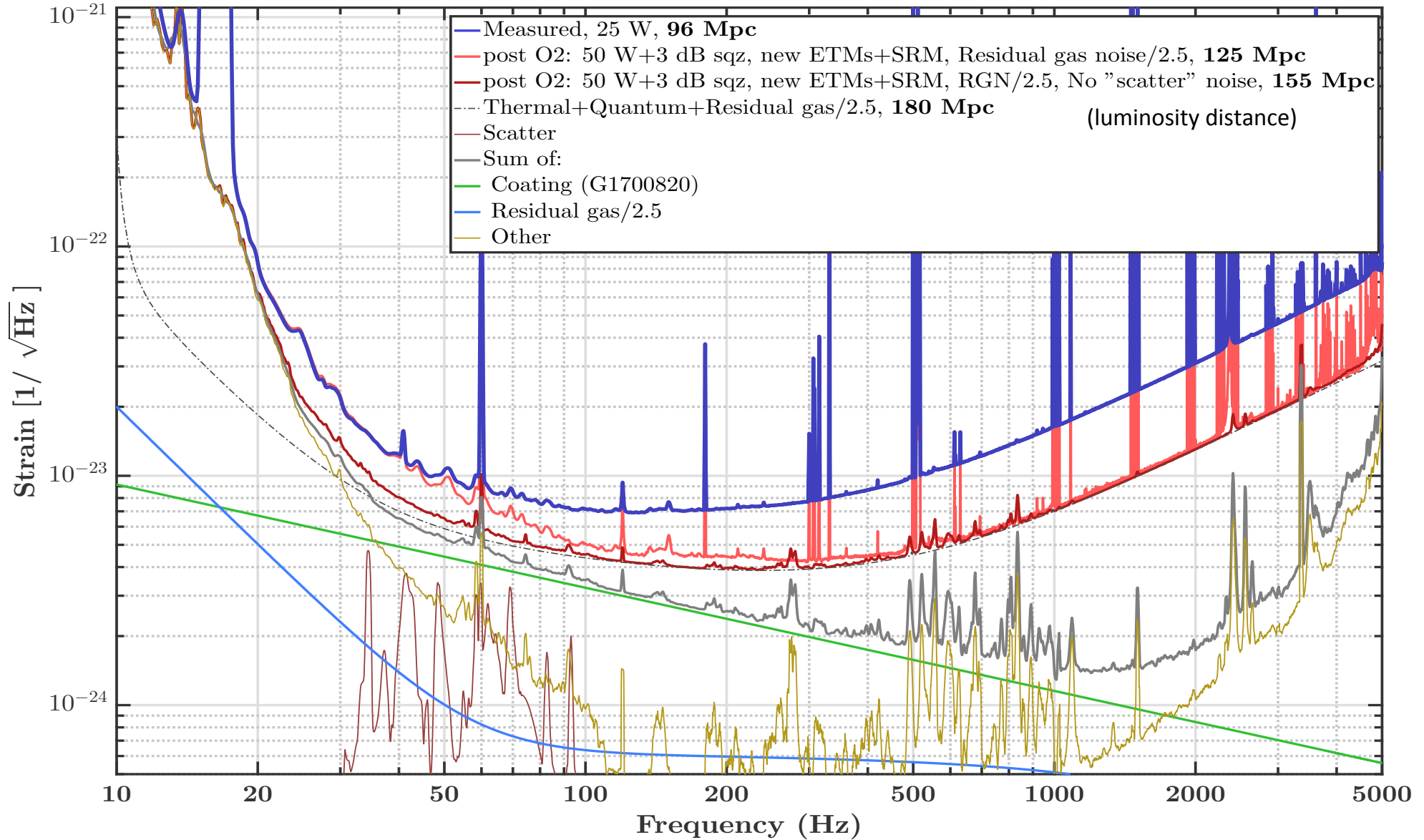
# Status



- 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



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# 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**

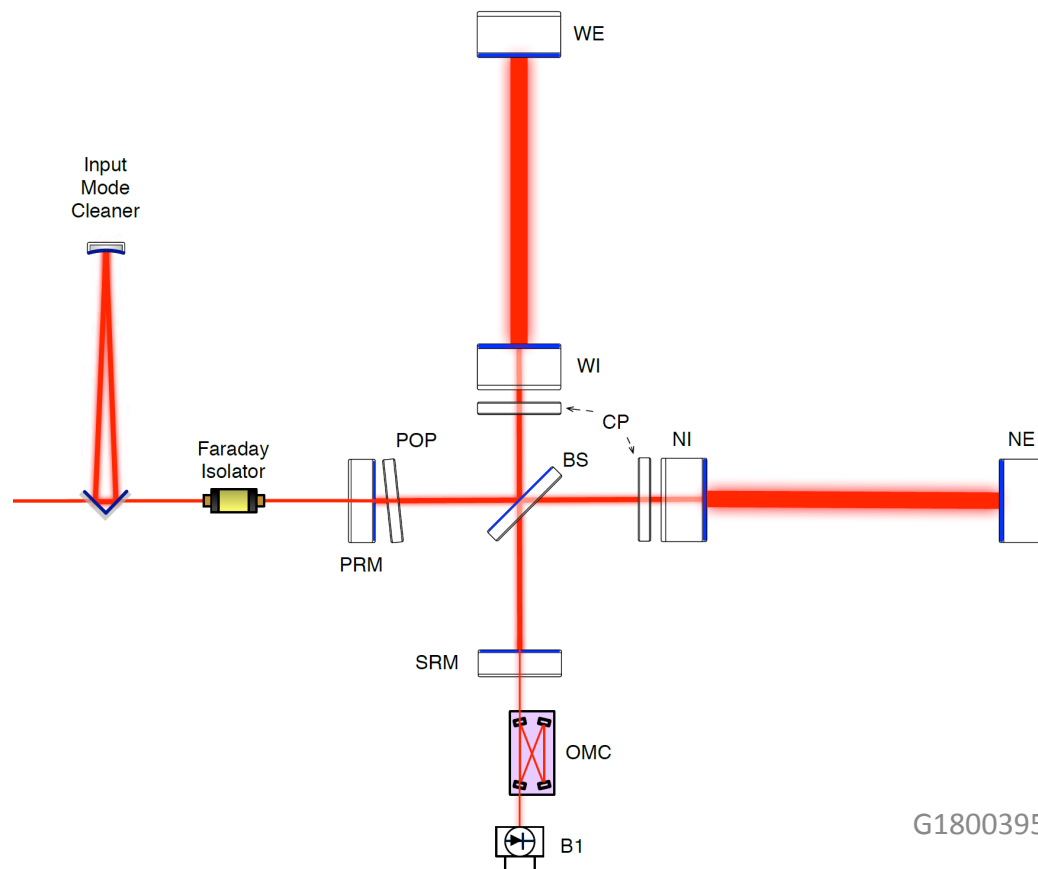


# Extra Slides

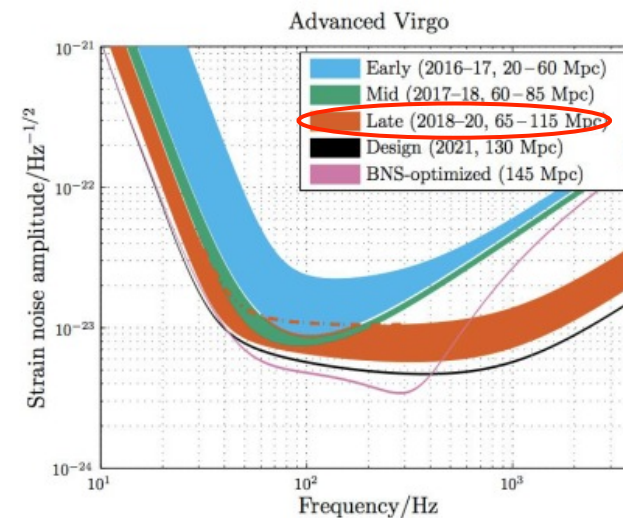
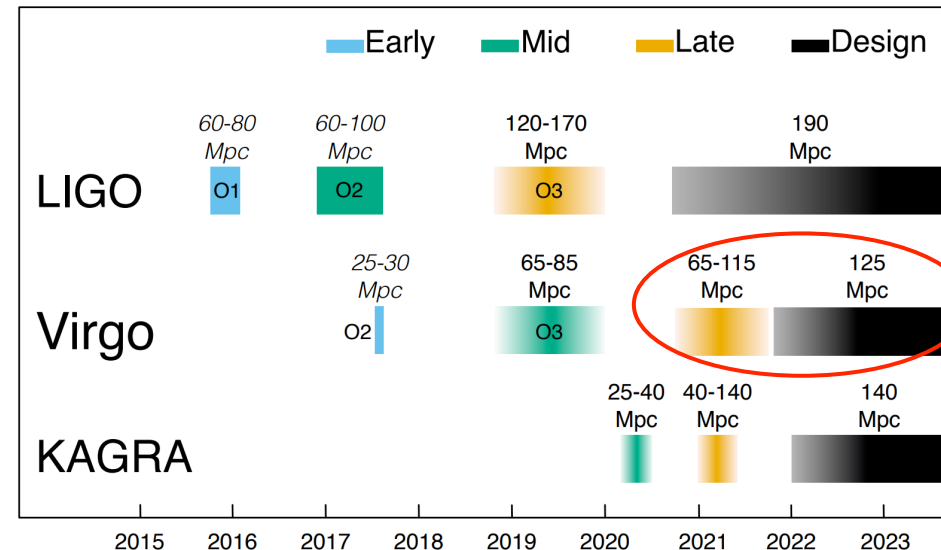


# Plans for O4 (2021)

- Install further upgrades:
  - Signal recycling mirror;
  - Input power increase to 125 W;
- Expected range for BNS in the range 100's Mpc;



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# 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.

