



NEWS



European Commission



H2020-MSCA-RISE-2016 — Grant Agreement N°
734303



UNIVERSITÀ DI PISA



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GW Physics

Massimiliano Razzano
SB Meeting - June 25, 2018

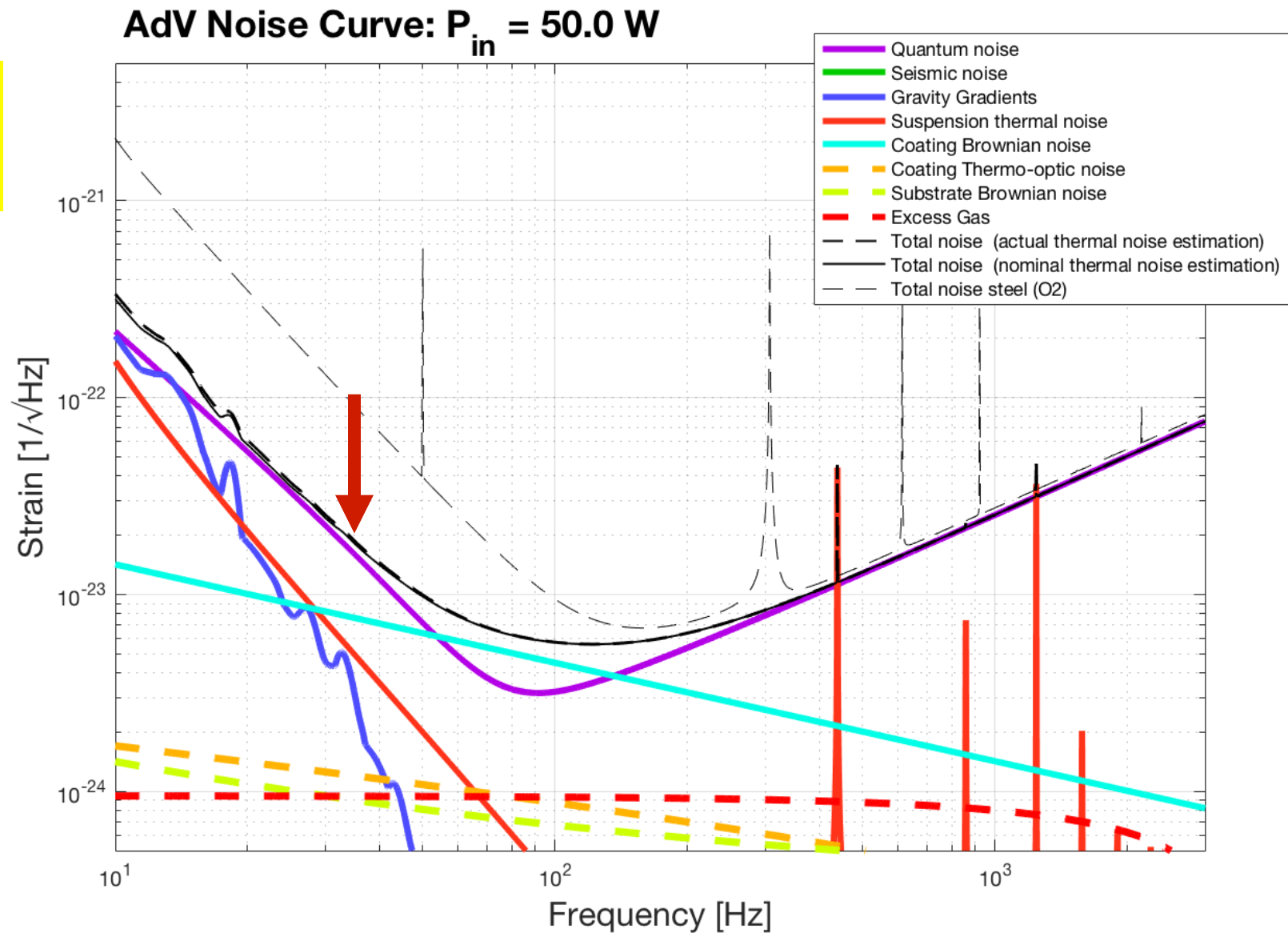


NEWS from GW Physics

- Second observing run (O2) finished successfully this summer
- Joint LIGO-Virgo run (1-25 August) yielded 2 detections
- Now moving toward O3
- Improving detectors and data analysis infrastructures
- Higher sensitivity → higher events (and noise transients rate)
- Both search pipelines and detector characterization activities
- Aiming at lowest latency possible



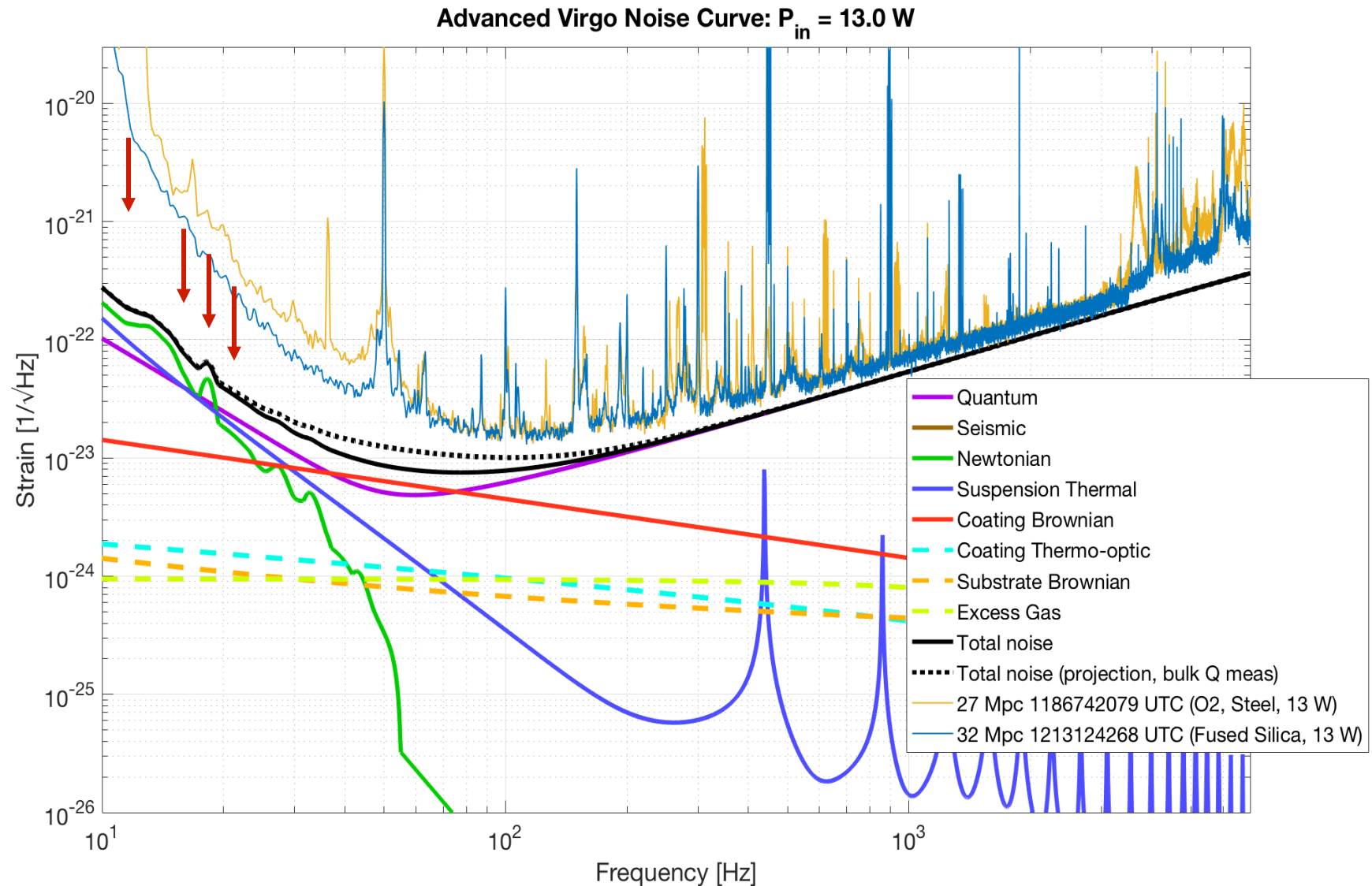
Summary O3 Target





Mid June

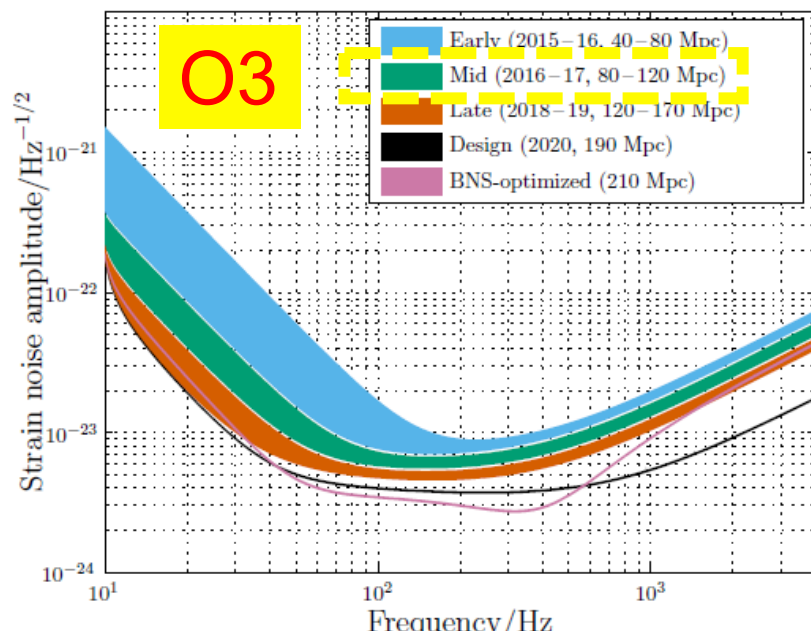
- LF gradually improving
- **Preliminary** estimate of bulk TN on going
- Effect of fused silica fibres clear
- Noise hunting dedicated to:
 - Control noise
 - Environmental
 - Stray light



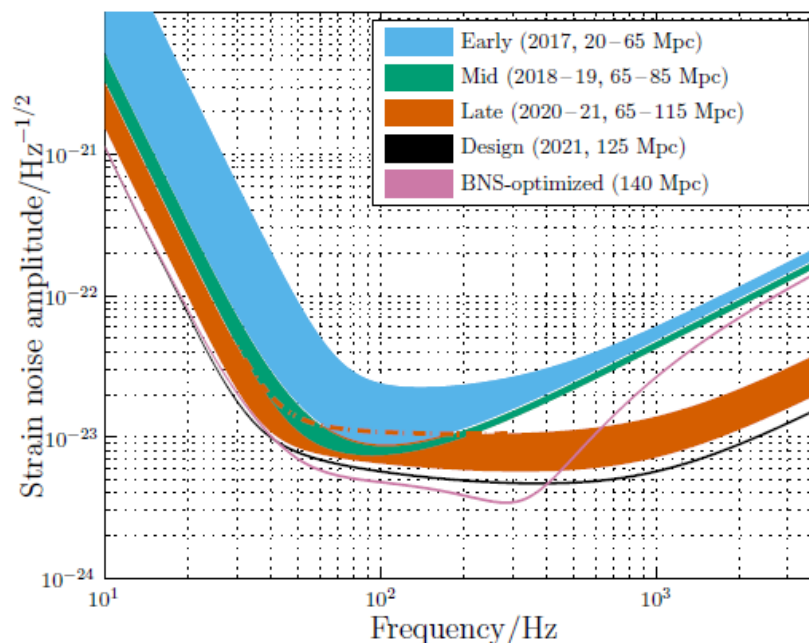


LIGO-Virgo-KAGRA observing scenario

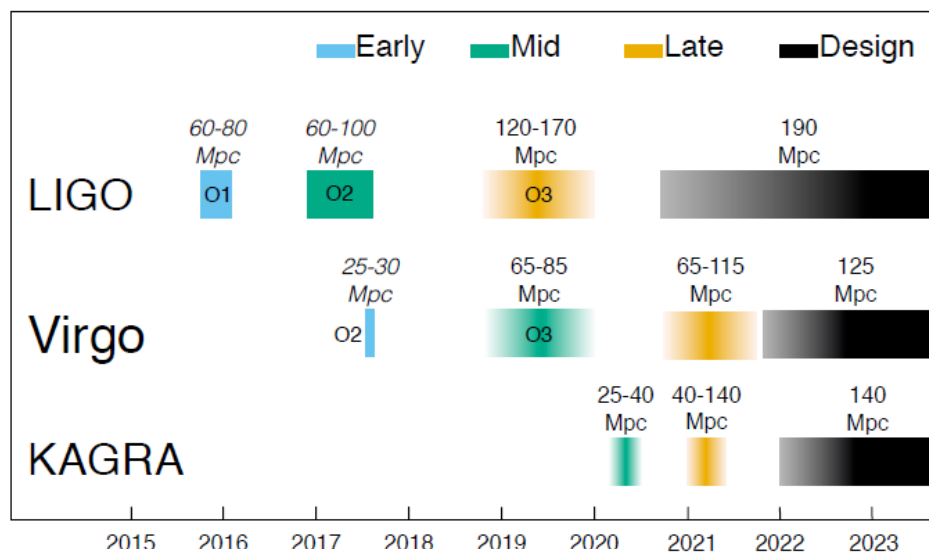
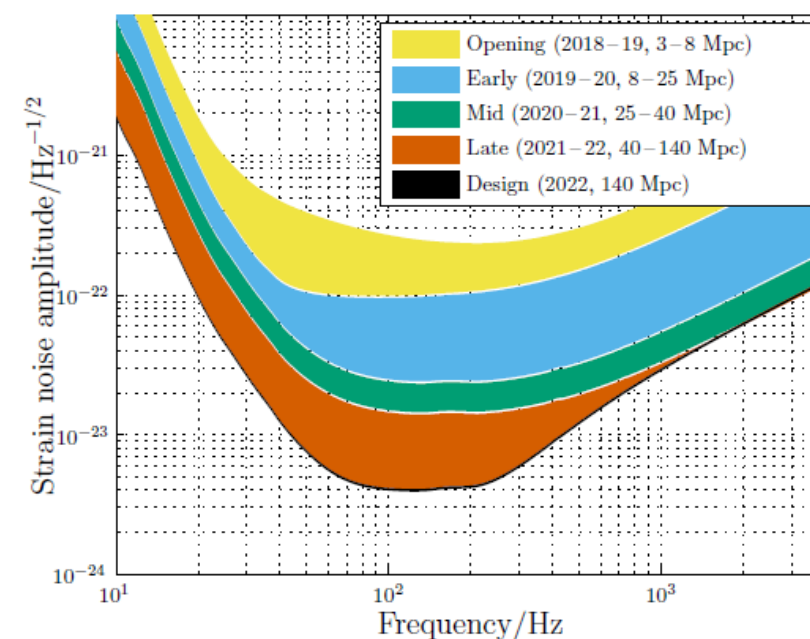
Advanced LIGO



Advanced Virgo



KAGRA



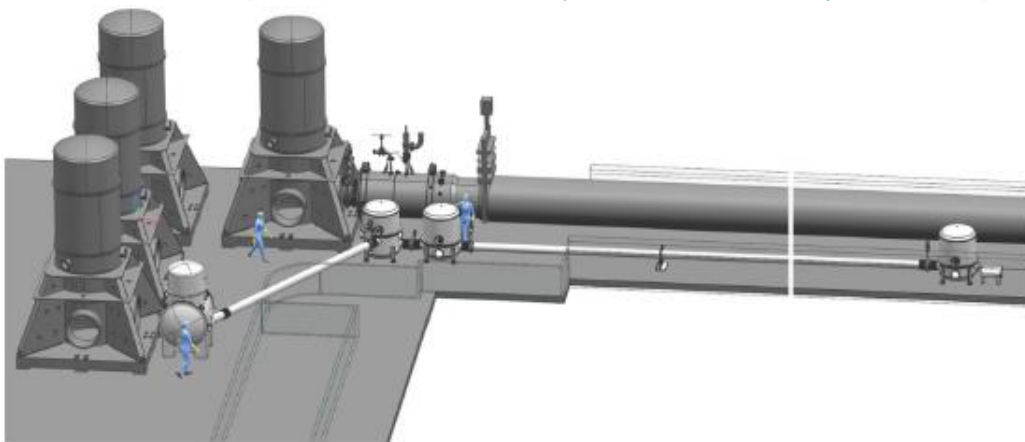
- O3 is a very exciting scenario (including KAGRA, a seed of 3G detector)
- What can we do after AdV to exploiting at the best the infrastructure ?
- **AdV+ vision document submitted to Virgo Council: a two-step approach, 160 Mpc/300 Mpc, 6-year**



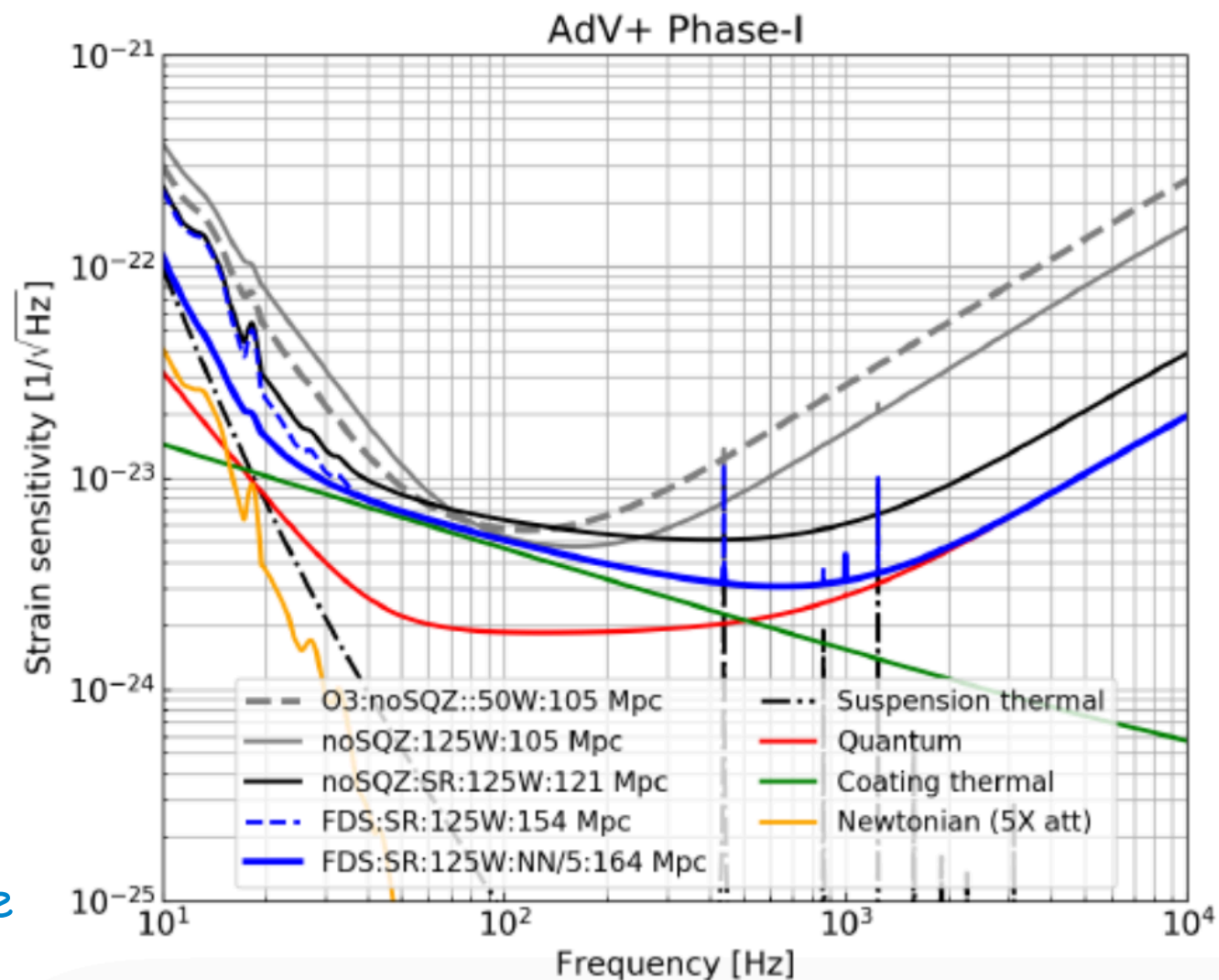
AdV+ **vision document**, phase I: *reaching AdV full target*

Complete the AdV program:
200 W laser; 125W at the ITF input
Signal recycling \rightarrow 120 Mpc range

Frequency Dependent Squeezing
300 m-long filter cavity \rightarrow 150 Mpc range



Newtonian Noise Cancellation \rightarrow 160 Mpc range





AdV+ **vision document** phase II: *Thermal noise reduction large beams*

Larger mirrors

Diameter: 550 mm, thickness: 200 mm, mass: 100-120 kg

Scenario 1: **ETM-only** → 200 Mpc range

Scenario 2: **Full** → 230 Mpc range

In parallel coating improvements:

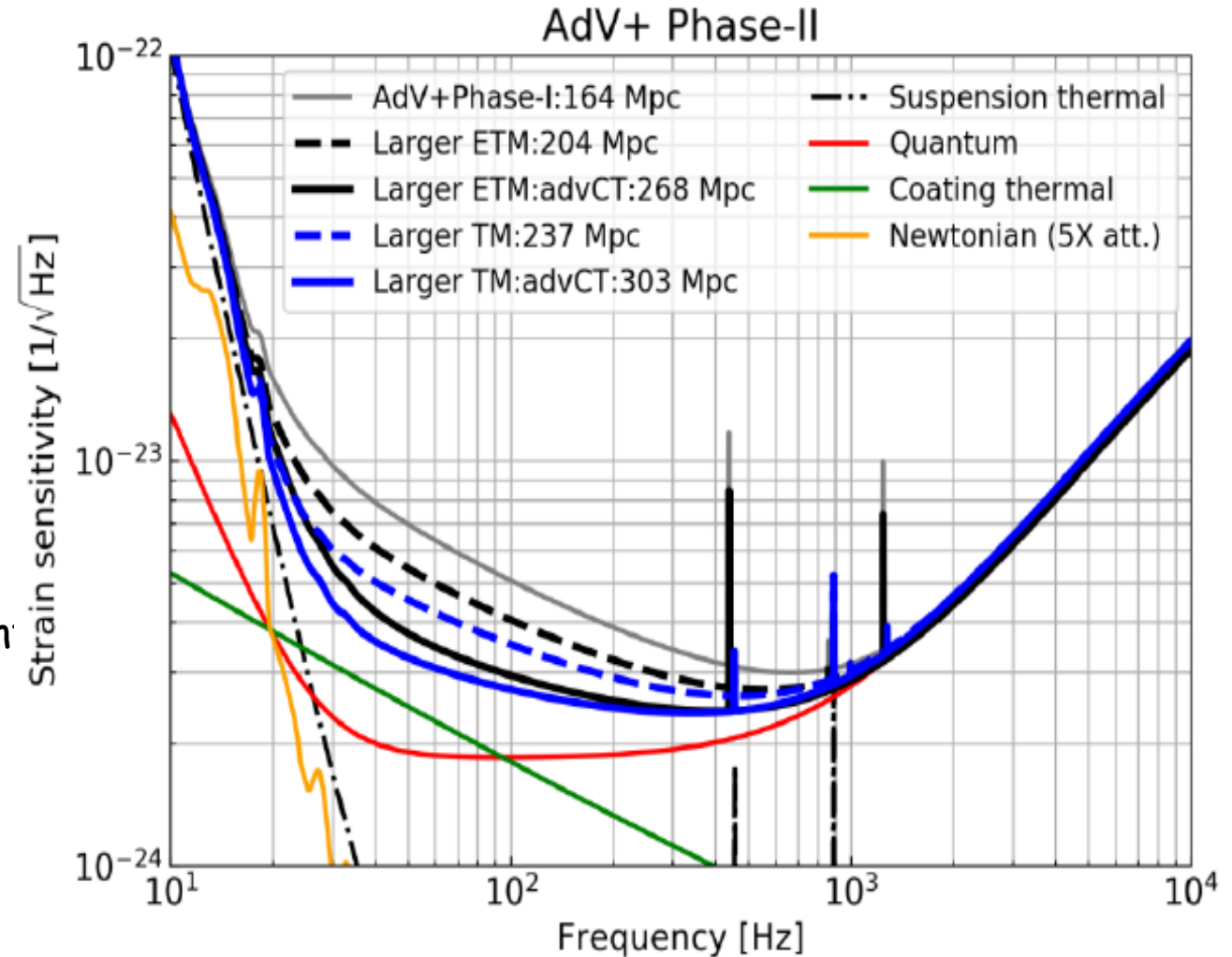
If factor 3 reduction in **Coating TN**:

Scenario 1: ETM-only → 260 Mpc range

Scenario 2: full upgrade → 300 Mpc range

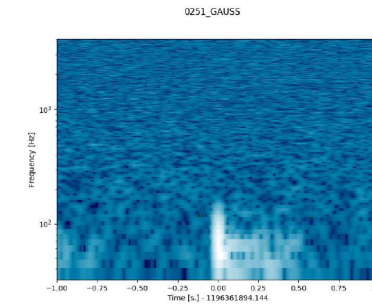
Several challenges, feasibility under study:

- Handling large masses (100kg-150kg for BS)
- Handling and integrating the payloads into present modified VACUUM system
- Folded VS marginally stable Recycling FP
- Design of very large baffles

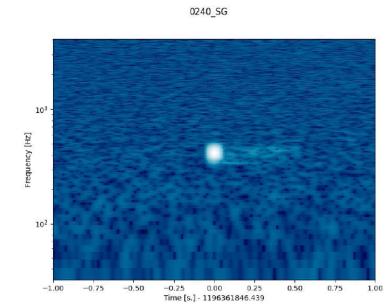


Ongoing projects – detector characterization

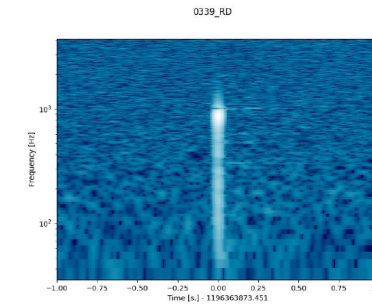
- Deep learning based pipeline implemented
- Tested on simulations
 - Details in Razzano & Cuoco, 218, CQG, 35, 9
- Now moving to Virgo data, in progress



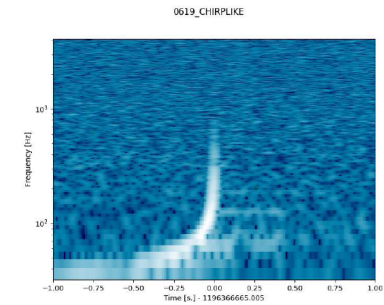
(a)



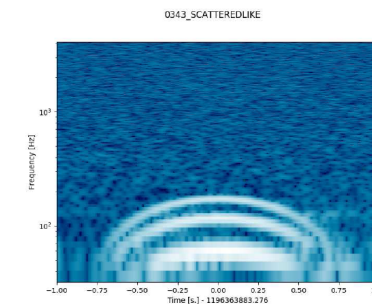
(b)



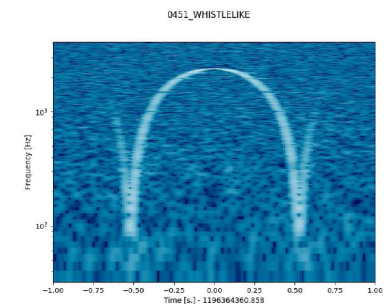
(c)



(d)



(e)



(f)

US

G. Intini, 1 secondment new algorithm to observe the presence of non-GR polarization is crucial for testing the Einstein equations for General Relativity

5-vectors with non-GR polarizations

Non GR polarization: introduction

2

The GR has
4 more
relations

 $h_{\mu\nu}$

16 Components

-6 Symmetry

-4 Reference frame

6 Different Polarizations

 h_{ij}

SPIN

$$3 \otimes 3 = 5 \oplus 3 \oplus 1$$

SPIN

Part of the matrix

Mode group

0

Trace

Scalar

1

Antisymmetric

Vectorial

2

Symmetric Traceless

Tensorial

Symmetric Matrix

From March 25 to April 24 2018

Difference with respect to Max Isi (2015, PRD 91)

5

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{pmatrix} \text{ Breathing: } e_b = 2e_t + \frac{2}{3}e_d$$

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix} \text{ Longitudinal: } e_l = e_t - \frac{2}{3}e_d$$

• In the (b,l) base:

- there are no undetectable polarizations
- b and l are degenerate and undistinguishable (same antenna pattern)
- we are mixing different spin particle

• In the (d,t) base:

- there are no degenerate polarizations
- t is undetectable in Virgo/LIGO but may be detectable in other interferometers

From March 25 to April 24 2018

ON GOING

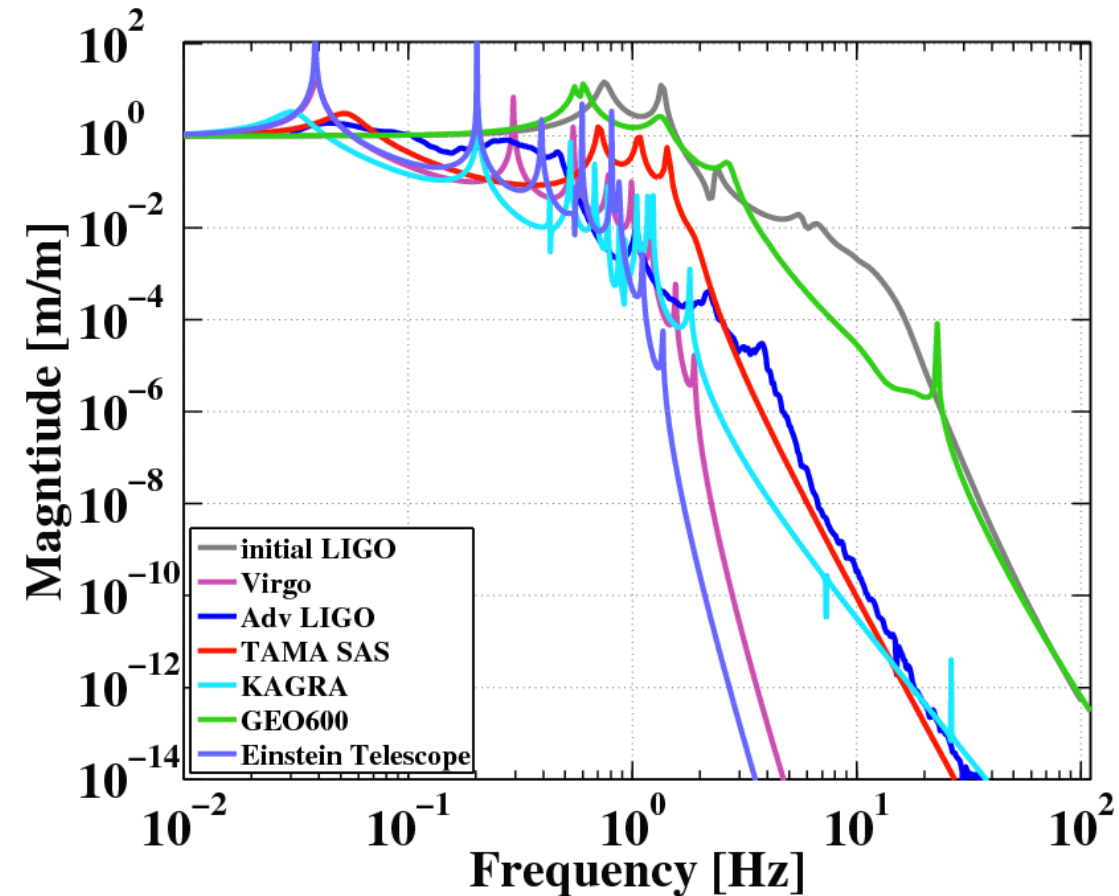
JAPAN

E. Majorana, 1 secondment from June 27^o 2018 :

- 4^o International KAGRA Workshop
- Seismic Suspension performance tests for KAGRA
- Payload works
- 3^o Generation detector roadmap

US

M. Razzano, 1 secondment from July 2018



Ongoing projects – Open Data portal

- Working with LIGO colleagues to new portal for GW open data
- New version of existing LOSC
- Close collaboration with Caltech researchers
- Hope to launch soon



The screenshot shows the LIGO Open Science Center website. At the top is a blue header with the LIGO logo and the text "LIGO Open Science Center". Below the header, on the left, is a vertical navigation menu with links: "Getting Started", "Data", "Events", "Bulk Data", "Tutorials", "Software", "Detector Status", "Timelines", "My Sources", "GPS -- UTC", "About the detectors", "Projects", and "Acknowledge LOSC". To the right of the menu are three aerial photographs of gravitational-wave observatories: LIGO Hanford Observatory, Washington; LIGO Livingston Observatory, Louisiana; and the Virgo detector in Italy. Below these images is a blue banner with the text: "The LIGO Open Science Center provides data from gravitational-wave observatories, along with access to tutorials and software tools." At the bottom of the page are four green icons with corresponding text: a waveform icon for "Download O1 data release", a power button icon for "Get started!", a circular arrow icon for "See LIGO and Virgo discoveries", and an envelope icon for "Join the email list".

LIGO LIGO Open Science Center
LIGO is operated by California Institute of Technology and Massachusetts Institute of Technology and supported by the U.S. National Science Foundation.

Getting Started
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LIGO Hanford Observatory, Washington
(image: C. Gray)

LIGO Livingston Observatory, Louisiana
(image: J. Giaime)

Virgo detector, Italy
(image: Virgo Collaboration)

The LIGO Open Science Center provides data from gravitational-wave observatories, along with access to tutorials and software tools.

 **Download O1 data release**

 **Get started!**

 **See LIGO and Virgo discoveries**

 **Join the email list**

Conclusions

- GW astronomy has begun
- Dawn of multimessenger observations
- Activities toward next run (O₃)
- Main topics
 - Detector characterization
 - Open data portal
 - Other?
- Secondments started, will continue during this year