

LIMMA2019, KIW5 and KAGRA-Virgo-3G Workshop Report

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LIMMA2019



Overview

- Conference on Multi-messenger Astronomy in the Era of LIGO-India
- The first opportunity to have science, EM and instrument people altogether
- I could attend only on Jan 17, while the conference was Jan 15-18
- Slides available at http://www.gw.iucaa.in/limma2019_slides/



The Venue and LIGO-India



RRCAT

Raja Ramana Centre for Advanced Technology

インド

IPR

Institute for Plasma Research

Aundha, Hingoli site

The Dukes Retreat

3 hour from Mumbai airport by car



IUCAA

Inter-University Centre for
Astronomy and Astrophysics

Google My Maps

ラッカディブ海

スリランカ

コロンボ
Colombo

LIGO-India Status

- Land acquisition completed
- DCSEM (infrastructure)
showed the movie of rendering images of the site for the first time
- IPR (vacuum)
prototyping of BSC and HAM chambers
- RRCAT (interferometer, mirror fabrication, DAQ)
plan to build
10 m prototype
- IUCAA (mainly
theoretical;
three people from
experiment)

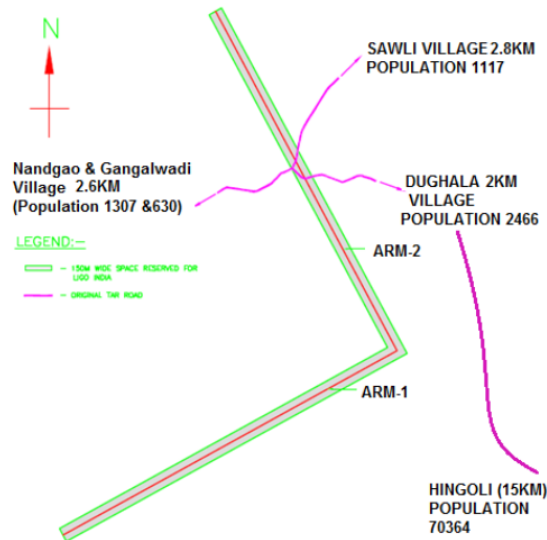


Figure 18 Existing road network

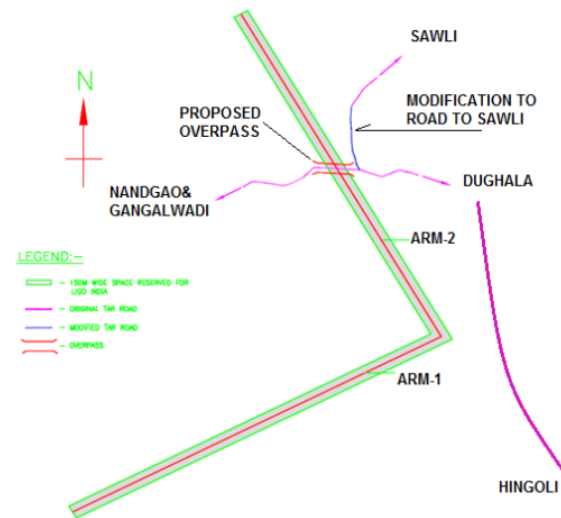
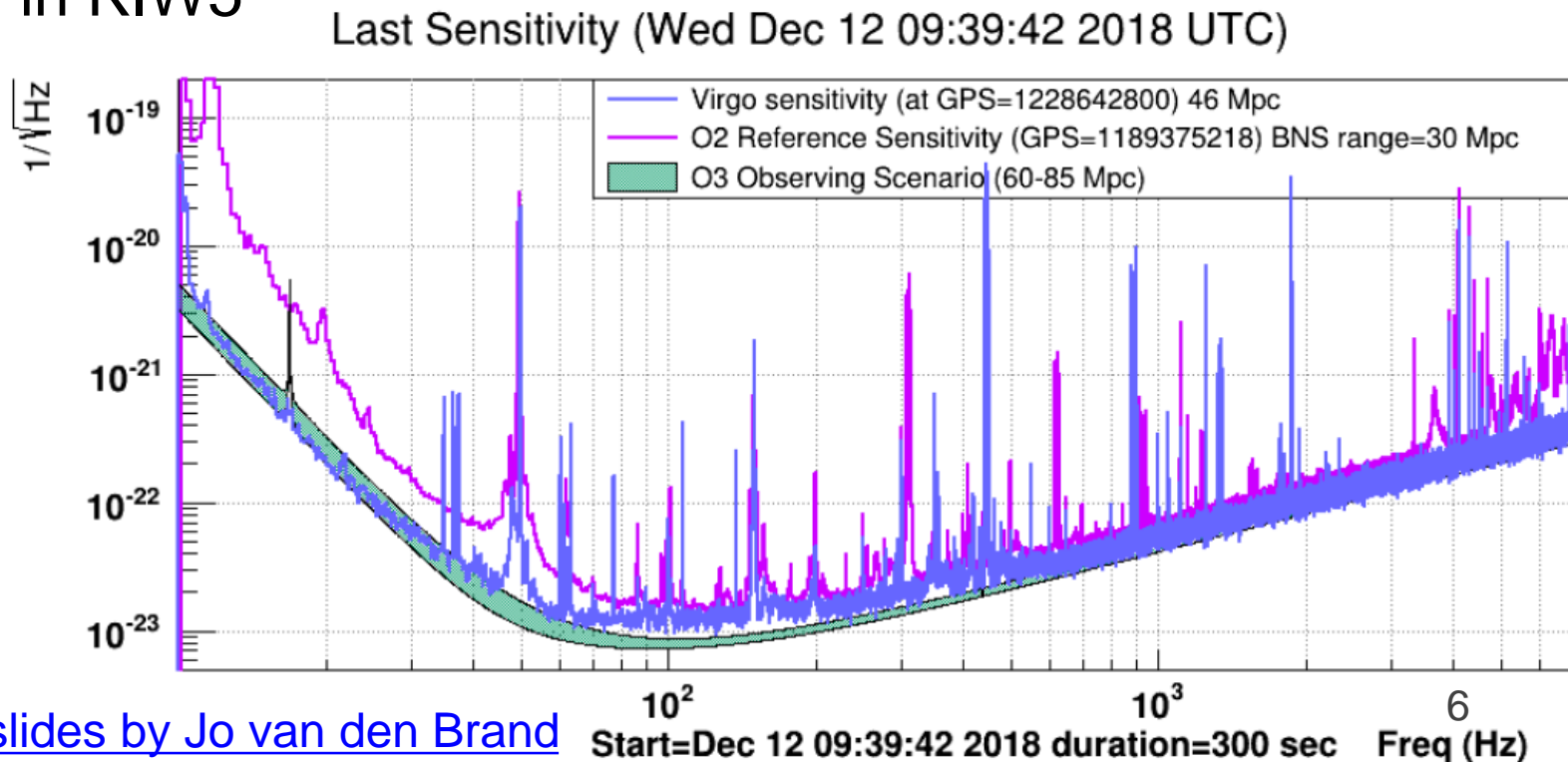


Figure 19 Proposed modification to road network

Virgo Status

- Low frequency sensitivity now compliant to O3 goal (It was so before power up in June 2018. After the power up, low frequency noise increased. It was due to electrostatic noise.)
- Signal recycling after O3
- More in KIW5



KAGRA Status

- Reported recent installation progress, Xarm commissioning results and upgrade plans
- Questions
 - Less high power issues due to cryogenic?
 - When do you decide KAGRA+ plan?
 - How to generate RF AM?
- Comment from Rana
 - Requirement of $<100\text{ppm}$ for arm cavity round-trip loss sounds fake. It should be less than 50ppm .
 - ITM reflectivity of 0.44% looks very different from the designed value (0.4%)

Summary

- LIGO-India is exciting
- It was very nice to meet 40-m friends again (Sendhil, Suresh, Manasa)
- Also very nice to meet Tarun Souradeep (PSO for CMBR analysis)
- Rana revealing the sensitivity evolution of GW detectors →
- There was also a talk by Rai Weiss ([slide](#))



KIW5 and KAGRA-Virgo-3G



Overview

- The 5th KAGRA International Workshop
The first KIW in Europe
- The 1st KAGRA-Virgo-3G Detectors Workshop
- Slides available at <https://indico.ego-gw.it/event/12/timetable/>



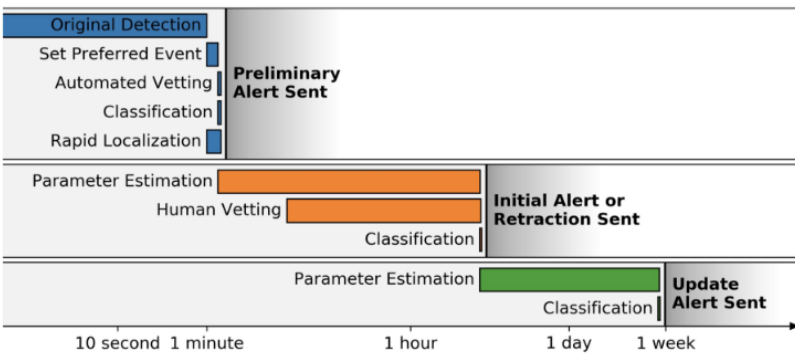
Sala dei Notali (公証人の間)



LIGO Status (Laura Cadonati)

- Livingston upto 135 Mpc with -3dB squeezing
50 W input (275 kW in arm)
- Hanford upto 90 Mpc
30 W input (143 kW in arm), observed 0.9dB squeezing
- Open public alert for O3 (no vetting for Preliminary Alert)

Figures from [slides by Laura Cadonati](#)



Main upgrades since O2

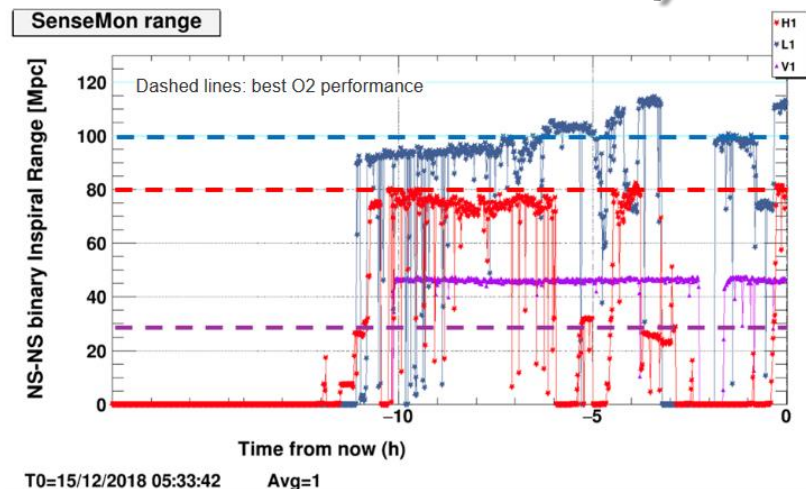
- Replaced H1's ITMX
- Replaced all End Test Masses
- Installed Tuned-mass Dampers, no Parametric Instability
- Monolithic Signal Recycling Mirrors
- Stray Light Control improvements
- Squeezed Light injection
- 70 W laser amplifier stage

Target contamination of public alerts

- Contamination ~10% of public alerts across all categories together
- BNS, NSBH & other transients may individually have higher contamination

Virgo Status (Jo van den Brand)

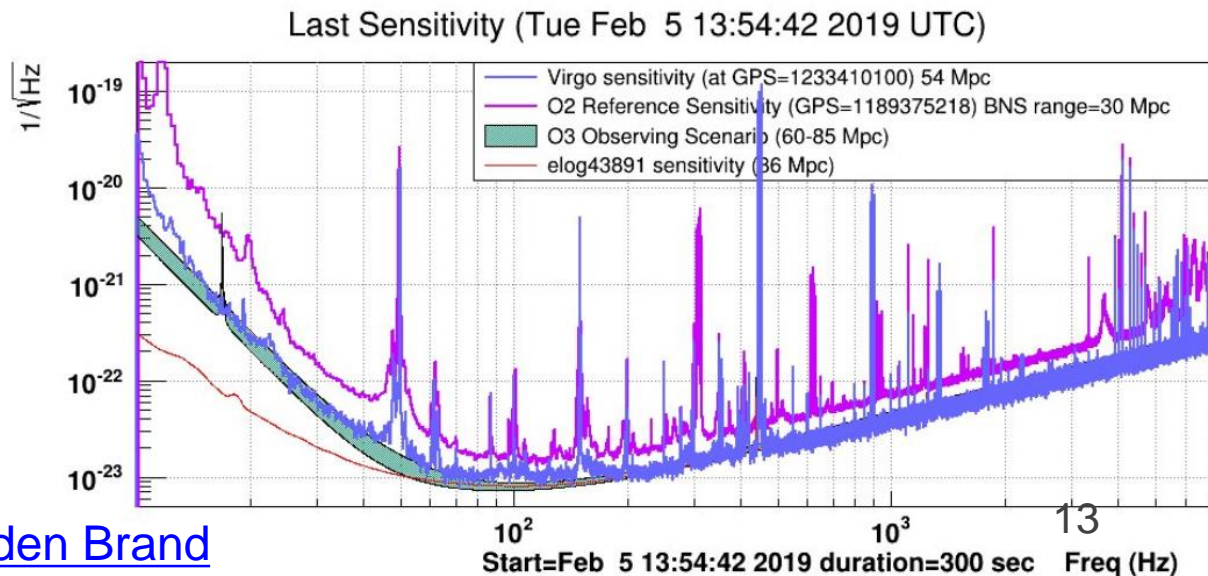
- 54 Mpc (aims at >60 Mpc)
- ER13 completed with 18W input (science mode 65%)
- ER14 planned Mar 4 – Mar 31
- O3 planned from Apr 1



Virgo sensitivity: significant improvement wrt O2

Comparison to the best sensitivity obtained in O2. Monolithic suspensions are now installed
Flat noise contribution in mid-frequency range, and significant 50 Hz noise

- Squeezing implemented



Virgo Status (Jo van den Brand)

- AdV+ Phase 1: installation in 2020 (after O3)
 - Power increase for 125W input (part of AdV)
 - Tuned signal recycling: 120 Mpc
 - Frequency dependent squeezing: 150 Mpc
 - Newtonian noise cancellation: 160 Mpc
- AdV+ Phase 2
 - Larger mirrors, coating research

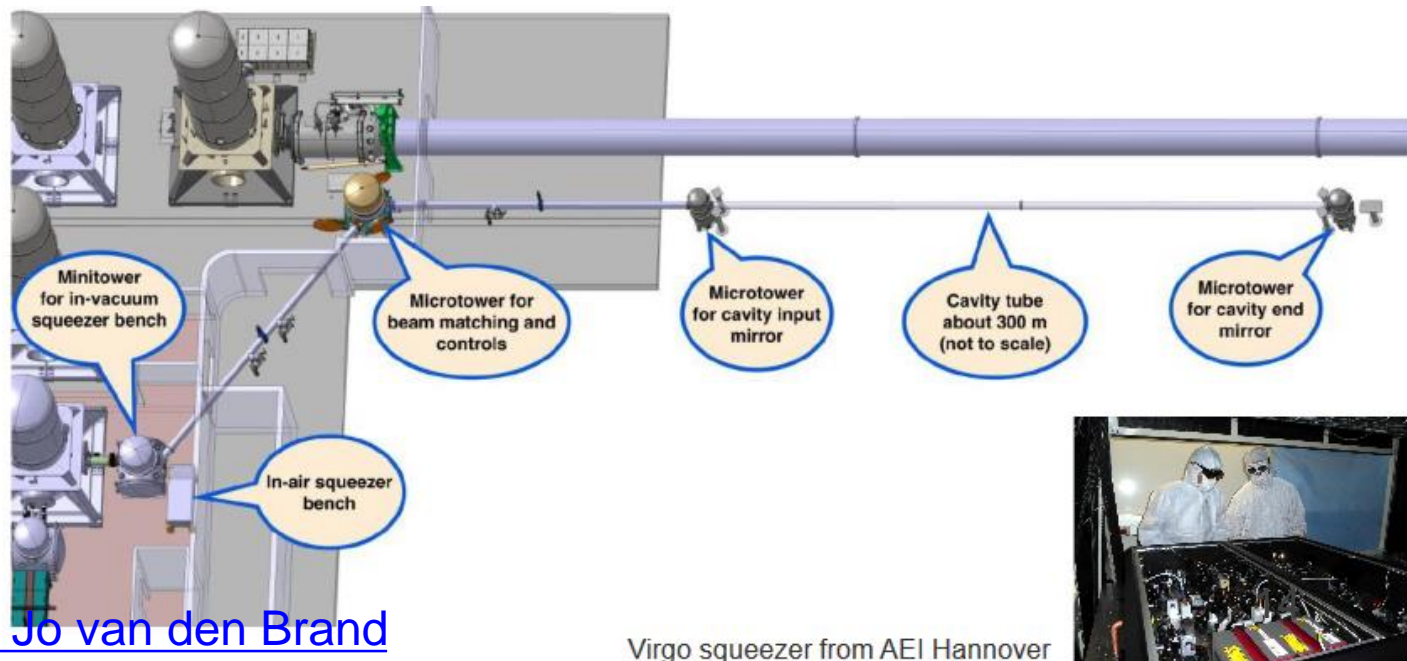
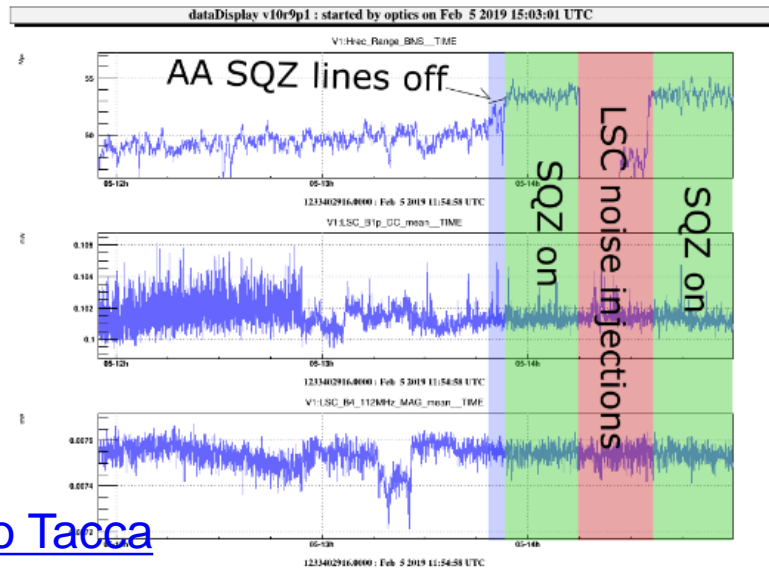
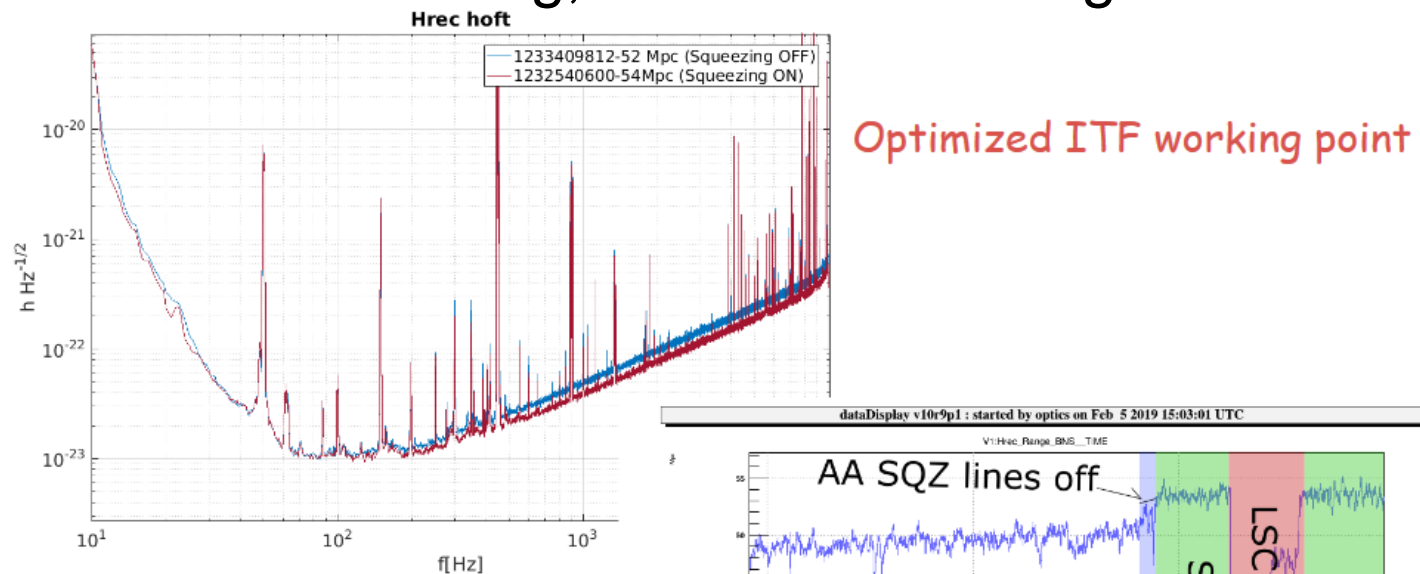


Figure from [slides by Jo van den Brand](#)

Virgo squeezer from AEI Hannover

AdV Squeezing (Matteo Tacca)

- -3 dB
- Matteo said it was amazingly straightforward
- Phase locking, fast automatic alignment etc. for next step



Clear improvement in
sensitivity and in BNS range

Figures from [slides by Matteo Tacca](#)

KAGRA+ (Sadakazu Haino)

- Reported a summary on past KAGRA upgrade studies and suggested a possibility of using speedmeter
- How about squeezing and thinner fiber to improve low frequency sensitivity? (Michele)
- How about thinner ITM for lower absorption? (Geppo)

ET Status (Michele Punturo)

- ET project roadmap defined
- ET proto collaboration (letter of intent)
720 scientists as of Feb 12
<http://www.et-gw.eu/index.php/letter-of-intent>

ET: project roadmap



- ET has a clearly defined project roadmap:
 - 2018-2019 Form the ET collaboration
 - 2019-2020 ESFRI roadmap
 - We need to define the site selection parameters before to submit the proposal
 - The requirement to be compliant with alternative design options (Δ vs L) could be a crucial point
 - 2022 Site Selection
 - Technical/political activity
 - Requirements need to be compared with the site characteristics through an intense experimental activity in the next 3 years
 - 2023 Full Technical Design Report
 - Cost definition
 - 2025 Infrastructure realization start (excavation,)
 - 2030 -2031 end of infrastructure construction, beginning of installation
 - 2032+: installation / commissioning / operation

ET Status (Michele Punturo)

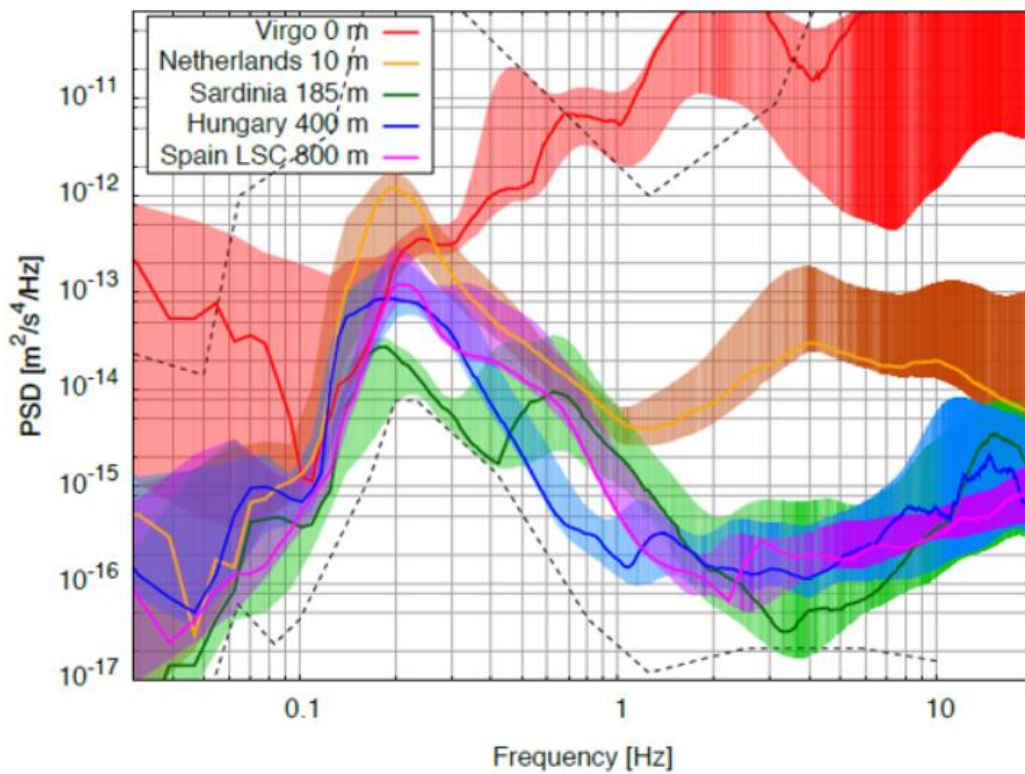
- 2 candidates
 - Belgium-Germany-Netherlands (more budget?)
 - Sardinia (less seismic)

Figure from [slides by Michele Punturo](#)

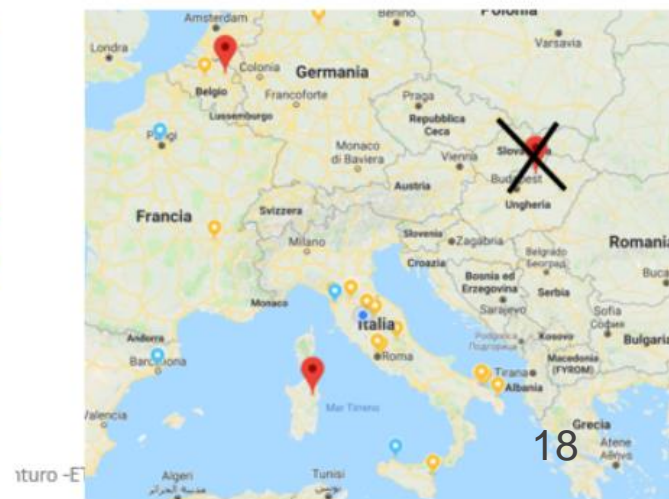
ET site: ~~23~~ candidates



Horizontal spectral motion at various sites



- What are the technical selection parameters?
- How the sites match these parameters?
 - Complete the site qualification



ETpathfinder (Stefan Hild)

- at Maastricht, Netherlands
- Cavity length 9.34 m, silicon, 10K/120K and 1.55 μ m/2 μ m

Footprint – Phase 1



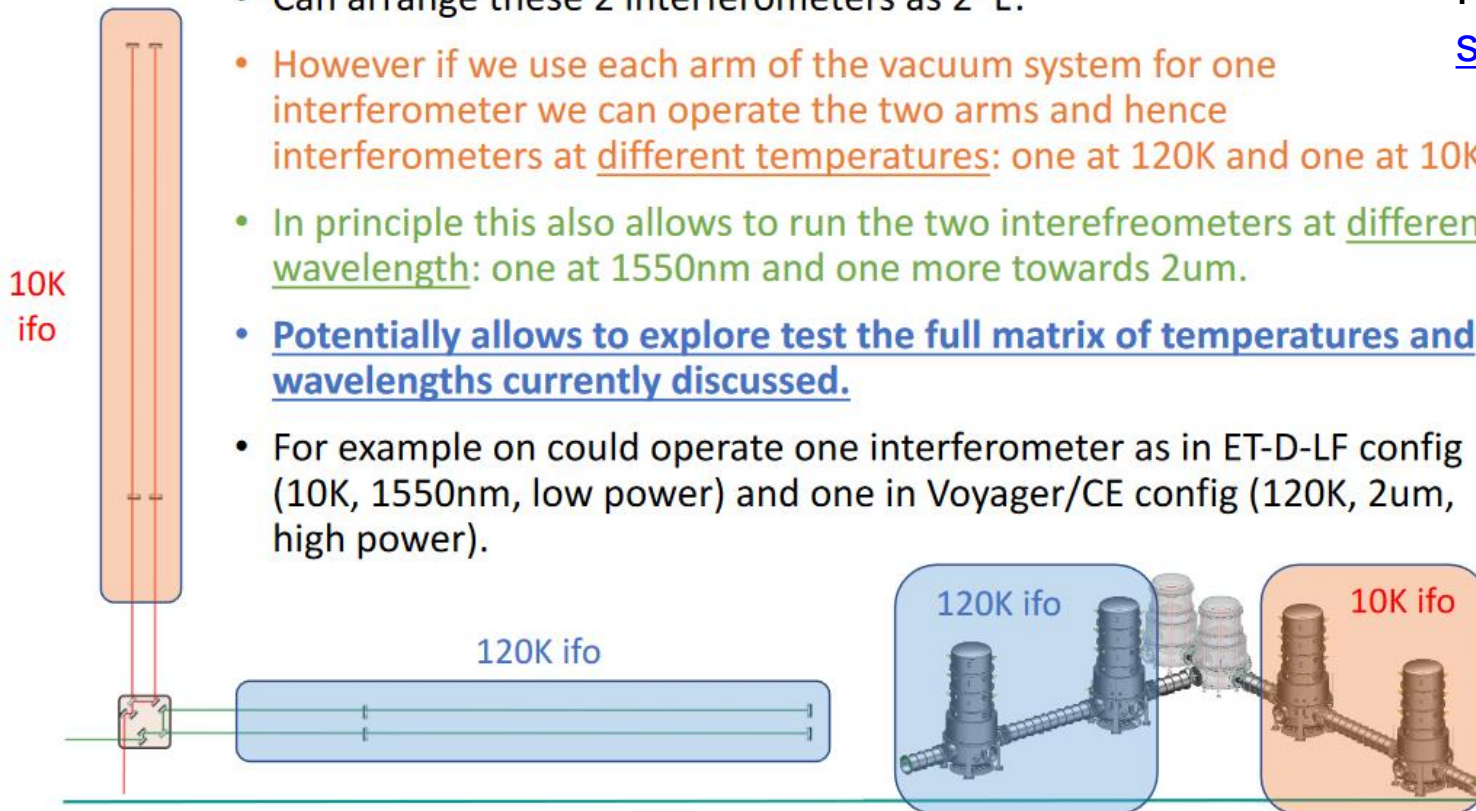
- Can arrange these 2 interferometers as 2 'L'.
- However if we use each arm of the vacuum system for one interferometer we can operate the two arms and hence interferometers at different temperatures: one at 120K and one at 10K.
- In principle this also allows to run the two interferometers at different wavelengths: one at 1550nm and one more towards 2 μ m.
- Potentially allows to explore test the full matrix of temperatures and wavelengths currently discussed.
- For example one could operate one interferometer as in ET-D-LF config (10K, 1550nm, low power) and one in Voyager/CE config (120K, 2 μ m, high power).

Figure from
[slides by Stefan Hild](#)

Silicon upto
100kg

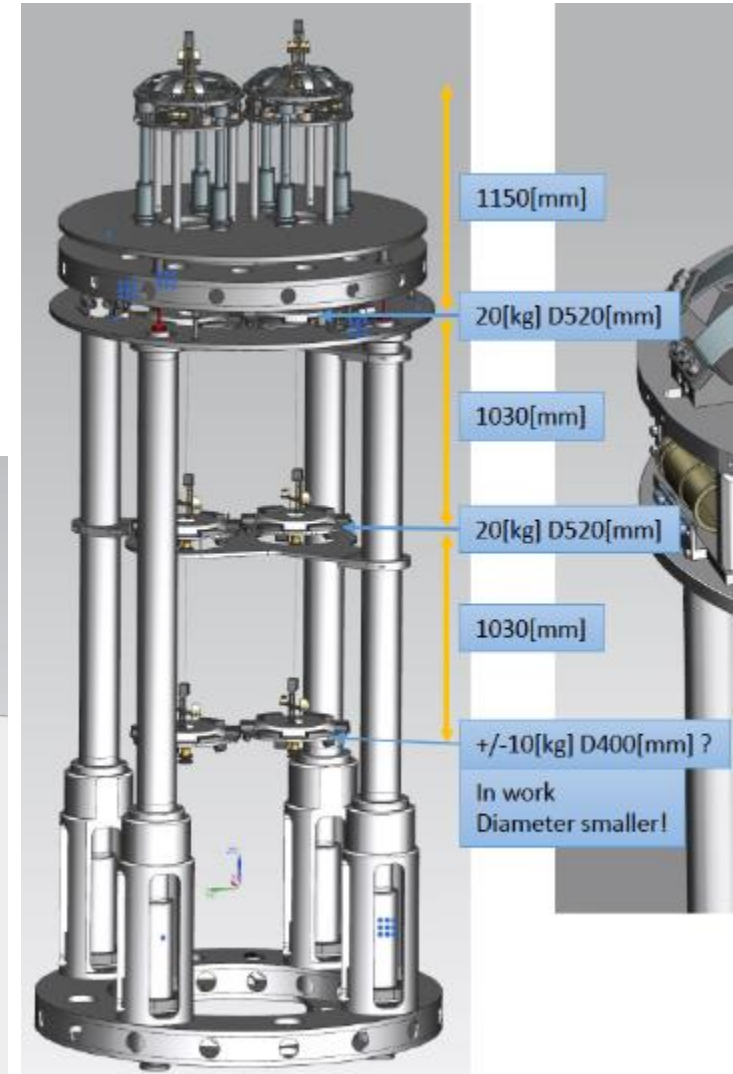
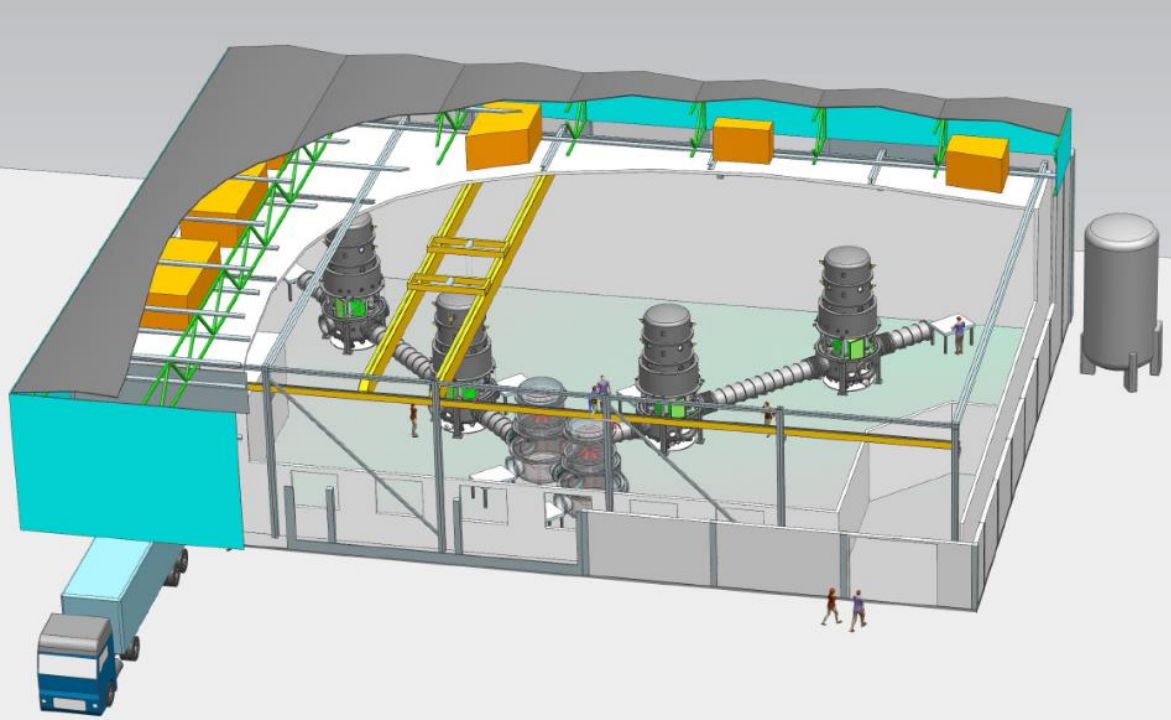
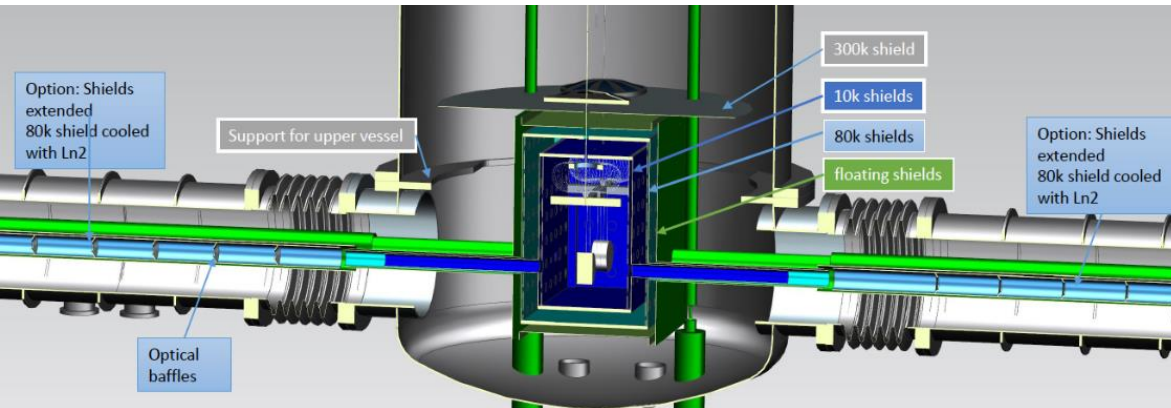
No speedometer
nor sapphire for
now, but could
be if reasonable.

Sounded very
promising and
interesting.



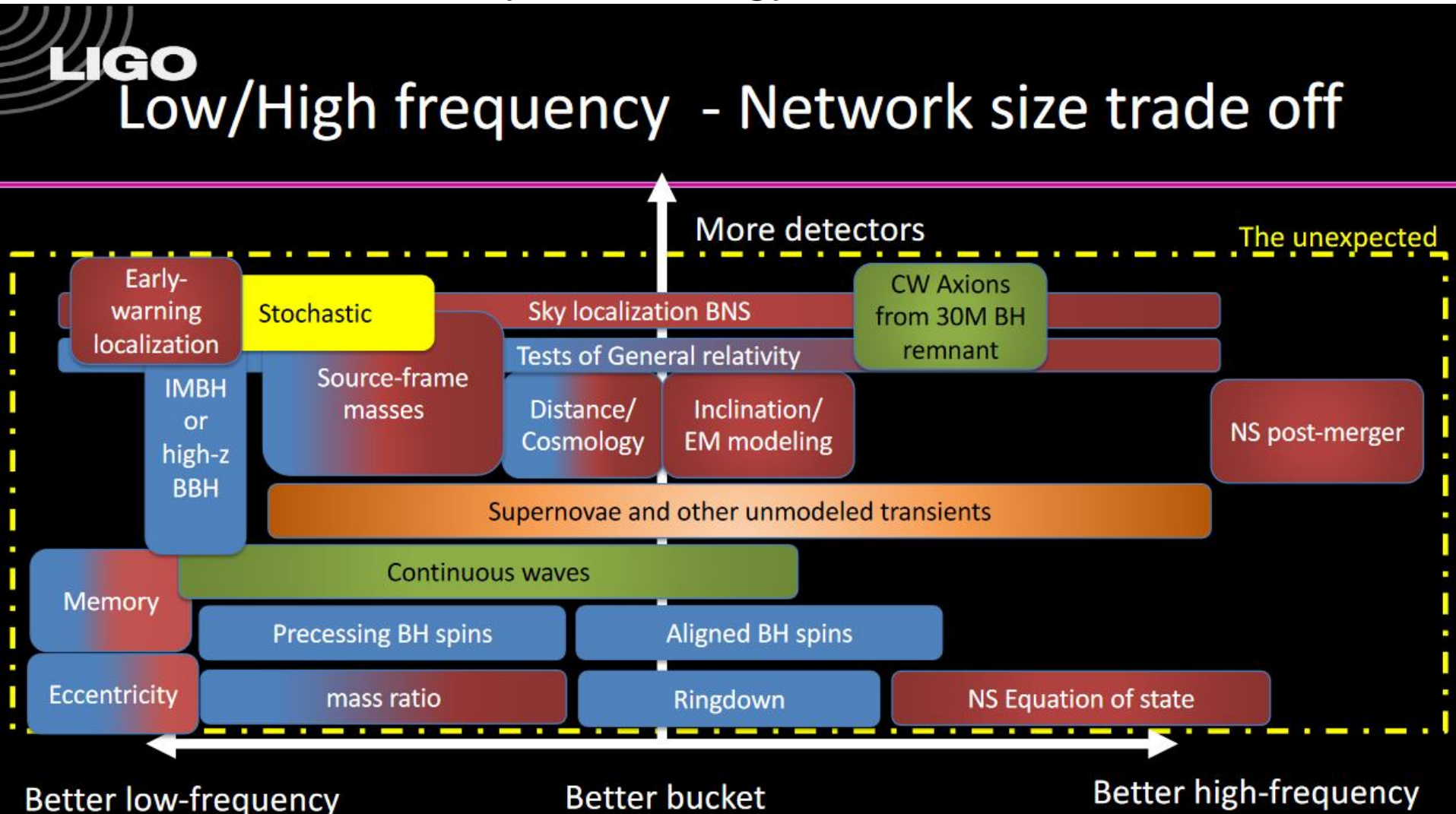
ETpathfinder (Stefan Hild)

- 14.5 MEuro



3G Science Case (Salvatore Vitale)

- NS EOS, Memory, Cosmology, BH formation etc.



3G Science Case (Salvatore Vitale)

- Question: Strong message is necessary to get a budget.
What is the most important target for 3G?
-> NS EOS

The LIGO logo, featuring the word "LIGO" in a bold, sans-serif font, with a stylized graphic of concentric arcs to the left.

Conclusions

- Advanced detectors will explore the local universe ($z \sim 1$)
- A new generation is required to detect sources everywhere in the universe
 - Characterization of BH masses and spins, formation channels, evolution,...
 - Thousands of neutron stars, EOS, cosmology,...
 - Precise tests of general relativity
 - Access to sources throughout cosmic history

Coating etc. (Gianpietro Cagnoli)

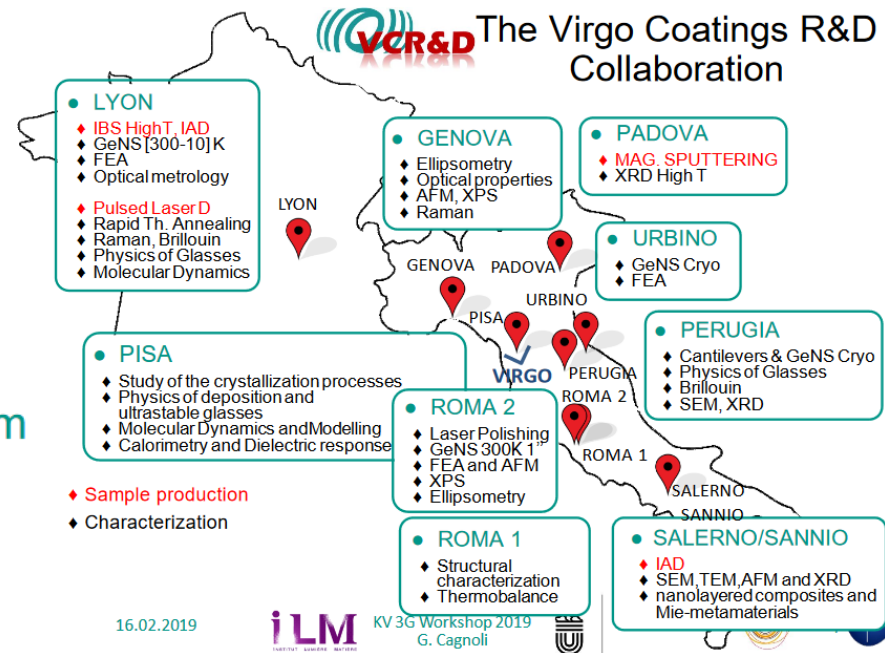
- VCR&D for coating research
- Suggested:

A possibility for a KAGRA upgrade?

- Si₃N₄ as high index material
- SiO₂/Al₂O₃ nanolayers for the low index film

Further tests are waited

- OSAG project submitted (1.2 MEuro) to produce 450 mm dia. 200 mm thick sapphire with 10 ppm/cm absorption



The project **OSAG**

- Gravitational Astronomy Sapphire Optics
- Project **submitted** to a University funding scheme (IDEXLYON): 1.2 M€
- Partners: **g-MAG** at **iLM** and **UMA** at **ipnl**
- Objectives
 - ♦ Ø450 mm, 200 mm thickness
 - ♦ 10 ppm/cm absorption
 - ♦ 50% success rate of bubble-free ingots production

CryoMirror (Giacomo Ciani)

- Proposal for CryoMirror project to reduce cooling time (something like heat switch)
- Comment from Tomaru-san and Yamada-kun.
 - It takes time to cool down the radiation shield

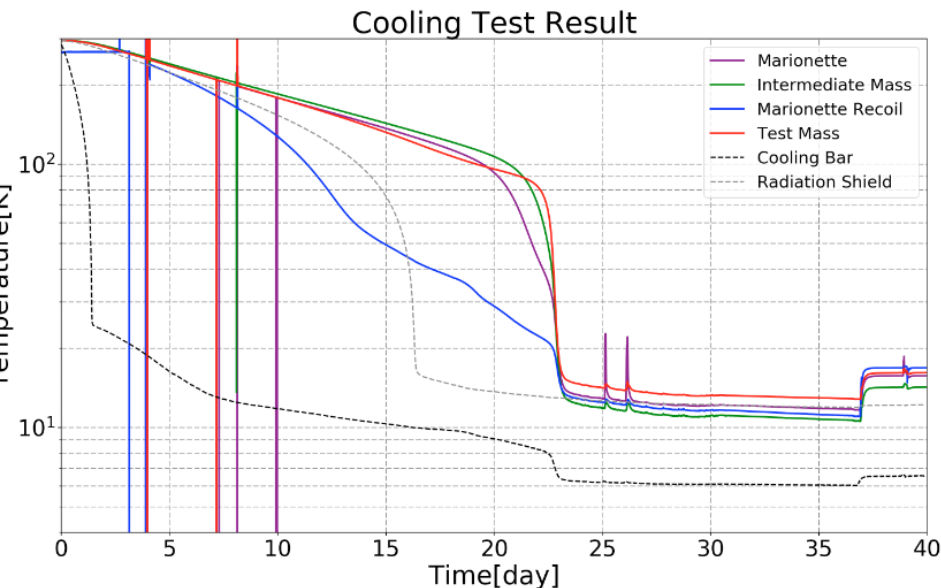


図 7.2 極低温鏡懸架システム冷却試験結果

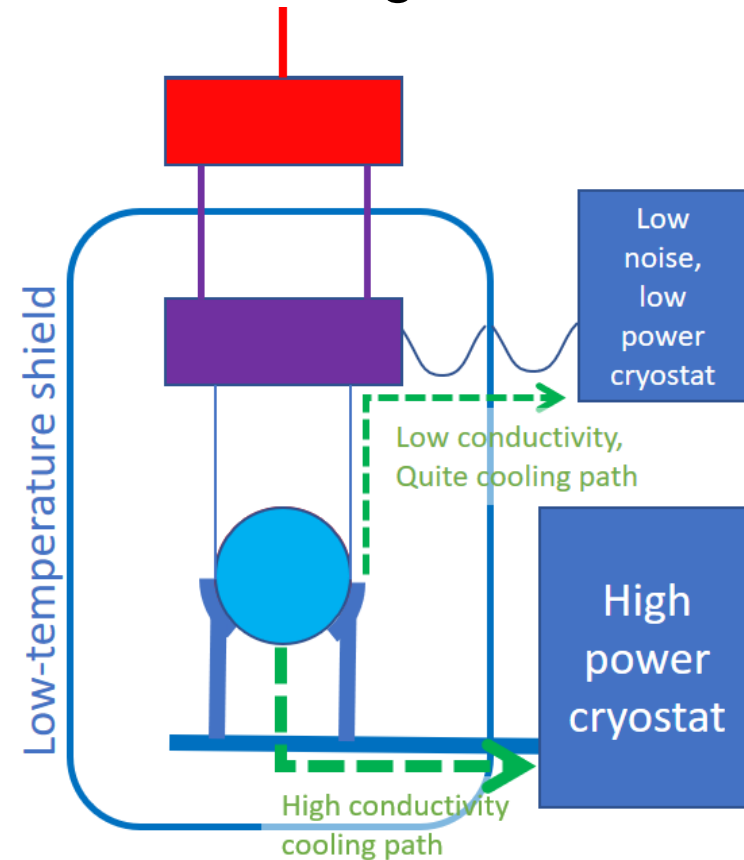
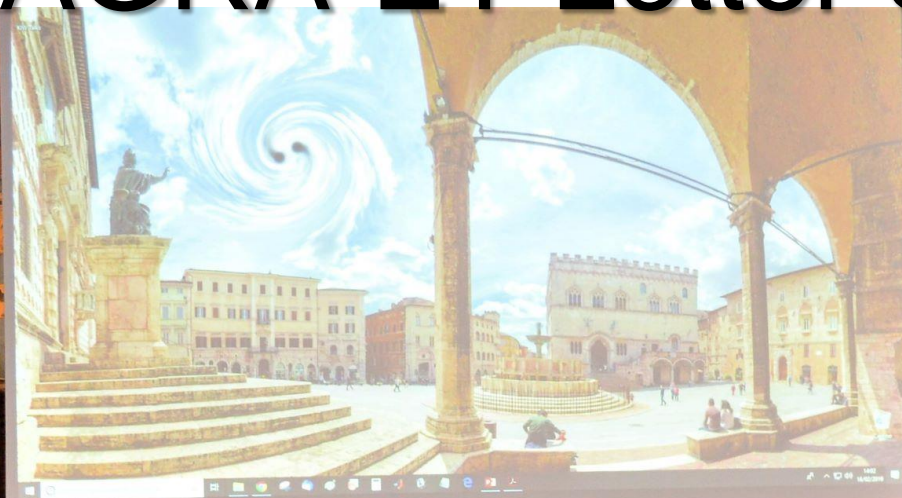


Figure from [slides by Giacomo Ciani](#)

KAGRA-ET Letter of Intent



Summary and Others

- Very nice opportunity to talk with Virgo and ET people
- Rare chance to have a workshop in historic place
- ET is becoming more realistic
- Also got information on beam shutters around OMC, suspension protection, in-vac RF PD and QPD
- SDB1 suspended platform follows ETM for scattered light noise reduction

