Q&A Session
Second generation experience

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European Gravitational Observatory (Consortium, CNRS & INFN)

GWADW2021 – May 18, 2021
https://agenda.infn.it/event/26121/overview

Day 2 Plenary Sessions

16:00 → 17:00 **Plenary Day 2: Q&A Second generation: experience and beyond**

16:00 **Second generation experience**

Q&A session

Speaker: NICOLAS ARNAUD (LAL ORSAY CNRS-IN2P3)

30 minutes Q&A Session (1/4)

16:30 **Beyond second generation**

Q&A session

Speaker: Viviana Fafone (ROMA2)

17:00 → 18:00 **Plenary Day 2: Q&A Third generation infrastructures and R&D facilities and plans**

17:00 **R&D facilities and plans**

Q&A session

Speaker: Stefan Hild (Maastricht University)

17:30 **Third generation infrastructures**

Q&A session

Speaker: Enrico Calloni (NA)

4 Pre-recorded Talks

10:00 → 11:20 **Recorded talks: Experience From Current Detectors: Current Detectors Talk Index**

Président de session: NICOLAS ARNAUD (LAL ORSAY CNRS-IN2P3)

10:00 **Scattering light modelling and subtraction** 20m

Advanced Virgo end benches were a significant source of scattered light noise during the third observing run. We describe how that noise could be subtracted using auxiliary channels during the online strain data reconstruction. We model in detail the scattered light noise coupling and demonstrate that further noise subtraction can be achieved. We also show that the fitted model parameters can be used to optically characterized the interferometer and in particular provide a novel way of establishing an absolute calibration of the detector strain data.

Orateur: Michal Was (LAPP/CNRS)

GWADW2021_scatt... Recorded talk

10:20 **Status of KAGRA mirrors** 20m

The Japanese gravitational wave detector KAGRA is unique since it is the only one, so far, which operates its main mirror at cryogenic temperature in order to reduce their thermal noise. To achieve good performances at such temperature, the chosen material for the mirror bulk is sapphire. After the successful finalization of the construction phase of KAGRA, during the commissioning phase, an unforeseen issue arised.
In this talk I will describe the status of KAGRA core optics and share the research performed so far on optical absorption and birefringence.

Orateur: Dr Matteo Leonardi (NAOJ)

20210517_GWADW... Recorded talk

10:40 **Suspension fibers for large masses of Advanced Virgo Plus and beyond** 20m

The observation of gravitational waves is highly influenced by the detectors sensitivity, that is limited at low frequencies (10 -100 Hz) by the thermal noise. For this reason, the monolithic suspensions are one of the most important upgrades of the interferometric detectors including Advanced Ligo (aLigo) and Advanced Virgo (AdV). The target sensitivity for the new updates of Advanced Virgo Plus (AdV+) passes through larger and heavy reference masses; this choice requires, among other things, a re-design of the silica fibers and a new capability to produce and test them, in order to minimize the thermal noise in the band of interest and to fit the load constraints.
The talk will present the design requirements of the silica fibers for large masses in terms of mechanical stress, thermal noise and resonant frequencies. Upgrades to the fiber manufacturing system and its advantages will be discussed. Moreover measurements of mechanical behavior and the comparison, in terms of thermal noise, with the AdV configuration will be presented.
Finally we will describe a project for the use of the fiber fabrication machine to produce silicon fibers using a silicon core surrounded by a silica cladding: some preliminary results will be shown.

Orateur: Matteo Montani (Istituto Nazionale di Fisica Nucleare)

GWADW2021_mont... Recorded talk

11:00 **Locking of Central Interferometer of Advanced Virgo+** 20m

The target sensitivity of Advanced Virgo for O4 is about 90-120 Mpc for the BNS range. To achieve this, several hardware upgrades are under process. One of the most relevant concerns the installation of the Signal Recycling Mirror. I will describe the procedure followed for locking the Dual Recycled Michelson Interferometer along with the tuning of CO_2 central heating, which assists the lock of DRMI by compensating for the (cold) optical aberrations.

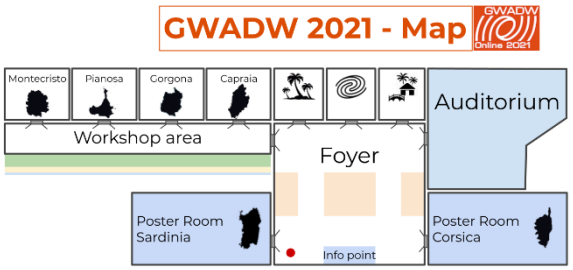
Orateur: Priyanka Giri (Istituto Nazionale di Fisica Nucleare)

GWADW21_GIRI.pdf Recorded talk

4 Posters

THURSDAY, 20 MAY

16:00 → 16:56 **Poster session 2**



16:00 **Actuation time optimization in the Advanced Virgo mirror thermo-elastic correction** 1m

Heating elements surrounding the core optics of Gravitational Wave Interferometer are used to correct the radius of curvature of the high reflectivity surface that can deviate from the nominal value because of manufacturing defects and the non-zero absorption of the laser power in the substrate and in the coatings of the test masses. The typical actuation time of these actuators (usually referred to as ring heaters) requires about 10 hours to reach the steady state; this long transient makes a significant impact on the commissioning time of the interferometer.
In this work a new strategy aiming at the reduction of the actuation time of the ring heaters is exposed together with the experimental results of the tests performed on the TeTis facility in the Virgo laboratory of Rome Tor Vergata.
By applying a time varying voltage on the ring heater, the steady state can be reached in less than an hour.

Speaker: Enrico Porcelli (University of Roma Tor Vergata)

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16:16 **Investigation and mitigation of anomalous power absorptions in the Advanced Virgo Plus core optics** 1m

Advanced gravitational waves detectors revealed until now a significant number of signals from the mergers of compact objects with amplitudes of the order of 10^(-21)-10^(-22). The necessity to increase the detection volume and the number of candidate sources requires an improvement of the sensitivity of the interferometers (ITF). For this purpose, an increase of laser power in the ITF and high stability are required.
During O3 observing run, small, highly absorbing areas on the surfaces of the main interferometer optics of Advanced Virgo have been observed. These anomalous micron-scale absorbers produce distortions as additional thermo-elastic deformation of the high reflectivity mirrors surfaces and thermal lensing in the optics substrate. With the aim to understand and mitigate their effects in the interferometer, a detailed and quantitative study of their characteristics has been carried out. The information about their position and fraction of absorbed power allows to put the basis for the development of an adaptive actuator, able to correct these aberrations in the Advanced Virgo Plus (AdV+) test masses. Here the analysis of AdV+ input mirrors surfaces, point absorbers identification and characterization, the corresponding thermo-elastic deformation and its compensation are presented.

Speaker: Maria Cifaldi (Istituto Nazionale di Fisica Nucleare)

PointAbsorbers_GW...

16:17 **The A+ Low-Loss Faraday Isolators** 1m

Advanced gravitational-wave detectors require low-loss Faraday isolators in the squeezer path, in order to maximize the benefits of the squeezed light injection. The University of Florida and Montclair State University have developed and are currently building two designs of low-loss Faraday isolators for the A+ upgrade, one output Faraday isolator (20 mm clear aperture) and two squeezer Faraday isolators (5 mm aperture). Both designs also serve as circulators. The required losses are <1% single pass, while maintaining an isolation ratio higher than 30 dB.

The designs use TGG as the magneto-optical material placed inside a vacuum-compatible magnet, with temperature tunability of the Verdet constant via a thermo-electric Peltier device. A single quartz rotator cut at 45 deg restores the initial polarization. The input polarizer is a wedged KTP prism while a thin film polarizer at the output allows for the injection of s-polarized light from the squeezer or the optical parametric oscillator. The output Faraday isolator design also includes a fused-silica wedge to compensate for the beam's angular displacement from the signal recycling mirror. All optics are super-polished and coated with high-performance IBS dielectric coatings. The Faraday devices assembled so far show 0.45% - 0.63% single pass loss, with better than 30 dB isolation.

This work was supported by National Science Foundation Awards PHY-1806839, PHY-2012021, CIT 75-S434395, and CIT 75-S434499.

Speaker: Dr Rodica Martin (Montclair State University)

16:22 **Influence of environmental noise on Virgo detector during O3** 1m

Sources of geophysical and anthropogenic noise, such as wind, sea activity, earthquakes, local traffic, etc., can impact gravitational wave interferometers by causing sensitivity drops and lock losses. During the 1-year long O3 observation run, the Virgo Collaboration collected a statistically significant amount of data to study the response of the detector to a variety of environmental conditions. We used this dataset to correlate different environmental parameters to quantities that monitor detector performance, such as its observation range and duty cycle. Where possible, we identified weaknesses in the detector and worked out strategies to implement to improve Virgo robustness against external environmental disturbances for the next observing run O4, planned for summer 2022. The lessons learned could provide useful insights for the design of the next generation of ground-based interferometers.

Speaker: Francesco Di Renzo (P)

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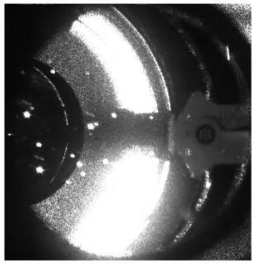
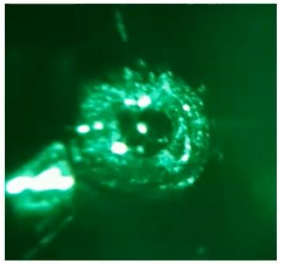
Conclusion


- Scattered light is an inherent problem of interferometric GW detectors
- With good sensors and models scattered light noise can be removed from data in some cases
  - Has been done online during O3, but only for the $\cos \phi_{sc}$ component

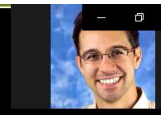
⇒ Any installed photodiodes should have electronic noise below shot noise in the audio band

⇒ Quadrant photodiode can be a dominating source of scattered light

- Controlled scattered light injection is a tool to characterize the interferometer
- A new method to check the GW strain data calibration with potential $< 0.5\%$ precision

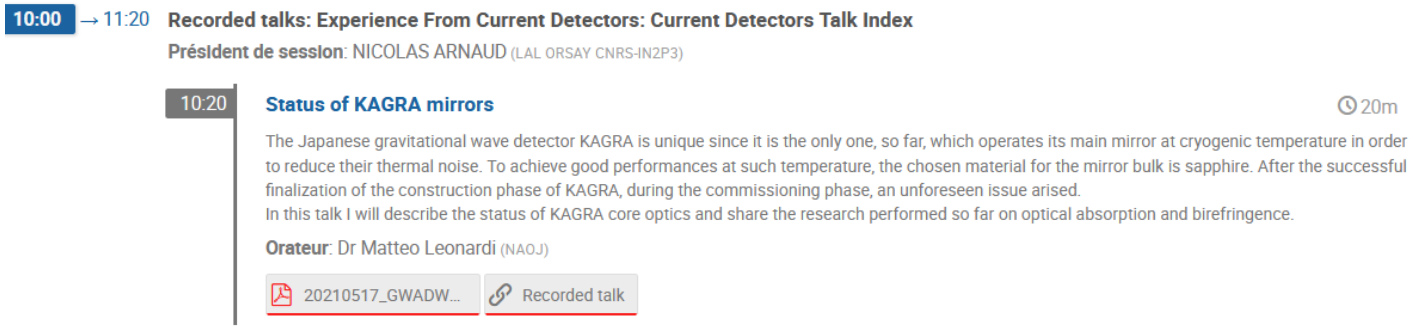
⇒ Requires good metrology of end mirrors transmission before installation
  - aLIGO, aVirgo changing mirrors for O5

https://arxiv.org/abs/2011.03539 – M Wąs et al 2021 Class. Quantum Grav. 38 075020



Michał Wąs (GWADW 2021) LAPP 2021 May 12 / 12

4 Pre-recorded Talks



Summary

1. KAGRA core optics installation terminated in 2018, but some issues were discovered
2. Birefringence effect was underestimated and lead to issues with polishing and PRC/SRC losses
3. Ad-hoc setup were created to investigate birefringence anisotropy and characterize new substrates
4. New collaboration were established to achieve better sapphire quality for new mirrors
   - We plan to install new ITMs before O5

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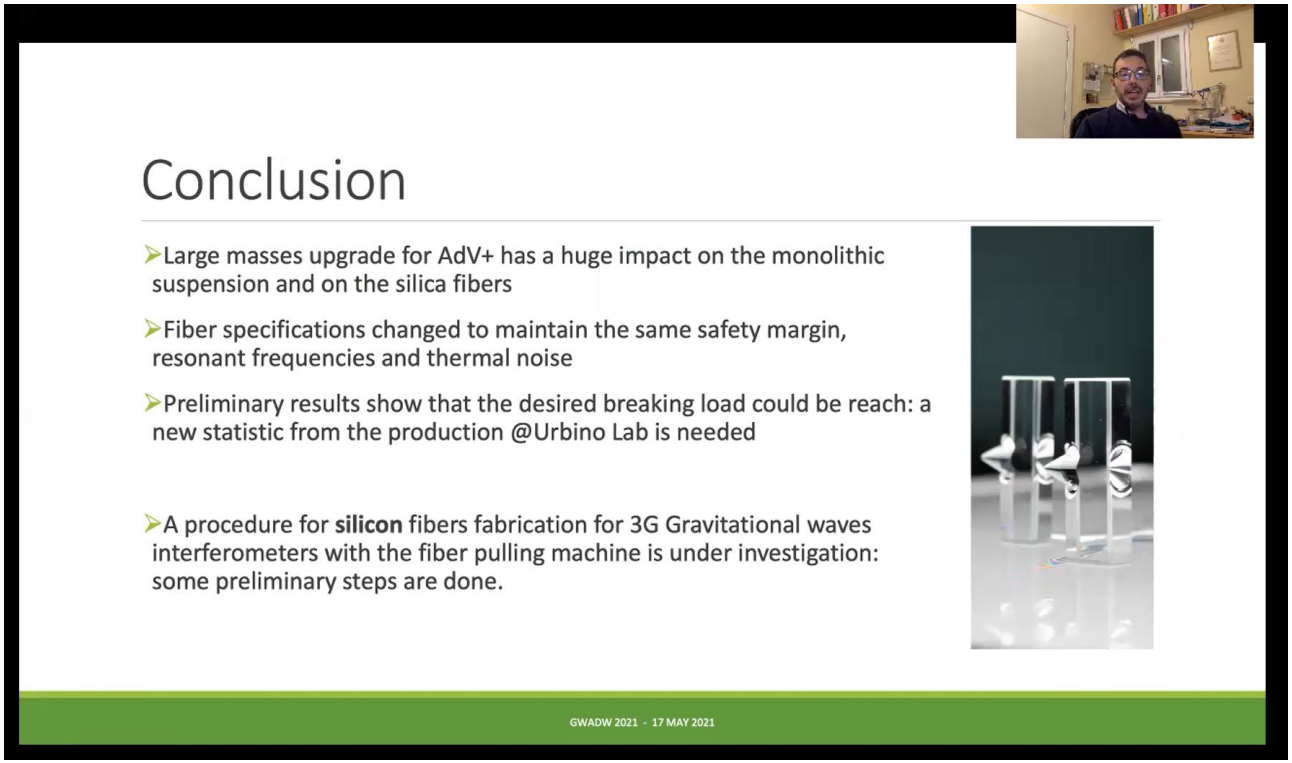

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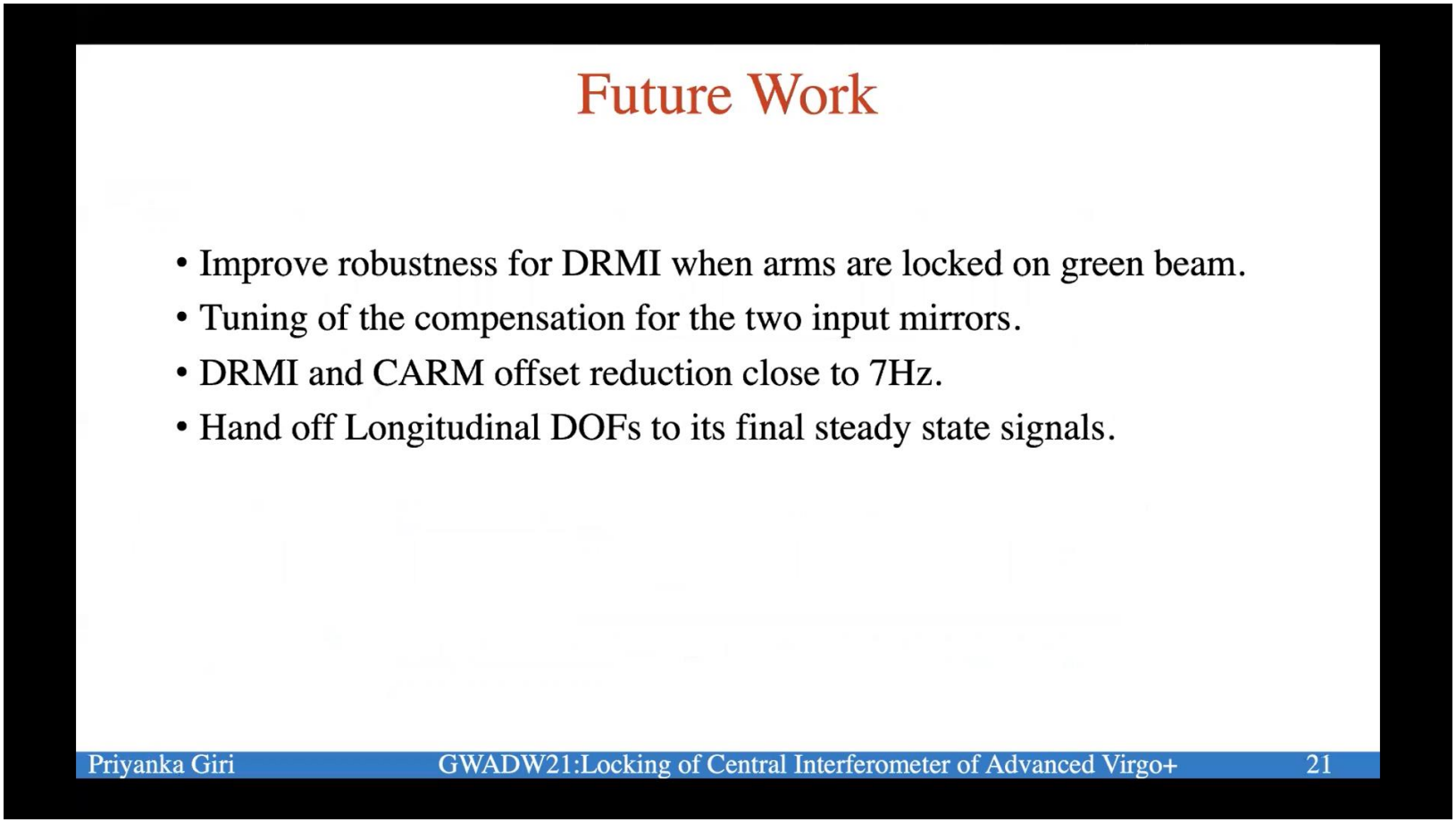
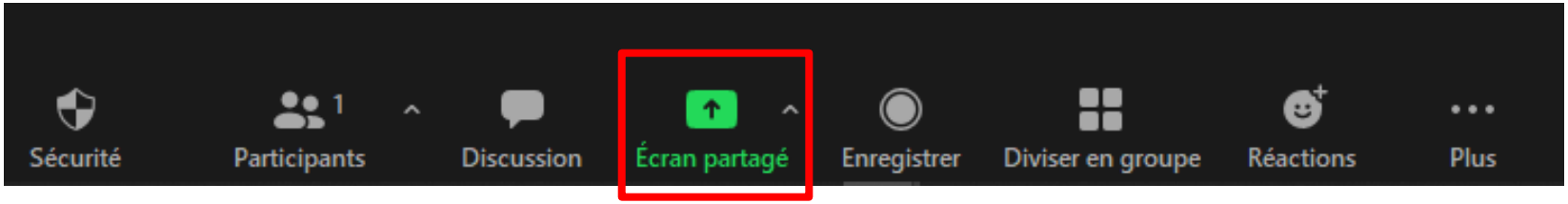
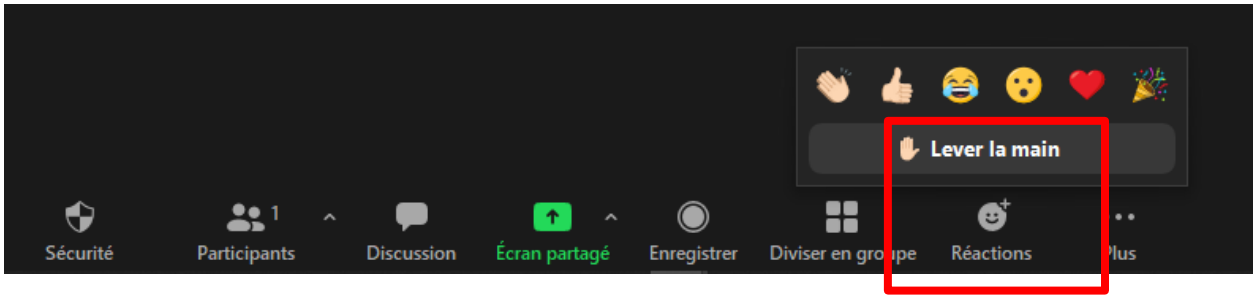


Q&A session

- 5 minutes / talk in a round-robin
  - Speakers welcome to share their screen to use their slides to support their answers



- Audience
  - Raise your hand in Zoom – time ordering
  - Lower it after having asked your question or if question already addressed



- Speakers and audience
  - Time is short: be brief!

- Time left at the end of the session (if any…) will be used to take some of the remaining questions that could not be asked during the talk dedicated Q&A times