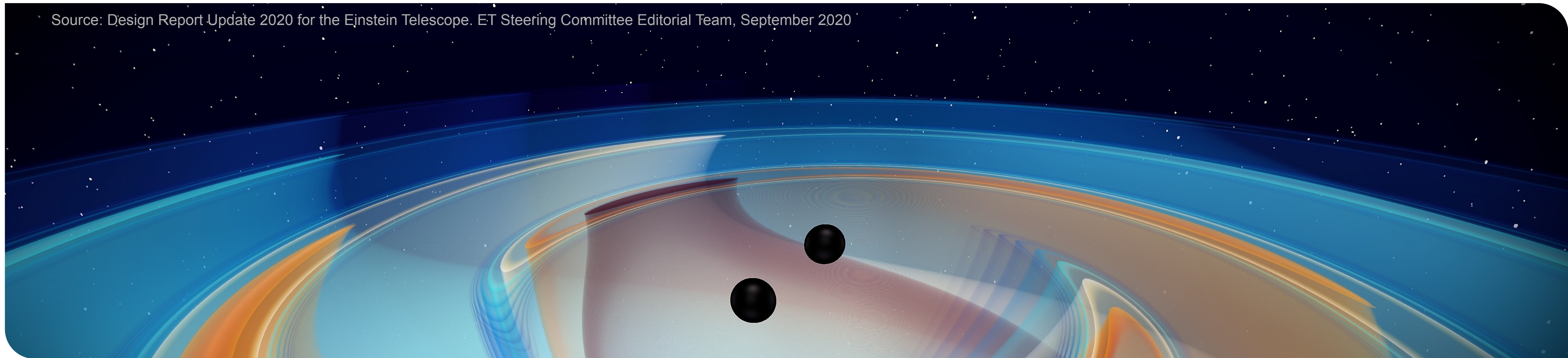


ET Cryogenics – What next

Steffen Grohmann

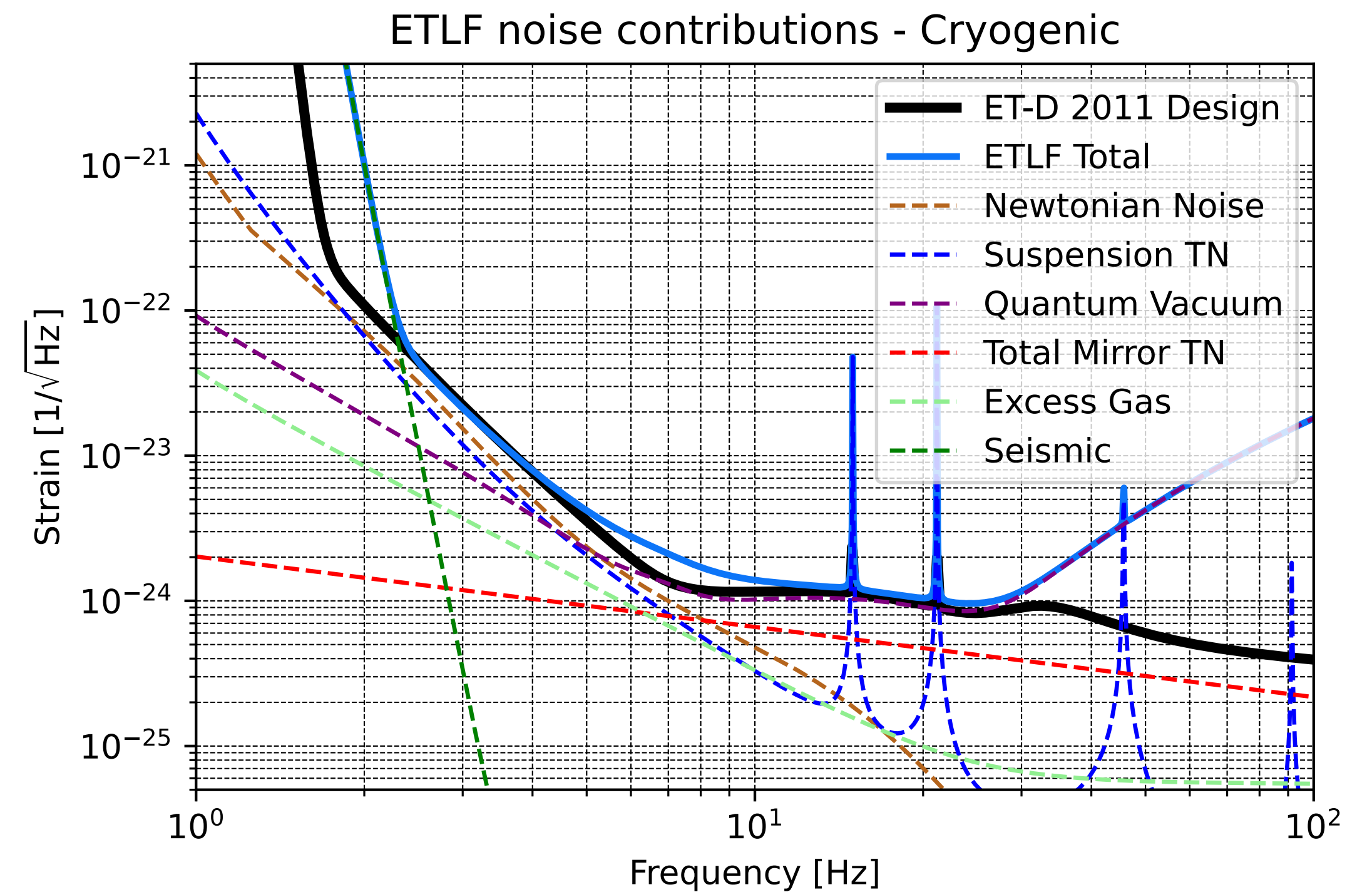
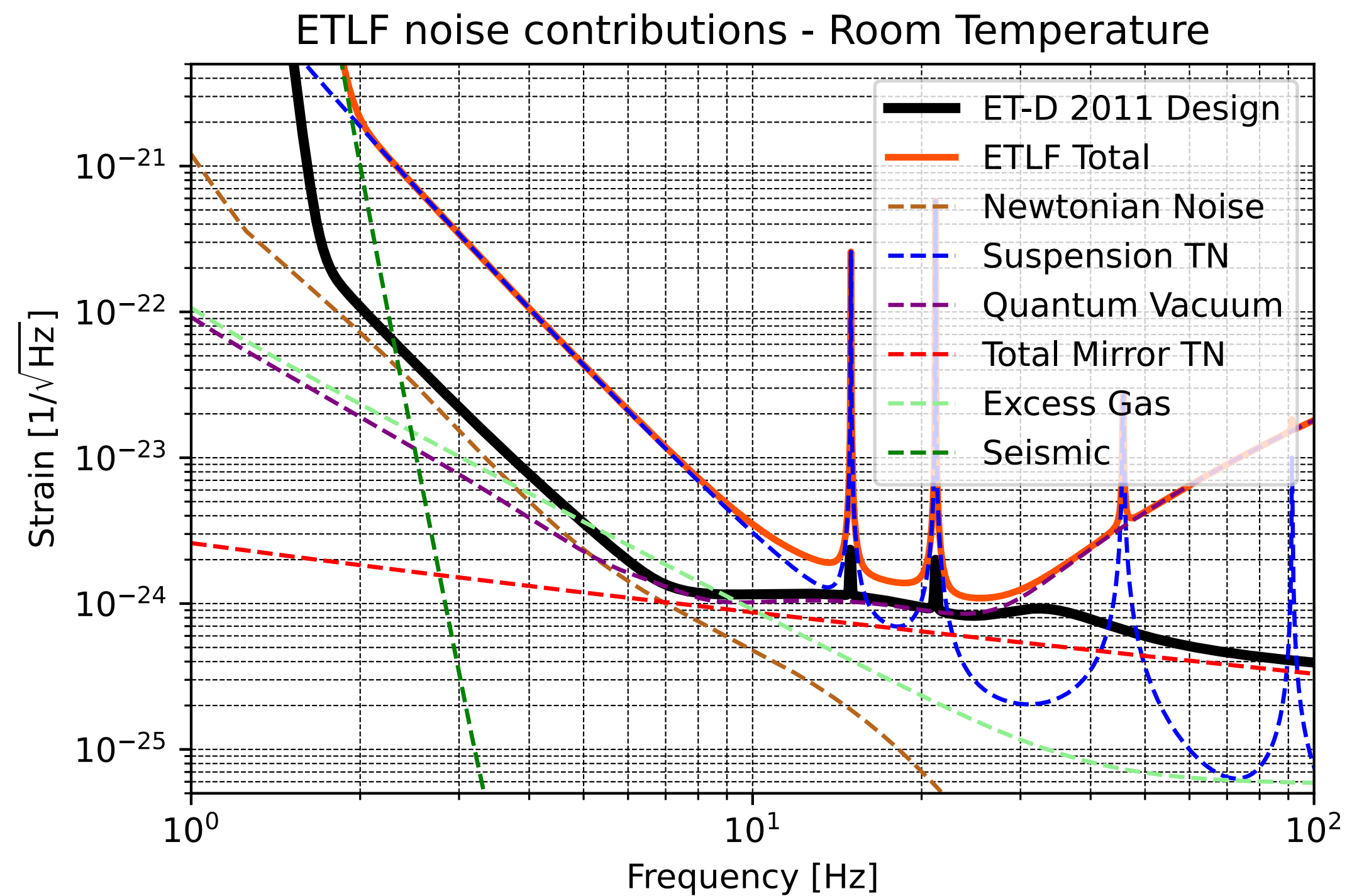
GWDVac'22 Workshop, La Biodola Bay, Isola d'Elba, 28.09.-01.10.2022

Source: Design Report Update 2020 for the Einstein Telescope. ET Steering Committee Editorial Team, September 2020



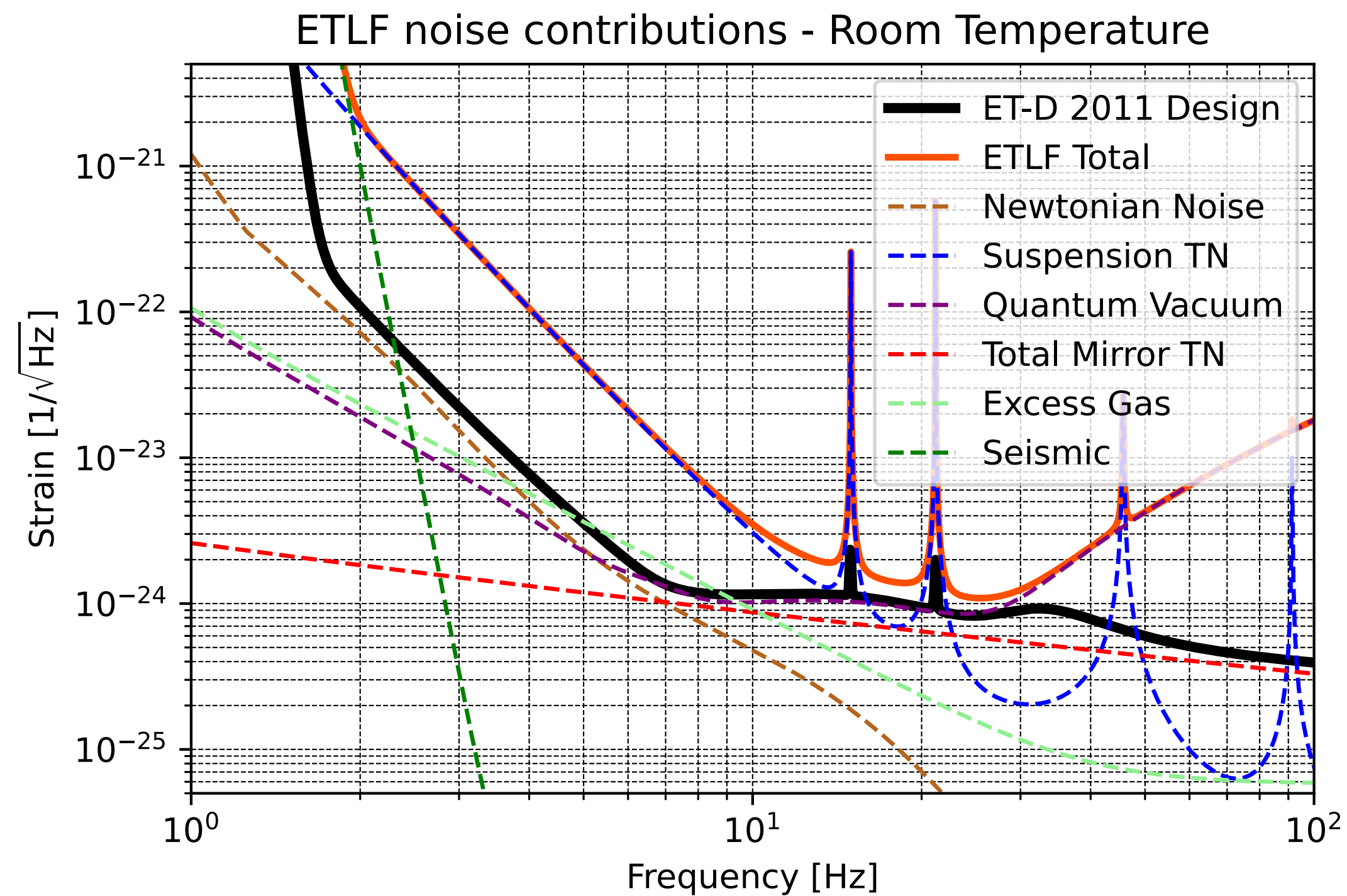
ET-LF noise contributions

Room-Temperature ET-LF

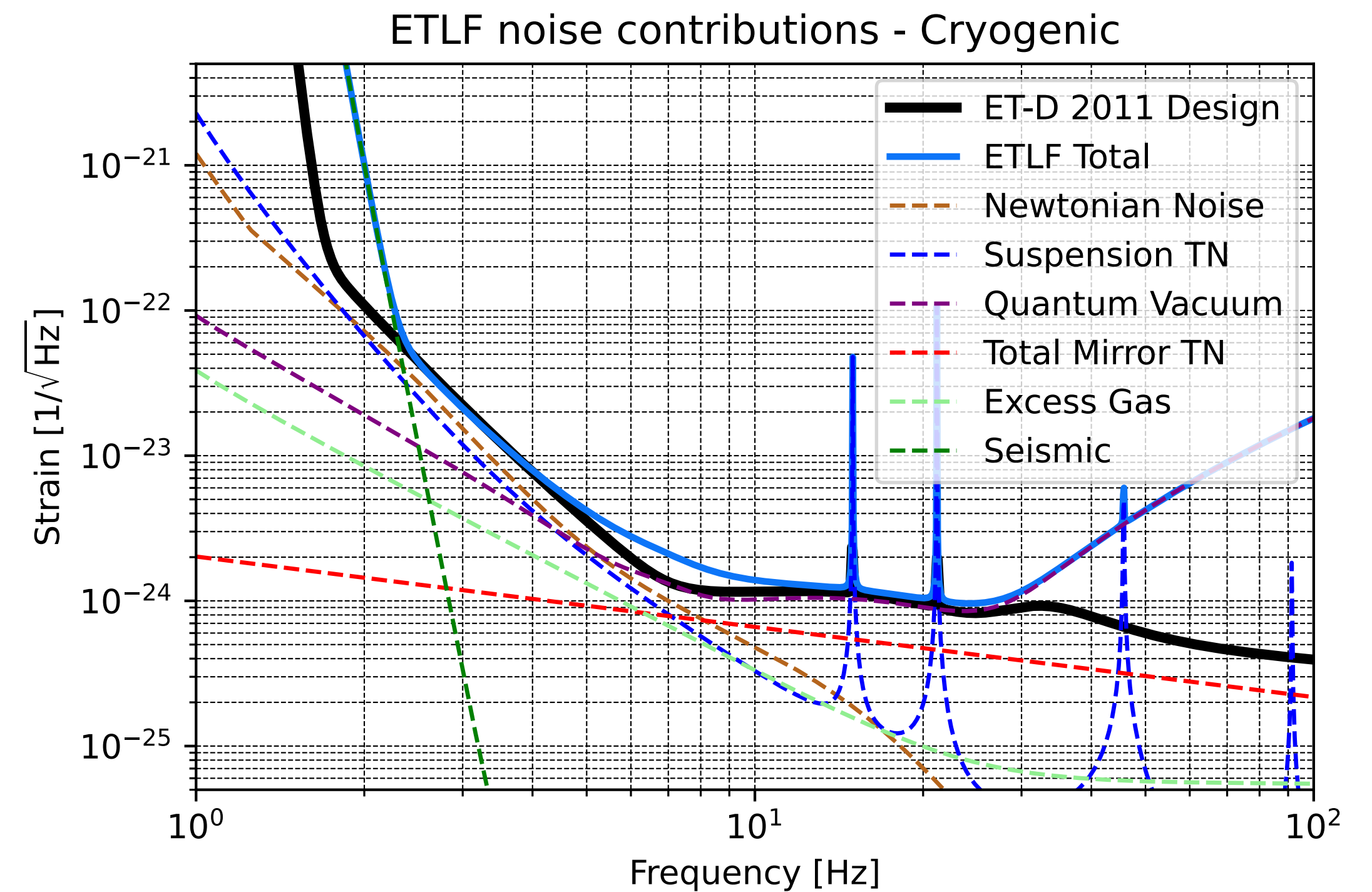


ET-LF noise contributions

Room-Temperature ET-LF

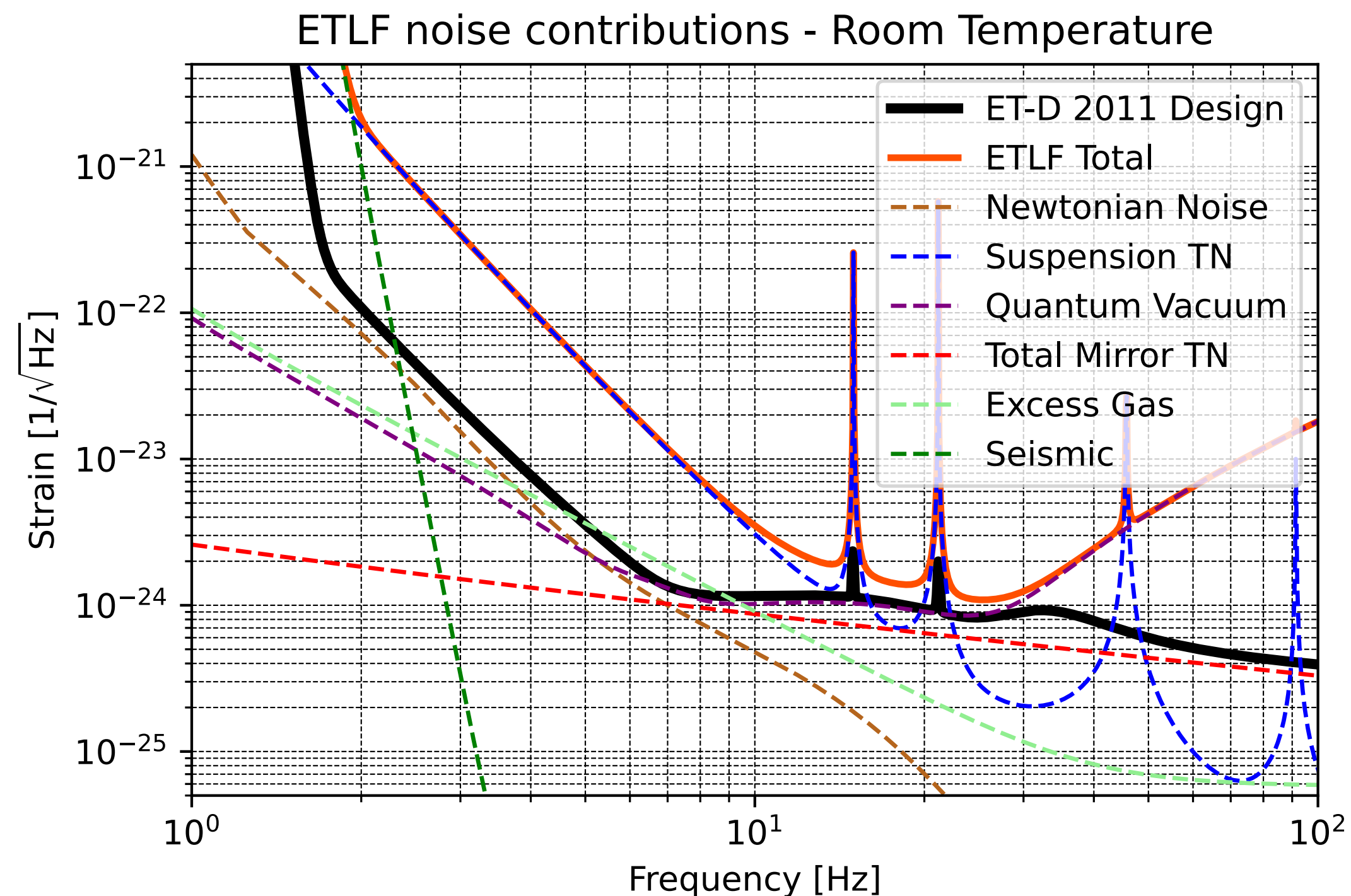


Cryogenic ET-LF

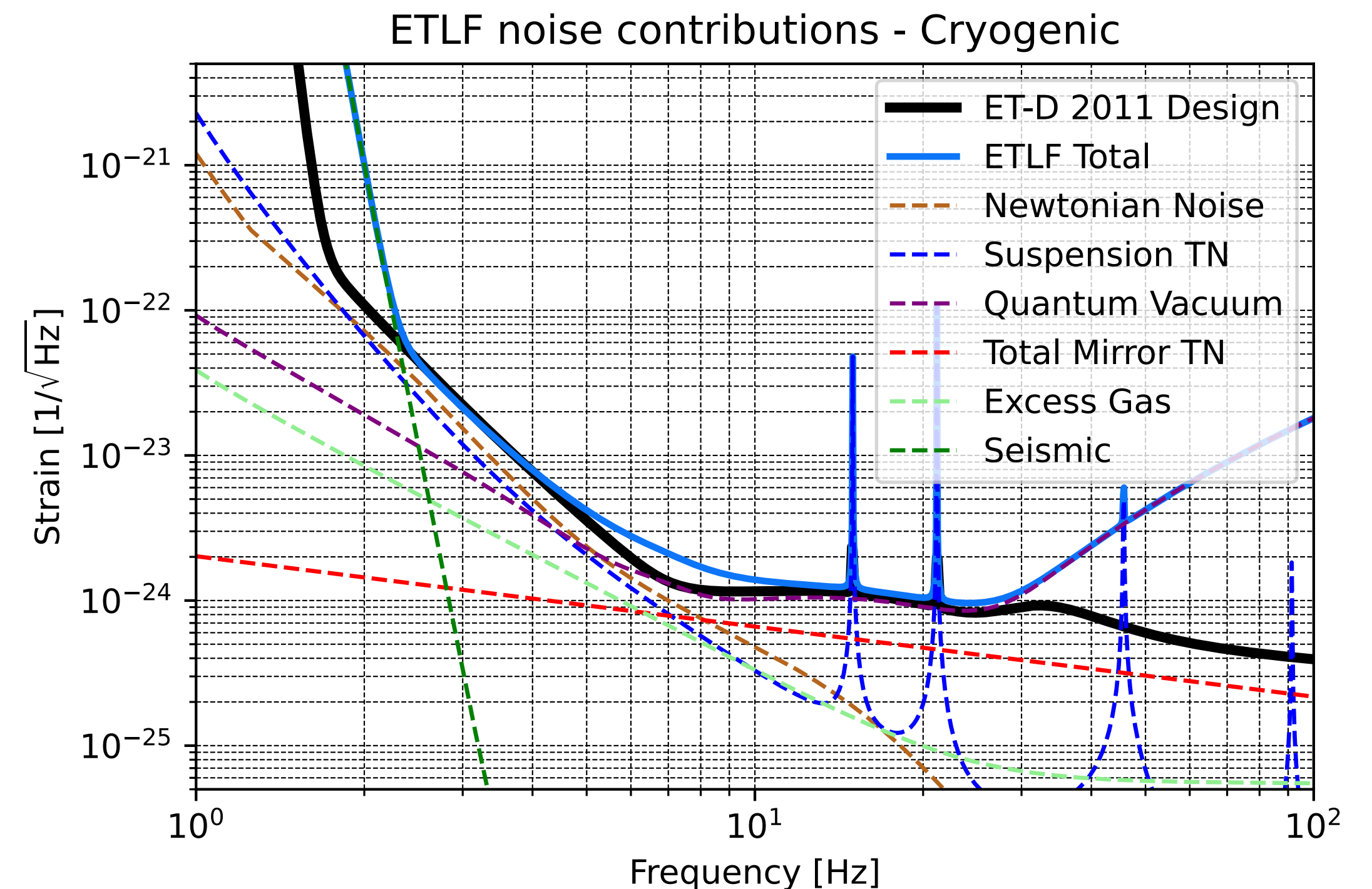


ET-LF noise contributions

Room-Temperature ET-LF

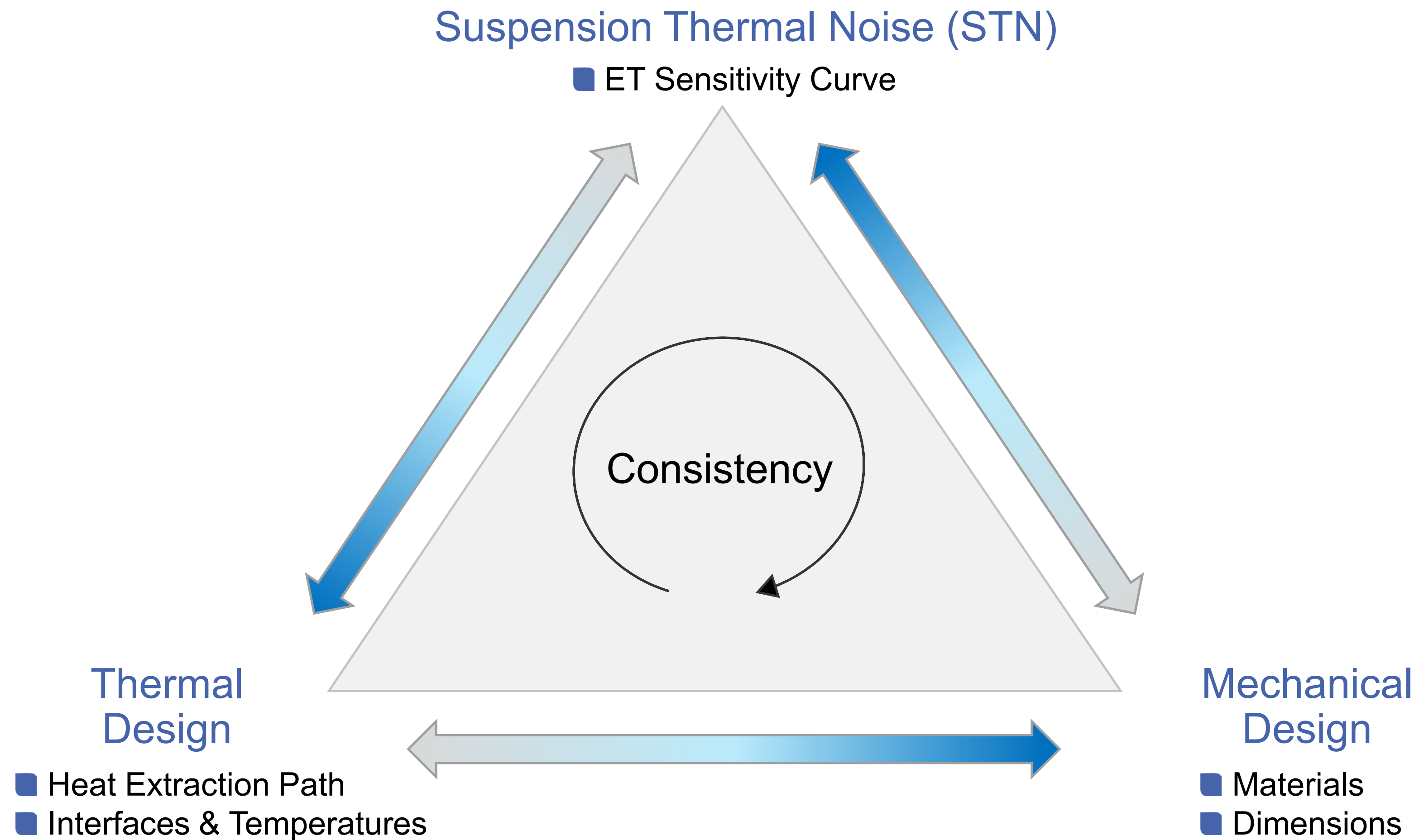


Cryogenic ET-LF



► Cryogenic operation of ET-LF is needed to bring STN down to the level of Newtonian Noise!

Consistency of ET-LF payload design



Status document: ET-ISB Vacuum & Cryogenics

- Status of achievements and perspectives
 - Follows ISB WP structure
 - To be published in TDS before ET-ISB Fall Workshop in l'Aquila
-
- Cryostat dimensions
 - Two viable cooling and payload design options

Status of the ET Tower Vacuum, ET-LF Cryostat and ET-LF Payload Cooling Design
ET-ISB Division IV, Vacuum & Cryogenics

Katharina Battes¹, Lennard Busch², Angelo Cruciani³, Christian Day¹, Julien Gargiulo⁵, Steffen Grohmann², Stefan Hanke¹, Xhesika Koroveshi², Ettore Majorana^{3,4}, Luca Naticchioni³, Antonio Pasqualetti⁵, Paola Puppo³, Piero Rapagnani^{3,4}, Fulvio Ricci³

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Introduction

This document summarises the present status of achievements and perspectives in the ET-ISB Vacuum and Cryogenics Division as contribution to the future TDR for ET. It follows the work package structure of our division, starting from the vacuum requirements of the towers hosting the mirrors. The beam pipe vacuum is not addressed, as it is not in the scope of the ISB activities. For the ET-LF cryostat, geometrical requirements are presented and aspects of the cryo-pumping concept are explained. Further, a brief update on the cryogenic infrastructure requirements is given. Finally, the ET-LF payload design and cooling options are being discussed in terms of suspension thermal noise, cool-down and steady-state operation.

1. WP IV.1: Tower vacuum

The contribution from the tower vacuum to the cryostat design is focused on gas load assessment and management, respectively, as well as interfaces definition.

1.1. Outgassing database and outgassing budget

The outgassing database is a tool to collect and categorize the outgassing data for single materials and assembly candidates for the installation inside the tower vacuum

Status of the ET Tower Vacuum, ET-LF Cryostat and ET-LF Payload Cooling Design⁵

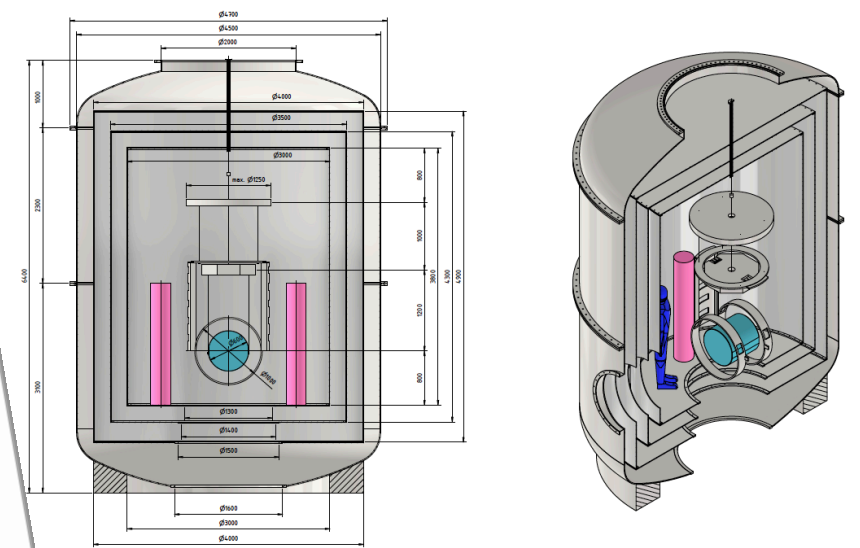
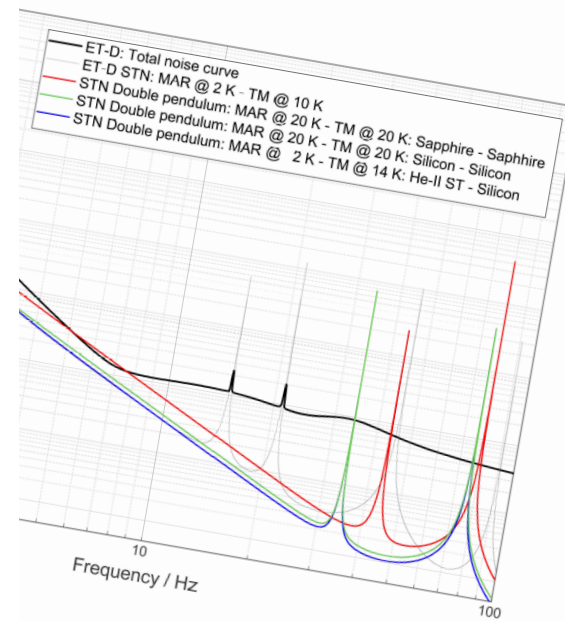


Figure 1. Conceptual layout of the ET-LF cryostats.

yields a diameter of the inner chamber of 3.0 m. The inner chamber may be passively cooled, depending on the noise contributions from a cooling system. The tower is surrounded by two actively cooled thermal shields, yielding a maximum diameter of 4.7 m. Re-inforcements on the vacuum vessel and/or the thermal shields may be required to prevent low resonant frequencies. In the vertical direction, a 1.2 m length is planned for the mirror suspensions from the top of the tower, and another 1.0 m for the marionette suspension from the platform. The platform, 0.8 m are needed for the junction box from the super-attenuator. The distance zone between the upper tower and the cryostat, which is not yet shown, does not require additional vertical space. The overall cryostat height up to the tower interface amounts to 6.4 m. The outer cryostat dimensions indicated in Fig. 1 may allow off-site pre-assembly and road transportation. Although concrete constraints underlie the structural regulation and specific constraints on a particular route, a maximum diameter of 4.7 m and a maximum height of 4.2 m (including vehicle) can be considered for the cryostat.

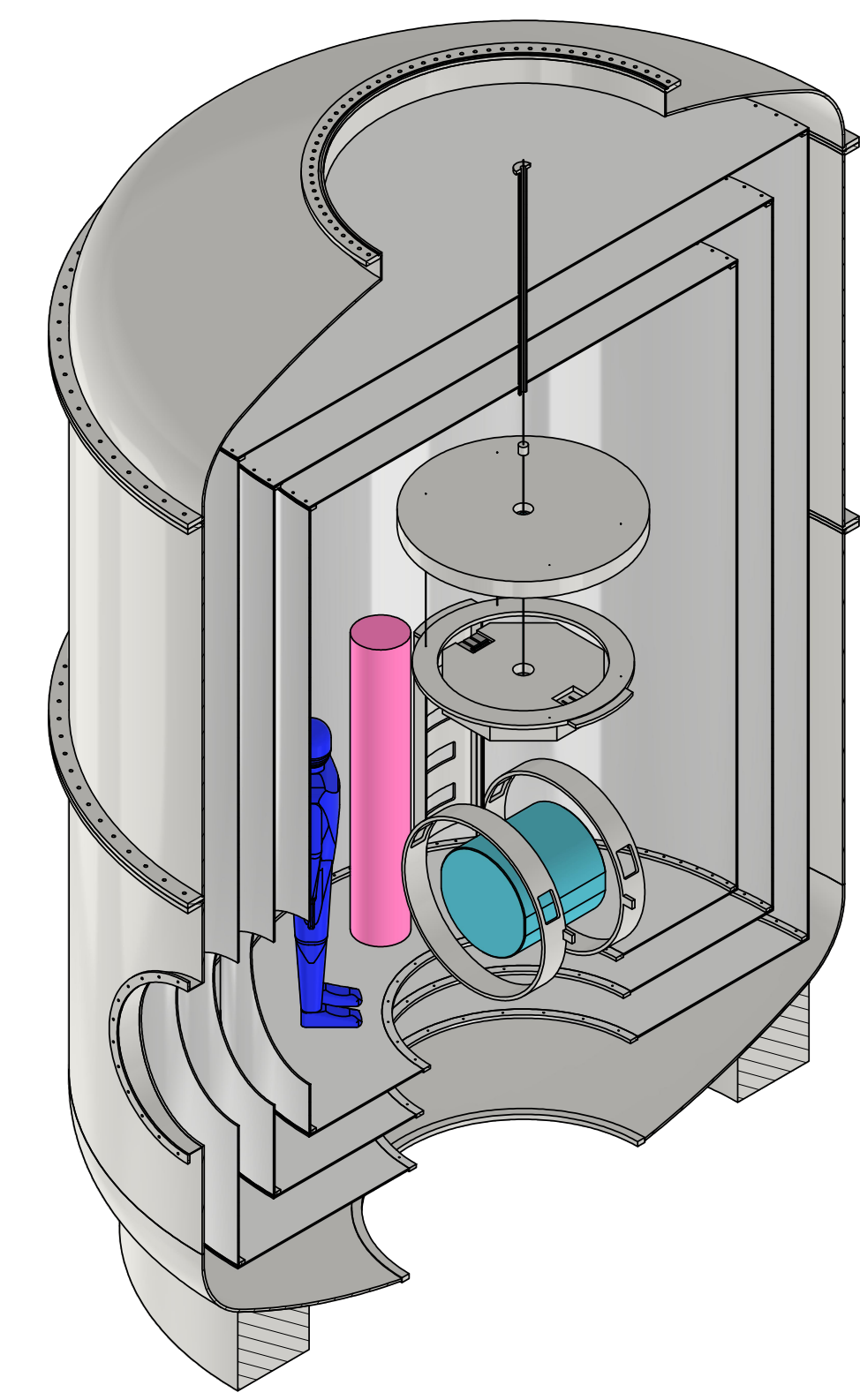
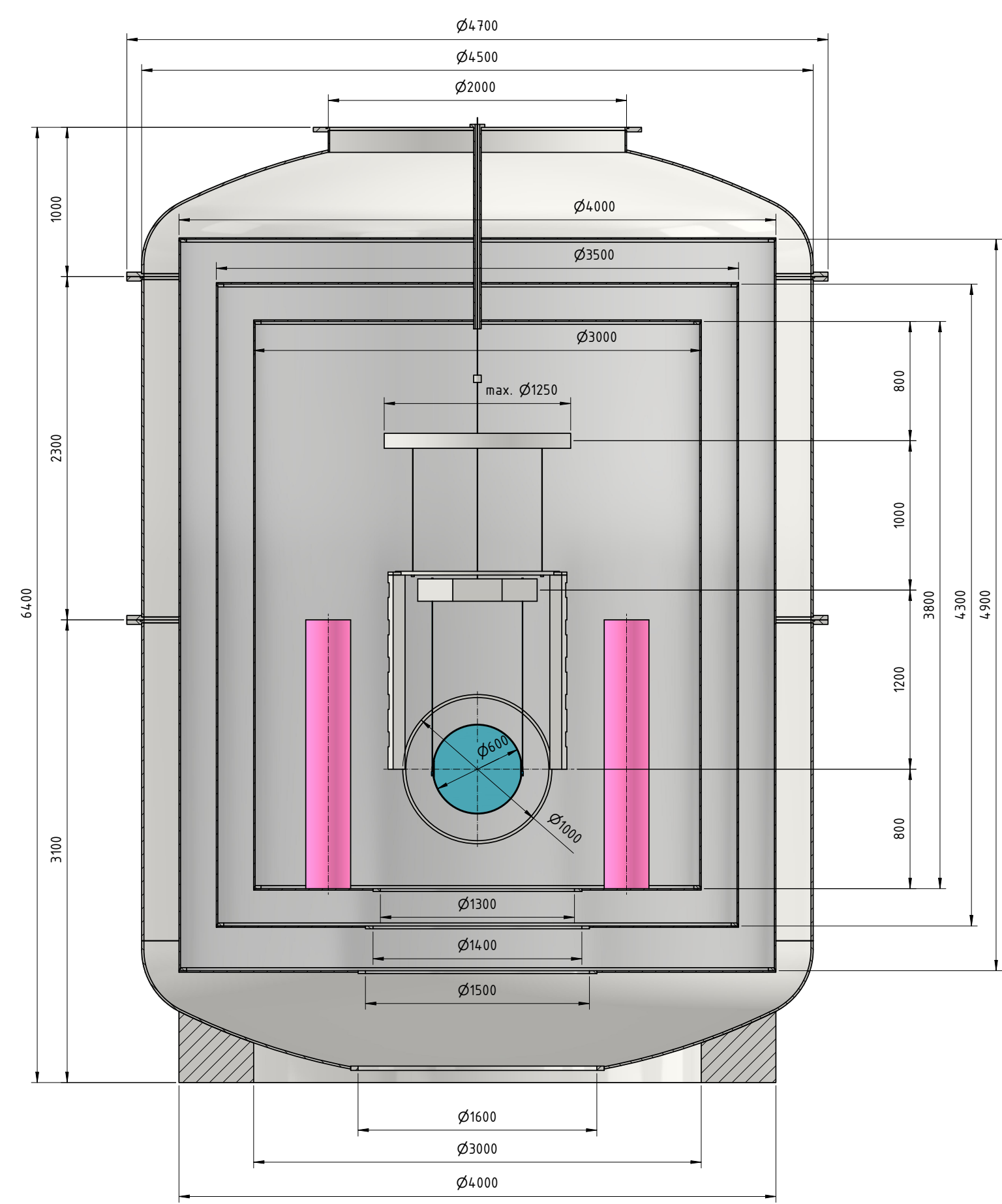
Status of the ET Tower Vacuum, ET-LF Cryostat and ET-LF Payload Cooling Design¹²



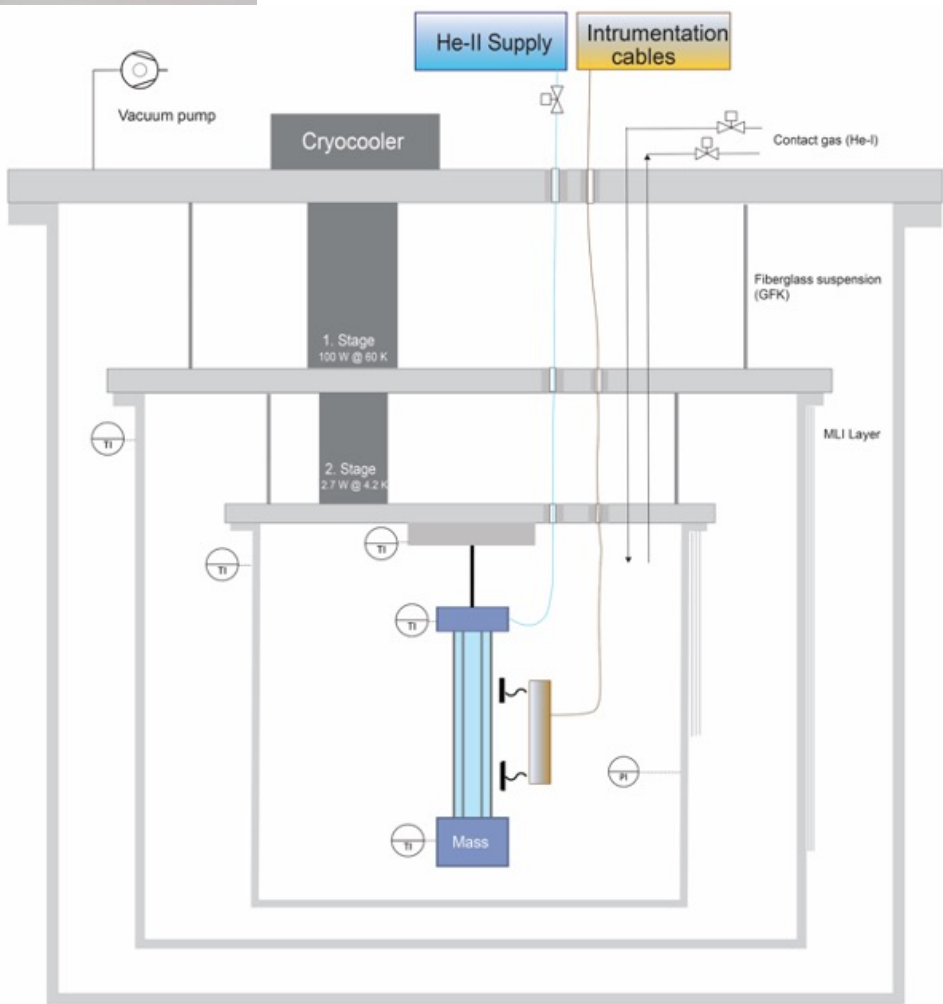
Comparison of the two possible ET-LF payload cooling concepts, compared with the noise level in the ET-D-LF. The red/green curves represent the suspension tube with silicon mirror fibers (red/green), and the blue curve represents the suspension tube with silicon mirror fibers (blue), as shown in Tables 1 and 2.

It must be remarked that the RMS vibration into the floor, due to the structure of the cryostat, is more critical, and special care must be taken. The cool-down of this concept has not yet been investigated. A cool-down more than two months as in KAGRA is not acceptable for ET.

ET-LF Cryostat Dimensions



ET-LF cooling test facilities



Test cryostat for He-II concept

ET-ISB Fall Workshop

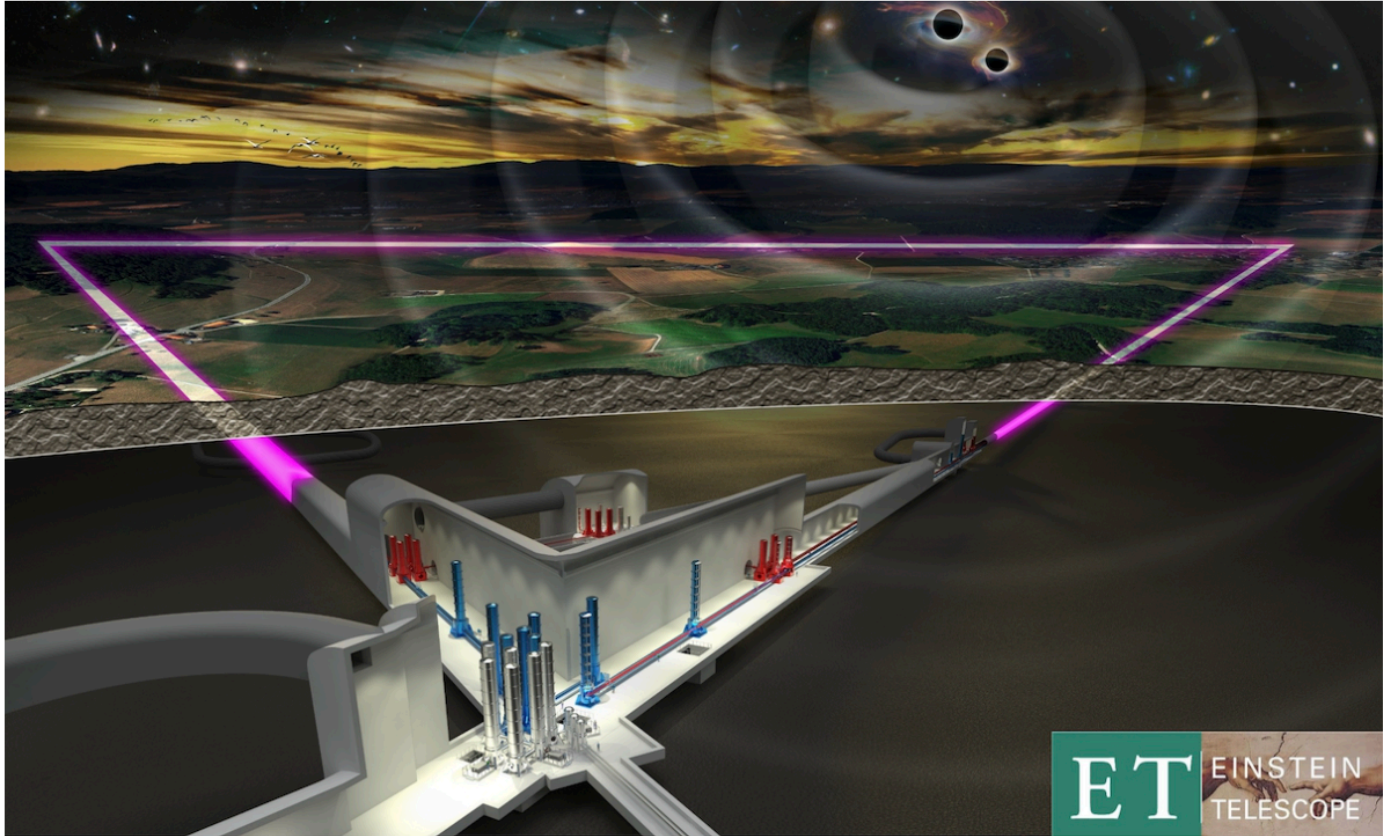
- Plenary talk on ET-LF cryostat design
- Organisation of parallel session outstanding

ET ISB workshop

17–21 Oct 2022
GSSI
Europe/Rome timezone

- Overview
- Timetable
- Contribution List
- Registration
- Participant List
- Travel and accomodation

Contact (LOC)
✉ jan.harms@gssi.it



The **Einstein Telescope** (ET) is a proposed underground research infrastructure in Europe to host future generations of gravitational-wave detectors. The Instrument Science Board (ISB) is currently working towards a preliminary technical design of a first detector implementation.

The 2022 workshop of the ET ISB will be held at the Gran Sasso Science Institute in L'Aquila with organizational support from INFN's National Laboratories of Gran Sasso.

The workshop will have a mixed format with plenary and parallel sessions for presentations as well as to work on key topics of the instrument design.

Remote connections will be provided to all plenary and parallel sessions, but the format of the parallel sessions might not be well adapted to remote participation.

A **social dinner** will take place in the evening of Wednesday, October 19. **Registrations should be made by September 30** to guarantee the participation in the social dinner.