Mirror position dynamics
VS
ET-LF tower structural dynamics

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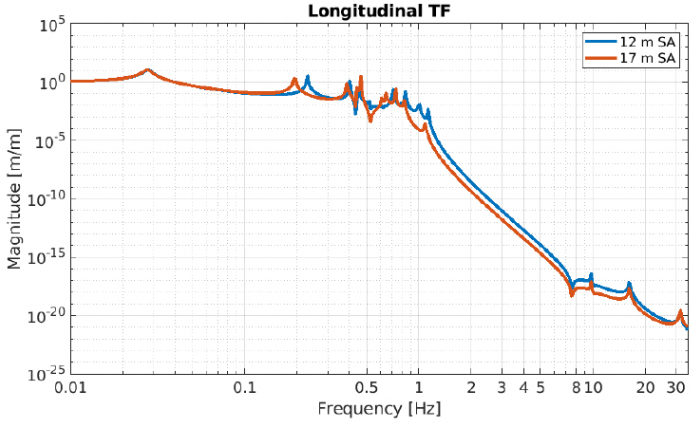
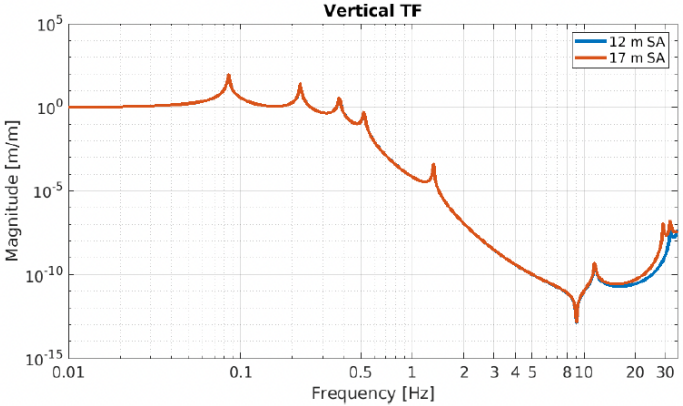
IV Workshop on ET-LF TM Tower Integration - Pisa - 18/03-20/03, 2026

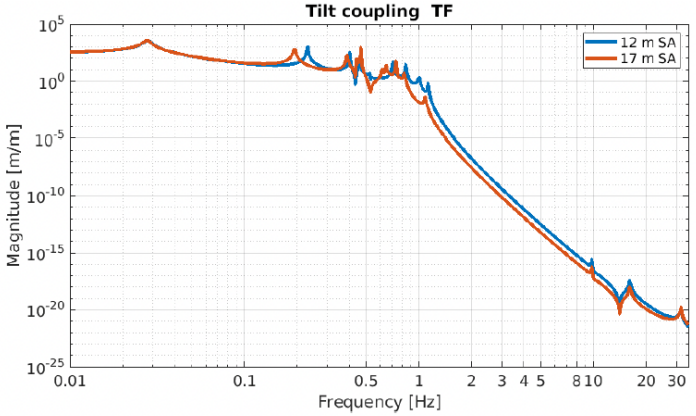
Seismic isolation system reference solution

Focus on the "12 m tall" chain:

we realized some mismatch in the seismic isolation system VS the assumptions concerning the tower geometry







Einstein Telescope Low–Frequency Interferometer Test–Mass Suspension Conceptual Design Update
By Suspension and Active noise mitigation divisions

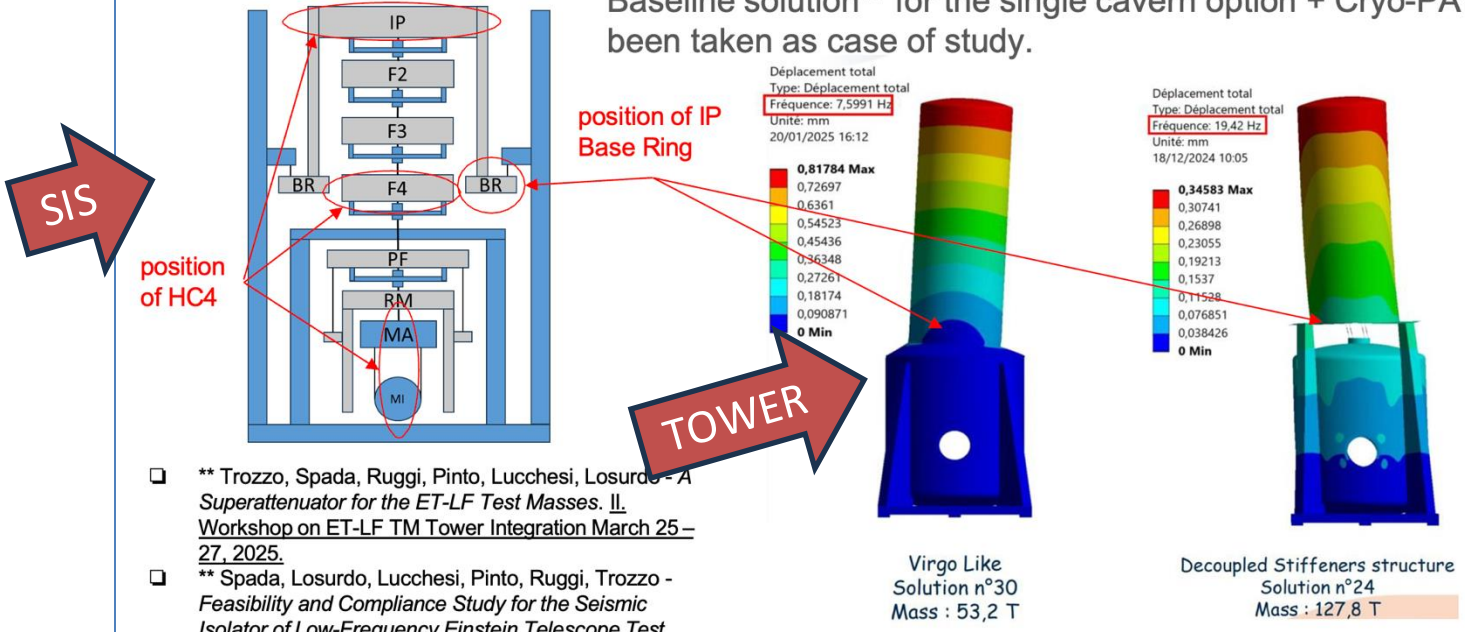
4.1 The reference solution: a Superattenuator 1 for Einstein Telescope

- overleaf technical document in preparation (2 years) re-checked
- Adjustment of the IP leg length ➔the parameters in section 4.1 could need an update (IP related)

Results at the III WS on Tower Integration (Elba, ET-0059A-26)

Seismic background effect through the structure* and impact on the design
Case of study: Baseline 12m Suspension and Cryo-PAY model

Baseline solution** for the single cavern option + Cryo-PAY have been taken as case of study.



- ** Trozzo, Spada, Ruggi, Pinto, Lucchesi, Losurdo - *A Superattenuator for the ET-LF Test Masses.* II. Workshop on ET-LF TM Tower Integration March 25 – 27, 2025.
- ** Spada, Losurdo, Lucchesi, Pinto, Ruggi, Trozzo - *Feasibility and Compliance Study for the Seismic Isolator of Low-Frequency Einstein Telescope Test Masses.* GR24/Amaldi16 Conference Proceedings.

* Credits: G. Iaquaniello - *Cryostat Simulations.* ET-ISB susp meeting. 24-01-2025.
An update might be elaborated soon by G. Iaquaniello

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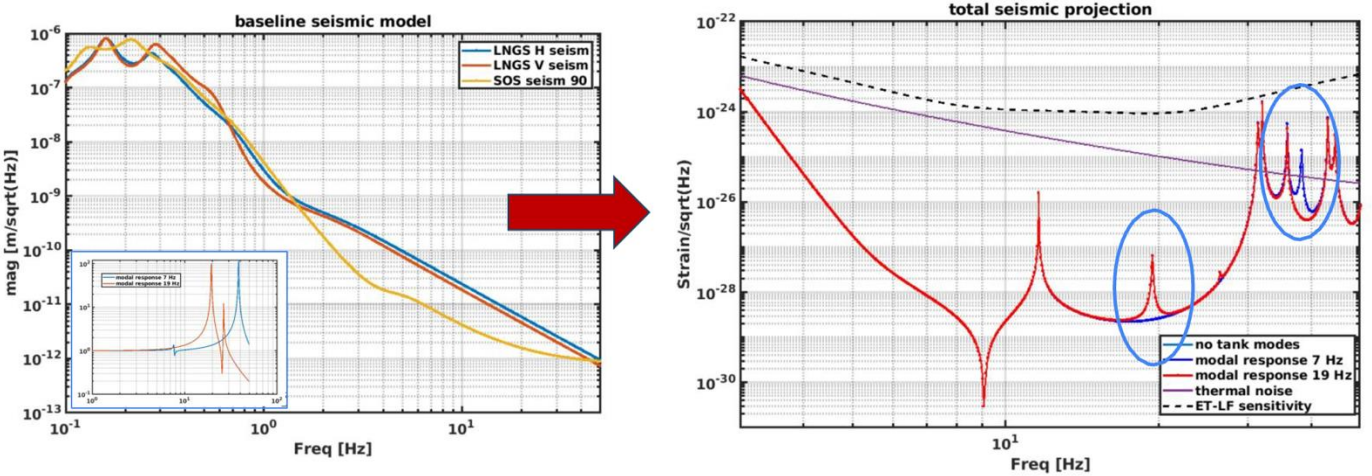
- First results after attenuation/control studies and first tower-base structural mode FEA
- Notice: the suspension concept is not in scale

Results at the III WS on Tower Integration (Elba, ET-0059A-26)

Seismic transfer down to TM - including tower modal response



Total transmission of ground noise (H and V) to the test mass. The dominant part is the vertical component, which allows to transmit the horizontal modes of the tower, given an arbitrary additional coupling mechanism.

- ➔ **At LF (3 Hz) the nominal Thermal noise dominates** and there is no reason to further constrain the system design to evade structural mode effects.
- ➔ **De facto a mode at 7 Hz is not harmful (not even visible in the projection)**, but the 2nd mode @ 38 Hz of the 1st solution may approach the sensitivity, but arises anyhow in the middle of vertical mechanical modes (crossbars…).
- ➔ **Iterative process**, we have the tool to properly design the tower base and make the effect negligible
- ➔ Too massive (deployment issues) is 53 and 128 T are to high? Can we optimize adopting smaller values (eg **40-50 T** Tower + Cryostat) ?

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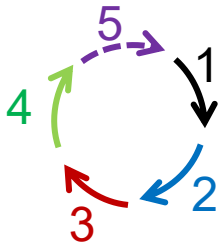
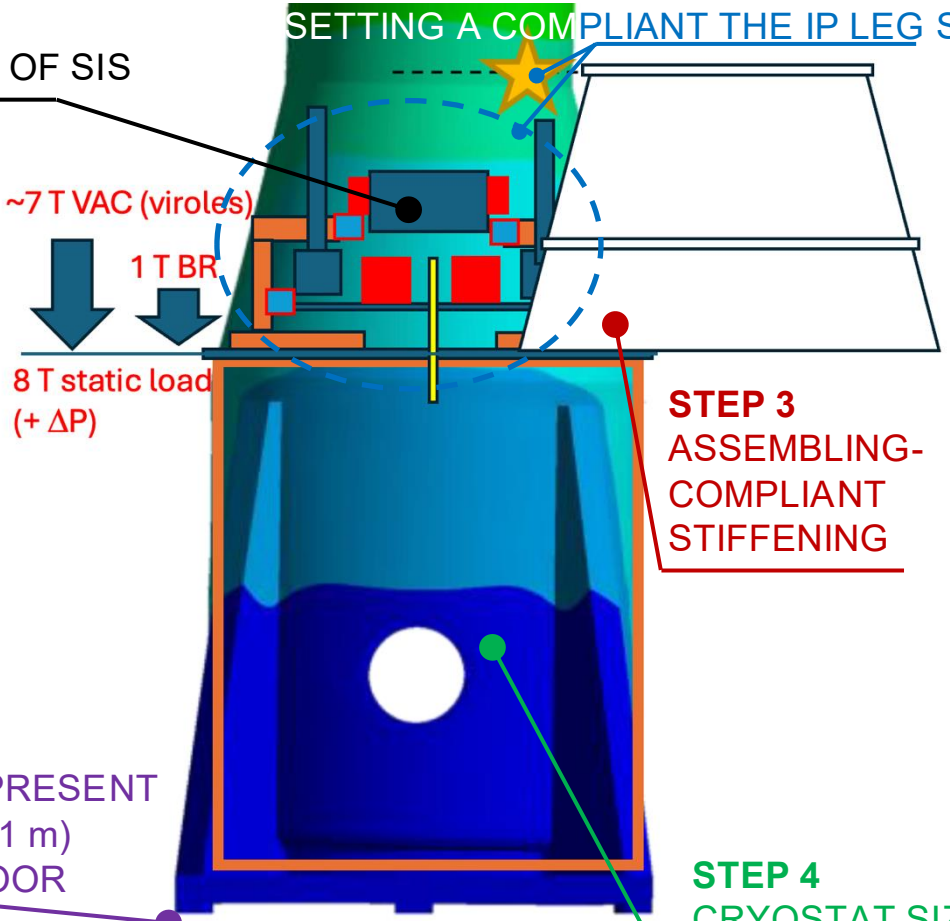
- Considering STD assumptions for the intrinsic noise (TN) first estimates provided the presence of two peaks and no criticalities at the level the mirror.
- Now we want to further tune our evaluations

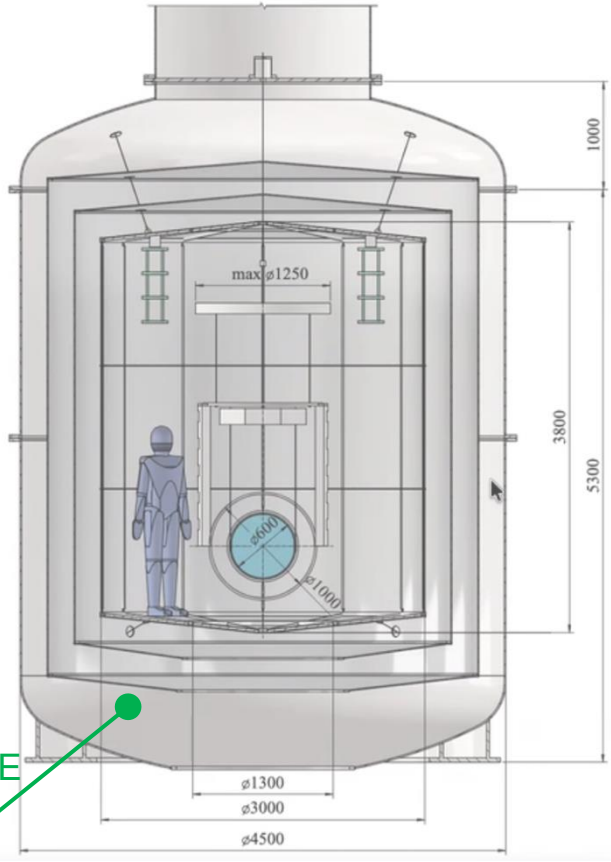
STEP 1
PROPER SCALE OF SIS

STEP 2
SETTING A COMPLIANT THE IP LEG STRUCTURE AND INJECTION HEIGHT





STEP 3
ASSEMBLING-
COMPLIANT
STIFFENING

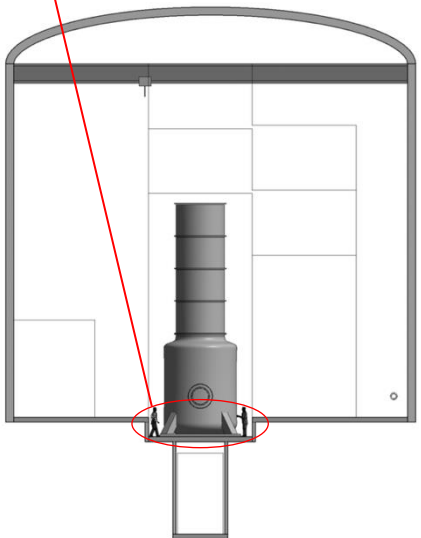


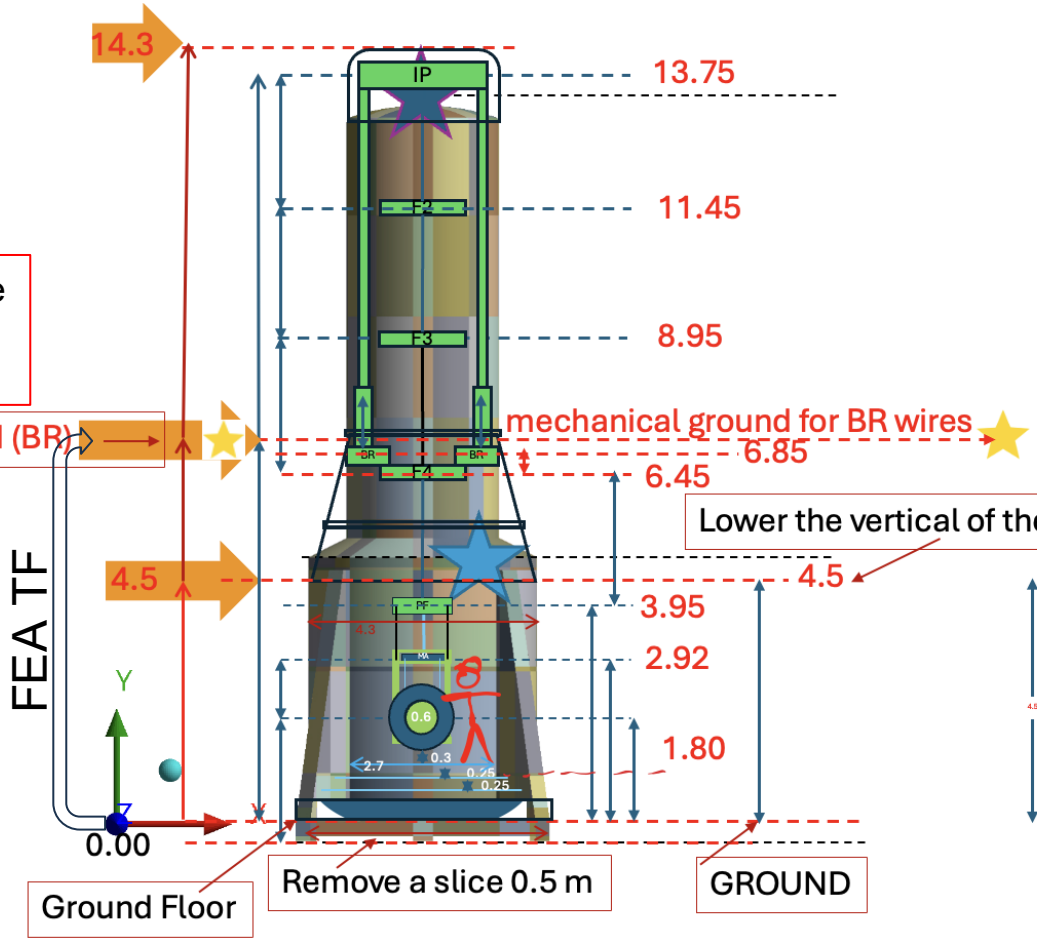
STEP 5
A GLANCE ON PRESENT
ASSUMTIONS (-1 m)
ABOUT THE FLOOR

STEP 4
CRYOSTAT SIZE
XCHECKING

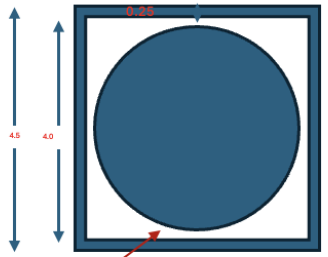
A new seed model for the tower based upon reference solution

It could be optimised with some advantages
(not considered in this study)



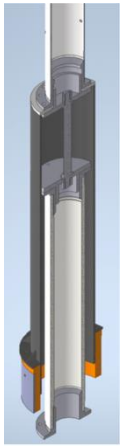


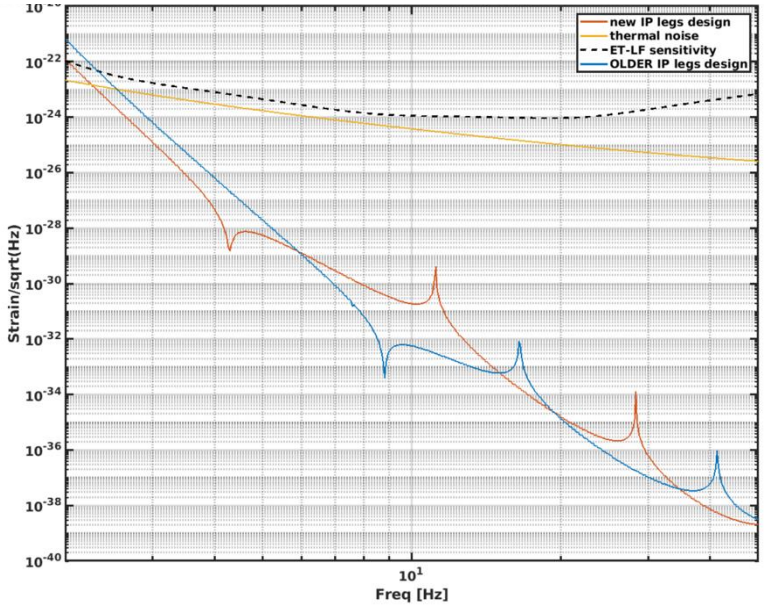
Lower the vertical of the cone base to 4.5 m



some margin to play with

Fitting the IP legs in the room-T part of the Tower

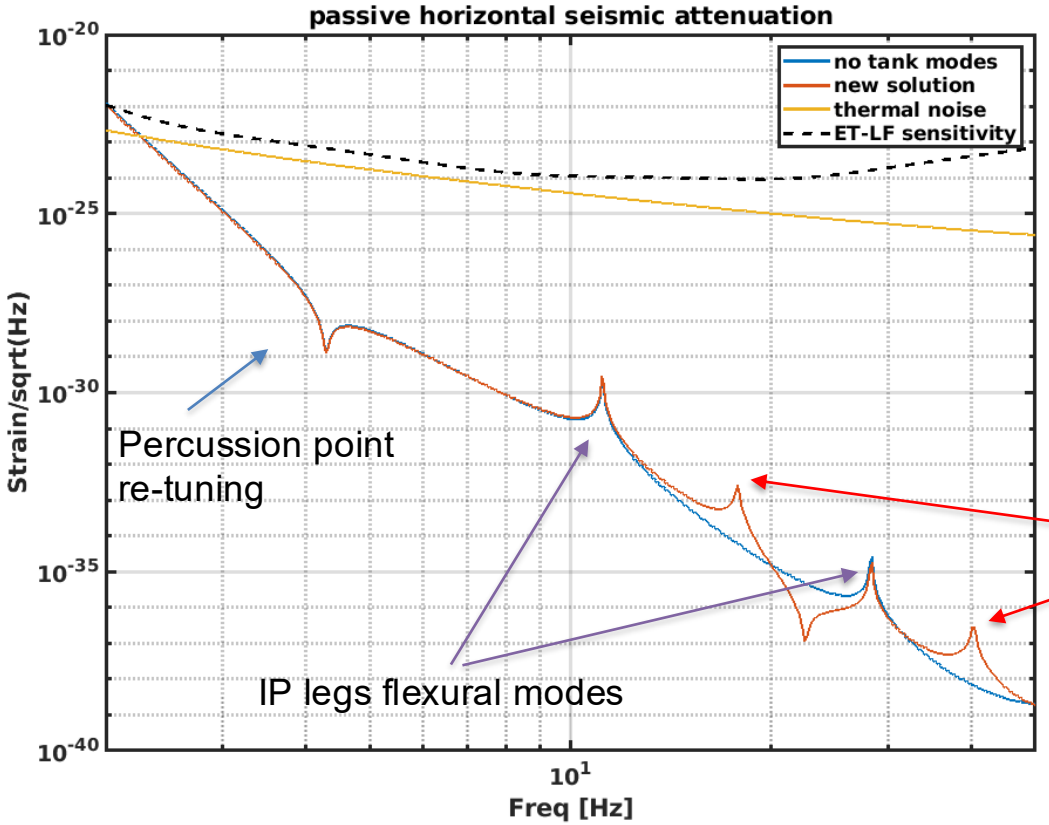




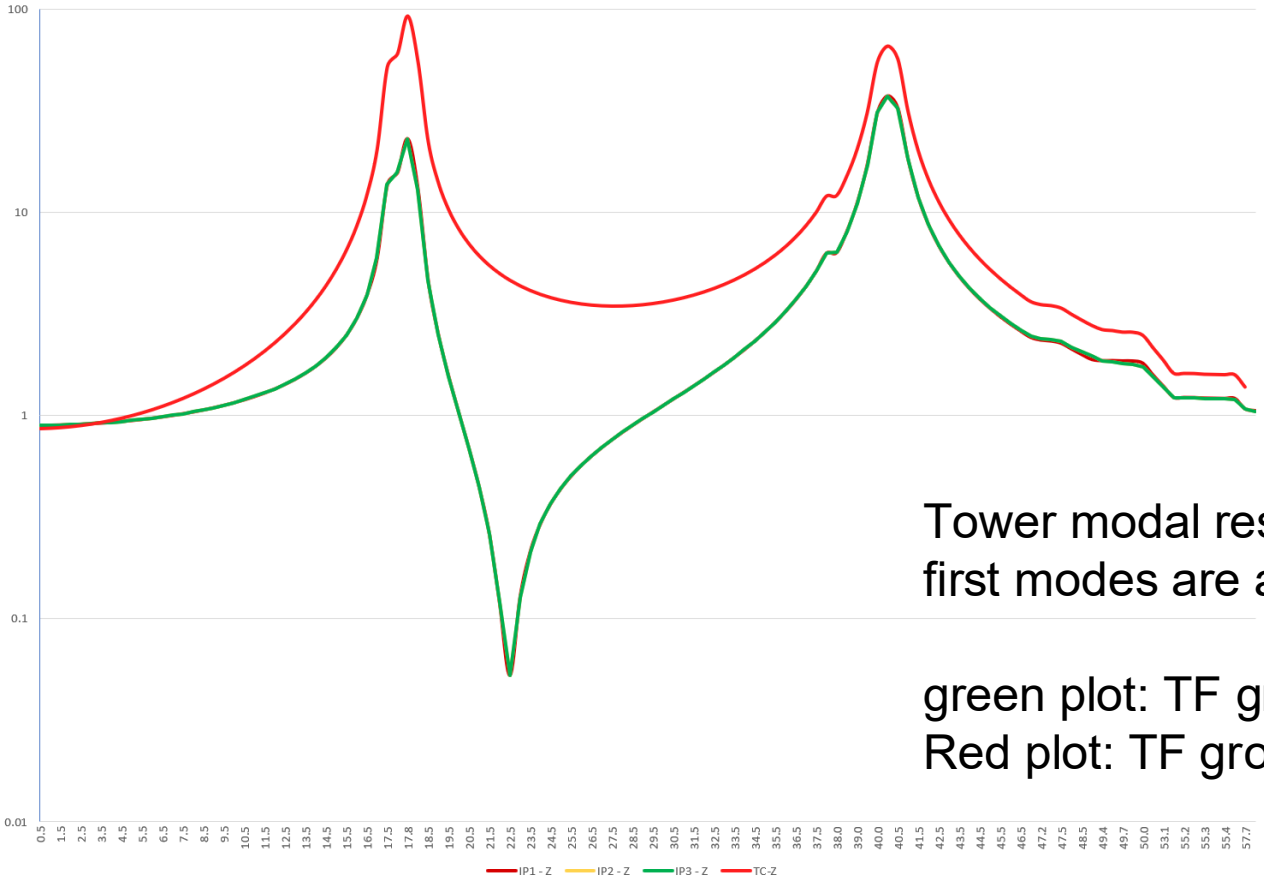
Longer and more massive composite counterweight and
FeC=1.136 m + ~0.1 mW75Cu25 counterweight

Bottom Ring suspended by
0.1 m maraging (3mm) wires

Seismic Isolation System response ground (SosEnattos➔ mirror) including the tower modal response



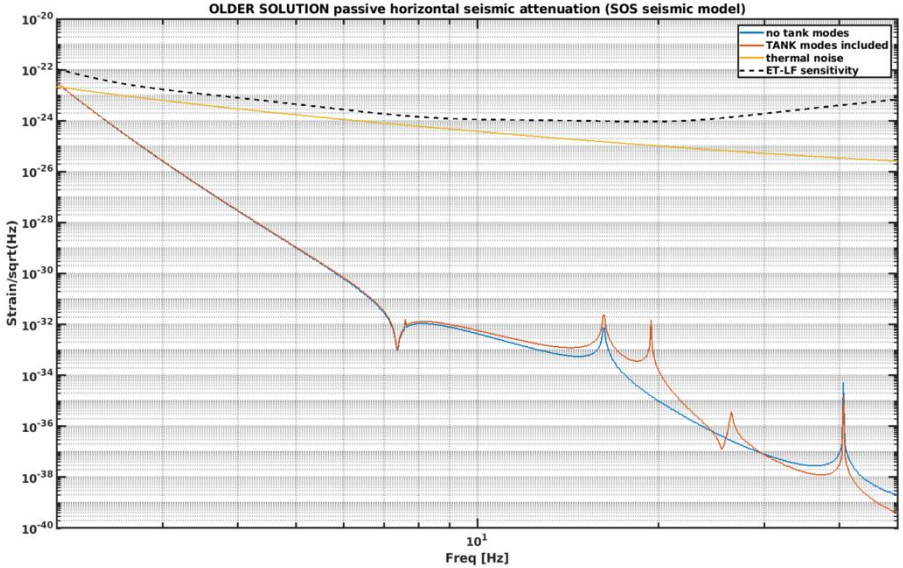
Propagation of **horizontal** seismic noise to the mirror

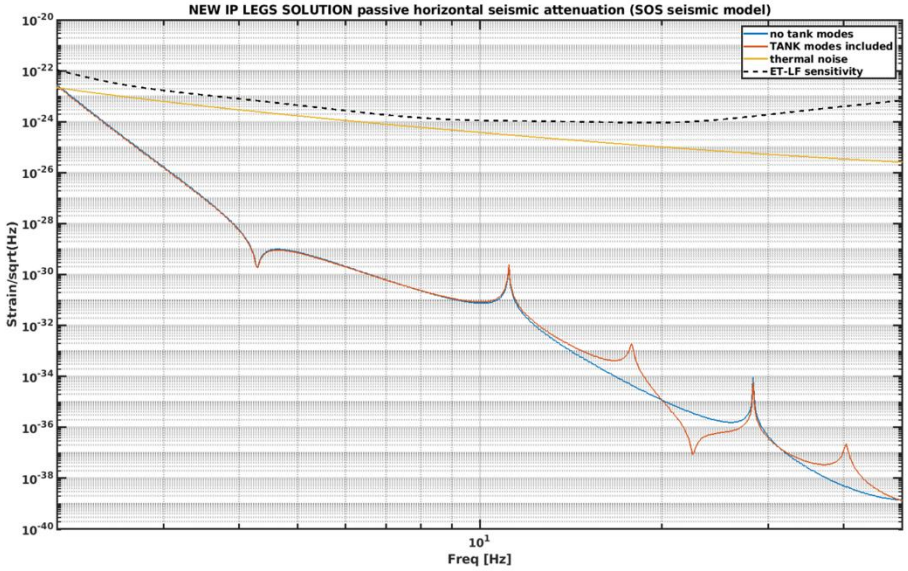


Tower modal response (Gregory):
first modes are at 17.8 and 40 Hz.

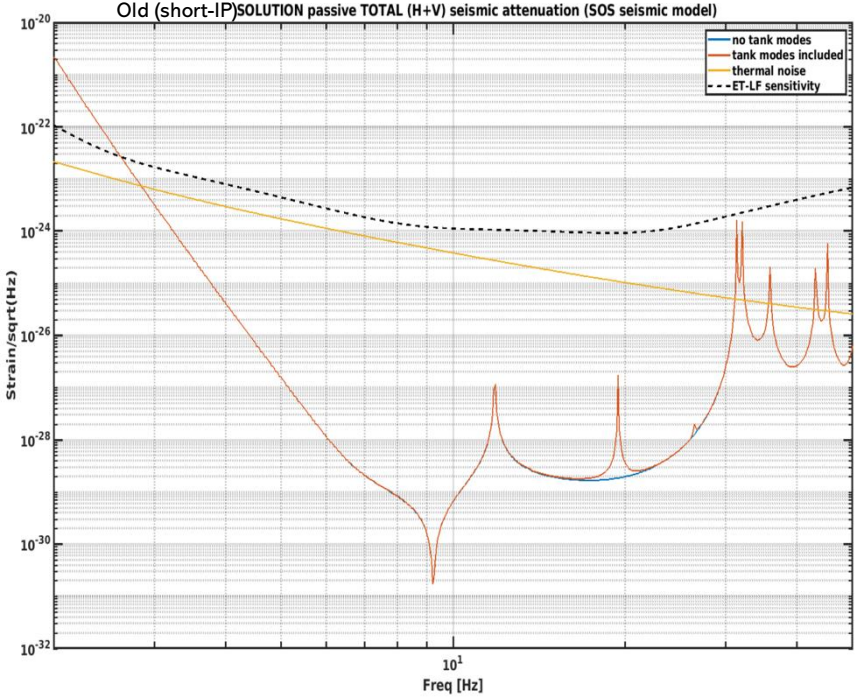
green plot: TF ground to BR
Red plot: TF ground to TOP

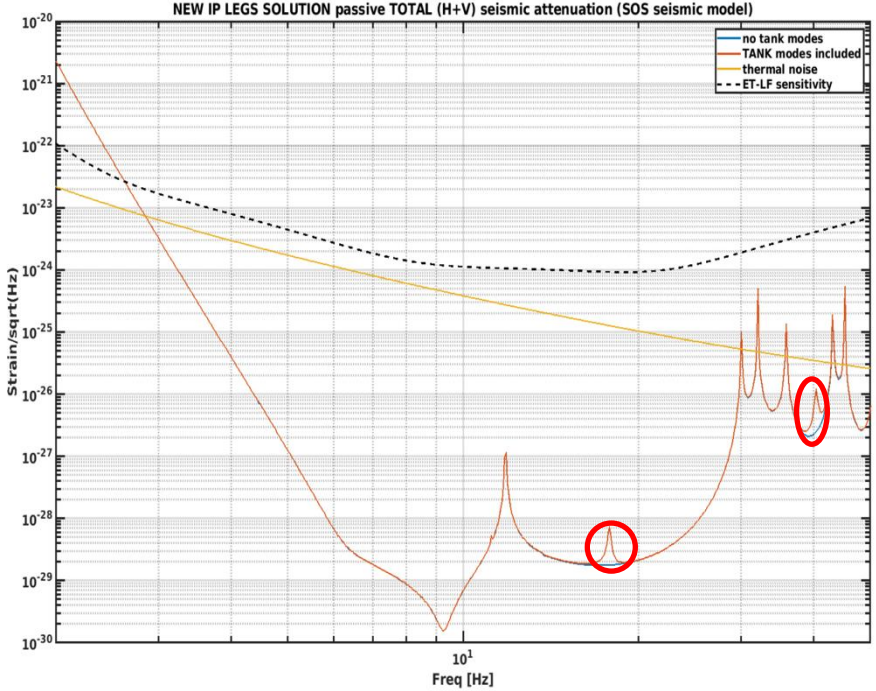
Re-tuned effect of ET-LF tower structural modes on H attenuation





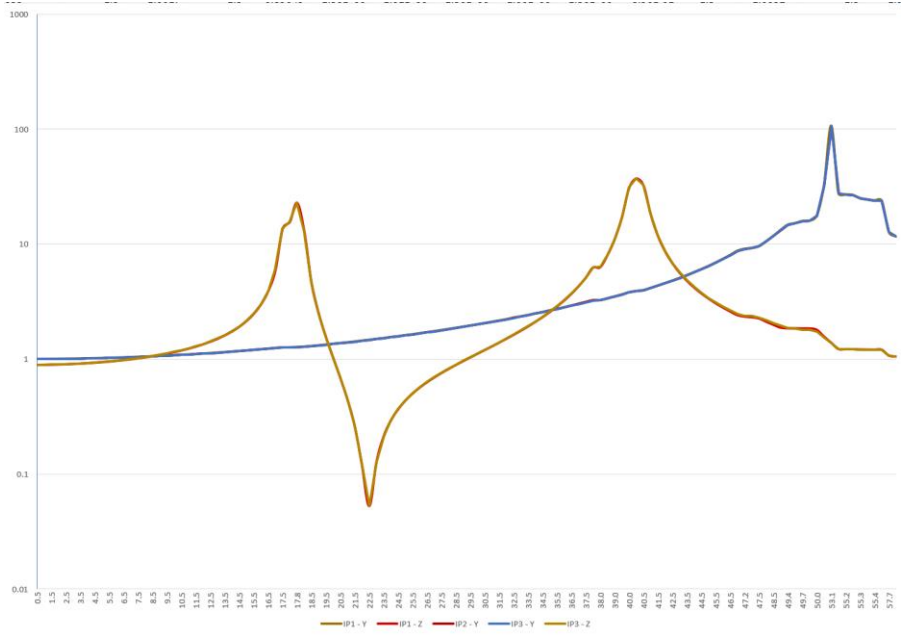
Re-tuned effect of ET-LF tower structural modes (H+V)

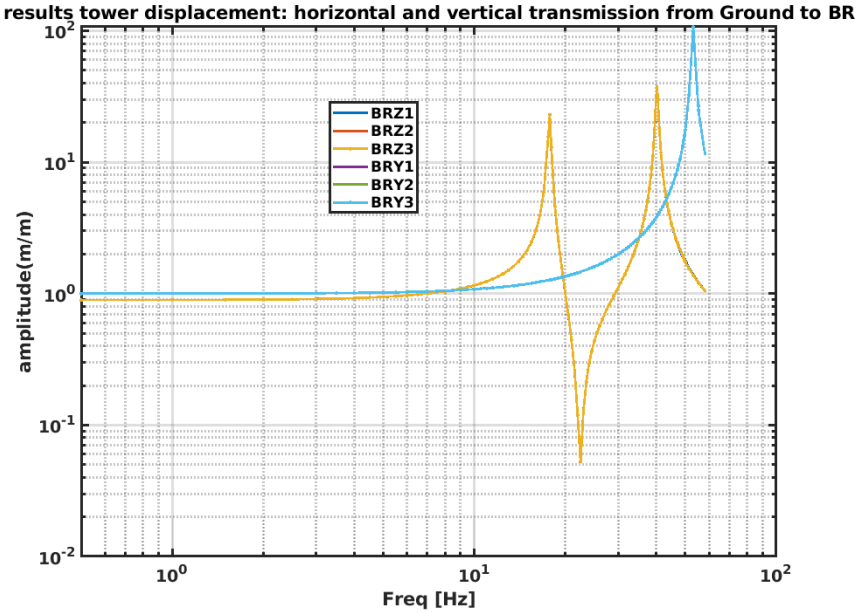




- The situation is quite OK and even better than previous estimates: **no matter if the BR is located above the cryostat**
- Though below the thermal noise, crossbar/filter modes excited from the ground have significantly larger effect compared to those of the tank

Vertical





Structural mode might be significant at 50 Hz, but outside the detection BW

However, the study will be completed considering the vertical background seism

Conclusions

We set the IP bottom ring above the cryostat. We tuned the tank design after re-adapting it to a more realistic use. We considered:

- Actual geometry of the Seismic isolation system integration ➔➔ **room temperature section (height, stiffening, hosting BR)**
- Geometrical Payload ➔➔ **Cryostat dimension xchecks**
- Integration operation checks on both aspects room temperature and cryogenic sections

➔ **IP BR can be hosted above the cryostat**

Next: vertical attenuation improvements may be needed (also concerning the tower structure),however

➔ **However, the overall height can be considered realistic**

By product:

➔ Suggestion to check the floor and volumes under the tower