NGSA

New Generation Super Attenuator

PI: Luciano Di Fiore (INFN-NA)

Durata: 3 anni (2022-2024)

Unità INFN coinvolte:

INFN-NA - A.Bertocco, M.Bruno, R. De Rosa, L. Di Fiore(RN), L. Trozzo (RL)
INFN-PI - F. Frasconi (RL), A. Gennai, L. Lucchesi, L. Orsini, F. Pilo, P. Prosperi, F.R. Spada
INFN-CA/Univ. di Sassari, N. Davari, D. Durso, D. Rozza (RL), V. Sipala

Partecipazione esterna:

European Gravitational Observatory (EGO) (P.Ruggi)

NGSA is strictly connected to the Einstein Telescope (ET)

It is a part of a general effort (including BETHSA) for improving seismic isolation systems with the goal to reduce the total height of the ET-LF Seismic Isolator

The proposed solutions are not in competition but can be applied together (if experimentally demonstrated) in the future ET SA

My talk will be organized ad follows:

- Short resume on goal and organization of NGSA
- Nested Inverted Pendulum (NIP) status and perspective

NGSA (New Generation Super-Attenuator)

The project is organized in two parallel research lines:

1) *Traditional solution:* optimized SA, starting form the AdV SA architecture:

- ➢ optimization of the mass distribution along the isolation chain
- ➢ improvement of the performance of the Magnetic Anti-Springs (MAS) of the single filters
- the goal is to keep the total SA length around 12 m
- if necessary, an active pre-isolator platforms, at the base of the IP, will be considered

2) *Innovative solution:* two-stage Nested Inverted Pendulum (NIP)

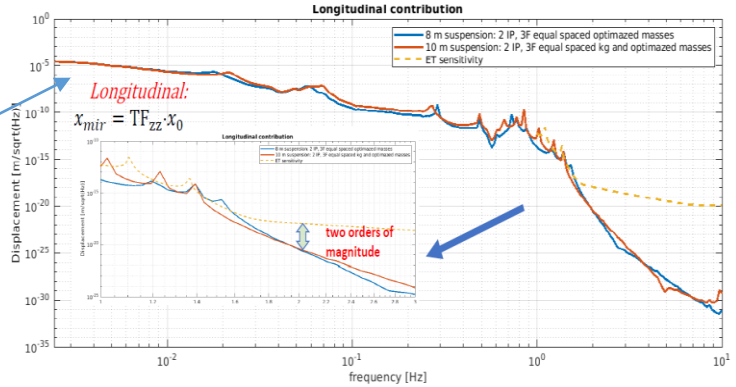
- ➢ Better horizontal attenuation of the pre-isolator but never experimentally demonstrated.
- Open questions to be addressed: reliability, stability, control systems, cross talks and vertical and angular noise suppression.
- ➢ A dedicate prototype (in 1:2 scale) will be realized to experimentally validate this configuration
- Goal is to keep the total SA length around 10 m

Final goal, after comparison of the two alternatives, will be the definition of a Conceptual Design of the SA for the ET Antenna.

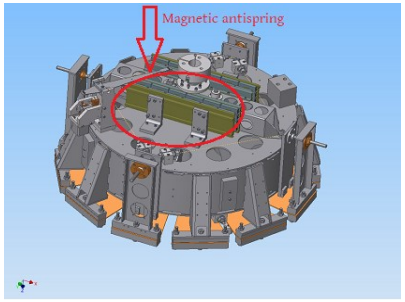
NGSA project Organization : WP

The project is organized in 4 WP:

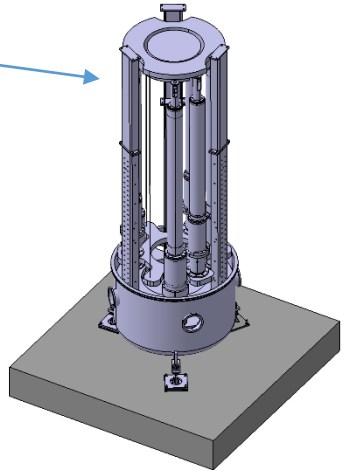
WP1 – Simulation and optimization of the Superattenuator
Coordinator: L. Trozzo (INFN-NA)



WP2 – Mechanical filter with improved Magnetic Anti-Spring (MAS)
Coordinator: F. Frasconi (INFN-PI)



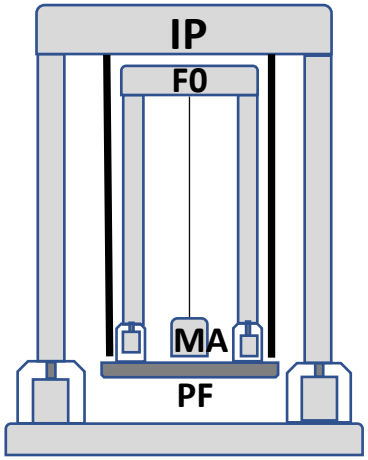
WP3 – Development and test of a Nested Inverted Pendulum (NIP)
Coordinator: R. De Rosa (INFN-NA)



WP4 – Sensing and Control (S&C)
Coordinator: A. Gennai (INFN PI)

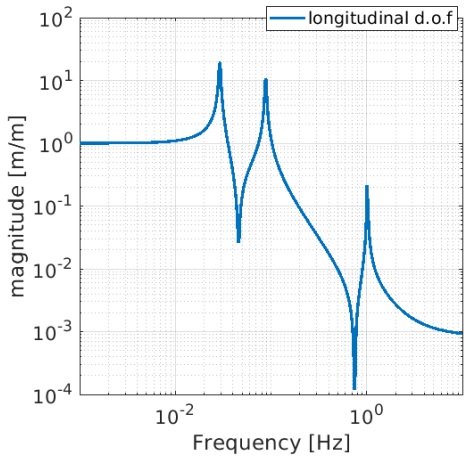
WP1 – Simulation and design of the NIP prototype

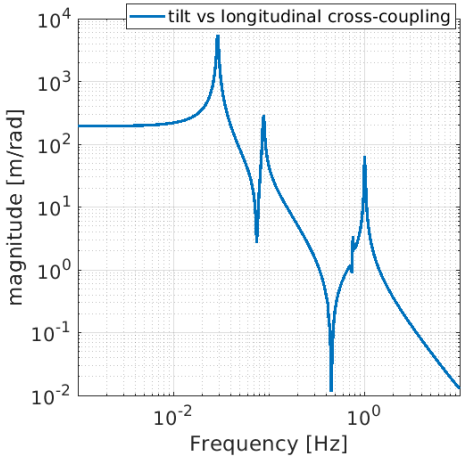
- The simulation tool (Octopus) is based on the impedance matrix formalism and was developed for the Virgo Project.
- Masses, flex-joints, legs, etc. have been defined
- Al the TFs have been computed with Octopus
- This was the starting point for the mechanical design of the prototype
- Simulation tools are crucial to evaluate the effect of mechanical design choices on system performance



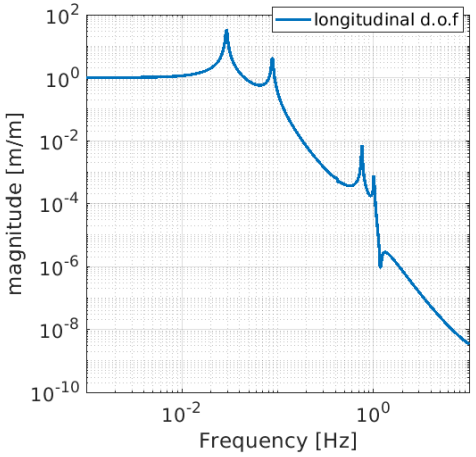
TF examples

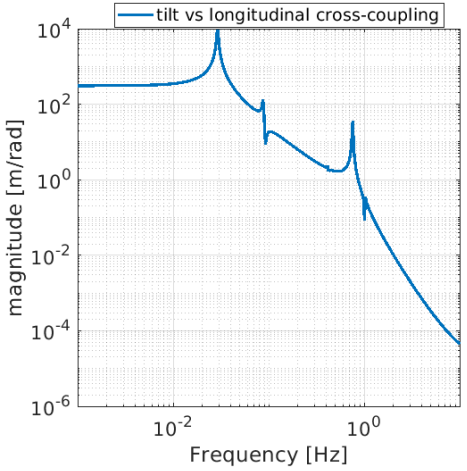
Ground to F0 TFs





Ground to Ma TF





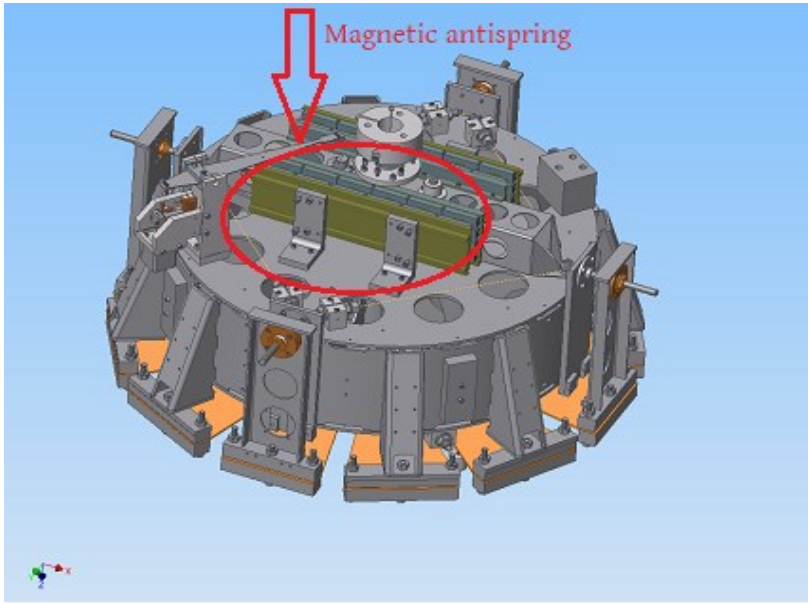
WP2 – Mechanical filter with improved Magnetic Anti-Spring (MAS)

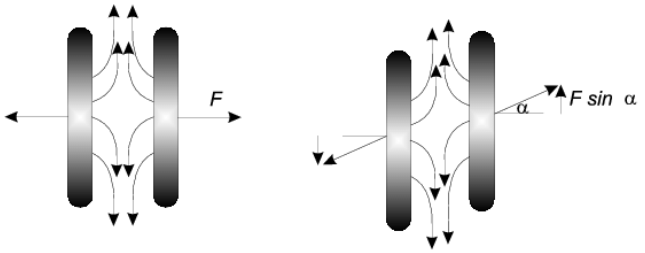
The goal is to improve the present MAS design

The ides is to replace ferrite magnets (0.35 T) with rare earth (SmCo or NeFeB) magnets (0.8 T)

The advantage is the larger Magnetic flux density providing:

- Large anti-stiffness with a reduced volume
- Lower filter resonance
- New cross-bar design to move its resonances at higher frequency





WP3 – Development and test of a Nested Inverted Pendulum (NIP)

The goal is to built and test a NIP prototype in 1:2 scale, to be tested in the Gravitational Physics Laboratory at INFN-Napoli

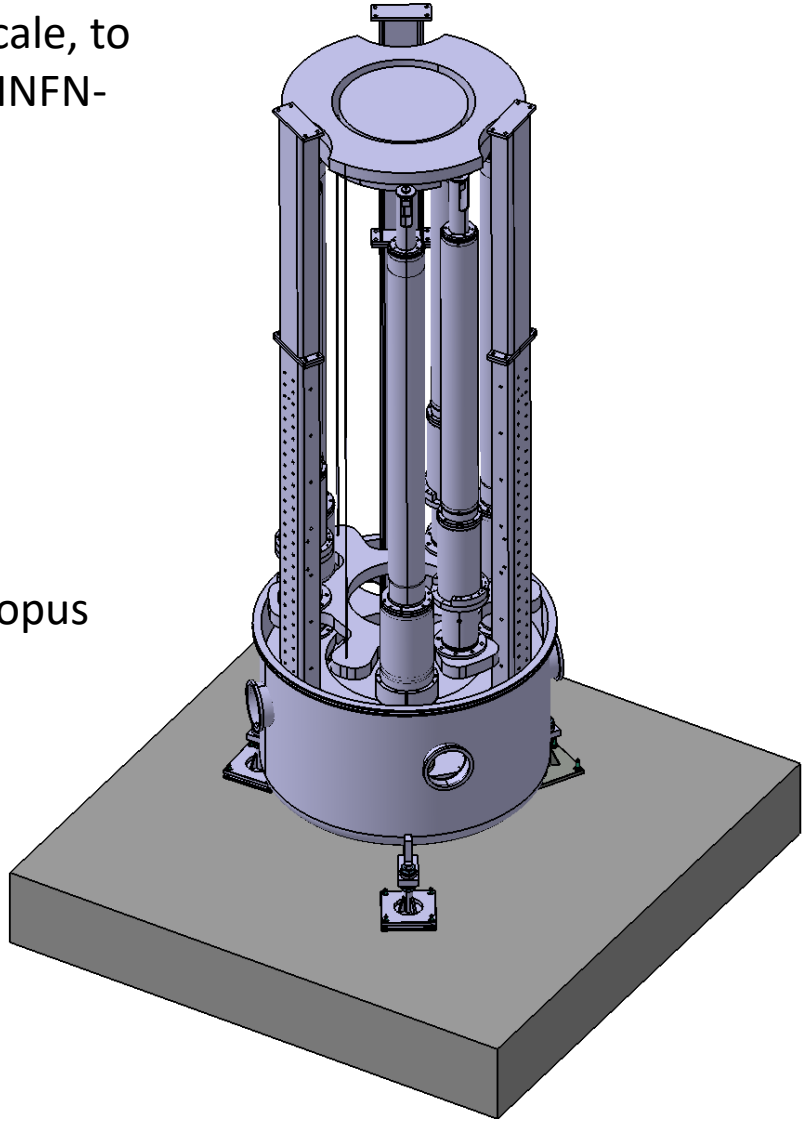
Total mass 1200 kg

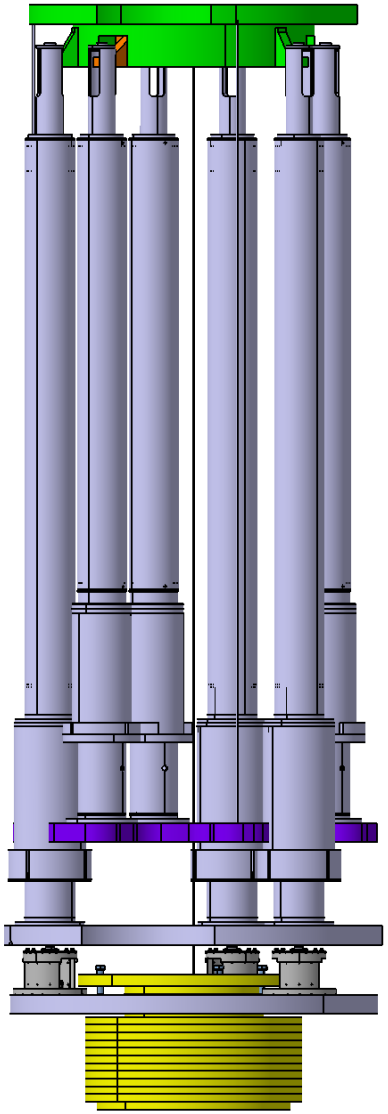
Legs of about 1.7 and 1.4 m (excluding flex joints)

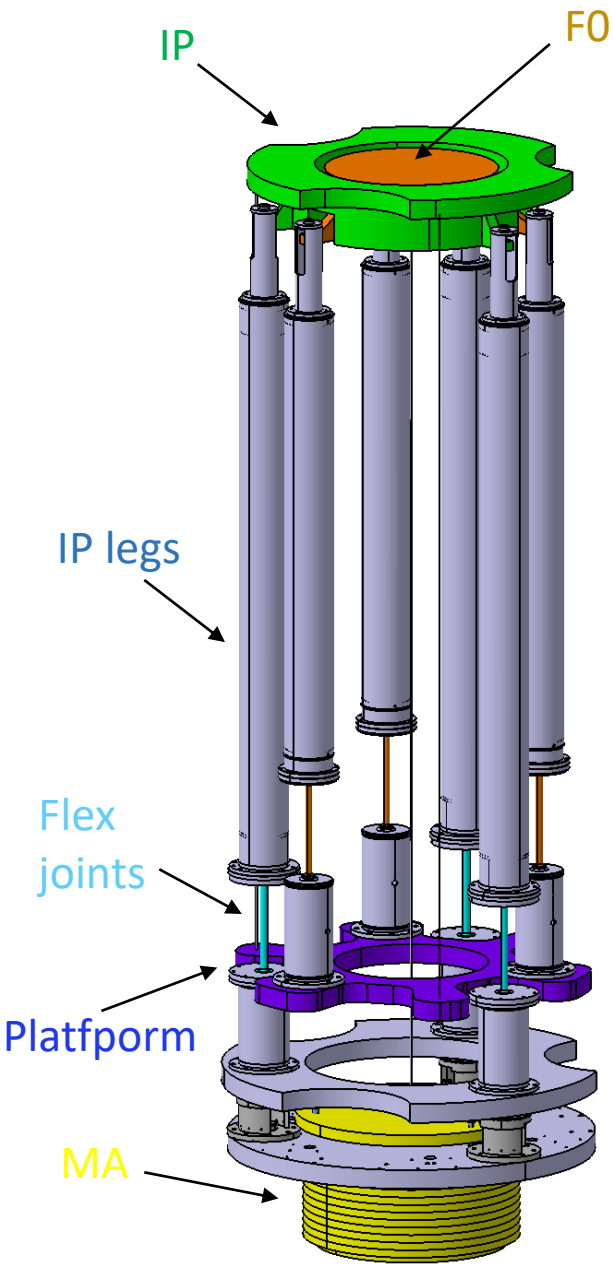
Dummy mass = 600 kg

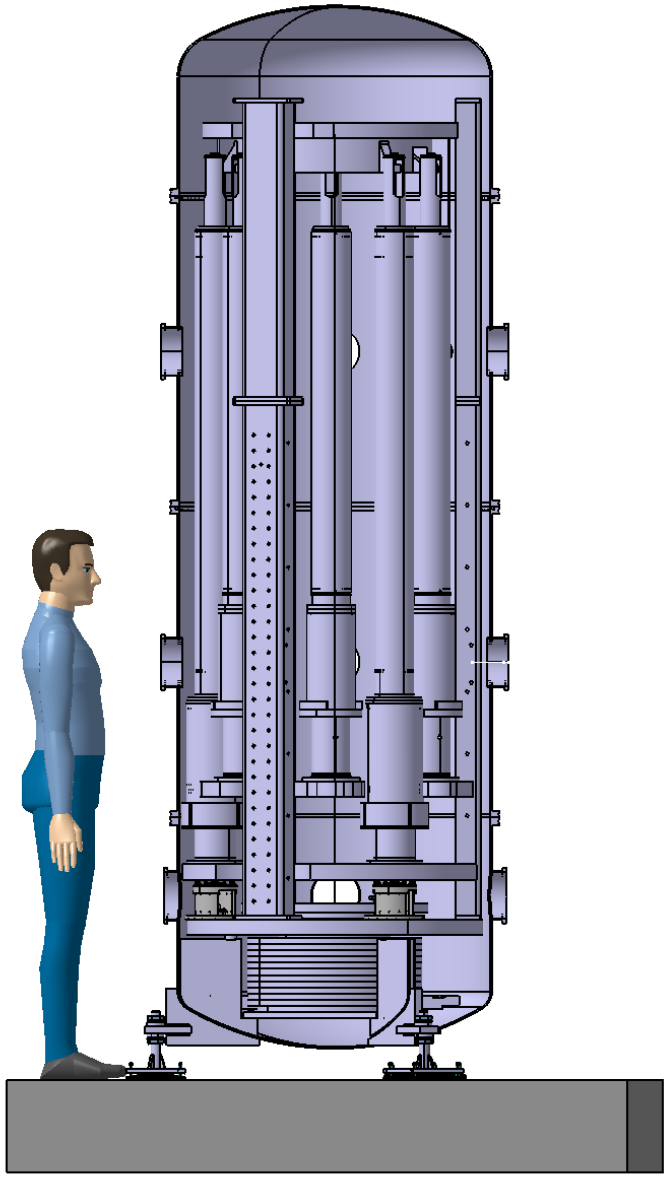
The design is based on preliminary studies with Octopus

The mechanical design is quite advanced
(it is supported by Octopus and FEM simulations)






IP
F0
IP legs
Flex
joints
Platfporm
MA



WP3 – Development and test of a Nested Inverted Pendulum (NIP)

Present status:

Mechanical design is quite advanced:

- Vacuum chamber base and feet (order placed, construction ongoing)
- Base ring, Flex joints, legs, IP top stage, Platform ,FO, Dummy test mass
- FEM simulation of critical components to check compatibility with system requirements

Orders have been placed for:

- legs, and the first three flex joints (due to maraging steel availability)
- Row materials for Base ring, IP top stage, Platform, FO

To do:

- supports and interfaces for sensors and actuators
- Wire supports and junctions
- Safety structure

We plan to complete mechanical design in the coming months.

Next year activity

- Production of all mechanical components: January-June)
- Assembling, integration and beginning of commissioning (July-December)

WP4 – Sensing and Control (S&C)

We have defined: Type, number and requirements for the various components:

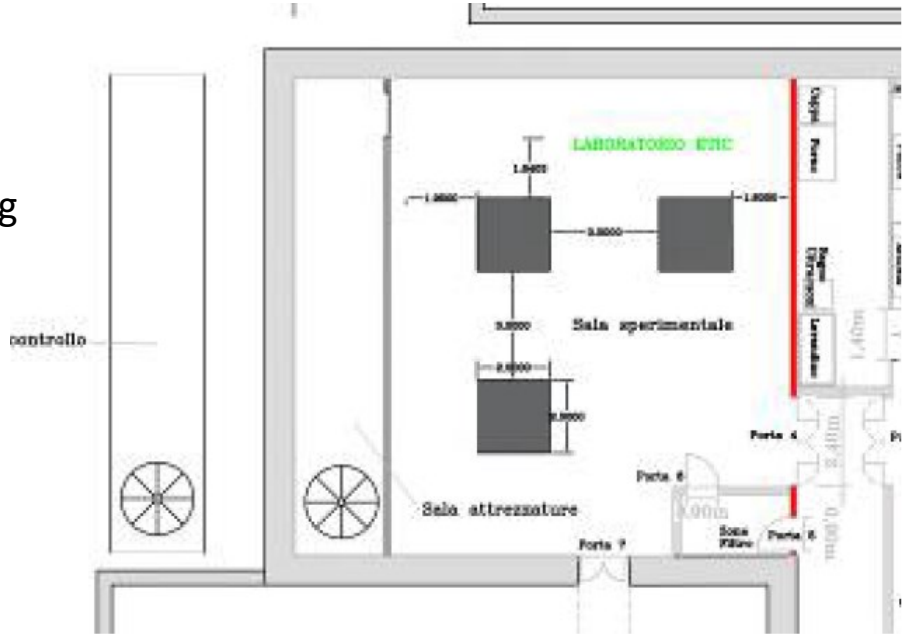
- Acquisition and control (National Instruments) → Purchased (under test)
- LVDT → Already available
- Accelerometers → Just ordered
- Optical sensors components → Purchased
- Optical sensors electronics → first prototype realized and under test (some extra noise under investigation)
- Actuators (coil/magnets) → under design
- Motors (for centering springs) → Already available

The new PLaNET Laboratory

We will get a new lab (~170 m^2) were will install the NIP prototype (previously hosting decommissioned accelerator for nuclear physics)

The restoration and upgrading works will include:

- A general renovation of the area
- A new air processing system providing:
  → Climatization for stable thermal condition
  → Smal overpressure for avoiding dust contamination form outside (gray area)
- A new crane with free eight under the hook of 5 m
- Realization of 3 reinforced concrete plinths (4 m^2 each) with foundations independent of the building
- Complete equipment of the lab (optics and electronic instrumentation, optical benches, data acquisition and control systems, cleaning equipment, vacuum systems …)



Opening of the construction site in December 2023
→ work duration 4-6 months

Conclusions

The NGSA NIP prototype is under development

All the components should be available by half 2024

The Prototype will be assembled as soon as the new lab will be available (There is always some indetermination with civil works)

Commissioning and data taking will be completed by 2025

Thank you for your attention