

NEW GENERATION SUPERATTENUATOR (NGSA) FOR SEISMIC NOISE SUPPRESSION

Proposal to CSN5 “Open Call” R&D Program Third Generation
Gravitational wave detector Einstein Telescope (ET) – Giant Laboratory

R&D PROGRAM ON VIBRATION ISOLATION SYSTEM FOR GW DETECTORS

- Summary :

Scientific Proposal & Goals of the experimental activities

Deliverables

Project Organization

WP, groups involvement and responsibility, funding

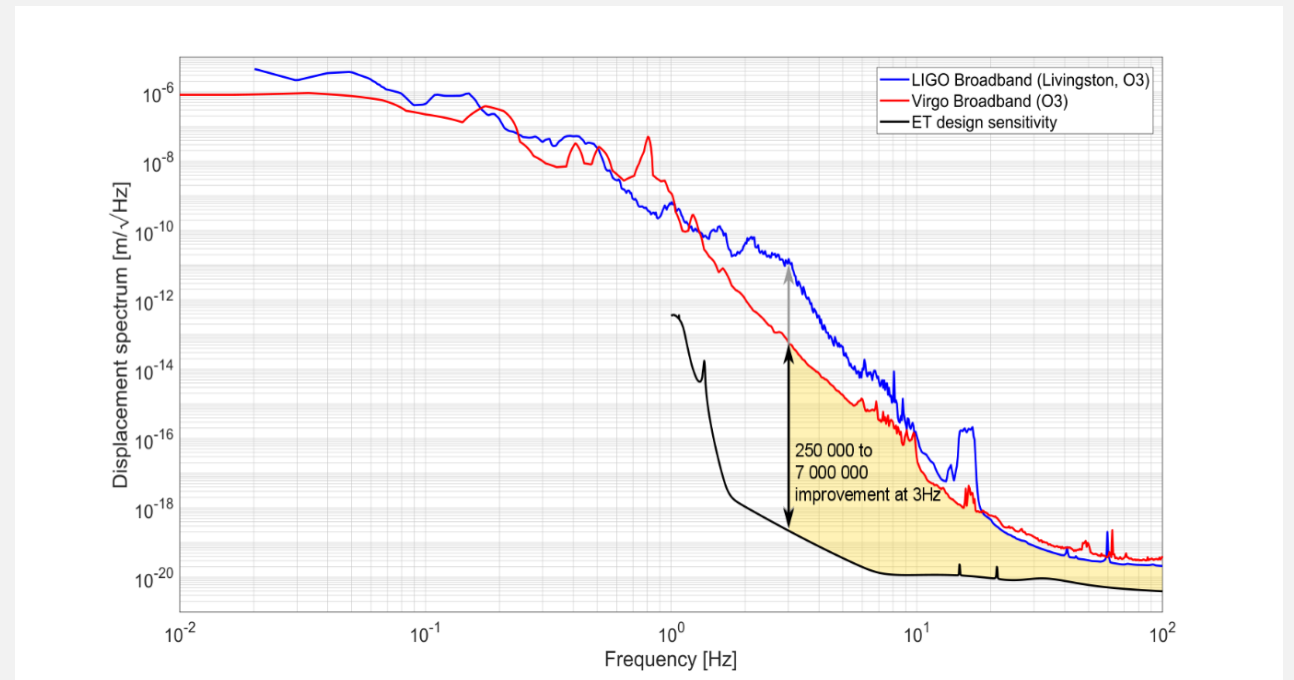
Impact of the experimental activity on INFN Pisa

SCIENTIFIC PROPOSAL AND GOALS

- The Project is based on the **improvement of vibration isolation performance** for 3rd generation detectors of Gravitational Waves – Einstein Telescope (ET) underground giant laboratory
 - ET is aimed to improve the current sensitivity (2nd generation) by a factor 10 extending the observation bandwidth in the low frequency region around 2 Hz

SCIENTIFIC PROPOSAL AND GOALS /2

- Displacement sensitivity of the 2nd generation detectors (O3 - Observation run 3) and ET design sensitivity
- Extending the bandwidth in the low frequency region around 2 Hz, requires an improvement with respect to the present experimental limits of more than 5 order of magnitude

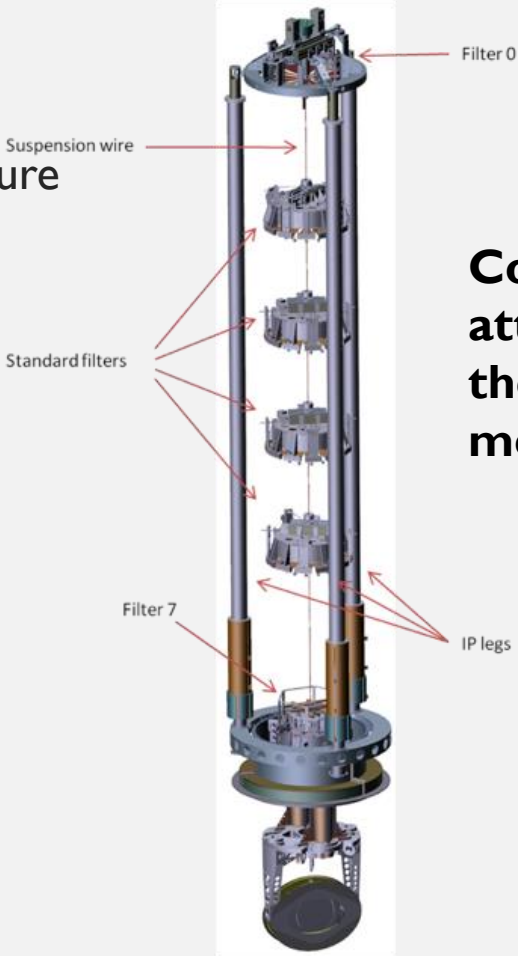


SCIENTIFIC GOALS

- Define guidelines for future seismic isolation systems to be extended down to 2 Hz: seismic noise is the dominant noise source in the low frequency region
- **Two different experimental lines:**
 1. Based on the **AdV mechanical structure** (Inverted Pendulum, Filters chain, heavy/cryogenic payload) with the intent to better distribute the mass all along the suspension chain, improving vertical attenuation performance and keeping the total length of the structure around 12 m
 2. Based on the use of a **two-stage Nested Inverted Pendulum (NIP)**: evident advantages from the point of view of the horizontal pre-isolation stages but never put in operation with many open questions (stability, automatic control, cross coupling of different d.o.f., vertical and tilt noise at ground level, ...)
- **Present mechanical system of the SA (2nd generation) is considered compliant with 3rd generation detector (see ET Conceptual Design)**

TWO EXPERIMENTAL LINES

1. Based on AdV mechanical structure

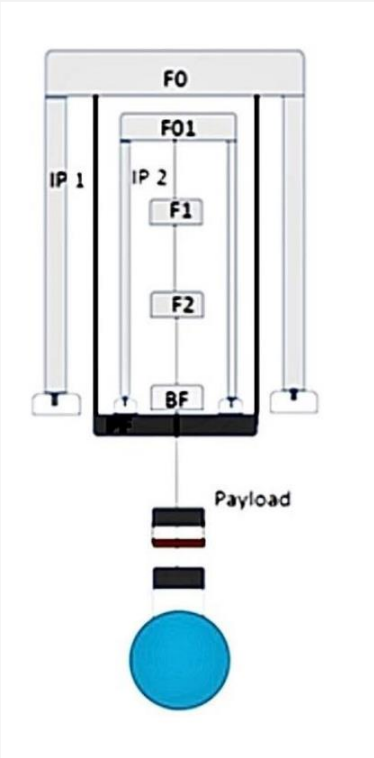


2. Based on two-stage NIP

Common Goal: fulfil the ET attenuation requirements keeping the whole length of the mechanical structure around 12 m



Great impact on the excavation cost of the caverns



PROJECT ORGANIZATION

- Project PI: Luciano Di Fiore (INFN NA)
- WP 1: **Simulation and Optimization of the Superattenuators**
Responsible: L. Trozzo (NA); Groups: NA, **PI**, EGO, LNS/SS; **AdR#1 (Na 50%)**
Deliverable: Modeling and Simulation for the two experimental lines
- WP 2: **Mechanical filter with improved Magnetic Anti-Spring (MAS)**
Responsible: **F. Frasconi (PI)**; Groups: **PI**, NA; **AdR#2 (Pi 50%)**
Deliverable: Filter prototype with new MAS geometry
- WP 3: **Development and test of a Nested Inverted Pendulum (NIP)**
Responsible: R. De Rosa (NA); Groups: NA, **PI**, LNS/SS; **AdR#1 (Na 50%)**
Deliverable: NIP prototype in reduced scale (1:2) and its characterization
- WP 4: **Sensing and Control (S&C)**
Responsible: **A. Gennai (PI)**; Groups: **PI**, NA, LNS/SS; **AdR#2 (Pi 50%)**
Deliverable: Sensor & Control system based on commercial devices for laboratory activity

FUNDING
REQUEST
2022-224

RU	WP	item	2022	2023	2024	type
NA	3	mechanics	10	40	5	cons
	3	electronics	5	20	5	cons
	3	vacuum equipment	40			cons/instrum
	3	optical sensors	5	35	5	cons/instrum
	1,3	manpower	30	30	30	AdR contract
	1,3,4	travel expenses	3	4	4	travel
		Total	93	129	49	271
PI	2	raw material mechanics	10	15	30	cons
	2	sensor tools	10			instm
	4	control system	60	10	10	cons/instrum
	4	software	15	5		software
	2,4	sensors & actuators	80	10	10	instrum
	4	cabling	10	5	5	cons
	2,4	manpower	30	30	30	AdR contract
	2,4	travel expenses	3	8	6	travel
	Total	218	83	91	392	
LNS/ Sassari	3	mechanics	5	5	3	cons
	3	electronic components	5	10	3	cons
	3,4	travel expenses	3	8	8	travel
		Total	13	23	14	50
TOTAL	1,2,3,4		324	215	154	713

PEOPLE INVOLVED

Researcher	RU	FTE	Contribution to Work Packages months/year			
			WP1	WP2	WP3	WP4
L. Di Fiore	INFN NA	0,40	1.1	1.1	1.1	1.1
R. De Rosa		0,20			1.7	0.5
L. Trozzo		0,40	3		1.4	
AdR #1		1,00	5		6	
Total		2	9.1	1,1	10.2	1.6
F. Frasconi	INFN PI	0,40	0.5	3.4		0.5
A. Gennai		0,40	0.5		0.5	3,4
F. Pilo		0.1		1.1		
AdR #2		1		5.5		5.5
Total		1,90	1	10	0.5	9.4
D. D'Urso	LNS/Sassari	0,2	1.2		1.	
D. Rozza		0,1			1.1	
V. Sipala		0,1			0.6	0.5
L. Tosta e Melo		0,3			3.3	
Total		0,7	1.2		6	0.5
P. Ruggi	EGO	0,25	2.75			
NGSA Total		4.85	14.05	11.1	16.7	11.5

SUPPORT REQUEST @ INFN PISA

- 2022 – 2023: 1 MU/year of mechanical workshop for construction of small mechanical parts for MAS prototype to be used in the test bench (VIRGO Lab INFN-Pi)
- 2022 – 2024: 1 MU/year for mechanical design and project activity for filter prototype construction (to be assigned to an external workshop)
- Standard support of “Alte Tecnologie People” for laboratory daily life