VIRGO

Gianluca Gemme – INFN Genova

Responsabile Nazionale Virgo

OUTLINE

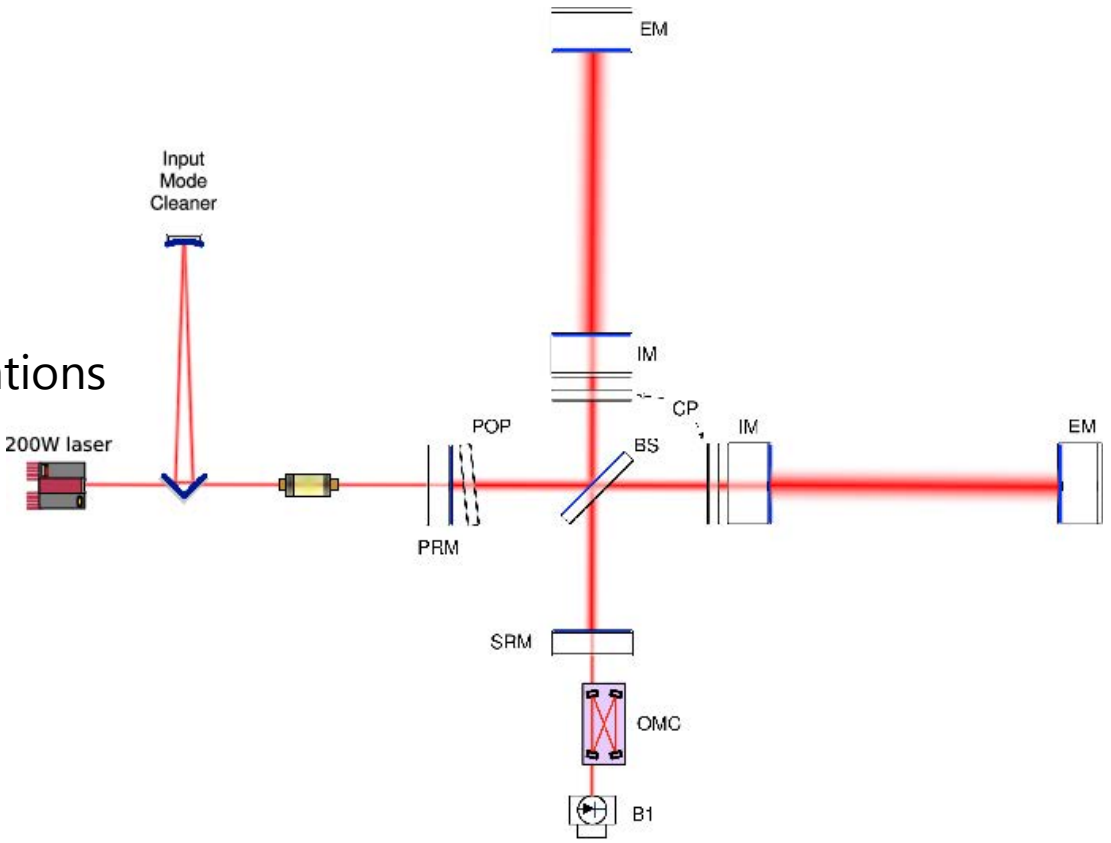
- ✓INTRODUCTION: THE ADVANCED VIRGO TARGETS
- ✓ADVANCED VIRGO STATUS: HIGHLIGHTS
- ✓MAIN ISSUES
- ✓VIRGO@GENOVA – STATUS AND PERSPECTIVES
- ✓ADCOAT & EXTERNAL PROJECTS

INTRODUCTION: ADV TARGETS

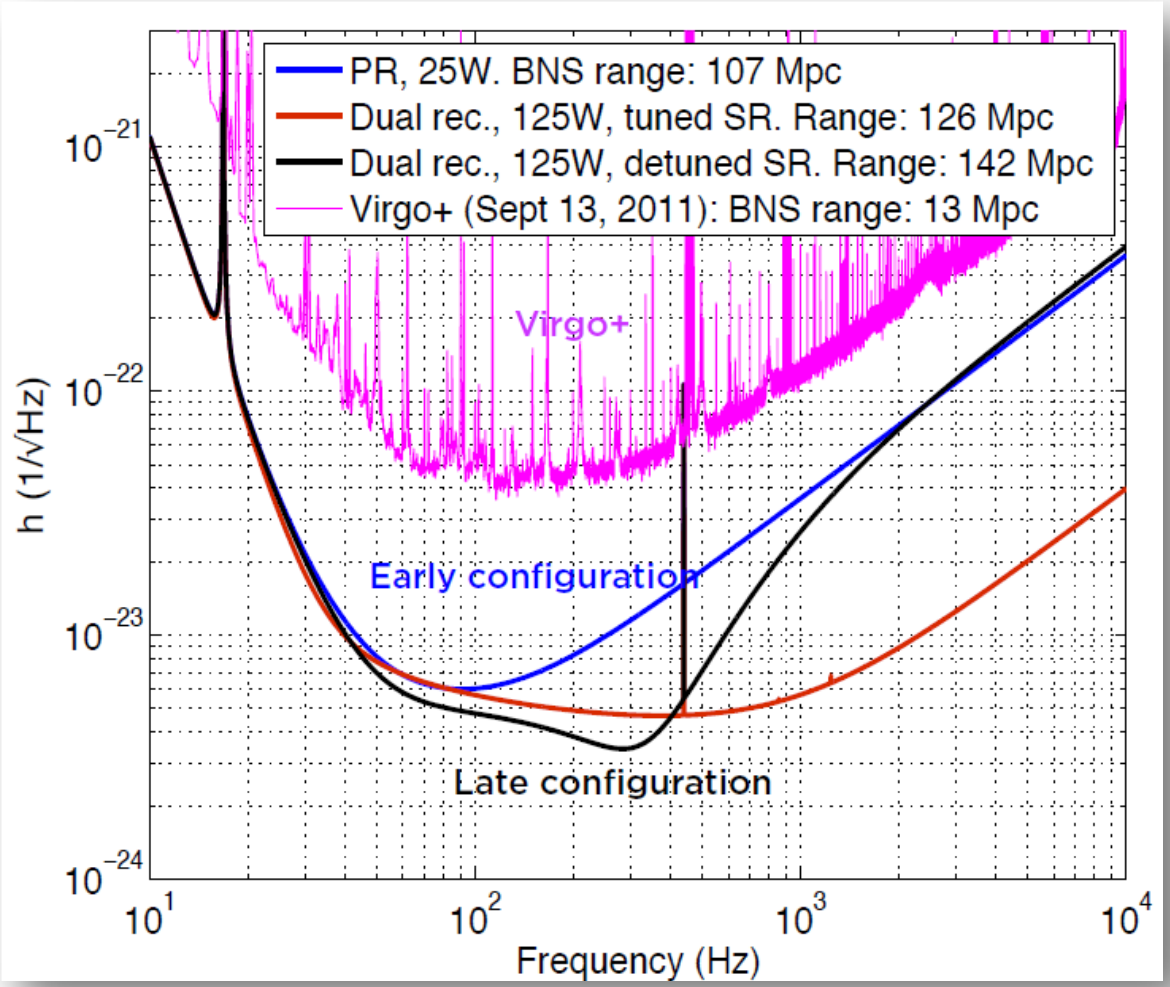
ADV DETECTOR DESIGN

- ✓TDR realeased in 2012
- ✓Main changes wrt Virgo
  - Larger beams
  - Heavier mirrors
  - Higher quality optics
  - Thermal control of aberrations
  - Stray light control
  - 200W fiber laser
  - Signal recycling

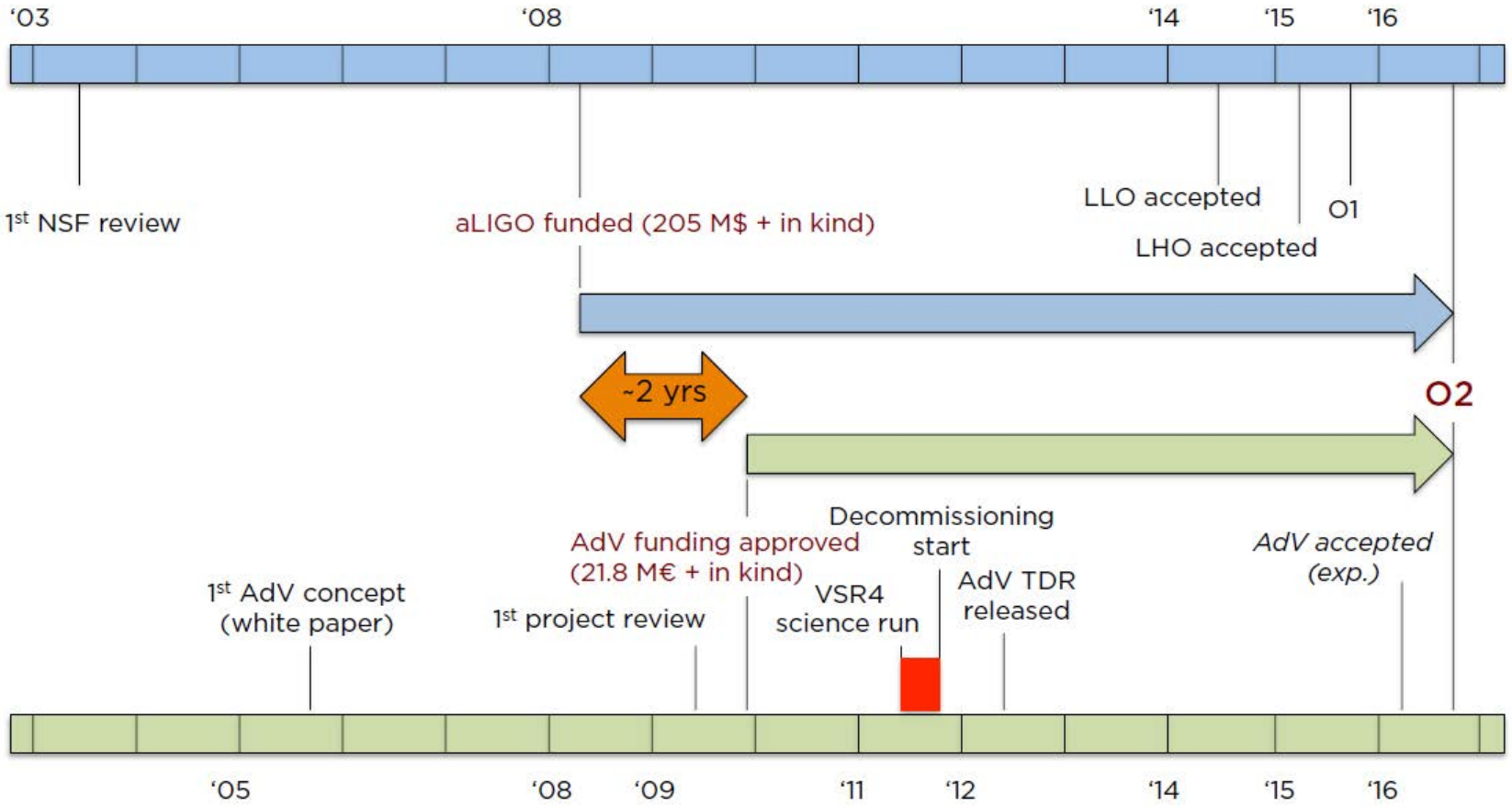
2017/18



SENSITIVITY TARGETS

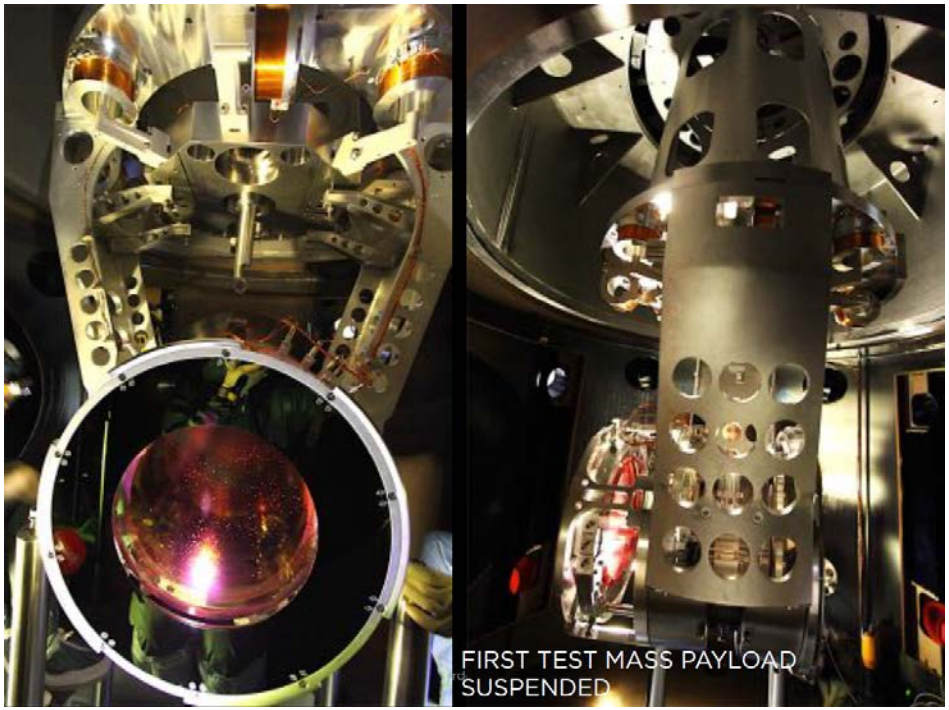


SOME HISTORY



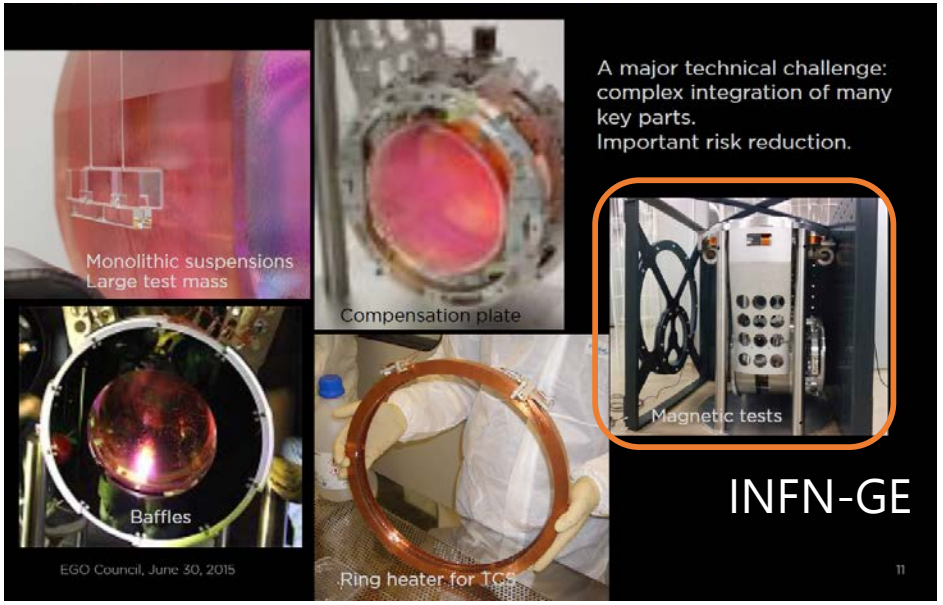
ADV STATUS HIGHLIGHTS

TEST MASS PAYLOADS

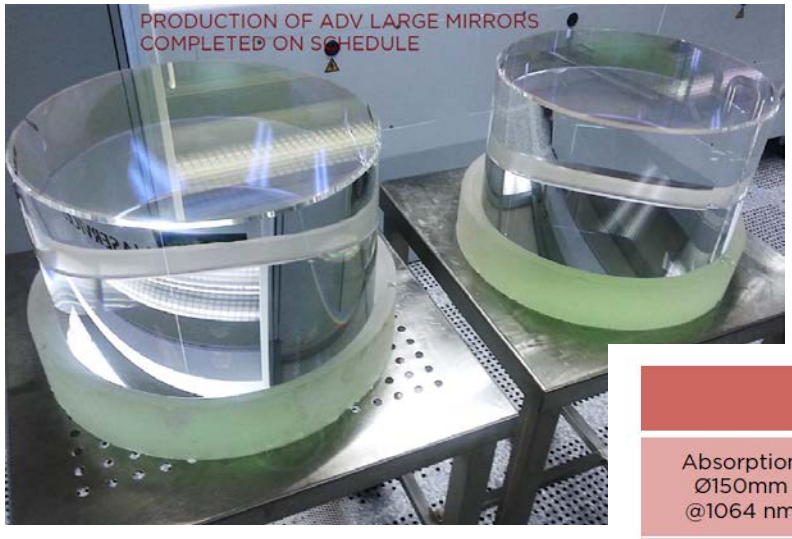


First test mass payloads suspended

A major technical challenge: complex integration of many key parts.
Important risk reduction

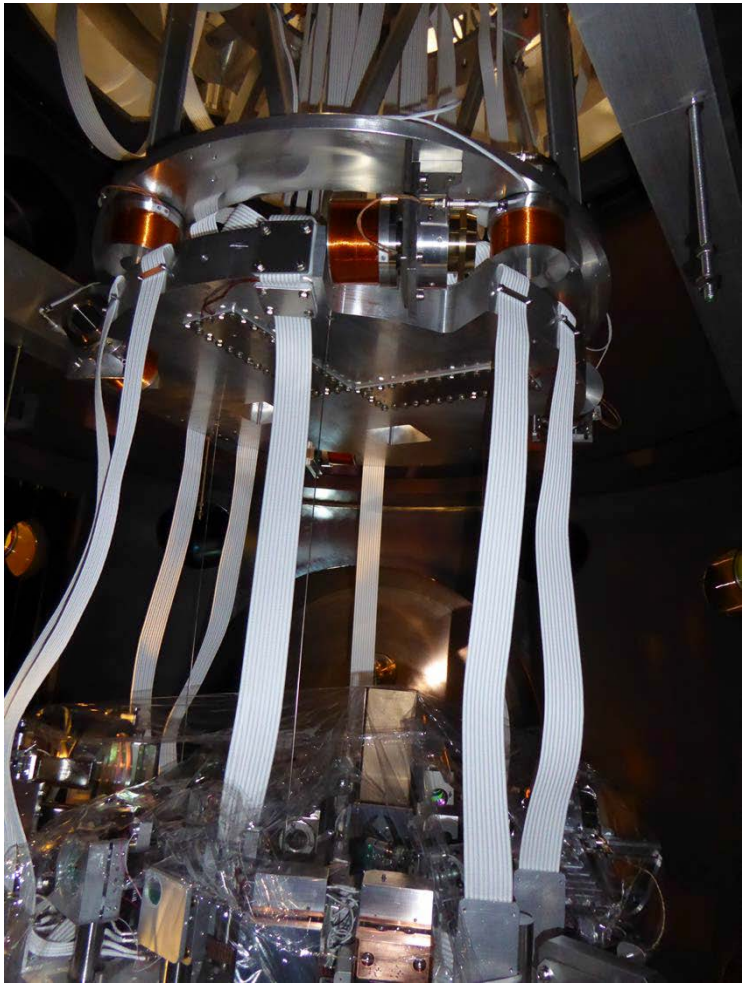


MIRRORS



		IM02	IM04	EM01	EM03
Absorption Ø150mm @1064 nm	TDR Spec.	< 0.5 ppm	< 0.5 ppm	< 0.5 ppm	< 0.5 ppm
	Result	0.22 ppm	0.19 ppm	0.24 ppm	0.24 ppm
RMS Flatness Ø150mm	TDR Spec.	< 0.5 nm	< 0.5 nm	< 0.5 nm	< 0.5 nm
	Result	0.31 nm	0.27 nm	0.50 nm	0.35 nm
ROC	TDR Spec.	1420 m -5m, +15 m	1420 m -5m, +15 m	1683 m -3m, +17 m	1683 m -3m, +17 m
	After polishing	1425.2 m	1425.2 m	1690.6 m	1690 m
	After Coating	1424.5 m	1424.6 m	1695.2 m	1696.3 m
AR reflectivity Ø150mm 1064 nm	TDR Spec.	<100 ppm	<100 ppm	<300 ppm	<300 ppm
	Result	58 ppm	32 ppm	133 ppm	155 ppm
RTL	TDR Spec.	x	x	< 75 ppm	< 75 ppm
	Result	x	x	12 ppm	12.5 ppm

SUPERATTENUATORS & SUSPENDED BENCHES



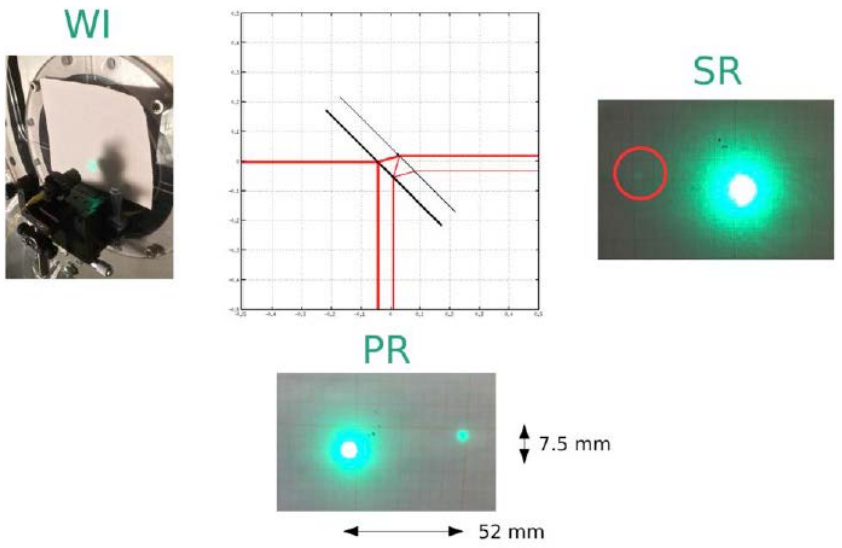
MAIN ISSUES

THE ***WEDGE*** ISSUE

THE ***BLADE*** ISSUE

THE WEDGE ISSUE

- ✓During the pre-alignment (mid-april) it was discovered that the Beam Splitter has a vertical wedge (should be horizontal)
- ✓This was originated by an error in the drawings sent to the polisher that leaked through the entire control chain
- ✓A systematic survey revealed that the same error was made also for the pick-off plate, facing the PR mirror



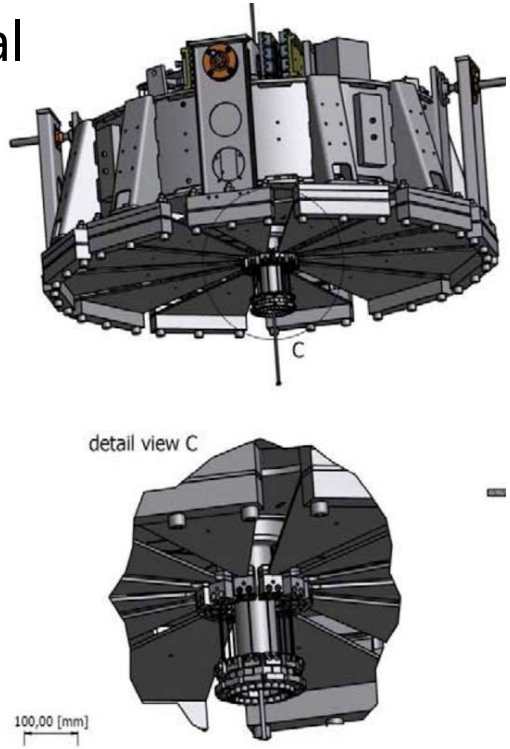
ISSUE MANAGEMENT

- ✓On the basis of the simulations performed we have identified a working configuration
  - Keep the BS as it is
  - Mount the POP with (vertical) wedge opposite to the BS
  - Lower the interferometer plane by 3mm
- ✓Solution reviewed and approved
  - Slightly modified positions/angles for the INJ/DET benches and the mirrors
  - Limited reshuffling of the SPRB/SDB1 benches

TEAM	PEOPLE	TOPICS	TOOLS
INJ	E Genin, A Chiummo, G Pillant, Ruggi	- SIB1 position/orientation - Vertical wedges vs adjustability of SIB1/ IB SA	Zemax, Optocad, analytic computation
DET	R Gouaty, C Buy, R Bonnand	- Check DFT translation to compensate the B1 vertical tilt - B1/B5 separation including effect of W arm tilt - Definition of required CP tilts	Zemax, Optocad, analytic computation
OSD	J Degallaix, M Pichot, B Swinkels, F Sorrentino	- 3D check of beam position and orientation on all mirrors - Redo the TDR simulation on the pickoffs - Effect of wedges on the distortion map	OSCAR, DarkF, FOG, analytic computation

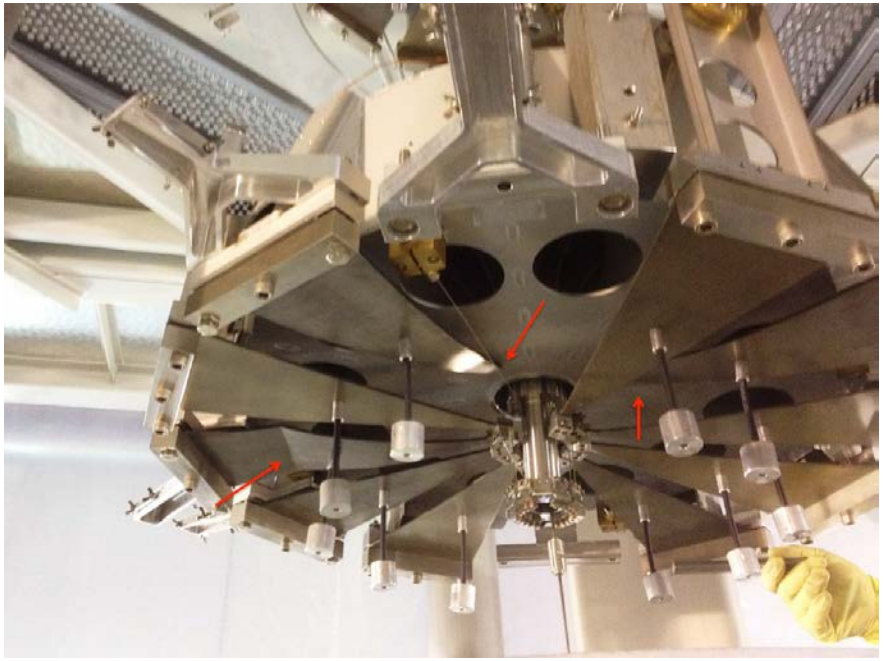
THE BLADE ISSUE

- ✓Cantilever blades are used to provide vertical isolation in the SA
- ✓They are made of maraging steel, which, properly treated, has been demonstrated to reduce drastically the creep
- ✓They have been one of the main innovation introduced by Virgo
- ✓They are installed since the early 2000s



BLADE FAILURES

- ✓9 blades have been found broken
  - 1 at the WI tower (March)
  - 8 at the WE tower (May)
- ✓Suspect: stress corrosion cracking by Hydrogen embrittlement
- ✓Some obvious questions:
  - What has caused the fractures?
  - What is the risk of new failures for the unbroken blades?
  - Do we have a diagnostic tool to identify the risky blades?
  - What is the best trade-off between minimizing the failure risk and the schedule risk?
  - …



LINES OF ACTION

- ✓SHORT TIME-SCALE: put the SA back in operation and suspend the payloads
- ✓MEDIUM TIME-SCALE: understanding the issue
- ✓Investigations are difficult for several reasons:
  - We don't have such a specific expertise on the field
  - We have the support of experts, but they are usually busy consultants or expensive ones
  - We have found helpful companies, but they need time and money to perform the tests and often the reporting is not compliant with our standards
- ✓Understanding the very nature of the problem will require time and money (and some real R&D)

UNDERSTANDING THE ISSUE

WHO	WHAT	OUTCOMES	REPORT
Dpt. of materials eng. Uni. of Pisa Prof. R. Valentini	H content, SEM on some broken blades	Preliminary	Preliminary
IMG (ref. R Passaquieti)	Eddy current scan of blades (survey of internal defects)	Blades of 5 towers analyzed and classified in 3 groups	Yes
ECO Acciai (ref. F Frasconi)	XRF: measure of chemical composition	Yes	Yes
INFN Genova + Chemistry/Eng. Dpts.	AES/SEM, mechanical tests, FEM	Work starting now	No
SMT (ref. R Passaquieti)	SEM and metallography on blades/wires, mechanical tests	Preliminary	1st part (wire)
REMET (ref. F Carbognani)	Ultrasounds	Preliminary	Yes
LAMBDA (ref. F Frasconi)	X-ray	Preliminary	No

VIRGO@GENOVA

STATUS AND PERSPECTIVES

LN2 PLANT & VAC

D. BONDI, G. GEMME

Terminal buildings lines: completed , no activity.

Central building lines: inlet/outlet piping completed, small works still in progress (thermal insulation of outlet, last section to Smalltrap)

LN2 supply contract: signed with **Linde Gas** . Tanks + Cryogen for 3 years

Installation on site starting in August

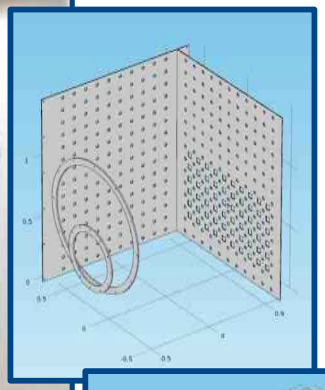
Liquid nitrogen available in central building from end September

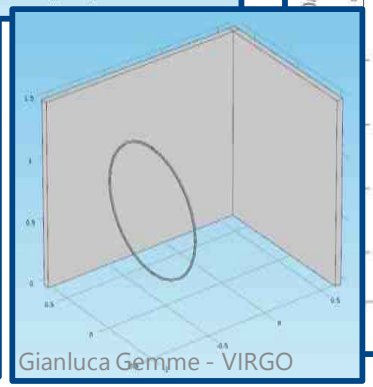
MAGNETIC CHARACTERIZATION OF PAYLOADS

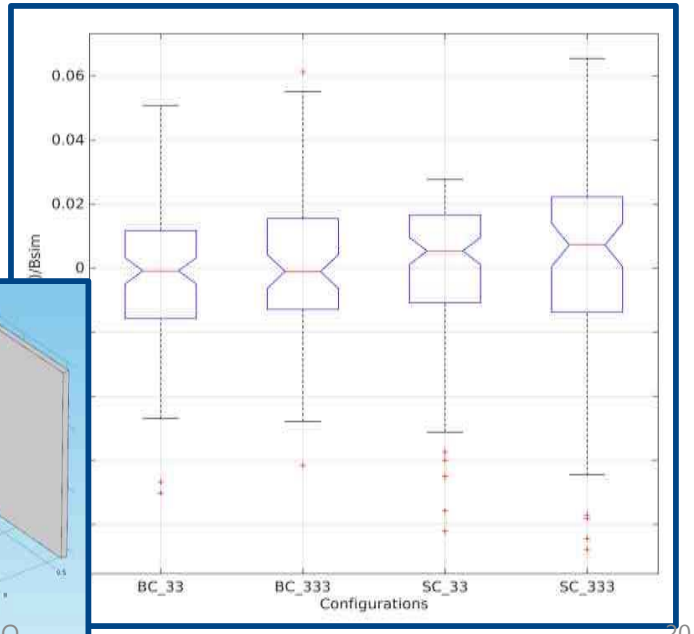
A. CHINCARINI, S. FARINON, M. NERI

Reference measurements for magnetic noise evaluation
- measurements VS simulation

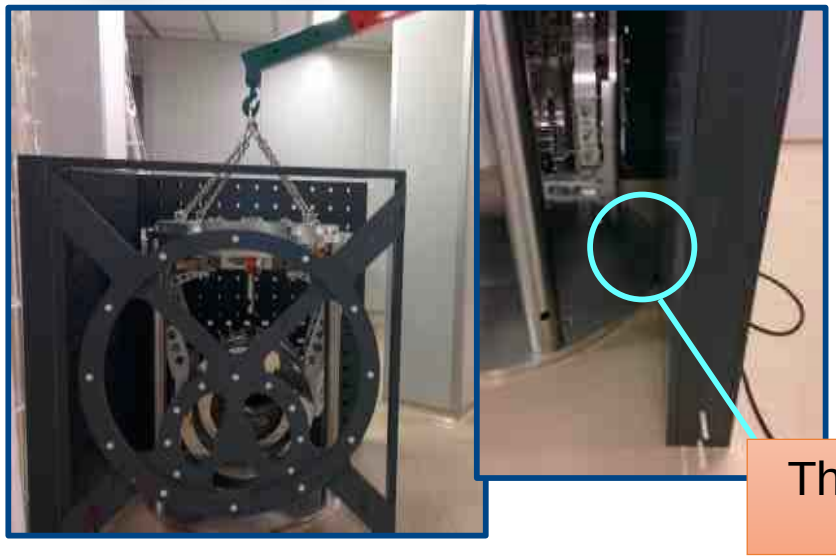
4 configurations:
- Big Coil @ 33 Hz
- Big Coil @ 333 Hz
- Small Coil @ 33 Hz
- Small Coil @ 333 Hz

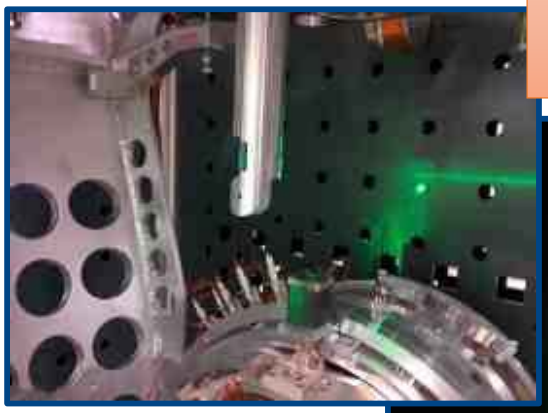


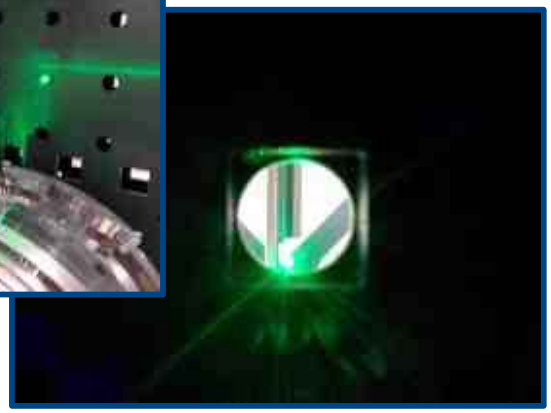




Positioning and alignment of the Payload inside the cage:







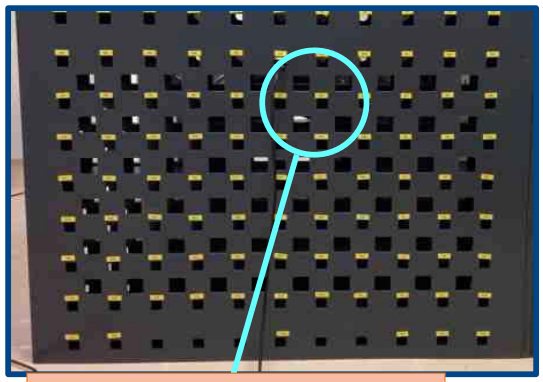
Green laser to align

The base is tangent to the cage

Measurements:

On the panels

Inside the volume

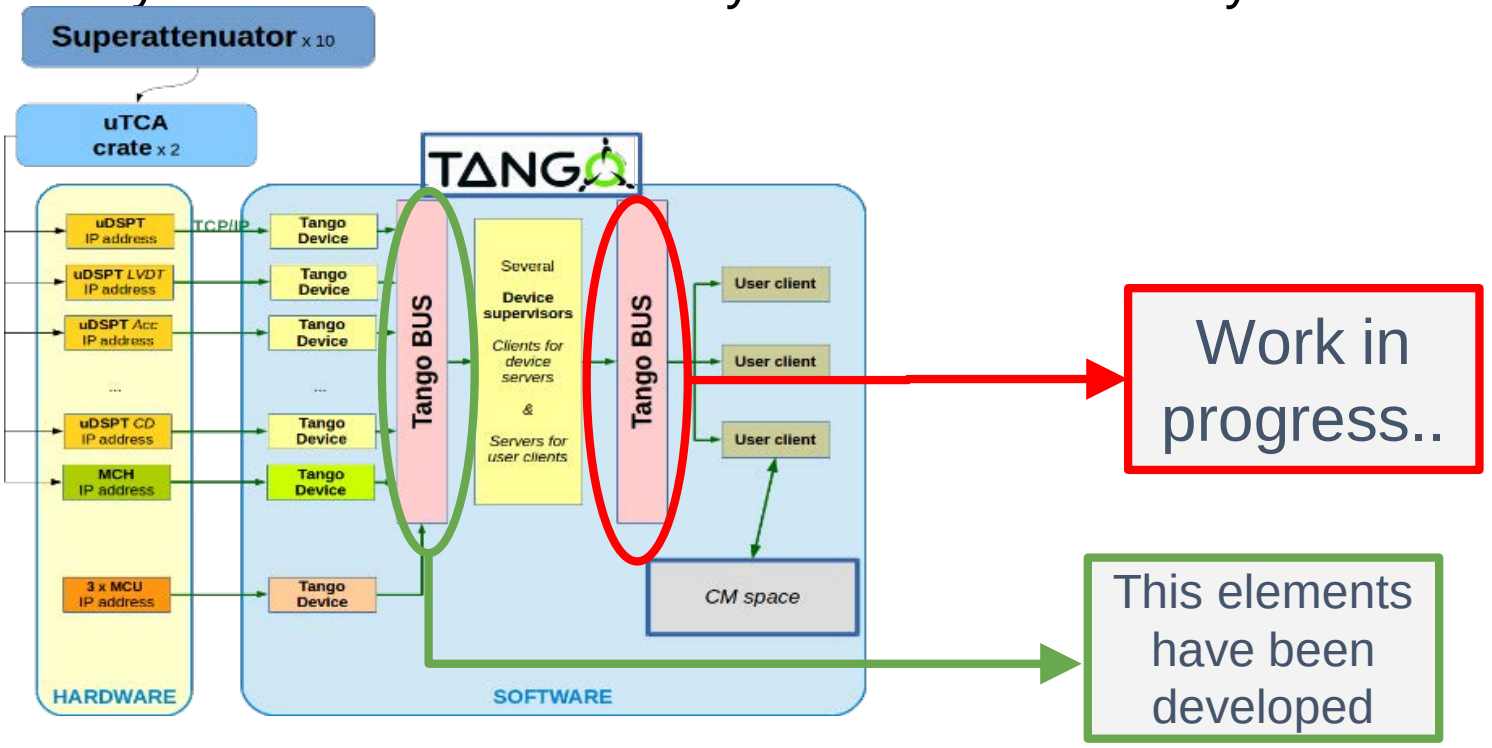


Tri-axial magnetic probe

SAT CONTROL ELECTRONICS

L. REI

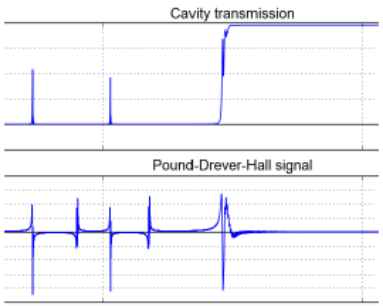
- ✓During the last months several tests and characterizations were carried on a set of 20 boards (240 channels) available since *February 2015*
- ✓Development of new Supervisor software is progressing: a preliminary version with several key features is currently under test



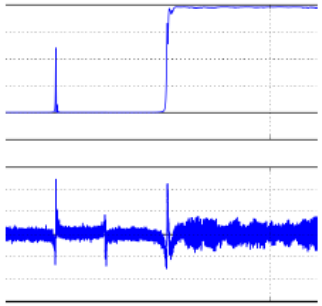
ISC: ARM CAVITY SIMULATIONS

D. BERSANETTI

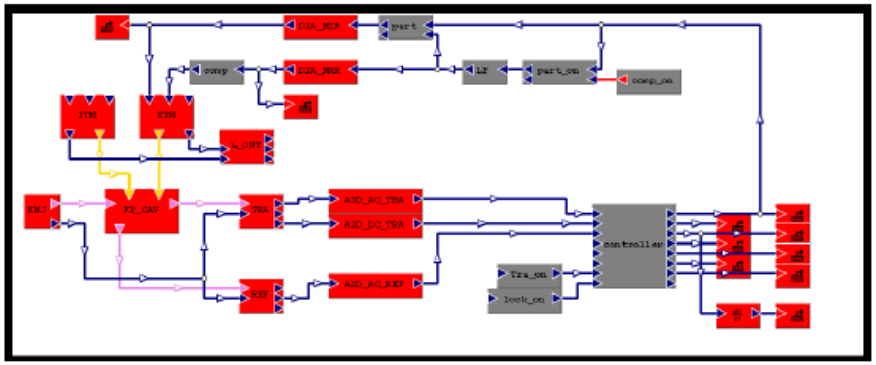
- ✓Redoing time-domain simulations of guided lock with E2E, including photodiode noise, realistic model for payload TF, actuator strength and seismic noise
- ✓Simulations are working, but need to fine-tune and double-check all parameters



PDH in reflection



PDH in transmission

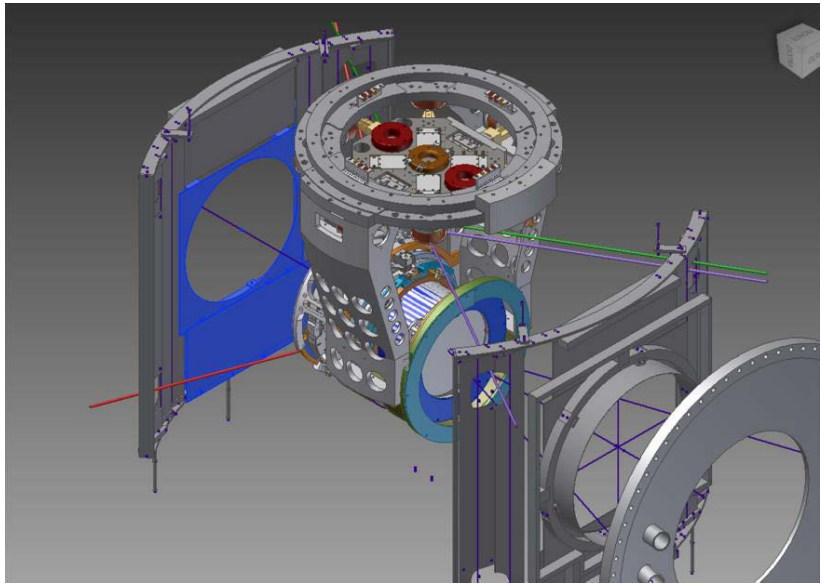


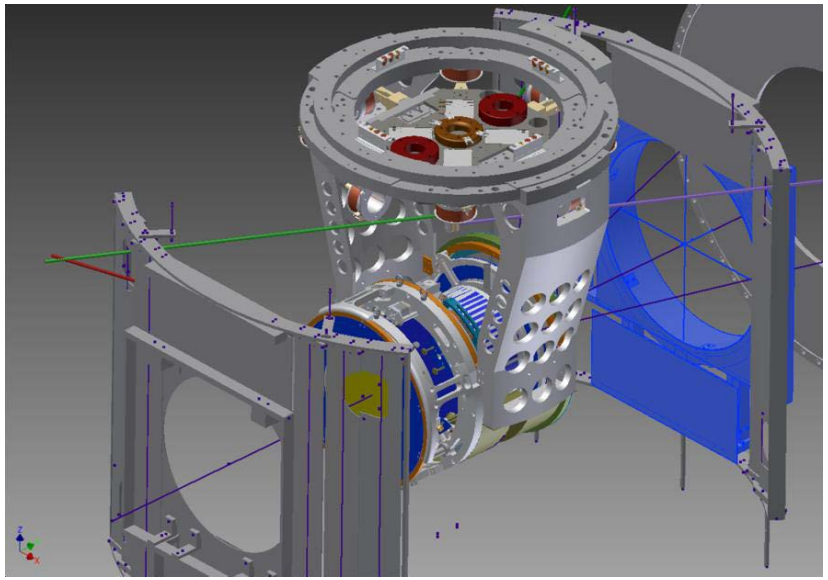
BAFFLES FOR STRAY LIGHT CONTROL

F. BRAGAZZI

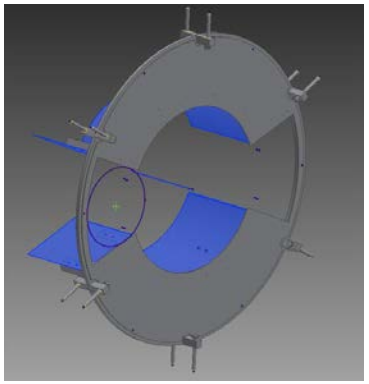
- Past generation glass baffles *difficult to re-machine* to fit AdV beam sizes and geometry
- Need to replace some of the glass baffles with stainless-steel

- Design and integration now well advanced, thanks to **F. Bragazzi** (INFN – Genova), and **A. Moggi** (INFN – Pisa).
  - ***But still to complete!***





- F. Bragazzi and A. Moggi promptly developed a concept design integrating the glass baffles

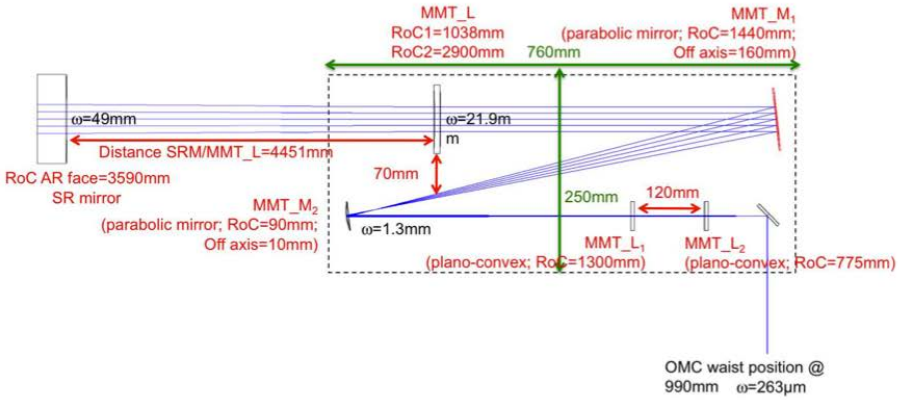


PRE-ALIGNMENT ACTIVITIES & DARK FRINGE TELESCOPE INSTALLATION

F. SORRENTINO

- ✓Align the INJ beam (and central interferometer optics) in order to reach end mirrors
  - angular precision ~200 µrad
- ✓Center INJ beam on central interferometer optics
  - ~1 mm precision

- ✓Catadioptric telescope
- ✓Parabolic mirrors in afocal configuration:
  - need a very precise relative alignment of transversal position, longitudinal position and angles
- ✓Study of the quality of the back-reflected beam after a double-pass



GROUP COMPOSITION

	RICERCATORI					
1	Bersanetti Diego	Associato	Dottorando	CSN II	50	*ISC - Scad. 30/6/2016*
2	Gemme Gianluca	Dipendente	Primo Ricercatore	CSN II	90	
3	Neri Martina	Associato	Dottorando	CSN II	50	*PAY - Scad. 30/6/2016*
4	Rei Luca	Associato	Assegnista	CSN II	10	*SAT-Electronics - Scad. 31/01/2016*
5	Sorrentino Fiodor	Dipendente	Ricercatore	CSN II	50	*ISC-DET-INJ*
				FTE	**2,5**	

	TECNOLOGI					
1	Chincarini Andrea	Dipendente	Tecnologo	CSN V	40	*PAY*
2	Farinon Stefania	Dipendente	Primo Tecnologo	CSN V	30	*PAY*
				FTE	**0,7**	

	SERVIZI		
1	Officina Meccanica	2.00	
2	Progettazione Meccanica	3.00	*SLC*
4	Servizi Generali	6.00	*VAC*

G. Gemme - Chair of the Virgo Editorial Board and National INFN Coordinator

Necessario dare continuità al gruppo

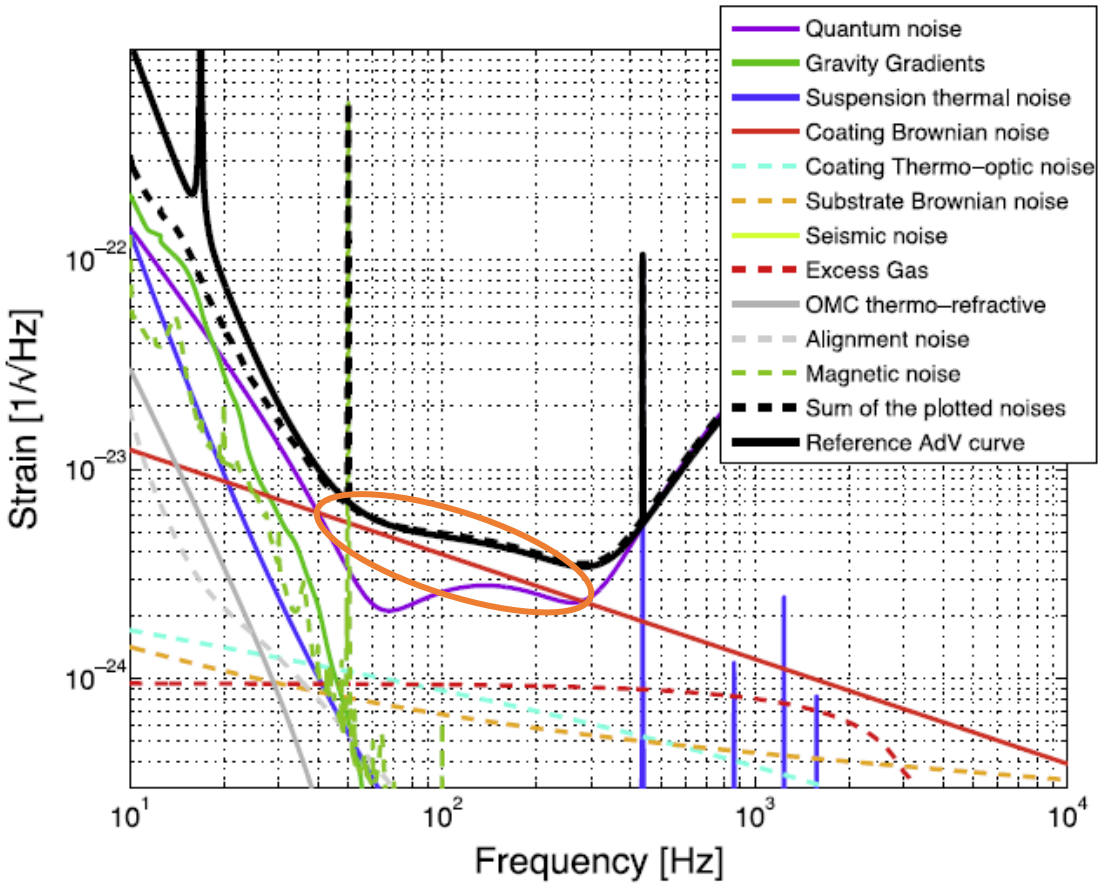
ADCOAT & EXTERNAL PROJECTS

EXTERNAL PROJECTS

- ✓PRIN 2010-2011
  Development of a squeezer based on the ponderomotive effect
  - F. Vetrano national coordinator
  - G. Gemme INFN coordinator
  - 2013-2016 (January)
    - WP3 – Simulation and modelling
    - WP5 – Definition of the technological solutions for a cryogenic development of the facilities

- ✓Premiale
- ✓Call H2020 – Grandi infrastrutture di ricerca (2016-2017)

ADCOAT - MOTIVATION



ADCOAT - PEOPLE

Innocenzo M. Pinto (PI, AdCOAT Coordinator) Vincenzo Galdi, Vincenzo Pierro, Maria Principe, Dario Castellano, Silvio Savoia

Maurizio Canepa (PI), Corrado Boragno, Francesco Buatier de Mongeot, Mauro Giovannini, Lorenzo Mattera, Gianluca Gemme, Martina Neri

Helios Vocca (PI), Marzia Colombini , Luca Gammaitoni, Fabio Marchesoni, Maurizio Mattarelli, Igor Neri

Alessio Rocchi (PI), Elisabetta Cesarini, Eugenio Coccia, Viviana Fafone, Yuri Minenkov

ADCOAT - STATUS

190 -1700 nm
Spectroscopic ellipsometry + transmission & scattering

- **Nanolayered Titania-Silica films**
- SE measurements (+ AFM) completed
- analysis

region of transparency, thickness and refraction index, completed
absorption edge, in progress (co.co.co. on UNIGE funds)
+ Raman (DCCI)

- **Ta2O5**
- measurements completed on first15 samples
- analysis in progress (region of transparence completed)
- + Raman (DCCI)
- Real time measurements during annealing (apparatus in commissioning)

ADCOAT – PLAN 2016

190 -1700 nm
Spectroscopic ellipsometry + transmission & scattering

- **nanolayered Titania-Silica films (collaboration with NU Taiwan)**
- 1-5-19 units, few nm each
- full structure (challenging, TEM useful, X-Reflectivity)

- **Ta2O5 (collaboration with LMA Lyon, doped with Ti)**
- Real time measurements during annealing

ADCOAT - ANAGRAFICA

	RICERCATORI				
1	Boragno Corrado	Associato	PA	CSN II	20
2	Canepa Maurizio	Associato	PA	CSN II	30
3	Gemme Gianluca	Dipendente	Primo Ricercatore	CSN II	10
4	Giovannini Mauro	Associato	RU	CSN II	30
5	Mattera Lorenzo	Associato	PO	CSNII	10
				FTE	**1**