

# CRYOMIRROR

A Fast Cooling System for Cryogenic Gravitational Wave Interferometers

proposta presentata per la call aperta di gr5, scaduta 11 giugno

Area di ricerca: interdisciplinare

Responsabile nazionale: Livia Conti

Unità partecipanti: Firenze, Padova, Perugia, Trento

# CRYOMIRROR

## THE PROBLEM:

long cooling times (several weeks) of mirrors in GW cryogenic interferometers, eg KAGRA, ET

## THE IDEA:

disentangle the process of initial cooldown of the mirrors from that of keeping them cold during operation: different requirements and constraints.

## THE METHOD:

by establishing an efficient temporary thermal link between the mirror and a cold source: the link is disengaged once the target temperature has been reached, leaving the cooled mirror ready for operation.

# International setting

Our proposal is reinforced by accompanying

- 1) letter of support signed by international coordinator of the Einstein Telescope project (M Punturo – INFN)
- 2) letter of support signed by the PI of KAGRA (T Kajita - ICRR)
- 3) recommendation letter signed by Chief Scientist of KAGRA Cryogenics Group (T Tomaru – KEK)

Furhermore:

- 4) letter signed by INFN Padova director granting adequate space and resources at LNL-AE

# Core of the project

design, realization & test of a prototype of  
movable thermal link

Basic requirements:

- establish a temporary but efficient thermal connection with the mirror
- be operative in the whole range between room and cryogenic temperatures,
- be clean and high-vacuum compatible,
- compensate for the thermal shrinkage of the payload suspension chain (order of some cm),
- be delicate and finely controllable so as not to damage the payload nor degrade its surface cleanliness or mechanical quality factor
- not pose additional constraints to the already complex payload design
- have no impact on the detector when in operation
- be reliable, repeatable and compatible with long term operation

# Work Organization

	Work Package Description	WP Leader
WP1	<b>Definition of requirements and control observables</b>	Vocca H
WP2	<b>Development of cryogenic test facility</b>	Taffarello L
WP3	<b>Development of the dummy payload</b>	Vocca H
WP4	<b>Development of the movable thermal link prototype</b>	Conti L
WP5	<b>Development of in-loop and out-of-loop sensors</b>	Perreca A
WP6	<b>Development of Payload/Device interface</b>	Bazzan M
WP7	<b>Functional test of the prototype</b>	Ciani G
WP8	<b>Tests of high-vacuum compatibility</b>	Bazzan M

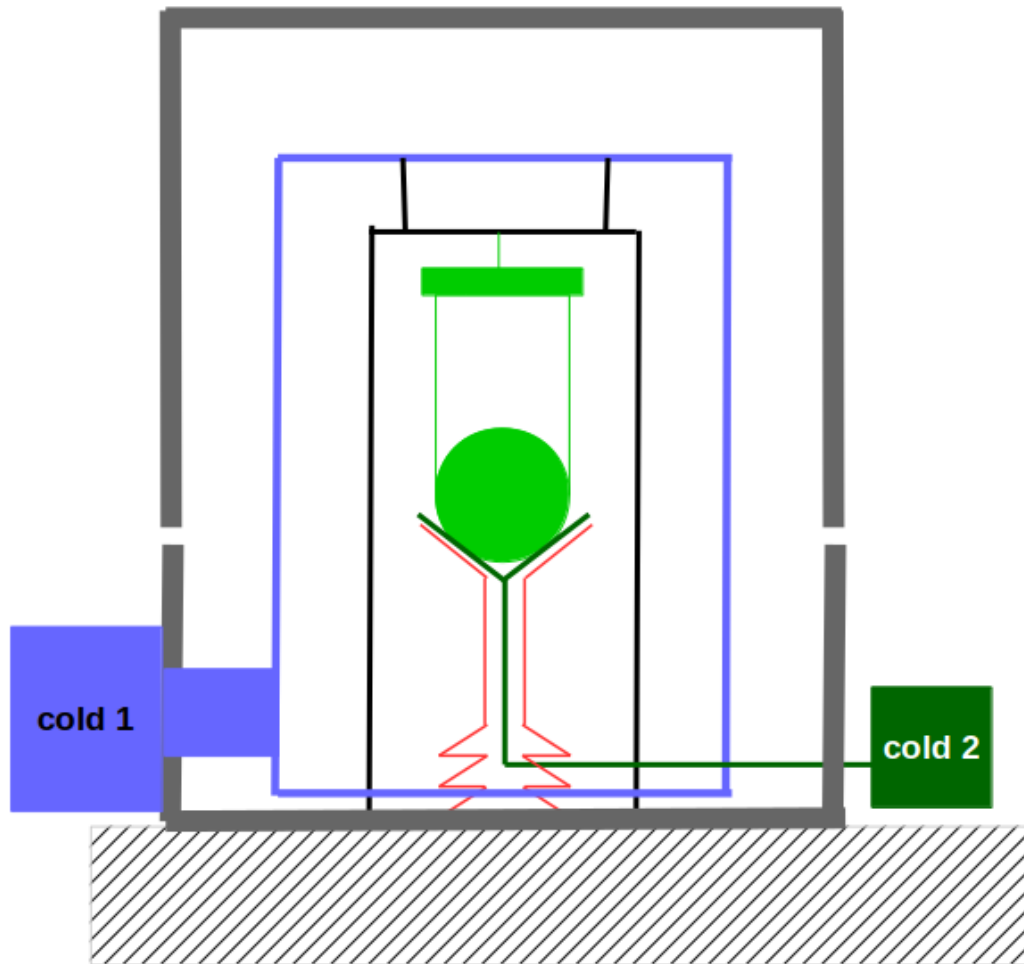
	YEAR 1	YEAR 2	YEAR 3
WP1	M MD		
WP2	D	D M	
WP3	MD	D M D	
WP4	D	M D D	M
WP5	M	D D	M
WP6	D MD	M D	
WP7			M M M D D
WP8			M D D

M = milestone

D = deliverable

# Basic idea of the prototype and its test facility

@LNL Alte Energie



chamber diameter about 2m  
chamber height about 3m

cryogenic liquids as cold1 source  
cryocooler as cold2 source

**Figure 3: conceptual scheme (not to scale) of the cryogenic facility to be installed at LNL for testing the prototype. The dummy payload is shown in green, the movable link in red, the vacuum chamber in gray (with separated top and bottom part, see WP2), the cold1 and cold2 sources are shown respectively in blue (as the shields) and dark green, the frame to hold the payload and the shields in black.**

# Timing in the GW research scene

(2011) Einstein Telescope (ET) design study, funded by the EU in FP7

(2018) 9th ET symposium: creation of the ET collaboration

(2020) ET proposal to be inserted in the 2020 update of the ESFRI roadmap

Timing of CRYOMIRROR matches the ET roadmap:

the ET team is planning to produce a technical design document, to constitute the base for a proposal for funding, in 2023.

The completion of our study before that time will allow the evaluation of the technology for implementation into ET, and its inclusion in the technical design.

# Anagrafica e servizi - Sezione di Padova

## Year 1

- Bazzan → 2 mesi/persona
- Ciani → 3 mesi/persona
- Conti → 4 mesi/persona
- Taffarello → 2 mesi/persona
- Zendri → 1 mesi/persona
- +2.5 FTE contratti

**ufficio tecnico:** 4 mesi/persona (disegno esecutivi)

**officina meccanica:** 2 mesi/persona (componenti per le camere, montaggi, organizzazione laboratorio)

**officina elettronica:** 0.3mesi/persona (attrezzatura/allacciamenti laboratorio)



# Budget

		consumabile	inv/app	missioni	consulenza	personale	tot
Fi-Urb	YEAR 1	2000		2500		12500	17000
	YEAR 2	4000	10000	2500		12500	29000
	YEAR 3			500			500
Padova	YEAR 1	30000	75000	10500	30000	62500	208000
	YEAR 2	55000	110000	17000	40000	112500	334500
	YEAR 3	35000	5000	15500		100000	155500
Perugia	YEAR 1	8000		4500		25000	37500
	YEAR 2	16000	40000	4250		25000	85250
	YEAR 3			1000			1000
Trento	YEAR 1			2250		12500	14750
	YEAR 2	30000	30000	3750		25000	88750
	YEAR 3	10000		2250		12500	24750
	tot	190000	270000	66500	70000	400000	996500