



ET-LCGT Interferometric Telescopes Exchange of Scientists

KAGRA 11th Face to face meeting

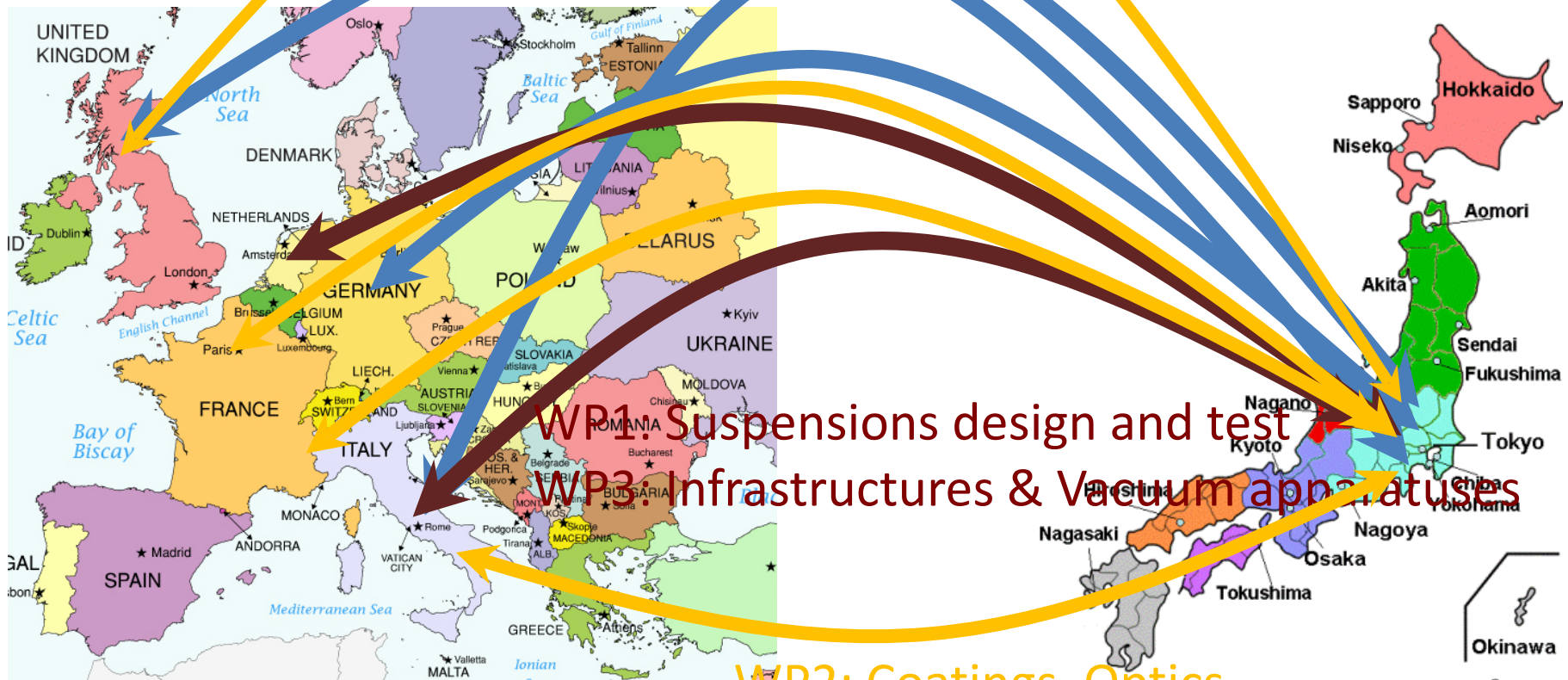
E. Majorana

February 5-7, 2015, Hongo Campus, The University of Tokyo

Project No.: 295153: ELiTES



WP1, WP2: Suspensions materials, fibres



WP1: Suspensions design and test

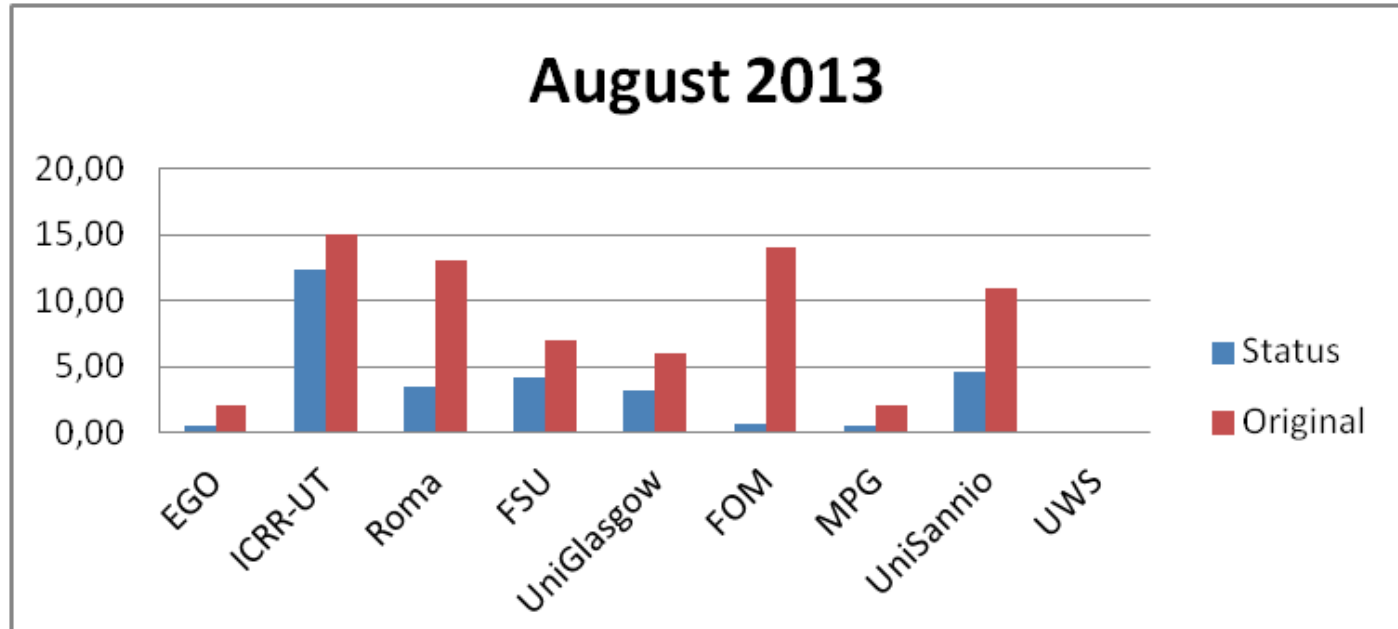
WP3: Infrastructures & Vacuum apparatuses

WP2: Coatings, Optics

ELiTES Partners

ID	Institute	Country
1	EGO	Italy/France
2	Institute for Cosmic Rays Research (ICRR)- University of Tokyo	Japan
3	Università degli Studi di Roma "La Sapienza"	Italy
4	Friedrich-Schiller-Universität (FSU) - Jena	Germany
5	University of Glasgow	UK
6	Stichting Voor Fundamenteel Onderzoek der materie - FOM	NL
7	Max Plank Gesellschaft zur Foerderung der Wissenschaften E.V. - MPG	Germany
8	Università del Sannio	Italy
9	University of West Scotland (UWS)	UK
10	Centre National de la Recherche Scientifique (CNRS)	France

MANPOWER



Just after 1.5 years (over 4) ELiTES experienced a dramatic reduction of exchange participation with respect to what planned, especially by some groups, mainly due to the engagements in construction of AdV. **The situation improved in 2014 but a lower impact had to be envisaged.**

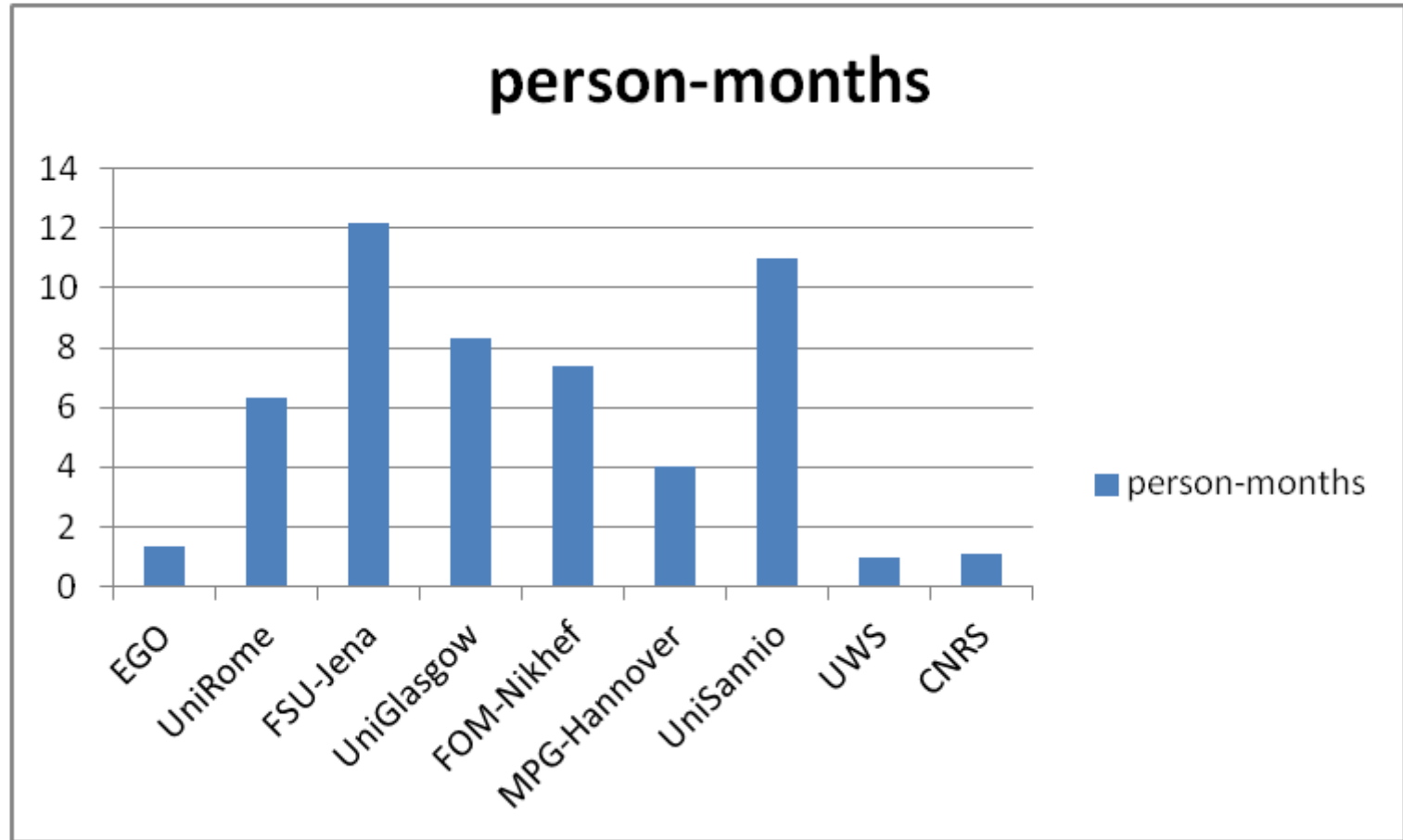
→ CNRS joined in 2014

→ A new plan was negotiated in 2014, in order to reallocate at least partially the initial funding.

CNRS, specifically, LMA is mainly involved in WP2 activities, coating thermal noise and optics

Secondments

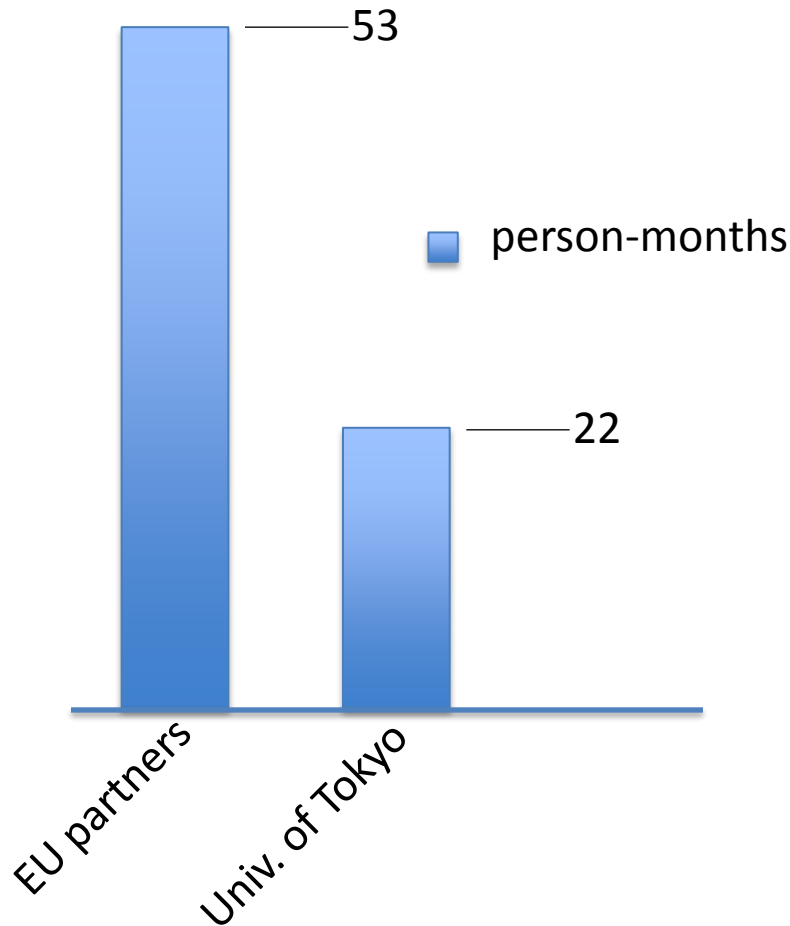
- However, ELiTES generated, until now, more than 53 man-months of presence of European scientists in Japan



- a stimulating bridge EU and JapaneseGW communities

Secondments

ELiTES motivated, **only upon the base of scientific exchange**, - i.e. by supporting scientific activity through laboratory facilities – **a significant participation of Japanese young scientists** in Europe supported by Japanese institutions (mainly JSPS).



University of Tokyo, as partner of ELiTES Program, gathers the contribution of research institutions involved in KAGRA

- ➔ Participation mainly leading to support KAGRA implementation
- ➔ Participation strictly coordinated with KAGRA manpower demand

Scientific production

ELiTES program aims to strengthen the collaboration and the scientific exchange of ideas and know-how between Japanese and European scientists and is focused practical solutions leading to the implementation of KAGRA as well as R&D subjects aimed to 3rd generation detectors.

- Scientific outcome, even if limited to specific items, is expected
- Mobility in international context, useful for young scientists
- ELiTES has no budget for experiments, only for traveling

Posters and talks provided at ET project conferences and GWDAW
At least 6 paper published reporting ELiTES acknowledgements.

<http://www.et-gw.eu/elites-related-publications>

Papers

D. Heinert, S. Kroker, D. Friedrich, S. Hild, E.-B. Kley, s. Leavey, I. W. Martin, A. Tünnermann, S. P. Vyatchanin, K. Yamamoto, **Calculation of thermal noise in grating reflectors**, *Phys. Rev. D* **88** (2013) 042001

R. Douglas, A. A. van Veggel, L. Cunningham, K. Haughian, J. Hough, S. Rowan, **Cryogenic and room temperature strength of sapphire jointed by hydroxide-catalysis bonding**, *Class. Quantum Grav.* **31** (2014) 4 5001

A. Khalaidovski, G. Hofmann, D. Chen, J. Komma. C. Schwarz, C. Tokoku, N. Kimura, T. Suzuki, A. O. Scheie, E. Majorana, R. Nawrodt, K. Yamamoto, **Evaluation of heat extraction through sapphire fibers for the GW observatory KAGRA**, *Class. Quant. Gravity*, **31**, 105004 (2014). arXiv:1401.2346 [astro-ph.IM]

M. Punturo, K. Somiya, **Underground gravitational wave observatories: KAGRA and ET**, *Int. J. Mod. Phys. D* **22**, 1330010 (2013)

F. Frasconi, E. Majorana, L. Naticchioni, F. Paoletti and M. Perciballi, **A vertical accelerometer for cryogenics implementation in third-generation gravitational-wave detector**, *Meas. Sci. Technol.* **25** (2014) 015103 (9pp)

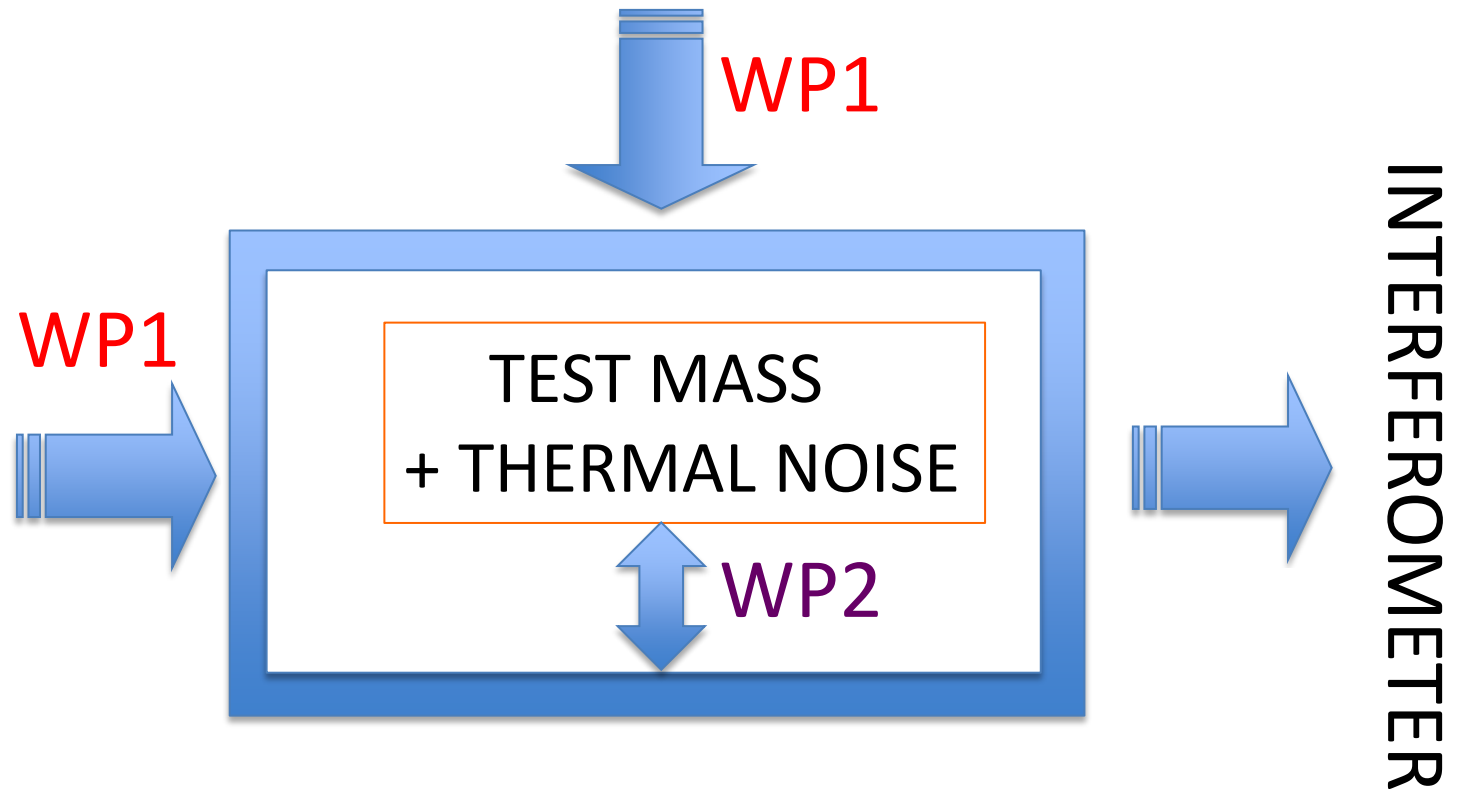
D. Chen, L. Naticchioni, A. Khalaidovski, K. Yamamoto, E. Majorana, Y. Sakakibara, C. Tokoku, T. Suzuki, N. Kimura, S. Koike, T. Uchiyama and S. Kawamura, **Vibration measurement in the KAGRA cryostat**, *Class. Quantum Grav.* **31** (2014) 224001 (12pp)

Conferences

- GWADW 2013 (Elba 19 May 2013),
<https://agenda.infn.it/conferenceOtherViews.py?confId=5484&view=standard>
- - 5th ET Symposium - Einstein Telescope (Hannover 22 Oct 2013) <http://www.et-gw.eu/meetandevt>
- GWADW 2014 (Takayama 25 May 2014),
<http://www.gravity.ircs.titech.ac.jp/GWADW2014/index.htm>
- - 2nd ELiTES general meeting (Tokyo 4 Dec 2013)
<https://events.ego-gw.it/indico/conferenceDisplay.py?confId=7>
-

JOINT TASKS RELATED TO THE CRYOGENIC PAYLOAD

SEISMIC ISOLATION



**FRUITFUL ACTIVITY
DELIVERED**

- **Cryostats technical noise** (KEK; ICRR, Roma)
- **Suspension design and modeling for KAGRA** (ICRR; NIKHEF, Roma, Sannio)
- **Sapphire thermal conductivity** (Jena; ICRR, NIKHEF, Roma)
- **Sapphire mechanical Q measurements** (ICRR; Jena, Glasgow, Roma)
- **Sapphire bonding techniques and breaking strength, cryogenic cycling** (Glasgow; KEK)
- **Q VS composite material and bonding** (Jena; ICRR, Glasgow, KEK, NIKHEF)
- **Sapphire Blade design and clamping** (ICRR)
- **Sapphire components design, selection and manufacturing** (ICRR; Jena, Roma)



ELiTES reports
(overall still missing)



Test facility at ICRR dedicated
to the test of payload concept



Test facility at KEK dedicated
to payload prototype

Optics (coatings)

New batch of nanolayered Silica/Titania films, featuring thinner layers (down to 2nm for Silica) [collaboration with NTHU, prof. S. Chao]

Mixture formulas for complex bulk and shear loss angles, in connection with new coating noise model proposed by Hong et al., PRD 87 (2013) 082001.

New coating thickness optimization code, allowing for nanolayered materials. Optimizes nanolayer thickness fractions as well.

[papers: Optics Express 22 (2014) 29847; PRD91 (2015) 022005; LIGO-P1500010]

Work sponsored in part by INFN through the AdCOAT grant and by EU-FP7 through the ELiTES grant

What is missing and next DELIVERABLES

urgent

- **KAGRA & ET: room temperature VS cryogenics interface, vertical mechanical filters for heat links and, for suspension thermal noise, parallel approaches, for ET and KAGRA (KEK, NAOJ, NIKHEF, Roma* ?, Sannio)**
- **KAGRA & ET: Direct payload control in cryogenic environment, partially addressed for KAGRA (NAOJ, UT, ICRR, NIKHEF?, Roma?, Glasgow?)**
- **ET: Stray-light baffles, successfully developed by KAGRA, no idea for ET (NAOJ, UT, ICRR, NIKHEF?, Roma?, Glasgow?)**
- **ET: Cryogenic system, successfully developed by KAGRA, just tentative ideas for ET (NAOJ, UT, ICRR, NIKHEF?, Roma?, Glasgow?)**

DELIVERABLES AREN'T JUST USEFUL STUDIES. THEY ARE, ALSO, DUE DOCUMENTS

Task 1.1

month 24; Seismic attenuator and Suspension overall model including control issues.

month 36; Standalone performance of seismic isolation system and payload prototype will be tested also in presence of cryogenic links.

Task 1.2

month 48; Overall report on cryogenic payload, including heat link, and projection of KAGRA design results on ET applications.

Task 1.3

month 36; The need of further seismic isolation chains dedicated to thermal links will be assessed and a preliminary design for cryogenic application will be focused in a dedicated note.

Task 1.4

month 48; A realistic scheme of sensor and actuators conceived for payload control in KAGRA and a possible application for ET will be resumed in a dedicated document.



Task 1.2 and 1.3 have to be delayed or re-negotiated with EC

DELIVERABLES AREN'T JUST USEFUL STUDIES. THEY ARE, ALSO, DUE DOCUMENTS

Task 2.2

month 24; Coating loss model, dielectric mixture mechanical loss model; database of cryogenic properties of bulk and coatings materials.

month 36; Report on mirror thermal noise: verify HR coatings on sapphire substrates for KAGRA and comparison with HR coatings on silicon substrates for ET.

Task 2.3

month 24 Report on the bonding of sapphire test pieces for KAGRA and comparison with bonded silicon components planned for use in ET.

month 48; Overview of the thermal noise and cryogenic performance of sapphire and silicon suspensions.

Task 2.4

month 48; Report on mirrors for filter cavities



Task 3.1:

month 40; Report about the impact of pulse-tube compressor disturbance onto environmental noise background in cavern GW interferometer installations

Task 3.2:

month 48; A preliminary study of ET radiation shield based upon KAGRA configuration.

Task 3.3:

month 48; Overview of contamination free designs, description and detailed analysis.

A major contribution towards ET design is probably expected by W3

conclusions

- The program covers four years and we are approaching to the last.
- Some partners, more directly involved in AdV were underperforming due to manpower lack
- Nevertheless the scientific outcome was effective and it is still quite promising.
- Next exchanges are crucial for KAGRA payload prototyping and suspensions.

K. Yamamoto and T. Tomaru special guests during AdV END mirror payload assembly (June-July '15)

