

The Italian Ministry of Research's Project 'Laser Ranging to Galileo'

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Laser Ranging to Galileo



'Premiale' Project funded by Ministry of Research (MIUR).

Laser Ranging to Galileo
(ASI-INFN, 2015-16)

ETRUSCO-2
(ASI-INFN, 2010-15)

ETRUSCO
(INFN, 2006-09)

2015 ILRS Technical Workshop

L. Porcelli for Th



Laser Ranging to Galileo



Matera Laser Ranging Observatory.
Led by G. Bianco, PI of "Laser Ranging to Galileo" for ASI.
Telescope diameter = 1.5 m
SLR. LLR since 2010



2015 ILRS Technical Workshop

L. Porcelli

Laser Ranging to Galileo



- ASI & INFN instrumentation upgrades (MLRO & SCF_Lab)
- ASI Laser ranging and SCF-Test of Galileo, GRA and LAGEOS



Macro-Activity 1 Year 1 and 2	Macro-Activ. 2 Year 1	Macro-Activ. 3 Year 1	Macro-Activity 4 Year 2	Macro-Activity 5 Year 2	Macro-Activity 6 Year 2	Macro-Activity 7 Year 2
MLRO-SCF_LAB Harmonization: Harmonization of MLRO and SCF_LAB upgrades and integration of the results of the upgraded MLRO and SCF_LAB (includes Management)	MLRO@CGS: Equipment Upgrade	SCF_LAB@LNF: Infrastructure Upgrade	Upgraded MLRO: Laser Ranging to LRAs onboard Galileo satellites	Upgraded SCF_LAB: Lab Characterization of Galileo LRA Flight Model (on loan to LNF from ESA)	Upgraded MLRO: Laser Ranging to LAGEOS	Upgraded SCF_LAB: Lab Characterization of LAGEOS Engineering Model (on loan to LNF from NASA)

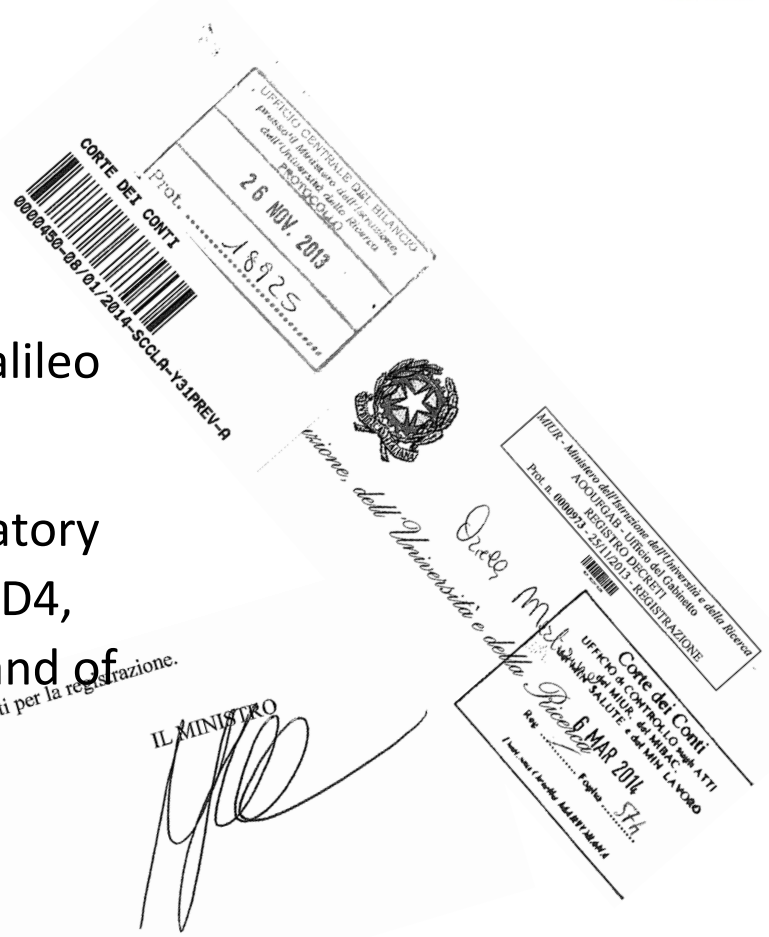
LRA = Laser Retroreflector Array

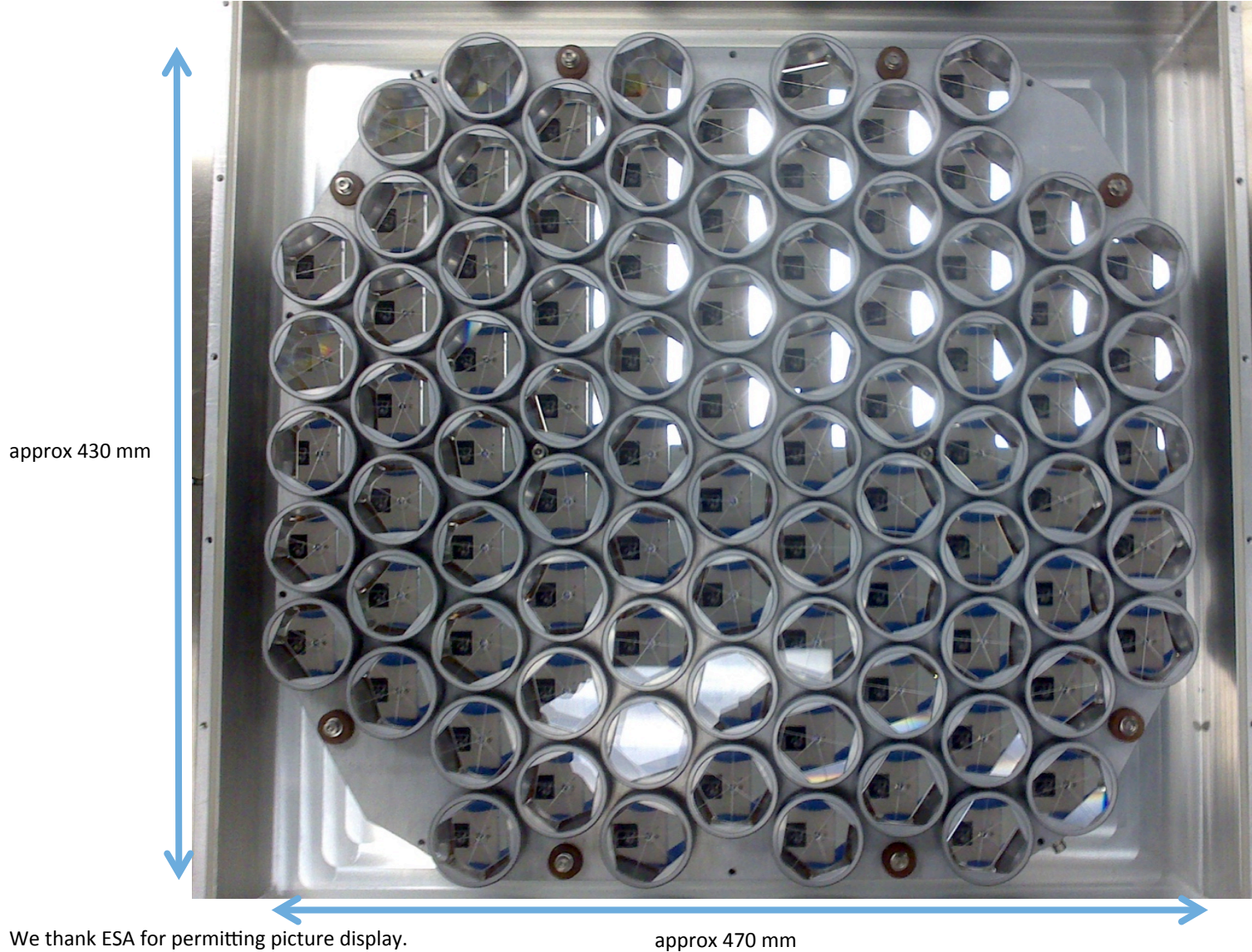
- Joint ASI-INFN project.
- Funded by Italian Ministry of Research.
- Upgrades of equipment and infrastructures.
- ASI-CGS will laser range to LRAs on board Galileo IOV vehicles and to LAGEOS satellites.
- INFN-LNF's SCF_Lab will complete full laboratory thermo-vacuum-optical characterisations [AD4, AD5] of the 5th spare flight Galileo IOV LRA and of the LAGEOS Engineering Model:
 - SCF-Test.
 - Orbit Test.
- Results will help optimize GRA design and manufacturing.

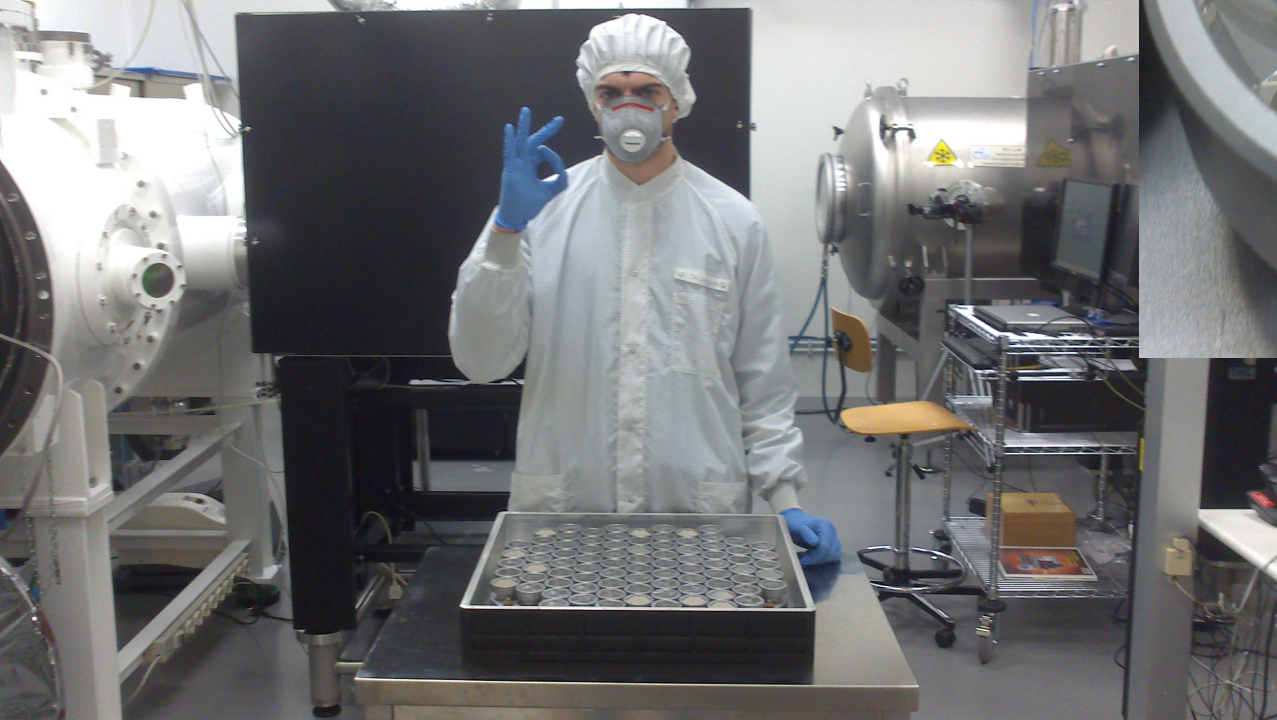
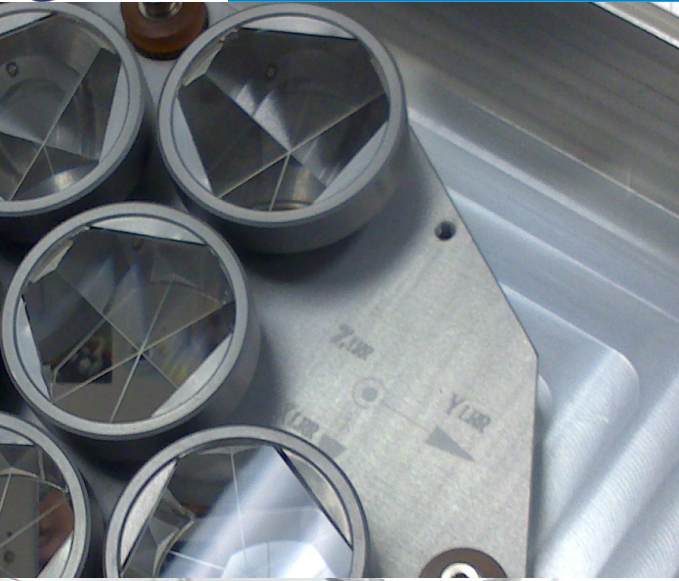
Il presente decreto verrà inviato alla Corte dei conti per la registrazione.

Roma,

Ministero dell'Economia e delle Finanze
Dipartimento della Ragioneria Generale dello Stato
U.C.B. - MIUR
Visto n. 1493 ex articolo 5, comma 2, D.lgs. n.123/2011

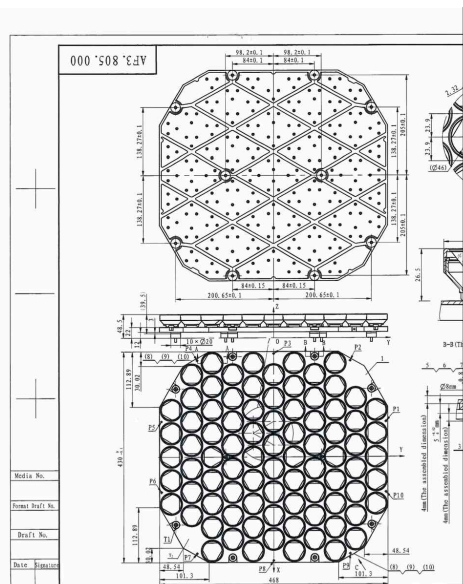




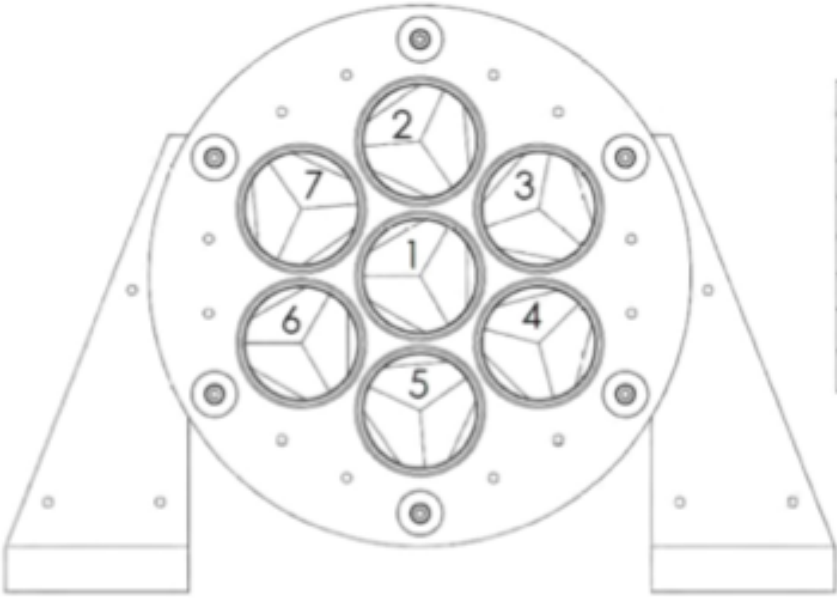


- 84 CCRs (solid, vertex-face height = 23.3 mm, clear aperture of front face = 33 mm, enclosed in a 40-mm across mounting capsule).
- Full spare flight array will undergo tests (2nd time on spare IOV HW) similar to ESA Contract Nr. 4000108617/13/NL/PA and following publication (1st time on spare IOV HW):

Dell’Agnello et al., ***Thermo-optical vacuum testing of Galileo In-Orbit Validation laser retroreflectors***, *Advances in Space Research*, 57 (2016), 2347-2358.

	<p>CGI Deliverable Document for Laser Retro-Reflector GAL-CH-LRR-3418 Issue 2 Rev0</p> <p>Title: LRR Reference: GAL-CH-LRR-3418 Issue 2 Rev0 Dated 16 Feb 2016</p> <p>DRL-SU</p> <p>China Galileo North China Research Ins</p>	<p>CGI Deliverable Document for Laser Retro-Reflector GAL-CH-LRR-3418 Issue 2 Rev0</p> <p>Title: Reference: D</p>	<p>Available online at www.sciencedirect.com</p> <p>ScienceDirect</p> <p>Advances in Space Research 57 (2016) 2347–2358</p> <p>Thermo-optical vacuum testing of Galileo In-Orbit Validation laser retroreflectors</p> <p>S. Dell’Agnello^a, A. Boni^a, C. Cantone^a, E. Ciocci^a, S. Contessa^a, G. Delle Monache^a, C. Lops^a, M. Martini^a, G. Patrizi^a, L. Porcelli^{a,*}, L. Salvatori^a, M. Tibuzzi^a, N. Intaglietta^a, P. Tuscano^a, C. Mondaini^a, M. Maiello^a, D. Doyle^b, R. García-Prieto^b, D. Navarro-Reyes^b</p> <p>^a Istituto Nazionale di Fisica Nucleare – Laboratori Nazionali di Frascati (INFN-LNF), Via E. Fermi 40, 00044, Frascati, Rome, Italy ^b European Space Agency – European Space Research and Technology Centre (ESA-ESTEC), Keplerlaan 1, 2201 AZ, Noordwijk, The Netherlands</p> <p>Received 12 January 2016; received in revised form 10 March 2016; accepted 12 March 2016 Available online 19 March 2016</p>
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5th Spare Flight Galileo IOV LRA



CCR	Serial	Orient.
1	LRR-S10-05	30°
2	LRR-S10-03	25°
3	LRR-S10-06	11°
4	LRR-S10-08	45°
5	LRR-S10-04	55°
6	LRR-S10-10	30°
7	LRR-S10-07	85°

Material	Dimensions	Properties

Fig. 1. Tested CCRs, with their orientation and numbering, from INFN-LNF exc

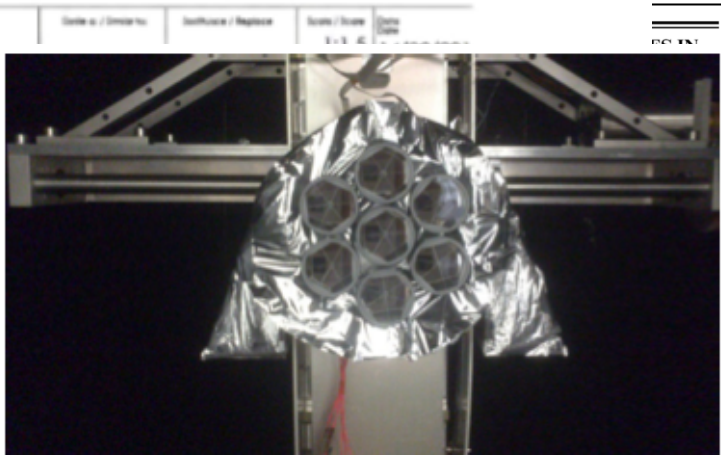
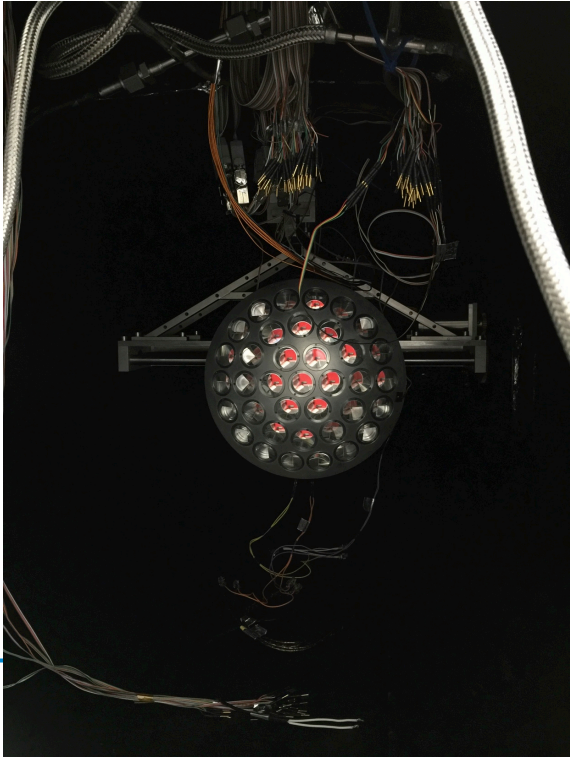
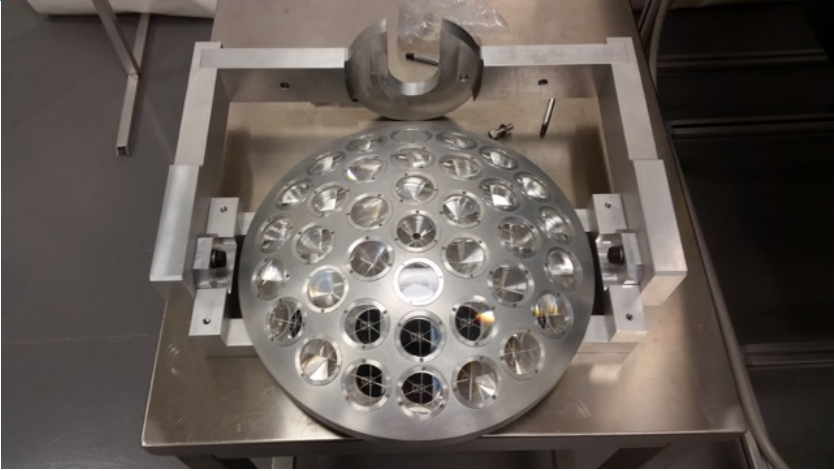
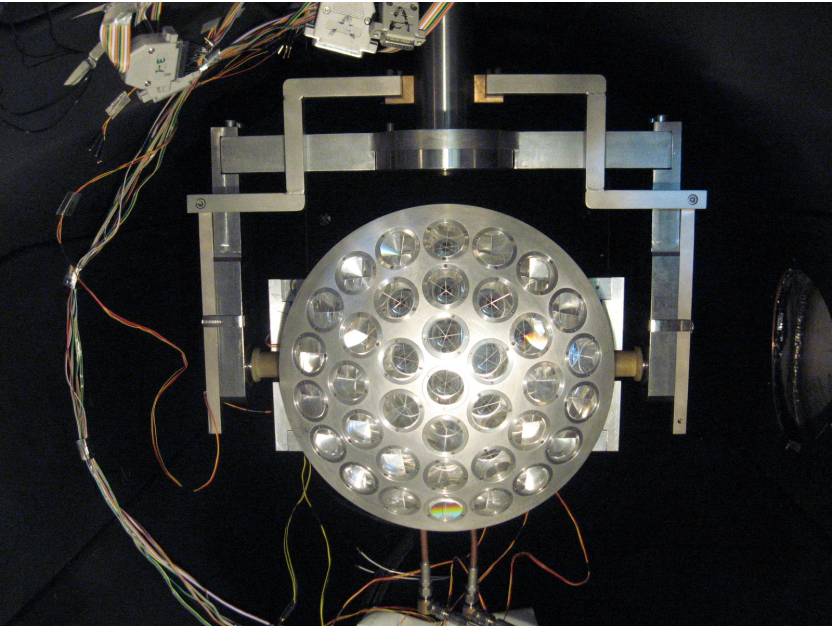


Fig. 2. Galileo IOV EM array in the cryostat ready for testing.

^a Istituto Nazionale di Fisica Nucleare
^b European Space Agency - ESA

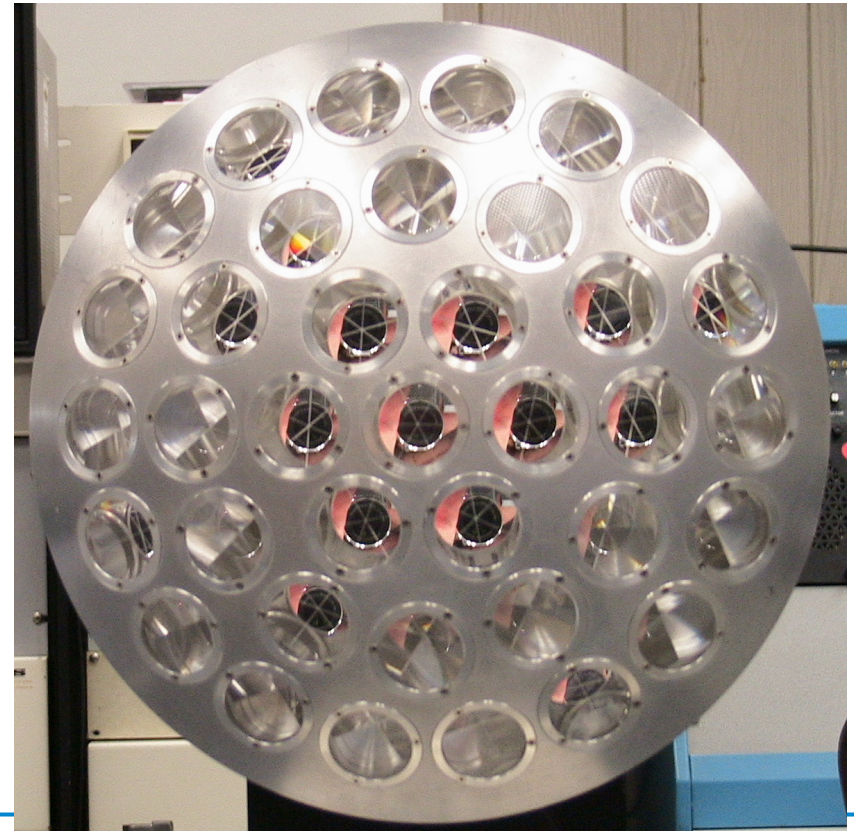
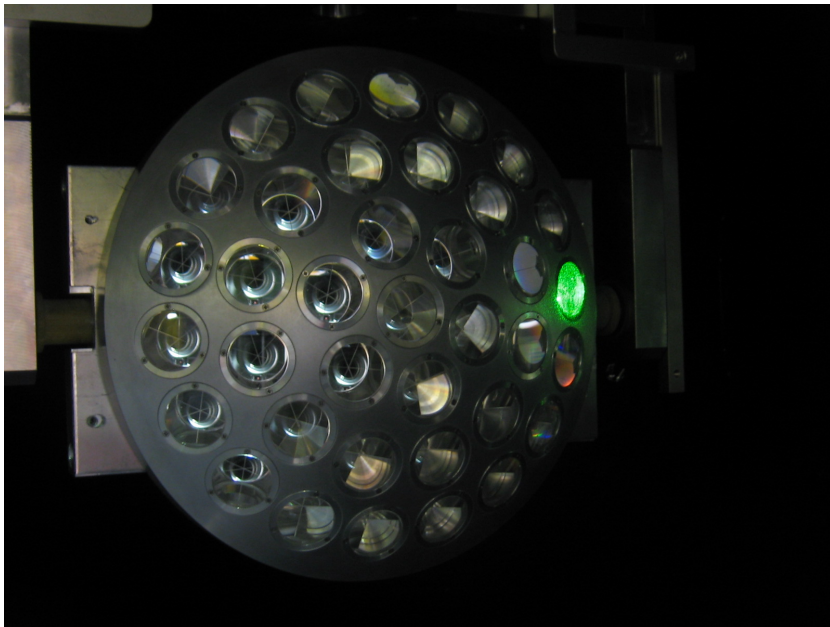
LAGEOS Engineering Model



We thank NASA for permitting picture display.

- Extension of what was done and published:

Boni et al., ***World-first SCF-test of the NASA-GSFC LAGEOS sector and hollow retroreflector***. In: Proceedings of the 17th International Workshop on Laser Ranging, Bad Kötzing, Germany, 2011.

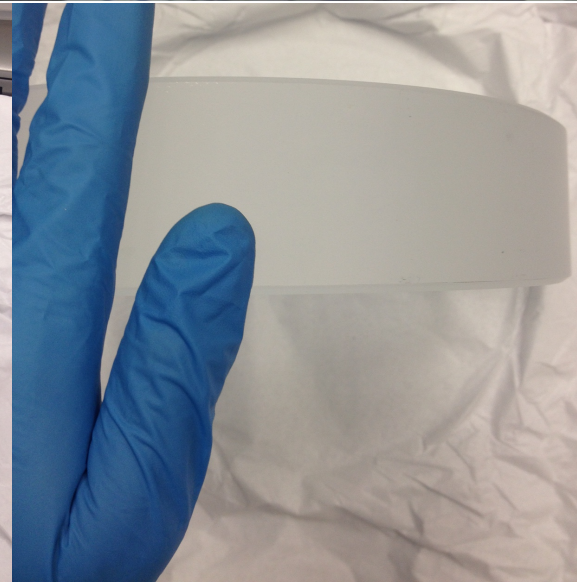
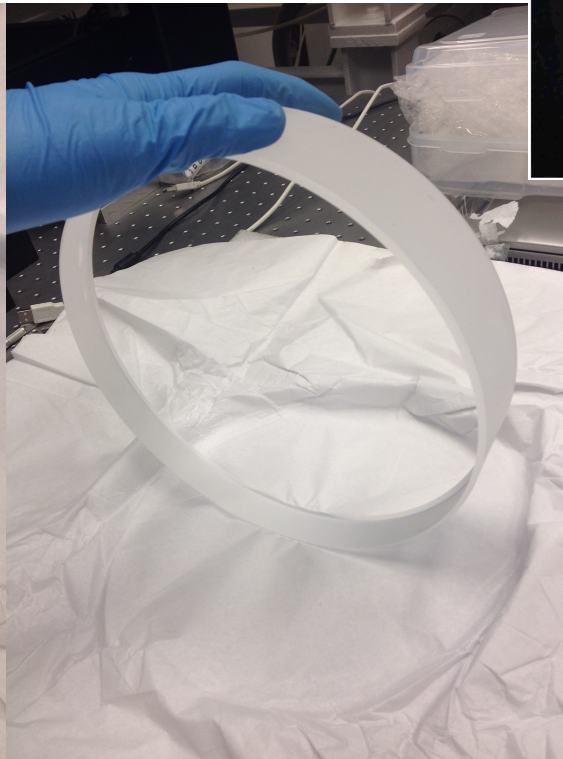
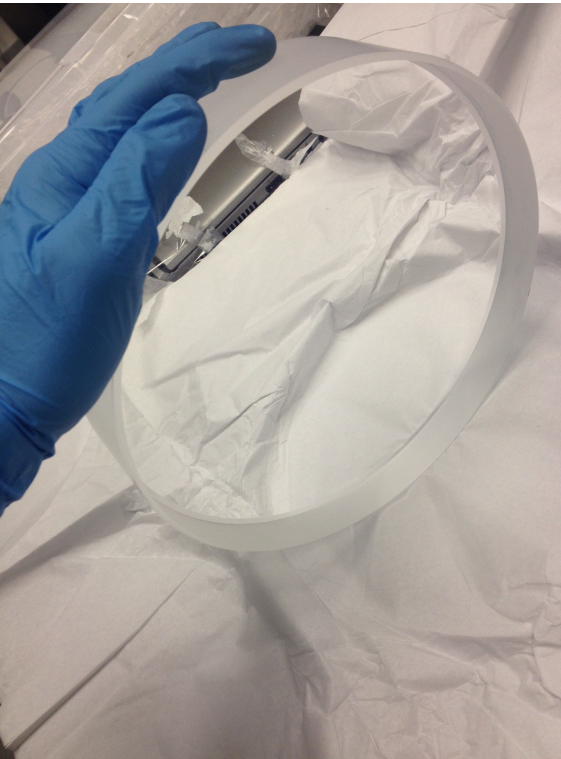
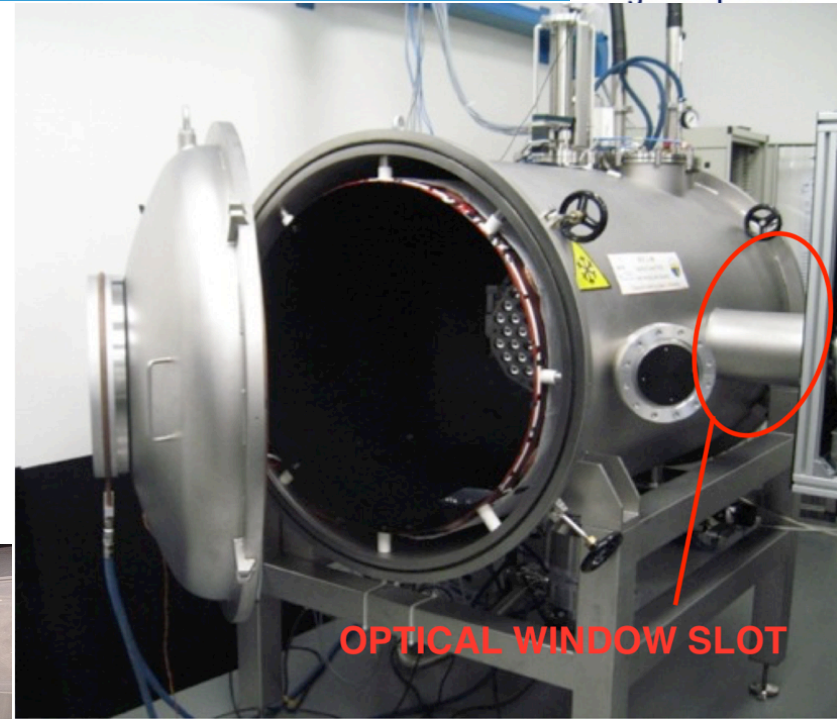


- Control electronics replacement.
- Telescope primary mirror re-plating (poster displayed).

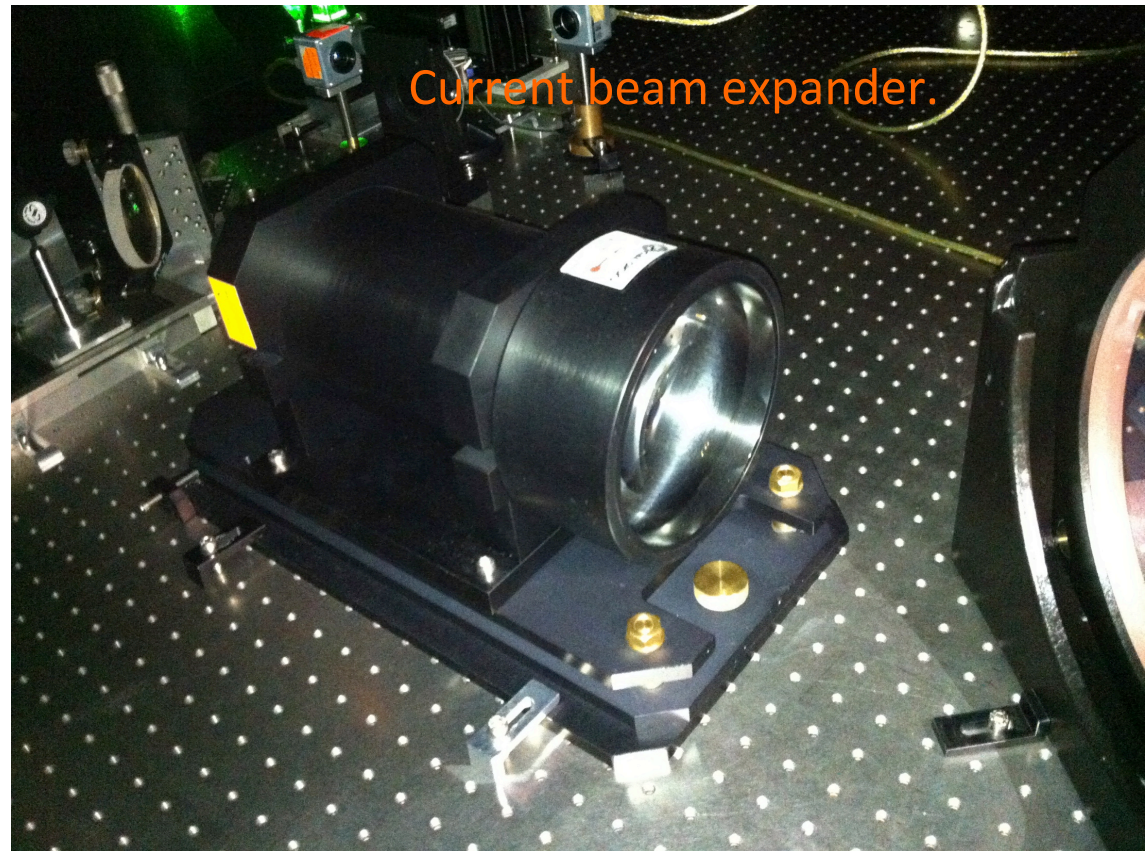
Matera Laser Ranging Observatory.
Led by G. Bianco, PI of “Laser Ranging to Galileo” for ASI.
Telescope diameter = 1.5 m
SLR. LLR since 2010



- New larger optical window:
 - Diameter = 230 mm.
 - Thickness = 2 inches.
 - OCA = 200 mm.
 - Match with optical tunnel diameter.



- New larger beam expander/reducer:
 - Overall dimensions about 500 mm x 250 mm x 250 mm (to replace current hardware).
 - Match with new optical window.





- ASI-CGS will laser range to LRAs on board Galileo IOV vehicles and to LAGEOS satellites.
- INFN-LNF's SCF_Lab will complete full laboratory thermo-vacuum-optical characterisations [AD4, AD5] of the 5th spare flight Galileo IOV LRA and of the LAGEOS Engineering Model:
 - SCF-Tests.
 - Orbit Tests.
- Results to come starting from early 2017.
- Results will help optimize GNSS Retroreflector Array design and manufacturing (INFN commitment, www.inf.infn.it/esperimenti/etrusco/documents.html).

APPLICABLE AND REFERENCE DOCUMENTS

AD1 Ministry of Research Decree 25 November 2013 Nr. 973.

AD2 ESA Contract Nr. 4000108617/13/NL/PA - Thermo-optical vacuum testing of Galileo IOV laser retro-reflectors.

AD3 Dell’Agnello et al., Thermo-optical vacuum testing of Galileo In-Orbit Validation laser retroreflectors, *Advances in Space Research*, 57 (2016), 2347-2358.

AD4 Boni et al., World-first SCF-test of the NASA-GSFC LAGEOS sector and hollow retroreflector. In: *Proceedings of the 17th International Workshop on Laser Ranging*, Bad Kötzing, Germany, 2011.

AD5 Dell’Agnello et al., Creation of the new industry-standard space test of laser retroreflectors for the GNSS and LAGEOS, *Advances in Space Research*, 47 (2011), 822-842.

RD1 ECSS-E-ST-10-02C “Verification”.

RD2 ECSS-E-ST-10-03C “Testing”.

RD3 ECSS-E-HB-10-02-A “Verification guidelines”.

RD4 ECSS-Q-20-07A “Quality assurance for test centers”.