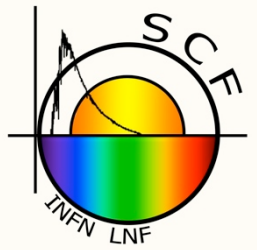
ETRUSCO-GMES @ SCF_LAB

SCF_LAB

Satellite/Lunar/GNSS laser ranging
Characterization **F**acility **LAB**oratory



Simone Dell'Agnello for the SCF_LAB Team

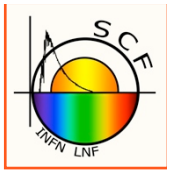
Italian National Institute for Nuclear Physics, Laboratori Nazionali di Frascati (INFN-LNF),

Via Enrico Fermi 40, Frascati (Rome), 00044, Italy

Consiglio dei Laboratori, Preventivi 2013

Frascati, July 3, 2012

Outline



- ETRUSCO/ETRUSCO-2 (INFN and ASI)
  - Galileo: **EU Flagship Program n. 1**
- GMES: **EU Flagship Program n. 2**
- ETRUSCO-GMES, new CSN5 project:
  - **ETRUSCO-IOV (INFN-ESA):** SCF-Test for Galileo IOV
  - **ETRUSCO-IRNSS (INFN-ISRO)**: SCF-Test for Indian Regional Navigation Satellite System (IRNSS)
  - Unification of GNSS and Earth Observations
- Personnel, Requests to LNF Services, Requests to CSN5

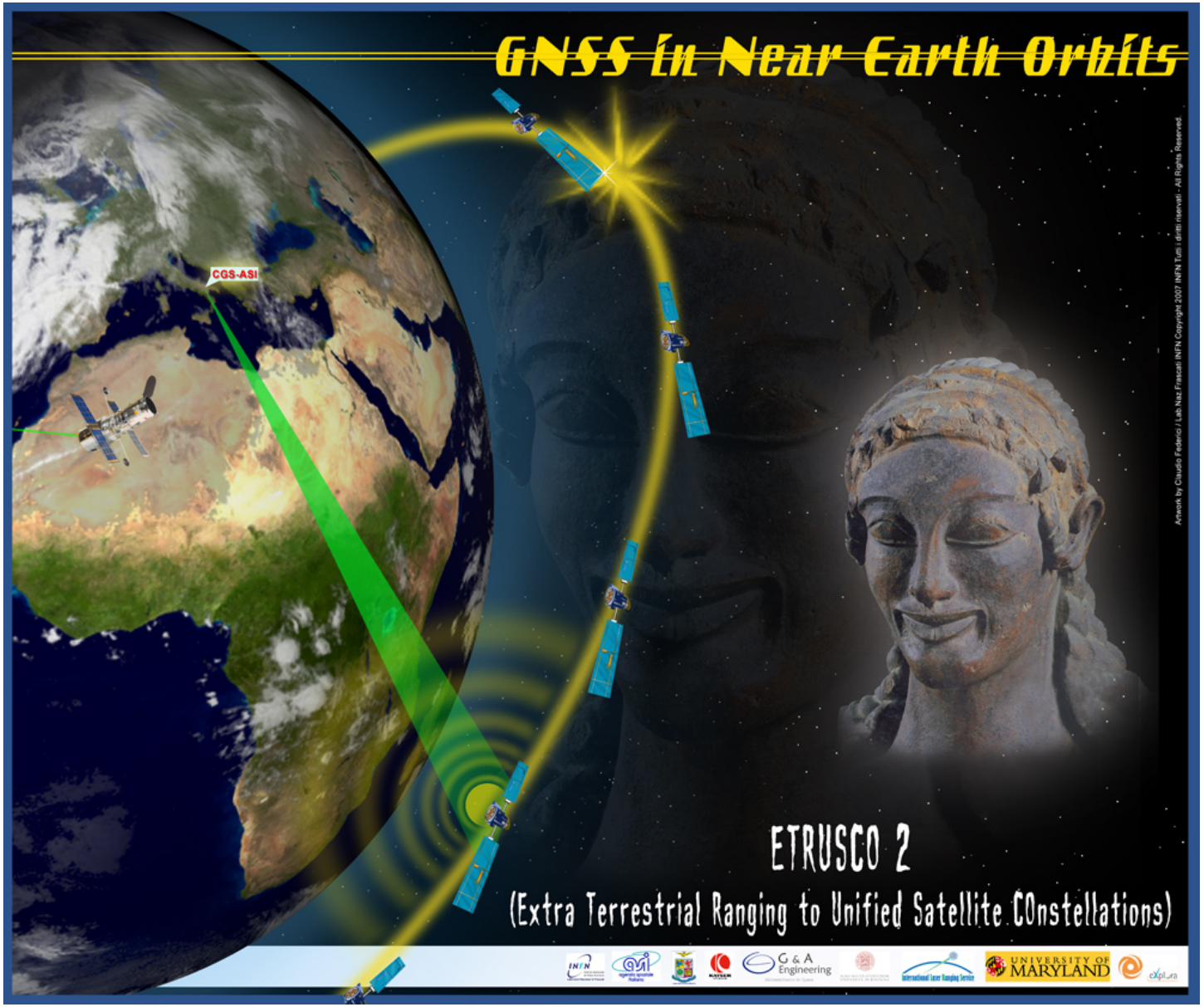
ETRUSCO-2: ASI-INFN project for GNSS, 2010-13

[RD-10]

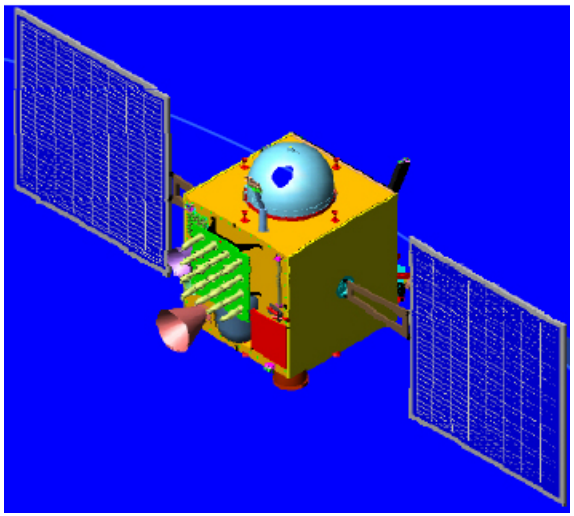
Optimized for Galileo and GPS-3

PI:
S. Dell'Agnello

Co-PIs:
R. Vittori, ESA
G. Bianco, ASI



Global Navigation Satellite System (GNSS): ~100 sats



Indian IRNSS: 7 regional satellites

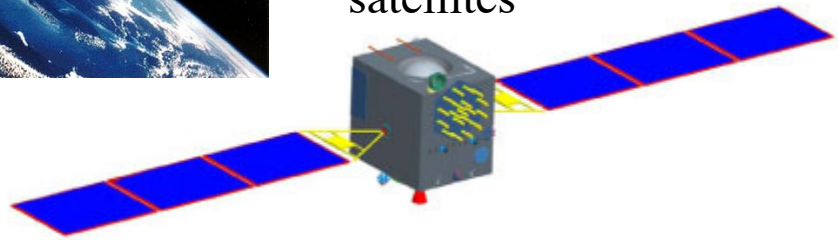
European Galileo: up to 30 satellites

American GPS: 24 global satellites

Japanese QZSS: 3 regional satellites

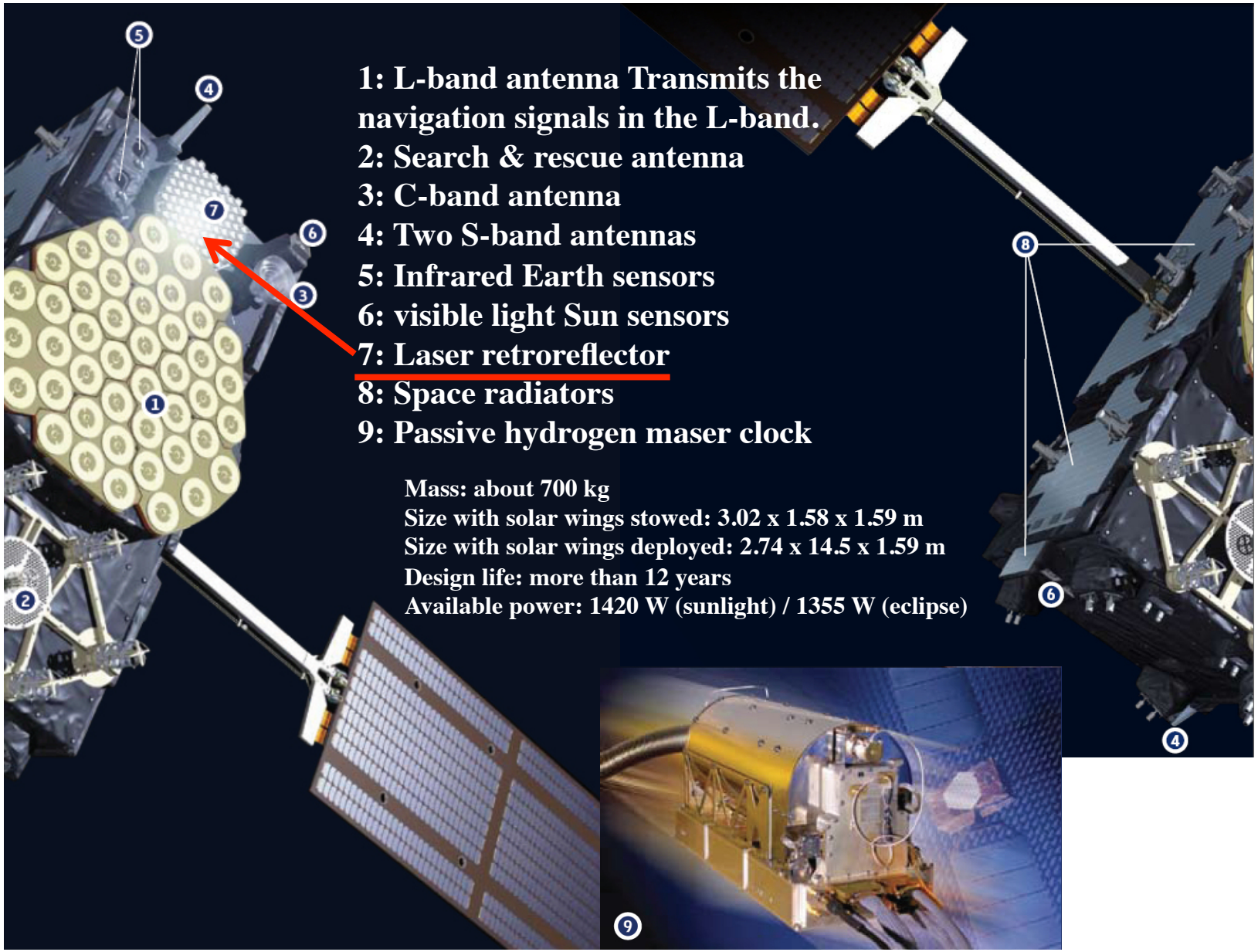
Russian GLONASS: 24 global satellites

Chinese COMPASS: 30 global and 5 regional satellites



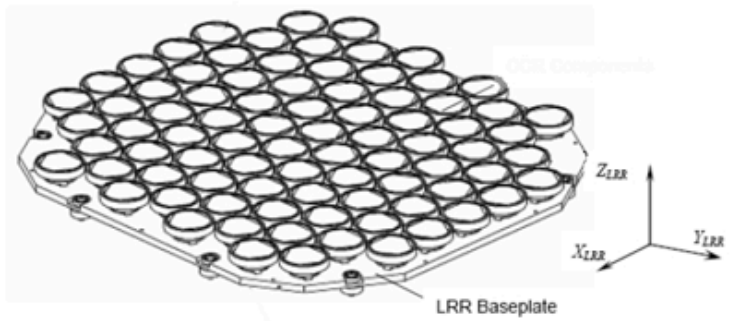
Galileo IOV (In-Orbit validation)

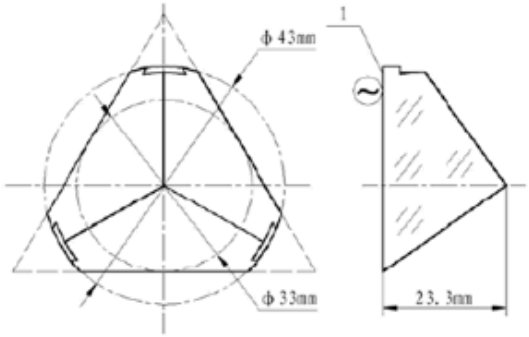
The First 4 Galileo IOV satellites



Public recognition of INFN work for Galileo by ESA on web site of Intern. Laser Ranging Service

Galileo retroreflector array location





Galileo retroreflector array — Galileo corner cube configuration

Retroreflector information courtesy of ESA

RetroReflector Array (RRA) Characteristics:

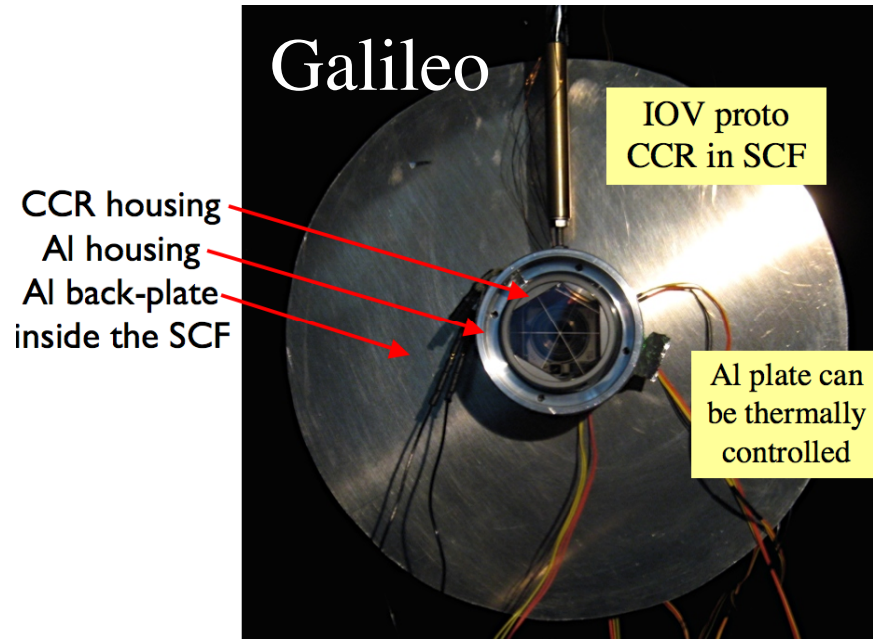
Additional information about the Galileo retroreflector array can be found in the Galileo-101 and -102 ILRS SLR Mission Support Request Form. Specifications for the Galileo retr extracted from this support request form:

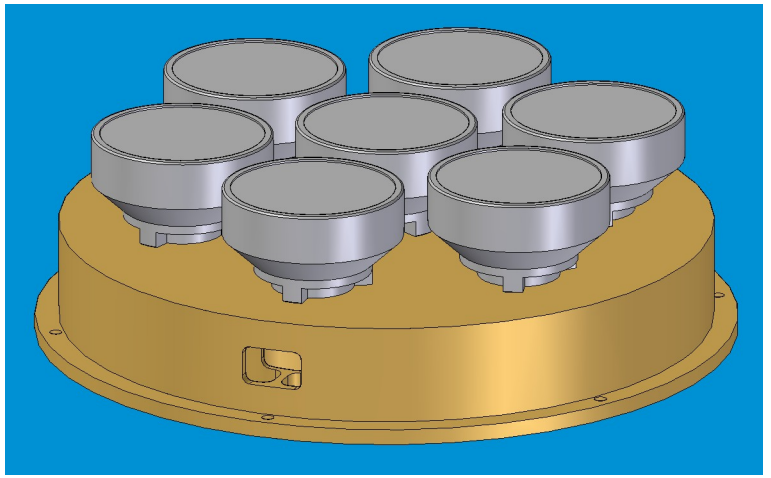
- Number of CCRs: 84
- CCR size: 33 mm diameter, 23.3 mm height
- Material: Doped fused silica (Suprasil 311)
- Coating: Reflective surface uncoaded, incident surface coated with indium tin oxide

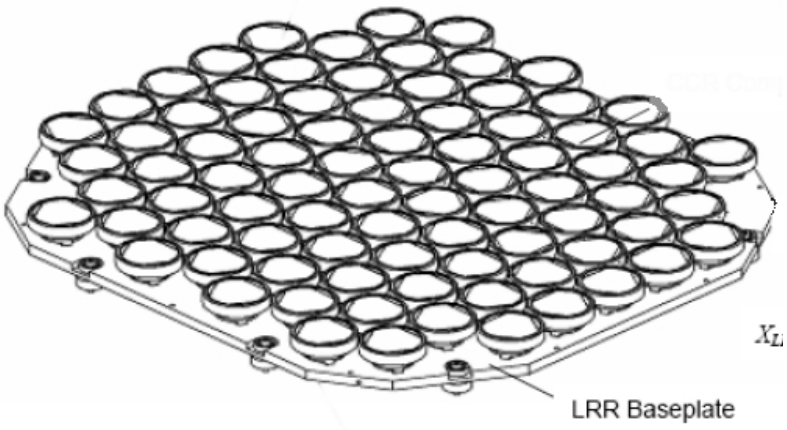
Additional information:

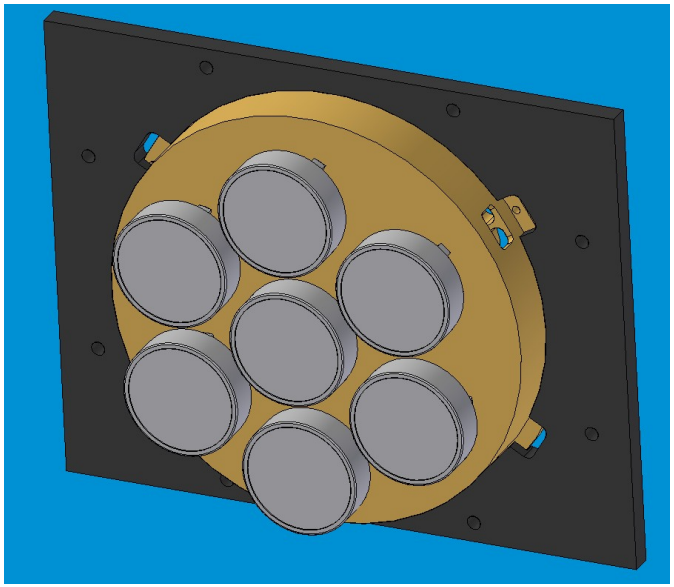
- ESA presentation on Galileo retroreflector design
- "ETRUSCO-2: An ASI-INFN Project of Technological Development and SCF-TEST of GNSS LASER Retroreflector Arrays"

ETRUSCO-IOV: SCF-Test of a retroreflector array for ESA (we published test of 1 with ESA permission)

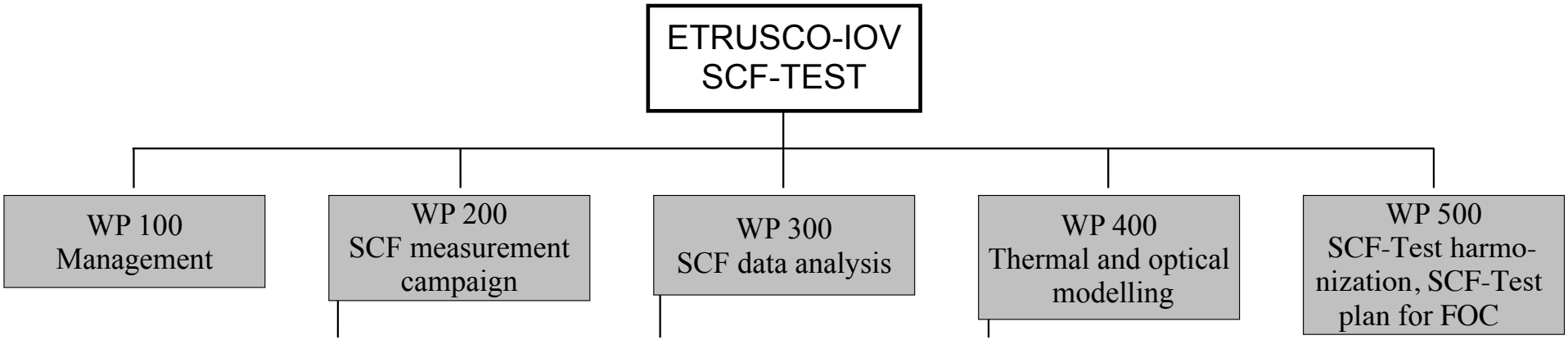








ETRUSCO-IOV: WBS



ETRUSCO-IRNSS: Invitation to Tender on SCF-Test of retroreflectors of the Indian GNSS (**IRNSS**) by the Indian Space Research Organization

S. Dell'Agnello (INFN-LNF) et al

GOVERNMENT OF INDIA
DEPARTMENT OF SPACE
LEOS - ISRO
1st CROSS, 1st STAGE, PEENYA INDUSTRIAL ESTATE, BANGALORE 560058
PURCHASE

Ph No: 080-28398836
Fax 080-28391964

Date :28/11/2011

INVITATION TO TENDER

Our Ref No : LEAO **2011-000261-01**

M/s I00464
INSTITATO NAZIONALE DI FISICA NUCLEARE (INFN)
VIA ENRICO FERMI, 40-00044
FRASCATI (ROME)
ITALY
Ph: 00 39 0694031 Fx: -

Tender Due: 16:00 **Hrs ISTon** 12/12/2011

Dear Sirs,

Please submit your sealed quotation , in the Tender Form enclosed here along with the descriptive catalogues / pamphlets /literature ,superscribed with Our Ref.No. and Due Date for the supply of the following items as per the terms & conditions mentioned in Annexure(Form No: ENCLOSED)

S.No.	Description of Items with Specifications	Unit	Quantity
1	FAR FIELD DIFFRATION PATTERN(FFDP)CHARACTERIZATION OF CORNER CUBE RETRO REFLECTOR ASSEMBLY IN THE SPACE CLIMATE CONDITIONS AS PER ENCLOSED RFP SPECIFICATIONS	set	1

DELIVERY AT: LEOS-STORES
MODE OF DESPATCH BY ROAD
DUTY EXEMPTIONS WE ARE EXEMPTED FROM PAYMENT OF CUSTOM DUTY/ EXCISE DUTY.
SPECIAL INSTRUCTIONS NIL
SPECIFIC TERMS ENCLOSED

S.SUBRAMANYA
PURCHASE OFFICER
For and on behalf of the President of India
The Purchaser

ETRUSCO-**IRNSS**: SCF-Test of retroreflectors of the Indian GNSS (IRNSS) for the Indian Space Research Organization

INFN Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

SCF INFN LNF

www.lnf.infn.it
DIVISIONE RICERCA
Ph. + 39 06 9403 2730
+ 39 06 9403 8036
Fax + 39 06 9403 2475
email: Simone.DellAgnello@lnf.infn.it

Frascati (Rome), Italy
March 15, 2012

To the Attention of:
S. Subramanya, Purchase & Stores Officer (Purchase)
Laboratory for Electro-Optics Systems (LEOS)
Indian Space Research Organisation (ISRO)
Department of Space, Govt. of India,
I Stage, I Cross, Peenya Indl. Estate,
Bangalore-560058, INDIA
Ph.: 0091-80-28398836/Fax: 0091-80-28391964
E-mail: Purchase Officer <subramanya@leos.gov.in>

Prot.: 0000739/2012

Subject: Submission of draft of Research Contract for the ETRUSCO[1]-IRNSS[2] project between LEOS-ISRO and INFN.

Dear LEOS-ISRO Representative,

With this cover letter I am submitting:

1. Draft of Research Contract with commercial terms and conditions.
2. Technical-Management Annex describing the work to be performed, delivery terms and delivery period.

GMES: from ESA Bulletin Feb. 2012

→ GLOBAL MONITORING FOR ENVIRONMENT AND SECURITY

GMES Space Component getting ready for operations

Monitoring of Environment with Galileo and for example Synthetic Aperture Radar (SAR), like ESA's Sentinel-2 and Italy's CosmoSkyMed

Next to Galileo, Global Monitoring for Environment and Security (GMES) is one of the two European Union flagship programmes in space, and another example of how space policy can contribute to improving European citizens' lives.

While the future of Galileo is secured through the EC's proposal to provide sufficient operational funding within the general budget of the EU, the long-term future of GMES has yet to be secured. Unexpectedly, last year the EC proposed to finance GMES outside the EU Multi-Annual Financial Framework (MFF), which covers the period 2014–20, suggesting instead to organise the required funding through a new intergovernmental mechanism.

In the GMES Space Component, the Sentinels and ground segment are currently in the final stages of their development and are getting ready for launch from 2013 onwards. Pre-operational data delivery from existing national and third party missions is well under way. What is most urgently needed now is securing the operational funds and consolidating the governance including Sentinel ownership and data policy.

Goal of ETRUSCO-GMES

Unification of Galileo and SAR observations, through absolute laser calibration, both in space and on the ground

> GMES will provide us with crucial imagery and data on the environment, which will enable us to understand better and mitigate climate change. It will also make our agriculture and fishery more efficient. This in turn will guarantee better food quality and food security. It will also be of great help in crisis response in emergency situations during natural or manmade disasters.
>
> J.M. Barroso, President of the European Commission, November 2011

Who are the users of GMES?

Based on global observations, GMES services, developed in close collaboration with users, will provide essential information in three Earth-system domains (atmosphere, marine and land) and three cross-cutting domains (emergency management, security and climate change).

These services, once operational, will provide standardised multi-purpose information common to a broad range of EU policy-relevant application areas:

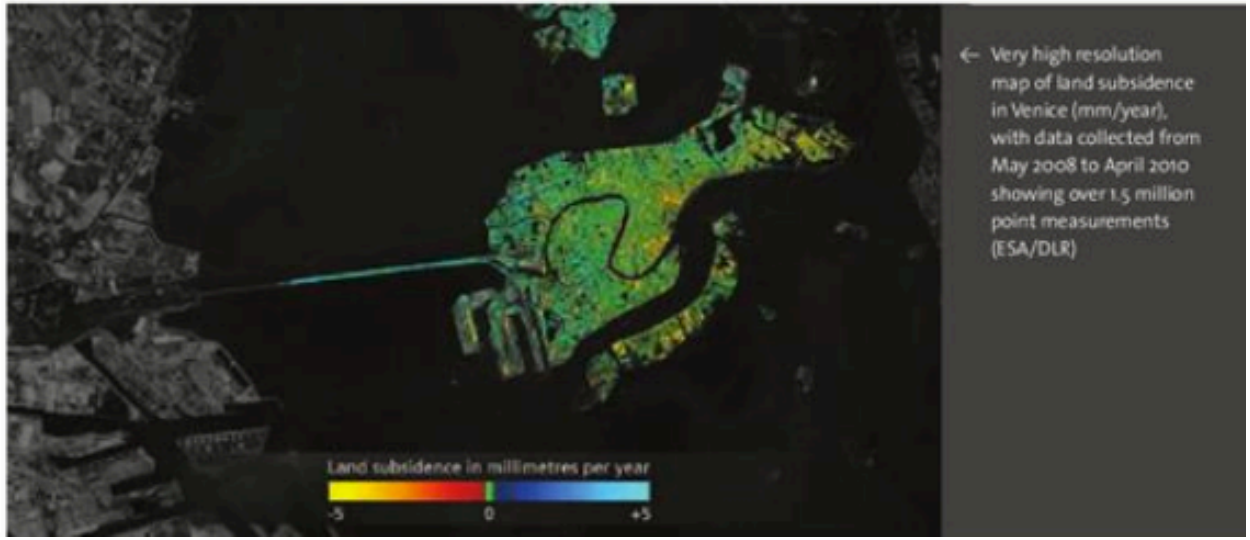
- GMES Marine Monitoring Service: focused on areas such as marine safety and transport, oil spill monitoring, water quality, weather forecasting and the polar environment.

European Union Satellite Centre), private business and individual citizens. A large variety of commercial industry segments will also benefit through the development and provision of operational geo-services.

At a regional level, GMES is already used to monitor air quality, map coastlines, regional areas and urban expansion and to manage marine and agricultural resources. GMES also plays a key role in disaster management and prevention.

On air quality, for instance, GMES currently provides daily (three-day) air quality forecasts and historical records of key industrial pollutants such as ozone, nitrogen dioxide, sulphur dioxide and aerosols for the major cities and regions of Europe. The forecasts form the basis for the management of health risks of citizens suffering from asthma or other symptoms. The

From ESA Bulletin Feb. 2012



← Very high resolution map of land subsidence in Venice (mm/year), with data collected from May 2008 to April 2010 showing over 1.5 million point measurements (ESA/DLR)

SCF_LAB Team (Full Time Equivalents)

	MoonLIGHT-INRRI (GR2)	ETRUSCO-GMES (GR5)
S. Dell'Agnello, Resp.	0.5	0.5
G. Delle Monache, Vice	0.4	0.3
R. Vittori,		0.2
C. Cantone,	0.3	0.7
A. Boni	0.3	0.7
C. Lops,	0.4	0.6
M. Maiello	0.4	0.6
S. Berardi,	0.4	0.6
G. Patrizi,		1
Manuele Martini	0.5	0.5
G. Bellettini	0.5	
R. Tauraso	0.5	
R. March,	0.4	
N. Intaglietta	0.4	0.3
M. Tibuzzi,	0.4	0.6
E. Ciocci,	0.5	0.5
L. Salvatori,		1
M. Lobello,		1
A. Stecchi		0.2
TOTALE	**6.0 FTE**	**9.2 FTE**

Students: L. Palandra, S. Contessa, S. Rinaldi, R. Heller (US DoE)

Requests

CSN5, in progress:

- EU's Galileo IOV: co-funding of ESA contract
- India's GNSS: co-funding of ISRO contract
- GMES: 50% co-funding of contract
- MI/ME

CIF (mu):

- SPCM officina 2, carpent. 1 (2012), officina 2, carpent. 1 (2013)
- SEA: autom. 4.5 mu (2012), 5.5 (2013); elett. 0.5 (2012), 0.5 (2013)
- Cryo: 0.5 mu (2012), 1 mu (2013)
- Laser: 0.5 mu (2012), 1 mu (2013).

Main Reference Documents

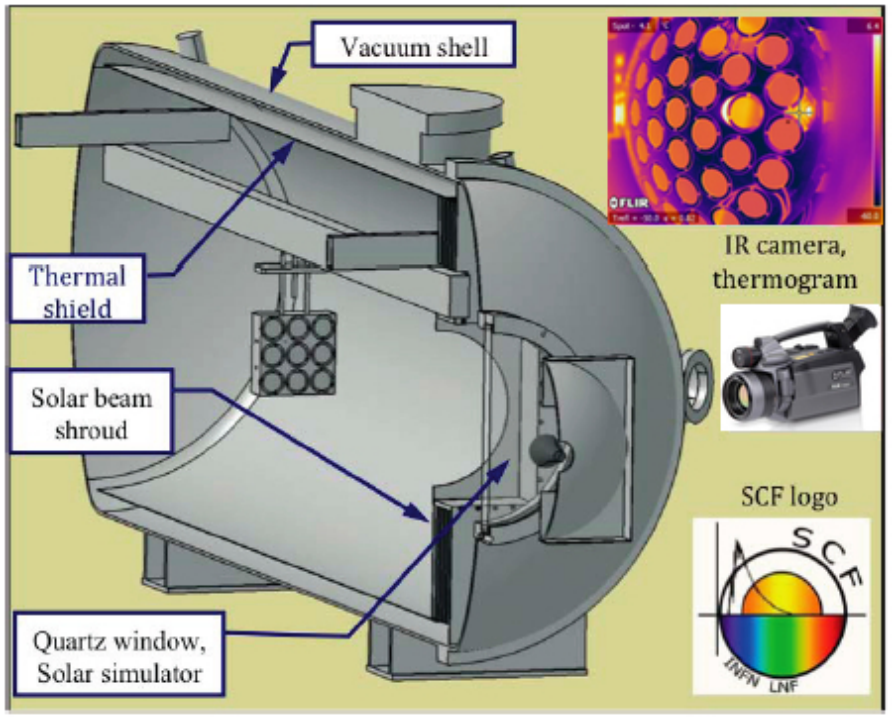
- [RD-1] Dell'Agnello, S., et al, **Creation of the new industry-standard space test of laser retroreflectors for the GNSS and LAGEOS**, J. Adv. Space Res. **47** (2011) 822–842.
- [RD-2] P. Willis, Preface, Scientific applications of Galileo and other Global Navigation Satellite Systems (II), J. Adv. Space Res., **47** (2011) 769.
- [RD-3] D. Currie, S. Dell'Agnello, G. Delle Monache, **A Lunar Laser Ranging Array for the 21st Century**, Acta Astron. **68** (2011) 667-680.
- [RD-4] Dell'Agnello, S., et al, Fundamental physics and absolute positioning metrology with the MAGIA lunar orbiter, Exp Astron, October 2011, Volume 32, Issue 1, pp 19-35 ASI Phase A study.
- [RD-5] Dell'Agnello, S. et al, **A Lunar Laser Ranging Retro-Reflector Array for NASA's Manned Landings, the International Lunar Network and the Proposed ASI Lunar Mission MAGIA**, Proceedings of the 16th International Workshop on Laser Ranging, Space Research Centre, Polish Academy of Sciences Warsaw, Poland, 2008.
- [RD-6] International Lunar Network (http://iln.arc.nasa.gov/), Core Instrument and Communications Working Group Final Reports.
- [RD-7] Yi Mao, Max Tegmark, Alan H. Guth, and Serkan Cabi, Constraining torsion with Gravity Probe B, Physical Review D **76,** 104029 (2007).
- [RD-8] March, R., Bellettini, G., Tauraso, R., Dell'Agnello, S., **Constraining spacetime torsion with the Moon and Mercury**, Physical Review D **83**, 104008 (2011).
- [RD-9] March, R., Bellettini, G., Tauraso, R., Dell'Agnello, S., **Constraining spacetime torsion with LAGEOS**, Gen Relativ Gravit (2011) 43:3099–3126.
- [RD-10] **ETRUSCO-2: An ASI-INFN project of technological development and "SCF-Test" of GNSS LASER Retroreflector Arrays**, S, Dell'Agnello, 3rd International Colloquium on on Scientific and Fundamental Aspects of the Galileo Programme, Copenhagen, Denmark, August 2011

SCF_LAB

Satellite/Lunar/GNSS laser ranging Characterization Facility LABoratory

Two unique OGSE (**Optical Ground Support Equipment**) facilities in a clean room to characterize the SLR/LLR/GNSS and Laser Altimetry space segments

SCF for SLR/LLR/Laser Altimetry (RD-1, RD-2)



SCF-G for GNSS (RD-10)

SCF-Test of GNSS Critical half-Orbit (GCO)

GCO: GNSS orbit whose angular momentum is orthogonal to the Sun-Earth direction

Sunrise-Eclipse-Sunset probes critical features of the thermal and optical behavior of the CCR, including optical breakthroug.

Galileo orbit:

- Altitude = 23222 km
- Period ~ 14 hr, shadow ~ 1hr