

LISA Pathfinder



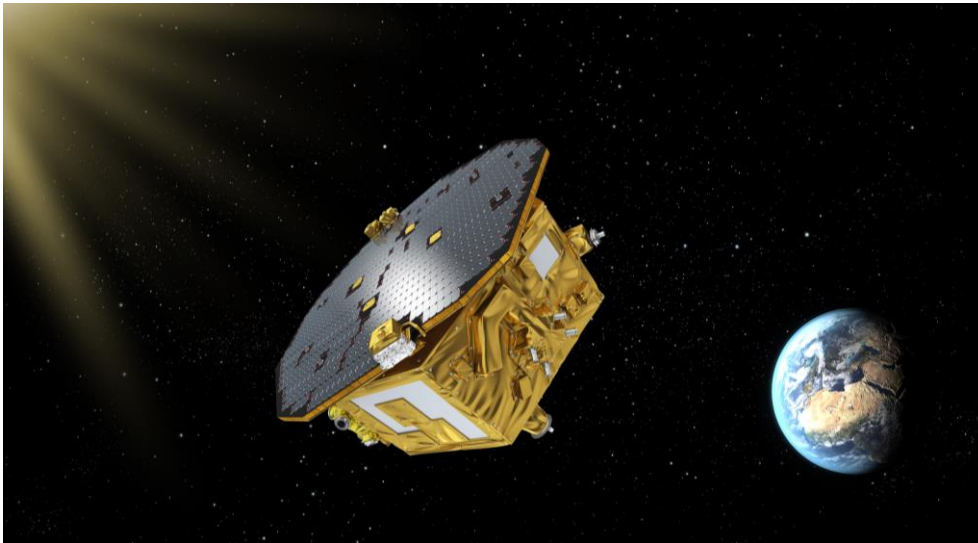
and LISA



LISA Pathfinder: closes in 2017 after 14 years

LISA Pathfinder:

ESA mission for technology testing of the instruments to be placed aboard LISA: the first interferometer for gravitational waves in space in the frequency range 10^{-4} - 10^{-1} Hz

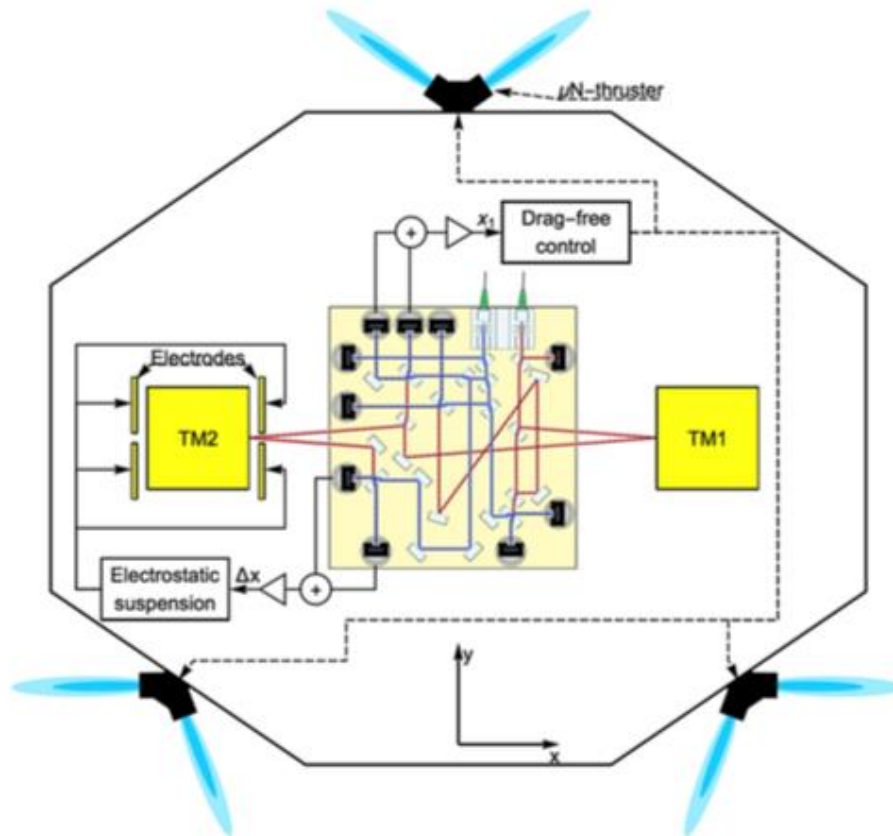


**2016 ESA Team
Achievement
Award for the
LISA Pathfinder Team
Ceremony:
October 4th 2017 Paris**

Launch: December 3rd 2015 5.04 GMT+1

Mission end: July 18th, 2017

LISA Pathfinder instrument



Test masses

electrode housing

(electrostatic shield

and 6 degrees of

freedom sensor and
actuator)

Spurious forces acting on

Test Masses:

Coulomb forces from

cosmic-ray charging

UV light discharge system

Two independent

laser interferometers

measure the differential

displacement between

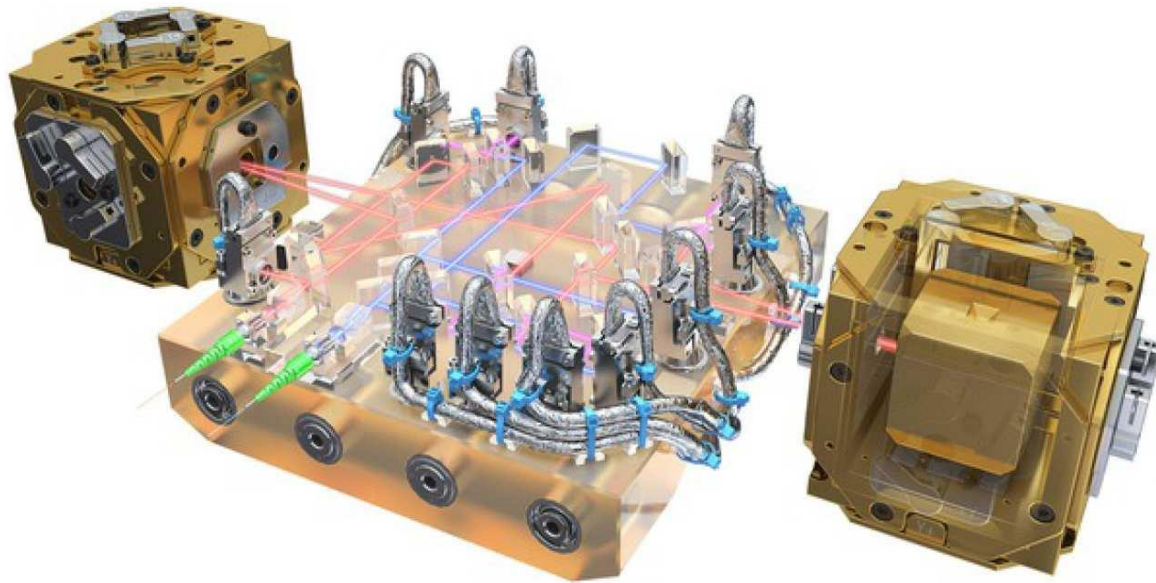
test masses and the

displacement of test-mass 1

with respect to the S/C

Armano et al., PRL, 116, 231101, 2016

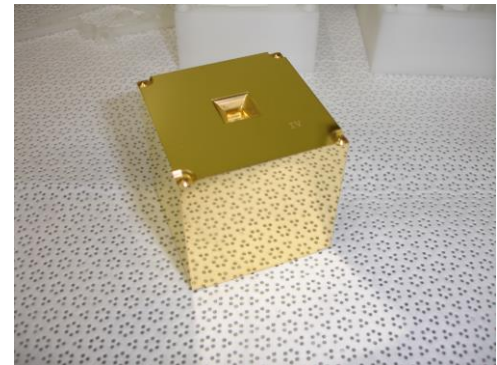
LISA-PF FREE-FALLING TEST-MASSSES



Test masses (TMs):
cubes of 70% Pt-30% Au
4.6 cm side
2 kg mass
38 cm distance

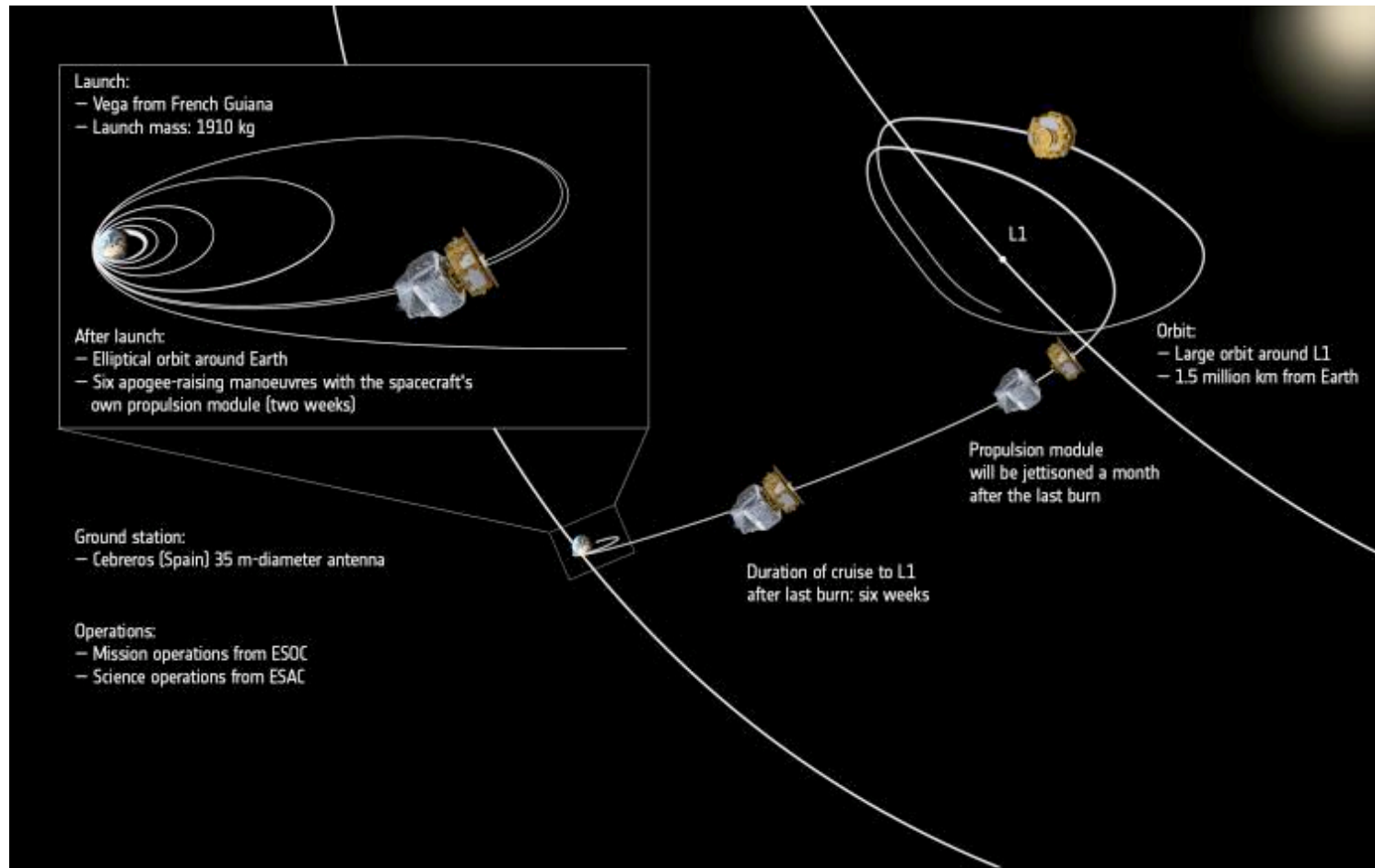
Approximately 13 g cm^{-2} of matter surround
the TMs

Armano et al., PRL, 116, 231101, 2016

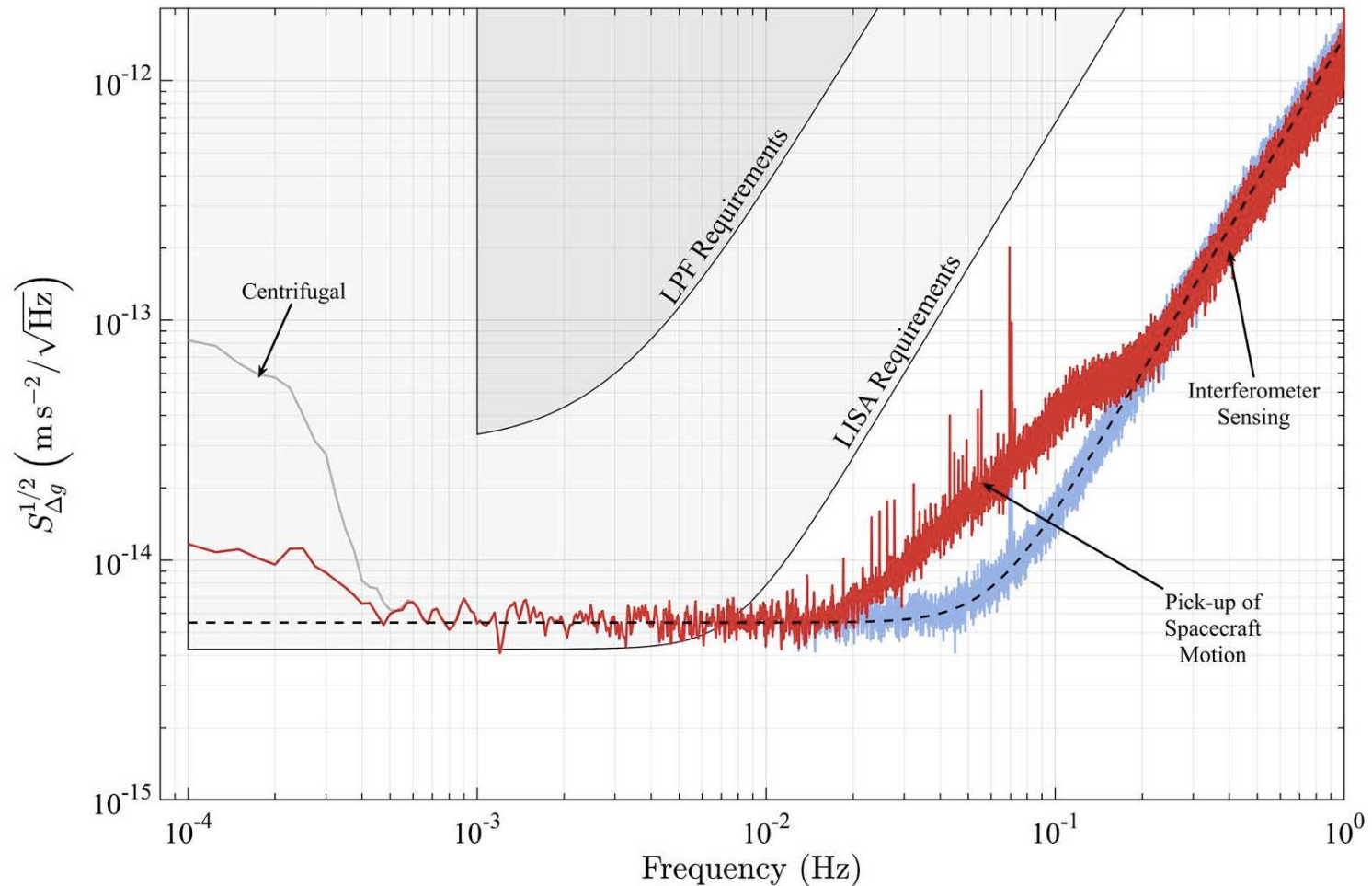


LISA-PF Orbit

Science operation mode: March 1st 2016 - June 30th 2017



LISA-PF ASD

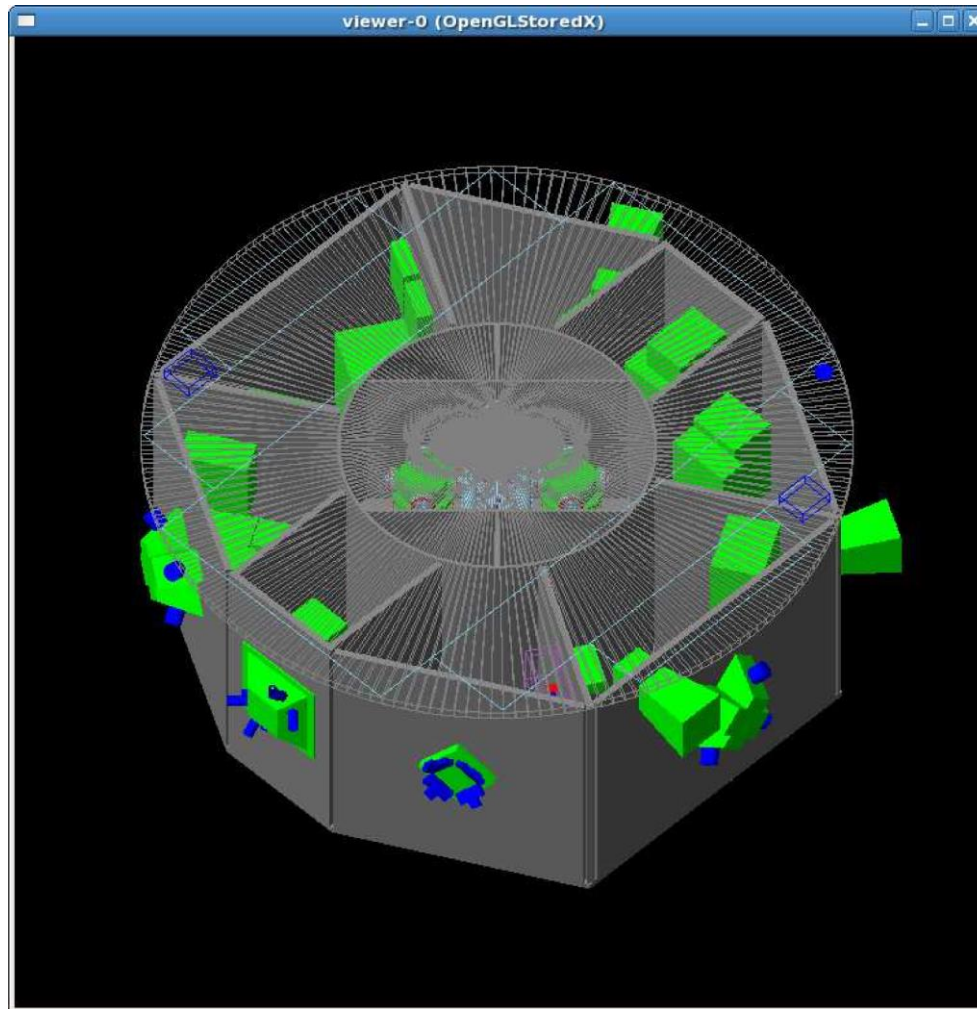


<0.1- 0.5 mHz 12 fm $\text{s}^{-2} \text{Hz}^{-1/2}$

0.7-20 mHz 5.2 \pm 0.01 fm $\text{s}^{-2} \text{Hz}^{-1/2}$ 5 times better than expected

> 60 mHz (34.8 \pm 0.3) fm $\text{Hz}^{-1/2}$

Work in Florence - Test-mass charging study with Fluka



FLUKA MC
Simulation

Wass et al., CQG, 22, 2005, S311-S317

CG et al., CQG, 32, 2015, 035001

Test-mass charging

Net and effective charging estimated with the
Fluka MC Program

2x10⁶ events
in each run
In order to
limit the
uncertainty on
 $\lambda_{\text{eff}} < 2\%$

$$I_{\text{NET}} = \sum_{j=-\infty}^{+\infty} \dot{q} j / j$$

*Ferrari et al., 2005-10
(Geneva:CERN)
Battistoni et al.,
AIP Conf. Proc. 896,
M. Albrow and R. Raja, 31-49*

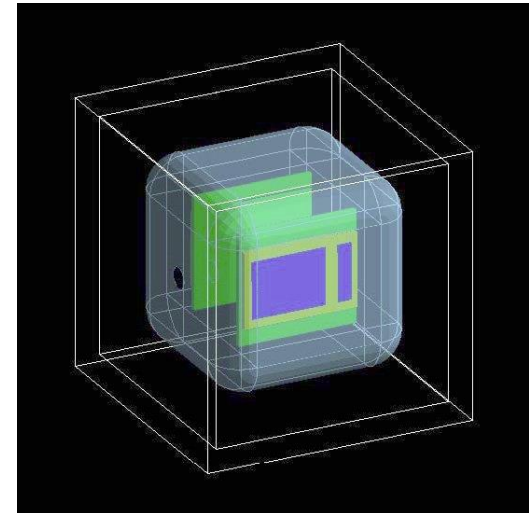
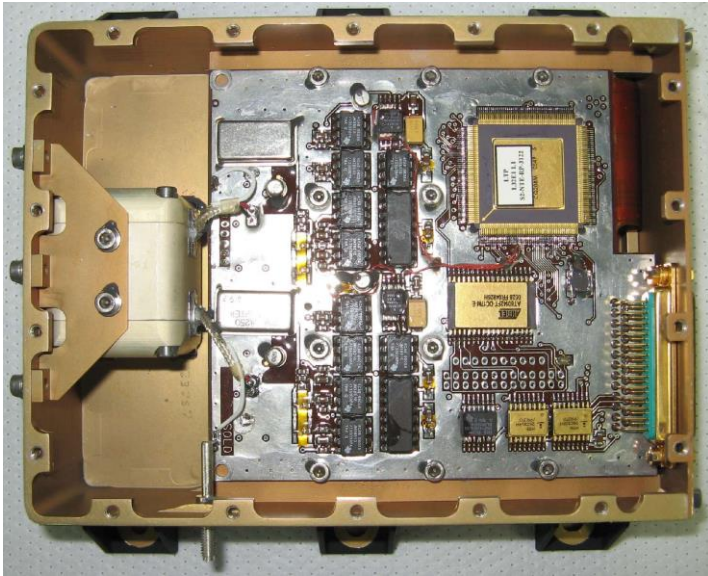
$$I_{\text{EFF}} = \sum_{j=-\infty}^{+\infty} \dot{q} j^2 / j$$

Where: j is the amplitude of the charge released by each event and λ_j is rate of occurrence of that event.

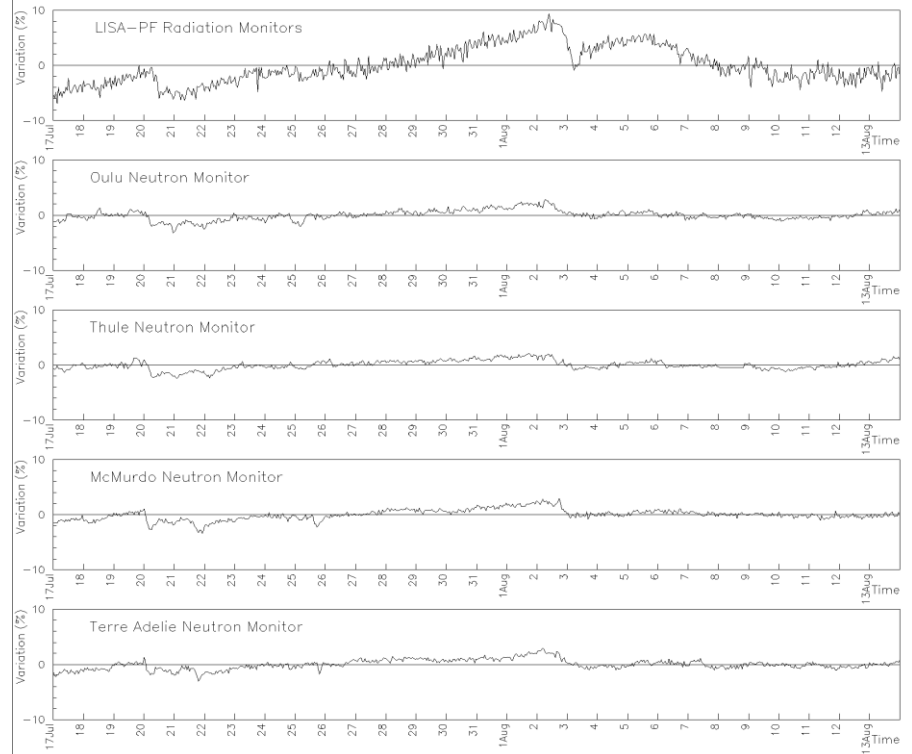
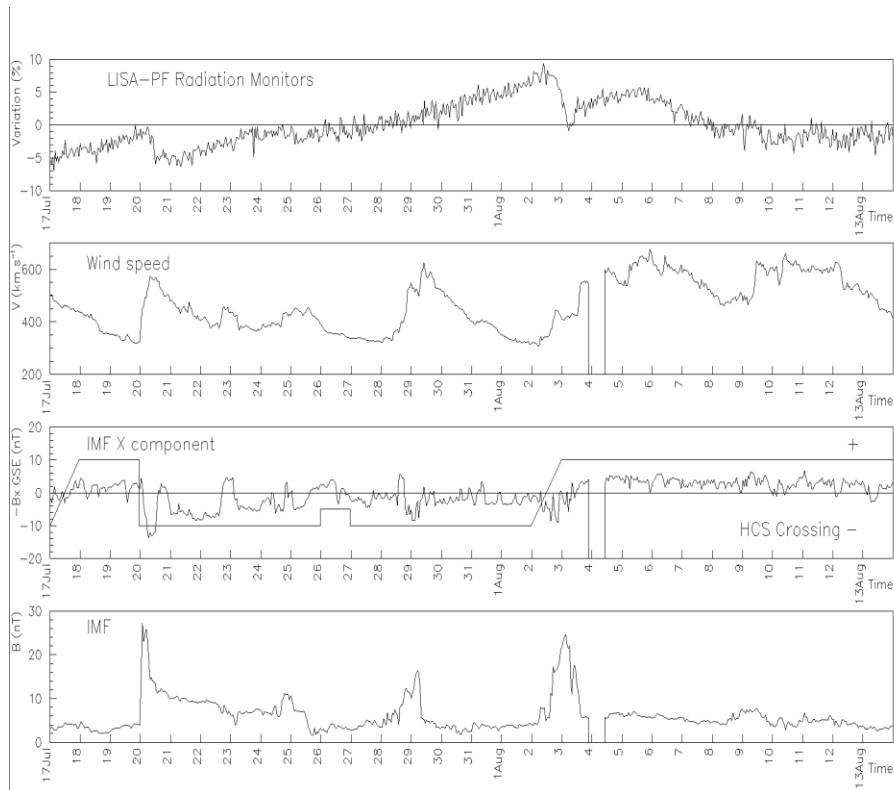
$$S_Q(\omega) = \frac{S}{\omega} = \frac{\sqrt{2e^2 \lambda_{\text{eff}}}}{\omega}$$

$$S = \sqrt{2e^2 \lambda_{\text{eff}}} \quad e \, s^{-1} \, Hz^{-1/2}$$

LISA-PF radiation monitors



2 silicon wafers
of $1.4 \times 1.05 \text{ cm}^2$ area
placed 2 cm apart.



BARTELS ROTATION 2496

http://omniweb.sci.gsfc.nasa.gov/html/polarity/polarity_tab.html
cdaweb.gsfc.nasa.gov

About gravitational wave detection

- ◆ In November 2013 ESA selected the Gravitational Universe as one of its corner-stone science themes.
- ◆ In June 2017 LISA was selected by ESA as the third large mission after JUICE (L. 2022) and ATHENA (L. 2028). initially scheduled for launch in 2034 will go probably by 2029.

LISA performance with the LISA-PF acceleration noise

- Black hole merging with total mass 10^6 solar masses at redshift $z=3$ with S/N ratio of 5000 (several % of LISA expected performance)
- Heavy black hole merger with 10^7 solar masses total mass at redshift $z=3$ with S/N ratio of 1400 (2000 expected with LISA).
- EMRIs and coalescing compact binaries will present S/N ratio similar to LISA.

Florence Activity - 2018

- ANALYSIS OF RADIATION MONITOR DATA AND INTERPLANETARY SOLAR WIND PARAMETER FOR SPACE WEATHER APPLICATIONS (END)
- PARTICIPATION TO THE OPTIMIZATION OF THE DIAGNOSTICS DETECTORS FOR LISA WITH BARCELONA TEAM
- TEST-MASS CHARGING IN LISA: the charging process will be studied with Fluka (BEGIN).

NEW LISA Group - Florence

- Catia Grimani 100%
- Ruggero Stanga 70%
- Noemi Finetti 60%
- Simone Benella 100% (Dottorando-nuovo)
- Assegnista di ricerca (100%)(Concorso da bandire in autunno 2017)
- Monica Laurenza 20%
- Daniele Telloni 20%
- **FTE: 3.7 + (1)**

Recent publications:

Grimani C. et al., CQG, 32, 035001 (14 pp), 2015
Armano M. et al., Ph. Rev. Lett., 116, 231101, 2016
Telloni D., Fabi M, Grimani C, Antonucci E,
AIP Conference Proceedings 1720 (1), 100001, 2016
Grimani, C., MNRAS 460 (2), 2186-2192, 2016
Armano, M. et al., CQG, 33 (23), 235015, 2017
Armano M. et al., PRL, 118 (17), 17110, 2017

FINANCIAL REQUESTS

20 keuro MISSIONI:

For collaboration meetings and conference presentations (participation to the LISA international collaboration activities).