Virgo
detektor fal grawitacyjnych

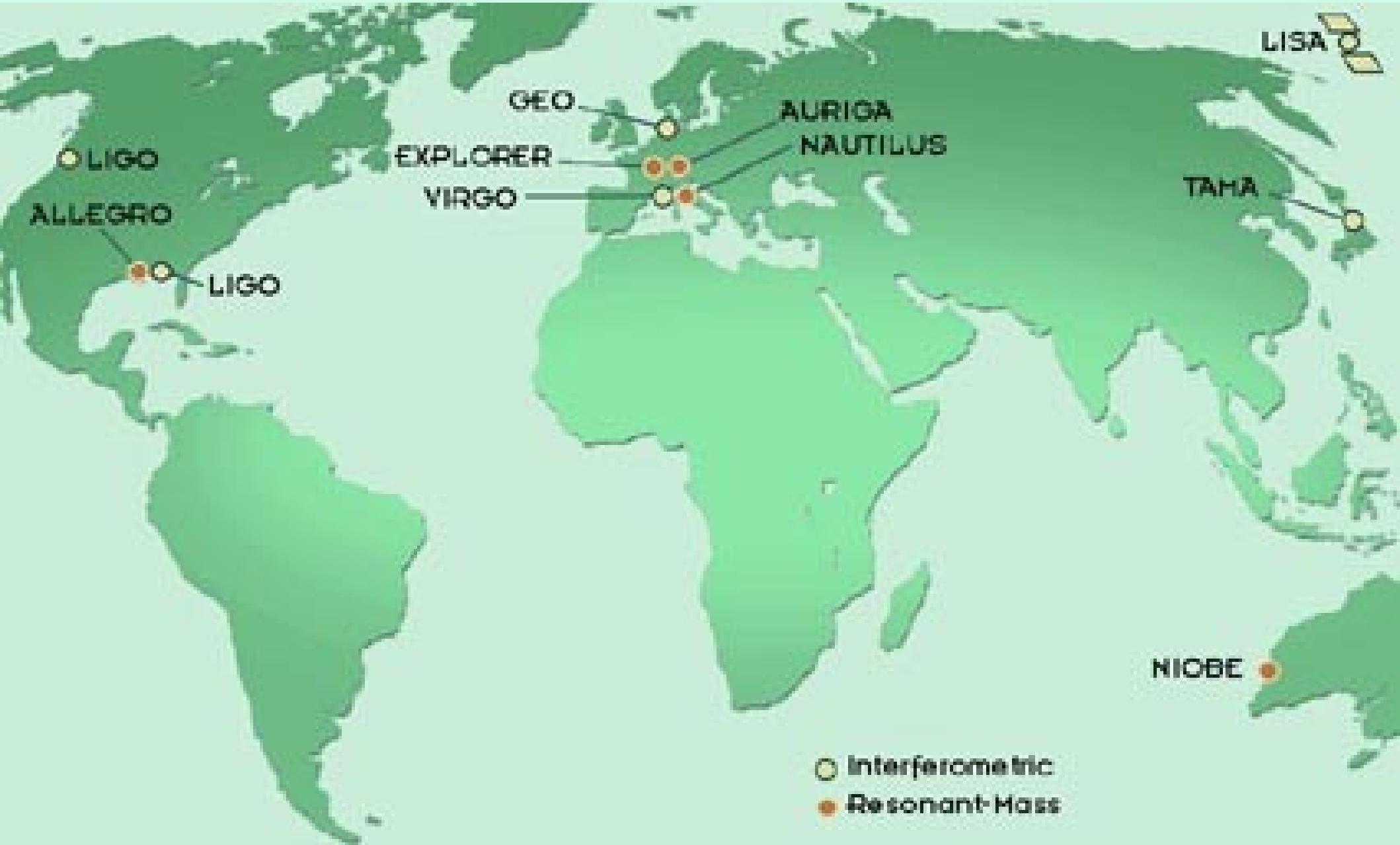
Prezentacja na seminarium Katedry Radioastronomii

28 X 2010 r.

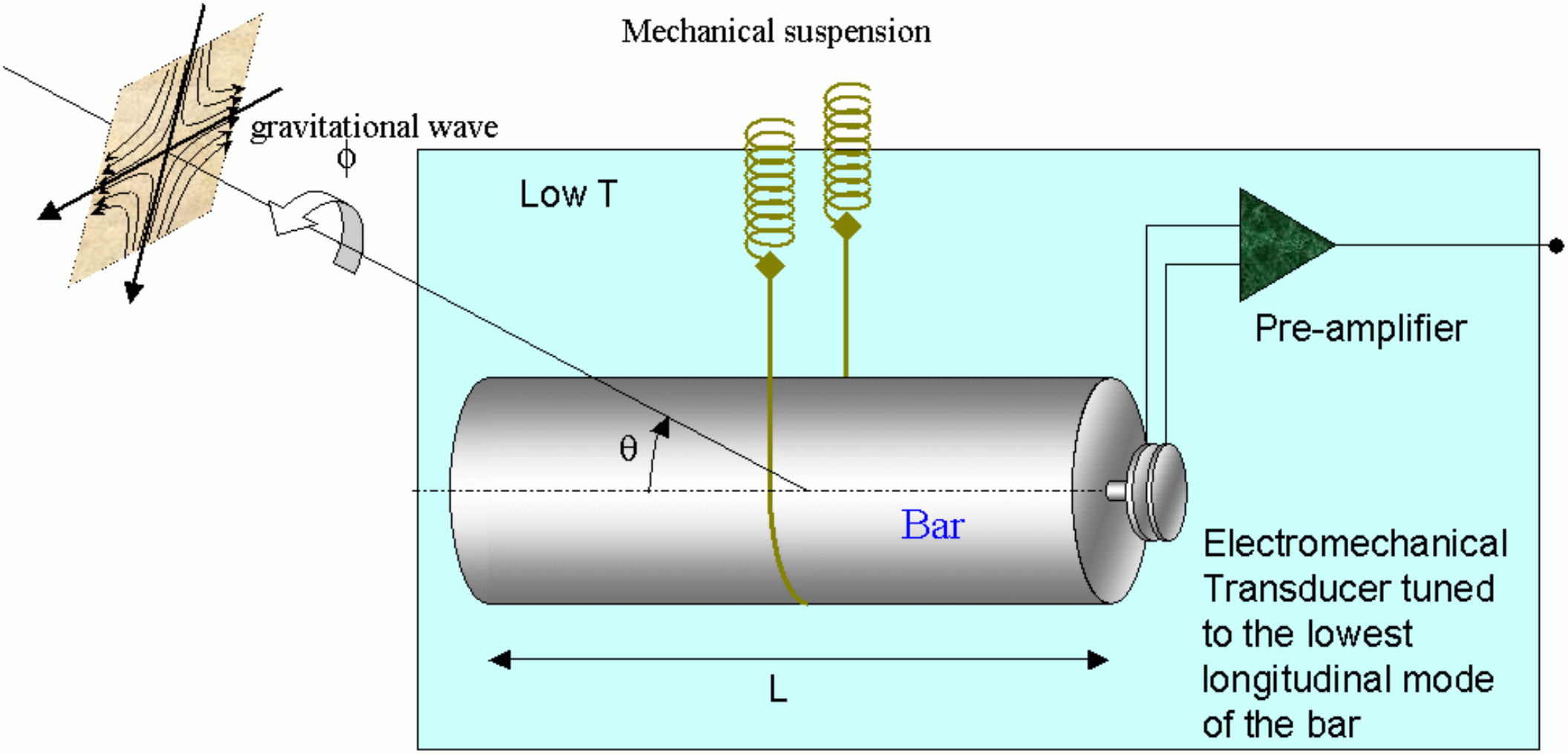
Kazimierz Borkowski

- **Detektory fal grawitacyjnych na świecie**
  Detektory w naszych grantach:
  Explorer, Nautilus i Virgo
- **Virgo**
- **Mój dyżur przy Virgo (IX 2010)**
- **Polska grupa analizy danych (POLGRAW)**
  Skład osobowy i publikacje
- **Źródła**
  (http://www.ego-gw.it/virgodescription/indice.html)

Detektory fal grawitacyjnych

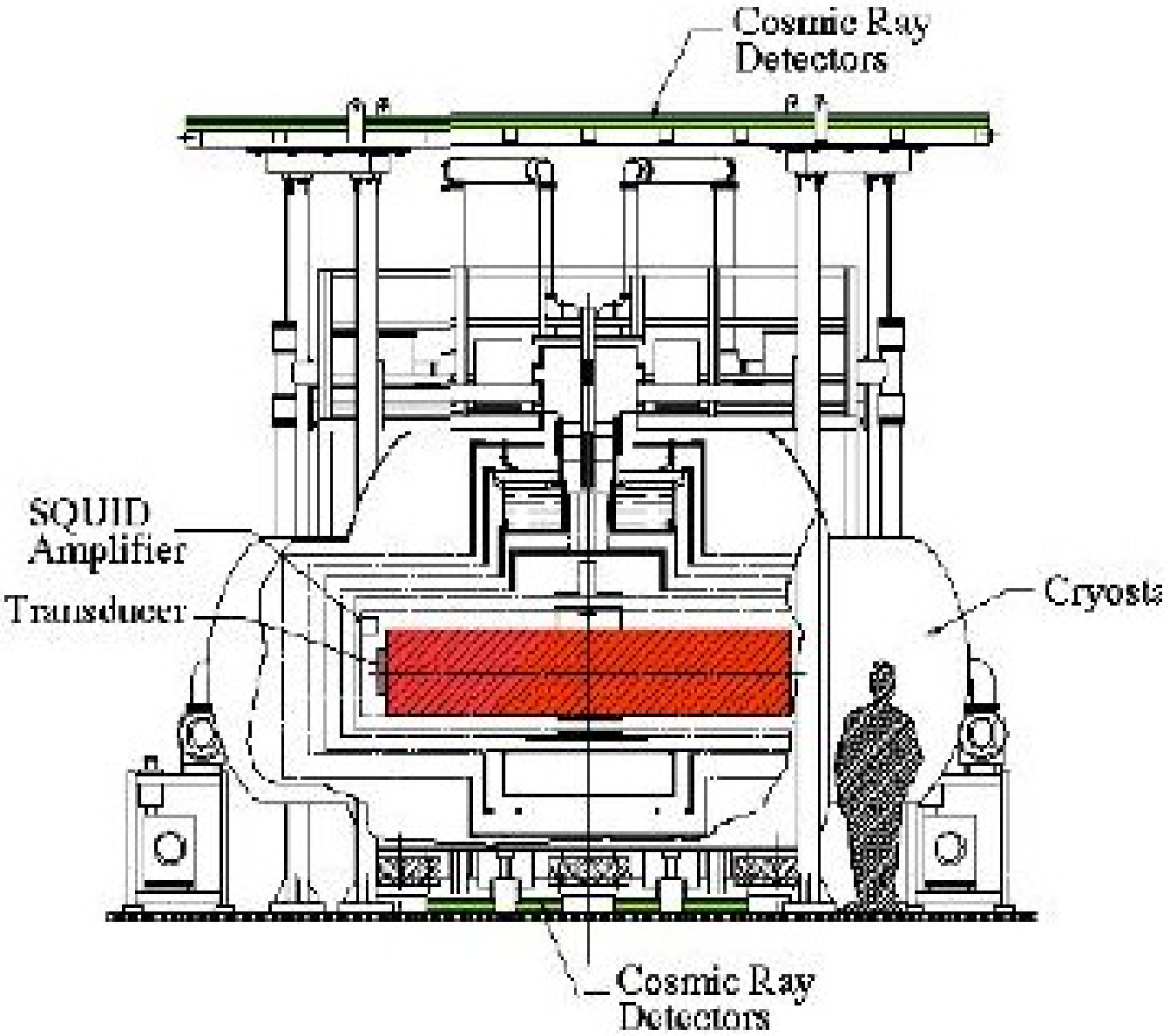


Idea detektora walcowego

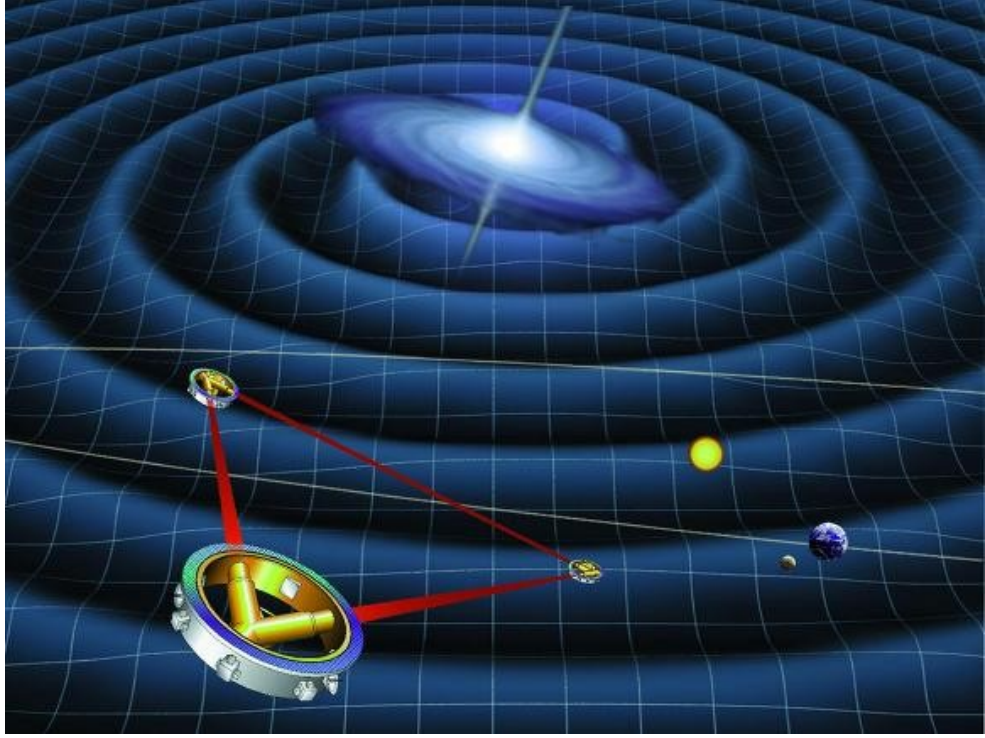


Explorer

Nautilus


Cosmic Ray
Detectors
SQUID
Amplifier
Transducer
Cryosta
Cosmic Ray
Detectors

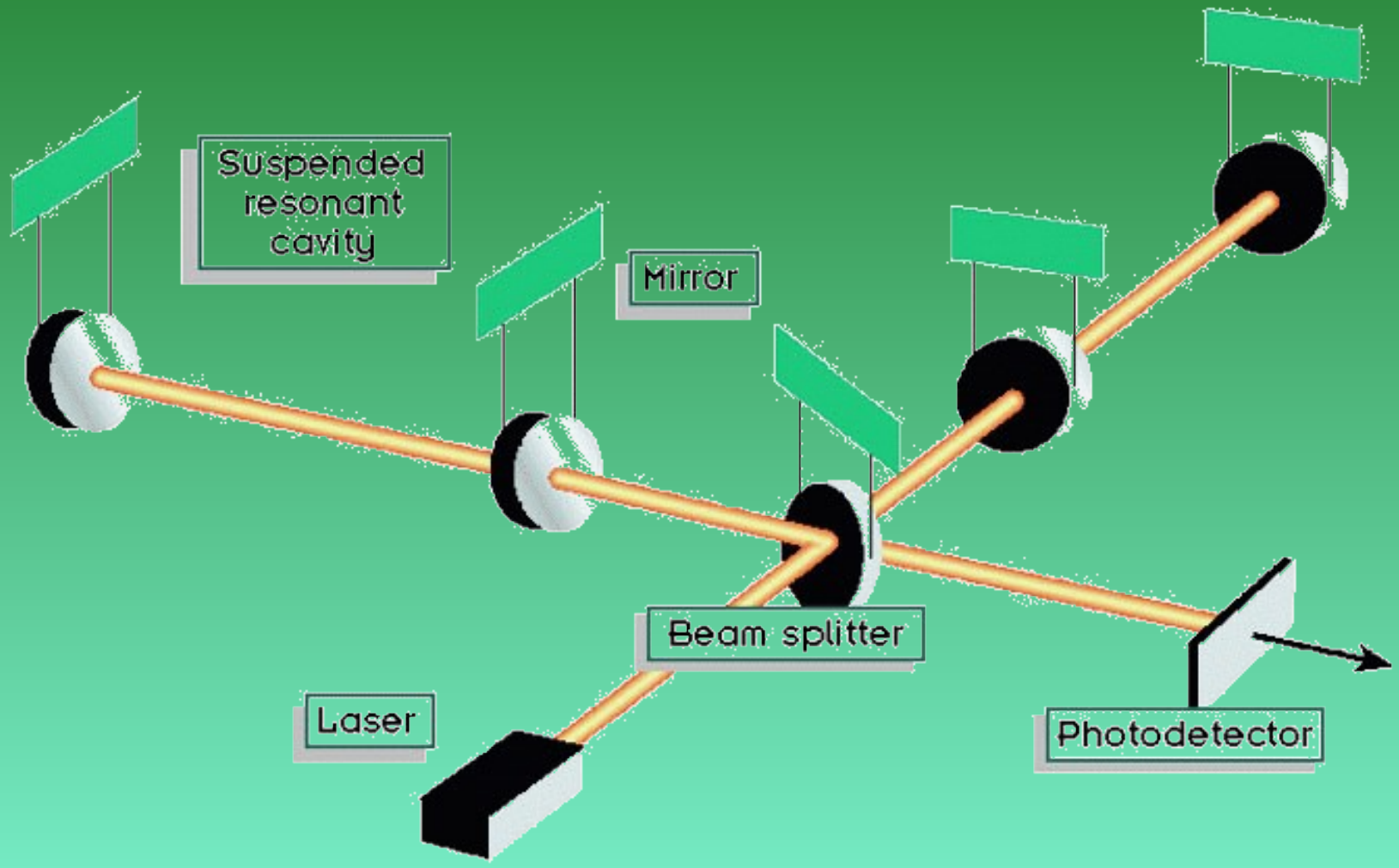
MiniGRAIL
Leiden

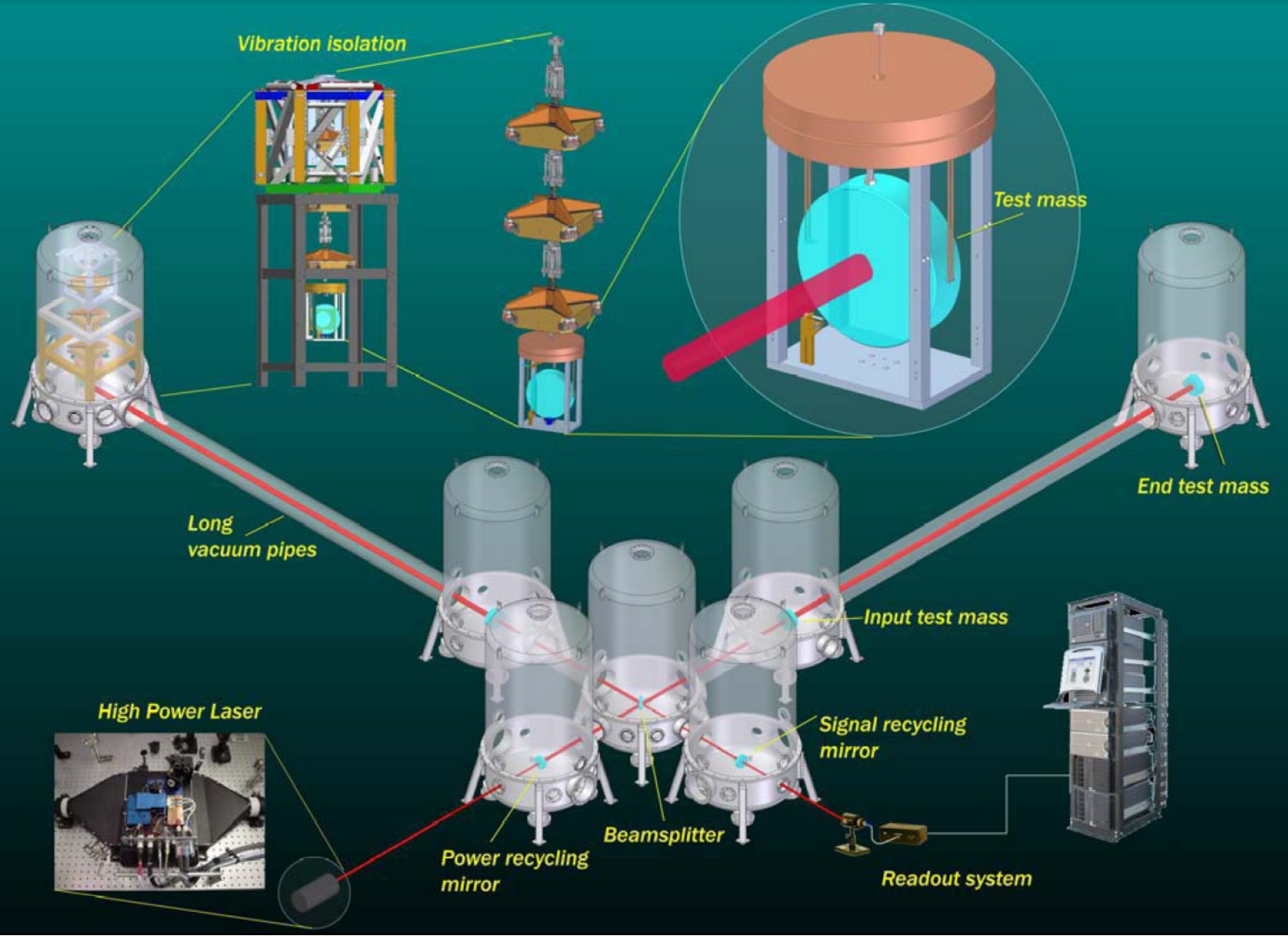


LISA - NASA/ESA

LIGO – Washington (left), Luisiana (right)

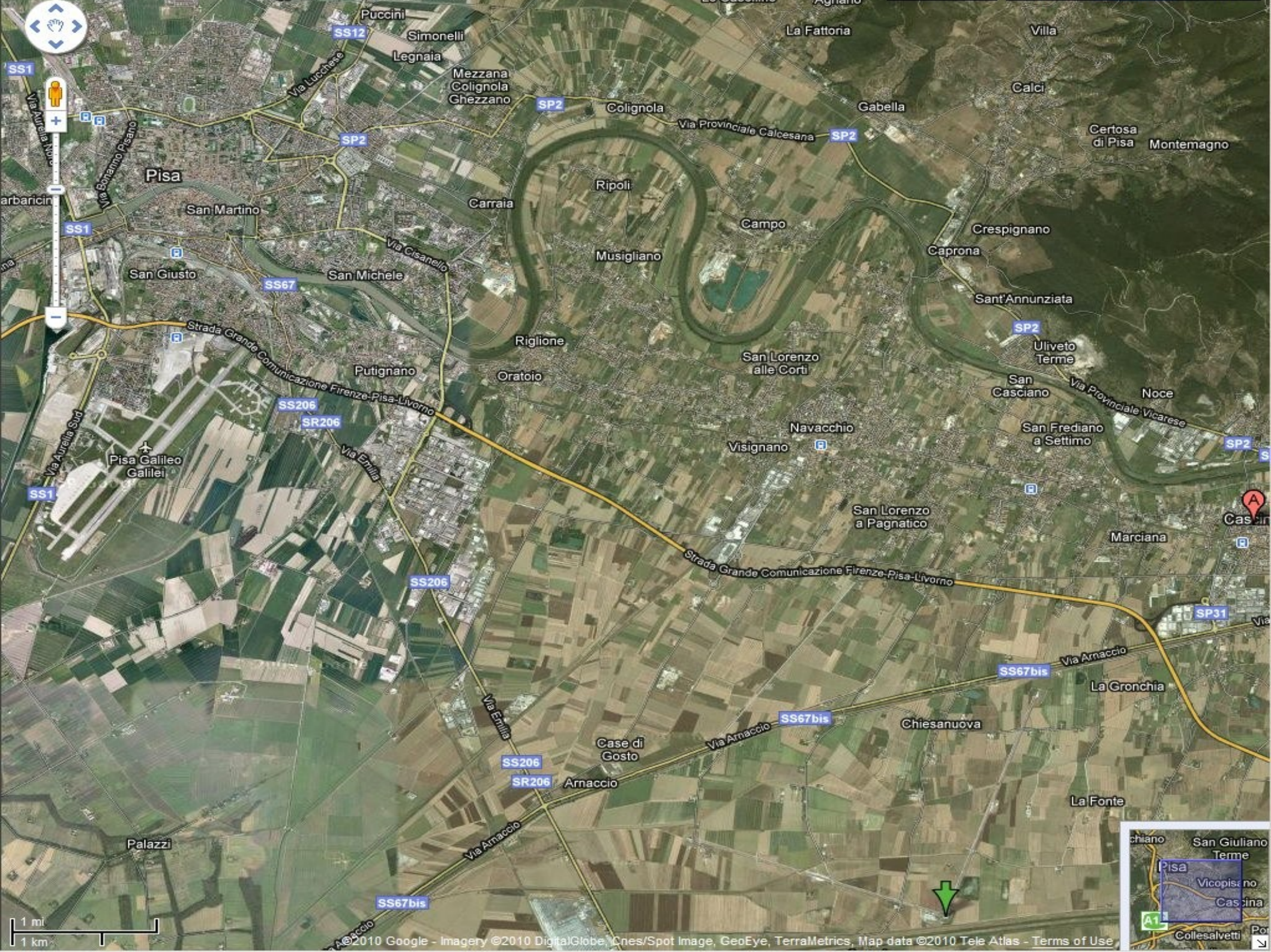
Idea detektora laserowego

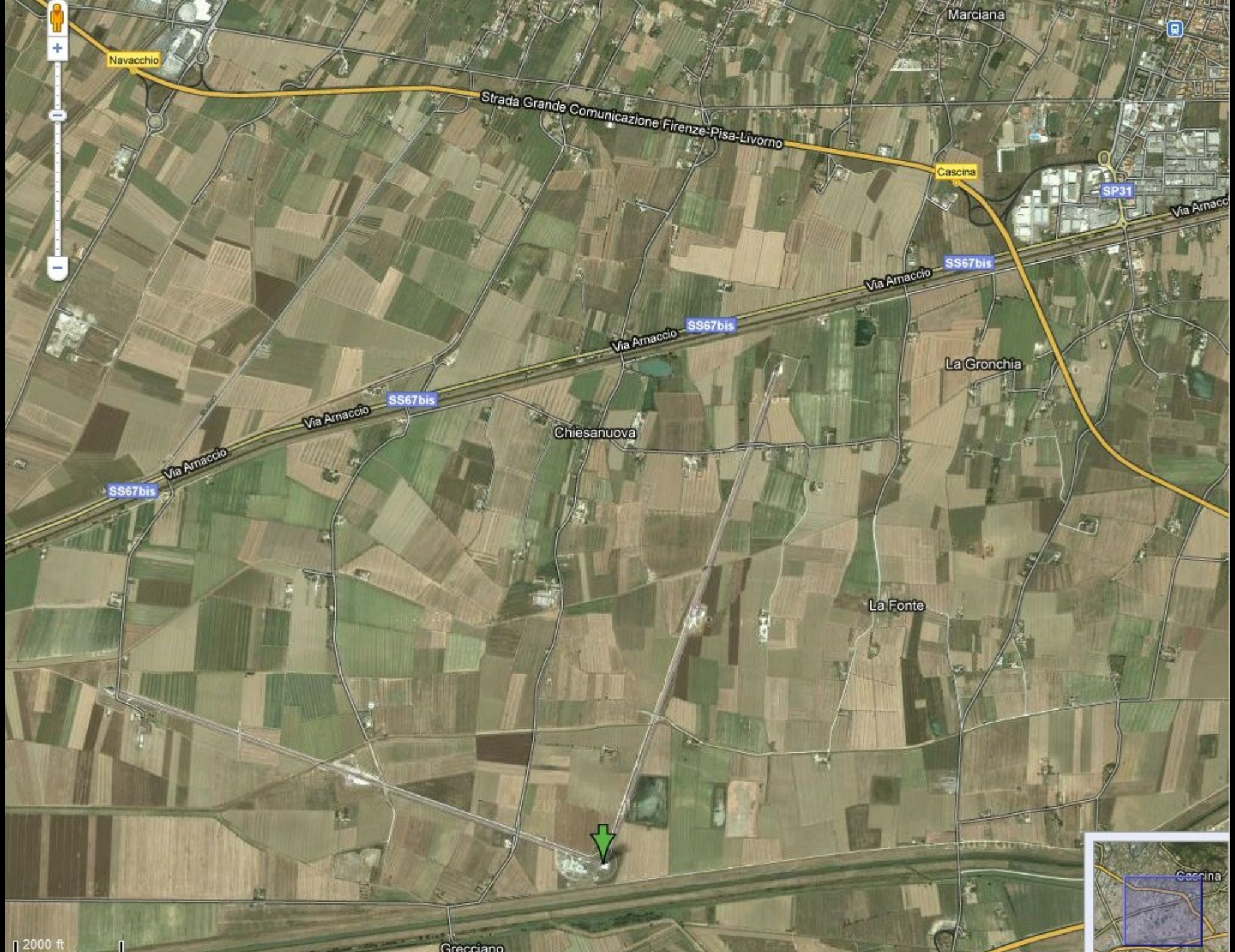


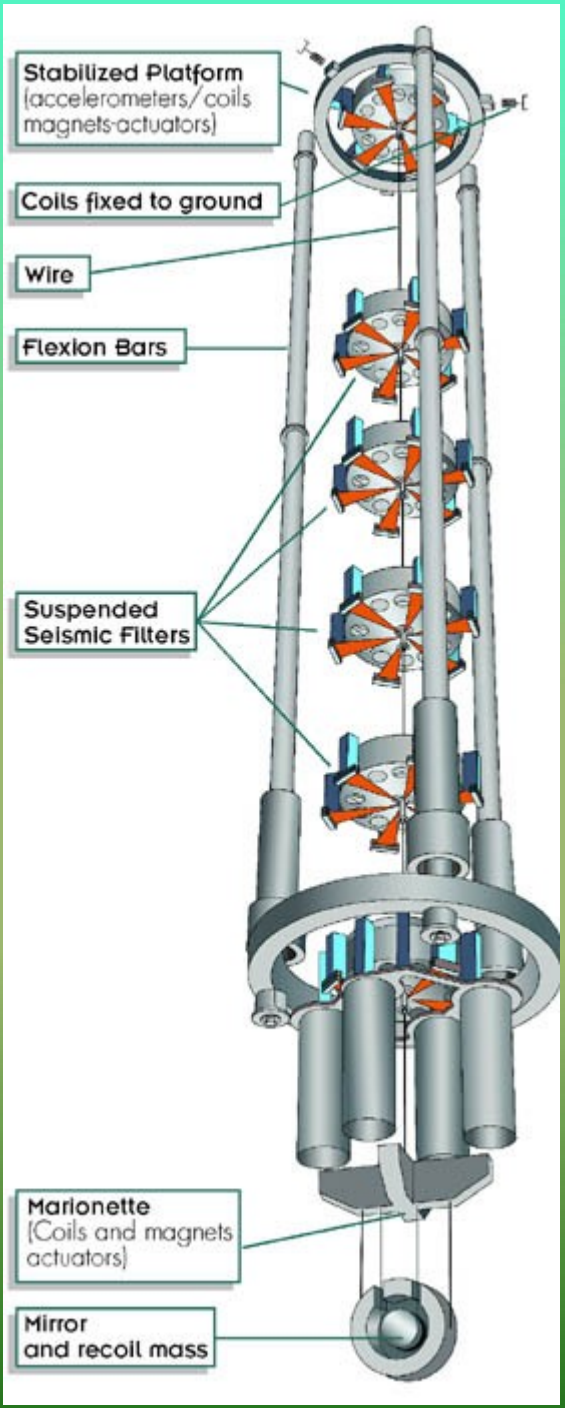


http://www.aigo.org.au/aigo_web_docs/aigo_prospectus.pdf


PISA NORD
S. Giuliano Terme
Calci
PISA
Riglione
Navacchio
ARNO
Cascina
S. Piero
a Grado
Aeroporto
internazionale
G. Galilei
Pontedera
EGO
VIRGO
LIVORNO
Vicarello
Cascina
Collesalvetti

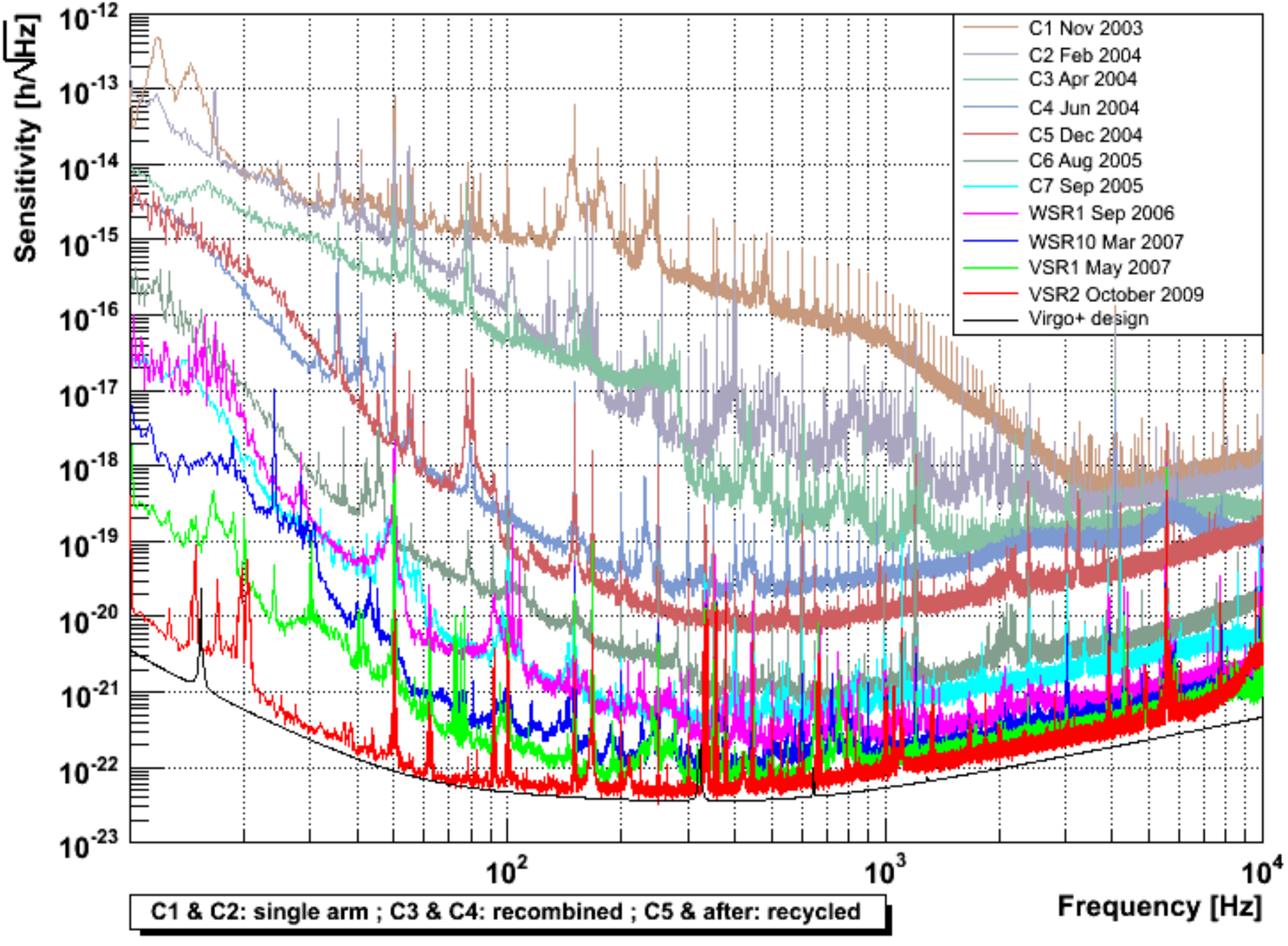

Puccini
Simonelli
Legnaia
Mezzana
Colignola
Ghezzano
Via Lucchese
La Fattoria
Villa
Calci
Gabella
Colignola
Via Provinciale Calcesana
Certosa
di Pisa
Montemagno
Pisa
Via Bonanno Pisano
Via Aurelia Nord
San Martino
Carraia
Ripoli
Campo
Crespignano
Caprona
Via Cisanello
Musigliano
San Giusto
San Michele
Sant'Annunziata
Strada Grande Comunicazione Firenze-Pisa-Livorno
Riglione
Uliveto
Terme
San Lorenzo
alle Corti
Putignano
Oratoio
San
Casciano
Via Provinciale Vicarese
Noce
Via Aurelia Sud
Pisa Galileo
Galilei
Via Emilia
Navacchio
Visignano
San Frediano
a Settimo
San Lorenzo
a Pagnatico
Marciana
Strada Grande Comunicazione Firenze-Pisa-Livorno
Via Arnaccio
La Gronchia
Chiesanuova
Case di
Gosto
Arnaccio
La Fonte
Palazzi
SS1
SS12
SP2
SS67
SS206
SR206
SS67bis
SP31
1 mi
1 km
©2010 Google - Imagery ©2010 DigitalGlobe, Cnes/Spot Image, GeoEye, TerraMetrics, Map data ©2010 Tele Atlas - Terms of Use
San Giuliano
Terme
Pisa
Vicopisano
A1
Collesalvetti

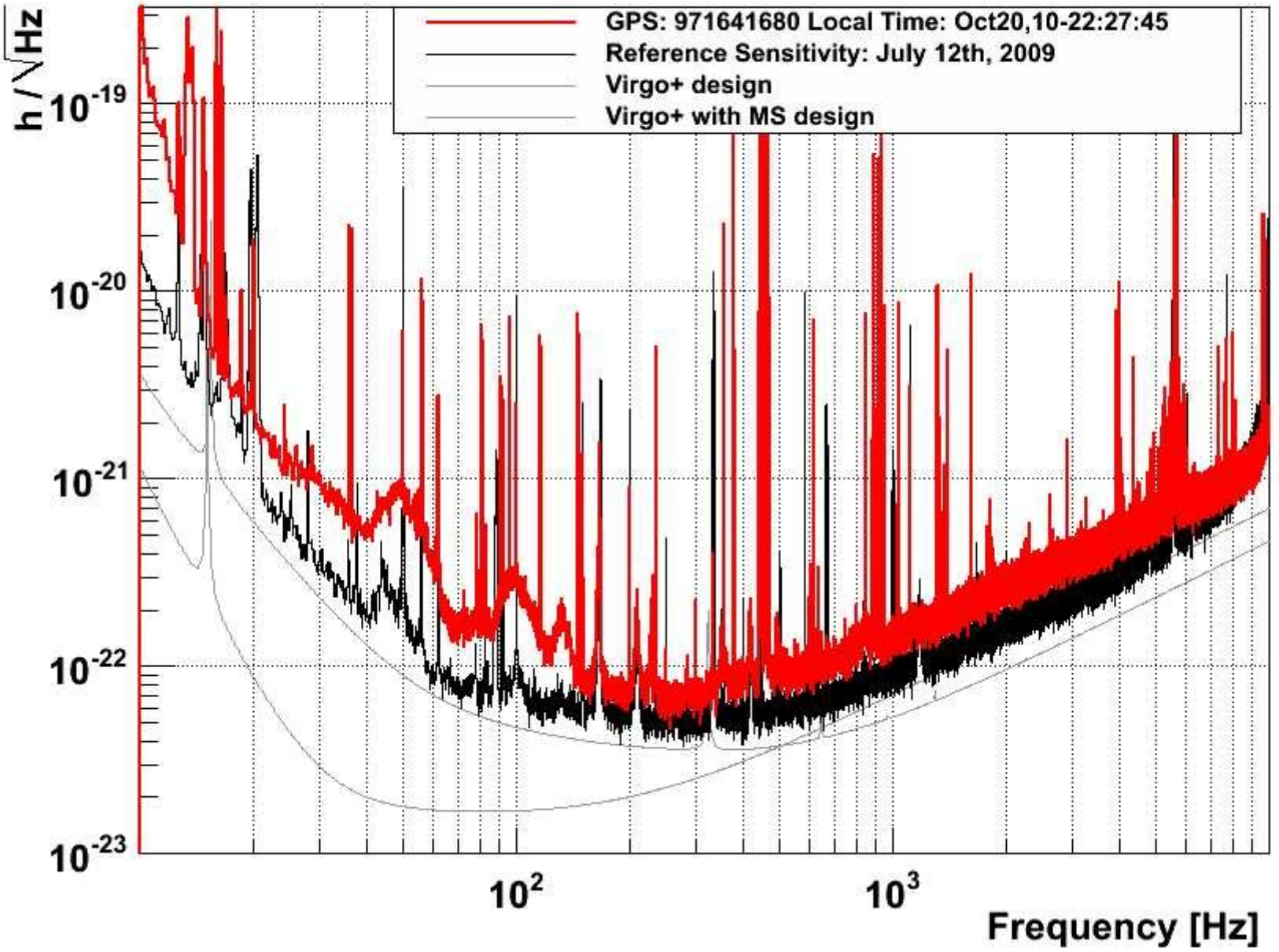

Marciana
Navacchio
Strada Grande Comunicazione Firenze-Pisa-Livorno
Cascina
SP31
Via Arnaccio
SS67bis
La Gronchia
Chiesanuova
La Fonte
2000 ft
Cascina

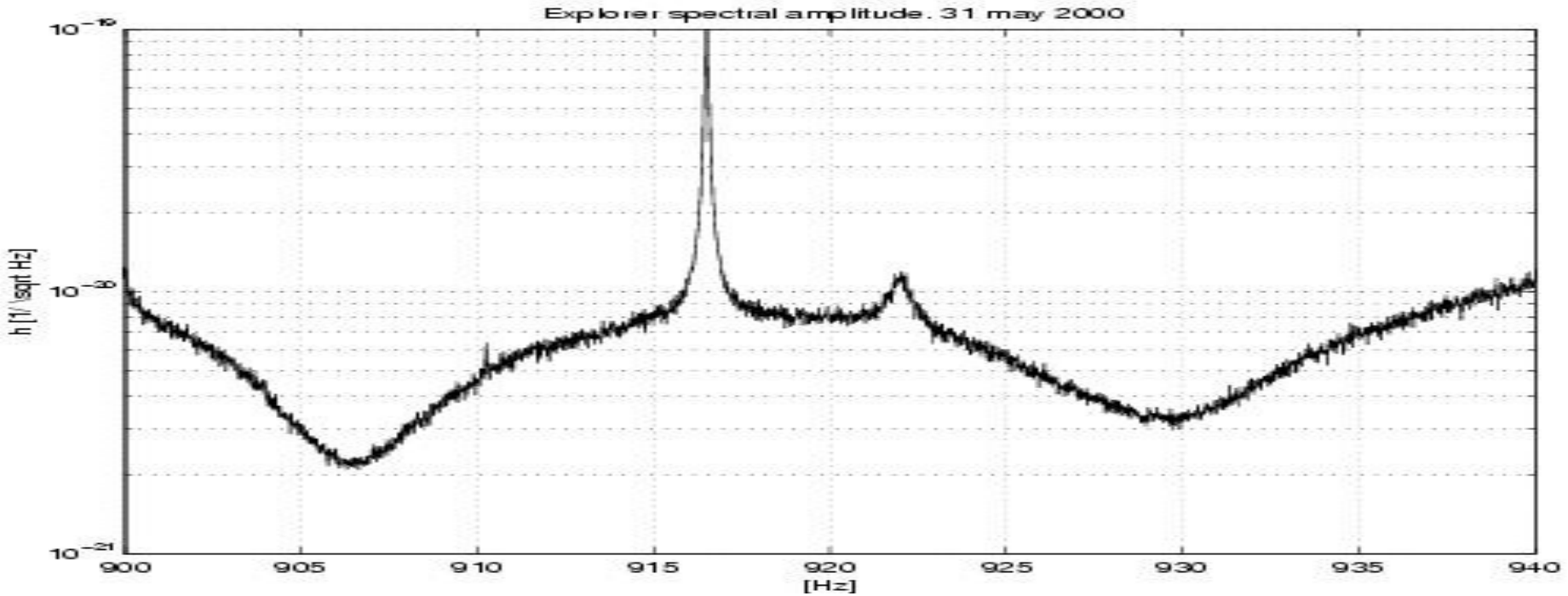

Stabilized Platform
(accelerometers/coils
magnets-actuators)
Coils fixed to ground
Wire
Flexion Bars
Suspended
Seismic Filters
Marionette
(Coils and magnets
actuators)
Mirror
and recoil mass

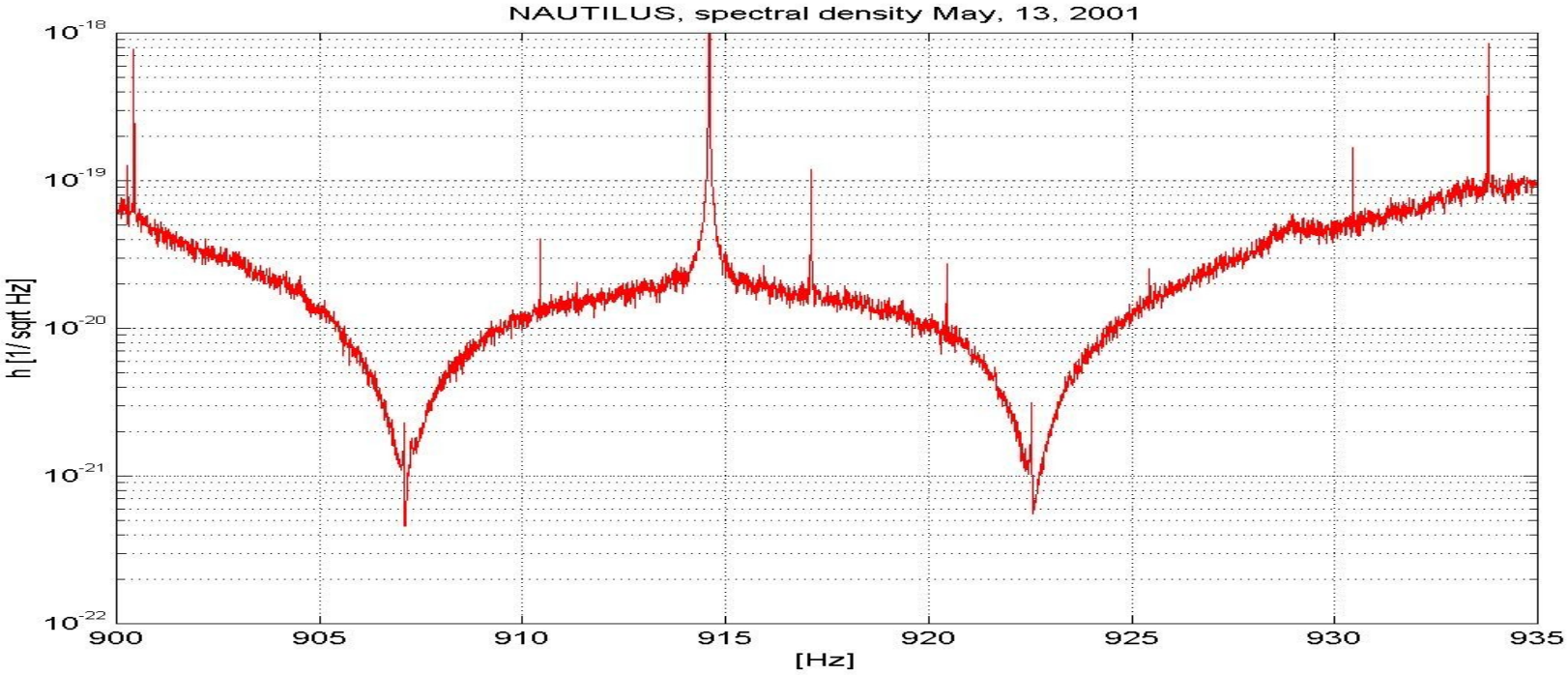
Virgo Data

Principle: Michelson laser interferometer with two Fabry-Perot cavities in the arms and power recycling.	
Arms length:	3 kilometers
Vacuum tube:	120 cm diameter, fully welded (no seal)
Vacuum performance:	
Pressure after baking at 150o C:	< 10-9 mbar
hydrocarbons partial pressure	10-13 mbar
Laser and injection system:	
Nd:YAG diode-pumped laser at 1064 nm	
Laser power:	20 W
Mode cleaner:	144 m long, 3 mirrors ring cavity
Finesse of mode cleaner cavity	1000
Frequency stability	< 10-4 Hz1/2 at 1 kHz
Relative Intensity Noise (RIN)	< 10-7 at 1 kHz
Power Stored in Fabry-Perot cavity:	15 to 50 kW (depending of finesse)
Power Stored in recycling cavity:	1 kW
Optics	
Main mirror substrates	special “Virgo” grade fused silica
	absorption < 1 ppm/cm
	diameter 350mm
Reflective coatings	absorption < 1ppm
Anti reflection coatings	reflection < 0.1 %
Surface quality	l/200 rms
Surface microroughness	< 1 Angstrom
Suspensions	
Inverted pendulum pre-isolator plus 6 passive stages.	
Active control on first and last stage and on mirror.	
Seismic attenuation	10-11 at 10 Hz
rms mirror motion before locking:	<1 mm, < 0.1 mradian
Thermal stabilization	+/- 0.1 degree C
Frequency range	10 Hz to 10 kHz
Sensitivity	h ~ 3 10-21 Hz-1/2 at 10 Hz
	h ~ 3 10-23 Hz-1/2 at 1 kHz


Sensitivity [h/√Hz]
10^-12
10^-13
10^-14
10^-15
10^-16
10^-17
10^-18
10^-19
10^-20
10^-21
10^-22
10^-23
10^2
10^3
10^4
Frequency [Hz]
C1 Nov 2003
C2 Feb 2004
C3 Apr 2004
C4 Jun 2004
C5 Dec 2004
C6 Aug 2005
C7 Sep 2005
WSR1 Sep 2006
WSR10 Mar 2007
VSR1 May 2007
VSR2 October 2009
Virgo+ design
C1 & C2: single arm ; C3 & C4: recombined ; C5 & after: recycled


GPS: 971641680 Local Time: Oct20,10-22:27:45
Reference Sensitivity: July 12th, 2009
Virgo+ design
Virgo+ with MS design
h / √Hz
10^-19
10^-20
10^-21
10^-22
10^-23
10^2
10^3
Frequency [Hz]


Explorer spectral amplitude. 31 may 2000
h [1/\sqrt Hz]
[Hz]


NAUTILUS, spectral density May, 13, 2001
h [1/\sqrt Hz]
[Hz]

Running processes

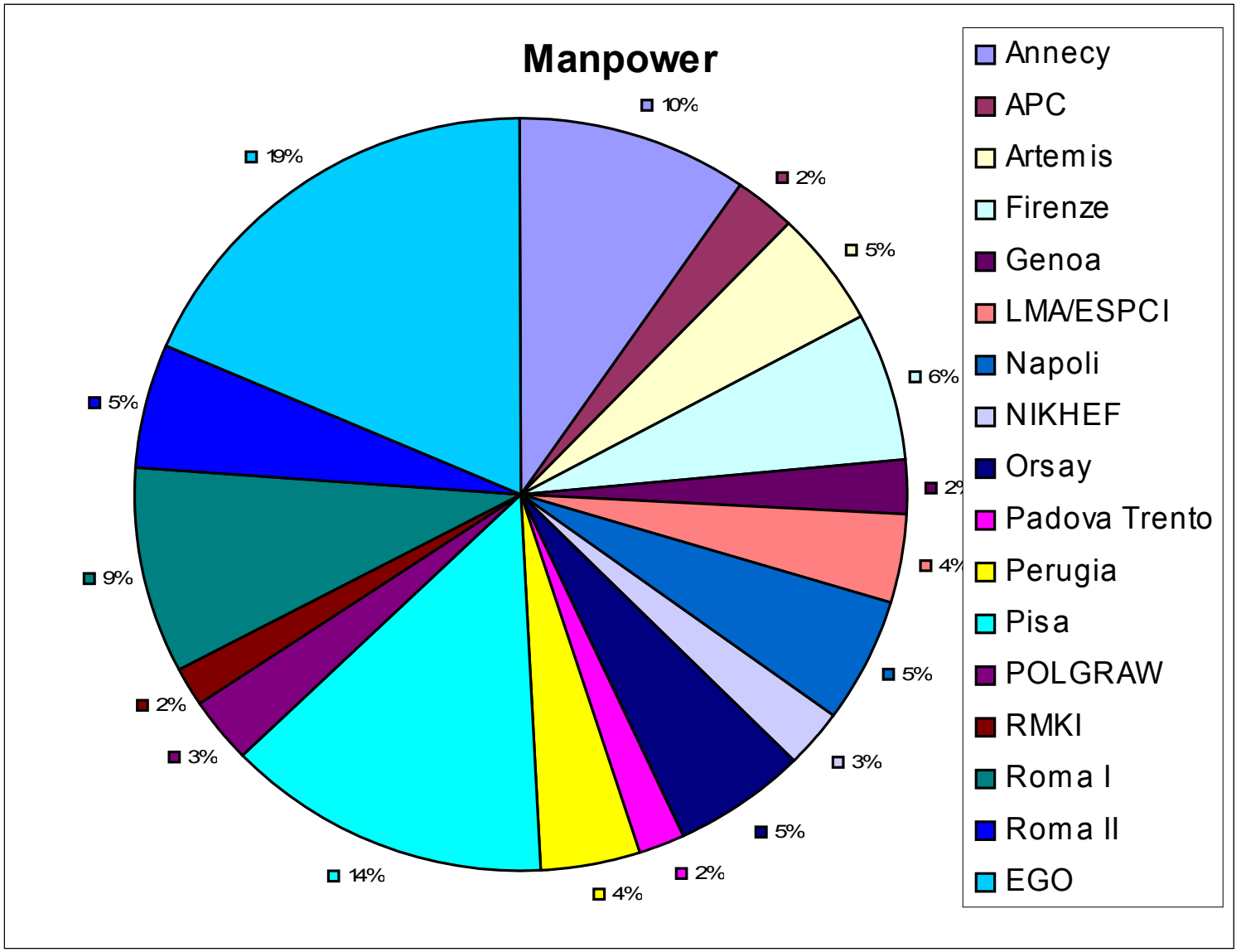
- **The color of each Cl boxes is a summary of the status of the processes monitored by this Cl**
- **Red=some processes stopped , Orange=some processes not reachable by Cl , Yellow=some processes in initialization step , DarkGreen=some processes active but not golden**
- **The number below the Cl name is the number of processes in the state corresponding to the box's color**

Click on a box to see the list of processes run by the corresponding Cl.
This page is mainly dedicated to on-call experts should take care of any color not green
For operators: If a box is grey and indicates that the Cl is inactive since xx minutes, it means that you must restart the Cl in control room

Last update: Fri Oct 22 11:30:46 CEST 2010 - Last access: 22 października 2010 11:30:46

ClAlp Automation	**ClBenchesE** End Benches User Interface 4	**ClBenches** Central Benches User Interface 5	**ClCalibration** Calibration 5	**ClISYS** ISYS Client
ClTCS TCS Servers Client	**ClEnvMon** Environmental Monitoring Client	**ClInfraMon** Infrastructure Monitoring Client	**ClITF** ITF Control 1	**ClDaqCollect** DAQ Collect line 2
ClDaqData Data access line 1	**ClDaqStorage** DAQ Storage line	**ClOP** Online Processing line	**ClDM** Detector Monitoring line 2	**ClDQ** Online DQ 1
ClNoise Noise Monitoring line 2	**ClWDF** NoiseWDF Monitoring line 11	**ClVeto** Online Veto	**ClCbcOnline inactive since 2637 mn**	**ClCbcHLV** MBTA Trigger Production for H1, L1 and V1

h 9/2008



Total members: 256

F. Fidecaro, *Virgo status report* (STAC meeting, Cascina, May 28, 2009)

POLGRAW contributions to VIRGO

- **Data analysis**

Participation in the all sky search for GWs emitted by rotating NS CW working group
Modeling populations and searching for GWs from coalescing NS and BHs including BH binaries with non-negligible spins

- **Detector characterization**

Search for periodic interferences in the data

- **Contribute to code simulating working and performance of the VIRGO detector**

- **Participation in data taking shifts**

Members of the POLGRAW

Kazimierz Borkowski, Centre for Astronomy, UMK, Toruń
Robert Budzyński, Instytute of Theoretical Physics,UW, Warsaw
Tomasz Bulik, Astronomical Observatory, UW, Warsaw
Piotr Jaranowski, Faculty of Physics, UB , Białystok
Maciej Kamiński, Astronomical Observatory, UW, Warsaw
Witold Kondracki, Institute of Mathematics, PAN, Warsaw
Izabela Kowalska, Astronomical Observatory, UW, Warsaw
Andrzej Królak, Institute of Mathematics, PAN, Warsaw
Maciej Piętka, Faculty of Physics, UB, Białystok
Andrzej Pisarski, Faculty of Physics, UB, Białystok
Dorota Rosińska, Institute of Astronomy, UZ, Zielona Góra

Refereed Publications

Pia Astone, K. Borkowski, Piotr Jaranowski,
(Maciej Piętka), Andrzej Królak

Astone P. *et al.*, 2002, Data analysis of gravitational-wave signals from spinning neutron stars. IV. An all-sky search, *Phys. Rev. D*, **65**, 042003.

Astone P. *et al.*, 2003, All-sky upper limit for gravitational radiation from spinning neutron stars, *Class. Quantum Grav.*, **20**, S665–S676.

Astone P. *et al.*, 2005, An all-sky search of EXPLORER data, *Class. Quantum Grav.*, **22**, S1243–S1254.

Astone P. *et al.*, 2006, All-sky search of EXPLORER data: search for coincidences, *Class. Quantum Grav.*, **23**, S687–S692.

Astone P. *et al.*, 2008, All-sky search of NAUTILUS data, *Class. Quantum Grav.*, **25**, 184012.

Astone P. *et al.*, 2010?, Data analysis of gravitational-wave signals from spinning neutron stars. V. A narrow-band all-sky search, *Phys. Rev. D (in preparation)*.