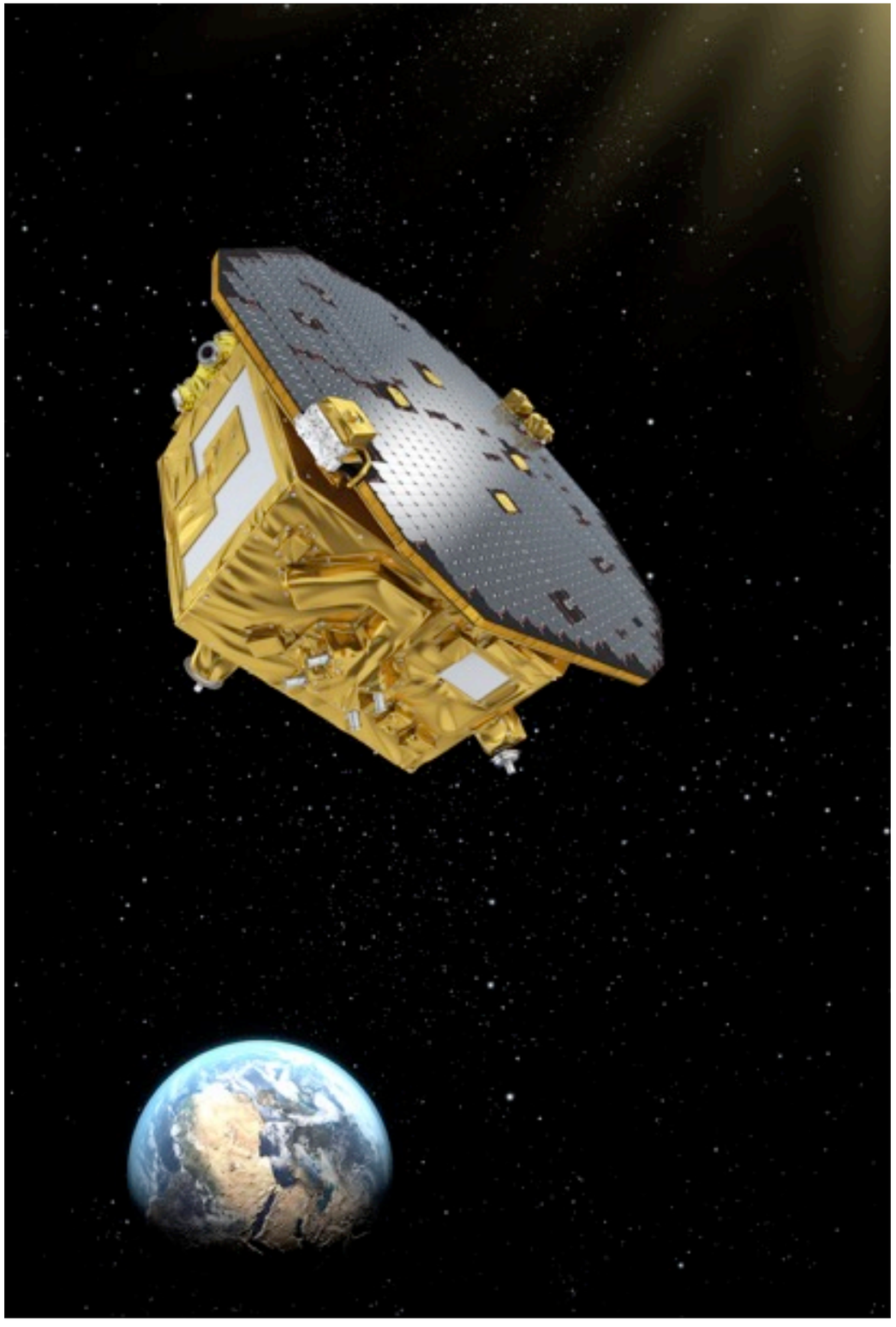
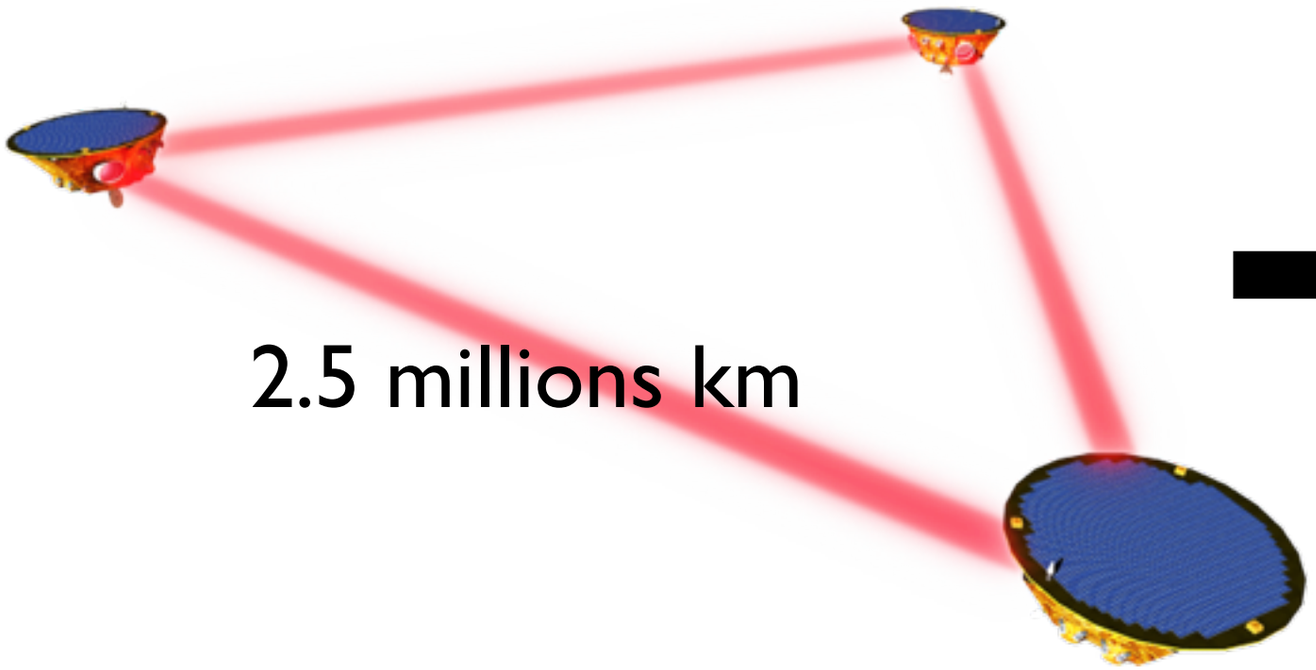
LisaPathfinder

LISA Pathfinder

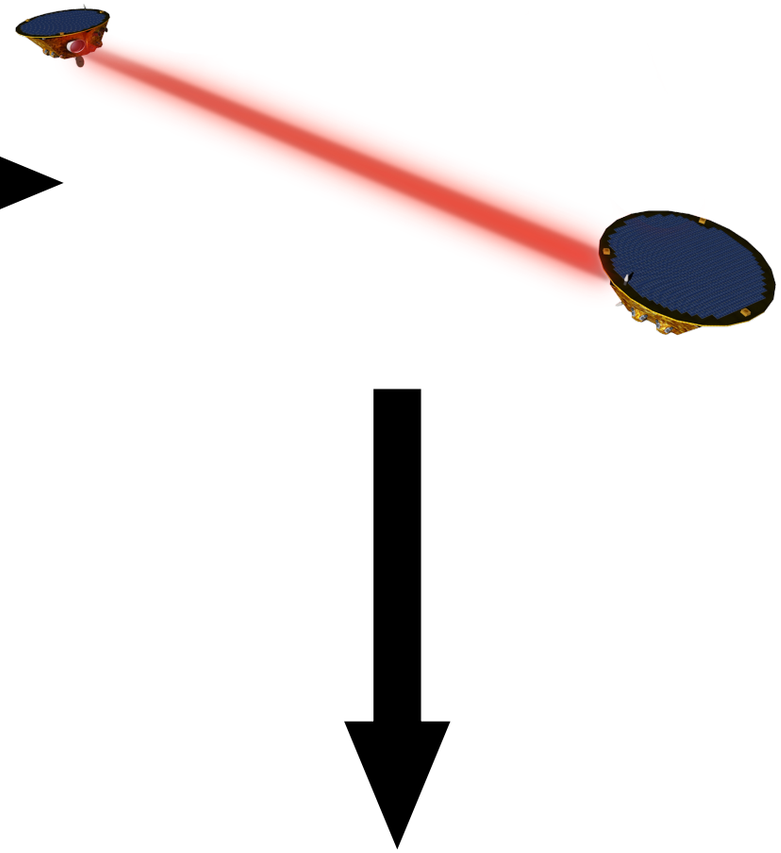


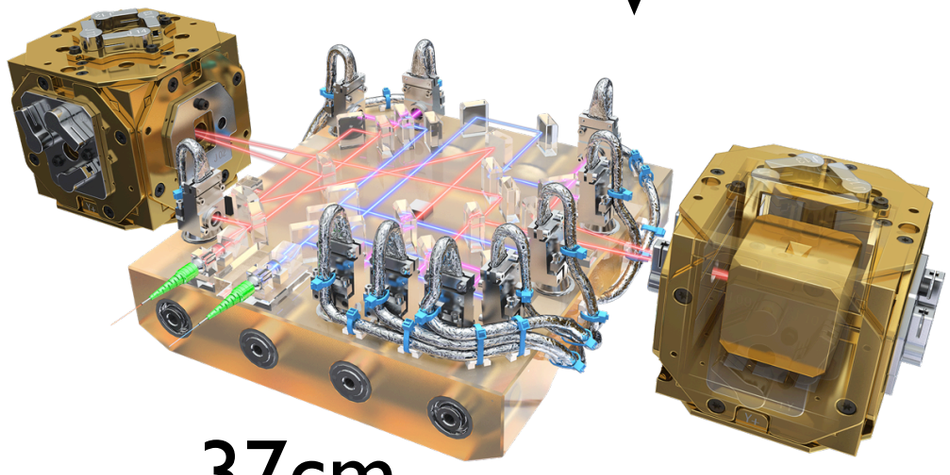
LisaPathfinder

Objectif de la mission



2.5 millions km

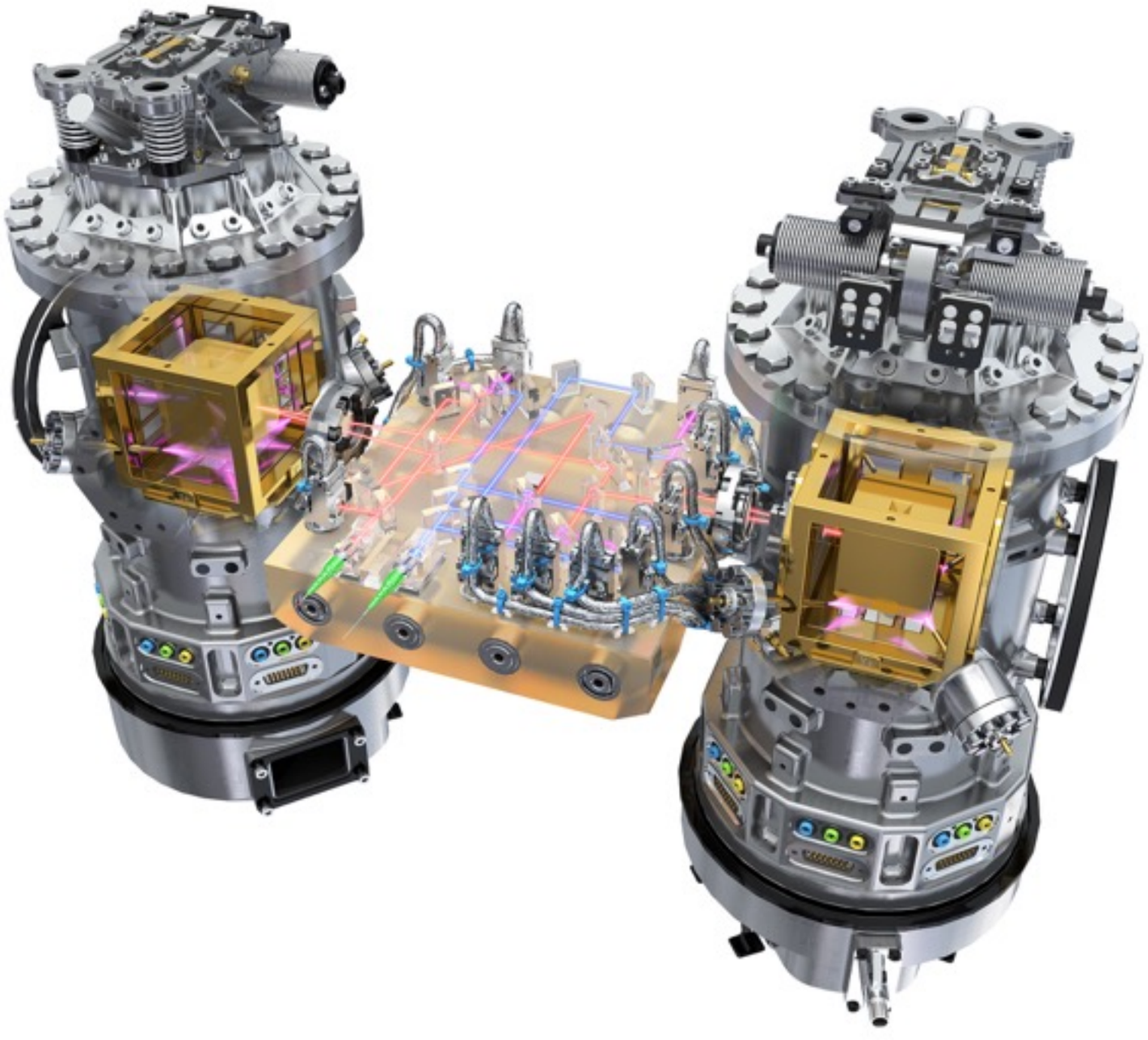




37cm

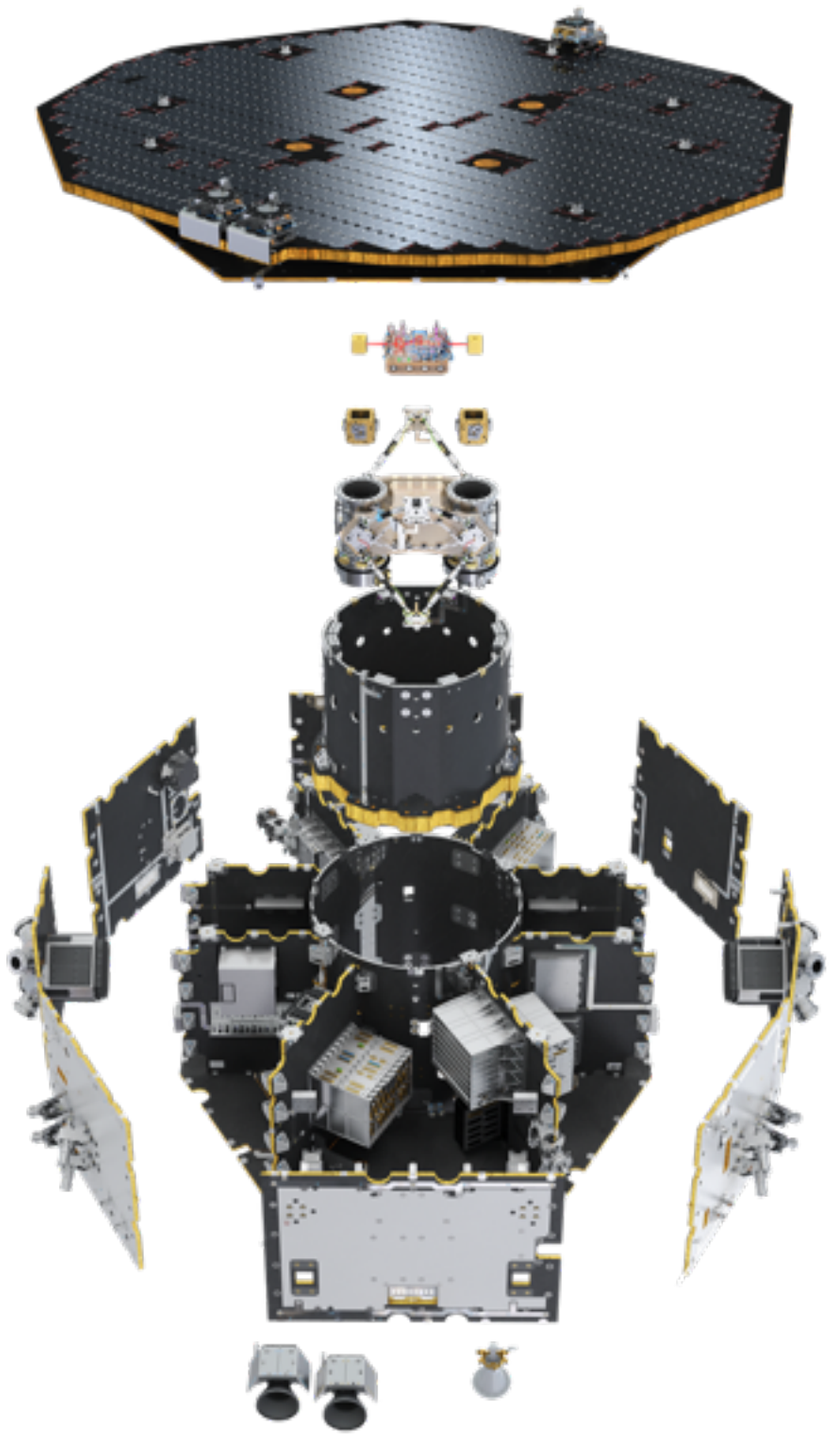
mesure perturbations locales

L'instrument - LTP



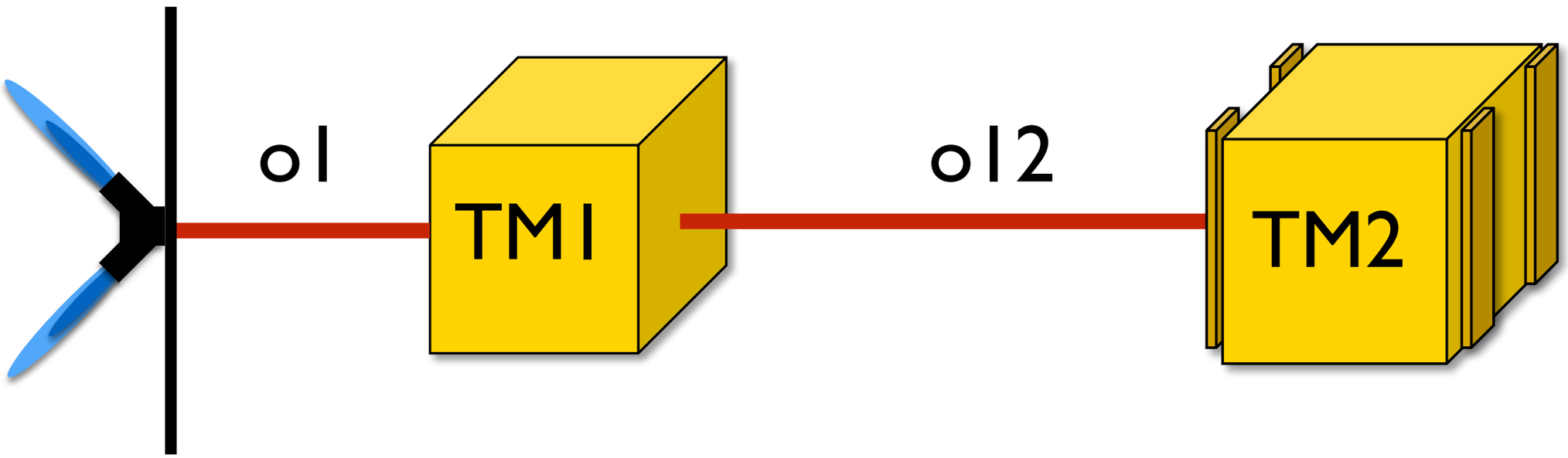
- Gravitational Reference Sensor
- Optical Bench
- Lampe UV
- Laser
- Compensation mass
- Under vacuum
- Caging Mechanism
- Thermal and magnetic monitoring

Echelle



La Mesure - deltaG

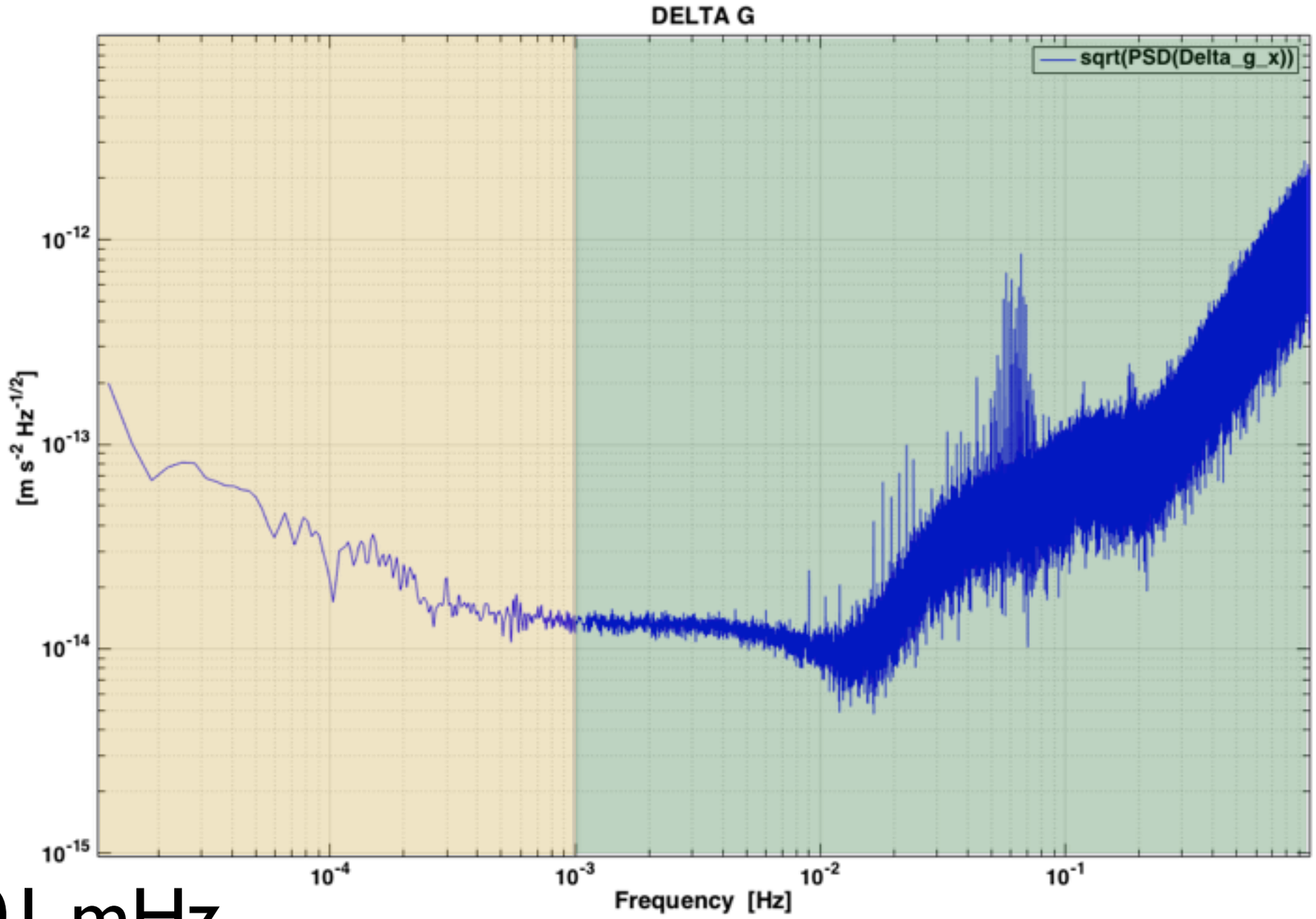
- Drag Free
- Suspension (f<1mHz)



deltaG = d^2(**o12**)/dt^2 - **Stiff**.* **o12** - **Gain** .* **Fx2**

deltaG - raw

- Accélération différentielle Test Mass1 - Test Mass2
- **deltaG** = d^2(**o12**)/dt^2 - **Stiff**.* **o12** - **Gain** .* **Fx2**



0.01 mHz

1Hz

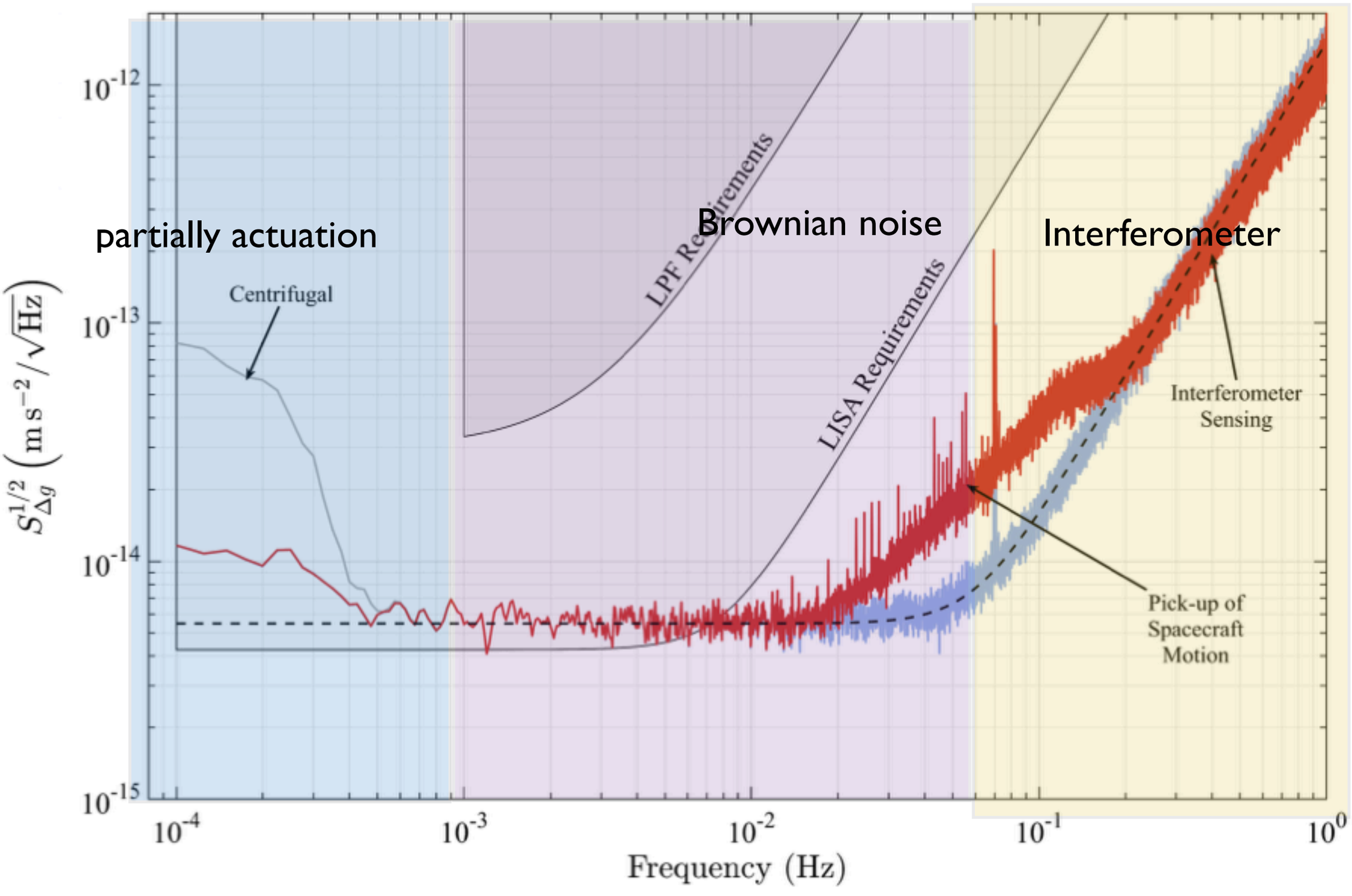
Investigations

Objectifs :
- Calibrer l'expérience
- Identifier toutes les sources de bruits
  - les soustraire si dominantes
  - les mesurer et modéliser

- Sys-ID
- Thermal housing/Optical
- Magnetic
- Charge
- AST guidance

- Cross-talk
- Thrusters
- Caltone
- Laser radiation pressure
- ….

deltaG - noise source



Enseignement Pathfinder

- Importance des données hors axe sensible (Diaphonie)
- Thermométrie plus fine /Stabilité thermique
- Une seule horloge !
- Contrôle alignement test Mass
- Pression résiduelle.
- Gravitational balance
- Interface ESA/scientifique/industriel
  Mission très intégrée - plateforme/payload

THANKS

Back-up

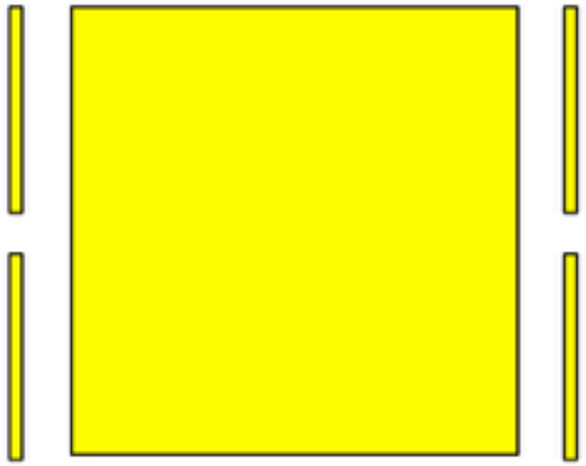
measurements list

- Laser LPF = 35mW (2mw on TM) : RIN = 0.4uW/sqrt(Hz)
- Laser Lisa = 2W
- Magnetic noise = 100nT/sqrt(Hz)
- T = 50uK/sqrt(Hz)
- Temperature => 20pm/s^2/K
- Actuation noise => 5ppm/sqt(Hz)
- Dérive 40pN ou 20pm/s^2 sur mission nominal
- Pression = 10uPa = 1e-8mbar
- IFO => 34.8 fm/sqrt(Hz) au lieu de 10pm/sqrt(Hz)
- Gltiches 5/week
- Calibration 5% => Statistic 10%
- AST sensing noise 10-3 rad for LISA = 10nrad
- Charge Investigation = fc/sqrt(Hz)   Temp inv => deltaT =10mK

Actuation Scheme

$$+V_{2x}\cdot\cos(2\pi f_x\cdot t)-V_{1\varphi}\cdot\sin(2\pi f_\varphi\cdot t)$$

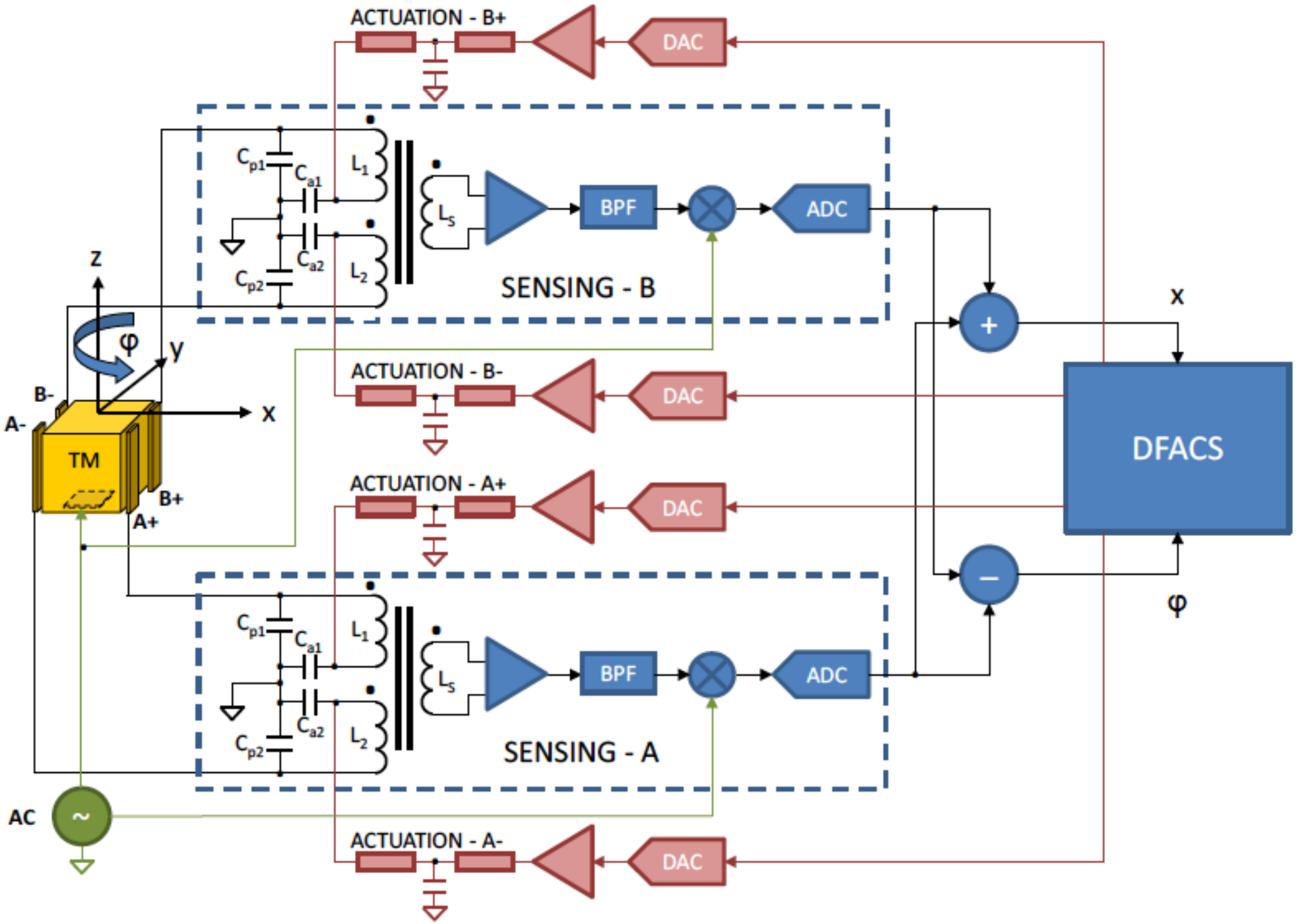
$$-V_{1x}\cdot\sin(2\pi f_x\cdot t)+V_{2\varphi}\cdot\cos(2\pi f_\varphi\cdot t)$$



$$-V_{2x}\cdot\cos(2\pi f_x\cdot t)-V_{2\varphi}\cdot\cos(2\pi f_\varphi\cdot t)$$

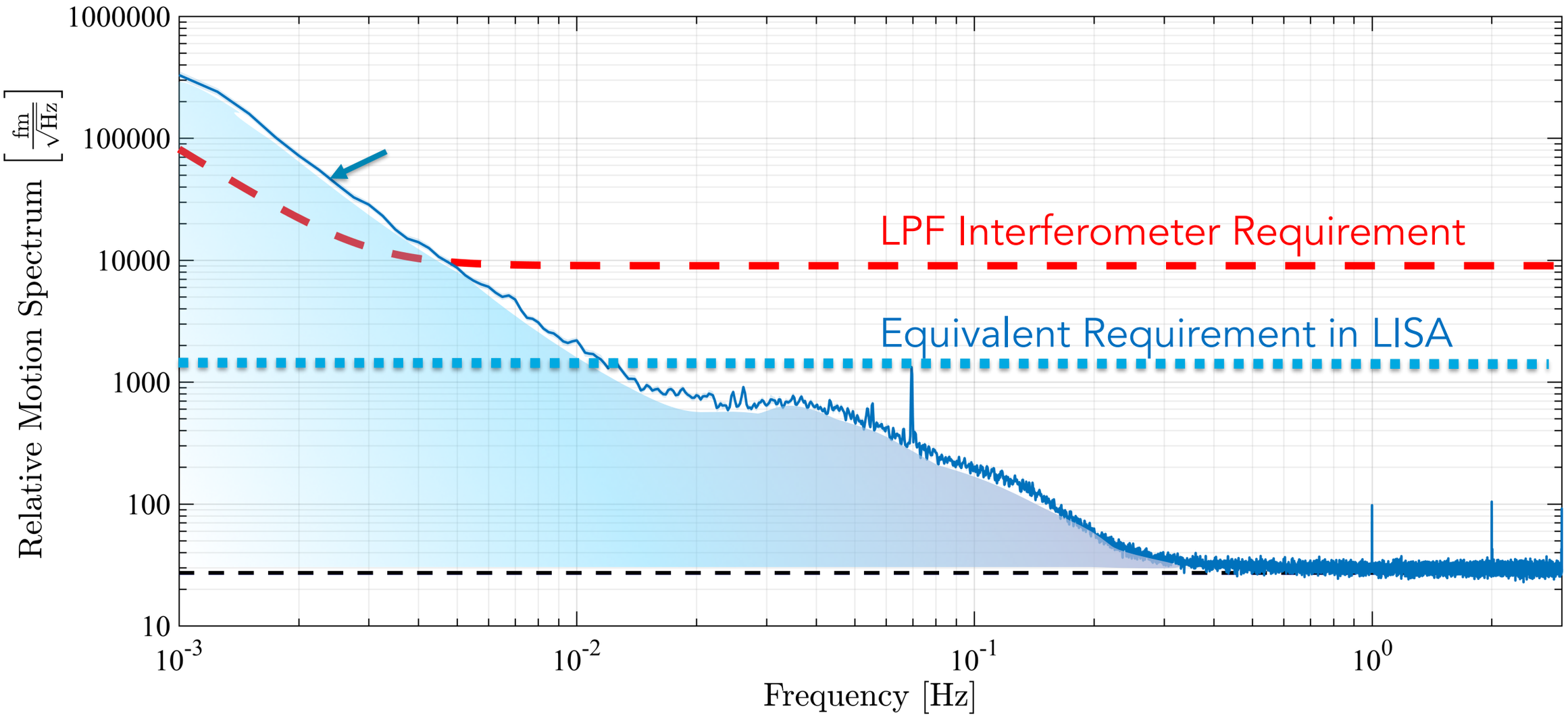
$$+V_{1x}\cdot\sin(2\pi f_x\cdot t)+V_{1\varphi}\cdot\sin(2\pi f_\varphi\cdot t)$$

Actuation & Sensing

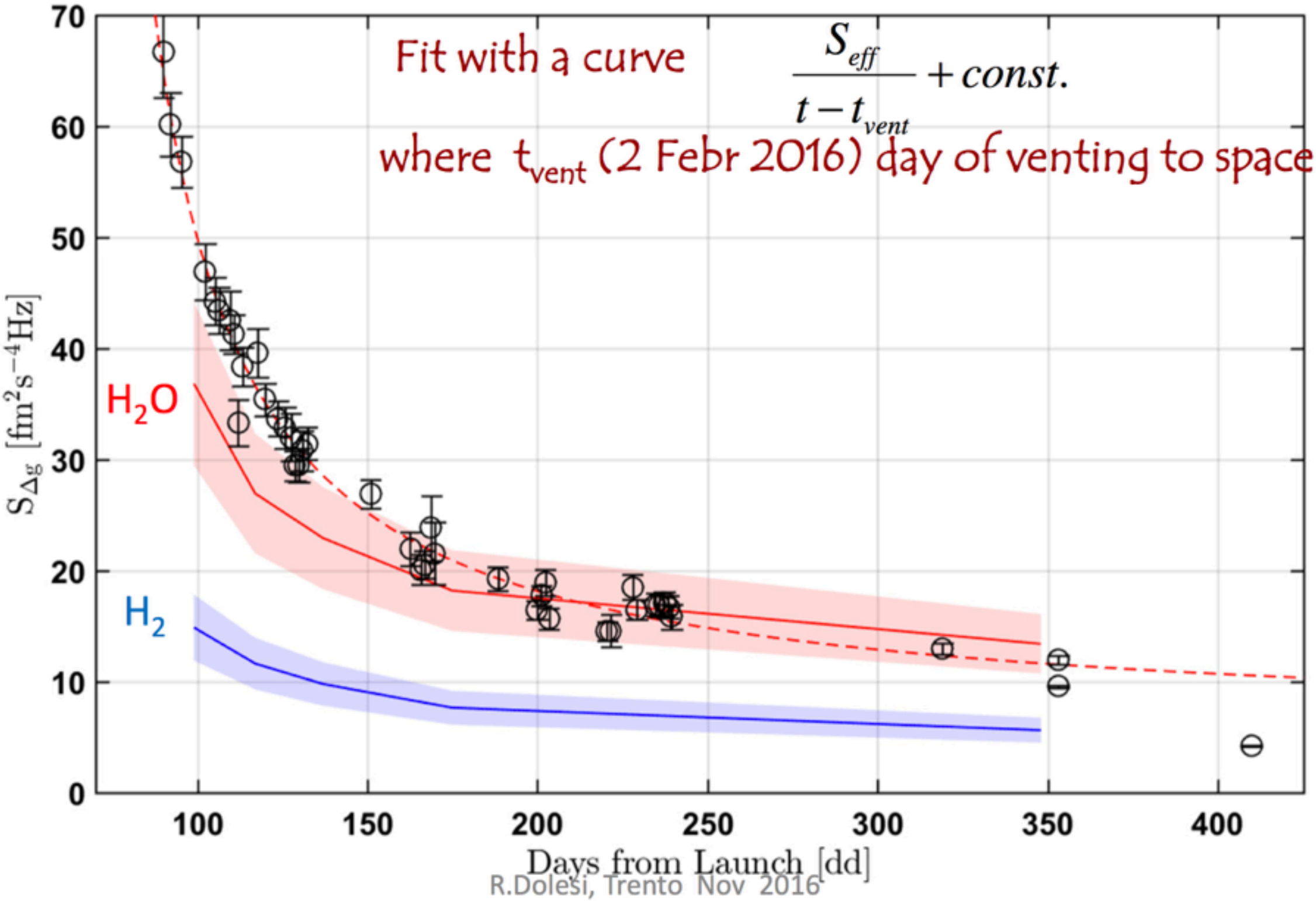


LisaPathfinder

Bruit interféromètre

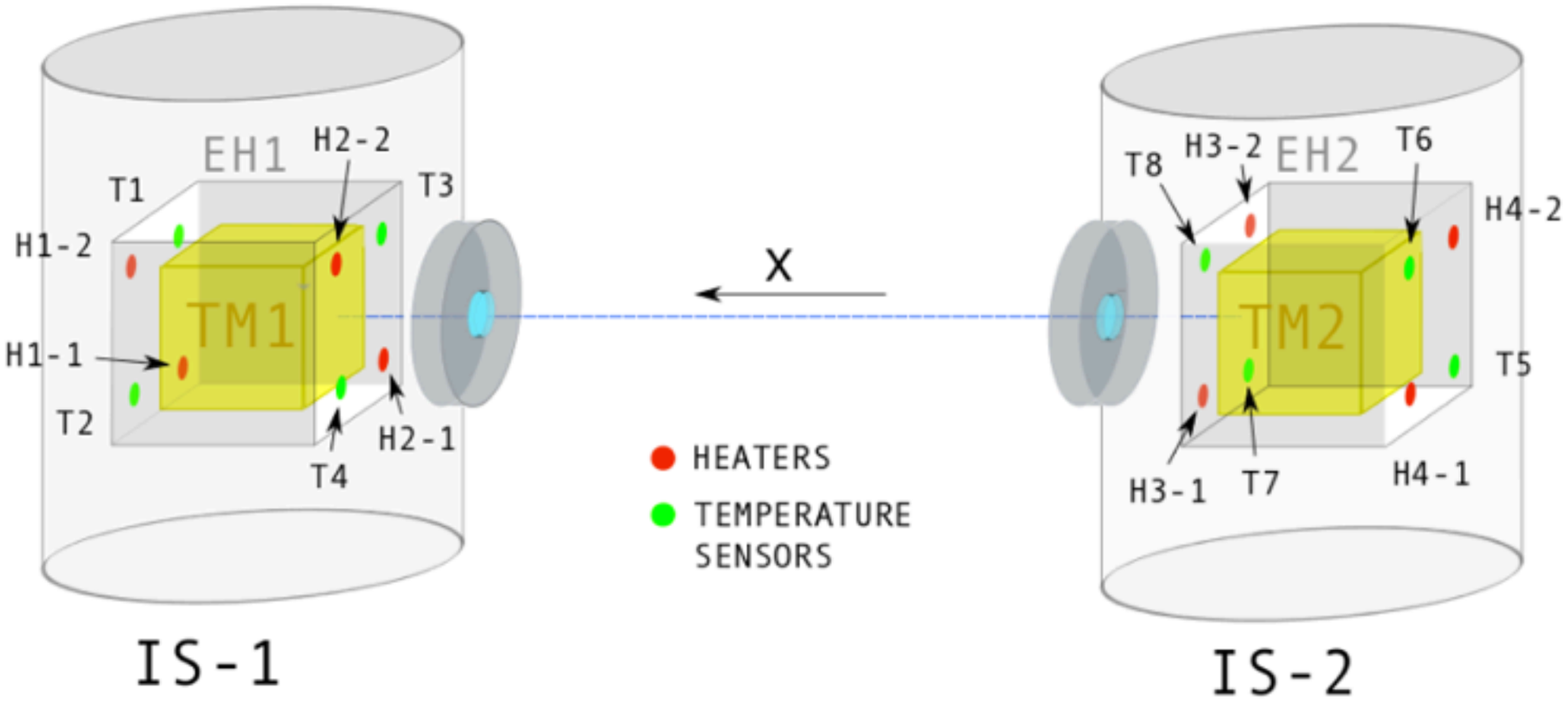


Brownian



R.Dolesi, Trento Nov 2016

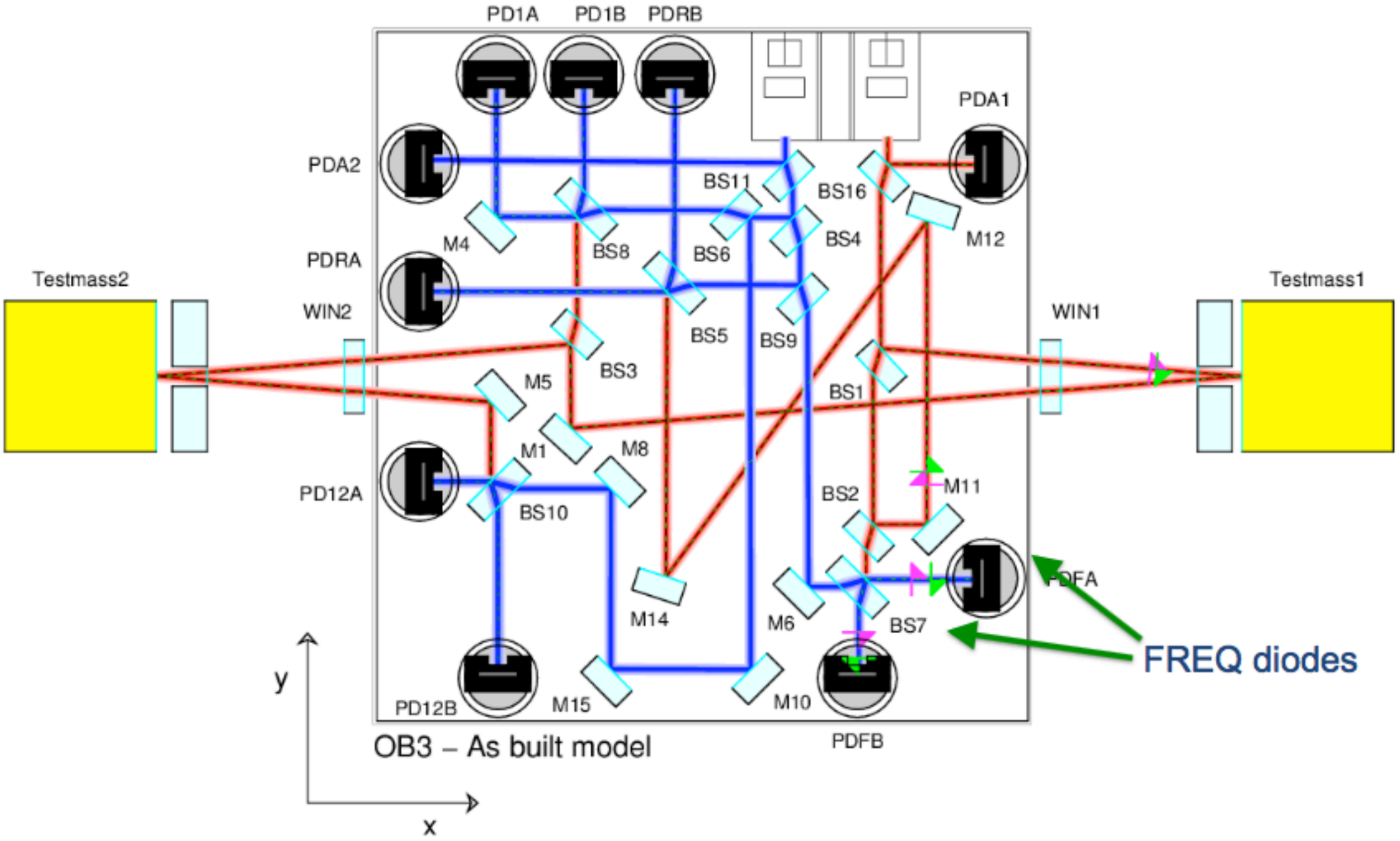
Thermal experiment



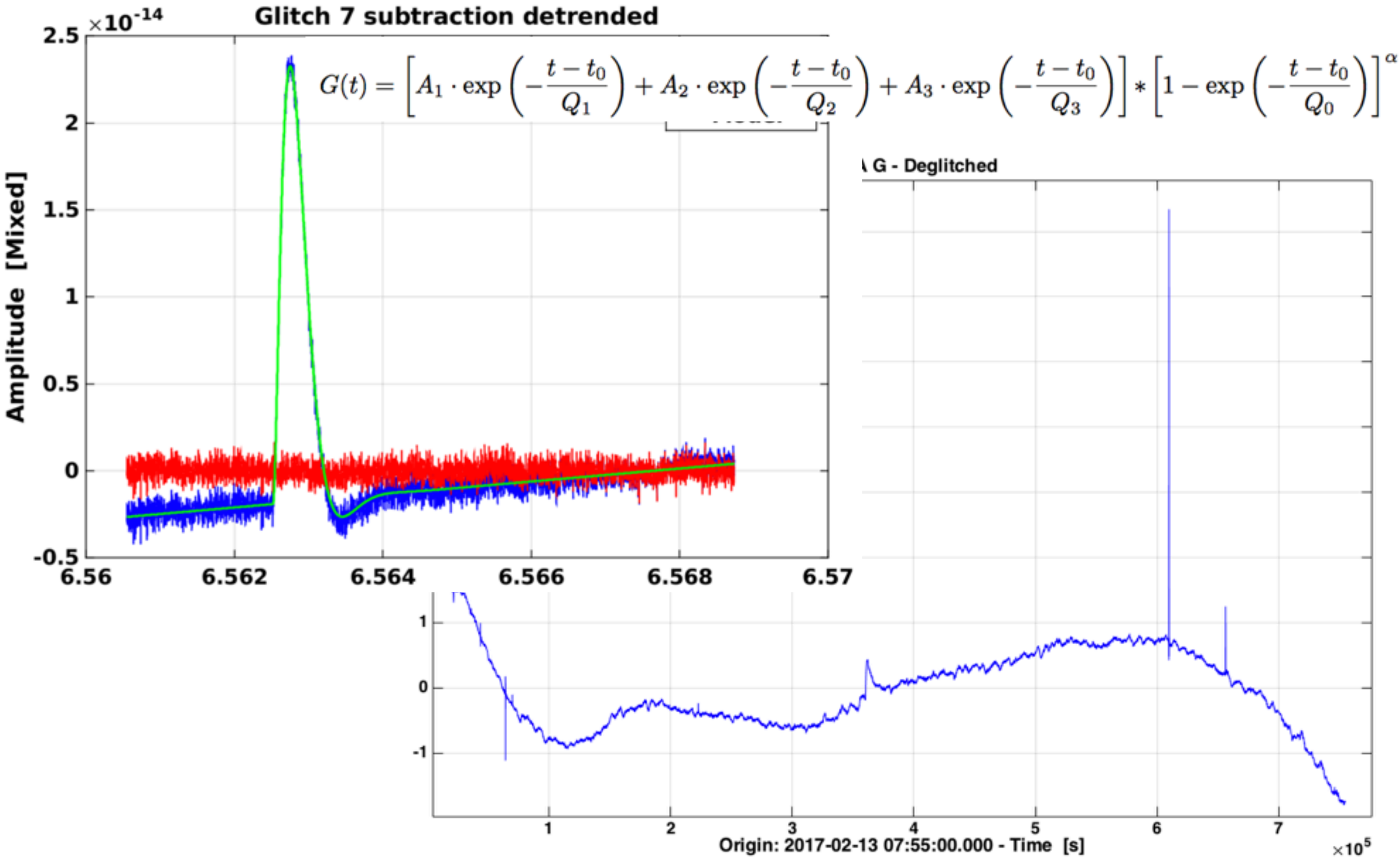
Radiometer effect — Radiation Pressure — Asymmetric Outgassing

$$F = \left[23\ \frac{\mathrm{pN}}{\mathrm{K}} \left(\frac{P}{10^{-5}\,\mathrm{Pa}} \right) \frac{293\,\mathrm{K}}{T_0} + 9\ \frac{\mathrm{pN}}{\mathrm{K}} \left(\frac{T_0}{293\,\mathrm{K}} \right)^3 + 40\ \frac{\mathrm{pN}}{\mathrm{K}} \left(\frac{Q_0}{1.4\,\mathrm{nJ/s}} \right) \left(\frac{\Theta}{3 \times 10^4\,\mathrm{K}} \right) \left(\frac{293\,\mathrm{K}}{T_0} \right)^2 \right] \Delta T$$

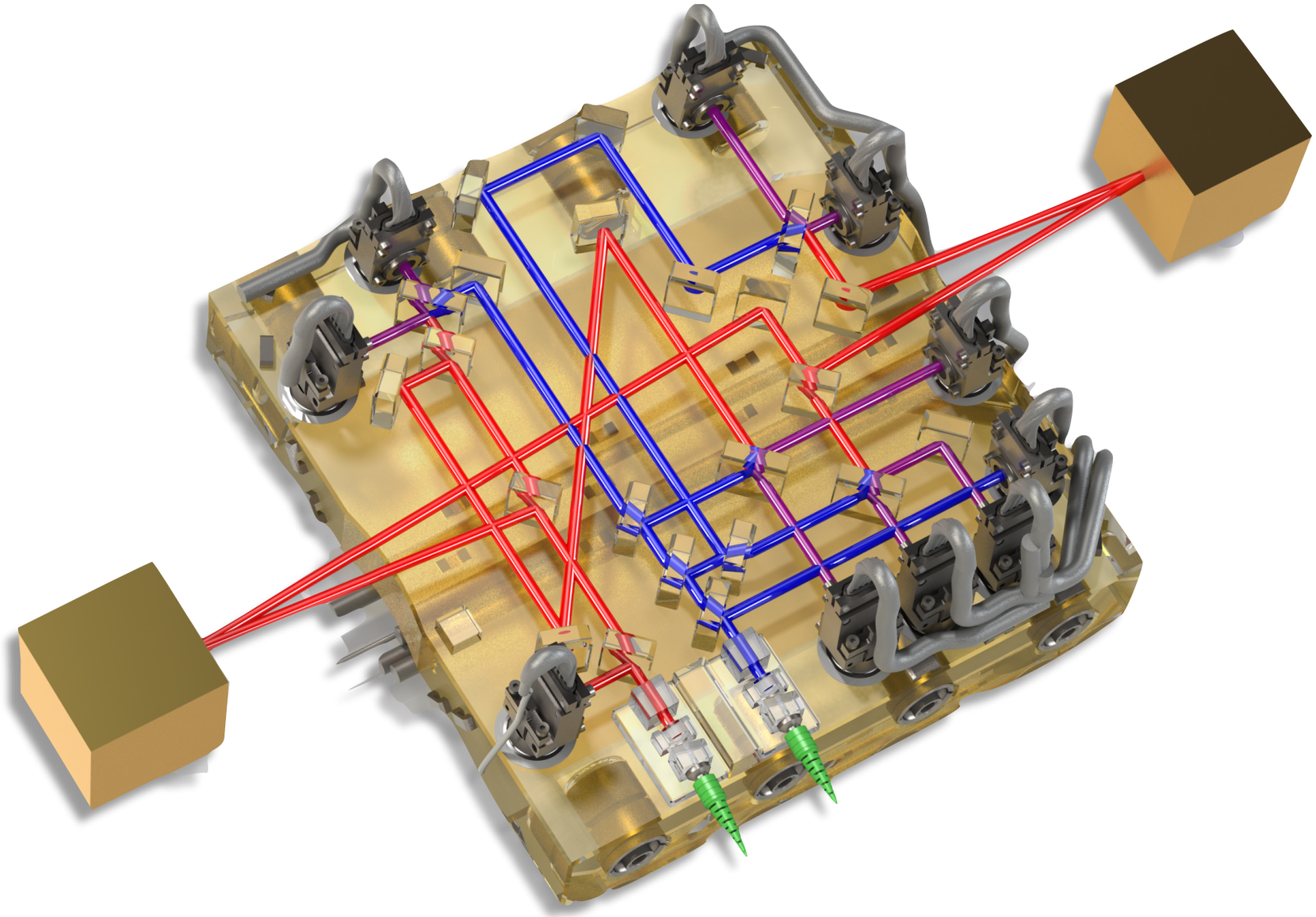
The Optical Bench



de-Glitch

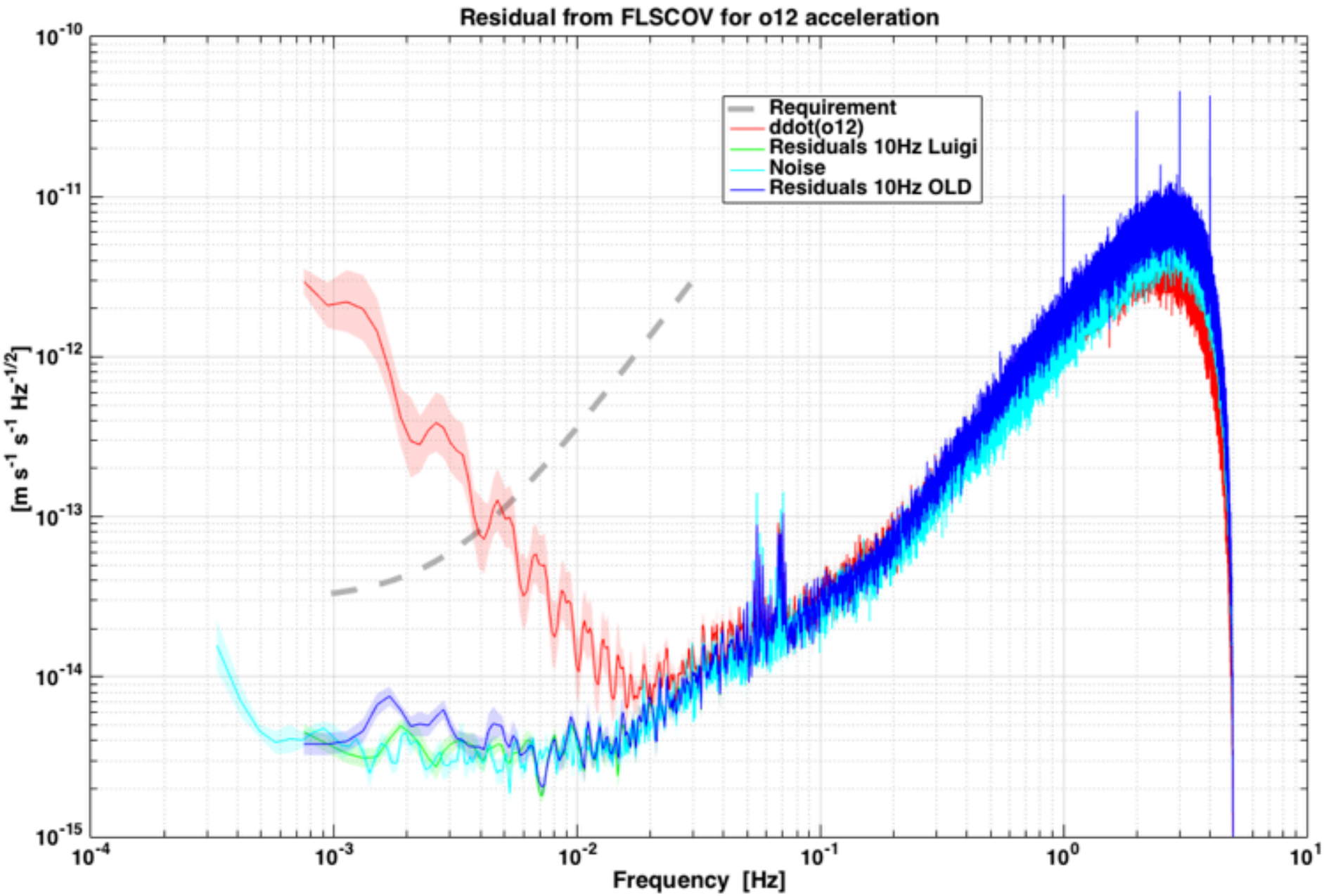

Glitch 7 subtraction detrended
×10^-14
2.5
2
1.5
1
0.5
0
-0.5
Amplitude [Mixed]
6.56
6.562
6.564
6.566
6.568
6.57
$G(t) = \left[A_1 \cdot \exp\left(-\frac{t-t_0}{Q_1}\right) + A_2 \cdot \exp\left(-\frac{t-t_0}{Q_2}\right) + A_3 \cdot \exp\left(-\frac{t-t_0}{Q_3}\right)\right] * \left[1 - \exp\left(-\frac{t-t_0}{Q_0}\right)\right]^{\alpha}$
G - Deglitched
1
0
-1
1
2
3
4
5
6
7
×10^5
Origin: 2017-02-13 07:55:00.000 - Time [s]

3d Optical Bench



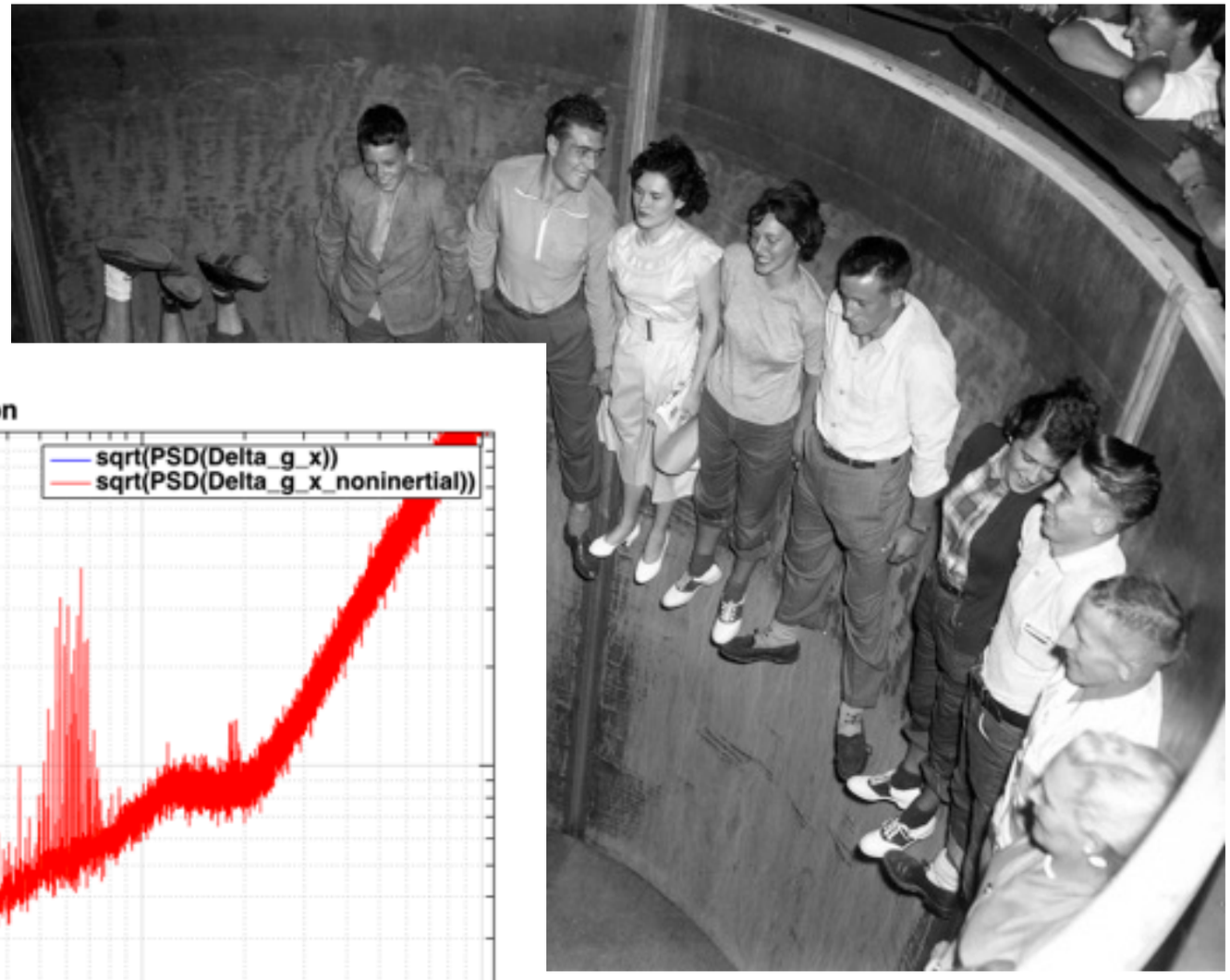
System-Identification

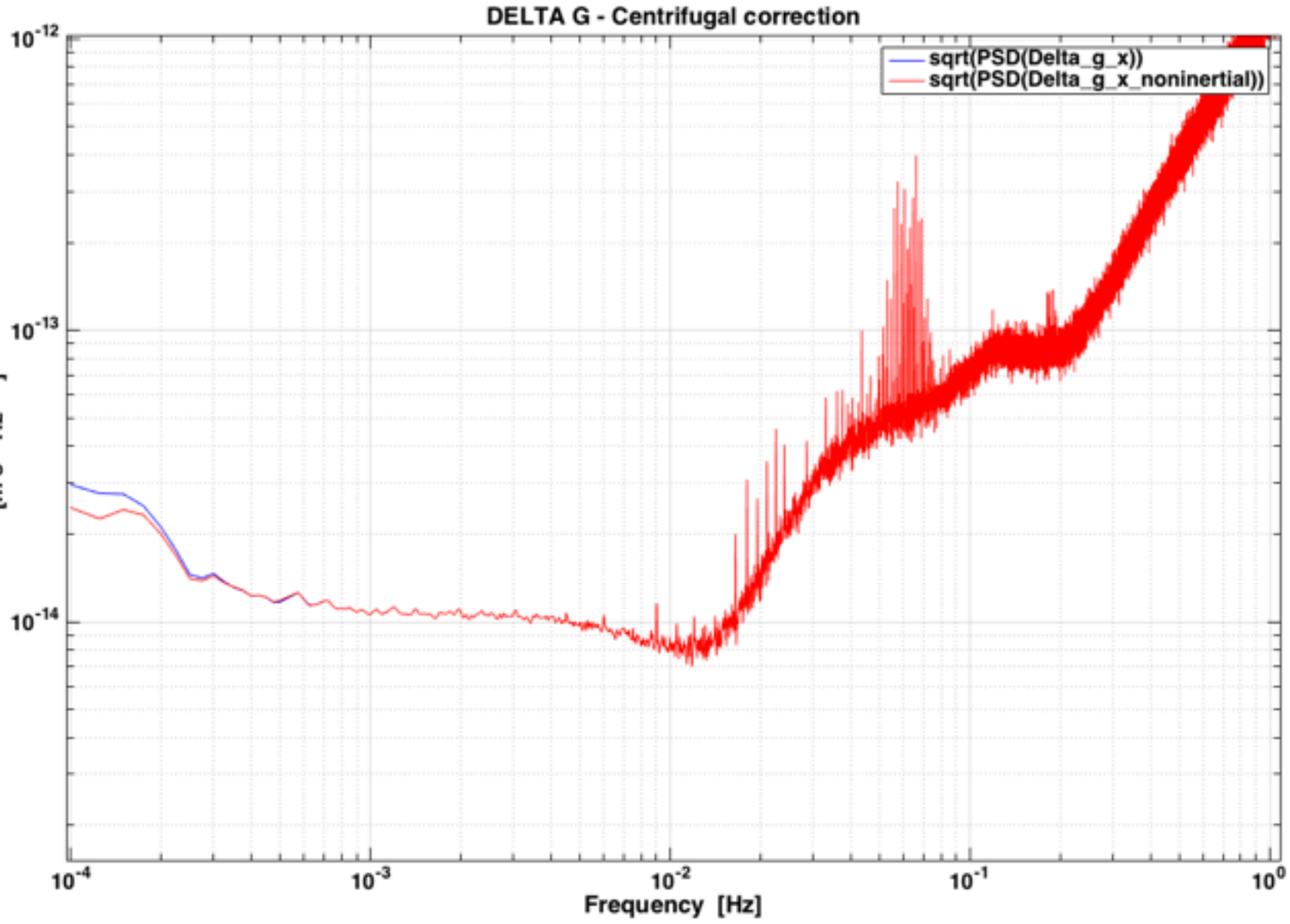
- Déterminer les gains et stiffness
- **deltaG =** d^2(**o12**)/dt^2 - **Stiff**.* **o12** - **Gain** .* **Fx2**



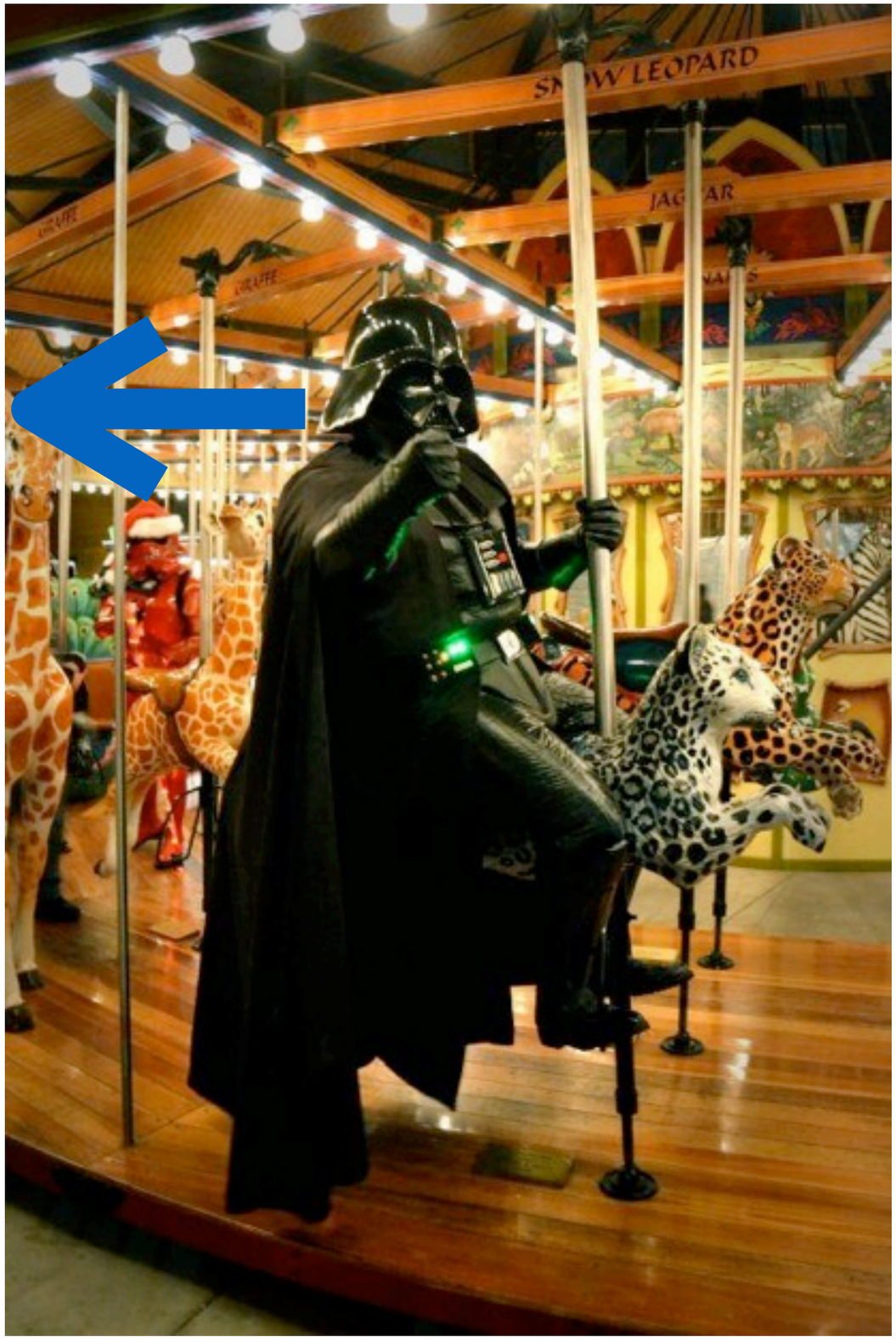
Centrifugal Forces

$$\vec{\Omega} \times \vec{\Omega} \times \vec{r}$$





Angle Decorrelation - Euler Forces



$$\Delta\vec{g}_{tang} = \vec{g}_{tang,2} - \vec{g}_{tang,1} = \left(\vec{r}_2 - \vec{r}_1\right) \times \dot{\vec{\Omega}}$$