

UNIVERSITÀ
DI TRENTO



From LPF to LISA

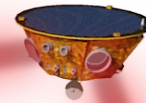
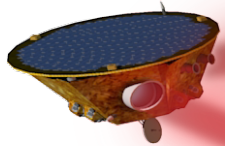
paving the way to the first gravitational wave
observatory from space

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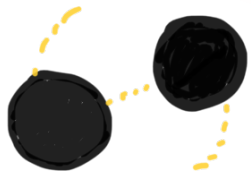
Laser Interferometer Space Antenna

2.5 million km



$$g \leq 3 \frac{f_m}{s^2 \sqrt{Hz}}$$

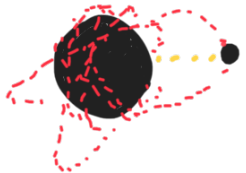
$$\sim 10 \text{ pm} / \sqrt{Hz}$$



SMBHBs



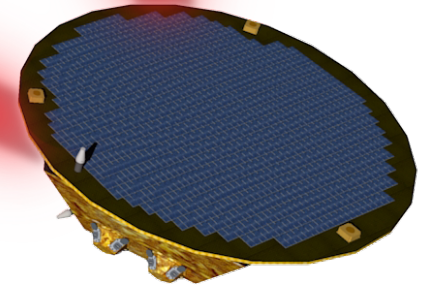
GBs



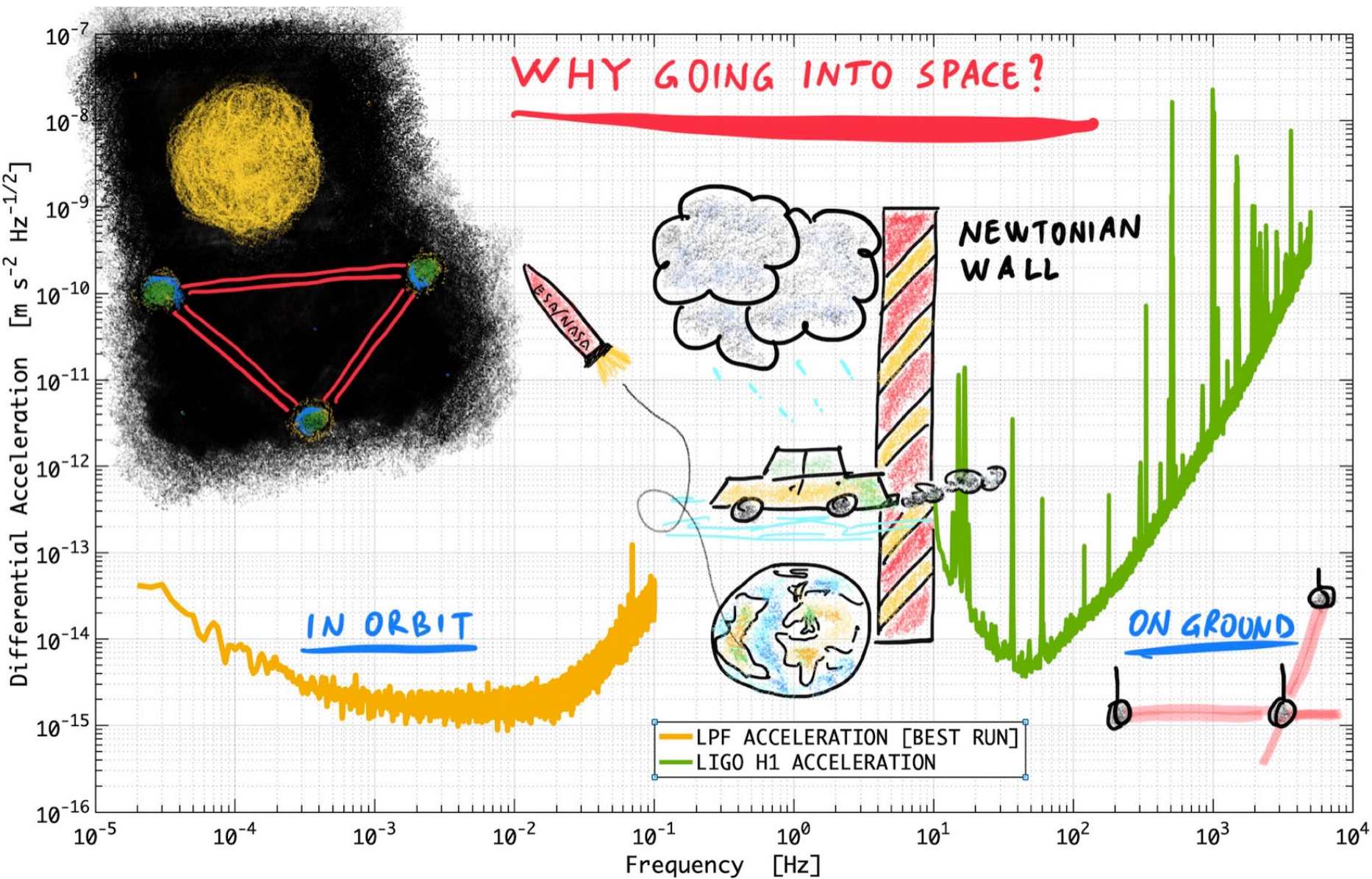
EMRIs

STOCHASTIC BACKGROUND AND...

UNPREDICTABLE DISCOVERIES!!!



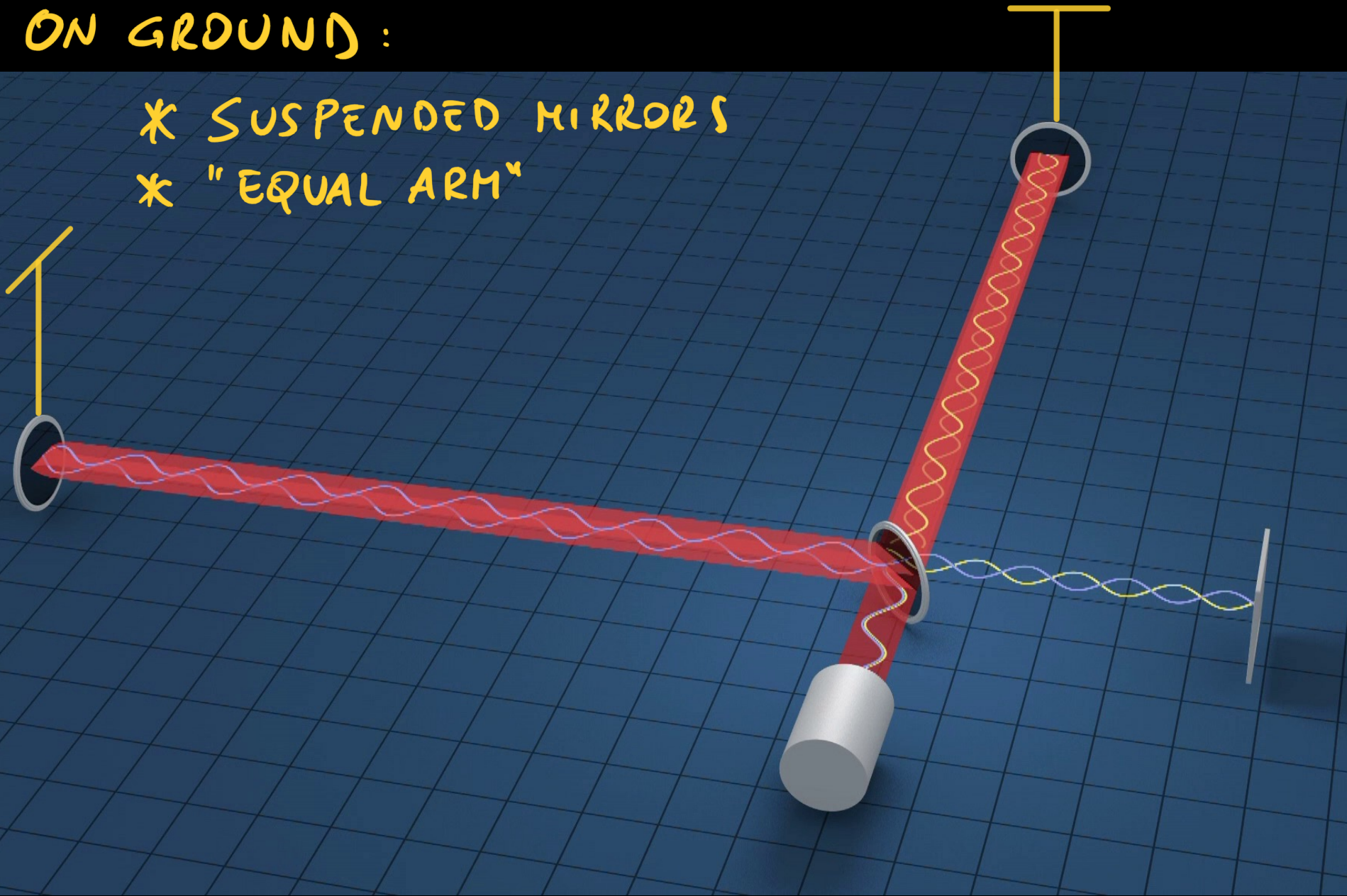
The image has the only purpose of presenting the product



ON GROUND:

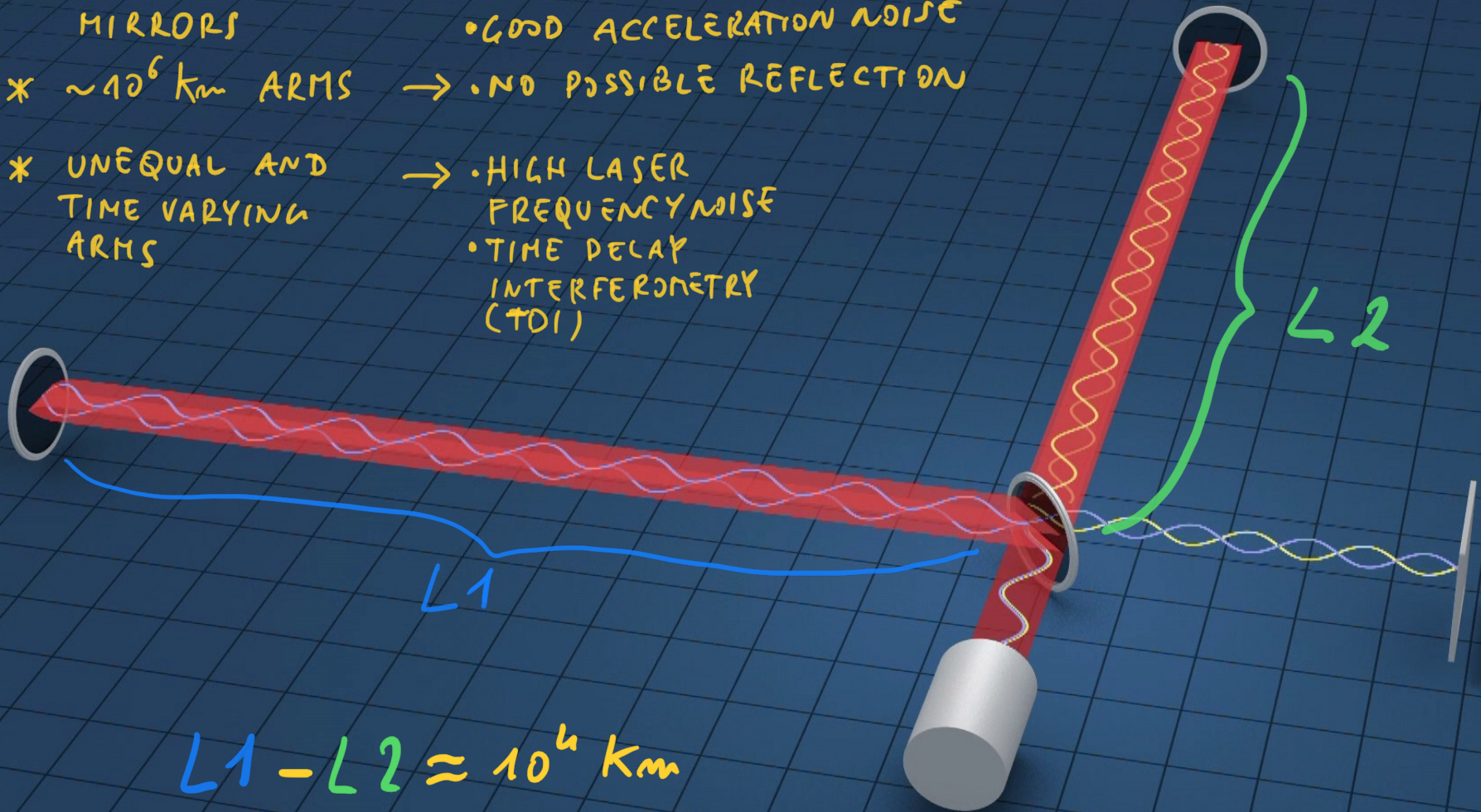
* SUSPENDED MIRRORS

* "EQUAL ARM"



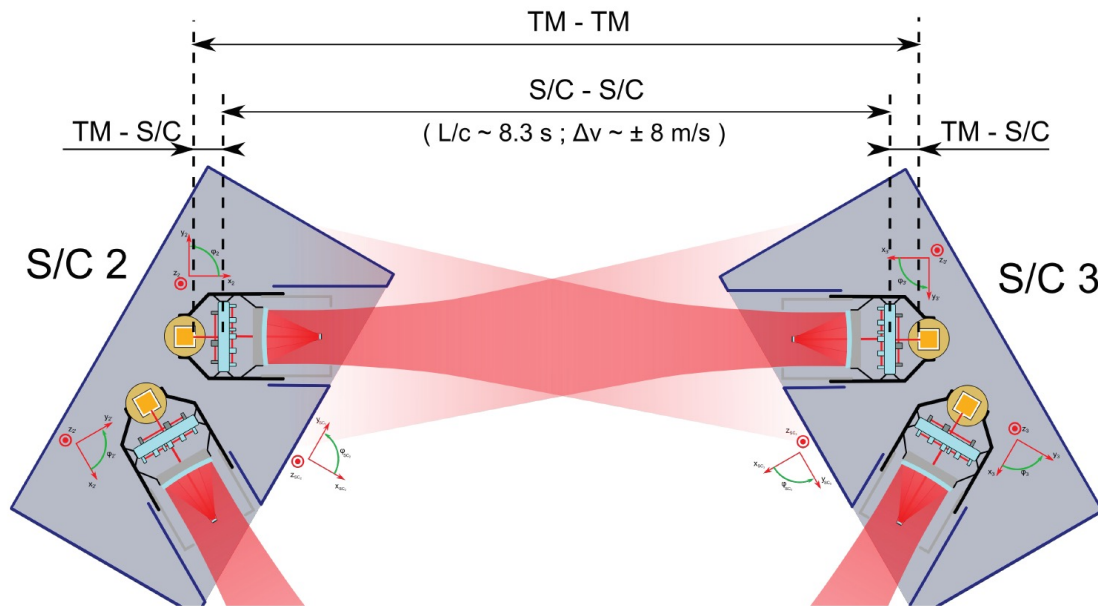
IN ORBIT:

- * FREELY FALLING → • DRAG FREE SATELLITES
- * MIRRORS → • GOOD ACCELERATION NOISE
- * $\sim 10^6$ km ARMS → • NO POSSIBLE REFLECTION
- * UNEQUAL AND TIME VARYING ARMS → • HIGH LASER FREQUENCY NOISE
- * → • TIME DELAY INTERFEROMETRY (TDI)

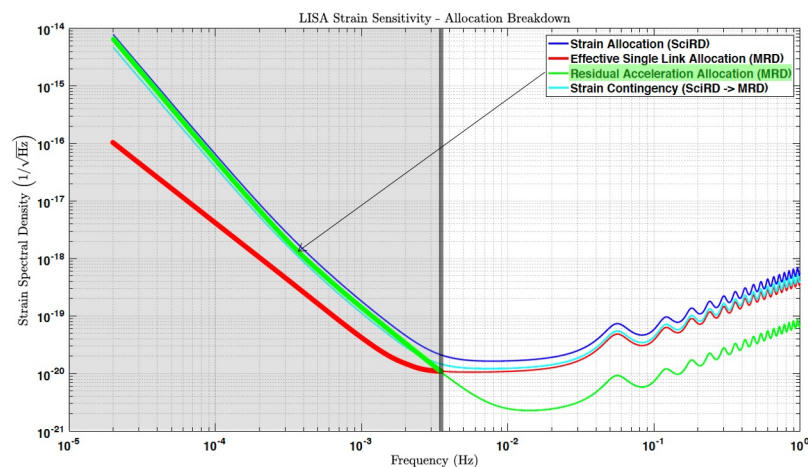


$$L1 - L2 \approx 10^4 \text{ km}$$

HOW DO WE DO LISA IN PRACTICE?



- MOSA: Telescope ($\varnothing = 30$ cm), Optical bench, Gravity Reference Sensor
- Split interferometry
- 2 W 1064 nm lasers
- Transponder: 100 pW at far SC
- Displacement noise $\sim 10 \text{ pm}/\sqrt{\text{Hz}}$
- Free-falling TM $\sim 3 \text{ fm/s}^2/\sqrt{\text{Hz}}$
- Relative velocity of 10 m/s

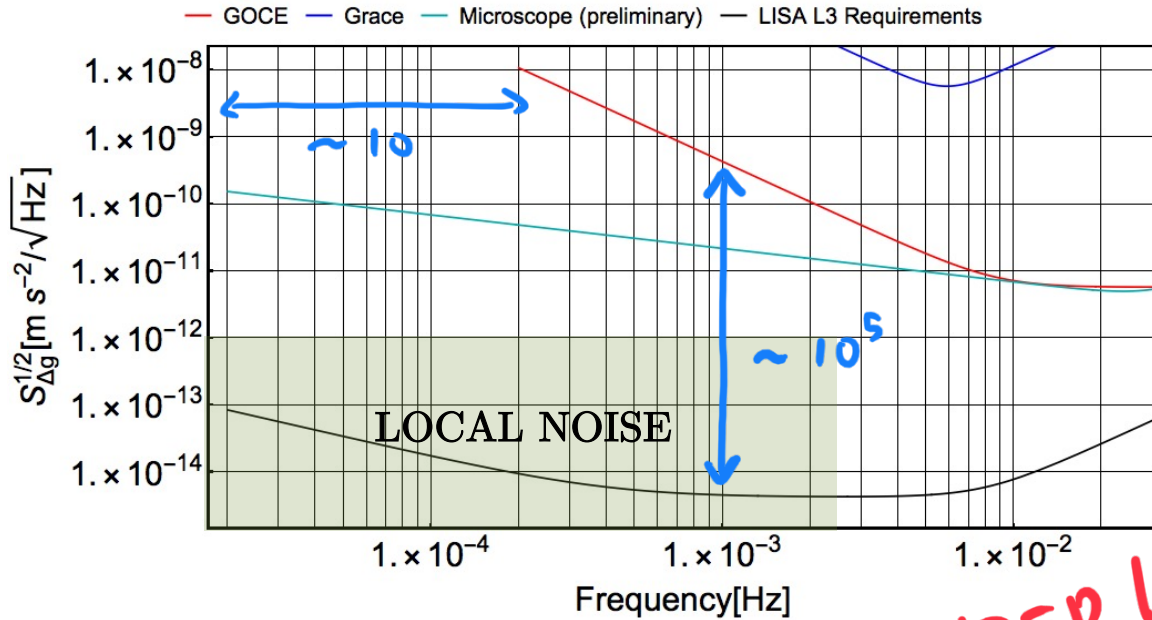


$$S_h = \frac{5}{\sin 60^\circ} \left(\frac{T_{\text{arm}}}{L} \right)^2 \left(\cancel{S_{\delta\nu} (\Delta L)^2} + S_{\text{IFO}} + \frac{4}{(2\pi f)^2} S_{\text{acc}} \right)$$

$\uparrow$ laser freq noise $\uparrow$ displacement noise $\uparrow$ acceleration noise

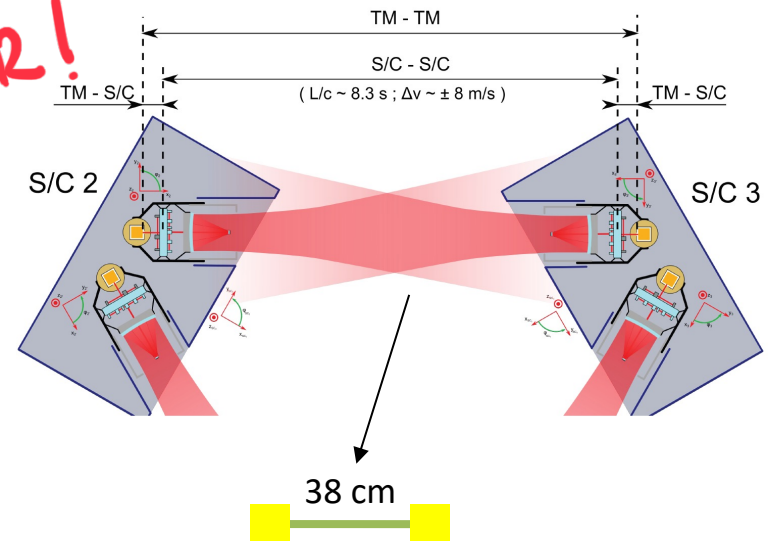
SIF 2021

FORCE NOISE FOR LISA WAS POORLY KNOWN!!!

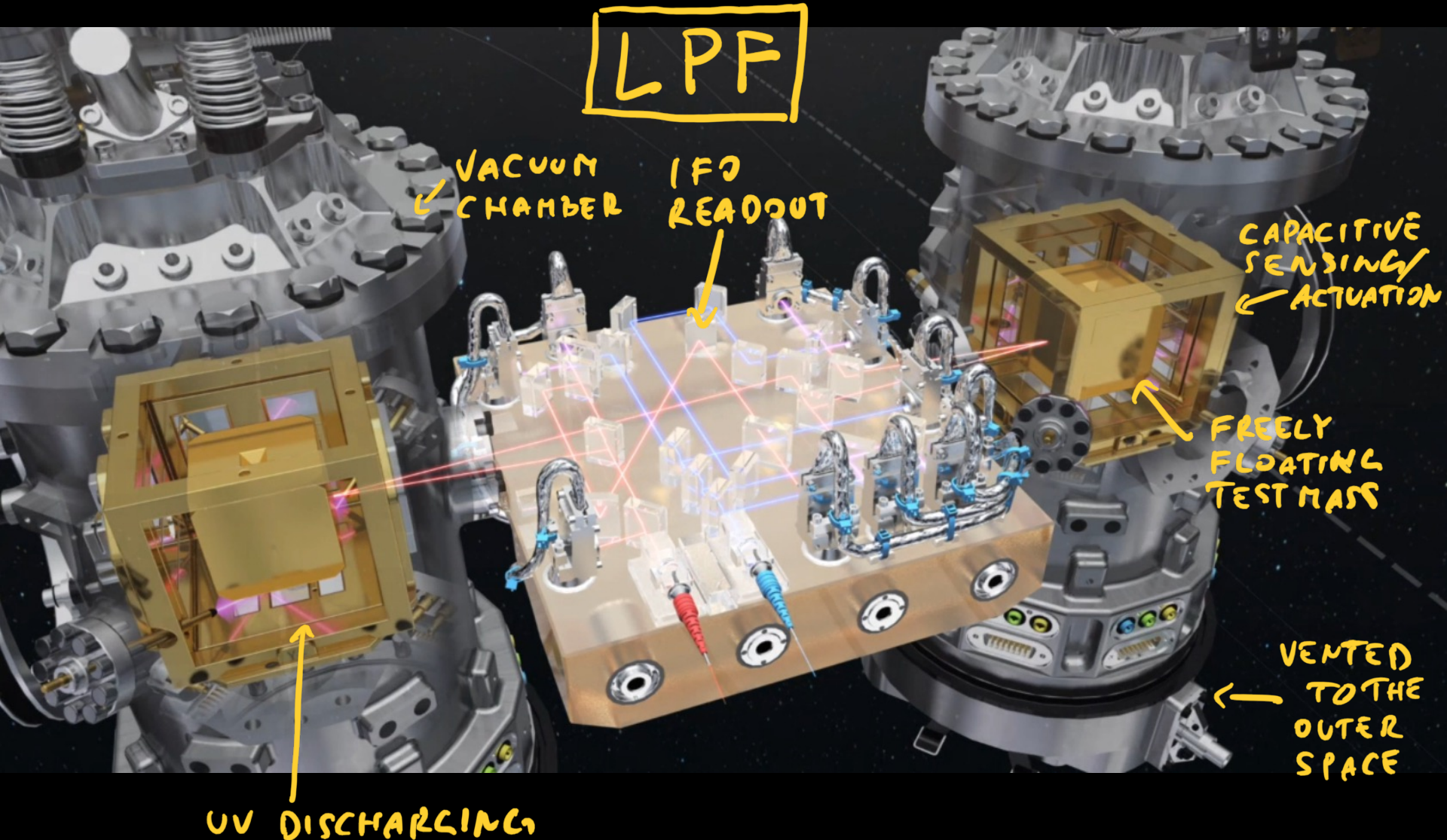


- MANY ORDERS OF MAGNITUDE OF UNKNOWN
- REQUIRE AN EXPERIMENTAL TEST
- FORCE NOISE IS LOCAL
→ NO NEED OF LONG ARM

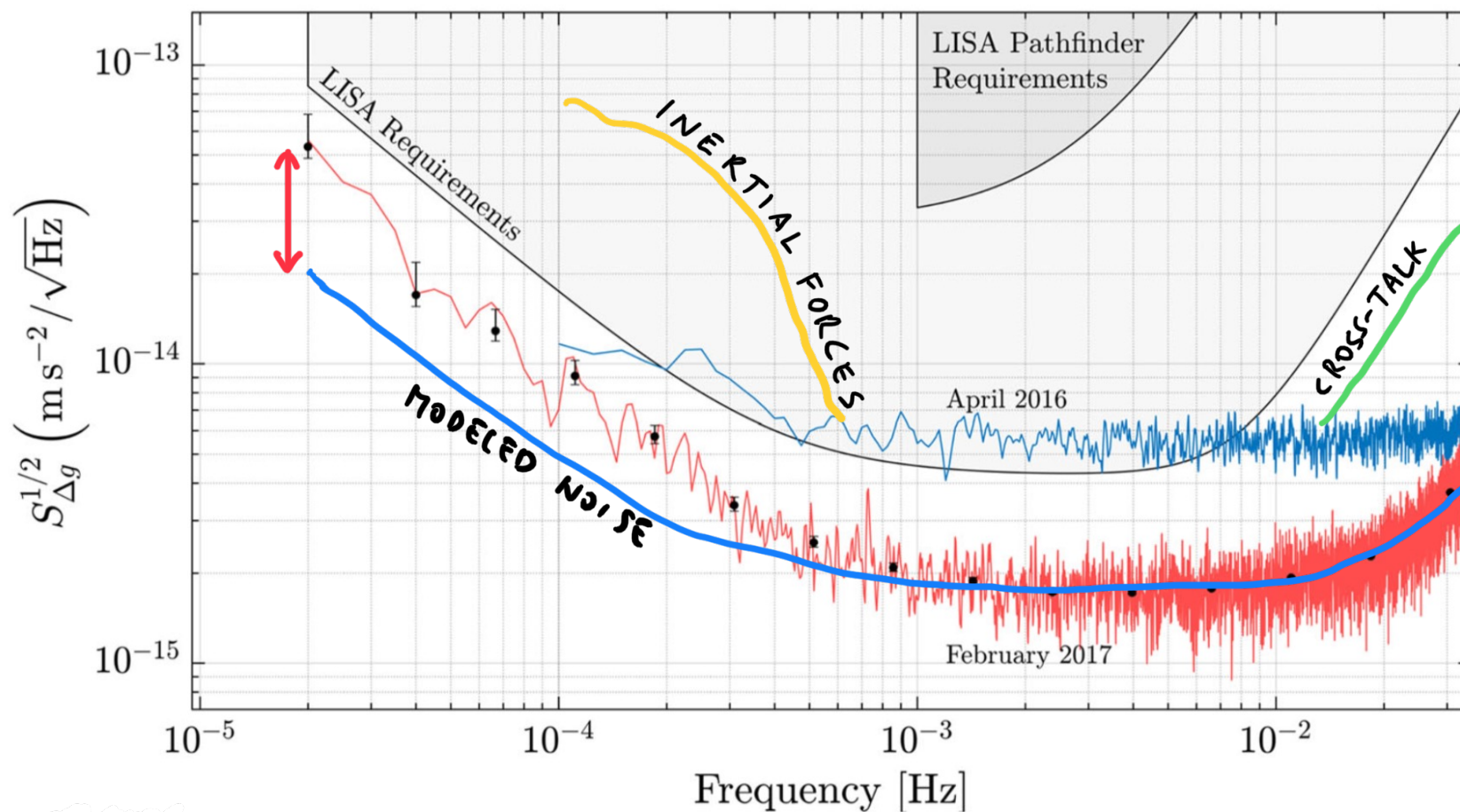
GO FOR... LISA PATHFINDER!
[LFP]
FROM $\sim 10^6$ Km TO 38 cm



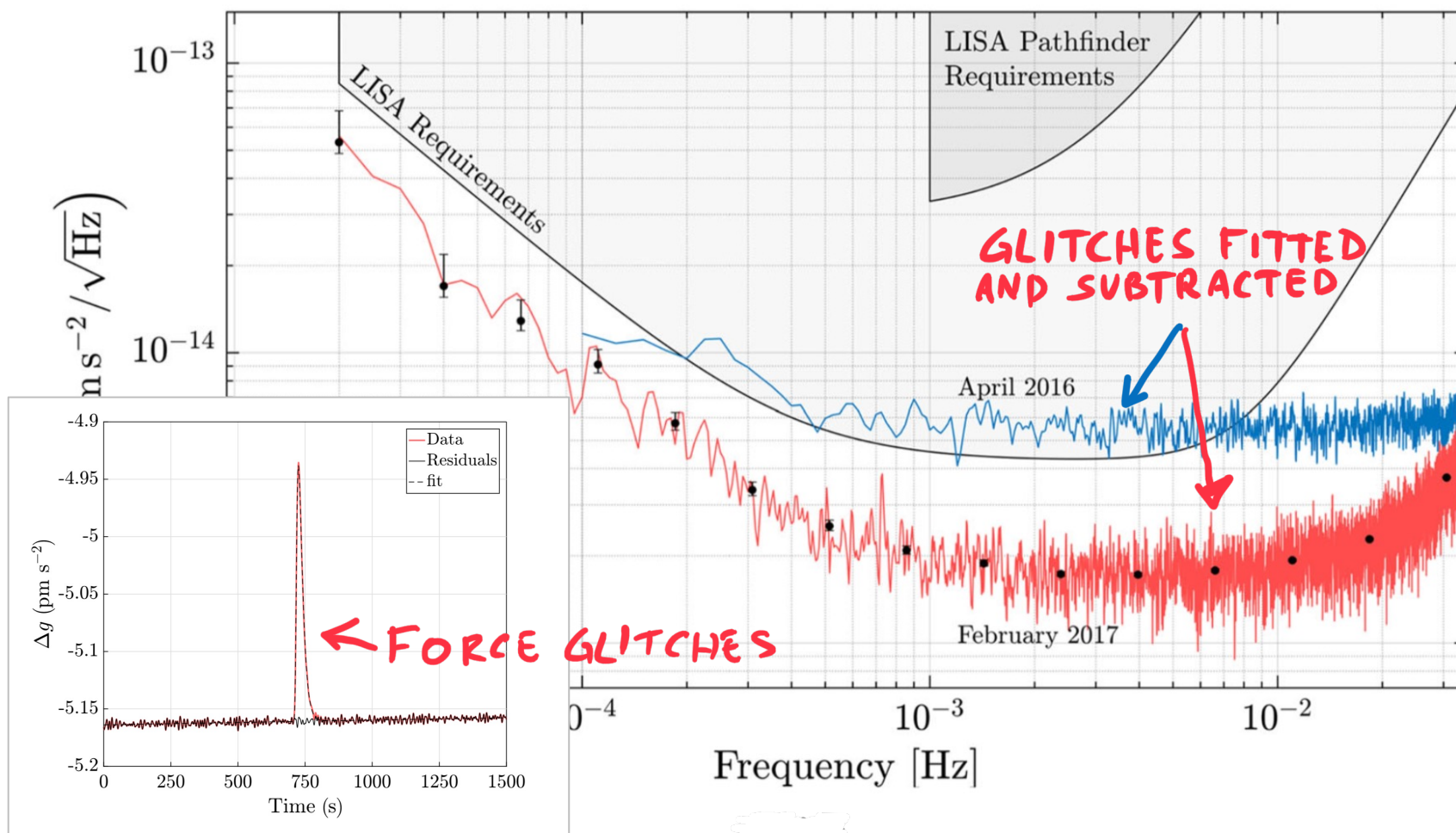
A SINGLE LISA ARM STRETCHED INTO ONE SC



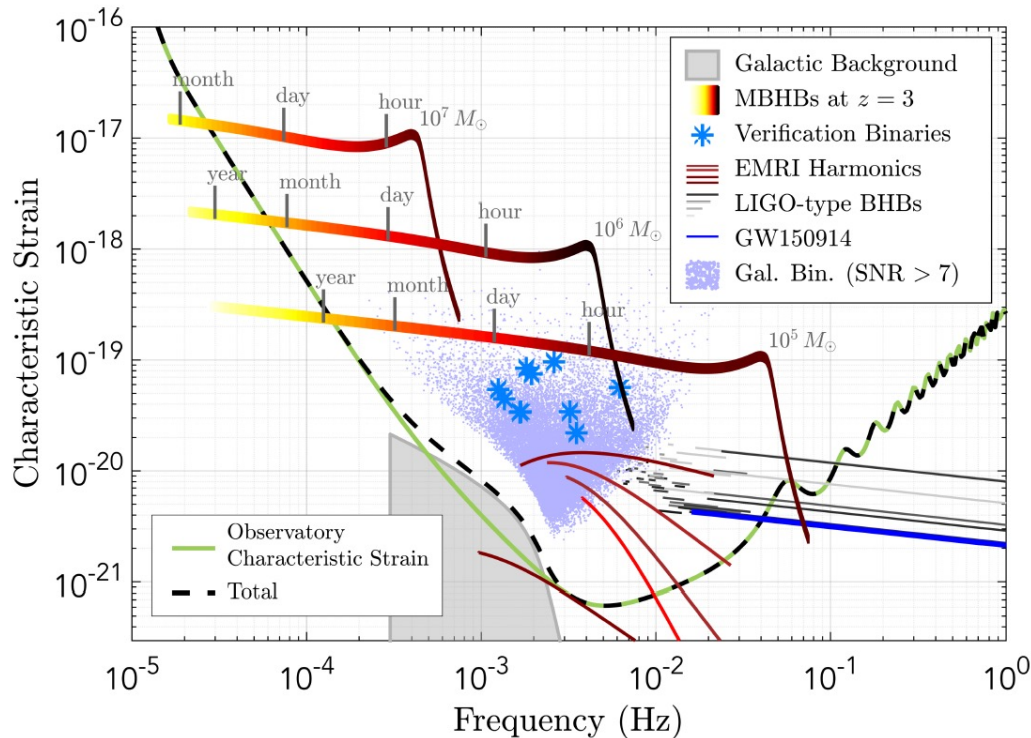
Beyond the Required LISA Free-Fall Performance: New LISA Pathfinder Results down to 20 μHz



Beyond the Required LISA Free-Fall Performance: New LISA Pathfinder Results down to $20\ \mu\text{Hz}$



THE PROMISED LAND OF LISA



Expected sources

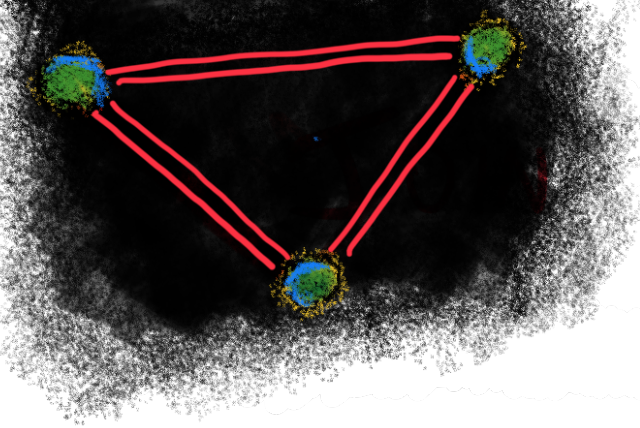
- $\sim 10 \div 10^2$ SMBHBs
- $\sim 1 \div 10^3$ EMRIs
- $\sim 10^5$ resolved galaxy binaries
- $\sim 10^6$ of unresolved
- LIGO/Virgo sources
- Discovery potentials
- Global fit in a huge high dimensional space, together with instrumental noise and GW stochastic foreground

Timeline



October 2013:	Selection of "The Gravitational Universe" as science theme for the 3 rd ESA flagship mission (L3)
October 2016:	Call for mission proposals for L3
June 2017:	Selection of LISA as L3 with an anticipated 2034 launch date
May 2018:	Phase A Kick-Off
2018-2020:	Mission Phase A
<Mid 2020:	Formulation Review (end Phase A)
>2020:	Mission Phase B1
<2024:	Mission Adoption
>Adoption:	Mission Implementation (Phase B2/C/D)
<2034:	Launch
>Launch:	6.5 years operations (+6 years potential extension)

Extension of phase A through 2021 (ready for MFR)



JOIN THE LISA CONSORTIUM!

<http://signup.lisamission.org>

LISA

We will observe gravitational waves in space

LISA MISSION

LISA PATHFINDER

GRAVITATIONAL WAVE ASTRONOMY

CONTEXT 2030

CONSORTIUM

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Consortium Code of Conduct

Consortium News

Join the community!

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share

The LISA community welcomes all scientists who wish to contribute.

Consortium membership for scientists

If you are a scientist and wish to contribute to the LISA mission, use this **scientist registration form**.