The Japanese Space Gravitational Wave Antenna - DECIGO

GWADW @ Elba, Italy

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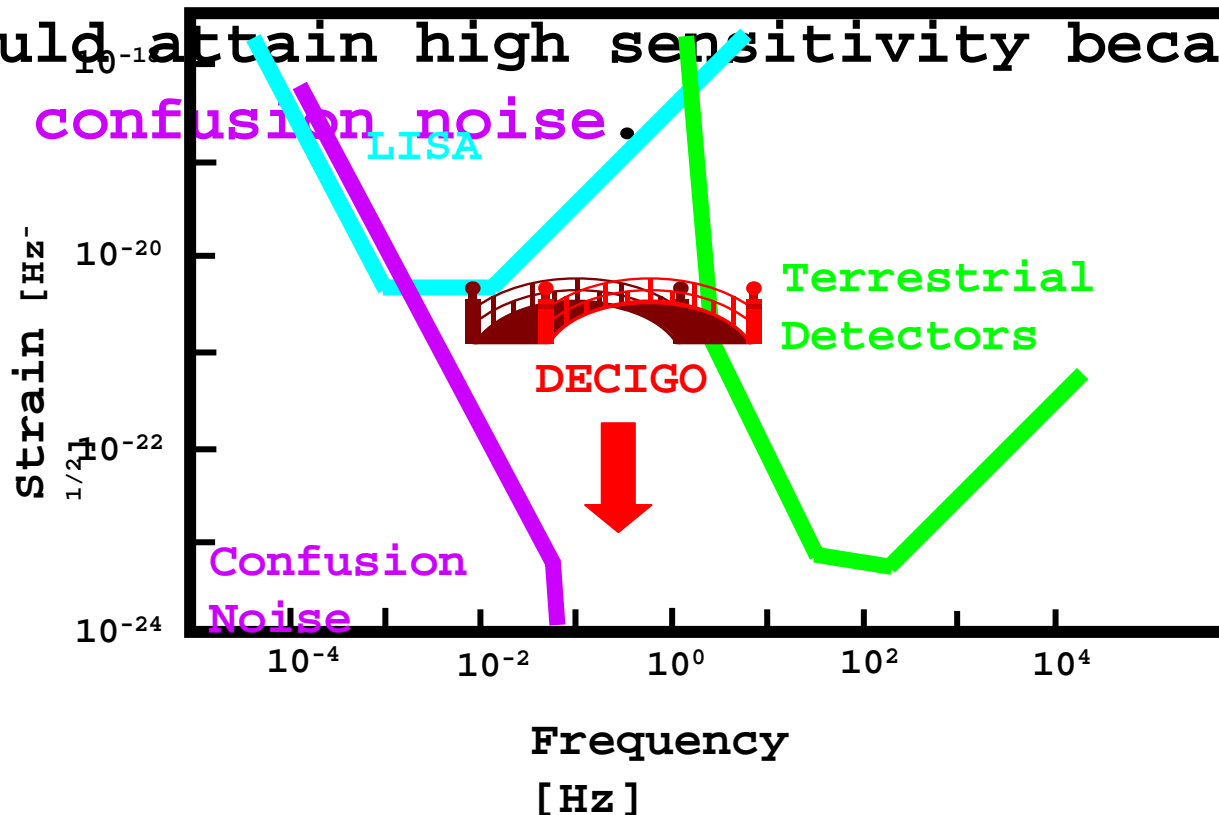
Contents

What is DECIGO?

Deci-hertz Interferometer **G**ravitational Wave **O**bservatory

- bridges the gap between LISA and terrestrial detectors.

- could attain high sensitivity because of lower confusion noise.

Pre-conceptual Design

FP-Michelson interferometer

Arm length: 1000 km
Laser power: 10 W
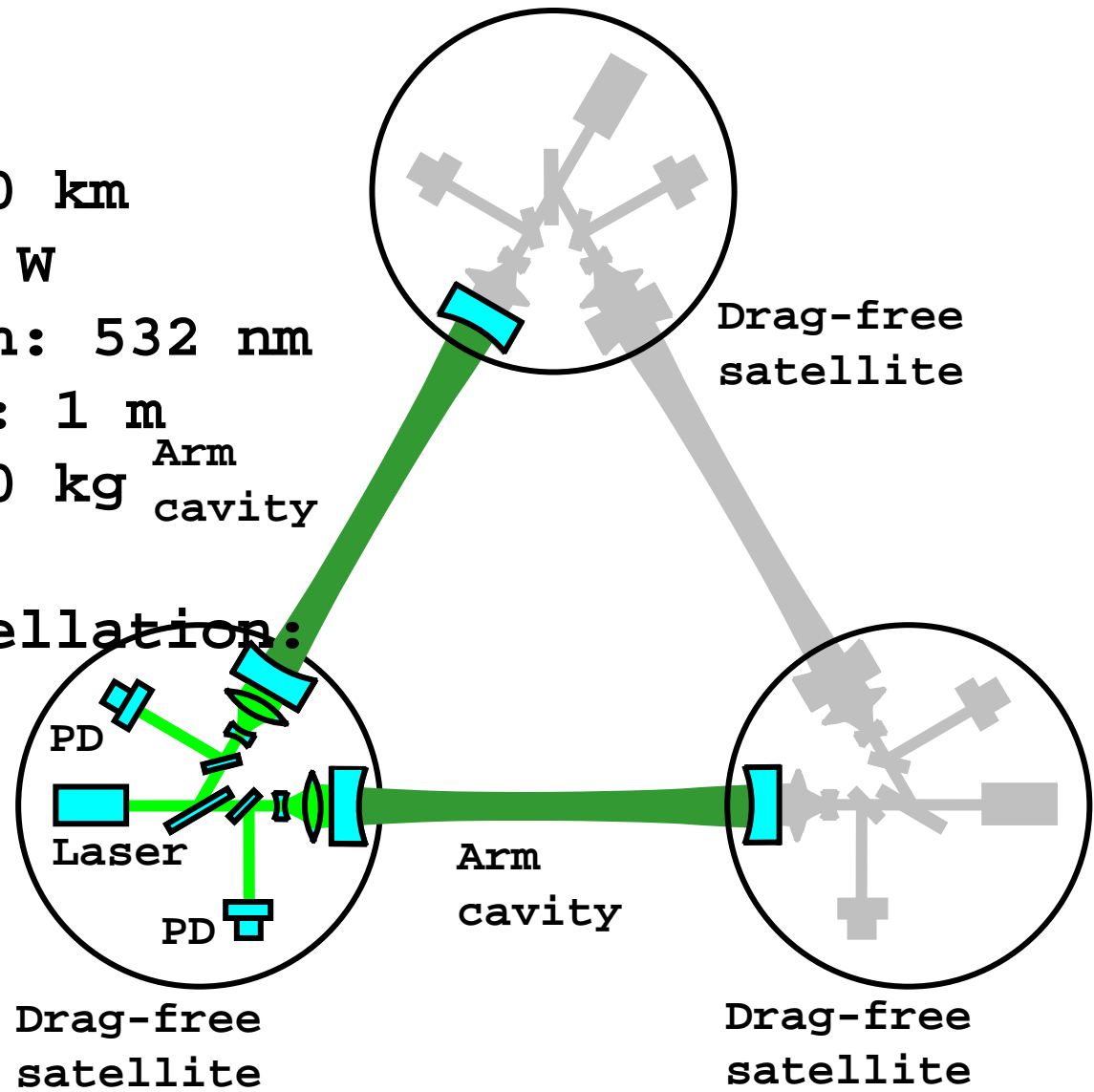**Laser wavelength: 532 nm**
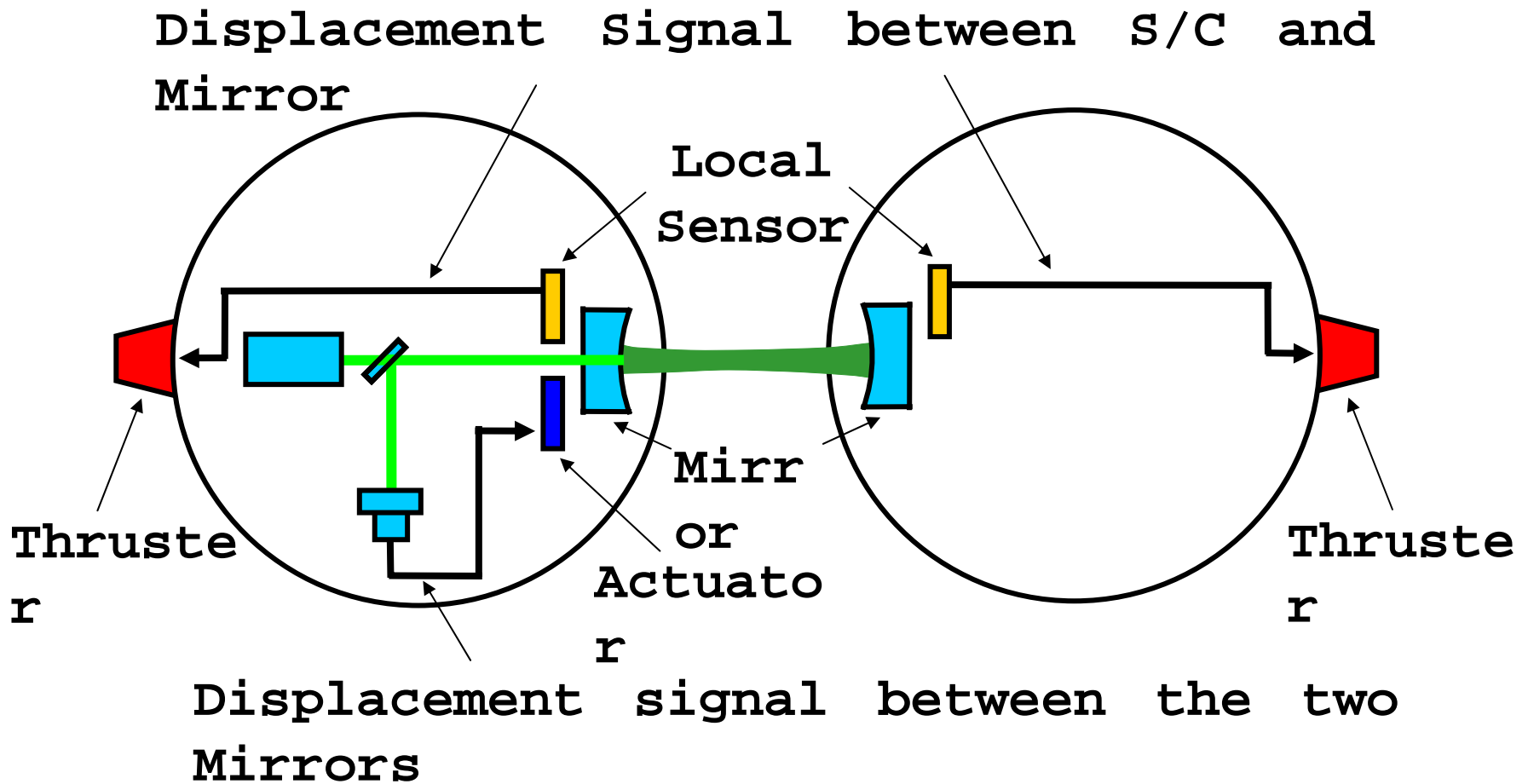**Mirror diameter: 1 m**
Mirror mass: 100 kg
Finesse: 10
Orbit and constellation: TBD

Kawamura, et al., CQG 23 (2006) S125-S131

Drag-free satellite

Arm cavity

PD

Laser

PD

Arm cavity

Drag-free satellite

Drag-free satellite

Drag-free and FP Cavity

Displacement Signal between S/C and Mirror

Local Sensor

Displacement signal between the two Mirrors

Mirror or Actuator

Thruster

Thruster

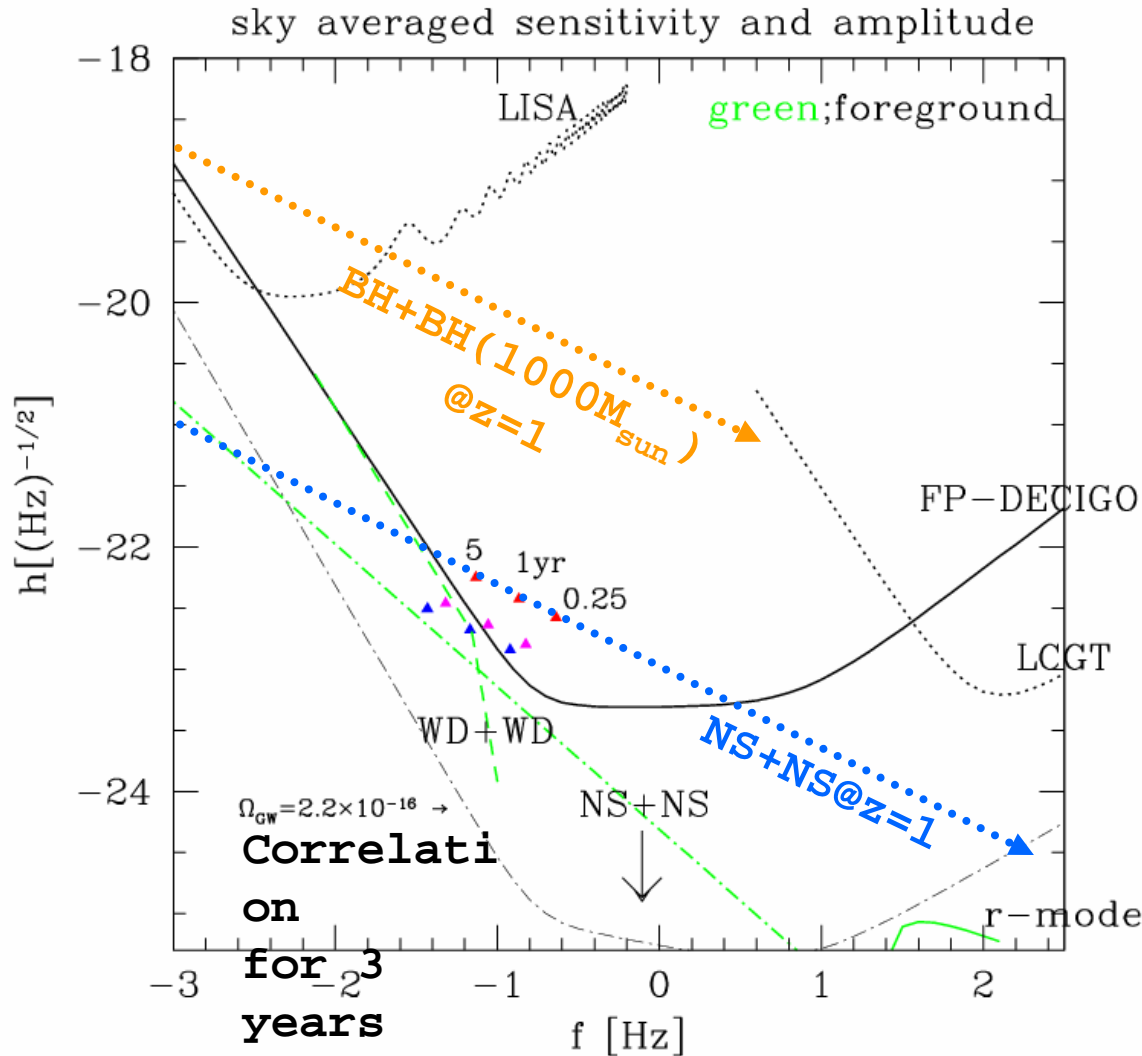# Sensitivity Goal
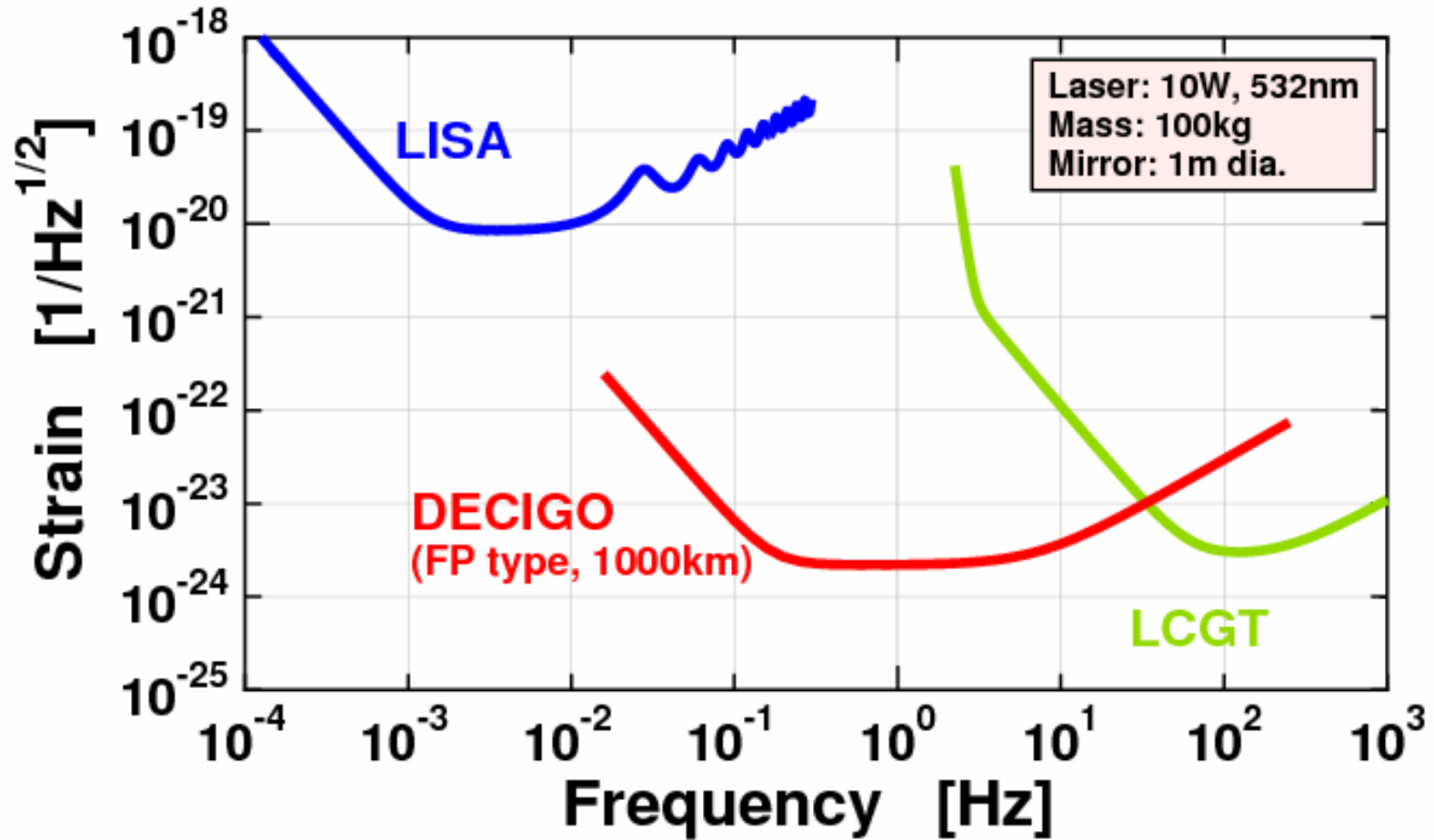
Requirements

[Practical force noise]

- **4×10^{-17} N/$\sqrt{\text{Hz}}$ per mirror**
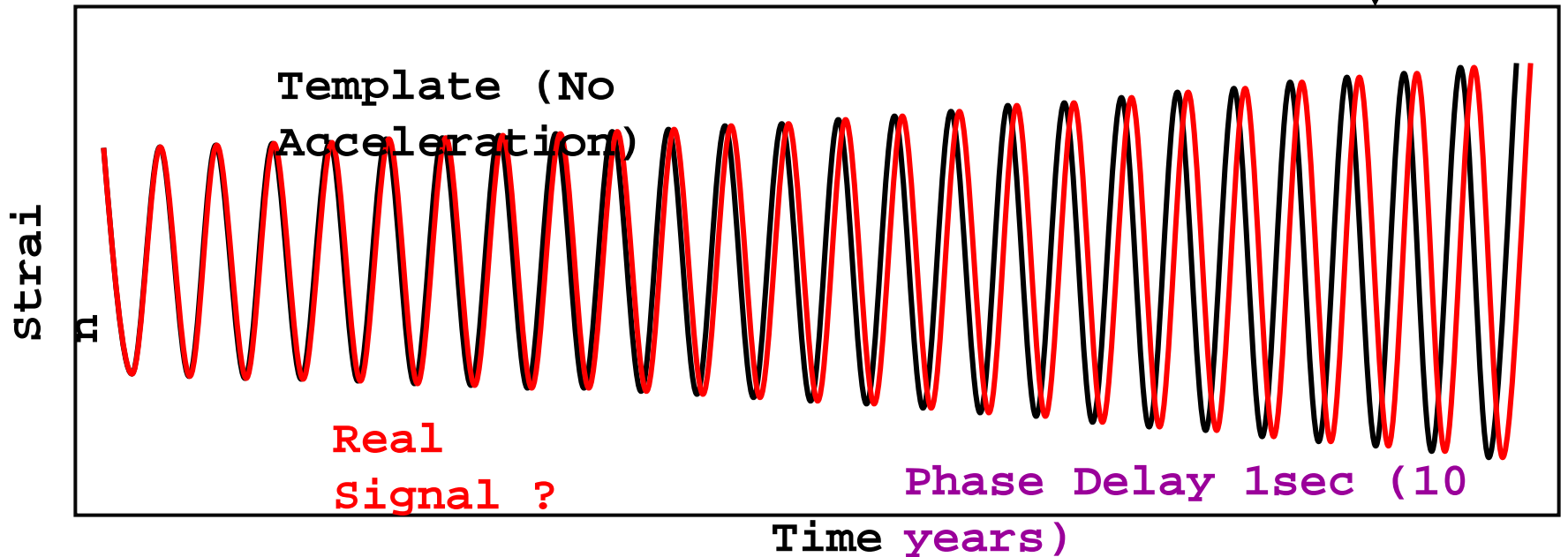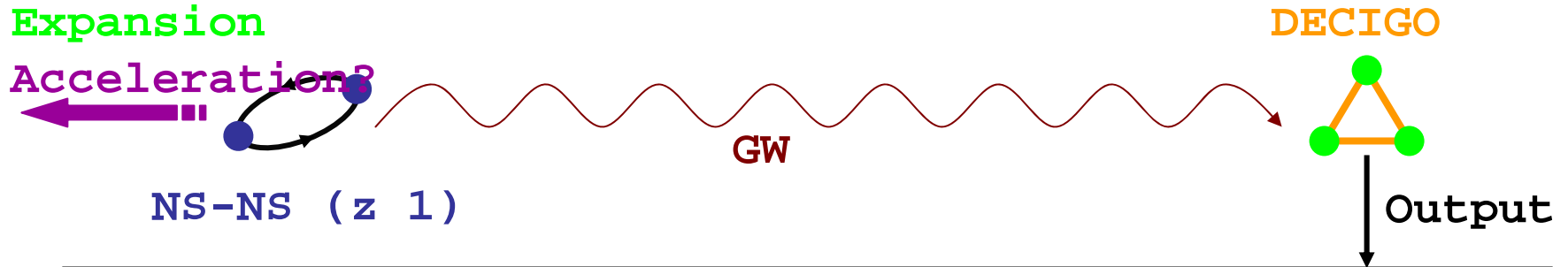
[Frequency Noise] @ 1 Hz

- **First-stage stabilization 1 Hz/$\sqrt{\text{Hz}}$**

- **Stabilization gain by common-mode arm length 10^5**

- **Common-mode rejection ratio 10^5**

Science by DECIGO

sky averaged sensitivity and amplitude

LISA   green;foreground

BH+BH(1000M$_{sun}$)@z=1

FP-DECIGO

LCGT

WD+WD

NS+NS

NS+NS@z=1

$\Omega_{GW}=2.2\times10^{-16}$ →

Correlation for 3 years

r-mode

5   1yr   0.25

h[(Hz)$^{-1/2}$]

f [Hz]

NS-NS (1.4+1.4M$_{sun}$)
   •z<1 (SN>26: 7200/yr)
   •z<3 (SN>12: 32000/yr)
   •z<5 (SN>9: 47000/yr)
IMBH (1000+1000M$_{sun}$)
   •z<1 (SN>6000)

Acceleration of Expansion of the Universe

Expansion

Acceleration?

DECIGO

GW

Output

NS-NS (z 1)

Template (No Acceleration)

Strain

Real Signal ?

Phase Delay 1sec (10 years)

Time
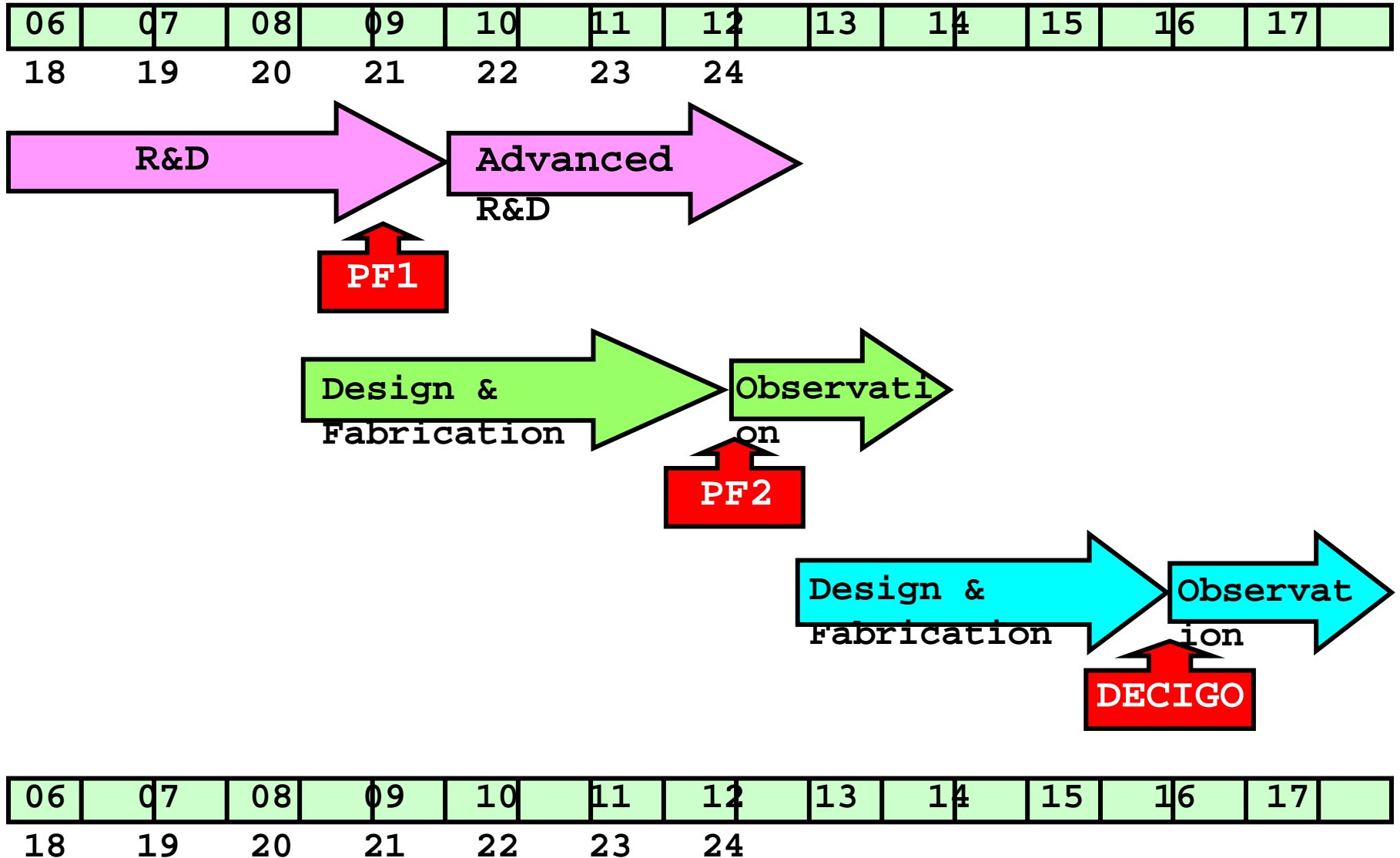
Seto, Kawamura, Nakamura, PRL 87, 221103 (2001)

Constraint to Dark Energy

Distance – Red shift relationship for NS-NS binaries
$\Rightarrow$ **Constraint to dark energy**

Distance: determined directly by GW observation

Red shift: determined by identifying the host galaxies (10 arcsec at z=1 for two far-

Roadmap for DECIGO

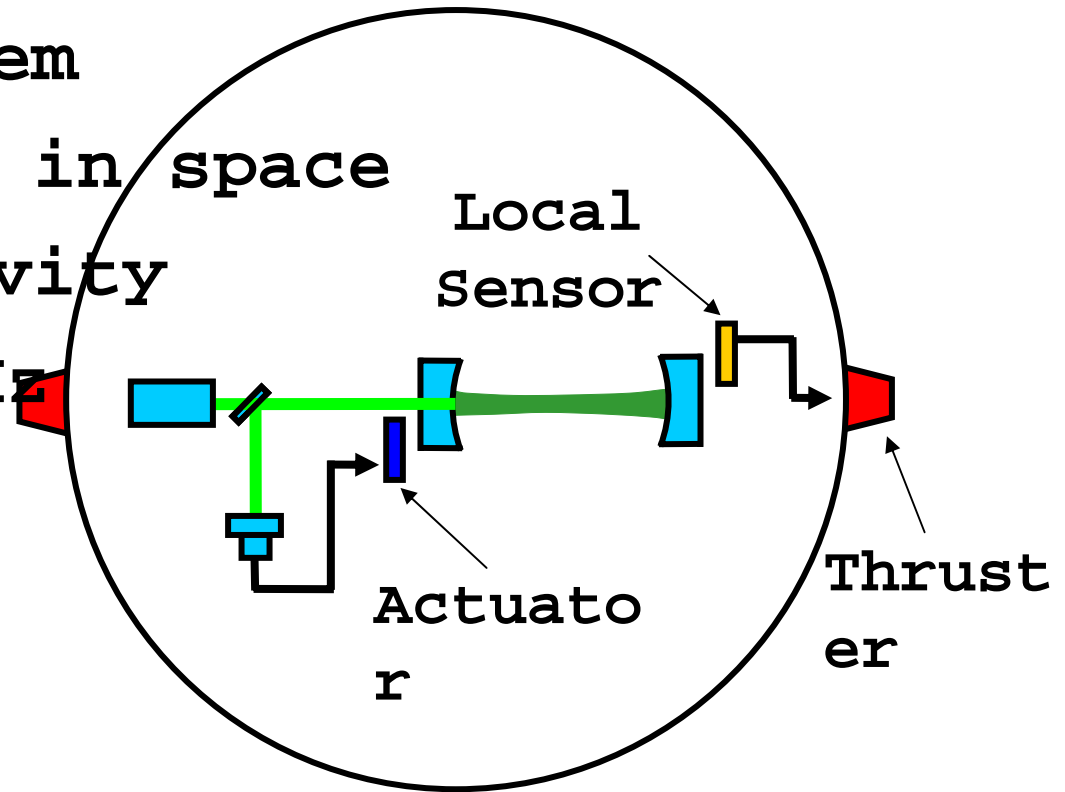# DECIGO Pathfinder1

Objectives

- **Drag-free system**
- **Cavity locking in space**
- **Modest sensitivity**
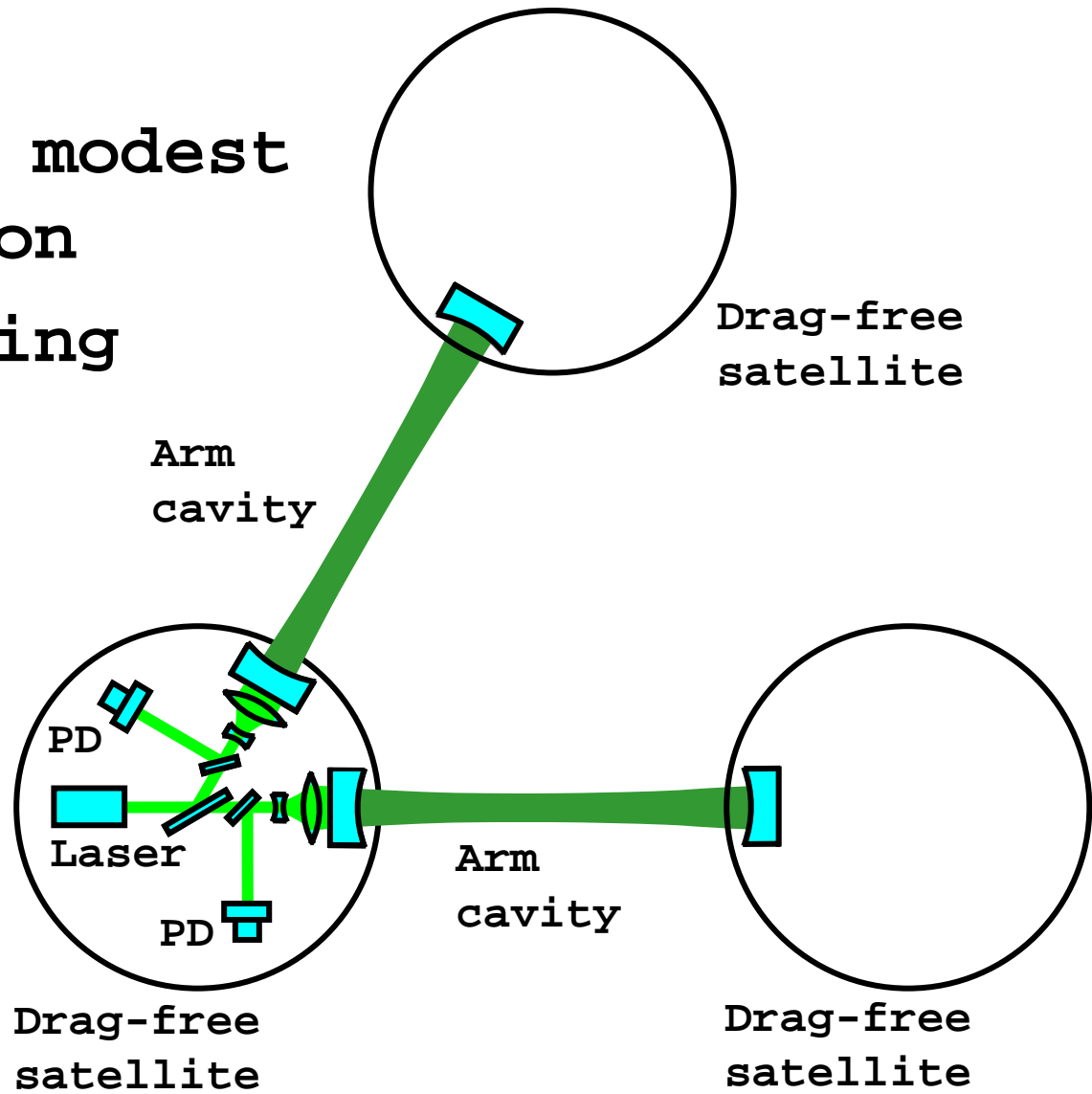 **at 0.1 - 1 Hz**

DECIGO Pathfinder2

Objectives

- **DECIGO with modest specification**

- **Cavity locking between two satellites**

- **Meaningful sensitivity**

Drag-free satellite

Arm cavity

PD

Laser

PD

Arm cavity

Drag-free satellite
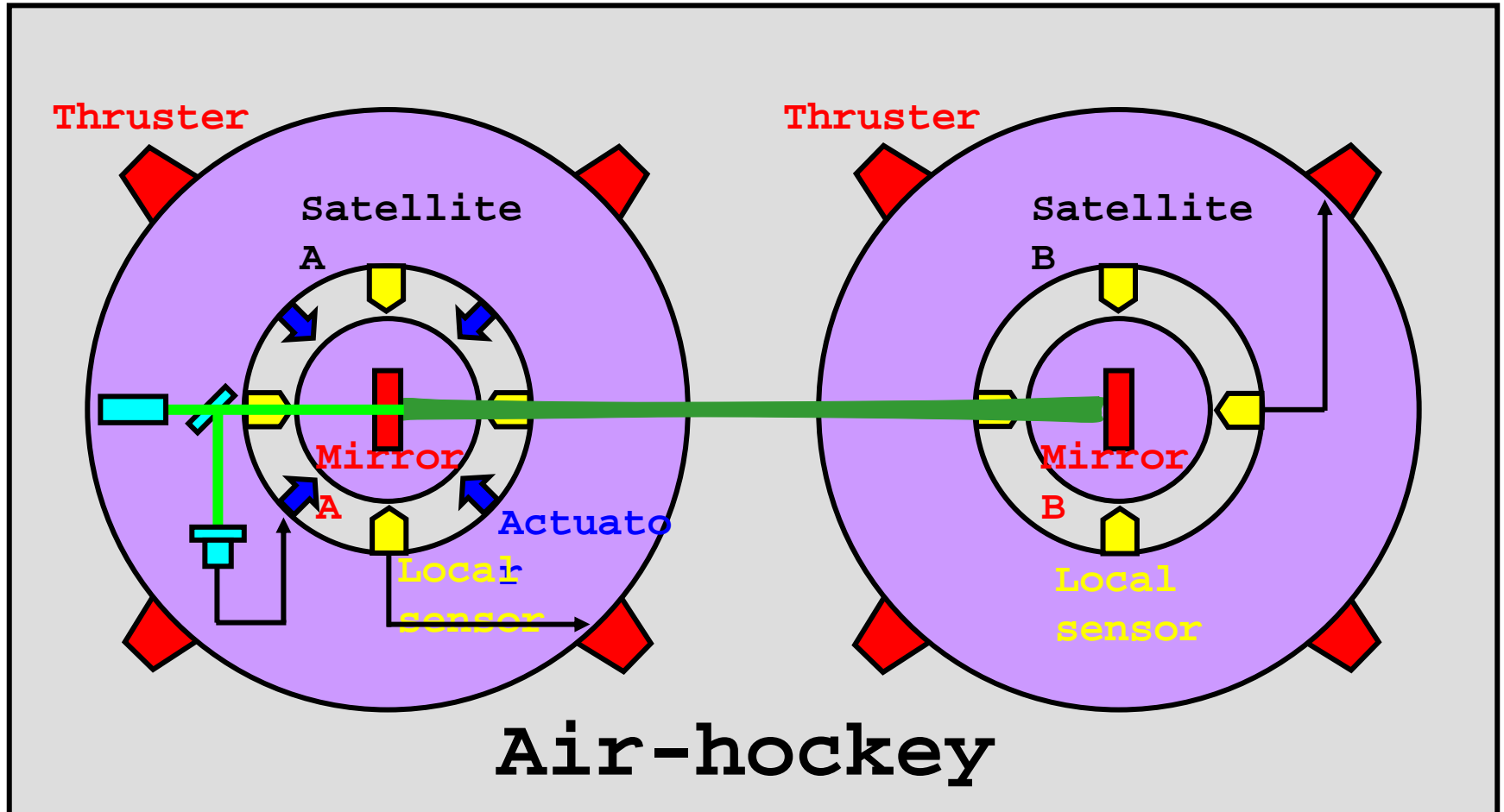
Drag-free satellite

DECIGO Simulator

Objectives

- **Continual free-fall environment**
- **Clamp release**
- **Modest sensitivity down to 0.1Hz**
- **Possibility of long arm**
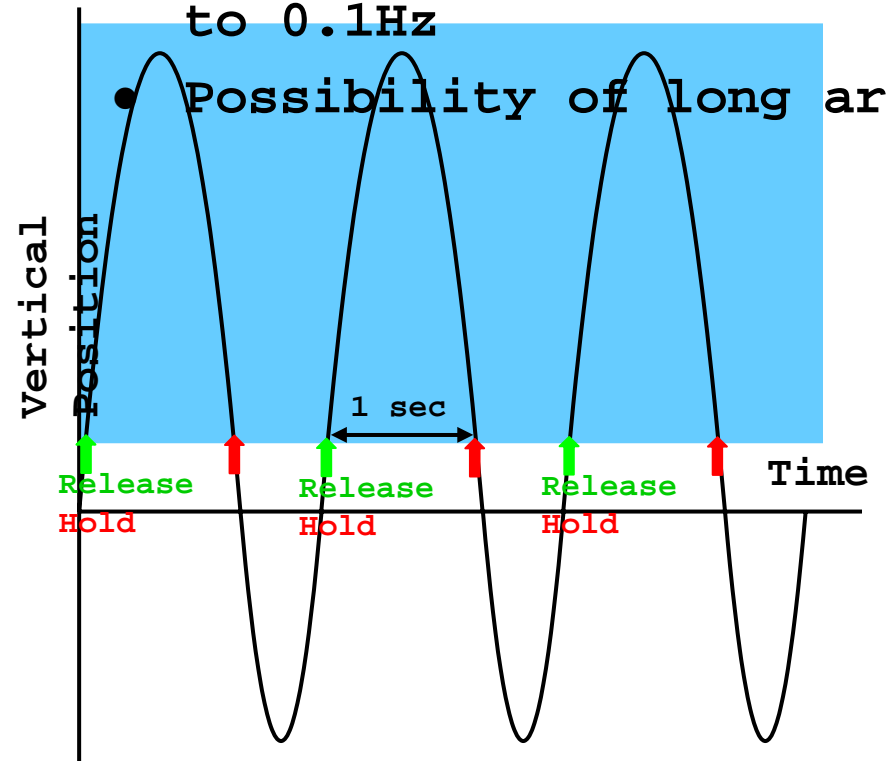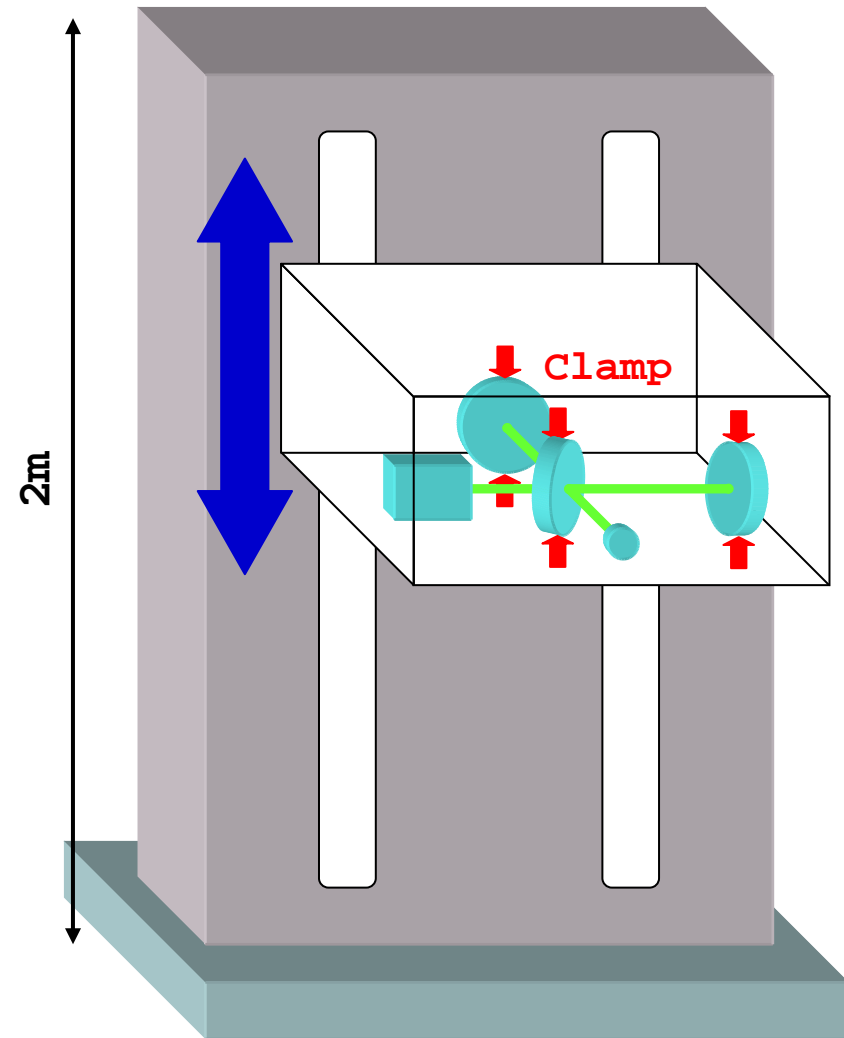
DECIGO Demonstrator

Objectives

- Lock acquisition

Budget Situation for DECIGO

- **Budget request for "Frontier of All Wavelength Gravitational Wave Astronomy" submitted in 2005**
  - TAMA and CLIO
  - R&D for DECIGO
  - Pulsar Timing
  - Super-high frequency G.W. detection
- **Not approved to our surprise**
- **Try again?**

Summary

- **DECIGO will have an extremely good sensitivity and open the GW window widely.**

- **DECIGO requires extremely challenging technology development.**

- **We hope that we will be able to start the R&D for DECIGO very soon.**