TAMA300 interferometer

● Laser interferometer GW detector

- Arm length: 300m
- Location: National Astronomical Observatory of Japan (Mitaka, Tokyo)

● Purposes

- Development of the detector capable to catch GW events in nearby galaxies
- Establishment of interferometer technologies for LCGT

Progress of TAMA300

1995-1997 Facility/Vacuum system construction

Recombined Interferometer

1999-2001 6 times of observation runs
(Total 1370 hours)

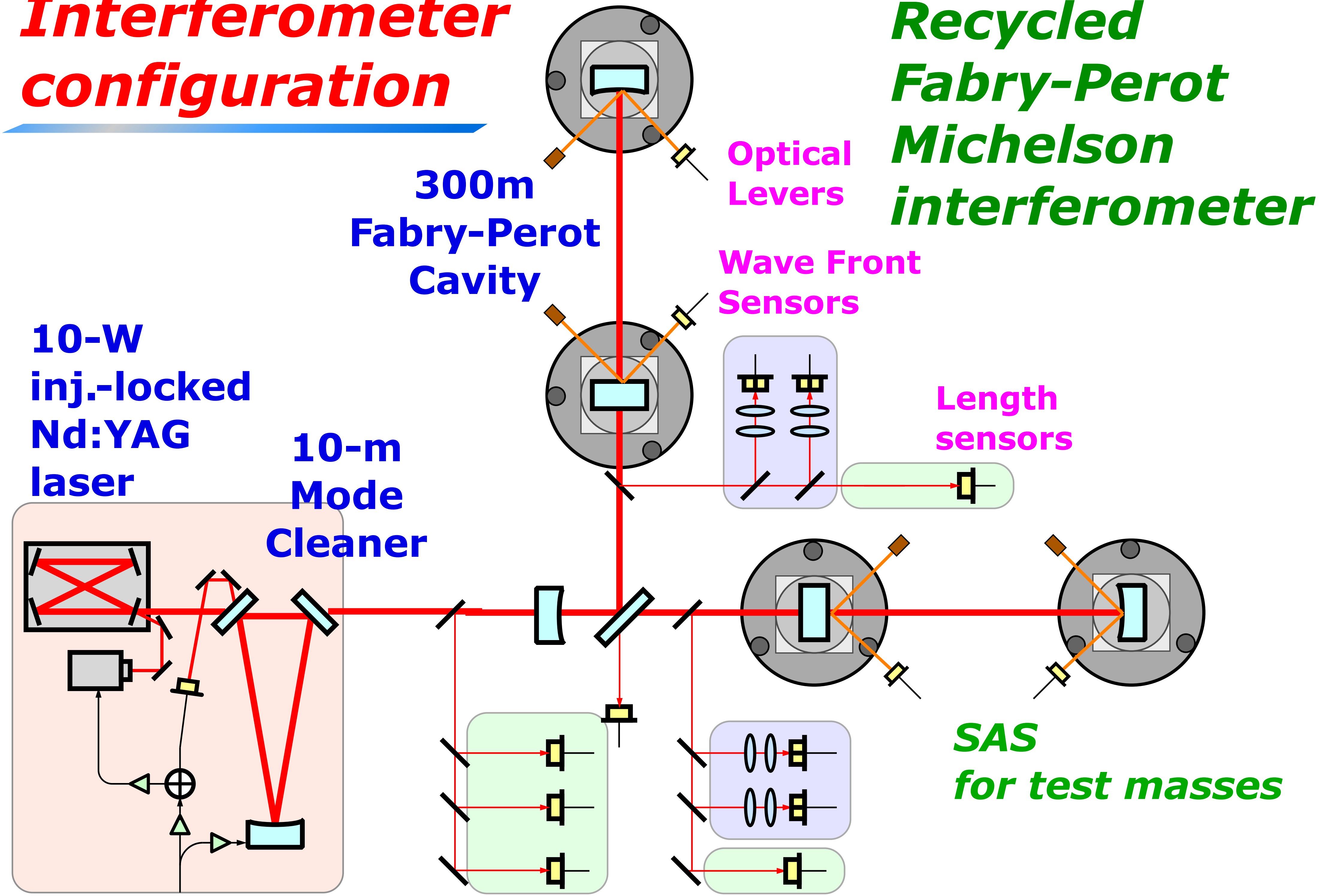
Recycled Interferometer

2001 Implement of power recycling
2003-2004 3 times of observation runs
(Total 1740 hours)

Seismic Attenuation System (SAS)

2005 Start installation of SAS
2007 Full interferometer lock with SAS
2008 Sensitivity improvement

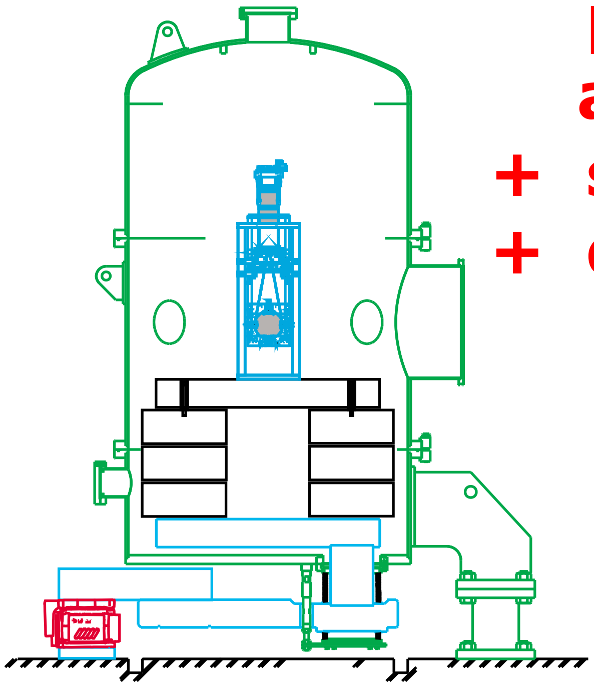
Interferometer configuration



Current focus

- **Establishment of detector operation with SAS**

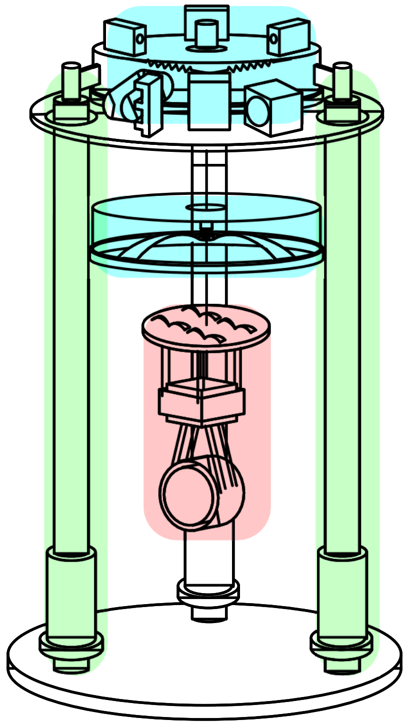
Replacement of the vibration isolation system



pneumatic active isolator + stack + double pendulum

→

inverted pendulum + vertical filter + multiple pendulum



To realize the improvement

- Optimization of SAS control
- Optimization of interferometer control
- Application of digital control system

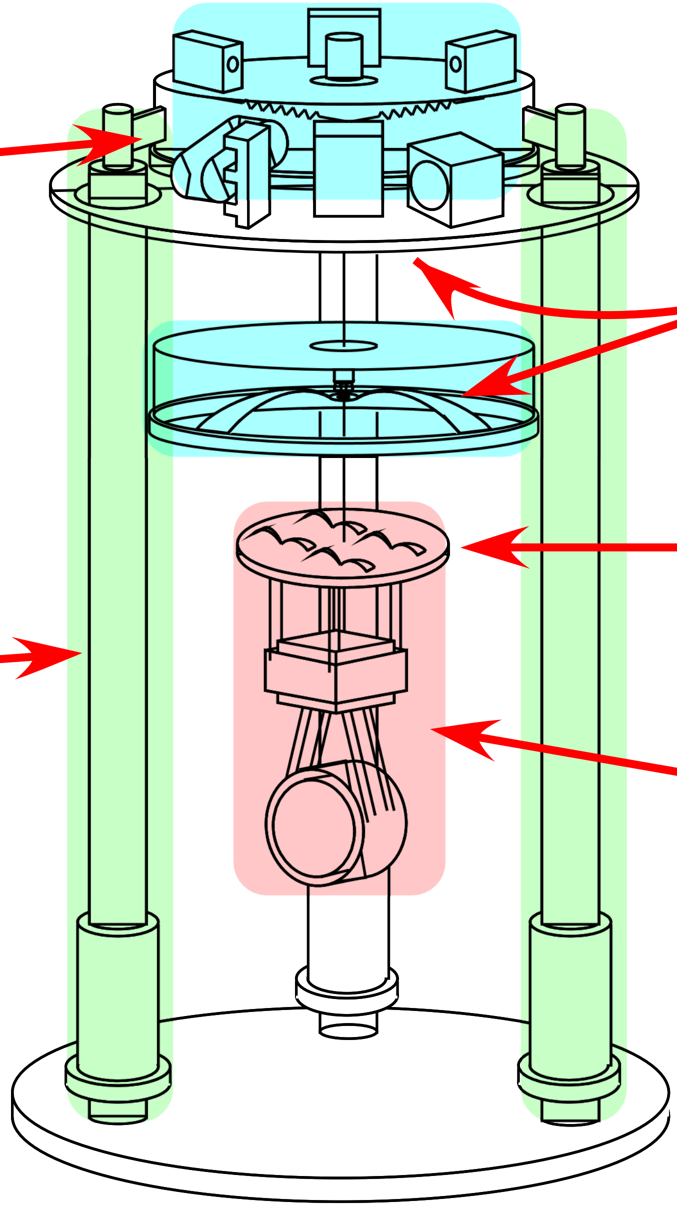
  =>Enables the complex servo system

  =>High level automatization of the operation

Seismic Attenuation System

● Structure of SAS

Multiple pendulum suspended from IP



Seismic Attenuation System

● Vibration Isolation

Passive isolation with soft springs + active damping

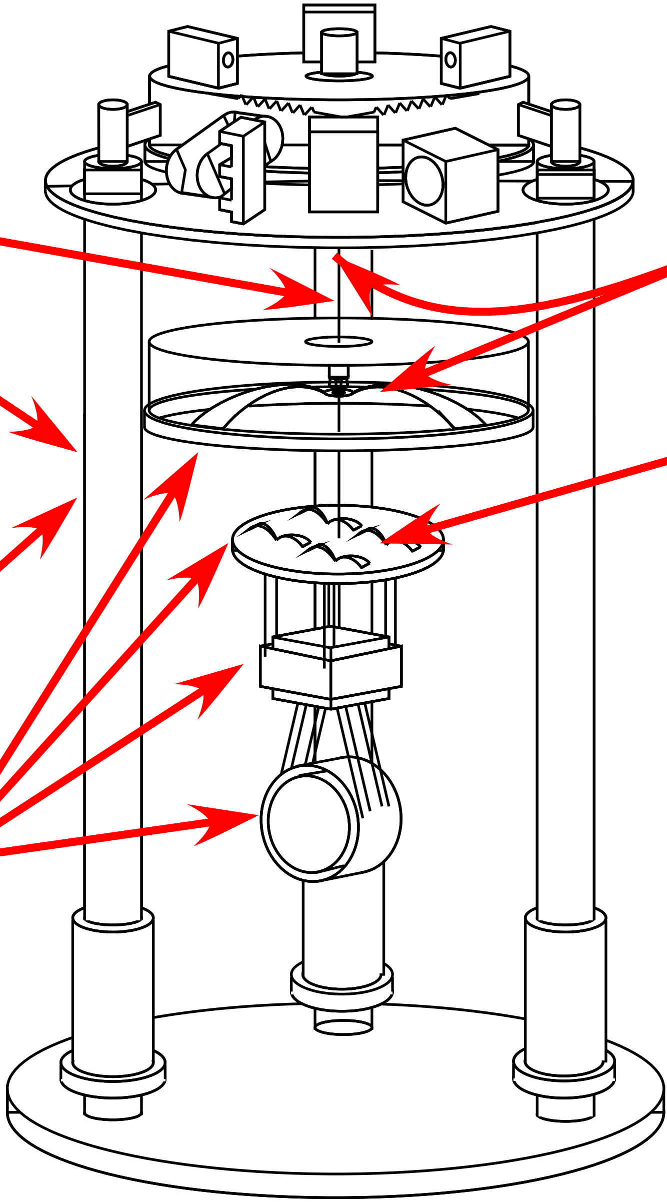
Tortional

Tortion Pendulum
f~40mHz
Inverted Pendulum
f~500mHz

Horizontal

Inverted Pendulum
f~30mHz

Multiple Pendulum
f~650mHz



Vertical

MGAS Filter
f~50mHz

MiniGAS Filter
f~1.5Hz

Seismic Attenuation System

- **Active Control of SAS**

Local control stabilize the mirror motion

=> to enable lock of the interferometer

Local control

IP Position

Sensor: LVDT

Bandwidth: ~60mHz

IP Inertial damping

Sensor: Accelerometer

Bandwidth: 60m~2Hz

Tortion damping

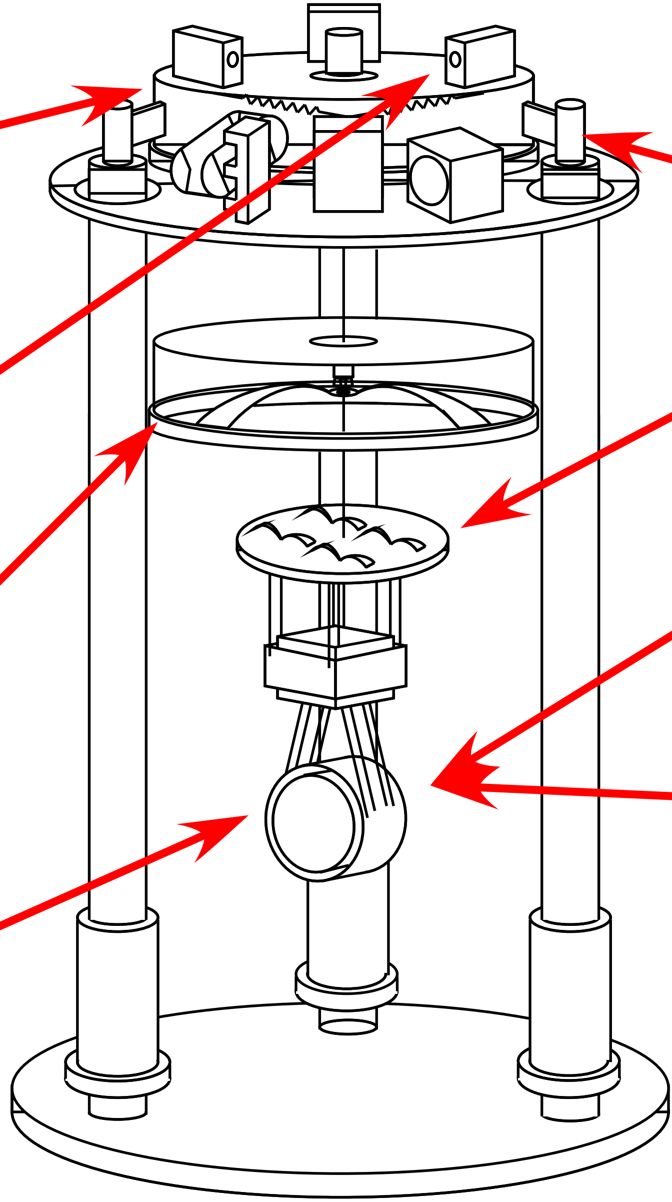
Sensor: Photo Sensor

Bandwidth: 40mHz

Test mass servo

Sensor: Optical Lever

Bandwidth: ~2Hz



Global control

IP Position

Bandwidth: ~10mHz

Plat form

Bandwidth: ~10mHz

Test mass (angular)

Bandwidth: <3Hz

Test mass (Length)

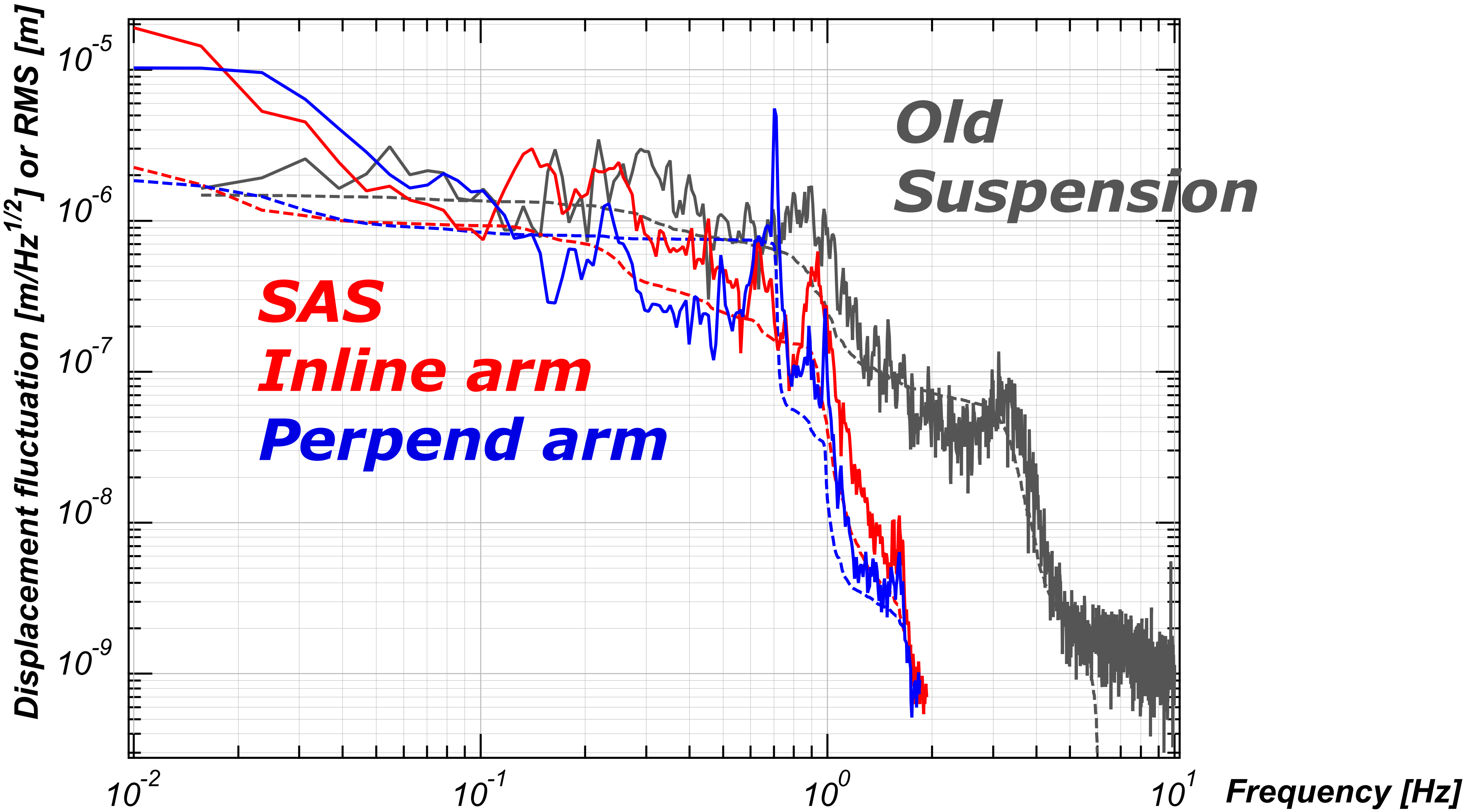
Bandwidth: <1kHz

Performance of SAS

- **Low frequency Legth Fluctuation of 300-m arm**

Comparison with the previous suspension system

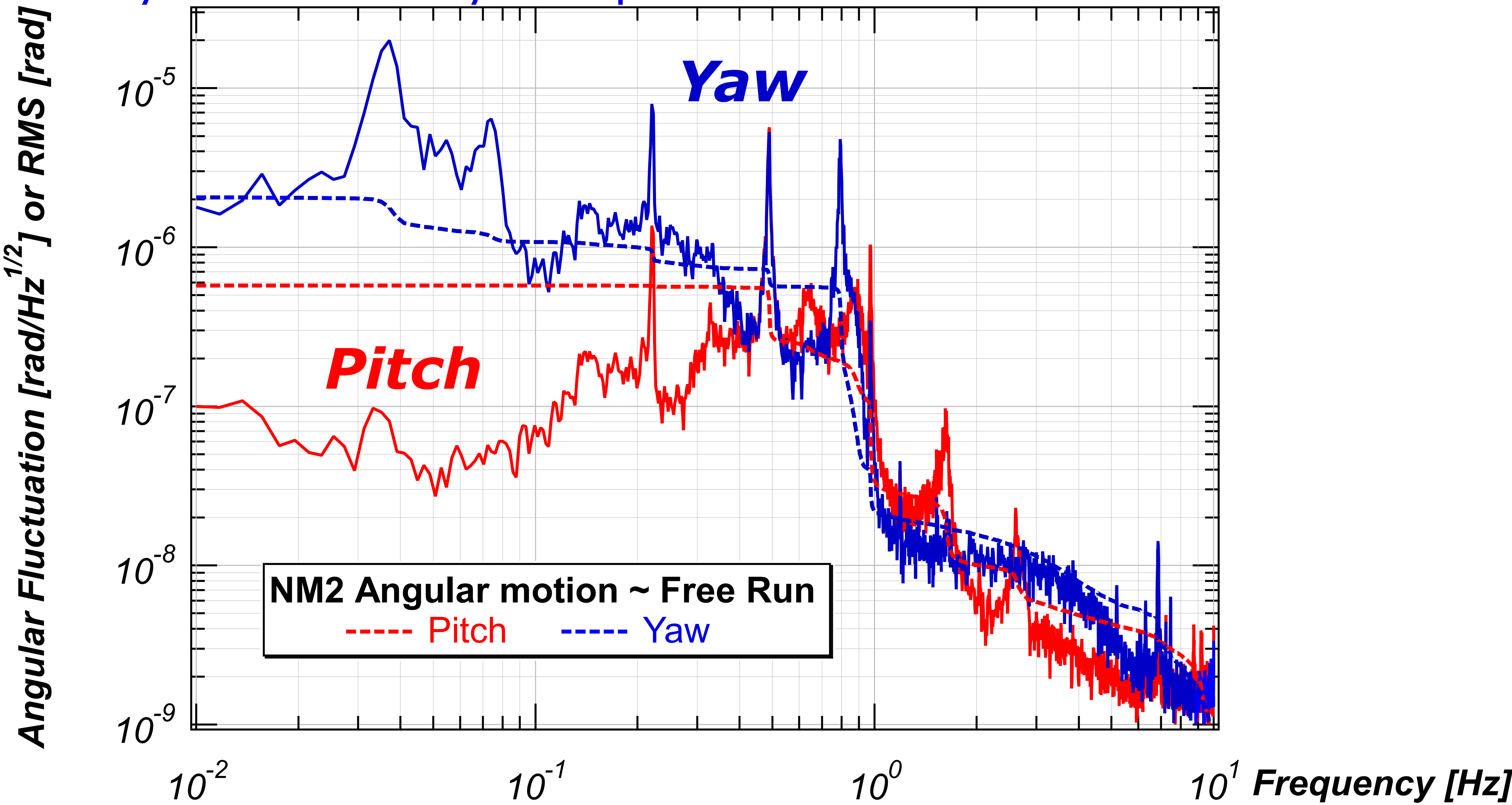
=> **improvement above 0.1Hz was confirmed**



Performance of SAS

● **Test mass angular motion (Free run)**

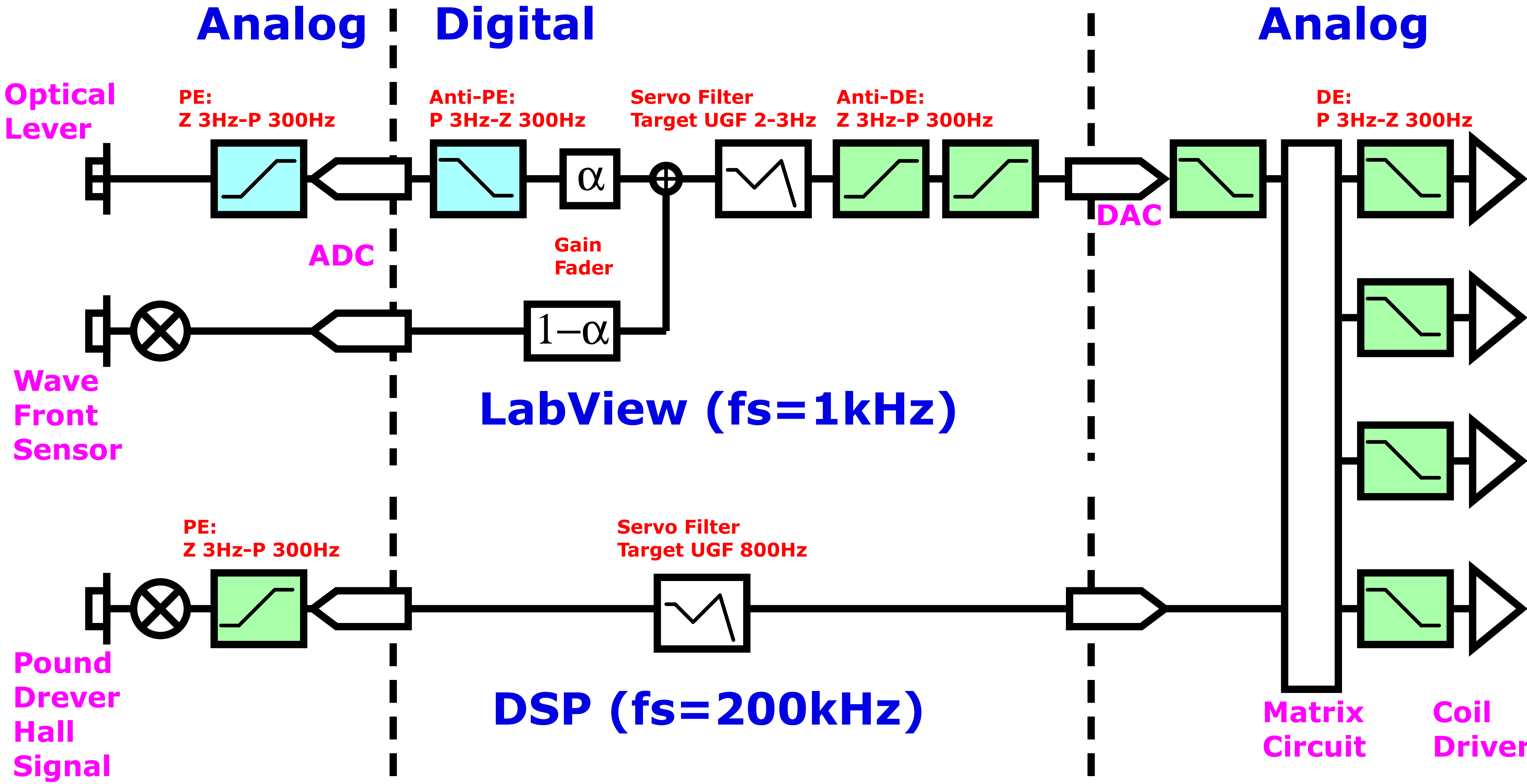
locally measured by an optical lever



Fluctuation Power concentrated on the low freq

θ_{RMS} ~ 30nrad (f>1Hz)

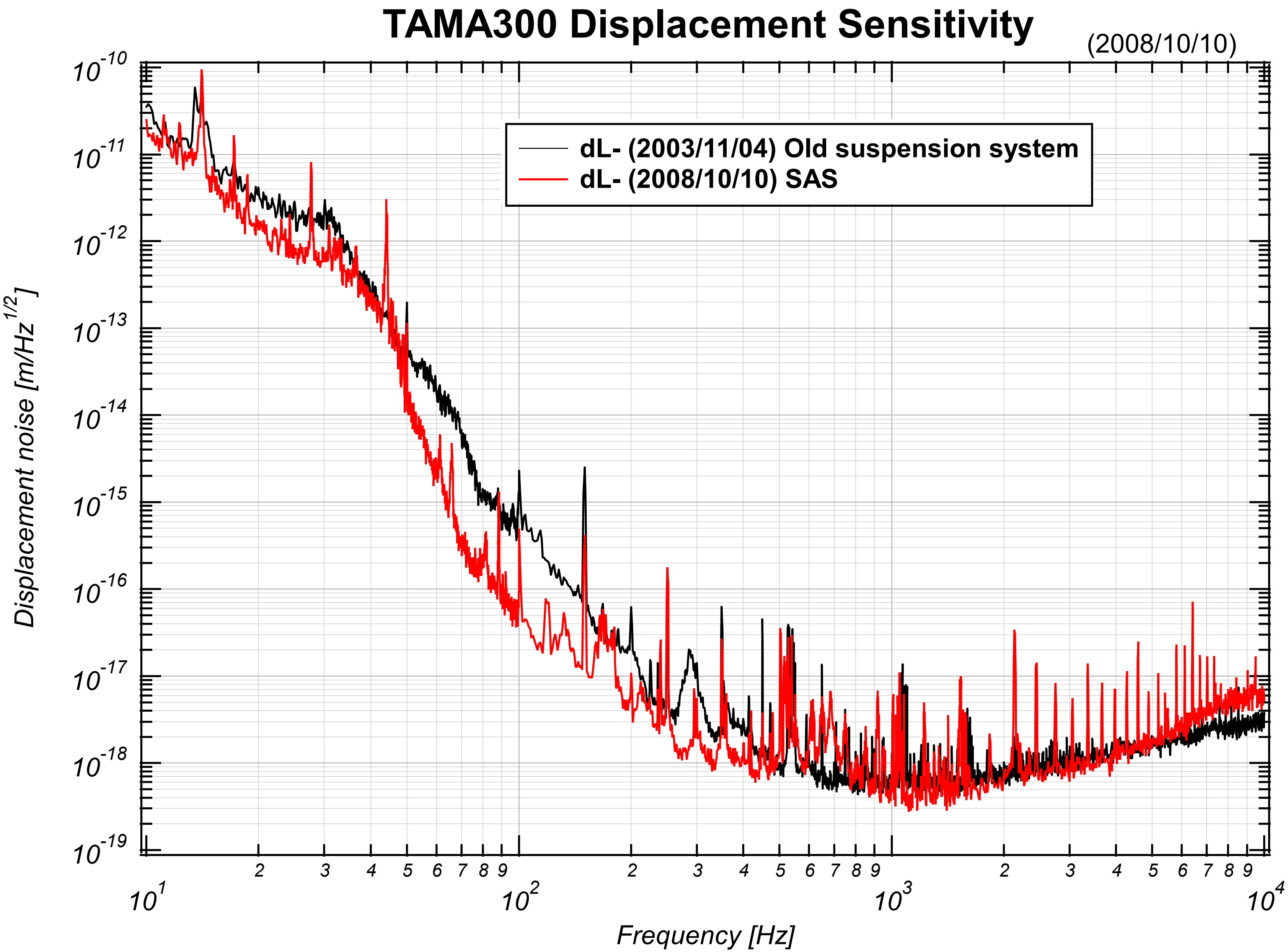
Digital Control System



Sensitivity

- **Sensitivity improvement achieved**

So far, improvement below 150Hz was confirmed



floor level
@1kHz

displacement
$dL = 4\times10^{-19}$ [m/rtHz]

strain
$h = 1.3\times10^{-21}$ [/rtHz]

Noise budget

- Estimated contributions of the various noise sources