

ET PERSPECTIVE

Third generation: TM at cryogenic temperature

The fundamental sensitivity limit is set by thermal noise of the suspensions.

- Thermal noise at 10 Hz lowered by a factor of 10.
- Low limit of the observation band moved to 3 Hz.

Interface with Cryogenic systems - heat extraction creates new issues:

- Stiffer TM suspension, because heat need to flow through large wires
- Contacts from cryostat to the penultimate mass, short cutting the seismic transmission

This will only matter if we can solve technical noise sources!

What is Inter-Platform Motion?

- Active stabilization for optical paths
- Feedback at early seismic isolation stages (e.g. platforms)
- Reduce the total residual motion between platforms
- Focused on Length, Pitch, and Yaw in corner station and arms
- Also important for, eg, suspended detection benches and squeezed light paths
 - Wherever phase-sensitive distance is accumulated.*
- RMS motion is typically dominated by 10mHz to 1Hz.

TASK LIST

- Suspension modeling (SUS + ANM, IPM/LF-Controls)
 - Select source code from LIGO + Virgo and translate into Python:
<https://wiki.et-gw.eu/ISB/ActiveNoiseMitigation/LFControlResources>
 - Inspiration from useful tools and interfaces to them (e.g. [SpicyPy](#), [Finesse](#))
- Tools for control strategy development (ANM, IPM/LF-Controls)
 - Functional integration into suspension model
 - Automated filter generation for ‘optimal’ or ‘MIMO’ control methods
([Particle swarming of sensor correction filters](#), [Optimal system identification for LIGO](#))
 - Virgo/LIGO provide excellent testing grounds for these techniques
- Design of new a suspension layout (SUS + IFO + ANM)
 - Controls co-design (sensing and actuation points)
 - Sensor and actuator R&D to meet above
 - Seismic isolation models generate the **output to IPM**

TASK LIST

- Noise source identification and noise projection (ANM + IFO)
 - Model/understand current (LIGO/Virgo) relative motion in each DoF (eg PRCL, Mich). E.g.:Can we explain SRCL open-loop spectrum? **(IPM)**
 - Measure prospective arm seismic differential input at sights **(IPM)**
 - Real tilt in a ventilated cavern (KAGRA LF seismometer/strain-meter spectra) **(IPM)**
- Improved and new sensors
 - Position, inertial for SUS (SUS)
 - Payload, especially angular (SUS)
 - Multi-DoF SPI (corner station, arm?) **(IPM)**
- Improving control electronics (LF Controls)
 - Deriving requirements on, eg, RMS motion based on [electronics](#).

Have a look at our [Wiki](#) or get in contact with [Sina](#) or [Paolo](#)!