HoQI: Interferometric Inertial and Suspension Sensors

UNIVERSITY OF BIRMINGHAM | GRAVITATIONAL WAVE ASTRONOMY

Nikhef

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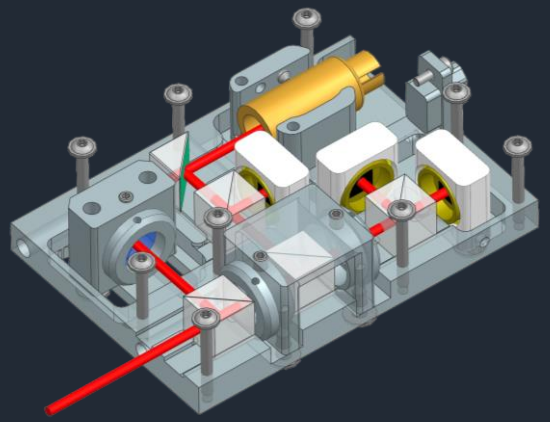
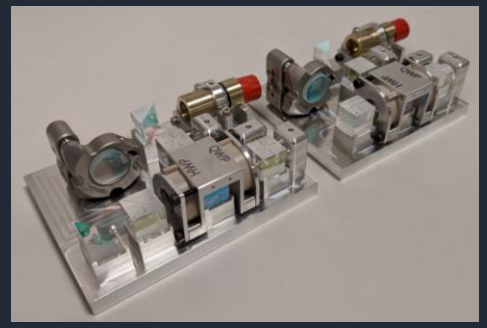
HoQI



HoQI is a compact interferometric readout device for suspension and seismic sensors

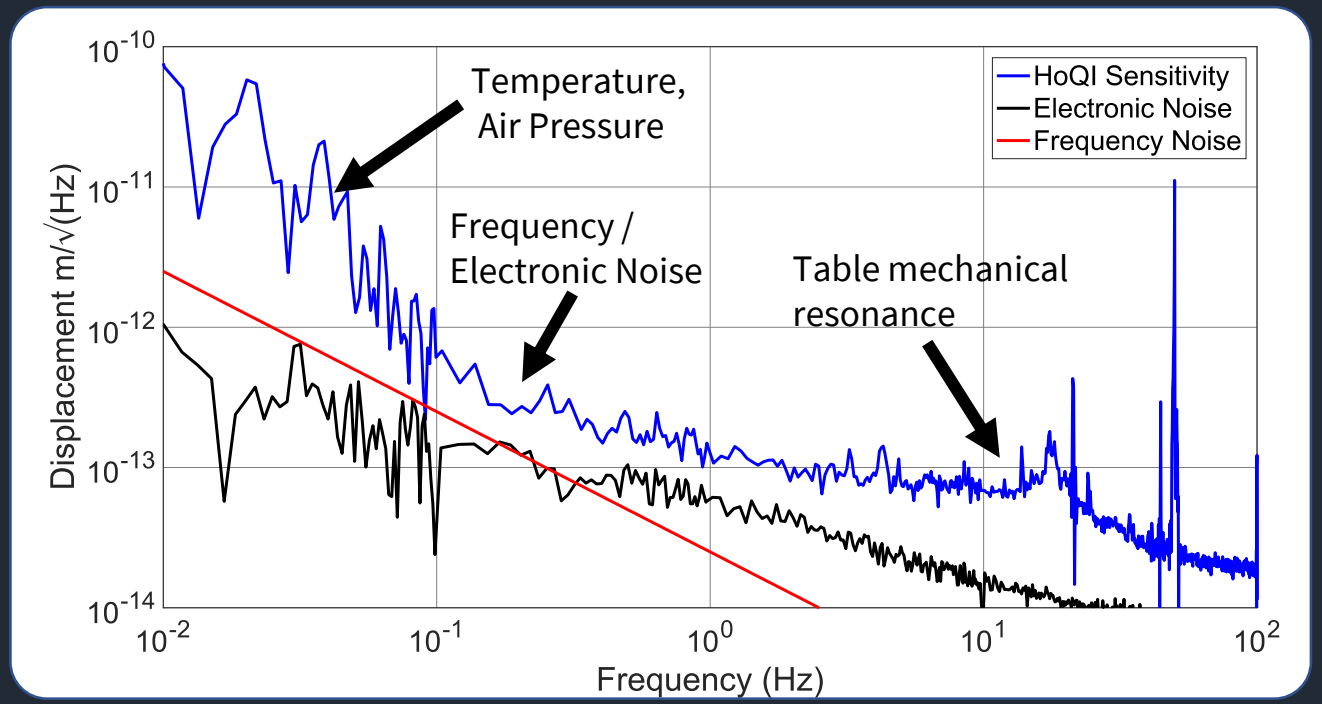
Displacement Sensor Sensitivity[1] Measured in air with no isolation. Expect 10-100mHz sensitivity to improve with testing in vacuum.

[1] S J Cooper *et al* 2018 *Class. Quantum Grav.*



Features

- Compact Footprint 60x85x25mm (W/D/H)
- Longitudinal range (10mm+)
- Max velocity tracking ~5mm/s
- Simple readout scheme
- Integration with LIGO CDS
- UHV compatibility testing to start soon.



HoQI as a inertial sensor readout

Can use HoQI to improve the readout noise of geophones, such as L-4C's and (G)S13's.
Used L4Cs as they're cheap and have known mechanics.
Resolution limited by thermal noise + mechanics

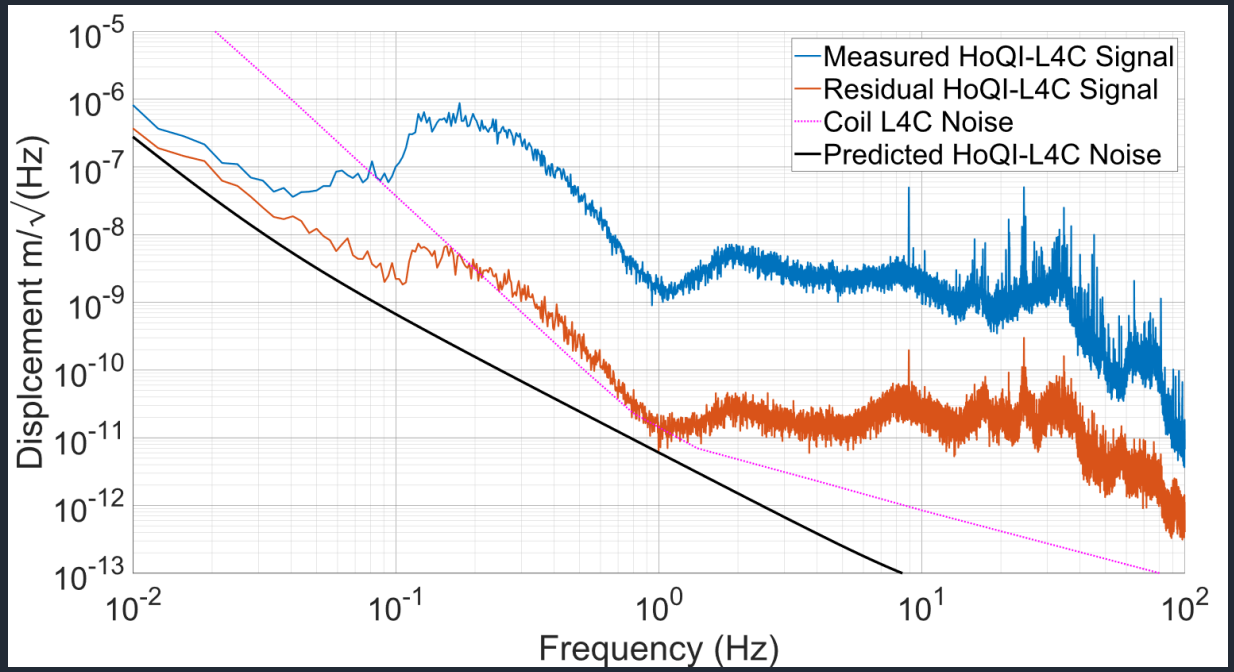
Huddle tested 3 L4C-HoQI's and subtracted all coherent motion from one sensor.

Measured over a weekend in air in an acoustic enclosure without active isolation.

Almost hit predicted noise at 10mHz (limited by a mixture of, readout and thermal noise).

0.1Hz resolution limited by real motion, need more isolation + additional sensors high resolution sensors to subtract to noise floor.

1Hz and above limited by real motion, need active control + additional sensors to reach the sensors noise floor.

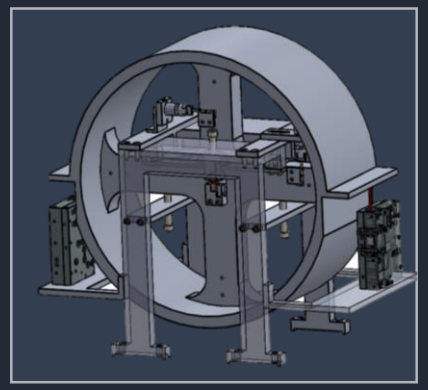


Paper in preperation

HoQI readout on other sensors

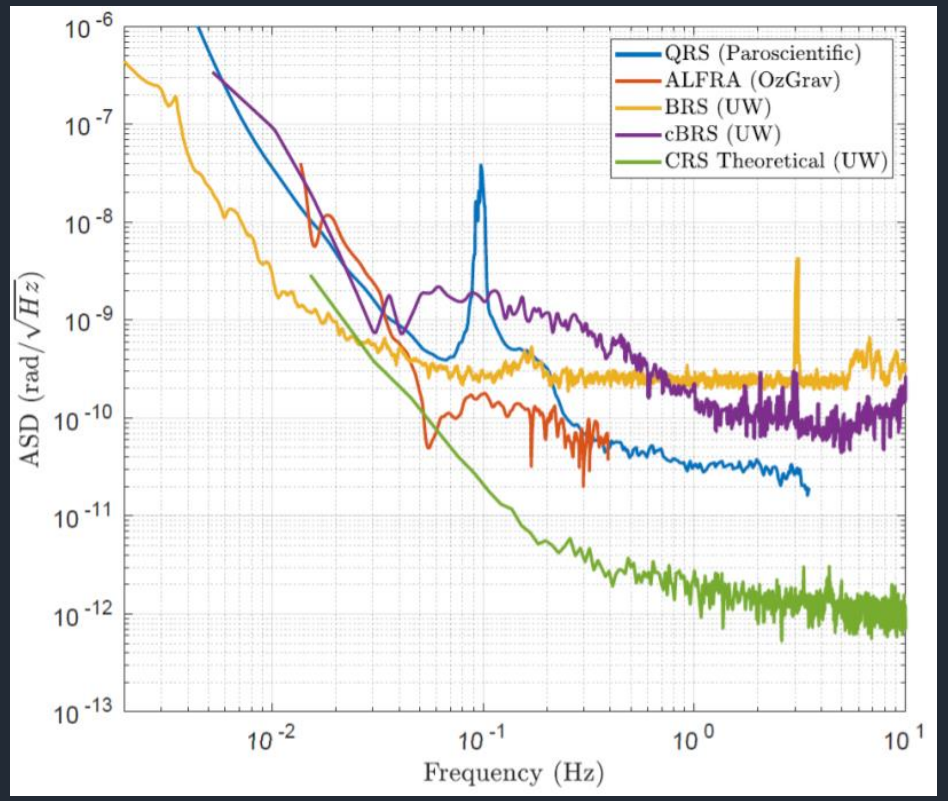
Watts linkages, rotation sensors, GS13's under consideration

Right: The CRS, an in vacuum rotation sensor with HoQI readout under development at the University of Washington.



Michael Ross: LIGO-G2100756

The estimated resolution of the CRS (green) compared against other rotation sensors.

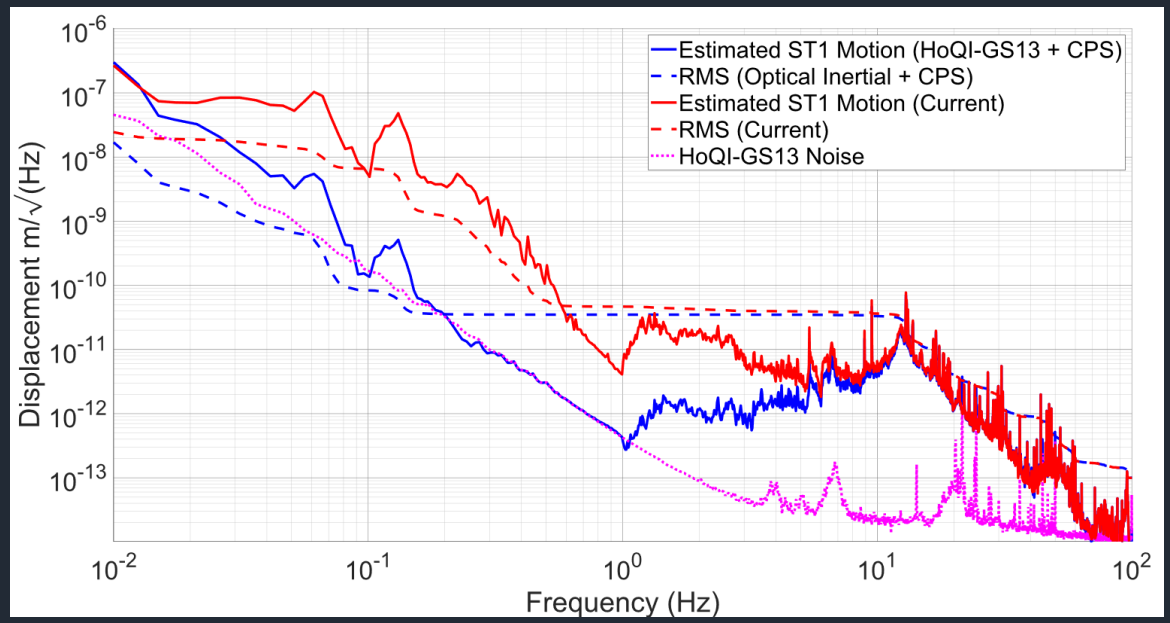


Improvements to seismic control

Built a modular model of an Advanced LIGO HAM-ISI to evaluate HoQI based sensors.

Designed new Z degree of freedom blend filters and used HoQI-GS13's and CPS's as sensors.

- Factor 70 reduction in predicted motion at the 0.1Hz
- Factor 70 reduction in predicted motion at 1Hz
- Limited improvement at 10Hz due to low loop gain.



S J Cooper PhD Thesis: Breaking the Seismic Wall (Chapter 5)

For improvements to suspension control

See Jesse van Dongen's poster for more details! https://agenda.infn.it/event/26121/abstracts/18360/