LIGO

UNIVERSITY of WASHINGTON

University of Washington LIGO Group Overview

Michael Ross

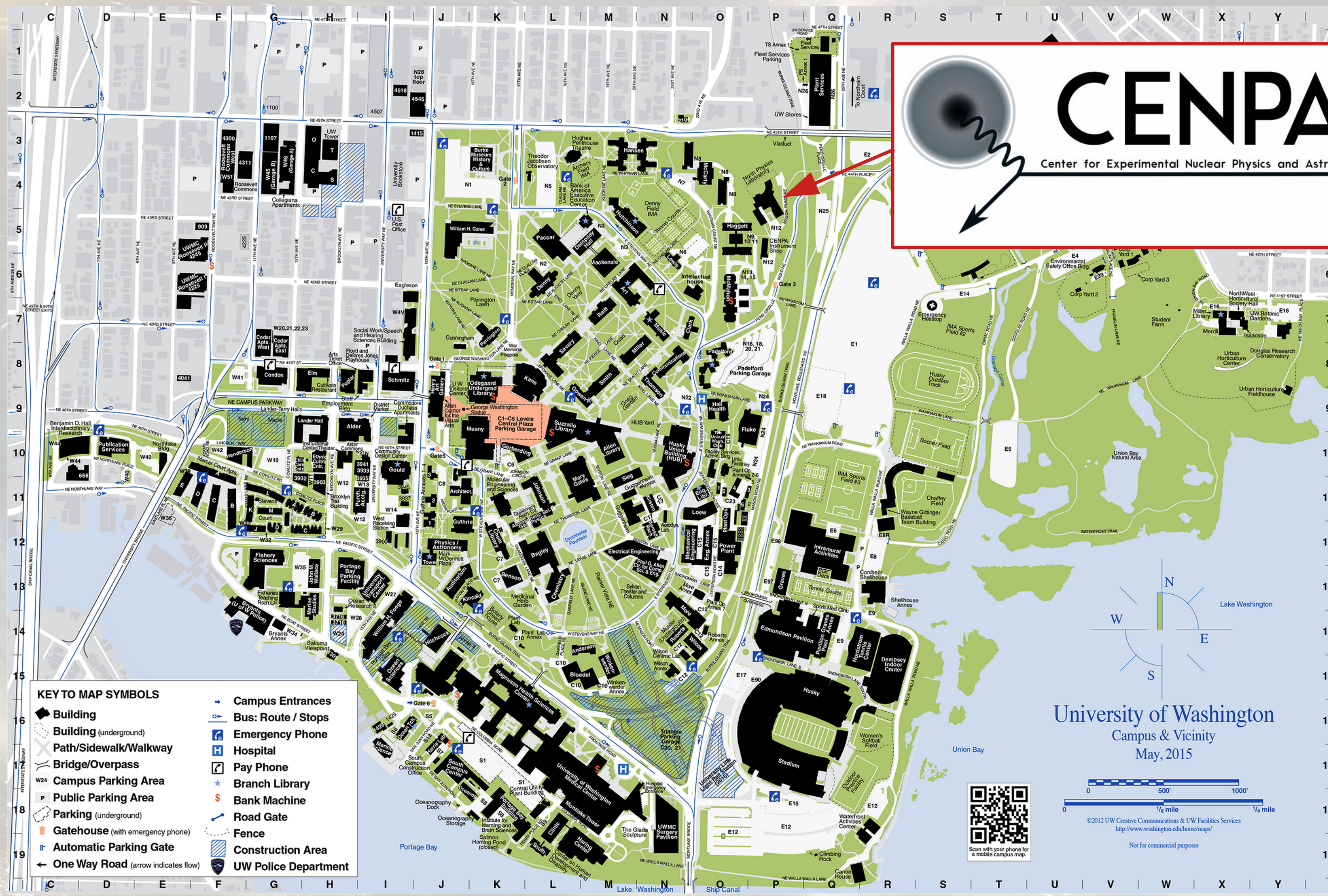
GWANW

June 2020

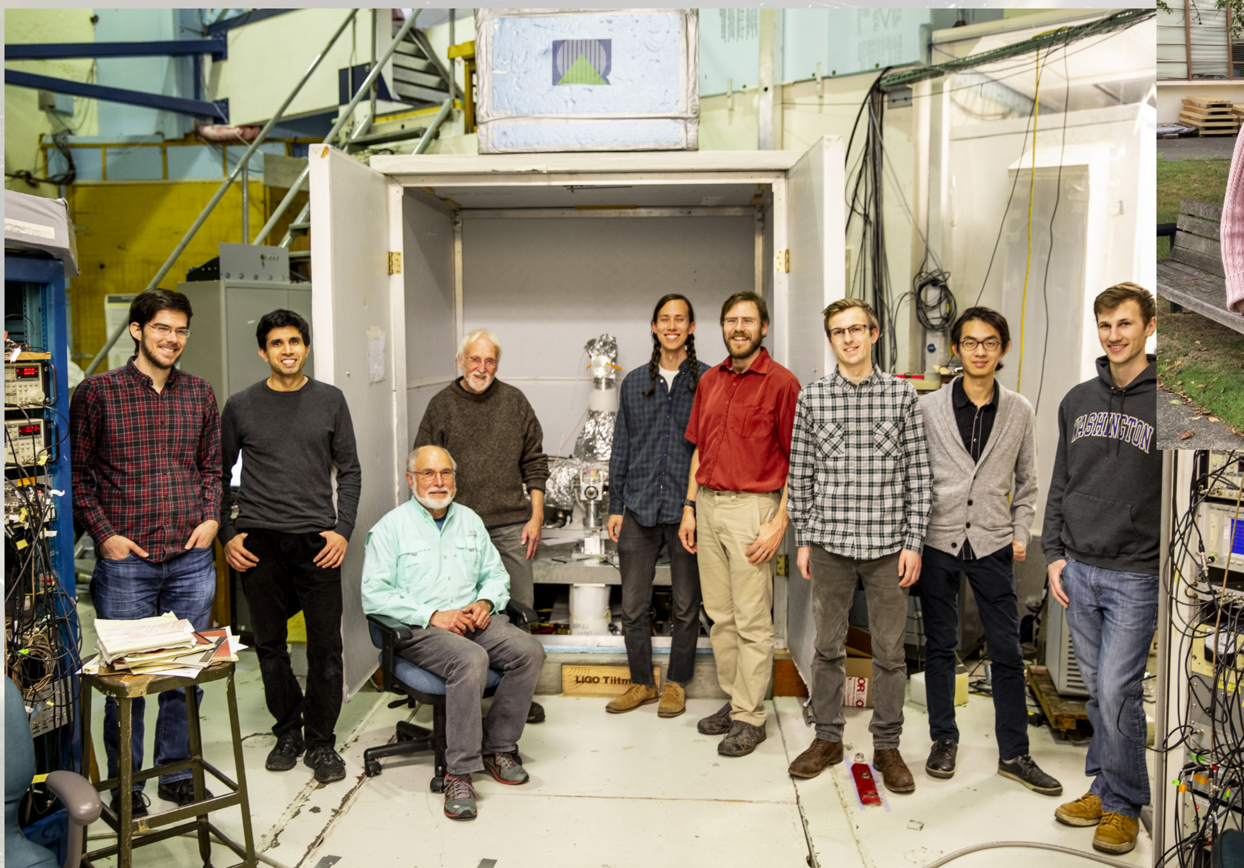
LIGO

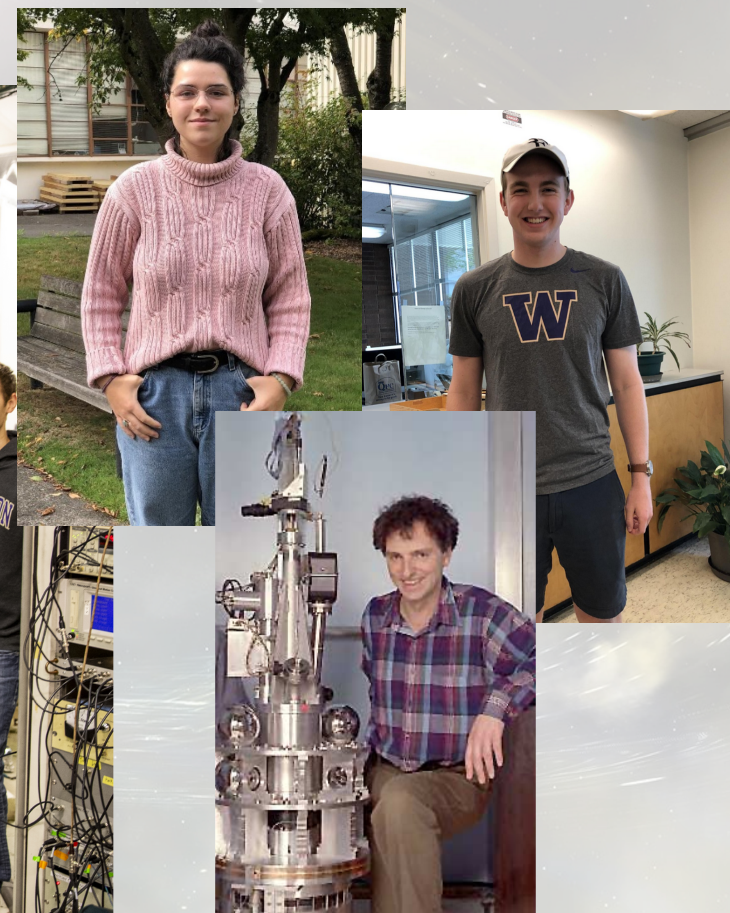
Center for Experimental Nuclear Physics and Astrophysics

W UNIVERSITY of WASHINGTON



Eöt-Wash Group





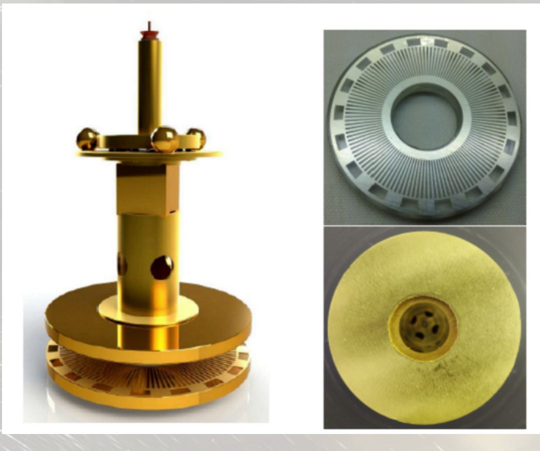
Torsion Balance Experiments

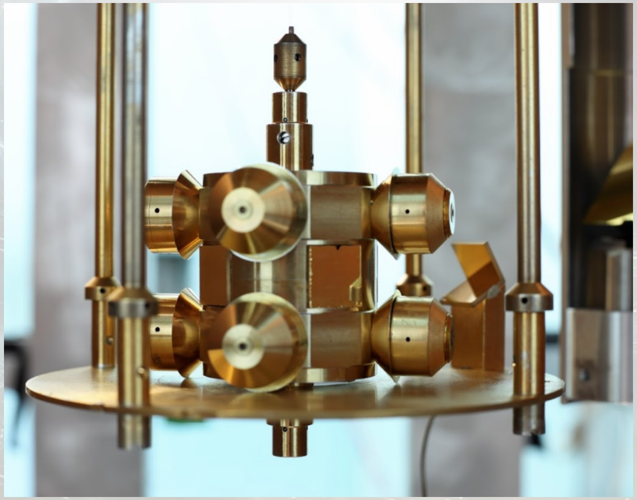
- Testing gravity since 1980s
- Using torsion balances
- Multiple Experiments:
  - Inverse Square Law
  - Weak Equivalence Principle
  - Big G
  - Ultra-light Dark Matter

Inverse Square Law

$$V(r) = -\frac{Gm_1m_2}{r}\left(1+\alpha e^{-r/\lambda}\right)$$

https://arxiv.org/abs/2002.11761





Equivalence Principle

$$\eta = 2\frac{a_1 - a_2}{a_1 + a_2}$$

https://arxiv.org/abs/1207.2442

https://arxiv.org/abs/1902.04246

LIGO Group

Alexandra Lockwood
Post-graduate RA

Colin Weller
Undergraduate RA

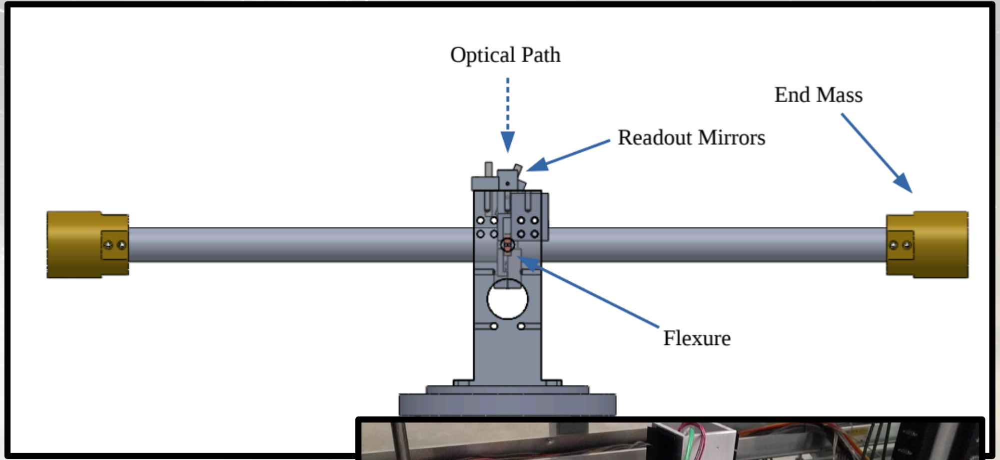
Michael Ross
Postdoc

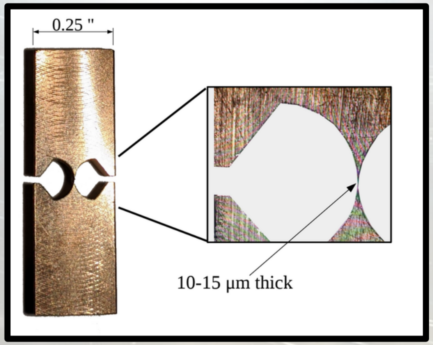
Jens Gundlach
Professor

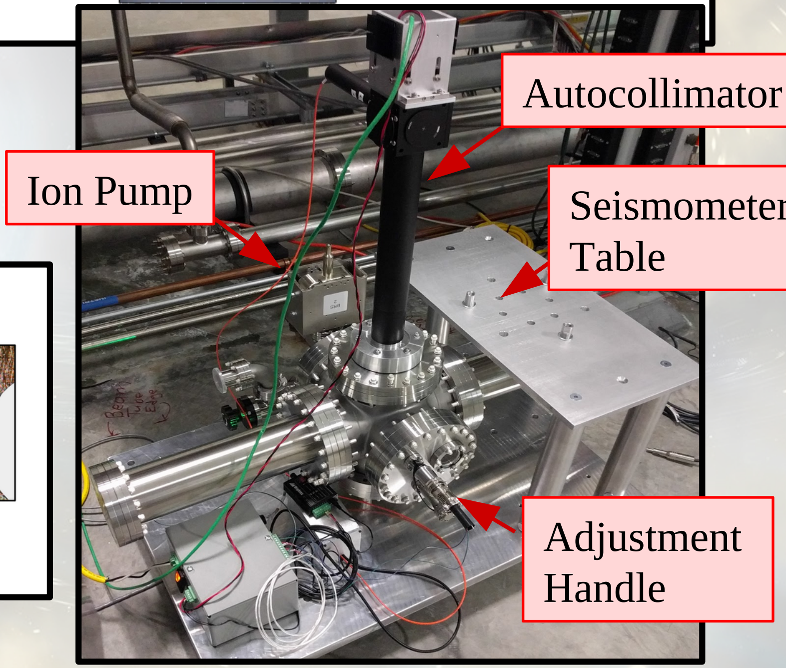
Krishna Venkateswara
Now at Paroscientific Inc.

Beam Rotation Sensors

- 1-m long beam hung from 10-15 µm-thick flexures with 3-8 mHz resonance
- Beam stays inertial while ground rotates around it
- Angle between beam and ground measured with autocollimator ~ 0.3 nrad/√Hz sensitivity at 0.1 Hz



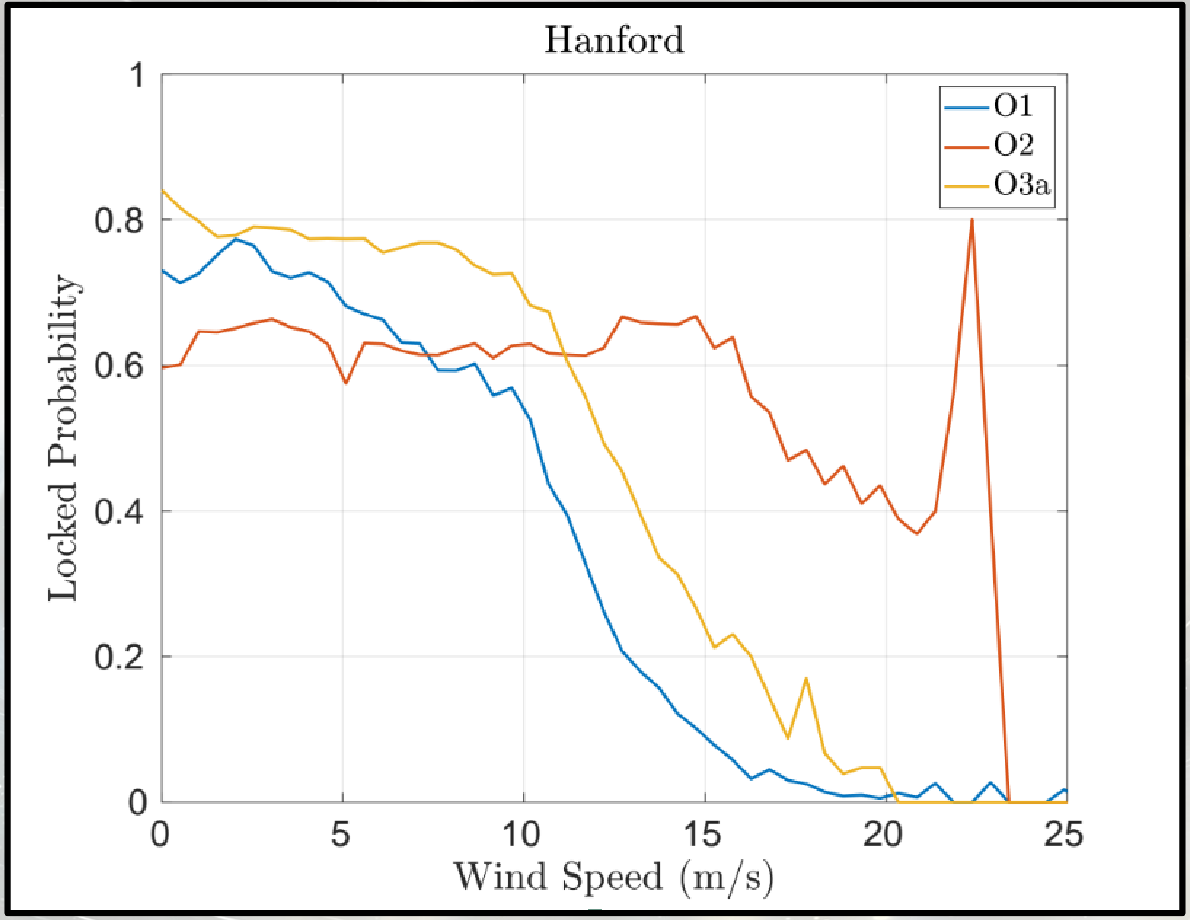




https://arxiv.org/abs/1401.4412

Rotation Sensors

- Deployed at both Hanford and Livingston
- Makes observatory more robust against wind
- Between O1 and O2: +13.1 observing days per year for LHO

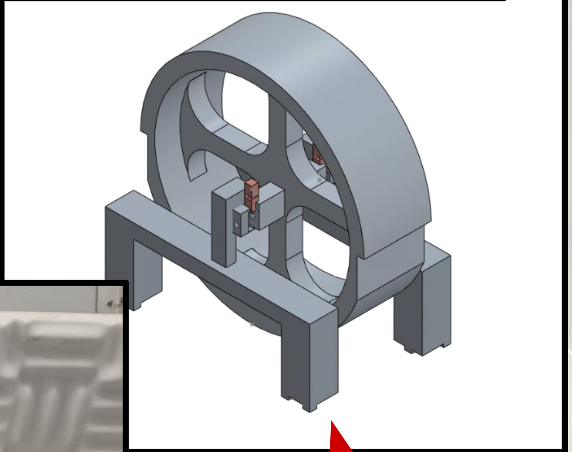


https://dcc.ligo.org/G2000802-v1

Compact Rotation Sensors

- Developing small rotation sensors
- Same concept at BRSs
- Vacuum-compatible On-platform version
- Small high-frequency sensor for Newtonian noise

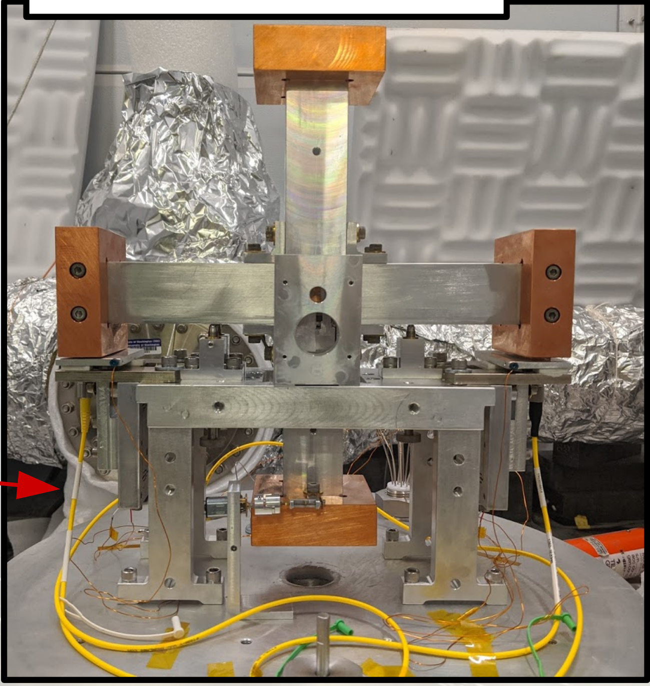
Newtonian Noise Sensor



Designed by Colin W.

https://arxiv.org/abs/1807.07427

On-Platform Sensor

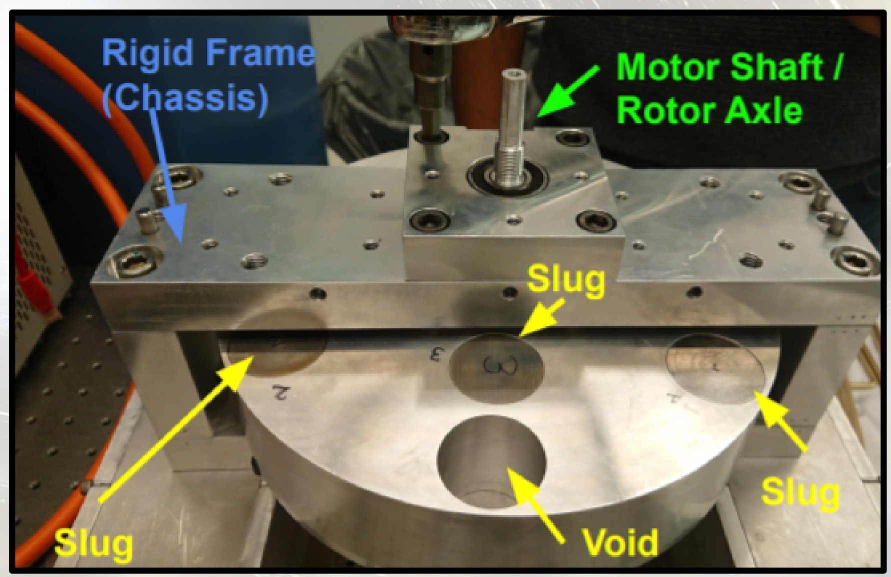


Alexandra L.
Developed In-Vacuum Fibers

https://dcc.ligo.org/G2000802-v1

Newtonian Calibrator

- Rotating mass distribution applies a force on the test mass
- Allows for independent absolute calibration
- Design and built at UW
- Installed at LHO by Timesh Mistry, Jeff Kissel, et. al.
- Gravitational force simulated with FEA and Multipoles
- Results coming soon

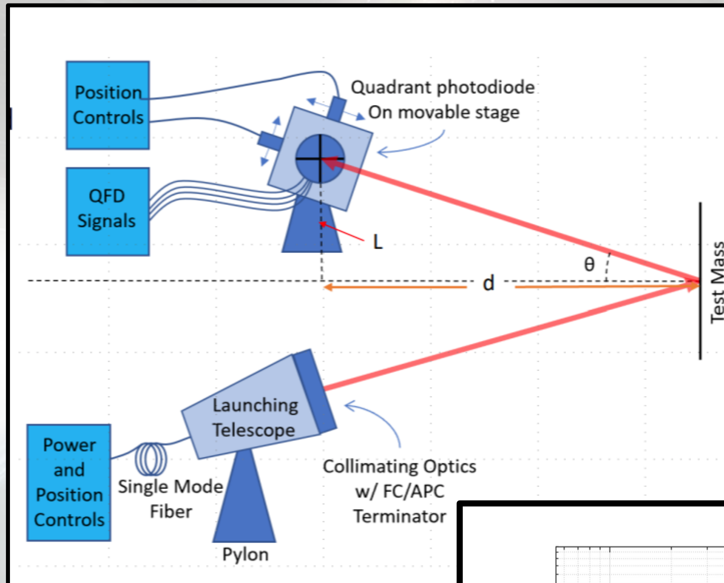


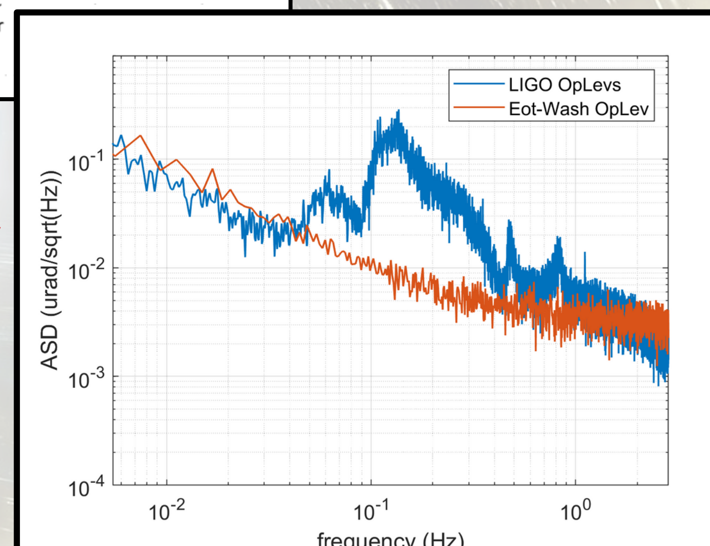
Gravitational force simulation by Colin W.

https://dcc.ligo.org/
LIGO-G2000352

Optical Levers

- OpLevs used to orient Test Masses
- Exhibit low frequency noise
- Hunting for the noise sources in optics
- Building system from the ground up to study each component





Alexandra L.
Led this entire project

https://dcc.ligo.org/LIGO-G1901168

Thanks!