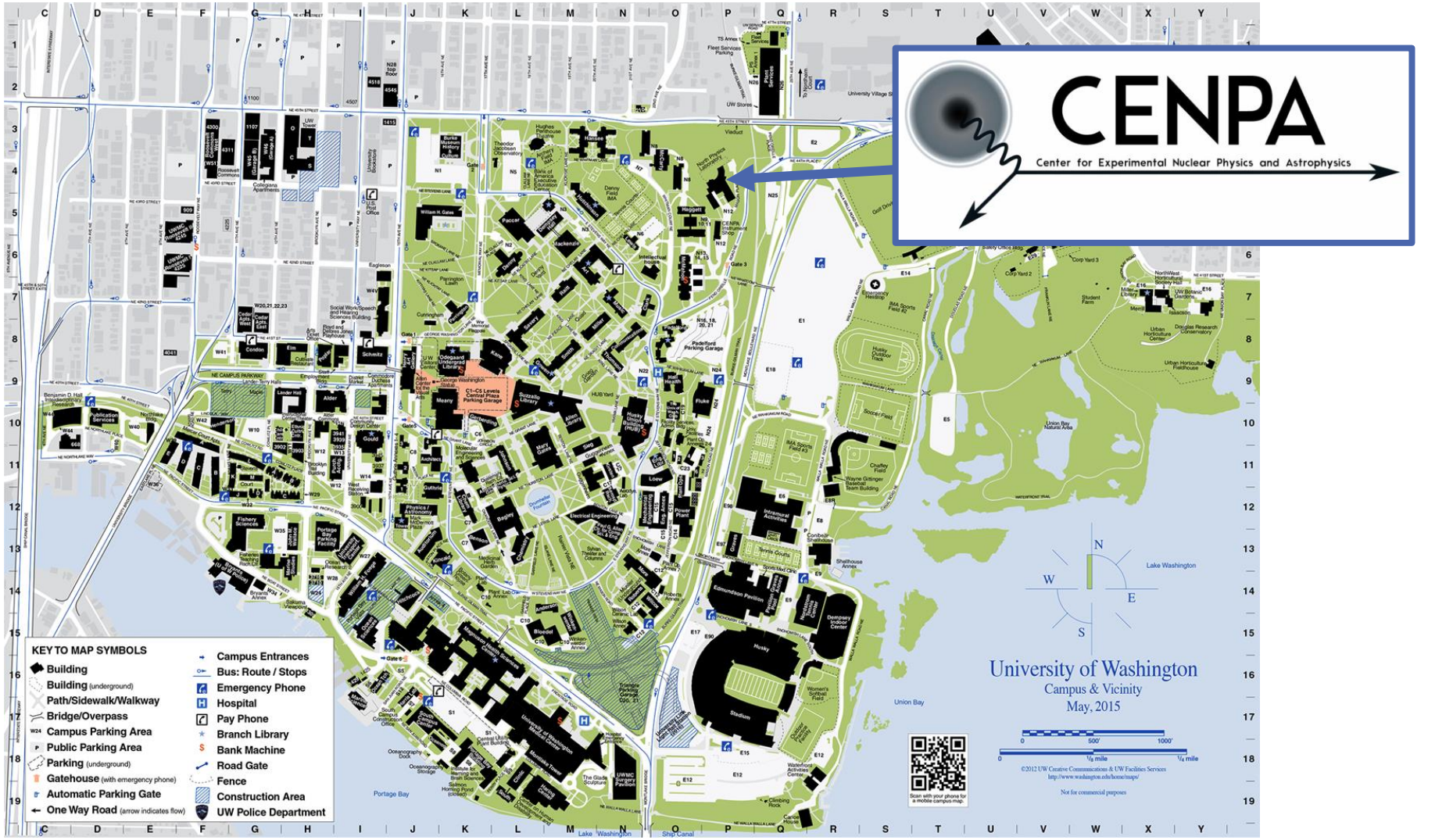
University of Washington Seattle Eöt-Wash Group Overview

GWANW 2024

Michael Ross

CENPA – Center for Experimental Nuclear Physics and Astrophysics

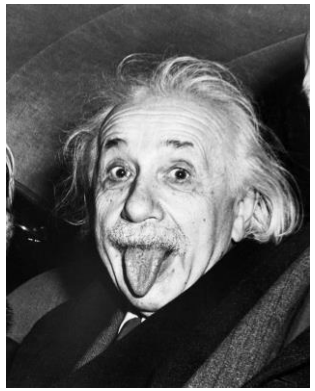


Eöt-Wash Group

Michael Ross
(Postdoc)

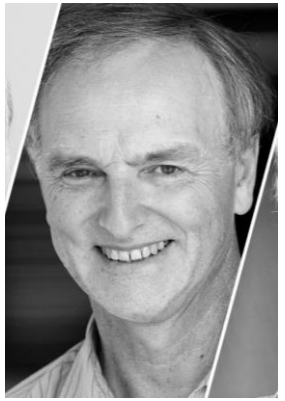
Shoshana Apple
(Grad student)

Conner Gettings
(Postdoc)



Peter Wu
(Graduated!)

Charli Chambers
(Undergrad. RA)



Jens Gundlach
(Professor)

Torsion Balance Experiments

Testing gravity since the 1980s

We use torsion balances to:

- Test gravity's short-range behavior
- Verify the equivalence principle (EP)
- Search for ultra-light dark matter
- Measure gravitational constant, G

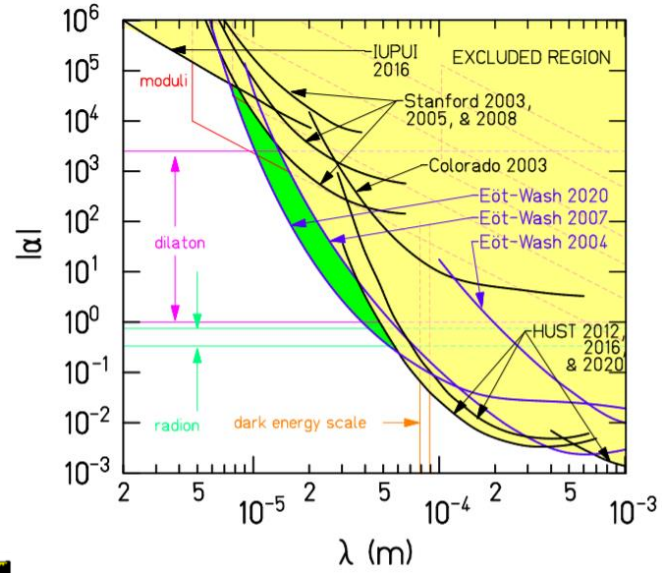
Recent Results:

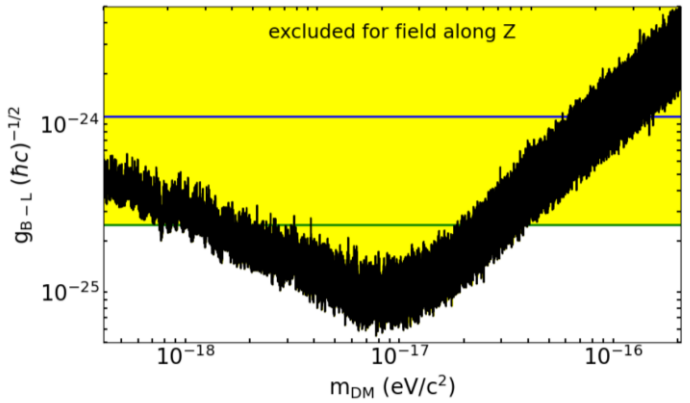
- Test of short-range gravity at separations of 52 μm: arxiv.org/abs/2002.11761
- Search for atto-eV (10^{-18}) mass dark matter: https://arxiv.org/abs/2109.08822

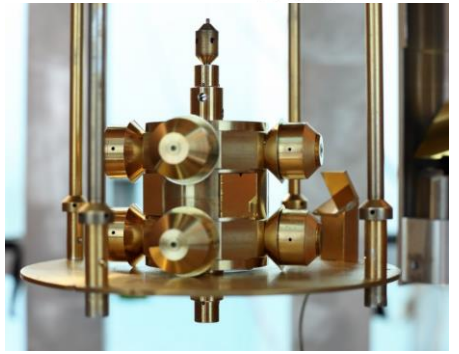
On-going/Soon to be released:

- Upgraded EP test
- Test of EP for Cooper pairs ($\eta_{CP} < 10^{-3}$)

$$V(r) = -\frac{G\, m_1 m_2}{r}\left(1 + \alpha\, e^{-r/\lambda}\right)$$







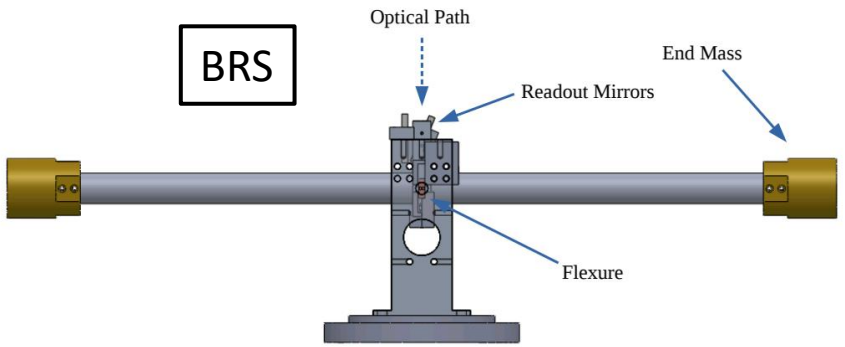
Rotation Sensors

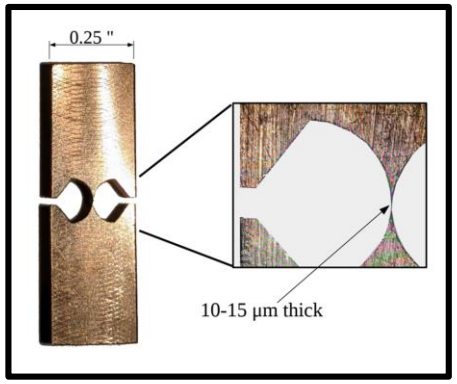
Developed beam-balance based rotation sensors (rotational seismometers)

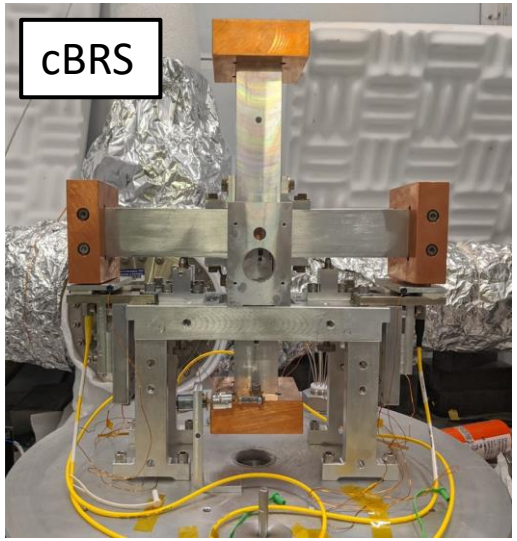
Proof-mass suspended from 10-15 µm thick Be-Cu flexures forms rotational spring-mass system

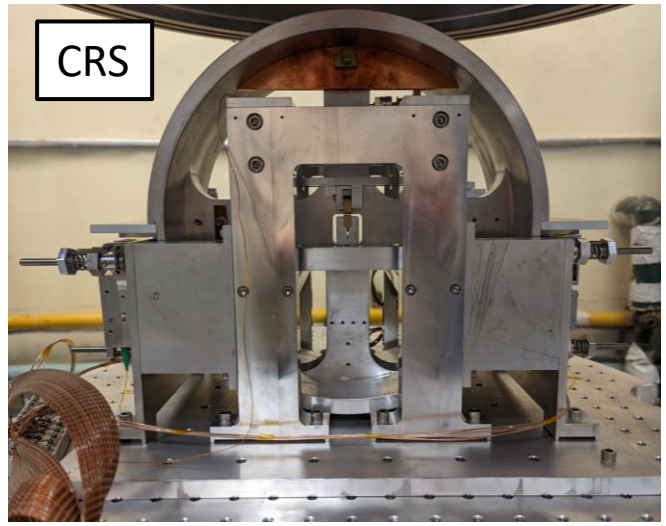
Three versions:

- Beam Rotation Sensors (BRS): 1-m long beam, used to sense ground rotation for seismic isolation systems, 6 deployed at LIGO (LHO: 2, LLO: 4)
- compact Beam Rotation Sensor (cBRS): 30-cm wide cross, installed on Stanford ETF ISI
- Cylindrical Rotation Sensor (CRS): In development, 30-cm diam. cylinder, HoQI readouts, to be installed on ISI









Newtonian Calibrator

"New" way to calibrate LIGO

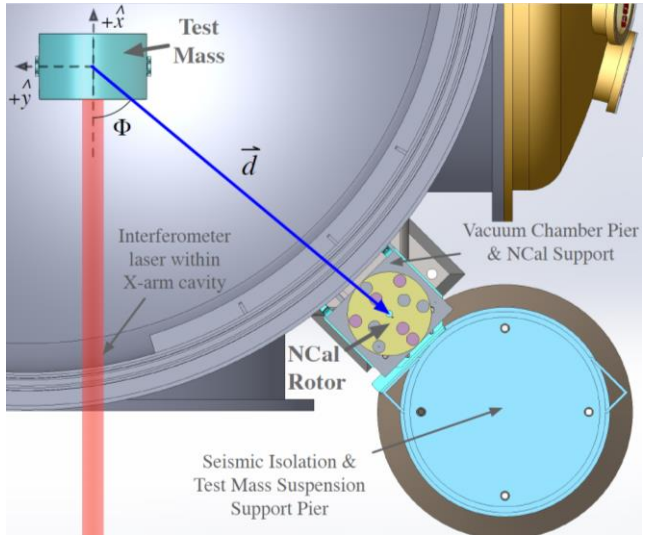
Injects forces on the test mass with gravity instead of photon pressure

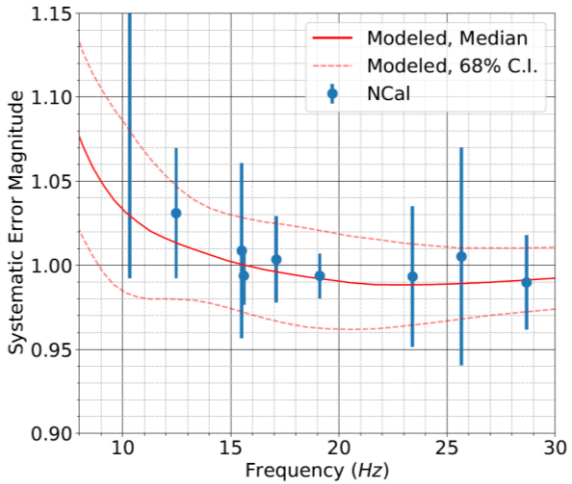
Aluminum rotor with tungsten slugs inserted into it injects at two times and three times the rotation rate

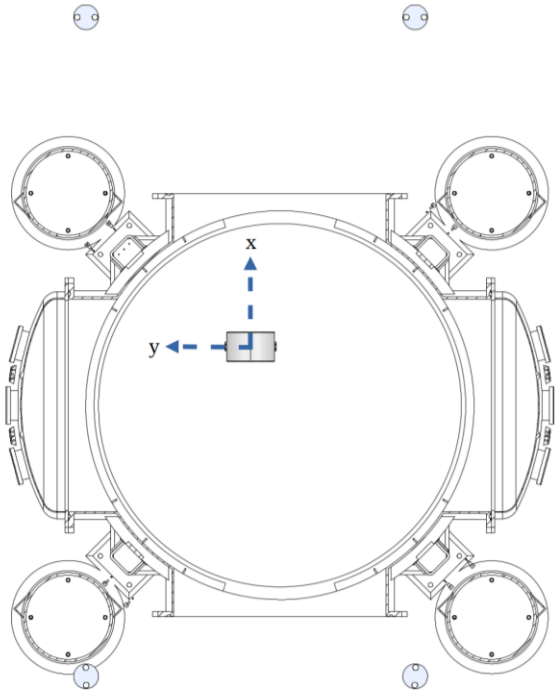
Successfully injected forces during LIGO's third observing run

Initial Results yielded ~1% absolute calibration: https://arxiv.org/abs/2107.00141

New design expected to reach ~0.1% uncertainty: P2200021







Thanks