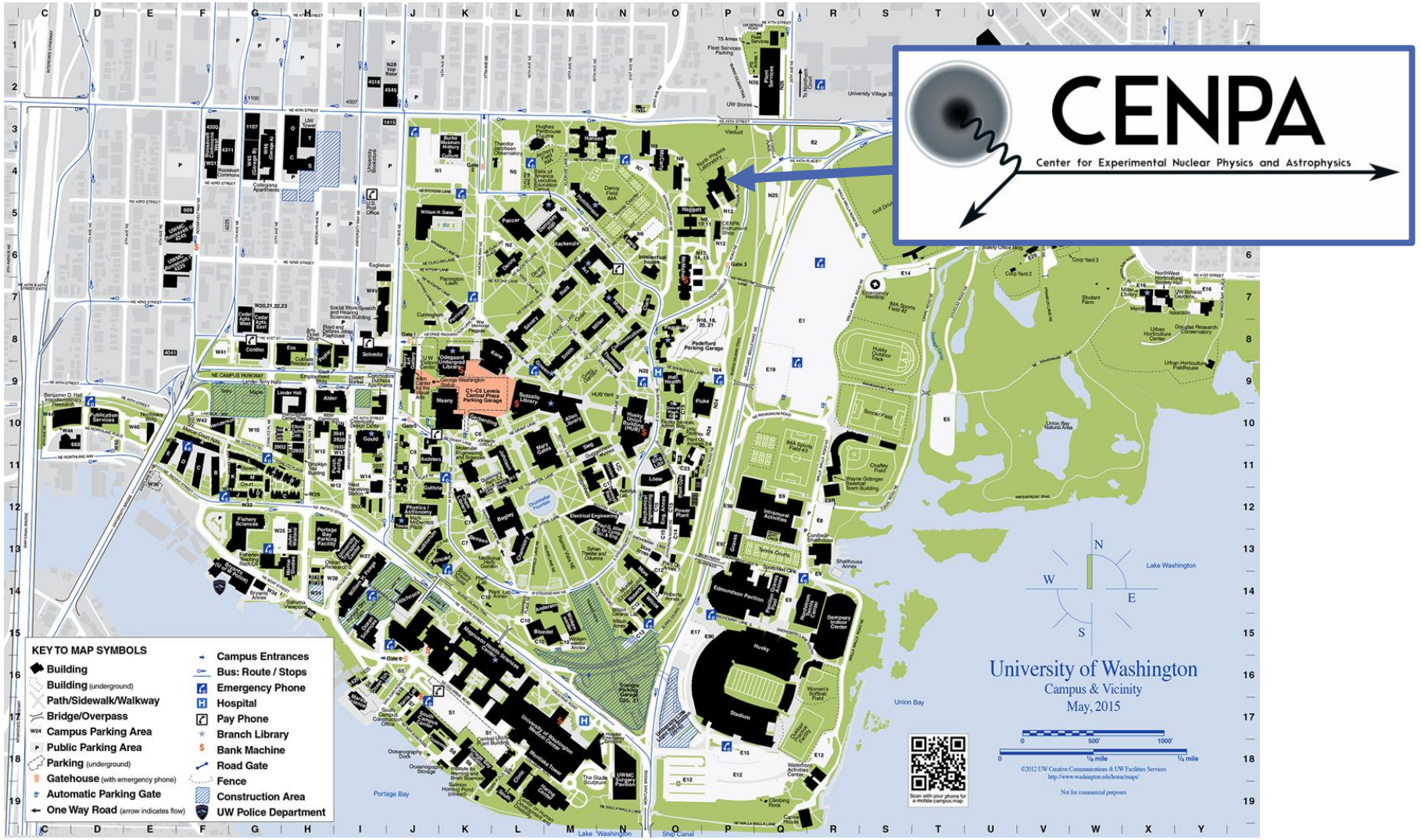
# University of Washington Seattle Eöt-Wash Group Overview

GWANW 2021

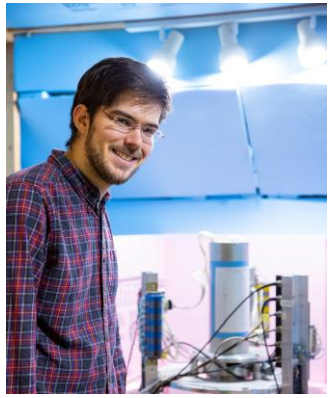
Michael Ross

# CENPA – Center for Experimental Nuclear Physics and Astrophysics



# Eöt-Wash Group

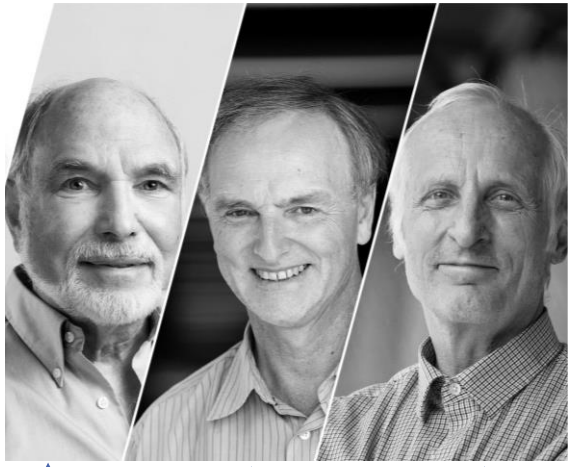
Michael Ross
(Postdoc)



Erik Shaw
(Grad. Student)

Conner Gettings
(Postdoc)

Professors

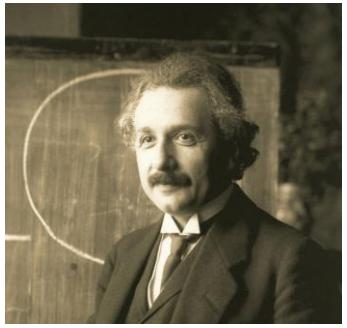


Eric Adelberger

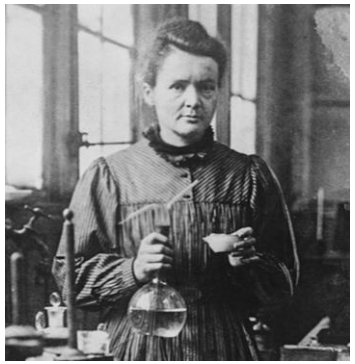
Jens Gundlach (PI)

Blayne Heckel

Colin Weller
(Undergrad. RA)



John Waldroup
(Postgrad RA)



Jade Cox
(Undergrad. RA)

Hopefully more students soon!

# Torsion Balance Experiments

Testing gravity since the 1980s

We use torsion balances to:

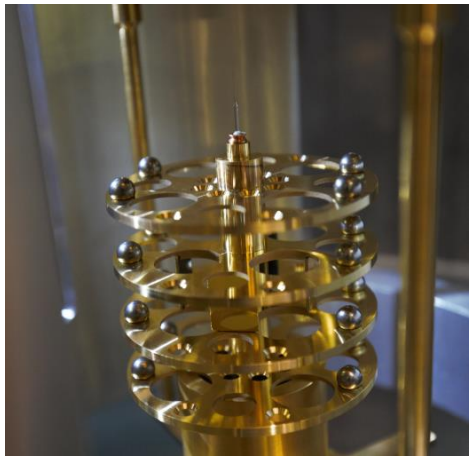
- Test gravity's short-range behavior
- Verify the equivalence principle (EP)
- Search for ultra-light dark matter
- Measure gravitational constant, G

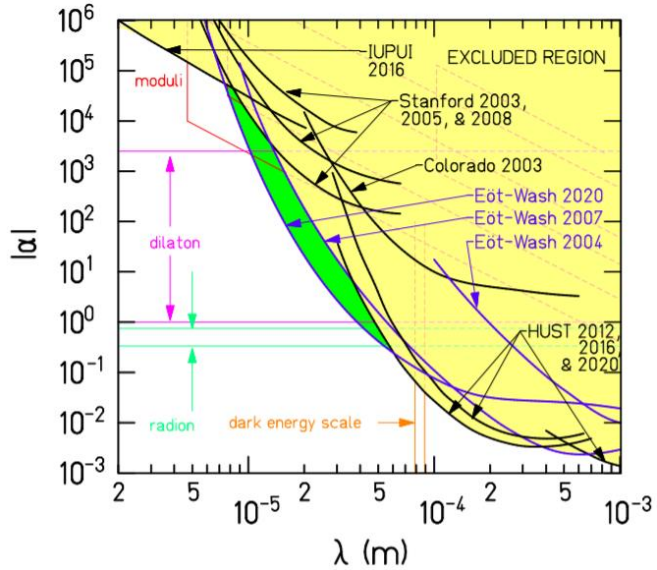
Recent short-range results reached separations of 52 µm: [arxiv.org/abs/2002.11761](arxiv.org/abs/2002.11761)

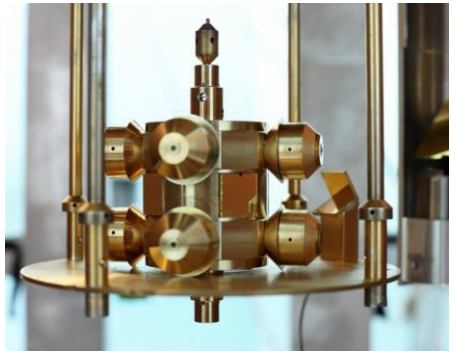
On-going experiments:

- Search for atto-eV ($10^{-18}$) mass dark matter
- Upgraded EP test
- Test of EP for superconductors

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





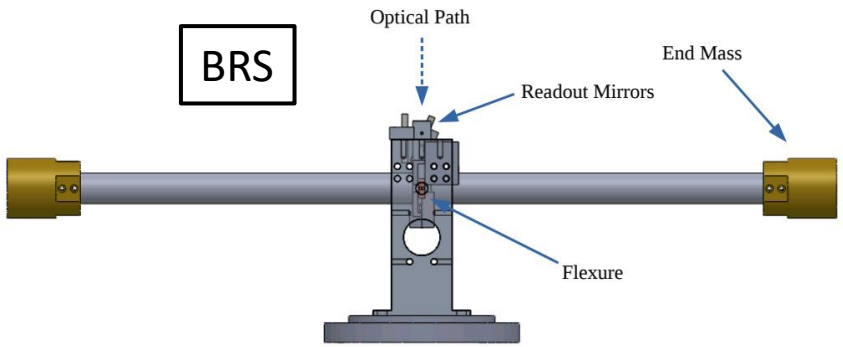
# Rotation Sensors

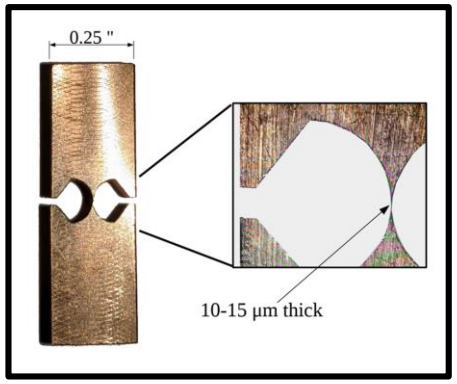
Developed beam-balance based rotation sensors (rotational seismometers)

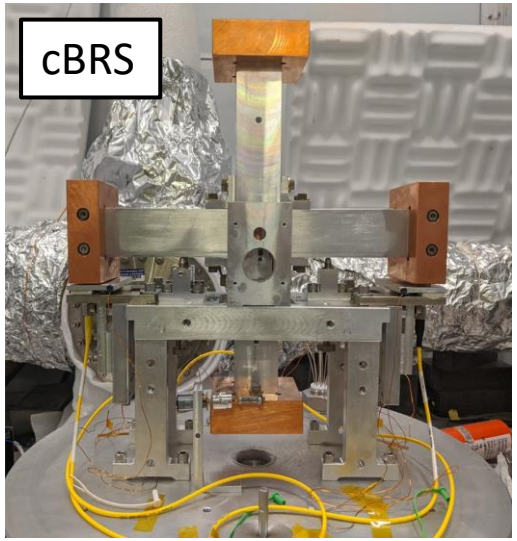
Proof-mass suspended from 10-15 µm thick Be-Cu flexures forms rotational spring-mass system

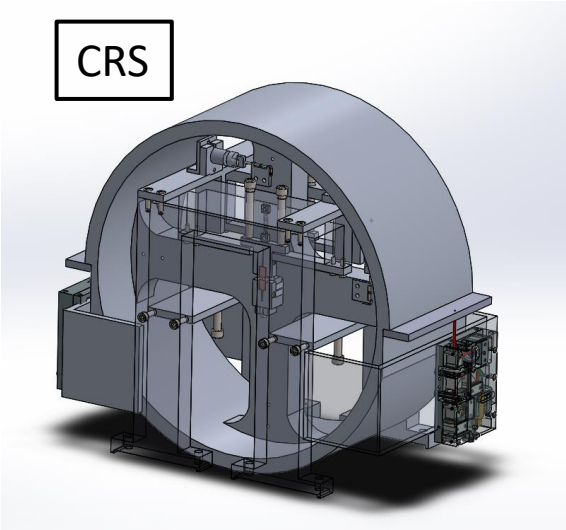
Three versions:

- 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, deployed for Newtonian noise test at LHO
- Cylindrical Rotation Sensor (CRS): In development, 30-cm diam. cylinder, HoQI readouts, to be installed on ISI



# Newtonian Calibrator

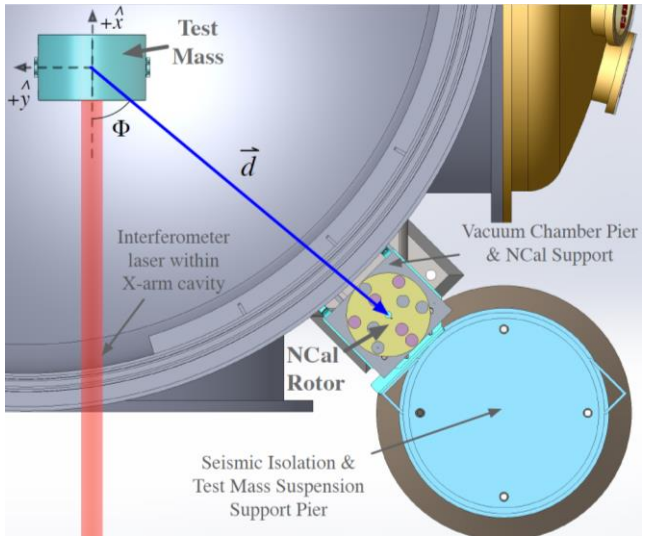
"New" way to calibrate LIGO

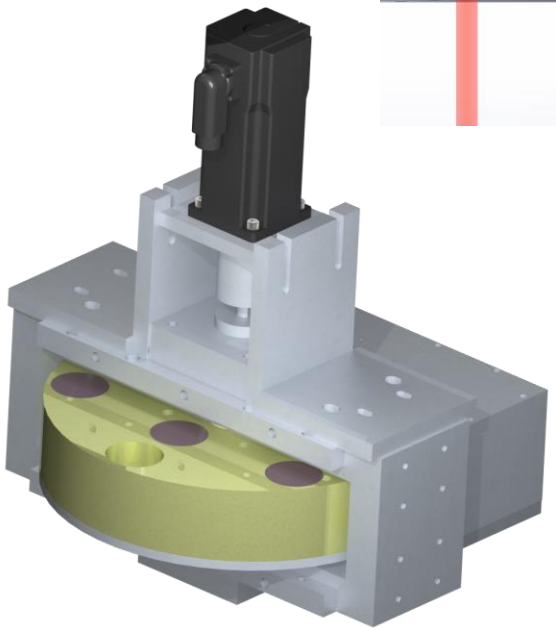
Injects forces on the test mass with gravity instead of photon pressure

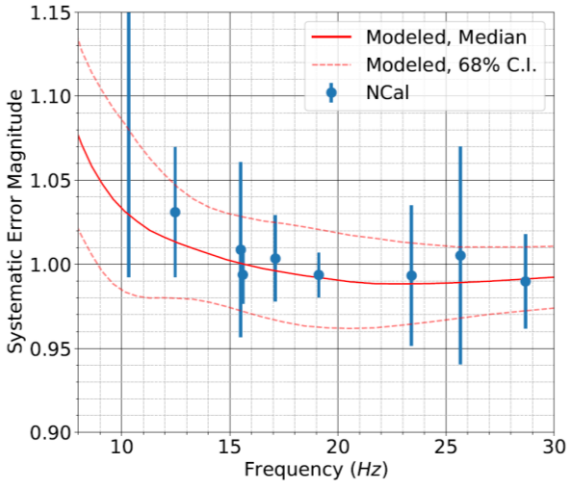
Aluminum rotor with tungsten slugs inserted into it injects at two times and three times the rotation rate

Successfully injected forces during LIGO's third observing run

Initial Results Paper (to be submitted tomorrow): P1900244





# GW Detection with GRACE Follow-On

Even though GRACE Follow-On only has one arm, it can still detect GWs

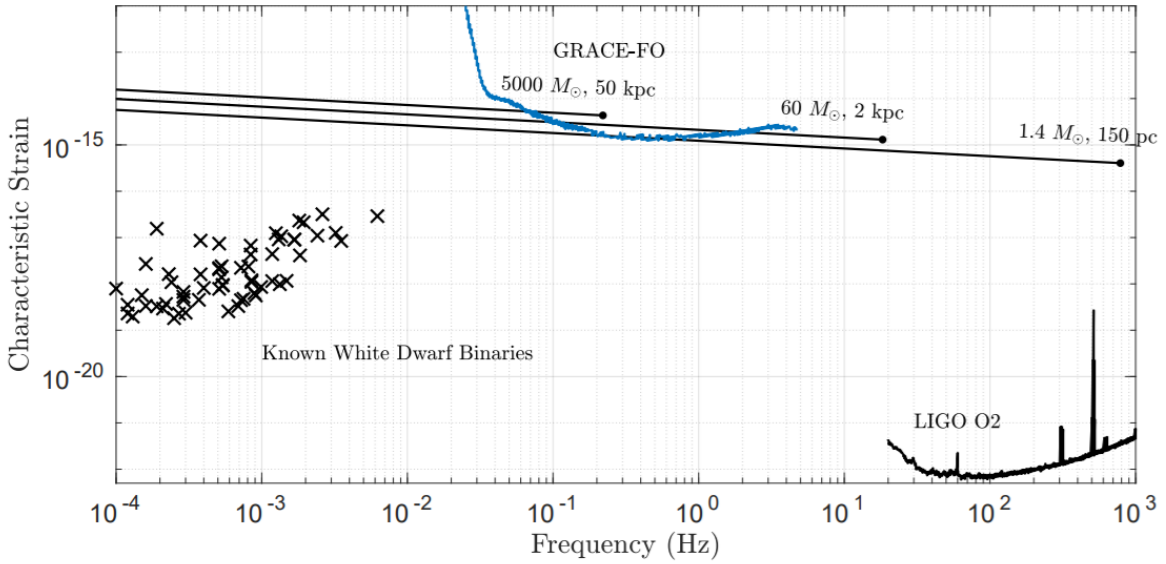
Should be able to detect IMBH mergers within the Milky Way

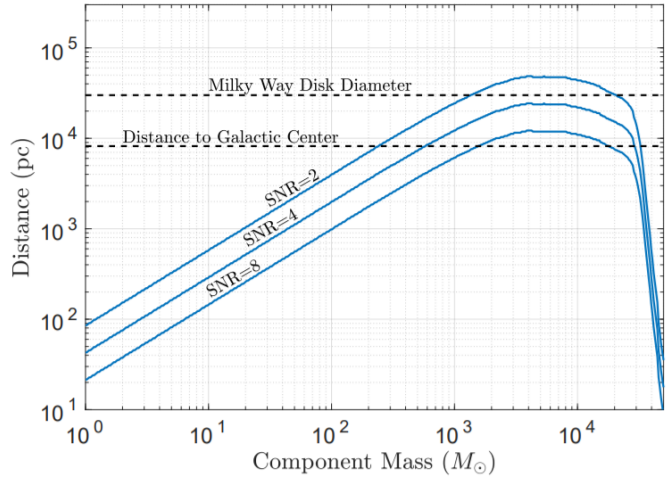
Set limits on stochastic GWs comparable with limits due to seismology

Feasibility Paper: [arxiv.org/abs/2002.02044](arxiv.org/abs/2002.02044)

Although unlikely, it's worth searching for events since GRACE-FO is already operational

**Very** early stage of data analysis pipeline in progress



# Thanks