# The QUEST Experiment

## The Quantum Enhanced SpaceTime measurement experiment
## Interferometry for stochastic signal search

A. Patra

On Behalf of the GWLab team
Gravity Exploration Institute
School of Physics and Astronomy
Cardiff University

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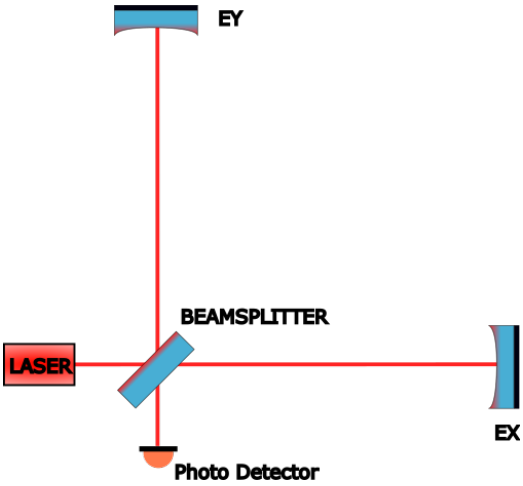
# Michelson Interferometer



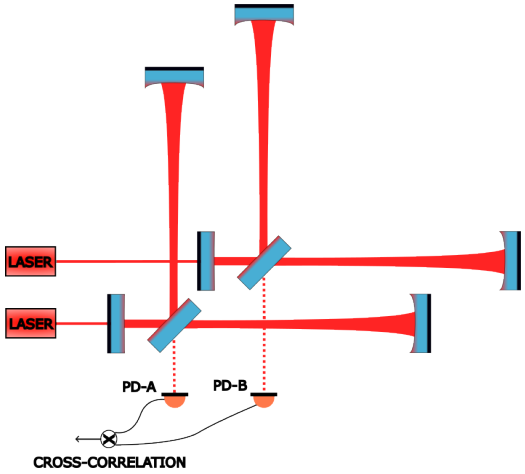
# Interfrometry and Gravitational Waves

- Gravitational waves signals from compact binary systems are ideal candidates to be detected by Interferometers.

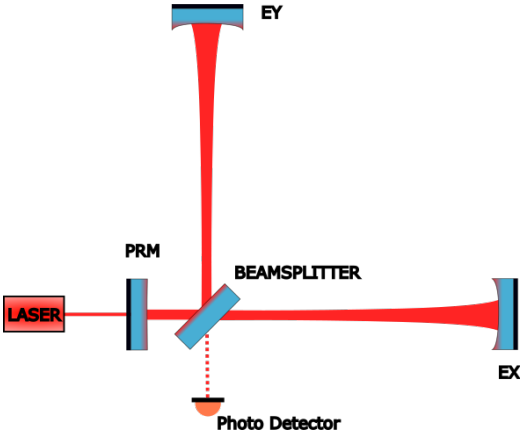
Figure: LIGO Living observatory

# What is QUEST?

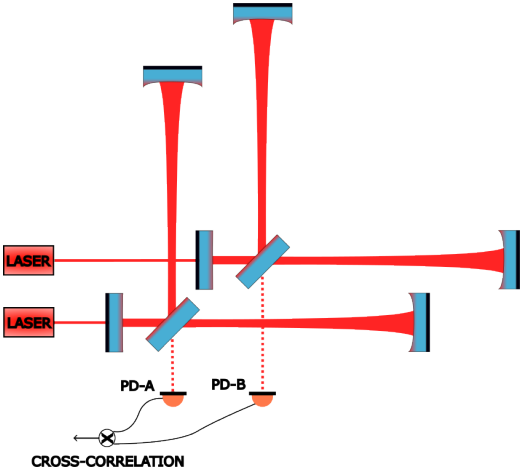
- The QUEST experiment is an interferometric system designed to be sensitive to broadband stochastic or continuous space-time strain signals between 1MHz and 250MHz.



# QUEST design - Power Recycled Michelson Interferometer

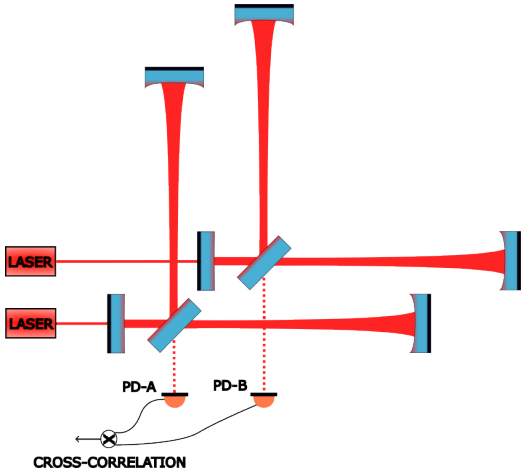


# QUEST design - Co-located Interferometers



# QUEST design - Co-located Interferometers

- Shotnoise is not correlation between the measurements in the two PDs, but the common signal is. With averaging of the cross-correlation we can get better SNR of signal against shotnoise.

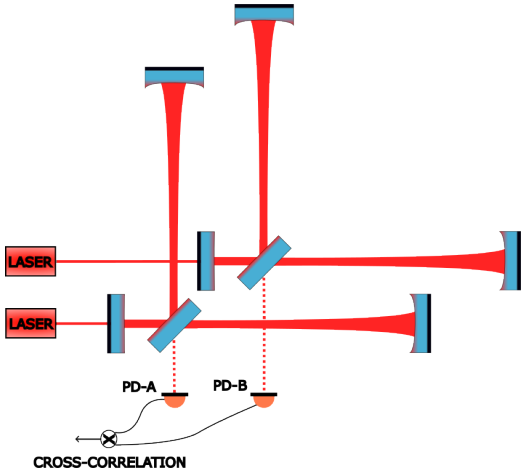


# QUEST Science Goals

- Test for a class of Quantum Gravity theories that are a consequence of the Holographic principle. [see references]
- Search and exclusion of parameter space for Scalar Field Dark Matter candidates.
- Search for very high frequency continuous/stochastic Gravitational Waves.

# QUEST - High Power and Squeezing

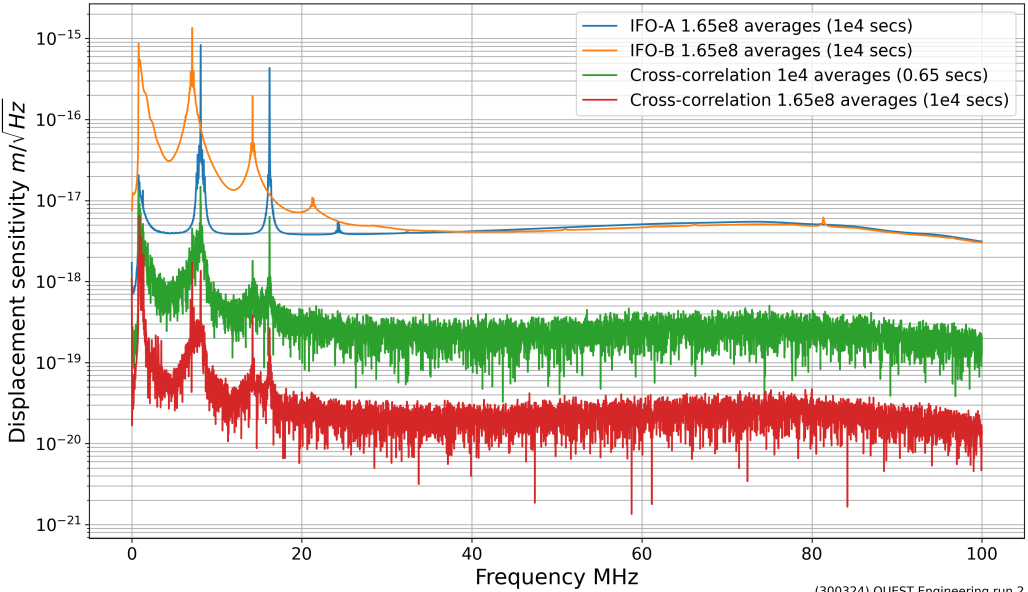
- The target shotnoise limited sensitivity for each interferometer is 2e-19 $m/\sqrt{Hz}$ between 1 MHz and 250 MHz.
- To achieve this sensitivity the goal is to have 10 kW of circulating power in the interferometers and squeezing to suppress the shotnoise level by 6dB.



# Current Commissioning Status

- The vacuum systems for the two interferometers are fully commissioned.
- The real-time control loops for frequency and length stabilization for the interferometers are also commissioned.
- The high frequency data acquisition and online FPGA based data processing and averaging pipeline is also fully commissioned.
- The squeezer and output mode cleaner for one interferometer are characterized and waiting to be integrated into the system.

# Engineering Run Results




(300324) QUEST Engineering run 2

# Commissioning Path Forward

- Increasing the circulating power in the interferometers and establishing an autolock scheme.
- Integrating squeezing light sources and observing the reduction of the shotnoise.
- Integrating output mode cleaners to filter the light at the output of the interferometers.
- Finally, conduct a full 1 million sec science run.

# Future Plans

- For a future iteration of QUEST, interferometers with different geometries are being planned.
- Different angle between the arms and bent arms designs are being looked into to improve the coupling to spherical modes of a stochastic signal.
- Instead of a Homodyne readout scheme a photon counting scheme is being investigated to improve the statistics of averaging.

# Acknowledgements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# References


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- Direct limits for scalar field dark matter from a gravitational-wave detector. S M Vermeulen, et al. 2021. DOI: 10.1038/s41586-021-04031-y
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# Thank You - QUEST Layout