

Program Update: Quantum

OzGrav 2018 Retreat

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- Cryogenic Ho-doped YAG injection-locked-power-oscillator (ILPO)

Beating the standard quantum limit

- Squeezed light (10 Hz-10 kHz) source at 2 μ m
- EPR frequency-dependent squeezing
- Squeezed-state reduction in quantum radiation pressure noise
- Intra-cavity squeezing
- White-light cavities

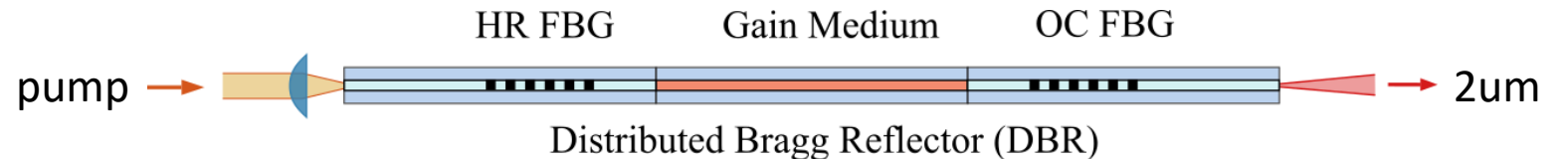


Tm: fiber MOPA 2um laser (UniAd/DST)

Status

- Direct-diode-pumped single-frequency 2um source for squeezing and IFO development
 - demonstrated single frequency, 70 mW, linewidth < 200 kHz
 - need to improve decoupling from environment
- Fiber-laser-pumped higher power (1W?) 2um master oscillator for MOPA system
 - demonstrated single frequency, 250 mW

2019



- Complete low-power seed source and frequency actuation
- Demonstrate higher power Tm: fiber master oscillator
- Begin development of first-stage power amplifier (PA)



Cryogenic Ho:YAG ILPO 2um laser (UniAd/DST)

Status

- Most of cryostat components acquired
- Pump diodes for Tm:fiber pump sources tested
- Tm:fiber pump sources available via DST collaboration

2019

- Confirm operation of cryostat
- High-precision spectroscopic measurement of cryogenic Ho:YAG gain medium
- Begin development of master oscillator



Squeezed light source at 2um (ANU)

Status

- Observed 4dB of quadrature-locked squeezing down to 500 Hz
 - limited by scattered light, laser instability and photodetectors noise floor and quantum efficiency (QE) of 2 um photodetectors
- Stable seed lasers under development: ECDL @ ANU & Tm: fiber laser @ UniAd
- Discussing problem of inadequate QE with Caltech

2019

- Produce squeezing from 10 Hz with loss dominated by QE
- Commence effort to improve QE with Caltech



EPR frequency-dependent squeezing (ANU)

Status

- Bench-top experiment assembled
- First observation of frequency-dependent squeezing

2019

- Complete experiment
- Write thesis (Yap)



Squeezed-state reduction in quantum radiation pressure noise (ANU/LSU)

Status

- ANU squeezer installed at LSU
- Injected into LSU high-reflectivity single-crystal micro-resonator
- Observed 1.2 dB reduction in QRPN between 10 kHz and 50 kHz

2019

- TBD



Intra-cavity squeezing (ANU/UWA)

Status

- Optical parametric amplifier (OPA) assembled at ANU
- Finesse model under development.
- Classical OPA enhancement of optical spring setup at UWA

2019

- Examine dynamics with signal injection ; build signal recycling cavity and servo bandwidth broadening; write Honours thesis
- ANU work with UWA to develop bench top optical spring enhanced squeezing and potential 80m cavity experiments.



'White-light cavity' using optomechanics (UWA)

Status

- Used Focused Ion Beam (FIB) technology to develop photonic-crystal (PC) mirror on a silicon nitride membrane for the cavity
- PC mirror had high reflectivity at 1064 nm but too much (10%) optical loss
- Carl Blair got a DECRA

2019

- Investigate source of high optical loss
- Demonstrate a controlled unstable negative-dispersion filter.

