Status of the squeezing experiment at ANU

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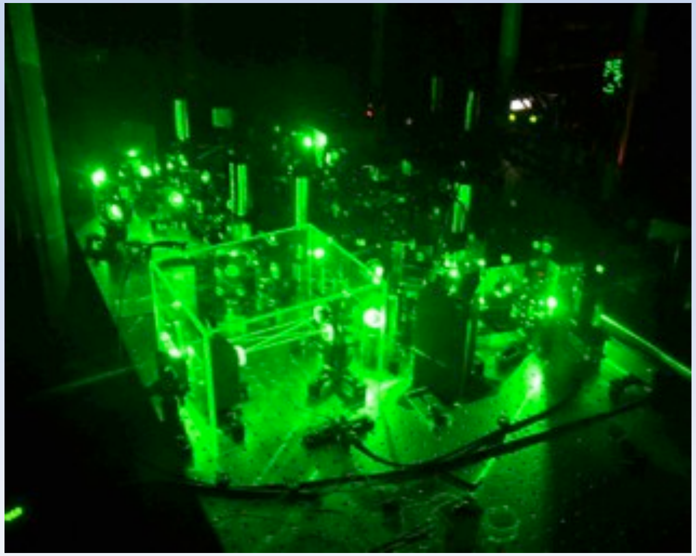
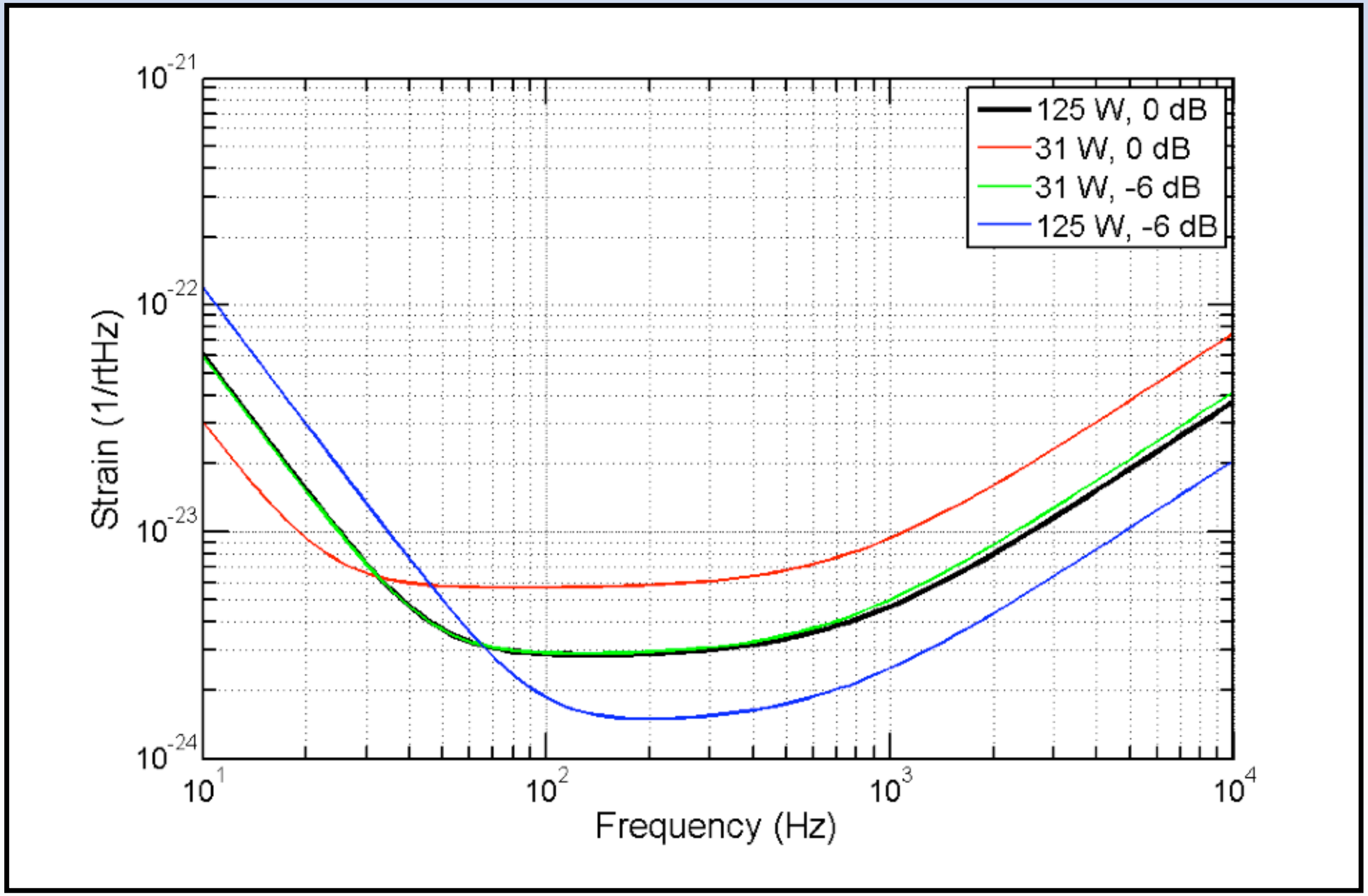


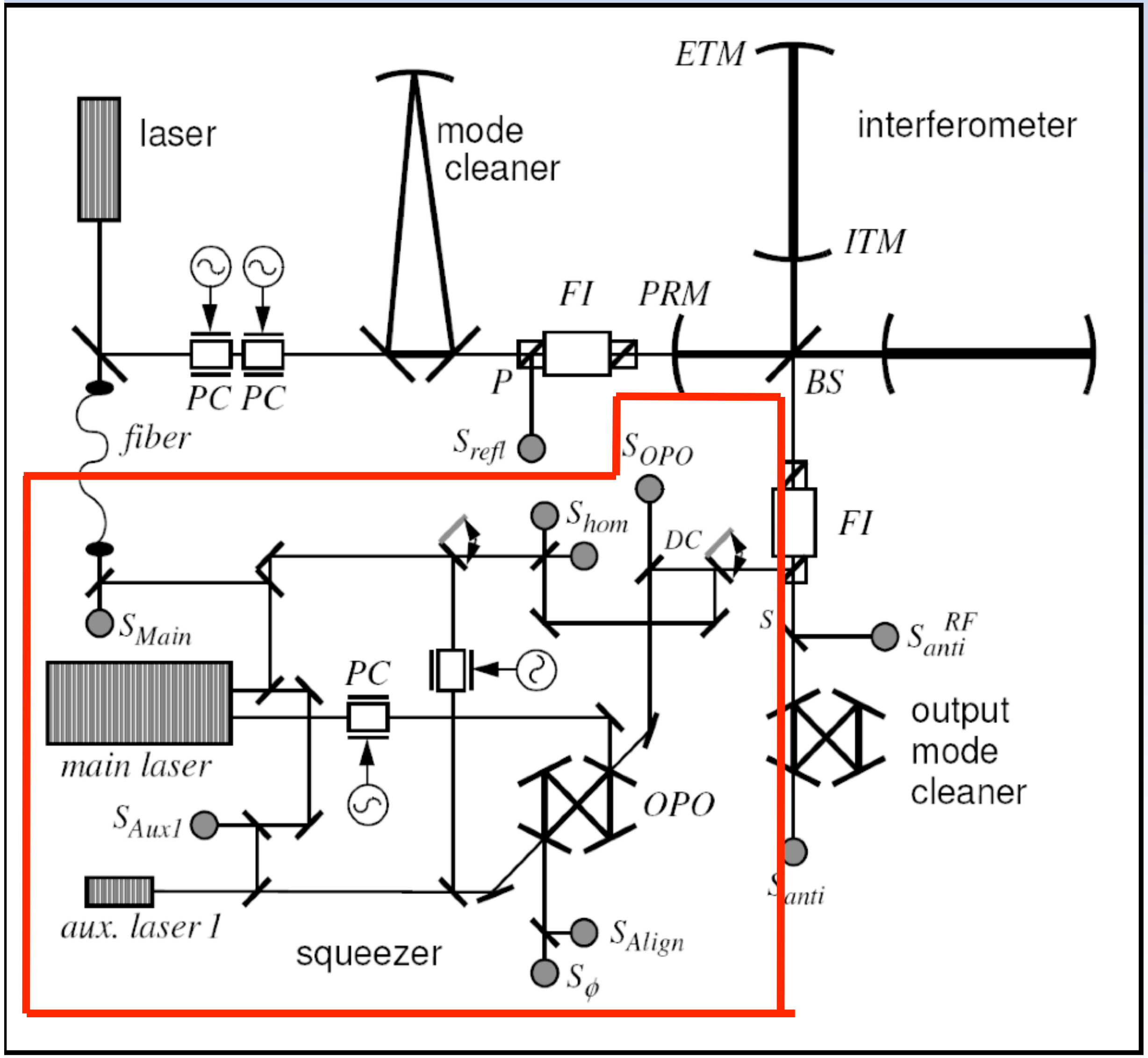
Motivation

- High optical power is needed to achieve Advanced LIGO sensitivity.
- Squeezing is a way to recover or improve baseline sensitivity



LIGO Working Note T070265

Squeezed Hanford 4km Project



- Squeezing to be injected into Hanford 4km detector asymmetric port Faraday Isolator
- Investigation into
  - Impact of squeezer on LIGO operation
  - Impact of injection losses
  - Impact of scattered light from LIGO to squeezer operation
  - Improvement in LIGO sensitivity (!)
- New squeezer to be constructed

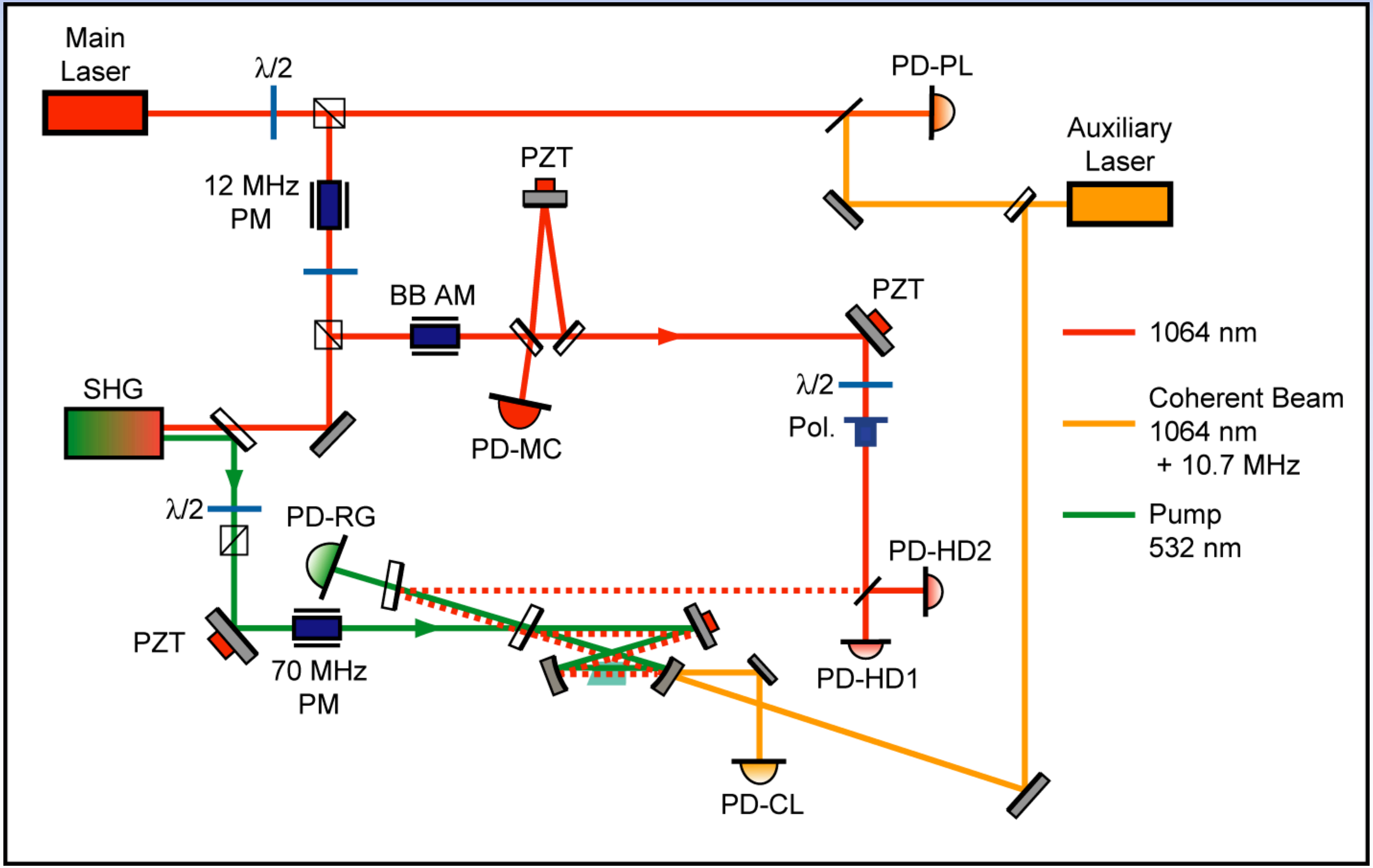
Low frequency Squeezing

- Pre-2004, the lowest squeezing frequency was ~80kHz
- In 2004, McKenzie at ANU showed that eliminating the OPO seed allows generation of squeezing in the LIGO band
- Low frequency squeezing was observed using a hemilithic (standing wave) OPO
- A design choice was made to use a doubly resonant bowtie OPO

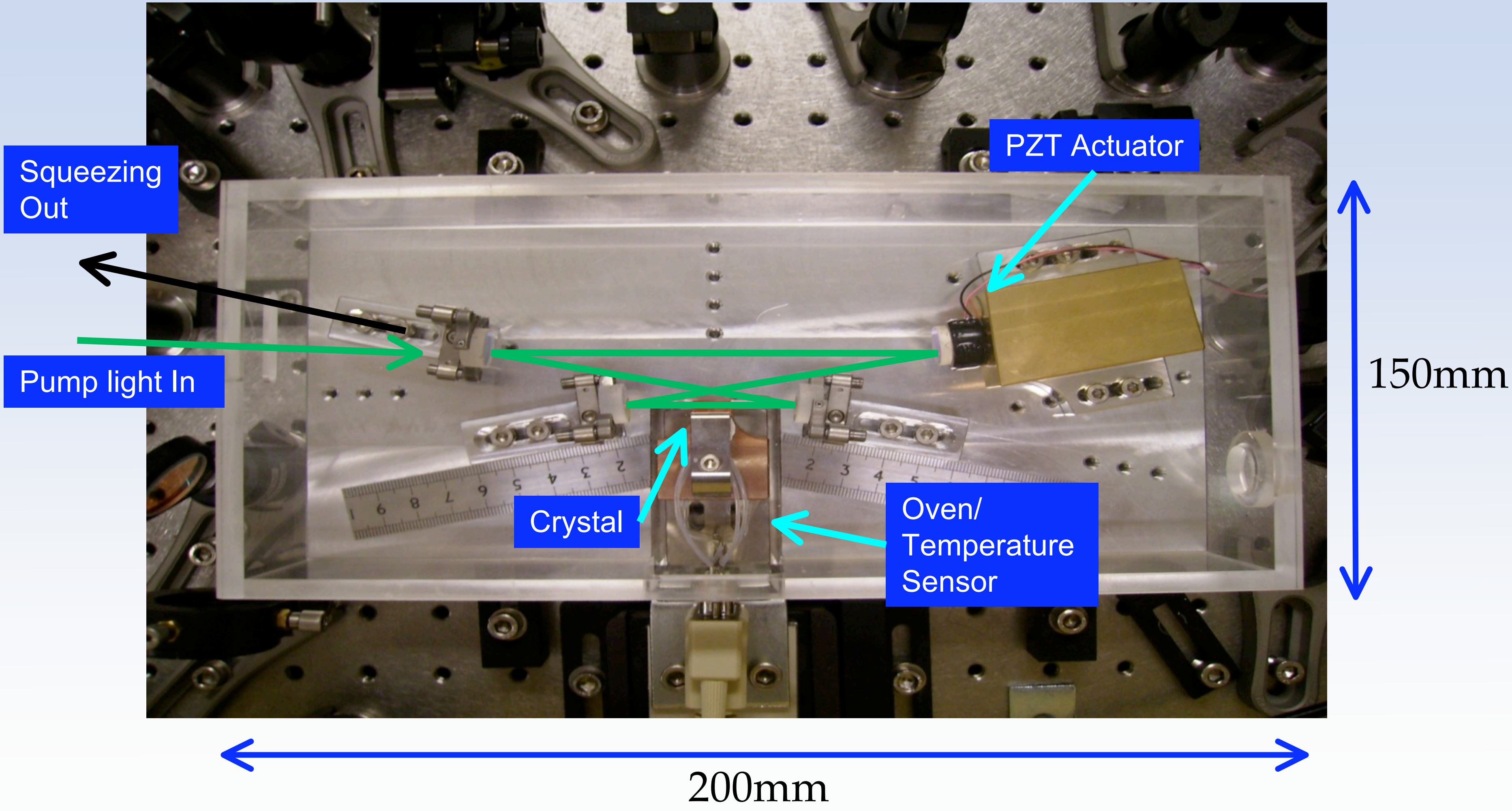
Doubly-resonant bowtie OPO

- Guarantees spatial overlap between green and red
- GrIIRA and photothermal effects minimized due to rejection of non-overlapping green
- Simplicity of control; green field is used to control OPO length
- Travelling wave design gives first-order immunity to backscatter - a source of OPO seeding

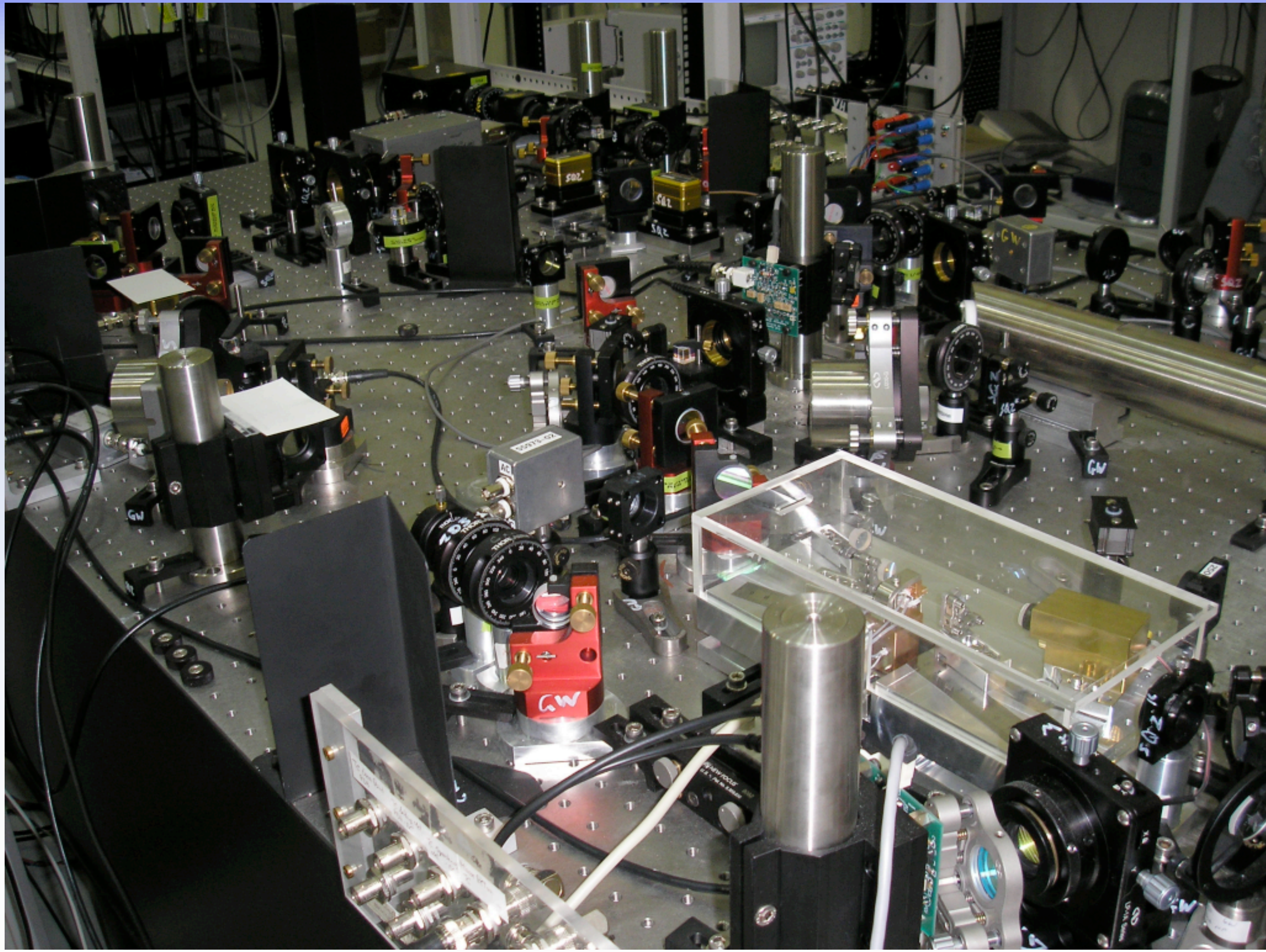
Optical Schematic



The Current ANU OPO



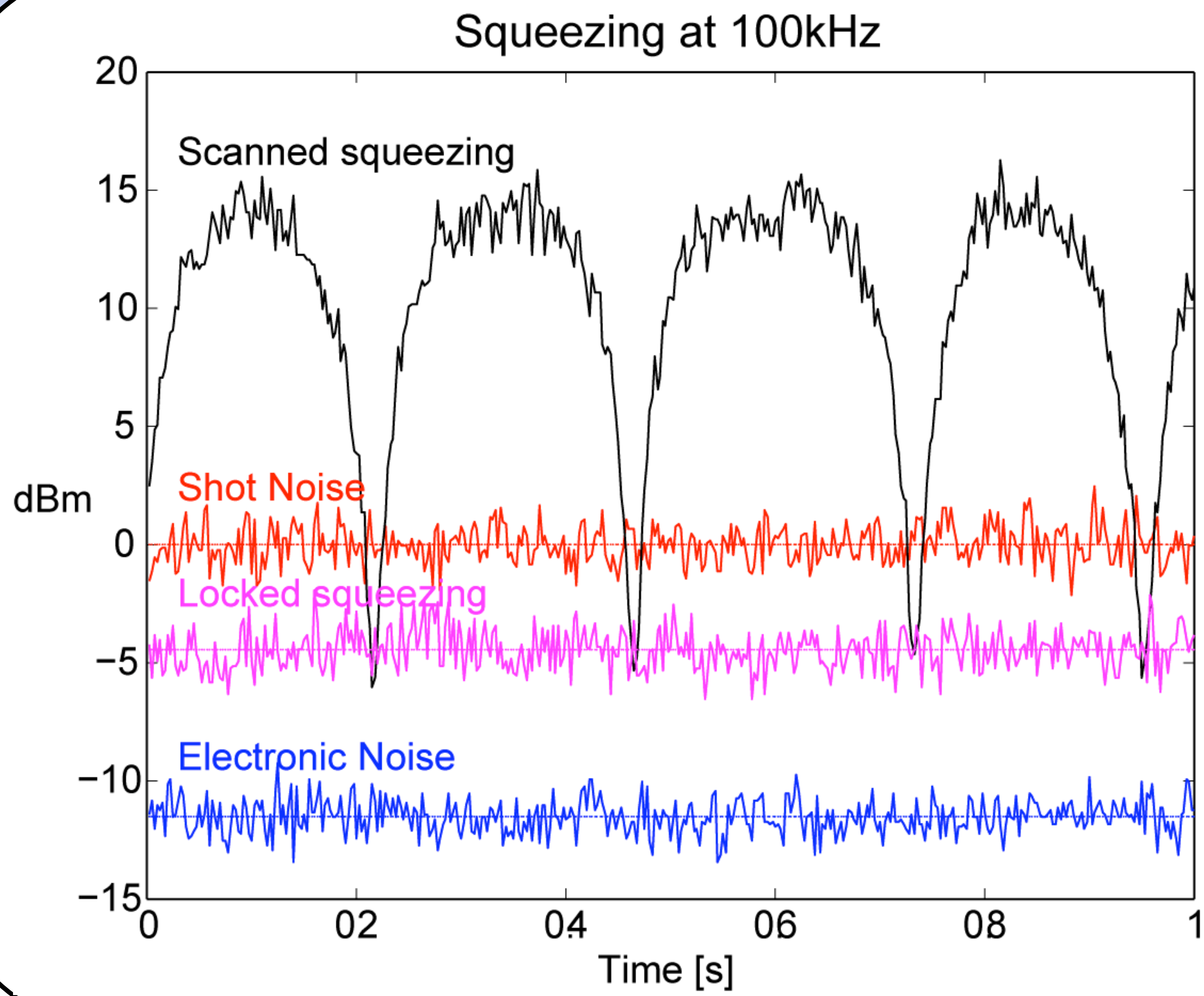
The ANU Squeezer



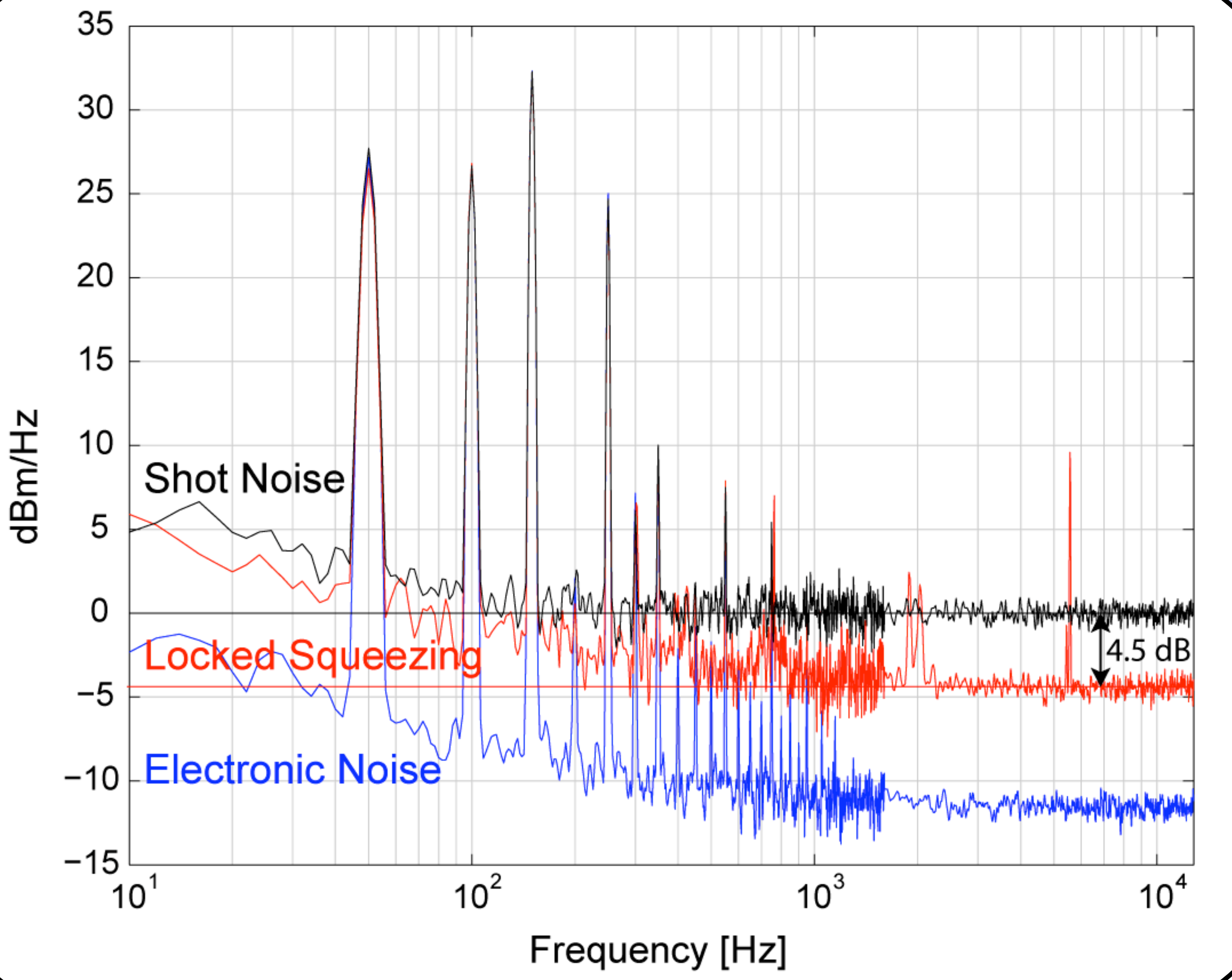
Observed Squeezing

- 95% escape efficiency; 90% reflectivity on the output coupler (Red), 53% green
- 15-20% total squeezing loss (97% Fringe visibility)
- 100 mW of green on PPKTP at 32 degrees C, gain of 11
- 320 μW of local oscillator power
- Squeezing is reduced when coherent power increases
- Significant electronic and signal-to-noise issues on the coherent lock

Observed Squeezing



Observed Squeezing



Observed Squeezing

Squeezing stability using quantum noise locking (from K. McKenzie)