UCSB

New Optical Cavity Developed for Ultracold Atom Experiment

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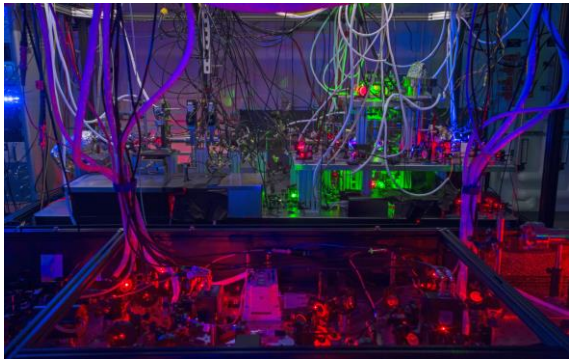
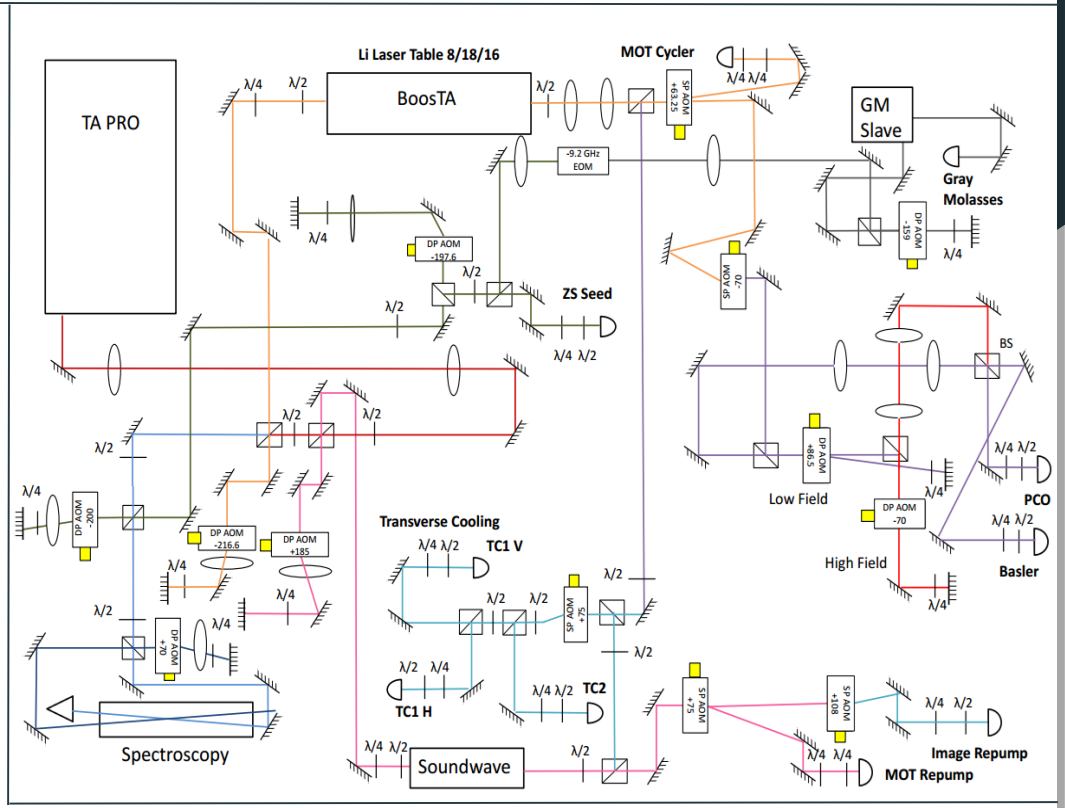
Application of Cavity



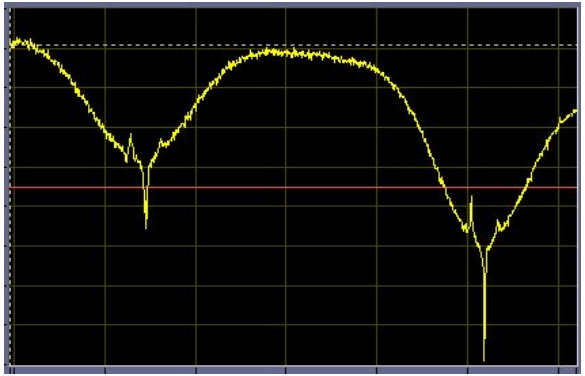
Lithium Machine

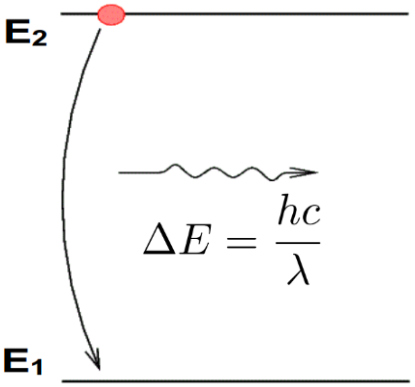
- About 20 laser beams in the Lithium Ultracold atom machine
- The method to choose the right beam



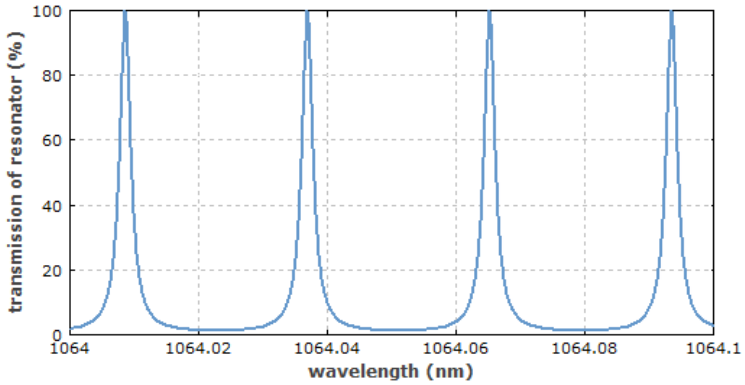
Laser layout of Lithium Machine

Application of Cavity





Lithium Spectrum

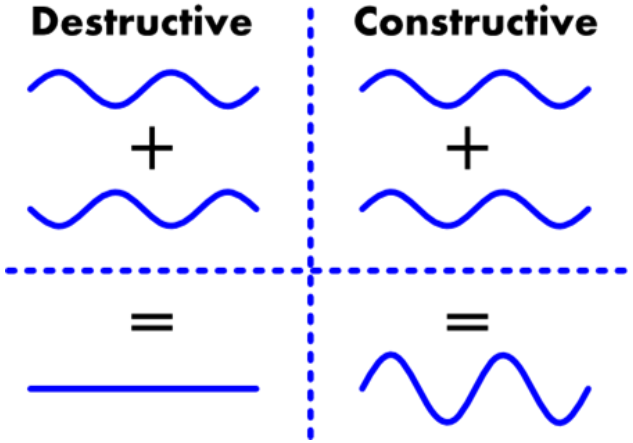


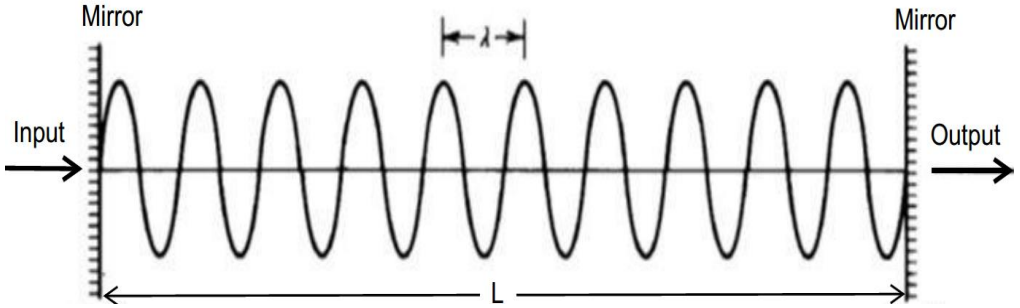
Optical Cavity Spectrum

- Discrete energy level of atoms
- Use atoms as the absolute measurement of wavelength of laser

- Optical resonant cavity as '**a tunable atom**'

Optical Resonant Cavity





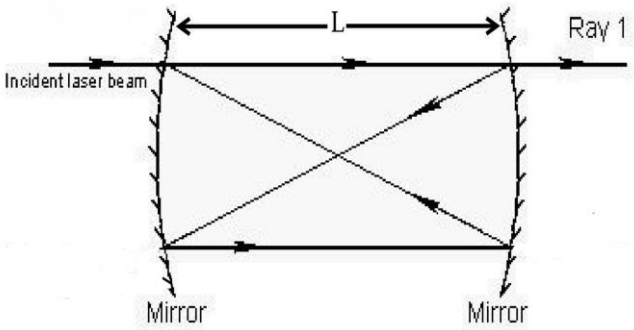
Planar optical cavity

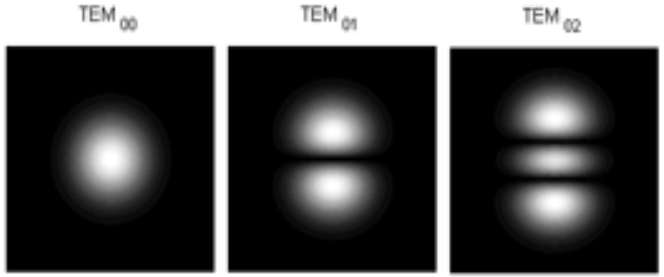
Basics

- Interference of light waves
- Certain wavelength transmitted

$$\lambda_m = \frac{2L}{m}$$

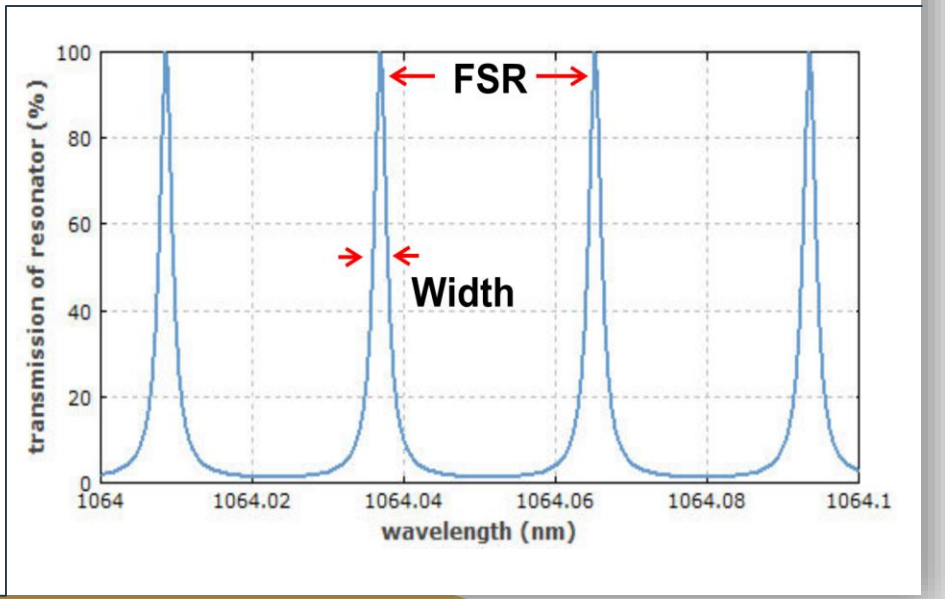
Confocal Cavity



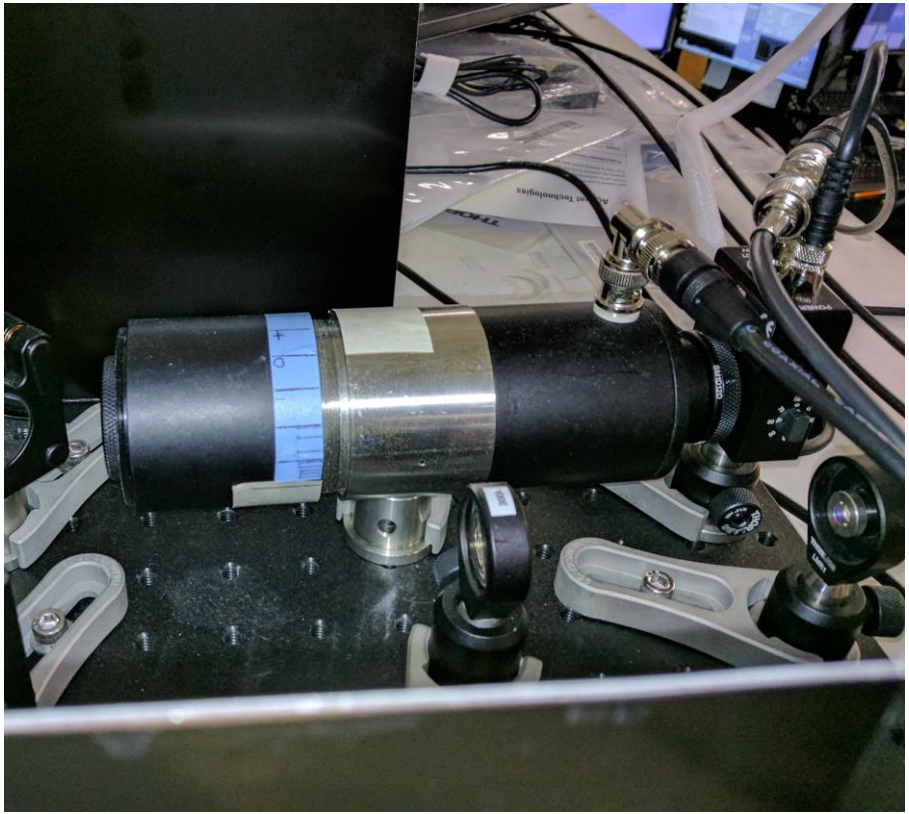


Features

- Low sensitivity of alignment accuracy
- Multimode output
- Free spectral range (FSR)
- Finesse: (FSR/Width)

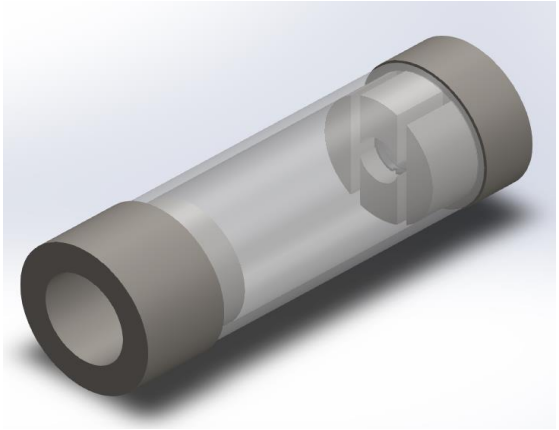


Invar Cavity

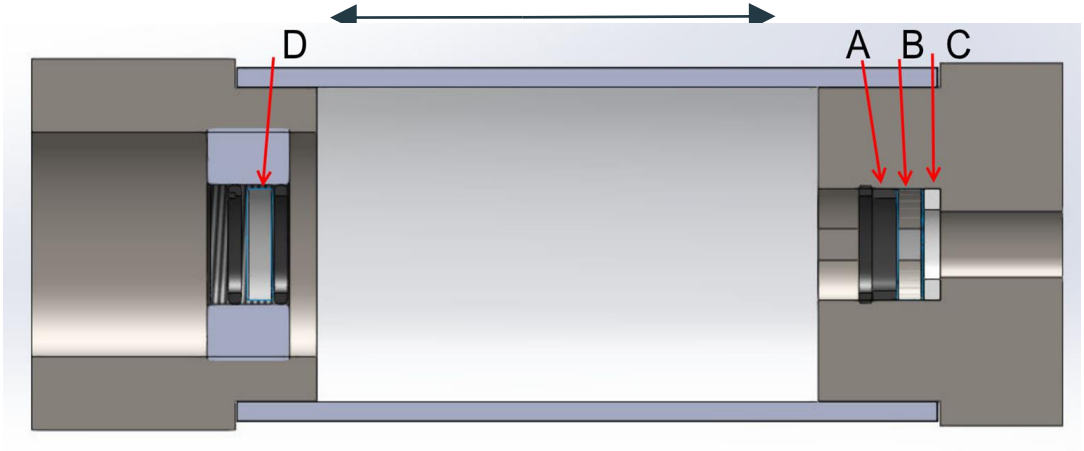


- Use Invar(low thermal expansion coefficient)
- Expensive
- Hard to tune the output after installed

New Design



Inspired by John Barry's design



Features

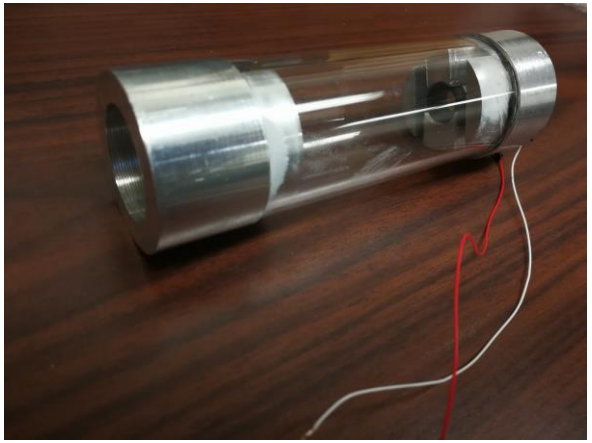
- Antithermal expansion design
- Capability to tune the transverse mode output
- Low Cost (600$) VS Commercial cavity (2500$)

Thermal expansion Coefficients

- Steel: $2.2 \times 10^{-5} K^{-1}$
- Quartz: $5.5 \times 10^{-7} K^{-1}$

A. Rubber ring
B. Concave mirror
C. Piezo
D. Concave mirror(Movable)

Real Cavity and Setup

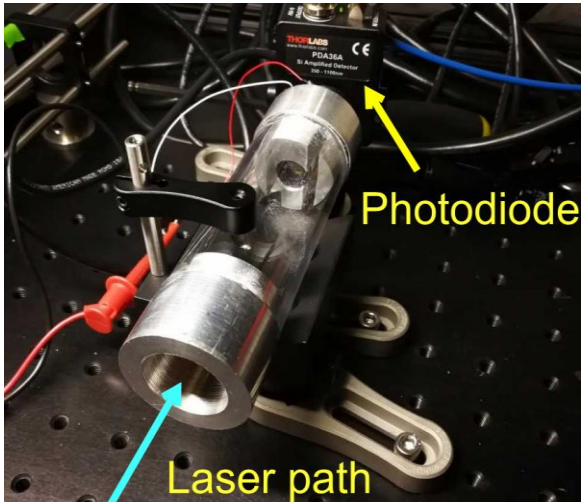


Cavity 1

- FSR: 1000MHZ
- Finesse:theoretical value ~3000

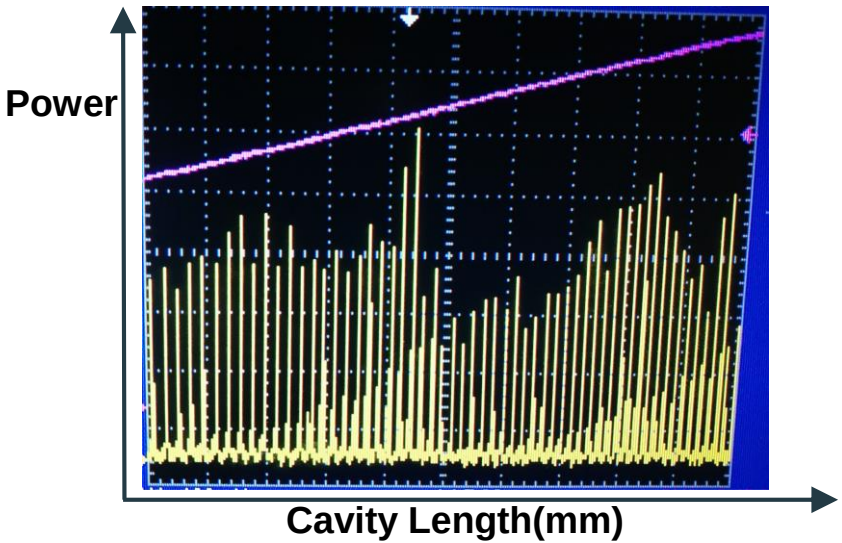
Cavity 2

- FSR: 750MHZ
- Finesse: theoretical value~4000

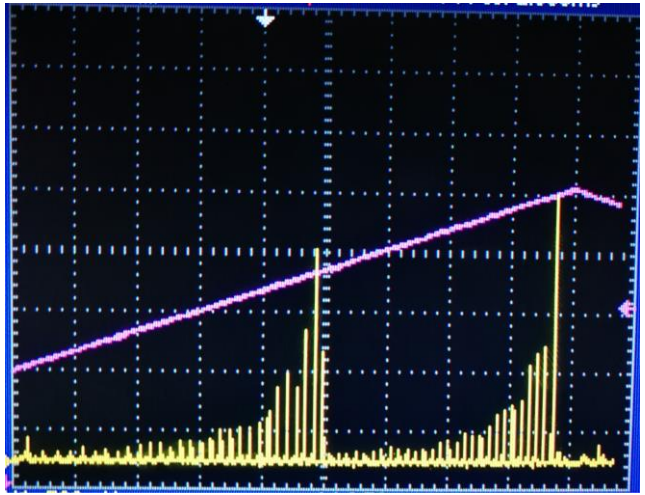


Setup

Results



Before Tuning



After Tuning

Measurement

- Experimental value of Finesse: ~400
- observed low drift under temperature change

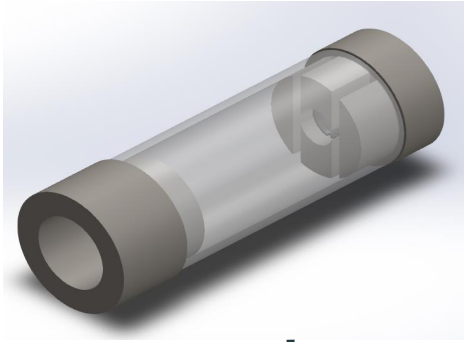
Possible reasons

- Dirt on the surface of mirrors
- Angular misalignment between two mirrors

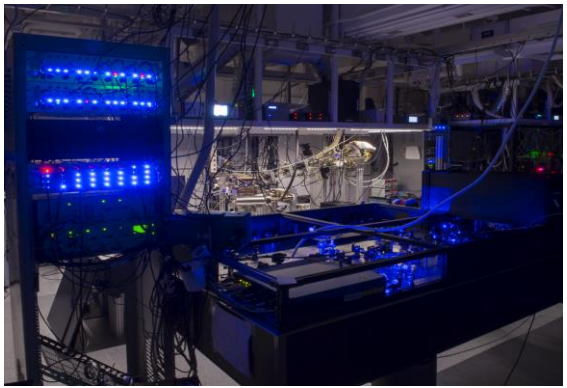
Conclusion and Future Work

- observed low drift
- The freedom to tune the output modes
- Finesse: 400
- Low cost ~600$

- Test the second cavity
- Integrate the cavity into the strontium machine as a tunable atom



Optical Resonant Cavity



Strontium Machine

Acknowledgement

Professor David Weld, Post-doc Toshi Shimasaki, and other members in Weld group for their great help and support.

Physics Department for arranging the talk.

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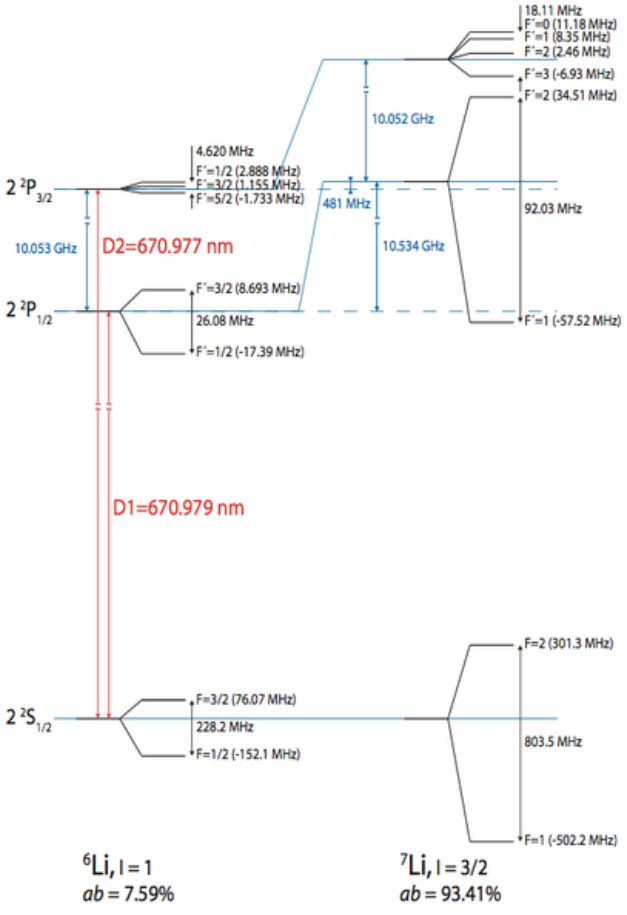

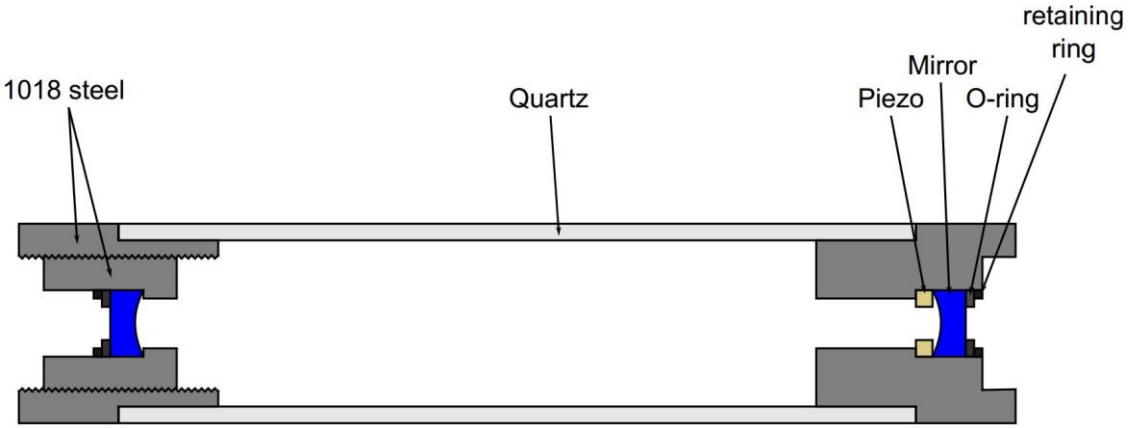

Design By John Barry