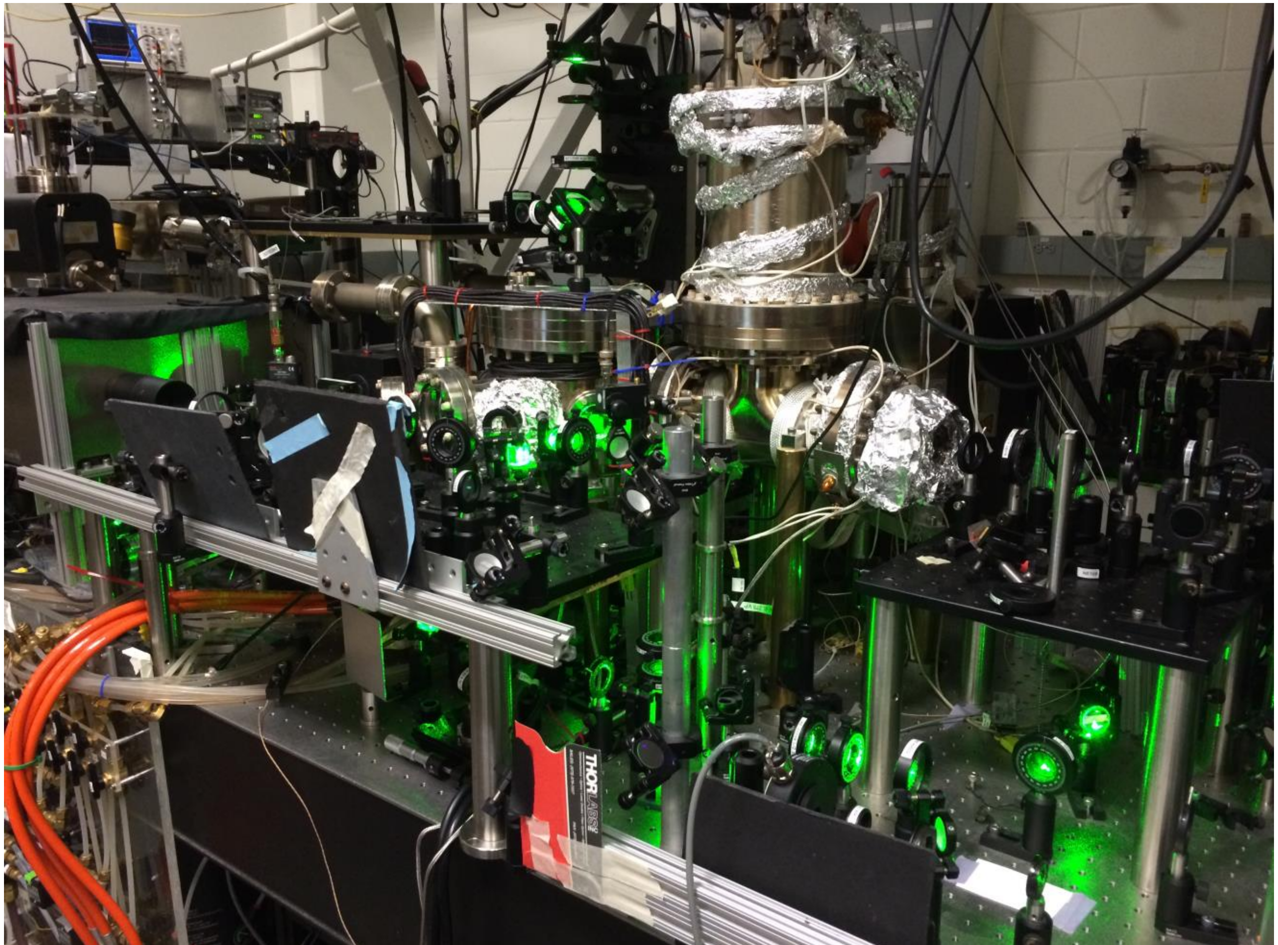
Second Generation ECDLs for Li-Yb PA Experiments

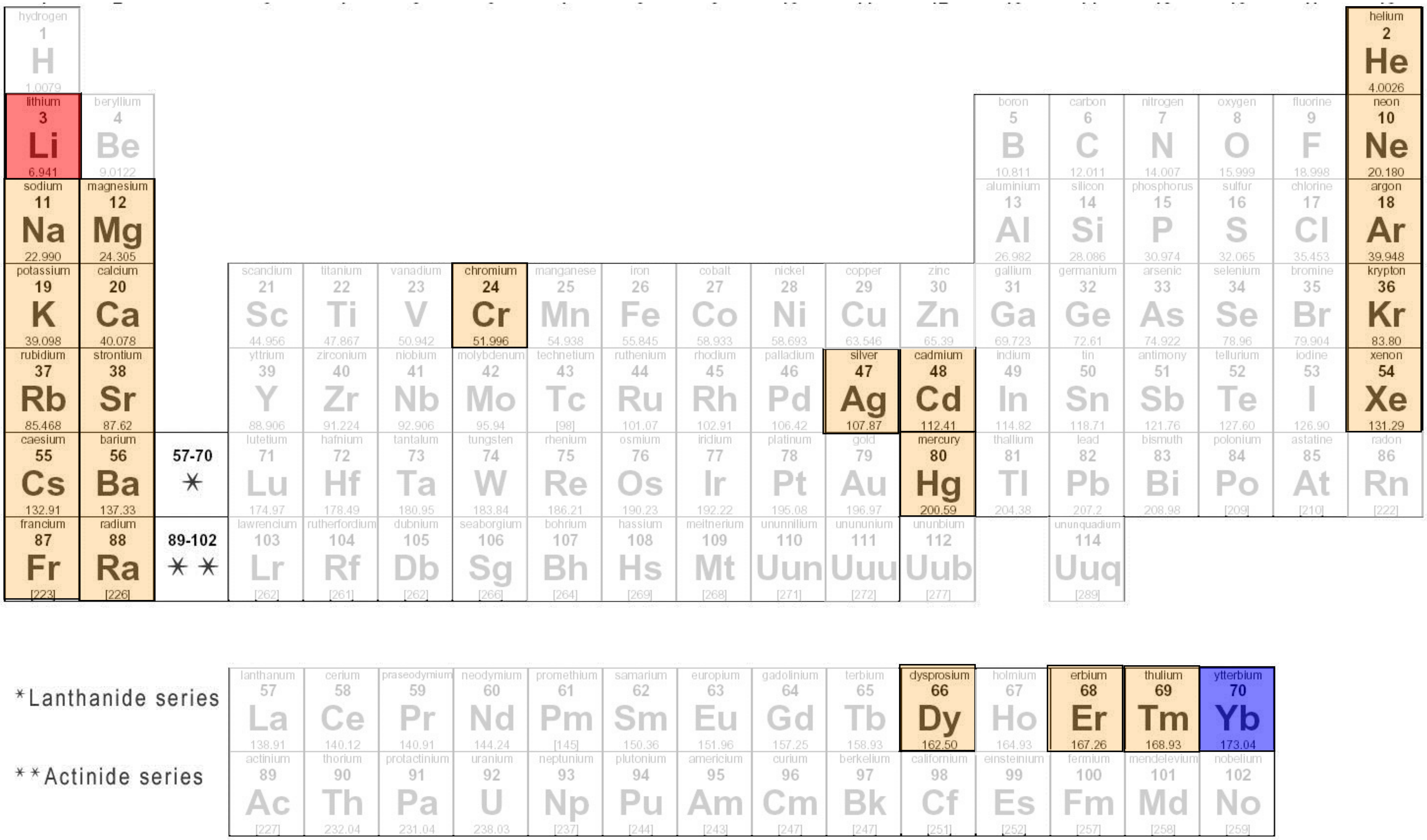


Stephen Dilorio
UW NSF-INT PHY REU
August 21, 2014

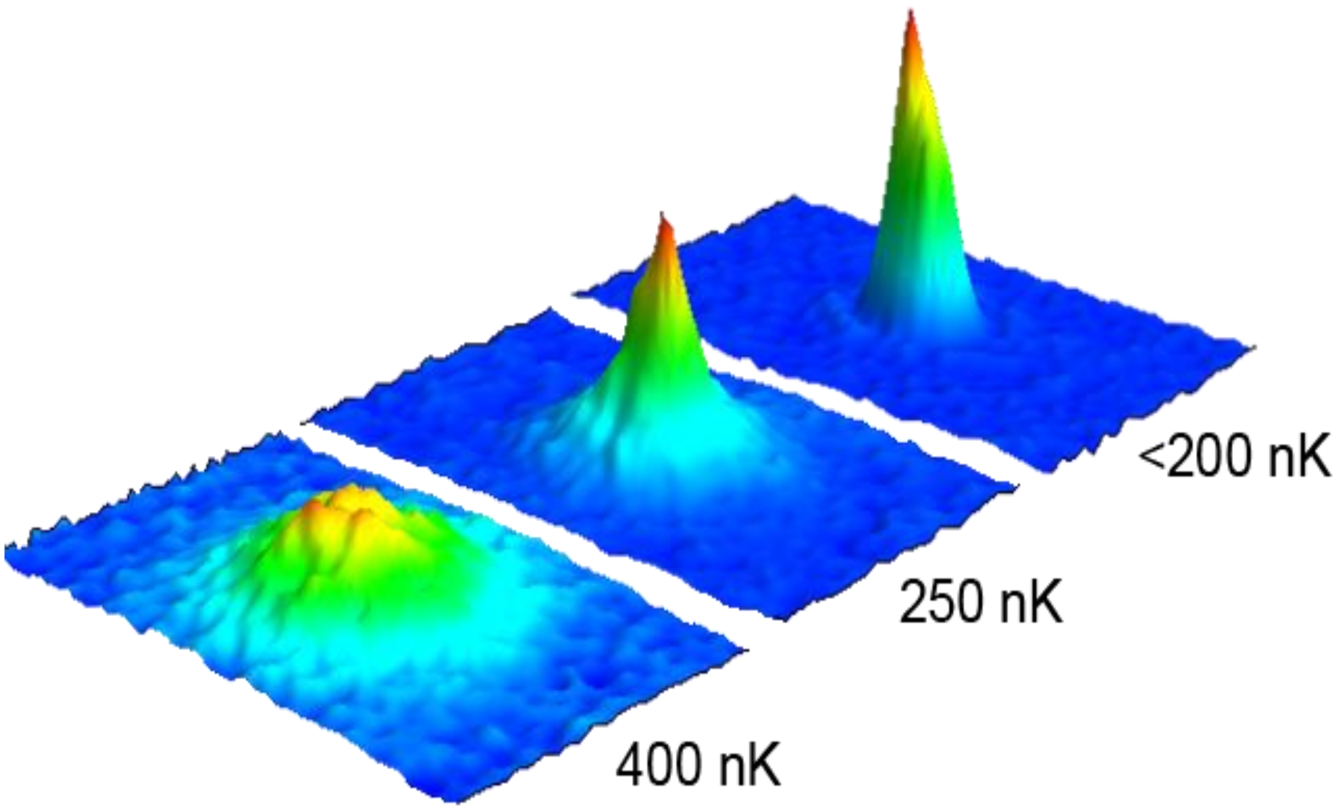
Outline

- Introduction
  - Why Cold Atoms?
  - Benefits of Cold Molecules
  - Precision Lasers
  - Photoassociation Spectroscopy
- ECDL
  - Old ECDL and Stability
  - New ECDL and Stability
  - Protection Circuit
- Locking PA Laser

Laser-Trapped Atoms



Bose-Einstein Condensates

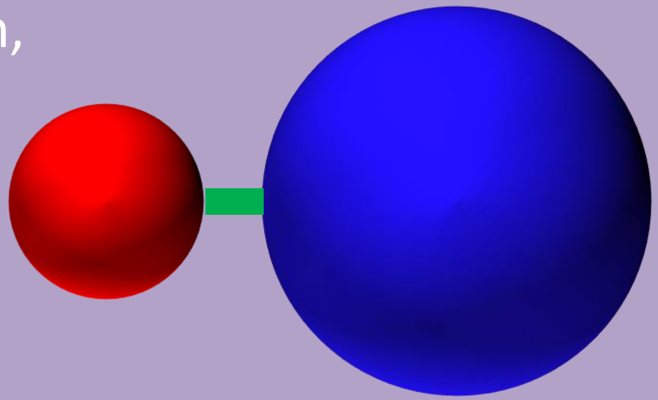


Ultracold Molecules

Gain control of new degrees of freedom

Atom: electric, motion, magnetic, nuclear

Molecule: Vibrational, rotational, molecular dipoles



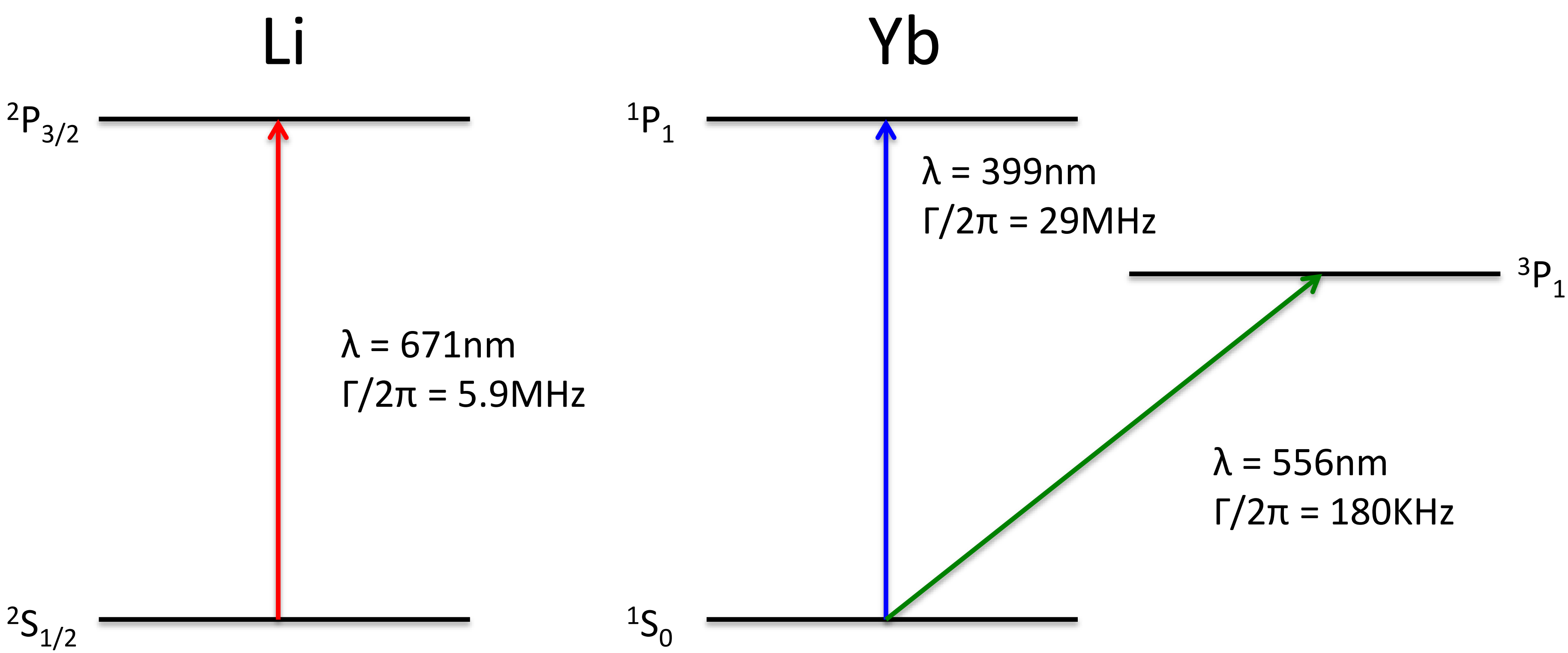
Long-range interactions ($1/r^3$ vs $1/r^6$)

Candidate for scale-able quantum information processing

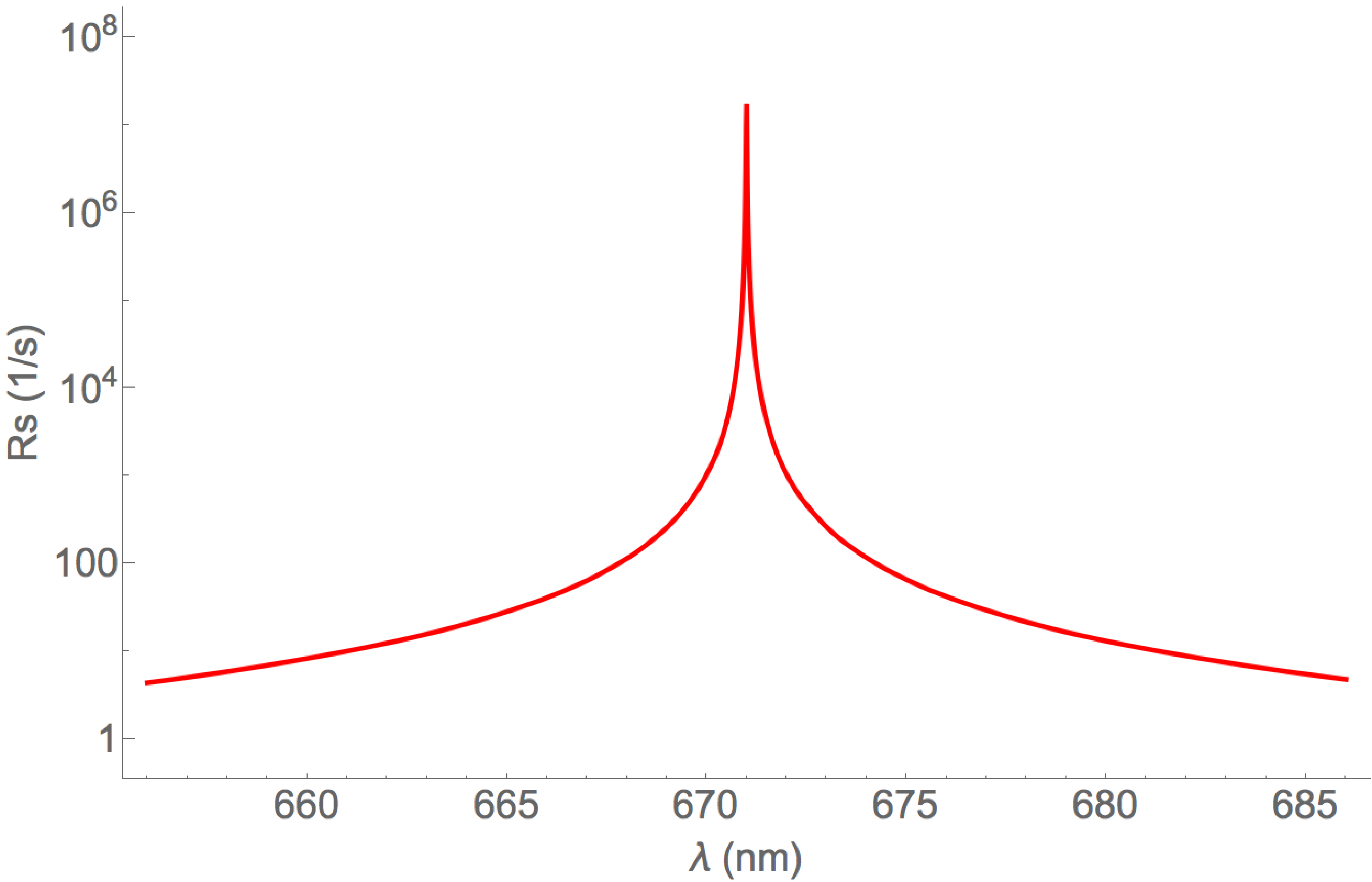
Precision Spectroscopies for m_p/m_e time variation

Controlled ultracold chemical reactions

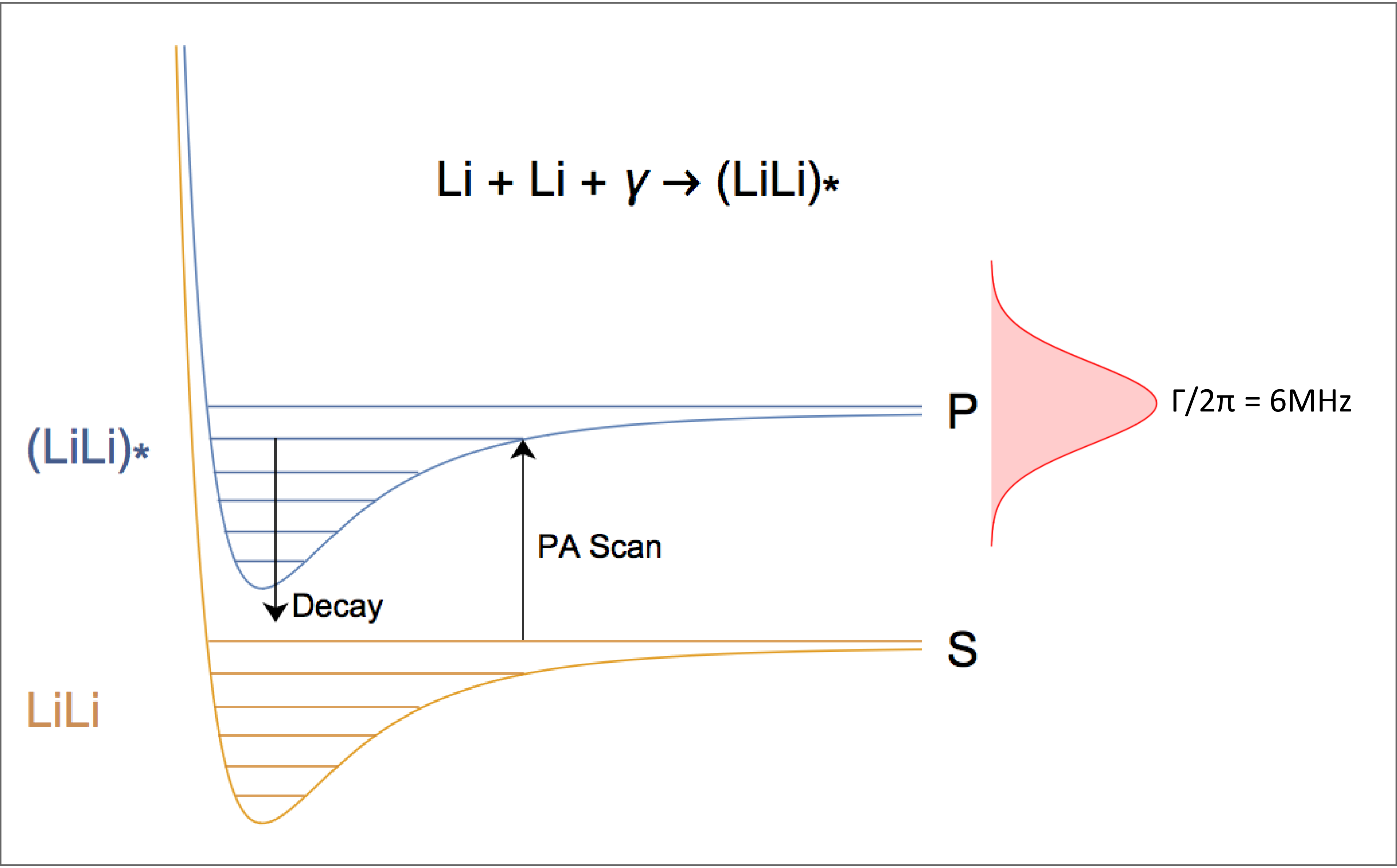
2-Level System



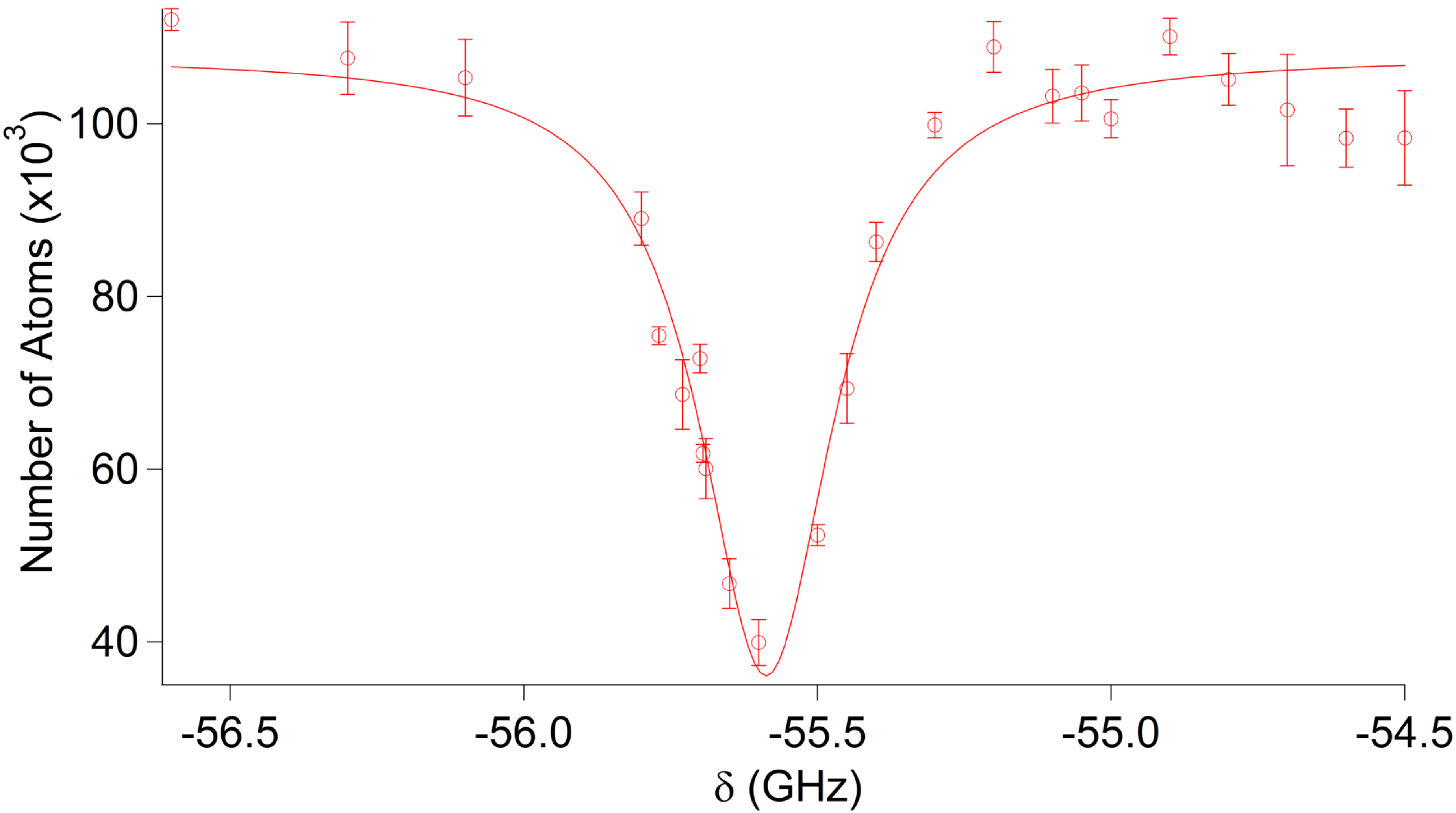
2-Level System



Photoassociation Resonance

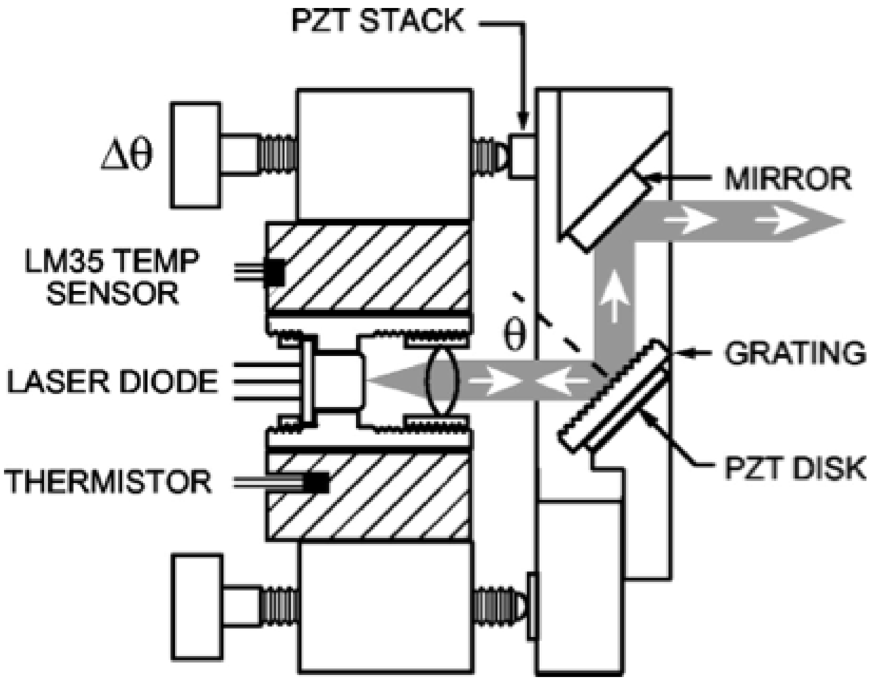


Photoassociation Spectroscopy



External Cavity Diode Laser

Littrow configuration



Frequency selective optical feedback

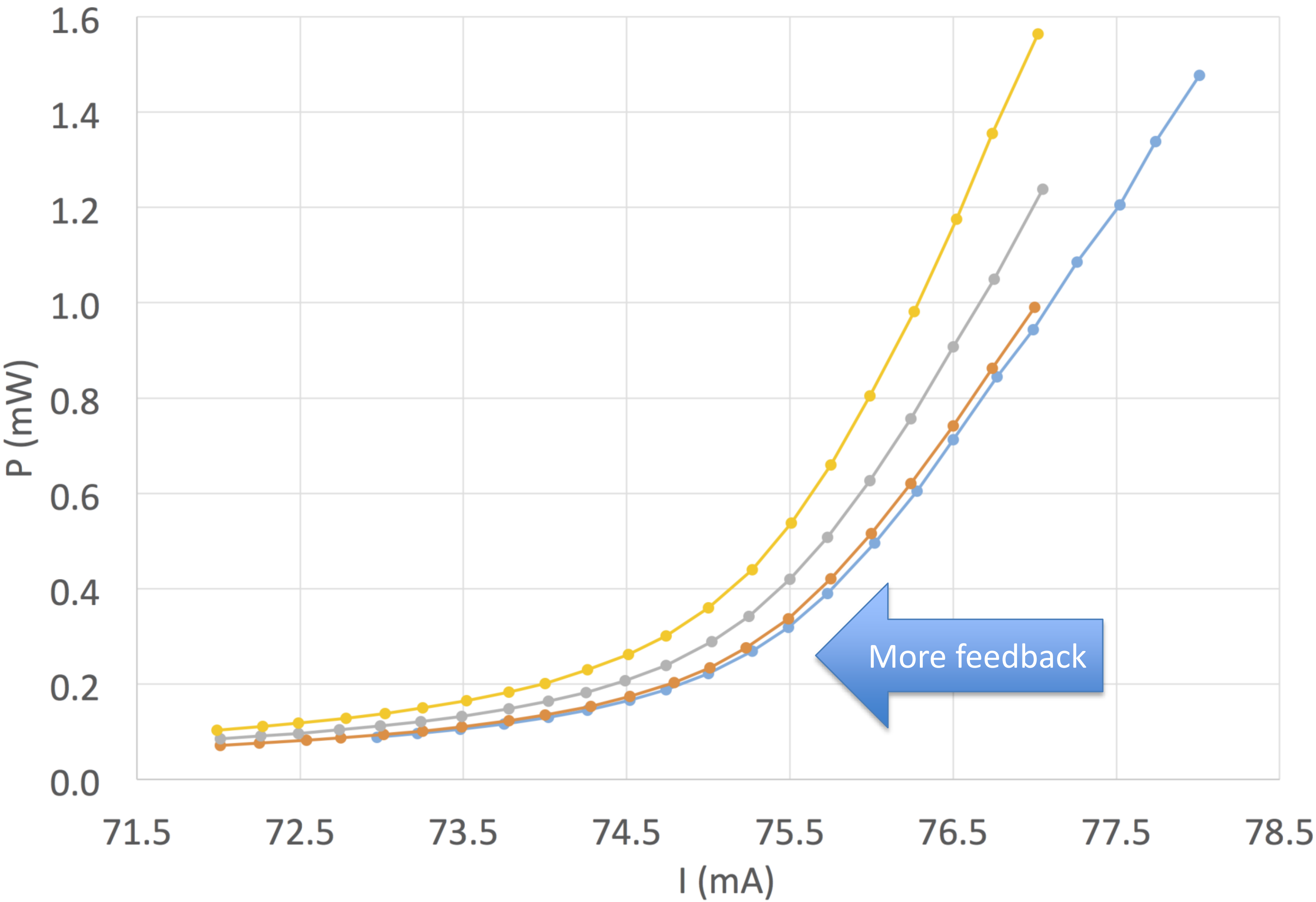
Fixed direction output beam (with minimal power loss)

Reflect 1st order beam to diode
0th order beam as output

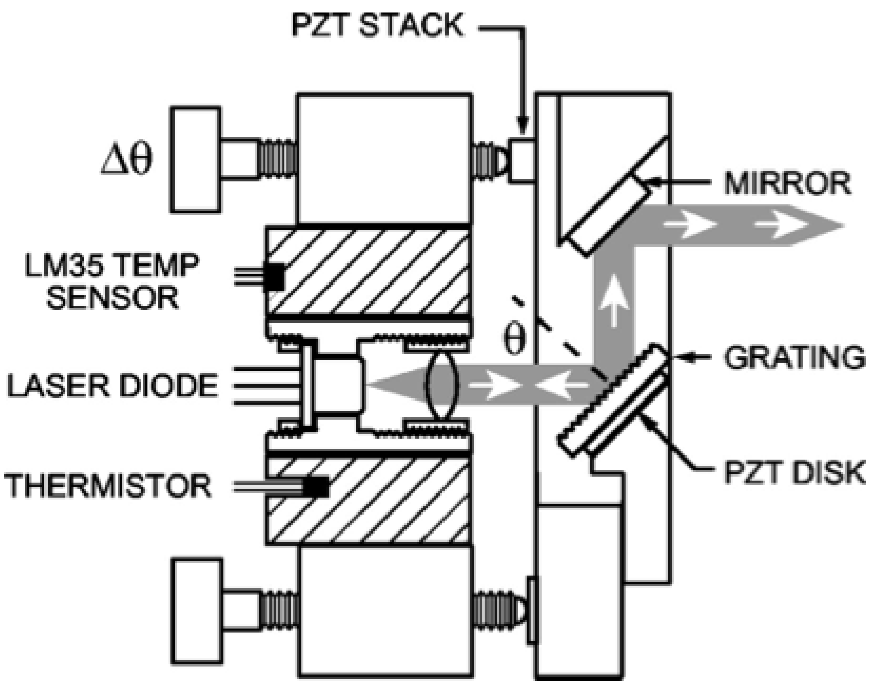
$\theta = \arcsin(\lambda / 2d)$

Hawthorn, C. J., K. P. Weber, and R. E. Scholten. "Littrow configuration tunable external cavity diode laser with fixed direction output beam." *Review of scientific instruments* 72.12 (2001): 4477-4479.

External Cavity Diode Laser



External Cavity Diode Laser

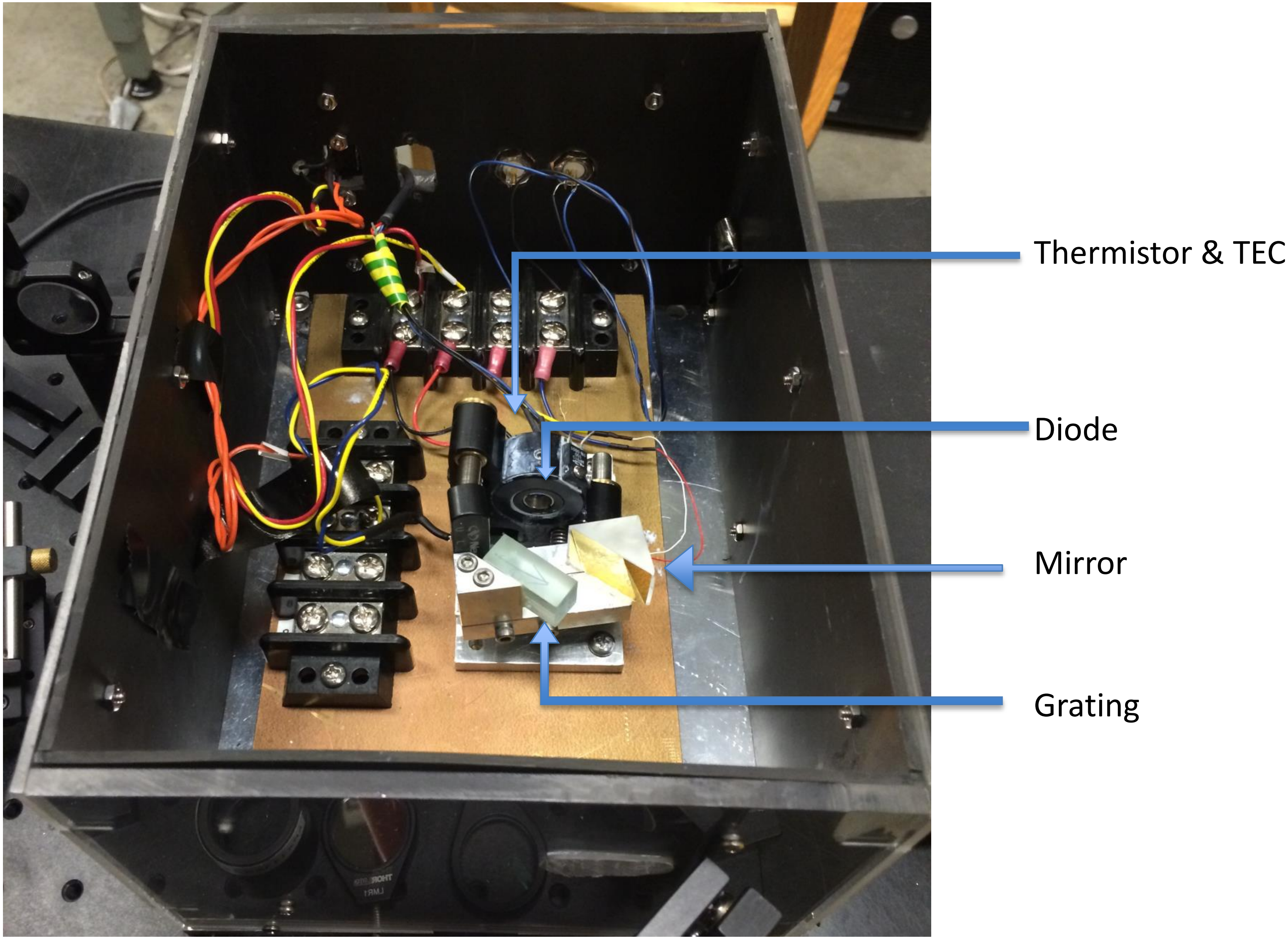


Interested in:

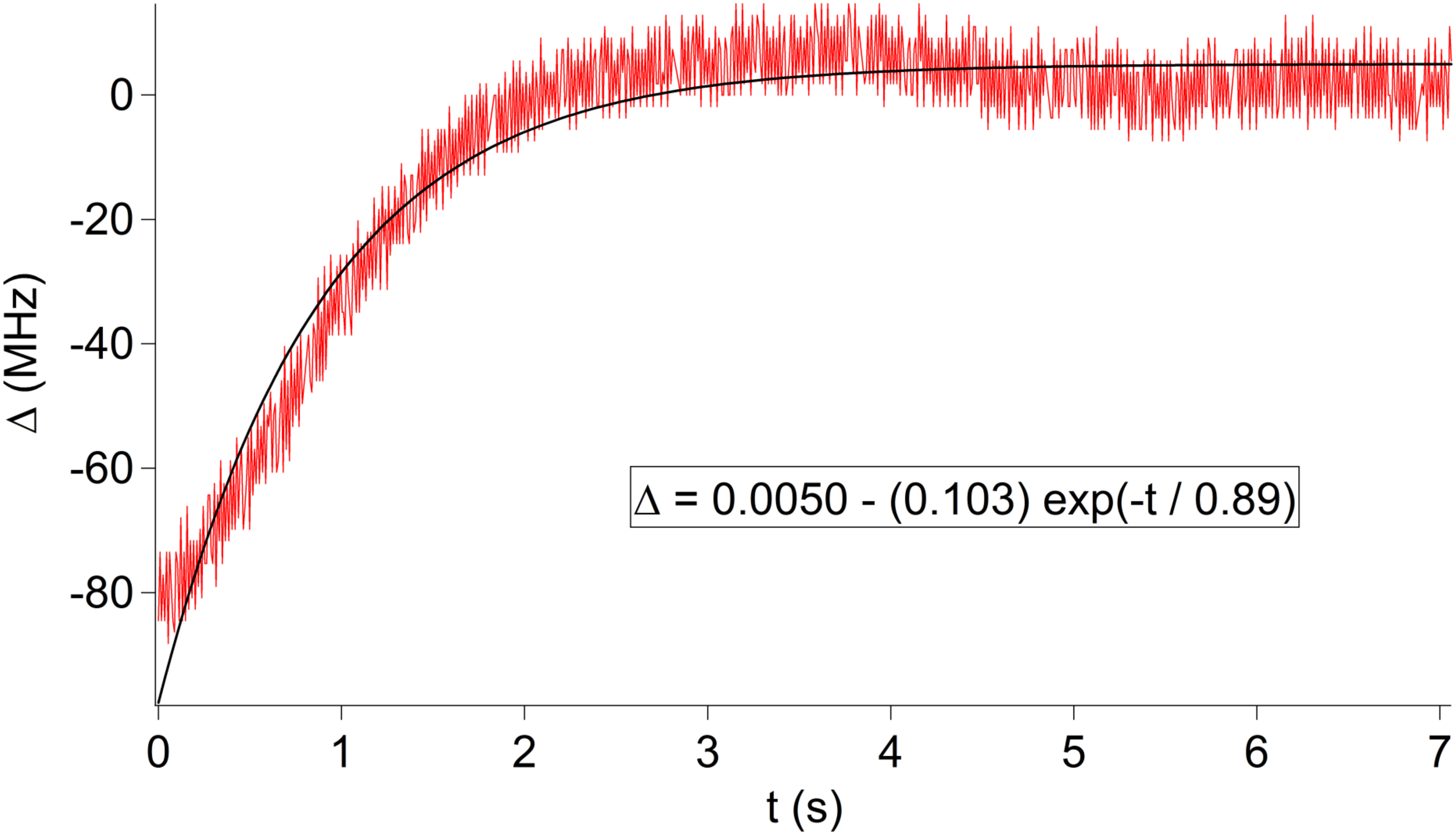
- Particular wavelength
- Long-term and short-term stability
- Diode protection

Hawthorn, C. J., K. P. Weber, and R. E. Scholten. "Littrow configuration tunable external cavity diode laser with fixed direction output beam." *Review of scientific instruments* 72.12 (2001): 4477-4479.

Old ECDL

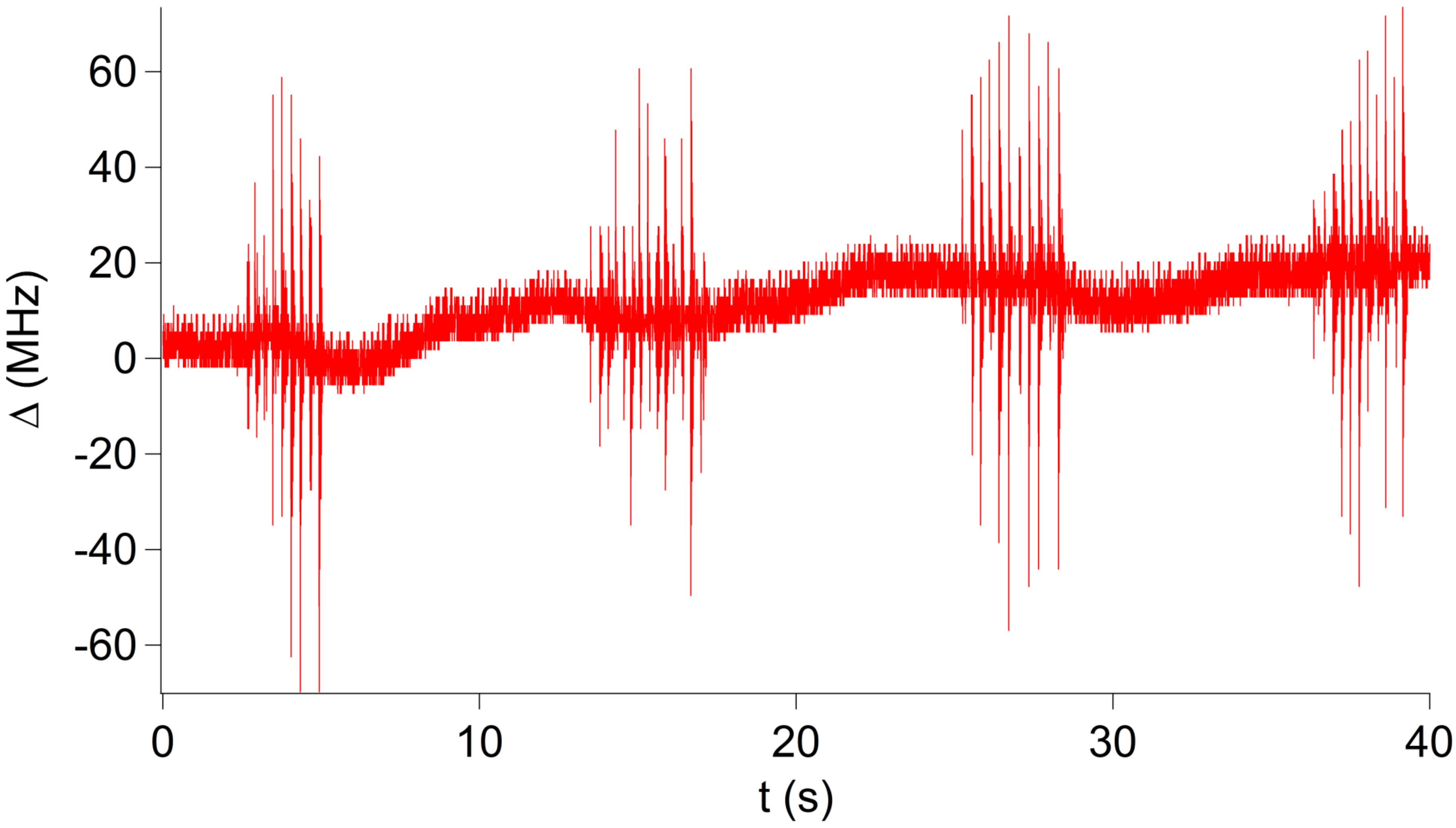


Old ECDL – Air Currents

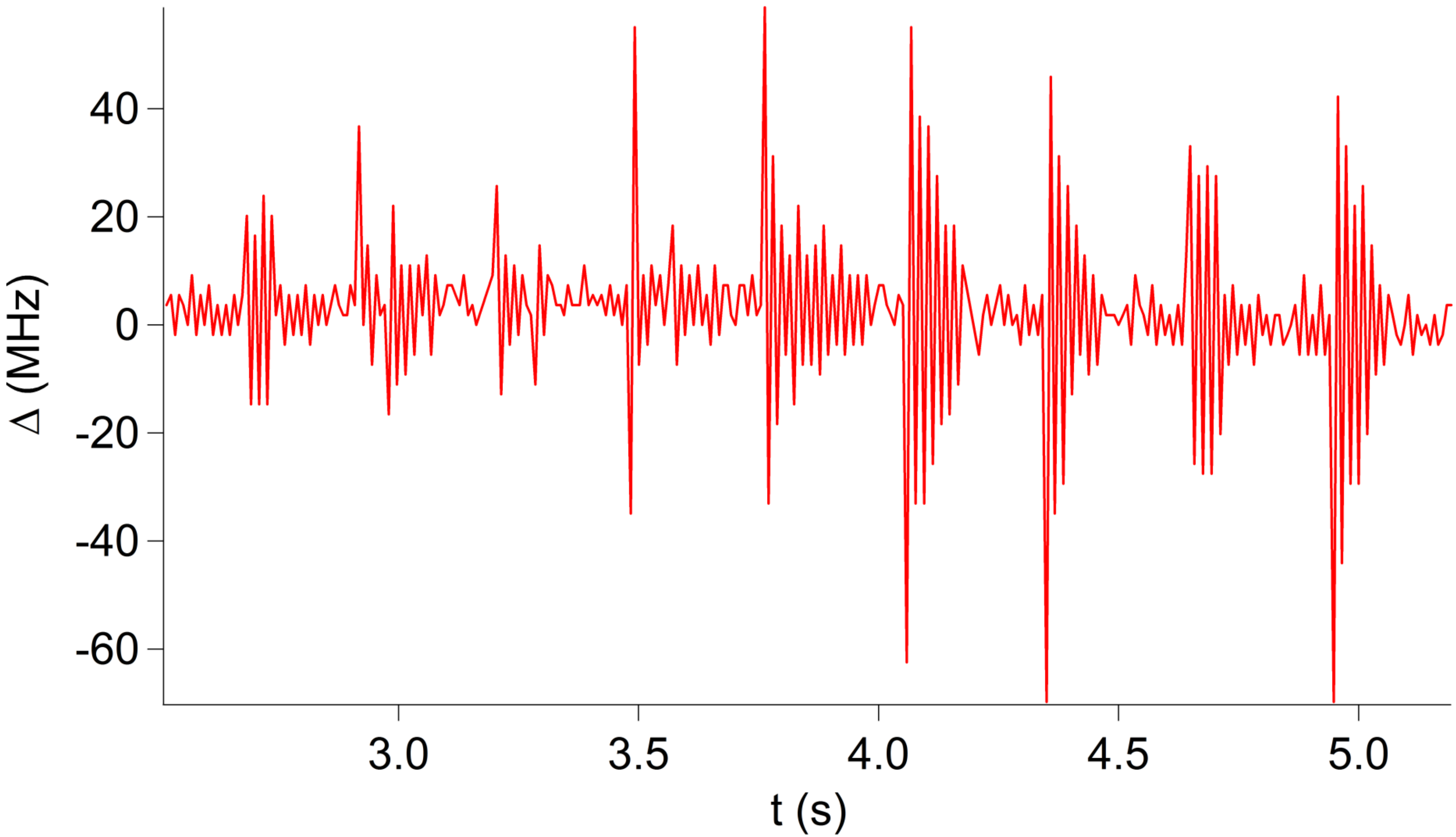


Roughly ~2.5s to equalize

Old ECDL – Vibrations



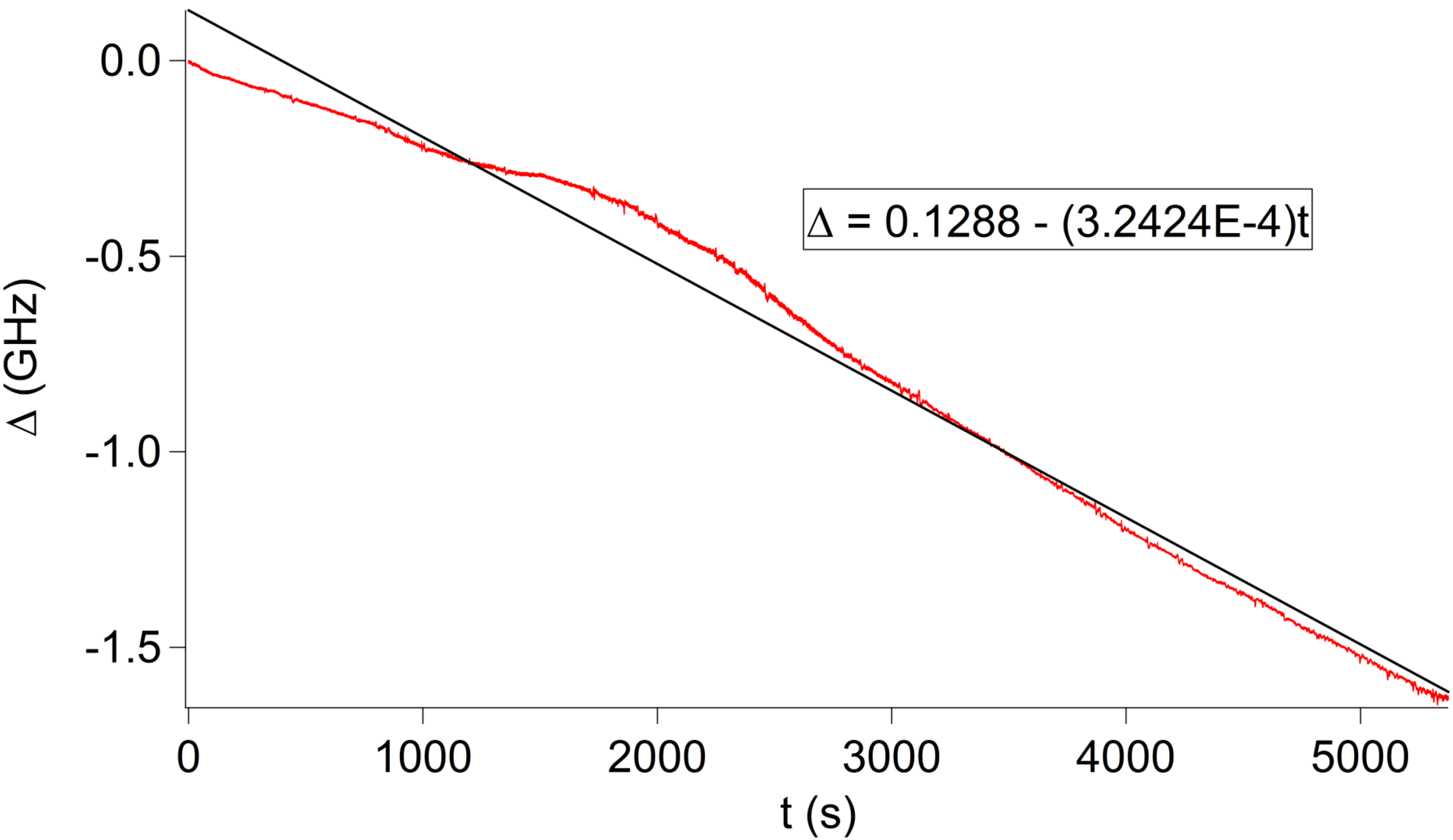
Old ECDL – Vibrations



Deviation of 60 MHz

Rings for ~.25s

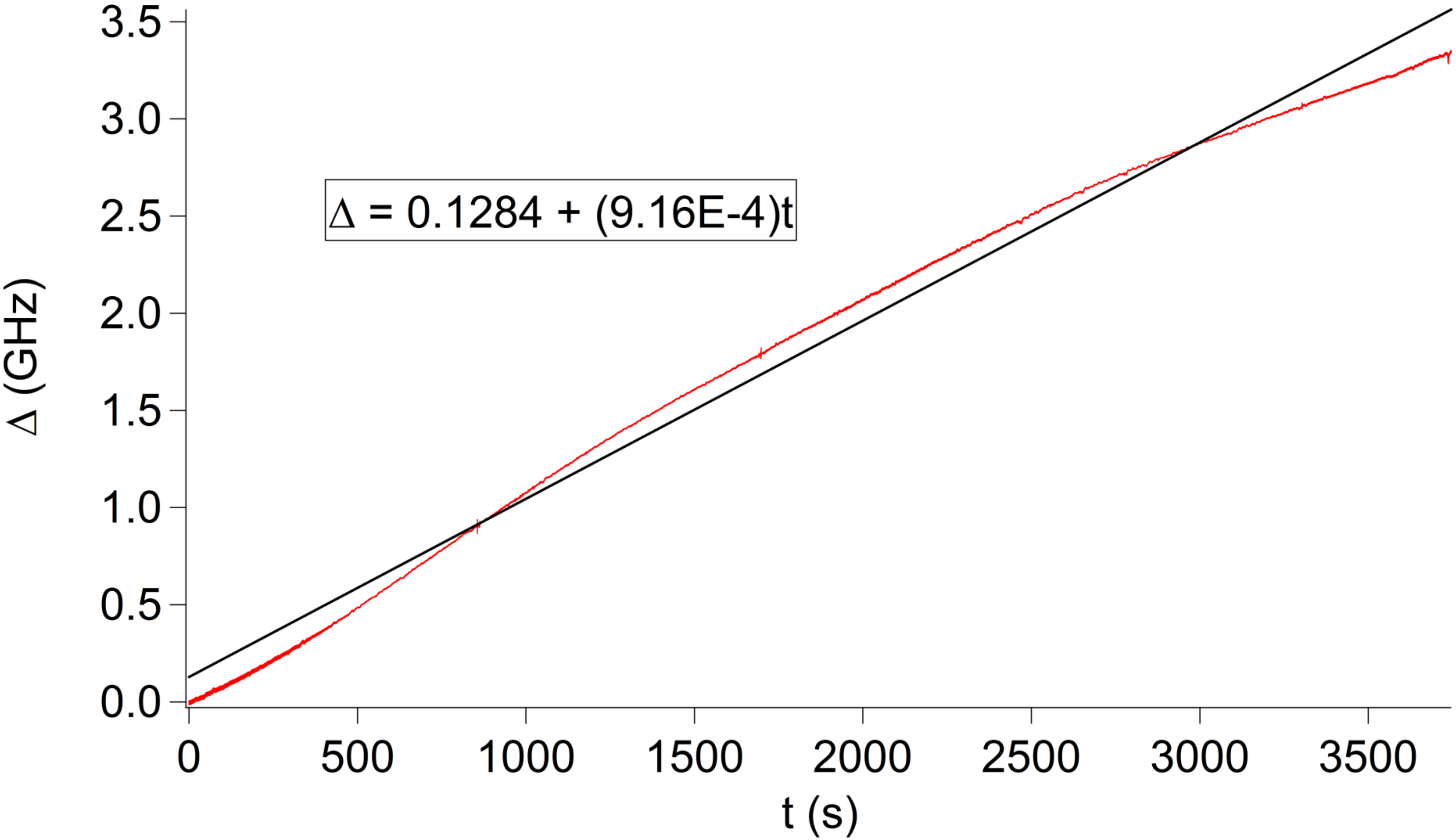
Old ECDL – Long-term Drift



Data taken in morning

~0.3 MHz/s change

Old ECDL – Long-term Drift



Data taken in afternoon

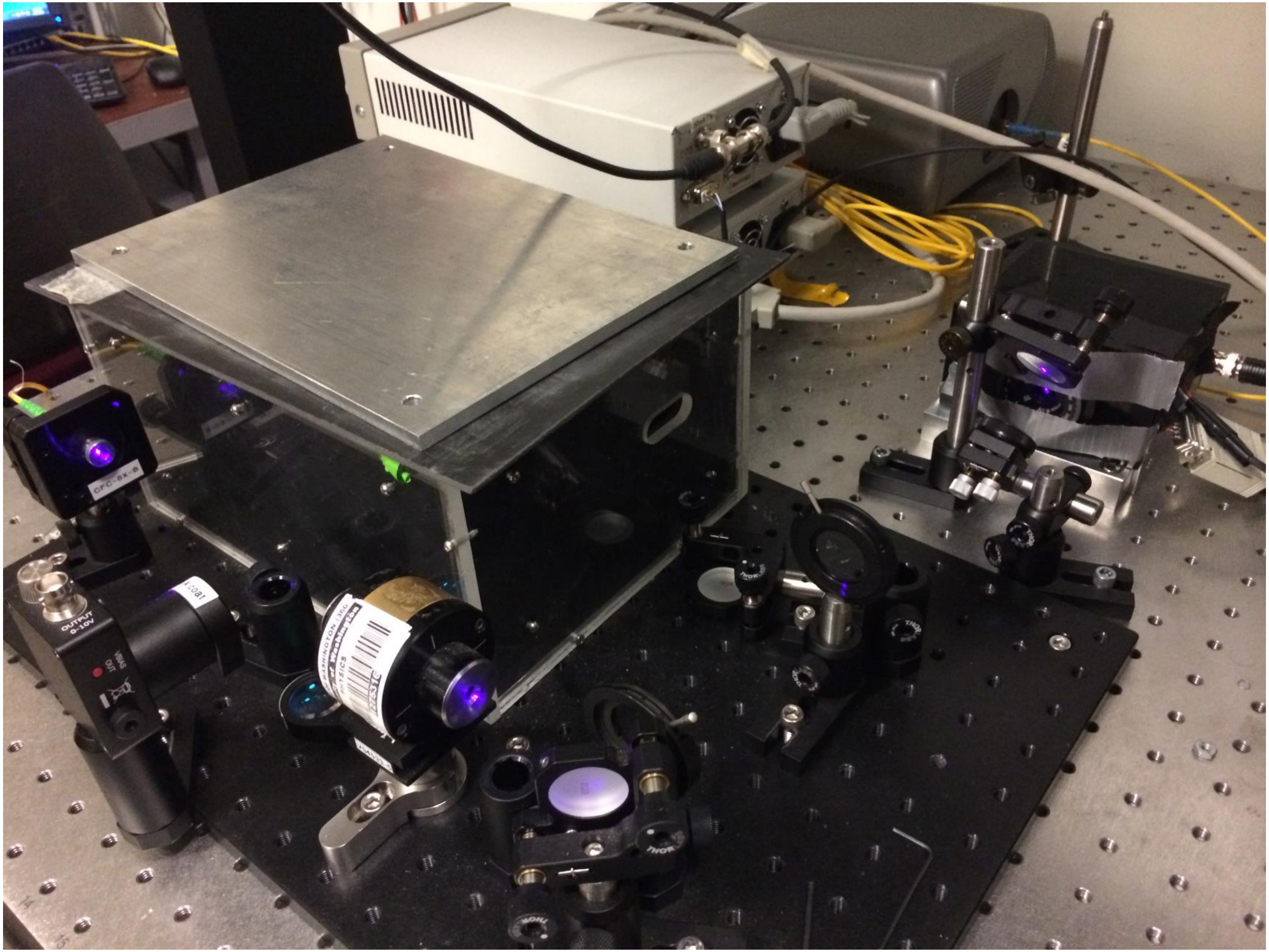
~1 MHz/s change

Old vs New

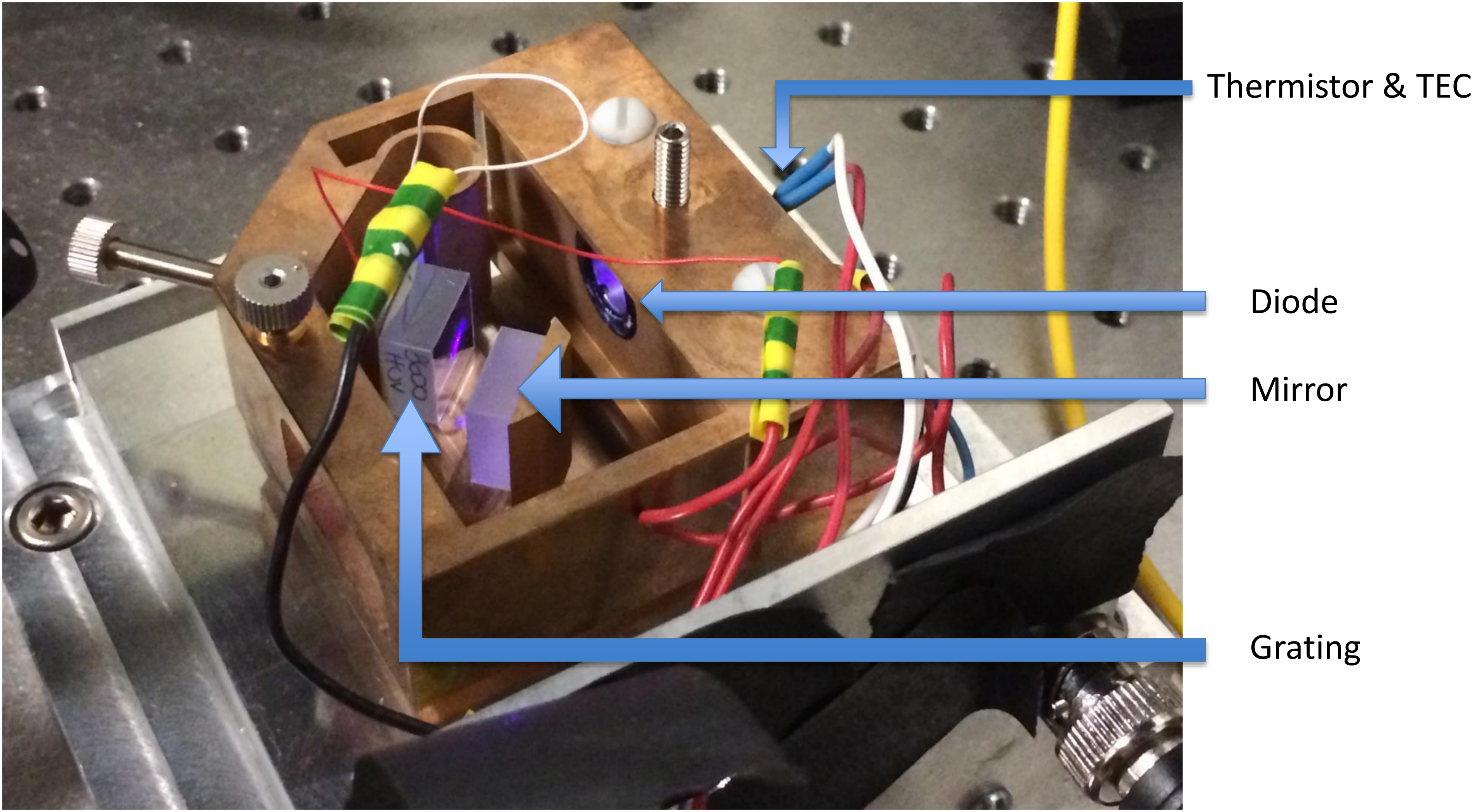
- Difficult to adjust position of grating
- Open cavity
- Thermistor far from diode
- Susceptible to air currents
- Uses gravity to hold itself down

- Easier to seed
- Thermally isolated
- Close off from the environment
- Monolithic
- Phosphor Bronze
  - High thermal conductivity

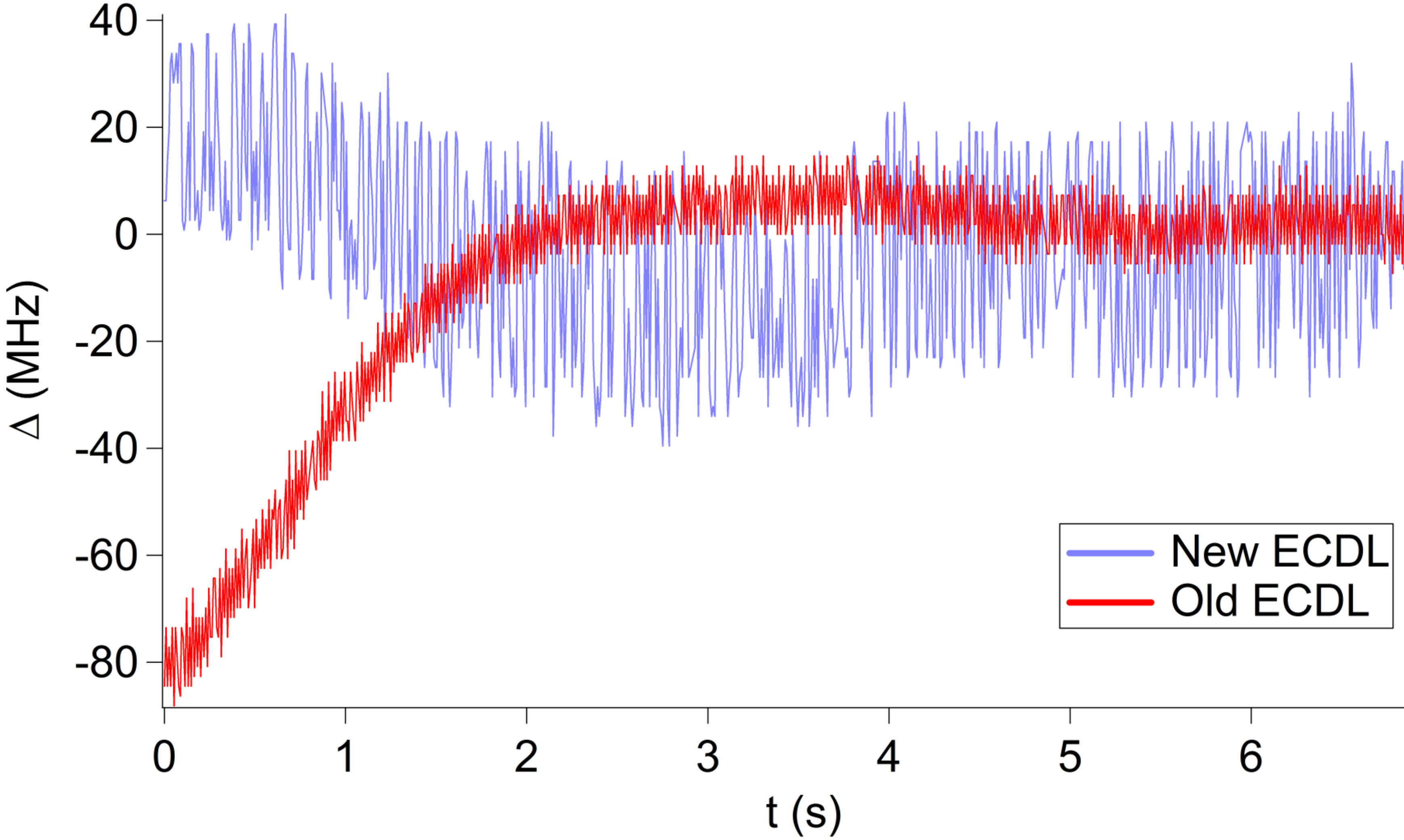
New ECDL



New ECDL

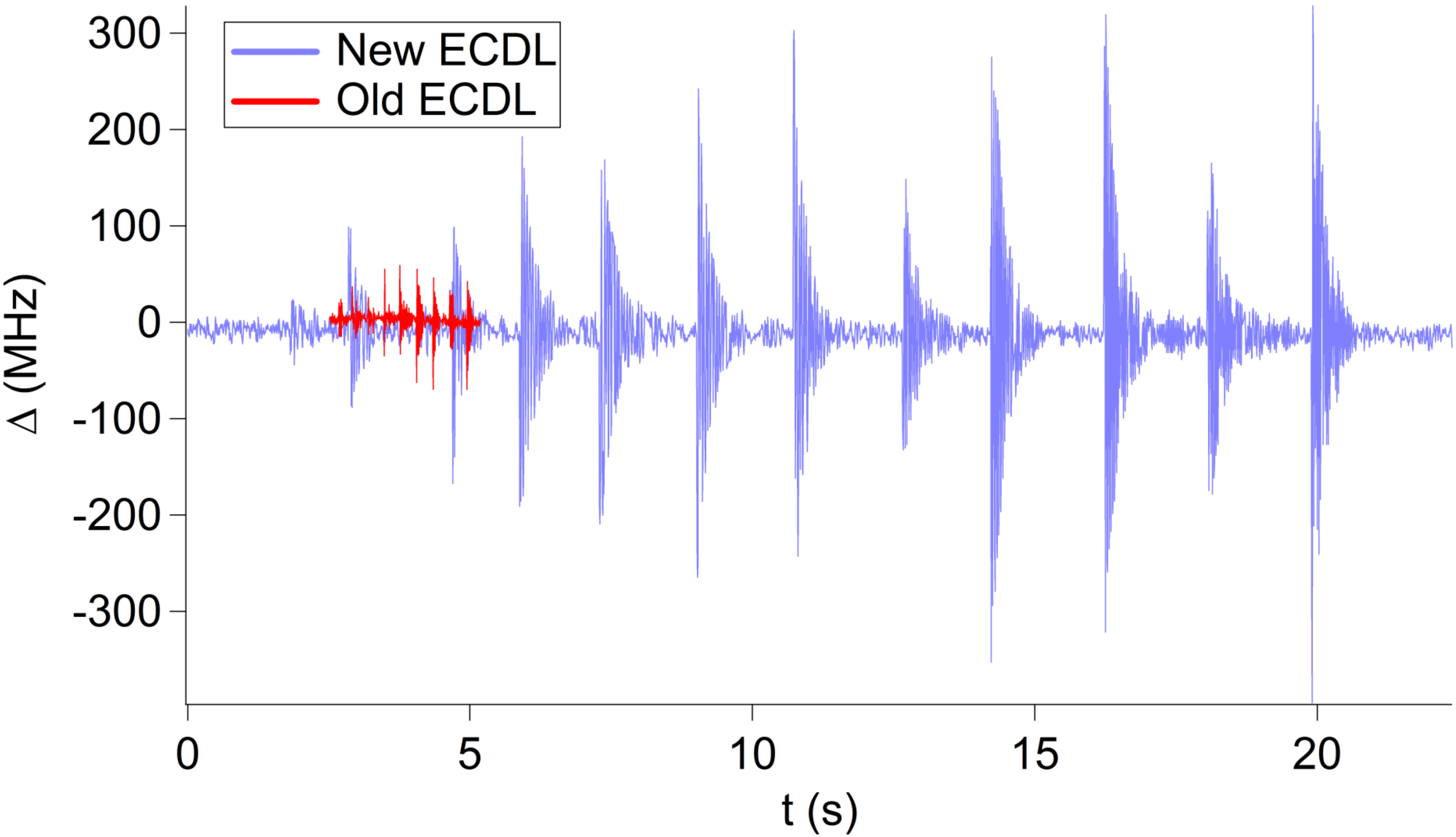


New ECDL – Air Currents



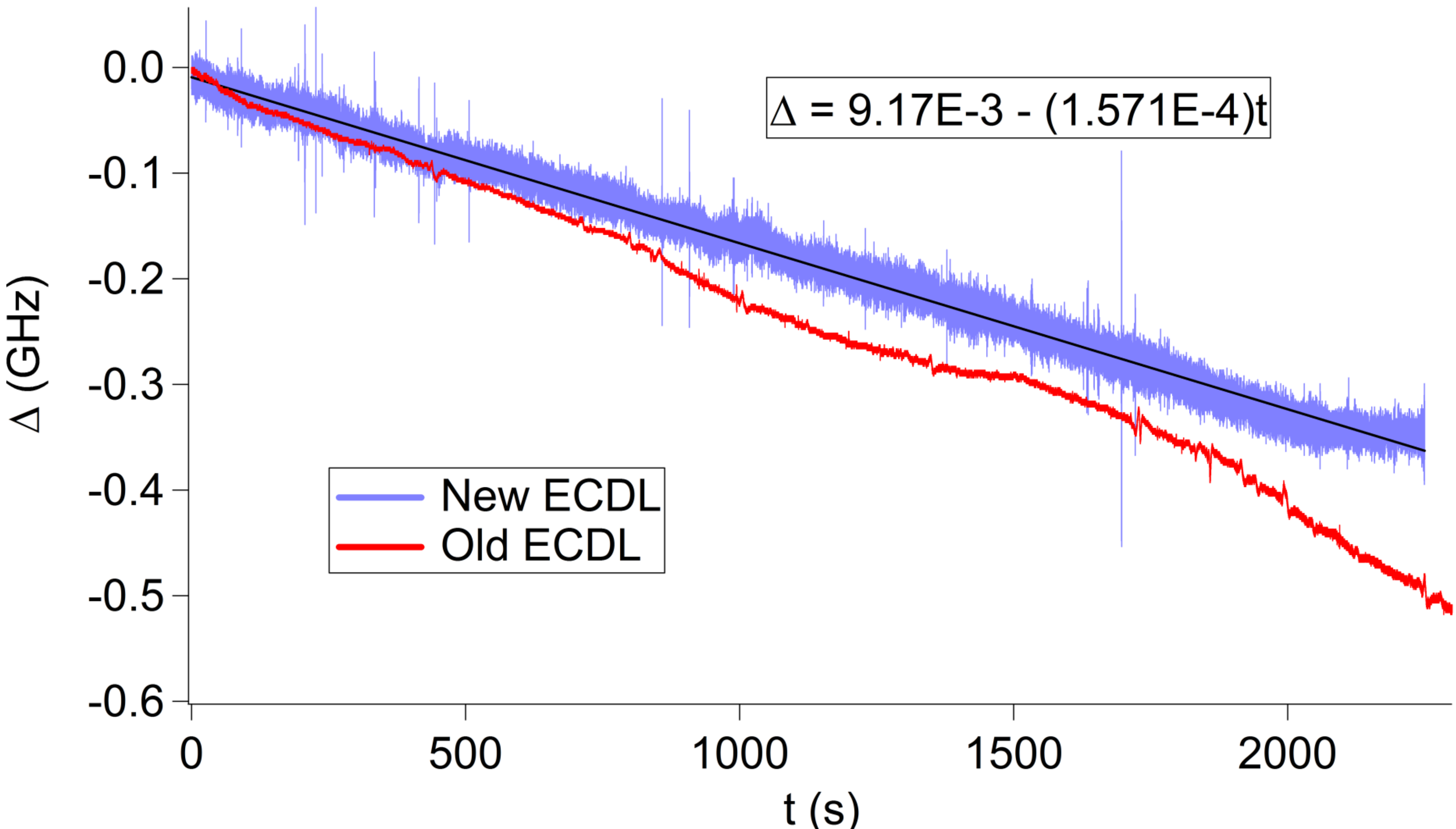
Roughly ~2s to equalize

New ECDL – Vibrations



Larger disturbance in wavelength (could be due to instability in mode)

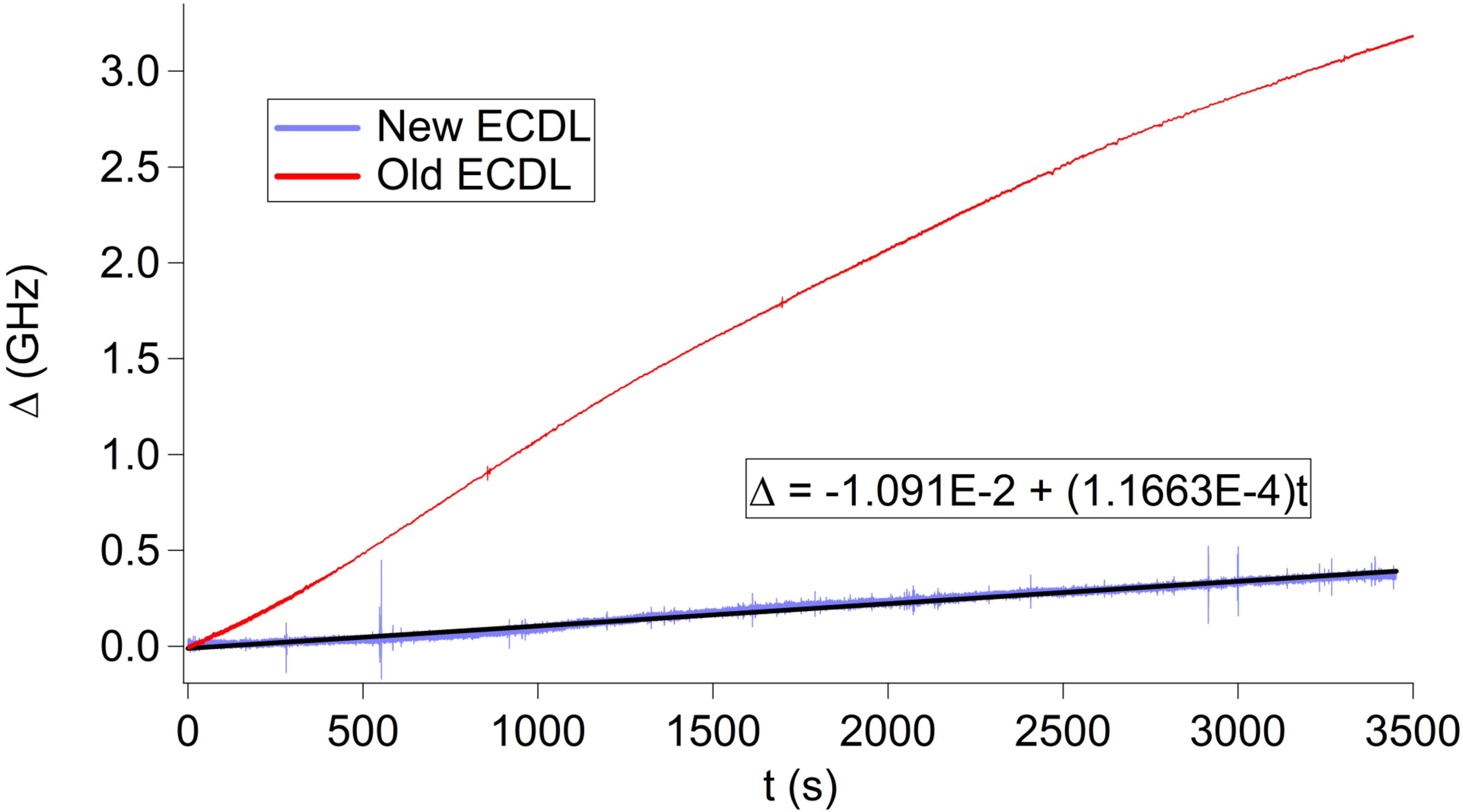
New ECDL – Long-term Drift



Data taken in morning

~0.2 MHz/s change

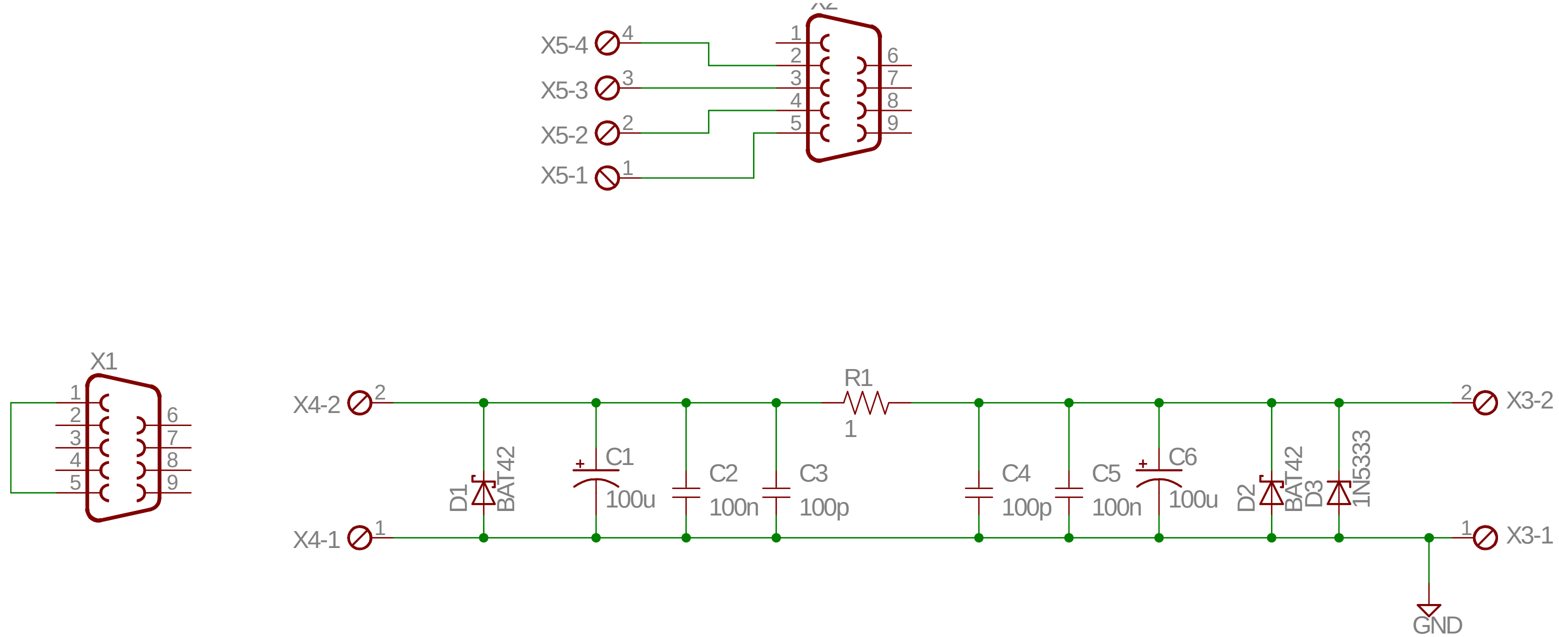
New ECDL – Long-term Drift

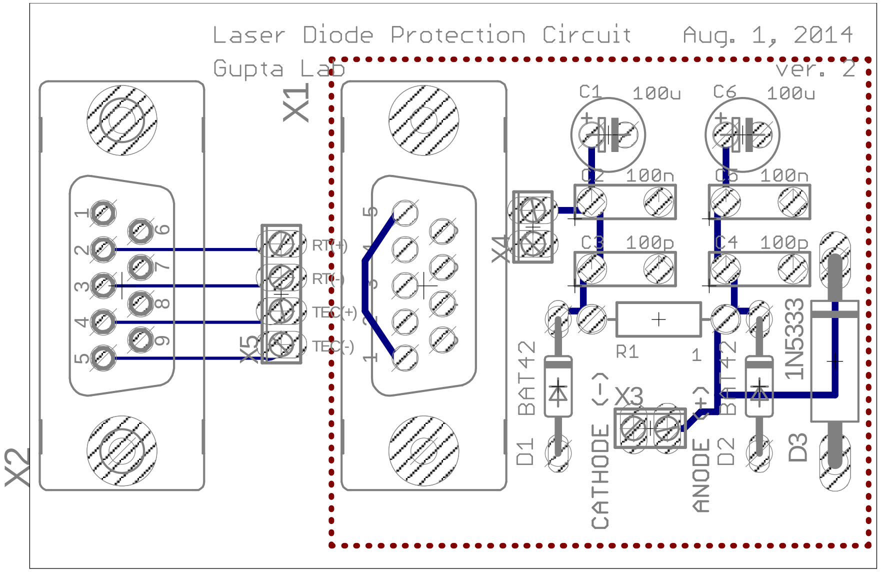


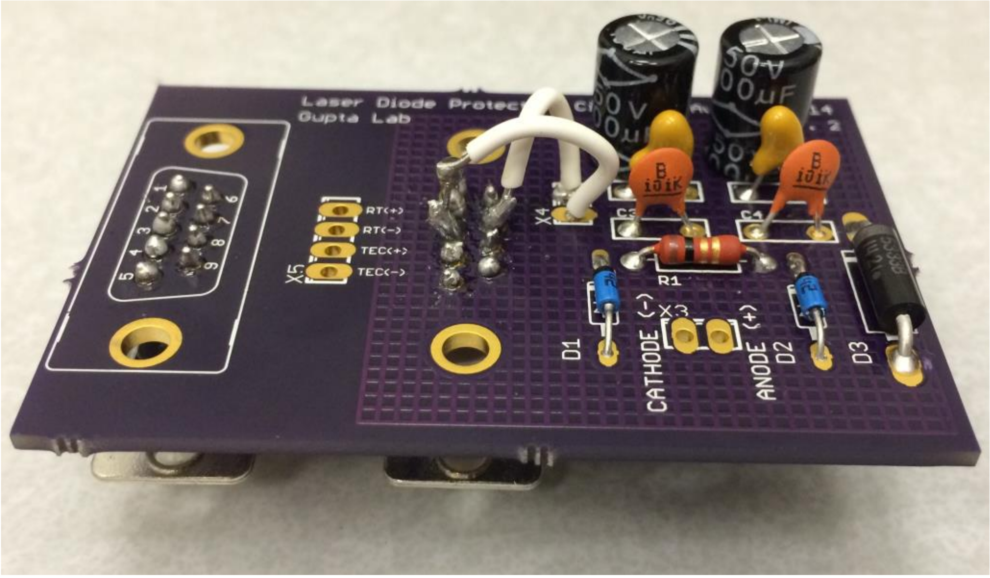
Data taken in afternoon

~0.1 MHz/s change

Protection Circuit

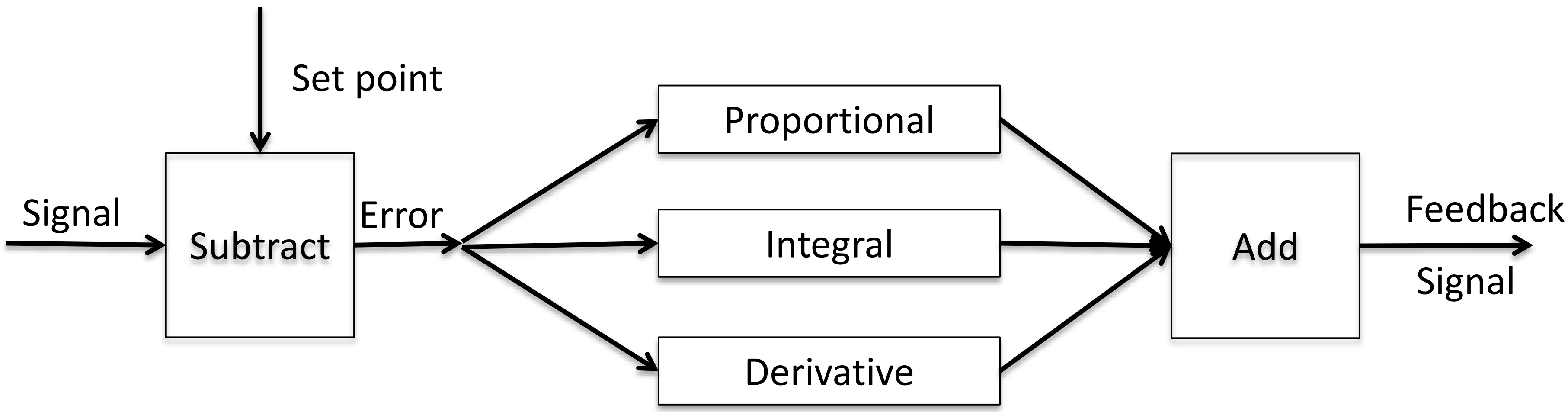






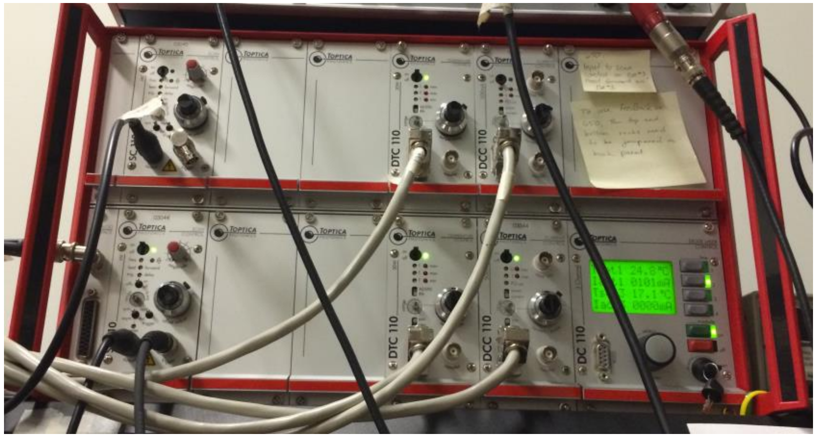
Locking Software

PID Controller

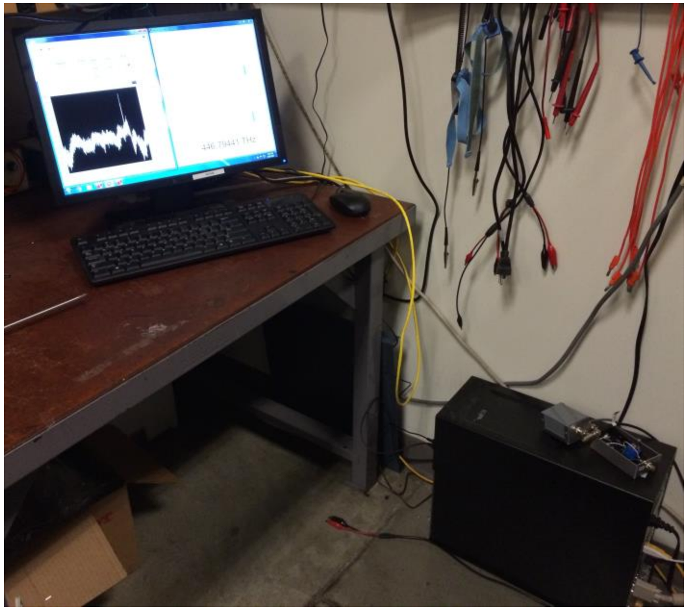


Set/control frequency of diode and stabilize output

Locking Software

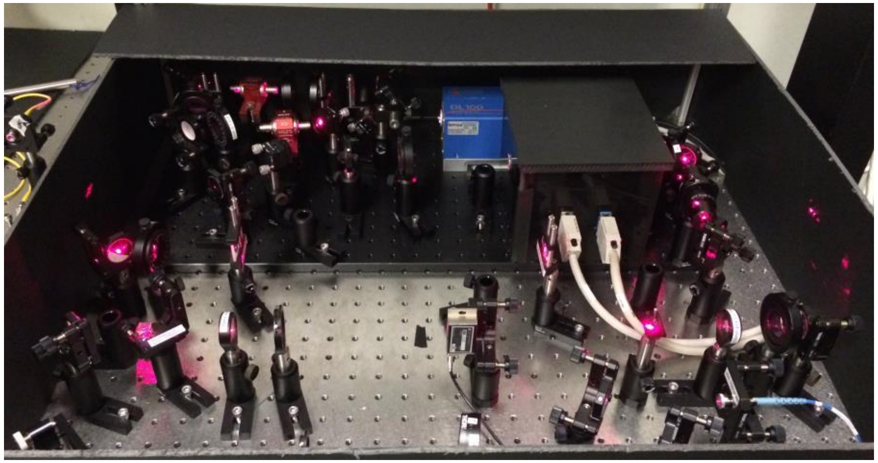


Signal to correct any deviation

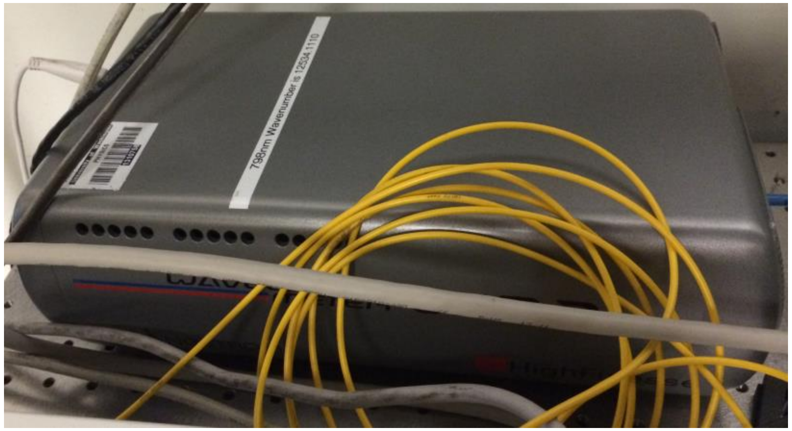


Send current
Drives piezo

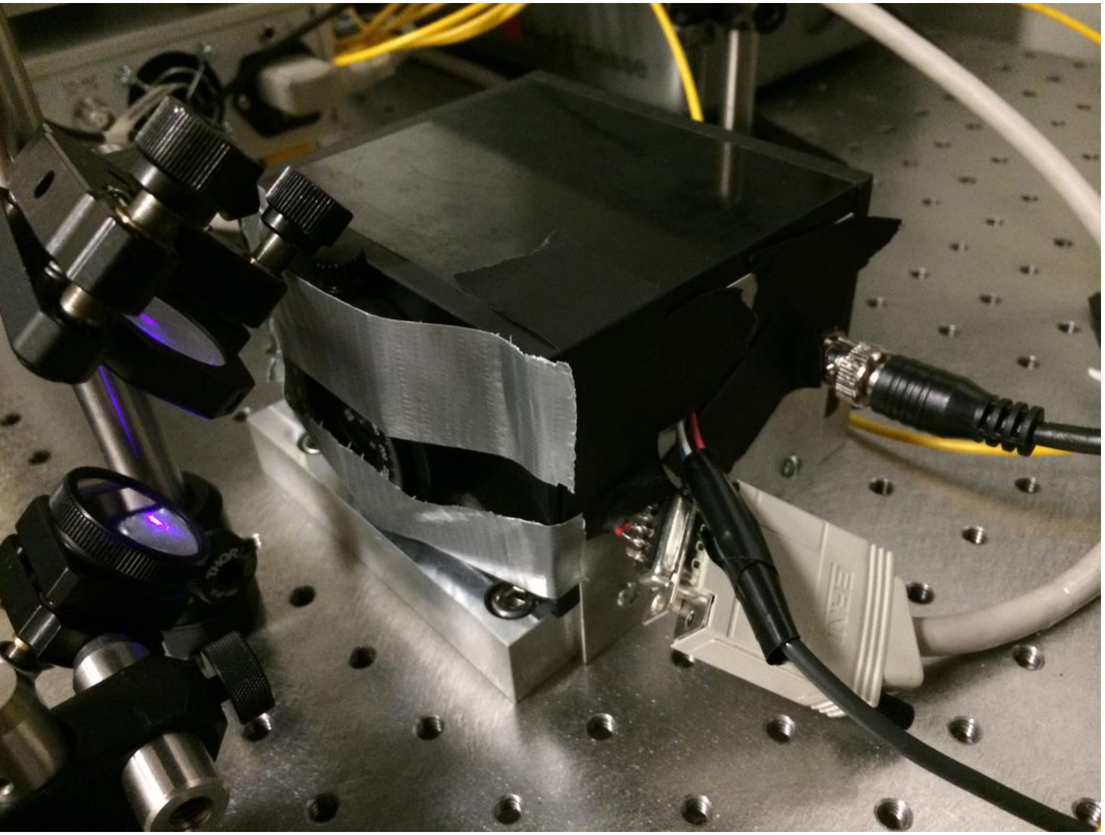
Data sent to computer



Measure
λ



Future Enhancements



Install circuit boards and finish construction of ECDL

Jury-rig old ECDL housing to hold the 2nd gen ECDLs

Run similar stability tests

Find the right conditions for the desired mode

Install in experiment and hope it does the job

Acknowledgements

- Dr. Subhadeep Gupta
- Ricky Roy, Raj Shrestha, Alaina Green, Will Dowd
- Ron Musgrave
- Linda Vilett, Janine Nemerever, Alejandro Garcia
- NSF-REU for funding