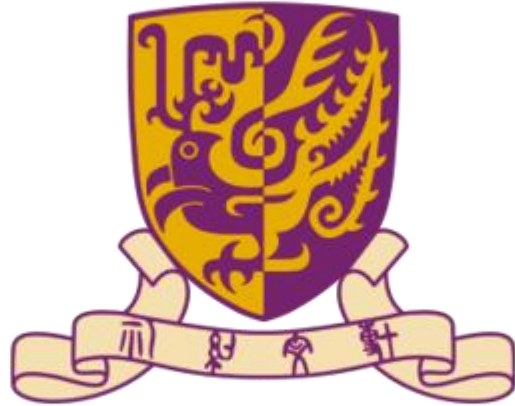


Laser Locking by Modulation Transfer Spectroscopy



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Background

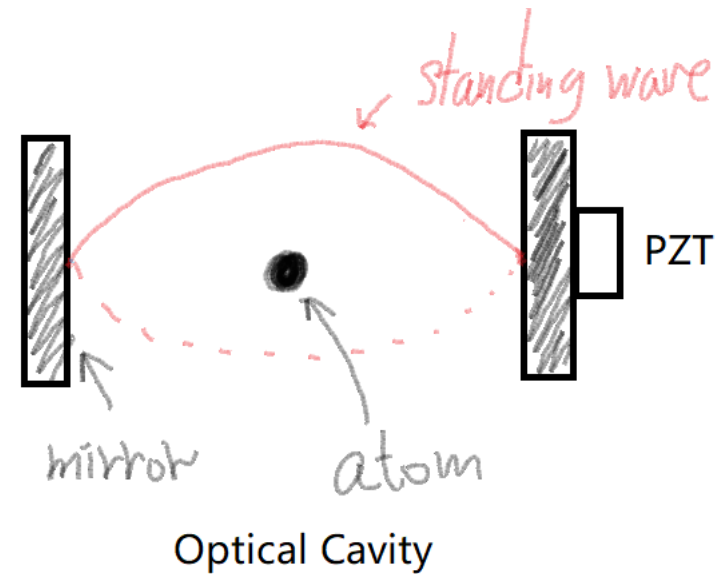
- Cold-Atoms Lab, playing with **synthetic lattices**
- Atomics Specise – Na, Rb
- Final goal is to study Cold NaRb molecule
- NaRb- Strong Dipole-dipole interaction for Quantum simulation



Why we need
LASER?

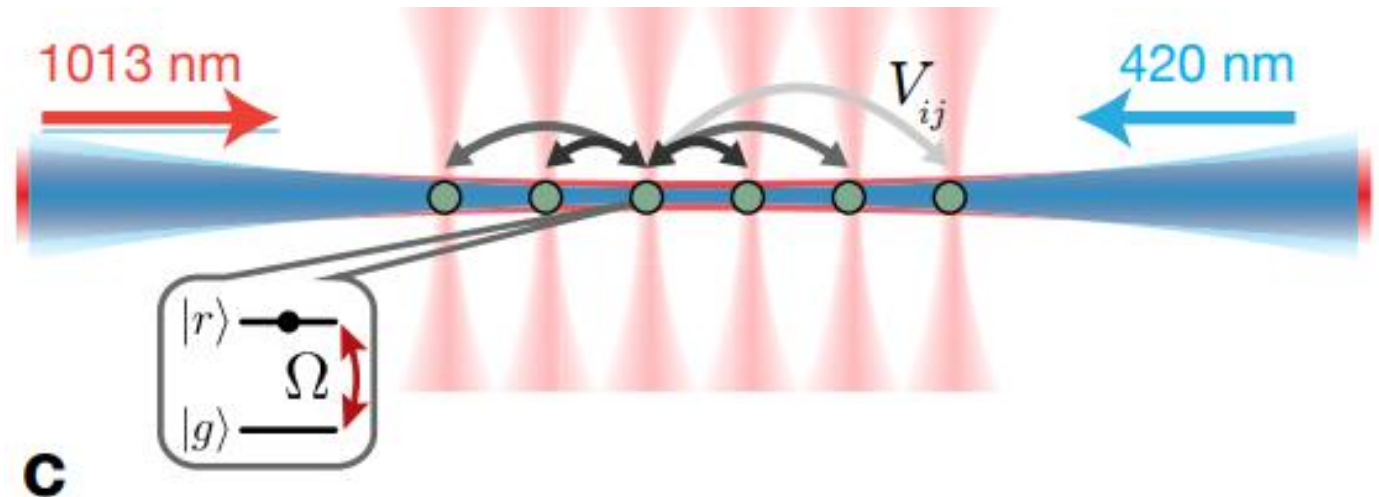
What is LASER

- Full name: Light amplification by stimulated emission of radiation
- Copy the photons (L). 1 to 2, 2 to 4, 4 to 8 ... (A) with same frequency, polarization and direction of propagation (SER)
- Repeat the identical transition



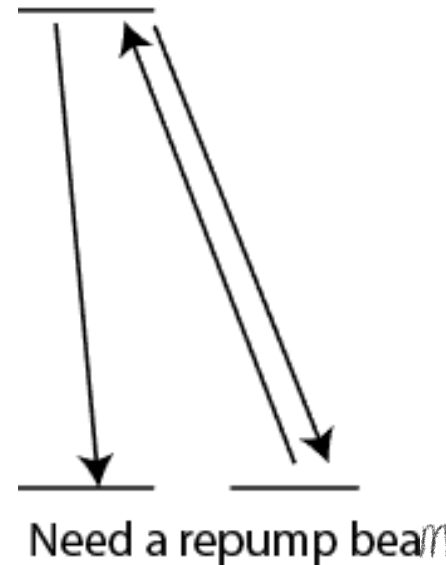
With LASER, we can...

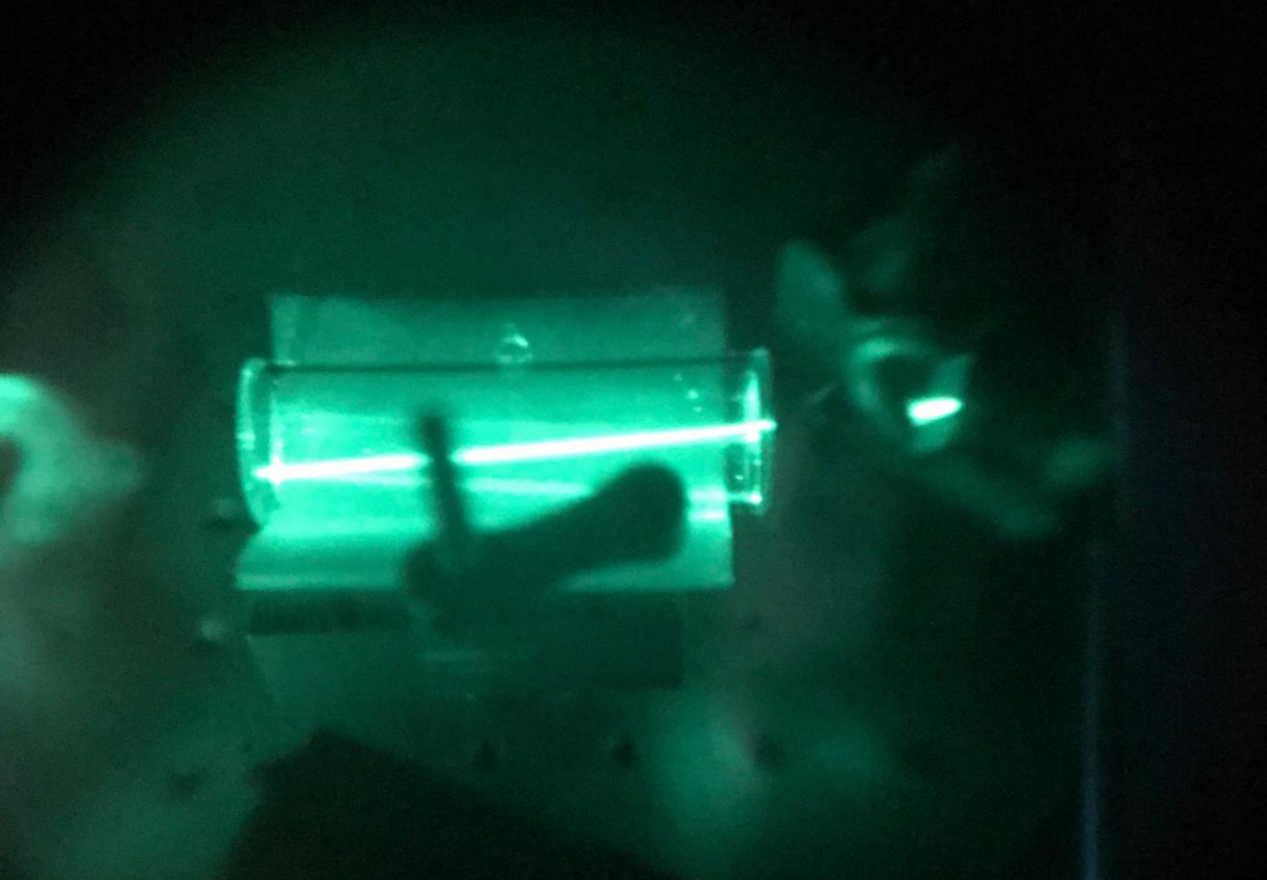
- Laser Cooling
- Create Optical lattice
- Create dipole trap for evaporative cooling
- Create optical tweezer to arrange atoms
- Some of them are calling for a precise laser frequency...



Calling for Precise Laser Frequency

- To achieve laser cooling, pump the atoms in to a cycling transition
- Some times we need to repump the atoms who went wrong...
- Especially for atomic species with narrow line-width...

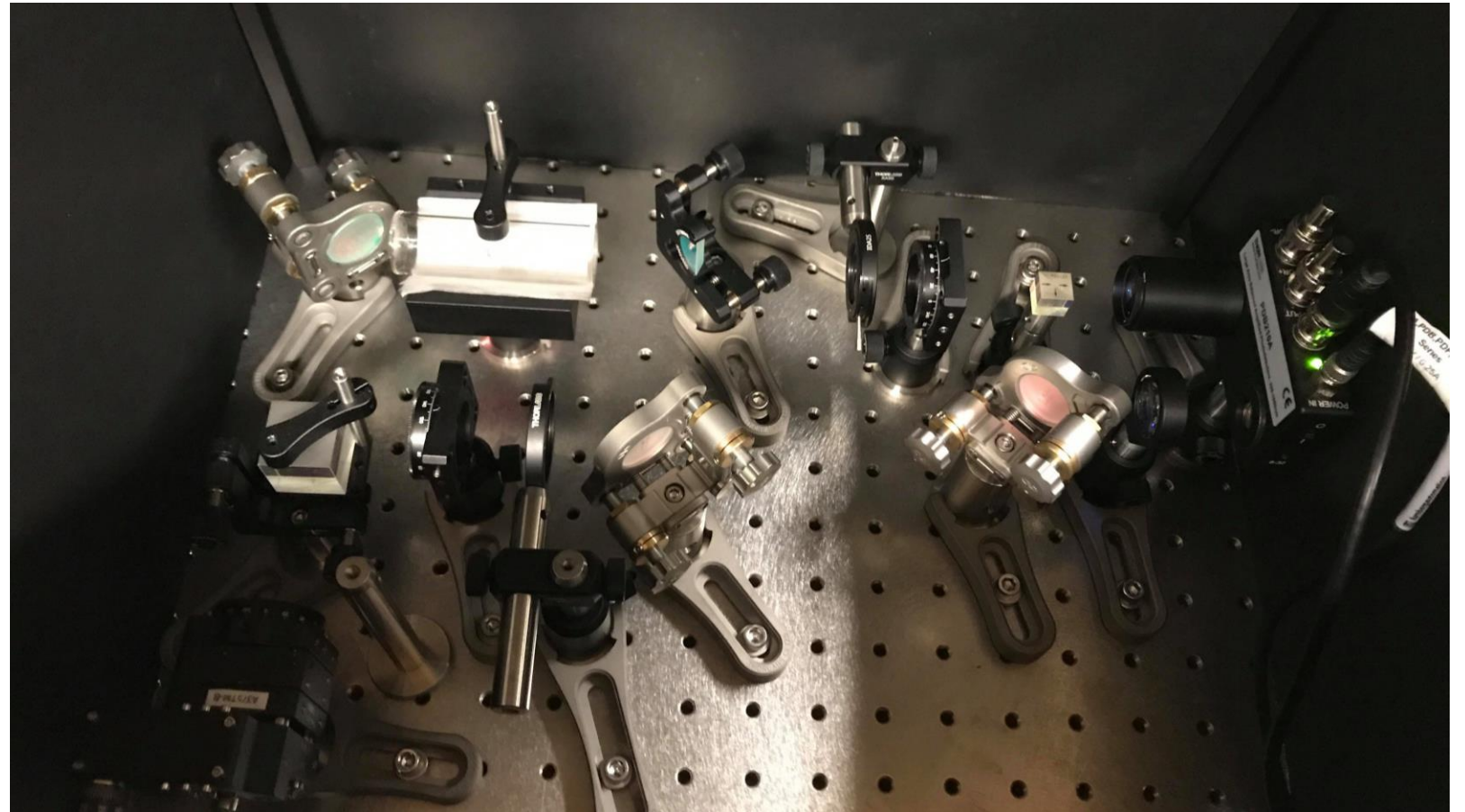




How do we know if the frequency is good..

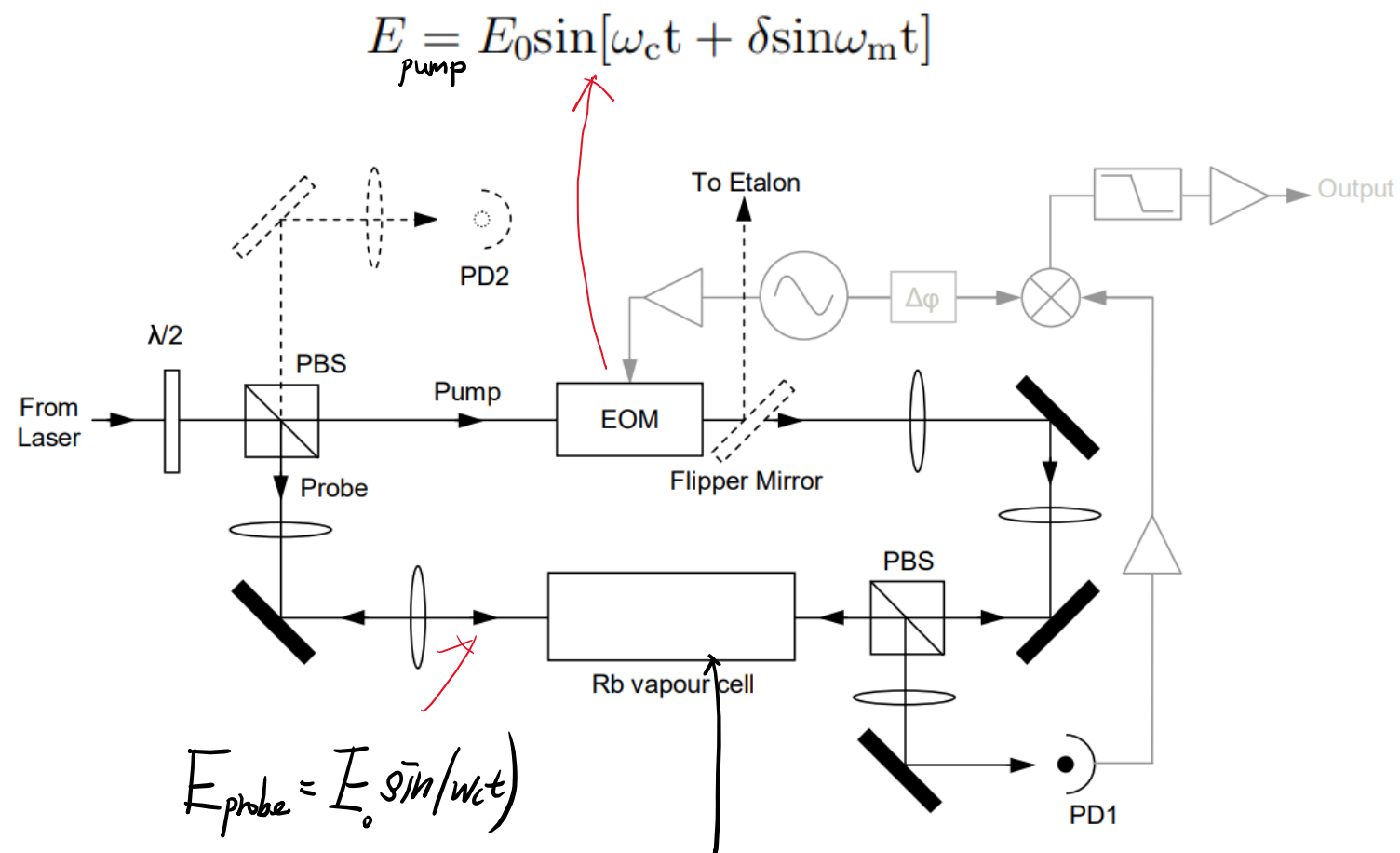
Spectroscopy

- Saturation Absorption Spectroscopy
- Polarization Spectroscopy
- Modulation Transfer Spectroscopy



(Phase) Modulation Transfer Spectroscopy

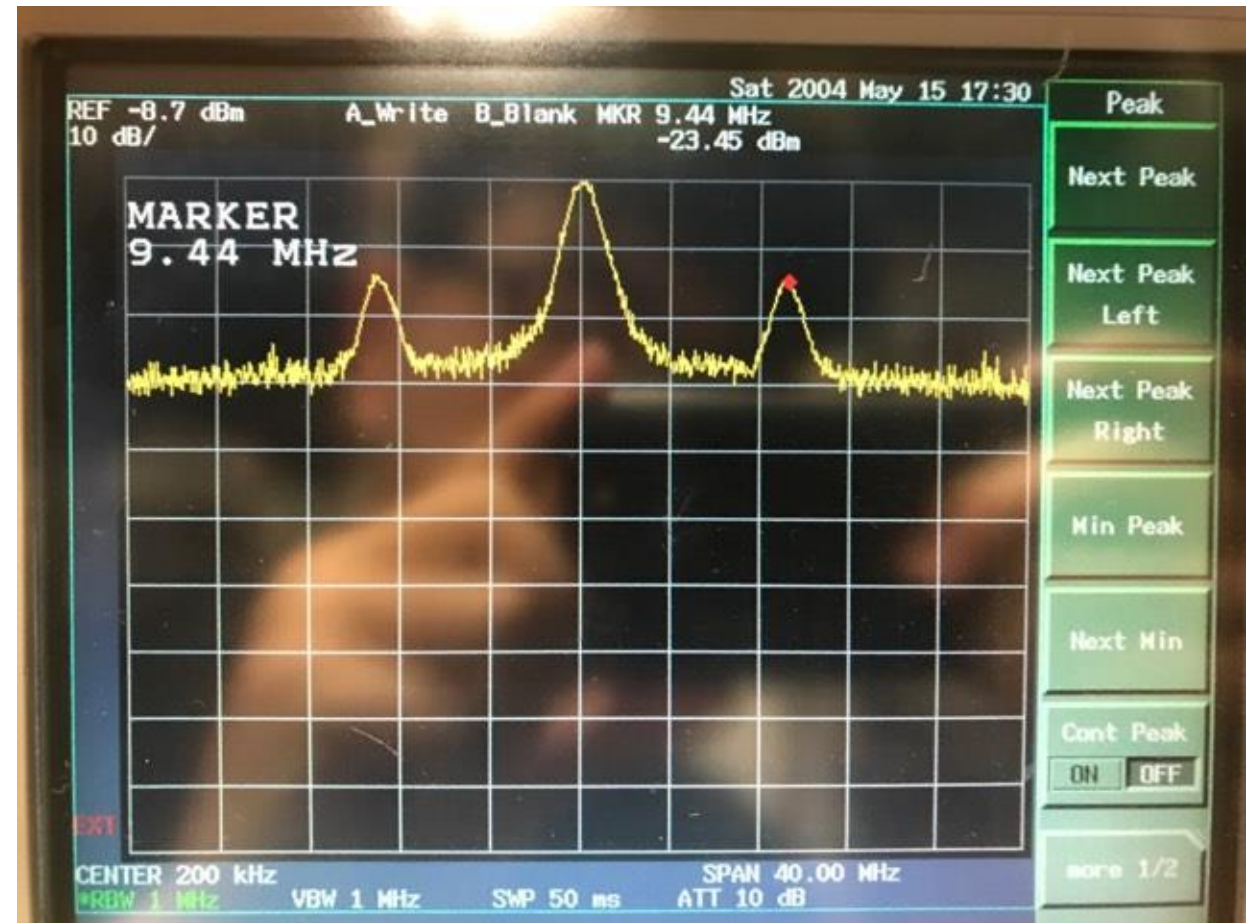
Let me explain...



$$P = \chi^{(1)} E + \chi^{(2)} E E + \chi^{(3)} E E E + \dots$$

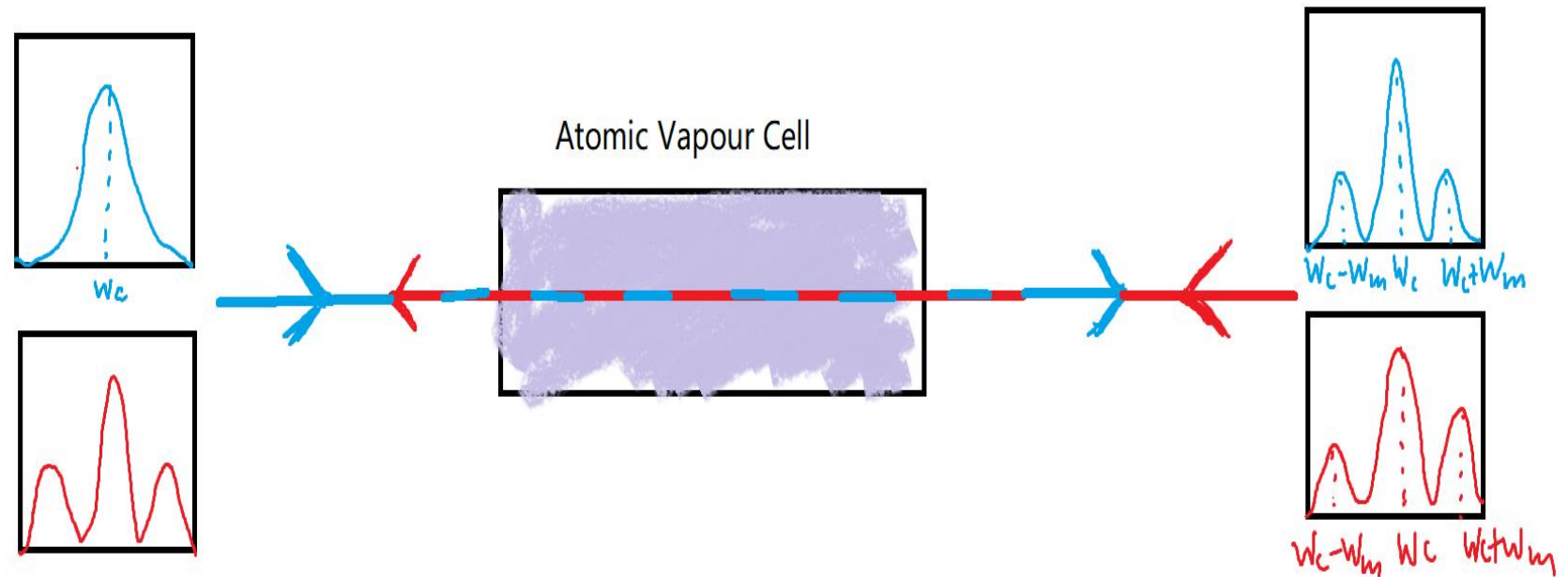
Phase modulation gives sidebands

- Looking at an old spectrometer
- Two obvious and strong sidebands



In the vapour cell

- The sidebands transfer to probe beam and beat with it via four wave mixing process



Frequency discrimination

- Four wave mixing only happen at certain frequency
- When we see the beat notes we know the laser frequency is detuned

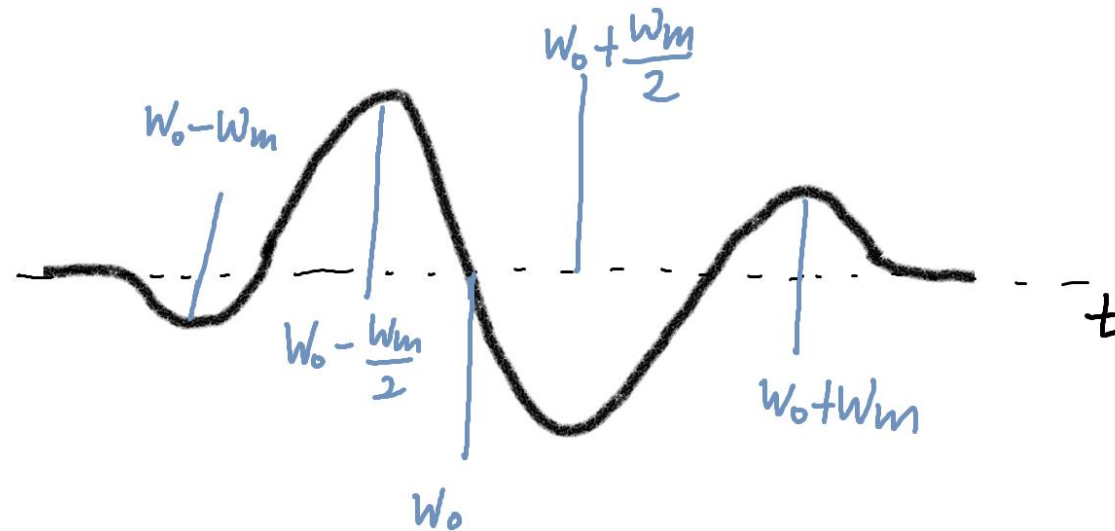
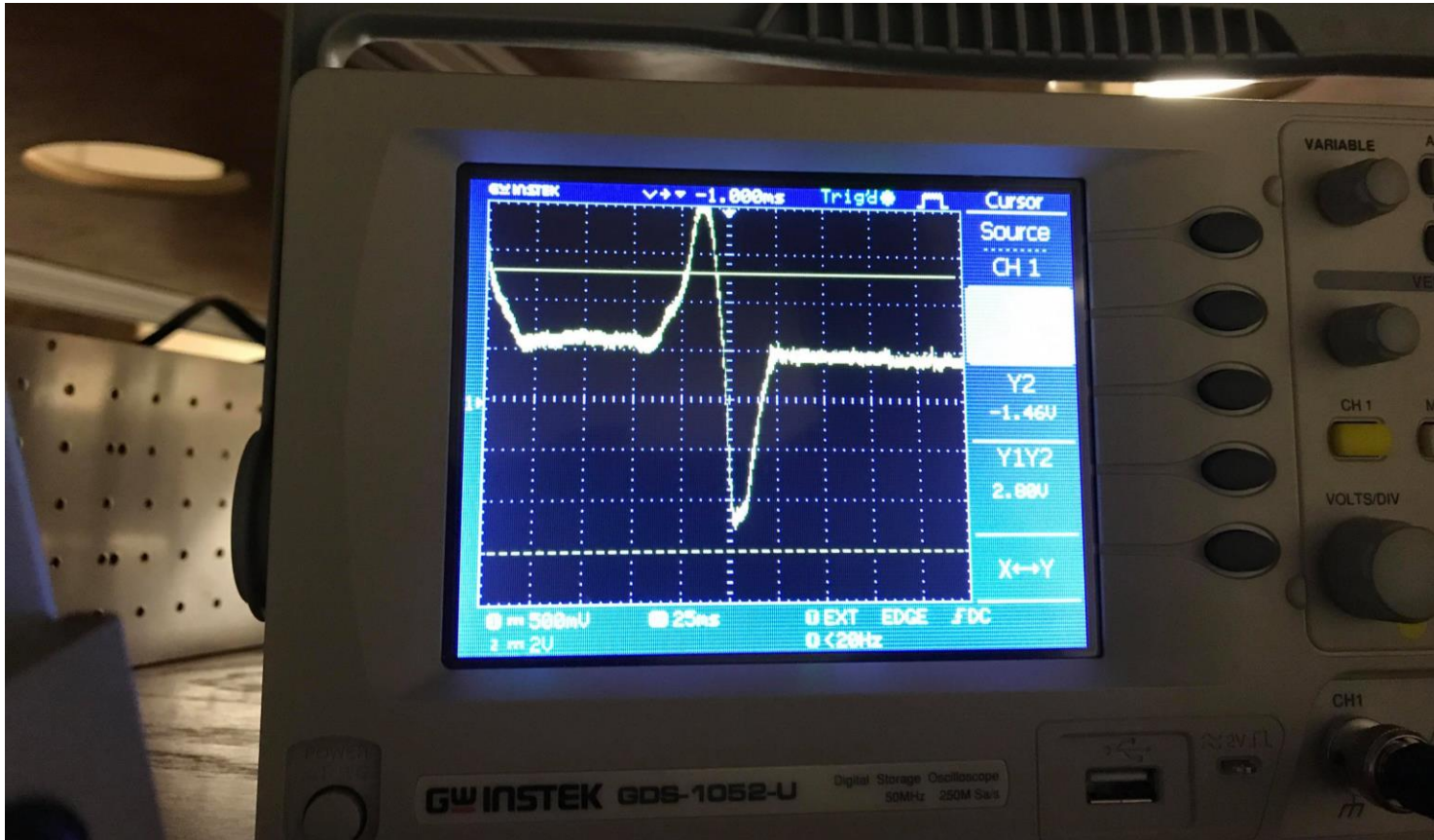


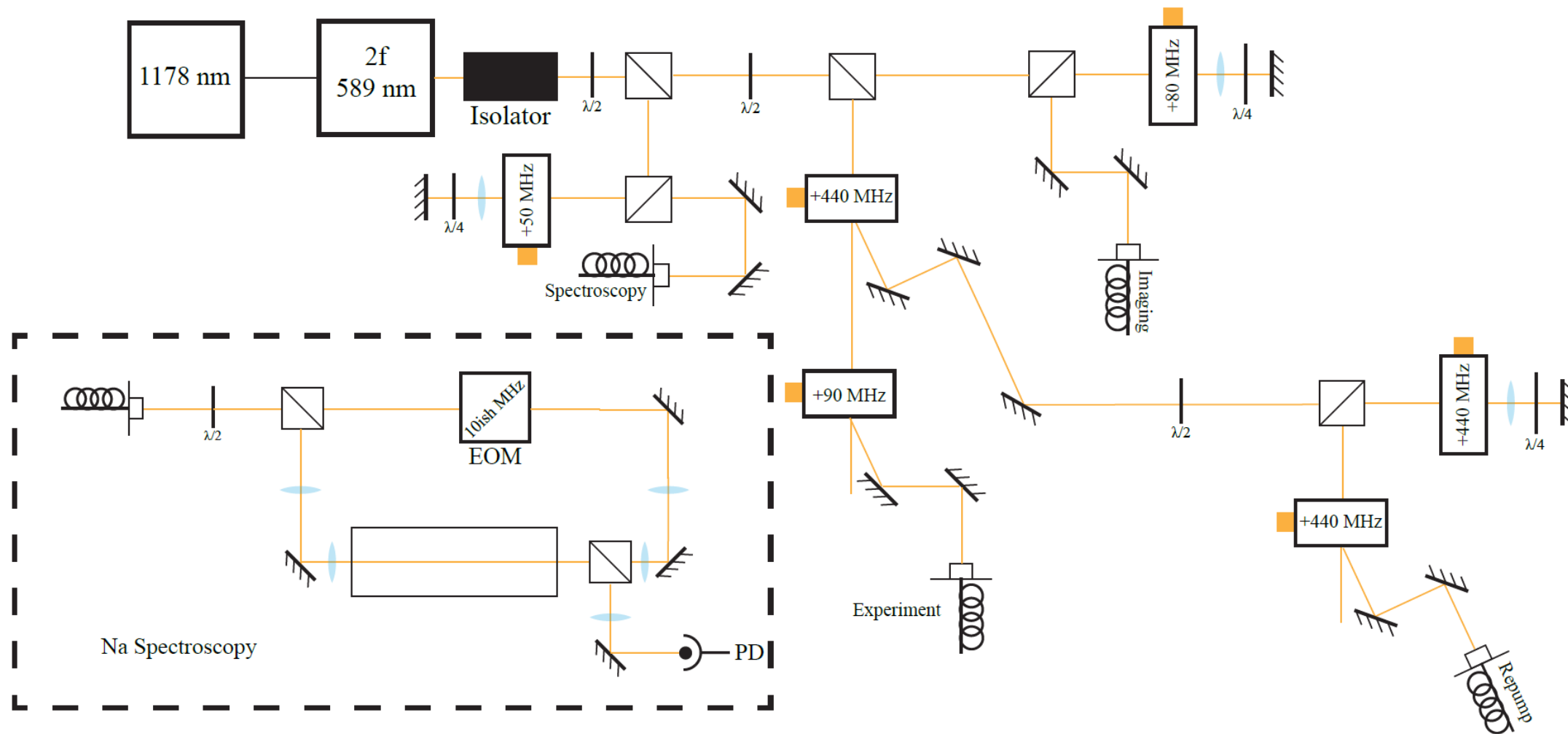
Image on oscilloscope



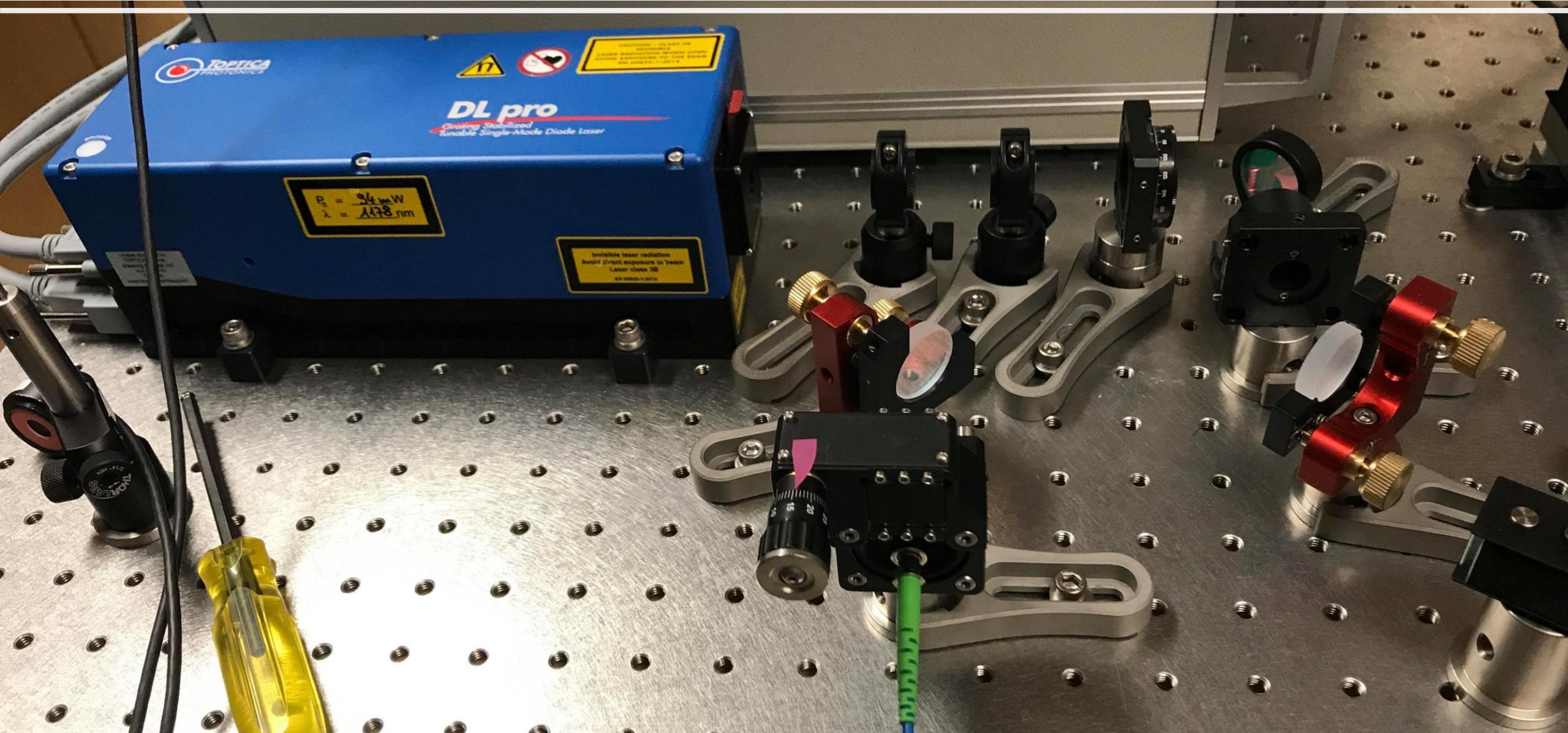
- With MTS, the signal will be much steeper and narrower bandwidth
- Also the Back ground noise is relatively low

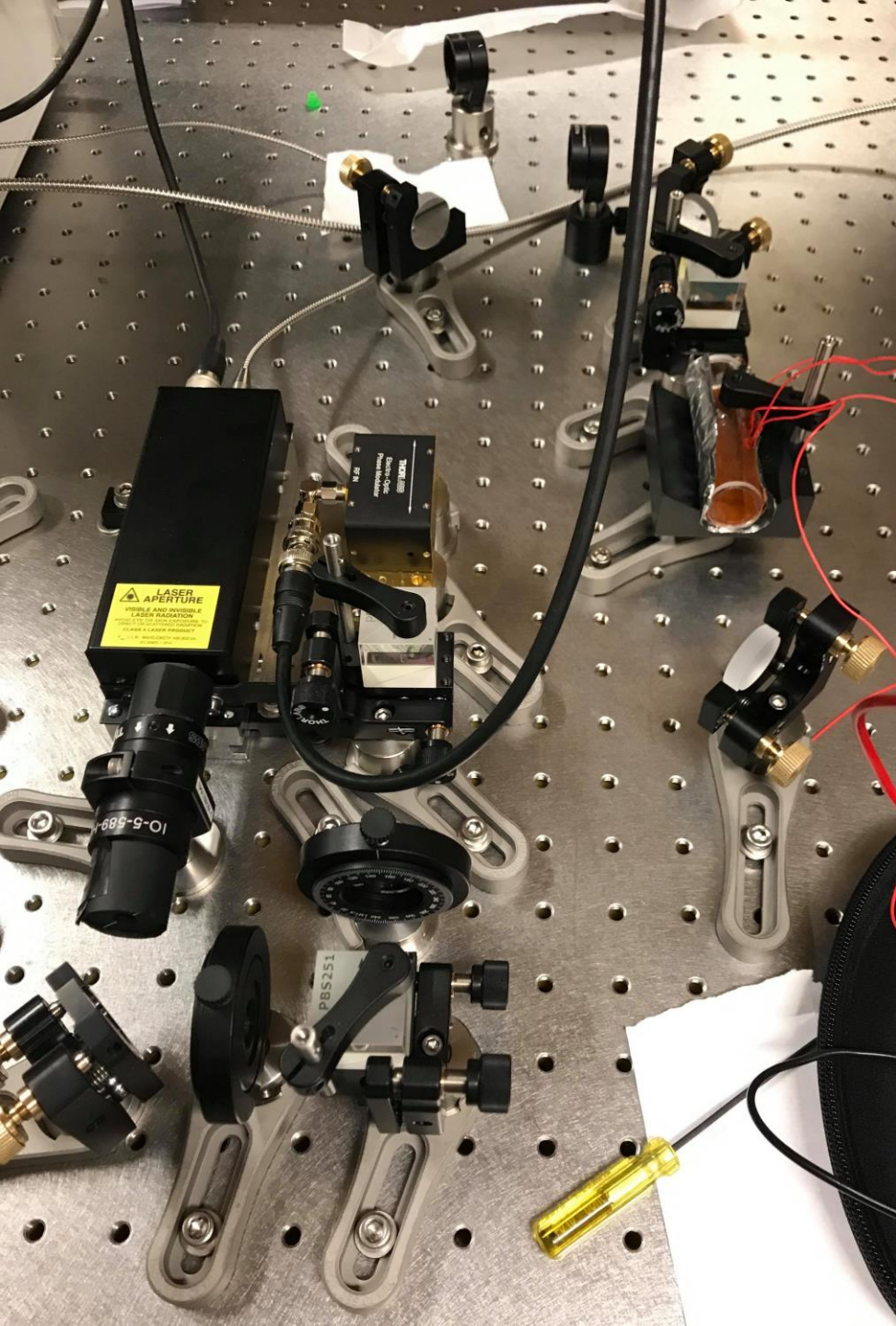
Similar Dispersive Line-shape
on Polarization Spectroscopy

Light for the experiment

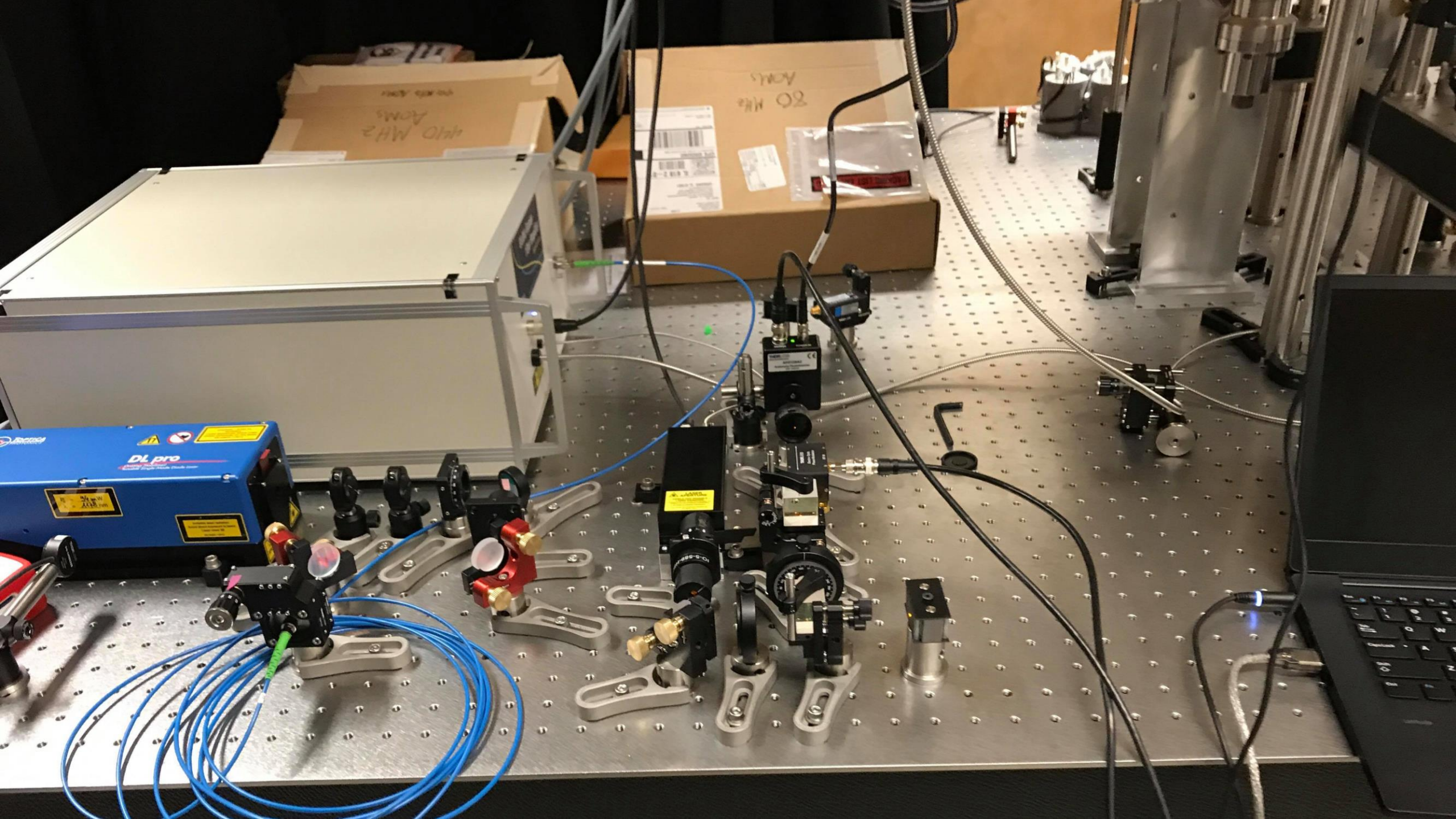


What it actually looks like





What it actually
looks like



Future work

- Use the locked sodium laser to create a MOT for sodium
- Place the BECs on top of each other...then molecules...and cool science



Acknowledgement

- Helped provide by Prof. Wang and Prof. Chu
- Supervised by Gadway Lab at UIUC
- Scholarship provided by Phys Dept

