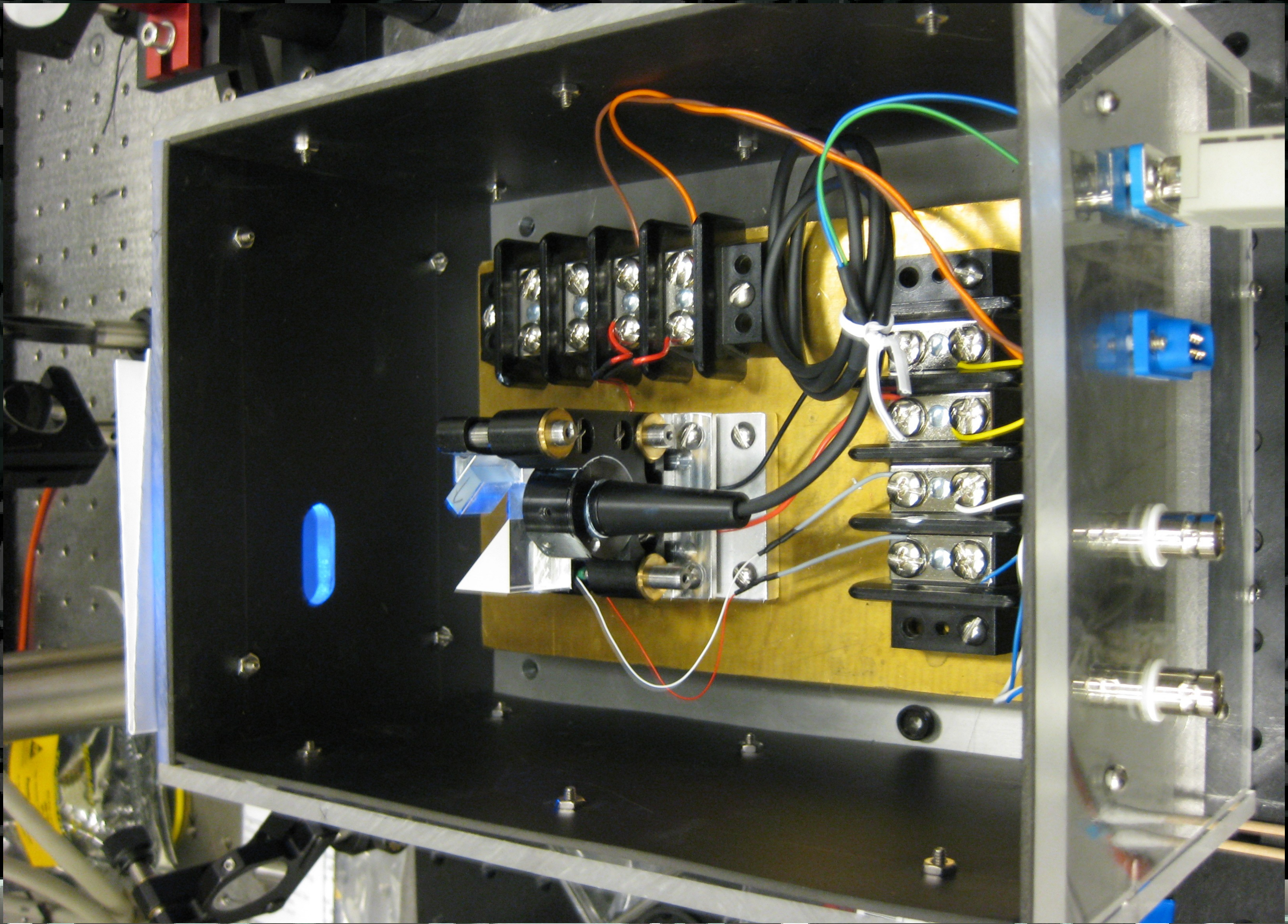
Violet External Cavity Diode Laser

Carson Teale



Diode Laser

Advantages:

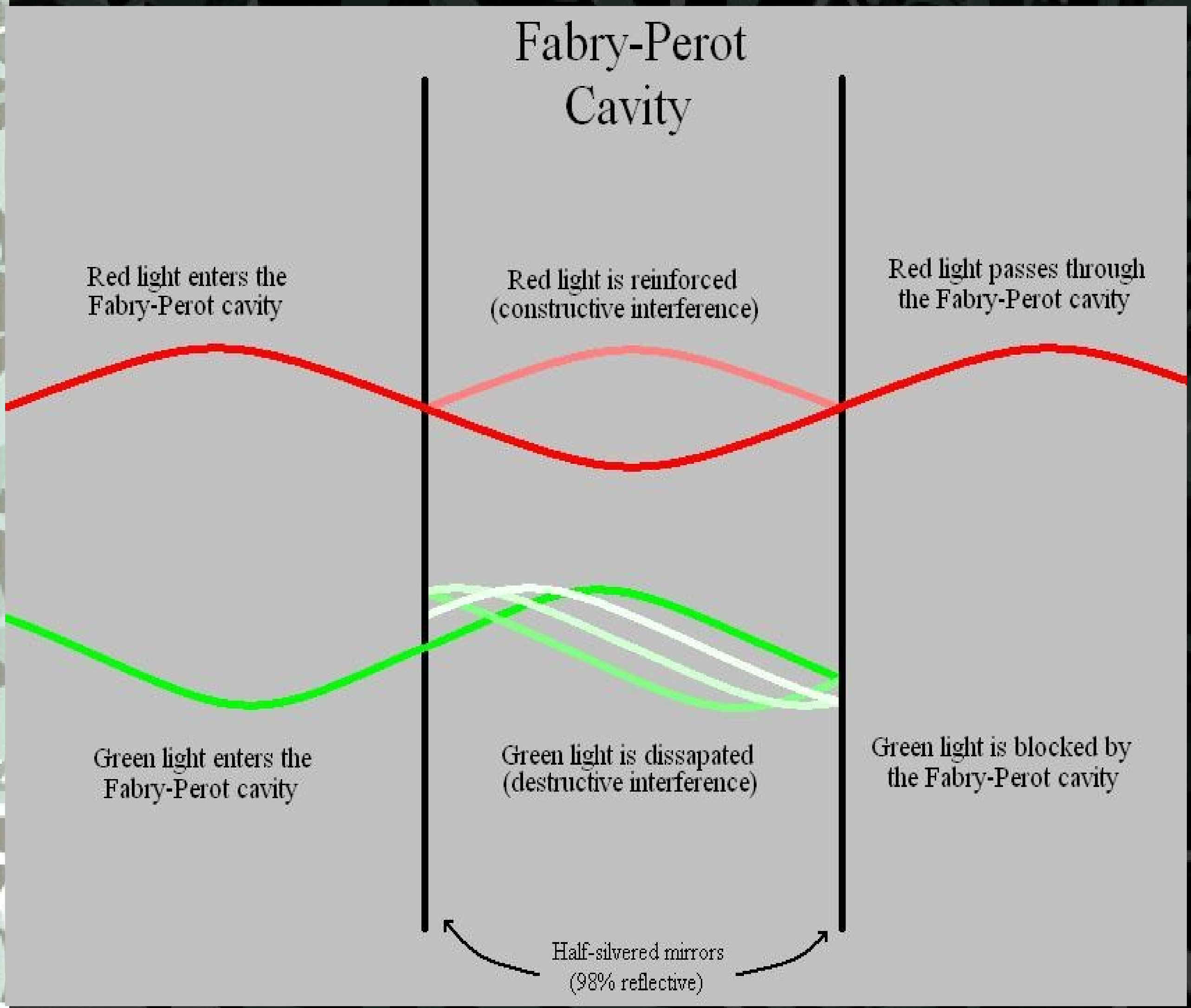
- Cheaper and smaller than many other types of lasers
- Minimal power requirements
- Stable amplitude

Problems:

- Large linewidth
- Poor tunability

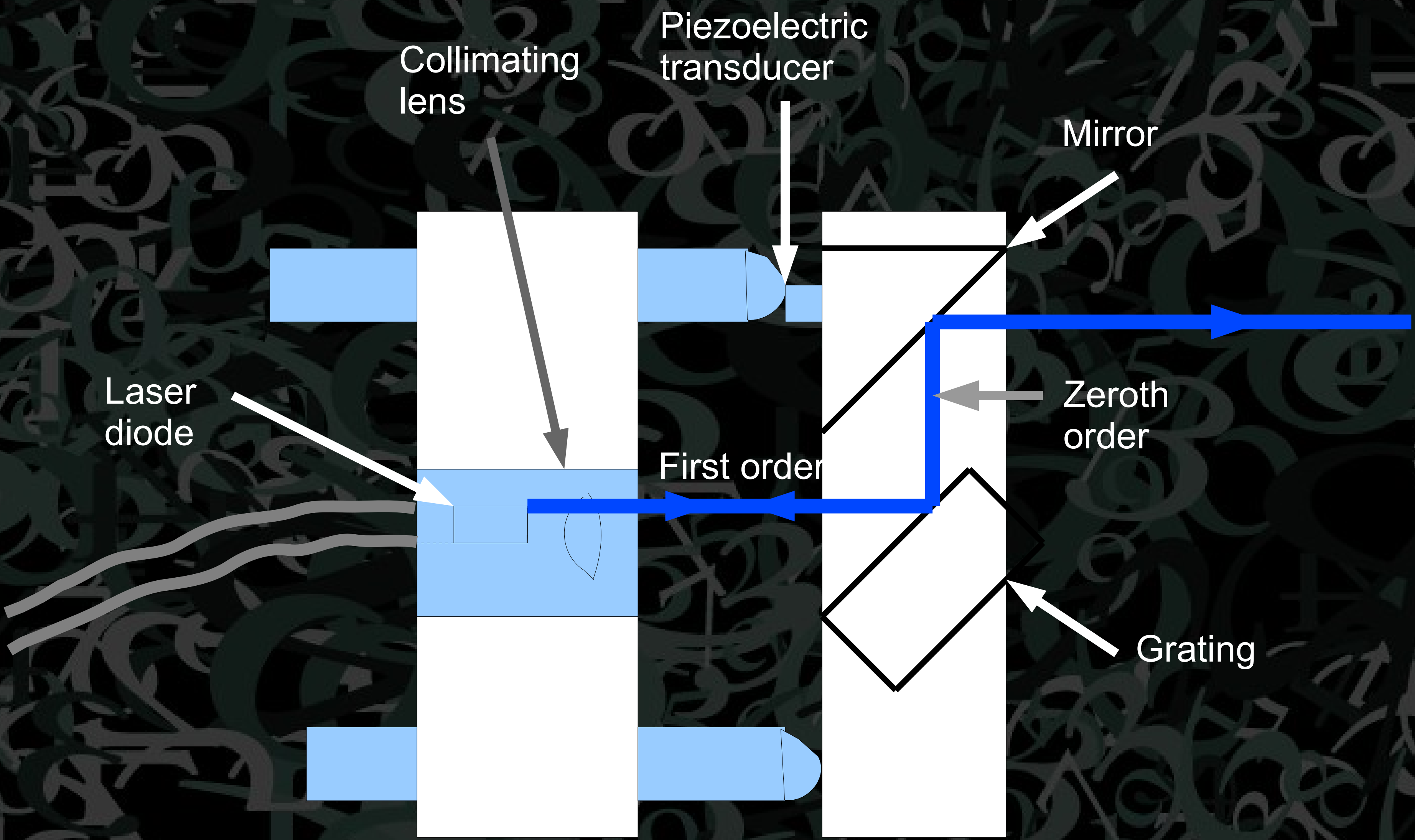
External cavity

- Creates a standing wave dominated by a single wavelength
- Narrows linewidth
- Increases tunability

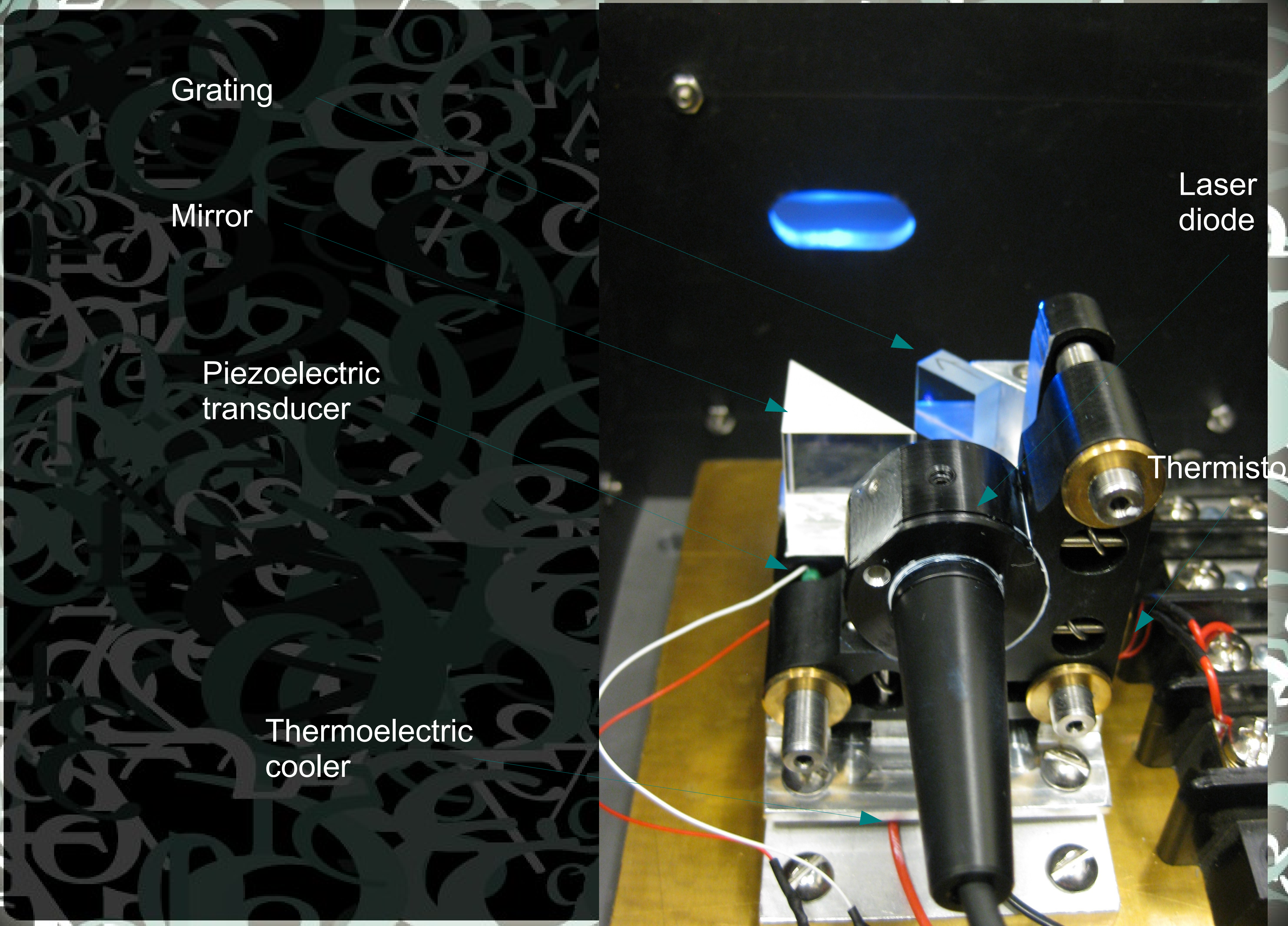


- Cavity cancels out all of the frequencies except those for which the length of the cavity is an integer number of half wavelengths
- Cavity is formed between the face of the diode and a diffraction grating

Top view of laser design

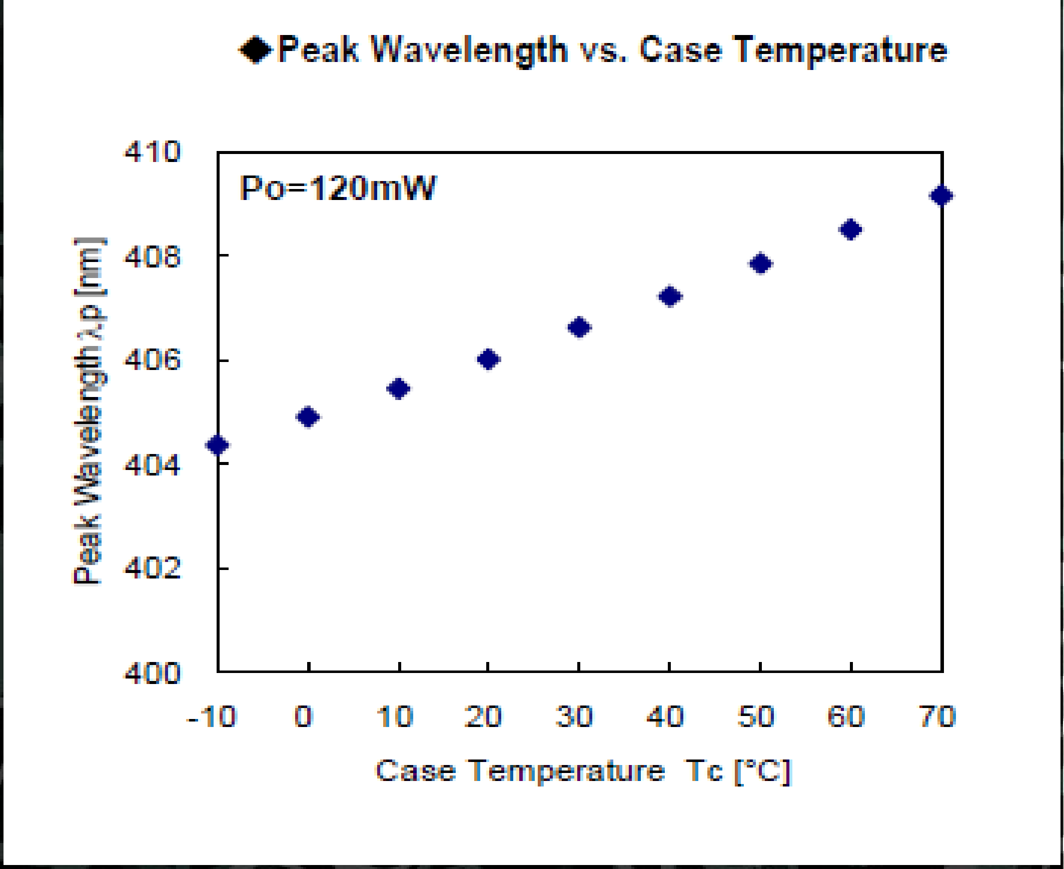


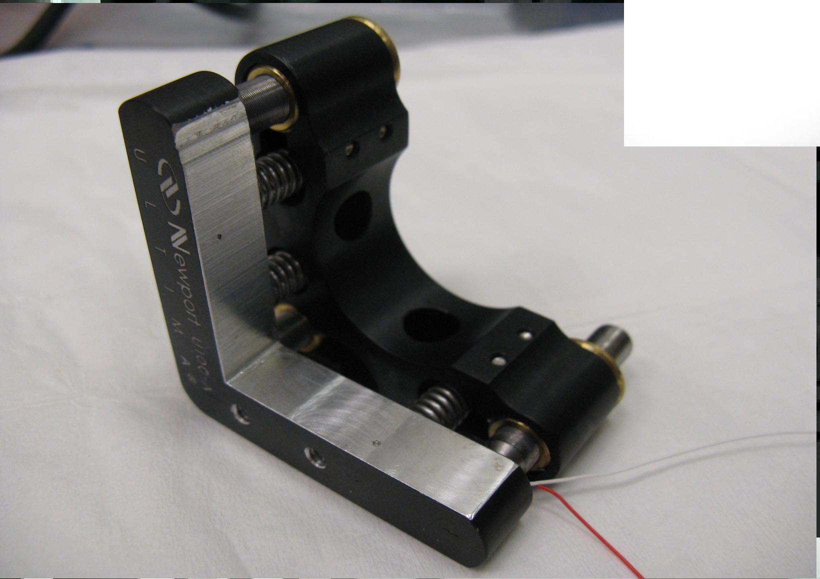
- First order reflects at different angles depending on frequency
- Length of cavity and grating angle can be controlled by adjusting the pins of the mirror mount
- Piezo allows for fine adjustment of grating angle

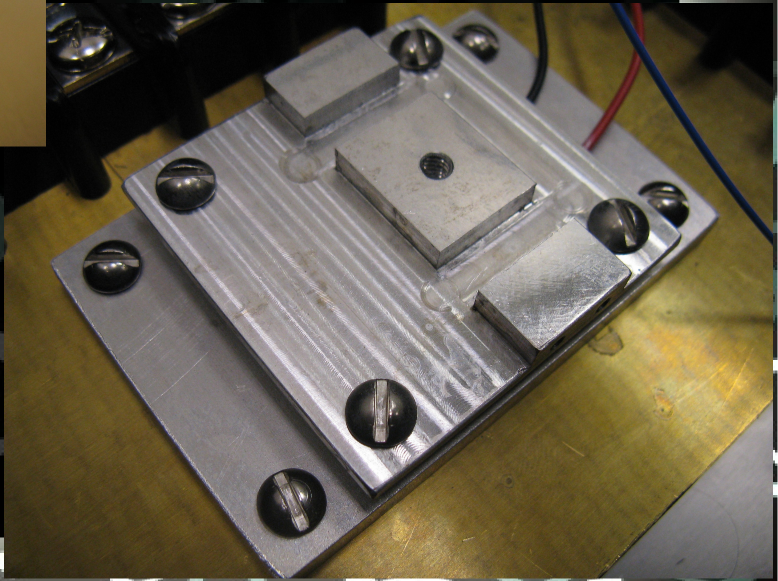

Grating
Mirror
Piezoelectric transducer
Thermoelectric cooler
Laser diode
Thermistor

Temperature dependence

- Wavelength is proportional to the temperature of the diode controlled by the thermoelectric cooler and thermistor

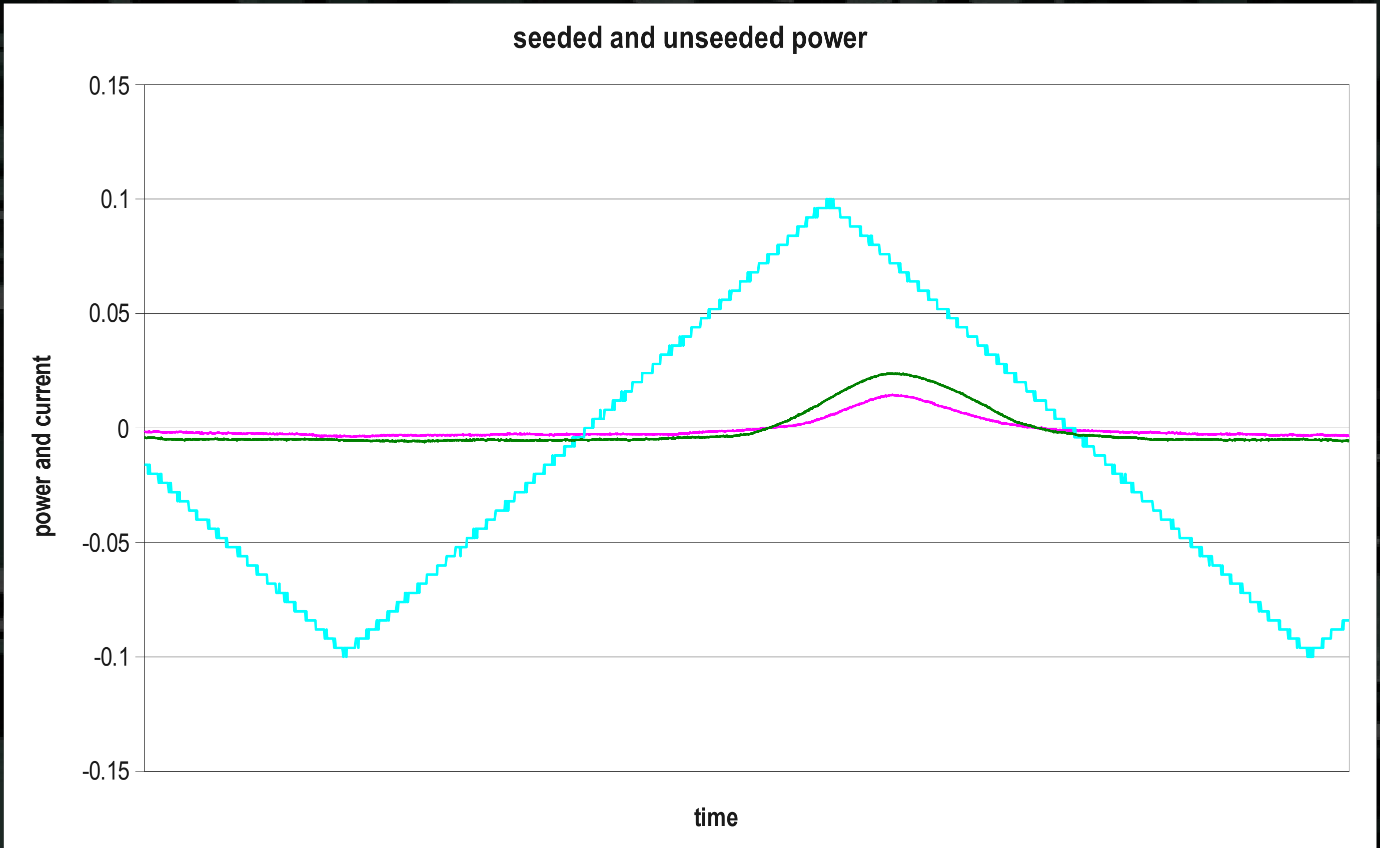



Newport



Seeding the laser

- Grating position adjusted so first order reflected back into diode
- Results in output power increase and threshold current decrease

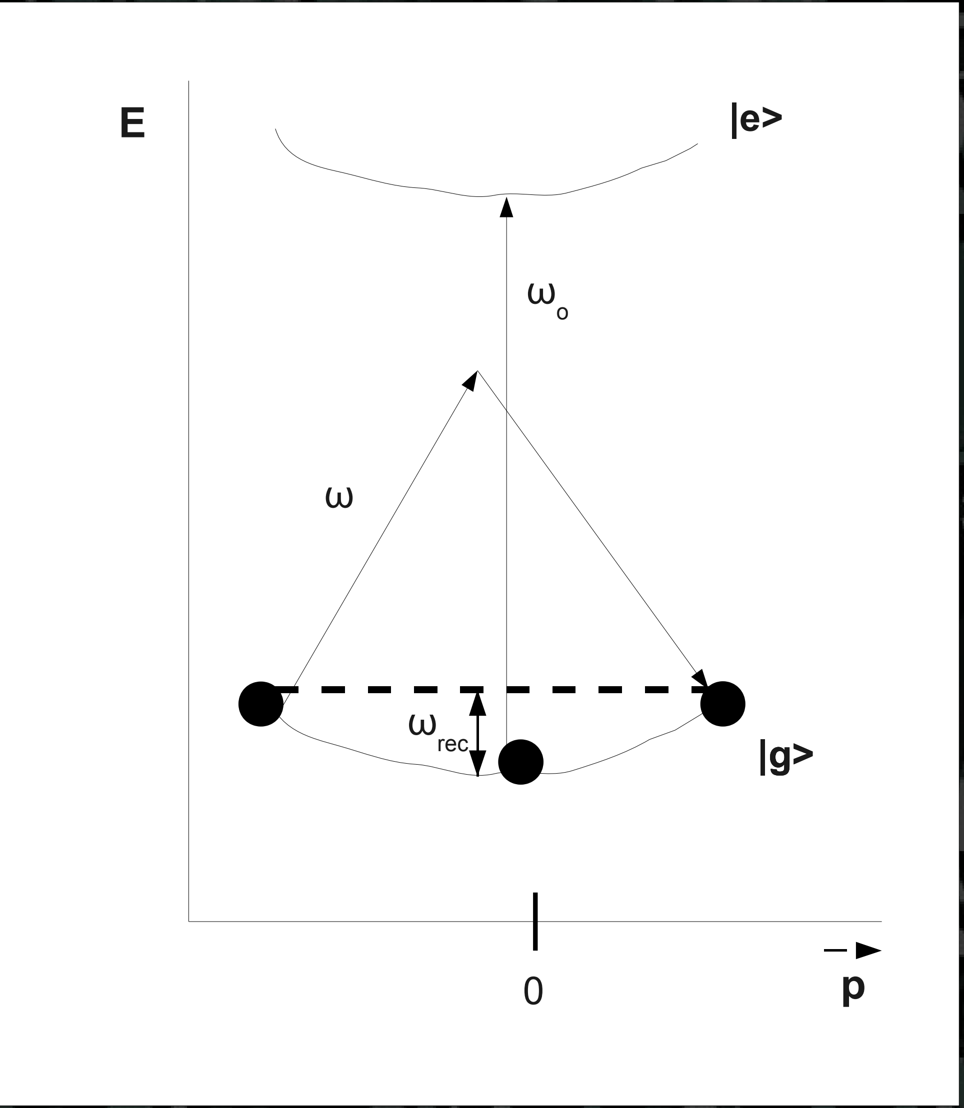


Atomic diffraction of ytterbium

- Purpose: precisely control momentum and energy of atoms
- Start with Bose Einstein Condensate where all atoms are in ground state with no momentum
- Done with standing wave created by two counter propagating plane waves
- Frequency of wave slightly detuned from atomic transition frequency of ytterbium ~ 399 nm
- Atoms will absorb photon from one wave and immediately re-emit a photon with same frequency to other wave

Kapitza Dirac diffraction

- Uses short pulse length to increase energy uncertainty
- Atoms in ground state with zero momentum can gain 2hk momentum, also gaining energy
- Chose pulse length for different proportions of momentum states

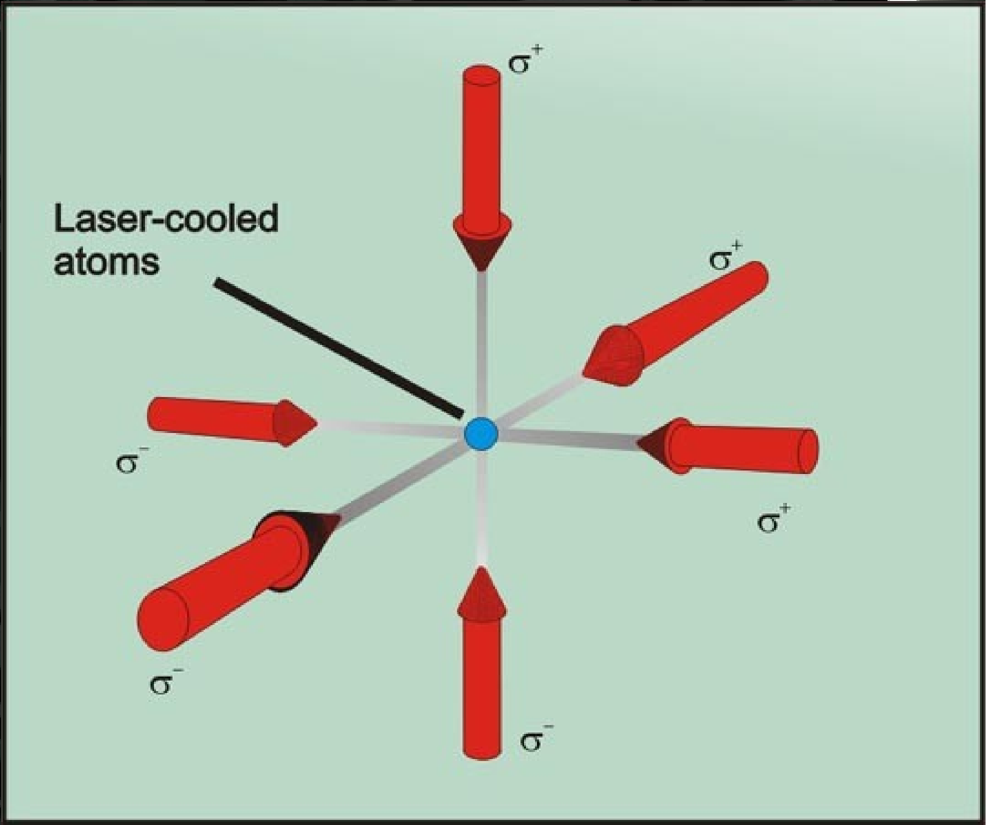


Bragg Diffraction

- Uses longer pulse lengths to minimize energy uncertainty
- Majority of atoms do not gain energy, only change direction
- To minimize spontaneous emission pulse length must not be too long
- Fraction of atoms that change direction is dependent on the pulse length
- Lower bound: 10 microseconds, for most of atoms to change direction, wavelength = 400 nm
- Upper bound: 100 microseconds, wavelength = 409 nm

Laser Cooling

- Uses three orthogonal standing waves formed by pairs of counter propagating beams
- Frequency of waves is red shifted from resonant frequency
- If atom is moving towards a beam, Doppler effect causes frequency of wave to increase to resonant frequency
- Atom will absorb photon and later spontaneously emit



References

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