Semi-Automatic Retrieval of Temperature and Density in a Magneto-Optical Trap

D.S. Mickelson[a], B.D. DePaola

J.R. Macdonald Lab, Department of Physics, Kansas State University,
Manhattan KS 66506, USA

[a]Present Address: Department of Physics, Augustana College, Sioux Falls, SD 57197

Abstract

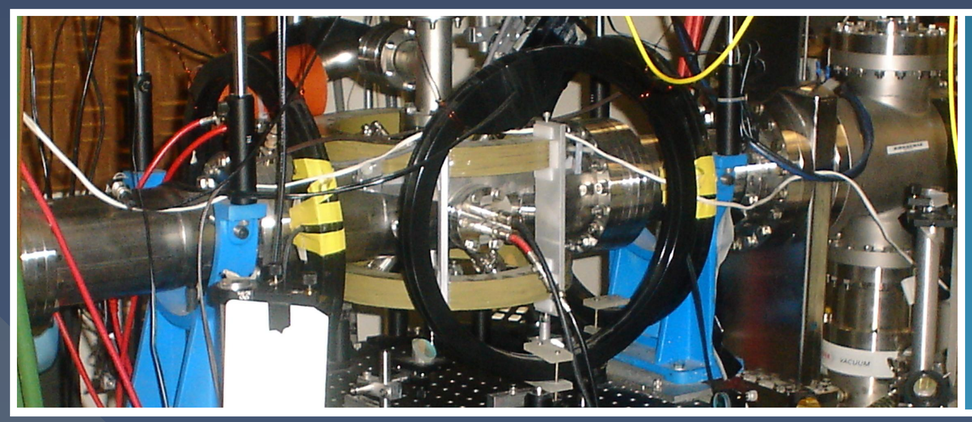
The MOTRIMS research group studies the formation of molecules through photoassociation. Photoassociation is achieved by exciting neutral atoms in a magneto-optical trap (MOT). The number of molecules formed is greatly affected by the temperature and density of the trapped atoms, due to the micro-Kelvin temperatures and range of densities possible in a MOT. We worked to design, build, and test an apparatus that will quickly take temperature and density measurements.

Motivation

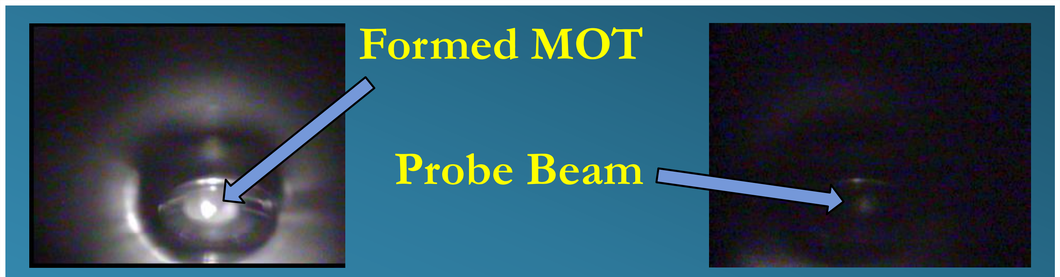
Since photoassociation measurements depend strongly on temperature and density conditions in a MOT, it is convenient to have the ability to describe these parameters quantitatively. Currently, methods to take measurements of temperature and density in a MOT can be complicated and expensive. We wanted an apparatus designed such that both types of measurements can be taken with no adjustment of the set-up and at our convenience.

Progress

We have effectively sent a probe beam through the MOT, and fabricated an effective shutter to fully and quickly switch the laser beam for imaging. We are using a recycled portion of the MOT trapping laser and successfully modulated the beam to an appropriate frequency for our measurements. In addition, this beam was attenuated to an intensity that will not saturate our detector. We are now ready to take focus on imaging the MOT and taking measurements



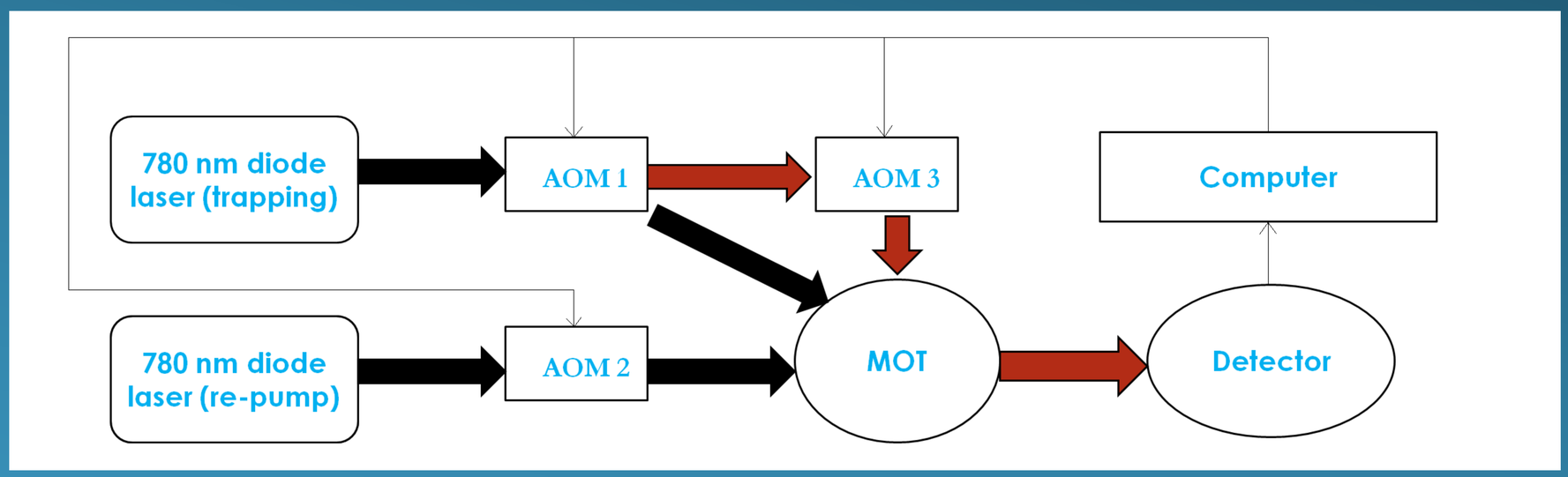
The MOTRIMS MOT



Images of a formed MOT (left) and the probe beam that will be used for measurements (right).

Future Work

- Implement a timing mechanism that allows to effectively take measurements without being affected by the MOT magnetic field and trapping lasers.
- Add a static magnetic field to define a quantization axis.
- Take quantitative measurements of both temperature and density, allowing to find optimal conditions for photo-association.
- Write software that will store and interpret the data.



Apparatus

- AOM shifts the frequency and modulates the intensity of the beam
- 780 nm laser is near resonant
- Detector will by synced with a mechanism to time the measurement with camera shutter speed
- Red beam represents the probe beam for measurements

Funding provided by the National Science Foundation through grant number PHY-0851599 and the U.S. Department of Energy