Optimizing the Laser Alignment Process: Automated Alignment for Enhanced Efficiency in Magneto-Optical Trap Calibration

McVay, Tatyana (School: Paul Duke STEM High School)

Magneto-optical traps (MOTs) stand out as essential tools in the field of Atomic, Molecular, and Optical Physics (AMO), enabling physicists to trap and manipulate atoms through the use of optical components and laser light. Currently, the calibration time needed for these experiments is significant, demanding hours of manual adjustments to optimize setup parameters. This project aims to reduce the calibration time necessary for these experiments through automating the laser alignment process. The setup utilized in this experiment involves four adjustable mirrors attached to servo motors, controlling the direction and angle of light from a <5mW red laser, allowing for four degrees of freedom. The laser light is guided by these adjustable mirrors to the end of a fiber optic cable, connected to a photosensor. Throughout the experiment, the intensity values of the detected light are printed to a console log and recorded alongside time changes. Various scanning algorithms, including circular, plane, and spiral scans, were tested in the experiment. Each scan comprised an xy-plane movement function and an angle scan function. During 20 trials of 2-minute scans, the spiral scan, executing a spiral movement on the xy-plane and performing an angle scan at the designated points, consistently produced the highest maximum sensor value. On average, it recorded approximately 2304 units on the photosensor, surpassing half of the maximum possible sensor value. The change in the maximum sensor value throughout the duration of the experiment was more gradual in the spiral and plane scans in contrast to the circular scan. These findings highlight the potential of achieving a high sensor value rapidly, demonstrating a significant enhancement in the efficiency of laser alignment processes.