Hands-on Sessions Projects

For all stages and experiments:

- find and download manuals and software for motorized components.
- Where applicable, try manual (using buttons/wheels) control of stages.
- Familiarize yourself with the commercial software associated with the components. Try running the experiment using the software.
- Once familiar, move to the coding part.

General Tips for All Projects

✅ Before You Begin
• Read the manuals for all hardware components to understand default behavior and limitations.
• Install and test any required software (e.g., Thorlabs Kinesis, OceanView).
• Understand coordinate systems and units (mm, microns, degrees, etc.).

🔄 While Developing Code
• Test incrementally with small snippets before full automation.
• Log raw data in .txt or .csv files, including timestamps and settings.
• Add delay after stage movements to allow settling. Mechanical stages often need a short delay to settle after movement. A `time.sleep()` can improve accuracy in measurements.
• Save plots and screenshots of key results.

⚙️ Debugging & Troubleshooting
• Stage not moving? Check homing, power, and connection.
• Code not running? Check if the device is connected and listed in the device manager. Test with GUI and check software recognition.

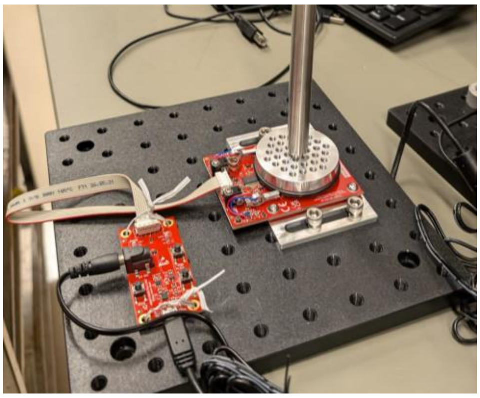
💻 Good Coding Practice
• Organize code using functions.
• Use comments generously.
• Write modular scripts: control, analysis, plotting.
• Use try/except blocks for robustness.

🧪 Scientific Practice
• Repeat measurements to check reproducibility.
• Include error bars or standard deviations in plots.
• Label axes clearly and include units.
• When comparing to theory, state assumptions and uncertainties.

Single-component stages

a) Rotating stage ELL18K (Thorlabs)

Tasks:



- Home the stage.
- Rotate continuously with a predefined speed.
- Make a full circle, every 5 degrees pause the stage for 1 second. At each pause read and save the position and current day and time in a .txt file.
- Plot position vs. time.
- Stability check: home the stage. Move to a fixed angle (e.g. 20 degrees), measure and save the position. Move further to a fixed angle (e.g. another 20 degrees), measure and save the position. Move backwards to the first angle and to starting position, measure and save the position every time. Repeat the procedure 10 times. Plot deviations from the angles that you set vs trial number for starting angle (e.g. 0 degree), intermediate angle (e.g. 20 degree), final degree (e.g.40 degree). Analyze the repeatability of the stage movement. Does it depend on the direction of rotation?
- Build a GUI.

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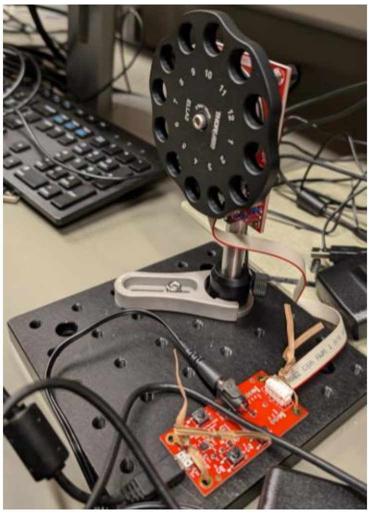
b) Rotating stage 2 ELL18K (Thorlabs)

Tasks:



- Home the stage
- Rotate continuously with a predefined speed
- Calculate the angle that the stage should be rotated so that the middle of each hole of the 12-position wheel stops at the same place. Rotate a full circle so that the stage pauses for 2 seconds every time a hole reaches “3 pm” position. At each pause read and save the position and current day and time in a .txt file.
- Plot position vs. time
- Stability check: home the stage. Move to a fixed angle (e.g. 20 degrees), measure and save the position. Move further to a fixed angle (e.g. another 20 degrees), measure and save the position. Move backwards to the first angle and to starting position, measure and save the position every time. Repeat the procedure 10 times. Plot deviations from the angles that you set vs trial number for starting angle (e.g. 0 degree), intermediate angle (e.g. 20 degree), final degree (e.g.40 degree). Analyze the repeatability of the stage movement. Does it depend on the direction of rotation?
- Build a GUI.

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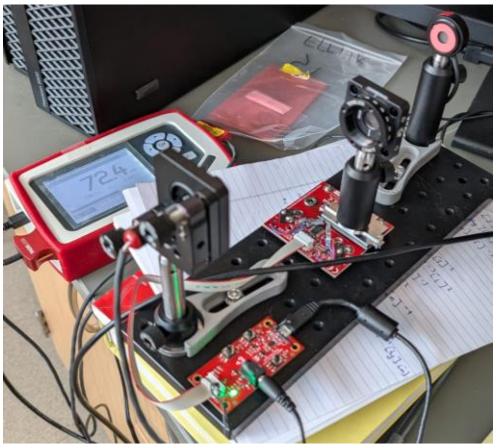
c) Multiposition slider ELL12K (Thorlabs)

Tasks:

- Home the stage
- Move the slider from home position to each position with a predefined speed and stop at each position for 1s. Save position and current time in a .txt file.
- Plot position vs. time
- Build a GUI.

Two component experiments

1) Knife-edge experiment. Linear stage ELL17K, Power meter (Thorlabs)
   Follow the tutorials from July 8th and 9th to perform a knife-edge experiment aimed at measuring the diameter of a laser beam.
   Repeat the measurement several times to evaluate the consistency of your results. Analyze the uncertainty in the derived beam size. Does the measurement speed affect the accuracy or precision of the results?



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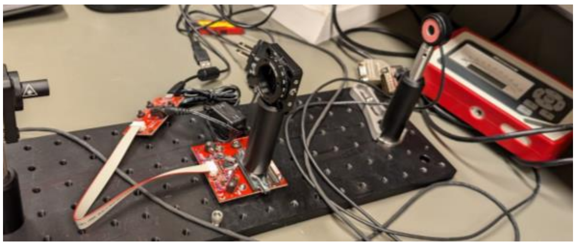
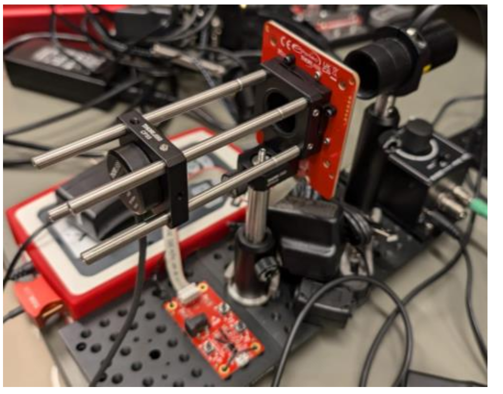
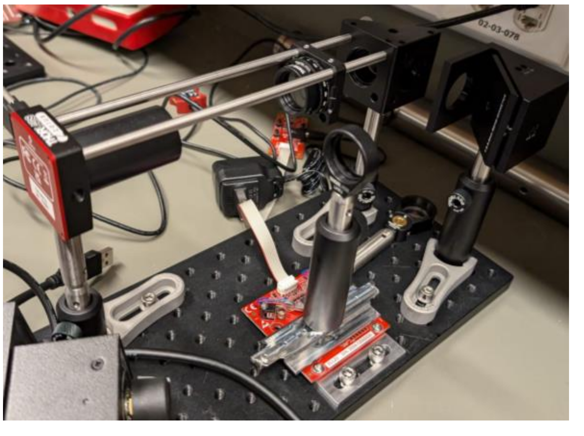
2) Knife-edge experiment 2, Linear stage ELL17K, Power meter (Thorlabs)
   Follow the tutorials from July 8th and 9th to perform a knife-edge experiment aimed at measuring the diameter of a laser beam.
   Repeat the measurement several times to evaluate the consistency of your results. Analyze the uncertainty in the derived beam size. Does the measurement speed affect the accuracy or precision of the results?



3) Radial intensity profile of a lamp. Motorized Iris ELL15Z, Power meter (Thorlabs)
- Measure the optical power of a lamp as a function of iris diameter using a power meter. By varying the aperture size of the motorized iris, record the corresponding incident power.
- Plot the measured power versus the iris diameter to explore the radial intensity distribution of the lamp. If the beam were Gaussian, what functional dependence would you expect? Compare your experimental data with the theoretical expectation for a Gaussian beam profile. Make a conclusion about the profile of the lamp (is it Gaussian?).
- Repeat the measurements multiple times to assess the reproducibility and consistency of your results. Analyze potential sources of error and comment on the precision of the power curve.



4) Shearing Interferometry. Linear stage ELL20, CMOS camera(Thorlabs)
Follow the experiment from (https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=2970). In this experiment, you will use shearing interferometry to analyze the wavefront of a laser beam. A shearing element is placed in the beam path to produce two laterally displaced copies of the wavefront, which interfere and form a fringe pattern. The amount of shear is controlled with a motorized linear stage (ELL20), allowing precise tuning of the lateral displacement. By examining the shape and orientation of shearing fringes, you can assess the beam's collimation and detect wavefront distortions, gaining insight into the spatial coherence and quality of the laser beam.



5) Spectrometer, Motorized rotating stage PRMTZ8 (controlled by KDC101 DC Servo Controller), Power meter (thorlabs)

In this experiment, you will build a simple spectrometer to measure the spectral components of light from a lamp. A diffraction grating is mounted on a motorized rotation stage controlled by a Thorlabs K-Cube, allowing precise angular positioning. As the grating rotates, it disperses the lamp light at different angles according to wavelength. A power meter positioned behind a narrow slit detects the intensity of the diffracted light at each angle. By recording the power as a function of the grating angle, you can reconstruct the spectrum of the lamp and identify its dominant wavelengths.

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6) Sample xyz positioning. Nanomax 300 (Thorabs).
   A sample is mounted on a motorized xyz stage (Nanomax 300). Make an experiment where the sample is mapped in xy plane for a fixed z. Now add a z scanning: for each z position make a xy map.

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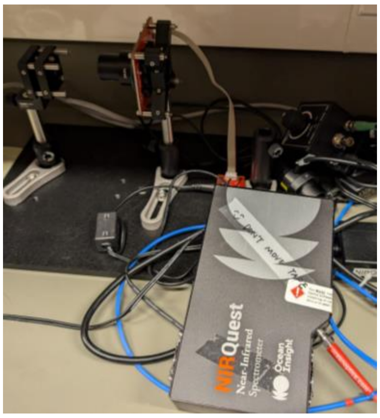
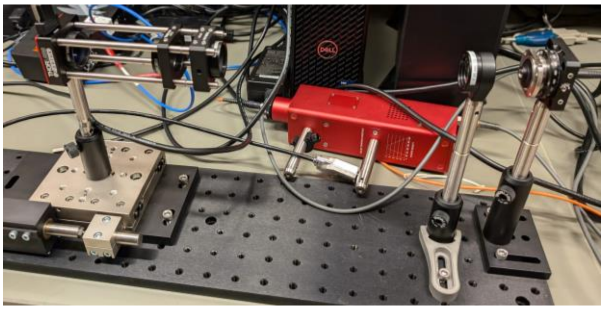
7) Polarization spectra. Lamp, rotating stage ELL14 with a polarizer, Ocean Insight Spectrometer.
   In this experiment, you will measure the polarization-dependent spectra of light from a lamp. A linear polarizer is mounted on a motorized rotation stage (ELL14), which allows precise control of its orientation. As the polarizer rotates, it selects different polarization components of the lamp light. The transmitted light is then coupled into an Ocean Insight spectrometer, which records the intensity as a function of wavelength. By acquiring spectra at various polarization angles, you will analyze how the spectral distribution and intensity of the light depend on its polarization state.



8) Z-scan imaging.



The lamp is focused using a lens to create a small spot, and a second lens system images this spot onto a camera. Both the camera and imaging lenses are mounted on a motorized linear stage controlled by a benchtop controller, allowing precise movement along the beam propagation (Z) axis. By scanning the imaging system through the focal region, you will capture images at different positions and analyze how the beam size changes. This allows you to characterize the focal position, depth of focus, and the degree of collimation or divergence of the lamp's output.