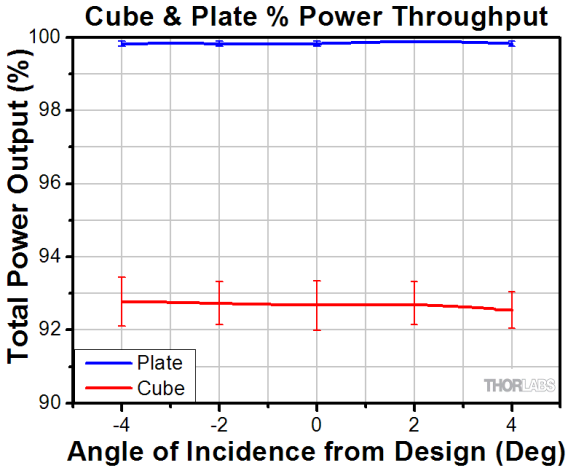
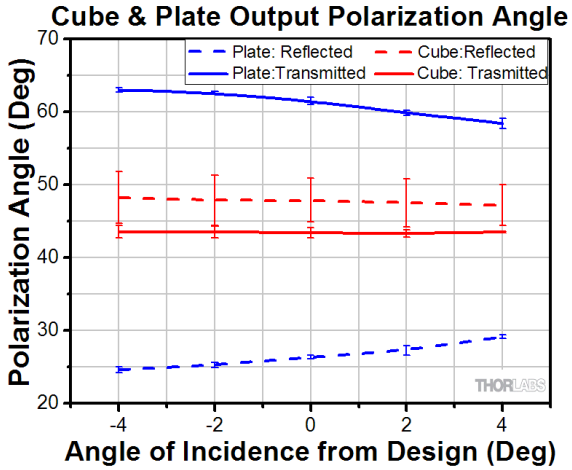
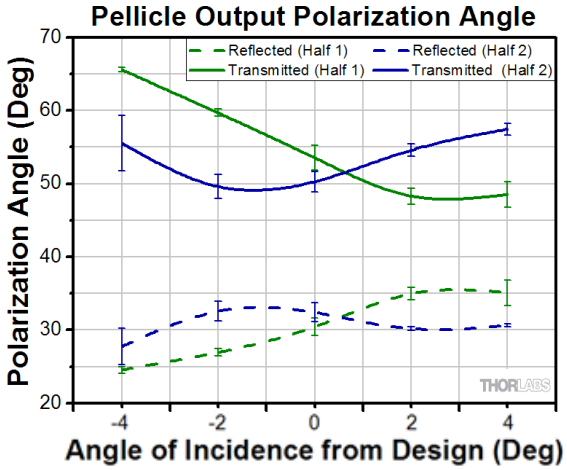
Output Optical Properties of Beamsplitters with Angle of Incidence

- Plate beamsplitter provided optimal throughput and split ratio with large change to polarization angle.
- Cube beamsplitter provided adequate throughput and maintained polarization angle, but split ratio was strongly dependent on angle of incidence.
- Pellicle beamsplitter provided optimal throughput with large variations to split ratio and polarization angle. Spatial dependence exists within measurements when comparing one half of pellicle to other.



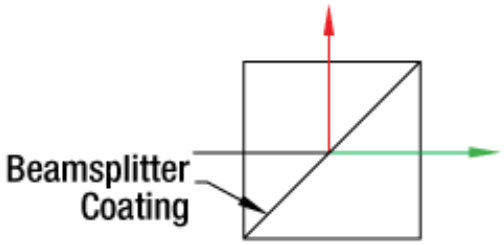




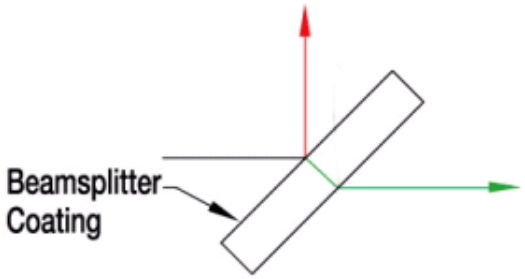
Background

- Nonpolarizing beamsplitters are typically used to split the power of an optical beam into two paths.
- A variety of beamsplitter types are available including cube, plate, and pellicle configurations, but little information about the optical properties of the output light from each type are provided.
- Here we investigate the spatial and angle of incidence dependence on the throughput, split ratio, and output polarization of a 50:50 cube, 50:50 plate, and 50:50 pellicle beamsplitter.

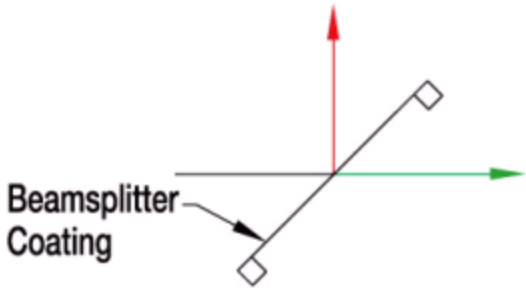
Cube



Plate

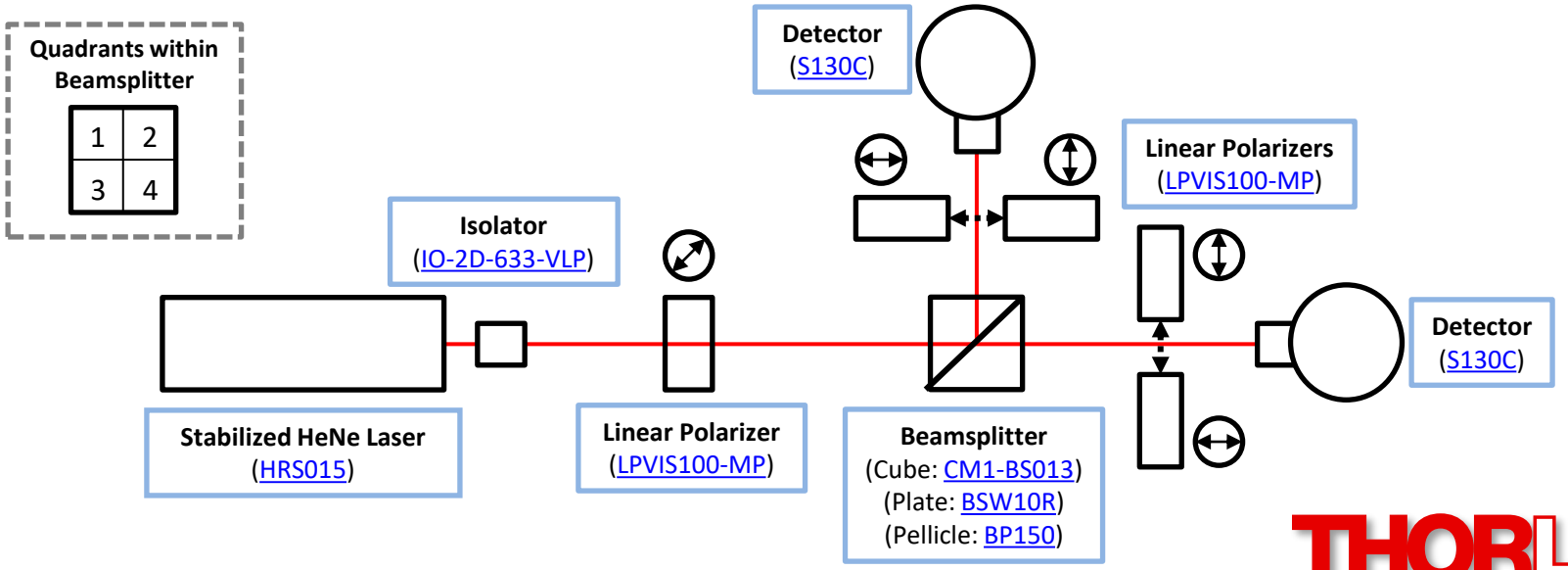


Pellicle



Experimental Design

- Stabilized HeNe laser (633 nm) aligned with an isolator and linear polarizer oriented at 45˚ to provide equal amounts of S- and P-polarized light.
- Each 1” beamsplitter (cube, plate, and pellicle) was divided into four quadrants and mounted on a rotation stage.
- Two polarizers, one optimized to block S-polarization and one optimized to block P-polarization were used to record the amount of polarized light output from both arms of the beamsplitter.
- Power measurement with and without polarizers recorded for -4˚, 2˚, 0˚, 2˚, and 4˚ angles from the optimal angle of incidence within each quadrant (see figure below).



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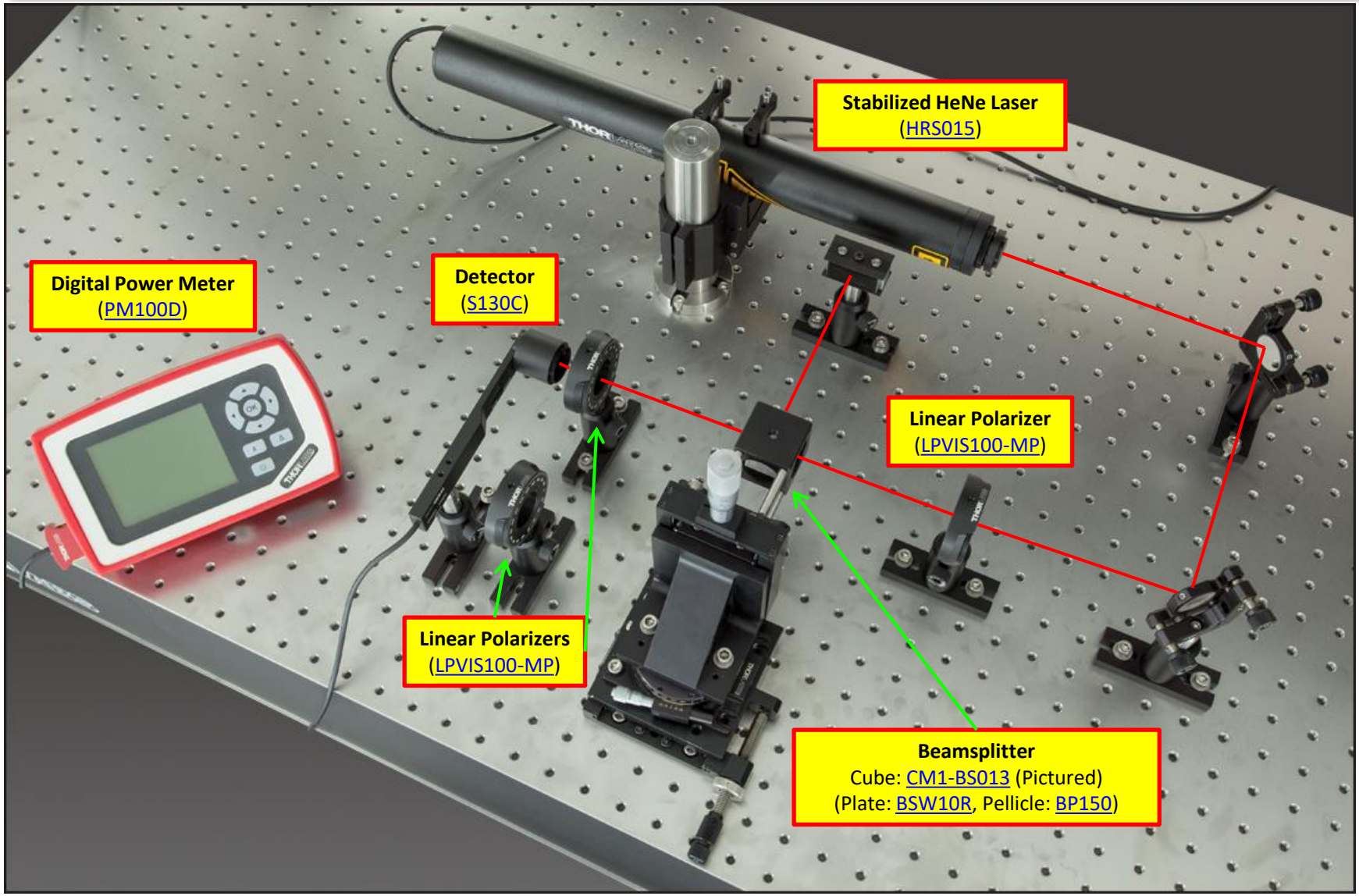
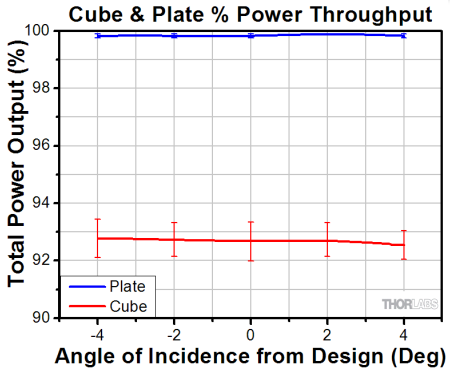
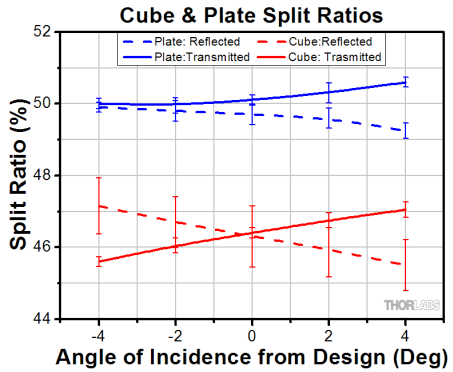
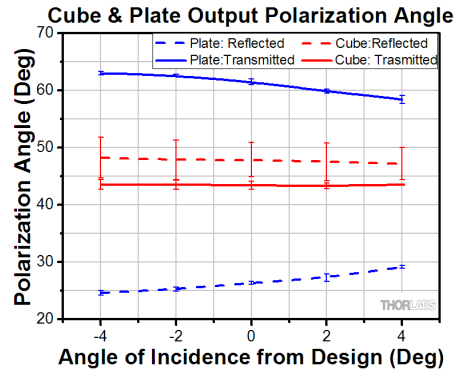
Experiment Setup



Results: Comparison of Cube and Plate Beamsplitters



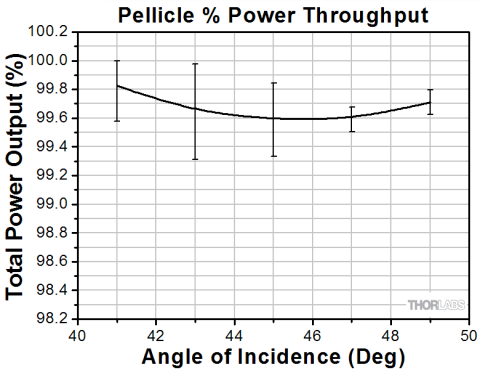


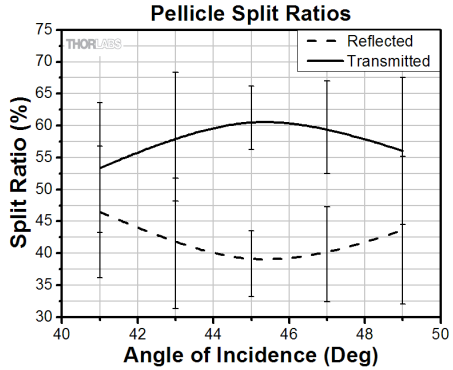


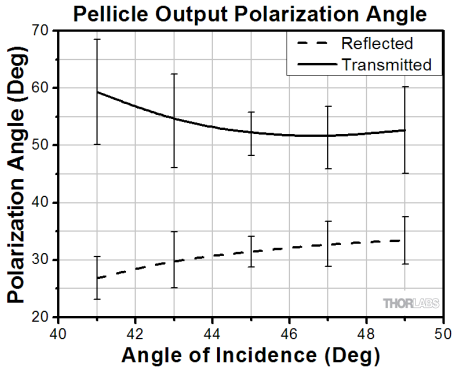
- Here we compare the throughput, split ratio, and resultant polarization angle for a 50:50 cube and 50:50 plate beamsplitter based on the angle of incidence.
- The plate beamsplitter provides optimal throughput and near expected split ratio but changes the polarization state.
- The cube beamsplitter provides adequate throughput and maintains the polarization angle of the incident light, but the split ratio is strongly dependent on the incident angle.

Error bars indicate the complete range of measurements taken from the four quadrants

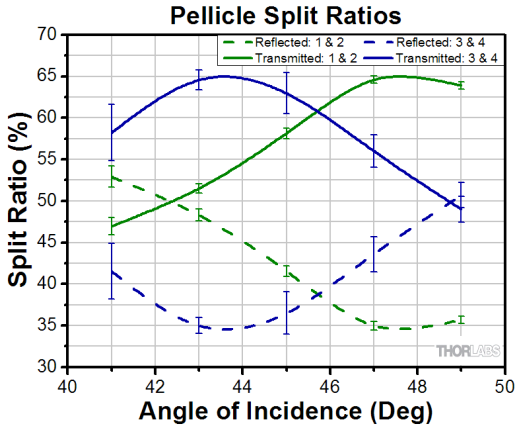
Results: Pellicle Beamsplitters

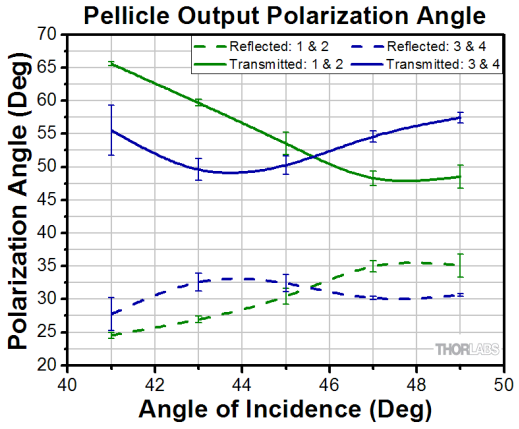






- Here we present the same measurements with the 50:50 (R:T) pellicle beamsplitter.
- The pellicle provided optimal throughput but the split ratio was dependent on the incident angle and the polarization angle was rotated for both outputs. Also a large range of measurements across the four quadrants.
- We also discovered a spatial dependence to the measurements where half of the pellicle provided repeatable measurements that differed from the opposite half.





Error bars indicate the complete range of measurements taken from the four quadrants

Experimental Limitations

- Only a single measurement was recorded in each quadrant and we assume minimal spatial dependence of the measurements within individual quadrants.
- Only light at a single wavelength (633 nm) was tested.
- Only a single cube, plate, and pellicle beamsplitter was assessed and we assume no changes between coating batches.
- Only the rotation of the polarization ellipse was measured and not the linearity of the polarization.

These results describe a brief investigation to provide insights into the general behavior of our components and should be interpreted with the experimental limitations in mind.

Summary

- Measurements were carried out to assess the throughput, split ratio, and polarization angle for light propagating through a 50:50 cube, 50:50 plate, and 50:50 pellicle beamsplitter while varying the spatial and angle of incidence.
- Experimental results show:
  - The plate beamsplitter provided optimal throughput and split ratio, but a large change to the polarization angle was observed.
  - The cube beamsplitter provided adequate throughput and maintained the polarization angle, but the split ratio was strongly dependent on the angle of incidence.
  - The pellicle beamsplitter provided optimal throughput, but large variations to the split ratio and the polarization angle were observed. There was also spatial dependence to the measurements when comparing one half of the pellicle to the other.
- These results indicate that the optical properties of output light should be considered when choosing a beamsplitter type.