

Introduction

Background

- The NASA Ocean Color Instrument (OCI) is an advanced optical spectrometer that will fly on board the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) spacecraft.
 - OCI will measure the color of the ocean in the ultraviolet to shortwave infrared range.
 - OCI utilizes two detectors that operate at $-20\text{ }^{\circ}\text{C}$ during flight
 - Movement between the detector and housing must be less than 6 microns

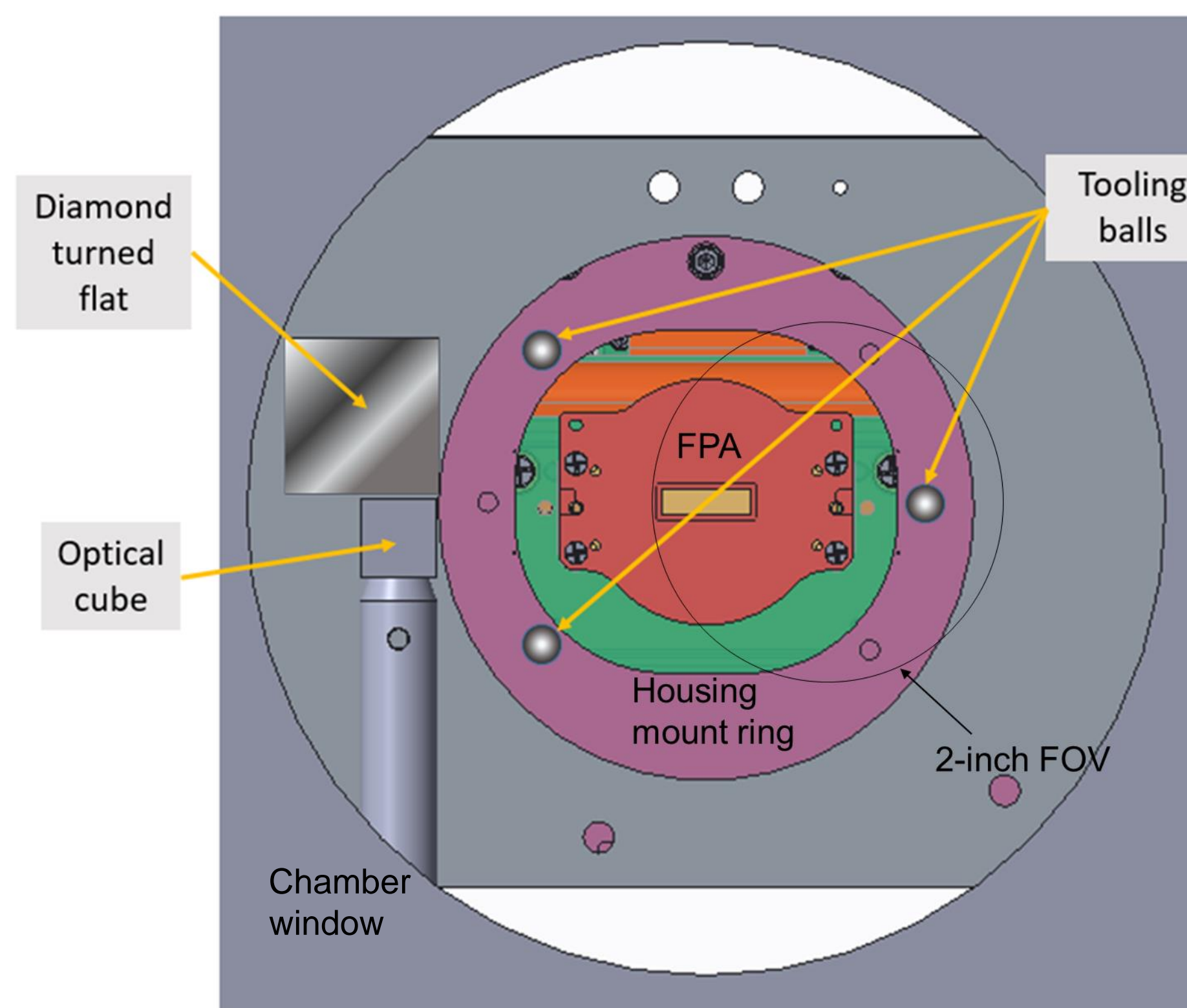


Figure 1. Cryogenic detector stability test setup

- An OCI detector stability test will determine the stability of the detector at space flight operating temperatures to ensure alignment is maintained
 - The detector and housing will be inside a thermal vacuum chamber (TVAC) during testing
 - Camera will be outside the chamber about 19 inches away from the detector surface
 - A 2-inch field of view (FOV) is required to achieve a resolution of 12 microns in object space

Purpose

- To develop and test an imaging technique that can be used for the OCI detector stability test with a measurement uncertainty of 6 microns (2-sigma) or better.
- Designing the imaging technique will involve:
 - Finding the optimum equipment and camera settings to meet test requirements
 - Determining the scale error between the plane of the detector and plane of the housing
 - Calculating the efficacy of the designed imaging technique with a mock test run of an engineering unit detector

Methods

1. Meet testing requirements

- Required: working distance of 19 inches, field of view of 2 inches, and high resolution
- The Nikon D500 camera with a Tamron AF 28-300mm Macro lens matched these requirements
- High precision manual and motorized stages (New England Affiliated Technologies, INC and Newport Corporation) were used for accurate small movements

2. Determine scale error

- FPA plane and front of housing mount are separated by 0.320701 inches
- The scale difference between images of these planes were determined by moving a ruler 0.3207 inches with a motorized stage

3. Mock run of detector stability test

- The engineering unit detector was mounted to a stage with the ruler in the position of the housing ring and the camera behind a window
- 5 and 10 micron movements of the scrap detector were analyzed using the symbols on the detector and the distance of the detector from the scale

- Image analysis was done with the ImageJ image processing program (NIH)
- Targets were affixed to a stage (Figure 2)
- Images were scaled using the in-frame rulers and target positions were determined using circle-fit centroid coordinates (Figure 4)
- Coordinates were added to a Microsoft Excel spreadsheet to calculate distance values
- Calculated movements were compared to the actual movements to determine accuracy and sensitivity of this imaging technique



Figure 2. Target setup

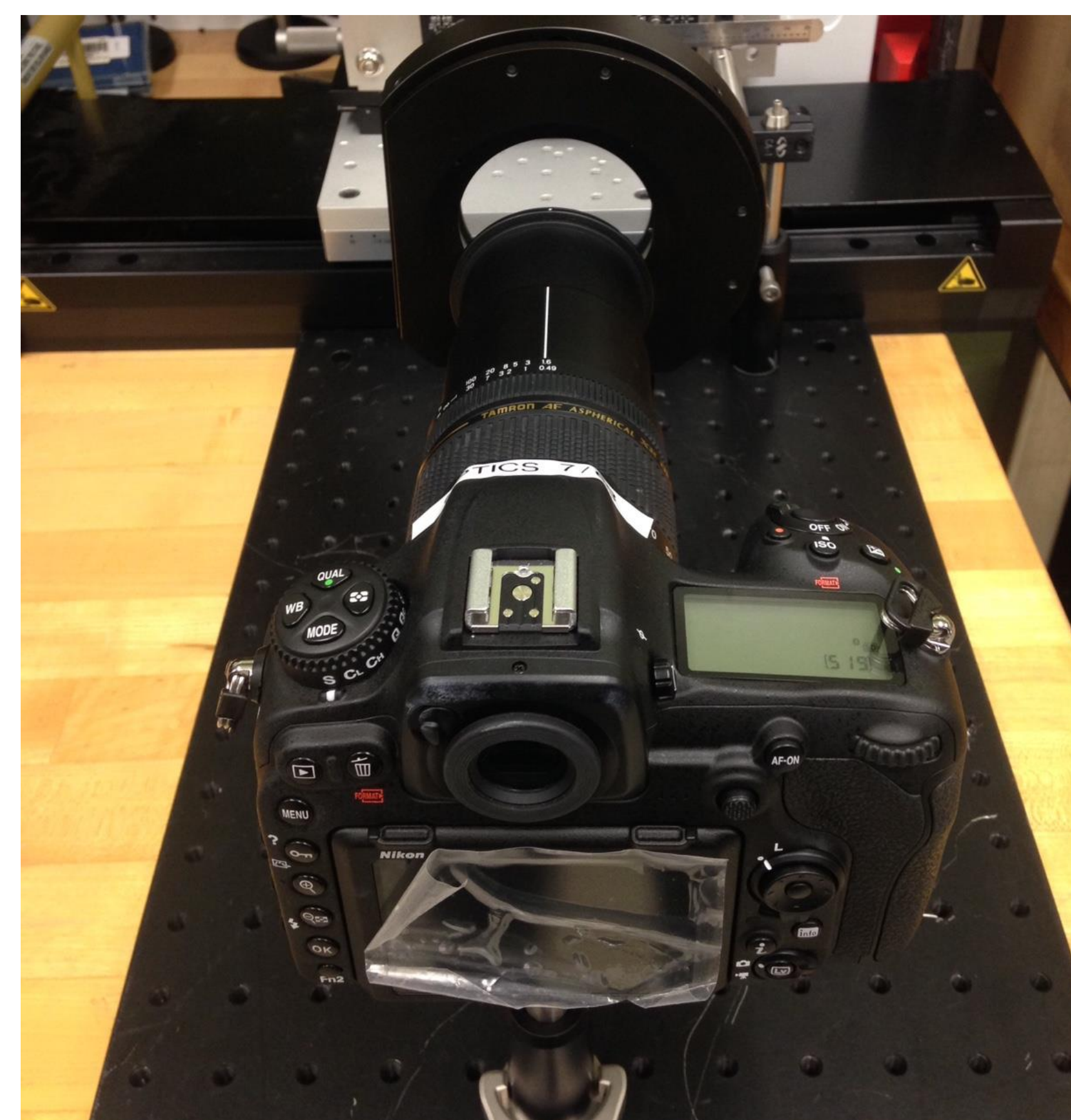


Figure 3. Mock run setup with window and engineering unit detector (not shown for security reasons)

Results

- A scale difference between the front position and back position was observed
 - This scale error will be corrected by putting scales on both detector and housing
- Movements of half and whole pixels (~ 5 and ~ 11 microns, respectively) were consistently detected
 - Measurement uncertainty was approximately 6 microns
 - This test shows that the camera can be moved in and out of position during testing

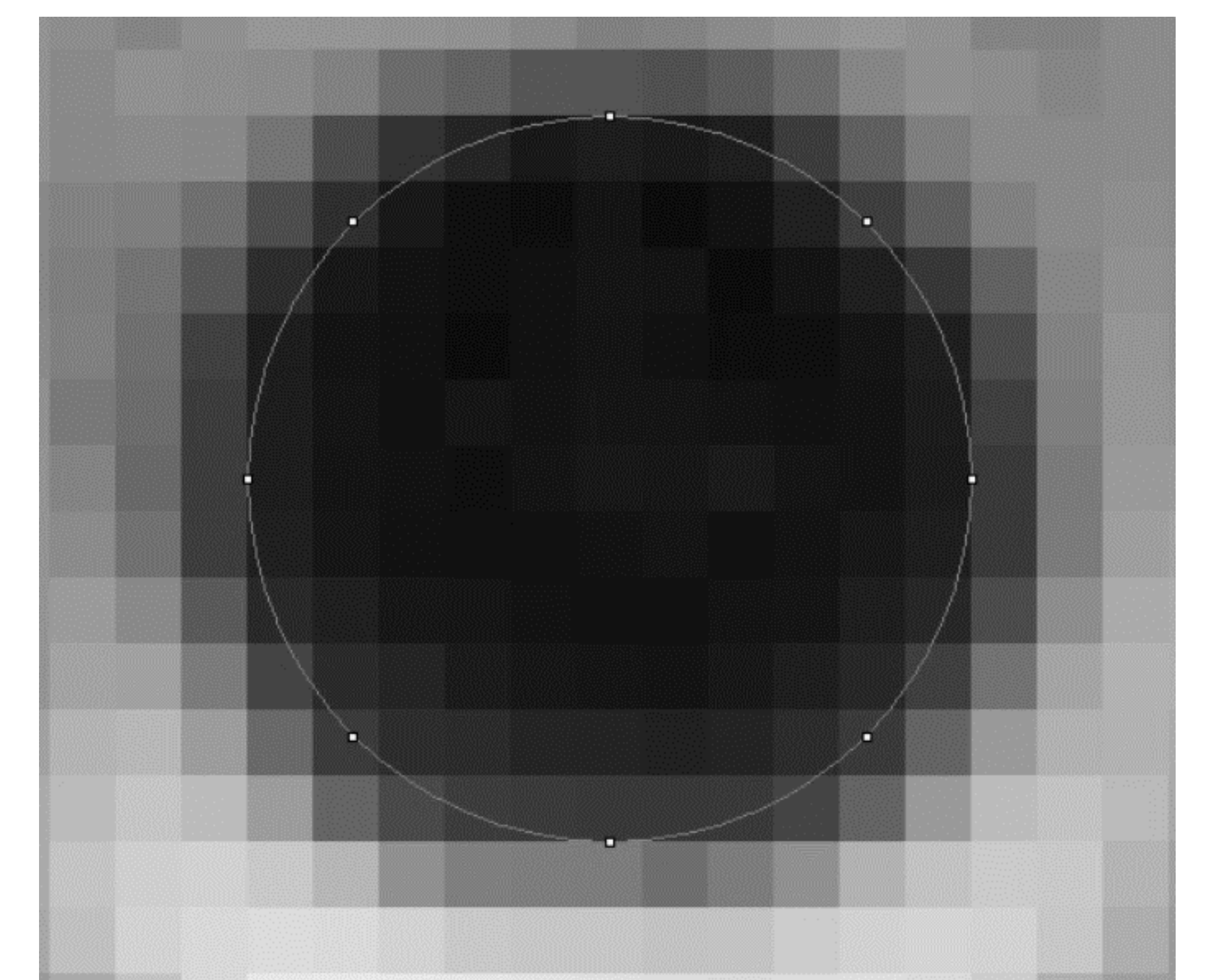


Figure 4. Circle fit of detector symbol.

Conclusions

- Macro lens fits resolution and field of view requirements
- Scale error between housing mount and detector will be accounted for with scales on both the detector and housing mount
- Minimum detectable movement was found to be 6 microns

Overall, I conclude that this image analysis technique fulfills testing and measurement requirements and will be an effective metrology technique for the OCI detector stability test.

Future Work

The next steps in this project will continue preparation for the detector stability test. This includes testing the repeatability of the motorized stages and programming the stages for movement of the camera and Keyence. The final part of this work will be the actual cryogenic test of the detector.

References

- Ocean Color Instrument. (n.d.). Retrieved from <https://pace.oceansciences.org/oci.htm>

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