

Repeatability Test of Attocube Piezo Stages

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Introduction

In preparation for the installation and assembly of the X-Ray Split and Delay system it was necessary to carry out some tests on components of the system. The Attocube piezo stages are one such component. These stages provide high resolution positioning using an optoelectronic encoder. There are three types of these stages to be used in the system: Goniometers, Linear Stages and Vertical Positioning Stages. The purpose of the tests are to determine the repeatability of the stages, and to ensure they adhere to specifications.

Research

The stage that was tested was the goniometer. The repeatability of the home, zero, and an arbitrary position on the encoder were tested. The arbitrary position selected was $200\mu^\circ$. The instrument used to measure the position of the goniometer was an ELCOMAT Autocollimator.

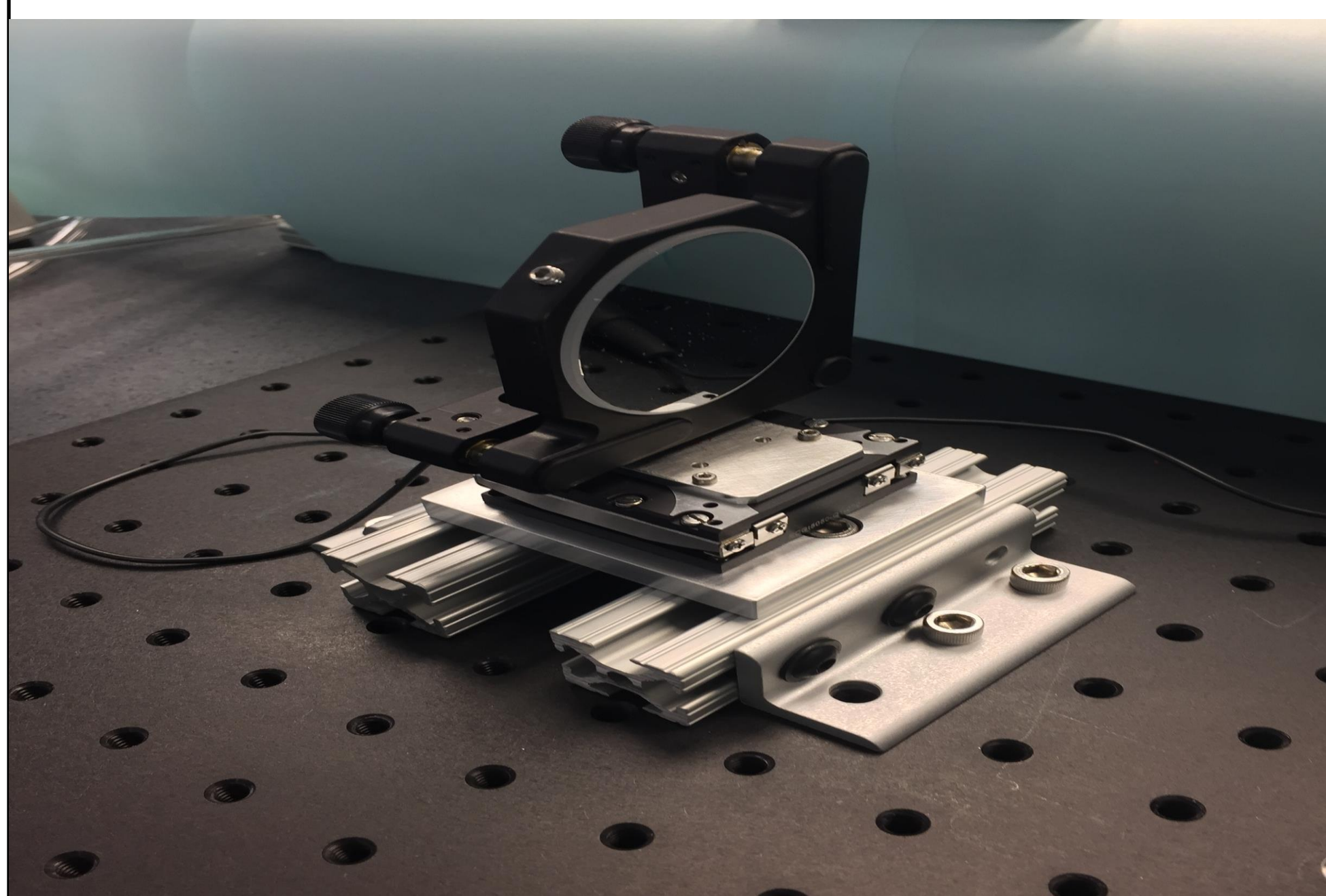


Fig 1: The stage propped up, with a mirror mounted on it.

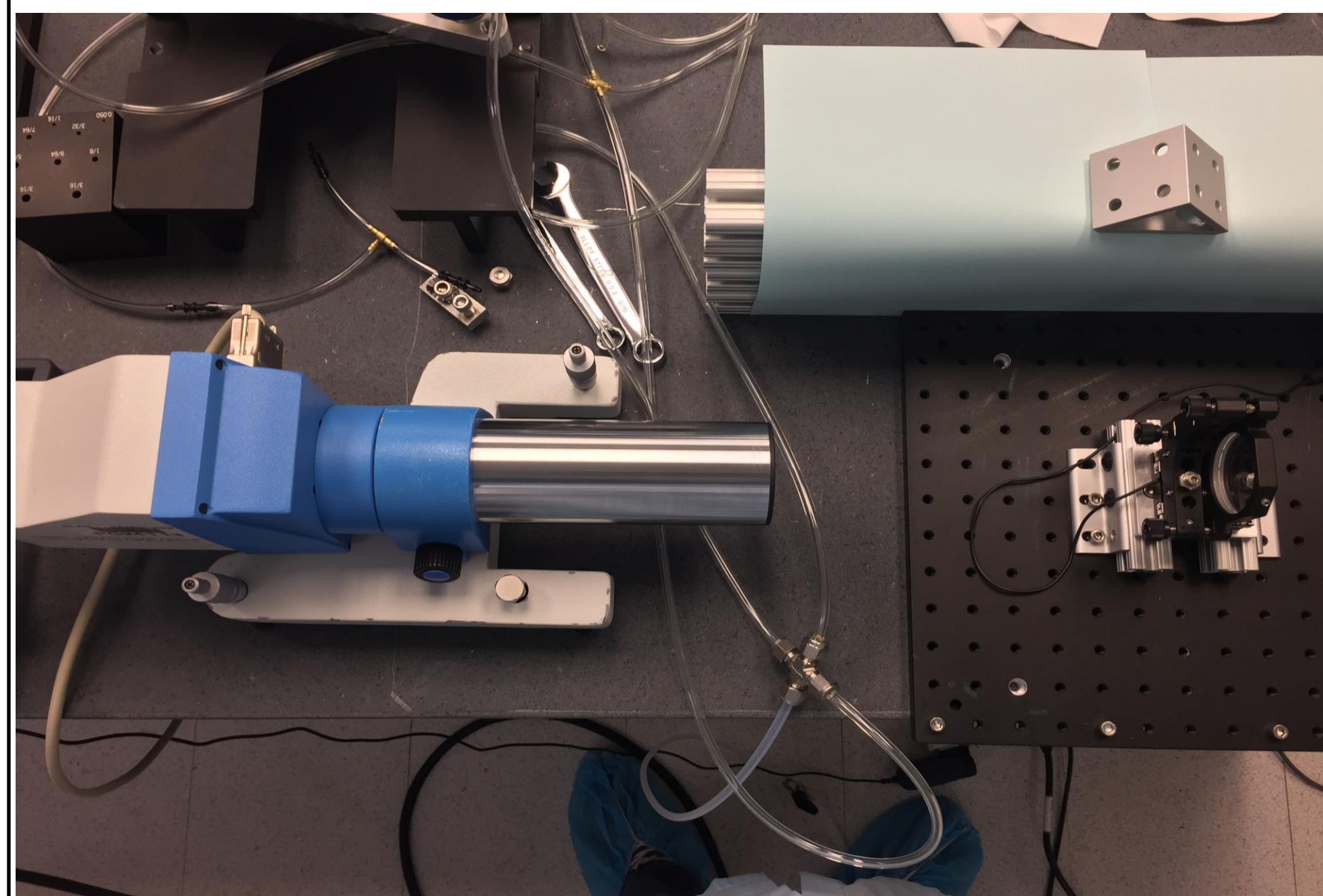
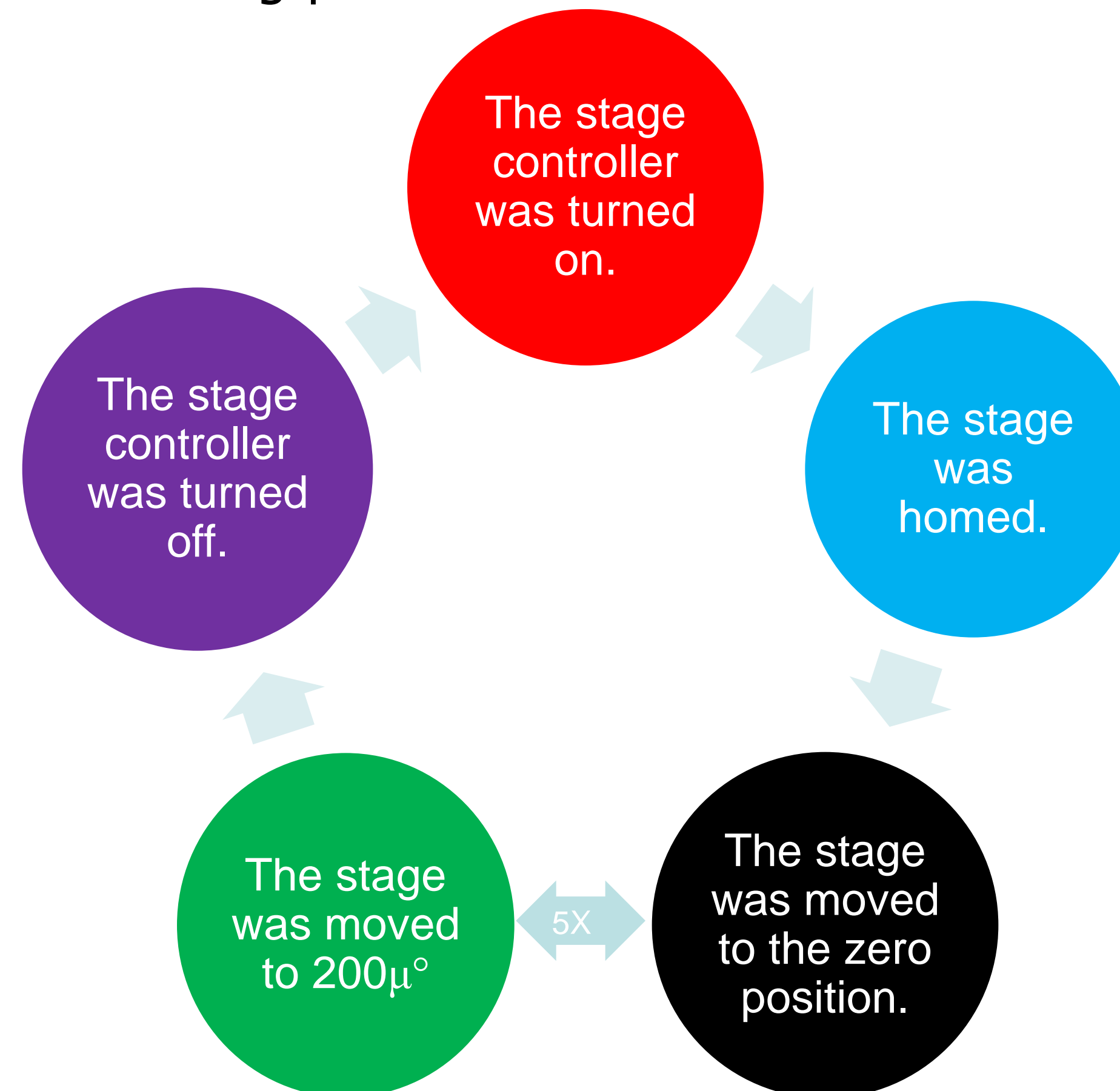


Fig 2: An aerial view of the Autocollimator/Stage setup used to take measurements.

The testing procedure used is shown below:



The repeatability for the stages was tested while trying to simulate a continuous working environment, i.e. when the controller is kept turned on for some time. Repeatability for a situation where the controller is used at different times was also simulated, i.e. when the controller is turned off and on again. Each test was conducted while values were collected within a period of 10 minutes.

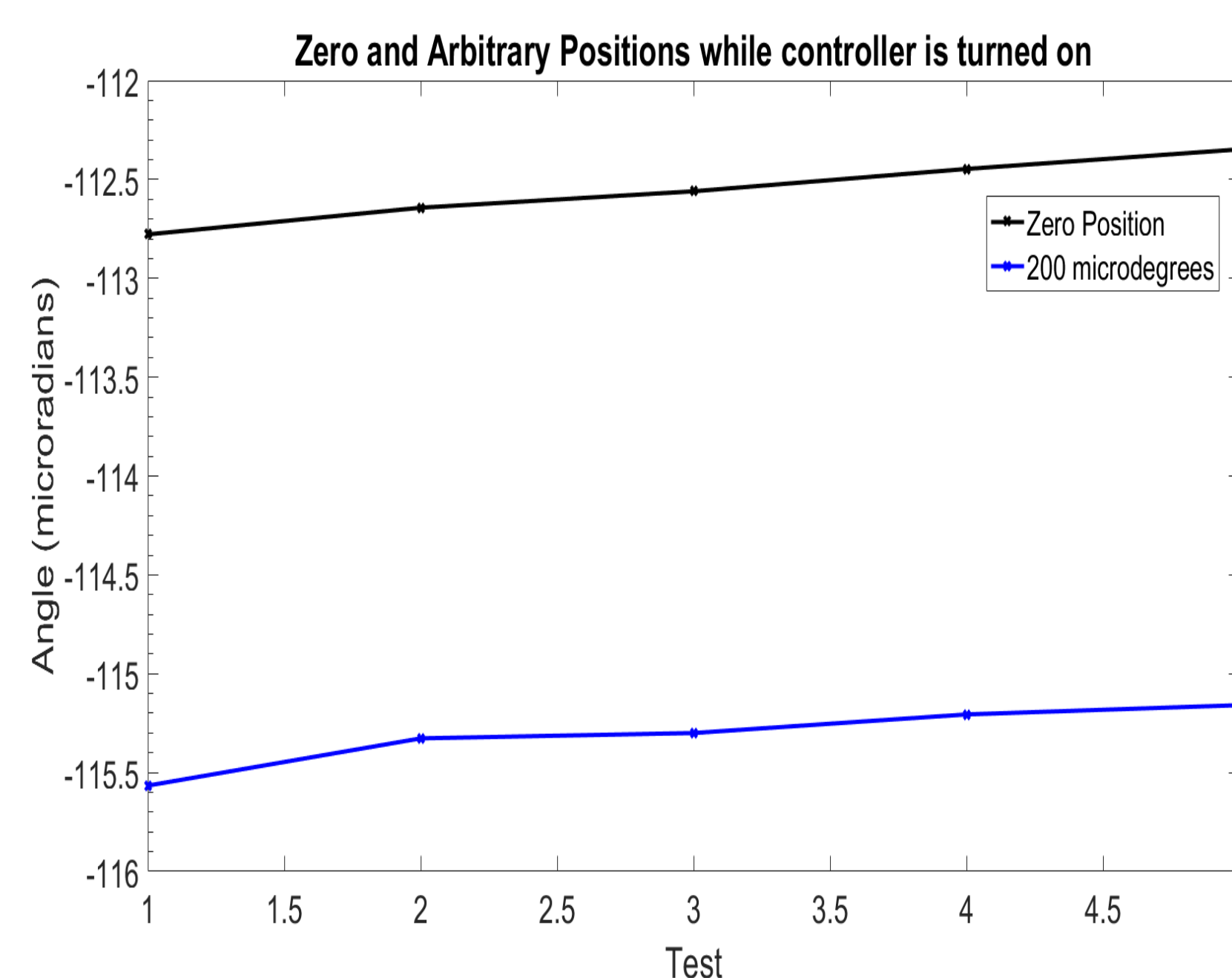


Fig 3: Graph showing the average values for the home and arbitrary position.

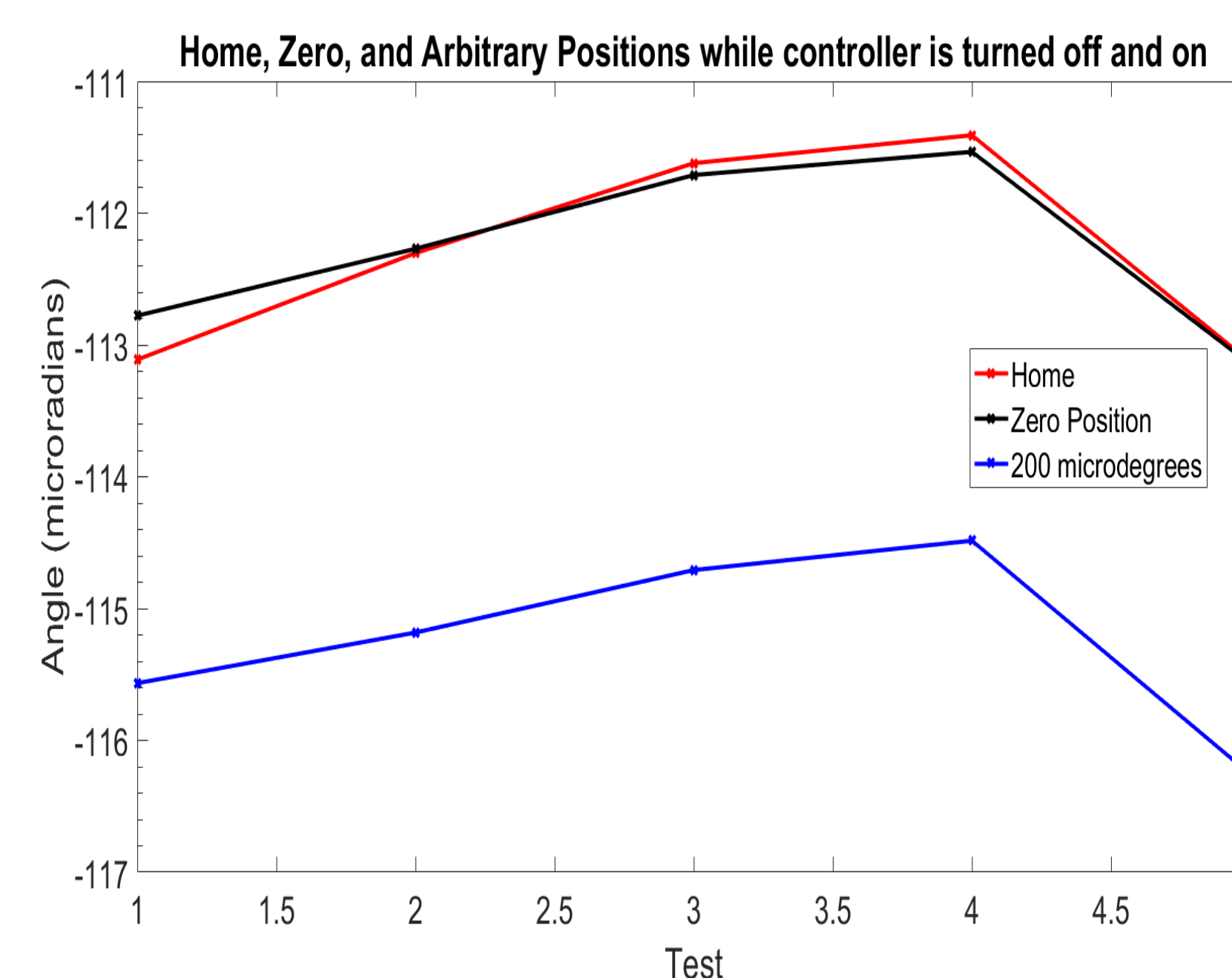


Fig 4: Graph showing the average values for the zero, home and arbitrary values while the controller was turned on and off.

Controller left on:

Repeatability of Zero position = $0.43\mu\text{rad}$

Repeatability of $200\mu^\circ$ = $0.407\mu\text{rad}$

Controller Turned off and on:

Repeatability of Home position = $1.72\mu\text{rad}$

Repeatability of Zero position = $1.611\mu\text{rad}$

Repeatability of $200\mu^\circ$ = $1.772\mu\text{rad}$

The stability of the Autocollimator itself was also examined to account for any noise in the readings for repeatability. This was done by recording the values gotten from the autocollimator while a fixed mirror was placed in front of it.

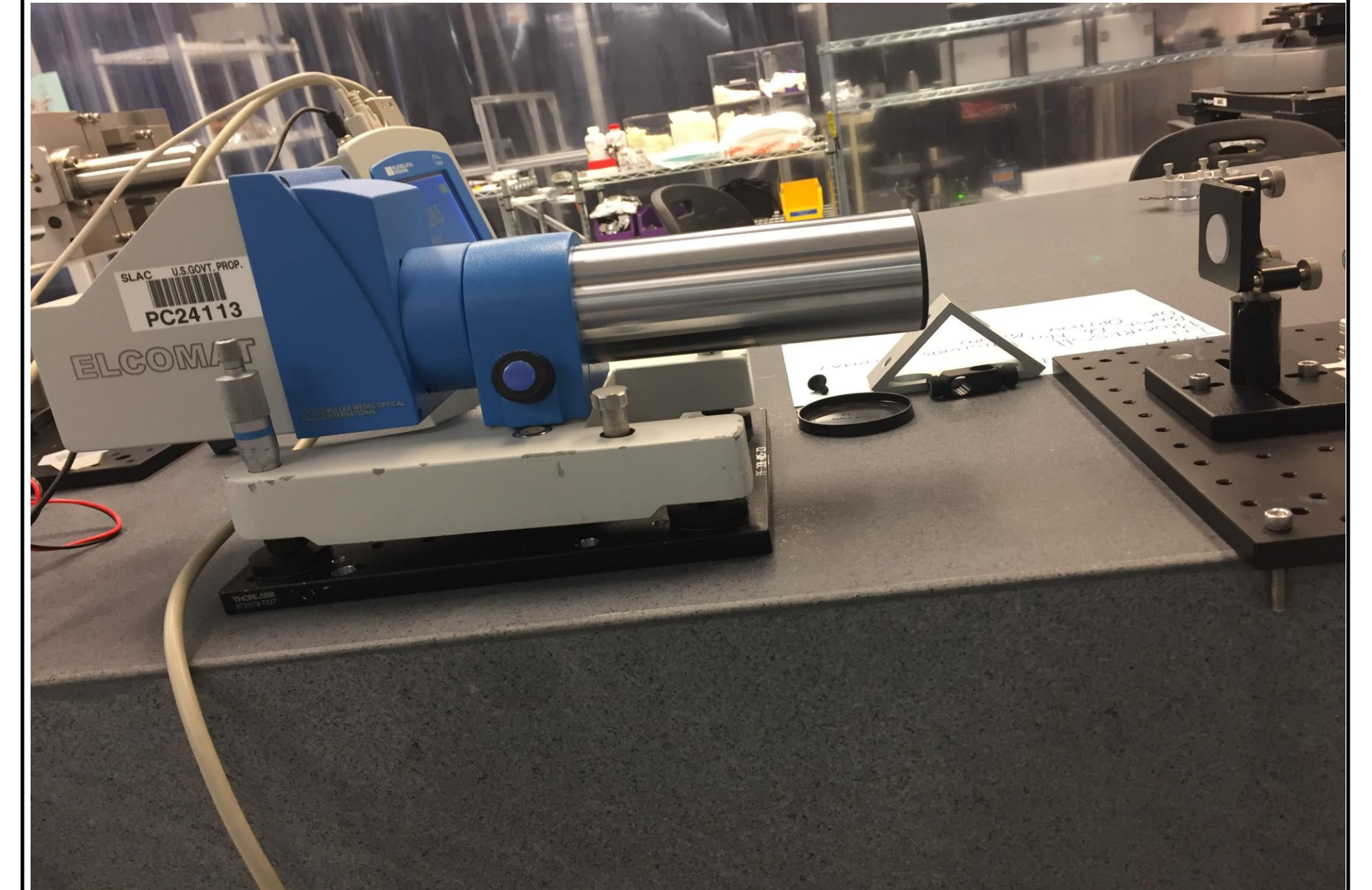


Fig 5: Setup used for fixed stability test.

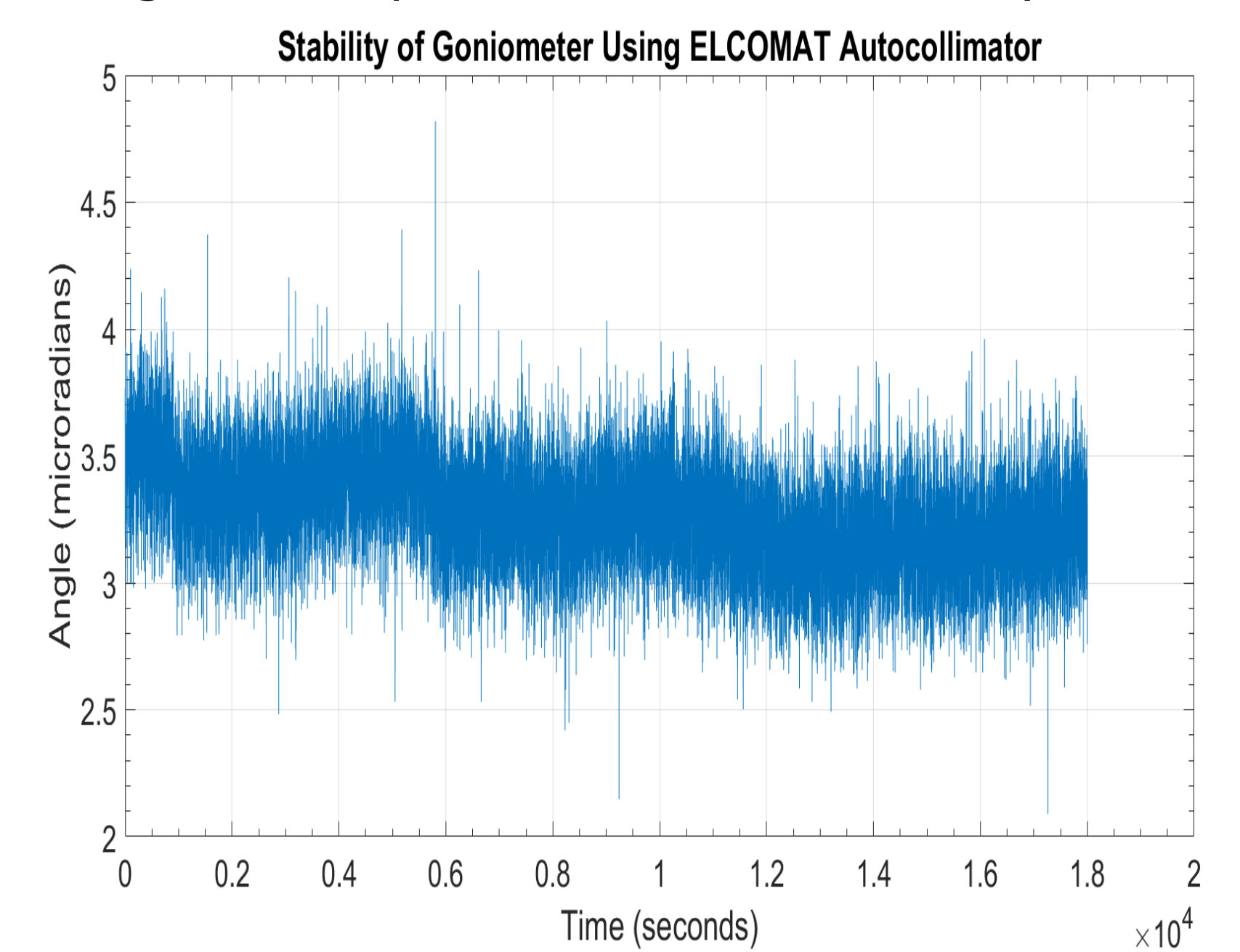


Fig 6: Graph showing the stability of Autocollimator over 5 hours.

It can be seen that the stability of the Autocollimator is about $1.5\mu\text{rad}$. This difference caused by subtle vibrations in the room will be taken into account when analysing the data.

Conclusions

The repeatability stated in the specifications for the stage states that the repeatability of the stage is $50\mu^\circ$, which is approximately $1\mu\text{rad}$. Based on the stability of the autocollimator, the expected repeatability was estimated to be around $2\mu\text{rad}$. The values obtained when the controller is left on, meet specifications. When the controller is turned off and on, the repeatability meets expectations.

The tests performed were closed loop tests, future tests with open loop settings should be carried out in the future to see how the stage reacts without feedback control.

Acknowledgments

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