



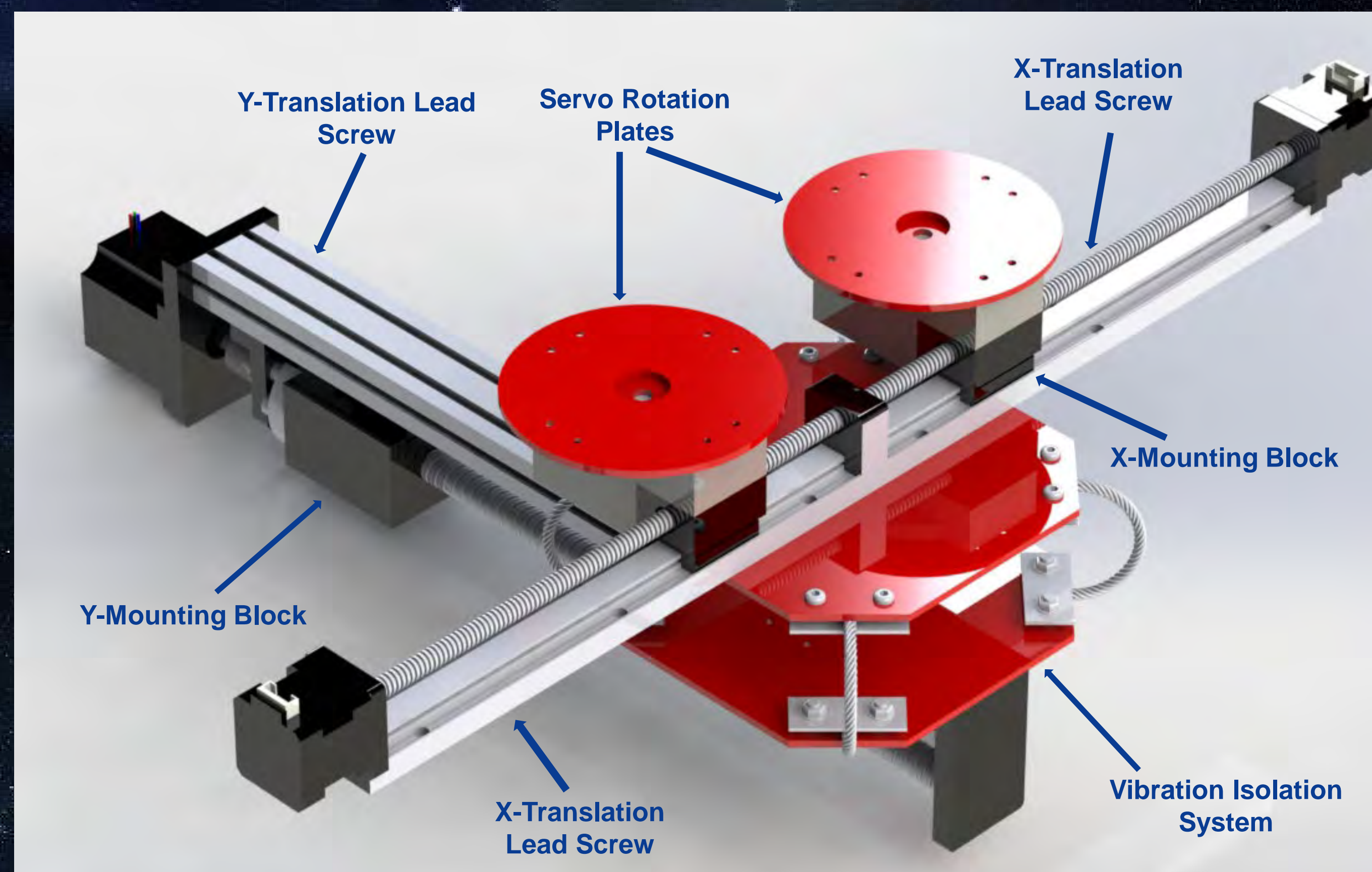
Improvement to DIC Strain Measurement System of Viscoelastic Materials

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Introduction

The main objective of the project is to be able to reduce the setup time for DIC measurements when testing viscoelastic materials. With what Northrop Grumman is currently using, it is hard to adjust the relative distance and angles between the two cameras. Northrop was running into the problem of having to recalibrate the system each time they wanted to test a new specimen. Along with the issue of having to set up the system manually for each test iteration, they also had to deal with recalibration issues caused by vibrations from external sources such as surrounding machinery. To resolve these problems, we have designed and fabricated a modular system prototype that automates the translation for the x and y directions. With an automated x-translation, the distance between the cameras will be easily adjusted and set up more quickly. The y-translation will be able to pull the system back and out of the way, so that the user can switch specimens without the need to realign the DIC system. The other portion of our product is a vibration isolator that is geared towards mitigating any small perturbations from external sources from reaching the cameras of the DIC.



Design Metrics	Value
Quick Setup	10 minutes
X – Axis Linear Accuracy	0.050"
Y – Axis Linear Accuracy	0.050"
% Change in Perturbation Measurement	50% reduction

Vibration Isolation System Testing

Data from creating impulses in various modes were collected. The isolator was not able to reduce vibrations in the direction of in-plane motion if the amplitude was large. Isolator was successful in reducing small steady state in-plane amplitudes and impulses applied in the out of plane axis.

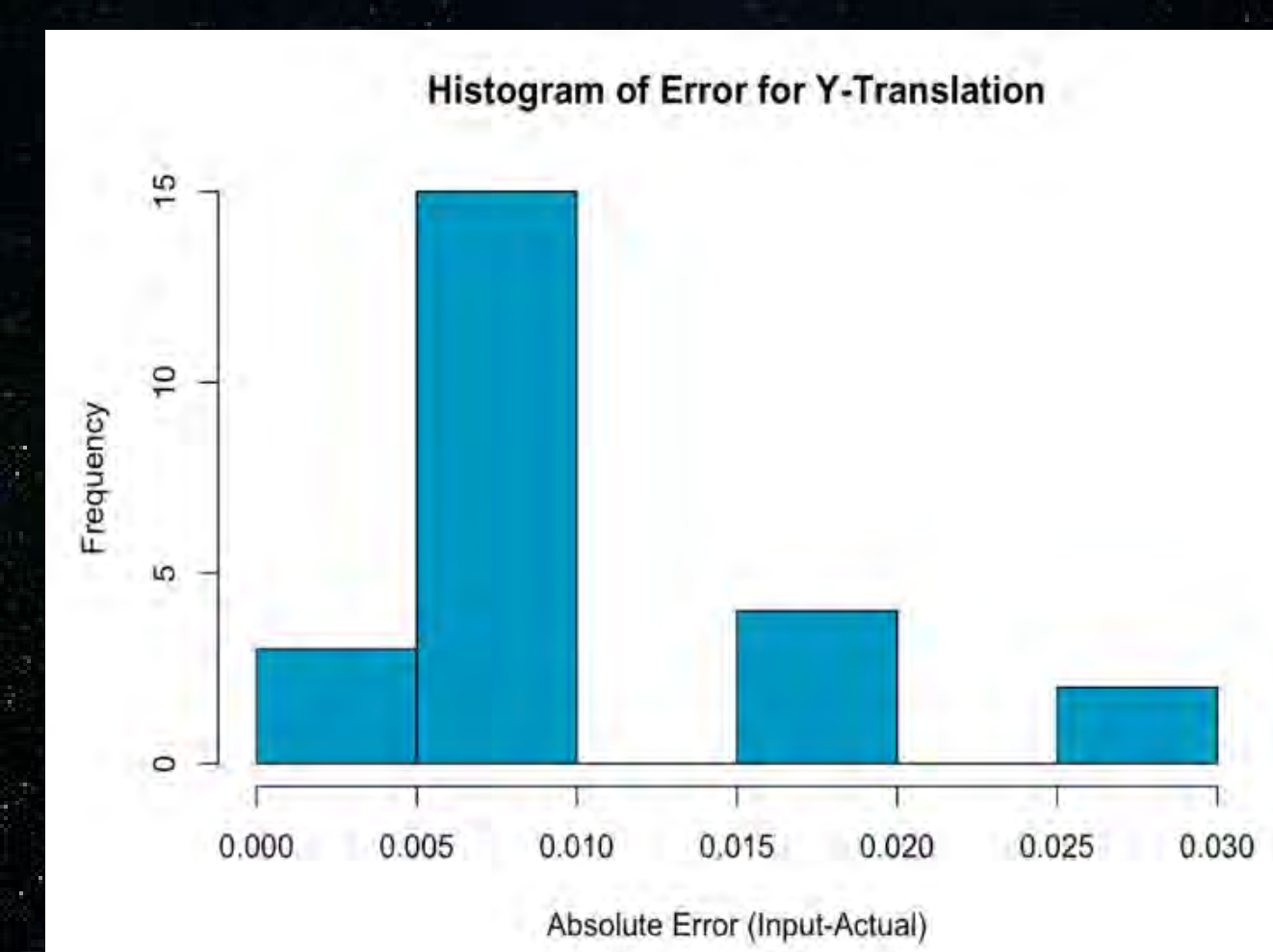
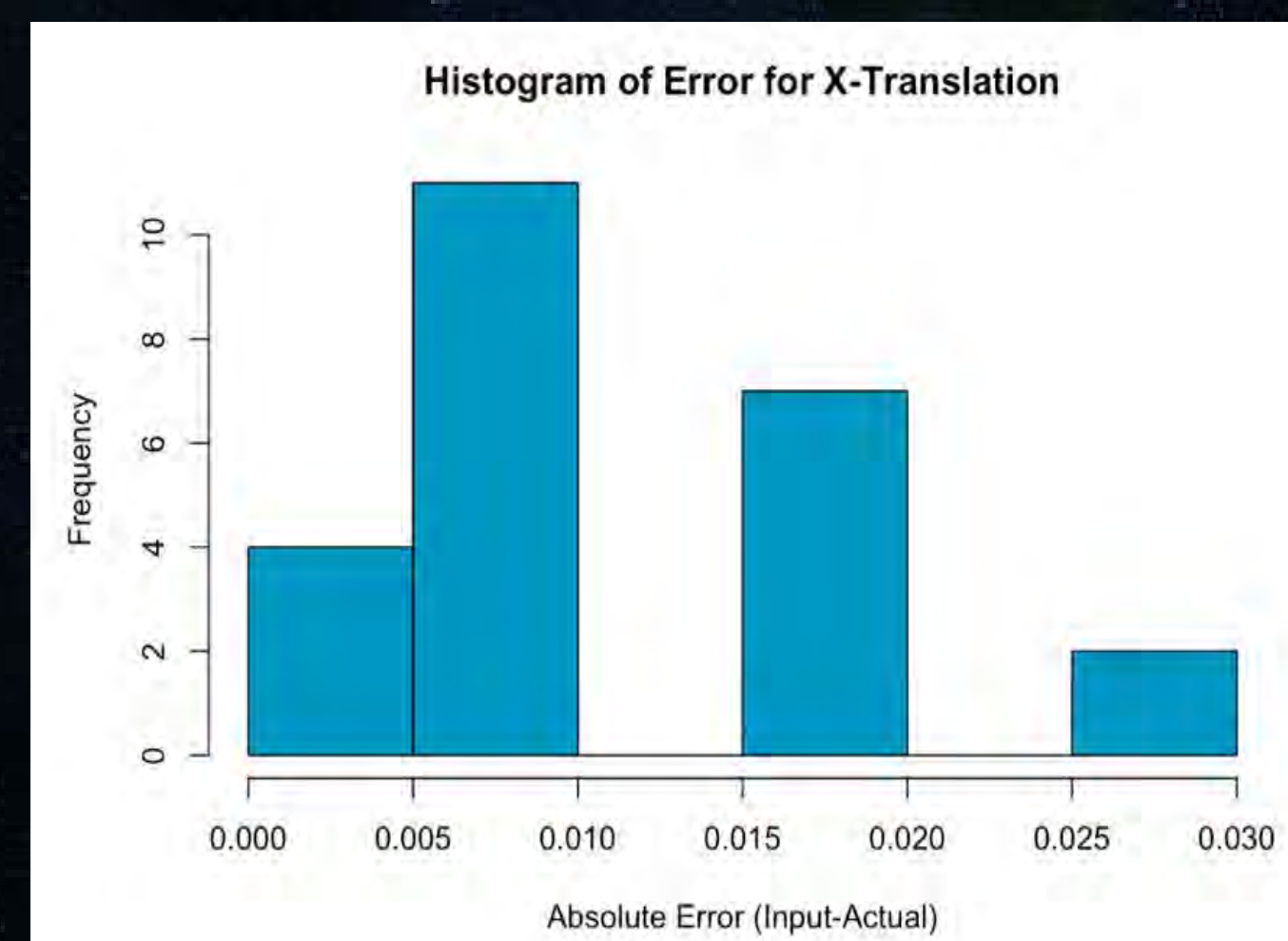
	Percent Reduction Ax (%)	Percent Reduction Ay (%)	Percent Reduction Az (%)
Dead Blow Drop (sand mallet)	53.7084	52.4851	12.1482
Shaker Table	52.8351	42.6230	0
Banging Table (sand mallet)	74.9009	-5.5402	1.0117
In-plane Impulse on Base	95.2806	-309.3472	-6.9446

X Translation Lead Screw Testing

Goal: Determine accuracy of the x-translation to within 0.050"
Method: 5 tests with 5 different input distances were tested. Output distances were computed and compared to physical distance measurements
Results: Accuracy achieved: Using a 95% CI We conclude maximum absolute error of 0.0165"

Y Translation Lead Screw Testing

Goal: Determine accuracy of the y-translation to within 0.050"
Method: 5 tests with 5 different input distances were tested. Output distances were computed and compared to physical distance measurements
Results: Accuracy achieved: Using a 95% CI We conclude maximum absolute error of 0.015"



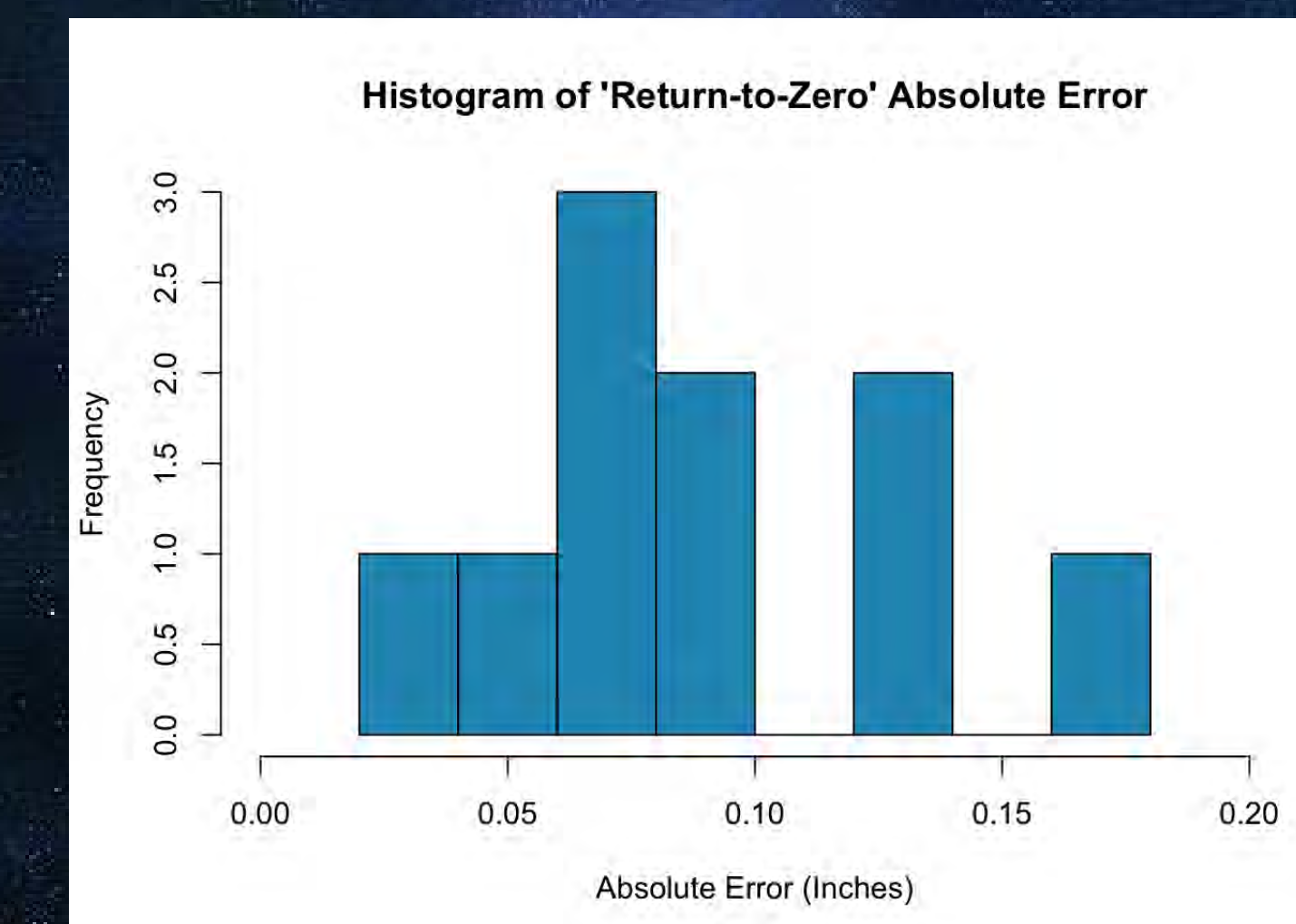
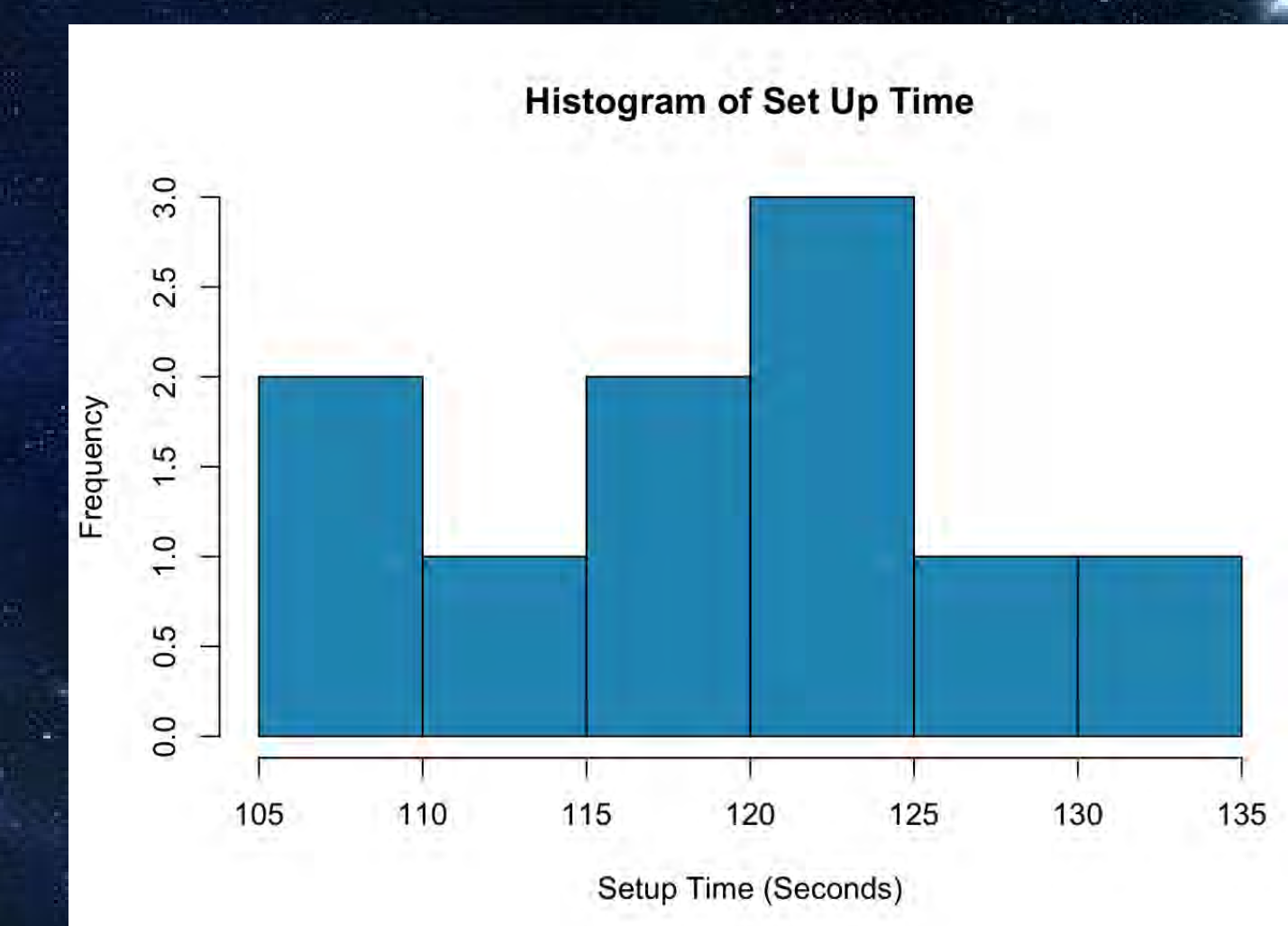
Results

Set Up Time Testing

Goal: Reduce set up time of the stand to be below 10 minutes.
Method: 10 timed tests that includes connecting the automation system to the stand, adjusting height, directing automation to zero out distance and then travel to desired position.
Results: Setup range: 105 to 133 seconds (1 min 45 sec to 2 min 13 sec)

Return to Zero Accuracy Testing

Goal: Determine the accuracy of the built system to be within 0.050"
Method: 10 tests with 5 different input distances were tested. Output Distances were computed and compared to physical distance measurements.
Results: Accuracy achieved: Using a 95% CI We conclude maximum absolute error of 0.016"



Conclusion

All of the testing results came out to be within Northrop Grumman's desired specifications. The lead screw design allows less than 0.016" of error. The system can move from its desired position and return with negligible change. The vibration isolator system can reduce most vibrations by 50%; with few exceptions of vibrations caused by the system being shoved to the side. We have reduced the time it takes to set up DIC testing using this automated system.