National Aeronautics and
Space Administration



Structural Model Validation – ALLVAR

2024 Mirror Technology Days

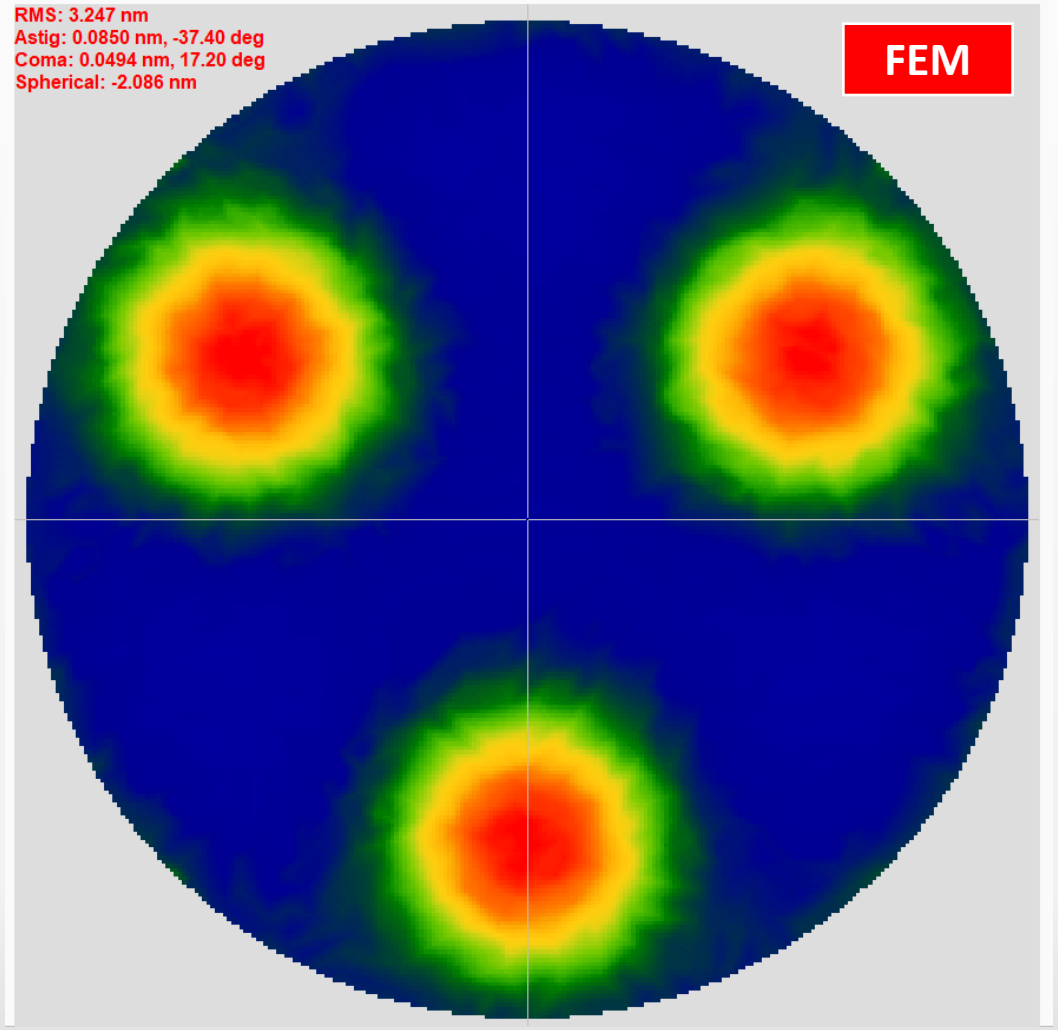
Jagan Ranganathan

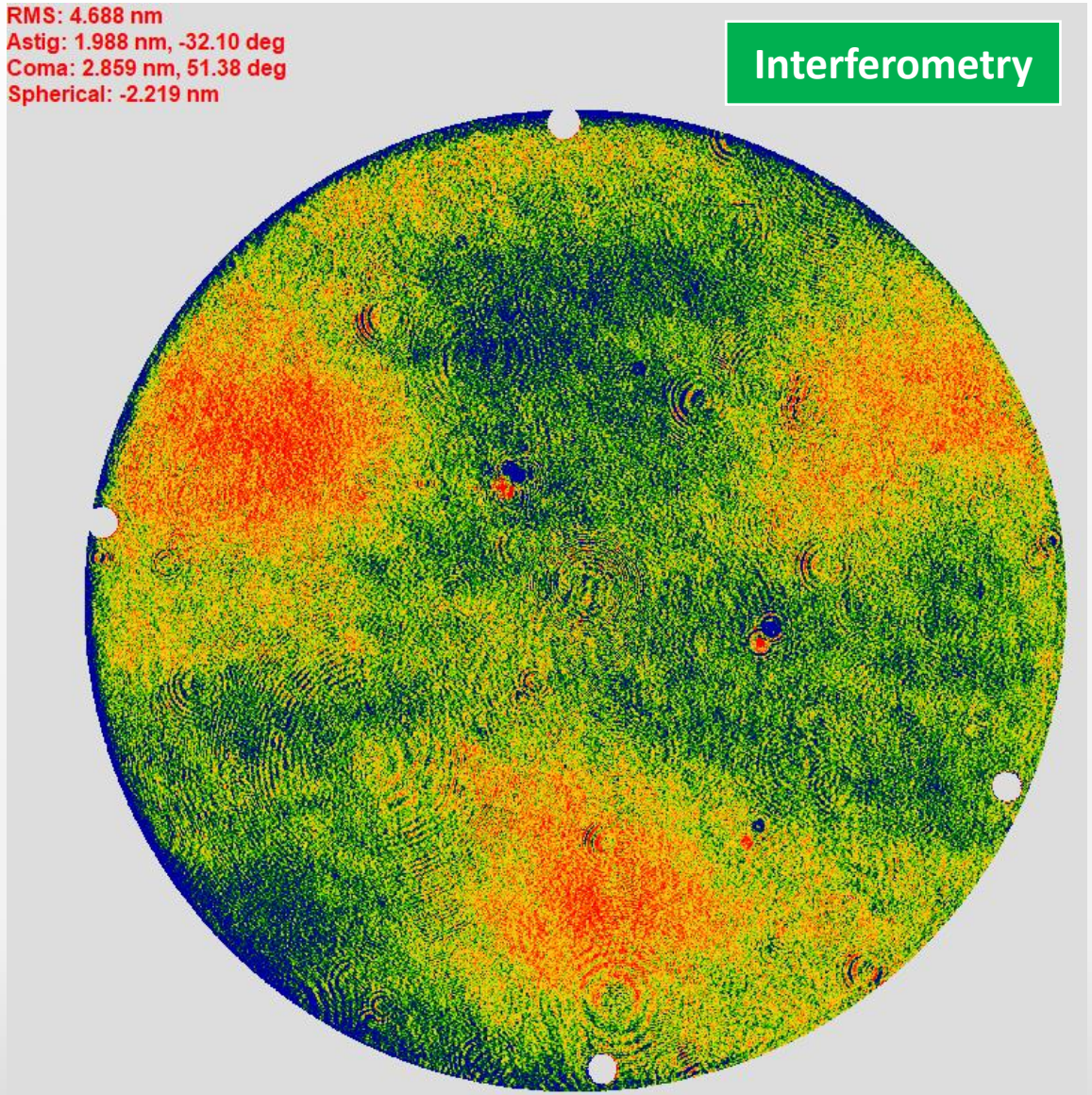
MSFC - ES23

November 19, 2024



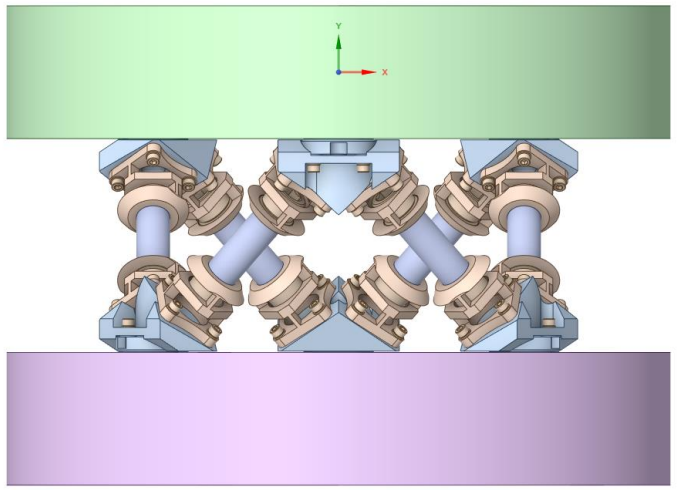
Cryo Deforamtion Comparison: FEM Vs Test

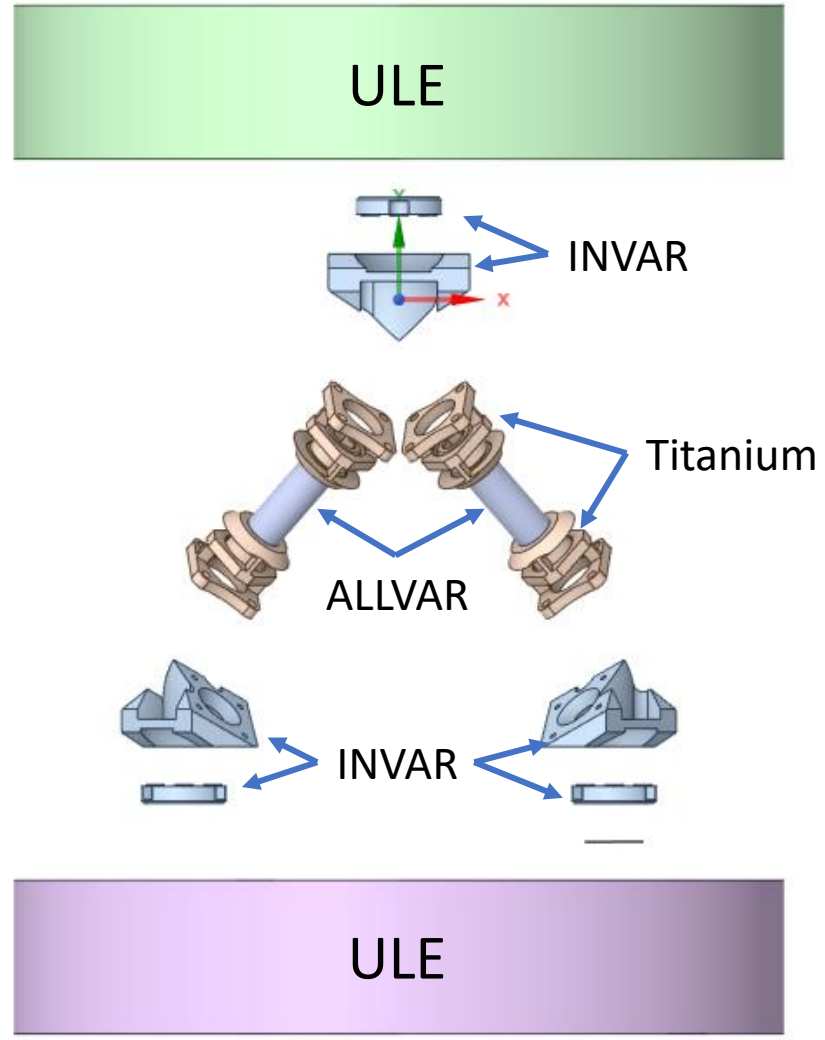




Ultra-Stable ALLVAR Alloy athermalized struts



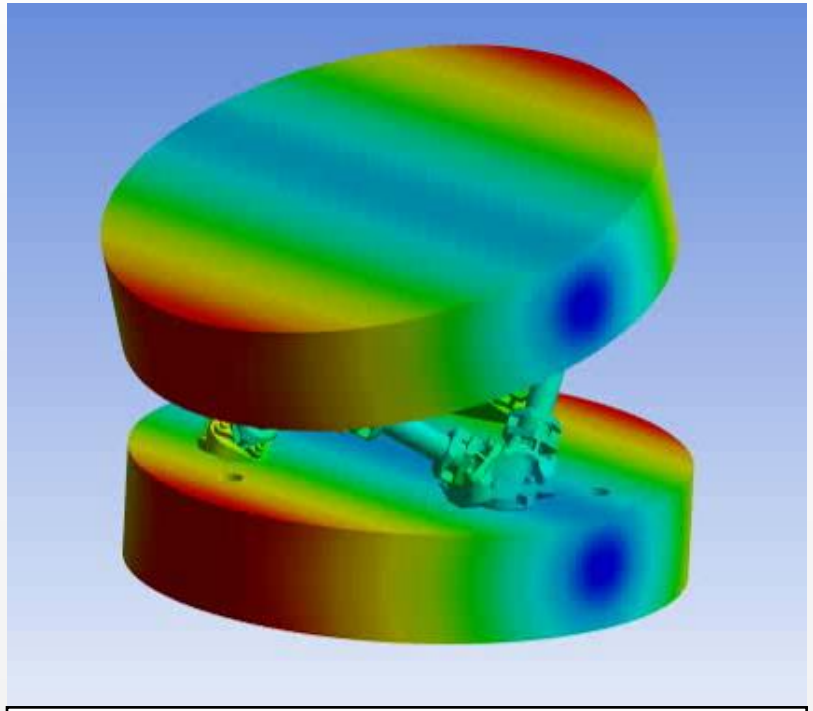




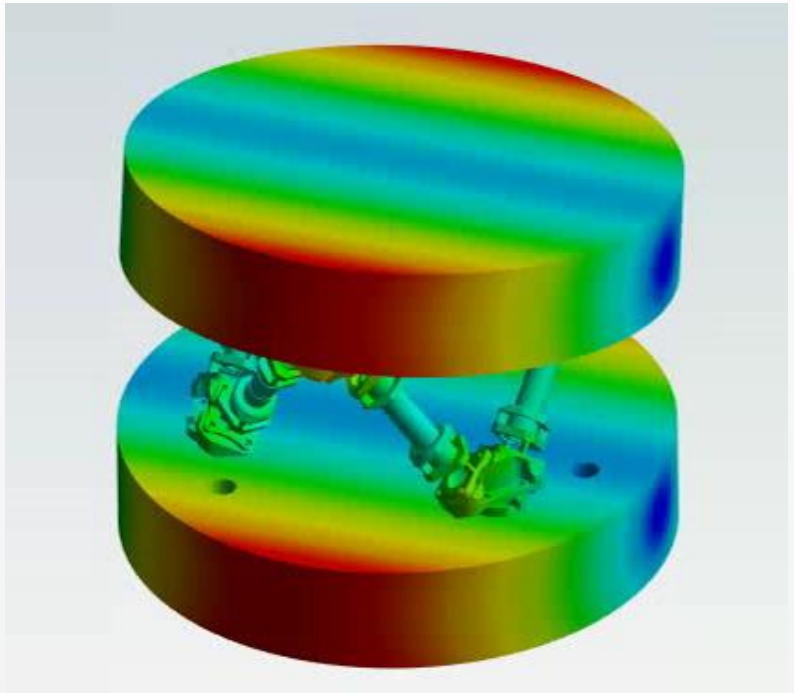
MSFC received the ALLVAR Strut Assembly for optical performance testing.

As part of our routine model correlation effort, we created a FEM and predicted the optical performance of the mirror surface in ~293K and ~265K temperature.

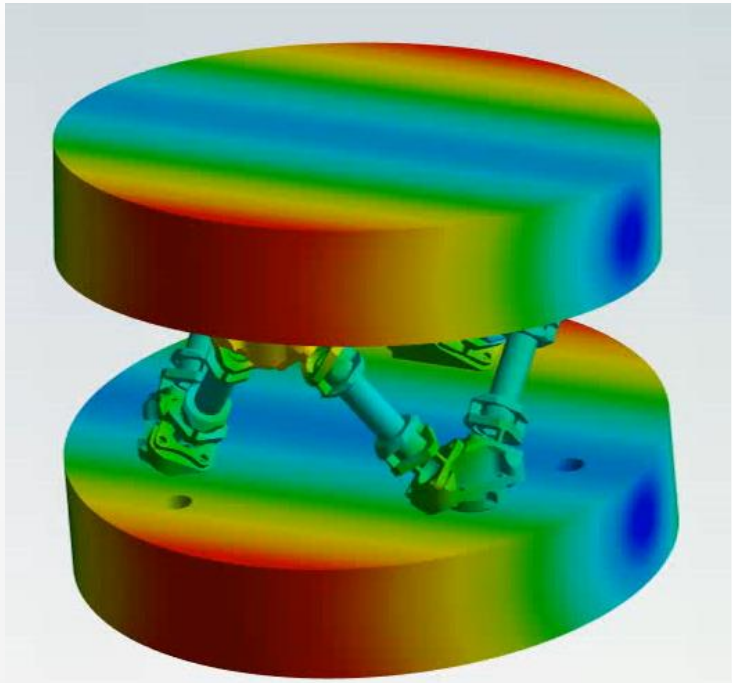
Finite Element Modeling: Modal Analysis Results



User 1: 269 Hz



User 2: 267 Hz



User 3: 307 Hz

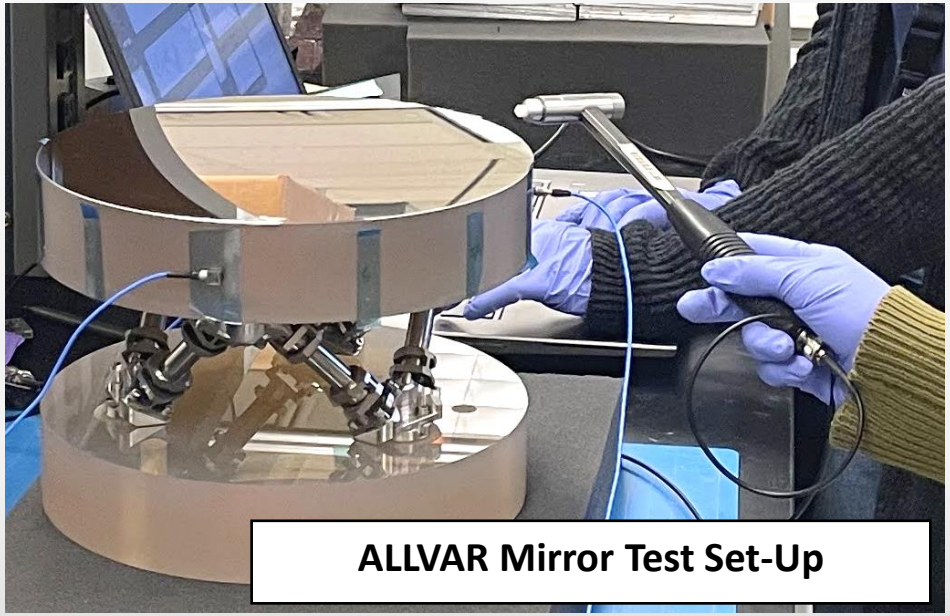
Variability in the analysis results highlights the differences in modeling technique and their assumptions.
The challenge - which one is correct?

Modal Tap Testing

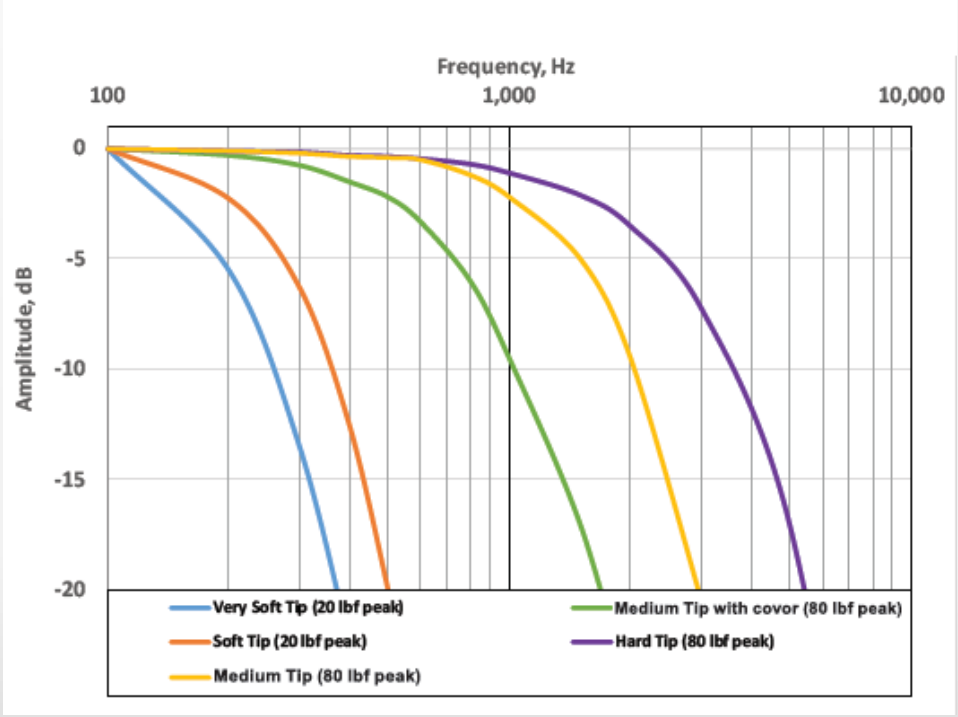
Purpose: To measure the Frequency Response Function (FRF) of a structure using an input and output signal.

- Input Signal: Produced by lightly tapping test article with a small hammer
- Output Signal: Produced from the reaction of the test article to the excitation force

- The FRF is dependent on the mass, stiffness, and damping of the mirror structure.



ALLVAR Mirror Test Set-Up



Testing Procedure for Modal Tap Test

- Important aspects of testing procedure were
  - Pre-test analysis
  - Calibration of accelerometers and impact hammer
  - Ensuring the quality of the hammer taps

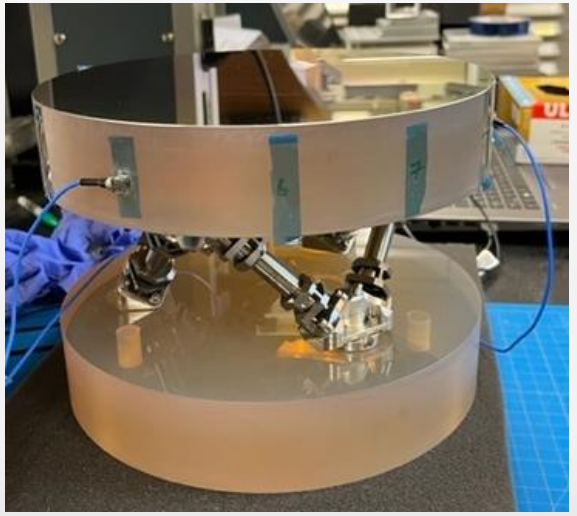


Good Input Signal

Bad Output Signal



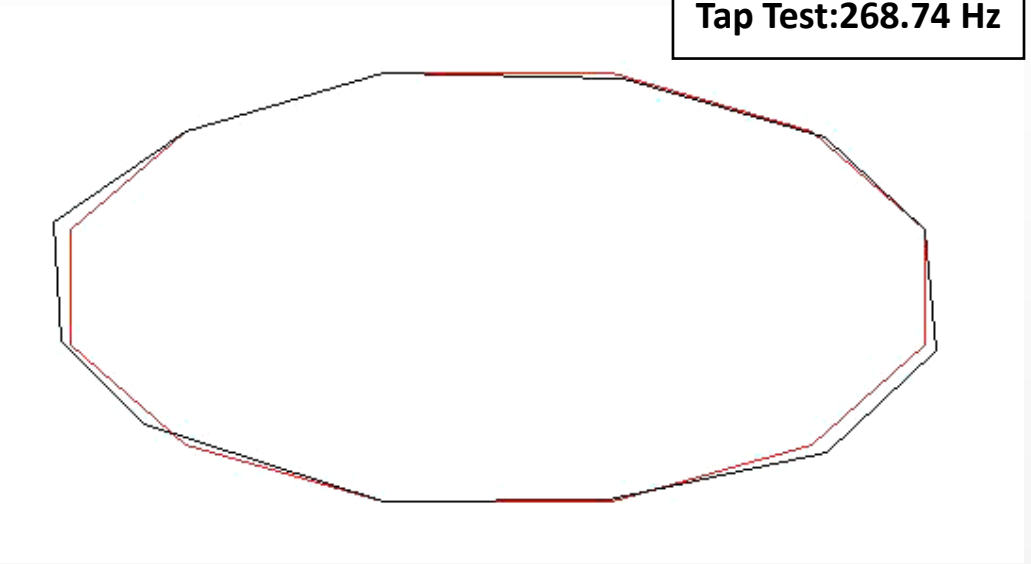
Data Acquisition (DAQ) System

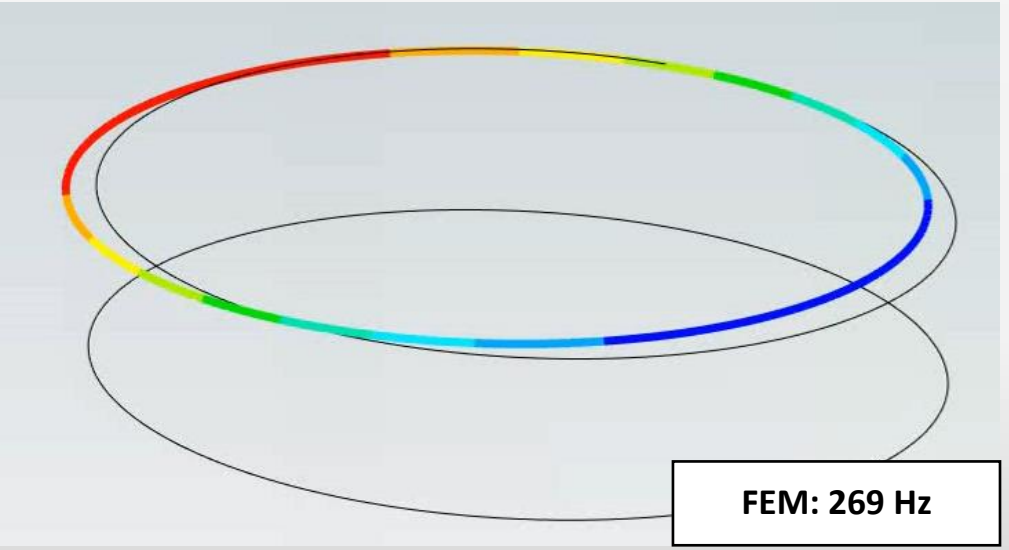


ALLVAR Mirror Test Set-Up

Experimental Results & Comparison

ALLVAR Mirror Natural Frequencies [Hz]		
Experimental/Test Data	**FEM Predicted**	**% Difference**
268.7	269.2	0.2%
270.8	269.2	-0.6%
278.5	280.4	0.7%
343.1	349.6	1.9%
346.3	349.6	1.0%
352.4	350.5	-0.6%





Summary

- Modal Tap Testing can be a low cost and effective way to reduce modal uncertainty
- <2% frequency difference was realized in ALLVAR Strut Assembly
- NASA Intern gained valuable skill and experience by performing the modal tap test