



Scan Analysis at 1m/s and ETFE Identification

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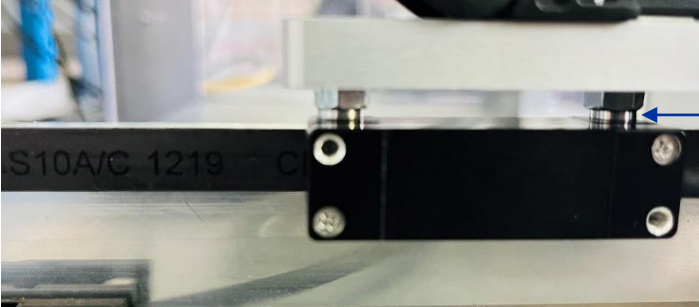
30.05.2023

Goals

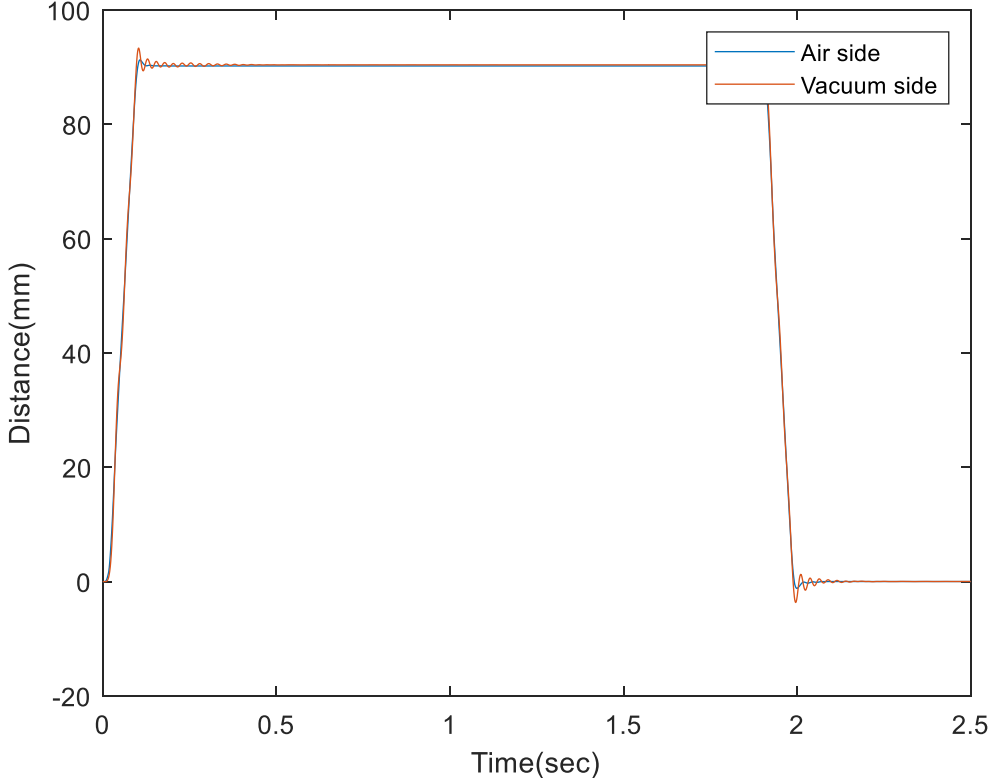
- Operate at different speeds and obtain corresponding measurements
- Study the reproducibility of encoder measurements
- Understand the relationship between the Air Side Displacement and Vacuum Side Displacement
- Identify the resonant frequency to minimize vibrations

Data Collection

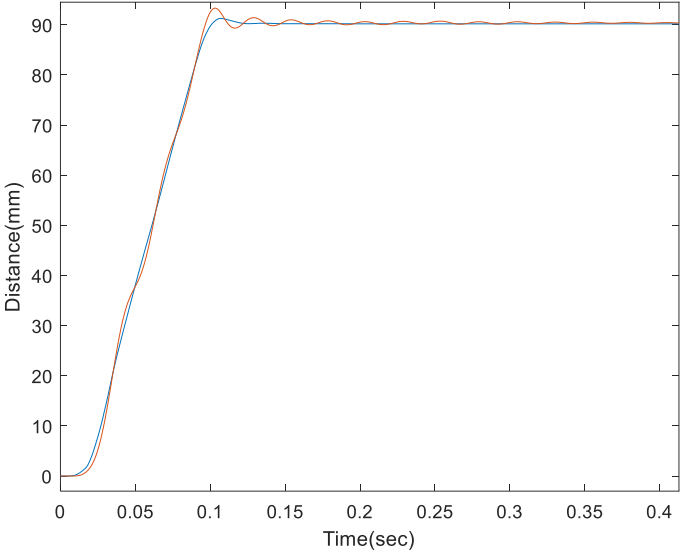
- Modifications done to the testbench:
 - i. Mechanism fixed on the support plate
 - ii. Re-aligned the vacuum side encoder better



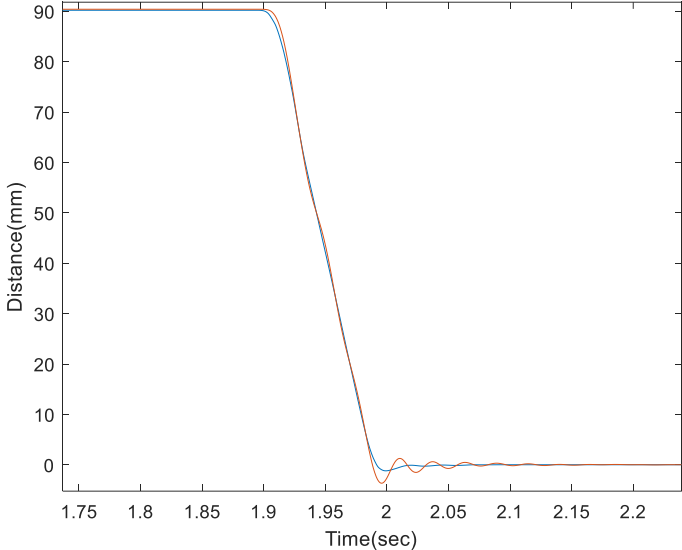
Added washers for better alignment



One Trial Run at 1 m/s

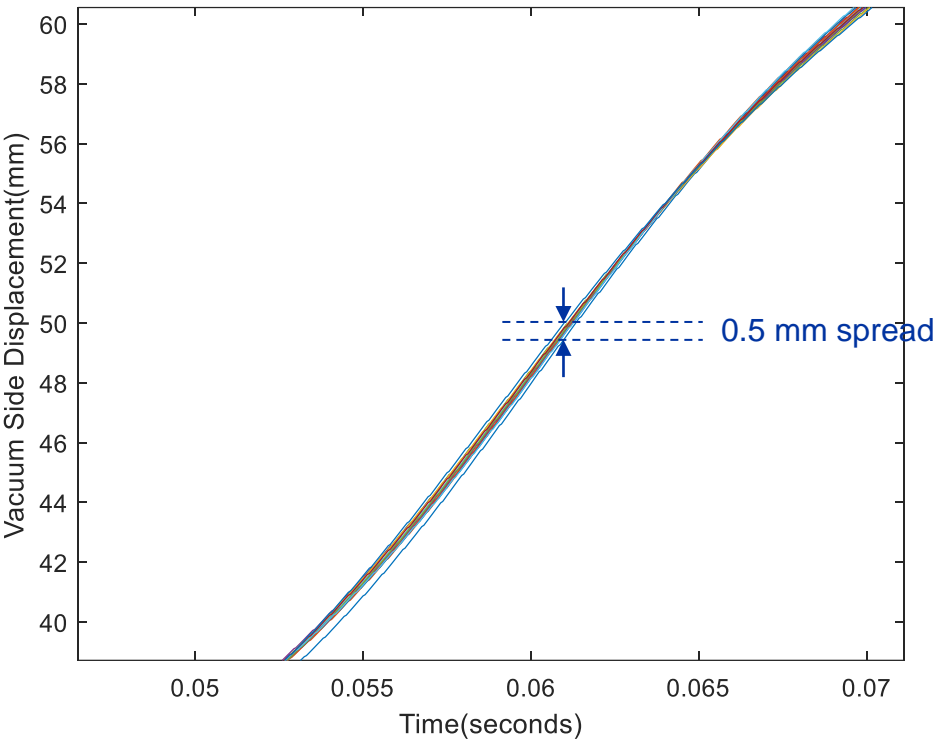


IN Stroke

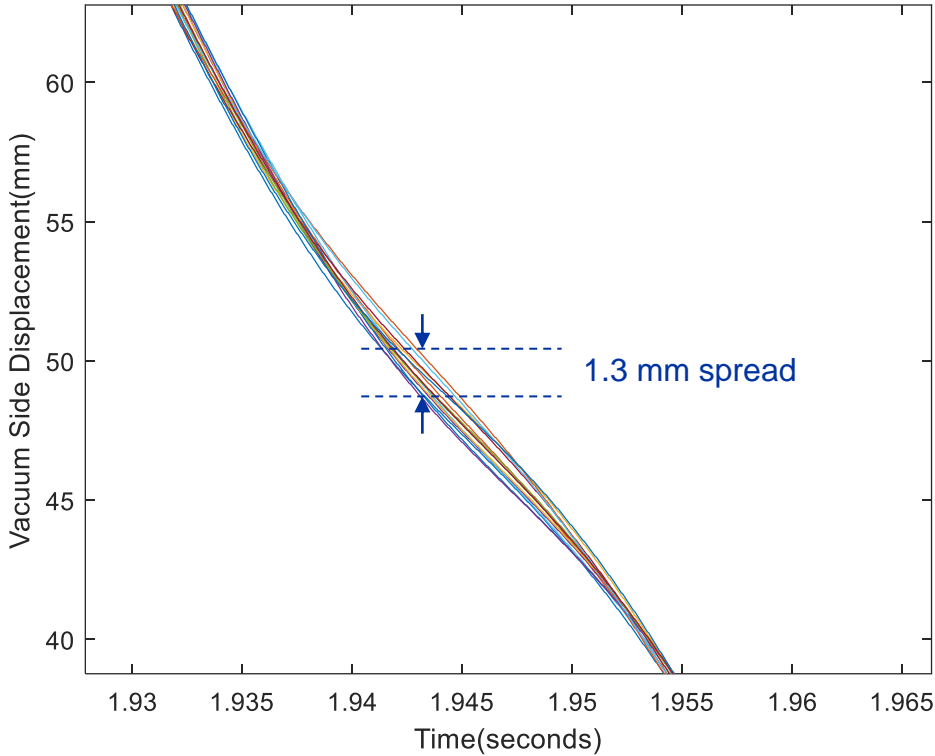


OUT Stroke

Reproducibility Analysis



15 IN Strokes

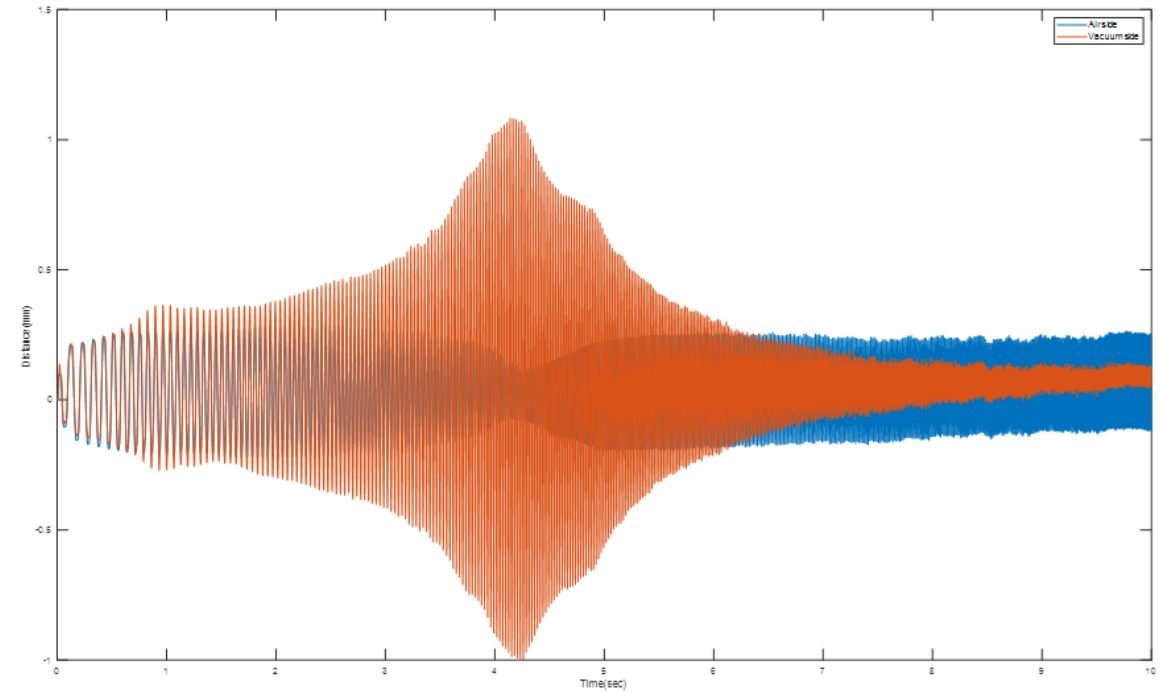
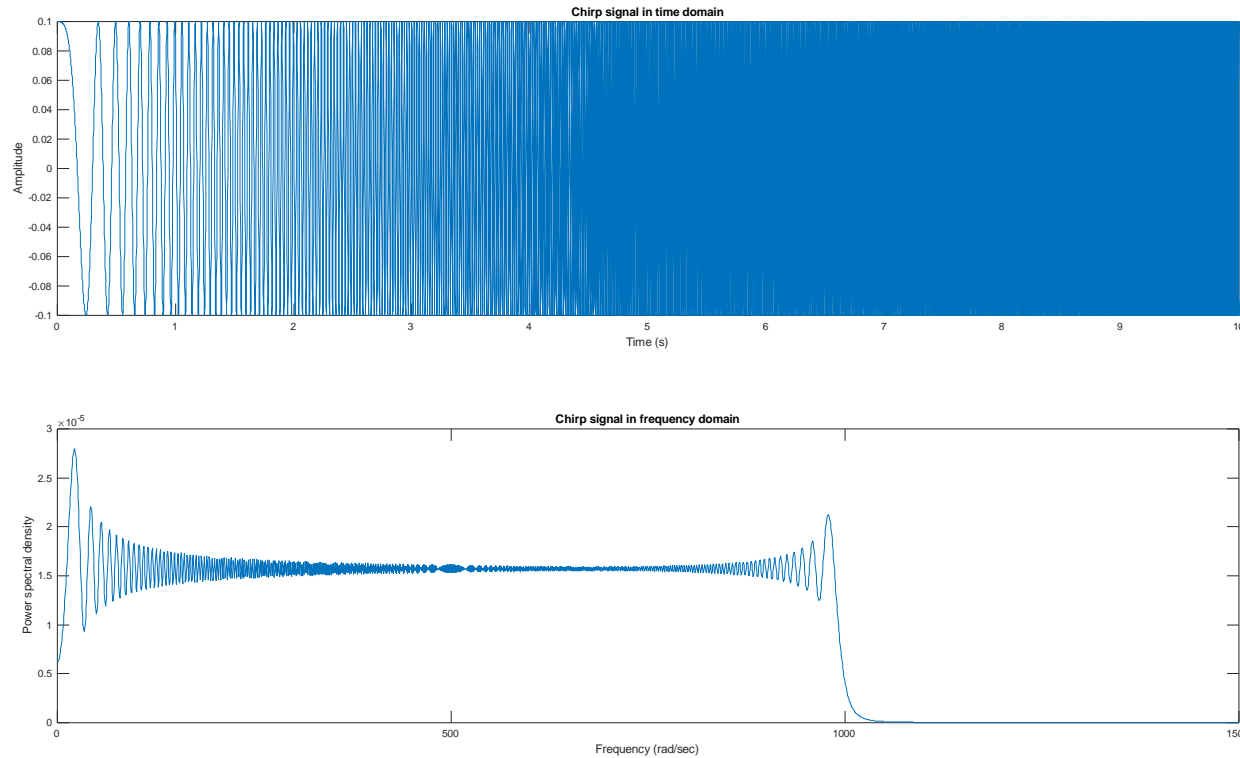


15 OUT Strokes

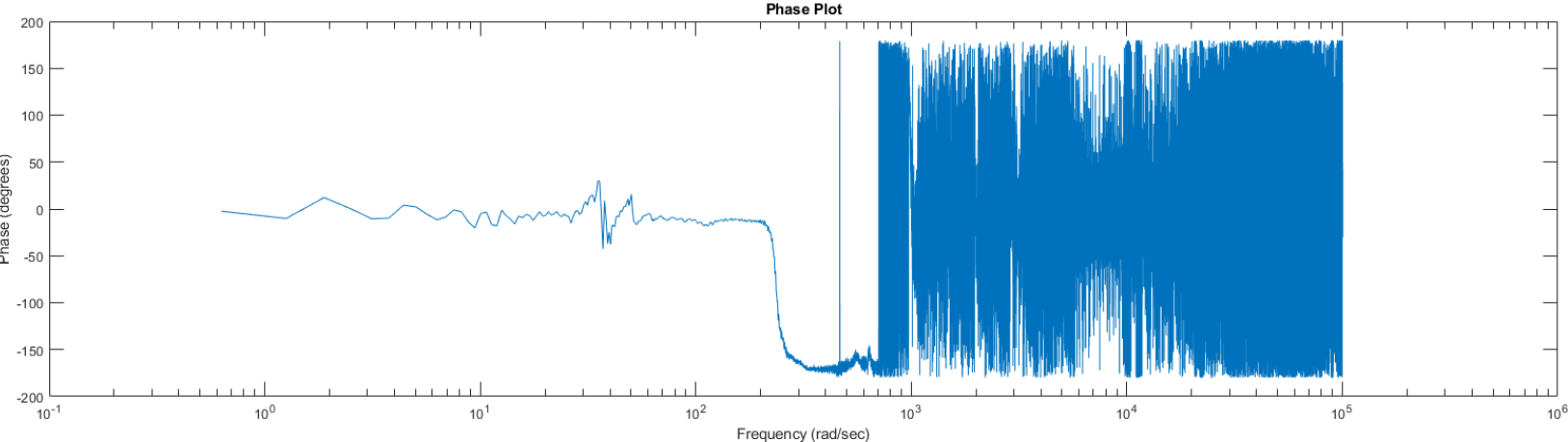
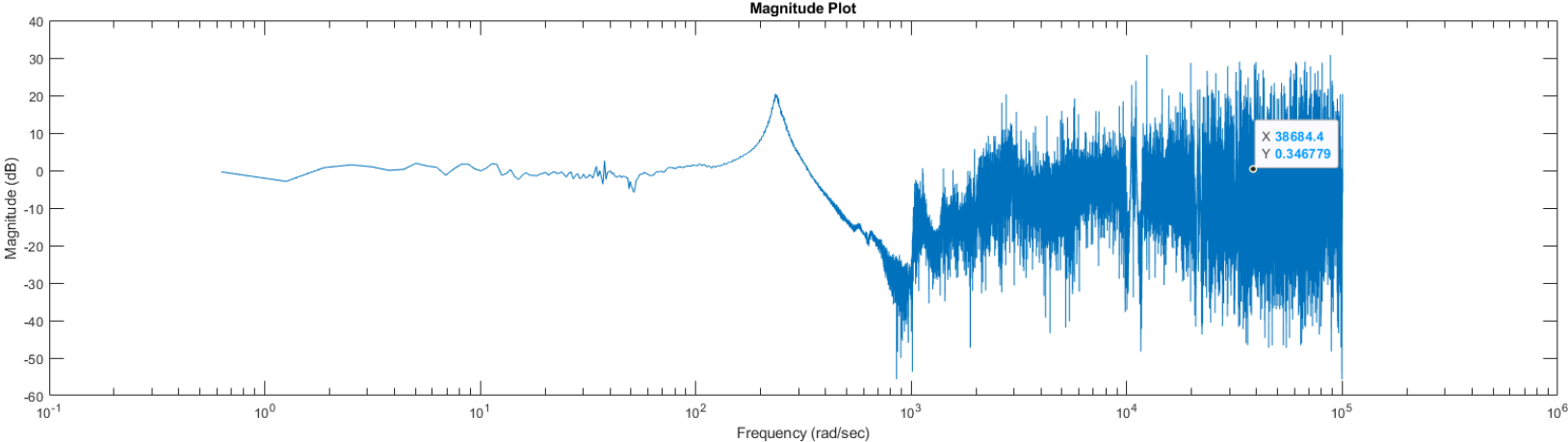
Working on optimizing the trajectory and filtering it to improve reproducibility in the strokes

System Identification

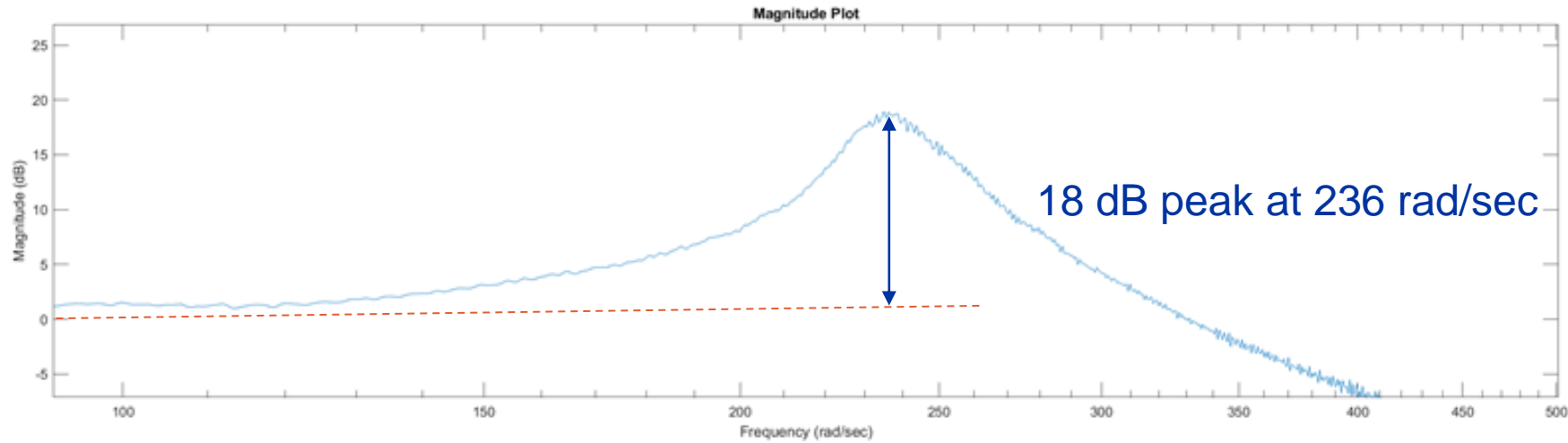
- ETFE with chirp signal (multisine)
- Energy concentrated in the frequency range 1 rad/sec – 1000 rad/sec



ETFE Results



ETFE Results – 2nd order approximation



$$M_p = \frac{1}{2\zeta\sqrt{1-\zeta^2}} = 18dB$$

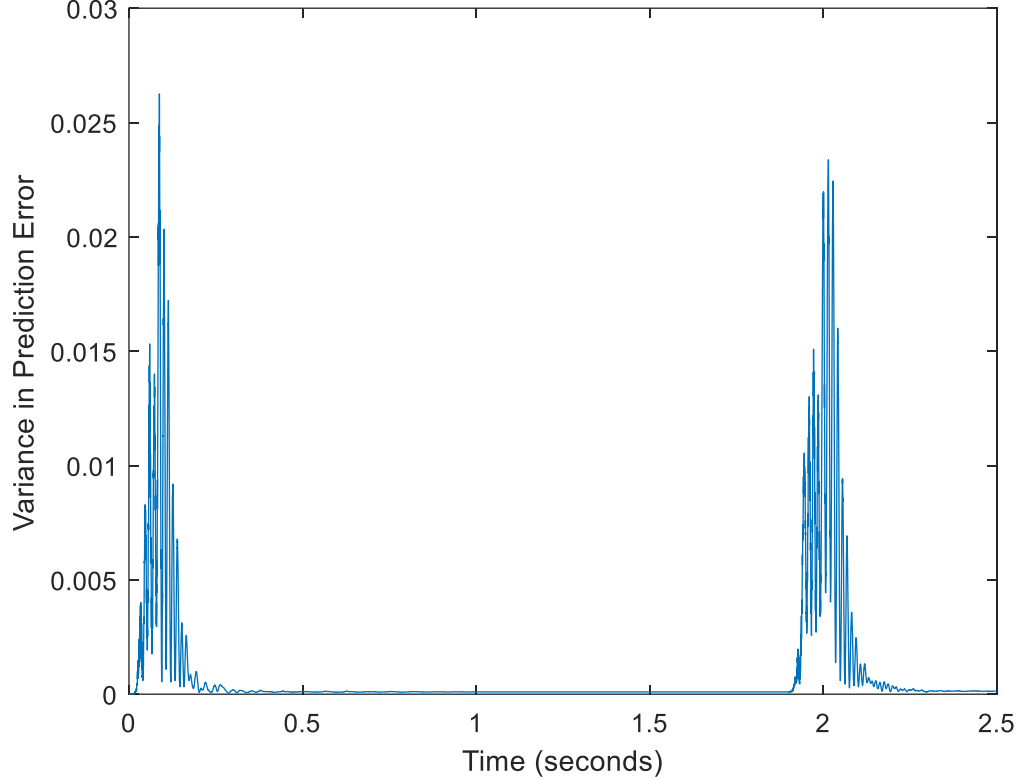
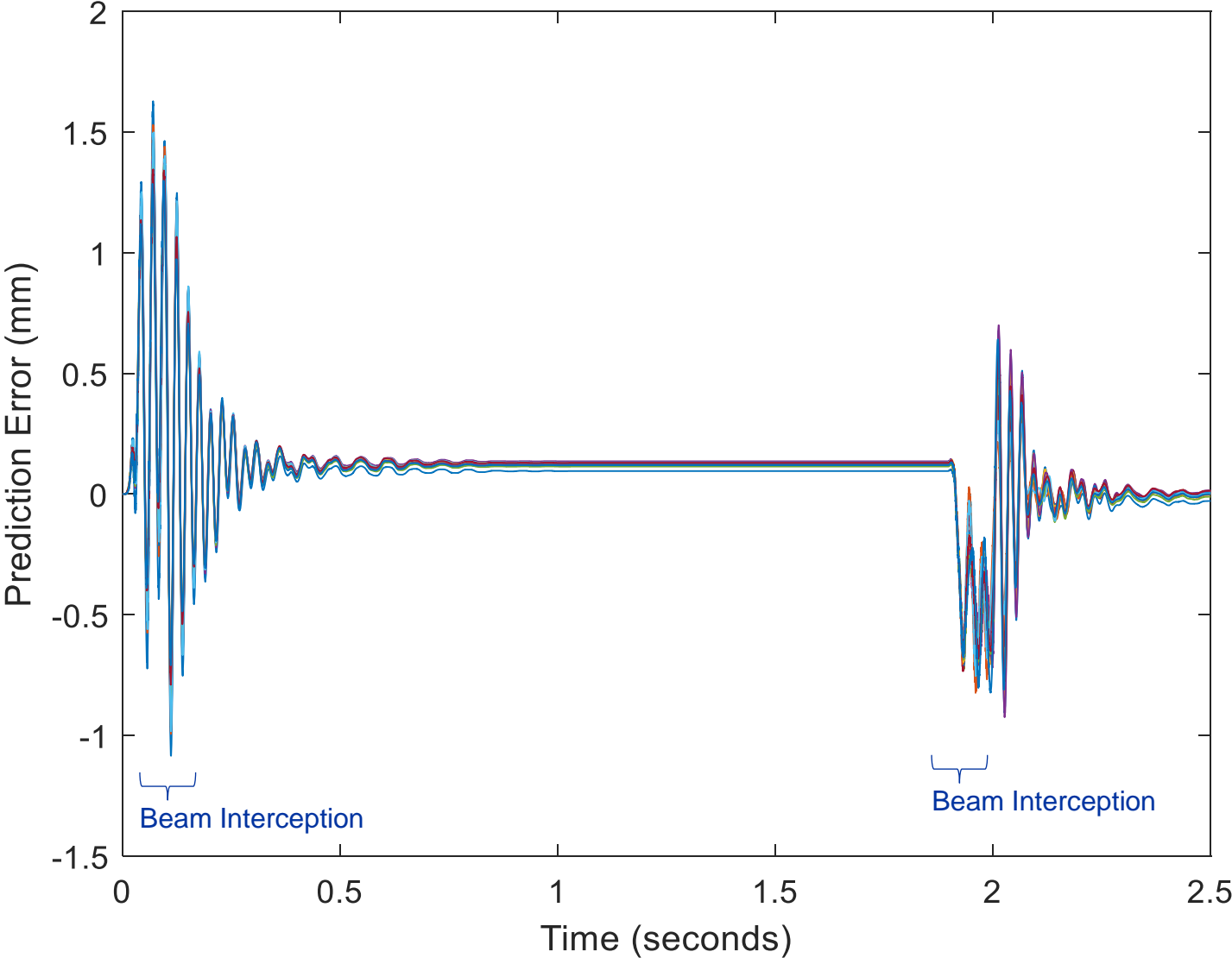
$$\omega_r = 236rad/sec$$

$$\omega_n = \frac{\omega_r}{\sqrt{1-2\zeta^2}}$$

Second Order Approximate Transfer Function

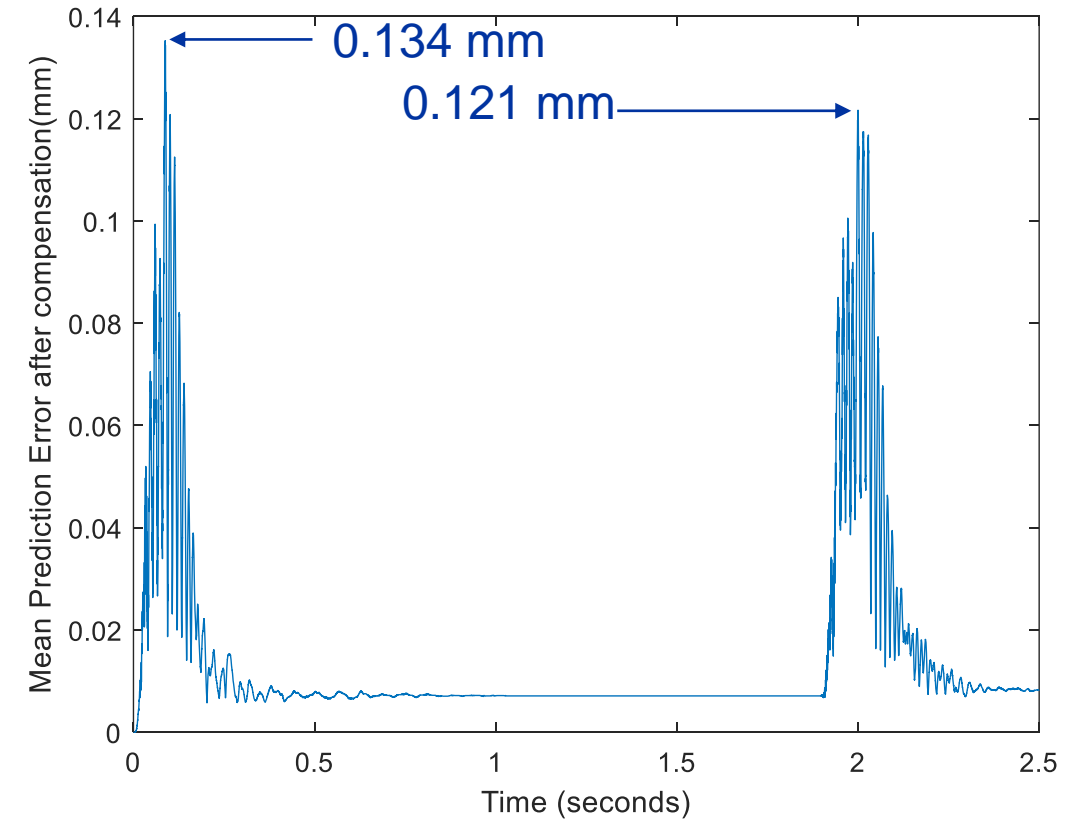
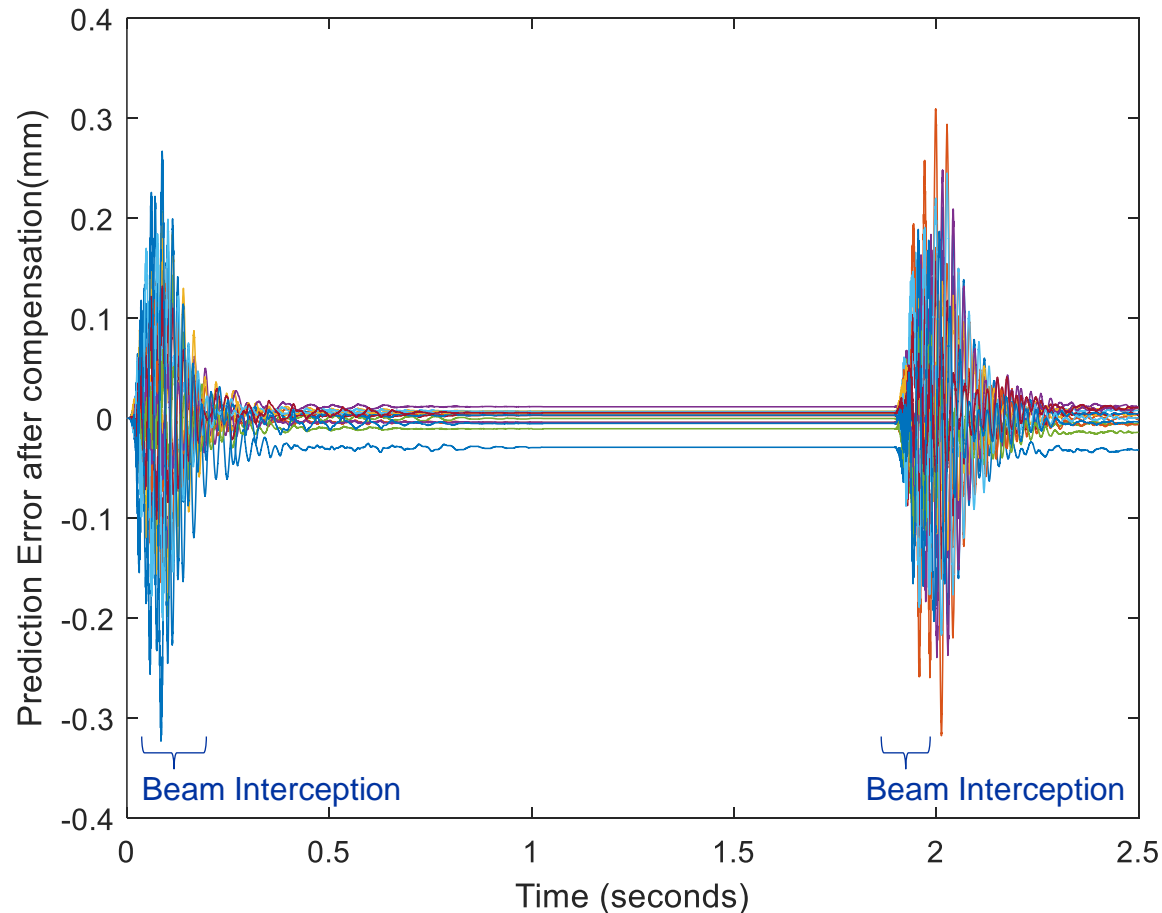
$$\frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2} = \frac{56412.6774}{s^2 + 29.88874s + 56412.6774}$$

ETFE Results – 2nd order approximation predictions of 1 m/s scan



- Small variance indicates that the prediction error is more reproducible
- Error could be reduced by compensation

ETFE Results – 2nd order approximation predictions of 1 m/s scan after compensation



Compensated Prediction = Prediction + Mean of Prediction Error

Outlook

- **Goal: Operate at different speeds and obtain corresponding measurements**

Next Step: Able to operate the system until 1 m/s at around 250V; Equipping the bench with Accelerometers/Force Sensors to obtain further measurements (Would need help with this)

- **Goal: Study the reproducibility of encoder measurements**

Next Step : Preliminary studies indicated a higher spread; Design trajectories that ensure reproducibility

- **Goal: Understand the relationship between the Air Side Displacement and Vacuum Side Displacement**

Next Step : ETFE 2nd order approximation shows promising results, other methods and more accurate models to be studied

- **Goal: Identify the resonant frequency to minimize vibrations**

Next Step: Multisine signal with ETFE was able to identify the resonant frequency. To work on trajectories that minimize vibrations



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