



VTT Rotor: Back EMF Test Fixture

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Introduction

Danfoss Turbocor is the leader in the oil-free centrifugal compressor industry due to their innovative magnetic bearing technology. In 2015, they are launching a new compressor model with a larger rotor which will be manufactured by a third party company. The focus of this project is testing the magnetic portion of the rotor as a means of quality control. This will be done by designing a test fixture that can rotate the rotor inside the stator and measure the back electromotive force generated.

Design Constraints

- Minimum rotation speed of rotor: **1000 RPM**
- Must overcome **magnetic force** during insertion (Approximately **80 lbs**)
- Rotor must be centered and axially aligned within stator with less than **0.5 mm tolerance** from the centerline

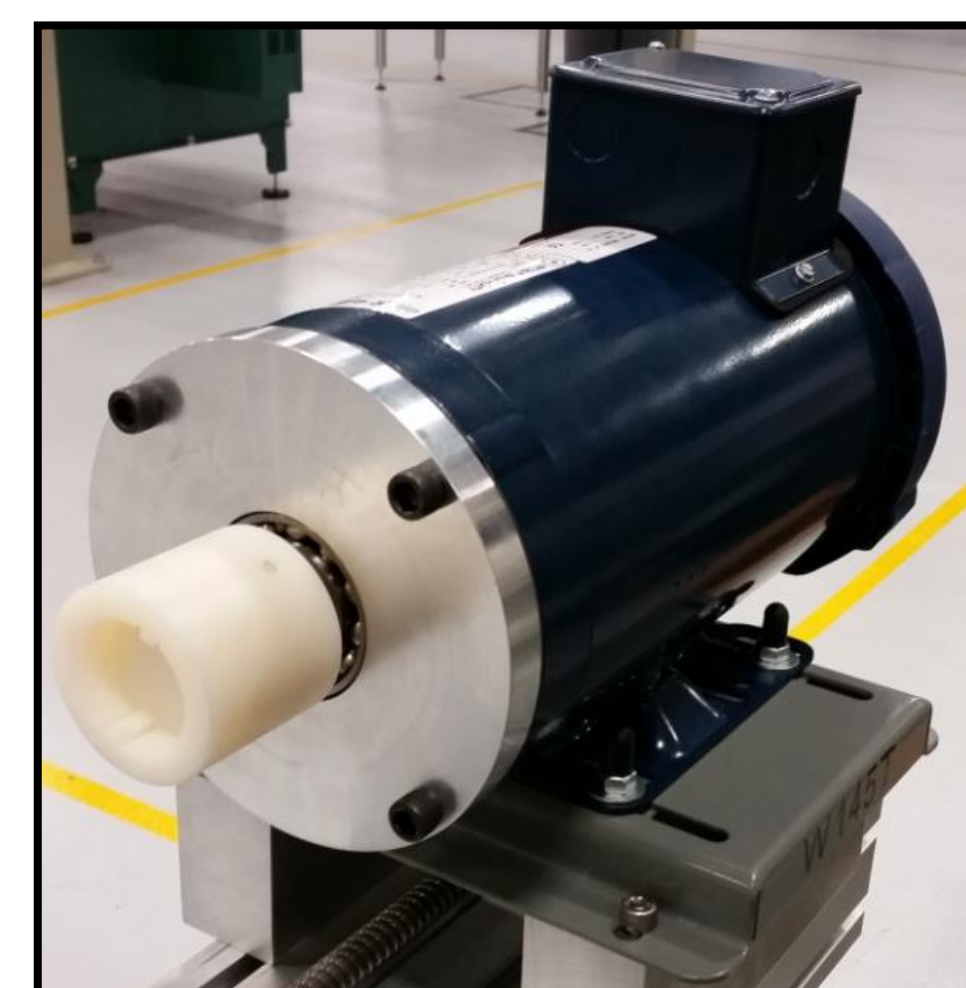
Test Fixture Components

Motor Assembly and Drive

- Marathon Electric AC motor selected
 - 2 HP, 1800 RPM
 - 0.875 inch shank
- External bearing supports shank
- Nylon rotor connection connects motor shank to rotor
- Speed controlled by Variable Frequency Drive (VFD)

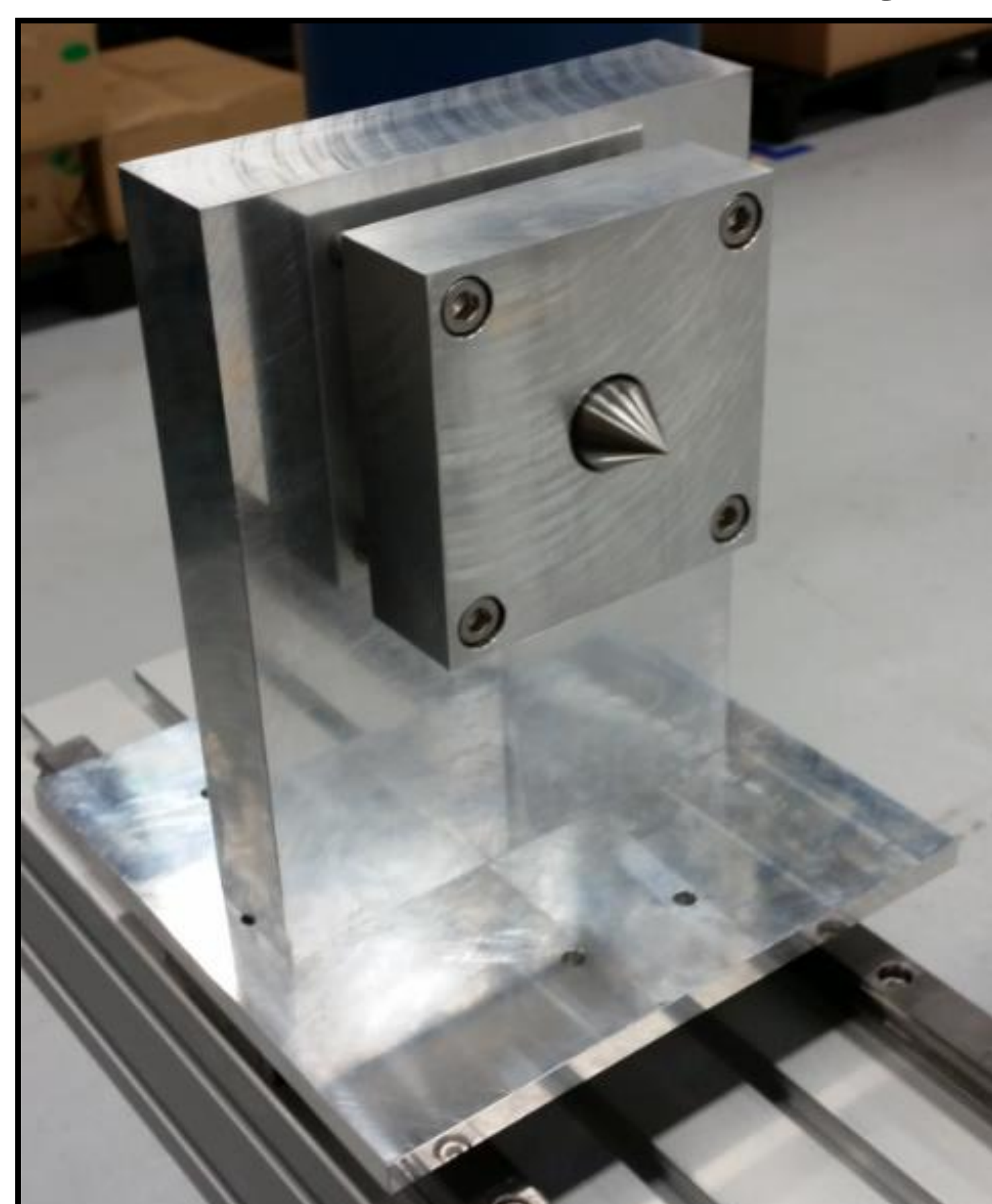


Variable Frequency Drive



Assembled Motor

Live Center Assembly



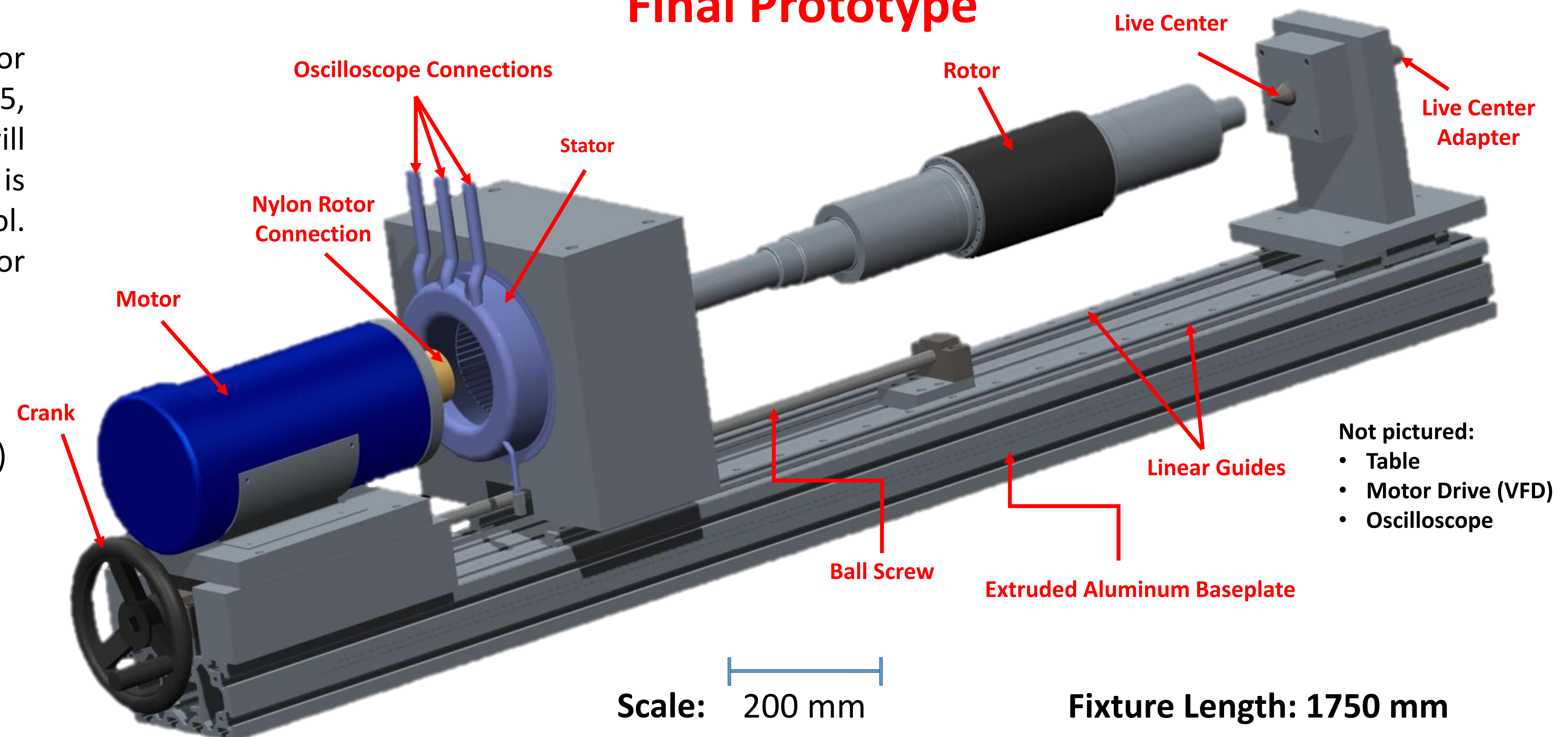
Live center assembly

- Live center specifications:
 - Rated for 5500 RPM,
 - 660 pound load capability
- Tapered end fit to adapter to simplify manufacturing
- Assembly rides on linear guides
- Locked into place with linear guide clamps

Ball Screw & Linear Guides

- Ball screw dynamic load rating – 1150 pounds, static load rating – 2370 pounds
- Linear guides 1240 mm long with guides two blocks each
- Linear guides rated for 115 ft-lb static moment (FOS = 1.6)

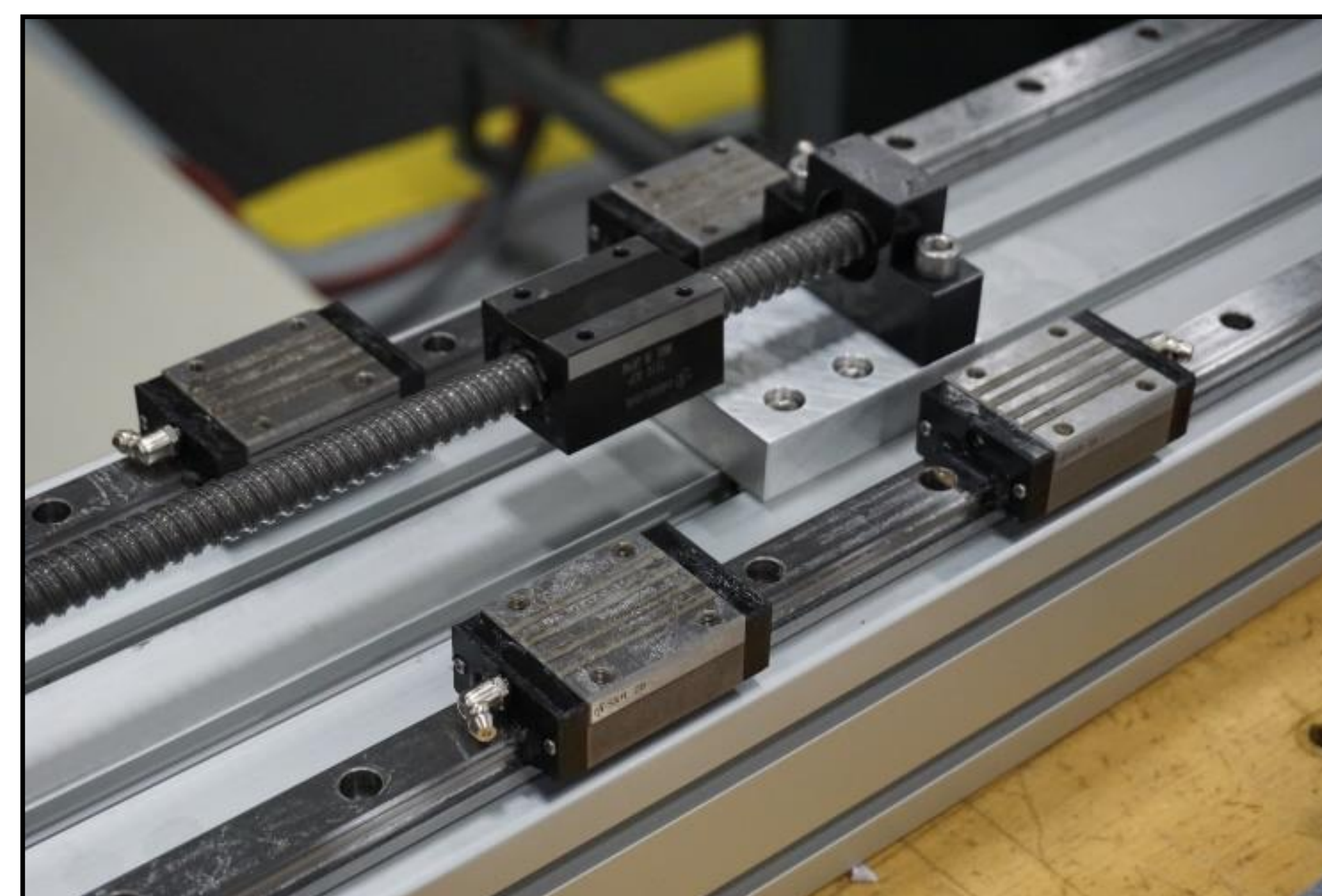
Final Prototype



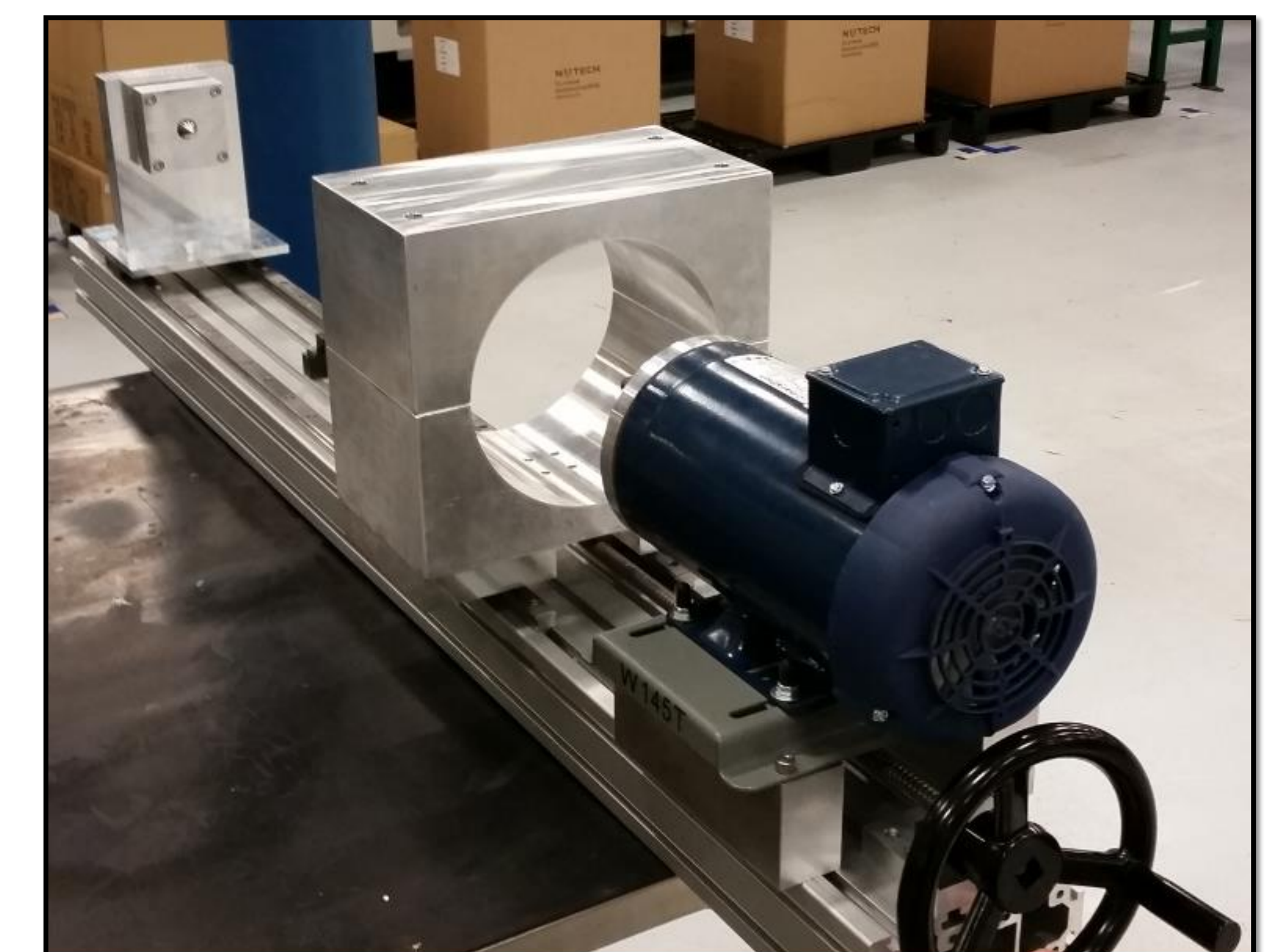
- Not pictured:
- Table
 - Motor Drive (VFD)
 - Oscilloscope

Design Solution

- Rotor locked into place between live center and motor, live center keeps rotor centered and allows rotation
- Stator contained in aluminum stator housing and moved into place with ball screw controlled via crank
- Live center and stator housing ride on heavy load linear guides which reduces friction and aids in alignment
- AC Motor with VFD used to rotate rotor within the stator



Ball screw and linear guides mid-assembly



Picture of assembled test fixture

Future Work

- Test fixture to be implemented on Turbocor's manufacturing line
- Ball screw rotation can be automated using second motor system