

# Design Team 5

## Production Test Fixture For Sensor Ring Testing

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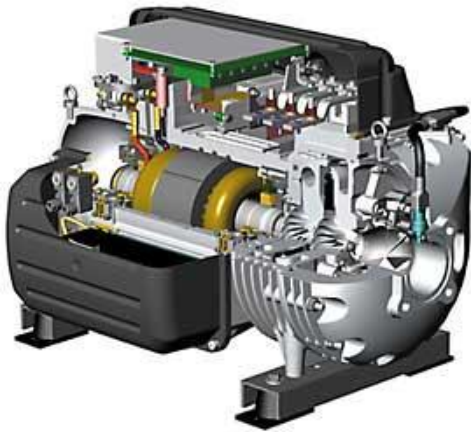


# Overview

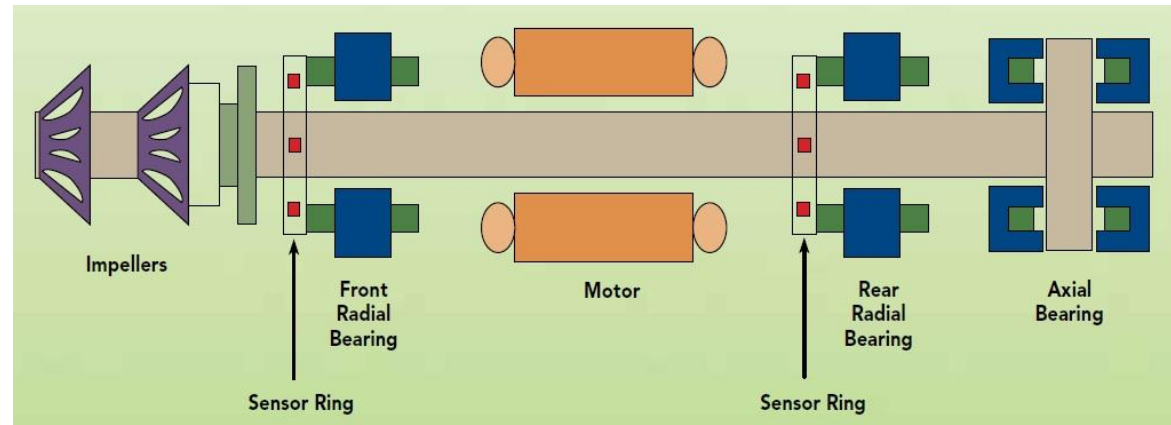
- Introduction
- Problem Statement
- Constraints
- Previous Design
- Final Design
- Load Analysis
- Cost Analysis
- Future Work



# Introduction



Turbocor's Compressor

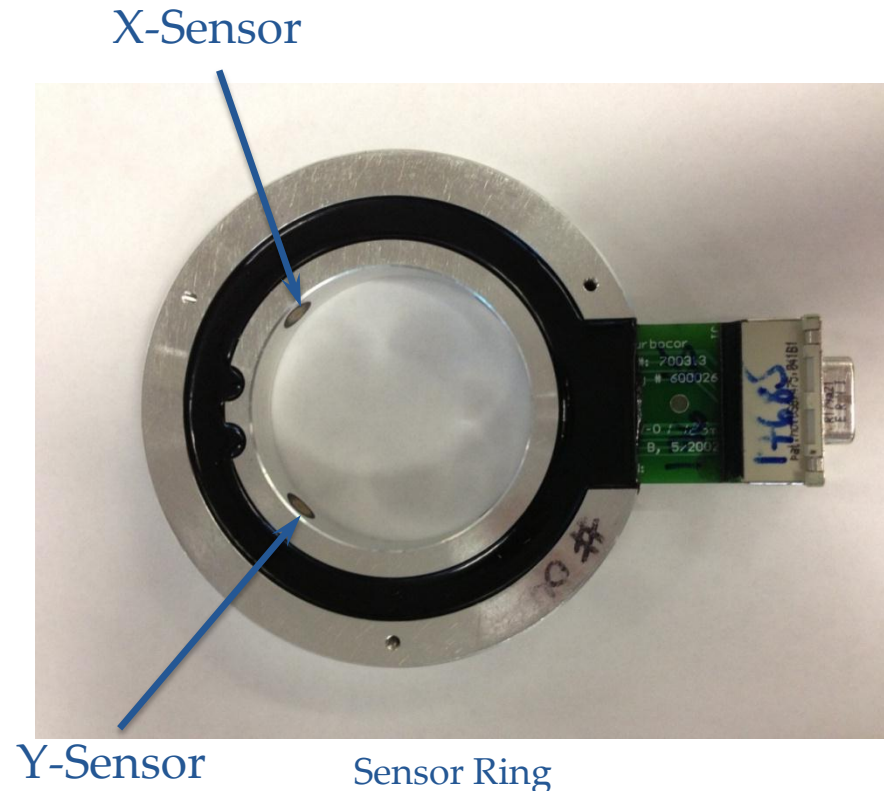


Internal view of compressor

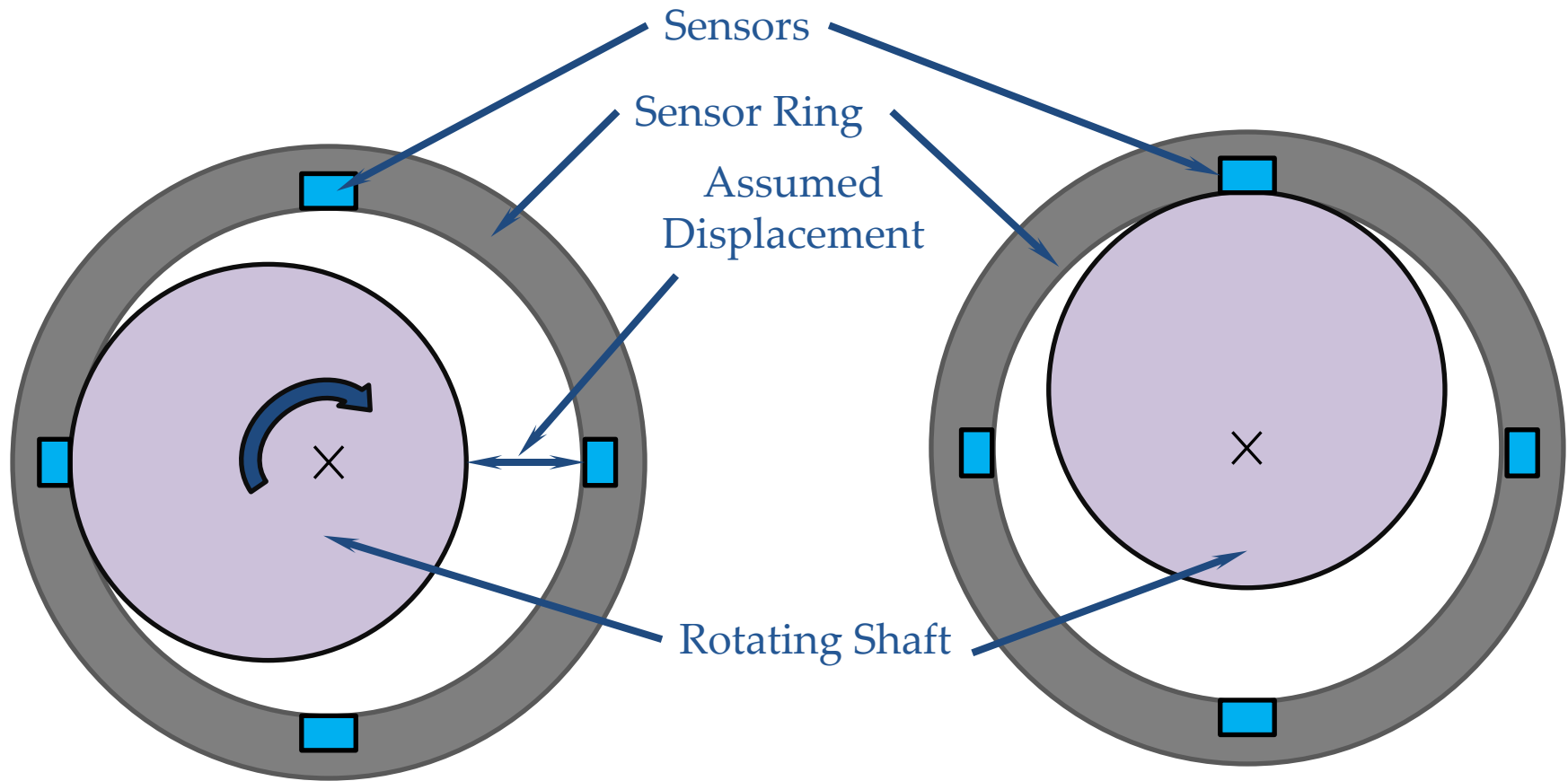


# Problem Statement

- Problem Statement
  - Current testing fixture is inaccurate and unreliable
  - Only tests in the X-Y directions
- Proposed Solution
  - Design fixture with XYZ movements and minimal backlash



# Current Fixture Schematic

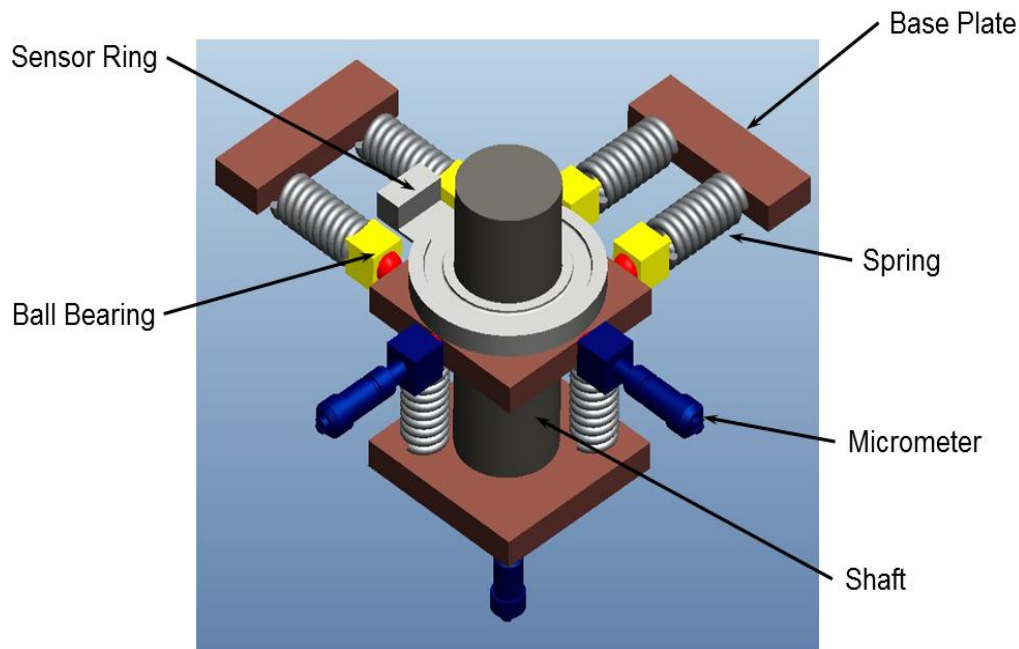


# Constraints

- Independent XYZ movements
- Measurements at three positions
  - Any 3 positions within 400  $\mu\text{m}$  range
- Accuracy of 2 micrometers
- Total displacement of 400 microns
- Minimal backlash



# Initial Design Concept



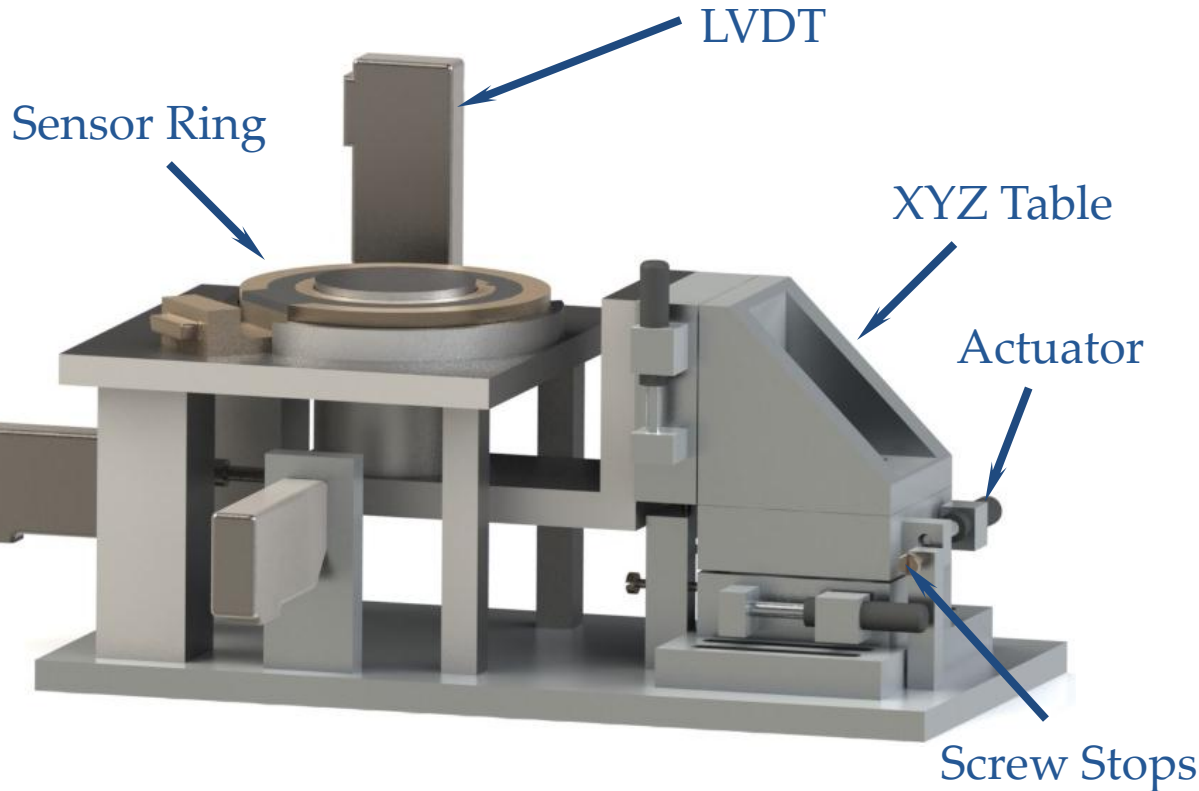
Concept 1: XYZ Table

7

- Pros
  - Inexpensive to build
  - Directionally independent
  - Three positions possible
- Cons
  - Difficult to machine
  - “Reinventing the wheel”
  - Backlash



# Initial Design



## ■ Pros

- Extremely precise
- Independent movements
- LVDT accounts for backlash

## ■ Cons

- High Cost
- Completely manual operation



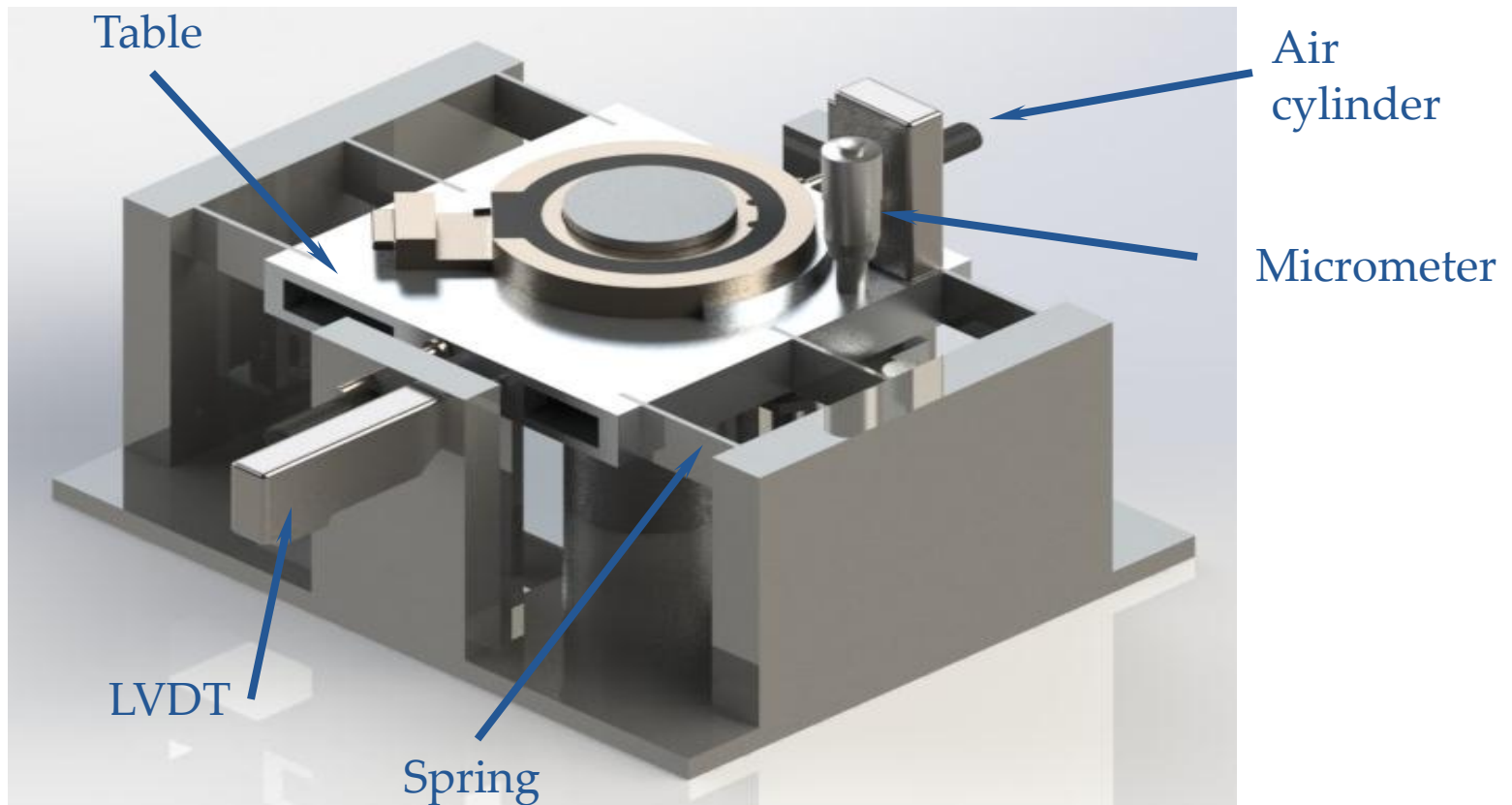


# Changes

- Changes from previous design
- Eliminate commercial linear stage
  - Air cylinder piston for actuation
    - Repeatable
    - Mechanical Stops
- Spring steel restricts movement
  - High resilience
  - Mechanical guides maintain linear displacements



# Final Design Proposal

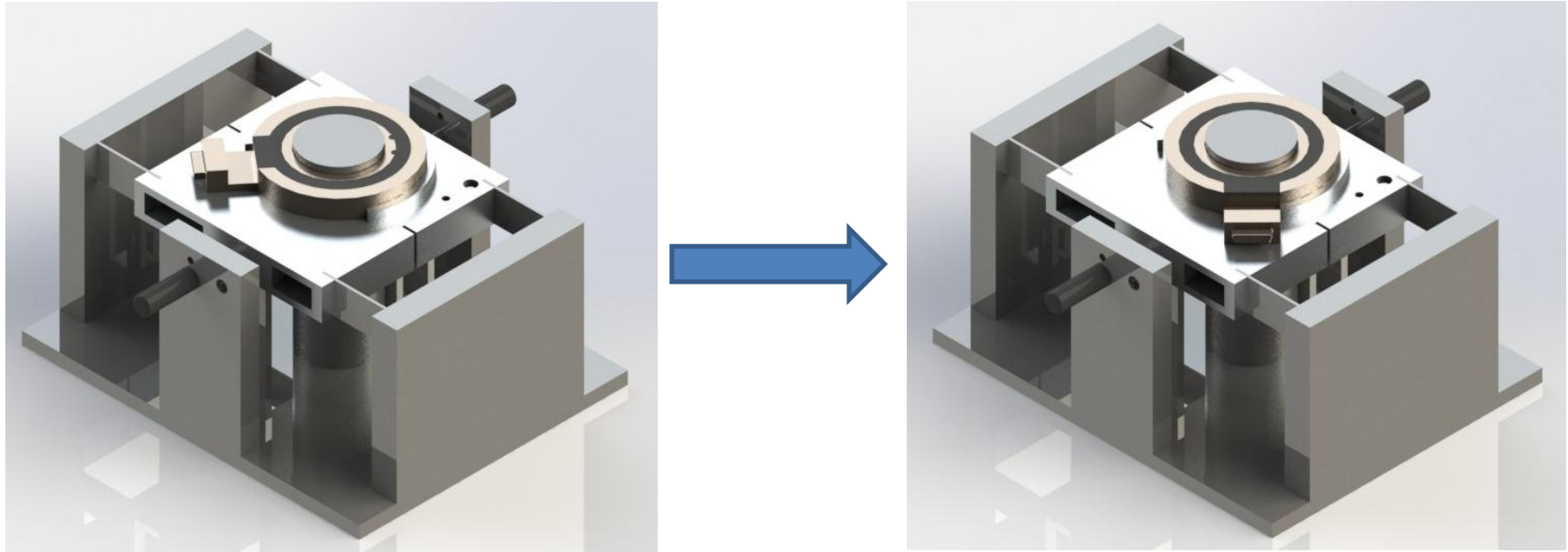


# Improvements

- Significantly reduces cost
- Avoids commercial stage and 3rd LVDT
- Independent displacement
- Testing stage movements are limited
- Extremely time efficient
  - Air cylinders displace almost instantly



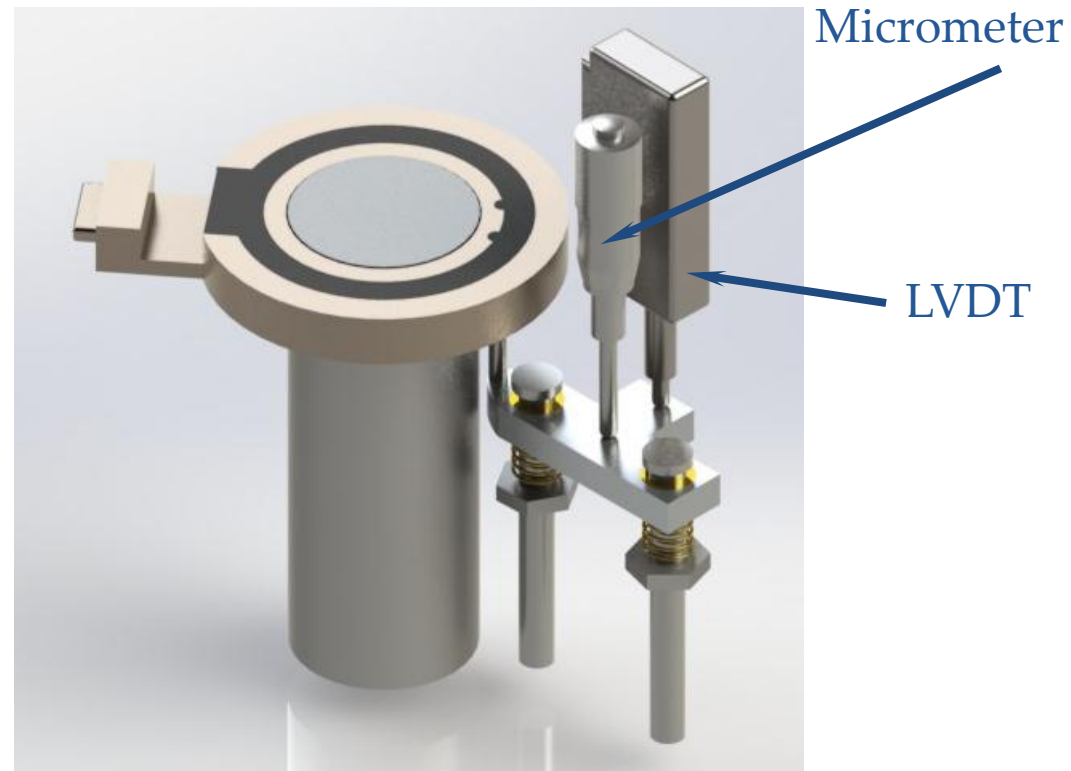
# XY Measurement



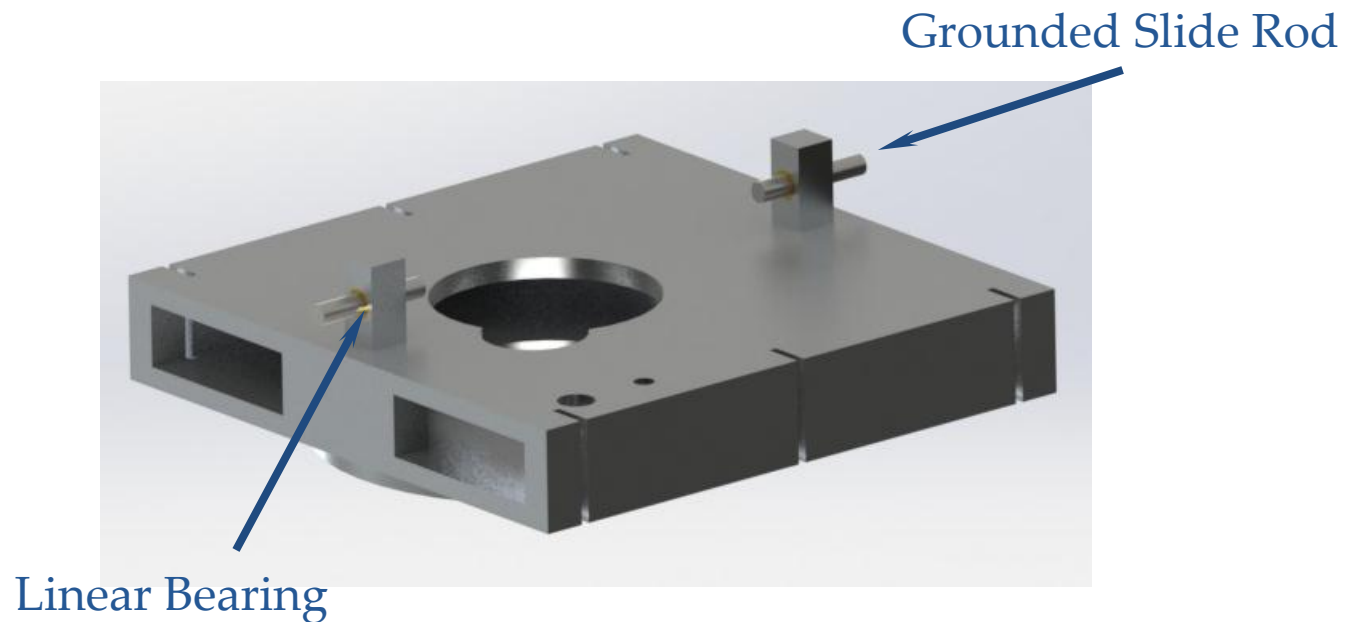
Rotate sensor ring 90 degrees to switch from X to Y sensor



# Z Mechanism

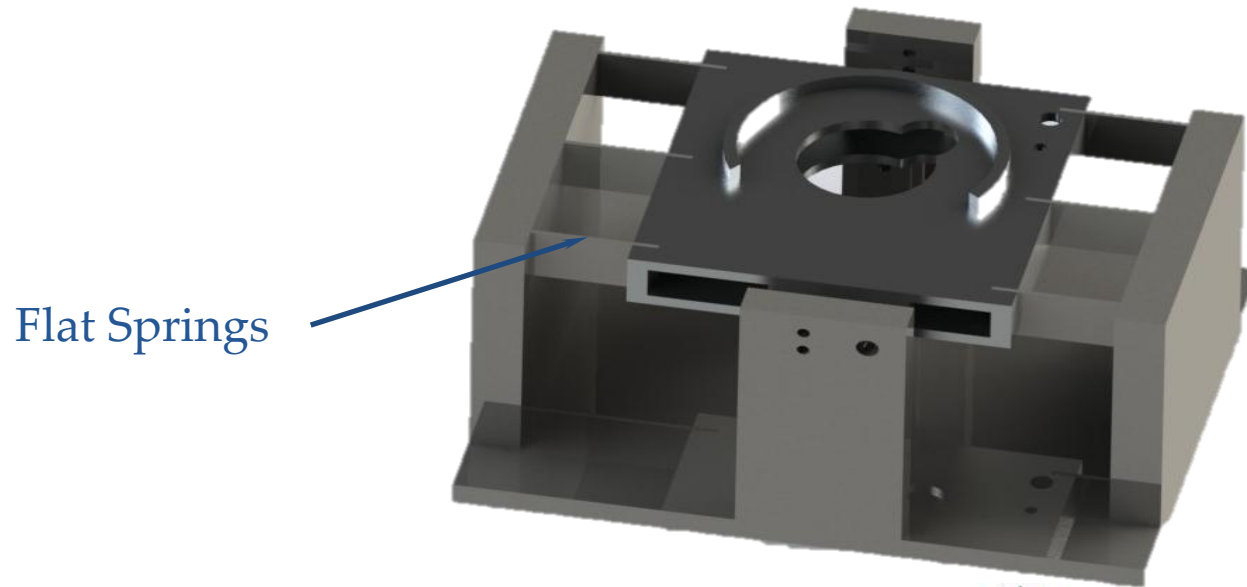


# XY Guides



# Spring System

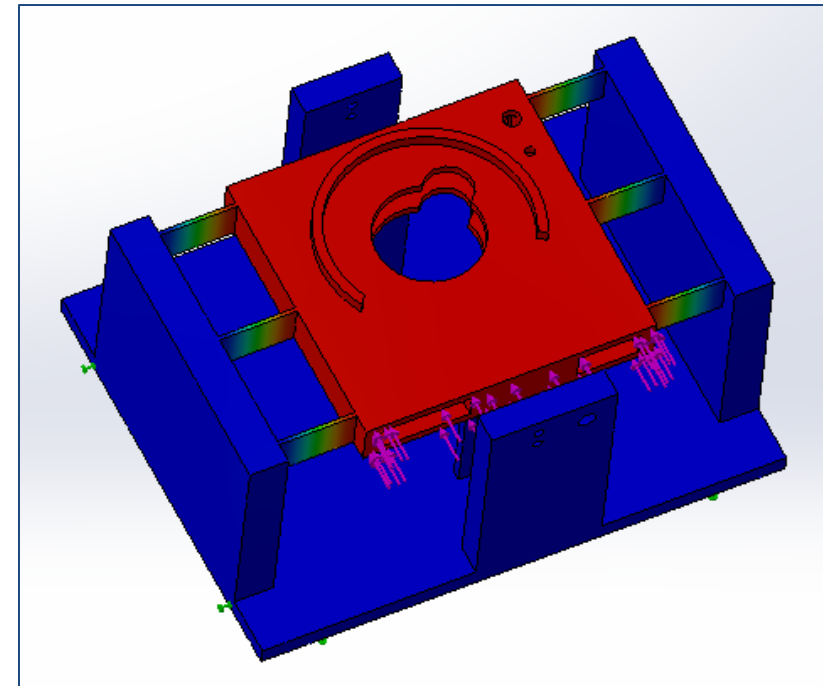
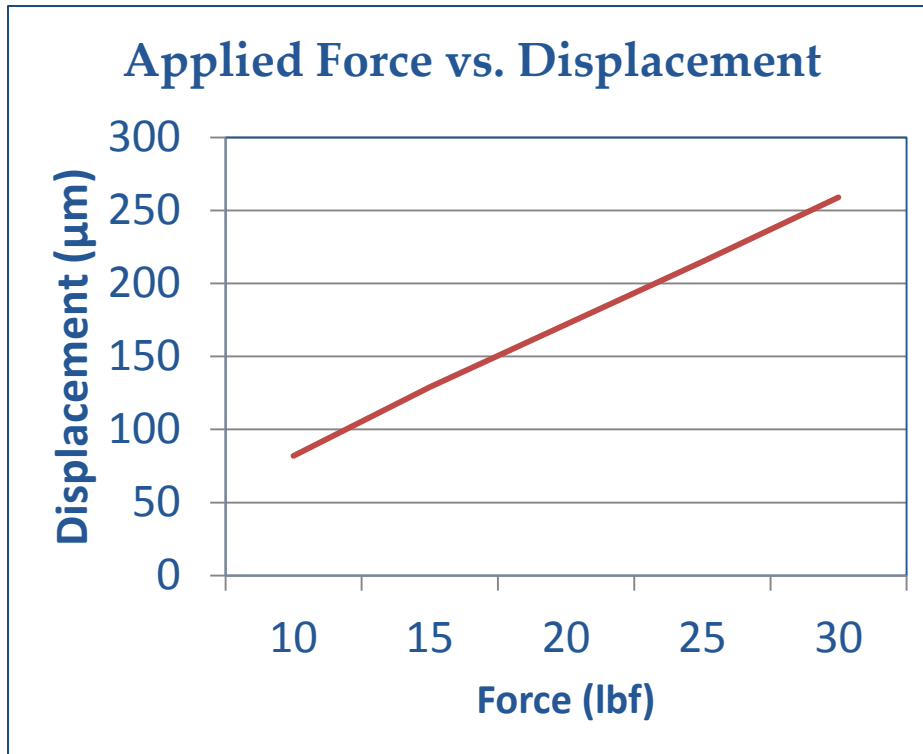
- Uses 6 flat springs, 1mm thick
- Mounted by hot press or weld method
- Designed to return to initial position
- Made with AISI 301 Spring Tempered Steel



Flat Springs



# Spring System Analysis

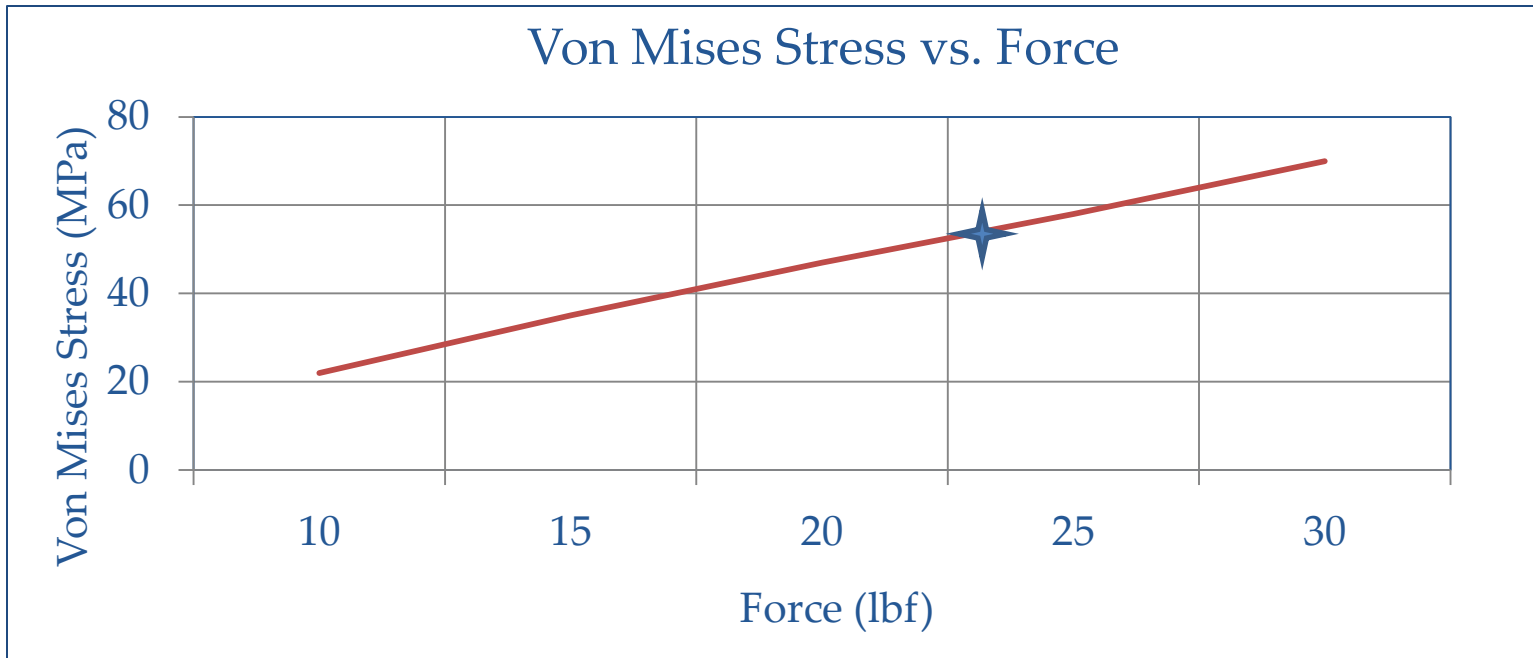


- Require 23 lbf for 200 microns displacement





# Spring System Analysis

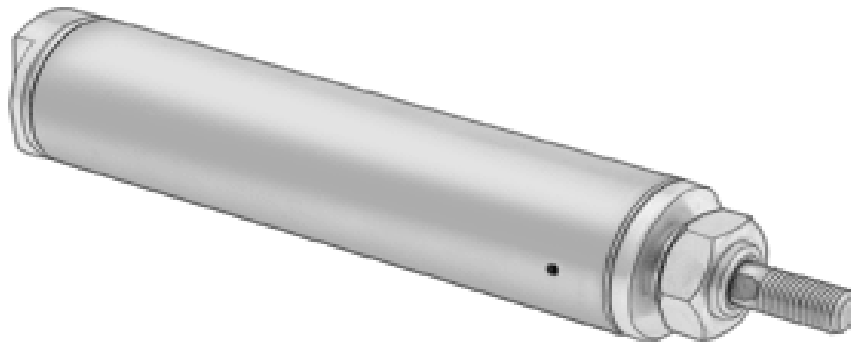


- Factor of safety approximately 3.5
- Maximum Von Mises stress 58.2 MPa at 200  $\mu\text{m}$



# Actuation – Air Cylinders

- 2 air cylinders on opposite ends of the table
  - 1/2 inch stroke
  - 5/8 inch bore
  - 28 lbf provided at 100 psi
- Engage one at a time to create extreme positions



# Cost Analysis

## Final Design

Quantity	Materials	Cost/Quantity	Cost
1	Multipurpose Aluminum 1/2" Thick X 8" Width X 1" Length	\$33.09	\$33.09
1	Multipurpose Aluminum 1" Thick X 6" Width X 1" Length	\$51.61	\$51.61
1	Spring Tempered 1074/1075 Spring Steel .094" Thick, 1/2" Wide, 5' Long	\$26.18	\$26.18
1	Multipurpose Stainless Steel (Type 304) 2" Square, 1' Length	\$130.39	\$130.39
1	Multipurpose Stainless Steel (Type 304/304L) 7/16" Diameter, 3' Length	\$14.04	\$14.04
1	Type 316 SS Compression Spring 2.656" Length, .625" OD, .054" Wire Diameter, packs of 6	\$10.75	\$10.75
1	Grade 8 Alloy Steel Hex Head Cap Screw Zinc Yellow-Plated, 7/16"-20 Thread, 4" Length, packs of 5	\$7.63	\$7.63
1	Type 316 Stainless Steel Hex Nut 7/16"-20 Thread Size, 11/16" Width, 3/8" Height, packs of 10	\$5.22	\$5.22
1	Multipurpose Stainless Steel (Type 304/304L) 3/16" Dia, 6' Length	\$9.36	\$9.36
4	Fixed-Alignment Linear Ball Bearing Closed, Stainless Steel, 3/16" Shaft Dia	\$9.18	\$36.72
1	Multipurpose Aluminum (Alloy 6061) 2-1/8" Diameter X 1' Length	\$24.62	\$24.62
1	Grade 8 Alloy Steel Hex Head Cap Screw Zinc Yellow Pltd, 1/4"-20 Thrd, 3/8" L, Fully Thrd, Packs of 100	\$12.30	\$12.30
2	18-8 SS Prcision Adjustment Thumb Screw 3/16"-100 Thread, 3/4" Length	\$14.88	\$29.76
2	Linear Variable Differential Transformer	\$600	Donated
		<b>TOTAL COST</b>	<b>\$391.67</b>



# Future Work

- Finish ordering materials
- Machine raw materials
- Assemble Fixture
- Calibration and testing



# Questions?



# Cost Analysis

## Design 1

Quantity	Materials	Cost/Quantity	Cost
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2	18-8 SS Prcision Adjustment Thumb Screw 3/16"-100 Thread, 3/4" Length	\$14.88	\$29.76
3	Linear Variable Differential Transformer (2 Donated)	\$600.00	\$600.00
1	Newport Gothic-Arch 65mm Platform Transition Stage Model 9063-XYZ	\$1,169.98	\$1,169.98
		<b>TOTAL COST</b>	<b>\$2,089.39</b>

