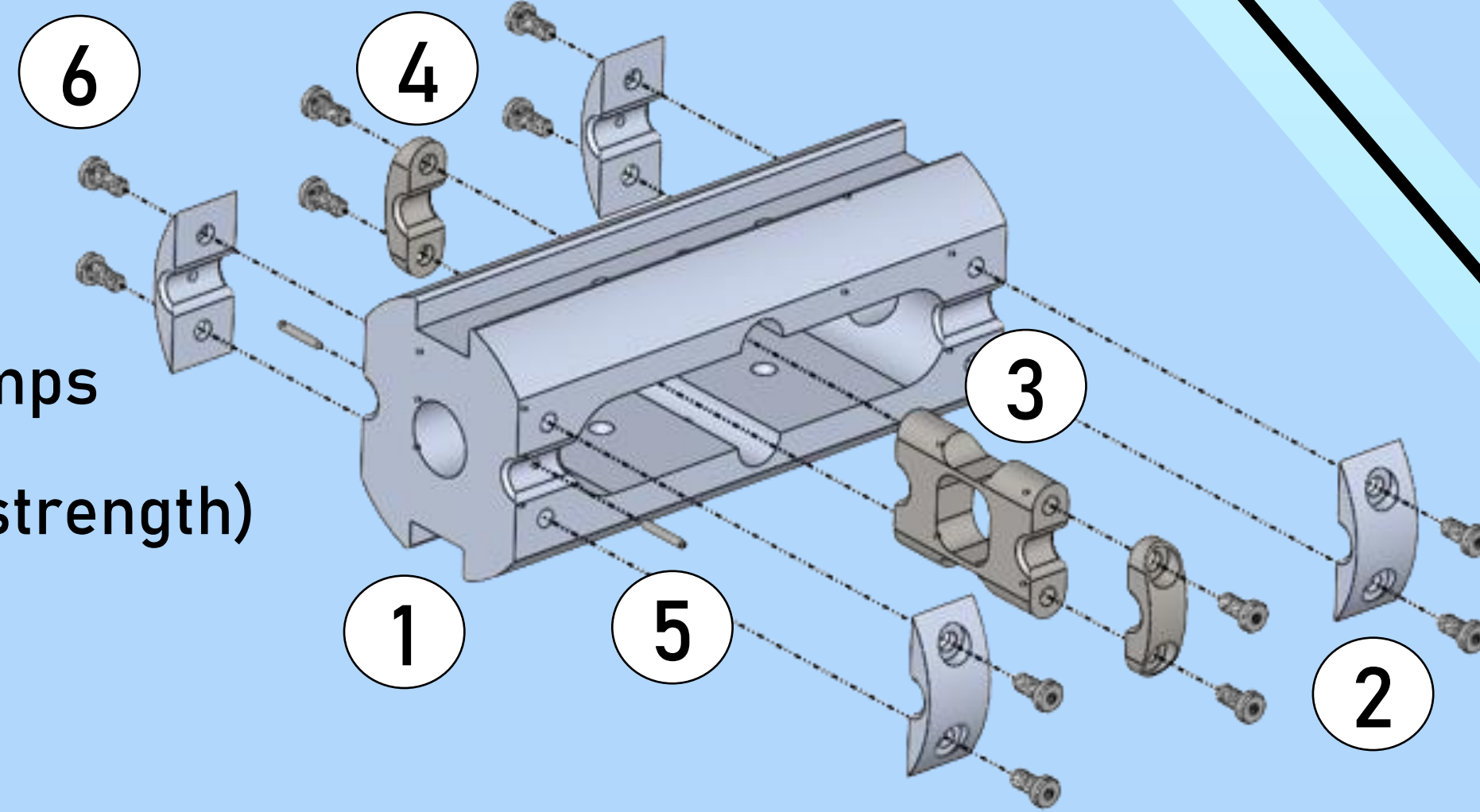


Towed Array Tension Measuring Station

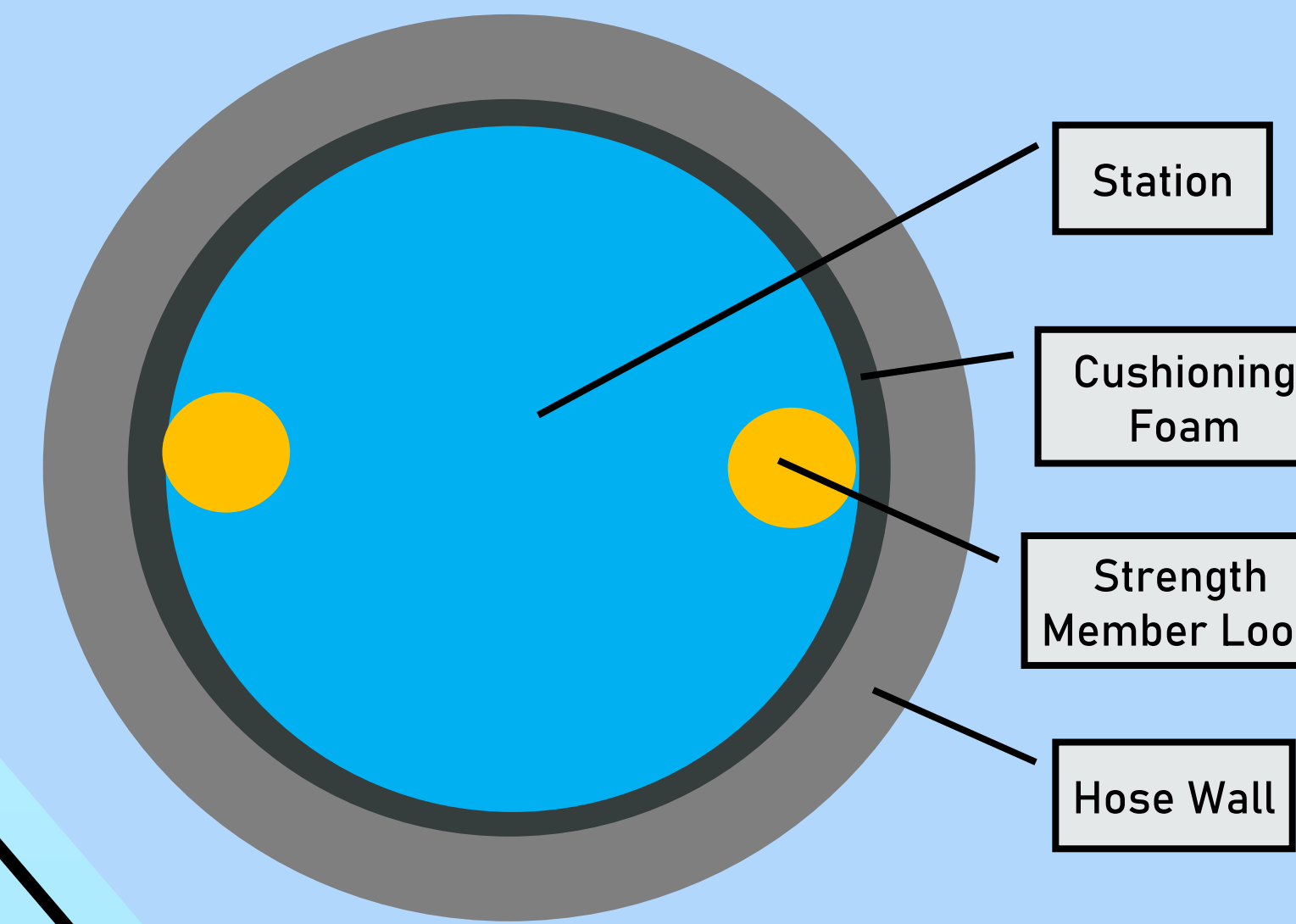


Mechanical Design

- 1 X 6061-T6 Al structural component
- 4 X 6061-T6 Al strength member clamps
- 1 X 304 SS load cell
- 2 X 304 SS load cell strength member clamps
- 2 X strength member pins (1000 lb. break strength)
- 12 X SS screws (2099 lb. proof load)

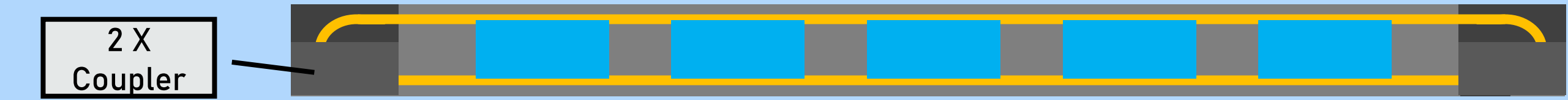


Project Description



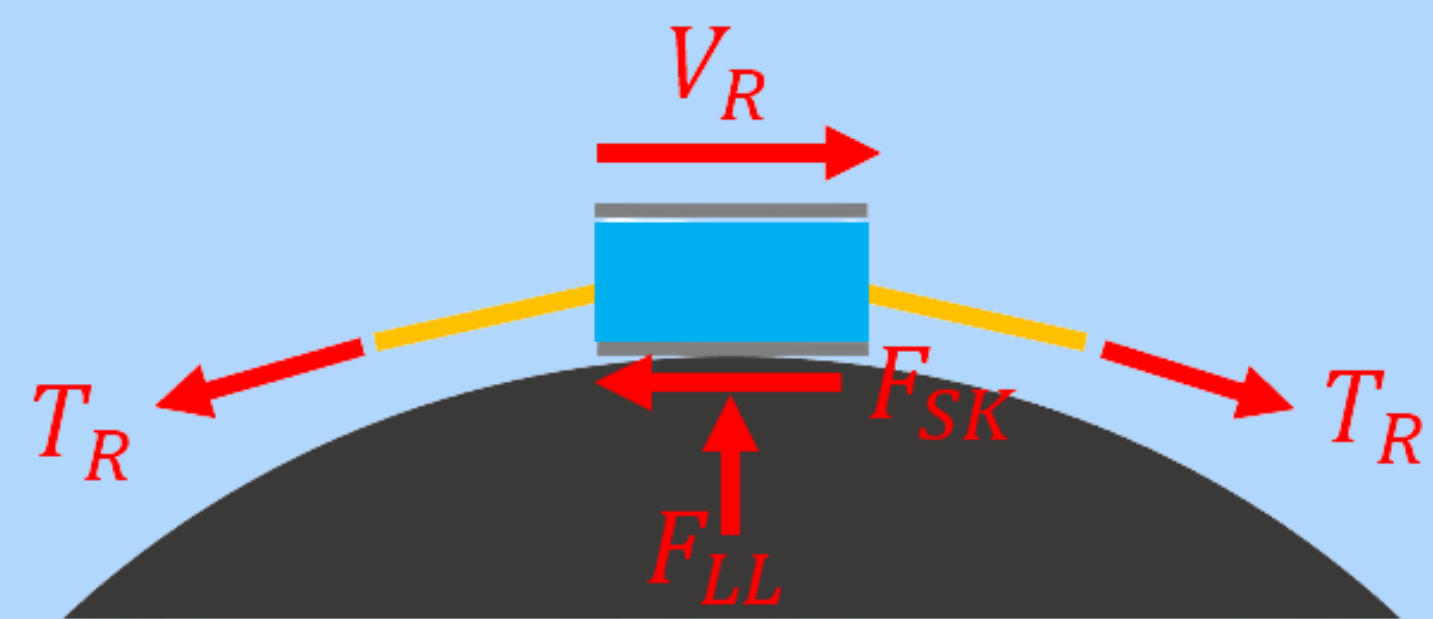
Ultra Electronics designs and builds towed sonar arrays that get dragged behind navy ships to listen for threats in the water. As they are dragged, a large, varying, tension force is built up along the array. Currently this tension is measured at one position, where the array attaches to the ship. However, measuring tension *throughout* the array is important for validating hydrodynamic models and monitoring the array's state.

To measure the array's tension, a device must be implanted within the pre-existing array anatomy. Inside the array stations are positioned by attaching to a spliced loop of rope called the strength member. The array stations and strength member is then enclosed by a rubber tube, capped with coupling ends, and filled with oil. The tension measuring station must attach to the strength member in the same fashion as the other stations.



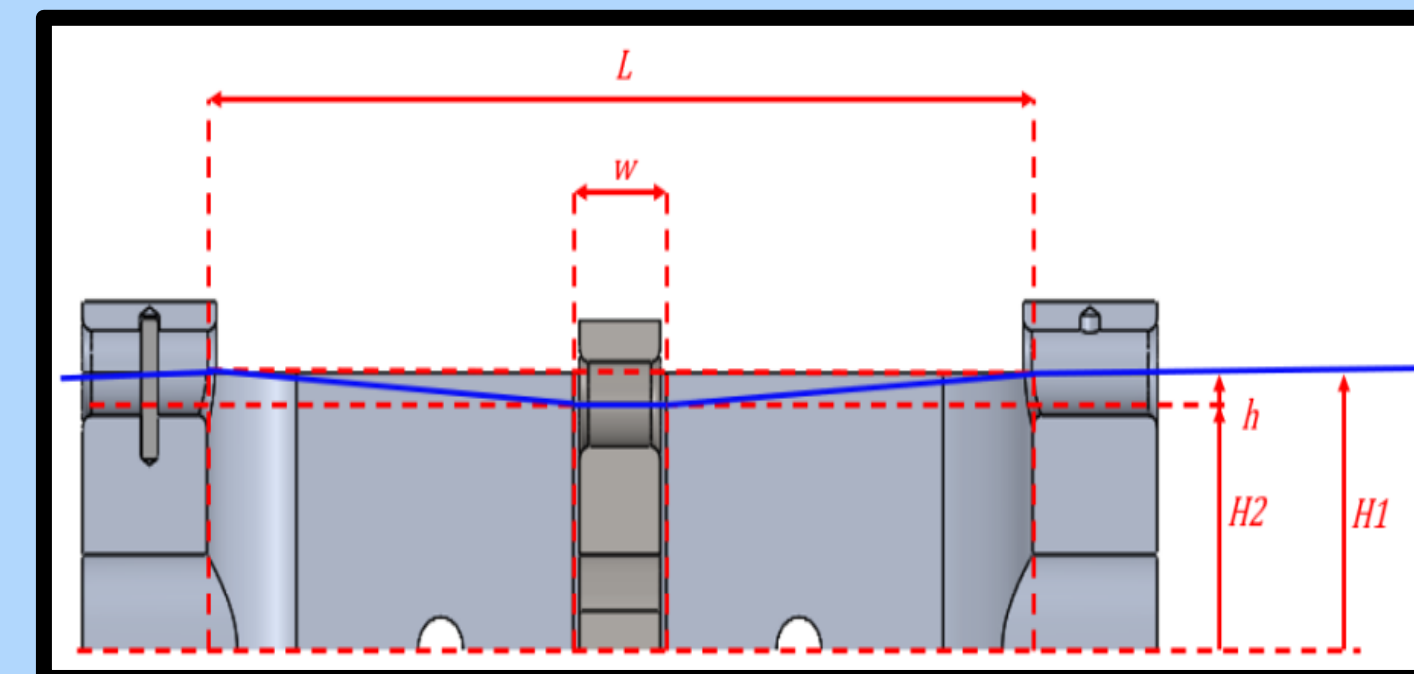
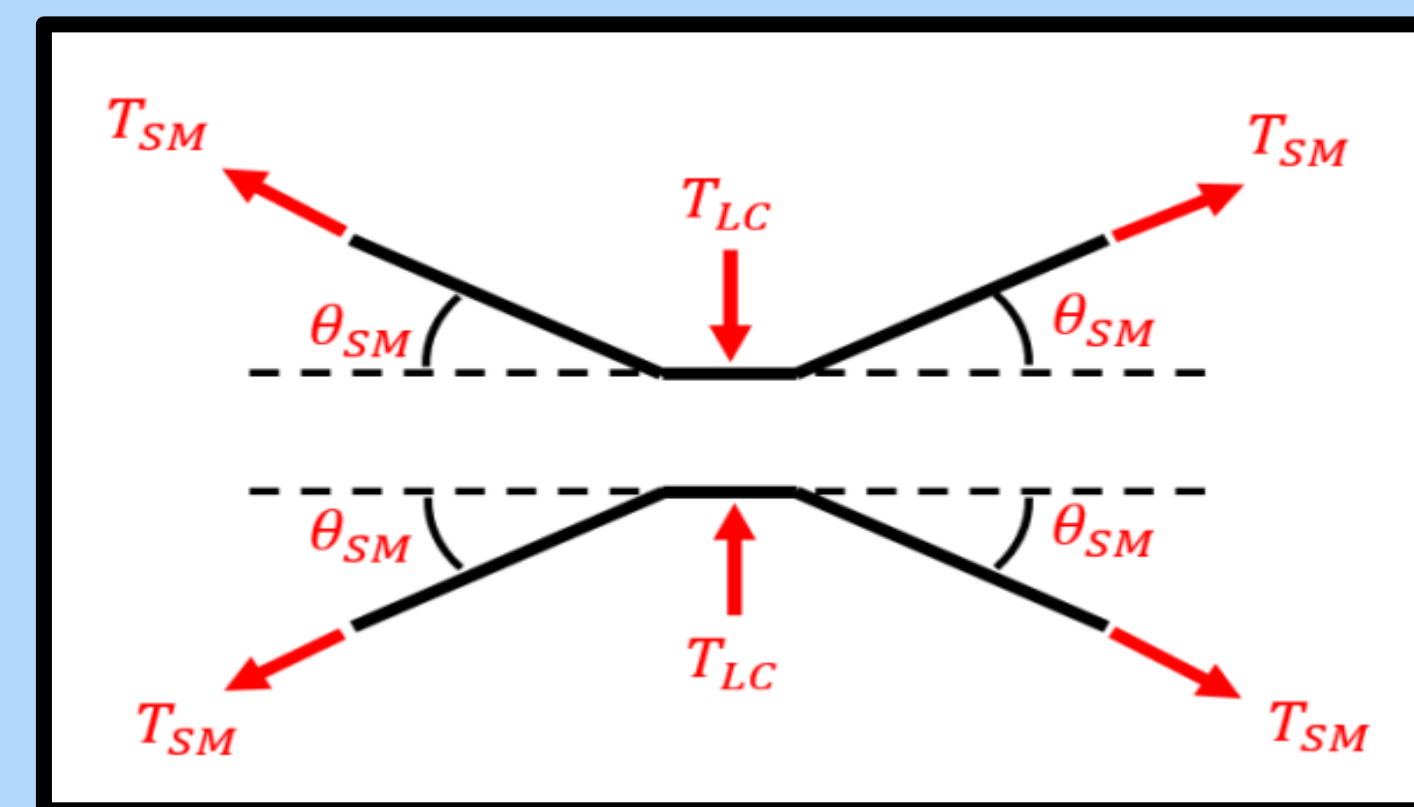
Key Requirements

- 1 Measure up to 10000 lb. of tension with 5% accuracy.
- 2 Withstand 1000 lb. station keeping load. (F_{SK})
- 3 Withstand 2000 lb. lateral load. (F_{LL})



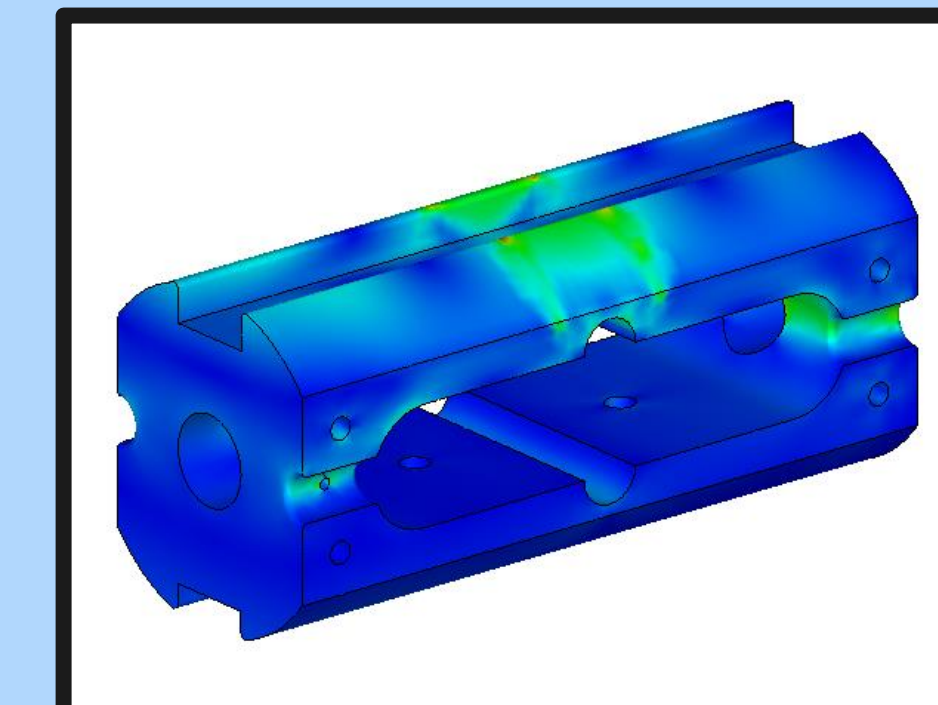
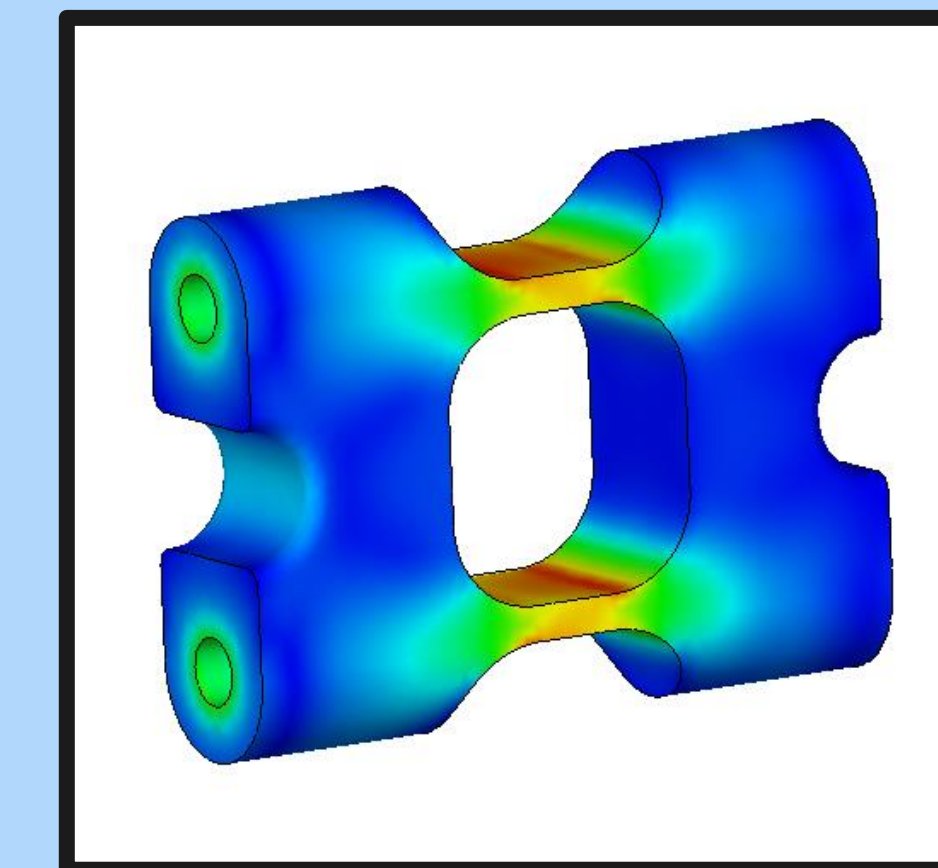
How it Works

- Strength member enters at a set width. (distance between loop sides)
- Strength member width constricted by load cell.
- Angled rope tension produces tensile force on load cell.
- Tensile force on load cell measured by strain gauges and related to rope tension.



FEM Analysis

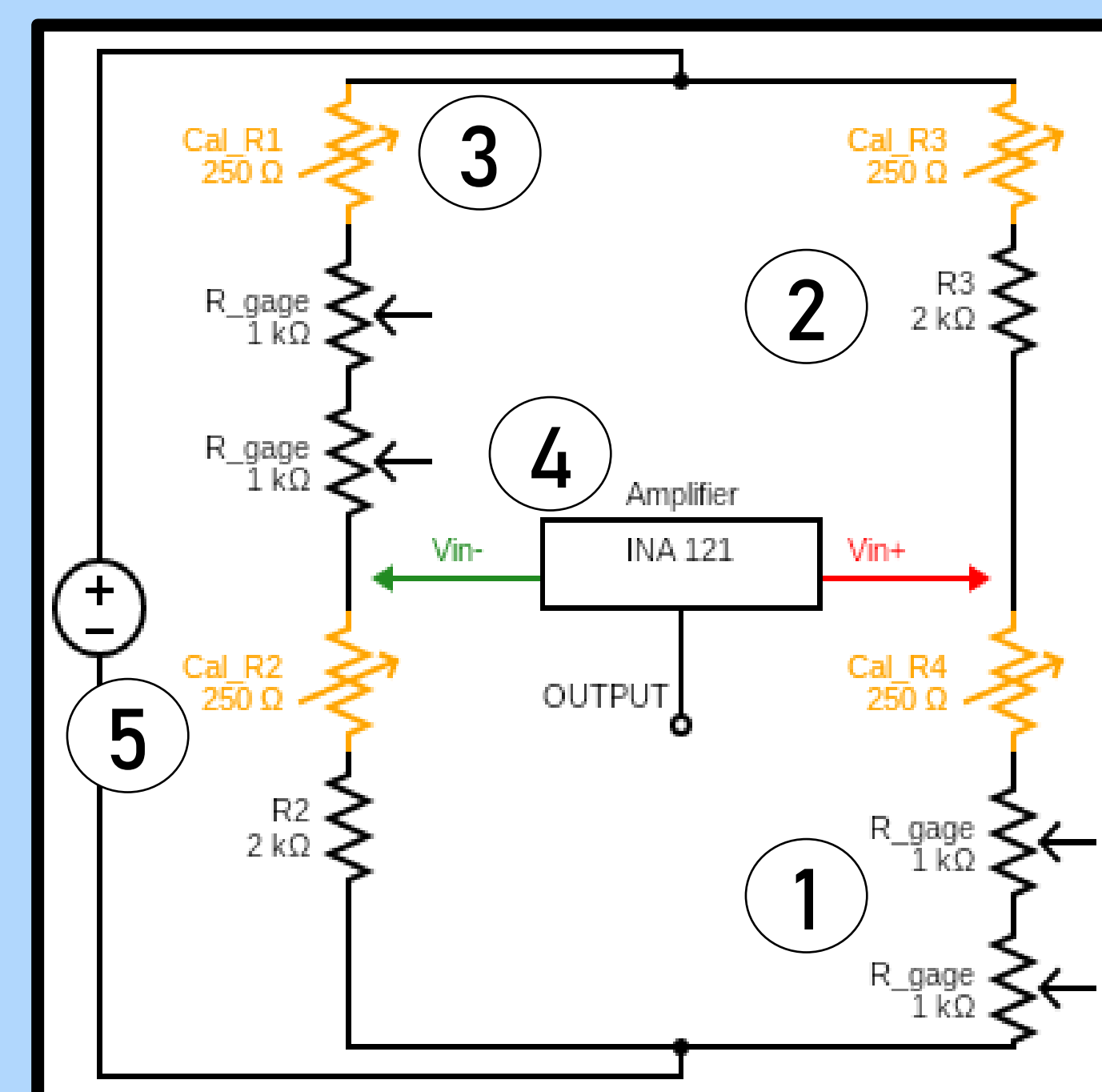
- Used SolidWorks FEM
- Currently confirming with NISA FEM
- Sized load cell to strain to 25% yield strength
- Analysis used to prove lateral load requirement of 2000 lb.
- Analysis used to prove station keeping load of 1000 lb.



Quick Summary

Who? Ultra Electronics, defense and security technology.
What? Tension measuring device for towed sonar array.
When? R&D project that could be used in future development of towed sonar arrays.
Where? Device will be used on a variety of sonar systems used by Ultra's customers (Members of NATO)
Why? Currently tension is only measured at the connecting end of the towed array. However, the tension needs to be measured at various points along the array.

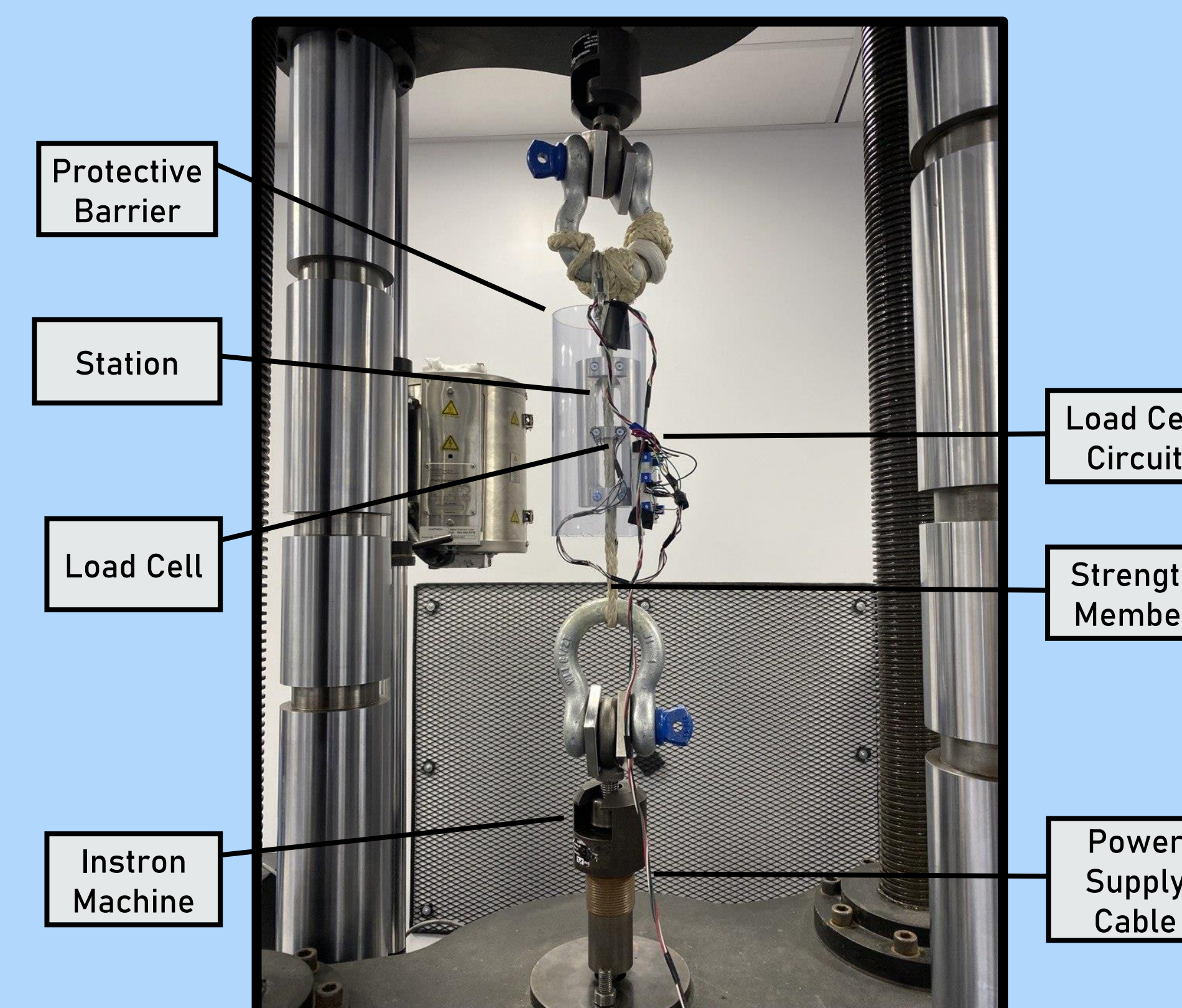
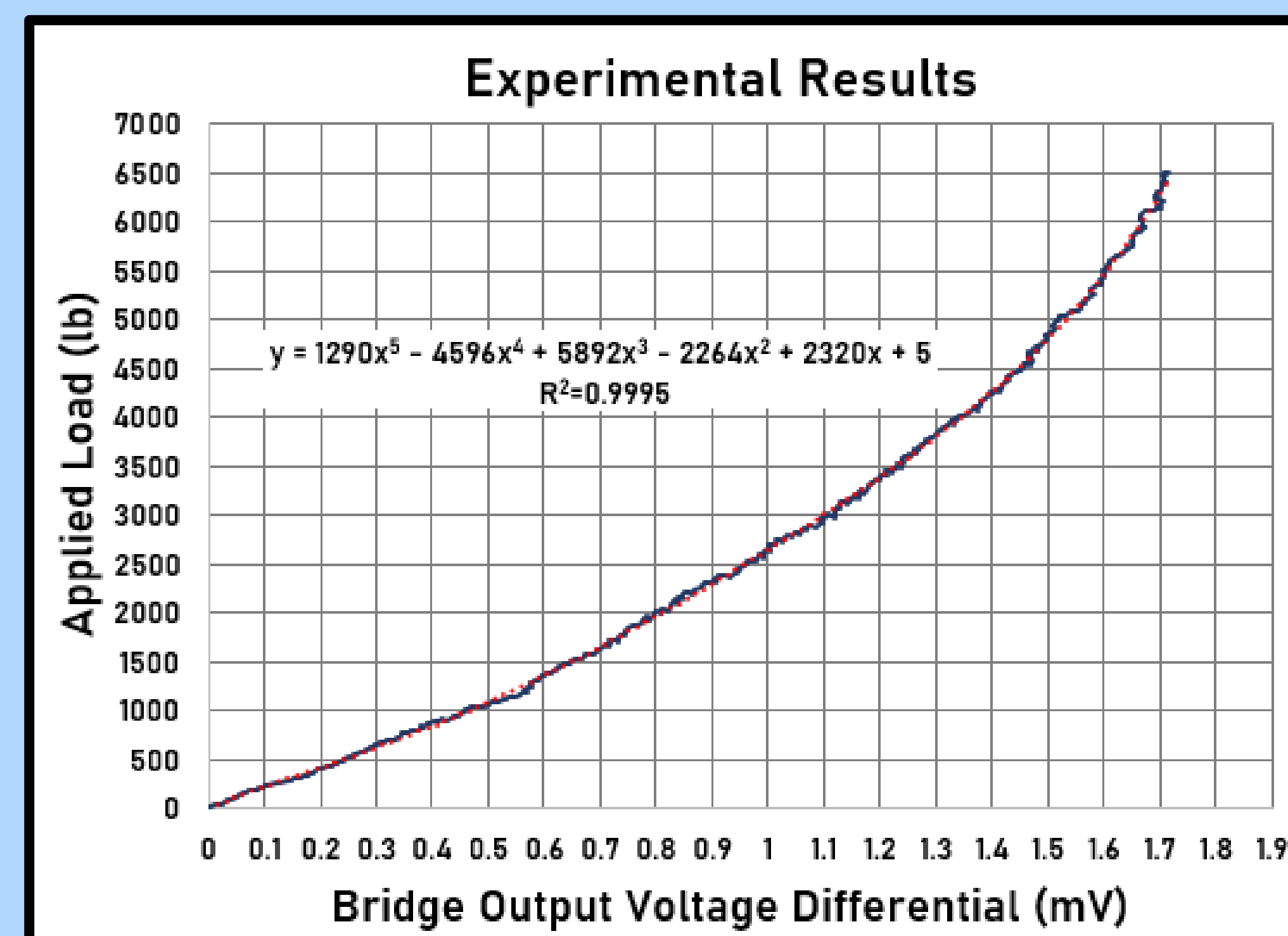
Electrical Design



- 1 4 X 1000 Ω Strain Gauges
- 2 2 X 2000 Ω Resistors
- 3 4 X 500 Ω var. Resistors
- 4 1 X INA 121 (Amplifier)
- 5 1 X 10 VDC Voltage Source

- Strain on the loadcell changes the strain gauge resistances.
- Creates voltage difference across Wheatstone bridge.
- Voltage difference amplified.

Testing and Results



Next Iteration

- Replace breadboard with printed circuit board.
- Replace var. resistors with higher tolerance resistors.
- Larger fillet on strength member clamps and structural component strength member tracks to reduce friction.
- Experiment with different size load cells to maximize sensitivity.
- Larger Instron machine for longer strength member loop.