



University of Idaho

College of Engineering

Team S.A.S.S

INL Remote Visualization System

Team Members: Jack Armstrong, Nick Sentieri,
David Severud

Mentor: Brandon Hilliard

Faculty: Matthew Swenson

Client

- INL is the nation's leading center for nuclear energy research and development.



Background

- The equipment inside is only accessible via robotic manipulators operated outside of the hot-cell and thus the system must be designed to this parameter.
- System will be exposed to Co-60 gammas with magnitude of 18rad/hr



Objective

- Design a remote visualization system needed in a hot-cell with a high radiation dose level to enable real time remote monitoring of microscopy equipment.



Value Proposition

- Our system will enable both the operator and the workstation user to have direct line of sight over the top of the microscopes and microhardness tester. These improvements will allow the MFC facility to more efficiently and properly characterize materials used everyday in the nuclear industry, which will inturn advance research and development overall.



Product Requirements

The visualization system must be accommodating to Met Box parameters:

- **Porthole:** 20 in diameter
- **Manipulators weight restriction:** 10 lbs
- **Manipulator maneuverability:** 3.55 in width
- **Electrical ports:** 110 Volt
- **Radiation Shielding:** 18rad/hour of Gamma radiation
- **Viewing angles**



Project Learning: Shielding Materials

- The type of radiation we must account for is 18rad/hour of Gamma radiation. Rad is a unit of radiation absorption.
- Half Value Layer(HVL): the thickness of material required to reduce the intensity of radiation by half.
- Stainless Steel
 - HVL: 2.159 cm (0.85 in)
- ClearView Radiation Shielding
 - Clear panels made by Radium
 - Contains liquid solution
 - HVL: 3.81 cm (1.5 in)



ClearView Panel
Source: Radium Inc.

Project Learning: Camera & Magnets



ACD Supply - Magswitch MagJig 60

Magnet Strength - 60 lbs
2:1 Shear Working Load - 17 lbs
Net Weight - 0.2 lbs
Overall Height - 1.7 in



Marshall CV350-10XB Security Camera

Net Weight - 0.82 lbs
10X Optical Zoom Function through HDMI
Regular Application through USB2 port
4-Pin Power and Signal Output

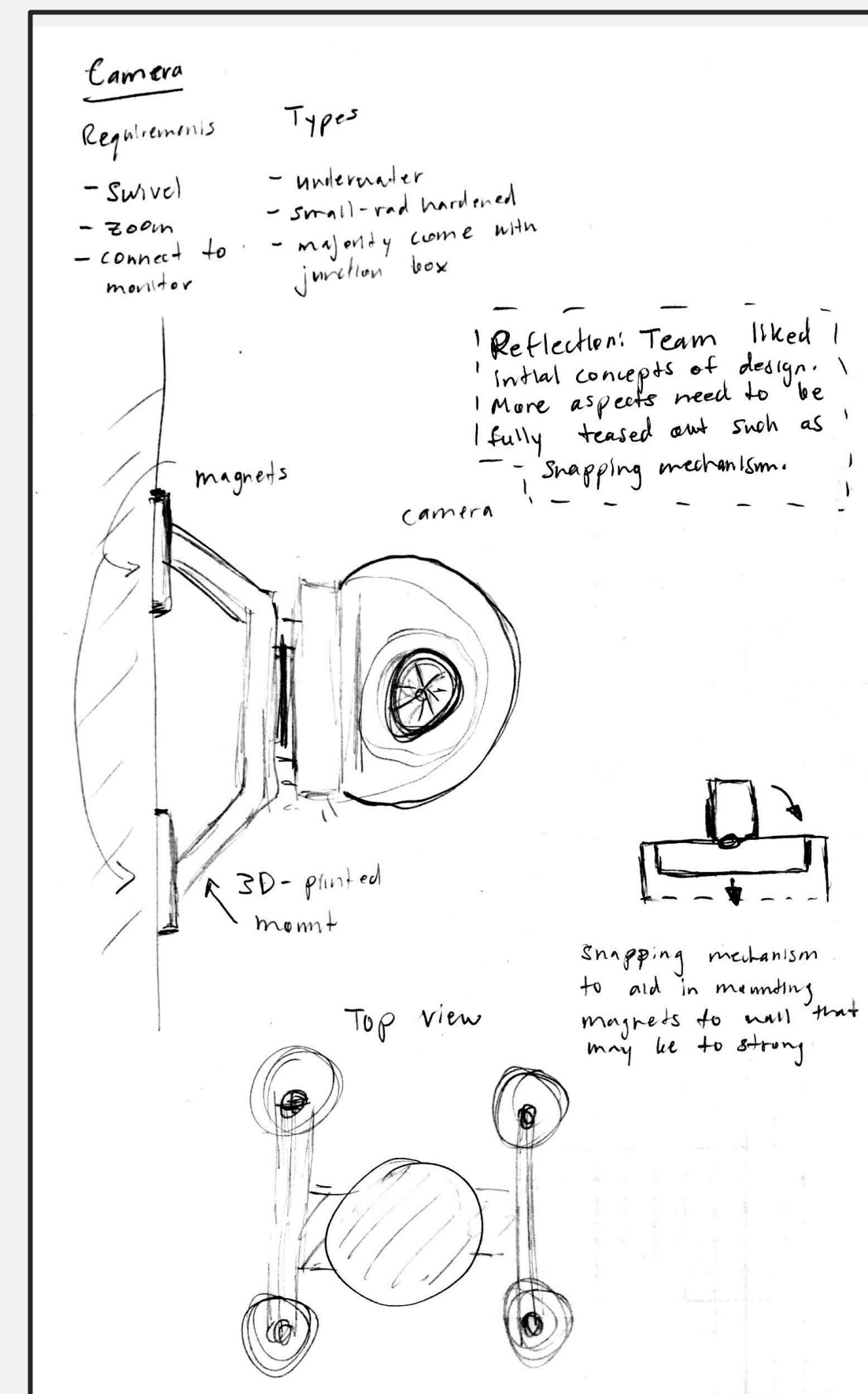
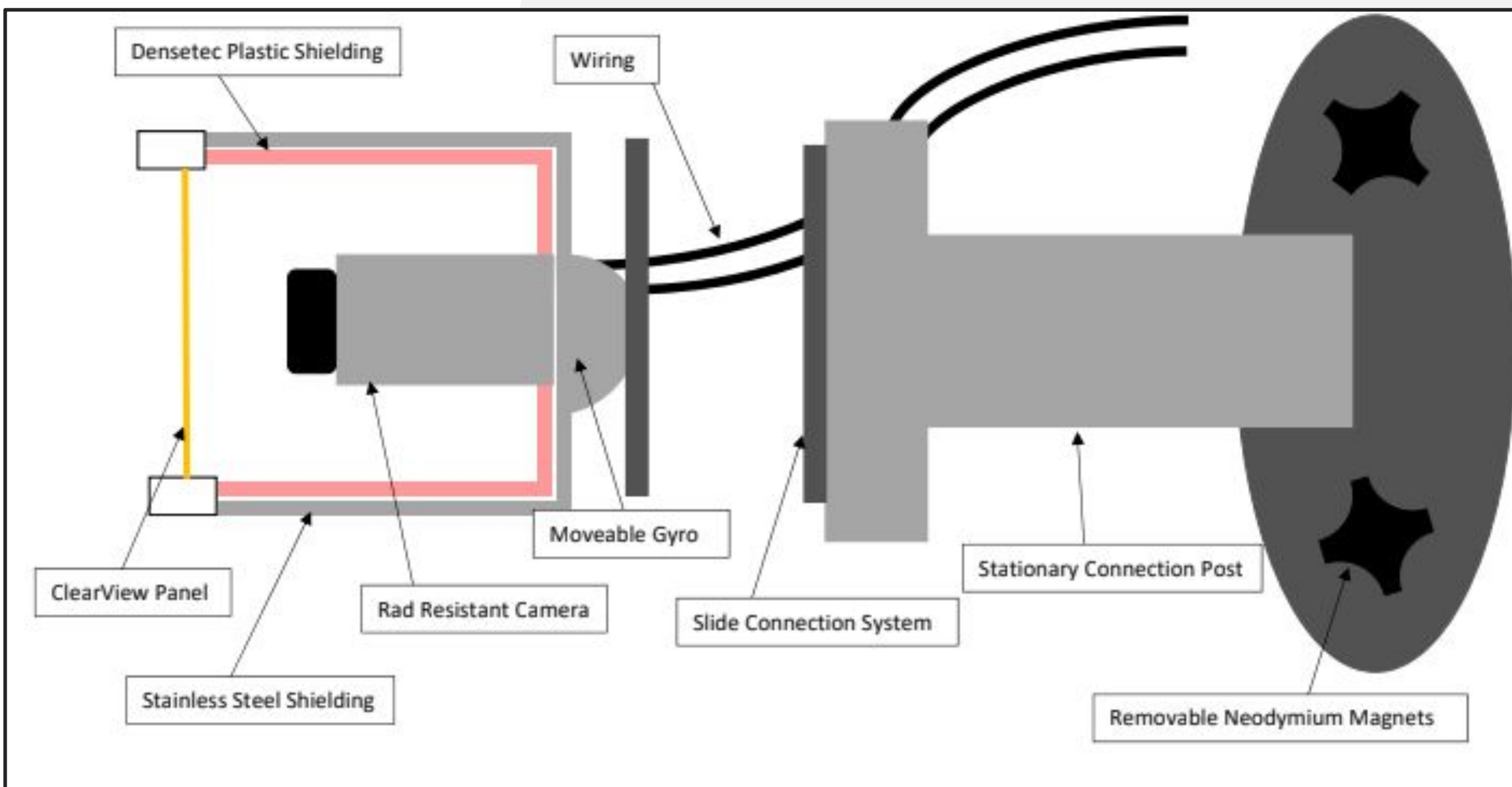
Shielding Calculations

- Mass Attenuation Coefficient
 - Stainless Steel : 0.1819/cm
 - ClearView : 0.321/cm
- Radiation Reduction
 - Stainless Steel at ¼ in
 - 19% Reduction
 - ClearView at 2.5 in
 - 68% Reduction
- Total Radiation to Front Camera
 - 6 months
 - 18 rad/hr
 - Total: 24.901 krad

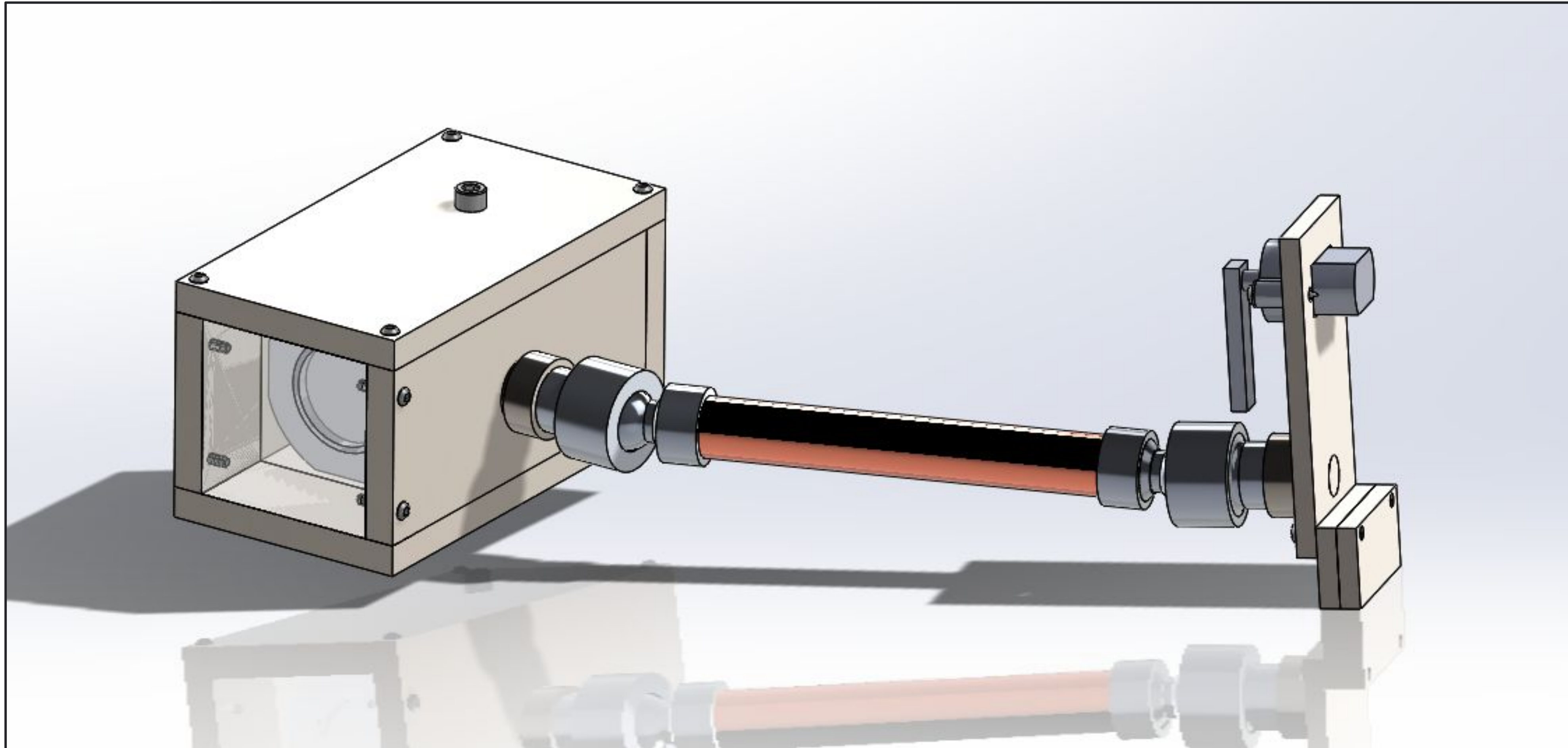
$$I = I_0 e^{-\mu x}$$

Equation for incident energy(I) which is equal to the transmitted energy(I₀) multiplied by the exponential of the mass attenuation constant(μ) multiplied by the thickness(x). When I is divided by I₀ is equal to 0.5, x will be the HVL.

Design Concepts



Initial Design

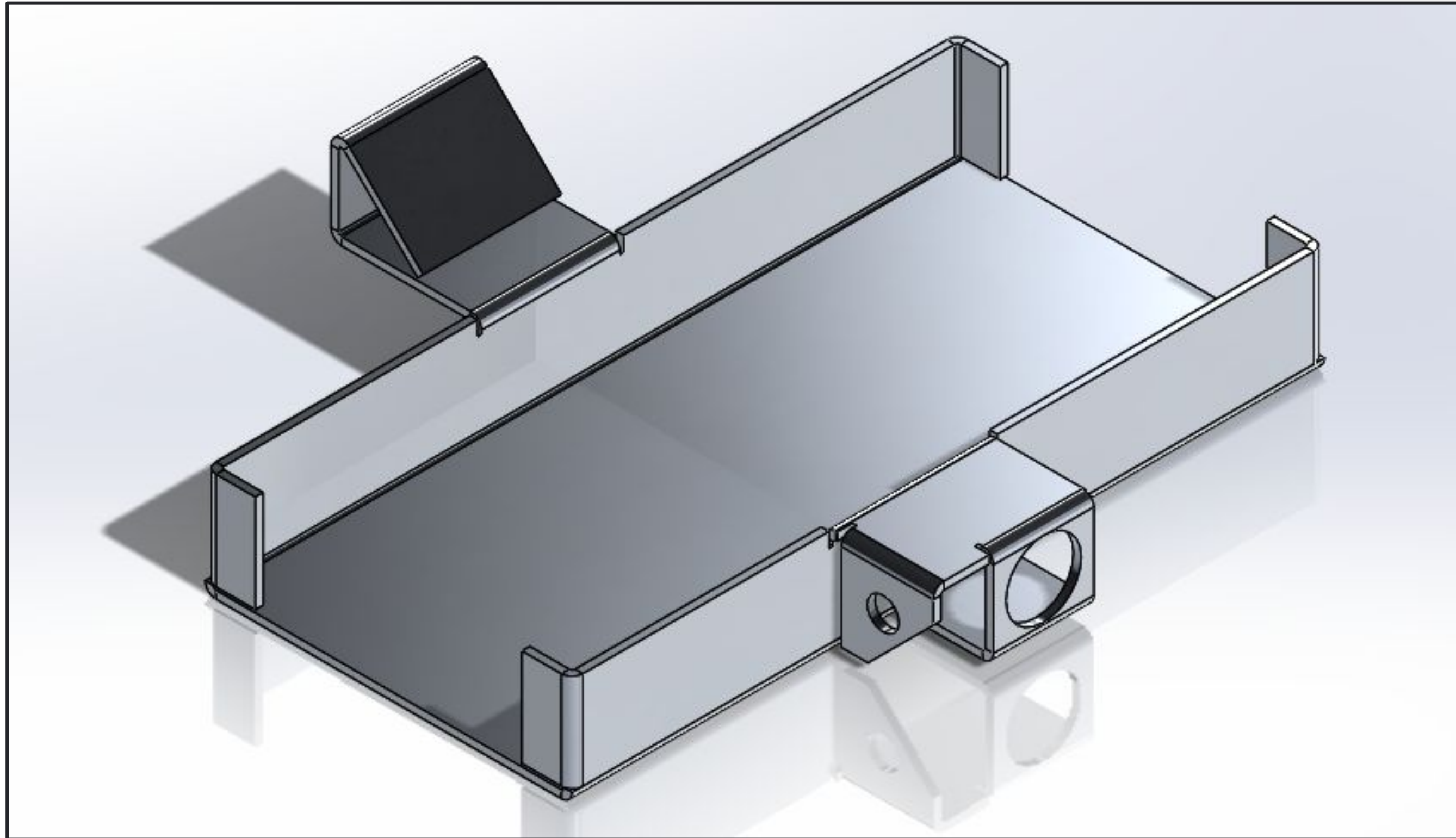


Manufacturing Plan

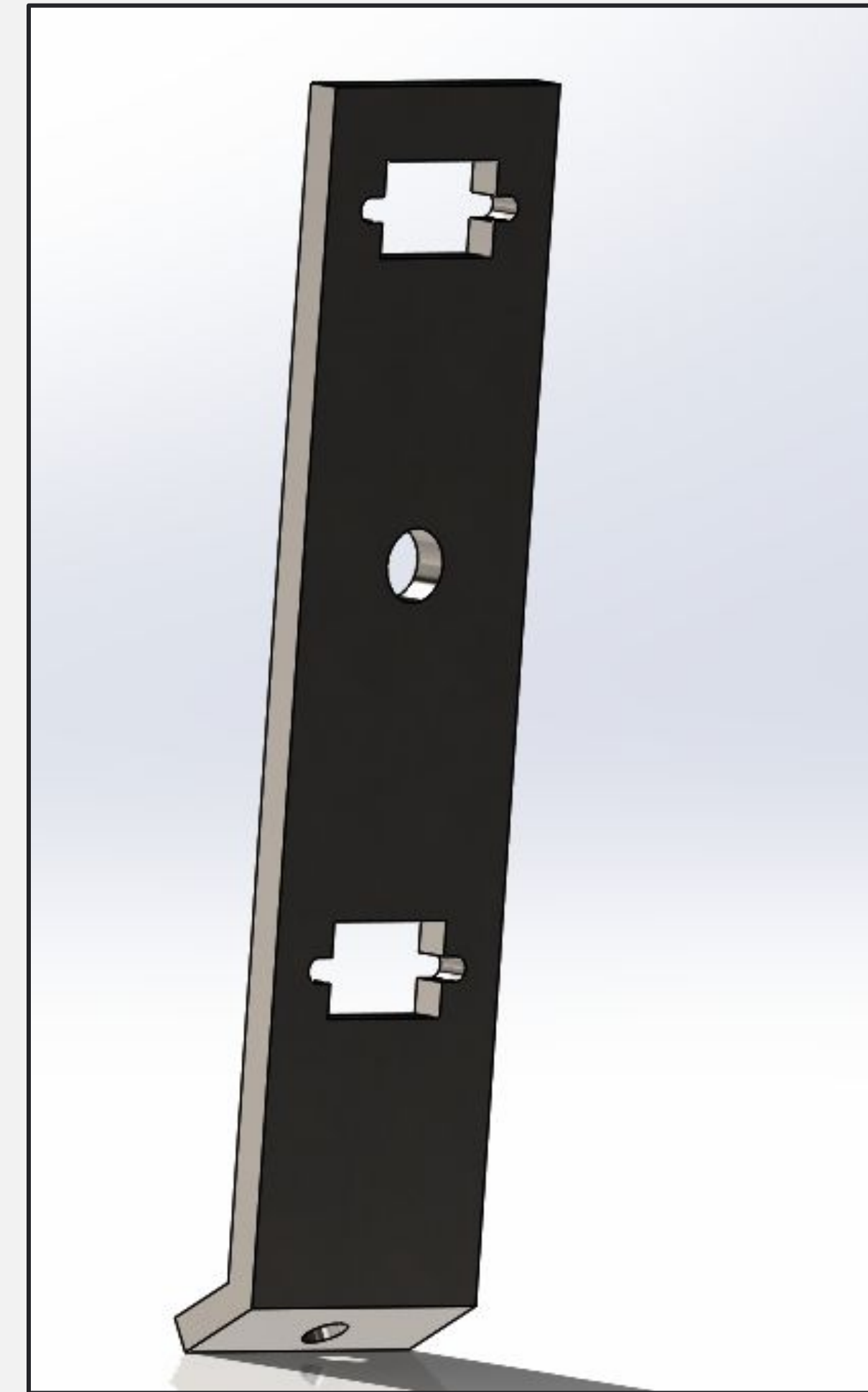
- Stainless Steel
 - 1/4" Stainless Steel Plate
 - Shielding
 - Wiring Side
 - ClearView Panel
 - Other Sides
 - Mount Plate
 - Welding
- Tapping
 - Mount Plate & Camera
- Aluminum Basket
 - 14 gauge 5052 series
 - Bend on press
 - Welding
- Magnet
 - Knob Attachment
 - Heat Gun



Final Design

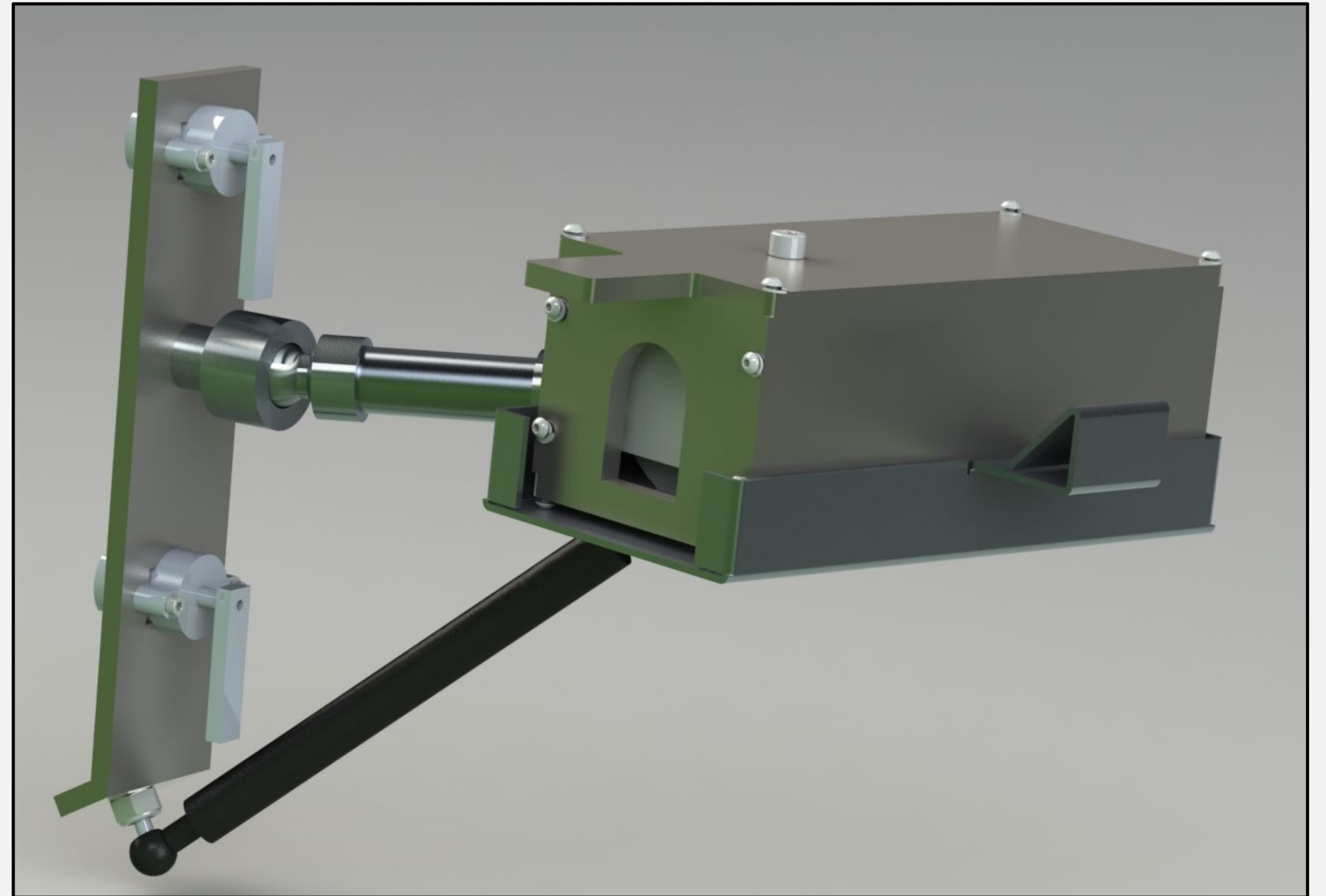
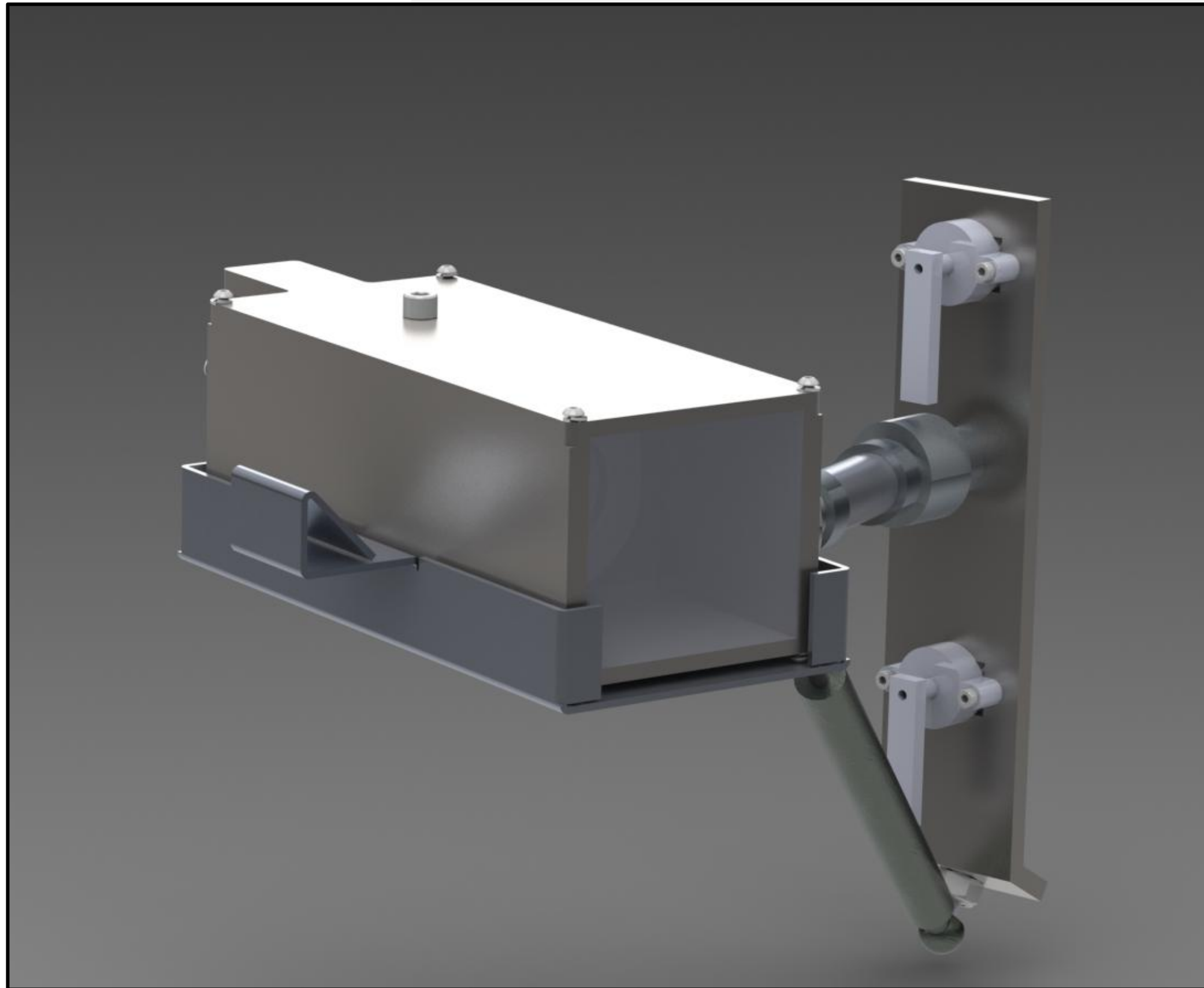


Material: 5052 Aluminum Alloy
Thickness: 14 gauge (0.65 in)

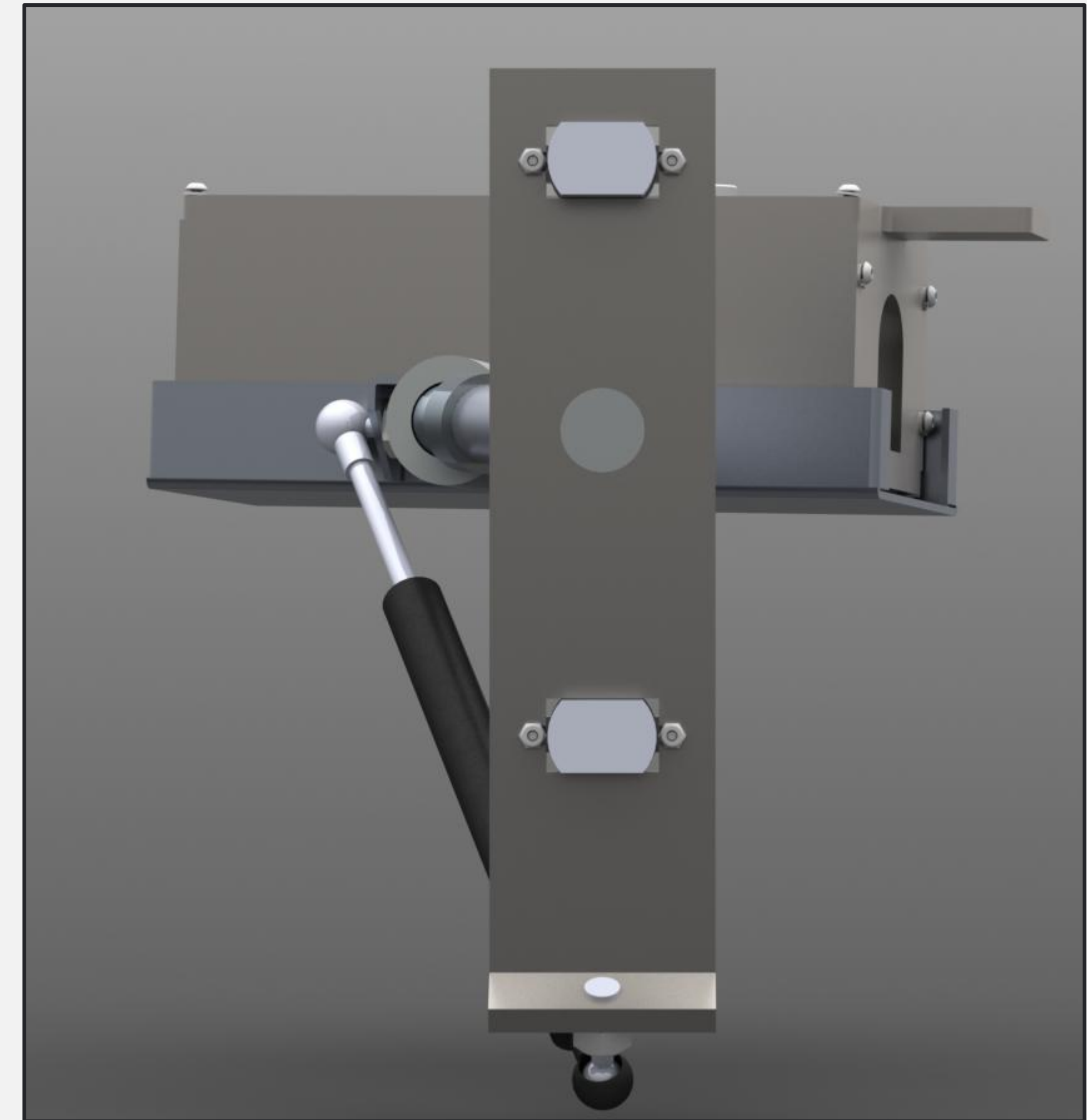
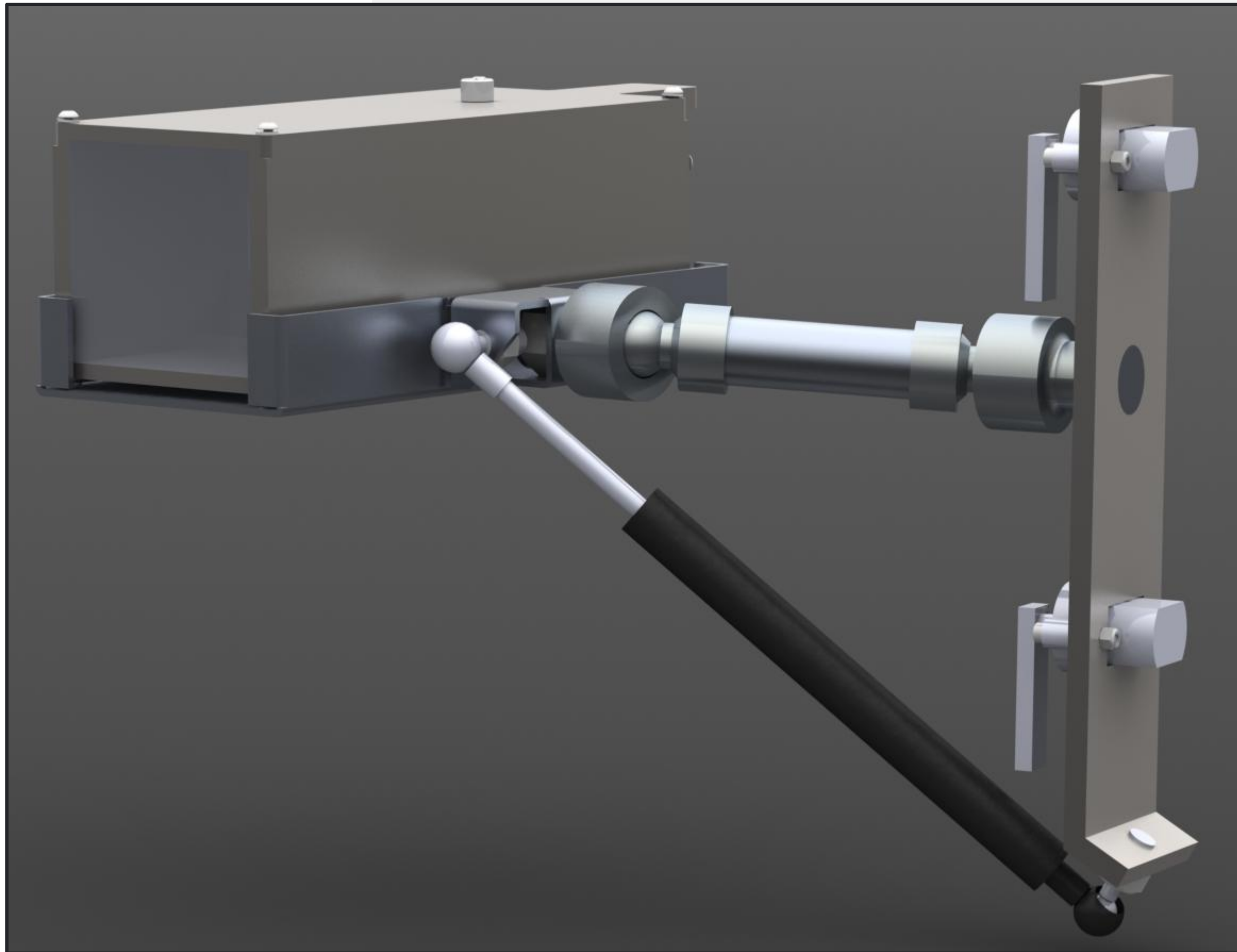


Material: 304 Stainless Steel
Thickness: 1/4 in plate

Final Design

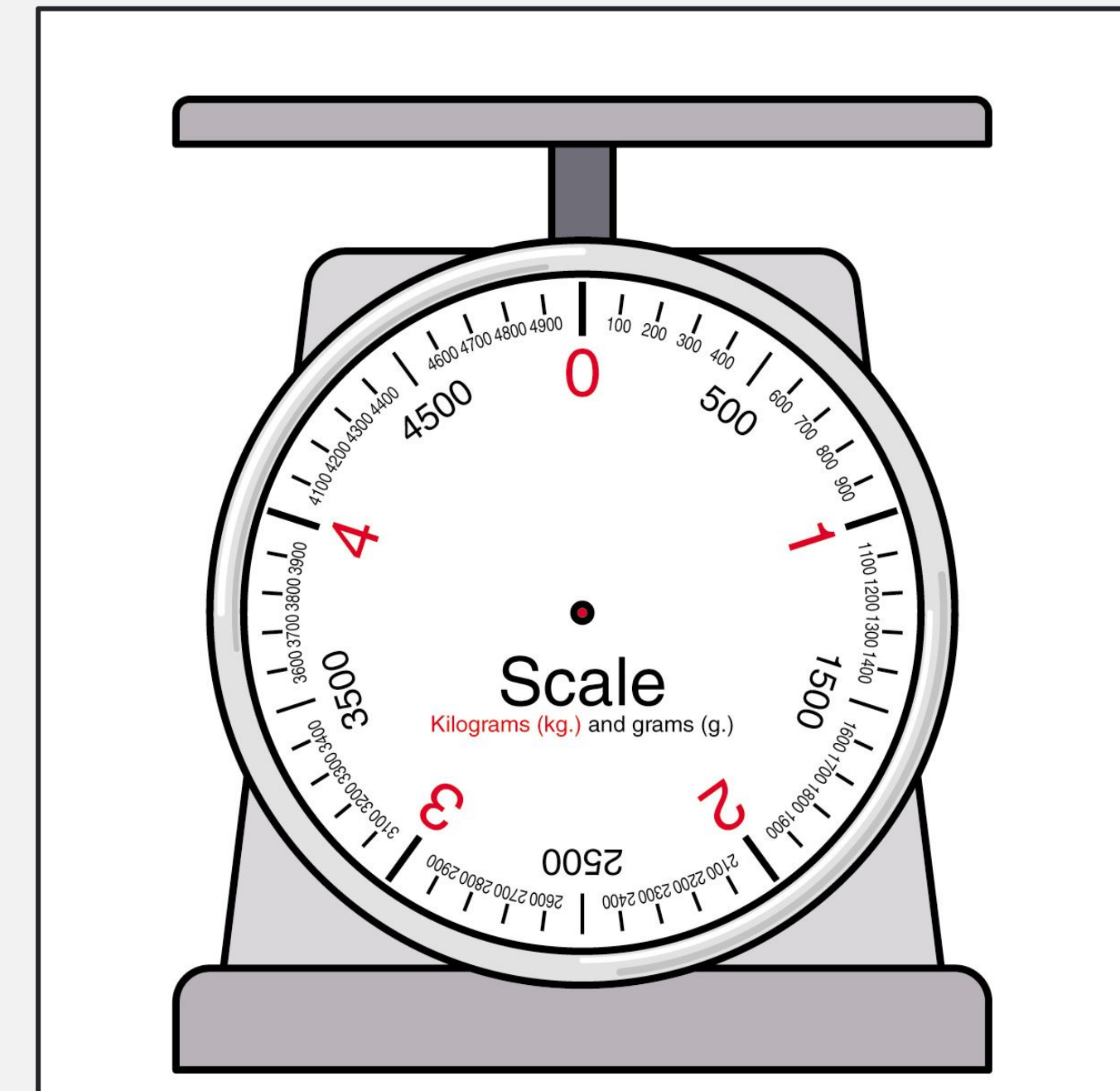


Final Design



Validation

- Comes in pieces: 9.36 pounds total
 - Arm & Mount 2.75 pounds
 - Camera & Shielding 6.61 pounds
- Able to maintain position under system loading
 - Magnets Capable of holding 60 lbs
- Resistant to background radiation
 - 19% radiation reduction from Stainless Steel
 - 68% radiation reduction from ClearView Panel
 - Total Radiation toward Front is 24 krad over 6 months
- Provides clear image to separate monitor



Acknowledgements

A special thank you to the following individuals and all those involved in our project.

- Dr. Matthew Swenson
- Brandon Hilliard
- Bill Magnie
- David Sell
- Francine Rice
- Tom Pfeiffer

Questions?

