



University of Idaho

College of Engineering

Team S.A.S.S

INL Remote Visualization System

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Mentor: Brandon Hilliard

Faculty: Matthew Swenson

Client

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



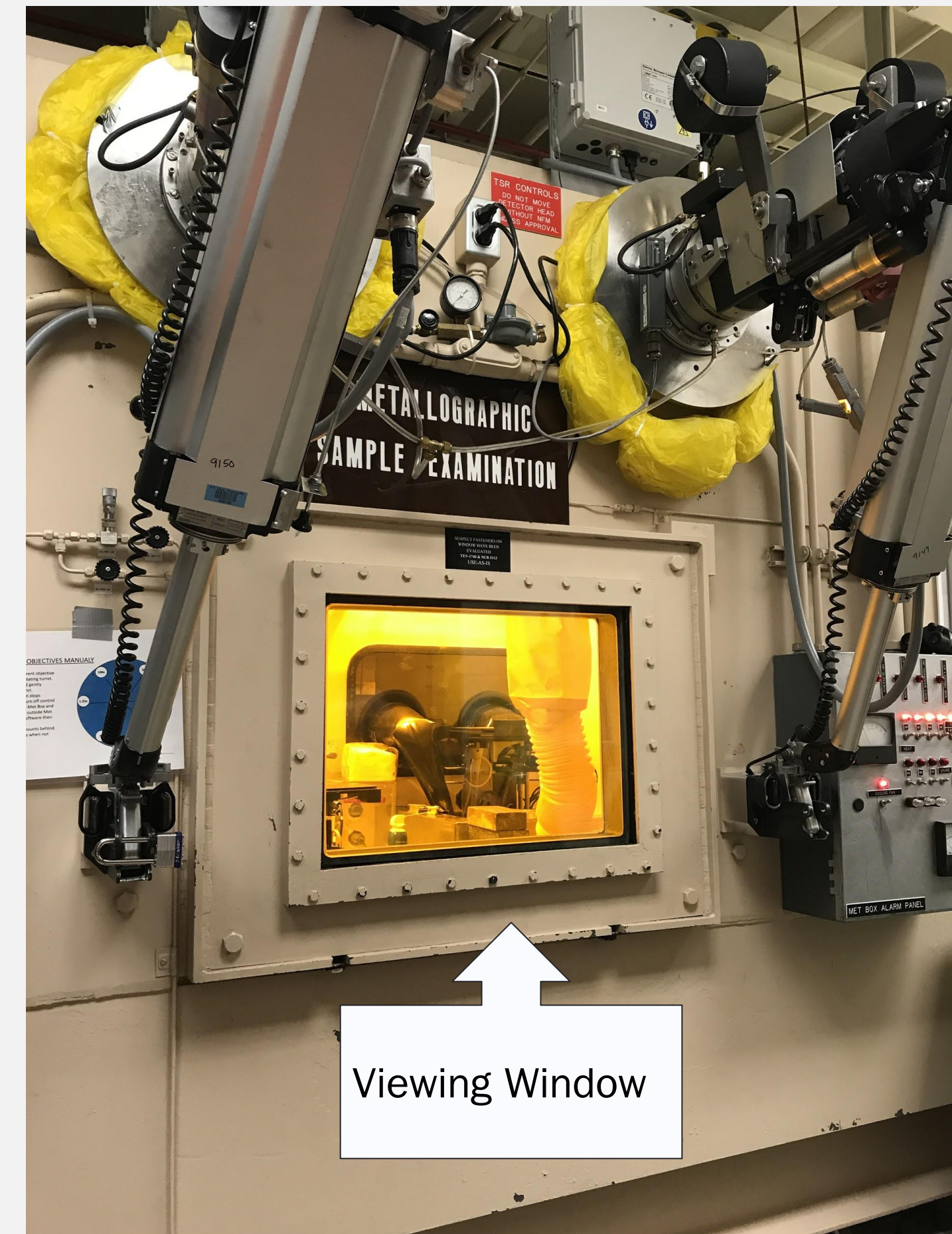
Background

- 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.



Objective

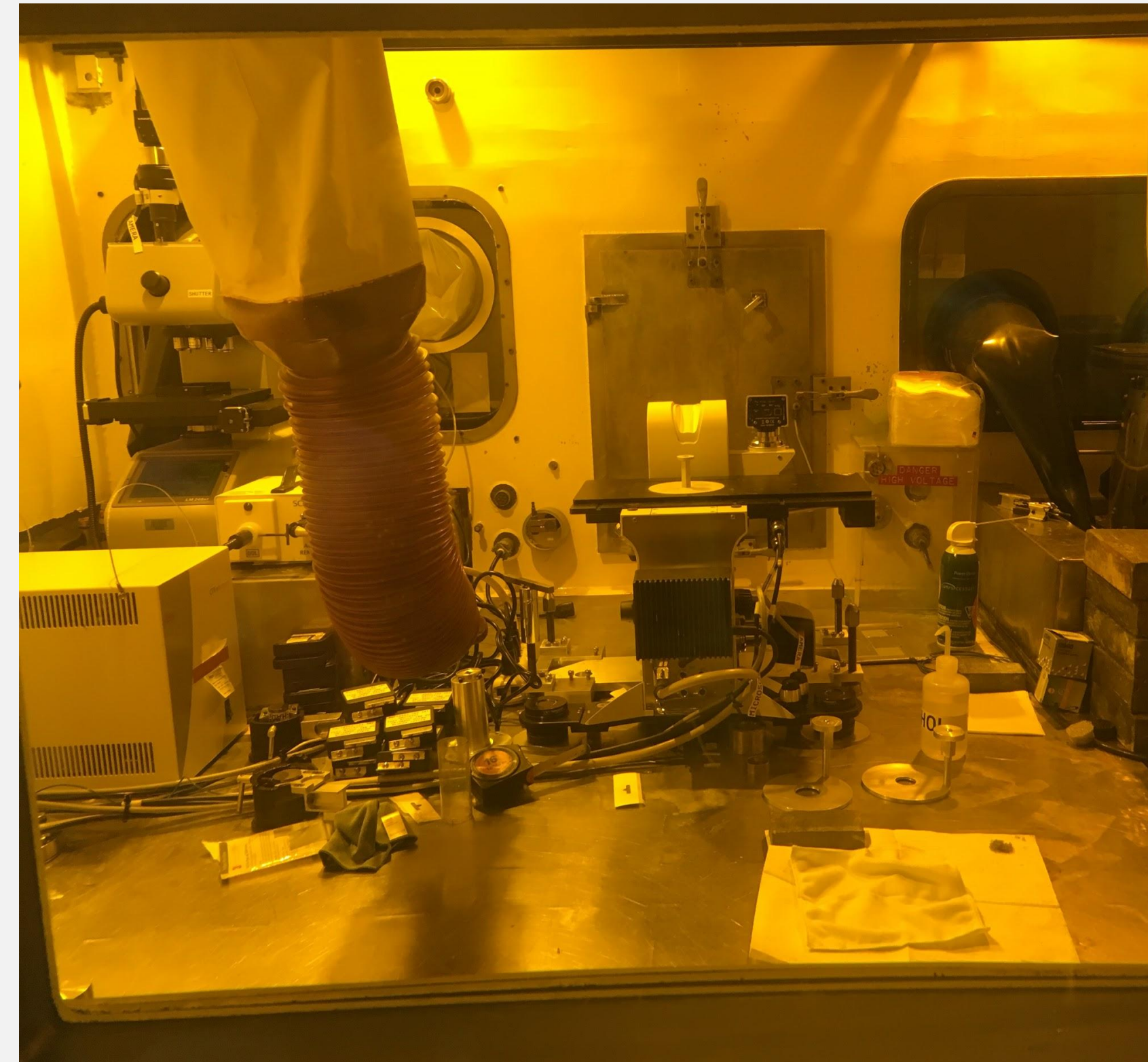
- Design a remote visualization system needed in a hot-cell with a high radiation dose level to enable real time remote monitoring of microscopy equipment.



Product Requirements

The visualization system must be accommodating to Met Box parameters:

- Porthole
- Manipulators weight restriction
- Manipulator maneuverability
- Electrical ports
- 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.
- Types of outer layer shielding:
 - Lead
 - HVL: 1.25cm
 - Price: \$0.87/lb
 - Stainless Steel
 - HVL: 2.16cm
 - Price: \$0.30/lb
 - Tungsten
 - HVL: 0.85cm
 - Price: \$22.07/lb

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

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.

Project Learning: Shielding Materials

- ClearView Radiation Shielding
 - Clear panels made by Radium
 - Contains liquid solution
 - HVL: 3.81cm
- Densetec
 - High density polyethylene
 - Easy to machine
 - Can resist bremsstrahlung radiation



ClearView Panel
Source: Radium Inc.



Densetec Polymer
Source: Redwood Plastics

Project Learning: Radiation Cameras

Camera Options



Lights, Camera, Action - Sony Module RT-200 Camera

Specs:

Zoom capability up to 432x
Designed for low-radiation inspections
Image stabilization with auto or manual focus
Lighting, pan & tilt, and console controls

Pro - Meets requirements

Con - May not be resistant enough, (waiting on quote)



Mirion Technologies - R941 Compact Nuclear Zoom Camera

Specs:

Radiation tolerant
Non-browning zoom lens
Remotely controlled via R90 Mk 3 Control Unit
Iris Range - f/2.8 to f16

Pro - Radiation tolerant and great controllability

Con - Expensive (waiting on quote from manufacturer)

Project Learning: Mechanical Assist Magnets

Magnet Options



ACD Supply - Magswitch MagJig 60

Magnet Strength - 60 lbs/27 kg
2:1 Shear Working Load - 17 lbs/7 kg
Net Weight - 0.2 lbs/0.1 kg
Overall Height - 1.7 in/44.1 mm

Pros - Lightweight, strong, small, inexpensive (\$18 each)

Cons - Difficult with manipulators



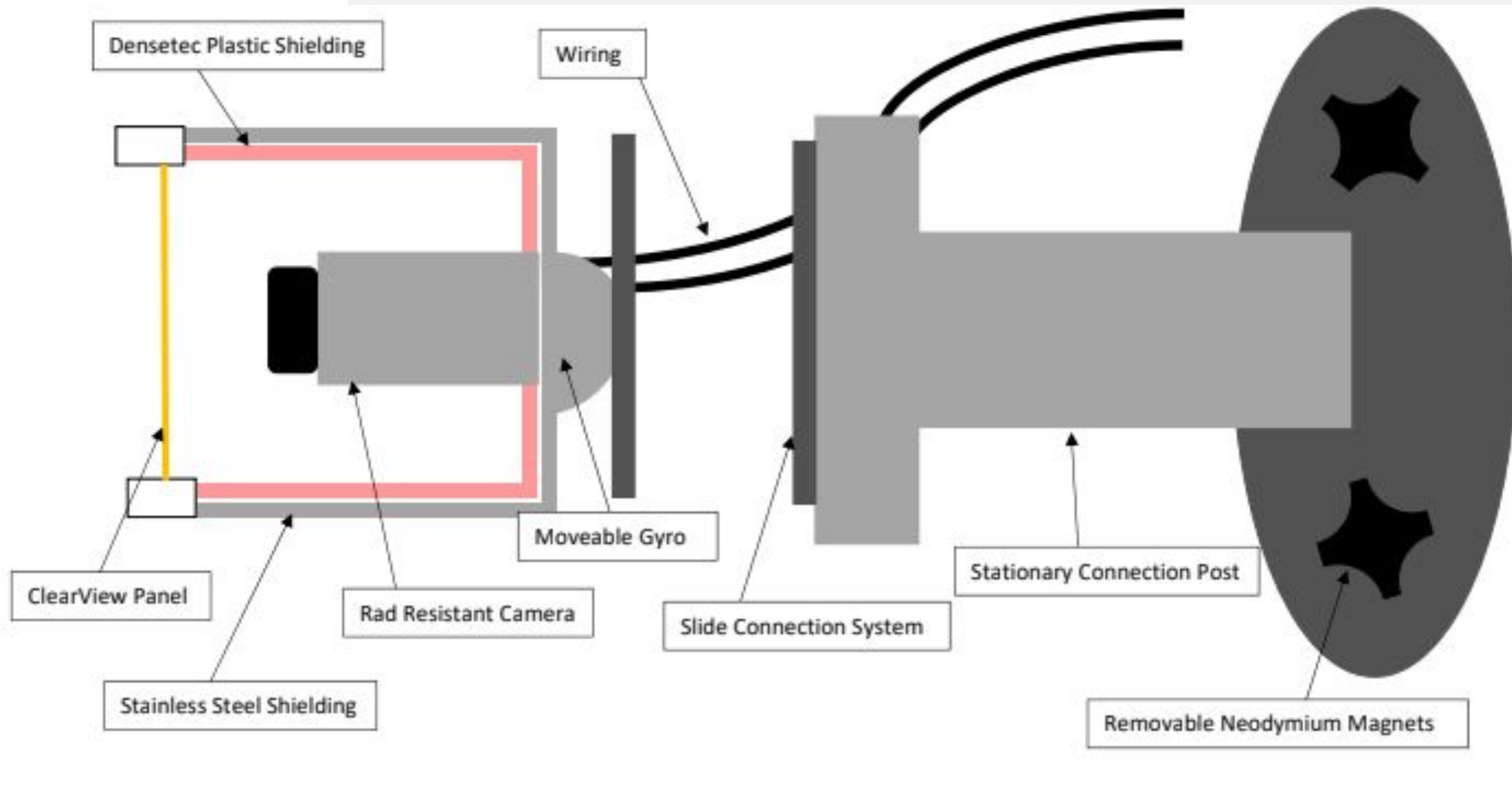
MSC - Mag Mate Rare Earth Magnetic

Magnet Strength - 150 lbs
Net Weight - 2 lbs
Overall Height - 2.5 in

Pros - Larger, still inexpensive (\$85 each), easy with manipulators

Cons - Considerable additional weight to system

Design Concept 1: Permanent Magnetic Wall Mount



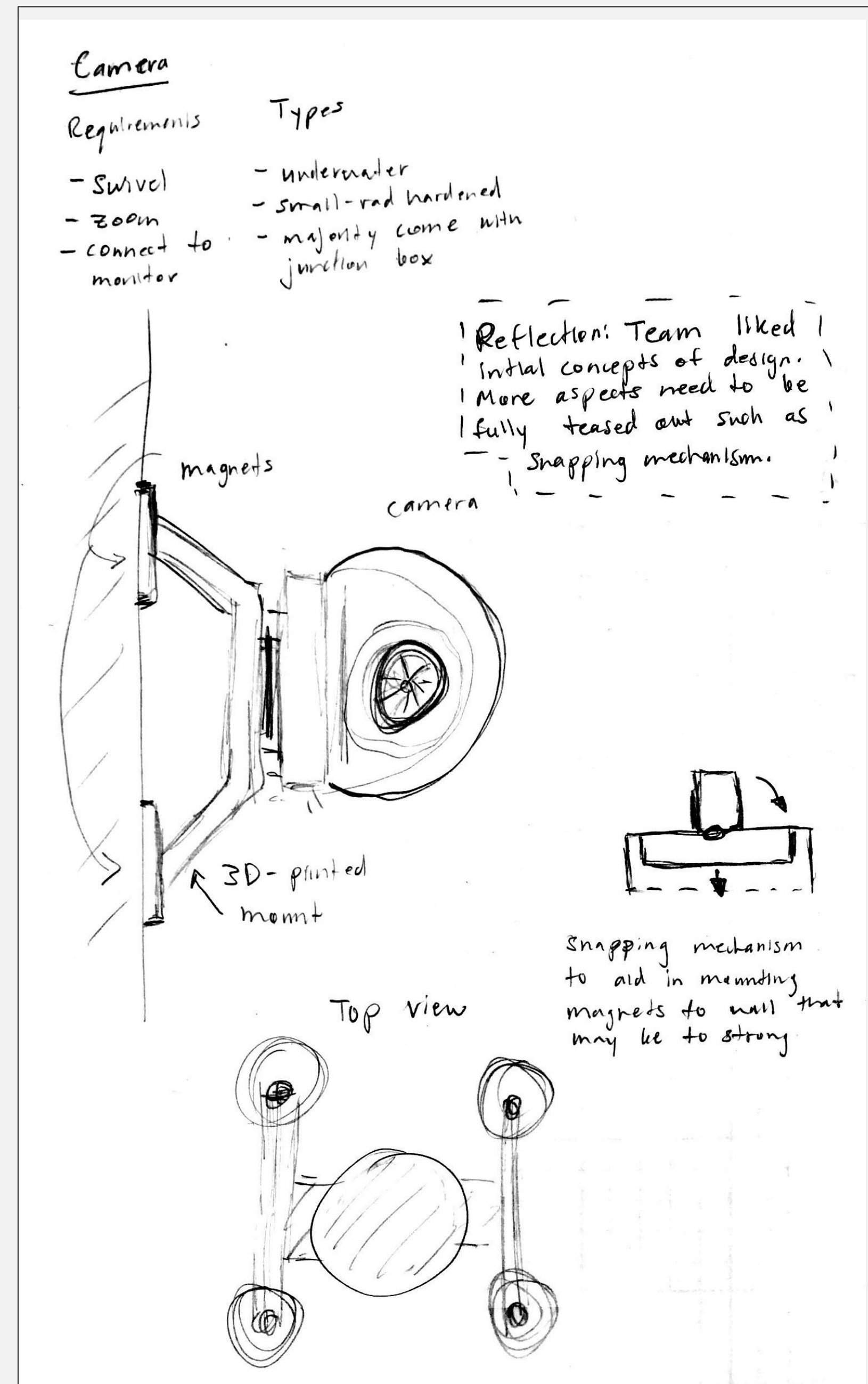
- Four or more magnetic “permanent” posts
- Camera and Shielding are separate pieces to posts
- Angles achieved using gyro
- Mechanically positioned
- Sliding system
- Removable Neodymium magnets

Design Concept 1: Permanent Magnetic Wall-Mount

- Pros
 - Several angles can be achieved easily
 - Height and location will not be a factor
 - Camera is easily moveable
 - Post and camera come as two pieces
 - Camera and shielding disposable
- Cons
 - Weight may be an issue, and the station and camera may have to be manipulated in pieces
 - Wiring must be taken into account whenever moving camera

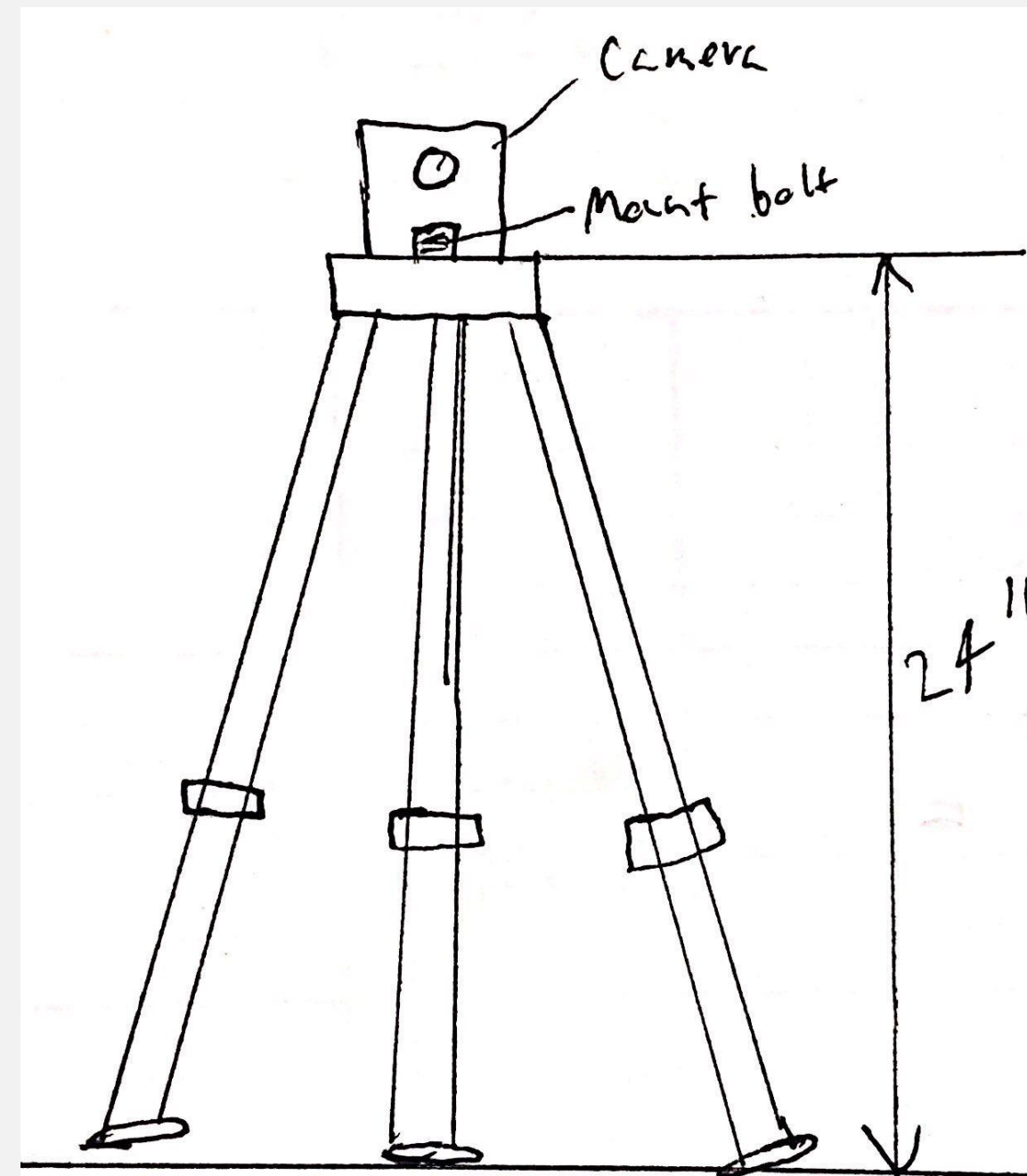
Design Concept 2: Movable Magnetic Wall-Mount

- Pros
 - Easy adjustability as well as placement within the Met-Box
 - Fairly customizable in design
 - Compact and simple with the right camera
- Cons
 - Weight is a major concern
 - Wiring must be taken into account
 - If an issue arises, entire system must be removed and replaced

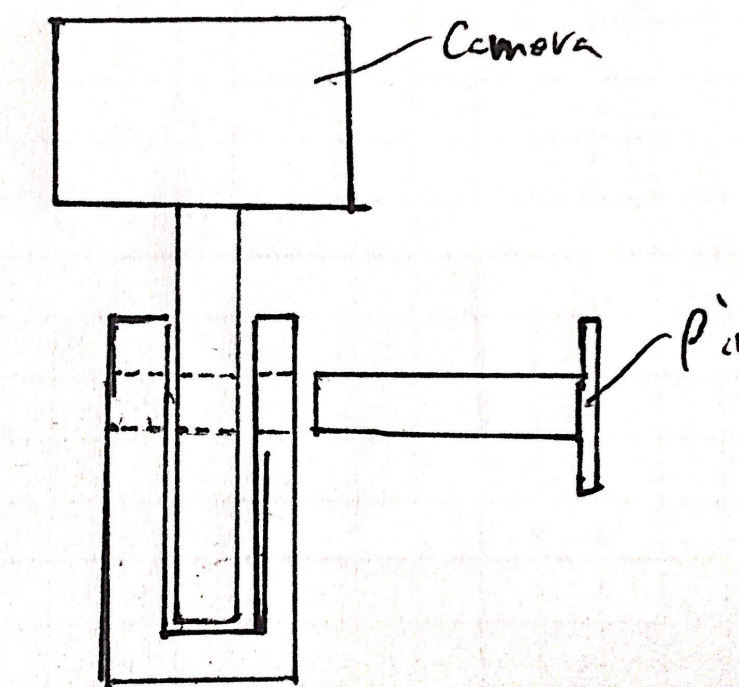


Design Concept 3: Preadjusted Tripods

- Pros:
 - Modify off shelf tripod from Amazon
 - \approx \$25 per tripod
- Cons:
 - May not fit spatial constraint of cell entrance
 - Weight of system could be an issue
 - System assembled in cell



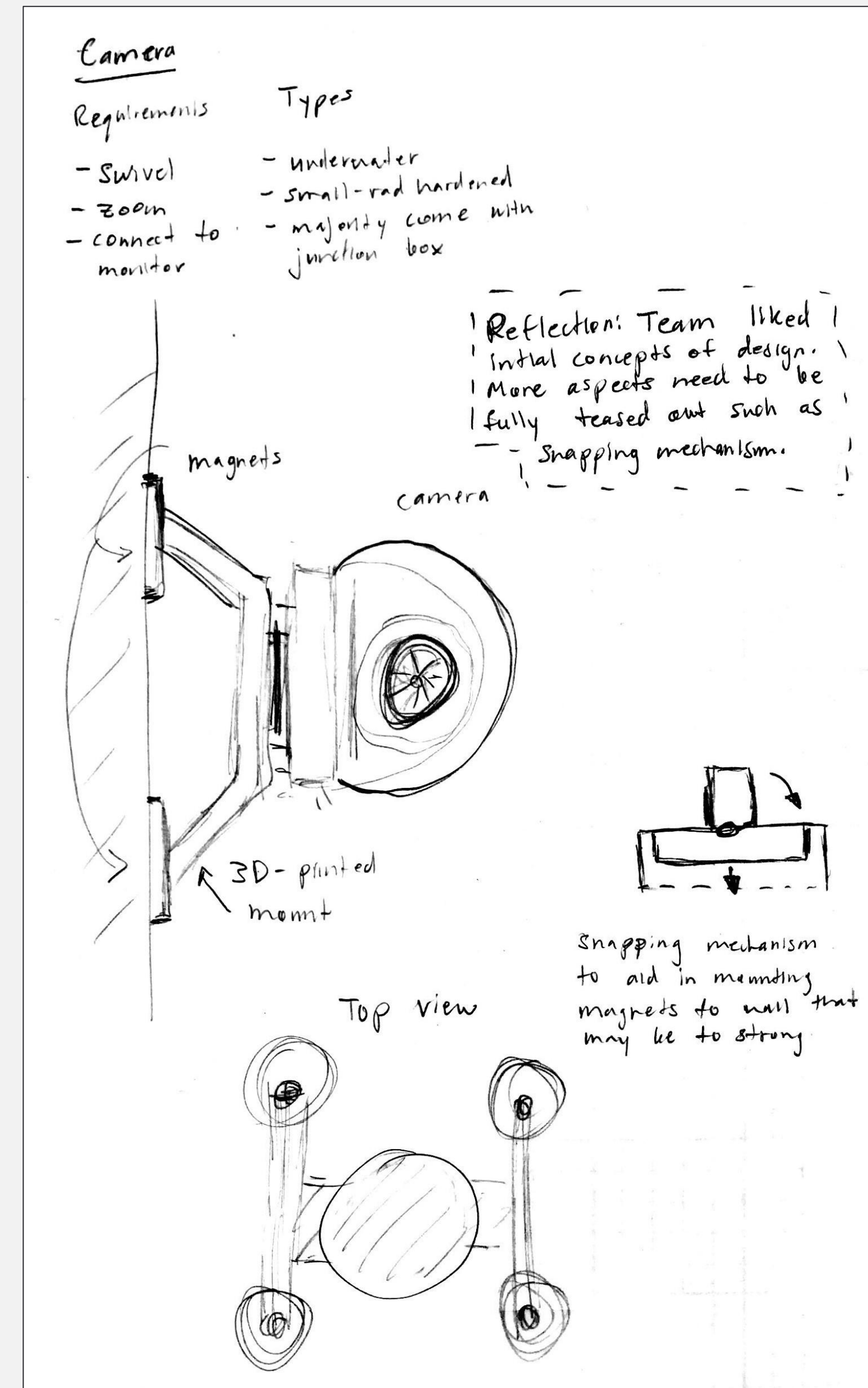
Camera Pin Mount



Recommendation:

Design Concept 2:

- Fewer moving parts
- Easily movable magnets
- 3D printed customizable chassis



Schedule



| Task Description | Assigned | Year | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|-----------|-------|-------|-------|------|-------|-------|-------|-----|-----|------|------|------|-----|------|------|------|-----|------|------|------|-----|-----|------|------|------|-----|------|------|------|
| | | 2018 | | | | | | | | | | | | | | 2019 | | | | | | | | | | | | | | |
| | | Month | Nov | | | | Dec | | | | Jan | | | | Feb | | | | Mar | | | | Apr | | | | May | | | |
| Assigned | 11/6 | 11/13 | 11/20 | 11/27 | 12/4 | 12/11 | 12/18 | 12/25 | 1/1 | 1/8 | 1/15 | 1/22 | 1/29 | 2/5 | 2/12 | 2/19 | 2/26 | 3/5 | 3/12 | 3/19 | 3/26 | 4/2 | 4/9 | 4/16 | 4/23 | 4/30 | 5/7 | 5/14 | 5/21 | 5/28 |
| Wikipage development | Jack | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Concept Design Review 11/16 | All | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Snapshot Presentation | All | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Snapshot Day 2 11/30 | All | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | |
| Semester Deliverables 12/7 | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | |
| Purchase requests | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Camera | Nick | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Magnets | Jack | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3D Printer Filament | David | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fasteners | David | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Design Expo Registration 1/23 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Detailed Design Review (w/client & lead instructor) 1/28 - 2/8 | | | | | | | | | | | | | x | x | x | | | | | | | | | | | | | | | |
| Modeling | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chassis | Nick | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mount | David | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3D Printing | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chassis | Nick | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mount | David | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Machining | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Misc parts for chassis | Nick,Jack | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Design Validation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Camera image validation | Nick | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Porthole Spatial test | David | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Manipulator Clamp extension validation | David | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cable management | Nick | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Radiation shielding | Jack | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Operation life | Jack | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Electrical capability | Nick | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Camera maneuverability | Nick | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| System weight | David | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Finished Prototype | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Snapshot day #3 3/5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| INL Spring Visit | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Booth Display/Poster at Expo 4/26 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Technical Presentation at Expo 4/26 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Course Deliverables 4/30 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Questions?

