Low-Cost Camera System for Deep Borehole Inspections: Evaluating the GISP2 Legacy Borehole

- Richard Moser,
- The University of Kansas
- Working with Dr. Dave Besson

Motivation: Inspecting the GISP Borehole

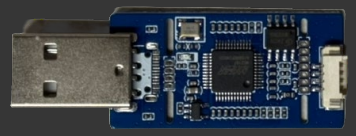
- Cost effectiveness
  - Complete commercial grade borescopes cost ~$10k+
  - Can a DIY solution meet our needs?
- Goals:
  - Develop a multi-camera borehole inspection rig
  - Maximize use of commercially available components
  - Minimize specialty equipment, proprietary software required

My work so far

Large and Mini versions

Mini Cam Electronics

DC-DC Buck Converter 5V -> 16V



Analog video to digital USB converter

Laptop

POC Transceiver

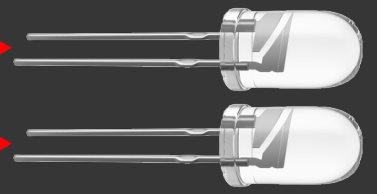
Spool

LEDs for illumination

Borehole

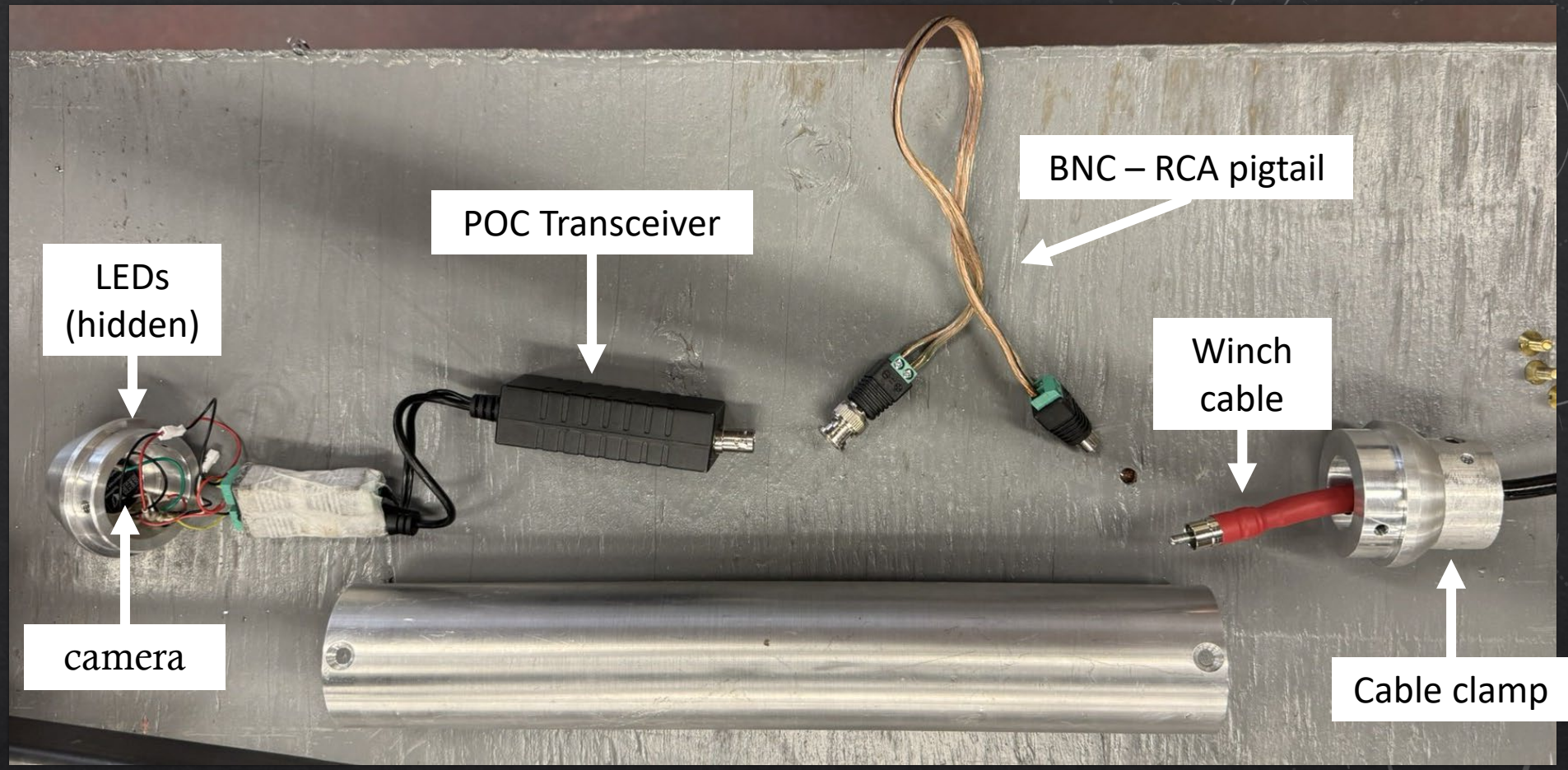
POC Transceiver

Power Over Coax transceiver set



Foxeer nano drone cameras

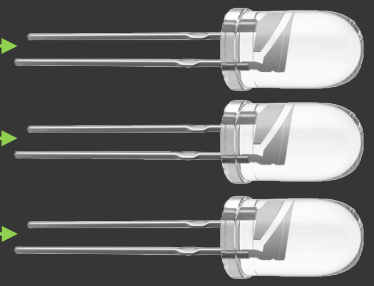
Mini Cam


LEDs
(hidden)
POC Transceiver
BNC – RCA pigtail
Winch
cable
camera
Cable clamp

Large Cam Electronics

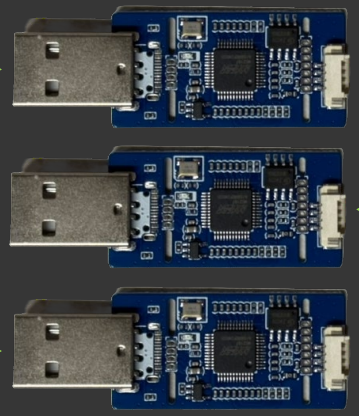
20Ah battery pack

Recording start/stop button & indicator LED



Dimmable LEDs for illumination

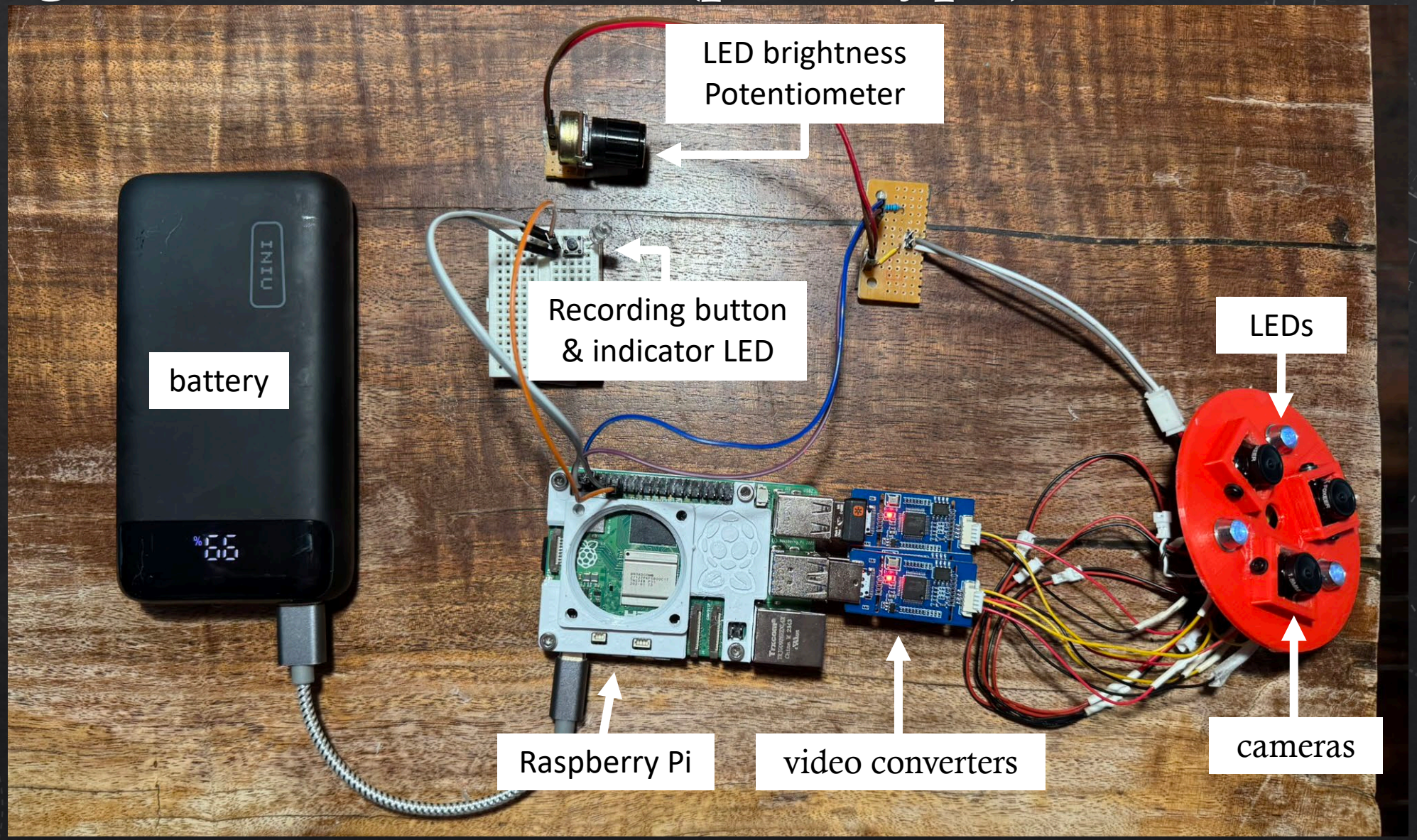
Raspberry Pi 5 Single Board Computer



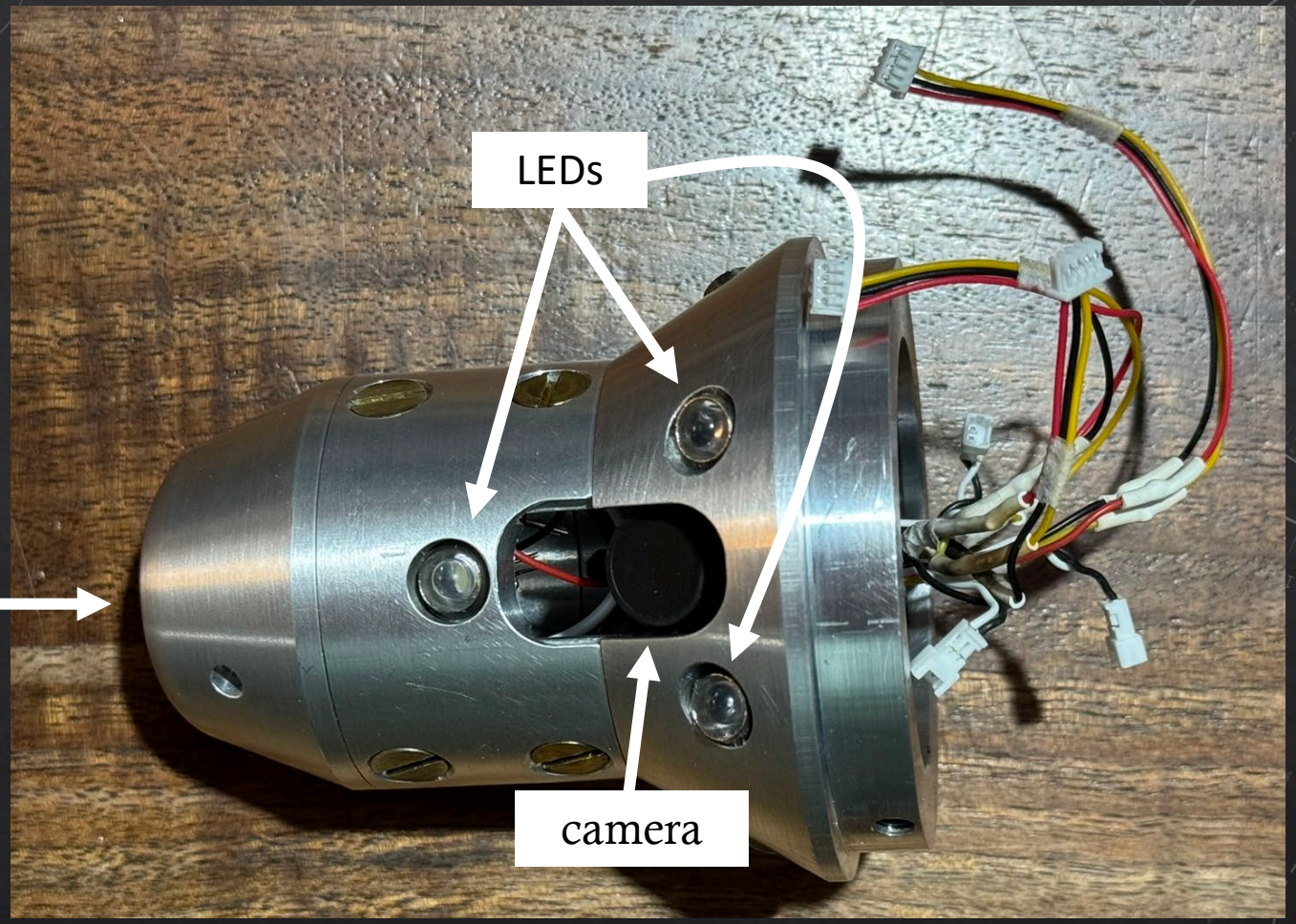
Analog video to digital USB converter

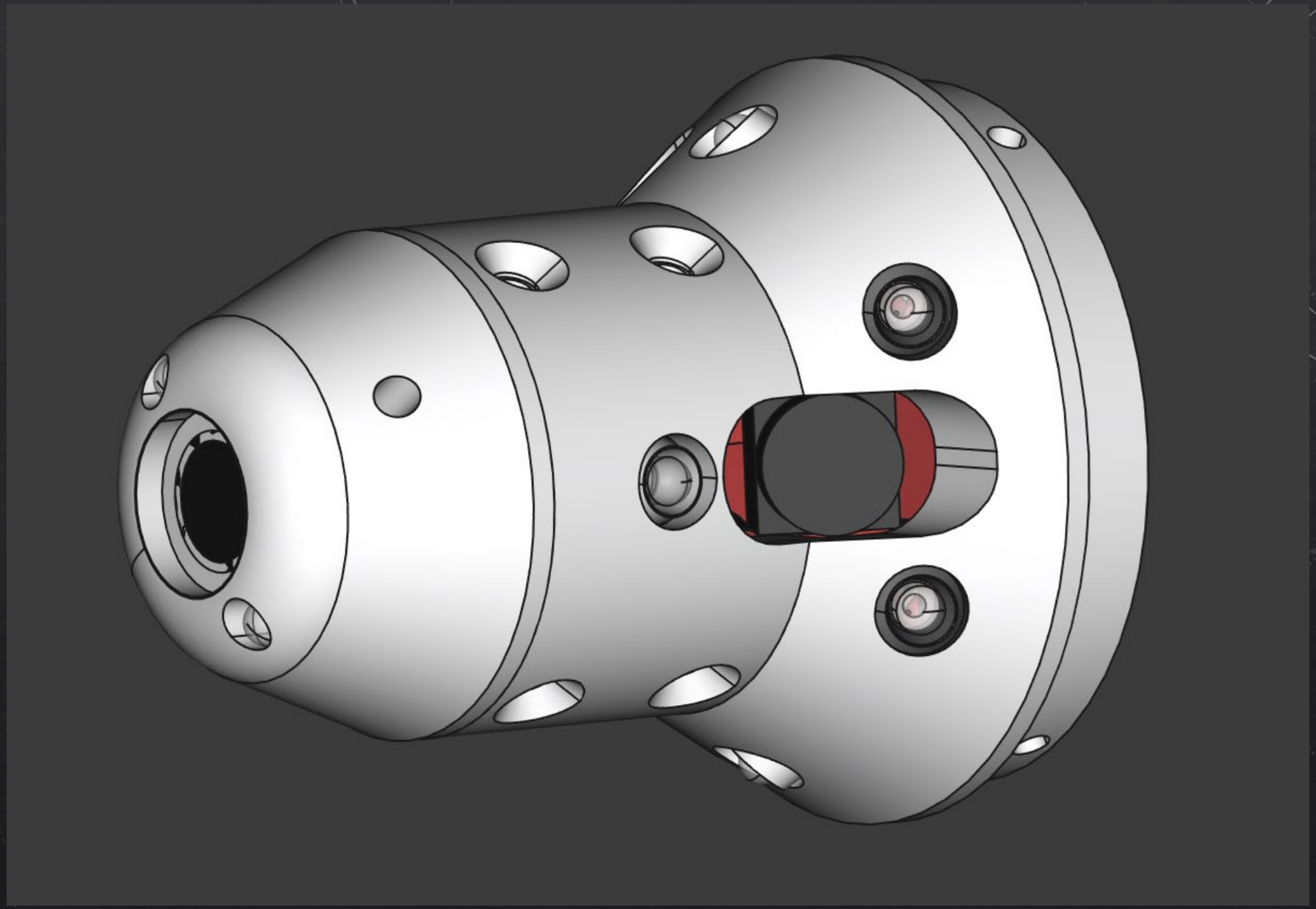
Foxeer nano drone cameras

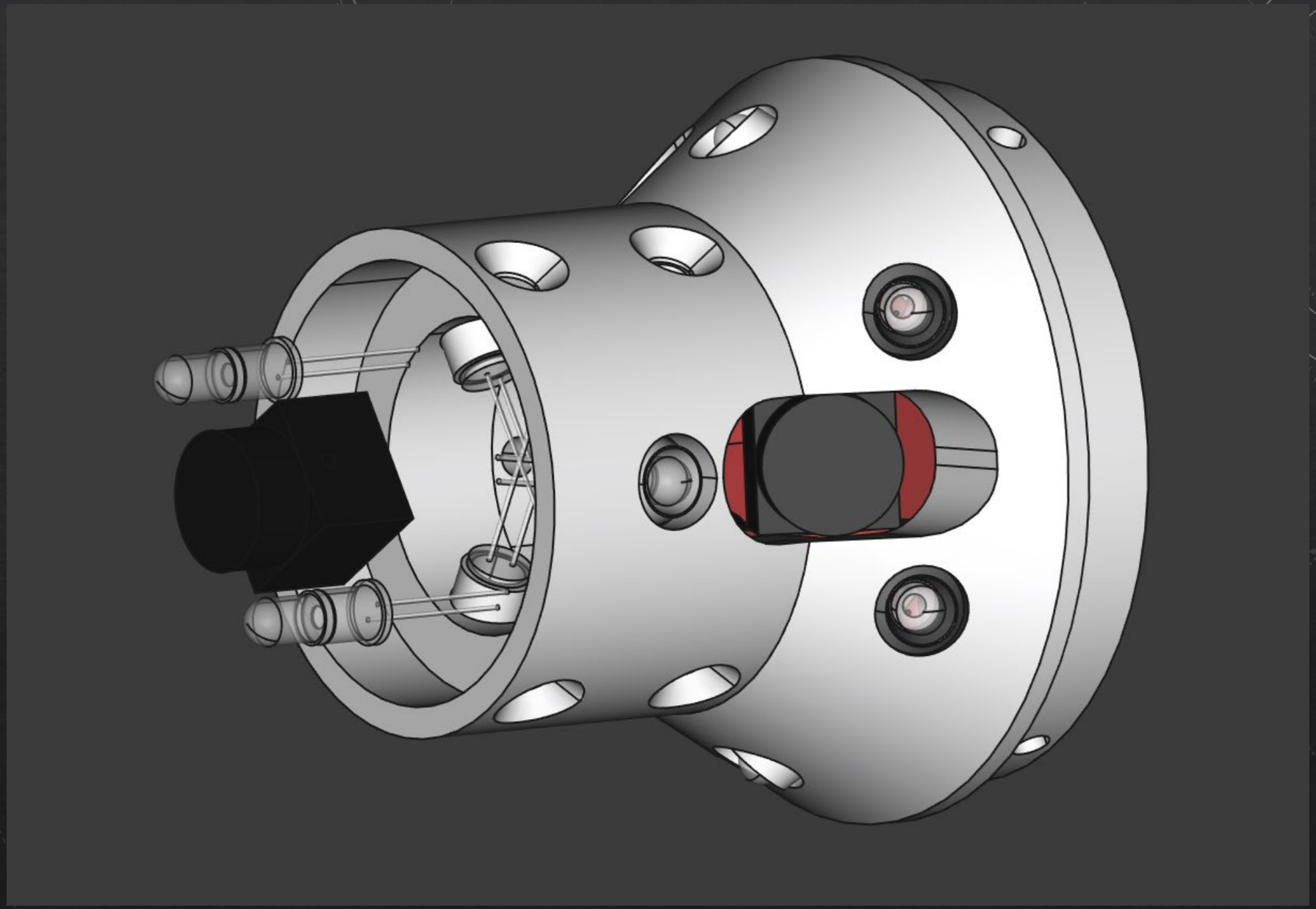
Large Cam Electronics (prototype)

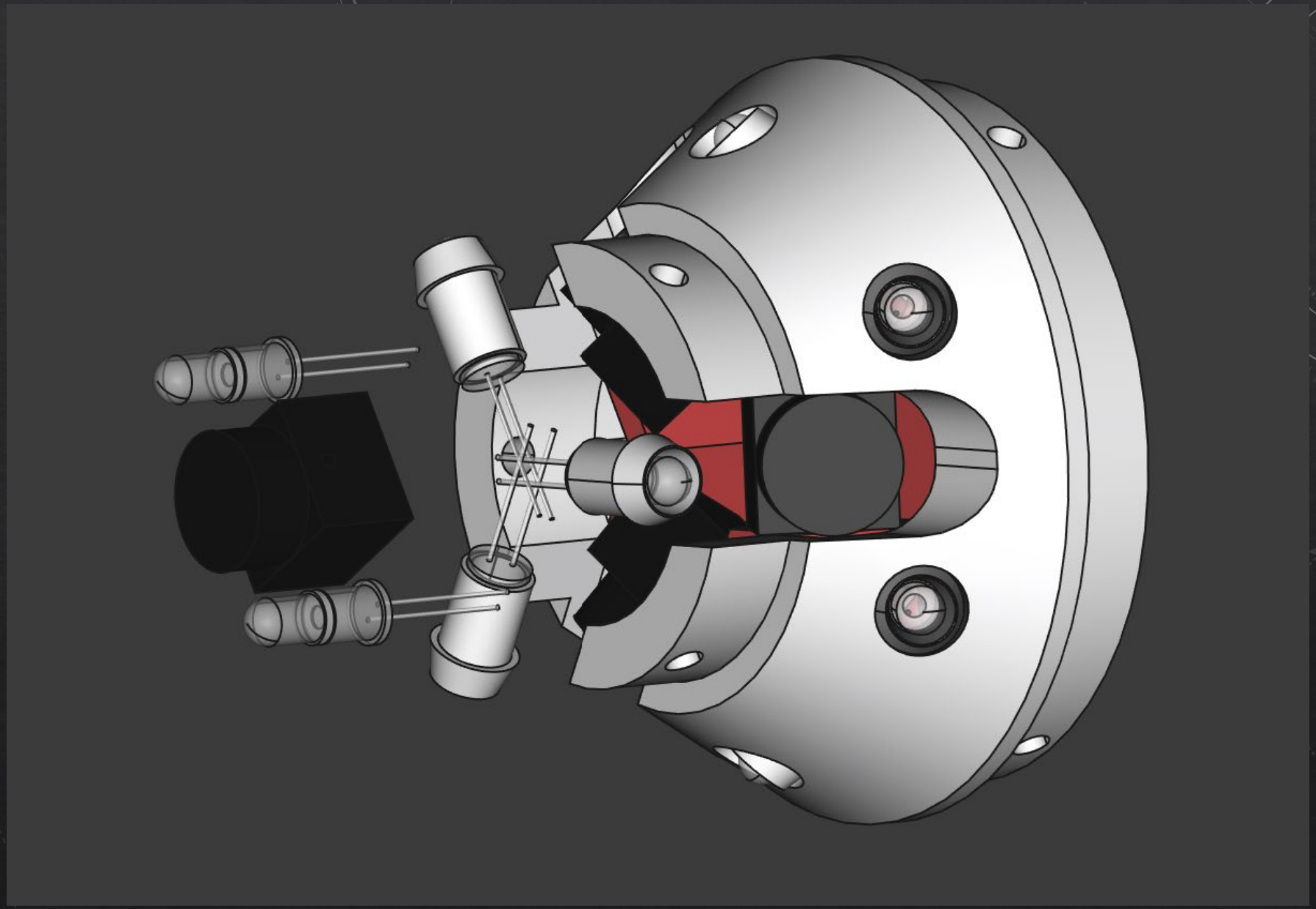


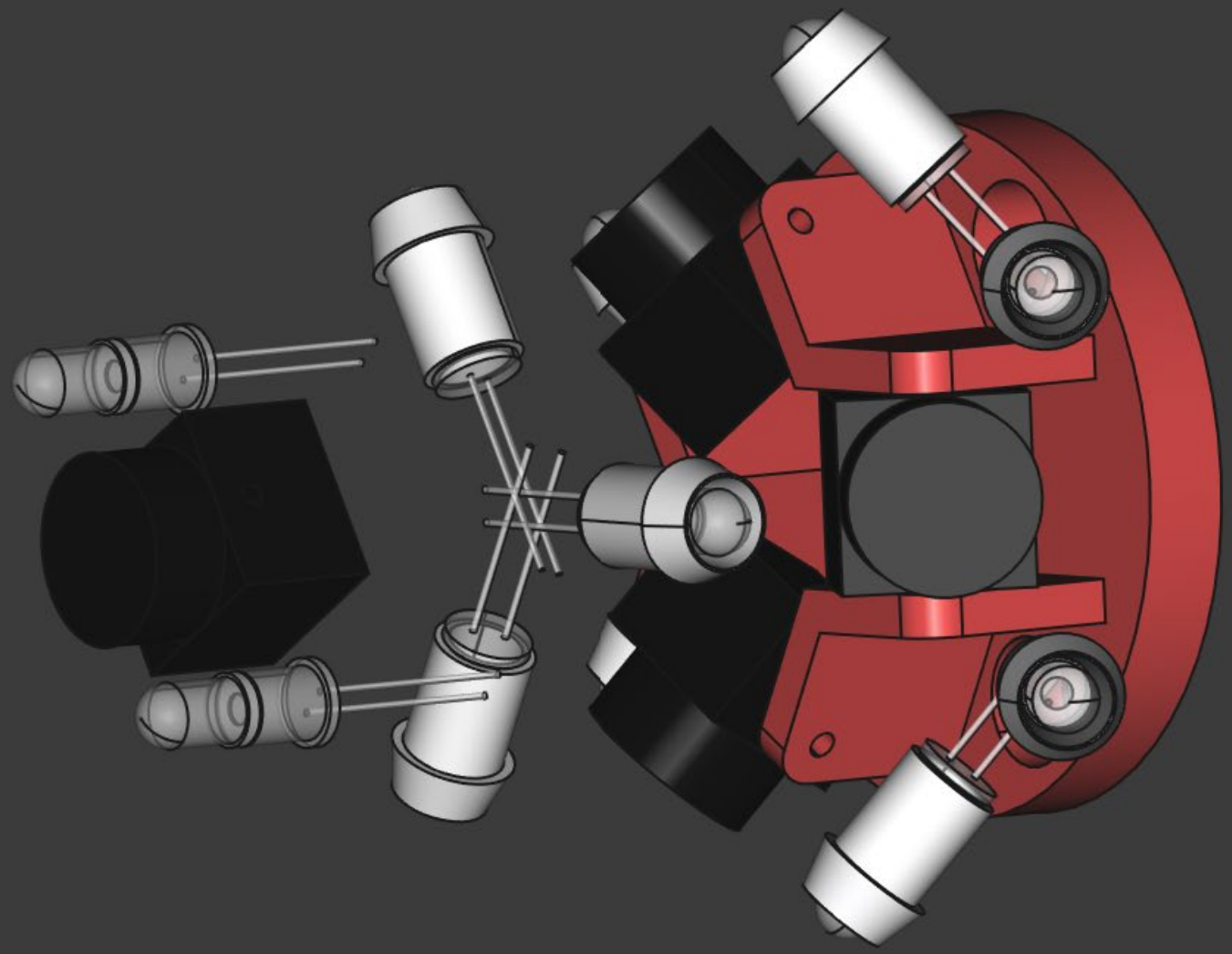
Large Cam Nosecone











Software

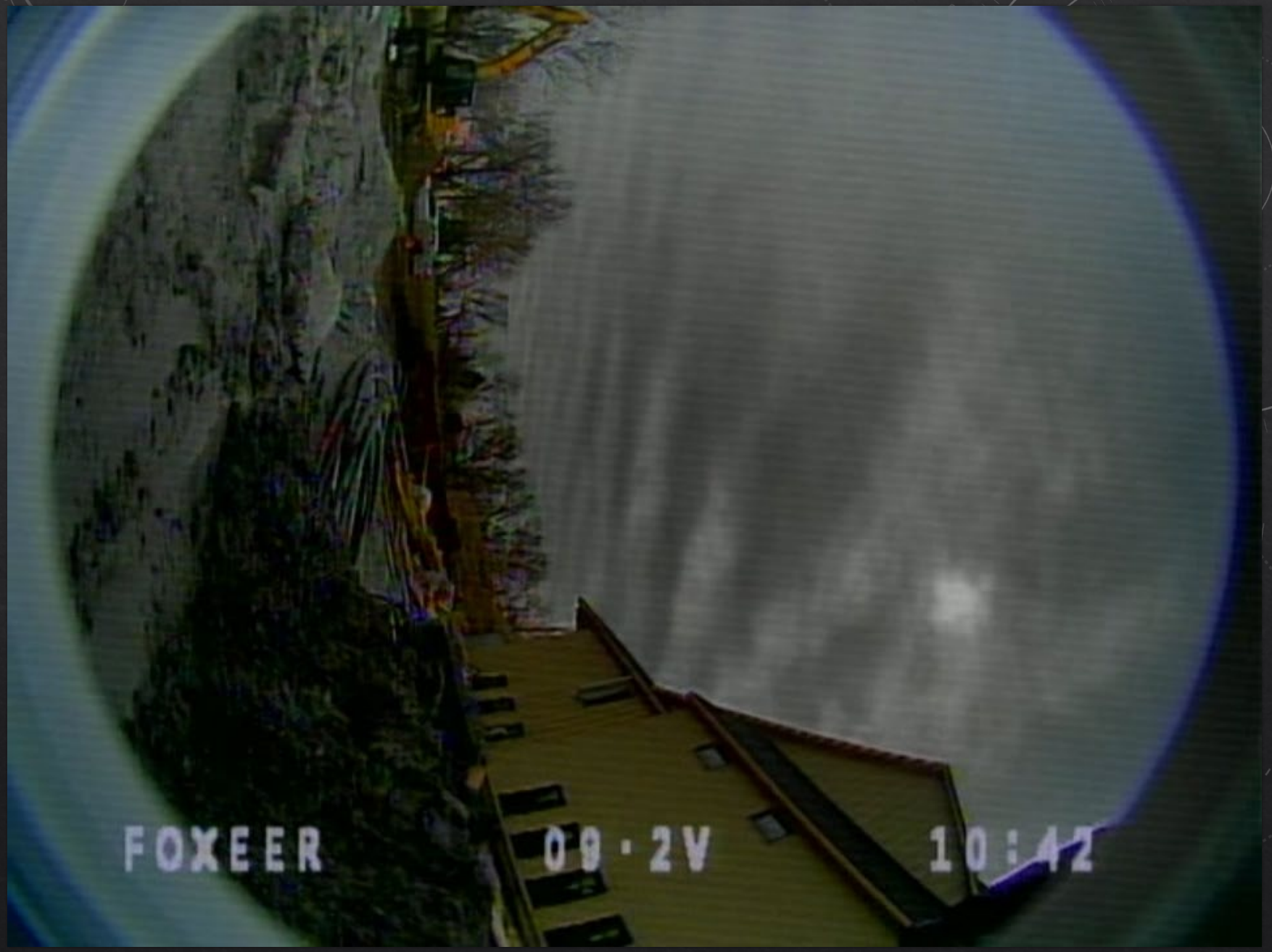
- Mini Cam
  - Python script for recording video (ran on a laptop)
- Large Cam
  - Standard Raspberry Pi OS on the Pi's SD card
  - Python script for recording video
    - Using the OpenCV library for computer vision allowing recording from multiple cameras
  - Other scripts
    - Run the recording script on startup
    - Restart the script if it stops running

Testing

Testing

- In early March, the mini cam was tested in a hole drilled for a residential geothermal system

Testing



Testing

- Last week it was tested in the stairwell of Malott Hall at KU

Testing

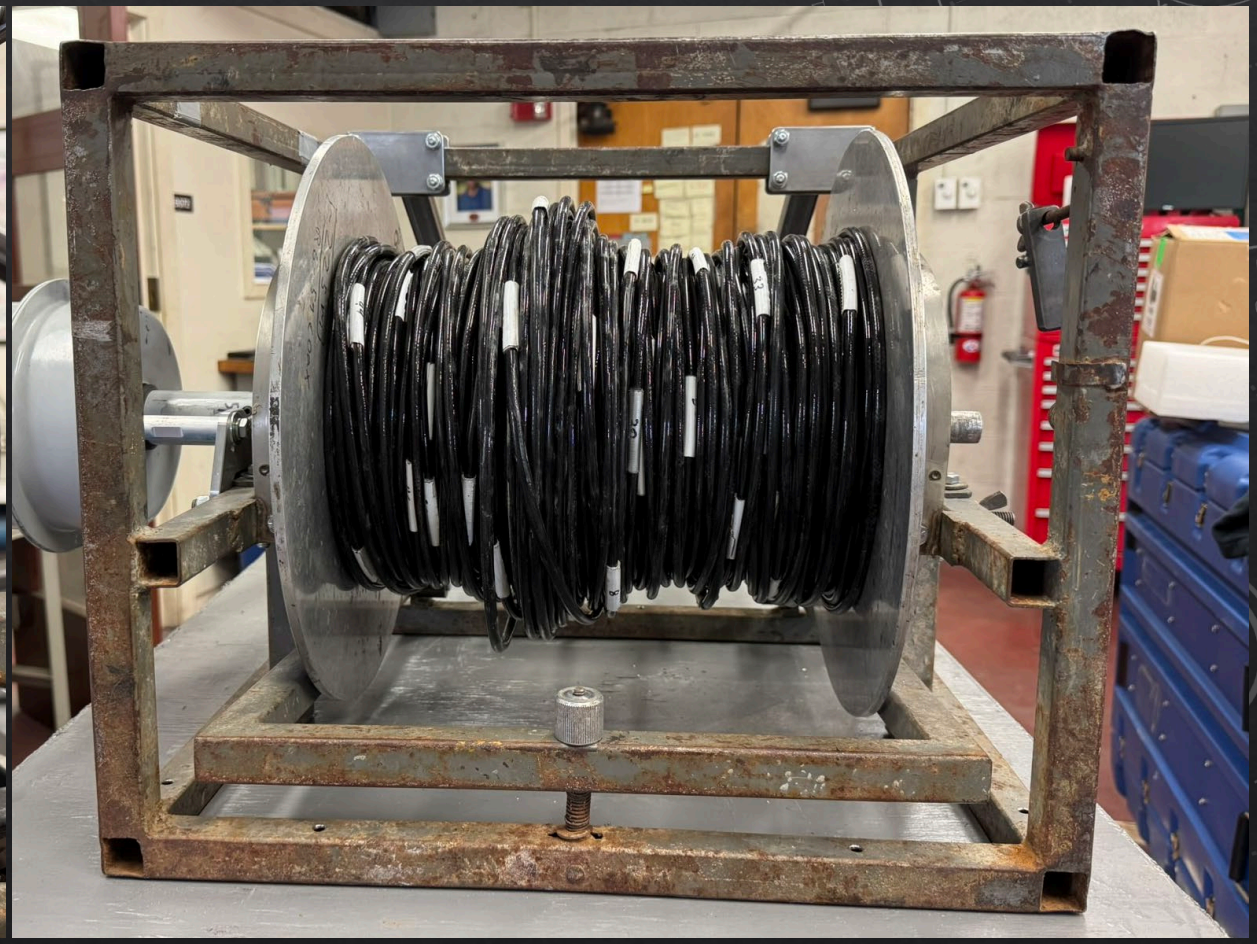
Next Steps

- Finalize electronics
  - Develop an internal frame/housing to hold the components and prevent stress on the wires and connections
  - Wire the large camera’s LEDs
- Transfer knowledge
  - Finish writing documentation
  - Walk Mohammad through the code and camera use

Questions?

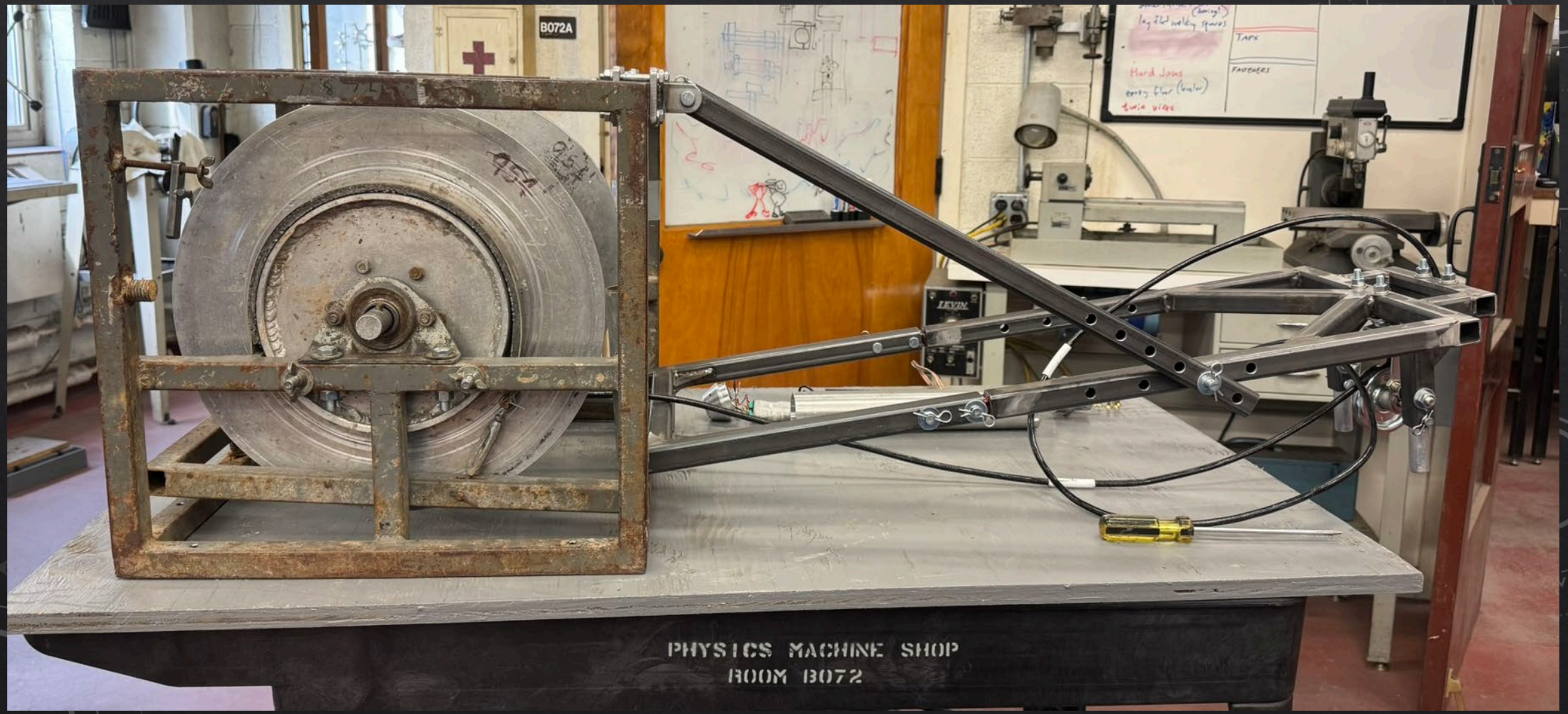
Backup

GISP Winch



GISP Winch

GISP Winch



GISP Winch

Estimated Electronics Cost

Large Camera

Raspberry Pi 5:	$80
Battery Pack:	$40
Video converters:	3x $15
Cameras:	3x $45
LEDs (100):	$5
Push button switch:	$5
Misc. wires, etc.:	$20
Total:	~$330

Large Camera

Video converter:	1x $15
Camera:	1x $45
POC Transceiver	1x $25
LEDs (100):	$5
Misc. wires, etc.:	$20
Total:	~$110

Performance - large cam prototype

- Simulated borehole (4” PVC tubing)


FOXEER
04·8V
07:41