

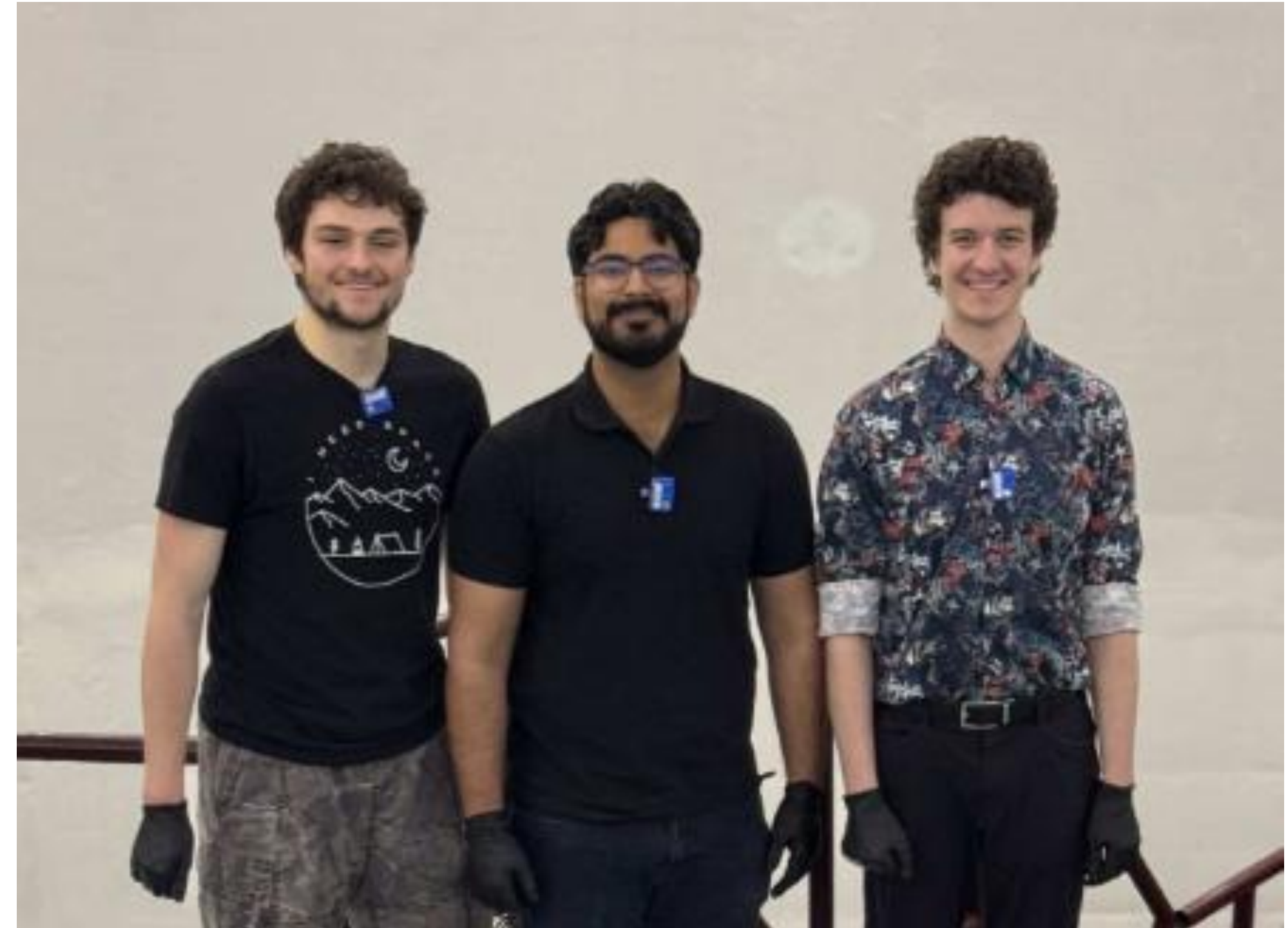
RAD-MAP: Live 3D Dose Rate Mapping

- By: Saarthak Midha
- September 25th, 2026

BACKGROUND

THE TEAM

- Final year Capstone Project
- 3 members Byron Josipovic, Gavin Cabral, and Saarthak Midha
- Engineering Physics Department
- Sponsored by McMaster Nuclear Reactor (MNR)



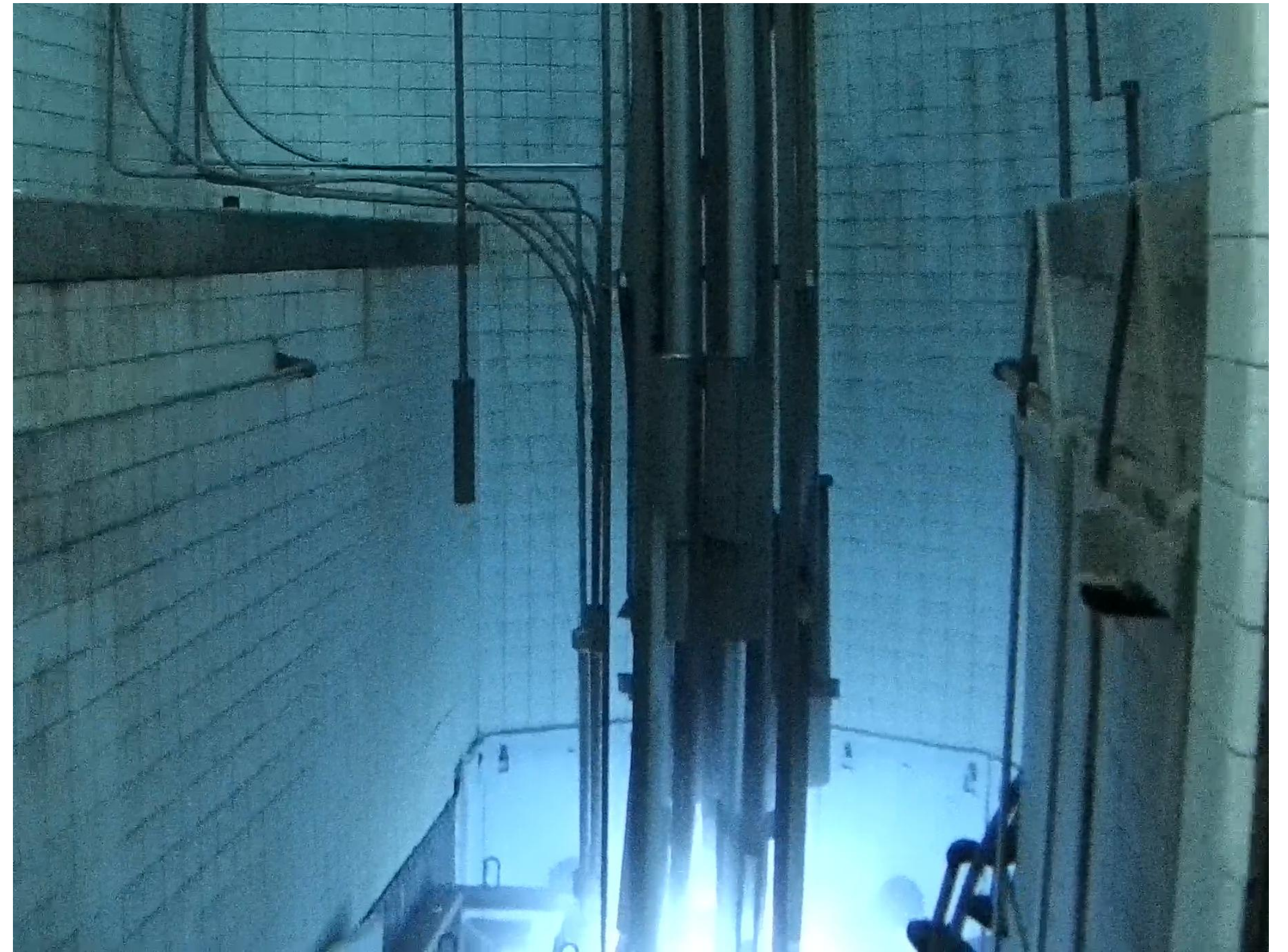
BACKGROUND

A LITTLE ABOUT MNR

- Open-pool type reactor
- First achieved criticality in 1959
- Licensed for 5MWth but runs at 3MWth
- Currently runs 24 hours 5 days a week
- World leader in the production of I-125

Project Sponsor Objectives:

- Thermal Column Window to be replaced with a new Beam port
- Want to conduct underwater surveys before work can be done



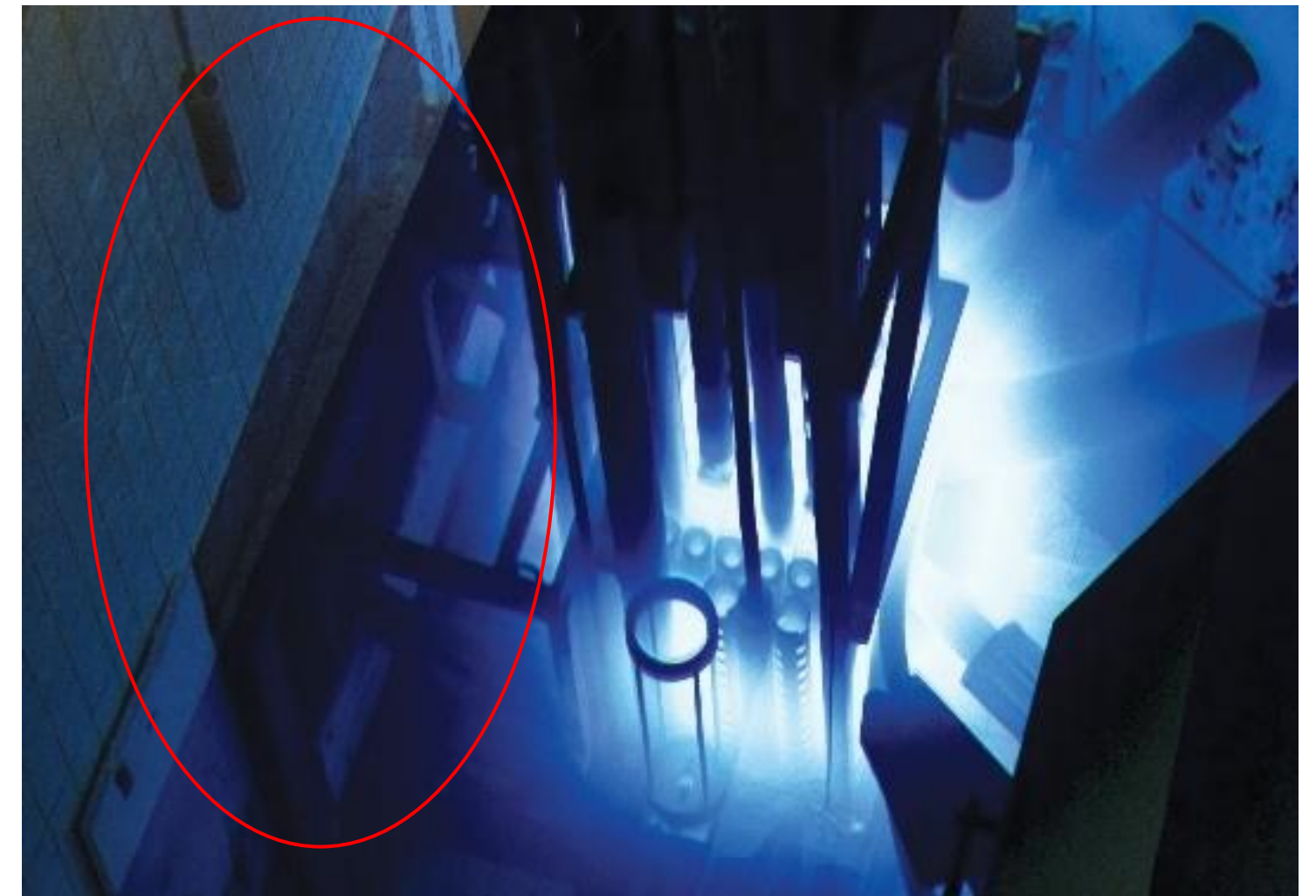
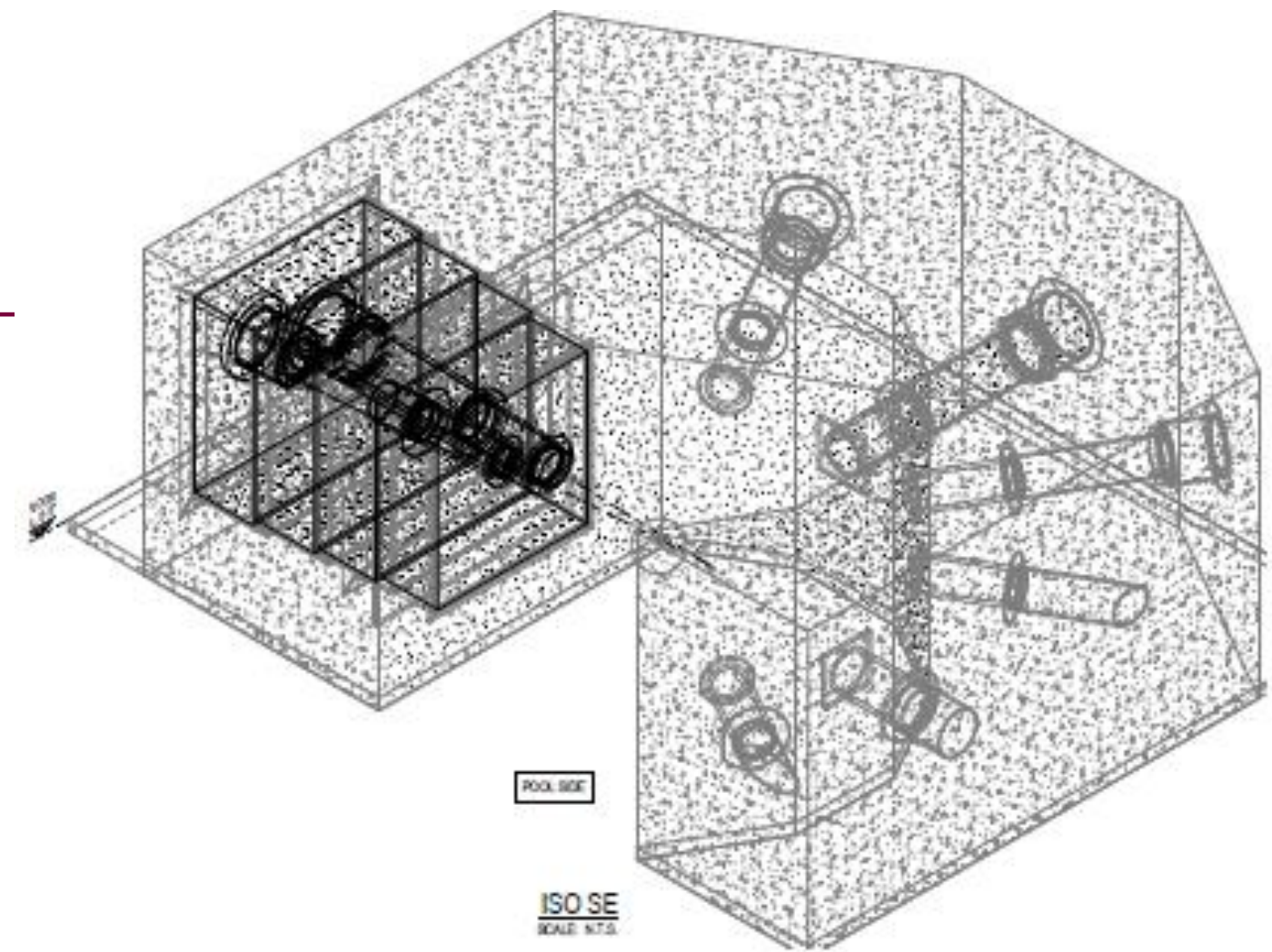
Canadian Neutron Beam Laboratory

- Establishing a national centre for neutron diffraction programs and positron studies
- Funded in part through \$57-million in investments to develop a **national neutron beam user laboratory** and fund access to international neutron sources
- Current offerings:
 - General purpose alignment diffractometer
 - Small angle neutron scattering
 - Intense positron beam facility
- Work underway to add
 - Industrial diffractometer
 - Powder diffractometer
 - Reflectometer



New Beamline Installation

- Replacement of a legacy thermal column with two new beamlines to support
 - Reflectometry
 - Digital neutron radiography
- Concrete filled 'plug' with mounted beamport embeddings
- To be scheduled during quarterly week-long outages

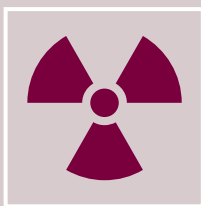


MOTIVATION & PROBLEM

INITIAL IDEA



OBJECTIVE: Can we make radiation surveys faster, safer, and easier to understand



Someone must be present in radiation field to conduct a survey



Radiological surveys are not always intuitive to understand



Robotic alternatives in industry are expensive and very time consuming.

SYSTEM OBJECTIVES

RAD-MAP Concept

The system should operate under water

The system should be able to collect and show data in 3D space



The System should collect data in live time

The system should be able to generate an easy-to-understand plot

SYSTEM ARCHITECTURE



The diagram illustrates the system architecture with three main components arranged horizontally. Each component is represented by a light purple rounded rectangle with a dark purple border and a dark purple shadow to its left. The components are labeled 'Physical System', 'System Backend', and 'User Interphase' from left to right.

Physical System

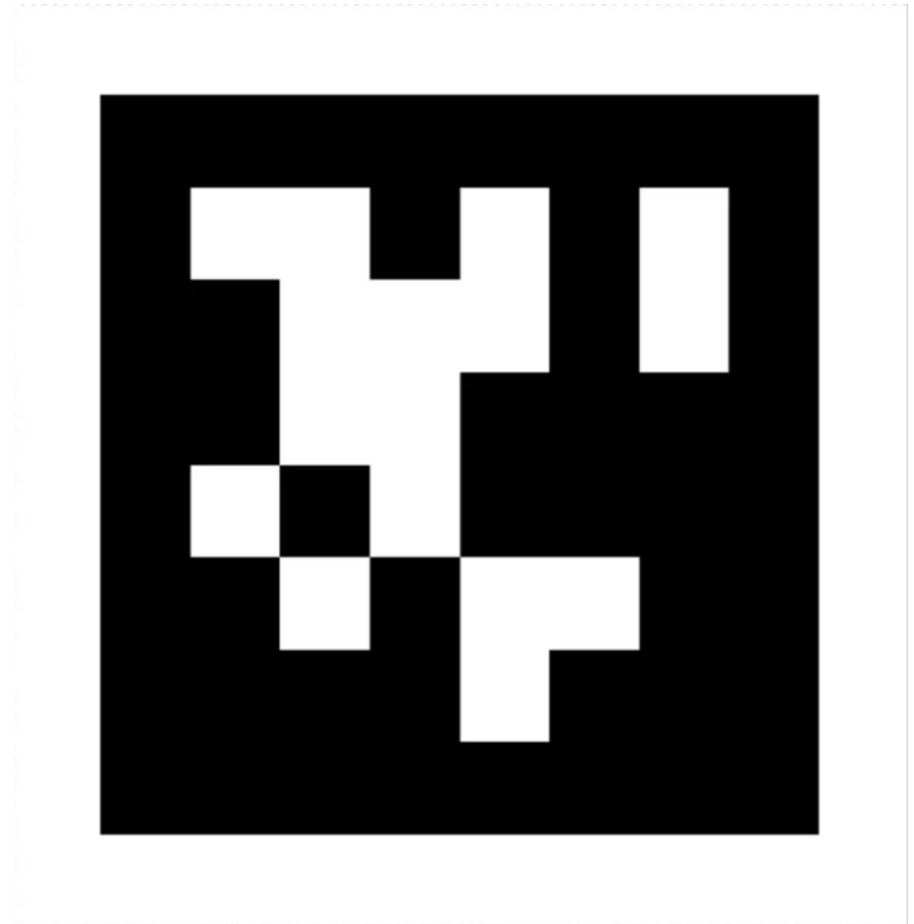
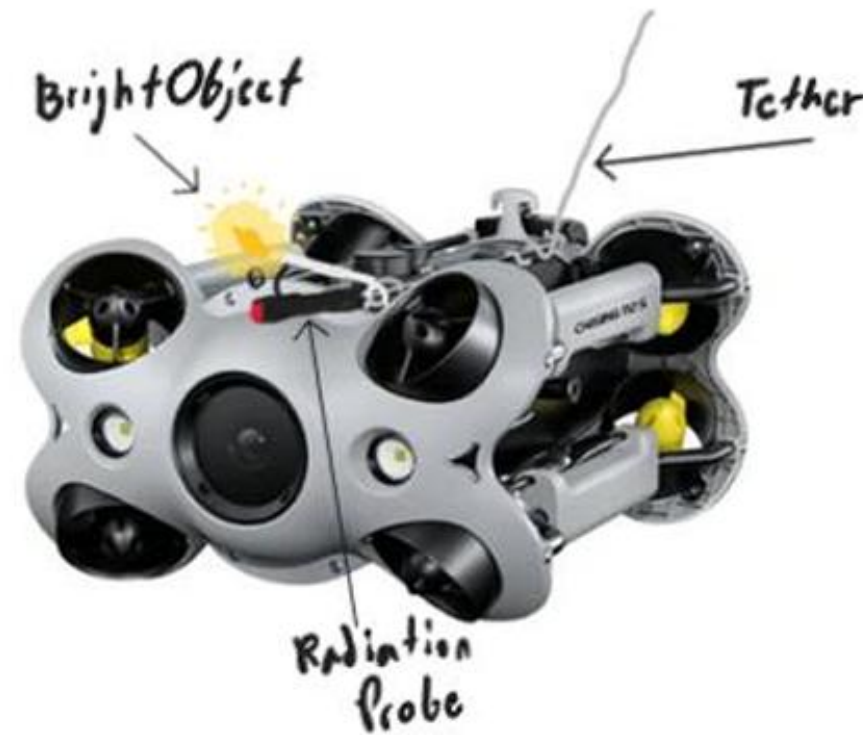
System Backend

User Interphase

SYSTEM ARCHITECTURE

PHYSICAL SYSTEM

- Underwater ROV
- Dose Rate Probe
- 2x Underwater Cameras
- Bright Object
- AprilTag



SYSTEM ARCHITECTURE

SYSTEM BACKEND



Utilizes Python libraries



3D position detection



Synchronize data with time



Create linked data sets

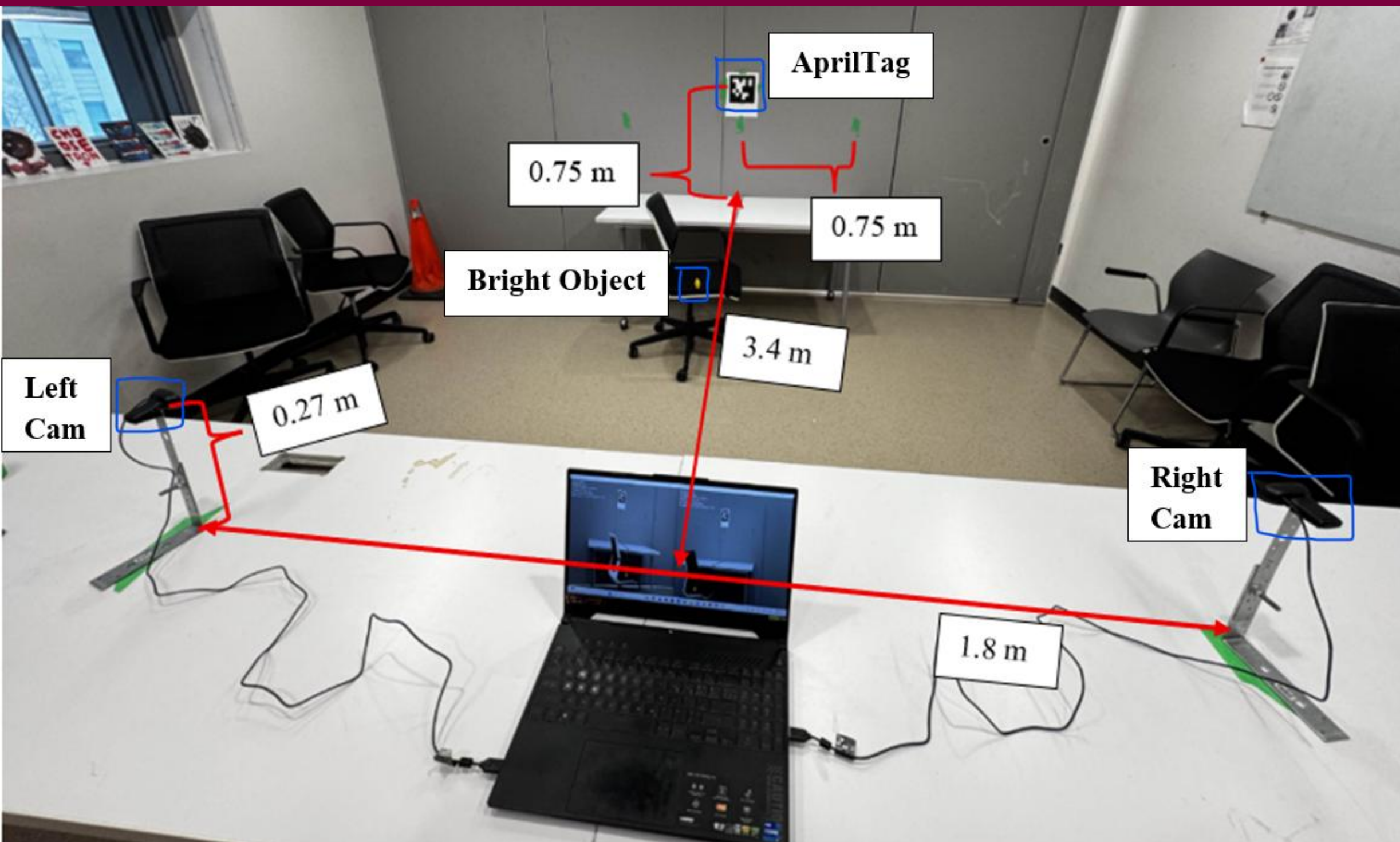


Plot data on 3D plot

SYSTEM ARCHITECTURE

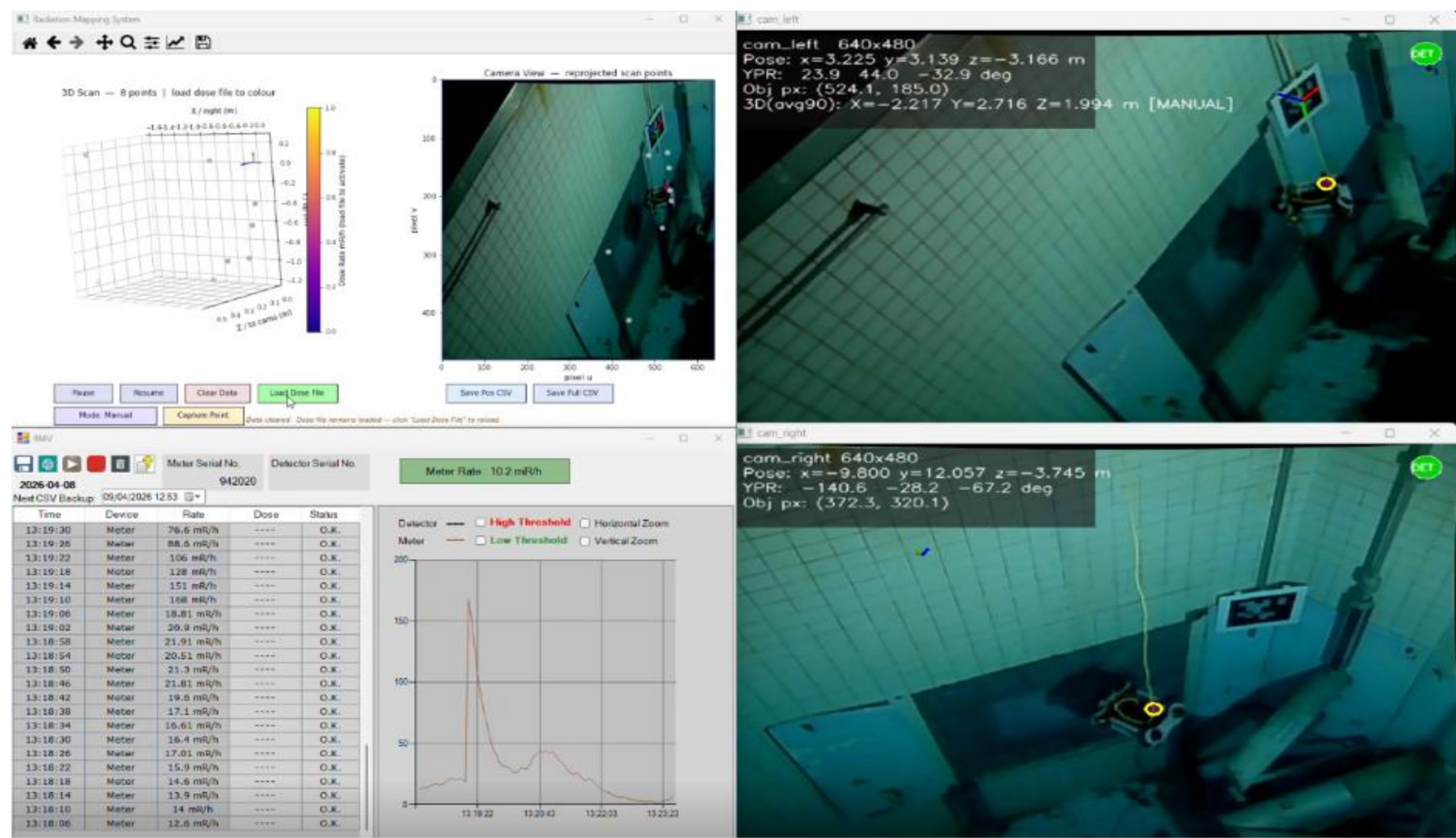
POSITION DETECTION TESTING

- Showcasing how things would work



SYSTEM ARCHITECTURE

USER INTERPHASE



SYSTEM ARCHITECTURE

Survey Results

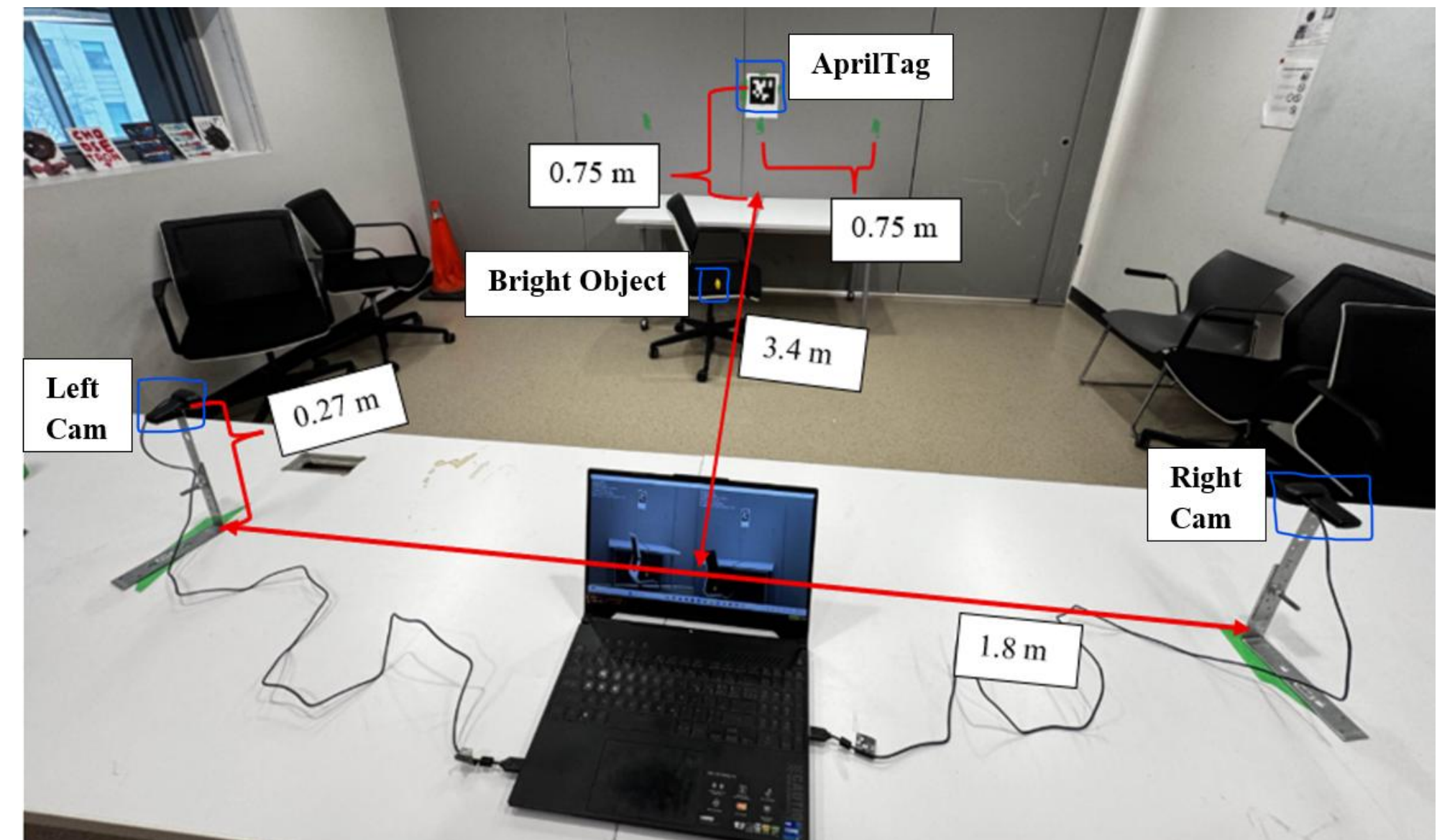


EXPERIMENTAL OBJECTIVES, SETUP, & RESULTS

EXTPERIMENTAL SETUP

OUT OF WATER

- Conduct experiment in similar work area in air
- Move tracer object to various location
- Look at real dimension and system dimension
- Compare results
- **720p Cameras Used**



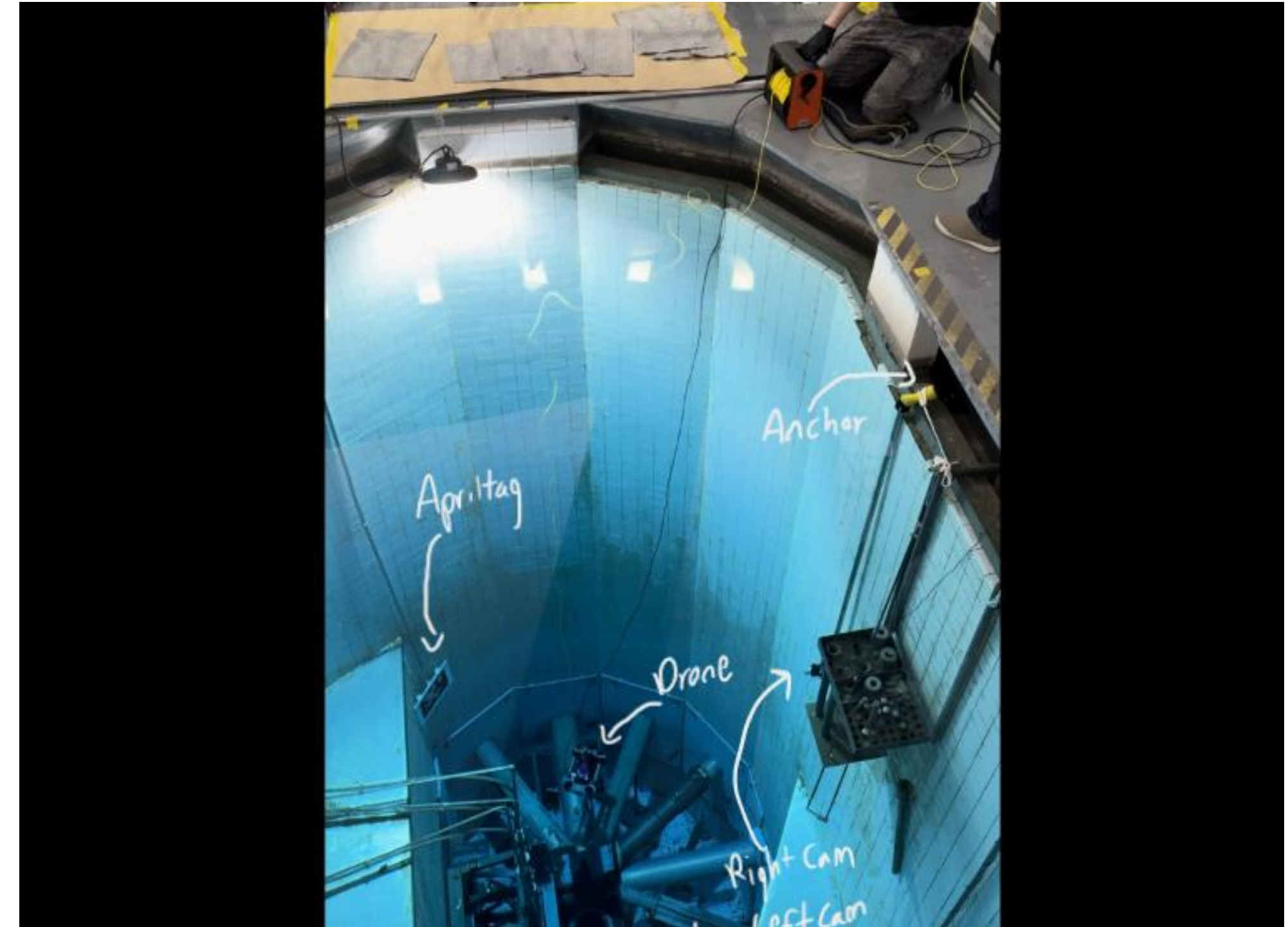
EXPERIMENTAL SETUP

IN WATER

- Conduct experiment in actual work area in water
- Move underwater ROV to each corner of the thermal column
- Compare known dimensions with system readings
- **480p Cameras Used**

Hiccups during Experiment:

- Proposed 1080p Cameras for underwater use failed during use.
- Pivoted to lower quality cameras



EXPERIMENTAL RESULTS

Out of Water:

- Error found to be x: 1.1cm, y: 1.8cm, z: 4.4cm

In Water:

- Error found to be 21cm in all directions

What Does This Mean:

- The greatest error was found in determining depth of the system.
- Lower camera quality leads to a greater error in position detection



FUTURE DEVELOPMENT

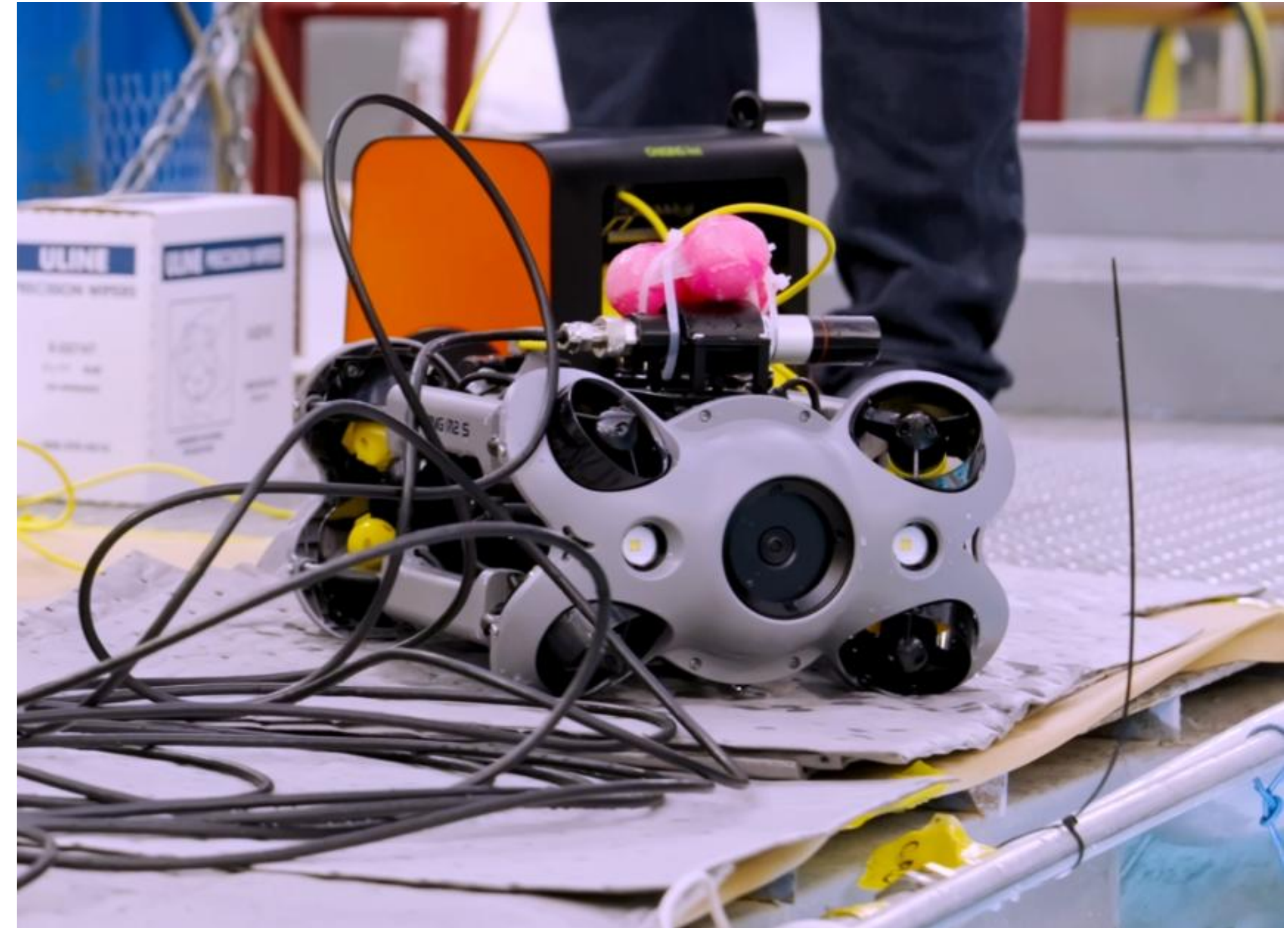
FUTURE APPLICATIONS AND IMPROVEMENTS

Future Improvements:

- Get better quality underwater cameras
- Include additional cameras to increase survey area

Future Applications:

- Incorporate system in out of water uses
- Expand use throughout facility





Thank you!

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