Future Robotic Residents in Experimental Caverns

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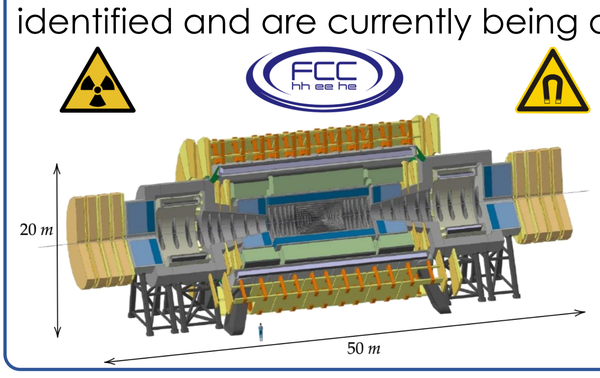
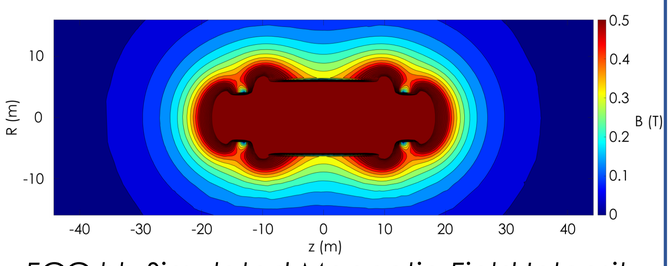
INTRODUCTION

EP-R&D WP4 Robotics for Detector is devoted to introducing robotic systems in **future high energy physics experiments** to assemble, maintain, inspect, and operate particle detectors. These robotic systems will have to deal with the **harsh cavern environment** characterized by high **radiation** levels and **magnetic field** intensities. To achieve this goal the robots will be initially deployed for cavern inspection, alarms verification, and environmental mapping, even during beam run. Several **mobile platforms**, both **ground** and **aerial,** with **specific payloads** have been identified and are currently being developed.



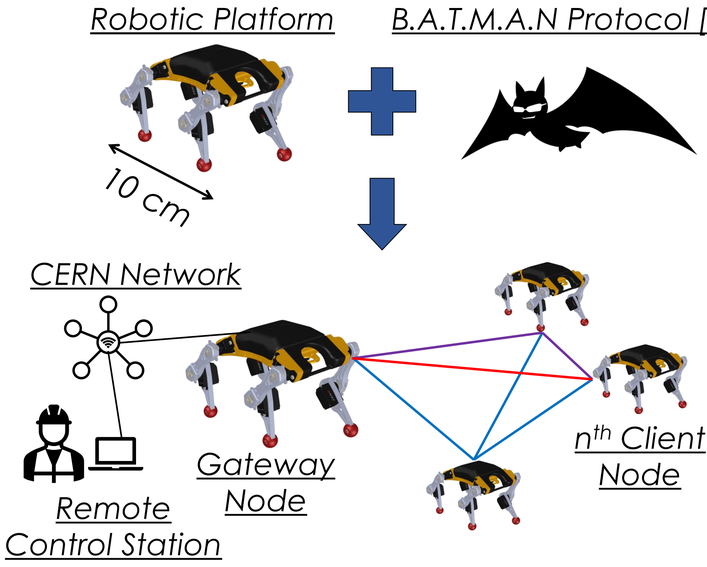


FCC-hh Simulated Magnetic Field Intensity

MOBILE AD-HOC MESH NETWORK

To inspect **confined spaces** and detect leaks or anomalies in between intricate detector services that have triggered alarms, there is the need to use a **swarm** of small robots (few centimetres in size). Within these areas, CERN network is usually unavailable;
therefore, a **mobile mesh network** protocol is under development to guarantee an uninterrupted and **efficient communication** within the swarm and between the swarm and the remote operator.

Robotic Platform *B.A.T.M.A.N Protocol [1]*

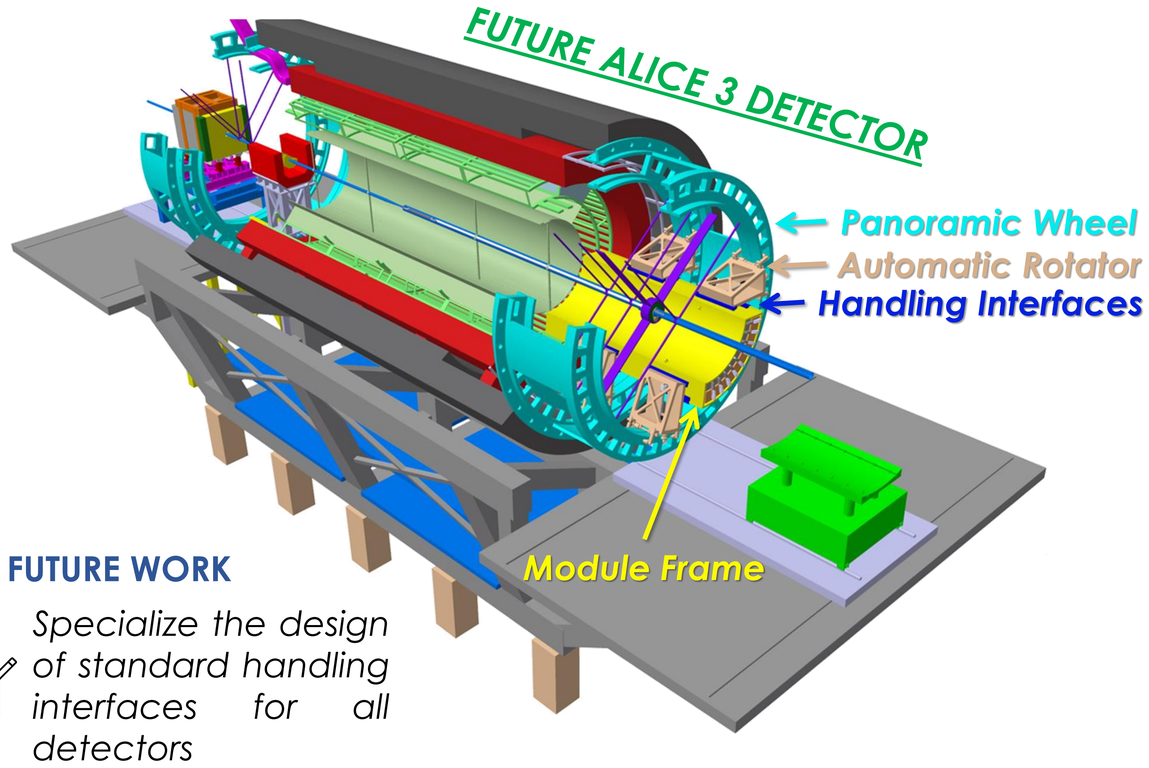


FUTURE WORK

- *Develop Automatic Gateway Failover Reconfiguration of the Network*
- *Test the network in a detector cavern confined space.*

AUTOMATIC DETECTOR INSTALLATION

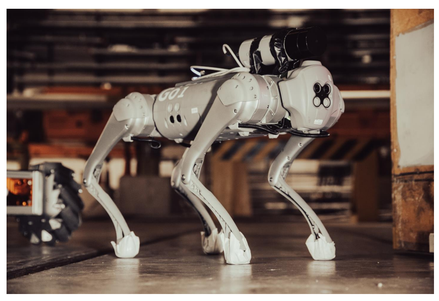
The employment of a **Global Robotic Detector Handling System** using **Standard Handling Interfaces** would ensure a **fast and safe access to the detector**, guaranteeing, for instance, a **quick, precise, and controlled installation.**



FUTURE WORK

Specialize the design of standard handling interfaces for all detectors

ROBOTIC QUADRUPED

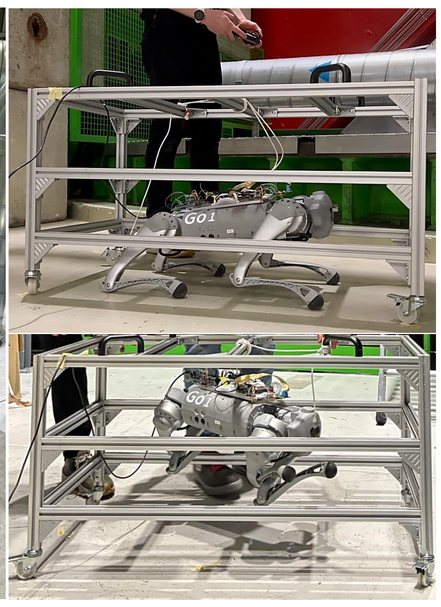


Robotic quadrupeds would allow an **automatic** and **on-demand inspection** and **monitoring** of the **harsh cavern environment**, patrolling it **even during the beam run**.
Given their high payload, they can be equipped with a **wide variety of sensors** and even a **robotic arm** to perform minor interventions.

Mobility Test in a Detector Cavern



Cavern Background Magnetic Field Test



FUTURE WORK

- *Develop motor shielding solutions*
- *Integrate payload*
- *Control model with magnetic disturbance*

BLIMPS

The robotic airships project focuses on the **design, development**, and **test** of an autonomous **flying robotic system** tailored specifically for **inspection** and environmental **mapping** [2].

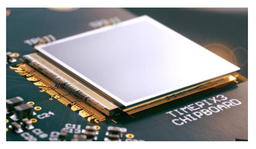


Test of the first teleoperated blimp prototype in the ALICE Cavern.

PROJECT GOALS

Mission & system
Software & Hardware
Validation and test

PAYLOAD



Radiation Sensor TimePix 3 (EP-R&D WP-1)



Magnetometer (EP-R&D WP-8)



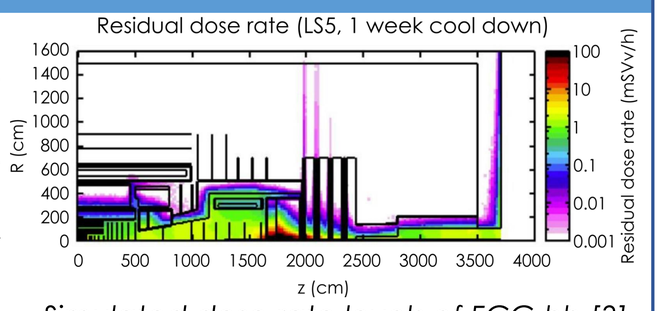
Cameras

FUTURE WORK

- *Build a fight software simulator*
- *Test the first autonomous blimp*

CONCLUSIONS

The employment of these robotic solutions promises to streamline the processes, reduce personnel exposure to radiation, increase the beam run time, and constantly monitor the detector right functioning, detecting anomalies at an early stage.



Simulated dose rate levels of FCC-hh [3]

Future work will focus on the investigation of radiation effects on the robotic systems and on the elaboration of common solutions to mitigate them.

REFERENCES

[1] https://www.open-mesh.org/projects/open-mesh/wiki
[2] https://doi.org/10.3389/frobt.2023.1238081
[3] https://cds.cern.ch/record/2651300

SCAN ME