ARCHER

Autonomous Robot platform for CHaractERization

Bert Van Den Broeck
Magics Instruments NV

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economie
FPS Economy, S.M.E.s, Self-employed and Energy

MAGICS®

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- MAGICS Instruments
- ARCHER
  - Industrial demand
  - Project scope
  - Robot overview
  - Challenges
  - Status

About MAGICS Instruments

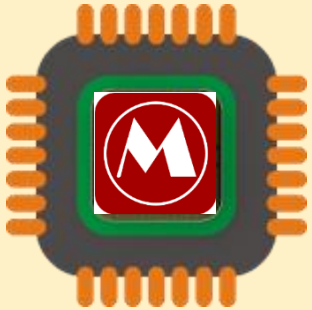
- MAGICS Instruments NV
  - Belgian high-tech company who specialized in
    - Rad-hard electronics
    - Robotics
    - Machine learning
  - Spin-off company from:
    - **KU Leuven** (Europe's most innovative university ranked by Reuters, 2018) and
    - **SCK•CEN** (the largest research institute in Belgium for nuclear technologies, nuclear medicine, and astronautics).

Mission

- Developing technologies to create intelligent and reliable machines for harsh environments
- Support mankind in exploration of other habitable planets and in accessing new resources (e.g., energy, food, and key elements) for our sustainable future.

- MAGICS is achieving this by leveraging its expertise in semiconductor chip design, machine learning, and radiation-hardening.

MAGICS activities



Rad-Hard ASIC development

"Customized radiation hardened systems-on-chips"

Smart Nuclear and Space robotics

"Closed-loop control systems for intelligent remote handling"

Intelligent sensing and machine learning

"Real-time monitoring to enable predictive maintenance"

Portfolio of world-renowned customers:

SCK•CEN STUDIECENTRUM VOOR KERNENERGIE CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

oxford technologies

FUSION FOR ENERGY

TECNUBEL Your project needs our care

amec foster wheeler

iter china eu india japan korea russia usa

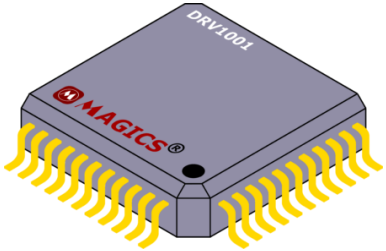
VEOLIA

ENIM

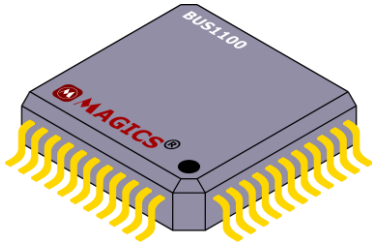
engie

IRID International Research Institute for Nuclear Decommissioning

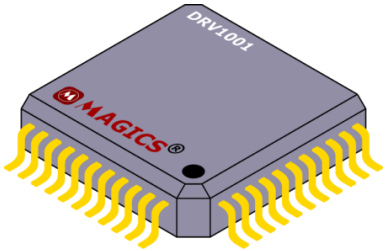
Featured rad-hard ASICs



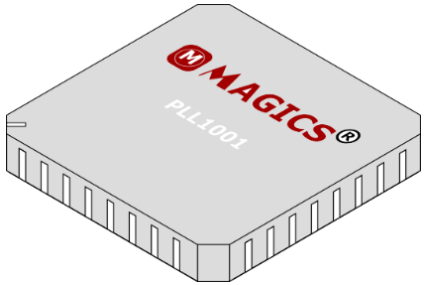
10-channel relay driver



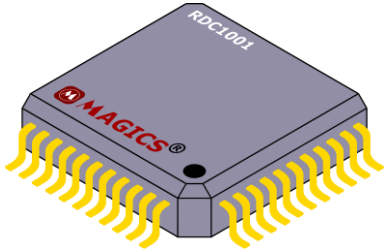
Digital BUS interface



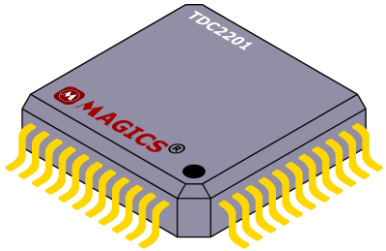
10-channel limit switch sensor



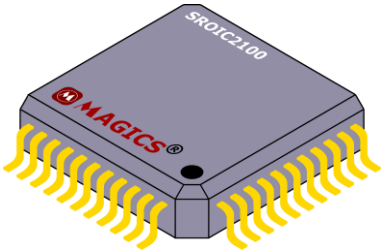
Frequency synthesizer



Resolver/LVDT
to-digital converter



DC-DC buck converter
5V-12V in; 1,2V-5V out



Resistive bridge sensor
signal conditioner

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Industrial demand

Decommissioning of nuclear plants

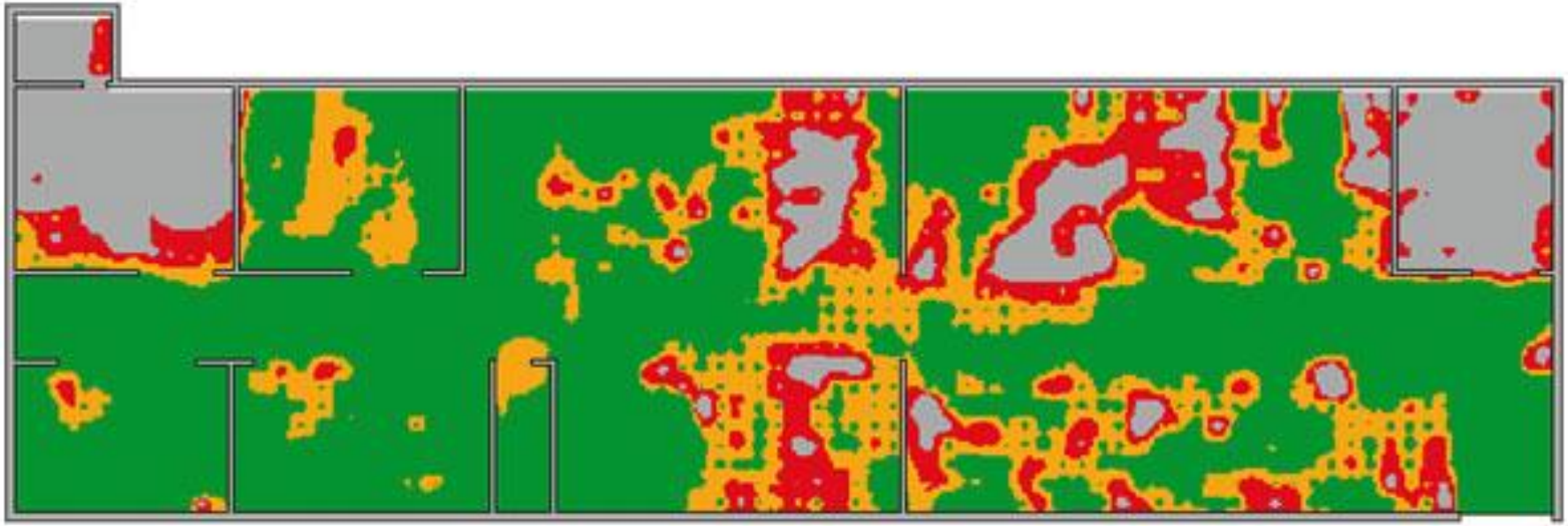
- Of the 160+ retired power reactors [1]:
  - at least 17 have been fully dismantled
  - over 50 are being dismantled
  - over 50 are in Safstor
  - three have been entombed
  - for others, the decommissioning strategy is not yet specified

1) https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/decommissioning-nuclear-facilities.aspx

Industrial demand

Radiologic mapping of the plant is one of the first steps in decommissioning

- Provide insights on decommissioning strategy



Industrial demand

Radiologic mapping of the plant is one of the first steps in decommissioning

- Currently manually measured
  - Human exposure
  - Measuring errors

Industrial demand

Radiologic mapping of the plant is one of the first steps in decommissioning

- Often hard-to-reach places

Industrial demand

- Currently low-tech equipment is used for repetitive measurements
  - Dose rate measurements
  - Characterization measurements

  - Atmospheric contamination
  - Surface contamination

  Industrial demand for a more automated method

Project scope

- ARCHER is:
  - Research
  - Design
  - Development
  - Build
- Of an Autonomous Robot platform for CHaractERization

Project scope

ARCHER = Autonomous Robot platform for CHaractERization

- ARCHER can fully automate measurements
  - Reduce human exposure
  - Increase measurement accuracy
  - Cover hard-to-reach places (pipes etc.)

Project scope

ARCHER = Autonomous Robot platform for CHaractERization

- ARCHER leverages state-off-the-art techniques in:
  - Robotics
  - Radiologic measurements
  - Radiation-hardened electronics

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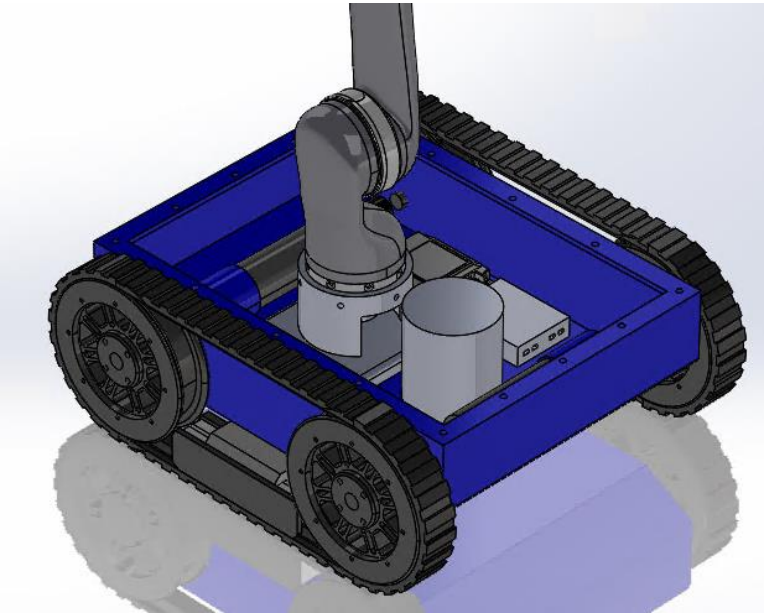
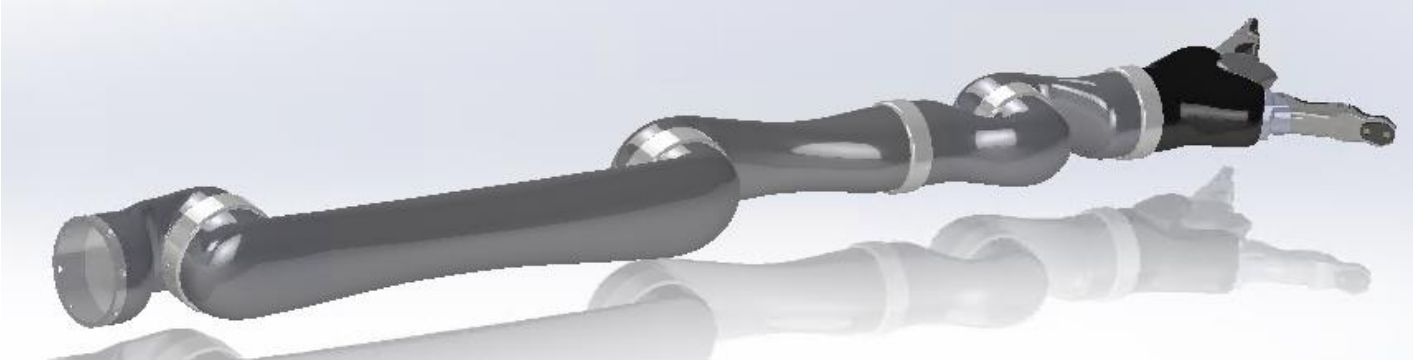
Robot overview

- Small robotic platform to reach narrow spaces
  - ~30x30x15cm

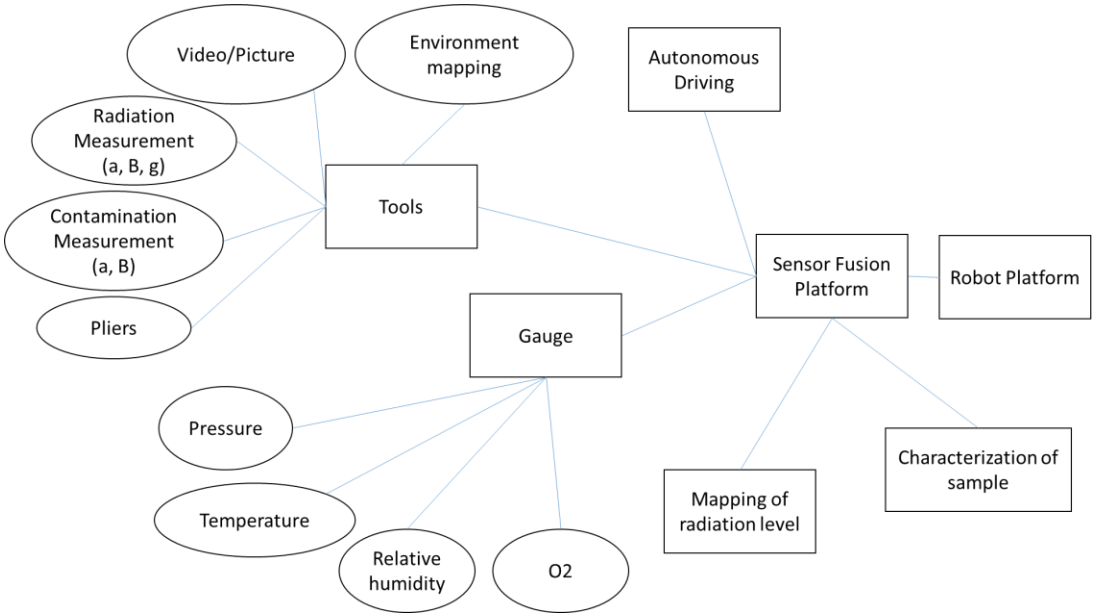


- Robotic arm to reach far and manipulations



Robot overview

- Large collection of onboard sensors and actuators:
  - Radiologic measures
  - Automated navigation
  - Automated remote handling



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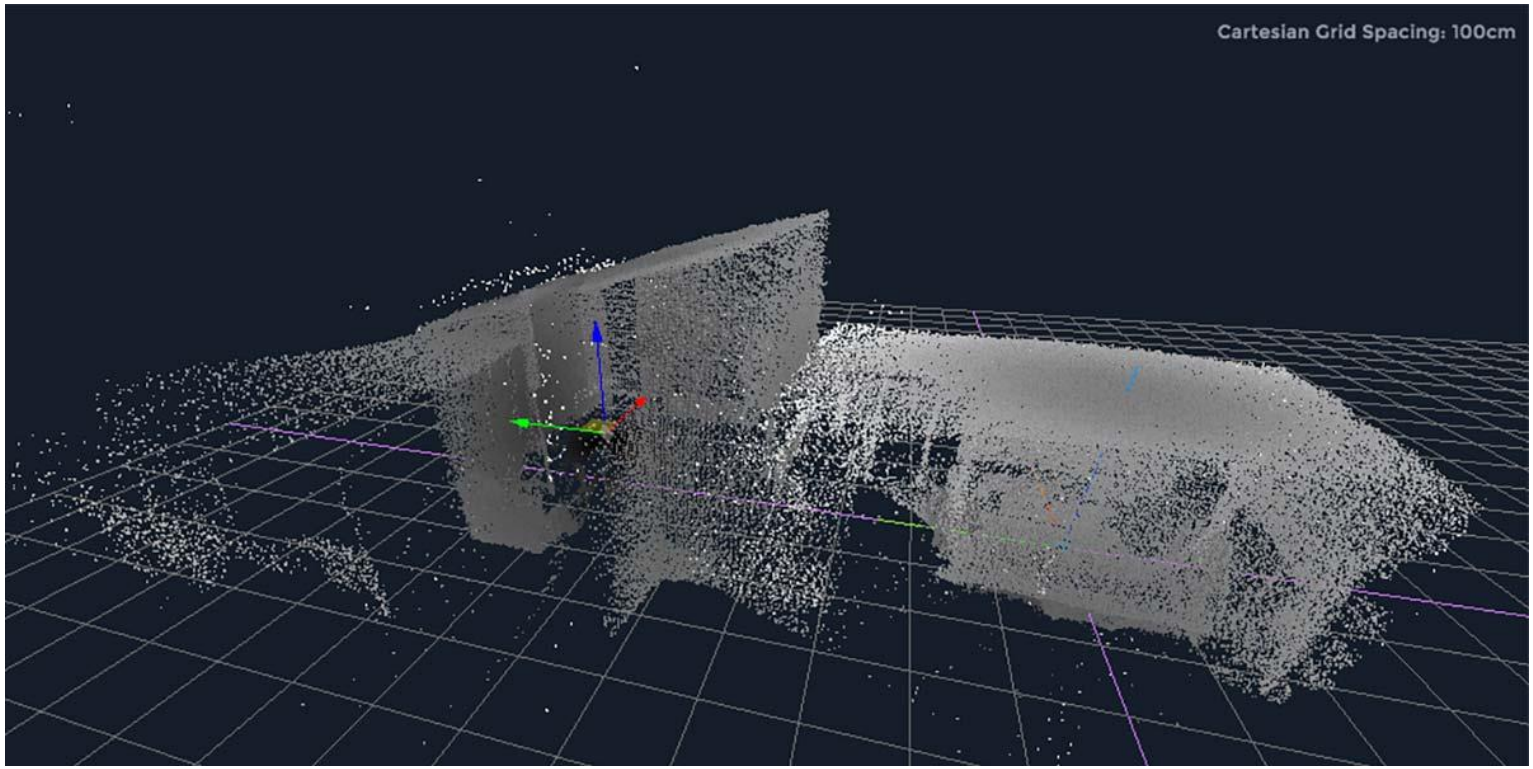
Challenges

- Robotic navigation precision in SLAM*



* Simultanious Localization And Mapping

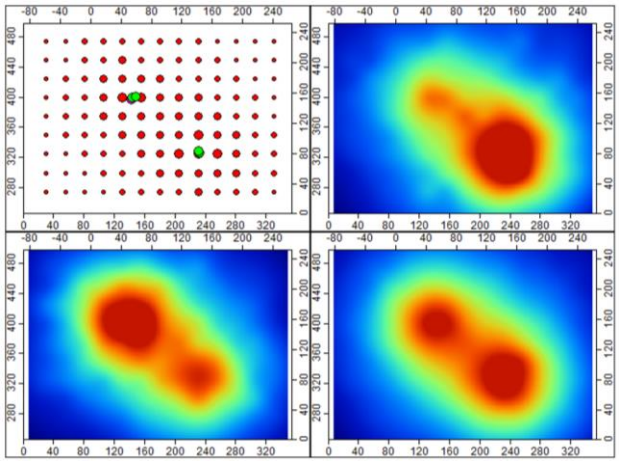
Challenges

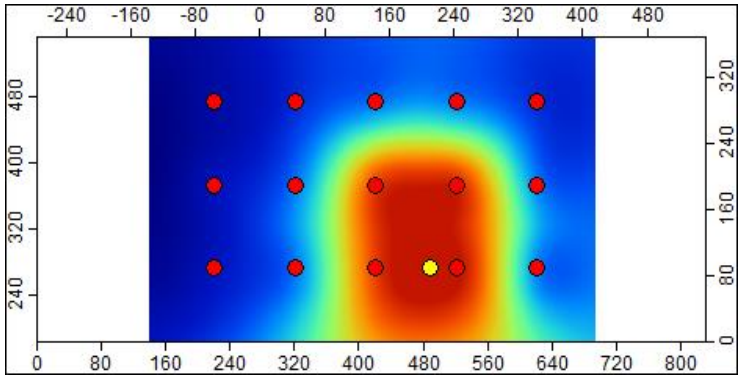
- Robotic navigation precision in SLAM*

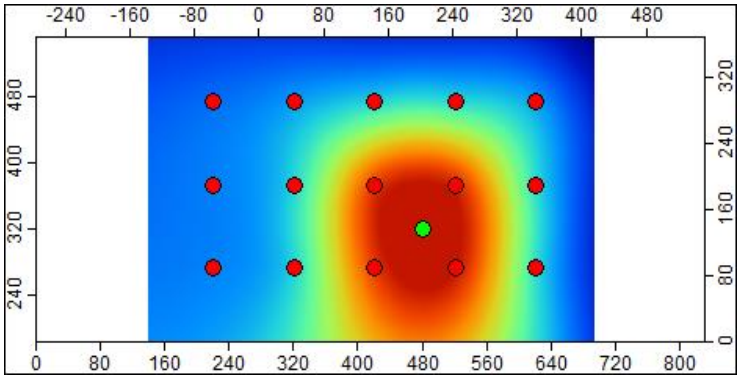
* Simultanious Localization And Mapping

Challenges

- Optimal scanning pattern/measurement techniques for radiologic mapping

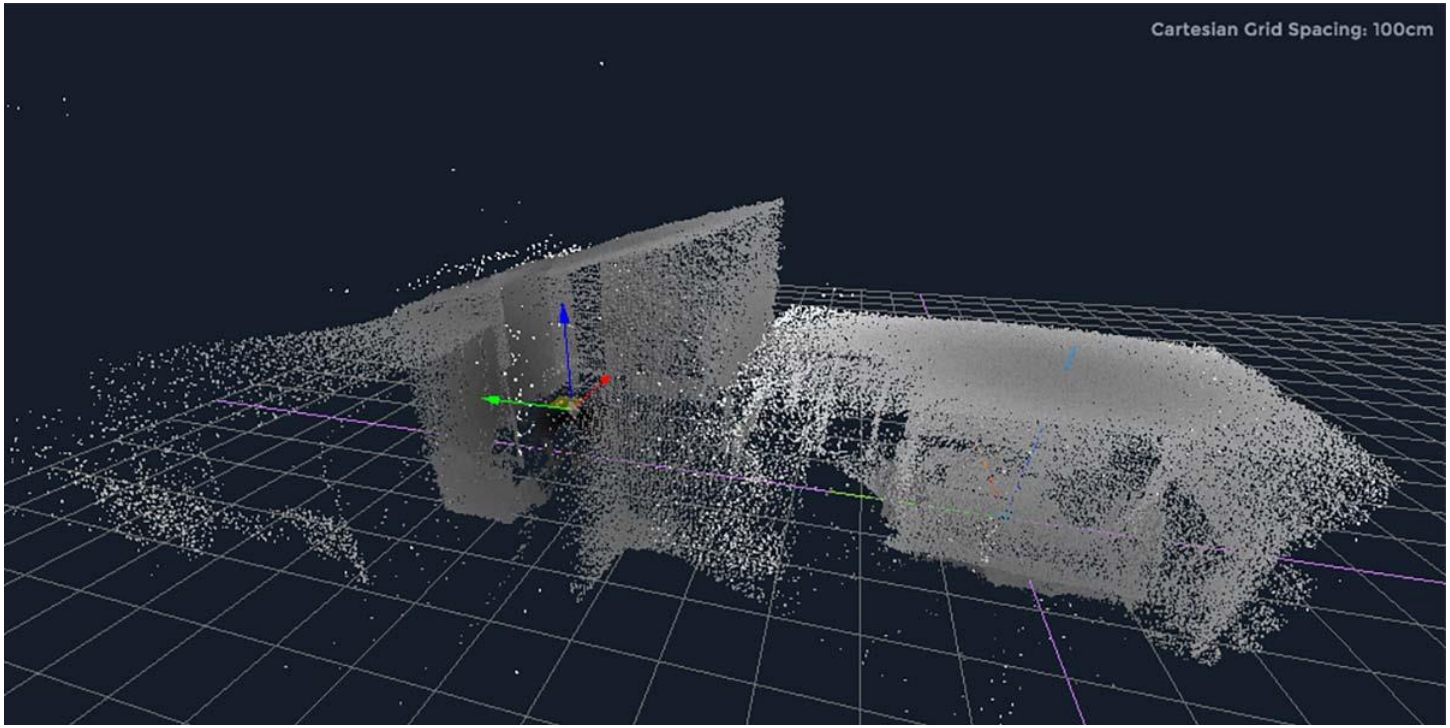






Challenges

- Radiologic measurements as input for SLAM



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Challenges

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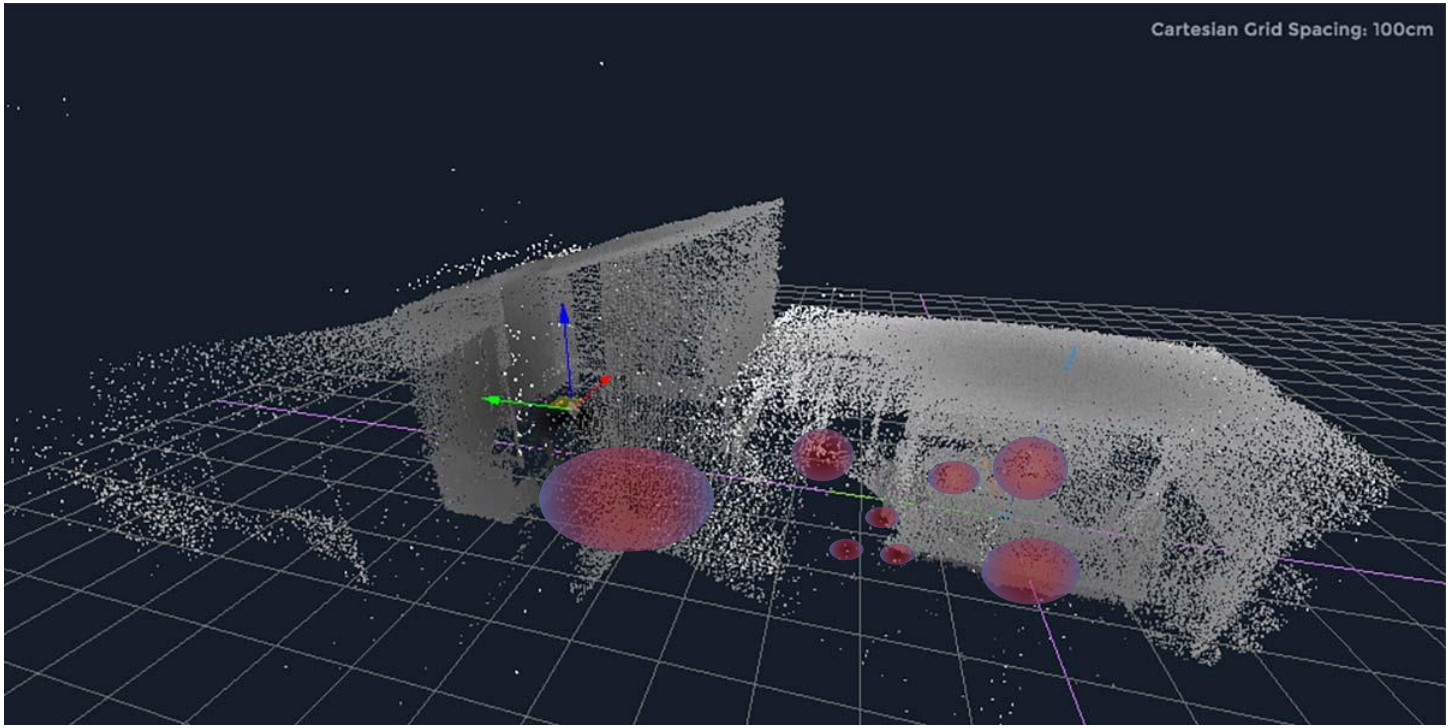

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Status

- Finished
  - Mechanical design
  - Sensor platform
- Ongoing research
  - Robotic mapping and navigation
  - Robotic mapping and navigation through radiologic measurements
  - Radiologic mapping
  - Compton camera