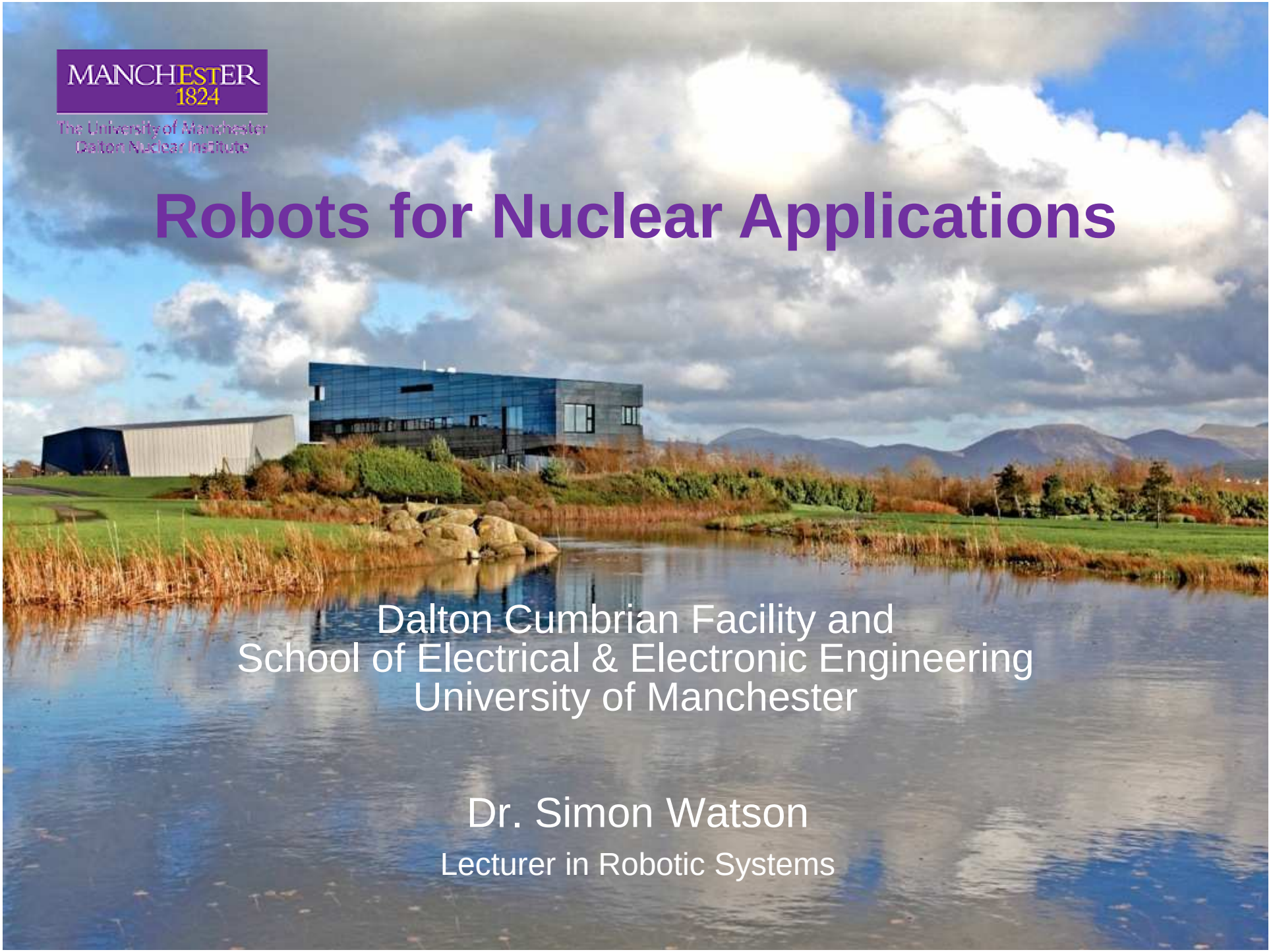


Robots for Nuclear Applications

Dalton Cumbrian Facility and
School of Electrical & Electronic Engineering
University of Manchester

Dr. Simon Watson

Lecturer in Robotic Systems

MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

National Importance

Decommissioning in UK is estimated to cost £115bn over the next 100 years

Sellafield costs account for >£80bn and conservative estimates suggest that robotic systems could reduce costs by 10%

Expected investment in UK nuclear new build is approximately £70bn by 2030

The University of Manchester
Dalton Nuclear Institute

Investment in Nuclear Robotics

The Government has put significant investment into nuclear robotics research in the last 12 months through the Industrial Strategy Challenge Fund

- Robotics for Nuclear Programme Grant
  - Universities of Manchester, Birmingham and West of England
- National Centre for Nuclear Robotics (Hub)
  - Universities of Birmingham, Bristol, Edinburgh, Essex, Lincoln, West of England, Lancaster University, Queen Mary University of London
- Robotics and Artificial Intelligence for Nuclear (Hub)
  - Universities of Manchester, Oxford, Liverpool, Sheffield, Nottingham, Lancaster, Bristol and the UKAEA's RACE centre

MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

AVEXIS

AVEXIS™

Aqua **V**ehicle **EX**plorer for **I**n-situ **S**ensing

- Designed to be deployed through 150 mm access ports.
- Water pumps provide 4 degrees of freedom
- Contains camera and radiological sensors.
- External vision-based localisation system

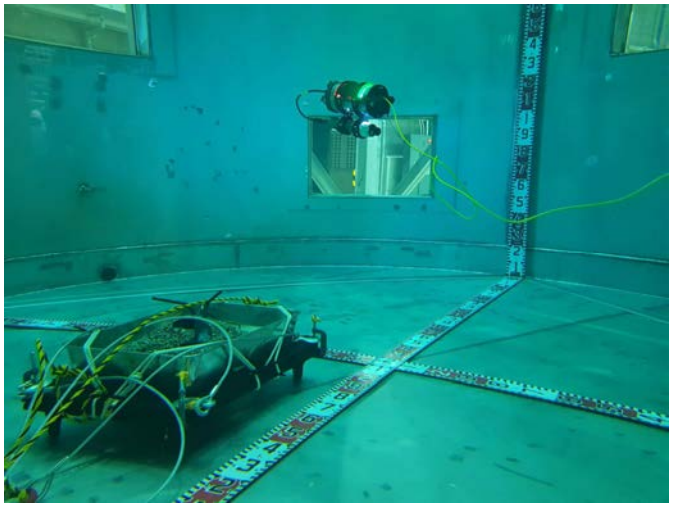
MANCHESTER 1824
The University of Manchester

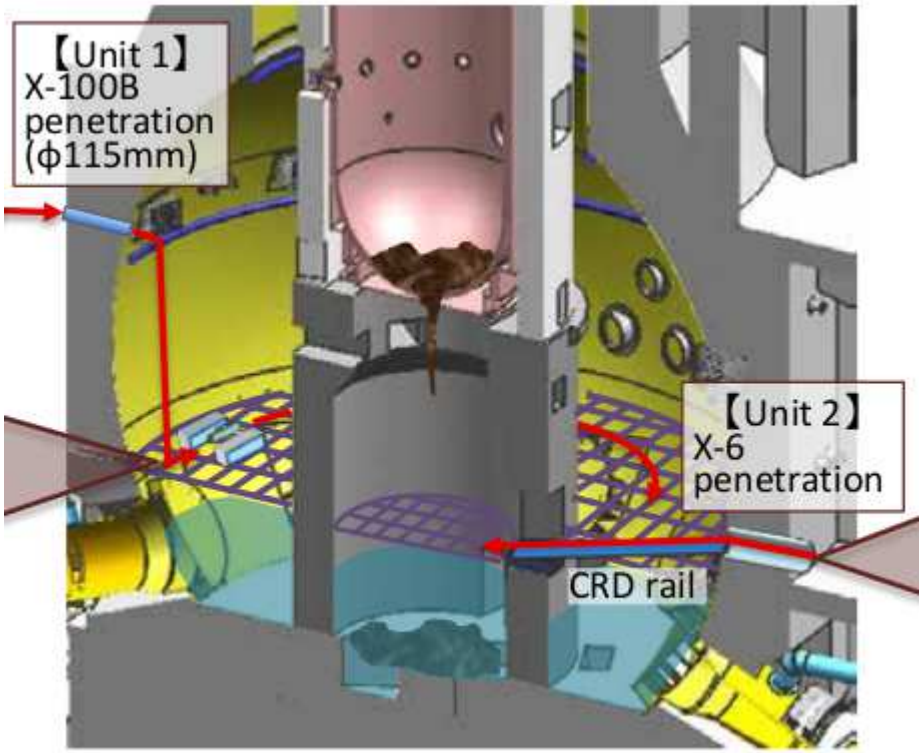
MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

AVEXIS

AVEXIS™ Fukushima

- AVEXIS has been equipped with neutron and gamma detectors (Lancaster) and sonar (NMRI) to help locate fuel in the Fukushima reactors.





MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

FORTH engineering

AVEXIS

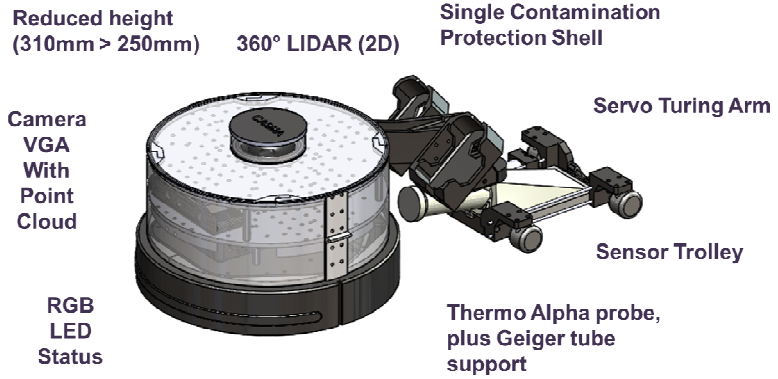
AVEXIS™ Sellafield Deployment

The University of Manchester
Dalton Nuclear Institute

CARMA

Continuous **A**utonomous **R**adiation **M**onitoring **A**ssistant

- Based on a commercially available Turtlebot 2 robot
- Fitted with alpha and gamma radiation sensors
- Uses the ROS architecture



MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

MIRRAX

MIni **R**obot for **R**estricted **A**ccess e**X**ploration

- Designed to be deployed through 150 mm access ports.
- ‘Snake’ design allows the robot to curl up so that it can maneuver up / down steps.
- Once deployed it will build a 3D map of an area, overlaid with radiometric information.

MANCHESTER 1824
The University of Manchester

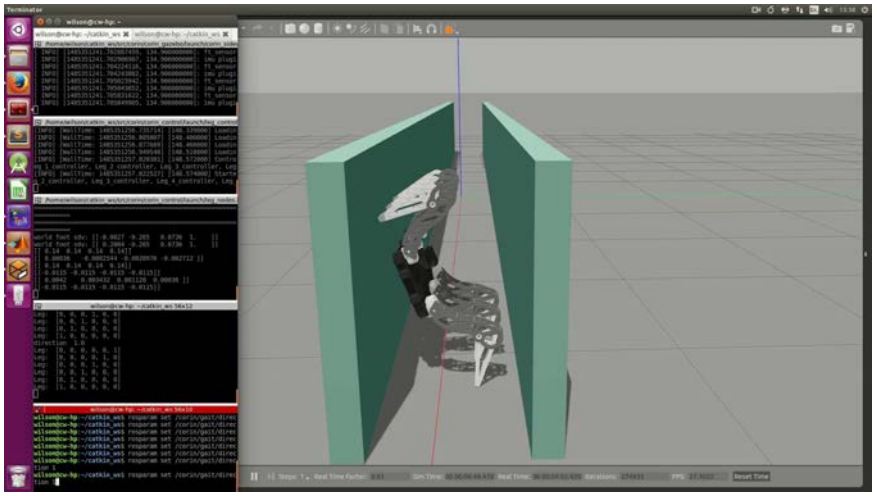
MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

CORIN

CORIN is a hexapod designed for characterisation of nuclear storage facilities.

The primary focus of the research is navigation in confined spaces

MANCHESTER 1824
The University of Manchester

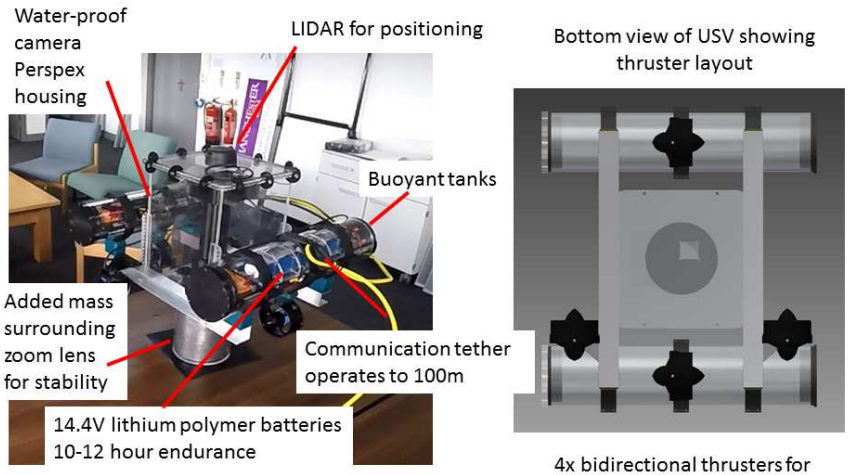


The University of Manchester
Dalton Nuclear Institute

MALLARD

The MALLARD is a surface inspection vehicle for storage pond monitoring.

Prototype Small USV: MALLARD



Max speed: 0-2m/s
Can be limited to 1-3cm/s

Bottom view of USV showing thruster layout

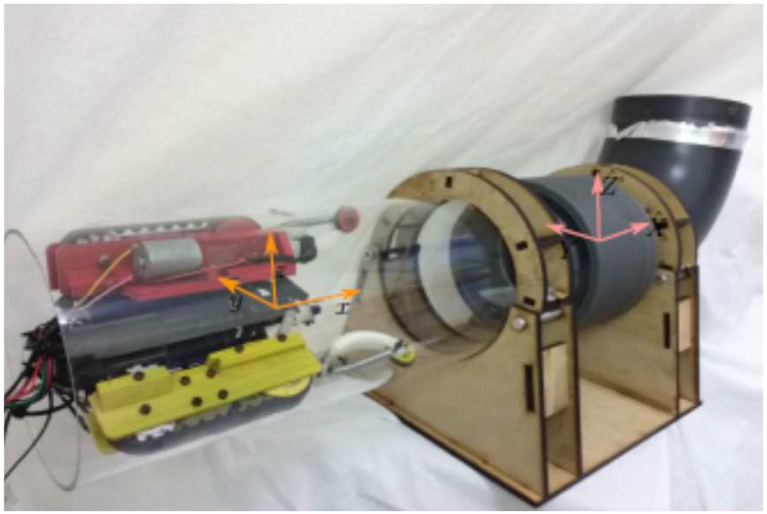
4x bidirectional thrusters for omnidirectional movement and maintaining orientation.

MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

FURO Pipe Crawler

Remit is to design a pipe crawler able to:

- Navigate through 2” – 3” pipework
- Cope with changes in pipe diameter
- Autonomously navigate through round bends



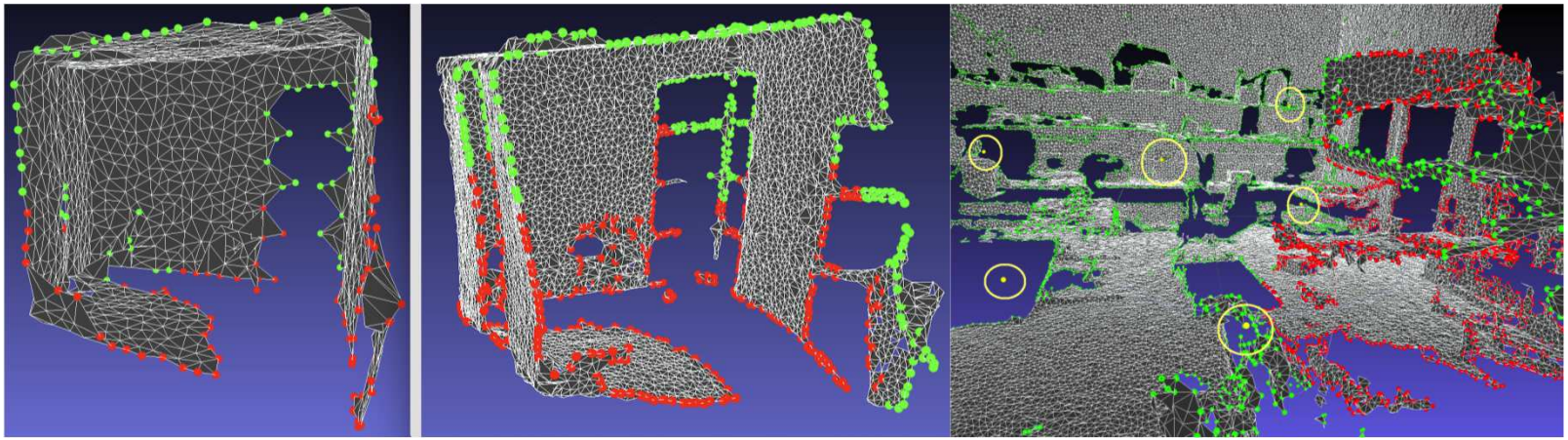
MANCHESTER 1824
The University of Manchester

MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

Void Detection in LIDAR Scans

LIDARs are often used to build geometric models of areas and for robot navigation.

Detecting voids (gaps) in the data autonomously allows the models to be completed through inference or rescanning.

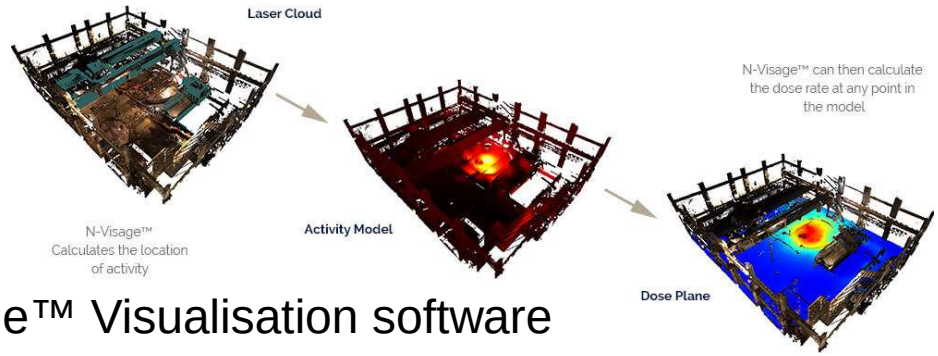


The University of Manchester
Dalton Nuclear Institute

TORONE

Total Characterisation by **R**emote **O**bservation of **N**uclear **E**nvironments

- "Total" characterisation on one platform, e.g.
  - Optical cameras and hyperspectral imaging
  - Lidar and 3D mapping
  - Thermocouples and pH monitoring
  - Gamma & Neutron detection
  - Raman spectroscopy & Laser Induced Breakdown Spectroscopy (LIBS)
- Combine all data together in software to produce a total representation



N-Visage™ Visualisation software

The University of Manchester
Dalton Nuclear Institute

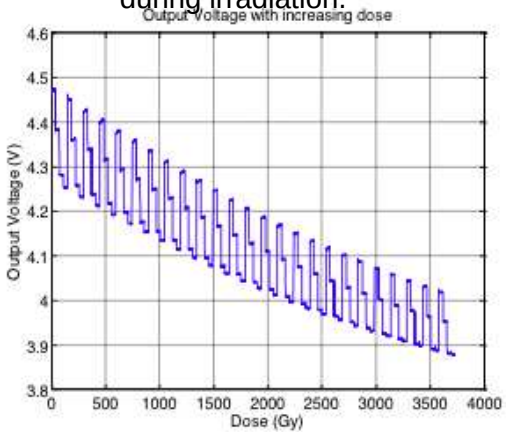
Electronic Component Testing

Work has focused on identifying susceptible components within embedded systems.

Raspberry pi, for example, was tested and found to fail after receiving a total dose of 1700 Gy.

- Recovered after annealing.

Individual components tested during irradiation.



MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

Challenges to Adoption

The primary challenge to the widespread adoption of robots in the nuclear industry is commercialisation.

The mobile robot supply chain is not well established.

UK is now the world leader in nuclear robotics research – this needs to be translated into a world leading supply chain

MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

Summary

University of Manchester has several robotics platforms:

- AVXIS Underwater Vehicle
- CORIN and LATRO Hexapods
- MIRRAX Reconfigurable Robot
- CARMA Autonomous Inspection Robot
- MALLARD Surface Vehicle
- FURO Pipe Inspection Robot
- MONA Swarm Robots

The next phase of research is to integrate sensing, and exploration technologies.

MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

Thank you…

Please visit http://uomrobotics.com for more details.

https://www.birmingham.ac.uk/research/activity/metallurgy-materials/robotics/index.aspx

http://www.brl.ac.uk/research.aspx