MAvRiC
Multi-Agent and Advanced Robotics Centre

A DfE-funded HERC State-of-the-Art Teaching and Research Facility

Dr Mark Ng, SMIEEE

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Vice-Chair, IEEE UK and Ireland Control Systems Chapter
EPSRC ILN+ Researcher in Residence with Digital Catapult

10th September 2025

Main Centrepiece

- 2x ER-FLEX Systems

  - UR5e robotic arms mounted on MiR250 AGVs

  - Arm payload ≈ 5 kg

  - Vehicle payload ≈ 180 kg

  - Operation time up to 20 hours per day

  - Automation in manufacturing and digital twinning

  - Automate lab/hospital tasks to limit human presence and reduce risk of contamination

  - Home assistance

Main Centrepiece

- 1st HEI on Island of Ireland to utilise **Collaborative Robots (Cobot) + Autonomous Mobile Robots (AMRs) Combo** for Research and Teaching*
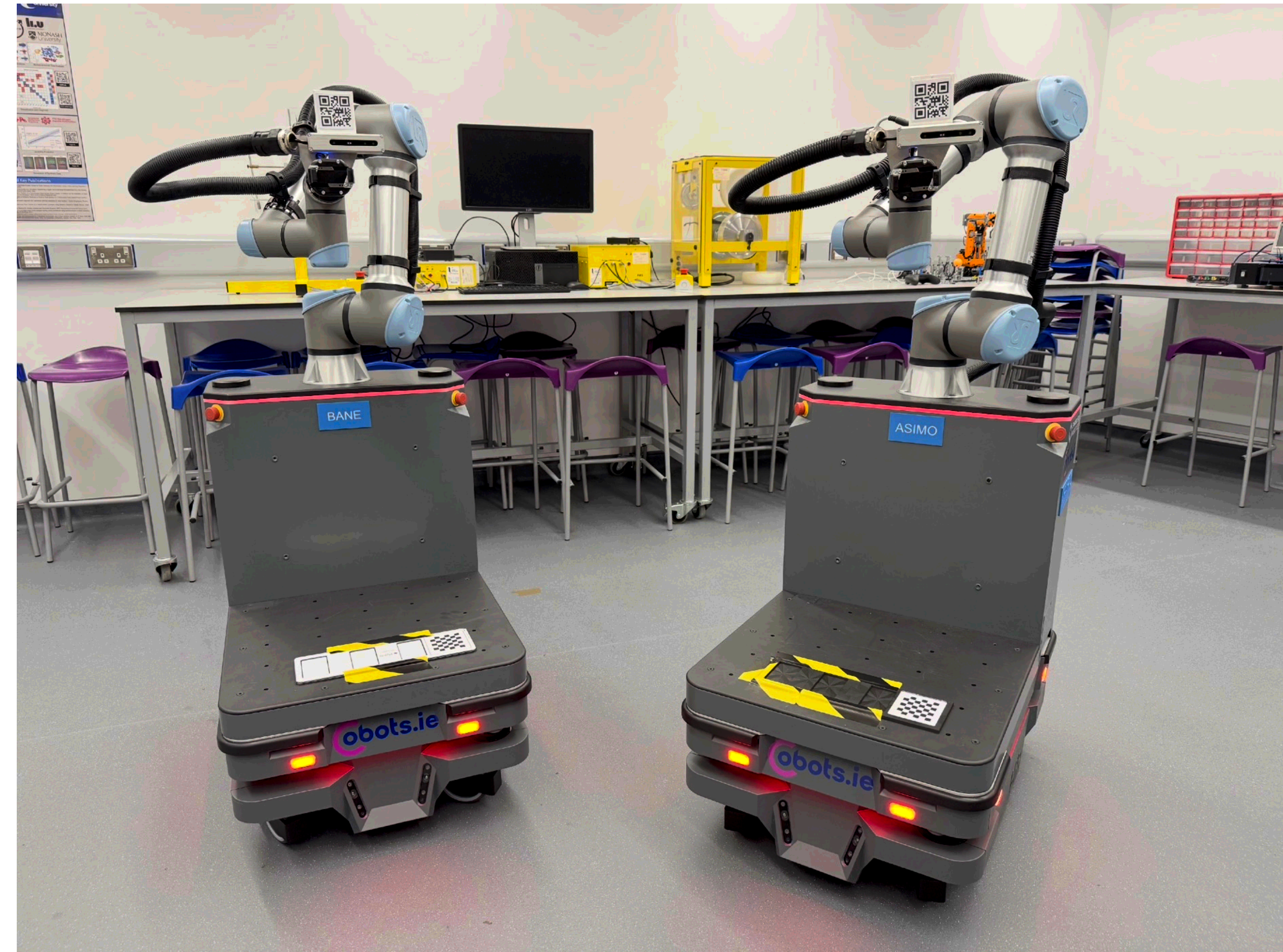
*As of June 2025

Key Equipment

- 4x Turtlebot4
  - Multi-sensor equipped AMRs
  - Max. payload ≈ 9 kg
 - Operation time: Up to 4 hours
  - LiDAR and depth camera

Key Equipment

- 3x Bambulab X1

  - Multi-Filament 3D Printers

  - 7μm LiDAR-assisted automatic calibration and inspection

  - CoreXY motion system

  - High-speed multicolor printing with AMS

 - Multi-material printing

Key Equipment

- 3x OrangeApps Robotic Arms

  - Mini KUKA-Compatible Robotic Systems

  - KUKA® OfficeLite, the virtual robot controller from KUKA®

 - Gearbox and kinematics to mimic actual industrial robots
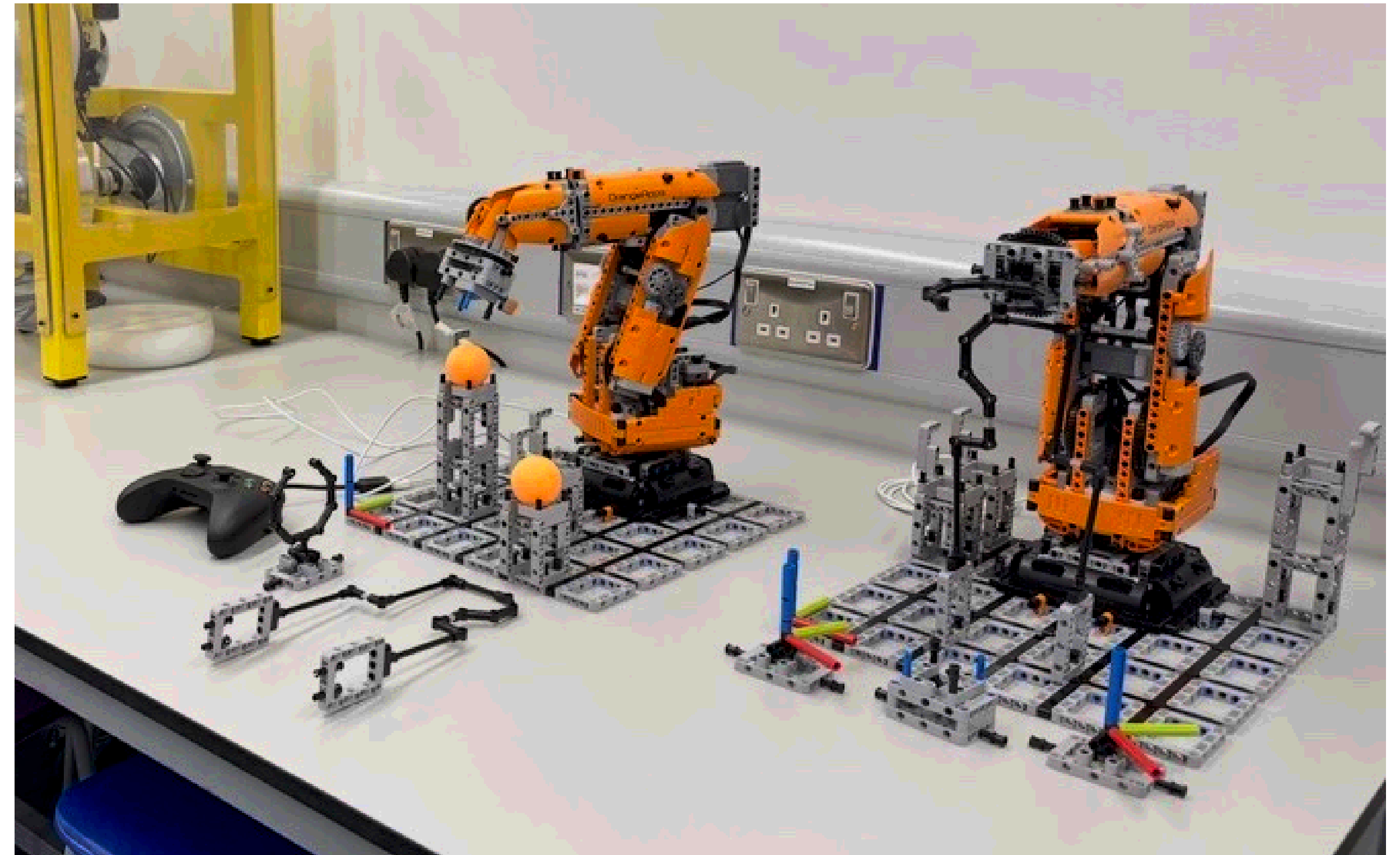
Key Equipment

- 4x MinSeg Robotic System

  - Multi-purpose advanced mini robots

  - Inverted pendulums — rockets, humanoids, etc.

  - Autonomous maneuverability

  - Real-time observation and control
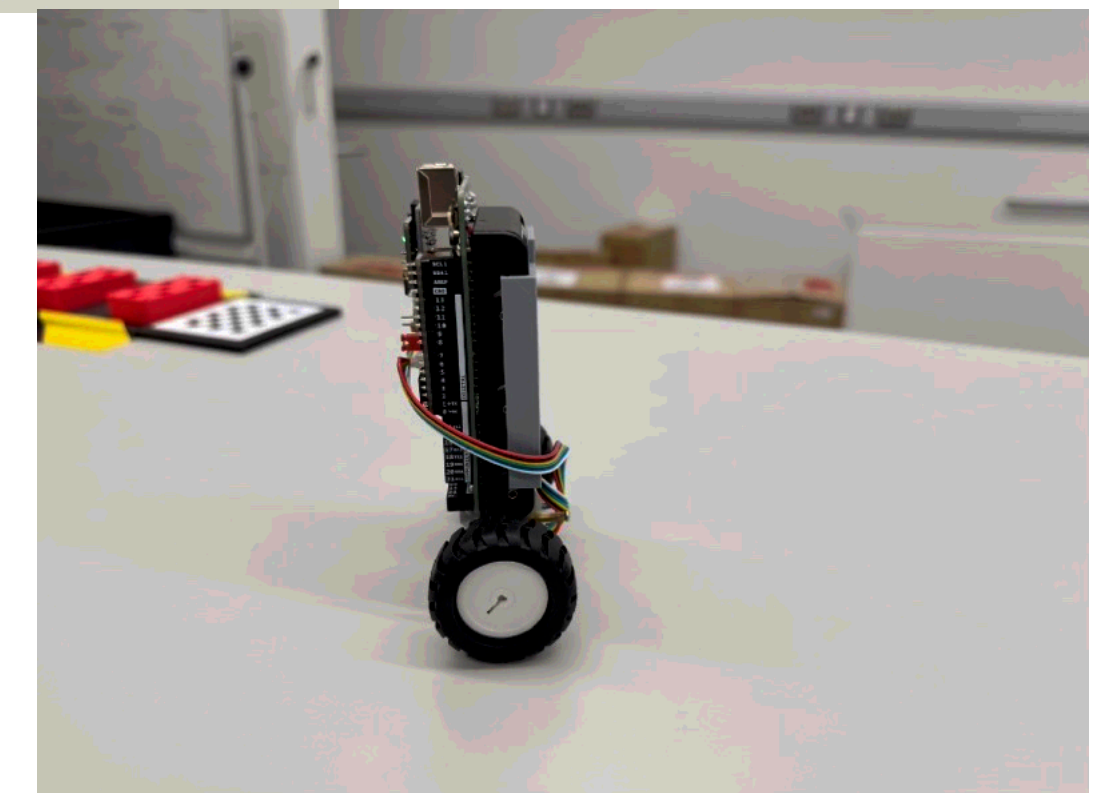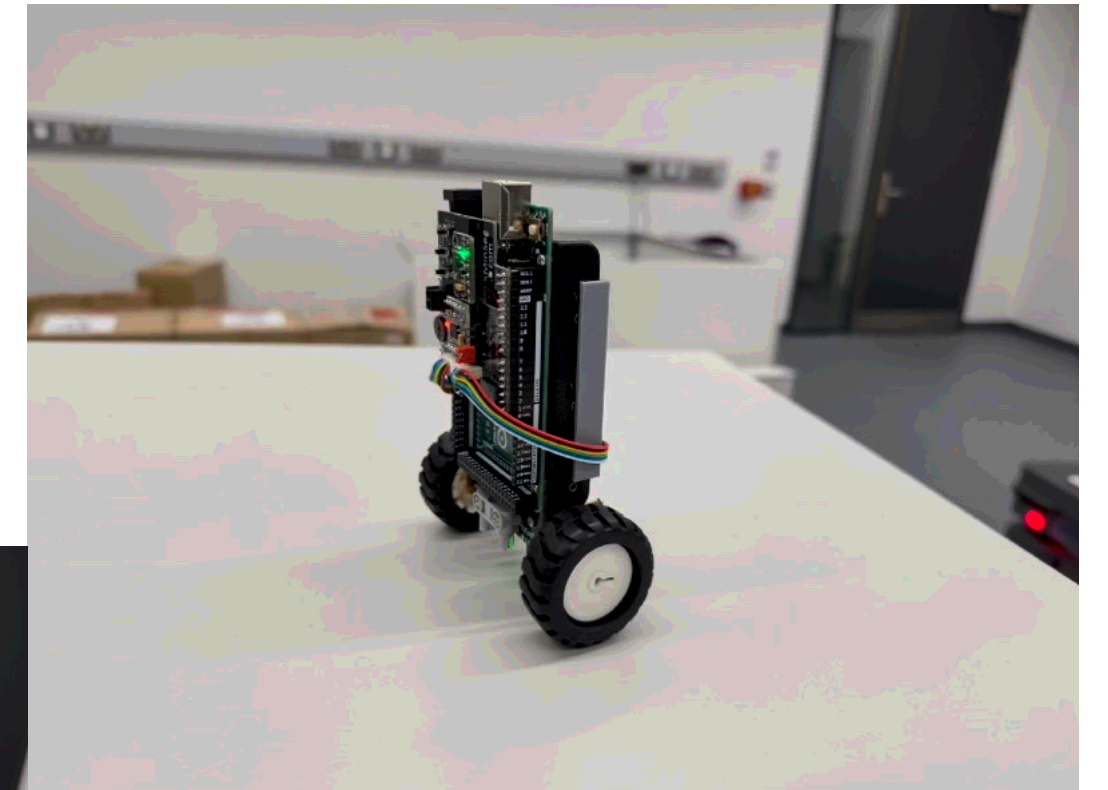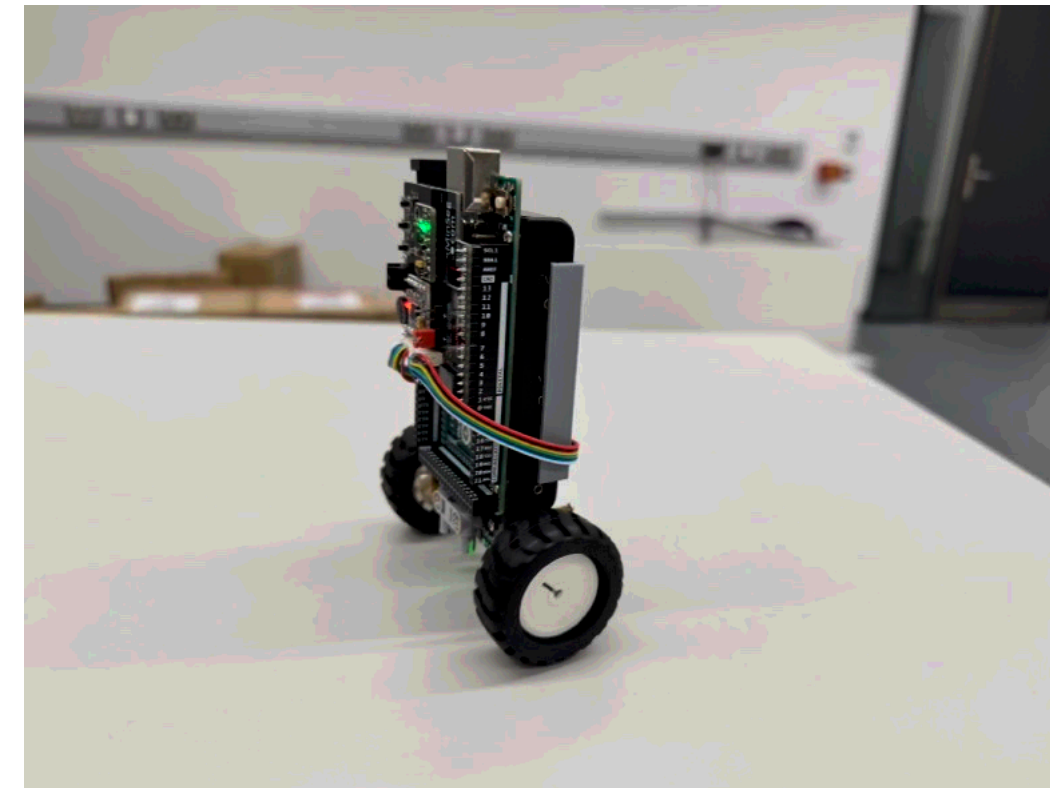
Key Equipment

- Sonotec PR 200 Combi Pulser

- Picoscope 5443D Oscilloscope

- Ultrasonic immersion and contact transducers
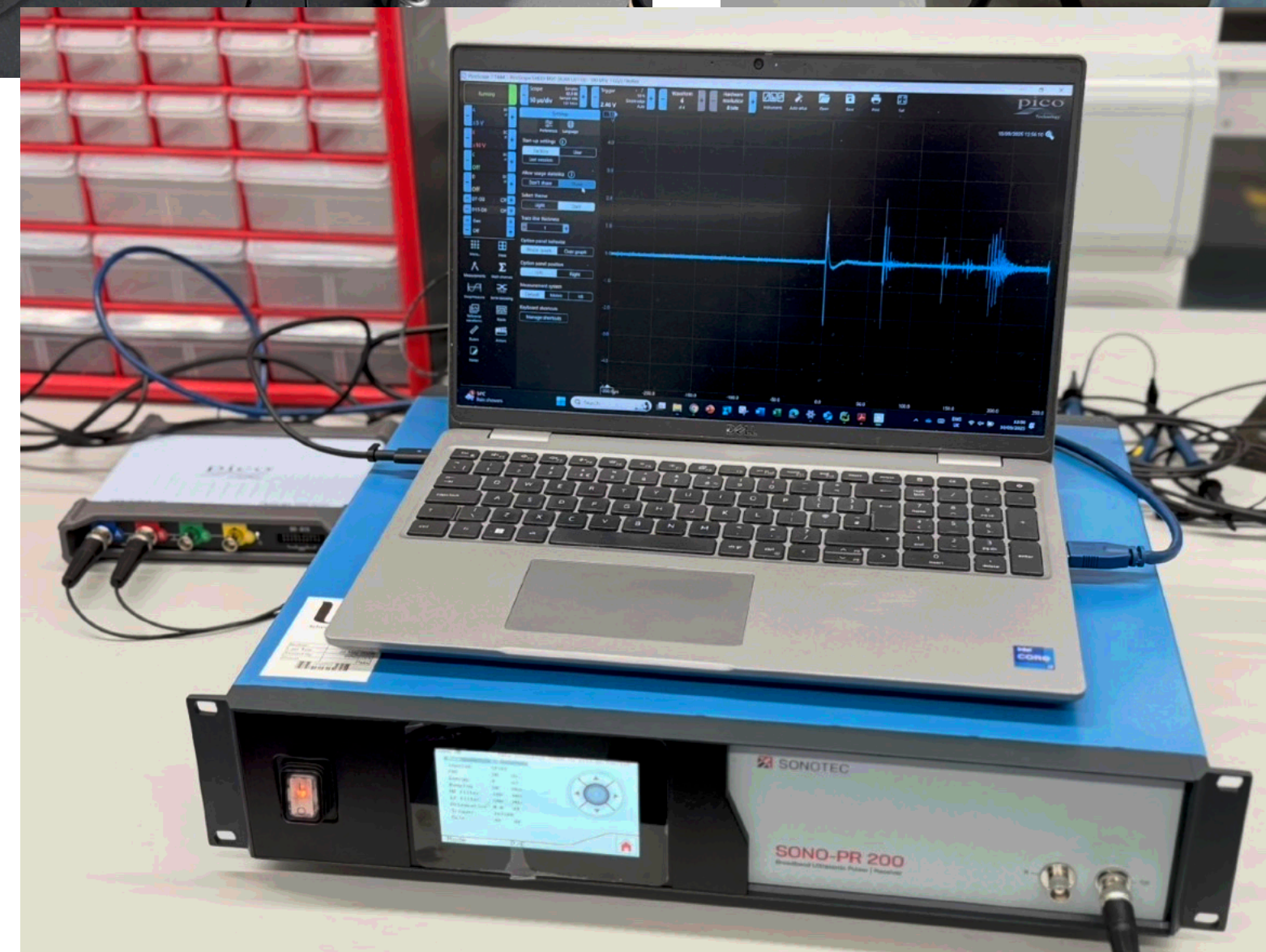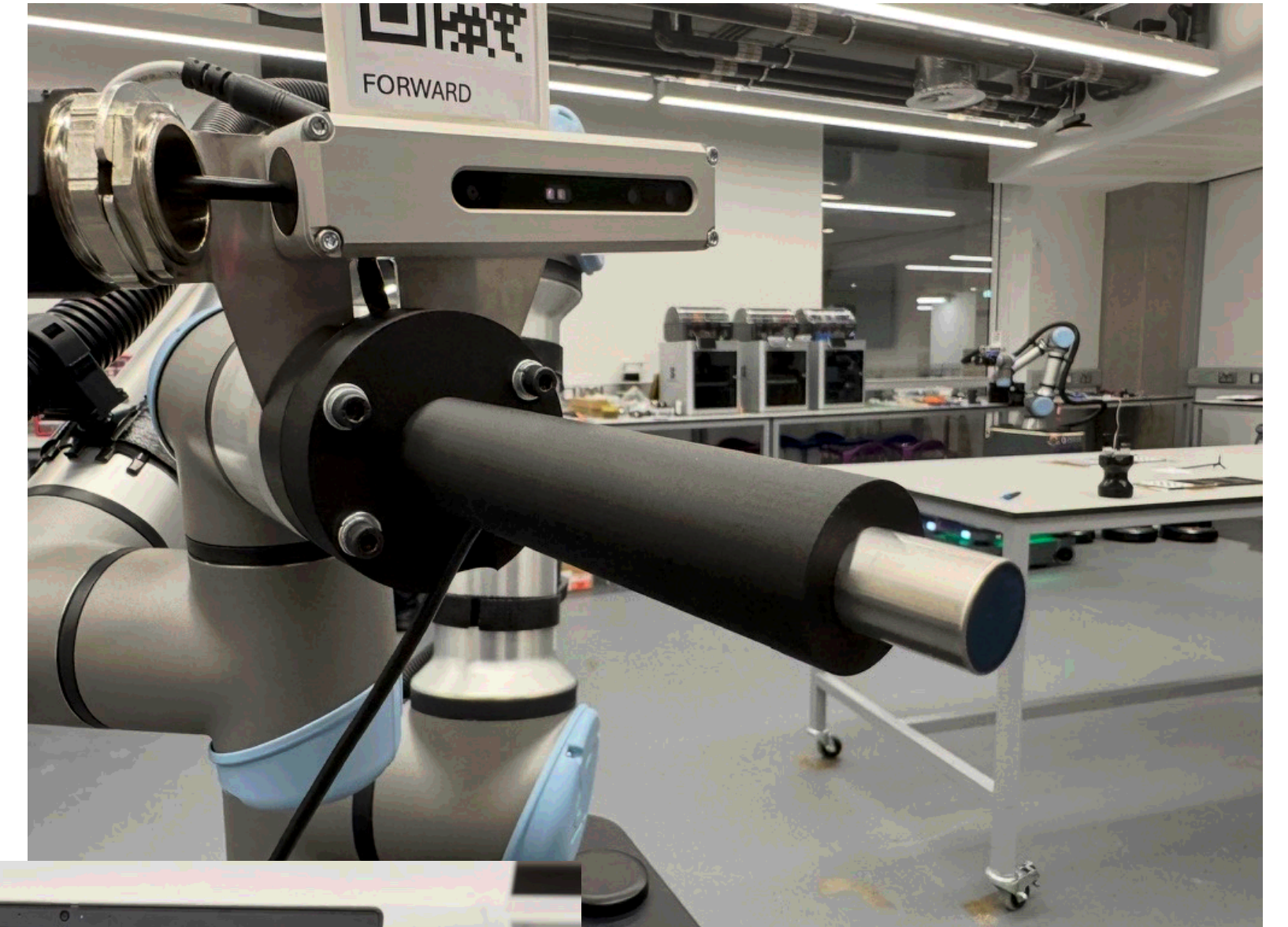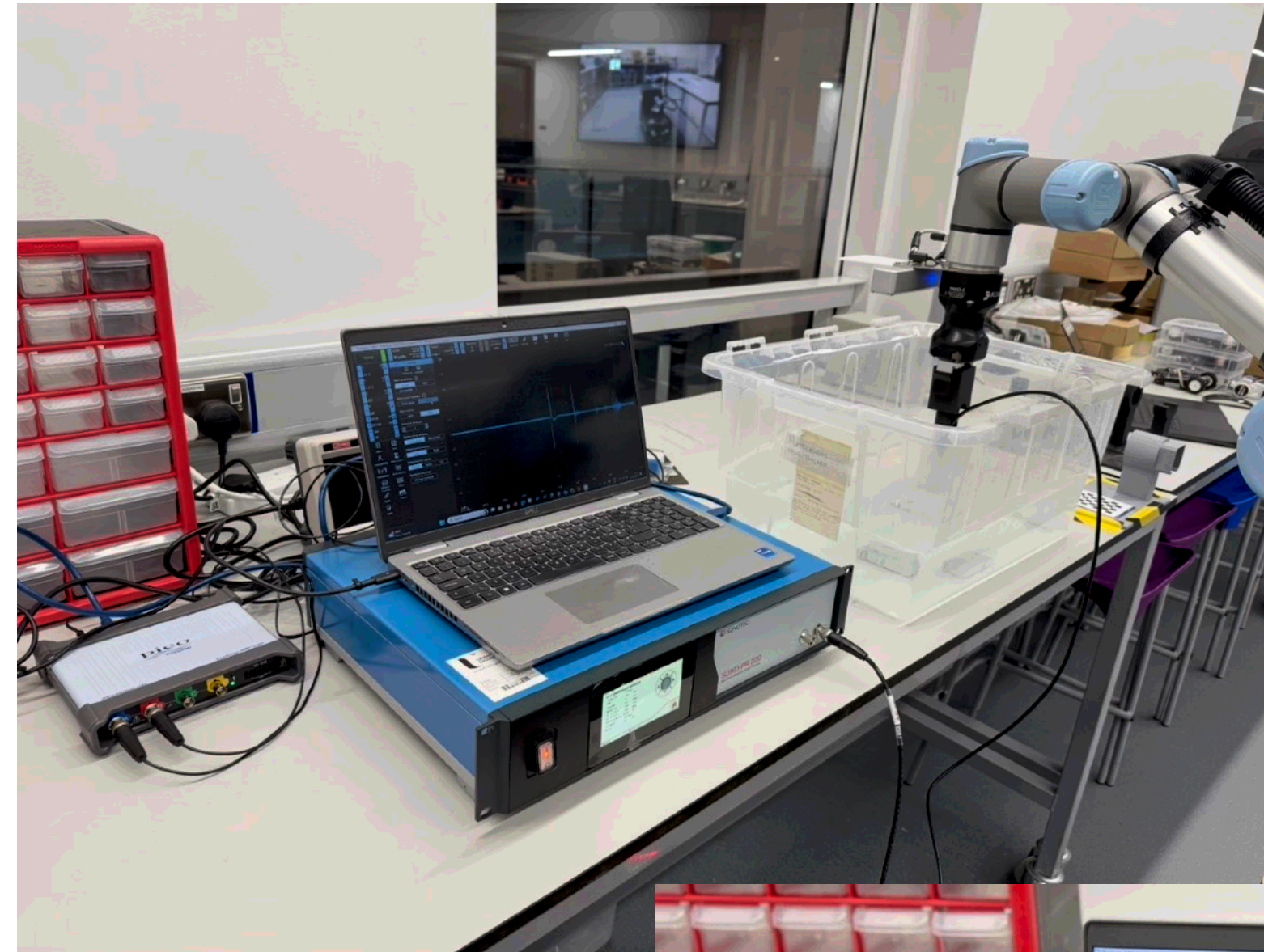
Other Existing Equipment

- Festo CP LAB
  - 6x pallet transfer system
  - 4x system trainers
  - 2x CP Bridge
  - 1x Robotino + SIM Environment
  - 2x magazine modules
  - 1x measurement module
  - 1x muscle press module
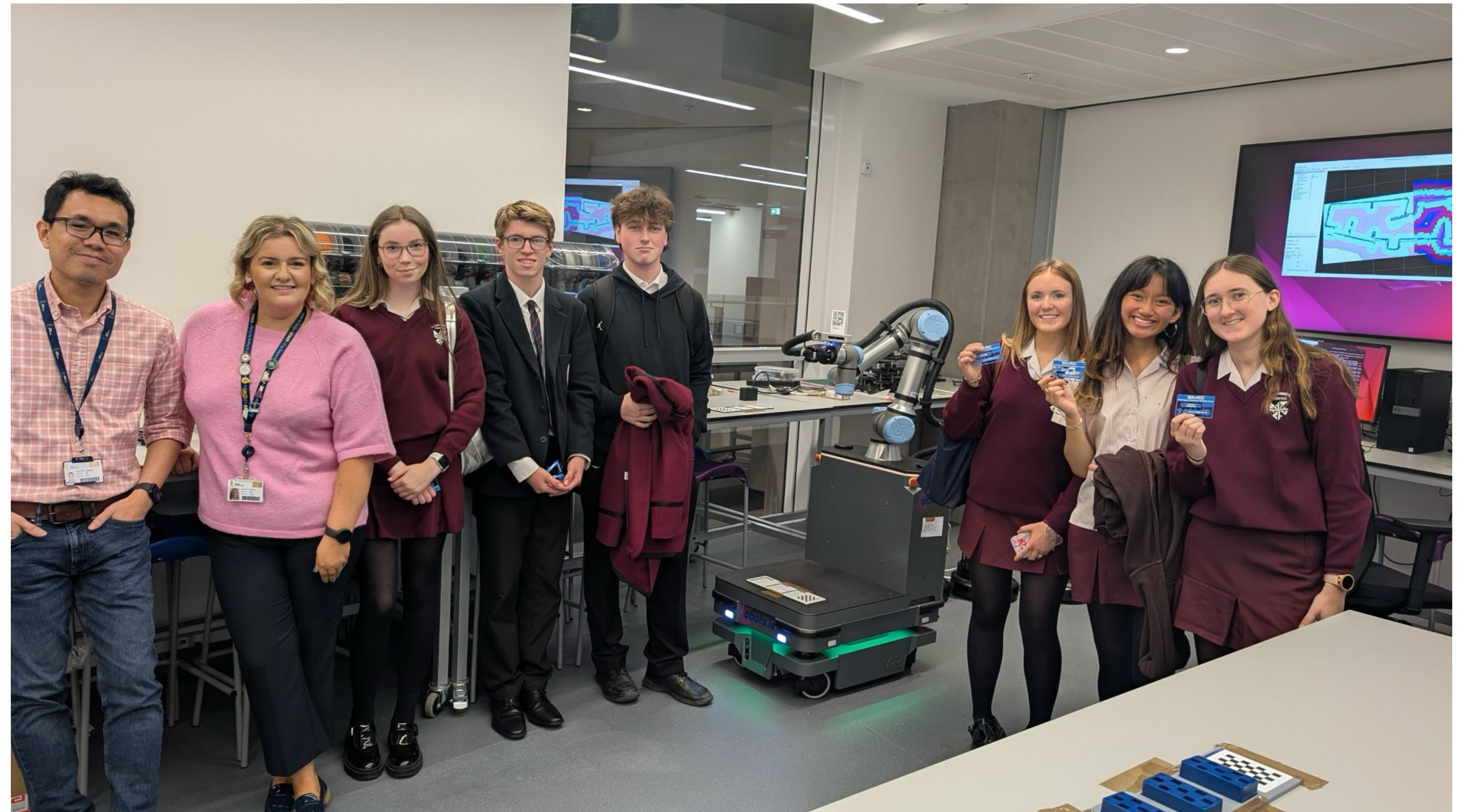 - 1x tunnel furnace module
  - 1x output module

Other Existing Equipment

- Inteco Control Systems
  - 1x helicopter system
  - 1x ABS braking system
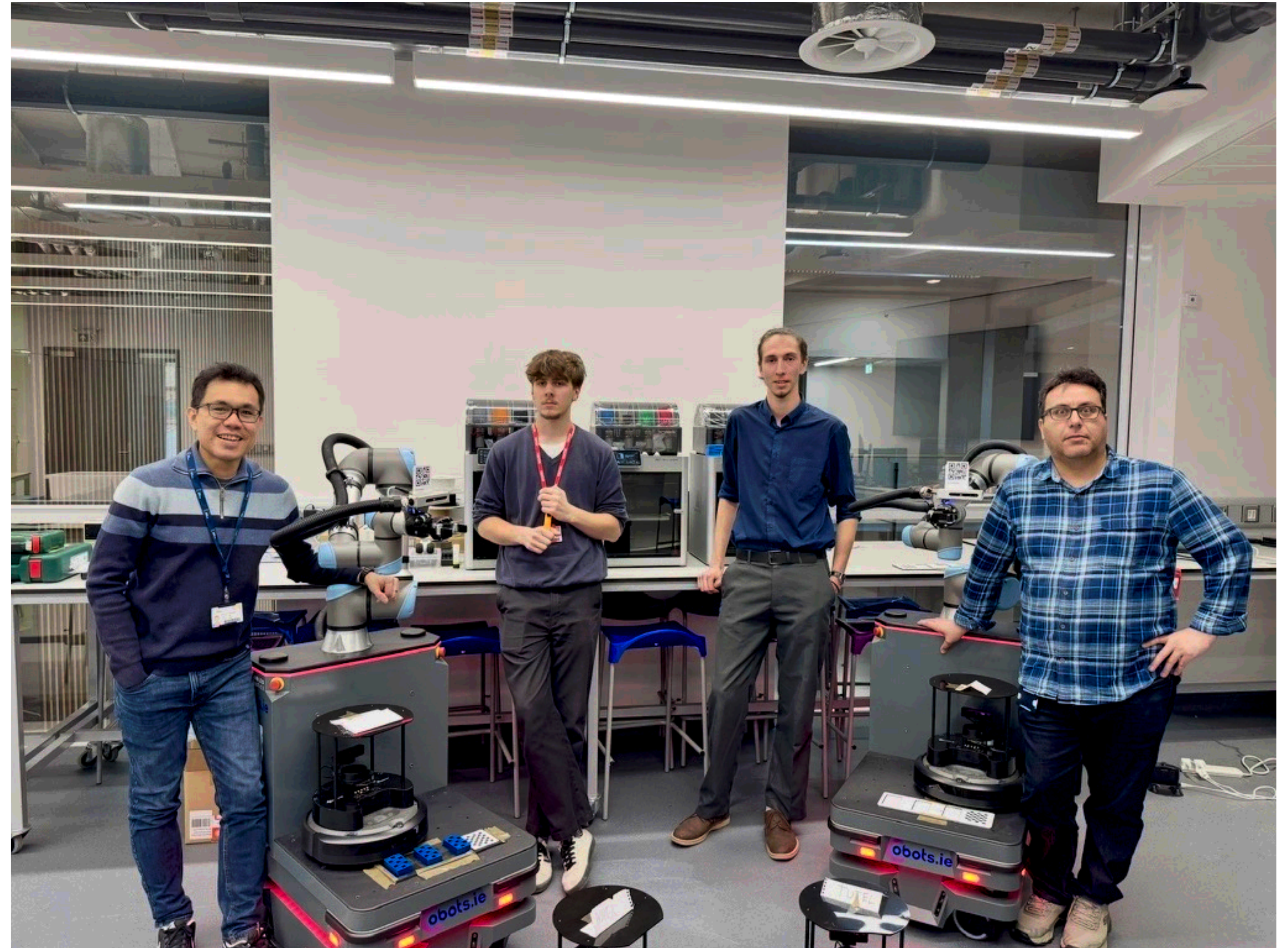
Key Achievements Thus Far...

- Outreach activities

- Encourage STEM in NI and ROI

- Produce future talents and tech-equipped workforce

  - UCAS Open Day 2025

  - East Belfast Summer School 2025
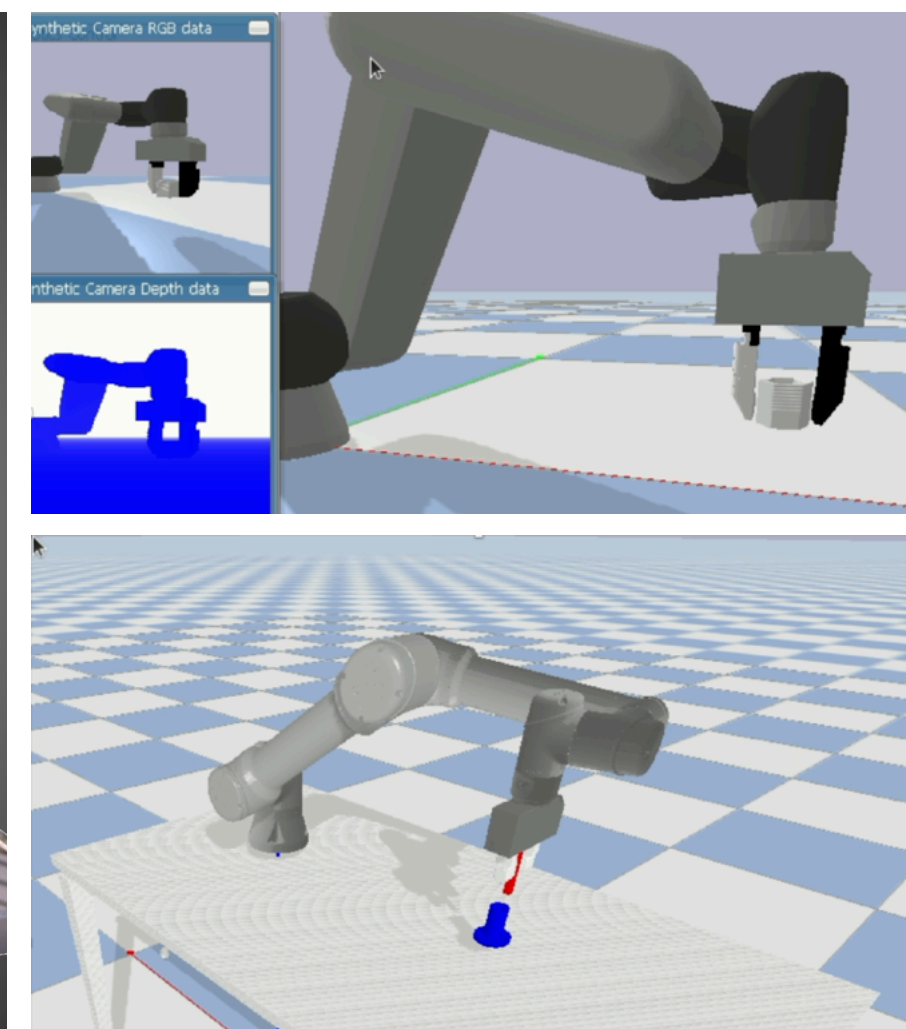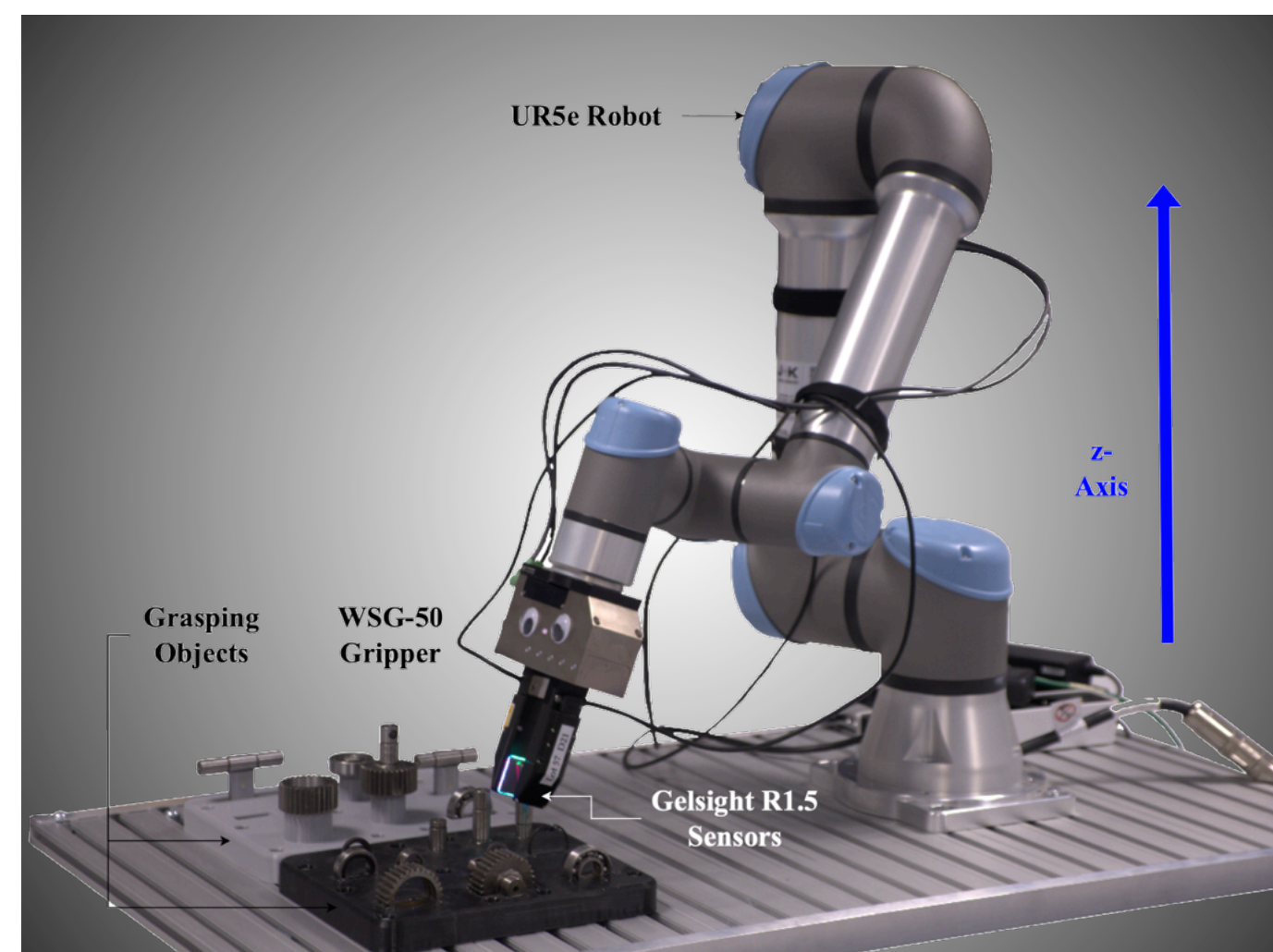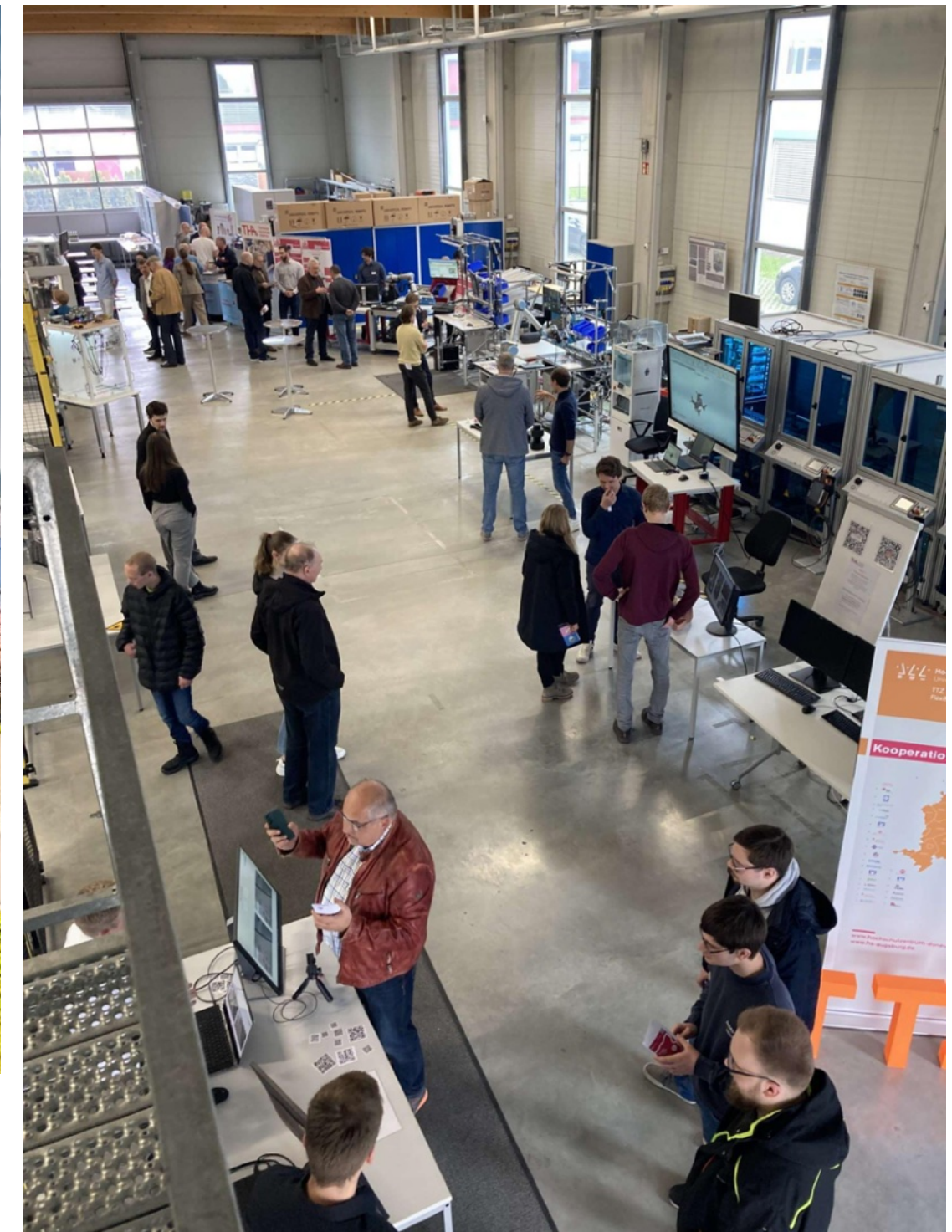

UCAS Open Day 2025

Key Achievements Thus Far...

- Hosted 2 exchange students via **EU Erasmus+ Traineeship Programme (June–August 2025)**

Key Achievements Thus Far...

- Further enhanced existing collaboration with **TTZ @ Nördlingen, Germany**

  - Joint PhD supervision

  - Multiple publications and organisation of conferences

Key Achievements Thus Far...

- **DfT** showcased and featured research from the lab at the **OECD Int. Transport Forum** (21–23 May 2025) as part of current UK research related to transport digital twinning

Digital Twin of a Turbocharged Spark-Ignited Engine System for Control and Fault Diagnosis

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ILN+ Researcher in Residence with Digital Catapult, UK

Key Achievements Thus Far...

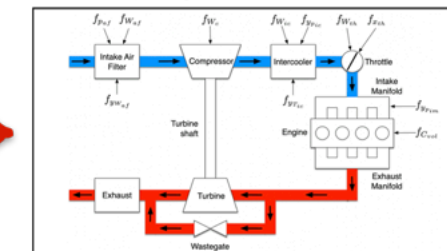https://youtu.be/Q9RnzF0kwnM?si=OaTWwnjr1jn8MSKf
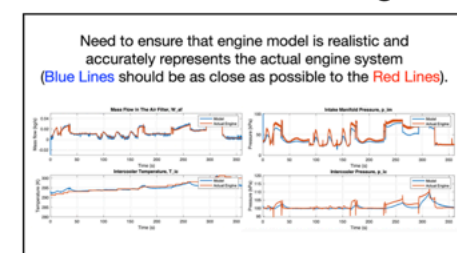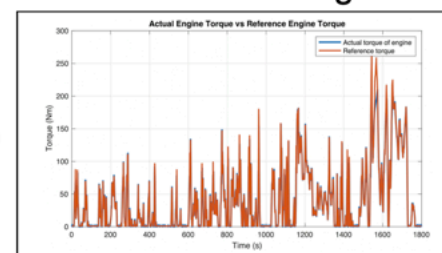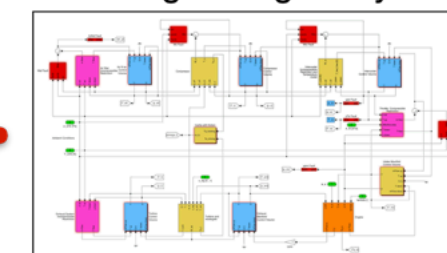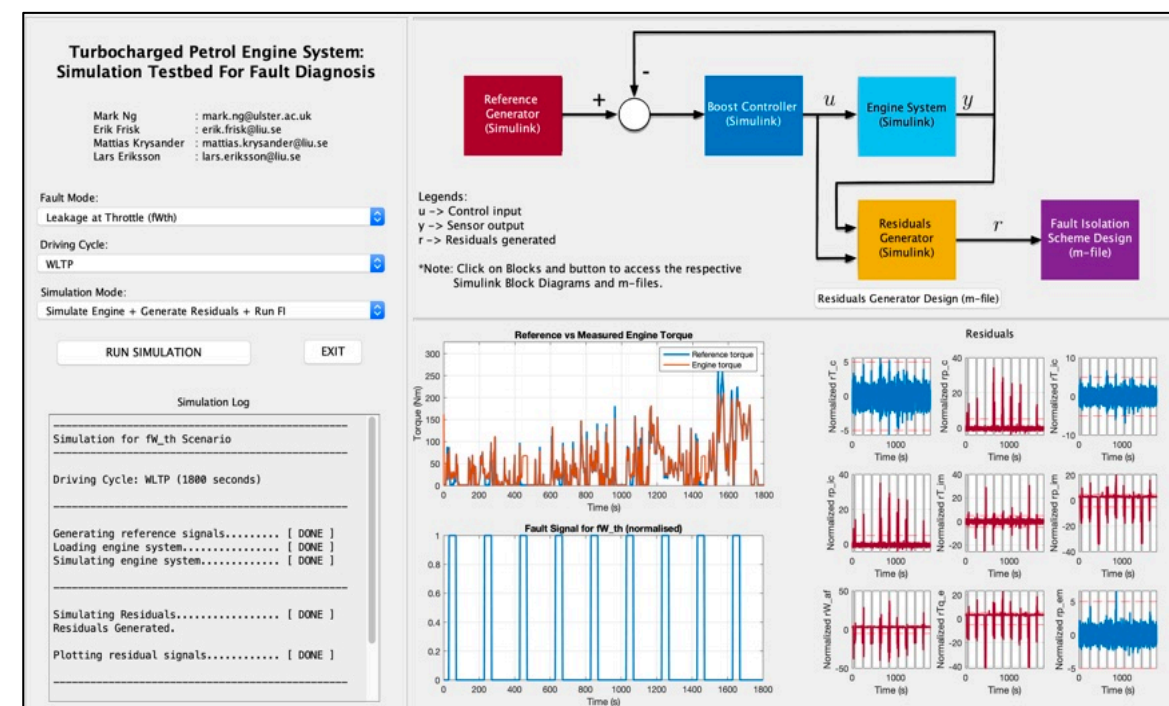
Non-verbal robot-robot communication (Research paper in writing)

Key Achievements Thus Far...
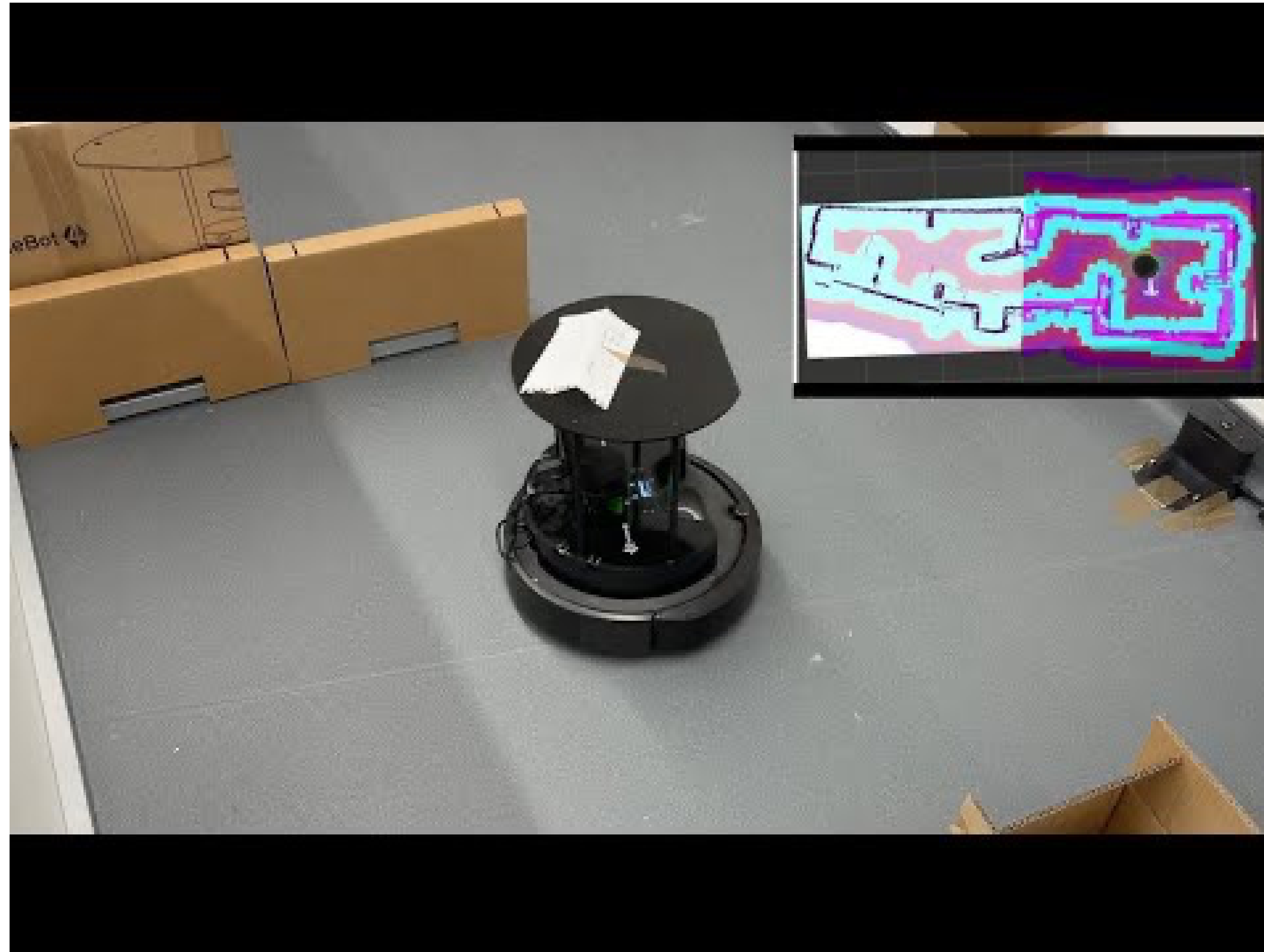
https://youtu.be/6QJiKrzK9bY?si=wmC_Io8Rxvqpczrt

Real-time Autonomous SLAM

UT and Characterisation for NDT in Manufacturing and Healthcare Diagnosis

Dr Morteza Tabatabaeipour

Key Achievements Thus Far...
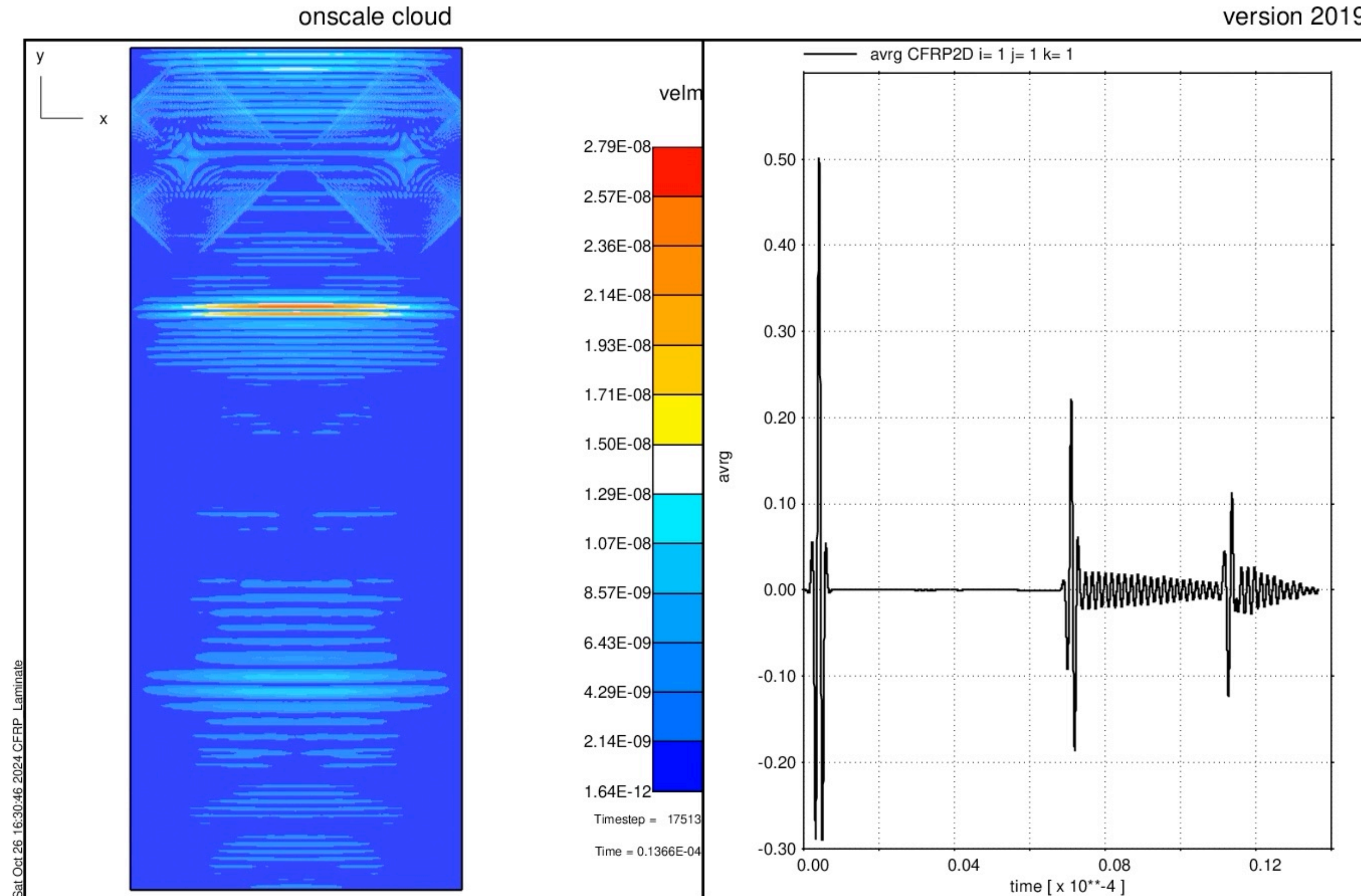
NDT of Composites Using UT

Dr Morteza Tabatabaeipour

Aims and Objectives

- **Research Excellence:**

  - Enhance research capabilities through **advanced robotics equipment** and cutting-edge techniques at UU

- **Innovation and Industry Engagement:**

  - The potential **industry partnerships**, **technology transfer**, and **commercialisation** opportunities promote innovation and entrepreneurship

- **Sustainable Technology and Manufacturing:**

  - By exploring **advanced control techniques** and **digital twins**, MAvRiC contributes to **sustainable and efficient manufacturing**

  - This also directly addresses the **UN SDG 9: Industry, Innovation and Infrastructure**

- **Regional Collaboration and Impact:**

  - Collaboration with industry partners and addressing regional challenges align encourage **regional development**

 - The project also contributes to **sustainable regional growth** and **societal impact**

- **Research-Led Teaching and Learning:**

  - MAvRiC enhances the teaching and learning environment by incorporating advanced robotics and digital manufacturing technologies

  - It provides students with hands-on experience and industry-relevant skills

Economic Prospects and Benefits

- **Large productivity gains:**
  - RAS could boost UK GDP by **~15% (>£200bn)** and raise manufacturing productivity by **~22%** (BEIS Research Paper Number: 2021/043)
  - **Robotics adoption still low in NI** — stands to capture these gains by modernising with labs like MAvRiC
- **Addressing skills/vacancy gap:**
  - UK manufacturing faces **~58,000 job vacancies** in automation roles (Mike Wilson, MTC)
  - MAvRiC can help fill this by training STEM graduates in advanced robotics
- **Strategic investment:**
  - NI-backed projects (e.g. **CDHT, AICC, AMIC,** etc.) show government focus
  - MAvRiC aligns with NI's Economic Vision by driving innovation that attracts collaborations and investments and boosts regional productivity
- **Skilled workforce:**
  - **DfE–funded PhDs** (e.g. robotics, digital twins) — graduates gain **hands-on experience** (e.g. AMRs, 3D printers, ultrasonic scanners) for industry/R&D roles
- **STEM enrichment:**
  - MAvRiC's equipment supports **UG/PG teaching**
  - Students work on **lab-based projects**, preparing them for NI's growing tech sector
- **Grant leverage:**
  - **Digital Catapult** and the **UK Digital Twin Centre** in Belfast
  - **UKRI DTNet+**

Economic Prospects and Benefits

- **Local manufacturers:**
  - MAvRiC actively partners with **NI firms** — **Elite Electronics Ltd** (KTP), **Thales** (HLA), **Artemis**, **Spirit AeroSystems**, **Catapults** (EPSRC-funded placements and RiRs), etc.
- **Healthcare & services:**
  - Support **NHS/health tech innovations**. For instance, DT is used to design more efficient heart pumps for transplant patients
  - **Ultrasonic robotics research** also underpins medical device quality control
  - **Small gains in efficiency** in health and manufacturing **could translate to millions** in NHS savings
- **Upskilling existing workforce:**
  - MAvRiC can host **industry workshops** and **KTPs**
- **UK/EU labs:**
  - MAvRiC complements UK centres such as the **National Robotarium (HWU)** and **Sheffield**
  - Also EU labs such as **TTZ** to encourage collaborations towards EU initiatives (e.g. **Horizon Europe** projects)
- **Adoption gap:**
  - UK ranks **~24th globally in robot density** (below average), highlighting growth opportunity (1st South Korea, 2nd Singapore, 3rd Japan)
  - MAvRiC helps close this gap

8 m

5 m

Wall Shelves

Dual-Rotor Experiment System

ABS Braking Experiment System

ER FLEX 1 (Mobile)

Wall Shelves

3D Printers

Mini Robotic Arms

Festo Island 1

Wall Shelves

Turtlebots (Mobile)

Robotic Ultrasonic Research Station

Robotino (Mobile)

Festo Island 2

ER FLEX 2 (Mobile)

40 L water tank

*NOT TO SCALE
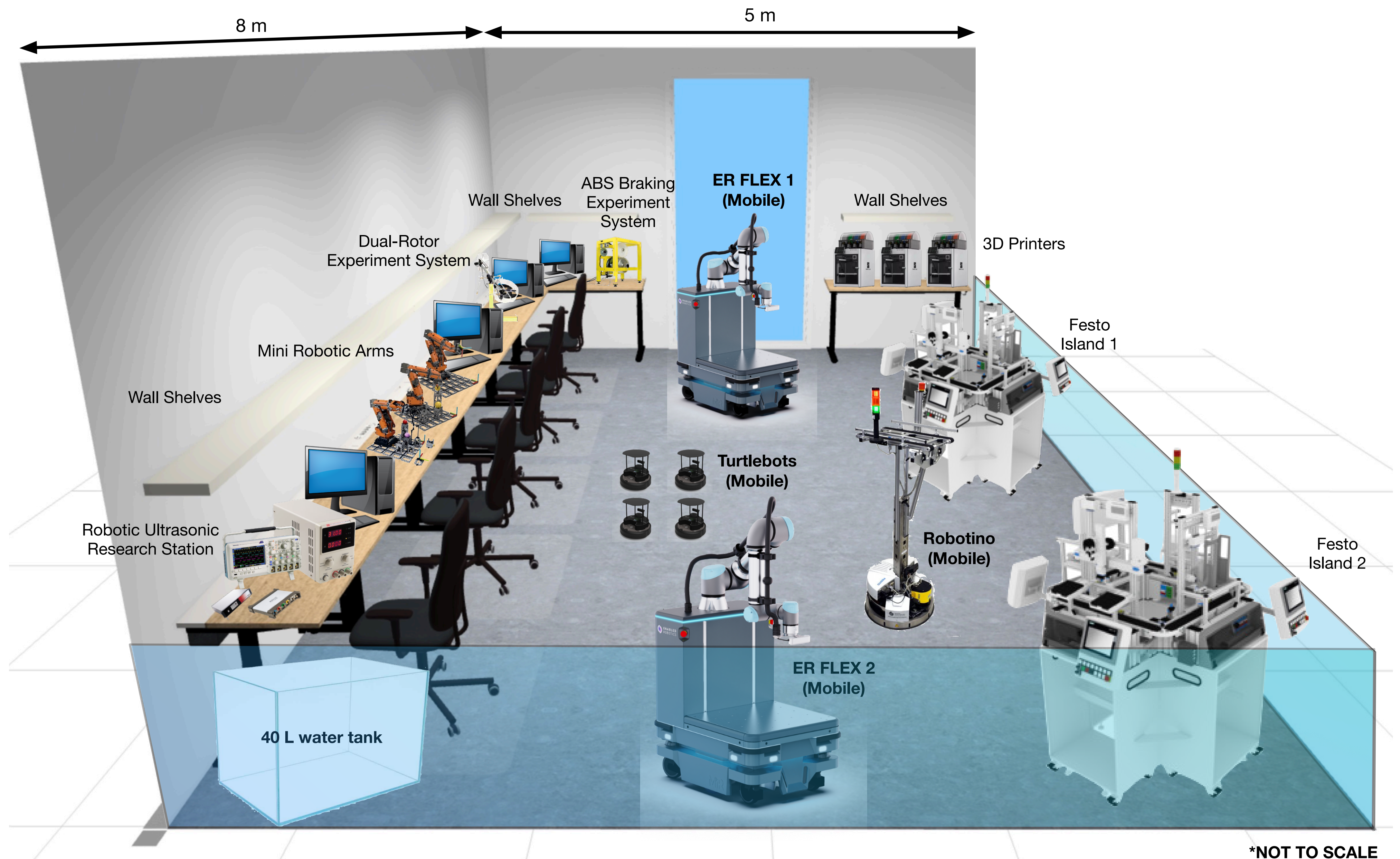
Research Collaborators and Partners

CATAPULT Digital

MONASH University

THA — Technische Hochschule Augsburg

CATAPULT Offshore Renewable Energy

VOLVO

li.u LINKÖPINGS UNIVERSITET

TTZ Nördlingen Flexible Automation

elite

Foras na Mara Marine Institute

Government of Western Australia Department of Health

QUEEN'S UNIVERSITY BELFAST

IEEE Region 8

IEEE Control Systems Society™

ARQ RELIABILITY

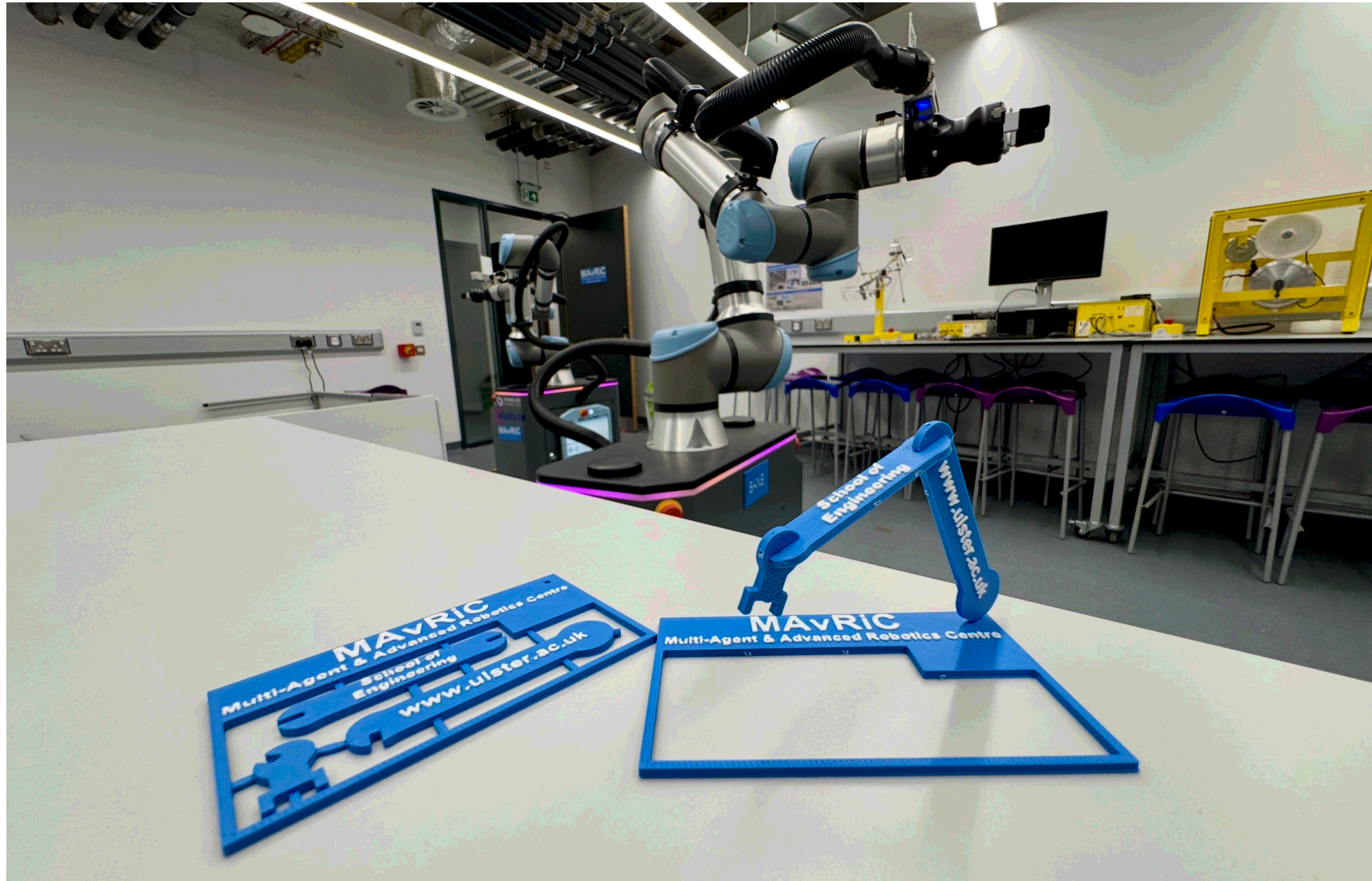Northumbria University NEWCASTLE
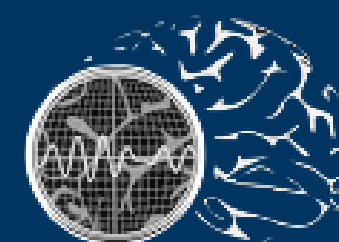
NEURAL ENGINEERING DATA CONSORTIUM

NIACE Advanced Composites and Engineering

Thank You