Sensor Technologies for Remote Environmental Aquatic Monitoring -STREAM

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STREAM

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Agenda

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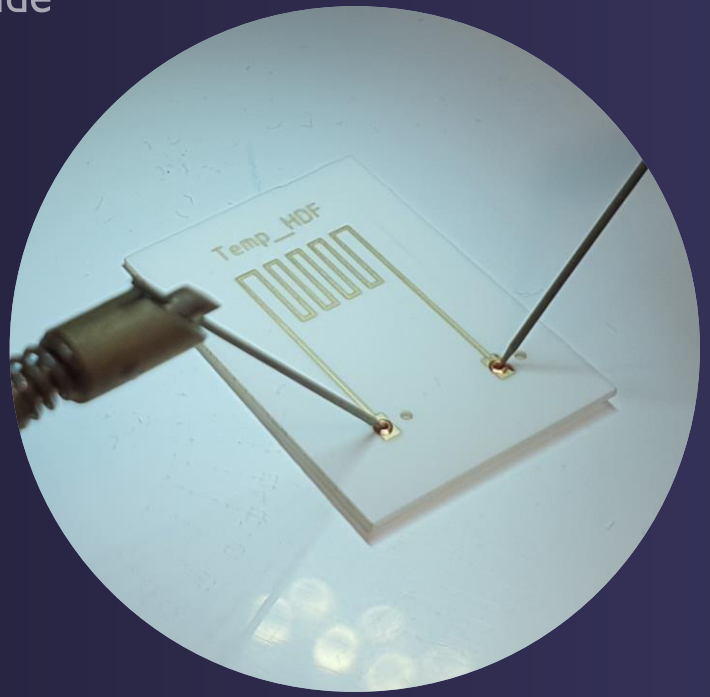
Commercial Sondes

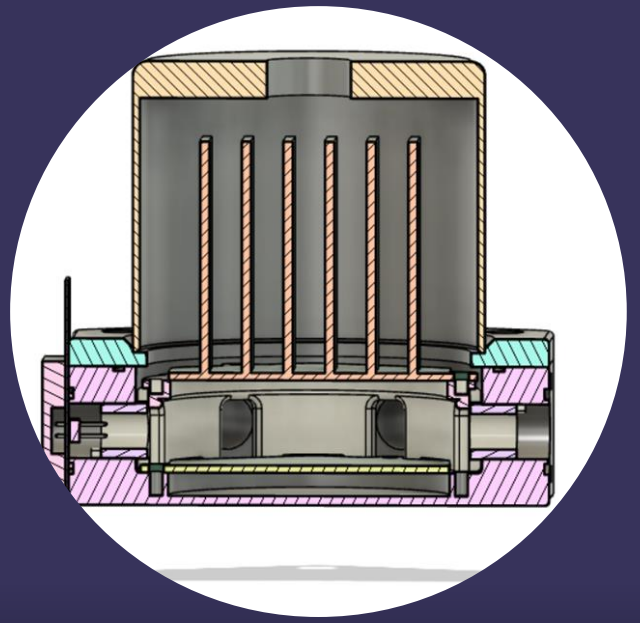
Printed Sensors

- Substrates
- Temperature
- Conductivity
- pH
- Dissolved Oxygen

Deployment

- Enclosure Design





STREAM

Introduction

The STREAM project aims to develop sensors capable of providing real-time environmental data and disseminating this data via web portals and mobile applications to organisations responsible for protecting and improving Welsh and Irish waters.

When assessing water quality, different chemical, physical, and biological properties can be tested to evaluate the status of a waterbody. These include temperature, dissolved oxygen, salinity, pH, turbidity, chlorophyll and nutrients.

The data collected from the project is publicly available through the STREAM portal - https://grafana.marinestream.eu/.

Swansea research centres – WCPC and CSAR

Prifysgol Abertawe
Swansea University

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South East Technological University

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Munster Technological University

Overview

PROJECT AIMS - WCPC

- To develop low-cost sensor systems consisting of printed physical and chemical sensor technologies for Estuarine Monitoring.
- Ensure the data collected from sensors is accurate and has sufficient resolution to provide value.
- Transmit the data to the public facing project server to allow dissemination of the information to concerned parties.

PROJECT CHALLENGES

- Identification of compatible material sets
- Construction/sealing/leak prevention
- Sensor degradation/lifetime
- Bio-fouling
- Mechanical damage to sensors or installation
- Deployment

Commercial Sensor Deployments

Two RS Hydro Sondes deployed in South Wales

Overview

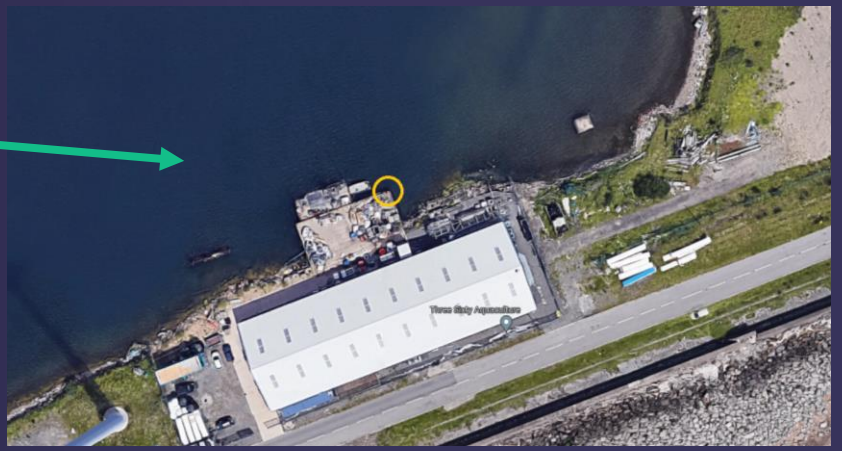
Two commercially available Proteus systems provided by RS Hydro are installed in Swansea as part of the STREAM project

Tendered Value: ≈£48,500 plus installation

- Temperature
- Conductivity
- pH
- Dissolved Oxygen
- Turbidity
- Total Organic Carbons
- Chlorophyl A
- Chromophoric Dissolved Organic Matter

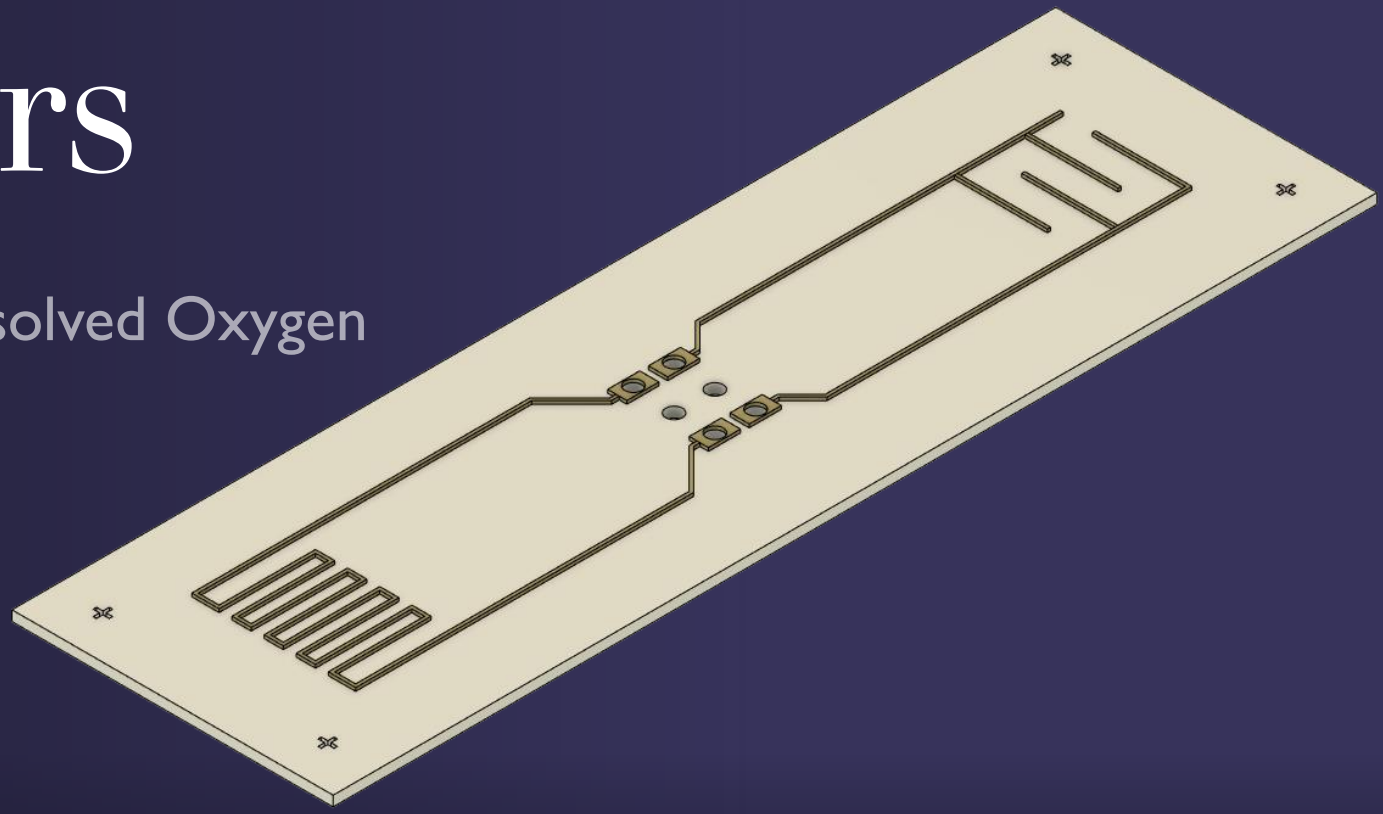
TAWE BARRAGE

360 AQUACULTURE



Printed Sensors

Temperature, Conductivity, pH, and Dissolved Oxygen



Biofouling Testing

- Several substrates were initially considered (including SU320 PET, 339 Melinex PET, Powercoat HD, glass, polycarbonate and ceramic) and subjected to biofouling testing.
- Samples were placed in the raceway at CSAR and visually monitored – Water was changed weekly
- None of the substrates performed well.
  - The PowerCoat HD (coated paper) failed completely.

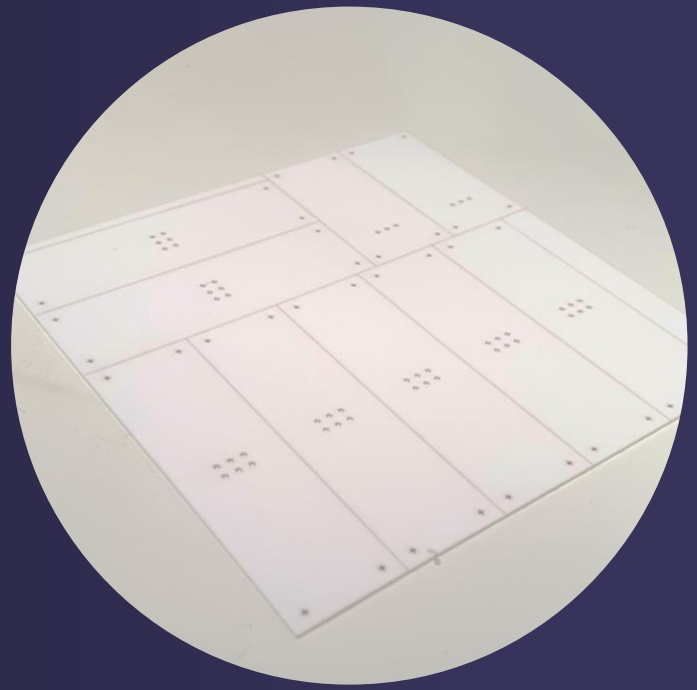
DAY 0

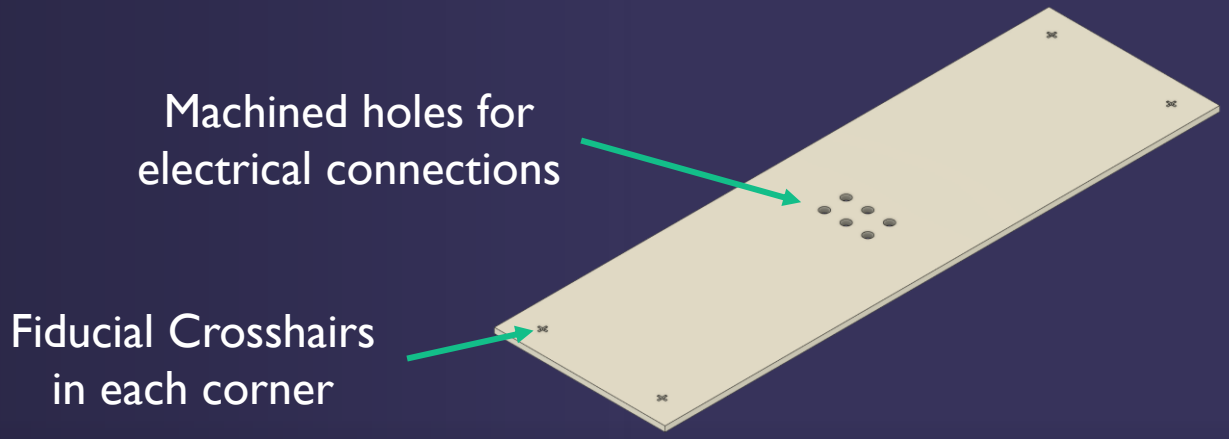
DAY 27

DAY 55

Substrate

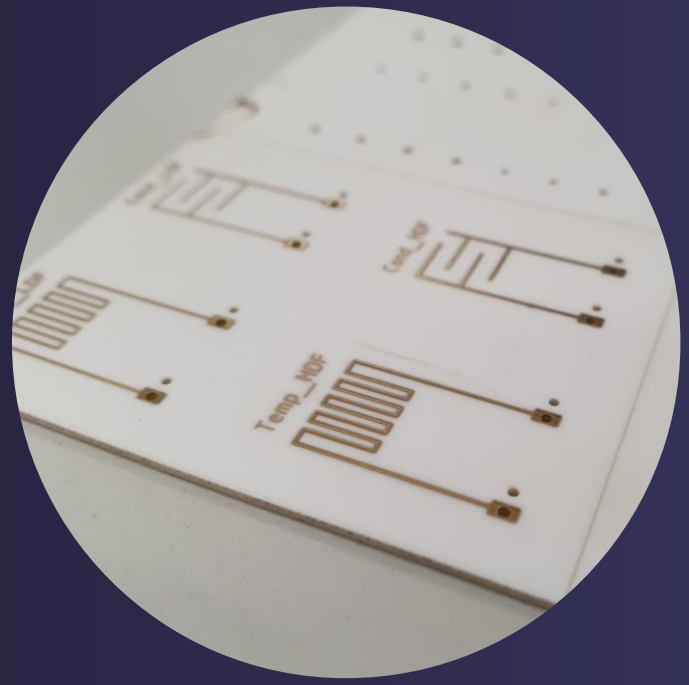
- Alumina - purchased as sheets with overall dimensions of 108 x 108mm and a thickness of 0.635mm.
- These sheets are then laser machined to produce a panel of substrate dies which can be singulated each with holes for electrical connections and fiducials for alignment in both the aerosol jet system and screen printers.
- The machined holes for the electrical connections consist of two rows of three holes allowing for both two and three electrode sensor designs.

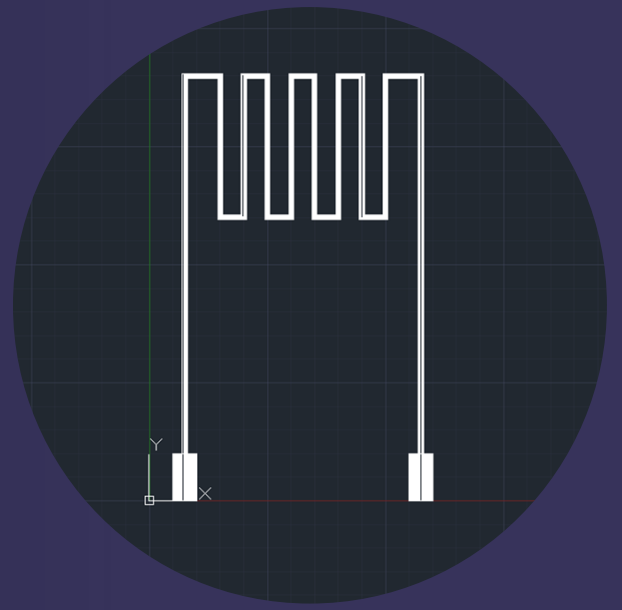


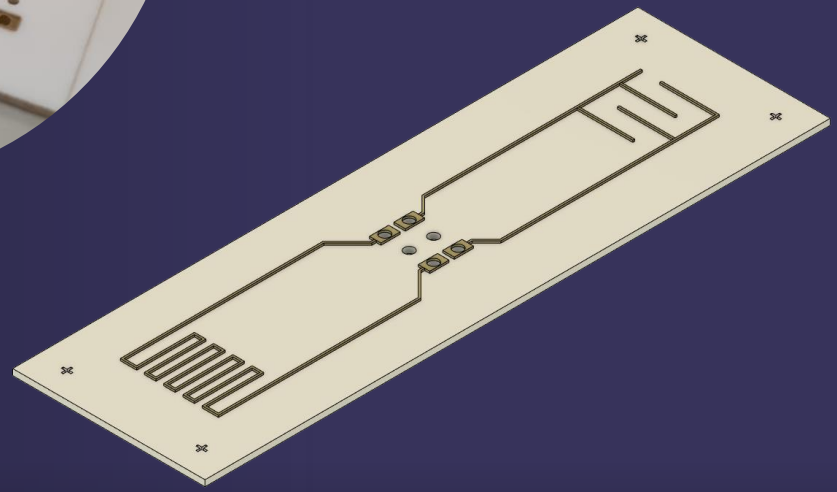


Temperature Sensors

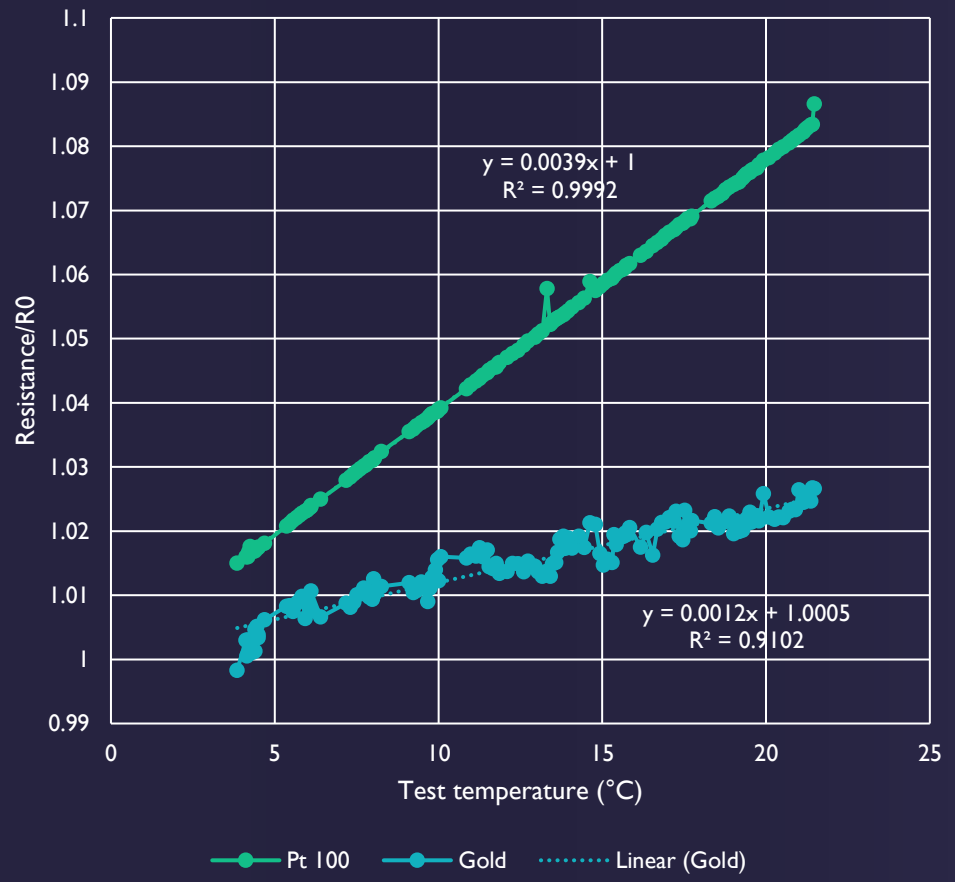
- Aerosol Jet Printed
- Nanoparticle Gold Ink – Solvent Based
- Low Binder Content
- Low Overspray







Temperature Sensors



The printed gold temperature sensor shows an increase in absolute resistance with temperature (Ohms/°C).

When normalised against it's "base" resistance (R0), it appears to be ~3 times less sensitive than the PT100 what would be expected from a pure gold layer.

Temperature coefficients of resistance:

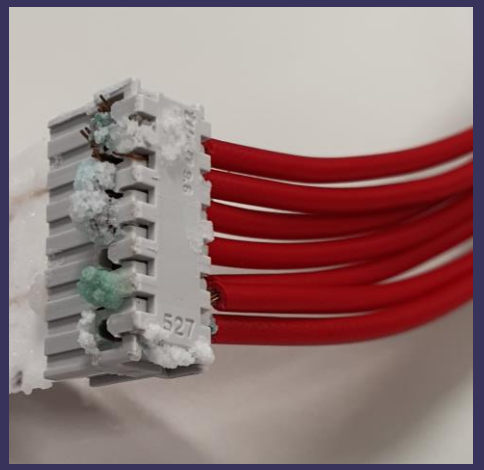
Platinum: 3.92 x 10-3
Gold: 3.4 x 10-3
Printed Gold: 1.2 x 10-3

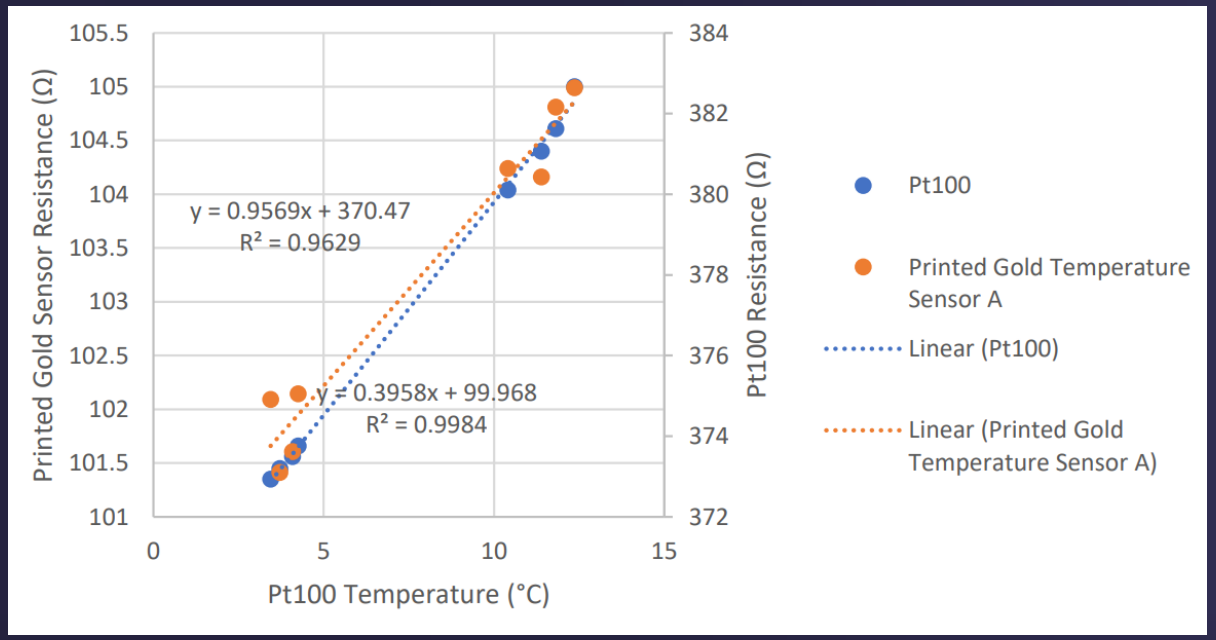
Some noise in the results as a result of long test leads and the board edge connection method.

Temperature Sensors

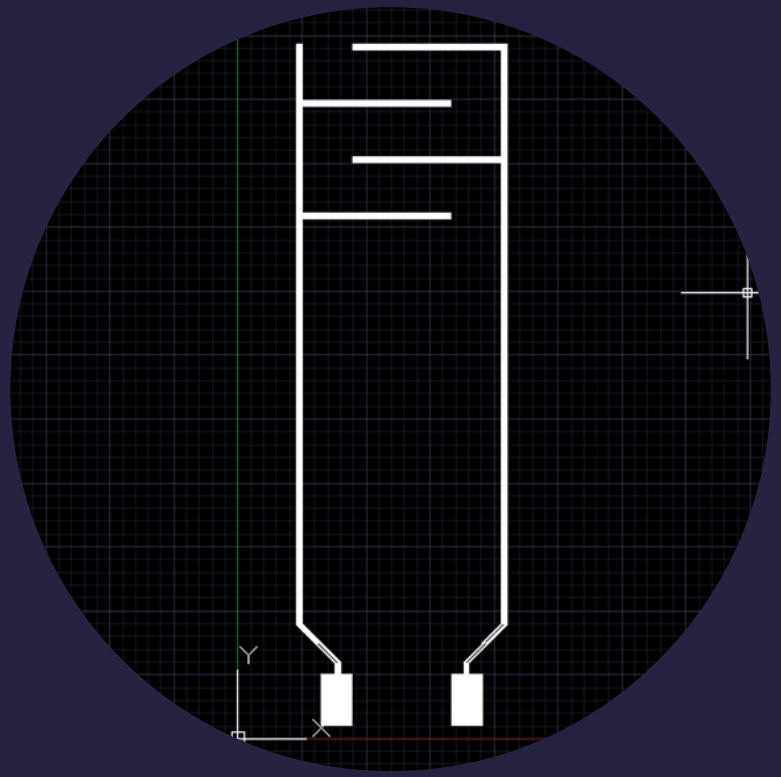
The printed gold sensors showed no significant difference in behaviour when the test was repeated once in salt water (Deionised water + Sodium Chloride).

Further tests showed inconsistencies which is believed to have been down to salt wicking over the sensor to the electrical connection resulting in partial shorting.





Conductivity Sensor - Current Design



Aerosol Jet Printed

Nano Gold Ink

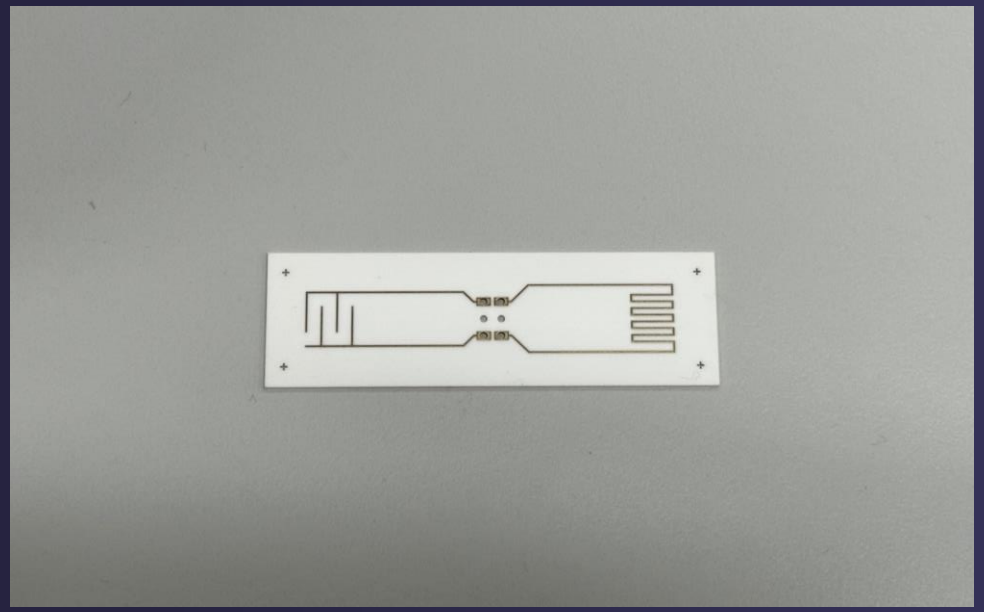
8.2mm x 7 mm (not including legs)

0.2mm Track

2.0mm Gap

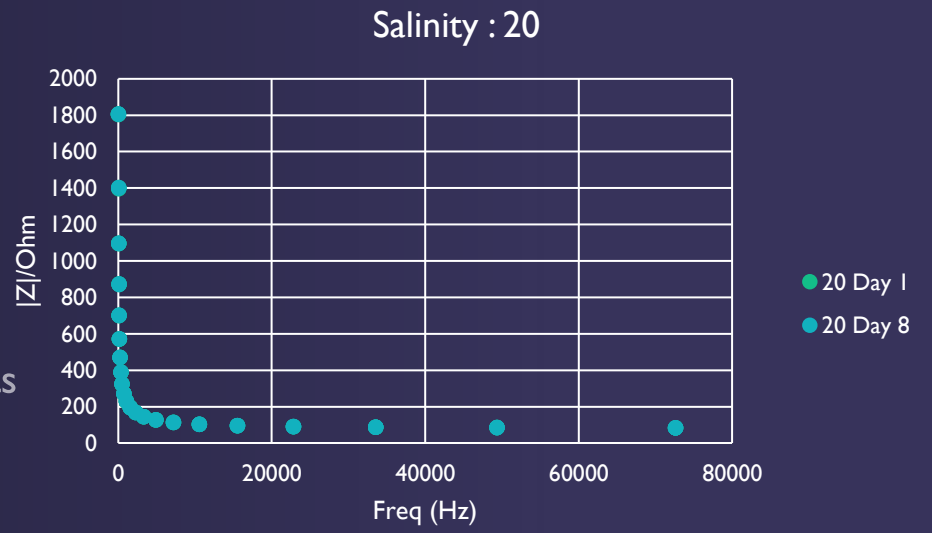
Cell Constant : 3

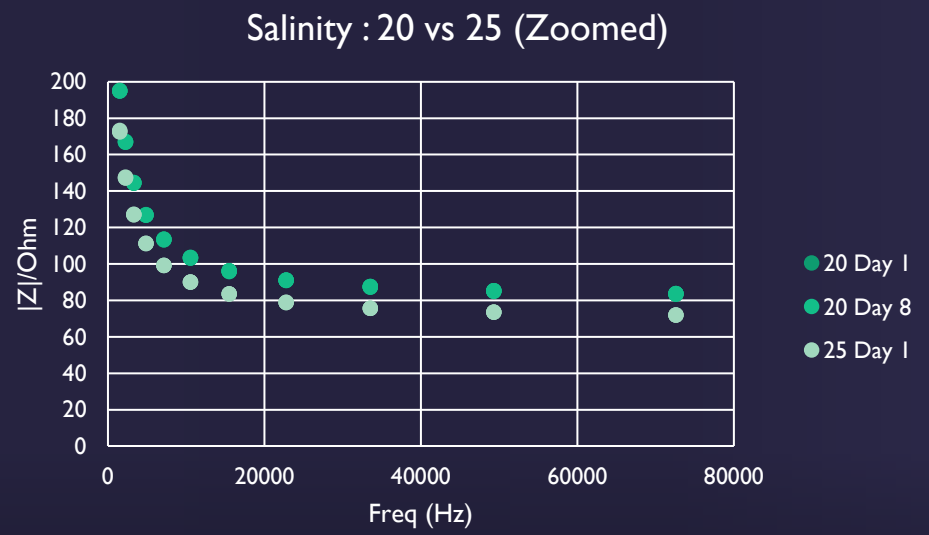
Temperature and Conductivity Sensor

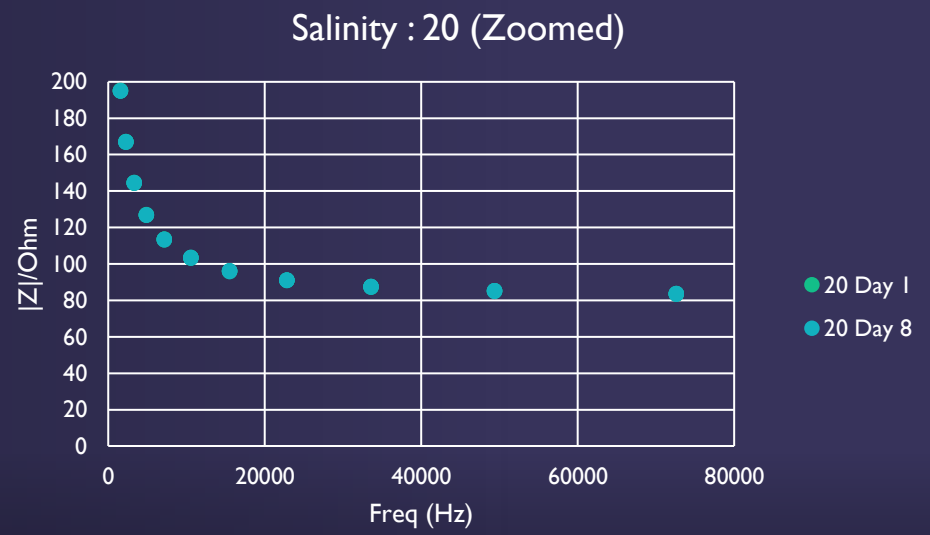


Conductivity Sensor - Current Results

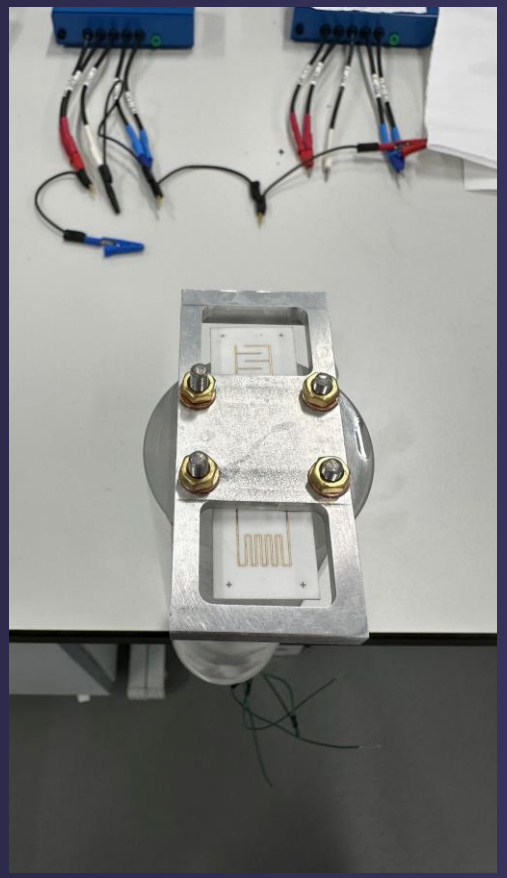
- Further Testing on Machined Substrates
- Long term evaluation of sensors connections in seawater
- Evaluation of effect on connections under AC measurements



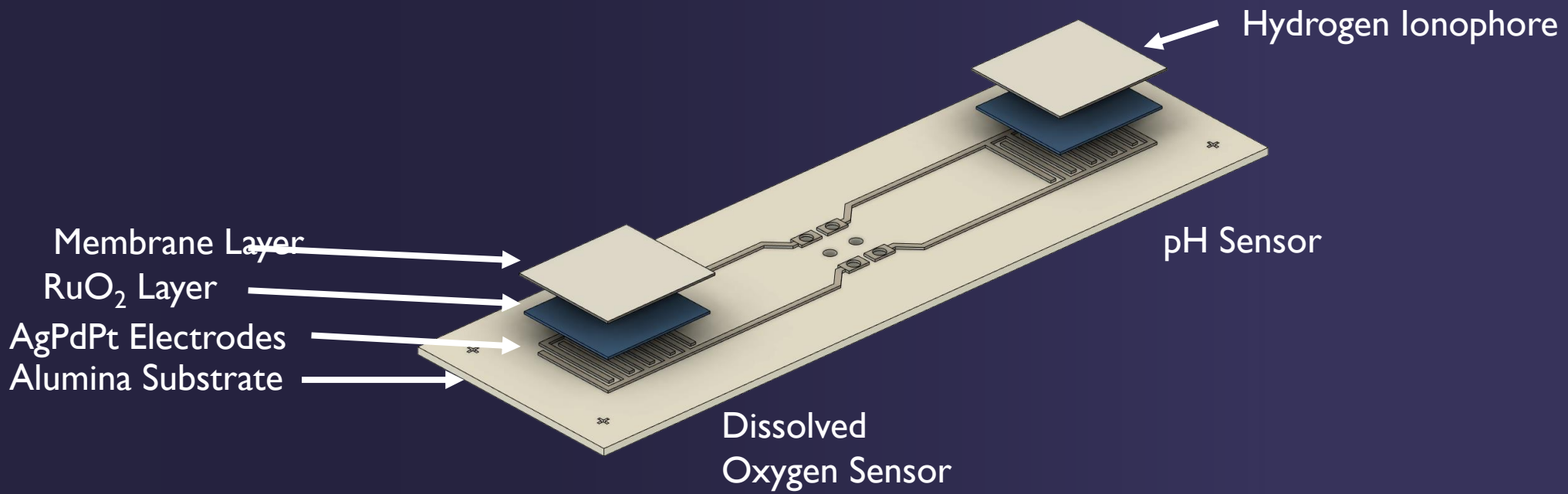




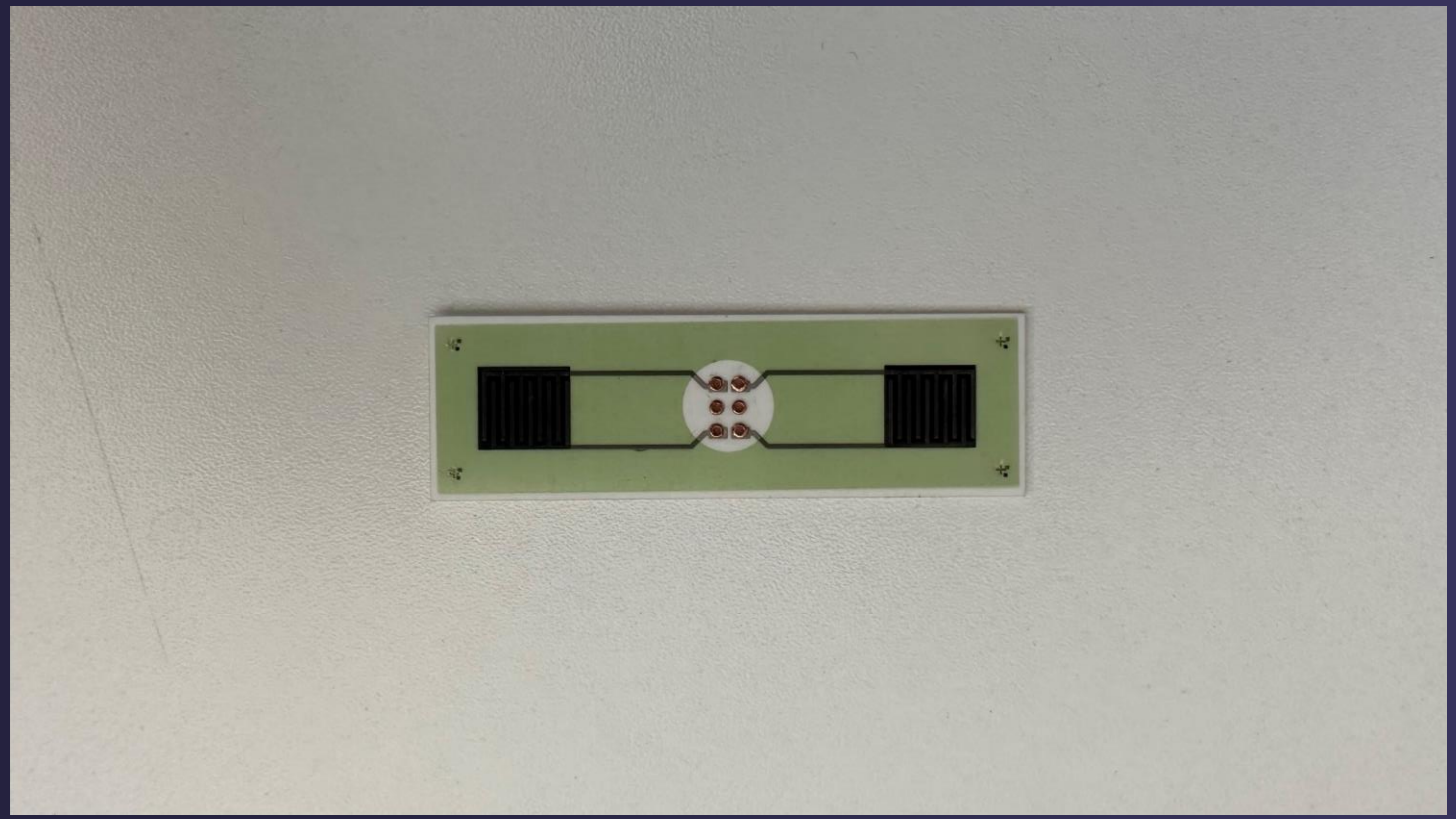
Tooling for testing



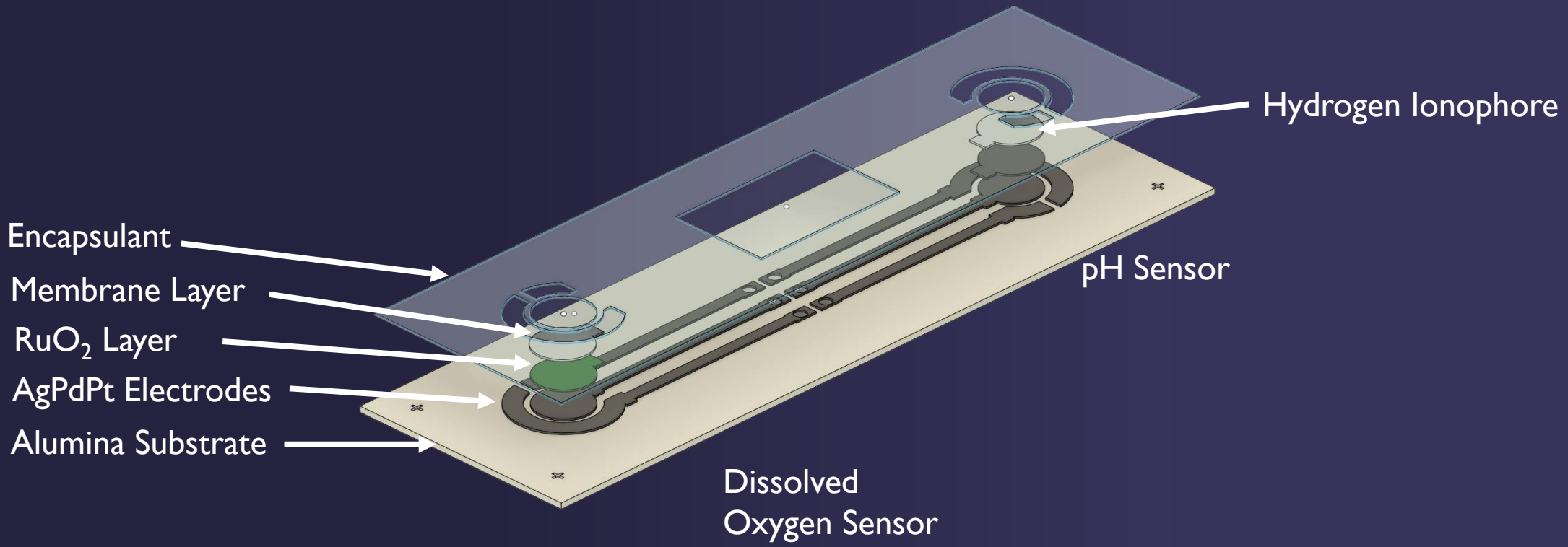
pH and Do Sensor Architecture 1 - IDT



pH and DO Sensor Architecture 1 - IDT

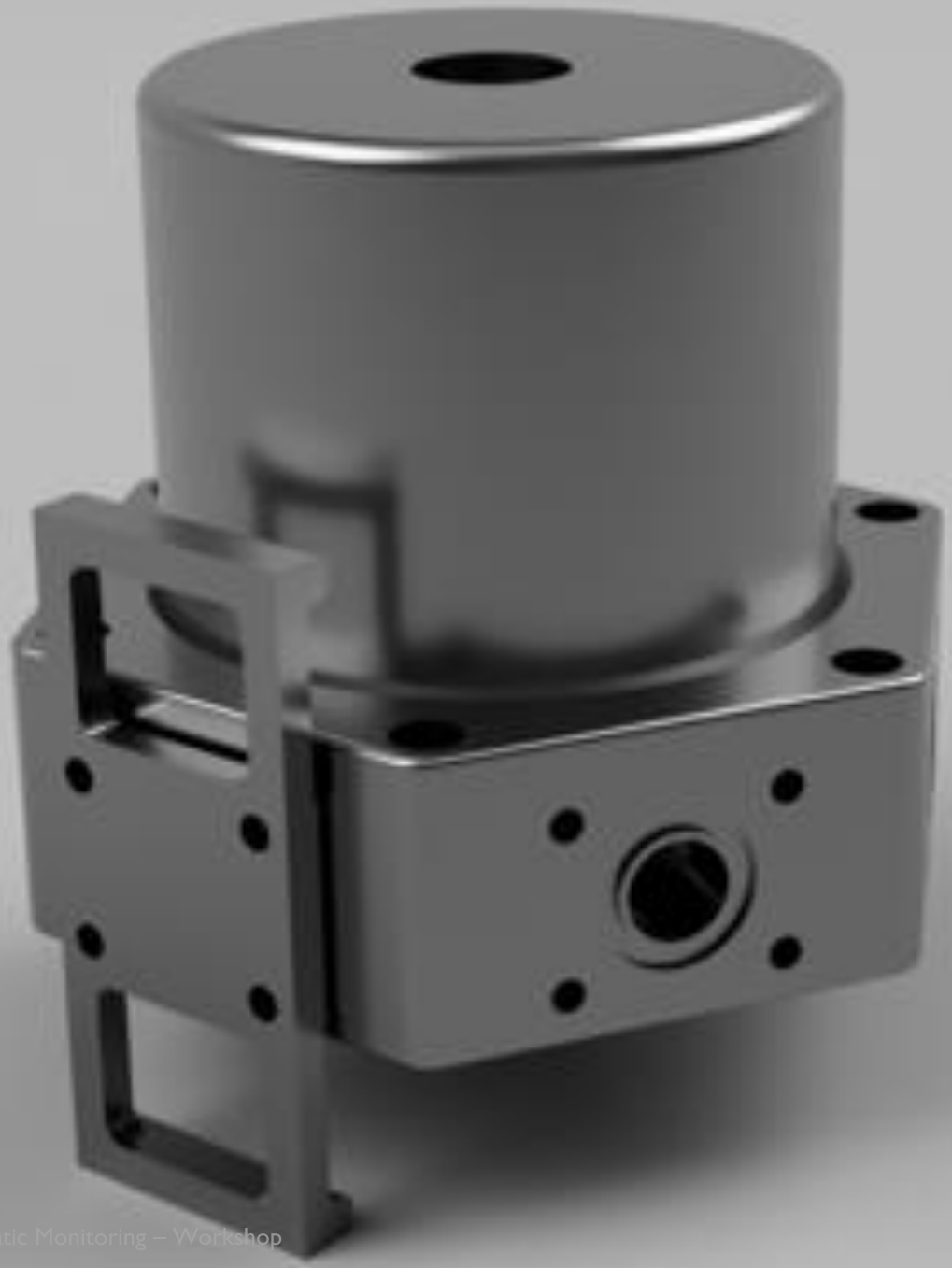


pH and Do Sensor Architecture 2 - Biosensor



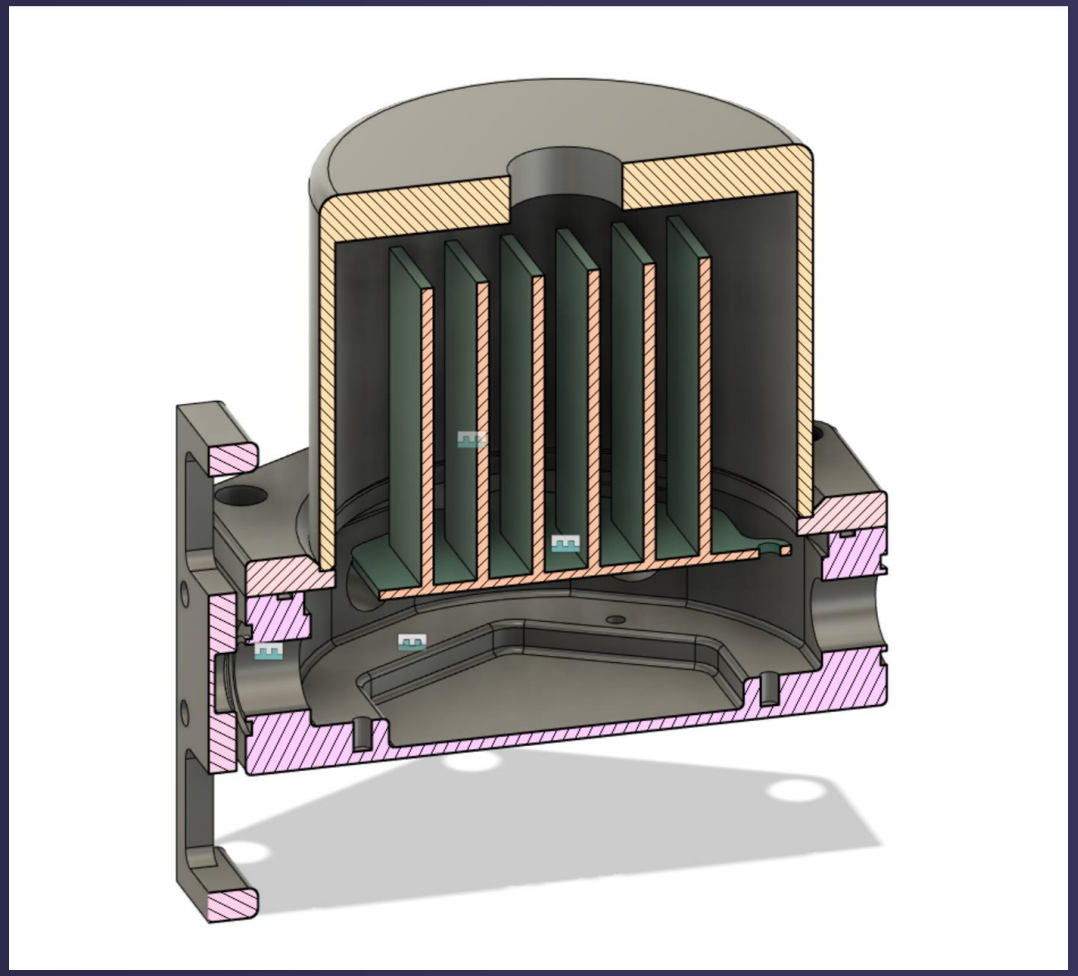
Enclosure Design & Deployment

Materials, Waterproofing, Sealing



Enclosure Design

- Main body has 6 attachment ports and protective mounting plate to reduce chance of damaging the fragile ceramics.
- Dome gives room for modular electronics and incoming connection to the surface .
- Stainless steel hardware to minimise corrosion and susceptibility for damage.
- Mounting points for the electronics to prevent accidental shorts or disconnects



The Deployable Unit

Thank You

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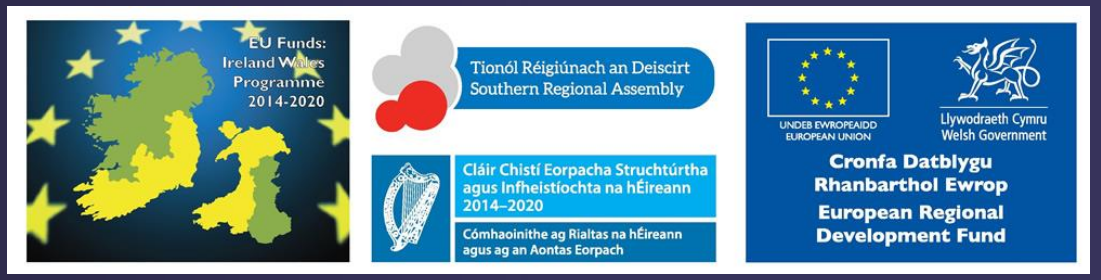
https://www.marinestream.eu/



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