DESIGN AND CONSTRUCTION OF AN INSTRUMENTATION PACK FOR THE RING VORTEX COMPLEX FLOW PHANTOM

Noora AlSaleis[1,2], Alana Matthews [2,3], Dr.John Fenner[2,3]

1 – Department of Electronic and Electrical Engineering, University of Sheffield, Sheffield.
2 – Insigneo Institute for *In Silico* Medicine, University of Sheffield, Sheffield.
3- Department of Infection, Immunity and Cardiovascular Disease, University of Sheffield, Sheffield.

The University Of Sheffield.

Introduction

- The ring vortex complex flow phantom is being designed to measure the accuracy of medical imaging technology such as CT, Ultrasound and MRI.
- A QA tool will increase the confidence of the user and report device functionality.
- A previous instrumentation pack was developed using lasers, a Doppler probe and linear encoder.
- The phantom has been expanded for use in MRI. This project will adapt the QA tool for MRI compatability for the refined device.

Aims

- Design MRI compatible QA tool that measures the ring speed and piston speed.
- Construct circuitry using an Arduino microcontroller, photodiodes and lasers.
- Design and 3D print structures to support the QA tool

Methods

- Fusion 360 and 3D printing were used to design and manufacture the infrastructure.
- Electronic circuits were build using Arduino to assess phantom functionality.
- An algorithm was written to control the photodiodes, recording and analyse the data.

Results

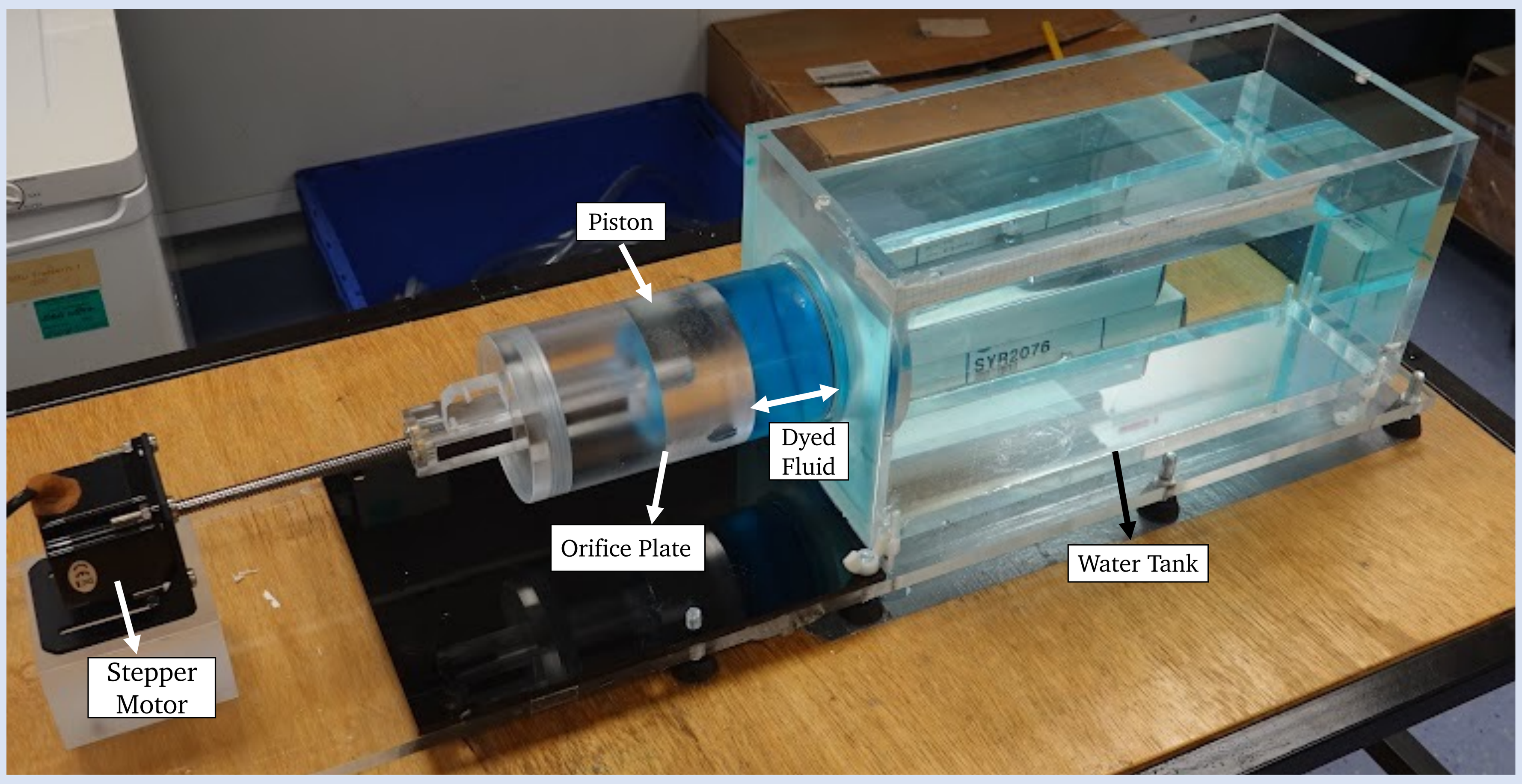


Figure 1 : A photo of the US-compatible ring vortex phantom, used for development of the QA tool

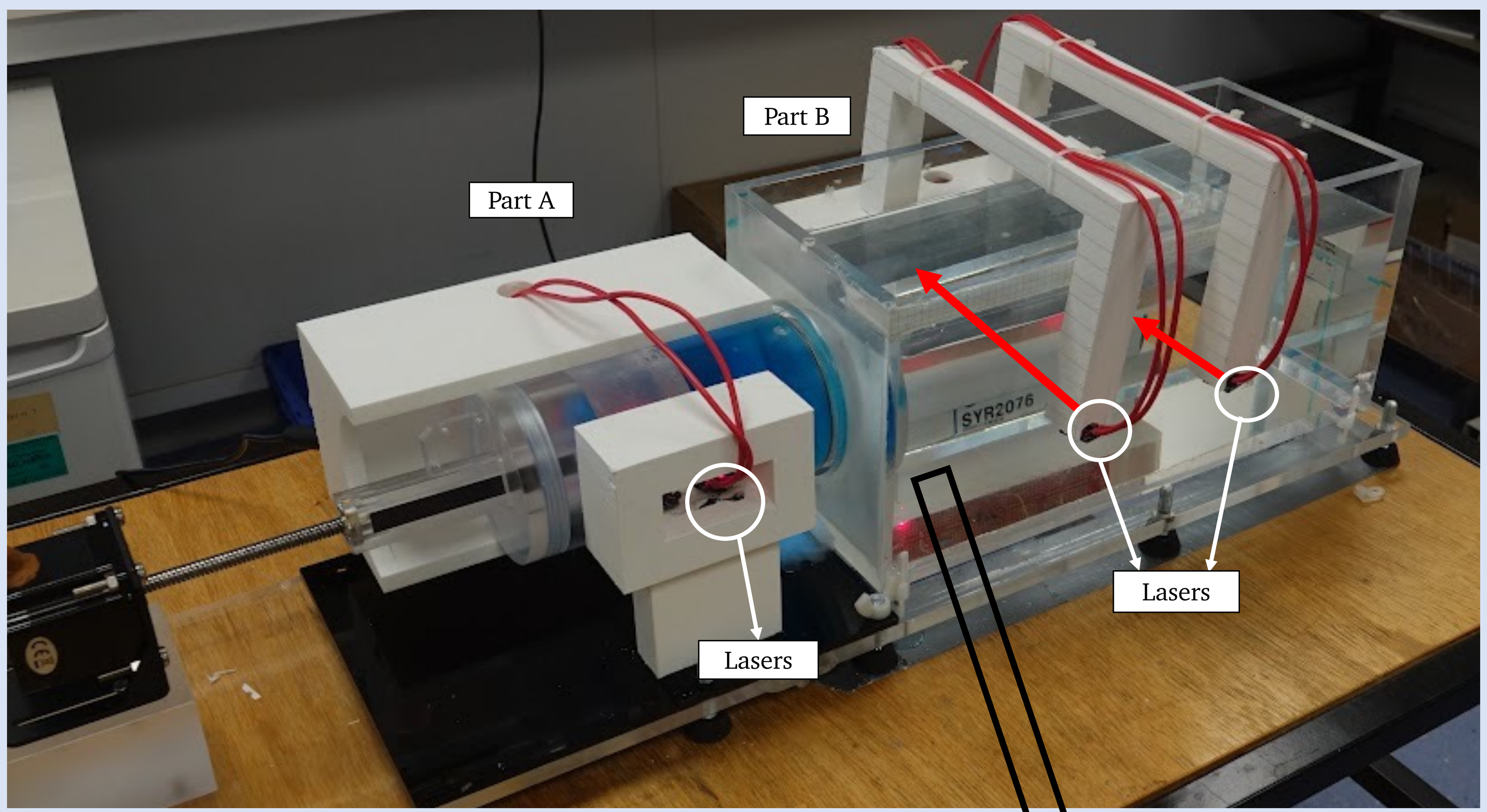
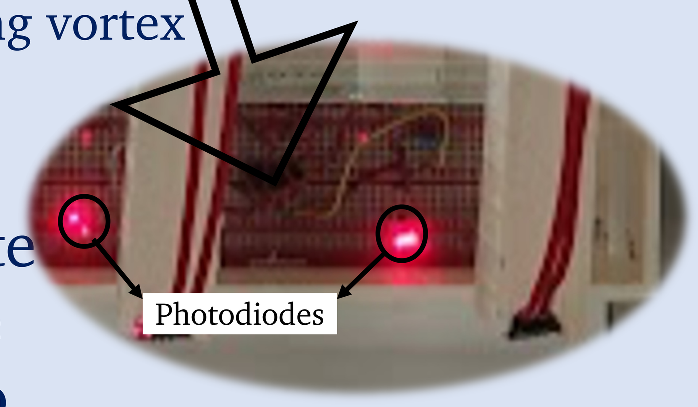


Figure 2: QA tool has been added to the ring vortex phantom.



- In figure 1, The ring vortex phantom with attached optical instrumentation pack. As shown in figure 2, The QA tool has 2 parts. Part A(figure 2), tracks the piston motion. Two lasers were added directly opposite the photodiode to measure the piston's speed movement. The 3D print is curved to darken the area for the photodiode to allow us to get a more accurate output. Part B (figure 2), measures the ring speed, with two lasers and photodiodes. The ring cuts the laser and the speed can be calculated.

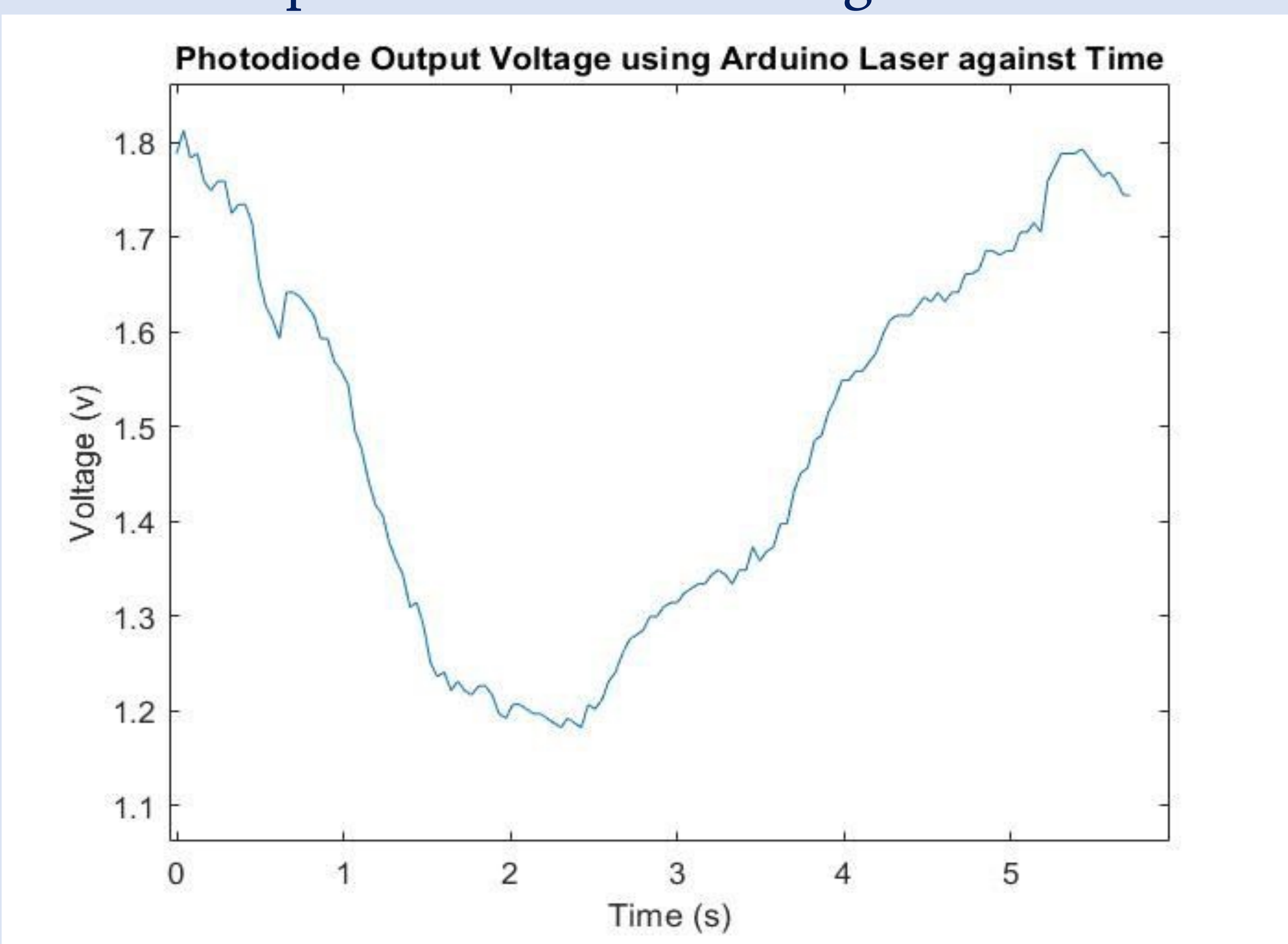


Figure 3 :shows how the photodiode voltage changes as the piston moves.

- As shown in figure 3,The result of applying the laser over the photodiode and measure the piston's movement. When the voltage drops, this represents that the piston moves forward and starts to push a ring.

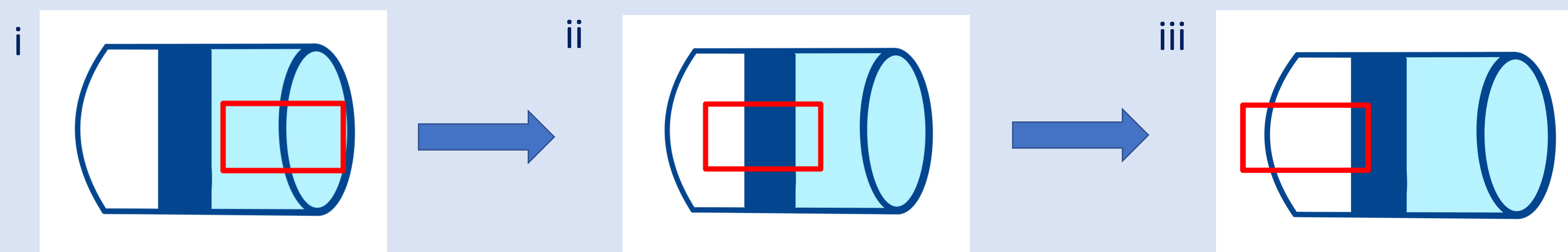


Figure 4: Present the movement of the piston in the plate, which moved using a stepper motor.

- Figure 4 shows the movement of the piston and it represent in figure 3.(i) represent the piston before it moves over the photodiode. In part (ii), the piston moves over the photodiode, stopping the laser from passing through. This is represented in figure 3 by the depth in a graph.(iii) is after the piston passes the photodiode.

Discussion

- The prototype QA tool has been designed and constructed using optical methods.
- Future work :
- Add optical fibers and relocate circuitry to MRI control room.
- Improve temporal resolution of photodiode readings.
- Build MATLAB interface to visualise data.

Conclusions

- An optical QA tool has been designed and constructed for use with the ring vortex phantom.
- To enable MRI-compatibility, the QA tool will be adapted and refined for regular use
- This will have significant impact on the development of this novel device.