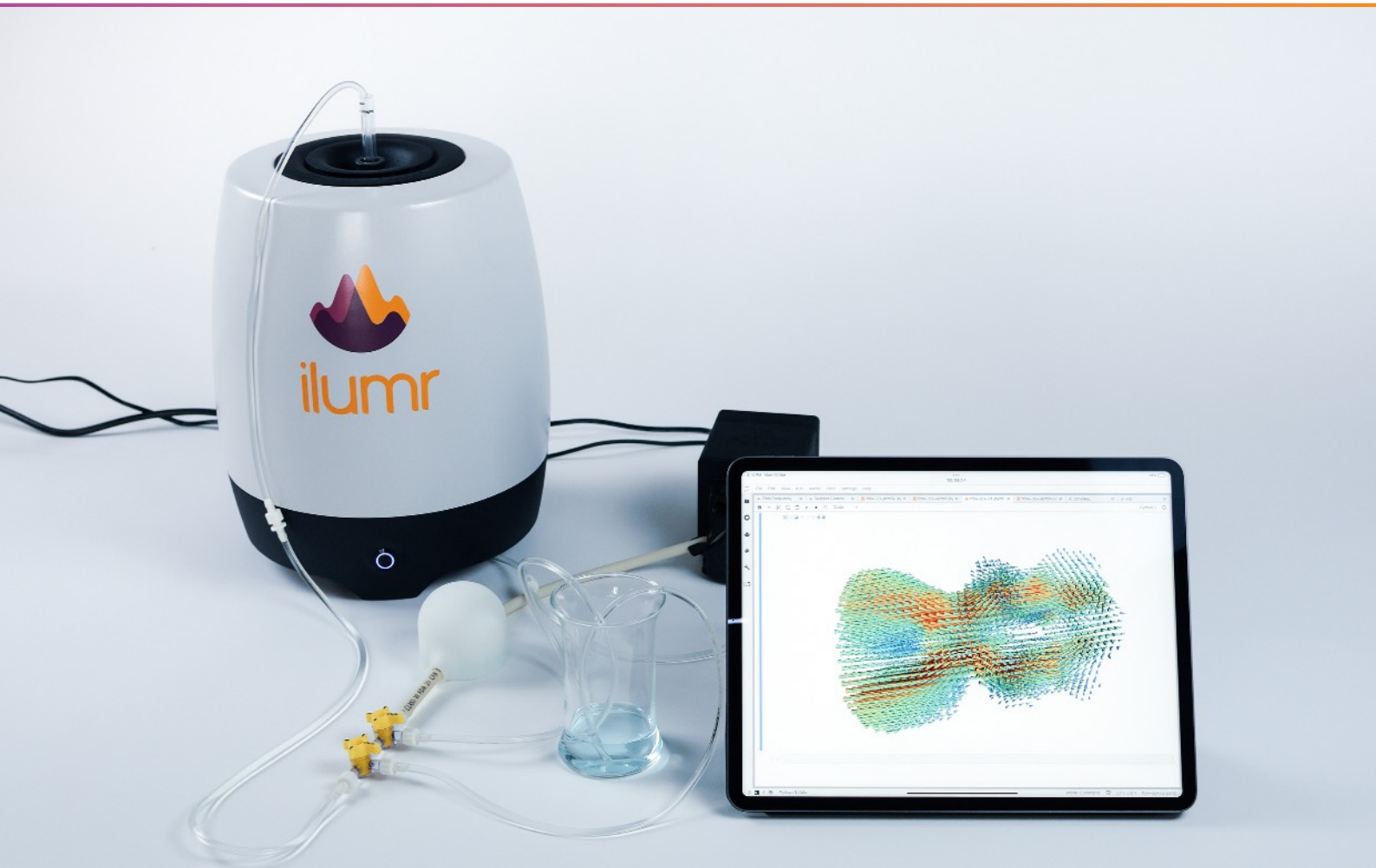
resonint

# ilumr - Flow Imaging Kit

## User Manual

September 2022

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# 1. Introduction

Welcome to the User Manual for the ilumr Flow Imaging Kit, please refer to the image below for a complete list of components.


Note - before continuing with this manual it is recommended to first read through the ilumr user guide supplied with your system. This will ensure the ilumr is setup and ready for use as well as provide you with support on running Notebooks, used to perform flow experiments.

## 1.1 System Components list

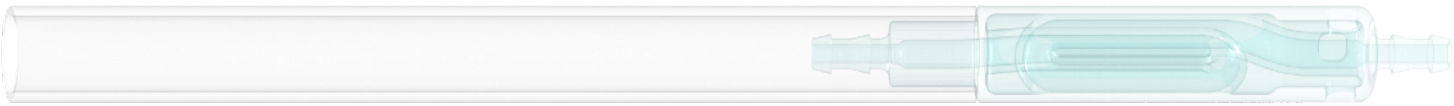
As described below, please refer to the image on the previous page when setting up the flow kit.

| Item Number | Description | Notes |
|---|---|---|
| 1 | Stepper motor controlled Peristaltic pump | |
| 2 | Ilumr control cable | |
| 3 | Flow cells | Kit ships with three flow cells, refer to images below |
| 4 | Pulse dampeners | 2 supplied |
| 5 | Dampener connection tube | 1x fitter with male Luer lock, 1x fitted with female Luer lock |
| 6 | Pump tubing | |
| 7 | 3 way valve | 2 supplied, connected as 4 way |
| 8 | Cell interconnect silicone tubing | 2 supplied, fitted with male & female Luer locks at each end |
| 9 | Cell bottom tubing section | Fitted with a male Luer lock |
| 10 | Priming & purging silicone tubing | Fitted with female Luer locks |

Three different flow cell designs have been shipped with this kit and are referred to as follows:

X Flow Cell - complex 3D flow

U Bend Flow Cell - multi directional flow



Tube Flow Cell - simple tube geometry

## 1.2 Setting up the flow kit

To setup the flow kit for use, please work through the following steps - using the diagram on page 3 to check components.

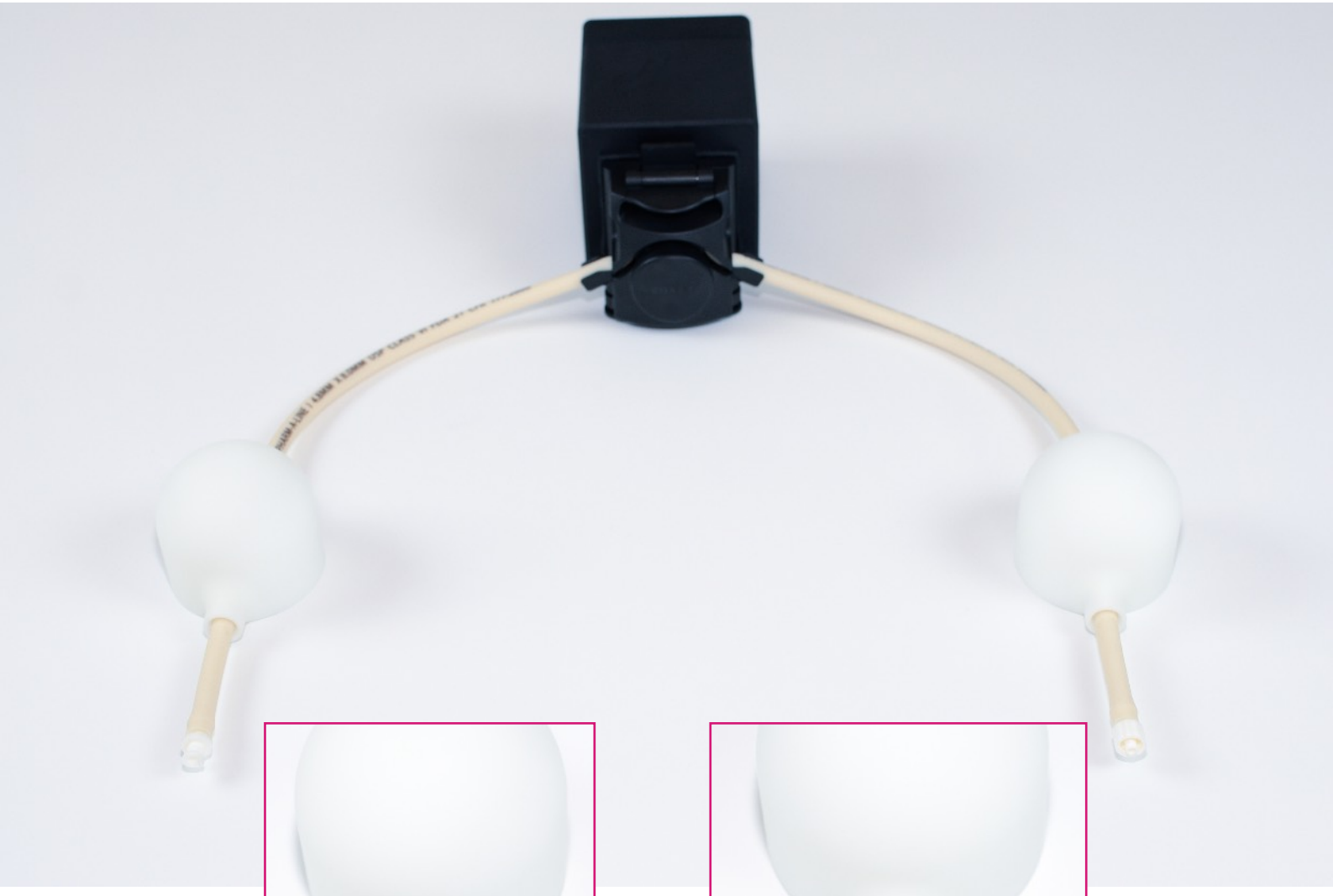
### Step 1

Pull the tab on the pump (1.) up to raise the rollers and insert the pump tubing (6.) ensuring it is centred between the rollers.

Press the pump tab down until it clicks, securing the tube in place.

## Step 2

Connect a pulse dampener (4.) to each side of the tubing, carefully pushing the tube all the way onto the fitting to ensure it seals. Fit the dampener connection tubes (5.) onto the the pulse dampeners, the male Luer lock on the right and the female Luer lock on the left, as shown below.

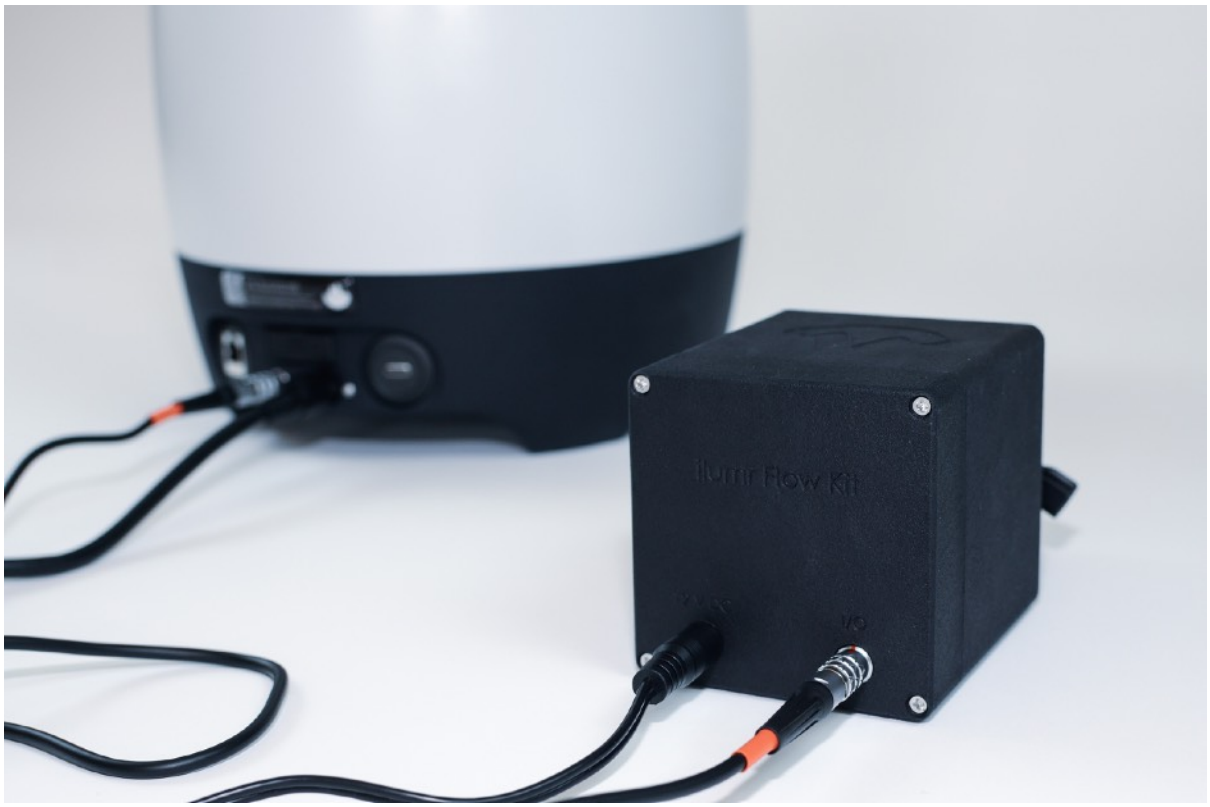


## Step 3

Fit the valve assembly (7.) to the left female Luer lock and then the interconnect tubing to the male Luer lock (8.) as shown below.

## Step 4

Before fluid is introduced, the next step is to connect the pump to the ilumr system. First connect the 12V DC power supply to the pump and then use the control cable (2.) to connect the pump to ilumr. Note that ilumr can remain powered up for this step.

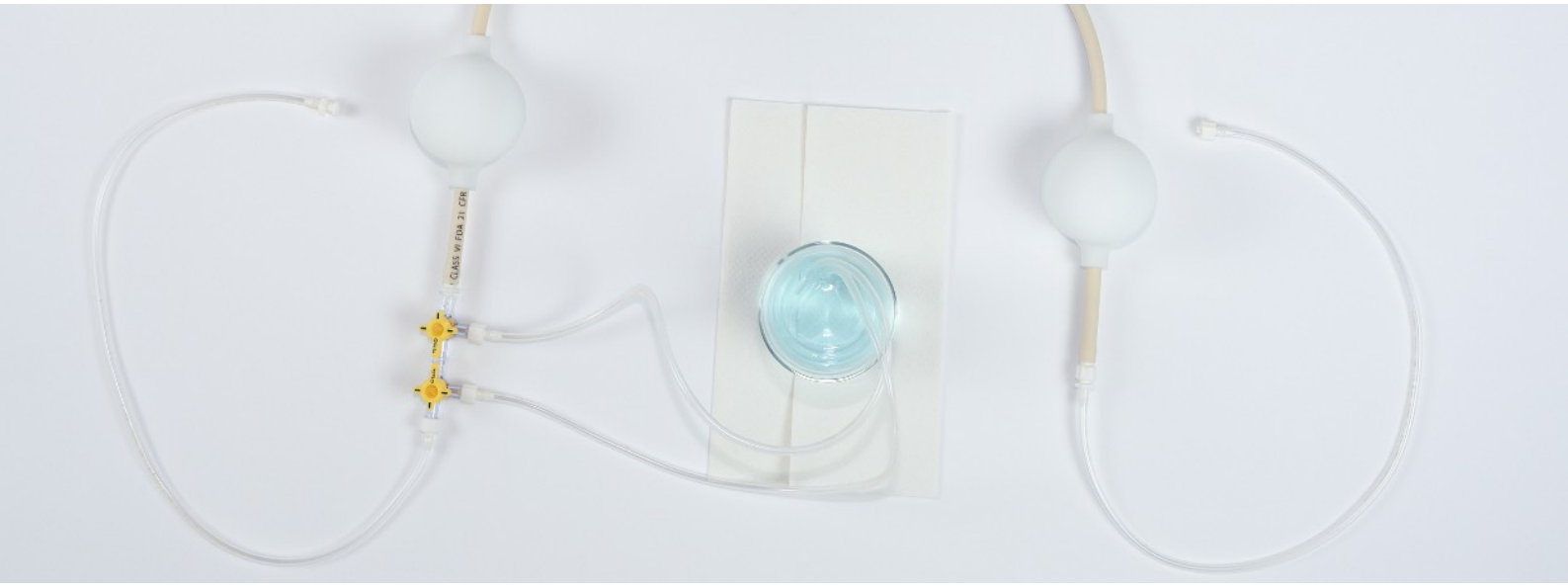



## Step 5

Connect the priming tubes (10.) to the remaining ports of the valve and submerge the other ends in the fluid to be flowed through the cell.

Note - for this setup a doped Copper Sulphate solution with a T2 of ~ 0.2ms was used. Ensure that there is at least 50mL of fluid prepared.

Check that the valves are correctly setup with the OFF labels facing each other as shown below. This is the correct position for priming the flow setup.




## Step 6

To prepare the flow cell, attach the bottom tubing section (9.) to the fitting at the base of a flow cell. The cell used as an example in the guide is the U Flow Cell and we recommend continuing with this cell to recreate the experiments shown in this guide.

Take 1 of the 10mm sample holders provided with this kit and place it on the cell approximately 50mm from the top as shown below. The height will be fine tuned later using a 2D Rare experiment.

## Step 7

Insert the prepared flow cell into ilumr, taking care to guide bottom Luer through the bore and out the side as shown below.

## Step 8

Complete the setup by connecting the flow cell to the pump system as shown below. When flowing the pump rotates clockwise with fluid flowing from left to right through the pump and then pushed up through the cell as shown in the image below.

Carry on with the next section to prime the system and perform flow imaging experiments.

## 1.3 Priming the system & running flow experiments

Now that the flow system is setup, the next step is to prime it. This involves pumping fluid from a reservoir using the priming tubes, filling and pressurising the dampeners to reduce flow pulsatility and removing small air bubbles from the system.

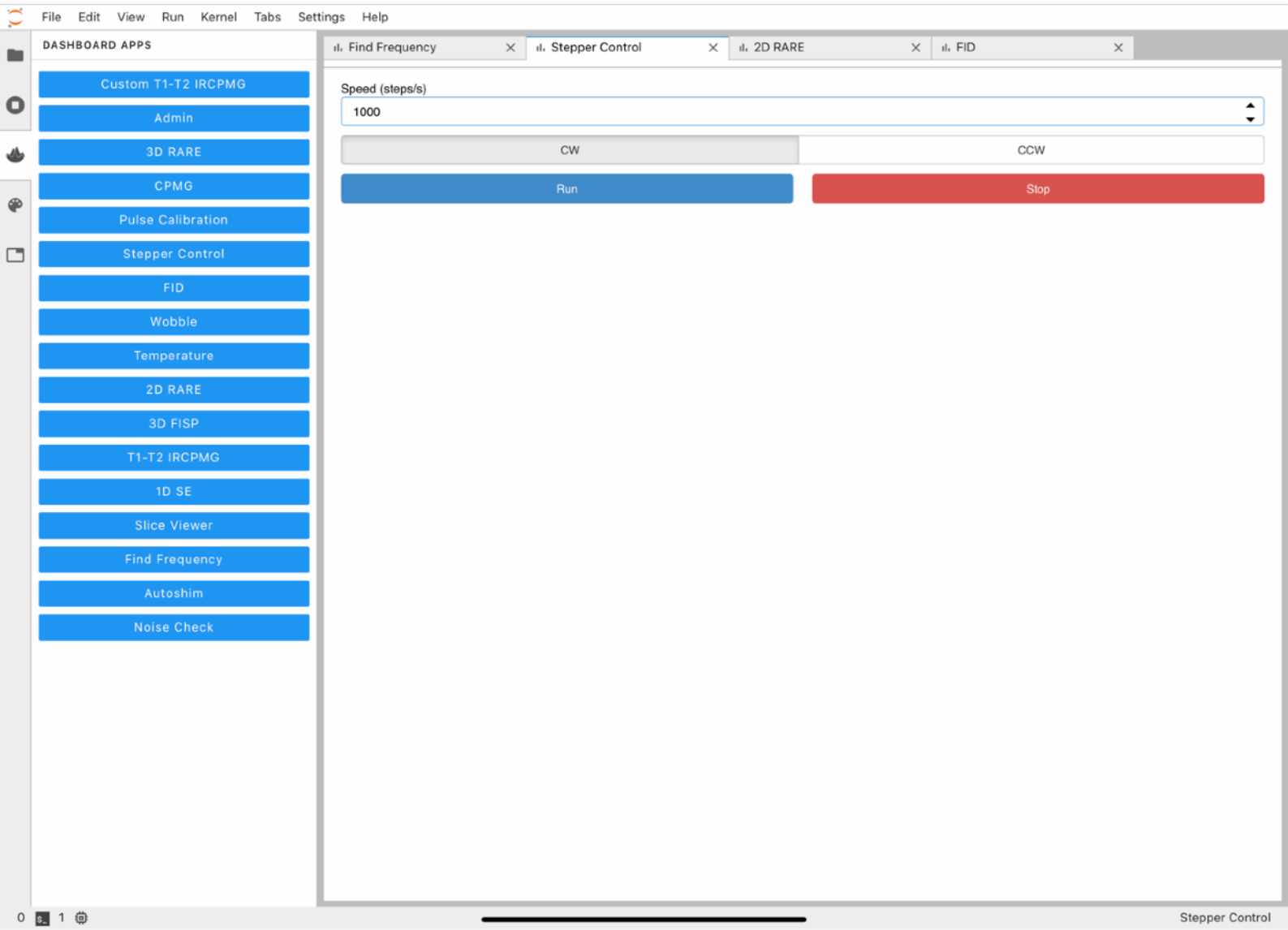
Follow the next steps to correctly prime the setup and perform flow imaging experiments.

### Step 1

Before continuing please ensure that the valves are setup correctly with the OFF labels facing each other. Once the system has been correctly primed, the valves can be rotated so that the OFF labels face down, parallel to each other.

In the ilumr software interface, open the Stepper Control dashboard, set the speed to 1000 steps/s and ensure the direction is set to CW (Clockwise). Then press the run button.

Let this run for ~3 minutes to prime the system, taking care to ensure the priming tubes remain submersed in fluid. Once complete there should be no air bubbling from the exhaust tube, inspect the fittings to make sure there are no leakages.



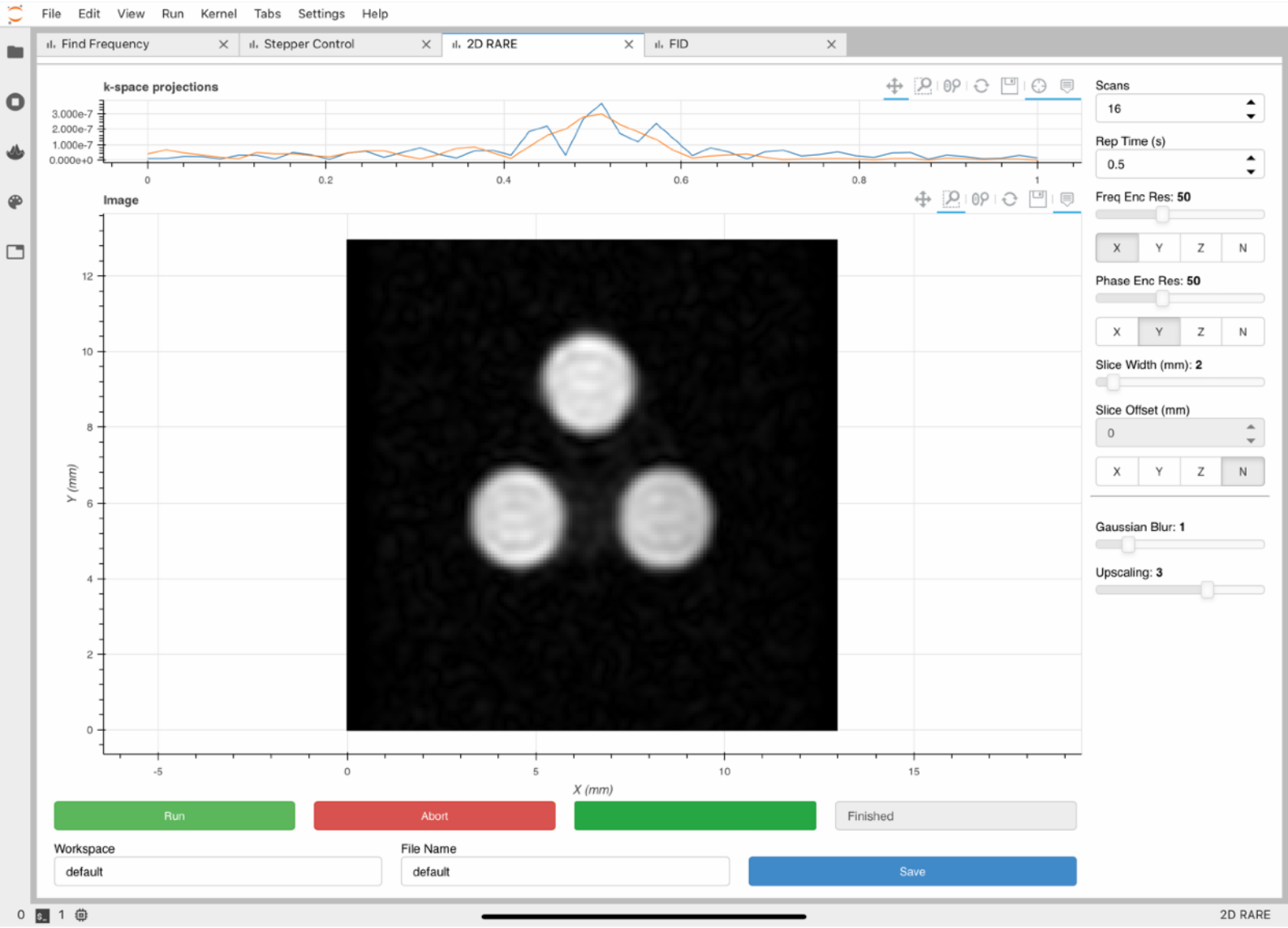
## Step 2

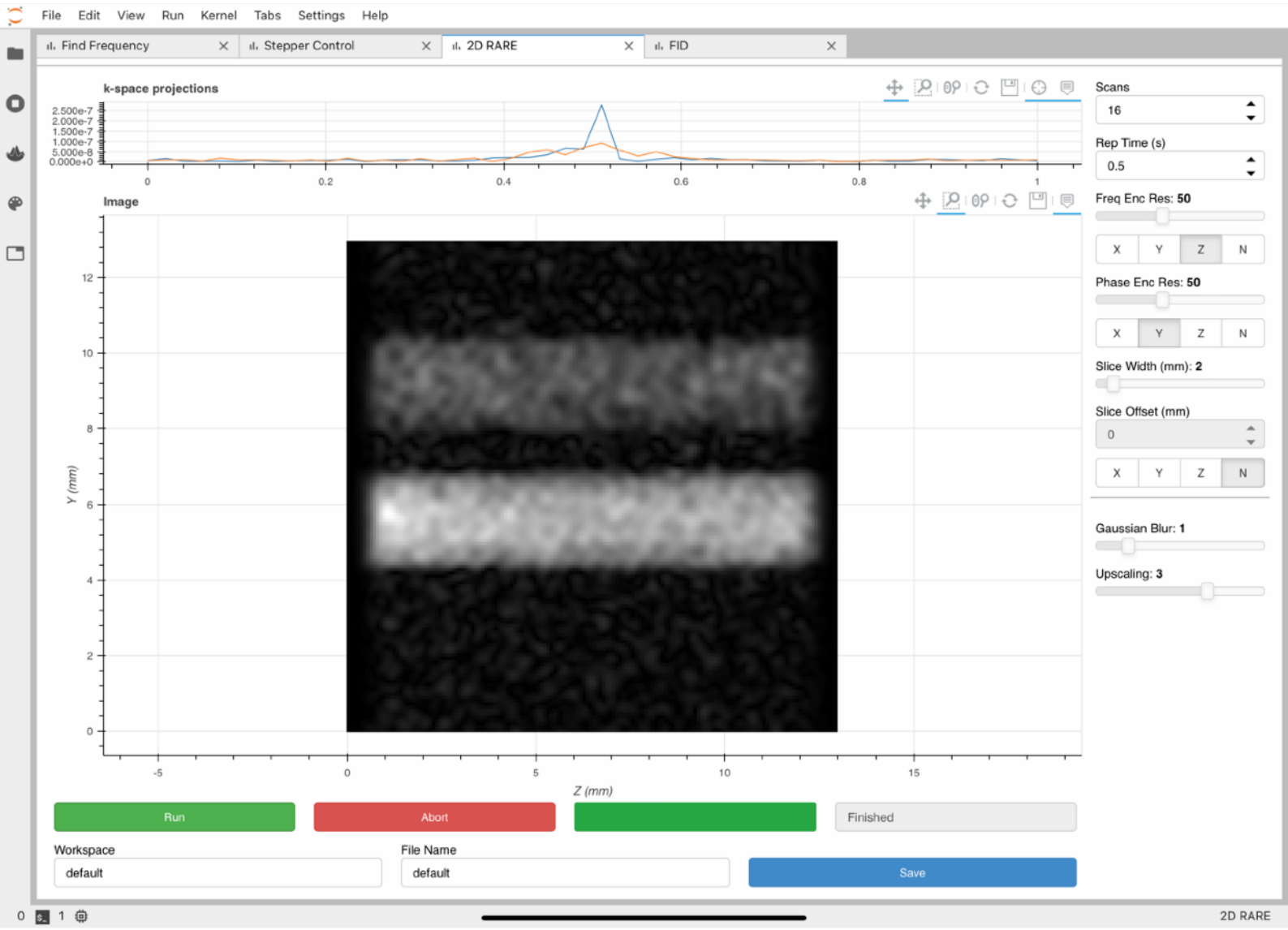
Once the system is primed, press stop on the Stepper Control dashboard and check that the pump has stopped rotating. The valves can then be rotated as shown in the image below to create a closed flow loop.

## Step 3

For this flow experiment we will perform a 2D flow profile of the U Flow cell to look at flow of fluid in the Z direction. Firstly check that the cell is correctly positioned in the RF probe by running some 2D RARE experiments using the 2D RARE dashboard.

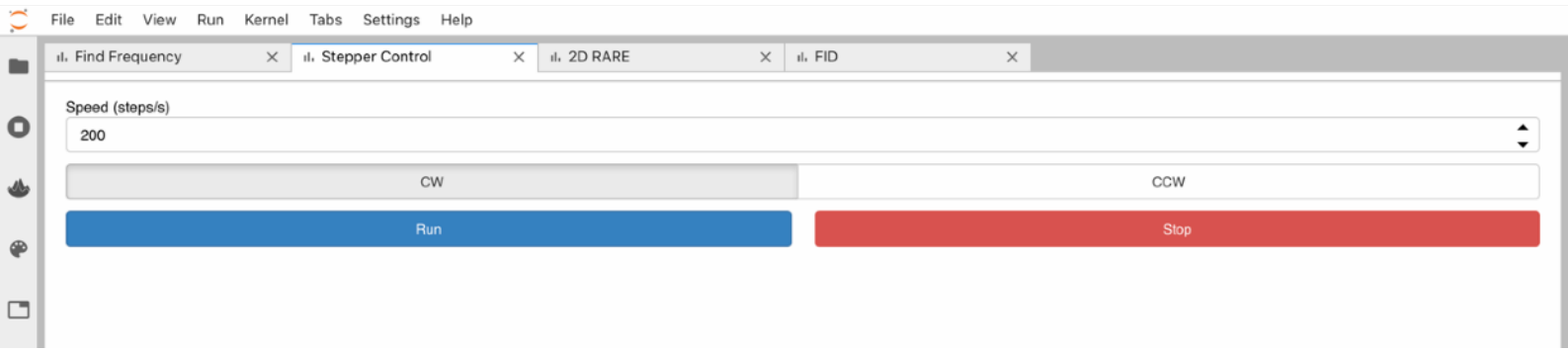
The U Flow cell has 3D flow geometries but for this experiment we want to position the cell in the FOV so that the flow is uniform in the Z direction. Run XY & ZY Projection 2D RARE experiments as shown below and on the next page to correctly position the flow cell. Ensure the system is primed and the pump is not running for these experiments.






## Step 4

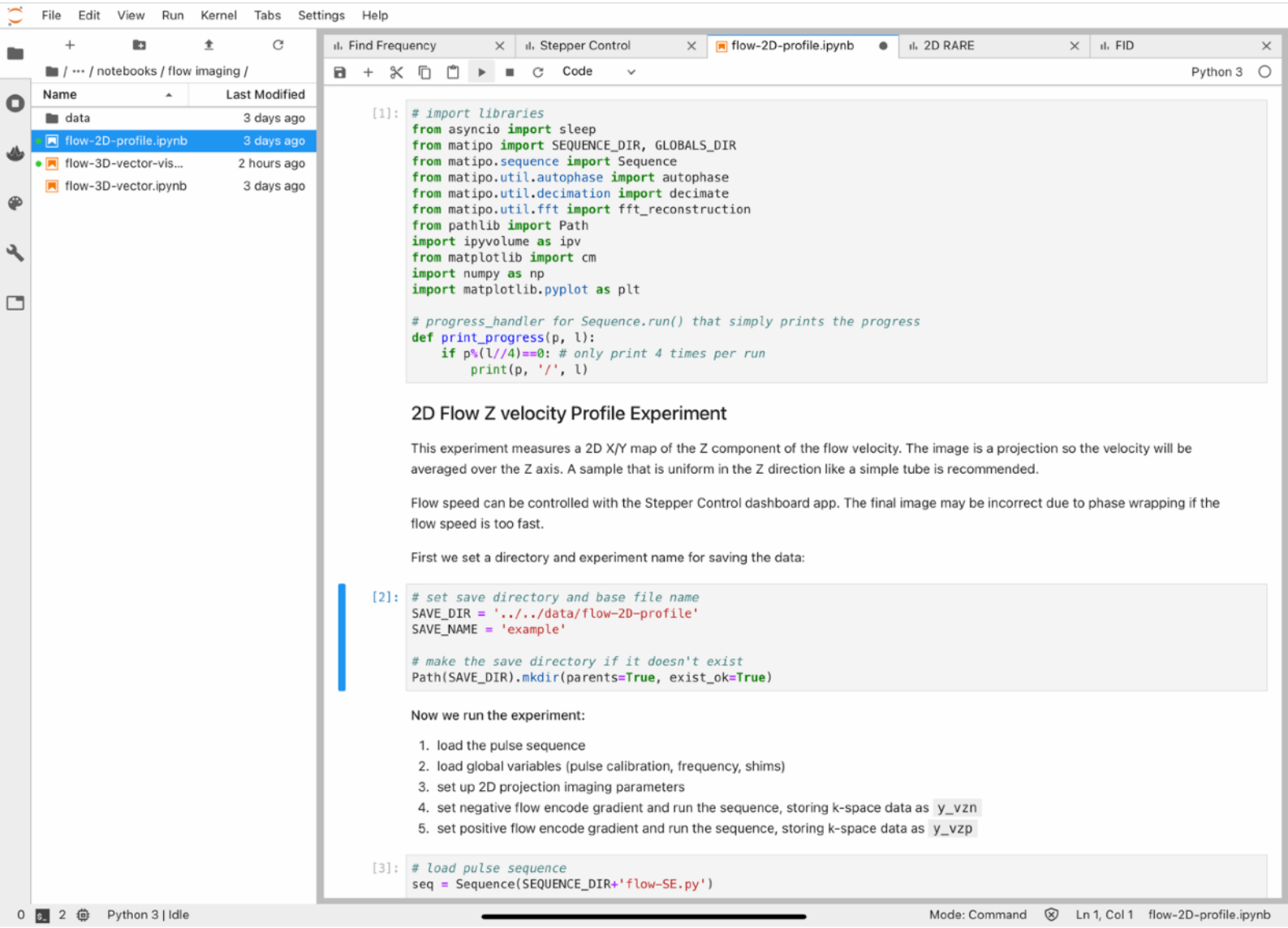
With the cell correctly aligned, set the pump speed to 200 steps/s, the direction to CW and run the pump.



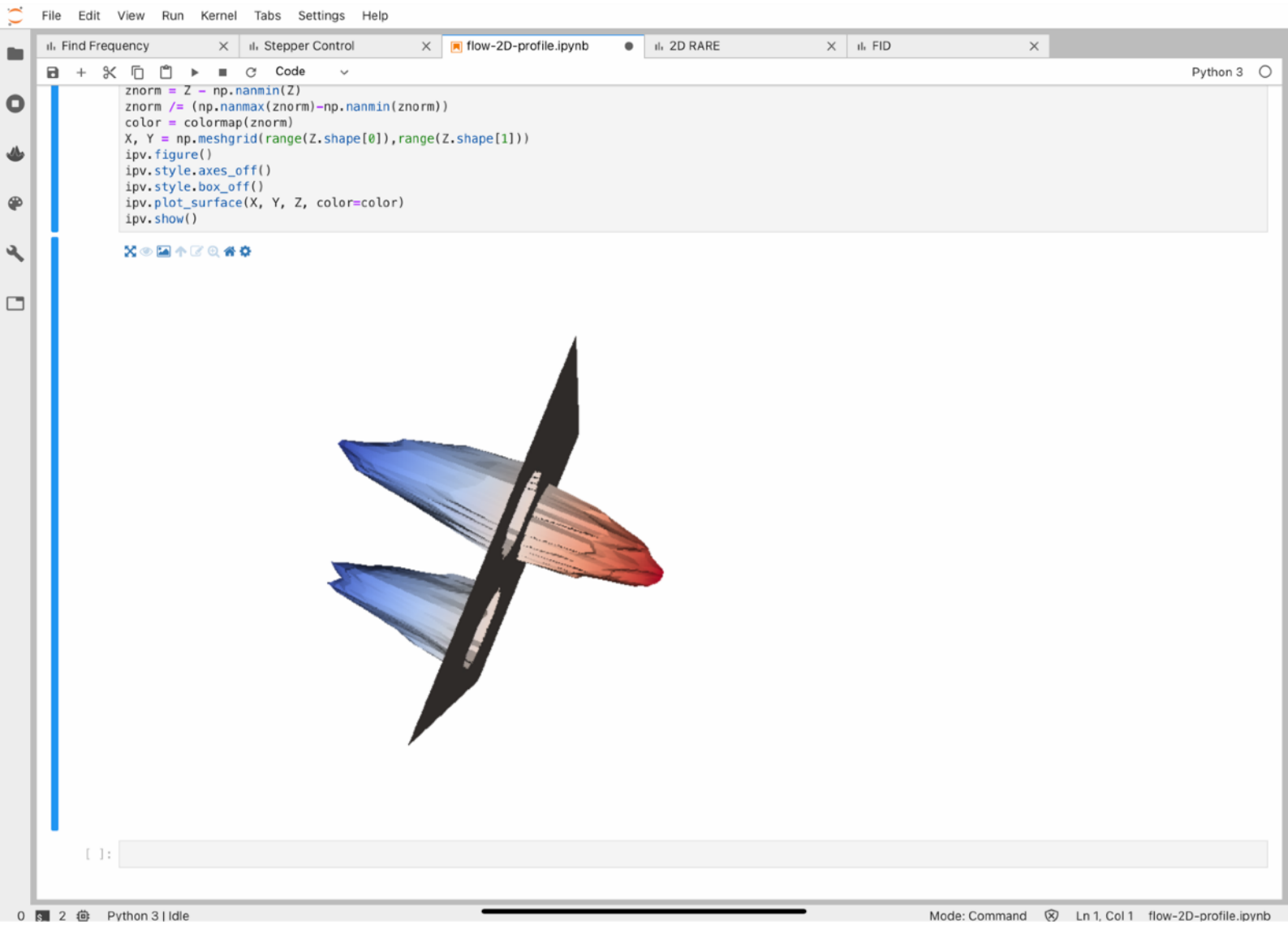
## Step 5

Navigate to the notebooks/flow imaging folder and double click the flow-2D-profile.ipynb notebook to run it.

Set up the directory and file names for saving the data and step through the notebook to perform a 2D Z flow velocity profile experiment. From this point refer to the notebook on ilumr for documentation of the experiment workflow and data processing steps.



On completion of the experiment, you should get a result similar to the image shown below showing speed and Z direction of flow through the tubes.




Following this you can work through the 3D - vector flow and the 3D vector flow visualiser notebooks to generate and view the vector flow data.

## Draining the Fluid

For draining fluid from the setup please follow this process.

- Stop pump - ensure the pump is not running.
- Rotate valves - set valves to connect the reservoir back into the fluid path.
- Priming tube - remove lower priming tube from the reservoir as shown below. Air will be drawn into the system through this tube.
- Run Pump - from the stepper control dashboard, set the speed to 100 steps/s and the direction to CCW (Counterclockwise) and press run.
- Wait - run this for ~3 minutes, until their is just air bubbling into the reservoir and the pipes are free of fluid.
- Stop pump - when drained the pump can be stopped and the system is ready for flow cell removal and replacement.