

Introduction

- Transcatheter aortic valve replacement (TAVR) is the most common type of aortic valve replacement.
- Lifespan of TAVR valves are limited to 10-15 years.
- Experimental systems and computational models can work in parallel to improve the design and subsequently increase the durability of these devices.
- The ViVtiro Pulse Duplicator is the most widely used in-vitro cardiovascular testing system of prosthetic heart valves.

Purpose: Design and implement a custom TAVR valve conduit to collect experimental data with the Pulse Duplicator system.

Experimental Setup

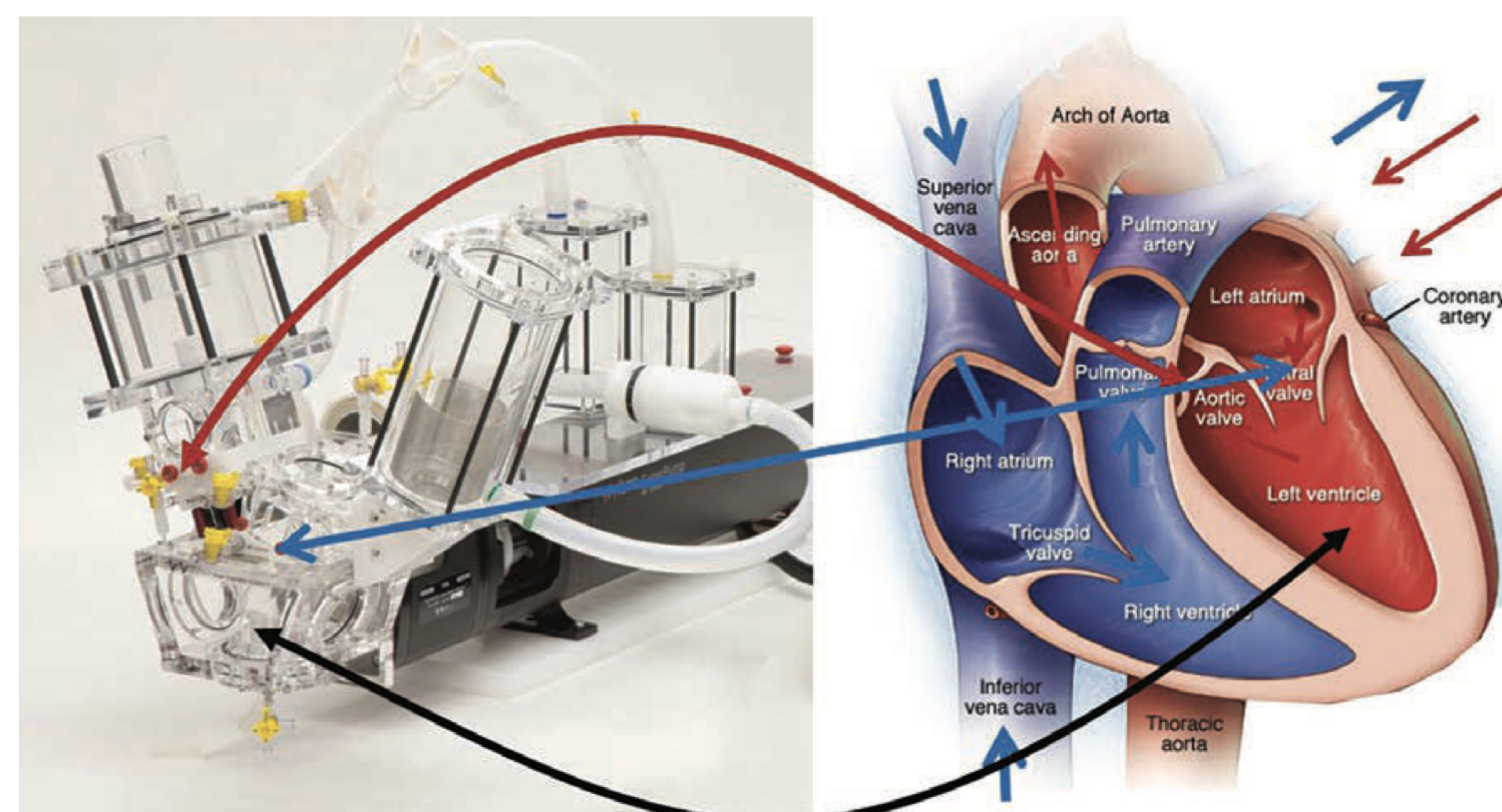


Figure 1. ViVtiro Pulse Duplicator System (left) relative to the chambers of the human heart (right).



Figure 2. ViVtiro Conduit Mount to load conduits for surgical device testing

Results

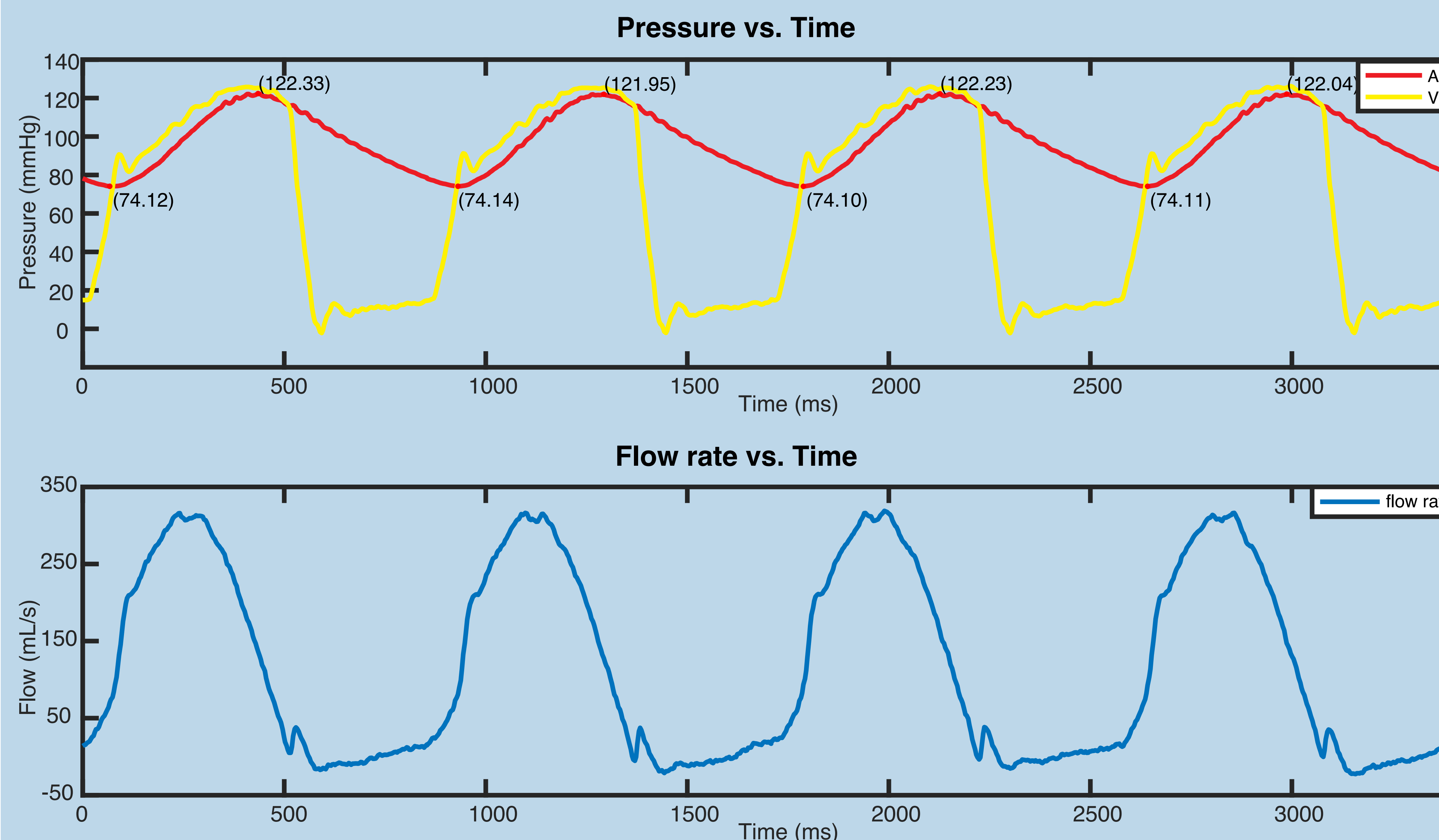


Figure 3. Aortic, Ventricular Pressures and Flow rate collected over four cardiac cycles with Medtronic CoreValve Evolut R loaded in the custom conduit.

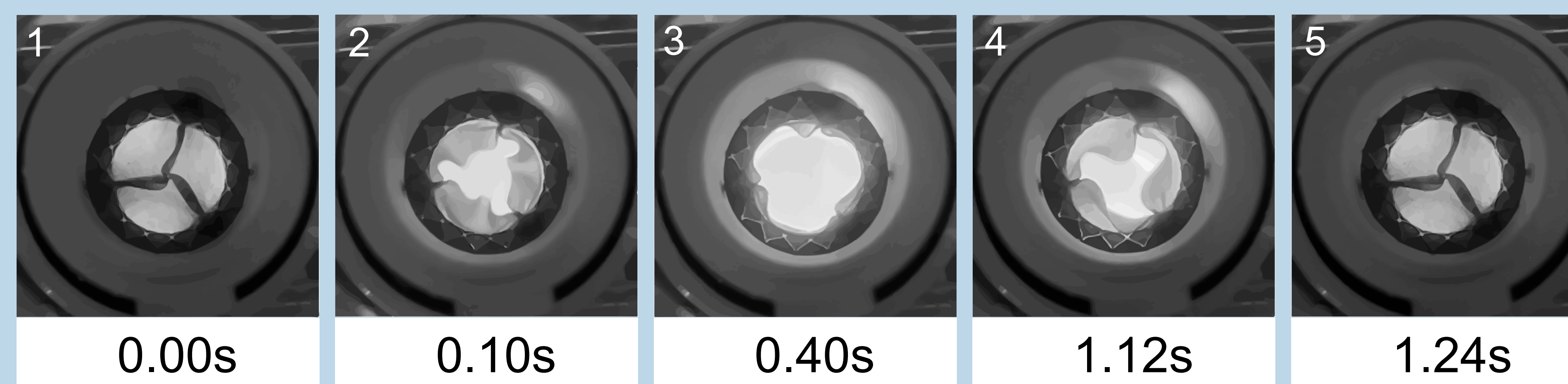
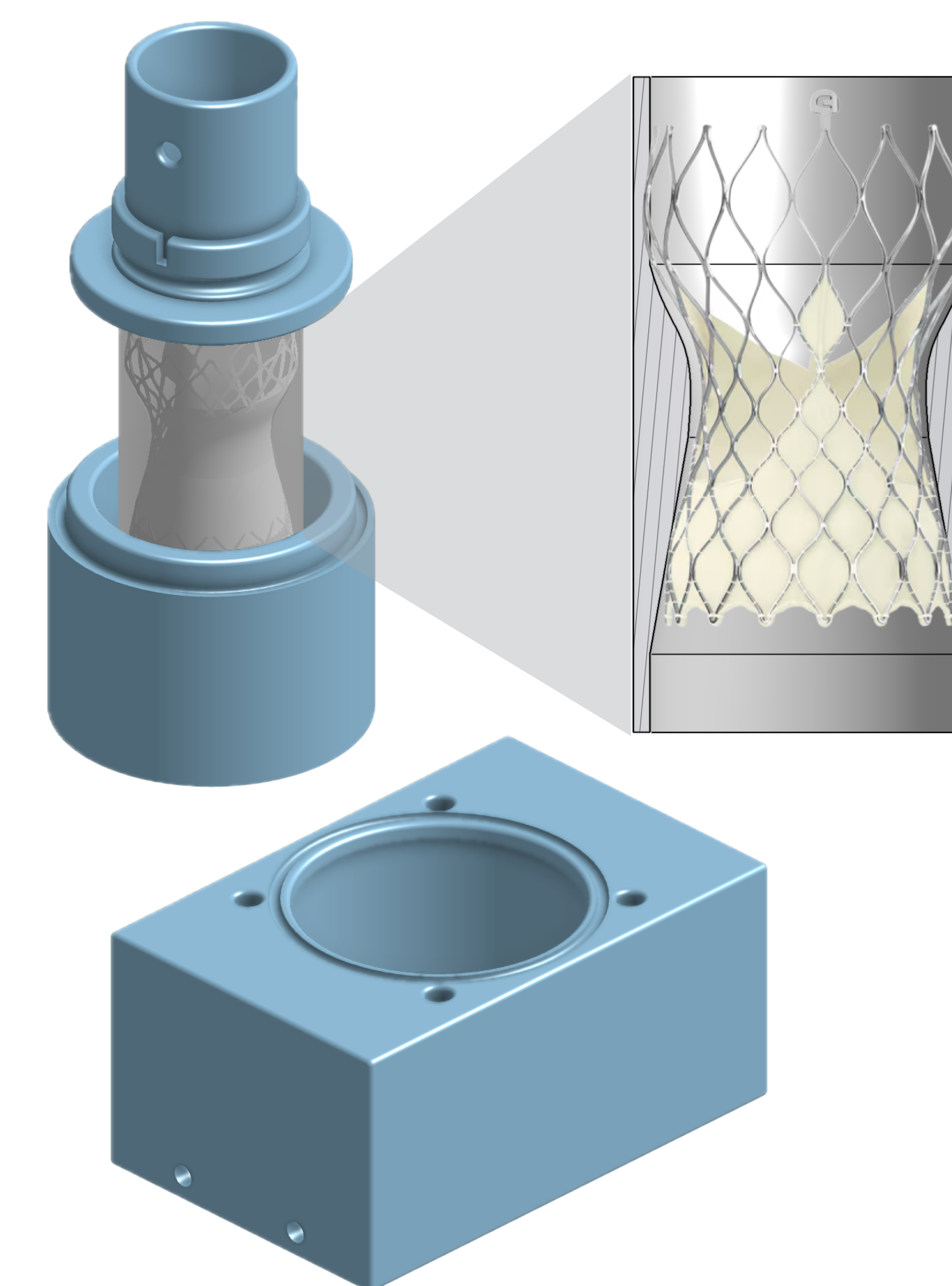


Figure 4. Timelapse of five representative frames within a cardiac cycle, taken from a slow motion video at 256 fps

Key Takeaways

- All experimental trials were performed with a stroke volume of 70 mL
- High-speed video synchronized with pressure/flow data to study leaflet kinematics
- Results were reliable and consistent over a range of tested heart rates (60-65-70-75-80-85-90 bpm)
- Conduit is compatible with the predecessor valve (29mm Medtronic CoreValve)
- Slight flow rate deviation at the end of systole suggests area for further investigation

Custom Conduit



- Modeled after the Vivitro Conduit Mount
- All components were 3D-printed using CPE at BeAM Makerspace
- All experimental trials were performed on a 29mm Medtronic CoreValve Evolut R (top right)

Future Directions

- Experimental data will be used to build a computational fluid-structure interaction model that enables precise control of the valve's leaflet biomechanics and flow conditions to isolate the effects of valve geometry on leaflet dynamics.
- The combined experimental and computational results will provide further insights into the assessment of TAVR devices.