Project Title: Imaging complex flows with magnetic resonance

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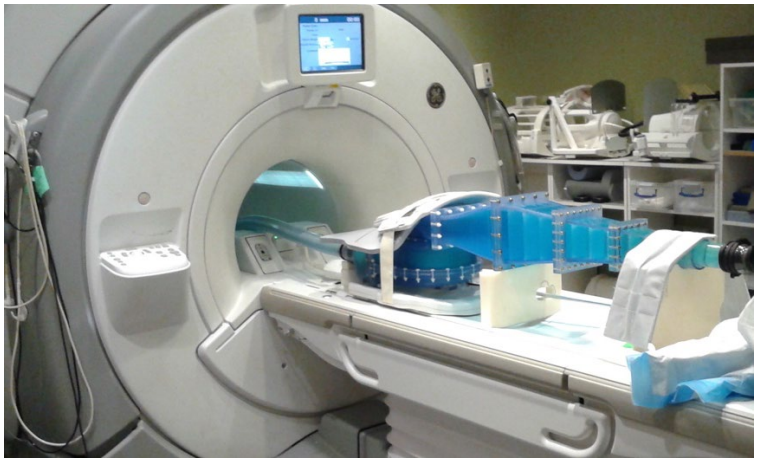
Project Description:

Internal flows in devices such as heat exchangers, in cooling passages and other turbomachinery components pose considerable challenges to designers who are often left with educated guesses and conservative safety factors. Reynolds-Average Navier Stokes (RANS) simulations are frequently used as a design tool despite the known fact that the turbulence closure models in RANS provide poor predictions of complex flows. As an alternative, the use of well-resolved simulations, is generally unaffordable for design purposes. Similar challenges arise when predicting flows along complex topographies or in human airways. Optical measurement techniques have greatly enlarged the possibilities and spatial range of flow measurements. However, they pose difficulties to measure internal and highly three-dimensional flow configurations due to the need of optical access. Magnetic resonance imaging (MRI) emerged as a non-invasive imaging technology to provide three-dimensional detailed anatomical images without the use of damaging radiation. Although its applications and developments are rooted in the medical community, it has already shown its enormous potential for the study of engineering flows and particularly, in applications where optical accessibility is limited or a large number of data points are needed.

This project is focused in fluid experiments using MRI techniques, which will be performed in collaboration with scientists at the Beckman Institute. The experiments use water as working fluid and the test-rig consists on a closed loop channel fabricated with non-ferromagnetic materials. The undergraduate researcher will assist in the design of experiments, from the conceptualization of new rigs to properly scale and reproduce the main non-dimensional flow parameters, to its CAD design, preparation for 3D printing and flow loop assembly. She/he will have the opportunity to learn the fundamentals of MRI, to obtain experience in design of flow experiments and to familiarize with several measurement techniques that will be used to ensure the correct rig operation.



MRI setup. The body coil is located around the region of interest prior to sliding the patient table into the scanner.

Student Background: We are seeking a highly motivated student interested in experimental fluid dynamics. Previous experience in measurement techniques is not required. Previous general fluids course work is desirable and familiarity with microfluidics or biological flows is a plus.

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