Development of an intracardiac flow-based energy harvesting mechanism for cardiac pacing

Background
Contemporary pacemakers are powered by primary batteries which have only a limited energy storage capacity. Thus, pacemakers have to be replaced after a few years. This re-intervention bears the risk of complications and is costly. To overcome these limitations, a long-term energy harvesting system is desirable. Due to its enduring and continuous contractions, the heart is a favorable energy source. To harvest energy from the relative movements between the endocardium and the blood flow, a floating lever-arm-like structure needs to be designed. This part captures the mechanical energy and transmits it to the conversion mechanism, consisting out of an electromagnetic generator (already existing project).

Aim
The aim of this project is to develop an intracardiac floating lever-arm-like structure capturing energy from the relative movements of the endocardium and the blood flow.

Tasks
• To familiarize with the concept of energy harvesting, cardiac anatomy and intracardiac pulsatile flow.
• Design study of possible floating structures (e.g. buoy (Fig. 1), sail, flag) with regard to optimal efficiency and minimal thrombogenicity.
• To minimize thrombogenicity, design criteria such as material and the shape of the lever-arm need to be taken into account. Moreover, the design of the lever-arm-like structure should be compliant with physiological blood flow (e.g. minimal blood stasis and turbulence).
• Experimental testing of the floating structure will be performed by either tomographic particle image velocimetry (PIV), computational fluid dynamics or a pulsatile flow setup with blood and blood analog. The group also provides the opportunity for in vivo testing (animal trial). The Master candidate can choose the experimental methods according to her/his preferences.

Nature of the Thesis
Analytical: 20%  Experimental: 35%
Hardware development: 35%  Documentation: 10%

Specific Requirements
Biomedical engineer with interest either in computational fluid dynamics and simulation or experimental methods.

Supervisors
1.) Adrian Zurbuchen, MSc
2.) Barna Becsek, MSc

Examiners
1.) Prof. Dominik Obrist, PhD
2.) Andreas Haeberlin, MD, PhD

Institutes/Collaborators
The student is given the opportunity to work on a highly innovative project, involving the following institutions:
• Department of Cardiology, Inselspital, Bern University Hospital
• ARTORG Cardiovascular Engineering, University of Bern

Contact
Adrian Zurbuchen (adrian.zurbuchen@artorg.unibe.ch), Murtenstrasse 50, 3010 Bern