# Cardiac Impedance Signal Acquisition and Processing for an Implantable Intraventricular Flow Accelerator

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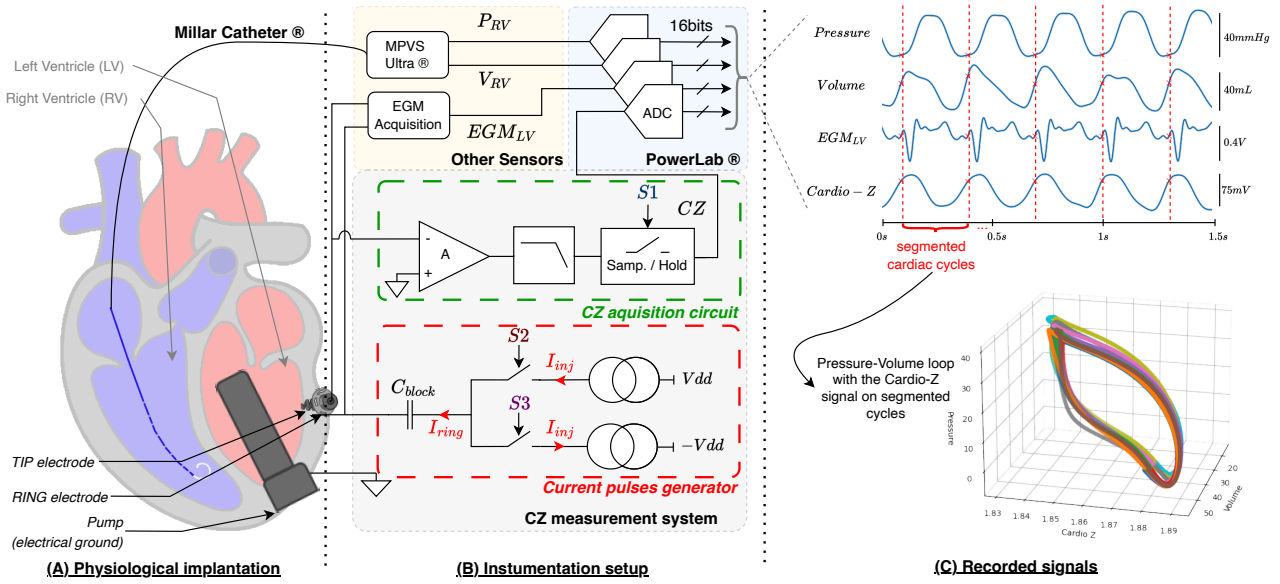


**Figure 1:** Overview of the investigated experimental setup: (A) The pump is implanted in the Left Ventricle (LV) and is used as electrical ground. The epicardial probe is bipolar: a RING electrode is used to inject a current ($I_{ring}$) and the resulting voltage is sensed on the TIP electrode. Both electrodes are used to measure $CZ$. (B) A Millar® Catheter records both right ventricule (RV) volume and pressure. The LV electrogram ($EGM_{LV}$) is acquired through the differential voltage between TIP and RING electrodes. The CZ measurement system is composed of a current pulses generator and a CZ acquisiation circuit. (C) Example of signals over several cardiac cycles.

Heart failure remains a major global health concern, affecting over 56.5 million people worldwide. The FlowMaker® designed by FineHeart is an intraventricular flow accelerator offering an innovative alternative to Left Ventricular Assist Devices (LVADs) by providing pulsatile blood flow without aortic bypass. However, current methods for adjusting its parameters rely on echocardiographic monitoring, limiting real-time adaptation. This study introduces an intracardiac impedancemetry system for the continuous monitoring of ventricular function, potentially eliminating the need for frequent echocardiographic assessments.

The proposed system currently investigated (see Figure 1) leverages an epicardial probe to measure intracardiac impedance ($CZ$) and electrogram ($EGM_{LV}$) in the left ventricle (LV), alongside usual hemodynamic data, i.e. pressure ($P_{RV}$) and volume ($Vol_{RV}$) signals, in the right ventricle (RV) for space reason. We designed an experimental setup integrating a Millar® catheter and PowerLab® acquisition system to simultaneously record these signals in an *in vivo* ewe model. Our methodology involves impedance measurement using a bipolar epicardial probe with a RING electrode for current injection and a TIP electrode for voltage sensing. Data acquisition follows a charge-balanced biphasic pulse protocol, ensuring safe tissue interaction.

Signal processing includes noise reduction via a low-pass FIR filter, segmentation based on $EGM_{LV}$ R-wave detection, and correlation analysis between $CZ$, $P_{RV}$ and $Vol_{RV}$. Initial results suggest a linear relation between impedance variations and hemodynamic data, supporting the feasibility of CZ-based cardiac function assessment.

Future studies will refine the correlations between those signals, focusing on timing paramaters and comparing their evaluation with conventional hemodynamic or cardioimpedance signals, at scale of the cardiac cycle. Such measurements can be used as biomarkers to tune the pump parameters and provide feedback on patient's health condition with the LVAD. Finally, we will explore the clinical applicability, and assess long-term signal stability of this new method through chronic experiments.

**Keywords:** LVAD, Intracardiac Impedance, Biomedical Circuit, Signal Processing, Cardiac Monitoring