Developing and measuring an impedance sensor in microfluidic channels for cell classification
Master student project assignment

Introduction
Despite a number of notable examples in which neural networks (Fig 1) are implemented in healthcare, such as recognizing skin cancer from images, assessing heart attack and heart failure and helping early detection of acute kidney failure, the unprecedented efficiency and wide applicability of machine-learning combined with dedicated analogue neuromorphic computing, has not been demonstrated to date and can open up a new multidisciplinary field of research with numerous pioneering applications.

Apart from primarily biochemical selection criteria, also physical sensing or “label free” sorting mechanisms can be used which can either be passive or active. These methods rely on cells’ intrinsic properties such as size or mechanical stiffness. Benefiting from the different physical and electrical properties of CTCs, microfluidic classification devices based on micro-impedance cytometry have been demonstrated, some of them combined with mechanical characterisation, making use of difference in mechanical properties between CTCs and blood cells.

However, despite various approaches to classify and sort CTCs, no method seems to be able to handle the detection of heterogeneous CTCs accurately and rapidly, which will be the strength of integrated neuromorphics and sensors.

Project
We want to exploit the remarkable efficiency of neural networks [1] in a dedicated lab-on-a-chip to recognize and classify circulating tumour cells (CTC) in blood (Fig 2). For that multiple sensor inputs to the neuromorphic array on the lab-on-a-chip are necessary. In this project one of those sensors will be developed and tested. The impedance sensor will be fabricated inside a microfluidic channel and can be tested on real cells as well as plastic microbeads.

The project will consist of the fabrication of microfluidic channels as well as electrical impedance sensors. Electrical measurement using LabView or related software and dedicated hardware is required. First, simple polystyrene beads will be assessed and classified according to size (see ref [2]) before moving to biological cells. See Figure 3 for an example of such a device. Another example of a small impedance sensor is given in ref [3].

Goal
Design and implement of an impedance sensor capable of in-line microfluidic cell sensing.