It has become clear that RNA plays a key regulatory role in cells, particularly in eukaryotic cells, where the discovery of RNA interference machinery has opened up possibilities for an entirely new array of therapeutics. Recently, RNA-based synthetic – non-living – devices were shown to be an ideal solution to detect viruses (e.g. Ebola and Zika) at the point-of-care, even discriminating between different virus strains.

We have adopted these novel RNA devices to answer more fundamental questions on the complex information processing capabilities of living cells. We aimed to achieve this by using the RNA devices to reconstruct a key regulatory network outside of the cell itself. Omitting the actual living cells allowed us to avoid time-consuming steps in the implementation procedure, as well as provide great flexibility in experimental conditions.

Long-lasting studies will be realized using state-of-the-art microfluidic devices that mimic bacterial cell division in minuscule reaction chambers. In addition, the unique minimalistic approach taken in this research allowed for the tight integration of computational methods to reason about the network and aid experiment design.

Experimental and computational workflows to rapidly implement and evaluate parts of the network were successfully set up and the network of interest was partially implemented. In parallel, the feasibility of implementation of more complex networks was assessed and parts necessary to achieve this were implemented.

**Figure 1: The experimental set-up to implement cellular functions outside of living cells.**

**Figure 2: Demonstration of the implementation of a simple gene cascade outside of living cells.**

Here, gene A activates gene B, producing an output protein. It was shown that gene A and gene B do not give output in isolation, but do produce a large amount of output protein when combined.