# In vitro test bench to reproducing pulsatile flow conditions

Cardiovascular diseases are among the top causes of mortality in the world. Huge efforts are made to fight against the cardiovascular diseases. However, the variability of the symptoms and risk factors makes this fight very challenging.

Fig. 1. The in vitro test bench (EP2779144 A1).

While the mechanisms leading to cardiovascular diseases are still not fully understood, experts agree that several cardiovascular complications are associated to endothelium response to the flow conditions. The cardiac pulsatile flow profiles induce mechanical forces, which are believed to control vessel wall expansion-retraction, vascular remodeling, the adhesion and infiltration of immune cells and vascular permeability. On the other hand, flow abnormalities resulting from the action of certain vascular pathologies or pathogenic agents can produce an abnormal endothelial response. This abnormal response can eventually lead in the development of cardiovascular diseases like atherosclerosis or the formation of aneurysms.

In order to better understand how these pathologies progress, *in vitro* systems were created to study endothelial behaviour in function of the flow conditions and in the presence of pathogenic factors, in a controlled environment. Several *in vitro* systems, with different degrees of complexity, have been created by different teams worldwide. However, none of them was capable to fully reproduce the physiological conditions (such as gas balance, temperature, proper pH, osmolality and sterility) and at the same time be capable of reproducing complex flow conditions, essential to properly reproduce the microenvironment to which the endothelium is exposed.

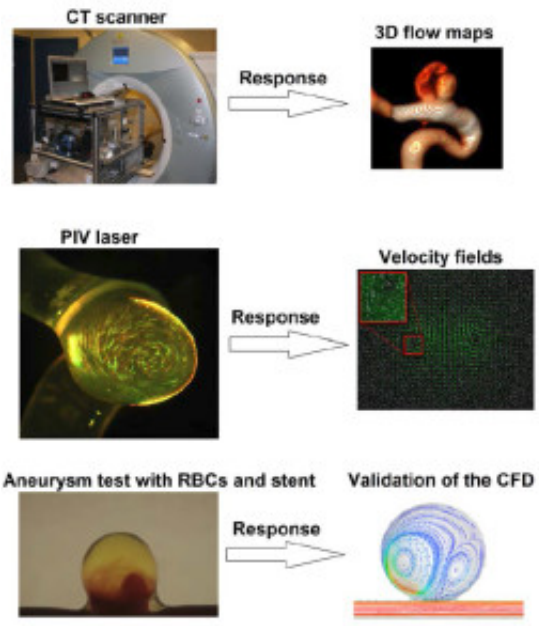


Fig. 2. Exploitation of the in vitro test bench capabilities.

With the purpose of fulfilling this gap, we built an *in vitro* device capable of mimic, *in vitro,* the exact signals encountered in the blood vessels under near to physiological conditions. This system, the *in vitro* test bench is composed of a linear motor with customized piston pump and a centrifugal pump reproduce together the mean flow rate as well fluctuations around this mean value. The test bench is also equipped with heating system and valves to mimic pressure and operates under sterilized conditions. The whole system is controlled by sophisticated set of controllers under Labview® environment.

Real flow conditions, obtained from patients, are recorded and post-processed to enable extraction of derived physical quantities, such as flow rate, and wall shear stress. The signals generated can then be applied to endothelial cells seeded in a transparent cylindrical culture chamber, which can be adapted to reproduce pathological environments like the intra-aneurysmal flow conditions. This culture chamber allows the recreation and recording of a more realistic hemodynamic environment (flow rate, pressure, temperature) and the microscopic follow up of the culture, while the system is running (Fig. 1). Moreover, the compact and versatile designed of the test bench, makes it very easy adaptable to work with additional supporting equipment such as participle image velocimetry laser or computer tomography scanner, expanding the potential applications of the device (Fig. 2). This patented (EP2779144 A1) test bench has successfully taken part of the European projects BioWin (WallBiostent, Belgium) and Thrombus (www.thrombus-vph.eu/).

## Publication

An in vitro test bench reproducing coronary blood flow signals.
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