Analysis of the flow field downstream a bileaflet valve inside an aortic arch laboratory model

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\textit{In vitro} analysis of the heart prosthetic valves has widely studied due to the effects that those devices can produce after the surgical replacement; in particular the study of the aortic valve is of great interest since the aorta is the largest artery leaving the heart and plays a fundamental role in the circulatory system during the systole phase. Worldwide several Pulse Duplicators (PDs) have been designed to simulate the heart/circulatory system behavior. The objective of this study is to analyze the performances of a mechanical bileaflet aortic valve placed in an elastic and transparent anatomically accurate replica of a human aorta, placed in a new PD sketched below.

In particular we propose an integrated approach aimed to define the following aspects: definition of the global parameters in agreement with the existing normative UNI EN ISO 5840 concerning the cardiac heart valves; analysis of the dynamics of the opening/closing mechanism of the valve leaflets; characterization of the flow field near the valve. The global hydrodynamic performance has been tested by analyzing the Effective Orifice Area (EOA) following the normative requirements.

The behaviour in time of the left and the right leaflet tilting angle highlights that the two leaflets move asynchronously, in particular during the opening phase.

To investigate the prosthetic valve leaflets dynamics, images were acquired by a camera.

Finally the viscous shear stresses have been computed, due to the fact that they are more likely related to blood cells damages. The presence of the bileaflet valve determines a complex texture of high shear streaks, due to the development of three jets. In particular it has been observed the asymmetry of the higher values reached, accordingly with the asymmetric phenomenon observed in the valve dynamics.