Combining multi-plane TR-SPIV measurements within a pump by assigning the rotation angle to POD coefficients

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Keywords: Combining multi plane PIV, POD, Regenerative flow pump

HIGHLIGHTS

• A 3D-3C flow field within a pump is reconstructed by combining multiple, independent 2D-3C Time Resolved Stereo PIV measurements.
• First, more common approaches (Time/Phase Averaging) per measurement plane are introduced to understand the basic flow situation.
• Finally, the flow is reconstructed by assigning the rotation angle of the impeller to Proper Orthogonal Decomposition (POD) coefficients.

ABSTRACT

The purpose of the present study is to combine the results of multiple 2D-3C Time Resolved Stereo Particle Image Velocimetry (TR-SPIV) measurements at different axial positions (Fig.1 c)) within the side channel of a regenerative flow pump (RFP) as seen in Fig.1 a). At first, the used setup as well as conclusions of previous more common approaches are presented (Fig.1 b)). Afterwards, the PIV data is processed by means of Proper Orthogonal Decomposition (POD) to analyze the various planes by their dynamics. In a final step the temporal contribution of each POD Mode is correlated to the angular position of the pump impeller gathered by a common sensor system, allowing an energy weighted reconstruction of the flow. Final result is a reconstructed 3D-3C time resolved flow field within the measured 3-dimensional regime (Fig.1 d)), giving an idea about the “footprint” of the impeller onto the main flow. The used method of combining, as well as the dynamic energy based filtering approach is presented.

Fig.1 a) Flow through the RFP: PIV measurement area marked in red. b) Exemplary dominant modal pattern within the side channel. c) axial slice through the side channel; Axial measurement planes in green; secondary flow indicated in red. d) Isosurfaces of reconstructed axial velocity distribution within the side channel (yellow: from impeller; blue: into impeller).