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### Validation of Intracranial Aneurysm Flow: Standard PIV vs.Stereoscopic PIV vs. Tomographic PIV vs. Phase-Contrast MRI vs.CFD

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Computational Fluid Dynamics (CFD) simulations to assess the rupture risk or improve the treatment planning of intracranial aneurysms have become popular recently. However, due to strong modelling assumptions and limitations, the acceptance of numerical approaches remains limited. Therefore, validation using experimental methods is mandatory. For such a validation two principle approaches are available: the in-vivo method, where the flow validation data is directly obtained from the patient using a phase-contrast magnetic resonance imaging (PC-MRI) measurement, or an in-vitro method, where validation measurements are undertaken under well-defined and controlled conditions using optical flow measurement techniques (often particle image velocimetry – PIV). In this study, the PC-MRI as well as different PIV techniques (standard, stereoscopic and tomographic) are applied to measure the flow in a patient-specific silicone phantom model of an internal carotid artery aneurysm. To evaluate differences between each technique, a similarity index with respect to the velocity vectors was determined. The qualitative comparison reveals that it is possible to properly describe the global flow structures with all five methods. High quantitative agreement was found between the PIV methods. However, quantitative differences were found between PC-MRI and the PIV measurements. The findings demonstrate that in-vitro measurements can be used to validate numerical simulations in intracranial aneurysms. However, each approach exhibits clear advantages and disadvantages, which influence the quality of every technique leading to quantitative deviations among them.