

PIV Validation of OpenFOAM Turbulence Models for LIMETS Project Water Test Section

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The spallation reaction is used in various directions – the material investigation, as well as medicine and fundamental research. In powerful installations of this kind, a large amount of heat is generated, consequently, the heat removal from the active zone is among the most important factors in optimizing a liquid metal target design. The LIMETS (Liquid Metal Target for SINQ) project consists of several steps involving both water and liquid metal tests. This work presents PIV (Particle Image Velocimetry) measurements, which have been carried out in a specially designed test section with water as a working fluid. The obtained data ensure reliable experimental validation of numerical calculations performed by RANS (Raynolds Averaged Navier Stokes) and LES (Large Eddy Simulation) approaches in OpenFOAM.

During this project, successful and extensive measurements and computations were carried out where significant experience was gained in conducting PIV experiments for constrained curved geometries. The knowledge acquired produces necessary reference basis for further development of the new targets in the future. It was proven that an obstacle in the flow can intensify turbulence, but the optimization is needed. The experimental results also show the zones of extensive turbulence energy generation, which concords well with the theoretical concept.

During the calculation phase of this project, RANS and LES results in using OpenFoam were compared (Figure 1). Both approaches showed a good performance in estimating the mean flow field, with small differences, mainly connected with the finite length of the computational domain. For the turbulent kinetic energy field, the RANS based calculations are considerably worse compared with the LES calculations – few qualitative differences are present, however, the turbulence energy field estimated by LES model is in better agreement with experimental data.

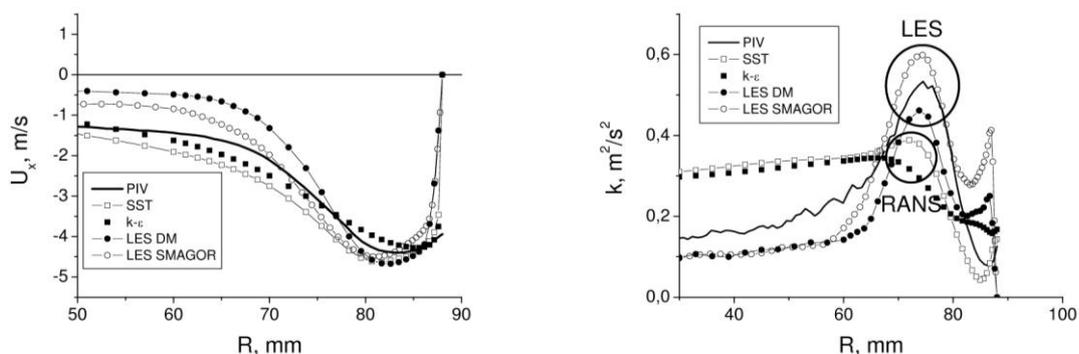


Figure 1. Profiles of the x-velocity component (left) and turbulence kinetic energy (right) along the line perpendicular to wall obtained with PIV and the different turbulent models.

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