Particle Image Velocimetry at a generic space launcher model at Mach 5.9

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This contribution discusses particle image velocimetry measurements at a generic space launcher model with the focus on liquid tracer particles at a Mach number of $M=5.9$. The test facility, the Hypersonic Ludwig Tube Braunschweig, is a blow down type wind tunnel which allows unit Reynolds numbers between $Re=3\times10^8$ m$^{-1}$ and $Re=20\times10^8$ m$^{-1}$ at a Mach number of $M=5.9$. Due to the conditions inside the storage tube, a pressure of up to 30bar and a temperature of up to 623K, the material of the tracer particles have to be chosen carefully. The presented work includes a qualification of the atomizer ATM210 with two different oils, Emery 3004 and PlantFluid. The results show that the quality of the tracer particles at the outlet of the atomizer complies with the requirements. During the wind tunnel measurements the effects of the aerosol facility operating parameters, wind tunnel parameters, and laser energy to the tracer particles were investigated. Both oils were tested and the oil PlantFluid was found to be more resistant to higher temperatures. Additionally, the number of particle images increased at higher laser energy. However, the resulting velocity vector fields show that the quantity of tracer particles inside the boundary layer, the wake, and the recirculation area behind the generic space launcher model was insufficient to measure turbulent stresses. A mean velocity vector field, based on 160 double images, could be computed. Based on numerical flow simulations and particle path calculations the problems with the tracer particles were analyzed. Measurements inside the recirculation area, using local seeding, was also tested.

References