# Tomographic shadowgraphy of swirled non-reactive spray injection in a generic aero engine burner under realistic operating conditions

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## HIGHLIGHTS

- A specifically designed optically accessible rig replicates the aero-thermal and aero-dynamic conditions of swirled fuel spray nozzles
- The unsteady kerosene spray distribution and velocity from a single jet-in-crossflow injection nozzle is captured using 4 cameras and pulsed LED illumination
- Macroscopic imaging with magnification exceeding unity resolves droplets down to 10 µm
- The recovered velocity data is in good agreement with corresponding PDA measurements

## ABSTRACT

This contribution describes the application of tomographic shadowgraphy to measure instantaneous droplet velocities undergoing airblast-atomization in the non-reactive flow of a generic aero engine burner model at Weber numbers of $We_{aero} = 360-770$, air pressures of $p_a = 4-7$ bar and air temperatures of $T_a = 440-570$K. The burner employs air-blast atomization of a single jet in cross-flow in the main stage. The measurement setup is described in detail and the depth-of-field with respect to droplet size is estimated. The latter was calculated on the basis of Mie simulations and calibration data of the point-spread function. At a given volume size of $16 \times 13 \times 10$ mm$^3$ it turned out that the minimum resolvable droplet diameter of $d = 10$ µm can be achieved within the focus and increases up to $d = 10$–$20$ µm towards the volume edges. Velocities of droplets above the resolution limit were retrieved by 3D correlation of two volumes recorded at consecutive time-steps. Droplet velocities are sampled at a vector spacing of $0.38 \times 0.19 \times 0.19$ mm$^3$ within interrogation volumes of $0.77 \times 0.38 \times 0.38$ mm$^3$. Extracted slices of the instantaneous axial velocity indicate strong motion and fluctuations of the spray tail with increasing temperature and Weber number. Validation against PDA data revealed good agreement at size classes d = 10 µm, 15 µm but some deviations in regions with strong velocity gradients.

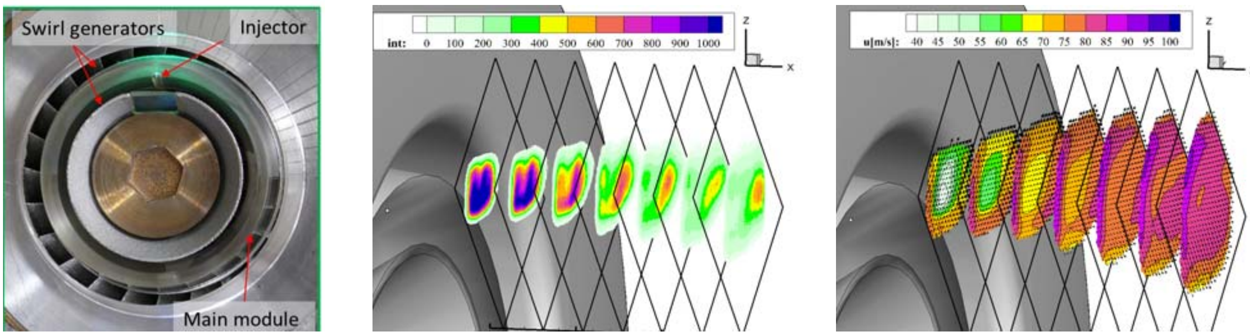


**Fig. 1** Generic fuel spray nozzle with single injection port (left), average spray density distribution (middle) and mean axial velocity of fuel spray (right) at $p_a$=4 bar and $T_a$=440K