

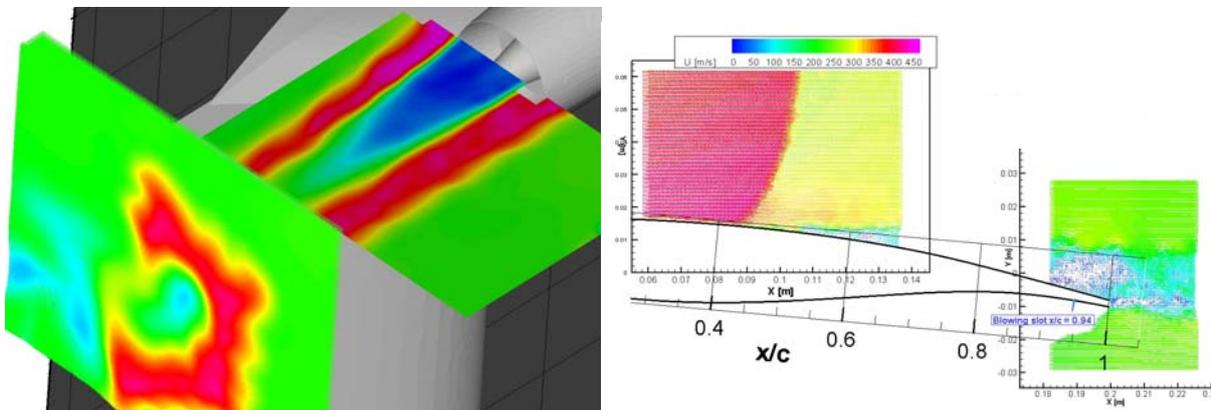
## Developments for Industrial PIV

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In the past decades several image based measuring systems have been developed for industrial aerodynamic research and in addition to classical wind tunnel measurement methods. These advanced optical and image based techniques are capable to deliver field data of the related physical quantities in a non- or minimal intrusive way: Pressure sensitive paint (PSP) is able to measure pressure distributions on the surface of models, marker based systems are measuring the position of the model during wind tunnel operation, image pattern correlation technique (IPCT) is even able to capture the surface deformation like bending and twist of airfoils quantitatively, temperature sensitive paint (TSP) images show transition line positions e.g. on a wing surface, microphone array techniques are creating maps of sound sources in various frequency domains along the model, background oriented Schlieren (BOS) can detect density gradients present at shocks and along vortex lines and, last but not least, PIV delivers a large number of instantaneous velocity vector fields in planes within the flow field in short wind tunnel run times. All these techniques give valuable information about the status of the fluid mechanical field around or its effects on a model in a wind tunnel test and have been developed for mobile use at DLR in Göttingen.

The first optical field measurement techniques used in industrial wind tunnels by DLR was PIV: Over the years many adaptations of the PIV system have been made in order to match the harsh boundary conditions in industrial wind tunnel facilities. Seeding density and homogeneity, precise triggering, optical path deviations, laser light reflections and vibrations of cameras are problems to be solved in each industrial PIV measurement. The development of industrial 2C PIV and 3C Stereo PIV applications has been matured nowadays. Time-resolved and 3D-3C PIV techniques are in development since a few years and are in the status to be tested in industrial wind tunnel investigations e.g. fat sheet tomo PIV. The most prominent feature of PIV is that it is capable of measuring large numbers of instantaneous velocity vector fields in a plane or volume of a flow with high spatial resolution and within short wind tunnel run times. From these velocity fields it is possible to calculate averages and related RMS- and fluctuation velocity fields, vorticity and other derivatives or products of fluid mechanical significance. PIV data are therefore well suited for validation of numerical codes. In several aeronautical research projects CFD, PIV and other experimental measurement techniques have been used jointly in order to capture a more holistic image of different complex flows.



Averaged 3C velocity vector fields measured behind the turbine power simulator CRUF by Stereo PIV in DNW-NWB (left) and velocity fields in a shock buffet experiment with flow control in transonic flow (right)