

## 2C and 3C PIV measurements on a rotor in hover condition

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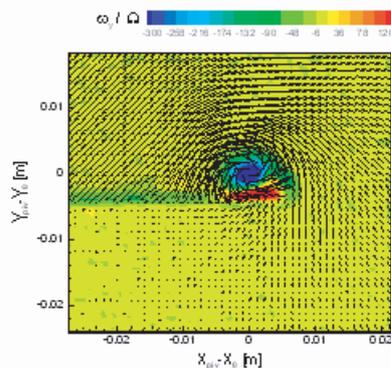
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In May 2005, 2C and 3C Particle Image Velocimetry (PIV) measurements were performed in the rotor preparation hall of DLR Braunschweig in order to investigate the development of the rotor blade tip vortex. The HOTIS (Hover Tip vortex Structure) campaign was performed using a 40% Mach scaled model rotor of the BO105 main rotor. The rotor which is shown on Fig. 1, was operated at hover condition in ground effect.



**Fig. 1** Photo of the experimental setup

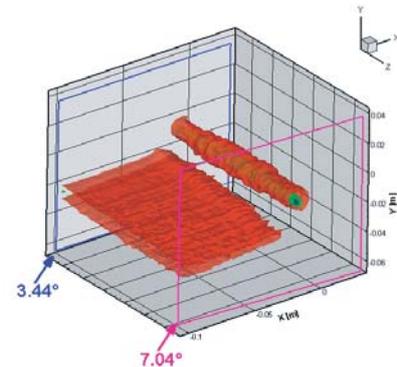
The vortex was investigated for different operational conditions in terms of tip Mach number:  $M_{H1} = 0.122, 0.33$  and  $0.633$  as well as rotor loading from 0 to 3500N. It was traced from its creation up to a vortex age in terms of rotor azimuth of 150deg with age increments of 5deg from 1deg to 90deg and 10deg for older vortices.



**Fig. 2** 2C-PIV result example

The blade tip vortex was measured with different spatial resolutions: low and very high spatial resolution in case of 2C-PIV measurements, Fig. 2, and with high spatial resolution for the 3C-PIV. A multi-grid interrogation algorithm was used to process the PIV images and allowed to use interrogation window sizes down to 20x20px. An overlap of 75% was used for the majority of analysis.

In addition, a sequence of 3C-PIV measurements was performed with vortex age increments of about  $\Delta\psi_v = 0.056\text{deg}$  for vortex ages from 3deg to 7deg. Conditional averaging techniques together with the dense sampling of the vortex age, allowed reconstructing the vortex in 3D as shown in Fig. 2. This 3D reconstruction offers the possibility to compute differential quantities like the 3 components of vorticity, whereas only the component normal to the plane ( $\omega_z$ ) can be determined with classical 2C or 3C-PIV results.



**Fig. 3** Volume view of the out-of-plane component

In total, around 300 PIV measurements with 160 repeats for each of these measurements were made during this campaign. The experimental setup is described in the paper as well as the processing and post-processing method used to obtain the velocity fields, including a PIV parameters study, and to extract the vortex characteristics. Finally a set of preliminary results has been given and discussed.