

# Investigation of a high Reynolds number turbulent boundary layer flow with adverse pressure gradients using PIV and 2D- and 3D- Shake-The-Box

A. Schröder<sup>1</sup>, D.Schanz<sup>1</sup>, M.Novara<sup>1</sup>, F. Philipp<sup>1</sup>, R. Geisler<sup>1</sup>, J. Agocs<sup>1</sup>, T. Knopp<sup>1</sup>, M. Schroll<sup>2</sup>, C. E. Willert<sup>2</sup>

1: German Aerospace Center (DLR), Institute of Aerodynamics and Flow Technology, Göttingen, Germany

2: German Aerospace Center (DLR), Institute of Propulsion Technology, Cologne, Germany

\* Correspondent author: andreas.schroeder@dlr.de

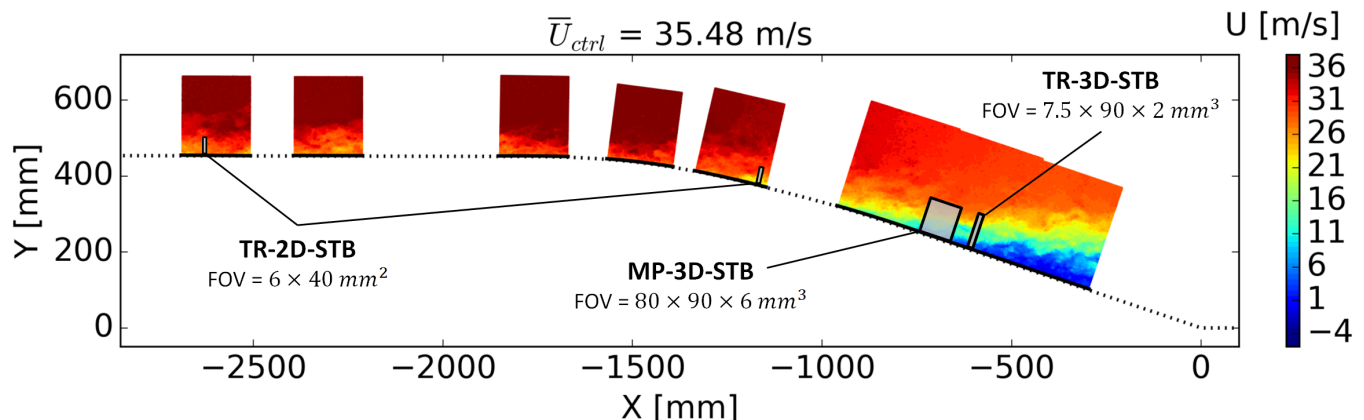
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## HIGHLIGHTS

- Flow field measurements of high Reynolds number adverse pressure gradient turbulent boundary layer
- Smooth curvature into APG avoids strong history effects
- 2D2C-PIV snapshot overview measurements
- Time-resolved 2D- and 3D-Lagrangian particle tracking by STB between 20 and 50 kHz frame rate
- Multi-Pulse 3D STB with high-dynamic spatial and velocity range
- Subpixel resolution mean velocity and Reynolds stress profiles

## ABSTRACT

We present an experimental adverse pressure gradient turbulent boundary layer (TBL) flow investigation at high Reynolds numbers (approx.  $10.000 < Re_{\theta} < 40.000$ ) using large field multi-camera 2D PIV and three different particle tracking methods based on the Shake-The-Box (STB) technique, namely time-resolved 2D- and 3D-STB and multi-pulse (MP-) STB. The experiments were performed within the frame of the DLR project *Victoria* and conducted in the Eiffel type atmospheric wind tunnel of the University of Armed Forces in Munich (AWM). After a ramp the TBL develops along a flat plate with nearly zero pressure gradients (ZPG) to an equilibrium state before it enters into a 2D diffuser geometry following a smooth and moderate curvature into a flat plate at  $\sim 18^\circ$  inclination angle while undergoing a significant adverse pressure gradient (APG) leading to flow separation. The field-of-views of the STB Lagrangian particle tracking techniques are located within the ones of the planar measurement to allow for a direct comparison of the results (Fig. 1). A statistical significant number of samples for four different free stream velocities have been acquired. PIV and Lagrangian particle tracking data have been achieved in order to gain high resolution wall-normal profiles of the mean velocities and related Reynolds stresses  $\langle u'iu'j \rangle$ .



**Fig. 1** Instantaneous  $u$ -velocity distributions of the APG-TBL flow along the wall contour evaluated by 2D-PIV ( $u$ -velocity contour color coded) for boundary layer edge velocity  $U_e = 35.48$  m/s (in ZPG region)