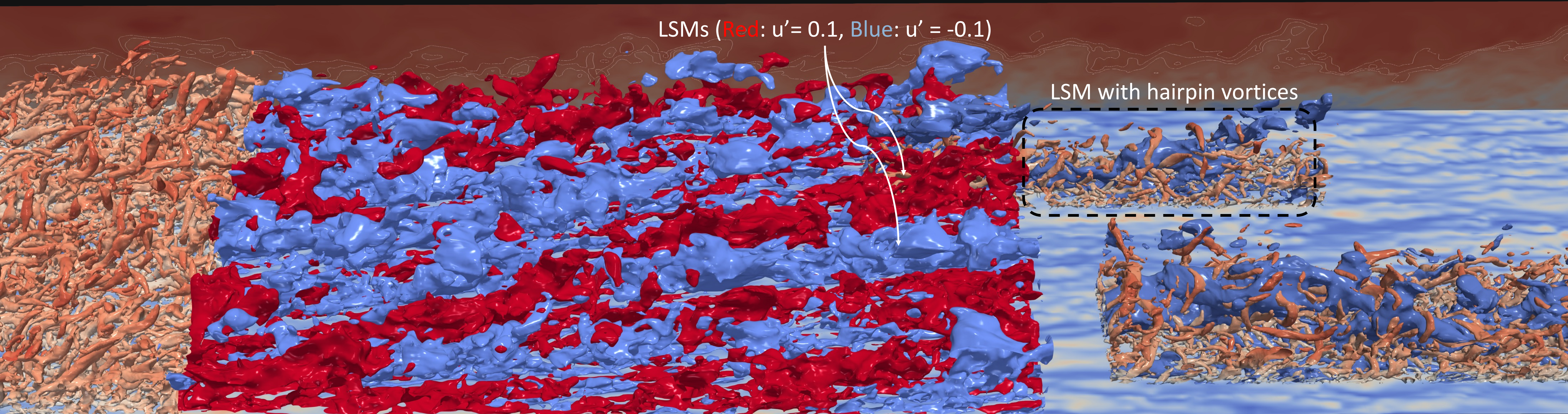


Generation of Hairpin Vortices via Physio-Cyber Data Assimilation Approach

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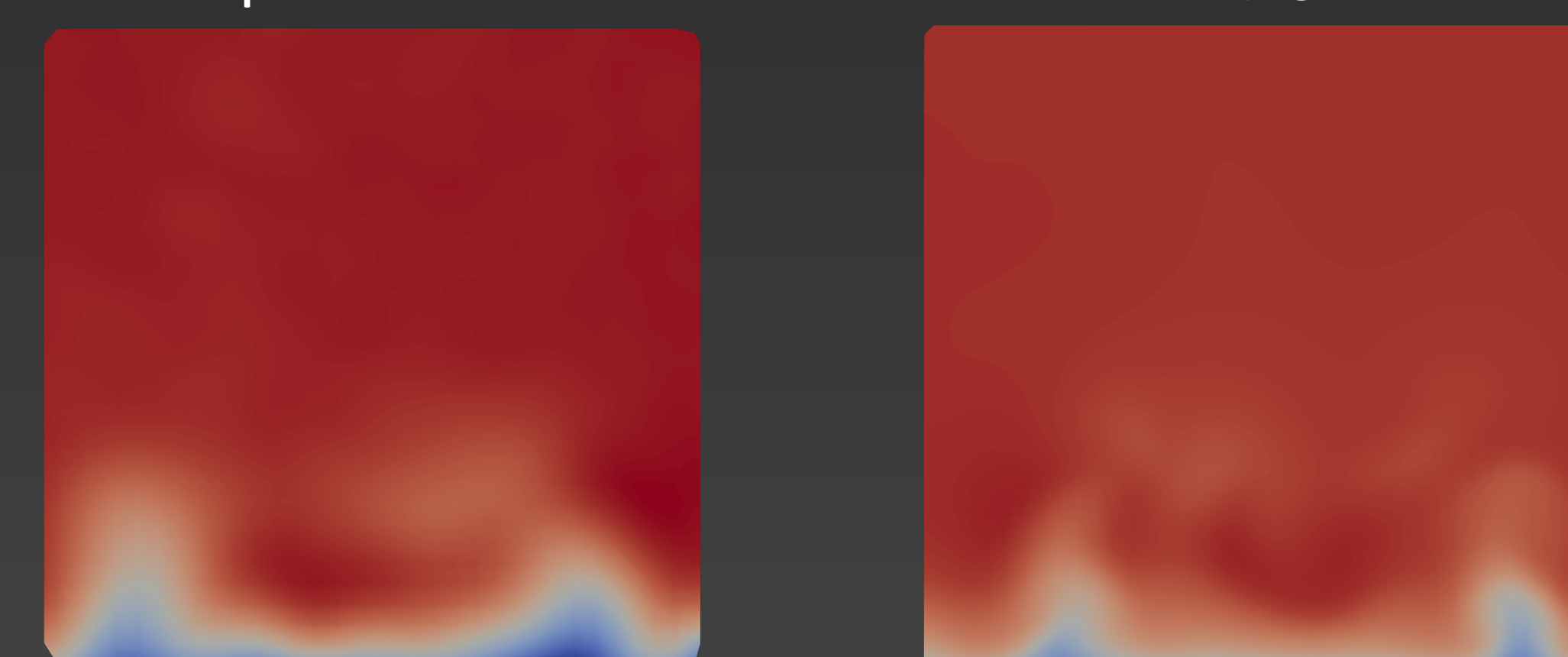
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 **Department of Mechanical Engineering, The University of Akron



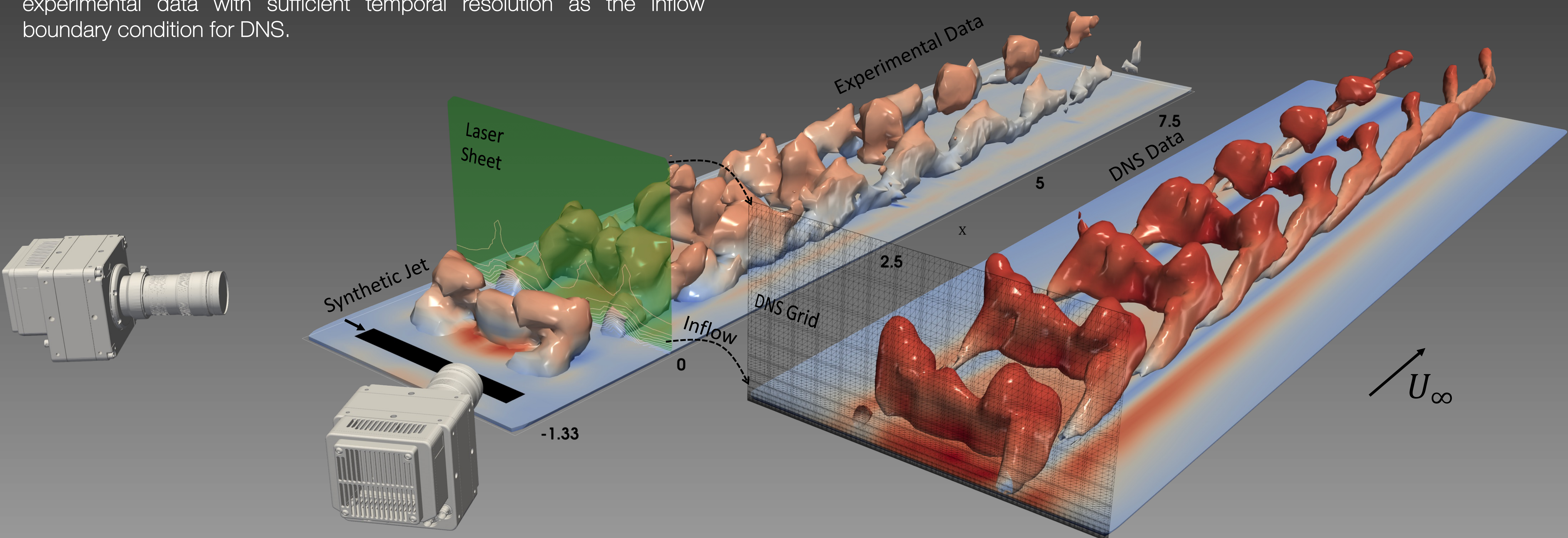
Large scale motions (LSMs) are regions of momentum surplus or deficit in turbulent boundary layers (TBLs). LSMs are prominent coherent vortical structures particularly when Reynolds number is moderate to high as shown in figure above (Red/Blue iso-surfaces of streamwise velocity fluctuations). These structures contain large amounts of TKE, which can be used for boundary layer re-energization. To reproduce LSMs and associated hairpin vortices in a laminar setting, a data assimilation approach is used. To reduce the amount of experimental testing, these physio-cyber simulations use a single plane of experimental data with sufficient temporal resolution as the inflow boundary condition for DNS.

Experiments

DNS

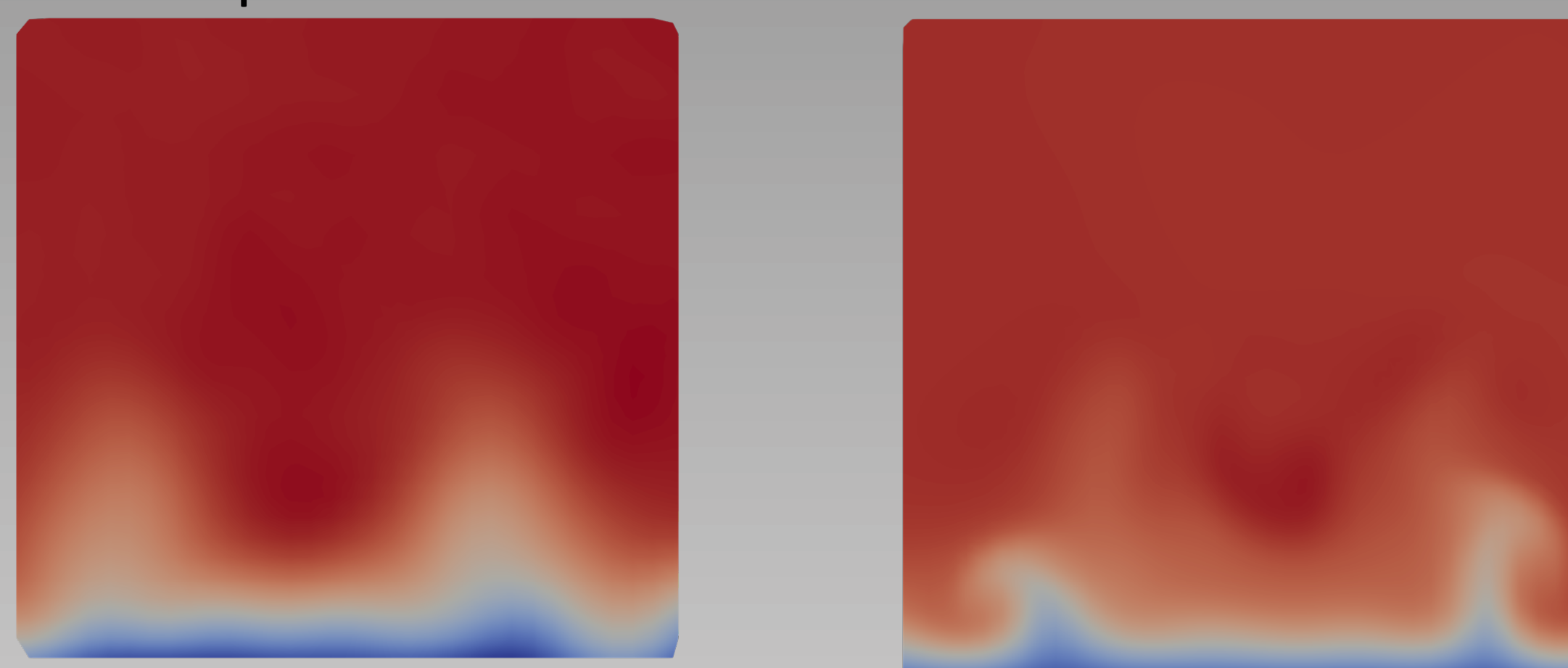


X = 2.67



Experiments

DNS



X = 5.33

This work seeks to pair experimental generation of synthetic vortical structures with direct numerical simulations (DNS). The experimental domain consists of a synthetic jet in a cross-stream. Planes of SPIV data are used as an inflow boundary condition to the computational domain. The velocity data are interpolated bilinearly in space and linearly in time to fit the DNS grid. The contour plots of wall-normal velocity are shown as a sequence of hairpin vortices. Comparison of streamwise velocity is shown at two X locations downstream of inlets (X=0).

