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Lessons Learnt from Chimera Method Application to a Deploying Krueger Device

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The Chimera method [1] is an established method for simulation of overlapping grids. Meshing parts independently has made this method popular for complex geometries as well as moving bodies like propellers and rotors (e.g. [2]) or control surfaces (e.g. [3]). It is thus a promising method to simulate deflecting high-lift systems.
The motion of the Krueger flap – as the most promising leading edge high-lift system device for laminar wing technology – is characterized by a relatively large movement (about 140 deg deflection) at a relatively high deflection speed (up to 200 deg/s) compared to classical leading edge devices. In terms of simulation, the grid properties of the overlapping mesh regions vary throughout the motion from a nearly sealed retracted position to a gapped flow in fully deflected position comparable to a slat device. This expects dynamic effects may get dominant and a valid simulation of this flow is needed for proper design and analysis.
In the frame of the UHURA project[1], several partners applied their CFD capabilities based on Chimera in order to validate the method for this specific application in comparison to wind tunnel tests. The presentation outlines the different Chimera approaches ranging from structured/2D to hybrid/3D in steady and unsteady simulations for the different type of setups investigated, namely straight and swept wing with full-span and part-span Krueger flap. It summarizes common challenges and best practice for application of the Chimera approach for such a device.

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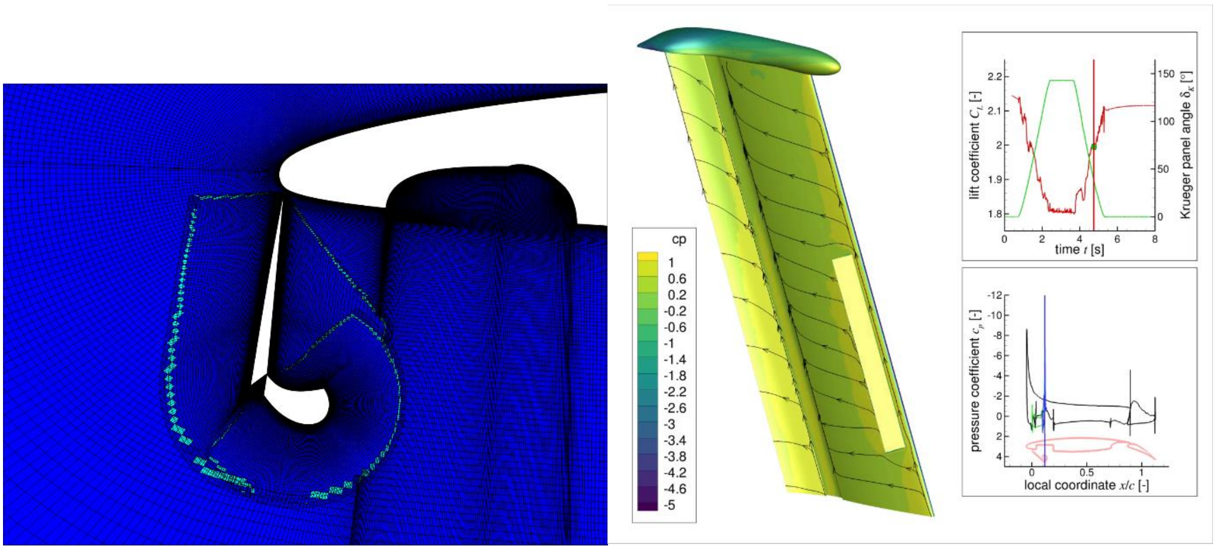

Figure 1: Chimera grid application for the deployment of a Krueger flap: (left) image of section through structured Chimera mesh with half deployed Krueger(courtesy NLR); (right) unsteady RANS simulation applying Chimera for DLR-F15S swept wind tunnel model with part span Krueger flap partially deployed (courtesy DLR)