

Workshop SciTech2024

Adaptive grid convergence study on the Joukovski airfoil

M. Visonneau, E. Guilmineau & J. Wackers

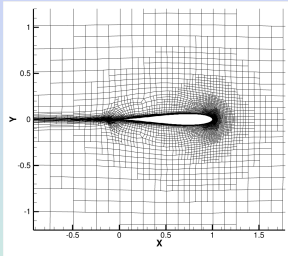


February 21, 2023

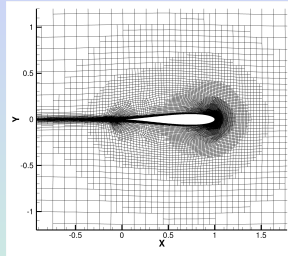
- ▶ ISIS-CFD, our in-house flow solver (aka FINE/Marine, Cadence Design System) is used for this 2D verification study around the Joukovski airfoil:
 - ▶ Spalart-Allmaras model with R rotation correction and QCR2000 non-linear addition (SA-R-QCR2000) with SA-neg formulation and ICCFD7 2012 modifications,
 - ▶ Anisotropic adaptive grid refinement based on the Flux-Component Hessian using a series of 11 grids, starting from an initial built with Hexpress,
- ▶ Systematic grid convergence based on a linear reduction of the threshold (Tr ranging from $L/2$ to $L/64$),
- ▶ Estimate of discretisation error based on Eca & Hoekstra procedure.

Series of adapted meshes - Global view

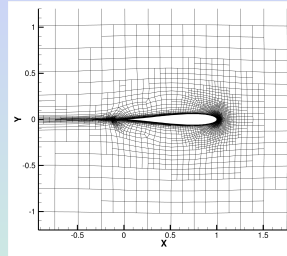
$Tr=L/2$



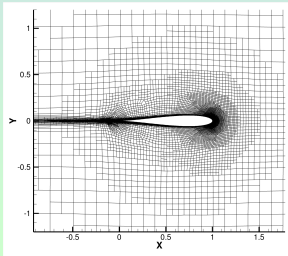
$Tr=L/4$



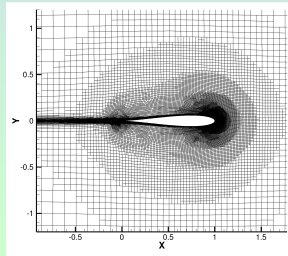
$Tr=L/8$



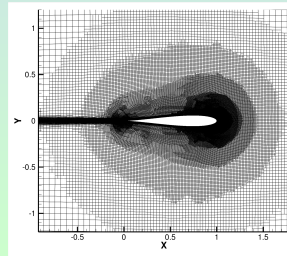
$Tr=L/16$



$Tr=L/32$



$Tr=L/64$



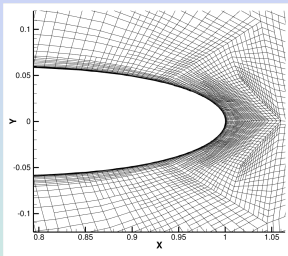
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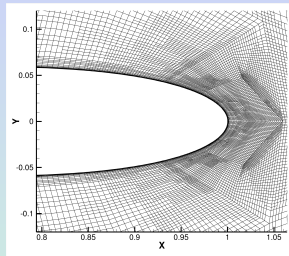
Conclusions

Series of adapted meshes - Leading edge

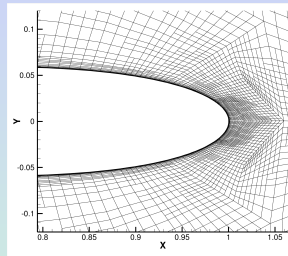
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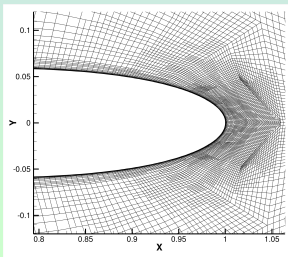
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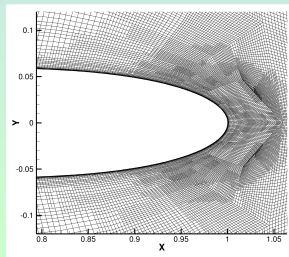
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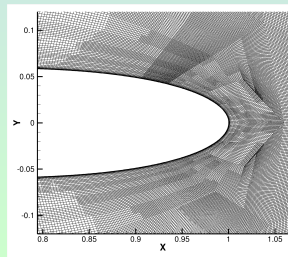
$Tr=L/16$



$Tr=L/32$



$Tr=L/64$



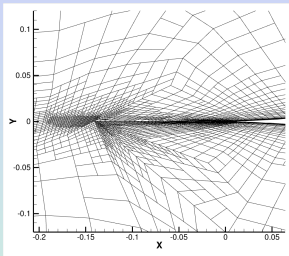
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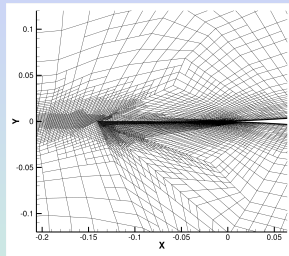
Conclusions

Series of adapted meshes - Trailing edge

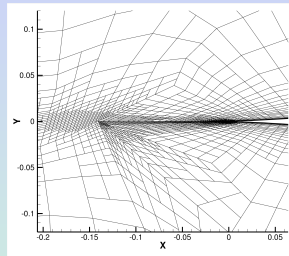
$Tr=L/2$



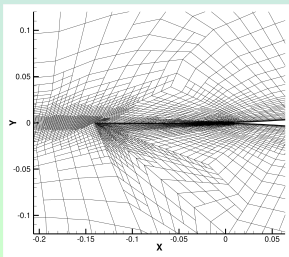
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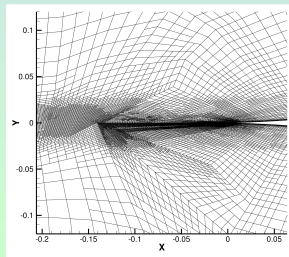
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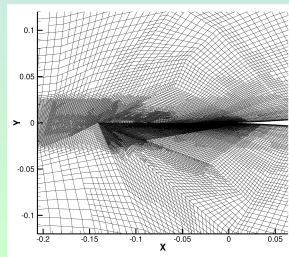
$Tr=L/16$



$Tr=L/32$

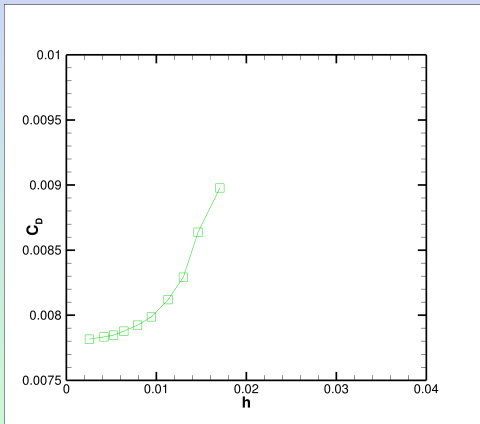


$Tr=L/64$

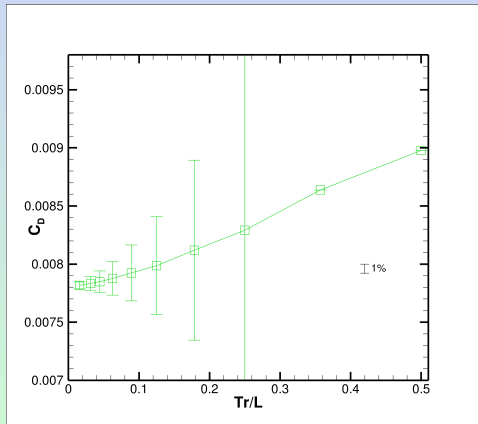


Grid convergence of the drag

Cd vs. h



Cd vs. Tr



Comparison with converged values mentioned in the paper

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Cd (SANS)	Cd (ISIS-CFD)	Cdv (SANS)	Cdv (ISIS-CFD)	Cdp (SANS)	Cdp (ISIS-CFD)
0.007872	0.007816	0.006627	0.006652	0.001244	0.001164

- ▶ First numerical study around the Joukovski airfoil with an initial grid built with Hexpress:
- ▶ Regular convergence wrt. the threshold,
- ▶ Converged values are not in perfect agreement with the ones obtained with SANS,
- ▶ Estimated order of accuracy: 1.3 (not a rigorous estimate with a series of adapted grids),
- ▶ Next step 1: perform the same study with the structured grids proposed in this collaborative action,
- ▶ Next step 2: Start from a more regular grid e.g. a coarse structured grid taken from this series.

Thank you for your attention !