FIRST WORKSHOP

(11) - Characterization of baseline flow on outer wing region for numerical sizing of AFC concepts

Delft, September 10, 2015

Presenter: Petr Vrchota (VZLU)
Authors: Petr Vrchota (VZLU), Alan Mann Airbus Defence and Space GmbH, Simone Crippa Airbus Operations GmbH, Pierluigi Ianelli (CIRA), Vlad Ciobaca, Jochen Wild (DLR), Peter Wong (ARA), Jean-Luc. Hantrais-Gervois (ONERA), Jean-Pierre Rosenblum (DASS).

AFLoNext

2ND GENERATION ACTIVE WING

Geometry and motivation

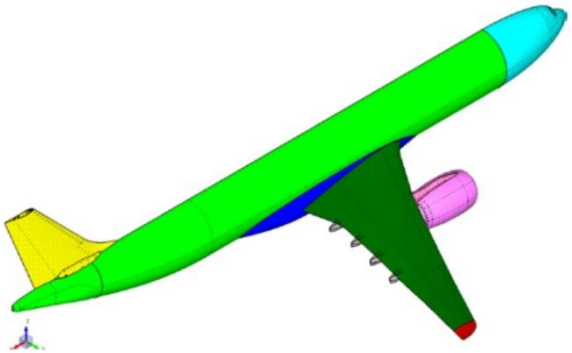
Research aircraft XRF1

\ Two wingtip extensions have been proposed by A-UK

  \ Simple wingtip extension

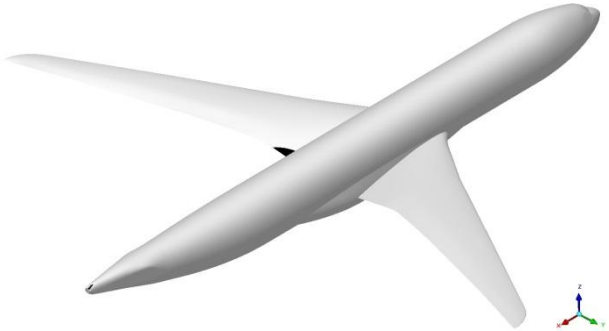
  \ Wingtip extension with curved LE - drag reduction by 2% in cruise

\ Cruise configuration



\ Take-off configuration

  \ Medium and simplified geometry



No protection by high-lift devices on LE

\ Flow separation is anticipated for higher AoA

\ AFC will be used to compensate the missing high-lift devices on LE

Cruise configuration

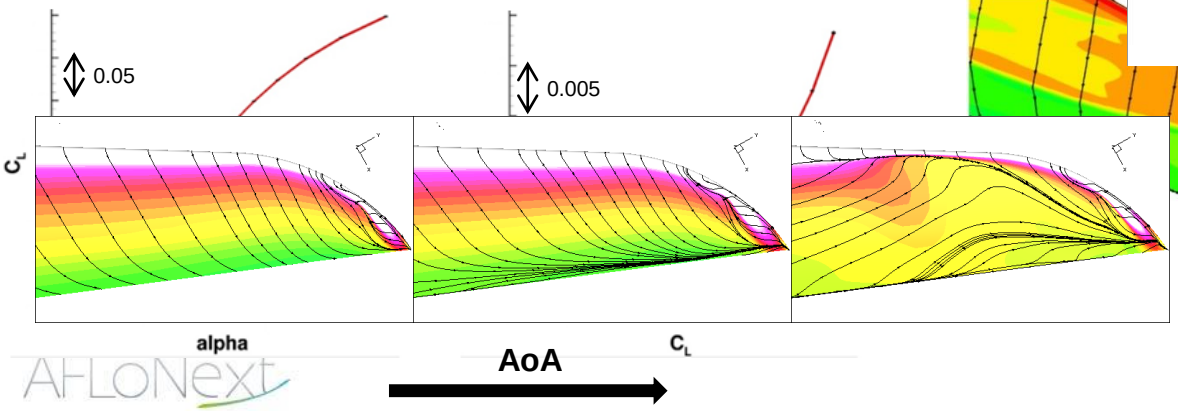
Flow conditions

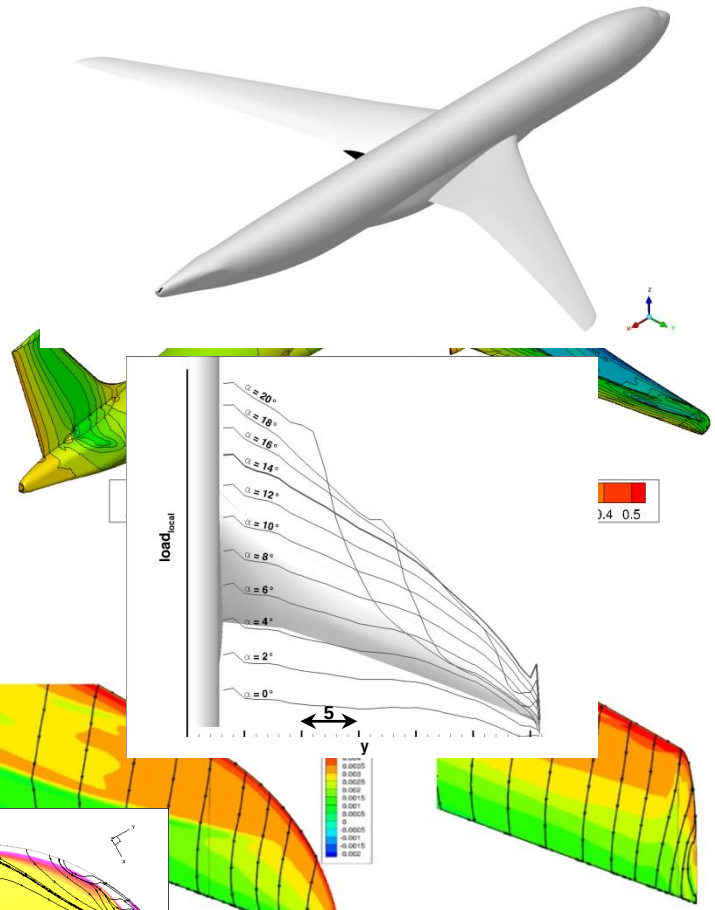
\ High-speed

Name	Symbol	Value
Freestream Mach number	M	0.83
Reynolds number unity	Re	$6.518 \cdot 10^6$
Altitude	h	35 000 [ft]
Cruise CL		0.5

\ Low-speed

Name	Symbol	Value
Freestream Mach number	M	0.2
Reynolds number unity	Re	$4.65 \cdot 10^6$
Freestream Temperature	T	288.15 [K]

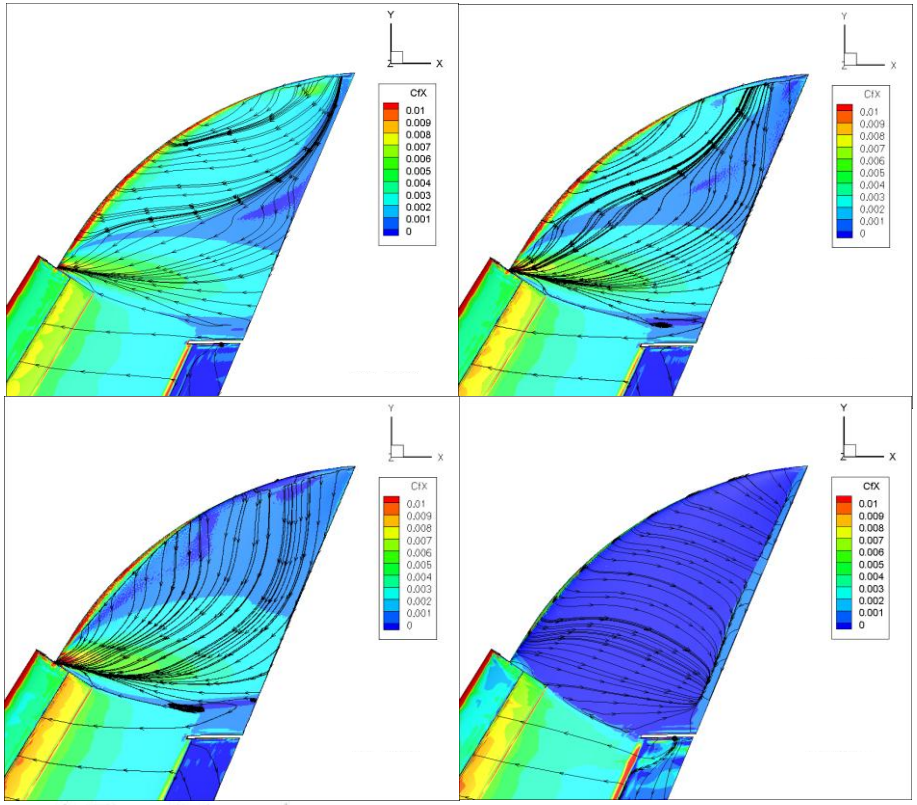


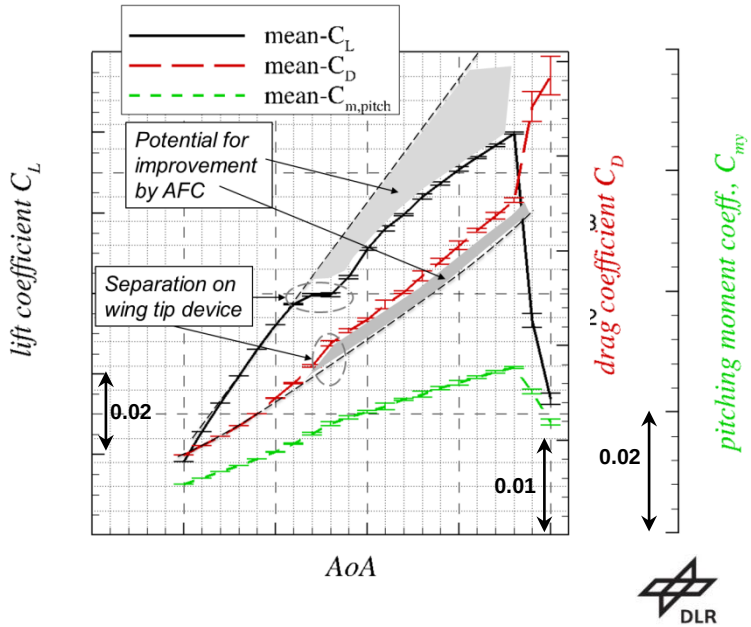


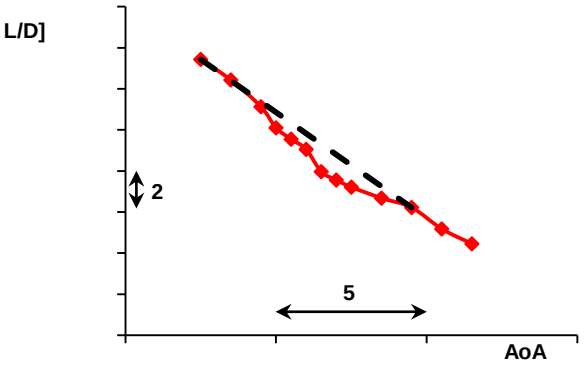
Take-off configuration

Flow condition

Name	Symbol	Value
Freestream Mach number	M	0.2
Reynolds number unity	Re	$4.65 \cdot 10^6$
Freestream Temperature	T	288.15 [K]



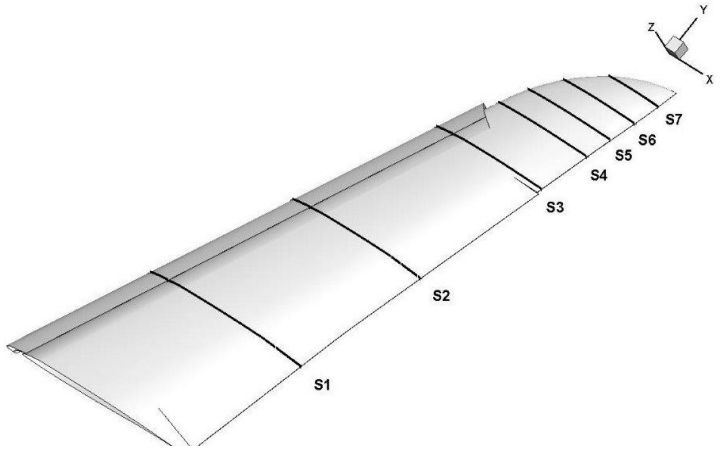


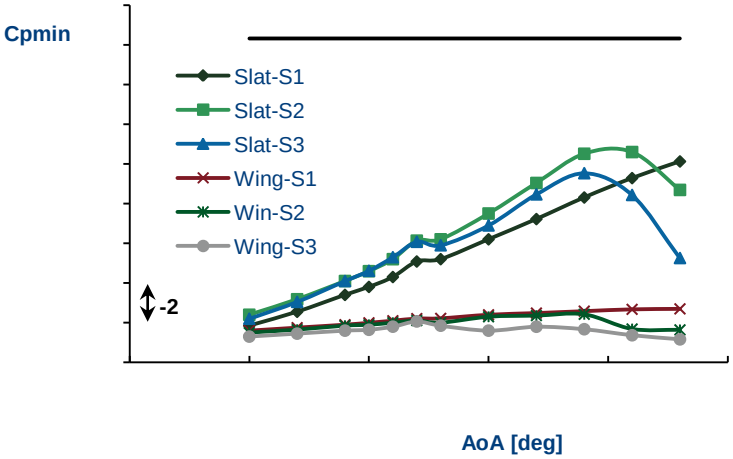


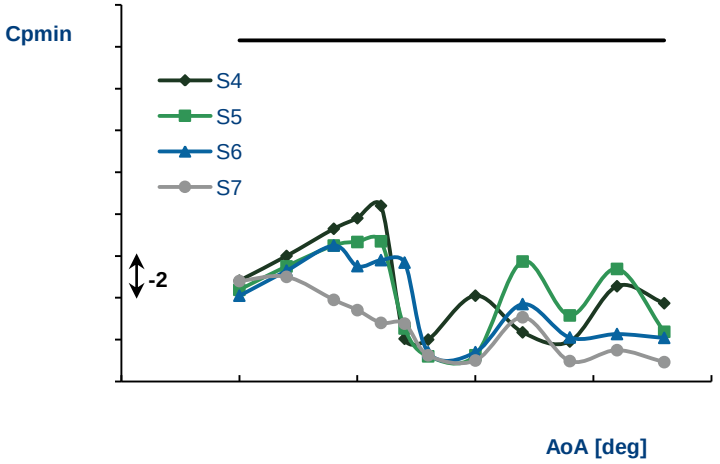
Take-off configuration

Smaller pressure peak at wingtip region

\ Smaller than classical criteria for high-lift airfoil stall







Take-off configuration

Medium range of AoA

\ Cross flow towards the wing tip caused by slat-end vortex

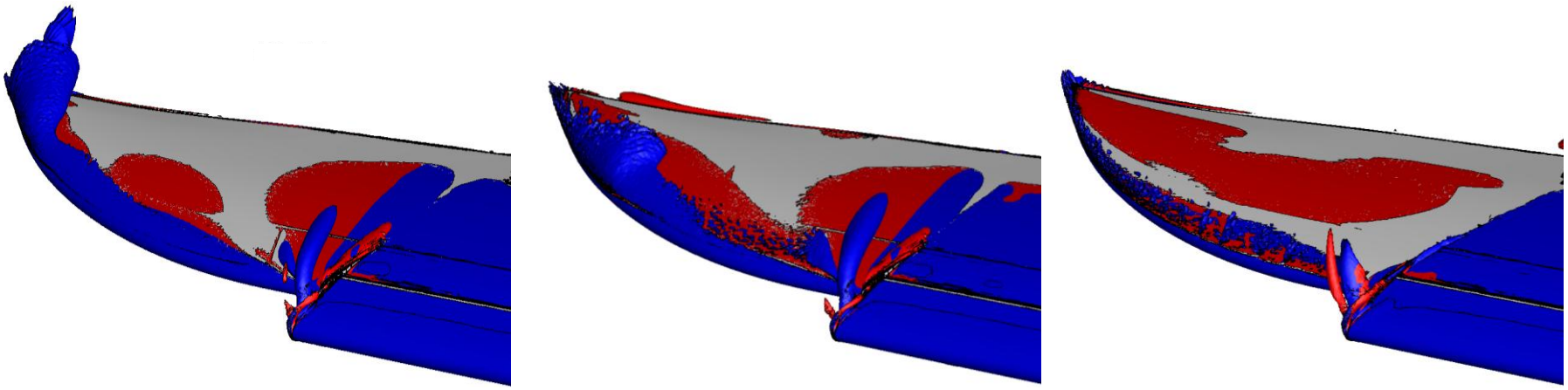
\ No significant effect on lift

High AoA

\ Wingtip vortex is moving towards inboard with increasing AoA

\ Intearction with slat-end vortex

\ Slat-end vortex is bursting and massive flow separation occurs



AoA

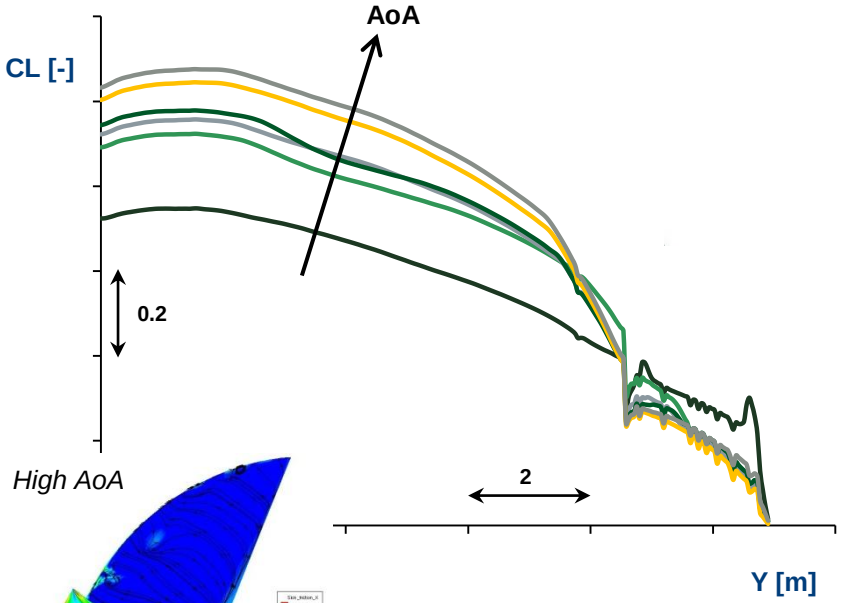
Take-off configuration

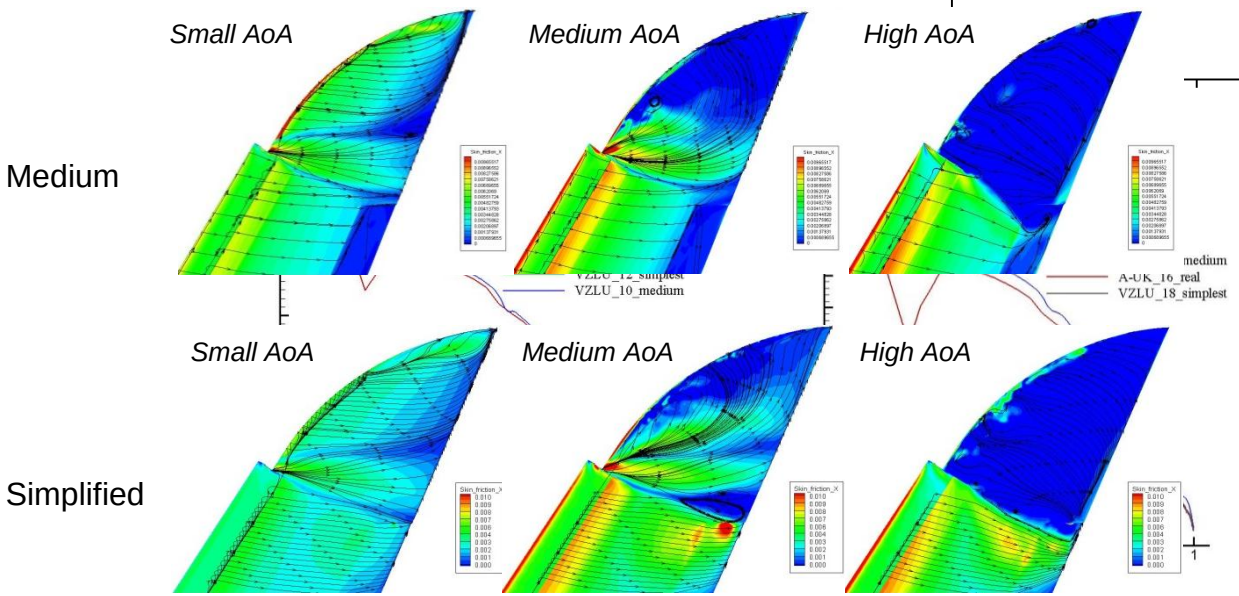
Medium vs simplified geometries

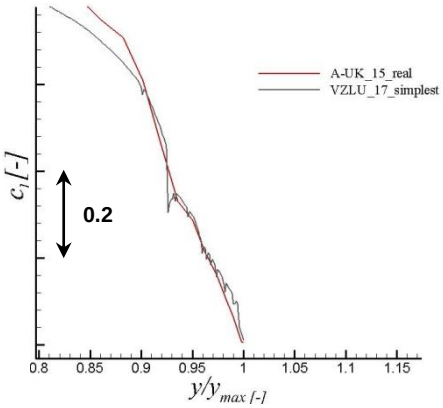
\ Effect on a shift of AoA ~ 2deg

\ Smaller effect on the spanwise loading at the wingtip region

\ Almost the same flowfield character







Conclusions

Wing tip extension has been designed to reduced the total drag by 2% in cruise

Medium range of AoA (below flow separation onset)

\ cross flow towards the wig tip has been observed caused by the slat-end vortex → very small effect on the lift

Higher AoA

\ Wingtip stall dominates → generates loss of lift and increase of drag

\ Interaction of the wing-tip vortex with slat-end vortex → flow separation

Simplified geometry can be used for application of AFC

\ Same character of the flow separation

\ Positive shift of onset of wingtip flow separation by 2deg

Thank you !

For more information:

Contact :

\ Petr Vrchota

\ VZLU

Or Contact@AFLonext.eu

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 604013, AFLONEXT project.