FIRST WORKSHOP

Computational Fluid Dynamics based landing gear wake - flap flow interaction analysis

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2ND GENERATION ACTIVE WING

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Overview

\ motivation (embedding in AFLoNext project)

\ geometry and RANS set-up

\ CFD verification and validation with WTT

\ results

\ conclusions

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MOTIVATION
(EMBEDDING IN AFLONEXT PROJECT)

Motivation

\ pre-FT study on MLG wake-flap interaction noise source at approach condition including impact of flap deflection angle

- \ since 3D acoustic prediction tool not available study limited to aerodynamic modelling and analysis
- \ set of flow parameter selected to provide information on interference MLG-flap noise sources

\ numerical pressure required to adapt geometrical angle in WTT due to lack of balance information

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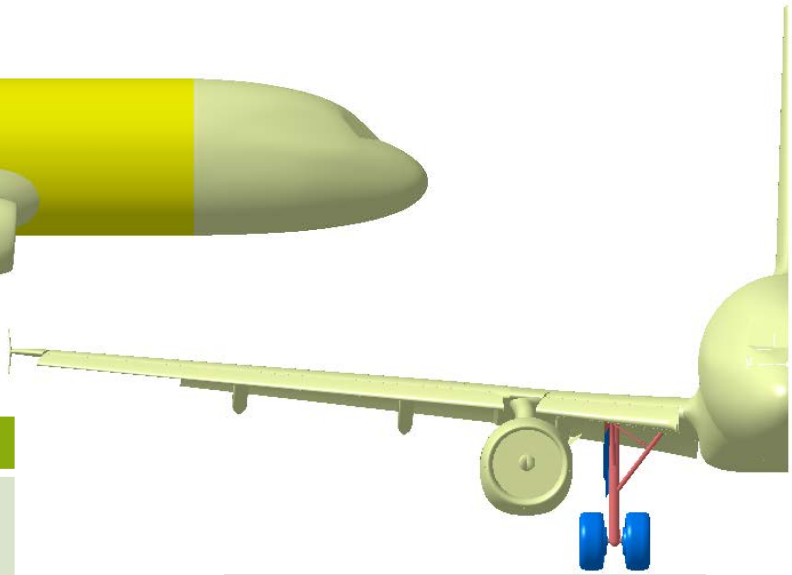
GEOMETRY AND RANS SET-UP

Aircraft assembly

A320 ATRA assembly as planned for FT

lateral view



front view

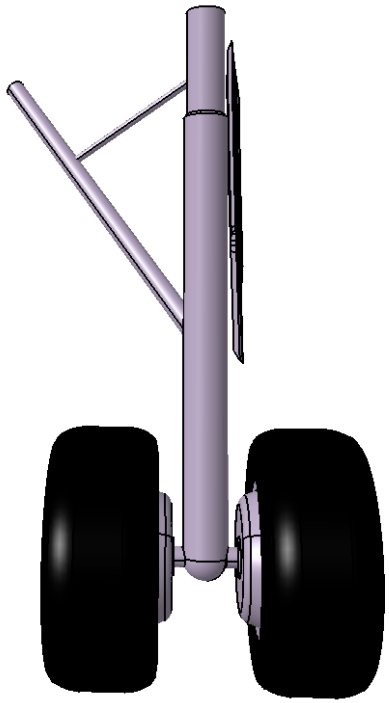
A/C components		
fuselage	WTF	nacelle with strake
belly	wing with FTFs	pylon
VTP	slats and flaps	MLG with leg door

Main landing gear assembly

MLG components			
main leg (fully deployed)	side stay	leg door	wheels
main fitting	lock stay	wheel axis	brakes

\ MLG assembly does not cover LG bay (as in WTT)

\ MLG and LG door simplified but still represented on a highly detailed level



lateral view

RANS settings and configurations

parameter	setting
AoA [°]	6
M	0.20
Re	19.3 millions
RANS solver	TAU
turbulence model	Menter SST k-Ω
mesh type / generator	hybrid / Centaur

high-lift configuration	slat deflection [°]	flap deflection [°]	aileron deflection [°]
CONF 3	22	20	5
CONF FULL	27	40	5

all high-lift configurations with MLG up and down

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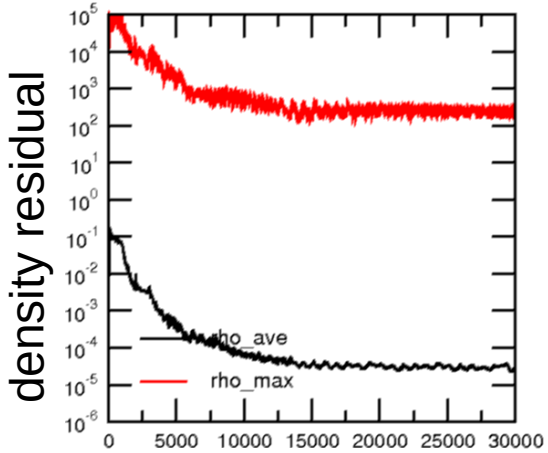
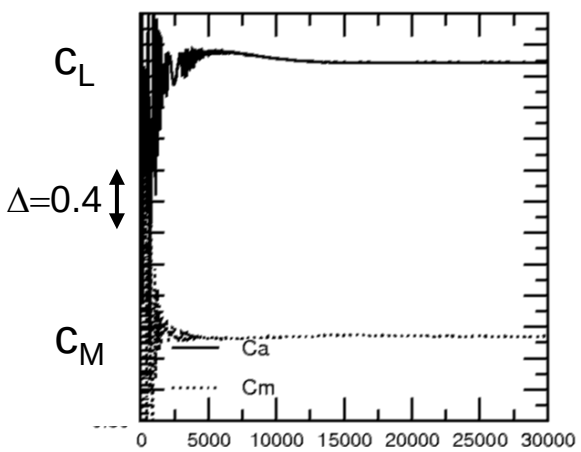
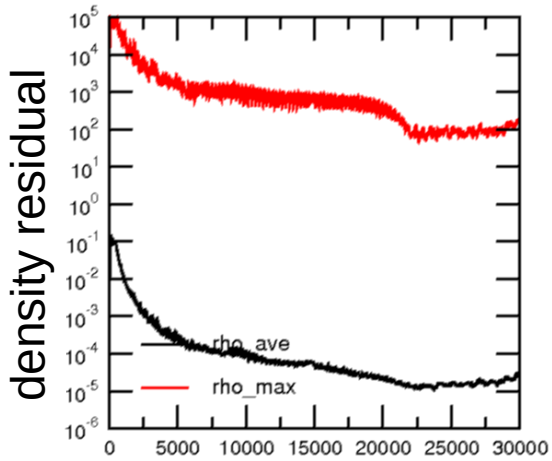
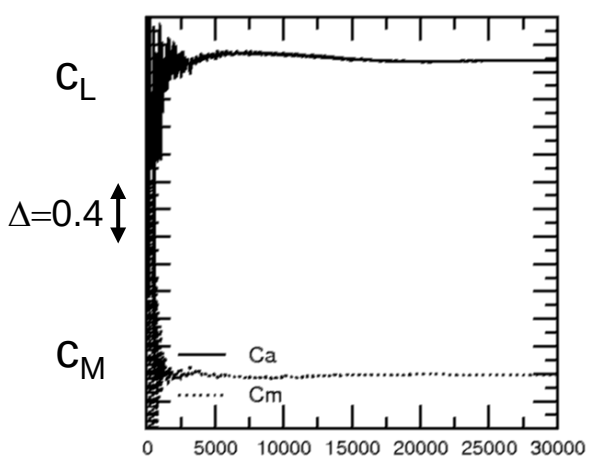
CFD VERIFICATION AND VALIDATION WITH WTT

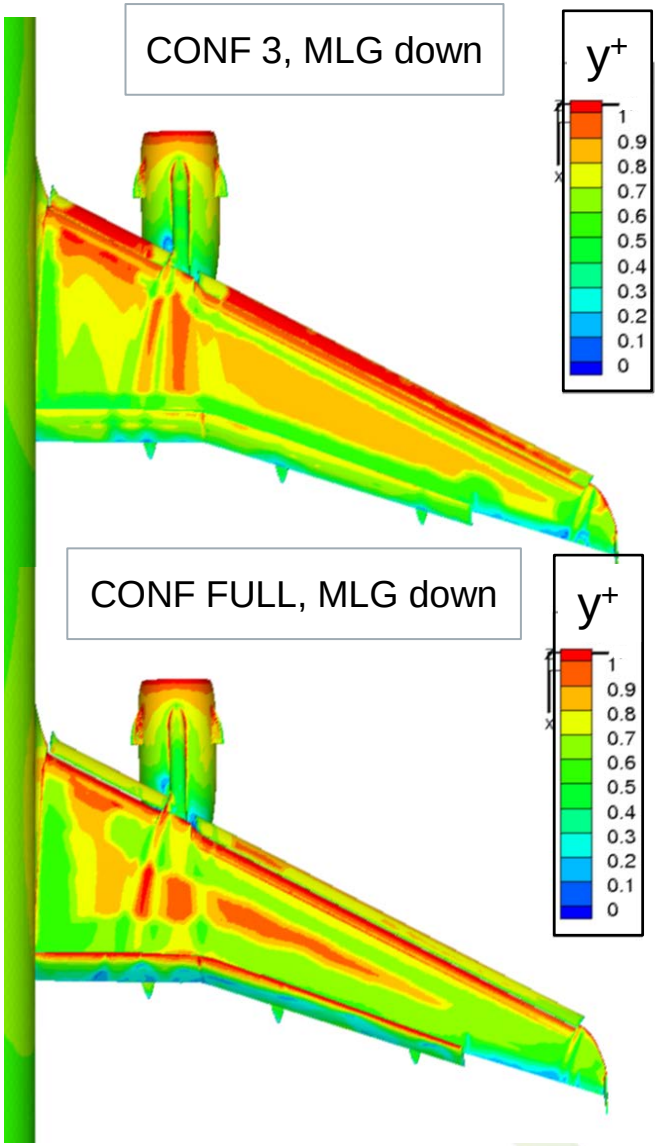
Density residual and y+ pattern





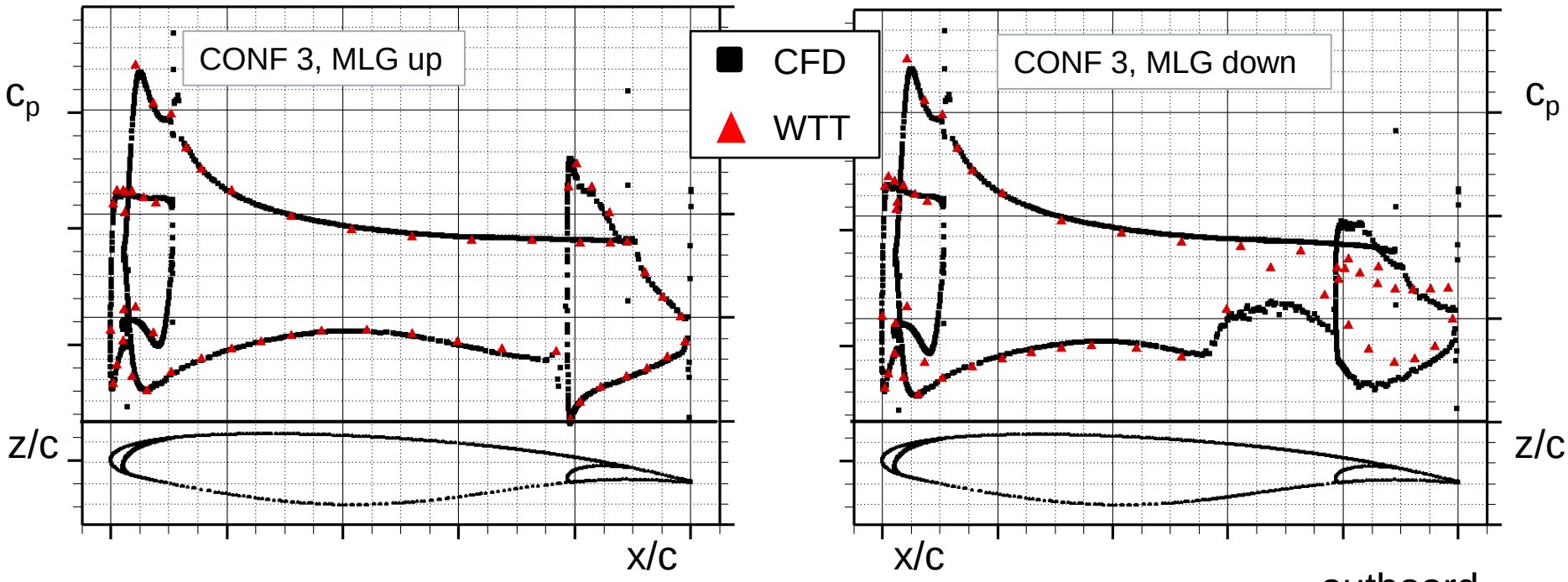






mesh and RANS quality sufficient

Comparison on inboard wing section

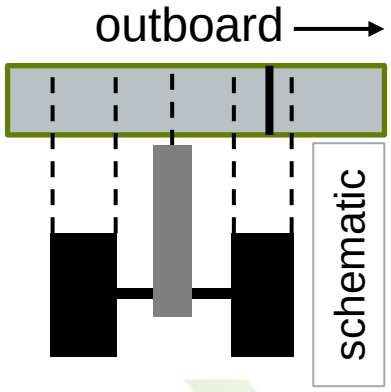


i/b wing main section (fully installed with pressure taps)

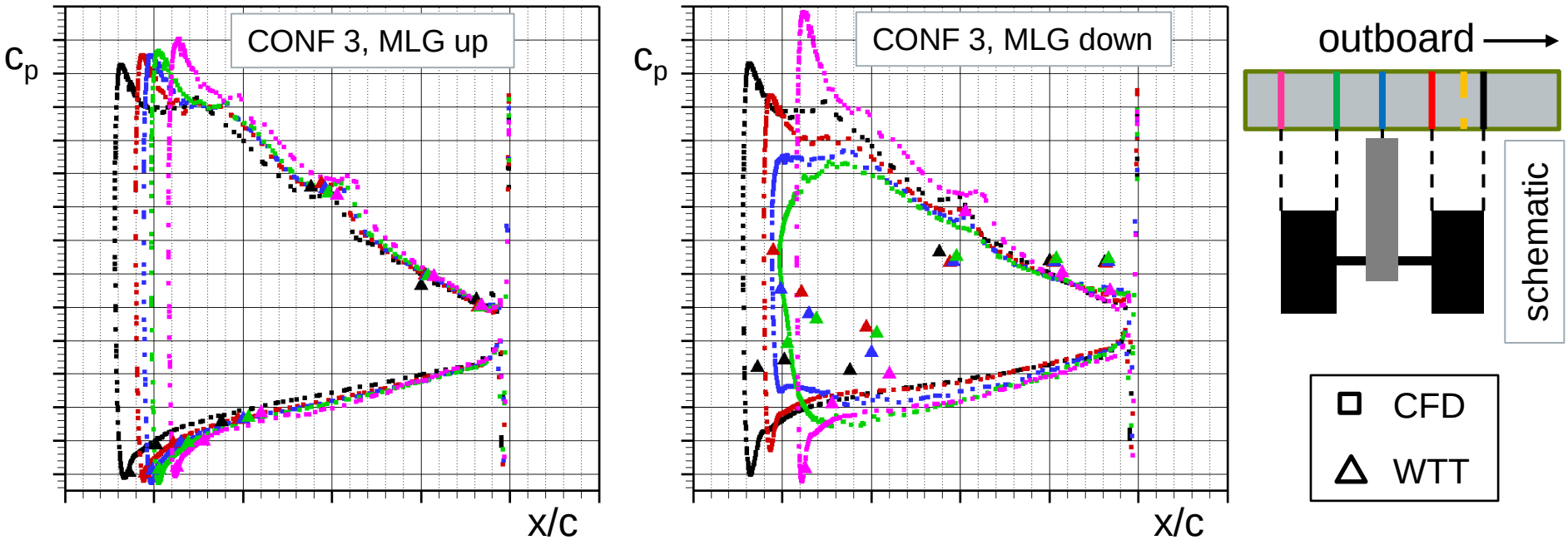
\ excellent agreement on all components for MLG up case

\ clear lift loss on rear wing and flap due to MLG deployment

\ differences in flow separation on flap at least aided by Re effect (Re_{WTT}=1.5m)



Comparison on inboard flap



i/b wing additional sections (flap only installed with pressure taps)

\ excellent agreement in all flap sections for MLG up case

\ spanwise and chordwise lift loss predicted differently in CFD and WT, significantly greater impact visible in WT data (mainly Re effect assumed, Re_{WTT}=1.5m)

\ innermost section shows small effect due to MLG deflection in CFD and WTT

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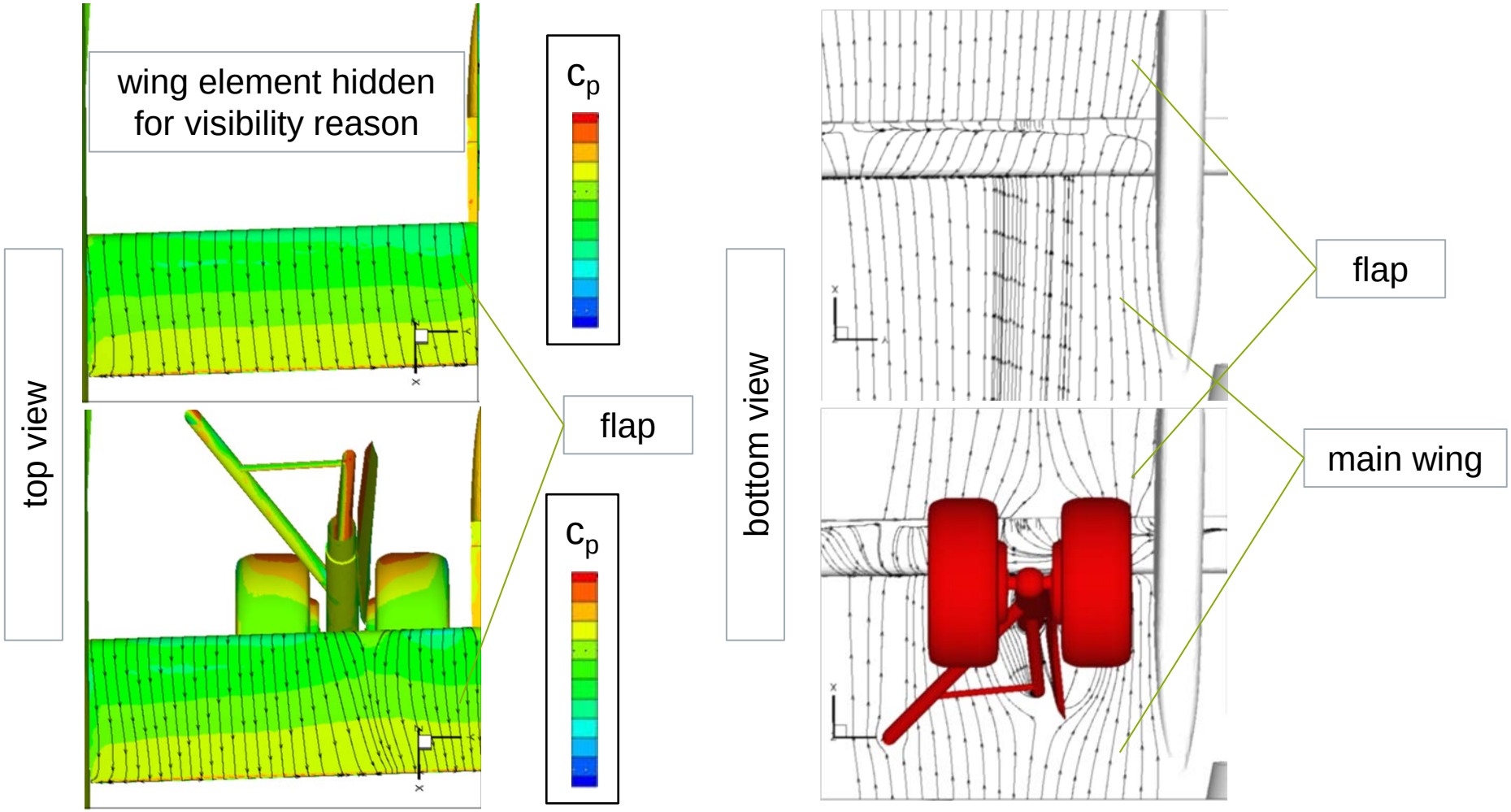
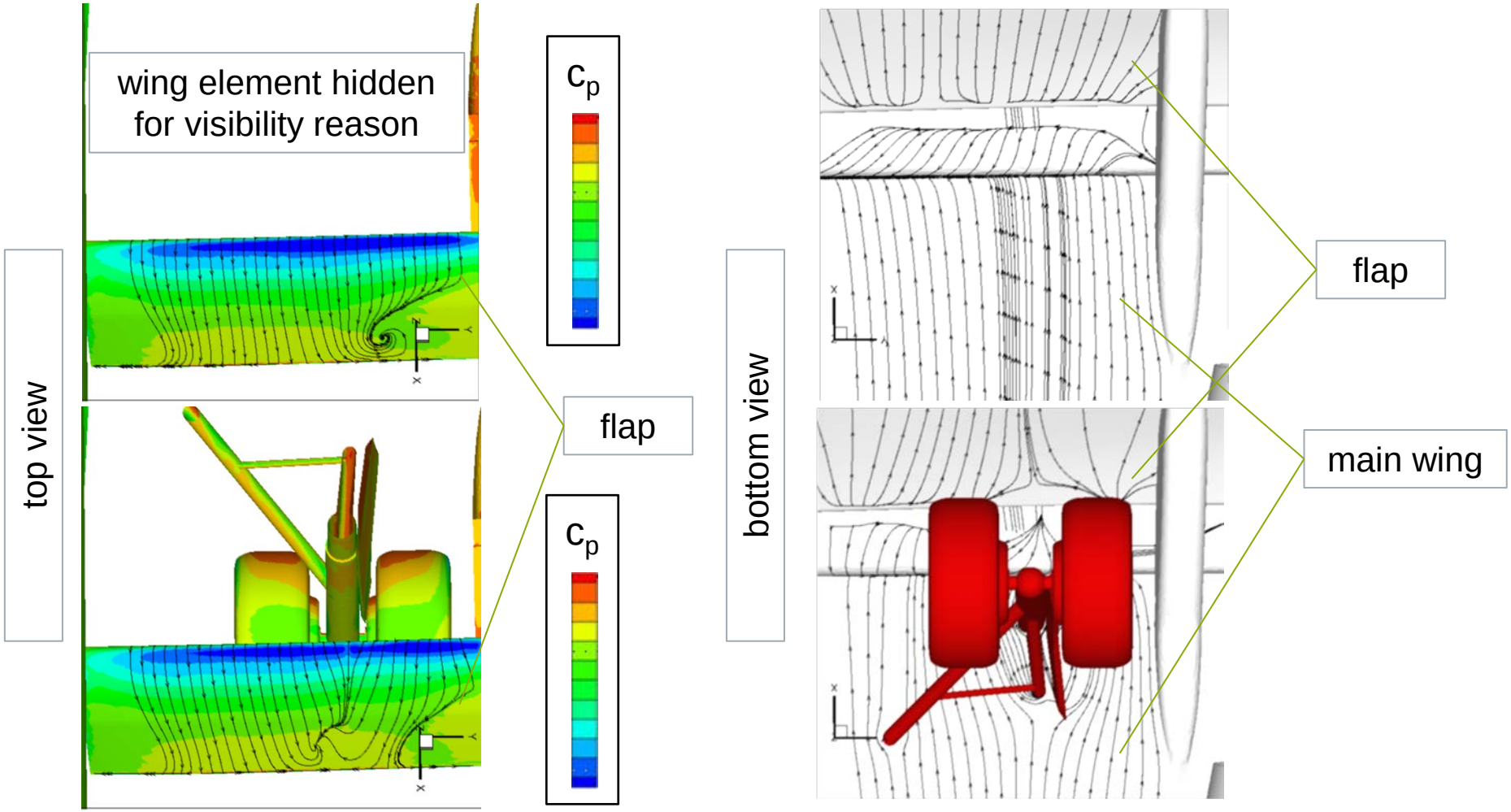
RESULTS

cp pattern and streamlines i/b flap CONF 3



flap flow slightly affected by presence of MLG and LG door

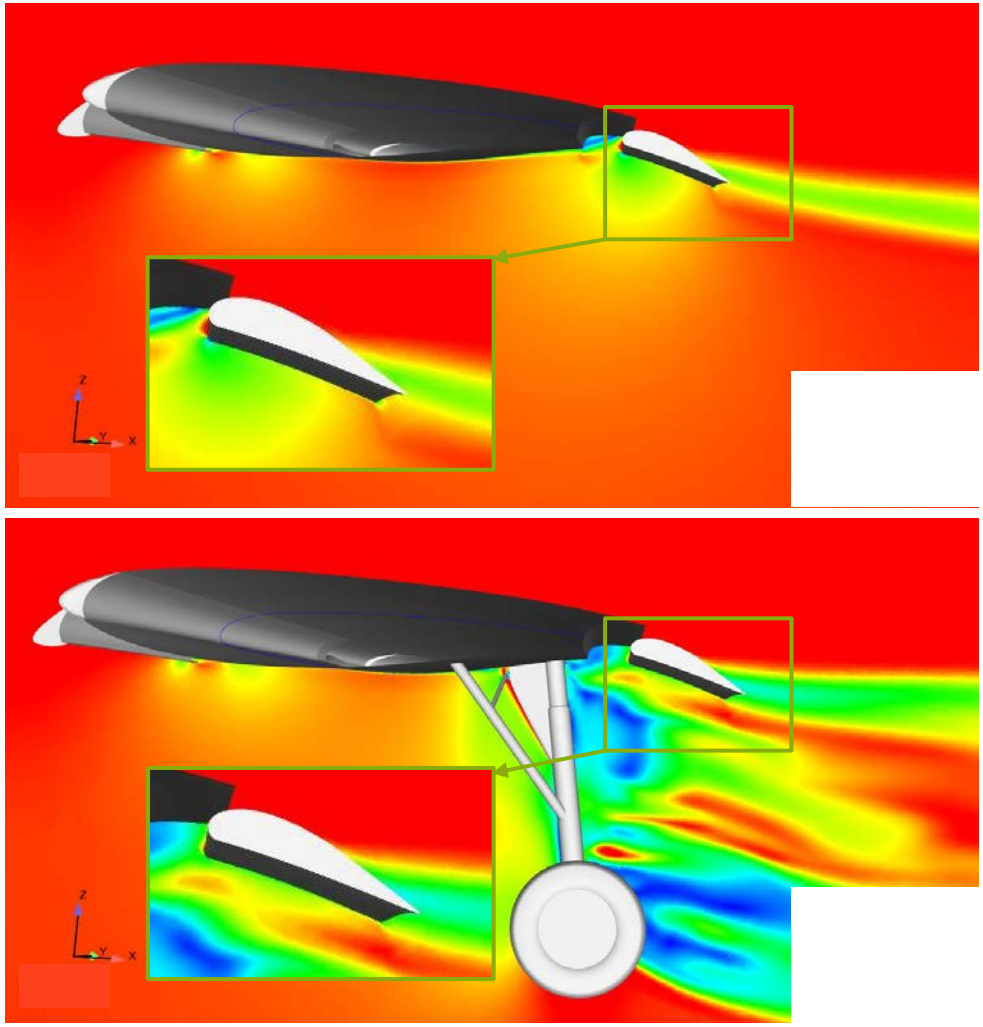
cp pattern and streaml. i/b flap CONF FULL



region of flow separation increased on flap by presence of MLG/door

Mach number pattern CONF 3

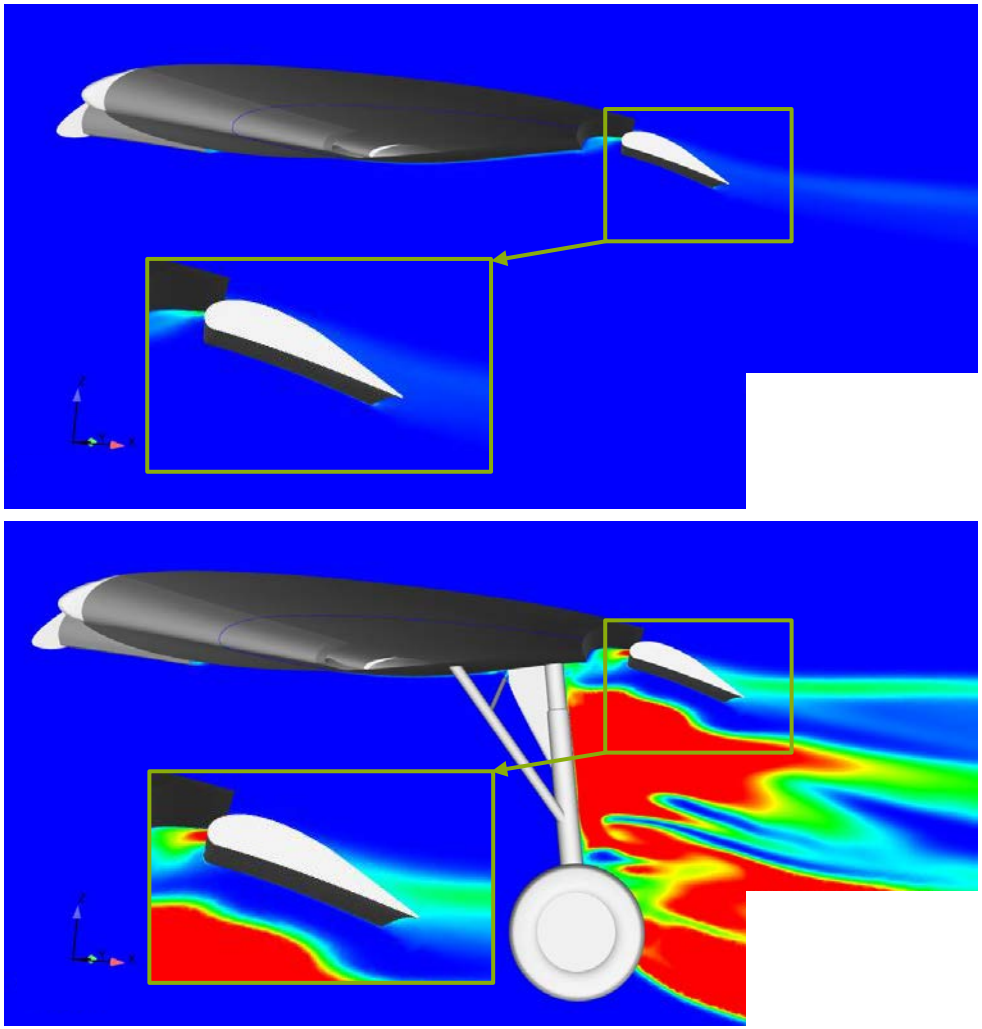
lateral view, centre main leg section



- Mach number plot shows clear impact of MLG and indicates LG noise source
- selected parameter hardly feasible for indication of interaction noise source

TKE pattern CONF 3

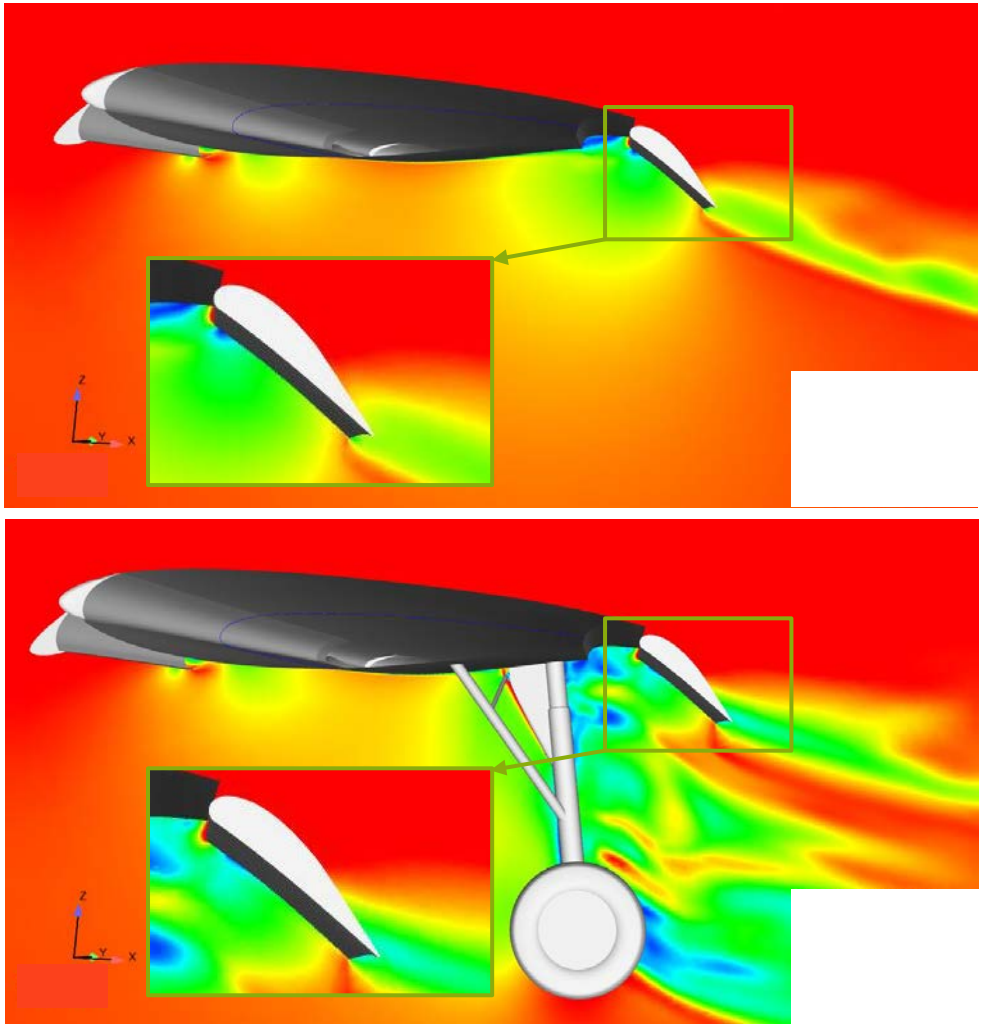
lateral view, centre main leg section



- TKE pattern shows significant impact in flap gap/leading-edge and flap upper trailing-edge regions
- TKE spot at flap leading-edge likely most important identified interaction noise source
- especially MLG door identified as interference noise driver

Mach number pattern CONF FULL

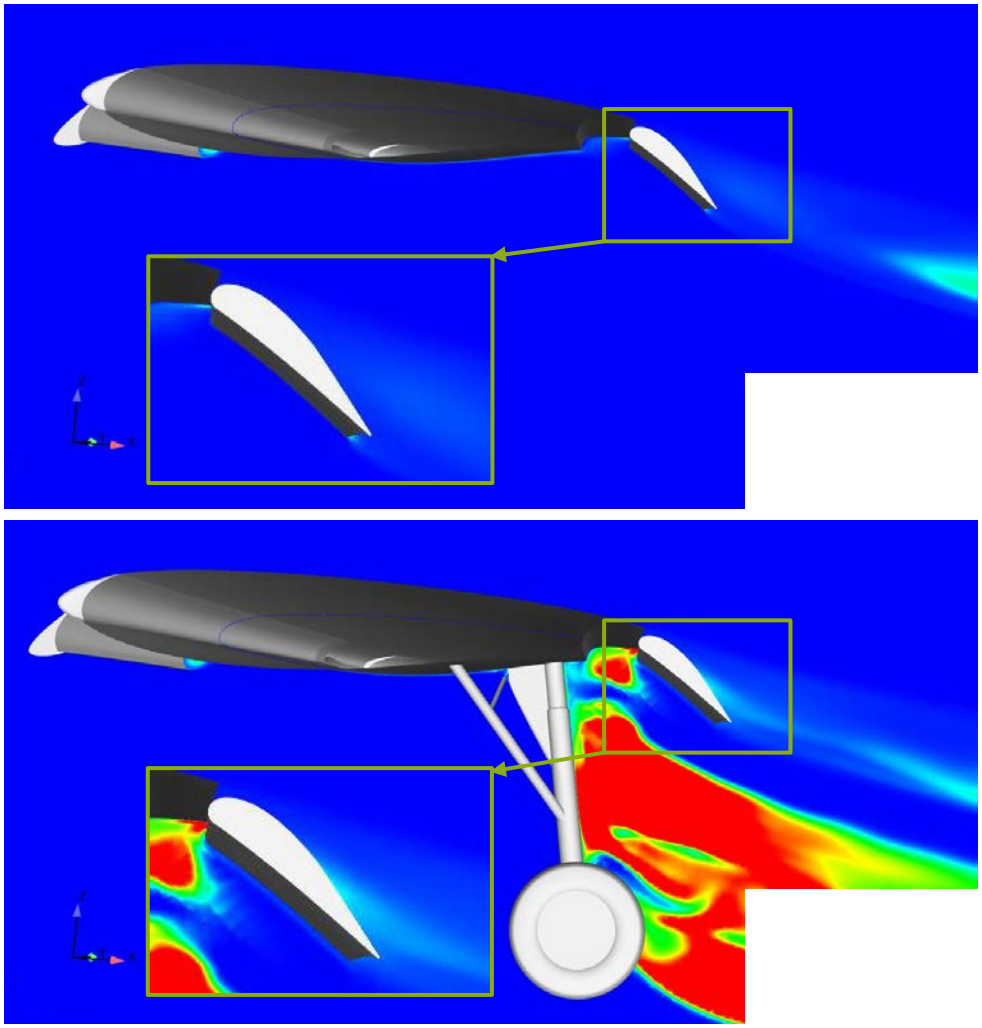
lateral view, centre main leg section



- Mach number plot shows clear impact of MLG and indicates LG noise source
- portion of flow separation on flap increased relative to CONF 3 may result noise increase
- selected parameter not feasible for indication of interaction noise source

TKE pattern CONF FULL

lateral view, centre main leg section



- TKE pattern shows significant impact in flap gap/leading-edge and flap upper trailing-edge regions
- TKE spot at flap leading-edge even more dominant than in CONF 3
- especially MLG door identified as interference noise driver

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CONCLUSIONS

Conclusions

\ excellent agreement between CFD and WTT for MLG up, differences in MLG down case assumed to be mainly caused by Re effect

\ regions with flow separation increase with increasing flap deflection angle indicating more noise

\ Mach number pattern not feasible to give clear view about potential MLG – flap interaction noise

\ better indications for interference noise given by TKE patterns showing increased values in regions of flap gap/leading edge and upper flap trailing-edge

\ TKE level in flap leading-edge regions likely identified as most dominant LG wake/flap interference noise source

\ investigation only indicator on acoustic behaviour and to be handled with care but beneficial for following WTT analysis

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Thank you !

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