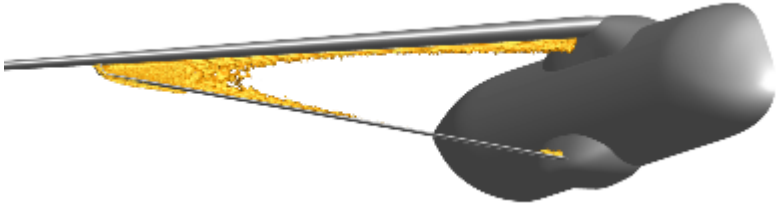
CIMNE

AIRBUS

PLATFORM FOR AIRCRAFT DRAG REDUCTION INNOVATION

Local flow control for the strut braced wing (SBW)

Results Comparison



A Consortium of:

Generalitat de Catalunya

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

In cooperation with:

UNESCO

CONTRIBUTIONS

Team	Title	Presenter	Co-authors
INCAS, Romania	Investigations of passive flow control devices for wave drag reduction	M.G. Cojocaru	D. Pepelea, M.V. Pricop, C. Nae, M.G. Stoican, M.L. Niculescu
NASA Ames, USA	NASA Ames contributions to the PADRI workshop	Gaetan Kenway	Jeffery Houseman, Cetin Kiris
NASA Langley, USA	Application of a Knowledge-Based Design Method and Passive Porosity for Drag Reduction on a Generic Strut-Braced Wing	Richard Campbell	Sally Viken, Michelle Lynde
Tsinghua University	PADRI: Shock Wave Reduction via Wing-Strut Geometry Design	Runze LI	Yufei ZHANG, Haixin CHEN, Song FU
Univ. of Concepción, Chile	Drag reduction in a wing-strut junction	Pablo Cornejo	
Stanford Univ.	Contribution to Padri	Juan Alonso	Brian Munguia, Victorien Menier, Jayant Mukhopadhaya.
DLR		Nico Bier	J.P.Hofmann

CONTRIBUTIONS

Team	Flow Control Device	Type of FC devices	Summary in two words
INCAS, Romania	Kuchemann Carrot (KC) and shock control bumps (SCB)	Passive device	No improvement obtained, so optimization required.
NASA Ames, USA	No Flow control Device: geometry modification	--	Optimization of truss shape. SQP optimizer.
NASA Langley, USA	1. No Flow control Device: geometry modification 2. Porous media	1. -- 2. Passive device	1. Reduction of shock, separation and drag 2. Reduction of shock but increase on BL separation
Tsinghua University, China	No Flow control Device: geometry modification	--	Shock wave reduction obtained
Univ. of Concepción, Chile	SCB + air injectors	Passive + active Devices	Drag reduction between 3.6-5.6 drag counts, power saved around 165kW
Stanford Univ.	Blowing and suction (Transpiration bc)	Active device	
DLR	Fluidic Gurney	Active device	10% drag reduction

CONTRIBUTIONS

Team	Solver	Mesh elements	Mesh size	Turbulence model
INCAS, Romania	RANS (Ansys Fluent)	hexahedral	~95M	k-ω SST with Intermittency Transition model
NASA Ames, USA	RANS (ADflow)		~7.5M ~60M	
NASA Langley, USA	RANS (USM3D)	tetrahedral	~60M	
THU, China	RANS (NSAWET)	Structured grid	~10M	k-ω SST
UdeC, Chile	RANS (Ansys Fluent)	Hexahedral and polyhedral	~20M	k-ω SST
Stanford Univ.	RANS (SU2 framework)	Unstructured Grid (Prisms, ...)	~10M	k-ω SST
DLR	RANS (Tao)			

CONTRIBUTIONS

Team	Optimizer	Type	Number of iterations	Computational time
INCAS, Romania	--	--		
NASA Ames, USA	SQP	Gradient based method		2h (480 cores)
NASA Langley, USA	CDISC	knowledge-based design method		
THU, China	2D optimization with GA	Stochastic method		
UdeC, Chile	--	--		
Stanford Univ.	SU2 framework	Adjoint-based method		
DLR				

CONTRIBUTIONS

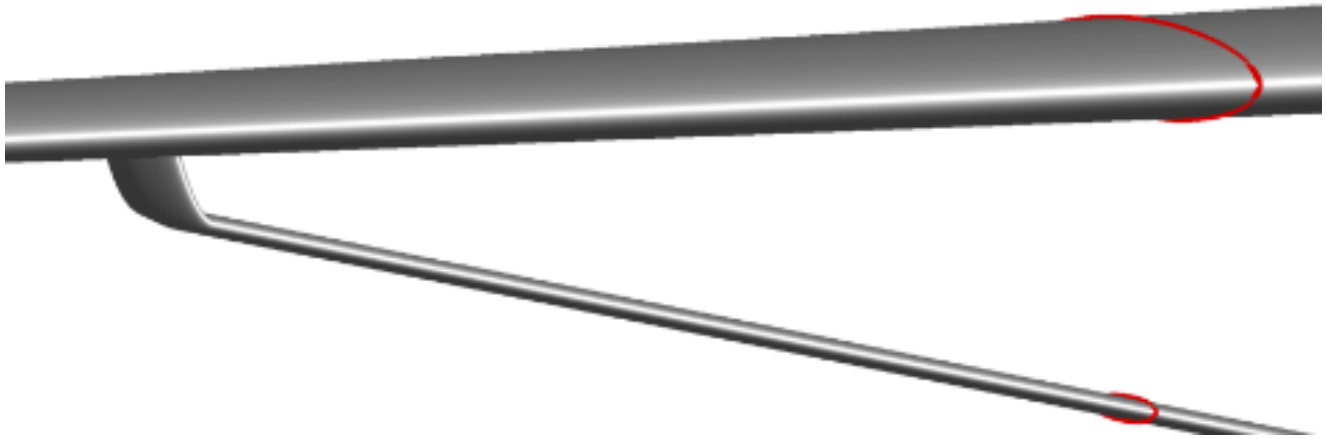
Team	Tecplot files	Shock Wave flag
INCAS, Romania	Surface only	No
NASA Ames, USA	Yes	Yes
NASA Langley, USA	Yes	Yes
THU, China	Yes	Yes
UdeC, Chile	No	No
Stanford Univ.	No	No
DLR	No	No

QUESTIONS

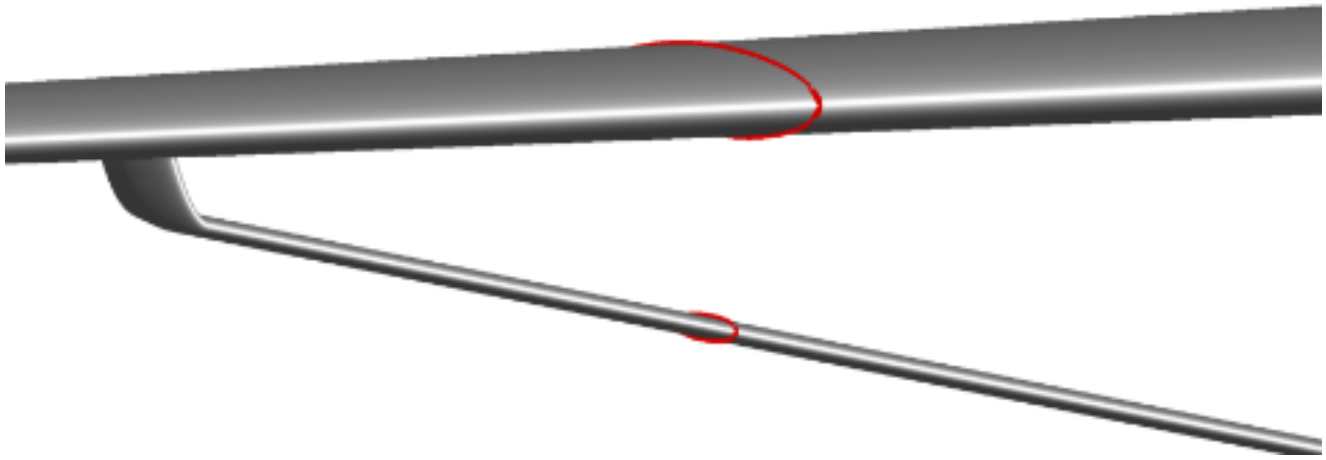
1) Baseline as a reference
2) Is lift maintained at the baseline value?
3) Robustness of the solution (Mach flexibility)
4) Adaptability of the solution to other Use Cases
5) Optimization analysis of the solution
6) Span loading; how is it affected? (wing + strut)

STATIONS

Y12

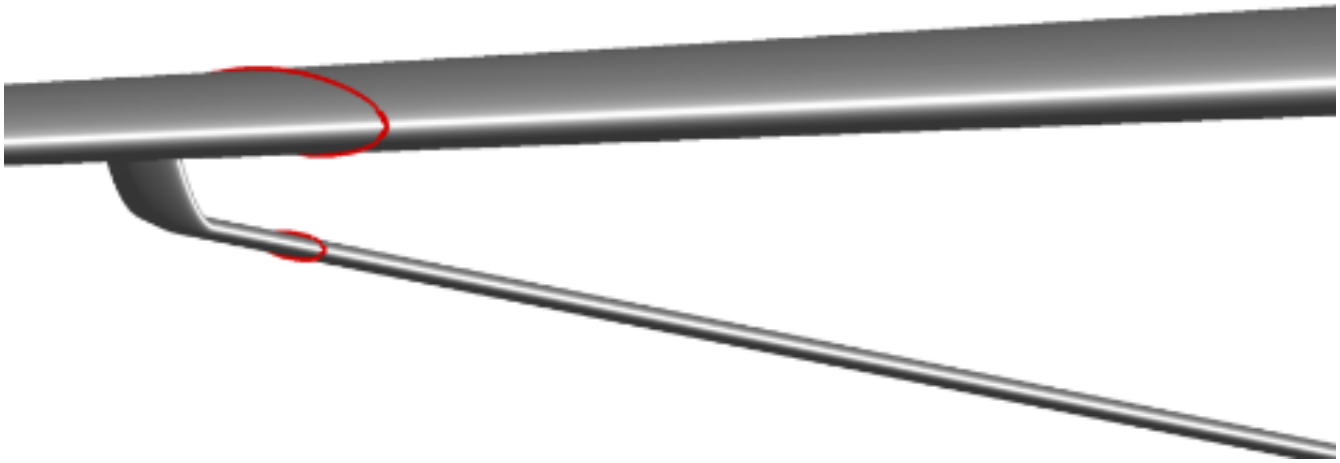


Y14



STATIONS

Y16



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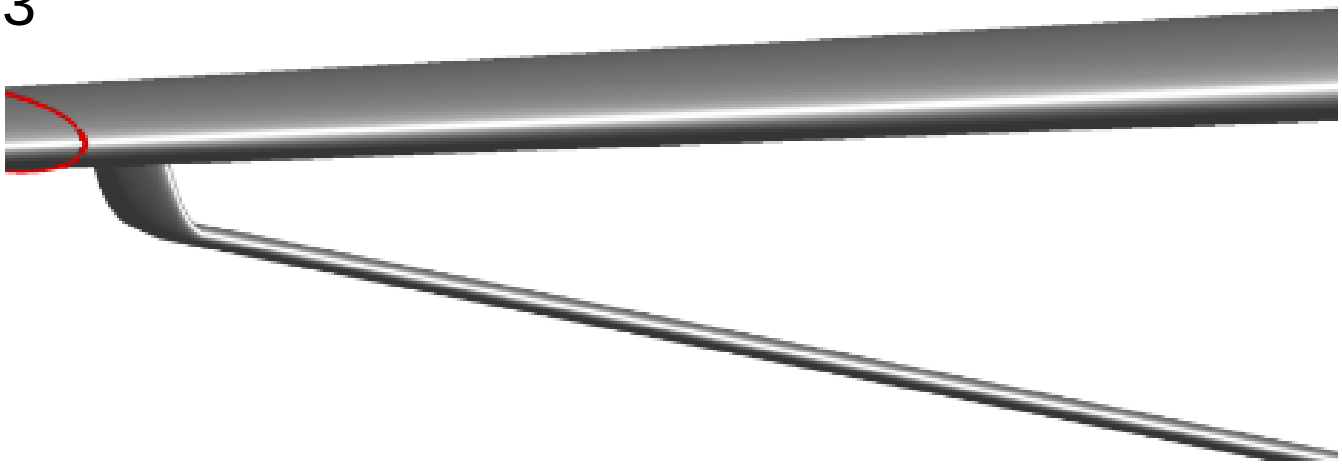
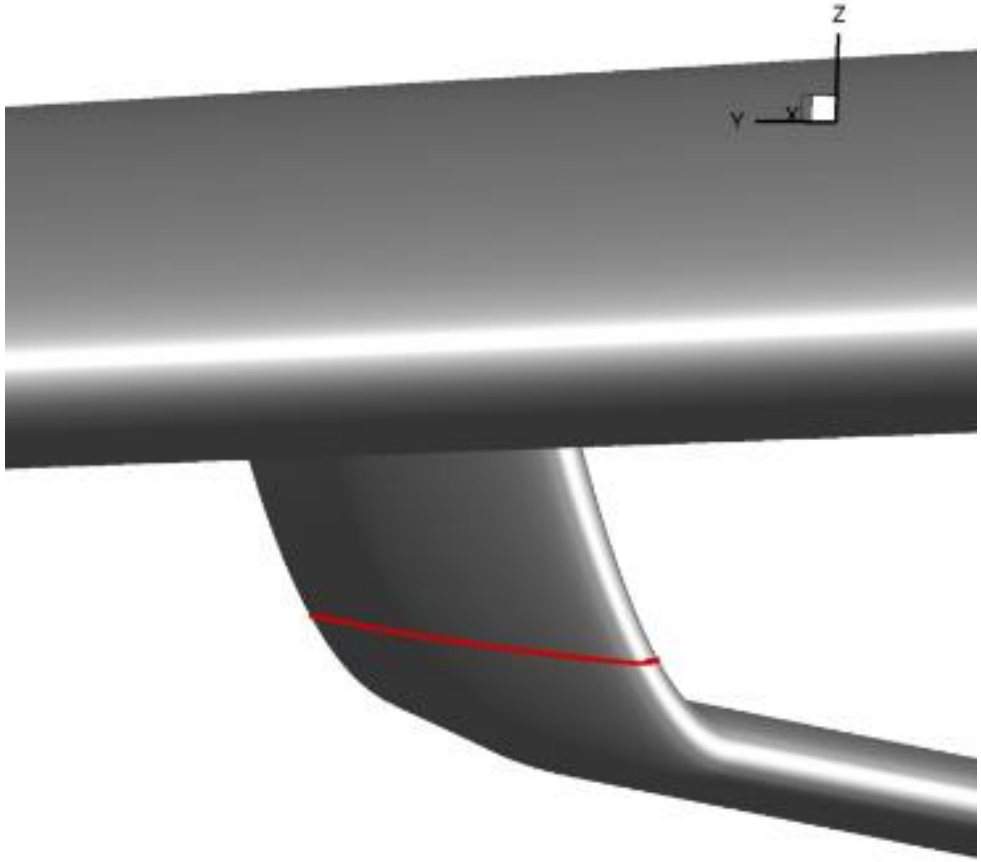


STATIONS

Z0.87



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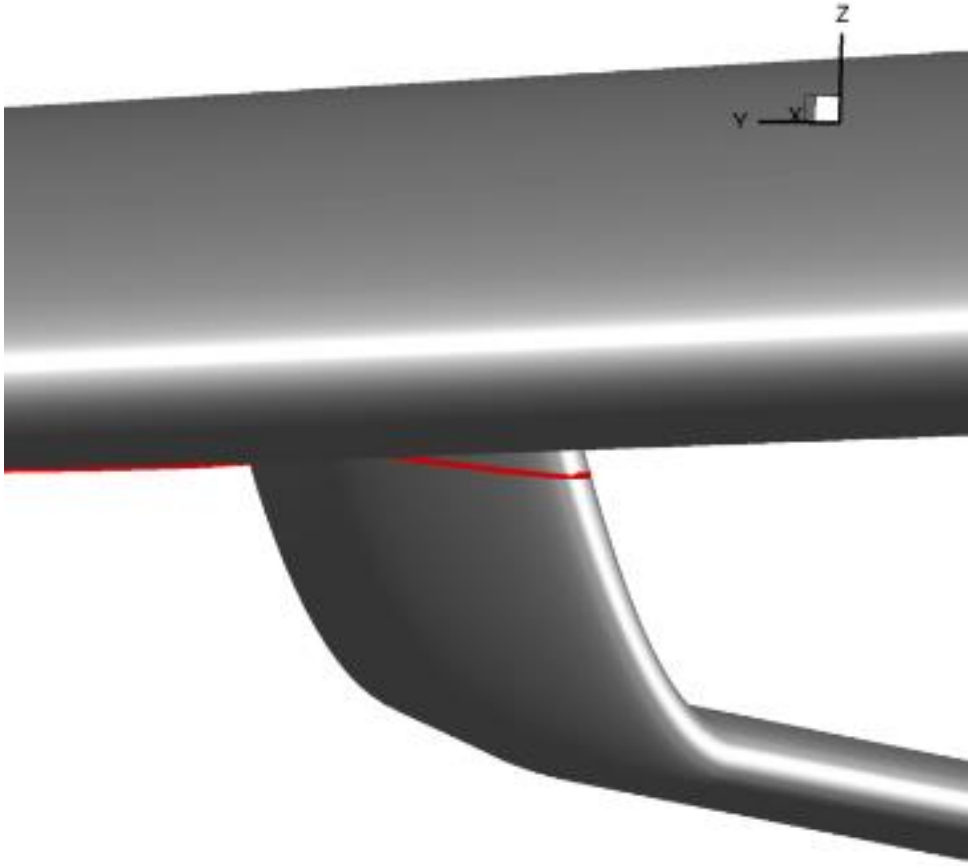
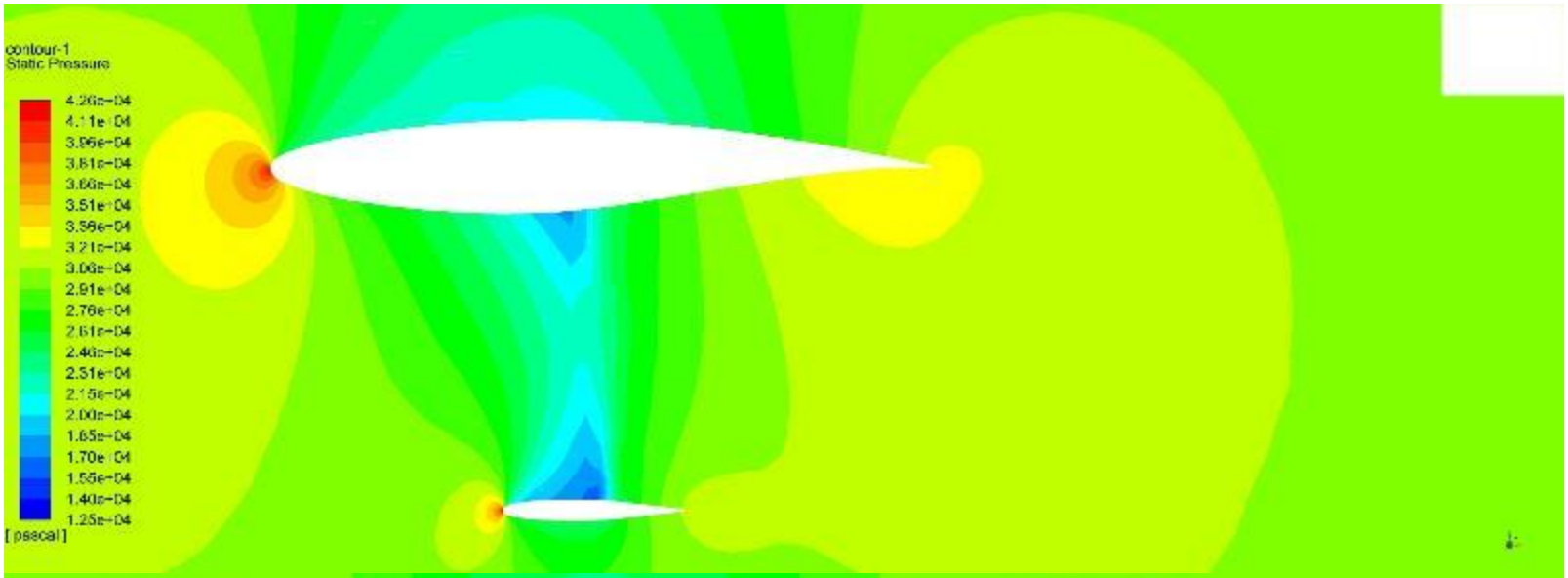
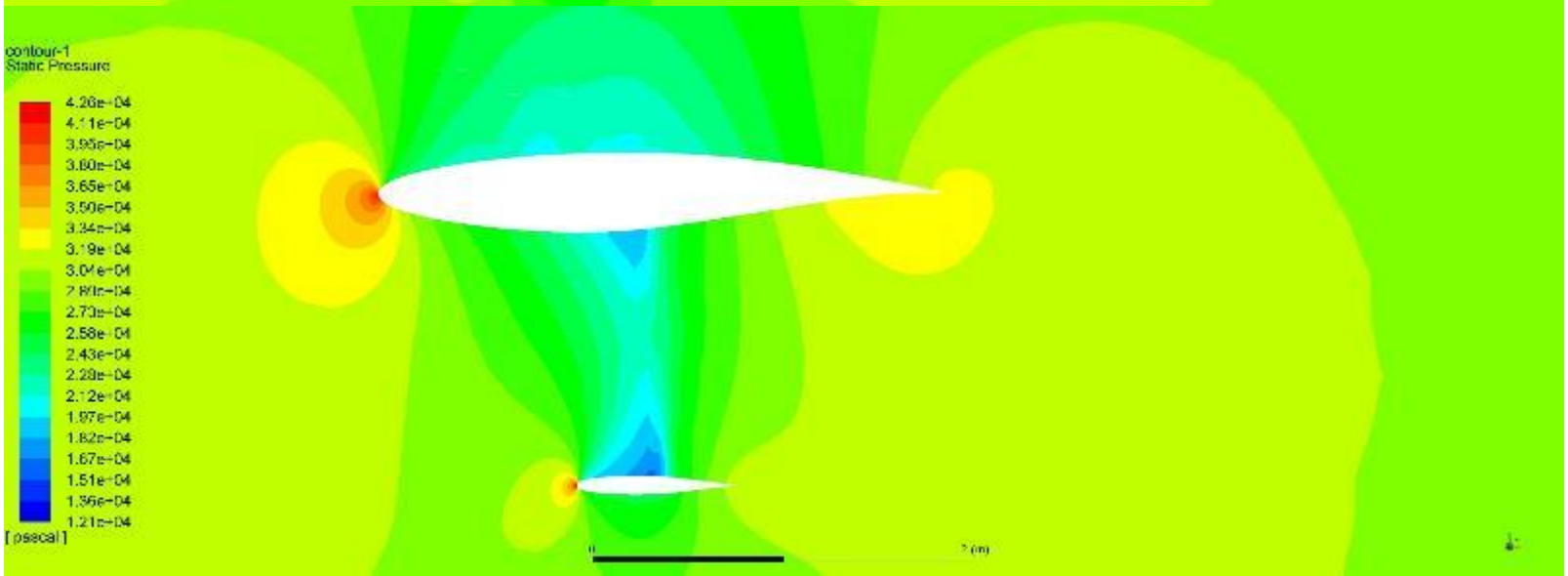


CP (STATION Y12)

INCAS KC

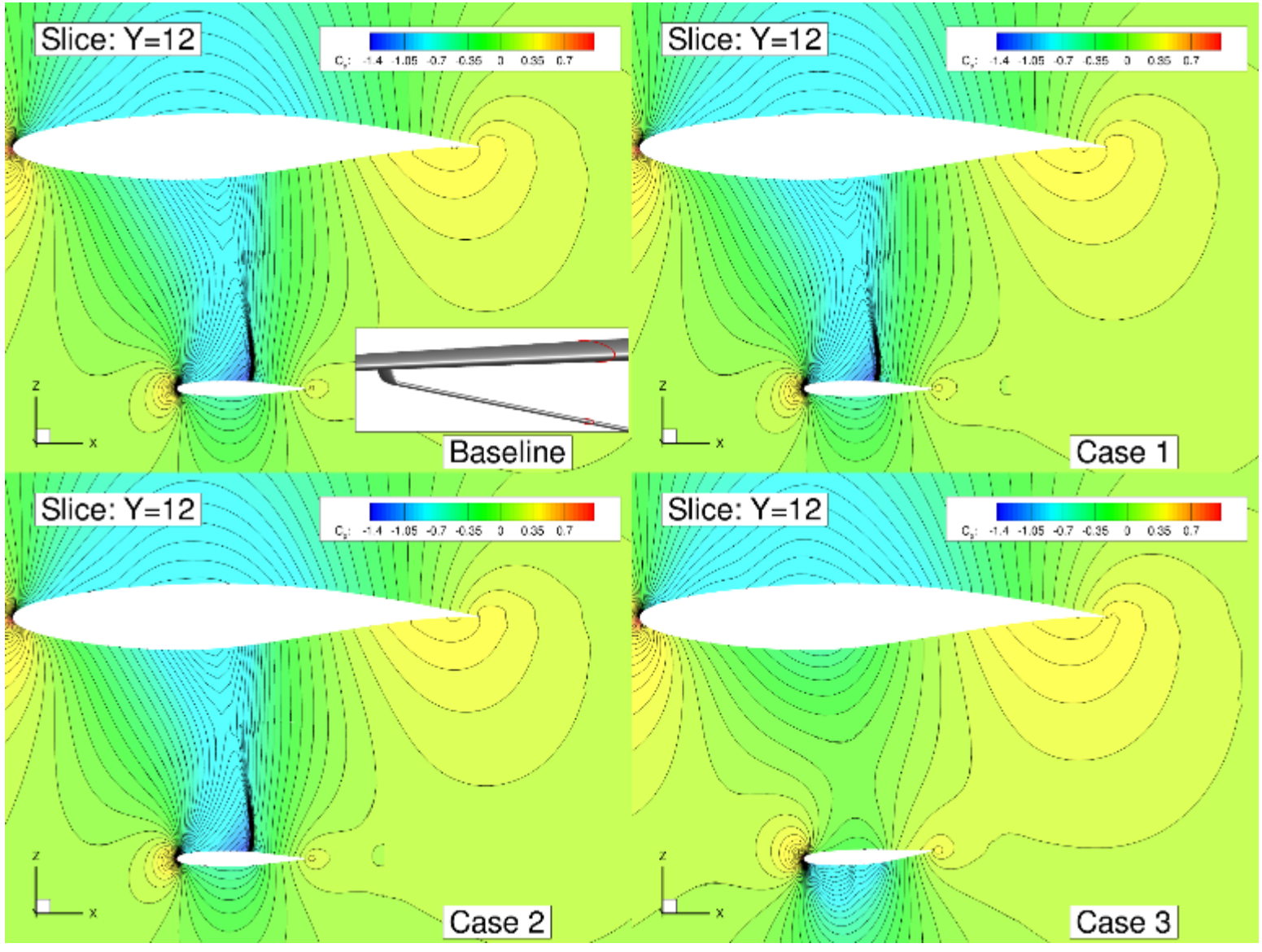


INCAS SCB



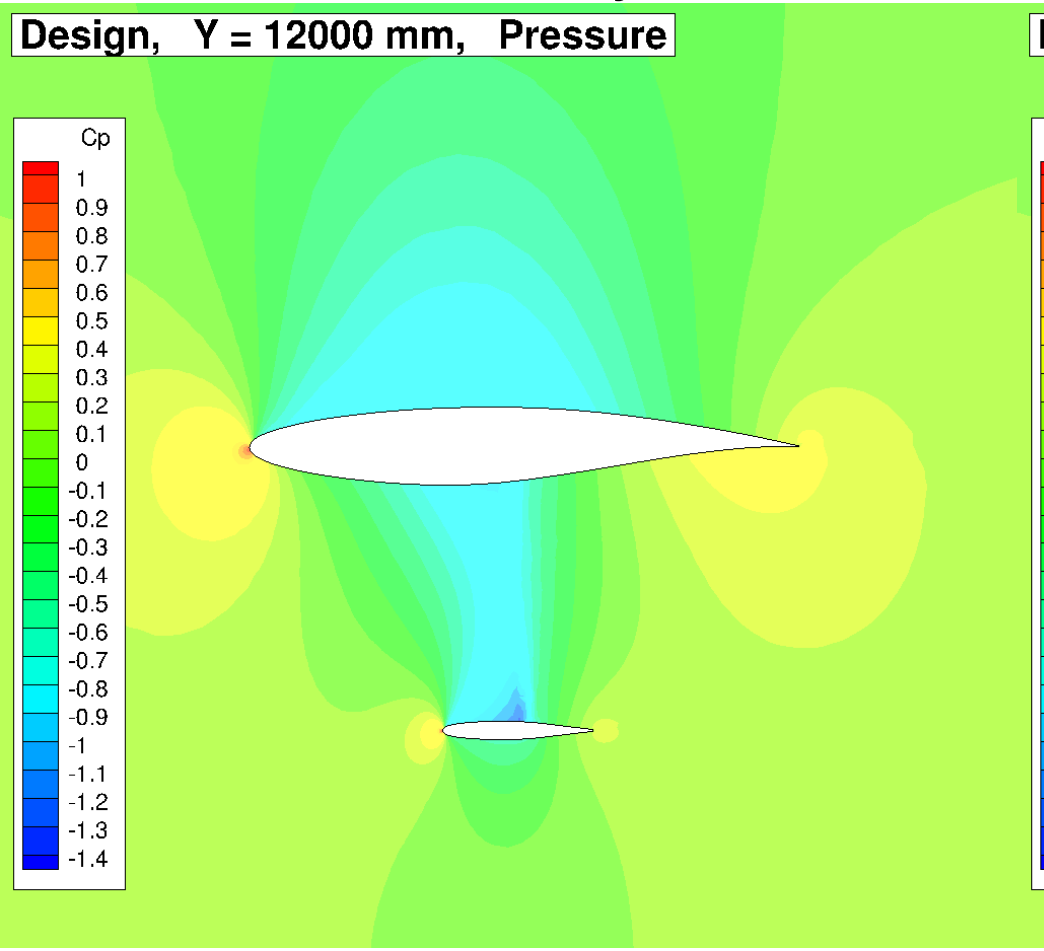
CP (STATION Y12)

NASA-AMES

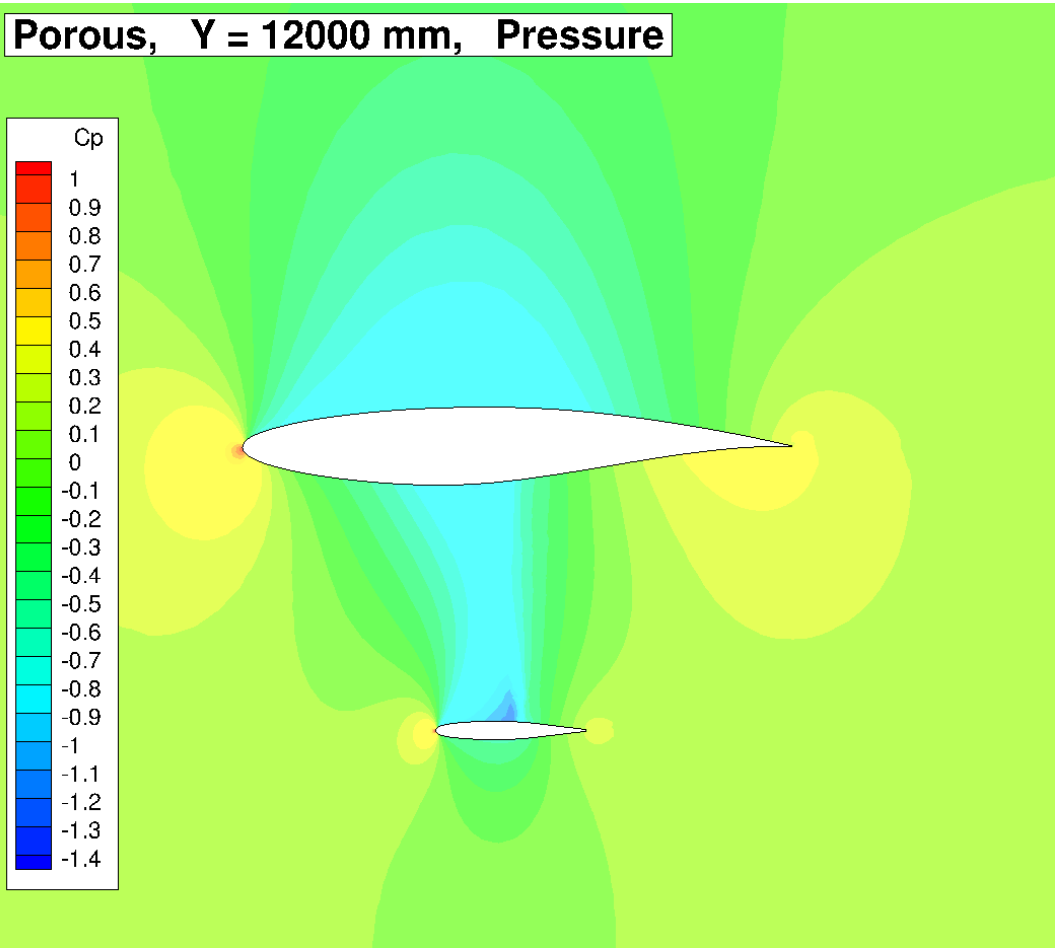


CP (STATION Y12)

LANGLEY - Geometry

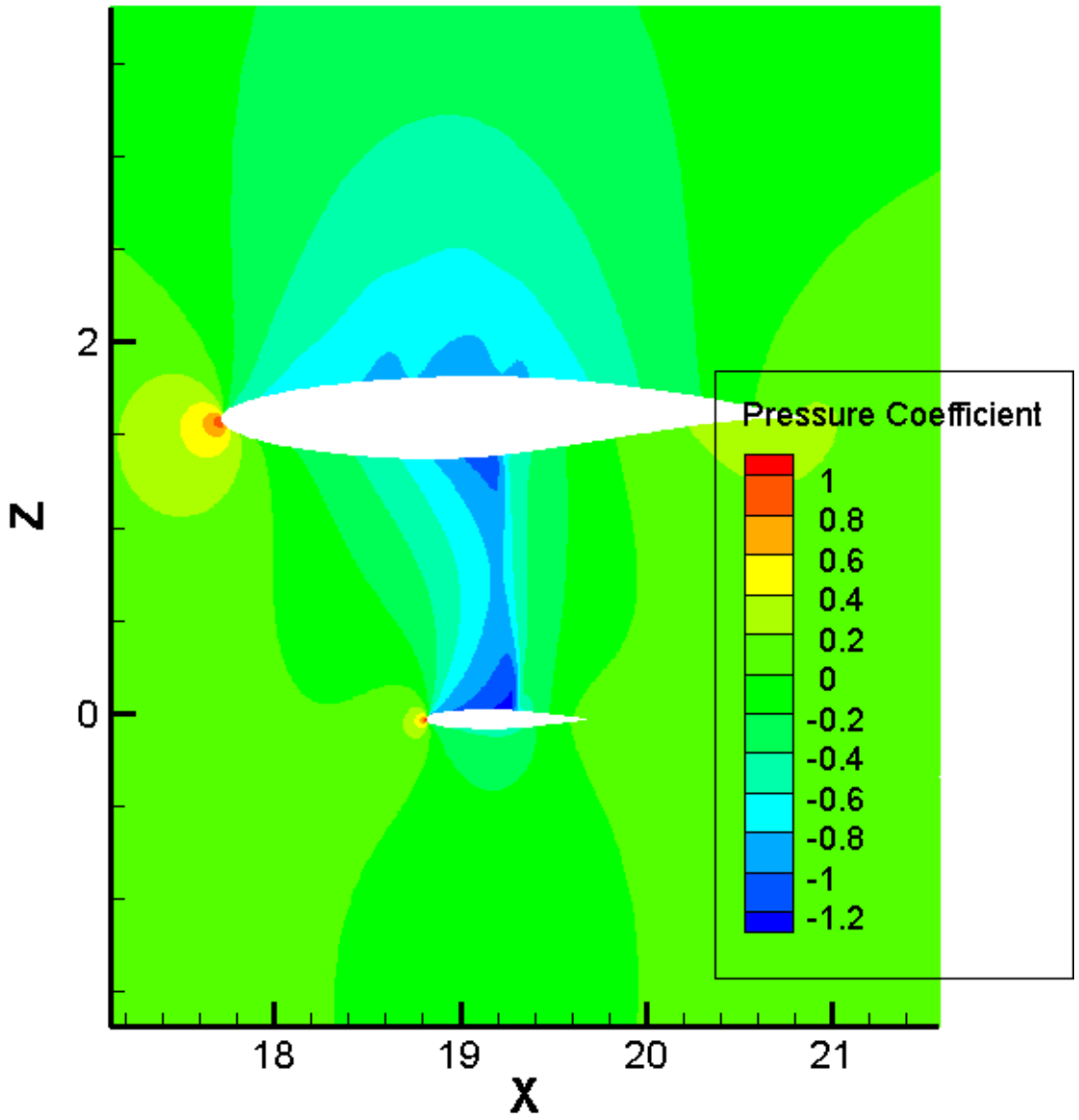


Porous



CP (STATION Y12)

THU - Geometry



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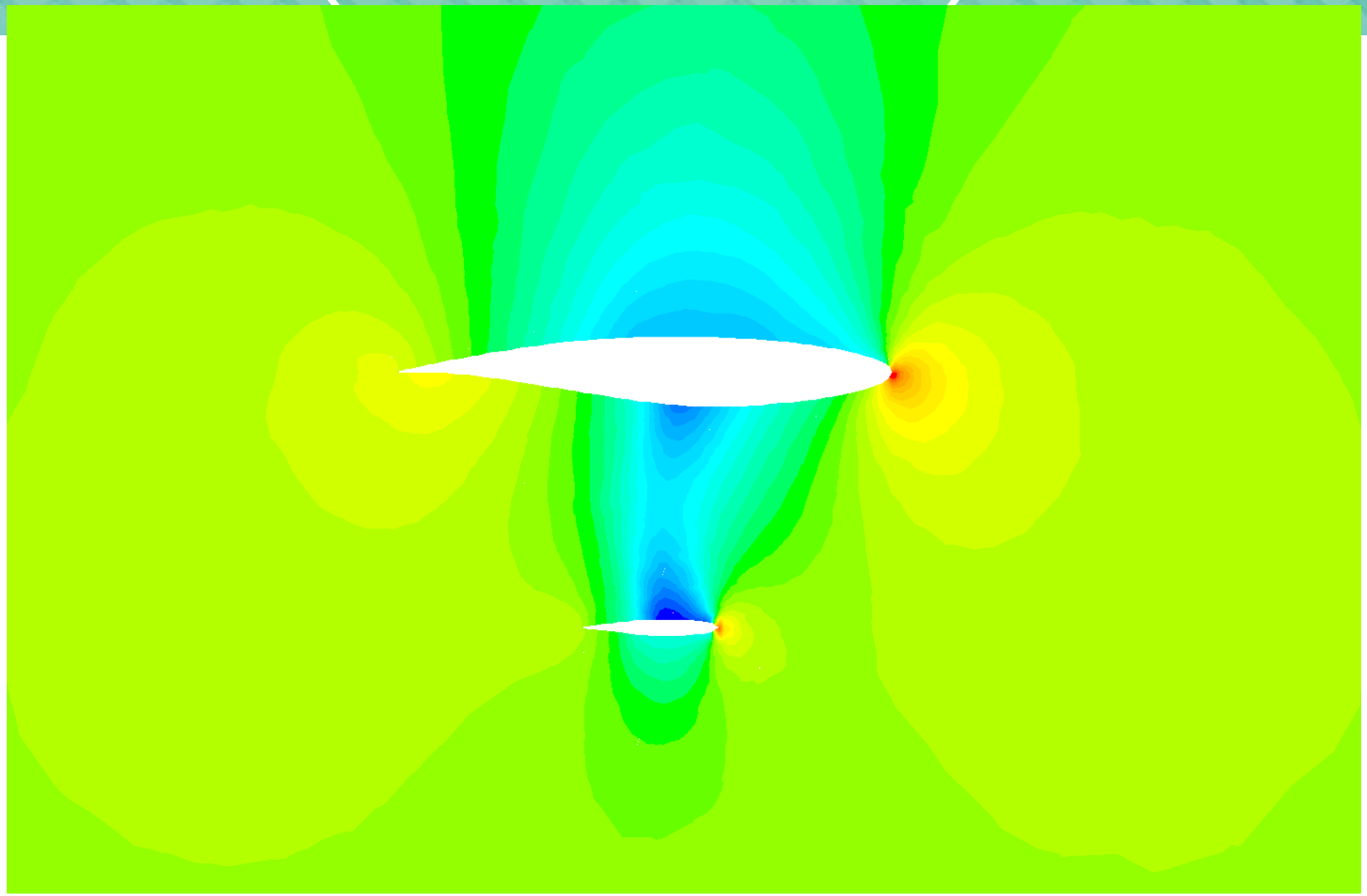
UdeC - SCB



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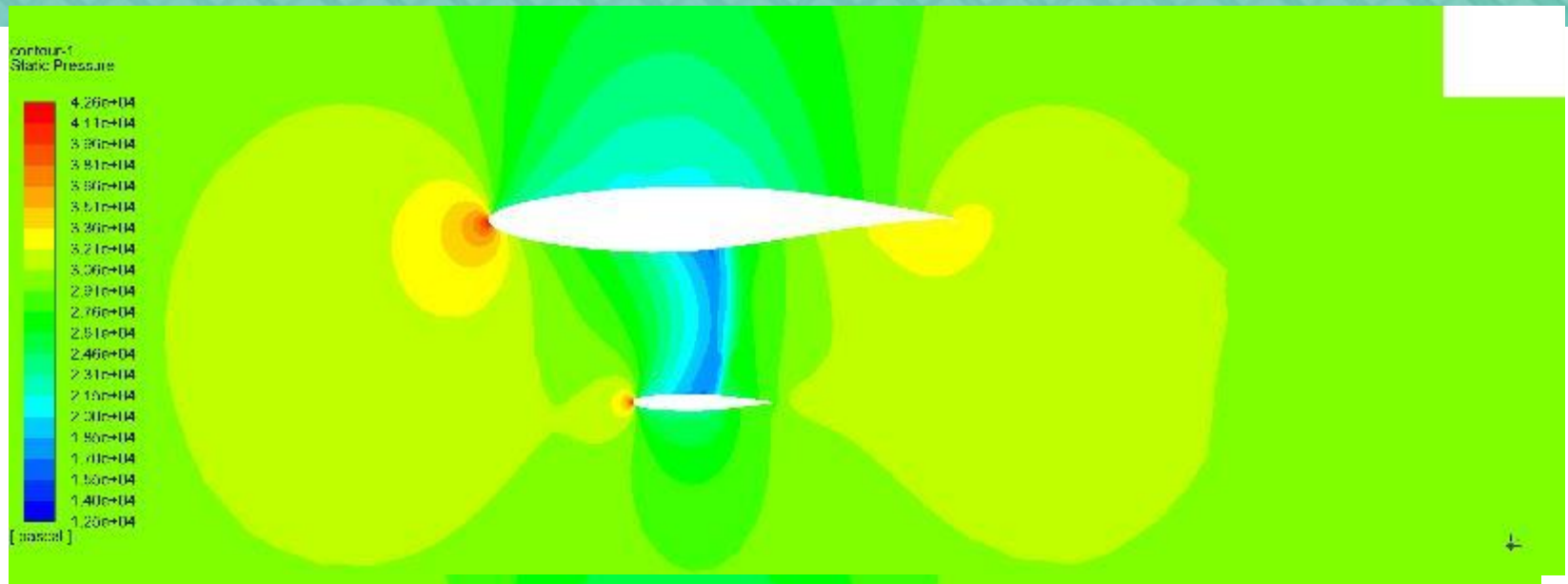
INCAS KC



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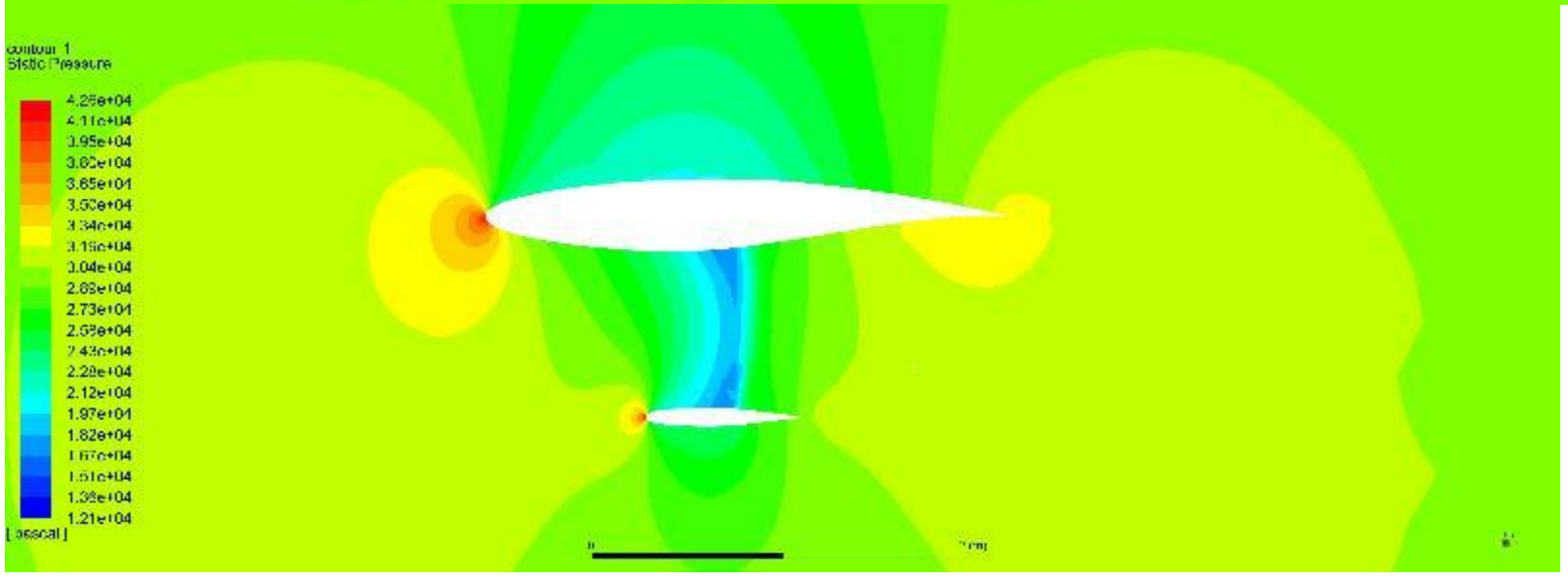

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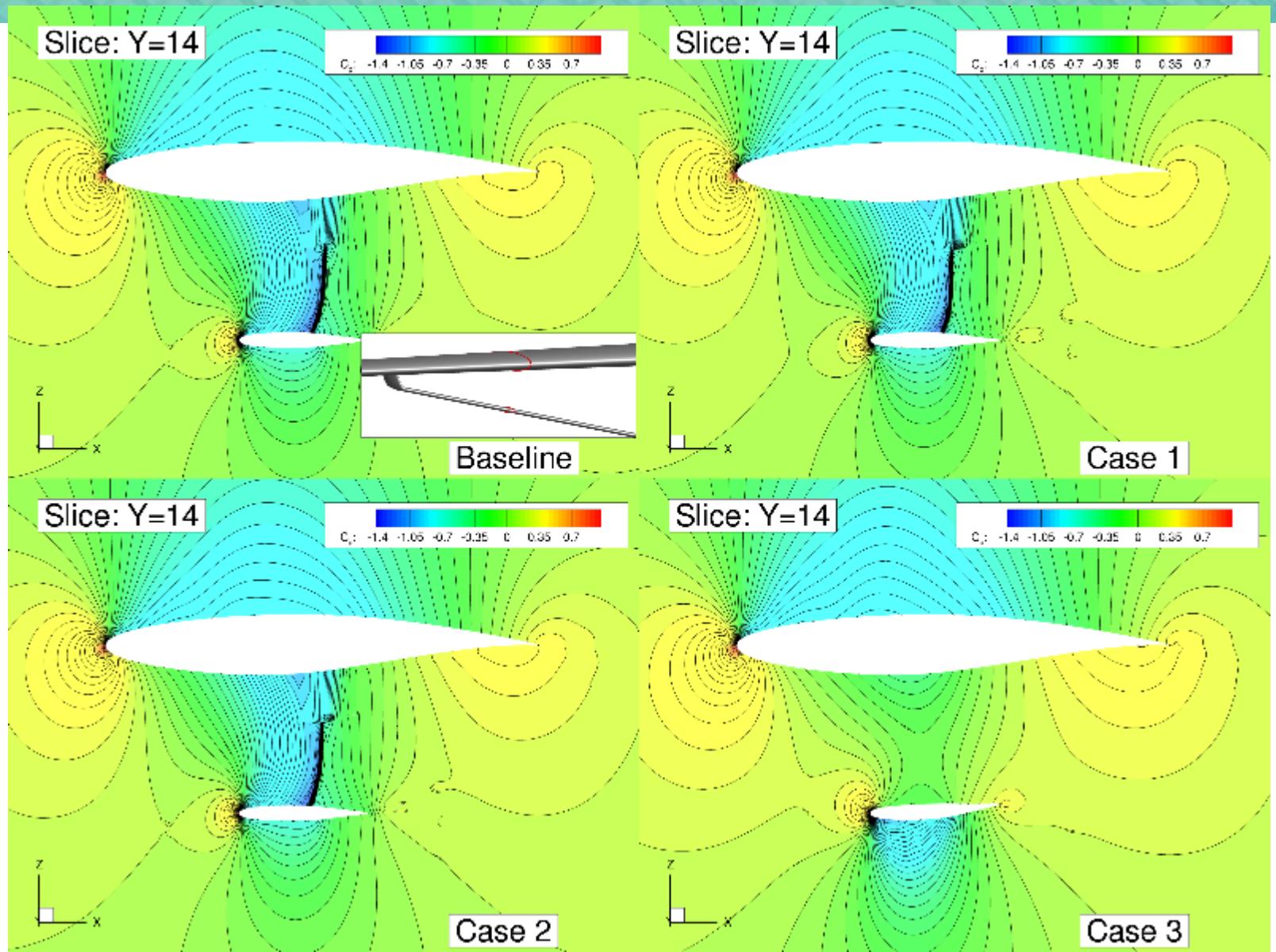
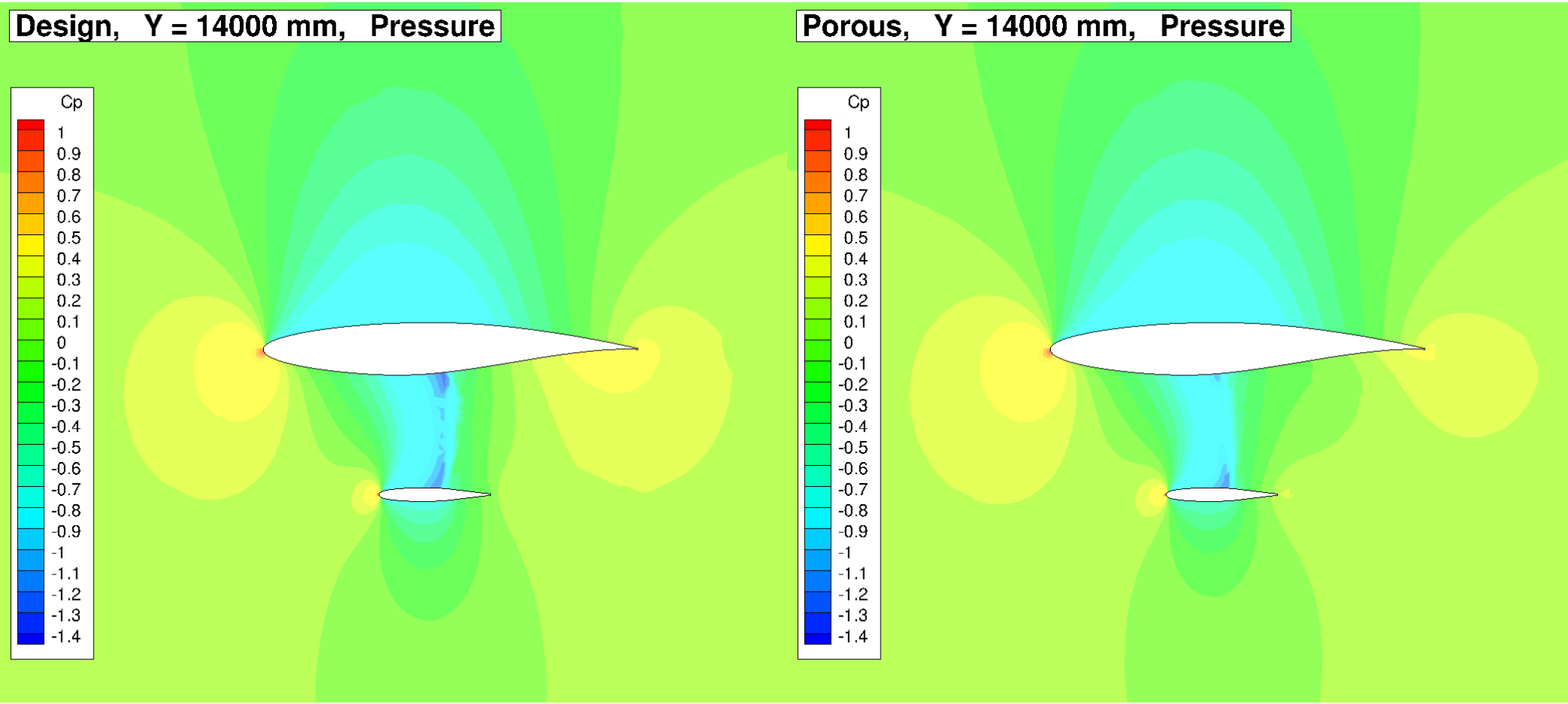


CP (STATION Y14)

LANGLEY - Geometry

Porous



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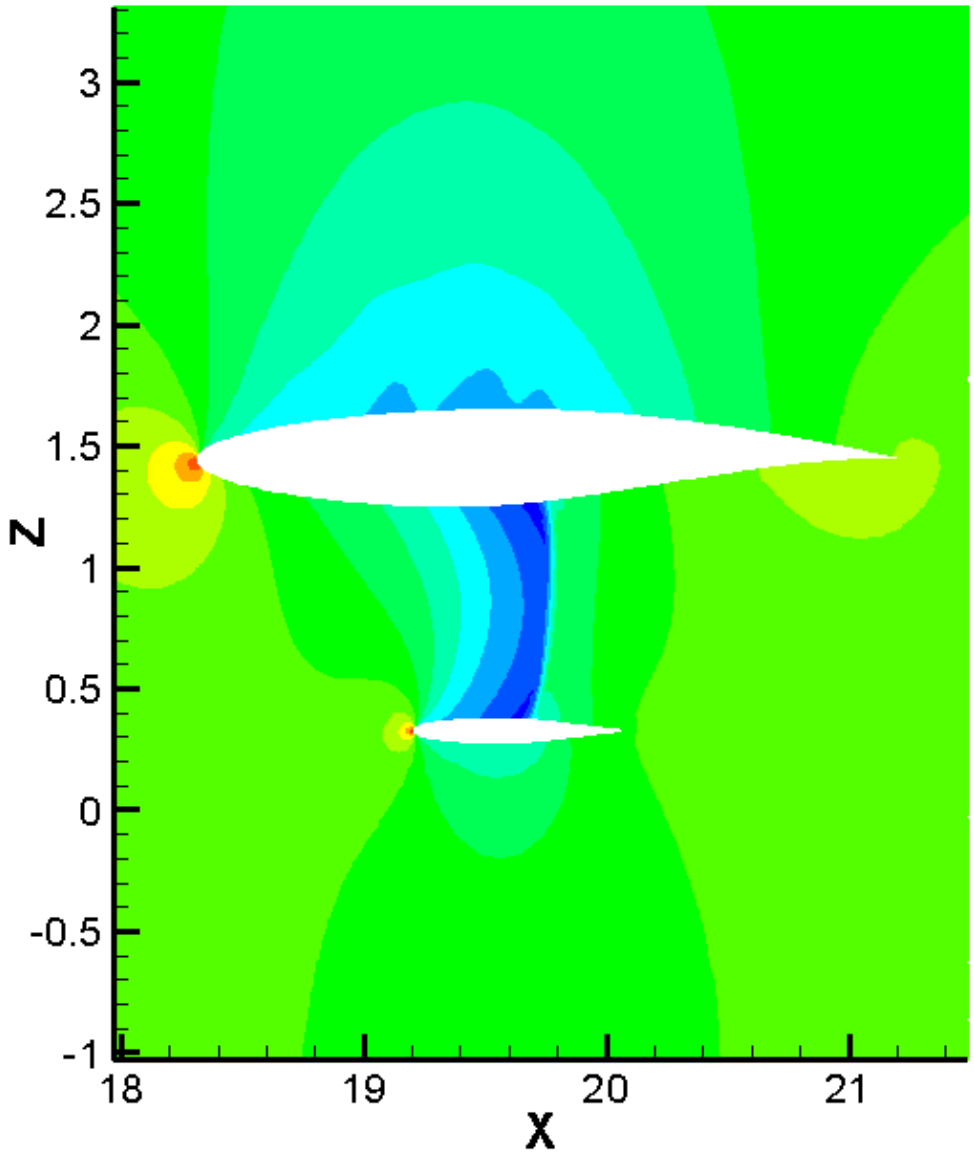
THU - Geometry



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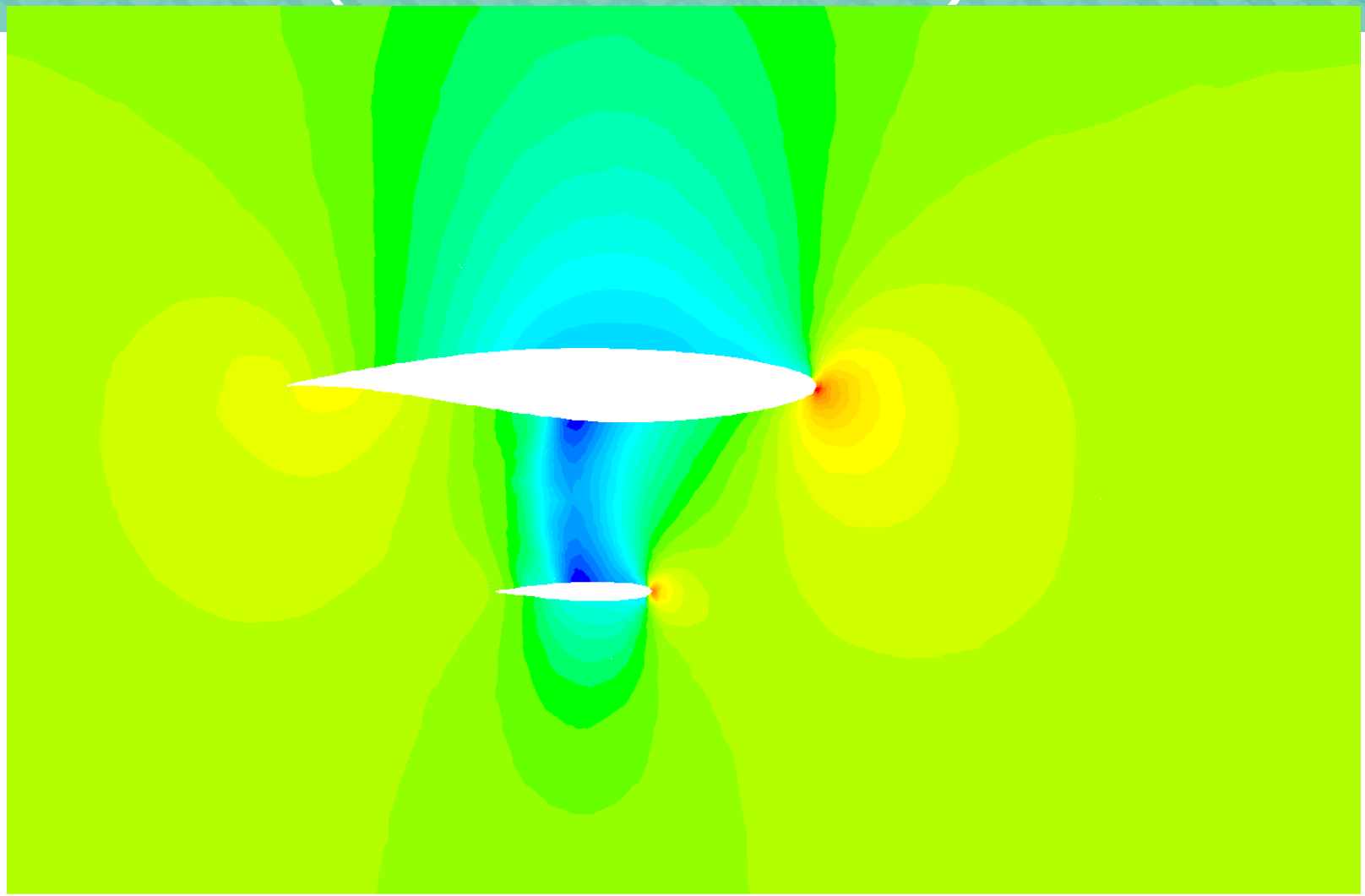
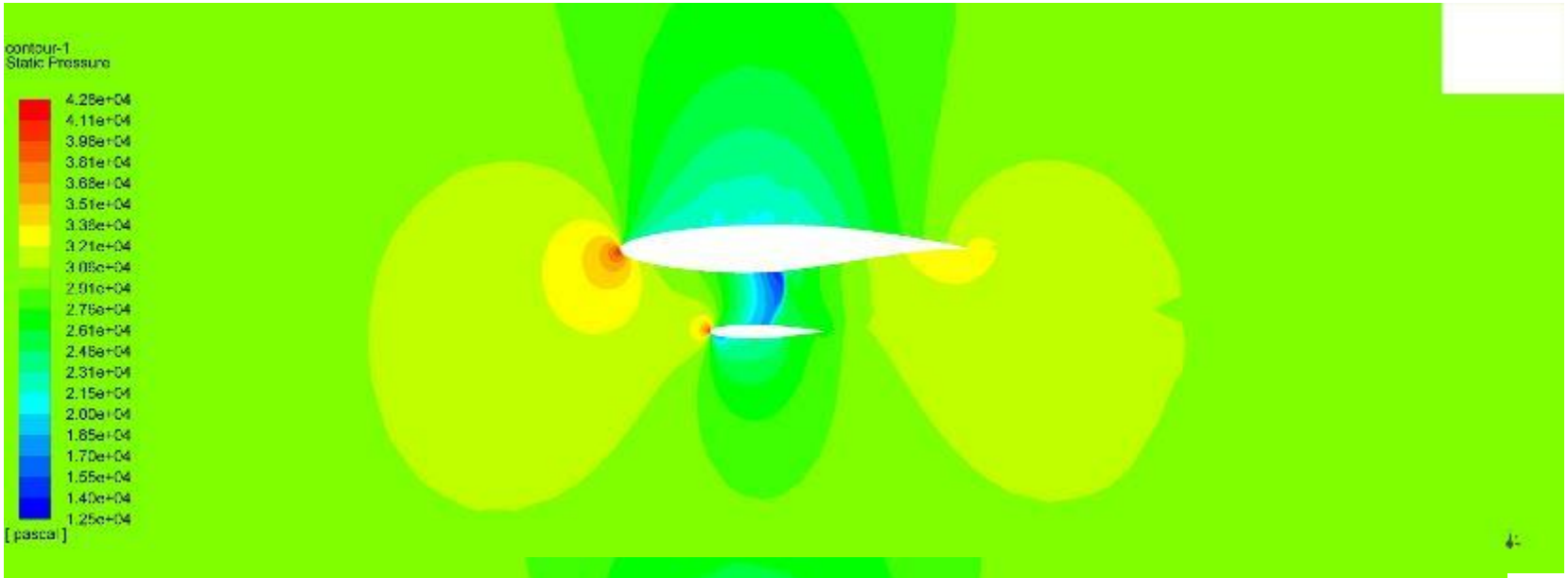


CP (STATION Y16)

INCAS KC



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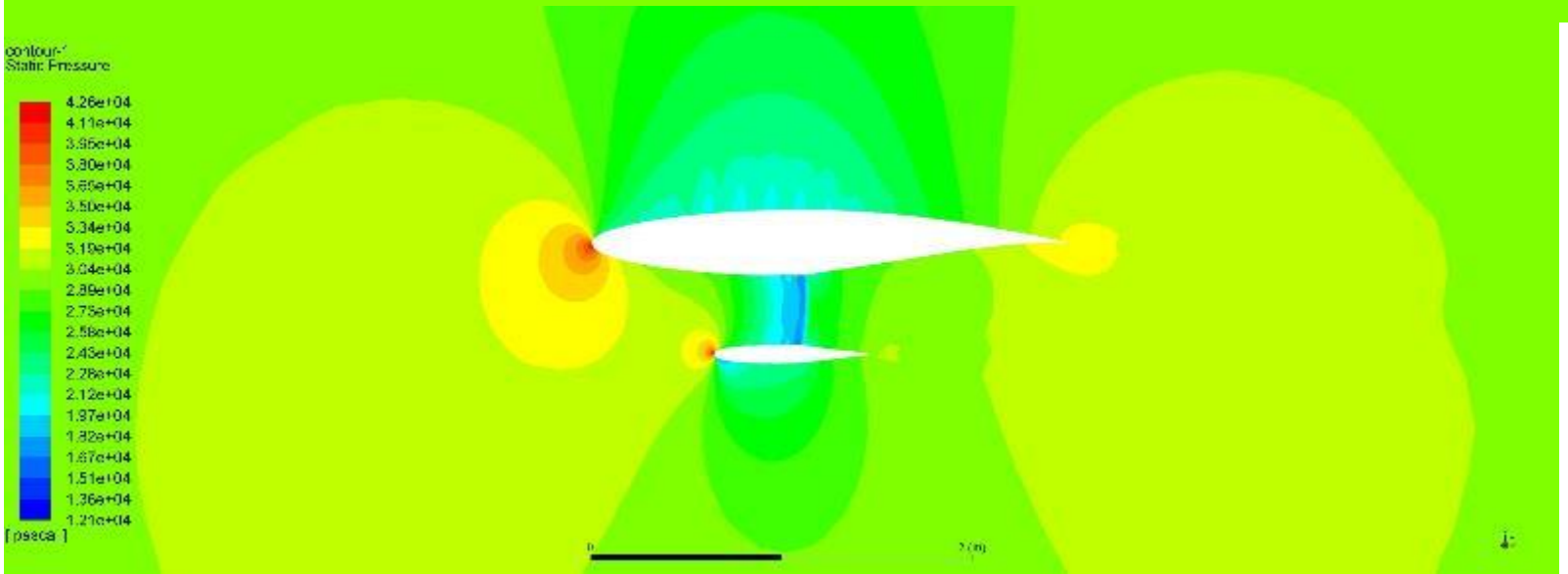

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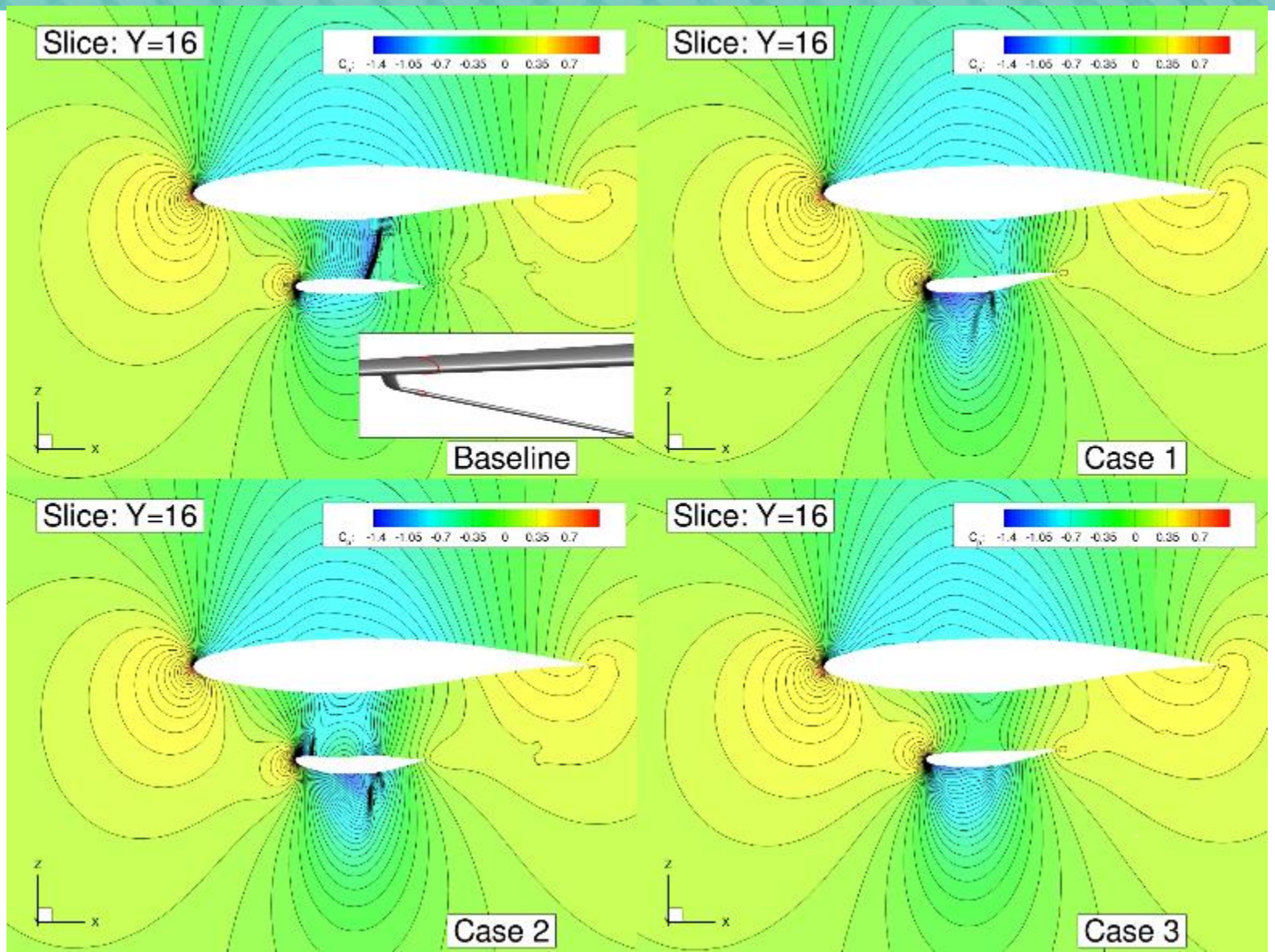
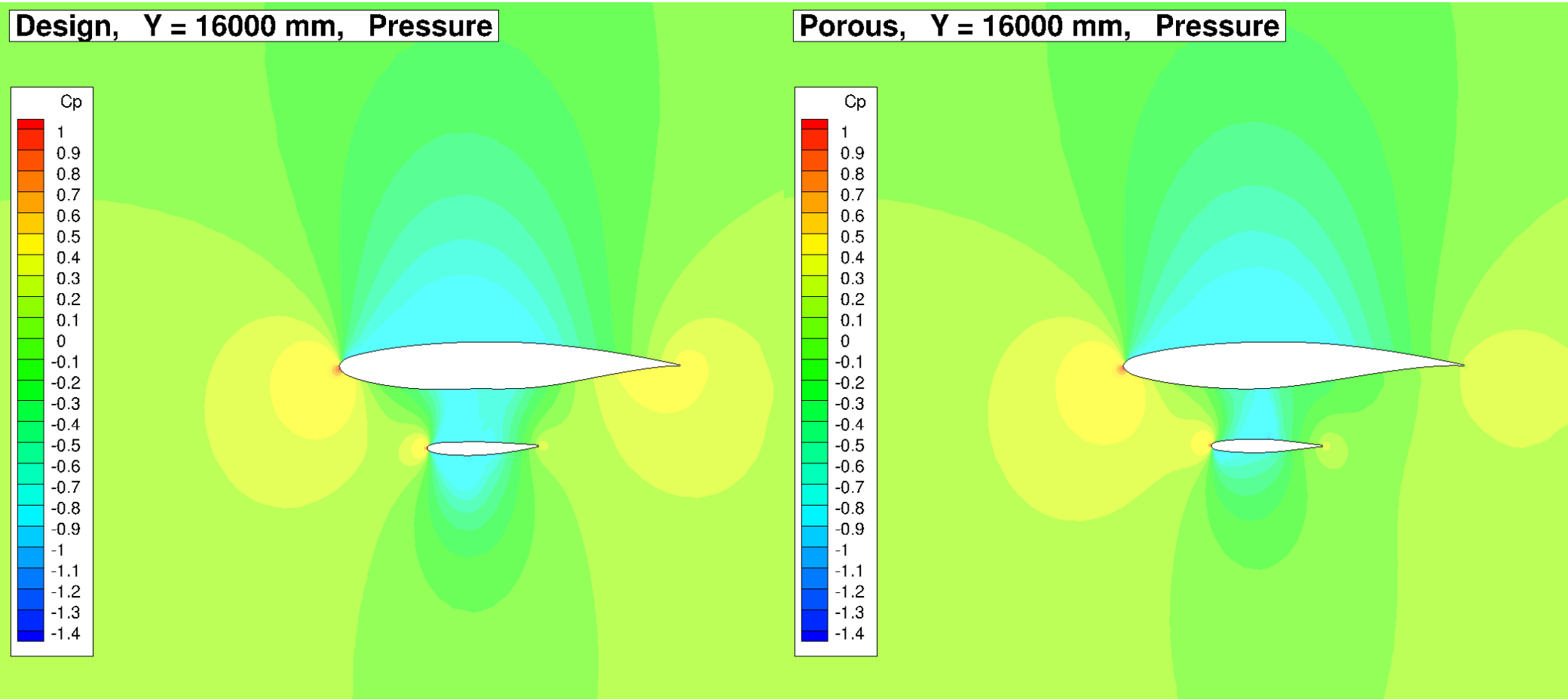


CP (STATION Y16)

LANGLEY - Geometry

Porous



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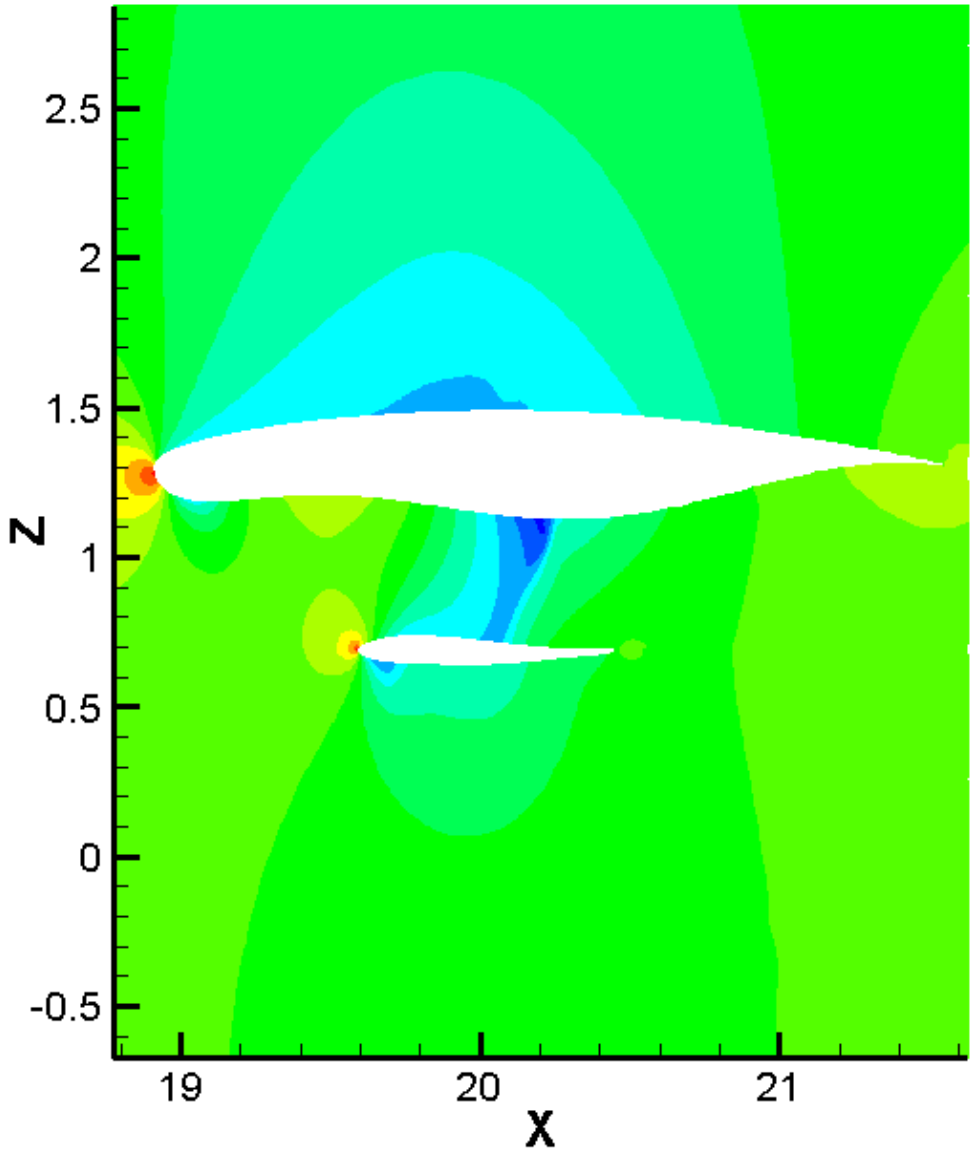
THU - Geometry



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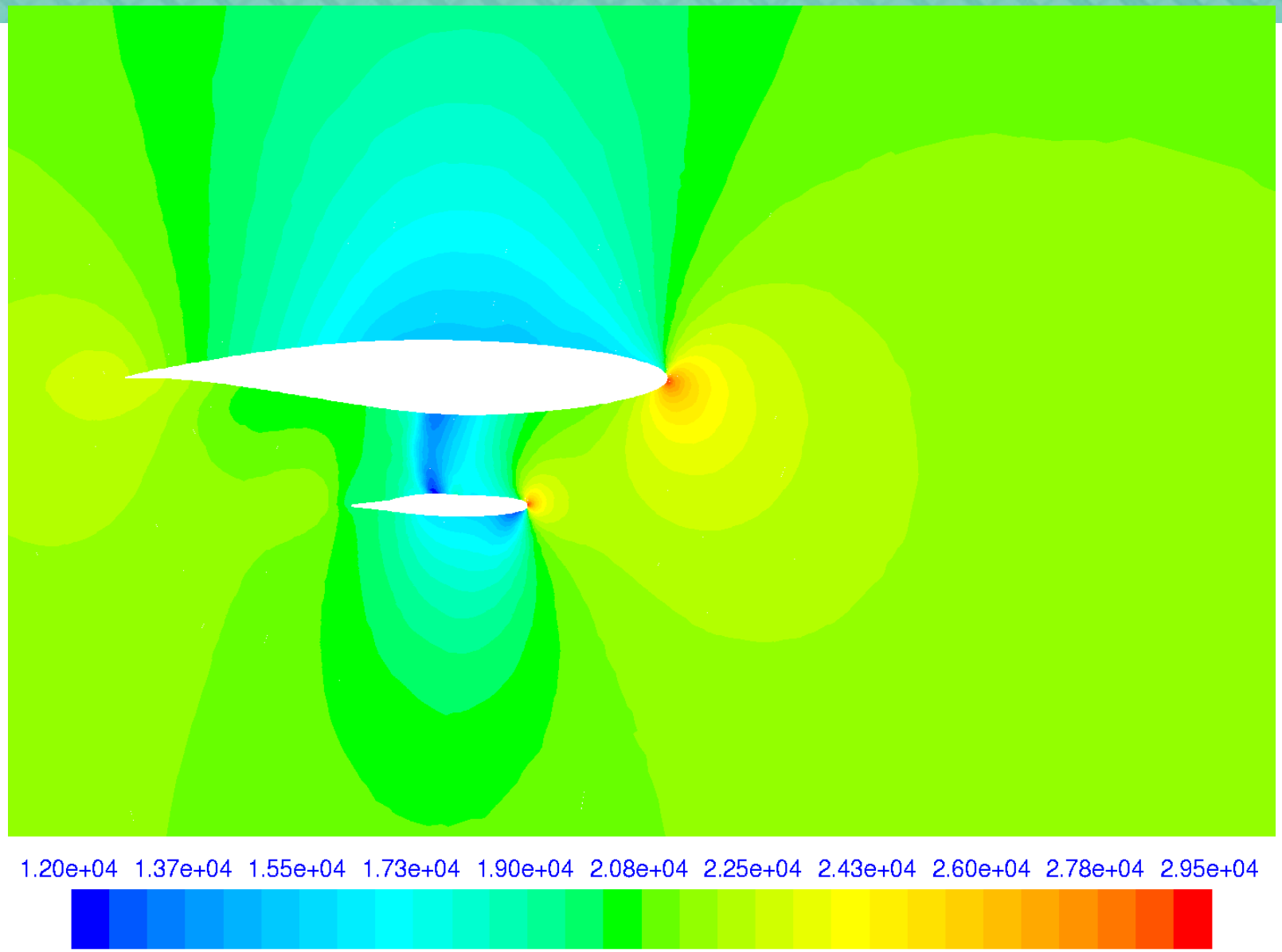
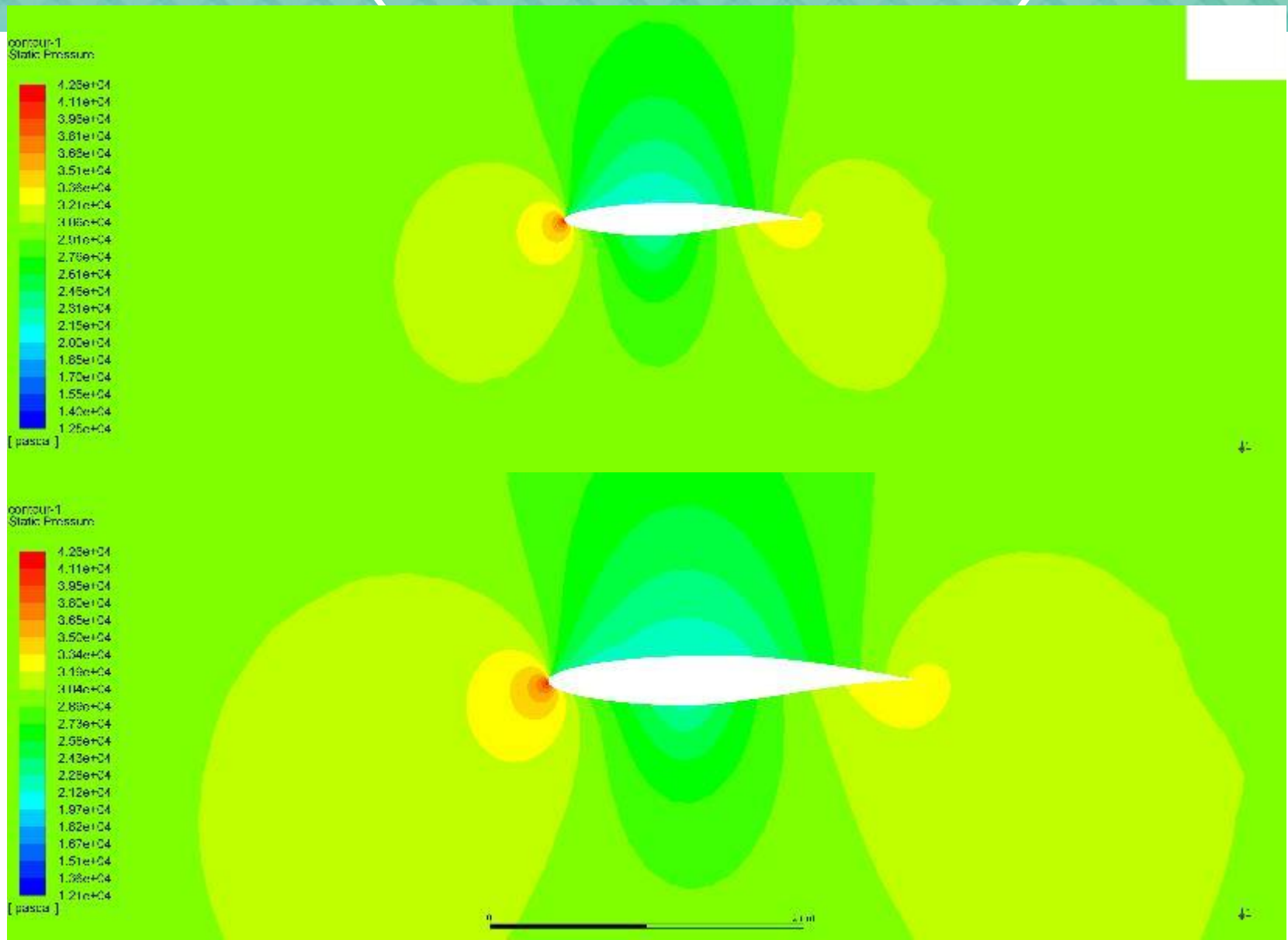


CP (STATION Y17.3)

INCAS KC

INCAS SCB



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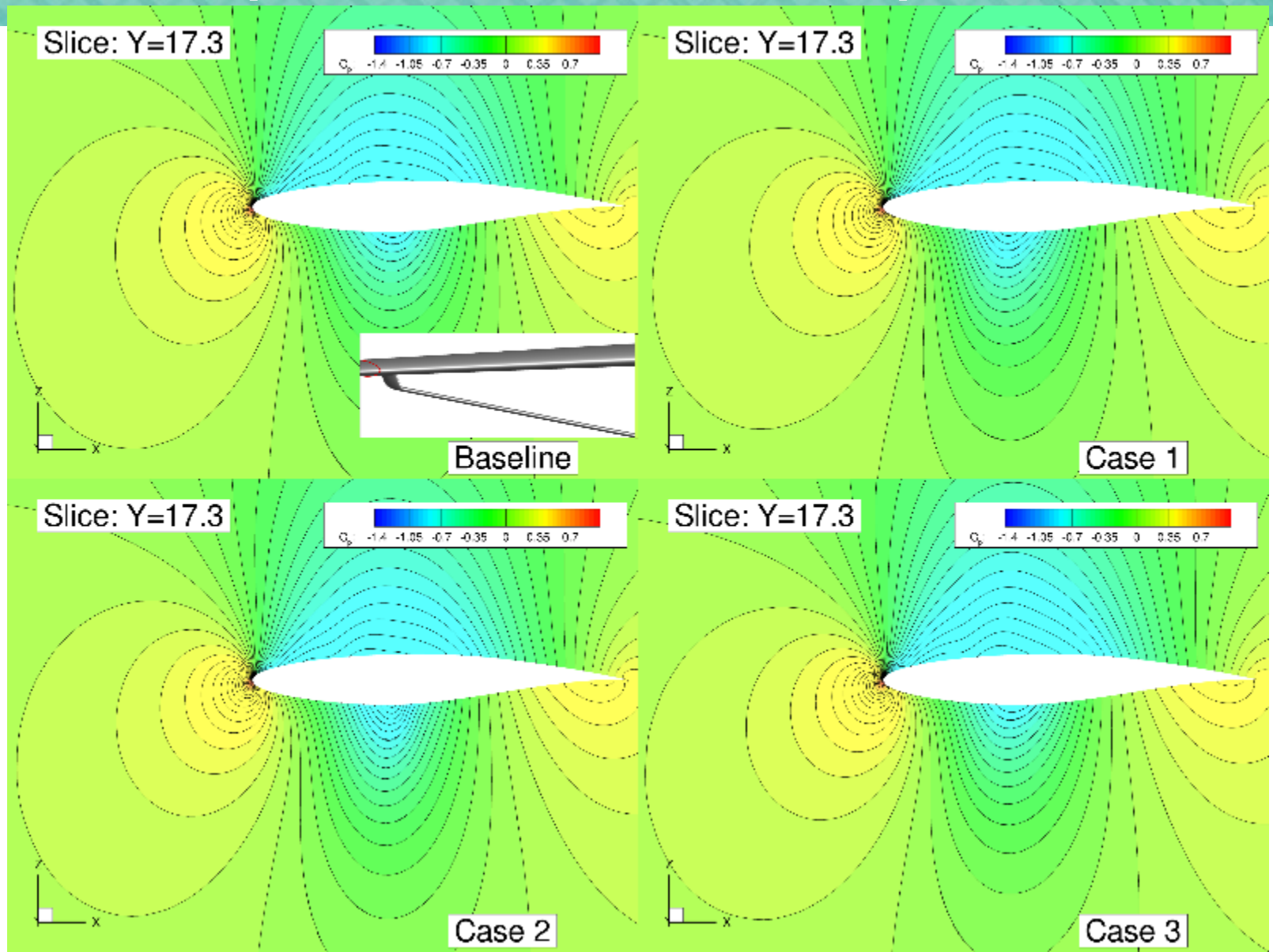

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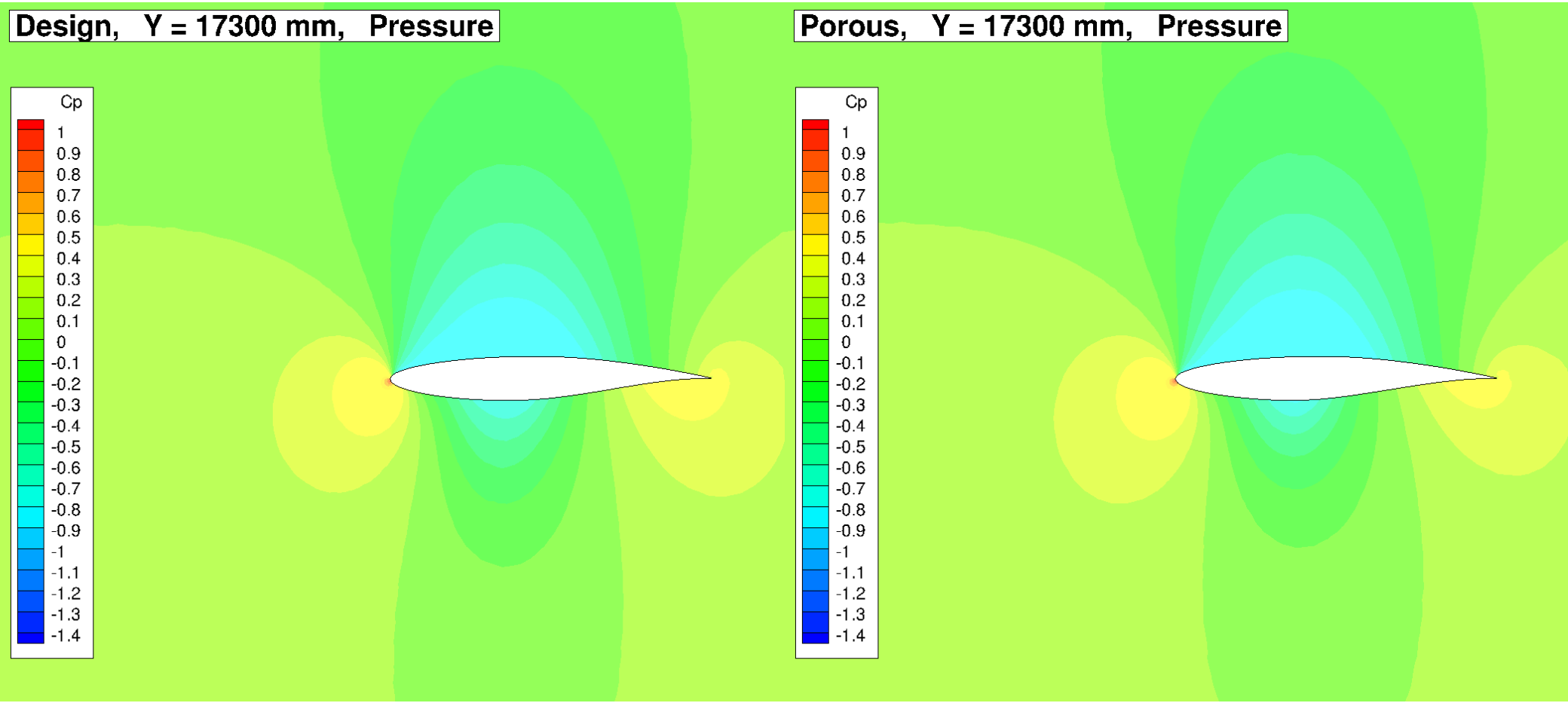
LANGLEY - Geometry

Porous



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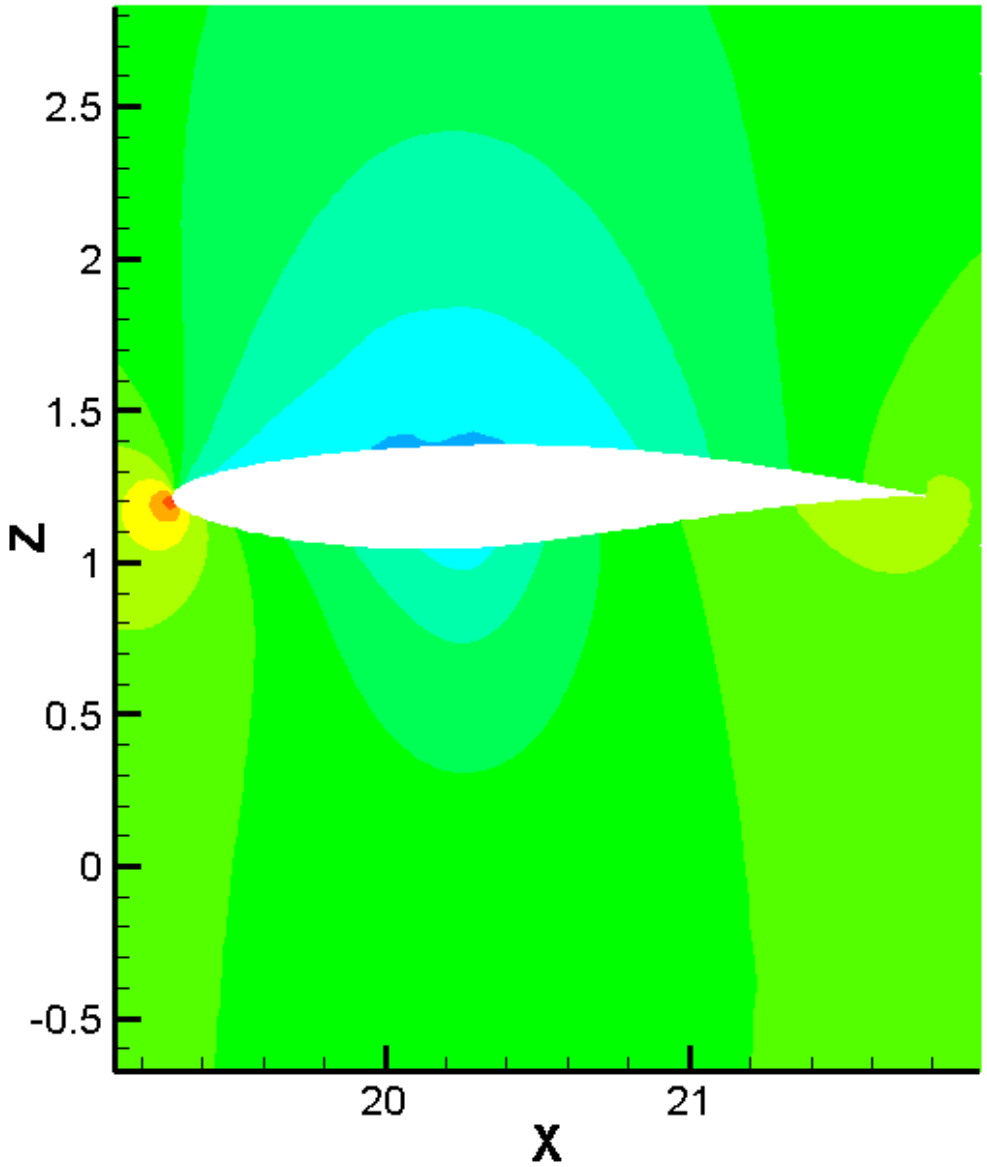

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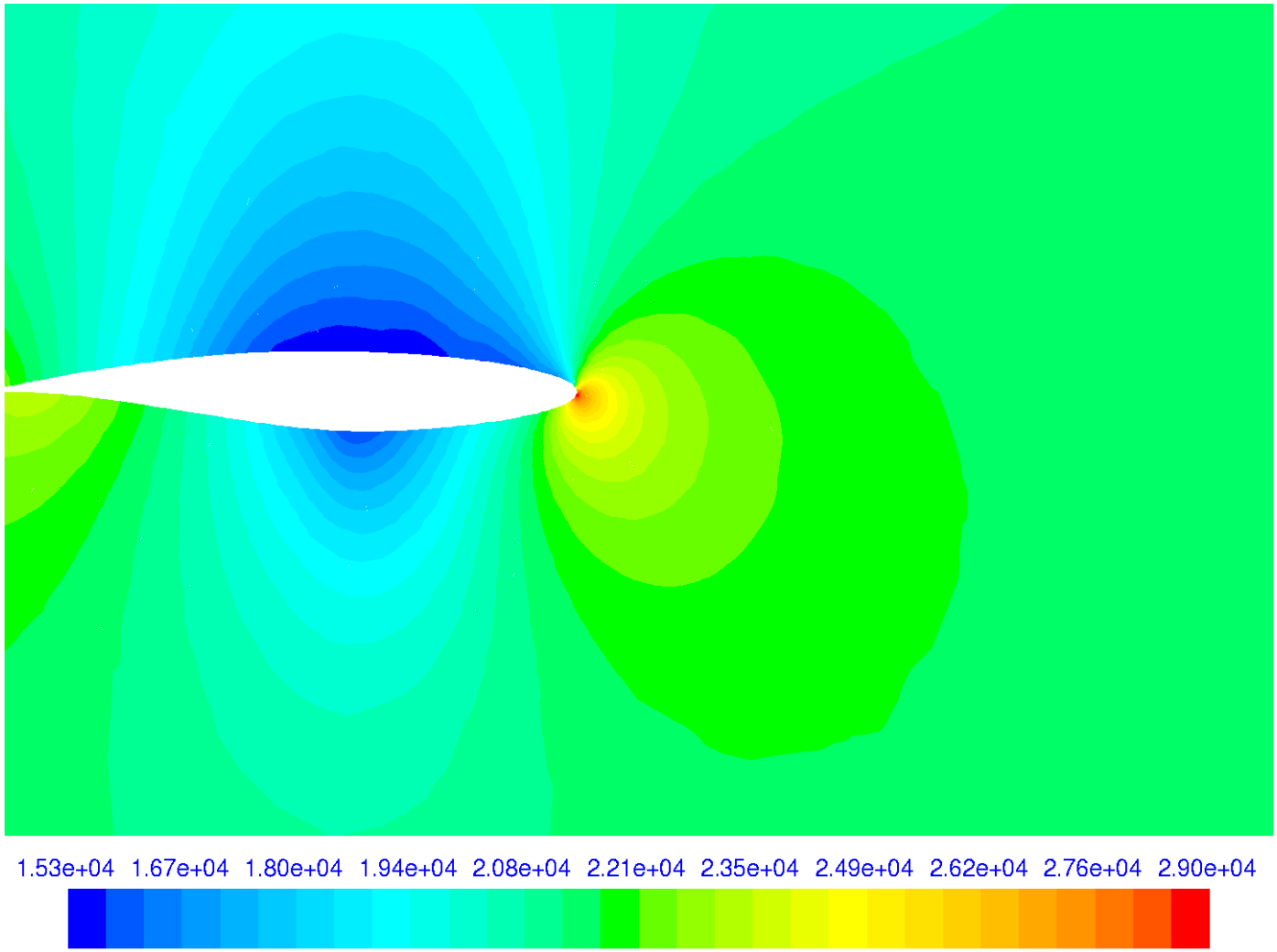
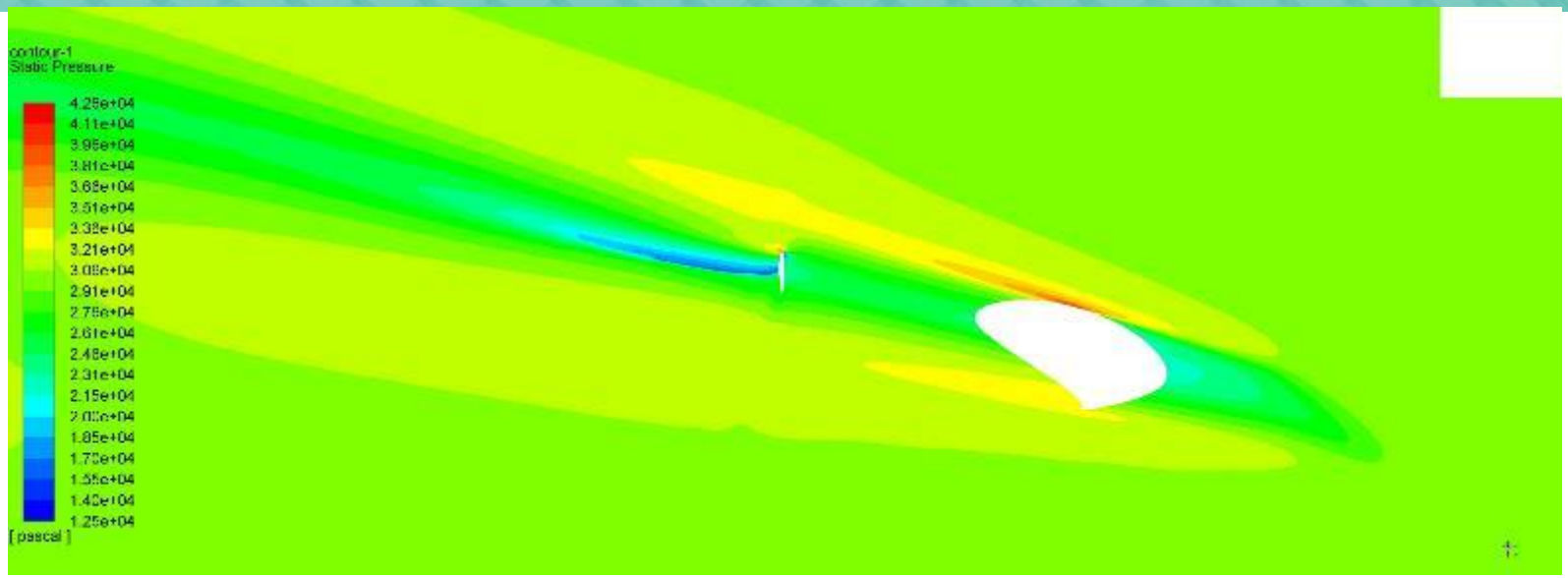
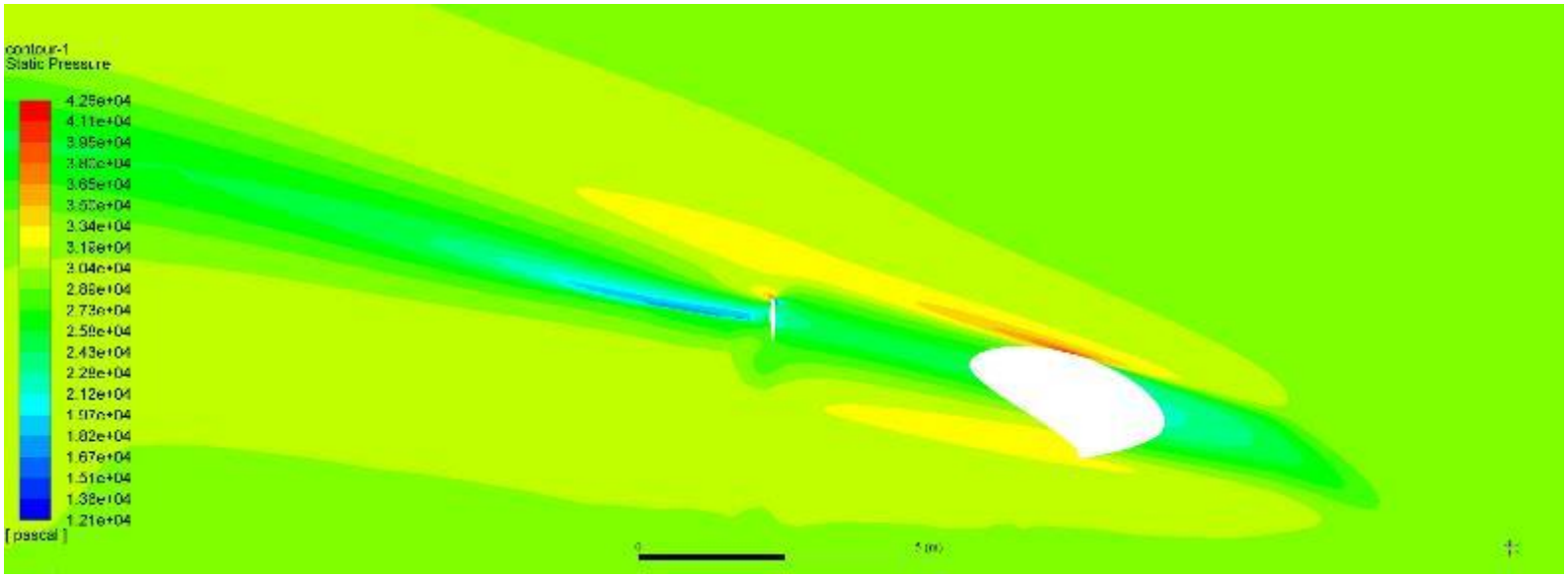


CP (STATION Z0.87)

INCAS KC



INCAS SCB



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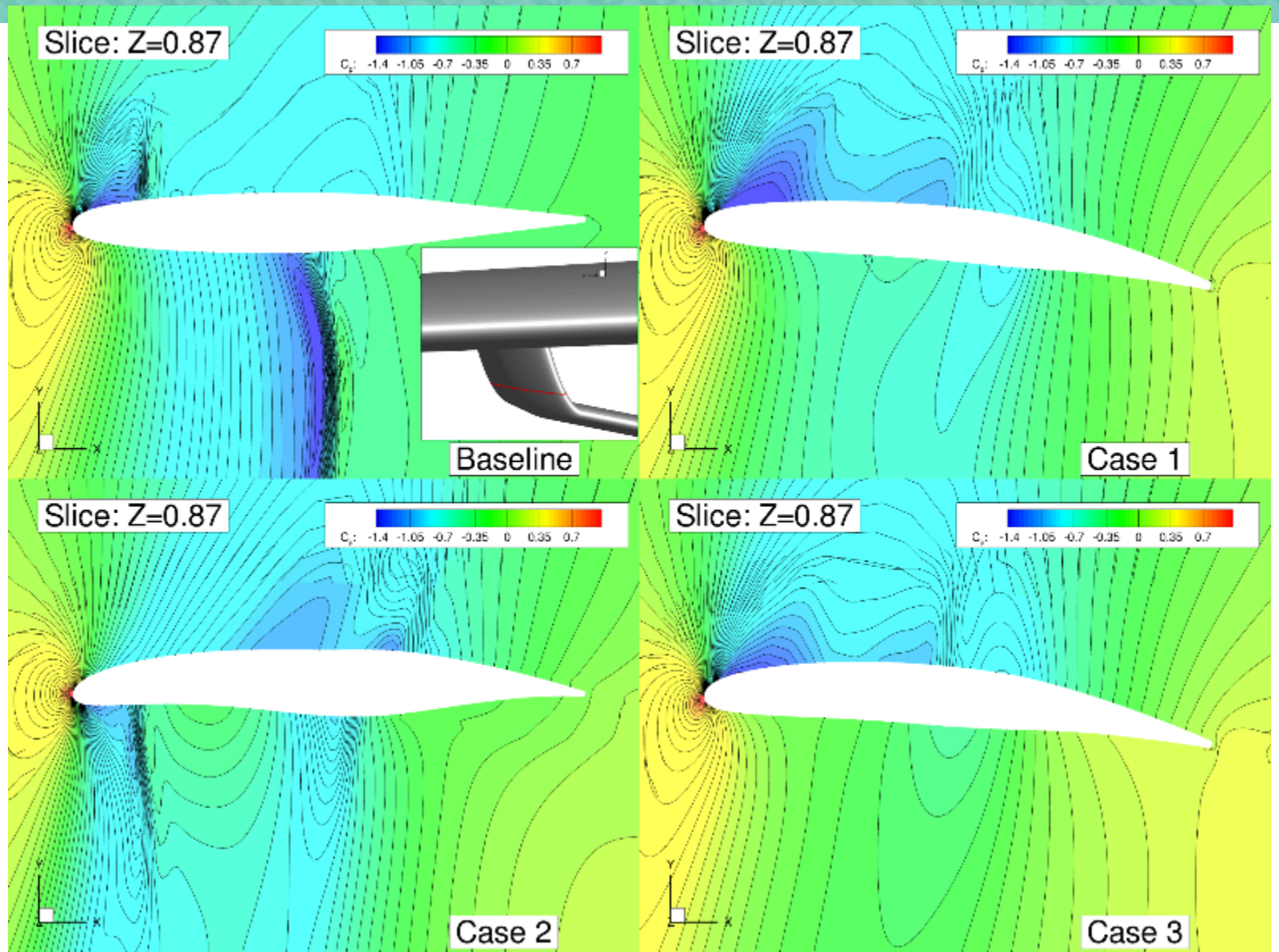

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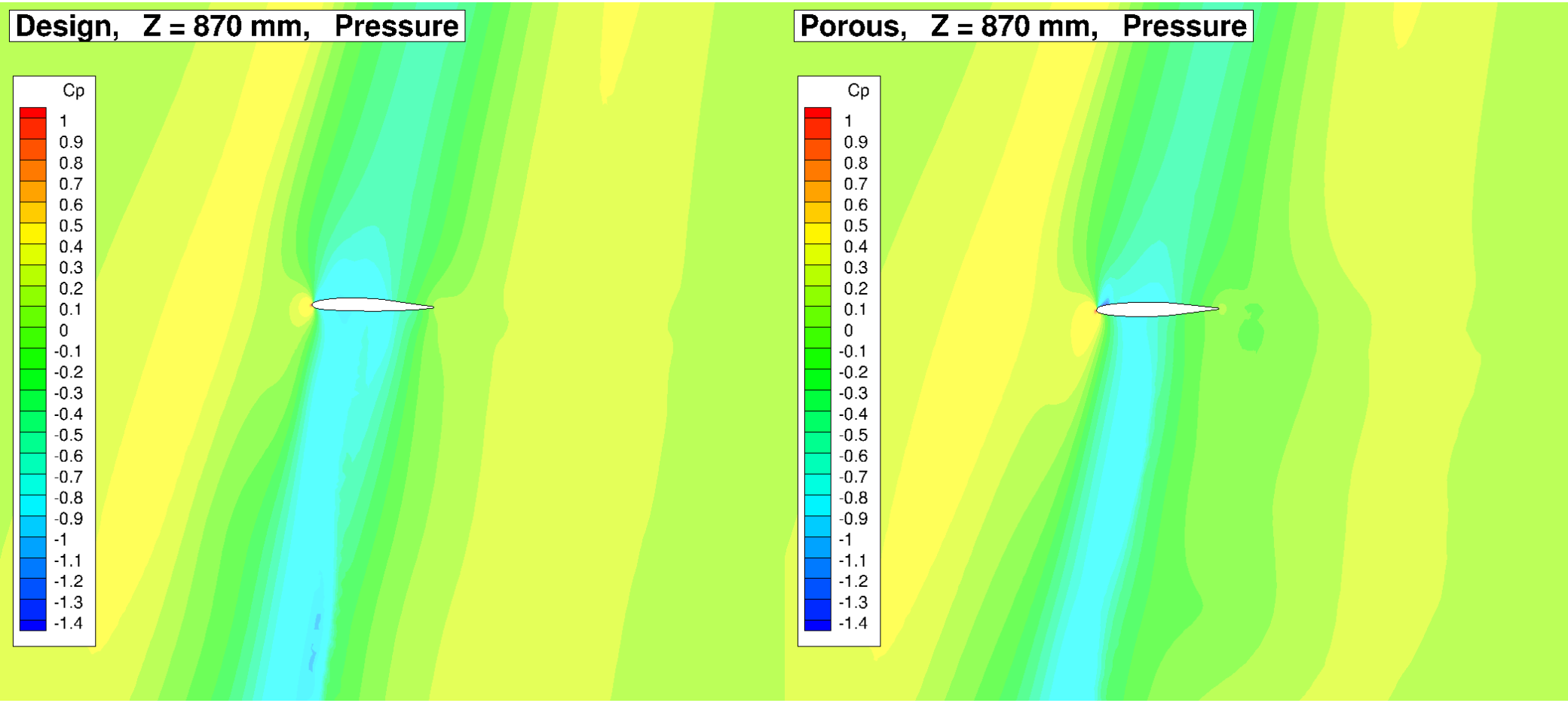
LANGLEY - Geometry

Porous



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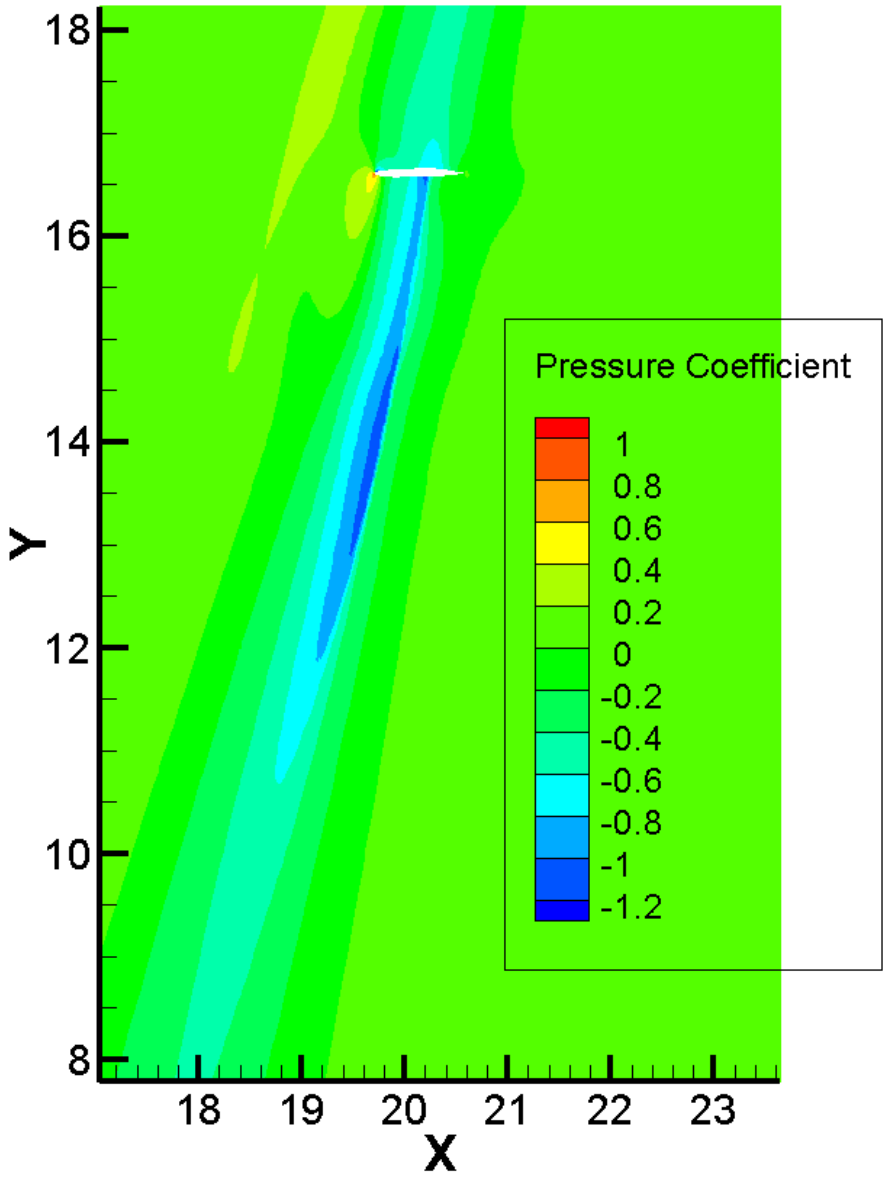
THU - Geometry



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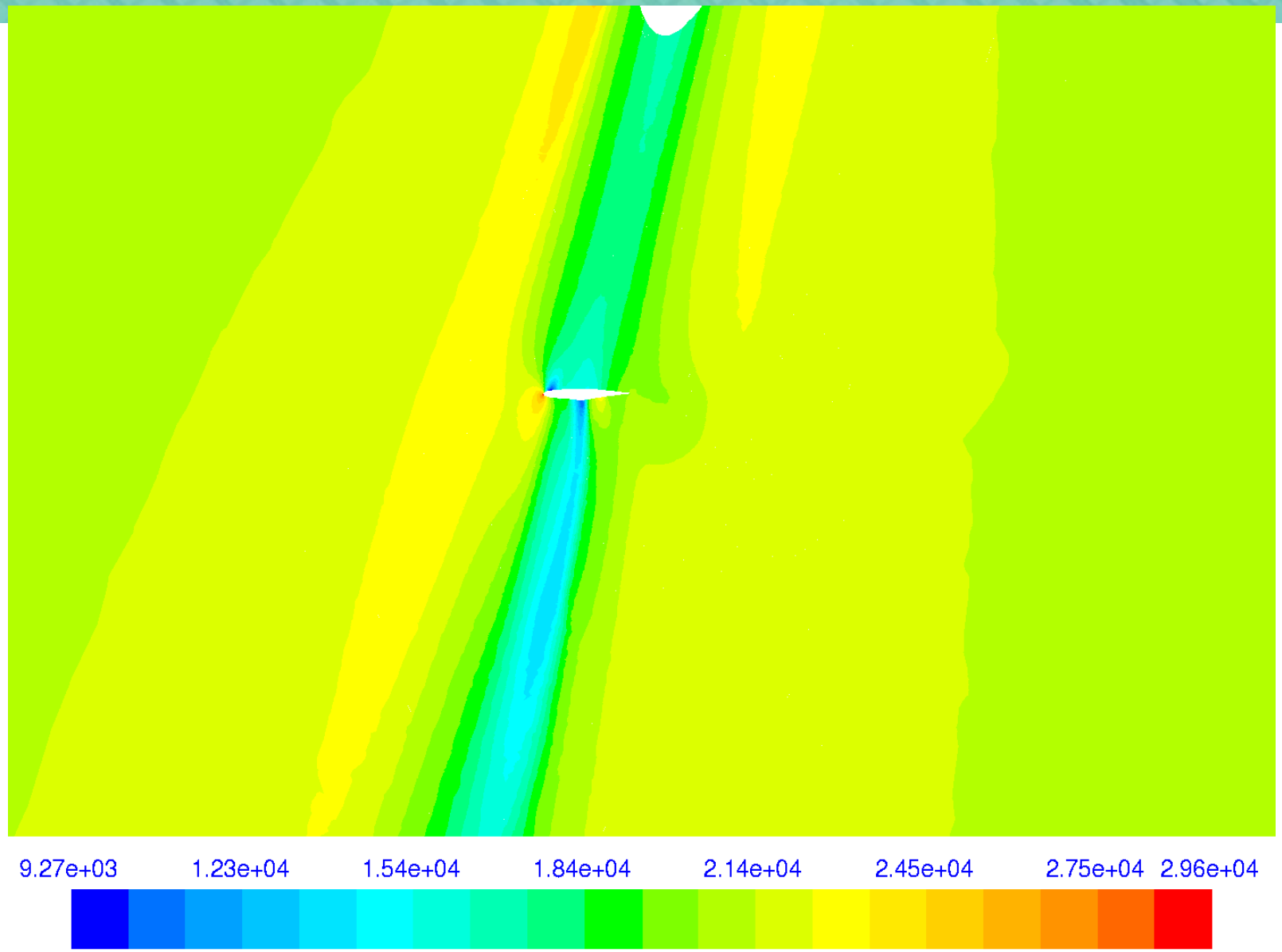

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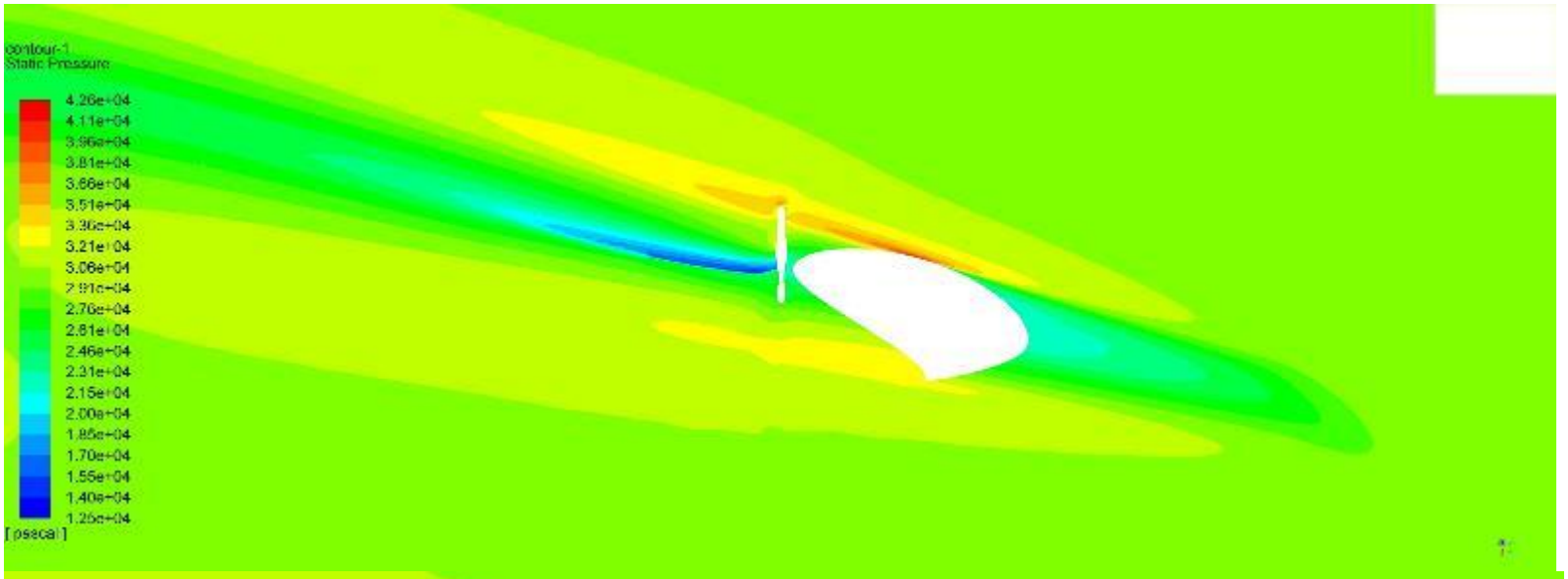

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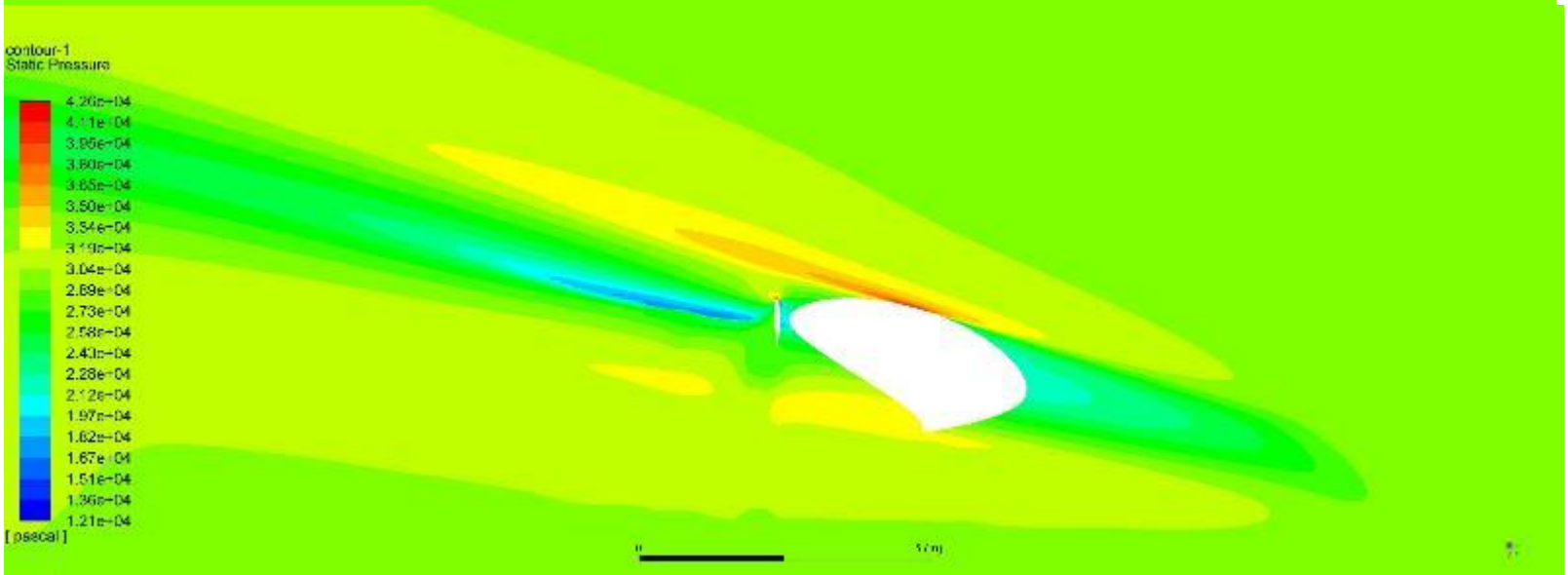

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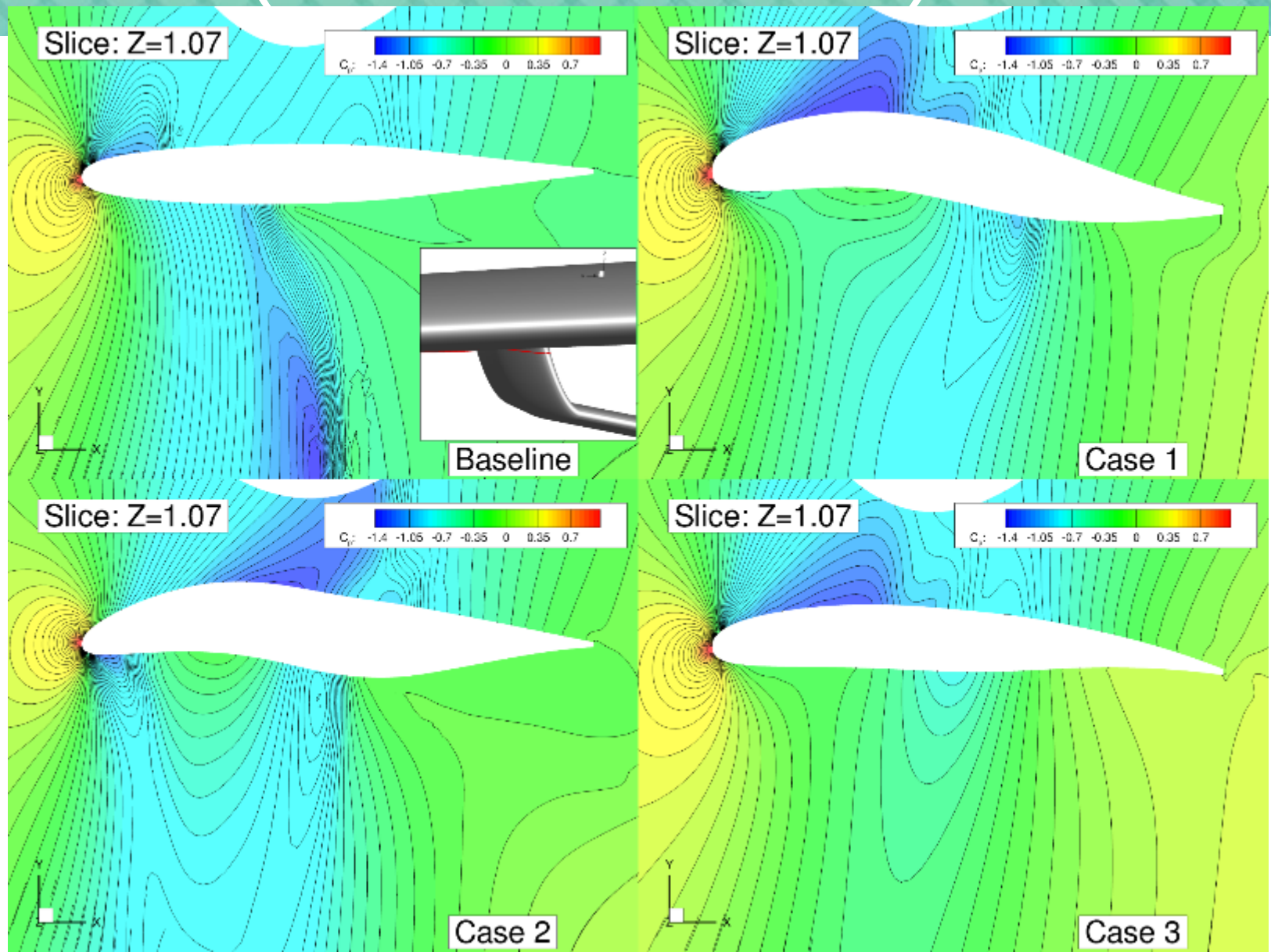
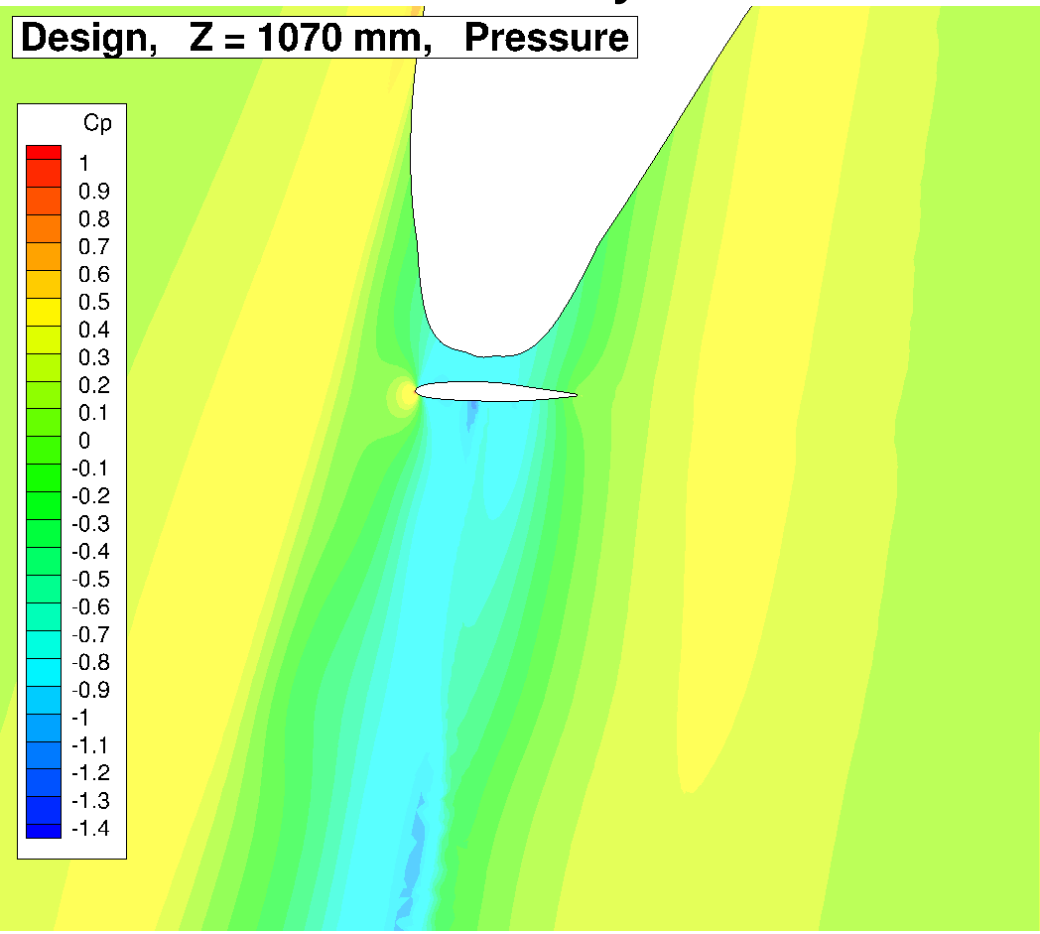
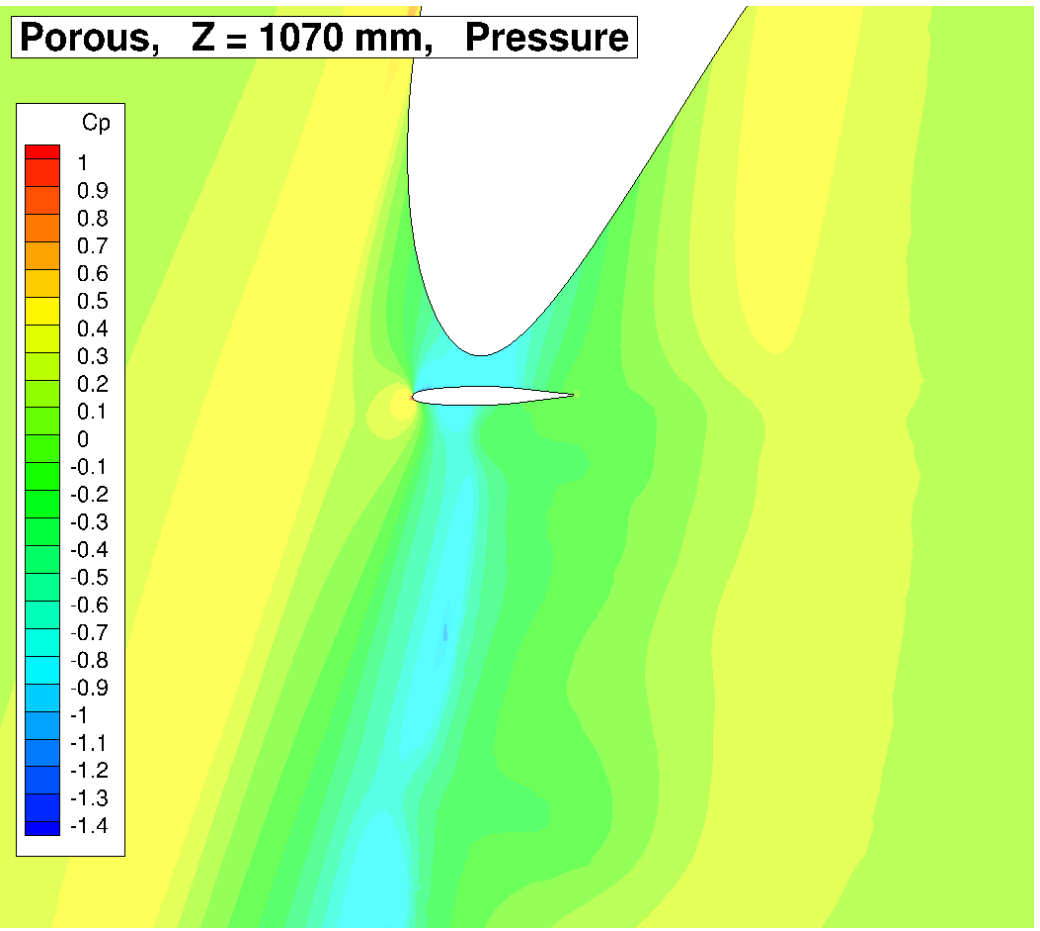


CP (STATION Z1.07)

LANGLEY - Geometry

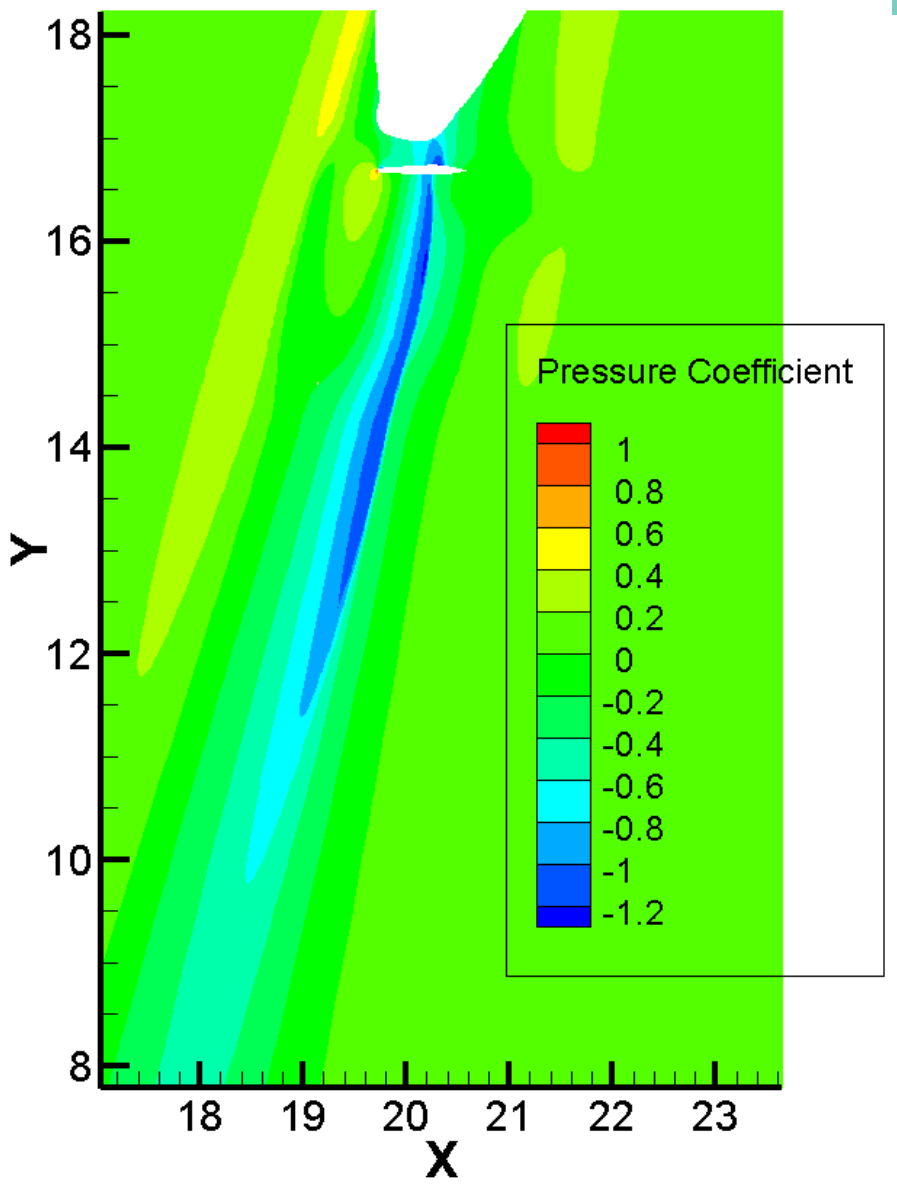


Porous



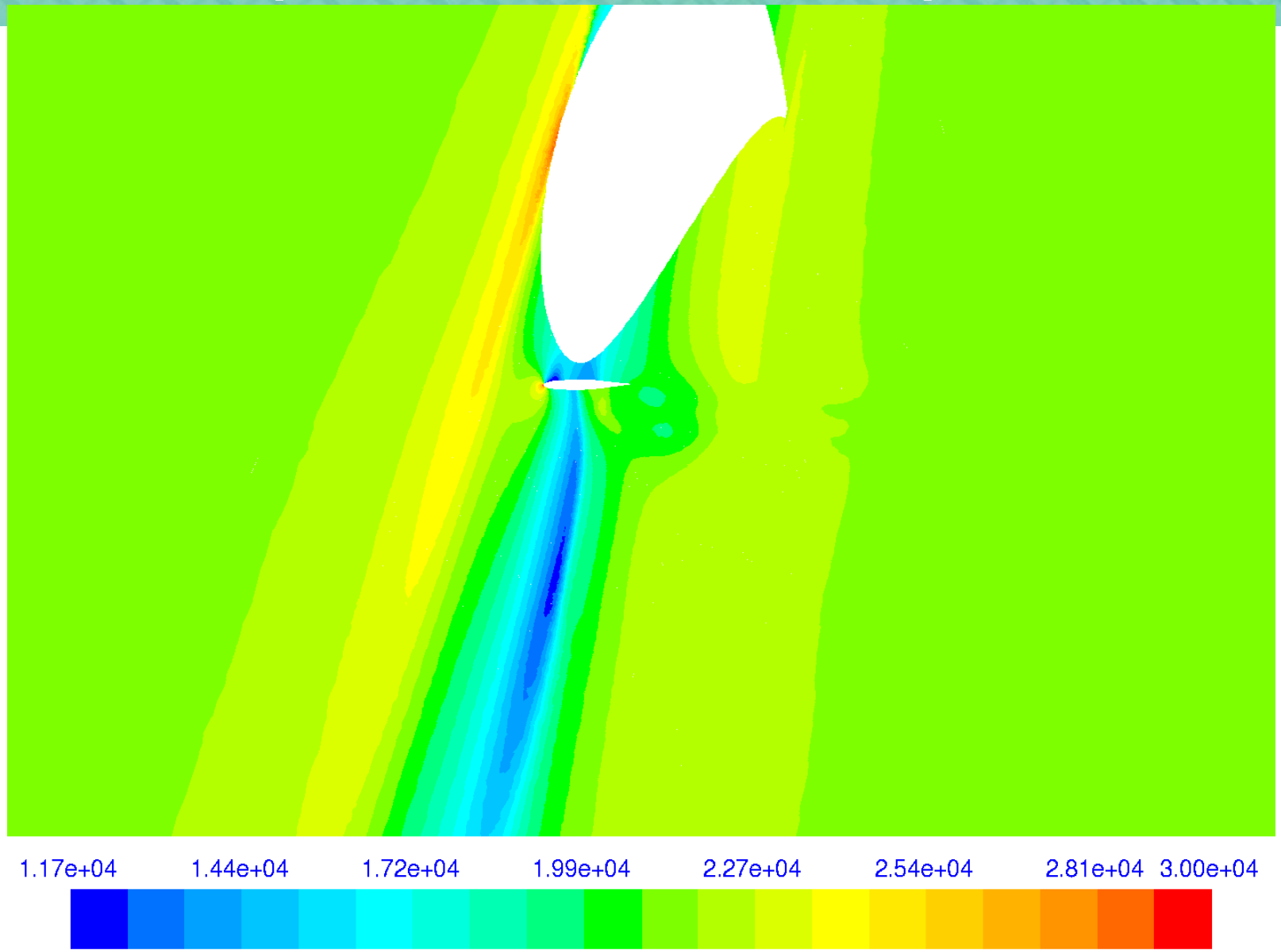
CP (STATION Z1.07)

THU - Geometry



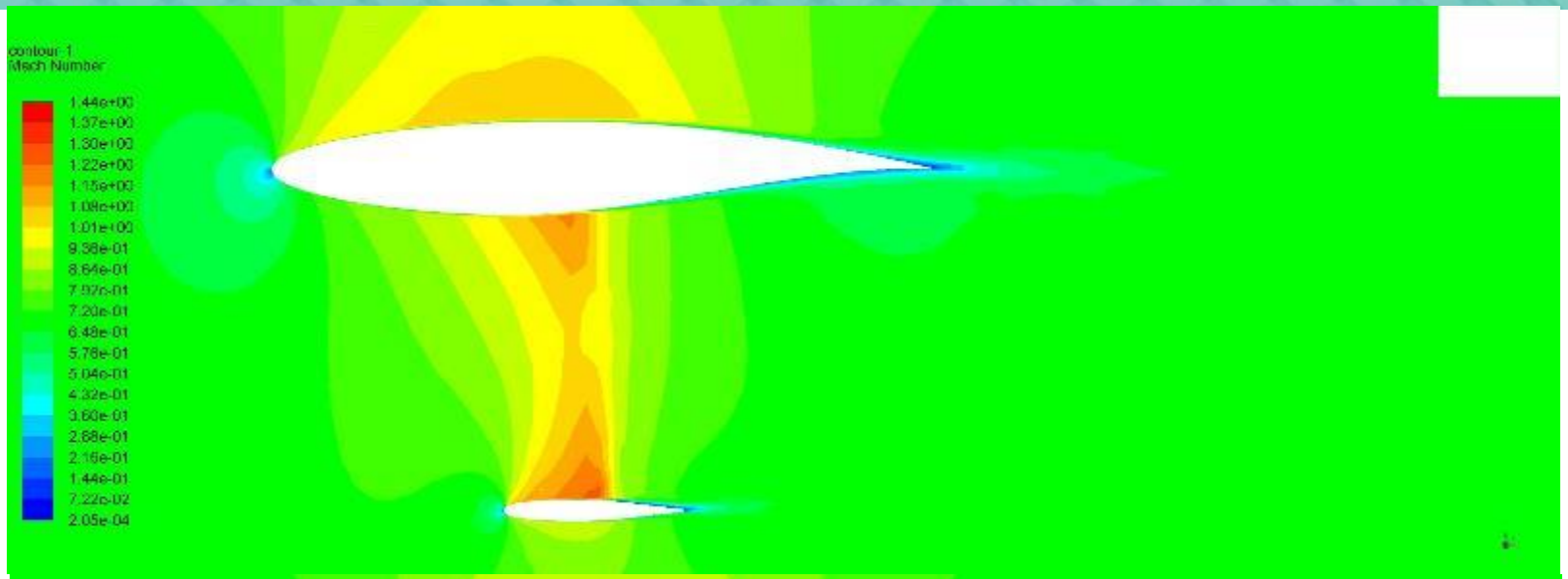
CP (STATION Z1.07)

UdeC - SCB

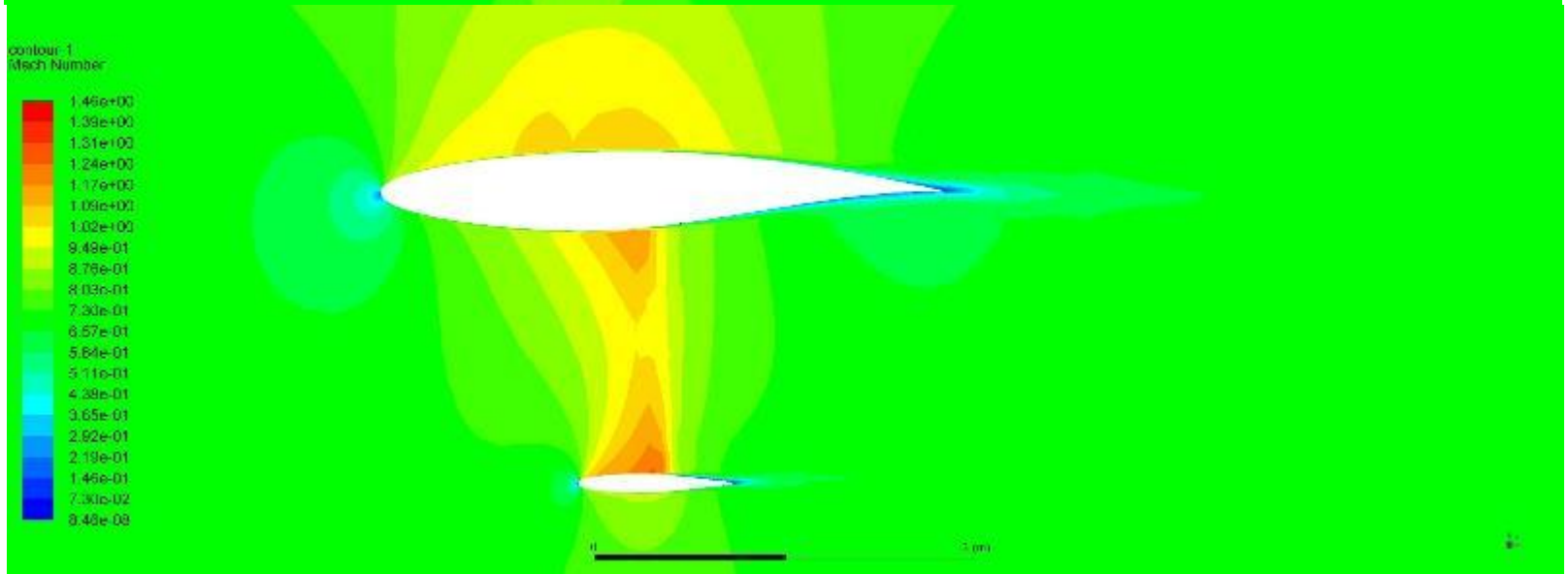


MACH (STATION Y12)

INCAS KC

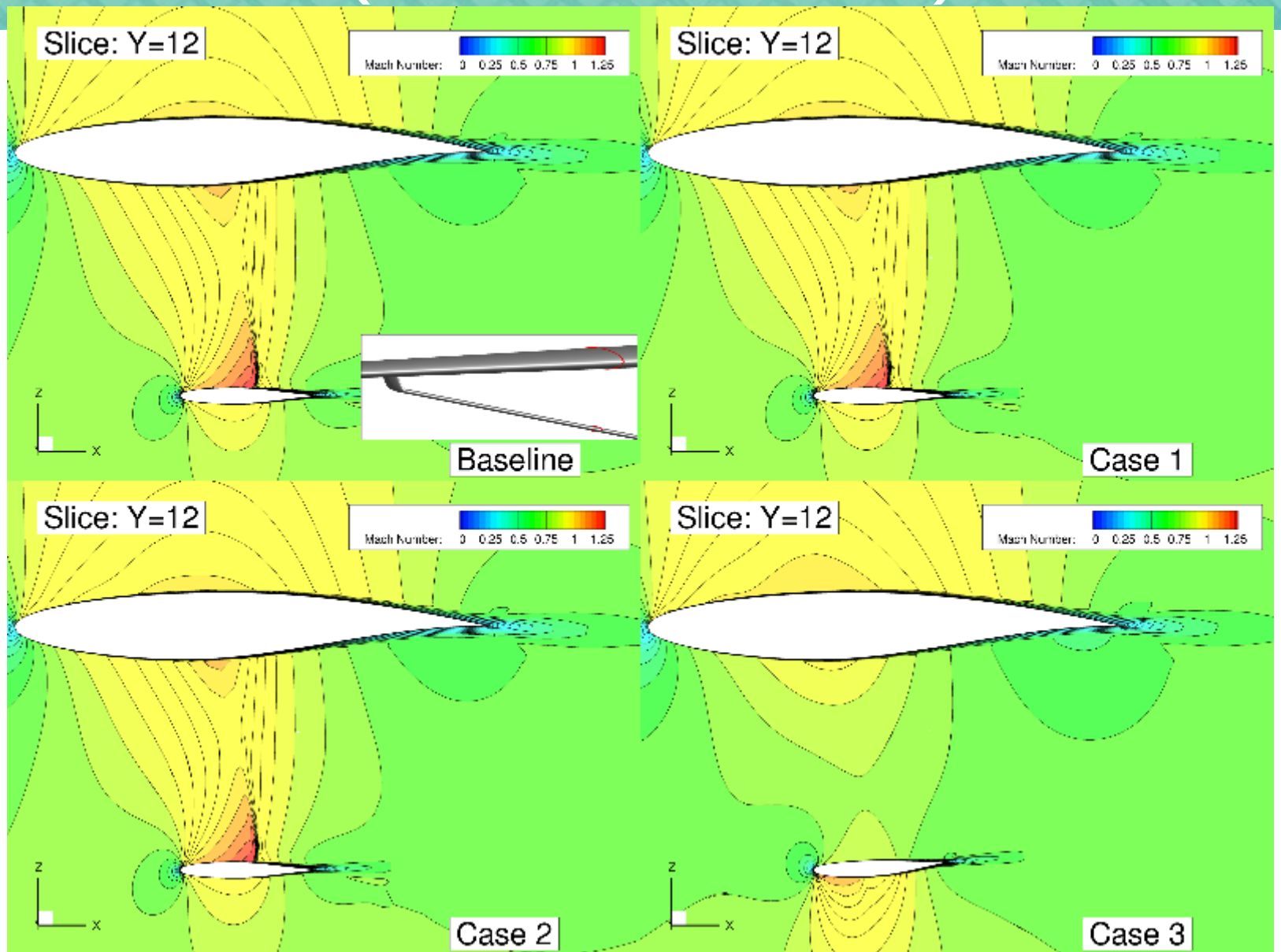


INCAS SCB



MACH (STATION Y12)

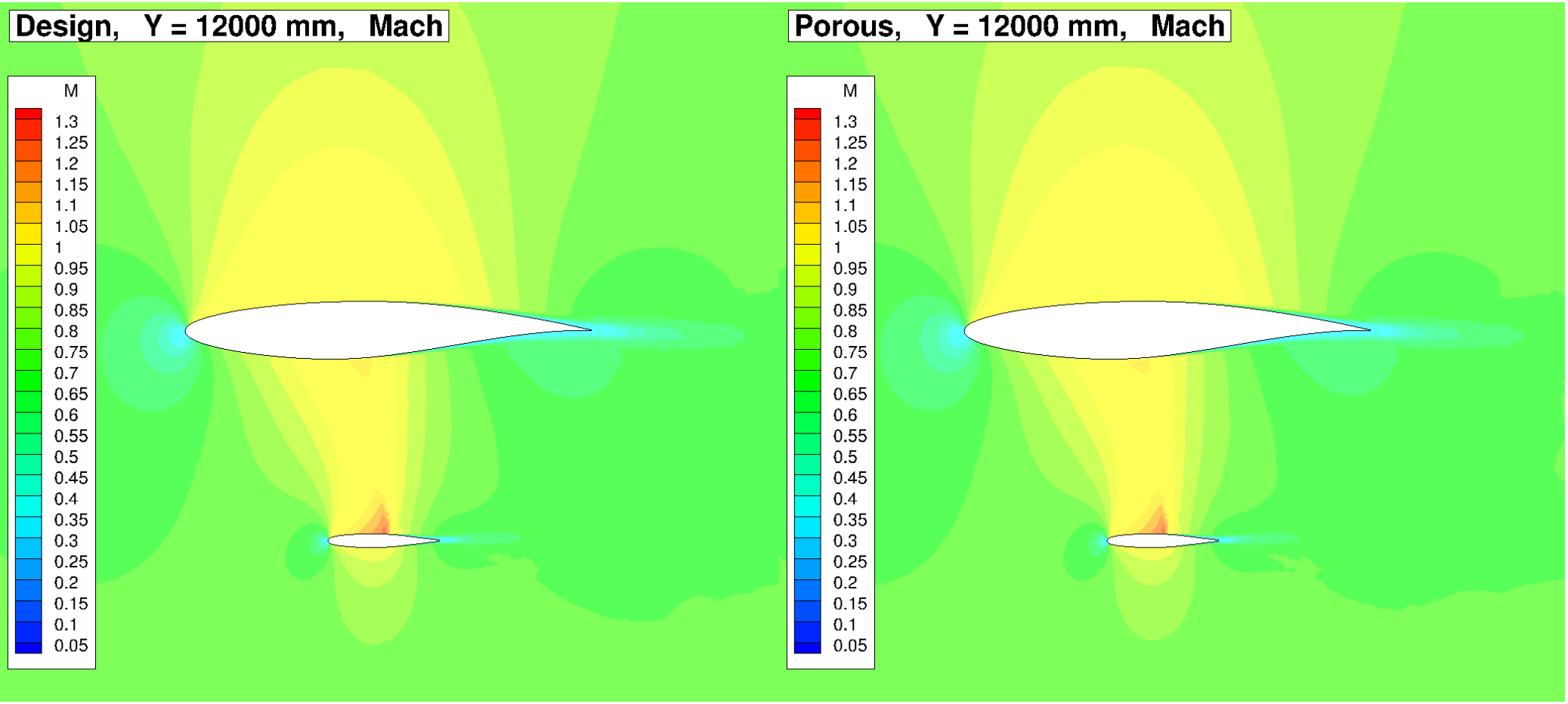
NASA-AMES



MACH (STATION Y12)

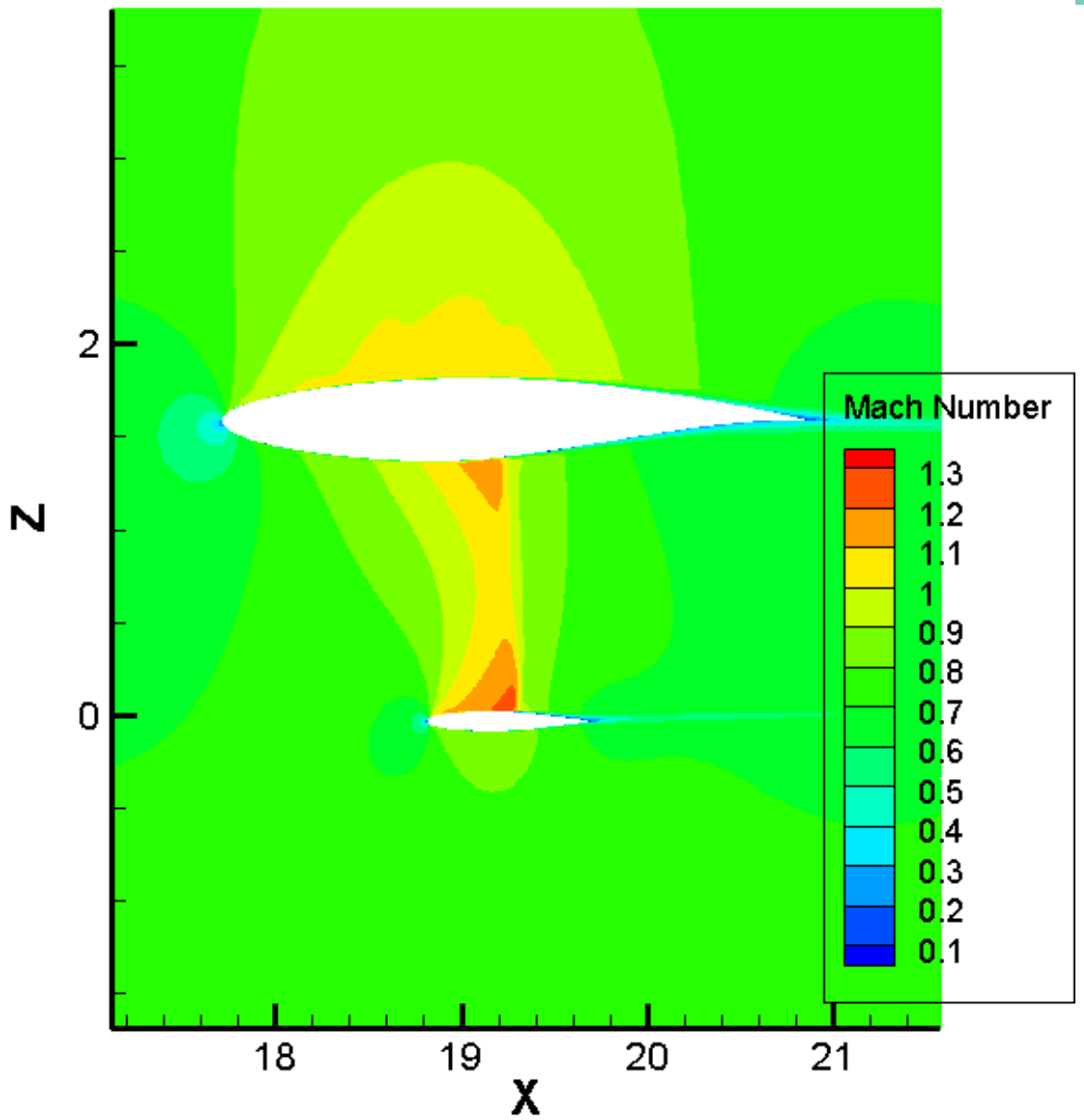
LANGLEY - Geometry

Porous



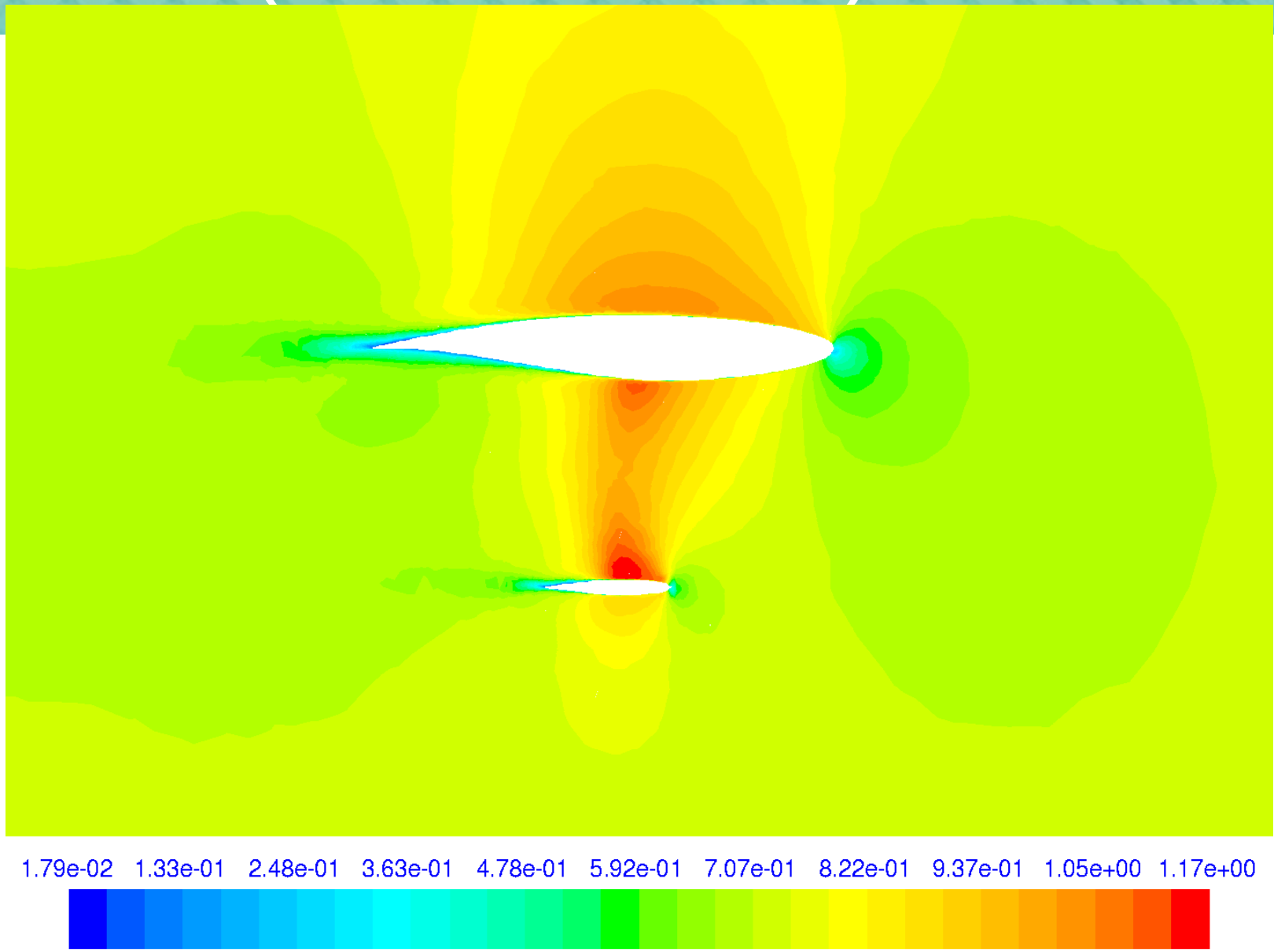
MACH (STATION Y12)

THU - Geometry



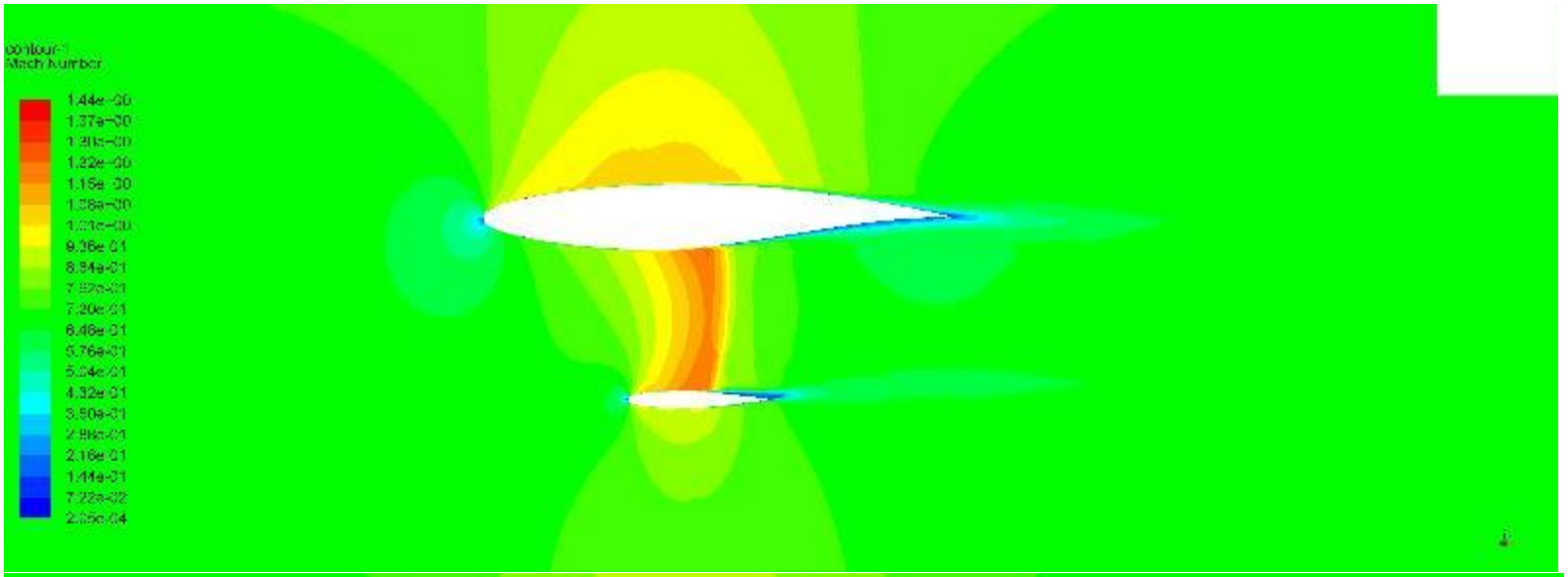
CP (STATION Y12)

UdeC - SCB

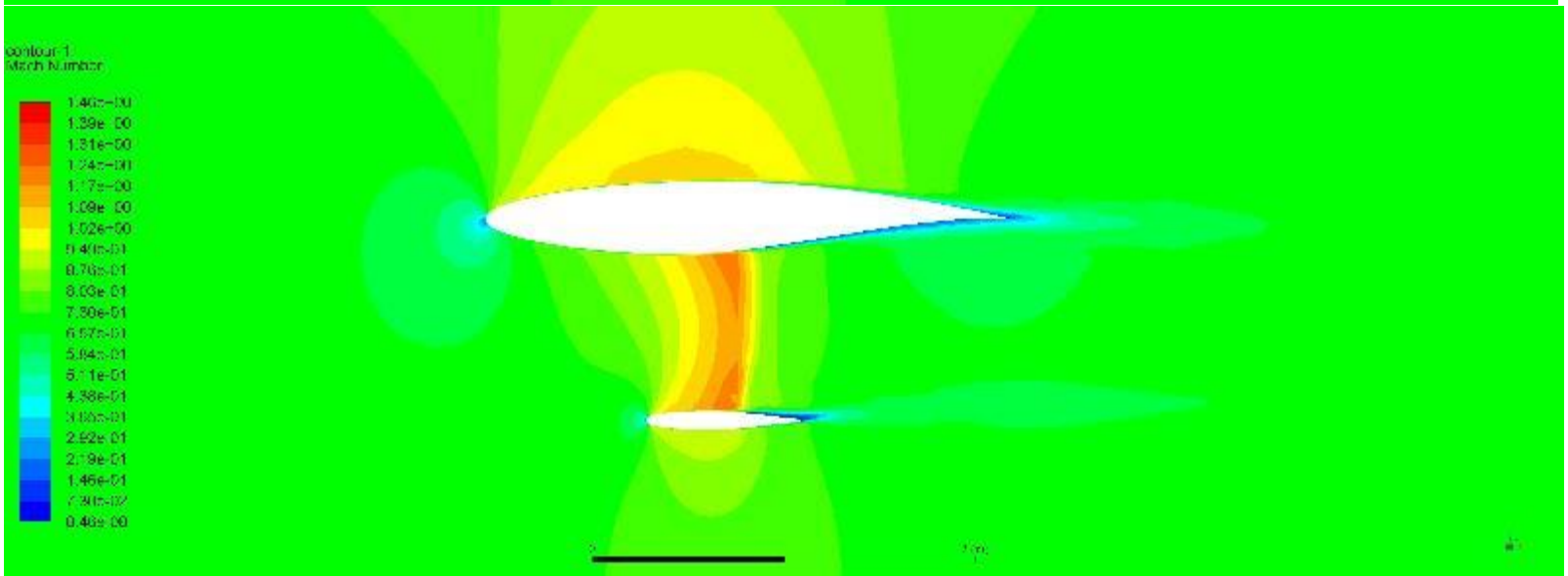


MACH (STATION Y14)

INCAS KC

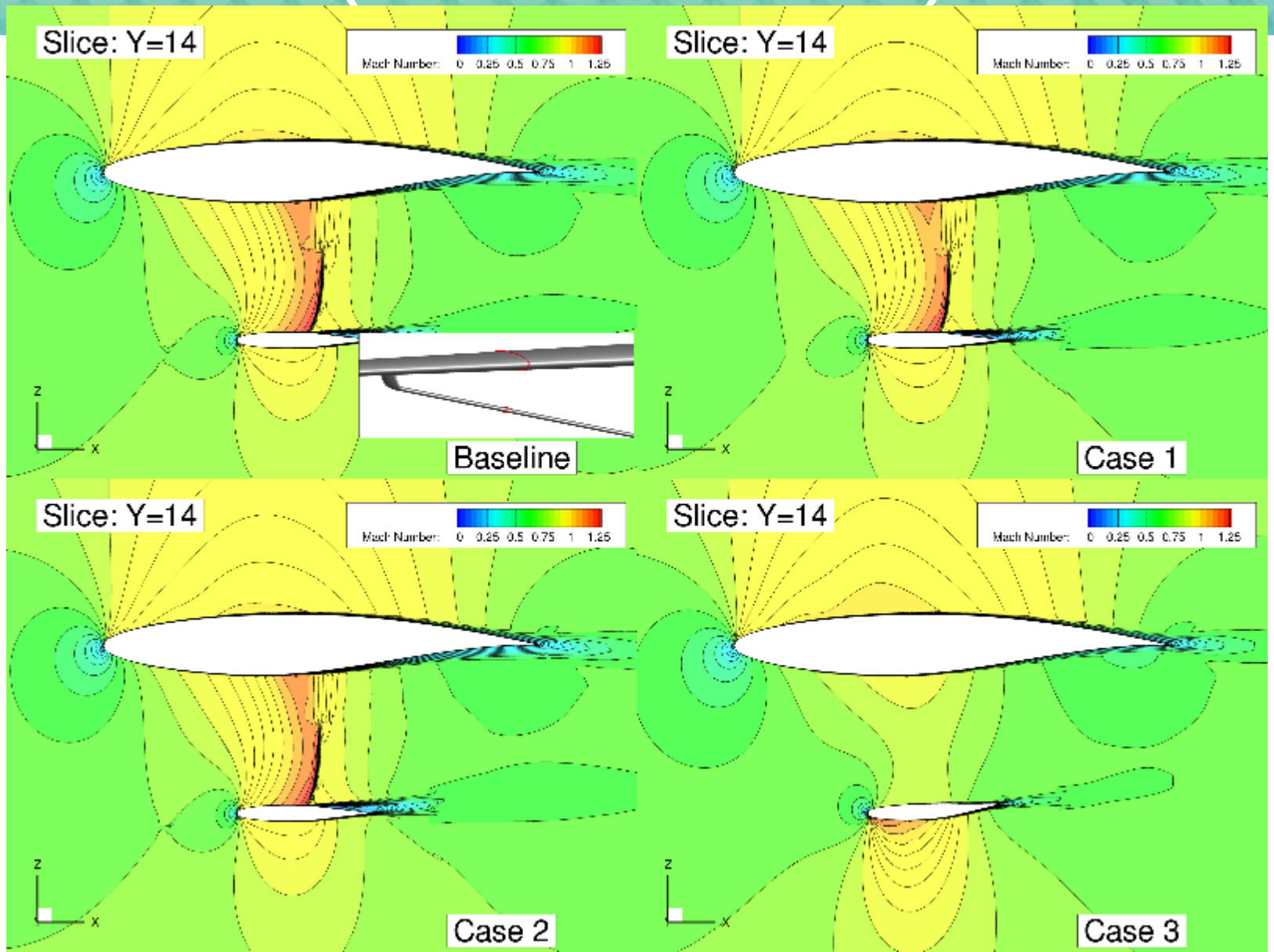


INCAS SCB



MACH (STATION Y14)

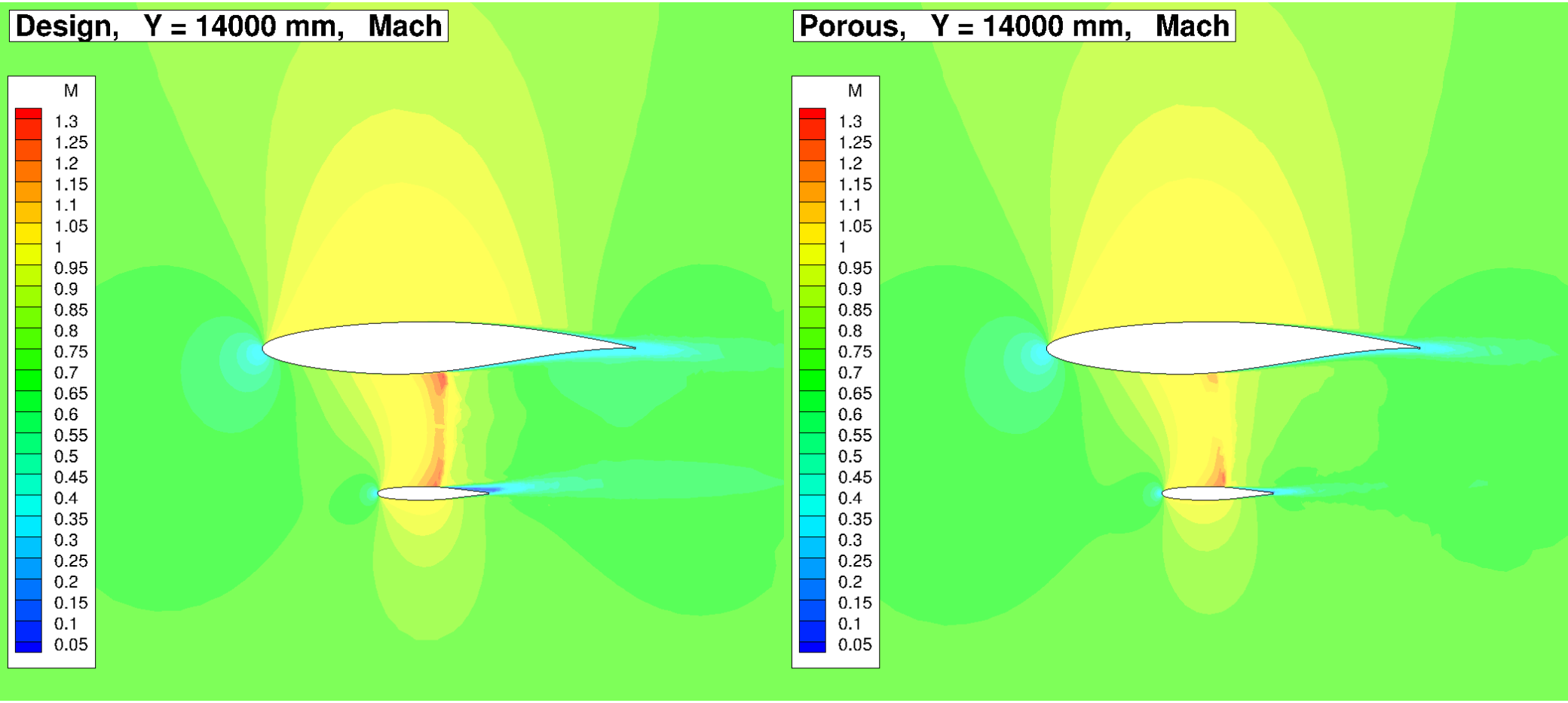
NASA-AMES



MACH (STATION Y14)

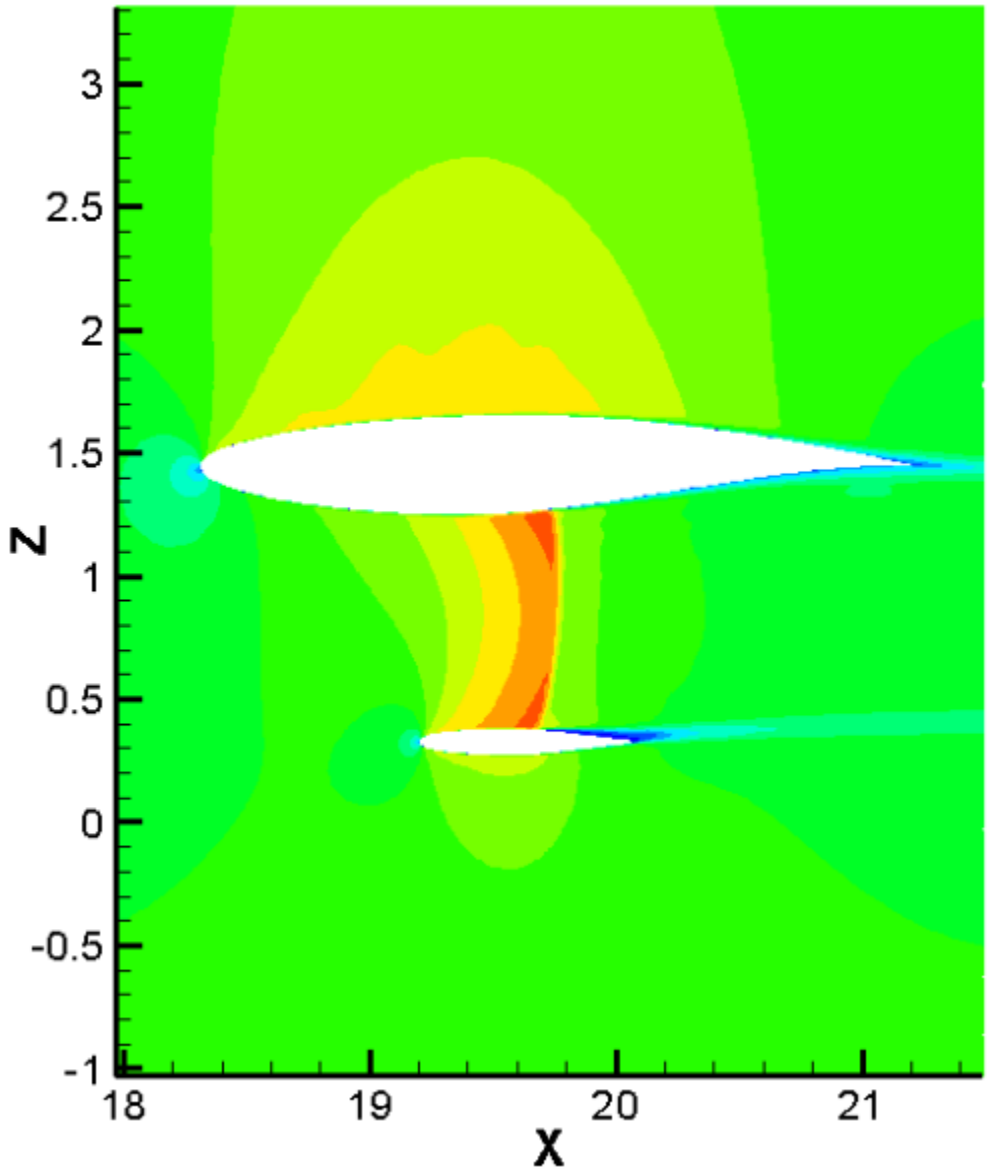
LANGLEY - Geometry

Porous



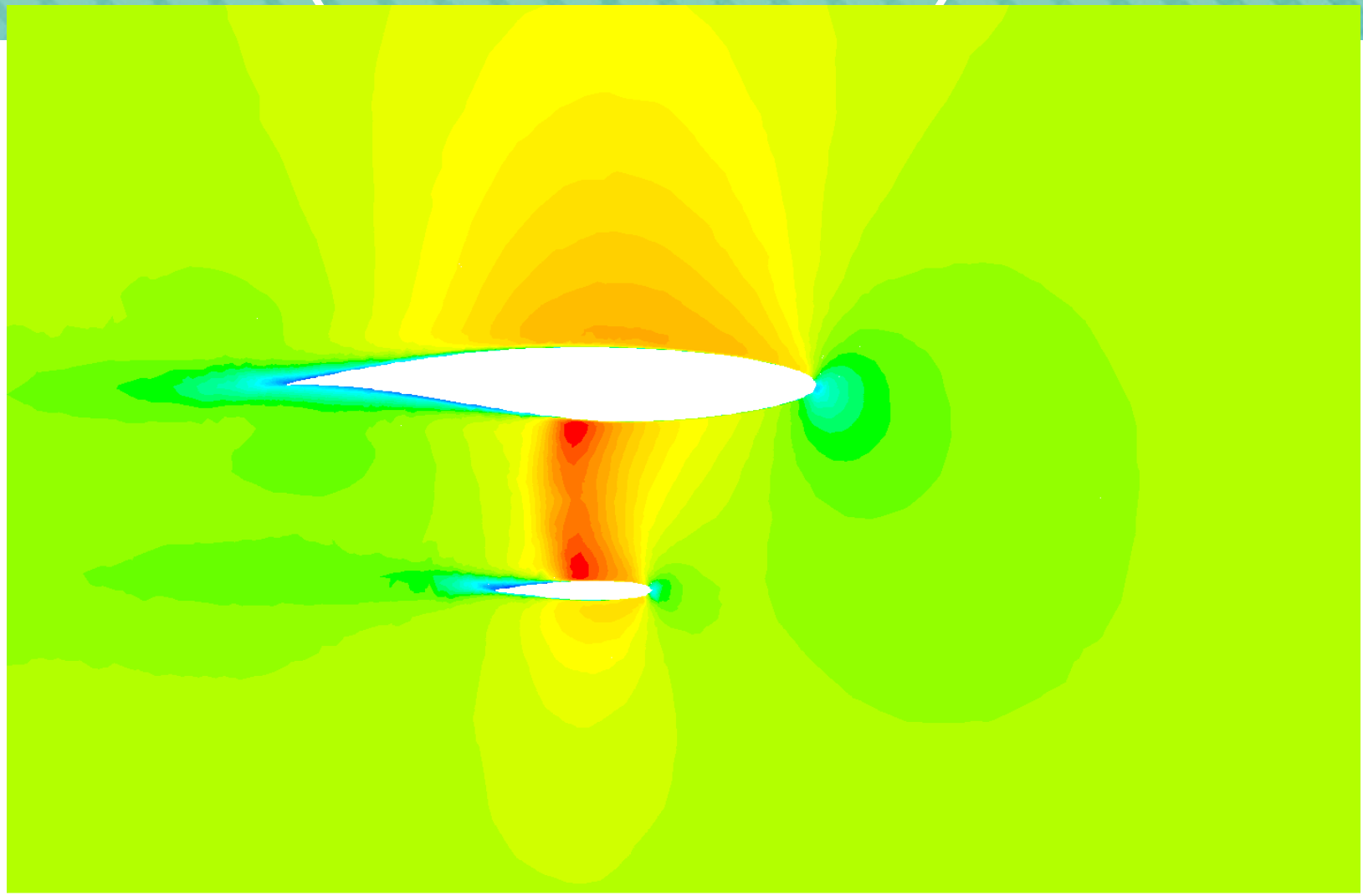
MACH (STATION Y14)

THU - Geometry



CP (STATION Y14)

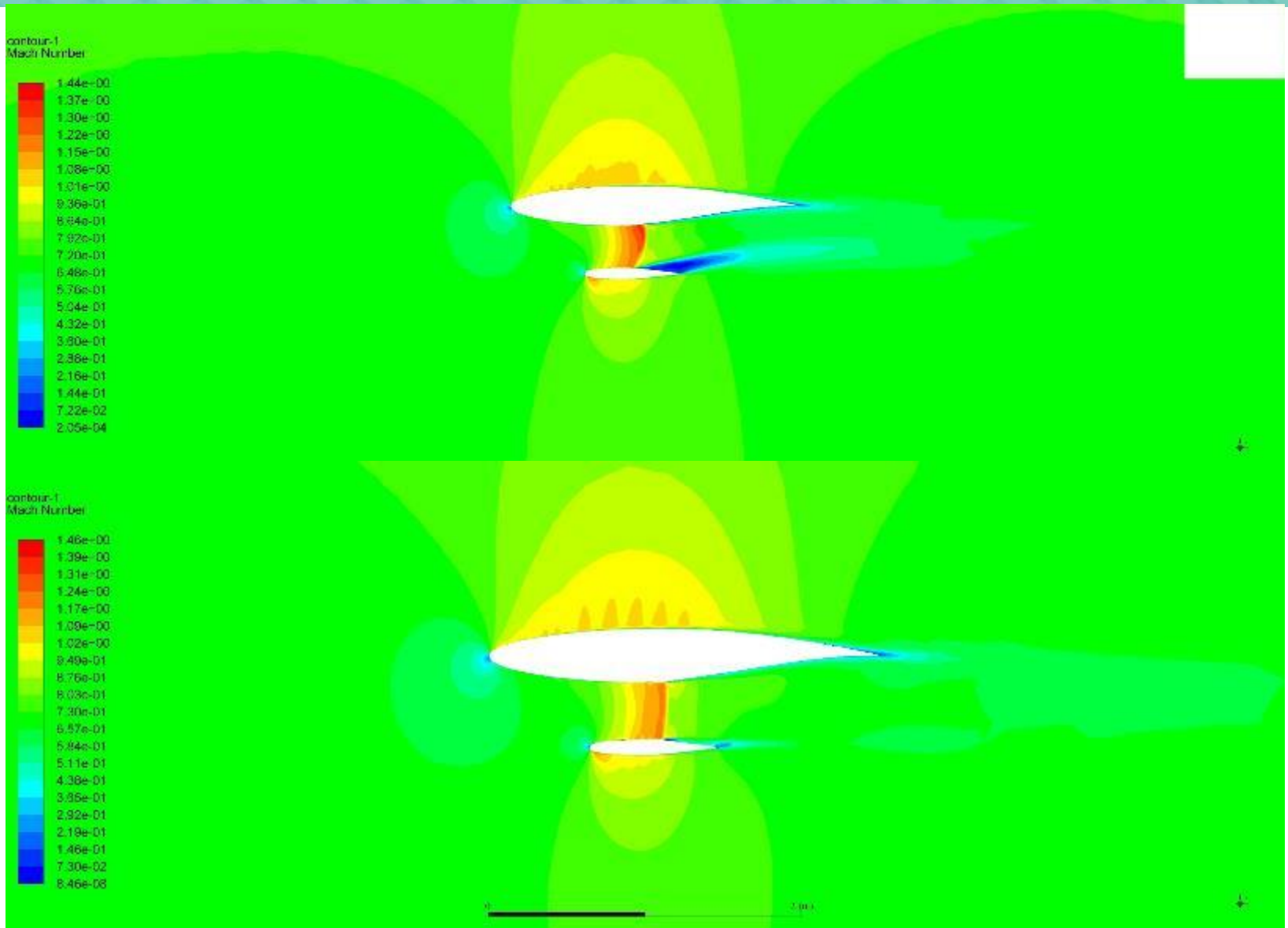
UdeC - SCB



MACH (STATION Y16)

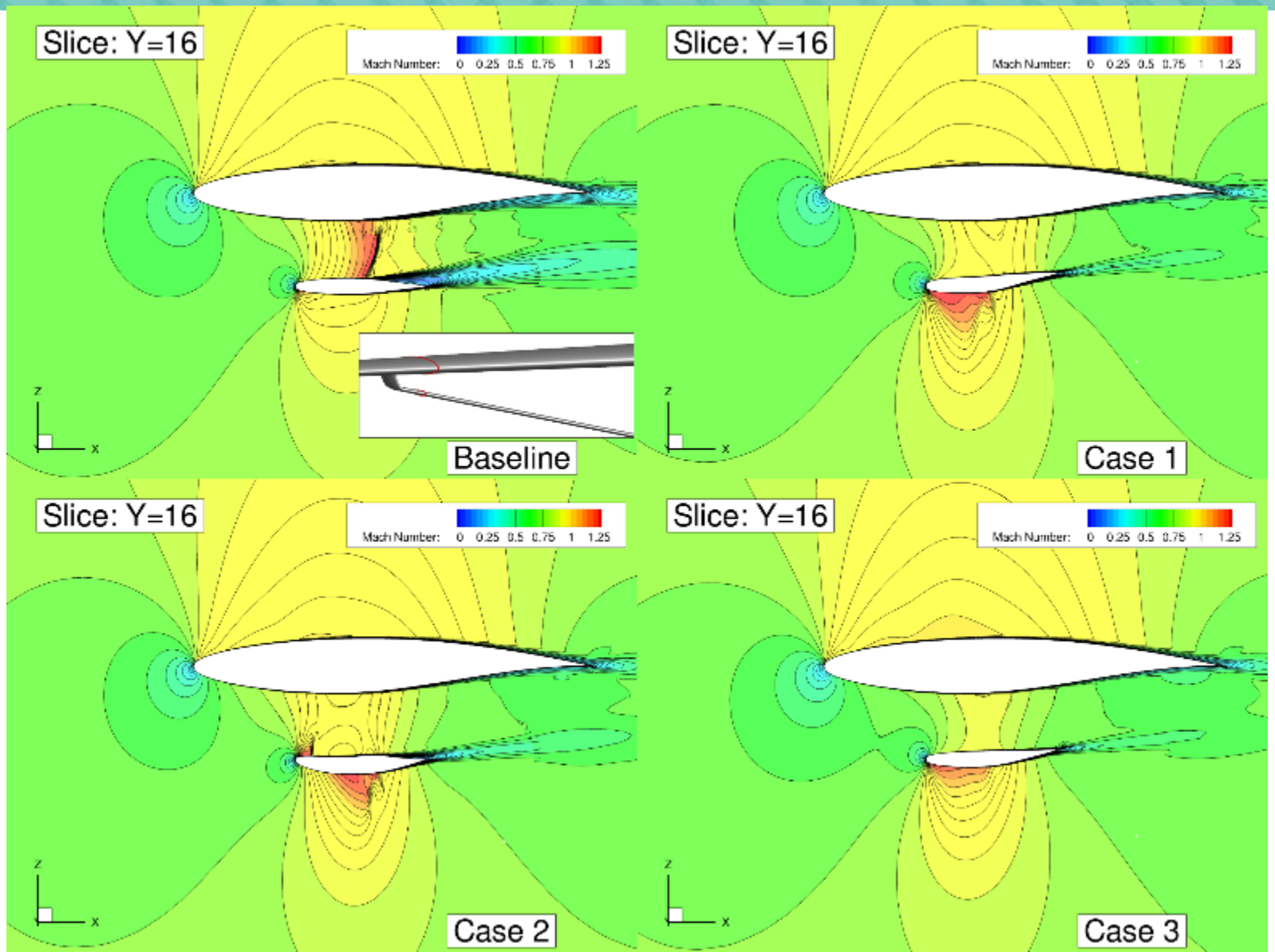
INCAS KC

INCAS SCB



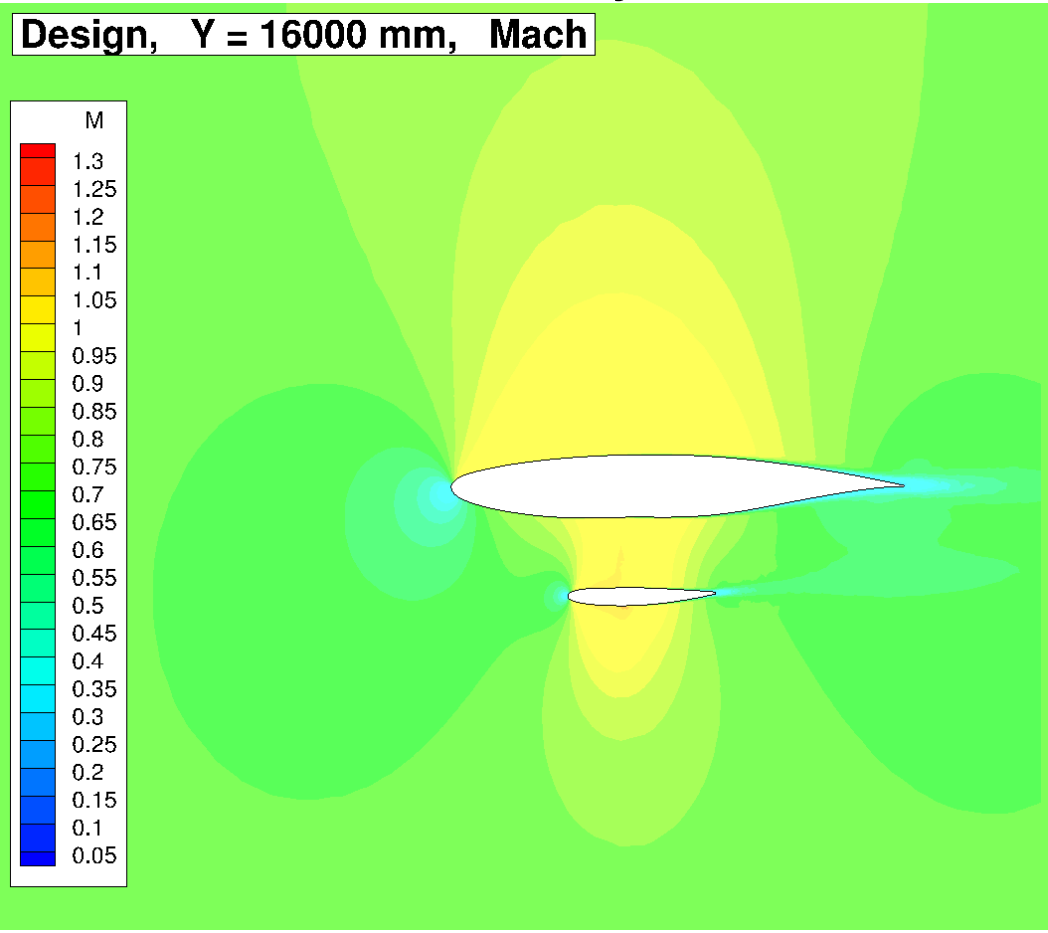
MACH (STATION Y16)

NASA-AMES

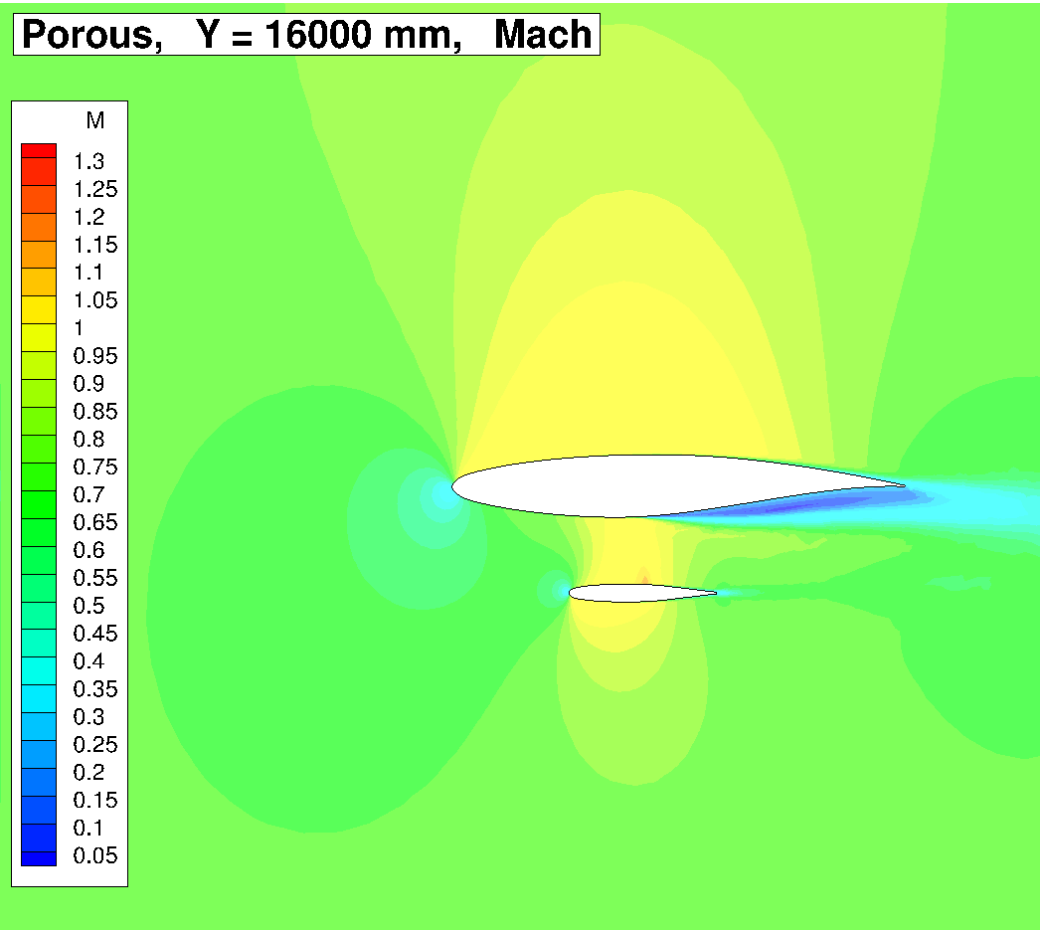


MACH (STATION Y16)

LANGLEY - Geometry

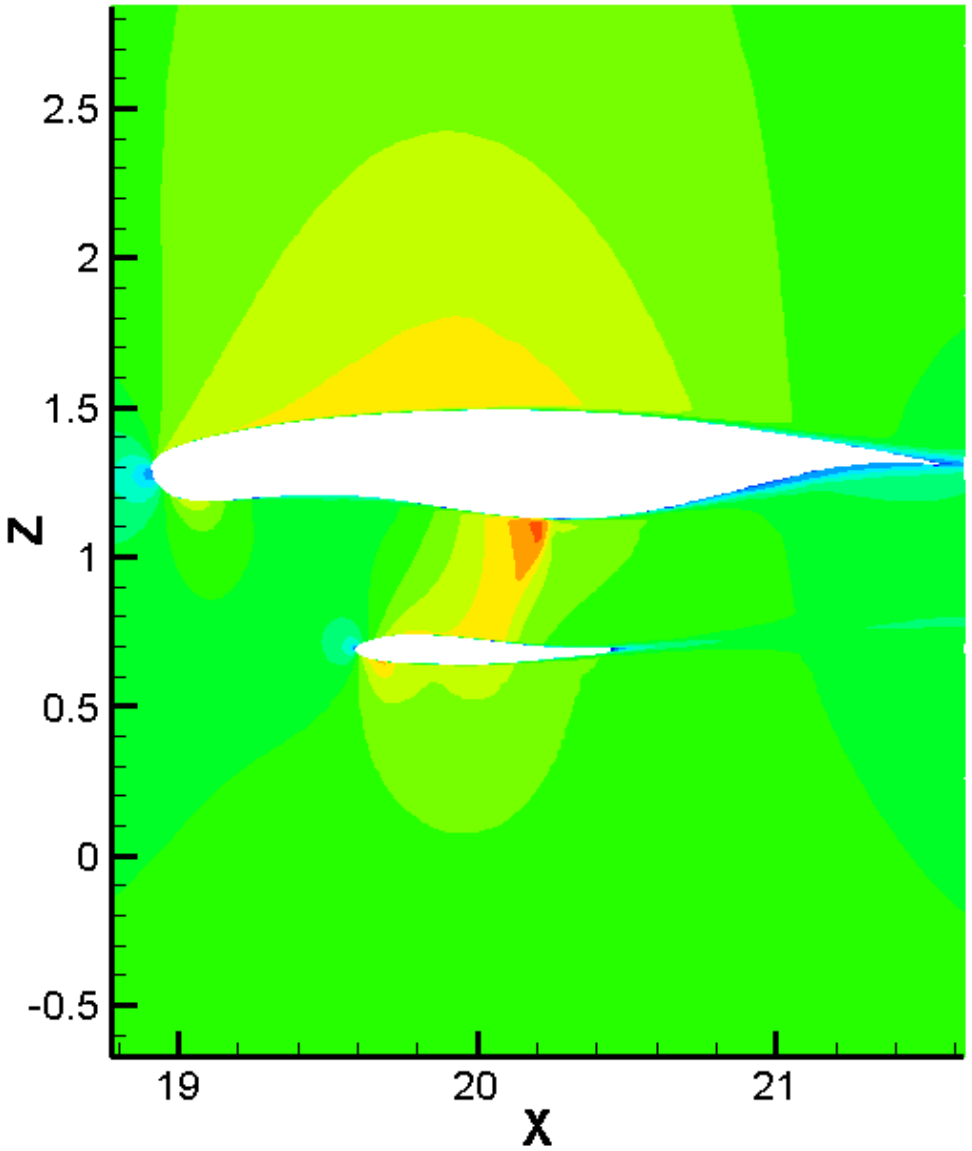


Porous



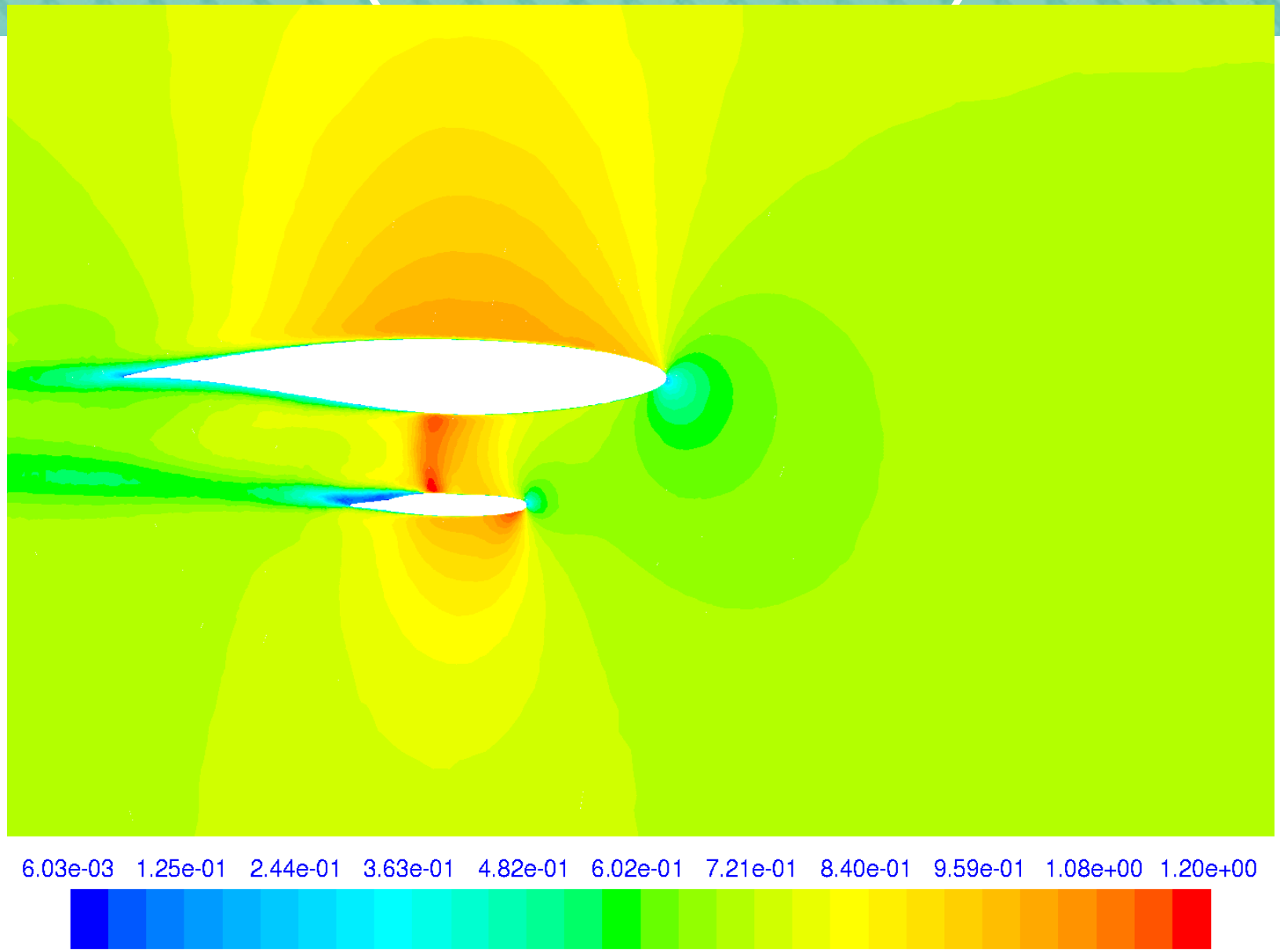
MACH (STATION Y16)

THU - Geometry



MACH (STATION Y16)

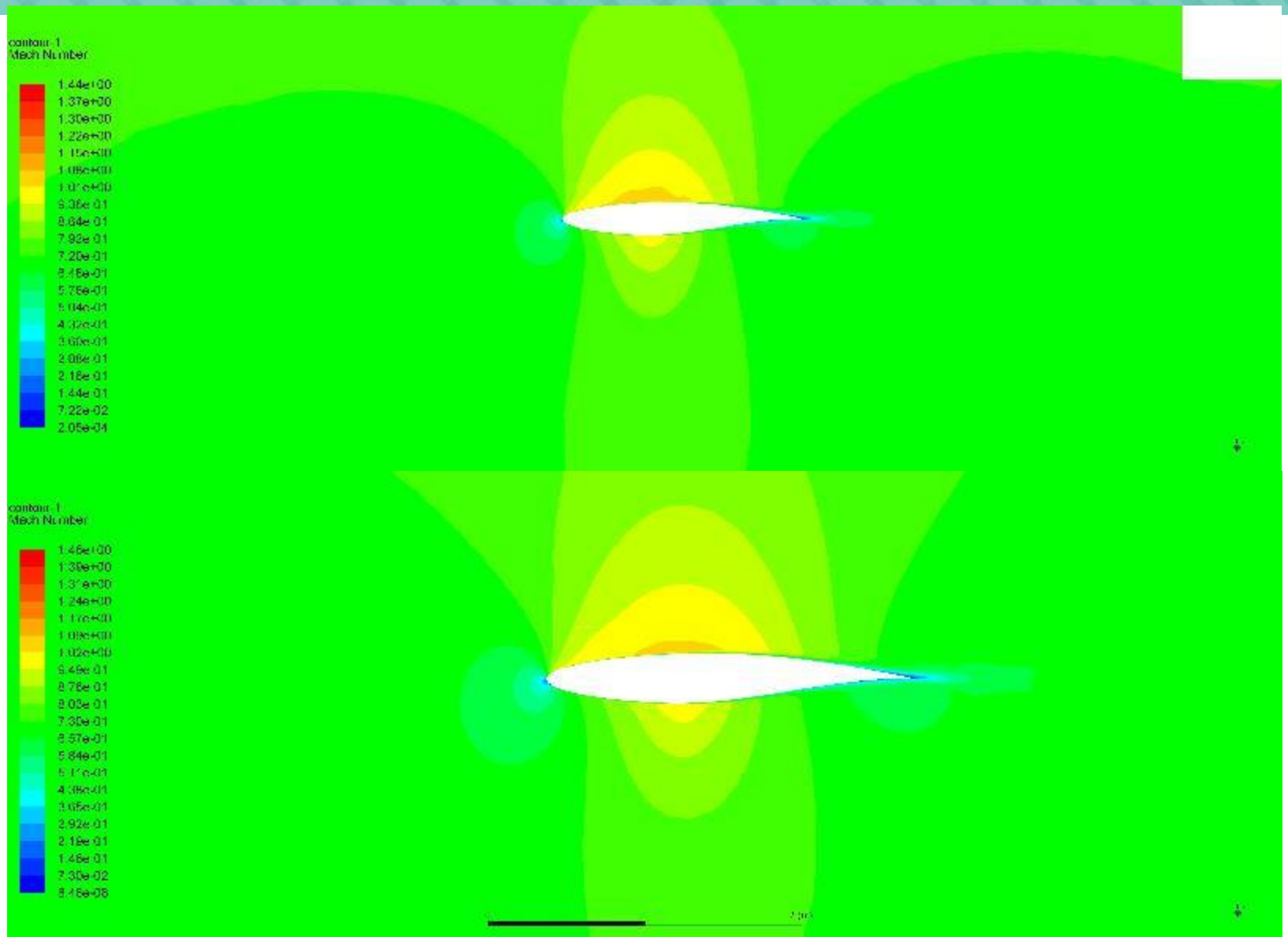
UdeC - SCB



MACH (STATION Y17.3)

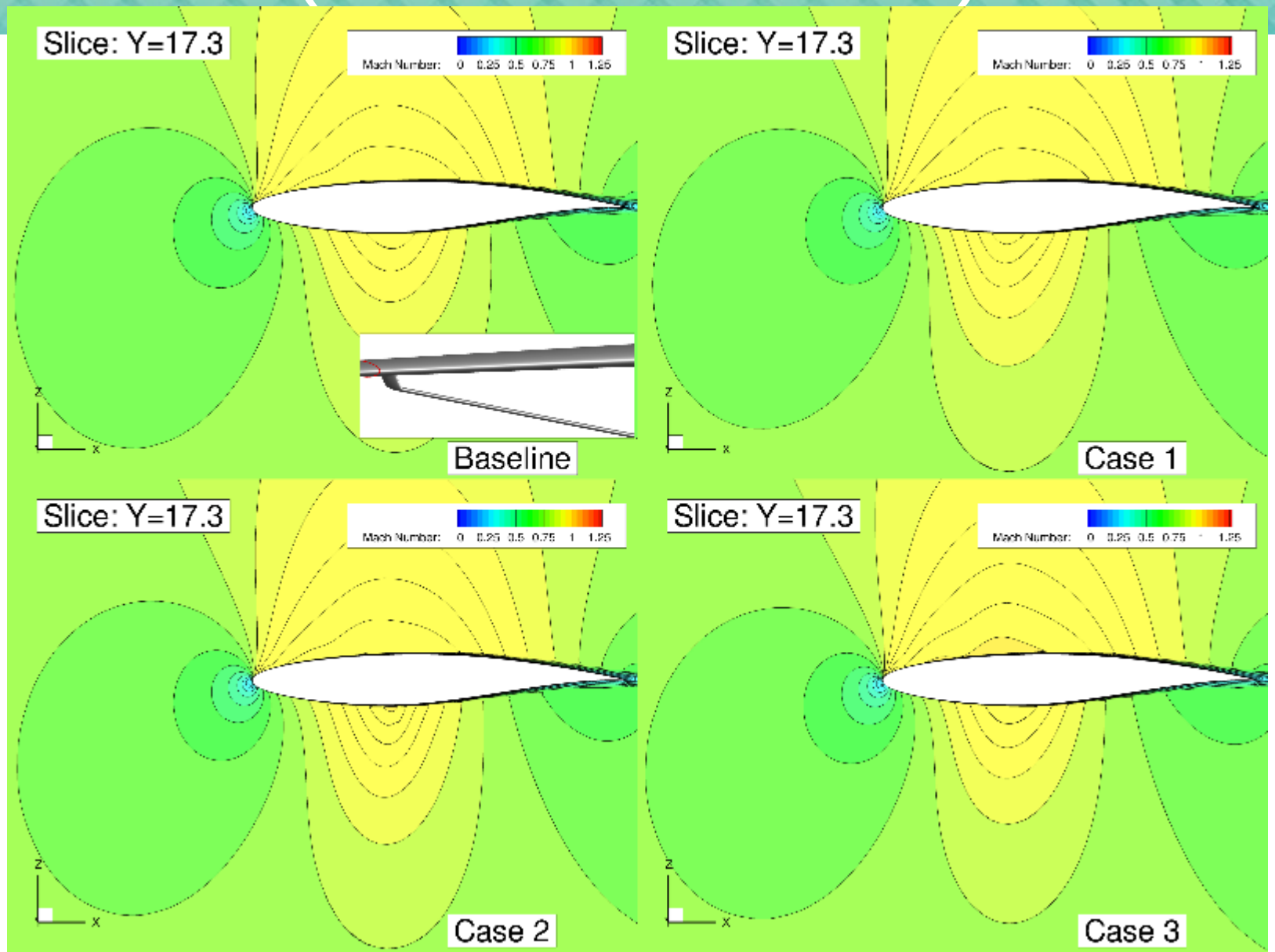
INCAS KC

INCAS SCB



MACH (STATION Y17.3)

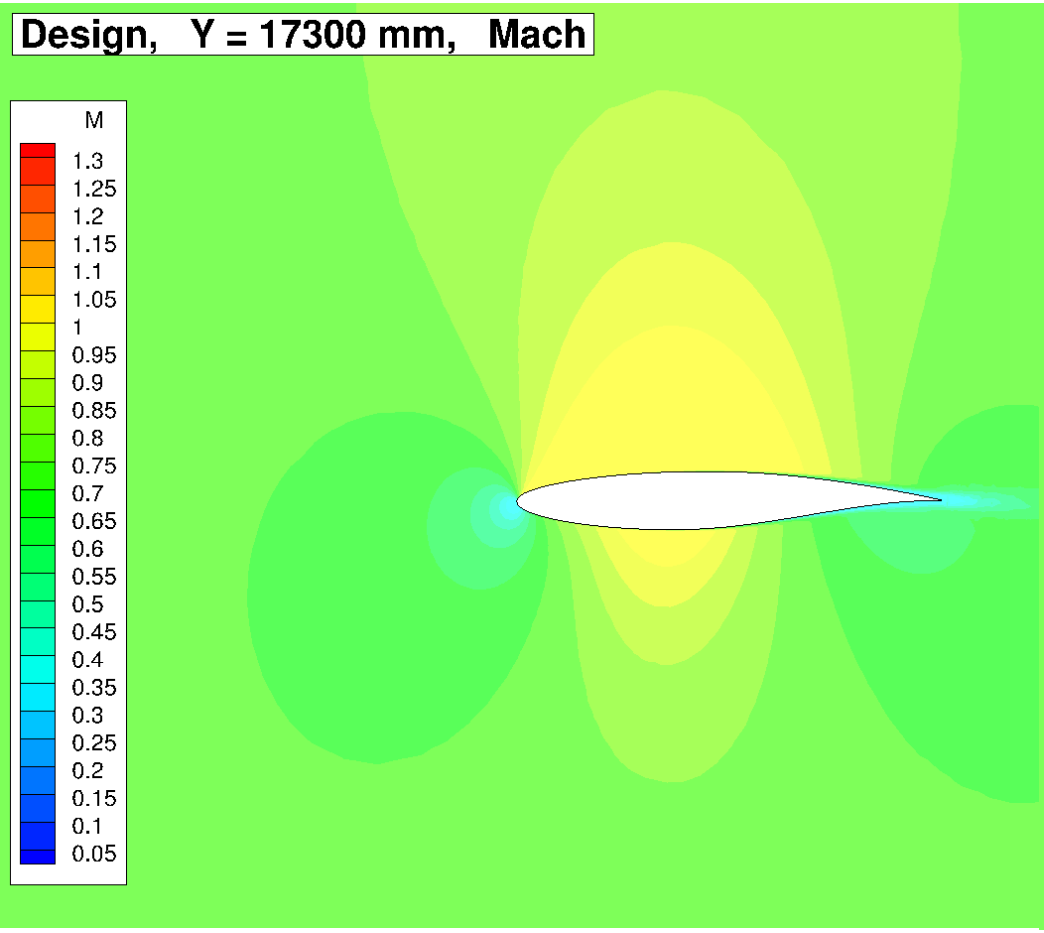
NASA-AMES

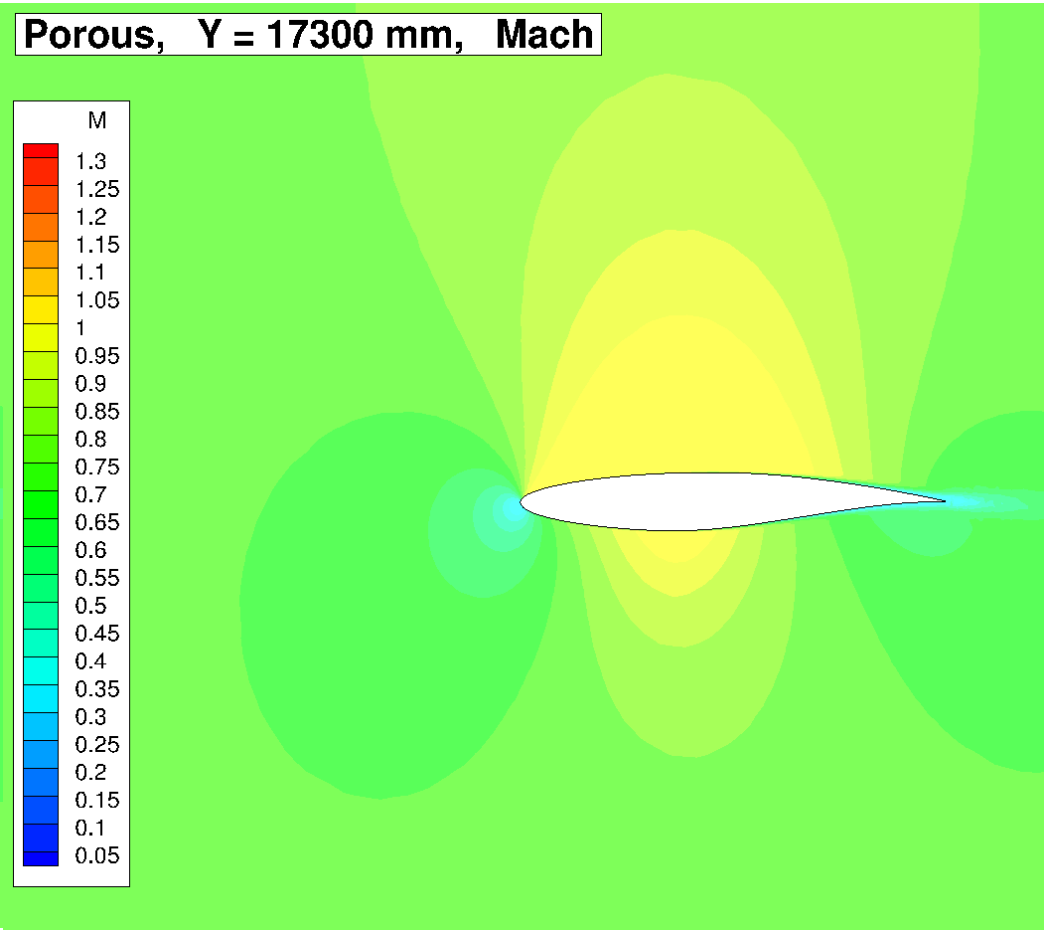


MACH (STATION Y17.3)

LANGLEY - Geometry

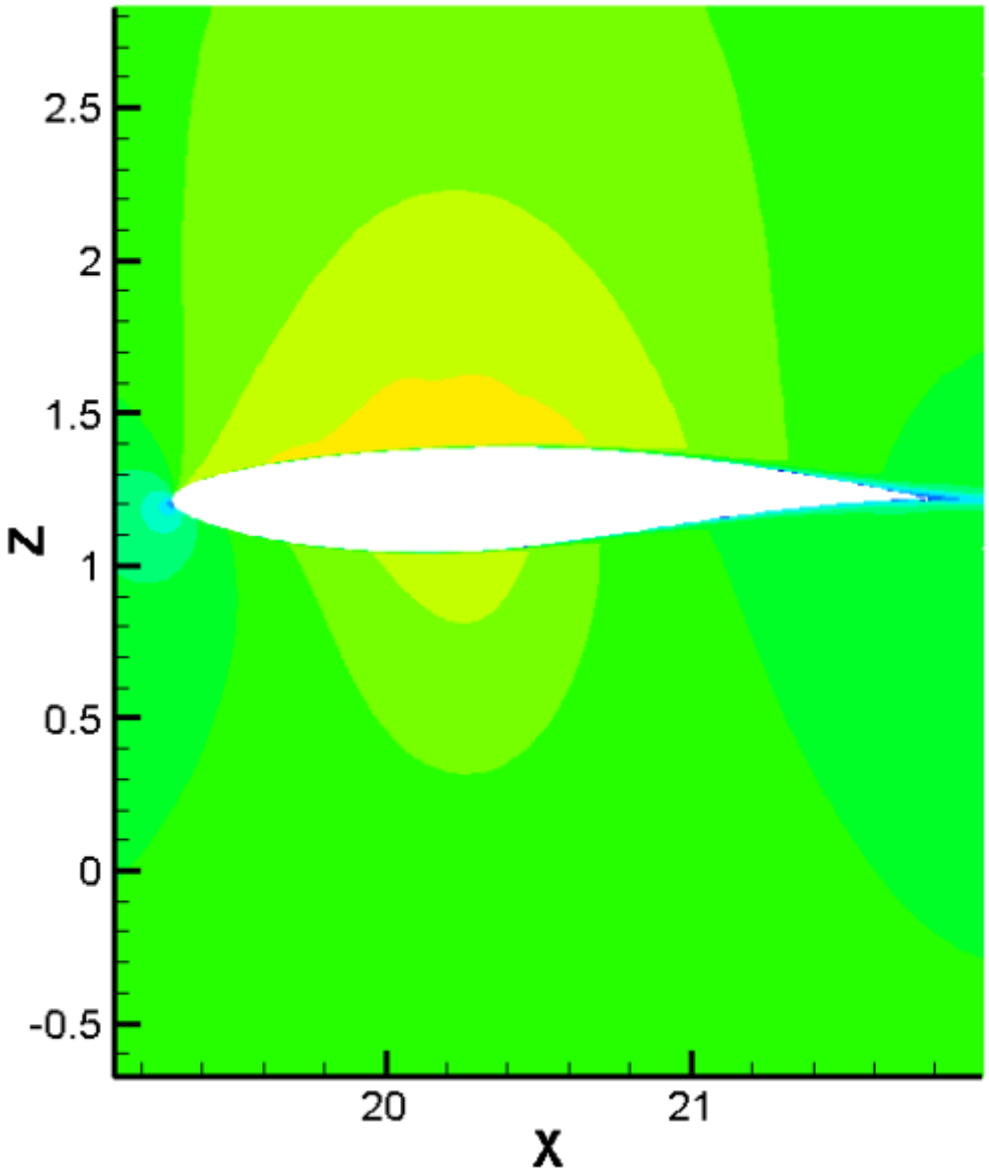
Porous





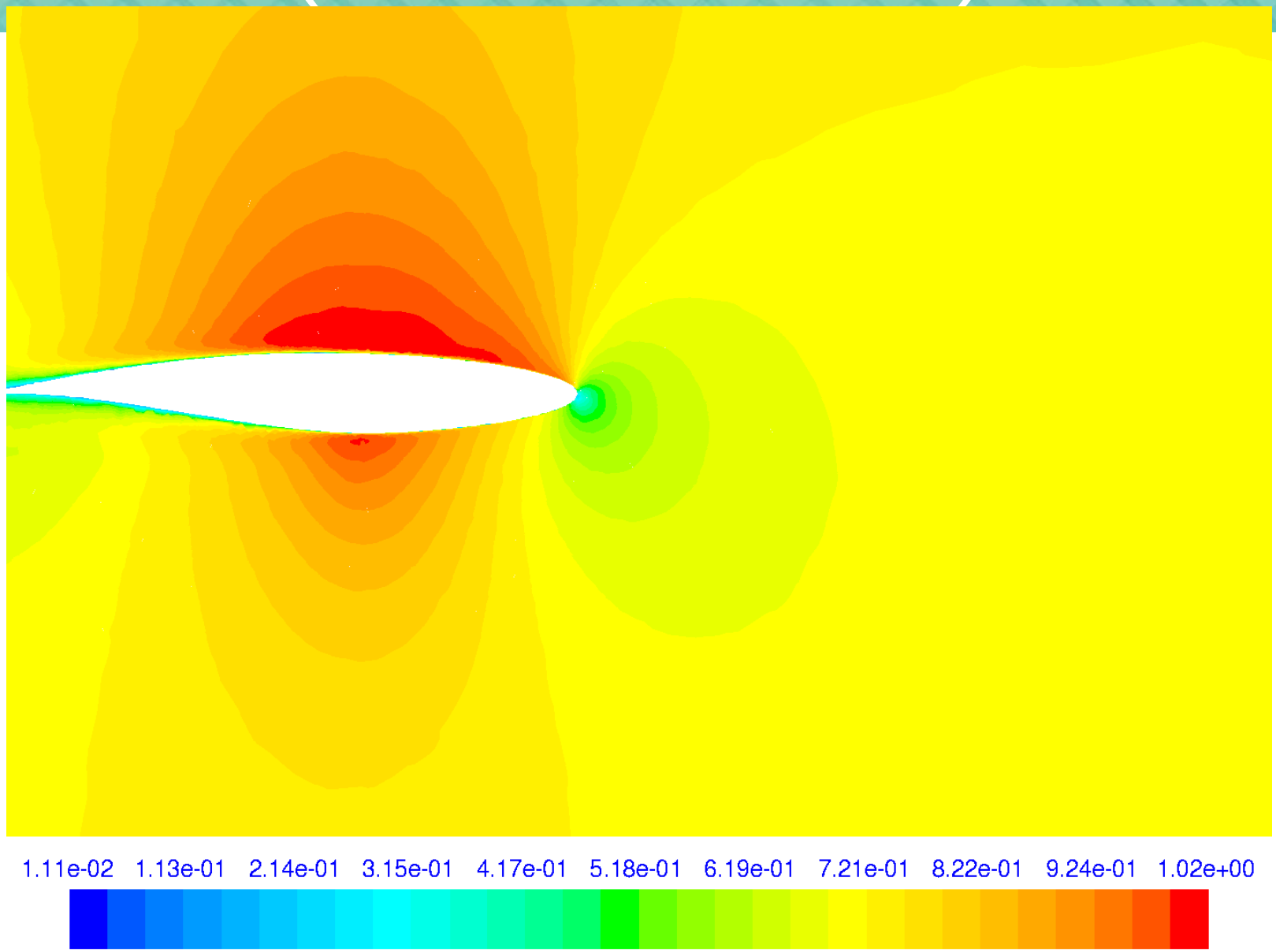
MACH (STATION Y17.3)

THU - Geometry



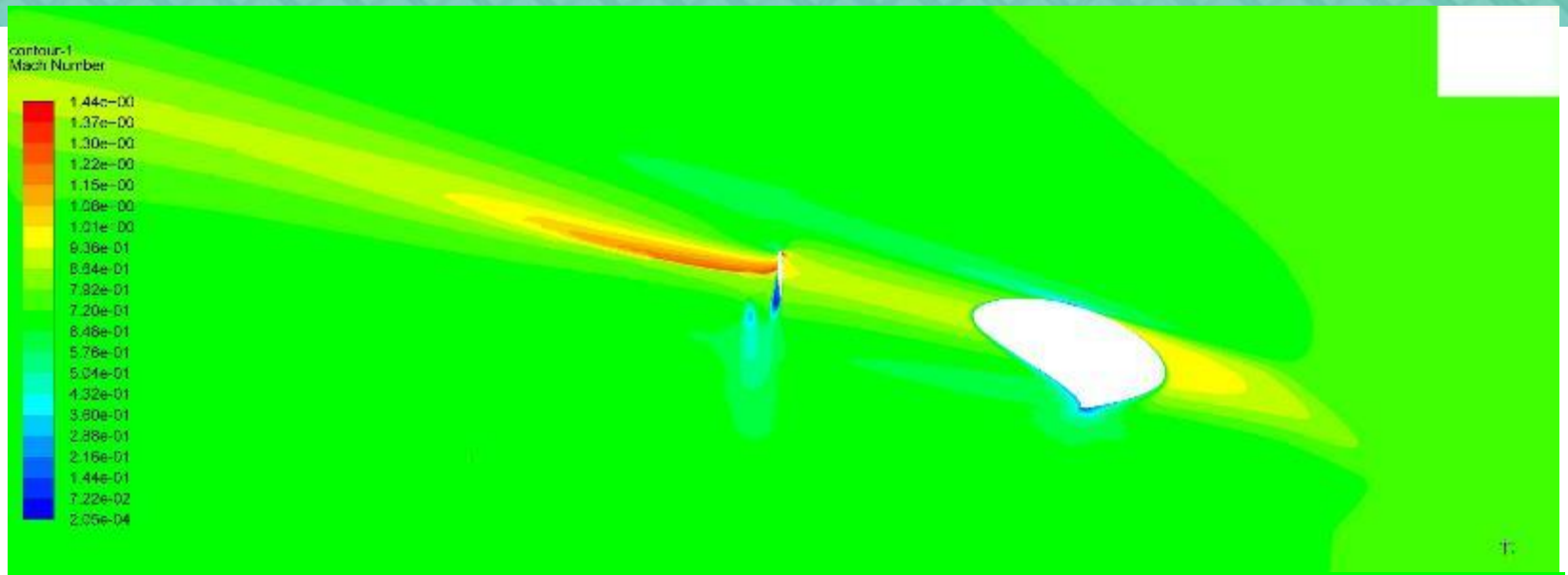
MACH (STATION Y17.3)

UdeC - SCB

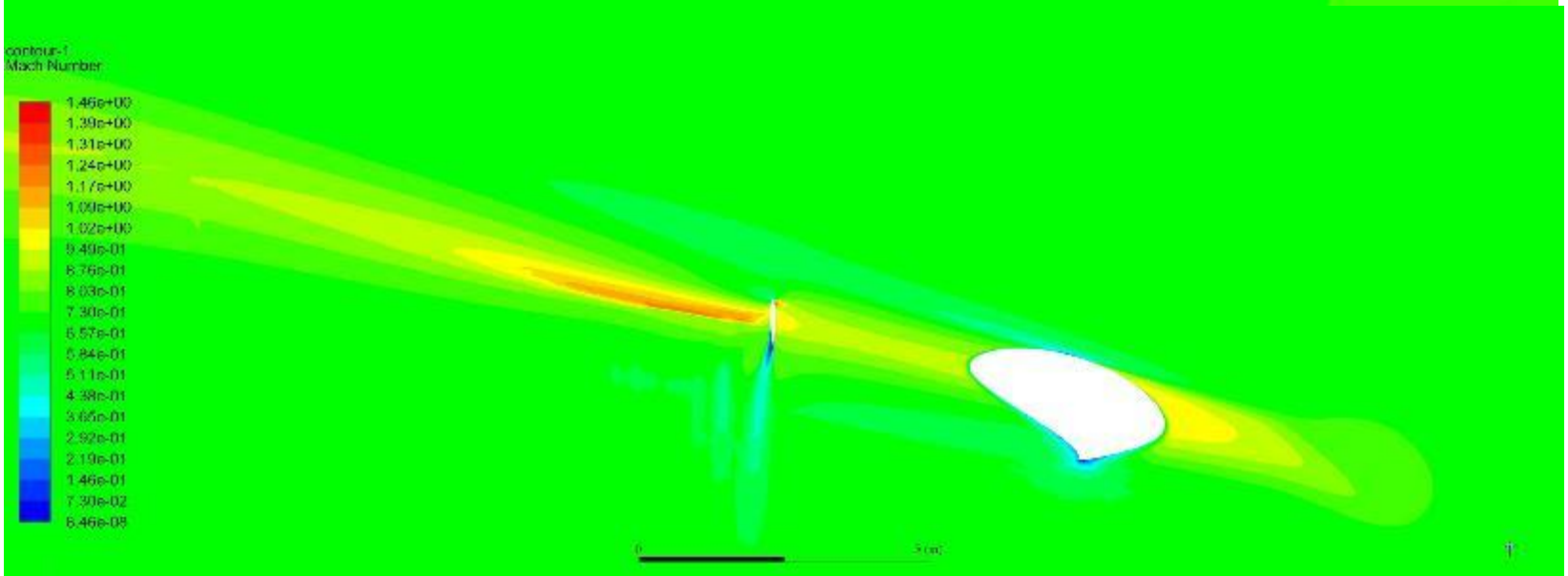


MACH (STATION Z0.87)

INCAS KC

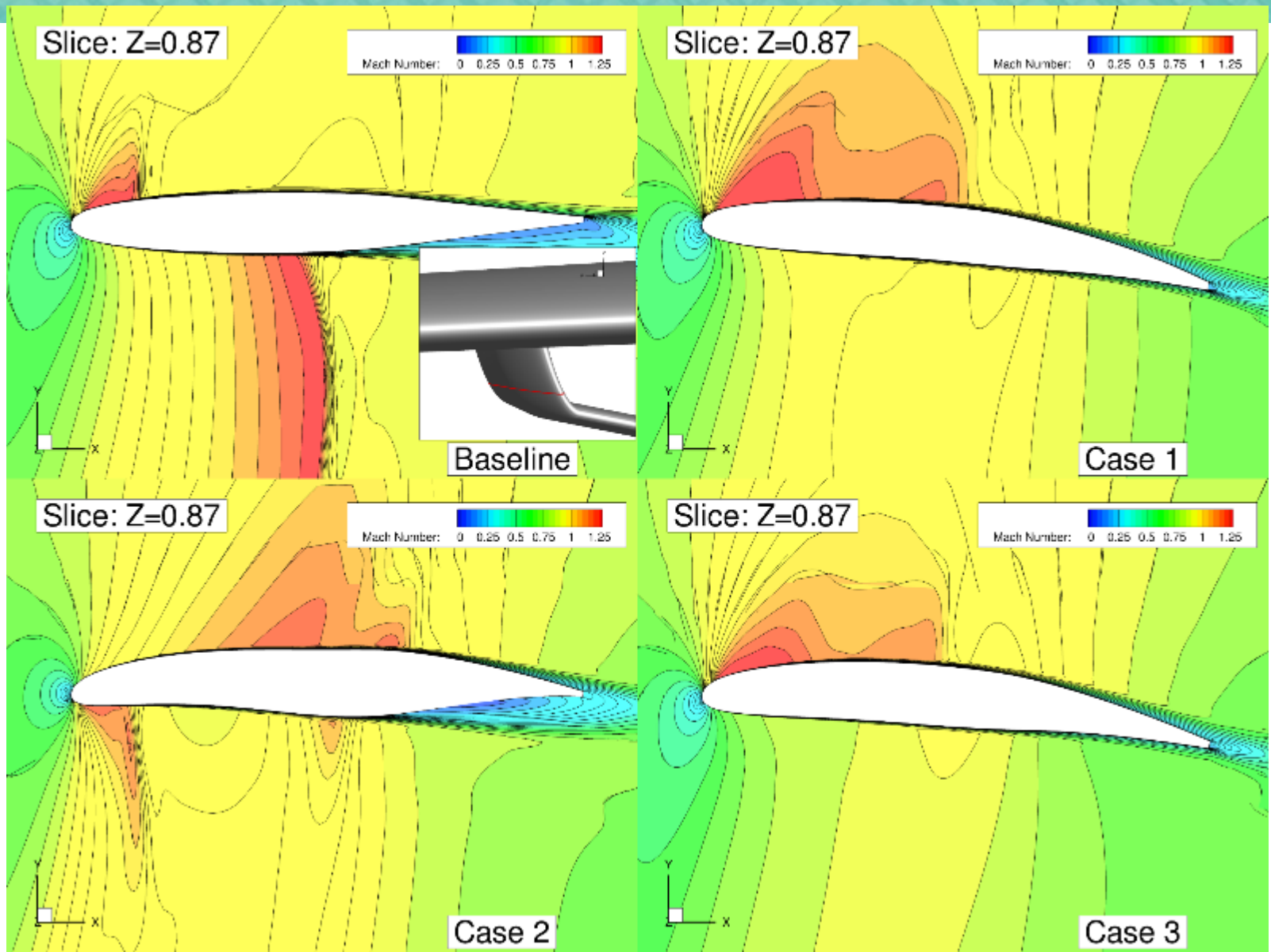


INCAS SCB



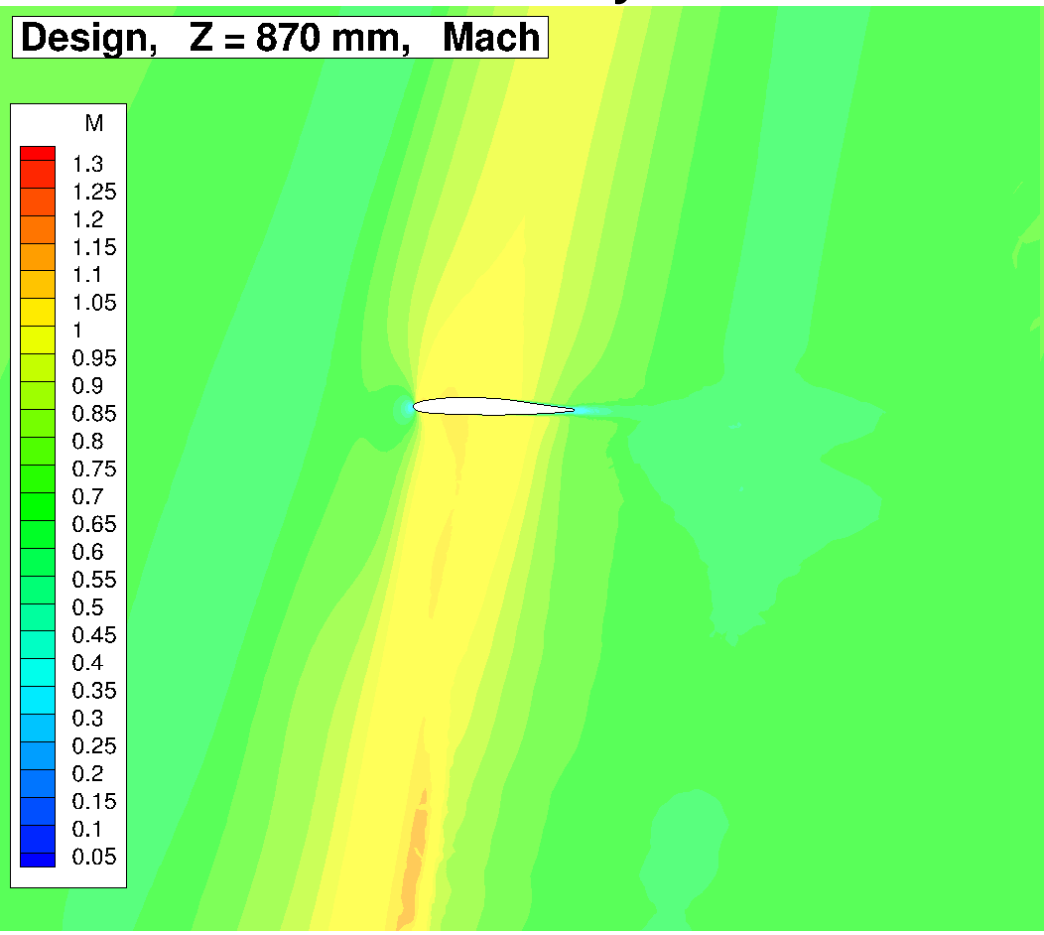
MACH (STATION Z0.87)

NASA-AMES

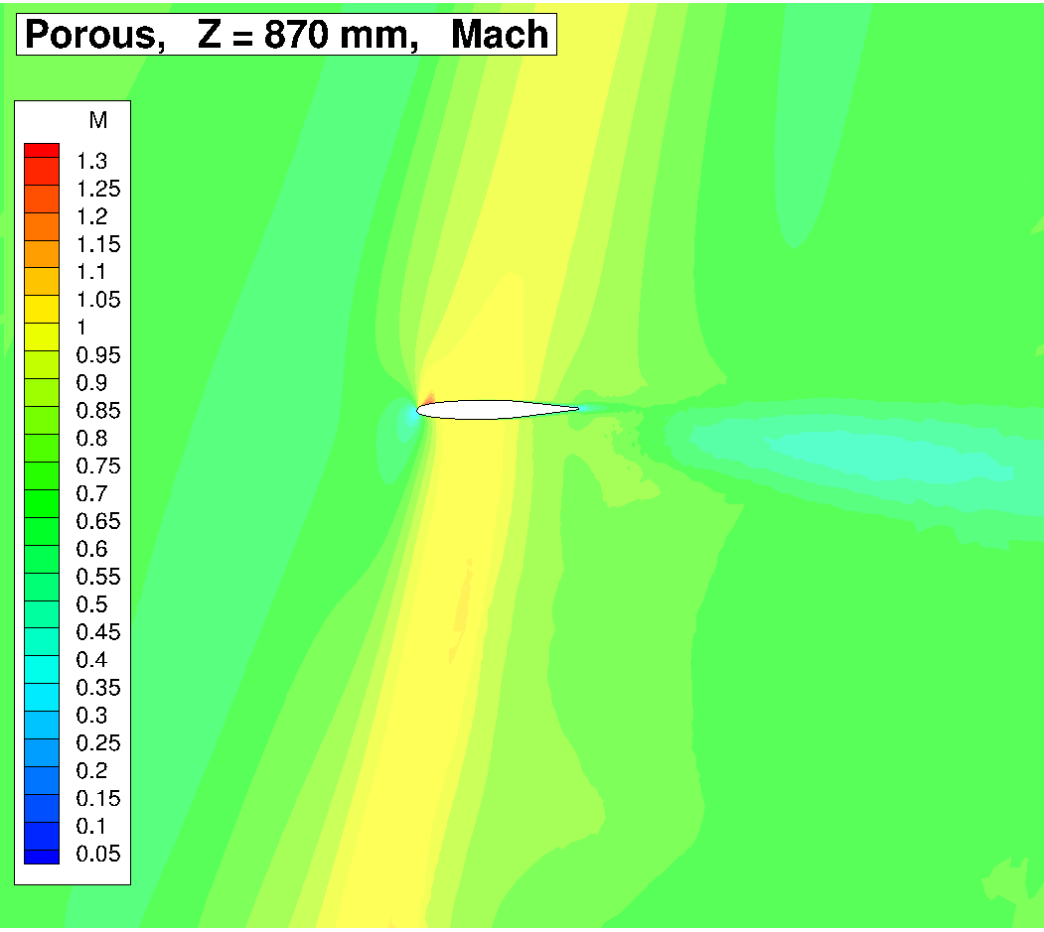


MACH (STATION Z0.87)

LANGLEY - Geometry

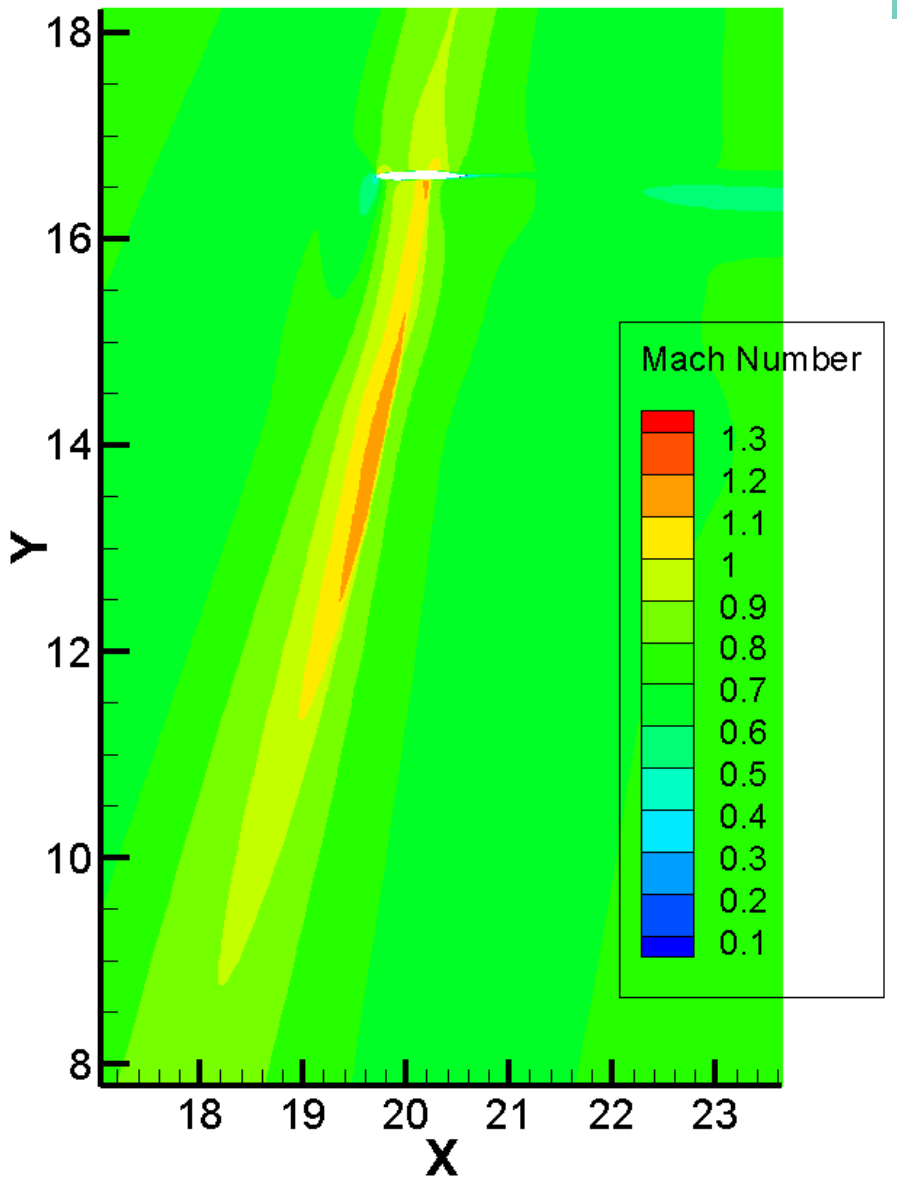


Porous



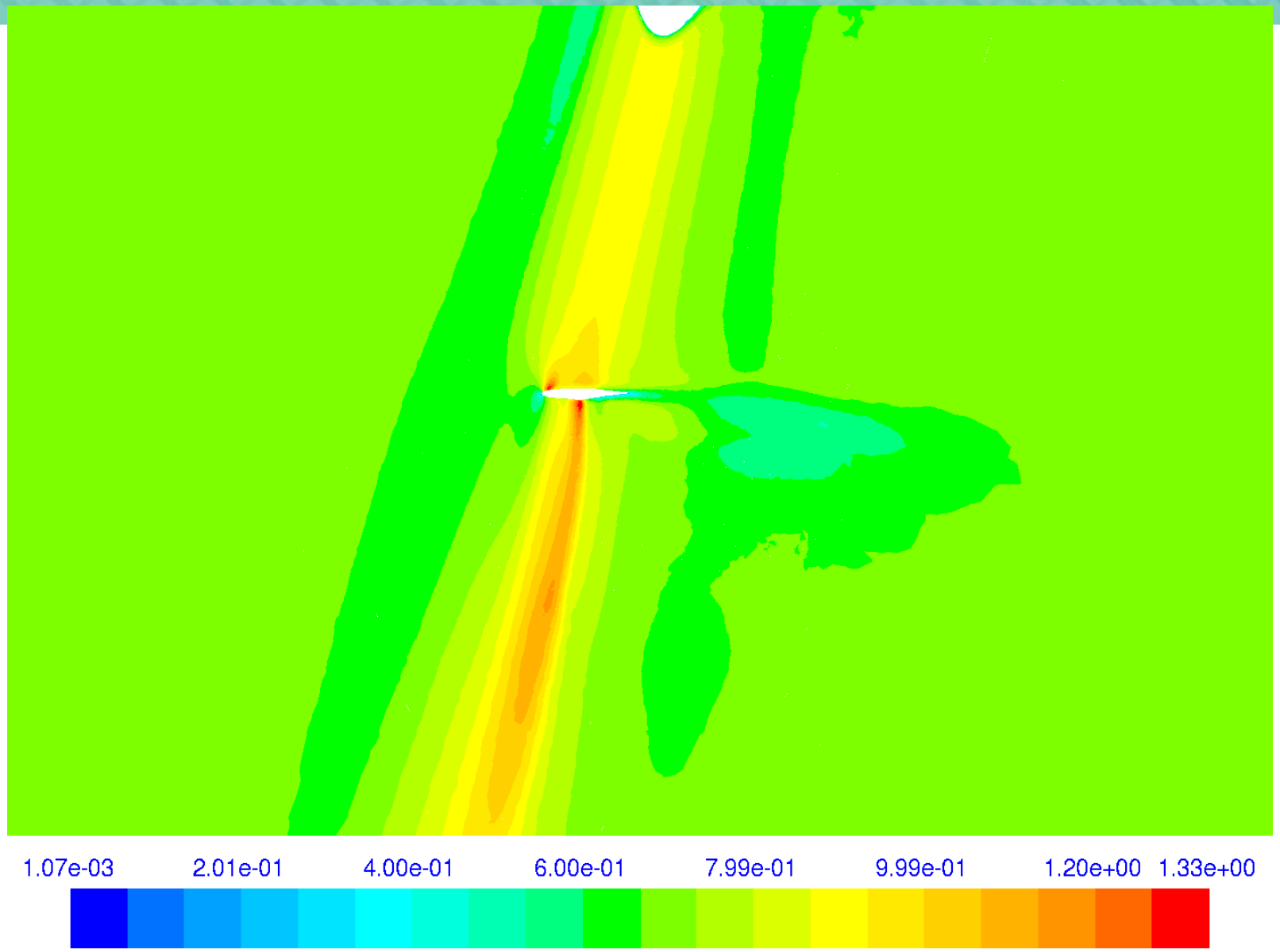
MACH (STATION Z0.87)

THU - Geometry



MACH (STATION Z0.87)

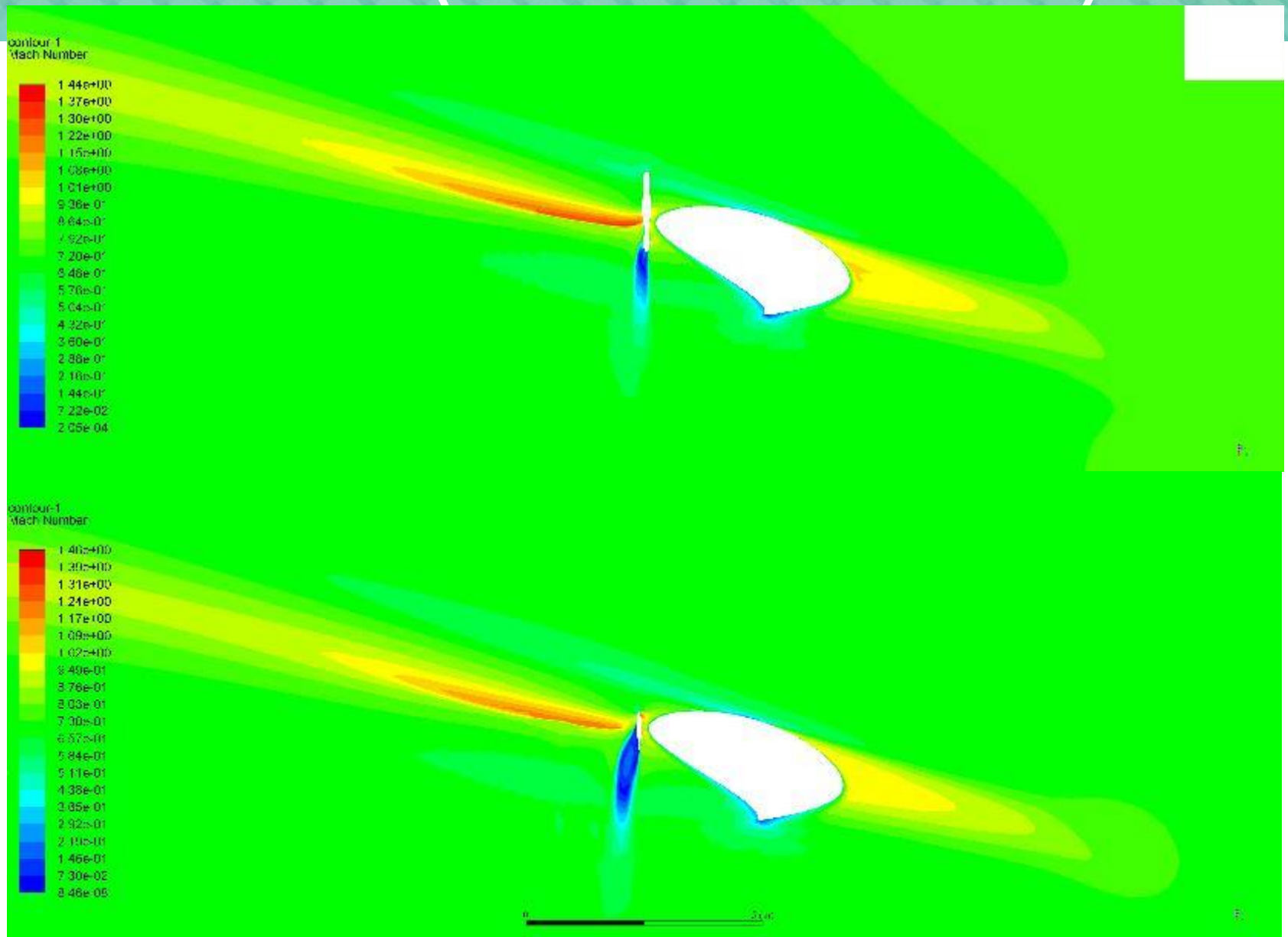
UdeC - SCB



MACH (STATION Z1.07)

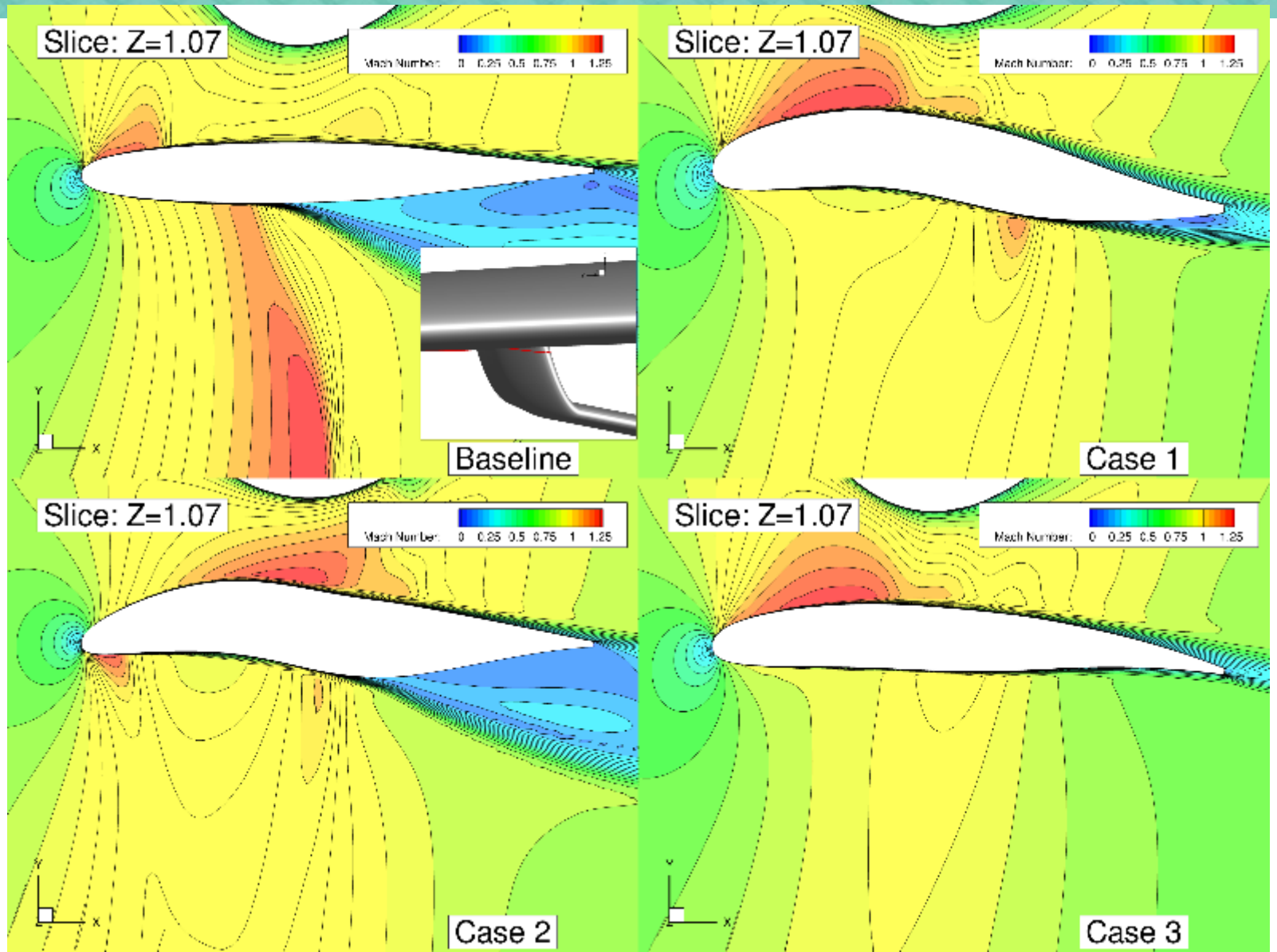
INCAS KC

INCAS SCB



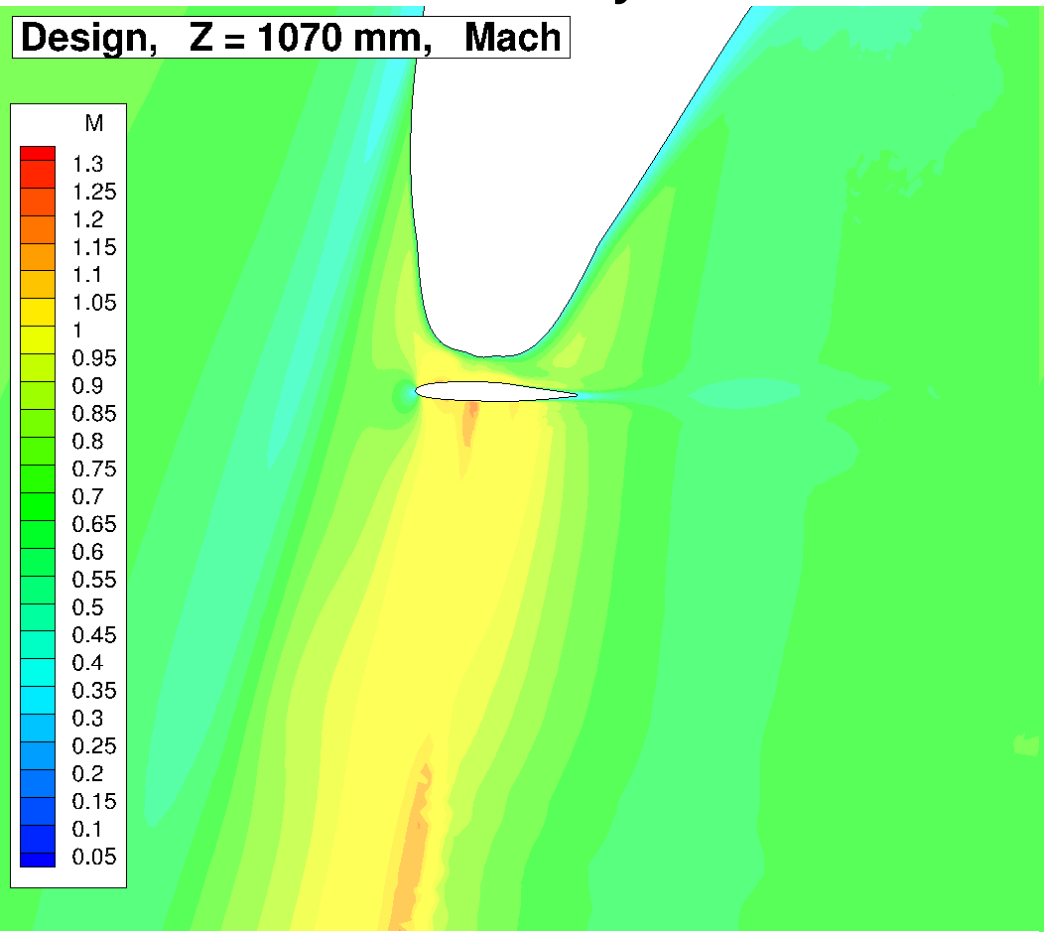
MACH (STATION Z1.07)

NASA-AMES

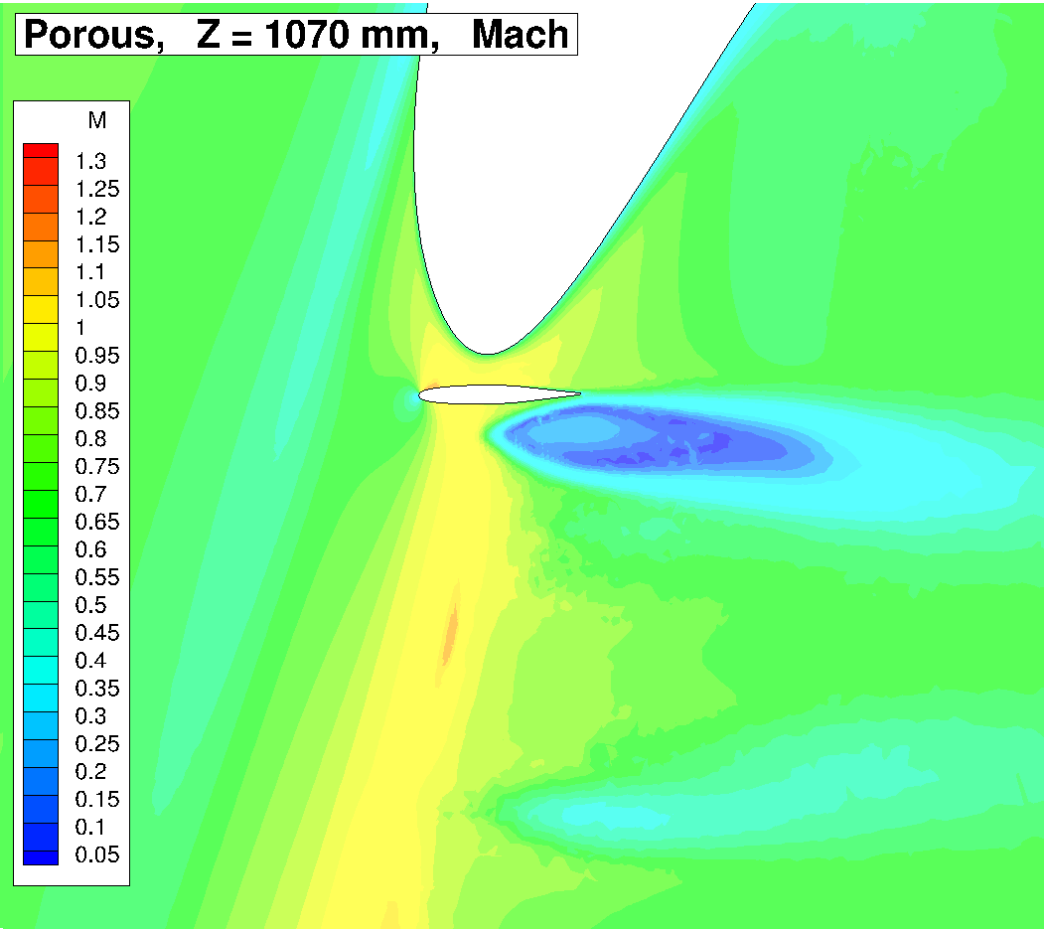


MACH (STATION Z1.07)

LANGLEY - Geometry

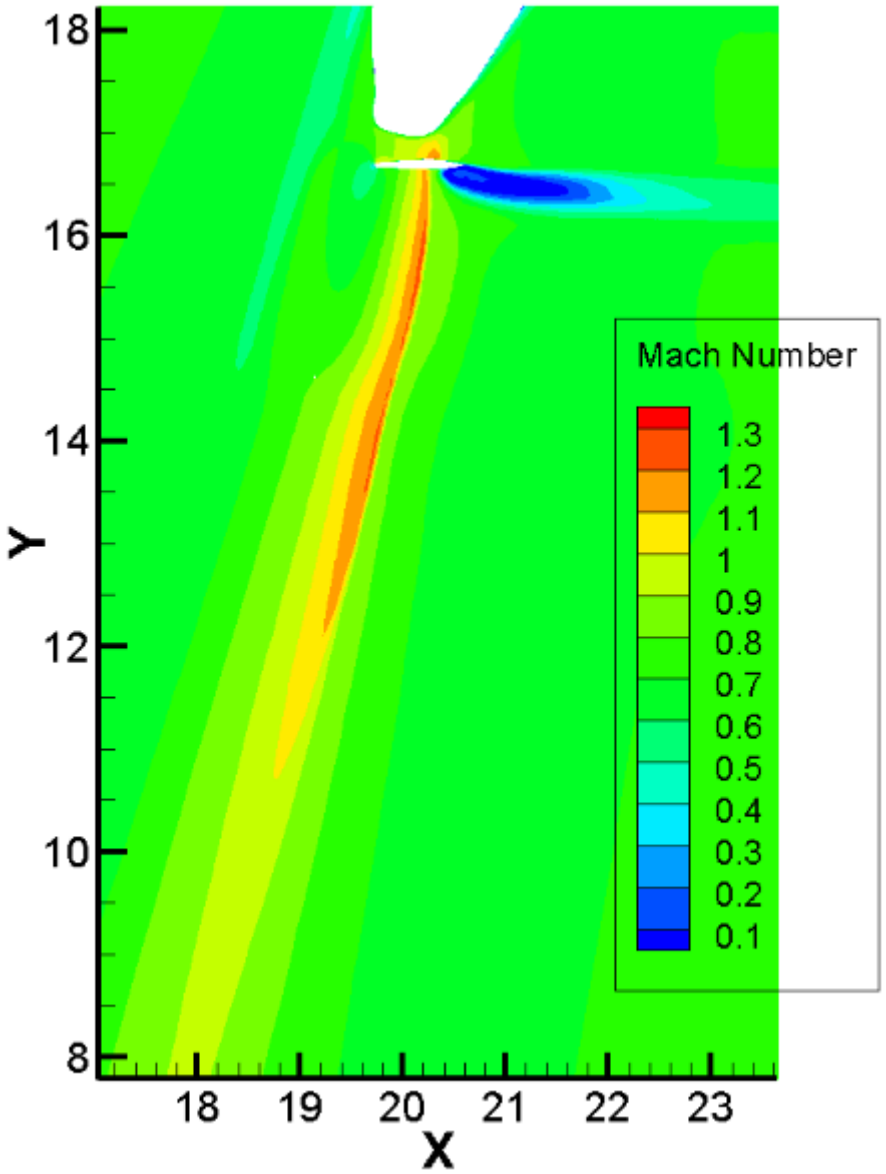


Porous



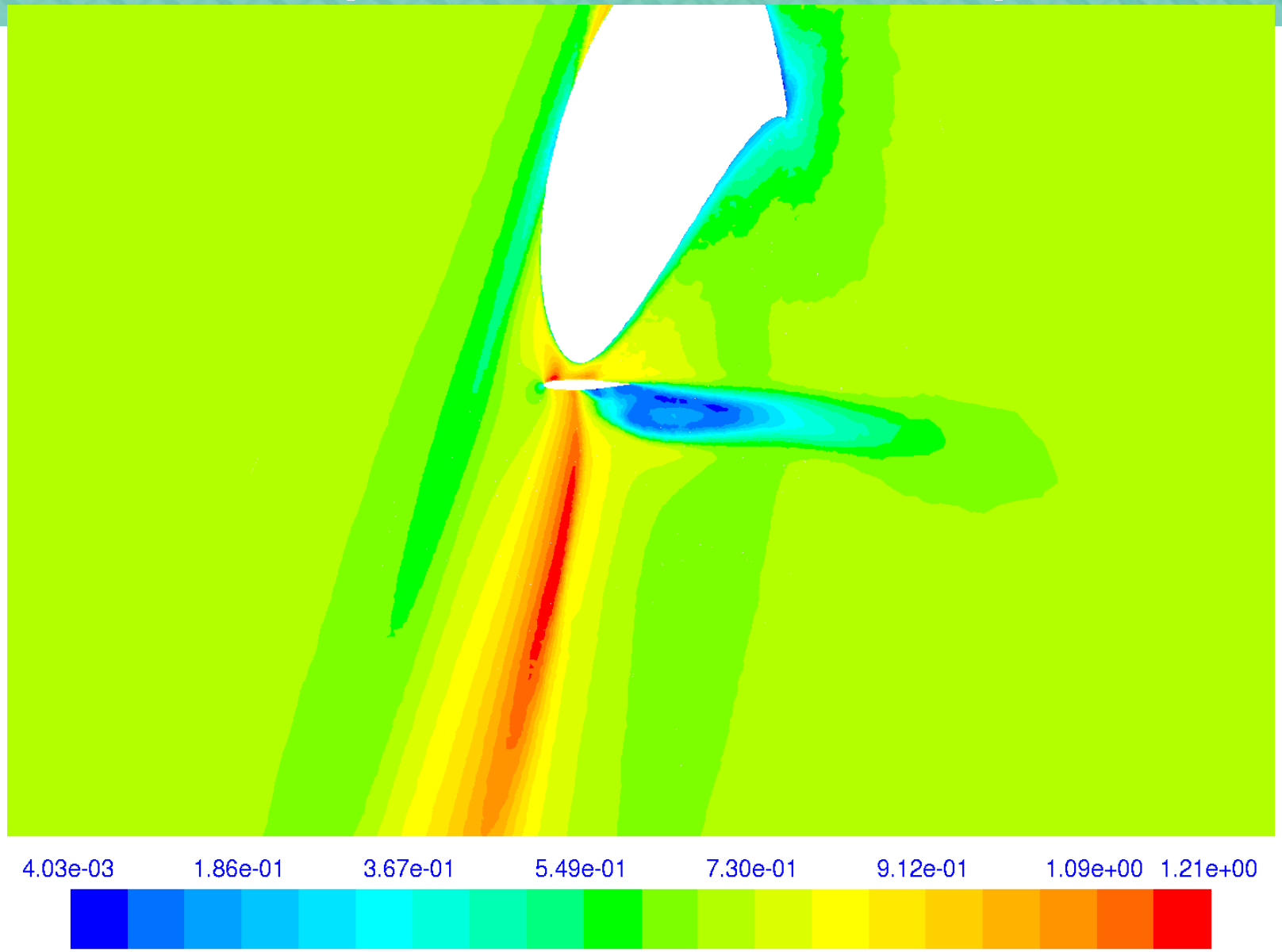
MACH (STATION Z1.07)

THU - Geometry



MACH (STATION Z1.07)

UdeC - SCB



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