

AIAA CFD Drag Prediction Workshop (9-10 June 2001, Anaheim, CA, USA)

✧ Stéphane AMANT,
French PhD student in aerodynamics

✧ Graduate engineer from SUPAERO

✧ Employed by Airbus France (Toulouse, France)
– Department : Aerodynamics
– Team : Methods of calculation for aerodynamics



Problems encountered during the calculations on the DPW structured grid

✧ Experimental data :

- CL = 0.5 for $\alpha \approx 0.2^\circ$
- Balance data : $CD_{total} \approx 290.10^{-4}$ at CL = 0.50

✧ Computational results :

- CL = 0.5 for $\alpha \approx 0.75^\circ$!!!
- Surface integration : $CD_{total} = 465,6.10^{-4}$ at CL = 0.500
... with $CD_{friction} = 248,3 .10^{-4}$!!!

✧ Reynolds number OK : problem with the grid ?



Brief description of the grids

✧ DPW grid :

- structured multiblock grid
- 3 394 000 grid points
- O topology with junctures at 45°

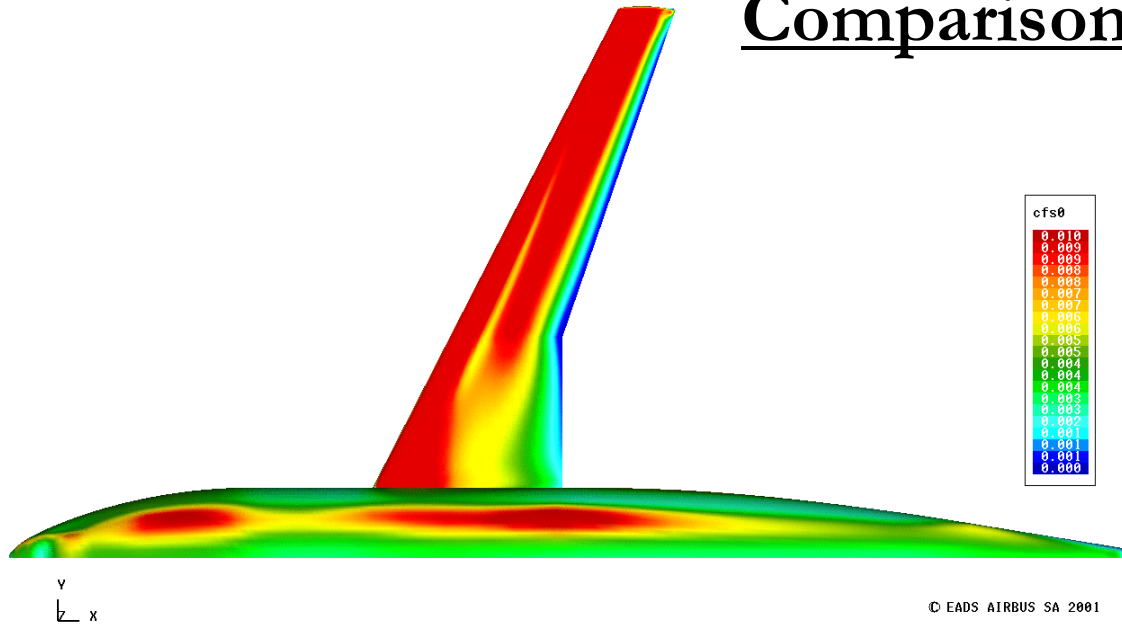
✧ Airbus France grid :

- structured multiblock grid
 - Euler mesh : 3 204 000 grid points
 - C topology with junctures at 90°
- ⇒ automatic generation of the Navier-Stokes mesh
with a refinement tool (5 324 000 grid points)



DLR-F4, skin friction (DPW grid, upper side)

Comparison of the skin friction (1/2)

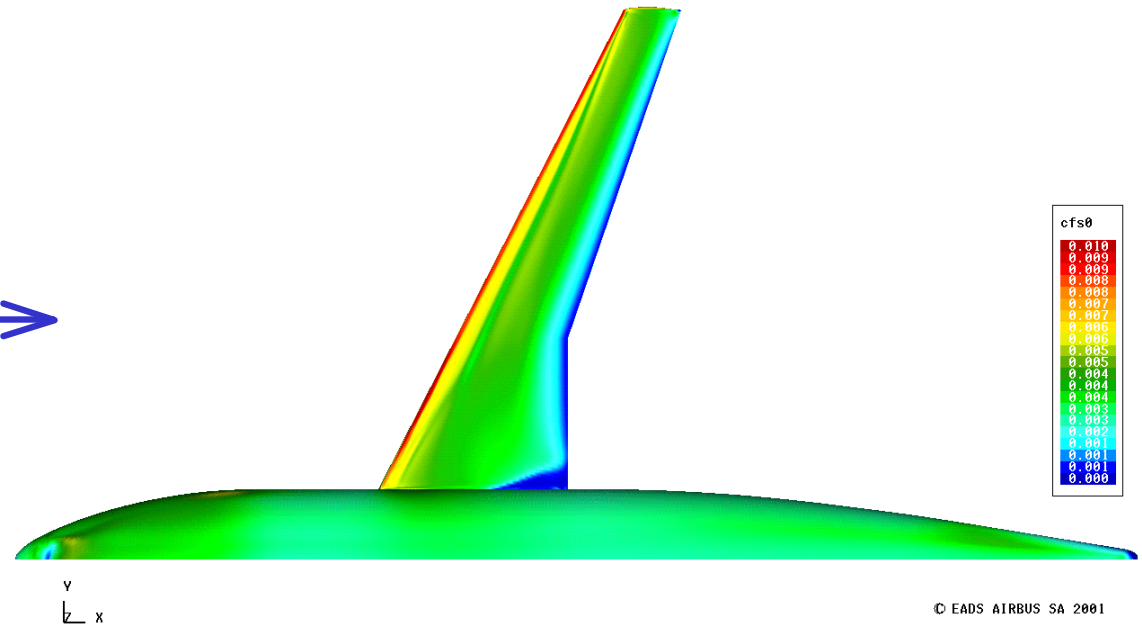


← DPW grid

© EADS AIRBUS SA 2001

DLR-F4, skin friction (EADS grid, upper side)

Airbus France grid →



© EADS AIRBUS SA 2001

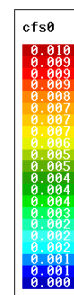
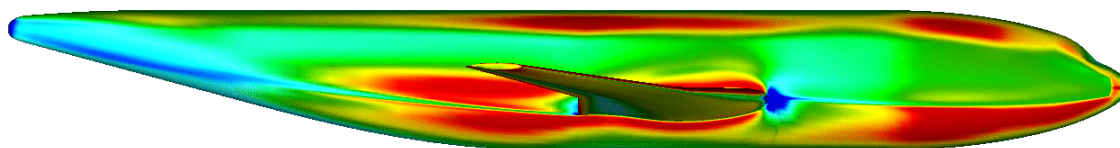


9-10 June 2001

AIAA CFD Drag Prediction

DLR-F4, skin friction (DPW grid, lateral side)

Comparison of the skin friction (2/2)

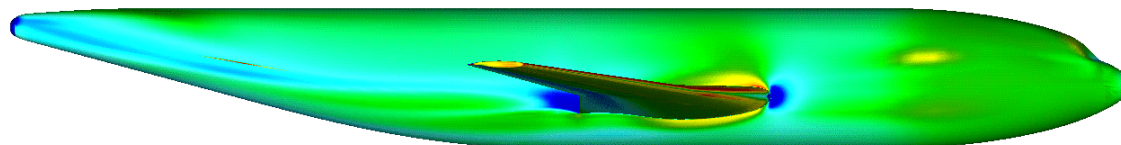


← DPW grid

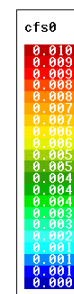
z
x

© EADS AIRBUS SA 2001

DLR-F4, skin friction (EADS grid, lateral side)



Airbus France grid



© EADS AIRBUS SA 2001



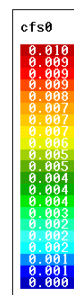
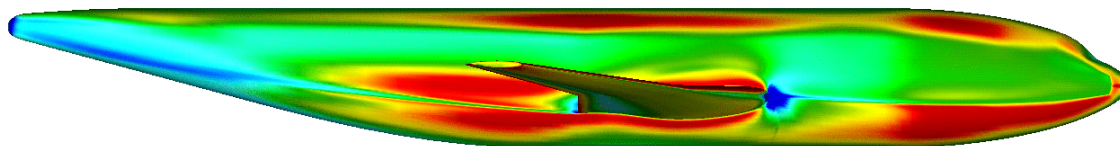
z
x

9-10 June 2001

AIAA CFD Drag Prediction

DLR-F4, skin friction (DPW grid, lateral side)

Relationship with the grid

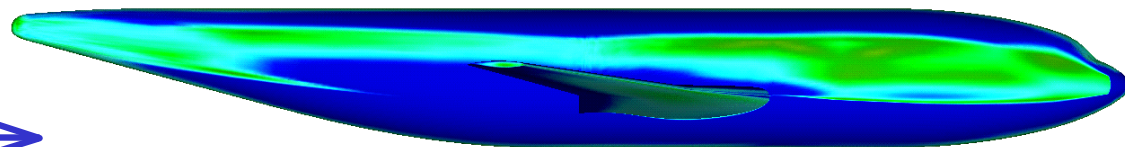


← Skin friction

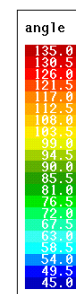
z
x

© EADS AIRBUS SA 2001

DLR-F4, DPW grid, lateral side



Grid orthogonality →



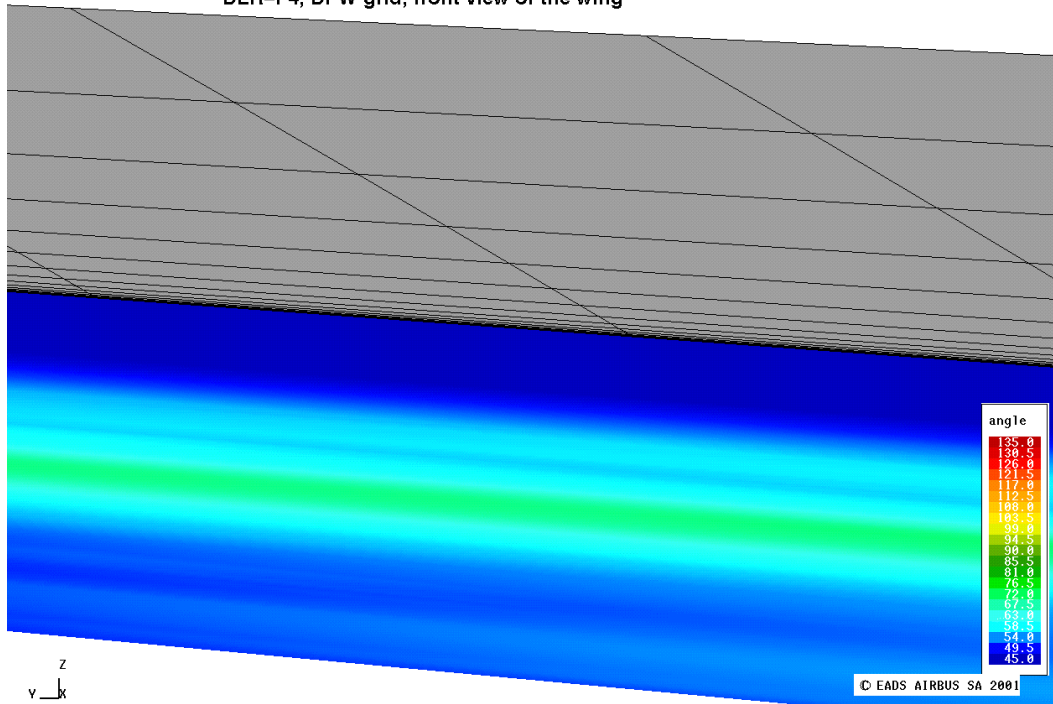
© EADS AIRBUS SA 2001



9-10 June 2001

AIAA CFD Drag Prediction

DLR-F4, DPW grid, front view of the wing

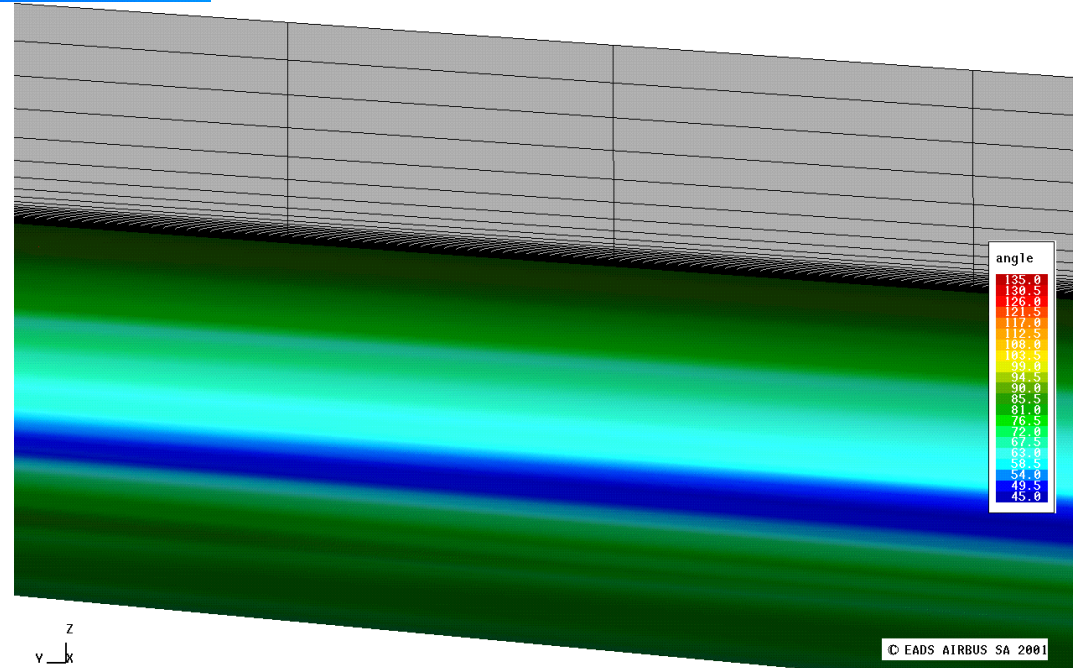


Comparison of the grids

← DPW grid

Airbus France grid →

DLR-F4, EADS grid, front view

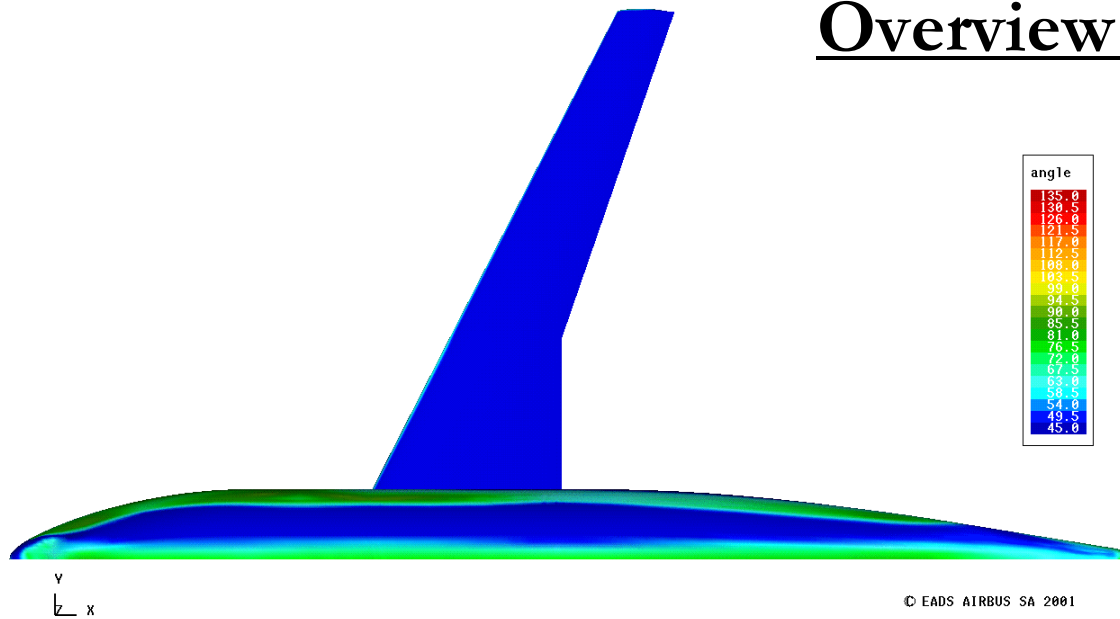


9-10 June 2001

AIAA CFD Drag Prediction

DLR-F4, DPW grid, upper side

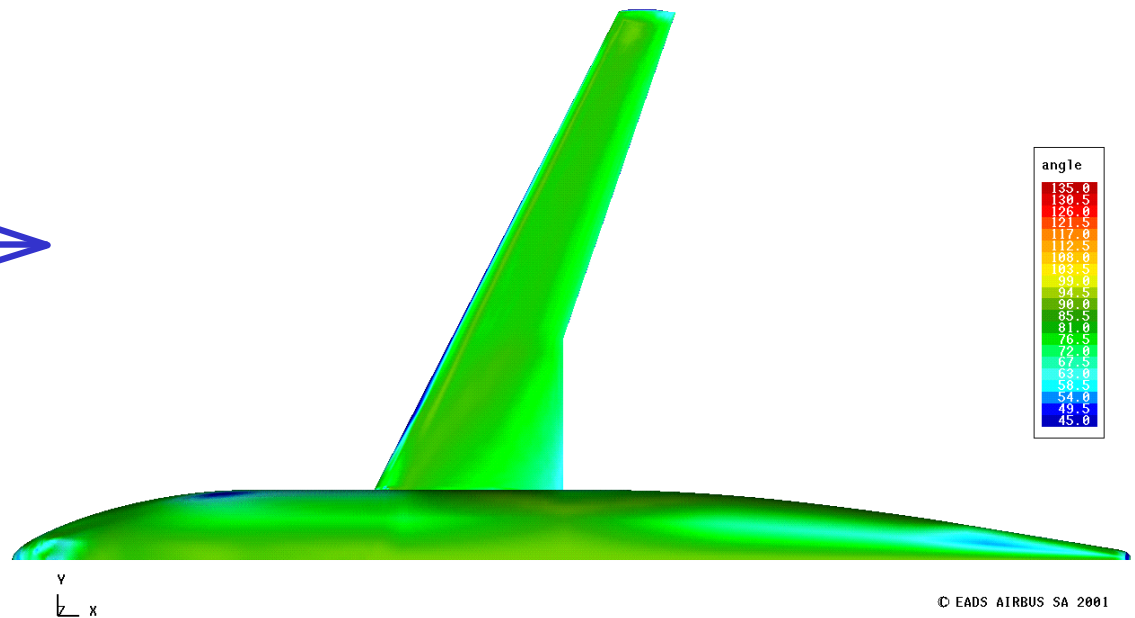
Overview of the grid orthogonality



← DPW grid

DLR-F4, EADS grid, upper side

Airbus France grid →

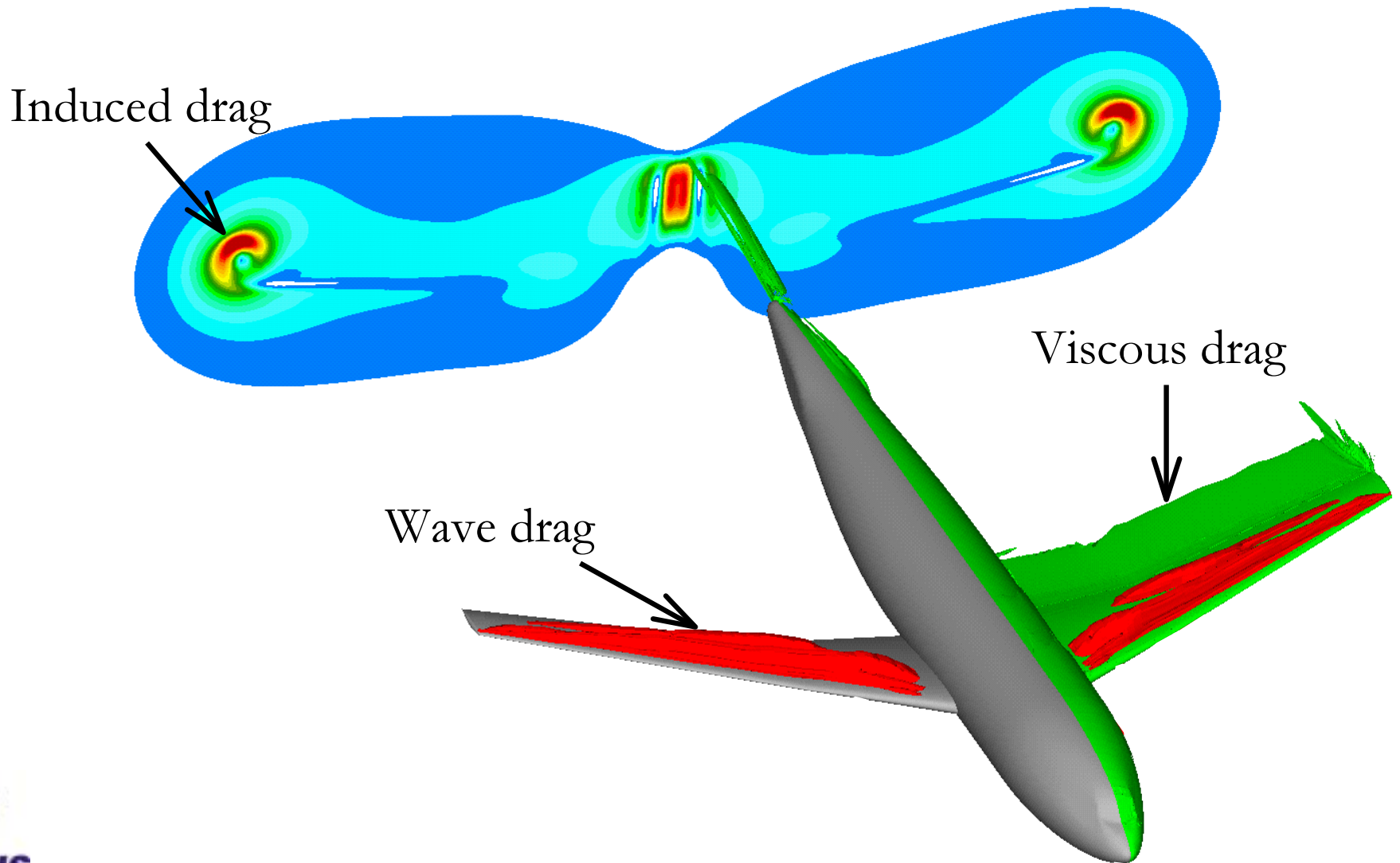


9-10 June 2001

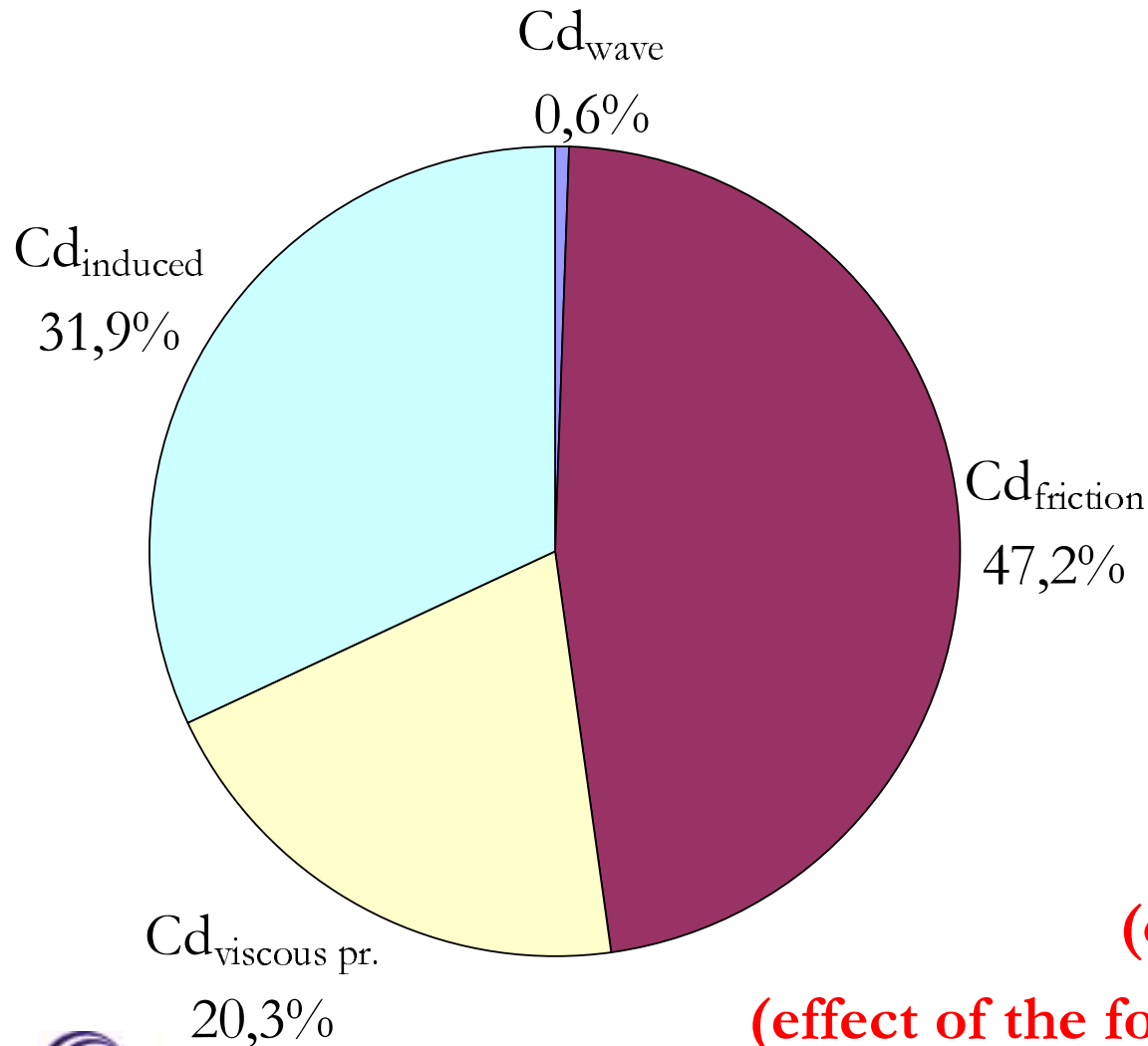
AIAA CFD Drag Prediction

Drag breakdown : illustration of the far-field method

DLR-F4 : spatial localization of the sources of drag (NSMB calculation on EADS Airbus grid)



Drag breakdown : numerical results



✈ Near-field method :

– $Cd_{friction} = 141,1 \cdot 10^{-4}$

– $Cd_{pressure} = 164,9 \cdot 10^{-4}$

$\Rightarrow Cd_{total} = 306,1 \cdot 10^{-4}$

✈ Far-field method :

– $Cd_{wave} = 1,8 \cdot 10^{-4}$

– $Cd_{viscous\ pr.} = 60,6 \cdot 10^{-4}$

– $Cd_{induced} = 95,3 \cdot 10^{-4}$

– $Cd_{friction} = 141,1 \cdot 10^{-4}$

$\Rightarrow Cd_{total} = 298,7 \cdot 10^{-4}$

(closer to the experiment)

(effect of the forced transition $\approx -10 \cdot 10^{-4}$

$\Rightarrow Cd_{total} \approx 288 \cdot 10^{-4}$)