

ONERA



2nd Drag Prediction Workshop meeting

Orlando (Florida), 21st - 22nd June 2003

F6 model tests in the ONERA S2MA wind-tunnel

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Outline

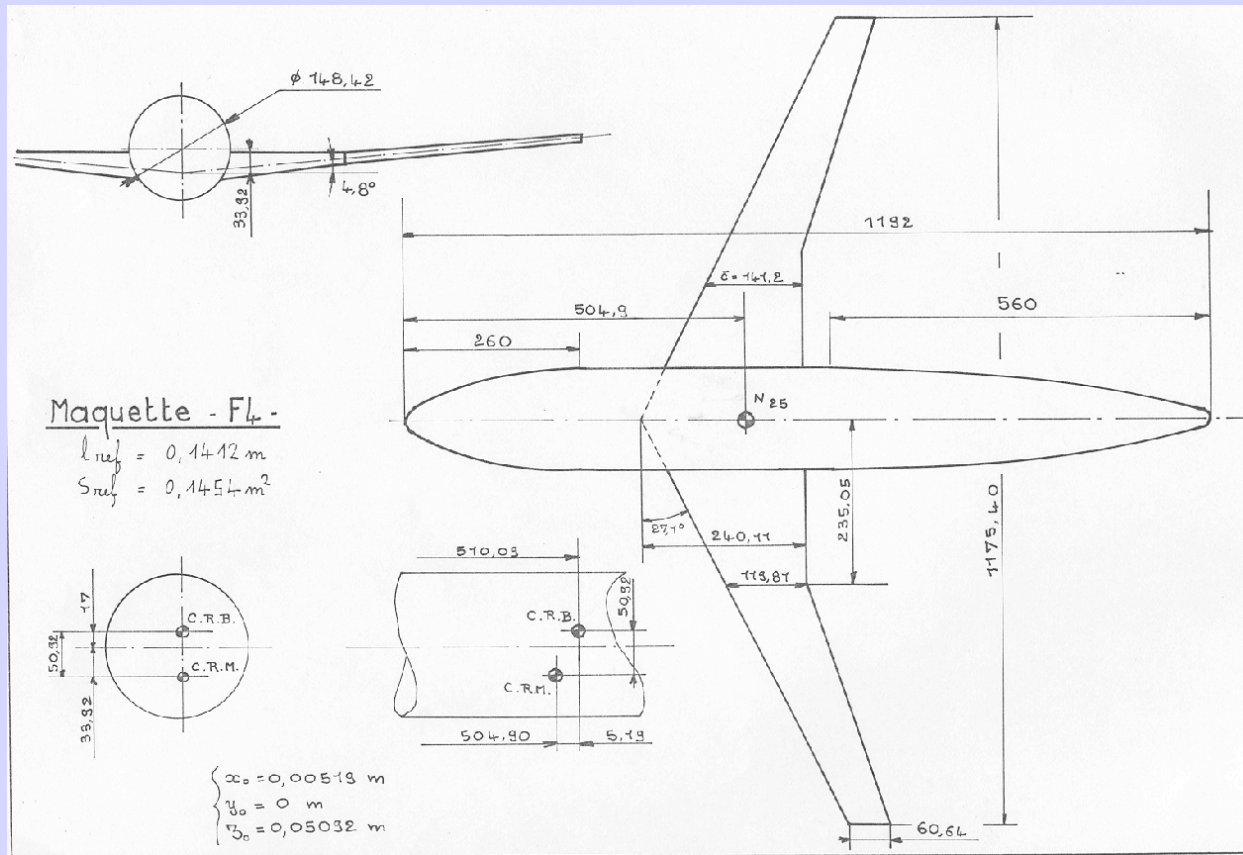
- **F6 model characteristics and instrumentation**
- **S2MA wind-tunnel and test set-up**
- **Data processing**
- **Test program and results**
- **Conclusions**

F6 model characteristics and instrumentation

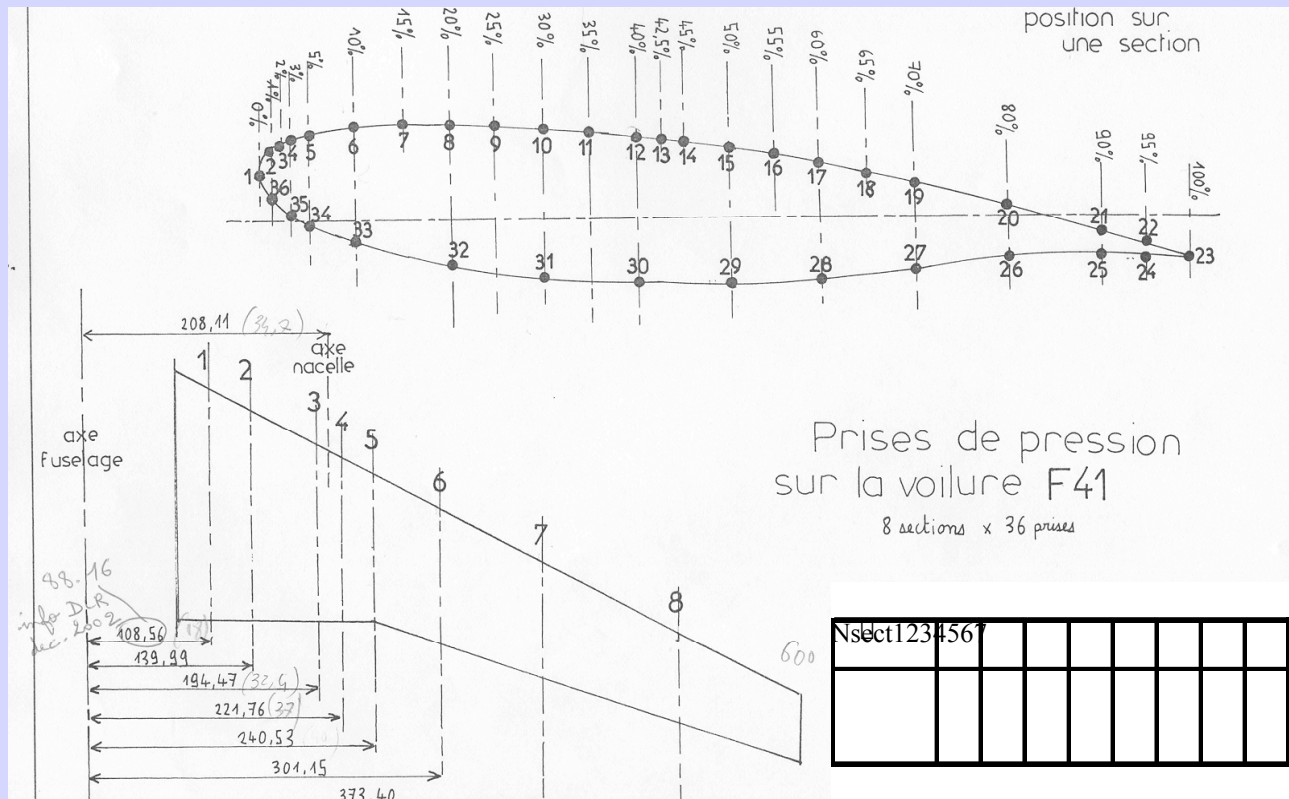
DPW 21st-22nd June 2003 fig3



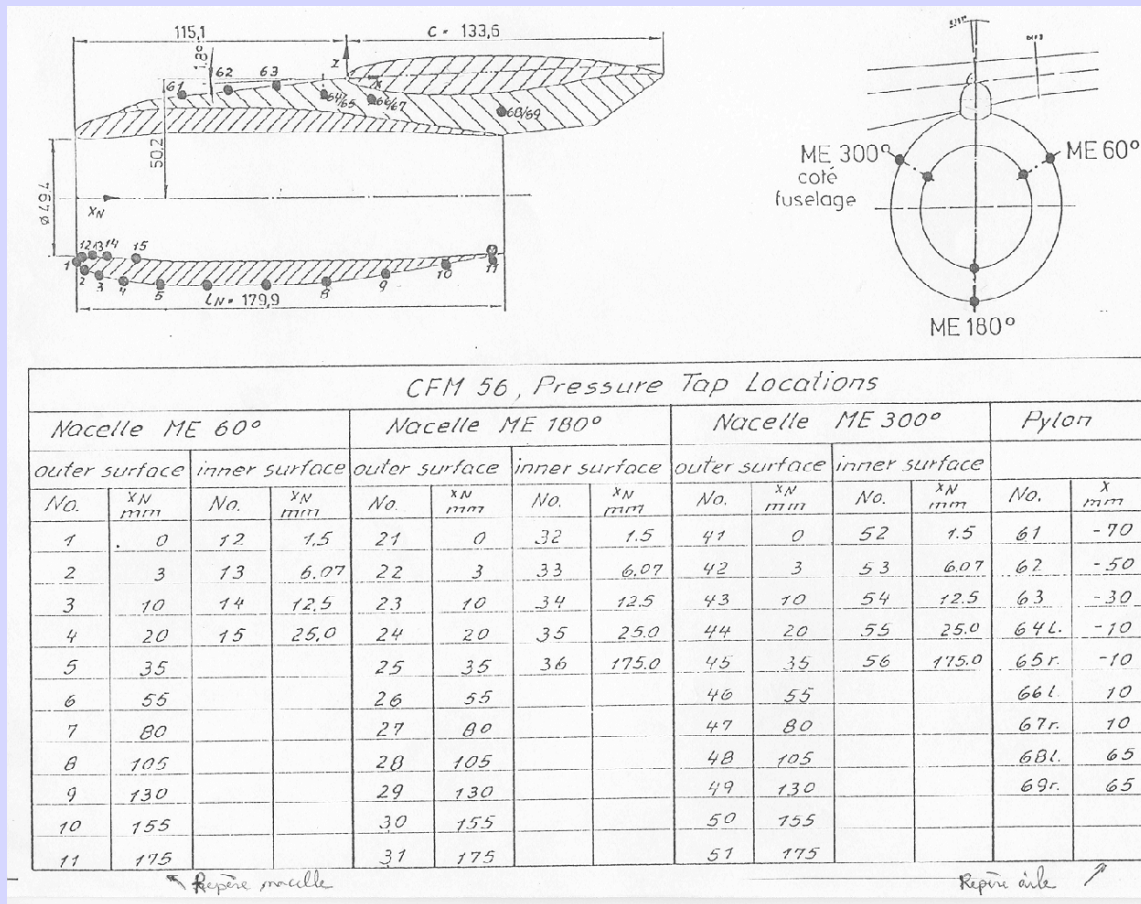
Geometrical characteristics of the DLR-F6 model



Equipment in static pressure taps on the wing



Geometry and instrumentation of the engine installation



S2MA wind-tunnel and test set-up

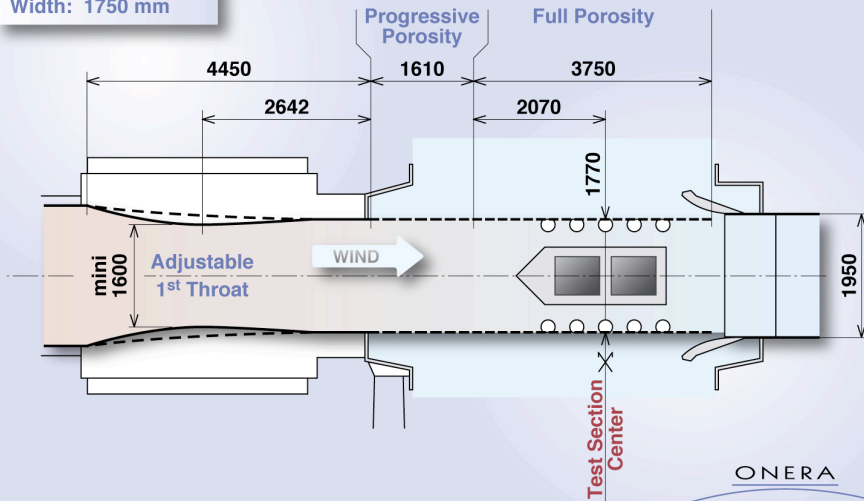
DPW 21st-22nd June 2003 fig7



ONERA S2MA wind-tunnel characteristics

S2 Modane - By-pass Mach number control Transonic nozzle

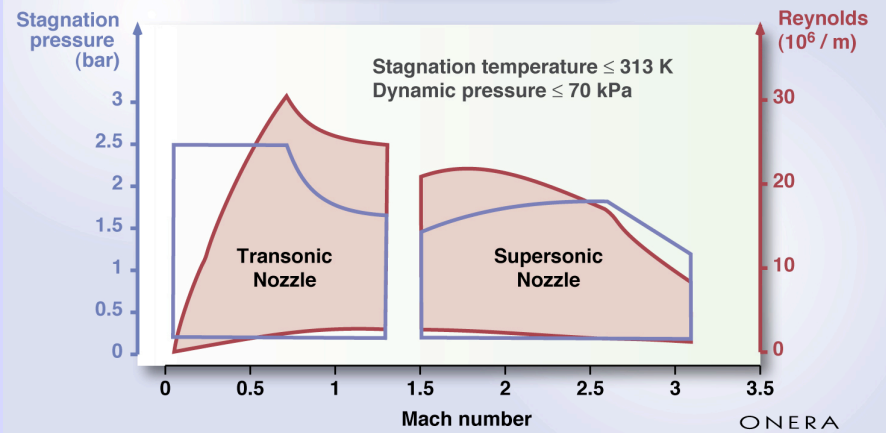
Rectangular section
Height: 1770 mm
Width: 1750 mm



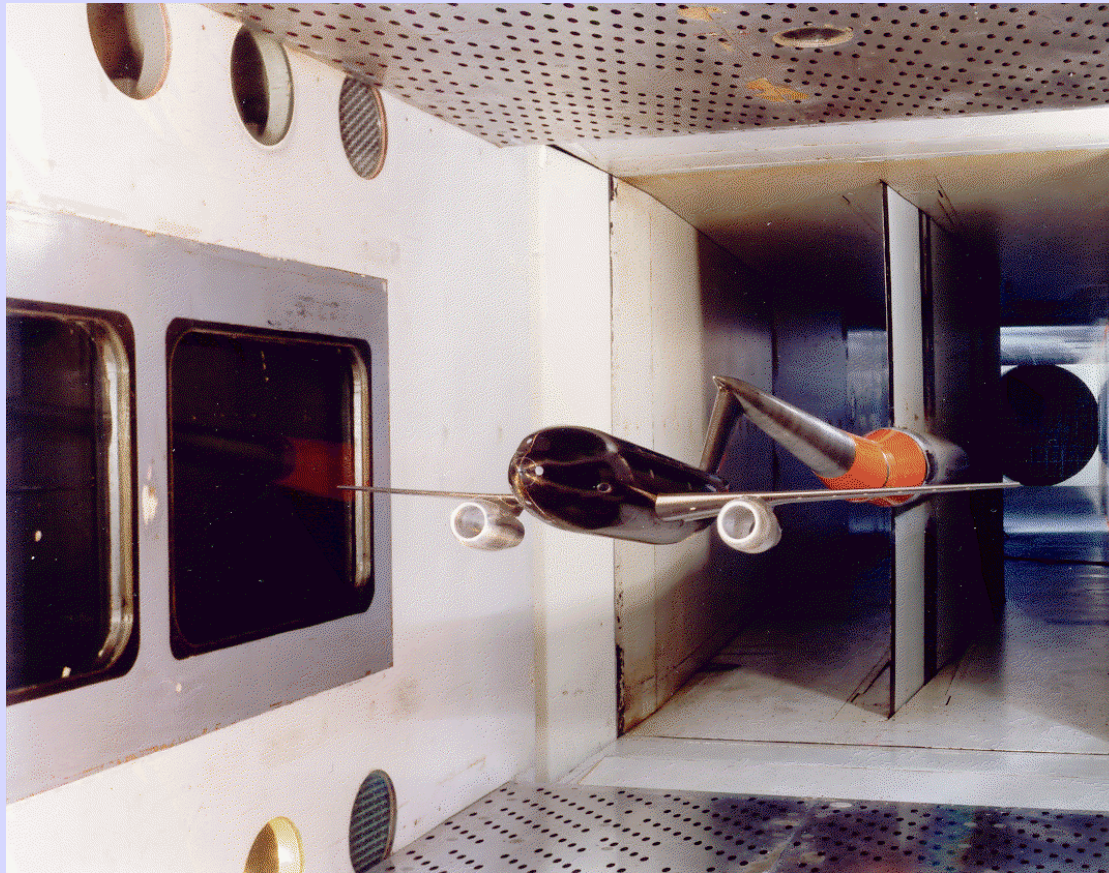
S2 Modane - By-pass Mach number control

Test range: Mach number - Pressure - Reynolds number

Stagnation pressure = $f(\text{Mach})$
Reynolds per meter = $f(\text{Mach})$



DLR F6 model in the ONERA S2MA wind-tunnel



Data processing

DPW 21st-22nd June 2003 fig10



Corrections on total forces

(fuselage-wing-nacelle or fuselage-wing configurations)

Corrections due to non-homogeneous flow in the test section:

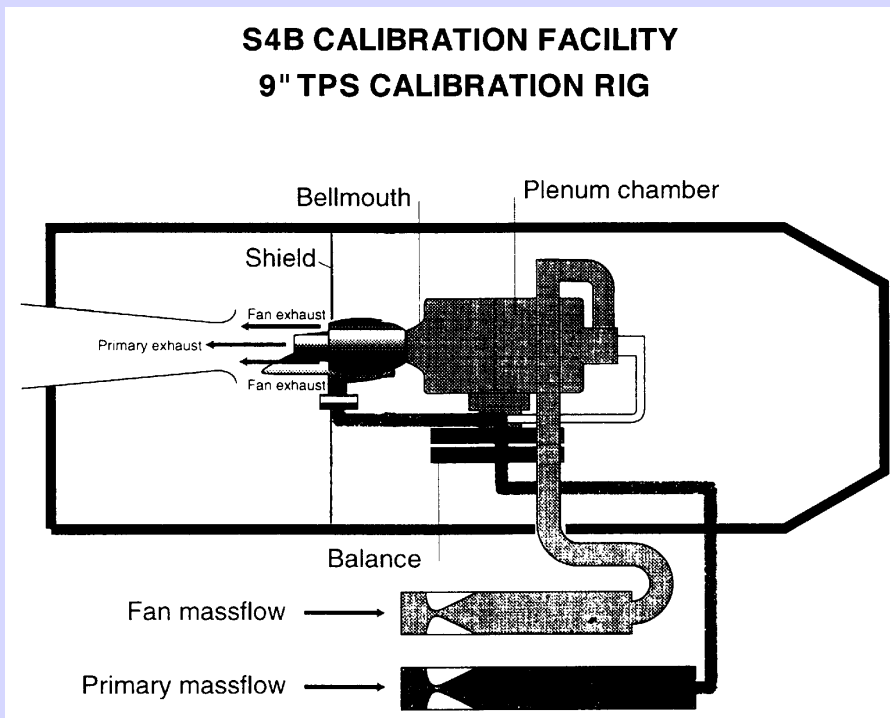
- Free-stream Mach number from wall (measurement point) to wind-tunnel axis: for $M= 0.75$, $\Delta M= -0.002$
- Buoyancy correction: for $M= 0.75$, $\Delta C_A= +6.1 \cdot 10^{-4}$
- Wind tunnel upwash: for $M= 0.75$, $\Delta \alpha= +0.038^\circ$

Corrections from wind-tunnel walls and model support:

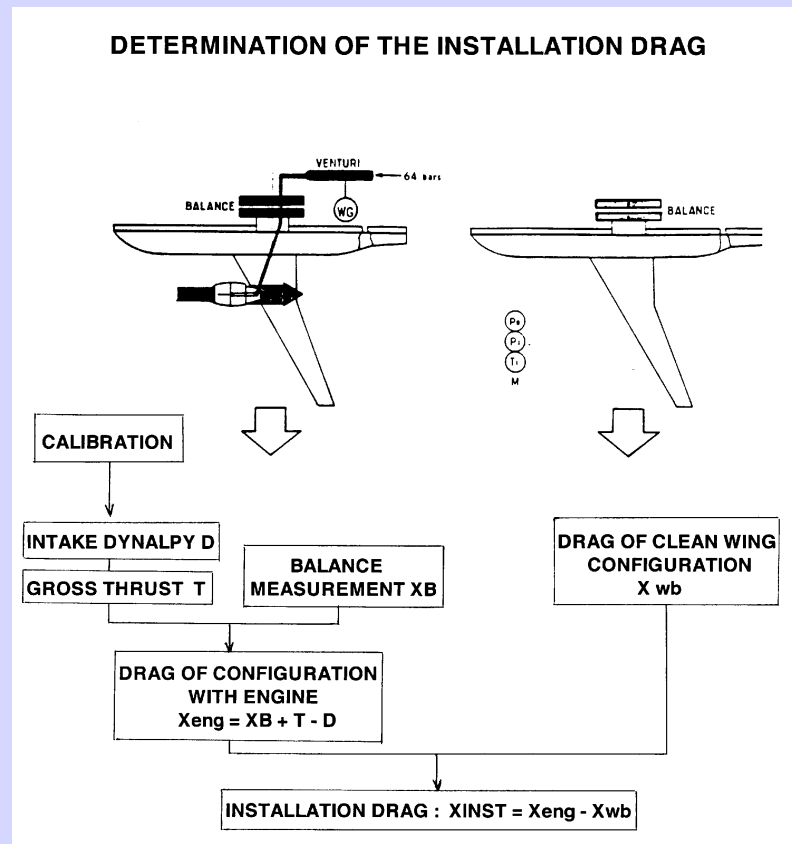
- for $M= 0.75$, $C_Z= 0.50$, $\alpha= 1.0^\circ$
- > $\Delta M= -0.0005$, $\Delta \alpha= +0.023^\circ$, $\Delta C_A= +5.8 \cdot 10^{-4}$

Installation drag assessment

S4B test bench for nacelle calibration



Drag balance



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S2MA test programme and results

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Summary of the S2MA test program

Configurations investigated:

- Wing-Body-Pylons-Nacelles (WBPN)
- Wing-Body (WB)

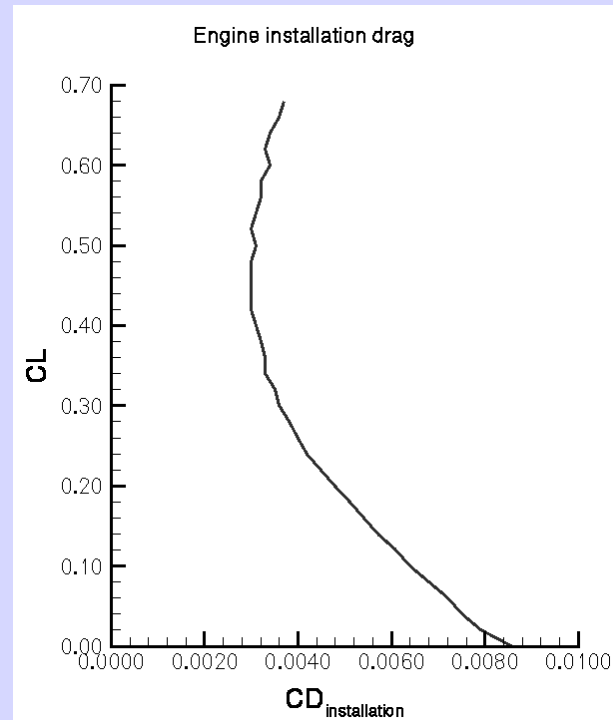
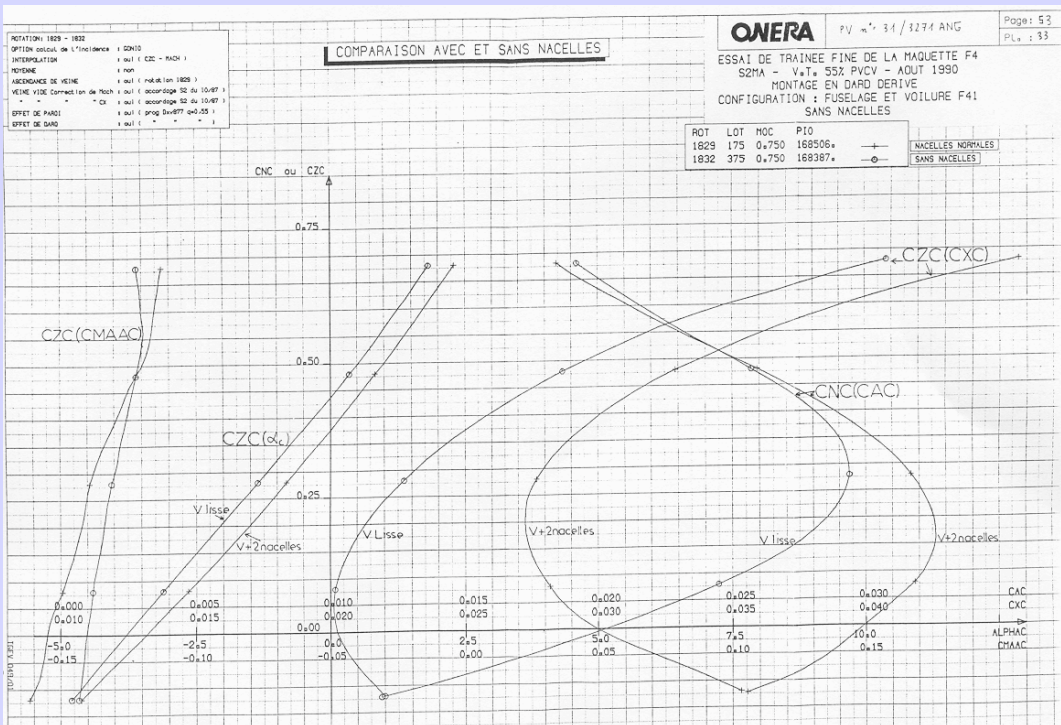
Aerodynamic conditions:

- Mach number 0.60 to 0.85
 - Lift coefficients 0.00 to 0.60
 - Reynolds number $Rec\ 3 \cdot 10^6$
- (cruise conditions: Mach number 0.75, CL 0.50)

Measurement techniques:

- Total forces through a 6 component balance
- Static pressures on the model

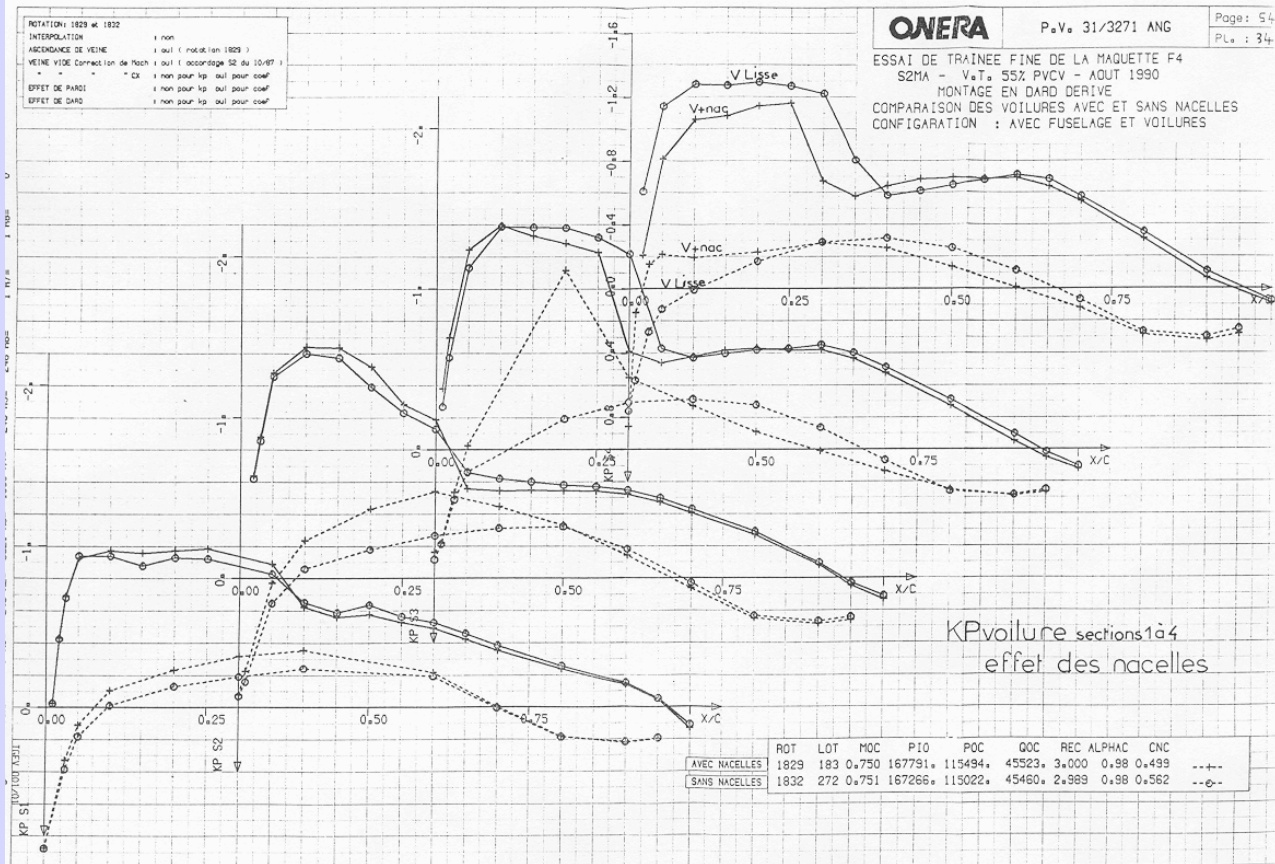
Influence of nacelles installation on total force measurements



DPW 21st-22nd June 2003 fig 16



Influence of nacelles installation on wing pressure distributions internal wing



DPW 21st-22nd June 2003 fig17

Conclusions

- **Performance tests were executed on the DLR-F6 model in the ONERA-S2MA wind-tunnel for the investigation of engine installation effects**
- **High quality drag measurements were done for this type of test, with in particular a good reproducibility**
- **The engine installation effects on total forces and static pressure distributions were clearly identified**