

## Wind tunnel AVERT model

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### Abstract

The AVERT project aims to assess the oscillatory blowing on the flap for a high-lift configuration (wing with flap), and involves both experimental (low speed wind tunnel INCAS) and numerical activities.

At low speed the active flow control may lead to a reduction or elimination of the flow separation on the high-lift devices, such as flaps, and involves the introduction or re distribution of momentum within the boundary layer.

High-lift systems utilized as particular profiles at a certain offset of the main wing may solve the disagreement between the requirements of cruise flight and landing, especially for low velocity take-off.

### Wind tunnel model

The flow control experiments were conducted on the 2- element configuration. The limits for the flap deflection angle and the flap gap are relevant parameters. Another factor of great importance for the actuation is the available space in the flap. The smaller is the flap the more restricted is the actuation system. The UE partner has requested a 600 mm model chord length which leads to approximate 170 mm flap chord.

Flap	Minimum	Maximum
Angle $\delta_f$ [°]	29	49
Gap $g_F/c$ [°]	0	2,6

Table 1 Flap model constrains

For the cruise configuration the model is described by 147 points, while the 3-element reference configuration contains 76 points for the flap and 141 coordinates for the main wing (75 for the slat-not manufactured, respectively).

The flap actuation system includes the compressed air supply, 19 switching valves with their wires and tubes and 19 actuator chambers together with their tubes connections.

183 pressure holes with their end tubing in three sections and 56 pressure holes with their end tubing in two sections, respectively, were installed on the main wing and on the flap.

The static pressure tubes were connected within the main wing to two electro-mechanical scanivalve pressure measurement systems and for the flap to two electronic scanivalve pressure measurement systems mounted outside the wind tunnel.

Pressure distributions on both main wing and flap top and bottom surfaces in the chordwise direction were recorded for these airfoils. Also, the span wise pressure distribution on both the airfoil surfaces at the sections  $Y_1=602.5$  mm and  $Y_2=867.5$  mm,  $Y_2=901$  mm for the flap, respectively, and  $Y_1=132.5$  mm,  $Y_2=397.5$  mm and  $Y_3=651.5$  mm for the main wing, was recorded.

The span of the AVERT wing with flap is of 2000 mm. End plates of 1200 mm diameter were mounted on the main wing.

The configuration is shown bellow.

The experiments were made with flap at  $40.011^\circ$ ,  $45.011^\circ$  and  $49.064^\circ$ , and gaps and overlaps for every angle at values in accordance with the table 2.

Tapes for transition fixing at different locations were stuck on the main wing and flap.

Angle $\delta_f$ [°]	40.011	45.011	49.064
Gap $g_F$ [mm]	5.0	15.92	6.45
Overlap ovl [mm]	13.88	3.303	13.88

Table 2 Flap positions during testing

The tests consist of:

- system testing without actuation ( $\alpha$  from 0 to 5 degrees);
- testing without actuation, data acquisition, without transition fixing ( $\alpha$  from -5 to 10 and back to 0 degrees);
- testing without actuation, data acquisition, with transition fixing for main wing at 0% and unroted flap at 0% (tapes of 0.5, 1, 2 and 3 mm width, with 0.05 mm height);
- visualization of the end plates impact on the airfoil flow (tufts, oil flow visualization) ( $\alpha = 0/5$  and 8 degrees – start the WT at  $\alpha=0^\circ$  with the model painted, increase the AOA up to  $8^\circ$  and then stop for the oil flow pictures);
- test of the system, with actuation  $f = 150$  Hz; DC = 50%;
- testing with actuation  $f = 100, 150, 200, 250, 300$  Hz, DC = 50% with oil flow pictures and tufts visualization; conduct pressure increase up to 8 bar for the selected frequencies (e.g.  $F = 100$  Hz).

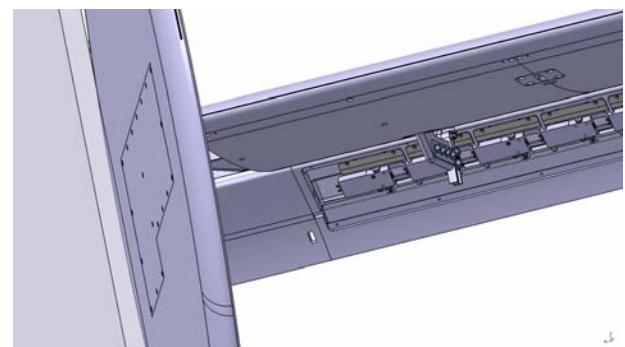


Fig 1 AVERT wing assembly

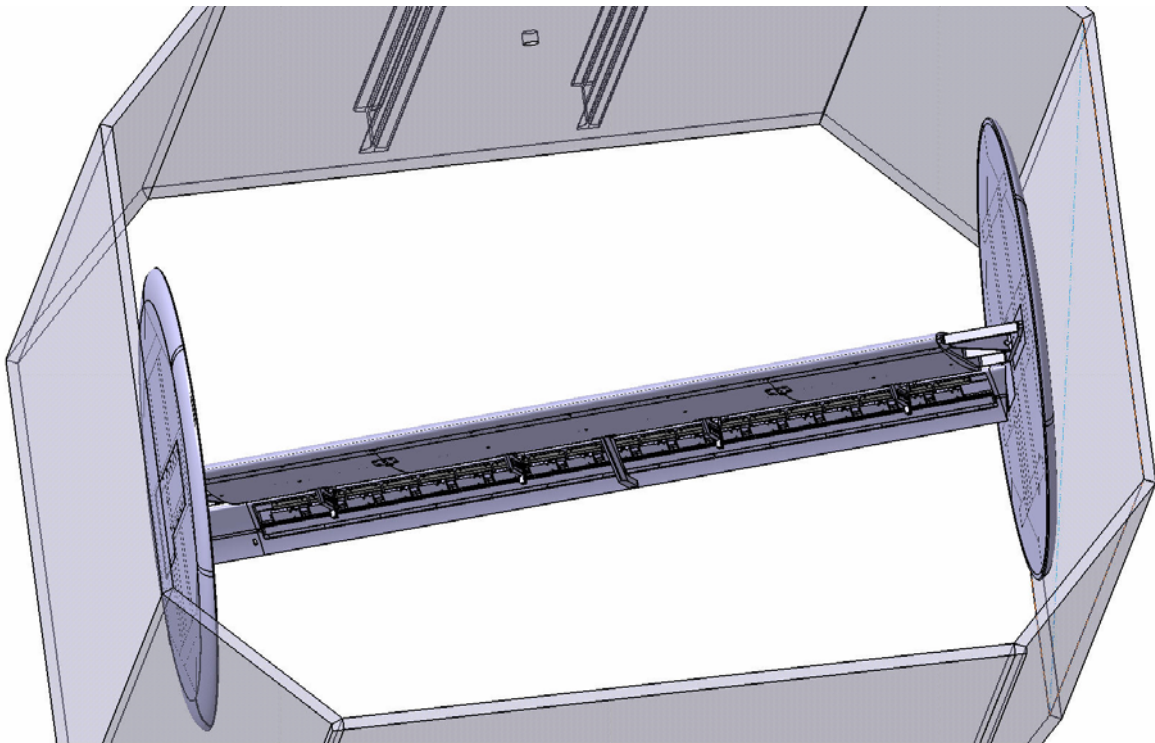


Fig. 2 AVERT wing assembly - without lower surface lid flap

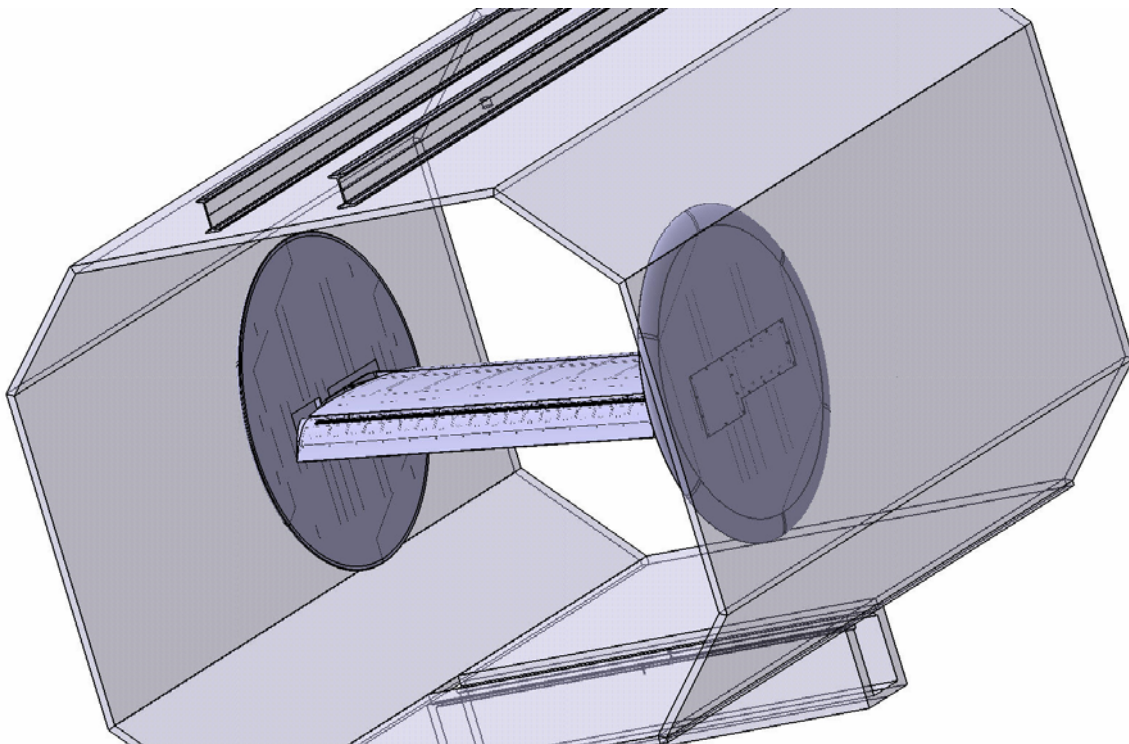


Fig. 3 AVERT wing assembly