Abstracts of the International Conference
ACOUSTIC CLIMATE INSIDE AND OUTSIDE BUILDINGS
held in conjunction with the workshop

"Aircraft Noise Reduction by Flow Control and Active / Adaptive Techniques"

23–26 September, 2014, Vilnius, Lithuania

eISBN 978-609-457-704-8
Abstract Number: *acoustic.18*

http://www.acoustic.vgtu.lt/

STAR: AN EFFICIENT MICRO-JET SIMULATOR FOR ACTIVE CONTROL IN CEPRA19. SOME APPLICATIONS

Denis Gely[1], **Olivier Piccin**[2]

Onera, 29 av. Division Leclerc, 92320 Chatillon

E-mail: [1]*Denis.gely@onera.fr,* [2]*Olivier.piccin@onera.fr*

Abstract. The need to evaluate news methods of jet noise reduction, amongst them shear layers active control with continuous or pulsed microjet concepts led the Onera Wind Tunnel Division to develop in the large anechoic facility CEPRA19 the necessary hardware to enable such concepts to be brought into operation.

This system enables microjet concepts to be tested on a large scale (typically 1:10) nozzle model on which most kind of nozzle operating points can be generated with external flow simulation. With such an efficient system called STAR, the evaluation of the efficiency of microjets to mitigate jet noise becomes very useful at large scale to increase the TRL. The nozzle can be tested either isolated or in so-called installed configuration. In this case, a typical underwing engine mounting can be rigged, featuring the wing itself and a pylon. The design of the STAR started in 2009, in the frame of the French research programme REBECCA. The first test using this took place in 2011, and its last use, this time in its final form, took place in 2013, for the REBECCA test campaign, and also for the OPENAIR one. A test campaign under French-Japanese collaboration has been also carried out.

CEPRA19 (Fig. 1) is an open free jet circuit wind tunnel designed on purpose for acoustic measurements. Its low velocity main jet (V_0 = 130 m/s max.) is pumped through the aerodynamic circuit by a powerful centrifugal turbine driven by a 7 MW electrical motor. The anechoic chamber is a portion of a 9.50 m diameter sphere made of steel concrete, limited by a vertical wall and a horizontal platform. The wind tunnel plenum section is 81 m² (9 x 9 m square section).

The nozzle rig duct is centered on the WT axis, which is also the convergent axis. In a few words, it is a long 400 mm diameter horizontal cylinder attached on top of a streamlined support passing through the convergent bottom side wall. Apart from holding the nozzle model in place, it is able to provide to a given nozzle up to three concentric flows: primary, secondary and tertiary flows.

Originally, this piece of equipment was designed and manufactured by ONERA to feed a microjet nozzle that could be fitted with up to 32 ports on its by-pass nozzle and 32 ports on its core nozzle. The price and the complexity of this design led to get a simpler one, where the core nozzle ports were dropped. However, the single piece nature of this design was kept. Thus the STA-R (Fig. 2) is made of: an outer (by-pass flow) ring; an inner (core flow) ring; 4 streamlined struts joining the two rings. The 32 ports are distributed on the outer ring downstream flange. Each compressed air supply is fitted with a thermocouple and a static pressure port for monitoring purposes. The initial requirements called for:

- 32 microjets installed at the trailing hedge of the bypass nozzle, the massflow being monitored and tuned for each of them up to a maximum of 5 g/s at moderate temperatures (450 K);
- 32 microjet installed at the trailing edge of the core nozzle, divided in 4 blocks of 8, each block massflow being monitored and tuned for each of them up to a maximum of 10 g/s at core flow temperatures (up to 900 K);
- Seeding capacity for velocity optical measurement surveys (PIV, …).

During the design of the nozzle microjet alimentation ring get, for the core microjets alimentation, serious difficulties arose to define the size et shape of ducts and plenums that would ensure an even mass flow repartition, and it was evident in the early stages that machining such ducts would have been extremely difficult (Fig. 3).

These technical difficulties, as well as costs and delays considerations led to drop this capacity: the STA-R would only have a capacity to feed a maximum of 32 by-pass nozzle microjet.

Since the nozzle rig is on the symmetry axis of the convergent and thus within the external flow, severe constraints were put on the design to keep the STA-R and ancillary hardware (compressed air feeding lines, measurement lines, …) within the 400 mm dia. nozzle rig external envelope. A dedicated fairing with a trapezoidal cross section was fitted and blended to the 400 mm dia. external envelope and the nozzle rig supporting strut trailing edge was extended to give room for the 32 flexible ducts feeding the corresponding microjets. A strong requirement in CEPRA19 is to get the nozzle reference point 2 m downstream from the facility 2 m dia. convergent exhaust plane. A totally new interface was designed for this including a thermal expansion ring.

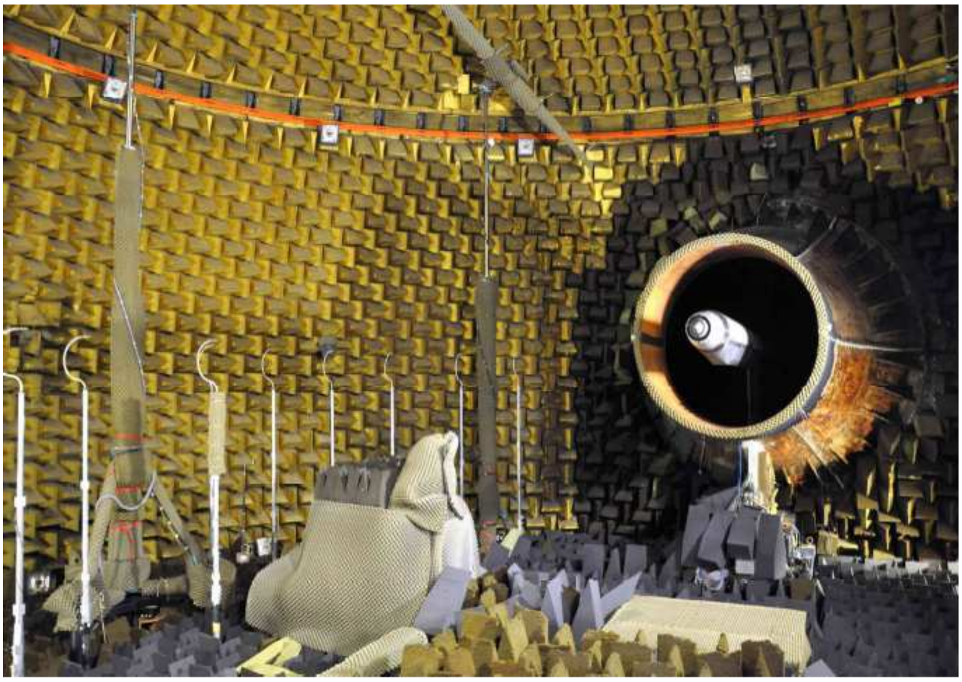

Fig. 1. CEPRA19 anechoic chamber – 2m dia. Convergent

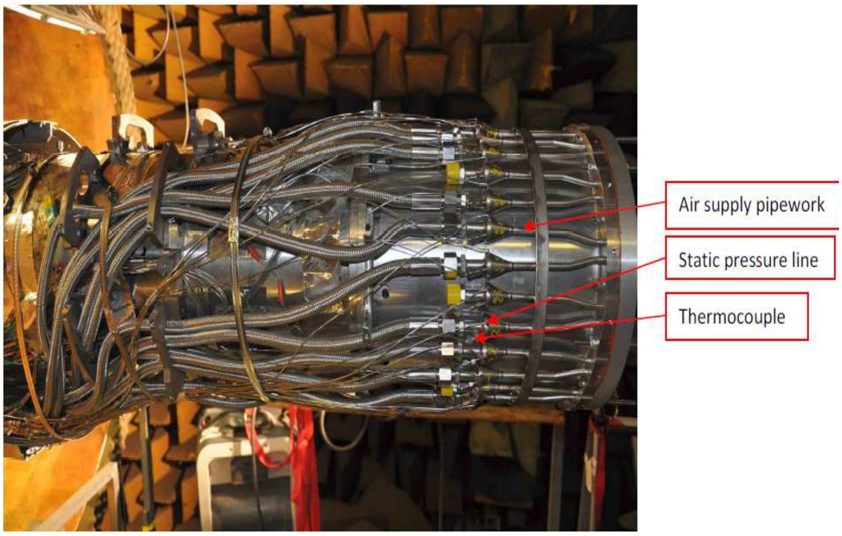

Fig. 2. STA-R attached to instrumentation rings, fitted with compressed air supply pipe work and relevant thermocouples & static pressure

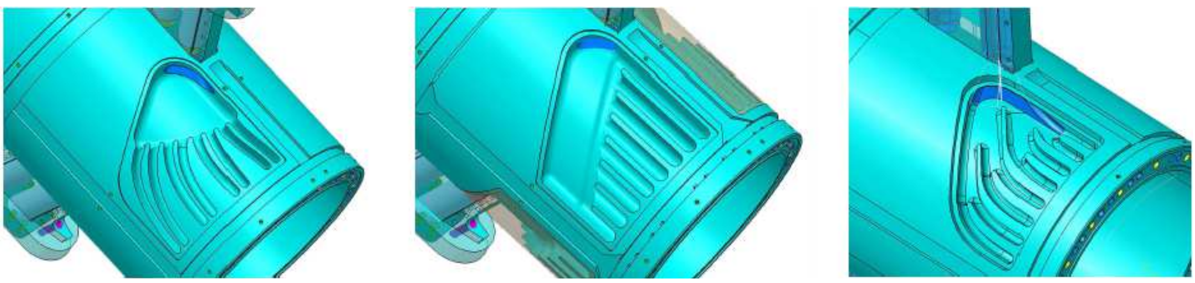

Fig. 3. STA-R design: core microjet flow feeding: various shapes studied

After the presentation of the validation test of the STAR, the authors present the main aeroacoustic results obtained during the last recent test campaigns with different configurations of nozzles and several test conditions aiming at jet noise reduction with flight conditions.

Keywords: microjet, jet noise reduction, large anechoic facility.