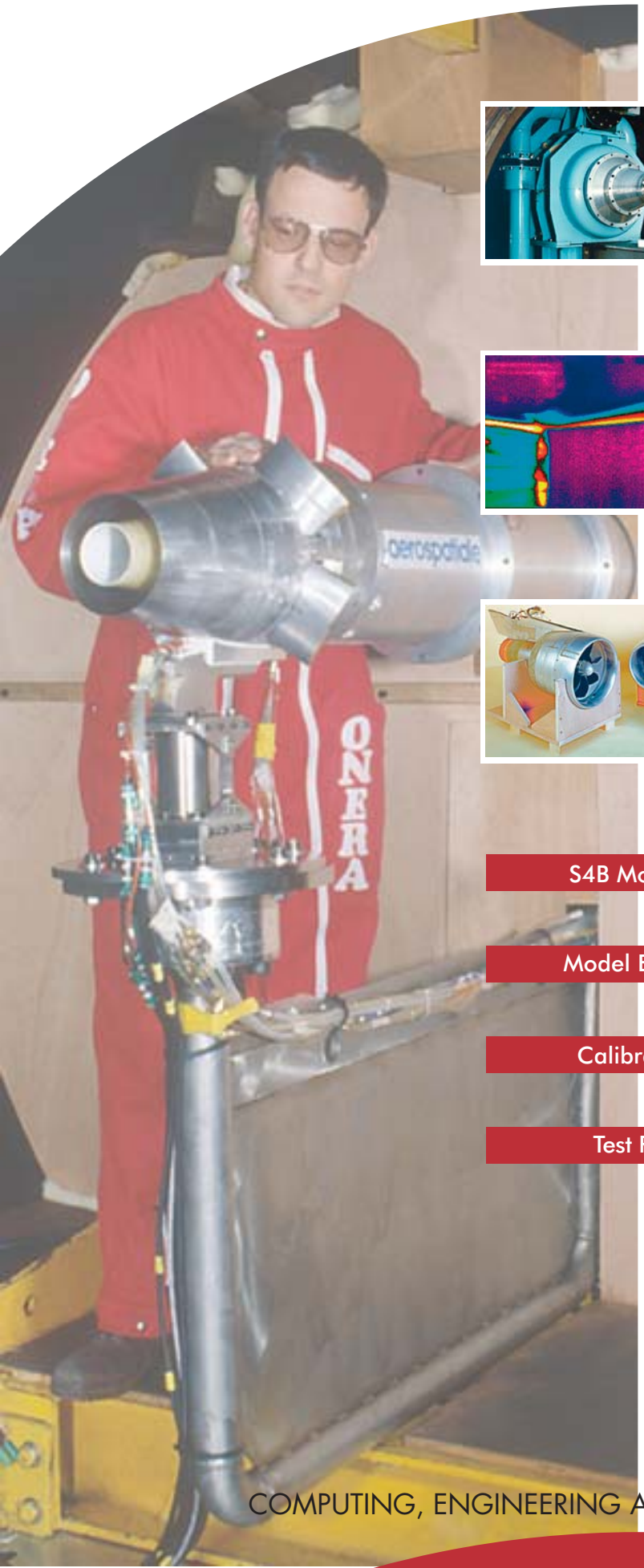
ONERA



S4B Modane

Model Engine

Calibration

Test Rigs

COMPUTING, ENGINEERING AND TESTING FACILITIES (GMT)

TPS and nozzle mass flow and thrust measurements

Vacuum chamber allowing model engine calibration, without external flow, at wind tunnel test conditions.

Test in S4B facility (M840122)

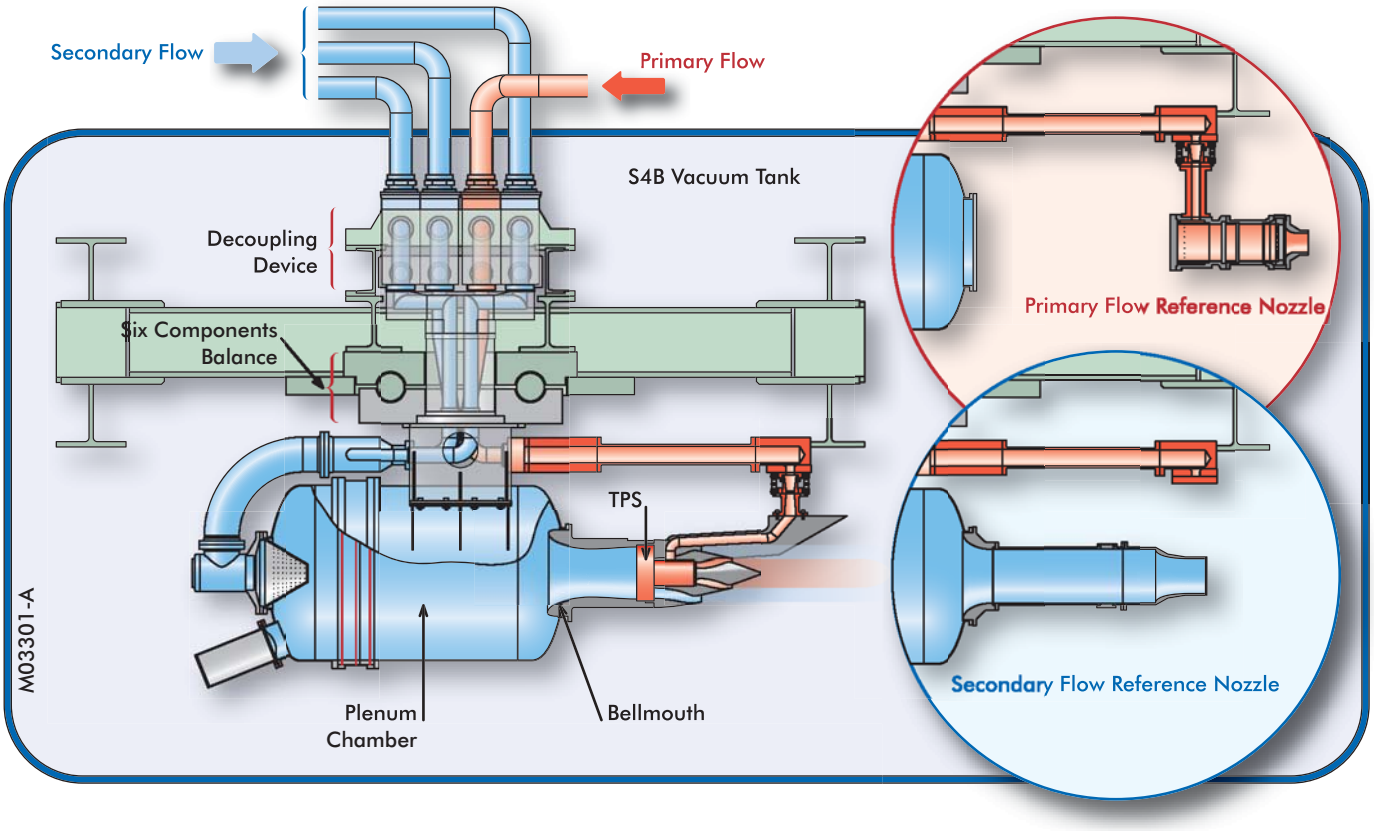
S4B vacuum tank

- Cylindrical sealed vessel, diameter 2.5 m, length 15 m.
- Fed by compressed air:
  - two pressure levels, 9 bar and 64 bar;
  - dry and clean air (12 µm mesh filtering, less than 5 mg of water per kg of dry air) with temperature controlled;
  - air storage: 9,500 m^3 at 9 bar and 109 m^3 at 270 bar.
- Vacuum connection:
  - internal absolute pressure level from 15 mbar to atmosphere;
  - connection pipes (diameter up to 1,200 mm) toward vacuum tanks with adaptable volume between 1,000 and 8,000 m^3;
  - possible vacuum setting by ejector effect (Bertin ejector or using the tested nozzle itself).

TPS calibration test rigs

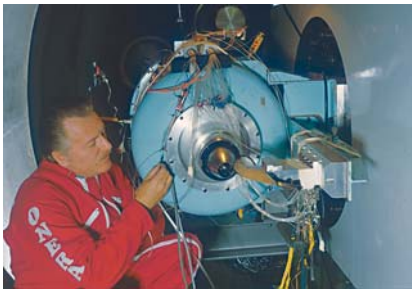
Mounting

- Test rigs for nozzle calibration or Turbine Power Simulator (TPS) calibration are mounted inside the S4B vacuum vessel.
- Two TPS test rigs are usable for the 100 mm to 254 mm diameter turbofan simulator range.
- The model engine is fitted on a bellmouth to the plenum chamber (see figure below).



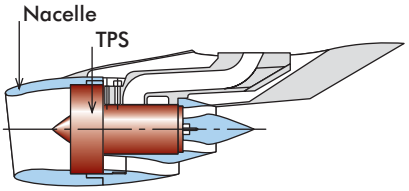
The test techniques

Characteristics of the two rigs					
Rig (nominal ø)	Mass Flow (kg/s)		Température (°C)		Thrust (N)
	Primary Jet	Fan Jet	Primary Jet	Fan Jet	
4"	< 1.6	< 2.8	< 60	< 30	< 3,300
9"	< 4	< 10	< 80	< 30	< 5,000



The 4" test rig (M880018)

- Mass flow control and temperature control of the two jets.
- Separate control of the pressure upstream of the fan, of the model engine RPM and of the nozzle exit pressure.
- Fan speed pressure < S4B vessel pressure + 1,5 bar.
- Test rigs checking using reference nozzles.
- Jet thrust vector measurement (module and angularity).



Nacelle-TPS mounting sketch (M980107)

The measurements

- Data acquisition system with 64 analog channels: steady measurement rate up to 25 Hz per channel with a 14 bits + sign A/D converter.
- Unsteady measurements: rate up to 20 kHz per channel.
- Pressure measurement by individual transducers or by PSI® electro pressure scanner.
- Temperature measurement by thermocouples, by PT100 probes or infrared thermography.
- Force measurement by ONERA six components balances (decoupling device for air flow crossing through).
- Sonic throat mass flowmeters for the primary and fan jets.
- On line data processing and data display on the spot in the facility (screens, editions, graphs, CD-Rom, DVD).
- Accuracy:
  the uncertainties in the 4" test rig with the Ø 100 mm reference nozzle are (from 41 test campaigns between 1987 and 2003),
  - flow coefficient: ± 0,1 % in 86 % of the test cases,
  - thrust coefficient: ± 0,15 % in 81 % of the test cases.
- Laser velocimetry on request.
- Data transfer to the customer computers by intranet, internet, ISDN...

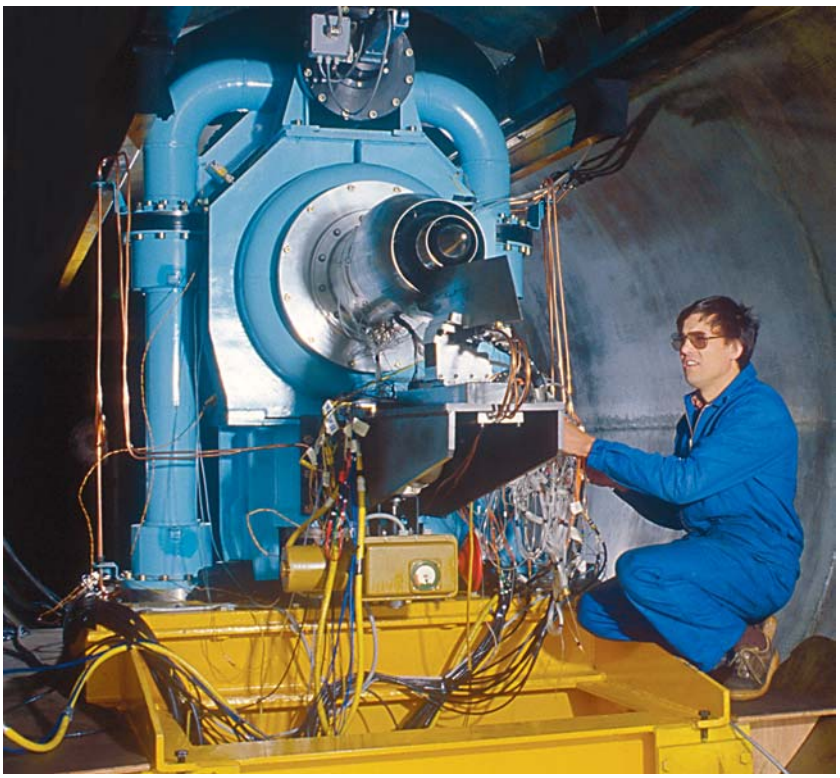
Engine models with Turbine Powered Simulators (M920291)

The typical tests

- Nozzle thrust tests with altitude simulation.
- Direct or reverse jet model engine calibration, with simulation of the wind tunnel test conditions.
- Through Flow Nacelles calibrations.
- Thrust reversers calibrations and jet angularities.

The assistance

- Assistance by ONERA specialists may be provided for aerodynamics, model design and manufacture, acoustics, unsteady system measurement, optics, etc.
- On the spot assistance (mechanical design office, workshop, instrument and balance lab., model dimensions measuring shop, computer).



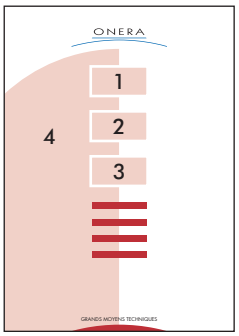
TPS sur le banc 9" dans le caisson S4B (M840120).

Warranted absolute confidentiality

Numerous test runs for foreign customers.

Quality management

The Quality System concerning the engineering of test facilities and the design and performance of tests is certified to NF EN ISO 9001-V2000 by BVQI.



First page pictures

1 - Reference nozzle (M920422).
2 - Infrared flow visualization on the rear part of a mast.
3 - Engine models with Turbine Powered Simulators (M980058).
4 - Reverse jet calibration, 7" TPS (M902358).

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