



**Wind Tunnel Division**

# S1MA

## Large Transonic Atmospheric Wind Tunnel

**Modane Avrieux Center**

**Unmatched combination of large model size and wind speed  
Excellent drag measuring capabilities in transonic cruise  
High levels of customer service**

**ONERA**  
THE FRENCH AEROSPACE LAB

# S1MA wind tunnel operation

Mach Number range: 0.05 to 1.

Reynolds number per metre: 11.8 million.

Fans driven by water power (up to 88 MW on fan shaft).

## Characteristics of the Different Test Sections

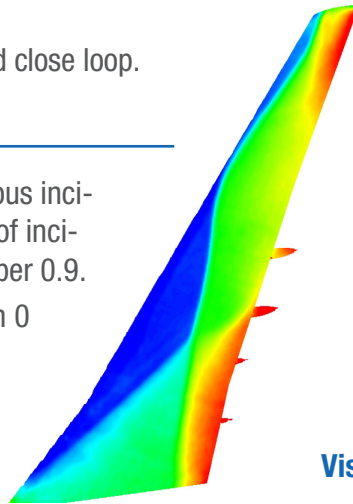
| Test sections Ø 8 m       | Cart 1  | Cart 2   | Cart 3  |
|---------------------------|---|--|---|
| X - Sectional Area:       | 44.8 m <sup>2</sup>   | 45 m <sup>2</sup>  | 45.4 / 47 m <sup>2</sup>  |
| Typical Tests:            | Half model testing.<br>Powered models (TPS and propellers).<br>Laminar flow testing on large scale wing/nacelle models. | Full models on sting line (straight, fin, Z-stings).<br>Powered models (TPS and propellers). | Open Rotor Fan testing.<br>Captive Trajectory testing with full model.<br>Aeroacoustics.<br>Helicopter rotor testing. |
| Typical Large Model Span: | 2.5 to 5 m half model   | 3 to 4 m for full model  | 3 to 4 m for full model   |

### High productivity

- Individual preparation rooms for model assembly.
- Three independent model carts.
- Acquisition rate : 15 to 30 polars per hour.
- Stable Mach number continuously adjustable from 0.05 to 0.97.
- Efficient Mach number control in tuned close loop.

### Performance

- Mach Number stability during continuous incidence polars with continuous change of incidence angle: ±0.001 up to Mach number 0.9.
- Compressed air for model supply: from 0 to 17.5kg/s up to 85°C and 200 bar.
- Low turbulence levels for laminar flow testing with solid test section walls.



### Acoustics

- High resolution data acquisition system dedicated to acoustic measurement (SYNAPS): 204 synchronized channels, 262kHz sampling rates, 24-bit resolution.
- High speed with no acoustic liner:
  - Far Field measurement through beam forming;
  - Near Field measurement with probe equipped with flush or wiremesh mounted microphones.
- Low speed with acoustic liner (up to Mach 0.32):
  - Far Field measurement with 4 lines of 18 microphones along wind axis for directivity measurement.
  - Near Field measurement with acoustic probe equipped with flush or wiremesh mounted microphones.

### Measurement Techniques

#### IR

- Visualisation of the transition of the boundary layer on wings with infra-red cameras; efficiency control of triggering devices for boundary layer transition.

#### PSP

- Measurement of the pressure field on the wings and moving surfaces (accuracy in Cp : ±0.025). Measurement of control surface local loads by pressure integrating methods.

#### MDM

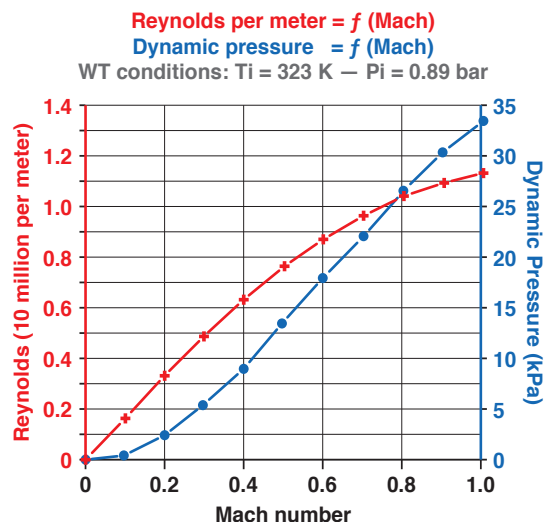
- Model Deformation Measurement (in bending and twist) on all kind of wings including control surfaces; accuracy: ±0.05° for twist, ±0.3 mm for bending.

#### Visualisations

- Acenaphten, coloured oil techniques, Back Ground Oriented Schlieren techniques, fast video (4000 frames per second).

#### PIV

- Being introduced.



## Typical tests

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- Large-scale full model: simultaneous measurement of aerodynamic loads, pressure and control surface hinge moments. Powered models with TPS or propeller.
- Half model. Installation effect tests on half models with TPS or propeller.
- Nacelle/pylon/wing interference testing with TFN, TPS, or propeller.
- Propeller test (isolated & installed propellers).

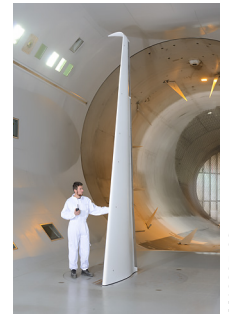
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- Laminar flow testing of large models.
- Captive Trajectory System for store release certification at 1/5<sup>th</sup> model scale.
- Isolated rotor test (helicopter or tilt rotor). Counter-Rotating Open Rotors (CROR) testing (isolated or installed).
- Air intake testing (steady & unsteady measurements).
- Full scale missile testing with real engine firing possibilities.



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## Model supports

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- Sting holder (tripod with straight/fin/Z-sting line):
  - angle of attack range =  $45^\circ$
  - yaw range =  $\pm 10^\circ$
  - roll angle range =  $180^\circ$

- Floor mast for special test setups.
- Rotor rig:
  - Power: up to 550 kW
  - Tilt capability:  $-95^\circ$  to  $+20^\circ$



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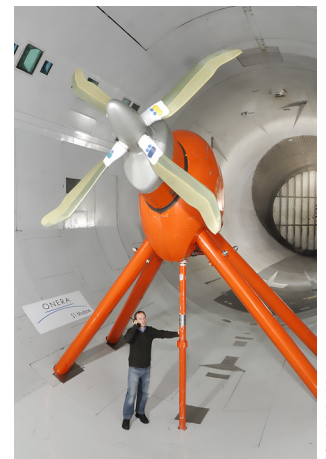


- Floor balances on a turntable for wing or half model testing, with air supply for TPS/propellers.

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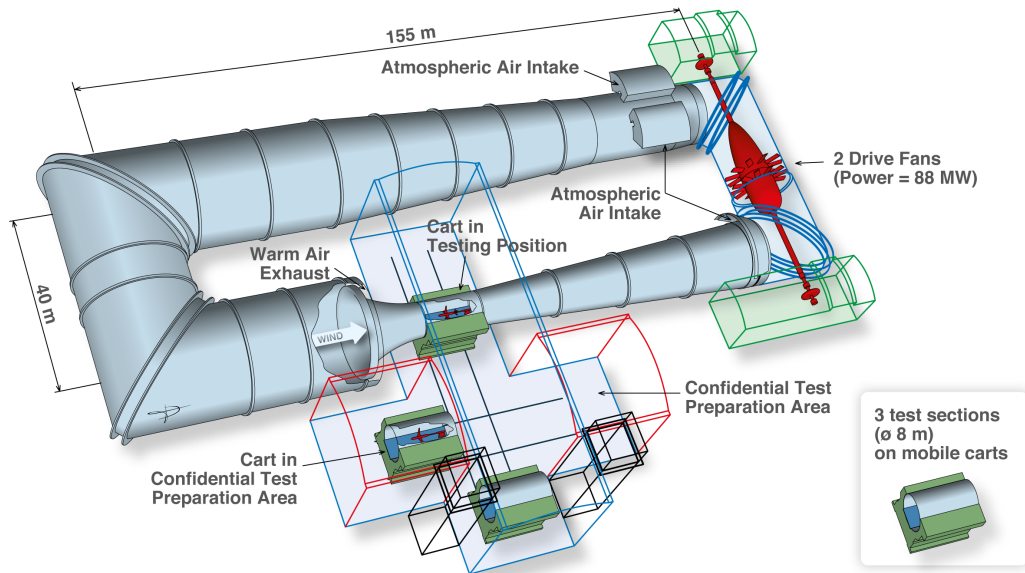


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## Data acquisition and processing

- Static Data Acquisition System with digital filtering for 128 channels, extendable to 256 channels. Accuracy :  $10^{-4}$  of FS, Static bandwidth: 0 to 10Hz.
- Real time corrections for wall and support interferences are applied to the data processing. Sting effects are assessed using CFD RANS calculations.

- Dynamic Data acquisition system with digital filtering for 80 channels, extendable to 256 channels. Sampling up to 100 kHz. Accuracy:  $10^{-3}$  of FS. Dynamic bandwidth: 10Hz to 30kHz.
- Pressure data acquisition system using pressure scanners (PSI® systems), 992 channels, expandable to 1984 channels.



## Quality Management

- Our Quality Management system is certified to be ISO 9001 management.
- High level of customer service.
- The ONERA wind tunnel division is committed to deliver the best service and value for money to its customers. Test matrices can be customised during the test itself, to maximise value to the customer.

## Quality in measurement techniques

- New capabilities are being introduced as part of our continual improvement strategy.

## Confidentiality

- Secure test preparation and testing sites with card access, data & computer firewalls.

## Carbon footprint

- S1MA is a water driven wind tunnel.

## Productivity / Availability

- Individual confidential preparation rooms for model assembly and equipment. Dedicated model carts. Productive testing. High stability in Mach number control.

## Design office & workshop

- In-house model design and manufacture capabilities. Internal balances: 80+ balances available and new ones designed and manufactured on request.

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