

MODEL DEFORMATION MEASUREMENTS (MDM) IN S1MA

MDM objectives on rotating blades

MDM measurements aim at determining the shape of a model as it deforms under aerodynamic loads. From these measurements, the corrected aerodynamic coefficients (drag, lift, pitching moment) can be derived, as compared to a reference shape (“rigid body”). The knowledge of the actual model shape is especially critical for CFD validation, but also for aileron effectiveness for example.

MDM application

The MDM system is an in-house development based on the determination of markers positions through stereoscopic photogrammetry. The markers are glued on the model and observed through two high resolution CCD cameras (4872x3248 pixels). A second system is available for specific measurements (on HTP for example) in parallel to the main system.

MDM measurements are available on both full-span models and half-models, over the entire operating domain of the wind tunnel.

In addition, two high speed cameras Phantom V341 (2560*1600 pixels) are available for phase-locked MDM measurements on rotating blades (BHCR rig for example).

Preparation

There is no specific requirement concerning the model preparation. The markers, provided by Onera, are glued on the model during test preparation phase. Usually, only one wing of the model is equipped with typically about 70 markers.

The setup of the cameras is carried out in parallel with other preparation tasks.

The final system adjustments and calibration requires about 2 hours of dedicated time inside the test section, wind-off, +1 hour per calibration analysis.

Testing

MDM measurements are performed simultaneously with forces and pressure measurements during pitch or yaw sweeps, therefore minimal extra time is required during the test execution: +0.2 hour per major configuration change.

The markers are thin and have no effect on aerodynamic characteristics.

No need for dedicated runs; 1 dedicated person to set-up and operate the MDM system.

Results

MDM system is fully integrated within the WT data acquisition and processing. MDM measurements are synchronized with classical measurements (force, pressure), and are available at a frequency of 1Hz.

MDM results are available immediately at the end of each run.

Accuracy

Typical repeatability

| | Twist | Bending |
|----------------|-----------------------------------------------------|--------------|
| Wing | $\pm 0.03^\circ$ ($\pm 0.05^\circ$ for yaw sweeps) | ± 0.5 mm |
| Rotating blade | $\pm 0.05^\circ$ | ± 0.2 mm |