RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

ONERA
THE FRENCH AEROSPACE LAB

BRAVoS: Rotor Hover test rig

A rotating rig fitted for hover flight with clean internal flow

Major fields of applications: helicopters, wind turbines, propellers, rotor drones

Scope of research: development and validation of experimental measurement methods (rotating blade deflections, …), characterization of rotating instrumentation under centrifugal loads, aeroelastic stability of hover helicopter rotors, preparation of wind tunnel forward flight rotor tests.

Main Features

Rotor diameter: 4m max
Rotor speed: 3000 RPM max
Driving motor Power: 37 KW

Cyclic pitch management system
- Akin to real helicopter system
- Hydraulic powered
- Remote controlled

Overall frame configurable for rotor/frame couplings:
- Rigid locked frame
- Soft hinged damped frame

Helicopter active two-bladed rotor

Main Equipment

Camera visualization: rotor tracking, rotating behaviour monitoring

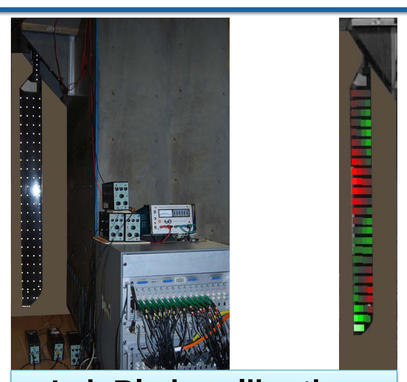
Telemetry system: 32 channels
Typical sensors: accelerometers, strain gages, displacement

Azimuthal position: optical 360 pulses/round

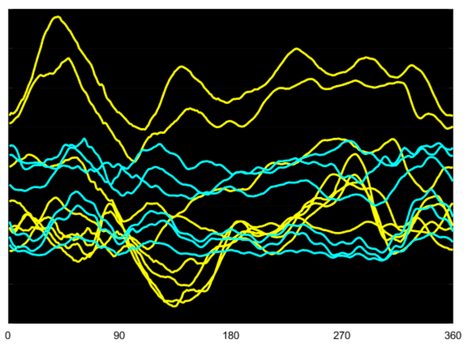
Experimental measurement techniques

SPA (Strain Pattern Analysis) : from strains to overall deflection displacements

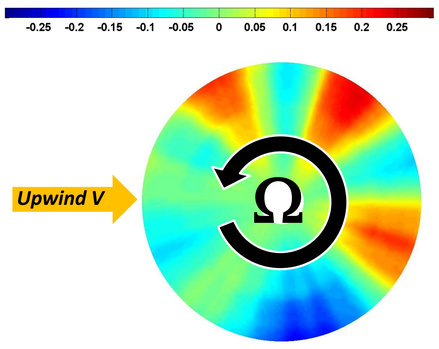
Based on a reduced number of blade embedded strain gauges & a suitable combination of modal shapes
Step 1: Appropriate blade calibration (modal shapes & strains)
Step 2: Setting Transfer matrix T
Step 3: Inferring rotating blade deflections Φ from measured rotating strain pattern under load ε : $\Phi = T * \varepsilon$



Lab Blade calibration



WTT Time strain acquisition



Rotating blade deflection

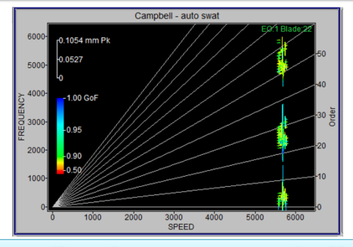
Tip-timing : from blades passage measurement to blades vibratory characteristics

Based on a set of fixed circumferential probes and a high sampling frequency acquisition system
Probes: 18 optical miniaturized laser probes
Tip timing acquisition frequency: 100 MHz

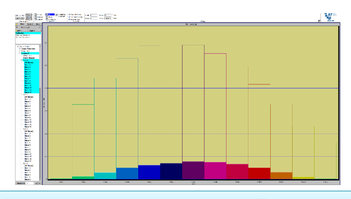
Probes

Probe Interface Unit

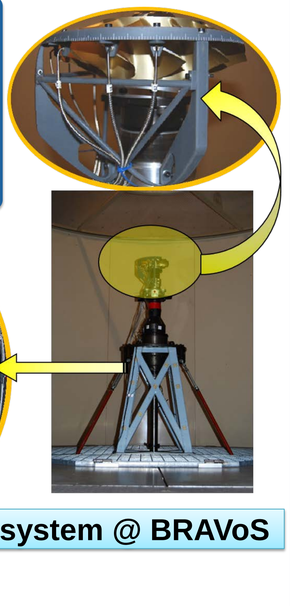
Data Capture Unit/ Controller



Deflection on Campbell



Blades vibratory deflections



Tip-timing system @ BRAVoS

Contact

https://www.onera.fr/en/daaa/contact