



RUAG

RUAG Precise New Propulsion and Measurement Technology



Michel Guillaume

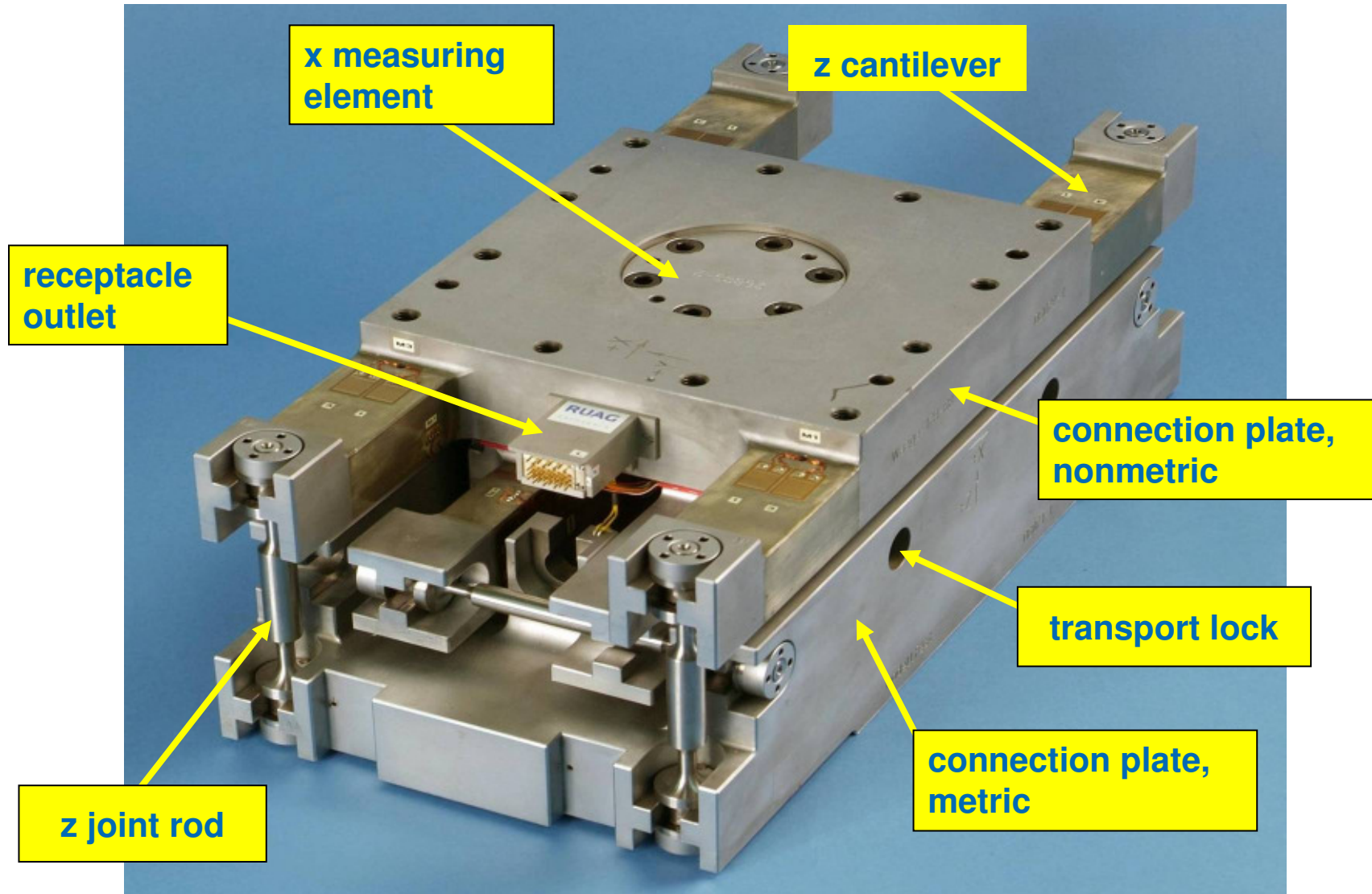


SATA 2010

RUAG

- **Block-Type Strain Gauge Balances**
- **New Family of Block-Type Balances**
- **Hydraulic Powered Models**
- **Modular Technology for powered Testing**
- **New 6 Component Rotating Shaft Balance**
- **Upgrade Study for LWTE**

Block-Type Strain Gauge Balances



Family of 6 Component Block-Type Balances **RUAG**

Load range

X = 20 to 7'300 N

Z = 10 to 25'000 N

Dimension (L x W x H)

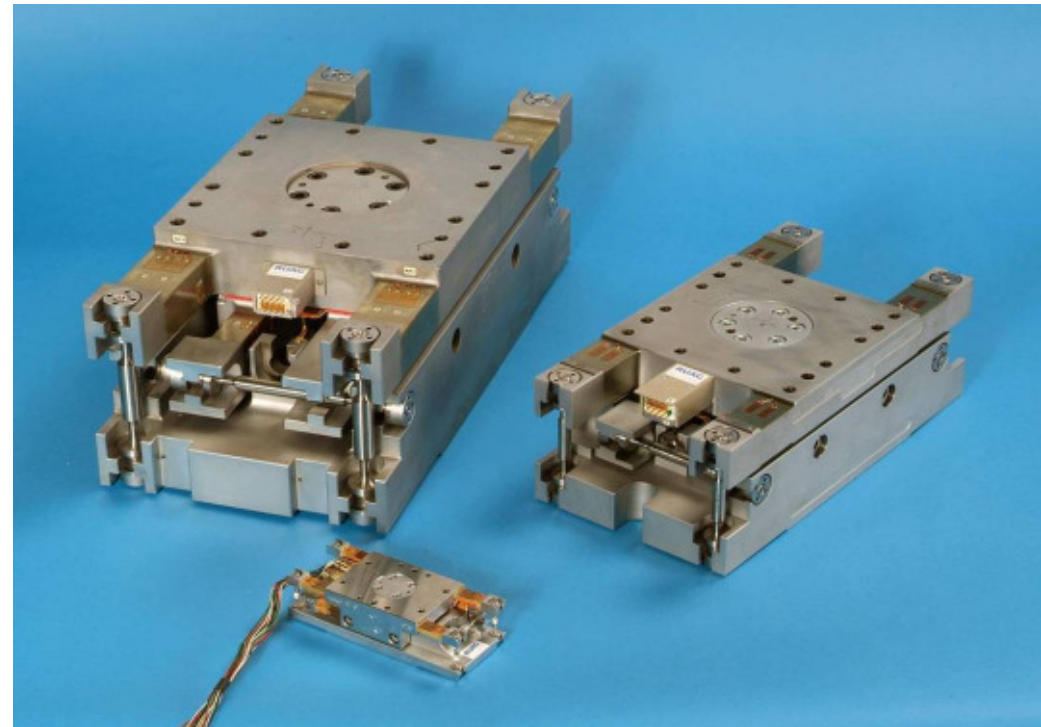
100 x 25 x 22 mm

to

540 x 260 x 230 mm

Weight

0.25 to 179 kg

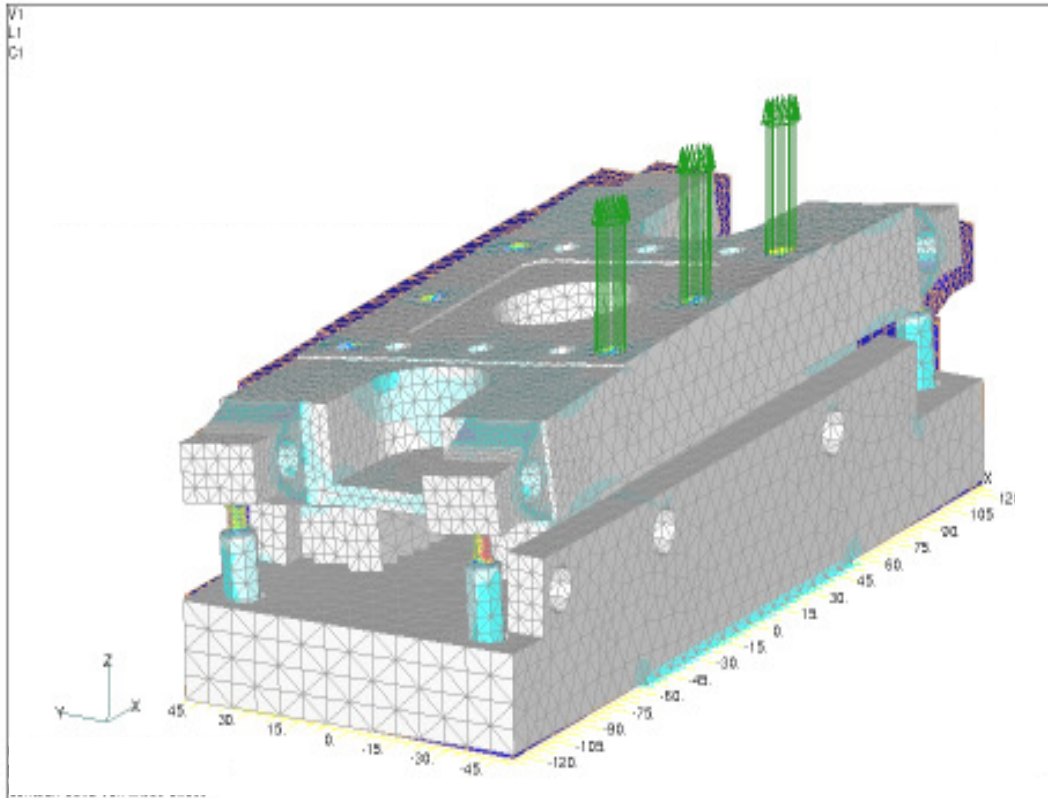


New Family 7xx of Block-Type Balances



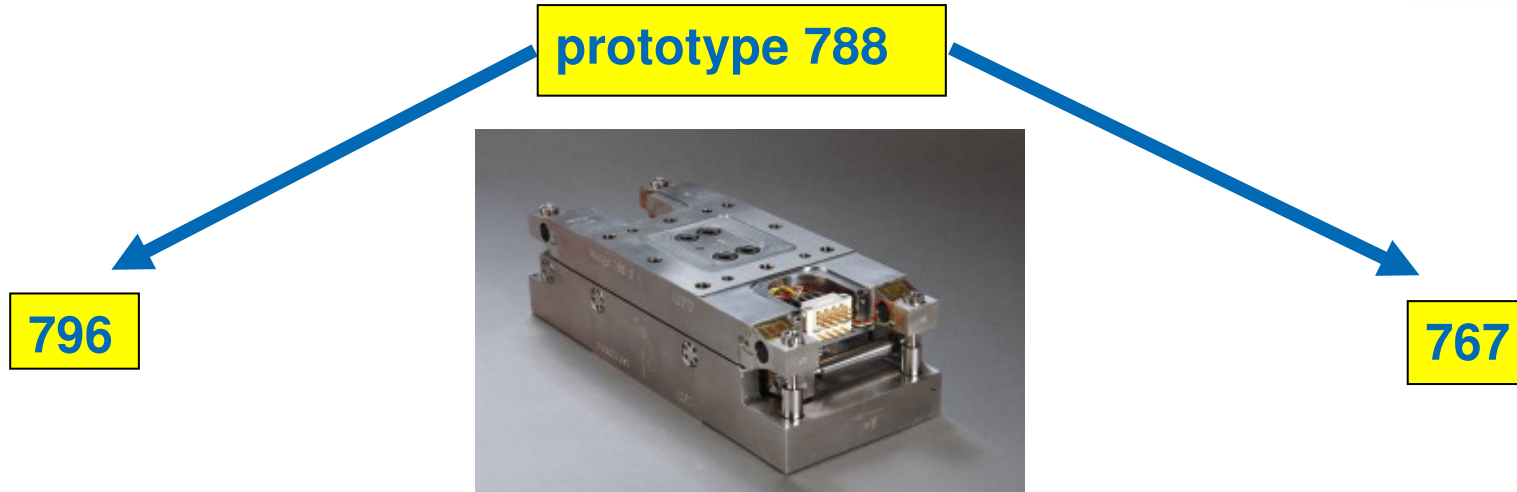
- **Higher stiffness, reduced deformation**
- **Higher loads per volume**
- **Precision, accuracy, and linearity**
- **Long-term stability and reliability**
- **Dynamic measurement capability**
- **Compact design and protective cover**
- **For Aerospace & Automotive testing**

Optimized with Finite Element Method (FEMAP/Nastran)



- **specific load envelope**
- **stiffness**
- **accuracy**
- **scalability**
- **same/similar external dimensions**
- **mechanical interfaces are compatible**
- **electrical interfaces are identical**
- **design improvements**

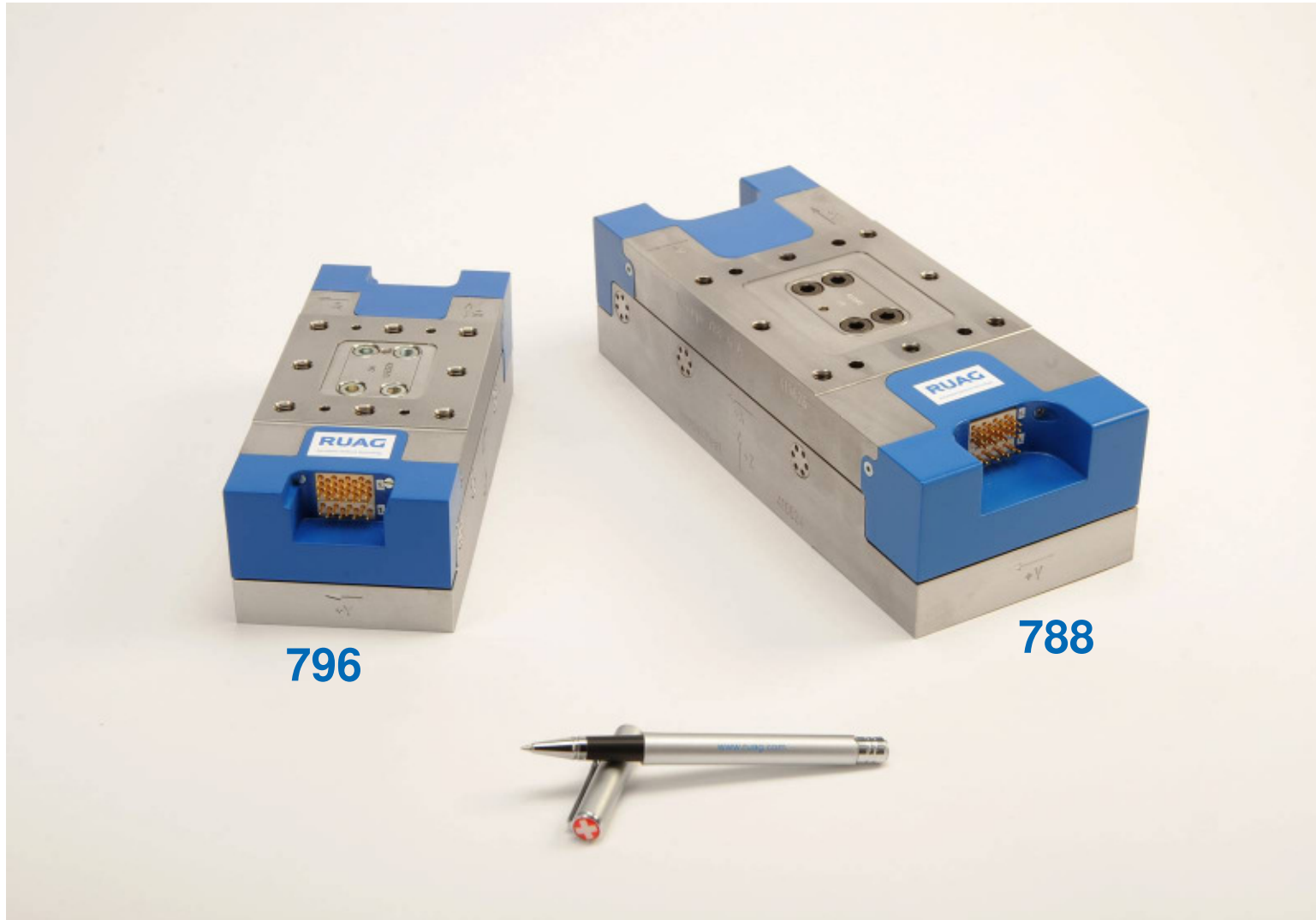
Scaling of Prototype 788



- **short, trapezoidal beams**
- **strain concentrated at gauge locations**
- **massive block parts**
- **symmetric fixation of x-element**
- **7 strain gauge bridges, 1'000 Ω**
- **nominal strain: 1'000 $\mu\text{m}/\text{m} \rightarrow 2 \text{ mV}/\text{V}$**
- **Souriau connectors**
- **protective cover**

New Block-Type Family 7xx

RUAG



New Family 7xx – Technical Data



Design Loads [1]	X* [N]	Y* [N]	Z* [N]	L* [Nm]	M* [Nm]	N* [Nm]
796	1'000	800	3'500	350	3'50	3'50
788	4'000	600	8'000	300	1'100	1'000
767	13'000	10'000	30'000	2'300	3'800	3'100
Limit Loads [2]	X' [N]	Y' [N]	Z' [N]	L' [Nm]	M' [Nm]	N' [Nm]
796	1'000	5'500	19'000	550	1'520	385
788	4'000	10'000	25'000	1'000	3'000	1'100
767	13'000	32'000	88'000	6'000	14'000	4'500

Deformations [3]	$\delta x/\delta X$ [m/N]	$\delta y/\delta Y$ [m/N]	$\delta z/\delta Z$ [m/N]	$\delta\phi/\delta L$ [°/Nm]	$\delta\alpha/\delta M$ [°/Nm]	$\delta\beta/\delta N$ [°/Nm]
796	$5.0 \cdot 10^{-8}$	$1.5 \cdot 10^{-8}$	$6.3 \cdot 10^{-9}$	$4.0 \cdot 10^{-4}$	$8.0 \cdot 10^{-5}$	$2.0 \cdot 10^{-4}$
788	$2.0 \cdot 10^{-8}$	$6.0 \cdot 10^{-9}$	$5.0 \cdot 10^{-9}$	$1.4 \cdot 10^{-4}$	$2.8 \cdot 10^{-5}$	$3.4 \cdot 10^{-5}$
767	$1.5 \cdot 10^{-8}$	$5.0 \cdot 10^{-9}$	$3.0 \cdot 10^{-9}$	$3.6 \cdot 10^{-5}$	$6.5 \cdot 10^{-6}$	$1.5 \cdot 10^{-5}$

Geometry / nominal signals	Length [mm]	Width [mm]	Height [mm]	Weight [kg]	Nominal excitation [V]	Nominal signal [mV]
796	180	80	60	5.0	7	14
788	250	100	70	10.3	7	14
767	350	180	120	50.0	7	14

[1] Design loads refer to a combined load case, i.e. all components are simultaneously acting on the balance.

[2] Limit loads refer to a load case where only a single load is acting on the balance.

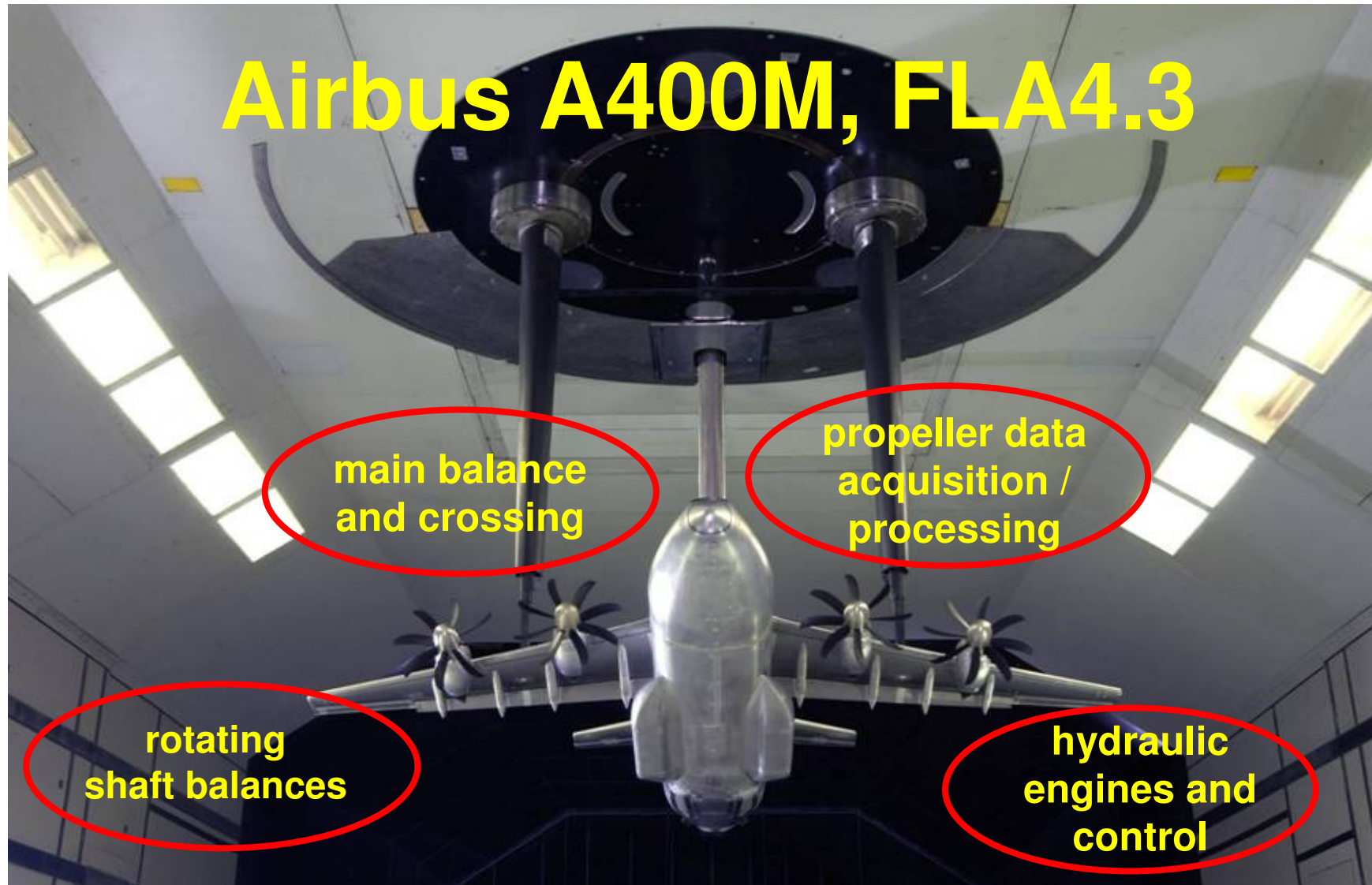
[3] Typical values

Characteristics of RUAG Balances

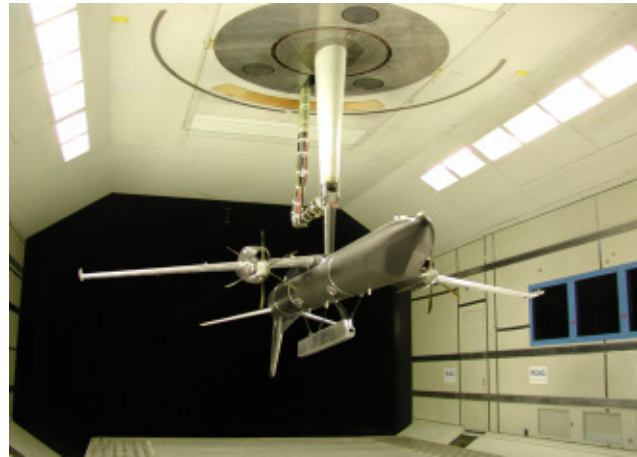


- **Long experience in designing, manufacturing, and operating balances – continuous improvements**
- **Diversity of load range and geometric sizing**
- **Stiffness**
- **Accuracy and linearity; precise 6-component sensor**
- **Long-term stability and reliability**
- **Compact design**
- **HighEnd product**
- **Fatigue tested of critical elements**
- **Process conform to ISO9001-2000**

- **Delivery time: typically 6 months**
- **Price range: € 65'000.– to 140'000.–**



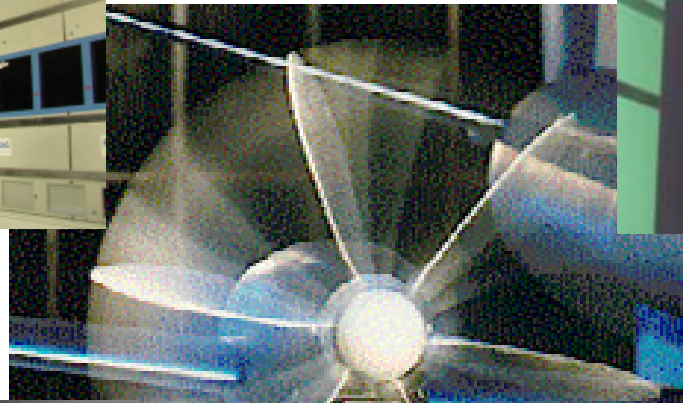
Our Experience



cost efficient



productive

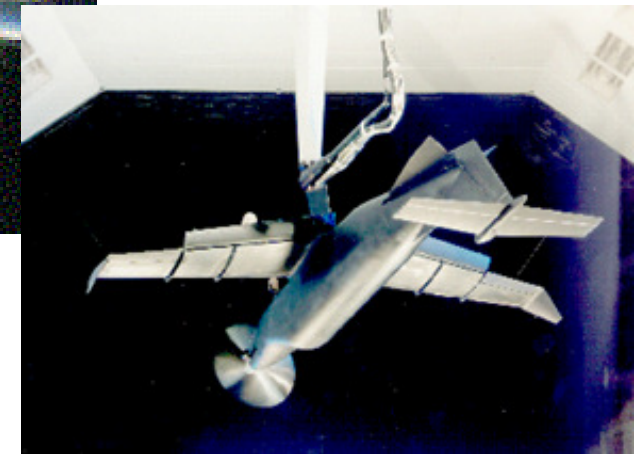


reliable



SAFE

precise



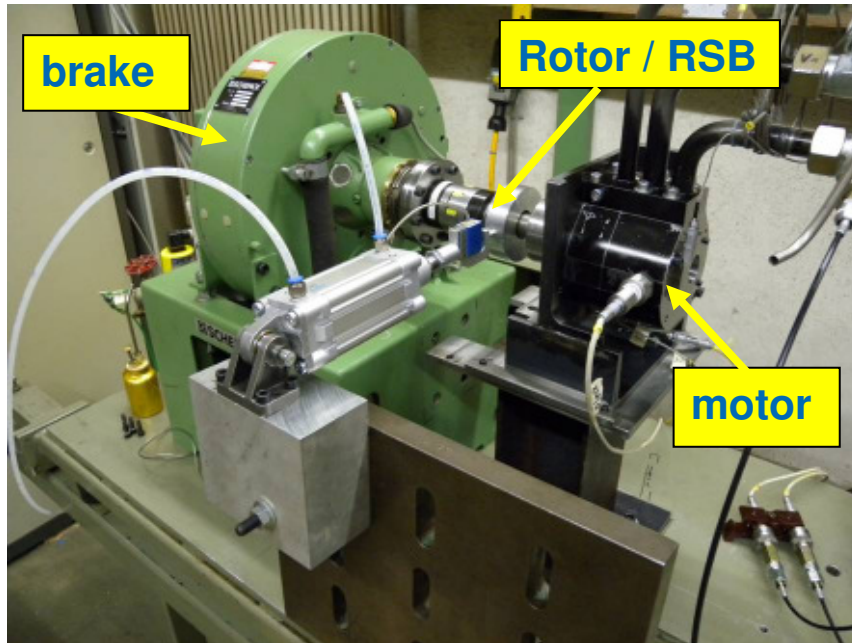
Modular Technology for CROR Testing

RUAG

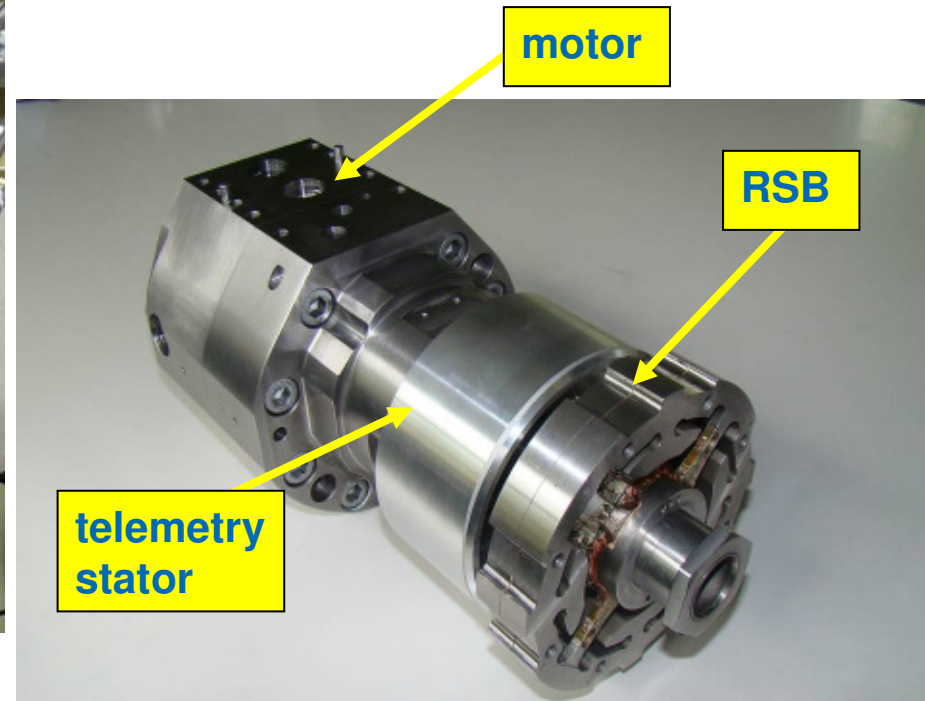
- High speed high torque hydraulic motors for single and counter rotating configurations (100 KW, 12'500 rpm)
- Main balance with balance crossing system
- 6 component rotating shaft balances (RSB)
- Slip rings and telemetry systems for data transmission
- High power hydraulic system with control software
- Independent rpm control system for 4 motors
- Test benches to test motors, telemetry, slip rings, RSB
- Setup for isolated tests over wide range of pitch and yaw angle



Dynamic Loading with Hydraulic Drive



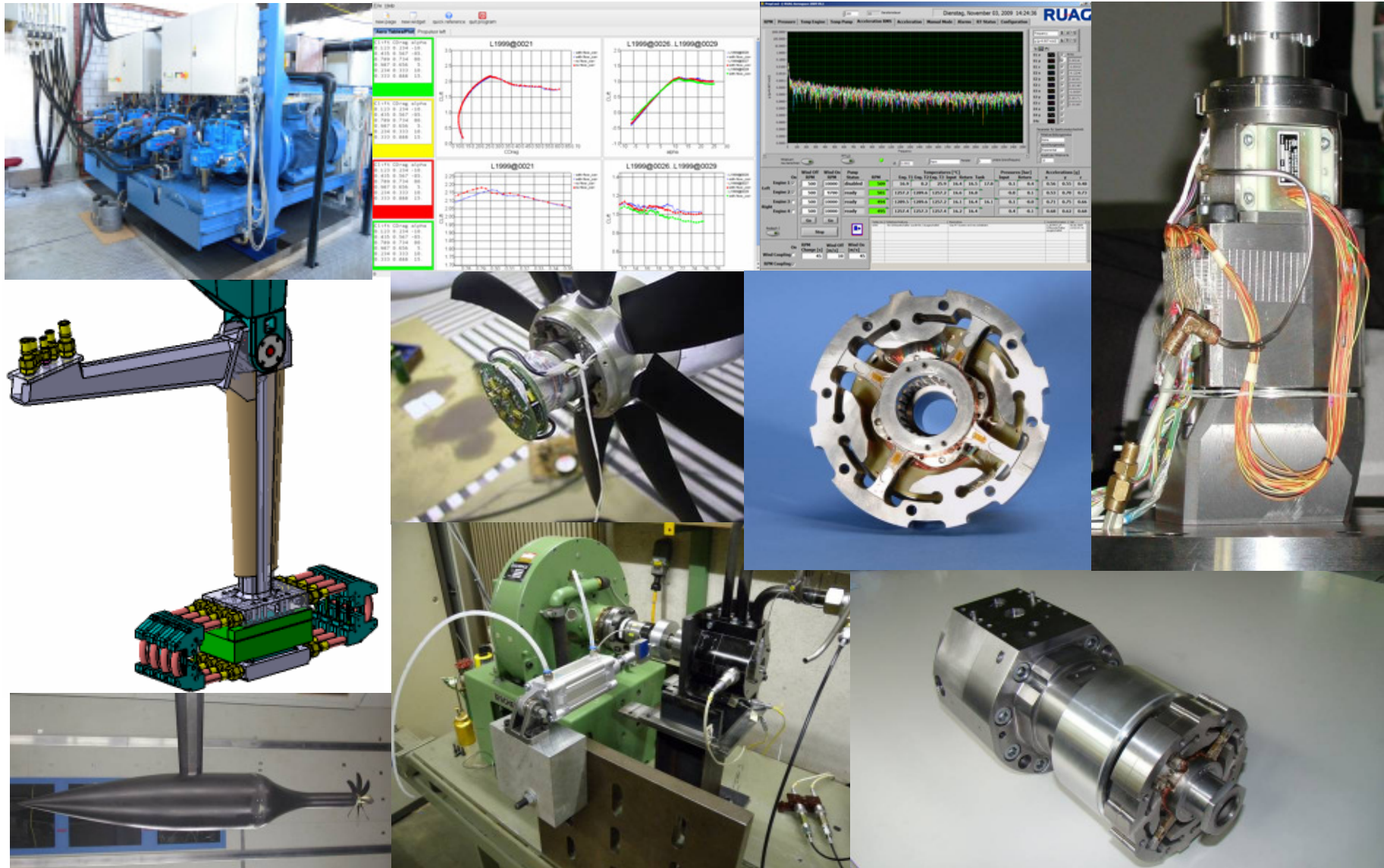
- hydraulic drive
- water brake
- rotor with RSB
- torque meter



CROR unit for powered models,
complete technology from motor
to RSB sensor with telemetry

Complete Technology for CROR available

RUAG



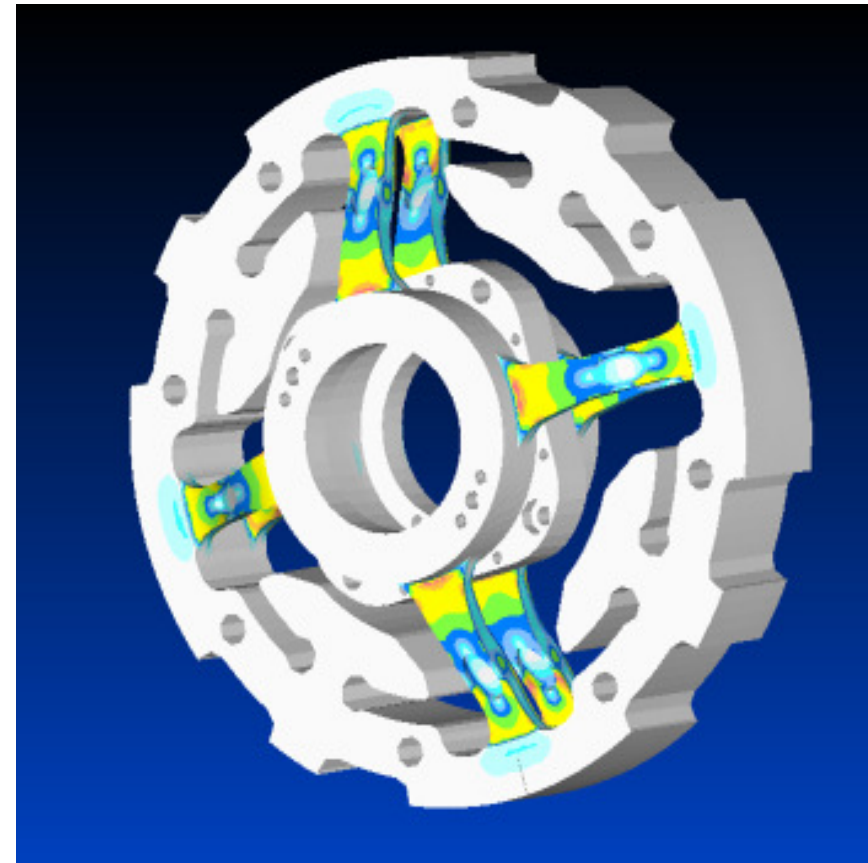
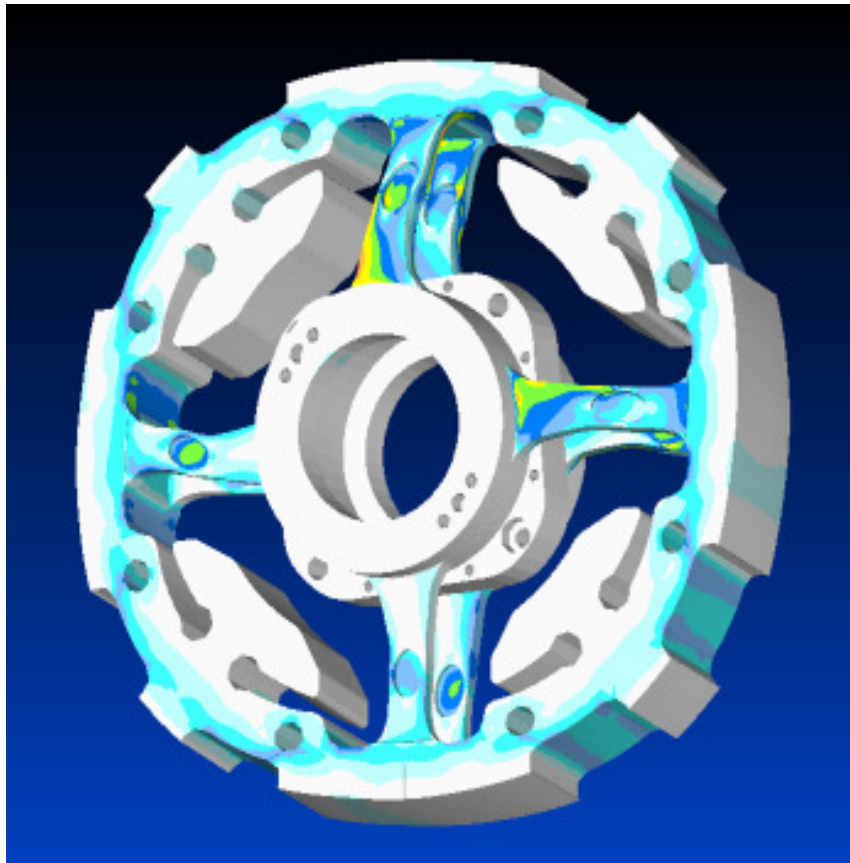
Rotating Shaft Balance RSB 320



- 6 components
- fully symmetric
- spoke-type in 2 planes
- 12'500 rpm



- 20 channel telemetry unit for
 - strain gauges
 - temperature sensors
 - angular position

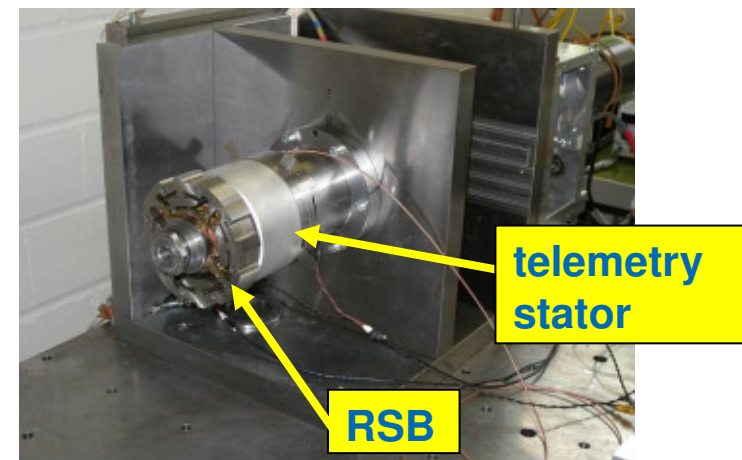
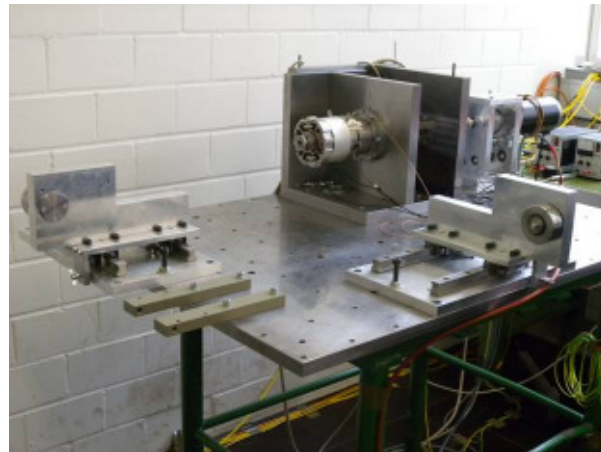


- **individual element**
- **static**
- **under rotation**
- **with blade hub / blades**

- **bending**
- **in-plane forces:**
tension / compression
- **6 bridges, 64 gauges**

Calibration and Checks of RSB

- static load calibration
- balancing of subunits
- dynamic loading in the lab
- dynamic loading with hydraulic motor
- isolated propeller test in the wind tunnel
- static check in the wind tunnel (comparison to main balance)



Hard- and Software Requirements

- **acquisition and monitoring**
 - **synchronization (MGCplus, Datatel, PSI)**
 - **one workstation / monitor per telemetry system**
 - **software for FFT, correlations etc.**

- **storage and backup**
 - **standard backup system (static data)**
 - **time-resolved data:**
 - **about 32 GB per run**
 - **hard disks (4 x 4 TB → 500 runs)**
 - **strategies**

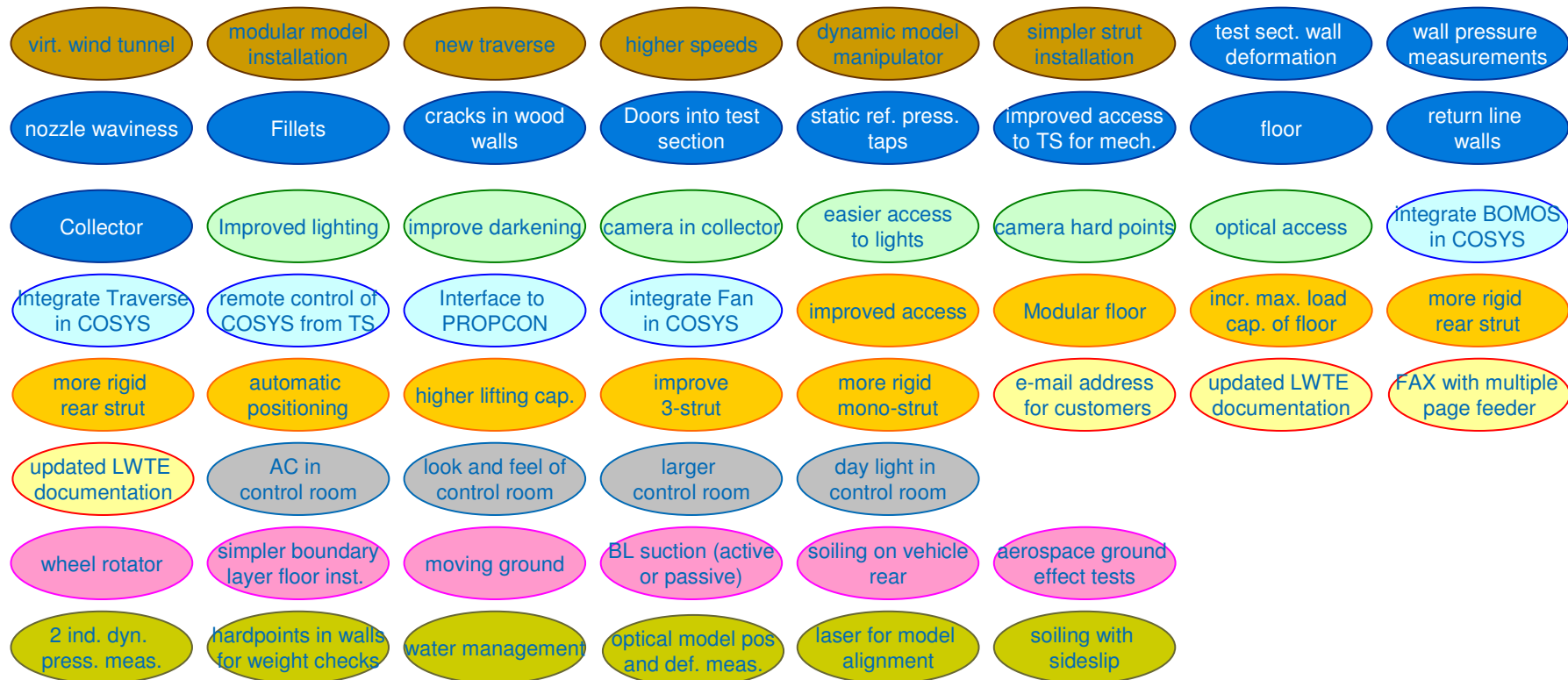


Upgrade Study for LWTE

Large Wind Tunnel Emmen



RUAG ideas based on internal and external customer feedback



LWTE Upgrade



Upgrade motivations

Improved quality:

Better flow and measurement quality,
reduced stress on tunnel structure

Maintain or increase max. speed of 68 m/s

Wider range of yaw angle for ground tests,
improved access to test section for shorter
turn around times

Higher test efficiency:

Longer multiple shifts

Better work environment:

Increased space for customers and
preparation space for models

Evaluated solution

**Cooling installation to limit
environmental air-flow temperature**

**Modification of test section to
maintain measurement capability**

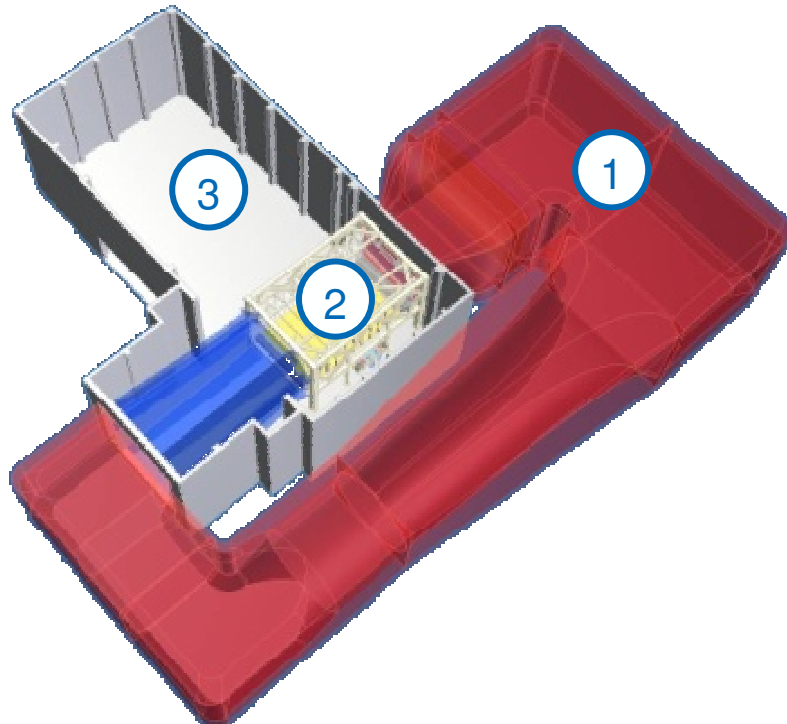
No more limitations for operations

**Larger and improved work
environment for customer and
operators**

LWTE Upgrade

Study done by Jacobs

Upgrade Content



Benefit

- 1. Integration of an airstream cooler**
Heat exchanger to stabilize the airflow temperature at maximum 30°
- 2. Installation of an improved test section**
Adaption of test section area to maintain max speed of 68 m/s
- 3. Control room & customer area upgrade**
More space and better access for efficient testing

RUAG

Aviation

RUAG Aerodynamics

Precise, Innovative, Flexible, Solutions on Demand

our Partners





RUAG

Efficiency, accuracy, competence, flexibility: This is what you can expect at RUAG Aviation's premium aerodynamic testing facility. We provide competent and highly skilled personnel, advanced instrumentation, high precision strain gauge balances and modern data acquisition software. This guarantees not only most accurate data but also a high efficiency during preparation and performance of the test – getting you the most out of your wind tunnel time. Whatever your low-speed wind tunnel testing needs are, RUAG Aviation can offer the solution. Why don't you put us to the test and experience the difference?

Too much drag? RUAG wind tunnel testing helps you do better.

RUAG Aviation

Aerodynamics Center · P.O. Box 301 · 6032 Emmen · Switzerland

Legal domicile: RUAG Switzerland Ltd · Seetalstrasse 175 · P.O. Box 302 · 6032 Emmen · Switzerland

Tel. +41 41 268 38 01 · Fax +41 41 268 38 97 · aerodynamics@ruag.com · www.ruag.com