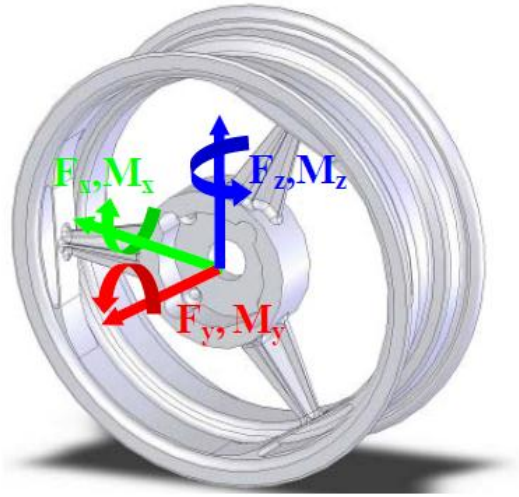
Smart Wheels



SMART Mechanical

spin off® POLITECNICO DI MILANO

marchesini

Smart Wheel - Introduction

Smart Wheel application has a double goal: safety and/or performance improvement

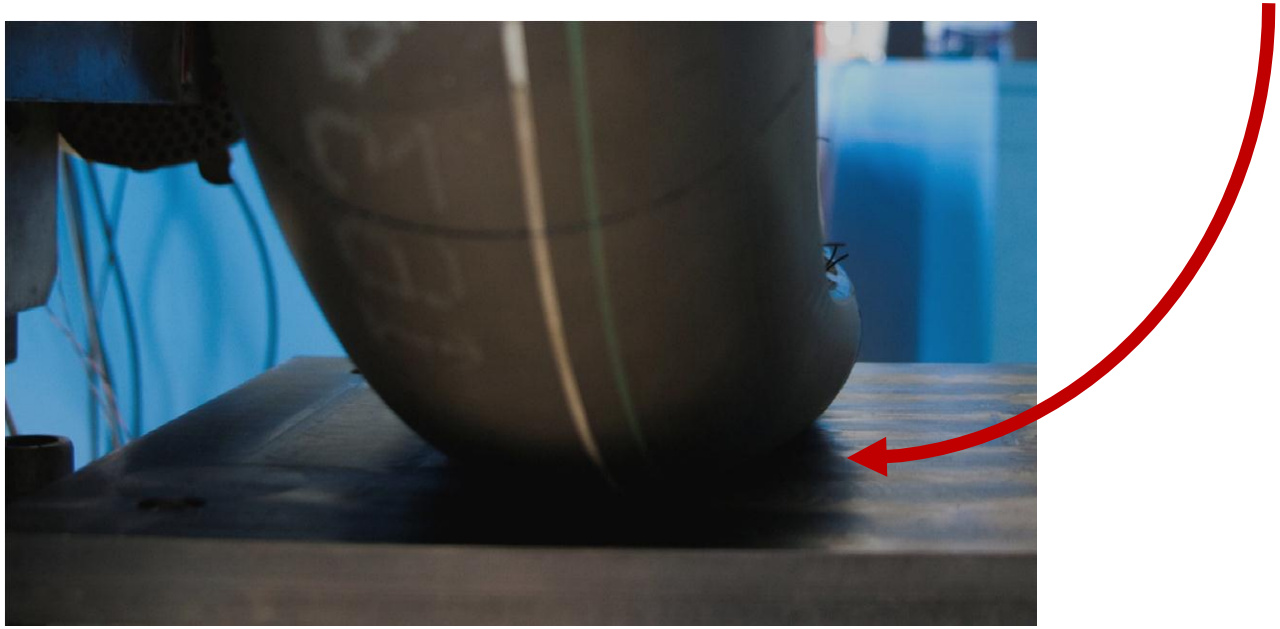
e.g.

- ✓ Validation of vehicles dynamic model
- ✓ Tire characterization
- ✓ R.T. data feeding to a new generation of anti lock braking systems and other safety applications
- ✓ R.T. data feeding to syncronized telemetry diagnostics

Smart Wheel - Introduction

The first step for “real time” or “off-line” applications is the knowledge of the actual forces at the road-tire interface.

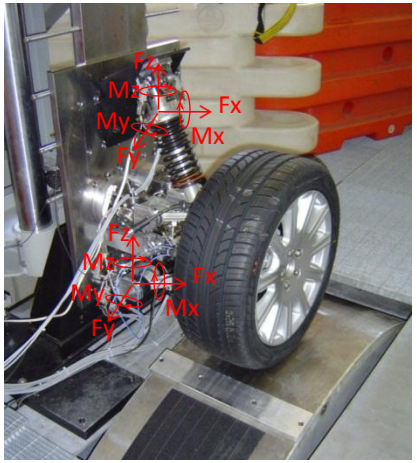
The reliability of the application strictly depends on the reliability and the effectiveness of their measurement.



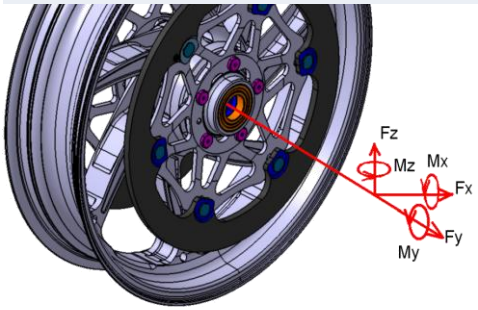
Smart Wheel - Introduction

The approach can be different depending on the final goal.

a) Measurement on the suspension system components

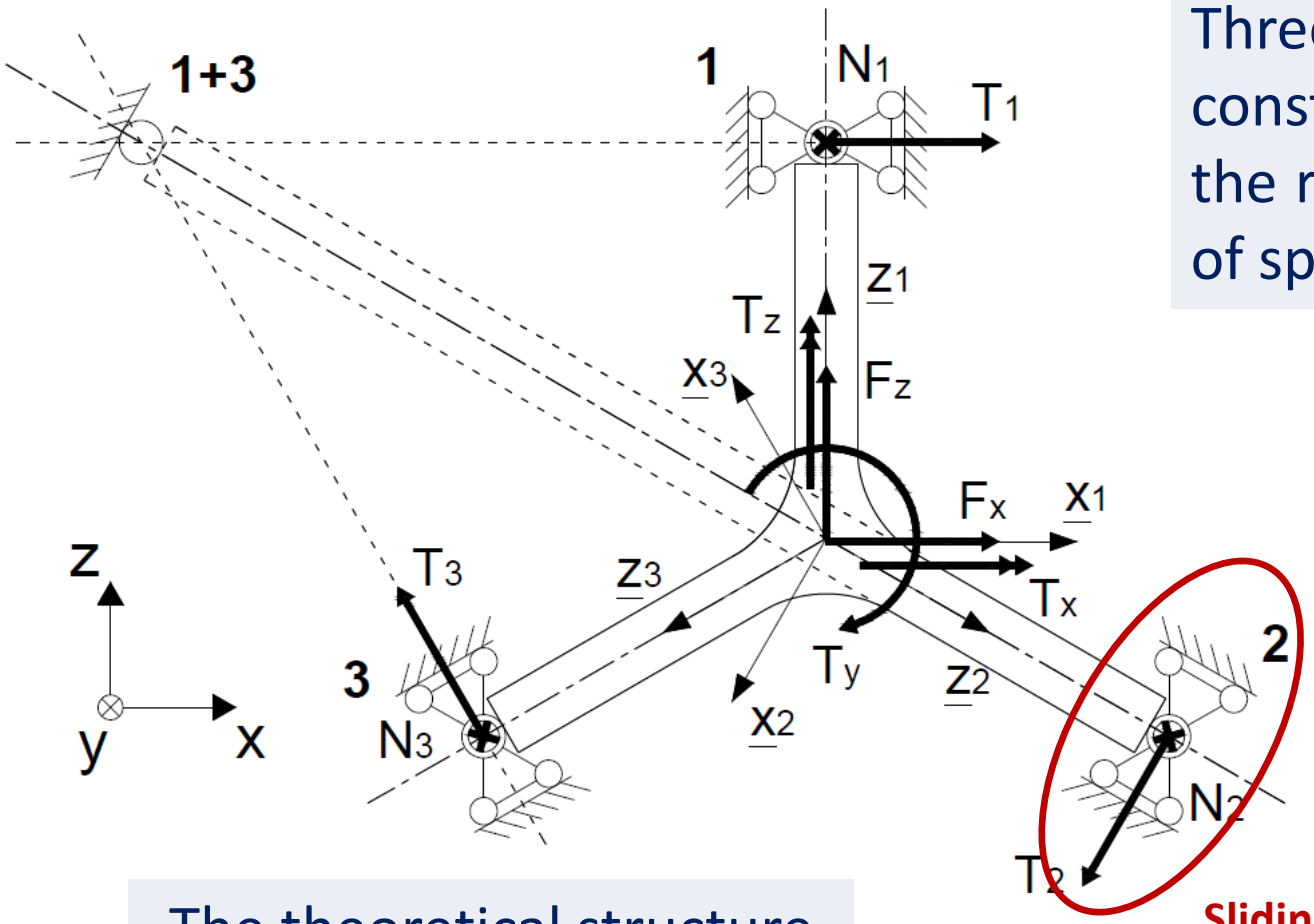


SMARTMechanical favourite approach



b) Direct measurement on the wheel

Smart Wheel – SM Concept

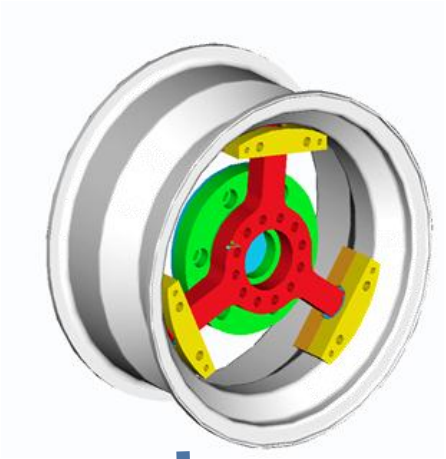


Three spokes constrained to the rim by means of special joints.

The theoretical structure is statically determined

Sliding spherical hinge joint

Smart Wheel – Design development

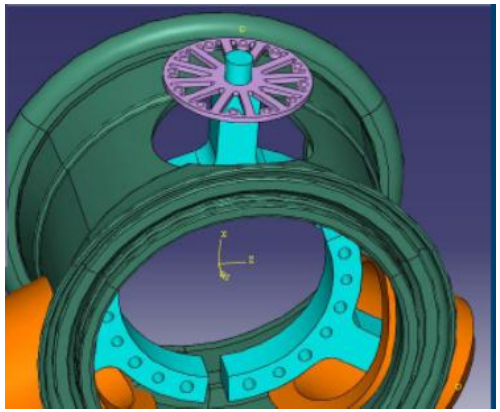


- Collaboration activities with companies have been active for more than 10 years
- Several different HW and SW versions have been realized to enhance measurement accuracy

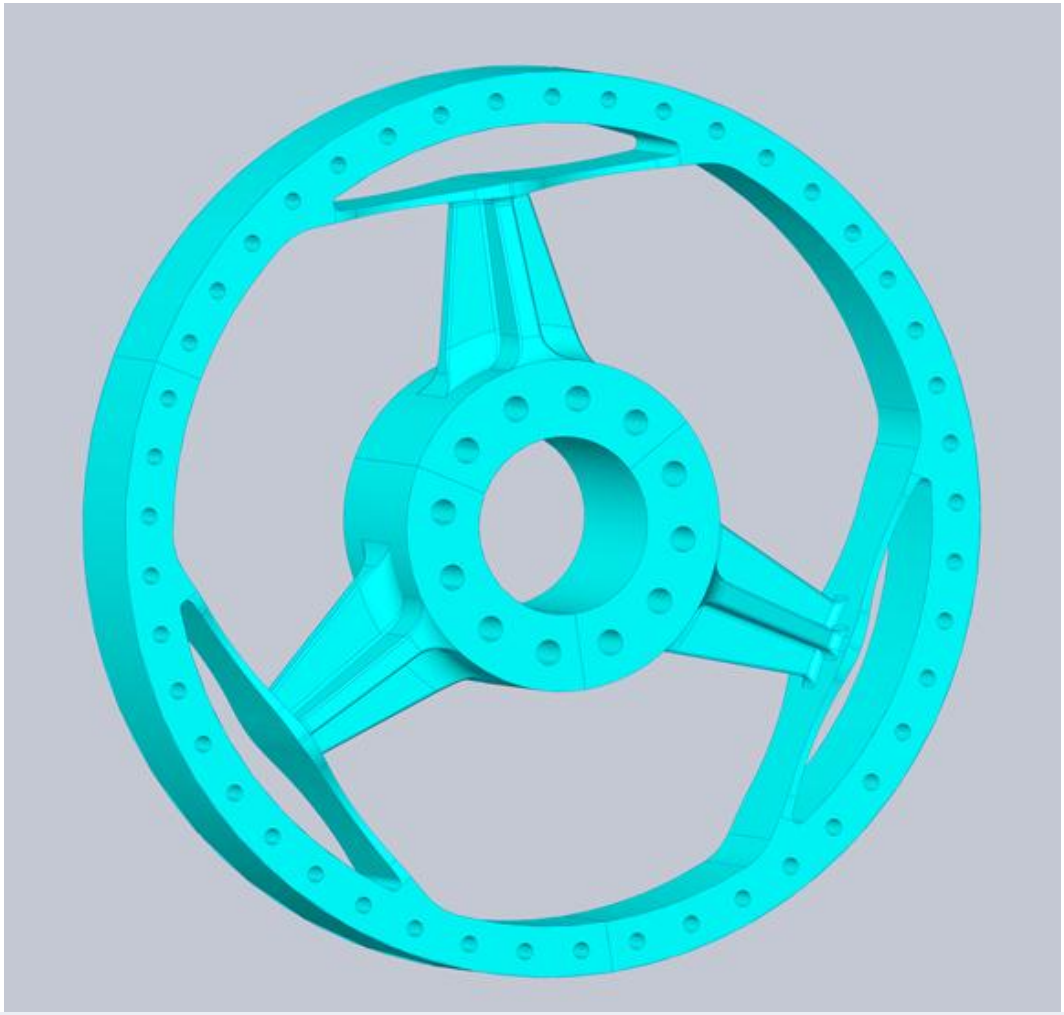
from friction joints

to

friction-less ones

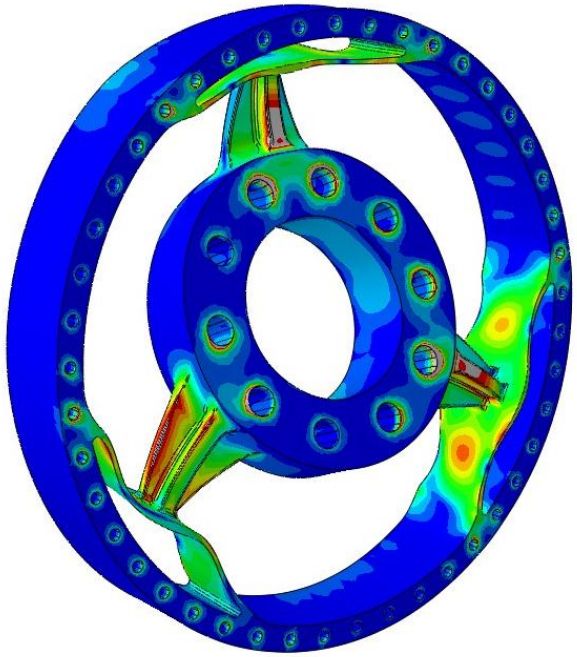


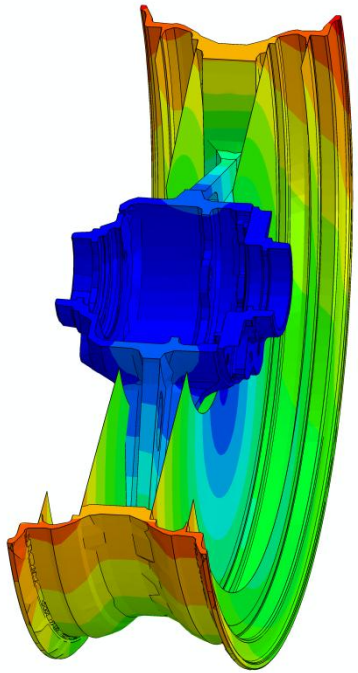
Smart Wheel – Design development



Enhanced joint version: thin plate or elastic spokes

Smart Wheel – Design development





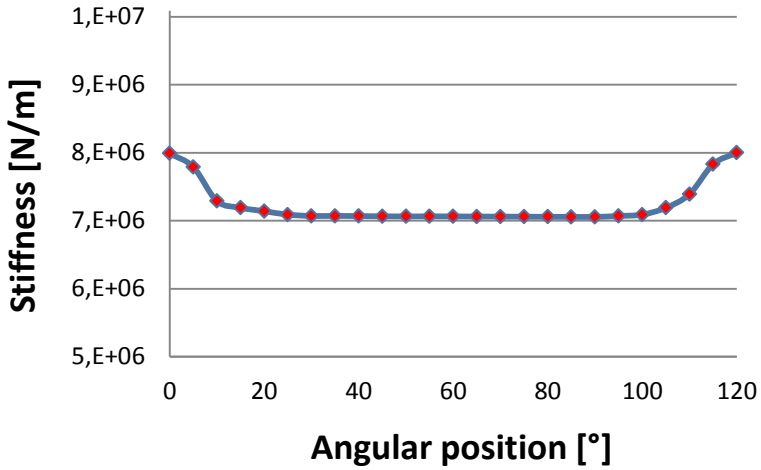
Multi objective structural optimization

Stress	Fatigue
Strain sensitivity	Temp. sensitivity
Stiffness	Weight

Smart Wheel – Design development

Calibration philosophy

- Different load combinations
- Different load magnitude
- Different angular positions



$$[F_x\ F_y\ F_z\ M_x\ M_y M_z]^T = \begin{bmatrix} C_{11} & C_{12} & & & & \\ C_{21} & C_{22} & & & & \\ & & C_{33} & & & \\ & & & C_{44} & & \\ & & & & C_{55} & \\ & & & & & C_{66} \end{bmatrix} [\varepsilon_1\ \varepsilon_2\ \varepsilon_3\ \varepsilon_4\ \varepsilon_5\ \varepsilon_6]^T$$

Four wheeled vehicles - Applications

Commercial passenger car

Four wheeled vehicles - Applications

Urban car prototype

Four wheeled vehicles - Applications

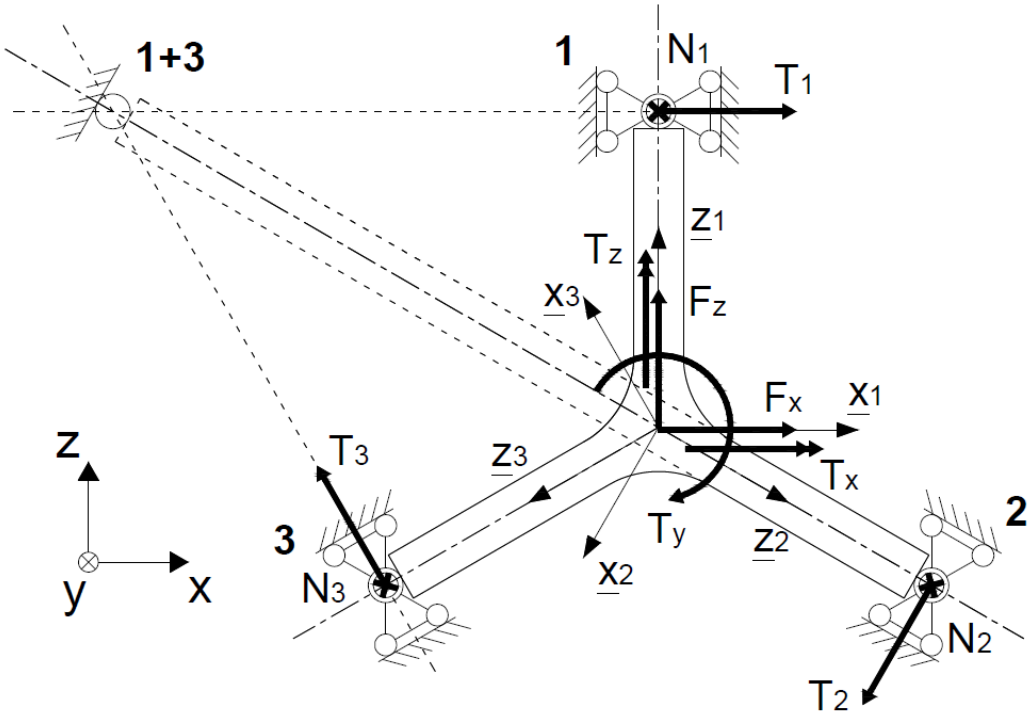
Work machines

Four wheeled vehicles - Specifications

- Real time measurement of 3 forces and 3 moments
- High accuracy and repeatibility
- System robustness
- Wireless data link

PASSENGER CAR			
Rim size	15”-19”	Total mass	10 kg
Max. force F_x F_y F_z	15 kN		
Uncertainty 95%	0.3% F.S.	1st nat. frequency	> 400 Hz
Resolution	1 N	Cross-talk 95%	< ±1% F.S.
		Max Overload	100% F.S.
Max. torque M_x M_y M_z	3.5 kNm	Data acquisition	6+1 ch. wireless
Uncertainty 95%	0.2% F.S.	Acquisition frequency	up to 400 Hz
Resolution	0.2 Nm	Power supply	Battery

Motorbike application – Architecture



Friction-less concept

Motorbike application – Architecture

New patented design for race application, developed in close collaboration with Politecnico di Milano and Marchesini Racing, a Brembo society

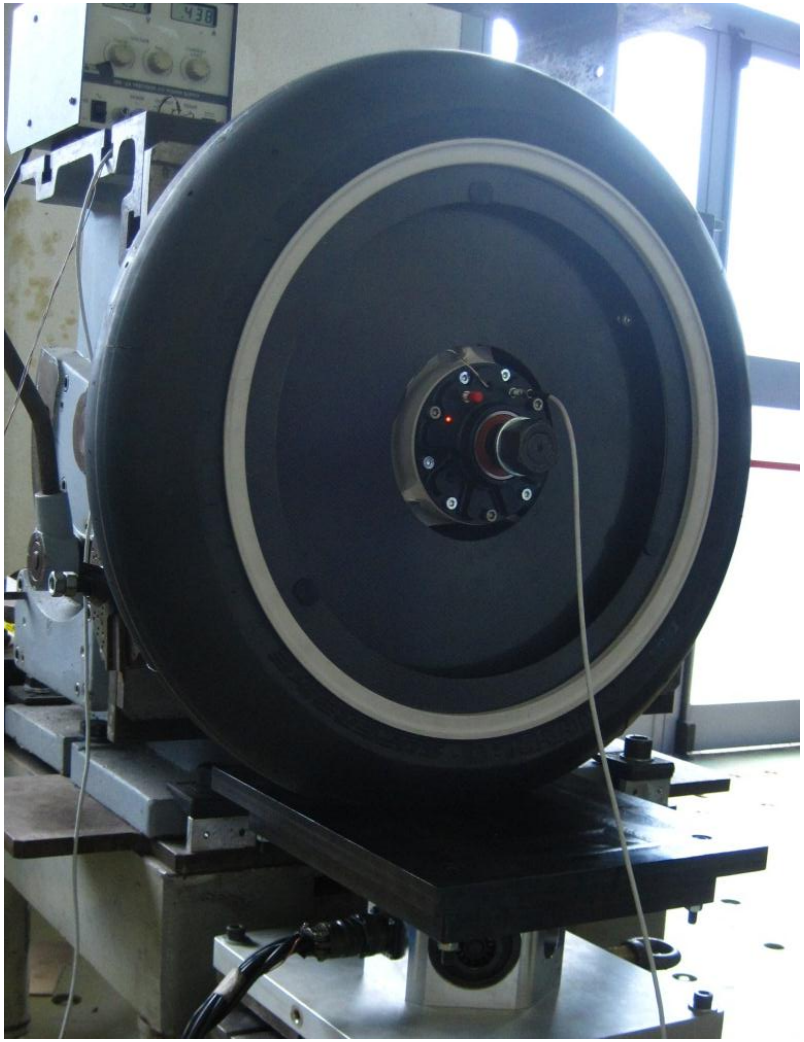
Motorbike application – Race wheel prototype

Electronics accommodated in the wheel hub

Motorbike application – Race wheel prototype

CFRP stiffening ribs glued to the rim

Motorbike application – Race wheel prototype

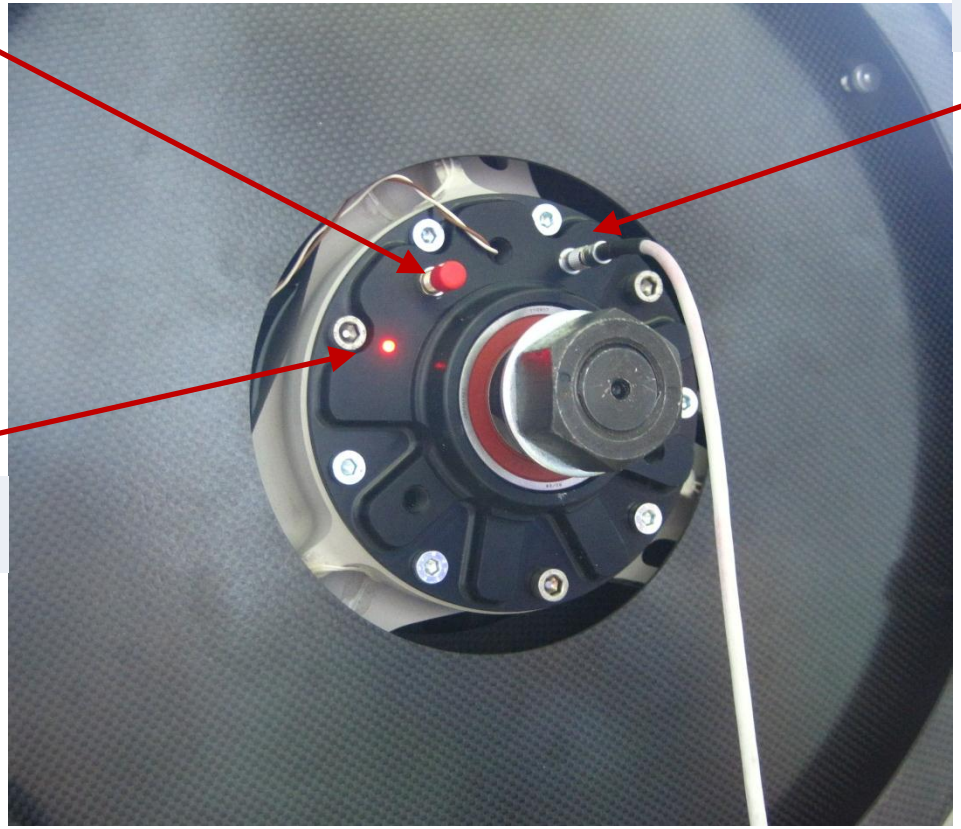


Final calibration

Motorbike application – Race wheel hub

On-off switch

Charge connector



On-off led

Motorbike application

The new motorbike Smart Wheel at the Automotive Testing Expo 2013 in Stuttgart

Motorbike application – Race wheel specifications

- Real-time measurement of 3 forces and 3 moments
- Lightweight and stiffness uniformity
- Very high accuracy and repeatibility
- Wireless data link

Rim size	15”-18”	Total mass	3 kg
Max. force F_x F_y F_z	6 kN		
Uncertainty 95%	0.5% F.S.	1st nat. frequency	> 300 Hz
Resolution	1 N	Cross-talk 95%	< ±1% F.S.
		Max Overload	+50% F.S.
Max. torque M_x M_y M_z	1.5 kNm	Data acquisition	6+1 ch. wireless
Uncertainty 95%	0.3% F.S.	Acquisition frequency	up to 400 Hz
Resolution	0.2 Nm	Power supply	Battery

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