



Layout of Test Chambers I

4th Training in Rio de Janeiro, BRA

6th-9th of May 2019

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1. Testing & Proving



Overview

Method \ Task	Real road	Proving ground	Test rigs	Dummy in the loop	Software/hardware in the loop	Man in the loop	Virtual rigs
Overall vehicle	Long-time tests	Functional tests	Aerodynamic, noise,...	Crash	Vehicle dynamics	Driving simulation	Energy management
Systems	Complex systems	Driveability	Engine, brakes,...	Pedestrian safety	Power grid, control units	ADAS	Mock-ups
Assemblies	Alternating conditions	Suspension tuning		Exhaust systems	Suspension control unit	Ergonomy	Functions of subsystems
Parts Materials Operating m.	Behaviour under service conditions	Behaviour under defined conditions	Behaviour	In-vitro and in-vitro tests	Fault detection of parts	Olfactory tests	Geometry of parts



Overview

functional tests — long-time tests

component tests — assembly/ system tests

laboratory and rig — driving tests

tests under intended use — misuse tests, crash simulation

tests with single effect — tests with combined effects

tests using objective criteria — tests using subjective criteria

model tests (small-scale test) — 1:1-tests



Overview

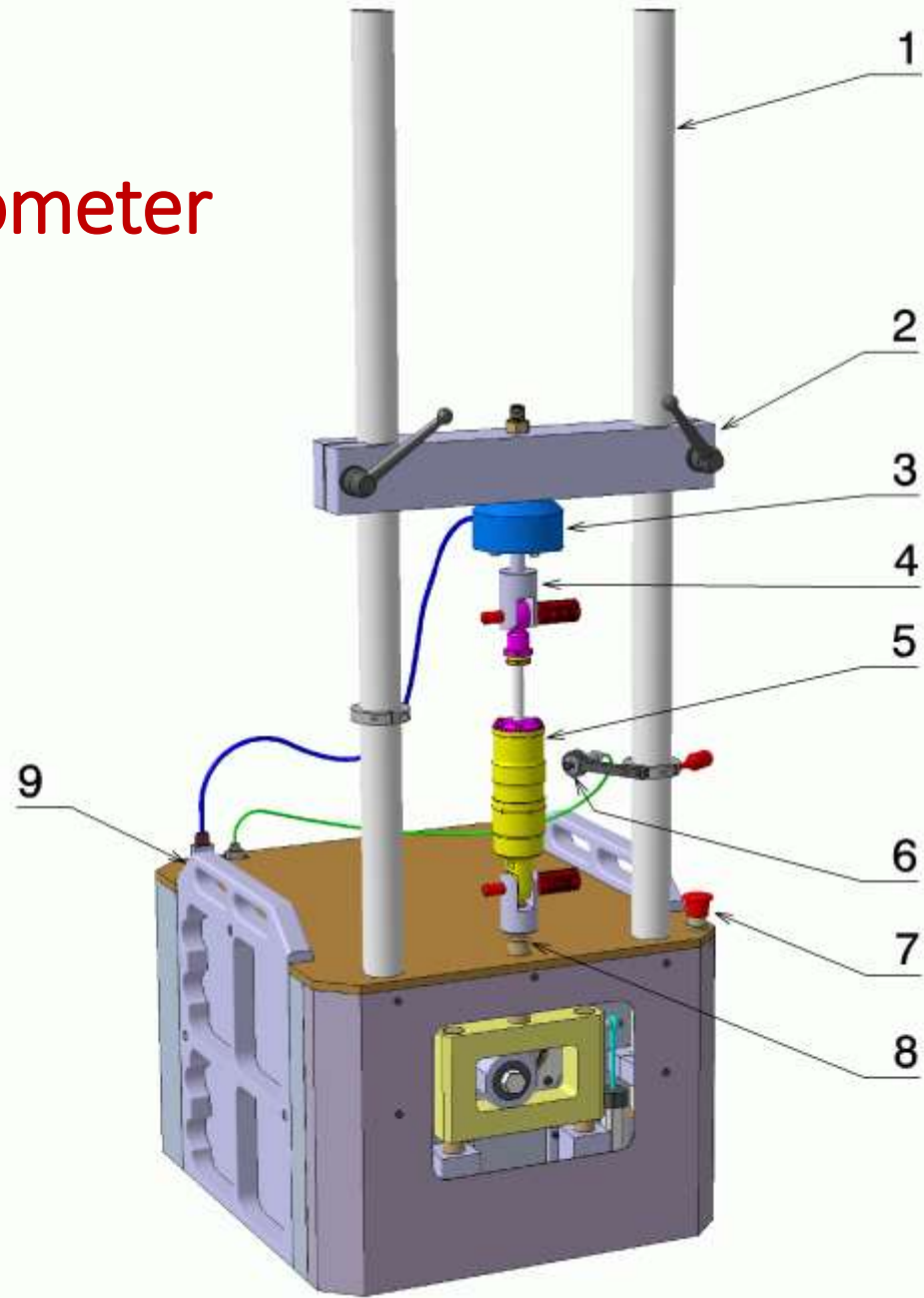
- Component tests: Fastenings, gaskets, vibration, ageing,...
- System prove: HiL
- Strength: Structural s., service s., corrosion, crash
- Driving tests: Calibration emissions and driving dynamics, bumpy-road test, high-speed track, summer tour, winter tour
- Validation of statutory acceptance requirements.



2. Test Facilities



Damper dynamometer



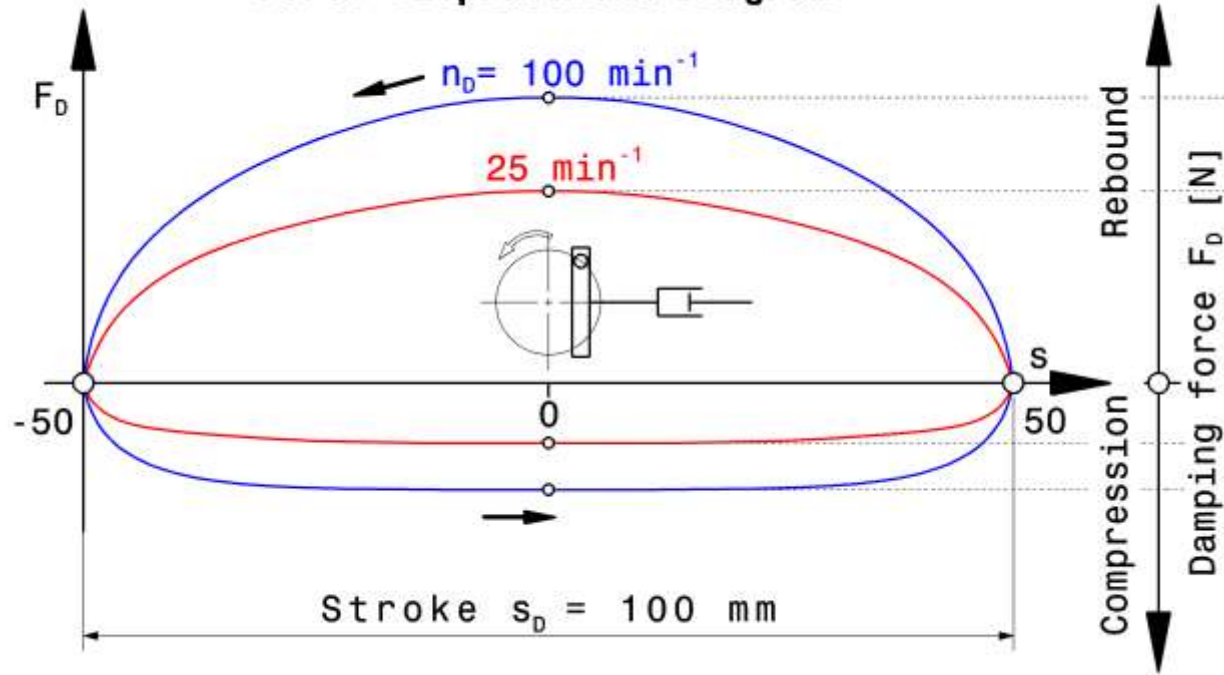
- 1 columns
- 2 crossbar
- 3 load cell
- 4 clevis
- 5 specimen
- 6 temperature sensor
- 7 emergency stop
- 8 actuator
- 9 handle

Sliding crank with scotch yoke

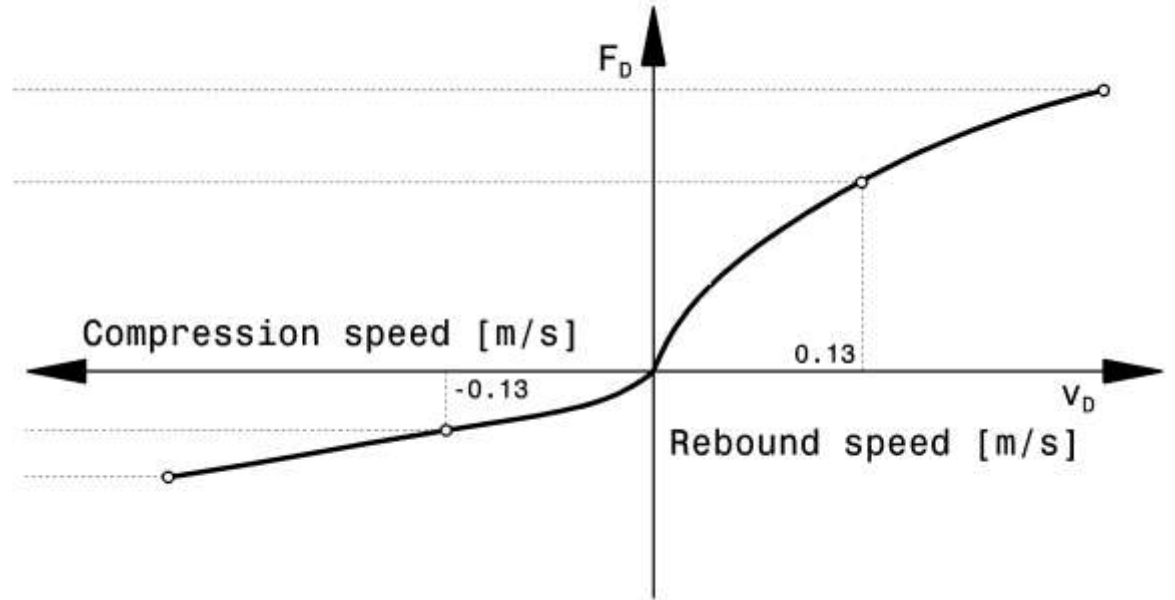


Damper dynamometer

Force-Displacement Diagram



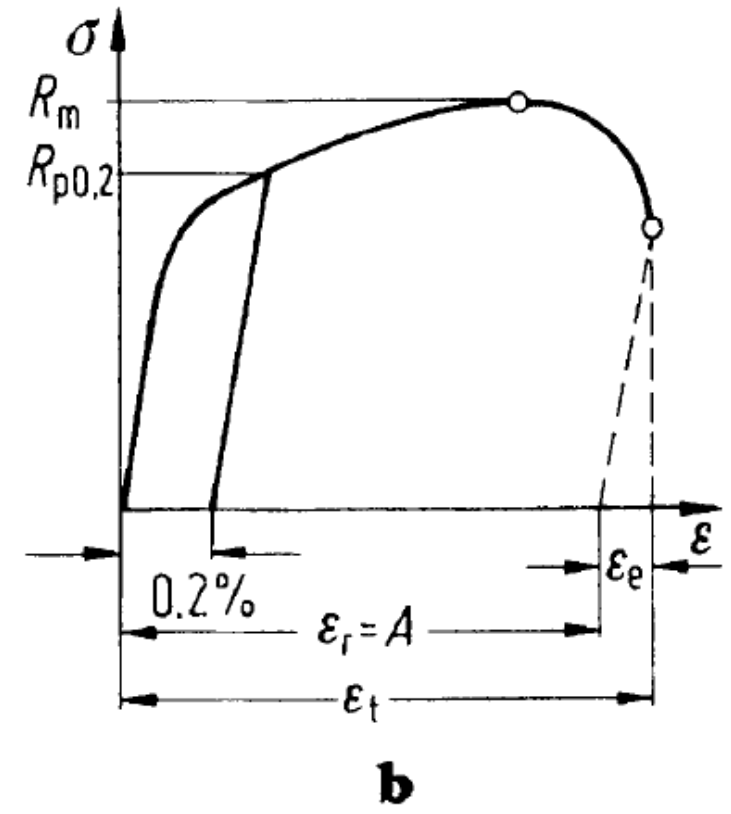
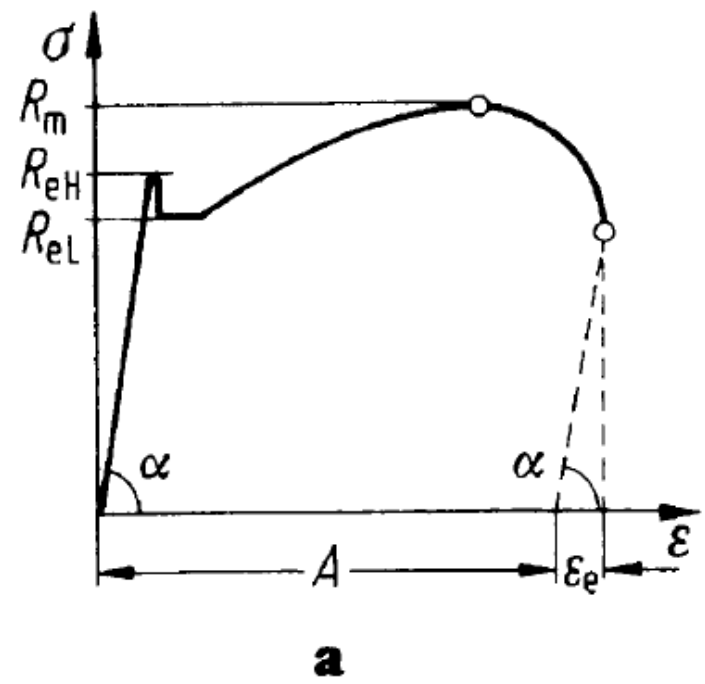
Force-Velocity Characteristic



Converting diagramms



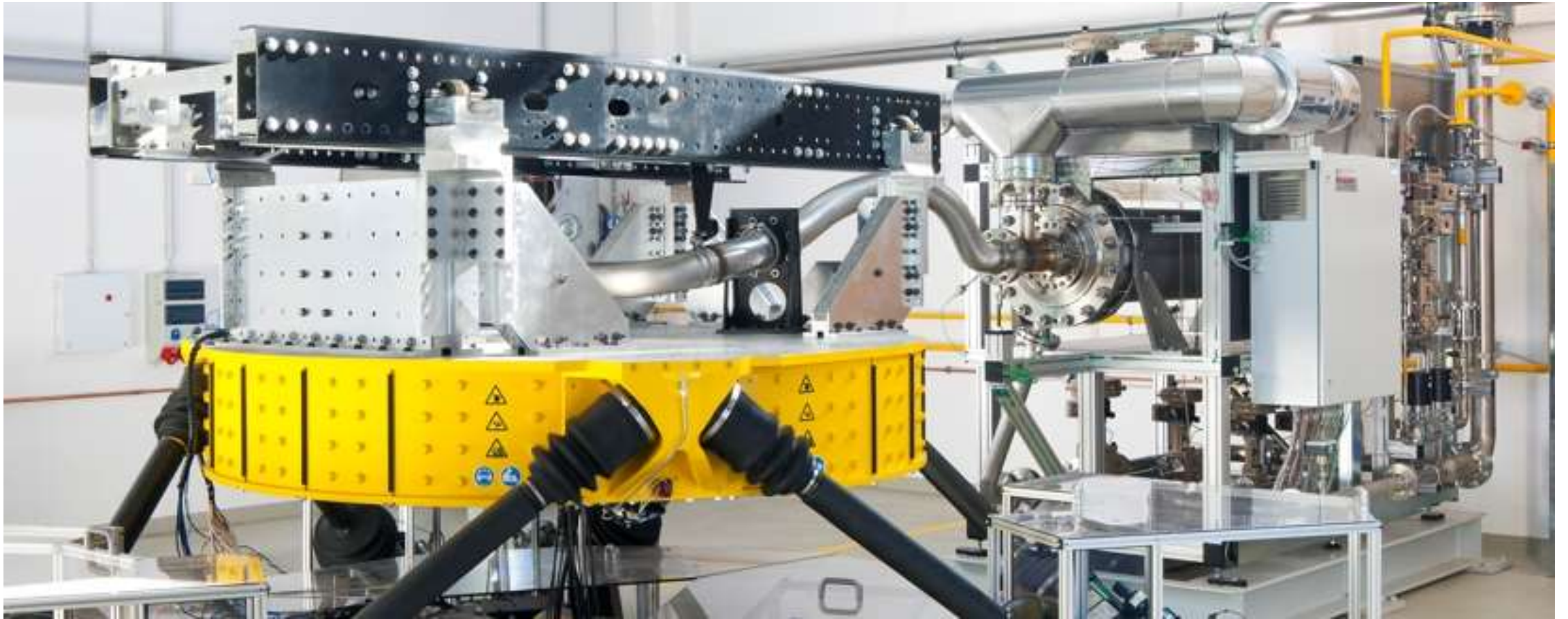
Tensile and compression test



Strength and deformation values in tensile test **a** with characteristic elastic limit, **b** with strain limit.



Vibration Test Rig



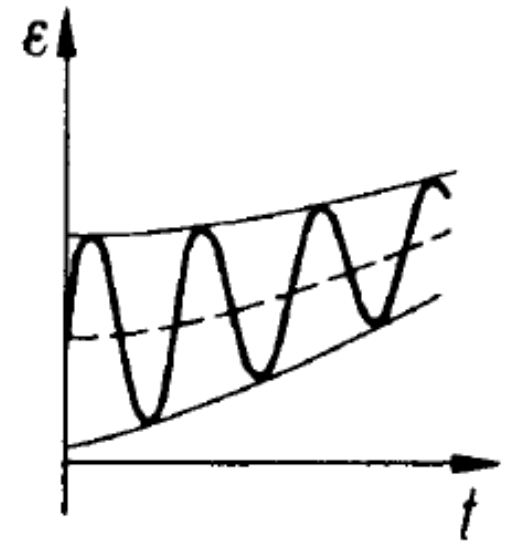
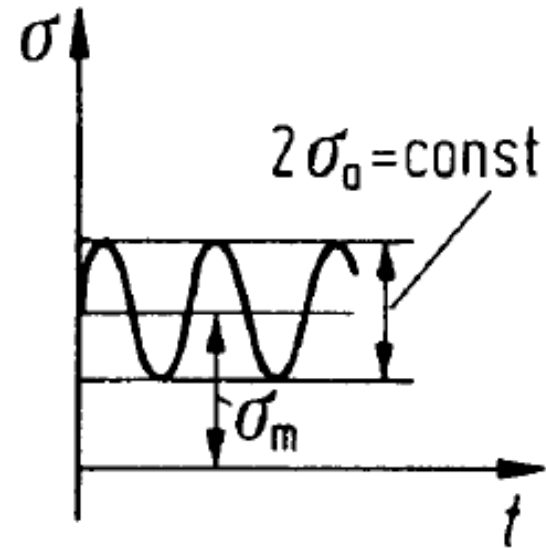
Multi axial vibration test rig for exhaust gas system (automotive)



Vibration Test Rig

- e.g. fatigue test of exhaust pipes
- cyclic loading
- temperature loading

Alternating
stress
 $\sigma = \sigma_m \pm \sigma_a$

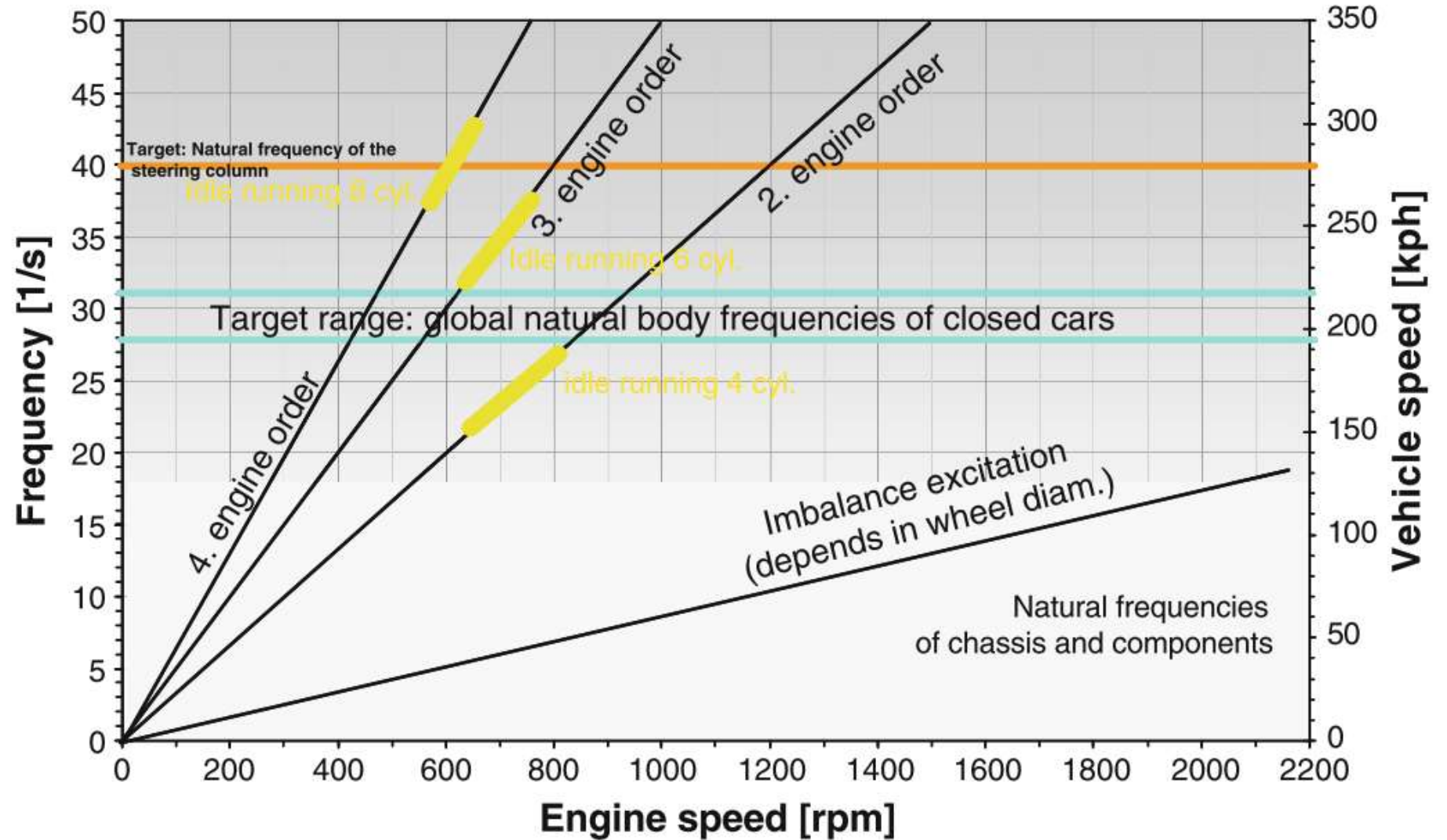


Steering-Gear Test Rig

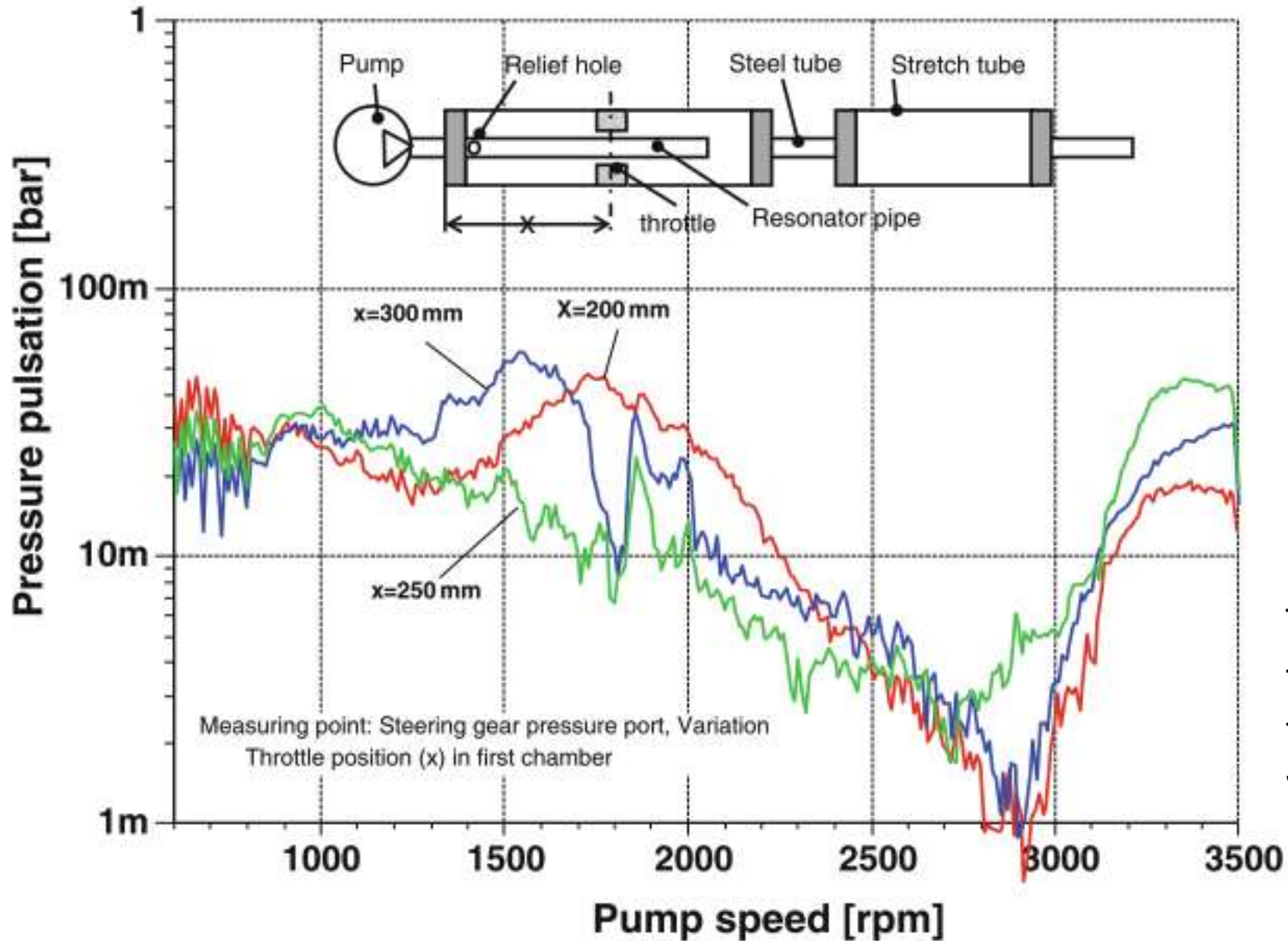


Steering-Gear Test Rig

Engine speed over excitation frequency and speed



Steering-Gear Test Rig



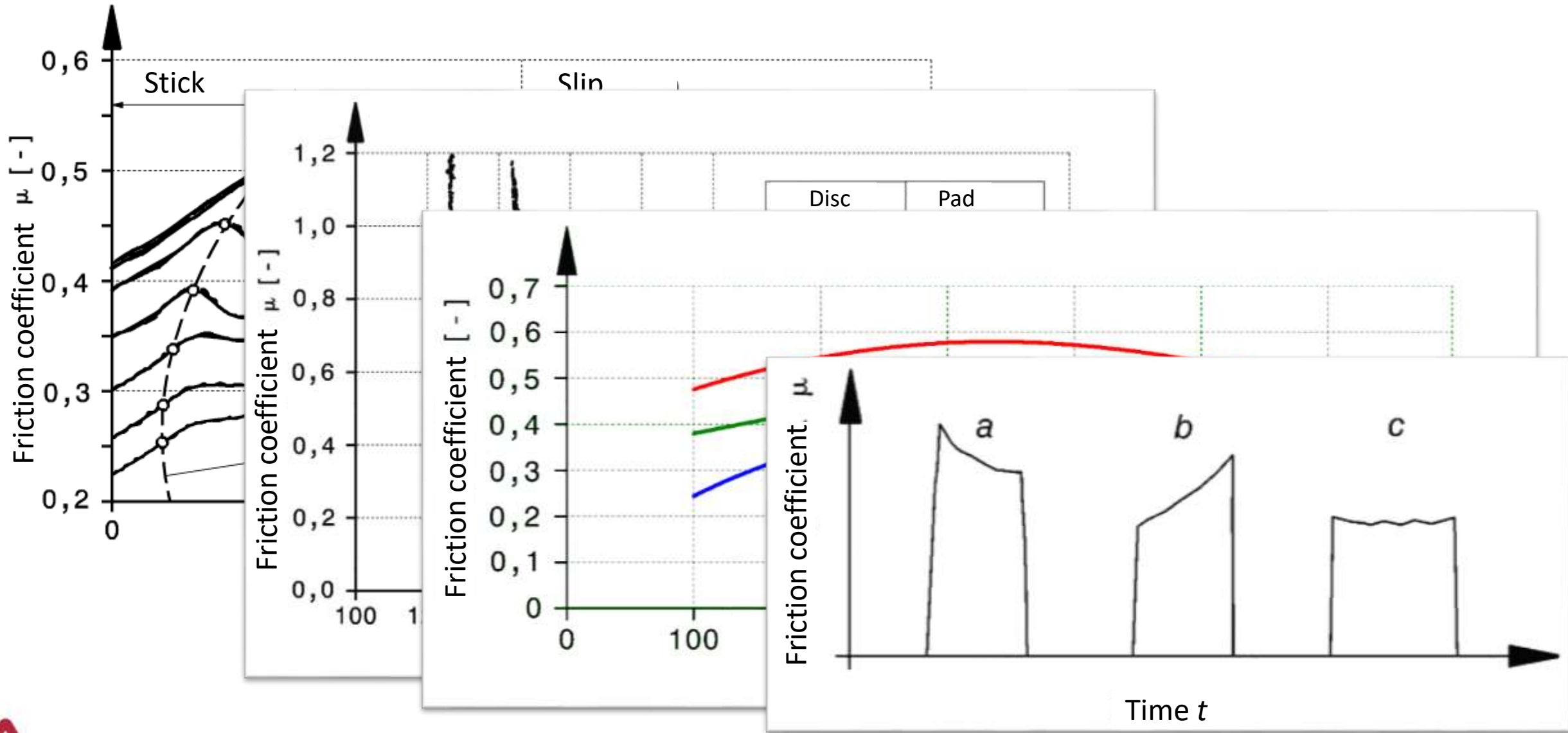
Tuning of stretch tube (position x of throat) during workbench tests



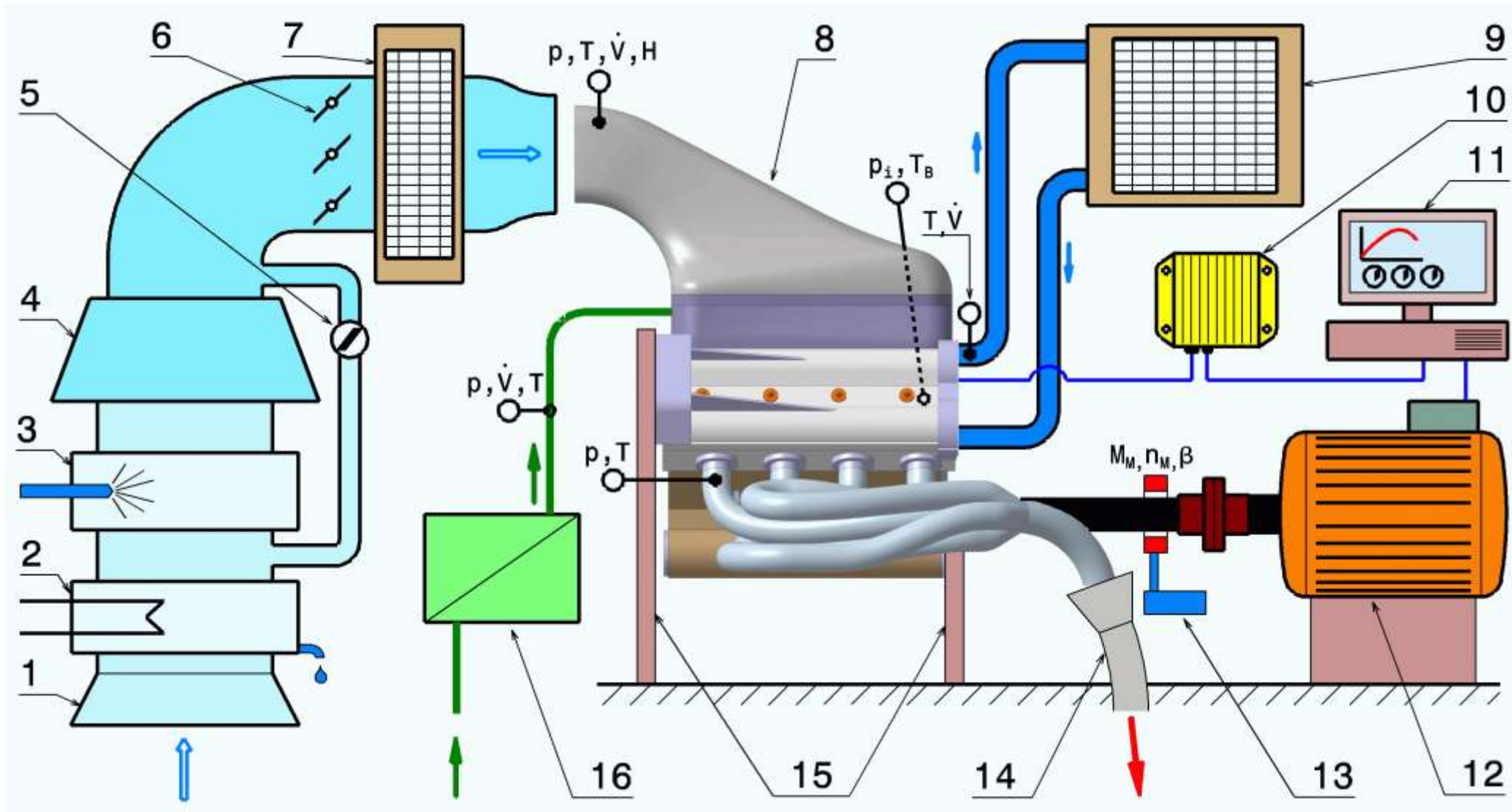
Brake Test Rig



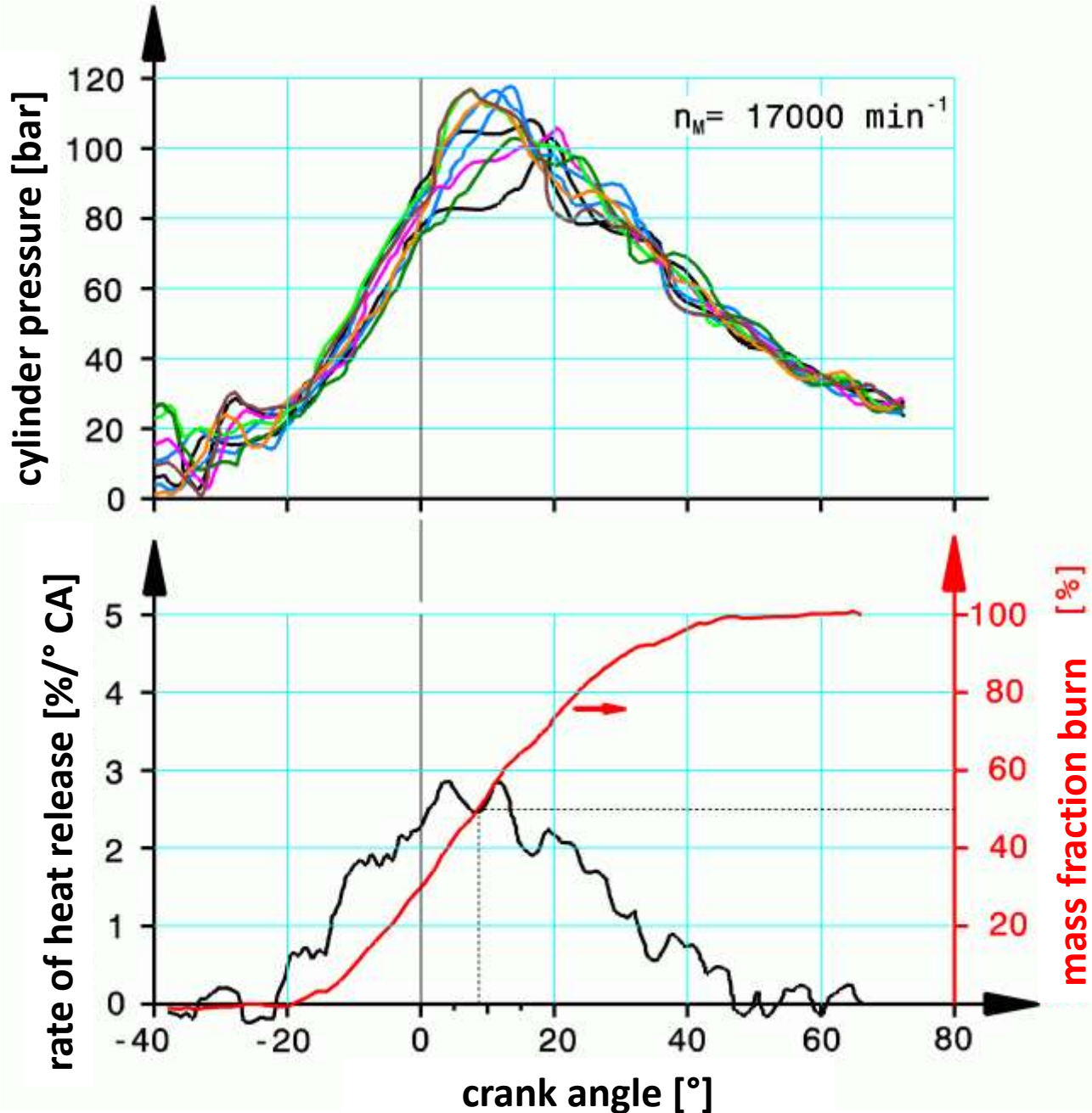
Brake Test Rig



Engine test rig



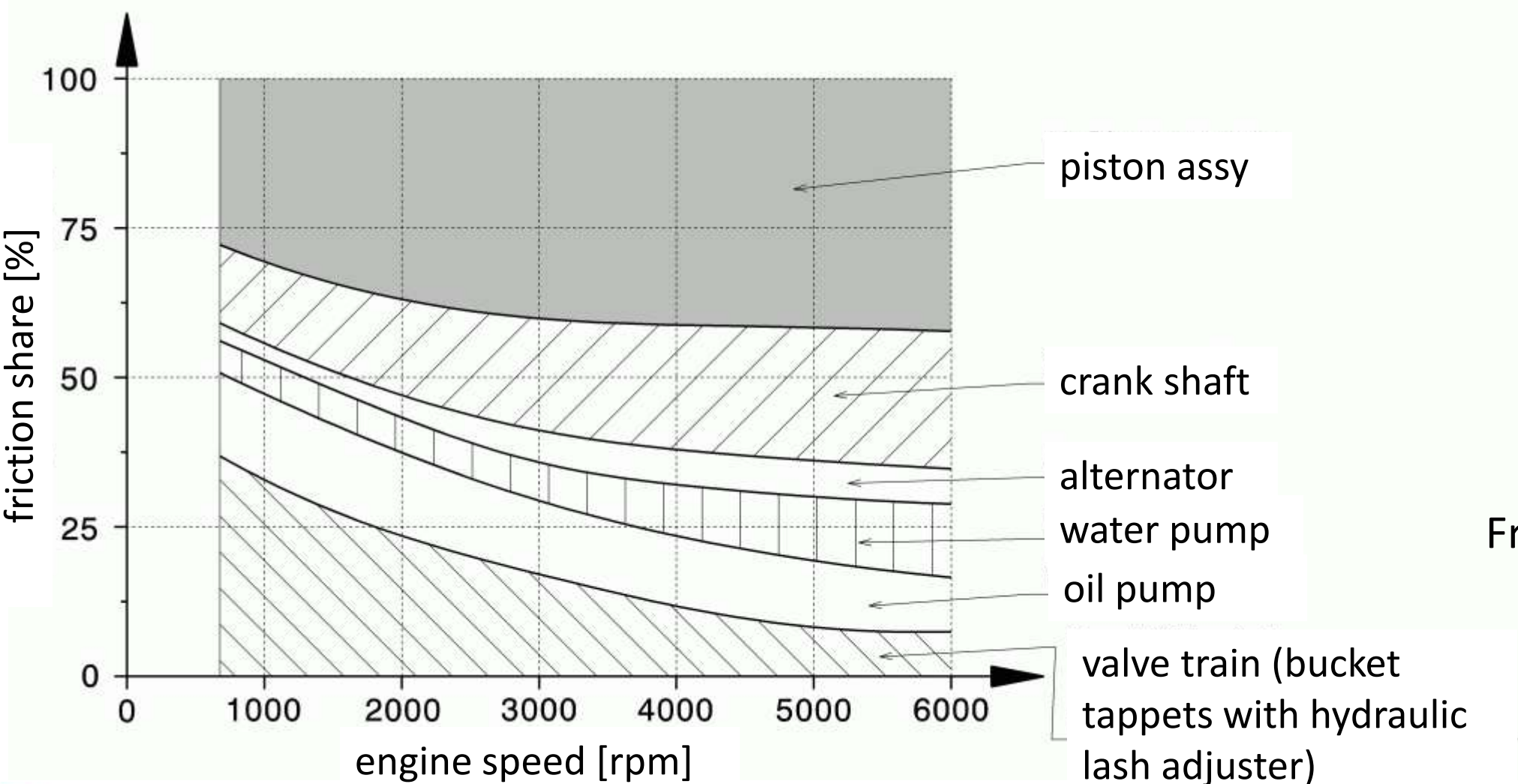
Engine test rig



Combustion diagnostic



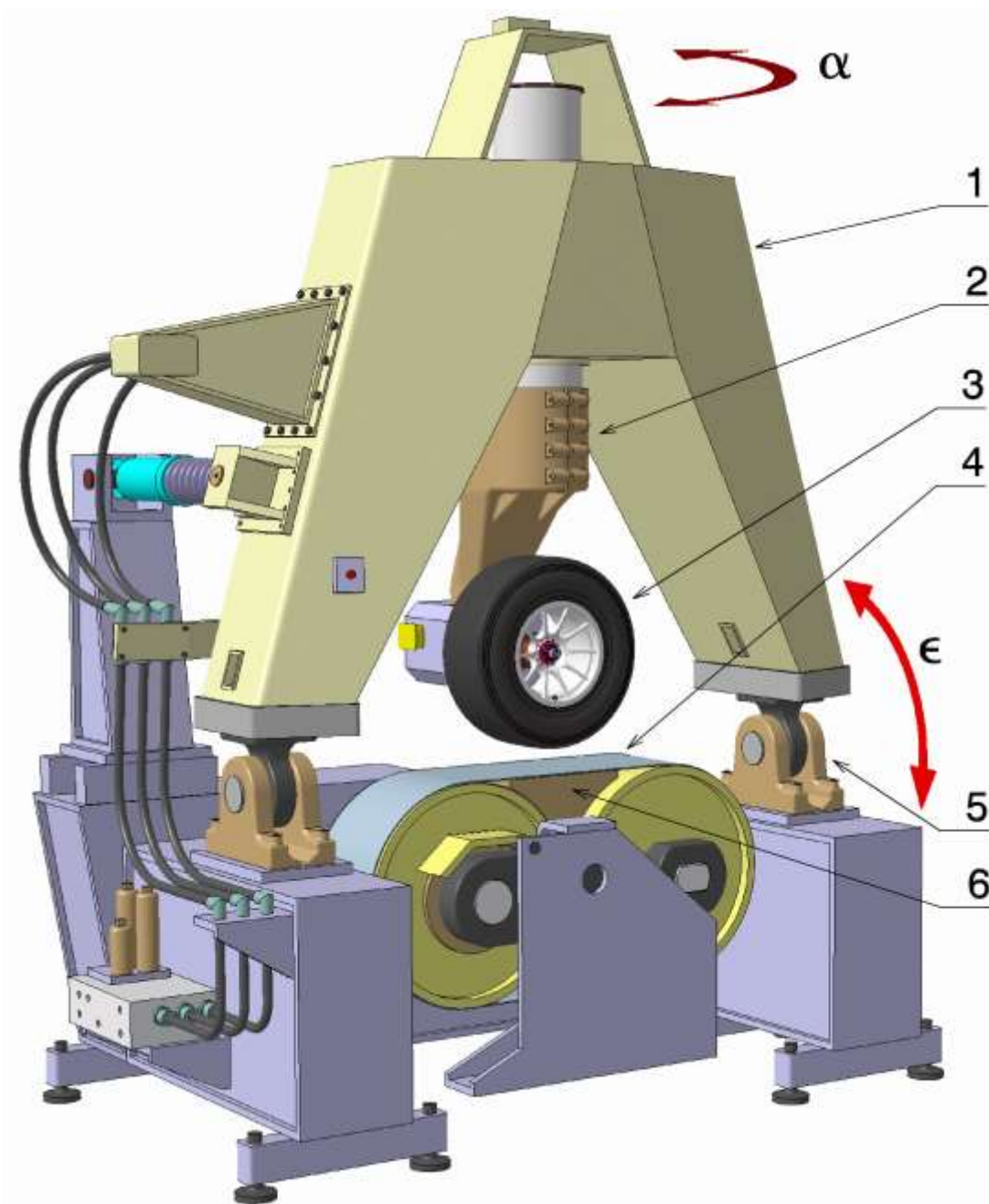
Motored test rig



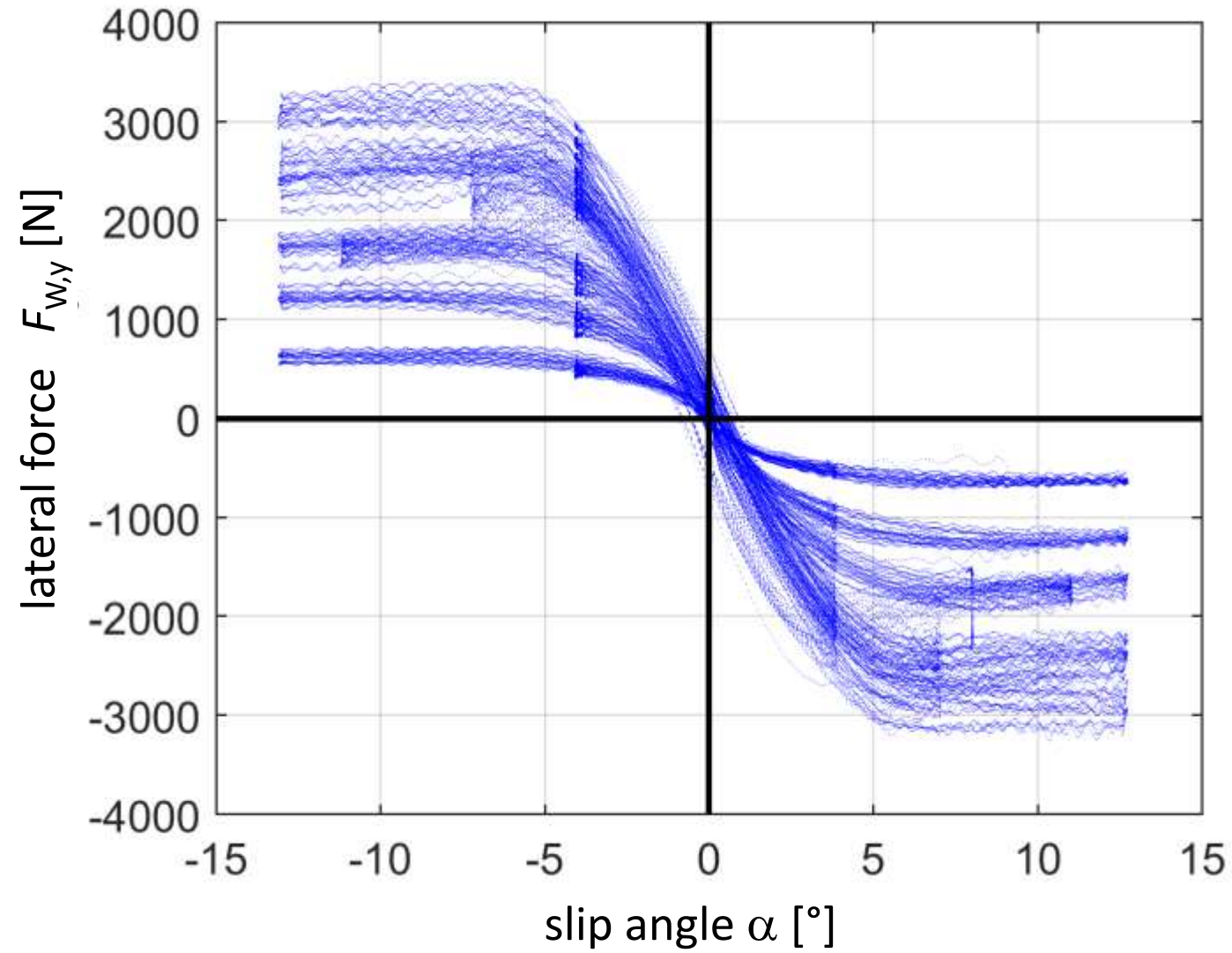
Friction analysis



Tyre test rig



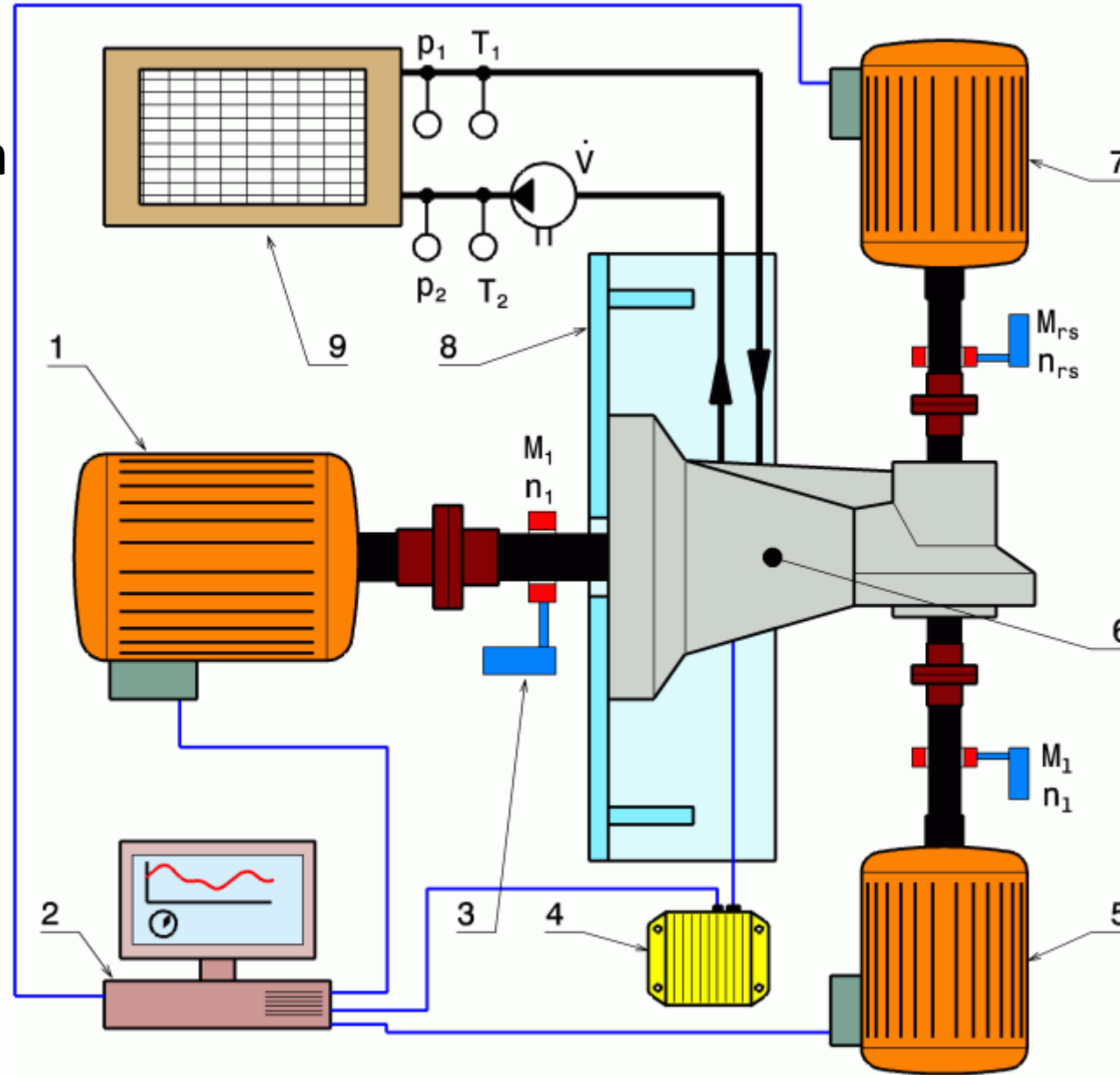
Tyre test rig



Typ. tyre behaviour laterally



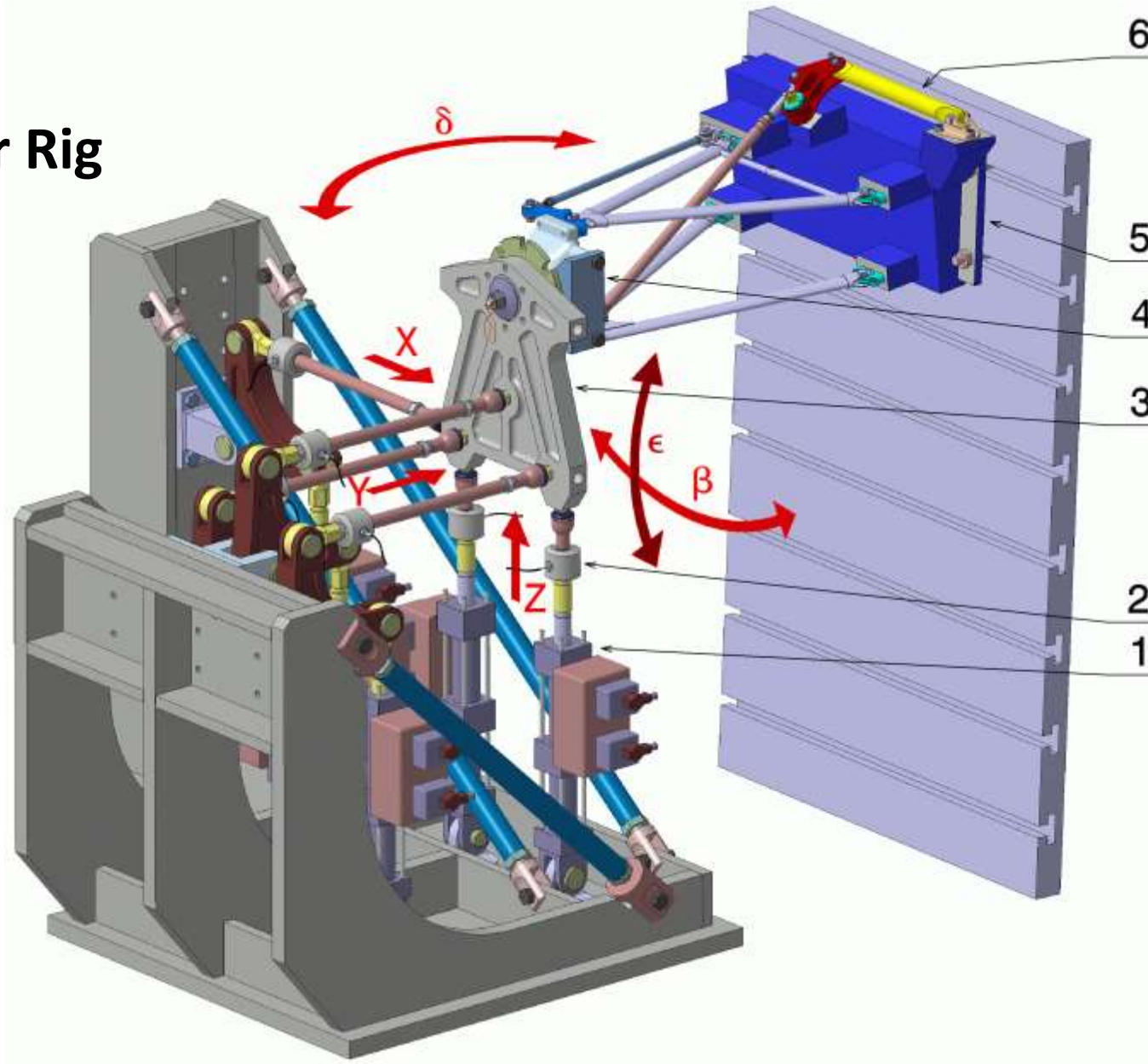
Transmission test rig



- 1 el. machine
- 2 control system
- 3 torque flange
- 4 el. controller (ECU)
- 5, 7 power absorber
- 6 unit under test (UUT)
- 8 rig
- 9 conditioning unit



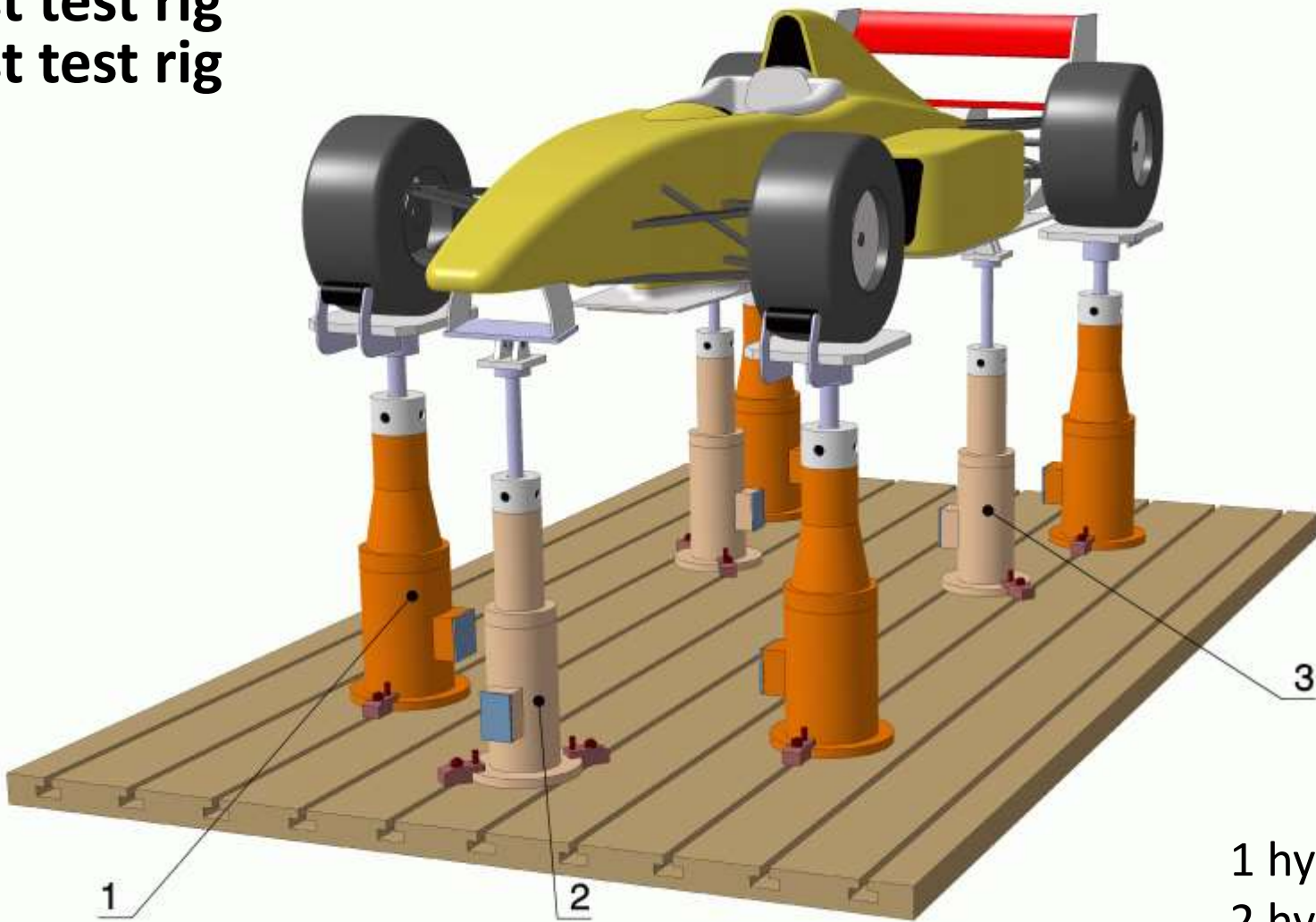
Single-Corner Rig



- 1 actuator (ram)
- 2 load cell
- 3 wheel dummy
- 4 calliper substitute
- 5 body mock up
- 6 solid bar



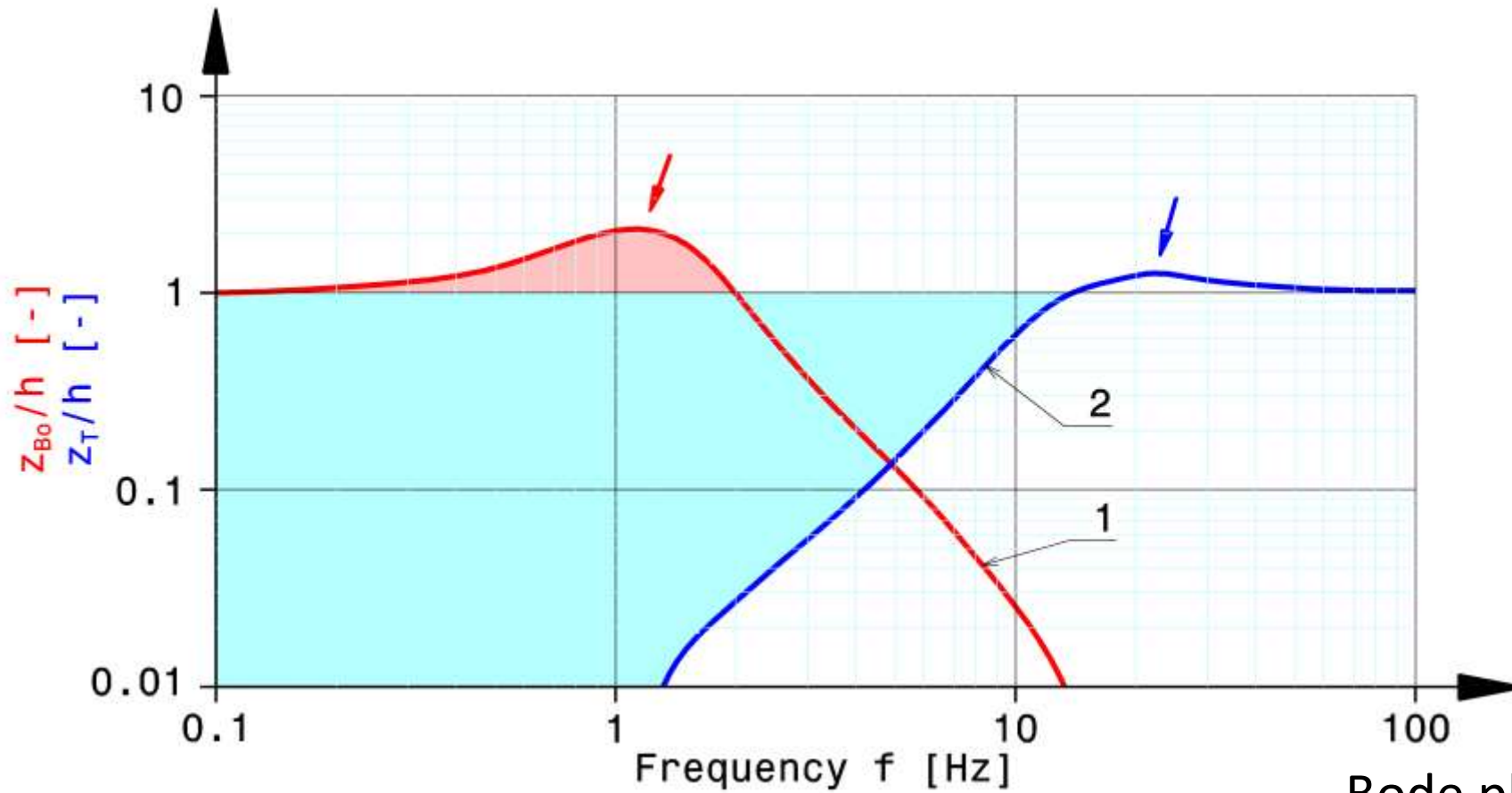
4-post test rig
7-post test rig



1 hydraulic post (corner)
2 hydraulic post (aerodynamic load)



4-post test rig 7-post test rig



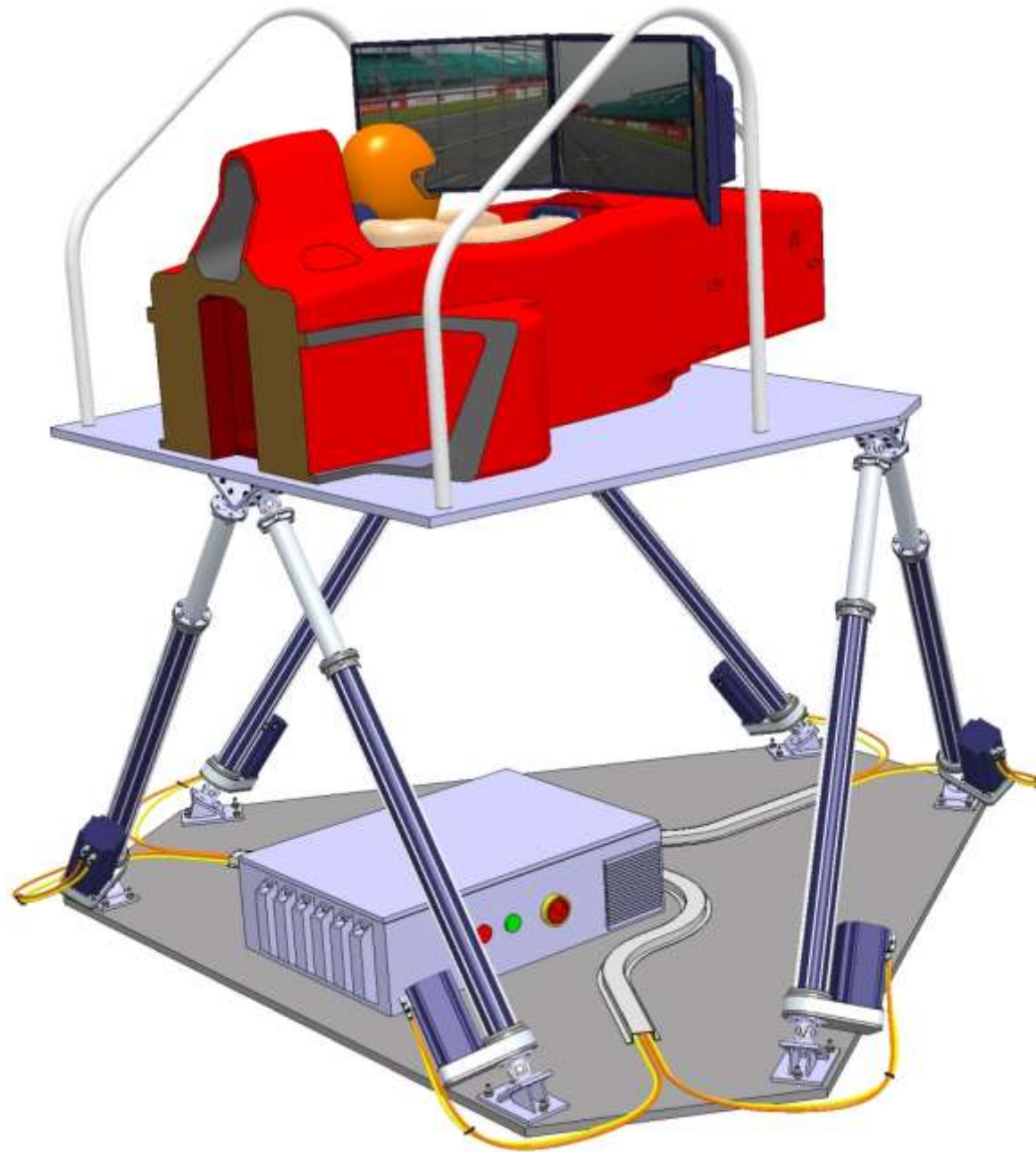
Bode plot

h excitation of road (or post)

z response of body resp. tire



Driving simulator (DIL)



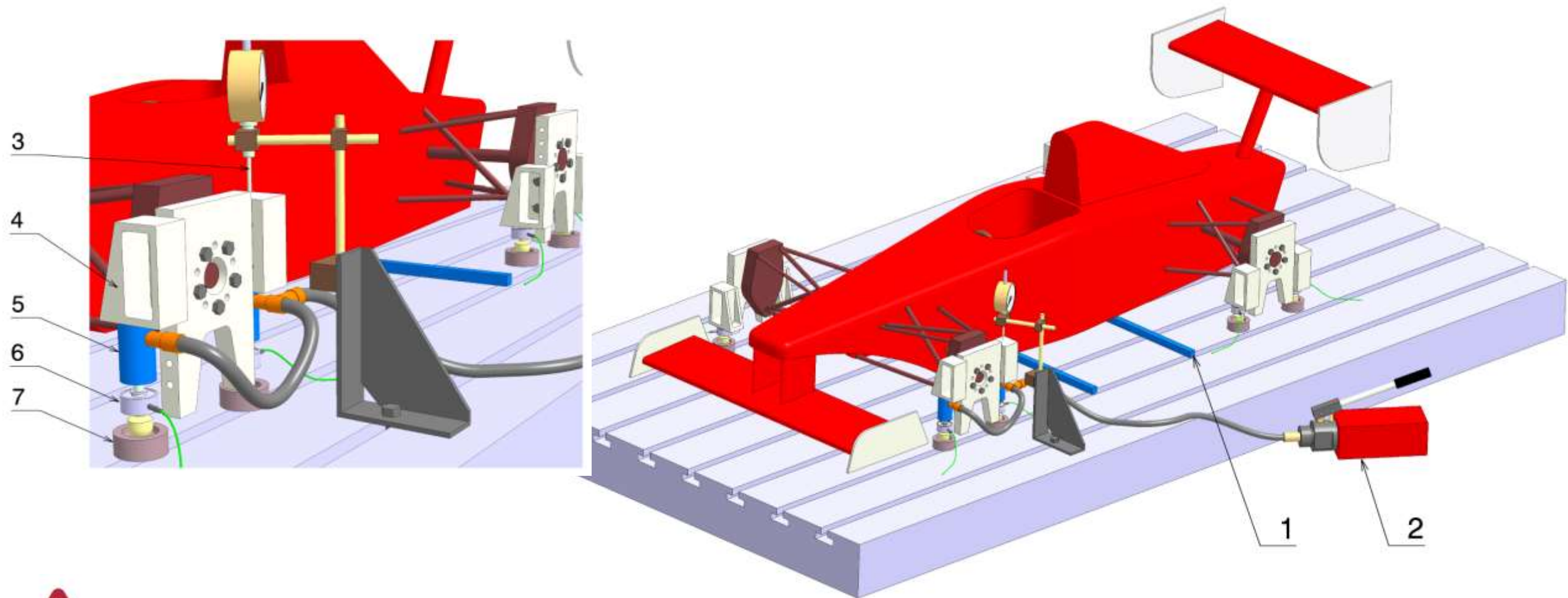
Test Facilities



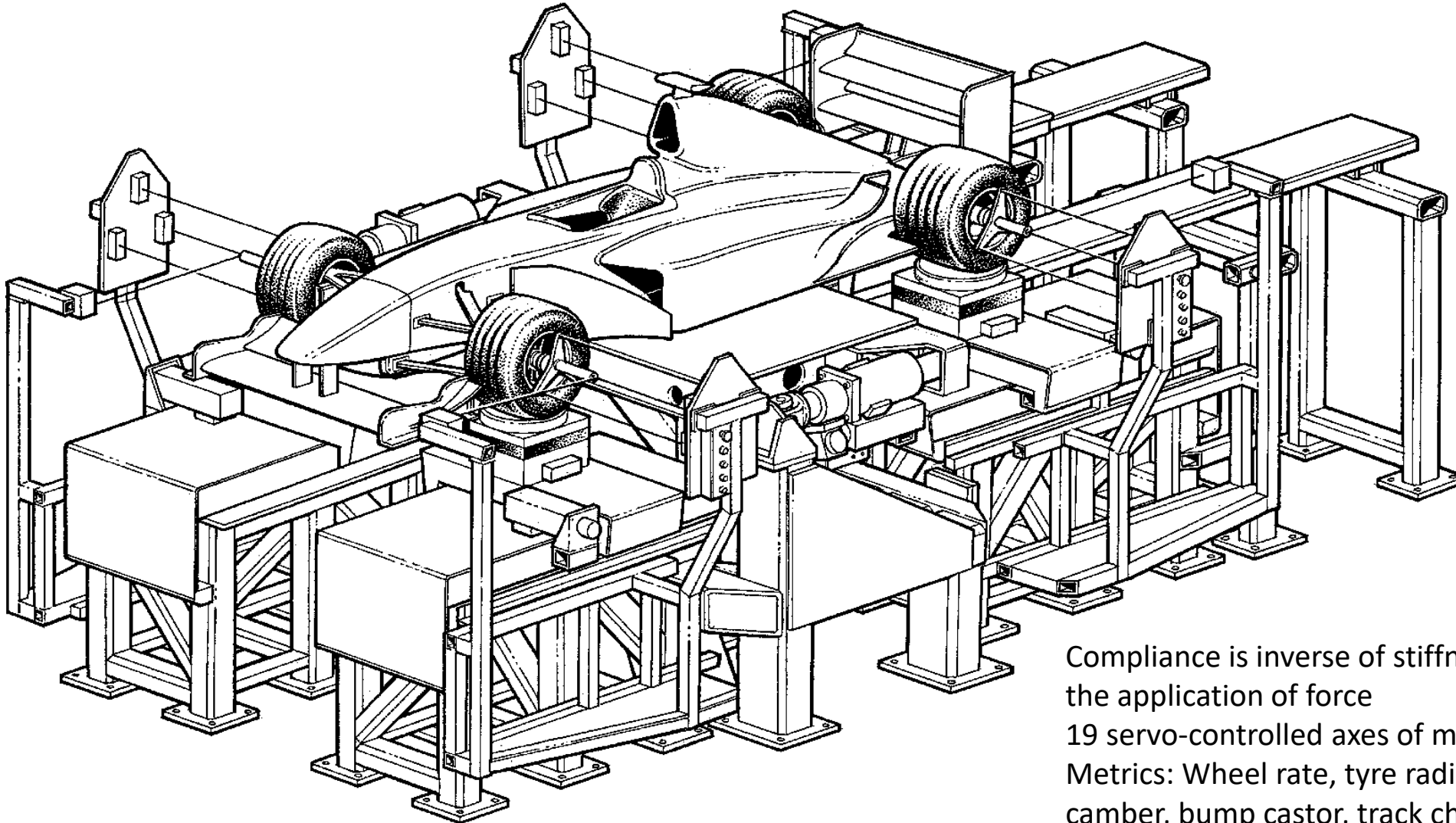
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Torsional chassis stiffness



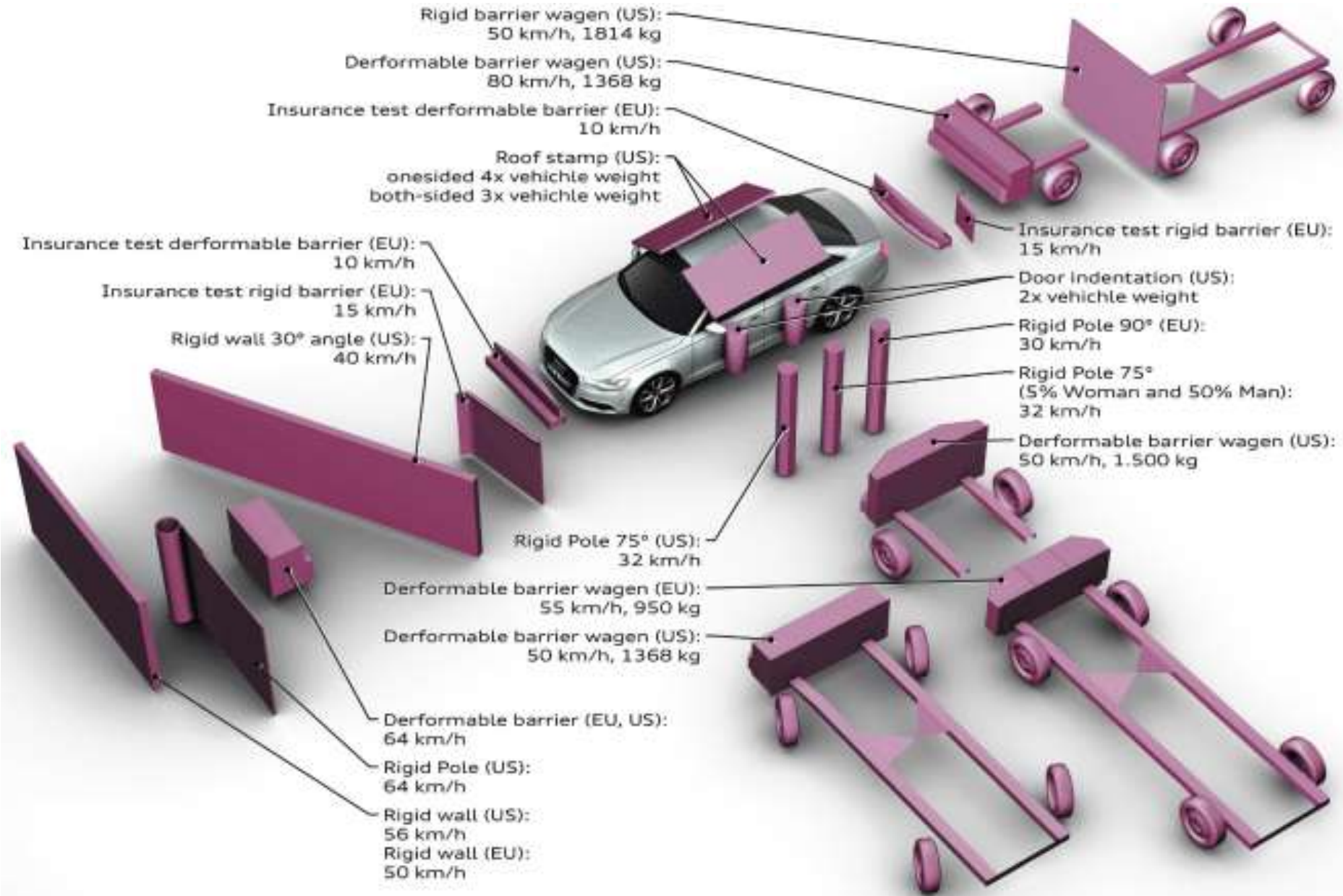
Kinematics & Compliance (K&C) Measuring Rig



Compliance is inverse of stiffness: Resulting deflection from the application of force
19 servo-controlled axes of motion
Metrics: Wheel rate, tyre radial rate, bump steer, bump camber, bump castor, track change, roll centre height,...



Crash Tests



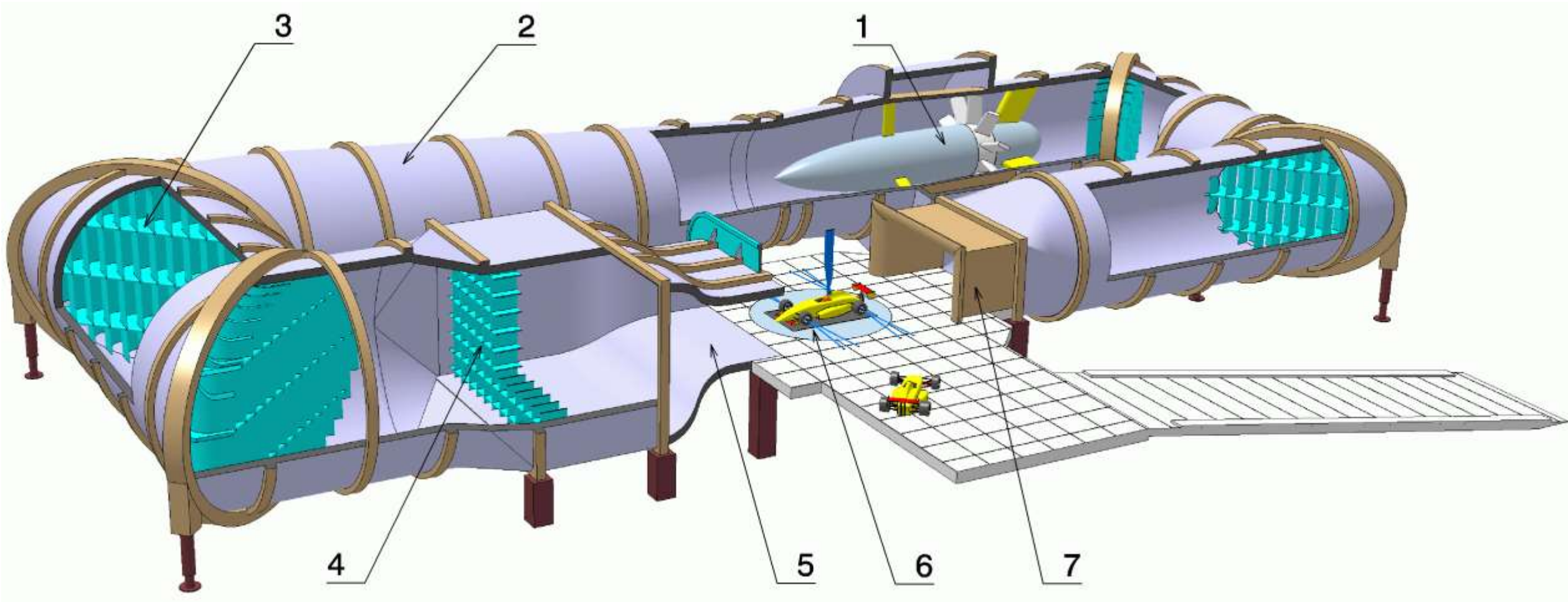
Crash Tests



Head impact test



Wind tunnel



1 fan
2 diffuser

3 turning vanes
4 anti-turbulence screen

5 nozzle
6 test section

7 collector



Chassis Dynamometer



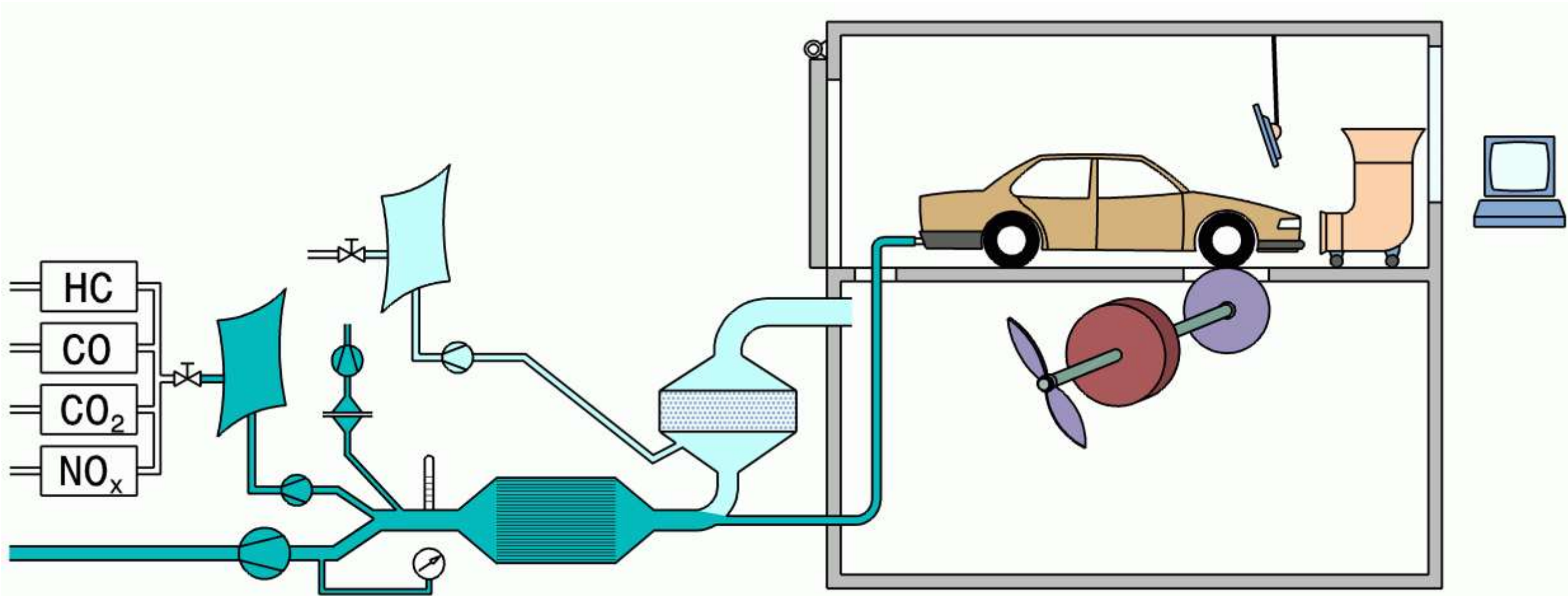
Test Facilities



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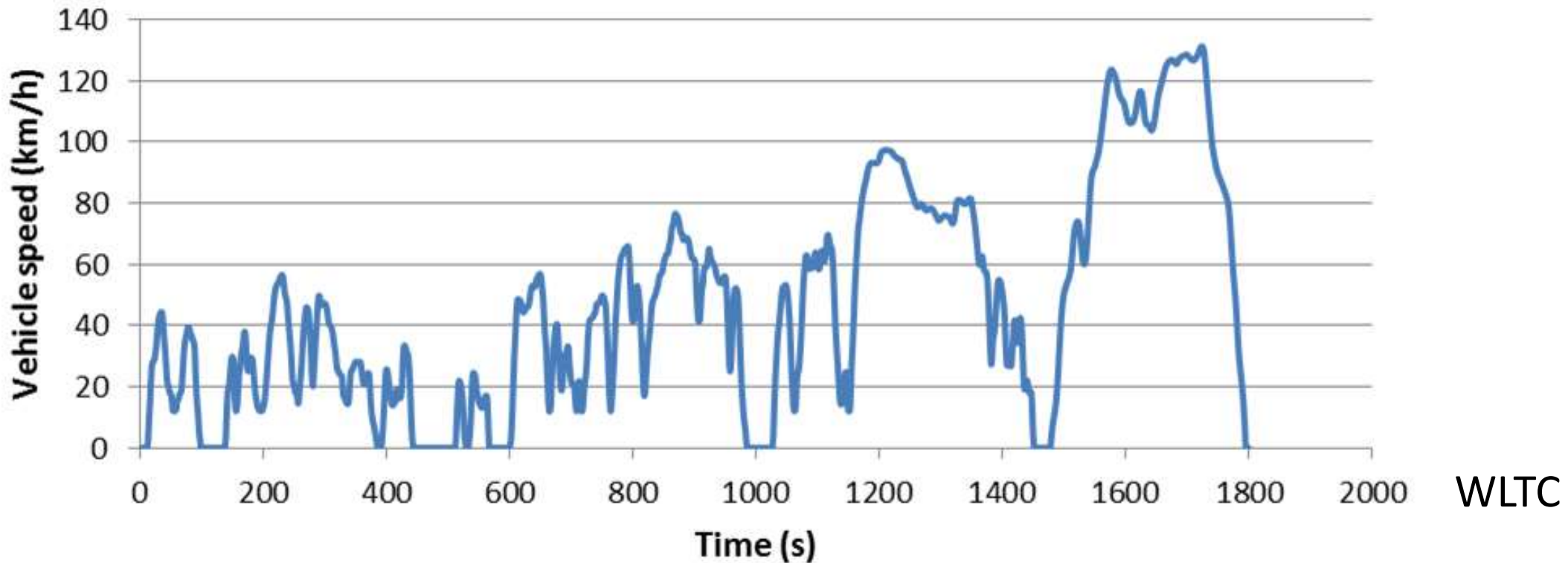


Chassis Dynamometer



Chassis Dynamometer

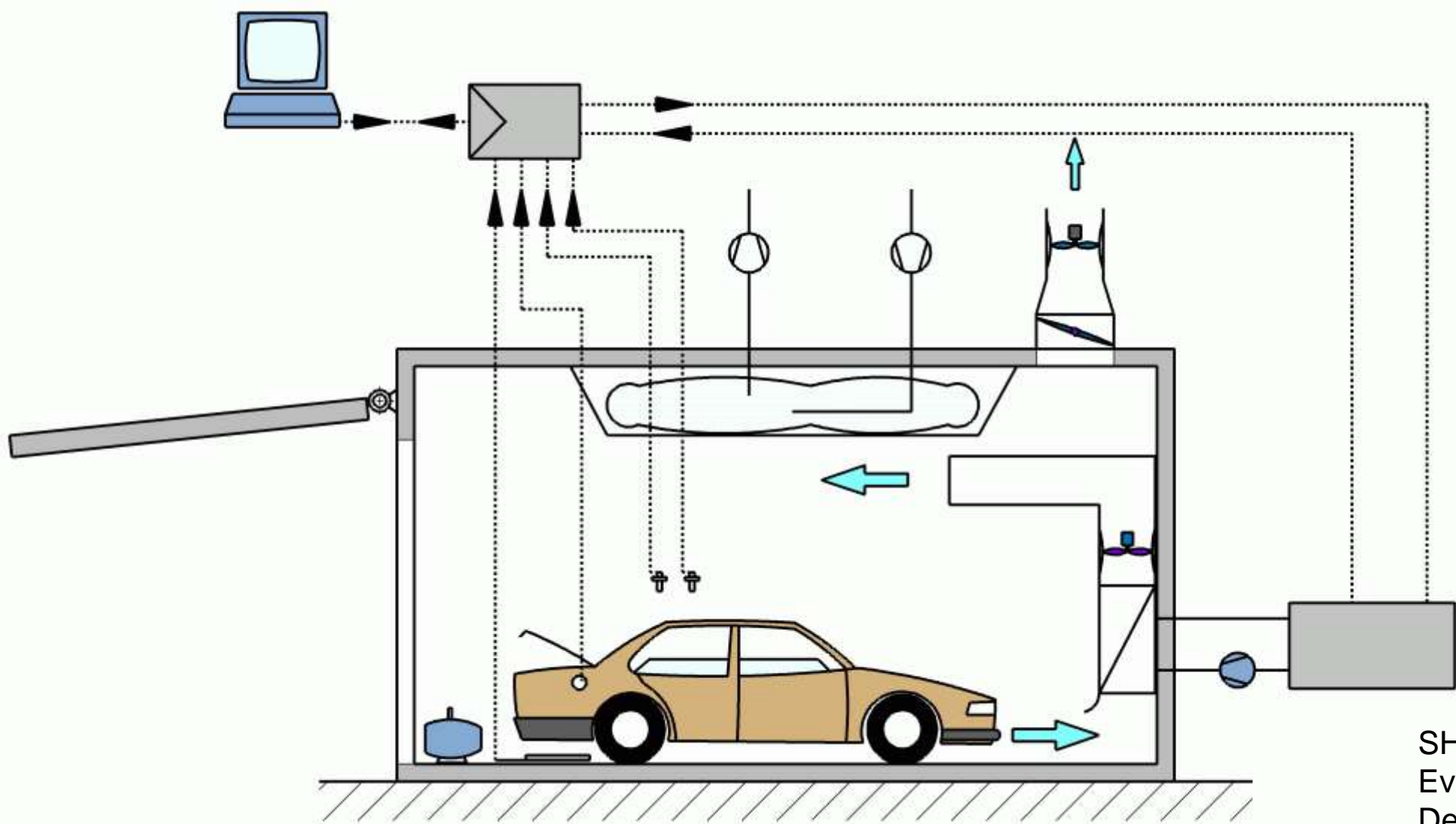
Worldwide harmonized Light vehicles Test Procedure (WLTP)



Exhaust gas emissions, fuel consumption



SHED Chamber



SHED: Sealed Housing for
Evaporative emission
Determination



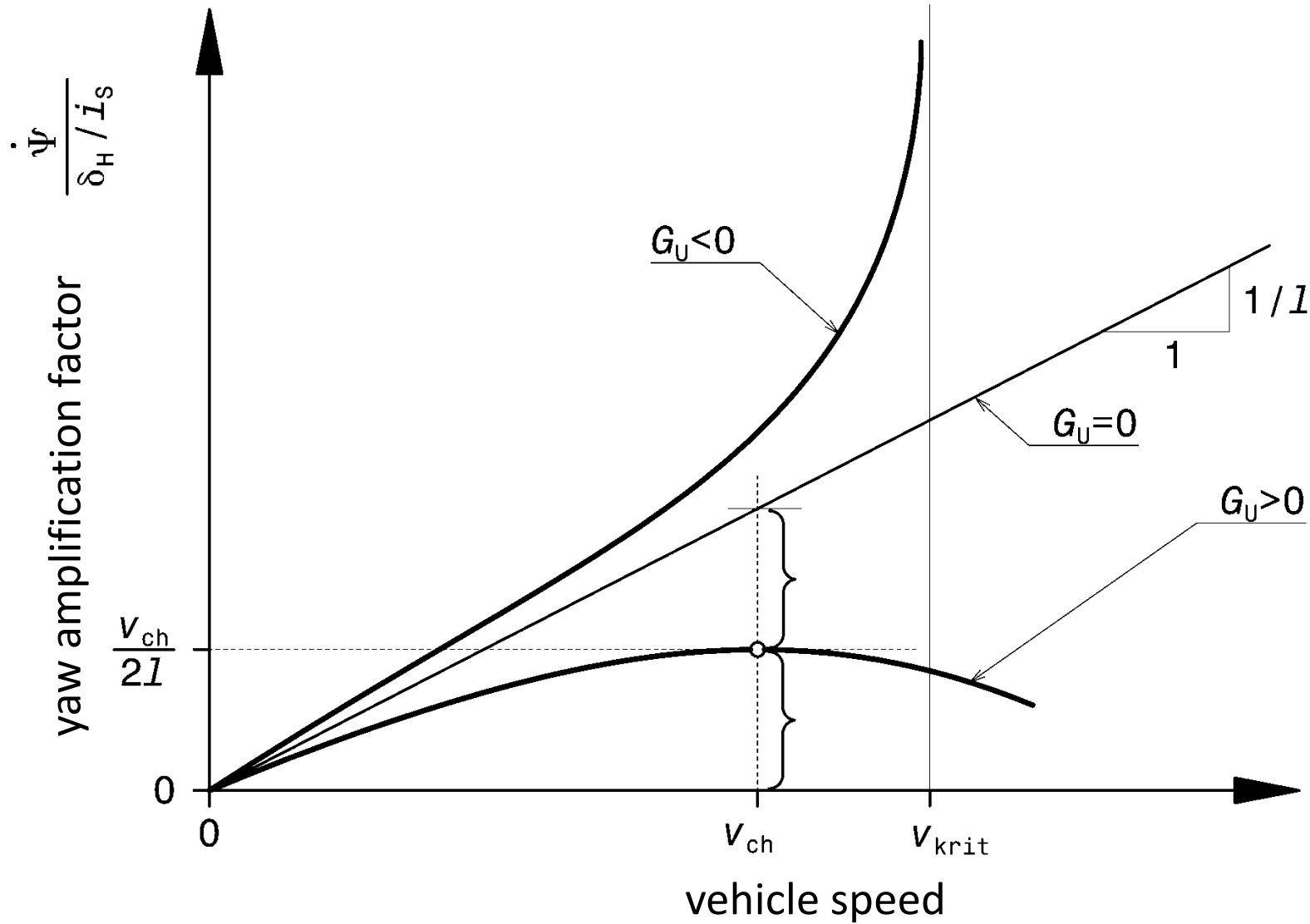
Driving Test



Test Facilities



Driving Test



G_U understeer gradient

Yawing behaviour of a vehicle

3. Test Cell Roles



Test Cell Roles

TEST CELL ROLES AND THEIR SPECIAL FEATURES

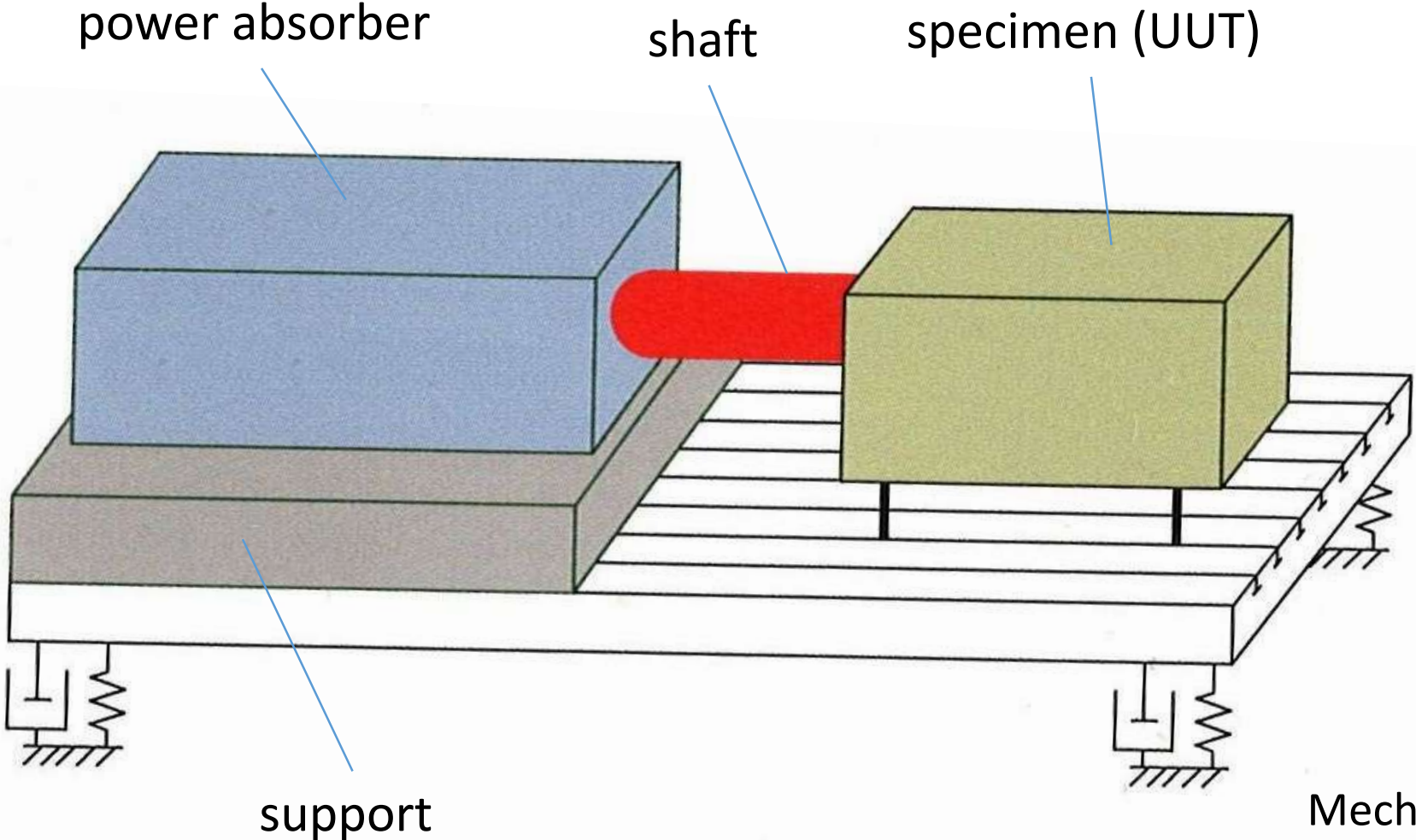
- Hybrid and Electric Vehicle Powertrain Testing
- Batteries and Battery Simulators
- Gearbox and Transmission Test Rigs
- Full Powertrain Test Rigs
- Inclined Engine Test Beds
- Automotive Engine Production Test Cells (Hot Test)
- Automotive Engine Production Cold-Test Stations
- End-of-Line (EOL) Test Station Facility Layout



4. Example Engine Test Rig



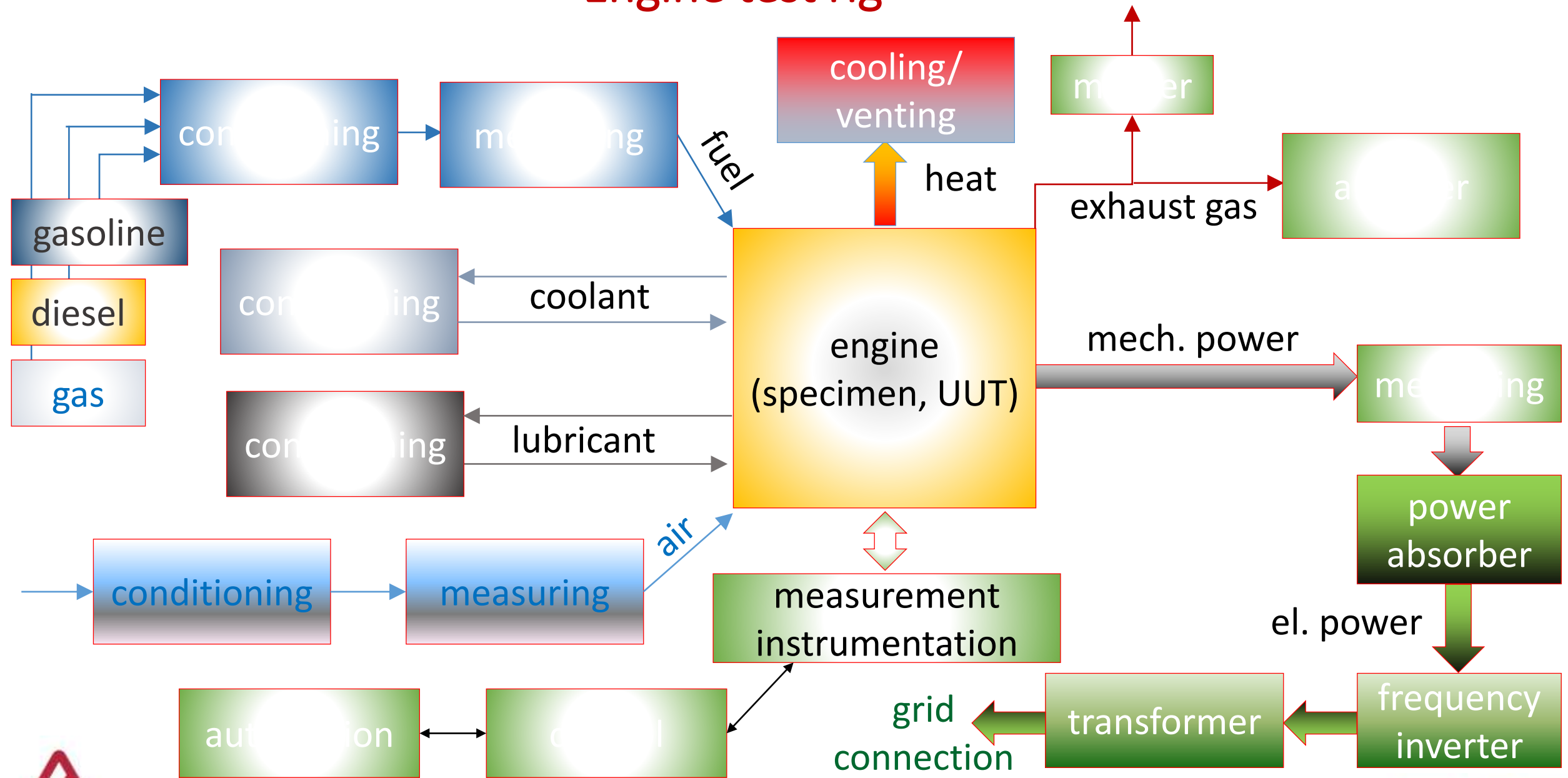
Engine test rig



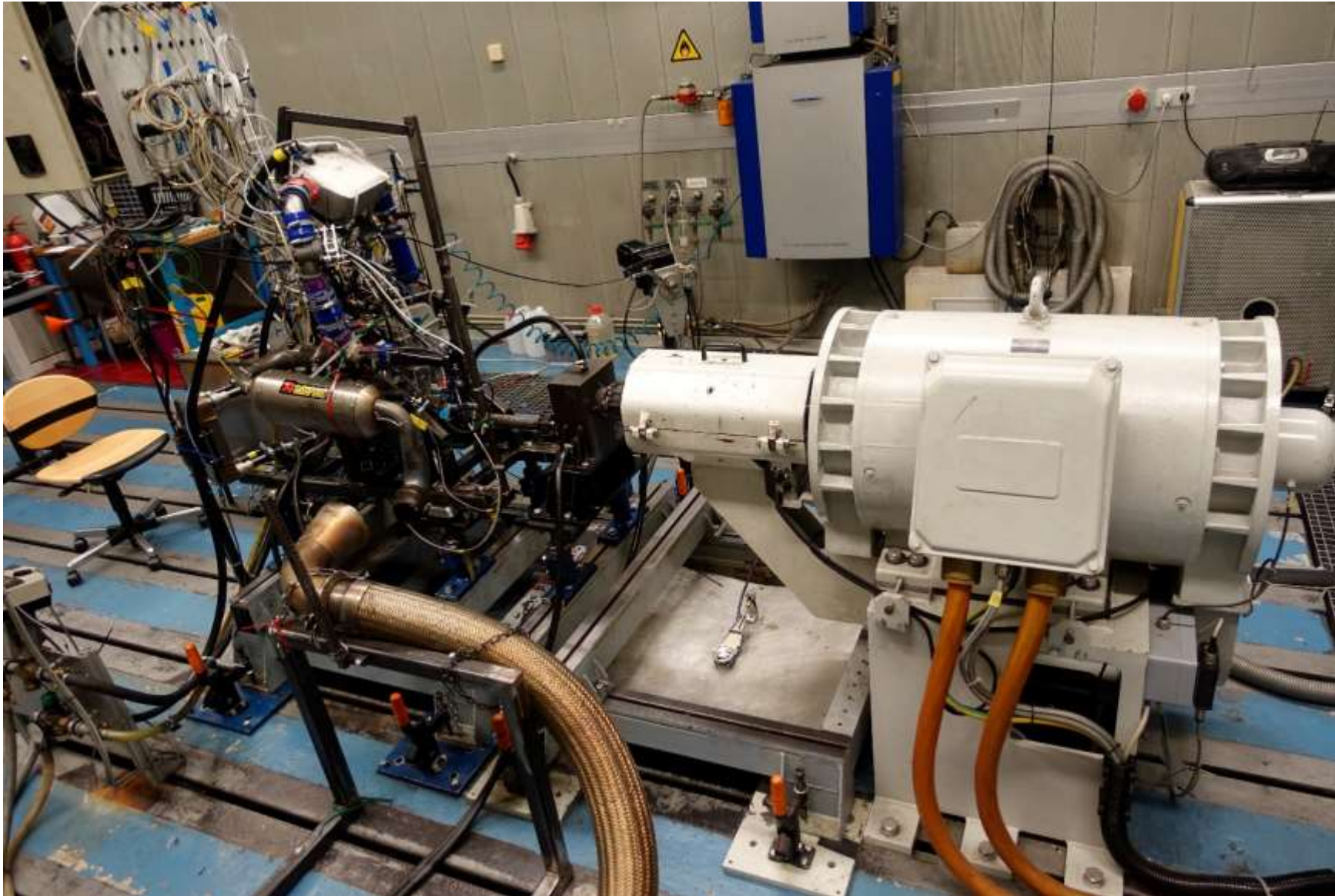
Mechanical point of view
(Functional point of view: Overleaf)



Engine test rig



Engine test rig



Engine test bed south of UAS Graz with AC power absorber (white)





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