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# FOCUS: TRE TECHNICAL CENTRE

## 7-POST RIG & DAMPER DYNAMOMETER @ TRE GMBH



# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

## SET-UP OF VERTICAL DYNAMICS (7-POST RIG)



### The Technology Centre Chassis Development in Neustadt offers you:

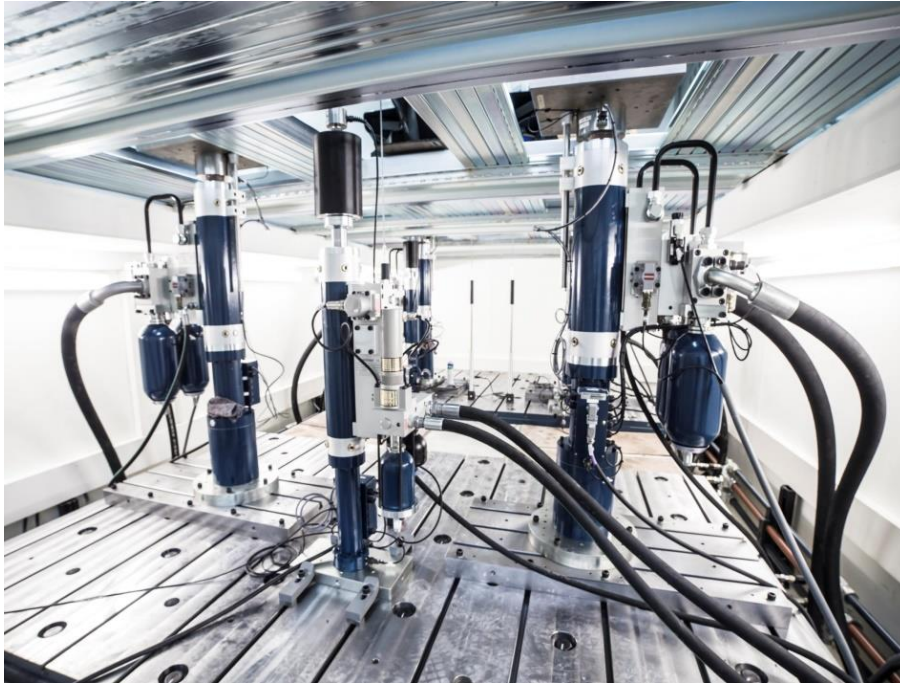
- Chassis development on a one-stop shop base
- Concept → Simulation → Design → Prototyping
- Independent development support for your team activities

### Set-Up of vertical dynamics (7-post rig) also includes:

- Built-in MAHA lift, „0-ground“ clearance of vehicles
- Integrated „car jack“ for sensor installation
- Integrated leveling system as optimum base for geometrical alignment before measurement takes place

# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

## RIG PERFORMANCE PARAMETERS - FORCE AND TRAVEL



### 7 Post Rig – Performance Parameters

7-poster with four wheel actuators and three aero loaders

#### Wheel-Actuator

- Dynamic capacity of wheel actuators up to **36kN** per actuator
- Working stroke **+/-125mm**
- Min/Max Wheelbase **1600/4600 mm**
- Min/Max Track width **740/2600 mm**

#### Aero-Loader-Actuator

- Dynamic capacity of aero loaders up to **29kN** per loader in pull-direction and up to **5kN** in push-direction
- Working stroke **+/- 150mm**
- Min/Max Aero loader X-axis **1300 / 4850mm**
- Min/Max Aero loader Y-Axis **300 / 2700 mm**



**One of the major advantages of the TRE 7-Post-Rig compared to its competitors is its large wheel actuator travel which especially improves replication of kerb-events and rough road inputs.**

# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

## TEST PROCEDURES AND RIG SETUPS



### Most common test procedures:

- Track replay using hub accelerations or damper displacement signals from on-track testing to exactly replicate car behaviour and dynamic contact-patch-loads
- Heave, pitch and roll sweeps
- Static roll, pitch and aero pulldown tests
- Single kerb events

### Poster Rig Setups:

#### 4-Poster Setup

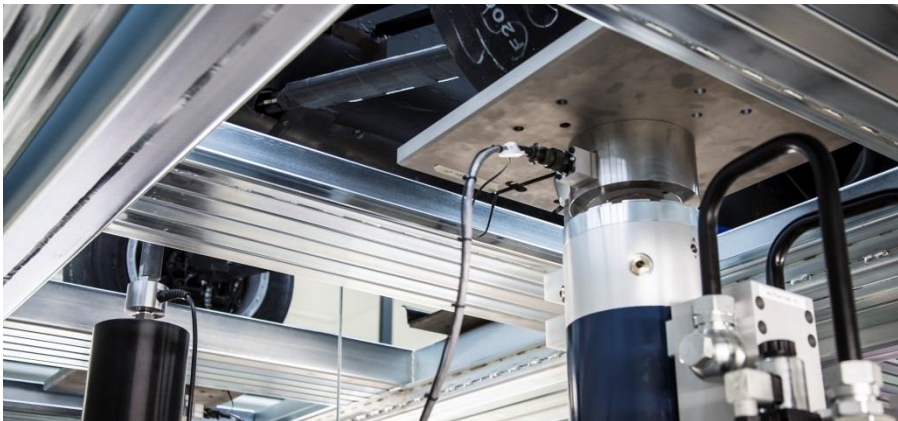
- Standard rig setup which only excites the wheels
- Good solution for cars which produce a negligible amount of downforce
- **Example cars:** GT cars, touring cars, cup cars & small formula cars

#### 6-Poster Setup

- Advanced rig setup using 4 wheel actuators and 2 aero loaders which also simulates created aerodynamics forces acting on the chassis and pitch motions
- **Example cars:** formula cars, LMP, GT Cars

#### 7-Poster Setup

- Full rig setup using 4 wheel actuators and 3 aero loaders which simulates created aerodynamics forces acting on the chassis plus roll and pitch motions
- This also improves track replays significantly and results in more realistic contact patch loads
- **Example cars:** formula cars, LMP, prototypes and GT Cars



# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

7-POST RIG – CUSTOMER REFERENCES



## Motorsport:

- Formula 1
- Formula 3
- Formula 4
- GT Cars
- Touring Cars
- LMP (Le Mans Prototype)
- Rally Cars
- Cup Cars



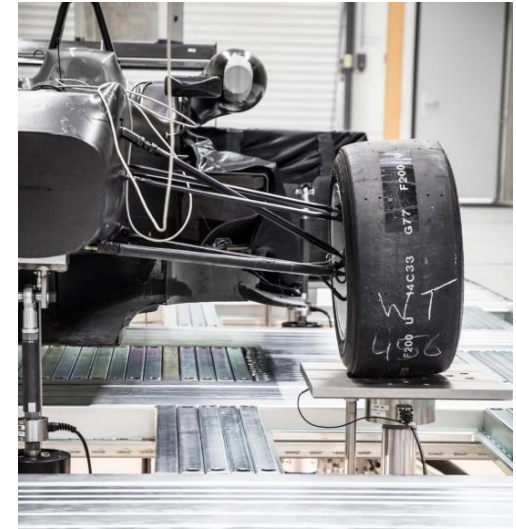
## Production Cars:

- High Performance Cars
- SUV's
- Damper development
- Benchmarking
- Basic research

# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

7-POST RIG SETUP – F3 TEST @ TRE CHASSIS DEVELOPMENT CENTRE – NEUSTADT

TRE



**Rig configuration:** 7-Poster-Setup

**Time frame of test:** ½ day installation, 3 test days

**Test focus:**

- Track Replay including aero forces, pitch and roll motions
- Heave, Pitch & Roll motions at different vehicle speeds and aero forces fitted specific to road input data

**Main targets:**

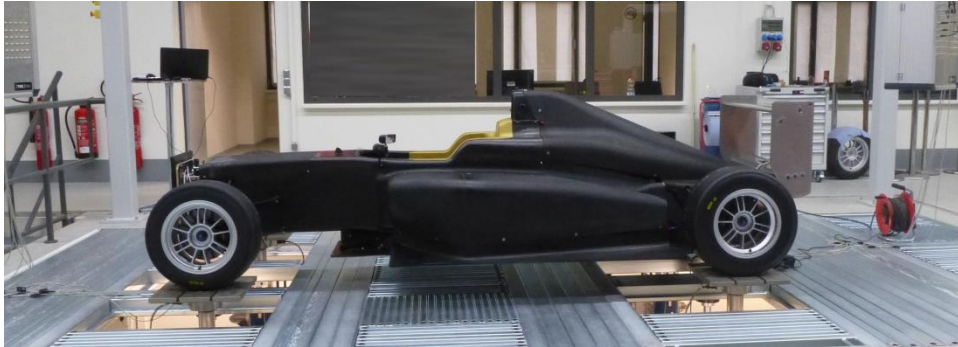
- Optimisation of damping for different spring and bump stop rate
- Specific setup optimisation on track conditions
- Influence of ride height changes , pitch and contact patch loads on car performance



# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

6-POST RIG SETUP – F4 TEST @ TRE CHASSIS DEVELOPMENT CENTRE – NEUSTADT

TRE



**Rig configuration:** 6-Poster-Setup

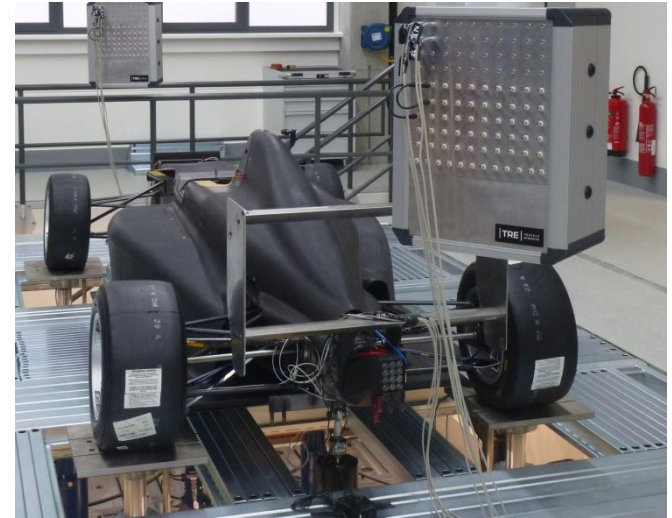
**Time frame of test:** ½ day installation, 2 test days

**Test focus:**

- Heave & Pitch motions at different vehicle speeds and aero forces
- Influence of aerodynamics on vehicle balance

**Main targets:**

- Finding the best compromise between mechanical & aerodynamical grip
- Evaluate possible adjustment range of spec-dampers
- Setup compensation of the often unsymmetric spec-dampers to gurantee symmetric car balance



# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

4-POST RIG SETUP – RALLY R2 CAR TEST @ TRE CHASSIS DEVELOPMENT CENTRE



**Rig configuration:** 4-Poster-Setup

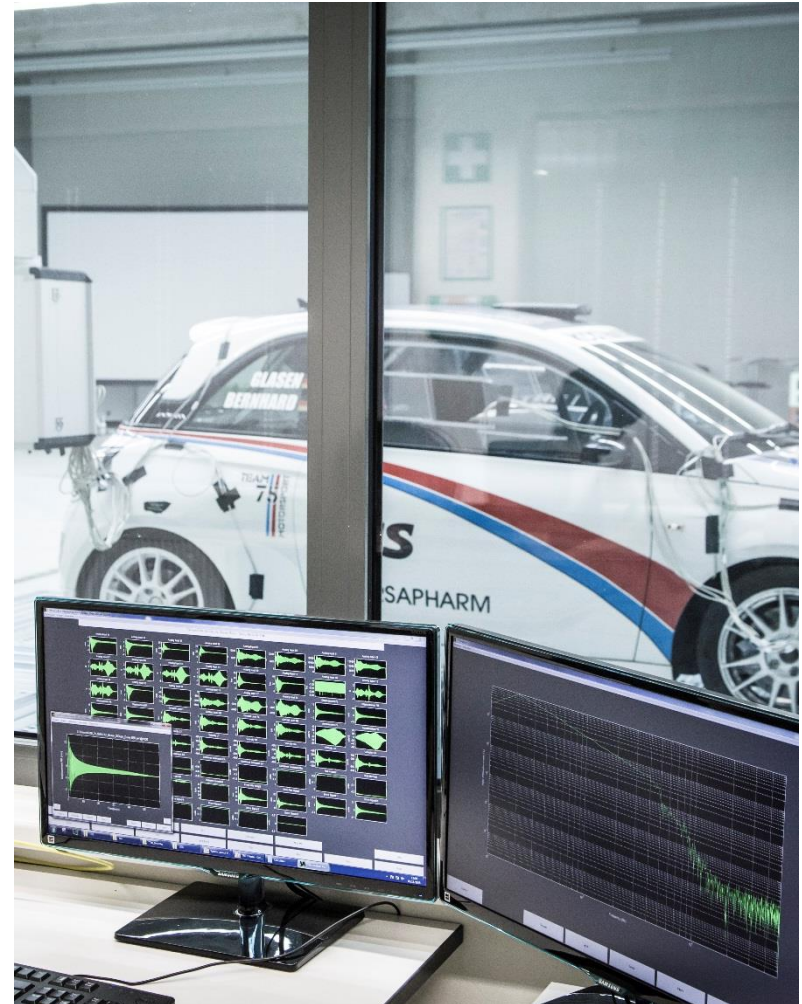
**Time frame of test:** ½ day installation, 1 test day

**Test focus:**

- Heave and roll sweeps at a wide range of wheel actuator speeds to take into account the many different rally stage conditions

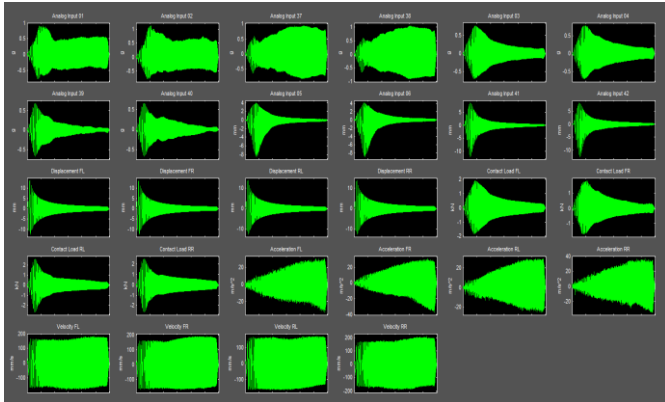
**Main targets:**

- Optimise ratio between bump and rebound damping
- Maximisation of mechanical grip by maintaining a needed level of body control and agility
- Providing a gravel and a tarmac optimised setup

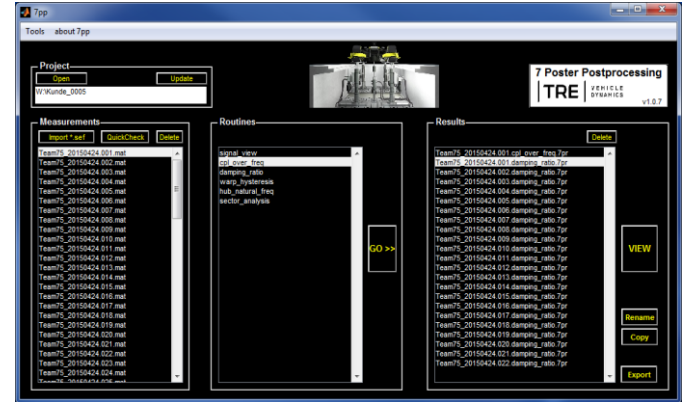


# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

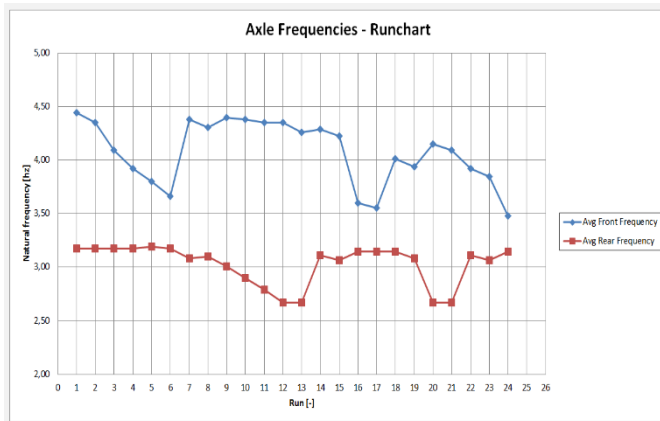
## TRE POST-PROCESSING PROCEDURE



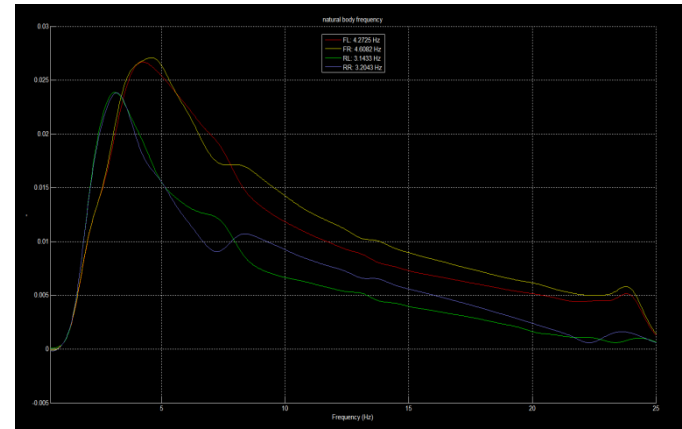
Recording and visualisation of all 7-poster inputs and sensor signals during the test runs including live-telemetry



All recorded raw-data can be exported into matlab or excel-format and analysed using TRE's custom made toolbox



Plot of basic analysis parameters in a excel runchart shows progress and influence of setup changes during testing



Automatic created graphs during post-processing according to analysis routines

# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

ADDITIONAL BENEFIT: DAMPER DYNAMOMETER



## Damper dynamometer performance parameters:

- Servo hydraulic test rig
- max. velocity **6 m/s**
- max. displacement **± 100mm**
- max. static force **45kN**
- max. dynamic force **36kN**
- friction and preload measurement
- temperature fading tests

## Additional features:

- Track replay
- High frequency tests up to 50Hz
- Damper shimming's can be measured and modified
- Defective dampers can be documented
- All in one support of derivate set-up variants
- We are experienced with dampers made by the main shock-absorber manufacturers
- Homologation approval and durability tests for road and racing cars

# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

7 POST RIG: POST INPUT / OUTPUT



## Our I/O options:

- 72 analog inputs (+/- 10V), upgradable if required
- 12 analog outputs (+/- 10V), upgradable if required
- In addition output of rig signals (displacement, force,...)
- individual analysis possible (Matlab)
- combination with TRE's simulation-expertise
- data-output in various formats (MS Excel, ASCII, .mat, ...)

## Bracket design - We can support you:

- We manufacture brackets for aero loaders according to your request or design from carbon fibre, steel, aluminium...
- F3 – Dallara F312 Bracket Set available (lightweight and stiff carbon design)
- F4 – Tatuus T014 Bracket Set available (lightweight and stiff steel design)
- Various production or cup car sets available

# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

7 POST RIG: OWN SENSOR POOL AVAILABLE



## Available sensors e.g.:

### **Acceleration Sensors:**

- MEAS 4203-10-10-10-A1 (3-axis 10g)
- MEAS 4201-30-G1 (1-axis 30g)
- MEAS 4201-10-G1 (1-axis 10g)

### **Displacement Sensors:**

- Damper travel linear potentiometers (e.g.: Variohm ELPM, different lengths)
- Damper travel cable extension transducers (e.g.: MEAS MT2A, different lengths)
- Capacitive travel measurement (e.g.: Waycon SMxy-T-KR)

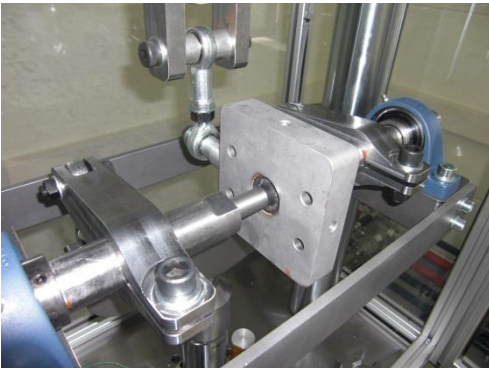
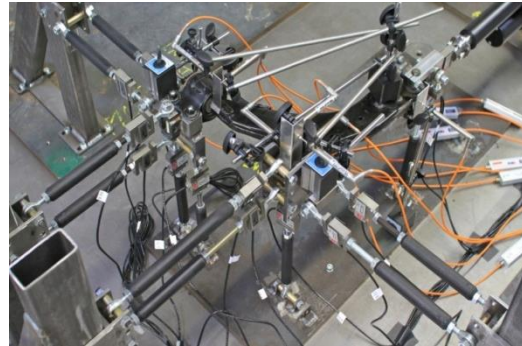
### **Temperature Sensors:**

- K-type temperature sensors
- PT1000-type temperature sensors

**Other sensors available on request**

# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

## 7 POST RIG: COMPONENT TESTING



## Component Testing Possibilities

### T-nut-plate

- 3 x 2 m t-nut plate, on air springs, automatic leveling
- Component stiffness and life-cycle testing
- Chassis torsional stiffness tests

### Full vehicle lifecycle testing

- Homologation approval and endurance tests for road cars

### Bushing Measurements

- Quasistatic & dynamic characterisation
- Dynamic measurement up to 30Hz
- Axial, radial, torsional and cardanic characterisation
- Durability tests

### What we can do for you:

- We offer test time on the rig and analysis competence in the field of car concept, configuration and development
- This could lead to chassis, component or control system modifications
- Optimisation of contact patch load variations, pitch and roll optimisation
- Analysis of brake-, cornering-, traction- and kerb sectors or low-, middle- and high speed sectors as the definition of under- and oversteer
- Definition of set-up variants, “real-time” support for road car development
- On-track support for track replay and data acquisition
- Own workshop and prototyping facilities
- Validation of simulation models (component, module, full vehicle-MBS)
- Synergy with driving dynamics simulation
- Lowest level could be the rental of pure test time on the rig

# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

## 7 POST RIG: SERVICES - OVERVIEW



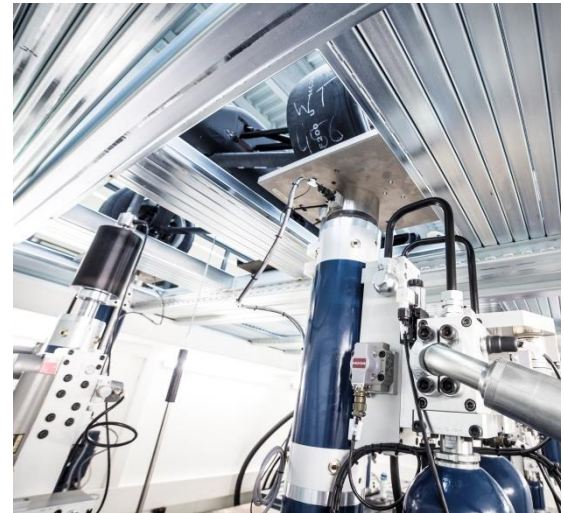
### 1. Rig- and vehicle preparation:

	Item	Description
1.1	Preparation and installation 1	- actuator adjustment according to track width and wheelbase - vehicle is already equipped with sensors and brackets which are supplied by the customer
1.2	Preparation and installation 2	- actuator adjustment according to track width and wheelbase - accelerometers on wheel hubs and chassis and additional linearpotentiometers on dampers - sensor installation and calibration
1.3	Preparation and installation 3	- actuator adjustment according to track width, wheelbase and aero brackets - vehicle is already equipped with sensors and brackets which are supplied by the customer
1.4	Preparation and installation 4	- actuator adjustment according to track width, wheelbase and aero brackets - accelerometers on wheel hubs and chassis and additional linearpotentiometers on dampers - sensor installation and calibration



### 2. Rig configuration 4-Post:

	Item	Description
2	4-Post configuration general information	- rig configuration with 4 wheel actuators - suited for vehicles without a significant amount of downforce
2.1	Test rig use 4-Post configuration	- rig configuration with 4 wheel actuators including TRE engineer - frequency-sweep - track-replay - modal-analysis - basic post-processing
2.2	Test rig use 4-Post configuration including additional post-processing	- rig configuration with 4 wheel actuators including TRE engineer - frequency-sweep & track-replay - analysis of damping ratio and contact patch load variation
2.3	Test rig use 4-Post configuration homologation approval and endurance tests	- vehicle & component tests - endurance tests for components and full vehicles - homologation approval tests for road vehicles



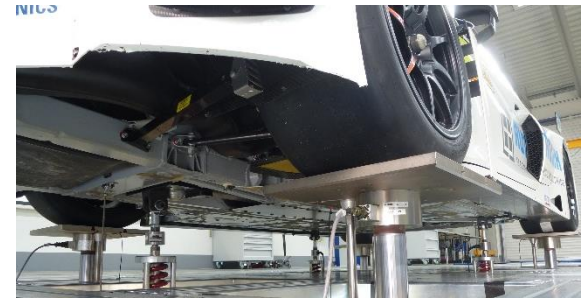
# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

## 7 POST RIG: SERVICES - OVERVIEW



### 3. Rig configuration 6-Post:

	Item	Description
3	6-Post configuration general information	<ul style="list-style-type: none"><li>- rig configuration with 4 wheel and 2 chassis actuators for generating the aerodynamic forces acting on the chassis</li><li>- suited for vehicles with a moderat amount of downforce</li><li>- besides aerodynamic forces, it is possible to generate the real pitch moments acting on the chassis</li></ul>
3.1	Test rig use 6-Post configuration	<ul style="list-style-type: none"><li>- rig configuration with 4 wheel and 2 chassis actuators including TRE engineer</li><li>- frequency-, roll- and pitch sweeps</li><li>- track-replay</li><li>- modal-analysis</li></ul>
3.2	Test rig use 6-Post configuration including post- processing	<ul style="list-style-type: none"><li>- rig configuration with 4 wheel and 2 chassis actuators including TRE engineer</li><li>- frequency-, roll- and pitch sweeps, track-replay and modal-analysis</li><li>- analysis of damping ratio,contact patch load variation and chassis movement</li><li>- analysis and setup optimisation for a whole lap or for specific lap sectors</li></ul>

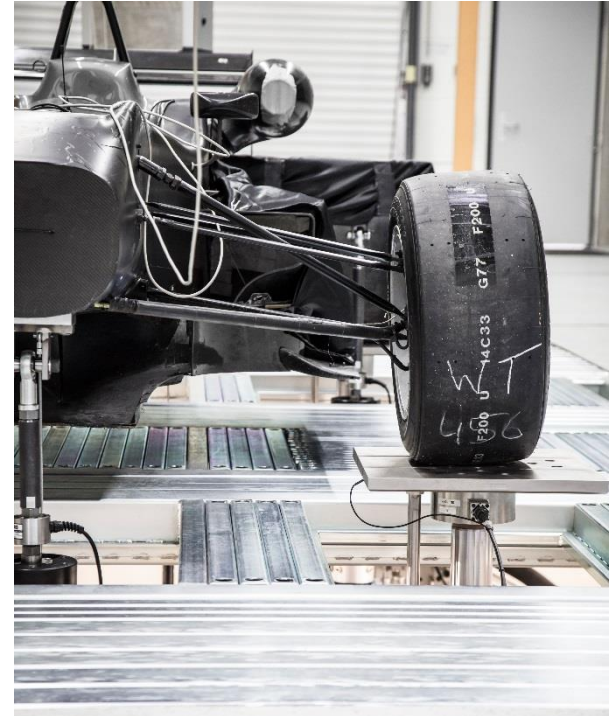


# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

## 7 POST RIG: SERVICES - OVERVIEW



4. Rig configuration 7-Post:		
	Item	Description
4	7-Post configuration general information	<ul style="list-style-type: none"> <li>- rig configuration with 4 wheel and 3 chassis actuators for generating the aerodynamic forces acting on the chassis</li> <li>- suited for vehicles with a significant amount of downforce</li> <li>- besides aerodynamic forces, it is possible to generate the real roll and pitch moments acting on the chassis</li> <li>- with this rig-configuration it is possible to create even more realistic track replays and analysis</li> </ul>
4.1	Test rig use 7-Post configuration	<ul style="list-style-type: none"> <li>- rig configuration with 4 wheel and 3 chassis actuators including TRE engineer</li> <li>- frequency-, roll- and pitch sweeps</li> <li>- track-replay</li> <li>- modal-analysis</li> </ul>
4.2	Test rig use 7-Post configuration including post- processing	<ul style="list-style-type: none"> <li>- rig configuration with 4 wheel and 3 chassis actuators including TRE engineer</li> <li>- frequency-, roll- and pitch sweeps, track-replay and modal-analysis</li> <li>- analysis of damping ratio, contact patch load variation and chassis movement</li> <li>- analysis and setup optimisation for a whole lap or for specific lap sectors</li> </ul>
4.3	Test rig use 7-Post configuration homologation approval and endurance tests	<ul style="list-style-type: none"> <li>- vehicle &amp; component tests</li> <li>- endurance tests for components and full vehicles</li> <li>- homologation approval tests for road vehicles</li> </ul>



# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

## 7 POST RIG: SERVICES - OVERVIEW



### 5. Extras

	Item	Description
5.1	Additional TRE-analysis-engineer	- additional TRE engineer who supports the analysis of the tests and helps speeding up the post-processing - makes it possible to test and analyse more setup iterations
5.2	TRE-mechanic	- TRE mechanic who supports the customer during the installation of different components during the test, which saves test time on the rig
5.3	Brackets for use of the 7-post-rig	- TRE designs, simulates (using FEA) and manufactures the brackets used for attaching the chassis to the chassis actuators of the rig
5.4	Tool development	- development of a customized post-processing-routine - development of a customized analysis and testing setup which can be further developed and expanded due to customer input
5.5	Installation of custom sensors packages	- equipment with sensors, which are not included in the items 1.3 and 1.4



### 6. Damper dynamometer

	Item	Description
6.1	Measurement of damper curves	- testing of damper functionality - characterisation of damper properties - measurement of damper curves, preload and friction - temperature fading tests and influence on damping
6.2	Technical approval- and durability tests	- damper & component tests - durability tests for dampers - technical approval tests for dampers



# TECHNOLOGY CENTRE CHASSIS DEVELOPMENT

## 7 POST RIG: SERVICES - EXAMPLES



### Starter – Package:

### 4-Post-Configuration

- Suited for:** new GT, touring & cup cars prior to first on-track testing (**for example**)
- Time needed:**
- 1/2 day installation and preparation
  - 1 day testing and basic post-processing
- Focus on:**
- fixed testing schedule according to adjustment possibilities of your car
  - aim is to provide a characterisation of the complete adjustment range of your new car to support you during your first on-track tests

### Basic – Package:

### 4-Post-Configuration

- Suited for:** touring cars & cup cars (**for example**)
- Time needed:**
- 1/2 day installation and preparation
  - 2 days testing and basic post-processing
- Focus on:**
- frequency-sweeps
  - modal-analysis

### Advanced – Package:

### 7-Post- Configuration

- Suited for:** formula cars & LMP cars (**for example**)
- Time needed:**
- 1 day installation and preparation
  - min. 3 days testing and post-processing
- Focus on:**
- frequency-, roll- and pitch-sweeps, modal-analysis
  - track-replays including aerodynamic loads, real roll and pitch moments
  - track specific setup optimisation

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**THANK YOU!**

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