**VEHICLE DYNAMICS AND CONTROL**

**Description**
Main activities of the Laboratory are focused on testing, modelling and control of vehicles, with particular attention to suspensions, tyres, braking systems, drivelines of conventional, hybrid or electric vehicles, control systems for active safety and performance, ADAS and autonomous vehicle control logics. The laboratory offers facilities and expertise for setting up road tests on the complete vehicle or indoor tests on single components. Commercial and innovative stability control systems (ESP, ABS, EBD, etc.) can be tested with a dedicated test rig based on hardware-in-the-loop technique.

**References**
Pirelli Tyres, Ferrari Auto, FIAT, CRF (Centro Ricerche FIAT), Bridgestone, Tenaris Dalmine, CIFA, Magneti Marelli, Autoliv, Brembo, TRW, SAME, Maserati Auto, CRA-ISMA, Nokian Tyres, Kymko, MV Agusta, Lamborghini Auto.

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Hybrid/Electric vehicle power train testing
- Detection of motor characteristics (nameplate).
- Performance analysis of a complete powertrain.

In our laboratories two test benches for the testing of hybrid/electric vehicle power trains are available ranging from small (from 7 kW) to high power trains (up to 200kW and 1300Nm). All electric quantities both on the electric motor and the power electronics can be assessed for measuring the efficiency, the operating range and the control behavior. Also regenerative braking tests can be performed.

Vehicle moving lab
- Vehicle dynamics test.
- Comfort, handling, performance and stability evaluation.
- Validation of numerical vehicle models.
- Validation of state estimators.

A vehicle moving lab is available in our laboratories. The vehicle standard measuring set-up includes: two measuring hubs, one inertial platform, accelerometers on suspensions upper mounts, measuring steering wheel, external optical device to measure vehicle speed, potentiometers to record suspensions displacements, pressure sensor on brake lines, a GPS platform and CAN-BUS acquisition system. Additional measuring devices can be added. The purpose of the vehicle is to test state estimator, in particular for vehicle speed estimation, tyre cornering stiffness, sideslip angle, road friction level and others.

Characterization of spring and damper
- Characterization of spring and damper.
- Evaluation of behavior with different active control logics.

Our laboratories host test benches designed for the testing of suspensions components. Static and dynamic characterization of springs (coil springs, leaf springs etc.) and dampers (viscous dampers, magnetorheological dampers etc.) can be carried out. The force developed as function of deformation, speed and other variables, in case of active or semi-active components, can thus be determined. Test bench can be easily adapted a series of different geometries.

Battery cell testing
- Charging/discharging curves generation.
- Lifecycle measurements considering constant or real profile of current.

A scalable battery cell test bench with controlled charge/discharge current up to 300A is installed in our laboratories. The bench is also equipped with thermal conditioning of the cells under test. The characterization of the charging and discharging curve under different C rates and temperatures is possible. Life endurance test under standard condition and driving cycle can also be carried out. The system is provided by embedded software able to collect all the necessary data for battery life test analysis.

Vehicle outdoor testing
- Contact forces measurements.
- Vertical dynamics under load spectrum condition analysis.
- Numerical model development.

Our staff have the expertise to install measuring and data-acquisition devices on passenger cars, motorcycles or truck vehicles to perform outdoor testing. Inertial platforms, accelerometers, potentiometers and optical devices represent a standard measuring set-up. Also non-standard measuring devices like strain gauges can be added to monitor stress condition of vehicle components like frame and suspension arms.