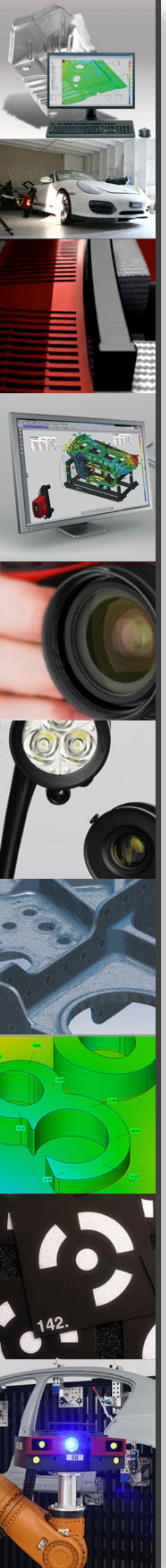


SCAN-XPRESS

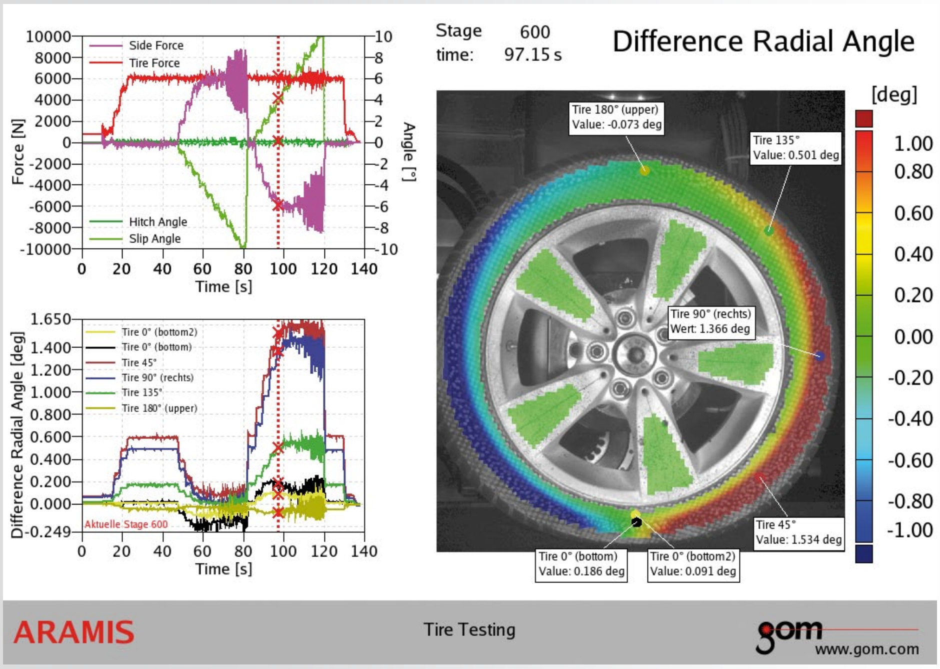
EXCELLENCE IN 3D MEASUREMENT

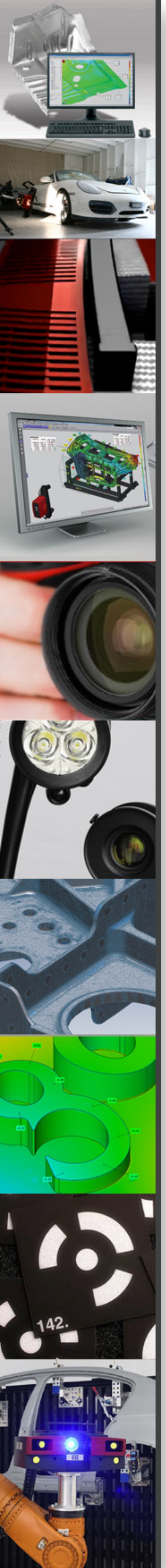
Application Example: Component Testing

3D Deformation Determination of Tire Surfaces Under Extreme Driving Conditions

Measuring Systems: ARAMIS
Keywords: dynamic load, 3D deformation, dynamic tire testing

Riding comfort, handling and last but not least the safety of tires mainly depend on their deformation characteristics. New developments based on the optical measurement technology allow for a full-field analysis of the 3D deformation behavior of tires tested under extreme conditions on a special setup. This application example examines the behavior of a tire side wall with large slip angles and presents the visual results.





EXCELLENCE IN 3D MEASUREMENT

Component Testing / Deformation

3D Deformation Determination of Tire Surfaces Under Extreme Driving Conditions

Measuring Systems: ARAMIS
Keywords: dynamic load, 3D deformation, dynamic tire testing

During the past years, the demands on modern tires increased continuously because of larger and faster vehicles. In addition to particularly low rolling resistances, more riding comfort and higher adhesion are required. The question of the precise shape under high dynamic loads is not only of interest for aerodynamic engineers of Formula 1 teams but also for tire manufacturers and chassis engineers.
In addition, the determination of multi-axial deformations or strain in the tire wall is valuable for the development of new tires.

Innovations in measurement technology now allow for a full-field analysis of the tire side wall under extreme load conditions. An easy to handle stereo camera system records 3D deformations and strain and displays them precisely. The computed data based on 3D correlation can be visualized by means of animated graphics, and is thus easy to understand.

In the following, this new method is described using a car tire as an example. The tire on a corresponding wheel rim was built on a rolling road test set-up. Figure 1 shows the principle setup of the measuring system.
At a constant conveyor belt speed, defined loads were applied to the wheel. Then, various slip angles up to max. 12° were applied. The loading profile was applied automatically (see Fig. 2).

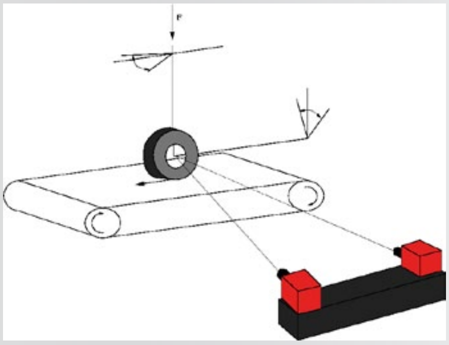


Fig. 1: Sketch: ARAMIS in front of a rolling road test set-up

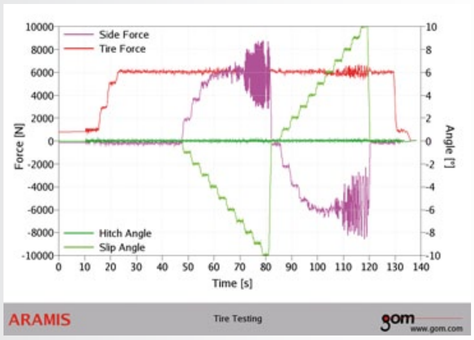
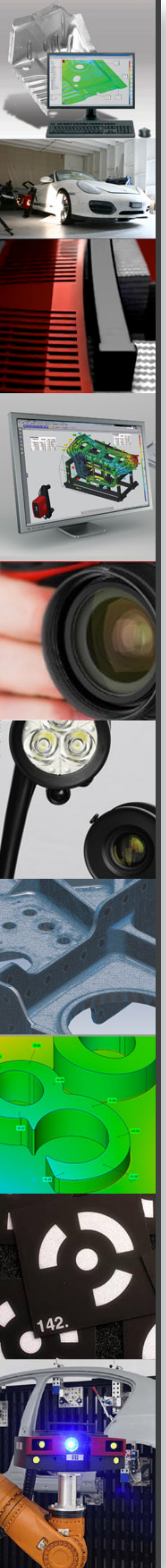


Fig. 2: Loads applied to the wheel during the test



The optical measurement technology is based on a correlation method which uses a visual texture on the tire side wall as data information. Prior to the test, this texture is applied to the measuring object, then it is recorded by the ARAMIS system during the test and computed subsequently. This results in the 3D coordinates of the surface which are available for any point of time. Triggering the wheel rotation guarantees an exactly repeatable recording of the respective rotation positions. The 3D results may be displayed in various forms to receive further information like deformations in any direction (e.g. axial deformations, radial deformations, tangential deformations) and strain on the surface. Due to the extremely short shutter times, high circumferential speeds (e.g. >>300 km/h) can be measured without any problems.
Figure 3 shows a typical evaluation in this procedure. The upper left diagram displays the applied loads and angles versus time. Under maximal loads, slipping occurs at the contact point between tire and conveyor belt. The resulting oscillations in this case reach amplitudes of up to 36 mm in axial direction. The full-field results are shown in the report. The deformation is displayed in color and by means of some selected points as an example in the bottom left diagram (axial displacement versus time).

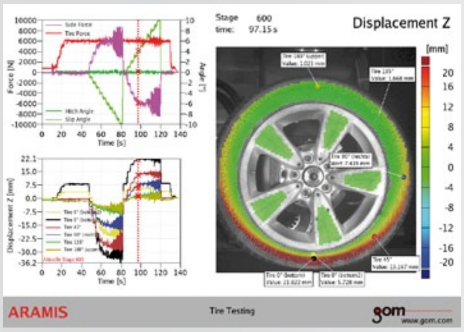


Fig. 3: Axial displacement of the side wall

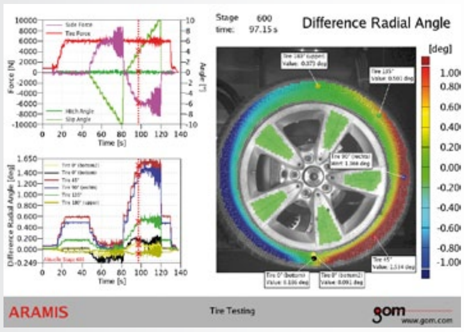


Fig. 4: Movement/deformation of the side wall in circumferential direction

Figure 4 shows the displacement in circumferential direction. Here, the local angle of twist is given for the tire wall with respect to the wheel axle. As in this test no braking or driving torques were initiated, the tangential deformation is, as expected, relatively symmetrical and has quite small angles (up to +/- 2°).
The radial displacement in Fig. 5 shows at the beginning of the test the deflection of the tire with increasing load. At a constant slip angle, a relatively constant value of approx. 5.5 mm is achieved close to the contact point. When changing the slip angle, values of more than 30 mm result.

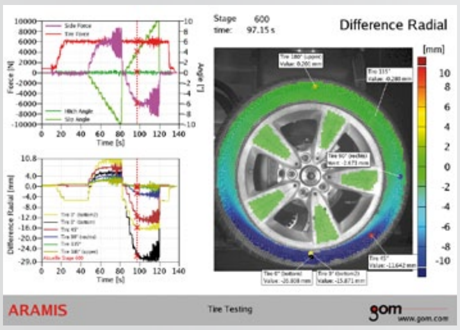
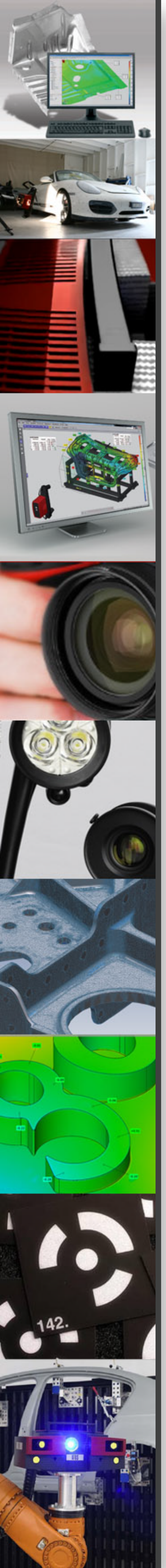


Fig. 5: Movement of the side wall in radial direction



The new method allows for precisely recording all deformations of the tire wall. The testable load conditions stretch from slip and hitch angles over wheel loads applied up to high speeds. In addition, the deformations of the tire at torque initiation (acceleration an braking) may be determined. Furthermore, the graphical representation allows for an easy interpretation of the results and may also be displayed as an animation. This method also provides for easily comparing the results with those of simulations.