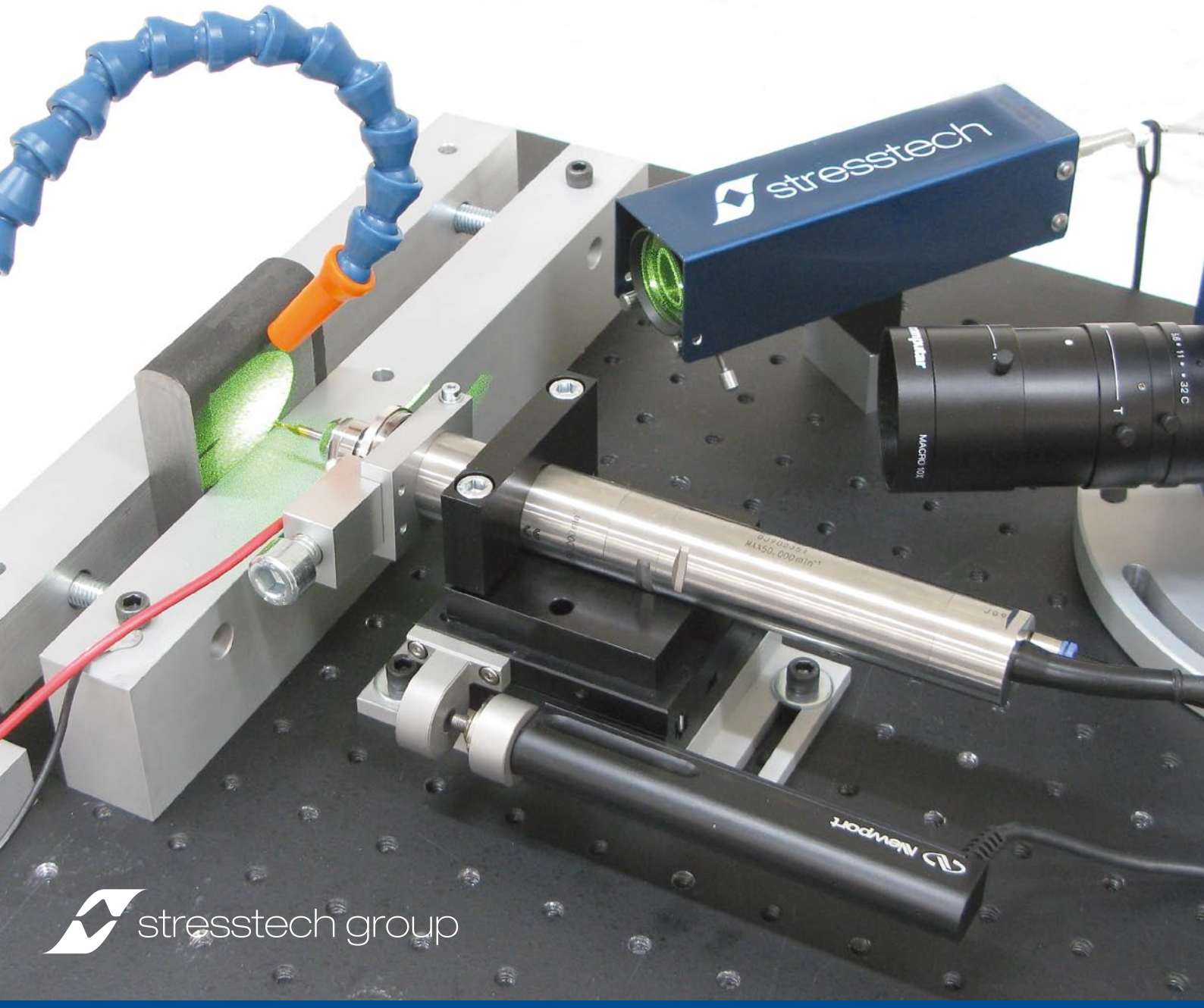
Prism®

Electronic Speckle Pattern Interferometry

Residual stress measurement based on hole-drilling and ESPI



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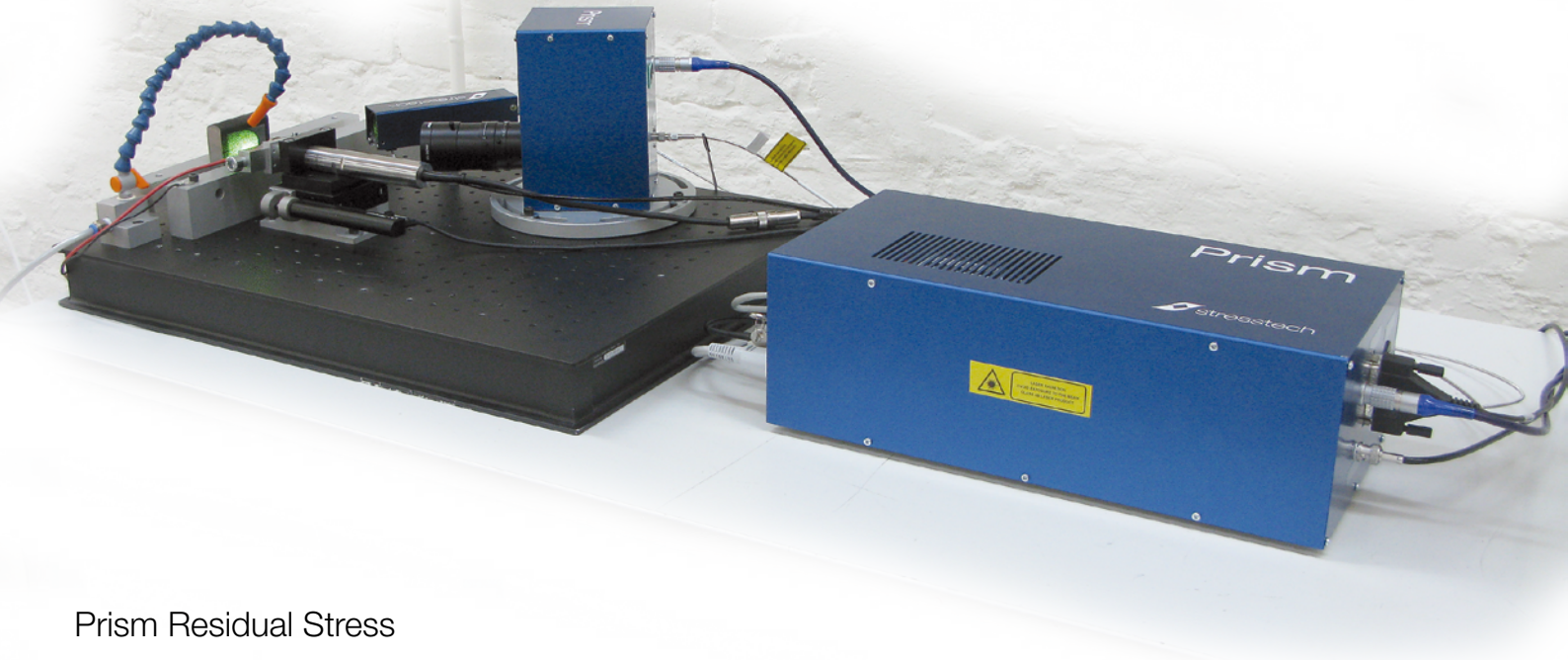
Prism® Unique Features

Prism is a new way to measure residual stress in a variety of materials, combining the tried-and-true hole-drilling method with digital imaging and ESPI (electronic speckle pattern interferometry). The instrument delivers the complete planar stress state.

Prism has particular advantages for stress depth profile applications with large number of similar samples, where measurement time can be minimized. Measurement is simple and fast, and possible also fully automated.



Prism Residual Stress

Prism residual stress is a measurement technology that dramatically improves the ability to make quick, accurate residual stress measurements. The technology utilizes stress-relaxation technique, where a small hole is drilled into the material thus relaxing the stress along the hole boundaries. The resulting surface distortion can then be measured precisely using electronic speckle pattern interferometry system (ESPI).

A standard **Prism** system comprises a computer and monitor for acquiring and viewing images of the part, a laser light source, illumination and video heads and a high-speed drill. The system software fully integrates the hardware to provide automated data capture, and analysis of the resulting images. The software allows different levels of automation, including performing drilling and data acquisition for a complete stress depth profile fully automatically. The instrument is easy to set up and easy to operate. The measurements are highly accurate and fast.

Key Benefits

- **Fast**: typical measurement and analysis in less than 5 minutes
- **High-resolution**: monitor stress changes much less than 7 MPa
- **Customizable**: affordable solution designed specifically for your application
- **Accurate**: more data with full field of view, real-time surface measurements
- **Non-contact**: only requires direct visual path to part; no strain gages to be applied
- **User friendly**: Easy-to-use Windows based software
- **Materials:** includes materials difficult for XRD like titanium and plastics; limited mainly by the ability to drill holes

Hole-drilling

Hole-drilling is a residual stress measurement technique, where stressed material is removed by drilling a small blind hole into the component of interest. After the drilling sequence the remaining material in the vicinity of the hole spontaneously finds a new stress equilibrium. This rearrangement of stresses leads to a slight distortion of the surface near the hole. Though the displacements are small, they are measurable and allow the calculation of the stresses that were present in the component prior to drilling.

The hole-drilling method is considered to be a semi-destructive measuring method, because the hole drilled may be negligibly small to the part performance.

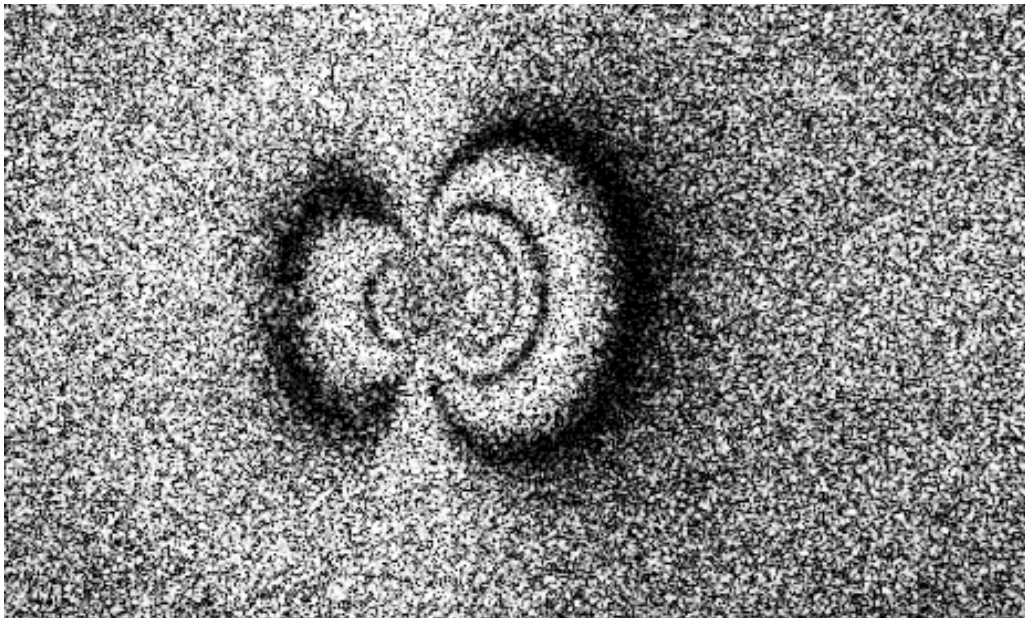
Measurement Procedure

The typical procedure starts with determining, where the sample surface is relative to the drill bit tip. Prism detects the surface by an electrical contact method, where the drill moves towards the part until it starts cutting it. Alternatively, visual surface detection may be used. The user then sets a list of depths for the drilling and starts data acquisition. The individual drilling step is always performed automatically. Laser images of the surface are taken after each drilling step. One additional image is taken for defining hole position and image scale.

Prism Software

The software integrates drilling and imaging. The user can perform measurements fully automatically for a list of depth increments set in advance, or control each step individually and change depths on-the-go. Image acquisition is automatic in the former case. Stress calculations are possible for any combination of the depths drilled, including as single-depth data. The data are output in graphical and in table form.

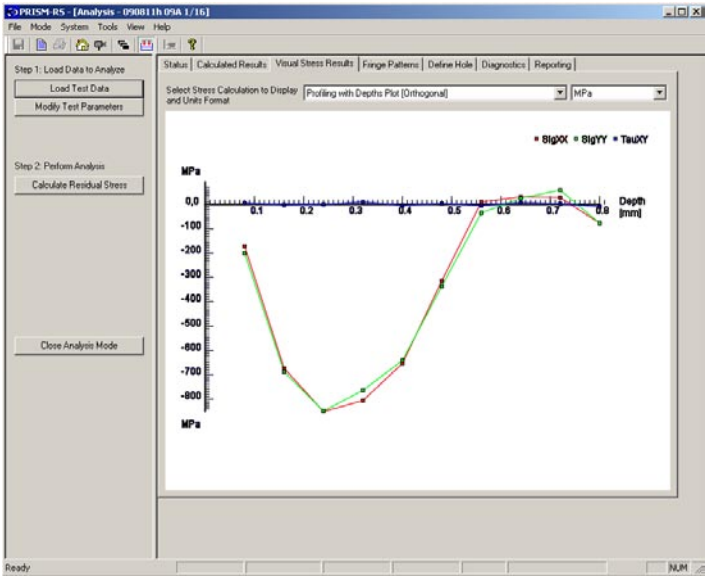
Prism stores its data in a Microsoft database. The user can organize measurements in folders and subfolders within a database or within multiple databases. This allows easy and quick access to all the data. The software also allows review and modification of measurement parameters. Thus, calculations can be rerun quickly using modified values, if desired.



Example of a speckle pattern near a drilled hole. The fringe pattern is a quantitative indication of the stress relieved.

Stress results

Stress values are calculated for the sample coordinate system – horizontal and vertical directions, and shear stress – and for the principal stress directions. For incremental hole-drilling non-uniform stress is assumed and the stresses are calculated using the integral method. Tikhonov regularization is optional.



Graphical output for a stress depth profile measurement.

Technical Specifications

Safety

- The system uses a Class 3B laser:
  Max. average output power 500 mW at
  520–540 nm,
  790–820 nm,
  1047–1350 nm.
  The typical configuration of the system includes a laser with a maximum output of 25 mW. After expansion of the laser beam, the light produced by the illumination stand poses only a minor potential health risk due to the reduced beam density. No special protective measures may be required. Please consult with your facility safety personnel on your local safety regulations and on pertinent safety procedures.
- Stresstech Oy has provided electronic shutters with this system. The shutters are closed unless opened using the Prism software

Prism system hardware

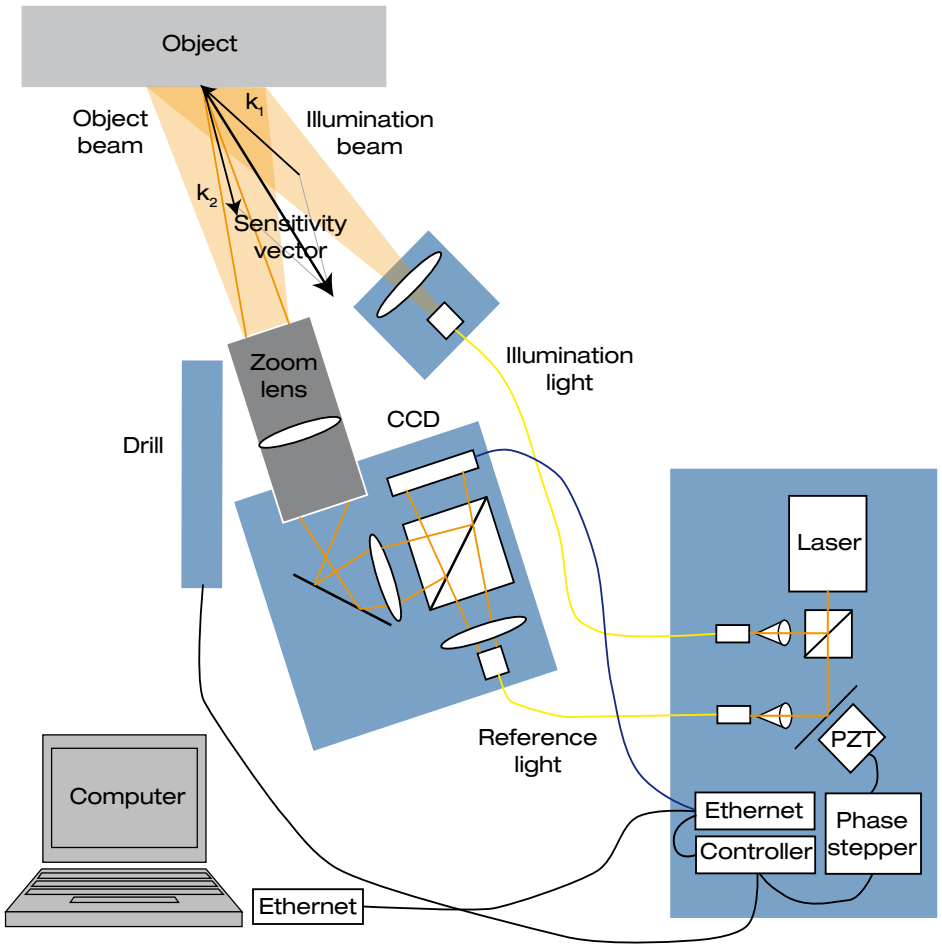
- Light source unit
- Illumination head
- Video head with optical zoom barrel
- Fiber optics
- Breadboard or optical table
- High-speed electric drill
- Linear stage, actuator and linear motion controller
- Pneumatic air controller
- Chip air system
- Personal Computer

Prism RS Software

- The software fully integrates the hardware to provide computer controlled hole-drilling and imaging.
- Stress calculations can be performed for single- and multiple-depth holes with non-uniform stress. Tikhonov regularization for stress profiles is integrated.
- Windows based software (Windows Vista, Windows XP, etc.)

Requirements

- Regular electrical power, 220 V / 110 V
- Vibration control via optical table / breadboard
- Pressurized air for cooling the high-speed electric drill and for chip removal



Contact Stresstech Group offices to discuss your particular application.

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