

Welcome to the webinar

‘Residual stress measurements by hole drilling: Calculation in accordance with ASTM E837-2013 standard’

The webinar starts at 10 a.m.

- Alessio Benincasa
Sales & Product Manager
SINT Technology srl
- Degree in mechanical engineering
- 10 years experience in
SINT Technology
- 9 years experience in the
residual stress field
- 5 years experience as Product Manager
of the MTS3000
- Certified at 3rd level as strain gage expert



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- Who is SINT Technology
- What are residual stresses
- The hole-drilling strain-gage method
- The MTS3000 system
- The ASTM E837 standard
- The new EVAL 7 software
- Typical measurement results
- Live test elaboration

SINT Technology is located in Calenzano, near **Florence**. The company was founded in 1990.

SINT Technology has **50 employees**. Most of them are engineers with average age of about 30 years. The company turnover is about **4 M€**



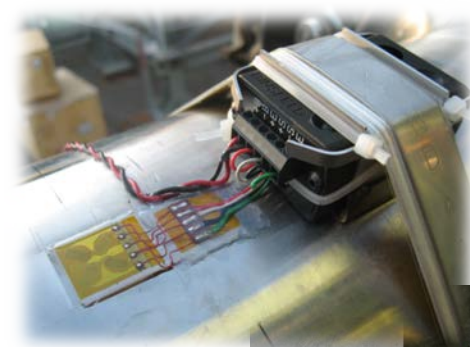
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Accredited Test Lab**



LAB N° 0910

Measurement Services:

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- Experimental and residual stress analysis
- Power plant performance tests



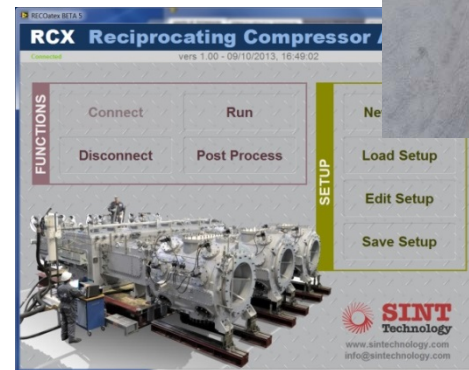
Production of measuring equipments:

- Restan-MTS3000
- DRMS Cordless
- Custom products



Design engineering

Software solutions



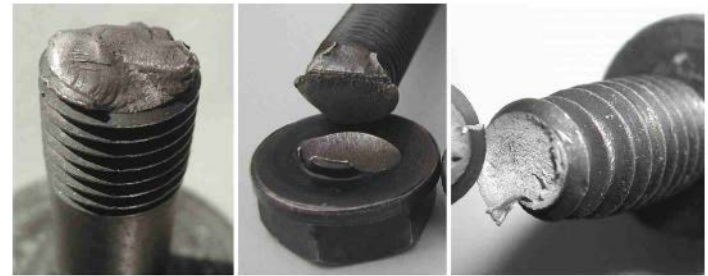
All stresses that occur in the materials, also without the application of any external load, are termed residual stresses.

Residual stresses influence a mechanical component's behaviour as they:

- Affect structural and dimensional stability
- Reduce fatigue strength and crack resistance
- Encourage surface crack growth



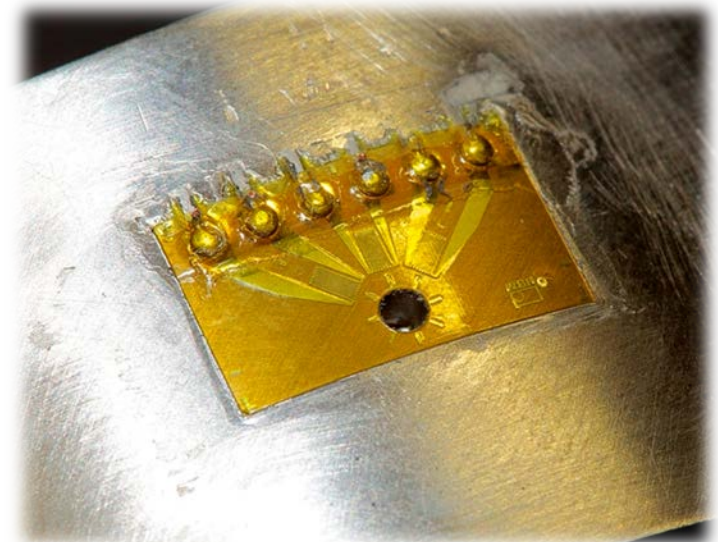
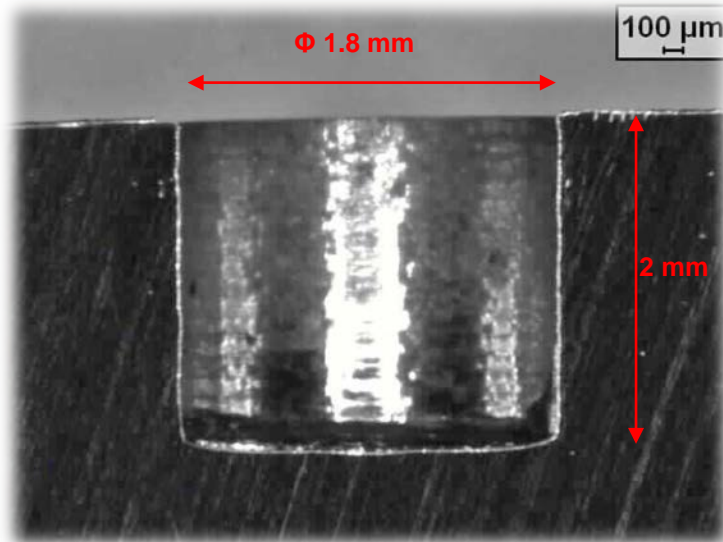
Residual stresses therefore limit load capacity and safety of mechanical components during operation.



The hole drilling method consists in drilling a small hole (**approx. 1.8 mm x 2.0 mm**) into the center of a special 3-element strain rosette.



The hole changes the initial strain allowing redistribution of the residual stresses originally existing in the material.



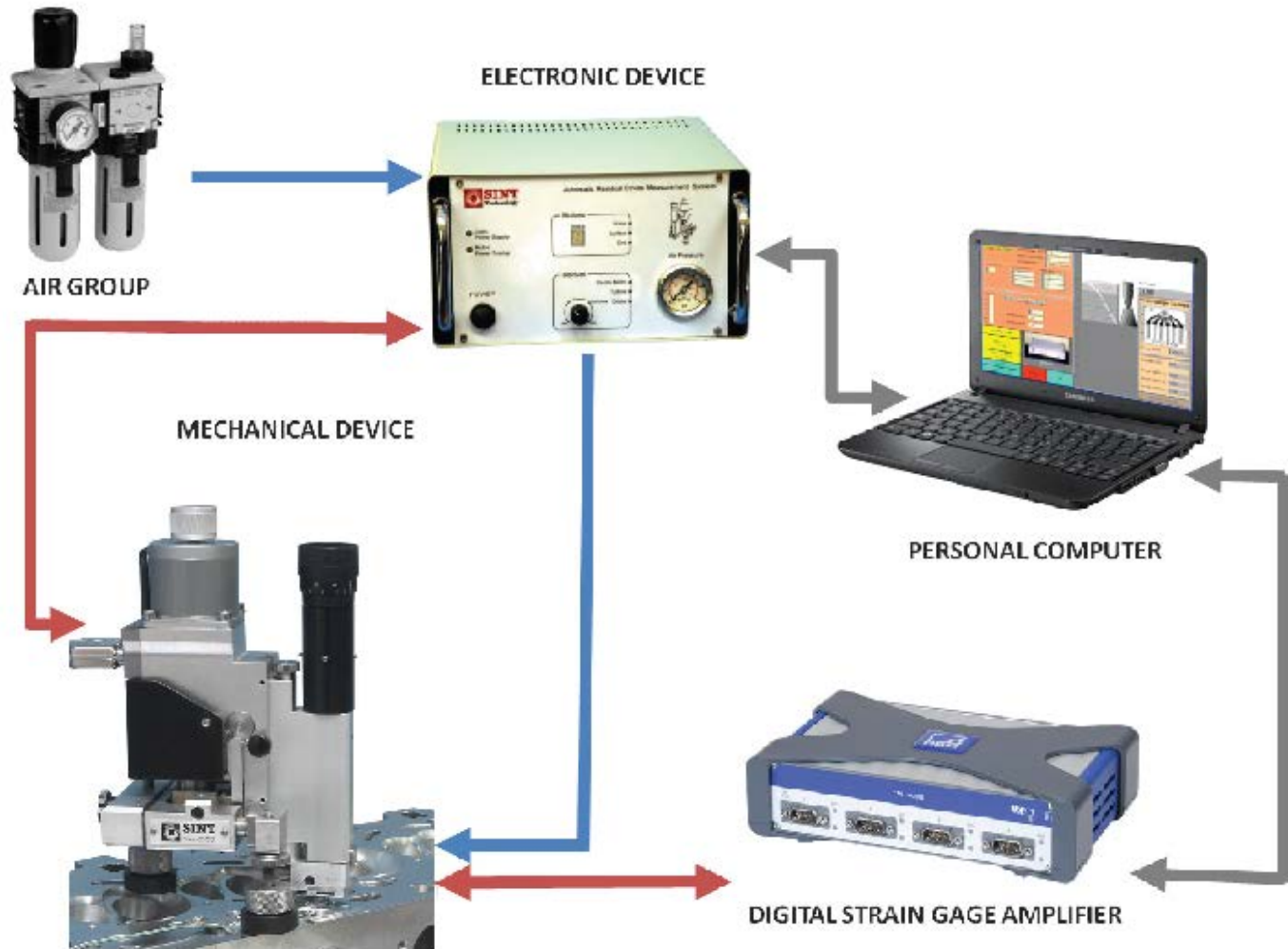
The **MTS3000 system** is the only fully **AUTOMATIC** and portable instrument in the world for determining residual stress by the hole-drilling strain-gage method.



The MTS3000 system **consists of**:

- A mechanical setup housing the optical system and drilling system
- An electronic control unit
- A digital strain gage amplifier
- Control and back-calculation software

The MTS3000 system: measuring chain



The hole-drilling strain-gage method is the only method for calculating residual stress that is **STANDARDIZED** at world level (**ASTM E837**).

The first version of this standard dates back to 1995, the latest upgrade is available since the end of 2013.



Designation: E837 – 13a

**Standard Test Method for
Determining Residual Stresses by the Hole-Drilling Strain-
Gage Method¹**

Standard ASTM E837 specifies:

- The number of **drilling increments** required
- The **numerical coefficients** for determining the value of residual stresses
- The **data processing** method
- The measurement-related **uncertainty**

Different types of holes, based on the workpiece thickness:

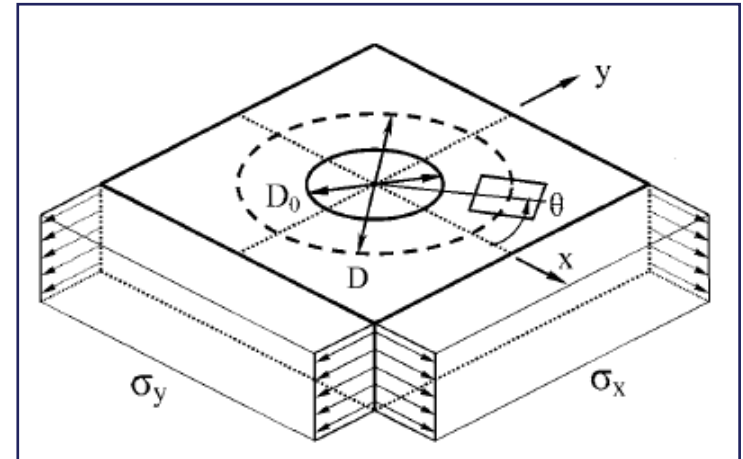
THROUGH HOLE - THIN WORKPIECE

Workpiece thickness $< 0.2 \cdot D_{\text{GAGE}}$ (std. 1mm)



stresses are considered uniform over the drilling depth

- Drilling depth: entire thickness
- Stresses are assumed to be uniform
- Acquisition of a set of 3 strain values once the through hole is completed



INTERMEDIATE HOLE

Workpiece thickness between $0.2 \cdot D_{\text{GAGE}}$ e D_{GAGE} (std. between 1mm and 5mm)

- Approximate results
- The elaboration of the test result is outside the scope of the ASTM E837-13 standard

BLIND HOLE (Typical) – THICK WORKPIECE

Workpiece thickness $> D_{\text{GAGE}}$ (std. 5mm)

UNIFORM STRESSES

- Drilling depth: $0.2 \cdot D_{\text{GAGE}}$ (std 1mm)
- Stress value over the drilling depth
- 10 drilling steps of $0.02 \cdot D_{\text{GAGE}}$ (std 0.1 mm)

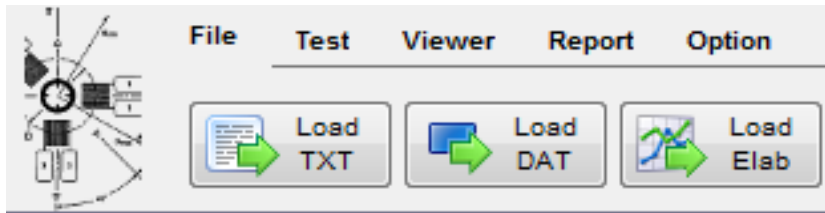
NOT UNIFORM STRESSES

- Drilling depth: $0.2 \cdot D_{\text{GAGE}}$ (std 1mm)
- Residual stress pattern over the drilling depth
- 20 drilling steps of $0.01 \cdot D_{\text{GAGE}}$ (std 0.05 mm)
- Evolution of the “old” Integral Method

A “uniform stress” calculation is appropriate when **prior information** is available, for example, based on workpiece geometry or processing procedure.

Another purpose of doing a uniform stress calculation is to determine a **representative size** of the residual stresses that are present.

Test elaboration: the new EVAL 7 software



- **Flexible** design of the software versions
- Users can buy only the function they need, depending on the types of the measurement
- Possibility to **upgrade** your software version
- **Easy** functions for the users that move the first steps into the hole drilling measurements
- **Complete** and further analysis of residual stress for the more skilled users
- Possibility to **customize** the software versions

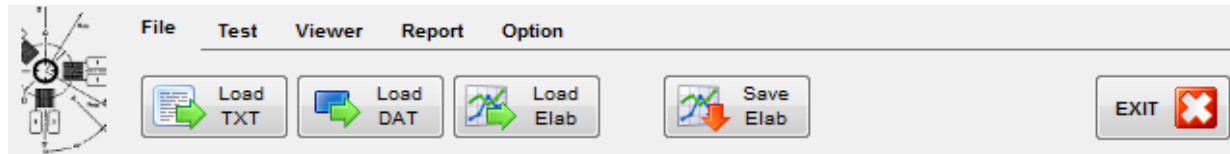
Software Features

	Base	Professional	Premium	Enterprise
Automatic input of .txt/.dat file	✓	✓	✓	✓
Edit Input Windows	✓	✓	✓	✓
Strains interpolation	✓	✓	✓	✓
Calculation as per ASTM E837-13 for uniform stress	✓	✓	✓	✓
Calculation as per ASTM E837-13 for non-uniform stress	✓	✓	✓	✓
Calculation by the Integral method	✓	✓	✓	✓
Calculation by the Schwartz-Kockelmann method	✓	✓	✓	✓
Export by .txt format	✓	✓	✓	✓
Strain gage rosette / calculation coefficients database	✗	✓	✓	✓
Extended version of ASTM E837-13 for uniform stress	✗	✓	✓	✓
Extended version of ASTM E837-13 for non-uniform stress	✗	✓	✓	✓
Viewer (Stress Graph, Direction Graph, Mohr Graph)	✗	✓	✓	✓
Load / Save calculation config	✗	✓	✓	✓
Automatic report of the measurement	✗	✓	✓	✓
HDM calculation algorithms	✗	✗	✓	✓
Eccentricity correction algorithms	✗	✗	✓	✓
Plasticity correction algorithms	✗	✗	✓	✓
Measurement uncertainty for uniform stress calculation	✗	✗	✗	✓
Measurement uncertainty for non-uniform stress calculation	✗	✗	✗	✓

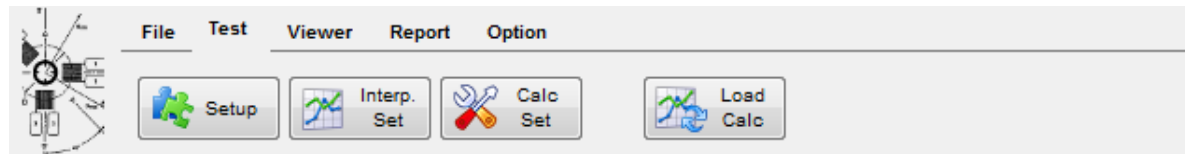
The main key features of the **EVAL7** software are:

- **Fully** compliant to the MTS3000 - RESTAN system
- Implementation of the **HDM method**
- Implementation of **eccentricity** correction
- Implementation of **local plasticity** correction
- **Upgraded** strain gage rosette database
- **New** graphical layout
- **Better** algorithms for the interpolation of acquired strains
- Graphical **comparison** between different calculation methods
- Plot of residual stress **Mohr circles**
- Calculation of residual stress in **any direction** (grids and custom direction)
- **Automatic** measurement report

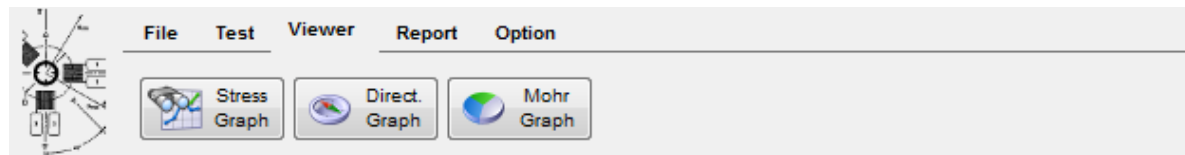




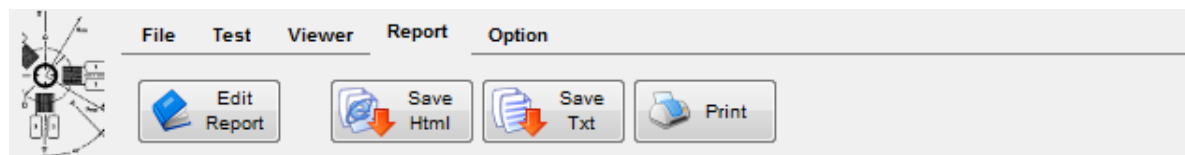
LOAD TEST



TEST SETUP



VIEW GRAPH



TEST REPORT

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Residual Stress Measurement by the Hole-Drilling Method

SINT Technology is an Italian firm located in Florence, Italy. The company, in partnership with HBM, produces and develops the **MTS3000**, an automatic system for measuring residual stresses by the hole-drilling method.

Residual stresses can be present in any **mechanical structure** because of many causes. They may be due to the technological process, such as plastic deformation or welding, non-uniform cooling of cast components, forging process or surface treatments like shot peening or surface hardening.

Residual stresses have the same role in a structure's strength as common mechanical stresses. However, while stress due to external loads can be calculated with a degree of accuracy, residual stresses are difficult to foresee. It is, therefore, very important to have a **reliable method** able to measure them directly with minimum damage to the surface.

This is why the **hole-drilling method** has been developed. Basically, the method consists in drilling a small hole in the component at the centre of a strain gauge rosette. The residual stresses, in way of the removed material, are released enabling the surface strains to be measured by the strain gauges. A suitable mathematical model is then used to evaluate the reduced residual stress from the deformation measurements.




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On evidence

March 7, 2014
New ASTM E837 standard – Version 2013


October 10, 2013
Seminar on Experimental Modal Analysis and Correlation FEM - at SINT Technology, Calenzano (FI)

October 7-10, 2013
Participation of SINT Technology in the Residual Stress Summit 2013

October 28-31, 2013
Participation of SINT Technology in the 17th Chinese National Residual Stress Conference

Products


Restan MTS3000



The automatic system for measurement of residual stresses, RESTAN (Residual Stress Analyzer)- MTS3000, patented, produced and developed...

[go to the page](#)

DRMS Cordless






The DRMS (Drilling Resistance Measurement System), patented, produced and developed by SINT to measure the drilling...

[go to the page](#)

Measurement services

SINT Technology is able to offer a wide range of products and services in the gage industry. The range of use of stress measures is extended to the most different applications, where a special sensitivity and accuracy is required.



All our services

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Title	Date	Time	Vacancies
Residual stress measurements by hole drilling: Calculation in accordance with ASTM E837-2013 standard	Oct 28, 2014	10:00 AM CET	<div></div>
High-speed Data Acquisition in Strain Measurement and Dynamic Material Testing Applications	Oct 30, 2014	10:00 AM CET (Amsterdam, Berlin, Paris)	<div></div>
How Mechanical Stress Testing of Materials Validates Finite Element Analysis (FEA)	Nov 04, 2014	2:00 PM ET	<div></div>
Strain gauge measurements on PCBs	Nov 10, 2014	10:00 AM CET	<div></div>
Simplifying Large Channel Count DAQ Systems	Nov 11, 2014	10:00 AM CET	<div></div>
Integration of torque sensors into automation environments using TIM-EC	Nov 12, 2014	10:00 AM CET	<div></div>
Efficient planning, commissioning and operation of industrial test stands using PMX	Nov 13, 2014	10:00 AM CET	<div></div>
Power measurement on wind turbine generators	Nov 14, 2014	10:00 AM CET	<div></div>

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Residual stress analysis using the hole drilling method