



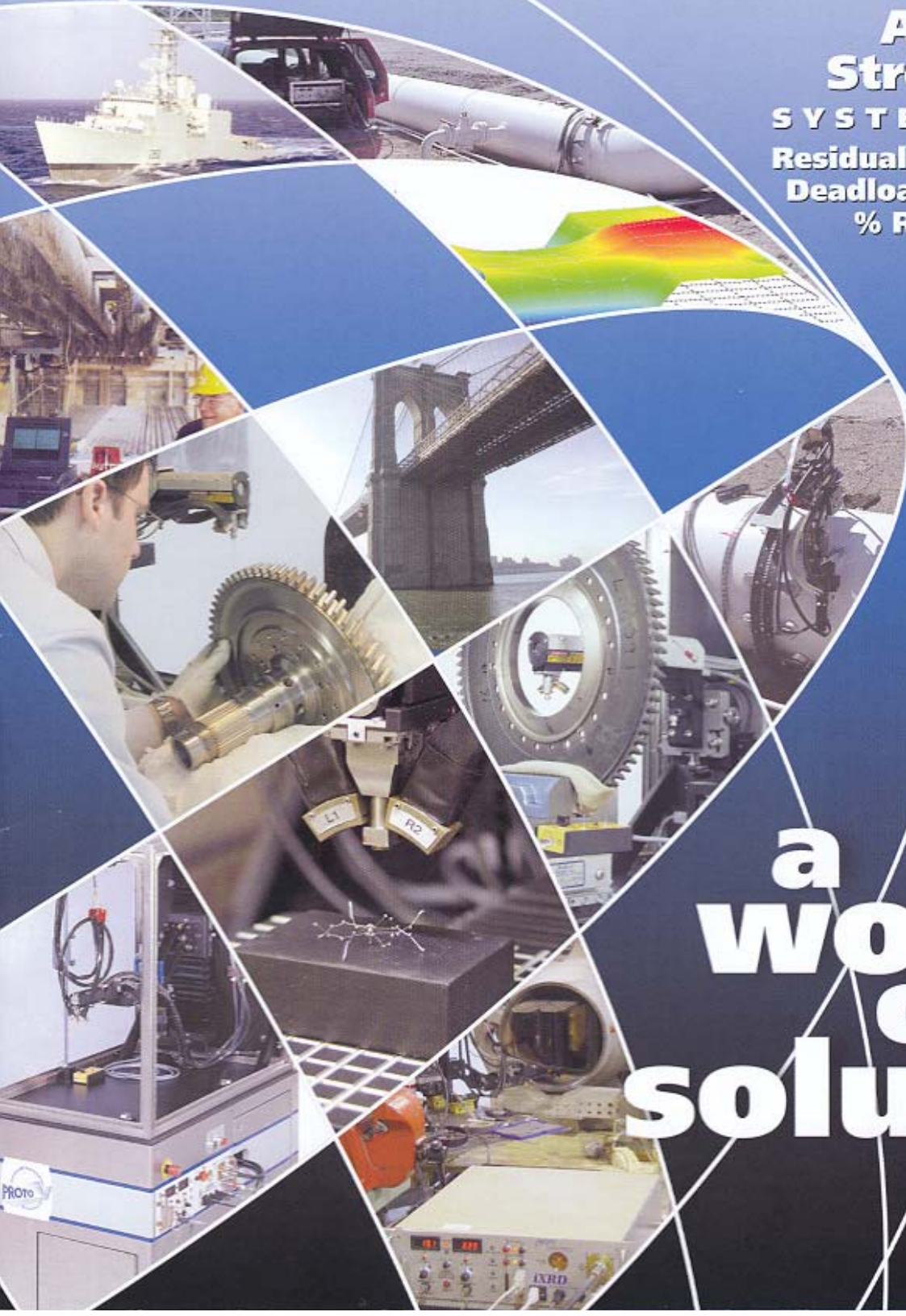
Automated Stress Analysis

SYSTEMS & SERVICE

Residual Stress • Applied Stress

Deadload Stress • Total Stress

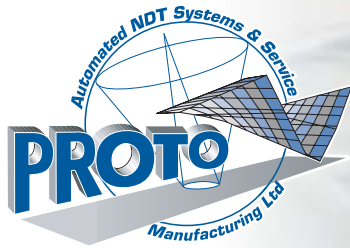
% Retained Austenite



**a
world
of
solutions**

About Proto Manufacturing

**Make your product
or process more
competitive and
efficient...**



With over 35 years of automated industrial NDT system experience and innovation, our engineering and manufacturing excellence ensures quality products and services. Our continuous research and development keeps Proto at the forefront of developments in residual stress analysis systems and services.

Our advances have freed the technology from the confines of the laboratory and removed the limitation of characterizing small coupons only. Proto innovations have included the successful development of an 18-kilogram portable device, automated residual stress mapping, simultaneous residual stress and retained austenite measurement, pioneering field and inline applications, high-speed x-ray diffraction and more. These innovations have placed Proto products and services in a position of leadership worldwide.

**Put our R&D team
to work for you**

Continuous internal R&D in both NDT systems and applications have placed Proto in a position of world leadership in XRD residual stress. The skills, knowledge and technology we have developed can be applied to your special projects.

Our people are highly educated, experienced and skilled at a wide variety of disciplines, and operate in a complete vertically integrated environment. The result is a very successful track record of adaptive design, from engineering vision to field-ready hardware.

Some of our research partners include Boeing, EPRI, the USAF, Ford Motor Company, DRDC and NRC.

A message from the President

Welcome! I am pleased to have this opportunity to introduce our expanding range of solutions and new product developments to you. Awareness of the important role residual stress plays in the issues of distortion, crack initiation, stress corrosion cracking and fatigue life has been growing steadily. Using Proto systems and services to characterize residual stress, our customers have made dramatic improvements in quality, reduced material and processing costs, shortened product development times, moved or removed failure locations, optimized the allocation of other NDE techniques, extended product life and improved product safety. They have characterized the conditions of structures and made informed decisions on the allocation of maintenance resources. All of this adds up to excellent returns on investment in Proto systems and services. I sincerely hope that you will join our growing family of satisfied customers. We're ready to help and look forward to your call!



Michael Brauss, President




Our Services



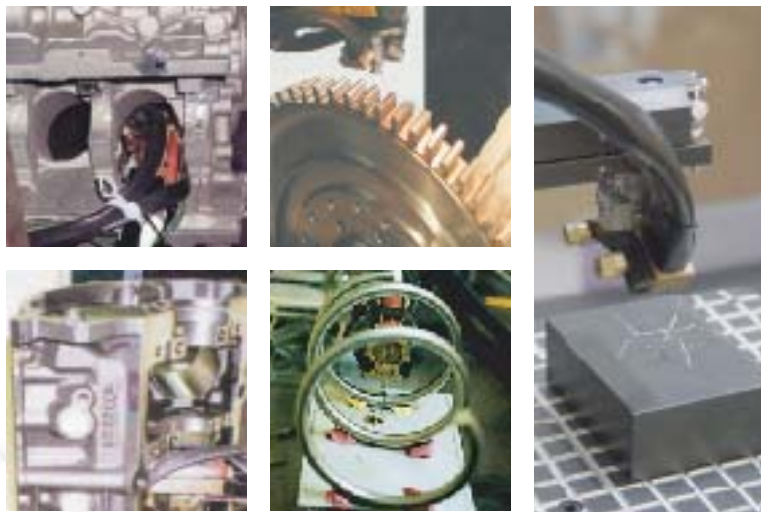
Residual stress and retained austenite characterization—no one does it faster, no one does it better, in the lab or in the field.

Rapid response, unmatched turnaround times with superior data and report quality, and the ability to provide services in the field have made our reputation second to none. When it's important, we get the call. Proto Manufacturing has pioneered the practical application of non-destructive x-ray diffraction based residual stress characterization of structures and large components. Some examples include bridges, pipelines, skyscrapers, power generation stations (both nuclear and non-nuclear), aircraft structures and propulsion units, large vehicles, rolling stock and track, post-tensioning cables, earthquake remediation and pressure vessels.

LABORATORY & FIELD SERVICES

- nondestructive residual stress measurement via x-ray diffraction
- stress concentration factor determination
- percent retained austenite measurement
- non-contact hardness measurement
- x-ray elastic constant determination
- stress versus depth characterization
- custom electropolishing masks
- custom machining
- metallographic services
- dye penetrate examination
- documentation/reports
- dead load stress measurement
- automated stress mapping and profiling of stress gradients
- strain gauging to support x-ray data
- dynamic load characterization, real time data collection
- total stress characterization
-    for your convenience

Measurements where you need them...
in the bore, on the small...



and on the very large!



Deadload stress characterization on the historic Brooklyn Bridge

When it's important, Proto gets the call



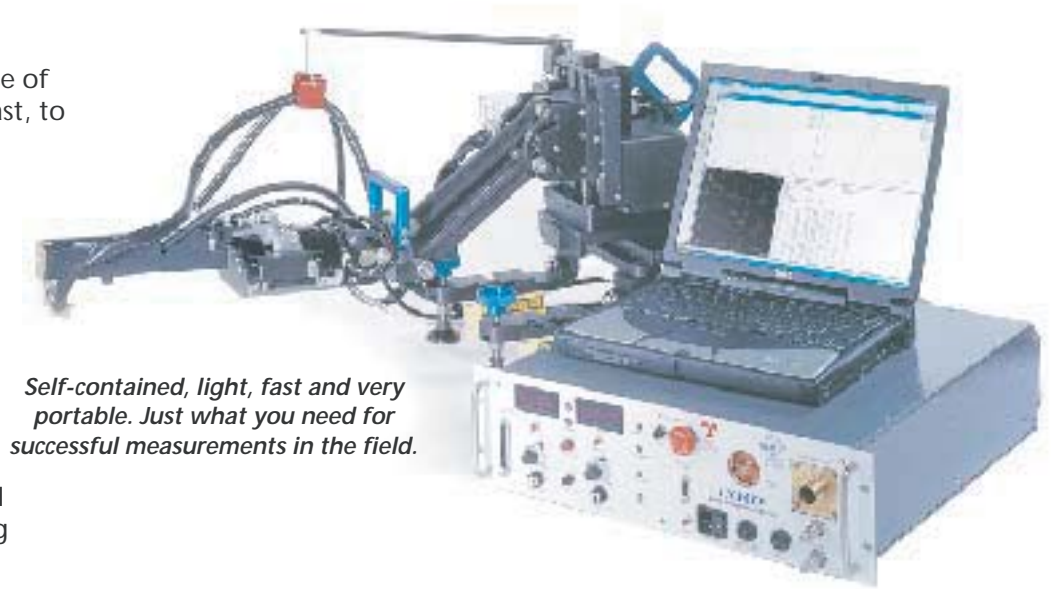
iXRD[®] - Portable Residual Stress Analysis System

World's smallest, lightest and fastest XRD based stress analysis system.

As pioneers in field residual stress characterization, Proto developed the iXRD for our own use in the field. We have distilled twenty-one years of experience into this unit.

We made it small and light, enabling ease of transport and positioning. We made it fast, to maximize the number of measurements taken in a day, while at the same time minimizing the interference with ongoing manufacturing and/or construction activities. We made it nimble with our modular field stand approach, adaptable software, easy to operate controls and our uniquely designed portable goniometers.

Inline version available – The iXRD is also designed for inline applications, and can be linked and synchronized, allowing up to four iXRDs to work in tandem.

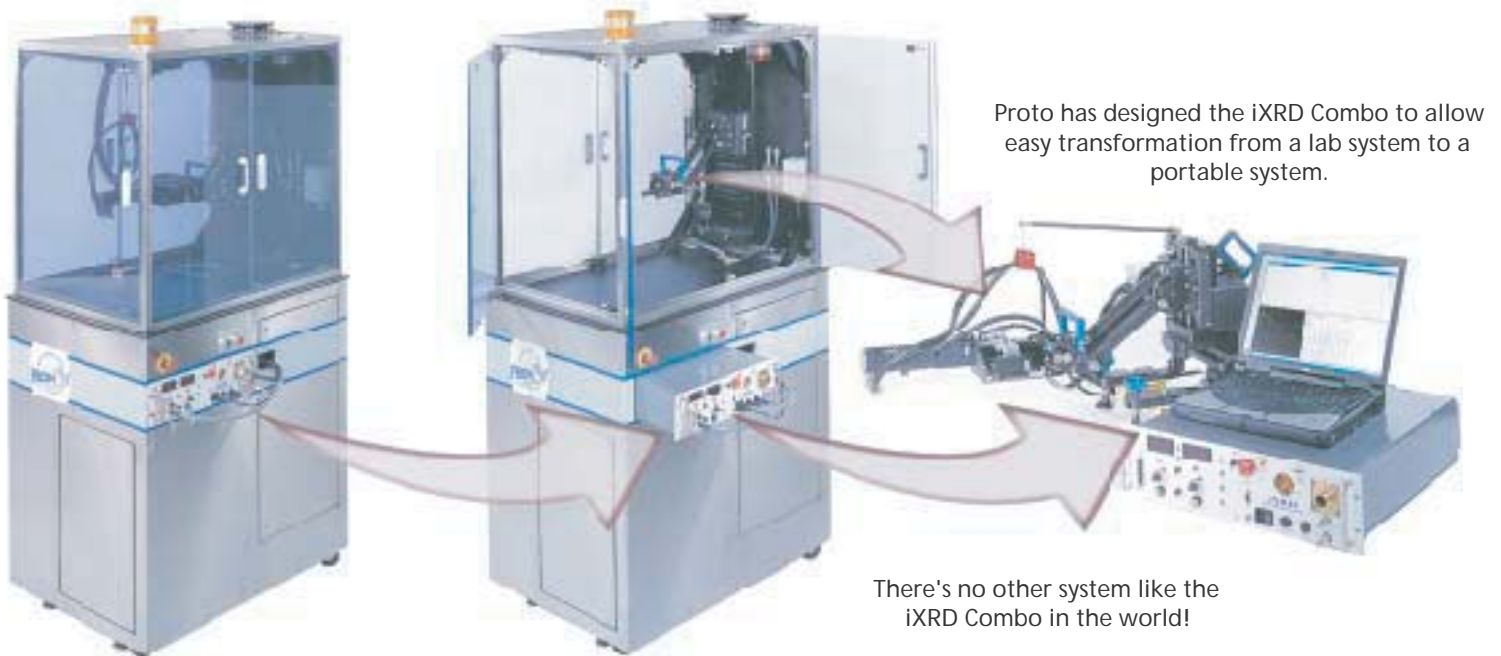


Self-contained, light, fast and very portable. Just what you need for successful measurements in the field.

iXRD Combo[®] - Laboratory/Portable Stress Analysis System

Provides the flexibility to use the iXRD as a laboratory or field instrument.

The iXRD Combo combines the versatility of the iXRD with the convenience and safety of a laboratory system. This unit features a fully interlocked enclosure which can be outfitted with any combination of laboratory, modular or portable stress mapping options. The iXRD Combo is ideally suited for laboratories which are in support of facilities manufacturing components or structures where the requirements are for in situ measurements on the factory floor or in the field.



Proto has designed the iXRD Combo to allow easy transformation from a lab system to a portable system.

There's no other system like the iXRD Combo in the world!



LXRD[®] - Laboratory Stress Analysis System

Provides unsurpassed measurement, repeatability and speed.

A new era of x-ray diffraction stress and phase analysis is ushered in by the LXRD. Designed from top to bottom without compromise for continuous heavy duty use. The LXRD features a unique Modular Goniometer System (patent pending) that offers the operator a new level of flexibility. Select from a range of goniometers tailored for specific attributes, and attach the chosen goniometer to the harmonized drive (patent pending). You will be able to characterize residual stress in more locations on more components than ever before. In addition, the LXRD demonstrates measurement speed unsurpassed by any other residual stress analysis system. Measurements can be performed in as little as a few seconds, and after initial setup, can generate compelling data without the presence of an operator.



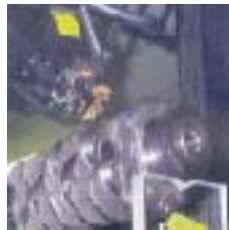
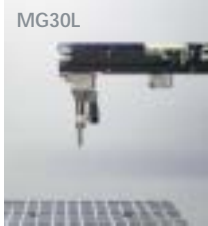
MG2000L



MG40L



MG30L



Proto's Modular Goniometer System offers a new level of flexibility.

The LXRD is designed to characterize larger components without the need to section.

LXRD Widebody

The LXRD Widebody features extra room to handle larger components. Designed with the same heavy duty specifications as the LXRD.



The LXRD-GR features the largest enclosure capacity of any residual stress analysis system in the world and is designed for easy large part access from three sides. This unit includes an integrated gantry robotic system with a modular goniometer interface allowing user selection of the most appropriate goniometer.

LXRD-GR Gantry Robot



Large part analysis with easy access

Fully enclosed and interlocked



UNLEASH
THE
power

Automated Stress Mapping

Intuitive Data Gets Results

POWERFUL COLLECTION OPTIONS

With Proto's extensive mapping options, data can be collected under a variety of conditions on any size part.

Laboratory Stress Mapping



Built into the enclosure, this option provides unequaled convenience. Our heavy duty design ensures high reliability and years of continuous use.

Modular Stress Mapping



Modular stress mapping allows for laboratory mapping capabilities in the field or on the shop floor.

Gantry Robot Mapping



Proto's unique gantry robot mapping system enables extra large part capacity in a fully interlocked enclosure.

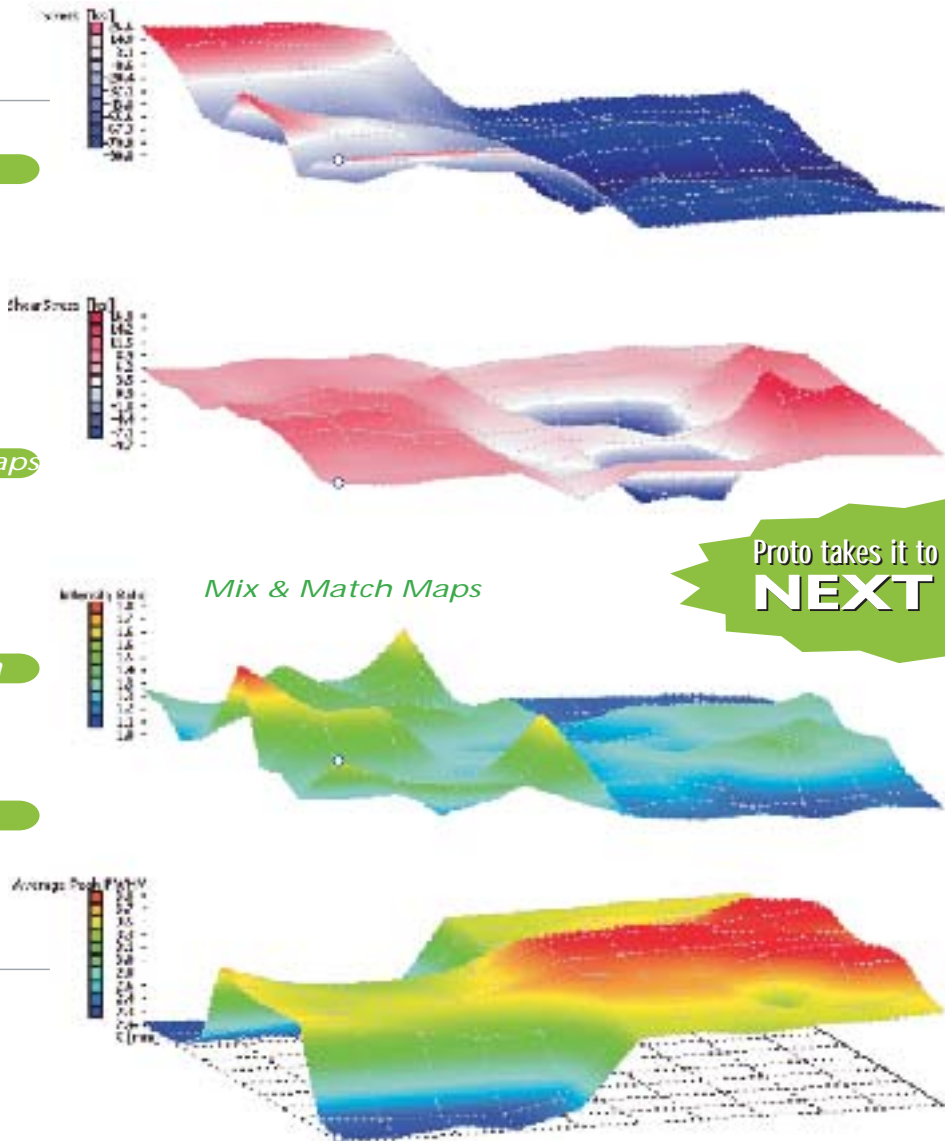
Portable Stress Mapping



Bring the mapping to the part or structure! Portable stress mapping enables characterization of large parts and structures.

POWERFUL PRESENTATION

Simultaneous display of multiple maps



Proto takes it to the
NEXT LEVEL!

Mix & Match Maps

- Residual Stress
- Peak Width
- % Retained Austenite
- Hardness
- Principal Stress
- Individual Stress Tensors
- and more...

Show Before & After Maps

- Compare Pre- and Post-Process
- Compare New & Used
- Track Life Cycle

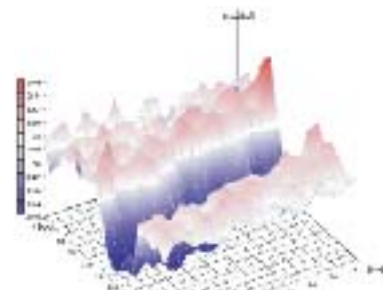
Perform Map Algebra

- +, -, X, /, Average
- Show Net Gains/Losses

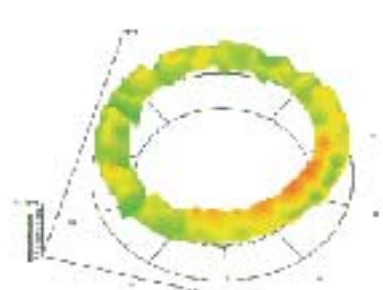
Display Results

- Customized Reporting
- Find Hidden Trends
- Pinpoint Hotspots

An exclusive feature of Proto systems, Automated Stress Mapping can be the key to solving many residual stress problems by providing an intuitive display of the distribution and magnitude of the residual stresses.



Weld residual stress map

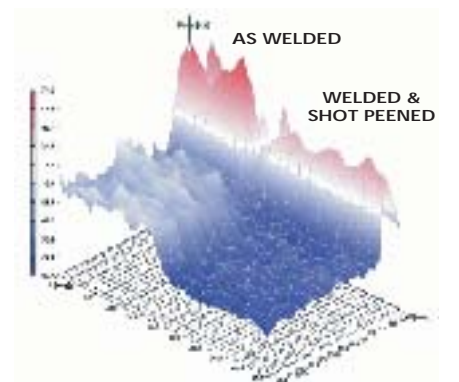


Annular residual stress map

POWERFUL INTERPRETATION

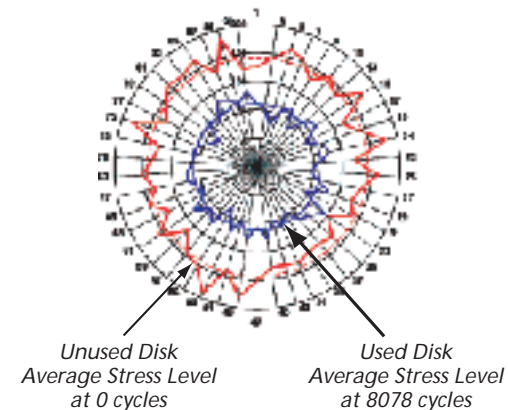
Automated Stress Mapping Tells The Story!

Welded Inconel 825 plate with Inconel 625 filler. Since tensile residual stress was expected in the weld and the HAZ, shot peening (CW-28 shot at 16-18A intensity and 125% coverage) was introduced to manage the potentially problematic tensile residual stresses. To verify the effectiveness of the peening, a section of the weld was masked so that the peened and "as welded" areas could be compared. The resulting residual stress map, as shown in the adjacent map, clearly indicates the area peened and not peened. Most importantly, the shot peened area indicates the tensile stresses were reduced in magnitude, however, not sufficiently reduced to prevent the potential for stress corrosion cracking to occur.



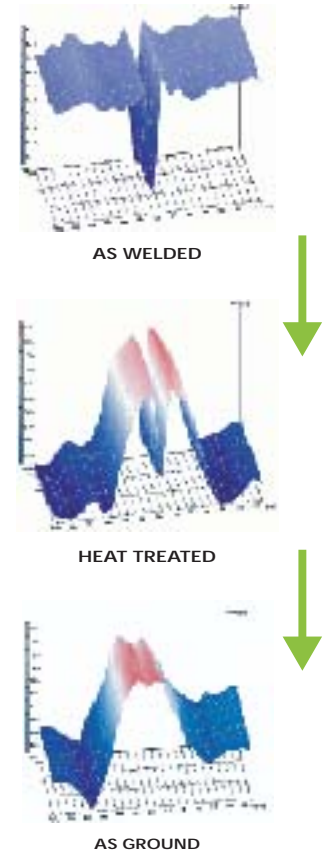
Stress Map of Inconel TIG Weld

Residual Stress Tracking



Non-destructive analysis lets you track stress distribution on a part or structure from process to process or cycle to cycle.

Various worldwide patents granted and pending.





mXRD[®] - Portable Stress Analysis System

The world's only XRD based stress analysis system designed specifically for harsh environments.

Take our self-contained, light, fast and portable iXRD concept, build it from scratch to be extra tough, water-, temperature- and shock-resistant, add voice control capability and a unique heads up display operator interface, and you have the mXRD. Whether suspended from a bridge truss, lashed to a ship hull, mounted on a pipeline or set up on a manufacturing process line, this system offers control under dynamic conditions and harsh environments. The mXRD incorporates ceramic x-ray tubes developed by Proto for better shock resistance and our own x-ray detectors that will not degrade with exposure to x-rays.



Features

Detectors

Patented PSSD x-ray detectors provide unexcelled speed, stability and wide 2-theta range, and, unlike other x-ray detectors, do not degrade with time exposed to x-rays.

The MG40

Versatile precision miniature goniometer is capable of S.E.T (Single Exposure Technique), $\sin^2\Psi$ (Multiple Exposure Technique) and $\sin^2\chi$ (Modified Side Inclination Technique).

Rugged & Truly Portable

The mXRD is designed expressly for field use and the marine environment.

Speed

The mXRD is the fastest portable stress measuring system in the world today.

mXRD/SE

This model features a unique low profile goniometer designed to provide S.E.T. access to areas which may be otherwise difficult or impossible to measure.

Above and below: The unit shown in use aboard a naval platform. The mXRD system is designed to provide the ruggedness and portability required for stress measurements in the field on marine structures and under extreme environment conditions. The mXRD features many advantages not available from other manufacturers.

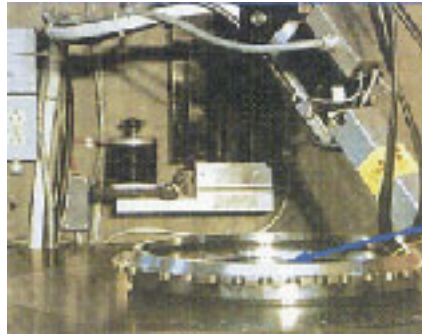


The mXRD has been developed in a joint effort between DRDC and Proto Manufacturing to address the residual and applied stress issues of marine structures. The mXRD has been applied to characterize various structural and propulsion components.

Custom XRD[®] Systems

Some situations demand unique solutions.
Proto provides the answers.

Turnkey installation / custom enclosure



Simultaneous residual stress and retained austenite via semi-robotic arm on jump side thruster bearing



Stress measurement on internal diameter deep inside long bore



System to measure post-tensioning cables, LaGuardia Airport, N.Y.



Whether it's a dedicated system inside a process line or a custom design for a specific application, Proto's custom system solutions all share the same attributes of

speed, accuracy and reliability that are the hallmark of our standard models. Our vertically integrated team of physicists, engineers, programmers, technologists and craftsmen are ready to design, develop, build and apply a custom solution to your unique application needs.



Custom system and integration for NIST Maryland, U.S.A.

Automated orientation fixture for programmed sequence measurement



Large area electropolishing probe



Options/Accessories

Proto uses a comprehensive approach to residual stress characterization. Our extensive line of options and accessories is specifically designed to work with Proto systems enabling maximum productivity with minimal effort.

Fields Stands for iXRD & iXRD Combo



No. 1 Field Stand
Pipeline or pressure vessel-capable with magnetic flex track and manual X,Y axis, auto Z axis
(Suction cup foot option available for all stands)



No. 2 Field Stand
Cobra-Link® magnetic feet, adjustable swivel pads, manual Z axis (shown with optional X,Y axis)



No. 3 Field Stand
Cobra-Link® telescoping legs, magnetic feet, adjustable swivel pads, manual X,Y axis, auto Z axis



No. 4 Field Stand
Cobra-Link® magnetic feet, adjustable swivel pads, manual X,Y axis, auto Z axis

Portable Electrolytic Polisher



Rugged industrial design specific for x-ray diffraction applications.

Electropolishing Probes



Collimator Extender

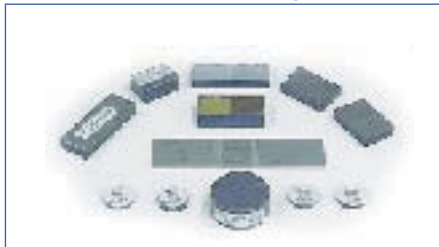


4-Point Bend Package



4-Point Bend Package with fixture, strain bridge, RS232 interface and Proto RS Strain 1.0 software.

Standards & Coupons



Automated Cylindrical Component Map Fixtures



X-Ray Tubes



Goniometers



MG20
MG30
MG30L
MG40
MG40L
MG2000L
XRD 2000GR

Proto's wide variety of goniometers gives you mapping ability where and how you need it.

Many more options available...

Software that's easy to use, yet ready to meet the challenge of the most demanding applications...

Residual Stress Measurement

- linear and elliptical regression of d vs. $\sin^2\Psi$ data with comprehensive error analysis
- psi and omega geometries
- numerous peak fitting routines: Parabolic, Gaussian, Pearson VII, Cauchy, Centroid, Centered Centroid, Mid-chord
- peak shift determination using absolute peak position or cross correlation method
- Dolle-Hauk method for Ψ_+ , Ψ_- data averaging using linear regression
- $K\alpha_1$ and $K\alpha_2$ multi-peak fitting or $K\alpha_2$ stripping
- graphical display of " d ", " 2θ ", "intensity", "breadth", "FWHM" vs. $\sin^2\Psi$ or $\sin^2\chi$, zoom-in, zoom-out, dynamic scale
- interactive mouse control of fitting and background selection allows fast modifications of fitting parameters
- results conveniently displayed in one view including raw data, corrected peaks, d -spacing vs. $\sin^2\Psi$ and text report **A**
- fully editable materials constants library and x-ray radiation constants chart
- raw data exportable to ASCII, MS Word, MS Excel and clipboard formats

Triaxial Stress Measurement

- manual and automated routines
- stress tensor determination, principle stress, max shear, equivalent stress determination

Automated Stress Mapping

- square, rectangular and circle grid mapping
- individual point selection allowing custom map trajectories
- multi-level 3D graphical representation of results **B**

Austenite Measurement

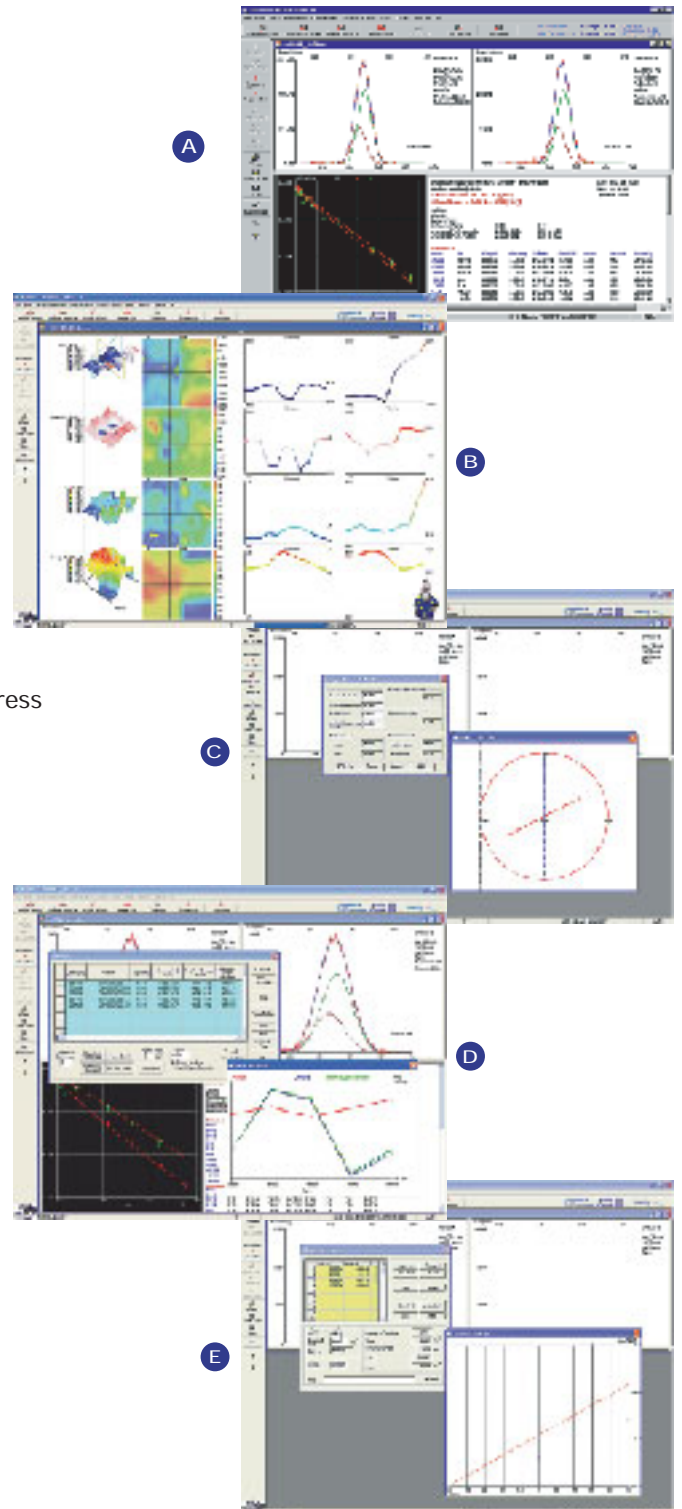
- R value calculation for different alloys
- average peak method using multiple (hkl) planes
- standard method with known calibration standards

Utilities

- principal stress calculator **C**
- material removal correction
- effective depth of x-ray penetration correction **D**
- X-ray Elastic Constant determination
- remote access through network or phone
- interactive help wizard for faster learning

Add-In Modules

- Pole-figure module
- Expert System module
- Database Management module
- Inline Inspection stress monitor
- Proto Strain Gauge Monitor module **E**
- Simultaneous Stress and Retained Austenite Measurement module



Built from the ground up and ready to empower you!