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# PROTO MANUFACTURING



# iXRD

## Residual Stress X-ray Diffraction

Portable Residual Stress & Retained Austenite  
Measurement Systems



MG40 WITH COBRA ARM ON FS2 Compact basic measurement system.

iXRD

## PORTABLE HIGH-SPEED RESIDUAL STRESS MEASUREMENT

A proven performer in the field, shop floor and laboratory, the iXRD brings you an advanced system for your portable residual stress and retained austenite measurement needs. With our modular approach, powerful software, easy to operate controls and our uniquely designed goniometers and stands, we offer one of the most flexible and sophisticated instruments available in the market.

The highly configurable iXRD system, ensures that an appropriately configured system is available for your measurements. With various options for sample handling, mapping, triaxial stress measurement, and enclosures, the iXRD meets the needs of all your diverse projects. For unique projects, we also have specialized miniature models that are able to measure inside small diameter bores.

# PORTABLE HIGH-SPEED XRD RESIDUAL STRESS MEASUREMENT SYSTEM

## GONIOMETER OPTIONS



MG40

The popular **MG40** offers a good balance between size and versatility. With a 40 mm focal distance and the standard 30 mm x-ray tube it can measure inside a 120 mm diameter bore.



MGR40

With its fully integrated phi rotation axis, the **MGR40** adds automated triaxial measurement capability in the field.



MG30

The smaller **MG30** is ideal for measuring in tight locations. With a 30 mm focal distance and our miniature 16 mm x-ray tube it is capable of measuring inside a 90 mm diameter bore.

## GONIOMETER MOUNTS



COMPACT

A compact mount is available for lightweight and simple field use.



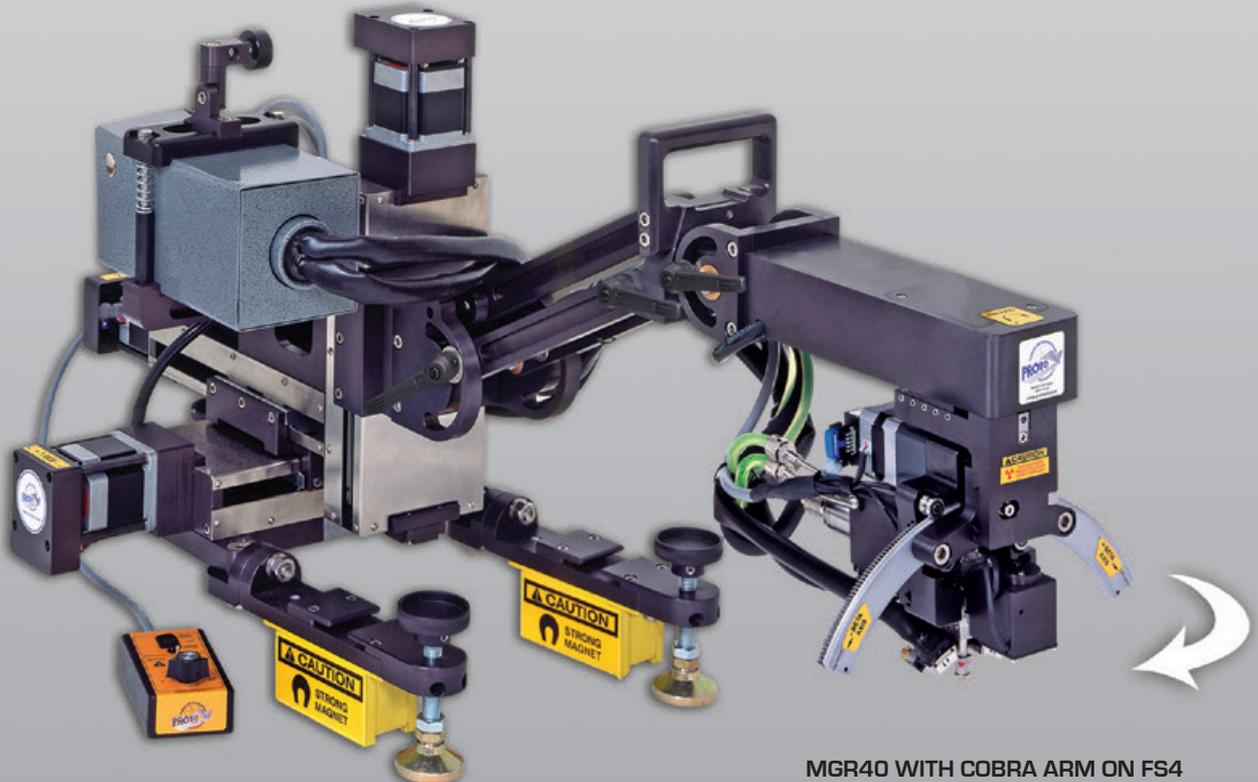
COBRA ARM

Our **COBRA ARM** for fast flexible positioning of the goniometer in any direction in space. It can be raised vertically, rotated horizontally, or turned upside down.



C-FRAME

The easily removable **C-FRAME** mount adds the convenience of triaxial measurements in the field, while retaining the accessibility of the MG40.



**MGR40 WITH COBRA ARM ON FS4**  
Automated triaxial measurement and residual stress mapping.

## FIELD STANDS



### FS2

#### A LOW COST BASIC STAND FOR ADDED FLEXIBILITY IN THE FIELD

Our basic field stand with a 100 mm automated Z-axis for focusing, Cobra Arm for flexible positioning of the goniometer, magnetic feet, and adjustable foot pads.



### FS4

#### OUR MOST POPULAR STAND FOR PORTABLE STRESS MEASUREMENT

This upgraded field stand has a 100 mm travel automated Z-axis for focusing, 100 mm travel X, Y-axes and Cobra Arm for flexible positioning of the goniometer, magnetic feet, and adjustable foot pads.

## SPECIALTY STANDS



PIPELINE STAND



FLOOR STAND



TRIPOD STAND



PHI TABLE

# PORTABLE HIGH-SPEED XRD RESIDUAL STRESS MEASUREMENT SYSTEM

## SAFETY & PROTECTION



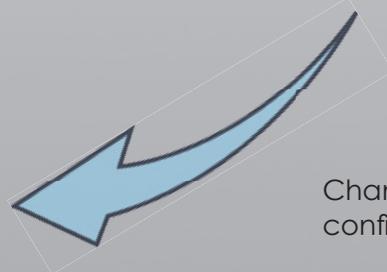
Our systems are compliant with ANSI N43.2 regulations providing full radiation protection. X-ray and shutter beacons conveniently notify the operator of the status of the x-ray beam. Enclosures and barrier screens provide full radiation protection for the operator.



## iXRD COMBO



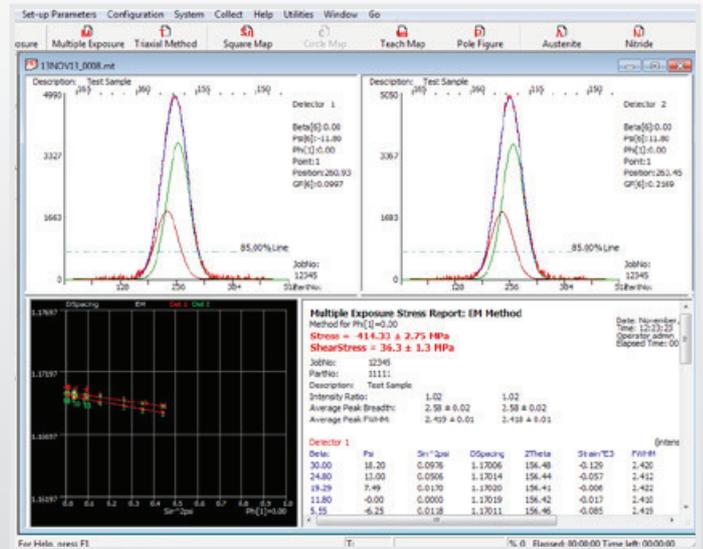
Take advantage of the convenience and safety of an **iXRD COMBO** enclosure. Transform your portable unit into a fully functional laboratory system in minutes. It can be purchased as a basic enclosure or upgraded with integrated sample handling stages. It provides a safe and convenient working environment, and is available in our standard size or customized to your application.



Change from laboratory to field configuration in a few minutes.

## ACCURACY WHEN IT MATTERS MOST

At the core of every iXRD system is the powerful yet easy to use PROTO XRDWin 2.0 software. A comprehensive Windows®-based data collection and stress analysis package with features such as: linear and elliptical regression, Dolle-Hauk, and triaxial methods. Advanced peak fitting functions: parabolic, gaussian, pearson VII, cauchy, centroid, centered centroid, and mid-chord. Graphical display of peak intensity, breadth, FWHM, and  $\sin^2\psi$  plots provides informative easy to read results. Software utilities for XEC determination, principle stress, material removal, depth of penetration, and retained austenite make a complete package.



## PROTO'S STATE-OF-THE-ART X-RAY DETECTORS

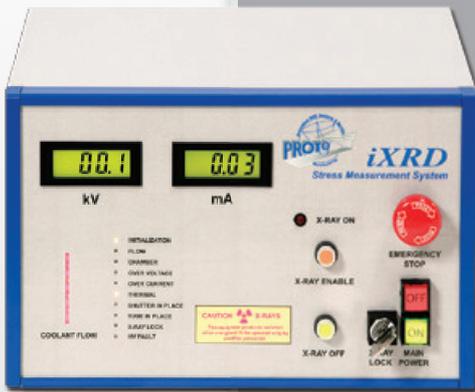
PROTO's proprietary position sensitive scintillation detectors (PSSD) provide unsurpassed speed, stability and a wide  $2\theta$  range. Unlike other x-ray detectors, they do not deteriorate with exposure to x-rays. No expensive replacements required. The detectors can be quickly positioned between iso (omega) or modified side inclination (psi) geometry. Two detectors for accurate shear stress determination. Available in standard  $2\theta$  range, wide  $2\theta$  range, and in a miniature package for our specialty miniature goniometers.

## ADVANCED FEATURES

1. **RESIDUAL STRESS MAPPING (PATENTED)** is available on all iXRD models, providing a comprehensive picture of the residual stress distribution. As the originators of residual stress mapping, PROTO is a leader in the field.
2. **AUTOMATED RETAINED AUSTENITE** ASTM E975 4 peak %RA analysis. R value calculator. Low concentration 2% detection limit. No changeover required between stress and austenite. Optional nitride layer analysis.
3. **X-RAY ELASTIC CONSTANT DETERMINATION (XEC)** Fully automated residual stress measurement material calibration as per ASTM E1426.
4. **X-RAY TUBE CARTRIDGES** allows for fast x-ray tube changes, while maintaining accurate system alignment.



# PORTABLE HIGH-SPEED XRD RESIDUAL STRESS MEASUREMENT SYSTEM



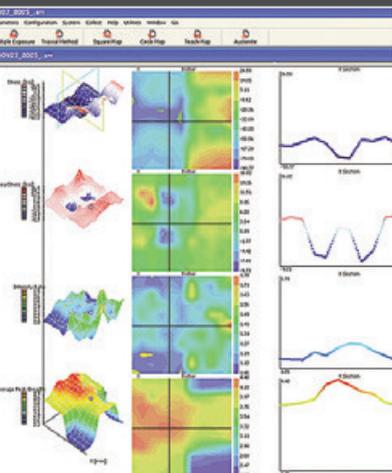
## LIGHTWEIGHT, PORTABLE AND FAST XRD BASED STRESS MEASUREMENT SYSTEM

All of PROTO'S iXRD models are built around our 300W self-contained control unit. This compact, portable heart-of-the-system contains a high-voltage supply, x-ray tube cooling, motor controls, and all system electronics. An integrated panel displays kV, mA, coolant flow, x-ray tube status and safety interlock status. Additional safety features include external ports for interfacing to an enclosure or barrier, and beacon lights for 'shutter' and 'x-ray ON'.



## EASY AND CONVENIENT TO USE

1. **HIGH PERFORMANCE GONIOMETER** maintains ASTM E915 accuracy in a low maintenance design.
2. **MANUAL FOCUS** pointer enables accurate positioning of the goniometer in complex geometries.
3. **AUTOMATED FOCUS** pointer for convenient automated focusing and fast focusing of large residual stress maps.
4. **X-RAY BEAM APERTURES** round 0.5, 1.0, 2.0, 3.0, 4.0 mm rectangular 0.5x3, 1x3, 0.5x5, 1x5, 2x5 mm
5. **HIGH STRESS STANDARDS, ZERO STRESS POWDERS, %RA STANDARDS** ensure accurate system results.
6. **QUICK ADJUST FEATURES** offer rapid positioning of the goniometer with easy-turn locking handles.





TRIAxIAL MAPPING



TRIAxIAL MAPPING

**iXRD MODULAR MAPPING**



MODULAR BASE REMOVED

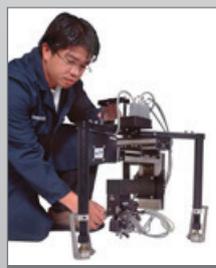
The iXRD MODULAR MAPPING system has a phi rotation stage and a fully automated 300 x 200 mm travel XY stage. All mounted on a removable base, the mapping stage provides comprehensive residual stress mapping, or can be detached for large part accessibility.

Additionally, the 200 mm Z-axis and MG40 goniometer can be removed together and mounted on magnetic feet for use in the field.



Z-AXIS MOUNTED ON FEET

**iXRD GANTRY**



CONFIGURED FOR FIELD USE

The iXRD GANTRY system has a variety of configurations. The overhead manual XY gantry enables easy positioning of the MGR40 goniometer over the steel table, or can be positioned outside the front of the enclosure for oversized parts.

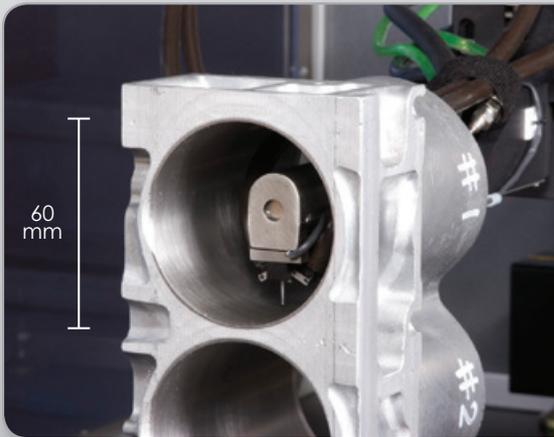
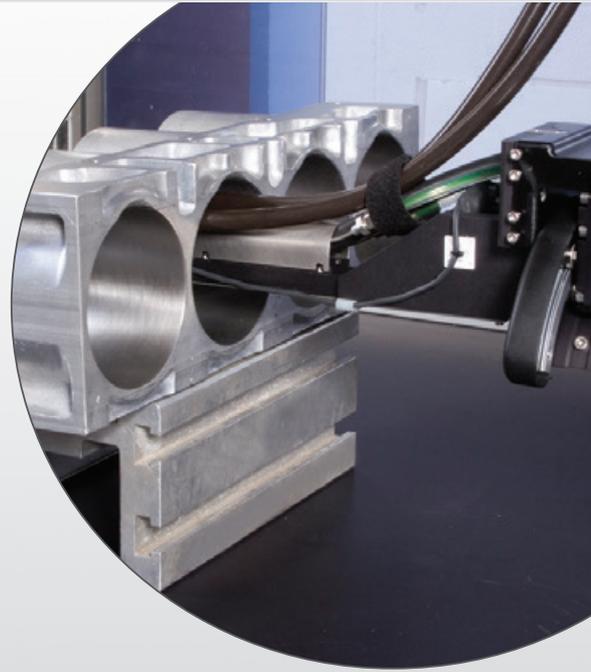
The 100 mm travel automated XYZ stage provides local mapping and positioning, or can be removed along with the goniometer and mounted on a tripod stand for field use.



GANTRY OUTSIDE OF ENCLOSURE

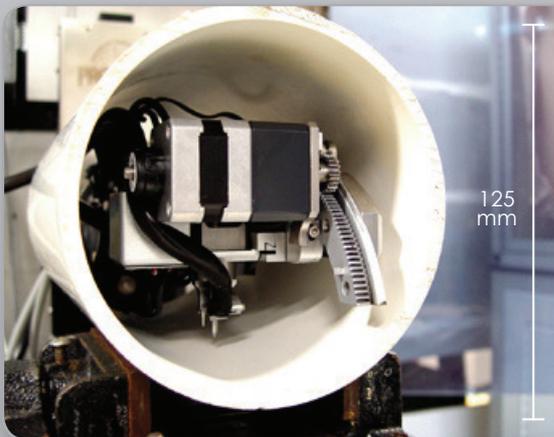
**SPECIALTY MINIATURE GONIOMETERS**

At PROTO we have pushed the boundaries of conventional stress measurement by creating the world's smallest residual stress measurement instruments. For your specialty application where small bore access is required, we have developed a unique line of miniature goniometers. By combining a smaller version of our PSSD detector and a 16 mm x-ray tube, we have made a product that eliminates the need to section or cut parts.



**MG15**

With a 15 mm focal distance, 16 mm x-ray tube and miniature PSSD x-ray detectors the **MG15** is capable of measuring hoop stress inside a 60 mm diameter bore.



**MG15 AXIAL**

With a 15 mm focal distance, 16 mm x-ray tube and miniature PSSD x-ray detectors the **MG15 AXIAL** can measure axial stress inside a 125 mm diameter bore.





## APPLICATIONS IN THE FIELD

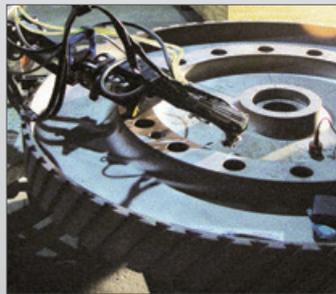
The iXRD system has been designed to be configurable to meet the requirements of your application. Whether you are measuring a turbine wheel, aircraft landing gear or the interior of a pipeline, the iXRD system has the flexibility to perform measurements in any environment.

- Automotive • Aerospace • Power Generation
- Bridges • Pipelines • Heavy Machinery • Marine



### TRAVEL CASES

Our heavy-duty travel cases ensure your iXRD systems arrives safely. Meets most checked baggage allowances.



### TURBINE WHEEL

Measuring residual stress on a large power generation turbine wheel on the shop floor.



### PIPELINE

Measuring residual stress on the inside of a large water pipe.



### HEAVY MACHINERY

Measuring residual stress on a large machinery component.

### FIELD SERVICES

PROTO field service technician working on site measuring residual stress on a gas pipeline.

### AIRCRAFT FRAME

PROTO field service Measuring residual stress on aircraft frame.



## PROTO'S HIGH QUALITY X-RAY TUBES

Our ceramic/metal x-ray tubes are produced in-house to provide you with the best quality, performance, warranty and support. These durable, stable and high flux tubes provide years of accurate measurements. For optimal results we utilize a wide range of anodes to ensure the best possible x-ray diffraction peaks on your materials.

Available anodes: Ti, V, Cr, Mn, Fe, Co, Cu.



	iXRD	iXRD COMBO	iXRD MODULAR MAPPING	iXRD GANTRY
Dimensions (L x W x H)	40 x 30 x 20 mm 16 x 12 x 8 in	1600 x 1100 x 1800 mm 63 x 43 x 71 in	2500 x 1900 x 2000 mm 98 x 75 x 79 in	2700 x 1100 x 2600 mm 106 x 43 x 102 in
Recommended Maximum Part Size	unlimited	500 mm 20 in	1000 mm 40 in	1000 mm 40 in
Goniometers	MG40, MGR40, MG30, MG15, MG15 axial		MG40	MGR40
Field Stands	FS2, FS4		FS2	tripod
HV Power	300 W			
Mapping Stages (X,Y)	FS4: 100 x 100 mm 4 x 4 in		200 x 200 mm 8 x 8 in	100 x 100 mm 4 x 4 in
Focusing Axis (Z)	FS2: 100 mm (optional 200 mm) FS4: 100 mm		400 mm 16 in	760 mm 30 in
Manual Stages (X,Y)	n/a			2100 x 650 mm 83 x 26 in
Phi Rotation Stage	MGR40 (0-360°), MG40 + CFrame, portable table	optional integrated phi 500 mm (20 in) rotation stage (0-360°)	integrated phi 500 mm (20 in) rotation stage (0-360°)	MGR40 (0-360°)
Sample Table	n/a	1600 x 1100 mm 63 x 43 in	180 mm (7 in)	heavy-duty steel table 2700 x 1100 mm 106 x 43 in
Geometry	iso (omega), modified side inclination (psi)			
X-ray Tubes	fine focus 30 mm diameter metal ceramic			
X-ray Tube Cooling	integrated recirculating liquid-to-air heat exchanger			
X-ray Beam Apertures	round: 0.5, 1.0, 2.0 mm rectangular: 0.5x3, 3x0.5, 1x3, 3x1, 0.5x5, 5x0.5, 1x5, 5x1, 1.5x5, 5x1.5 mm			
X-ray Detectors	proprietary dual position sensitive scintillation detectors (PSSD)			
Detector Width (2θ)	standard 18.4°, wide 29.5°			
2θ Range	residual stress: 123°-171°, retained austenite: 70°-171°			
Focusing	manual, automated			
X-ray Filters	diffracted beam Kβ filters			
Safety	independent warning light beacons for "x-ray on" and "shutter open", emergency stop with lockout key, x-ray protective glass for zero x-ray emission from enclosure			
Computer	latest generation brand name desktop or laptop computer with each LXR D			
Software	powerful yet easy to use XRDWin 2.0			
Enclosure Features	enclosure light, fully interlocked, clear view windows, hand-held motion control pendant			
Operating Temperature Range	0°C to 35°C non-condensing humidity			
Power Requirements	90-240 VAC, 50/60 Hz, single phase			
System Compliance	ASTM E915, ANSI N43.2, CE			

Proto Manufacturing engages in continuous research and development, therefore specifications in this publication are subject to change. Please call for details. Various items and methods in this brochure are covered by patents or patents pending.



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