iXRD®
Portable Residual Stress & Retained Austenite Measurement

TECHNOLOGY
THAT DELIVERS
ACCURATE RESULTS™

X-ray Diffraction
Systems & Services

PROTO
PORTABLE HIGH-SPEED RESIDUAL STRESS MEASUREMENT

A proven performer in the field, shop floor and laboratory, the iXRD is 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 appropriate system is available for your measurement needs. With numerous 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.
GONIOMETER OPTIONS

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.

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

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

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

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.

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
BASIC STAND FOR 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 XY-axes, 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.

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 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^2ψ 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 2θ 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 2θ range, wide 2θ range, and in a miniature package for our specialty miniature goniometers.

ADVANCED FEATURES

1. PORTABLE 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.
LIGHTWEIGHT, PORTABLE AND FAST XRD BASED STRESS MEASUREMENT SYSTEM

All of PROTO’S iXRD models are built around our 300W control module. This self-contained unit contains a high-voltage power 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, 1.5x5, 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.
**iXRD MODULAR MAPPING**

The iXRD MODULAR MAPPING system has a phi rotation stage and a fully automated 300 x 200 mm travel XY stage for part positioning and residual stress mapping. The mapping stage can be detached for large part accessibility. Additionally, the MG40 goniometer and 200 mm Z-axis can be removed and mounted on magnetic feet for use in the field.

**iXRD GANTRY**

The iXRD GANTRY system has an overhead manual XY gantry that enables easy positioning of the MGR40 goniometer over the steel table. It 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.
MINIATURE MODELS

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 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

PROTO’s iXRD system is easily configured for your measurement 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

HEAVY MACHINERY
Measuring residual stress on a large machinery component.

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.

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

PROTO’S ELECTROPOLISHER
Lightweight, compact, rugged industrial design for etching or polishing tasks. Used for residual stress with depth determination by removing layers from the specimen without incurring cold working stresses.

0.65 VDC / 0.10 A, timer, stainless steel pump and tank, magnetic and clip ground, 6, 9, 12 & 15 mm spot tips, optional custom mask/molding kit
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.

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<thead>
<tr>
<th></th>
<th>IXRD</th>
<th>IXRD COMBO</th>
<th>IXRD MODULAR MAPPING</th>
<th>IXRD GANTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions (L x W x H)</td>
<td>400 x 300 x 200 mm 16 x 12 x 8 in</td>
<td>1600 x 1100 x 1800 mm 63 x 43 x 71 in</td>
<td>2500 x 1900 x 2000 mm 98 x 75 x 79 in</td>
<td>2700 x 1100 x 2600 m 106 x 43 x 102 in</td>
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<tr>
<td>Recommended Maximum Part Size</td>
<td>unlimited</td>
<td>500 mm 20 in</td>
<td>1000 mm 40 in</td>
<td>1000 mm 40 in</td>
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<tr>
<td>Goniometers</td>
<td>MG40, MGR40, MG30, MG15, MG15 axial</td>
<td>MG40</td>
<td>MGR40</td>
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<tr>
<td>Field Stands</td>
<td>FS2, FS4</td>
<td>FS2</td>
<td>tripod</td>
<td></td>
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<tr>
<td>HV Power</td>
<td>300 W</td>
<td></td>
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<tr>
<td>Mapping Stages (X,Y)</td>
<td>FS4: 100 x 100 mm 4 x 4 in</td>
<td>200 x 200 mm 8 x 8 in</td>
<td>100 x 100 mm 4 x 4 in</td>
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<tr>
<td>Focusing Axis (Z)</td>
<td>FS2: 100 mm (optional 200 mm) FS4: 100 mm</td>
<td>400 mm 16 in</td>
<td>760 mm 30 in</td>
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<tr>
<td>Manual Stages (X,Y)</td>
<td>n/a</td>
<td>2100 x 650 mm 83 x 26 in</td>
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<tr>
<td>Phi Rotation Stage</td>
<td>MGR40 (0-360°), MG40 + C-Frame, portable table</td>
<td>optional integrated phi 500 mm (20 in) rotation stage (0-360°)</td>
<td>integrated phi 500 mm (20 in) rotation stage (0-360°)</td>
<td>MGR40 (0-360°)</td>
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<tr>
<td>Sample Table</td>
<td>n/a</td>
<td>1600 x 1100 mm 63 x 43 in</td>
<td>180 mm (7 in)</td>
<td>heavy-duty steel table 2700 x 1100 mm 106 x 43 in</td>
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<tr>
<td>Geometry</td>
<td>iso (omega), modified side inclination (psi)</td>
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<tr>
<td>X-ray Tubes</td>
<td>fine focus 30 mm diameter metal ceramic</td>
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<tr>
<td>X-ray Tube Cooling</td>
<td>integrated recirculating liquid-to-air heat exchanger</td>
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<td>X-ray Beam Apertures</td>
<td>round: 0.5, 1.0, 2.0, 3.0, 4.0 mm rectangular: 0.5x3, 1x3, 0.5x5, 1x5, 1.5x5, 2x5 mm</td>
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<td>X-ray Detectors</td>
<td>proprietary dual position sensitive scintillation detectors (PSSD)</td>
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<tr>
<td>Detector Width (2θ)</td>
<td>standard 18.4°, wide 29.5°</td>
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<tr>
<td>2θ Range</td>
<td>residual stress: 123°-171°, retained austenite: 70°-171°</td>
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<tr>
<td>Focusing</td>
<td>manual, automated</td>
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<td>X-ray Filters</td>
<td>diffracted beam Kβ filters</td>
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<td>Safety</td>
<td>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</td>
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<tr>
<td>Computer</td>
<td>latest generation brand name desktop or laptop computer with each LXRD</td>
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<td>Software</td>
<td>powerful yet easy to use XRDWin 2.0</td>
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<tr>
<td>Enclosure Features</td>
<td>enclosure light, fully interlocked, clear view windows, hand-held motion control pendant</td>
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<tr>
<td>Operating Temperature Range</td>
<td>0°C to 35°C non-condensing humidity</td>
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<td>Power Requirements</td>
<td>90-240 VAC, 50/60 Hz, single phase</td>
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<td>System Compliance</td>
<td>ASTM E915, ANSI N43.2, CE</td>
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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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