PROTO

IMPROVE YOUR SCIENCE™

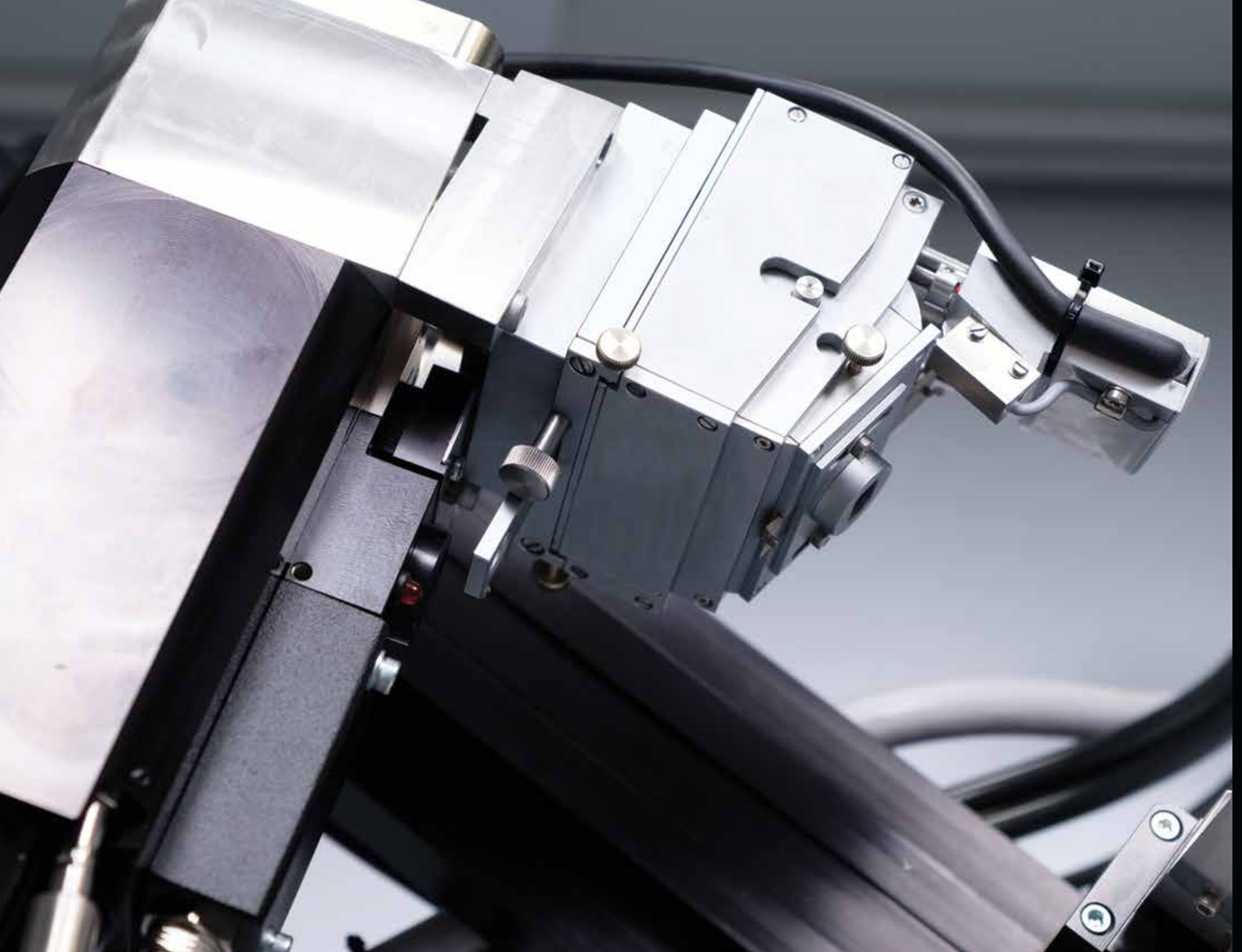
AXRD PRODUCT LINE
POWDER DIFFRACTION

PROTO

HIGH-ACCURACY POWDER DIFFRACTION

At PROTO, we make scientific advancement possible by bringing you highly accurate and precise x-ray diffractometers. You work hard to achieve your results, so we work hard to provide you with the best equipment on the market. Our highly configurable powder diffraction systems include benchtop units, compact floor units, and full-sized laboratory units.

The compact AXRD Benchtop system is full-featured yet highly cost effective. The AXRD Theta-Theta system provides a unique solution for high-temperature diffraction, with temperature stages from -190–2000°C, in the convenience of a compact footprint. The powerful AXRD LPD laboratory system can be customized with x-ray optics to best suit your powder experiment needs. Finally, the AXRD HR is a cutting-edge high-resolution diffractometer that enables characterization of thin films and single-crystal materials. Whether you need to determine the composition of raw materials or characterize your products, you can count on our versatile powder diffractometers to provide accurate results.

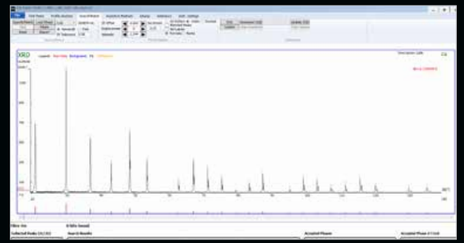


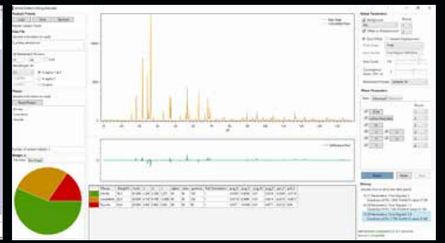
SOFTWARE & APPLICATIONS

XRDWIN PD is our data collection software, optimized for collection versatility. XRDWIN PD makes it easy to set up personalized scan parameters for individual XRD scans and analyze data in real time during acquisition. It can be customized to perform multi-scan collections that vary in temperature, pressure, measurement conditions, or geometries. Built-in prompts optimize alignment and calibration, making the process approachable to even a novice user.

PDAnalysis enables users to analyze powder data acquired with XRDWIN PD. PDAnalysis has an unlimited number of licenses, allowing users to analyze data on or off site with no additional cost. Advanced features of our software enable users to conduct several qualitative and quantitative analyses:

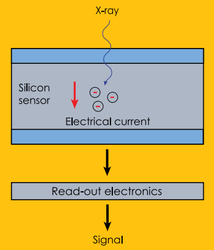
– Phase identification
– Search/match against COD or ICDD databases
– Quantitative phase analysis
– Whole-pattern fitting (Rietveld refinement)
– Percent crystallinity
– Crystallite size & strain
– Lattice parameter refinement & indexing
– Retained austenite, residual stress, pole figures, & texture
– XRF analysis for data collected with SPD detector
– High-resolution analysis: x-ray reflectivity (XRR) curves, rocking curves, & reciprocal space maps





ADVANCED PHOTON-COUNTING DETECTORS

At PROTO, we always choose the best possible x-ray detection systems for our equipment, which is why all of our powder diffractometers are equipped with photon-counting detectors. These detectors directly capture x-ray photons and convert them into an electrical signal. This direct conversion is advantageous because it yields zero dark noise, zero readout noise, high dynamic range, and excellent signal to noise.



Choose from the SPD advanced point detector with true energy discrimination, the DECTRIS MYTHEN2 linear detector for high-speed powder diffraction, or the DECTRIS EIGER2 detector for 2D powder diffraction.

PROTO® SPD SILICON POINT DETECTOR

ADVANCED ENERGY-DISCRIMINATING SINGLE-CHANNEL DETECTOR

- Single-channel point detector
- Direct detection of x-rays with a count rate of 10^6 cps
- Energy resolution of 200 eV FWHM
- Eliminates need for a diffracted beam monochromator or Kβ filter
- Significantly improves data collected from highly fluorescing samples (i.e., Fe and Co)
- Collect data using $K\alpha_{1,2}$ or Kβ wavelength
- Collect x-ray fluorescence (XRF) data to help chemically identify your sample & improve search/match results

DECTRIS® MYTHEN2 R 1D DETECTOR

HIGH-SPEED DATA COLLECTION

- 640 channel high-speed linear detector
- Collects data up to 100 times faster than a scintillation counter
- 32 mm x 8 mm sensor area
- Global count rate of 10^9 cps
- Excellent signal-to-noise ratio & very high dynamic range
- Variable electronic receiving slit
- 0D & 1D modes

DECTRIS® MYTHEN2 R 1K DETECTOR

HIGH-SPEED DATA COLLECTION

- 1280 channel high-speed linear detector
- Large 2θ coverage ideal for time-resolved diffraction experiments
- 64 mm x 8 mm sensor area
- Global count rate of 2×10^9 cps
- Excellent signal-to-noise ratio & very high dynamic range
- Variable electronic receiving slit
- 0D & 1D modes

DECTRIS® EIGER2 R 500K DETECTOR

AREA DETECTOR

- Large area detector with small pixels & high frame rates
- 77.3 mm x 38.6 mm sensor area
- 75 µm x 75 µm pixel size
- Max count rate of 3.6×10^8 cps/mm²
- Dual energy discrimination (low & high thresholds)
- 0D, 1D, & 2D modes

ADVANCED MEASUREMENT STAGES AND CELLS

1. COMPACT HEATING STAGES
   Heat samples from room temperature to 500°C or cool samples to -10°C in a controlled environment under inert gas such as nitrogen (N_2) or argon (Ar).

2. VARIABLE-PRESSURE STAGE
   Investigate material-gas interactions directly at pressures ranging from 10^{-3} atm (vacuum) up to 30 atm (440 psi).

3. ROTATING SAMPLE STAGE
   Variable-speed sample spinner for improving particle statistics of samples with preferred orientation.

4. SAMPLE CHANGER
   Automated sample changers for unattended operation. Each position can be fixed or contain a built-in rotating stage.

5. REACTOR CHAMBER
   A unique tool for studies of solid state and solid state-gas reactions up to 900°C and 10 bar.

6. HIGH-TEMPERATURE CHAMBERS
   High-temperature options up to 2000°C, low-vacuum and high-vacuum options.

PROTO is also pleased to offer custom stages and holders upon request.

X-RAY TUBES AND OPTICS

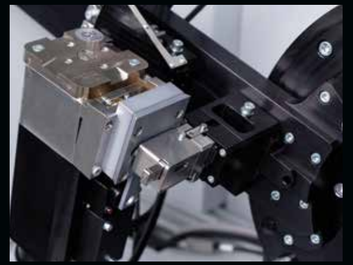
X-RAY TUBES

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: Ag, Cu, Cr, Co, Mo

X-RAY OPTICS

We offer a wide variety of optics options for Bragg-Brentano, glancing incidence, focusing, and parallel geometries, including $K\alpha_1$ beam options. Outfit your powder diffractometer with the latest state-of-the-art multilayer x-ray optics, slit configurations, and variable knife edges for your measurement applications. A full suite of monochromators is available for high-resolution diffraction, including symmetric and asymmetric channel-cut Germanium crystals.



AXRD BENCHTOP

SUITABLE FOR:
Routine material investigation

The AXRD Benchtop provides a low-cost alternative for powder diffraction. This compact model is unmatched in capability, achieving a high level of performance for even the most demanding x-ray diffraction material investigation.

The AXRD Benchtop offers all the features of the most sophisticated powder diffractometer at a fraction of the size and cost. With an achievable FWHM peak resolution of < 0.04° 2θ and an angular accuracy of < ± 0.02° Δ2θ over the full angular range, the AXRD Benchtop is capable of producing high-quality results without occupying the space of a traditional diffractometer.

SPECIFICATIONS	
Geometry	Vertical θ/2θ
Goniometer radius	143 mm (high intensity) or 191 mm (high resolution)
Angular range	-4° to 154° 2θ
Motor resolution	0.0003°
Accuracy	< ± 0.02° 2θ
Slits	Divergence slits, anti-scatter slits, Soller slits, receiving slits, multilayer optics (parallel beam)
Achievable peak width	< 0.05° 2θ (143 mm) or < 0.04° 2θ (191 mm)
X-ray tube	Standard: 1500 W fine-focus Cu x-ray tube Optional anodes: Cr, Co, Mo
X-ray tube cooling	Internal water-cooling radiator and tank
X-ray power supply	600 W
Detectors	SPD (point), MYTHEN2 R 1D (linear), MYTHEN2 R 1K (linear)
Sample holders	Single, bulk sample, rotation, 6-sample changer
Non-ambient stages	Temperature, pressure, humidity
Dimensions (W x D x H)	77 x 56 x 66 cm (30 x 22 x 26 in)
Weight	95 kg (210 lbs)
Power requirements	90–240 V, 50/60 Hz, 10 A

AXRD

THETA-THETA

SUITABLE FOR:
Large samples and non-ambient diffraction

The AXRD Theta-Theta brings non-ambient diffraction to your lab in a cost-effective, compact unit. This system provides a unique solution for high-temperature diffraction, with temperature stages from -190–2000°C.

The AXRD Theta-Theta has been designed to handle larger samples or accommodate situations in which more room is needed for experimental stages, such as temperature stages or pressure cells. The flex-stage option makes mounting large samples easy, while the fully integrated cooling system keeps facility requirements to a minimum.

SPECIFICATIONS	
Geometry	Vertical θ/θ
Goniometer radius	200 mm
Angular range	-4° to 150° 2θ
Motor resolution	0.0001°
Accuracy	< ± 0.02° 2θ
Slits	Divergence slits, anti-scatter slits, Soller slits, receiving slits, multilayer optics (parallel beam, focusing beam)
Achievable peak width	< 0.04° 2θ
X-ray tube	Standard: 1500 W fine-focus Cu x-ray tube Optional anodes: Cr, Co, Mo
X-ray tube cooling	Internal water-cooling radiator and tank
X-ray power supply	1200 W
Detectors	SPD (point), MYTHEN2 R 1D (linear), MYTHEN2 R 1K (linear)
Sample holders	Single, bulk sample, rotation, 6-sample changer
Non-ambient stages	Temperature, pressure, humidity
Dimensions (W x D x H)	100 x 61 x 171 cm (38 x 24 x 68 in)
Weight	200 kg (440 lbs)
Power requirements	200–240 V, 50/60 Hz, 10 A

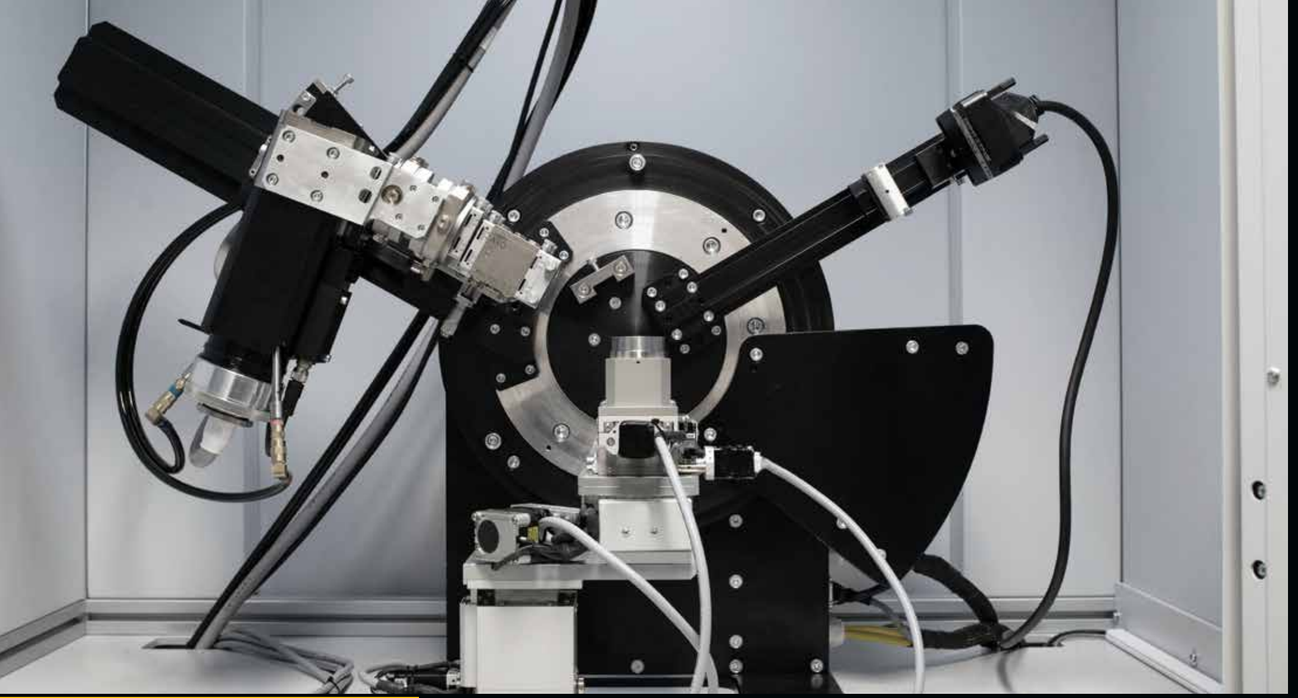
AXRD LPD LABORATORY

SUITABLE FOR:
Advanced diffraction experiments

The AXRD LPD is the ultimate multipurpose platform for all of your powder diffraction experiments. This high-power, versatile system allows you to easily swap out optics, sample stages, environmental cells, x-ray detectors, and x-ray optics. As your measurement requirements change, you can transform a standard LPD into a fully customized unit, ensuring your system is always configured optimally for your needs.

With an angular accuracy of < ± 0.01° Δ2θ over the full angular range, the AXRD LPD has the ability to take on highly complex diffraction challenges. This system is ideal for single crystals, thin films, and bulk and powder samples. The AXRD LPD has everything you need for phase identification, quantitative phase analysis, percent crystallinity, crystallite size and strain, Rietveld refinement, characterization of films and thin coatings, structure analysis, and in-plane diffraction. With multiple sample stages, powerful software, and comprehensive database options, the AXRD LPD is as versatile as your diffraction needs.

SPECIFICATIONS	
Geometry	Vertical θ/θ
Goniometer radius	Variable 200–300 mm
Angular range	Standard range -4° to 160° 2θ; range can be customized depending on application"
Motor resolution	0.0001°
Accuracy	< ± 0.01° 2θ
Slits	Divergence slits, anti-scatter slits, Soller slits, receiving slits, multilayer optics (parallel beam, focusing beam)
Achievable peak width	Standard < 0.04° 2θ width. Other widths depending on which x-ray beam optics installed
X-ray tube	Standard: 2200 W long-fine-focus Cu x-ray tube Optional anodes: Cr, Co, Mo, Ag
X-ray tube cooling	External self-contained recirculating liquid-to-air water chiller
X-ray power supply	1200 W or 3000 W
Detectors	SPD (point), MYTHEN2 R 1D (linear), MYTHEN2 R 1K (linear), EIGER2 500K (area)
Sample holders	Single, bulk sample, rotation, multi-sample changers
Non-ambient stages	Temperature, pressure, low & high vacuum options, humidity
Dimensions (W x D x H)	144 x 92 x 195 cm (56 x 36 x 76 in)
Weight	600 kg (1320 lbs)
Power requirements	200–240 V, 50/60 Hz, 22 A

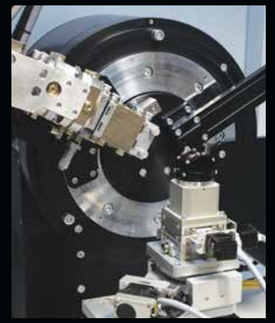


AXRD HR
HIGH-RESOLUTION

SUITABLE FOR:
Epitaxial thin films, multilayer coatings, and single crystals

The AXRD HR is a customizable high-resolution diffractometer for characterizing thin films and single-crystal materials.

- X-RAY REFLECTIVITY (XRR)
- ROCKING CURVES
- RECIPROCAL SPACE MAPPING



The AXRD HR features an innovative goniometer designed to provide the utmost in accuracy and precision. Utilizing the latest advancements in motor and encoder technology, this system has the capabilities necessary to perform high-resolution experiments on your epitaxial thin films, multilayer coatings, and single crystals.

With this top-of-the-line system, you can perform x-ray reflectivity (XRR) to characterize the physical surface properties of your thin films, multilayer coatings, and interfaces. High-resolution rocking curves can be used to analyze epitaxial single-crystal films and determine the crystalline perfection of bulk single crystals. Finally, reciprocal space maps provide valuable information about epitaxial thin films and make it possible to analyze strained films.

SPECIFICATIONS	
Geometry	Vertical θ/θ
Goniometer radius	Variable 200–300 mm
Angular range	Standard range -4° to 160° 2θ; range can be customized depending on application
Motor resolution	0.0001°
Incident beam optics	Parallel beam multilayer optic 2-bounce symmetric cut Ge 2-bounce asymmetric cut Ge 4-bounce symmetric cut Ge 4-bounce asymmetric cut Ge
Diffracted beam analyzer	1-bounce Ge analyzer 2-bounce Ge analyzer 3-bounce Ge analyzer
Sample stages	X,Y mapping stage Rx, Ry tilt Eulerian cradle with phi rotation
X-ray tube	Standard: 2200 W long-fine-focus Cu x-ray tube
X-ray tube cooling	External self-contained recirculating liquid-to-air water chiller
X-ray power supply	3000 W
Detectors	SPD (point), MYTHEN2 R 1D (linear), MYTHEN2 R 1K (linear), EIGER2 500K (area)
Dimensions (W x D x H)	144 x 92 x 195 cm (56 x 36 x 76 in)
Weight	600 kg (1320 lbs)
Power requirements	200–240 V, 50/60 Hz, 22 A

MAIN OFFICES

USA
PROTO Manufacturing Inc.
12350 Universal Drive
Taylor, Michigan
48180-4070
Tel 1-734-946-0974
info@protoxrd.com

CANADA
PROTO Manufacturing Ltd.
2175 Solar Crescent
Oldcastle, Ontario
N0R 1L0
Tel 1-519-737-6330
protocanada@protoxrd.com

JAPAN
PROTO Manufacturing K.K.
3-1-22-402 Nishi Inazawa
Aichi
492-8218
Tel +81 587-81-6531
info@protoxrd.jp

SALES & SERVICE CENTERS

CHINA
EPCO Test Tech LTD
B2301 Tomson Center
188 Zhangyang Rd.
Pudong, Shanghai, 200120
Tel +86 21 38870960
sales@epco.com.cn

INDIA
Elico Marketing PVT. LTD
57, Phase-V, Near Telephone Exchange
KPHB, Kukatpally, Hyderabad
500 072
Tel +91 40 2315 3322, 2315 3388
info@elicomarketing.com

EUROPE
METLAB - PROTO EUROPE
ul. Ibn Siny Awicenny 14
Wroclaw, Poland
54-611
Tel +48 (885) 200 993
protoeurope@protoxrd.com

PROTO

www.protoxrd.com

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