

## RC43 Ion Beam Analysis Endstation



The NEC Ion Beam Analysis (IBA) Endstation, Model RC43, when combined with the NEC Pelletron® accelerator and extended beamline, provides a complete IBA system offering automatic unattended data collection.

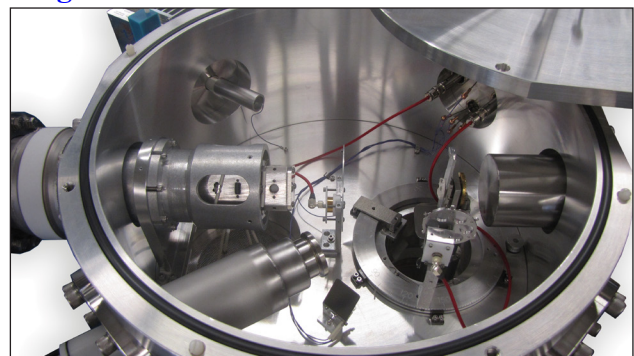
### APPLICATIONS

Applications for thin film profiling and crystal defects are dominant with RBS and Channeling. With the addition of high depth resolution, monolayer depth sensitivity of the near surface is available. Impurity information from PIXE give PPM levels of trace elements for art and archeology applications. Biomedical applications include ion beam genetic modification of seeds for disease resistance. External (in air) beam PIXE can be used to analyze cultural heritage and other sensitive samples. Chemical information is also available through Ion Beam Induced Luminescence. These are just some of the many applications of the analysis methods of which the RC43 endstation is capable.

The standard RC43 Endstation includes a particle detector for RBS analysis. Additional detectors can be added for ERD, NRA, PIXE, PIGE, and IBIL analysis. NEC also offers a microprobe for beam sizes of 20 microns and external beam capabilities. Please contact NEC for more details.

### DESIGN

#### Target Chamber



*Inside of chamber. In addition to standard components, this chamber also includes an X-ray detector, Gamma Detector, and Microprobe.*

The scattering chamber is constructed primarily from aluminum with a 17" (43 cm) inside diameter and an 8" (20 cm) inside height. The base of the chamber provides stable support for the target manipulator, solid state particle detector, beam collimator, and turbo-molecular pump. The chamber lid is designed to limit its weight for ease of removal. A target load lock is placed in the lid to permit quick (less than 5 minute) changes of target holders while maintaining high vacuum. The chamber can accommodate up to 16 samples, 1cm x 1cm, side by side. The chamber is vacuum sealed with Viton O-rings and has a view port, target alignment laser, and video camera. The chamber is electrically isolated and can be used as a Faraday cup for precise beam current measurements.

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## Target Manipulator

Vacuum Generators Stepper Motor Driven Model HPTRX Manipulator with a motorized rotary drive specimen attachment modules. This manipulator provides X and Z motions of +/-12.5 mm and Y motion of +/-50 mm with resolution of 0.001 mm. Theta axis rotations ( $\theta$ ) of +/-90° and Phi ( $\phi$ ) rotation is continuous, both having 0.01° resolution. The stepper motor controller is interfaced to the control computer and will control all five (5) motors at one time. Local control of the manipulator is also available when adding samples.

## Current Integrator

A digital current integrator is provided to measure total ion beam current and provide gate signals for the RBS or NRA measurements by monitoring total ion current on the target. The target chamber is electrically insulated from ground potential so that all ion current that interacts with the sample can be integrated. The incident beam collimator at the chamber entrance is insulated from the target chamber and the lead is brought out of the chamber for grounding or monitoring.

## Pumps and Valves

A turbo-molecular pump with a minimum rating of 250 l/s for air and forepump with a minimum rating of 190 l/m are furnished to pump the target chamber and beamline near the chamber and the target load lock. Solenoid and pneumatic valves with appropriate controllers and gauges are provided to automatically pump out or vent the chamber. This system is interlocked to the turbo pump gate valve and the beamline gate valve so that these valves will close or open dependent on the vacuum status in the target chamber and the connecting beamline.

## CONTROL AND DATA ANALYSIS

Sample positioning and data acquisition is accomplished with a remote control system. This control system utilizes a modern, up-to-date computer with digital pulse processing MCAs. NEC software programs are incorporated to allow automatic data collection and automated channeling analysis.

The RC43 Analytical Data Collection software performs qualitative analysis during data collection. Up to six (6) spectra can be gathered simultaneously, including RBS, ERD, NRA, and PIXE. The data is computer analyzed to yield a fast, verified, qualitatively complete real time materials analysis of the sample. To assist the operator performing crystalline or elemental mapping analysis, the software also prints plots of channeling and microprobe data.

Quantitative analysis is done by the RUMP program developed by L.R. Doolittle of Cornell University\* as well as other analysis programs. This analysis system allows for automatic calibration of the theoretical model and automatic chi squared fitting of the model to the experimental data. Data may be presented either in depth profile format or various yield vs. energy formats. An element's surface scattering energy and height can be displayed. Peak thickness can be calculated and a peak can be plotted in atomic fraction vs. depth format. Up to 10 spectra can be plotted and overlaid with color and line styles automatically changed. Selective plots of individual elements can be done to separate overlapping data.

The RC43 control system also communicates with the accelerator control system itself, receiving beam energy information and sending instructions to produce the optimal beam conditions during real time runs.

*\*For further information on RUMP see: Quantitative Data Analysis for Rutherford Backscattering; A Thesis by Lawrence Doolittle, Cornell University.*



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7540 Graber Rd., P.O. Box 620310, Middleton, WI 53562-0310 USA

TELEPHONE: 608-831-7600 ♦ FAX: 608-831-9591 ♦ E-MAIL: [nec@pelletron.com](mailto:nec@pelletron.com) ♦ WEB-SITE: <http://www.pelletron.com>

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## OPTIONS

The standard RC43 Endstation includes a Silicon Surface Barrier detector of 50mm<sup>2</sup> area and a detector preamplifier with digital pulse processor for RBS analysis. Additional detectors available include:

### ERD Particle Detector

NEC offers, as an option, an additional silicon surface barrier detector for ERD, or glancing RBS measurements. This option includes an insulated feedthrough with a support arm to allow movement of the detector from 30° to 170°. An ERD foil holder is also mounted on the support arm with positions for up to 6 different foil thicknesses. The electronics include the detector preamp, bias supply, and digital pulse processor.

### Gamma Ray Detector

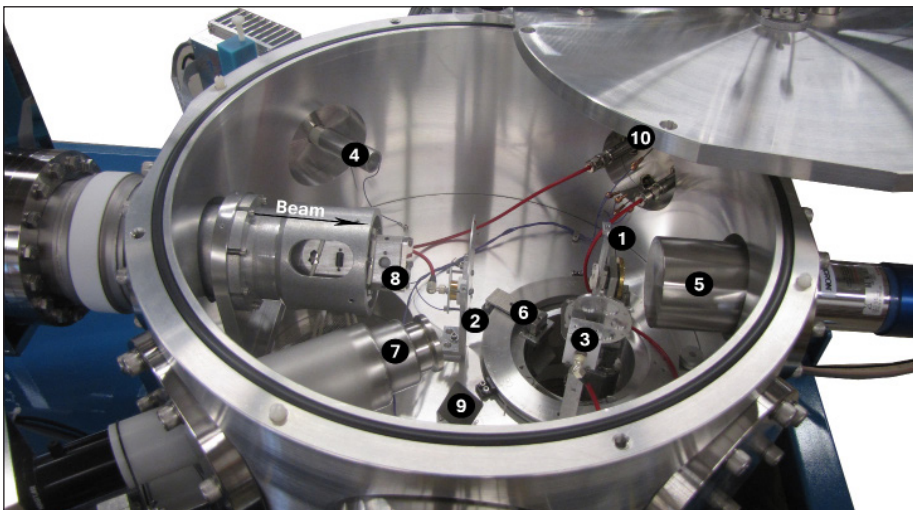
NEC offers, as an option, a 2" x 2" NaI(Tl) Scintillation Detector, preamplifier, amplifier and high voltage bias power supply for NRA analysis. A reentrant tube allows the detector to be closely placed directly behind the target. A higher resolution HPGe detector is also available. Please contact NEC for more information regarding this detector.

### PIXE Detector

NEC offers, as an option, a 25mm<sup>2</sup> Silicon Drift Detector (SDD) for PIXE analysis. Also included is a preamp, spectroscopy amplifier, power supply, X-ray filter holder, MCA with KLM lines, and necessary cables. A modern, up-to-date computer with GUPIX analysis software, color monitor, keyboard, mouse, and stand are provided. Files of data acquired on the RC43 computer are easy to transfer directly to the PIXE analysis computer via Ethernet.

## ACCESSORIES

NEC offers, as an option, a high resolution RBS detector system. This detector adds the capability of Ångstrom range depth profiling. Please contact NEC for further information regarding this detector system.



1. Sample
2. Fixed SSB at 170°
3. Moveable SSB and Filters at 180° to 30°
4. X-Ray Detector
5. Gamma Detector at 0°
6. X-Ray Detector Filters
7. Zoom Camera
8. Microprobe Lens
9. Light
10. Chamber Feedthroughs

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## SPECIFICATIONS

### RC43 System

Endstation: 54"L x 36"W  
Console: 72"W x 24"D x 60" H

### Chamber

8" x 17" OD, Aluminum  
(other chamber sizes available upon request)  
Base Vacuum: 1 x 10<sup>-7</sup> Torr  
Operating Vacuum: 5 x 10<sup>-7</sup> Torr  
Number of Targets: 10/holder  
Change Targets: 5 minutes  
Number of Ports: 5 to 7 Radial  
ERD Filters: 6  
X-ray Filters: 4  
Beamline Flange: 6" OD CF  
Beam Collimation: 2.5mm to 0.5mm  
or MicroProbe Lens  
Target Movement: 5 axis  
100mm Z; 16mm X; 16mm Y,  
180° Theta; Continuous Phi

### Software

Operating System: Windows

### Power

Endstation: 30A, 110VAC  
Console: 10A, 110VAC

### Compressed Air

80 psi

### Vent Gas

Dry Nitrogen 5cfm @ 5psi

### Rough Pump Vent

1" base, oil resistance

## TECHNIQUES AVAILABLE

### Rutherford Backscattering (RBS)

Elemental composition, thin film thickness and depth profiling measurements

### High Resolution RBS\*

Ångstrom level thin film resolution

### Channeling\*

Crystal structure, purity, damage, and film alignment vs. substrate measurements

### Elastic Recoil Detection (ERD)\*

Depth profiling of light elements with 10 PPM sensitivity (1H and 2H with He beam)

### Particle Induced X-ray Emission (PIXE)\*

Trace elemental analysis with high sensitivity (0.1 to 10µg/gram) with GUPIXWIN

### Particle Induced Gamma Emission (PIGE)\*

Selective depth profiling of elements with enhanced sensitivity and resolution

### µPixe and µRBS\*

Trace elemental concentration image of near surface region with 10 micron spatial resolution

### Nuclear Reaction Analysis (NRA)\*

Selective depth profiling of elements with enhanced sensitivity using nuclear reactions

### Ion Beam Induced Luminescence (IBIL)\*

Chemical bonding, crystal defects, and impurity information

\* OPTIONAL. Additional detectors and related equipment needed for these techniques are available from NEC.



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