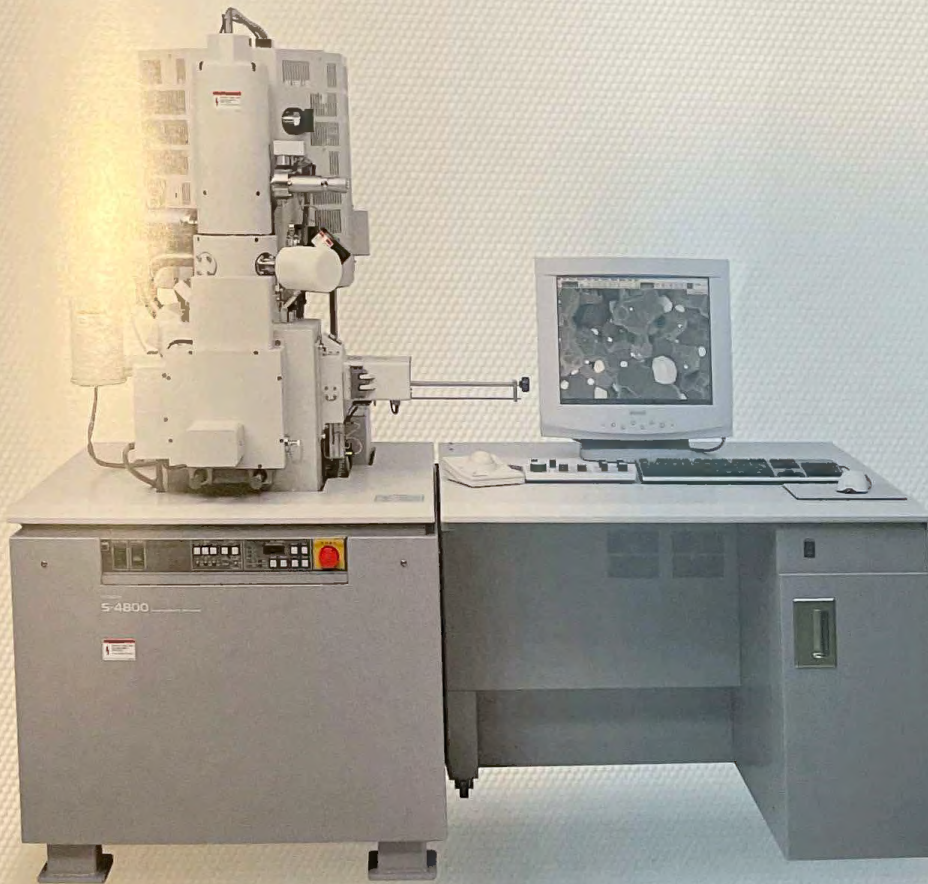


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**Hitachi High-Technologies**

# Ultra-high Resolution Scanning Electron Microscope

# S-4800



**HITACHI**

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# S-4800 Field Emission SEM

INNOVATIVE IMAGING SOLUTIONS FOR NANOTECHNOLOGY APPLICATIONS

## IT'S TIME FOR ANOTHER REVOLUTION .....

At Hitachi, we have never been known to follow trends. We do however listen to the advice of our customers. Since the First Field Emission Microscope was launched by Hitachi in 1972, we have relied upon the comments and suggestions of working Electron Microscopists to help us build the finest Electron Microscopes known to man. Now, as the world of Nanotechnology is changing the way we look at everything around us, Hitachi introduces yet another revolutionary system.

The decision to develop an Ultra High Resolution SEM, capable of handling large specimens, was not made overnight. The S-4800 is a marriage between technology and creativity, between vision and imagery. It's about having the freedom and the power to get the results that you need. We have never been a company that favors compromise, and it shows in our commitment to quality and service that is reflected in the world renowned Hitachi reputation. Our Electron Microscopes combine technology and craftsmanship that we make available to the world's finest scientists and technologists. In turn, they reward us by using our equipment to make new discoveries to improve our lives.

If you have experienced the pleasure of owning a Hitachi Electron Microscope, then you know what we are talking about. If you haven't, don't you think it's about time that you did?

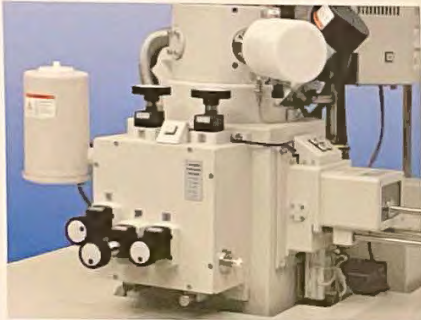
When we designed the S-4800 we knew that people would expect a great deal from a new generation of Field Emission Scanning Electron microscopes. Just as our legendary S-4700 has been the tool of choice for high-resolution electron microscopy, we wanted to build a microscope to remove the barriers between the sample and the final result.

The S-4800 is a truly versatile platform boasting impressive high resolution performance, advanced detection technology, and a user interface that makes it possible to capture even the most short lived moments accurately and clearly.

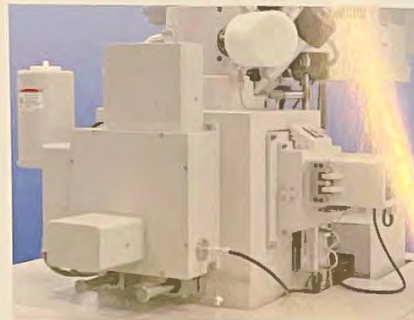
From precision crafted electron optics to rigid vibration resistant mechanics, from a unique detection system to a user-interface designed to make electron microscopy as effortless as possible, the S-4800 was built to fit your needs. We believe that you will be as proud to own this system as we are to make it.



## Stage and Sample Handling



Type I Stage (3 axes motor stage, option)



Type II Stage (5 axes motor stage, standard)

One of the essential components in any high resolution SEM is the sample stage. The S-4800 has a new stage design that combines a stable, vibration resistant platform with a large range of movement. The stage can be motorized in 3 or 5 axes using a trackball (standard) or joystick (option) control. Our innovative computer interface extends the capabilities of the stage's motion making operation intuitive and smooth.

## Sample Exchange

Ease of use, high throughput, and a clean, high vacuum are also essential components to a high performance field emission scanning electron microscope.

- Our sample exchange chamber ensures that optimum vacuum is maintained in the sample chamber.
- Sample exchange time is typically two minute from loading to imaging the sample.
- Hitachi offers a variety of specimen exchange chamber sizes to fit various sample needs. Wafer samples, up to 200 mm dia. in diameter, can be accommodated in our specimen chamber.



Type I Specimen Exchange



Standard (150 mm dia.)



Option (200 mm dia.)

Type II Specimen Exchange

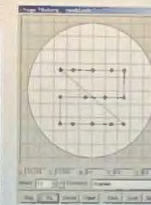
## Stage Control Software

The Hitachi S-4800 is equipped with several software features that inform the operator of the position and status of the sample.

- The Image Navigation system can utilize imported optical images, low magnification images or a schematic of the sample to traverse the sample. A single click on the reference image will drive the sample to the chosen location.
- Every captured image is stored with complete stage coordinates. Revisiting a position of interest is as simple as clicking on the corresponding image of interest.
- The Stage History feature records significant positions on a map of the sample undergoing examination. The Stage History maps can be saved and recalled for the analysis of similar samples.



Virtual Joystick (for Type II)



Stage History

- Control of the Motorized Stage is achieved through the use of a Trackball or Joystick (option) system. A virtual joystick graphical user interface can be superimposed on the specimen image, providing fully interactive control of specimen movement using the computer mouse.

## Specimen Holders

Hitachi's sample holders are available in various shapes and sizes. In addition to the starter kit of standard mounts and plates, Hitachi also offers a variety of custom designed holders to meet the needs of specific applications. These holders are designed to take advantage of the maximum available space inside the chamber.



Standard Holder/Stub Kit



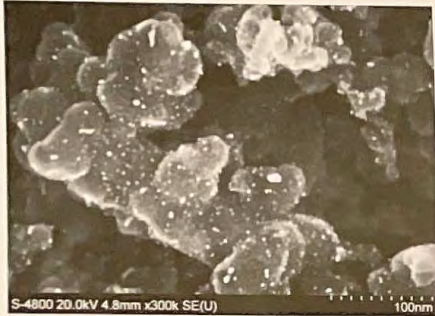
Cross-section Holders/stubs (option)



Wafer Holders (option)

## High Resolution Imaging (1.0 nm/15 kV, 1.4 nm\*/1 kV)

\* Deceleration mode (option)



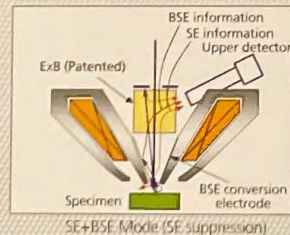
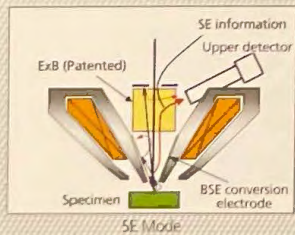
Specimen: Catalyst

High resolution imaging is achieved not only from a small final probe size, but from a combination of factors: stage stability, resistance to vibration, powerful electron optics and minimal contamination. The catalyst images above demonstrate excellent signal collection of a low Z material, high resolution imaging of 1nm platinum particles, and vibration resistant design with minimal interference seen at the S-4800's highest magnification.

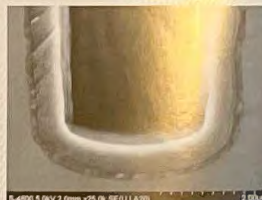
## Signal Detection and Processing

The Hitachi S-4800 is equipped with both a lower and an upper secondary electron detector system. The lower detector is utilized for enhanced surface topography imaging while the "through the lens" upper detector is utilized for high resolution imaging. Hitachi's patented ExB Filter has been refined to offer the operator powerful imaging capabilities.

- Controlled signal mixing: allows the operator to control the signal in the image. The operator can select a pure secondary electron image or a pure backscattered electron image and any signal combination in between.
- Pure BSE imaging at low voltages.
- High resolution SE/BSE imaging at short working distances.
- Reduction of charge and contamination effects in the image.



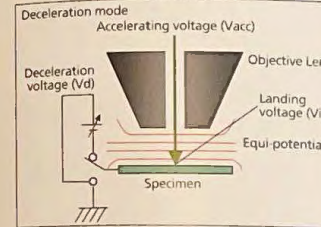
SE Mode



SE+BSE Mode

Specimen: Deep Trench Cross-section  
Courtesy of the University of South Florida, Center for Ocean Technology

## Beam Deceleration Technology (1.4 nm/1 kV)



New to the Hitachi field emission product line is our Beam Deceleration Technology. Our unique control of the electron beam has improved resolution by 30% at 1 kV. Operating on the simple principle that a higher accelerating voltage has small chromatic aberration coefficients and better resolution this technology paves the way to ultra low voltage imaging like never before. By decelerating the primary beam, just before it interacts with the sample ( $V_d$ ), we give the operator the advantage of the resolution of the higher accelerating voltage ( $V_{acc}$ ) while enjoying the less intrusive sample interactions of a low energy beam ( $V_l$ ). By adding the Beam Deceleration Technology to our list of credits, we are confident that the S-4800 is the solution to all your microscopy needs.

### Advantages of Beam Deceleration

- Resolution improvement (2.0 nm improved to 1.4 nm at 1 kV)
- Ultra-low landing voltages (100–500 V) for shallow surface topography
- Less beam damage during observation of uncoated samples

Specimen: Evaporated Au particle on magnetic tape

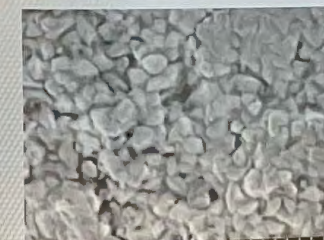


Landing voltage: 500 V



Accelerating voltage: 500 V

Specimen: Fluoride Resin Layer



Landing voltage: 100 V

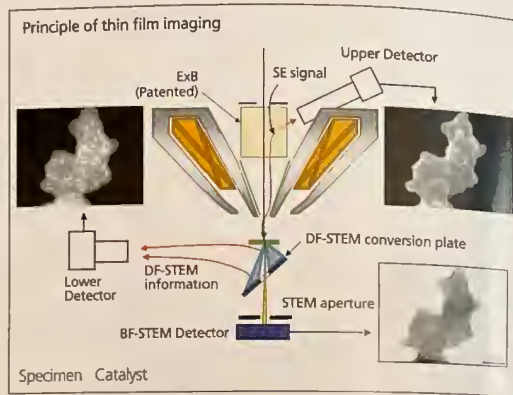


Landing voltage: 500 V

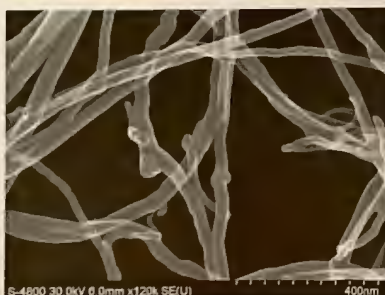
## STEM Imaging

The S-4800 is the only semi-in-lens microscope to image both bright field (BF) and dark field (DF) information simultaneously. The Hitachi design offers numerous benefits to any microscopy laboratory.

- A variety of sample types can be imaged such as semiconductor cross-sections, powders, biological thin sections and nanotubes.
- The detector controls are integrated into the software for simple and familiar operation. Easy alignment and focusing can be performed using the SE image.
- Low voltage (10-30 kV) STEM provides high contrast imaging of low Z materials.
- Simultaneous collection of BF-STEM and the other signal (SE, DF-STEM or SE+DF-STEM) provides an efficient solution (patent pending).



Specimen: Carbon Nano-tube



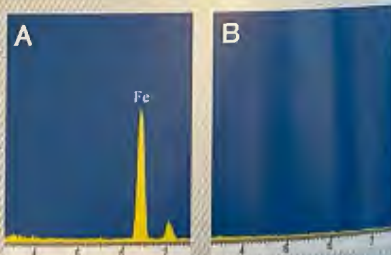
SE image



Bright Field STEM Image



Dark Field STEM image



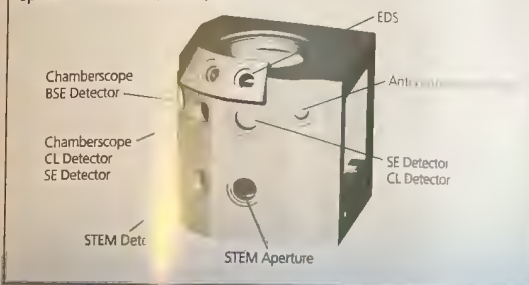
EDS Analysis of CNT and FE particle

## X-ray Microanalysis

The Hitachi S-4800 design provides optimum resolution and high beam current for fast and accurate analytical x-ray mapping and quantitative analysis.

- The high take-off angle EDS port is positioned horizontal to the stage's tilting plane for optimum collection of EDS information and accurate quantitative results.
- A standard TMP and LN cooled cold finger, encasing the objective lens and EDS detector, reduce any hydro-carbon contamination introduced by the sample.
- The electron probe produced, using our unique analysis conditions, increases the final specimen current for analytical work without requiring mechanical realignment.

Specimen chamber port layout



Specimen: Thin Film Transistor (TFT)

BF-STEM

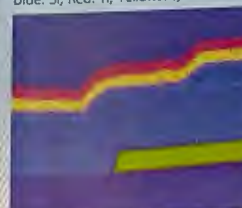


DF-STEM

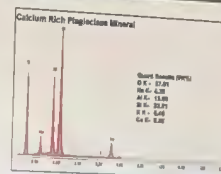
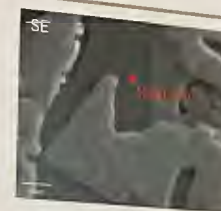


The small excitation area of this TFT sample (thickness: <100 nm, prepared by FIB) provides the spatial resolution needed to collect EDS X-ray maps and differentiate the layers within.

Blue: Si, Red: Ti, Yellow: Al, Green: Cr



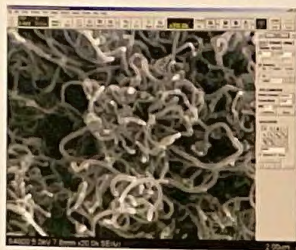
Specimen: Basalt



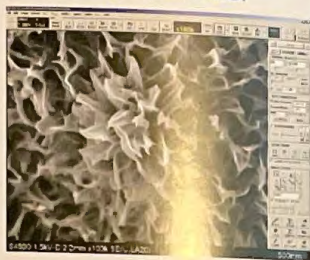
The 512x400 pixel resolution of these x-ray maps delineates thin inclusions in the basalt at low magnifications while a high count rate shortens the required collection time.

## Sophisticated GUI Control

Sophisticated GUI Control

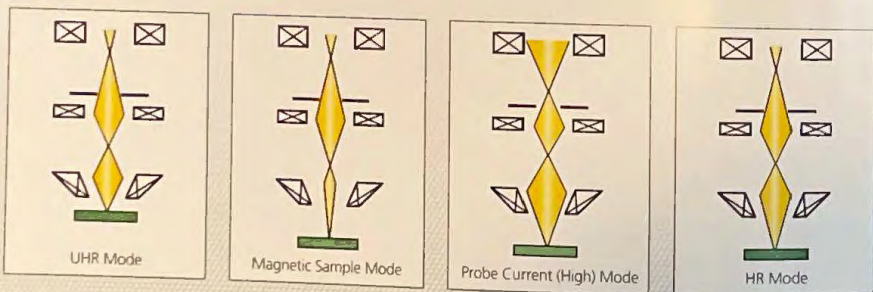


Comprehensive GUI



Hitachi's S-4800 graphical user interface is the epitome of intuition. Large buttons, at the top of the GUI, control major functions such as scan speed, auto features, image capture and data storage options. We recognize that many laboratories have SEM operators with a variety of skill and knowledge in the operation of the SEM. We offer a system that can display different GUI and dialog configurations to match various operators' needs. The GUI can be configured for beginners or experts and the personalized GUI is displayed when the user logs in to the system. Previous settings can be personalized to allow a user to return to a particular set of operating conditions.

## Lens Mode



The Electron Optics control system represents the versatility and strength of the S-4800. The imaging modes are designed to optimize the lens system for a variety of purposes.

- UHR Mode: Achieving our resolution specification and high contrast, complete SE/BSE collection at short working distances.
- Magnetic Sample Mode: The effect of the stigmation coils is increased to overcome magnetic fields at the sample.
- Probe Current (High) Mode: For EDS analysis, e-beam lithography, and cathodoluminescence, our high probe current mode doubles the current at the specimen.
- HR Mode: Used when observing at longer working distances.

All modes make use of an automatic alignment memory system that provides the operator with the ability to transition from one electron optic setting to another without having to realign the column or change an objective aperture.



The Wide Area Microscopy (WAM) system is a complete package that allows you to set up the SEM for video conferencing with your colleagues, co-workers or students over a broadband Internet or Network connection. Featuring a high speed video server that transmits live video at up to 30FPS at 640x480 pixels the WAM system is ideal for Collaboration microscopy sessions. The WAM system includes a high resolution video camera for displaying a clear view of the laboratory and SEM operator.



Remote control with live video image transmission via Network or broadband Internet connection from SEM laboratory to classroom.



Light microscopes



EM laboratory



With multiple levels of security access and connections to most imaging systems, the WAM system allows users to access their data privately or to share their data with co-workers and colleagues.

In addition, an optional Remote Control module allows full remote control operation of the SEM via a broadband Internet or Network connection. The system transmits and displays the GUI at a resolution of 1,280x1,024 pixels. The video image is displayed at a resolution of 640x480 pixels.

The installation of a WAM system offers the opportunity for any number of users to securely access information and images from any location with an Internet connection.

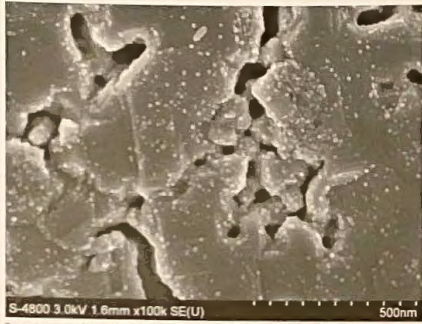
Central Image Database



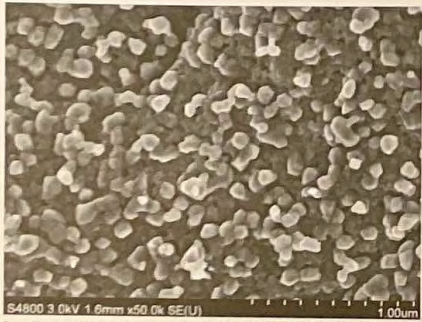
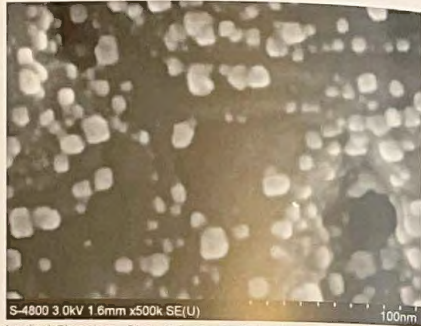
Access from home



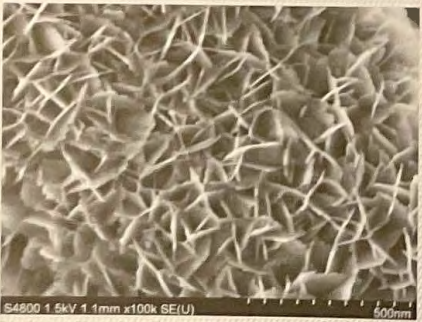
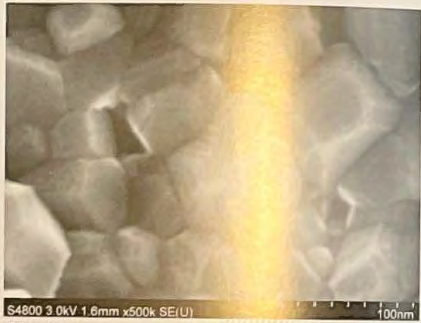
Multiple external PC access



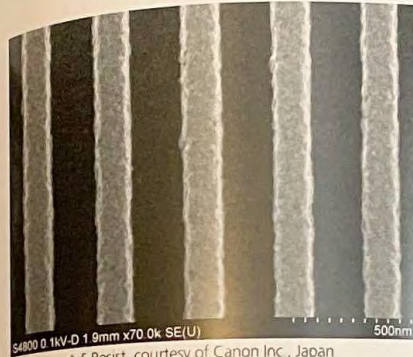
Specimen : (Ba, Sr) TiO<sub>3</sub>, courtesy of Prof. Jun Tamaki, Department of Applied Chemistry, Ritsumeikan University, Japan



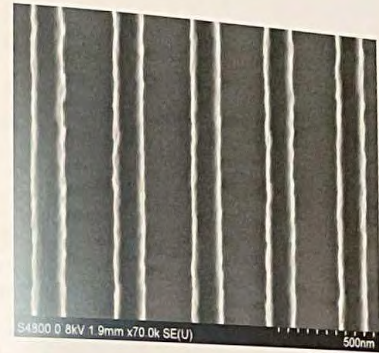
Specimen : LiMn<sub>2</sub>O<sub>4</sub>, courtesy of National Research Council of Canada, Canada



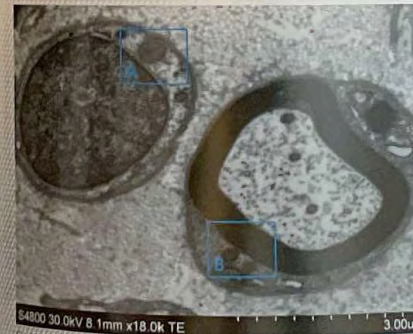
Specimen - Electrolytic Film, courtesy of Saint Jude Medical Research, U.S.A.



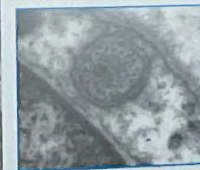
Specimen : ArF Resist, courtesy of Canon Inc., Japan



Specimen : MWCNT (multi-walled carbon nano-tube)



Specimen : Human Nerve Tissue (2,560 x 1,920 pixels)



## Standard Specifications

### Secondary electron image resolution

- 1.0 nm (15 kV, WD = 4 mm)
- 1.4 nm (1 kV, WD = 1.5 mm, Deceleration mode\*)
- 2.0 nm (1 kV, WD = 1.5 mm, Normal mode)

### Magnification

- LM mode 20 ~ 2,000X
- HM mode 100 ~ 800,000X
- (Magnification range varies with WD and HV)

### Electron optics

- Electron gun Cold cathode field emission electron source
- Probe current 1 pA ~ 2 nA
- Accelerating voltage (Landing voltage) 0.5 ~ 30 kV (normal mode)  
0.1 ~ 2.0 kV (deceleration mode\*)
- Lens system 3-stage electromagnetic lens reduction system
- Objective lens aperture Variable type (4 openings selectable and finely adjustable from outside the vacuum, 100-50-50-30 μm)
- Stigmator coil Octapole electromagnetic system
- Scanning coil 2-stage electromagnetic deflection

### Specimen stage

	Type I	Type II
Stage control	Manual (3-axis motor drive, option)	5-axis motor drive
Movable range		
X	0 ~ 50 mm	0 ~ 110 mm
Y	0 ~ 50 mm	0 ~ 110 mm
Z	1.5 ~ 30 mm	1.5 ~ 40 mm
T	-5 ~ +70°	-5 ~ +70°
R	360°	360°
Sample size (maximum)	100mm dia (standard) 150mm dia (option)	150mm dia (standard) 200mm dia (option)

Movable ranges are limited by the size of a mounted specimen

Electrical image shift ± 12 μm (WD = 8 mm)

### Detectors

- Secondary electron detector (Upper/Lower)
- Backscattered electron detector (option)
- Energy dispersive X-ray detector (option)
- Transmitted electron detector (option)
- Faraday cup (option)
- Cathodoluminescence detector (option)

### Signal selection

- SE (secondary electron) signal, x-ray signal, AULX signal (2 systems for optional detectors)

### Evacuation system

- Auto evacuation Fully automatic pneumatic valve control system
- Ultimate vacuum Electron gun chamber:  $-10^{-7}$  Pa  
Specimen chamber:  $-10^{-4}$  Pa
- Vacuum pumps Ion pump 60 L/s × 1  
Ion pump 20 L/s × 2  
Turbomolecular pump 300 L/s × 1 (magnetic bearing type)  
Oil rotary pump 133/160\*2 L/min × 1
- Vacuum gauges Penning gauge × 1  
Pirani gauge × 2
- Contamination prevention Anti-contamination trap

### Protective functions

- Protection against power, water and vacuum failures

### Personal Computer

- IBM PC/AT compatible, OS: Windows\* 2000\*\*3

### Monitor

- For viewing 18 type FPD (subject to change without notice)  
21 type color CRT (option)

### Image display mode

- Full screen display 1,280 × 960 pixels
- Reduced area display 640 × 480 pixels
- Reduced area display 320 × 240 pixels
- Dual image display 640 × 480 pixels

### Scanning speeds

- TV scan (640 × 480 pixel display, 25/30\*\*2 frames)
- Fast scan (full screen display, 6.25/7.5\*\*2 frames)
- Slow scan (full screen display, 1/4/20/40/80 s/frame)  
640 × 480 pixel display, 0.5/2/10/20\*\*2

### Image data saving

- 640 × 480, 1,280 × 960, 2,560 × 1,920, 5,120 × 3,840 pixels

### Image data printing

- Free layout print function provided

### External device connection port

- USB interface (2 ports)
- Network interface (Ethernet\*\*4)

## Optional accessories

- Detectors/Electron optical system
  - BSE detector
  - TE detector with preamplifier (for BF-STEM)
  - Dark STEM holder (for DF-STEM)
  - EBIC image observation device
  - Video amplifier unit
  - Faraday cup unit
  - Photomultiplier power supply unit
  - Deceleration function
  - Energy dispersive X-ray spectrometer
  - Cathodoluminescence system

- Stage controller/specimen holders
  - 3-axis stage controller (for Type I)
  - 6" specimen exchange device (for Type I)
  - 8" specimen exchange device (for Type II)
  - Cross-section specimen holder (90°, 60° pre-tilted)
  - Cross-section mounting holder
  - Cross-section specimen stub (90°, 75°, 60° pre-tilted)
  - Wafer holder (2", 3", 4", 5", 6")
  - Wafer holder (8") (for Type II)
  - Rectangular specimen holder (30 × 5, 30 × 10 mm)

### Software

- CD measurement function
- Hi-Mouse
- RS-232C communication interface
- DBC interface
- SEM Data Manager for external PC

### Utilities

- Water circulator
- Scroll type dry pump (fore pump)
- Ion pump backup power supply
- N<sub>2</sub> Gas leak port

### Others

- Microscale (standard sample for calibration)
- Objective lens aperture plate (50 μm dia. × 4)
- Chamberscope

## Utility requirements

- Temperature 15 ~ 25°C
- Humidity 60% RH or less
- Power Single phase AC 100 ~ 240V ± 10%, 4 kVA
- Grounding 100 ohms or less
- Cooling water
  - Flow 1.0 ~ 1.5 L/min
  - Pressure 50 ~ 100 kPa
  - Temperature 10 ~ 20°C (allowable fluctuations 0.5°C/10 min or less, difference from room temperature must be within 7°C)
- Supply faucet Rc3/8 tapered female thread × 1 (20mm dia. or more) × 1 (Natural drain type located on floor)

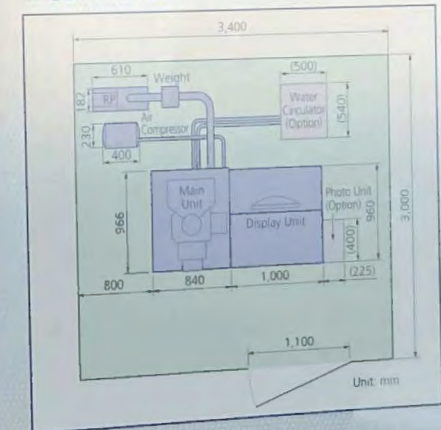


S-4800 Type I

## Dimensions & Weight

	Width	× Depth	× Height	Weight
Main unit (Type I)	840	966	1,620 mm	583 kg
Main unit (Type II)	840	966	1,660 mm	651 kg
Display unit	1,000	960	1,200 mm	205 kg
Oil rotary pump (RP)	610	182	376 mm	30 kg
Air compressor	400	230	550 mm	18 kg
Weight	200	180	160 mm	40 kg

## Suggested layout



- \* 1 Deceleration mode: option
- \* 2 50Hz/60Hz
- \* 3 Windows 2000® is a trademark of Microsoft Corp., U.S.A.
- \* 4 Ethernet is a trademark of Xerox Corp., U.S.A.
- \* Images on the monitors are insets at printing
- \* GUI images include optional functions
- \* Necessary hazard warning labels conforming standards required at the destination are stuck on the instrument