JEM-2100F

Field Emission

Transmission Electron Microscope

(JEOL Ltd. / Japan)

Contents

- *Introduction*
- *Features of JEM-2100F*
- *JADAS software*
- *SerialEM software*
- *Digital Image (CCD) and Cryo Transfer holders*
- *Service Support*
- *Conclusion*

This is how it looks!

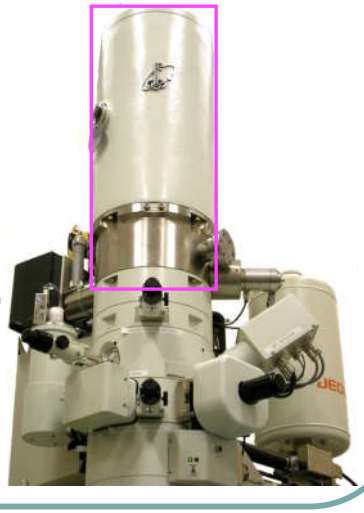
Specifications

Confi gurati on	HR (High Resoluti on P/P	CR (Cryo P/P)	HC (High Contrast P/P)
Resoluti on Point Latti ce	 0.23nm 0.1nm	 0.27nm 0.14nm	 0.31nm 0.14nm
Accelerati on Voltage	200, 160 kV (Opti on: 120, 100kV)		
OL Focal Point	2.3mm	2.8mm	3.9mm
OL Cs	1.0mm	2.0mm	3.3mm
OL Cc	1.4mm	2.1mm	3.0mm
Minimum Step	1.4nm	2.0nm	5.2nm
Magnifi cati on Range	X50 to X1.5M	X50 to X1.0M	X50 to X800K
Specimen Tilt W/914	50 degrees	80 degrees	80 degrees
Specimen Tilt W/626	22 degrees	70 degrees	70 degrees
Specimen Tilt W/3500TR	20 degrees	50 degrees	50 degrees

Thermal Field Emission Gun for Analytical TEM

ZrO/W(100) Schottky Type

- Higher brightness, 100 times greater than LaB6 gun
- Higher coherency
- Higher energy resolution, 0.7 to 0.8eV
- Higher stability emission over then cold FEG
- Longer life time 2 to 4 years (guarantied time: 5,000 hours)



Features of the JEM-2100F

1. Full PC Control Operation control system :

- Simple GUI : Excellent easy of use.
- Reliable system design
- Independence Network System
- high resolution and full Digital STEM and

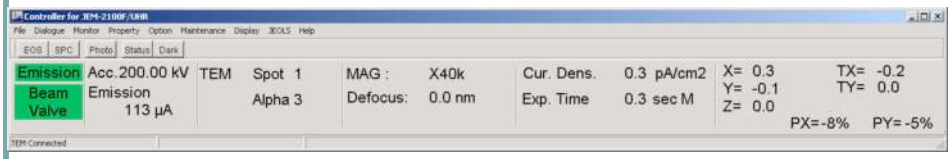
2. Piezo control stage: Piezoelectric element **built in as standard Min. move step=0.04nm/step**

3. Anti-vibration system: **New designed Flame and Passive type air-mount(2100/2100F),Easy to replace of Active type vibration isolator.**

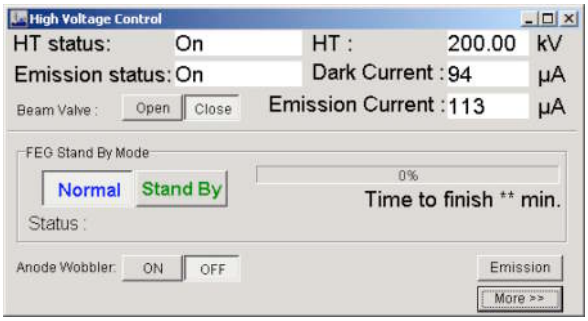
4 · Integrated with analytical tools such as EDS, CCD, GIF…etc. Excellent **easy of use.**

5. Two OL Apertures system.

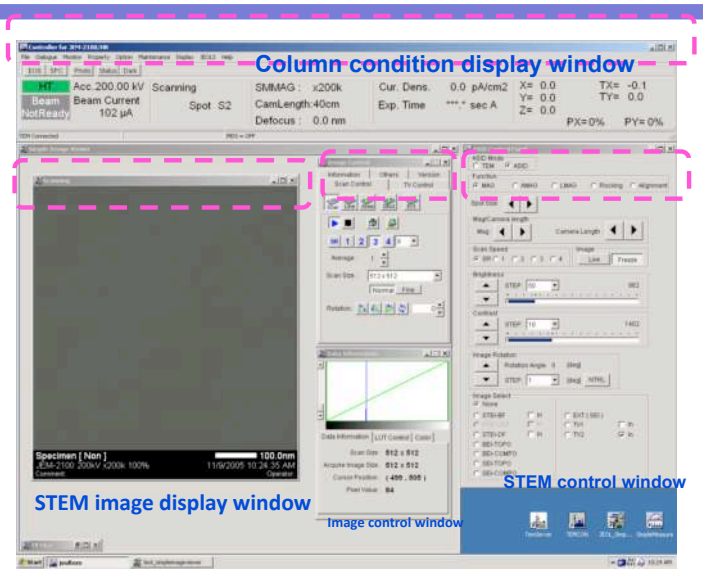
Operation window



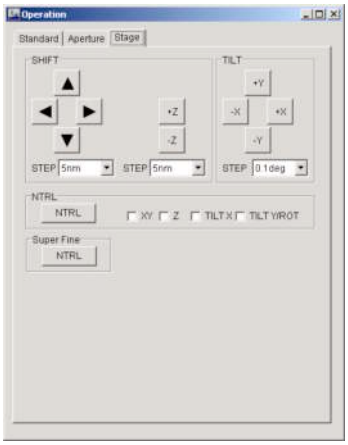
High voltage control window



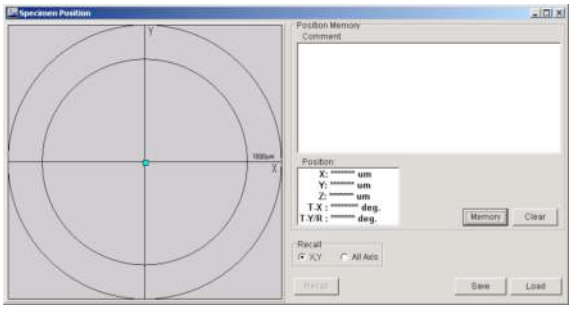
Graphic User Interface



Stage control window



Specimen position display window



Control Knob Set

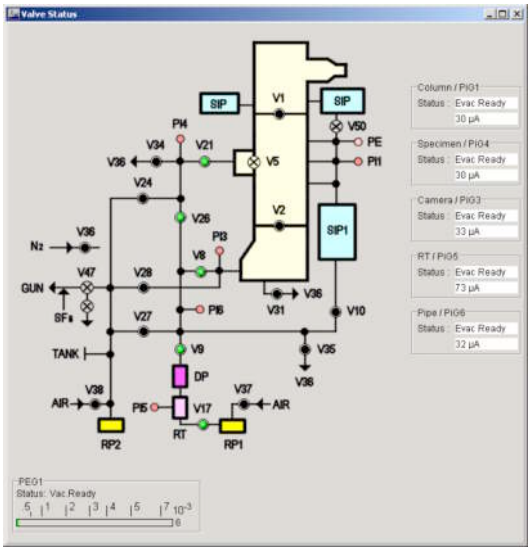
Fast, Easy and Intuitive Operation

Left panel

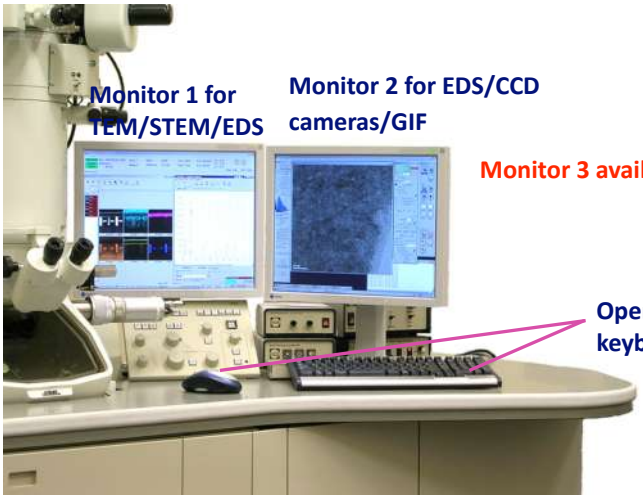
Right panel

All functions can be controlled via the PC.

Vacuum display window



2PC Kit for Integrated Control



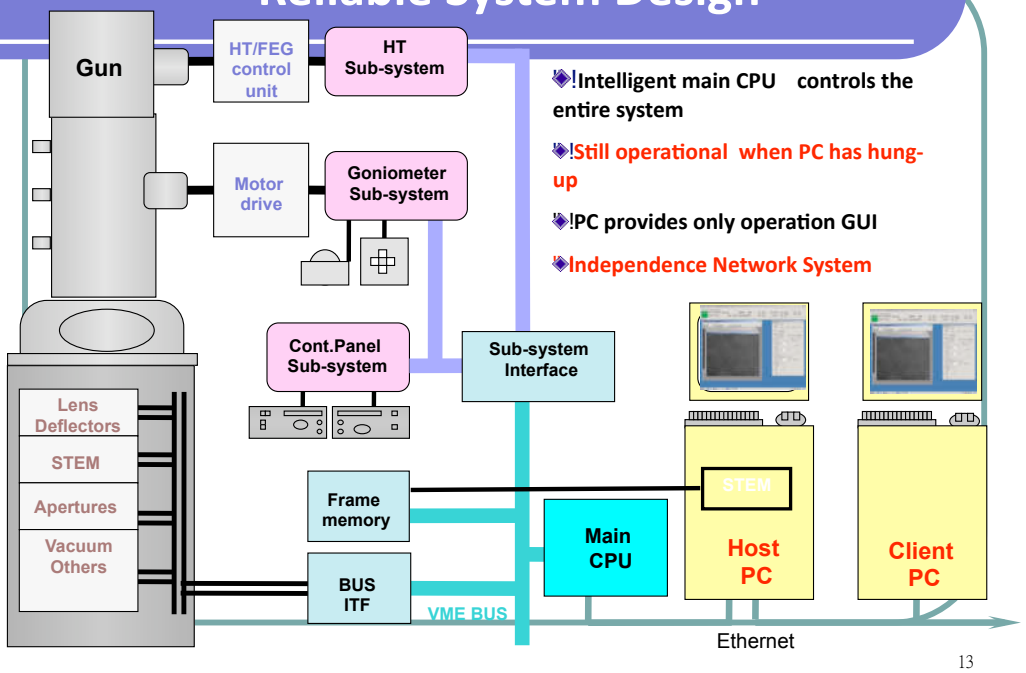
Monitor 1 for TEM/STEM/EDS

Monitor 2 for EDS/CCD cameras/GIF

Monitor 3 available

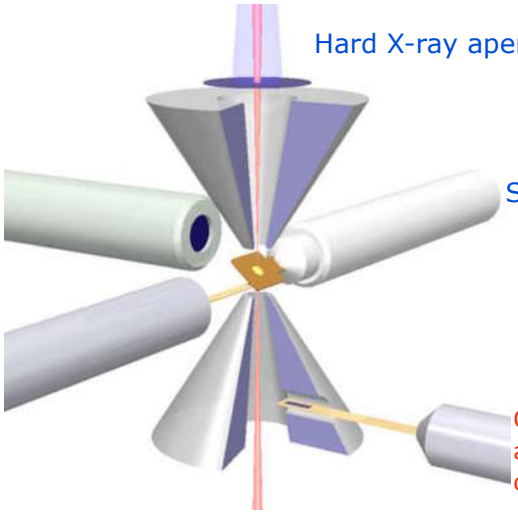
Operation in one keyboard and mouse

Reliable System Design



- Intelligent main CPU controls the entire system
- Still operational when PC has hung-up
- PC provides only operation GUI
- Independence Network System

Mechanically Minimal Interference



Hard X-ray aperture

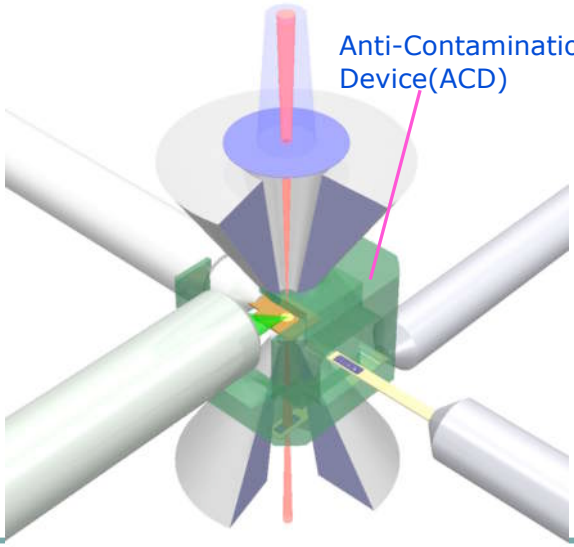
EDS detector

Specimen holder

OL in-gap aperture

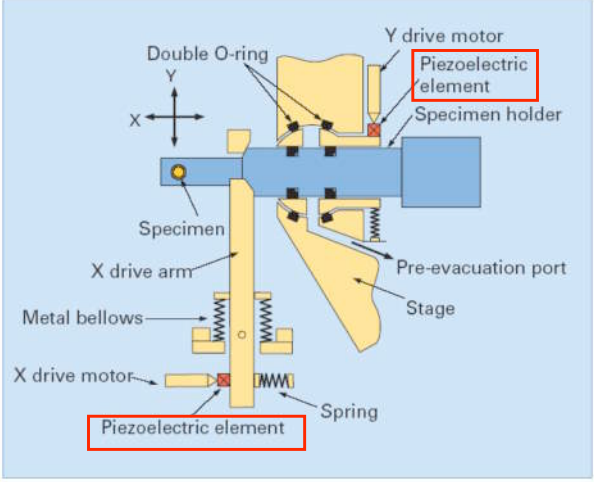
OL aperture for EDS analysis with high contrast image

Exceedingly, Effectively, Traps Contamination Around the Specimen



High Precision 5-Axis Motor Driven Goniometer Stage

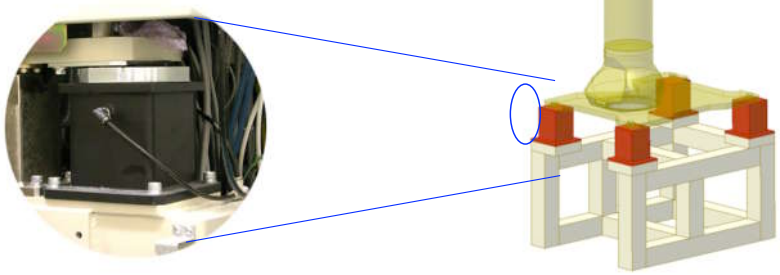
Piezo Actuator for Sub-Angstrom Movement



- Piezo actuator for high magnification imaging
- Minimum move step: 0.4 Angstrom
- No back lash
- Double O-ring for clean vacuum
- Minimal drift for heat/ cooling experiment
- Versatile holders available
- Built-in baking function

Newly Designed Base Frame

- *Higher Performance for Isolation of Floor Vibration*
- *More Stable than Ever, than Any Others*
- *Passive Air Mount Locates As Close As Possible to the Center of the Gravity*



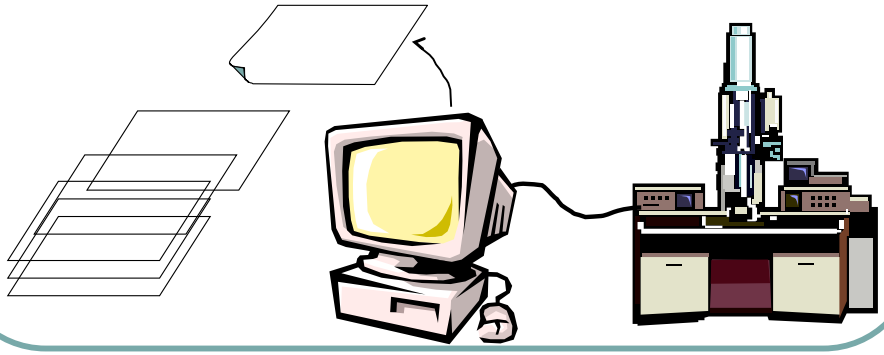
For presentation purpose, the 3D drawing above is simplified.

JADAS

- The JEOL Automated Data Acquisition System

What is JADAS?

- A software system to automate routine works of TEM data collection.



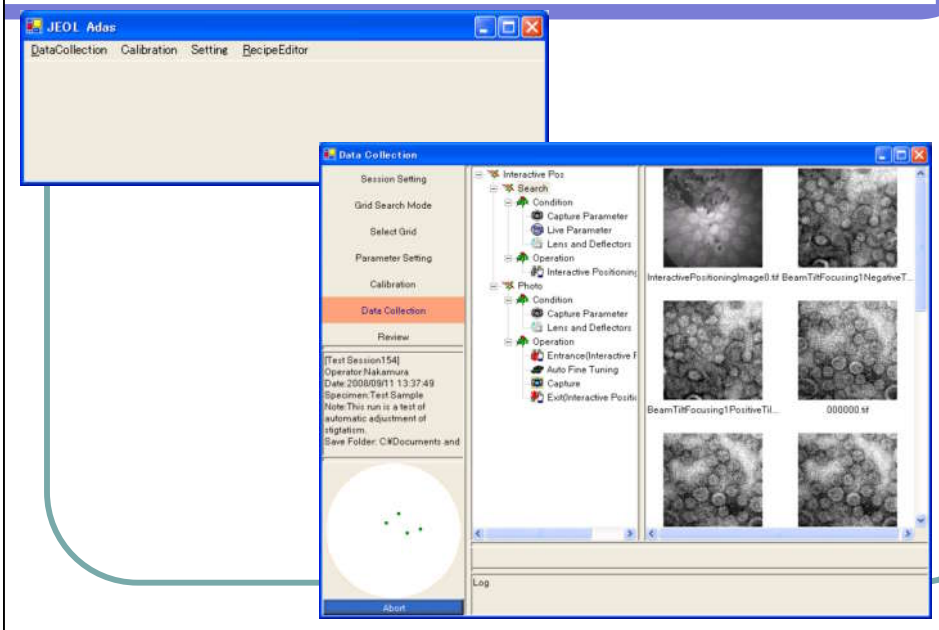
Configuration

- Supported TEM models
  - JEM-1230, JEM-1400, JEM-2100, JEM-2100F and JEM-3200FSC
- Digital Camera
  - Gatan
- User interface
  - GUI on Windows XP operation system

Operation Flow

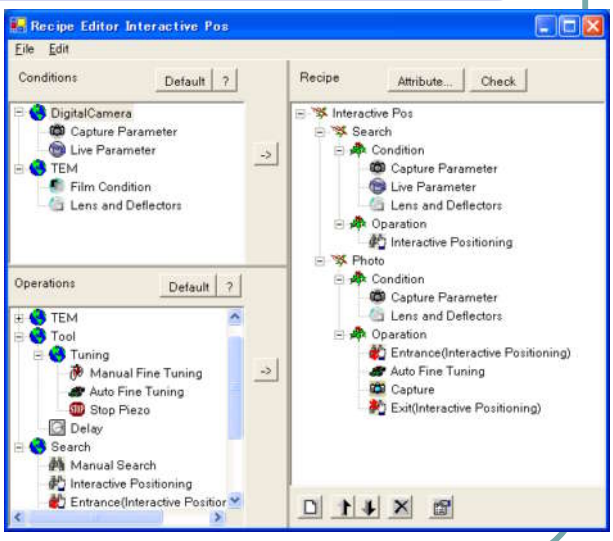
- Create a *Recipe*
- Global Search
- Parameter Setup
- Calibration
- Image Collection (Execute the recipe at each selected specimen position)

User interface



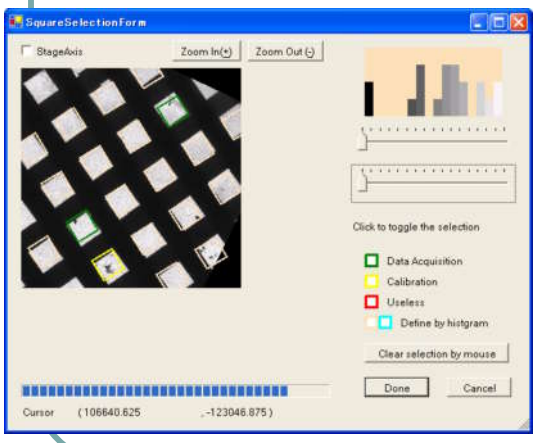
Recipe

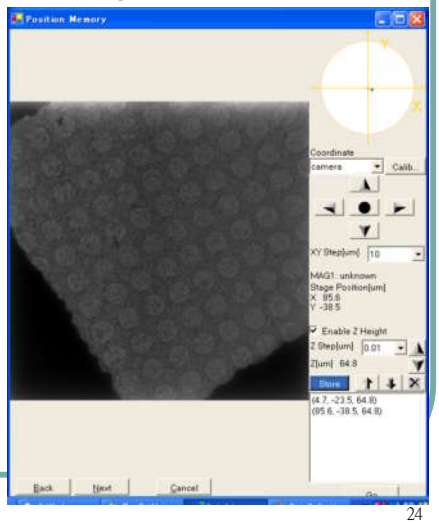
- User-defined operation sequence



Global Search

- Select grid squares for image collection





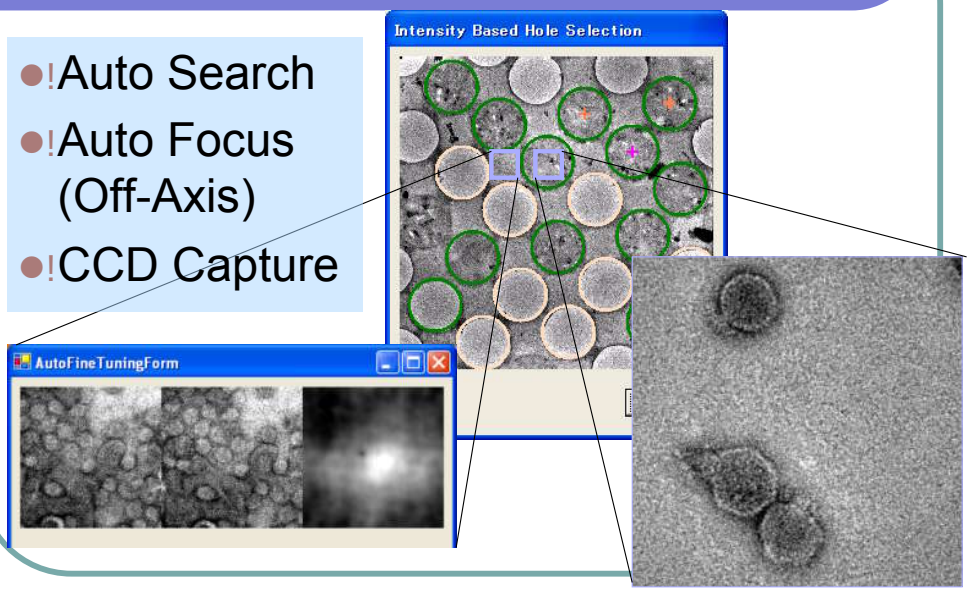
Recipe Elements

- Interactive Search
- Automatic Search
- Auto-focusing
- Automatic adjustment of stigmatism
- Automatic drift compensation with piezo
- Digital camera capture
- Photographic film exposure

and more...

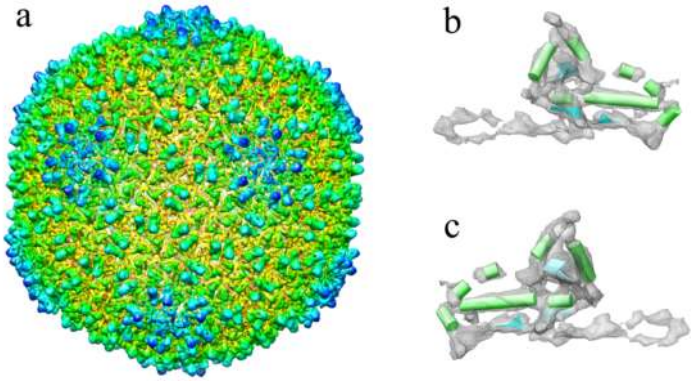
A typical recipe

- Auto Search
- Auto Focus (Off-Axis)
- CCD Capture



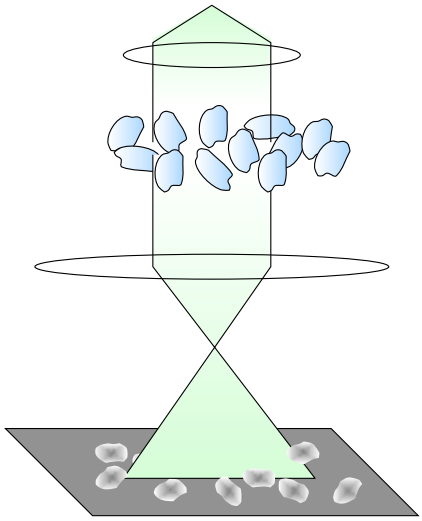
An application result

- Single particle analysis on ice-embedded Epsilon 15 bacteriophage with JEM-3200FSC



Single particle analysis

- One of analytical methods of structural biology
- Reconstruct 3-D structure of a protein or a virus by integrating TEM images of 1,000～100,000 particles

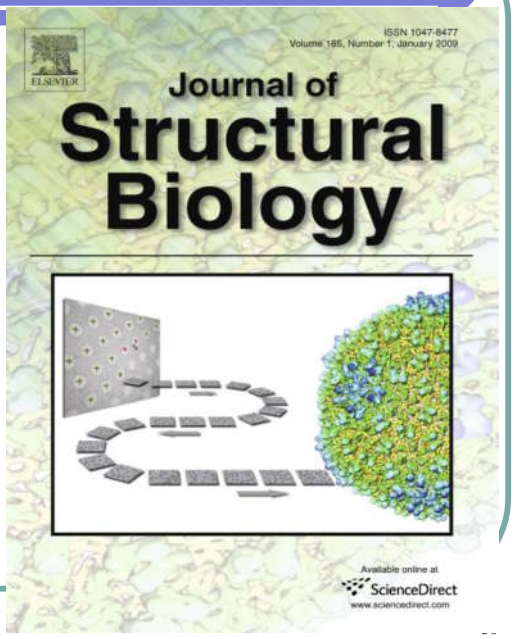


Performance

- Single 8-hour session
  - including column alignment (~30min) and Liquid N_2 refill (~30min)
- Number of images: 155 were used for the reconstruction / 181 were automatically collected
  - using Gatan 4k x 4k Ultrascan camera
- 7,543 particles were picked
- The structure was resolved to 7.3 Å resolution

For details about the application

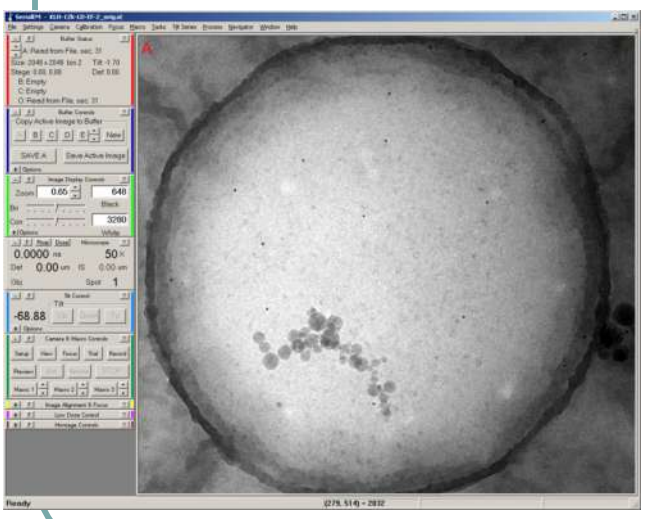
- please refer to
  - J. Zhang et al. / Journal of Structural Biology 165 (2009) 1–9



SerialEM

- A free software for control TEM and intergrated with CCD Camera
- Built-in Montage and Tomography acquire function

Tomography using SerialEM



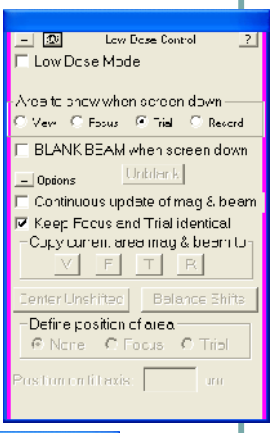
- **Developed by D. Mastronarde @ UC Boulder**
- **Freeware along with IMOD**
- **There is *no* licensing agreement on either SerialEM or IMOD!**
- **Ran on UC Boulder's 1 MV JEOL**
- **First port to UCB 3100FFC**
- **Now installed on >30TEMs**

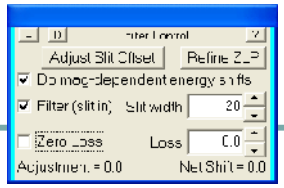
SerialEM Features

- Tasks (complex multi-step operations @ different magnifications):
  - Eucentricity (coarse & fine; capable of ~ 200 µm offset)
  - Beam centering
  - Walk-up to starting angle with retention of ROI
  - Reset of Image Shift w. stage movement
- Montaging:
  - Deflector- or stage-based
- Macro environment:
  - Extreme montaging
  - Conical tomography
  - User-programmable
- Tomography aspects:
  - Wobbler-based focusing at user-defined focii
  - Constant & Saxton-type tilting
  - Dose adjustment ∝ $1/\cos^n$, n=1 thru 4
  - Series imaging (focus, energy-loss)
  - Montaging and tomography
  - PREDICTION

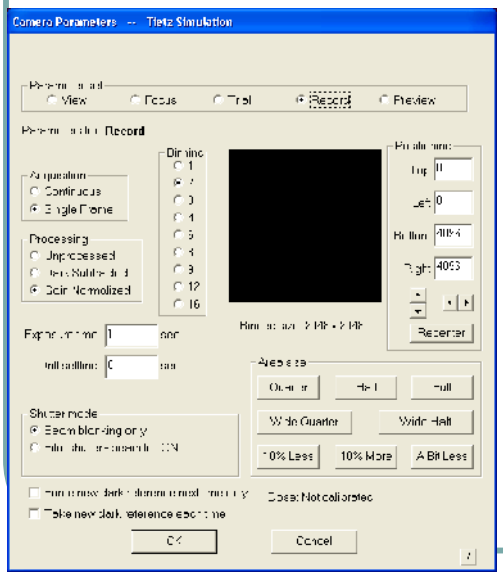
SerialEM Features II

- Low Dose:
  - Fully integrated and very powerful.
  - Grid mapping at low magnification
  - Montaging (w. tilt acquisitions)
  - Helps the user with off-axis setup
  - Keeps track of the dose
- Integrated support for energy filter
  - Omega & GIF
  - Imaging modes:
    - Coreloss
    - ZL





SerialEM Features III



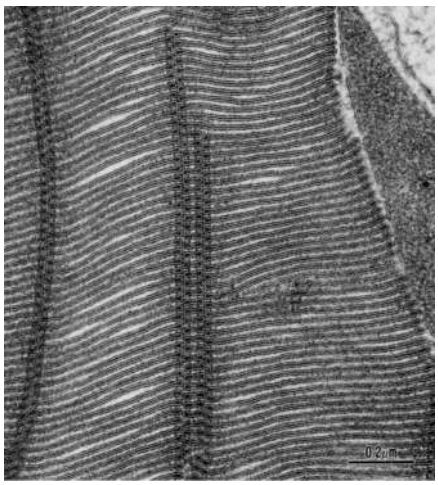
- Transparent multi-camera Support:
  - Gatan, Tietz & AMT (still & video-rate cameras)
  - Integrated camera controls
  - Dual shuttering for flexible pre-exposures

JEM-1400

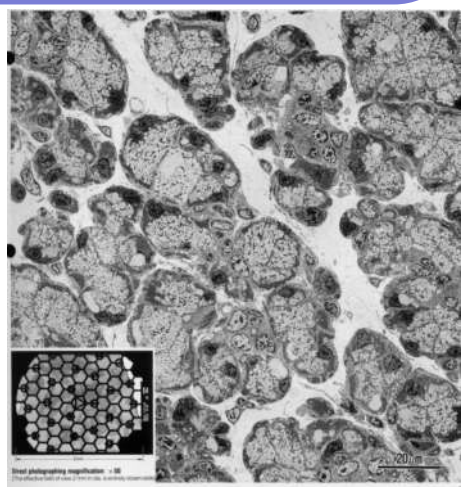
Features of JEM-1400

- W or LaB_6 filament (40~120KV)
- Lattice resolution:0.2nm with tilt 25 °, up to 70 °with High Tilt Retainer
- Wide view and full range magnification: X50 ~ X800K
- Windows XP Operating System
- Auto HT and filament heating
- Rotation free in Magnification and Diffraction
- Image Orientation System (IOS)
- Minimum Dose System (MDS)
- Integrated System with Digital Camera (Dual Monitors W/one K.M.)
- 5 specimens holder (Option)

High Contrast image

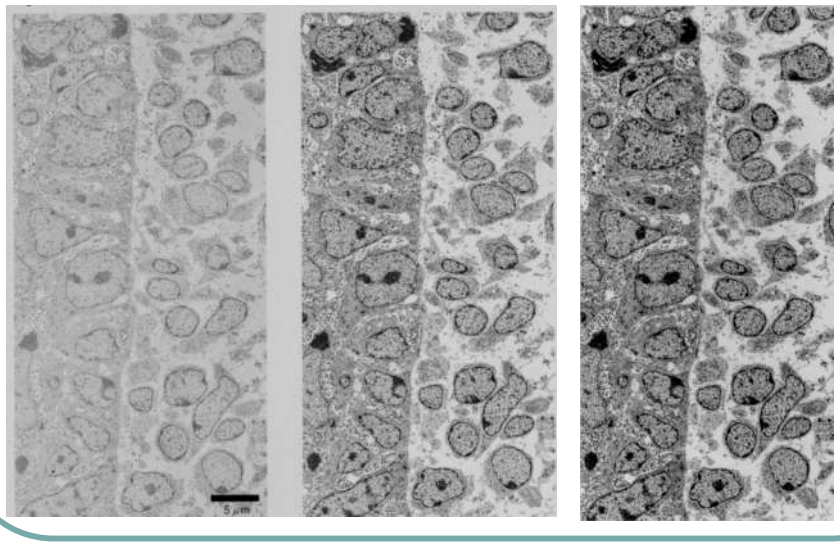


Frog retina (unstained)

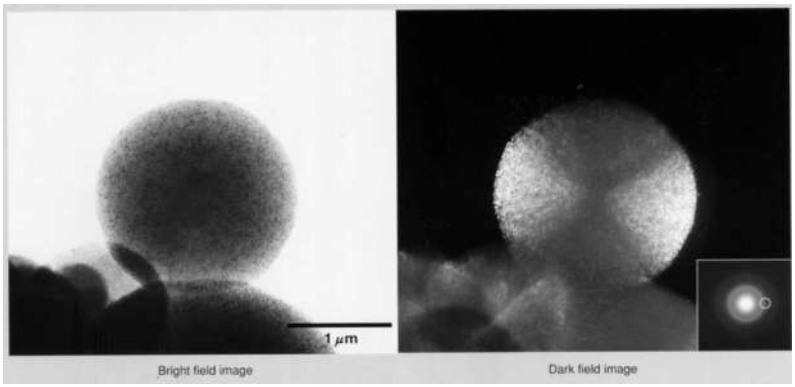


Submaxillary grand of rat

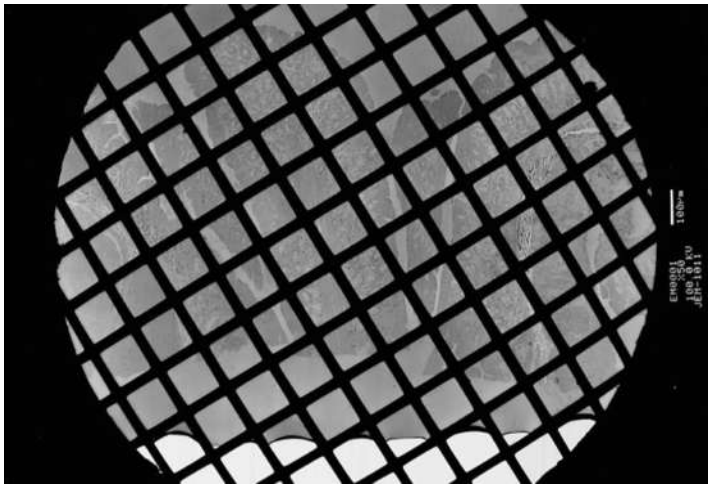
Contrast enhanced by different OL aperture



Application-BF/DF (Carbon black)

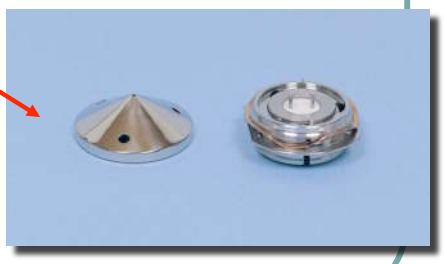


Large effective field of view on a film: 2 mm in dia.(@X50)

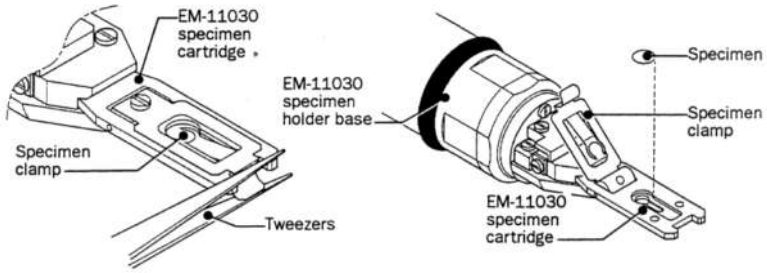


Simple Filament Exchange

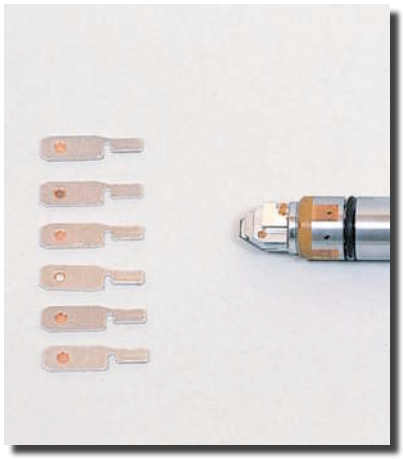
Pre-center filament



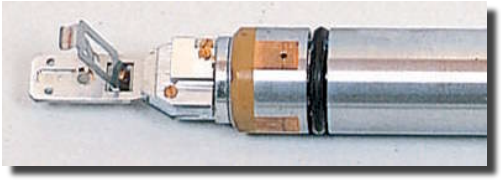
TEM sample loading



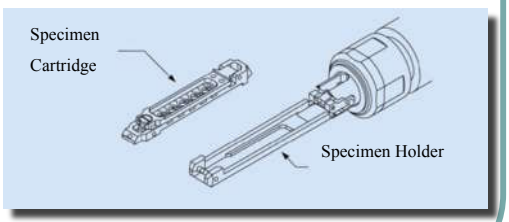
Advanced Holder System for ultimate ease-of-use: provide versatile functions by only changing the holder tip



Permanent Storage Specimen Cartridge (Option)

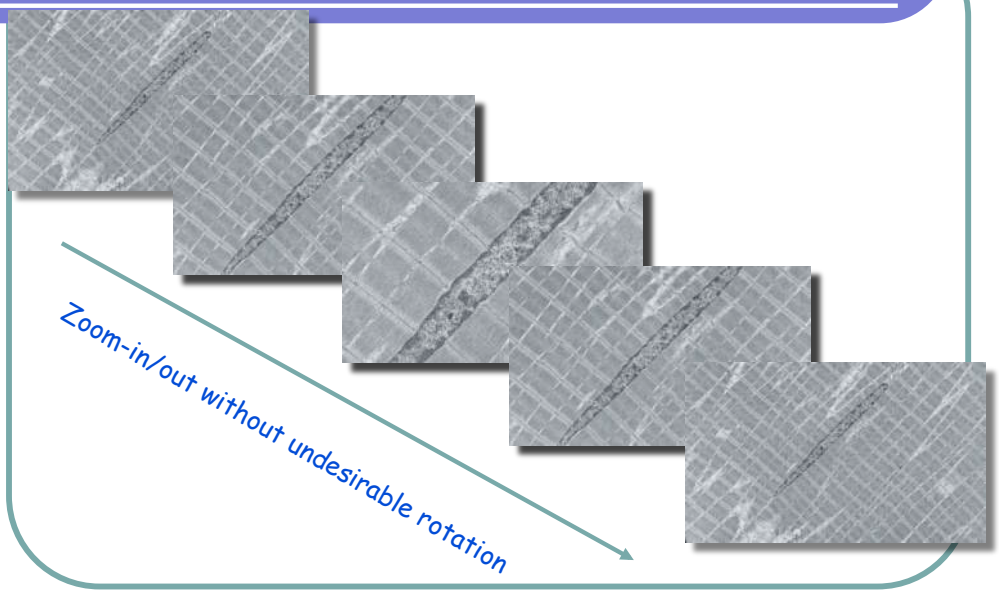


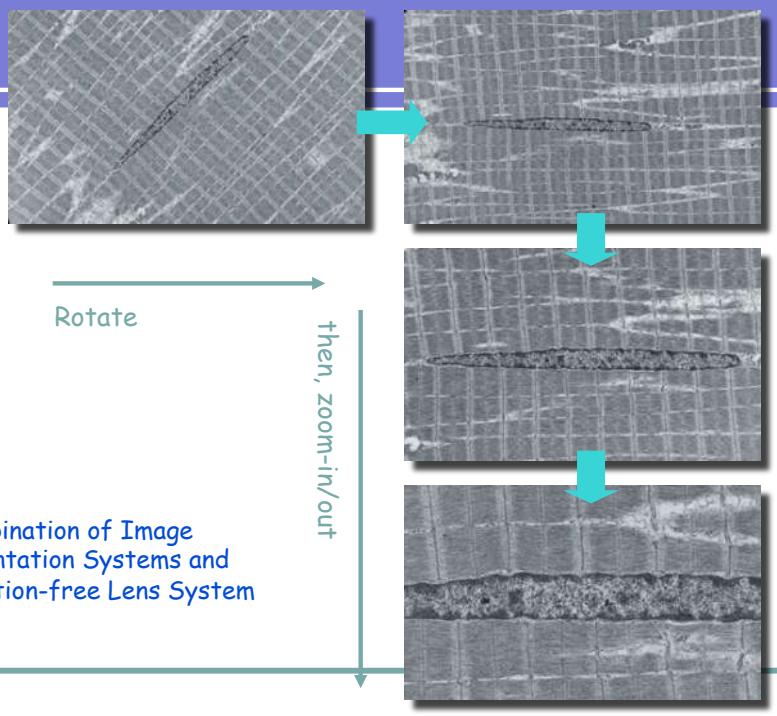
Quick Change Specimen Cartridge (Standard)



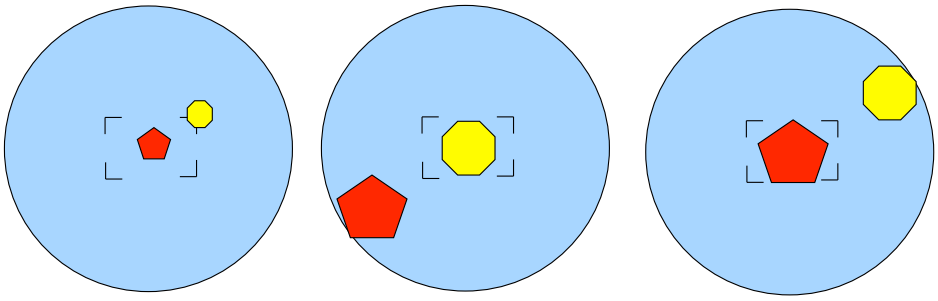
Penta holder(5 specimens holder, option)

Rotation Free Lens System





Minimum Dose System (MDS)



Search mode
(low mag)

Focus mode

Photo mode

Electronically shift (target)

Mag.
~~Brightness~~
Exp. time

JEM-1400

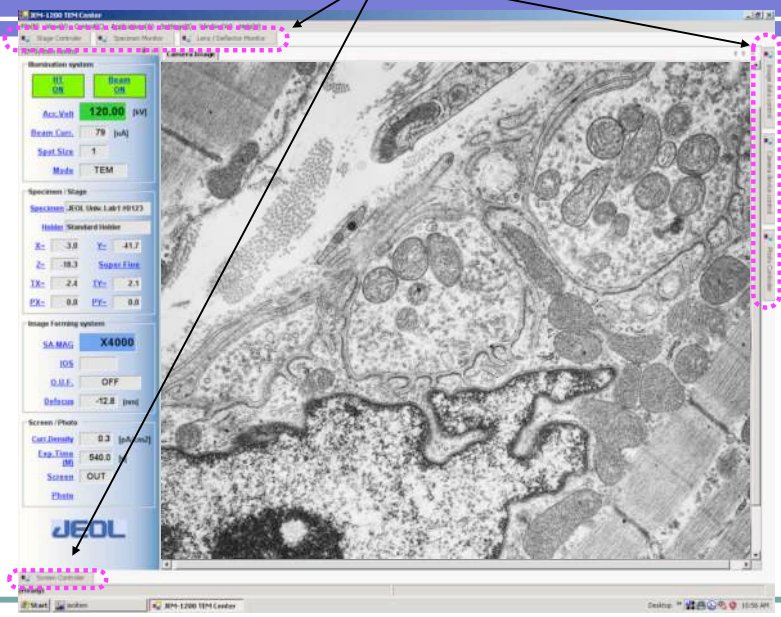
Software System

Wide view area for imaging, neatly designed control windows, low-profile tool bar and tabs

* GUI design may be changed without notice for improvement purpose.

JEOL

The control panels promptly appear by only pointing the tabs by the cursor

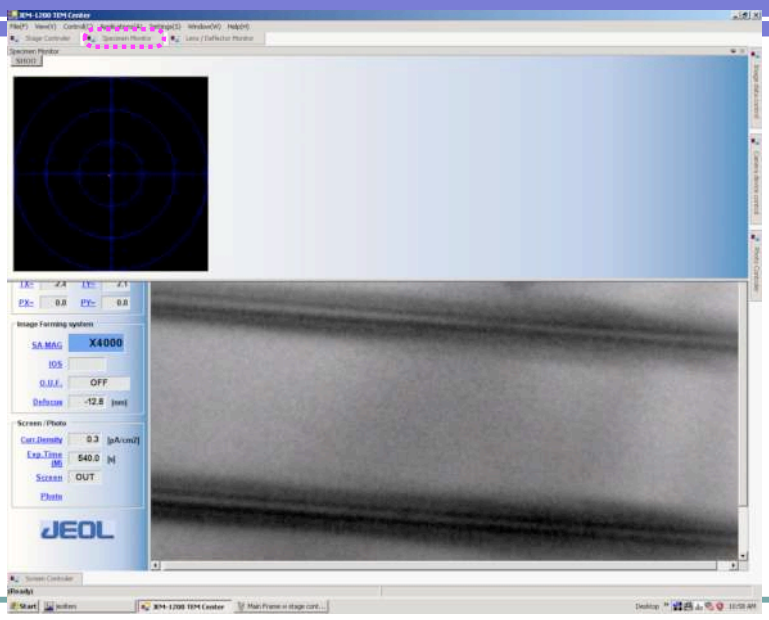


* GUI design may be changed without notice for improvement purpose.

Specimen Stage Controller

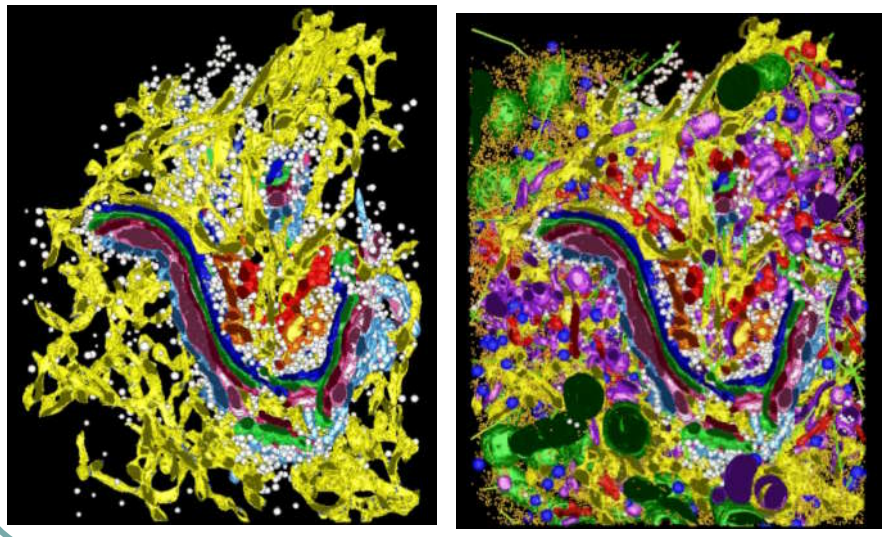
* GUI design may be changed without notice for improvement purpose.

Specimen Position Monitor



* GUI design may be changed without notice for improvement purpose.

3D Tomography

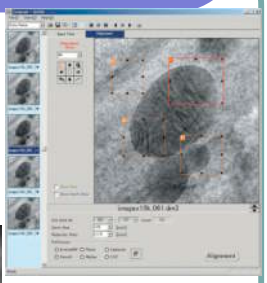


Vesicles in the vicinity of the Golgi(HVEM tomography on Golgi)

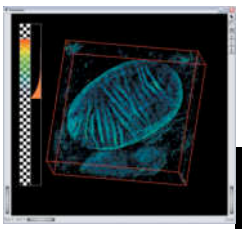
3D Tomography

High Tilt Retainer

Recorder

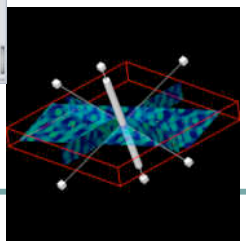


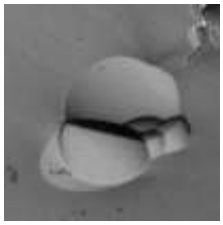
Composer



Visualizer

Slicer

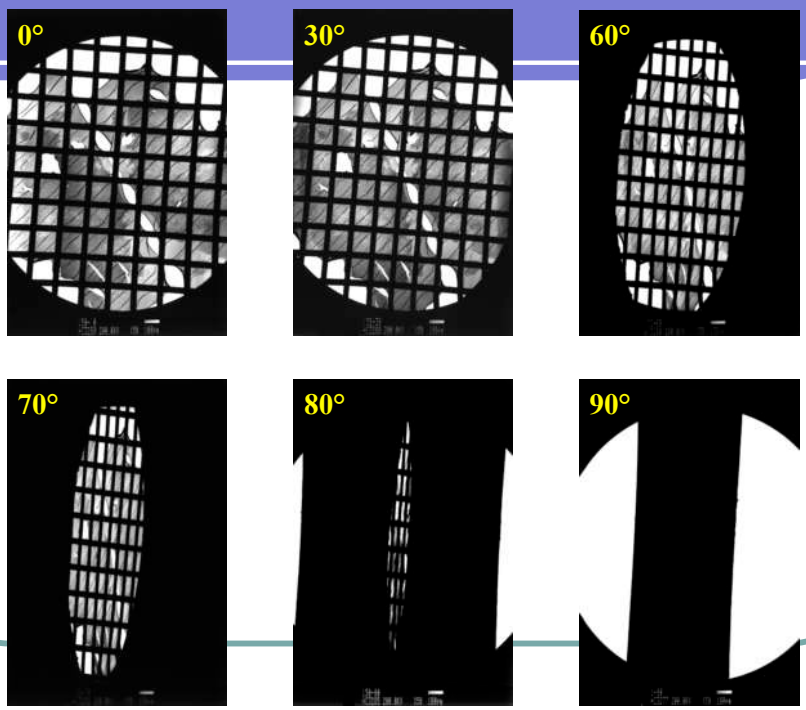




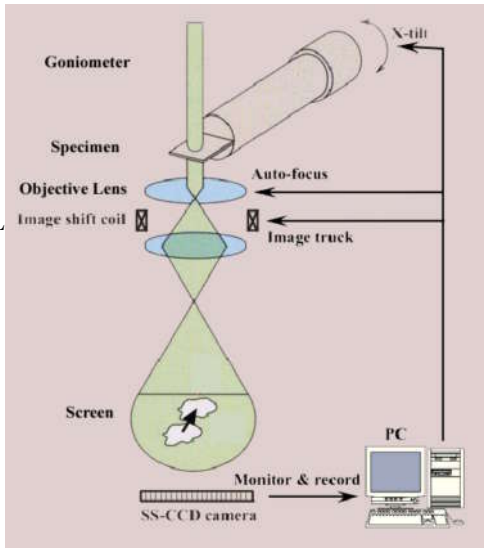
AVI

3D Tomography-CNT

Changes of field-of-view with specimen tilting

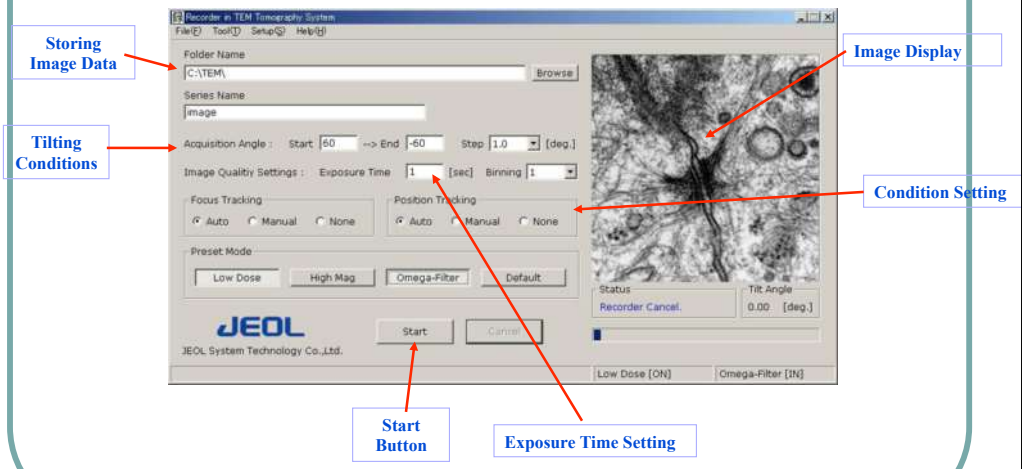


Method and flow of Tomograph auto-acquisition

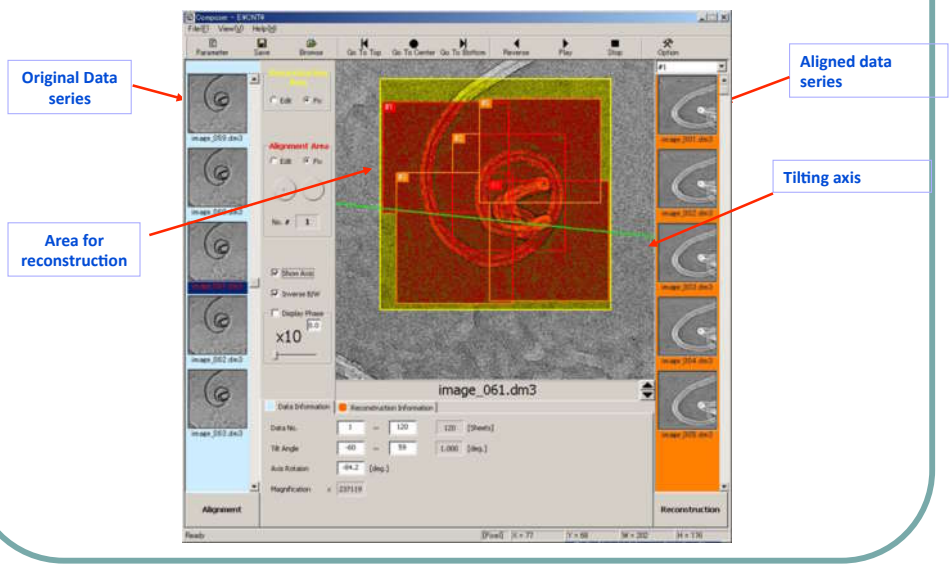


1. Tilting
2. Image tracking
3. OL-focusing
4. Recording
5. Data saving

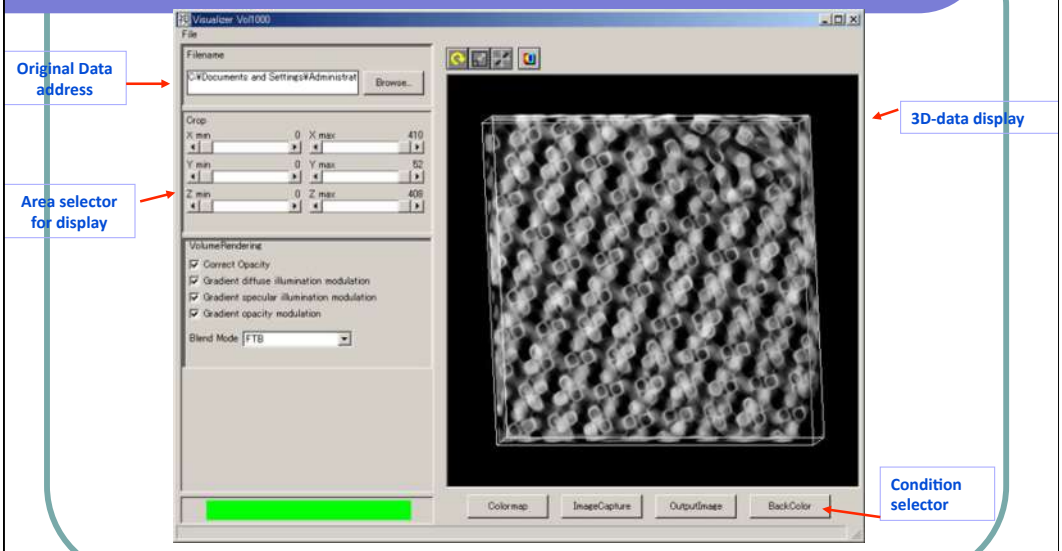
Operation window of Tilt-Images Auto-Acquisition System (Recorder)



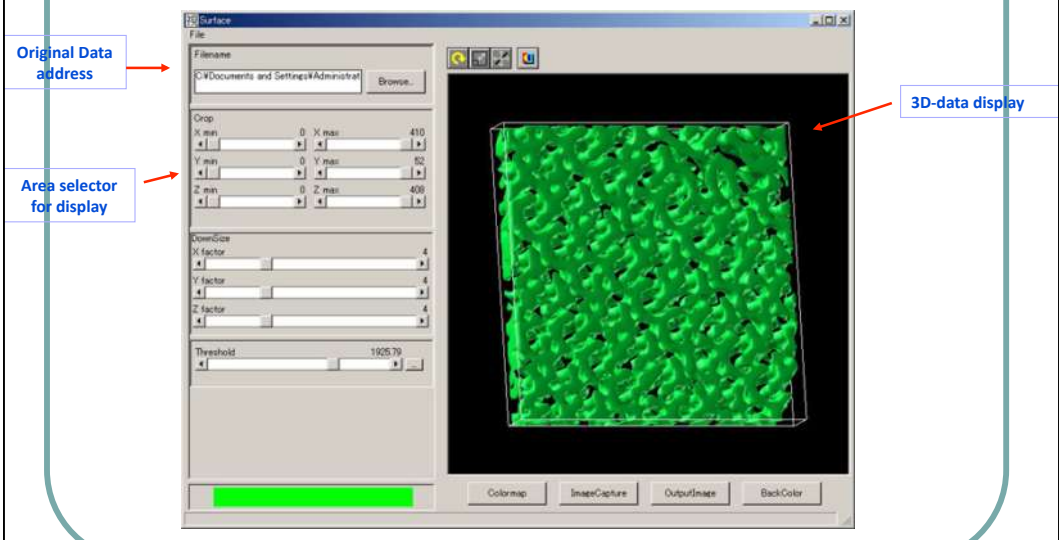
Operation window of Reconstruction System (Composer)



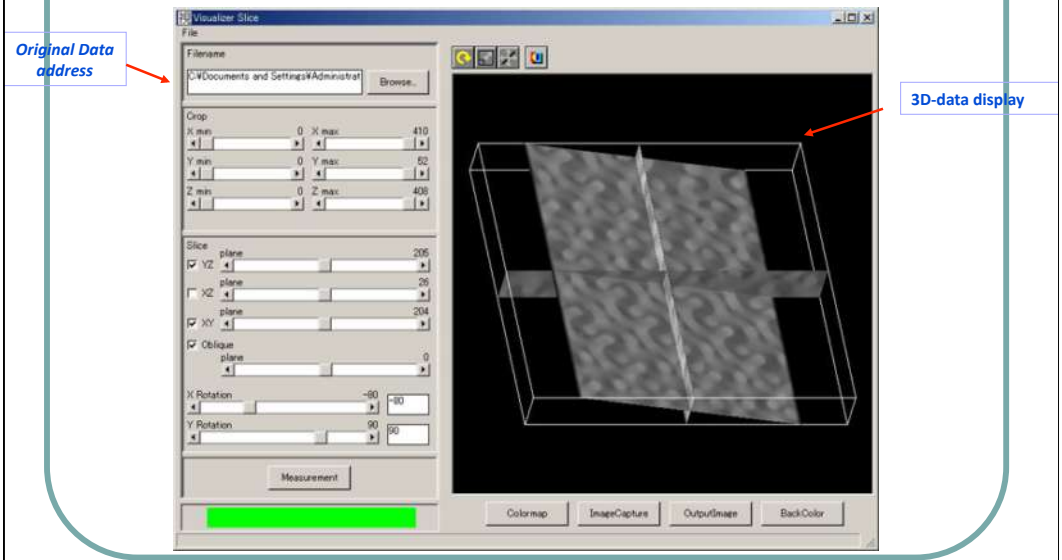
Operation window of Viewing System (Volume rendering)



Operation window of Viewing System (Surface rendering)



Operation window of Viewing System (Slicing)



Lamellar of Polycaprolactane – 3D-Reconstructed

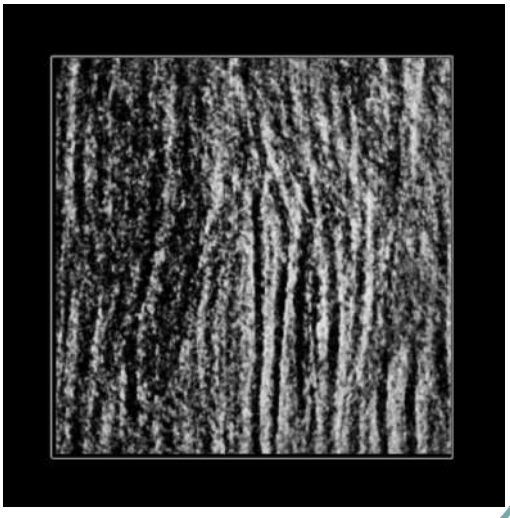
<Imaging> Acc. V : 200kV

Mag : ×20k

Tilting : +60°～ －60° (2.5°Step, 49 Images)

＜Specimen＞ Thickness：100nm
RuO4 Stained

Specimen courtesy of Professor Nishi of University of Tokyo



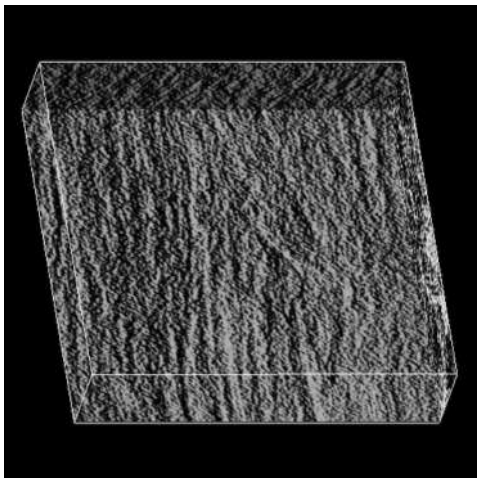
Lamellar of Polycaprolactane
3D-Reconstructed (Slicing)

<Imaging> Acc. V : 200kV
Mag : ×20k

Tilting : +60°～ −60°
(2.5°Step, 49 Images)

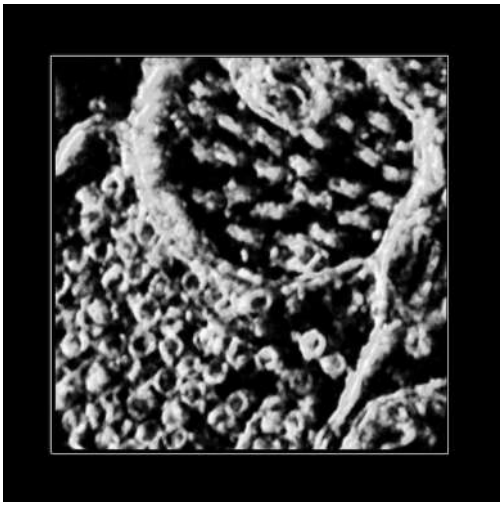
＜Specimen＞ Thickness : 100nm
RuO4 Stained

Specimen courtesy of Professor Nishi of University of Tokyo



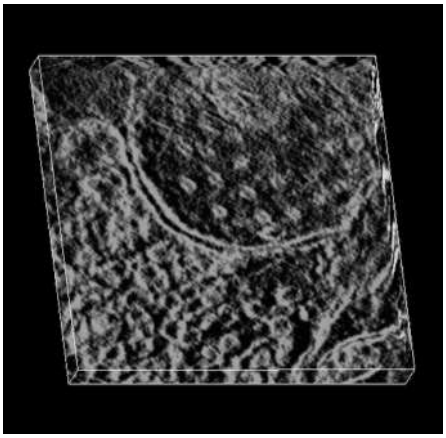
Synapse of Spinal Cord of Frog
3D-Reconstructed

Specimen : Spinal Cord of Frog
(OsO4 Stained)
Thickness: 70 nm
Tilting : -60°~ + 60°(1°Step)
Instrument : JEM-2010 / Auto-Acquisition System(AIA)
Acc V : 200kV



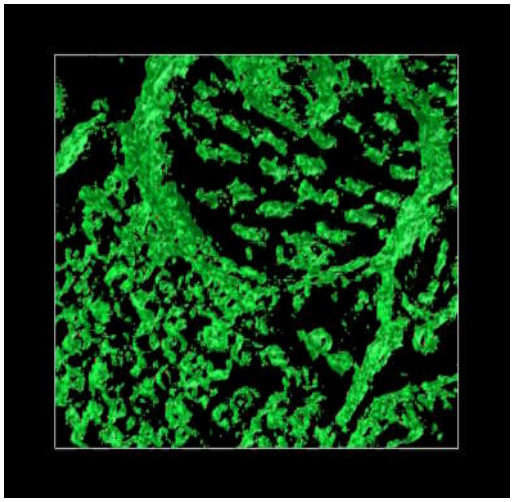
Synapse of Spinal Cord of Frog
3D-Reconstructed (Slicing Display)

Specimen : Spinal Cord of Frog
(OsO4 Stained)
Thickness: 70 nm
Tilting : -60°~ + 60°(1°Step)
Instrument : JEM-2010 / **Auto-Acquisition System(AIA)**
Acc V : 200kV

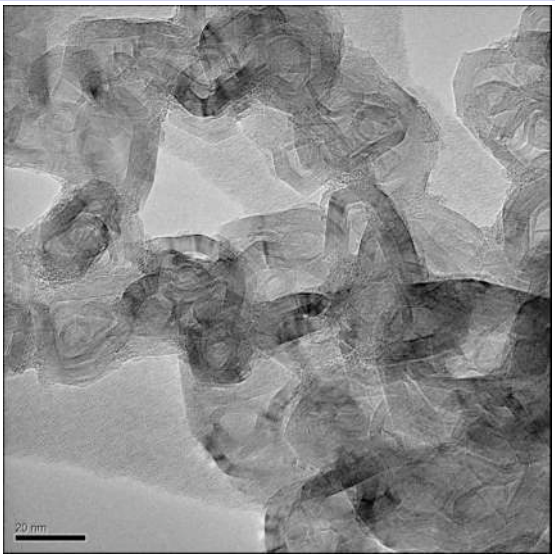


Synapse of Spinal Cord of Frog
3D-Reconstructed

Specimen : Spinal Cord of Frog
(OsO4 Stained)
Thickness: 70 nm
Tilting : -60°~ + 60°(1°Step)
Instrument : JEM-2010 / **Auto-Acquisition System(AIA)**
Acc V : 200kV



Digital Image System



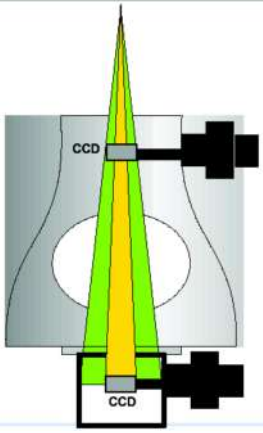
Location of Digital Cameras

Attaching CCD Camera to TEM Column

Magnification on CCD

Less than film (~ 70-75% less)

Close to film (~ 30-40% more)

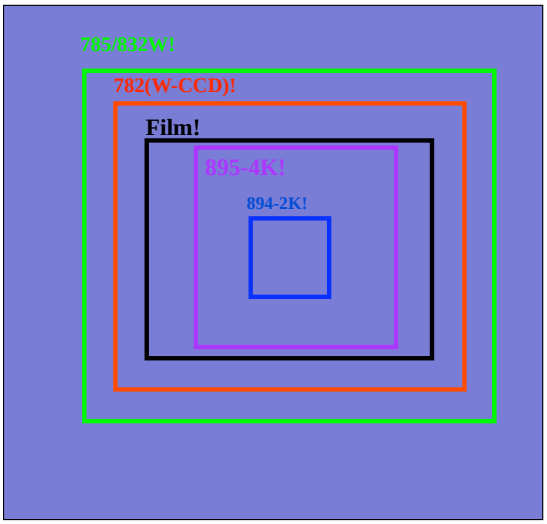


TEM Applications

(35 mm Port)
Large field of view
Life science

(Bottom)
High resolution
Materials science

Field of View Comparison



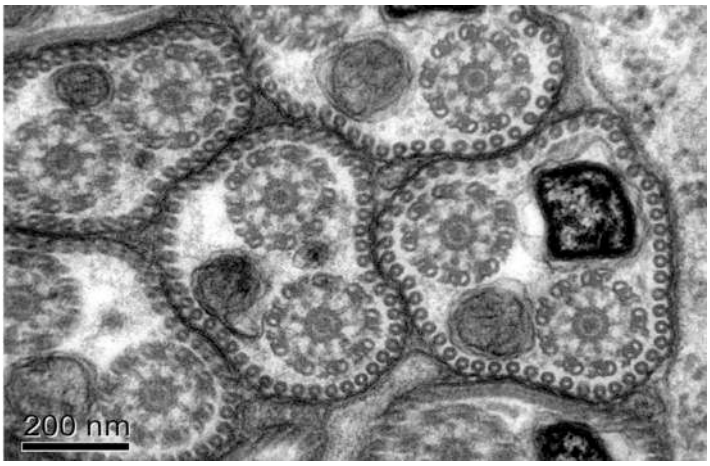
Digital Camera models

	895 (US4000)	894 (US1000)	782(ES500 W)
Scintillator	Phosphor	Phosphor	Phosphor
Cooling	Peltier	Peltier	Peltier
CCD Size	4080 X 4080 @15umn	2048 X 2048 @14umn	1350X1040 @6.45um
Camera-Computer Interface	PCI	PCI	IEEE 1394b
Magnification on CCD with respect to film	1.3 – 1.5x	1.3 – 1.5x	0.2 – 0.3x
Dynamic range	16-bit	16-bit	12-bit
View Area	~45% of Film	~10% of Film	Film+33%
Coupling System	HCR™ Fiber Optic	HCR™ Fiber Optic	Lens Optics
CCD Active	61.2 X 61.2	28.7 X 28.7	8.7 X 6.7

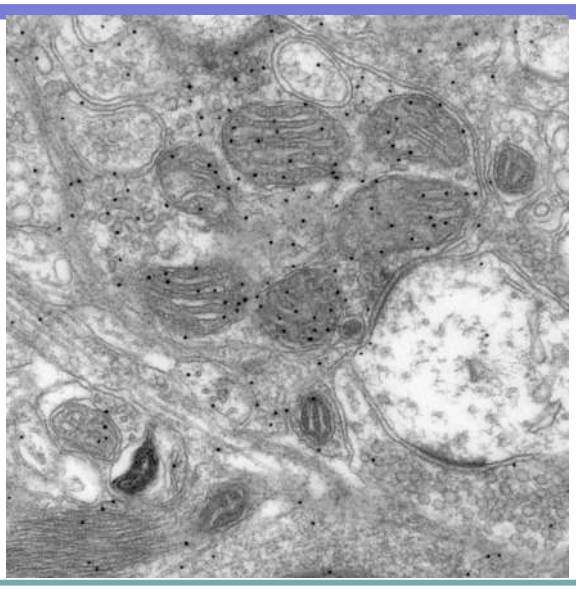
895(US4000)

782(ES500W)

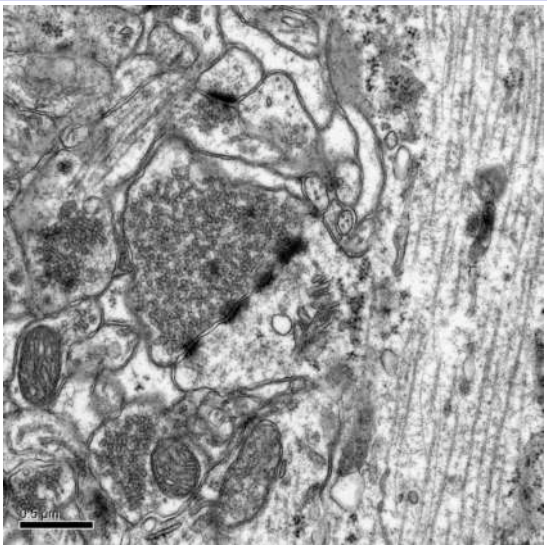
782(1350 X 1040,12-bit)



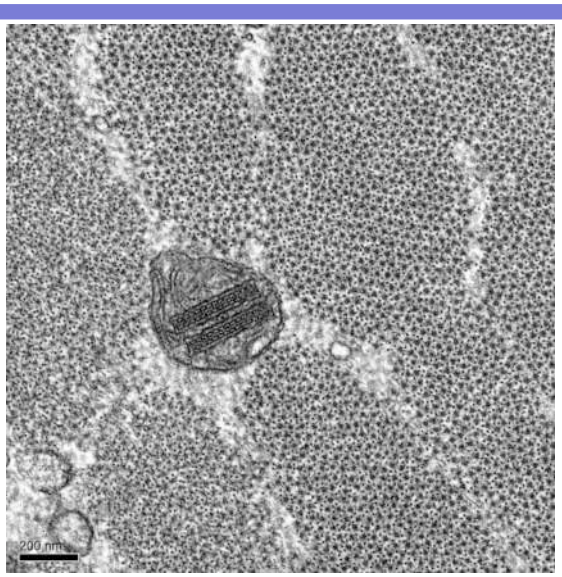
894(2K X2K,16-bit)



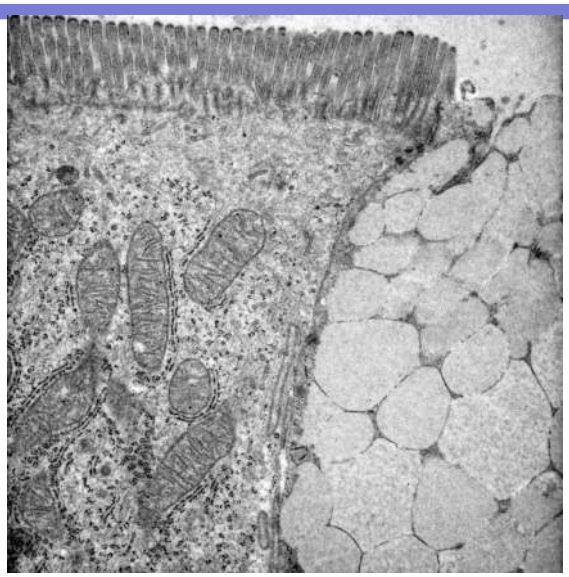
894(2K X2K,16-bit)



894(2K X2K,16-bit)

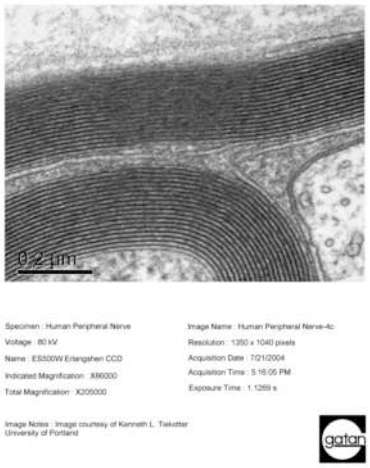


895(4K X 4K,16-bit)



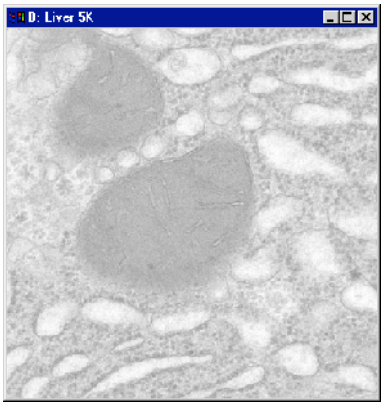
Software - *DigitalMicrograph Working Environment*

Software function – *Image output formats*

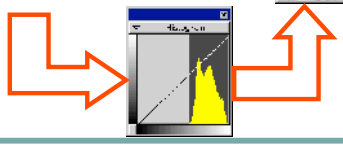


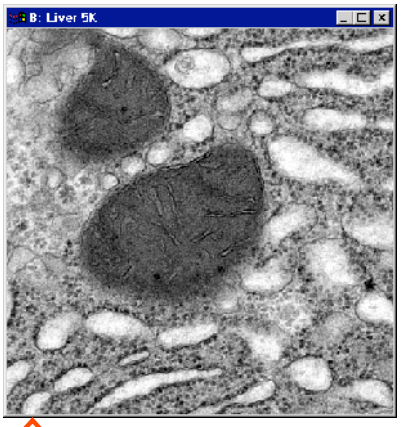
The image can be export as many formats such as JPEG, TIFF, BMP….etc

Software function - *Brightness/Contrast Adjustment*



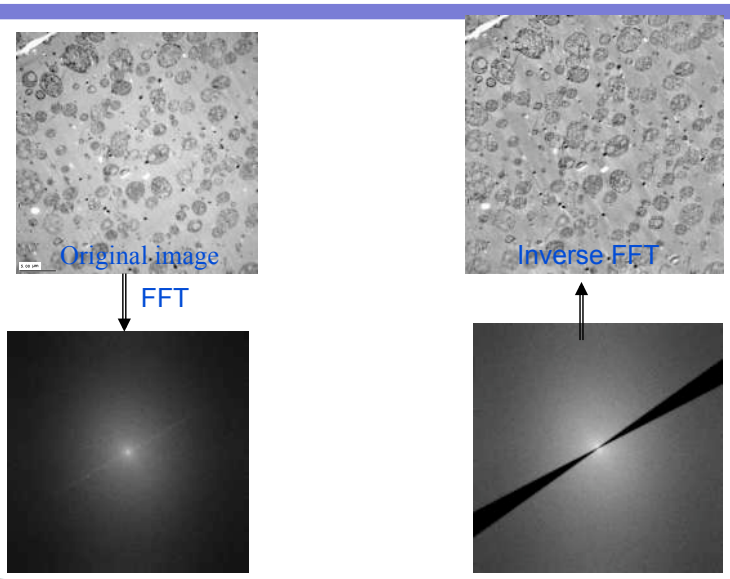
Before



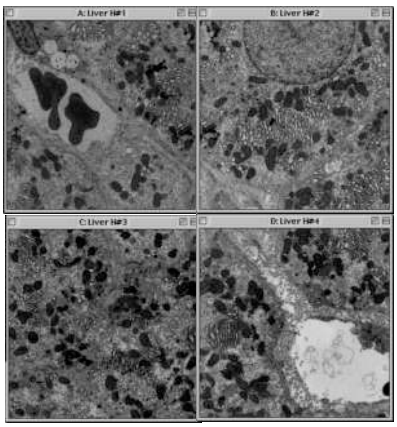


After

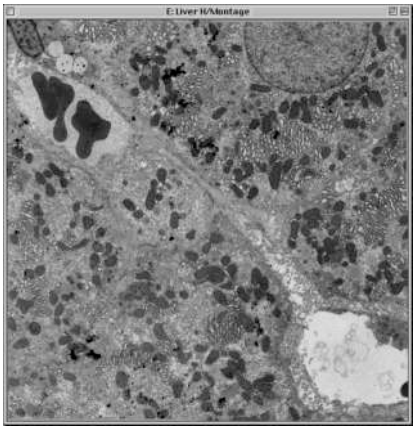
1D Noise reduction



DigialMontage - Enlarge photographic Area by software (Option)

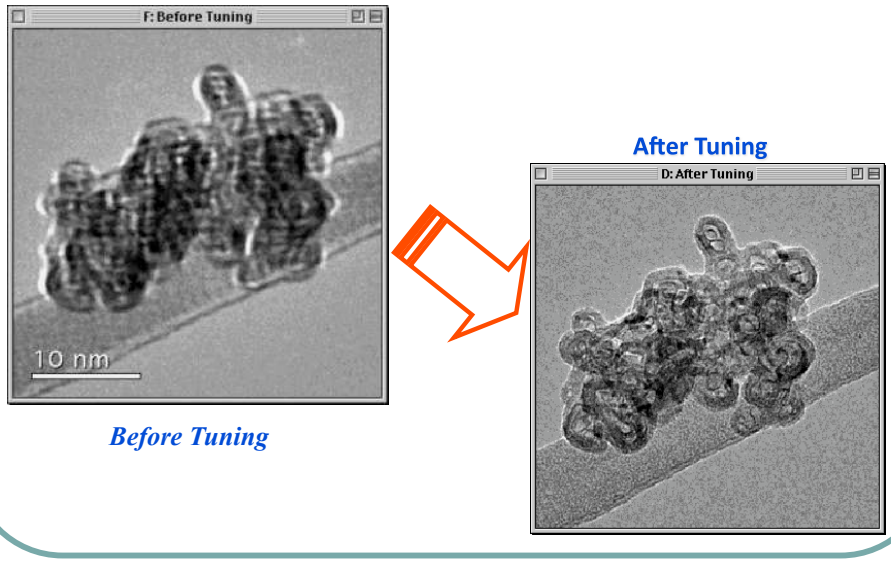


These are 4 images in 1024x1024 size.



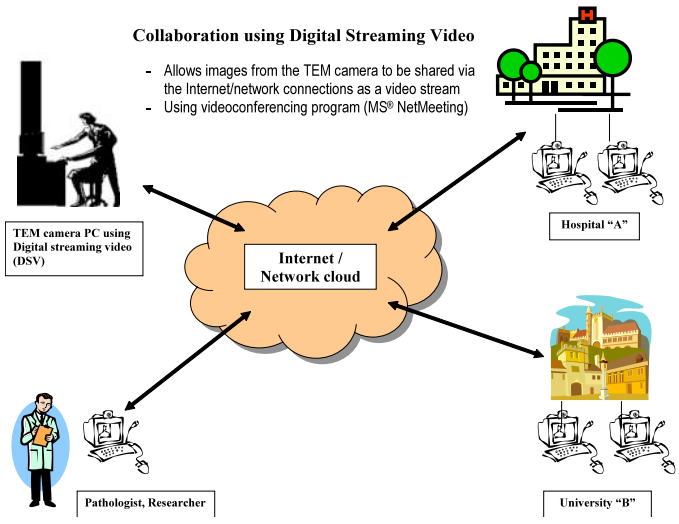
This montage is 1953x1952 pixels.

EM *AutoTuning* – Auto Focus by software (Option)



Before Tuning

Digital Streaming Video for Network Meeting



Cryo-Transfer Holder

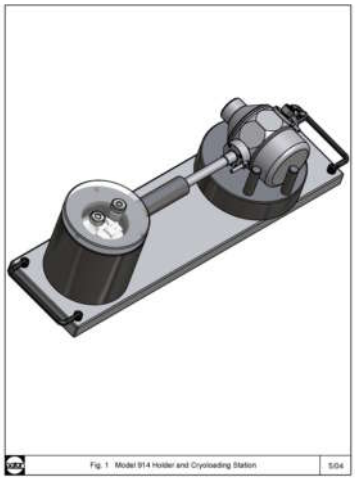
914

CT3500TR

626

914 Cryo-Transfer Holder

Workstation



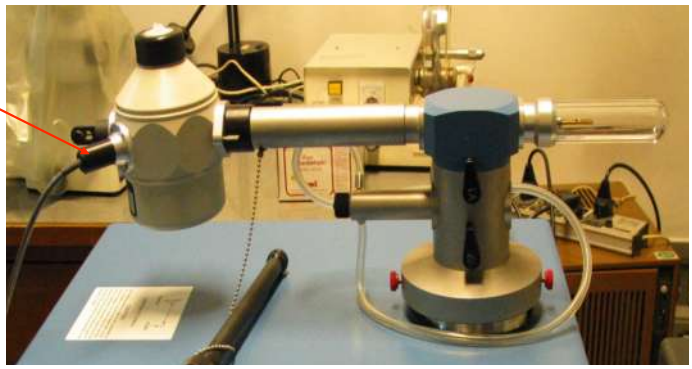
Holder

Gatan 914 Cryo Transfer holder

- Minimum temperature attainable in the microscope: -170°C
- Minimum temperature attainable in the cryo-workstation: -185°C
- Cool down time to within 10°C of T min <15 minutes
- Typical specimen temperature rise during transfer to the TEM: <20°C
- Resolution at T min better than 0.5nm
- Tilt range (With CR and HC Pole Piece): ±80°
- Dewar capacity 4 hours

655 Pumping Station

連接smart set 裝置



655 Pumping Station

Thank you for your attention.