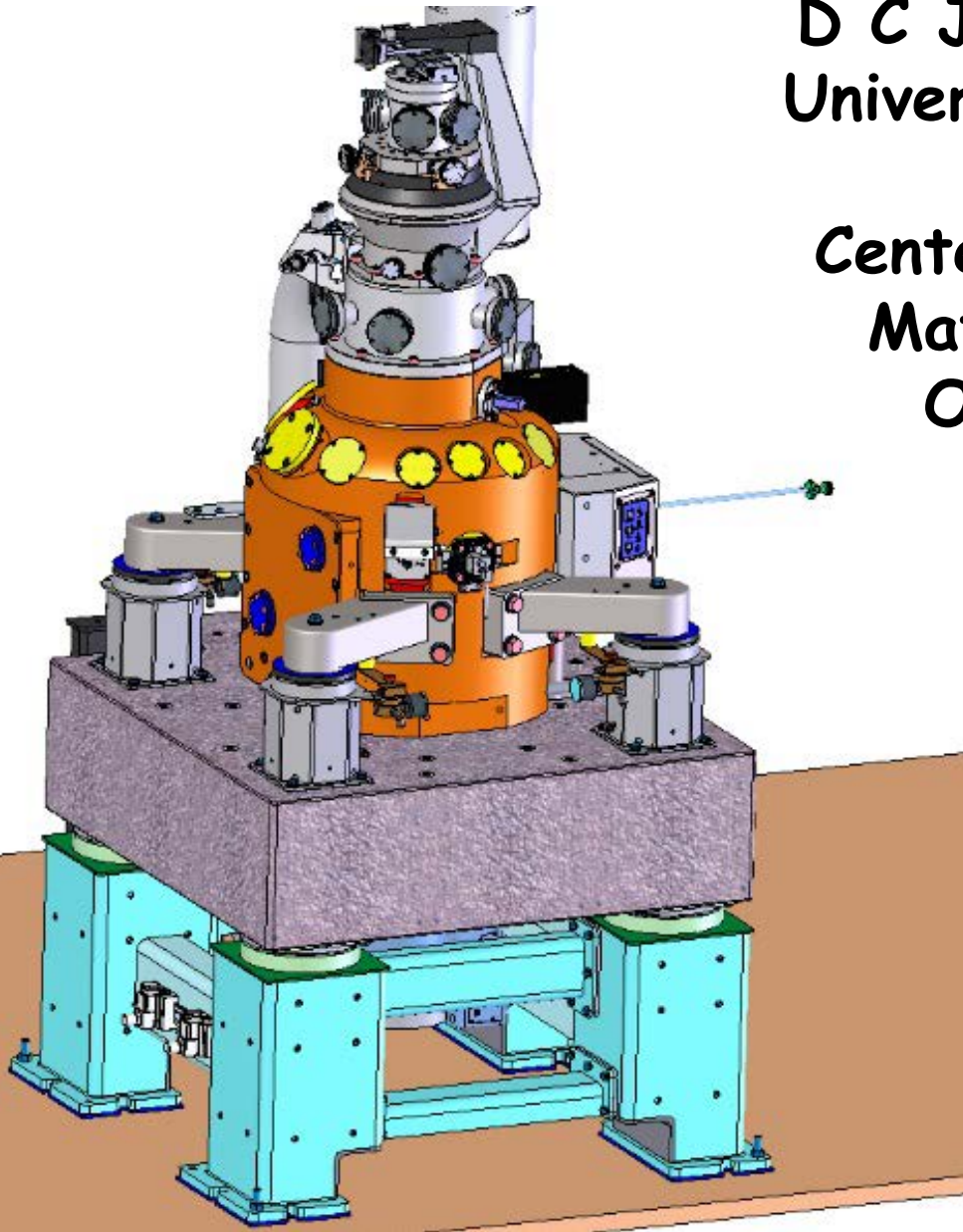


MC Simulations of He, Ne deposition

D C Joy and P D Rack
University of Tennessee
and
Center for Nanophase
Materials Science,
Oak Ridge, TN



The ORION NF
HIM

A new type of "Dual-Beam"



- *HIM with extras !*
- *More compact*
- *He+ & Ne+ capable*
60 sec change-over
- *45keV beam energy*
- *Pattern generator*
- *0.4nm resolution*

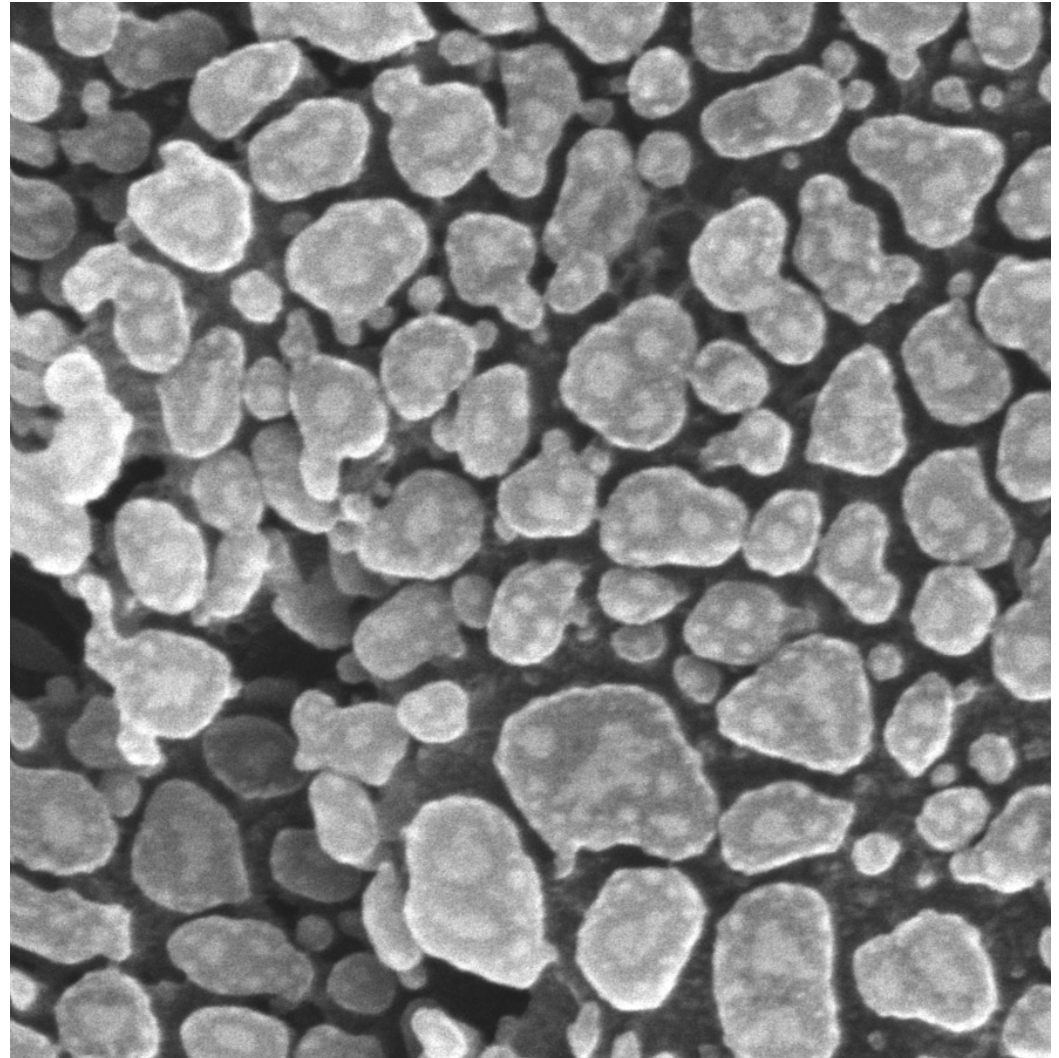
Zeiss ORION NF

iSE image of
cross-sectioned
Nano particles

Beam energy
28keV

1 μ m FoV

He+ beam



ZEISS

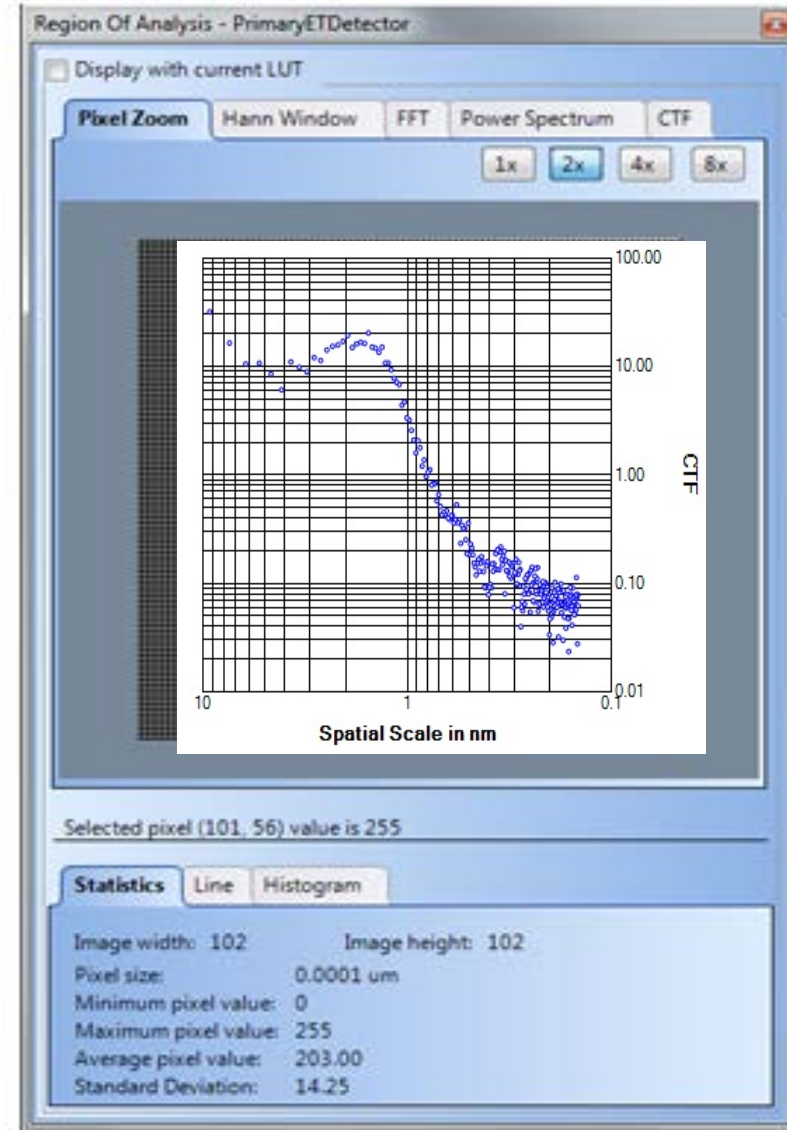
Field Of View 1.00 μ m	100.00 nm	Dwell Time 0.5 μ s	Date: 10/17/2012 Time: 4:59 PM
Working Dist 5.6 mm	Blanker Current 0.0 μ A	Acceleration V 28.4 kV	Line Averaging 128

Optimizing Images

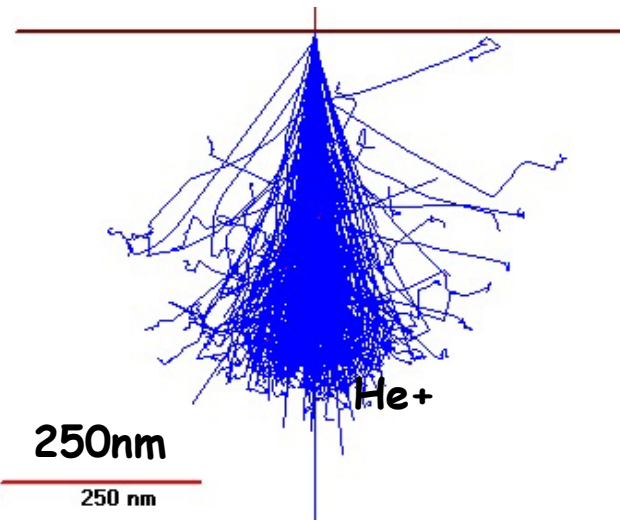
Contrast Transfer Function (CTF) tool built into software

High speed analysis - less than one second/image

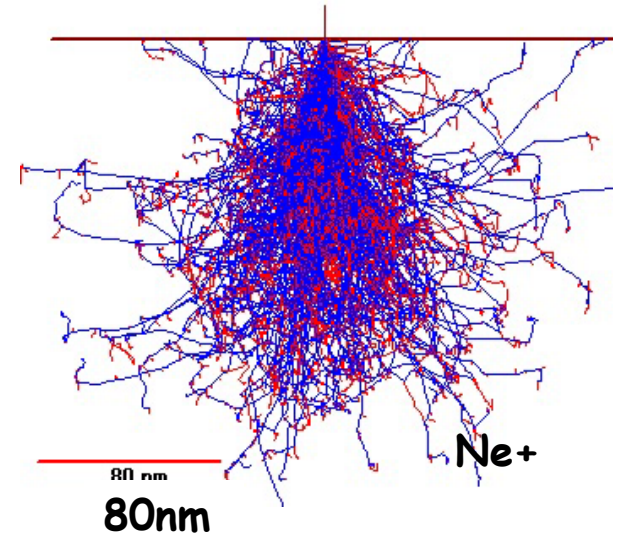
Monitors alignment, focus, astigmatism etc. in **real time** to ensure optimum performance and control



Why add a Neon Beam?



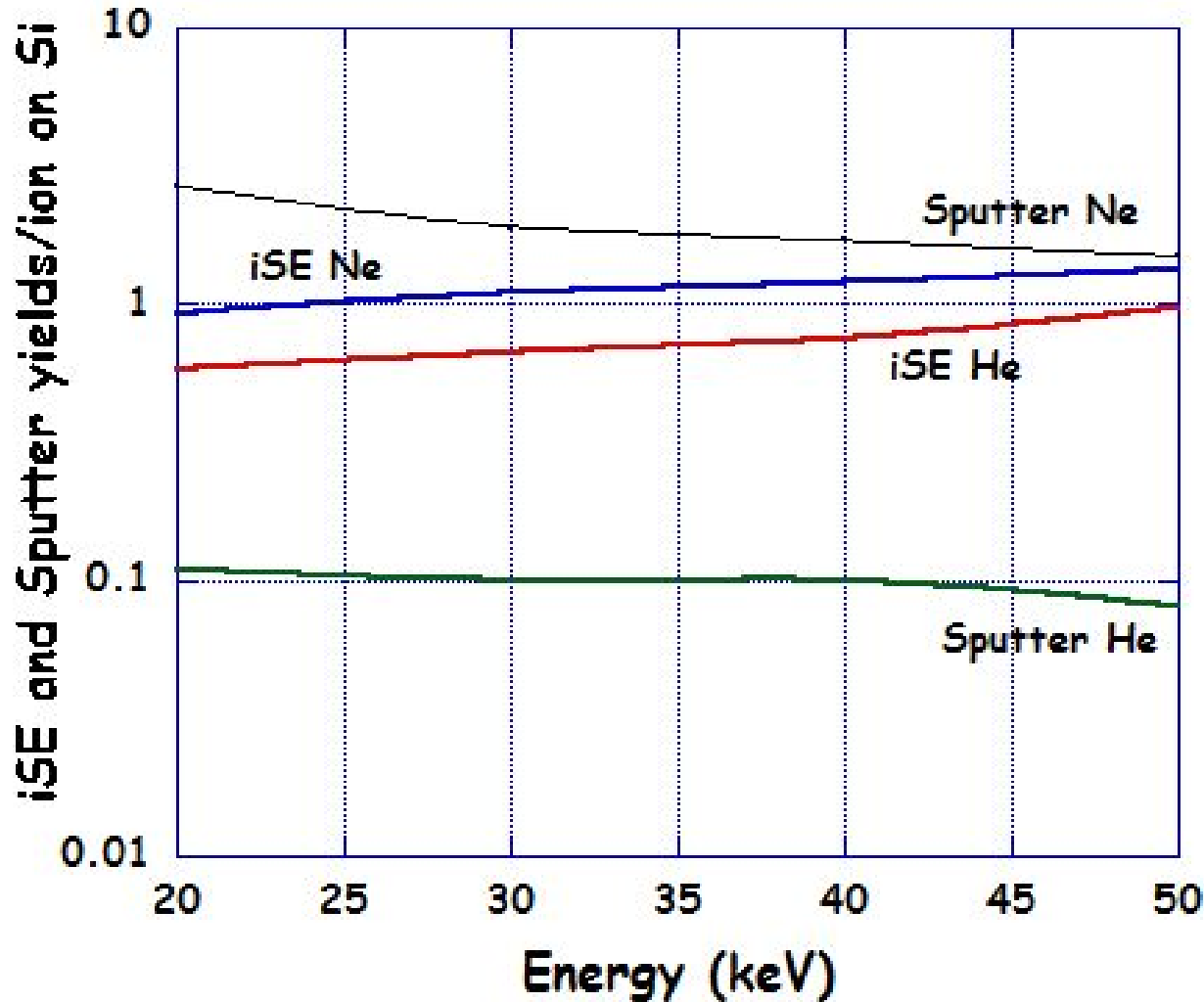
He+ is gentle beam - slow
removal of material
No residual deposit
High resolution - minimum
feature <2nm



Ne+ 10x faster than He+
No residual deposit
Beam range is shorter
Minimum feature size <5nm
- set by chromatic error in
the beam

Interaction volumes @40keV in Mo (Blue=forward, red = back)

Comparing He+ and Ne+ Properties



MC Models show how iSE and sputter yields compare for He+ and Ne+ beams

He+ - low sputter, and moderate iSE yield

Ne+ - 50x higher sputter rate, 50% more iSE at same energy

□ Emitter needs re-tuning He <- - > Ne

↑
Trimer Emission Current (arb. units)

*BIV for Ne+ is 3.3V/A
but 4.4eV/A for He+
So emitter requires
adjustment when
changing gas*

Ne BIV

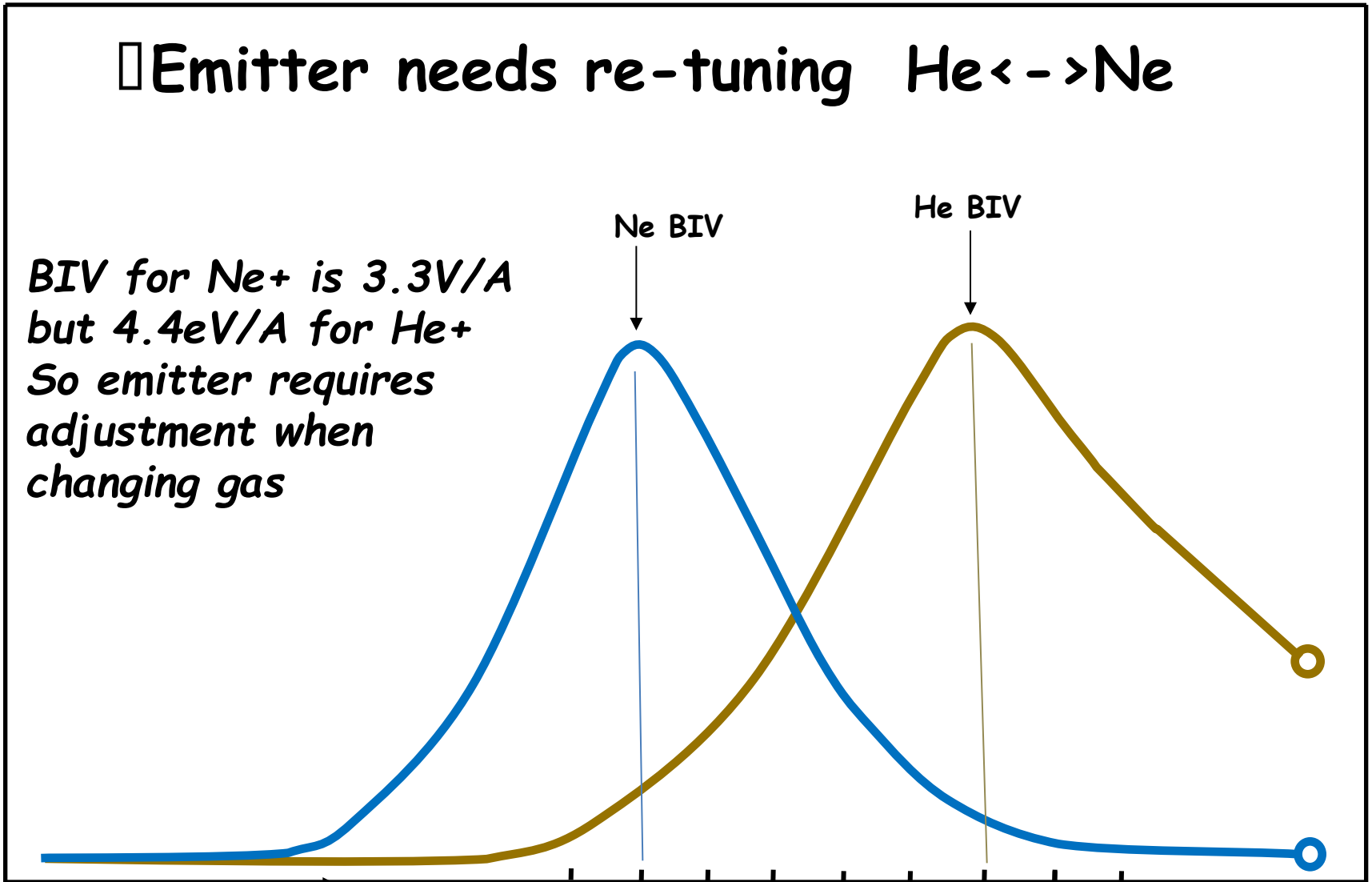
He BIV

70% 75% 80% 85% 90% 95% 100% 105% 110%
(Ne BIV)

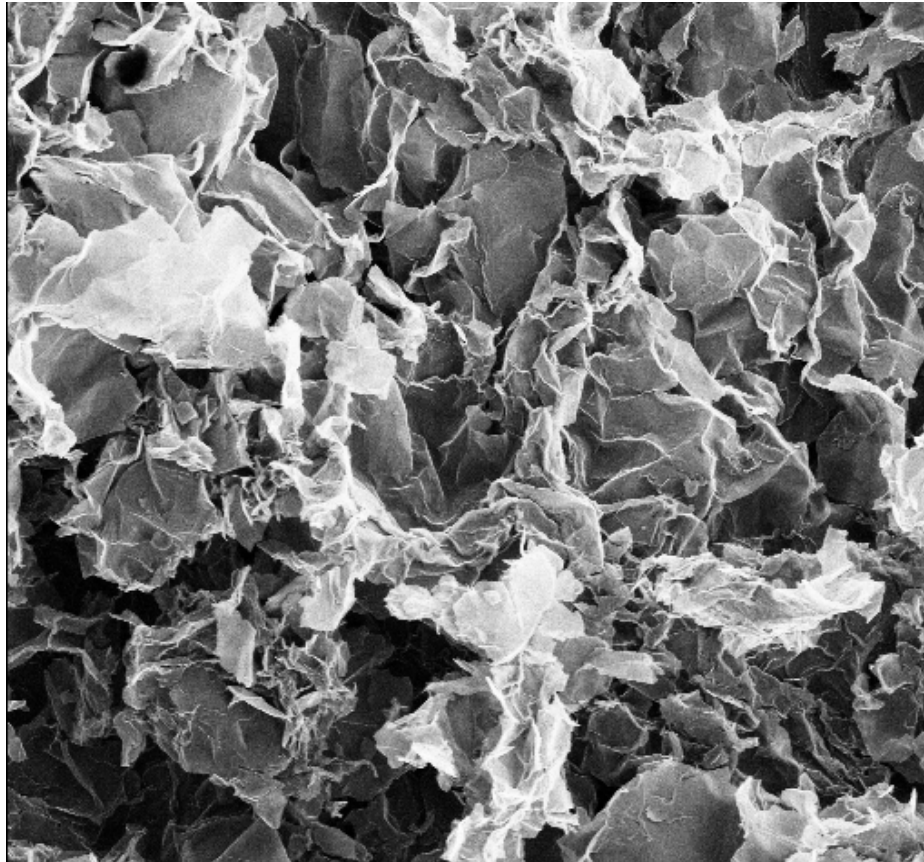
He BIV units

BIV=Best Imaging Voltage

Courtesy Dr. John Notte



What comes next?



ZEISS

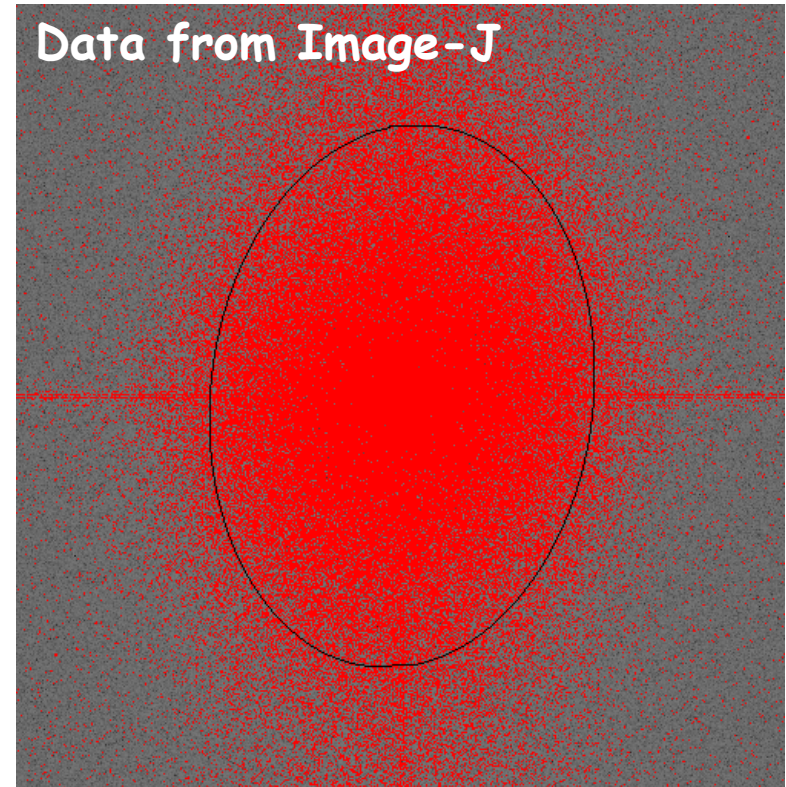
Field Of View
30.00 μm
Working Dist
4.4 mm

2.00 μm
Image Size
1024x1024

Dwell Time
20.0 μs
Acceleration V
27.9 kV

Date: 3/7/2013
Time: 3:02 PM
Averaging
Off

Graphene catalyst 27.4 kV, He⁺ iSE
SNR 14.6, resolution 3.3nm = 2pix



...but eccentricity ~ 0.3 - why is it so high? How can it be reduced?

CNMS User Program

*The ORION NF is in the
Center for Nanophase Material Science,
Oak Ridge National Laboratory,
and is a US DOE User Facility*

*User time on this instrument will soon be
available contact djoy@utk.edu for details*