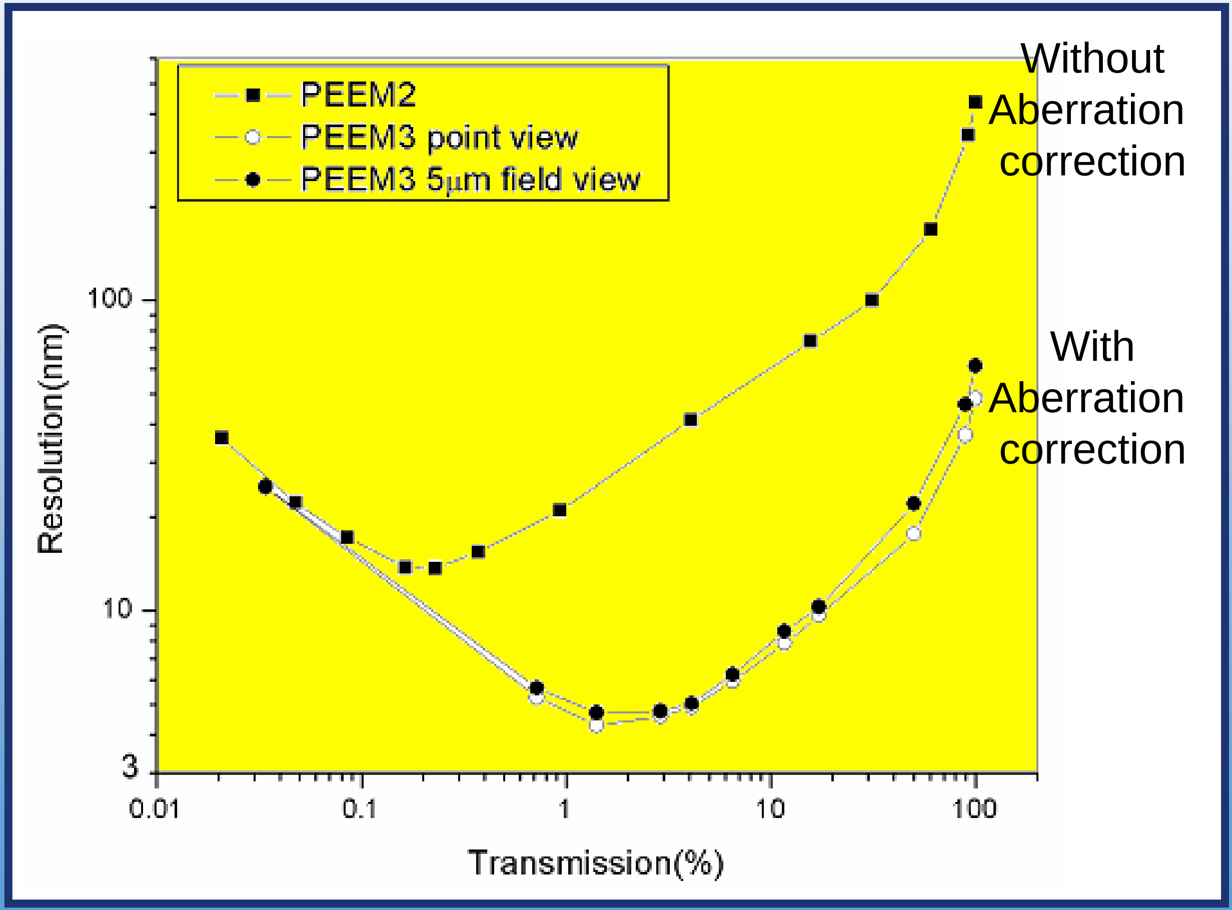
1st PEEM-3 Experiments

ADVANCED LIGHT SOURCE
EXPERIMENTAL SYSTEMS GROUP

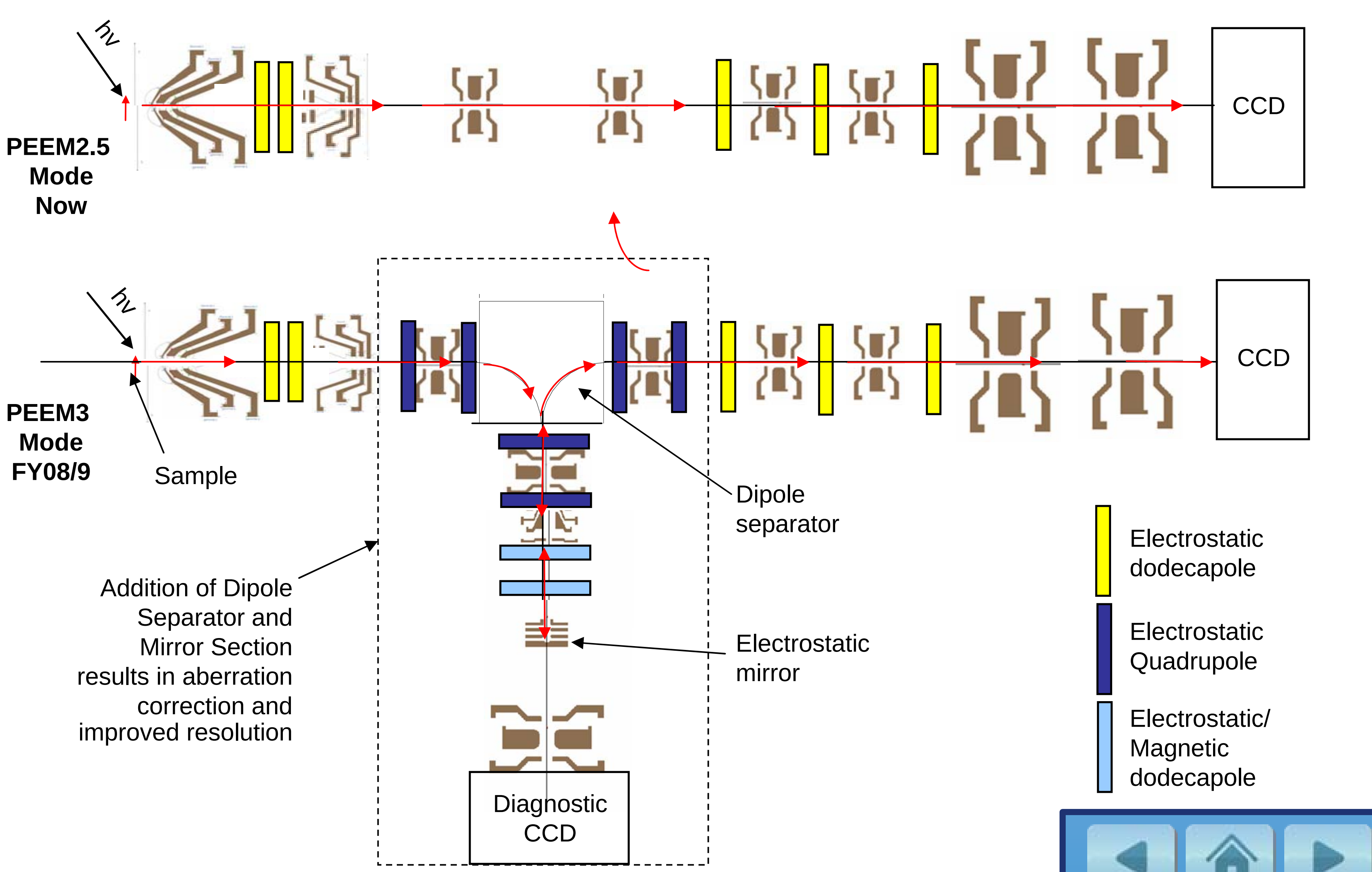
Hardware Status PEEM3 End station

Aim – Build an Aberration Corrected PEEM End-station

The Resolution and throughput does improve with Aberration Correction

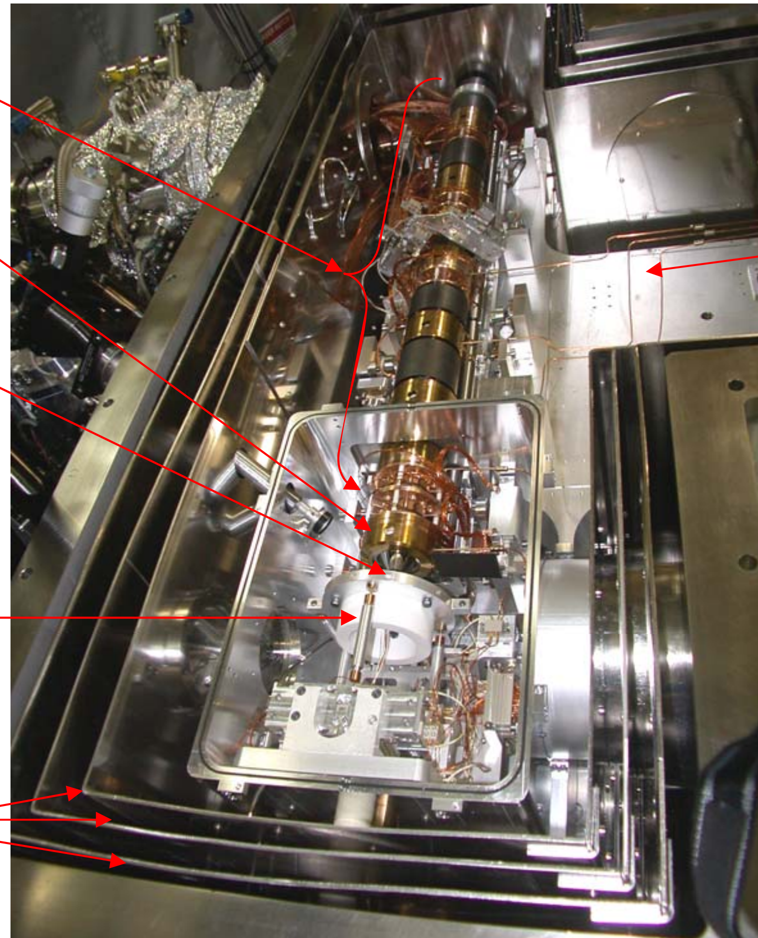


Staged Buildup of Aberration Corrected End Station — PEEM3



PEEM3 Microscope – Without Aberration Correction – 2.5 mode

CCD



Single Straight Electron Column

Objective Lens

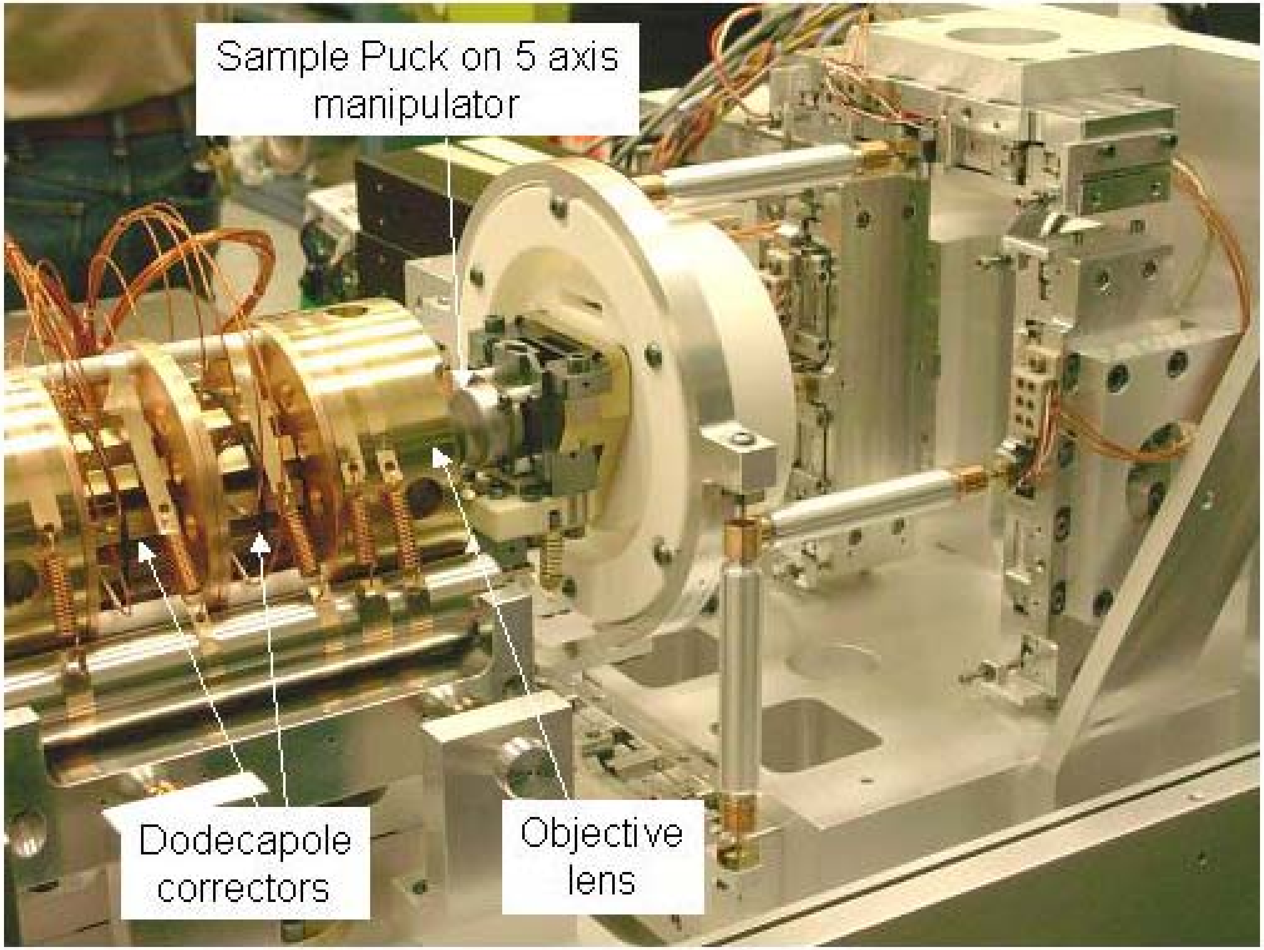
X-rays

Sample Stage

Triple layer Mu metal shields AC magnetic field < 10^{-7} Gauss

Space for Mirror & Separator

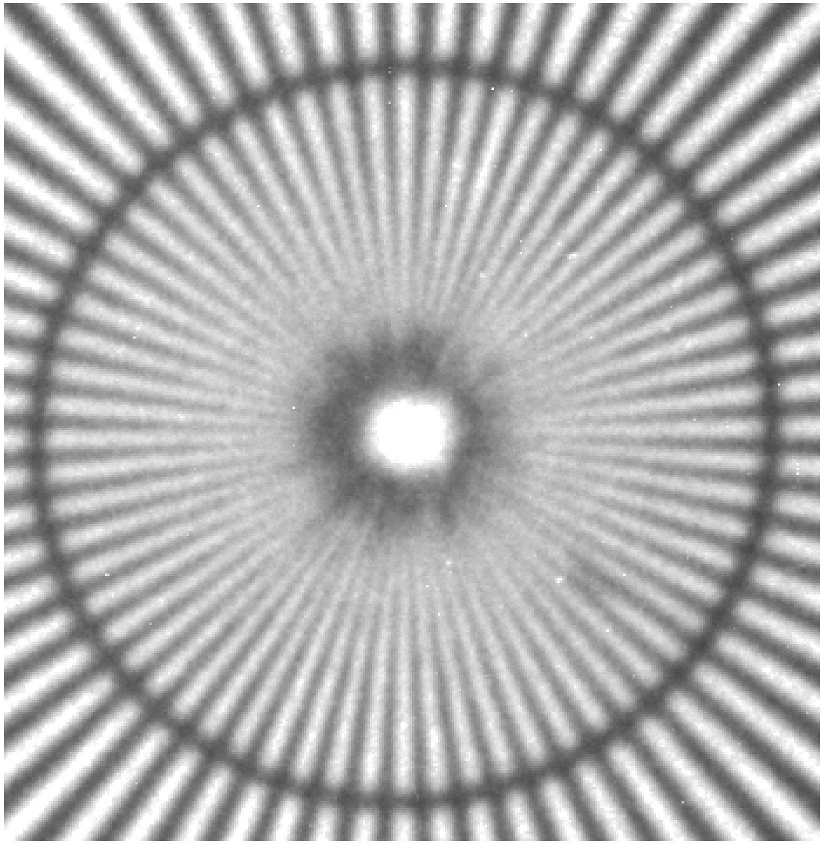
Cooled PEEM3 sample manipulator



Sample temperature down to ~ 50K

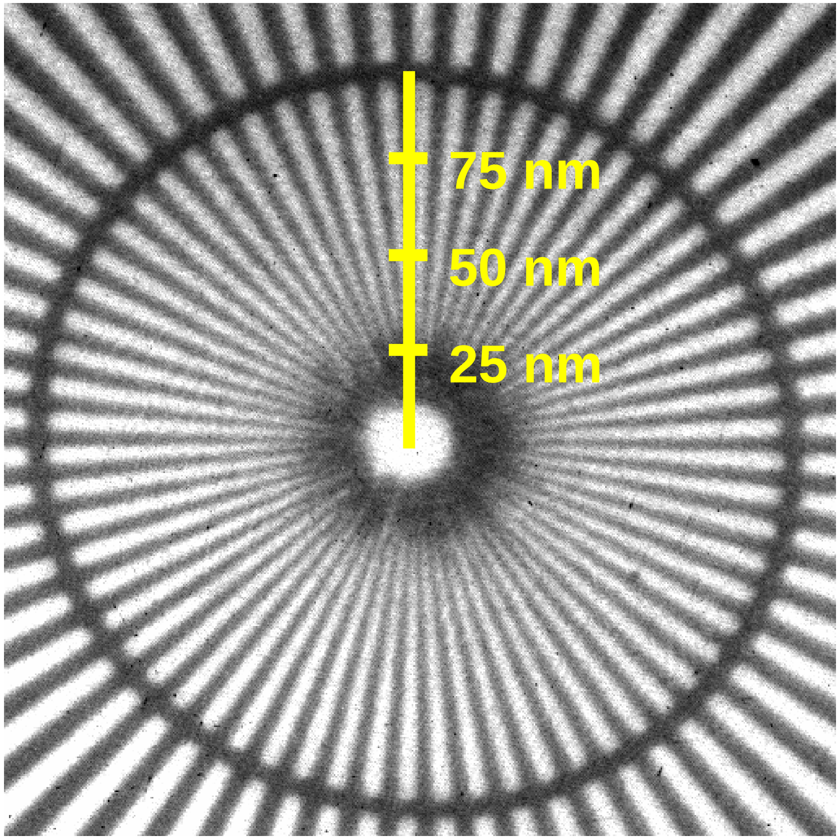
Resolution Comparison PEEM2 vs. PEEM3 (2.5)

PEEM-2 BL 7.3.1



~10 min exposure

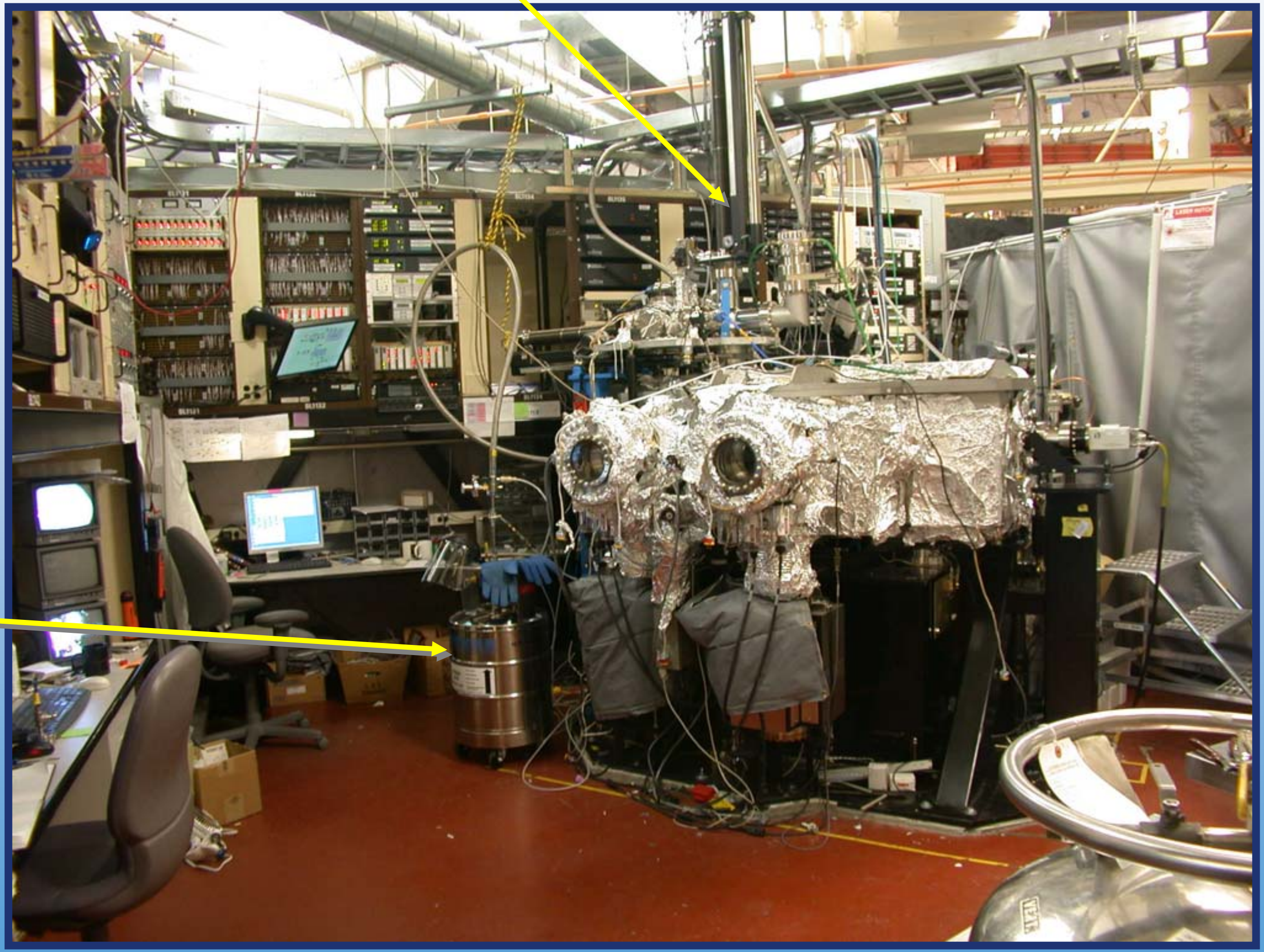
PEEM-3 (2.5)



20s exposure
30 nm features well resolved

PEEM3/2.5 Microscope End Station Now Operational at Resolution = 25nm – Dec 07

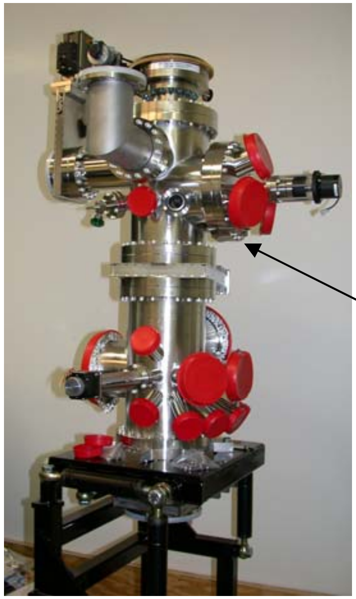
Load lock and sample loading system



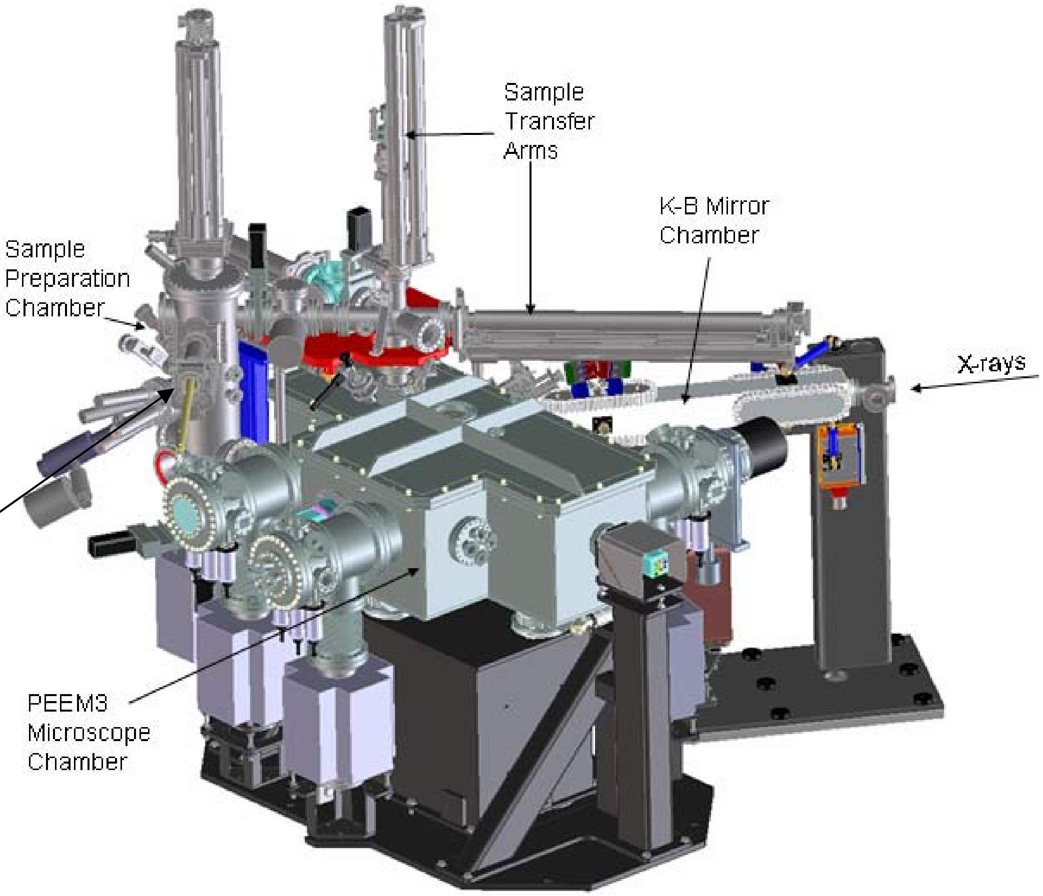
Liquid Helium for sample cooling

2008 – PEEM3 microscope Final realization

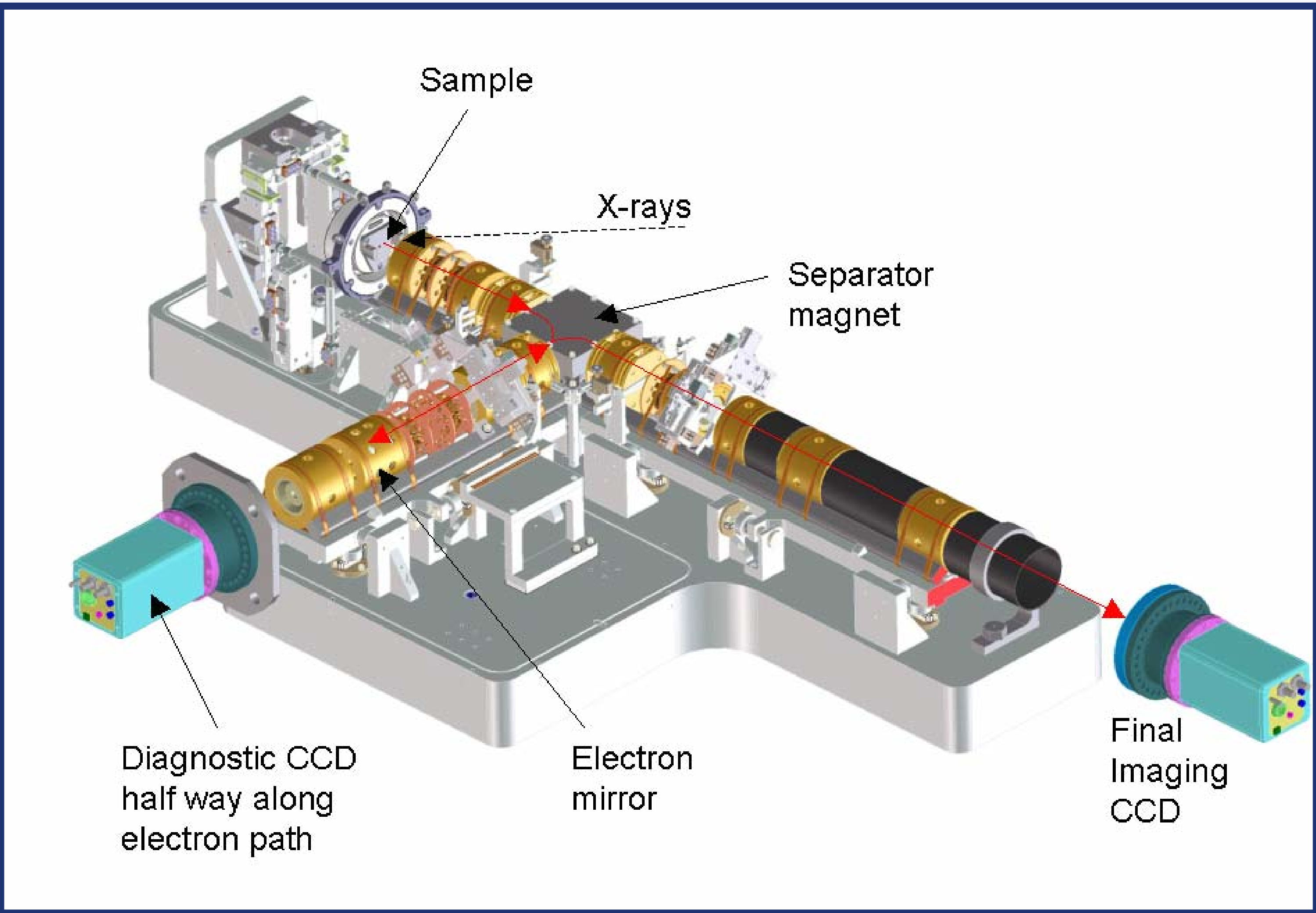
Final instrument to include Aberration Correction Sample prep Chamber Cooled sample pucks



Sample Prep chamber under construction

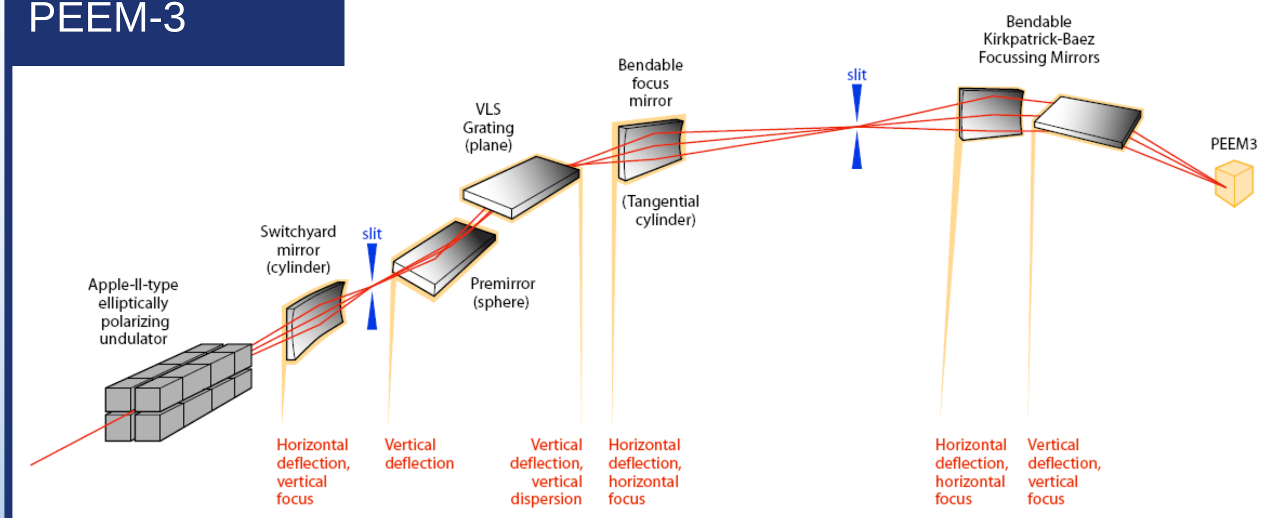


Internal Electron Optics and Separator Magnet Under Design and Construction (Dec 2007)

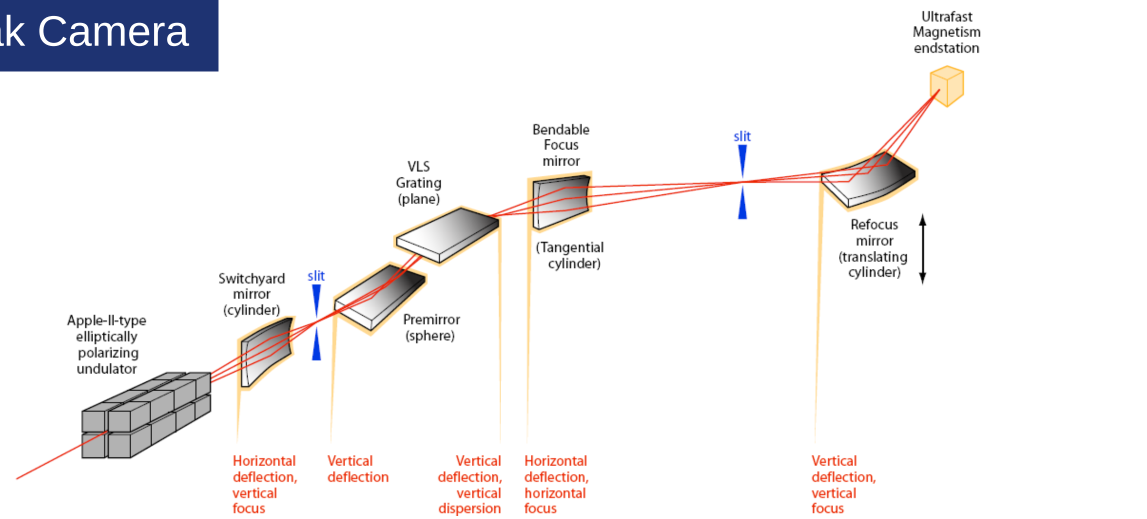


Beamline Layout

PEEM-3

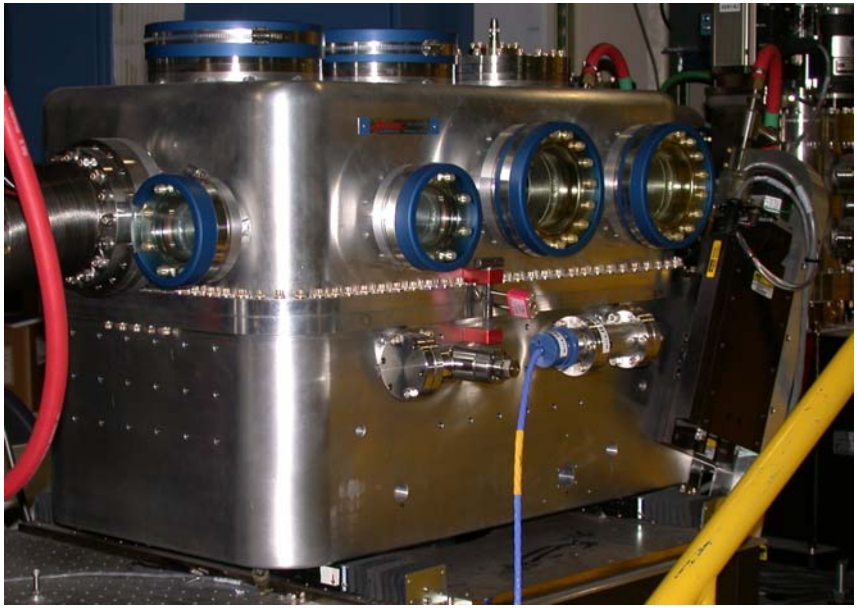


Streak Camera



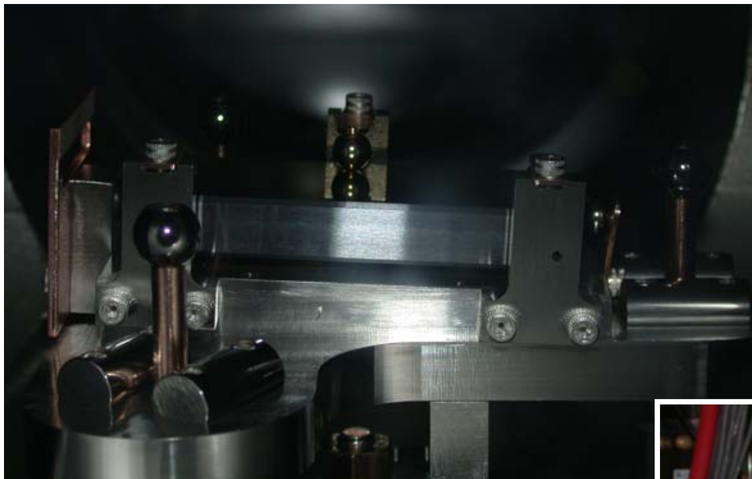
BL 11.0.1 features. . .

An Apple-II type Elliptically Polarizing Undulator (EPU) for full control of the x-ray polarization

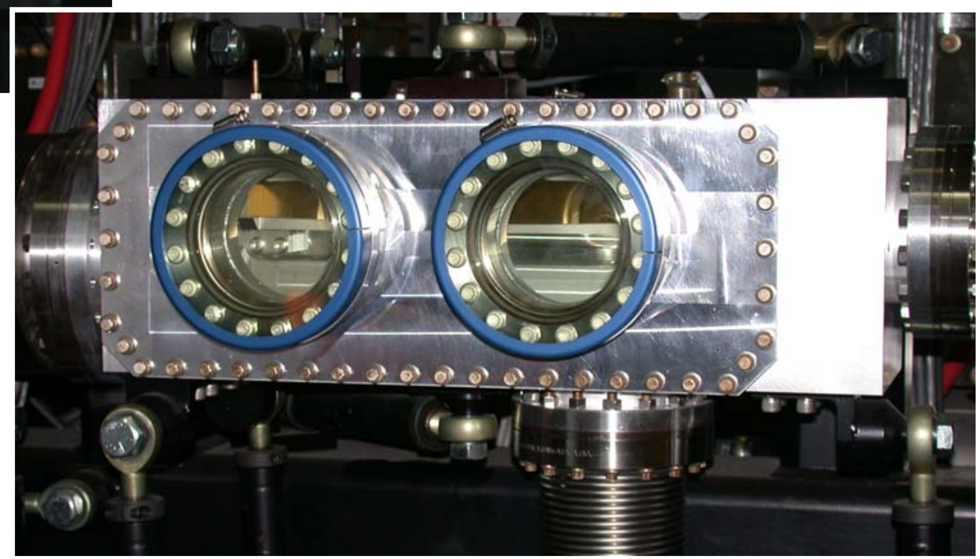


A Variable Line Space (VLS) grating design is used to produce moderate resolving power with a high efficiency

BL 11.0.1 features. . .



The optical design incorporates several bendable and retractable mirrors, yielding a beamline which can be used for both microscopy (PEEM) and ultrafast magnetization research.



Abalone Nacre

Rebecca Metzler, Dong Zhou, Mike Abrecht, Sue Coppersmith, and Pupa Gilbert

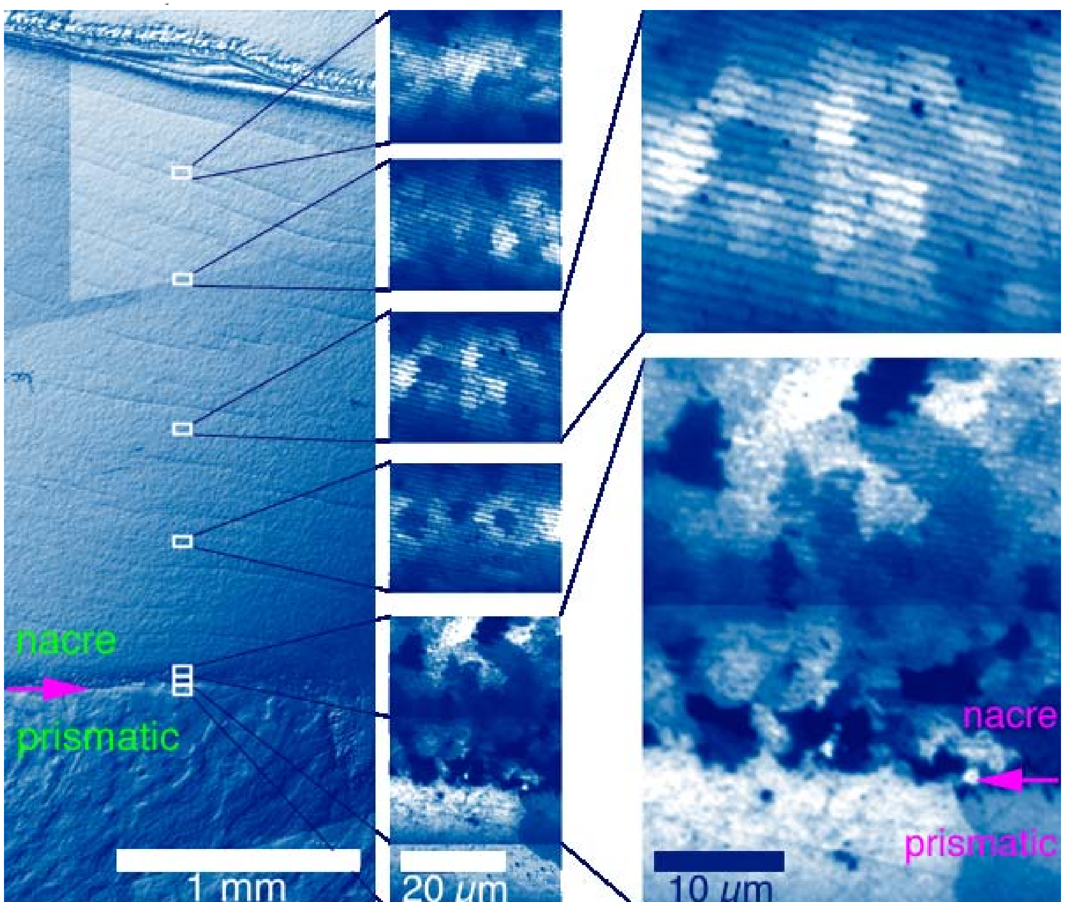
- 95% aragonite ($CaCO_3$), + 5% organic matrix
- 3000x more resistant to fracture than aragonite
- Open questions:
  - Nacre microarchitecture (how single-crystals are oriented with each other)
  - Nacre formation mechanism

Polarization-dependent Imaging Contrast (PIC) reveals new nacre architecture

PRL **98,** 268102 (2007) PHYSICAL REVIEW LETTERS week ending 29 JUNE 2007

Architecture of Columnar Nacre, and Implications for Its Formation Mechanism

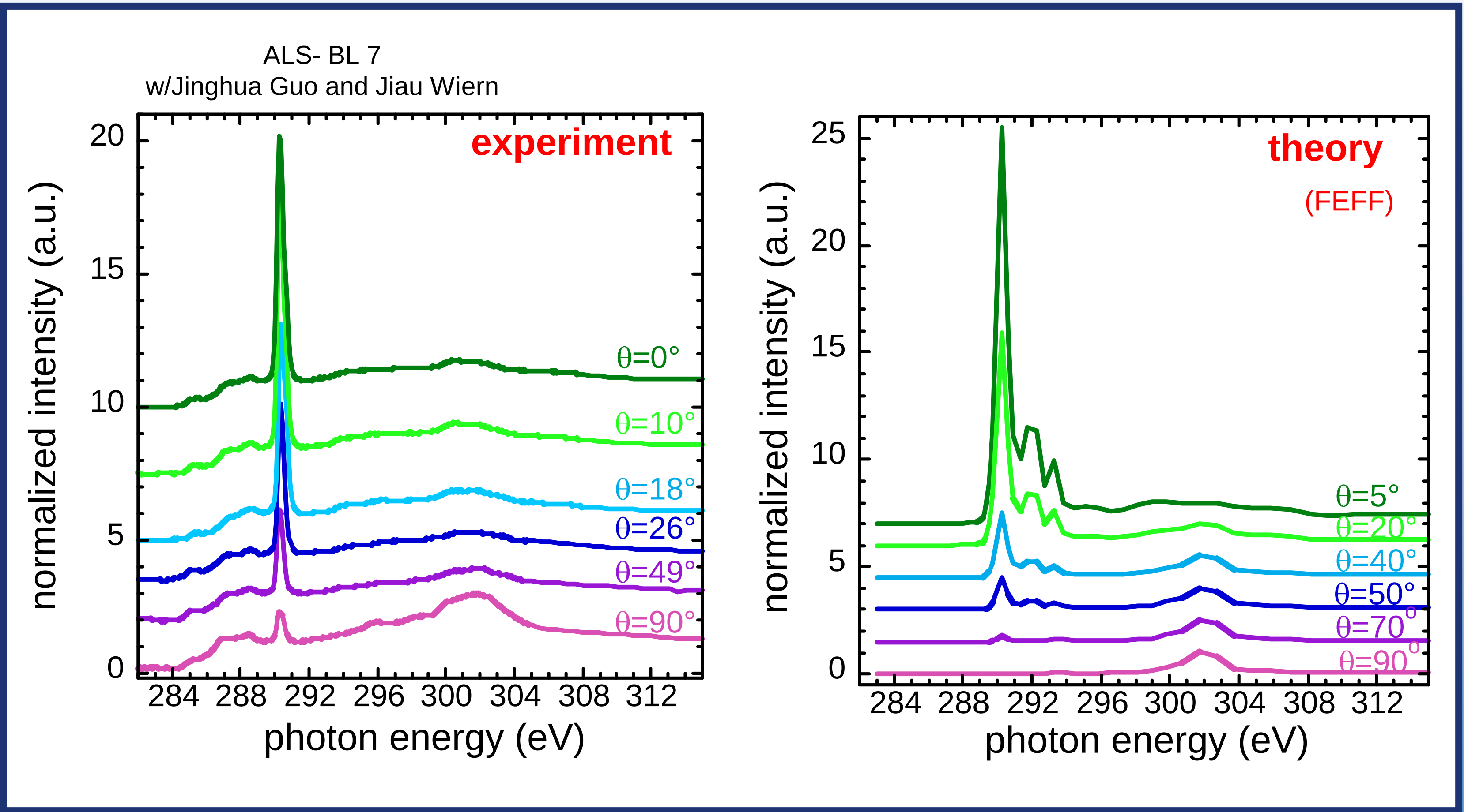
Rebecca A. Metzler,[1] Mike Abrecht,[2] Ronke M. Olabisi,[1] Daniel Ariosa,[3] Christopher J. Johnson,[4] Bradley H. Frazer,[2] Susan N. Coppersmith,[1] and P. U. P. A. Gilbert[1,*]



SRC
Home of Aladdin

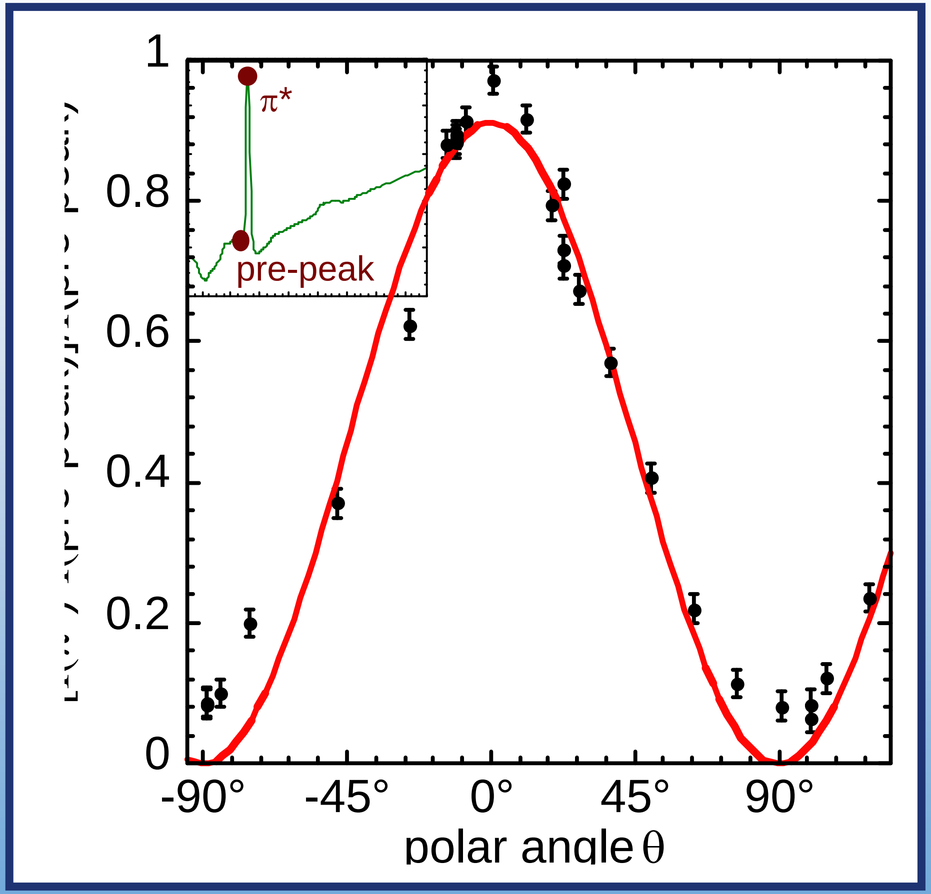
Origin of Polarization-dependent Imaging Contrast (PIC) confirmed in geologic aragonite single crystals

X-ray linear dichroism



RA Metzler, D Zhou......J. Guo, J. Wiern.....SN Coppersmith, PUPA Gilbert. submitted.

Polar dependence in aragonite single crystals

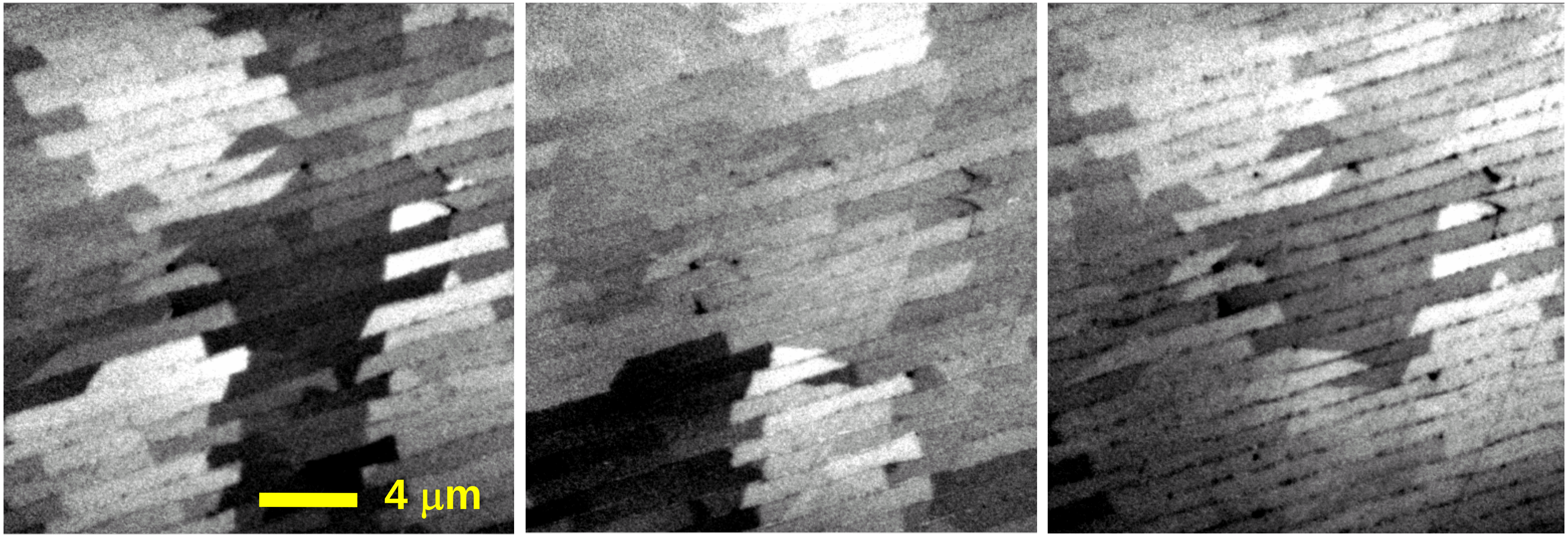


ALS- BL 7
w/Jinghua Guo and Jiau Wiern

RA Metzler, D Zhou......J. Guo, J. Wiern.....SN Coppersmith, PUPA Gilbert. submitted.

XLD Imaging Using an EPU

X-ray linear dichroism images at horizontal, vertical and diagonal polarization of cross-sections of nacre –mother-of-pearl



Rebecca Metzler, Dong Zhou, Mike Abrecht, Sue Coppersmith, and Pupa Gilbert

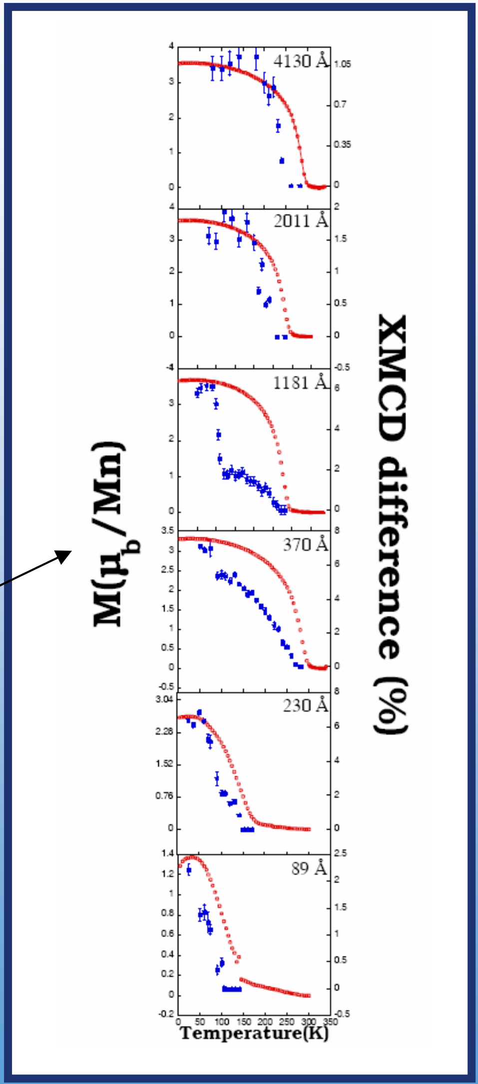
Magnetic Imaging of the Surface of Manganite Films: Exploring Surface Phase Separation

T. A. Tyson, M. A. Deleon (NJIT), C. Duborudieu (CNRS), A. Scholl and A. Doran (ALS)

- Motivation
- Manganites exhibit strong electron-spin-lattice coupling. In bulk samples, strain/pressure has been found to increase the insulator to metal transitions. Pressures beyond ~3 GPa leads to re-entrant low-temperature insulating behavior (Chen, Tyson *et al*.)
- Theoretical analysis has shown that Tc is extremely sensitive to biaxial strain – Tc reduction is quadratic in the JT distortion (Millis *et al*.). This suggest that strain can be used to probe the spin lattice coupling.
- In films samples, compression/tensile strain can be used to tune the magnetic anisotropy
- Low magnetization has been observed at the surface of manganite films
- To understand the effect of strain on the magnetic properties of manganites a range of films with thickness varying from 2.5 to 413 nm are being studied
- This research was funded by NSF DMR-0512196, NSF INT-0233316, and CNRS/NSF project No. 14550.

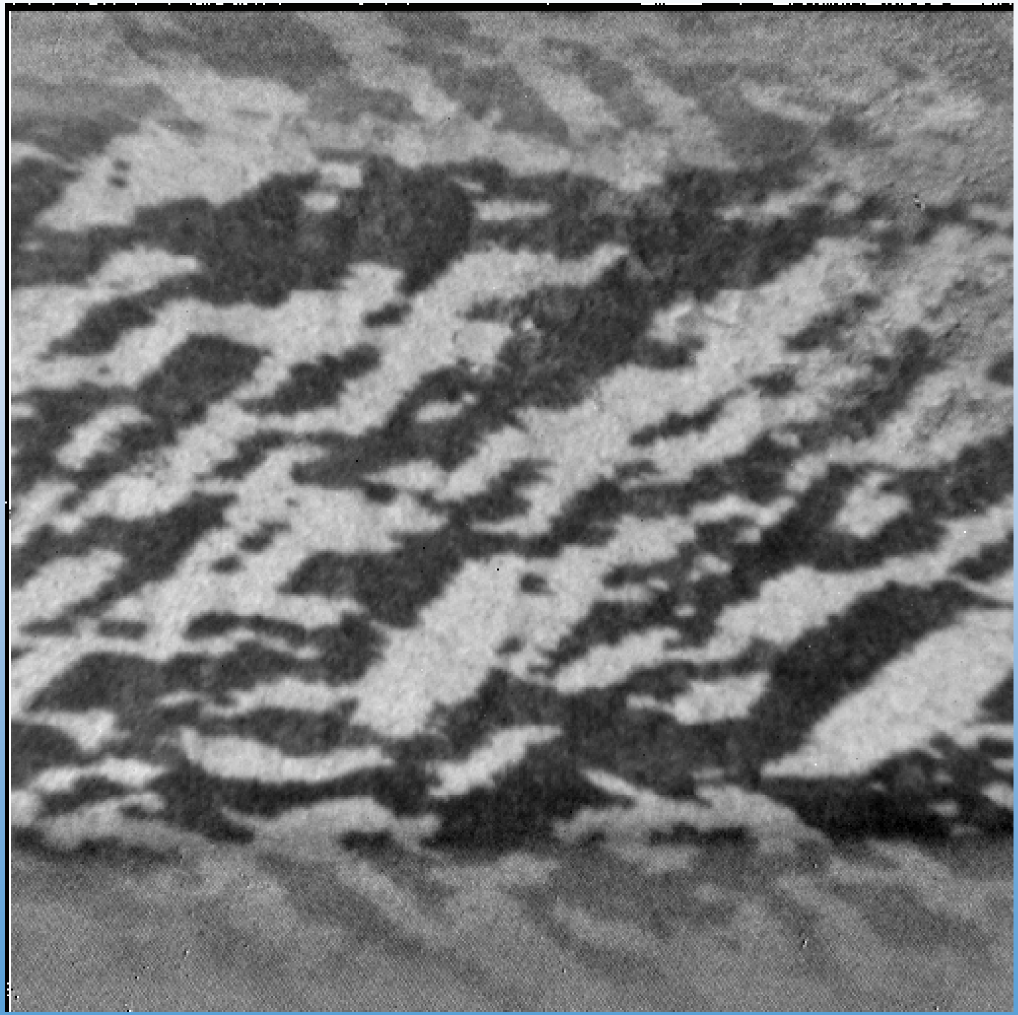
Temperature Dependence of Magnetic Moment in $La_{0.8}MnO_3$

- La_xMnO_3 is chemically simple
- Possesses the same magnetic, structural and transport properties of the classic $La_{1-x}Ca_xMnO_3$ (LCMO) system
- Theoretical bulk magnetization (left, red curves) is achieved at low temperature thick films
- Low surface magnetization (blue dots) observed by XMCD with large beams (U4B NSLS experiments)
- Bulk XMCD (dots) measurements reveal two phase behavior in 118nm (1181 Å) film. Position sensitive chemical analysis of film surface is needed.



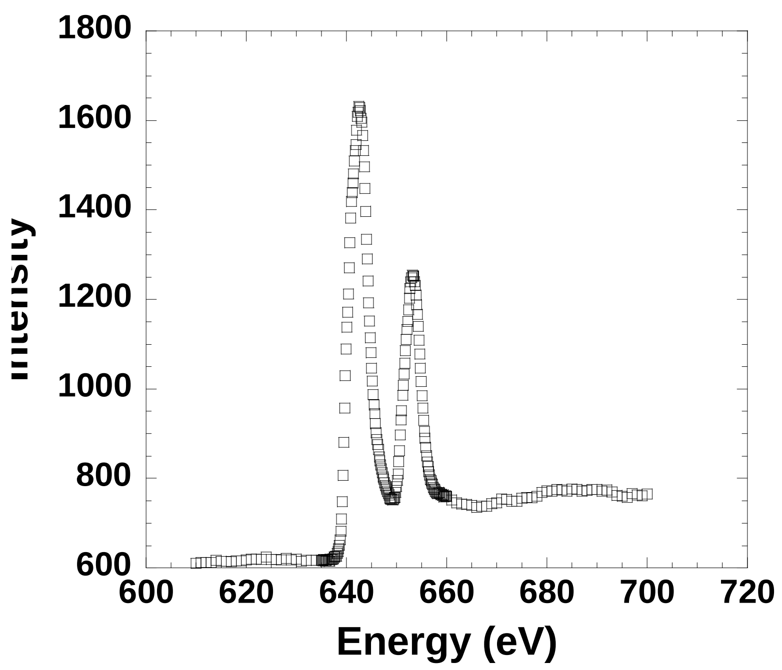
Magnetic Circular Dichroism Imaging Using an EPU

Magnetic Domains (Mn (L3/L2)) of 413nm La0.8MnO3 Film at 140K



Local Spectroscopy at Low Temperature

Mn L3/L2 Edge at 140K- Full Image Spectrum



O K-edge Edge at 140K- Full Image Spectrum