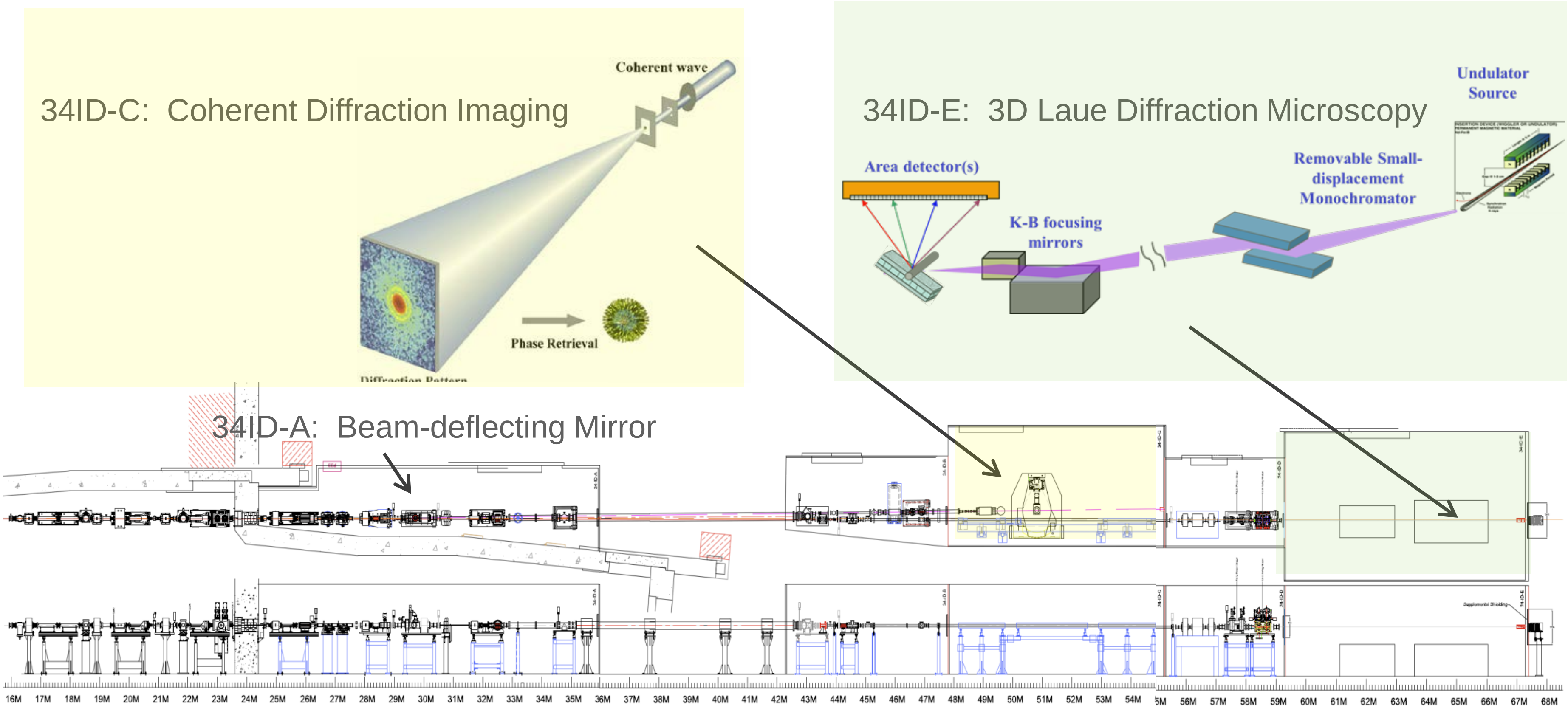
34-ID Canting Upgrade

23 September 2011

P. Zschack

X-Ray Science Division

34ID Experimental Programs



- *Each technique is brilliance limited*
- *Both experiments ran simultaneously (2000-2011), but shared the ID spectrum*
- *Limited GUP access – highly oversubscribed (by 2010-2, ~7x typical with 1.4 cutoff)*
- *Canting provides spectral independence & effectively doubles General User access*

34ID General User Demand & Oversubscription

Run Cycle	# Allocated	#BTRs	Ratio	Ave. Score (Awarded)	Ave. Score (Not Awarded)
2005-1	4	5	1.25	2.00	2.30
2005-2	5	9	1.80	1.90	1.98
2005-3	4	8	2.00	1.85	1.95
2006-1	7	10	1.43	1.83	1.94
2006-2	6	12	2.00	1.93	2.22
2006-3	3	14	4.67	1.57	1.76
2007-1	4	20	5.00	1.65	1.91
2007-2	6	19	3.17	1.58	1.93
2007-3	6	23	3.83	1.50	1.77
2008-1	5	27	5.40	1.40	1.77
2008-2	3	25	8.33	1.43	1.70
2008-3	3	30	10.00	1.37	1.76
2009-1	6	37	6.17	1.37	1.74
2009-2	9	37	4.11	1.37	1.78
2009-3	7	39	5.57	1.43	1.78
2010-1	8	39	4.88	1.39	1.76
2010-2	6	44	7.33	1.30	1.73
2010-3	6	40	6.67	1.27	1.77
2011-1	10	42	4.20	1.34	1.83
2011-2 (C+E)	10	36	3.60	1.47	1.86
2011-3 (C+E)	15	40	2.67	1.49	1.82
totals	133	556	4.18	1.54	1.86

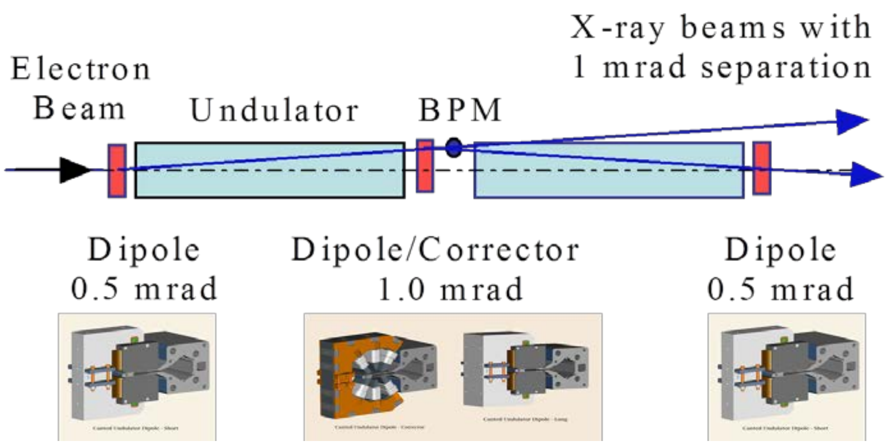
34-ID Canting Upgrade Timeline

- 2000: Sector 34 begins operations – shared undulator source
  (Designed to permit canting at future time)

- July 13, 2009: ARRA Funds ($3.6M) awarded for 3 FE canting proposals
- Sept 2009 – Aug 2010: Design and planning
- December 2010: Vacuum chamber replaced & shortened U33 installed
- May 2011: Canted front-end installed
- June 2011: Beamline reconfiguration completed
- June 16, 2011: First light from canted beamline(s)

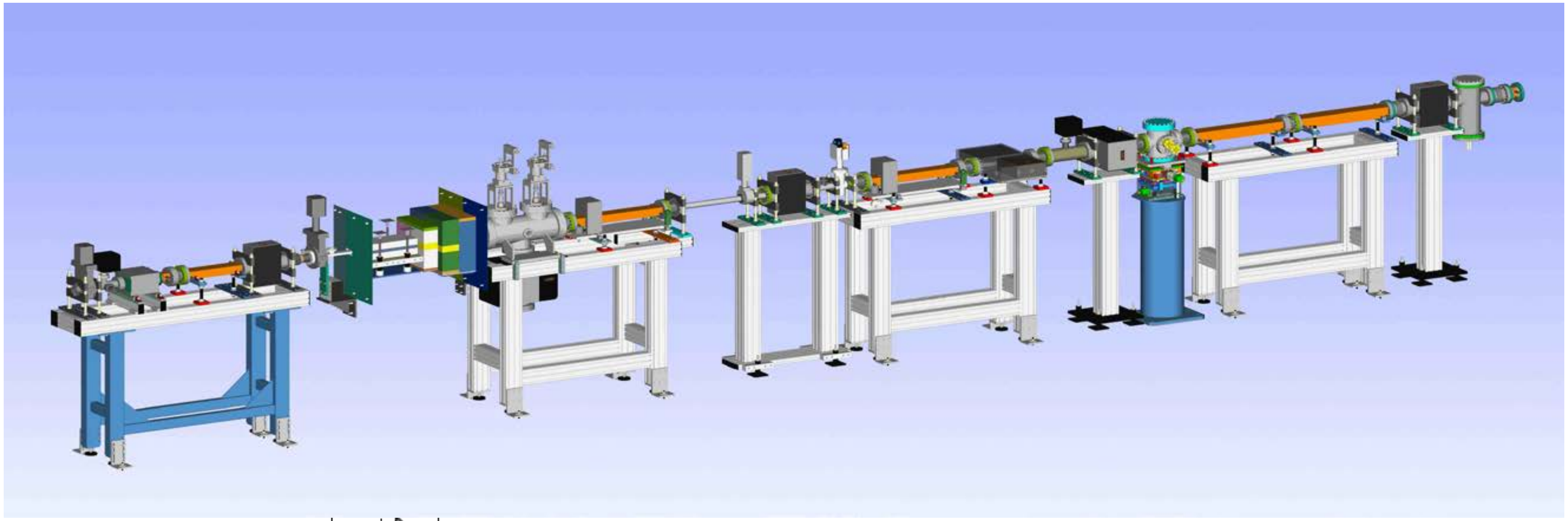
- July 13, 2011: Operations resume with General Users

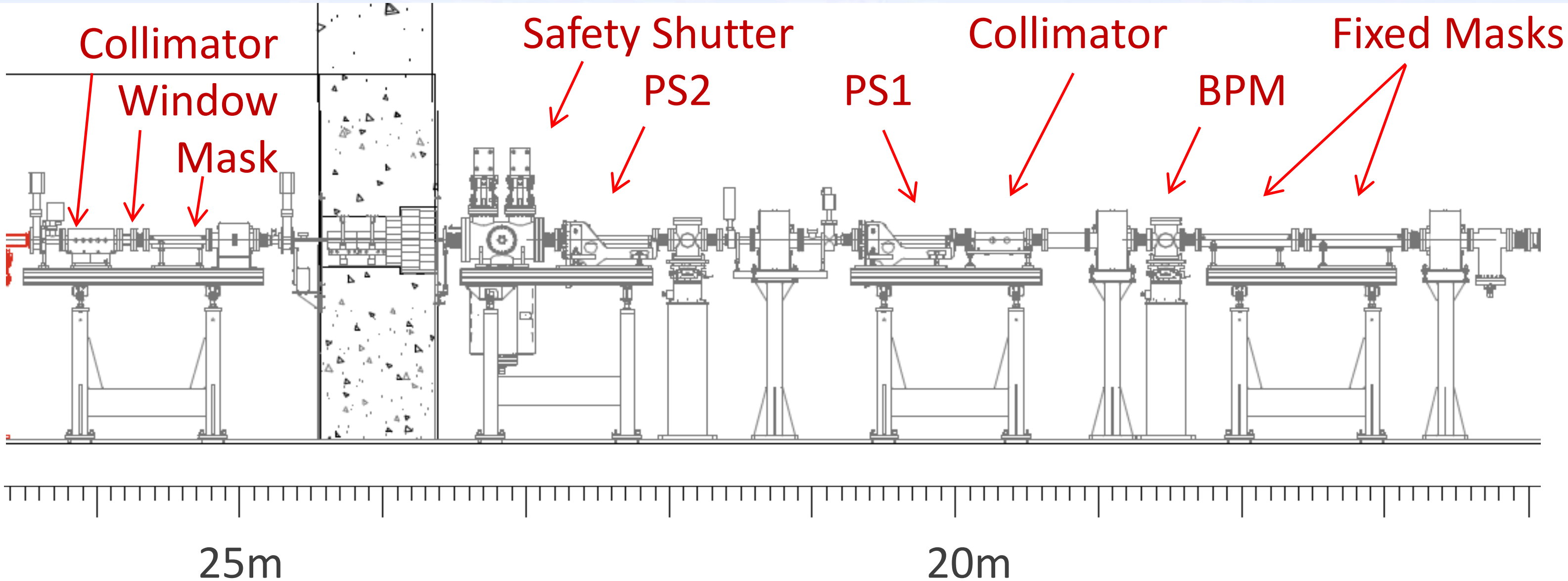
34ID Canted Geometry



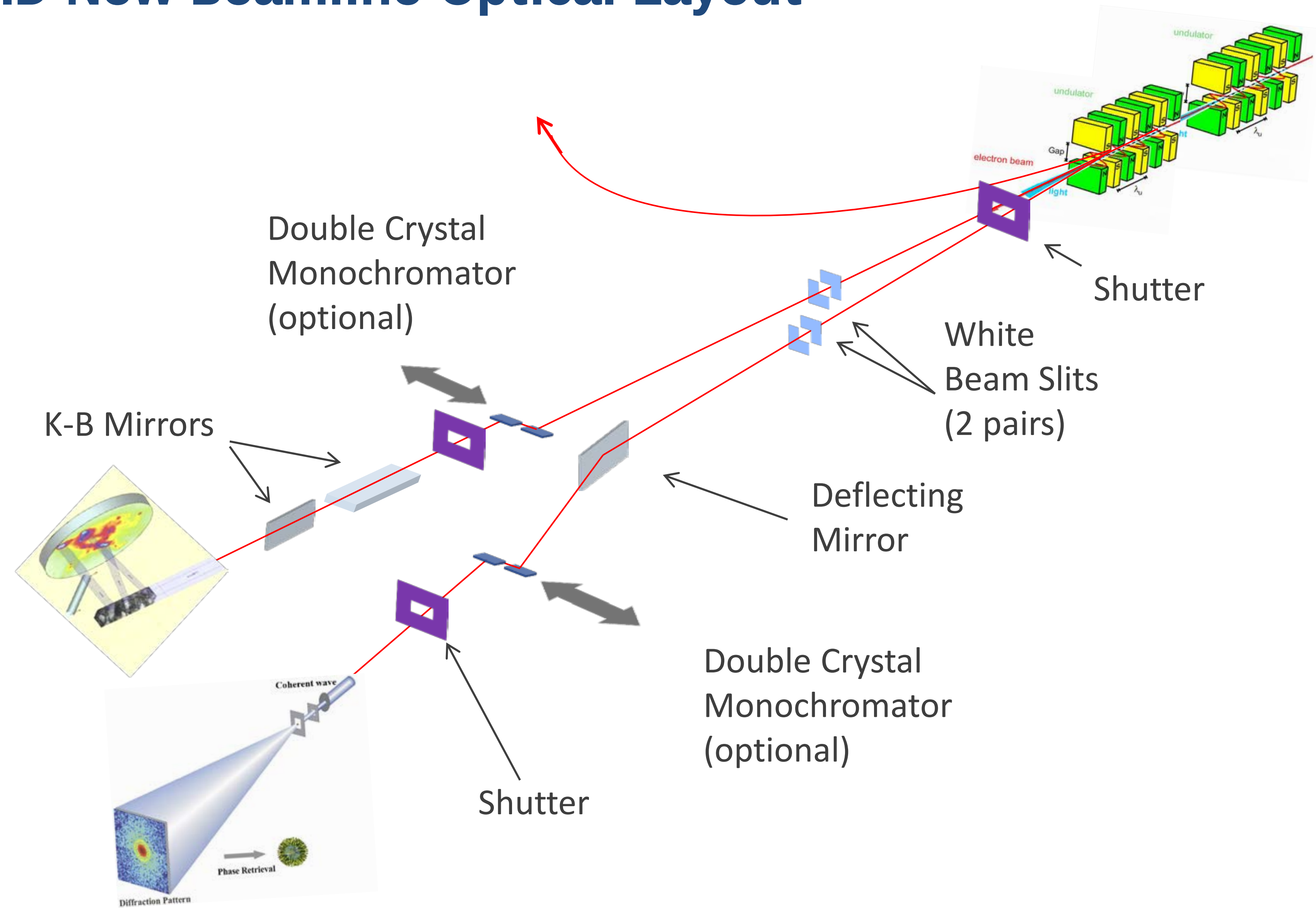
Maximum storage ring beam current	200 mA
Length of each undulator	2.07 m
Undulator period length λ	3.0 cm
Number of periods N	69
Undulator period length λ	3.3 cm
Number of periods N	62
Undulator minimum gap	10.5 mm
Corresponding deflection parameter K at min. gap	2.76
Horizontal beam size σ_x	352 μm
Vertical beam size σ_y	18.4 μm
Horizontal beam divergence σ_x	22 μrad
Vertical beam divergence σ_y	4.2 μrad
Total power emitted from each undulator	10.2 kw
Total power emitted from both undulators	20.4 kw
Peak power density at normal incidence	281 kw/mrad^2

34ID Front End Configuration



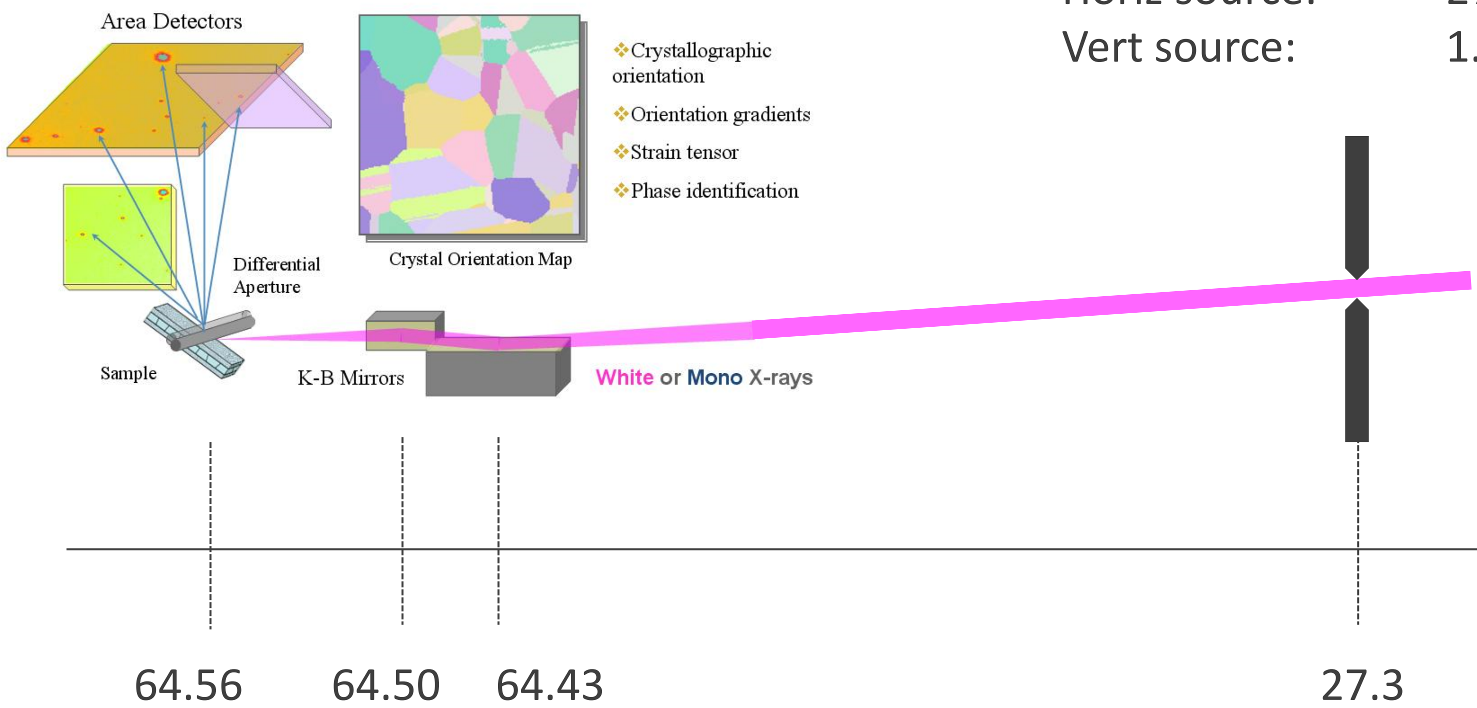


34ID New Beamline Optical Layout



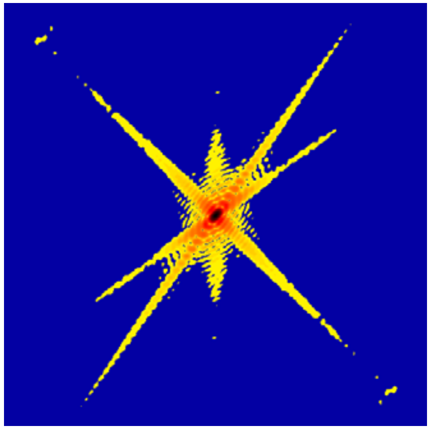
34ID-E Experiment Layout

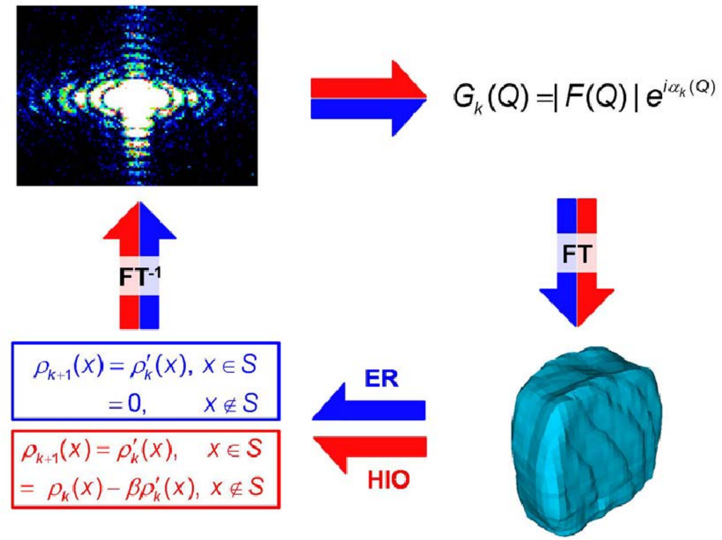
Energy Range: 7 – 30 KeV
Horiz source: 27.3 m
Vert source: 1.2 m



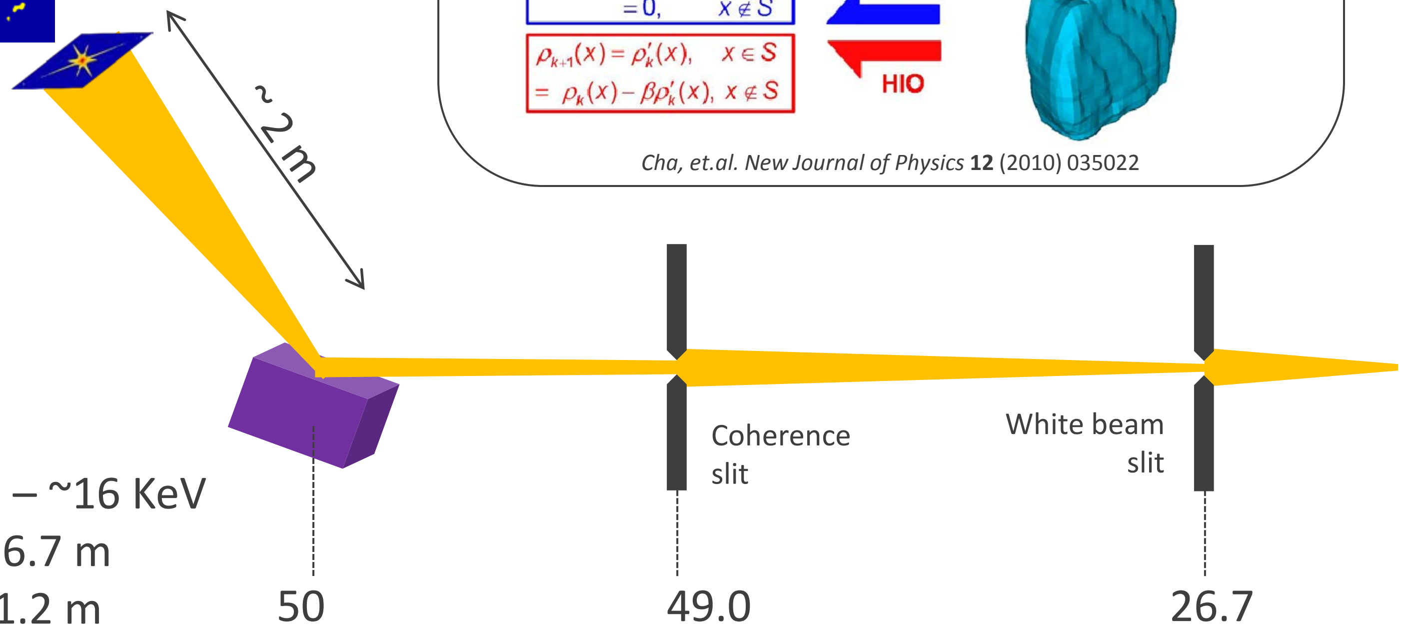
Demag		Resolution				Flux Density	
Vertical	Horizontal	Transverse	Depth	Angular	Strain	White	Mono
496	620	300 nm	500 nm	0.01	1.0E-04	1.0E+13	1.0E+11

34ID-C Experiment Layout



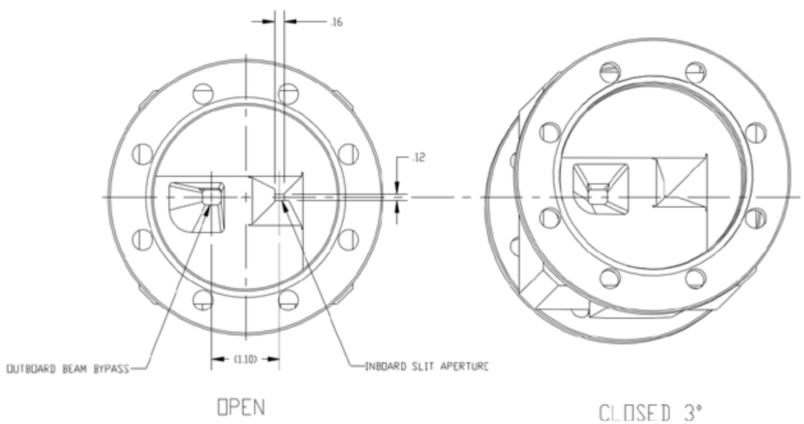


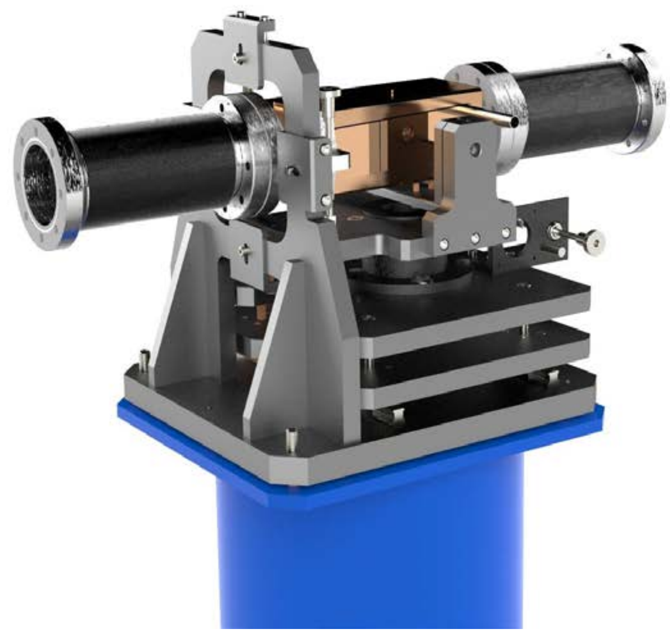
Cha, et.al. New Journal of Physics **12** (2010) 035022

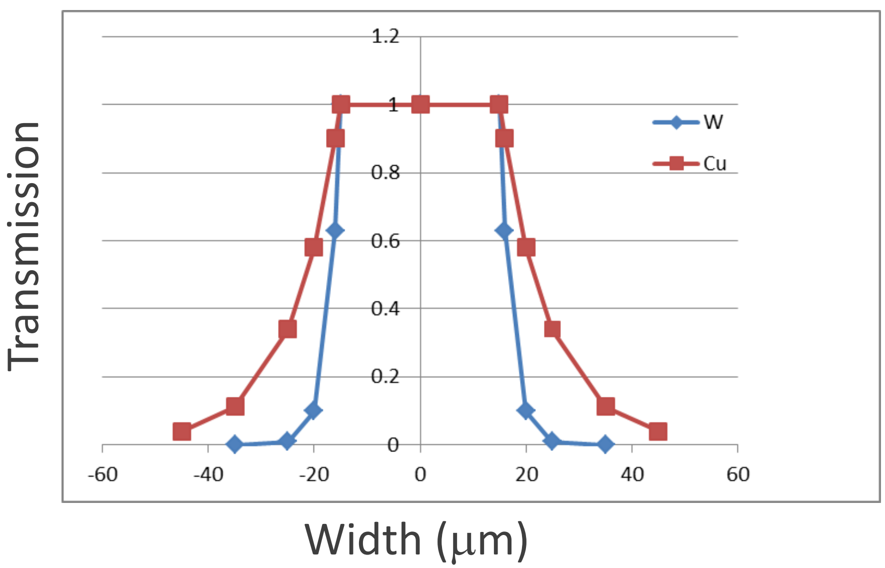


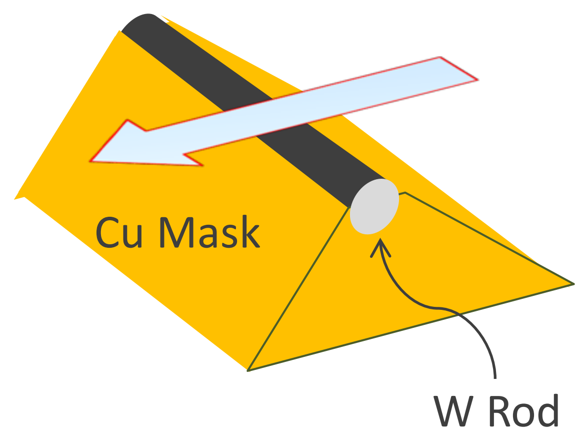
Energy Range: 5 – ~16 KeV
Horiz source: 26.7 m
Vert source: -1.2 m

34-ID White Beam Slits









Beam Line Upgrade Modifications

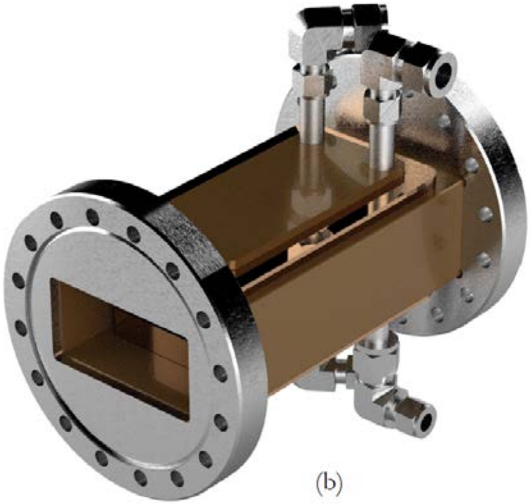
- 3.3 cm Undulator in upstream section – 3D Laue Diffraction Microscopy
- 3.0 cm Undulator in downstream section – Coherent Diffraction Imaging

- New Front-end Mask – Canted Geometry
- New Front-end Collimator – Canted Geometry
- New Window termination of Front-end

- New Beamline Masks
- New Beamline Collimators
- Shielding modifications

- White Beam Slit Assemblies for each Branch Line
  - W source-defining edge
- New Mirror with white-beam aperture

- Beamline realignment to +/- 0.5 mRad



(b)

Sector 34 VC & IDs:	$222K
Sector 34 canted front end:	$575K
Sector 34 beamline components:	$250K
Sub-total – Sector 34:	$1.047M

Photo Gallery

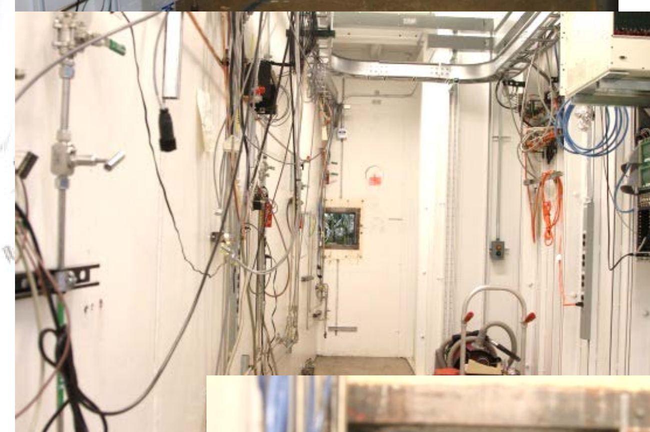
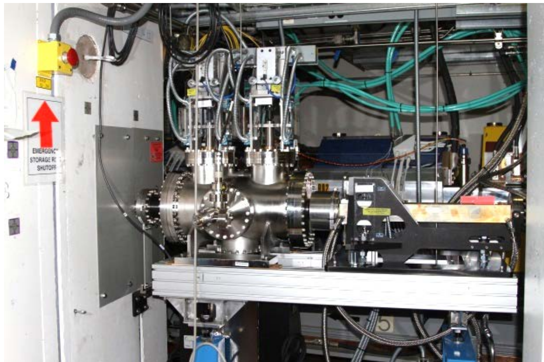
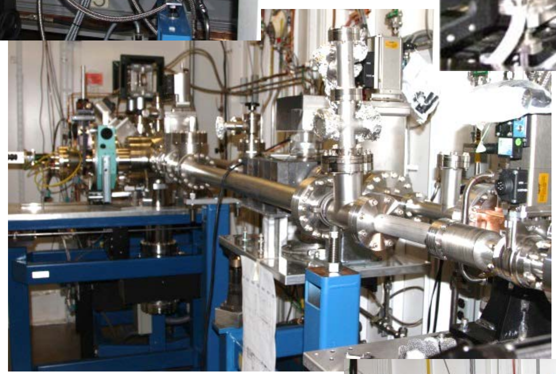


Photo Gallery





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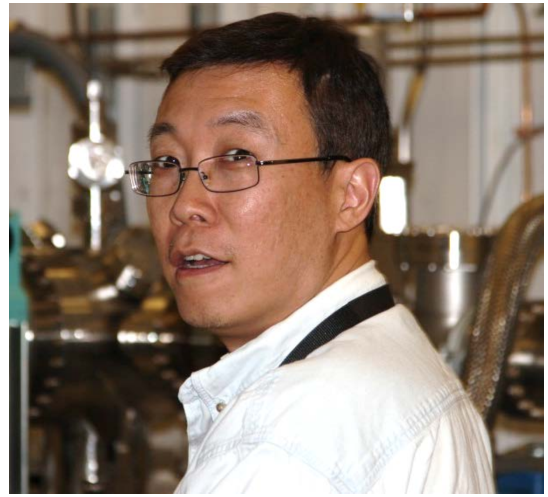
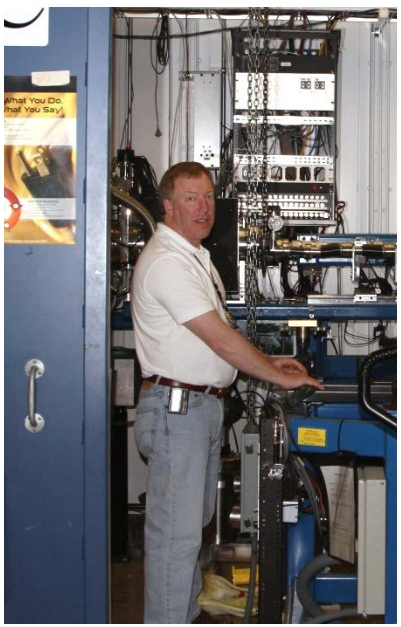
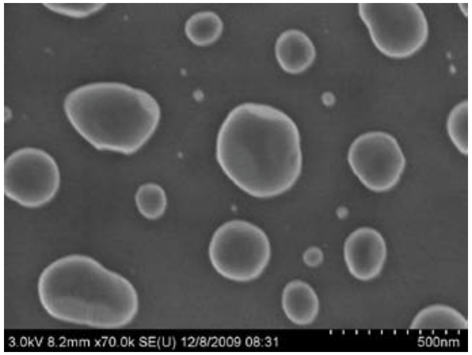




Expanded Opportunities for 34-ID-C

In-situ characterization

- Structural response to chemical reactions during in-situ catalysis
- Decomposition of semiconductors in contact with noble metals
- Alloying and dealloying at high temperature
- Electrochemical response of nanoporous materials
- Mechanical response to strain at nanometer length scales

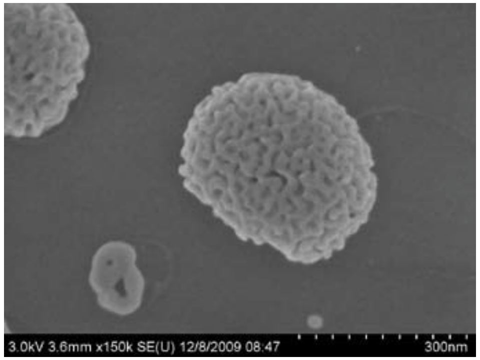


Condensed matter

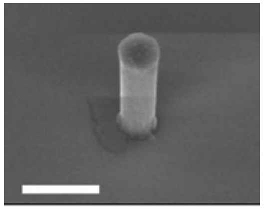
- Domain wall structure and transport in complex oxides
- Phase transitions vs temperature, magnetic field, pressure
- Faults, defects, and strain in nanocrystals, nanorods, and nanowires

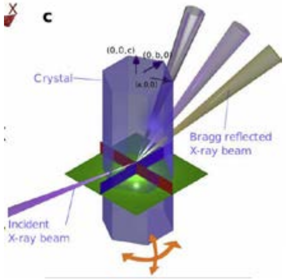
Biomaterials

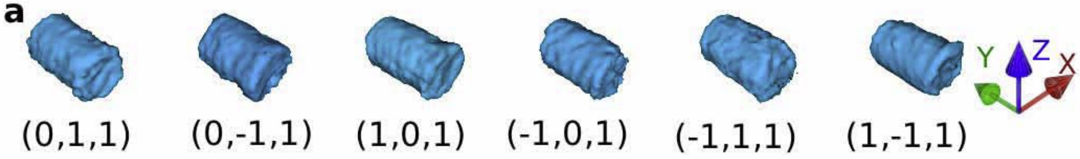
- Nanocrystalline order in cellulose, plant cell walls
- Biomineralization and ordering in collagen and bone



AgAu nanocrystals





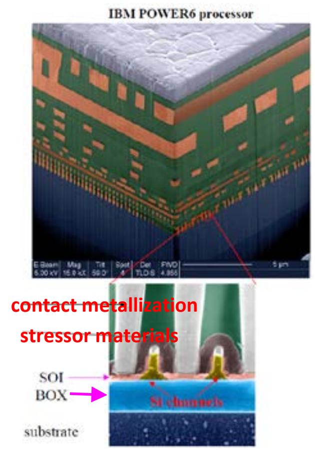


Newton, et.al., Nature Materials **9,** 120–124 (2009)

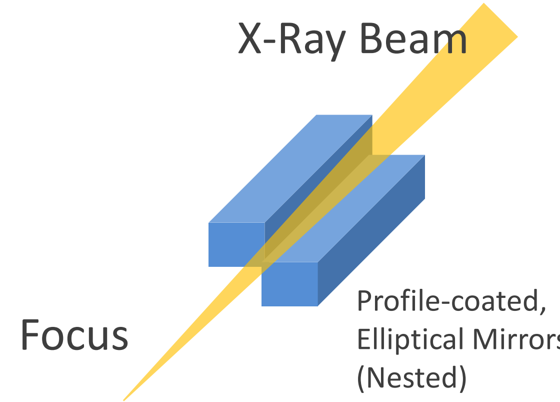
Expanded Opportunities for 34-ID-E

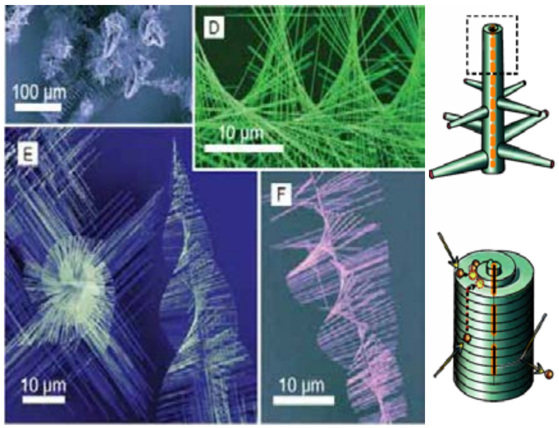
Mechanical Properties
- Deformation
- Composites
- Grain Growth

Semiconductor technologies
- Strain localization
- Electromigration
- Whisker growth



Condensed matter physics
- Complex oxides – phase separation
- Correlated electron materials
- Metal-Insulator transition
- Ferroelectric Domains

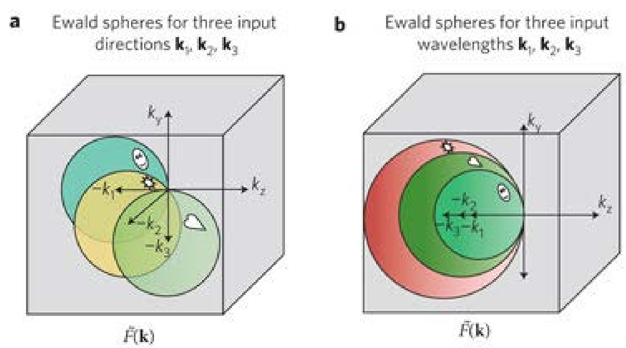




High pressure studies, Geophysics

Nanostructured Materials Crystallography
- Individual free standing
- Embedded – active elements

Chemistry – Corrosion, Catalysis



Tim D. Gerke & Rafael Piestun, Nature Photonics 4, 188 - 193 (2010)

Thanks...