Argonne NATIONAL LABORATORY

Development of a Hard X-ray Beam Position Monitor for Insertion Device Beams at the APS

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Office of Science
U.S. DEPARTMENT OF ENERGY

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- Advanced Photon Source Beam Stability Goals
- Present Level of Performance
- Hard X-ray Beam Position Monitor Design
- First Results, Future Plans

Advanced Photon Source Beam Stability Goals

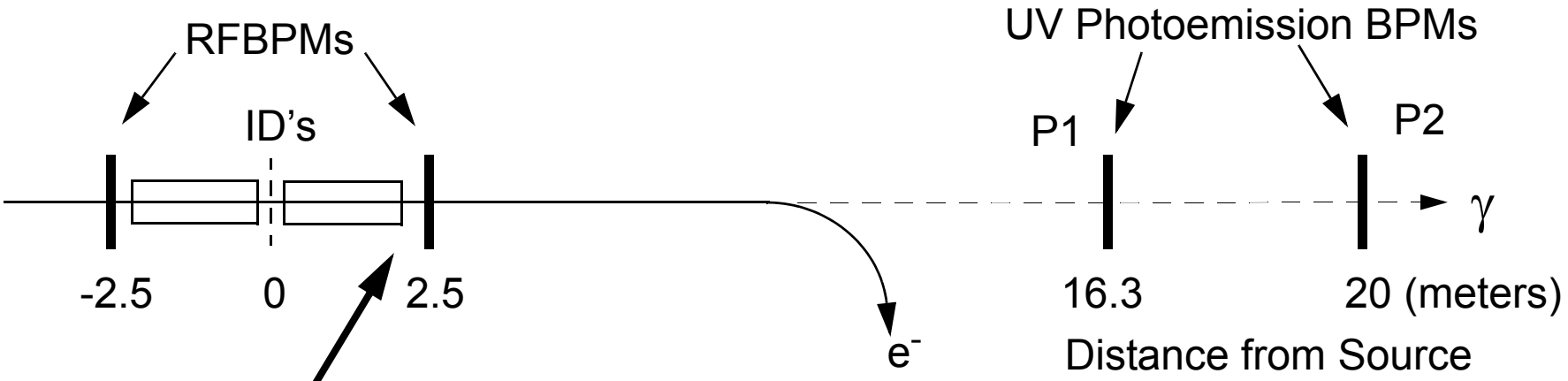
AC goals
(based on 5% of present APS beam size, 0.017 Hz to 200Hz)

	Displacement (microns rms)	Angle (nanoradians rms)
Vertical	0.42	220
Horizontal	3.0	530

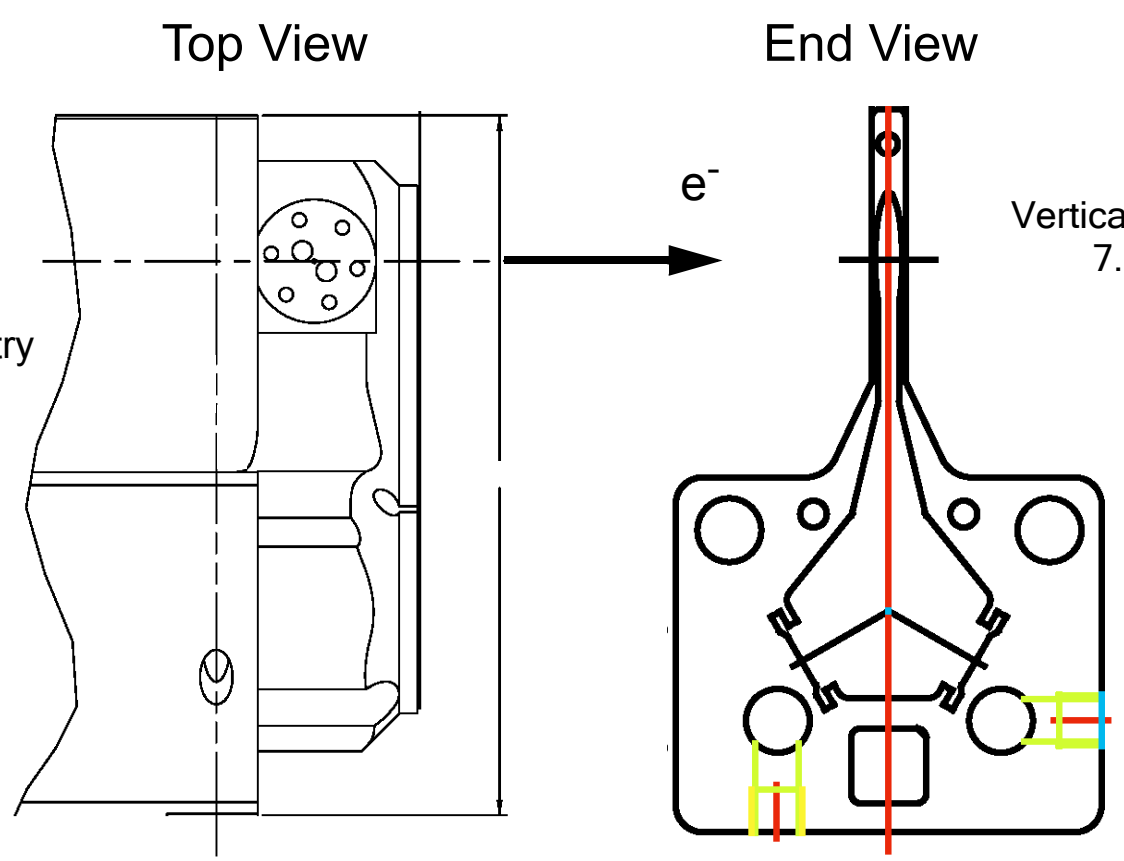
One week drift specification

	Displacement (microns p-p)	Angle (nanoradians p-p)
Vertical	1.0	500
Horizontal	5.0	1000

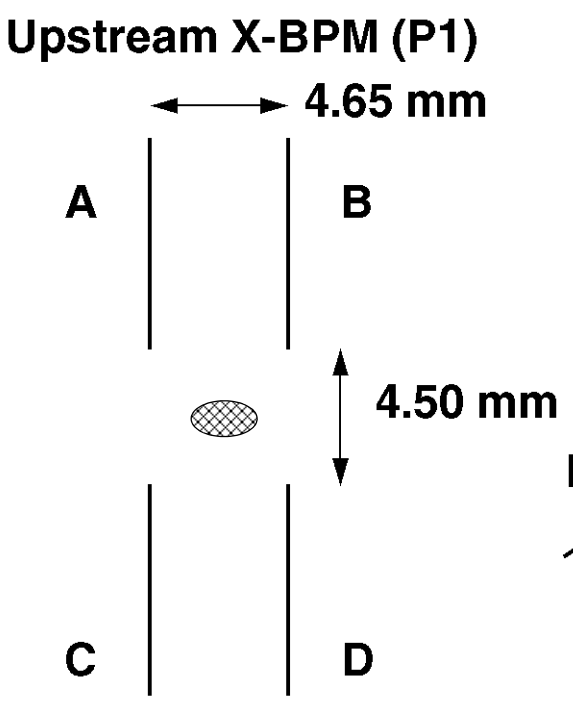
Existing Insertion Device and BPM Layout

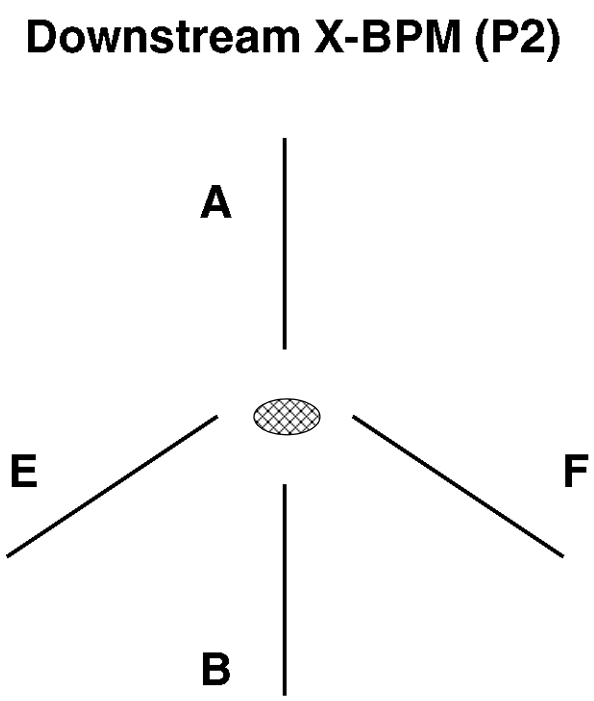


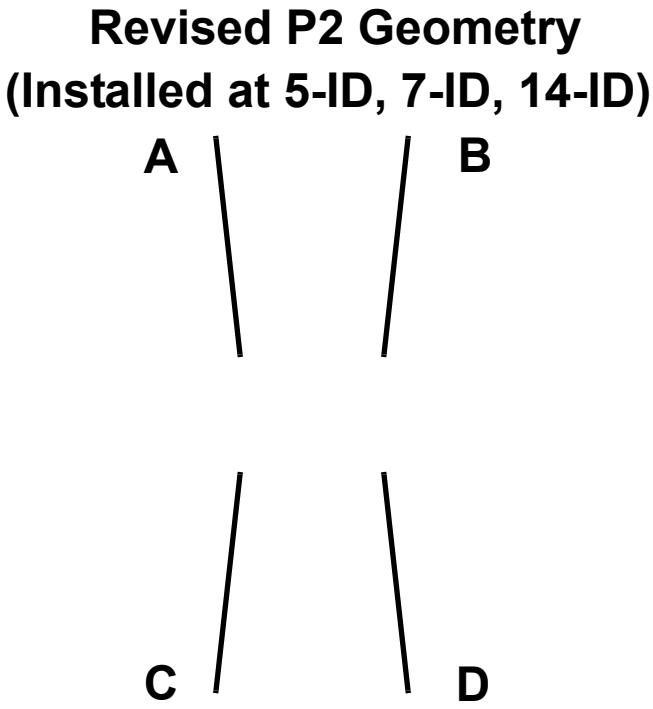
Detail of RF BPM
Pickup Electrode Geometry
4 mm Diameter, rotated

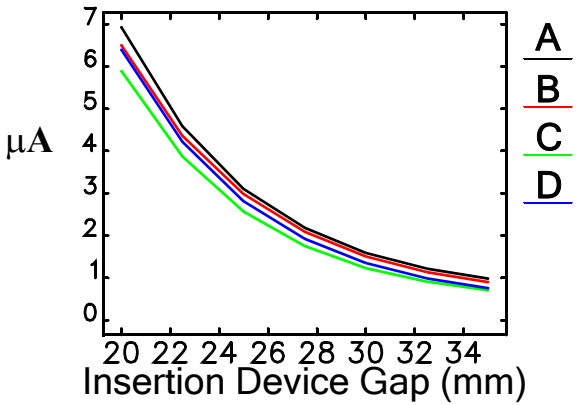


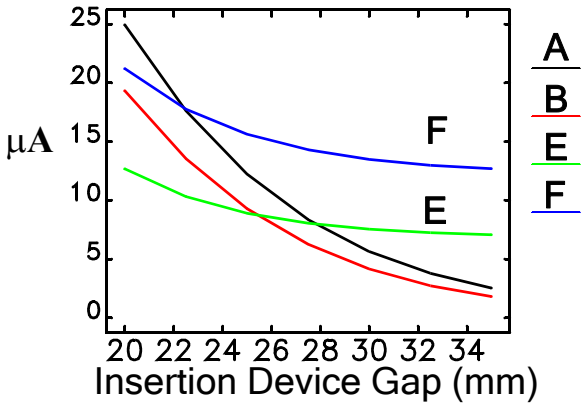
Insertion Device Ultraviolet Photon Beam Position Monitor Blade Geometries

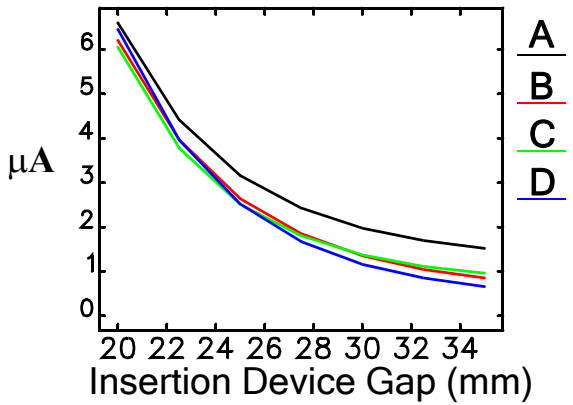






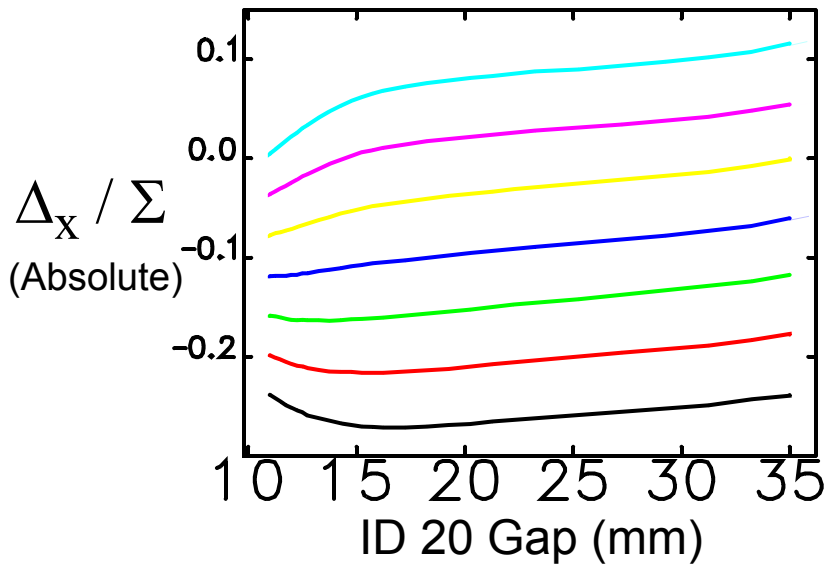




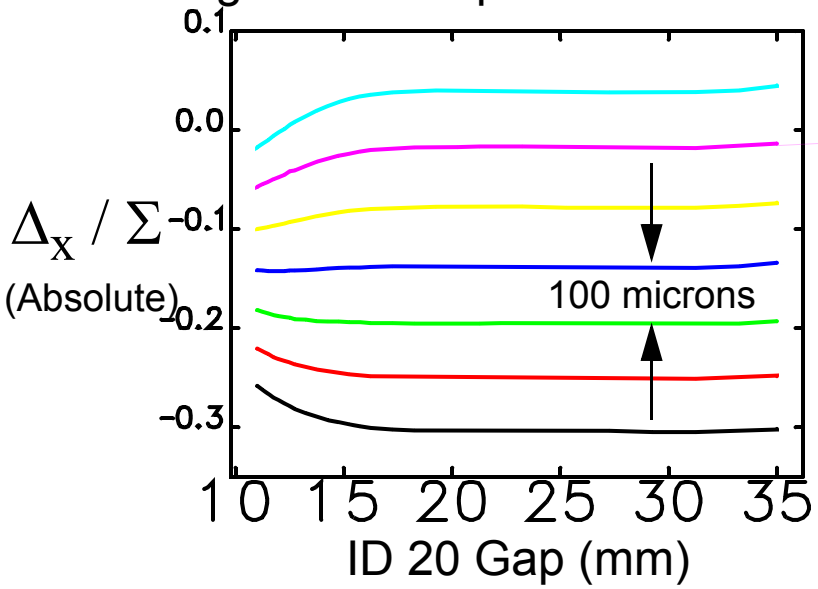


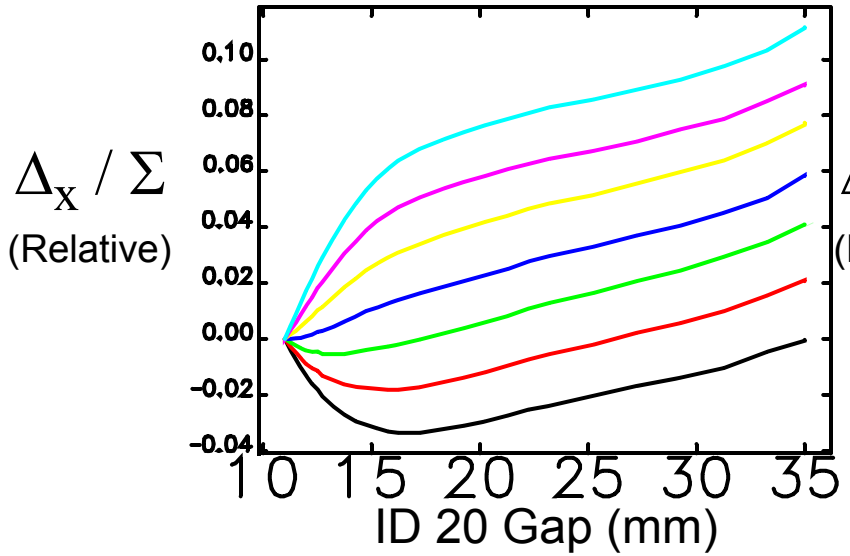
Correction of Residual ID Photon BPM Gap-dependent Systematic Errors

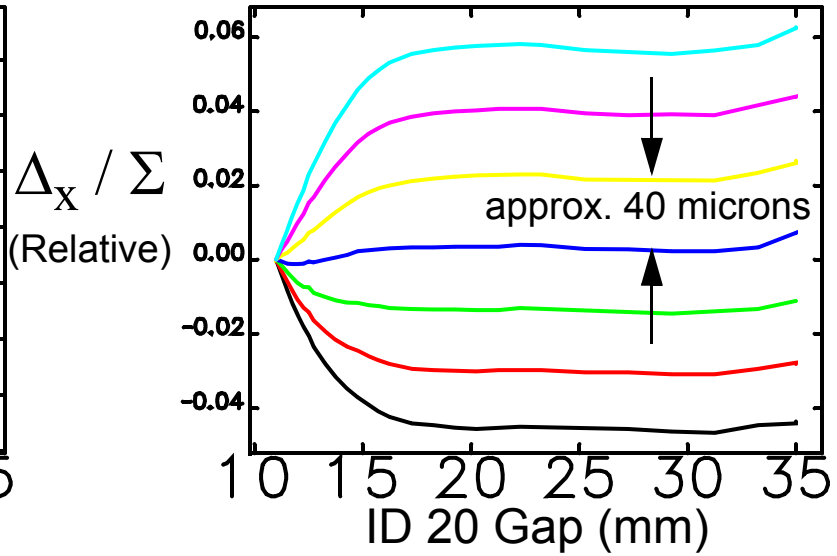
Background Subtraction Only



Background + Exponent Corrections







APS AC Pointing Stability, c.2005

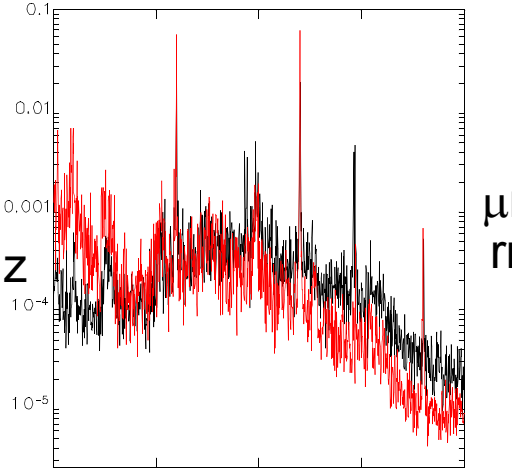
Power Spectral Density

Sqrt[Integ[PSD]]

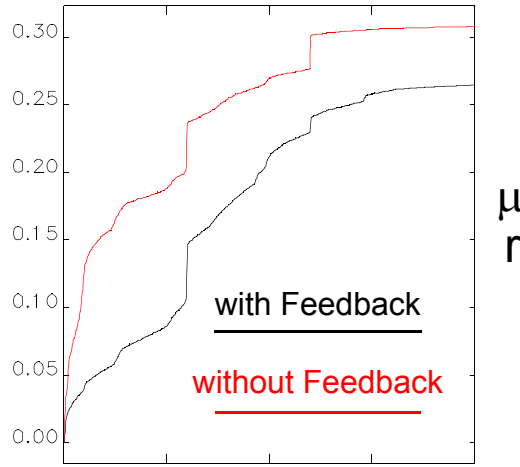
Sqrt[ReverseInteg[PSD]]

Horz.

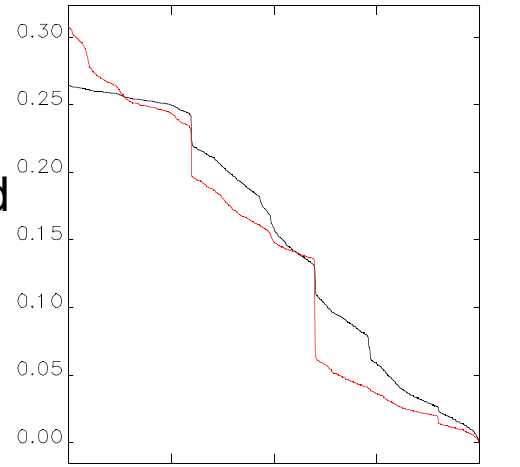
$\mu rad^2/Hz$



μrad rms

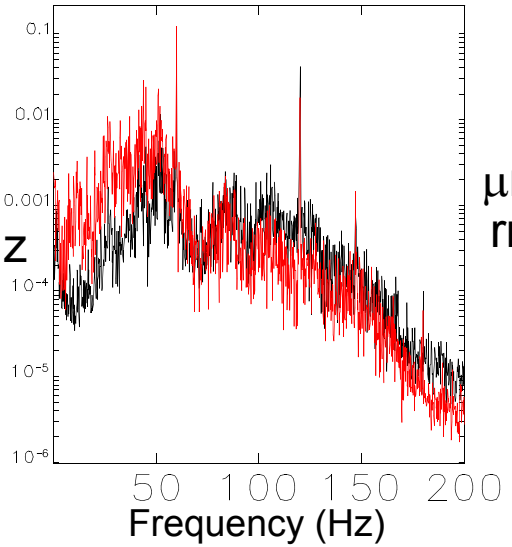


μrad rms

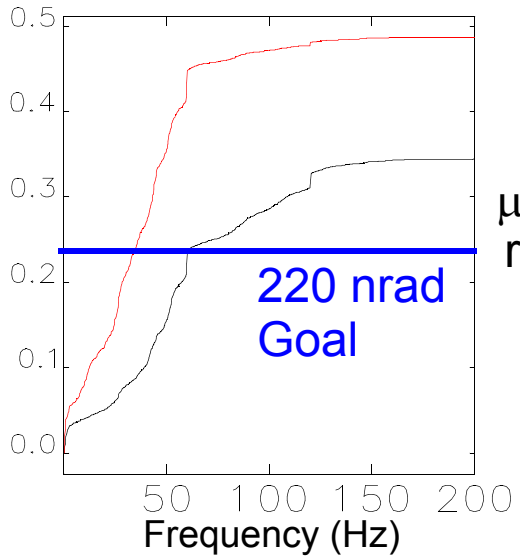


Vert.

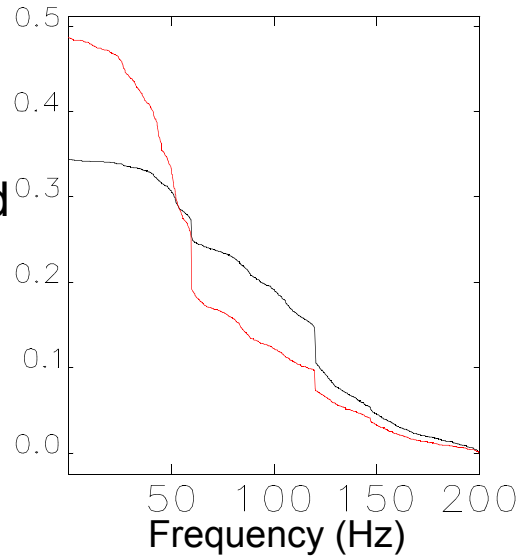
$\mu rad^2/Hz$



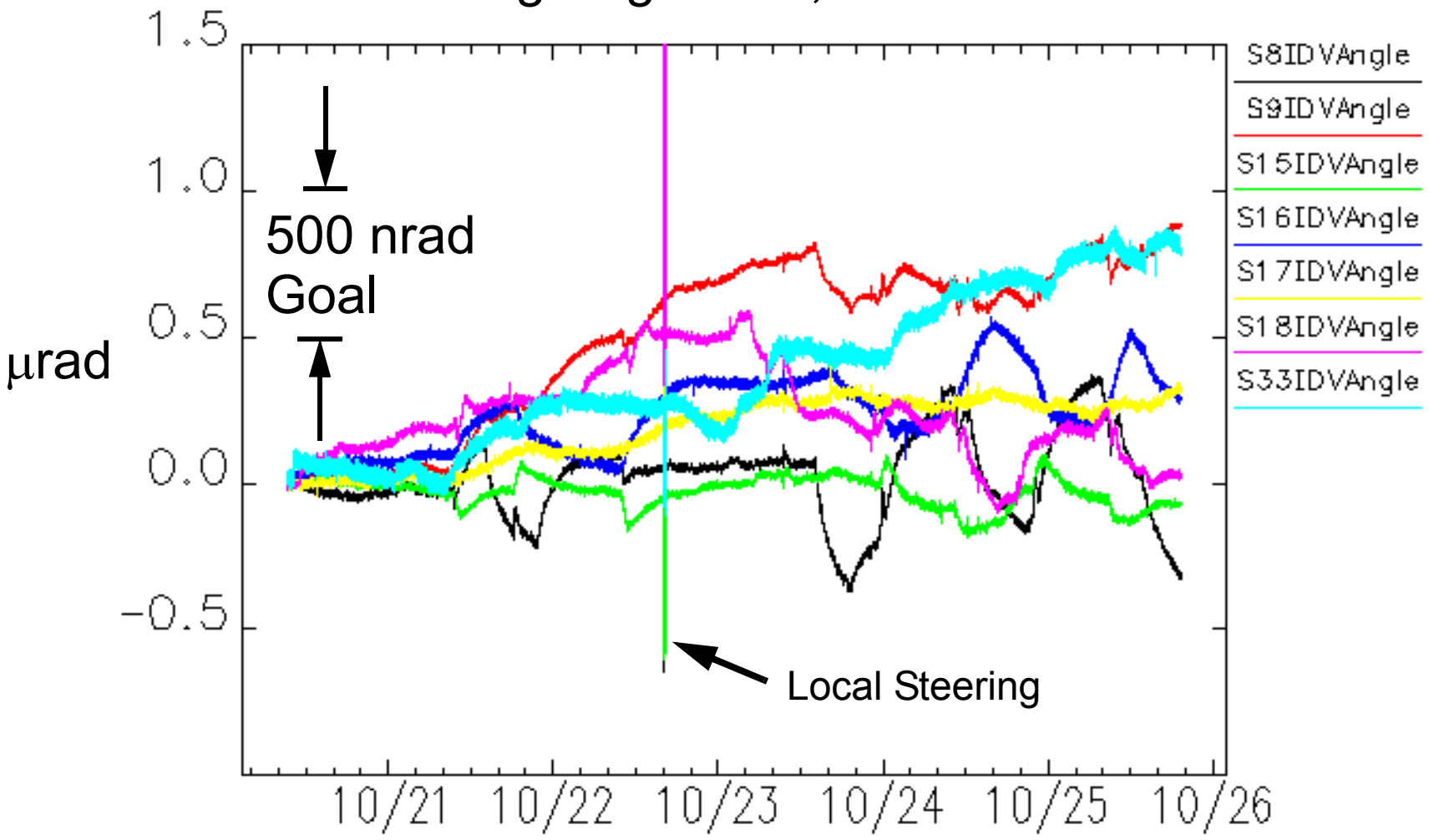
μrad rms



μrad rms

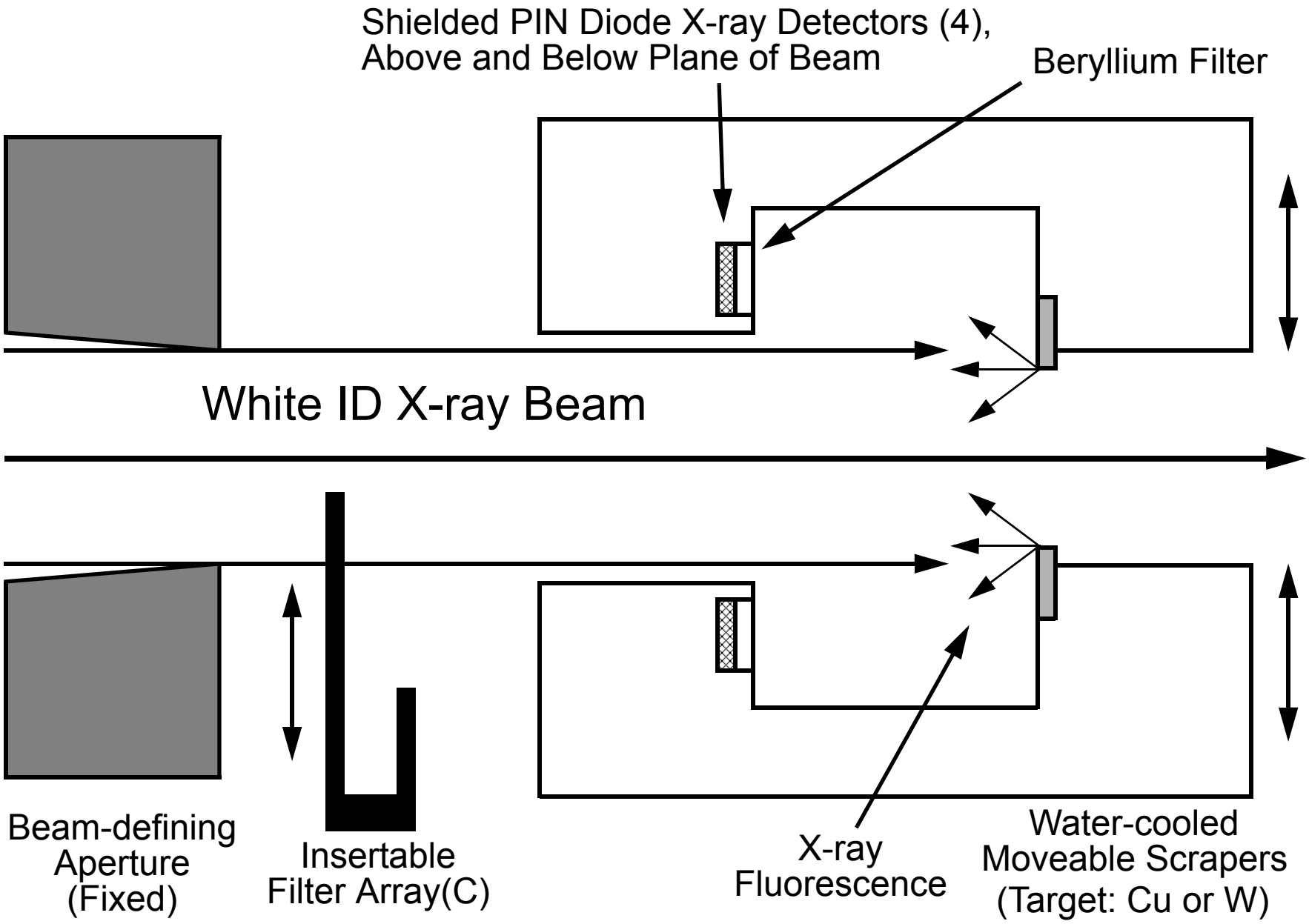


Pointing Angle Drift, One Week*



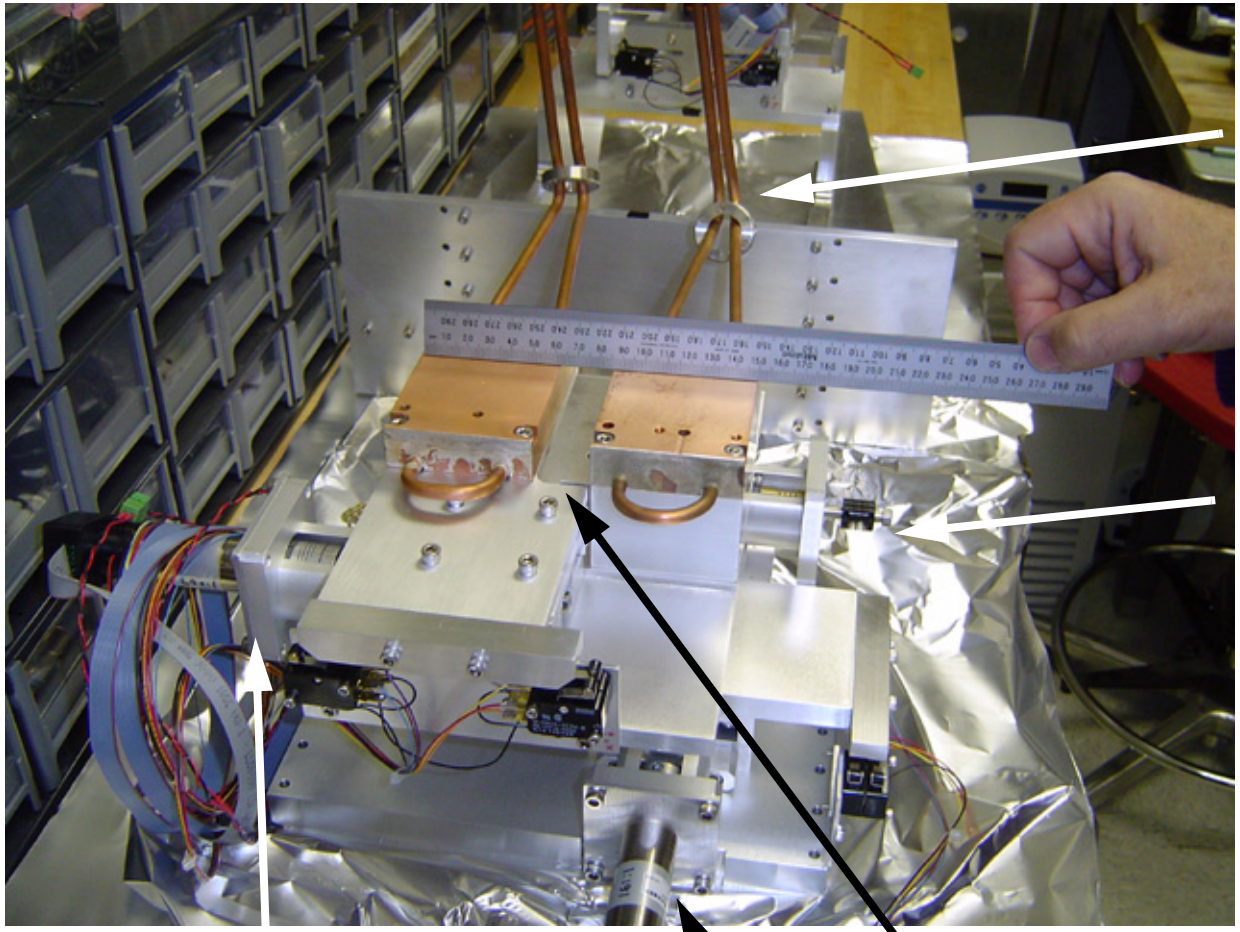
*Pointing Angles derived from UV photon bpms,
fixed gap operation

Plan View of Hard X-ray Beam Position Monitor Concept

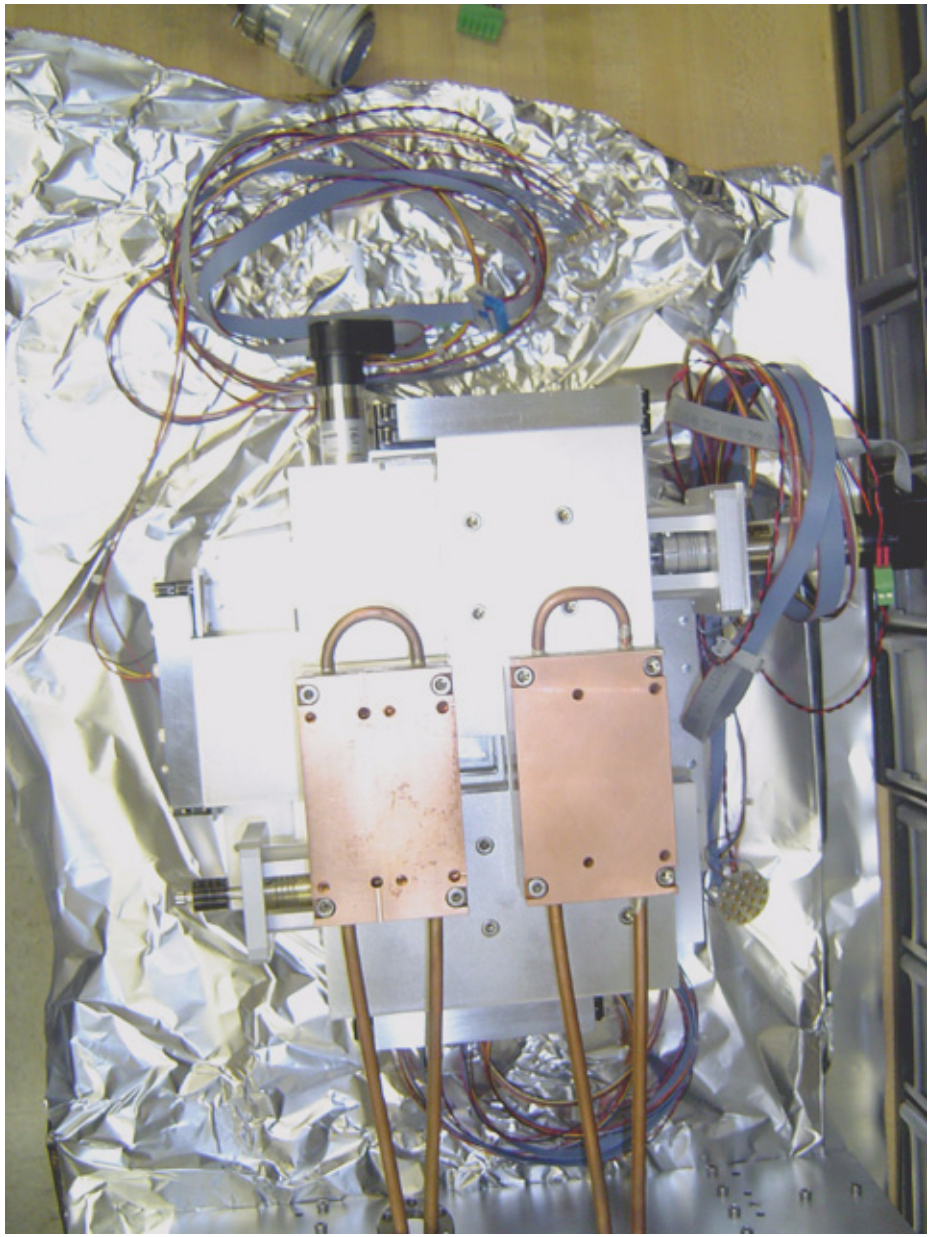


Early Assembly of First Hard XBPM Prototype

"Top View"



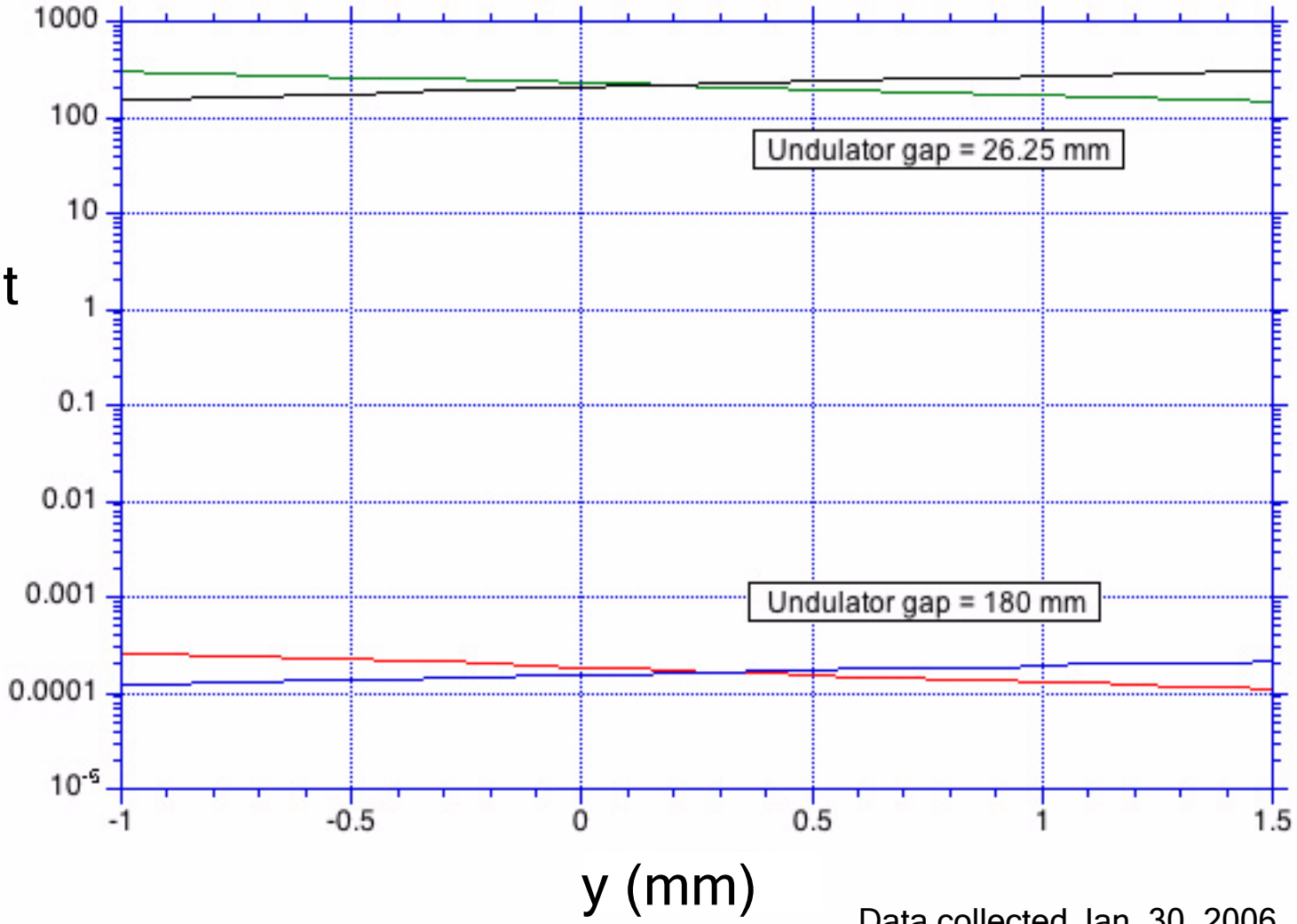
View along beam direction



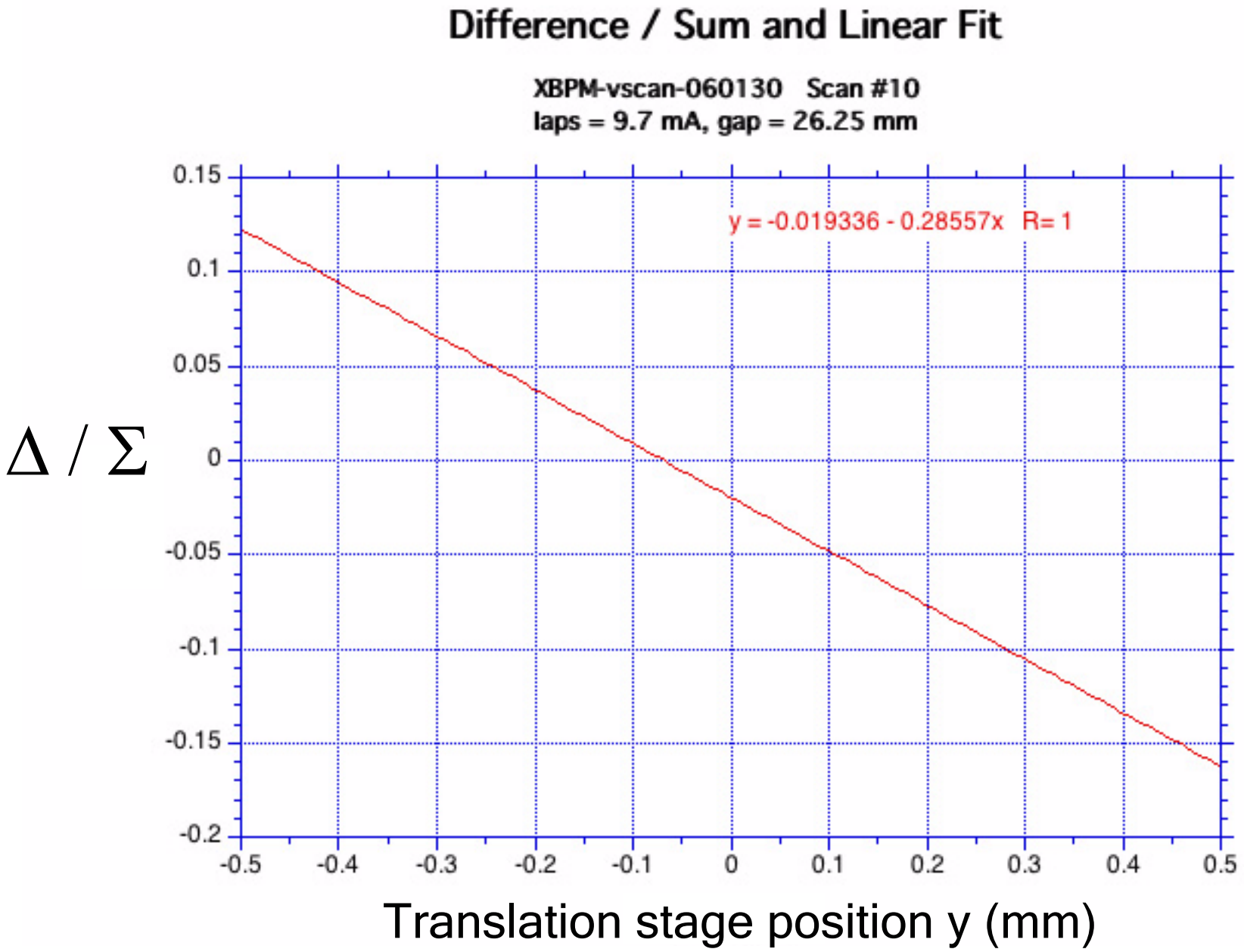
Vertical direction, “Up”

Outboard Direction,
away from the center of the
storage ring

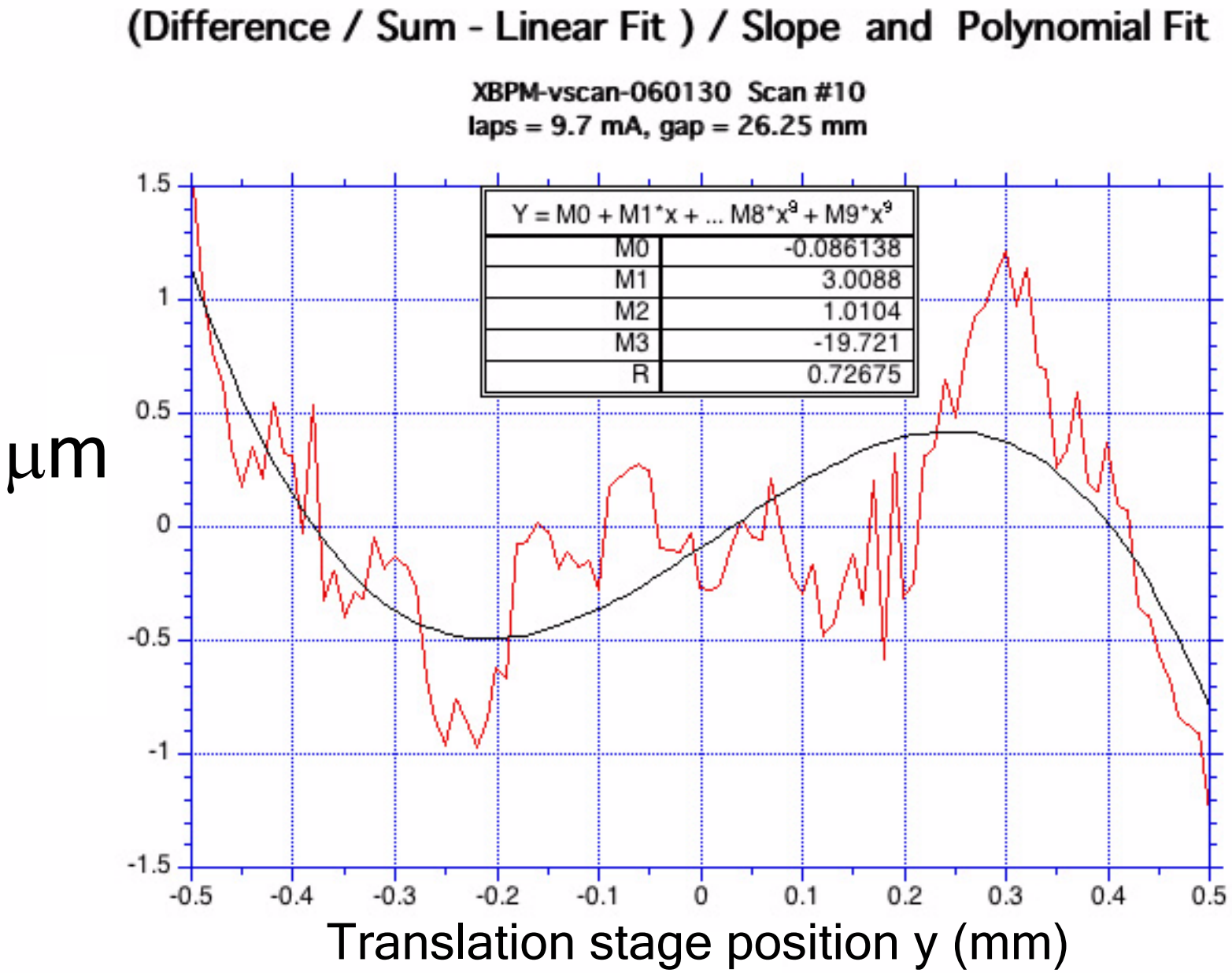
Results of Diode Vertical Translation Stage Scan



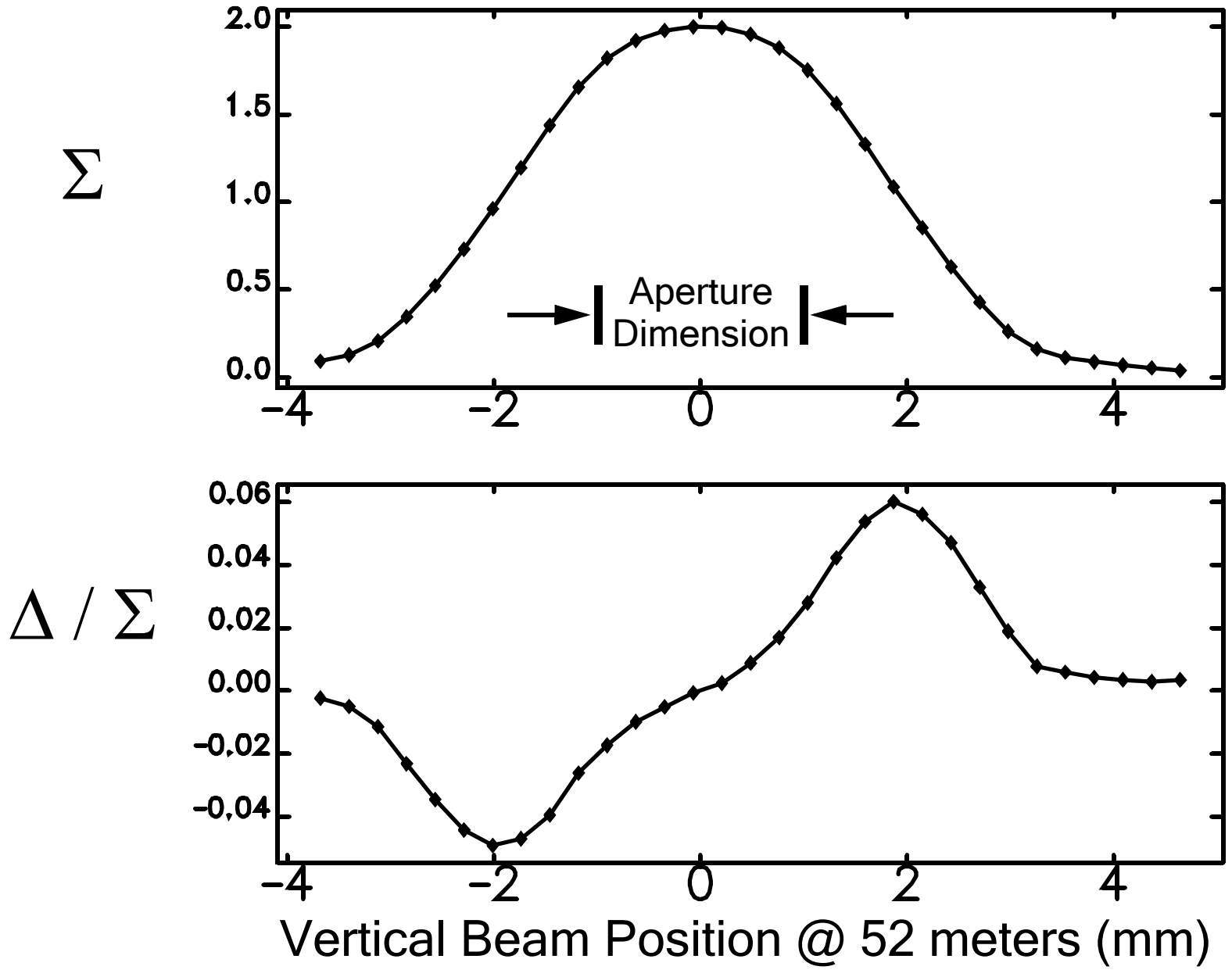
Data collected Jan. 30, 2006
By G. Rosenbaum APS Sector 19


Difference / Sum and Linear Fit
XBPM-vscan-060130 Scan #10
laps = 9.7 mA, gap = 26.25 mm
y = -0.019336 - 0.28557x R= 1
Δ / Σ
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
Translation stage position y (mm)

Residual


(Difference / Sum - Linear Fit) / Slope and Polynomial Fit
XBPM-vscan-060130 Scan #10
Iaps = 9.7 mA, gap = 26.25 mm
Y = M0 + M1*x + ... M8*x^8 + M9*x^9
M0 -0.086138
M1 3.0088
M2 1.0104
M3 -19.721
R 0.72675
μm
1.5
1
0.5
0
-0.5
-1
-1.5
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
Translation stage position y (mm)

Result of Scanning Beam Across Aperture with Local Angle Bump



Summary / Future Plans

- Research is underway using the device at 52 meters from the source toward a photon bpm sensitive only to hard x-rays (> 9 keV) to achieve 500 nrad p-p pointing angle stability. Early results are very encouraging.
- Alternate detectors, including photoresistive single crystal CVD diamond (SLS development) and vibrating wires (Arutunian DIPAC '05) will be investigated.
- The effects of x-ray spectral shaping using photon filtering remain to be studied.
- A second retractable high-power destructive diagnostic is being designed to be placed 25 meters from the source, downstream of the beam defining aperture.
- Ultimate goal is a non-destructive high-power device to be placed inside the accelerator enclosure, 20 meters from the source using existing UV bpm infrastructure.