Argonne NATIONAL LABORATORY

ADVANCED PHOTON SOURCE
APS OPERATIONS DIVISION

Progress on Photon BPMs and Related Issues

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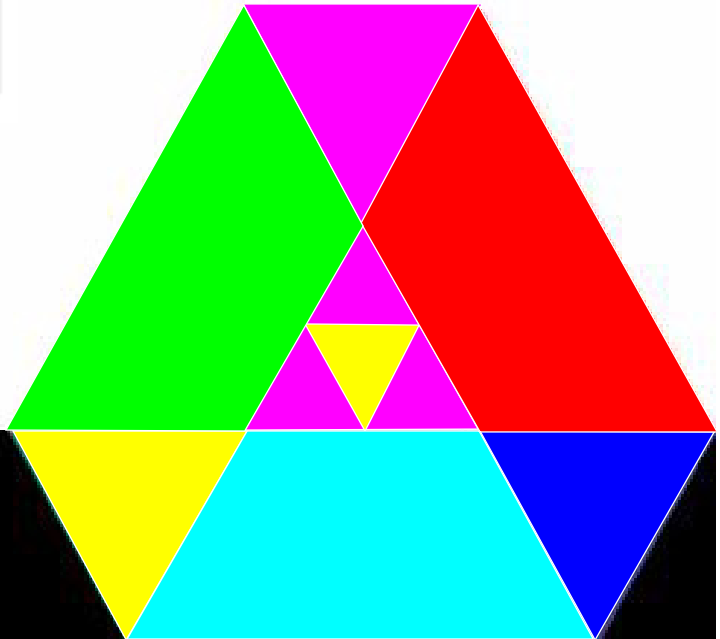
(formerly, and soon to be member of)

ADVANCED PHOTON SOURCE
ACCELERATOR SYSTEMS DIVISION

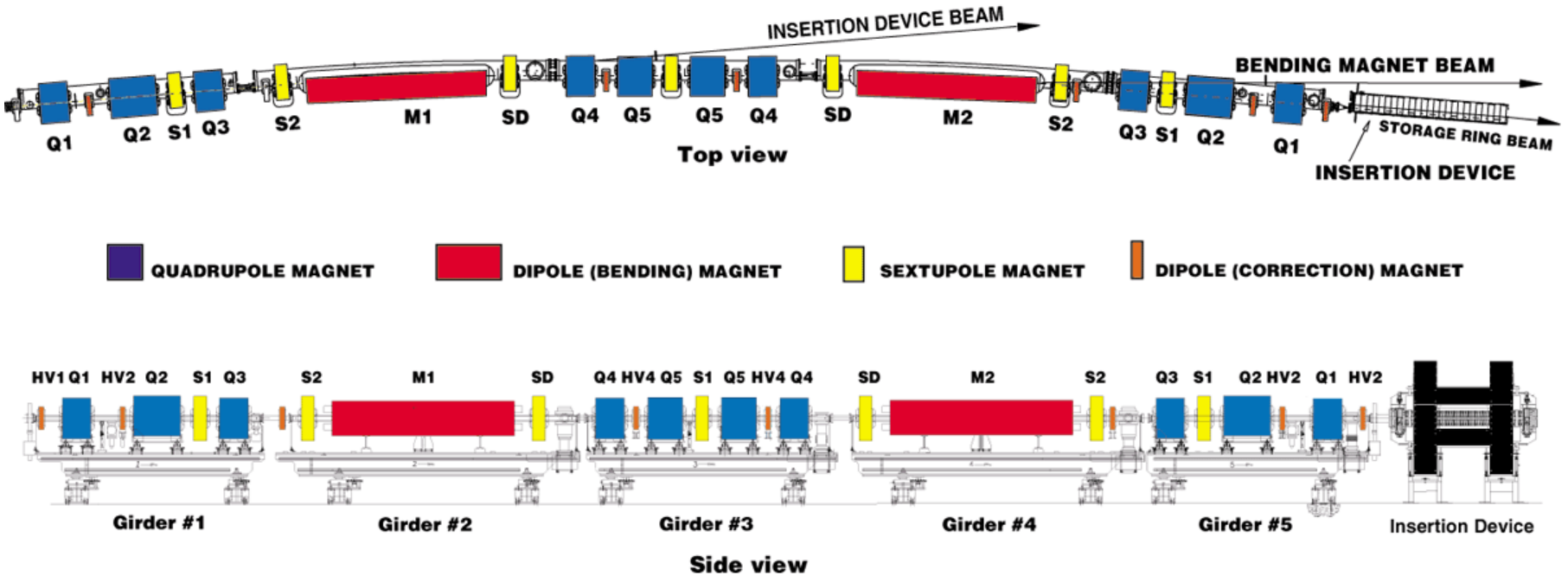
APS Technical Working Group Meeting
March 16, 2006



Overview

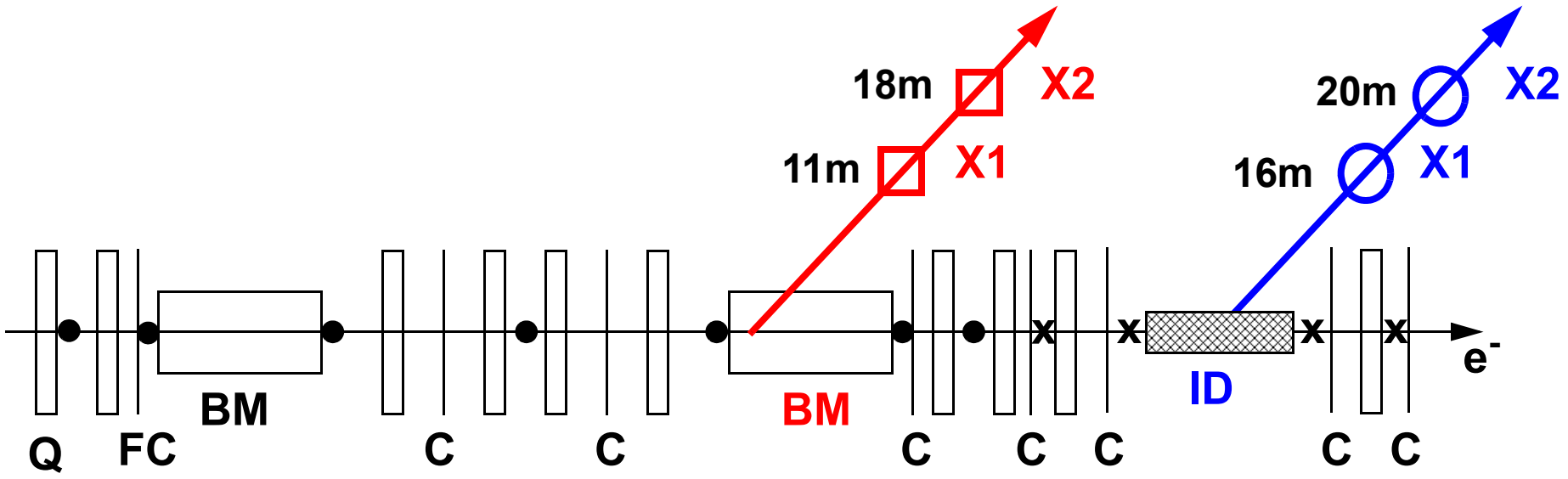
- Review of orbit control system / implementation
- New developments -
  - Refinement of photoemission photon bpm blade geometry
  - First results from hard x-ray bpm development at 19-ID
- Future plans / Summary

One Sector of the Advanced Photon Source Storage Ring



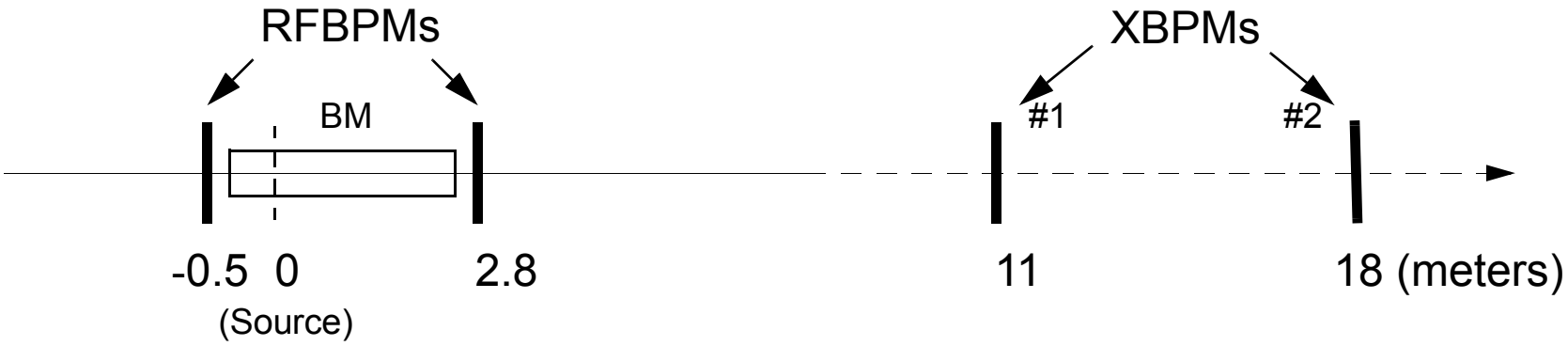
27.6 meters

Beam Position Monitors and Magnets in One Sector

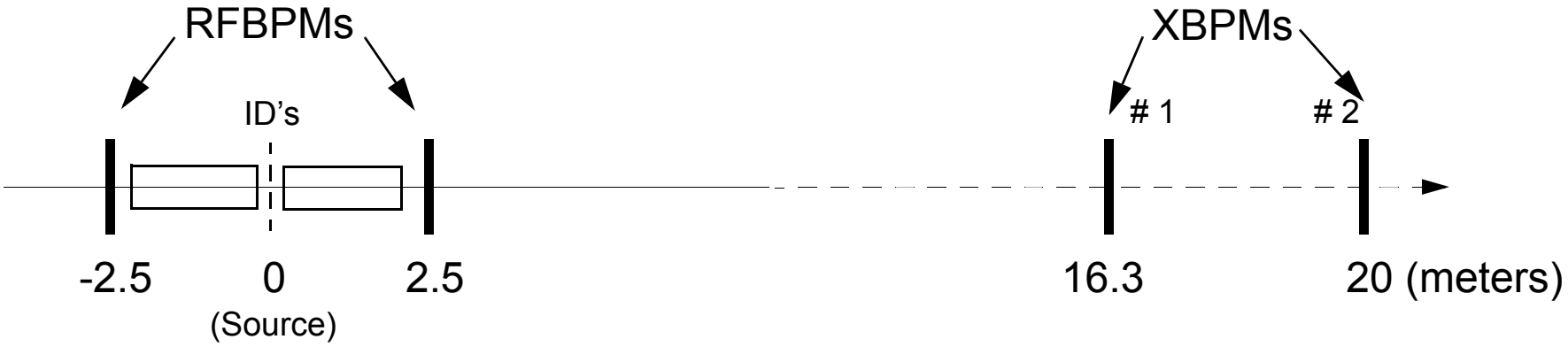


- ● : Broad-band RF Beam Position Monitors (7) (Turn-by-Turn)
- x : Narrow-band RF Beam Position Monitors (4) (~ 300 Hz)
- □ : BM X-ray Beam Position Monitors (2 - Vertical Only) (~165 Hz)
- ○ : ID X-ray Beam Position Monitors (2) (~165 Hz)
- FC : “Fast” Corrector Magnet (1) (~ 1000 Hz)
- C : “Slow” Corrector Magnets (7) (few Hz)
- Q : Quadrupole Magnets

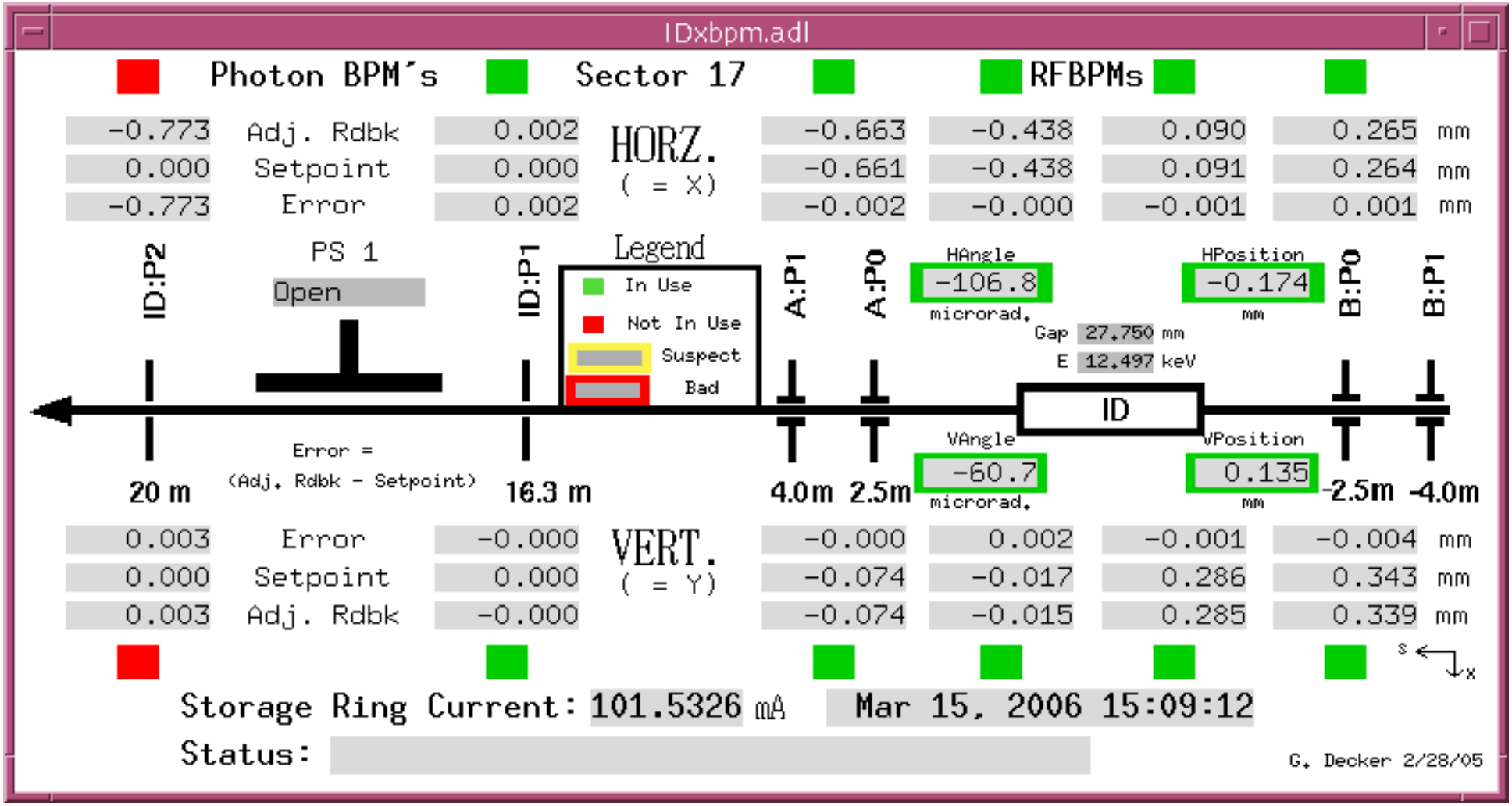
Bending Magnet and BPM Arrangement



Insertion Device and BPM Layout



Beamline Steering Displays



http://www.aps.anl.gov/asd/diagnostics/xbpmDisplays/index.html

Beam Position Monitors used for Vertical Orbit Correction (3/15/06)

= In Use

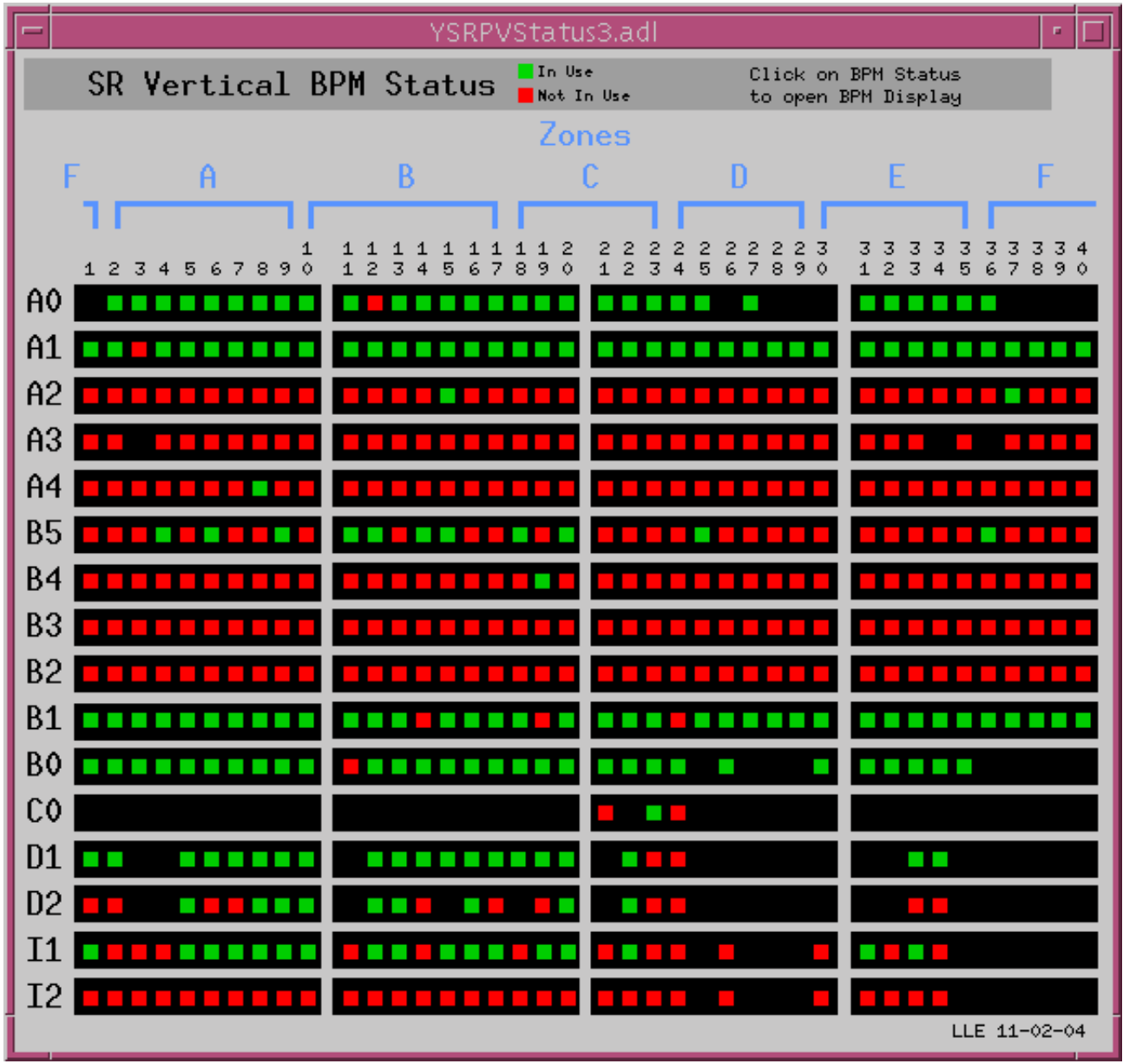
Narrowband RF bpms

Broadband RF bpms

Narrowband RF bpms

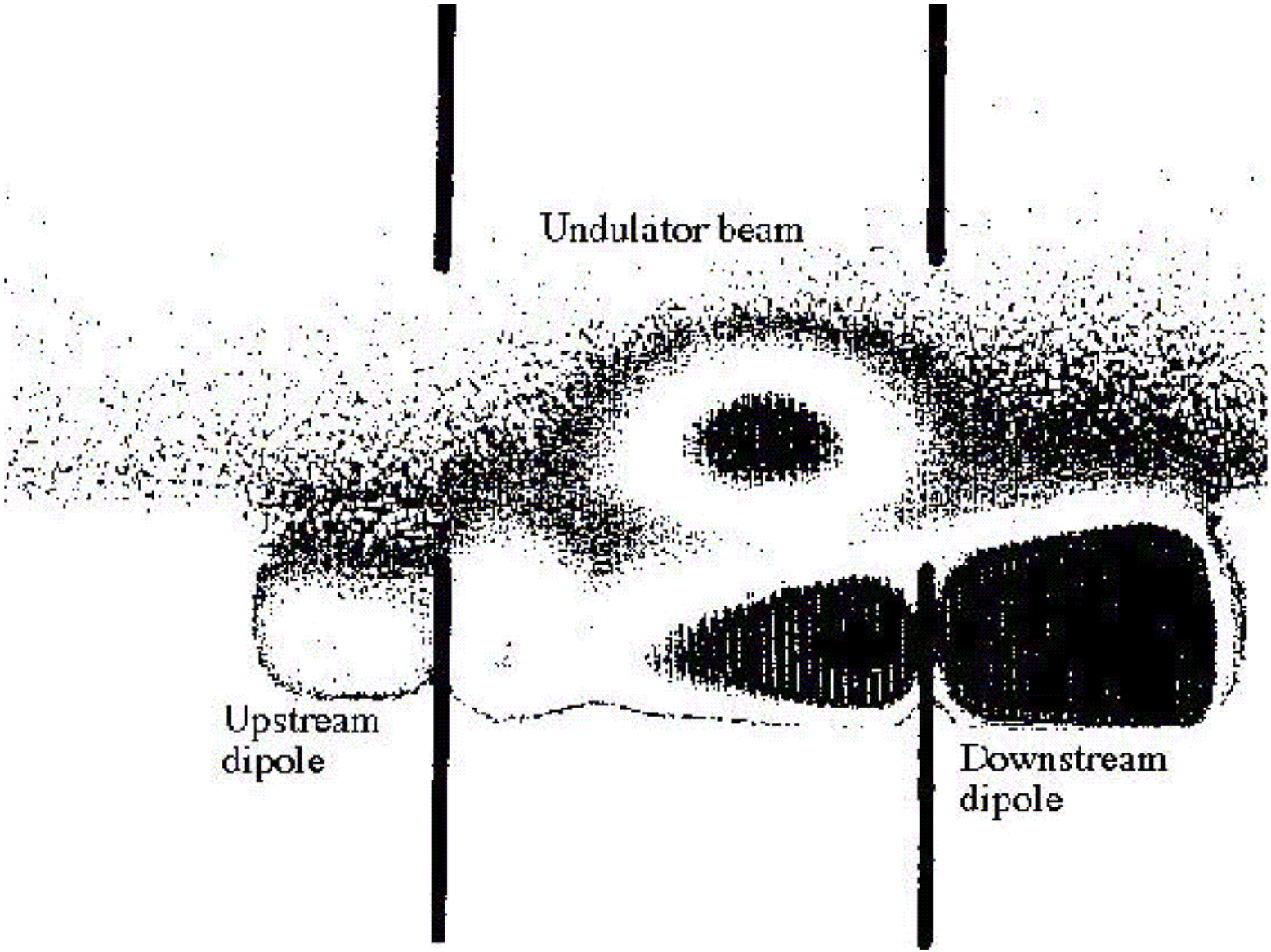
BM Photon bpms

ID Photon bpms



Sector 1 10 20 30 40

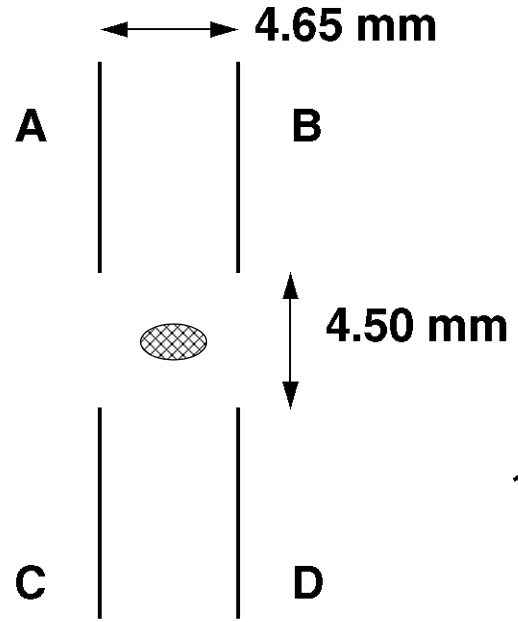
Photon Beam Position Monitor Stray Radiation Background



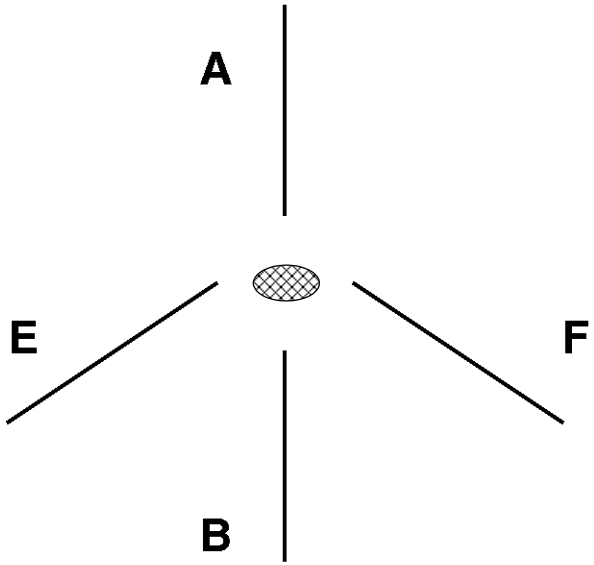
Courtesy ESRF / R. Hettel

Insertion Device
Photon Beam Position Monitor
Blade Geometries

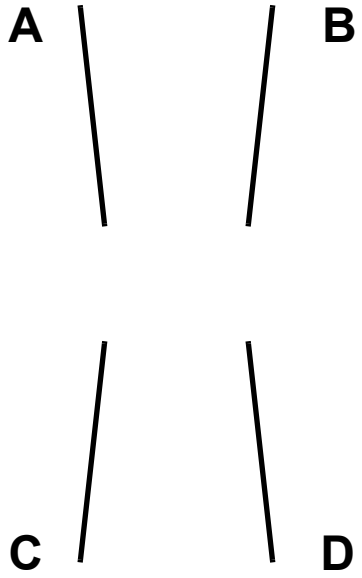
Upstream X-BPM (P1)

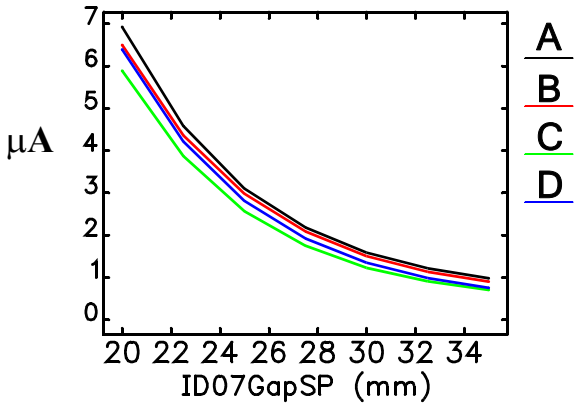


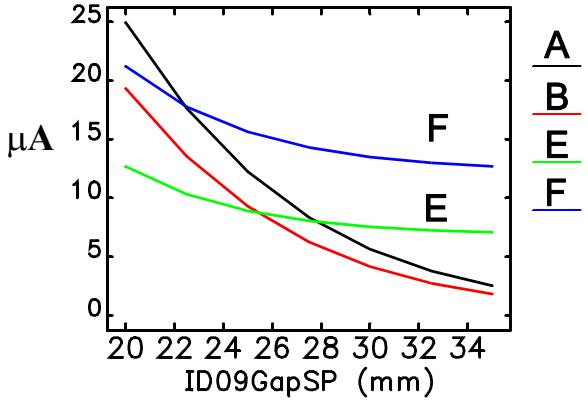
Downstream X-BPM (P2)

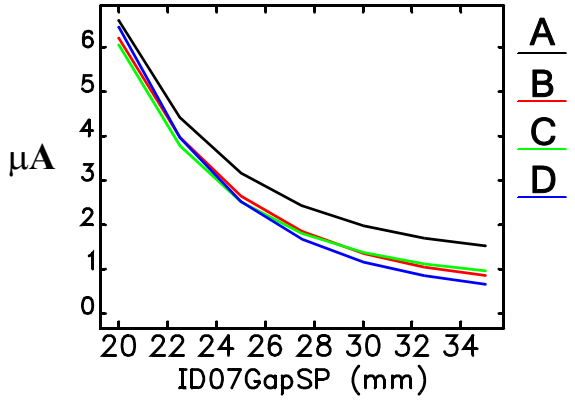


Revised P2 Geometry
(Installed at 5-ID, 7-ID, 14-ID)

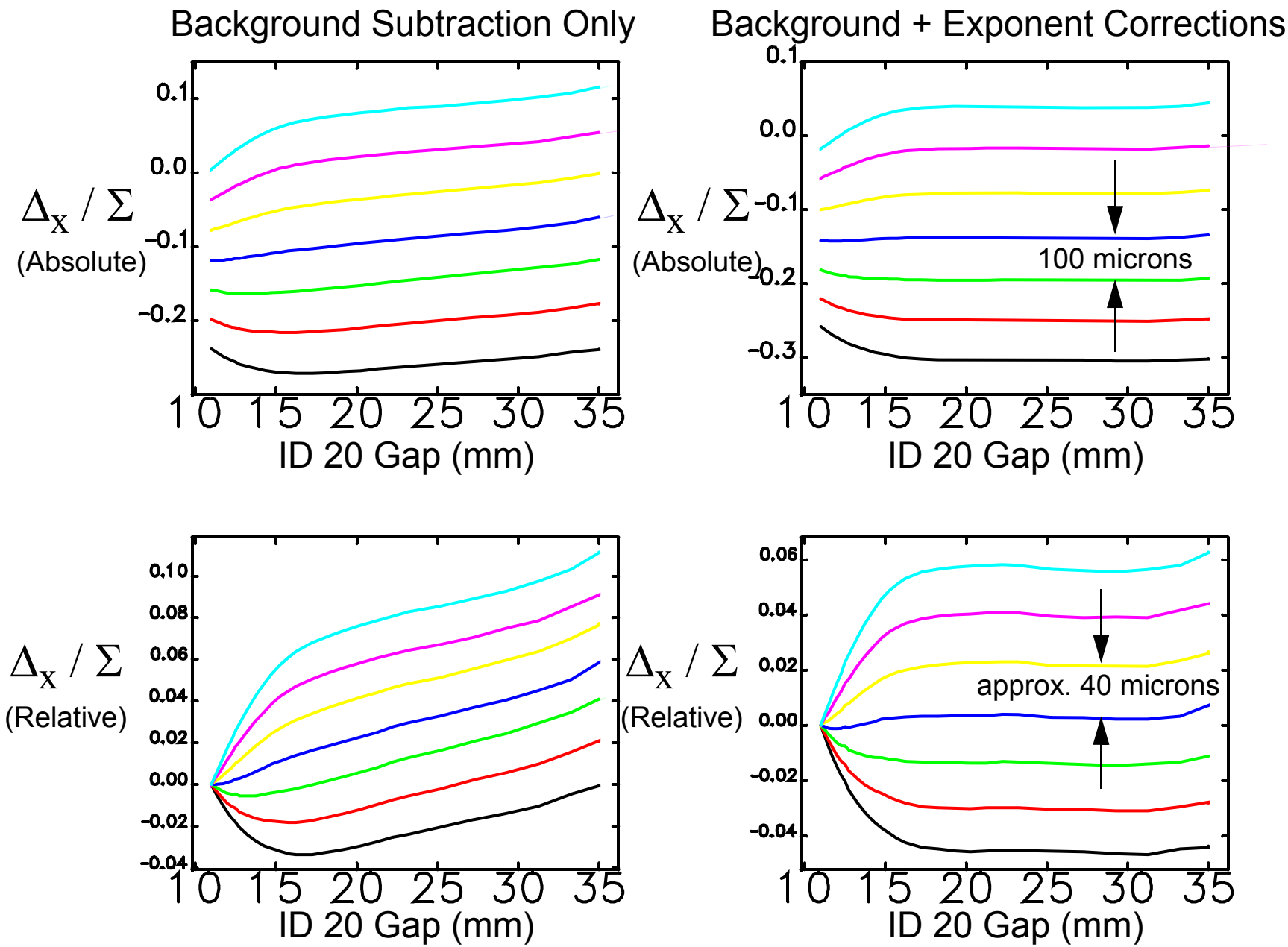






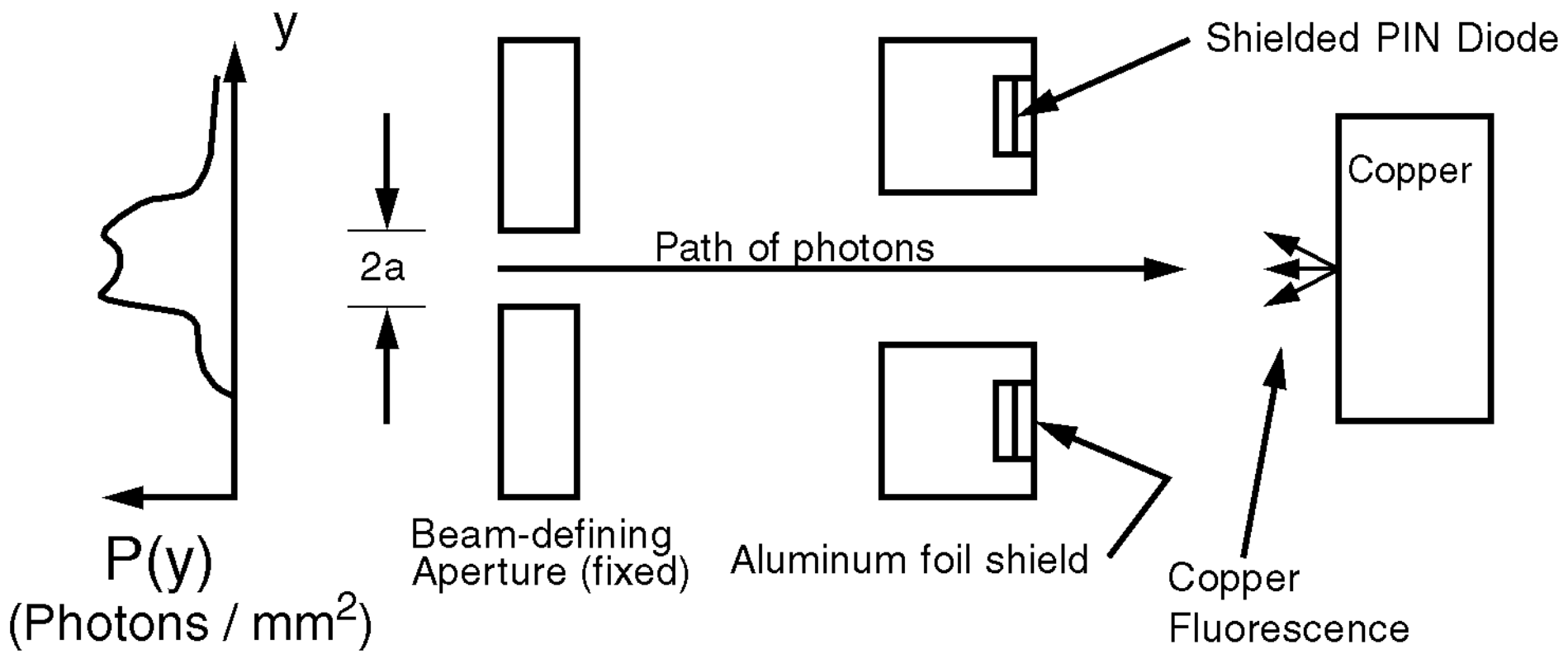


Correction of Residual ID Photon BPM Gap-dependent Systematic Errors

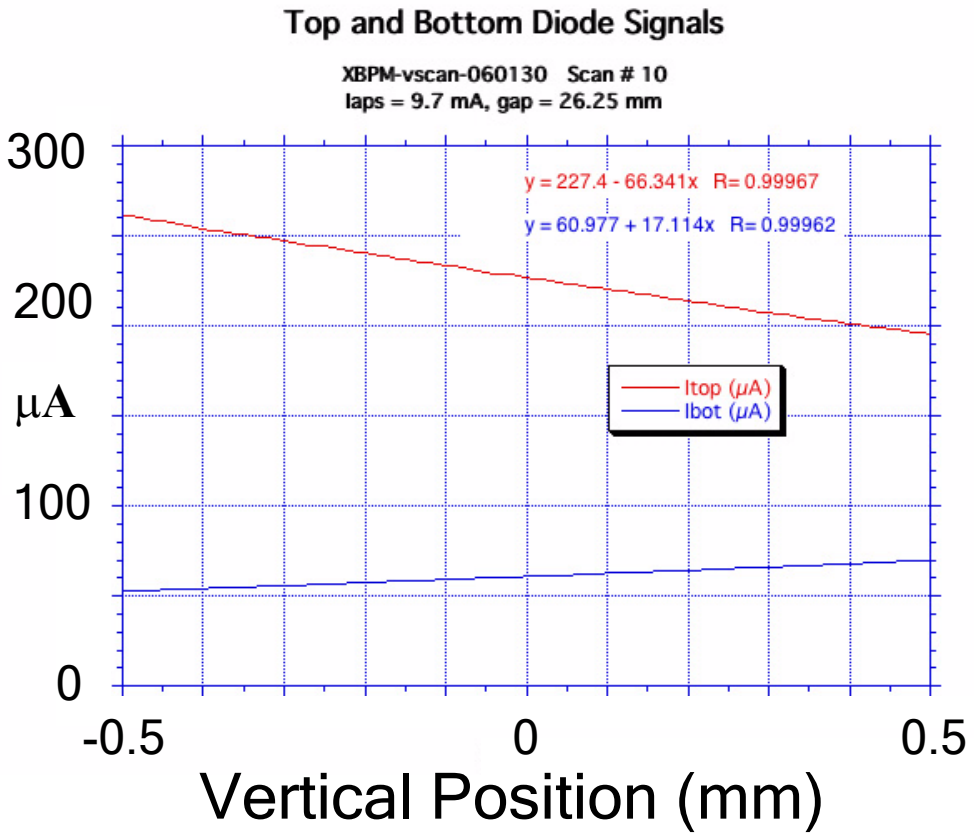


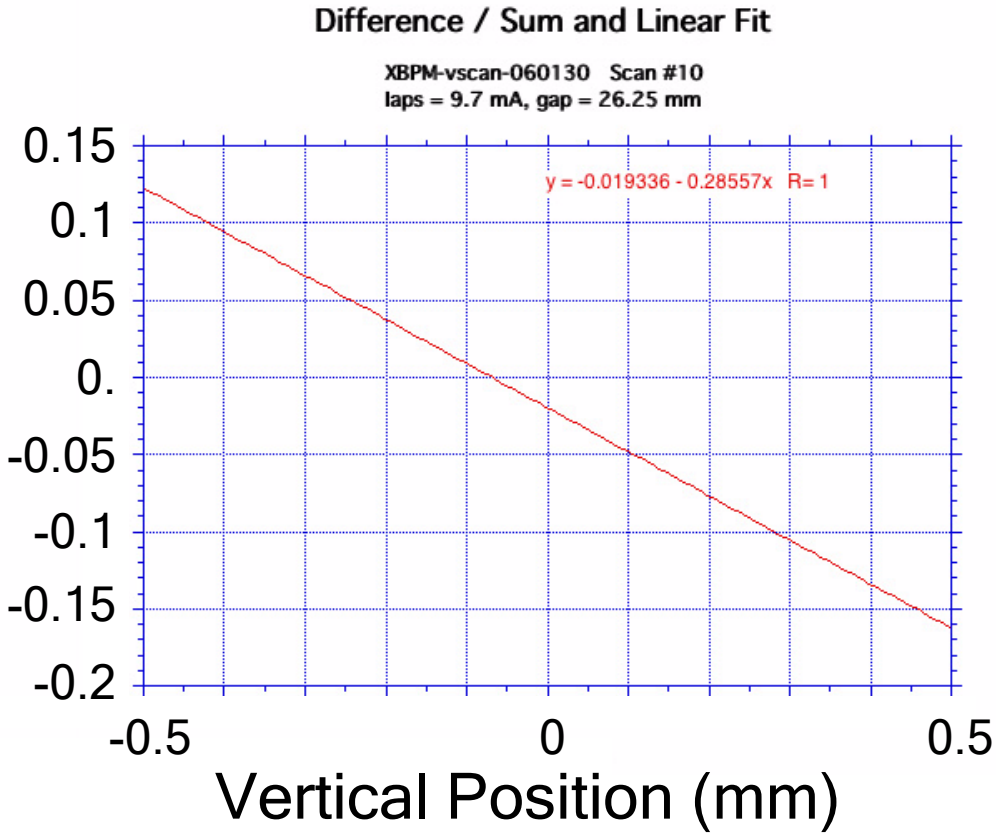
http://www.aps.anl.gov/asd/oag/APSOnly/technicalNotes/tnote2004-033.pdf

Hard X-ray BPM Prototype at 19-ID



First Results from Hard X-ray Beam Position Monitor, 19-ID-C 1/30/2006



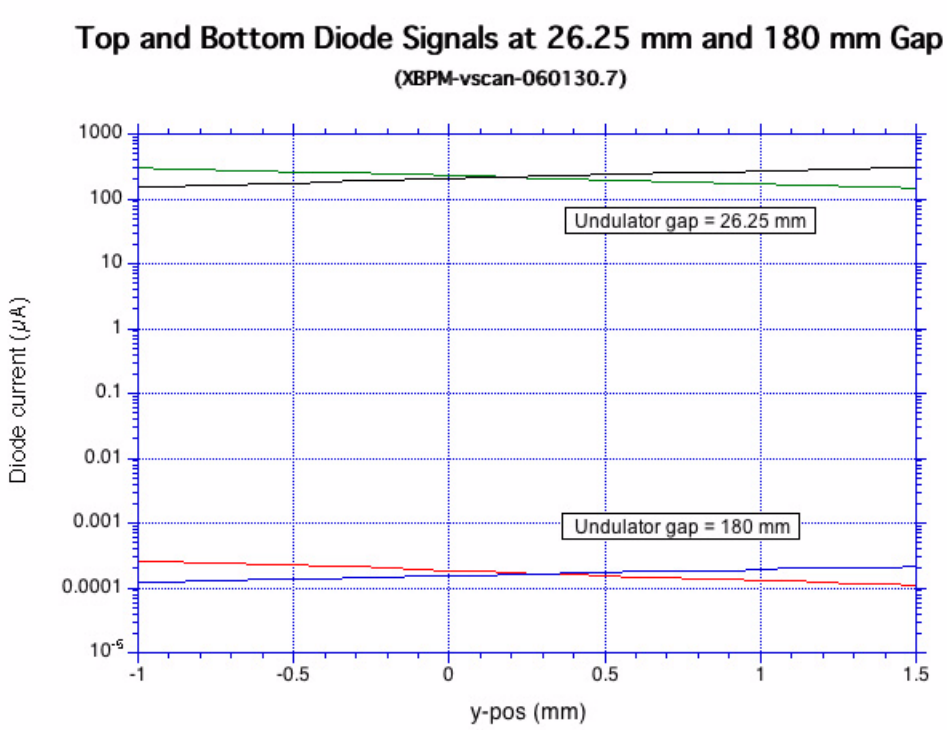


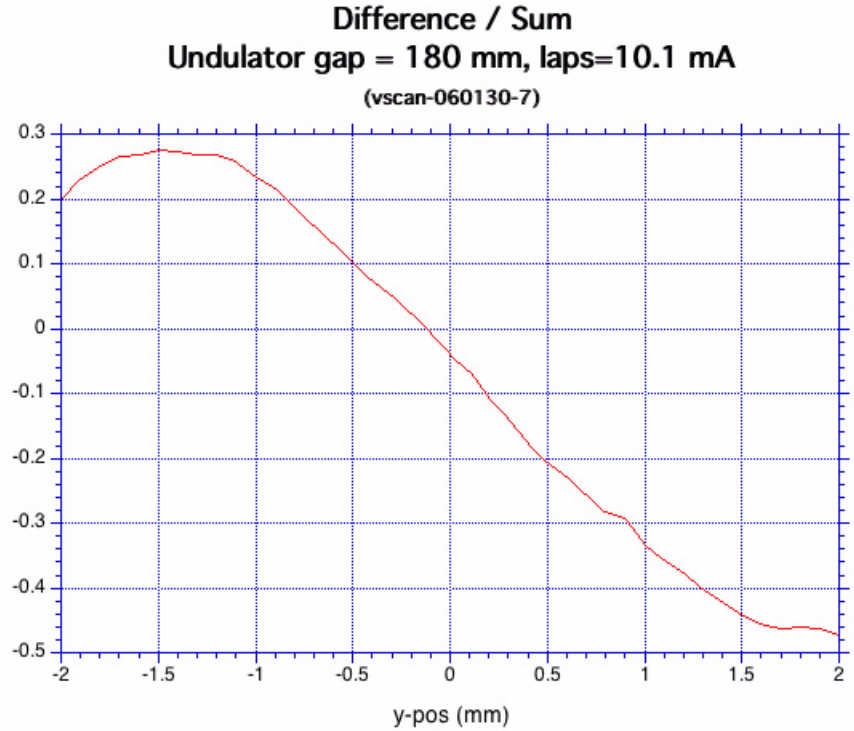
@ 52 meters from source

Total Stored Beam Current = 10 mA (!)

Data courtesy G. Rosenbaum

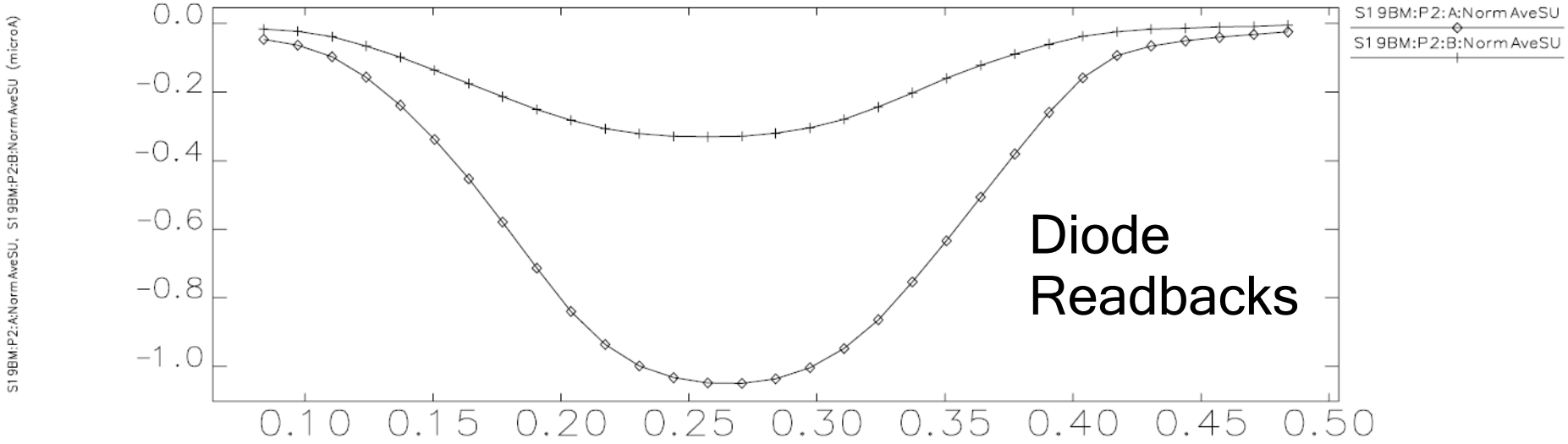
Comparison of Gap Open vs. Gap Closed



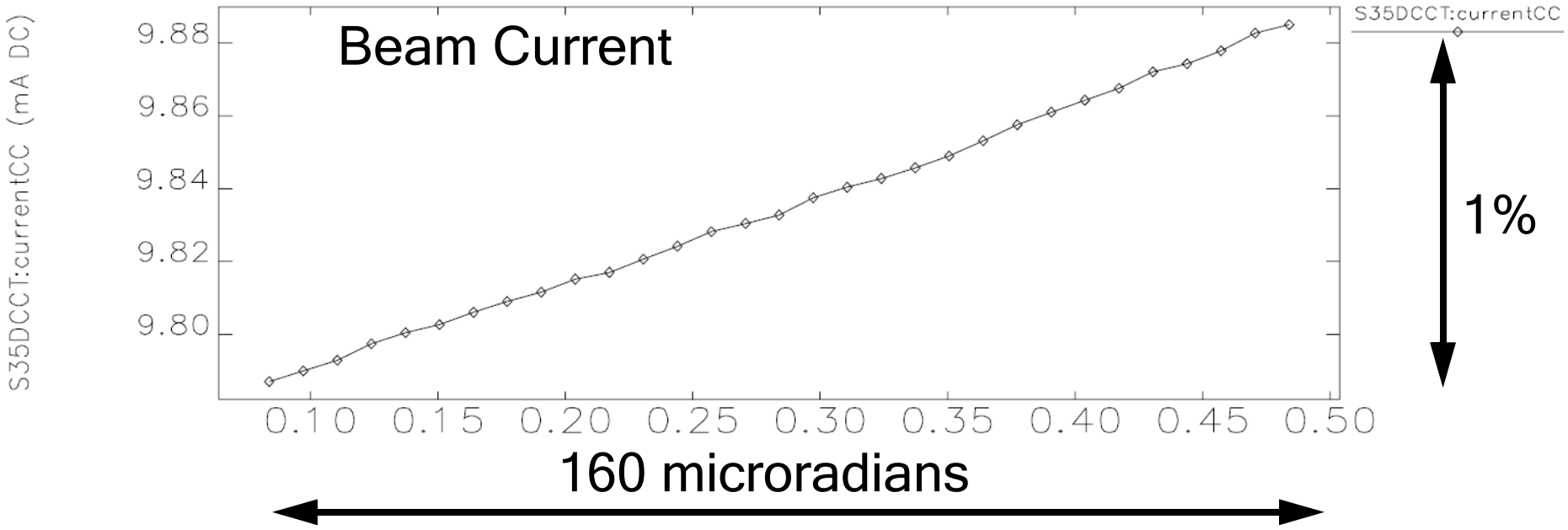


Signal / Noise (Gap Closed / Gap Open, 14 keV) = 1×10^6

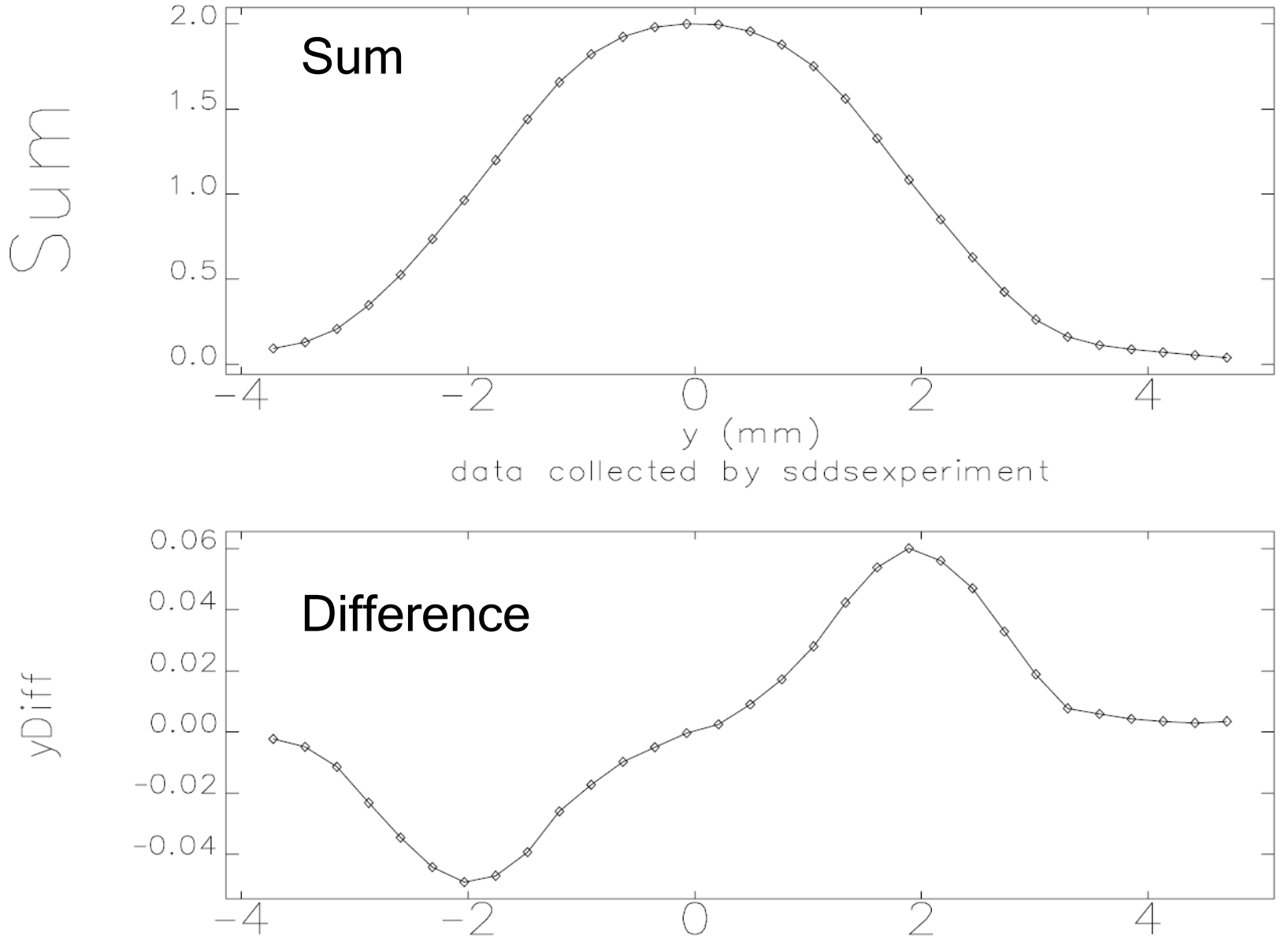
Result of Angle Bump Scan



Downstream RF BPM Setpoint



Sum and Difference Signals from Angle Bump Scan



Vertical Position (mm) @ 52 meters from source

Zeroeth Moment (Sum)

$$f(x) = \int_{-a}^{a} P(x-y)\mathrm{d}y$$

$$\frac{\mathrm{d}f}{\mathrm{d}x} = P(x+a) - P(x-a).$$

First Moment (Difference)

$$g(x) = \int_{-a}^{a} yP(x-y)\mathrm{d}y.$$

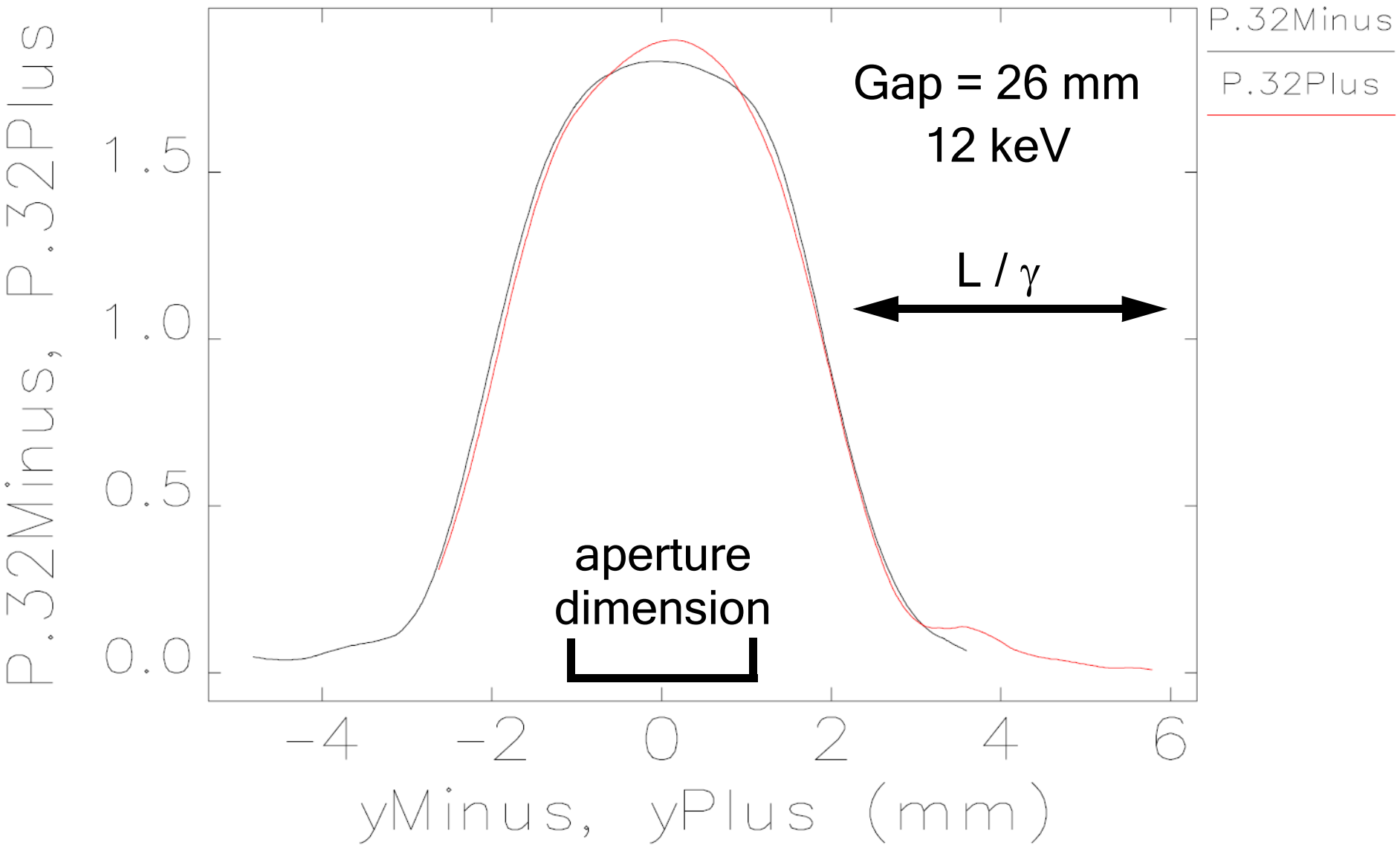
$$\frac{\mathrm{d}g}{\mathrm{d}x} = f(x) - a[P(x+a) + P(x-a)]$$

Original Flux Distribution from 0th and 1st Moments

$$2P(x+a) = \frac{1}{a}f(x) + \frac{\mathrm{d}f}{\mathrm{d}x} - \frac{1}{a}\frac{\mathrm{d}g}{\mathrm{d}x}.$$

$$2P(x-a) = \frac{1}{a}f(x) - \frac{\mathrm{d}f}{\mathrm{d}x} - \frac{1}{a}\frac{\mathrm{d}g}{\mathrm{d}x}.$$

Inferred Flux Distribution from Angle Bump Scan



http://www.aps.anl.gov/asd/diagnostics/profiling.pdf

Future Plans / Summary

- Incremental upgrades of P2 photoemission-based bpms
- Completion of hard x-ray bpm characterization at 19-ID
  - Development of high-power production version for front-end and / or FOE installation
- Inclusion of non-canted dual undulator ID photon bpm's
  - Feedforward based on photon energy vs. gap(?)
- Upgrade photoemission-based bpms at canted undulator beamlines