Progress on Photon BPMs and Related Issues
Glenn Decker
(formerly, and soon to be member of)

APS Technical Working Group Meeting
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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)
- 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)
- “Fast” Corrector Magnet (1) (~ 1000 Hz)
- “Slow” Corrector Magnets (7) (few Hz)
- Quadrupole Magnets
Bending Magnet and BPM Arrangement

Insertion Device and BPM Layout
Beamline Steering Displays

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

- Narrowband RF bpms
- Broadband RF bpms
- Narrowband RF bpms
- BM Photon bpms
- ID Photon bpms

![Graph showing beam position monitors status](image)

- Green square = In Use

### Table: SR Vertical BPM Status

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Click on BPM Status to open BPM Display.
Photon Beam Position Monitor Stray Radiation Background

Undulator beam

Upstream dipole

Downstream dipole

Courtesy ESRF / R. Hettel
Insertion Device
Photon Beam Position Monitor
Blade Geometries

Upstream X-BPM (P1) 4.65 mm

Downstream X-BPM (P2)

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

μA

μA

μA

20 22 24 26 28 30 32 34
ID07GapSP (mm)

20 22 24 26 28 30 32 34
ID09GapSP (mm)

20 22 24 26 28 30 32 34
ID07GapSP (mm)
Correction of Residual ID Photon BPM Gap-dependent Systematic Errors

Background Subtraction Only

Background + Exponent Corrections

Δx / Σ
(Absolute)

Δx / Σ
(Absolute)

Hard X-ray BPM Prototype at 19-ID

$P(y)$ (Photons / mm$^2$)

Beam-defining Aperture (fixed)

2a

Path of photons

Shielded PIN Diode

Aluminum foil shield

Copper

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

Top and Bottom Diode Signals

X BPM-vscan-060130 Scan #10
laps = 9.7 mA, gap = 26.25 mm

\[
\begin{align*}
y &= 227.4 - 66.341x, R = 0.99967 \\
y &= 60.377 + 17.114x, R = 0.99962
\end{align*}
\]

Vertical Position (mm)

Data courtesy G. Rosenbaum

Total Stored Beam Current = 10 mA (!)
Comparison of Gap Open vs. Gap Closed

Signal / Noise (Gap Closed / Gap Open, 14 keV) = 1x10^6
Result of Angle Bump Scan

Diode Readbacks

Downstream RF BPM Setpoint

Beam Current

160 microradians

1%
Sum and Difference Signals from Angle Bump Scan

**Sum**

Vertical Position (mm) @ 52 meters from source

**Difference**

Vertical Position (mm) @ 52 meters from source
Zeroeth Moment (Sum)

\[ f(x) = \int_{-a}^{a} P(x - y) dy \]

\[ \frac{df}{dx} = P(x + a) - P(x - a). \]

First Moment (Difference)

\[ g(x) = \int_{-a}^{a} y P(x - y) dy. \]

\[ \frac{dg}{dx} = f(x) - a[P(x + a) + P(x - a)] \]

Original Flux Distribution from 0th and 1st Moments

\[ 2P(x + a) = \frac{1}{a} f(x) + \frac{df}{dx} - \frac{1}{a} \frac{dg}{dx}. \]

\[ 2P(x - a) = \frac{1}{a} f(x) - \frac{df}{dx} - \frac{1}{a} \frac{dg}{dx}. \]
Inferred Flux Distribution from Angle Bump Scan

Gap = 26 mm
12 keV

L / γ

aperture dimension

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