Experience with Insertion Device
Photon Beam Position Monitors at the
APS

Glenn Decker
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27.6 meters
(The APS has forty sectors - 1104 meters total circumference)
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)
- 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
**Insertion Device**
**Photon Beam Position Monitor**
**Blade Geometry**

**Upstream X-BPM (P1)**

- A
- B
- C

**Downstream X-BPM (P2)**

- A
- E
- F

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**Stray Radiation Sources**

- Insertion Device
- ID photons
- Main Dipole Bend Magnet
- 78 mrad

**Legend**

- Focusing Quadrupole Magnet
- Defocusing Quadrupole Magnet
- Sextupole Magnet
- Combined Function Horz./ Vert. Steering Corrector Magnet

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X-ray BPMs (16, 20 meters from source)
Re-direction of Stray Photons by Girder Alignment*

Stray radiation from upstream dipole, quadrupoles, sextupoles and correctors

ID photons

77 mrad

1 mrad

Stray radiation from downstream dipole, quadrupoles, sextupoles and correctors

Raw Corrector Settings

<table>
<thead>
<tr>
<th>ID</th>
<th>Undistorted</th>
<th>Distorted</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1 mrad</td>
<td>-1 mrad</td>
<td>-1 mrad</td>
</tr>
<tr>
<td>-77 mrad (= -78+1)</td>
<td>-78 mrad</td>
<td>-78 mrad</td>
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<tr>
<td>-77 0.67 mm</td>
<td>-0.5 -0.5 -0.5 -0.5</td>
<td>-0.5 -0.5 -0.5 -0.5</td>
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<tr>
<td>-77 0.33 mm</td>
<td>0 -0.5 0 -0.5</td>
<td>0 -0.5 0 -0.5</td>
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<tr>
<td>-77</td>
<td>0 -0.5 0 -0.5</td>
<td>0 -0.5 0 -0.5</td>
</tr>
</tbody>
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Geometries of Canted Undulators and decker Distortions
Correction of Residual ID Photon BPM Gap-dependent Systematic Errors

Long Term Drift of BM and ID Photon BPM Readbacks
One-Week Angular Drift

Local Tunnel Air Temperature Impacts Pointing Stability
Conceptual Design of Hard X-ray Beam Position Monitor (Top View)

- Rectangular Beamline Limiting Aperture (Approx. 3 x 2 mm)
- ~30 meters from source

- Cooled Cu X-ray Fluorescent Source

- Be. Filter

- Photo-resistive Diamond Detectors

- Diamond Detectors (Approx. 3 x 2 mm)

Plan View
- Fluorescence Sensors
- Water-cooled Cu Aperture
- W-Shield
- Thermocouples

Elevation
- Thermocouples
- Fluorescence Sensors, Inclined (Mount Not Shown)

Thermal Protection for Sensors

Argonne National Laboratory
Advanced Photon Source

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Summary

- An extensive accelerator re-alignment is near completion after a 6-year effort, resulting in reduced insertion device photon bpm stray radiation background signals.

- Correction of residual gap-dependent systematic errors is presently performed using lookup tables.

- Careful alignment, background subtraction, and algorithm refinement should further reduce systematic errors to the +/- 10 to 20 micron level (~0.5 - 1 μrad). (but depend critically on assumptions / constraints)

- Development of a “gold standard” hard x-ray bpm located 30 meters from the source should allow achieving +/- 100 nrad-scale long-term pointing stability (perhaps the only way).