ADVANCED PHOTON SOURCE
APS OPERATIONS DIVISION

X-ray Beam Position Monitors and Feedback

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APS/Users Monthly Operations Meeting
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Argonne National Laboratory

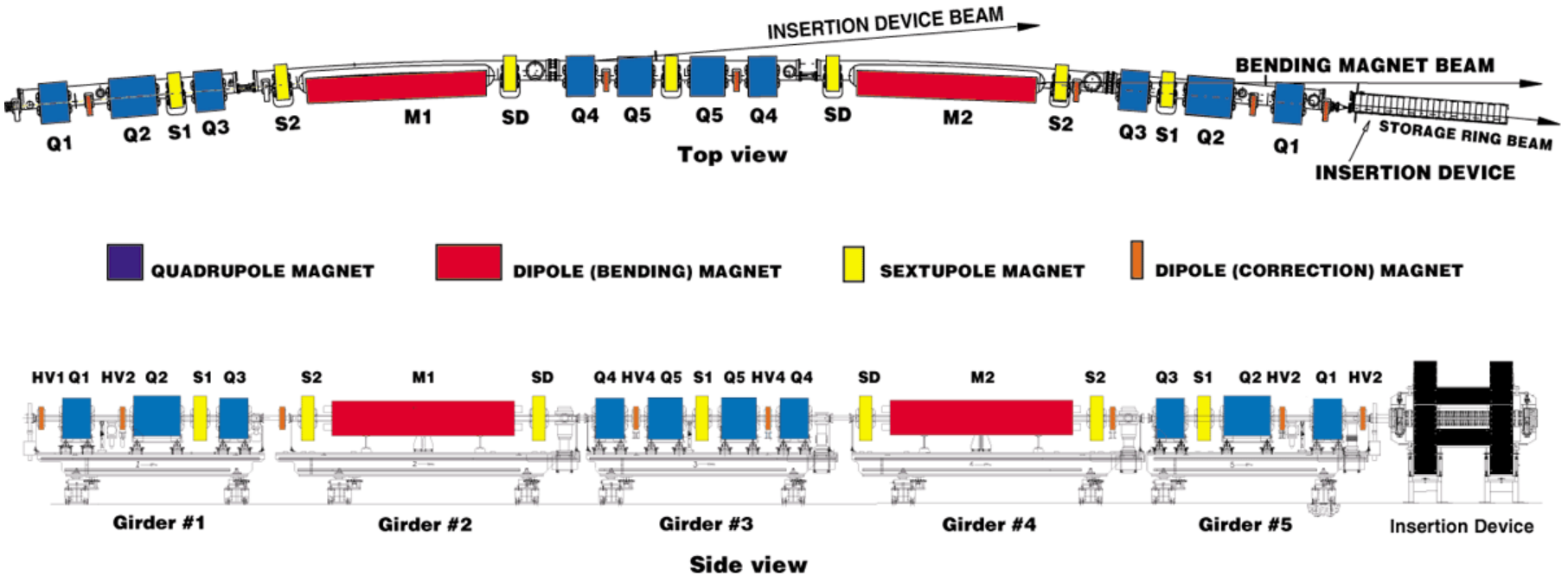
Office of Science
U.S. Department of Energy

A U.S. Department of Energy
Office of Science Laboratory
Operated by The University of Chicago

Overview

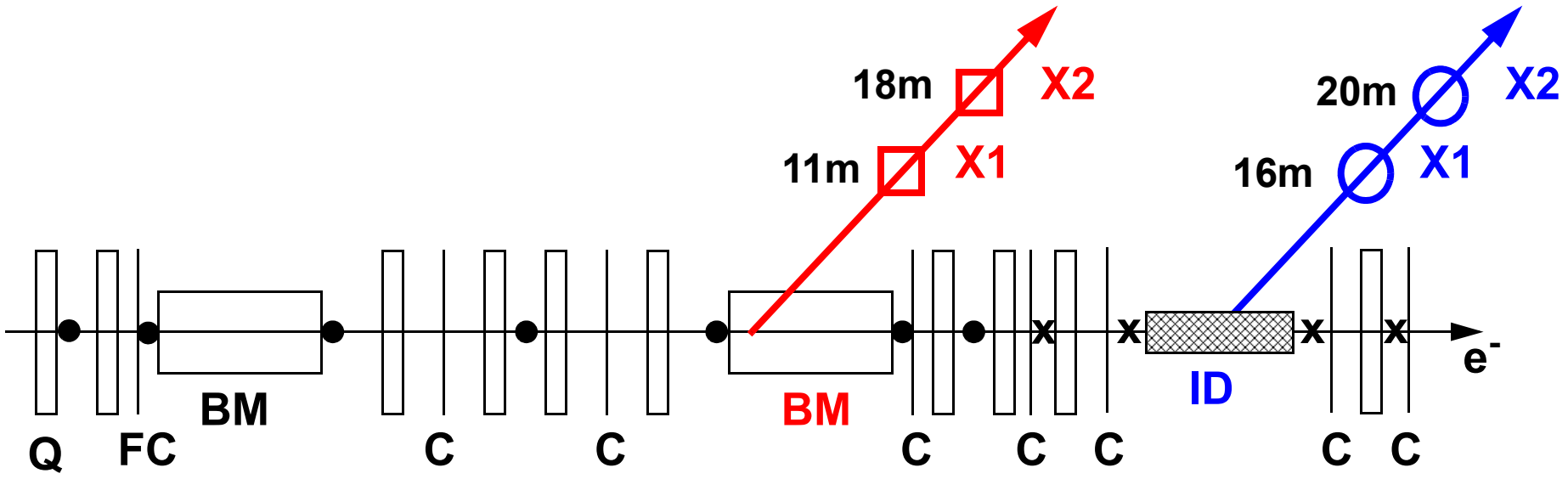
- Review of orbit control system / implementation
- New developments -
  - Refinement of photoemission photon bpm blade geometry
  - First results from hard x-ray bpm development at 19-ID
  - Beamline optimization (Operations analysis group)
  - Portable detector suite
- Future plans / Summary

One Sector of the Advanced Photon Source Storage Ring



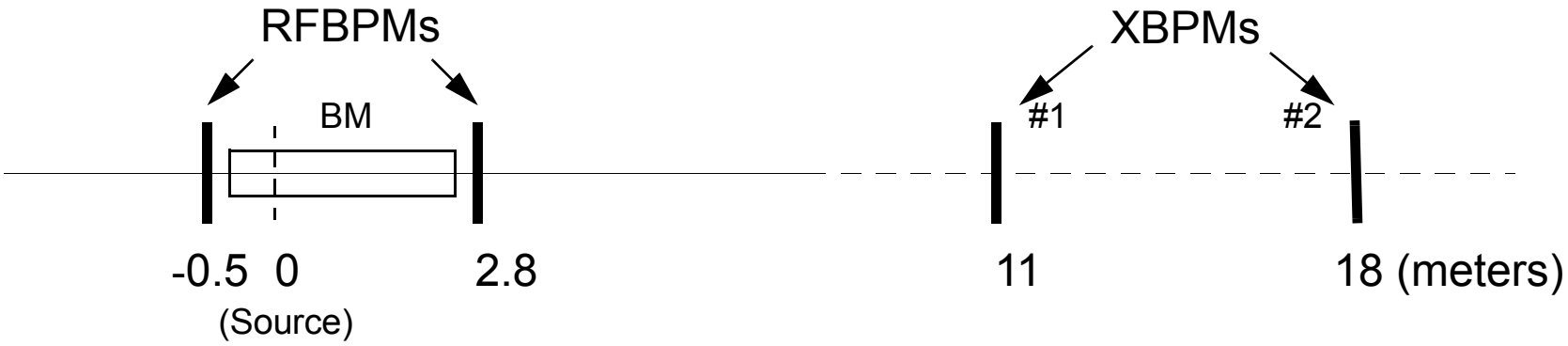
27.6 meters

Beam Position Monitors and Magnets in One Sector

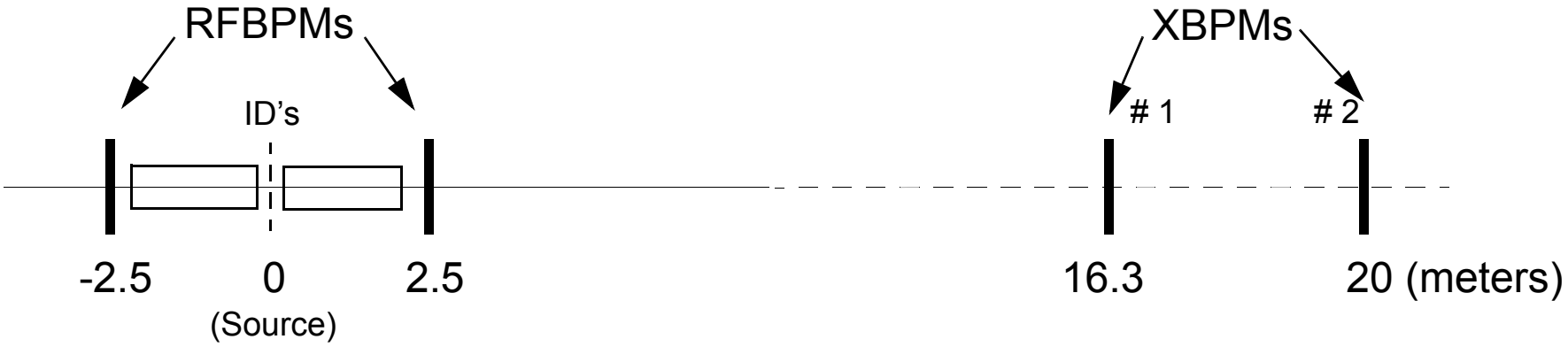


- ● : Broad-band RF Beam Position Monitors (7) (Turn-by-Turn)
- x : Narrow-band RF Beam Position Monitors (4) (~ 300 Hz)
- □ : BM X-ray Beam Position Monitors (2 - Vertical Only) (~165 Hz)
- ○ : ID X-ray Beam Position Monitors (2) (~165 Hz)
- FC : “Fast” Corrector Magnet (1) (~ 1000 Hz)
- C : “Slow”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

Bending Magnet and BPM Arrangement

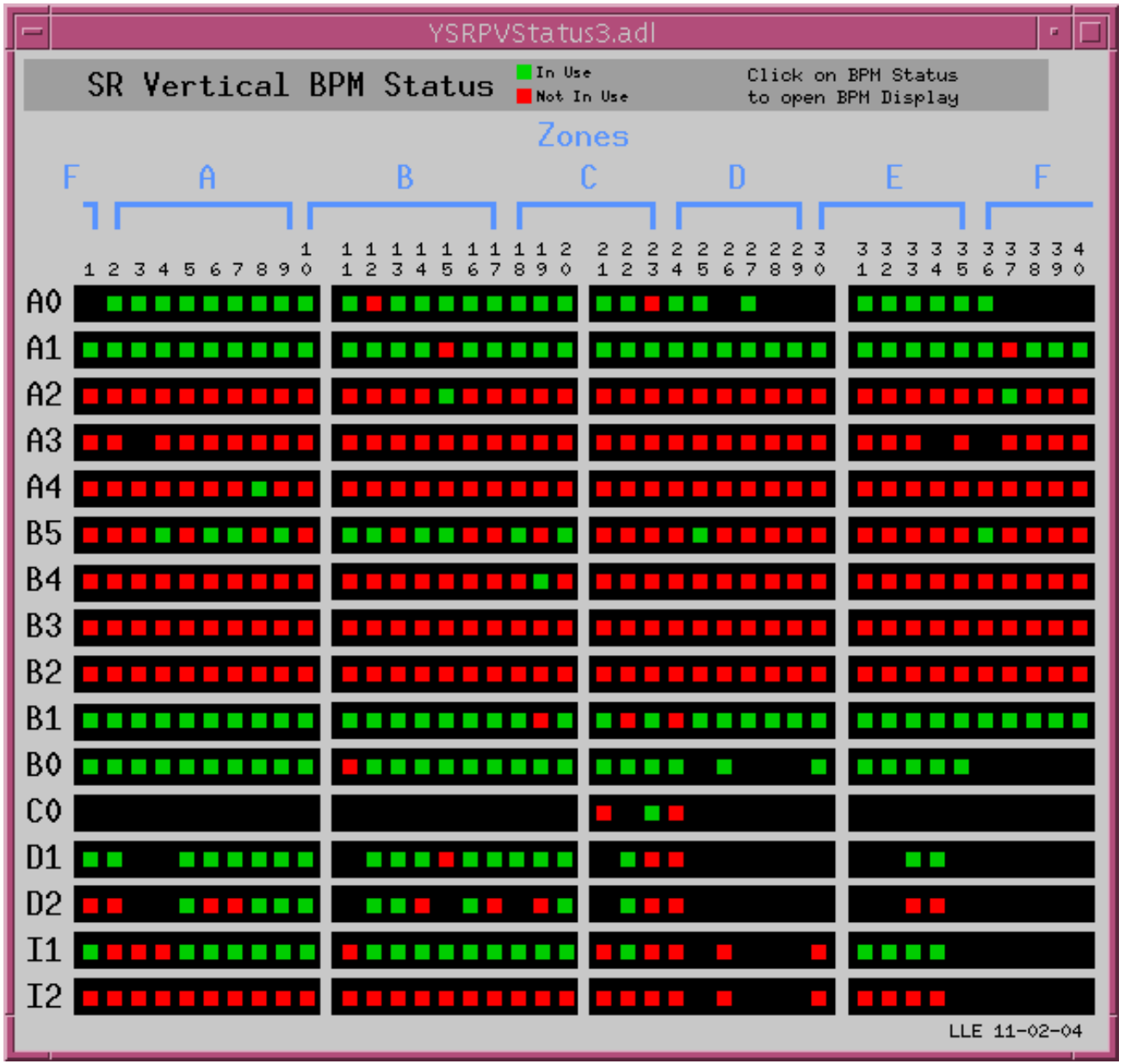


Insertion Device and BPM Layout



Beam Position Monitors used for Vertical Orbit Correction (2/9/06)

= In Use



Narrowband RF bpms

Broadband RF bpms

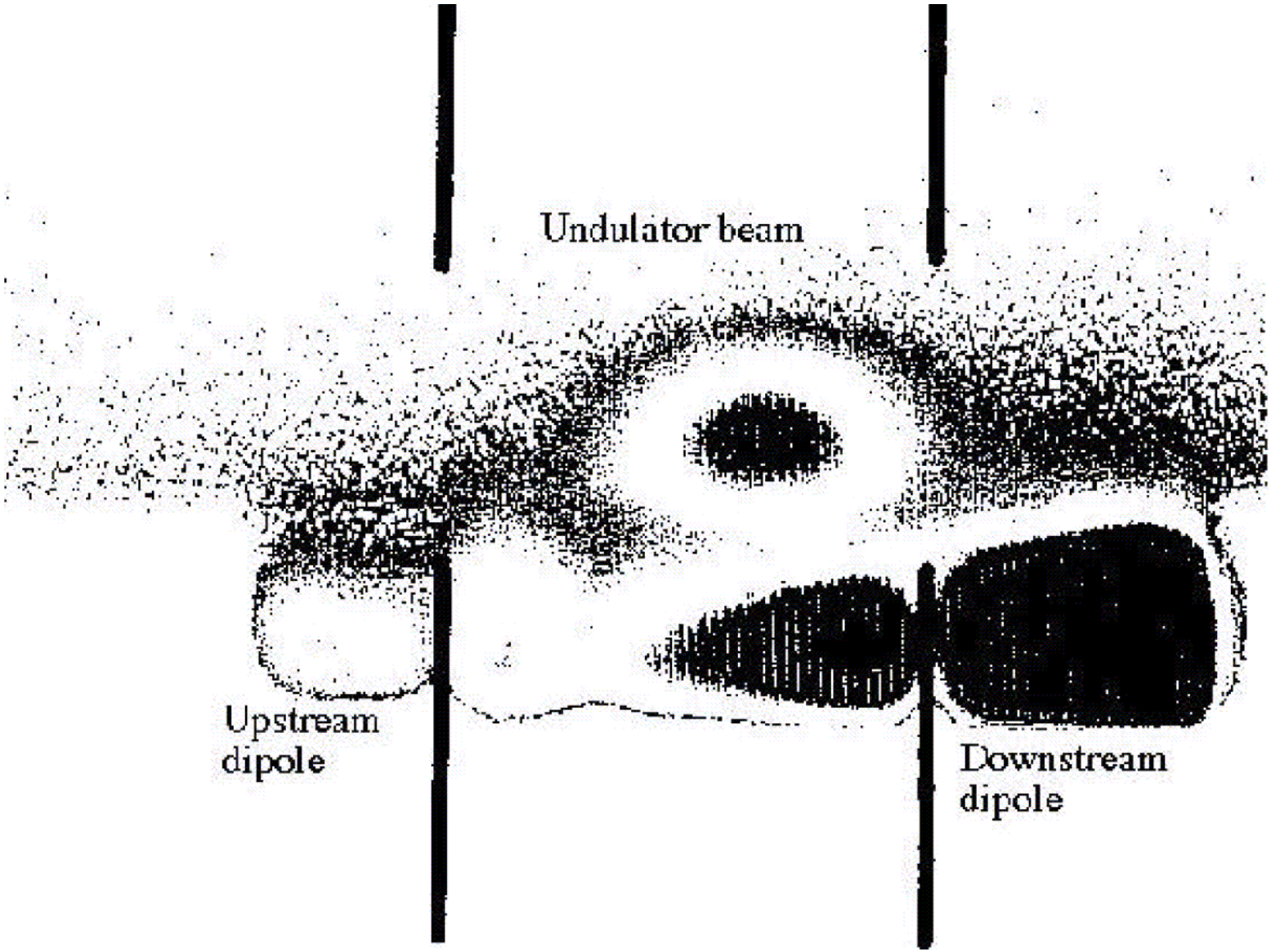
Narrowband RF bpms

BM Photon bpms

ID Photon bpms

Sector 1 10 20 30 40

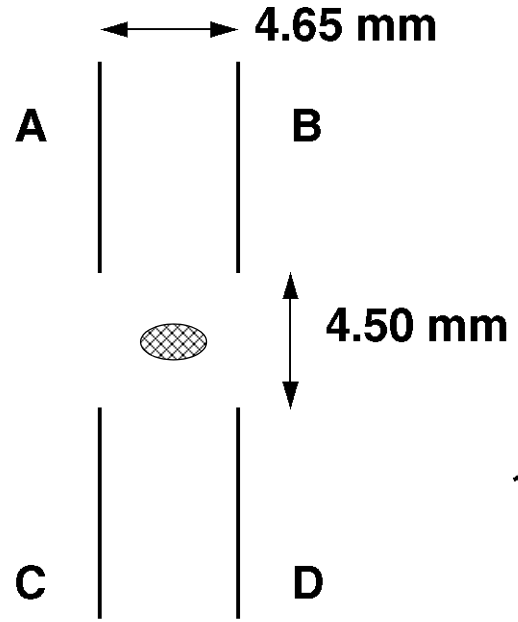
Photon Beam Position Monitor Stray Radiation Background



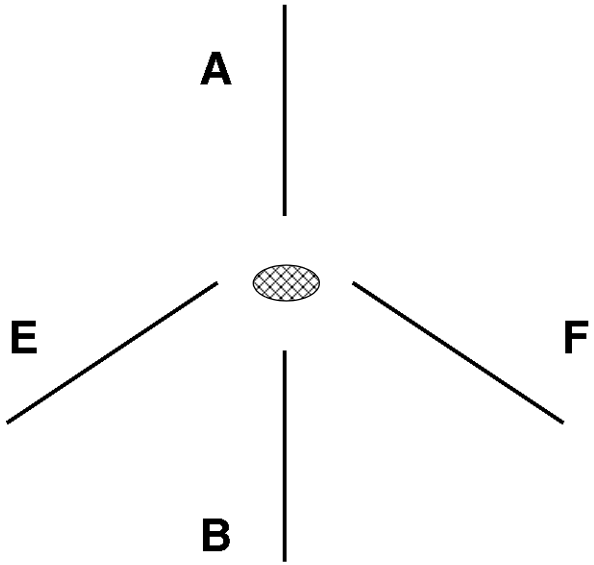
Courtesy ESRF / R. Hettel

Insertion Device
Photon Beam Position Monitor
Blade Geometries

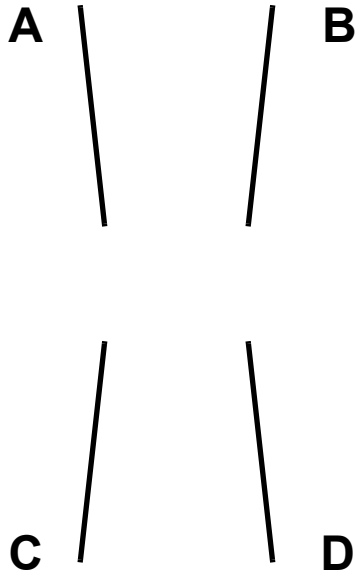
Upstream X-BPM (P1)

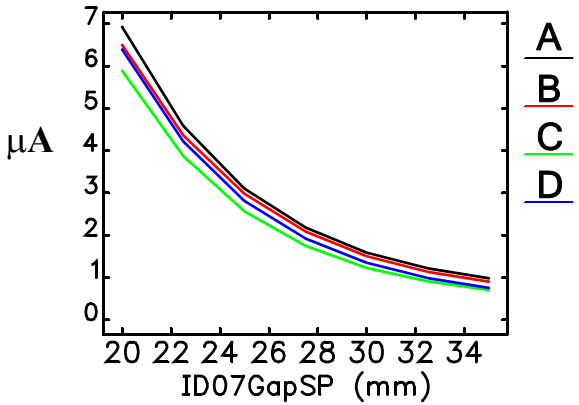


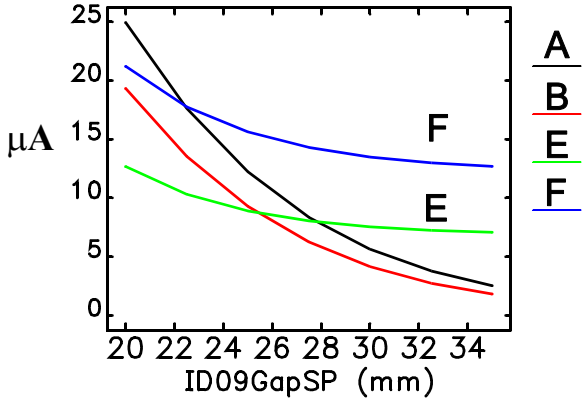
Downstream X-BPM (P2)

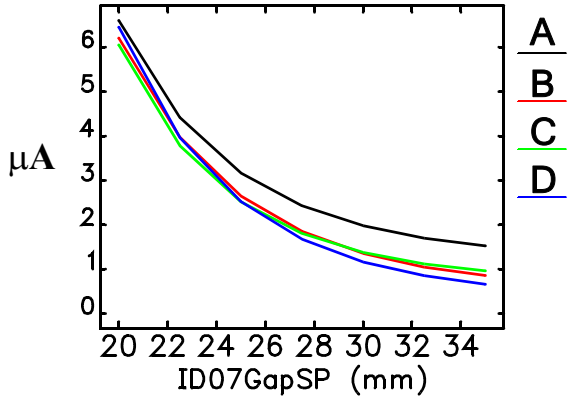


Revised P2 Geometry
(Installed at 5-ID, 7-ID, 14-ID)

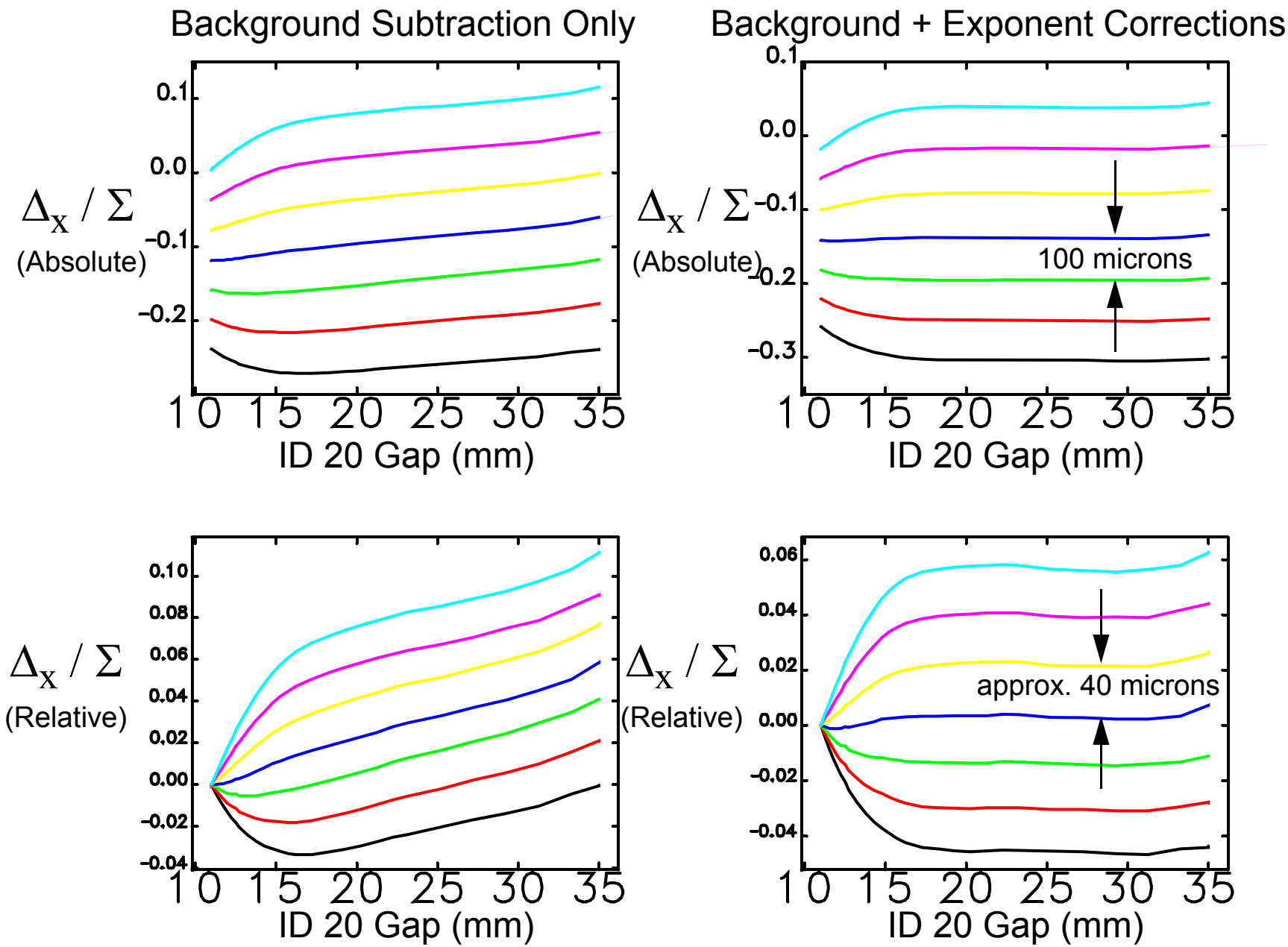




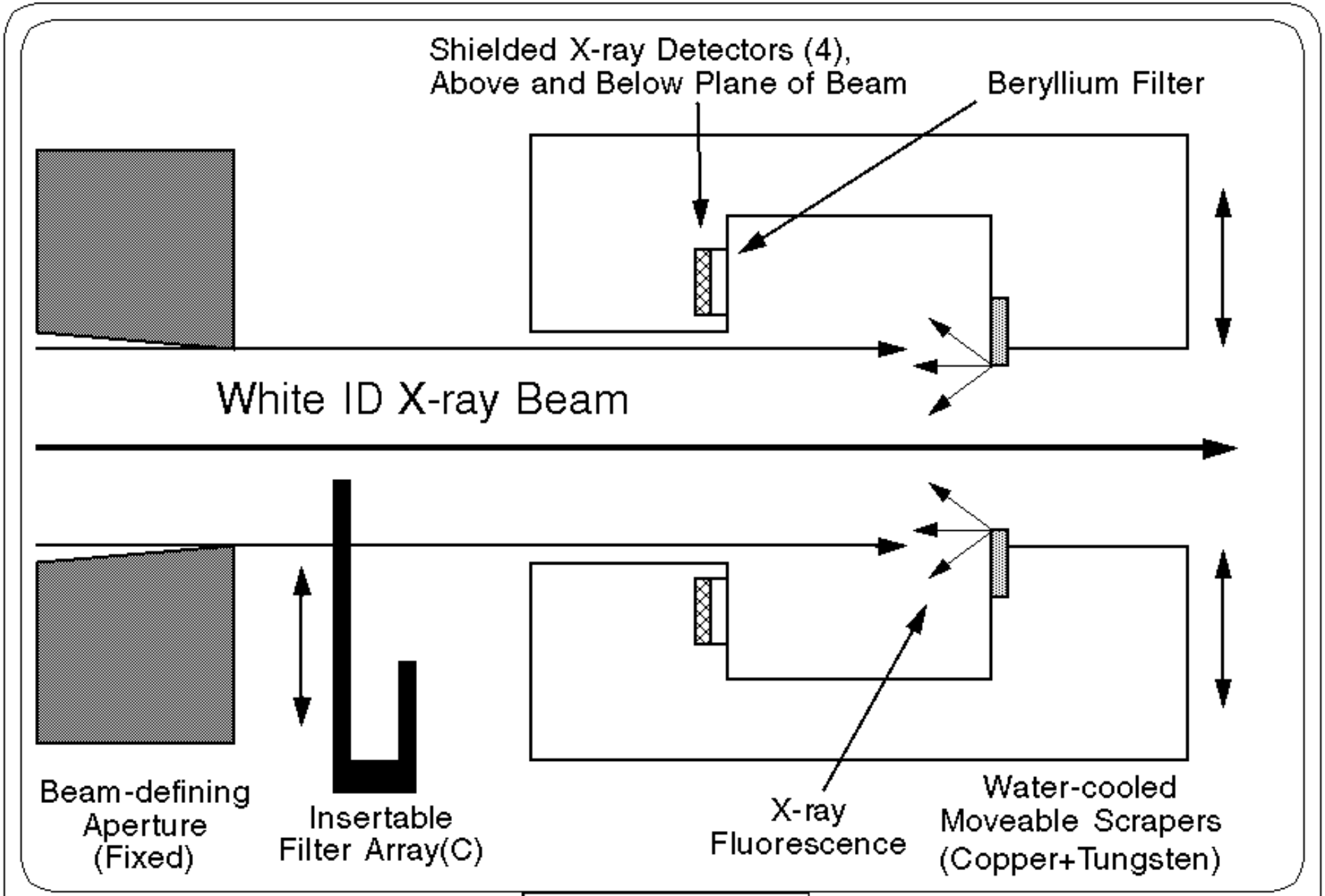




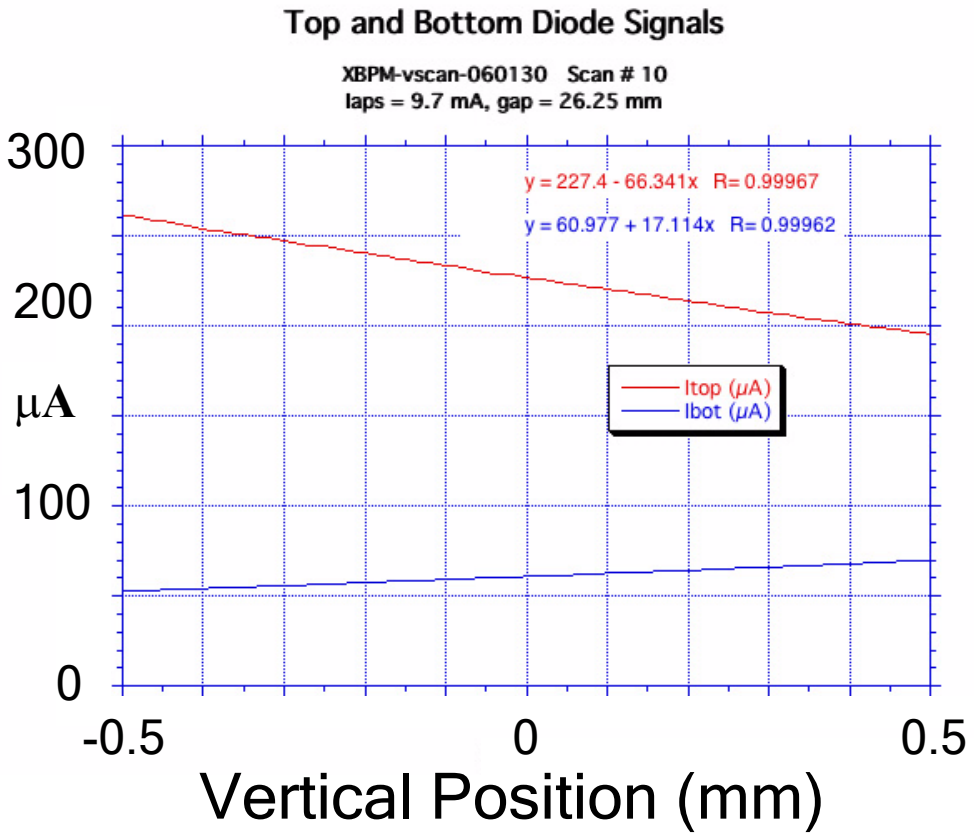
Correction of Residual ID Photon BPM Gap-dependent Systematic Errors

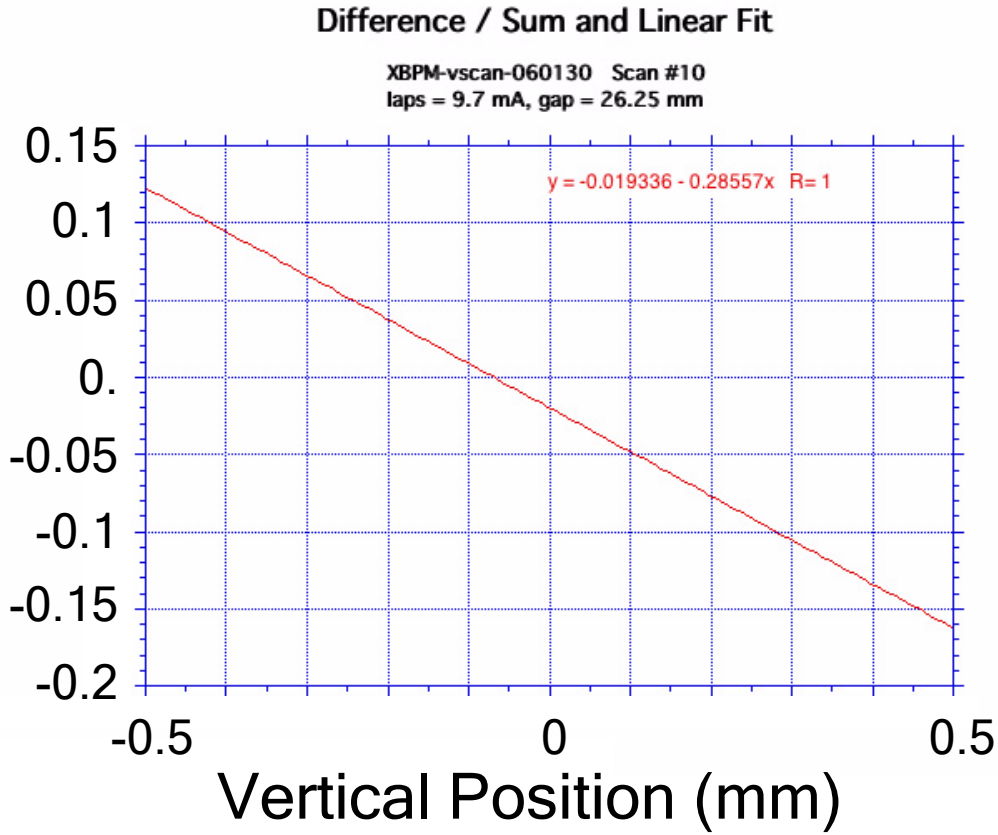


Plan View of Hard X-ray Beam Position Monitor Concept



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





@ 52 meters from source

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

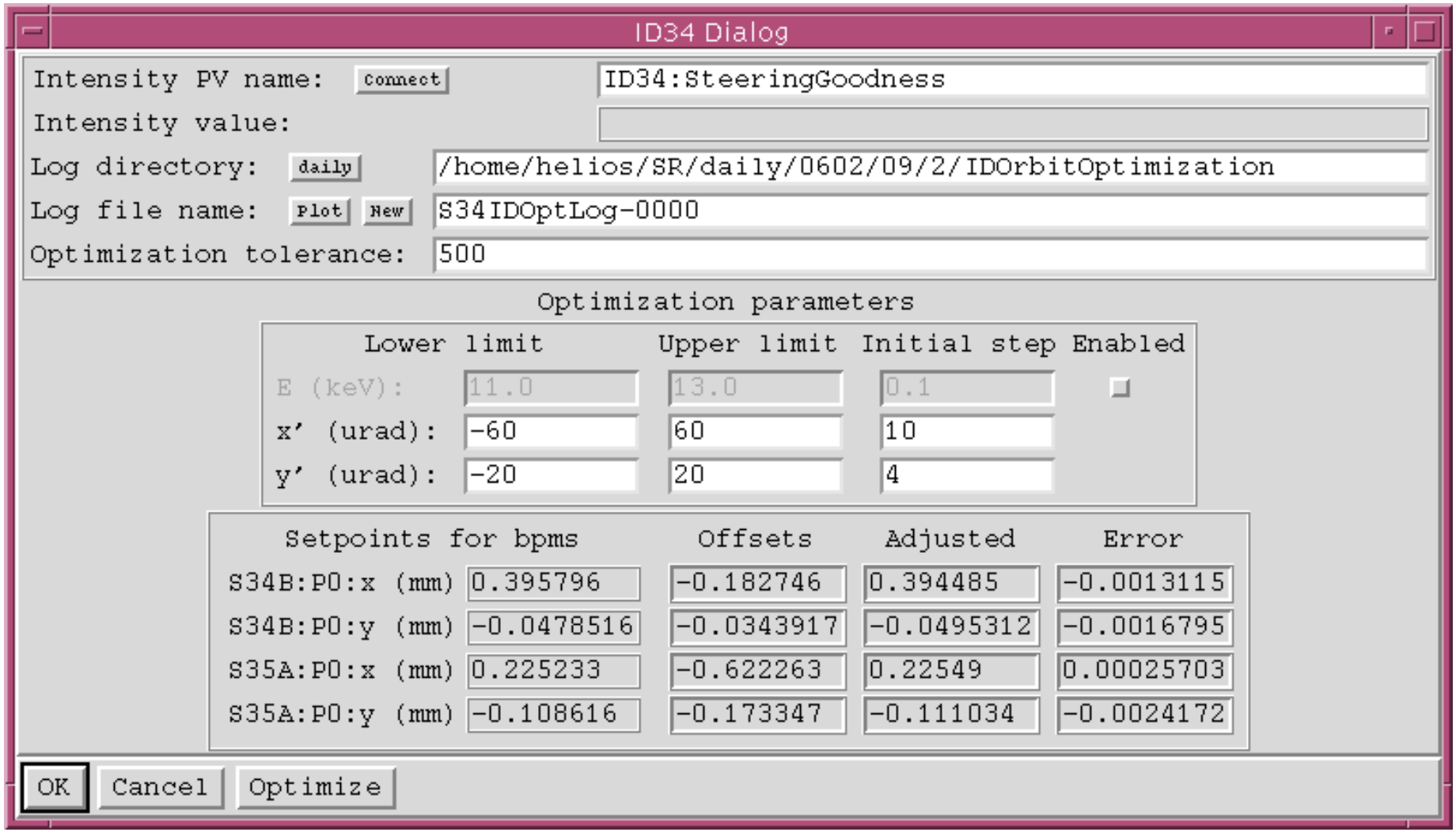
Total Stored Beam Current = 5 mA (!)

Data courtesy G. Rosenbaum

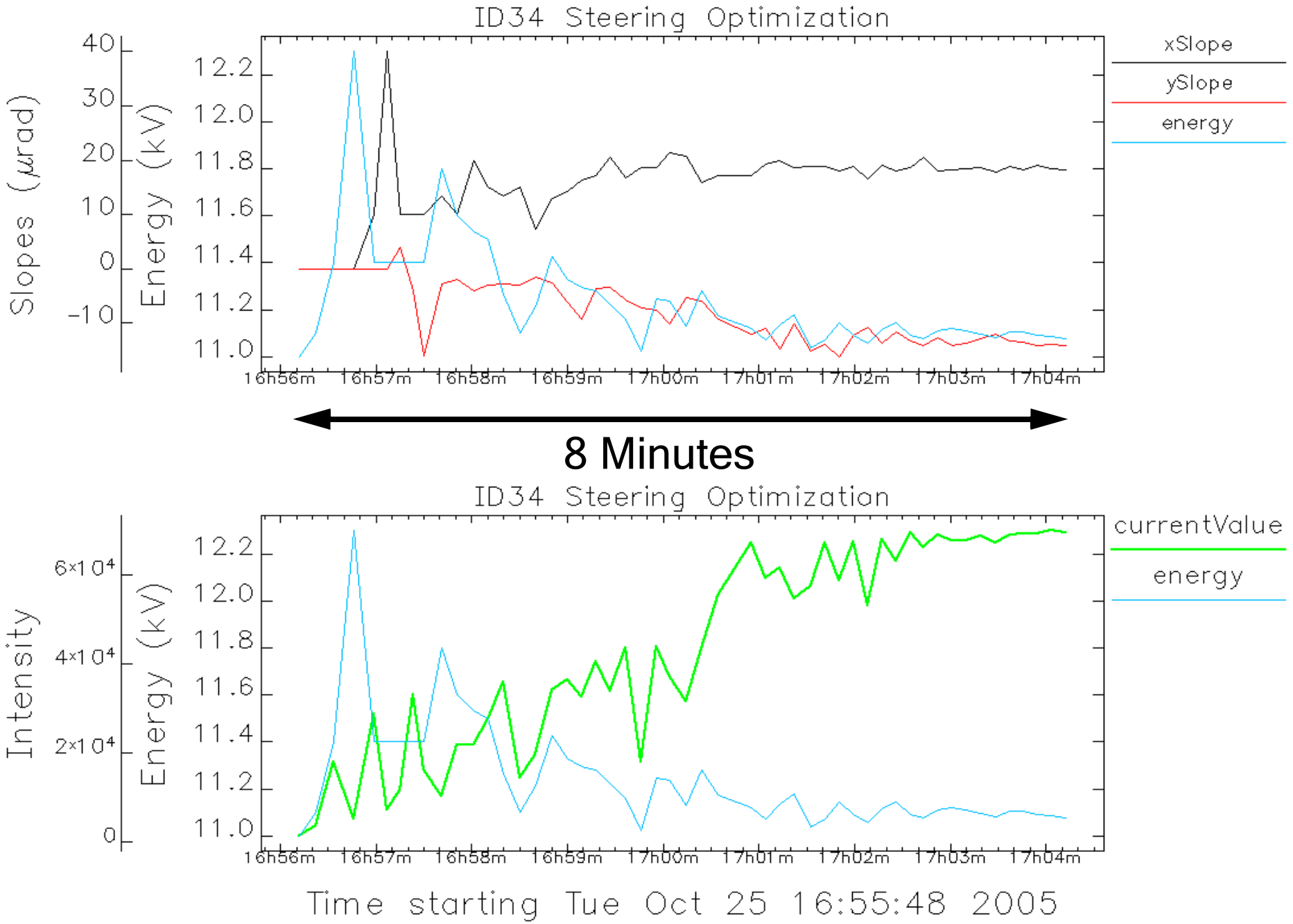
Beamline Steering Optimization

- Optimizes an intensity process variable for each beamline
  - Would like to standardize the process variable name to ID<n>:SteeringGoodness, but any other can be used.
  - PV update should be about 1 second
  - Need relatively low noise signal from the beamline
- PV can also be a trajectory quantity such as x^2 + y^2, that needs to be minimized.
- Optimizations are reproducible - After steering away, a second optimization returns the variables to previously optimized values.
- Takes about 10-15 minutes

Beamline Optimization



Operational Analysis Group Software



Data
Courtesy L. Emery (OAG)

Portable Detector Suite

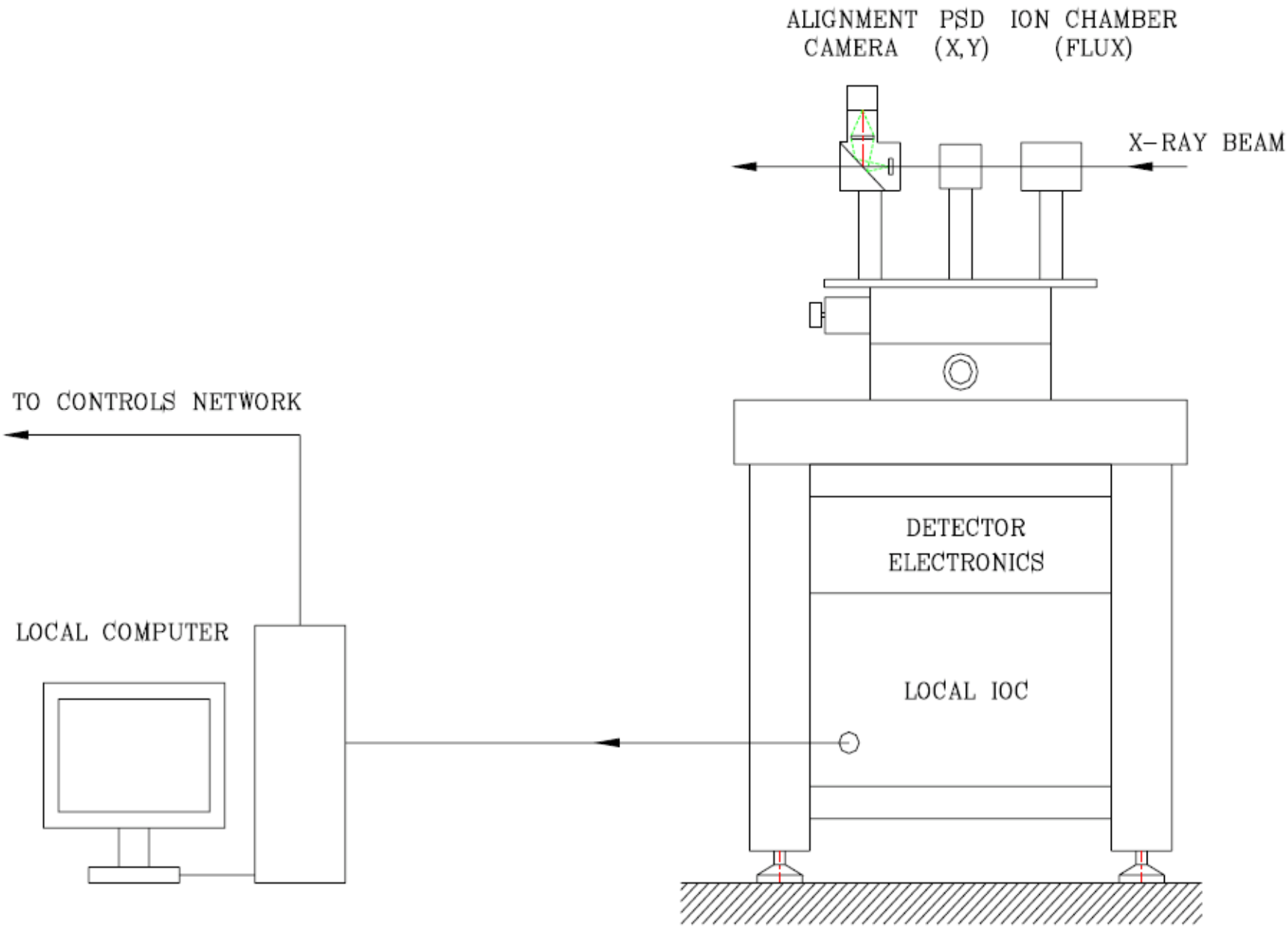
- Objective is to quantitatively characterize end-station x-ray beam properties from one beamline to the next.

  - Flux, spectrum, stability of beam centroid and size

- Currently funded project (FY06) in AOD-DIAG

- Uses standard commercial detectors

SCHEMATICS OF DETECTOR ASEMBLY FOR FY06



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 installation
- Proliferate OAG beamline optimization to more beamlines
- 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