ADVANCED PHOTON SOURCE
APS OPERATIONS DIVISION

Experience with Insertion Device Photon Beam Position Monitors at the APS

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Argonne National Laboratory

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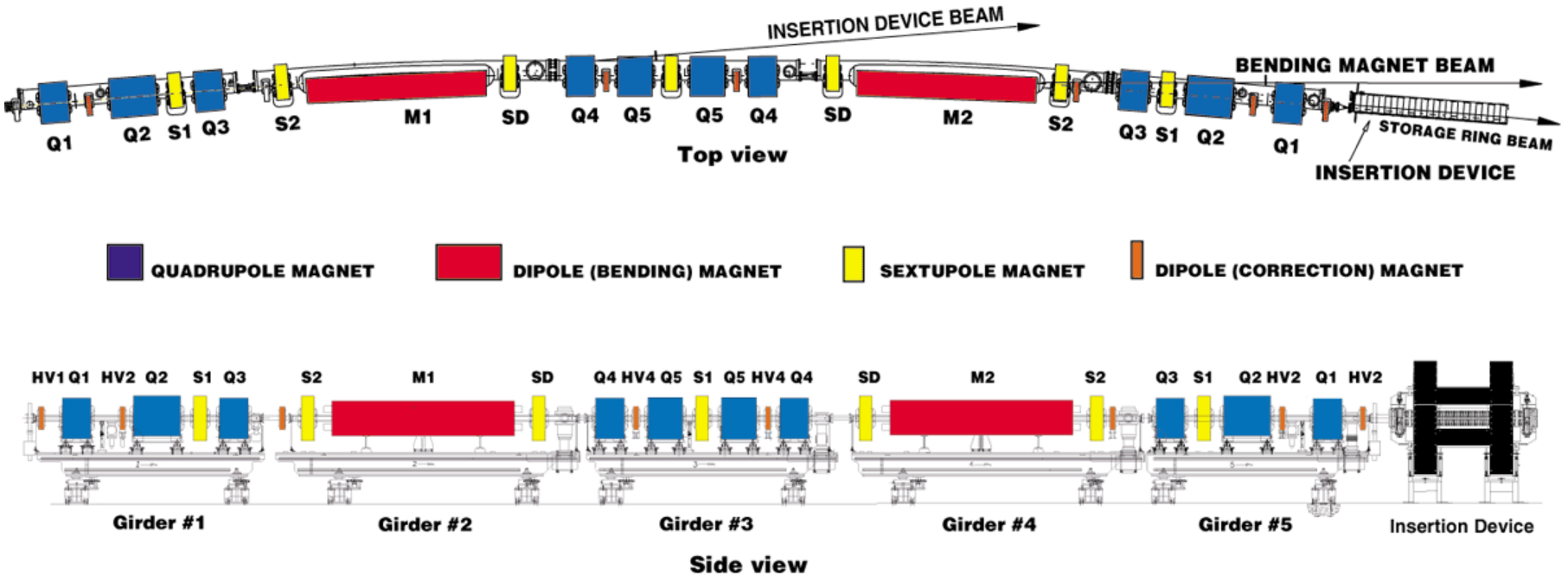
Office of Science Laboratory
Operated by The University of Chicago

Office of Science
U.S. Department of Energy

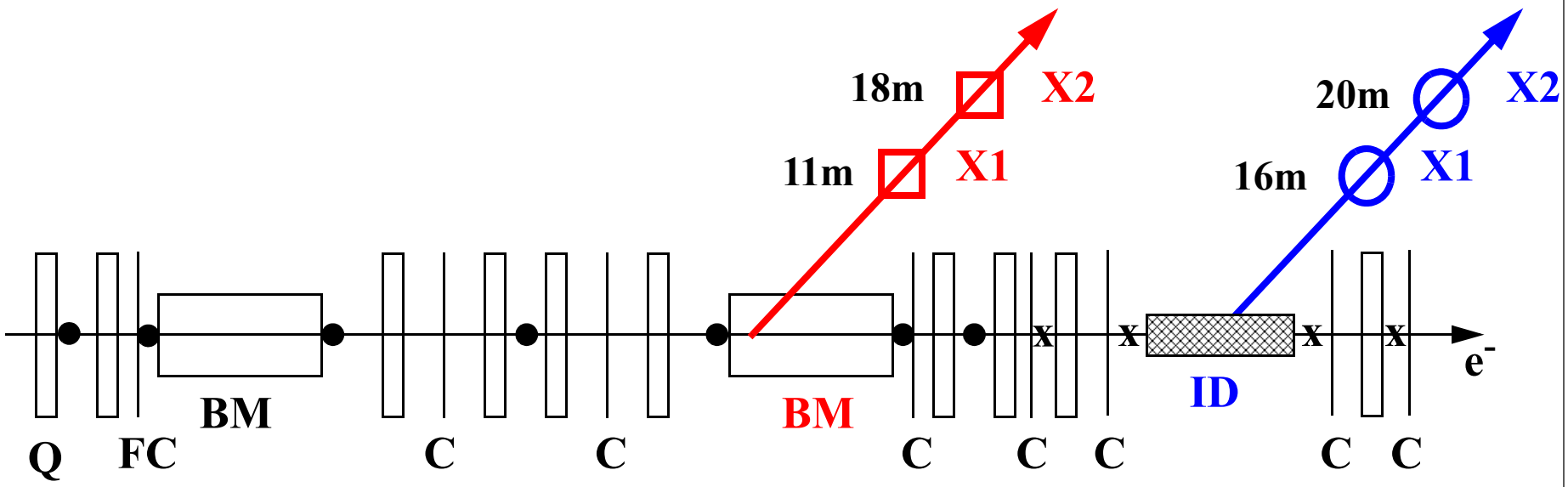
One Sector of the Advanced Photon Source Storage Ring



27.6 meters

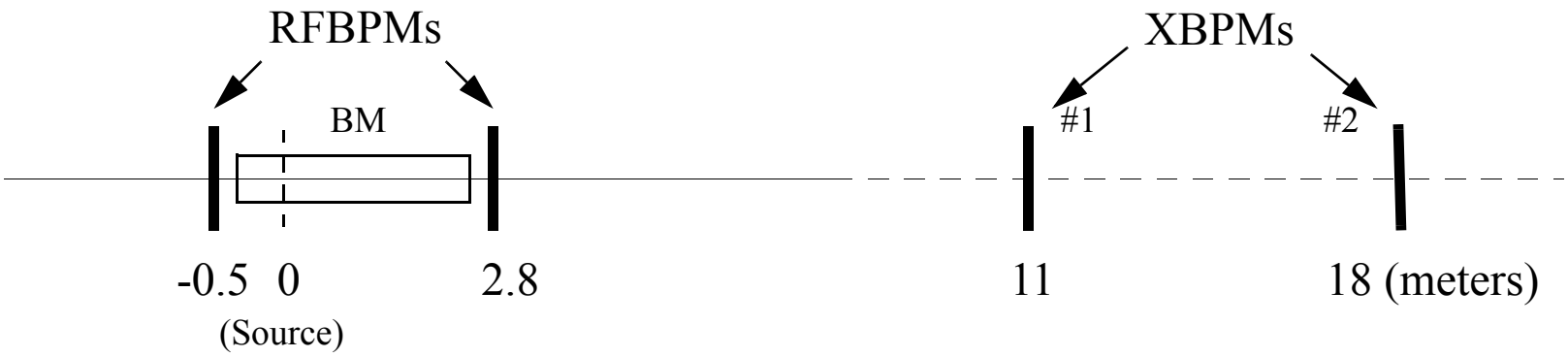
(The APS has forty sectors - 1104 meters total circumference)

Beam Position Monitors and Magnets in One Sector

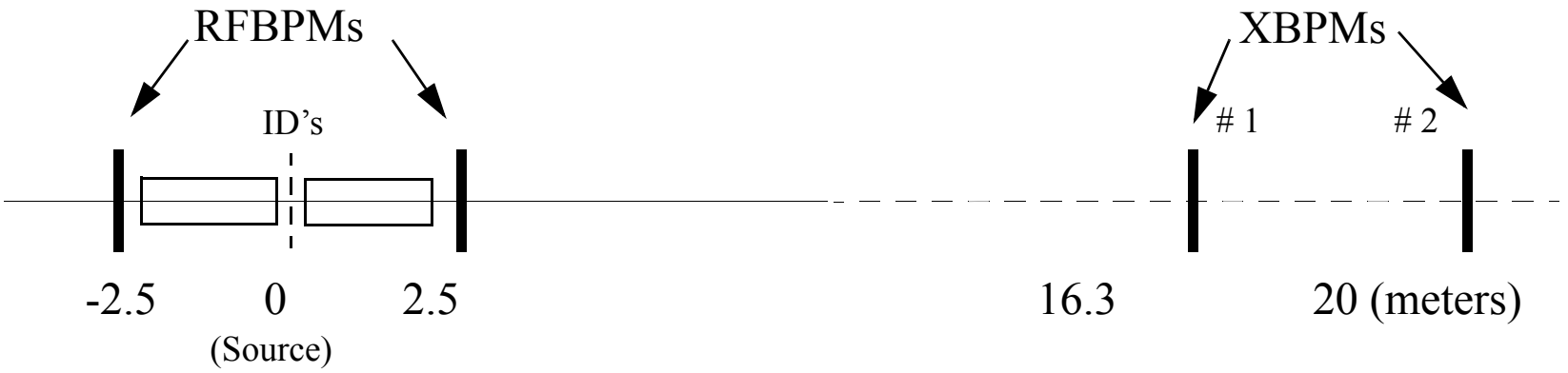


- ● : Broad-band RF Beam Position Monitors (7) (Turn-by-Turn)
- x : Narrow-band RF Beam Position Monitors (4) (~ 300 Hz)
- □ : BM X-ray Beam Position Monitors (2 - Vertical Only) (~165 Hz)
- ○ : ID X-ray Beam Position Monitors (2) (~165 Hz)
- FC : "Fast" Corrector Magnet (1) (~ 1000 Hz)
- C : "Slow"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

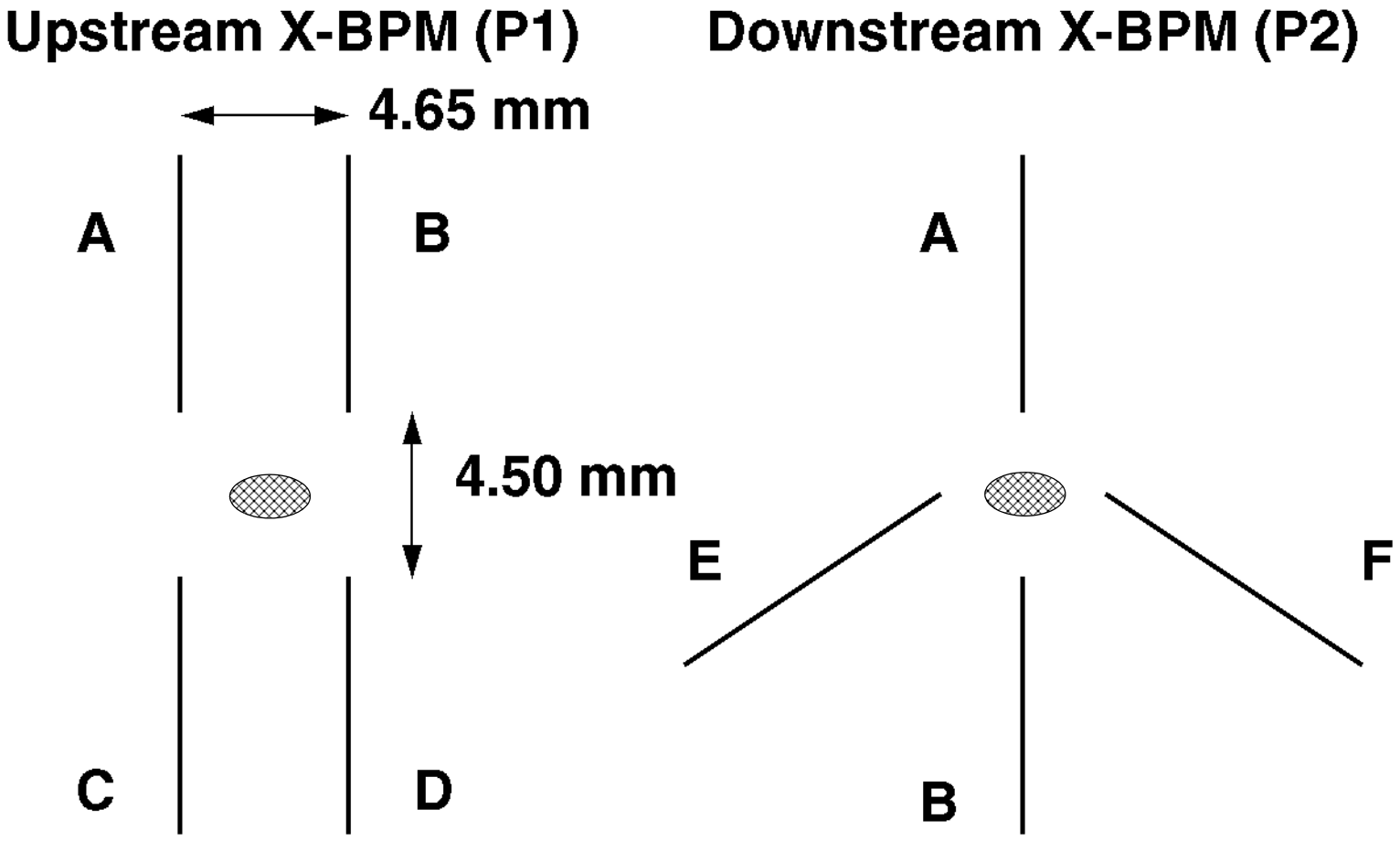
Bending Magnet and BPM Arrangement



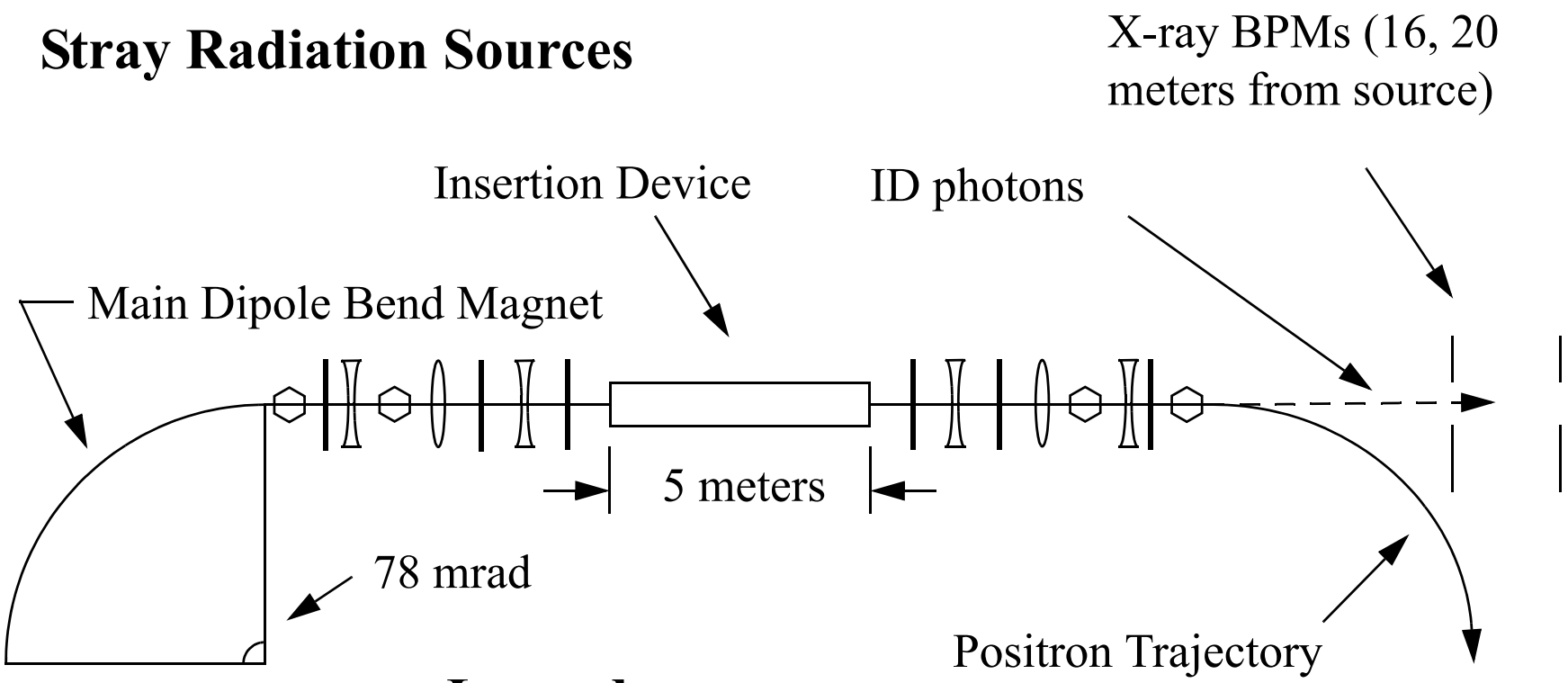
Insertion Device and BPM Layout



Insertion Device
Photon Beam Position Monitor
Blade Geometry



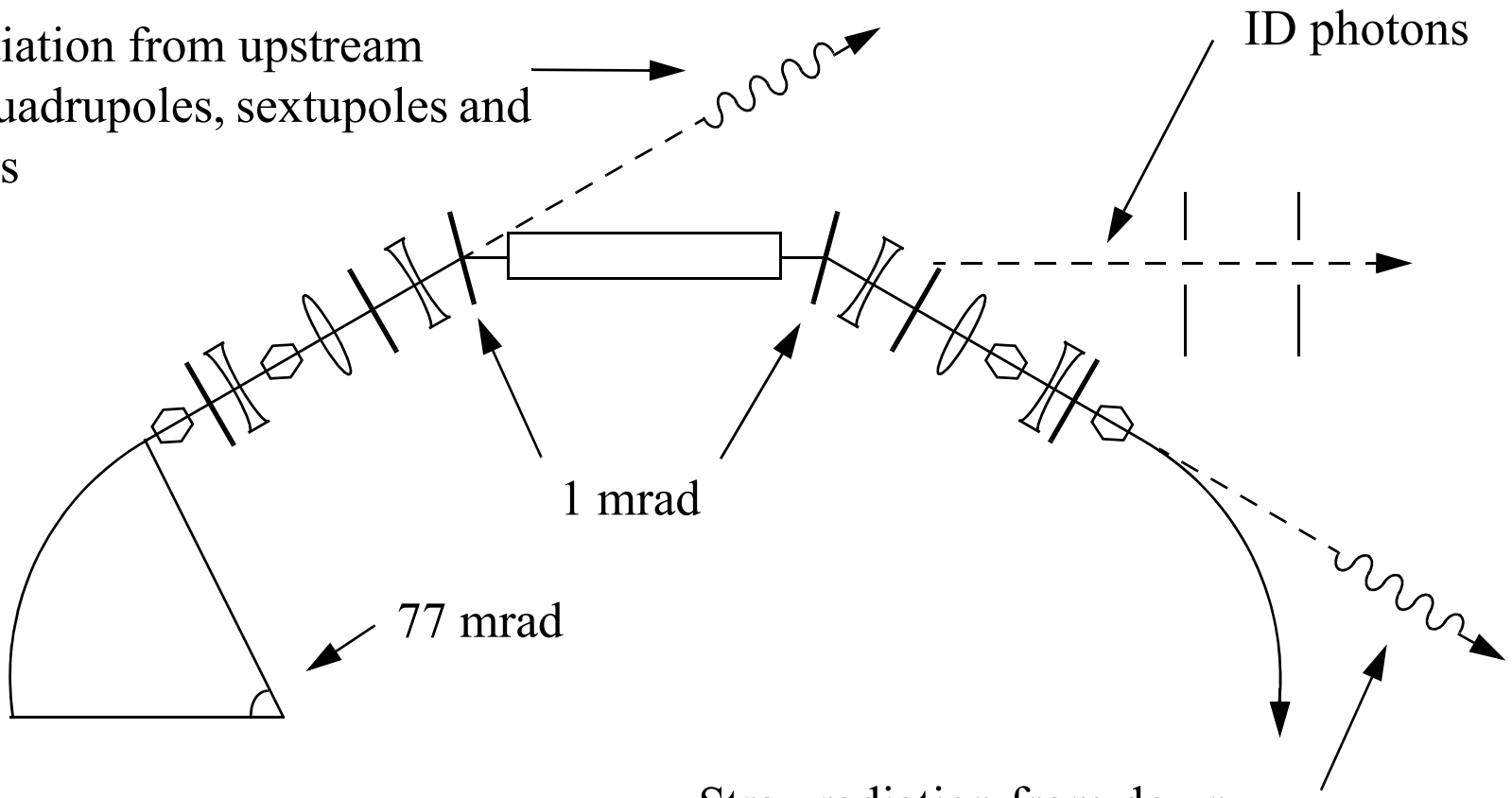
Stray Radiation Sources



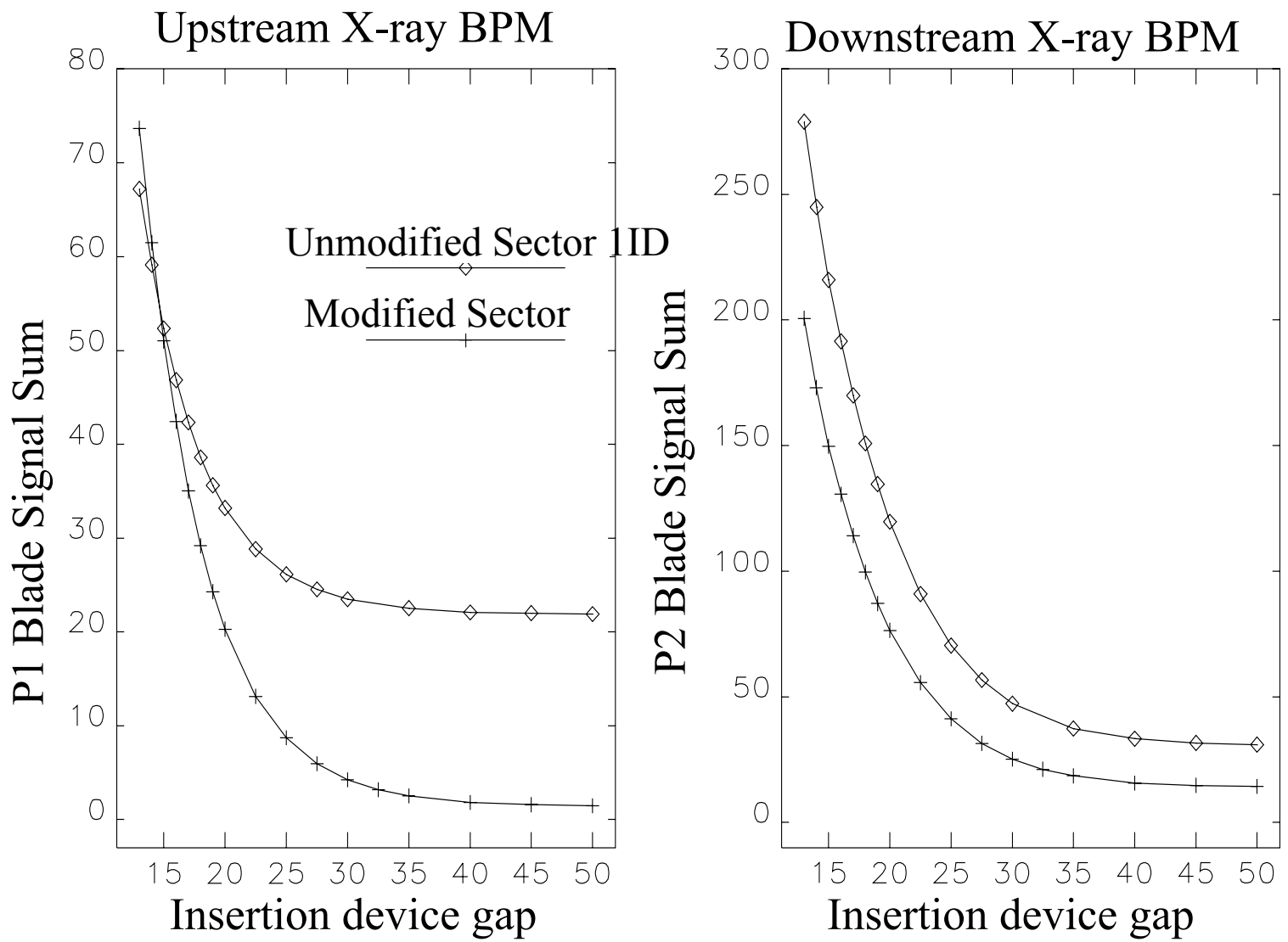
Legend

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

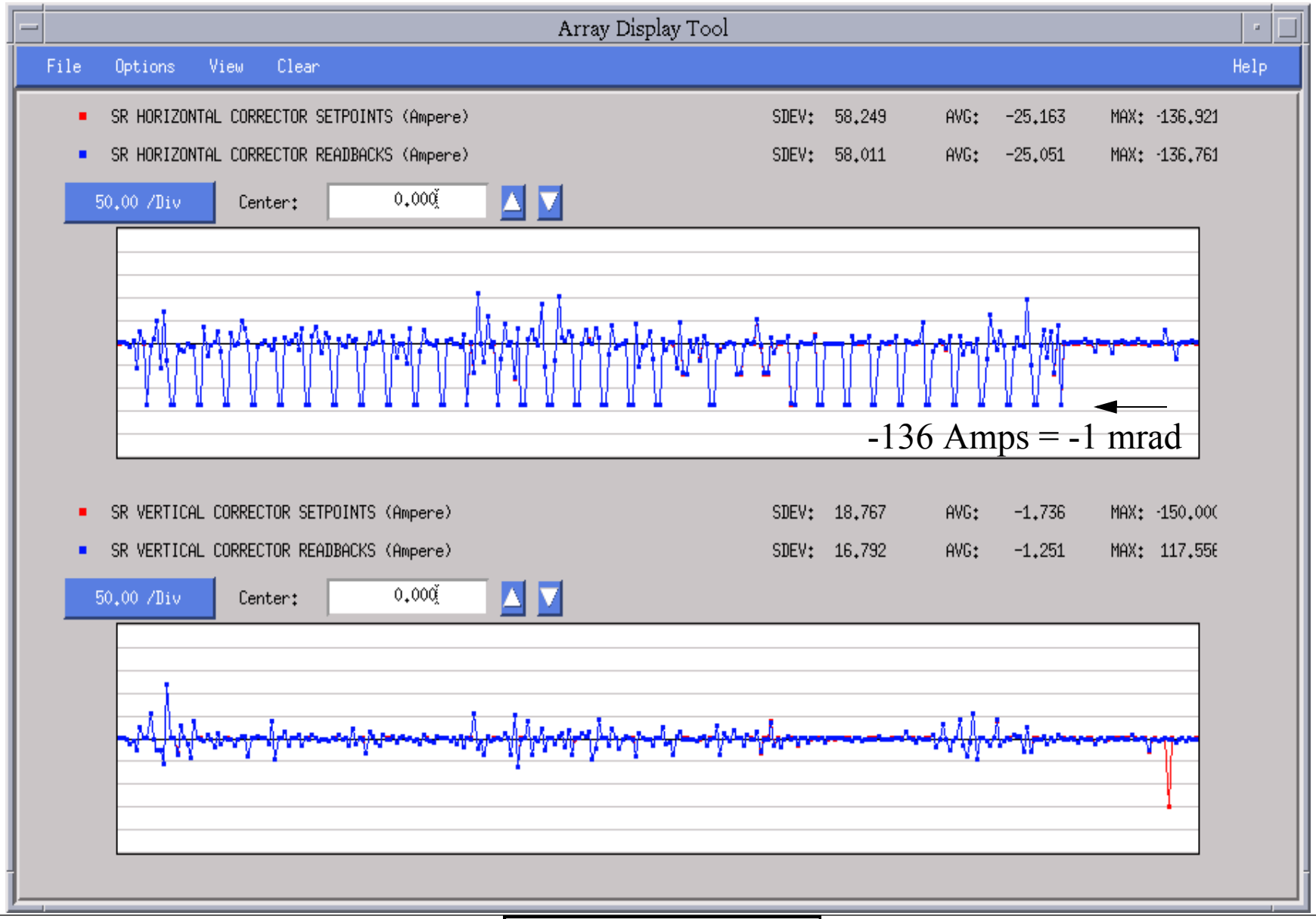
Re-direction of Stray Photons by Girder Alignment*



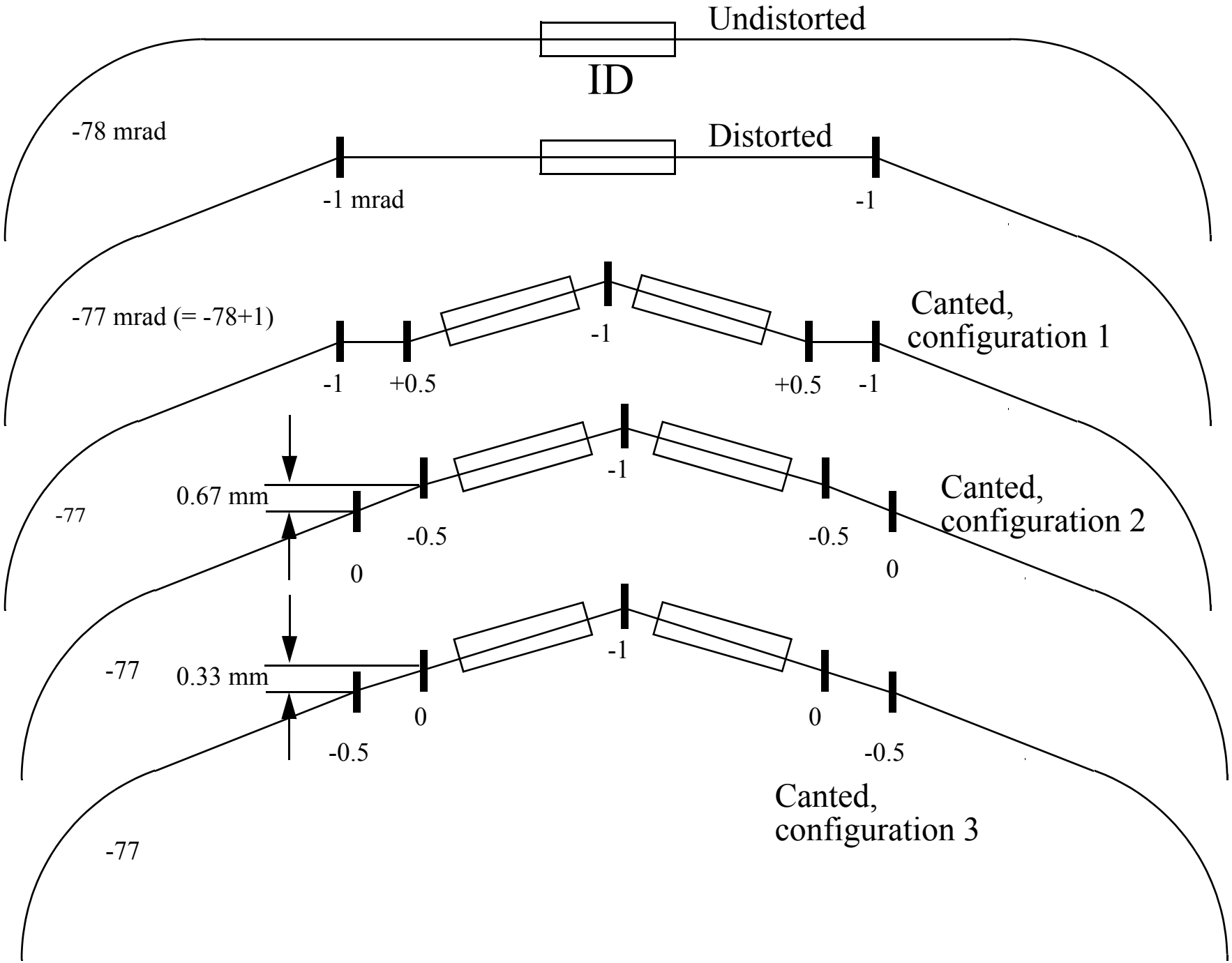
*Phys. Rev. ST Accel. Beams 2, 112801 (1999)


Upstream X-ray BPM
P1 Blade Signal Sum
80
70
60
50
40
30
20
10
0
15 20 25 30 35 40 45 50
Insertion device gap
Unmodified Sector 1ID
Modified Sector
Downstream X-ray BPM
P2 Blade Signal Sum
300
250
200
150
100
50
0
15 20 25 30 35 40 45 50
Insertion device gap

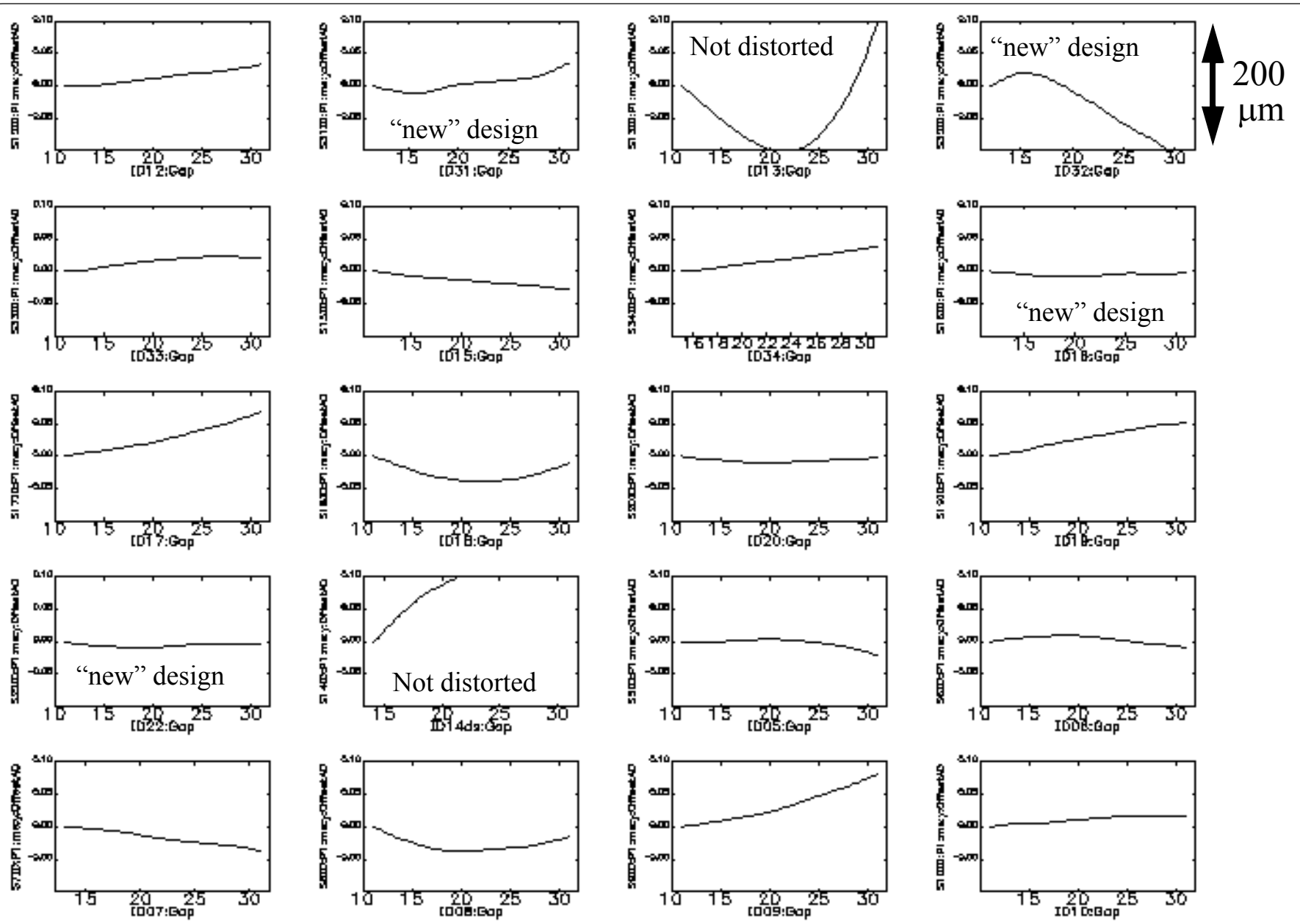
Raw Corrector Settings



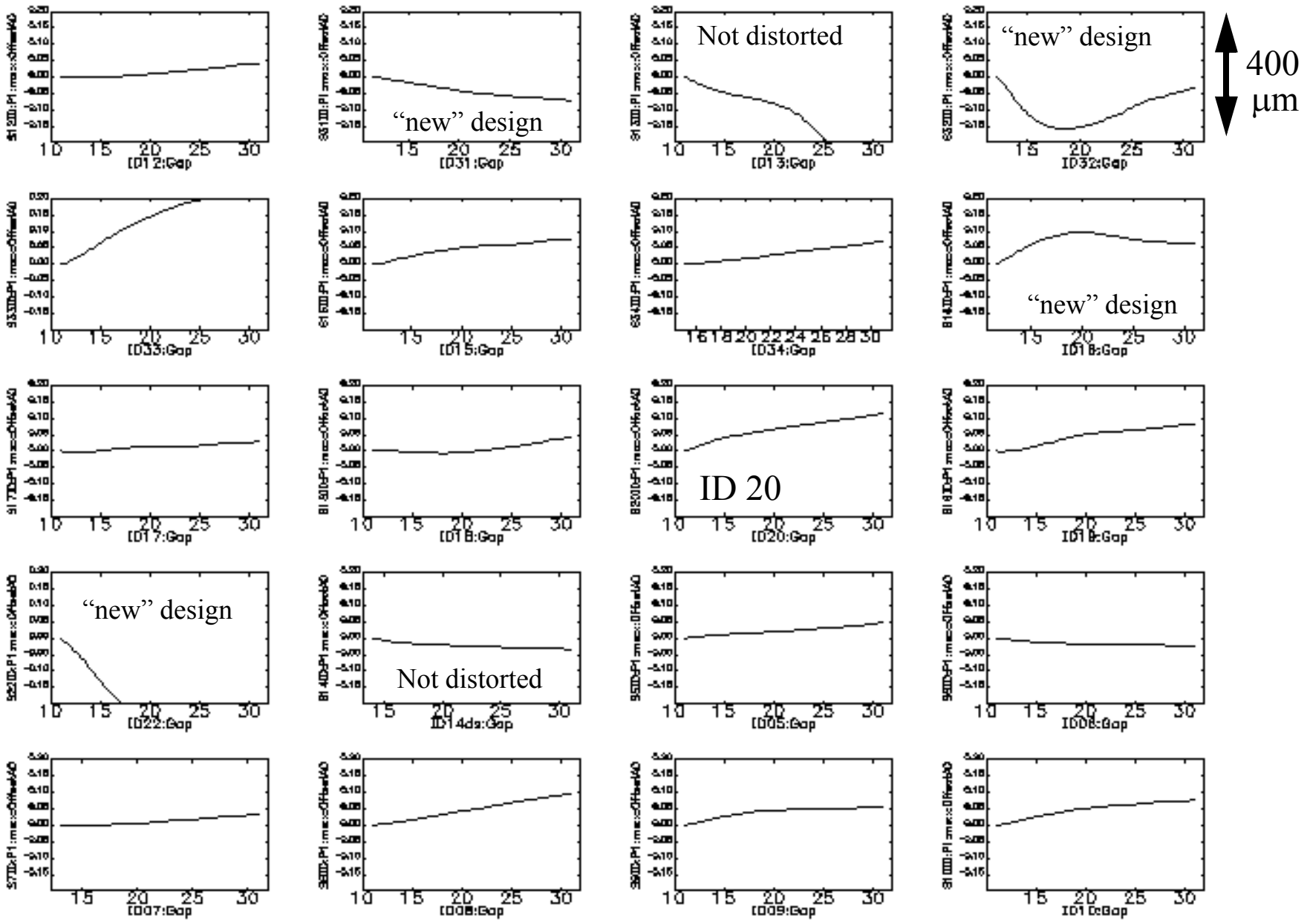
Geometries of Canted Undulators and decker Distortions



BPM Offset vs. Gap Lookup Tables (Vertical)

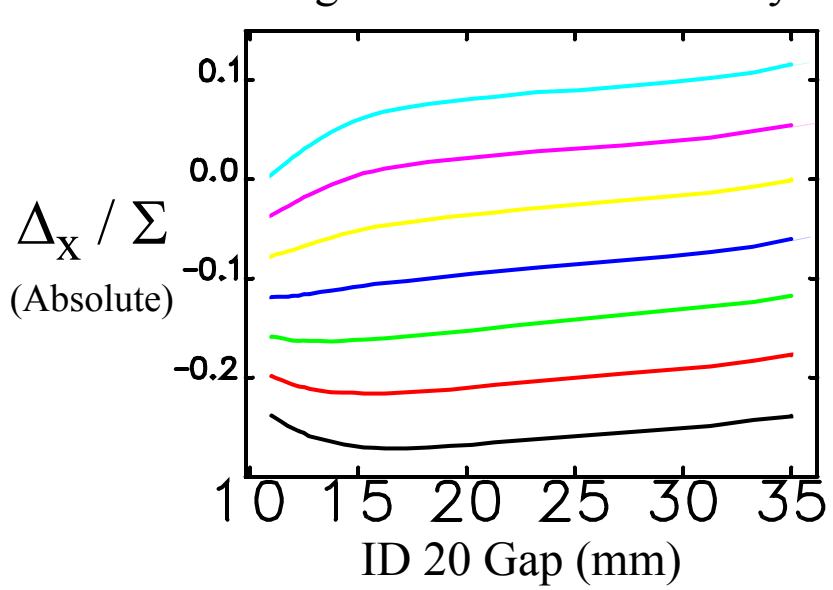


BPM Offset vs. Gap Lookup Tables (Horizontal)

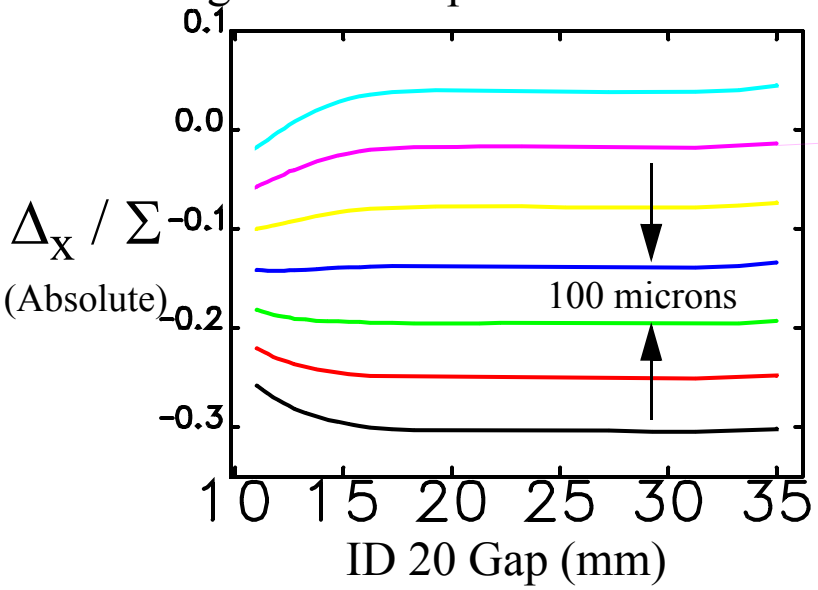


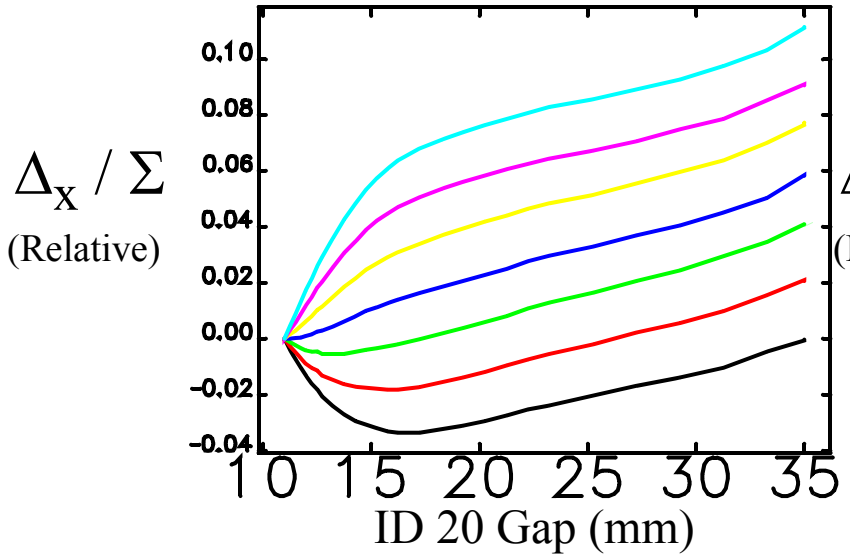
Correction of Residual ID Photon BPM Gap-dependent Systematic Errors

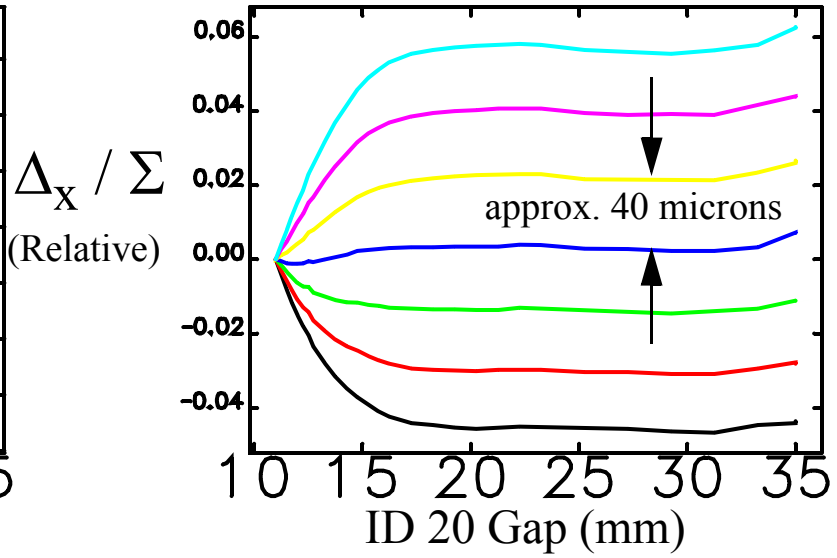
Background Subtraction Only



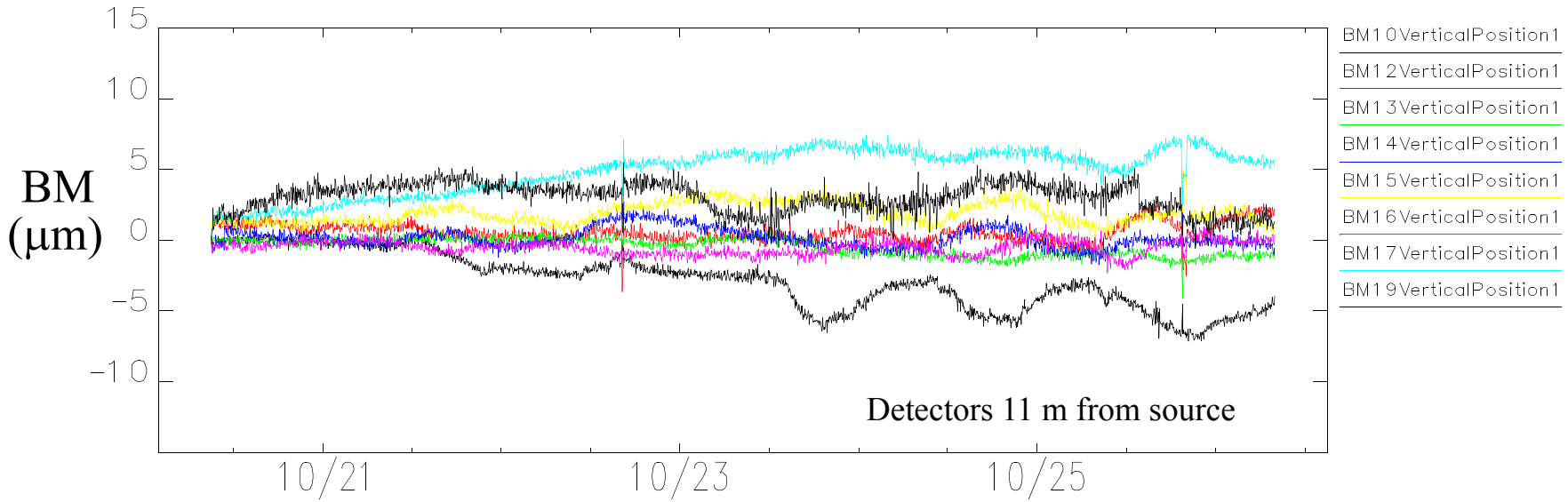
Background + Exponent Corrections

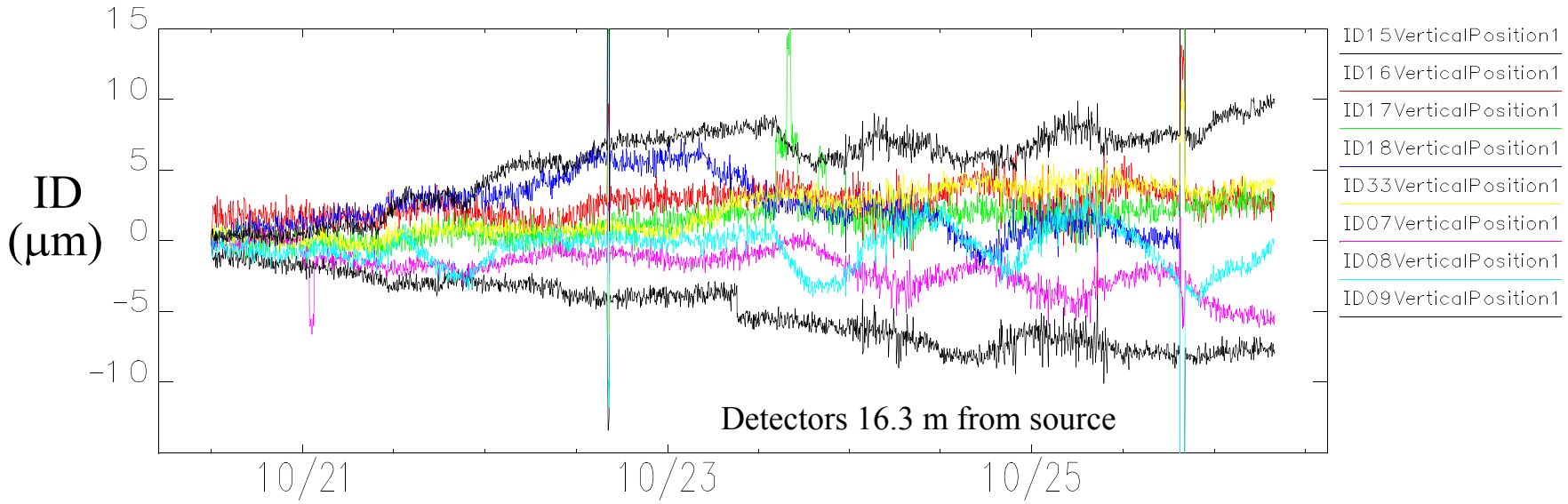






Long Term Drift of BM and ID Photon BPM Readbacks





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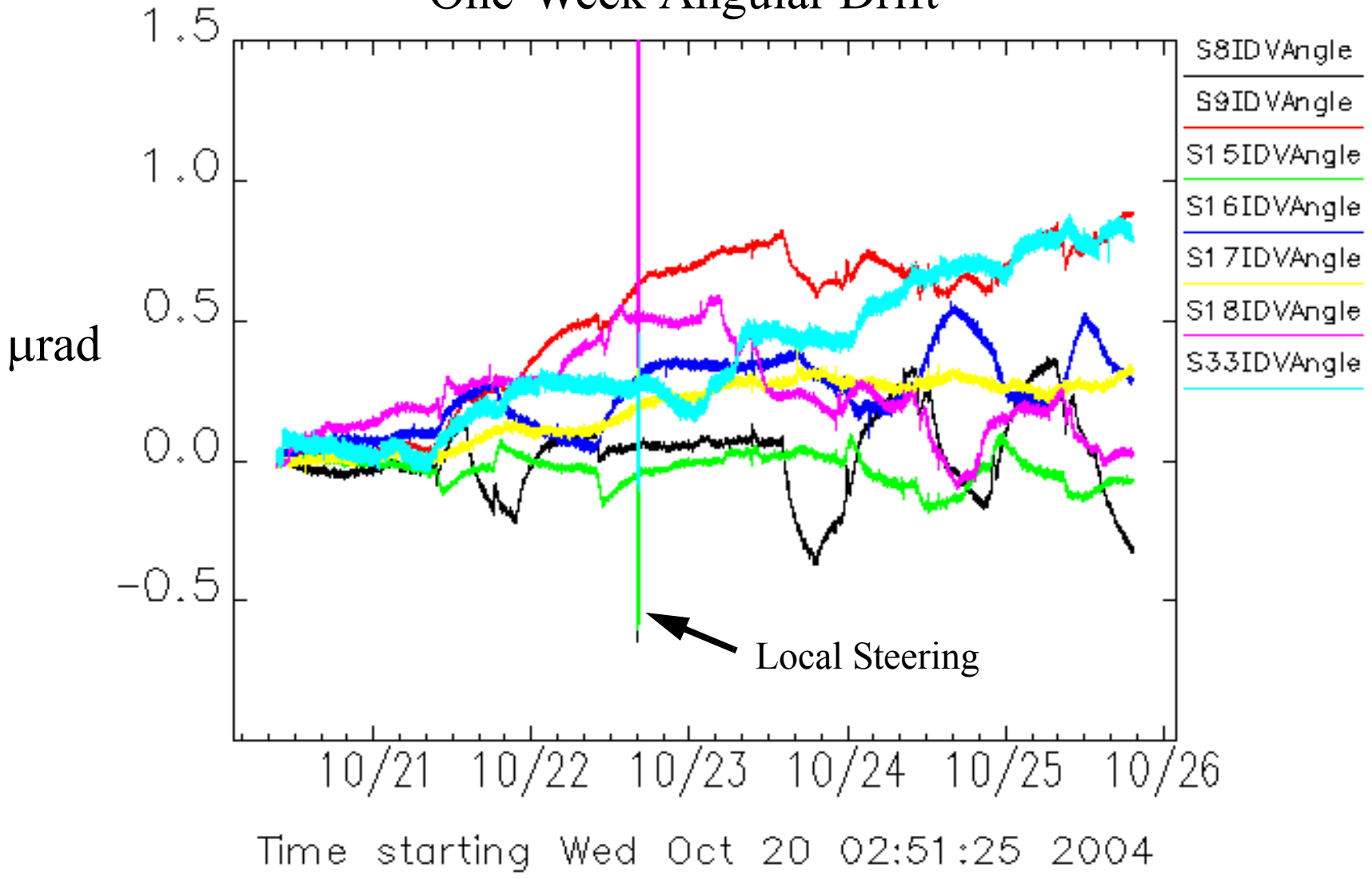
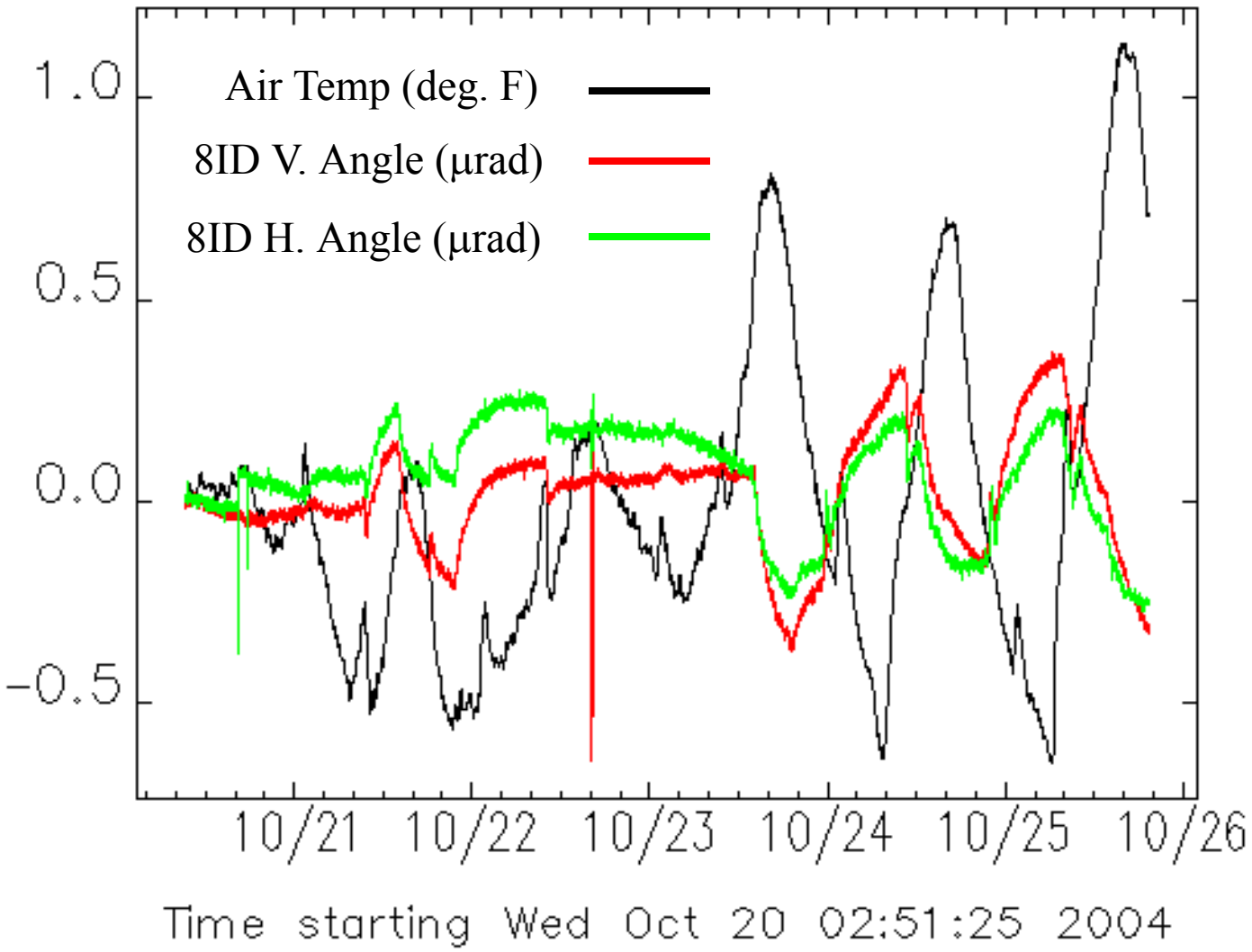
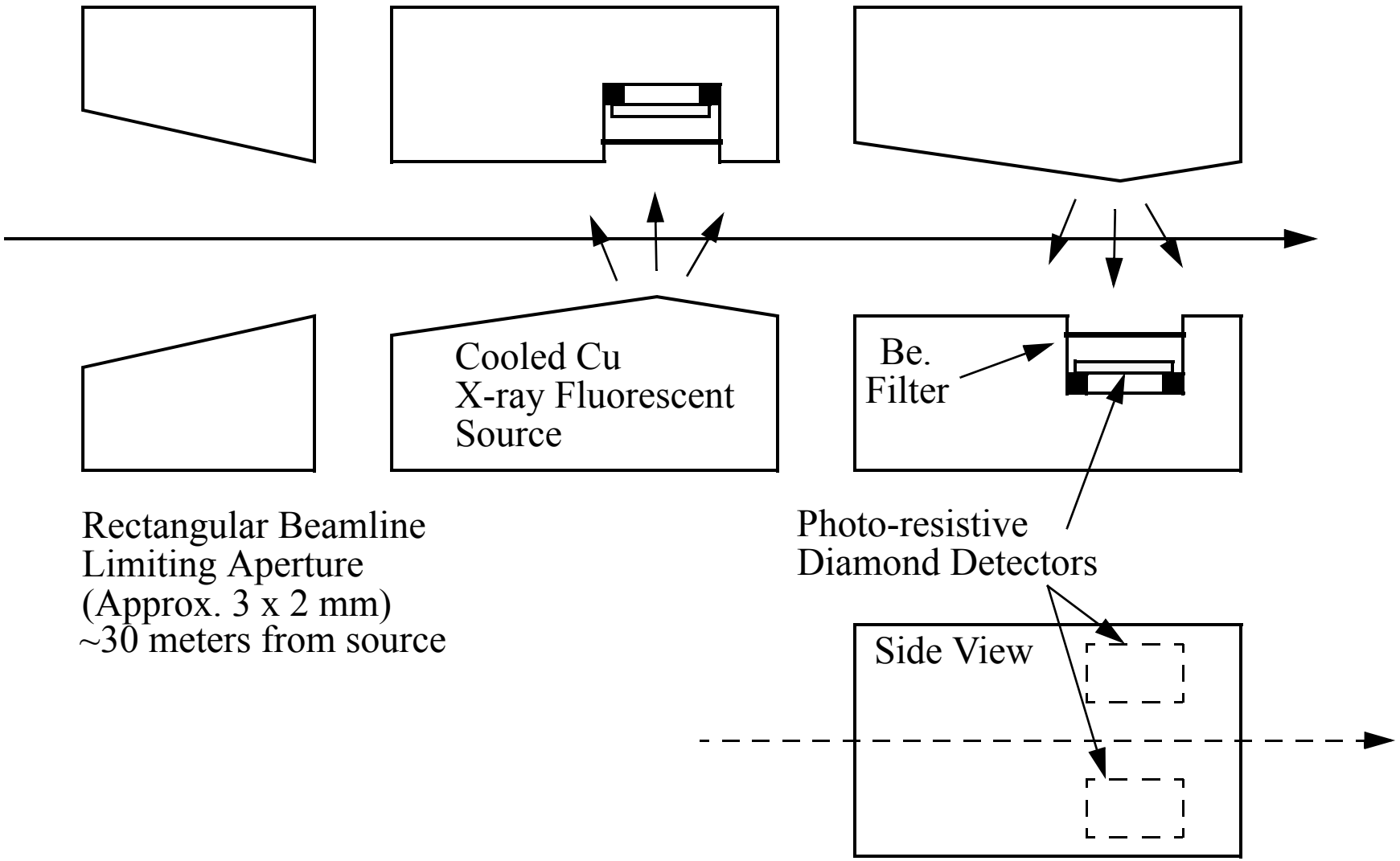
One-Week Angular Drift

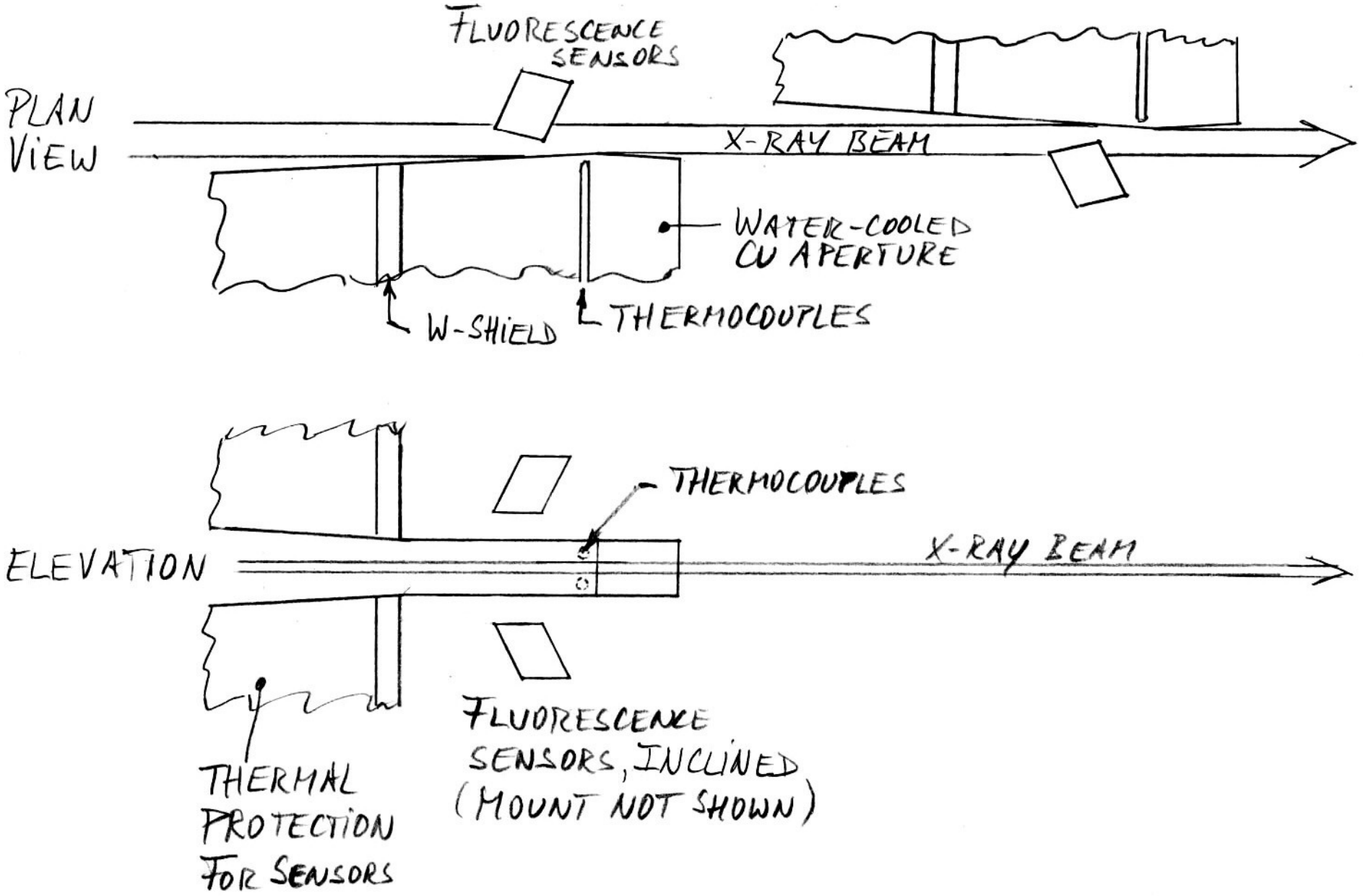


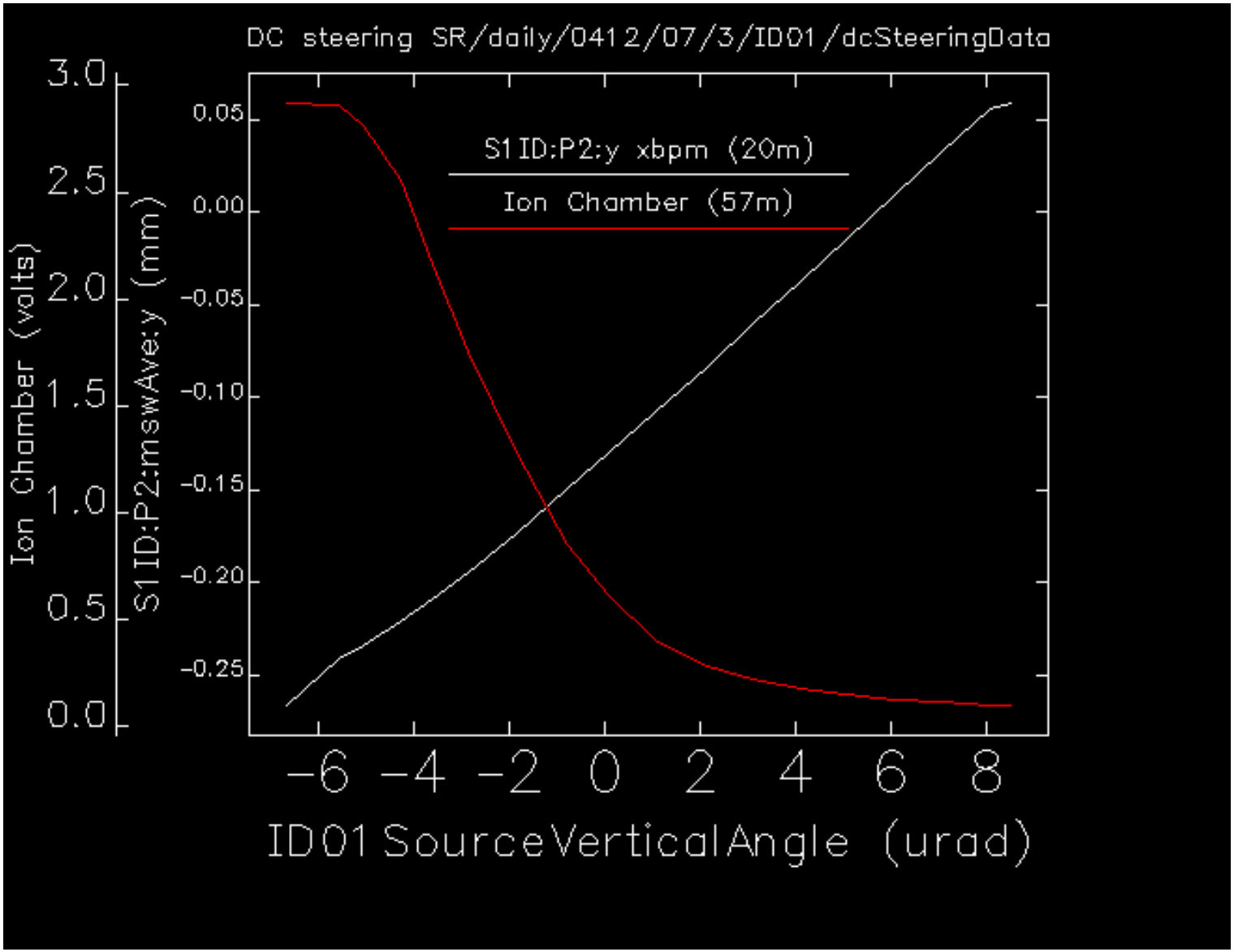
Local Tunnel Air Temperature Impacts Pointing Stability



Conceptual Design of Hard X-ray Beam Position Monitor (Top View)




PLAN VIEW
FLUORESCENCE SENSORS
X-RAY BEAM
WATER-COOLED CU APERTURE
W-SHIELD
THERMOCOUPLES
ELEVATION
THERMOCOUPLES
X-RAY BEAM
THERMAL PROTECTION FOR SENSORS
FLUORESCENCE SENSORS, INCLINED (MOUNT NOT SHOWN)


DC steering SR/daily/0412/07/3/ID01/dcSteeringData
S1ID:P2:y xbpm (20m)
Ion Chamber (57m)
Ion Chamber (volts)
S1ID:P2:mswAve:y (mm)
ID01SourceVerticalAngle (urad)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-6 -4 -2 0 2 4 6 8

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).