Improvement of Storage Ring Beam Position Missteering Interlock Reliability using Narrowband BPMs and Digital Beam Position Limit Detectors

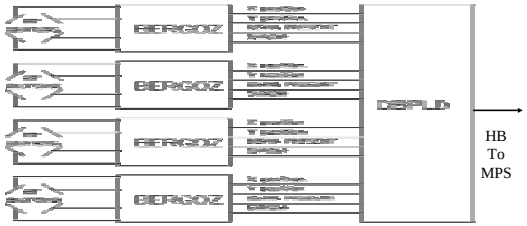
O. Singh, L. Erwin, and A. P. Pietryla
Advanced Photon Source, Argonne National Laboratory, Argonne Illinois, USA

Abstract

An upgrade of the APS Storage Ring beam position missteering interlock system for the high power insertion device beams is in progress and status will be discussed. The existing system hardware configuration, installed in 1995, has a number of long-standing maintenance and operations deficiencies, and is prone to inducing false trips. An updated digitizing beam position limit detector was developed to interface with new narrowband beam position monitor (bpm) electronics. This system is robust, reliable and primarily utilizes existing hardware.

Eighty new channels of narrowband rf bpm electronics are presently being installed in the APS storage ring. Many of these new units will serve the dual purpose of enhancing beam stability while providing more reliable beam missteering interlock capability.

Missteering Interlock system



Digital Beam Position Limit Detector module (DBPLD)

1) Processes four BPMs (8 channels) to provide interlock protection for 2 insertion devices
2) Employs digitizers with 0.03 millisecond conversion time to collect and process BPM data
3) Maintains "low" and "high" limit values for each BPM, providing larger trip window
4) Keeps a watch dog on each BPM functionality by monitoring presence of the sync signal
5) Monitors "beam present" and ID gap status to arm/disarm interlock system
6) Provides heartbeat (HB) RF trip signal when beam position falls out of limit conditions

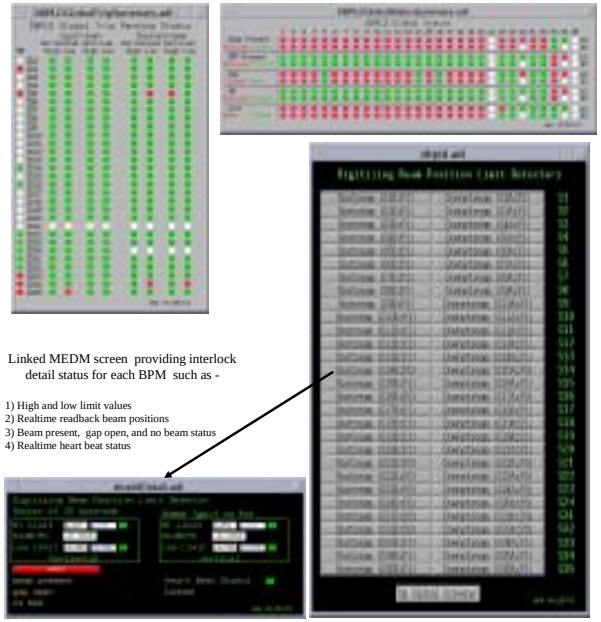
Narrowband Beam Position Monitor Module (Bergoz)

1) Packaged in a single-height, rugged , Industrialized Euro card module
2) Functions as standalone BPM unit requiring no computers and software – easy start up
3) Provides fast beam position analog signals with less than 0.4 millisecond rise time
4) Included in orbit control as a 2nd pair of narrowband BPM for enhancing beam orbit stability

RF Buttons

1) Eight interlock systems are connected to the small gap chamber RF buttons (P0) where 4 mm-dia buttons are installed in rotated (optimized) configuration.
2) With un-rotated 4 mm-dia button configuration, the vertical position exhibits transient during top-up injection horizontal kick and, if used for interlock system, will cause false trips. At a given y0 vertical position, the 3-D simulation plots show that the variation in vertical sum over diff signal (Vy) due to horizontal kick (x0) is greatly reduced with rotated 4 mm buttons.
3) Twenty one interlock systems are connected to the standard elliptical chamber RF buttons (P1) where 4 mm-dia RF buttons are not rotated (optimized).

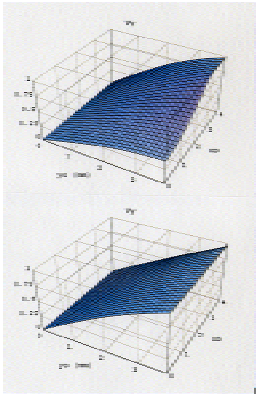
Global MEDM Screens Providing Real-time Interlock System Status



Linked MEDM screen providing interlock detail status for each BPM such as -

1) High and low limit values
2) Realtime readback beam positions
3) Beam present, gap open, and no beam status
4) Realtime heart beat status

3-D Simulation plots for normalized vertical sum/diff (Vy) for small gap insertion device chamber's 4 mm RF buttons



Vertical diff/sum (Vy) With Unrotated buttons

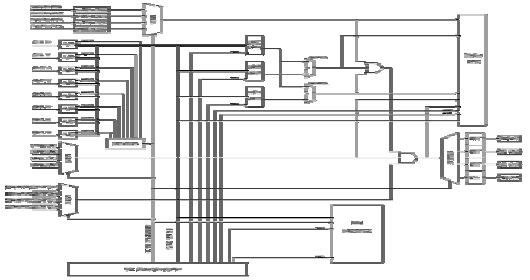
Vertical diff/sum (Vy) With Rotated buttons

DBPLD module

Narrowband BPM module

4mm Rotated RF button Assembly

Digital Beam Position Limit Detector module block diagram



References

1. **"Design of the Digitizing Beam Position Limit Detector" – R. Merl and G. Decker; 1998 Beam Instrumentation workshop, Stanford, California.**
2. **"The APS Machine Protection System" – R. Fuza et.al; 1996 Beam Instrumentation Workshop, Argonne, Illinois.**
3. **"Calculating BPM Coefficients with Green's Reciprocation Theorm" – S. H. Kim; L.S. Note**