

APS Upgrade Beam Diagnostics and R&D Results

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Beam position measurement diagnostics required for the APS upgrade (APS-U) are driven by challenging beam stability requirements resulting from the small beam size due to the machine design emittance of 42 pm. Similarly beam size measurements to derive emittance and energy spread are also made difficult by the small beam size. The AC stability specification states that rms beam motion must be corrected to 10 % the rms beam size at the insertion device source points from 0.01 to 1000 Hz. The vertical plane has the tightest rms AC stability requirement of 400 nm which approaches the noise floor of the bpm electronics. In addition long term drift over a period of 7 days is required to be 1 micron or less. The small beam emittance results in beam sizes as small as 1 micron depending on the machine lattice X-ray source and coupling setting. Major diagnostic systems for the APS-U to address beam stability and beam size measurements include rf beam position processing using commercially available fpga based bpm processors, new X-ray beam position monitors based on hard X-ray fluorescence from copper, absolute and relative beam size measurement systems that utilize X-ray pinholes and a new feedback system featuring a tenfold increase in sampling rate and a several-fold increase in the number of fast correctors and bpm's in the feedback algorithm. We discuss the design of these major diagnostic systems as well as report results from R&D using them.

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