Contribution ID: **96** Type: **not specified**

Electron and Photon beam monitors

A variety of beam position and diagnostic monitor (BPDM) technologies have been proposed for the aim of maintaining the beam focusing and alignment of accelerators and beamlines in Synchrotrons and FEL. Metal wires, Compton scattering from laser beams and image currents from the electron beam are the most applied methods to estimate the performance and quality of synchrotron radiation.
We can distinguish BPDM in two main categories: BPDMs: intercepting and non-intercepting methods. While non-intercepting (such as cavity electron) BPDMs, together with a beam-based alignment system, are the best solutions for the monitor purpose, intercepting wire monitors are valuable for rough alignment, for beam size and shape measurements, and for simultaneous measurement of electron and photon beam position by detecting bremsstrahlung radiation from electrons and diffracted x-rays from the photon beam.
Wire scanners require sequential measurements in orthogonal directions. They are used successfully at SLAC to measure micron, or smaller, beam sizes. The working principles consist of sliding a wire (generally metallic) across the beam using a linear motion stage, or by steering the beam across the wire, obtaining indirectly the profile of the beam. While the beam central position resolution is determined by the properties of the stage, the beam shape reconstruction depends on the wire size: the thinner the wire, the higher the accuracy.
By using a carbon wire, simultaneous characterization of electron and photon beams is possible. High energy electrons generates bremsstrahlung, radiation while the x-ray photons are diffracted from the wire crystal structure; however the photon wavelengths that produce a detectable diffraction patterns are limited to a narrow range around 1nm. Metallic wire BPDMs: have several drawbacks: the wire size cannot be reduced over the limit imposed by the material properties and the intensity of the acquired signal is generally too high, further limiting the beam measuring resolution.
To address these problems, we substituted the metal with a microfabricated Silicon Nitride device, eventually coated with thin metal film, which allows the reduction of the radiation emission to detectable values. We produced several microfabricated prototypes consisting in Si_3N_4 bridges as small as to 2x2 um in cross section and as long as 2 mm,. Thanks to the flexibility of the fabrication process, the geometry of the wire can be easily engineered according to beam size and energy. The bridges were successfully coated with different metals (Pt-Al-Cr-Ti) in order to make them conductive and tune the emission efficiency.
With the proposed approach the size and the shape of an high energy beam could be obtained in real time in a non interfering fashion with spatial resolution in the micrometer regime.

Summary

Beam position monitors, Beam Diagnosys, wire scanner, FEL, Synchrotron beam alignment

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