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Invitation

Microwave Sensors and Sensor Systems for Accelerators

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For diagnostic applications of charged particle beams in circular and linear accelerators a considerable number of elements and systems were developed over the last 80 years. Here the discussion is mainly focused on electromagnetic sensors which refer to structures interacting with the image current of the beam on the inner surface of the vacuum chamber and which are not intercepting the beam. Also synchrotron light emitted by any changed particle on a curved trajectory in the frequency range from about 1 GHz up to very hard gamma rays plays an important role in beam diagnostics. Classical electromagnetic sensors include wall current monitors capacitive pick-ups and a large family of directional coupler like structures for measurements of longitudinal and transverse emittance, tune and chromaticity . Beam induced signals can be divided into coherent and incoherent signals, where for the coherent case all particles in a bunch act as a single macroparticle. Incoherent signals are much smaller in intensity than coherent ones and usually referred to as Schottky signals. One important application of Schottky signals is stochastic cooling, which permits obtaining an increase of particle density in 6 dimensional phase space by many orders of magnitude. The sensitivity of such electromagnetic sensors is high enough to observe a single ion in a circular machine or a single antiproton oscillating in a trap. Further RF and microwave applications are magnetic markers (NMR and FMR systems) for precise and online calibration of the magnetic fields. The diagnostic of beam induced electron clouds using waveguide modes has been developed in the last decade. In the context of axion and paraphoton research microwave systems with an electromagnetic shielding of more than 300 dB are under construction.

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