BEAM CHARACTERISTICS CONTROL USING OPTICAL TRANSITION RADIATION (OTR)

M.Castellano, L.Catani, R.Chehab, M.Taurigna-Quere, A.Variola
LNF-INFN-Frascati, INFN-Roma-2, LAL-Orsay, CERN

Abstract

The Transition Radiation of a charged particle, emitted at the boundary between two media of different dielectric properties, has been largely used in beam diagnostics since the pioneering work of L.Wartski. The radiation, detected in the optical domain, can be extensively used for large ranges of energy (from some eV to tens of GeV), different kinds of particles (electrons, protons), short bunches (of picosecond duration); moreover, no redhibitory limit, concerning the diffraction phenomenon, was found at GeV energies and submillimeter dimensions.

LAL-Orsay and INFN-Frascati have experienced these diagnostics in their laboratories and on the TESLA Test Facility (TTF). After some theoretical introduction, we present the main features of the OTR and precise its capabilities in the measurement of beam emittance, energy dispersion and beam position through the observation of the transverse beam profiles and also beam energy and divergence obtained from the characteristic angular pattern of the OTR. Both kinds of observations are using CCD cameras.

When intensified, these cameras present an optical shutter which allows a scanning analysis inside the macropulse: this possibility is very useful for beam dynamics analysis. When associated to streak-cameras, the OTR provides bunch duration determination: the latter is also attainable when using the spectral informations given by OTR. Examples, mostly gathered at the TTF in Hamburg, are presented. Additional information is also provided concerning the associated instrumentation with its hardware (Optics, Electronics) and software aspects. The performances as resolution and velocity of the overall set-up based on OTR are precised.

If the emittance determination is requiring an execution time between 15 and 20 minutes, the observation of the transverse profiles or positions needs only 1 to 2 seconds if using a numerical filter and much less if not. That opens some perspectives for rapid controls of beams with moderate intensity. Efforts are undertaken to optimize the time duration of OTR observations, as for instance for bunch length determination.