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Radiation protection at synchrotron radiation beamlines-challenges

Synchrotron radiation source (SRS) is a unique photon source of high brightness with a broad energy range extending from infra-red to hard x-ray. SRS is essentially a storage ring in which relativistic electron beam is stored in the vacuum chamber for several hours during which synchrotron radiation is emitted tangential to the circular path of electrons. The radiation is then transported to the experimental station tens of meters away from the source through specially designed beamlines, where experimental investigations are carried out. The radiation environment of a synchrotron beamline consists of (a) gas bremsstrahlung radiation (having a broad energy spectrum extending upto the electron energy, typically upto few GeV) (b) synchrotron radiation (up to few tens of keV) and (c) photo-neutrons. Primary radiation hazard is the gas bremsstrahlung radiation, produced by inelastic scattering of high energy electrons with residual gas molecules inside the vacuum chamber of storage ring [1-3]. The gas bremsstrahlung photons channel to beamline along with the intense synchrotron radiation and produce scattered photons and photo-neutrons on interaction with the beamline components. Thus the radiation scenario in a synchrotron beamline is complex because of mixed radiation field of photons (direct and scattered) and neutrons with broad spectral range and sharp angular distribution. Radiation dosimetry in such radiation environment is very challenging due to limitations in conventional detector system in terms of its energy response, angular distribution of radiation and mixed field. Hence the beamlines are housed in specially shielded hutches to ensure radiation safety of the beamline scientists and users. In the present paper, theoretical and experimental studies for evalaution of gas bremsstrahlung and synchrotron radiation for radiation protection in the beamlines of the synchrotron radiation source, Indus-2 will be discussed (Indus-2 is a 2.5 GeV electron storage ring operational at Raja Ramanna Centre for Advanced Technology, Indore, India for production and utilisation of synchrotron radiation). The challenges in the evaluation of radiation source terms for gas bremsstrahlung radiation and its shielding requirements for ensuring radiation safety will be discussed. In the low energy front, as the conventional personal dosimeters (CaSO4:Dy based) are error prone due to dominance of photoelectric effect, a free air ionization chamber (FAIC) has been designed, developed and characterised in house for accurate dosimetry of intense synchrotron radiation from Indus-2. The design aspects and the characterisation details will be discussed. Additionally the safety procedures, interlocks and monitoring of radiation around the beamlines of Indus-2 and future plans to strengthen radiation safety will be outlined.

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