SIMULATION OF INDUCED RADIATION IN COMPONENTS OF A PROTON BEAM LINE SEGMENT PRODUCED BY PROTON BEAM LOSSES

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A simplified Fluka model of a typical proton beam line segment consisting in a sequence of quadrupole, bending and kicker magnets has been developed to determine the level of radiation caused by proton beam losses and released into the magnets and penetrating through the surrounding shielding. The shielding consists of one meter thick “heavy” concrete blocks near the beam line. An iron liner was also considered on the surface of the concrete blocks for further analysis. In simplified model all components of the segment of interest were placed along the central line of the beam tube.

A cylindrical beam with 590 MeV protons was considered for this study. The protons are emitted from the beginning to the end of the segment with a typical angular divergence of 1.7 mrad.

A calculation of the residual nuclide distribution into the magnet system (including Fe-core and core coil), the beam line and the shielding was carried out in the case of 1 year of irradiation time and different cooling times (1 month, 1, 3 and 5 years). The most volumetrically active nuclides after 1 year of cooling time are ^{3}H, ^{45}Ca, ^{22}Na, ^{55}Fe and ^{54}Mn for the concrete and ^{55}Fe, ^{54}Mn, ^{49}V for the Fe-liner, given in order of importance. The simulation shows that the total induced activity in Fe-liner is about two times greater than in concrete. It may worth to mention that 1-cm thick Fe-liner reduces the total activity in concrete of 3% at most.

The total activities, the volumetric and the specific activities were also calculated for all components of the model. After 5 years of cooling time the most important radioactive nuclides are indeed ^{3}H, ^{22}Na, ^{55}Fe, ^{152}Eu and ^{55}Fe in both concrete and Fe-liner. The total activity in concrete decreases 3.9 and 3.7 times in 5 years of decay with and without the Fe-liner, respectively. The total activity of Fe-liner itself decreases, during this period, 9 times.

The dependence between the total induced activity and the energy fluence with the cooling time was also analyzed and here reported. The concrete activation was determined as a function of the block thickness by calculation of a step-wise distribution (10 cm step) of induced activity inside the concrete depending on the presence or absence of Fe-liner.

Finally, the proton and neutron spectra before and behind the shielding were calculated and here illustrated.