Contribution ID: **16** Type: **not specified**

Neutron double differential distributions, dose rates and specific activities from accelerator components irradiated by 50 – 400 MeV protons

Thursday, June 3, 2010 9:40 AM (20 minutes)

Systematic Monte Carlo simulations with the FLUKA code were performed to estimate induced radioactivity in five materials commonly found in particle accelerator structures: boron nitride and carbon (dumps and collimators), copper (RF cavities, coils and vacuum pipes), iron and stainless steel (magnets and vacuum pipes). Using a simplified geometry set-up, the five materials were bombarded with protons in the energy range from 50 MeV to 400 MeV. This energy range is typical of intermediate energy proton accelerators used as injector to higher energy machines, as research accelerators for nuclear physics, and in hadron therapy. Ambient dose equivalent rates were calculated at distances up to 1 metre around the target, for seven cooling times up to six months. A complete inventory of the radionuclides present in the target was calculated for all combinations of target, beam energy and cooling time. The influence of target size and of self-shielding was investigated. The energy and angular distributions of neutrons escaping from the target were also scored for all materials and beam energies. The influence on the neutron spectra of the presence of concrete walls (the accelerator tunnel) around the target was determined. The results of the present study provide a simple database to be used for a first, approximate estimate of the radiological risk to be expected when intervening on activated accelerator components.

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Session Classification: Session 2 - Induced radioactivity

Track Classification: Induced radioactivity