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Shielding design for the electron tunning beam Dump

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The upcoming ARIEL facility at TRIUMF will have a new electron beam line, delivering a maximum of 500 kW beam (10 mA at 50 MeV) to one of the target stations in the newly built target hall for Rare Isotope Beam (RIB) production. In preparation for this, a tunning beam dump (BD) is designed and located upstream in the electron hall. This tunning beam dump will be in use until the completion of the electron beam transport line to the target station and the target itself.

Due to the limited availability of the space and accessibility to the BD through a hatch above the beam dump, the shielding needs to be compact and remote-handleable. The production version of FLUKA was utilized to determine an optimum solution in terms of shielding material and configuration, given the above constraints. The design of the shielding was divided into two stages: local shielding and upstream (EHDT) shielding. The beam dump will be operated under two different irradiation conditions: 1) 1.3 mA at 75 MeV and 2) 4 mA at 25 MeV. Since the first case results in higher radiation fields, it was used in the simulations for shielding design. Simulation results showed a layered design, consisting of low Z, high Z material, to be the most effective in reducing the dose rates. Taking into account the radiation hardness of the shielding material available (given the radiation fields outside the BD) and magnetic properties of the shielding material, the final design c!
onsisted of a lead enclosure around the BD, followed by slabs of concrete and carbon steel. Designing the upstream shielding required employing the two-step method where particles crossing the local upstream end of the shielding were written out in the first step and used as the source in the second step. This saved considerable time evaluating different configurations of shielding for the EHDT area, while the beam line components and their position along the beamline were still under design and changing.

FLUKA was also used to extract power deposition in the BD and the shielding immediately surrounding the dump. This information was used as input into ANSYS for thermal and stress analysis. The second beam conditions were used in these studies since due to the shorter range of electrons in the beam dump, it poses a worse case in terms of energy deposition in the dump. FLUKA was also used to determine activation of the BD components and the shielding and the residual dose rates from the activation of these components.

Since the BD insert may need to be moved for service, a casket is required for its transport to a hot cell or storage area. The development version of FLUKA was used to find the minimum thickness of carbon steel or lead required to satisfy the dose rate limit specified.

This talk will cover the procedures and steps involved in completing the above.

Summary

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