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Bask-splash shielding of SEQ for E160

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Abstract

An estimation of the neutron flux back-streaming into the E160 spectrometer detectors and the Compton polarimeter detectors shows that about 6 feet of concrete shielding is needed, filling the tunnel just beyond the Compton polarimeter detectors.

The distance from the SEQ to the Compton Polarimeter detectors is about 18 m. The detector area is about 5 cm^2 per detector element. On the other hand, the E160 detectors are twice as far away (about 32 m), but much larger, so the shielding requirements will be determined by these detectors. The biggest ones are the "muon" detectors, 10 cm by 160 cm scintillator bars that are 10 cm thick, and these determine how much shielding is needed.

We estimate the total number of neutrons produced in the SEQ using SHIELD11, for the maximum E160 intensity of 1 kW (simulated using 20 GeV electrons, which may overestimate the high energy neutron component somewhat). At 180 degrees and a distance of 30 m, and assuming a repetition rate of 120 Hz, the prediction gives 100, 10, and 0.5 neutrons per cm^2 for low ($<$ 25 MeV), medium (25 $<$ 100 MeV), and high ($>$ 100 MeV) energy neutrons. Therefore, each "muon" detector will be hit with about 10^5, 10^4, and 10^3 low, medium, and high energy neutrons/spill. Since the scintillators are 10 cm thick, about 10% of the neutrons will make a signal, yielding 10^3 signals/spill with no shielding from the SEQ, if we don't count the low energy neutrons because the delay between where the beam passes through the target and when a neutron arrives back at the detectors is longer than the spill length for neutrons below 25 MeV [and in any case they are much easier to shield than medium and high energy neutrons].

To keep the TDC from getting swamped, we need to reduce this to about 1/spill with enough shielding to attenuate the flux by about a factor of 1000. Using 6 feet of concrete, the flux is reduced to about 0.004, 0.5, and 1.6 neutron/spill/detector for the low, medium, and high energy neutrons, which is approximately what is needed. Note that we are now dominated by the high energy neutrons, because they are attenuated less per foot of concrete than medium energy neutrons.

To help reduce the flux further, we plan to put two feet of lead in front of the SEQ, with a 3 cm diameter hole for the photon beam to pass through. This will help attenuate some of the flux right at the source, although many of the high energy neutrons will scatter back through the beam pipe hole.

In the future, a more detailed Monte Carlo study is planned using the exact geometry and more accurate simulation programs.