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Radiation Safety Calculations for iThemba LABS ACE Isotopes facility design - Faraday Cups

The design of iThemba LABS Accelerator Centre for Exotic (ACE) Isotopes facility was proposed to have four beam-lines feeding the beam to two production vaults, with each vault having two production stations. The plan is to simultaneously operate one production station in both production vaults, meaning that only two opposite beam-lines will be delivering the beam at a time, with each of the two beam-lines feeding 70 MeV energy proton-beam of up to 350 μA current.

Two Faraday cups will be simultaneously used to stop 50 μA (standard beam current) proton beams during the optimization of beam-lines parameters.

The whole ACE operating system will be accompanied by an interlock system that will switch off the parameters of the cyclotron, e.g. the RF, and insert a Faraday cup in the axial injection line in case the beam is accidentally stopped in the beam-line. Moreover, less than 5% beam loss is expected to occur in the cyclotron. Beam-pipes of 150 mm diameter were proposed, therefore, the beam losses in beam-lines are not expected to be significant. Radiation resulting from beam loss in the cyclotron (35 μA at most) will, to a large extent, be shielded by the magnet of the cyclotron. The magnet shielding of the radiation caused by beam loss inside the cyclotron is better in the vertical direction. Therefore, radiation that will make it through the cyclotron vault floor to the basement is not expected to be significant.

Consequently, for the shielding of the cyclotron, the main source of radiation to consider was the beams on Faraday ups; Hence, this study was looking at the optimal shielding design especially when the proton beams hit the Faraday cups during optimization of the cyclotron beam-line parameters. This study was conducted using the FLUKA Monte-Carlo transport code.

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