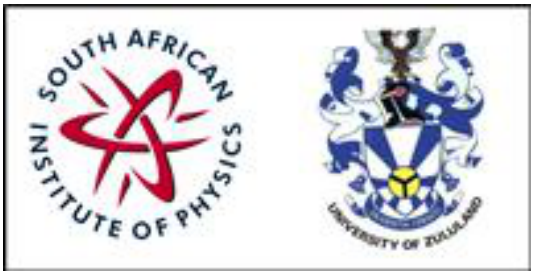

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Validation of a passive beam Monte Carlo model for measuring prompt gamma rays during proton radiotherapy

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Abstract content
   (Max 300 words)

In proton beam radiotherapy, secondary gamma rays are produced by proton-nuclei inelastic collisions within the treatment volume. A Monte-Carlo model of the iThemba proton treatment nozzle was developed using the Geant4 toolkit to detect these secondary or prompt gamma rays, which will be used for on-line treatment verification. The passive beam proton treatment facility at the iThemba labs in Cape Town, South Africa was studied in detail and all the nozzle components that interact with the proton beam were built and positioned in the model at the locations specified by the manufacturer. NaI detectors with different dimensions of 2x2 inch, 3x3 inch, 4x4 inch and 6x6 inch were modeled and standard gamma emitting sources (energy range from 0.661 to 4.438) were used to determine Gaussian broadening (Detector Response Function). The selected physics model (QGSP_BIC_EMY) is recommended and validated for medical applications. The simulated treatment nozzle was validated against depth dose and lateral profiles in a water phantom for therapeutic proton ranges of 24cm, 15cm and 10cm. The beam range was measured at the 50% distal falloff position in water. The position of the double graphite wedge energy degrader (used to produce the proton range) was calibrated within the model and used to select the different ranges. Range uncertainties due to secondary production energy threshold were calculated and 0.01 cm range cut was selected. We found that the Geant4 treatment nozzle model is in good agreement with measurements and has the ability to produce depth dose profiles and lateral profiles in different proton range. Finally the simulation was carried out to detect prompt-gammas produce in the water phantom and the resulting energy spectra will then be compared with measured data.

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PhD

Main supervisor (name and email)
and his / her institution

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