Radiation Detector Responses to Applied Homogeneous Transverse and Parallel Magnetic Fields

**Innovation/Impact:** This work applies to all integrated teletherapy-MRI systems currently being developed.\(^1\)\(^2\)\(^3\) The radiation detectors’ relative response within homogeneous magnetic fields is studied, and is critical for the reference dosimetry of such systems.

The present work extends the similar investigation\(^4\) that studied the relative response of NE2571 ion chamber in a transverse magnetic field. We have determined the relative response of several ion chambers (only PR06 data shown) and a diamond detector (PTW 60003) in magnetic fields that are oriented both perpendicular and parallel to the central axis of the radiation beam. For each case, both parallel and perpendicular orientations of the long axis of the detectors to the central axis of the beam are investigated. The Monte Carlo code system PENELOPE contains a well established electromagnetic field macro and was used for the calculation of detectors’ response. In all calculations, a generic 6 MV photon beam spectrum and homogenous magnetic fields of various strengths in the two orientations were considered. The structure and materials for each detector were taken from the manufacturers’ drawings; the response was calculated in air. In order to validate the Monte Carlo results, transverse magnetic field results were verified experimentally up to ~0.2T with the aid of a small electromagnet in the 6 MV beam of Varian 600C linac. The results are presented as a normalized detector signal to the zero magnetic field case.

Our calculated detector responses for the PR06 and diamond detector in transverse magnetic fields match the experimental data well. The general trends of the PR06 response are similar to the ion chamber data work in ref. 4. Figures 1 and 2 show the relative response of the PR06 and diamond detector for the two orientations of the magnetic field and detector long axis. In a transverse magnetic field, the PR06 response increases for perpendicular chamber orientation ((+8.5% at 1T), and decreases for parallel chamber orientation ((-8.5% at 0.9T) with the increasing magnetic field strength. The PTW60003 response increases with the magnetic field strength in a transverse field geometry irrespective of detector orientation; the diamond detector responds this way to the transverse magnetic field since it contains a small air cavity in its construction. However, for parallel magnetic fields, both detectors are relatively insensitive to the magnetic field, with a maximum deviation from zero field of about 2% at 1.5T (fig 1,2). For parallel magnetic fields below 0.5T, the change in detectors’ response is too small to need any corrections for reference or relative dosimetry.


