

**Purpose:** To develop an energy-independent Gafchromic film through optimization of the film absorbed dose energy response using accurate Monte Carlo modeling.

**Methods:** A prototype radiochromic film (similar in construction to EBT2) was simulated accurately using the DOSRZnrc of EGSnrcMP Monte Carlo user-code. The composition of the film active layer was changed according to physical limits set by the manufacturer. The dose to film was scored in a 3cm radius region of active layer centered on the central beam axis. The film was simulated inside a large body of solid water for megavoltage beams, while at kilovoltage energies, the film was modeled in air. The simulations were repeated to score the dose to water as well as water kerma in air for megavoltage and kilovoltage beams, respectively.

**Results:** The absorbed dose energy dependence  $f(Q)$  was studied in detail for a wide variety of film active layer compositions in a 10keV-100keV energy range as well as at Co-60. Addition of bromine was found to affect  $f(Q)$  in the 40-50keV region, while chlorine significantly affected the lowest energies. We determined that intrinsic (LET-dependent) energy dependence  $kbq(Q)$  also plays an important role on the total energy dependence of Gafchromic films and cannot be ignored. Subsequent measurements unexpectedly showed changes in  $kbq(Q)$  as a function of chlorine and bromine content. Intrinsic energy dependence was determined indirectly by measuring the total energy-dependence of prototype films and taking out the calculated extrinsic portion. This formed the basis for an iterative process for film development.

**Conclusions:** Through numerical optimization of the composition of the active layer of a new prototype radiochromic film, we have thus far been able to compensate for intrinsic energy response of the films and produce a new film with a total response of +2% to -6% in 50kVp to Co-60 energy range.