AbstractID: 4999 Title: Characterizing a Monochromatic X-ray Beam from a 1.3 GeV Synchrotron for Auger Electron Radiotherapy and Dosimetry Studies

Purpose: Auger electron radiotherapy and dosimetry methods are being studied in preparation for future small animal irradiations using monochromatic x-ray beams and IUdR. Aims of the present study are: (1) establish methods for characterizing the LSU CAMD synchrotron monochromatic x-ray beam and (2) validate MCNP dose calculations in polymethylmethacrylate (PMMA).

Method and Materials: The synchrotron's tunable (6-40 keV), monochromatic beam was set to 15 keV and collimated to ≈2.5-mm wide. Beam energy was determined from photons Compton scattered by a 56 $mg{\cdot}cm^{-2}$ aluminum target, whose energy was measured using a thin window 1-mm thick × 2.54-cm diameter NaI(Tl) scintillation detector. Beam cross section and divergence were measured using radiochromic film digitized with an Epson 1680 scanner. Depth-dose measurements within a PMMA phantom were made using a 0.23 cm^3 air-ionization chamber. Ionization was converted to dose in air and PMMA at each depth and a percent depth-dose curve generated. Results of MCNP5 Monte Carlo dose calculations simulating measured conditions were compared with measured data.

Results: Measurements indicated the nominal 15 keV beam had energy of 15.5 keV, horizontal width of 3.1 cm, Gaussian distribution vertically with FWHM = 0.1 cm, and beam divergence <0.004 horizontally and vertically. A dose rate of 69 $cGy{\cdot}s^{-1}$, measured at 0.58-cm depth in PMMA with 92 mA beam current, corresponds to $3.4{\times}10^{11}$ $photons{\cdot}cm^{-2}{\cdot}s^{-1}$. Measured percent depth-dose curve agreed with MCNP5 simulated curve, yielding a PMMA mass attenuation coefficient of 1.1 $cm^2\, g^{-1}$, approximately equal to the NIST value.

Conclusion: The LSU CAMD 15-keV monochromatic beam has been characterized demonstrating utility of the measurement methods for future studies at energies suitable for iodine k-edge capture (>33.2 keV). MCNP5 Monte Carlo calculations have been shown to predict depth dose in PMMA validating its use and showing its potential for future treatment planning dose calculations in small animals.