Purpose: To determine the concentration of gold (Au) nanoparticles presented within the tumor during in vivo demonstration of tumor dose enhancement by detecting gold fluorescence x-rays.

Method and Materials: Gold nanoparticle solution of 1% by weight in saline was prepared using commercially available gold nanoparticles with 1.9 nm core diameter. A cylindrical sample container (2.5 cm in diameter and 5.0 cm in height) was irradiated with 110 kVp and 200 mA x-rays from conventional radiotherapy simulator for 40 seconds with 1 cm x 1 cm x-ray beam at 85 cm source-to-surface distance (SSD) and spectrum was obtained using either Si-PIN or CdTe photodiode detector using a container-to-detector geometry to minimize unwanted photons entering the detector. Results: The spectrum collected using the Si detector successfully captured the Au La and Lβ fluorescence lines at 9.7 and 11.4 keV, respectively, well above the background. Au K lines could not be measured with Si-PIN photodiode due to Si-PIN detection inefficiency above 60 keV. To capture the Au K lines, CdTe photodiode detector was employed which has high detection efficiency for energy range of Au K lines. The spectrum collected using CdTe detector clearly showed the Au Ka2, Ka1, and Kβ lines corresponding to energies of 67.0, 68.8, and 77.9 keV, respectively. Conclusion: The magnitude of obtained Kα fluorescence signal (i.e. greater than 50% above all background scattering) is very encouraging considering the tested gold concentration. With more sophisticated geometry to minimize scattered photons reaching the detector, Au fluorescence output from K lines can be used to measure even lower concentrations of gold nanoparticles. Fluorescence output as a function of Au concentration can be developed to accurately measure gold nanoparticle concentration.