# AbstractID: 9545 Title: New method of an HPGe detector precise efficiency calibration with experimental measurements and Monte Carlo simulations

**Purpose:** Developing a method of an HPGe detector precise γ efficiency calibration which is very important for accurate radiation detection during cancer radiotherapy practices.

**Method and Materials:** $^{24}$Al radioactive nucleus produced and separated with Momentum Achromat Recoil Spectrometer (MARS) at the K500 superconducting cyclotron of Texas A&M University has positron decays followed by γ transitions up to 8 MeV from $^{24}$Mg excited states, which is used for a β-γ coincidence measurement with a 1-mm-thick BC404 plastic scintillator, an HPGe detector and a fast tape-transport system to calibrate the HPGe detector.

**Results:** By carefully considering the effects of summing, positron annihilation, internal conversion, and β detector efficiency when analyzing $^{24}$Al spectrum, we got the efficiency for γ-ray 7070 keV at 49 mm distance away from the source sample $^{24}$Al, which was 0.192(6)%. The Monte Carlo (MC) simulation with CYLTRAN code gave a value of 0.189%, which was in agreement with our measurements. The precise efficiency calibration curve of the HPGe detector up to 7070 KeV at 49 mm distance away from the source sample was obtained. By using the same procedure, we got the efficiency for the 7070 keV γ-ray at 151 mm distance away from the source sample $^{24}$Al, which was 0.0385(8)%. MC simulation value was 0.0399%, which differed from measurement by 4(2)%. This discrepancy led us to assign an uncertainty of 4% to our efficiencies at 151 mm up to 7070 KeV. The Monte Carlo calculations also reproduced the intensity of observed single- and double-escape peaks, providing that the effects of positron annihilation-in-flight were incorporated.

**Conclusion:** A new method was established. The precise calibration curves obtained from this work are useful for accurate radiation detection and improving quality control to quality assurance (QA) for intensity-modulated radiation therapy (IMRT).

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