MAR14-2013-001265

Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

Development of Traceable Phantoms for Improved Image Quantification in Positron Emission Tomography

BRIAN ZIMMERMAN, National Institute of Standards and Technology

Clinical trials for new drugs increasingly rely on imaging data to monitor patient response to the therapy being studied. In the case of radiopharmaceutical applications, imaging data are also used to estimate organ and tumor doses in order to arrive at the optimal dosage for safe and effective treatment. Positron Emission Tomography (PET) is one of the most commonly used imaging modalities for these types of applications. In large, multicenter trials it is crucial to minimize as much as possible the variability that arises due to use of different types of scanners and other instrumentation so that the biological response can be more readily evaluated. This can be achieved by ensuring that all the instruments are calibrated to a common standard and that their performance is continuously monitored throughout the trial. Maintaining links to a single standard also enables the comparability of data acquired on a heterogeneous collection of instruments in different clinical settings. As the standards laboratory for the United States, the National Institute of Standards and Technology (NIST) has been developing a suite of phantoms having traceable activity content to enable scanner calibration and performance testing. The configurations range from small solid cylindrical sources having volumes from 1 mL to 23 mL to large cylinders having a total volume of 9 L. The phantoms are constructed with ^{68}Ge as a long-lived substitute for the more clinically useful radionuclide ^{18}F. The contained activity values are traceable to the national standard for ^{68}Ge and are also linked to the standard for ^{18}F through a careful series of comparisons. The techniques that have been developed are being applied to a variety of new phantom configurations using different radionuclides. Image-based additive manufacturing techniques are also being investigated to create fillable phantoms having irregular shapes which can better mimic actual organs and tumors while still maintaining traceability back to primary standards for radioactivity. This talk will describe the methods used to construct, calibrate, and characterize the phantoms, focusing on the preservation of the traceability link to the primary standards of the radionuclides used. The on-going development of specialized traceable phantoms for specific organ dosimetry applications and imaging physics studies will also be discussed.