Update on NIST Radiation-Processing (High-Dose) Dosimetry Services

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NIST/NPL High-Dose-Rate Gamma-Ray Source Comparison

The high-dose dosimetry service of the NIST Ionizing Radiation Division performs comparisons with its counterpart at the National Physical Laboratory (NPL) of the United Kingdom. For this periodic comparison, the NIST and the NPL exchange about 12 alanine dosimeters for irradiation of four dosimeters to each of three pre-specified absorbed doses (5 kGy, 15 kGy and 30 kGy) followed by return to their respective institutions for measurement. Historically, for annual comparisons dating back to the late 1990s, absorbed doses to water at radiation-processing levels measured by the two institutions differed by between 1.5 % and 2.0 %.

The source of the ≈1.5 % difference in NIST/NPL comparisons has been more-or-less accepted without further study. The internal calibration process for each laboratory can be broken down into three common stages:

- Realization of the absorbed dose to water in a low-rate source.
- Irradiation of reference-class transfer dosimeters in the low-rate source.
- Transfer dosimetry to establish high-rate-source dose rate

The source of the difference lies in any one or multiple combinations of these three stages.

A study to investigate the historical NIST/NPL differences would begin at the first and last stages of the respective calibration schemes. Although there have been no direct comparisons using calorimetry between the two laboratories, the older reported difference between standards of absorbed dose to water from therapy-level ^{60}Co beams is less than 0.1 %. To examine the final transfer stage of the calibration, the NIST tested the calibration-curve protocol described by NPL. Using the NPL protocol, but retaining the NIST alanine measurement system, the absorbed-dose rate determined by this method agreed with the established NIST method result to within 0.3 %. Lastly, based on an analysis of the 2008 NIST/NPL comparison data, it was concluded that greater insight may be gained by expanding the dose range of future NIST/NPL comparisons with inclusion of 0.1 kGy, 0.5 kGy, and 50 kGy, in addition to the recently used 1.0 kGy, 5.0 kGy, 15 kGy, and 30 kGy. The NIST welcomes a dialogue to address these unresolved issues and looks forward to future collaborative work with the NPL.

Small-Field Medical Dosimetry

In collaboration with the Department of Radiation Oncology, University of Pittsburgh Cancer Institute (USA), we are evaluating alanine as a reference dosimeter for the small and non-standard fields increasingly used in medical-therapy applications. An initial comparison produced results that agreed well between alanine dosimetry and ionization-chamber dosimetry. At absorbed doses of about 40 Gy, the mean deviations between both dosimetric methods for the Leksell Gamma Knife Perfexion was found to be -0.6 % for 16 mm fields, and for the Leksell Gamma Knife 4C it was -0.2 % for 8 mm and 18 mm fields. Additional measurement comparisons are planned. Other efforts include the development of an alanine-pellet dosimeter with smaller dimensions.