AbstractID: 13170 Title: Generalized formalism and optimization of the calibration sequence of plastic scintillation detectors

Purpose: Effects of Cerenkov light on plastic scintillation detectors (PSD) can be successfully corrected, but an inadequate calibration might result in erroneous measurements. The purpose of this work is to establish a general calibration formalism and to perform a systematic study of calibration sequences to optimize PSD performances.

Methods and Materials: A general mathematical formalism has been developed with no *a priori* assumption on the physical characteristics of the detector system. This formalism was used in simulations of realistic PSD systems (i.e. similar to PSDs published in the literature) for over 1000 different calibration sequences. The accuracy and precision of dose measurements with PSD calibrated with each sequence were then analyzed and compared. We also studied the propagation of errors in the whole measurement chain.

Results: Optimized calibration sequence can improve precision by a factor of 3 when dose readings are performed with more than 15 cm of optical fibers irradiated. In addition, a 3-point calibration sequence prevents systematic error in calibration factors measured in the presence of large ($>0.5\%$) statistical noise. Our study also outlined several "calibration pitfalls" that should be avoided: Calibration points that are too similar will unduly deteriorate measurement precision (e.g. calibration with fields of 10 and 30 cm will increase the measurement standard deviation by 1.5 compared to calibrations with fields of 3 and 30 cm); Small dosimetric errors made at calibration time can result in large systematic measurement error with PSDs. A 1% dose error on one of the calibration measurements can result in a 4% to 10% accuracy error with the PSD when more than 15 cm of clear optical fiber is irradiated.

Conclusions: We developed a new PSD calibration formalism. After optimization of the calibration sequence of PSDs we showed improvements in both precision and accuracy of current PSD systems.