SUBJECT: Calibration of the Exradin W1 Scintillator for Small Field Measurements

The following information is provided as a service to our users and customers:

The spectral method of correcting for Čerenkov light in plastic scintillation fibers described by Guillot *et al.* (2011) has been applied to the Exradin W1 Scintillator, with calibration techniques for determining the Čerenkov light ratio (CLR) and signal gain described in the user manual. Use of the detector for small field measurements has revealed that the orientation of the scintillating fiber relative to the radiation beam axis plays a significant role in the accuracy of the CLR applied to these measurements.
The purpose of this document is to guide users in properly establishing baseline measurements – and thereby an appropriate CLR – for their measurement orientation.

Baseline values should be obtained in a setup similar to the one used for general measurements. Thus, for measurements in water or in water-equivalent material with the scintillator axis oriented perpendicular to the beam axis, baseline measurements in the calibration slab following the procedure outlined in the W1 user manual are recommended. Users may choose to set a 30x30 cm^2 field for CLR measurements instead of the 40x40 cm^2 field listed in the manual and in the SuperMAX interface, as some users have found that choosing this field size improves the stability of their measurements.

For measurements in water with the scintillator axis oriented parallel with the beam axis, baseline measurements should be performed with the same setup as for measurements. Following the procedure used by Morin *et al.*, the reference field size (often 6 cm or 10 cm, depending on the system) should be used. **Please note that this orientation is NOT recommended for use with fields larger than 10 cm.**

- For the minimum fiber condition, the effective point of measurement, which is the center of the scintillating fiber, should be at a fixed reference depth such as d_{max} or 5 cm, with the optical fiber gently pulled out of the field so that only approximately 10 cm of optical fiber is within the beam. Care should be taken to avoid sharp bends in the optical fiber.
- For the maximum fiber condition, the detector should remain at the depth used above, and the optical fiber allowed to remain within the beam until it reaches the bottom of the water tank, so that approximately 25 – 30 cm of optical fiber is being irradiated.
- For both minimum and maximum fiber conditions, care should be exercised to ensure that the fiber bend radius remains approximately the same. The most important things to consider when assessing the bend is that it should be unforced, and the fiber should not be coiled within this small field.

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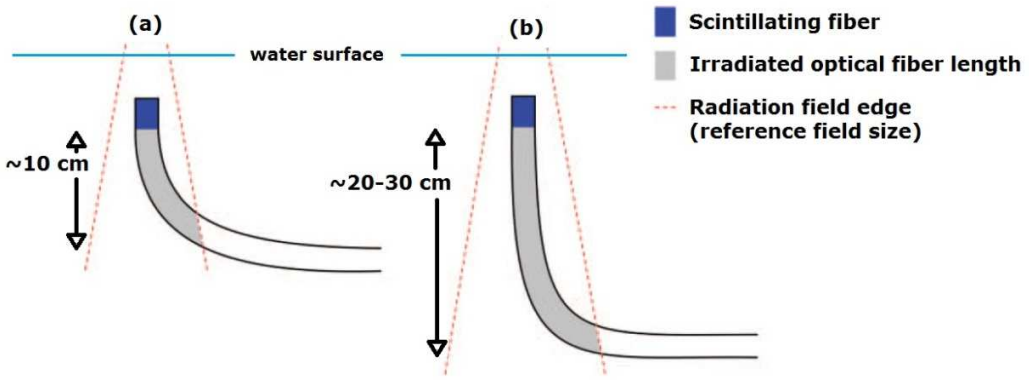

Figure 1: Minimum (a) and maximum (b) fiber conditions in water using the reference field size. (Morin *et al.*, 2013, dimensions added.)

Dose calibration for this detector orientation should likewise be performed with the W1 scintillator in water and oriented with the scintillator axis parallel to the radiation beam axis. A known dose should be given to the detector by placing the effective point of measurement of the scintillator at the reference depth and for the reference field at which the output of the accelerator is calibrated. The SuperMAX software can be used for performing baseline and dose calibration measurements and for storing and applying calibration factors regardless of how the minimum fiber, maximum fiber, and dose calibration exposures are defined.

References:

1. M. Guillot, L. Gingras, L. Archambault, S. Beddar, and L. Beaulieu, “Spectral method for the correction of the Cerenkov light effect in plastic scintillation detectors: A comparison study of calibration procedures and validation in Cerenkov light-dominated situations,” Med. Phys. 38, 2140-2150 (2011).
2. J. Morin, D. Beliveau-Nadeau, E. Chung, J. Seuntjens, D. Theriault, L. Archambault, S. Beddar, and L. Beaulieu, “A comparative study of small field total scatter factors and dose profiles using plastic scintillation detectors and other stereotactic dosimeters: The case of the CyberKnife,” Med. Phys. 40, 011719 (2013).