Reproducibility
Using Model TN-RD-22 Dual Sensitivity Bias Supply

Introduction

Dose reproducibility is a critical indicator for the usefulness of a patient dose verification system. Some authors have stated that in clinical use, a dose to dose reproducibility of better than +/-7% is needed if tumor control is to be assured [1]. The current Thomson & Nielsen MOSFET based system readily meets this criterion for doses above 100 cGy. A sample of measured nominal 200 cGy doses using several TN MOSFET dosimeters shows a Normal distribution with a range (3σ) of +/-4.5% centered on the mean [2].

In many applications, the doses delivered to patients or scattered to important organs are much lower than 100 cGy, for example; thyroid scatter doses as low as 1 cGy have been measured during stereotactic radiosurgery procedures, ocular doses rarely exceed 20 cGy and many pelvic treatment plans call for 4 dose fractions in the 50 cGy range totaling 200 cGy. In such circumstances, the statistical spread of the measured doses with the current Thomson & Nielsen system increases beyond what is acceptable to the physicians and physicists responsible for treatment quality. The parameter that limits the dose reproducibility is the magnitude of the MOSFET response to the radiation absorbed. In the standard TN-RD-50, this response is typically 1 mV/cGy at D_{max} and as Soubra et al [3] have pointed out, is governed largely by the bias voltage applied to the MOSFET during irradiation. By increasing this bias, the MOSFET response can be enhanced creating larger dosimetric quantities at all doses and leading to improved statistics and reproducibility.

This technical note shows performance data for the High Sensitivity setting on the new Thomson & Nielsen dual bias supply, TN-RD-22. This unit is 100% compatible with the TN-RD-10 reader and the standard TN-502RD dosimeters. It enhances system sensitivity to 2.7 mV/cGy at D_{max} and leads to twofold improvements in dose to dose reproducibility. When used on High Sensitivity setting, the system dynamic range is reduced to 7000 cGy.

Results

Fig. 1 on the following page shows the dose reproducibility as a function of dose fraction for the Standard setting and High Sensitivity setting on the new TN-RD-22 bias supply.

It is clear that, while the greatest benefit from using the High Sensitivity setting is obtained at lower doses, reproducibility is enhanced at all dose levels. In these tests a reader having enhanced software was used. This software gives a resolution of 0.1 cGy, and is beneficial at doses below 10 cGy.

Specifications

Table 1 compares the performance of the system using the two different settings on the TN-RD-22 dual bias supply.

	Standard	High Sensitivity
Sensitivity	1 mV/cGy	2.7 mV/cGy
Reproducibility		
3σ @ 3.5 cGy	45%	16.1%
3σ @ 18.8 cGy	22%	8.9%
3σ @ 100 cGy	7.8%	3.5%
3σ @ 200 cGy	4.6%	2.3%

TABLE 1. Comparison of TN-RD-50 system performance with different bias box settings.

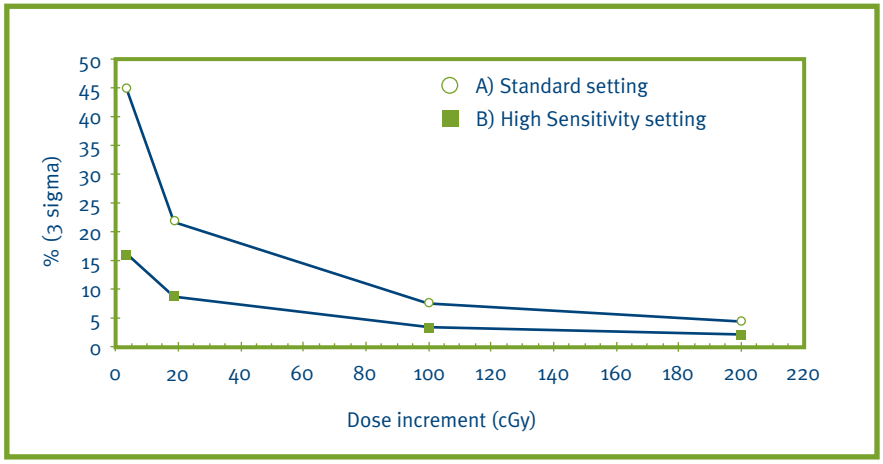

FIGURE 1. Reproducibility for sensors connected to TN-RD-22 dual bias box on Standard Setting and High Sensitivity setting.

References

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2. Thomson & Nielsen Technical Note No. 1. Dose reproducibility assessment for the Thomson & Nielsen Electronic dosimetry system .
3. M. Soubra, J. Cygler, and G.F. Mackay, "Evaluation of a dual bias dual metal oxide-silicon semiconductor field effect transistor detector as a radiation dosimeter", Med. Phys. 21. (4) pp 567-572 (1994).

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