Evaluation of the OSLD system for remote dosimetry audits implemented by the RPC

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RPC Radiological Physics Center Excellence through Quality Assurance

Introduction

The Radiological Physics Center (RPC) commissioned an Optically Stimulated Luminescence Dosimeter (OSLD) beam output remote audit system based on the microStar® reader and nano dot dosimeters from Landauer. Results of the OSLD commissioning have been previously reported (1). Since June 2010 the OSLD program for verification of output for photon and electron beams replaced the RPC's thermoluminescent dosimetry (TLD) system for gantry based linacs. Only output checks for Gamma Knife and TomoTherapy units are still performed with TLD because of dose level and geometrical dose delivery issues. The analysis of the performance of the OSLD system is presented and compared to the historical results from the TLD system.

Materials

The nano-dot dosimeters from Landauer are use as detectors. Two dots are used per verification point. Acrylic blocks are used as mailable miniphantoms. These blocks are designed to provide sufficient electronic equilibrium (Figure 1). The OSLD miniphantoms are the same as the ones used by the RPC's previous TLD system, just modified to fit in the new dosimeter.

Figure 1: OSLD and acrylic block for irradiation

Dosimeters are irradiated by each megavoltage beam under specific geometric conditions. The geometry for irradiation is such that the miniphantom are located on a platform as shown in figure 2.

Figure 2: Geometry used for irradiation in photon beams

The dose level to be delivered changed from 300cGy for TLD to 100cGy for OSLD. Since the OSLD are reusable, the lower dose allows for the dosimeters to be used up to 9 times. Both system are designed for X-ray beams from 4 to 23 MV and electrons beams from 6 to 23 MeV.

Methodology

The OSLD dose calculated by the RPC system is compared to the dose reported by the institution at its reference calibration point. The ratio between RPC dose and institution dose (RPC/Inst) is reported to the medium (water or muscle) used by the institution. The acceptance criterion is 0.95 - 1.05 which is the same as used for the previous TLD system. Results outside criterion are investigated and followed up by a second irradiation of dosimeters to confirm the discrepancy or resolution of the discrepancy. The logistics dose calculation for both the TLD and OSLD systems, is managed by the RPC's Oracle database known as (RADS).

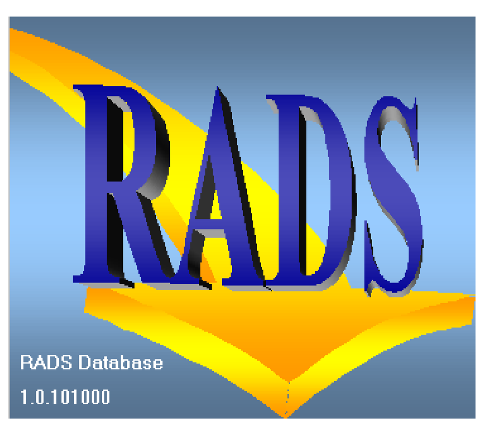


Figure 3: Logo of RPC's data base RADS

The RADS database is able to organize shipments of dosimeters to and from institutions. Every dosimeter sent to the institution for the audit is identified by a bar code. In the particular case of the OSLD system, the history of each nano-dot can be followed based on institution, machine, beam and dose level used for irradiation. 1

The organization of an OSLD reading session is also managed by the database. RADS is able to identify the OSLD batch used during the session, to determine the sensitivity of the reader, to perform evaluation of internal quality assurance steps inside the session and to calculate the dose to the institution point based on commissioning data. The process of checking a session as well as final approval and issue of reports are handled by the database (Fig 4)

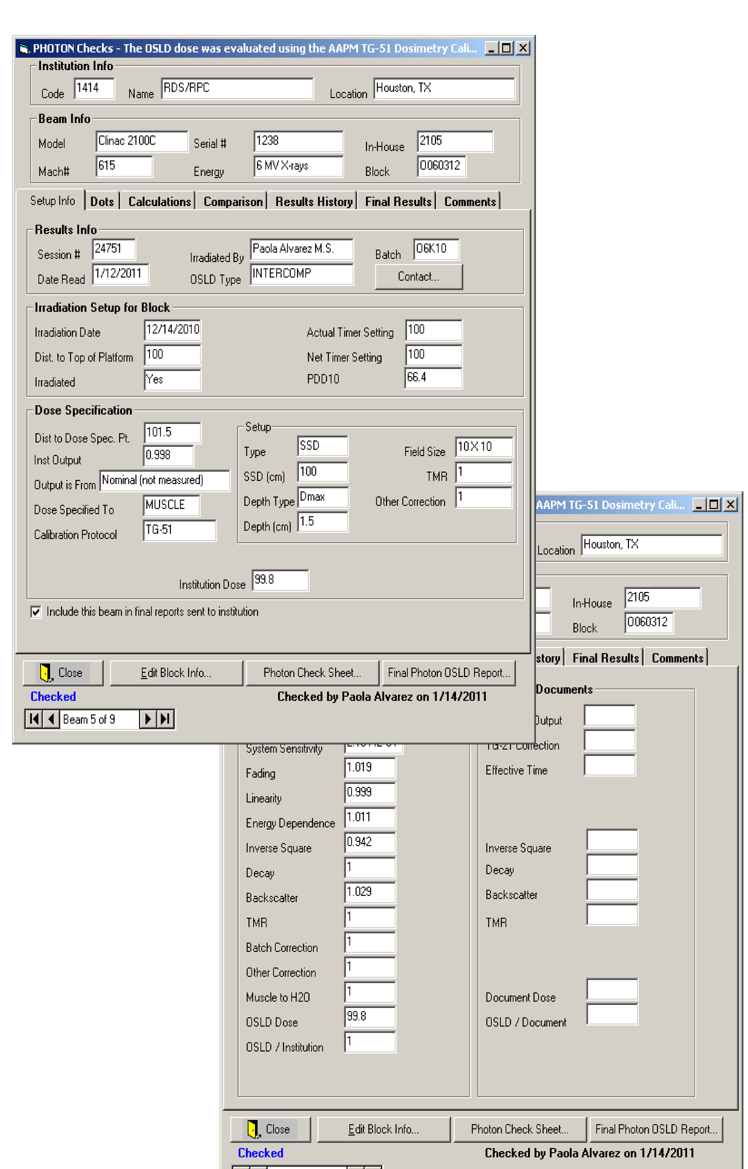


Figure 4: Different screens from data based used during the process of analysis of OSLD results

Results

The average ratio between the RPC dose and the institution dose to the point of dose verification is 1.000 ± 1.9% for TLD system between 2005 and 2010. The average is 0.999 ± 1.7% for the OSLD system since it was implemented. This average was analyzed based on the whole population of results (n=16024 TLD system and n=4227 for OSLD system). Values lower than 0.90 or higher than 1.10 are consider outliers for the analysis presented in this work. All the values are based on comparison of dose to the same medium and output calculated based on AAPM task groups for output calculation (TG 21 and TG 51). Figure 5 shows histogram of distribution of the results.

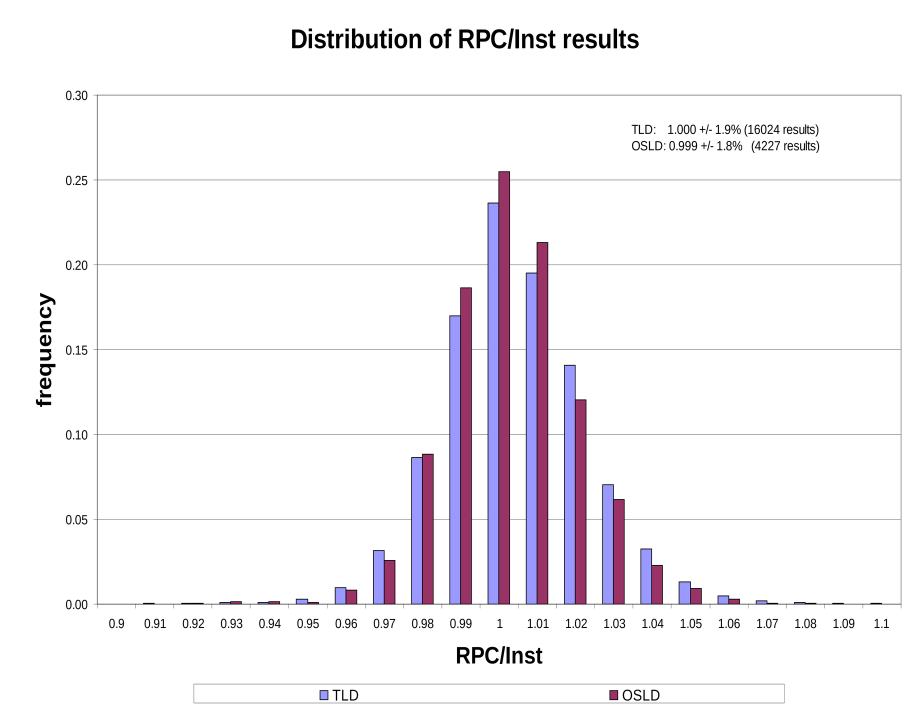
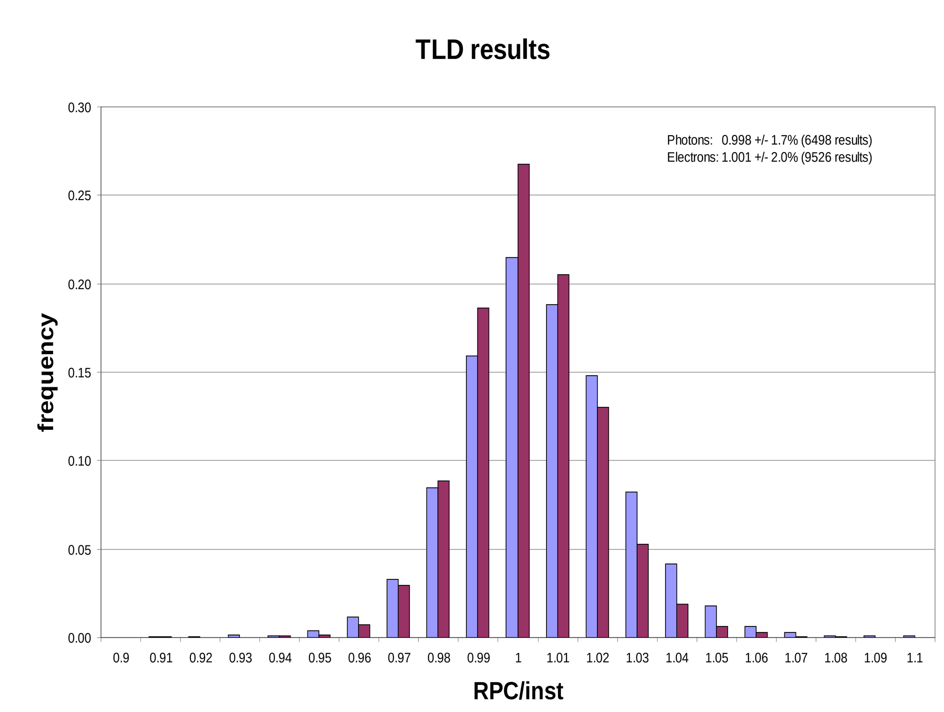


Figure 5: Histogram of the results for all beams for TLD and OSLD systems

The RPC/Inst ratio average was also analyzed per type of beam and per energy without showing any differences. The results based on the TLD system are 0.998 ± 1.7% for photon beams and 1.001 ± 2.0% for electron beams. In the case of the OSLD system the values are 0.997 ± 1.5% for photon beams and 1.000 ± 1.8% for electron beams (Fig 6).



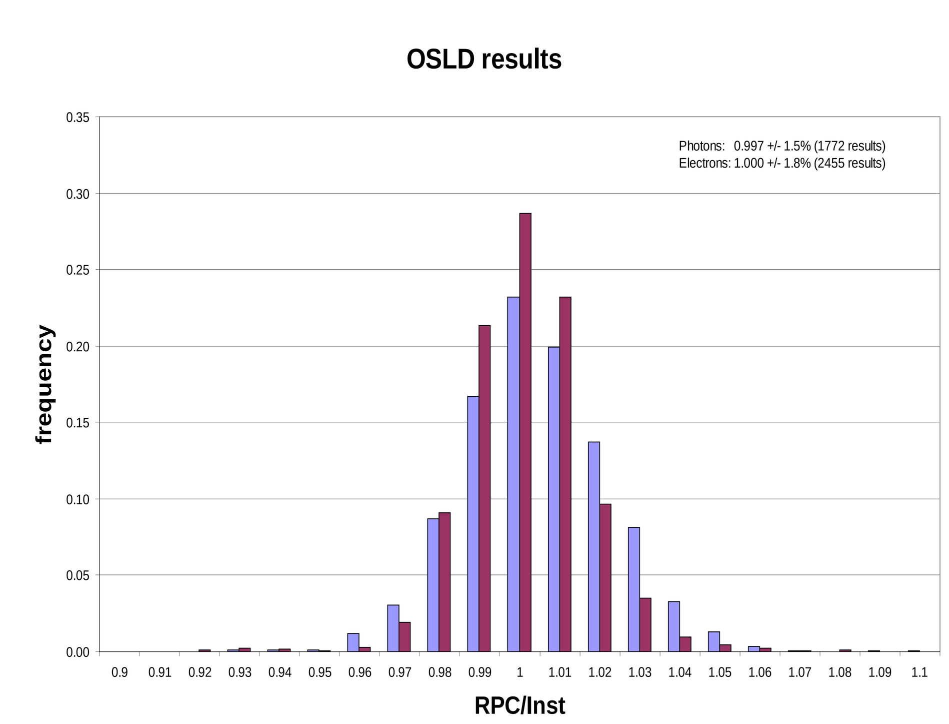


Figure 6: Histogram of the results per type of beams

Results (cont'd)

The OSLD system allows the RPC to evaluate more beams during reading sessions. The system change from a maximum of 24 to 26 dose calculation points for TLD to up to 50 dose calculation points for OSLD under the same reading process conditions (reading time and stability of the reader). History of the dosimeter were accumulated dose, measurements done and characteristic of the measurements performed with the dosimeter are easily followed by RADS. This tools is an important features added to our data base to follow the requirements of this new system. The commissioning data used for calculation of dose has a limit of 10Gy accumulated dose to the dosimeter. (Fig 7)

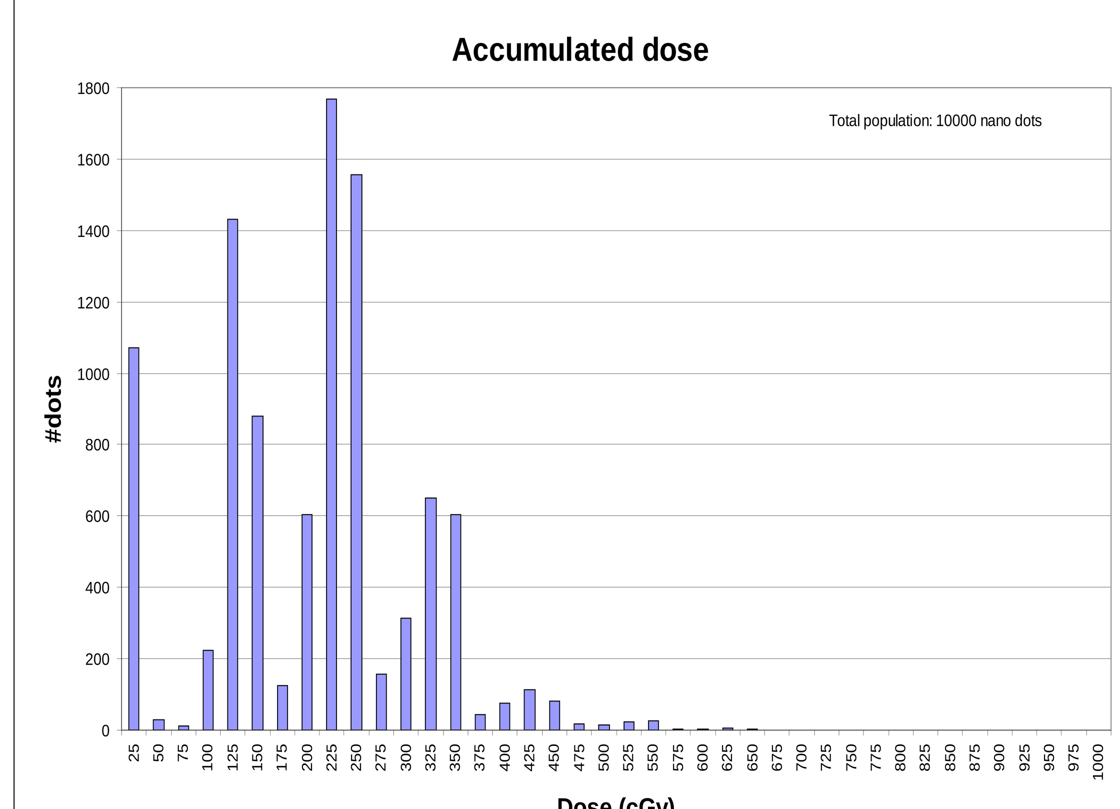


Figure 7: Analysis of accumulated dose to the whole population of dots

Conclusions

The average ratio between RPC dose and institution dose at the point of dose verification did not change between the conversion from the TLD system to the OSLD system.

The barcode identification of each of the OSLD dosimeters is important to keep track of irradiations especially when reuse of the dosimeter is one of the advantages of this system.

References

[1] Aguirre J, Alvarez P, Followill D, Ibbott G. Optically Stimulated Light Dosimetry: Commissioning of an OSL System for Remote Dosimetry Audits: The Radiological Physics Center Experience. Medical Physics 36: 2591, 2009. [2] Kirby TH, Hanson WF and Johnston DA. Uncertainty analysis of absorbed dose calculations from thermoluminescence dosimeters. Med Phys 1992; 19:1427–1433.

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