



TASLIMAGE System #2 Technical Equivalence Evaluation

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Auspices

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Introduction

In early 2017, a second TASLIMAGE system (TASL 2) was procured from Track Analysis Systems, Ltd. The new device is intended to complement the first system (TASL 1) and to provide redundancy to the original system which was acquired in 2009. The new system functions primarily the same as the earlier system, though with different X-Y stage hardware and a USB link from the camera to the host computer, both of which contribute to a reduction in CR-39 foil imaging time. The camera and image analysis software are identical between the two systems. Neutron dose calculations are performed externally and independent of the imaging system used to collect track data, relying only on the measured recoil proton track density per cm² for a set of known-dose CR-39 foils processed in each etch.

Method and Results

To verify compatibility between the two systems, three sets of 10 CR-39 foils were exposed to zero dose, 100 mrem, and 300 mrem using unmoderated ²⁵²Cf neutrons. Additionally, five foils to be used as normalization foils were exposed to 500 mrem using unmoderated ²⁵²Cf neutrons. Exposures in this dose range were deemed appropriate, as this range represents more than double the largest dose assigned to any single personnel CR-39 foil since the TASL system has been accredited at LLNL, and includes the normalization foils (500 mrem) that are used for each etch process. The foils were then scanned on each system and the doses were calculated and compared. Table 1 and Figures 1 and 2 summarize the data.

Table 1. Comparison of TASL 1 and TASL 2.

Delivered Dose (mrem)	TASL 1 Calculated Dose (mrem)	TASL 1 %CV	TASL 1 95 th Confidence Interval	TASL 2 Calculated Dose (mrem)	TASL 2 %CV	TASL 2 95 th Confidence Interval	%Difference
0	0	-	-	0	-	-	0.0%
100	109.57	8.5%	±5.79	120.23	6.3%	±4.67	9.7%
300	292.83	5.4%	±9.71	289.06	4.1%	±7.30	-1.3%
500	500.00	4.5%	±13.89	500.00	3.2%	±10.07	0.0%

The results are documented in the following spreadsheet:

<\\\\dellforce2\\xforce2\\dosimetry\\Technical Basis Docs\\TASL2 Technical Equivalence\\Technical Equivalence Calculations.xlsx>.

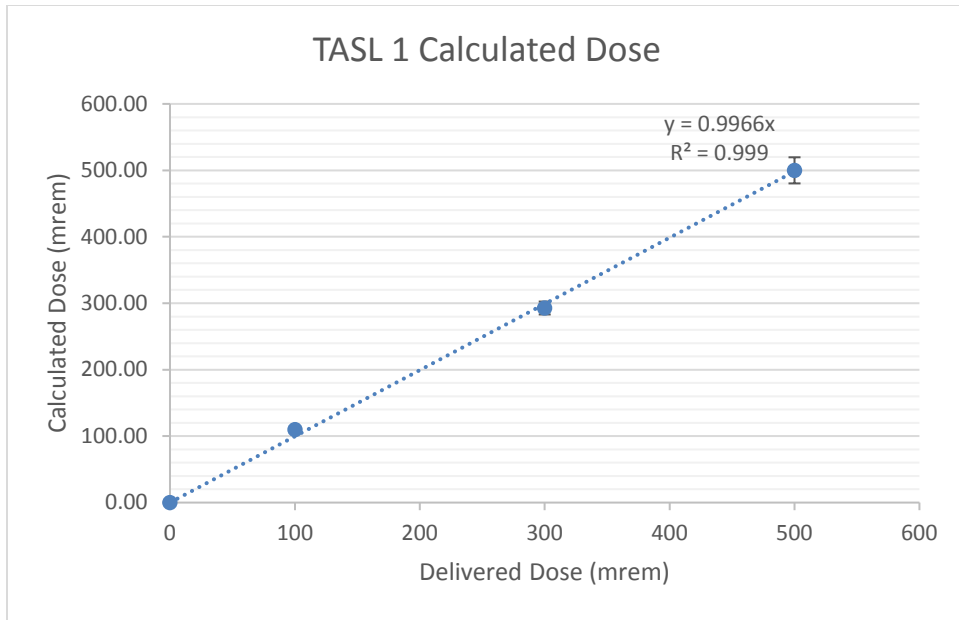


Figure 1. TASL 1 Technical Equivalence Test: Calculated Dose vs Delivered Dose in mrem.

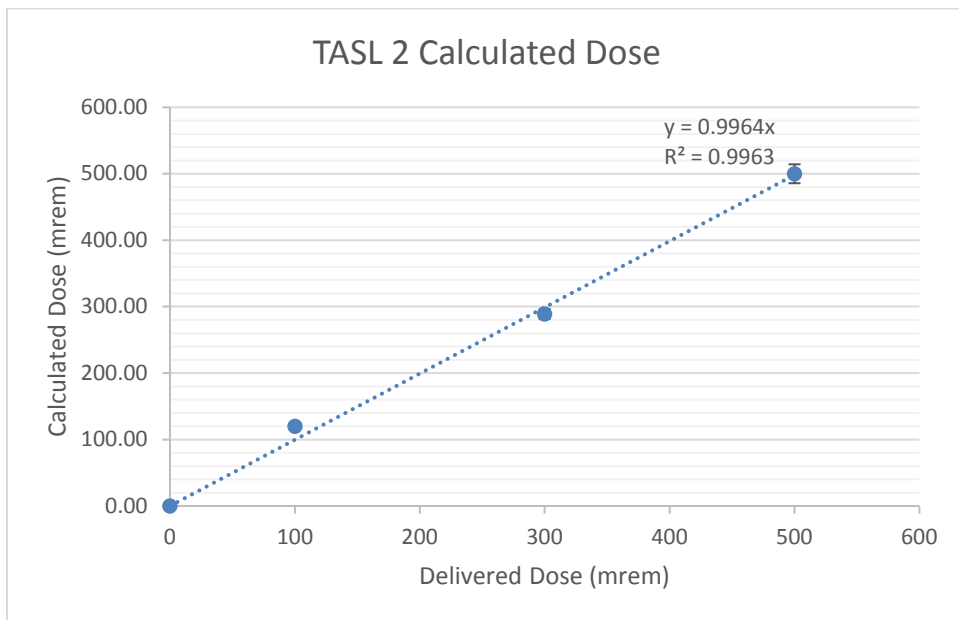


Figure 2. TASL 2 Technical Equivalence Test: Calculated Dose vs Delivered Dose in mrem.

To further test the TASL2 system, CR-39 foils that were originally used to characterize the TASL 1 system in 2012 were retrieved from storage and scanned on the TASL 2 system. This test evaluates the linearity of the TASL2 system. Additionally, this test demonstrates the durability of recoil proton tracks in previously etched CR-39 foils that have been properly cared for. Although the sensitivity of CR-39 plastic does vary with the age of the material, the results show that track fading post-etch is not a factor.

Table 2. 2012 Linearity Study using TASL 2 System.

Delivered Dose (mrem)	Track Density	Calculated Dose (mrem)
0	2.4	0.5
100	405.4	91.3
200	913.4	205.6
500	2221.2	500.0
1000	4322.8	973.1
2000	8562.2	1927.4
5000	22134	4982.4
10000	44512.4	10019.9
30000	127728.2	28752.1
50000	168440.4	37916.5

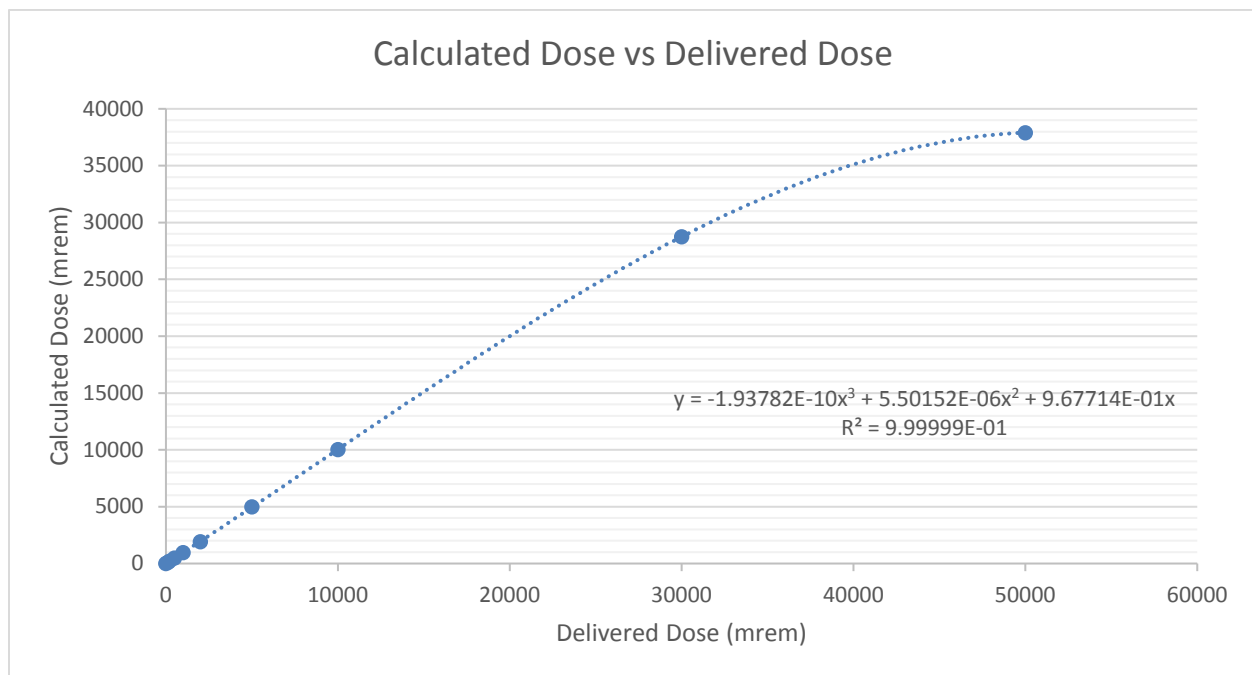


Figure 3. Calculated Dose of Linearity Study vs Delivered Dose in mrem.

Figure 3 indicates that the track density per cm² is clearly not linear above about 30 rem. Limiting the extended linearity dataset to exposures ≤30 rem yields the following data from the TASL 2 system displayed in Table 3 and Figure 4.

Table 3. Extended Linearity Study TASL 2 data.

Delivered Dose (mrem)	Reported Dose (mrem)	Accuracy (Normalized to Delivered Dose)
0	0.5	-
100	91.3	0.91
200	205.6	1.03
500	500.0	1.00
1000	973.1	0.97
2000	1927.4	0.96
5000	4982.4	1.00
10000	10019.9	1.00
30000	28752.1	0.96

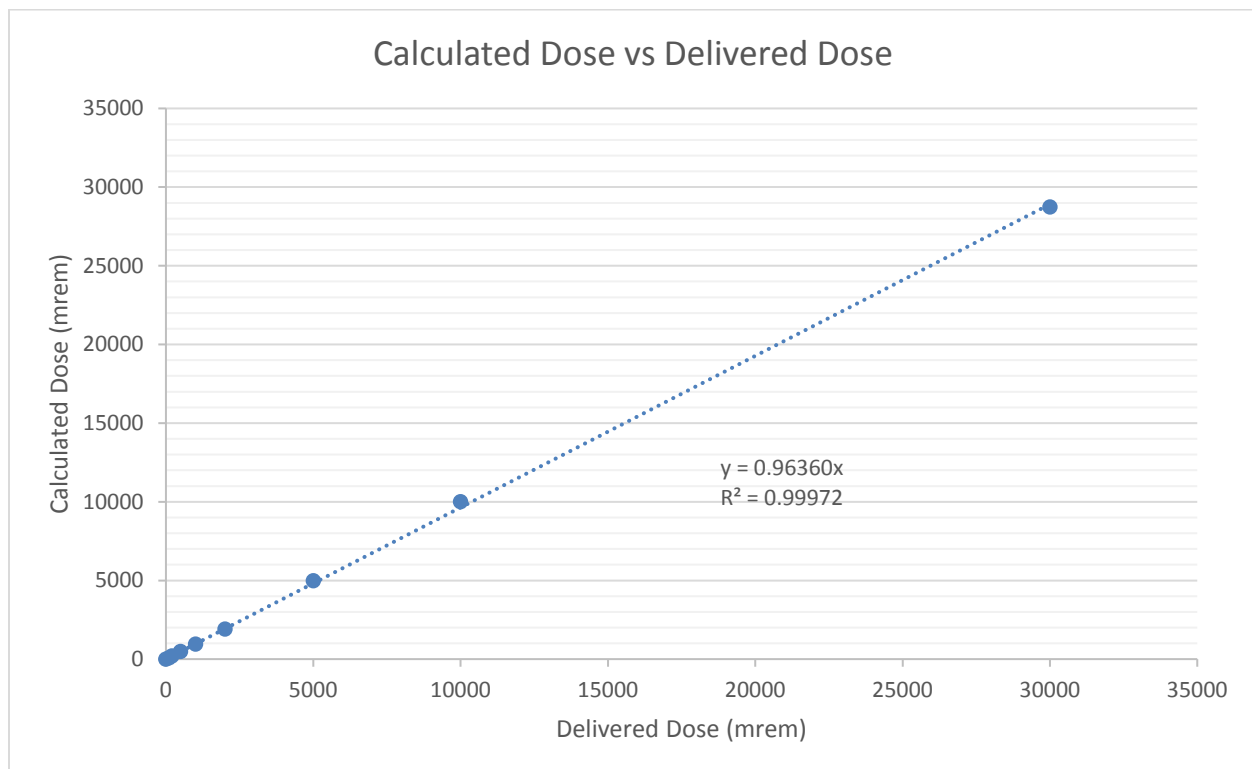


Figure 4. Extended Linearity Response Test using TASL 2 to 30 rem.

Extended linearity testing of the TASL 2 system demonstrates that the system is linear to approximately 30 rem, which is far in excess of the 5 rem total deep dose proficiency requirement found in the ANSI N13.11-2009 Standard, Category V Neutron/photon mixtures. The data for the expanded linearity testing can be found in spreadsheet <\\dellforce\xf2\dosimetry\technical basis Docs\TASL2 Technical Equivalence\TASL 2 Linearity.xlsx>

In addition to the technical equivalence documented herein, the TASL2 system provides significant advantages in processing speed. It is anticipated that this system will reduce CR-39 imaging time by about a factor of two. The TASL 2 system should be placed in service as soon as DOELAP technical equivalence is granted.