

Supplementary File

Quartz Tuning Fork Sensor-Based Dosimetry for Sensitive Detection of Gamma Radiation

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Statistical Analysis

The number of experimental runs required to run the experiment was designed using the Taguchi L9 design. From the literature, among the dominant parameters of detecting radiation sources from gamma, time and dose played an vital role in contributing the output response resonance frequency. So, time and dose have been considered in this L9 Taguchi experiment.

Table S1. Design of Experiment with Main Variables.

Input Parameters	Levels	Actual Values
Time	(−1, 0, +1)	(0, 1, 2.5)
Dose	(−1, 0, +1)	(0, 7.64, 19.10)

Experimental Data Sets

Table S2. Taguchi Experimental Design Test Matrix (L9) for Detection of gamma radiation as a function of dose and time duration.

Time (hr)	Dose (μGy)	QTFg	QTFgl	QTF
0.0	0.00	32.62	32.73	32.16
0.0	7.64	32.63	32.76	32.18
0.0	19.10	32.64	32.77	32.19
1.0	0.00	32.65	32.78	32.20
1.0	7.64	32.67	32.79	32.21
1.0	19.10	32.69	32.81	32.22
2.5	0.00	32.71	32.82	32.24
2.5	7.64	32.73	32.84	32.25
2.5	19.10	32.75	32.86	32.26

Results

The regression equation (1) of

$$QTFg = 32.6767 - 0.04667 \text{ Time (hr)}_{0.0} - 0.00667 \text{ Time (hr)}_{1.0} + 0.05333 \text{ Time (hr)}_{2.5} - 0.01667 \text{ Dose (}\mu\text{Gy)}_{0.00} + 0.00000 \text{ Dose (}\mu\text{Gy)}_{7.64} + 0.01667 \text{ Dose (}\mu\text{Gy)}_{19.10}$$

Table S3. ANOVA for resonance frequency response of QTFg vs time (hr), dose (μGy) level.

Source	df	Sum of Squares	Mean of Squares	F- Value	P-Value
Time (hr)	2	0.015200	0.007600	228.00	0.000 Significant
Dose (μGy)	2	0.001667	0.000833	25.00	0.005 Significant

The regression equation (2) of

$$QTFgl = 32.7956 - 0.04222 \text{ Time (hr)}_{0.0} - 0.00222 \text{ Time (hr)}_{1.0} + 0.04444 \text{ Time (hr)}_{2.5} - 0.01889 \text{ Dose (}\mu\text{Gy)}_{0.00} + 0.00111 \text{ Dose (}\mu\text{Gy)}_{7.64} + 0.01778 \text{ Dose (}\mu\text{Gy)}_{19.10}$$

Table S4. ANOVA for resonance frequency response of QTFgl vs time (hr), dose (μGy) level.

Source	df	Sum of Squares	Mean of Squares	F- Value	P-Value
Time (hr)	2	0.011289	0.005644	203.20	0.000 Significant
Dose (μGy)	2	0.002022	0.001011	36.40	0.003 Significant

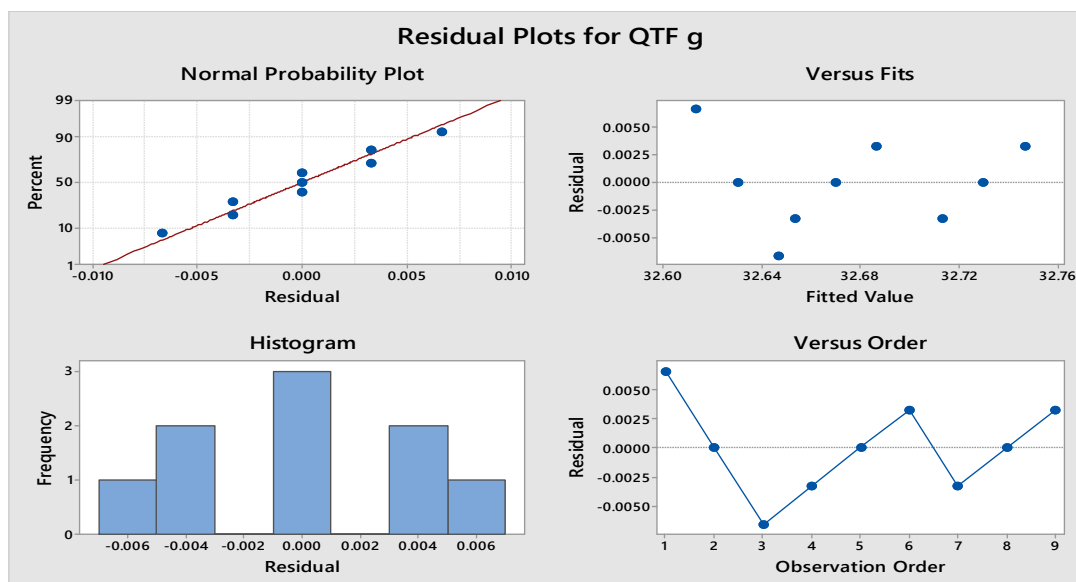
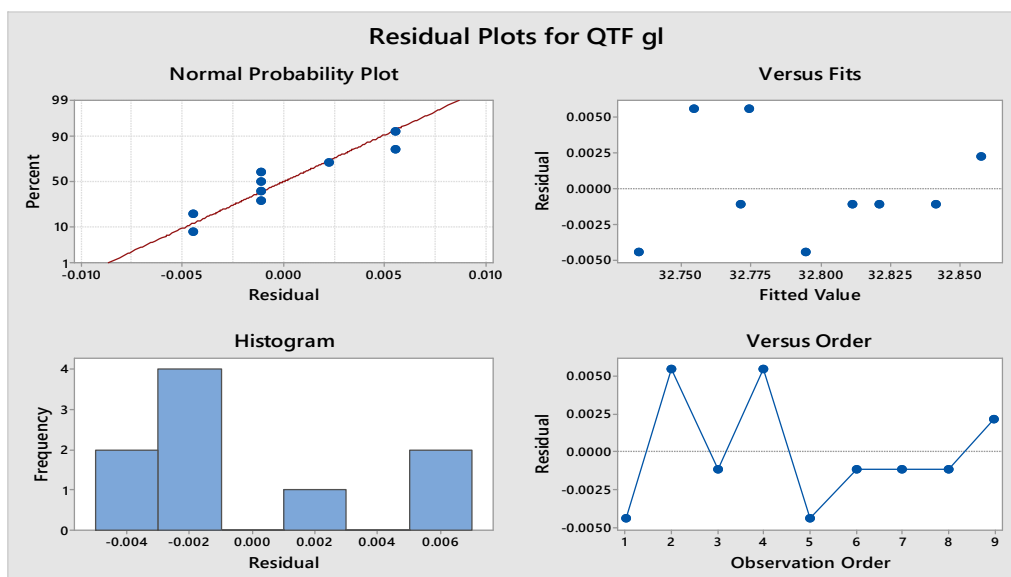
The regression equation (3) of

$$QTF = 32.2122 - 0.03556 \text{ Time (hr)}_{0.0} - 0.00222 \text{ Time (hr)}_{1.0} + 0.03778 \text{ Time (hr)}_{2.5} - 0.01222 \text{ Dose (}\mu\text{Gy)}_{0.00} + 0.00111 \text{ Dose (}\mu\text{Gy)}_{7.64} + 0.01111 \text{ Dose (}\mu\text{Gy)}_{19.10}$$

Table S5. ANOVA for resonance frequency response of QTF vs time (hr), dose (μGy) level.

Source	df	Sum of Squares	Mean of Squares	F- Value	P-Value
Time (hr)	2	0.008089	0.004044	364.00	0.000 Significant
Dose (μGy)	2	0.000822	0.000411	37.00	0.003 Significant

From the ANOVA tables, the results inferred that the parameters with p value <0.05 is considered to be the significant and actively contributed to the experimental responses. The model fit found to be linear and there is no interaction exists between the two input parameters. From this observation, it is evident that both input parameters efficiently contributed with its individual ability towards the active responses under desirability 1. In addition, the predicted all analysis R^2 value (99.42 ± 0.3) is closely matches with adjusted R^2 (96.72 ± 0.1) which makes the data scatters of actual and predicted as very close fit data.

**Figure S1.** Residual Plots for QTF : resonance frequency vs time (hr), Dose (μGy) level of gamma source.**Figure S2.** Residual Plots for QTFgl : resonance frequency vs time (hr), Dose (μGy) level of gamma source.

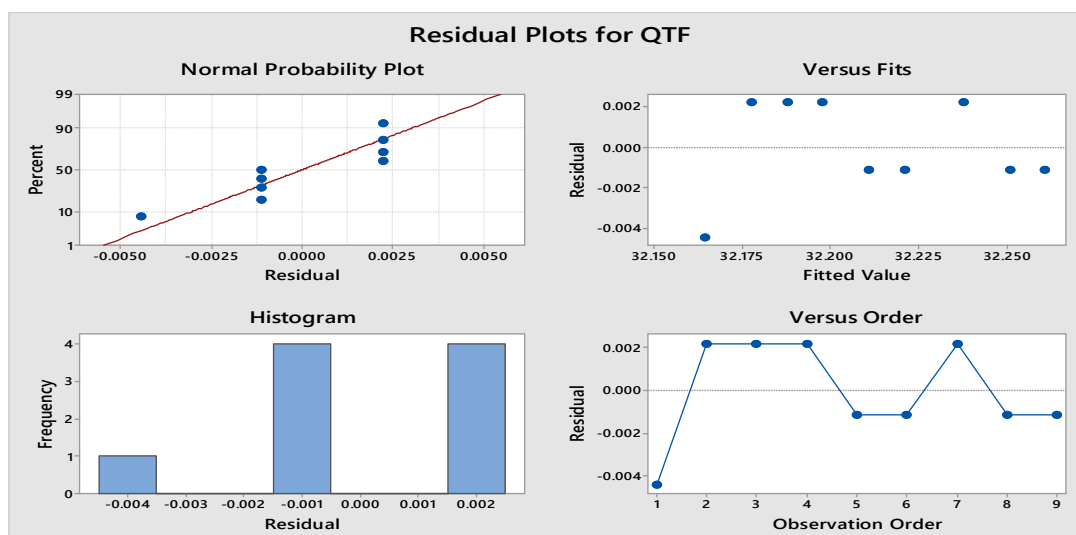


Figure S3. Residual Plots for QTFgl : resonance frequency vs time (hr), Dose (μ Gy) level of gamma source.

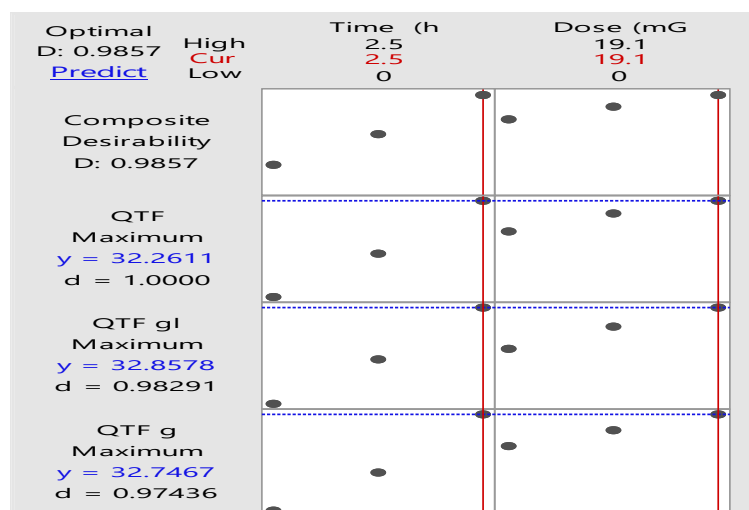


Figure S4. Response optimizer for time, dose level vs resonance frequency.

From the response optimizer, it was concluded that increase in the time and dose obviously increasing the frequency of the selected QTF systems (QTFgl, QTFg and QTF).