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# SPHINX PULSED POWER AND RADIATION OUTPUT EXPERIMENTS

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**Abstract:** *Experiments were performed on the SPHINX pulsed power machine at Sandia to determine how the radiation output varies with converter material properties. Simulation of the expected radiation profile and results from the experiments are presented.*

## Introduction and Motivation

➢For many years, the pulsed power machines at Sandia National Laboratories have used tantalum (Ta) converters to produce Bremsstrahlung radiation.

➢Typically, the converter material has been ordered from commercial vendors with different amounts of tungsten (W) alloy, and variability in the cold working (shaping) and annealing processes.

➢The focus here is whether these material properties create a relative difference in the radiation output between the modeling and experiments with Ta-W alloy and Ta of differing grain size.

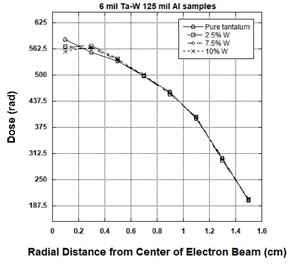
➢Experiments were performed on SPHINX which can be fired every 15 minutes, operates up to 2 MeV with 25 kA and 15 ns pulse width.

## Modeling and Simulation

➢The radiation output on SPHINX for pure Ta, 2.5% W, 7.5 %W and 10% W was simulated using MCNP.

➢The samples were modeled as a homogenous mass and electrons were treated uniformly with respect to the experiment setup geometry.

➢The plot shows minimal to virtually no expected variation in the radiation signal output with an increasing level of W added to the Ta converter.



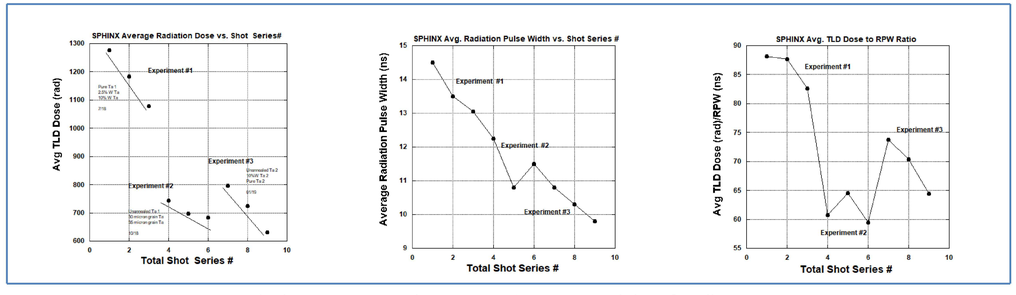

*Sigma Science, Inc.

## Experiment Results and Discussion

➢The experiment was divided up into a series of 9 tests (10 shots per test) including pure Ta, 2.5% W Ta, 10% Ta alloy mixtures as well as 30 and 35 micron grain size samples.

➢Even though the experiments showed variation in the relative radiation output, the variation (as shown in the plot) was later determined to be due to machine performance. In particular, variation SPHINX pulse width affected the radiation pulse width.

➢The average pulse width varied significantly from first experiment and the last two experiments in the series. Due to this variation, the ratio of the average TLD dose rate to pulse width per shot proves a more accurate comparative estimate of radiation output.




➢The time averaged representative integrated dose for all TLDs over the entire experiment series fits within a much narrower range compared with the raw radiation output data.

➢The uncertainty in the time averaged representative integrated dose is approximately 11.30 rad/ns which is slightly more than the 10% reported error of TLD measurements.

➢The modeling and simulation is consistent with the expected relative change in the radiation output.

➢There is no variation in the radiation output attributed to material differences outside of the measurement capability of TLDs.

## Conclusion

➢A series of experiments with Ta of varying material properties aimed at examining the output of the SPHINX pulsed power machine has been treated.

➢The simulation agreed well with the experiment to within the measurement uncertainty of the TLDs in considering average pulse widths for each shot.

➢Even though the validity of this experiment is primarily relevant to the SPHINX machine, there is future interest in repeating the tests at higher power levels on the larger pulsed power machines.

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