INL/MIS-24-79189-Revision-0

Intern Sized Poster for Dosimetry Research

August 2024

Changing the World's Energy Future

Derek Tian Lewis, Connor Cronin Williams

Idaho National Laboratory

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http://www.inl.gov

Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

X-ray Security Imaging on Personal Dosimetry

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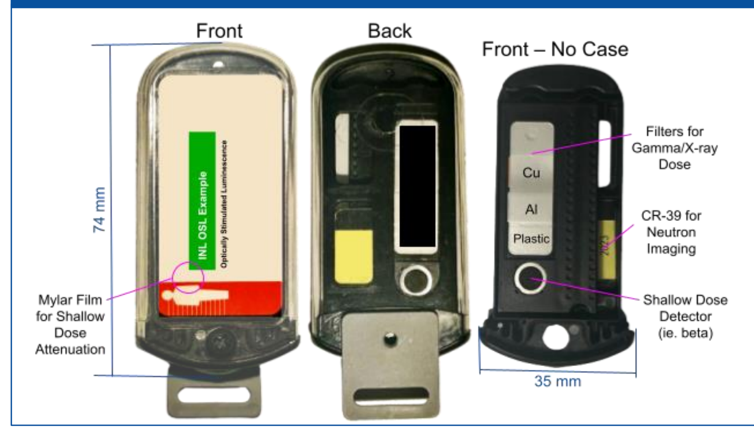
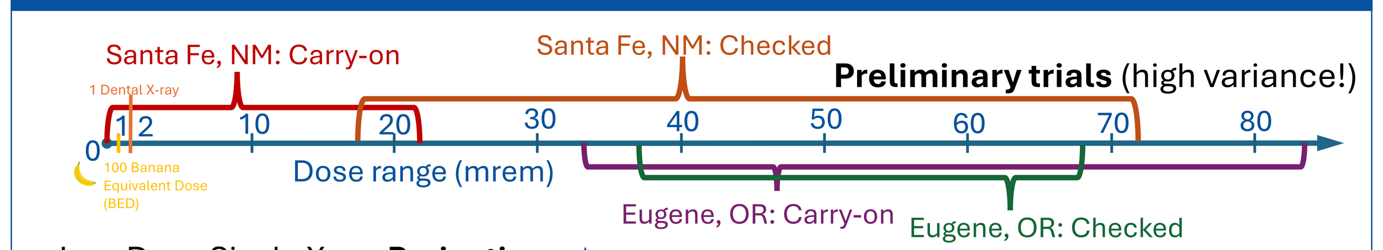
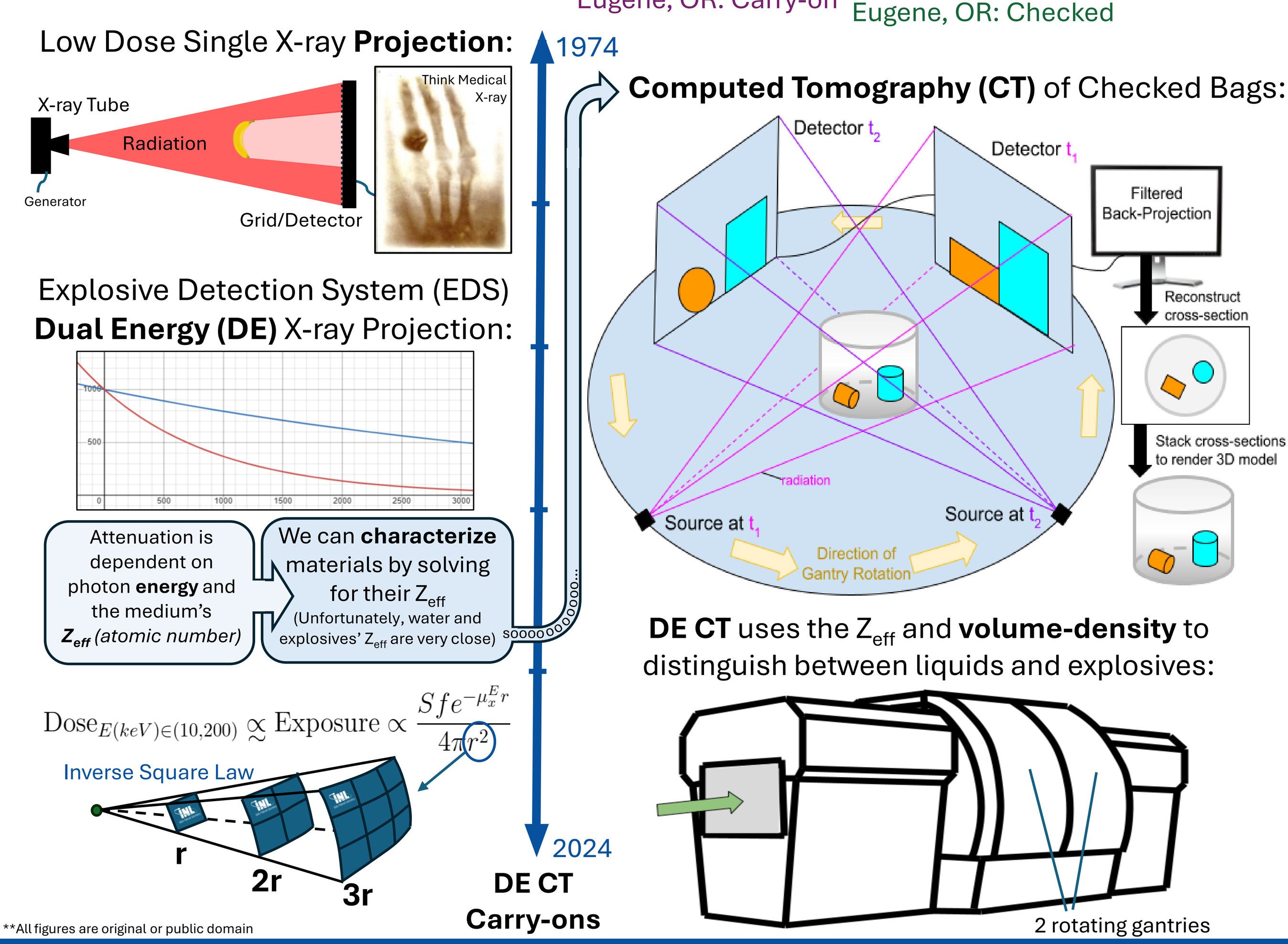
Abstract



Federal regulations mandate that **personal dosimetry devices — like optically stimulated luminescence (OSLs) — must be worn** by all US Department of Energy (DOE) and associated radiation workers to track their occupational dose. Unfortunately, the inadvertent passage of **OSLs through x-ray security scanners can compromise their validity**. With the advent of high energy, advanced resolution security technology used in airports, this once insignificant issue now requires that Radiological Control (RadCon) be able to accurately discern non-occupational dose to effected OSLs. This presentation will discuss the principles, methods, and, rather interesting, models for **establishing the corrective dose estimates at the Idaho National Laboratory (INL), and its implication across the DOE.**

Introduction

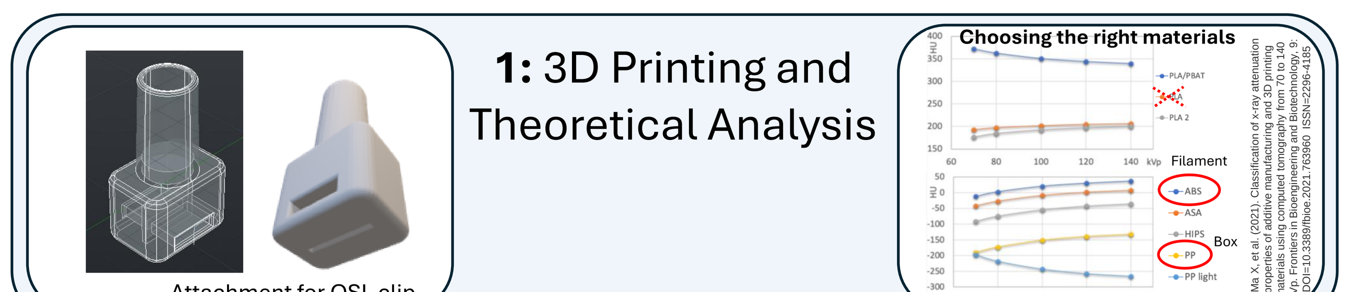


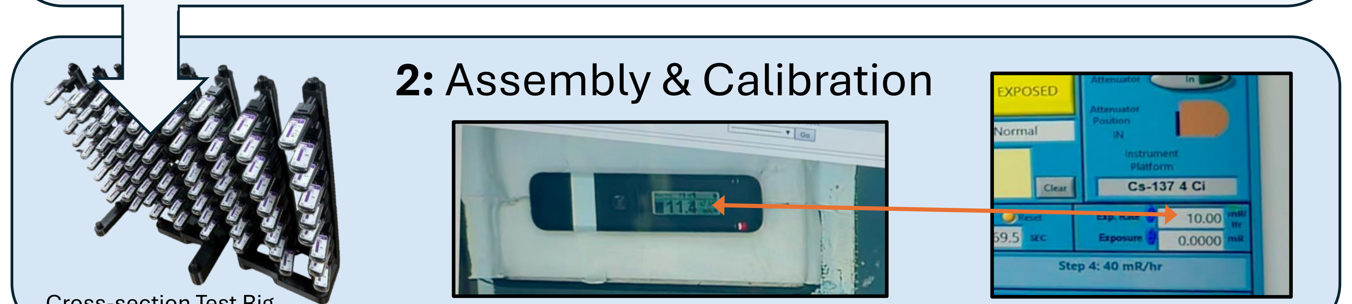


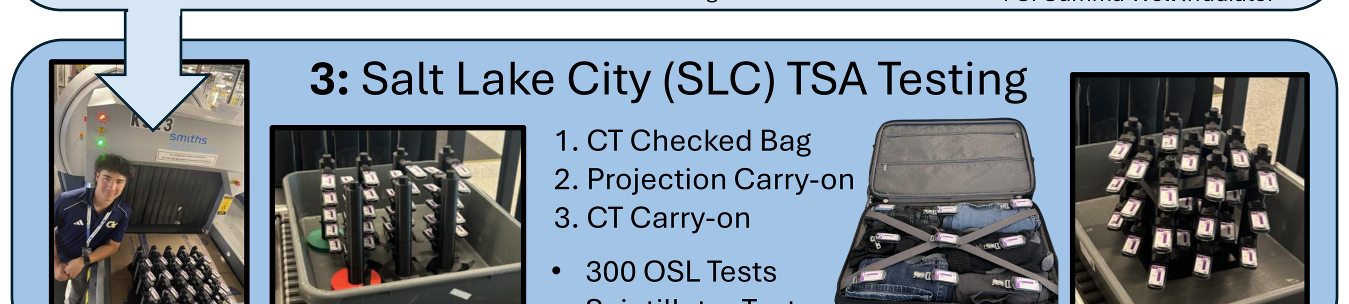
$$\text{Dose}_{E(keV)\in(10,200)} \propto \text{Exposure} \propto \frac{S f e^{-\mu_E^L r}}{4\pi r^2}$$

**All figures are original or public domain

Methods





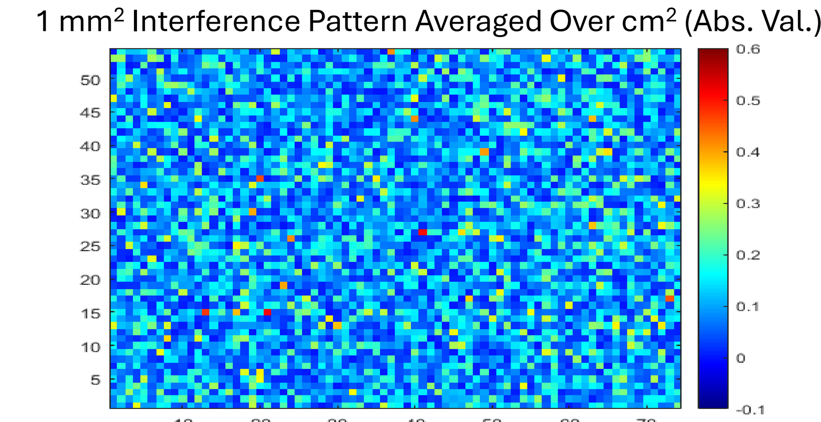


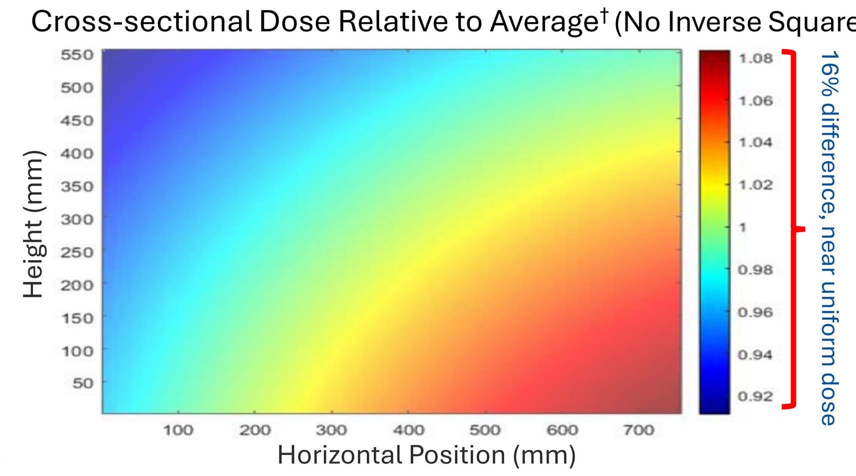
Acknowledgements

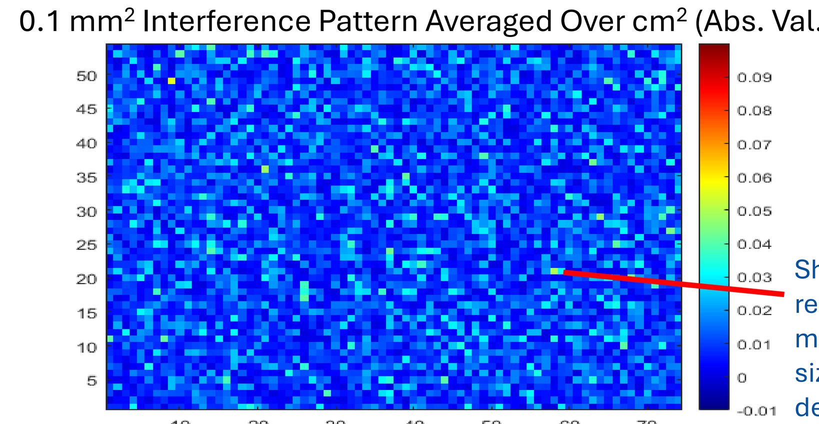
U.S. Department of Energy; Transportation Security Administration; SLC International

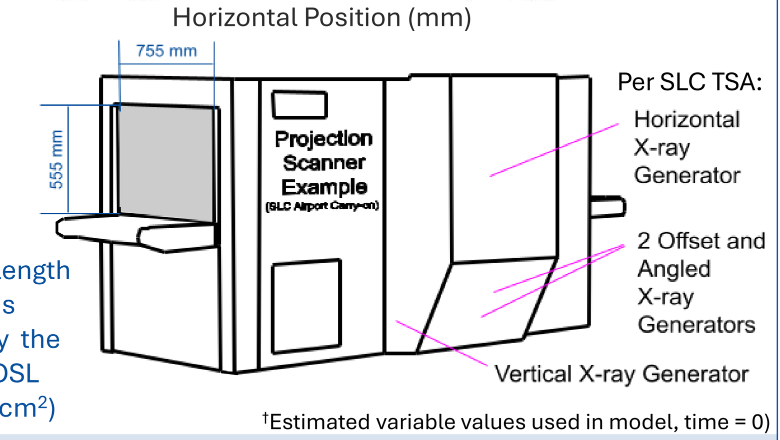
Theoretical Predictions

Resonance and Projection Imaging



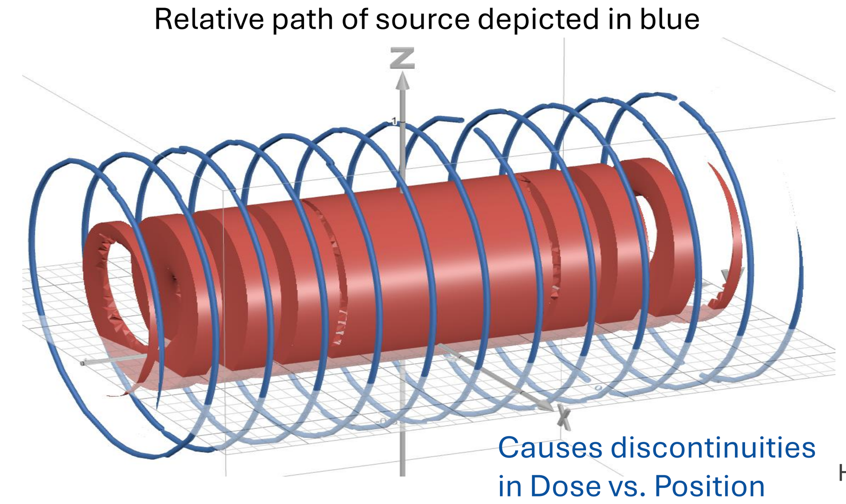


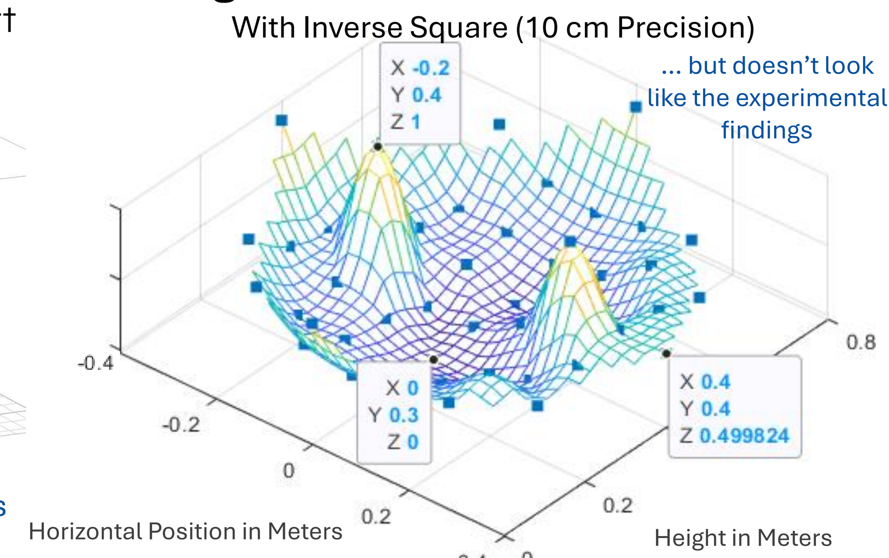




†Estimated variable values used in model, time = 0)

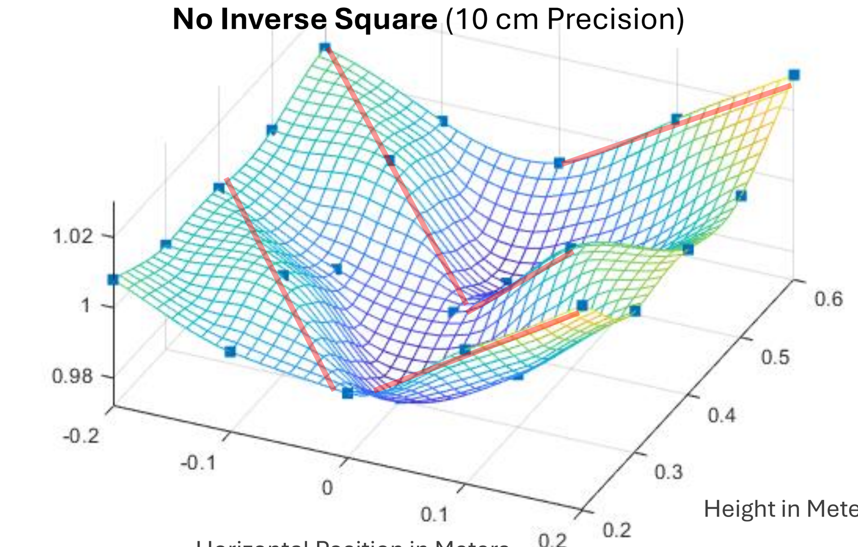
CT Imaging

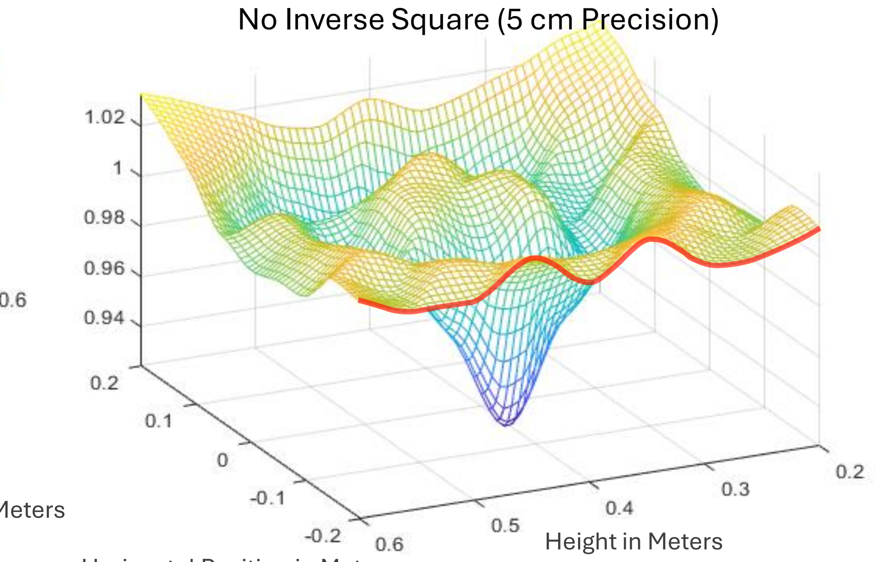




$$\pm vt\cot(\theta_A) \le \sqrt{(R\cos(\omega t)-x)^2+(R\sin(\omega t)-z)^2}\qquad x^2+z^2 \le r_{in}^2$$

$$\text{Dose}(x,z) \gtrsim \sum_{m=1}^{k/2}\int_{t_{2m-1}}^{t_{2m}} \frac{e^{-\mu\sqrt{((R\cos(\omega t)-x)^2+(R\sin(\omega t)-z)^2+(vt)^2)}}}{(R\cos(\omega t)-x)^2+(R\sin(\omega t)-z)^2+(vt)^2}\,dt$$
$$\text{when } \sin(\theta_A)\sqrt{-2Rx\cos(\omega t)-2Rz\sin(\omega t)+R^2+x^2+z^2} - vt\cos(\theta_A) = 0$$

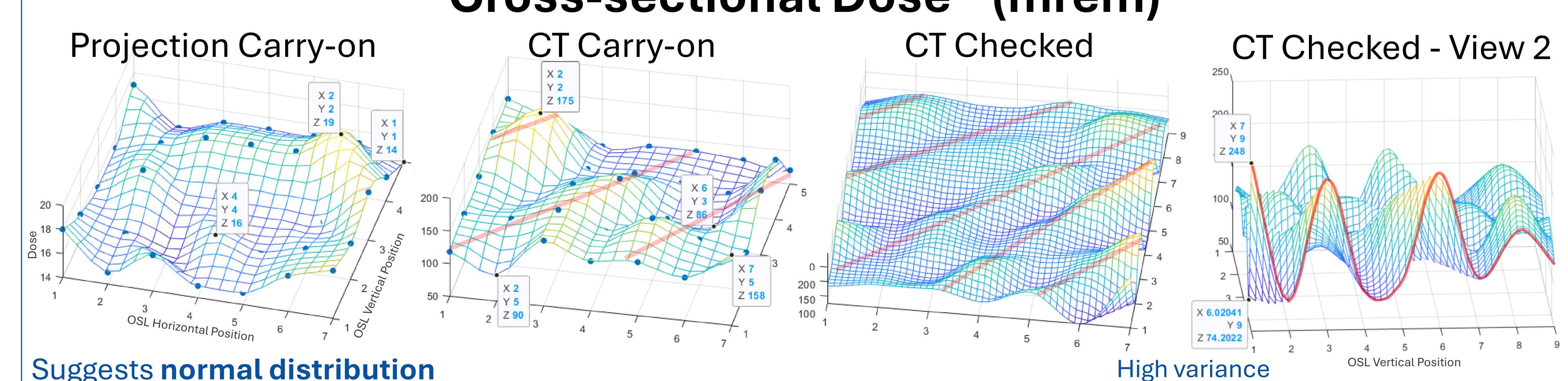




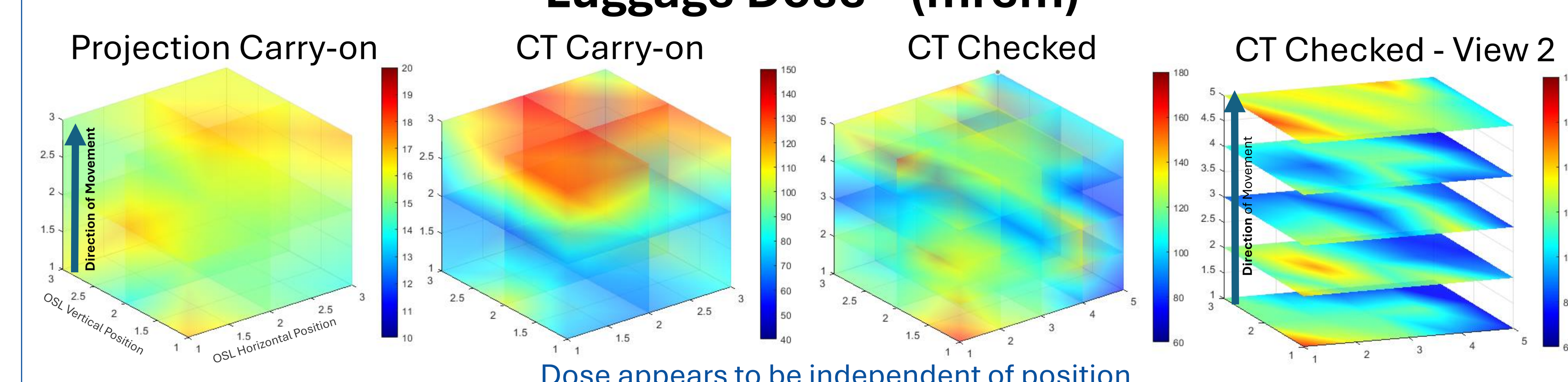
††Interpolated   †††Estimated variable values used in model

Experimental Findings

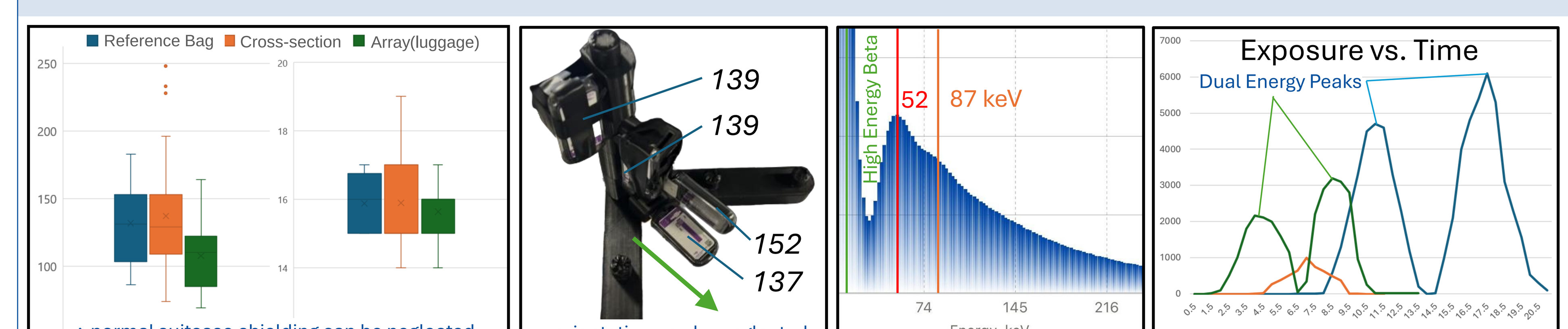
Cross-sectional Dose†† (mrem)



Luggage Dose†† (mrem)



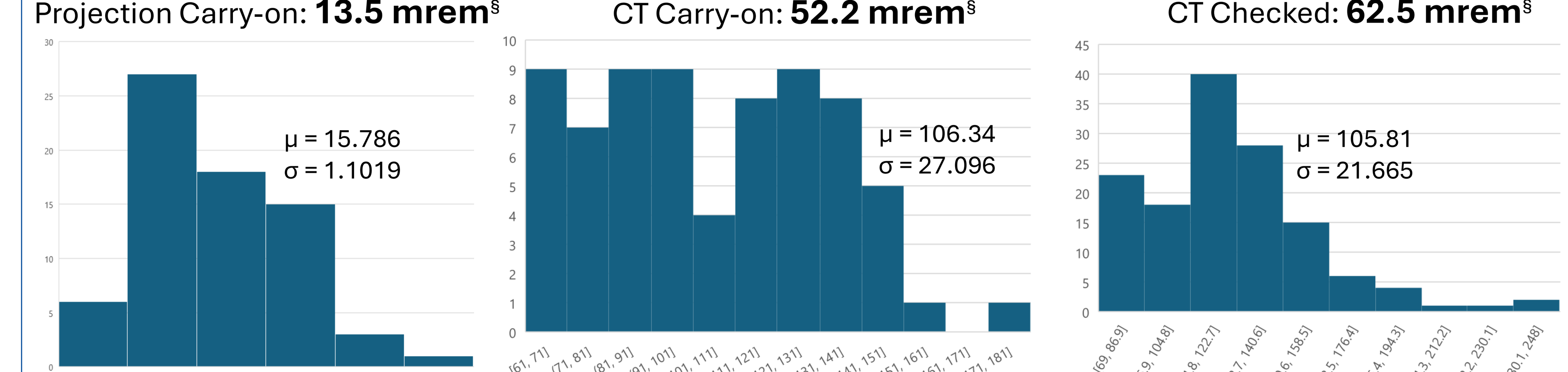
Attenuations, Orientations, Energy Spectra, & Exposures Tests



Conclusion

Recommendations for Radiological Control

Projection Carry-on: **13.5 mrem**§   CT Carry-on: **52.2 mrem**§   CT Checked: **62.5 mrem**§



§**With 97.5% confidence** that the true mean dose is greater than the recommendation

Limitations and Future Works

- Additional Airports & Scanners
- Proprietary and Security Concerns
- **Shallow Dose Variance in CT**

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