# Improving Dynamic Radiation Background Projection Through Interpolated Categorization

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## Background

- High-precision measurements of nuclear material require background radiation to be controlled. This is typically achieved by transporting the material away from a working area to a centralized lab.
- Movement of nuclear material increases radiation exposure to workers, creates contamination risk, and bottlenecks production in the facility.
- Dynamic Material Control (DYMAC) aims to avert these obstacles by implementing in-line nondestructive assay methods for near real-time material accountancy.
- This will optimize production and inventories while reducing radiation source handling and exposure to workers.
- Real time source location and strength predictions are vital for estimating dynamic background radiation.
- Better predictions for background sources' locations and strengths can produce more accurate analysis of material.

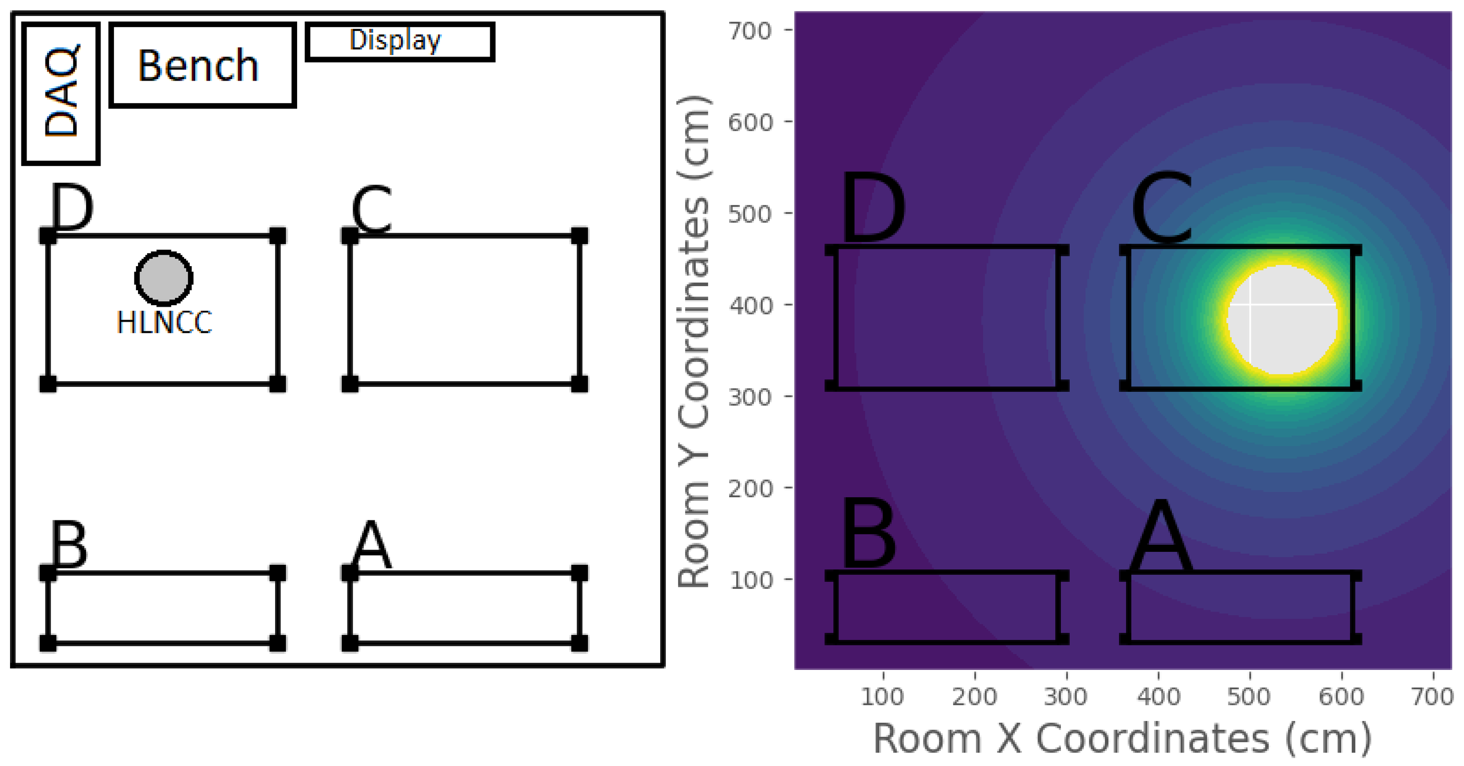


**Figure 1. Layout of the DYMAC Nuclear Material Testbed with a simulated image of a radiation source emulating effects of dynamic background radiation.**

## Methods

- Sets of templates model expected count rates at known locations evenly spaced throughout each glovebox.
- The gloveboxes have detectors on each corner to capture observed neutron count rates. Observed count rates are compared to the expected seen in the model templates.
- The source localization algorithm predicts source location and strength based on an interpolation made between all templates with similar categorization coefficients.
- When near multiple templates, the interpolation chooses a centralized point between all close template locations.
- When near only one template, the interpolation simply chooses that template location.

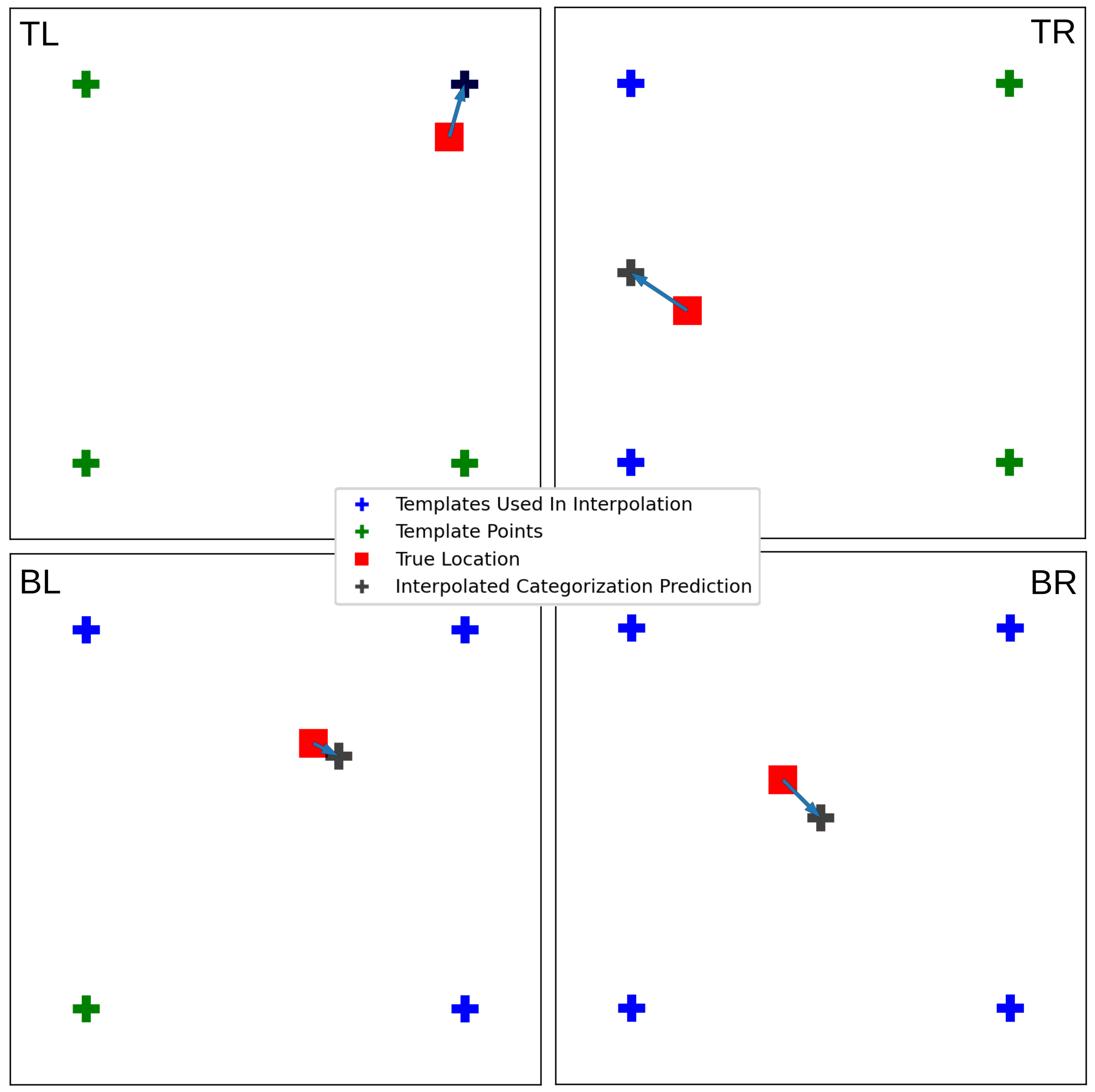


**Figure 2. Examples of how the interpolated categorization algorithm predicts source location. Source close to one template (TL). Source between two templates (TR). Source between three templates (BL). Source between four templates (BR).**

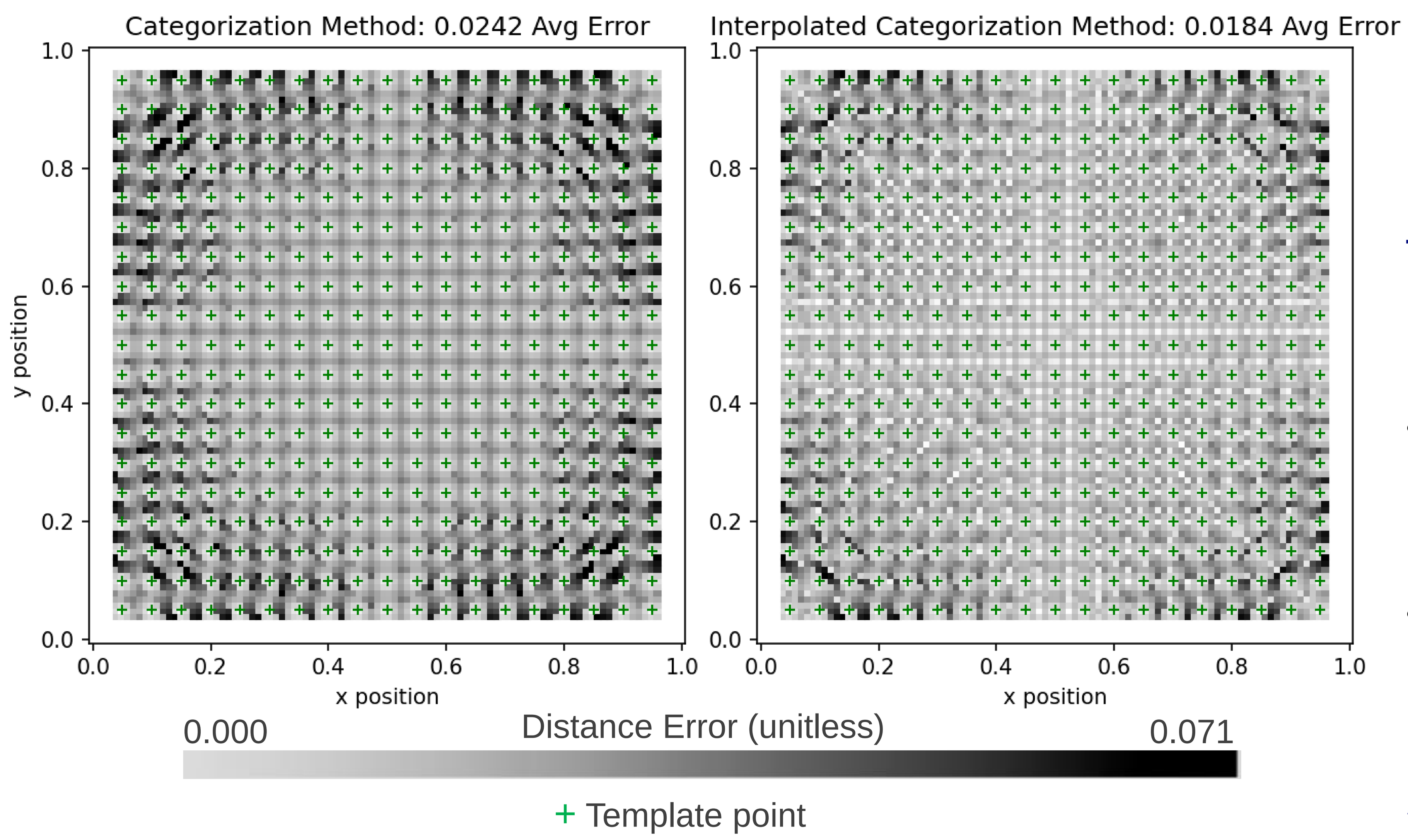


**Figure 3. Simulated gloveboxes shown using the simple categorization method (left) and the interpolated categorization method (right) to determine source location.**

- Figures 2 and 3 show comparisons of the categorization algorithms in simulated space. Figure 4 compares these methods with real measurements from the DYMAC testbed.
- Real measurements 1-16 were taken in gloveboxes A-D (4 per glovebox) with sources of varying strengths. Only one source was present in the testbed during each measurement.
- The interpolated categorization algorithm chose the same point or a closer point to the true location than the simple categorization algorithm in 15 out of 16 measurements.
- The categorization algorithm had an average error of 3.14 cm. The error is 35% lower using the interpolated categorization method resulting in an average error of 2.04 cm.

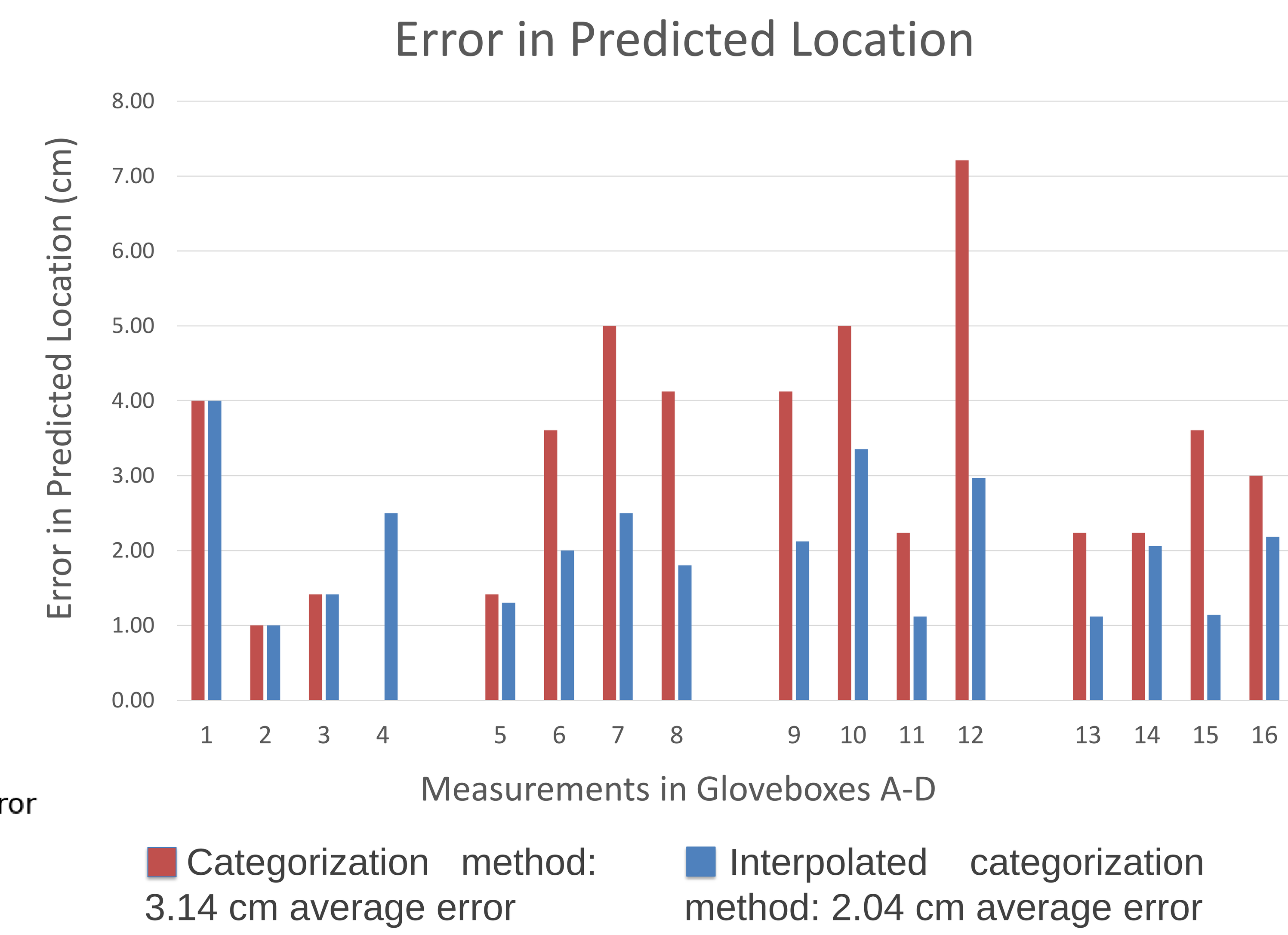


**Figure 4. Distance from true location to predicted location taken from real measurements of a radiation source.**

## Conclusion

- An improved algorithm was made to reduce uncertainties for background source location and strength estimations in simulation and real experiments while increasing computational time by only 5%.
- In the future, this work could be adapted and applied to predict location and strength during multi-source experiments.

## Acknowledgements

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