# Radiographic Density of Selected Materials at Different Thicknesses

**Thien Vu-Nguyen[1], Bernice Mills[2]**

[1]STAR, Templeton High School, Templeton, CA, [2]Sandia National Laboratory, Livermore, CA



## Introduction and Objective

- Current method of using x-rays to identify the thickness of a material:
  - Collect a radiograph using estimated conditions and evaluate results. Then make changes to conditions.
  - By rescanning the residual image it is possible to obtain an image of lower radiographic density, i.e. lighten the image to provide more information in the thinner range of an object.
- By tabulating or graphing the effect of energy changes and rescans, a more informed choice of conditions is possible. The data for two of the samples is displayed.

## Materials Selection

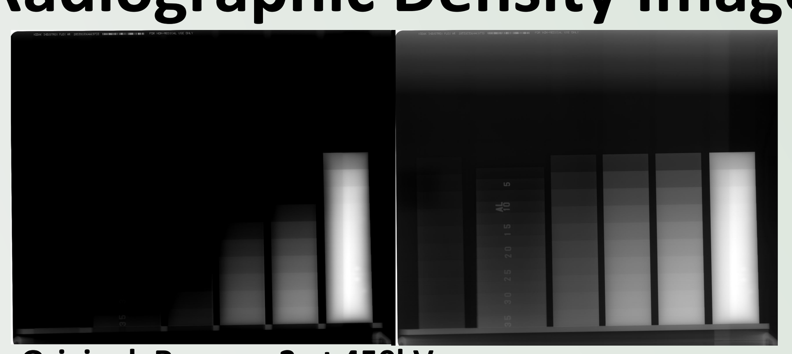
- Materials with varying densities are chosen to get a wide selection.
- The experiment used six base materials:

| Material | Abbreviation | Density (g/cc) |
|---|---|---|
| Magnesium | Mg | 1.74 |
| Aluminum 1100 | Al | 2.61 |
| Titanium | Ti | 4.43 |
| Stainless Steel 304L | SS | 8.09 |
| Copper | Cu | 8.96 |
| Tantalum | Ta | 16.65 |

- All the materials used are step wedges.
  - Five of the materials are 1 inch thick and the thickness decreases by 0.1 inch at each step.
  - Al is 1.75 inches thick and the thickness decreases by 0.125 inches at each step.


Six materials used arranged in order of increasing density in front of the plate.

## Radiographic Density Image Comparison



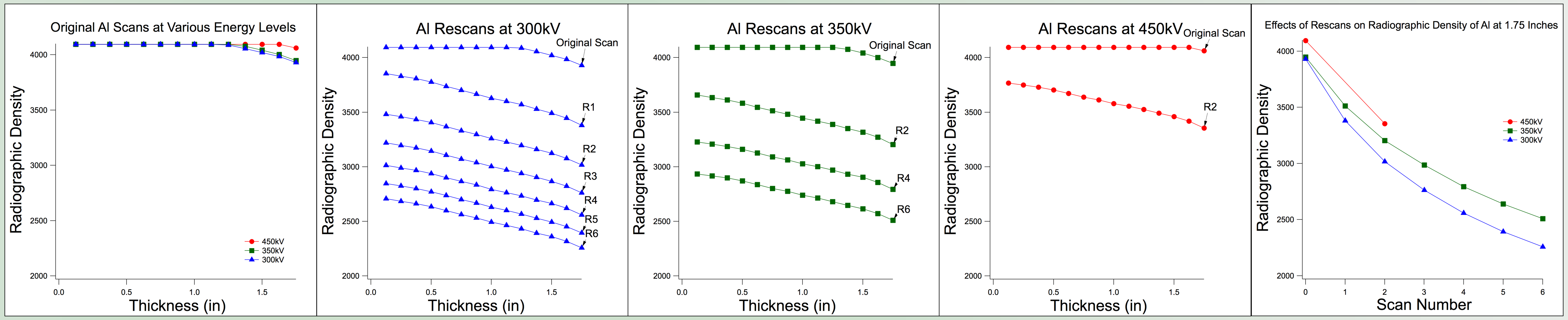
Original, Rescans 2 at 450kV.

Original, Rescans 2 and 4 at 350kV.

- With each rescan, the images have lower radiographic density, seen as lighter in the above images.
- Lowering the voltage also lowers the radiographic density, as seen by comparing scans at 450kV and 350kV.

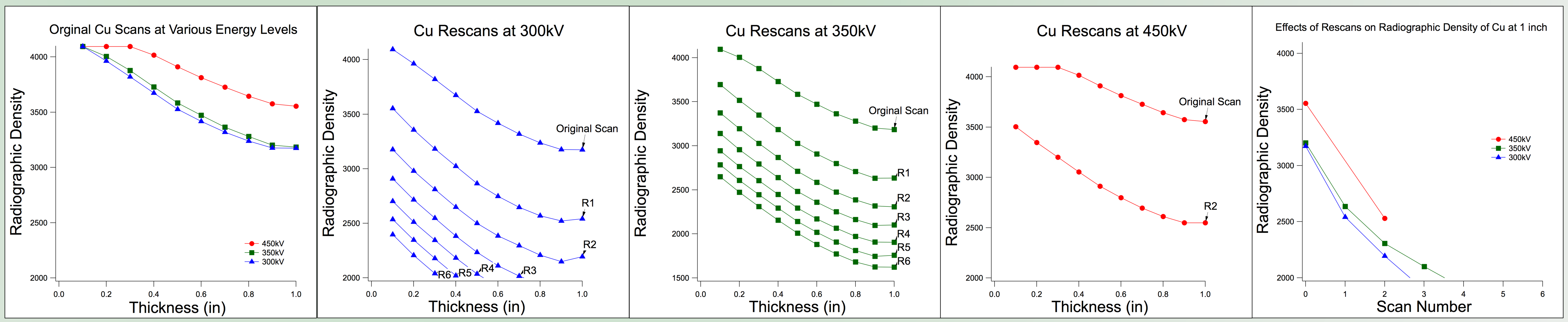
## Results

- General Trends
  - The area considered the optimal density range where the different steps are visible is between 2500 and 3500 radiographic density.
  - There is a larger drop in density between the original and the first rescan than there is between subsequent rescans.
  - As the energy (kV) level is reduced, the radiographic density decreases .
  - The increase in thickness lowers the radiographic density.
  - The last graph summarizes the effect of rescans on the radiographic density at different voltages.
- Aluminum
  - The kV of the x-rays were too high for the entire Al sample. The original scans were saturated for most thicknesses and the steps could not be differentiated.
  - In order to have the Al data to be within the optimal radiographic density range, several rescans had to be taken.




Sample Al graphs displaying the radiographic density of the rescans and voltage changes.

- Copper
  - 350 kV and 300 kV places the thicker half of the Cu sample within the upper threshold of the optimal radiographic density range in the original scans.
  - Since the thicker half was already in the optimal range, rescans past two began to show the radiographic density leaving the point of distinguishing between the thicknesses.
  - After several rescans, the Cu reached below the radiographic density of 2000, when it becomes difficult to distinguish the different thicknesses. These data are not shown.




Sample Cu graphs displaying the radiographic density of the rescans and voltage changes.

## Conclusions

- Rescans
  - The percentage drop in radiographic density between each scan ranges from 4-12%. The relative amount of radiographic density decreased is lower after each scan.
  - Samples with the higher material density exhibited a 2-3% larger drop in radiographic density throughout all rescans.
- Voltage Variations
  - Because the voltages were more suited to the samples with higher material density, those samples showed greater radiographic density changes with voltage. This energy range is more suited for copper and aluminum.

## Next Steps

- Future work focusing on a larger range of voltages should produce enough data to make a comparison between rescans and the voltages. This will allow a better subsequent choice of voltage by comparison to initial rescans.

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