



# Radiographic Density of Selected Materials at Different Thicknesses

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## 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 the 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.

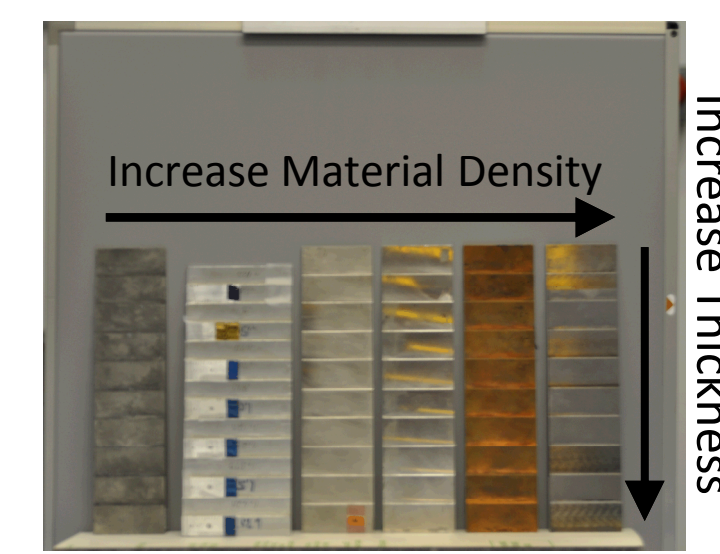
## Materials Selection

- 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

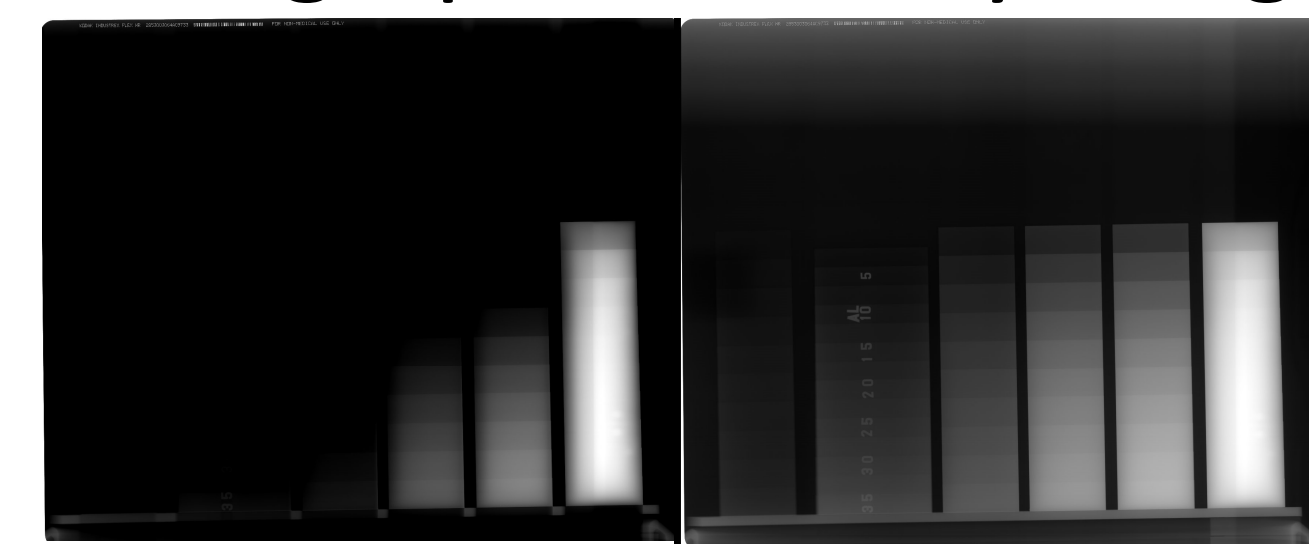
All the materials used are step wedges.

- Al is 1.75 inches thick and the thickness decreases by 0.125 inches at each step.
- The other five materials are 1 inch thick and the thickness decreases by 0.1 inch at each step.



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

## Radiographic Density Image Comparison



Original, Rescans 2 at 450kV.

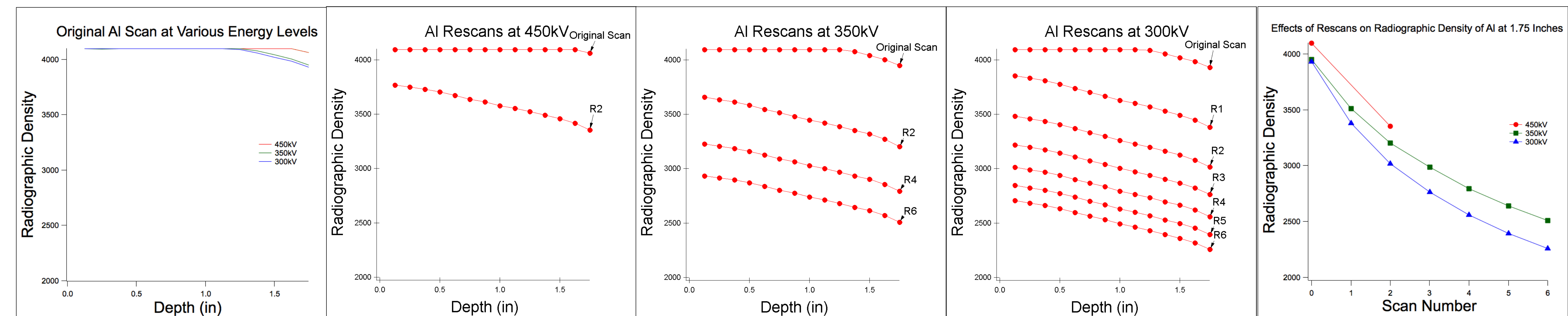


Original, Rescans 2 and 4 at 350kV.

- 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.

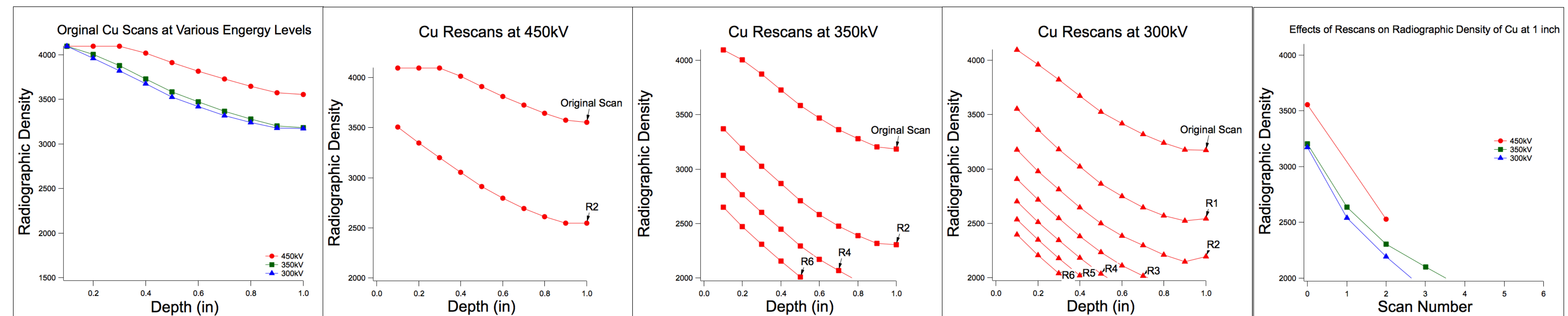
## Results

- General Trends
  - The last graph shows changes in density with rescans eventually plateauing to the point where no change will occur in the density.
  - 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.



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

- 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 Cu 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.

## Conclusions

- Rescans
  - The percent change in radiographic density between each scan ranges from 4-12%. In each trial, the drop in radiographic density starts high and plateaus.
  - Samples with the higher material density exhibited a 2-3% larger drop in radiographic density throughout all rescans.
- Voltage Variations
  - The high voltages used caused the higher material density samples to experience a greater affect from the voltage change.
  - The percent change in radiographic density decreases as the material thickness decreases.
- If more data at lower voltages were taken, it is possible to determine the initial conditions needed.
- Use materials with a smaller density range to maximize data collected and to use time efficiency.

## Next Steps

- Compare data from lower voltages to the rescans to determine the optimal initial conditions for a material at a specified thickness.

