

Generating Simulated Data for Spot Heating/IR Camera Analysis of Coal Slag Surfaces

M. Silva¹, T. Ring¹

1. Department of Chemical Engineering, University of Utah, Salt Lake City, UT, USA

Introduction: For combustion simulations, the wall temperature and heat transfer is an important piece of information. Coal combustion system typically have walls that are initially a cast ceramic, but, with time, slag is deposited on the surface and coal and soot are incorporated into the slag. It is this slag coated ceramic that determines the rate at which heat is transferred from the wall combustion system. A new *in situ* method is developed to determine thermal properties of the slag material on site.



Figure 1 & 2. Inside furnace images.

Computational Methods: COMSOL's Heat Transfer Module was used for the simulation using a Gaussian function to simulate the spot heating of the slag surface.

$$f(x, y) = C \exp\left(-\left(\frac{(x - x_0)^2}{2\sigma_x^2} + \frac{(y - y_0)^2}{2\sigma_y^2}\right)\right)$$

Synthetic data from the COMSOL simulation was used to calibrate the thermal diffusive estimation method for IR camera data.

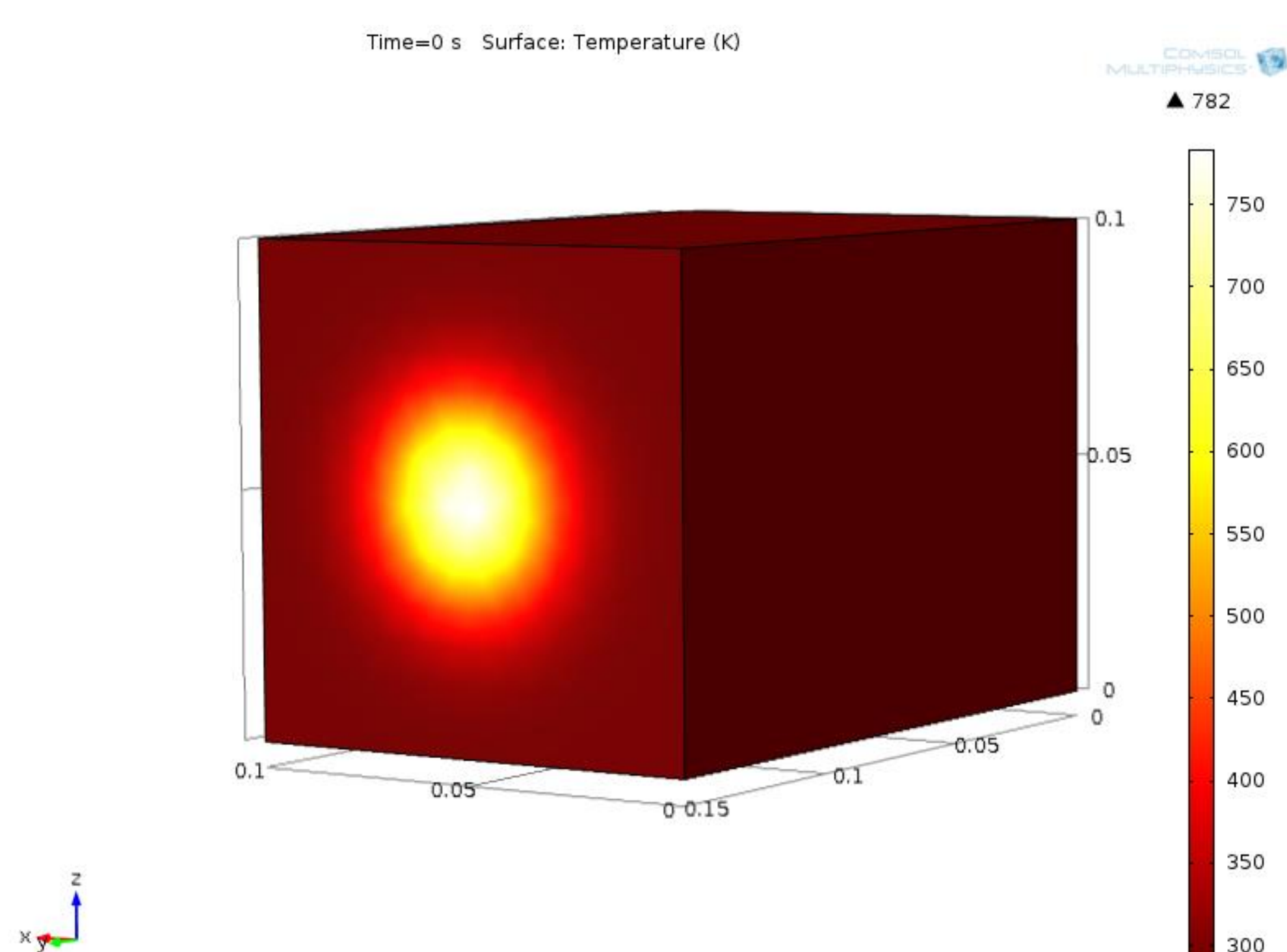


Figure 3. Simulation on COMSOL.

Results: Video animation data created in COMSOL was analyzed in a MATLAB code, to determine the change in size of the heat effected zone with time. A calibration curve was built based upon the results from this analysis:

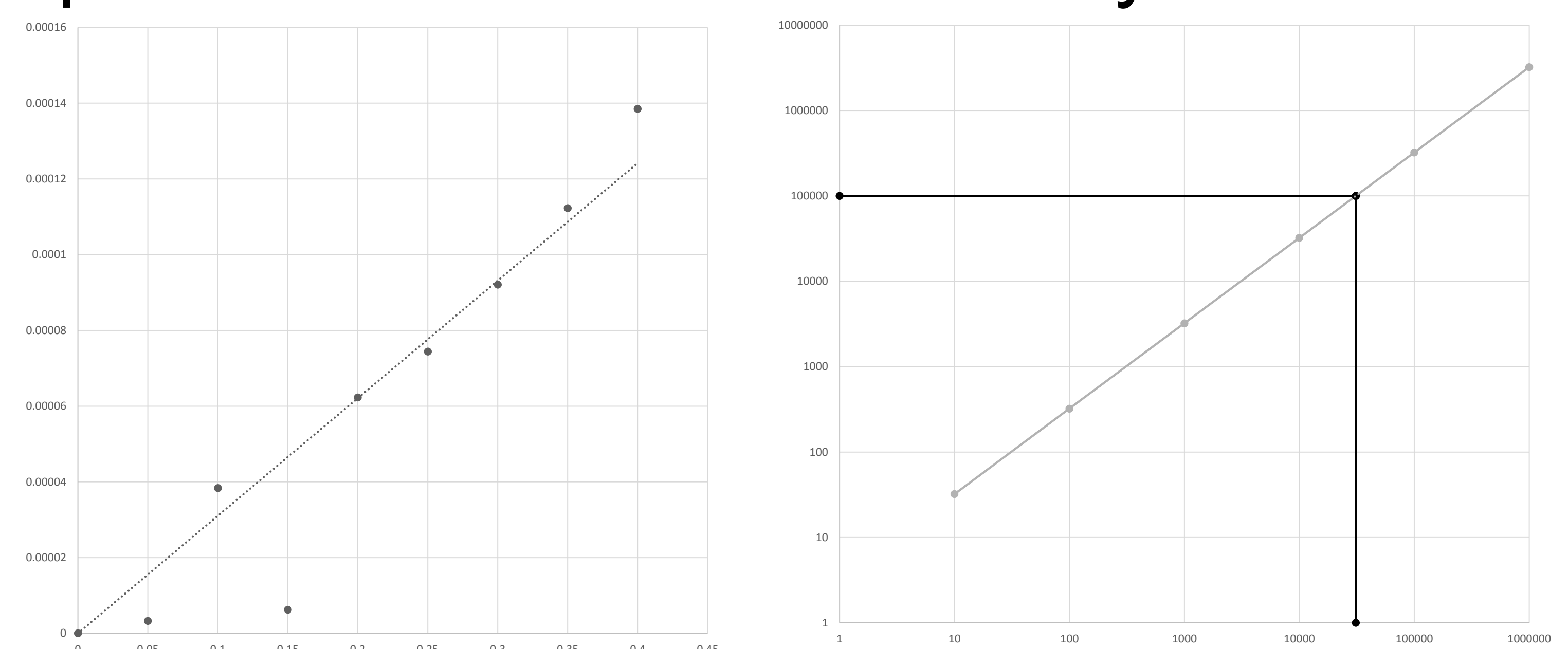


Figure 6 & 7. Calibration curves.

After the model was calibrated, it was used to analyze the frames from the IR camera taken upon heating the slag surface. The slag's thermal diffusivity was found to be $3.22 \times 10^{-5} \text{ m}^2/\text{s}$.

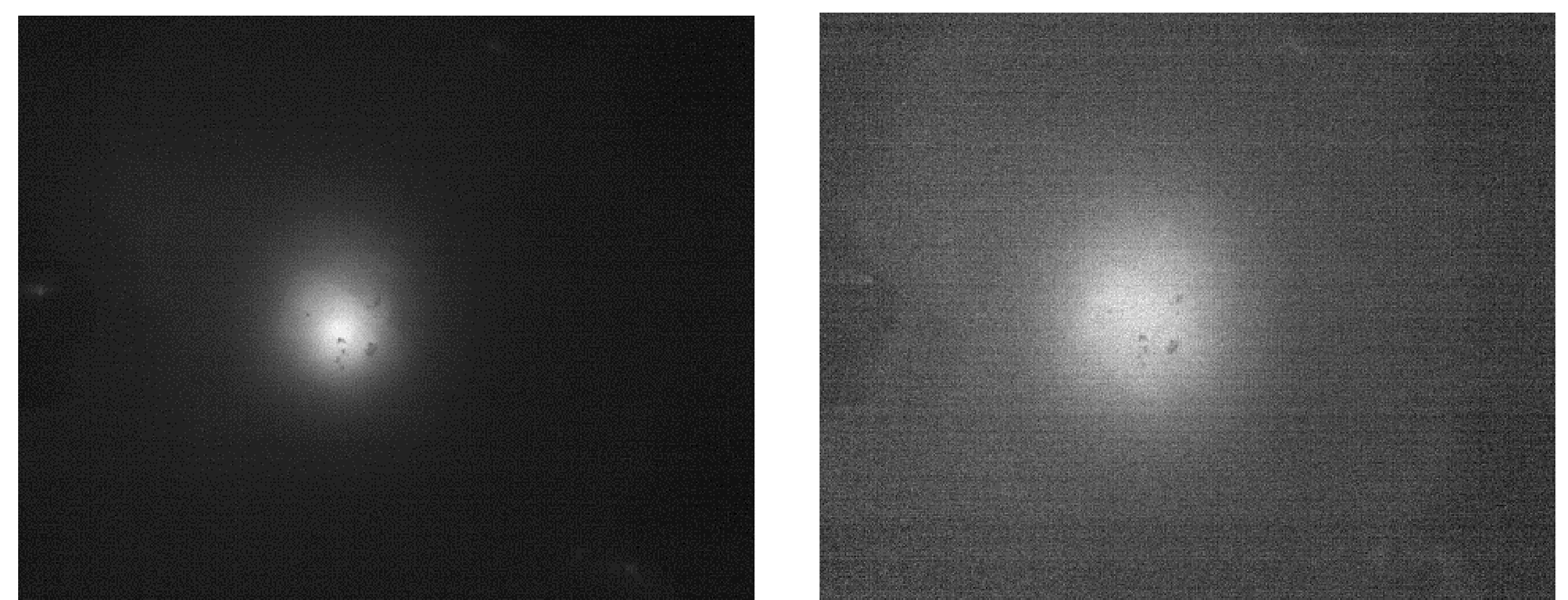


Figure 4 & 5. Frames of the first and last moment of the experiment with the IR high speed camera.

Conclusions: COMSOL was a key feature for the project as it allowed testing and calibrating this new method of data analysis. This method is useful for nondestructive *in situ* tests, and also can be performed on any materials with a large enough heat source for the IR camera to observe.

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