COMSOL Thermal Model for a Heated Neural Micro-Probe
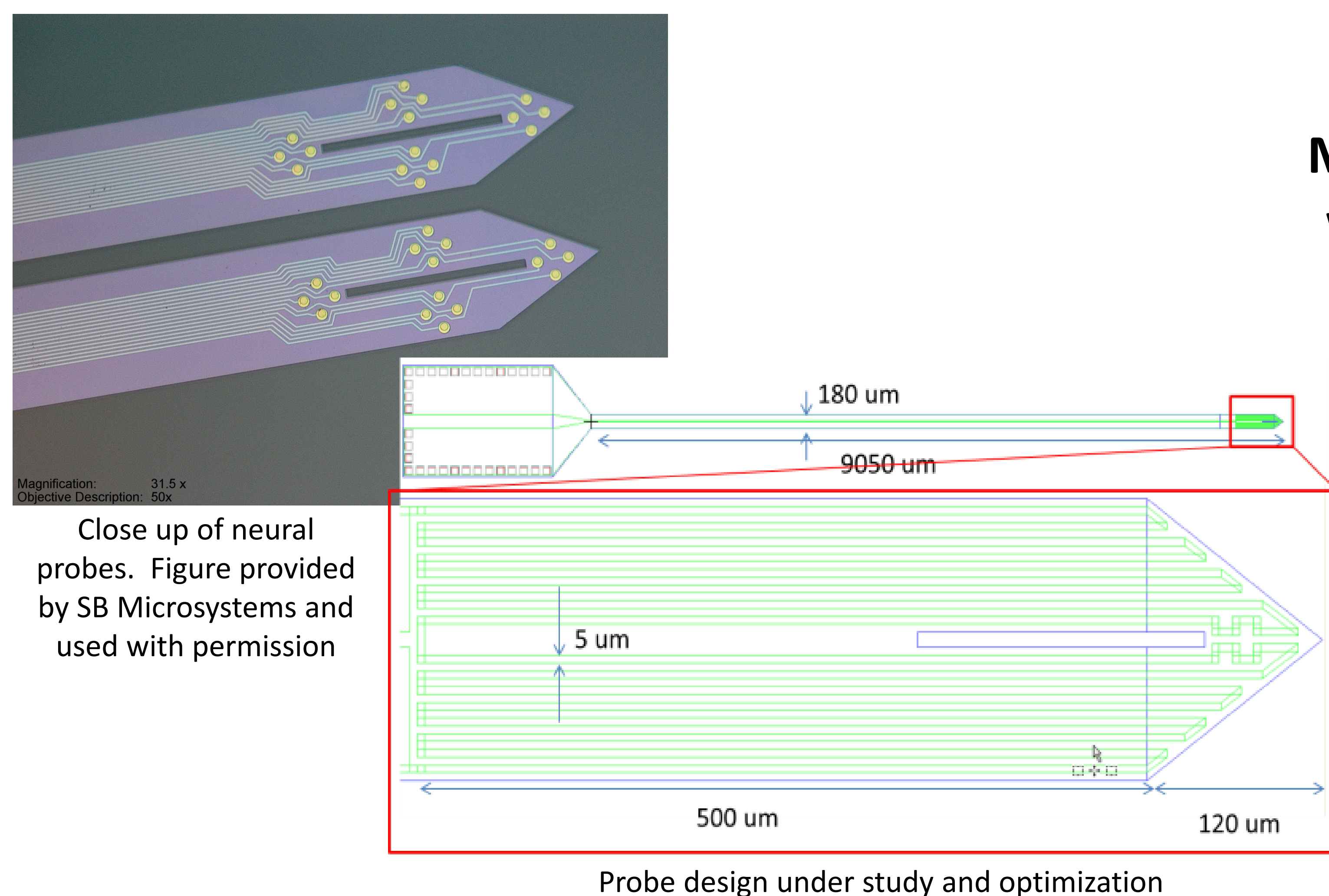
Midshipman Matthew Christian[1]*, Associate Professor Samara Firebaugh[2], Associate Professor Andrew Smith[3]
1. United States Naval Academy, Mechanical Engineering Department
2. United States Naval Academy, Electrical Engineering Department
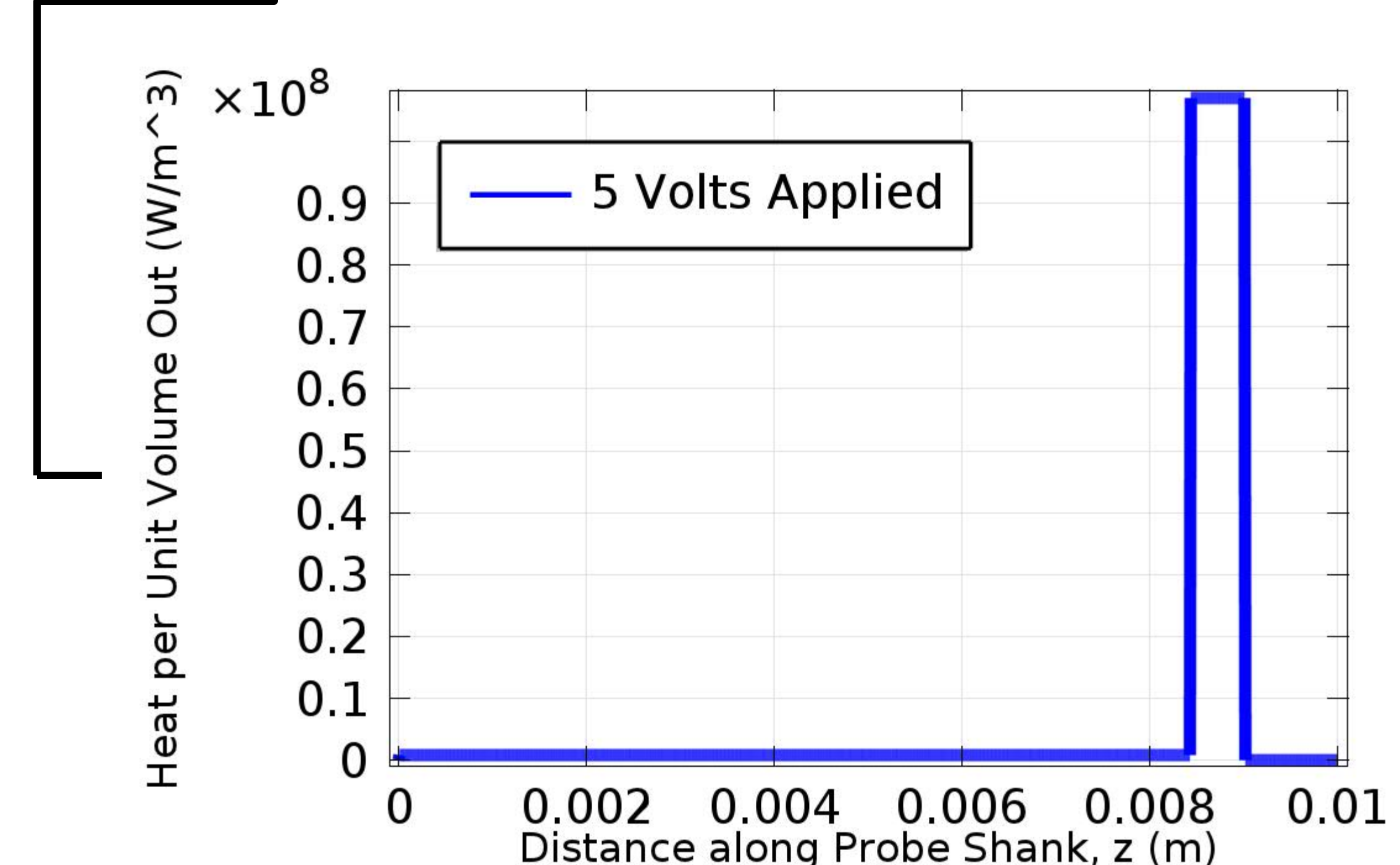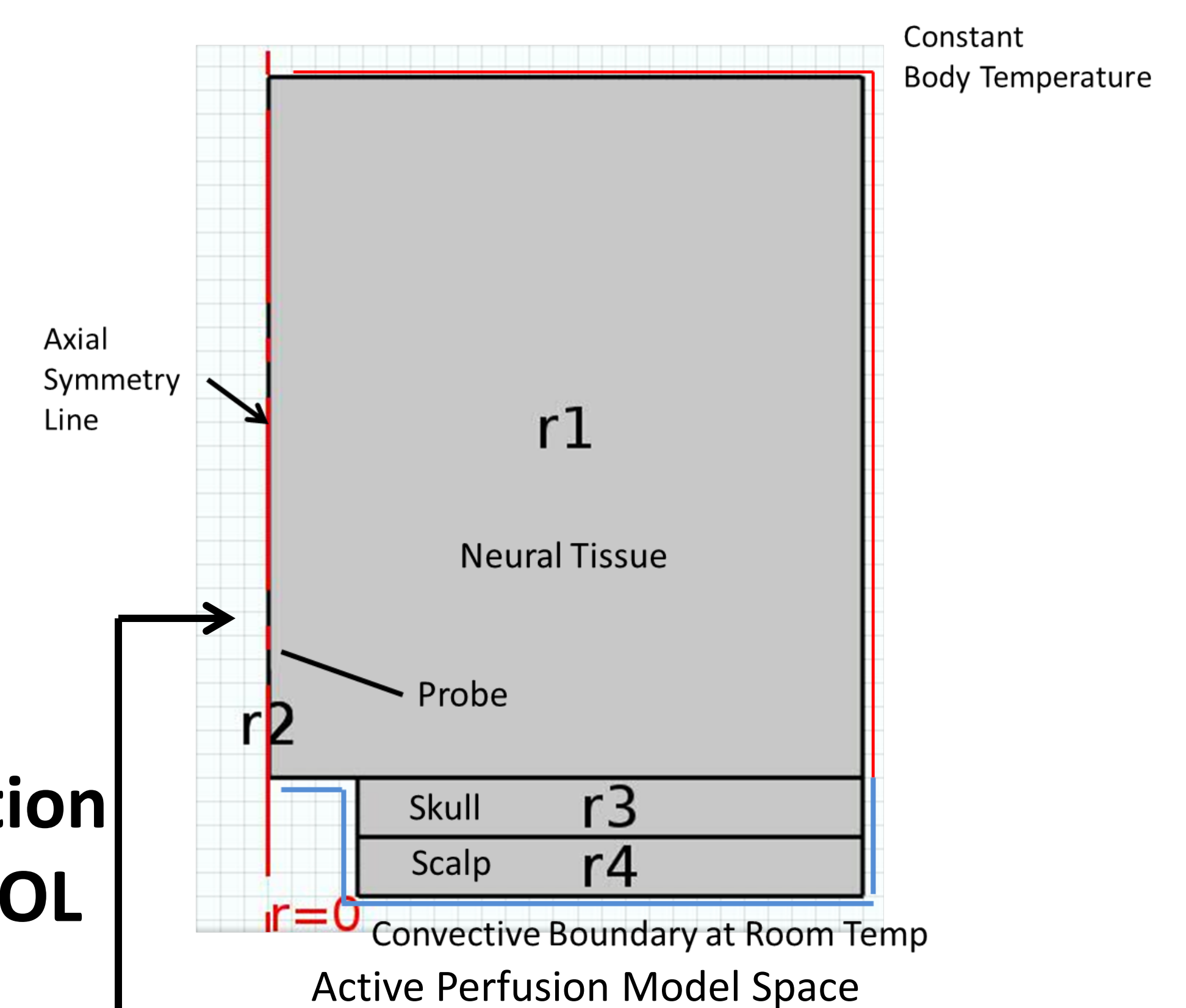3. United States Naval Academy, Mechanical Engineering Department
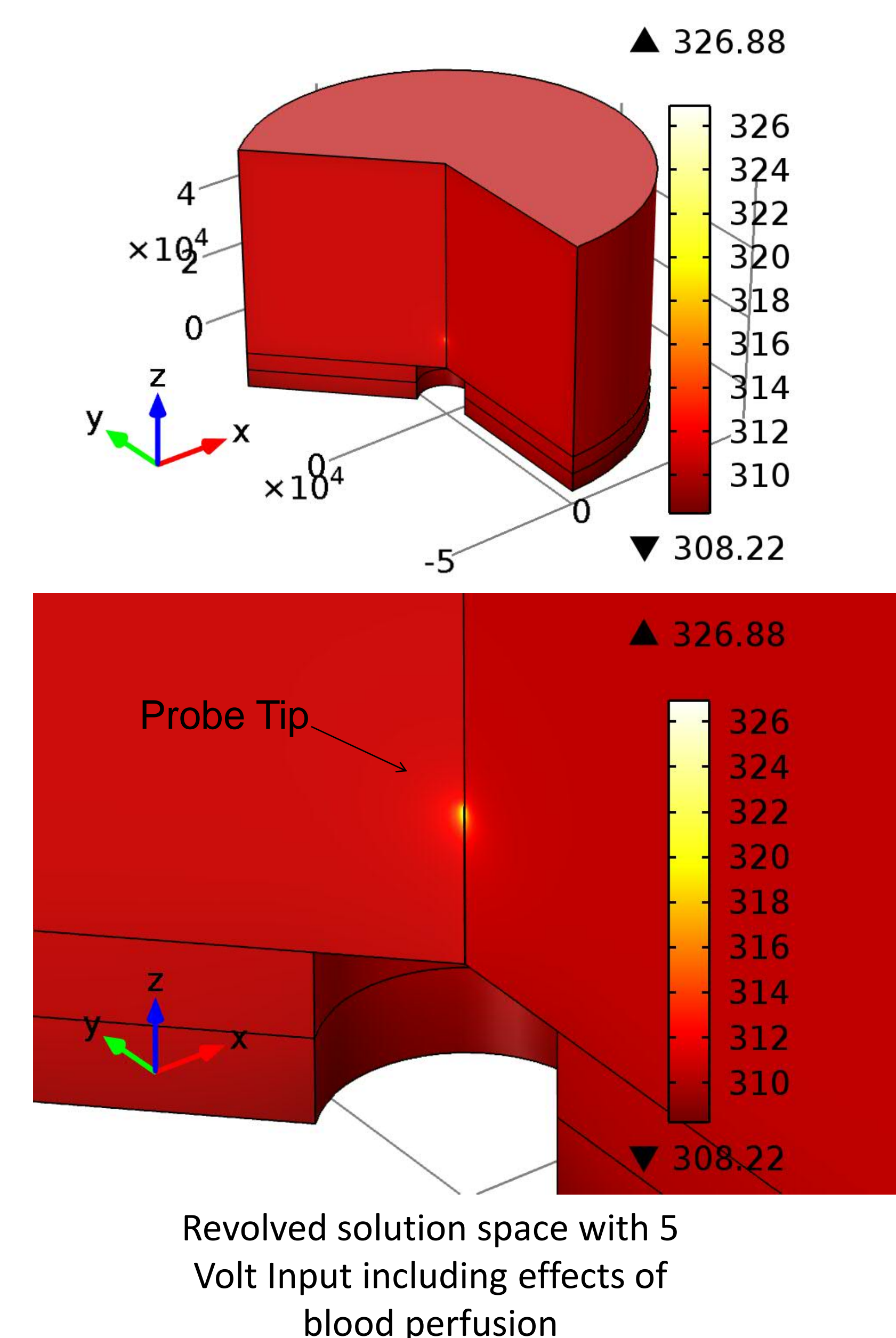*Corresponding Author's Address: PO Box 11699. United States Naval Academy. Annapolis, MD 21412
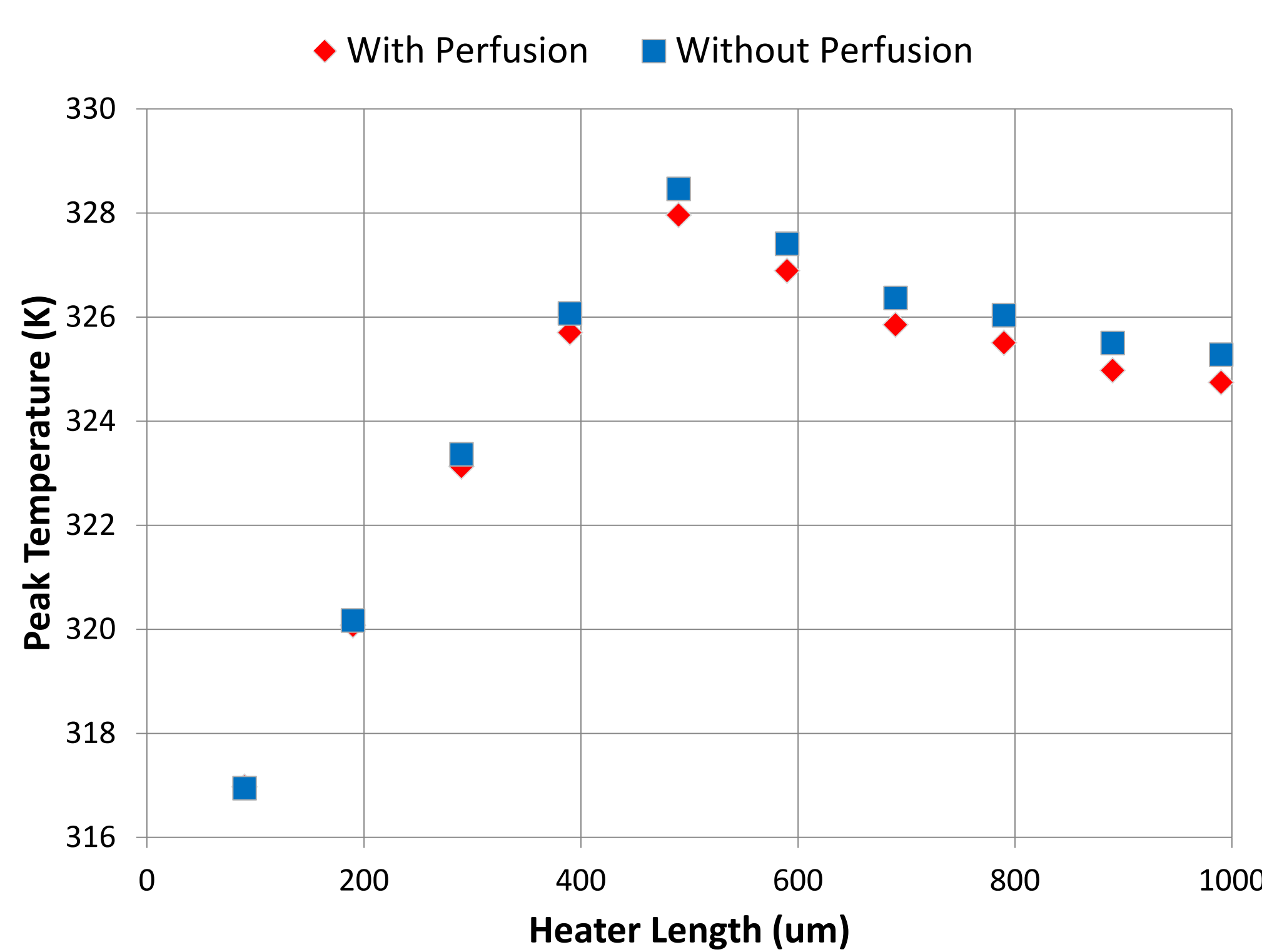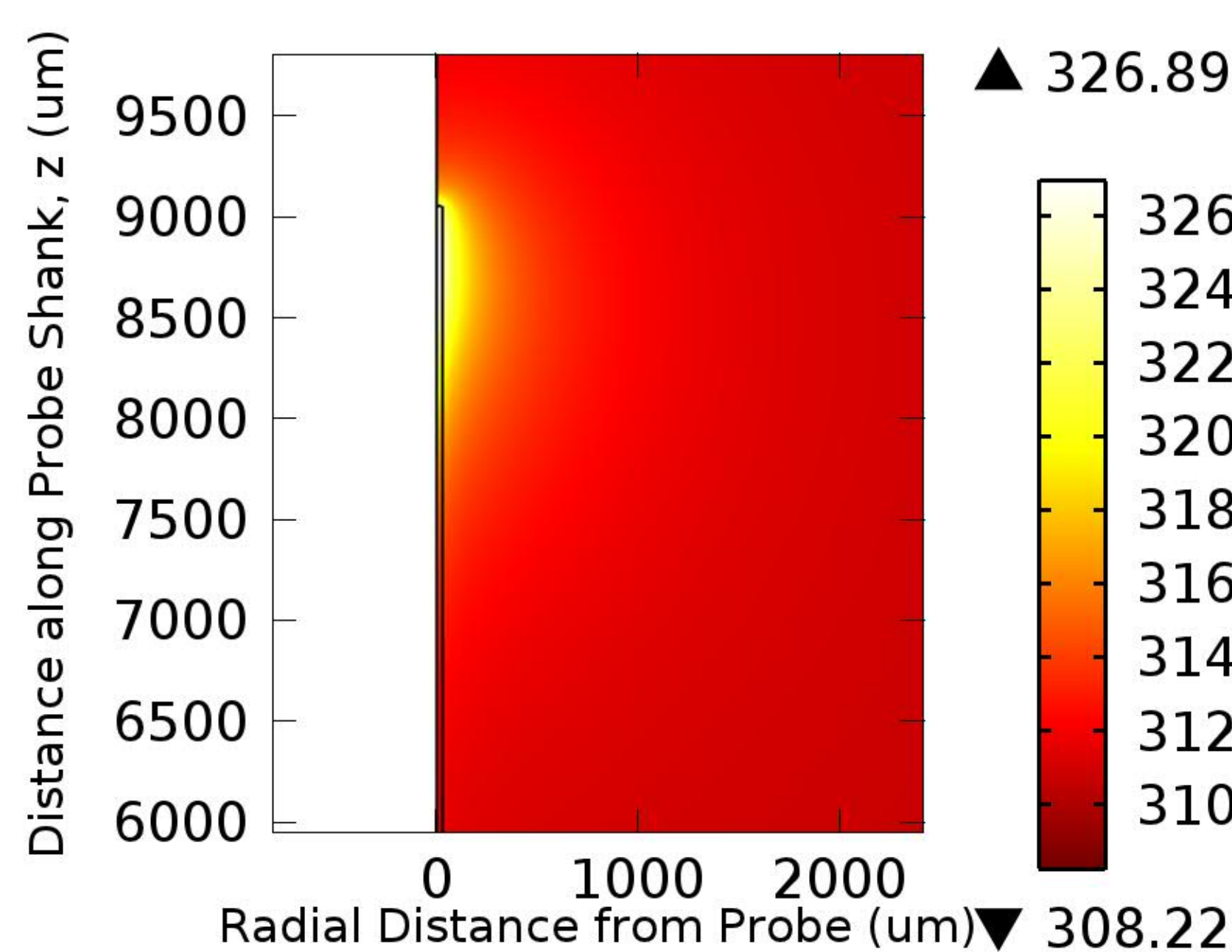
Introduction: The field of neuroscience is rapidly growing, requiring the use of more complex methods for measuring and quantifying brain activity and associations. This model is a part of a larger project to create a model in which to test active thermal management systems for use in novel probe designs.

Close up of neural probes. Figure provided by SB Microsystems and used with permission

Probe design under study and optimization

MATLAB function within COMSOL

Active Perfusion Model Space

Heat output as a function of length, z (m), along the shank and voltage input

Computational Methods: The Pennes' Bioheat equation was used to model an ohmic heating micro-probe in neural tissue, bounded by the skull and surrounding tissues. A MATLAB function was written and utilized within COMSOL to provide a volumetric heat generation term describing the heat generation within the probe.

2-D Temperature plot with 5 volt input including the effects of blood perfusion

Results of parametric study of peak temperature output vs. heater length

Revolved solution space with 5 Volt Input including effects of blood perfusion

Conclusions: A valuable tool has been created that will greatly assist in determining the feasibility of active thermal management of probes that may someday have therapeutic applications.

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