

# Optimal Control of Coefficients in Parabolic Free Boundary Problems Modeling Laser Ablation

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## Abstract

Optimal control of coefficients in the free boundary problem for the second order parabolic PDE modeling biomedical engineering problem on the laser ablation of biological tissues is analyzed. Optimal control in Hilbert-Besov spaces framework is employed where coefficient of the PDE and free boundary are components of the control vector and optimality criteria are based on the final moment measurement of the temperature and position of the free boundary. Discretization by finite differences is pursued, and convergence of the discrete optimal control problems to the original problem is proved. Gradient descent algorithm based on Frechet differentiability in Hilbert-Besov spaces complemented with preconditioning or increase of regularity of the Frechet gradient through implementation of the Riesz representation theorem is implemented. Numerical results are demonstrated for the optimal control of the two-phase Stefan problem based on the optimize-then-discretize approach through implementation of the gradient method in Hilbert-Besov spaces, preconditioning, simultaneous and individual identification of control parameters, as well as sensitivity analysis with respect to initial data.