1116-35-90 **Dylanger S Pittman*** (dsp1@williams.edu), 1436 Paresky Center, Williamstown, MA 01267, **Jessica Pillow** (pilja-16@rhodes.edu), 979 Belton Rd, Ripley, TN 38063, **Ugur Abdulla** (abdulla@fit.edu), Mathematical Sciences, 150 West University Blvd, Melbourne, FL 32901, **Jim Jones** (jim@fit.edu), Mathematical Sciences, 150 West University Blvd, Melbourne, FL 32901, and **Jonathan Goldfarb** (jgoldfar@gmail.com), Mathematical Sciences, 150 West University Blvd, Melbourne, FL 32901. *Frechet Differentiability in Optimal Control of Free Boundary Problems for the Second Order Parabolic PDE.*

We consider an optimal control of the Stefan type free boundary problem for the following general second order linear parabolic PDE:

$$(a(x,t)u_x)_x + b(x,t)u_x + c(x,t)u - u_t = f(x,t)$$

where $u(x,t)$ is the temperature function. The density of heat sources f, unknown free boundary, and boundary heat flux are components of the control vector, and cost functional consists of the L_2-declination of the trace of the temperature at the final moment, temperature at the fixed boundary and final position of the free boundary from available measurements. We follow a new variational formulation developed in *U. G. Abdulla, Inverse Problems and Imaging, 7,2(2013),307-340.*

In this project we prove Frechet differentiability of the cost functional in Hilbert space framework. Extension of the differentiable calculus to the infinite-dimensional setting is the major mathematical challenge in this context. We apply the idea of decomposition of the domain, and analyse carefully effect of boundary integrals on the derivation of the first variation of the cost functional. With the delicate use of sharp embedding theorems in fractional Sobolev-Besov spaces we prove Frechet differentiability, and derive the formula for the Frechet gradient. (Received July 21, 2015)