Contribution ID: **13**  Type: **not specified**

# High performance computing for computational electrocardiology. Part II: scalable solvers.

*Thursday, February 25, 2016 5:15 PM (30 minutes)*

The complex interaction between the cardiac bioelectrical and mechanical phenomena is modeled by a system of non-linear partial differential equations (PDEs), known as cardiac electro-mechanical coupling (EMC) model. Due to the extremely different spatial and temporal scales of the physical phenomena occurring during a single heartbeat, the discretization of the EMC model with finite elements in space and finite differences in time yields the solution of thousands of large scale linear systems, with $O(10^6 - 10^8)$ degrees of freedom each. The effective solution of such linear systems requires the use of hundreds/thousands processors and, consequently, of highly scalable preconditioners. In this presentation, we will first introduce two classes of Domain Decomposition preconditioners, the Multilevel Additive Schwarz (MAS) and the Balancing Domain Decomposition by Constraints (BDDC) preconditioners, in the simple setting a scalar elliptic PDE. Then, we will extend such preconditioners to the solution of the reaction-diffusion PDEs and of the non-linear elasticity system constituting the EMC model. Finally, the results of three-dimensional parallel simulations will demonstrate the effectiveness of the resulting algorithms.

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**Session Classification:** HPC in Mathematics