8th. World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineeering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

A HIGH PERFORMANCE COMPUTATIONAL ELECTROPHYSIOLOGY MODEL

Mariano Vázquez[1], Ruth Aris[1], Adrian Rosolen[2] and Guillaume Houzeaux[1]

[1] Barcelona Supercomputing Center
CASE Department - Nexus II Campus
Nord UPC - Barcelona - Spain
mariano.vazquez@bsc.es -
http://www.bsc.es

[2] LaCàN, Univ. Politècnica de
Catalunya,
C/Jordi Girona 1-3, Campus Nord
UPC - Barcelona - Spain
adrian.rosolen@upc.edu

Key Words: *High Performance Computing, Computational Electrophysiology, Finite element methods, Fenton-Karma models*

ABSTRACT

This paper presents a parallel implementation of Computational Electrophysiology (CEPh) schemes applied to cardiac tissue simulation, being the computational strategy briefly introduced in a previous paper (see references).

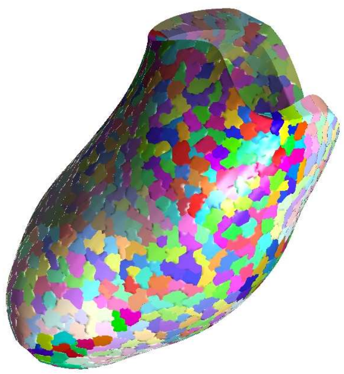

Figure 1: 1000-domain left ventricle partition.

The main features of the proposed strategy are: a computational method based on variational principles, a Finite Element space discretization, a shock-capturing technique to cope with the strong nonlinearities of the physiological models, an anisotropic (although with strong gradients) cardiac fibers distribibution, and a parallelization method based on automatic domain decomposition for distributed memory facilities. The resulting code is able to run using elements of different space order (P1, P2, Q1, Q2) and higher order time schemes, in bi and tri-dimensional domains of a non-homogeneous

anisotropic excitable media. Fully implicit and explicit schemes are implemented. The CEPh models under test in this paper are those of Fenton and co-workers (see references). In this paper we show at what extent an anatomical description can influence in the strongest way by taking into account the strong gradients in the fiber orientation of the heart, regardless the simplicity of the CEPh model in itself. We introduce a way to deal with this gradients inspired in boundary condition matching for coupled thermal models. Escalability figures are shown up to 2000 CPU's in a distributed memory supercomputing facility. All the tests are carried out using Alya, an in-house high performance computational mechanics code of the BSC.

REFERENCES

[1] A. Rosolen, S. Ordás and M. Vázquez. "Numerical schemes for the simulation of three-dimensional cardiac electrical propagation inpatient-specific ventricular geometries". *Proceedings of the European Conference on Computational Fluid Dynamics ECCOMAS CFD 2006*, Egmond aan Zee, The Netherlands. 2006.

[1] F. Fenton and A. Kama "Vortex dynamics in 3-dimensional continuous myocardium with fiber rotation: filament instability and fibrillation". *Chaos*, Vol. **8**, Num. 1, 1998.