

FEBio: Finite Elements for Biomechanics

Steve A. Maas¹, David S. Rawlins¹, Gerard Ateshian³, Benjamin J. Ellis¹, Jeffrey A. Weiss^{1,2}

1. Department of Bioengineering and Scientific Computing Institute, 2. Department of Orthopedics, University of Utah, 3. Departments of Mechanical and Biomedical Engineering, Columbia University

1. Introduction

FEBio is a nonlinear finite element solver that is specifically designed for biomechanical applications. It offers modeling scenarios, constitutive models and boundary conditions that are relevant to many research areas in biomechanics.

FEBio implements the weak form of the governing equations of solid continuum mechanics. The nonlinear finite element equations are solved implicitly, using a quasi-Newton method called BFGS.

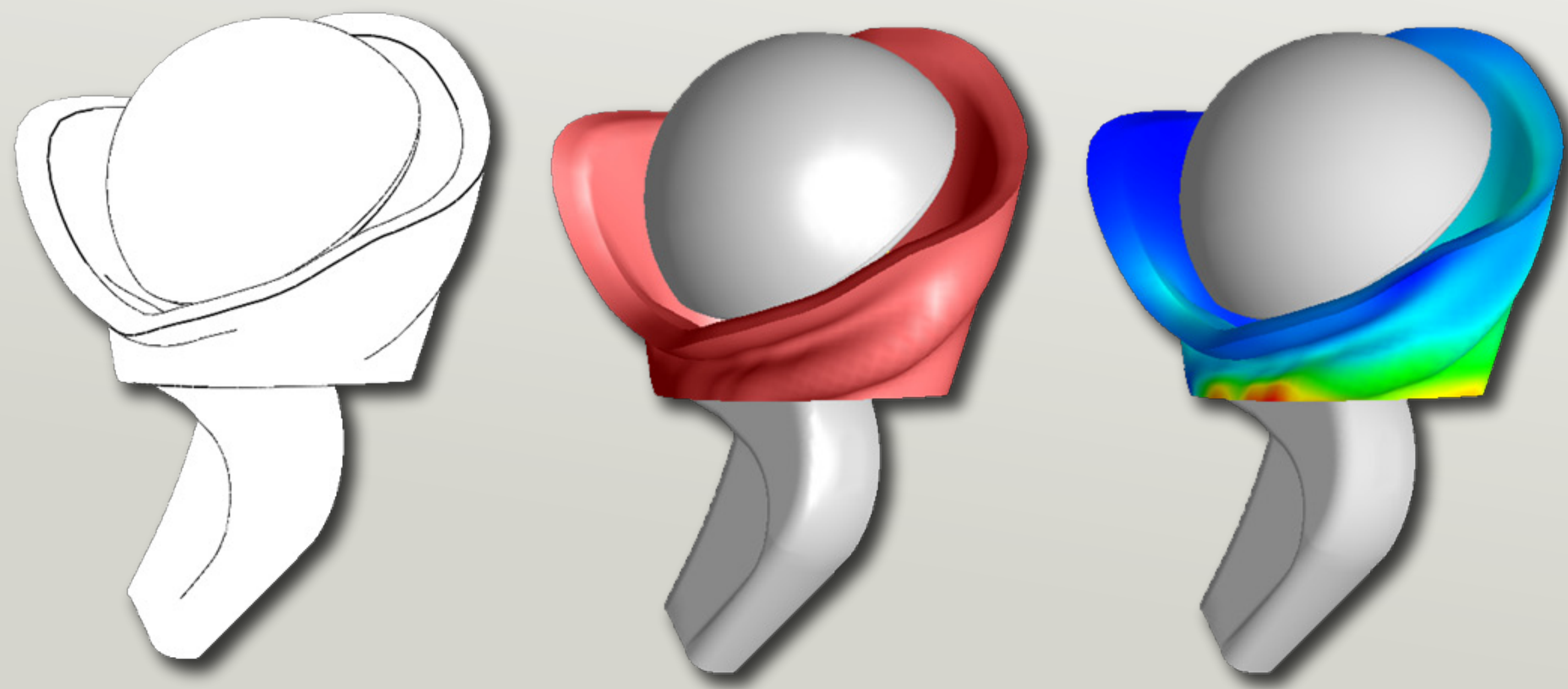


Figure 1. Finite element analysis of a hip implant device showing high stresses in areas of impingement.

2. Verification

Verification is an important aspect of any software development project. Therefore, a large suite of over one hundred verification problems has been developed and is run every night on all supported platforms to make sure new additions to the code don't break existing functionality.

3. Modern Software Design

- Developed in C++
- Support for WinXP, Win7, Linux, MAC
- XML based input format
- Fast parallel linear solvers (Pardiso, SuperLU, etc.)
- Code documentation by Doxygen
- Custom tensor library for easy material implementations.
- Source code is open-source

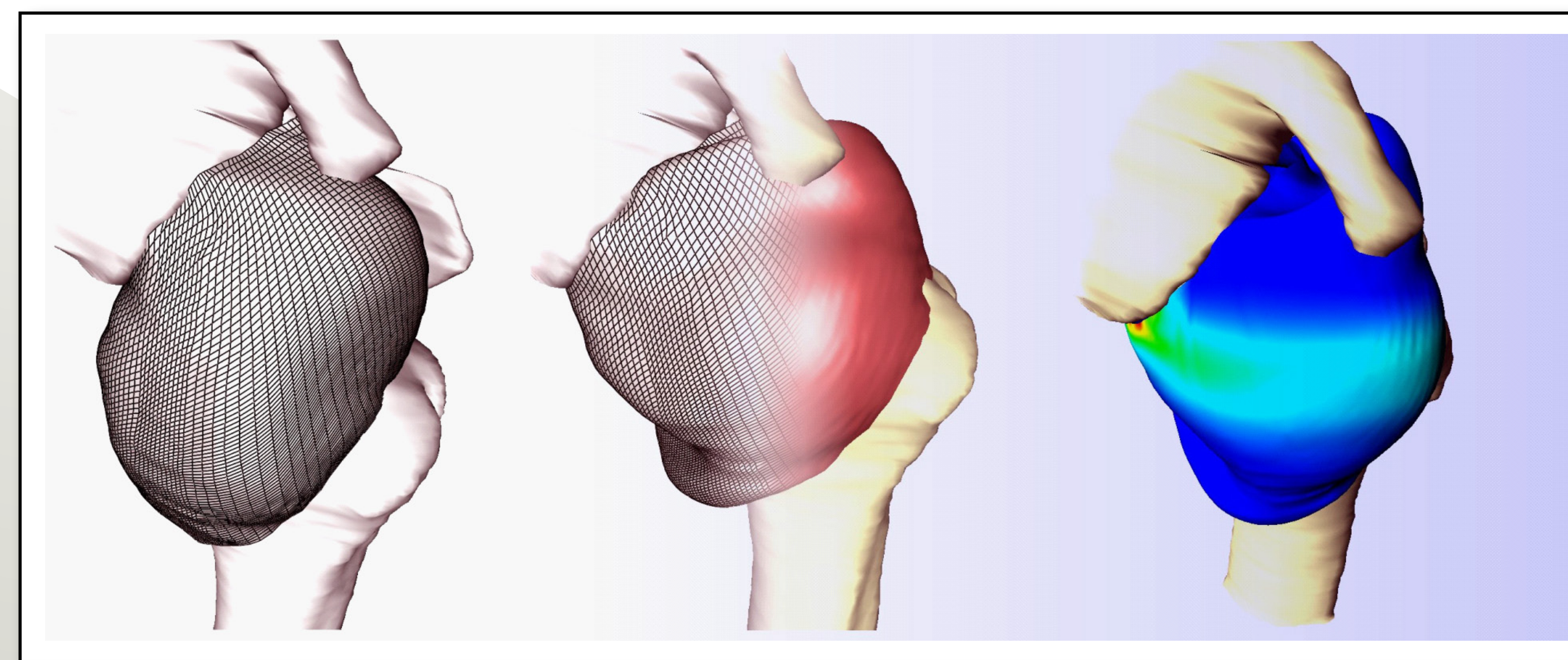


Figure 2. FE Analysis of shoulder capsule stresses during simulated clinical exam.

4. Support

The developers have placed considerable emphasis on supporting new and established users.

- Online and pdf documentation of Theory Manual, User's Manual and Developer's Manual.
- Online User's forum where users can ask questions, report bugs and request features.

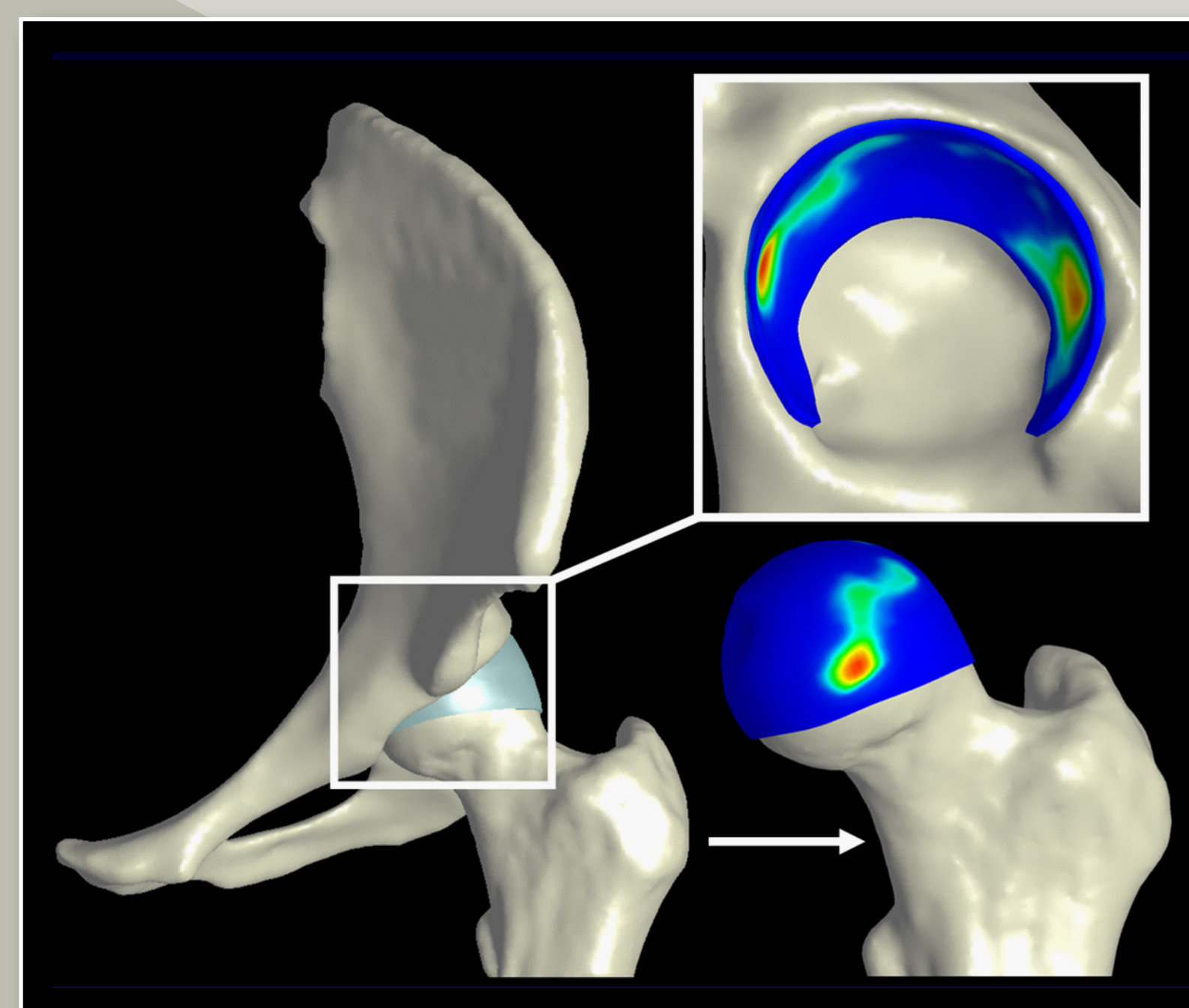


Figure 3. Finite element analysis of articular cartilage pressures in the hip joint of a normal hip during walking.

5. PreView

- PreView is a finite element pre-processor that was specifically designed to create FEBio input files.
- Intuitive GUI-based design of FE models
- Simple geometry and mesh creation
- Tetrahedral meshing with Tetgen (tetgen.berlios.de)
- Support for many input formats (e.g. ABAQUS, NIKE3D, LSDYNA, ANSYS, IDEAS, etc.)

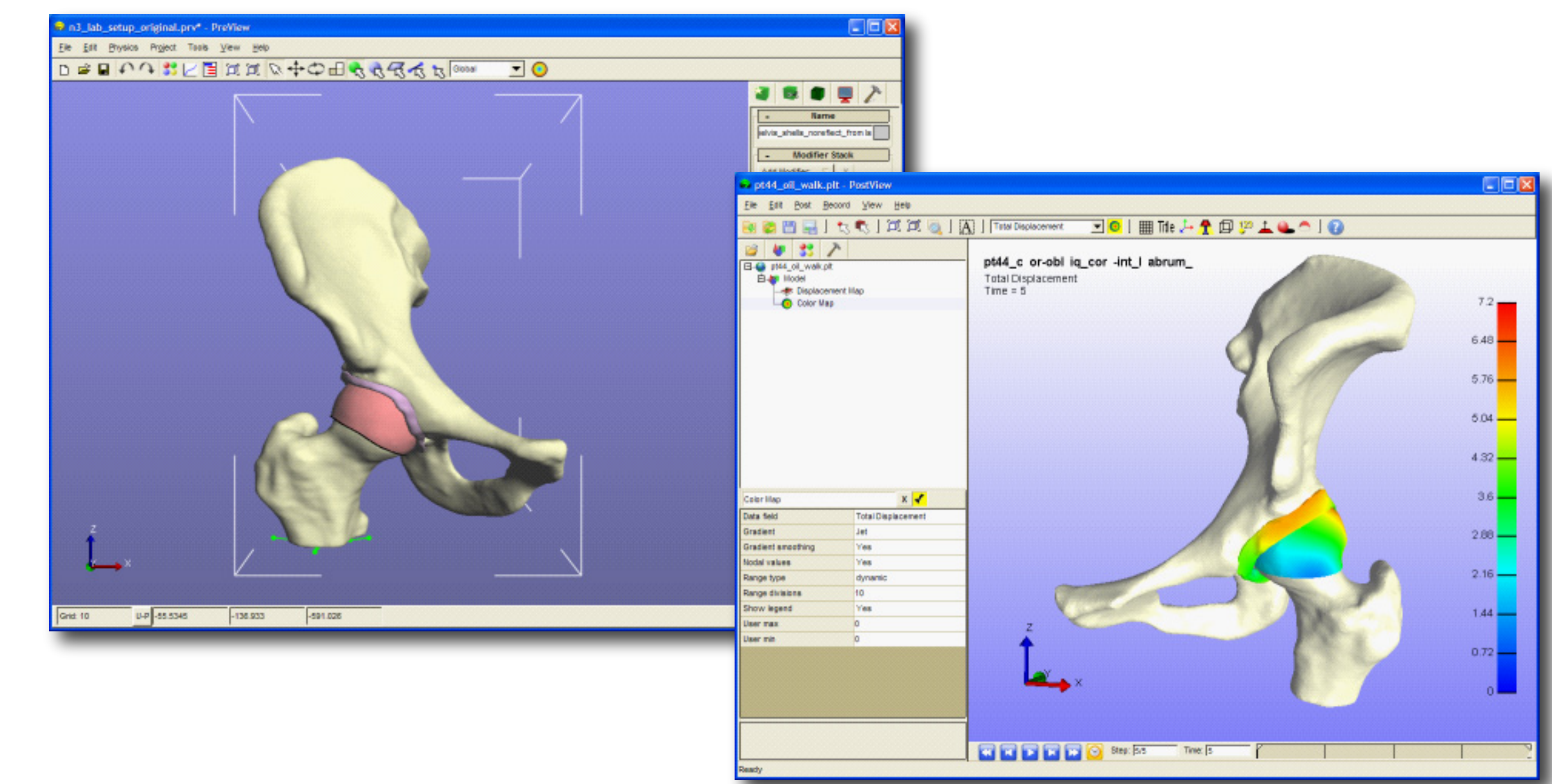


Figure 4. Screen shots of PreView (left) and PostView (right).

6. PostView

- Finite Element post-processor designed for visualizing and analyzing FEBio results.
- Uses OpenGL to create nice graphics.
- Different plot types (contour, isosurface, vector, etc.)
- Screen capture and animation recording capability.

7. Download

- All software, including FEBio source code can be downloaded free of charge from:
<http://mrl.sci.utah.edu/software>
- Online documentation is available at:
<http://mrl.sci.utah.edu/software/febio>



Financial support from NIH grants # R01GM083925, R01AR047369 and R01AR053344 is greatly appreciated.

