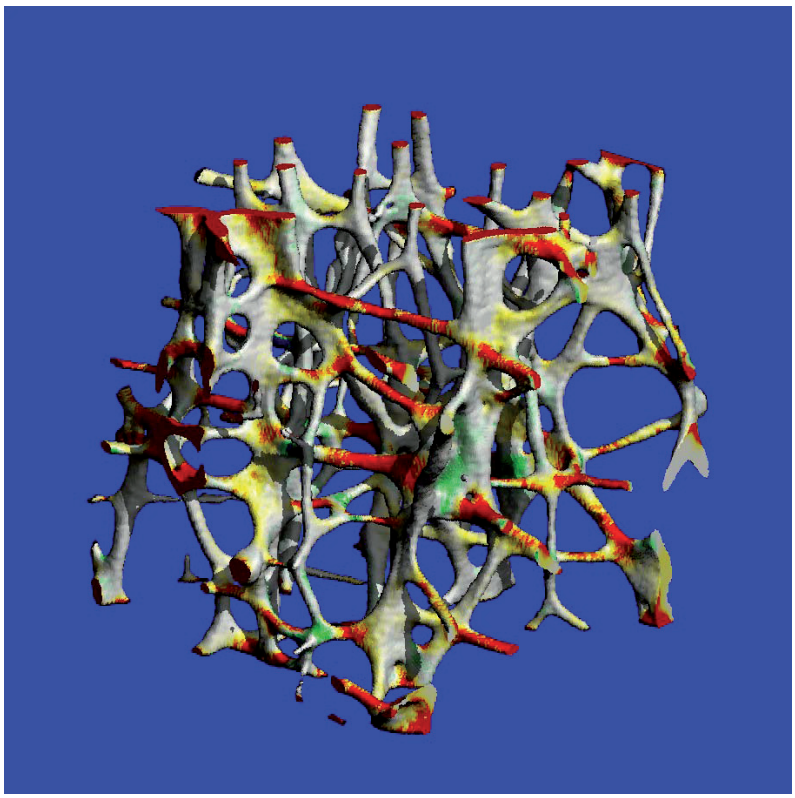
Finite Element Analysis Software



SCANCO MEDICAL

SCANCO Finite Element Software

The Scanco Finite Element software consists of several additional modules for the Scanco Image Processing Language (IPL) program to enable Finite Element (FE) analyses. With this type of analyses it is possible to simulate mechanical tests in order to calculate bone mechanical properties and loading conditions.

Includes

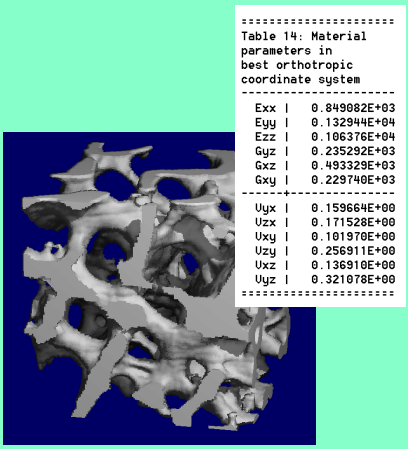
- a dedicated solver for linear elastic finite element analyses with tools for easy pre- and post-processing
- an export tool to convert micro-CT images to input files for 3rd party FE-solvers

Built-in FE solver features:

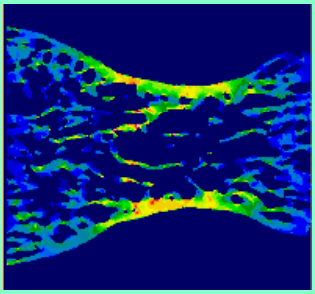
- Highly efficient Element-By-Element solver for linear elastic analyses
- Can solve models with millions of elements on workstation computers
- Possibilities to redirect the solving step on parallel (super) computers for solving of very large problems
- Build-in library of pre-defined tests (compression, tension, torsion, etc.) for easy generation of boundary conditions
- Fully-automated calculation of averaged properties of bone specimens
- Can assign density-dependent element material properties

Applications:

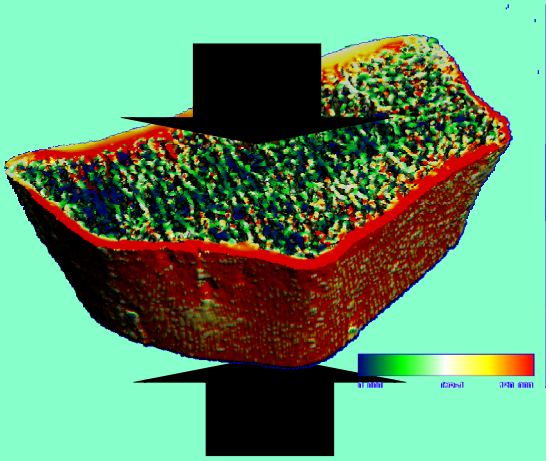
- *Mechanical analysis of bone samples*
  - Simulation of mechanical tests
  - Complete characterization of elastic properties of bone samples
  - Determination of bone tissue-level loading
- *Mechanical analysis of XtremeCT images*
  - Direct determination of *in-vivo* bone mechanical properties
  - Determination of mechanical parameters:
  - Stiffness
  - Estimated failure load
  - Load distribution (cortical/trabecular)
  - Measurement of changes in mechanical properties over time



Example 1: Calculation of average elastic properties of a cube of trabecular bone



Example 2: Von Mises stress distribution in a mid-section of the vertebrae (blue=low, red=high).



Example 3 Finite element analysis of bone in-vivo measured with the XtremeCT. A compression test is performed on the measured section of the radius.

For further information regarding the equipment and software as well as contract imaging research options contact SCANCO Medical AG
via email at: **info@scanco.ch**
or visit our website at: **http://www.scanco.ch** **http://www.microct.com**

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SCANCO Finite Element Software

Export tool for FE-models features:

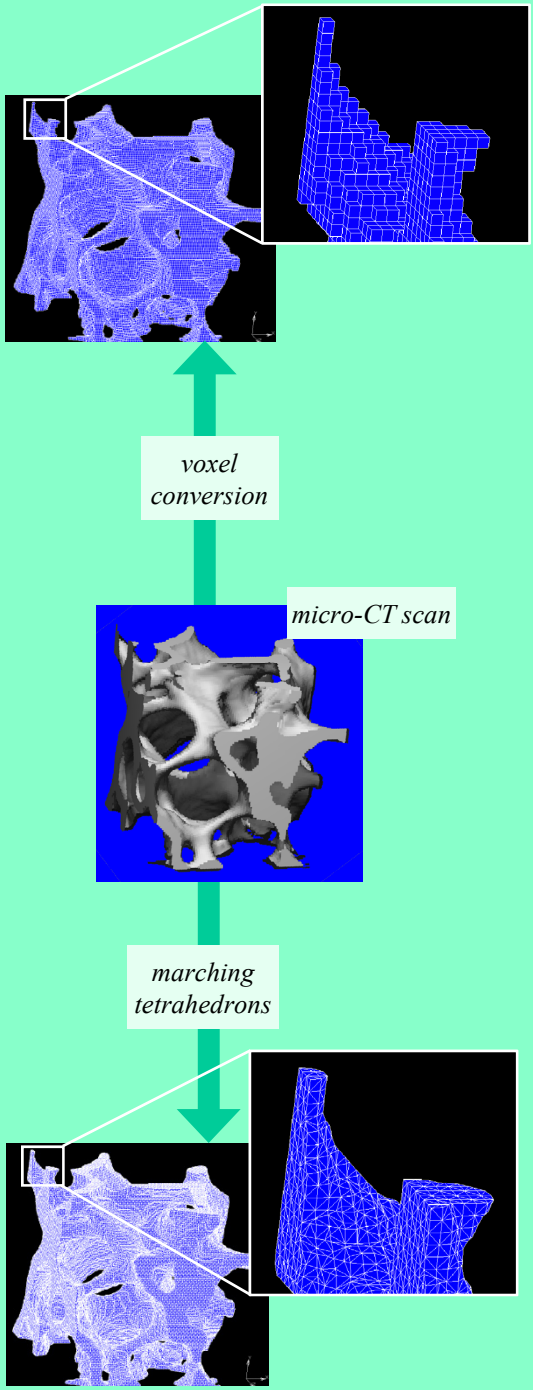
- Supports MSC.MARC™, ABAQUS™ and ANSYS™ format
- Voxel conversion and marching tetrahedrons algorithms
- Can generate 1st/2nd order hexahedron/tetrahedron models
- Can generate mixed hexahedron/tetrahedron models (bricks inside, tetrahedrons at the surface)
- Build-in library of pre-defined tests for easy generation of boundary conditions
- Can assign density-dependent element material properties

Applications

- Prepare models for non-linear analysis using third-party FE-software

Selected studies in which this software was used

- Dalzell N, Kaptoge S, Morris N, Berthier A, Koller B, Braak L, van Rietbergen B, Reeve J. Bone micro-architecture and determinants of strength in the radius and tibia: age-related changes in a population-based study of normal adults measured with high-resolution pQCT. Osteoporos Int. 2009
- Boutroy S, Van Rietbergen B, Sornay-Rendu E, Munoz F, Bouxsein ML, Delmas PD. Finite element analysis based on in vivo HR-pQCT images of the distal radius is associated with wrist fracture in postmenopausal women. J Bone Miner Res., 2008 23:392-9.
- Verhulp E, van Rietbergen B, Huiskes R. Load distribution in the healthy and osteoporotic human proximal femur during a fall to the side. Bone. 2008, 42:30-5
- Mulder L, van Ruijven LJ, Koolstra JH, van Eijden TM. The influence of mineralization on intratrabecular stress and strain distribution in developing trabecular bone. Ann Biomed Eng. 2007, 35:1668-77
- Gong H, Zhang M, Qin L, Hou Y. Regional variations in the apparent and tissue-level mechanical parameters of vertebral trabecular bone with aging using micro-finite element analysis. Ann Biomed Eng. 2007, 35:1622-31.
- Nagaraja S, Couse TL, Guldberg RE. Trabecular bone microdamage and micro-structural stresses under uniaxial compression. J Biomech. 2005, 38:707-16.
- Ito M, Nishida A, Aoyagi K, Uetani M, Hayashi K, Kawase M. Effects of risedronate on trabecular microstructure and biomechanical properties in ovariectomized rat tibia. Osteoporos Int. 2005, 16:1042-8
- Van Rietbergen B, Huiskes R, Eckstein F, Rüegsegger P. Trabecular bone tissue strains in the healthy and osteoporotic human femur. J Bone Miner Res. 2003, 18(10):1781-8.



Example 4: conversion of a micro-CT scan to an input file for 3rd party solvers. The tool implements a voxel-conversion algorithm to generate brick element models (top) and a marching tetrahedron algorithm to generate tetrahedron element models (bottom) or mixed hexahedron/tetrahedron models.

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