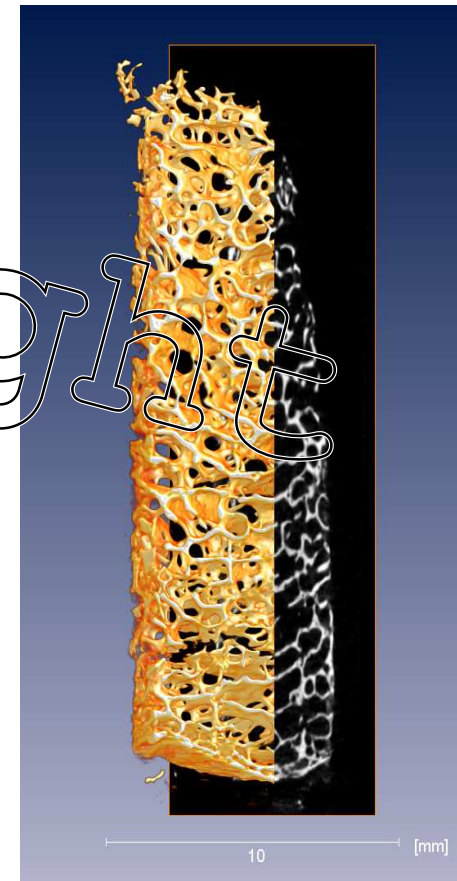
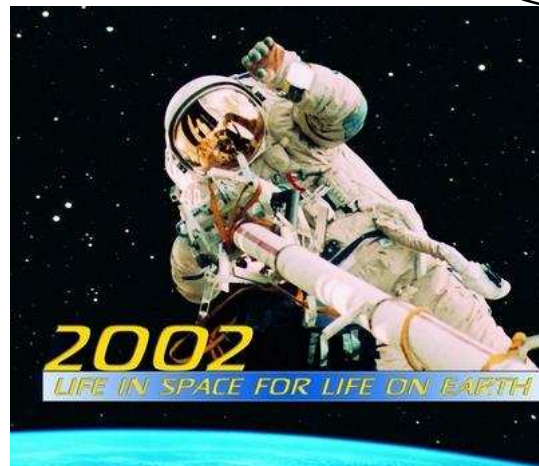


# VISUAL ANALYSIS OF TRABECULAR BONE STRUCTURE

Steffen Prohaska  
Hans-Christian Hege  
Michael Giehl  
Wolfgang Gowin

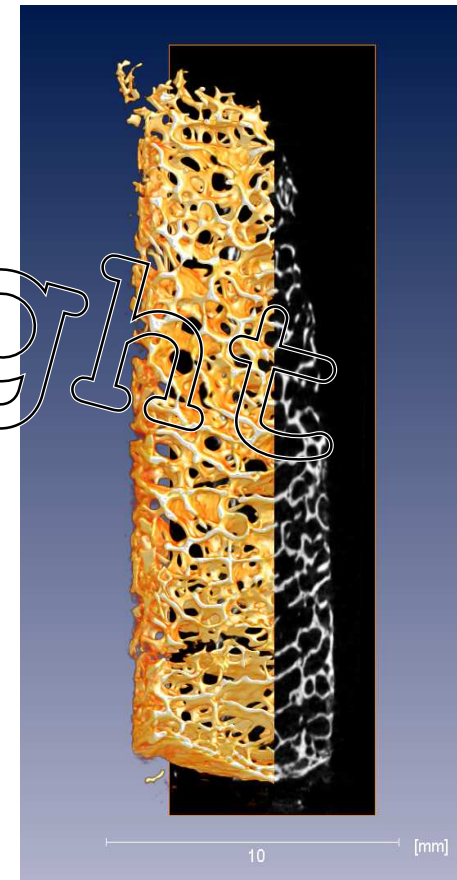


# Image Data

## z micro-CT

- y Voxelsize down to  $15\mu$
- y Matrixsize up to  $1024^3$

Large main memory needed  
or out-of-core processing



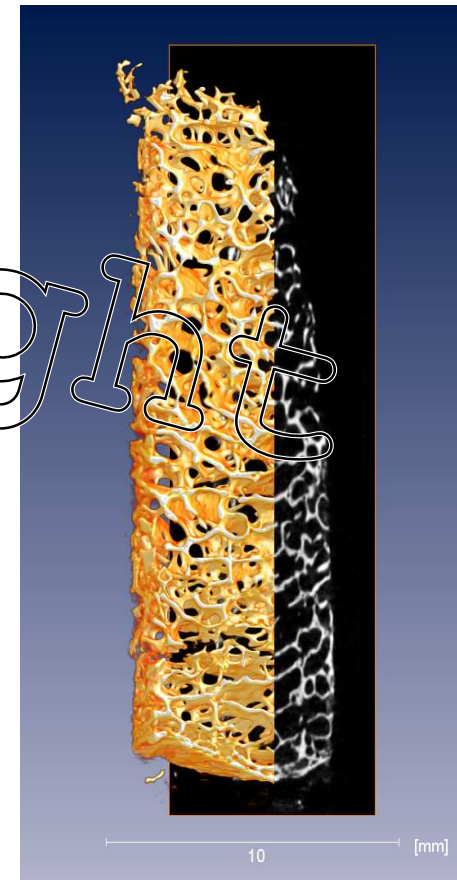
# Tasks

## z Quantitative analysis, e.g.

- y BV/TV
- y Mean grey value
- y Local thickness
- y More advanced measures

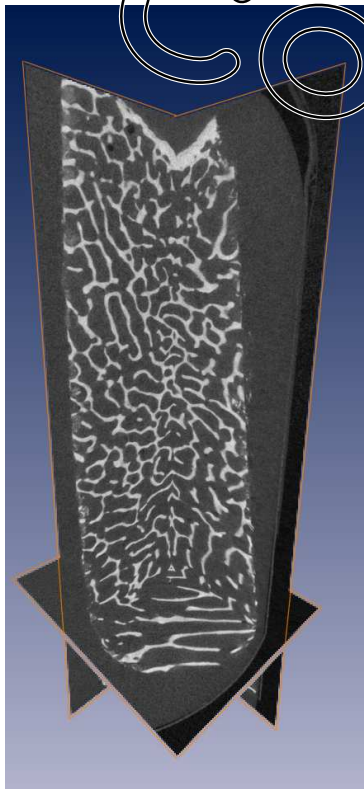
## z Visualization

- y Interactive frame rates
- y Overall structure
- y Measures

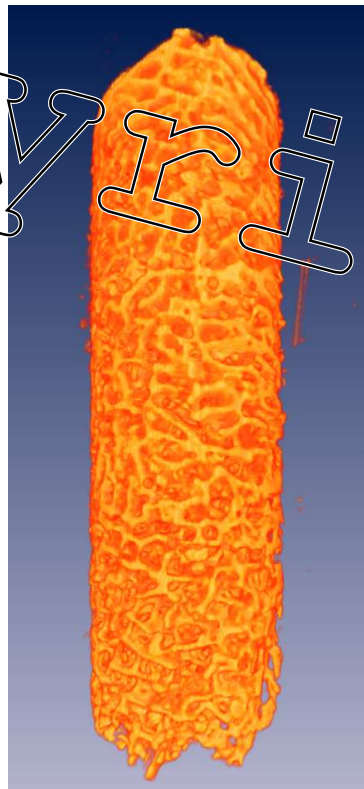


# Basic Visualization

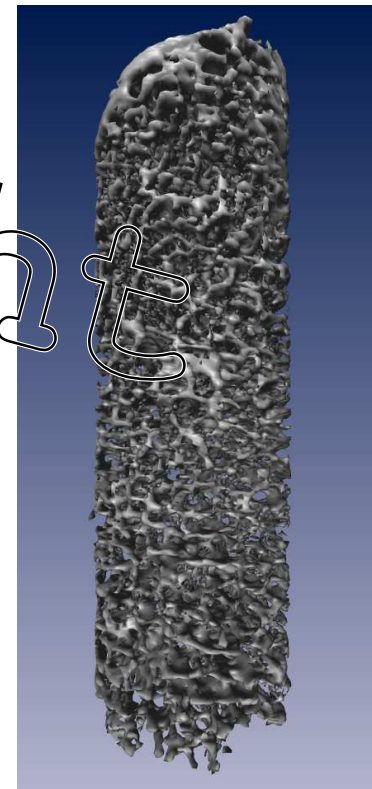
Slicing



Volume rendering



Isosurface

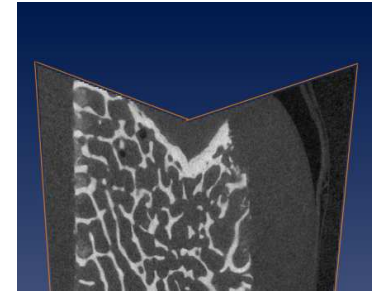


Copyright

# Basic Visualization

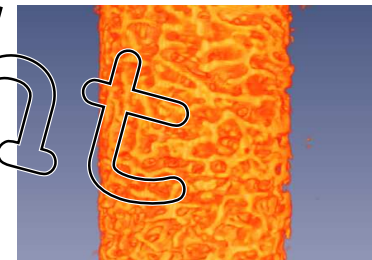
## z Slicing

- y Fast at full resolution
- y Hard to realize 3D structure
- y No preprocessing → reference



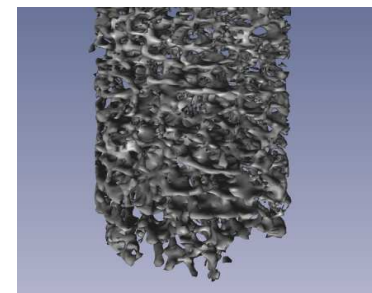
## z Volume rendering

- y Downsampled (here  $8 \times 8 \times 4 = 256$ )



## z Isosurface

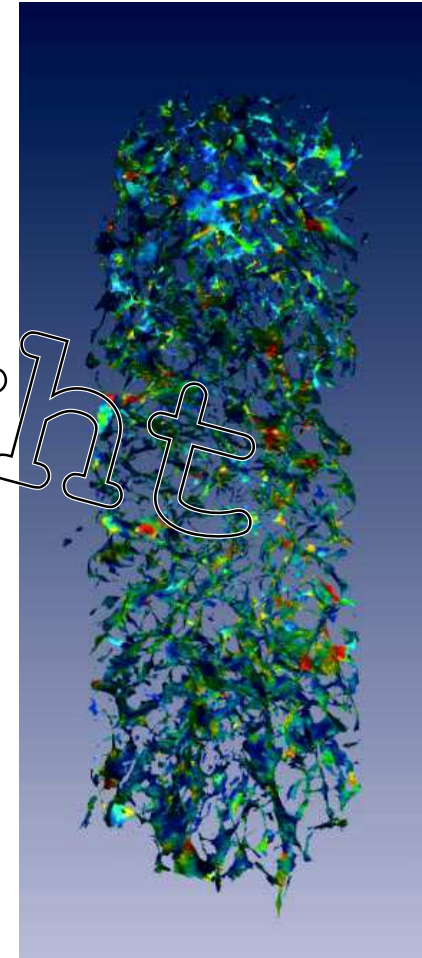
- y 10.000.000 triangles at full resolution
- y Downsampled only



High resolution & 3D structure?

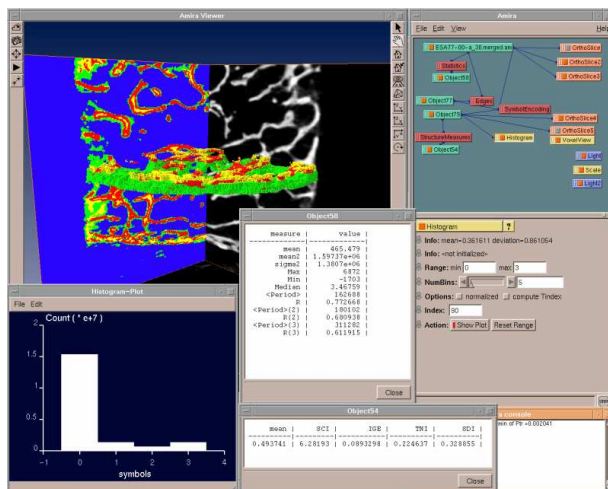
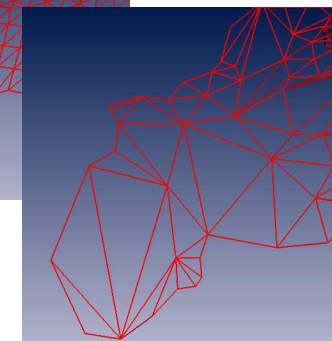
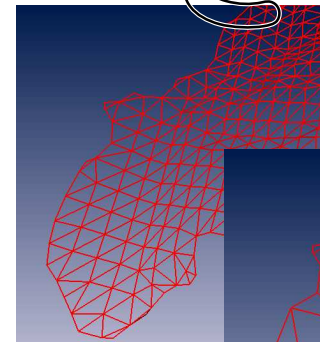
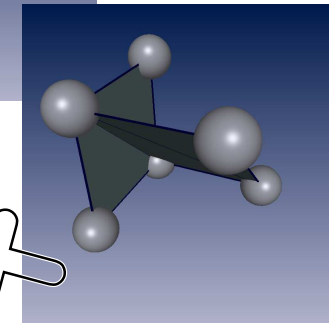
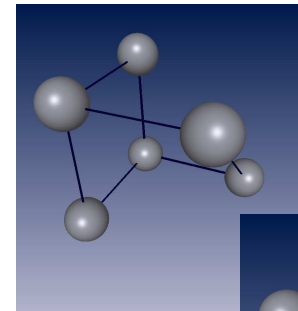
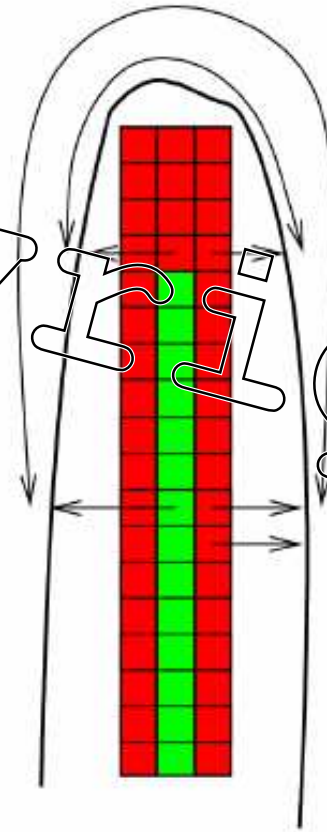
# Advanced Visualization

- z Medial surface (skeleton)
  - y Overall structure
  - y Interactive frame rates
- z Color coding
  - y Local measures
  - y Highlight special features

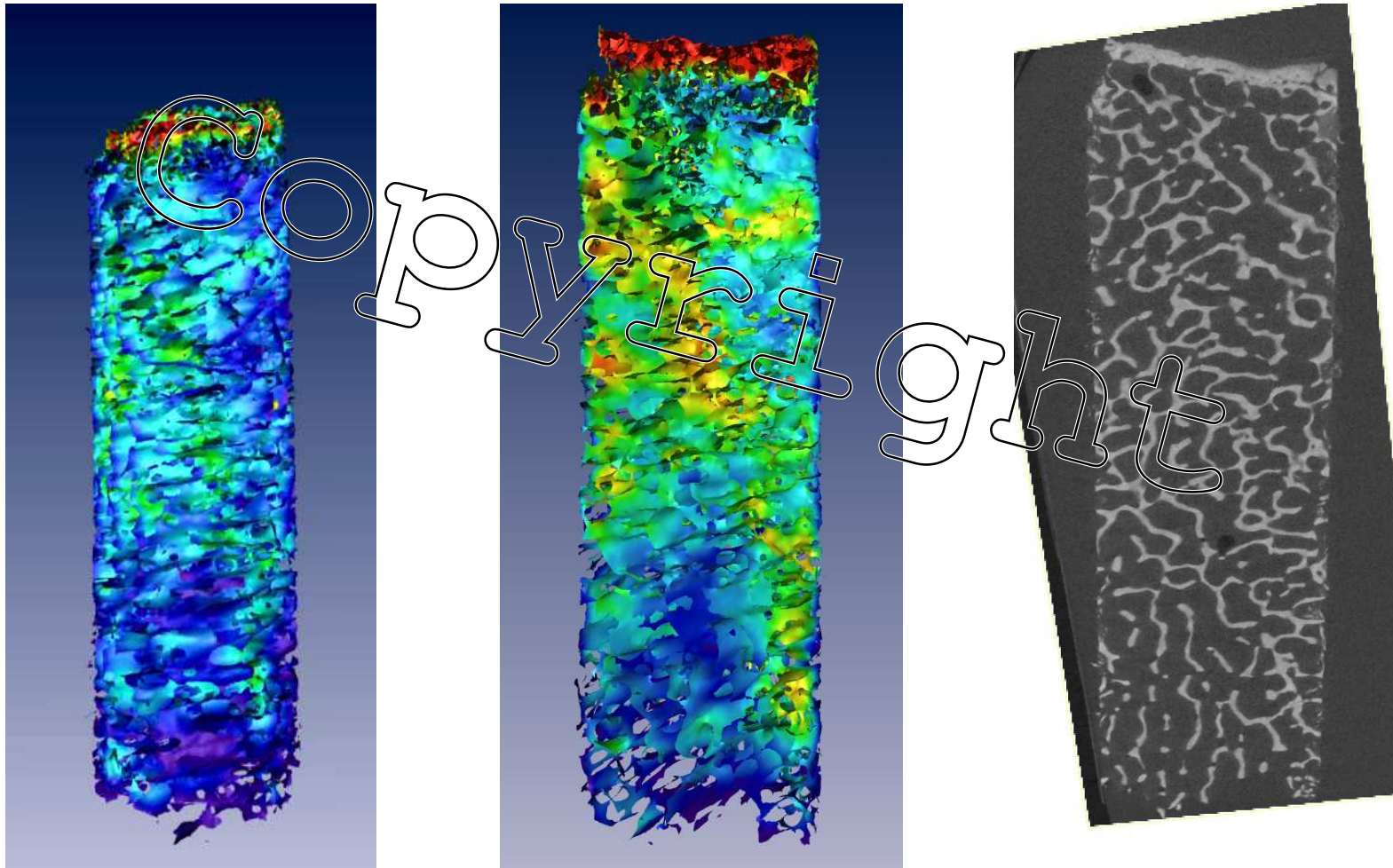


# Skeletonization

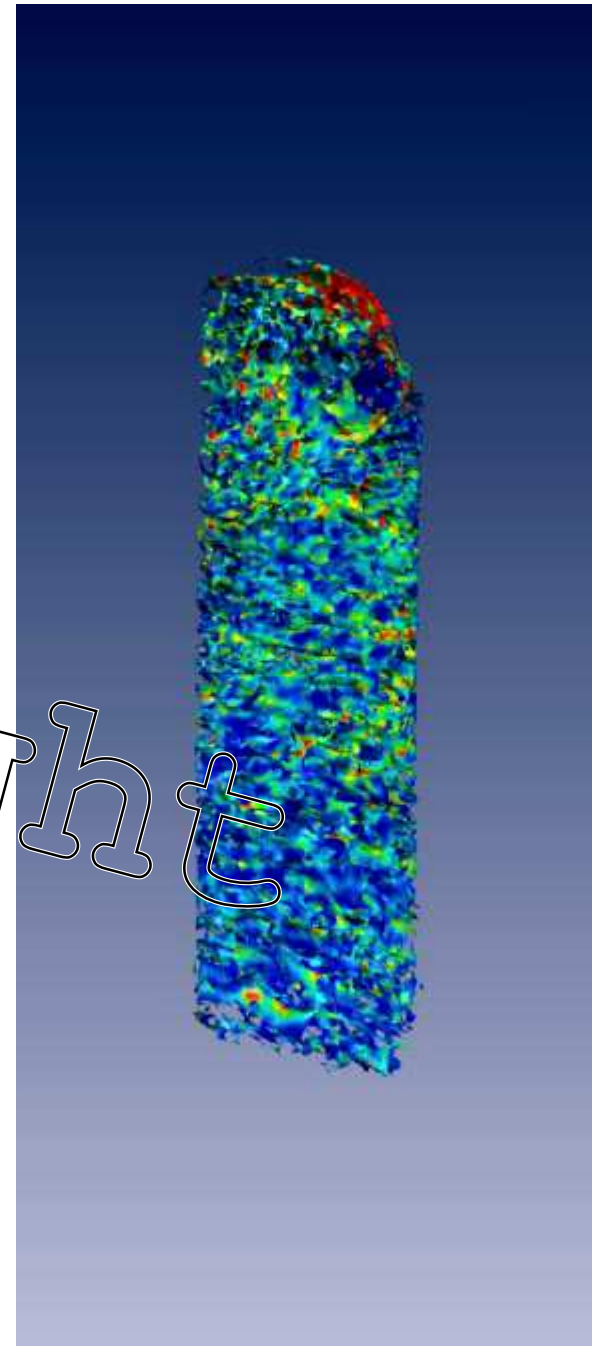
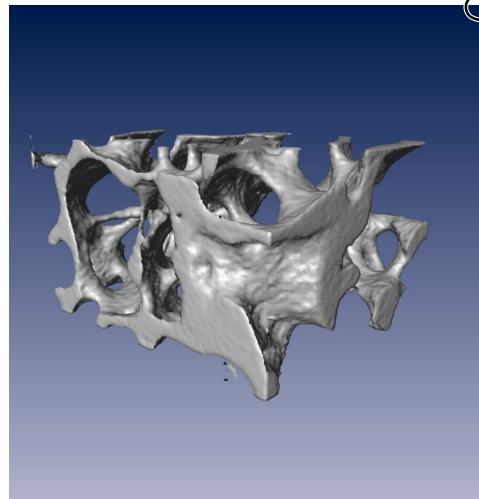
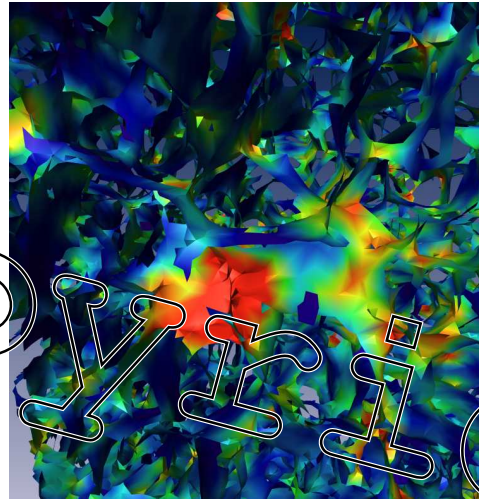
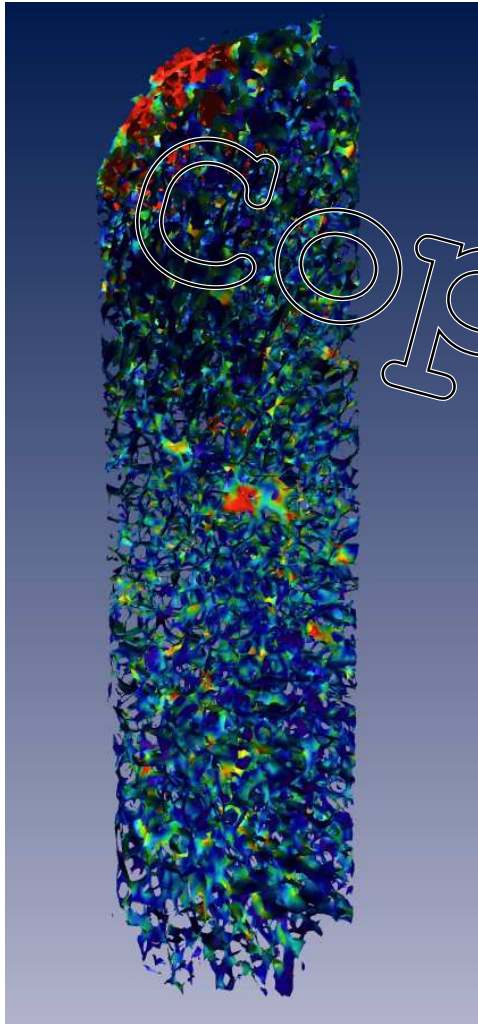
- z Segmentation
- z Voxel skeleton
- z Triangulation
- z Triangle reduction
- z Integrated into Amira



# Colored by mean CT value



# Colored by local thickness



# Conclusions



- z Interactive visualization of high resolution images of bone biopsies possible
- z Overall structure together with local measures points to special features
- z Interactive exploration useful

# Future



- z Visualization of rod-like structures
- z Out-of-core processing

## Acknowledgement

Visualization framework: Indeed – Visual Concepts,  
[amira.zib.de](http://amira.zib.de)

Funding: ESA, Roche Pharmaceuticals, Siemens AG.

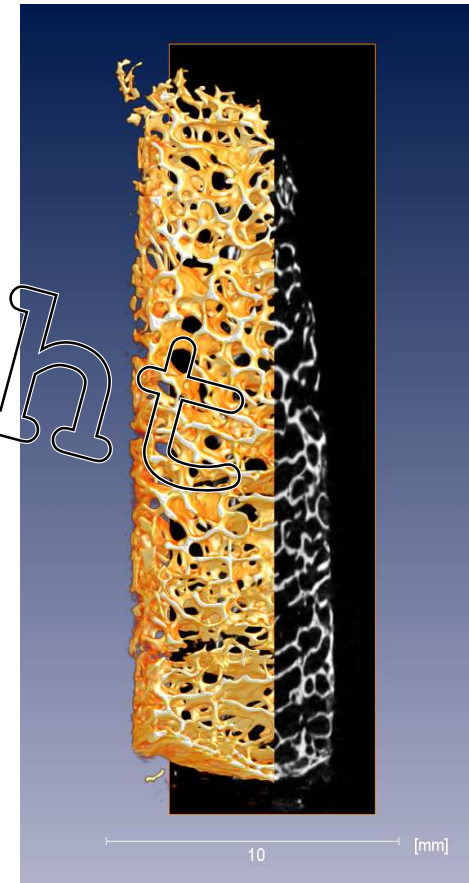
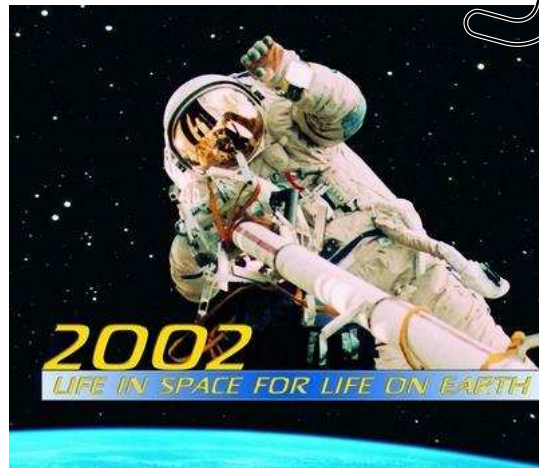
Specimens are a courtesy of the Anatomical Institutes of  
the Humboldt University and the Free University Berlin.

# Thank you...

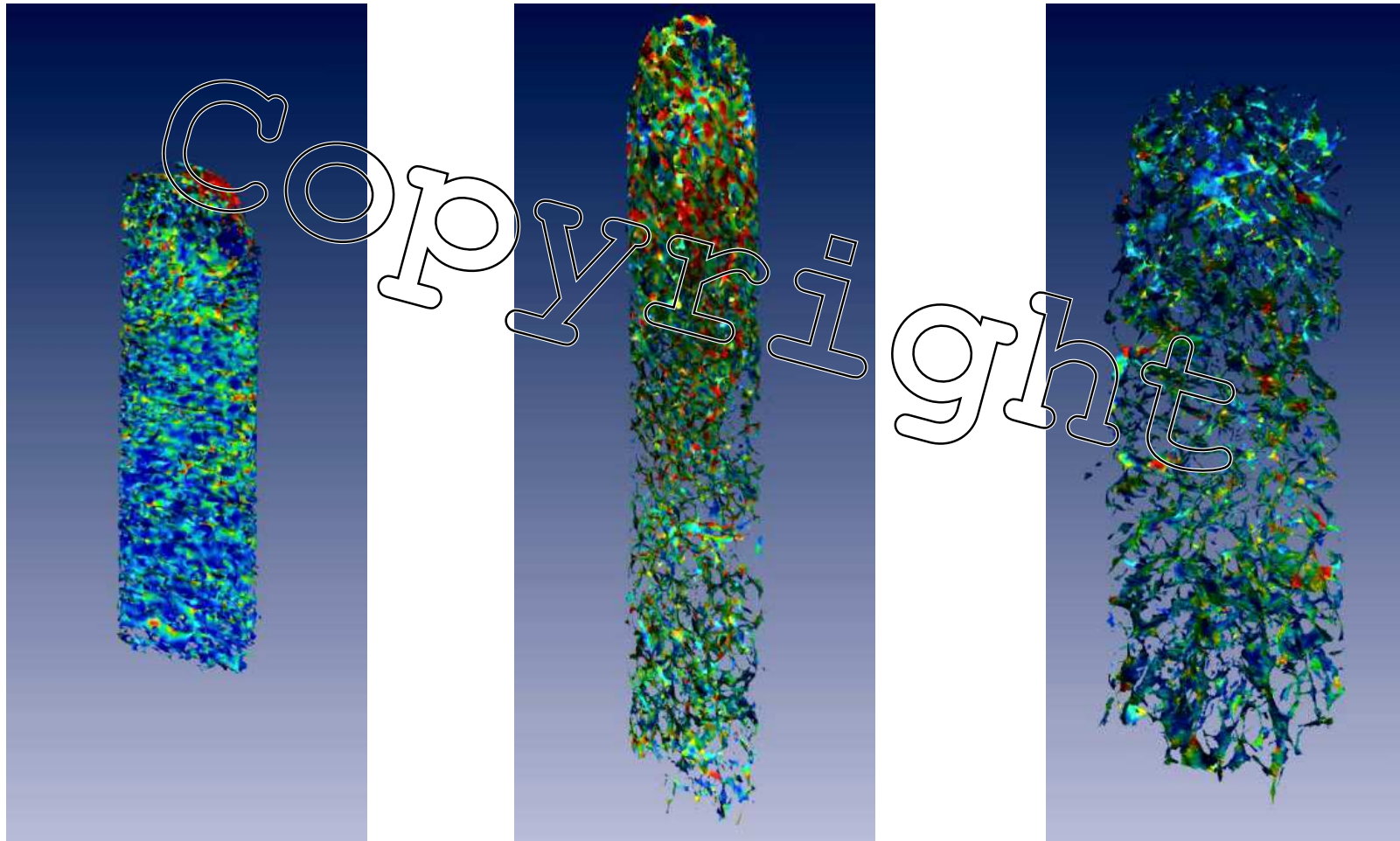
## ... for your attention.

### Questions?

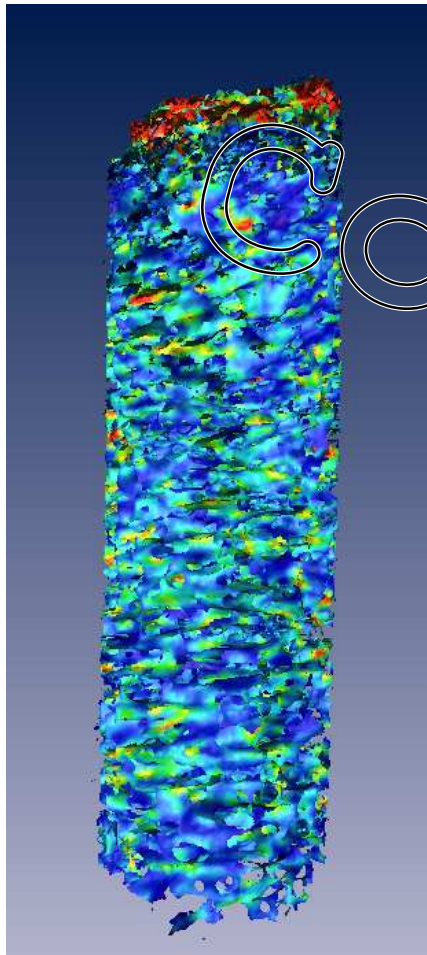
Copyright



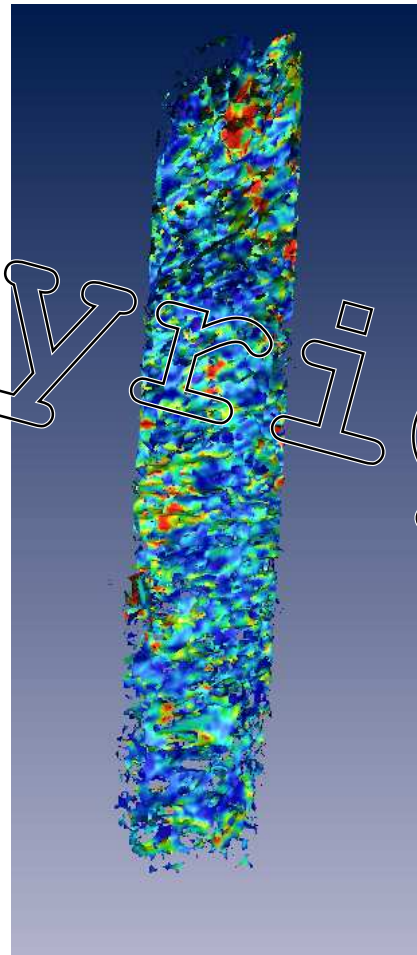
# Colored by local thickness



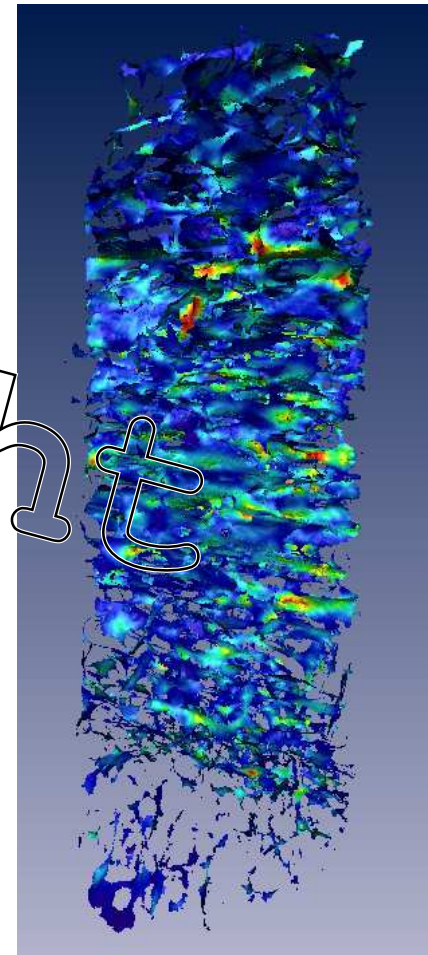
# Colored by local thickness



BV/TV 20%



BV/TV 15%



BV/TV 9.5%

# Skeletonization

- z Segmentation
- z Voxel skeleton
- z Triangulation
- z Triangle reduction

