Analyze and validate structures with PoroDict and MatDict

Erik Glatt,

Math2Market GmbH,

erik.glatt@math2market.de

MATH 2 MARKET

PoroDict

Characterize the pore space of a structure

Validate geometry models via comparison with CT-images

Validate geometry models via comparison with experiments

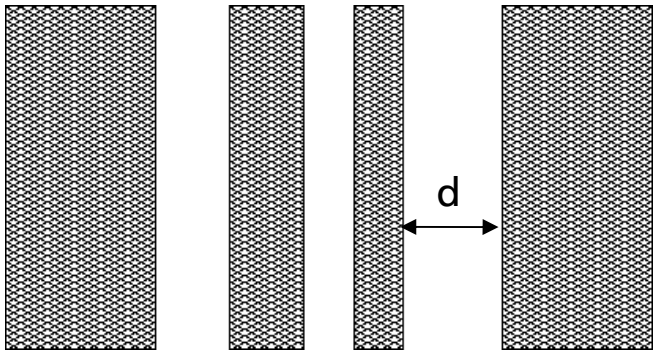
Compare the pore space of different structures (materials)

- Geometric Pore Size Distribution (PSD)
- Pore Size Distribution by Porosimetry
- Percolation Path
- Estimate Surface Area
- Three-Phase Contact Line
- Open and Closed Porosity
- Chord Length Distribution
- Bubble Point
- Euclidean Distance Transform
- Identify Pores (Watershed)

MATH 2 MARKET

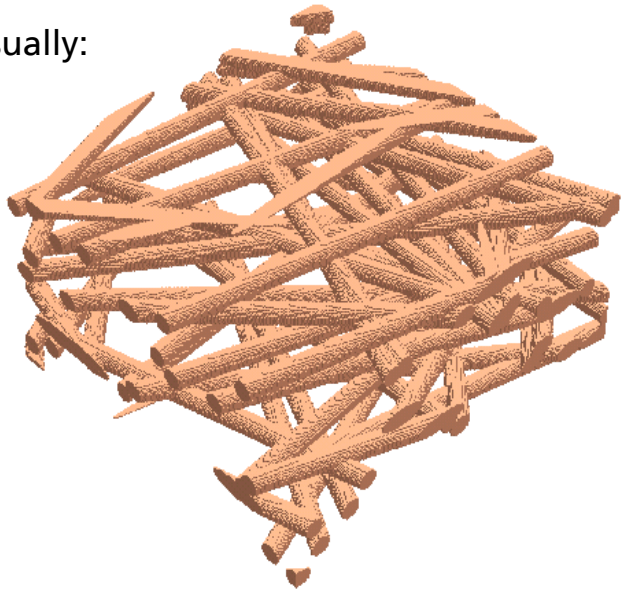
Geometric Pore Size Distribution

simple geometry:



Pore sizes well defined and easy to measure

usually:



How to define a pore size ?

What is measured?

Defining Pore Sizes

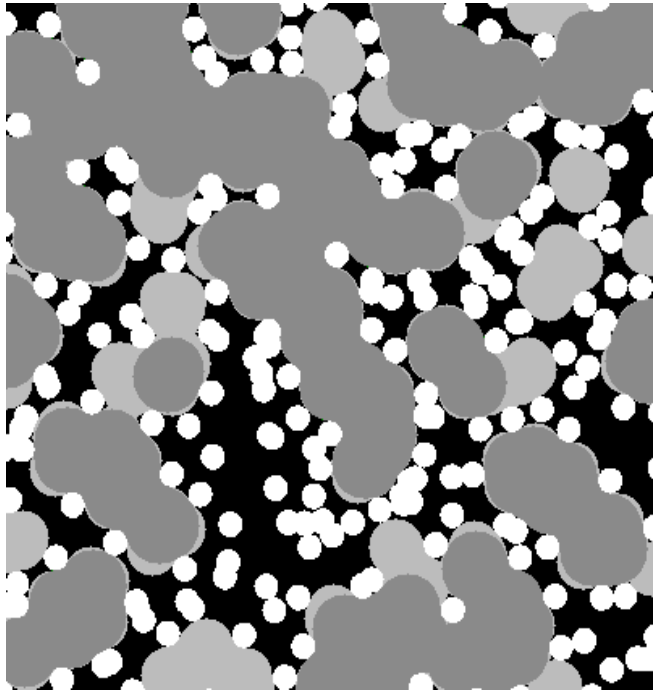
Pore space : X

Opening of radius r:

$$O_r(X) = \bigcup_{B_{r,x} \subset X} B_{r,x}$$

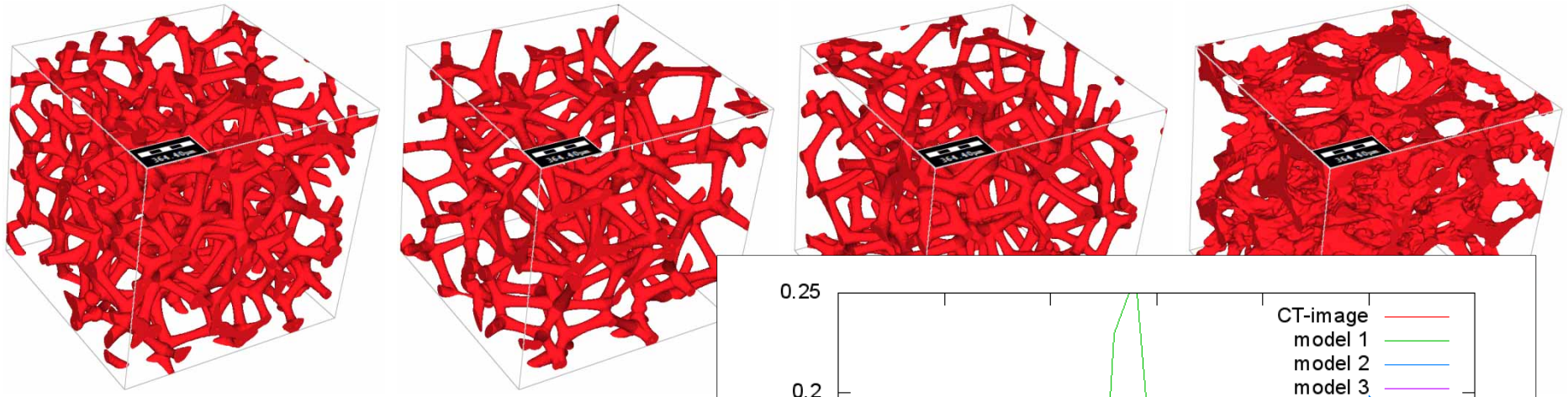
Volume of pores with radius $r_1 \leq r \leq r_2$:

$$O_{r_1}(X) - O_{r_2}(X)$$

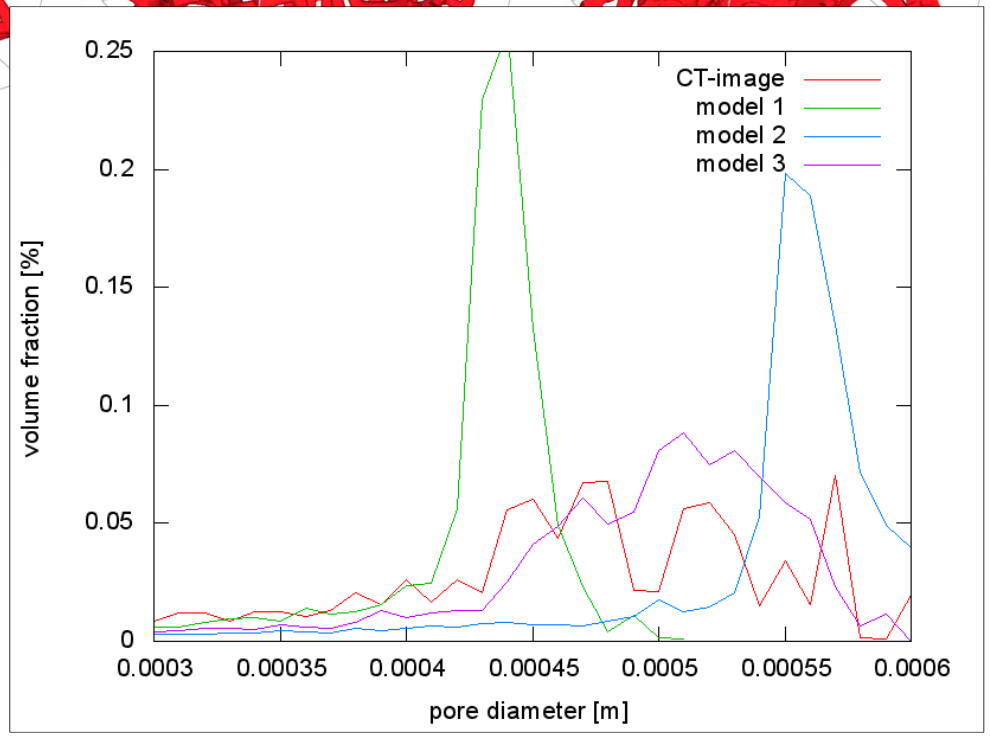


dark grey: $r \geq 20$
light grey: $16 \leq r < 20$

Analyze the PSD of a Sponge



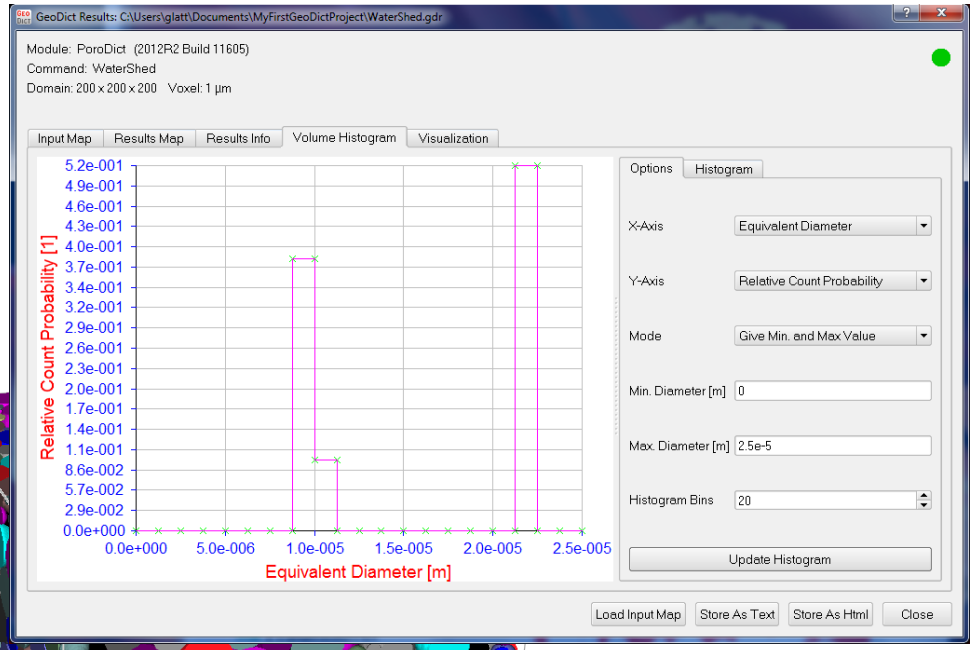
Validate the model of a sponge via comparison of the PSD for model and CT-image

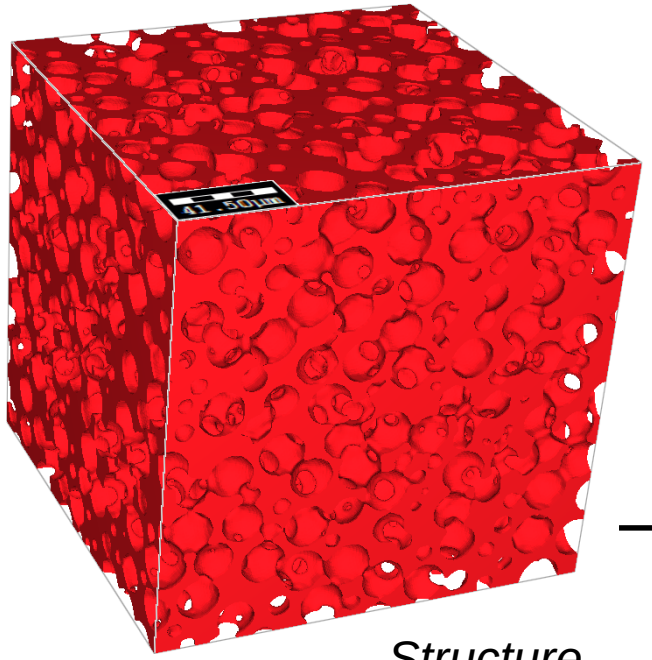


Identify Pores (Watershed)

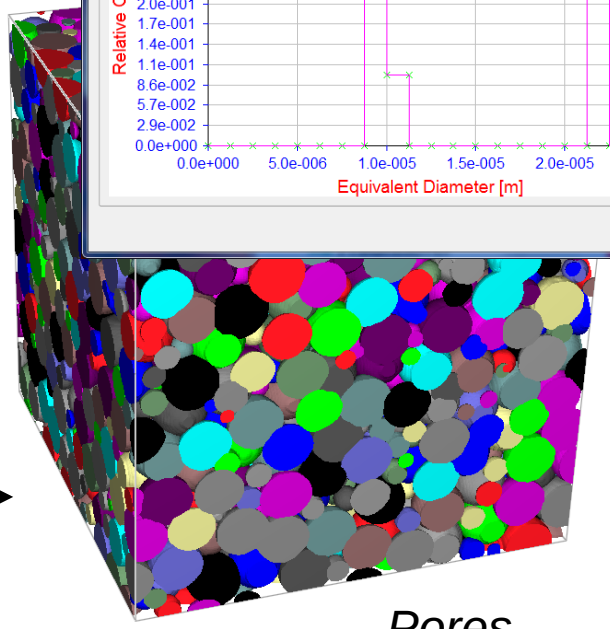
Use the watershed algorithm to:

- Separate pores
- Get a pore size analyzes





Structure



Pores

MatDict

Characterize the material phases of a structure

Validate geometry models via comparison with CT-images

Validate geometry models via comparison with experiments

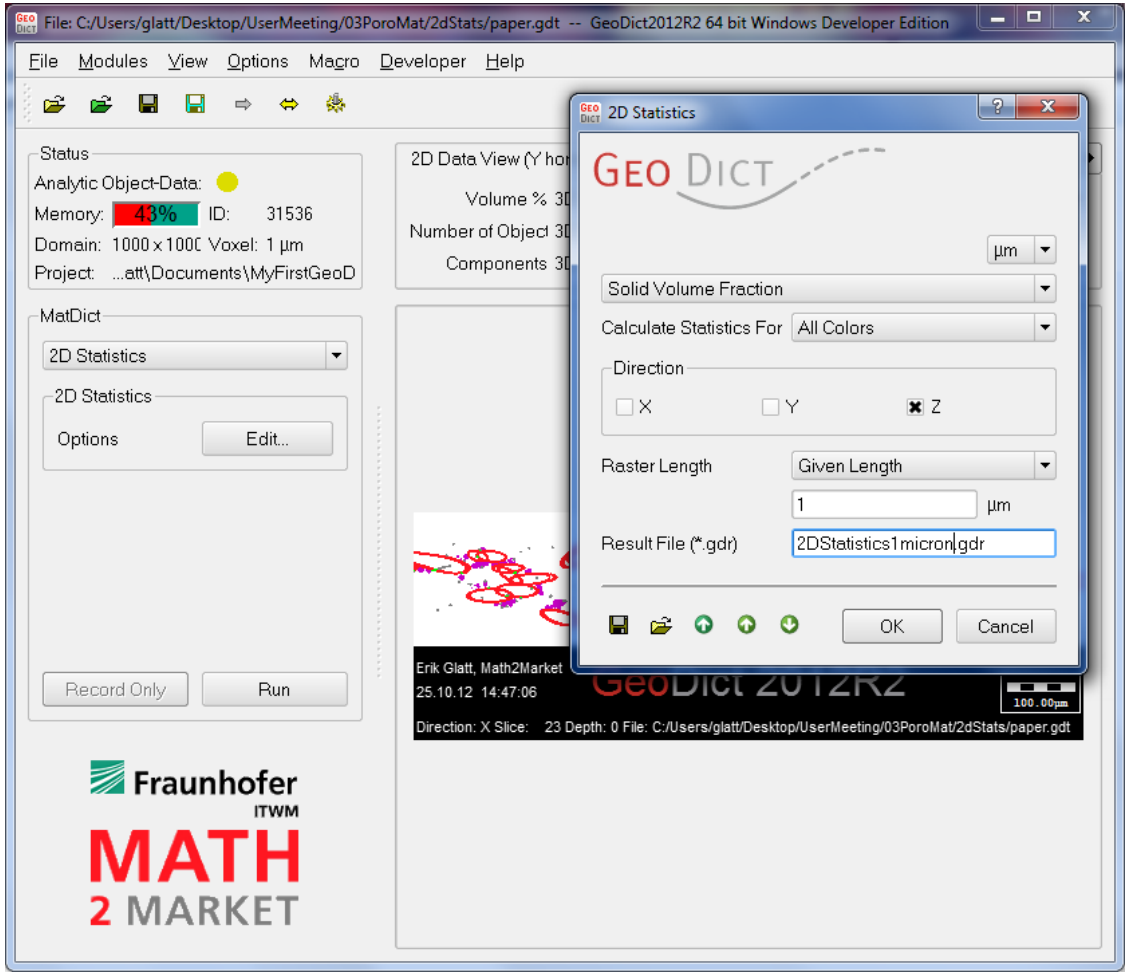
Compare the material phases of different structures

- Connected Components
- 1D Statistics
- 2D Statistics
- Analyze Objects

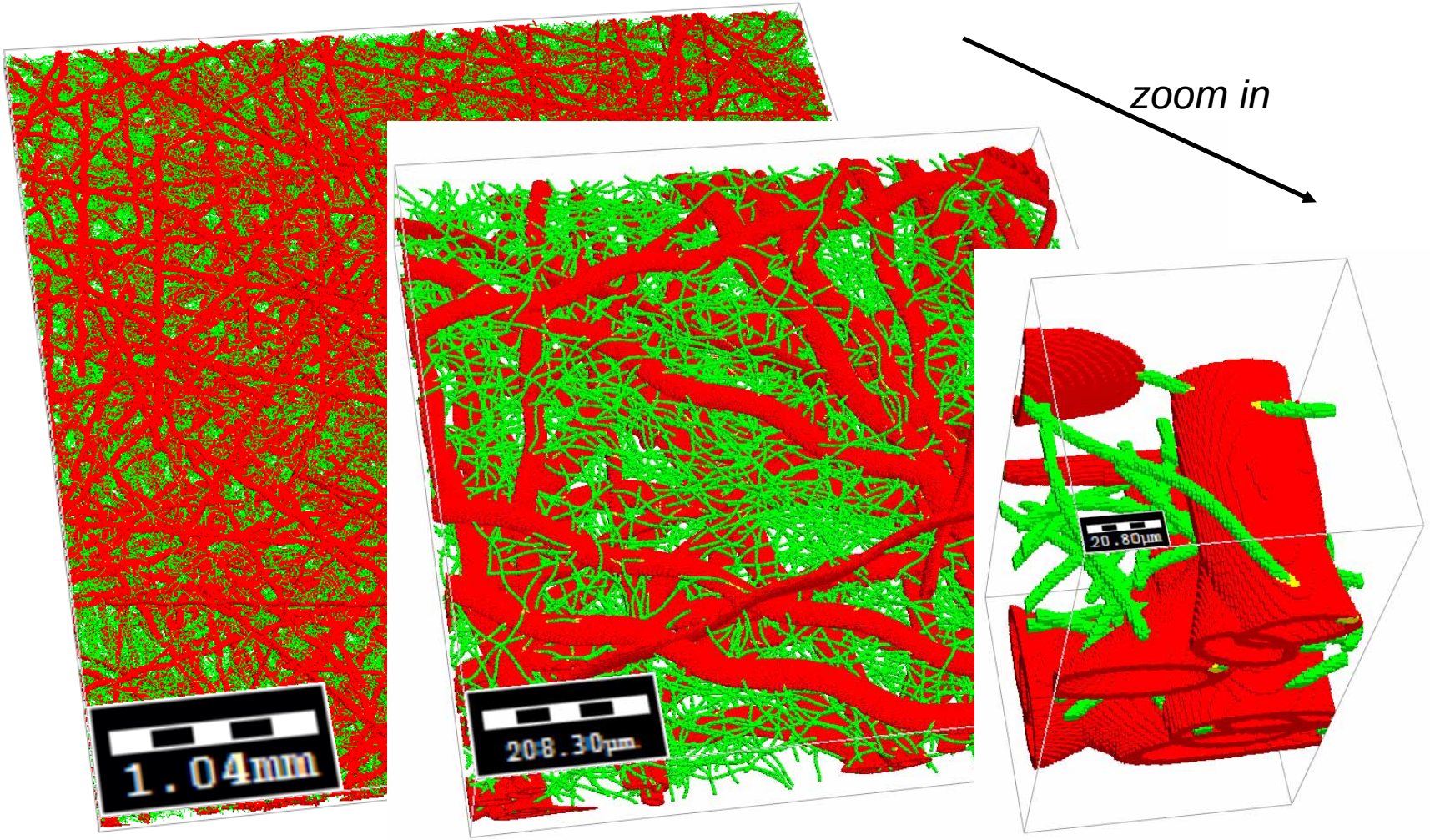
2D Statistics

Calculate the SVF along rays in x-, y- or z-direction

Example:
Use the 2D statistics to study the heterogeneity of a paper sheet

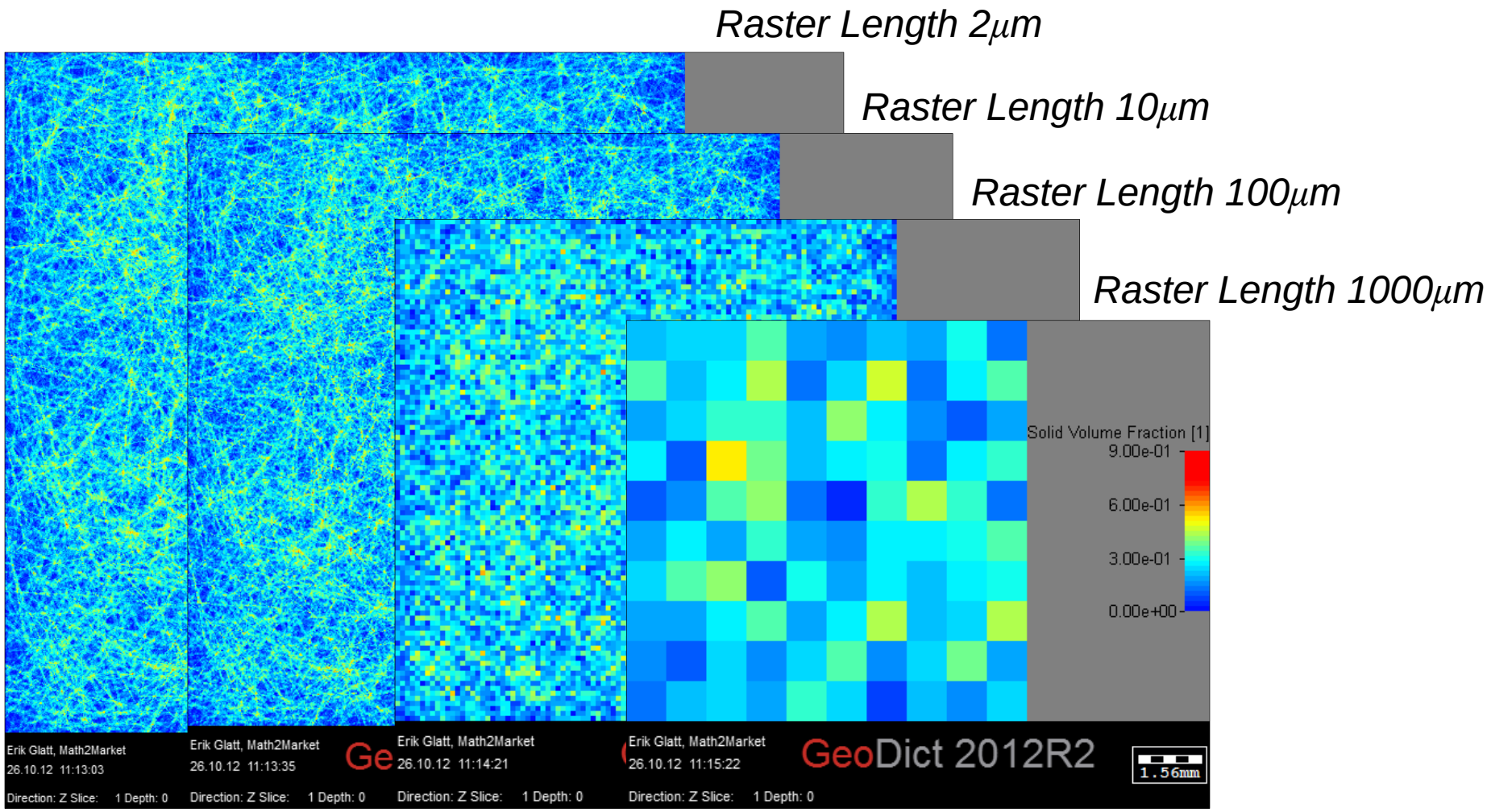


Heterogeneity of a Paper Sheet 1



5mm *1mm* *0.1mm*

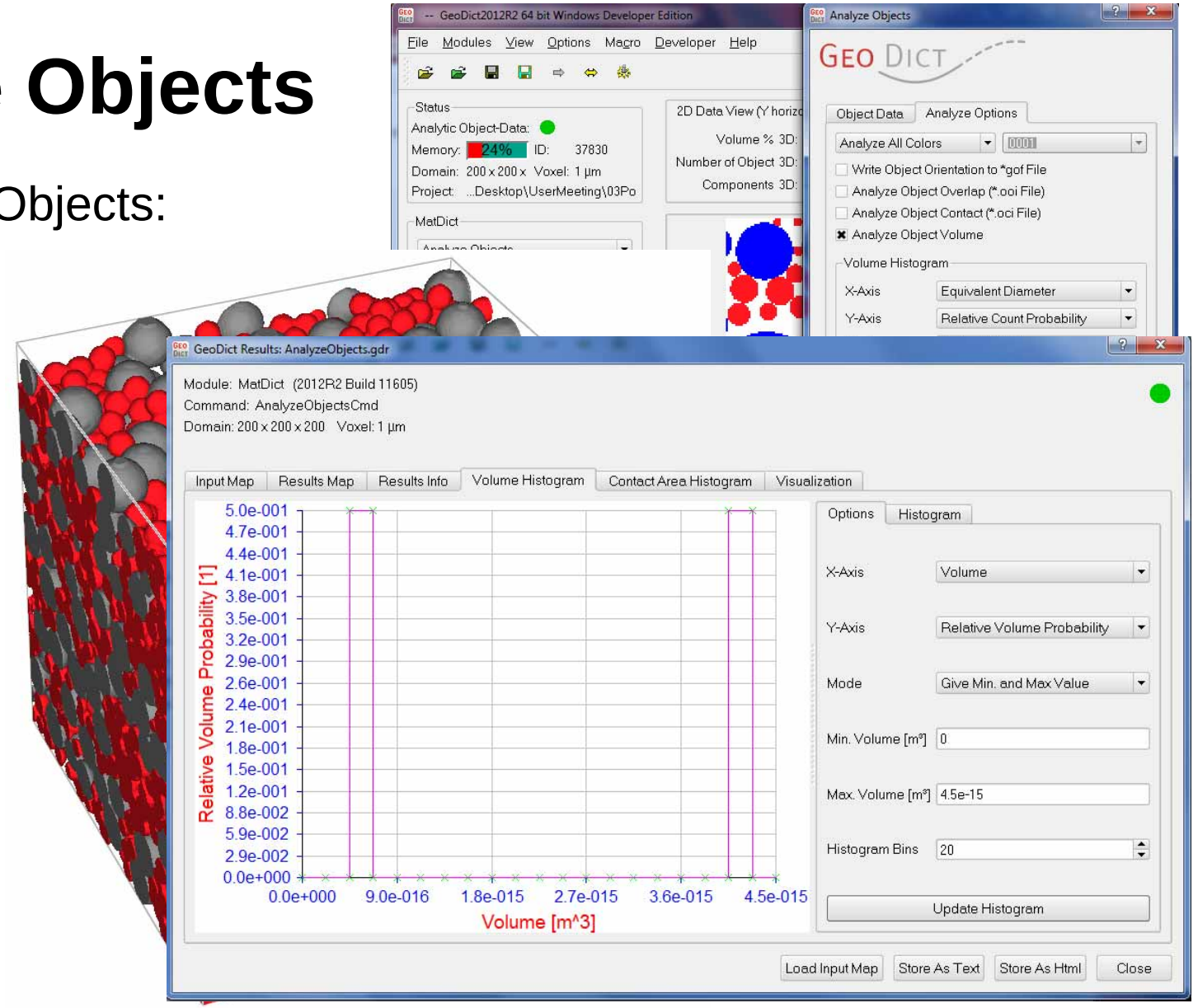
Heterogeneity of a Paper Sheet 2



Analyze Objects

Analyze Gad-Objects:

- Volumes
- Contacts
- Overlaps



Conclusions

PoroDict and MatDict are powerful tools to **analyze** and **validate** the geometry of material models and CT-images.

Examples:

- validation of a sponge model via comparison of the PSD
- Study the heterogeneity of paper with the 2D statistics

Outlook

Planed new features:

- Skeletonization algorithm
- Fiber property estimation (diameters,..)
- 3D Statistics