Extraction of boundaries from 3D CT data

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Supervisor

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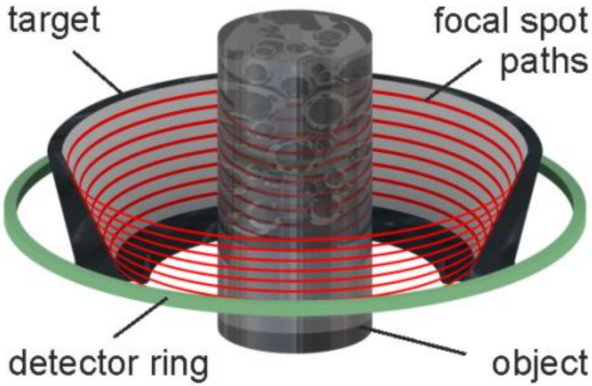
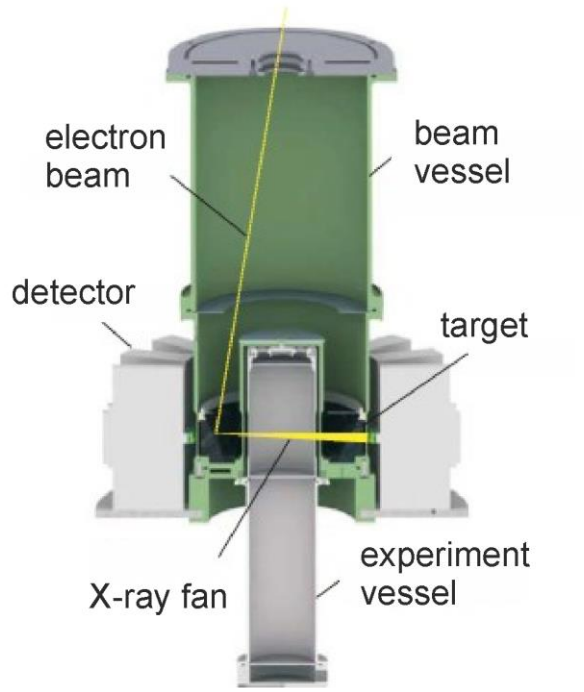
Contents

Ultrafast 3D X-ray tomography (full angle type)

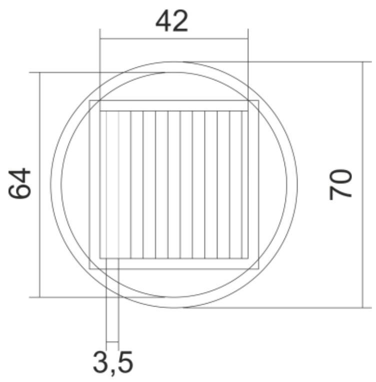
Principle:

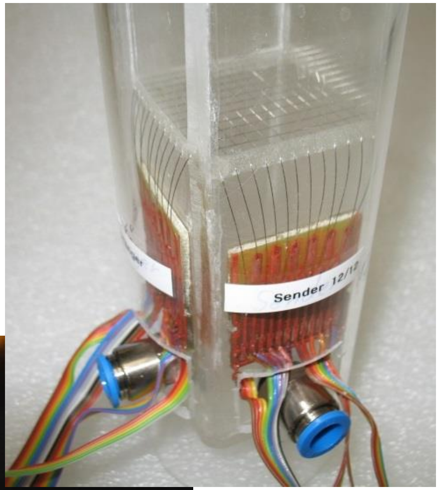


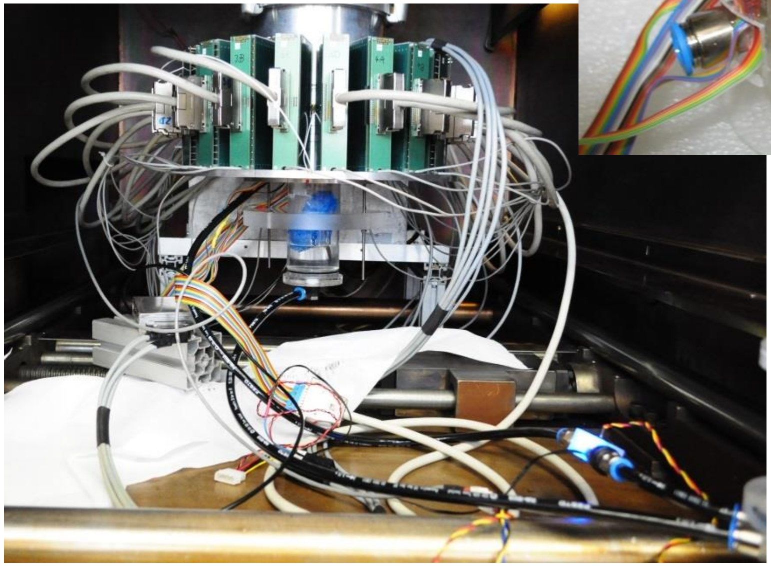


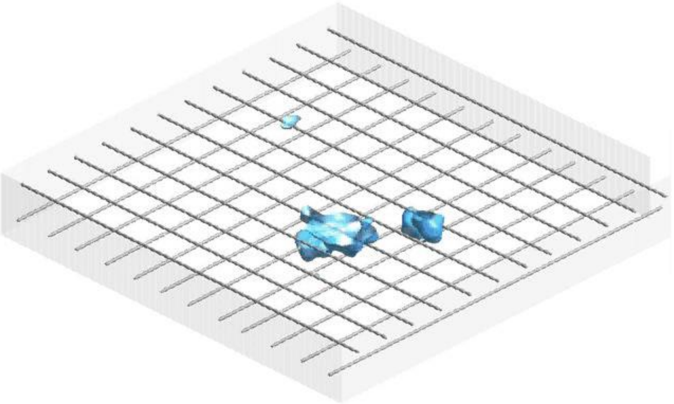
📖 Stürzel T., Bieberel M., Laurien E., Hampel U., Bartehl F., Menz, H.-J., Mayer H.-G., (2011), Experimental facility for two- and three-dimensional ultrafast electron beam X-ray computed tomography, *Rev. Sci. Instrum*. 82 023702

Ultrafast 3D X-ray tomography of a two-phase flow at a wire-mesh sensor

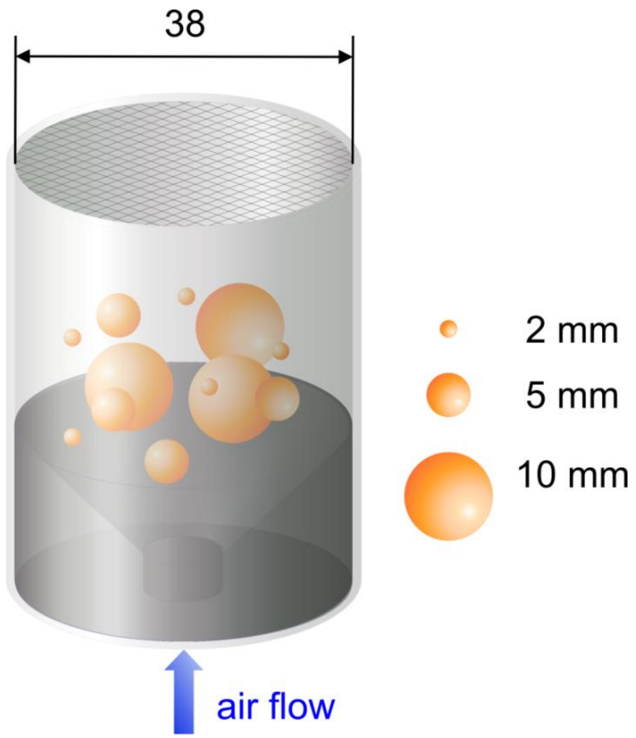


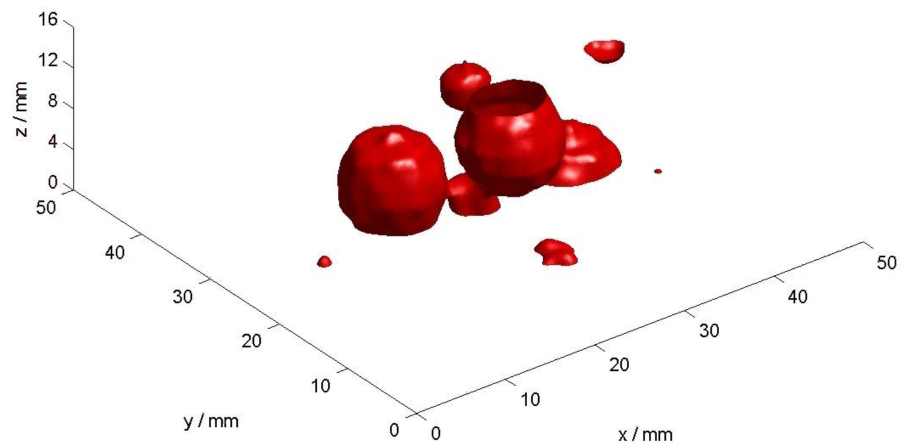






Ultrafast 3D X-ray tomography of fluidized particles





volume rate: 500 s^{-1}

Bieberle et al., Appl. Phys. Lett. 2011

DRESDEN concept

HZDR

Problem statement

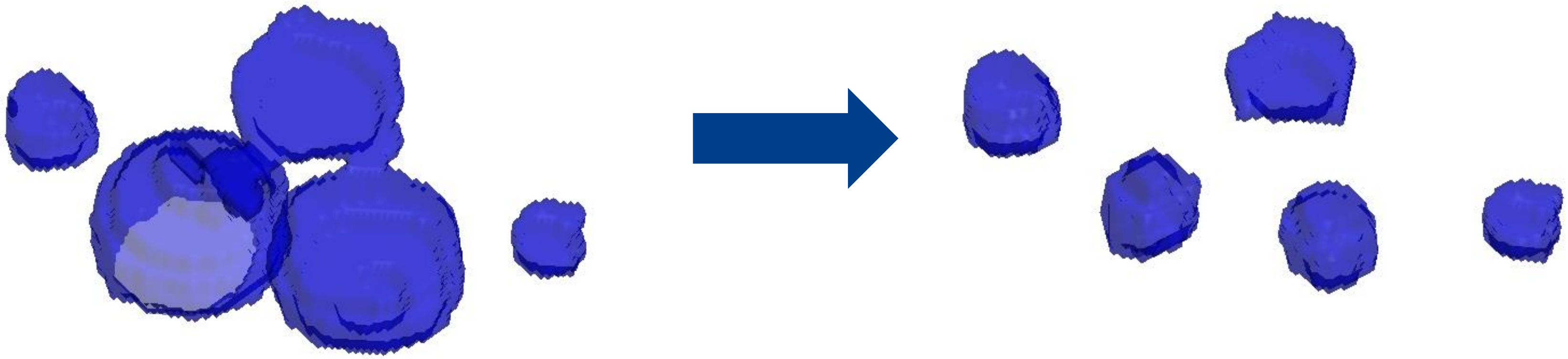
- **Explore the movement of the bubble surfaces**
  - **set the correspondence between the bubbles on the subsequent moments of time**
  - **set the correspondence between the surface points of the corresponding bubbles**

Preparation steps

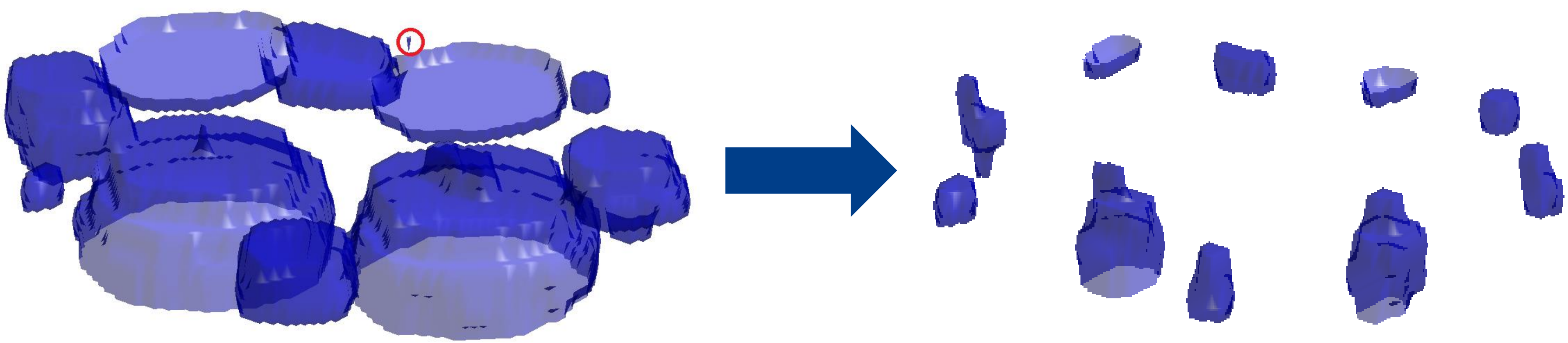
- find connected components
- delete too small bubbles
- separate the bubbles which are sticked together
- isosurface extraction (matlab function)

Bubbles separation

Example 1



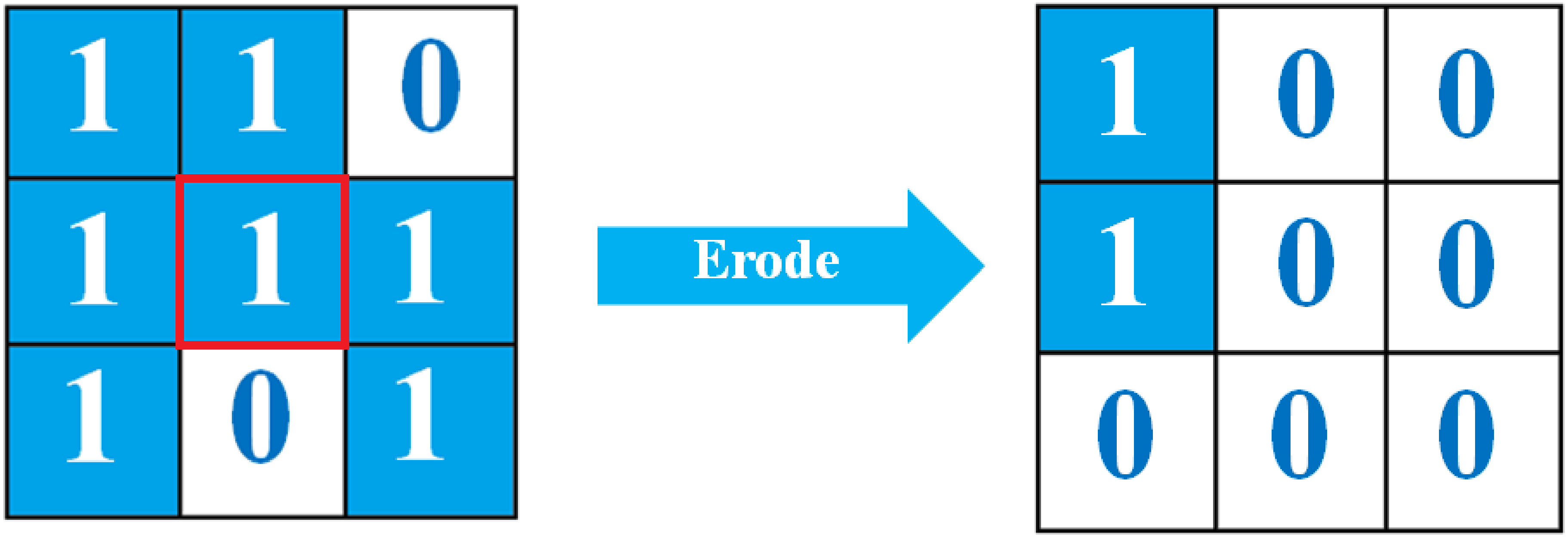
Example 2



Bubbles separation

Masks and logical operations

data(i) = 0, i = 2,7
data(i) = 1, i =0,1,3,4,5,6,8

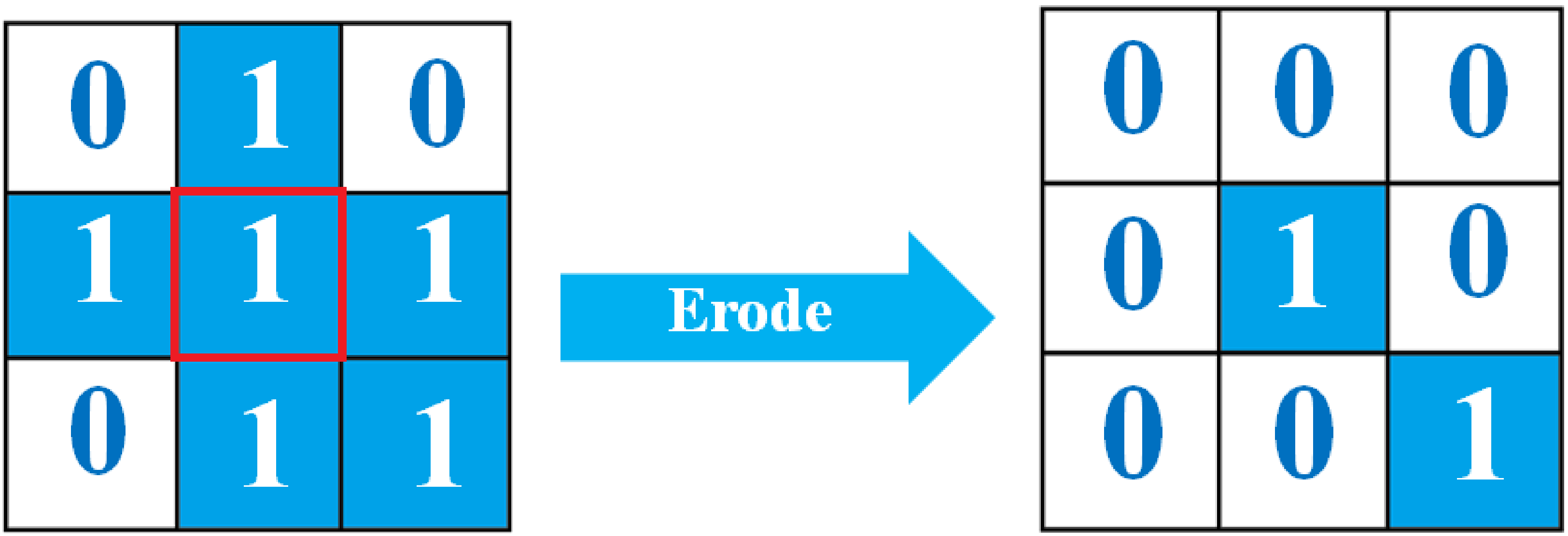


data(1)&data(3)&data(4)
&
data(5) &data(7) = 0

Bubbles separation

Masks and logical operations

data(i) = 0, i = 0,2,6,8
data(i) = 1, i = 1,3,4,5,7



data(1)&data(3)&data(4)
&
data(5) &data(7) = 1

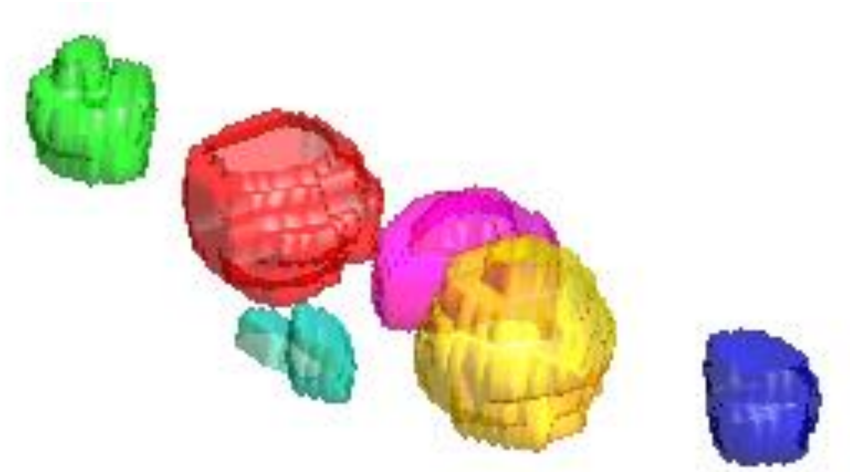
Isosurface extraction

matlab function

[f,v] = isosurface(V,isovalue);

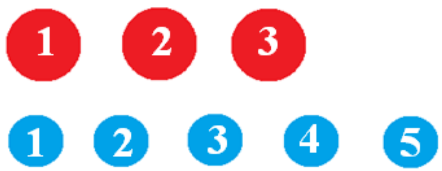
Output: faces and vertices in separate arrays

They are used as input data for the function, which finds connected components among already separated bubbles:



A bit combinatorics…

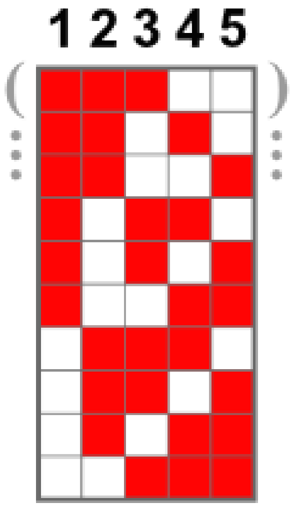
1.



t = k

t = k+1

2.



1	2	3
1	2	4
1	2	5
1	3	4
1	3	5
1	4	5
2	3	4
2	3	5
2	4	5
3	4	5

All possible combinations

$$C_n^{\,k} = \frac{n!}{k!\,(n-k)!}$$

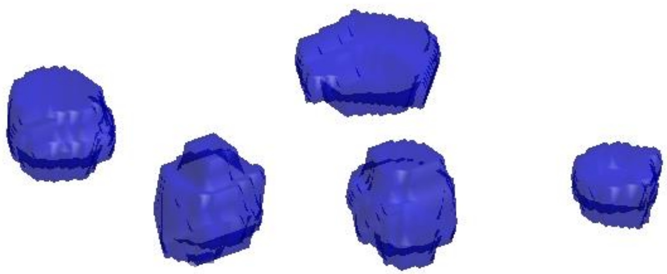
3. **All possible permutations of each combination**

For the case {1,2,3}: (1,2,3), (1,3,2), (2,1,3), (2,3,1), (3,1,2), (3,2,1)

$$P_n = k!$$

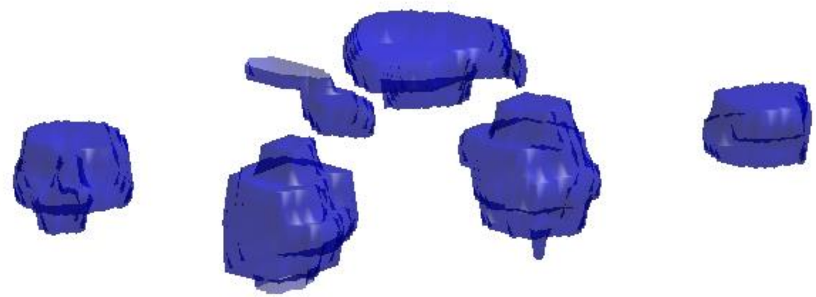
Total number of variants: $\frac{n!}{(n-k)!}$

Set correspondence between the bubbles



t = k

#bubbles = 5



t = k+1

#bubbles = 6

$A_i^k(x_i, y_i, z_i)$ - center of mass of the i-th component, t = k

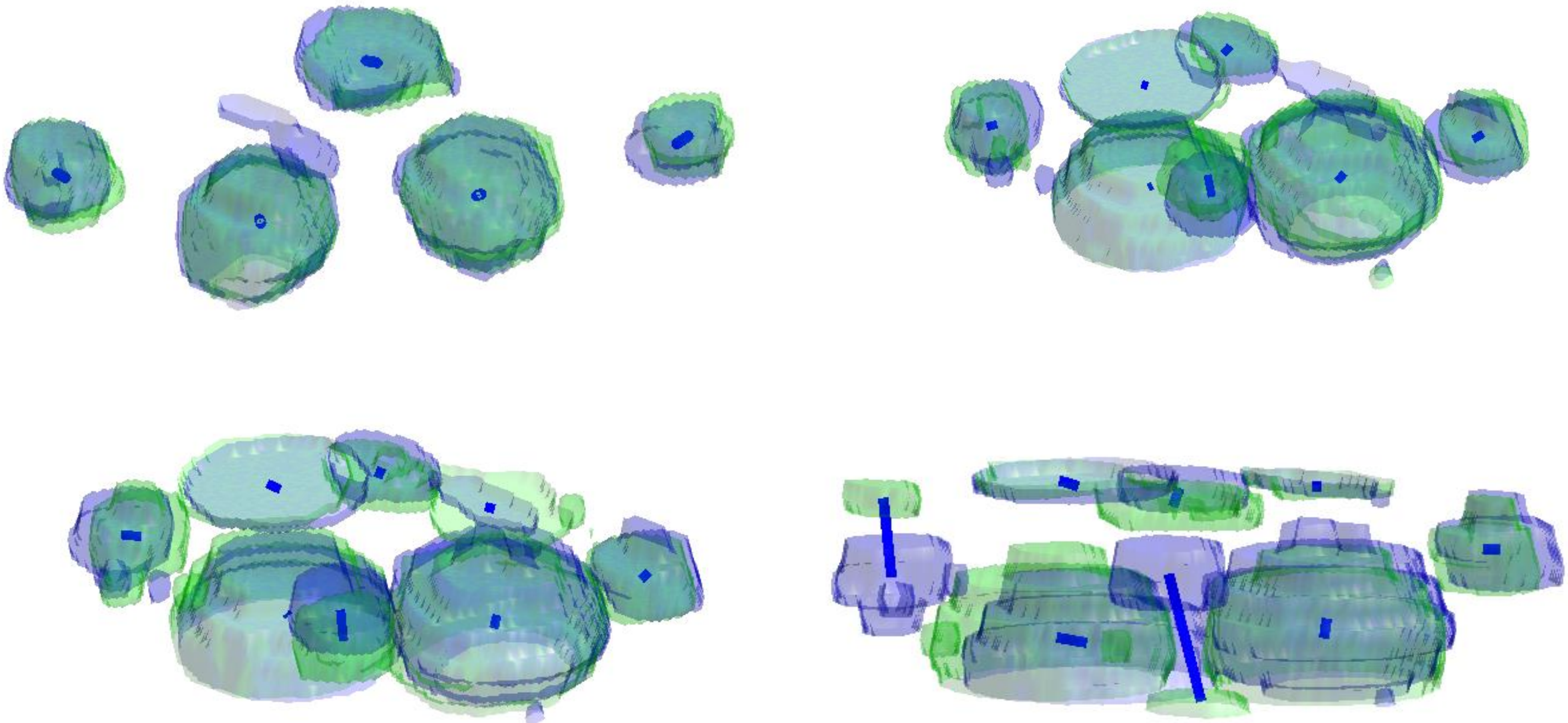
$A_i^{k+1}(x_i, y_i, z_i)$ - center of mass of the i-th component, t = k+1

$$\min_{\sigma} \sum_{i=1}^{cn} dist(A_i, A_{j_l}) \text{ , } l \in \overline{1, cn},\ k_l \in \sigma$$

$cn = \min_{t} Number\_of\_bubbles(t)$, t $\in \{k, k+1\}$

σ – all possible permutations of cn elements

Some examples



green bubbles t = k

blue bubbles t = k+1

segments show the correspondence