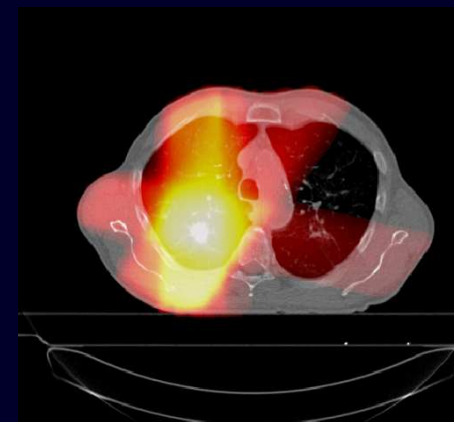


Deformation of planned dose distribution to track delivered dose to Non Small Cell Lung Cancer (NSCLC) patients

ESTRO25 – Leipzig 2006



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Background and purpose

- Radiotherapy :
 - treatment planning for non-small cell lung cancer
 - Importance of respiratory motion
- Challenges to take care of respiratory motion :
 - Delineation on every phases ⁽¹⁾
 - Total dose received by each voxel

1. *Semi-automatic delineation of moving lung tumours using deformation fields based on RC-CT: improvement of the internal target volume definition.*, G. Janssens, J. Orban de Xivry, et al., ESTRO25, 2006. Abstract 247

Deformation study – registration pipeline

Rigid
registration

Fixed image



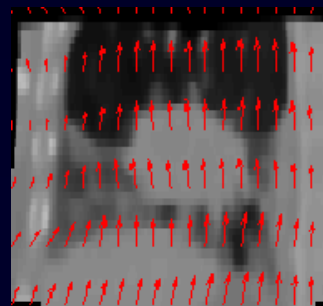
Moving image



Difference



Deformable
registration



Deformed image



Difference

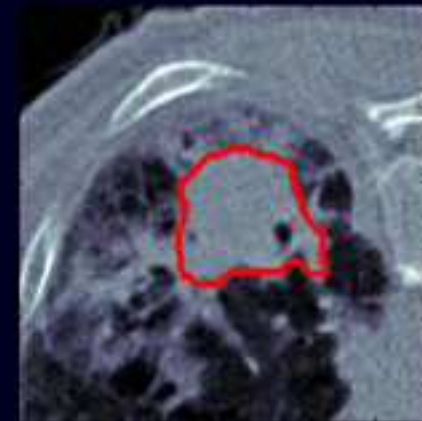
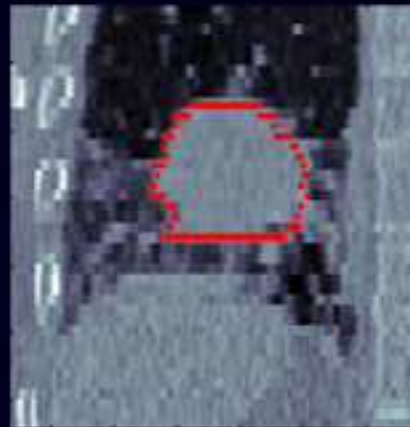
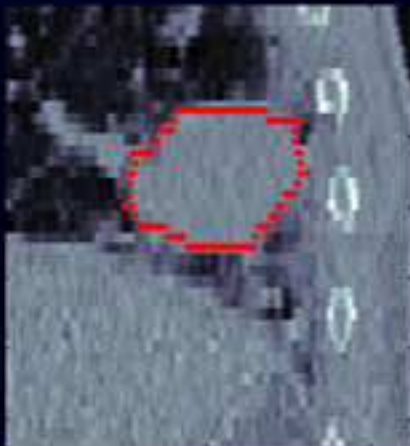
Deformation study – registration

- Metric : normalized correlation
- Deformable registration :
 - 3rd order b-splines on a regular grid (spacing 12 – 20 mm)
 - Optimizer: quasi-Newton method (LBFGS¹)

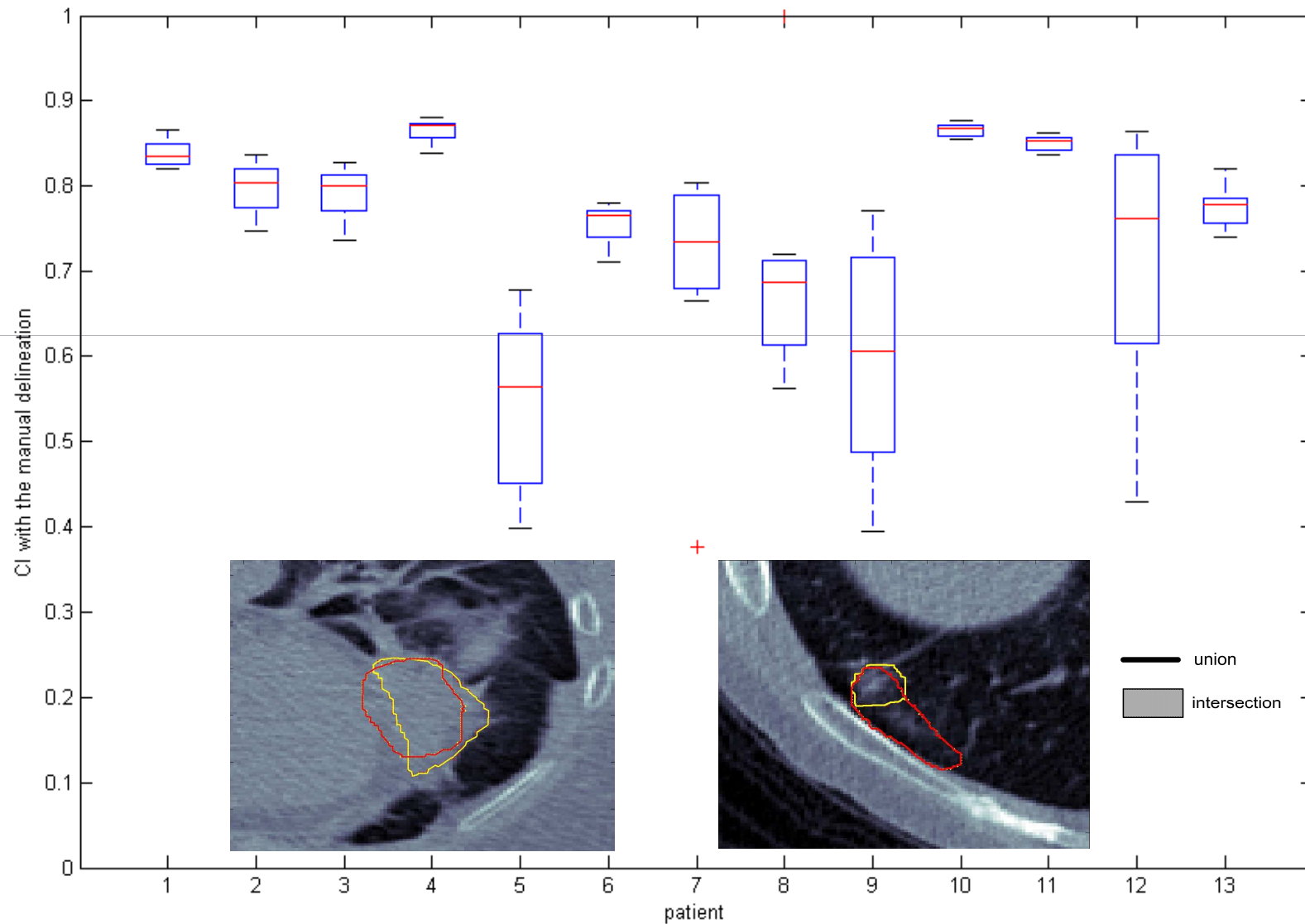
(*implemented with ITK*)

1. Limited memory Broyden-Fletcher-Goldfarb-Shanno optimizer.

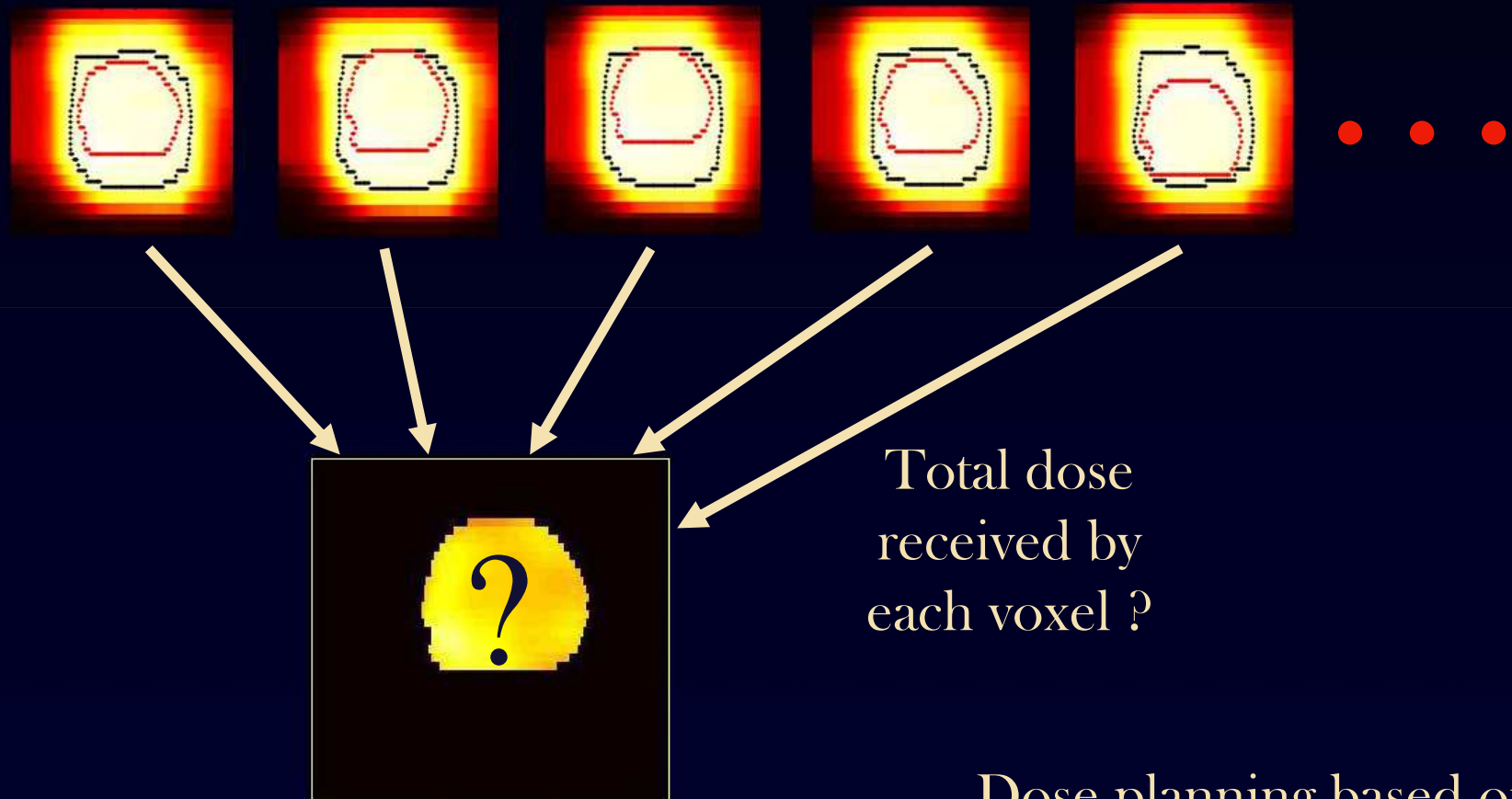
Semi-automatic delineation – results



Semi-automatic delineation - results



Dose deformation – purpose



Total dose
received by
each voxel ?

Dose planning based on
the ITV and computed
on a XiO workstation

Dose deformation - pipeline

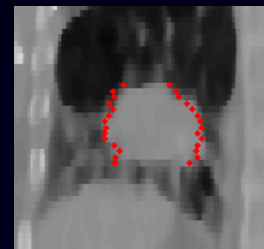
Dose distribution
on each phase



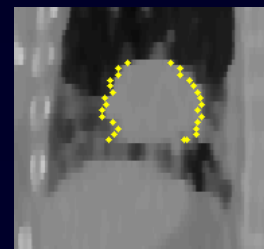
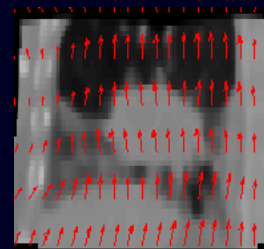
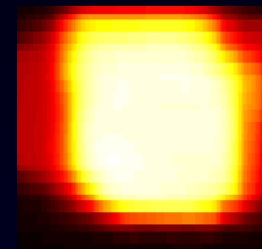
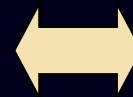
Deformation of the
dose distributions



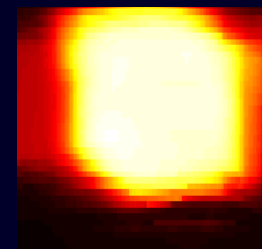
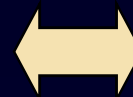
Total dose per voxel
computation



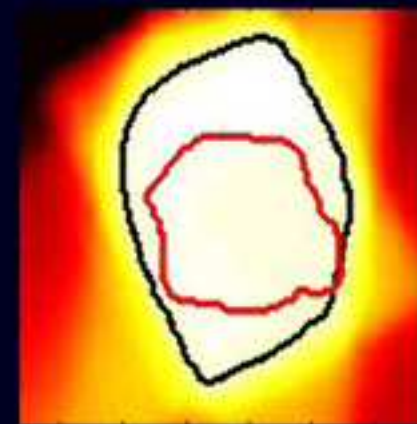
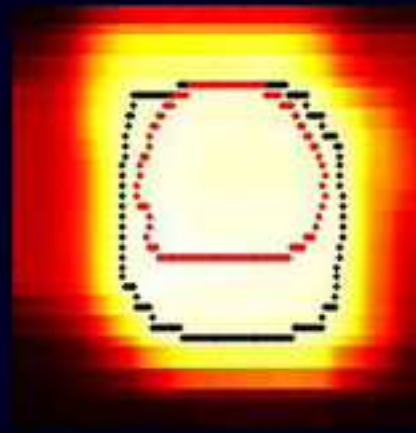
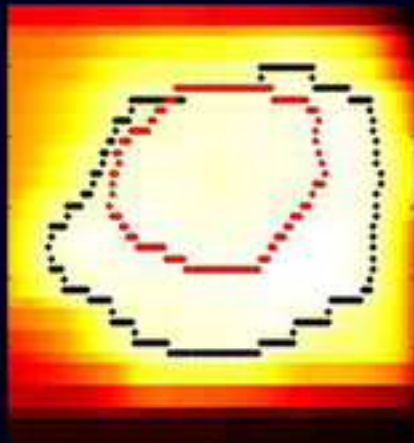
Phase X



Reference
phase



Dose deformation - results



Dose deformation - results

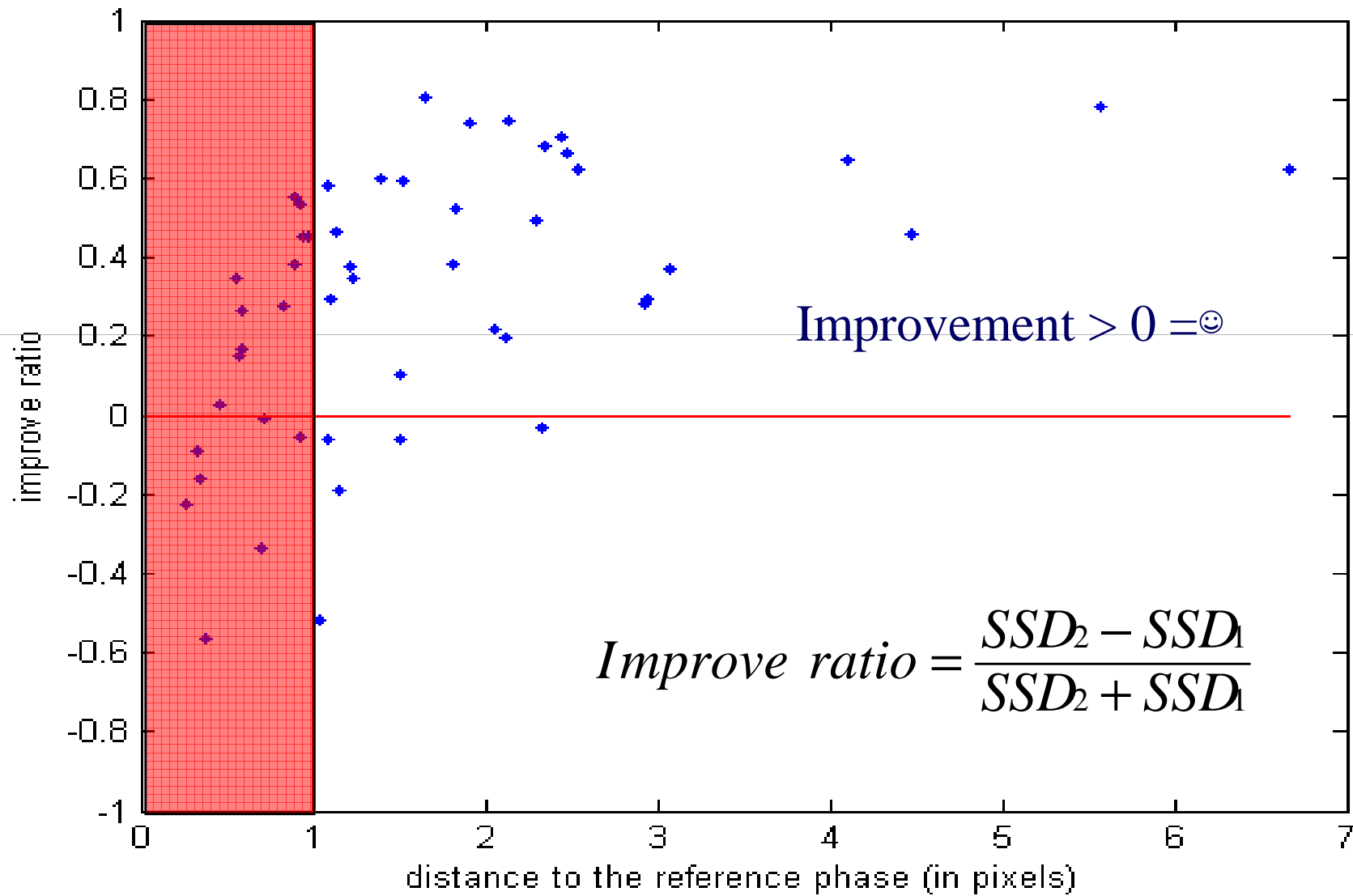
| | Deformed distribution | Gold standard | Dose to the reference phase |
|-------------------|------------------------------|-------------------------------------|------------------------------|
| Dose distribution | <i>Deformed</i> | <i>Original</i> | <i>Original</i> |
| Delineation | <i>Reference delineation</i> | <i>Semi-automatic on each phase</i> | <i>Reference delineation</i> |

SSD₁

SSD₂

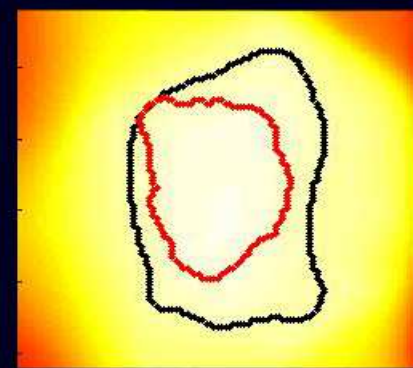
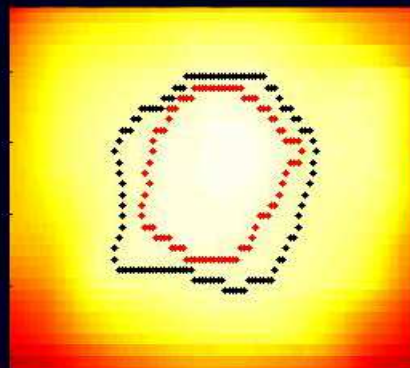
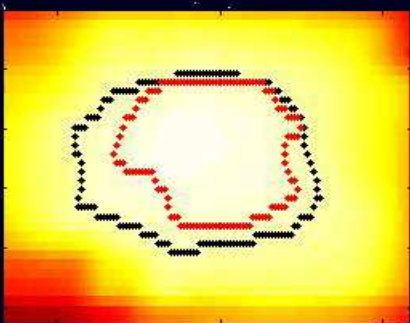
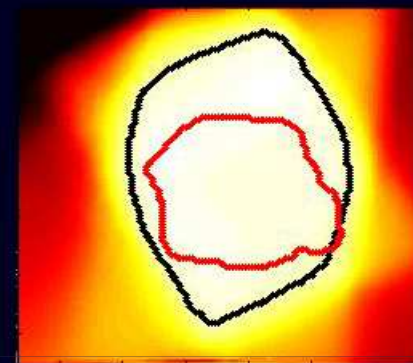
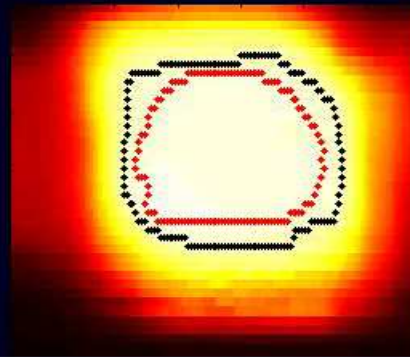
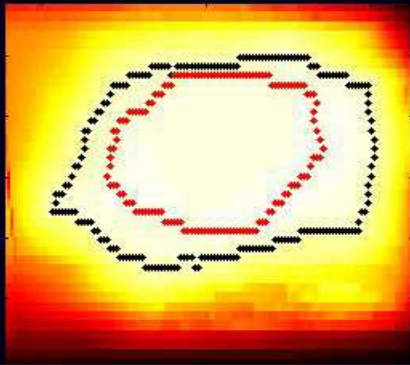
SSD = Sum squared difference
between dose distribution histograms

Dose deformation - results



Dose deformation - results

Mean received dose



Conclusion and further improvements

- Delivered dose estimation
 - Further uses in dose-guided radiotherapy
 - Add dose distributions from different treatment session.

Real voxel tracking based on Finite Element Methods (FEM) should make more physical deformations.