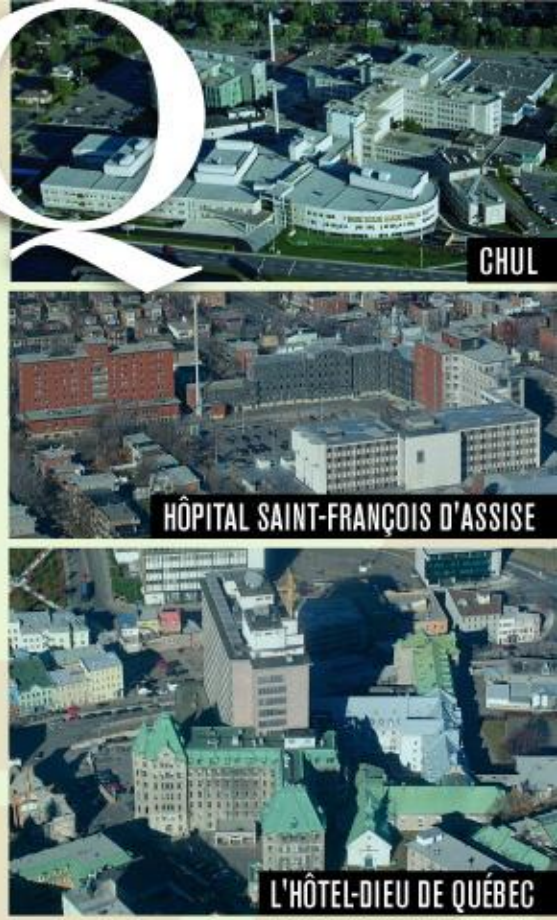
C H U Q



Geant4 Collaboration workshop

Layered Mass Geometry Improvements for Brachytherapy Applications

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Brachytherapy

- The radiation sources are concentrated in the target volume giving optimal absorbed dose inside or near the tumor, while sparing the surrounding healthy tissue
- The radioactive sources used
  - small seeds
  - Wires

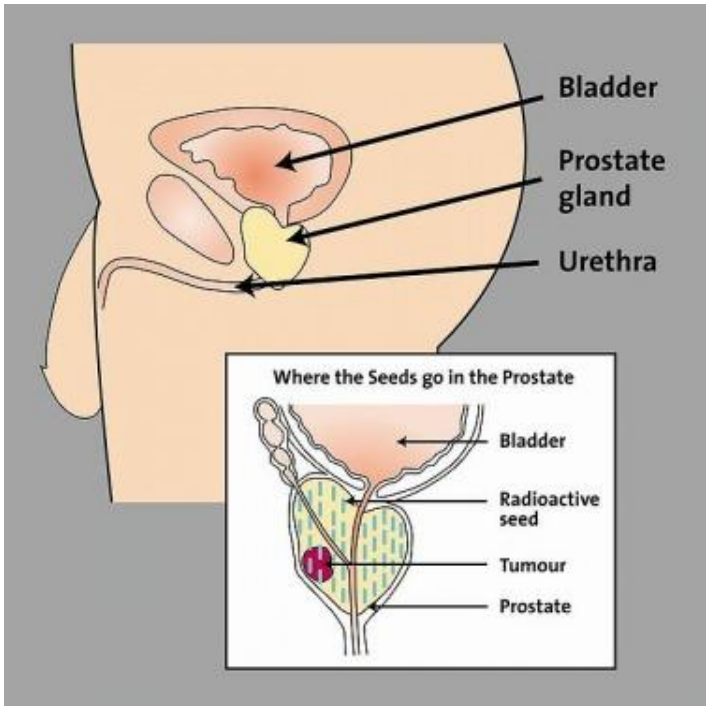

Photo includes stainless steel and Flexiguide™ needles


1


2


3

CT images, contours and seed positions are imported
Via DICOM RT in Geant4



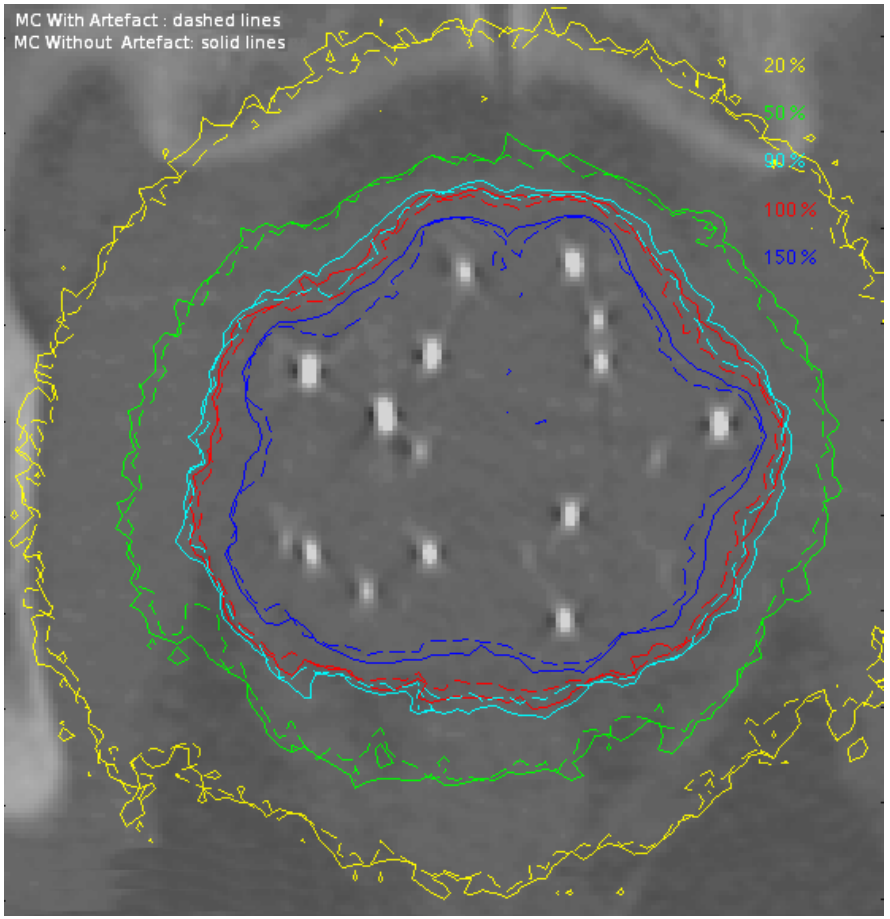
The clinical CT calibration curve are applied to extract voxel densities

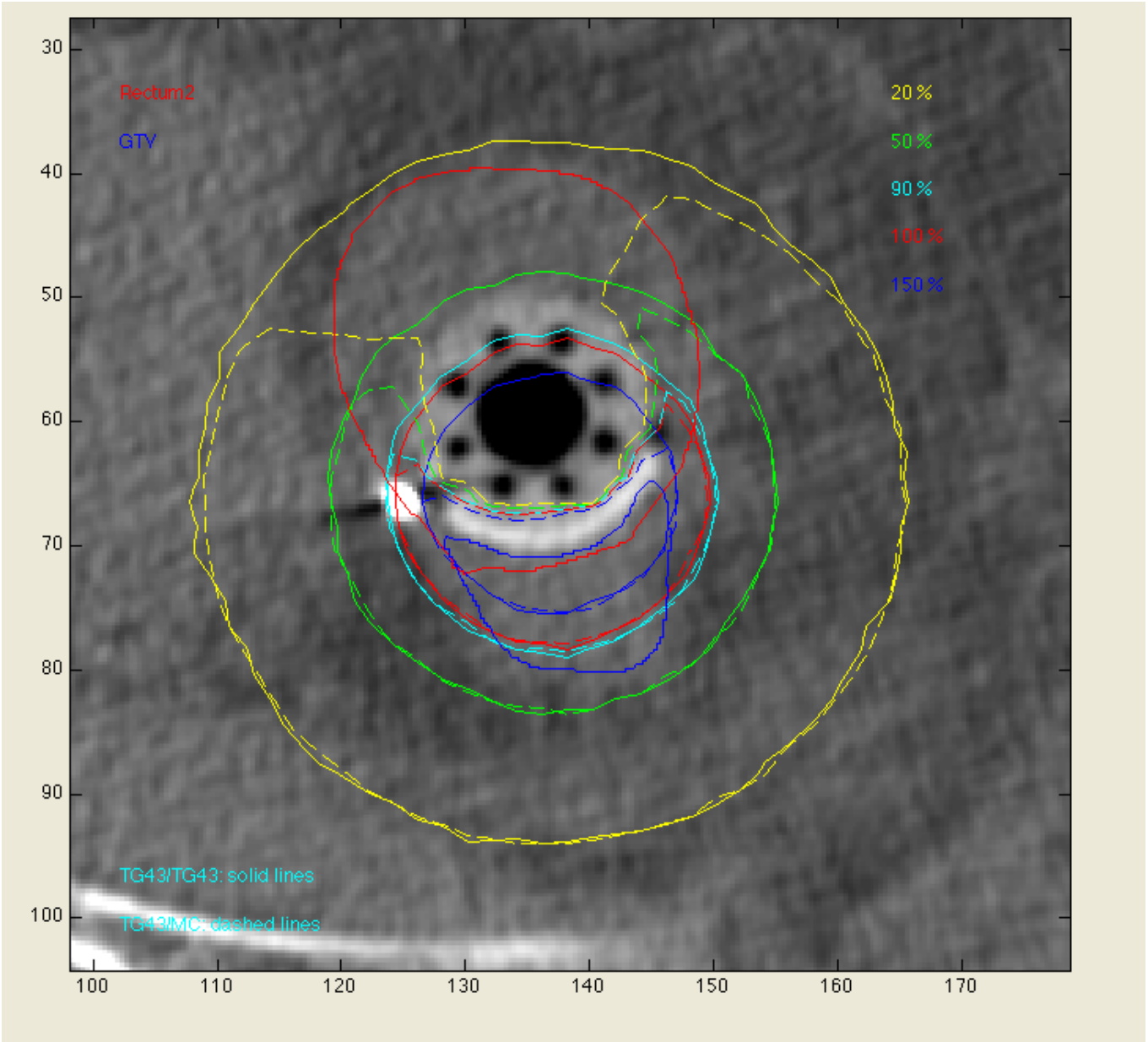
Absorbed dose to prostate, rectum, bladder, urethra and inter-organ tissues are calculated

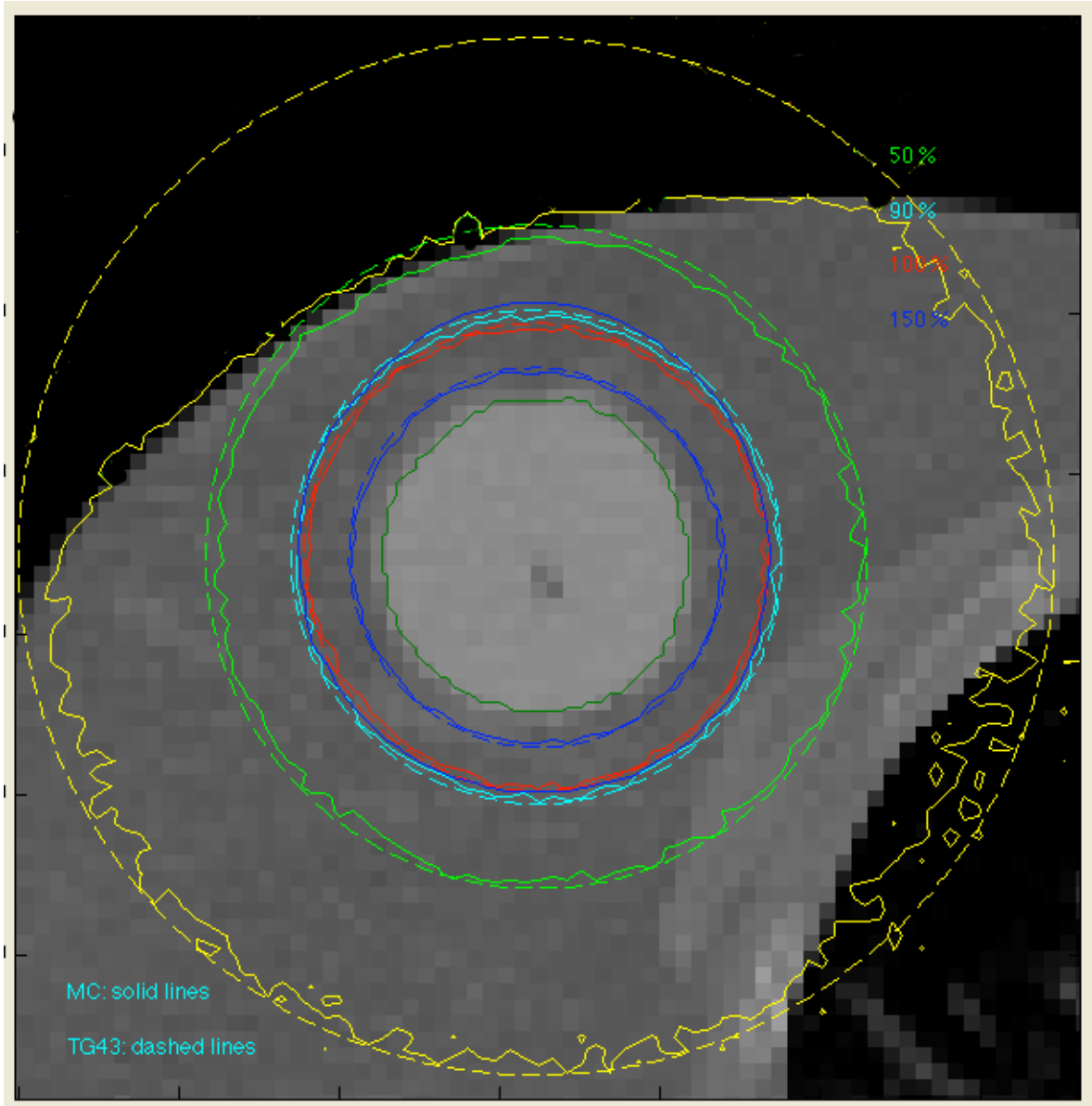
$D_{ww\text{-}TG43}$

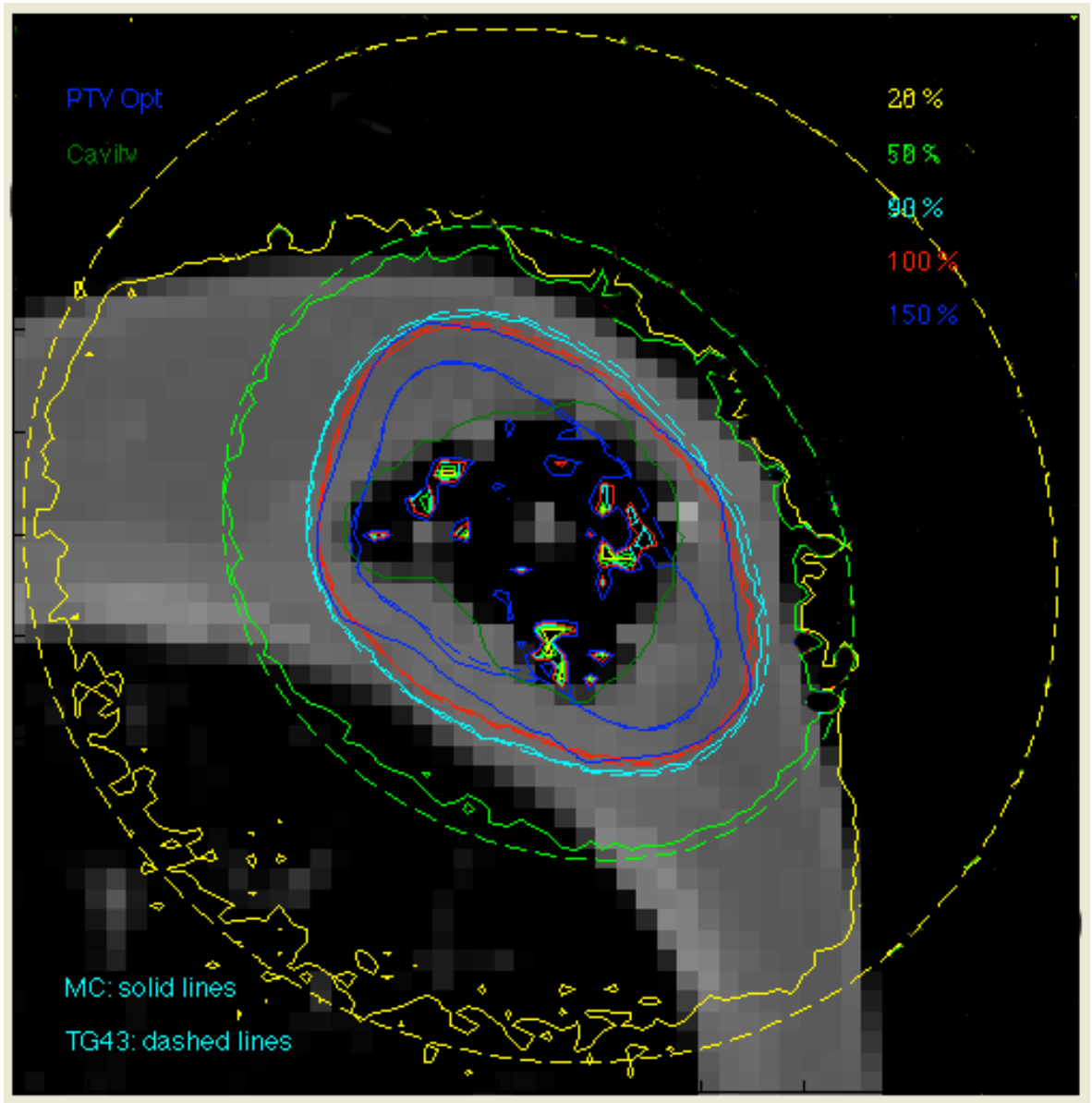
- superposition of single source doses previously calculated in water
- There is no consideration of the composition and distribution of media or the dimensions of individual patients, i.e. heterogeneities are ignored

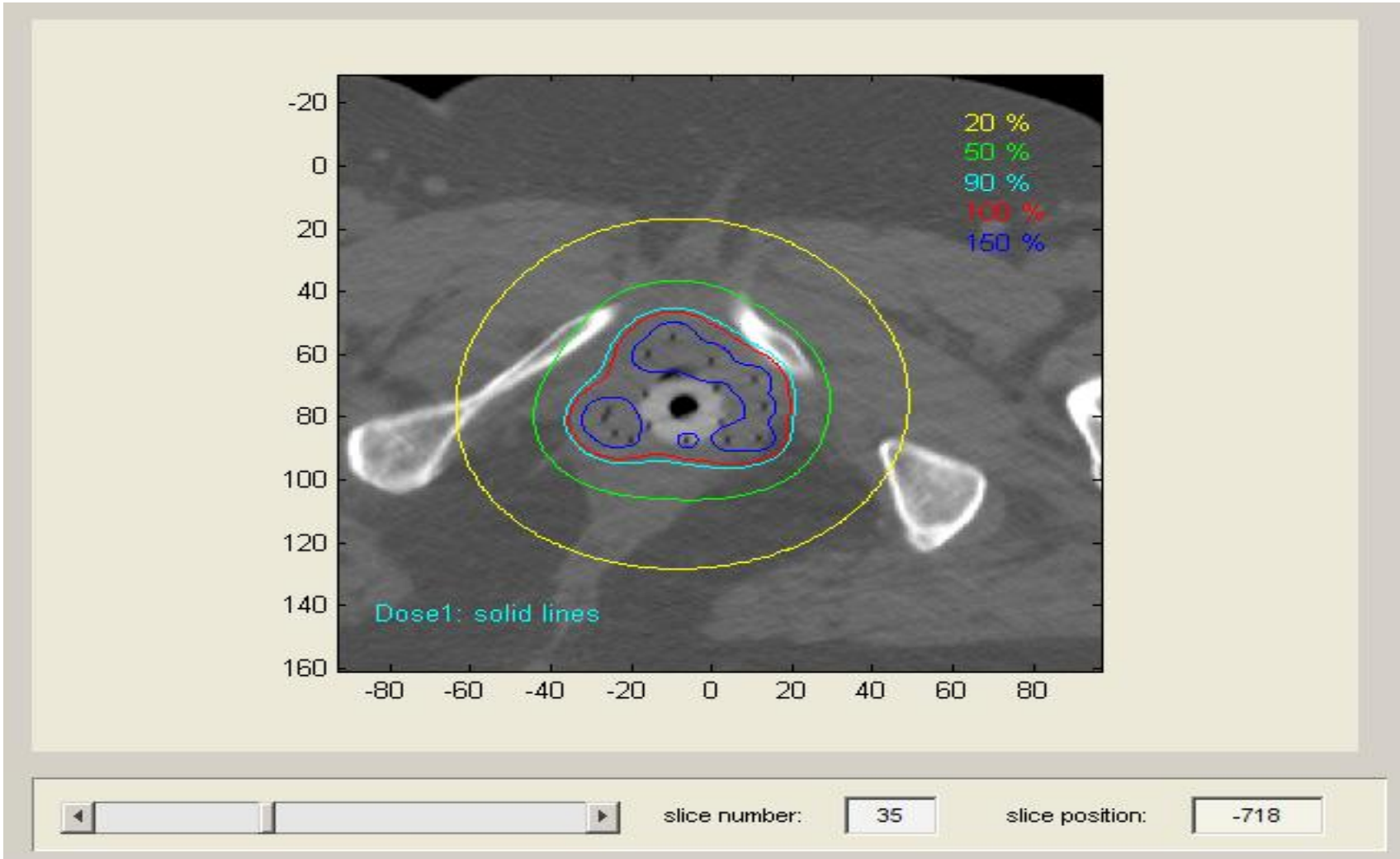

Permanent
Seeds


MC With Artefact : dashed lines
MC Without Artefact: solid lines
20 %
50 %
90 %
100 %
150 %


Rectum2
GTV
20 %
50 %
90 %
100 %
150 %
TG43/TG43: solid lines
TG43/MC: dashed lines
30
40
50
60
70
80
90
100
100
110
120
130
140
150
160
170


50 %
90 %
100 %
150 %
MC: solid lines
TG43: dashed lines


PTV Opt
Cavity
20 %
50 %
90 %
100 %
150 %
MC: solid lines
TG43: dashed lines


20 %
50 %
90 %
100 %
150 %
Dose1: solid lines
-20
0
20
40
60
80
100
120
140
160
-80
-60
-40
-20
0
20
40
60
80
slice number:
35
slice position:
-718

Great things about Geant4

- Complex geometry system
  - Easy* to modelize complex applicator and brachytherapy sources !
- G4PhantomParameterization
  - Low RAM usage.
  - Great CPU speed for navigation.

Applications where we have more than one material definitions in the same voxel

Can not use:

- RegularNavigation
- PhantomParameterization

Only

- G4VPlacement

Improvements:

- Layered mass geometry
  - Extension of parallel geometry
  - Priority to have the choice to travel in the main or parallel geometry
    - For example when applicator/seed/ion chamber are described with a parallel geometry and the particle is inside the applicator/seed/ion chamber it should be given the highest priority and therefore use the cross section from the material it is traveling through.

- A workaround is already developed by the GAMOS project
- GAMOS also brings solutions to various common problems, for example the standard deviation estimator for dose scorer
- It seems to work, but I hope that Medical Physics users could use directly Geant4 instead of a derivative project