Commissioning of a Siemens 160-MLC Geant4 geometry model constructed automatically with an inhouse algorithm

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AIMS OF THE STUDY

- PhD Thesis: Implications on the uncertainties of dose calculations by means of Treatment Planning Systems with extreme density variations, using the Geant4 Monte Carlo (MC) toolkit.

- Main Aim: Commissioning of the 160-MLC™ Geant4 geometry model made by an inhouse algorithm.

- ITEMS OF THE GEANT4 SIMULATION
  - DICOM CLASS
- 160-MLC™
- DEVELOPMENT OF THE CODE
- DOSIMETRIC VALIDATION OF THE 160-MLC™
  - EXPERIMENTAL FIELDS
- RESULTS
- CONCLUSIONS
- WORKGROUP
- REFERENCES

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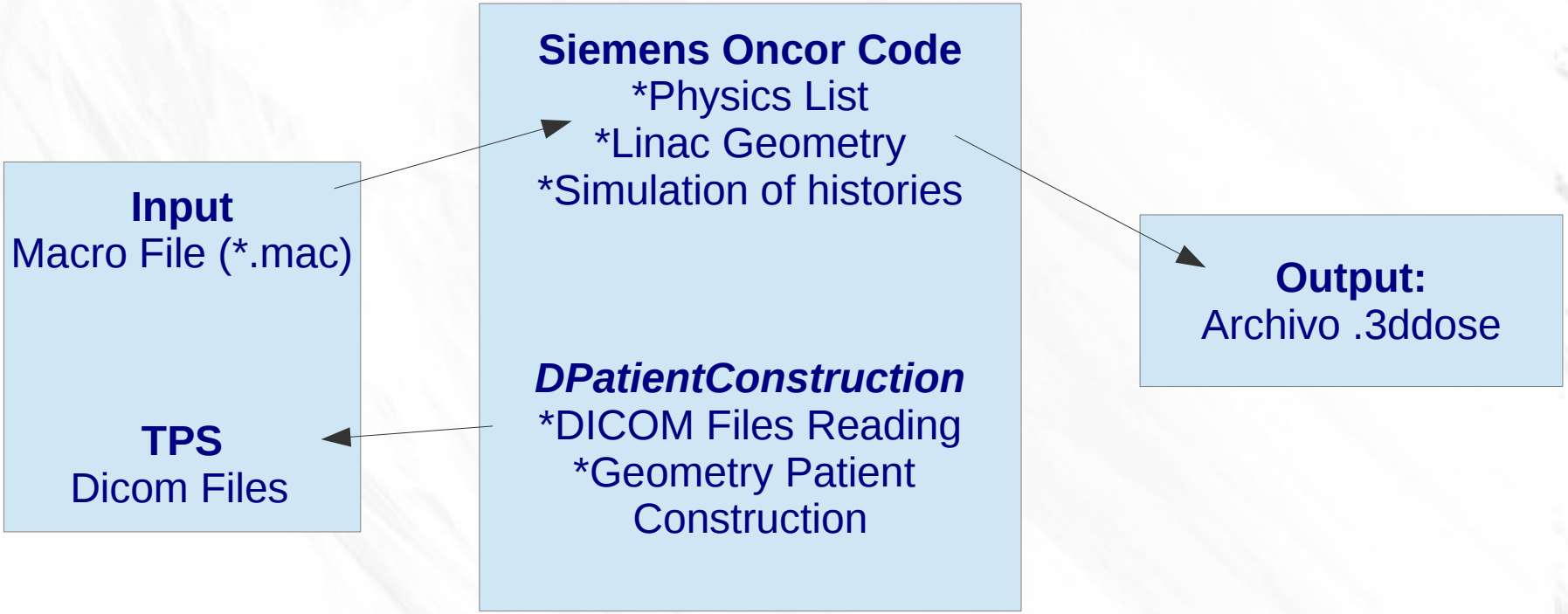
ITEMS OF THE Geant4 SIMULATION



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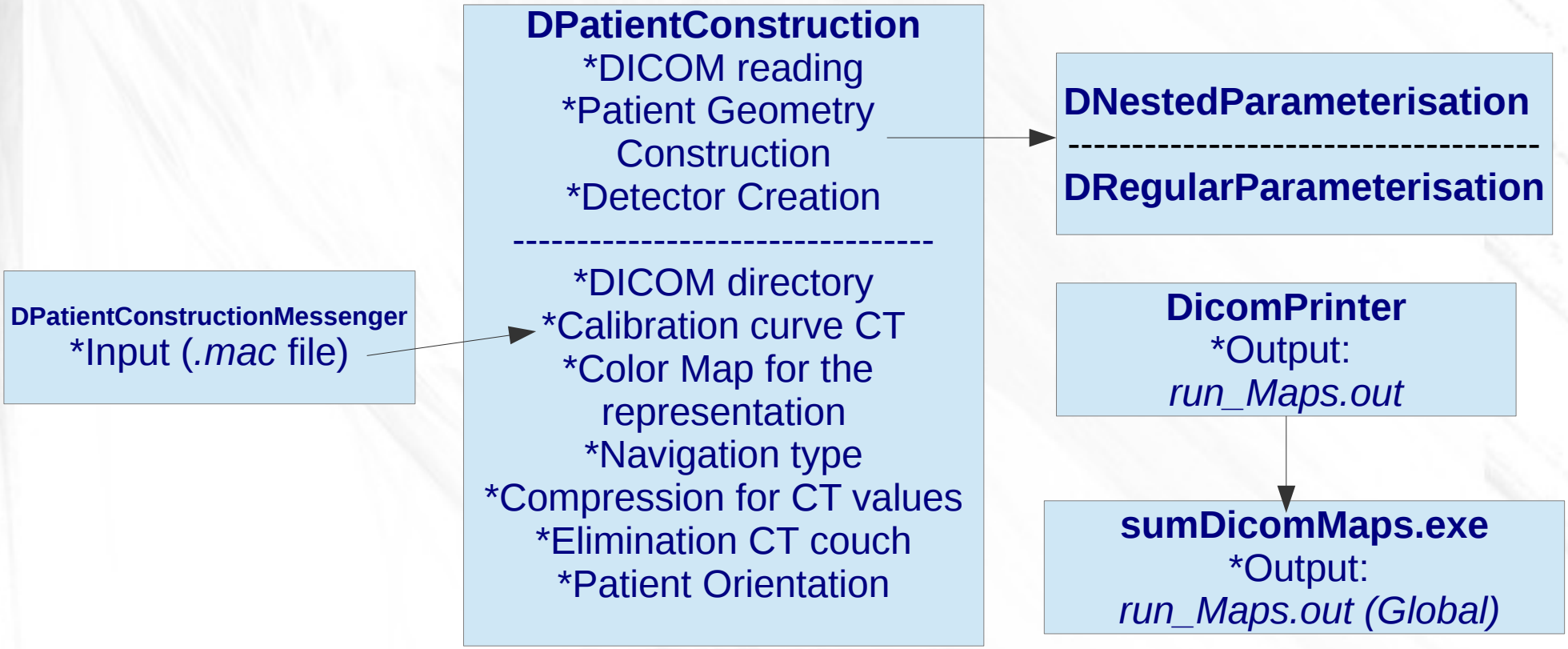
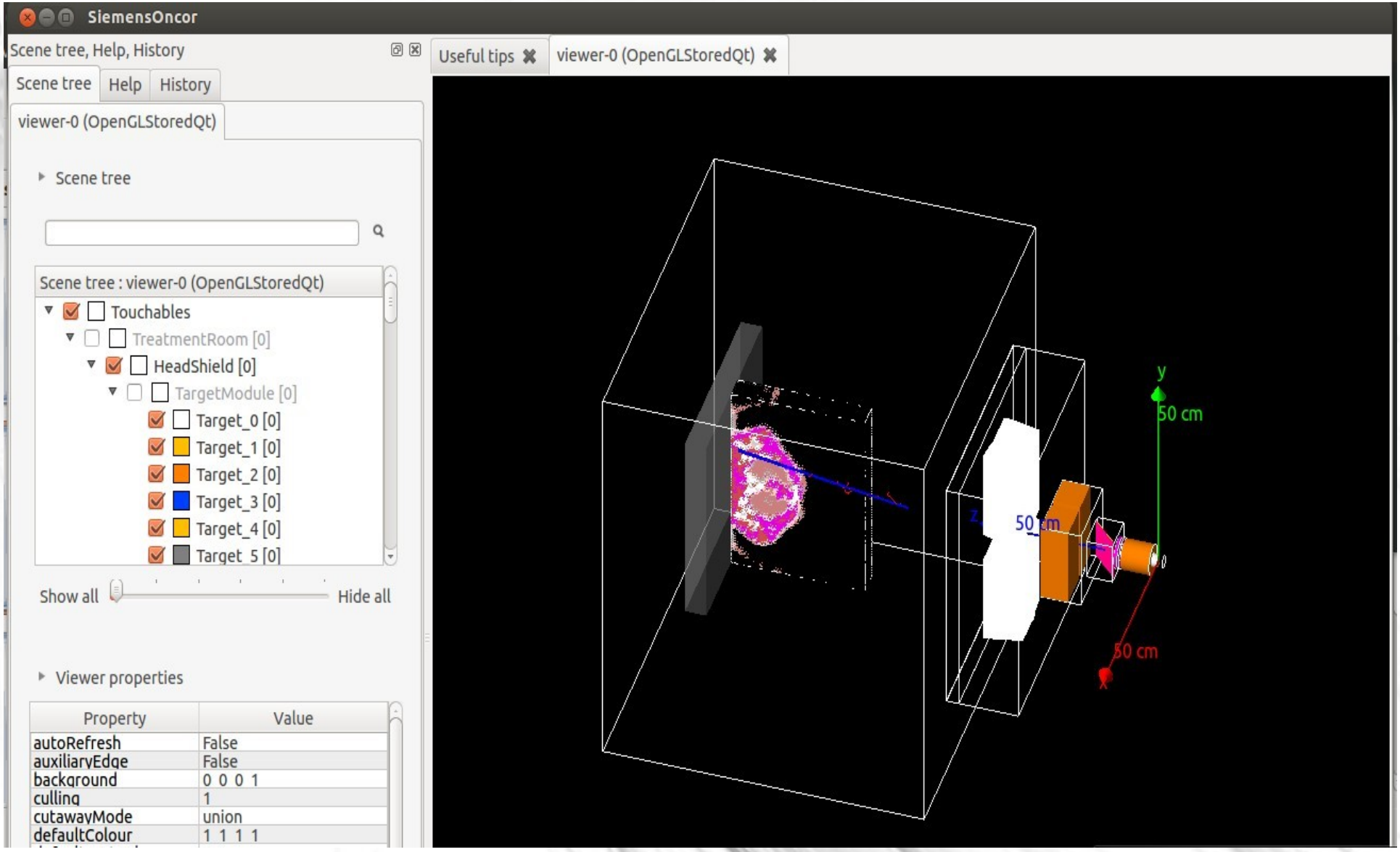
DICOM CLASS

- Class for the reading of Dicom Files and the construction of the patient geometry.



DICOM CLASS


SiemensOncor
Scene tree, Help, History
Scene tree
Help
History
viewer-0 (OpenGLStoredQt)
Scene tree
Scene tree : viewer-0 (OpenGLStoredQt)
Touchables
TreatmentRoom [0]
HeadShield [0]
TargetModule [0]
Target_0 [0]
Target_1 [0]
Target_2 [0]
Target_3 [0]
Target_4 [0]
Target_5 [0]
Show all
Hide all
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autoRefresh
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auxiliaryEdge
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Useful tips
viewer-0 (OpenGLStoredQt)
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50 cm
50 cm
50 cm

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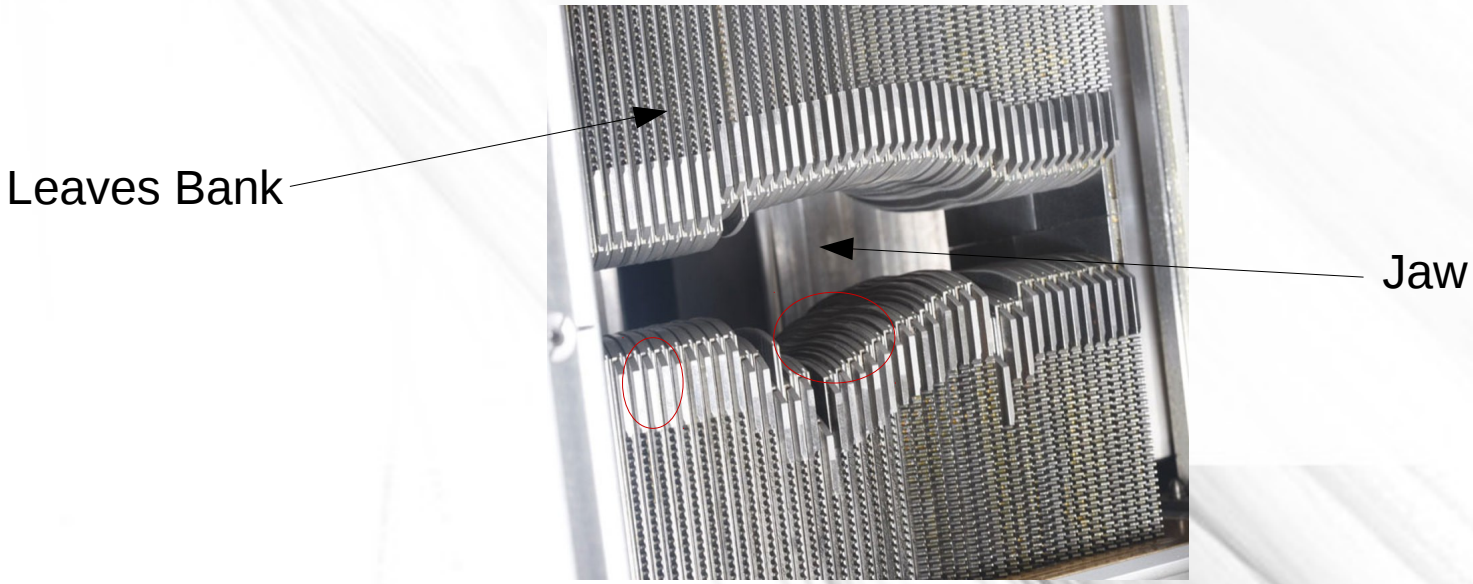
160-MLC™

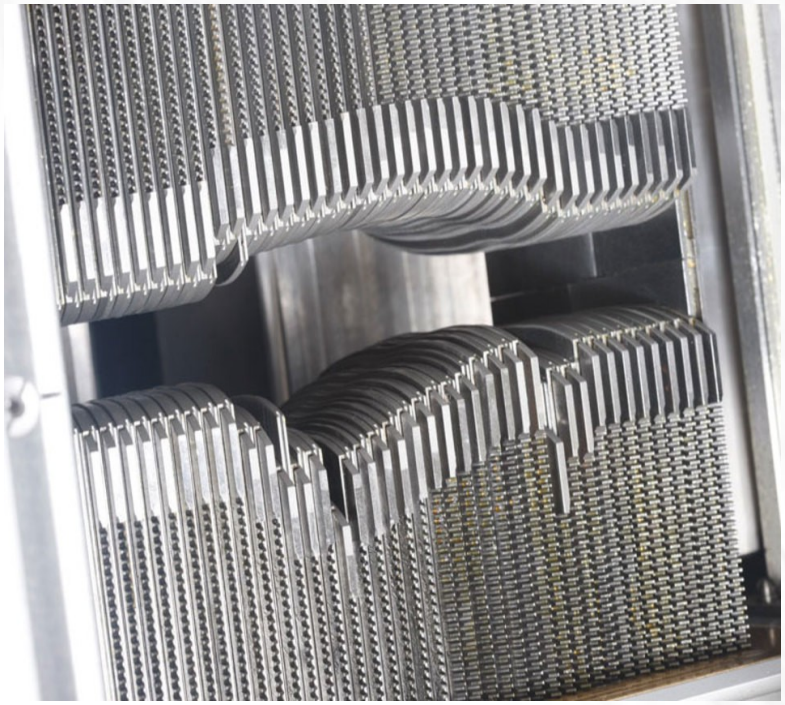
- Made by Siemens Medical Solutions.
- 160 leaves with a width of 5 mm projected at the isocenter plane.
- Leaf ends follow a pattern with alternated concave and convex curvatures.
- Disposition of upper and lower leaves in each bank.



160-MLC™

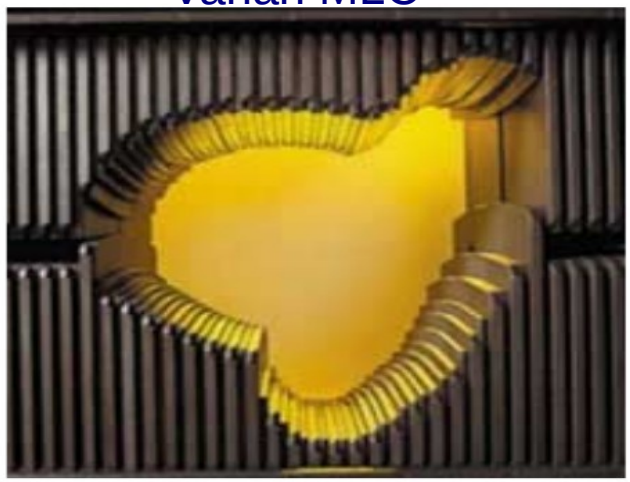
- 160-MLC™ vs Elekta MLC / Varian MLC

160-MLC™



Elekta MLC

Varian MLC



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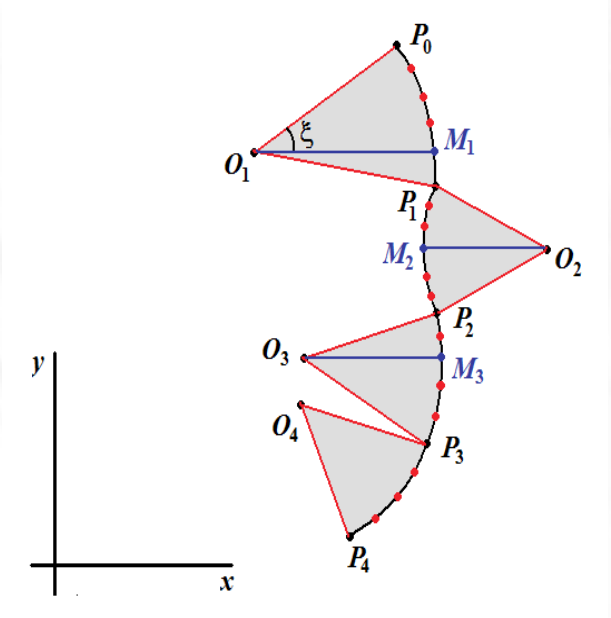
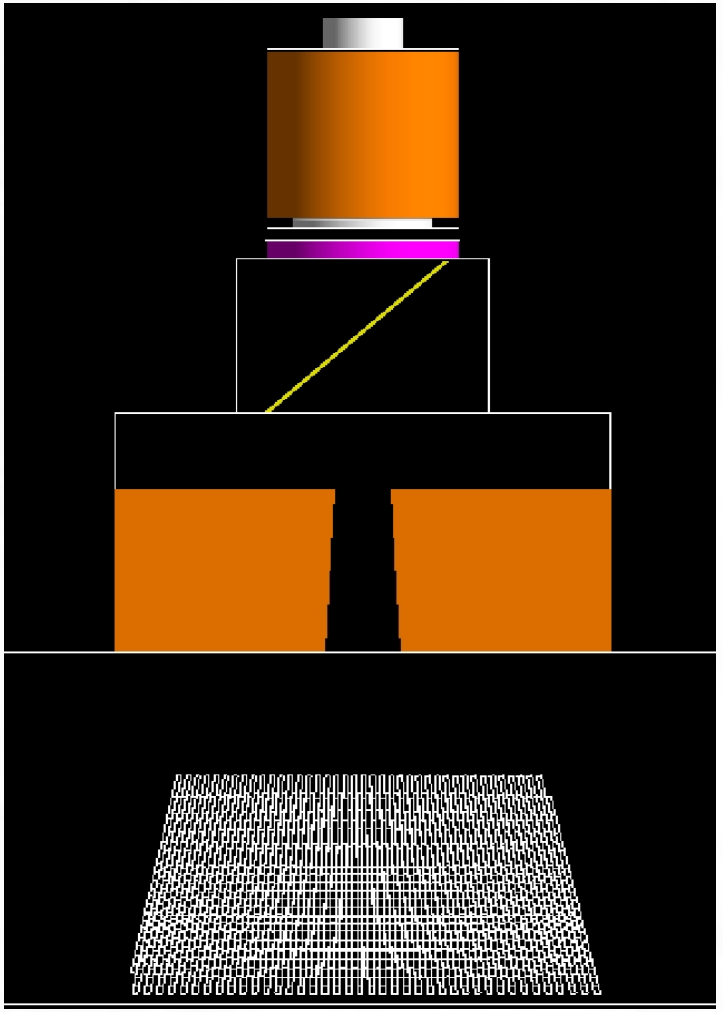
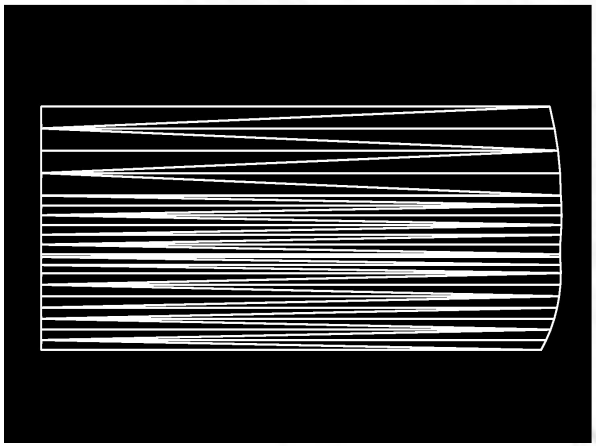
DEVELOPMENT OF THE CODE

- Siemens Oncor MC Simulation
  (M. A. Cortés-Giraldo, “Desarrollos y aplicaciones de Geant4 para radioterapia y microdosimetría en detectores y circuitos integrados”. Tesis Doctoral. Universidad de Sevilla, 2011)
- Commissioning through experimental measurements with 6 MV photons.
- Geometry model for its multileaf collimator (MLC) 160-MLC™.
- Sub-milimetric accuracy.

DEVELOPMENT OF THE CODE







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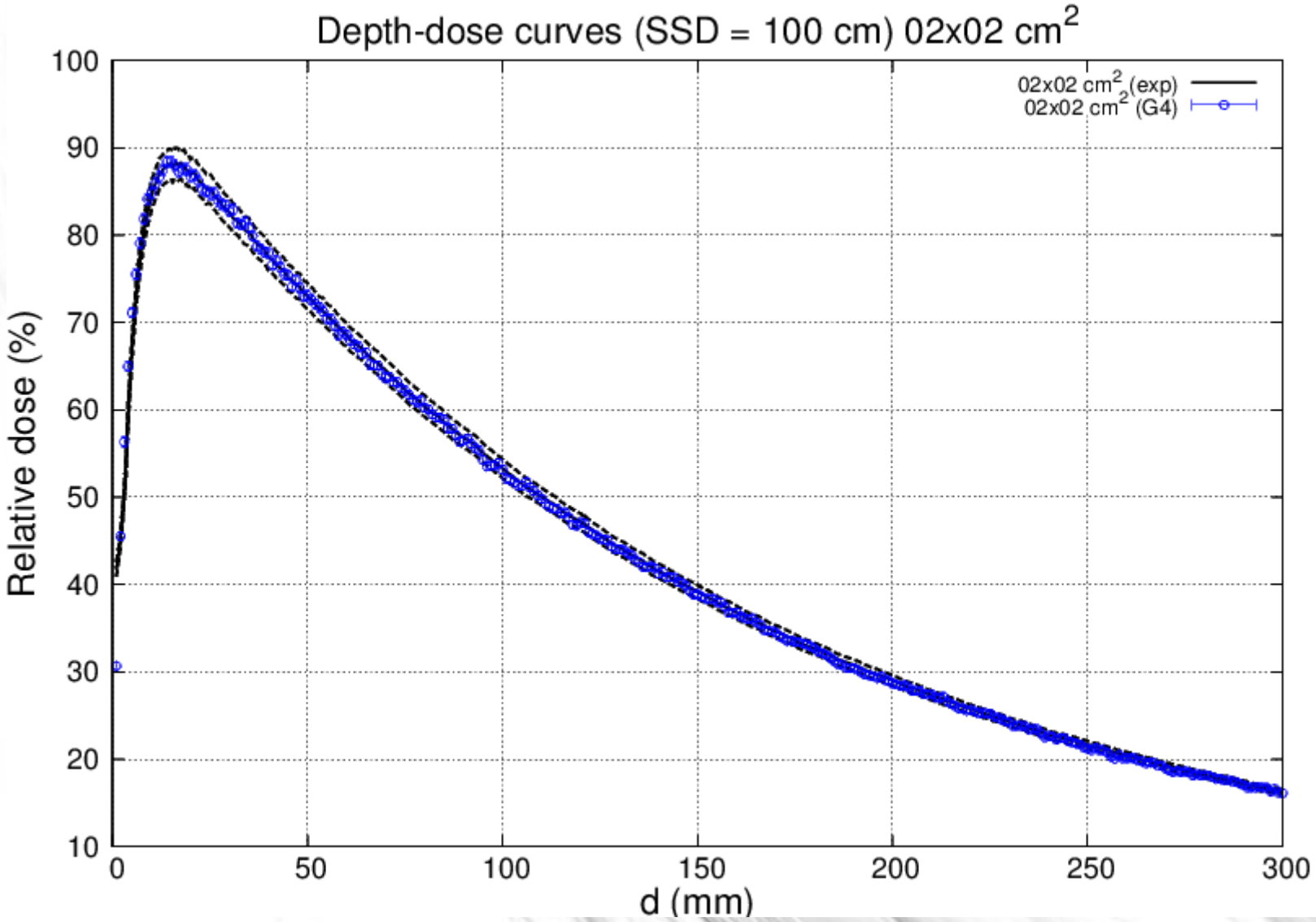
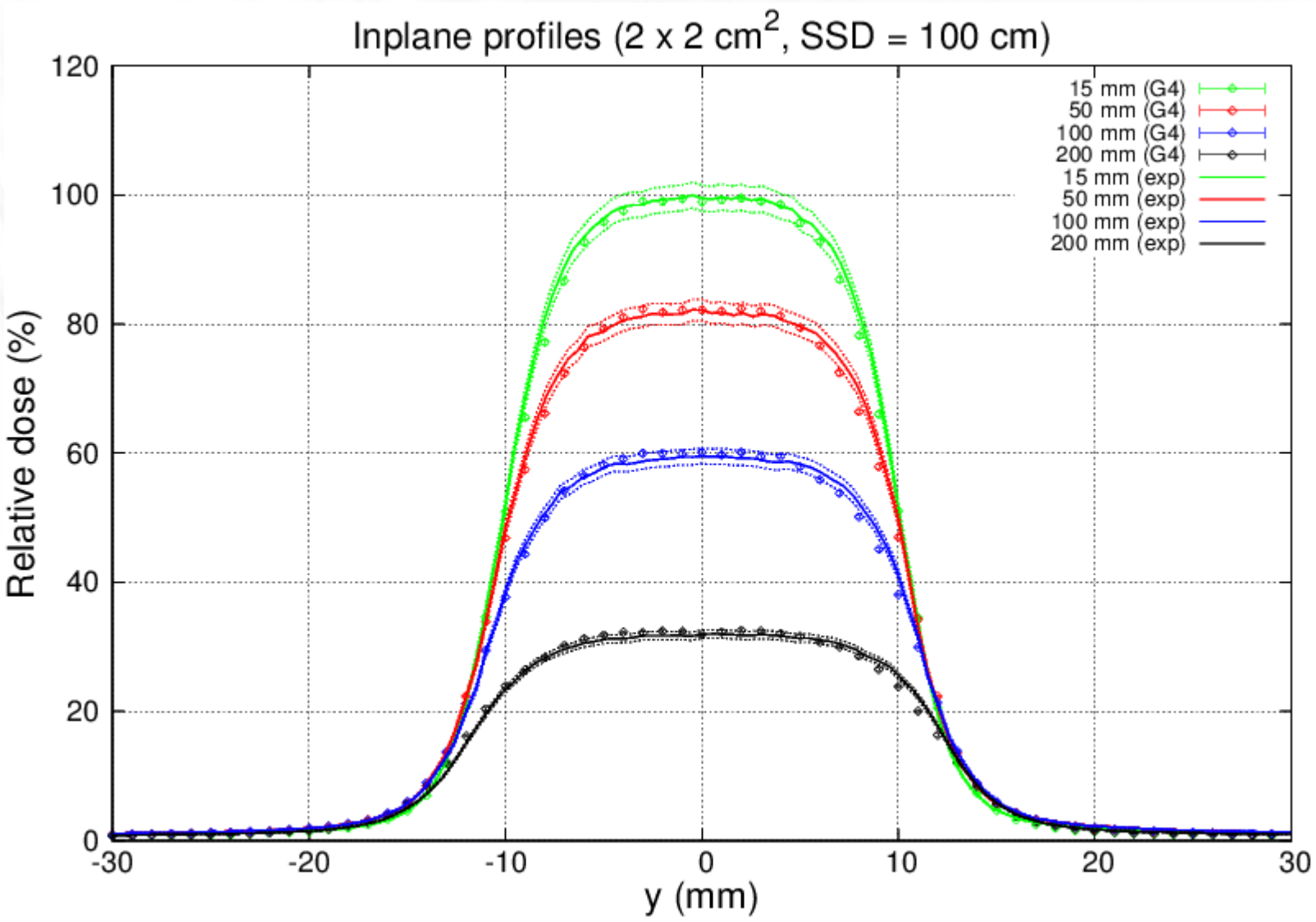


DEVELOPMENT OF THE CODE



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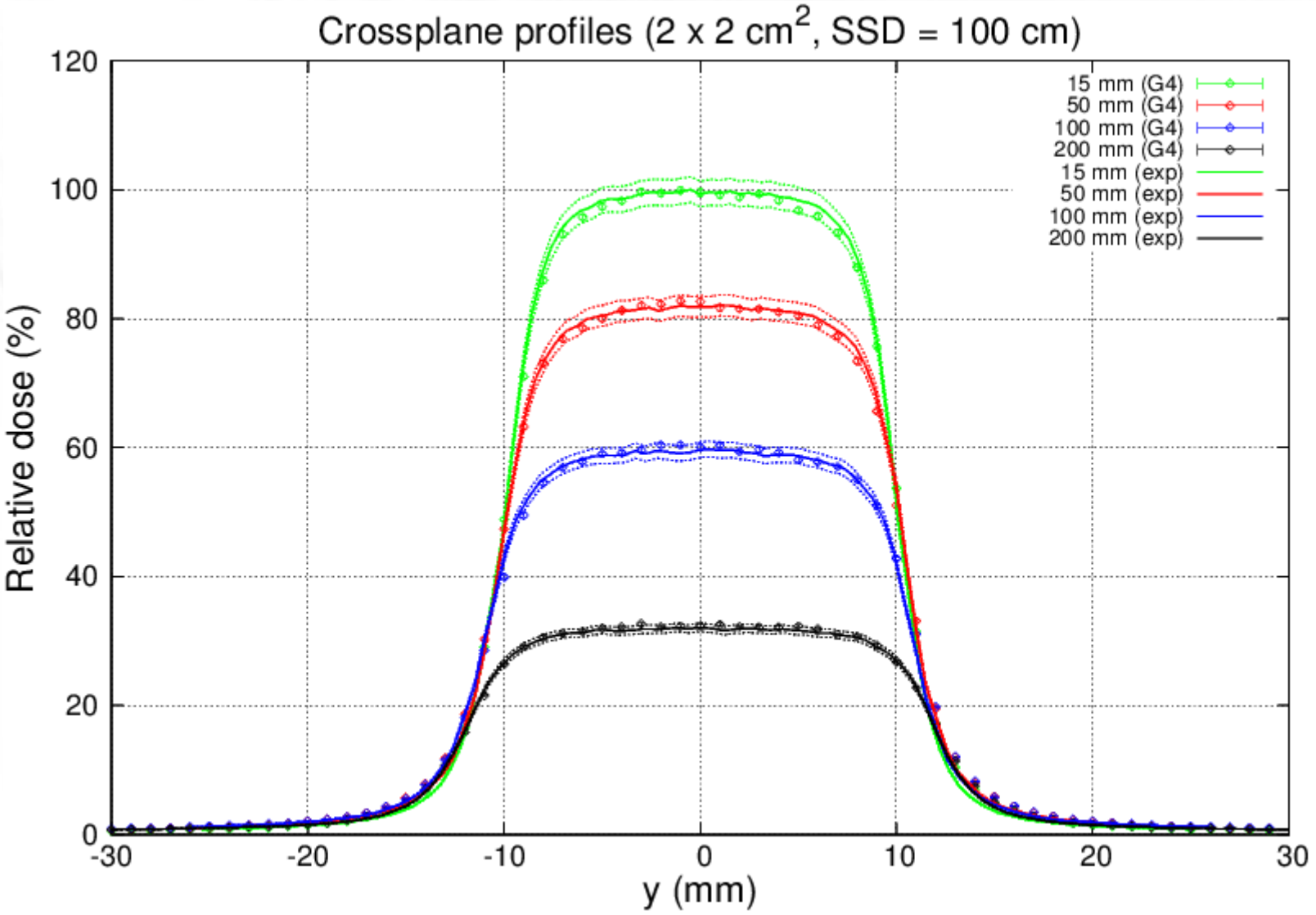

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DOSIMETRIC VALIDATION OF THE 160-MLC™

- Experimental measurements with radiochromic film and water solid phantom slabs.

- Three dosimetric tests for the study of the following parameters: (1) tilt angle, (2-3) intra- and interleaf leakage profile, (4) distance between opposite leaves for a closed MLC disposition and (5) leaf end.

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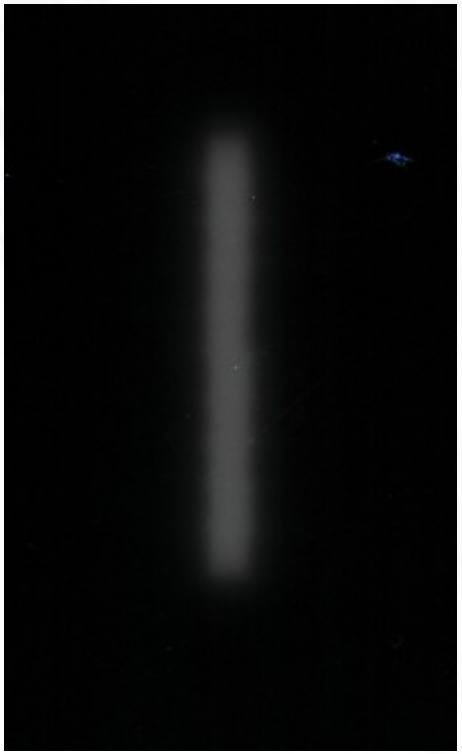
EXPERIMENTAL FIELDS

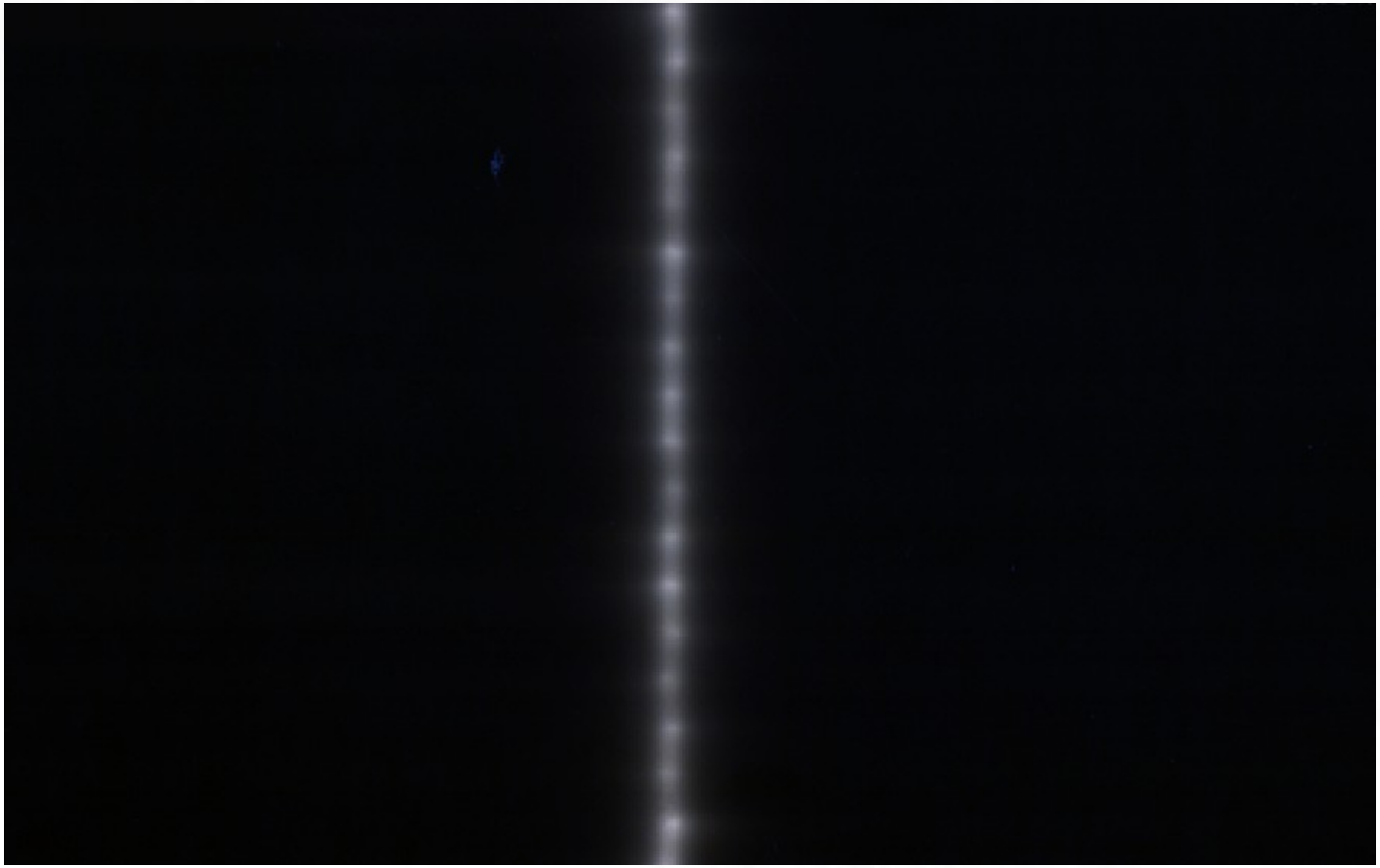
- Leaf-Ends Field



* 200 MU
* SDD = 100 cm
* z = 1.5 cm
* z_{red} = 9 cm
* X_{bank1} = - 2.5 mm ;
  X_{bank2} = 2.5 mm
* Y_{Jaw1} = 5 cm ;
  Y_{Jaw2} = - 5 cm

EXPERIMENTAL FIELDS

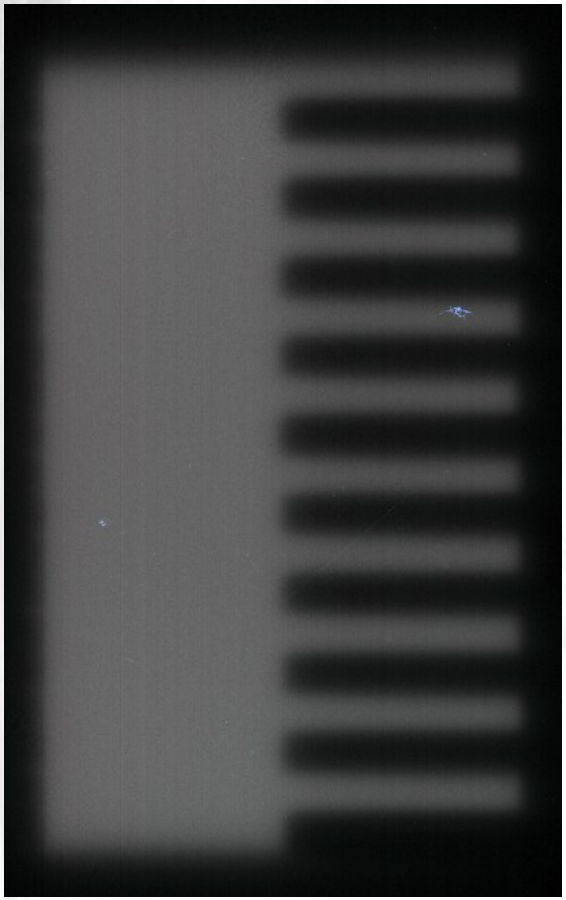
- Transmission Field



* 5000 MU
* SSD = 100 cm
* z = 1.5 cm
* z_{red} = 9 cm
* MLC closed
* Jaws fully open

EXPERIMENTAL FIELDS

- Picket Fence



Even Leaves Field

+

Odd Leaves Field

* 200 MU per field
* SDD = 100 cm
* z = 1.5 cm
* z_{red} = 9 cm
* Even Field. X_{even} = 0 cm ; X_{odd} = -3 cm
* Odd Field. X_{odd} = 0 cm ; X_{even} = -3 cm
* Y_{Jaw1} = 5 cm ; Y_{Jaw2} = -5 cm

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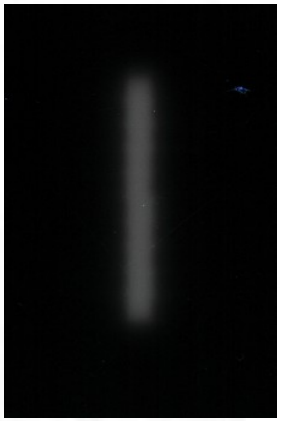
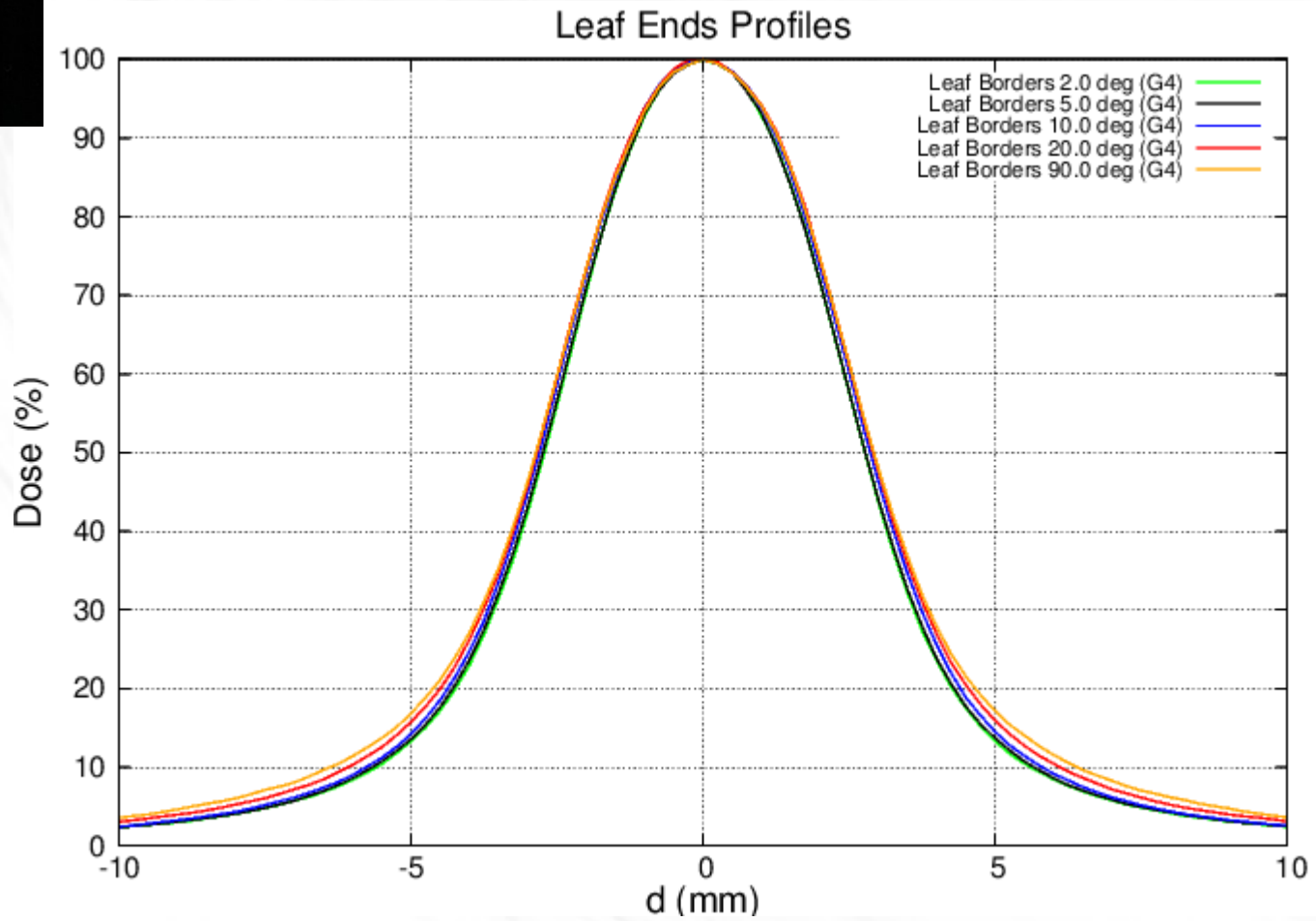
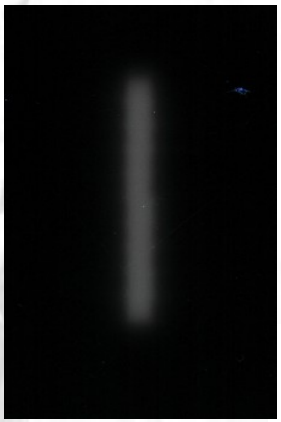


RESULTS

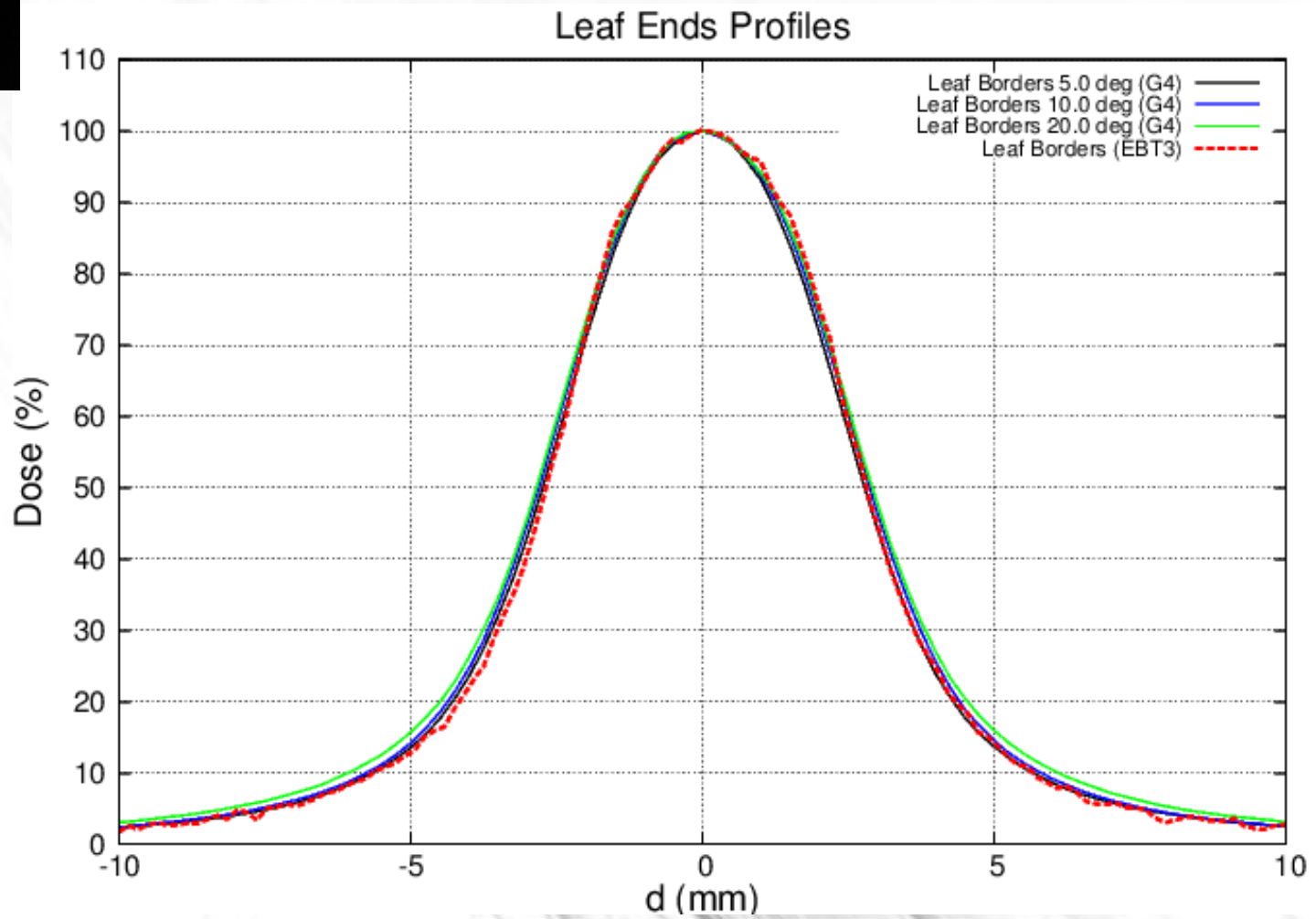
- Leaf ends

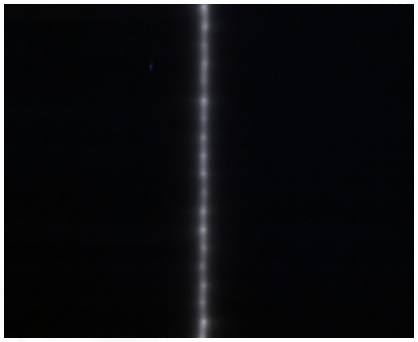




RESULTS

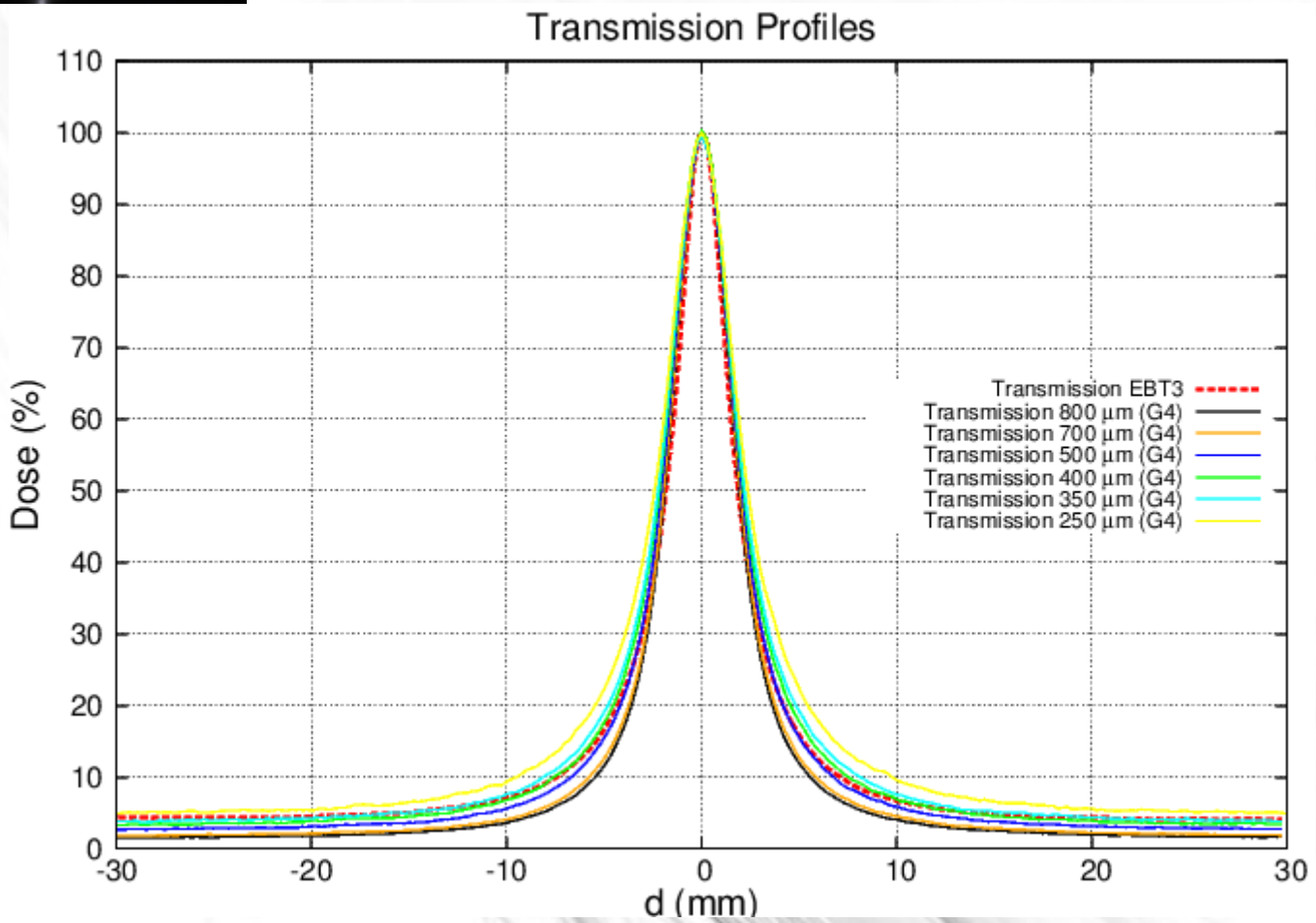
- Leaf ends

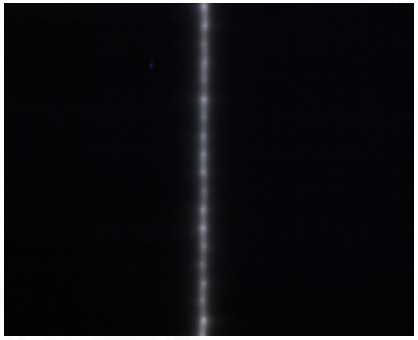




RESULTS

- Transmission Field





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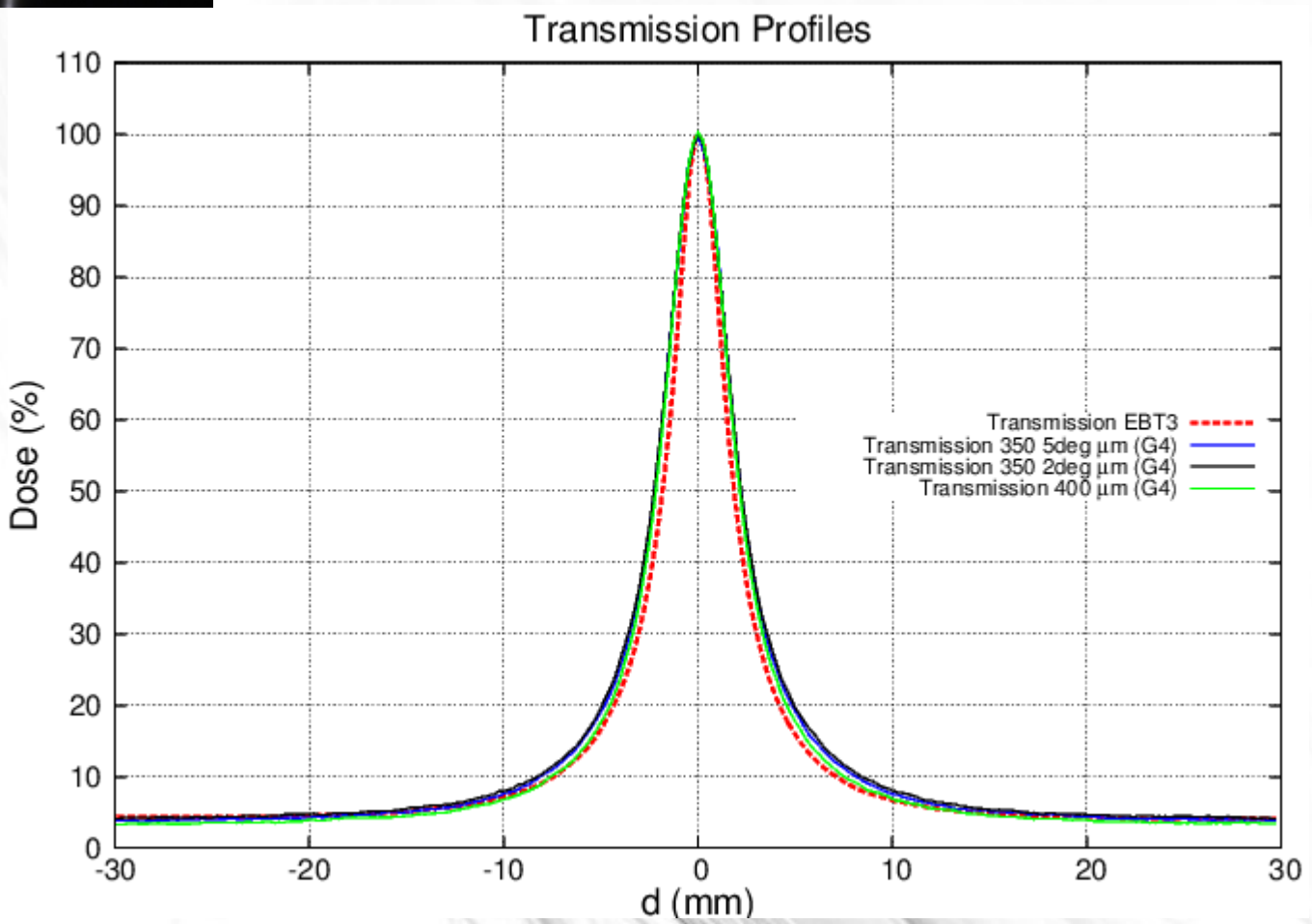
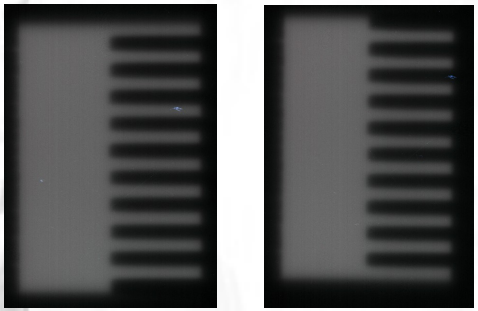
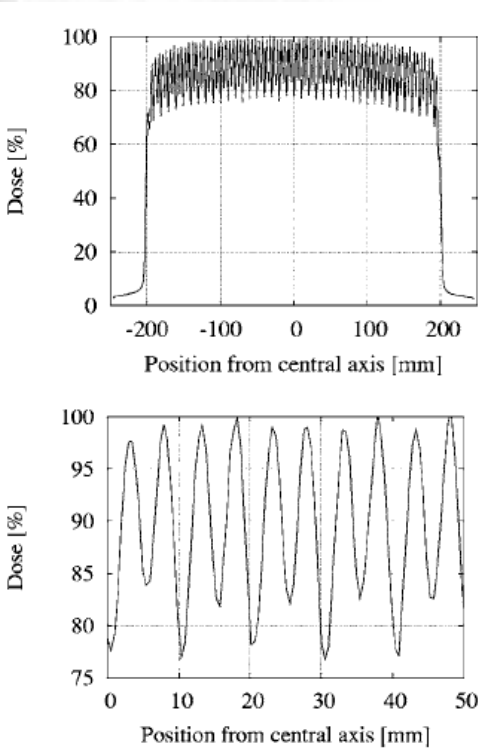


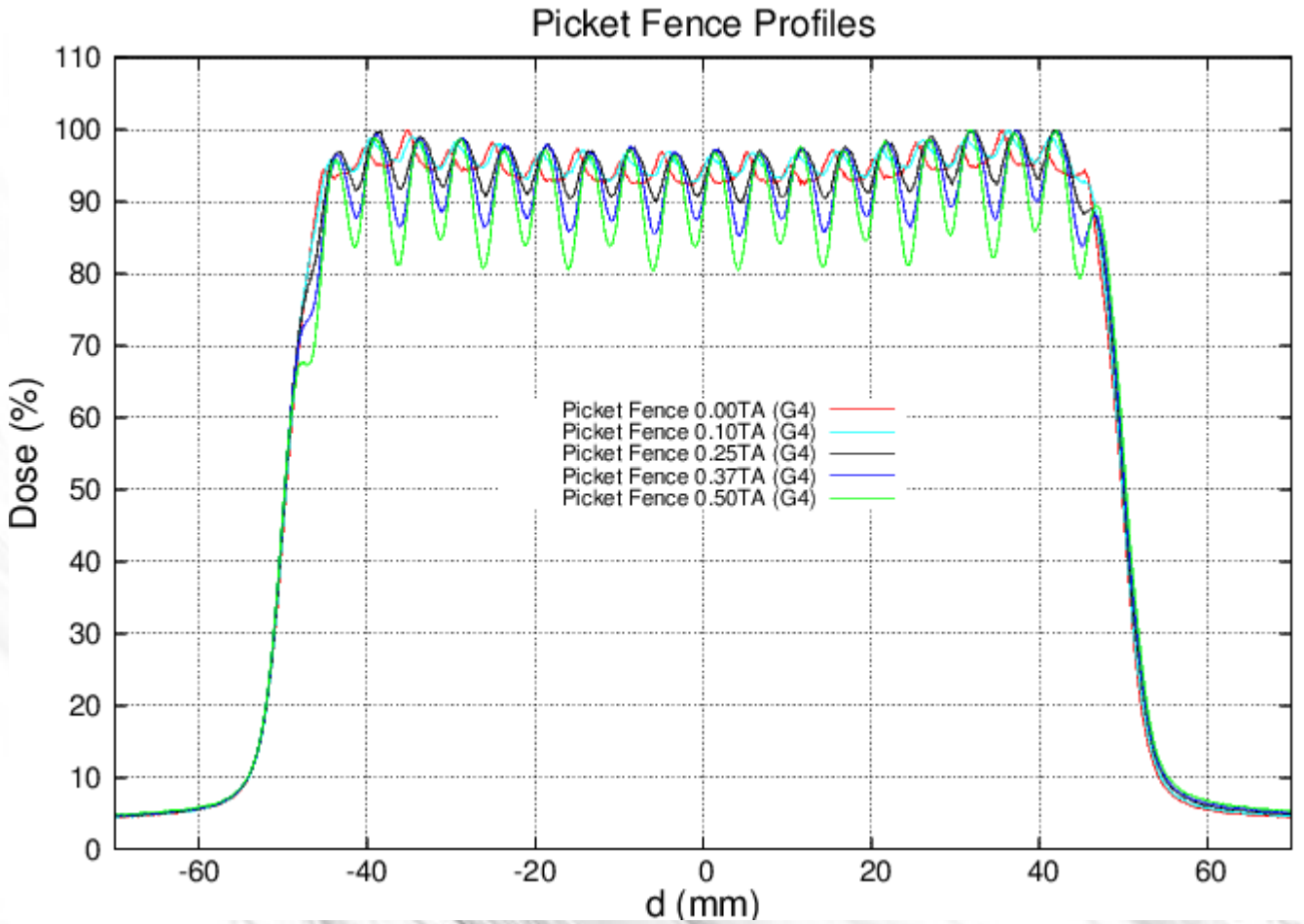


RESULTS

- Picket Fence



Tacke et al. (2006)



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CONCLUSIONS

- We have created a tool which allows us to obtain dose distributions with a submilimetric spatial accuracy.
- Dosimetric validations of MLCs as complex as 160-MLC^{TM} can be done.
- Clinical impact of the parameters.
- Mechanical tolerance of the MLC.
- To-do list:
  - Study of the parameters relation involved in the Geant4 calculations.
  - Other comparisons experimental measurements vs Geant4 data.

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WORKGROUP

- GETERUS (Grupo de Estudio del Transporte y Efectos de la Radiación de la Universidad de Sevilla). Dpto. De Física Atómica, Molecular y Nuclear.

- Proyecto Junta de Andalucía P12-FQM-1605 (Dosivrad).
- Proyecto MINECO FPA2014-53290-C2-2-P.

REFERENCES

* S. Agostinelli, et al. “Geant4: A simulation toolkit”, Nucl.Instrum.Meth. A 506 (2003) 250-303.

* M. A. Cortés-Giraldo, Tesis Doctoral. Universidad de Sevilla (2011).

* M. B. Tacke, et al. “Assessment of a new multileaf collimator concept using Geant4 Monte Carlo simulations ”, Medical Physics. Vol. 33(4), (2006) 1125-1132.

* R. Arráns, et al. “Dosimetría con películas radiocrómicas”, Rev. Fis. Med.Vol. 10(2), (2009) 83-104.