

Monte Carlo and Dosimetry
for Medical Physics
RESEARCH GROUP



INTERPOLATION STUDIES OF A 3D DOSIMETRIC SYSTEM FOR QUALITY ASSURANCE IN RADIATION THERAPY

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INTRODUCTION

- Evolution of RT techniques; accurate; VMAT;
- VMAT: MLC, dose rate and rotation speed;
- Quality assurance: improve in order to ensure the proper functioning of the system;
- ArcCHECK: QA for VMAT and Tomotherapy;
- ArcCHECK: QA and patient-specific QA.



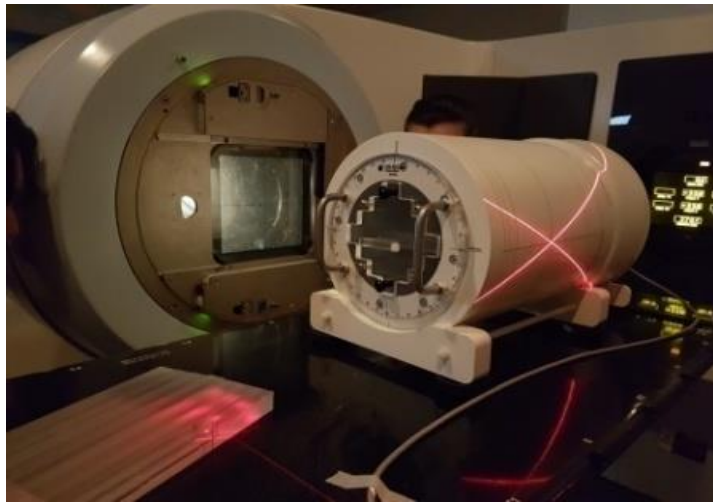
Fig. 1: QA performed at Mater Dei hospital using ArcCHECK.

OBJECTIVE

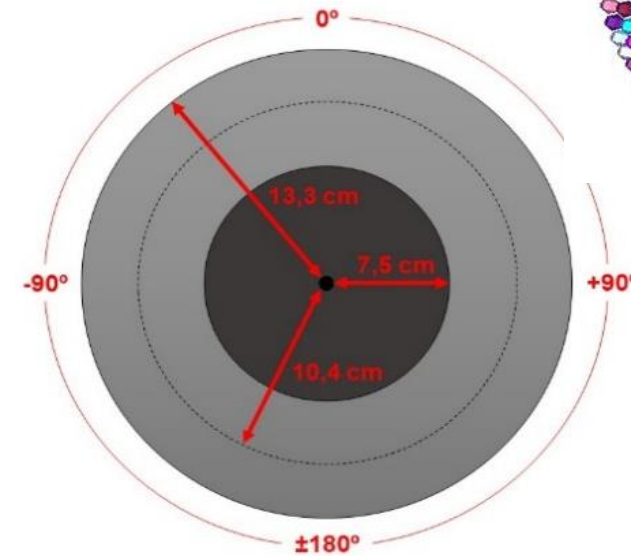
- The scope of this work is to develop an algorithm to evaluate the influence of different dose interpolation methods on the dataset acquired by ArcCHECK.

MATERIALS AND METHODS

- ArcCHECK:
 - 1386 diodes; PMMA;
 - Radius;
 - Sensitive area: 0.64 mm^2 ; volume: 0.0019 mm^3 ; accurate.



(a)



(b)



Fig. 2: (a) ArcCHECK during a day of measurements at BP hospital; (b) representation of the radial distances of ArcCHECK.

MATERIALS AND METHODS

- ArcCHECK:
 - 2D plane: 21x66;
 - Data corrections, interpolation: 41x131 (5371 points);
 - At BP: 10x10 cm² photon static field, 100 MU, 6 MeV.

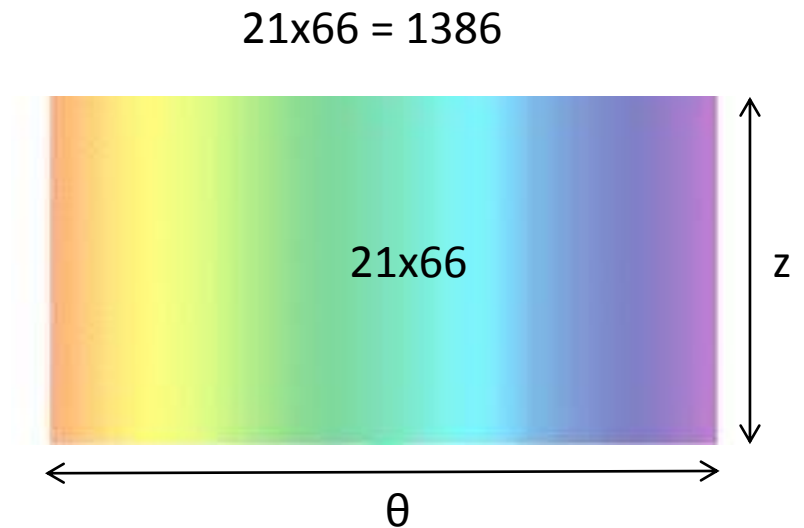
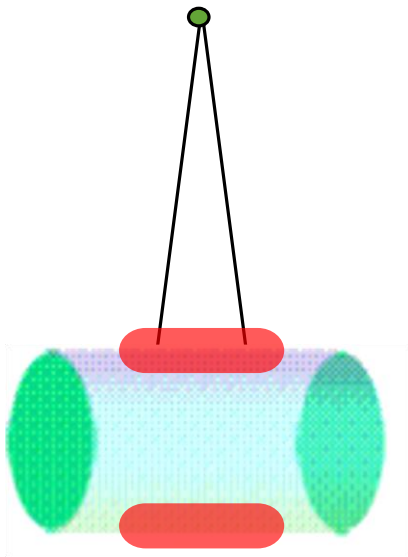


Fig. 3: Dose map acquisition illustration.

MATERIALS AND METHODS

- Monte Carlo simulation:
 - MCNP6: ArcCHECK model;
 - In the location of the diodes: a cylindrical shell-shaped mesh;
 - Dose values: 21x66 (1386) and 41x131 (5371) volumes.

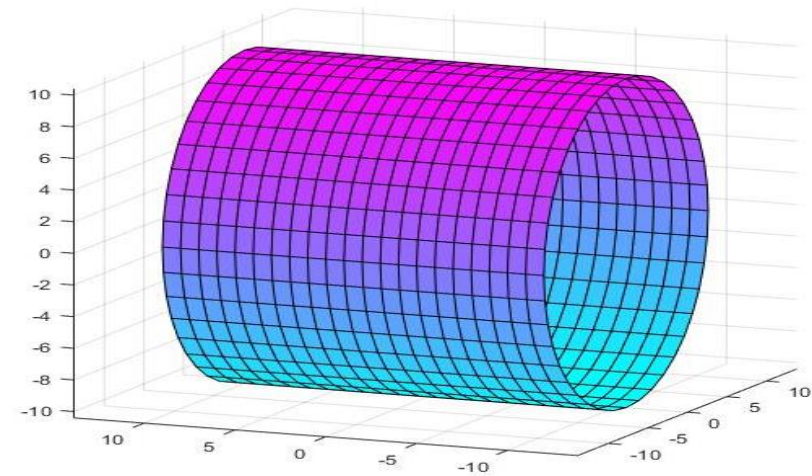


Fig. 4: Illustration of a 3D cylindrical shell-shaped mesh.

MATERIALS AND METHODS

➤ Interpolation:

- Evaluate the influence of dose interpolation: algorithm in MATLAB;
- 2D positions: dose values; 41x131;
- Inverse Distance Weighting (IDW) interpolation method; four nearest neighbor points;
- Relative difference.

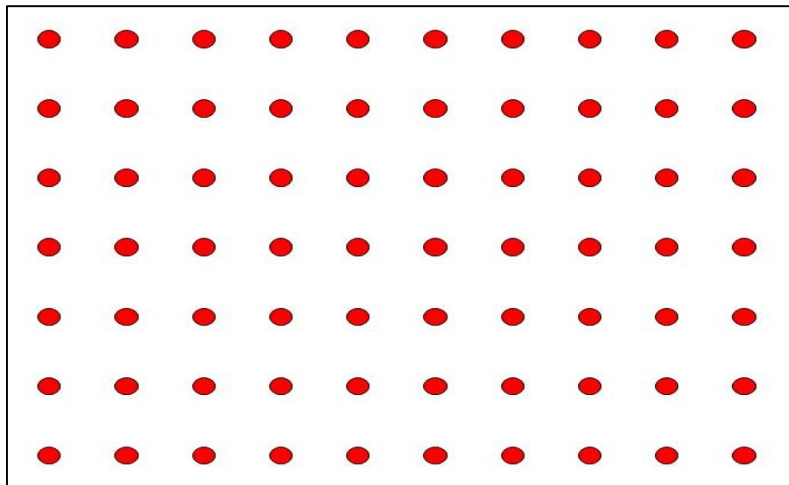


Fig. 5: Positions for the dose values in the algorithm.

$$D_{int} = \begin{cases} \frac{\sum_{i=1}^N \frac{D_i}{[(x_i - x)^2 + (y_i - y)^2]}}{\sum_{i=1}^N \frac{1}{[(x_i - x)^2 + (y_i - y)^2]}}, & \text{if } x_i \neq x \text{ or } y_i \neq y \\ D_i, & \text{if } x_i = x \text{ and } y_i = y \end{cases}$$

$$Diff = \left[\left(\frac{M_{int}}{M_{ref}} \right) - 1 \right] * 100$$

RESULTS AND DISCUSSION

- Algorithm validation:
 - 21x66 data: interpolated using the algorithm developed;
 - Relative dose difference: 21x66 interpolated / 41x131;
 - Very small, except for a few points in the penumbra region;
 - Validated.

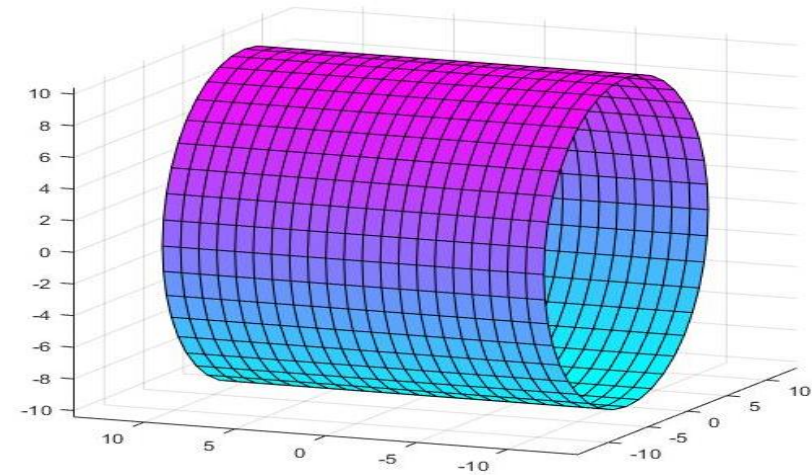


Fig. 4: Illustration of a 3D cylindrical shell-shaped mesh.

RESULTS AND DISCUSSION

- Application to ArcCHECK data:
 - Crude dose ArcCHECK matrix interpolated in MATLAB / matrix interpolated by ArcCHECK;
 - Difference: 110% by one or two points;
 - Edges of the field: $\pm 30\%$, due to the interpolation method; shear.

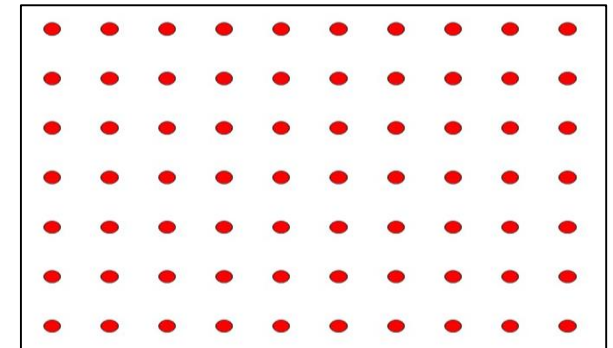
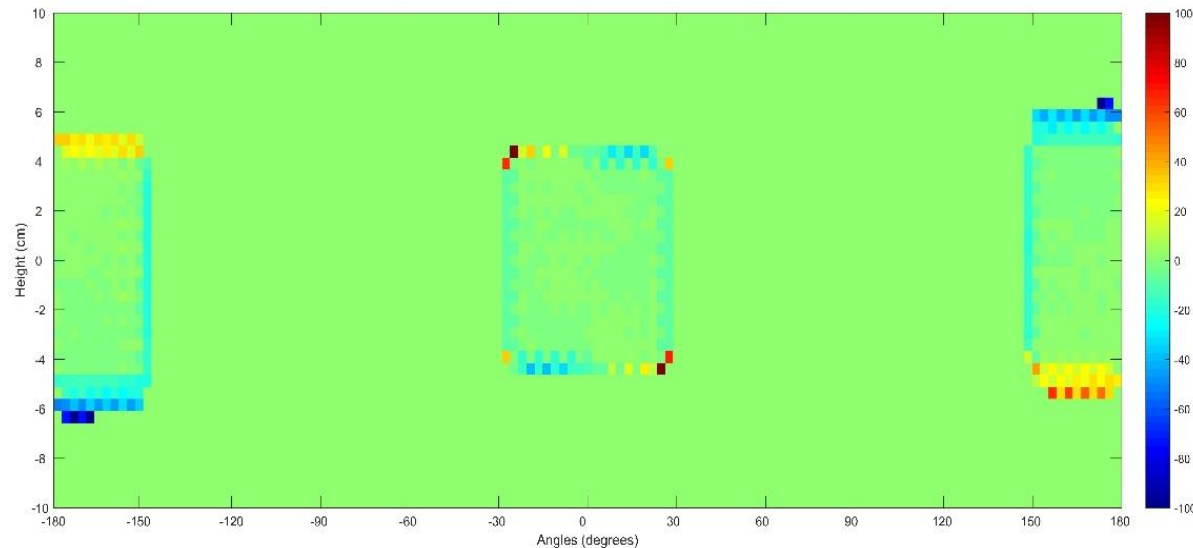


Fig. 6: Map of the difference between the data interpolated in MATLAB and the data interpolated by ArcCHECK.

RESULTS AND DISCUSSION

- Application to ArcCHECK data:
 - When adjusting the color scale...
 - Effect not observed in simulated meshes;
 - Due to the interpolation method used by the ArcCHECK software.

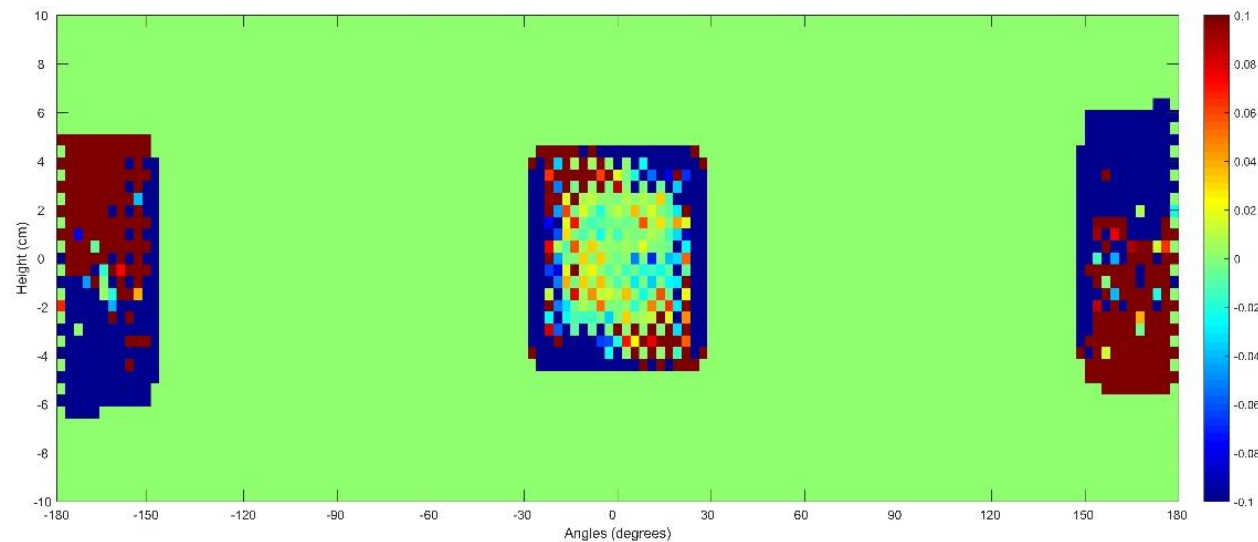
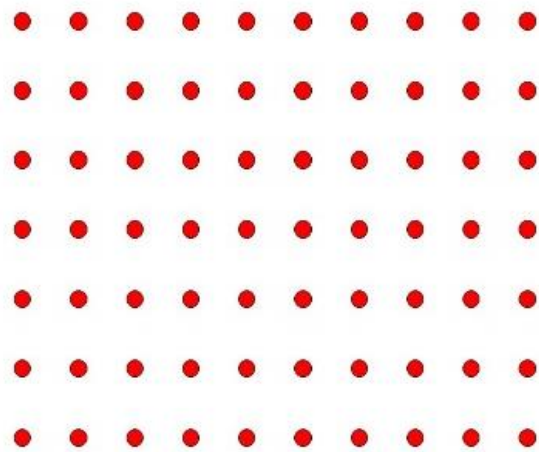


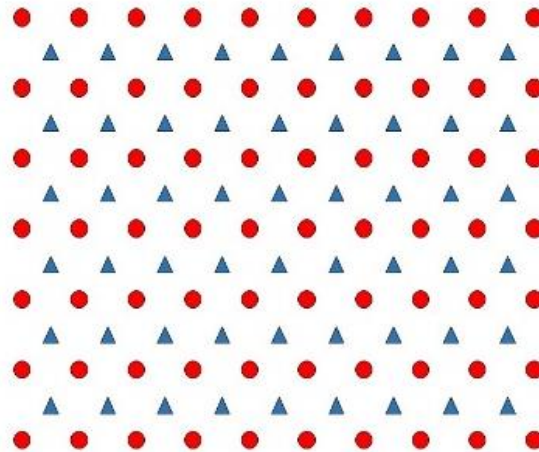
Fig. 7: Map of the difference between the data interpolated in MATLAB and the data interpolated by ArcCHECK, with scale readjustment.

RESULTS AND DISCUSSION

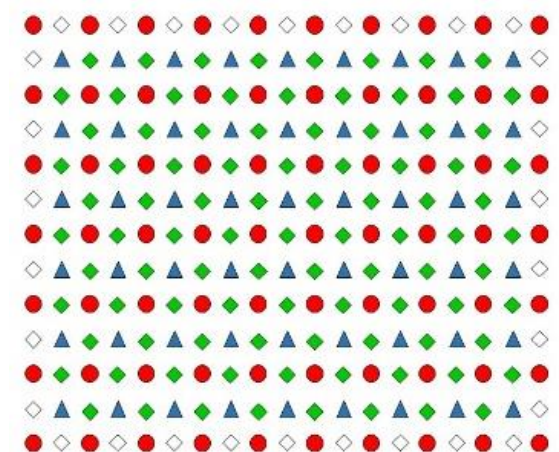
- Application to ArcCHECK data:
 - How ArcCHECK performs the interpolation;
 - Empty lozenges.



(a)



(b)



(c)

Fig. 8: Illustration of the interpolation methodology of ArcCHECK software; (a) red circles represent the diodes; (b) blue triangles represent the first interpolated points; (c) green lozenges represent the second interpolated points.

CONCLUSIONS

- The algorithm developed: investigate the effects of the interpolation performed by ArcCHECK;
- Visualize the dentate pattern of zero doses;
- Select crude dose visualization;

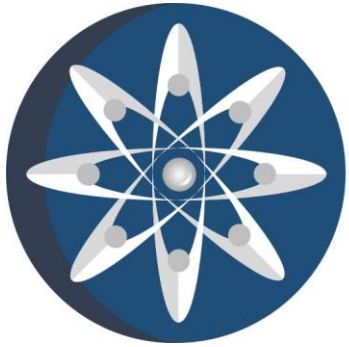
ACKNOWLEDGMENTS



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THANK YOU!

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