MELODI Workshop 2013: new developments in dosimetry

The use of a graphics library in multisource modelling for out-of-field head scatter assessment

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Out-of-field dose:

- Not modelled in TPS
- Clinical Application:
  - Dose at a specific volume: fetus, pacemaker, ovaries, testis
  - Remaining volume at risk (RVR) ICRU 83
- Epidemiology
  - Dose estimation in clinical irradiation reconstruction: secondary cancer, heart diseases
Out-of-field dose, the 3 main components

- Leakage radiations
- Scattered photons from the collimation system
- Scattered photons in the medium
Focus of this study: collimator scattered photon dose

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This study sole focus: collimator scattered photon dose

- Leakage radiations

- Scattered photons from the collimation system

- Scattered photons in the medium

Hypothesis:
The amount of scattered radiations reaching any point in the patient’s plane and the scattering surfaces of the beam limiting devices visible from this point are strongly correlated
Variations of the scattering surfaces

- Field size
- Position of the point of interest
- Structure of the collimation elements of the linear accelerator:

Reference:
Programming a 3D scene for a multisource model

- Programming language: C++
- Graphics library: OpenGL®
- Standard computer: - Intel® Core™ 2 Duo E8500 CPU (3.17 GHz)
  - 8 Gb of RAM
  - integrated Intel® Q45/Q43 express chipset graphic card
The components of the multisource model

The disk source:
- Direct photons
- Scattered photons from the primary collimator and the flattening filter

\[ D_{src}(M) = \sum_{i=0}^{n} \delta_i \times A_i(M) \]

The in-beam collimators surface:
- Scattered photons from the secondary and tertiary collimators

\[ D_{coll}(M) = \sigma \times \sum_{j=1}^{l} \left[ A_j(M) \times D_{src_j} \times P(r_j, \theta_j) \right] \]

Parameters determination and model validation

TLD 700 and build-up caps for 25 MV and 6 MV

Calculated scattering surfaces devices distribution (10 cm × 10 cm field)

Calculated collimator scatter dose distribution for two collimation systems (10 cm × 10 cm field)

Calculated collimator scatter dose distribution for different energies (10 cm × 10 cm field)

Calculated collimator scatter dose distribution for a complex fields

Agreement between calculations and measurements: gamma index

Dose-to-agreement: 15%
Distance-to-agreement: 1 cm
85% pass the test (145 points)

Conclusion

- The scattering surface visible from a point of interest and the amount of scattered radiations reaching this point are strongly correlated.
- OpenGL is a suitable tool for multi-source modelling for medical linear accelerator collimator scatter assessment.
- The 3D representation helps us to enhance our own perception.
- Possibility to use the same framework for the other out-of-field component.
- Ultimately, built a complete out-of-field dose estimation solution for integration in a TPS.
Thank you for your attention.