Study of Scatter Contribution From Prone Breast Board to Breast Apex Skin Dose Using Monte Carlo Simulations

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INTRODUCTION

- In prone breast radiation, the beam may pass through additional scatter material, i.e. the breast board, potentially resulting in an increased skin dose.

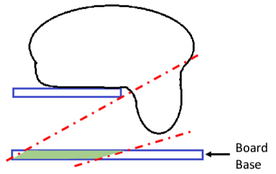

Fig 1: Typical patient setup with prone breast board.

- Monte Carlo (MC) simulations are expected to provide better computational accuracy in the buildup region than the conventional model-based treatment planning algorithms.

METHOD

- The breast board base is composed of two layers of carbon fiber with hard foam in between.
- Shallow depth measurements in a phantom with a parallel plate chamber were performed with varying air gaps (0 -10 cm).
- Air gaps represented a range of breast-to-board distances (i.e. breast sizes).

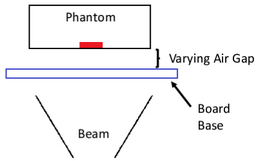

Fig 2: Experimental setup for shallow depth phantom measurements.

- Phantom setup was modelled in EGSnrc.
- The board base was represented in two ways:
  - Uniform density: 0.3 g/cm^3
  - Sandwich structure: 0.9 g/cm^3 (shell) and 0.13 g/cm^3 (inside)
- All values were normalized to air gap of 10 cm to demonstrate the relative increase of shallow-depth dose with increasing breast sizes.

RESULTS

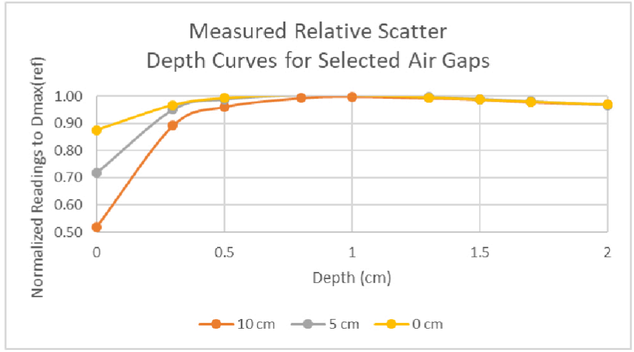

Fig 3: Measured relative scatter depth curves for selected air gaps. Readings are normalized to a reference reading at d_{max} where the setup in Fig. 2 was used and the board base was removed.

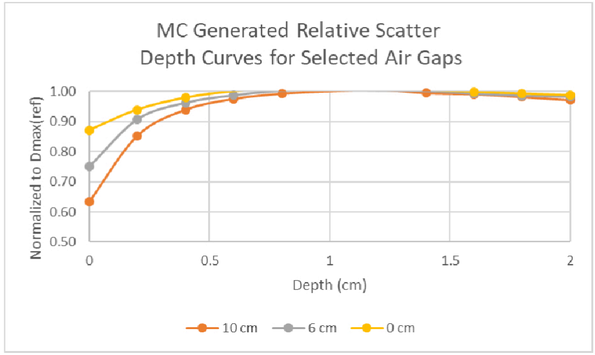

Fig 4: Example of MC generated relative scatter depth curves for uniform density of 0.3 g/cm^3. Values normalized to a reference value at d_{max} similar to Fig. 3.

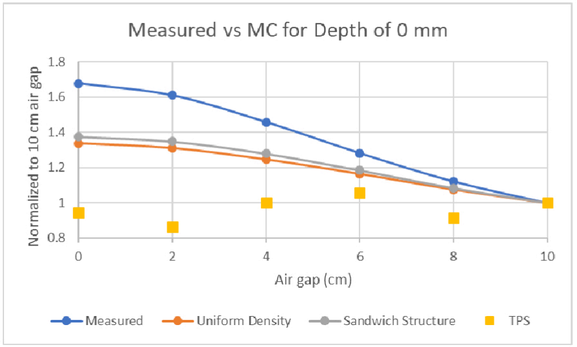

Fig 5: Comparison of measured, MC and TPS results at depth of 0 mm. Values are normalized to the 10 cm air gap. Percentage differences up to 20 % are seen at this depth between measured and MC results.

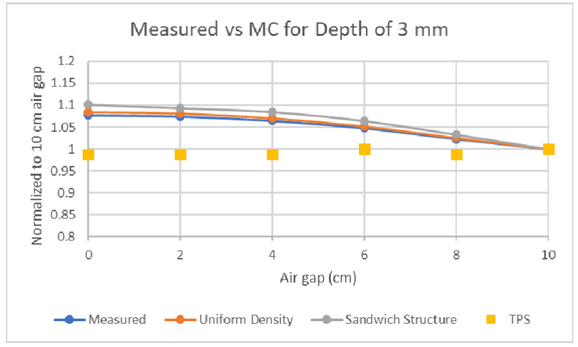

Fig 6: Comparison of measured, MC and TPS results at depth of 3 mm. Values are normalized to the 10 cm air gap. Percentage differences are within 2 % at this depth between measured and MC results.

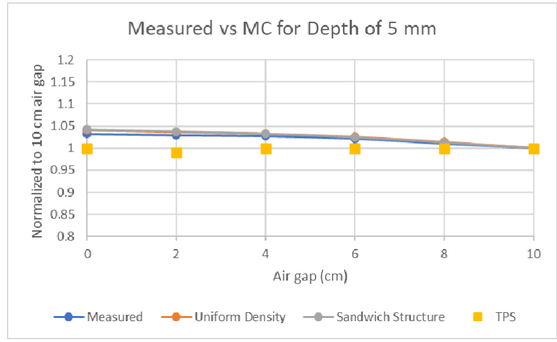

Fig 7: Comparison of measured, MC and TPS results at depth 5 mm. Values are normalized to the 10 cm air gap. Percentage differences are within 1% at this depth between measured and MC results.

CONCLUSIONS

- The ability to model the prone breast board base as an uniform effective density and a composite structure was shown in this phantom study.
- Results demonstrate the ability of MC to more accurately illustrate the air gap effect that is not seen in treatment planning system dose calculations.
- Larger discrepancies between measured and MC results were seen at the surface which could be due to limitations of surface dose measurements using an ion chamber and can be supplemented by measurements using other detectors.
- Additional skin dose information may be provided for clinical prone breast treatments by applying this approach to evaluate potential skin toxicity.

CONTACT INFORMATION

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