Computer simulation to support mammography physics education

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Introduction

The teaching of mammography X-ray physics forms an important part of several professional qualifications, including Radiology, Radiography and Medical Physics.

Teaching X-ray imaging physics via lectures can lead to low levels of student engagement and may not allow students to adequately link underlying theory with clinical practice.
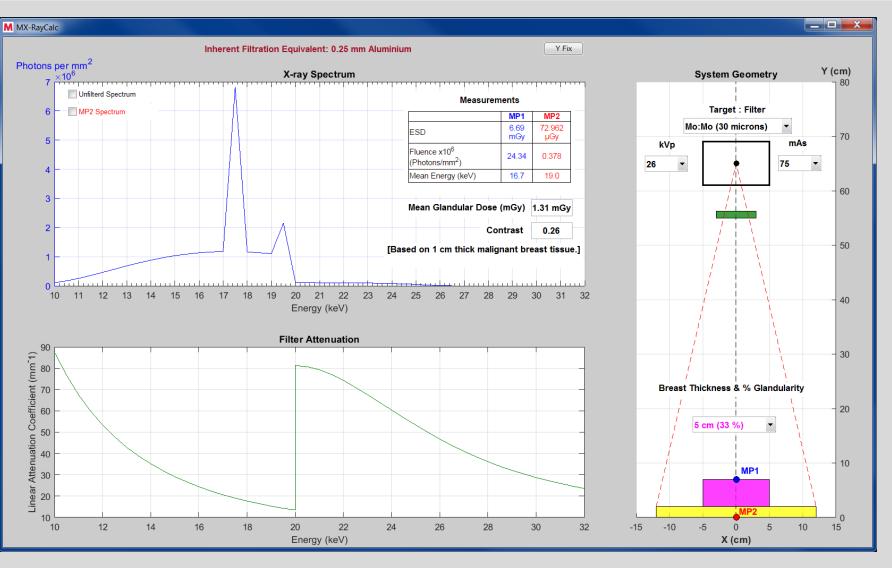
We have addressed these issues by designing and implementing a software tool called MX-RayCalc, that simulates mammography X-ray production and transport, to create an interactive environment to support learning in either an instructor-led or self-directed environment.

MX-RayCalc

MX-RayCalc allows students to alter radiographic factors and visualise the impact on the X-ray spectrum. Different X-ray target materials and beam filters are available.

Breast equivalent tissue of different thickness and composition can be selected and the impact on the subject contrast of a test detail composed of a given thickness of malignant breast tissue is calculated along with entrance surface dose (ESD) and mean glandular dose (MGD).

These are calculated for typical breast glandularities for women in the age range 50-64 years and breast thickness range 2-11 cm. No special skills are required to operate the software and it is easy to deploy on either Windows or Mac operating systems via a single-window graphical user interface.

MX-RayCalc software interface showing X-ray Spectrum, Filter Attenuation, Measurements table, and System Geometry.

Inherent Filtration Equivalent: 0.25 mm Aluminium

Measurements	MP1	MP2
ESD	6.69 mGy	72.962 µGy
Fluence x10^6 (Photons/mm^2)	24.34	0.378
Mean Energy (keV)	16.7	19.0

Mean Glandular Dose (mGy) 1.31 mGy

Contrast 0.26

[Based on 1 cm thick malignant breast tissue.]

Target : Filter — Mo:Mo (30 microns)

kVp 26   mAs 75

Breast Thickness & % Glandularity — 5 cm (33 %)

Conclusions

By linking physical theory to dosimetry and subject contrast in an interactive environment we hope to facilitate deeper understanding that students can relate to clinical practice.

Future work will focus on providing a greater selection of target filter combinations and the modelling of scatter which is not currently included.

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