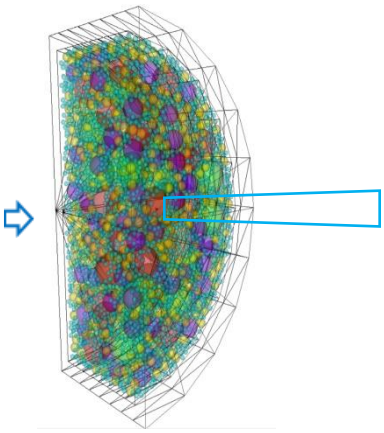
Bio-Phantom Explorer: 3D Simulation of Mammary Gland, Tumour Analysis & Future

Bio-Phantom Explorer represents a software solution that simulates three-dimensional (3D) models of mammary glands and 3D cancerous tumours. It identifies tumours at a very early stage and predicts their future developments.

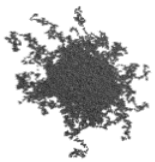
Usage:

- Enables the predictability of tumour growth and makes it possible for tumours to be clustered, recognised and analysed, using features such as neural networks, advanced mathematical algorithms, artificial intelligence, etc.
- Builds 3D phantoms of cancer formations that can be generated through 3D-printers for a more realistic analysis.
- Can be used for educational (e.g. training of young medical doctors), scientific and industrial purposes.
- Provides reports and images between users within different organisations.

Mammary gland with cancer tumour



Cancer tumour in the 3D model as a 3D image:



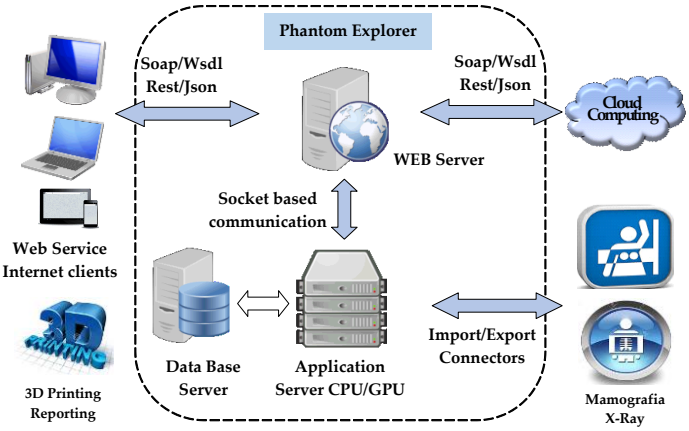
A 3D computer model of the mammary gland (a semi-cylinder filled with spheres, analogous to the different tissues) with a cancer tumour located between the spheres.

Purpose:

- Developing, storing, retrieving and managing advanced 3D computational phantoms of human breasts and real object images, that will incorporate realistic anatomical details and tissue properties, dynamically reflecting the development of breast changes (generation of a 4D model, incl. future developments of the tumour).
- Modelling breast cancer tumours and their growth, maintaining a tumour database, as well as generating realistic X-ray images using Monte Carlo simulation.

Technical Features:

- WEB-server solution based on large multi-type database/clouds, that manages real images and phantoms, properties and analytical results.
- WEB-service-based multi-language WEB-GUIs and 3D graphics for PC/tablets/smart phones, enabling users a broader access to main functionalities.
- Import/Export of data from/to MS Office Excel, WinWord, Power Point, PDF, XML, etc.
- Connectors to external devices, such as x-ray, mammograph, tomography, etc.
- Flexible reports, image printings and 3D-printings.



Bio-Phantom Explorer: Technical Realisation in Two Stages

Stage 1:
Developing a 3D computer model of a mammary gland that consists of two semi-cylinders, consecutively filled with 6 different types of spheres. The spheres have different sizes and colours, analogous to the different tissues in individual mammary glands, Fig. 1.

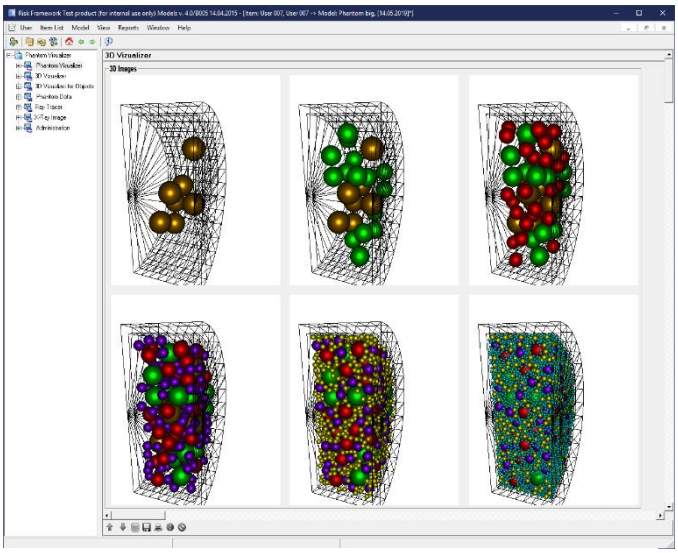


Fig. 1. 3D model of a mammary gland in Phantom Explorer: semi-cylinder consecutively filled with spheres

Main idea: The 3D model can be rotated and disassembled by the user, making it possible for the cancer tumour to be identified between the spheres, Fig. 2:

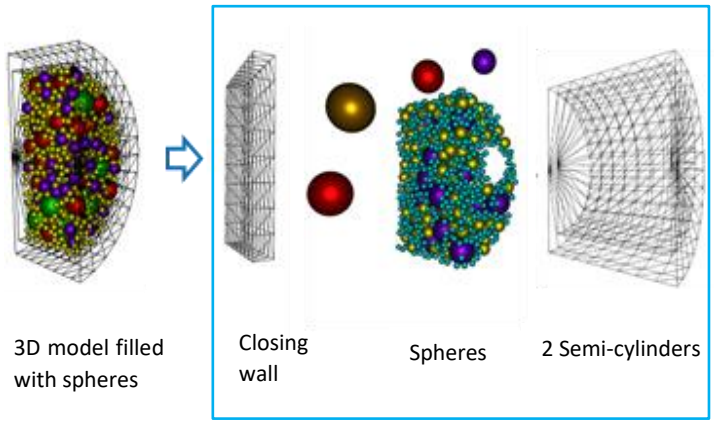
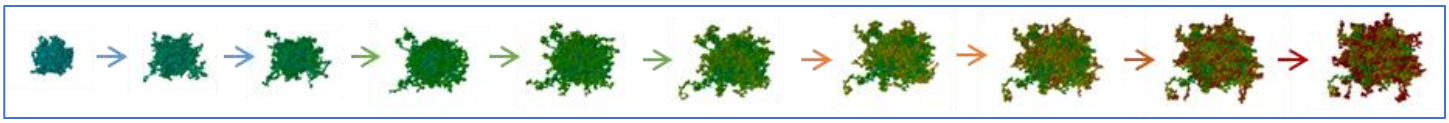


Fig. 2. In search for the tumour: disassembling the 3D model

Stage 2:
Simulated ray tracing of the 3D model from stage 1, using traditional and innovative imaging geometry, Fig. 3. A virtual x-ray image is generated, Fig. 4. Then, a cancer tumor is applied to it. A new image of the mammary gland with a cancer tumour in it is generated and then ray traced, Fig. 5.
Main idea: the user can "cut" the new image in slices (Fig. 6.) to search for the cancer tumour inside.

Simulated future development of the cancer tumour along the time axis:



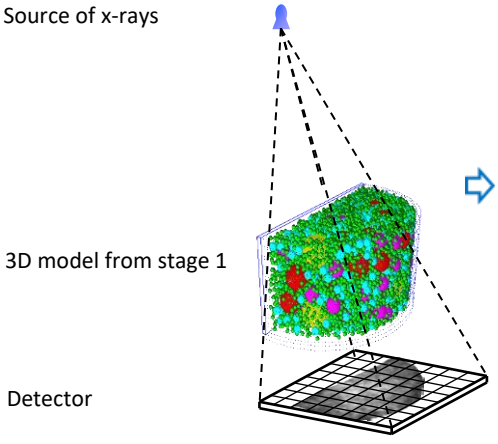


Fig. 3. Simulated ray tracing of the 3D model

A tumour is applied to:

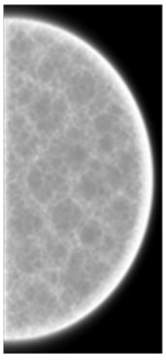


Fig. 4. Obtained image of individual mammary gland

Result:

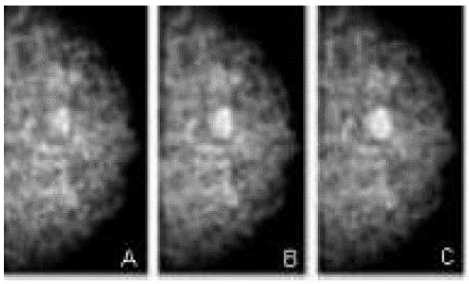
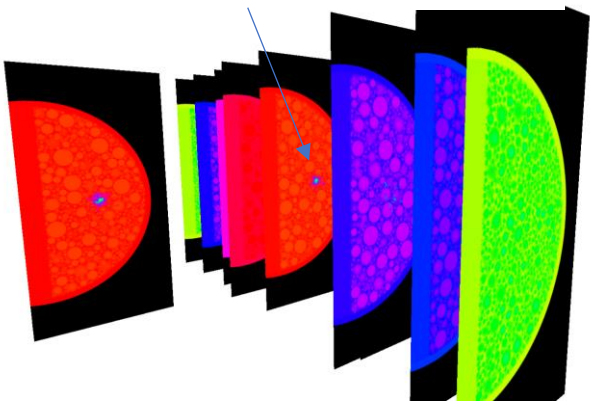


Fig. 5. The cancer tumor is inside the x-ray image

Fig. 6. The image is cut in slices enabling a precise search for the tumour inside



Bio-Phantom Explorer is developed by Eurorisk Systems Ltd. (see: www.eurorisksystems.com) and is based on advanced IT technologies, such as Monte Carlo simulation, rule-based systems, neural network prediction, multi-core CPU/GPU, 3D images and visualisation.

The object modeling is supported and powered by the biomedical engineering community in Varna, led by Dr. Kristina Bliznakova and her team of researchers at the Laboratory of Computer Modelling and Simulations in Medicine at the Technical University of Varna.