# A Geant4 tool for the simulation of contrast enhanced dual-energy mammography – Study of polychromatic versus quasi-monochromatic X-ray spectra and different contrast agents

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**Background:** Conventional X-ray sources for medical imaging use polychromatic (bremsstrahlung) radiation. Many of the emitted photons do not contribute to image production, but impart dose to the patient. Quasi-monochromatic sources, such as the ones based on synchrotron radiation or inverse Compton scattering [1], can be tuned so as to take advantage of K-edge contrast enhancement, reducing at the same time the imparted dose. By acquiring two images at energies straddling the K-edge of a contrast medium, it is possible to enhance the visibility of details perfused with the contrast medium and virtually remove the anatomical background. In this contribution, we present a Geant4 tool for the simulation of contrast enhanced dual-energy mammography (CEDEM). Through this tool, we quantified the advantages of using quasi-monochromatic radiation with respect to the conventional polychromatic one. We also assessed the performance of gadolinium-based contrast media with respect to iodine-based ones in CEDEM with quasi-monochromatic beams.

**Material and Methods:** We carried out a set of simulations with the developed code to investigate CEDEM performance in different conditions. Our tool includes all the features of a mammography unit and can handle patient specific voxel phantoms or geometrical ones. For this study, we considered a semi-cylindrical phantom with inner spheres of random size to simulate the glandular tissue and a detail perfused with the selected contrast medium. Regarding the source, we considered diverging X-ray beams uniformly irradiating the phantom with properly filtered bremsstrahlung spectra or with narrow-band Gaussian spectra. For all the considered cases, we calculated, as a figure of merit, the square of contrast-to-noise ratio in the contrast image over the mean glandular dose imparted to the phantom.

**Preliminary results:** We found that quasi-monochromatic beams lead to figures of merit one order of magnitude better than the ones obtained with conventional beams. On the other hand, iodine-based contrast media performed about 4 times better with respect to those based on gadolinium, at the same concentration and X-ray photon fluence.