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EP-1502: High resolution portal image prediction for radiotherapy treatment verification & in vivo dosimetry

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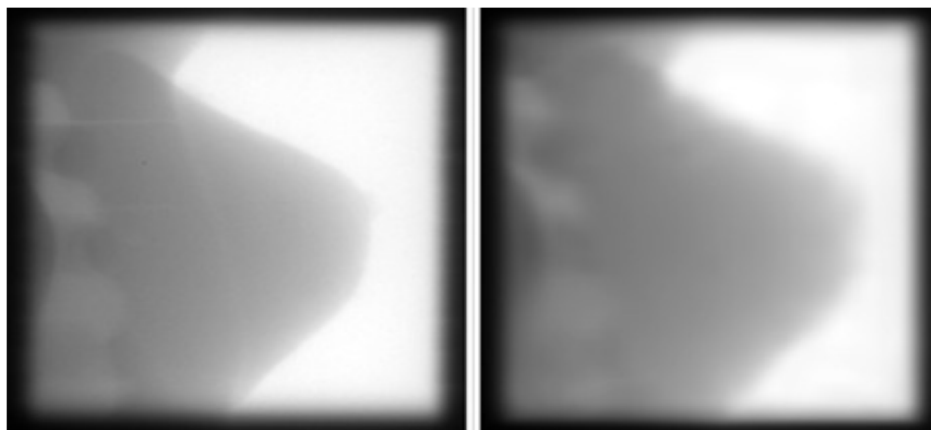
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Purpose/Objective: Historically designed as a control system for patient positioning for radiotherapy treatment, Electronic Portal Imaging Devices (EPIDs) are nowadays widely used for quality assurance and dosimetric verifications in new irradiation techniques. One of the main advantages of the EPID is its high resolution which can detect small details. The objective of this study is to compare the EPID image acquired during the treatment with a predicted high resolution portal image computed by Monte Carlo (MC) simulation. A new method for prediction of high resolution EPID images is tested for in vivo treatment verification.

Materials and Methods: Experiments were carried out on a Siemens ARTISTETM, equipped with a 160-MLCTM, and its Siemens OptivueTM 1000 EPID. This EPID has an active detection area of 41 x 41 cm² and a matrix of 1024 x 1024 pixels. A model of this linac and the EPID was developed with the MC code Penelope, and commissioned. We focus on a breast treatment conformational beam (6 MV) on the CIRS adult female phantom. The CT-scan of the phantom was used as input, and Hounsfield numbers were converted in density and atomic composition, so as to obtain a voxelized geometry used in the Penelope code. Particles exiting the phantom and impinging on the EPID are simulated up to the EPID in order to compute the predicted portal image by scoring the energy deposited in the phosphor layer on a 1024 x 1024 virtual grid. The simulated image was then smoothed using a denoising algorithm in order to keep the high resolution advantage. Several denoising algorithms were tested, among them IRON, LASG and a recently developed one called DPGLM. For now, we use the gamma-index technique to evaluate the accuracy of the simulated image against the experimental one.

Results: Figure 1 shows the acquired image and the simulated one. The gamma-index is satisfied for 94.4 % of the pixels for 3.5 % and 3.5 mm criterion. The DPGLM gives the best result toward accuracy and computed time. Indeed, the denoising of 1024 x 1024 images takes about 1h30 mn, 2h and 5 mn using DPGLM, IRON, and LASG, respectively. The LASG algorithm is really fast but the result is too smoothed for the high resolution purpose.



Conclusions: This work is the first step in the aim of in vivo dosimetry by comparing experimental portal images with high resolution predicted images obtained using MC simulations in a voxelized geometry. First results obtained on a breast treatment are encouraging, and we can expect to detect treatment errors.