3D image reconstruction of Boron Dose distribution in BNCT with CZT-based Compton camera

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Background: The Boron Neutron Capture Therapy (BNCT) is innovative radiotherapy with high selectivity capability over cancer tissue based on nuclear capture reaction 10B(n,α)7Li [1][2]. Nowadays the BNCT effectiveness depends on the delivery of 10B in the tumor and a qualified in-vivo imaging dosimetry method. In this context, it becomes important to be able to reconstruct the spatial distribution of the dose in the area of interest and the related isodose curves with imaging technique methods such as emission computed tomography. It has been proposed to reconstruct in vivo imaging of the spatial distribution of the dose from 10B by "Compton Camera techniques", taking advantage of the 478 keV photon emitted. In this contest is has been proposed a 3D cadmium-zinc-telluride (CZT) based drift strip detector [3], able to perform room temperature measurements of photon energy, timing, and 3D positioning up to the MeV region

Material and Methods: In this work, we have performed Monte Carlo simulations and image reconstruction with iterative methods and morphological filtering to study the real-time imaging therapeutic dose monitoring capabilities of 3D CZT parallel planar field sensors in the BNCT framework. The simulated set-up was composed of a phantom made of soft tissue with a gamma source inside and a CZT detector Compton camera based as is shown in Figure 1. Different gamma sources with configurations of 5 vertexes point like and spherical were analyzed in several setups to study gamma dispersion in phantom, image reconstruction of the three-axis, and realistic therapeutic ratios dependence.

Preliminary results: Preliminary evidence that this approach would be capable to reconstruct the boron dose inside the patient is reported. The study of Z-axis profiles gives the possibility to estimate the distance between the source and detector, although for the case of 200 mm offset we couldn't get any conclusion probably because of long stretching and low events statistics.

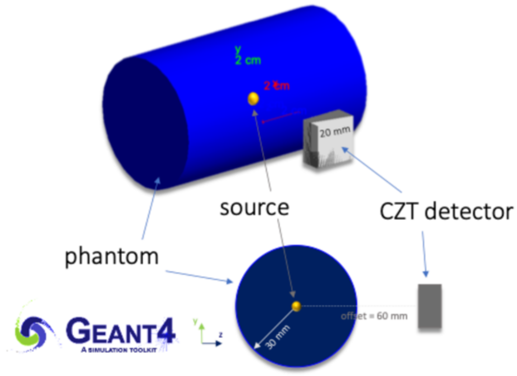

Figure 1: Simulated setup

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[2] M. Dymova, S. Taskaev, V. Richter, and E. Kuligina, Boron neutron capture therapy: Current status and future perspectives, Cancer Communications 40 (2020).
[3] L. Abbene, G. Gerardi, F. Principato, A. Buttacavoli, S. Altieri, N. Protti, E. Tomarchio, S. Sordo, N. Auricchio, M. Bettelli, N. Sarzi Amad`e, S. Zanettini, A. Zappettini, and E. Caroli, Recent advances in the development of high-resolution 3d cadmium-zinc-telluride drift strip detectors, Journal of synchrotron radiation 27, 1564 (2020).