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Dual gamma-neutron imaging device GN-Vision: development of the first demonstrator and first field tests in BNCT

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Compton imaging is a promising technique for Prompt Gamma (PG) imaging in range verification during hadron therapy (HT). In neutron monitoring, however, most existing systems register only integral off-field neutron fluence values, without providing information on the spatial origin. Dual neutron–gamma imaging is also of significant interest for applications in nuclear safety and security. To address these challenges, we have designed and patented an innovative dual neutron and γ-ray imaging system, so-called GN-Vision, which aims to overcome the current limitations in these fields. The device is compact, portable, and capable of simultaneously measuring and imaging γ-rays and slow neutrons, from thermal energies up to 100 eV.
GN-Vision builds on the design of the previously developed i-TED detector [1], an array of Compton cameras based on large monolithic position-sensitive $LaCl_3$(Ce) crystals originally conceived for neutron-capture experiments at CERN [2]. The applicability of i-TED has already been demonstrated for range verification in ion-beam therapy [3,4,5] and for imaging-based dosimetry in Boron Neutron Capture Therapy (BNCT) [6,7]. In addition to these features, GN-Vision incorporates a neutron–gamma discriminating detector and a passive collimator to enable neutron imaging while preserving Compton γ-ray imaging capabilities.
The dual imaging functionality of GN-Vision was first conceptually demonstrated through Monte Carlo simulations [8]. More recently, we have concentrated our research on developing and validating the neutron imaging capability with a CLYC-based neutron-gamma discrimination detector [9], and on evaluating and optimizing the performance of the full prototype through detailed simulations [10]. This contribution will summarize the latest experimental advances in this project, with particular emphasis on the development and characterization of the first demonstrator integrating both neutron and γ-ray imaging in a single device with compact electronics. Moreover, this contribution will present the results of the first field tests performed in the context of BNCT, carried out at ILL [11] and at the research reactor in Pavia. Finally, we will outline future plans for pilot experiments to validate the system in clinically and technologically relevant scenarios.
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Abstract

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