Contribution ID: **278** Type: **Oral Presentation**

#9-278 Hybrid Compton-PET imaging for ion-range monitoring in hadron therapy

Tuesday, June 10, 2025 3:00 PM (20 minutes)

Hadron therapy offers significant advantages over conventional radiotherapy, primarily due to the maximization of the applied dose during treatment at the Bragg peak. However, additional benefits could be realized if a quasi-real-time monitoring system for ion-range verification were available. Such a system would help reduce safety margins and enhance the therapy's potential benefits by addressing various sources of systematic uncertainty.

Two of the most promising methodologies for in-room, real-time monitoring are positron emission tomography and prompt-gamma imaging. The PGI technique is particularly well-suited for real-time monitoring because of the prompt nature of the emitted radiation. In contrast, PET imaging offers tomographic and functional information, making it valuable for studying physiological processes and tumor response.

In 2016, Parodi discussed the concept of a PGI-PET hybrid imaging system as an alternative to address some of the limitations inherent to each technique. As suggested by Lang in 2014, this concept could be realized by adapting systems based on multiple Compton cameras. Hybrid PGI-PET systems are anticipated to open new avenues for in-vivo real-time range monitoring. This expectation arises from the complementary strengths of the two techniques: prompt-gamma emission is more suitable for real-time monitoring, while PET imaging provides tomographic and functional information valuable for studying physiological processes and tumor response.

For the first time in hadron therapy, we have implemented a hybrid imaging system that combines both PGI and PET within the same setup, thereby harnessing the advantages of both approaches. This is achieved using an array of Compton cameras in a twofold front-to-front configuration operating in synchronous mode.

In this contribution, I will present a summary of a proof-of-concept experiment conducted under pre-clinical conditions at the HIT-Heidelberg facility with proton, alpha, and carbon ion beams, and the the preliminary results of the 2024 campaigns with only protons at two different facilities such as WPE (Germany) and IBA-Reading (UK).

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Session Classification: #09 - Environmental and Medical Sciences

Track Classification: 09 Environmental and Medical Sciences