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Beyond Protons: Unlocking ^{67}Cu Production with Triton Beams for Next-Generation Theranostics

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The radionuclide ^{67}Cu is a highly attractive theranostic agent, combining β^- emission for radiotherapy with γ-rays suitable for SPECT imaging. However, achieving efficient and clean cyclotron-based production remains a major obstacle. In this study, we explore an alternative nuclear reaction route using triton beams on zinc targets—specifically ^{68}Zn(t,x)^{67}Cu—as part of the NUCSYS CSN4, CUPRUM-TTD CSN5, and SPESMED CSN3 initiatives. Given the absence of experimental cross-section data for these triton-induced reactions, we employed comprehensive TALYS simulations across 24 model combinations, generating uncertainty bands and benchmarking against the well-documented ^{68,70}Zn(p,x)^{67}Cu proton-induced reactions.

Our simulations predict that triton-based reactions can outperform proton routes by more than an order of magnitude in yield for E > 30 MeV, while also significantly reducing stable copper contamination and cooling times. Notably, triton irradiation requires substantially thinner targets, translating into lower consumption of costly enriched material. These findings position triton-induced production as a superior and scalable route to ^{67}Cu, pending experimental validation. This work paves the way for novel strategies in the production of key theranostic radionuclides, potentially transforming their accessibility for nuclear medicine.

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