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Applied nuclear physics for materials research and medicine

Recent advances in detector developments, accelerator technology, and demands in medical treatments have driven intense knowledge transfer and applications of nuclear physics techniques towards societal relevant areas like particle tumor therapy, future energy production, astrophysical and materials research. In the contribution some selected examples will be presented regarding these areas. Superconducting RF-accelerator technology allows creating intense and high-repetition rate beams of direct and secondary beams. As one example, the ELBE facility at Dresden will be presented, where a superconducting electron linear accelerator is used to drive secondary photon beams (bremsstrahlung, monochromatic X-rays from laser-Compton backscattering) [1], fast neutrons from a photo-neutron source [2], coherent IR laser and THz light, and positron beams for materials research. Besides employing radioisotope sources in conventional positron annihilation spectroscopy, high-energy electron bremsstrahlung serves as an efficient source for pair-produced positrons.
Radiation safety issues, converter design, charged particle transport, and last-not-least high resolution detector designs highly benefit from nuclear physics expertise. Some examples of positron lifetime and Doppler-broadening measurements for defect spectroscopy, porosimetry, and positron chemistry will be presented [3-5]. As an example for the interplay between nuclear physics and medicine, developments for range verification and in-vivo dosimetry during proton tumor therapy at the Oncoray facility will be discussed. Proton-induced nuclear reactions enable new ways for spatially resolved dose delivery through prompt-gamma ray imaging [6] and single-plane Compton-imaging [7].
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