Online-Seminar

der GSI, der TU Darmstadt und der Universitäten Frankfurt, Mainz und Gießen zur

Physik dichter Plasmen mit Schwerionen- und Laserstrahlen

Veranstalter*innen: P. Neumayer, O.N. Rosmej, R. Bock, V. Bagnoud, A. Blazevic, D.H.H. Hoffmann, J. Jacoby, Th. Kühl, P. Mulser, M. Roth, Th. Stoehlker, M. Thoma

Dienstag, 6. Dezember 2022, 14:30h

Ort: Zoom-Meeting Room
(ID: 966 2996 3798 / PW: 130302)
or
SB3 3.170a Seminarraum Theorie

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Record-breaking efficiency of the multi-MeV bremsstrahlung production in interaction of direct laser accelerated electrons with high-Z convertor

In the present work, we demonstrate an approach to generate ultra-high flux, multi-MeV bremsstrahlung based on interaction of high current direct laser accelerated (DLA) electrons with high Z convertor. Directed beams of relativistic electrons with effective temperature 10x higher than ponderomotive potential were produced in interaction of the sub-ps PHELIX pulse of 10^{19} W/cm^2 laser intensity with pre-ionized low density polymer foams. Measurements show that in this scheme, electrons with energy up to 100 MeV can be produced and the charge of electrons which propagate in 2π with energy greater than 1.5 MeV reaches 1 μC. The charge of electrons with energy more than 7.5 MeV, responsible for generation of bremsstrahlung photons in the range of giant dipole resonance, attains 200 nC. Conversion efficiency of the laser energy to electrons is up to 40% (> 1.5 MeV) and 18% (> 7.5 MeV). For the fraction of the electron beam directed along the laser axis, it is 11% and 9% respectively.
For characterization of the bremsstrahlung spectrum (BS) produced by the DLA electrons in high Z convertor, photonuclear reactions, in particular (γ,n), (γ,3n) and (γ,5n) in gold and tantalum have been studied. We observed high yield of nuclear reactions demanding photons with energies above 50 MeV. Evaluated number of isotopes allowed concluding about the number of MeV photons in the range of giant dipole resonance and the effective temperature of the bremsstrahlung spectrum. In particular, we report about BS spectrum> 8 MeV that can be approximated by an exponential distribution with an effective temperature of 13-16 MeV and contains $1\text{-}4\times10^{11}$ (~ 10^{12}/sr) photons per laser shot in the energy range of 8 MeV to 70 MeV propagating within a half angle of 17°.
These numbers manifest a record-breaking conversion efficiency of the laser energy to MeV-bremsstrahlung photons in the GDR range (> 8 MeV) that approaches 2%. The experimental results are in good agreement with GEANT4 simulations.

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