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Preliminary measurements of the Bremsstrahlung doubly differential cross section for electrons between 20 and 100 keV in Au

J. A. García-Alvarez[*,†], N. L. Maidana[*1], T. F. Silva[*], J. M. Fernández-Varea[‡,*] M. N. Martins[*] and V. R. Vanin[*]

[*] Instituto de Física da Universidade de São Paulo, Travessa R 187, Cidade Universitária, CEP:05508:900, São Paulo, Brazil

[†] Instituto Superior de Tecnologías y Ciencias Aplicadas. Quinta de los Molinos, Ave. Salvador Allende, Esq. Luaces, CP:10600, Havana, Cuba

[‡] Facultat de Física (ECM and ICC), Universitat de Barcelona, Diagonal 645, E-08028, Barcelona, Spain

Synopsis Electron Bremsstrahlung cross sections were experimentally determined, for five kinetic energies, unfolding the measured photon spectra with an analytical detector response function.

The electron Bremsstrahlung doubly differential cross section (DDCS) in Au for kinetic energies $E = 22.4$, 42.0, 61.7, 80.8 and 100.8 keV was measured at the São Paulo Microtron.

Au targets were prepared by chemical vapor deposition over a C backing material, previously placed over a frame of amorphous C fiber, (30 mm × 15 mm × 0.3 mm) with a central hole of 10 mm in diameter. The target thickness $t_{\rm Au} = 32.6(18)\mu{\rm g/cm}^2$ was determined by Rutherford Backscattering Spectrometry at the LAMFI/USP tandem van de Graaff, employing a 2.2 MeV He^+ beam and two Si detectors at 120^0 and 170^0 with respect to the incident beam.

The Microtron delivers a continuous electron beam with dimensions of $\sim 2 \times 2$ mm^2. During the irradiations, the charge was collected both in the Faraday cup and the irradiation chamber that is electrically isolated from the beam line.

A planar HPGe detector positioned at $\theta = 48.8^0$ was used to acquire the Bremsstrahlung spectra. The solid angle Ω subtended by the detector with respect to the target was determined as done by Maidana et al [1], measuring the detector efficiency from the ^{57}Co γ-rays. Seltzer's efficiency model [2] was fitted to the experimental points with Ω as a linear adjustable parameter. The recorded pulse-height distributions were corrected for the background, pile-up and dead time effects.

The emitted photon spectra were obtained unfolding the net spectra with an analytical model that describes the detector response function (RF). Our RF considers the photon total absorption, the escape of Ge $K\alpha$ and $K\beta$ x-rays and the escape of photons after one Compton interaction. We adopt the relativistic impulse approximation to describe the incoherent scattering process in the Ge crystal. We also take into account the continuous spectrum produced by the escape of photo-electrons from the active volume. The included external interaction contributions to the RF were: the incoherent photon scattering in the detector Be window and the effect of photo-electrons created in the Ge dead layer that reach the active volume. We obtained the emitted Bremsstrahlung spectra with an energy bin $\Delta = 1$ keV, for photons between 14 keV (above the Au L x-ray region) and the tip region.

Our uncertainties are around 6–7% and its main contributor is the target thickness ($\sim 5\%$). The experimental DDCSs were compared with the theoretical data of Pratt et al [3] and Kissel et al [4] for Au. Experimental results are systematically above the theory, except for $E = 22.4$ and 42.0 keV in the tip region where both, theoretical and experimental data are in agreement.

References

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[1]E-mail: nmaidana@if.usp.br