

$^{207}\text{Pb}(n,2n\gamma)$ Cross-Section Measurements by In Beam Gamma-Ray Spectroscopy

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Innovative systems for energy production and/or waste transmutation require new nuclear data in a wide neutron energy range. For (n,xn) reactions with $x > 1$ at $E_n > 6-8$ MeV, experimental data are very rare and evaluated data show large discrepancies. Thus, in the frame of the n_TOF project a program to measure (n,xn) cross-sections was initiated.

This paper presents $^{207}\text{Pb}(n,2n\gamma)^{206}\text{Pb}$ cross-section measurements with a lead target enriched in ^{207}Pb at the GELINA white neutron beam at IRMM, Geel, Belgium. This experiment was performed in parallel with (n,n' γ) measurements by the detection of prompt γ rays in HPGe detectors.

The main difficulty was the presence of a strong γ flash which only arrives a few μsec before the fastest neutrons (2.5 μsec for 20 MeV neutrons). For the reactions corresponding to high energy neutrons, pile up of pulses from the γ flash together with events from neutron-induced γ rays may occur. This condition deteriorates the energy resolution in the γ spectra and increases significantly the dead time. To solve these problems we have developed a data acquisition system based on digital pulse processing techniques. Signals from the preamplifier of the HPGe crystals were sampled at a rate of 65 MS/s using 14-bit Flash ADC modules developed at IReS, Strasbourg. These modules use built-in-Field-Programmable Gate Array (FPGA) to analyse the samples online. For the energy determination, the trapezoidal shaping technique was used. The algorithm for time determination consisted in a digital timing filter followed by a digital constant fraction discriminator.

The lead sample enriched to 92% in ^{207}Pb was placed at 200 m from the neutron source. For the $^{207}\text{Pb}(n,n'\gamma)$ measurements, conventional electronics was used, while for the (n,2n γ) measurements two of the HPGe detectors (70% and 100% relative efficiency) were also read out with digital electronics. The neutron flux was measured with a ^{235}U fission-chamber. The data were collected for three months.

We will present the cross-section data for incident neutron energies between 6 and 20 MeV for the main γ transitions in ^{206}Pb . Our data will be compared to the results obtained by Vonach et al. [1] and to the TALYS [2] and EMPIRE-II [3] code predictions. With the help of model calculations [2,3], the (n,2n) cross-section values can be deduced and will be presented.

[1] H. Vonach et al., Phys. Rev. C50, 1952 (1994)

[2] A. J. Koning, “Upgrading JEFF-3 With TALYS – Low and Intermediate Energy Data”, Talk given at JEFF Meeting, April 24 – April 26, 2002, Aix en Provence, France

[3] M. Herman, “EMPIRE-II”, <http://www-nds.iaea.org/empire/>