The ^{58}Ni(γ,n) cross section: a benchmark for the s287 experiment*

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A systematic investigation of Coulomb excitation of neutron-rich nickel isotopes has been carried out at the LAND/R^{3}B setup in Cave C at GSI. Beams of stable and unstable nickel isotopes at approximately 500 AMeV have been produced using fragmentation of ^{58}Ni and ^{86}Kr beams on a thick Be target and subsequent separation in the FRagment Separator (FRS). To study electromagnetic excitation, lead and carbon tagets were used, in order to disentangle the electromagnetic and nuclear contributions. Tracking of the heavy fragments has been performed using position-sensitive pin diodes, scintillating glass fiber detectors and a time-of-flight wall of plastic scintillator paddles. Gammas were detected using a CsI scintillation detector in barrel geometry. Since mainly neutron-rich nuclei were under investigation, high-energy neutrons have been detected with the Large Area Neutron Detector (LAND), located at 0° and 15 m distance from the target.

Considering the nickel isotopes that have been measured during this experiment, a comparison with published data is possible for ^{58}Ni. Fultz *et al.* [1] provide photoneutron cross-sections, which may be converted to Coulomb excitation cross-sections using the Weizsäcker-Williams virtual photon approach for the given beam energy of 500 AMeV. For ^{58}Ni, Fultz *et al.* provide an inclusive photoneutron cross-section, leading in our case to the evaluation of not only the (γ,n) reaction channel, but also the (γ,np) channel. After folding the published cross-section with the virtual photon spectrum, an integral value of 127 $\pm$ 12 mb is obtained. Considering the data measured in the s287 experiment, the differential cross-sections for the (γ,n) and (γ,np) channels are shown in figure 1. Integrating these distributions provides cross-sections that need to be corrected for acceptance and efficiency of LAND.

The correct interpretation of the experimental data relies on simulations of the neutron detector. Figure 2 shows the dependence of the LAND acceptance and efficiency as a function of neutron kinetic energy in the rest frame. The acceptance remains at 100% up to 3.07 MeV and then decreases exponentially; its shape is determined by the geometry of the experimental setup. The total LAND efficiency is divided into a nominal and a calculated part. The nominal efficiency of 94% is equal to the intrinsic neutron detection efficiency of LAND for 500 MeV neutrons. This efficiency has been measured in a calibration experiment using neutrons at various energies, including 500 MeV. The calculated efficiency depends on experiment-specific detector effects, *e.g.* individual energy thresholds and inactive LAND subunits. Since the latter are not homogenously distributed over the detector volume, position-dependent, and therefore energy-dependent effects arise. The calculated efficiency is well described by a second-order polynomial up to 3.58 MeV (starting at 88.8%), and by a constant value of 74.7% from that energy upwards.

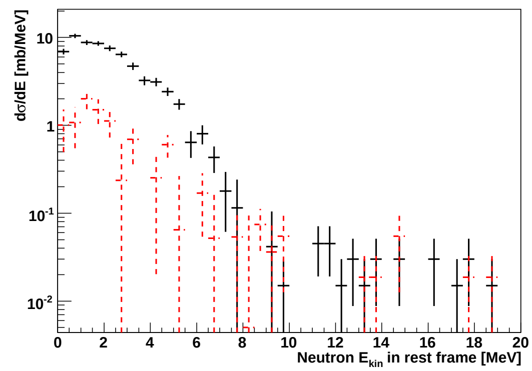

Figure 1: Differential cross section for ^{58}Ni(γ,n) (solid black lines) and ^{58}Ni(γ,np) (dashed red lines).

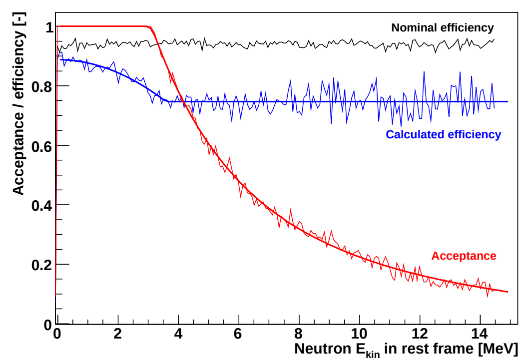

Figure 2: Neutron kinetic energy dependence of the LAND acceptance and efficiency.

Based on this information, the measured cross-sections (for neutron energies up to 20 MeV) are corrected to 98 $\pm$ 2 mb and 9.9 $\pm$ 1.6 mb for the (γ,n) and (γ,np) channels respectively. Taking into account a systematic error of 6% on the efficiency, the resulting Coulomb excitation cross-section is 108 $\pm$ 10 mb, which is within agreement with the value provided by [1].

References

[1] S. C. Fultz *et al.*, Phys. Rev. C **10**, 608 (1974)

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