

J. Zdebik^a and P. Moskal^{a,b} on behalf of the COSY-11 collaboration.

The efficiency of the COSY-11 neutral particle detector – which is an important factor for determining the absolute values of cross sections – was determined using two independent simulation programs. In one program, a procedure based on the GEANT-3 (GEometry ANd Tracking) code [1] was used for simulation of the hadronic cascades induced in matter by neutrons. The same procedure was repeated using the FLUKA¹ (FLUKtuierende KAskade) [2, 3] simulation program.

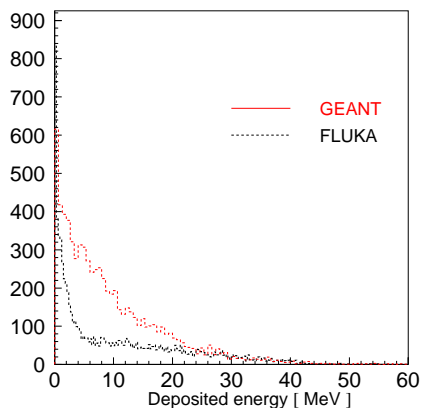


Fig. 1: The total energy deposited in the neutral particles detector for neutrons impinging on the detector with kinetic energy equal to 300 MeV as simulated using FLUKA-2008 (dashed line) and GEANT-3 (dotted line) packages.

The comparison of the simulated distributions of the total deposited energy in the neutron detector using FLUKA-2008 and the GEANT-3 packages is presented in Fig. 1. The simulation was performed for neutrons with a kinetic energy equal to 300 MeV. As can be seen, the range of deposited energy is the same for both cases, however GEANT simulations yield on the average higher energy response.

The efficiency of the neutron detector is given by the ratio of the number of generated neutrons to the number of events, for which an energy deposited in the scintillator material was larger than the threshold value in at least one of 24 detection units. The value of the calculated efficiency as a function of the kinetic energy of neutrons is shown in Fig. 2 (up). In this figure open squares denote result obtained using the GEANT-3 package and the outcome of simulations using FLUKA-2008 is presented as black circles.

The kinetic energy of neutrons from the $pn \rightarrow pn\eta'$ reaction varies from 300 MeV up to 700 MeV for the 3.35 GeV/c beam momentum, and as can be inspected from Fig. 2 the efficiency is fairly constant in this range.

It is worth to stress that two independent simulation tools lead to fairly good ($\pm 3\%$) agreement for the values of efficiency in the range of energy relevant for the studies of the $pn \rightarrow pn\eta'$ reaction.

We have also conducted studies of the variation of the efficiency depending on the threshold value.

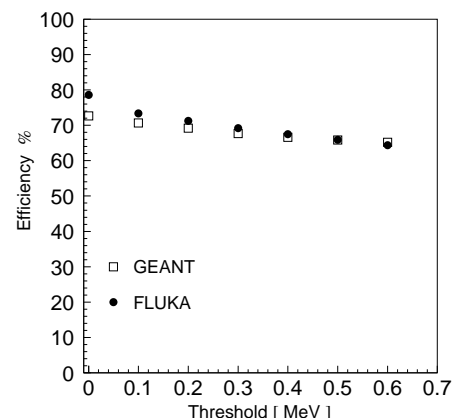
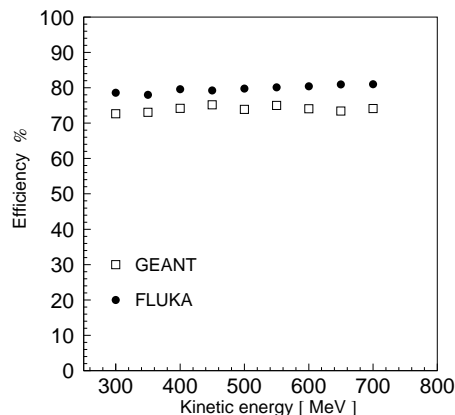


Fig. 2: **Top:** The efficiency distribution as a function of the kinetic energy of neutrons determined assuming that the threshold is equal to 0 MeV. **Bottom:** The relation between the threshold value and the efficiency for neutrons with energy of 300 MeV.

In the experiment the threshold was set to about 0.1 MeV and therefore we scanned the values from 0 up to 0.6 MeV. The result is presented in Fig. 2 (lower part). For both the GEANT and FLUKA-2008 simulations the values of efficiency change by about 10% over the 0.6 MeV range of the threshold.

References:

[1] <http://wwwasdoc.web.cern.ch/wwwasdoc/geant.html3/geantall.html>
 [2] <http://www.fluka.org>
 [3] J. Zdebik, Diploma Thesis, Jagiellonian Uni. (2008), arXiv:0811.1377.

^a Institute of Physics, Jagiellonian University, PL-30-059 Cracow, Poland

^b IKP & ZEL, Forschungszentrum Jülich, D-52425 Jülich, Germany

¹The simulations were performed with the new 2008 version.