Activity on Nuclear Data Project in Korea

Guinyun Kim
Pohang Accelerator Laboratory, Pohang University of Science and Technology, San 31 Hyojadon, Namgu, Pohang 790-784, Korea

Jonghwa Chang
Nuclear Data Evaluation Laboratory, Korea Atomic Energy Research Institute, P. O. Box 105, Yosung, Taejon 305-600, Korea

1. Introduction

The nuclear data project as one of the nation-wide nuclear R&D programs was launched by the KAERI in 1997[1]. Its main goals are to establish a nuclear data system, to construct the infrastructure for the nuclear data productions and evaluations, and to develop a highly reliable nuclear data system. In order to build the infrastructure for the nuclear data production, KAERI wants to build an intense pulsed neutron source by utilizing accelerator facilities, technologies, and manpower at the Pohang Accelerator Laboratory (PAL). The PAL proposed the Pohang Neutron Facility (PNF), which consists of a 100-MeV electron linac, a water-cooled Ta target, and at least three different time-of-flight (TOF) paths [2]. The 100-MeV electron linac was designed and constructed based on experiences obtained from construction and operation of the 2-GeV linac at PAL.

We present the status of the pulsed neutron facility, and activities on the nuclear data production, evaluation, and processing.

2. Status of the Pulsed Neutron Facility

The PAL has constructed an electron linac for the various R&D activities of the neutron facility by utilizing the existing components and infrastructures at PAL on December 1997 [3]. The linac consists of a thermionic RF-gun, an alpha magnet, four quadrupole magnets, two 3-meter SLAC-type accelerating sections, a quadrupole triplet, and a beam-analyzing magnet. The beam acceleration experiment was performed on April 1998 [4]. The bunched electron beam was accelerated in the accelerating sections and transported to the end of the

linac. The maximum energy is 75 MeV up to now which is still lower than the target value. The measured beam currents at the entrance of the first accelerating structure and at the end of linac are 100 mA and 40 mA, respectively. The length of electron beam pulse is 1.8 μs and the pulse repetition rate is 12 Hz. The measured energy spread is ±1% at minimum.

The target system, which is composed of ten sheets of Ta plate with 4.9-cm in diameter, 7.4-cm in length, and 0.15-cm water gap between them, was designed and fabricated [5]. The estimated flow rate of the cooling water is about 5 liters per minute in order to maintain below 45 °C. The estimated neutron yield per kW beam power at the target is 2.0×10^{12} n/sec by the MCNP code, which is about 2.5% lower than the calculated value based on the Swanson's formula.

They constructed a 15-m long TOF path perpendicular to the electron linac and an experimental hall. With this, the test of the Ta-target system and a data acquisition system will be performed from the middle of Sep., 1999.

3. Activities on Nuclear Data Production

Since there was no nuclear data production facility in Korea, there was no activity until the KAERI decided to launch the nuclear data project in 1997. Since then, the collaboration group for nuclear data production was organized from five universities in Korea and joined some experiments in the various neutron facilities in the world. They have measured the capture cross-sections [6] and the total cross-sections [7] of natural Dy and Hf samples in the energy region from 0.001 eV to about 100 keV by using the neutron TOF method at the 46 MeV electron linear accelerator of the Research Reactor Institute, Kyoto University. They also have measured the capture cross-sections for ^{232}Th [8] at the 122-m flight path of the IBR-30 pulsed neutron source of Joint Institute of Nuclear Research (JINR) in Dubna, Russia. The capture cross-sections of ^{164}Dy isotope [9] was measured by using pulsed neutrons provided from the 3.2 MV Pelletron Accelerator of the Research Laboratory for Nuclear Reactors at the Tokyo Institute of Technology. They have planed to measure the capture cross-sections for ^{162}Dy and ^{164}Dy isotope samples at KURRI in this year. There is also a discussion with Prof. M. Baba to join an experiment at the Tohoku University 4.5 MV Dynamitron facility in this year in order to get experiences.

As explained on the previous section, they have completed to construct a 15-m TOF facility at PAL. After checking the radiation level around the TOF facility and the linac, they would like to measure the angular distributions and energy spectra of photoneutrons from Ta-target system with the activation method and the TOF method. From the next year, they would like to measure total cross-sections for the well-known samples with TOF method.

4. Activities on Nuclear Data Evaluation, Processing, and Service

The Nuclear Data Evaluation Laboratory (NDEL) of KAERI consists of 7 regular and 5 temporally members at present. Among them, 7 are working for the evaluation, 4 for processing, and 1 for computer maintenance. The main computer facility is a linux cluster composed of 12 pentium PCs and three HP-700 series.

The NDEL has started re-evaluation of long-lived fission product nuclides with BNL NNDC. Currently, they are re-evaluating the resolved resonance parameters and the average resonance parameters for the unresolved energy region [10]. They will extend the evaluation up to 20 MeV with the model calculation by ABAREX, ECIS, and GNASH.

Intermediate energy data needs in Korea are mainly to support the design of a proton accelerator driven nuclide transmutation system [11]. In that purpose, they have developed a computer code system ECISPLOT based on ECIS and GNASH, joint with Japan Nuclear Data Center (JNDC). They have finished initial work with ECISPLOT[12]. They will continue this work under collaboration with JNDC.

There are several medical cyclotrons ranging from 30 to 50 MeV in Korea. To support the activity in producing nuclear medicine and industrial usage such as thin layer analysis (TLA), they started the evaluation for production cross-sections and the model calculations to estimate the subsidiary unwanted isotope production cross-sections with a scientist from China Nuclear Data Center (CNDC) [13].

For the feasibility study of constructing a pulsed neutron facility based on an electron linac, they have begun to study the photoneutron production cross-section [14]. They have joined the IAEA CRP on "Compilation and evaluation of photonuclear data for application". The scope of KAERI is about Mo, Sn, Zn, S and Cl. This work is performed together with an invited scientist from CNDC [15].

The NDEL has been providing various libraries for the lattice neutronics codes WIMS-D, CASMO-3, and HELIOS to support the nuclear fuel design and development activity in Korea.

They are supporting nuclear data requested by researchers inside of KAERI as well in Korea. To supply the nuclear data, they are collecting and upgrading the nuclear data from various sources, such as IAEA/NDS, OECD Databank, etc. The KAERI web service was designed to provide nuclear data for those who need the data but do not have time to study various conventions in nuclear data society. The table of nuclides provides nuclide-wise information about the mass based on Audi and Wapstra[16], decay property based on NUDAT[17], capture cross section graph based on NGATLAS[18], fission yield table based

on ENDF/B-6, and summary of neutron interaction cross section based on JENDL-3.2[19]. For easy access, they have provided the hypertext link to other nuclides in the decay chain and between natural elements and nuclides. References to the sources of data are provided. A link to the decay diagram is provided based on ENSDF. The decay diagram displays a level diagram and radiation intensity.

The cross section plotter service provides the on-line generation of graphs for each nuclide and reaction type. They are providing ENDF-B/VI and JEF-2 pointwise files and the MCNP library. The user may plot several nuclide and reaction types on one graph to make a comparison between nuclides, reactions or libraries. The user can change the energy and the cross section range and scale. The output is provided in GIF, EPS and ASCII text as well as on-screen display.

5. Summary

After the nuclear data project was launched by the KAERI in 1997, there are lots of progress on the nuclear data production, evaluation, processing and service in Korea. The PAL constructed a test neutron facility based on 100-MeV electron accelerator and joined various nuclear data production experiments in the world. The NDEL started lots of evaluation work and maintained Web server for nuclear data service inside Korea as well as all over the World. The nuclear data community in Korea is growing every year. I hope we will be ready to collaborate with other country for nuclear data production and evaluation.

6. References

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