

# Development of an Automatic Control Program for a Neutron Measurement in a Spent Fuel Assembly

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## 1. Introduction

The previous neutron measurement for a spent fuel assembly was carried out by manually moving the neutron source and the detector [1-4]. It resulted in an inaccuracy of the measurement interval and an inefficiency of the measurement time, which have largely affected the uncertainty of the measurement.

In this study, to improve this situation, a computer program has been developed for an integrated control of two devices: one is based on a PLC(Programmable Logic Controller) to move the neutron source and the other is a MCA(Multi Channel Analyzer) based on GENIE 2000 [5] to measure the neutron count. We have developed a control program that has an user-friendly interface and automatic control functions [6]. And we present the measurement of the background count based on the J14 assembly as the application of this control program.

## 2. Methods and Results

The automatic control program of the neutron measurement has been developed based on Visual C++. The program is equipped with a user-friendly interface of the input/output (I/O) and a display function for the measuring conditions. Figure 1 shows the main window of an executed program with the explanations of the fill-up the items.

This program consists of three parts which are the port communication, PLC and MCA control parts.

The first is the communication part. The communication type between the CPU of the PLC module box and the computer is a Rs-232 asynchronous type and the thread method is used in this program, which is a kind of process for multi-tasking in a communication between the PLC and the computer. When the communication condition is initialized as a 19200-baud rate, none parity, 8-data bit, 1-stop bit, the thread is created and operated, which means the writing, reading, analyzing, and monitoring modes can be used in the PC.

The second is the PLC part. The data communication between the PLC CPU and the computer is processed with the unique commands which have already been defined in the PLC. The PLC protocol is a Bit type which is a kind of toggle switch type. The object (neutron source or detector), direction (up or down) and handle (manual or automatic) can be chosen at each measurement point with this program.

The third, the controlling MCA program has been developed with Canberra's programming library. The library consists of several files including the head files in which the variables and the functions are declared according to the MCA's action. This program supports the various functions that display the time information and save the spectrum and its analysis results.

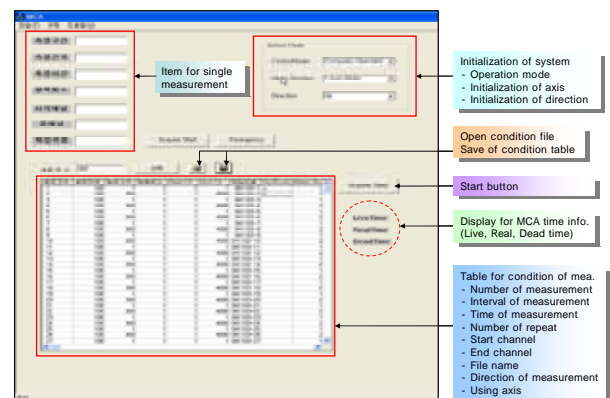


Figure 1. Main window of the automatic control program.

Figure 2 shows the whole algorithm for an automatic control program for the neutron measurement. The procedures according to the algorithm are as follows;

- 1) When the program is executed, the thread for the port communication is created on the main window.
- 2) After the initial conditions such as the operation mode, the object and the moving direction are set up, the measuring conditions are filled in the blank of the text box by using the keyboard or importing a text file.
- 3) The measurement is started by clicking the start button.
- 4) When the measurement is started, the PLC is operated according to the variables such as the moving object, the moving direction and the measuring interval which are prepared in the main window.
- 5) When the PLC operation is finished, the process for the MCA control is executed by reading the other variables such as the measurement time, the repeating number, the start channel, the end channel and the output filename which are prepared in the main window.
- 6) MCA process is repeated only if the repeating number is non-zero.

- 7) When the MCA process is finished, the next measurement is carried out. That is, the step in (2) is carried out continuously.

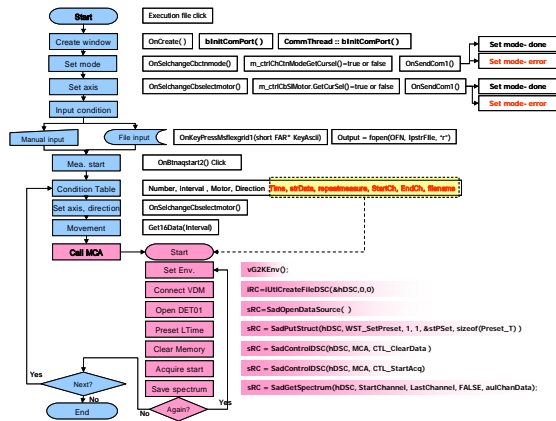


Figure 2. Whole algorithm of the automatic control program.

The performance test for the background count rate based on the J14 assembly has been carried out by using the control program. There are some grid lattices in the assembly. So, the count rate of the positions as grid lattices is measured less than the other positions because the burn-up of the spent fuel is relatively lower. The measurement conditions are as follows. The measurement interval has been set up to be 1500 points per 2 mm, and the measurement time has been set up to be 3 minutes per each position based on the axis length, 600-3600 mm range, of the spent fuel assembly. The measurement has been continuously processed for four days by using the automatic control program.

Figure 3 shows that the positions of the grid lattices of the spent fuel assembly are accurately observed and the result is more enhanced than that of the previous experiment [7]. In addition, we have verified that positions of the grid lattices are very consistent with those of the gamma scanning spectrums.

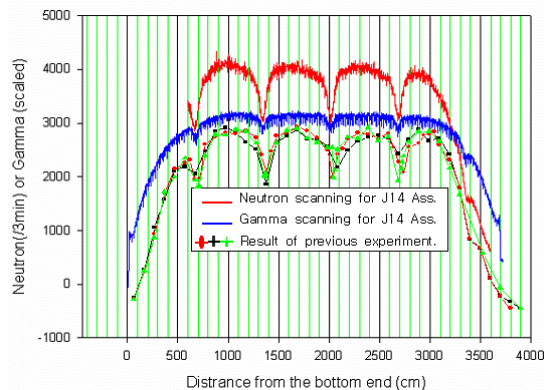


Figure 3. Comparison of neutron and gamma scanning results for J14 Assembly.

### 3. Conclusion

The integrated control program has been developed and its performance test has been successfully carried out. It is, therefore, concluded that the integrated control program improves the neutron measurement system from the view of the measurement accuracy and a measurement time saving.

We will further study the burn-up determination of the spent fuel rod with an application of the automatic control program and the neutron measurement system after developing the technology of a neutron scanning.

### ACKNOWLEDGEMENTS

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