CO3-1 Basic Research for Sophistication of High-power Reactor Noise Analysis (V)

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INTRODUCTION: Reactor noise for high-power reactors were actively measured in the 1960's and 1970's. The major focuses of those researches were for the abnormality diagnosis or the output stabilization diagnosis, and almost researchers were in the field of system control engineering or instrumentation engineering. High-power reactor noise measurements for dynamics' analysis of reactivity change, reactivity feedback or reactor characteristics itself were few in the time (1960's and 1970's), because of the powerless measurement system. In this research, we plan to measure KUR's output with present-day measurement system and plan to analyze with several analysis methods. The results of this work will supply some knowledges and technics in the aspect of sophistication of reactor noise analysis or simulation methods.

In this year, we tried to measure the reactor nuclide noise of the critical state KUR core via a ^{6}Li Lithium glass scintillator (GS20: Scintacor) at B-3 port focused on epi-thermal neutrons. The experimental work was done on 24th November 2022. As the result of the experiment, a result looks like the nuclear reactor noise was observed in 100W critical state.

EXPERIMENTS:
In this experiment, the output signal of the ^{6}Li Lithium glass scintillator was put into Spectro Scopy AMPs (2022: Canberra and 590A: ORTEC), and the output of the SSAs were measured with a time-series measurement system (HSMCA4106_LC: ANSeeN Inc.). A schematic view of the measurement is shown in Fig.1, and the counter installation overview is shown in Pic.1.

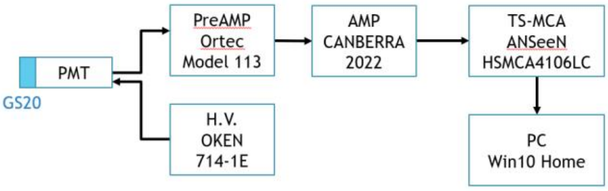

Fig. 1. Schematic view of the measurement.

The experimental condition is shown in Table.1. The reactor Power was set in 100W. The measurement time was 1,000 sec.

Pic. 1. An overview of the counter installation.

Table 1. Experimental condition.

Reactor Power [W]	Measurement Time [sec]	Count Rate [cps]
100	1,000	23 ～ 26

RESULTS:
The measurement results were analyzed by Feynman-α / bunching method and Rossi-α method.

As a result of the Feynman-α analysis, plot shapes like Feynman's theoretical formula were not obtained, because of the automation operation of the KUR.

As a result of the Rossi-α analysis, plot shapes like Orndoff's theoretical formula were obtained on the result.

An analysis results of the Feynman-α and the Rossi-α analysis are shown in Fig.2. The result of this work has large error bar even with the high-counting efficiency counter; GS20, and it means that the nuclide noise of the water moderate reactor has a trend to be trapped in a water moderator "prison".

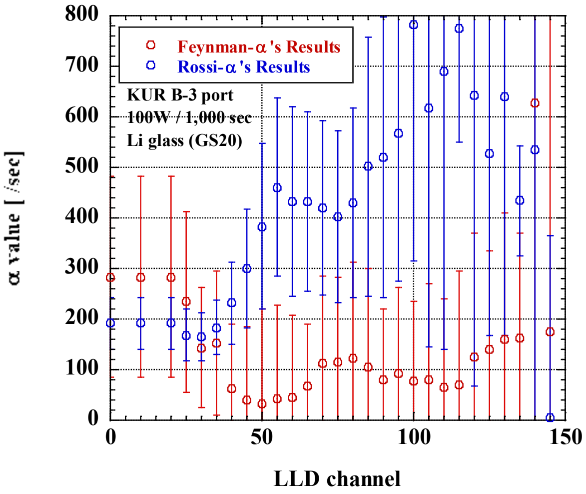

Fig. 2. A result example of Rossi-α analysis.

CO3-2 Reactor Keinetics Experiment in KUR

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INTRODUCTION: Reactor kinetics is the response of the reactor power obtained when the reactivity is inserted into a reactor core. This response is usually obtained as a change in reactor power and includes information on reactor kinetics parameters. Typically, reactor kinetics experiments are conducted using low-power reactors or critical assemblies. On the other hand, data obtained from reactor kinetics experiments in power reactor or high-power research reactor include various feedback reactivity that does not occur in low-power reactors or critical assemblies, so obtaining these data is very important for understanding reactor safety. However, in these high-power reactors, kinetic experiments are mostly measurements for tests and inspections for facility management, and it is impossible for researchers to utilize these data with some exceptions.

Therefore, the purpose of this study is to observe the KUR-specific feedback reactivity, and so on, by measuring the reactor power change during the startup of the KUR. The obtained data is important because such the kinetics experiments can be conducted only at KUR in Japan.

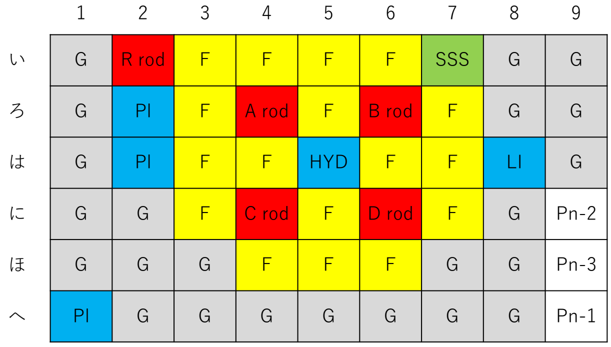
EXPERIMENTS: An experiment was conducted at the startup of the KUR as following processes.

1. Time series data of the startup system from two fission chambers, linear power meter, core outlet temperature and primary clear up system inlet temperature were measured at critical state with a thermal power of 20W. At this time, the A to D control rods has same positions, and criticality adjustment was operated by R rod.
2. The D rod was withdrawing out from the critical position and the time series data were measured. Here, the drawing distance was 1.21 cm. In addition, control rod maneuvers for negative reactivity compensation were not performed until the end of the measurement.
3. When the reactor power achieved about 15.6 kW, the measurements were completed. Because the negative reactivity by core temperature increasing compensated for the positive reactivity by control rod withdrawal, sot that the reactor power did not increase.

The time series data were obtained using a digital data collection system for operator assistance called the Harmonas system already installed on the KUR control console.

The KUR core location was shown in Fig.1. and table 1 shows the control rod positions and core outlet temperature at the low power (20W) criticality. The KUR was operated by natural circulation cooling mode. Thus, the generated heat was not cooled by the cooling system and increases the core temperature.

RESULTS: Fig. 2. shows the time series data of the reactor power by linear power meter. The initial reactor period (795 sec to 882 sec in the figure) by D rod withdrawing was 125.5 sec. Without feedback reactivities, a reactor power would increase exponentially. However, because of the heat generation in the KUR core, a negative feedback reactivity was observed in the time range from 1200 sec to 2200 sec.



	1	2	3	4	5	6	7	8	9
い	G	R rod	F	F	F	F	SSS	G	G
ろ	G	Pl	F	A rod	F	B rod	F	G	G
は	G	Pl	F	F	HYD	F	F	LI	G
に	G	G	F	C rod	F	D rod	F	G	Pn-2
ほ	G	G	G	F	F	F	G	G	Pn-3
へ	Pl	G	G	G	G	G	G	G	Pn-1

Fig. 1. Core location of the KUR .
F : Fuel element, G : Graphite reflector
Pl : Water plug, LI : Long irradiation element

Table 1. Control rod positions and core outlet temperature at the criticality with thermal power of 20 W.

A rod	41.65 cm
B rod	41.65 cm
C rod	41.65 cm
D rod	41.65 cm
R rod	24.98 cm
Core outlet temperature	23.83 ℃

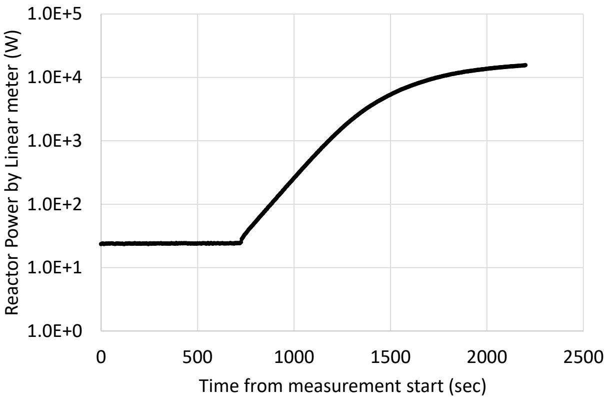


Fig. 2. Reactor power.