（別紙様式５）

変革を駆動する先端物理・数学プログラム（FoPM）
国外連携機関長期研修　報告書

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1. Background and Purpose

In order to explore new physics beyond the Standard Model, the Belle II experiment plans to accumulate the integrated luminosity of 50 ab^{-1}. The superKEKB collider, an accelerator used in the Belle II experiment, is designed to achieve the world's highest luminosity of 6.0×10^{35} $cm^{-2}s^{-1}$ so that we can accumulate the target integrated luminosity in reasonable time scale of about 15 years. The Belle II detector surrounds the beam collision point and consists of seven sub-detectors.

The Silicon Vertex Detector (SVD) is a type of silicon strip detector and responsible for particle decay vertex reconstruction, which has high position resolution for charged particles. The SVD, placed closest to the beam collision point within the Belle II detector, is exposed to intense radiation conditions. Therefore, it is crucial to monitor the radiation dose that the SVD is experiencing on daily basis. Diamond sensors placed near the SVD measure instantaneous radiation dose data, which is called "10Hz data". To understand the cumulative effect of the radiation on the SVD, it is necessary to integrate that 10Hz data after pedestal correction to calculate the integrated radiation dose. So far, this integration was performed manually over several days by an expert. However, by the last year, I developed a computational system to automate this calculation process. We call this system the "Calculation System".

Currently, access to 10Hz data and the operation of the Calculation System are managed by a few experts, including myself. On the other hand, considering the SuperKEKB collider aims to achieve a luminosity of 6.0×10^{35} $cm^{-2}s^{-1}$, the luminosity will further increase in the future, leading to more intense radiation conditions. In the light of this, it is desirable to establish a framework, where anyone can access data and perform radiation dose analysis at any time.

Therefore, we had two purposes for this overseas training. The first one was to construct a "Cycle System" that automatically calculates the integrated radiation dose for each day at that day's end and dumps it into the archiver. The second one was to build a "Visualizing System" with a user interface (UI) that responds to user requests by plotting and displaying the integrated radiation dose, and allows users to download the data in formats like CSV files. This enables users to conduct analyses at any time without waiting for long time to compute the integrated radiation dose from raw 10Hz data.

2. Achievement and what I learned

This study was conducted in three steps, each has the following content.

The design of the overall system:
The system is implemented on a Windows server. In our concept for the system design, the "Cycle System" incorporates the "Calculation System" we have already developed internally and shares the archiver with the "Visualizing System" (see Figure 1).

The implementation of the "Visualizing System":
The UI of the "Visualizing System" consists of a "Control Panel" and a "Plot Panel". In the Control Panel, users can select sensors, time period, and data types (integrated dose, pedestal value, luminosity) to be displayed on the Plot Panel. Depending on the selected items, graphs are displayed on the Plot Panel on-demand. Moreover, the Control Panel includes a "Download Button" that allows users to download the plotted data as a CSV file to a local directory.

The implementation of the "Cycle System":
The server checks the current time once every hour. If the time has passed more than one hour past midnight (00:00:00), it calls the "Calculation System". It calculates and outputs integrated radiation dose and pedestal correction values corresponding to the time period from the midnight of the previous day to the midnight of the day, and dumps them in the archiver.

This research was conducted in collaboration with software development experts from HEPHY. The design and implementation strategies of the system were discussed with these experts, and I was responsible for most of the actual implementation. The research progressed according to the planned schedule, and almost all of the work was completed during my stay at HEPHY. The remaining minor debugging and fine-tuning is planned to be completed before the next run period of the SuperKEKB collider.

Through this research, I learned about the method for system designing that can function stably even when accessed by a large indefinite number of users, as well as method for coding that can be operated and maintained by multiple experts. While I have some experience of programming extensively for various other research projects, this experience was unique and special. Furthermore, I obtained valuable experience in discussing system construction using specialized English terminology.

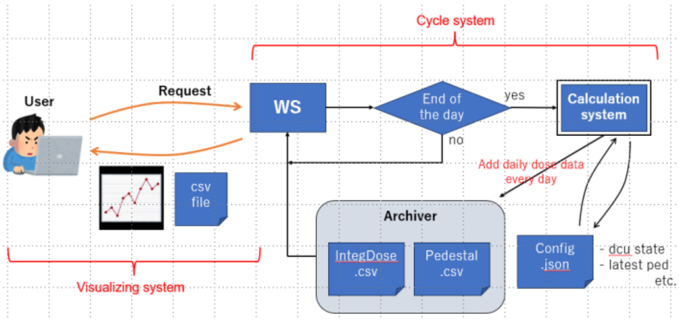

Figure 1: The design of the overall system

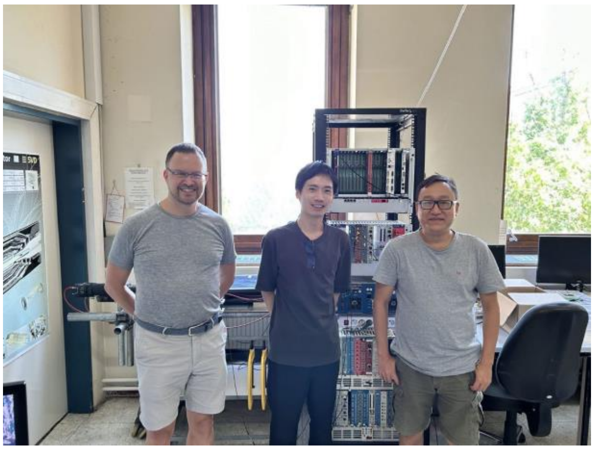

Figure 2: Photo with experts in HEPHY

3. Other experience
For me, visiting Europe was a first-time experience in my life. Austria is primarily a German-speaking country, and English is not its native language. Under such circumstances, it was a refreshing experience to communicate with local people with English as a second language to each other. Additionally, encountering the differences in rules and cultures between Japan and Austria in various aspects of daily life, such as restaurants, supermarkets, laundry, trains, and so on, was quite stimulating. I am grateful for the FoPM program, which provided me with such valuable opportunity.