

# ACCELERATOR CONTROL CLASS FOR GRADUATE STUDENTS IN SOKENDAI, KEK

N. Kamikubota<sup>1†</sup>, K. Furukawa<sup>1</sup>, M. Satoh<sup>1</sup>, S. Yamada<sup>1</sup>, and N. Yamamoto<sup>1</sup>, KEK, Ibaraki, Japan  
<sup>1</sup>also at the Graduate University for Advanced Studies, SOKENDAI, Hayama, Kanagawa, Japan

## Abstract

The Graduate University for Advanced Studies, known as SOKENDAI, provides educational opportunities for graduate students in collaboration with national research institutes in Japan. KEK is one of the institutes, and has a program *Accelerator Science*. Since 2019, we started two classes: *Introduction to accelerator control system* for one semester, and a two-day *Control of distributed devices for large systems*. The former consists of 12 lectures on various topics of accelerator controls by teachers, followed by a presentation day by students. The latter consists of lecture and hands-on, which enables students to practice EPICS with Raspberry-pi based devices. In the paper, status of accelerator control classes are reported.

## SOKENDAI AND KEK

### About SOKENDAI

SOKENDAI, the Graduate University for Advances Studies, was established in 1988, as a national university of Japan [1]. The headquarter is located in Hayama, Kanagawa, Japan. SOKENDAI does not have an undergraduate course. In close partnership and collaboration with research institutes, SOKENDAI operates Ph.D doctoral programs [2].

There are 20 research institutes in the scheme (see Fig. 1). They cover variety of fields: sciences of information, statistics, physics, accelerator, astronomy, fusion, space, molecular, material, environment, biology, physiology, polar, and cultural studies of anthropology and Japan. In 2023, 20 programs are available for education of graduate students, associated with the above research institutes.

### KEK and Accelerator Science Program

Since the foundation of SOKENDAI in 1988, KEK has been one of the research institutes of SOKENDAI. With the partnership, KEK provides three programs: a) Particle and Nuclear Science Program, b) Materials Structures Science Program, and c) Accelerator Science Program (see Table 1). The Accelerator Science Program is associated with two laboratories of KEK, Accelerator Laboratory and Applied Research Laboratory. The latter concerns radiation science, computing research, cryogenic research, and mechanical engineering. Table 2 shows the number of students of KEK's Programs in 2023. All of the programs contain certain amount of international students. They are mostly from Asian countries.

The Accelerator Science Program consists of various courses related to accelerator technologies as in Fig. 2. There are two types of courses, a half-year course and a

short course (less than a week). Most of them are the courses which will be held on a student's request. The complete list of the courses is given elsewhere [3].

Table 1: Programs and Associated Research Institutes or Laboratories of KEK

| Program                      | Research Institutes                                      |
|------------------------------|--|
| Particle and Nuclear Science | Institute of Particle and Nuclear Physics, KEK           |
| Materials Structure Science  | Institute of Material Structures Science, KEK            |
| Accelerator Science          | Accelerator Laboratory, Applied Research Laboratory, KEK |

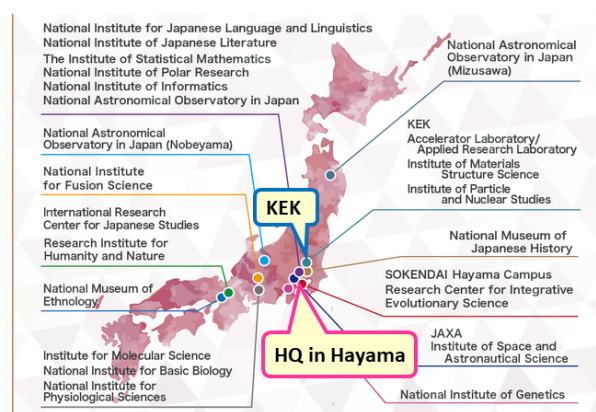


Figure 1: Partner research institutes of SOKENDAI [1] with highlights of the headquarter (HQ) and KEK.

Table 2: Numbers of Students of KEK's Programs

| Program                      | Number of Students | Number of International Students |
|------------------------------|--------------------|----------------------------------|
| Particle and Nuclear Science | 48                 | 13 (27%)                         |
| Materials Structure Science  | 8                  | 4 (50%)                          |
| Accelerator Science          | 14                 | 5 (36%)                          |

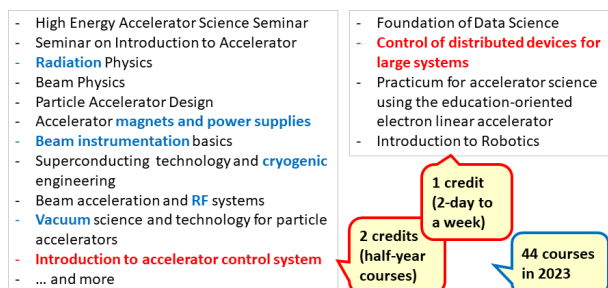


Figure 2: Part of courses of the *Accelerator Science Program*.

<sup>†</sup> norihiko.kamikubota@kek.jp

Content from this work may be used under the terms of the CC BY 4.0 licence (© 2023). Any distribution of this work must maintain attribution to the author(s), title of the work, publisher, and DOI

## ACCELERATOR CONTROL CLASS

### Two Accelerator Control Courses

As shown in Fig.2, there are two courses related to accelerator controls: (A) “Introduction to accelerator control system” and (B) “Control of distributed devices for large systems”. The former is a half-year course, consists of 12 lectures etc. by teachers, followed by a presentation day by students. The latter is a 2-day course, provides seminars with EPICS training materials, and hands-on experience of EPICS using a Raspberry-pi microcomputer.

The first accelerator control class, the course (A), was held in 2019-2020. During 2019-2022, classes of the course (A) were held three times, and the course (B) twice. The number of students are summarized in Table 3.

In total, 10 students attended so far. While 3 students joined both courses, the total number of personnel is 7. The accelerator control courses are open for all the Programs of SOKENDAI. It is worth noting that one student joined from Particle and Nuclear Science Program, and another from Materials Structure Science Program.

Table 3: Numbers of Students of Accelerator Control Classes. The Parentheses Mean International Students.

| Year of Course                    | Course (A) | Course (B) |
|-----------------------------------|------------|------------|
| FY2019-2<br>(Oct. 2019-Feb. 2020) | 4 (3)      | -          |
| FY2020-2<br>(Oct. 2020-Feb. 2021) | -          | 3 (2)      |
| FY2022-1<br>(May. 2022-Aug. 2020) | 1 (1)      | 1 (0)      |
| FY2022-2<br>(Oct. 2022-Feb. 2023) | 1 (0)      | -          |

### Control Classes in Reality

Typical contents of the half-year course (A) are shown in Fig. 3. There are 4 type of days: a) lecture day by teachers (red text), b) guided tour (blue text), c) hands-on day (green text), and d) presentation day by students (purple text). A photo of a lecture day and a photo of hands-on day are given in Figs.4 and 5.

| Date                        | Title                              | Contents   | Teacher(s)                 |
|-----------------------------|------------------------------------|--|----------------------------|
| 1: May 12                   | Controls: <b>Introduction</b>      | Control system design and operation                      | K. Furukawa                |
| 2: May 19                   | Controls: <b>History</b>           | History of accelerator control systems                   | N. Kamikubota              |
| 3: May 26                   | Controls: <b>Software</b>          | Software technology                                      | S. Yamada                  |
| 4: June 02                  | Controls: <b>Hardware</b>          | Hardware technology                                      | K. Furukawa                |
| 5: June 16                  | Implementation (KEKB&Linac)        | <b>Guided tour</b> to KEB&Linac                          | M. Satoh, K. Furukawa      |
| 6: June 23                  | Implementation (J-PARC)            | <b>Guided tour</b> to J-PARC                             | N. Kamikubota, S. Yamada   |
| 7: July 06                  | Controls: <b>Timing</b>            | Timing system  | N. Kamikubota              |
| 8: July 14                  | Controls: <b>Cyber security</b>    | Cyber security for control systems                       | N. Kamikubota              |
| 9,10: July 21<br>(full day) | EPICS lecture and hands-on         | Lecture and <b>hands-on</b> of EPICS with a Raspberry-pi | S. Yamada, N. Kamikubota   |
| 11: July 28                 | International <b>collaboration</b> | Introduction of EPICS collaboration                      | K. Furukawa, N. Kamikubota |
| 12: Aug.04                  | Controls: <b>protection</b>        | Safety protection systems                                | K. Furukawa                |
| 13: Aug.25                  | Presentation day                   | <b>Summary presentation by student</b>                   | by Student (J.P)           |

Figure 3: Contents of the course *Introduction to accelerator control system* in the FY2022-1.

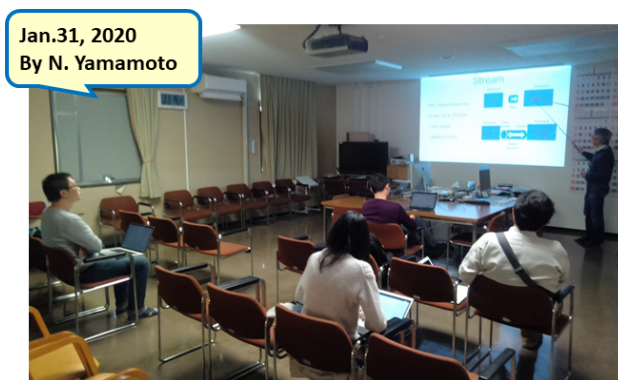


Figure 4: A photo of seminar day.

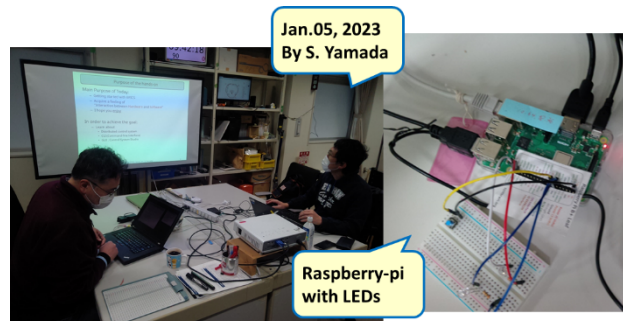


Figure 5: A photo of hand-on day.

A typical lecture by a teacher takes 40-60 minutes, followed by discussion time between teachers and students. In Fig. 6, part of the material for the lecture on *History*, used on May 19, 2020, is shown as an example.

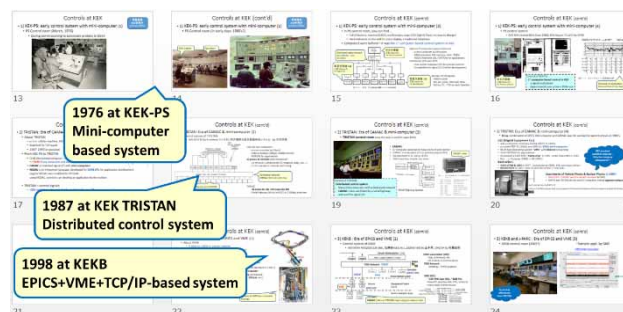


Figure 6: Part of material used in the *History* lecture.

## DISCUSSION

The fact, 10 students over 4 years attended the control classes, is not satisfactory for us. However, keeping the accelerator control classes at a graduate university is significant to enhance future human resources in the accelerator control field. We will keep the accelerator control courses, but more promotion to students, more improvements of materials are needed.

## CONCLUSION

With close partnership between SOKENDAI and KEK, KEK provides research and educational environment to graduate students for Ph.D. In the Accelerator Science Program, there are 14 graduate students in 2023. Among

various courses, two courses are related to accelerator control. Contents of the half-year course, *Introduction to accelerator control system*, are explained in detail in this paper.

During 2019-2022, 10 students attended the accelerator control classes. More promotion to students, and more improvement of materials are preferable for the future.

### ACKNOWLEDGEMENTS

The SOKENDAI office in KEK provided us detailed information of the student's statistics on our request. During

the control classes in 2019-2022, we received various helps and encouragements from the accelerator staff members of KEK. We deeply thank them and kindly ask for continuous helps in the future.

### REFERENCES

- [1] SOKENDAI, <https://www.soken.ac.jp/en/>
- [2] [https://www.soken.ac.jp/en/outline/organization/educational\\_research/](https://www.soken.ac.jp/en/outline/organization/educational_research/)
- [3] [https://www.soken.ac.jp/en/education/curriculum/course/file/9\\_kasoku\\_e.pdf](https://www.soken.ac.jp/en/education/curriculum/course/file/9_kasoku_e.pdf)