DEVELOPMENT STATUS OF PPS, MPS AND TS FOR IFMIF/EVEDA PROTOTYPE ACCELERATOR

H. Takahashi #, T. Kojima, K. Tsutsumi, K. Narita, K. Nishiyama,
Japan Atomic Energy Agency (JAEA), Rokkasho, Aomori, JAPAN
H. Sakaki, JAEA, Kizugawa, Kyoto, JAEA, JAPAN
S. Maebara, JAEA, Tokai, Ibaraki, JAEA, JAPAN

Abstract

Control System for the IFMIF/EVEDA Prototype Accelerator consists of six subsystems; Central Control System (CCS), Local Area Network (LAN), Personnel Protection System (PPS), Machine Protection System (MPS), Timing System (TS) and Local Control System (LCS). The Prototype Accelerator provides the deuteron beam with the beam power more than 1 MW, and this control system is required the high reliability and usability to perform various operation modes for beam commissioning. To satisfy these requirements, we are developing mainly PPS, MPS and TS at the beginning. This paper presents the status of hardware development of the PPS, MPS and TS.

INTRODUCTION

The IFMIF/EVEDA Prototype Accelerator is a deuteron accelerator with a huge beam power. The control system for the Prototype Accelerator must have functions to reduce radioactivation of accelerator vault and the accelerator components as low as possible, and to realize efficient validation tests with small beam losses. To realize these functions, this control system consists of six control subsystems, which are PPS and MPS for the safety function, and CCS, LAN, TS and LCS for the control and monitoring function [1]. It is important that the high reliability of hardware for the control system is realized by reduction of the development risk and the initial failure. Therefore, we have decided that the control system is developed by customizing proven systems and hardware. We have been conducting the development of PPS, MPS and TS utilizing the knowledge accumulated for J-PARC control system development.

BACKGROUND

The Prototype Accelerator consists of a 100keV injector equipped with an electron-cyclotron-resonance type ion source (ECR-IS) and a low energy beam transport line (LEBT), 5MeV RFQ, the medium energy beam transport line (MEBT), 9MeV four half-wave-resonator type superconducting linacs (SRF linac), a high energy beam transport line (HEBT), beam diagnostic system, a beam dump (BD) to receive the high energy beam power up to 1.2 MW in CW operation, and RF high power sources and subsystems [2]. These accelerator subsystems are developed by F4E (CEA, INFN, CIEMAT) and will be delivered and installed at Rokkasho site in Japan from 2012.

On the other hand, the IFMIF/EVEDA Accelerator Building was completed at the end of March 2010. The auxiliary facilities, such as the shielding door of accelerator vault, air-conditioning and ventilating system and so on, are also installed in the building.

In order to utilize the building, a function of PPS to manage the radiation safety was needed. Then, we started to develop and install the equipments for the radiation safety function, for example, electric keys, monitoring cameras, limit switches to manage the accelerator vault door open/close.

Because design and development of accelerator components are ongoing, we have to progress the control system development corresponding to the development of each accelerator subsystem in parallel.

We started to develop in 2010, and test and check the performance of the MPS backbone which is the most important part for beam inhibit after interlock signals from accelerator subsystems are sent out. We also started to develop the test bench for TS in 2010 to test and check. We found that the developed TS performance was enough to satisfy the requirement from the accelerator subsystems.

PPS

PPS protects the personnel against the radiation, the high current and the other risk factors. The PPS also have two functions; the radiation safety management function and the accelerator management function. The function for the radiation safety manages the door at the accelerator vault open/close for the entering/leaving, etc. That for the accelerator manages the accelerator subsystem action (permission/restriction) etc. PPS consists of Programmable Logic Controllers (PLCs), which are the core part of the PPS, and the console, the personnel key box, the emergency stop button, the monitoring cameras, the signal cables for accelerator operation status etc. Fig.1 shows the kinds and the locations of main PPS components which have been developed. After these components installation in the building, we have been designing and programming the management sequence on PLC since April 2011. At the present time, it is possible to manage the door for the entering/leaving in the radiation controlled area.

MPS

MPS controls the beam rapid stop to minimize the beam loss. The target time of the MPS signal transfer, which is the time from "the MPS unit received the

takahashi.hiroki@jaea.go.jp

Copyright © 2011 by IPAC'11/EPS-AG — cc Creative Commons Attribution 3.0 (CC BY 3.0)

interlock signal from accelerator subsystem" to "the MPS send the beam stop signal to the injector", is less than 10 micro seconds. To achieve the target time, the performance of MPS backbone is important. We have been conducting to test and check its performance. We installed and connected the MPS modules in the building. At present, we have completed the development of MPS hardware (modules, cables etc.) for performance test. Fig.2 shows the location of MPS modules for the performance test, and the MPS modules installed in one rack. We executed possible to control and monitor these MPS modules remotely by using EPICS. From autumn 2011, we will start to test and check the performance of MPS backbone (the signal transmission time etc.).

TS

The 1 MW beam is performed by CW operation mode. The pulse operation mode will be also necessary to be employed not only for beam operation for commissioning in order to reduce the radioactivation by the beam losses, but also for aging of RF conditioning. Therefore, it is important for the TS to have the performances that both modes are effectively performed and changed rapidly. At first, we developed TS test bench at JAEA, and succeeded in 2010 that TS test bench could output the timing signals for both pulse operation and CW operation [1]. As a next step, we got the timing signal information for Injector test from Injector group at CEA/Saclay (Fig.3). We also checked that TS test bench could output the trigger signals and the gate signals for Injector (Fig.4).

LINKAGE TEST

We planned and have been performing the linkage test of the PPS, MPS and TS in EU, to check "the interface" and "the behavior" between these systems and accelerator subsystems before each accelerator subsystem will be

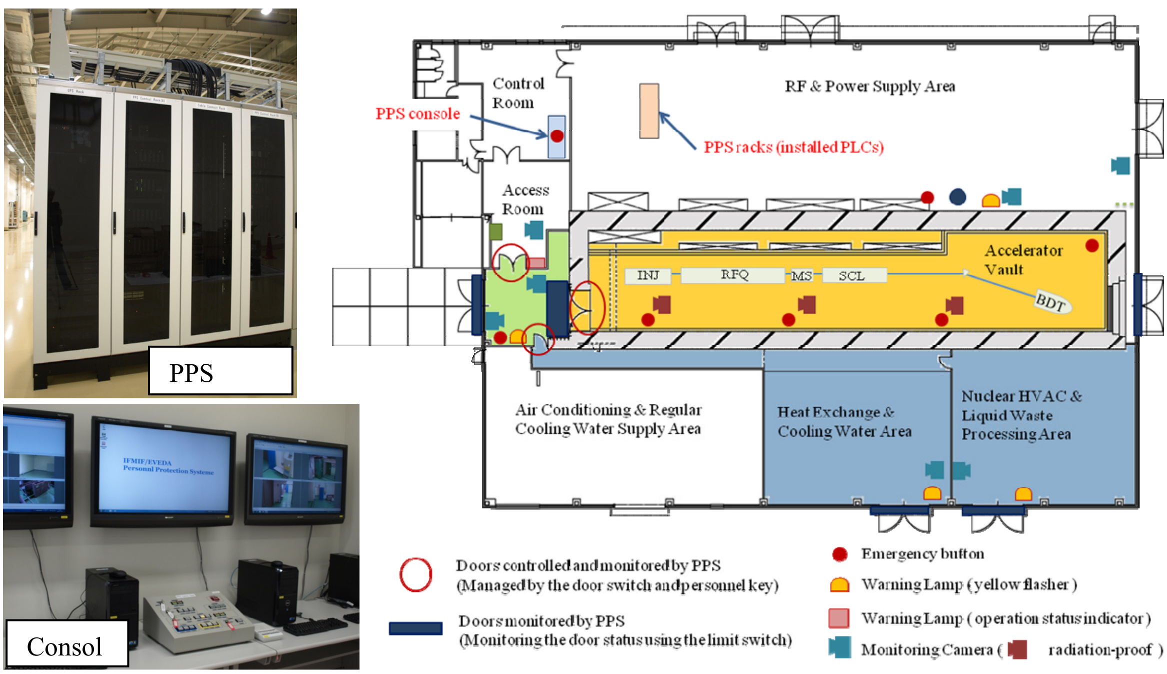

Figure 1: The kind and the location of main PPS components

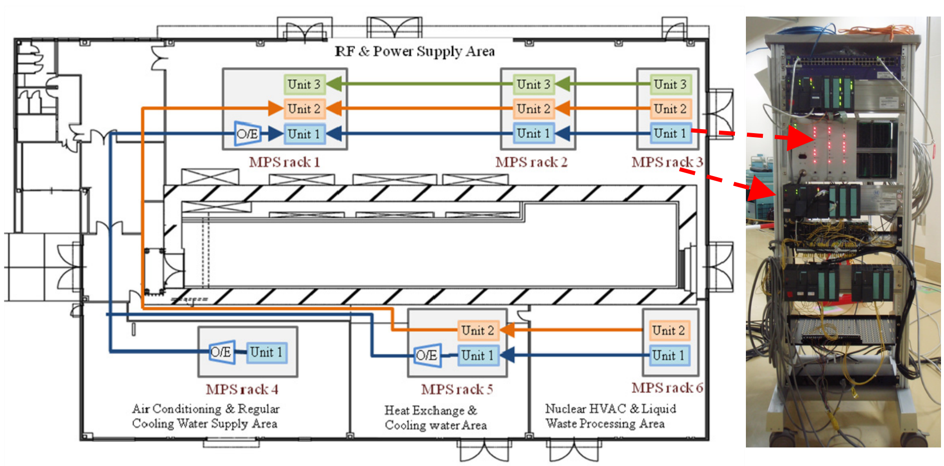

Figure 2: MPS modules location, connection and installation

Copyright © 2011 by IPAC'11/EPS-AG — cc Creative Commons Attribution 3.0 (CC BY 3.0)

delivered to Rokkasho site.

Injector Test

The Injector has been assembled and being tested at CEA/Saclay since January 2011. At first, we planned to perform the linkage test of TS with the Injector to check our TS performance. We delivered our TS test bench to CEA/Saclay in December 2010, and we visited to Saclay at the end of January 2011. With support from the control group members at CEA/Saclay, we could construct the TS test bench and check the behavior of TS for the Injector. At that time, we showed the TS usage to a responsible officer of Injector LCS. By this cooperation with CEA/Saclay, the environment of TS usage was prepared for Injector test. At present, our TS is still installed in the control rack for the Injector in CEA/Saclay and used for the Injector test (Fig.5). We are evaluating that our TS have the enough performance for Injector.

After autumn 2011, we will operate our PPS and MPS with the Injector test in EU to check the linkage of our PPS, MPS to the Injector. For the MPS, we plan to test the beam inhibit function. At this test, we will check the action of beam inhibit by MPS output signal for the beam inhibit to the first interlock circuit in the Injector. At present, we progress the preparation for this test.

Future Plan

The linkage test with other accelerator subsystems procured by EU will be performed similar procedures to that with the Injector to check the performance of PPS, MPS and TS. In addition, if needed, we will modify them based on the result of these linkage tests. At present, we are checking and fixing the interlock signal lists submitted from each accelerator subsystem. In addition, we will design and develop the MPS logic by discussion with officers for control system of accelerator subsystems.

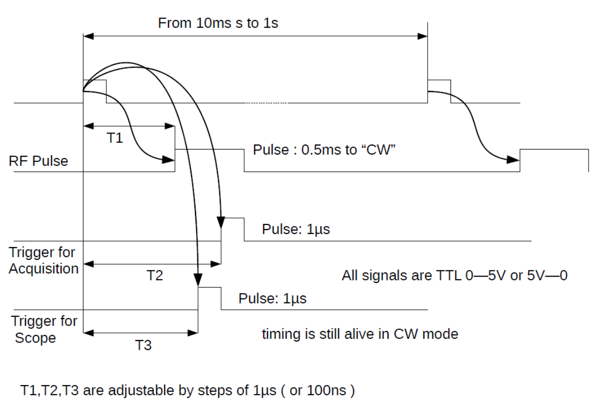

Figure 3: Timing chart for Injector

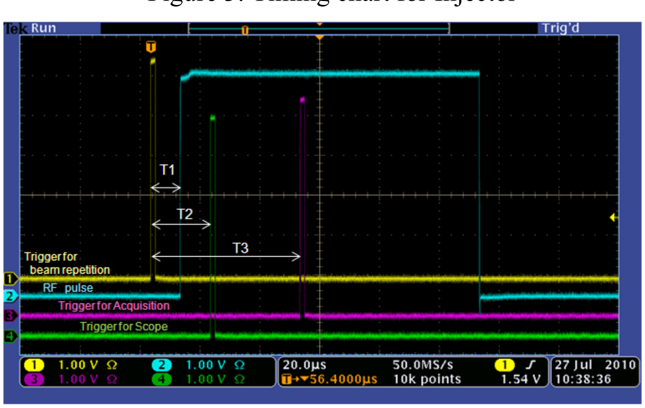

Figure 4: Timing signals output from TS test bench

CONCLUSION

One part of PPS for radiation safety was completed and is used to manage the accelerator vault door open/close. The MPS backbone for performance test was also installed in the IFMIF/EVEDA Building, and the hardware and software are ready for the performance test. The TS test bench for the Injector was completed and deliver to CEA/Saclay. According to the results of the TS test with the Injector, we confirmed that the TS have the abilities enough for the Injector operation. As the next step, we will perform the linkage test of "PPS and MPS" with the Injector from autumn 2011. The linkage test will be performed with other accelerator subsystems as well and the results of this test will feedback the design of PPS, MPS and TS.

ACKNOWLEDGEMENTS

The authors would like to express their thanks to Dr. Gournay Jean-Francois and Dr. Daniel Bogard, in the control group of CEA/Saclay, for their support of TS modules delivery, TS test and the TS setup for the Injector. We also would like to acknowledge for the support of the other IFMIF/EVEDA Accelerator System Group members in EU.

REFERENCES

[1] H. Takahashi, et al., "Present Status of MPS and TS for IFMIF/EVEDA Accelerator", Proceedings of IPAC'10, WEPEB006, Kyoto, Japan"

[2] A. Mosnier, et al., "The Accelerator Prototype of the IFMIF/EVEDA Project", Proceedings of IPAC'10, MOPEC056, Kyoto, Japan

Figure 5: TS installed in Injector rack

Copyright © 2011 by IPAC'11/EPS-AG — cc Creative Commons Attribution 3.0 (CC BY 3.0)