

# Implementation of EBIS Control System for a Pulsed Neutron Source at KOMAC

Sung-yun Cho <sup>a\*</sup>, Jae-Ha Kim, Young-Gi Song, Lee Seunghyun, Han-Sung Kim  
 Korea Multi-purpose Accelerator Complex, Korea Atomic Energy Research Institute 181 Miraero, GyeonCheon,  
 Gyeongju 38180

\*Corresponding author: Sungyun@kaeri.re.kr

## 1. Introduction

In Korea Multi-purpose Accelerator Complex (KOMAC), A 100MeV proton linear accelerator has been operated from 2012. A pulsed proton beam is extracted from ion source and accelerated to a tungsten target to generate pulsed neutron beam. The neutron beam has been demanded from many users. In order to provide a variety of neutron beam width, The Electron Beam Ion Source (EBIS) has been installed additionally in the tunnel [1][2]. The peripherals of the EBIS such as vacuum control system, High Voltage Power Supply (HVPS) have to be controlled in the control room because of dangers that are radiation and high-voltage. Accordingly, the integration control system has been configured with the distributed system based on Experimental Physics and Industrial Control System (EPICS) framework [3]. The user interfaces are displayed using Control System Studio (CSS) tool [4].

This paper explains the EBIS configuration and the control system. It also shows that the EBIS operation variables have been added to the client interface such as the alarm system, the data archiving system and user interfaces.

## 2. Design of the EBIS for short pulse proton beam

The KOMAC 100MeV linac was designed to transmit long pulse (>1ms) but also short pulse (<1μs) proton beam. The Microwave Ion Source (MWIS) has been operated for the injector which generates long pulses (>1ms). Since a permanent magnet EBIS (EBIS-A) [2] which generates short pulses (<1μs) has been installed, the KOMAC can provide long pulse and short pulse proton beam. In case of the MWIS injector, it was already aligned with 100MeV linac. On the other hand, since the EBIS was installed with the quadrupole deflectors, it transmits pulses to the acceleration line using bending magnet. The structure of the EBIS is shown in Fig.1

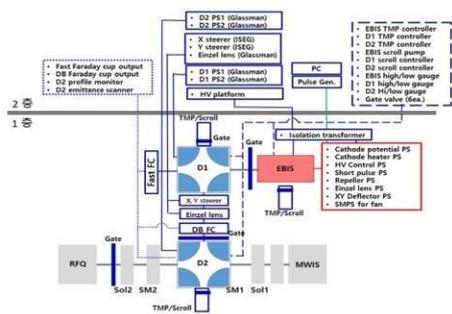


Fig 1. Structure of EBIS with control devices

## 3. Control system for EBIS

### 3.1 KOMAC control system

KOMAC control system based on EPICS framework has been implemented. The Input Output Controllers (IOCs) acts as each distributed system for control and monitoring. Each IOC consists of some modules such as Asyn, Streamdevice for communication with local devices by protocol communication [5] [6].

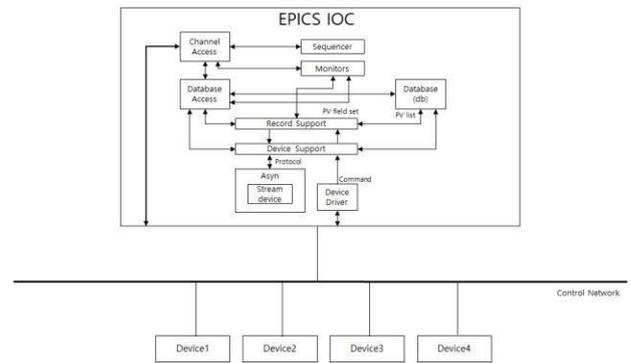


Fig 2. Structure of IOC

When an IOC is built with modules, Process Variables (PVs) are implemented and communicate with CSS tool using Channel Access (CA) protocol. Following Fig.3 shows the block diagram of KOMAC control system.

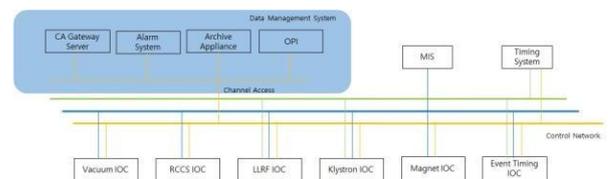


Fig 3. Block diagram of control system

### 3.2 EBIS control system

The EBIS is located beside to MWIS in parallel. In order to provide short pulse beam, the beam which is generated by EBIS must be transmitted to RFQ for acceleration. In this process, the quadrupole magnets are used to bend the beam. The vacuum environment in the EBIS system is also important for the beam transmission. So peripheral devices related to the magnet PS and vacuum devices are controlled by EPICS framework. Gate valves, TMPs and scroll pumps are controlled and monitored by PLC. The PLC communicates with the independent IOC using the tag address. Degree of vacuum and power

supply parameters are integrated at one IOC. The specifications of the EBIS control devices are summarized in Table I.

Table I: Problem Description

Device	Quantity	Remark
Glassman HVPS	7	Magnet power supply
ISEG HVPS	1	Polarity magnet
XGS 600 Gauge controller	2	EBIS, Quadrupole degree of vacuum
vacuum PLC	1	Valves, TMPs, scroll pumps
Nport	2	serial to ethernet
Switch	2	network

Devices for the EBIS are installed in the klystron gallery and the tunnel EBIS rack. In the case of the tunnel, some HVPS is floating high voltage during operation. A serial to ethernet converter and a network switch may be damaged by high-voltage. Therefore, the networking devices have been installed in the ion source control room that is located in the tunnel outside. Between the networking devices and devices, the optical communication is adopted since the networking devices can be damaged from the noise voltage. The layout of connection diagram is shown below in Fig.4

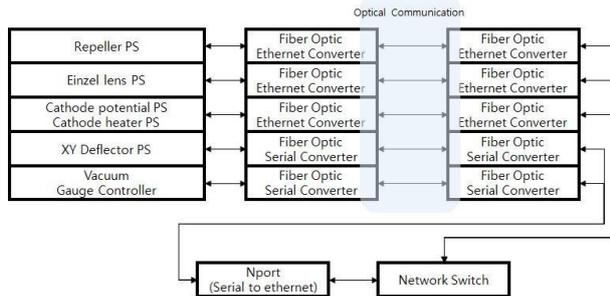


Fig 4. Diagram of communication devices

The EBIS IOC is installed on mini PC, Centos7 linux OS, linux-x86\_64 architecture. The IOC was configured on EPICS base 3.14.12.8, asyn 4-34, stream R2-6, calc R3.6.1, sscan 2.10 and Glassman module.

### 3.3 User Interface

The KOMAC user interfaces have been implemented based on CSS tool that communicates with EPICS IOC via CA protocol. User Interfaces of EBIS are also implemented based on the same tool. Operators control and monitor the status of process variables (PVs) via integrated UI. EBIS user interface integrates with the existing magnet and vacuum control user interface. It can access from main Operation Interface (OPI).

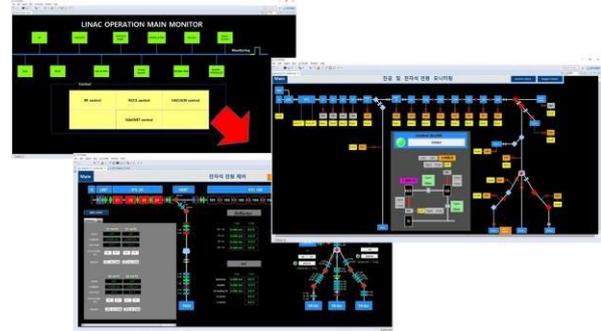


Fig 5. EBIS User Interface into existing UI

### 3.4 Archive system

The operating data of EBIS are archived into the archiver appliance server. Data are saved whenever the values are changed. The OPI can receive data from the archive system and also can export the data in file format.

### 3.5 Alarm system

The BEAST Alarm system based on CSS tool has been tested since it had been built last year [7]. This system provides functions such as alarm logging, alarm description, PVs group interface. Operating, parameters send an alarm information to alarm parameters if the parameters value reaches the limit. The limits are set with HIHI, HI, LOW and LOLO field of EPICS Database (DB). The EBIS alarm parameters about the vacuum system were added into the alarm system by importing the file based on XML extensible Markup language into the Alarmconfig tool. As a result, the EBIS group is generated on the CSS interface and the alarm system monitors degree of EBIS vacuum.

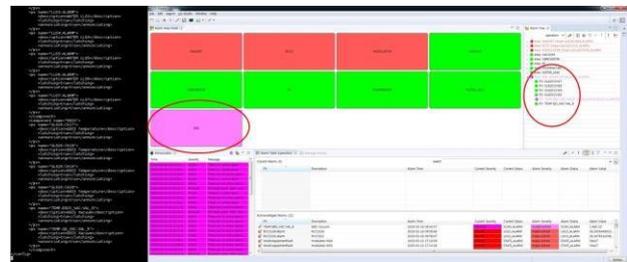


Fig 6. Alarm system based on CSS with alarm configuration

## 3. Conclusions

The EBIS system has been installed in the gallery and the tunnel ion source rack. The EBIS control system was implemented using EPICS framework. The EBIS operation parameters are controlled and monitored from the CSS interface and the EBIS IOC. The values of parameters are saved using the archive system and monitored using the BEAST alarm system. Accordingly, the EBIS system has been tested commissioning using the implemented EPICS control system. So the control system was successfully confirmed at this test.

## **REFERENCES**

- [1] Lee Seunghyun, Dang-Jeong-Jeung, KWON Hyeok-Jung, Jim Han-Sung, “EBIS Based Short Pulsed Proton Injector of 100MeV Linac for a Pulsed Neutron Source at KOMAC”
- [2] S.Lee, H.-J.Kwon, J.-J.Dang, H.-S.Kim, “Characterization of Short Pulse Extraction from EBIS and Status on 7T EBIS at KOMAC”
- [3] Experimental Physics and Industrial Control System (EPICS). [URL:http://www.aps.anl.gov/epics](http://www.aps.anl.gov/epics)
- [4] Control System Studio (CSS).  
[URL:http://controlsystemstudio.org](http://controlsystemstudio.org)
- [5] asynDriver : Asynchronous Driver Support (ASYN).  
[URL:http://epics.anl.gov/modules/soft/asyn/](http://epics.anl.gov/modules/soft/asyn/)
- [6] StreamDevice\_  
[URL:http://epics.web.psi.ch/software/streamdevice/](http://epics.web.psi.ch/software/streamdevice/)
- [7] Sung-yun Cho, Jae-Ha Kim, Young-Gi Song, Han-Sung Kim, “Build KOMAC Alarm System based on CSS BEAST Tool”