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Development of BPM/BLM DAQ System for KOMAC Beam Line

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1. Introduction

The 100-MeV proton linac at the Korea Multi-purpose Accelerator Complex (KOMAC) is composed of a 50-keV proton injector, a 3-MeV Radio-Frequency Quadrupole (RFQ) and a 100-MeV Drift Tube Linac (DTL). The proton beam is accelerated from 3 MeV to 100 MeV through 11 DTL tanks. The KOMAC installed 10 beam lines, 5 for 20-MeV beams and 5 for 100-MeV beams [1]. The proton beam is transmitted to two target room. The KOMAC has been operating two beam lines, one for 20 MeV and one for 100 MeV. New beam line, RI beam line is under commissioning. A Data Acquisition (DAQ) system is essential to monitor beam signals in an analog front-end circuitry from BPM and BLM at beam lines.

2. Beam Diagnostics

The KOMAC comprises beam diagnostics systems including a Beam Position Monitor (BPM), Beam Loss Monitor (BLM), and Beam Current Monitor (BCM). For beam position / phase measurement, 14 strip line type BPM sets were designed and fabricated for increasing the sensitivity. 20 BLM sets, four proportional types and 16 scintillation types, are installed with 20 pre-amps for beam loss monitoring. A layout of KOMAC beam diagnostic is shown in Fig. 1.

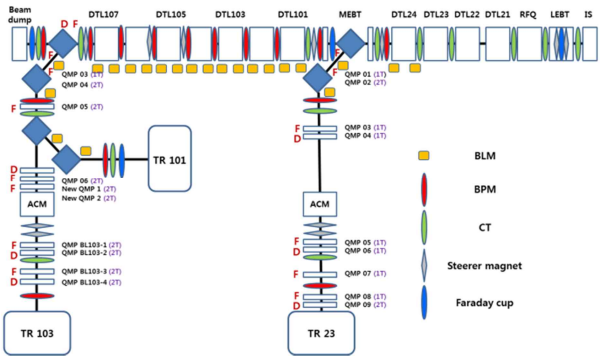

Fig. 1. Layout of beam diagnostics in KOMAC linac and beam lines

The KOMAC linac is operated by limiting beam losses to less than 1 W/m. When the un-intended excessive beam loss occur, the BLM inform this beam loss to operator and transmit the signal to the Machine Protection System (MPS) for the rapid shut-off of the machine [2]. The beam signals are fed to the data acquisition systems which operate in sampling mode. They sample the signals from the detectors and measure the beam loss through the pre-amp and position of X-Y +/- 2 V signal. A schematic view of the beam loss and position diagnostics is shown in Fig. 2.

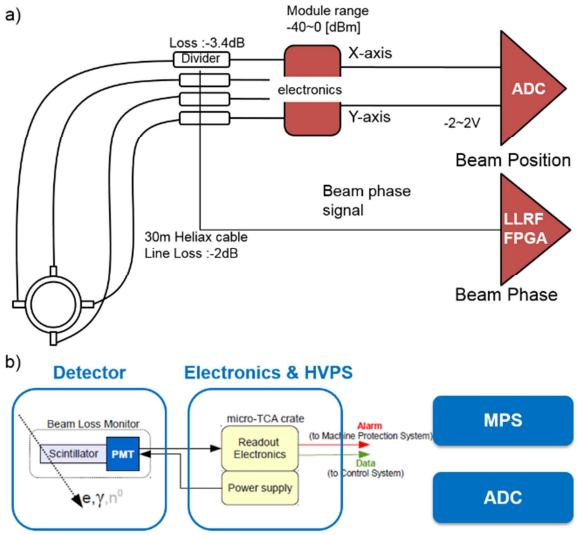

Fig. 2. Schematics of data acquisition of beam signals from the detectors for a) beam position monitor and b) beam loss monitor.

3. Beam Monitoring System

A data acquisition (DAQ) system is essential to monitor beam signals in an analog front-end circuitry from BPM and BLM at beam lines. The DAQ digitizes beam signal and the sampling is synchronized with a reference signal which is an external trigger for beam operation. The digitized data is accessible by the Experimental Physics and Industrial Control System (EPICS)-based control system, which manages the whole accelerator control [3].

3.1 DAQ system

The DAQ have to support external triggering for data sampling, high repetition rate that corresponds to beam repetition rate and Ethernet for external interface. To satisfy the requirement, an Input /Output Controller (IOC), which runs Linux on a CPU module with PCI-based DAQmx, PCI-6143, of National Instrument (NI) DAQ, has been adopted. An associated linux driver and EPICS device support module have been implemented. The IOC meets the requirements and the maintenance of the software for the IOC is considerably efficient.

A data acquisition system of a beam monitor with dual high speed CPUs is installed for the parallel processing of multiple threads in DAQ. We adopted CentOS6.6 which supports dual CPU hardware. Figure

3 shows the test device with Linux-based IOC including PCI ADC card and a terminal board.

Fig. 3. Data acquisition system under test.

3.2 EPICS IOC

The EPICS has a distributed architecture that provides several solutions such as independent programming tools for the operating system, operator interface tools, and archiving tools. The beam signals are sampled at a 3 MHz sampling rate. The AD data FIFO are made of 1024 samples, and one ADC card has 8 analog input channels. The analog input resolution is 16 bits. Once the ADC card operation stars by the external trigger, the control returns to the IOC. The ADC temporarily stores the acquired data in the onboard AD data FIFO and then transfers the data to a user defined DMA buffer memory in the IOC.

The sampled data are available to the EPICS device and driver, which contains dedicated equipment controllers, which in turn interface with the PCI ADC card through a PCI bus, and also support the production of an averaging value and waveform data. We can define the number of average length samples through an Operator Interface (OPI).

3.3 User Interface

A Control System Studio (CSS) OPI is used for displaying average values of the BLM and BPM. The OPI displays waveform data of BPM and BLM as indicated in Fig. 4. A WaveProc of EPICS module is used for processing information from waveform records [4].

4. Conclusions

The beam monitoring system integrates BLM and BPM signals into the control system and offers real-time data to operators. The IOC, which is implemented with Linux and a PCI driver, supports data acquisition as a very flexible solution. The data acquisition system is integrated with KOMAC control system.

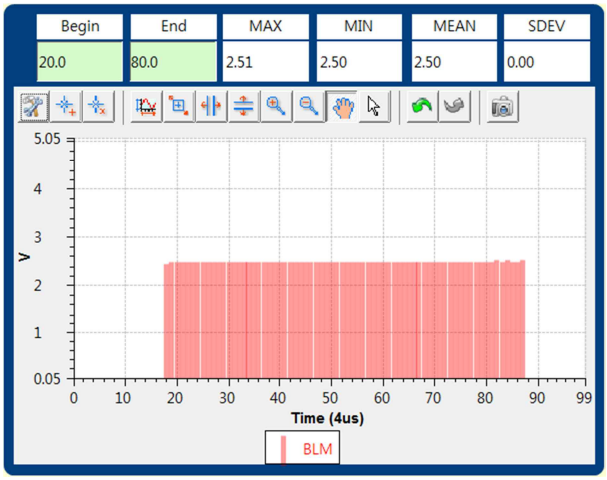

Fig. 4. Main screen for the user interface of BPM and BLM of linac and beam lines.

ACKNOWLEDGMENT

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REFERENCES

[1] Yong-Sub Cho, Hyeok-Jung Kwon, Dae-Il Kim, Han-Sung Kim, Jin-YeongRyu, Bum-Sik Park, Kyung-Tae Seol, Young-Gi Song, Sang-Pil Yun, Ji-Ho Jang, "The Komac Accelerator Facility", Proceeding of International Particle Accelerator Conference, Shanghai, China, 2013.

[2] Y.G. Song, "Interlock system for machine protection of the KOMAC 100-MeV proton linac", J. Korean Phys. Soc. 59, 577 (2013)

[3] Experimental Physics and Industrial Control System (EPICS). URL:http://www.aps.anl.gov/epics.

[4] Waveform Processing Module. URL:http://www.aps.anl.gov/epics/download/modules/index.php.