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The Construction of Beam Diagnostics system for the 100-MeV Proton Accelerator

Sang-Pil Yun*, Hyeok-Jung Kwon, Kyung-Tae Seol, Han-Sung Kim, Young-Gi Song, Ji-Ho Jang, Yong-Sub Cho
KOMAC, Korea Atomic Energy Research Institute
Daedeok-Daero 989-111, Yuseong-Gu, Daejeon, Korea
Corresponding author : spyun@kaeri.re.kr

1. Introduction

The 100-MeV proton linear accelerator of the Korea Multi-purpose Accelerator Complex (KOMAC) has been developed and has been installed at the Gyeong-ju site. After the 100-MeV machine is installed, the beam commissioning was performed in 2013. Nowadays, 20-MeV or 100-MeV proton beam are supplied to users. For accelerator operation and beam service, we have prepared various kinds of beam diagnostic instruments to measure beam position, profile, current and other properties.

2. Beam Diagnostic for KOMAC

The beam diagnostics system for KOMAC 100-MeV Linac consist of 14 BPM (beam position monitor), 13 CT (current transformer), 5 FC (Faraday cup), 20 BLM (Beam loss monitor) and 7 Steerer magnets. Figure 1 and Table 1 shows that the installation and their use of diagnostics instuments.

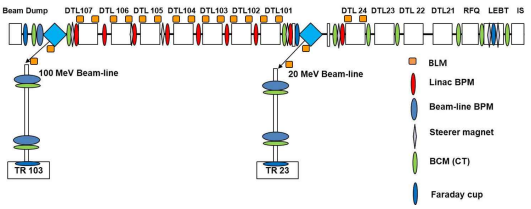


Fig. 1. Layout of beam diagnostics in KOMAC Linac

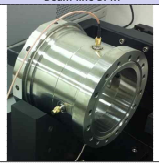
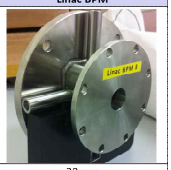
Table 1: Diagnostic instruments and their use

Instrument type	Functions
Beam Position Monitor	Beam position, phase
Faraday cup	Beam current, time structure
Current transformer	Beam current, time structure
Fluorescent screen	Beam profile, image
Beam loss monitor	To minimize radiation

3. Beam Position Monitor

We have selected the strip line type BPM for the increased sensitivity of the relatively long bunches at the ends of the beam lines. Two types of BPM were designed and fabricated. 14 BPM consist of 9 BPM for linac and 5 BPM for beamlines. Table 2 shows their design parameters.

Table 2: The specification of the fabricated BPM

Parameters	Beam-line BPM	Linac BPM
Photo		
Electrode inner diameter	100 mm	20 mm
Electrode thickness	2 mm	2 mm
Electrode angle	45 degree	60 degree
Electrode length	70 mm	25 mm
Electrode gap	15 mm	3.5 mm
Feed through	SMA type	SMA type
Signal frequency	350 MHz	350 / 700 MHz

The generated signal from BPM is converted to the voltage signal by BPM signal processing unit, and then the converted signal is transferred to ADC (analog to digital convertor). By this process, we can monitor the information of beam position through the whole linac and beamlines. . Figure 2 shows schematics of beam position monitoring system.

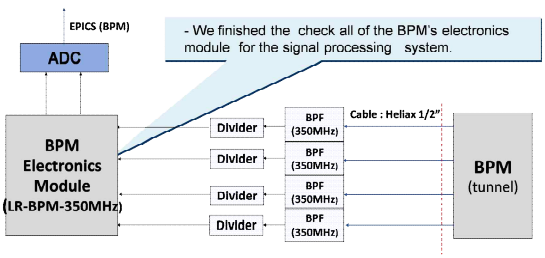


Fig. 2: Layout of beam position monitoring system

3. Beam current monitor

For beam current measurement, we have prepared two typed of diagnostic instruments, which are faraday cup and CT. the beam current signal from FC and CT is converted to voltage signal by the low noise pre-amplifier, and their signal is monitored by the oscilloscope. Through these systems, we can measure the beam intensity and time structure during the accelerator operation.

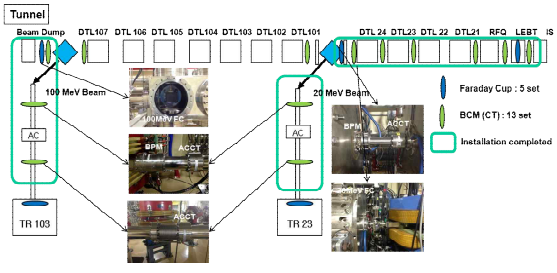


Fig. 3: Installation of beam current monitor

Faraday cup is fabricated with carbon beam stopper which produce low residual activity and motorized linear motion. They can be operated remotely. The CT is produced by Bergoz (France), and their sensitivity is 10 mA / V. Thus CT can measure from 1 mA up to 50 ma of beam current.

4. Beam loss monitor

The accelerator operation has to be carried out with the objective of limiting beam losses to less than 1 W/m [1]. When the un-intended excessive beam loss occur, the BLM(Beam Loss Monitor) inform this beam loss to operator and transmit the signal to the MPS (Machine Protection System) for the rapid shut-off of the machine. The scintillating detector and proportional counter were selected as the BLM detector because of their fast response time and high sensitivity. At the beam commissioning stage, 20 BLMs will be prepared for the beam loss monitoring. Figure 4 shows the installation layout of beam loss monitoring system.

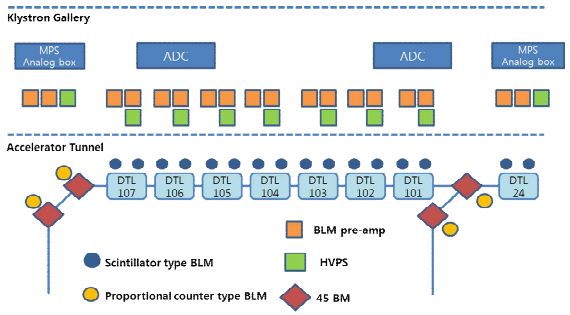


Fig.4: Installation layout of beam loss monitoring system

The scintillation detector and the proportional counter are typical current source. Therefore, the current pre-amplifier is required, to transform the voltage analog signal which can process the signal at the ADC (Analog to digital convertor) for the beam loss monitoring. And also, the signal processing unit can produce the inhibit signal and transfer to the MPS for the rapid beam shut-off. Figure 5 shows the design of the signal processing unit.

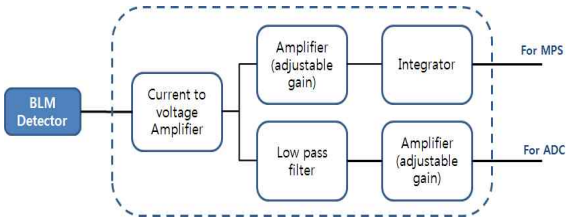
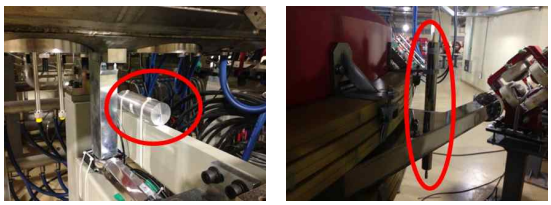


Fig.5 Schematics of signal processing unit

The 16 scintillation detectors will be installed at the middle of and the end of the each DTL tank . the 4 proportional counter detector are installed at the 45 degree bending magnets in the 20 MeV, 100 MeV beam line. The total 20 beam loss monitors are installed at the beam commissioning stage. Figure 6 shows the installation status of BLM



(a) scintillation detector (b) Proportional counter

Fig. 6: Installation of beam loss monitor

5. Summary

For accelerator operation and beam service, we have constructed and installed various kinds of beam diagnostic instruments to measure beam position, profile, current and other properties. That beam diagnostics system didn't stabilized but will be improved step by step.

Acknowledgements

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[3] Saint-Gobain Industrial Ceramics, Inc "Organic Scintillators, Related Materials and Detectors", 12345 Kinsman Road, Newbury, OH. (http://www.saint-gobain.com)