Preliminary Study on BLM-based RF stabilization technique for KOMAC DTL tanks

Gyuhaeng Jo[1], Sang-Pil Yun[1], Jae-Ha Kim[1], Young-Gi Song[1],
HanSung Kim[1], and Hyeok-Jung Kwon[†,1]
[1]Korea Multi-purpose Accelerator Complex, Korea Atomic Energy Research Institute,
181, Mirae-ro, Gyeongju-si, Gyeongsangbuk-do, Republic of Korea

Abstract

The beam loss monitor (BLM) is a key device for protecting accelerator systems, as it measures secondary radiation produced by a particle beam colliding with the inner wall of the accelerator. Therefore, in the KOMAC 100 MeV proton accelerator, BLMs were installed on the 20 MeV DTL (Drift Tube Linac) and 100 MeV DTL tanks for the purpose of machine protection. These BLMs are scintillator-based radiation detectors capable of operating in high-radiation environments, with two or more devices installed on each DTL tank [1]. In this study, BLM signals under unstable beam conditions were analyzed to verify that BLMs could not only measure proton beam loss but also detect RF instabilities.

METHODS AND RESULTS

Specifications of BLM at KOMAC

In this study, two types of scintillator detectors were utilized, and both detectors have the same electrical systematic structure, as described in Fig 1[2]. The first old scintillator detector type for BLMs is a hand-made type developed at KOMAC, while the other new type is a full-packaged Libera BLM [3]. Detailed BLM specifications are summarized in Table I.

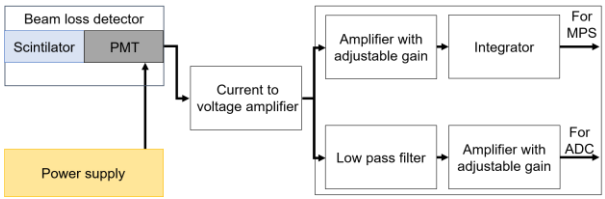


Fig 1: Typical beam loss monitor structure

Table 1: BLM specifications at KOMAC [3]

	Old BLMs	**New BLMs**
Scintillator type	BC-408 plastic (Saint-Gobain)	EJ-200 plastic (Scionix)
Scintillator size	ϕ25.4 × 30 mm	ϕ22 × 100 mm
PMT	R1924A	H10721-110
type	(Hamamatsu)	(Hamamatsu)
Applied voltage	-500 V	PoE
Sampling rate [kHz]	800	976.6

BLMs at the KOMAC 100 MeV proton accelerator are installed as shown in Fig 2. The two old, hand-made BLMs are installed in one DTL tank, located from DTL 24 to 107. Proton energy passing through DTL24 is 20 MeV while that after DTL 107 is 100 MeV. Additionally, the eight new BLMs are mounted from DTL 21 to 24. BLM placed at the center of each DTL tank is defined as 'Ch1', and that at the high energy end of the tank is denoted as 'Ch2'. Under these conditions, the preliminary beam loss monitor calibration experiments were conducted by varying beam duty.

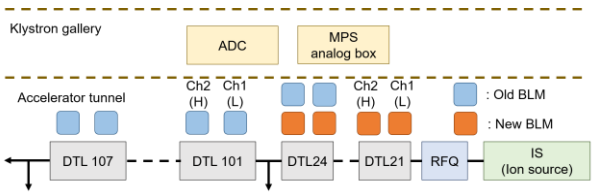


Fig 2: Scintillator BLM spots at KOMAC 100 MeV accelerator

BLM Signal Acquisition Results

Fig 3 and 4 illustrate the signals generated at both old and new BLMs when a 100 MeV proton beam is extracted for 100 μs. Unlike the old BLMs, background radiation signals whose width is 400 μs are reduced at the new BLMs due to the thin cover around them. Since the main component of the cover is aluminium, it can be deduced that the main flat background is the cavity x-ray induced by the klystron radiofrequency.

* This work was supported through KOMAC operation fund of KAERI (KAERI ID no.524320-26) funded by MSIT (Ministry of Science and ICT).
† hjkwon@kaeri.re.kr

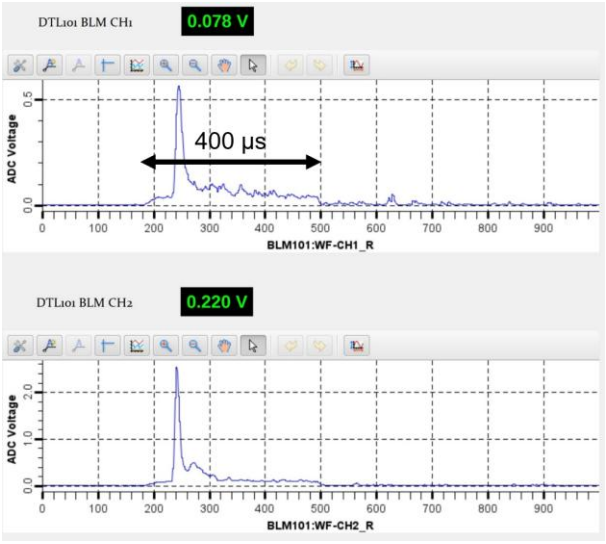


Fig 3: BLM signal acquisition results at the DTL 101

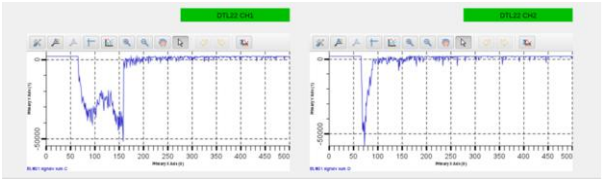
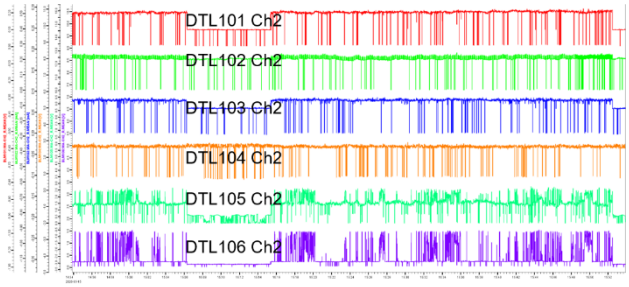


Fig 4: Example of reduced background radiation effects at the new BLMs

Fig 5 demonstrates BLM signal stabilization after maintenance and repair for DTL 105 tank and the detailed values are listed on Table 2. Due to the momentum conservation, secondary radiation is detected at the BLMs behind the actual proton beam collision point. Therefore, it was certified in this study with BLMs under the DTL tanks that the tuner seals at the DTL105 which are worn out is the main cause of the RF instabilities. Additionally, due to the fast response of the plastic scintillator, the detection of sudden RF instabilities is achievable with BLMs at KOMAC.



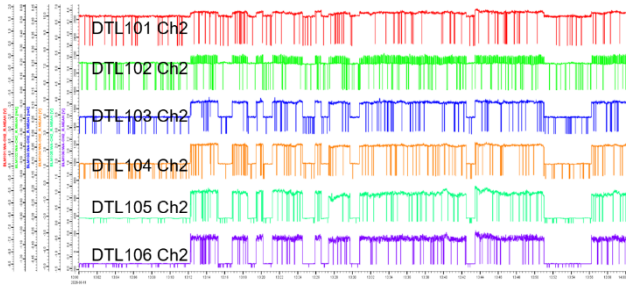


Fig 5: Average BLM voltage before (upper) and after (lower) DTL105 tank maintenance and repair

Table 2: Reduced DTL105 BLM signal fluctuations after DTL105 tank maintenance and repai

	DTL105 BLM ME		DTL105 BLM HE	
	BLM signal to MEBT current ratio [V/mA]	Relative standard deviation	BLM signal to MEBT current ratio [V/mA]	Relative standard deviation
Before maintenance	1.712E-1	1.825E-1	1.330E-1	3.628E-1
After maintenance	5.437E-2	2.323E-2	6.423E-2	1.657E-1

CONCLUSION

Beam loss monitoring through the scintillator detectors in the KOMAC DTL tanks was conducted under unstable RF conditions. As a result, it was confirmed that beam loss monitors installed at the KOMAC 100 MeV accelerator can serve not only for proton loss detection but also for monitoring RF instabilities.

DAQ system of BLMs improvement based on pulse shape discrimination method is on progress to separate neutron signals from cavity X-ray. After completion of this improvement, further BLM usages applicable after the accelerator upgrade, such as supplementary tools during the RF phase scan, would be conducted.

ACKNOWLEDGEMENTS

This work was supported through KOMAC operation fund of KAERI (KAERI ID no. 524320-26) funded by MSIT (Ministry of Science and ICT)

REFERENCES

[1] G. F. Knoll, Radiation Detection and Measurement, John Wiley & Sons, New York, 1999.

[2] G. Jo, S. Yun, J. Kim, Y. Song, D. Kim, H. Kim and H. Kwon, “A Preliminary Study on Beam Loss Monitor Calibration for KOMAC DTL tanks”, in *Proc. 2026 KNS Spring Conference,* Jeju Island, Republic of Korea, May 2026

[3] Libera BLM, Beam Loss Monitor Readout System User Manual, Instrumentation Technologies, Solkan, Slovenia, 2019.