MEASUREMENT OF THE BEAM POSITION MONITOR'S ELECTRICAL PERFORMANCE AND ELECTRONICS SENSITIVITY FOR 100-MEV PROTON LINAC AND BEAM LINES

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Abstract

The development of the beam position monitor (BPM) is in progress for the 100-MeV proton linac and 10 beam lines of the 1st phase of KOMAC. Those were selected the strip line type BPM for the proton linac and beam lines. 5 beam-line BPMs and 9 linac BPMs were checked their electrical performance in the RF test using by developed test stand and tested the Log-ratio BPM (Beam Position Monitor) electronics module of the Bergoz Instrumentation for direct beam position derivation signal from the pickup signal. After then, those will be installed 100-MeV proton Linac and beam lines for beam commissioning in February 2013. This presentation summarized the results of measured BPM's electrical performance and the Log-ratio BPM electronics pickup sensitivity.

INTRODUCTION

KOMAC is developing a 20-mA, 100-MeV proton linac and 10 beam lines for 20-MeV and 100MeV proton beams. The beam position is one of the important physical quantities to be monitored in a beam line [1]. The information can be used to steer the beam center position and reduce beam loss. The strip-line type BPM chosen for the increased sensitivity of the relatively long bunches at the ends of the beam lines and those 5 beam-line BPMs and 9 linac BPMs will be install beam-lines and Linac [2]. The layout of the beam diagnostics in KOMAC 100-MeV linac and beam-line is given in Figure 1. The finished fabrication of the prototype BPMs electrical performance was tested in the low power RF system and 20-MeV proton beam. The next, those were under the tested to use the Log-ratio BPM electronics module of the Bergoz Instrumentation for direct beam position derivation signal from the pickup signal. I have calibrated the Log-ratio BPM electronics using the RF signal which enables us to adjust the offset of Log-ratio BPM electronics. Those were measured specifics of BPM's electronics module and actual dynamic range. It was showed the pickup sensitivity of BPM's electronics and summarized results of the pickup sensitivity and Log-ratio BPM electronics calibration. Also those were checked the all of the BPM's electronics modules can be used for beam commissioning before installation.

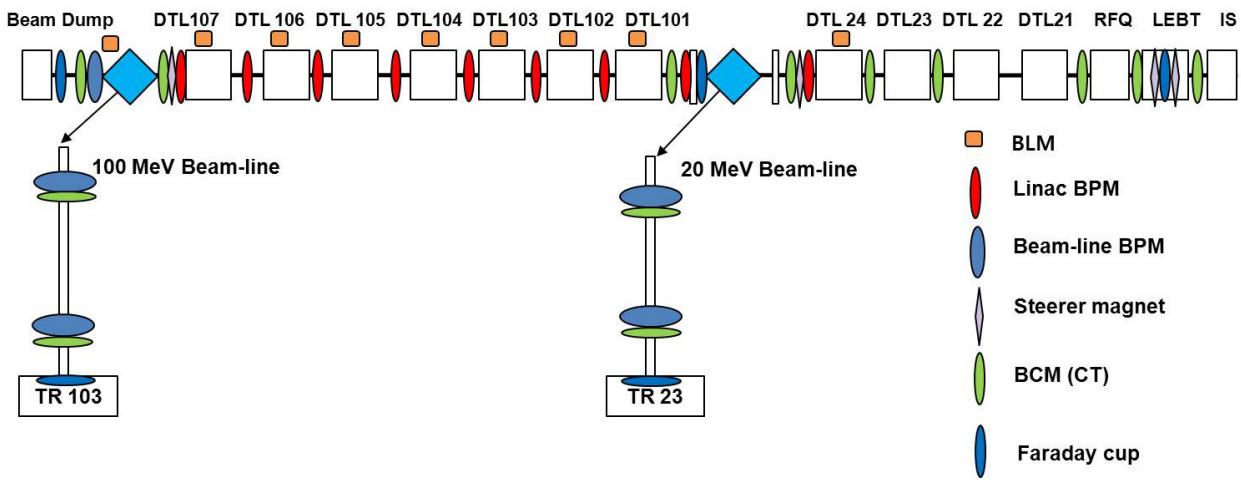

Figure 1: Layout of beam diagnostics in KOMAC 100-MeV linac and beam lines.

CHECK THE PERFORMANCE OF THE BPM ELECTONICS

The Log-ratio BPM electronics module of the Bergoz Instrumentation were under the test for measuring the direct beam position derivation from the pickup signals. The parameters of specifications of the LR-BPM electronics board are summarized in Table 1. The layout of the BPM electronics system is given in Figure 2. The signal from the BPM is through the 350 MHz band pass filter and signal divider for measured beam phase, after then we got the x-axis and y-axis position signals from electronics modules.

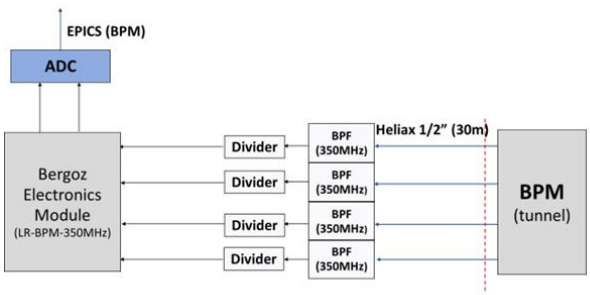

Figure 2: Layout of the BPM electronics system.

The fourteen LR-BPM boards were checked in this test and confirm the actual dynamic range in use. The condition of the measurement was 100 μs and 2 Hz. The measured minimum available value is about -60 dBm from the manual. IF the smaller than -60 dBm input signal, occurred the excessive noise and rapidly reduced output signal. Figure 3 showed the graph of the output signal due to the input signal using the BPM electronics. The reliability of the LR-BPM electronics boards was also checked by that test system. The characteristic of board is determined that consistently result in several times of measurement. Figure 4 showed the continuity of the BPM electronics signal measurement. The results of graph showed different values for x- and y-axis because the electronics boards were didn't zero offsets. Both x axis and y axis standard deviation are less than 5.

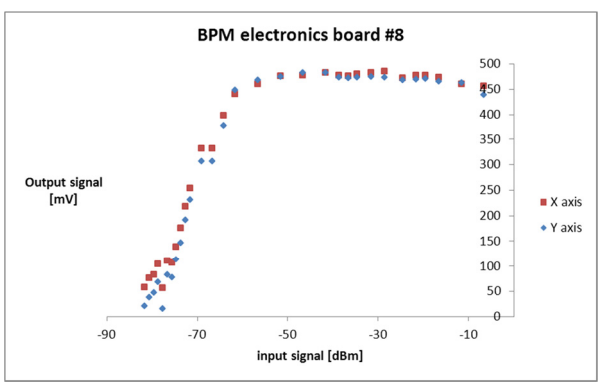

Figure 3: The result of the lowest measurable signal using the BPM electronics board.

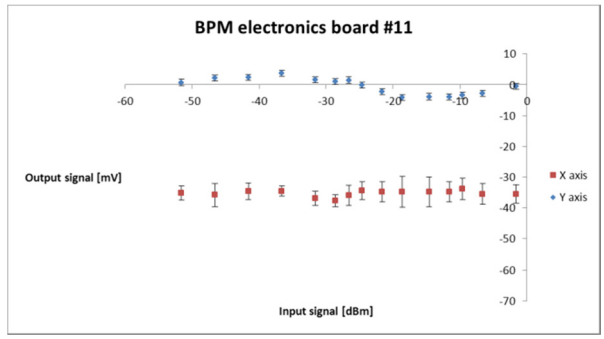

Figure 4: Measurement of the BPM electronics board signal reliability.

Table 1: Parameters of LR-BPM Electronics.

Parameter	Value
Operation frequency	350 MHz
Operation mode	CW or Pulsed
Accuracy	<50 μm
Bandwidth of output signal	>5 MHz
Dynamic range	-60 dBm ~ 5 dBm

MESUREMENT OF SENSITIVITY OF BPM ELECTRONICS

The BPM electronics boards have pick-up sensitivity x-axis and y axis separately. Those were measured sensitivity in the test was consist of RF signal generator, pulse delay generator and oscilloscope. Photo of the set-up the test is shown in Figure 5. The fourteen BPM electronics boards set in eight chassis case in order to minimize the occurrence of cable losses. The signal from the signal generator to the power splitter then 4 signals to board it was converted x-axis and y-axis signal values. Those were checked that signal from the oscilloscope. Using by the oscilloscope measurement condition are 100 μs and 2 Hz in pulse mode, and used boards are LR-BPM-350 MHz # 1 to # 14.

$$S_x = \frac{160}{Ln10}\frac{sin\left(\frac{\varphi}{2}\right)}{\varphi}\frac{x}{b}$$

From the equation [3] calculated position sensitivity is 3.3 dB per mm in linac BPM and 0.8 dB per mm. When we multiply two values, got the average sensitivity 140 mV per mm (x-axis), 145 mV per mm (y-axis) in linac BPM, 36 mV per mm(x-axis), 37 mV per mm(y-axis).

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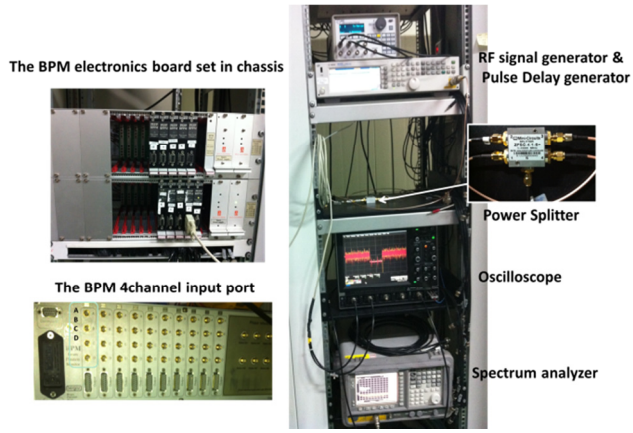

Figure 5: Photo of the set-up the electronics test.

CONCLUSION

KOMAC is developing a 20-mA, 100-MeV proton linac which consists of a 50-keV injector, a low energy beam transport (LEBT), a 3-MeV radio frequency quadrupole (RFQ), a 20-MeV Drift tube linac (DTL), a medium energy beam transport (MEBT), and a100-MeV DTL. KOMAC user facility includes 10 beam lines for 20-MeV and 100-MeV proton beams [4]. A strip line type BPM for KOMAC beam lines was designed and fabricated. The RF properties of the BPM we rechecked and the results of BPM sensitivity were tested using by 20-MeV proton beam in beam line. Those were finished checking of the compatibility with all of BPM electronics module for signal processing in beam position monitoring system. After then those were measured the pickup sensitivity of 14 BPM's electronics modules for signal processing system. The BPMs will be used in beam commissioning and operation of the 20-MeV and the 100-MeV linac and beam lines in May 2013 [5].

ACKNOWLEDGEMENT

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