ISBN: 978-3-95450-221-9 ISSN: 2226-0358 doi:10.18429/JACoW-ICALEPCS2021-THPV037

THE IMPLEMENTATION OF THE BEAM PROFILE APPLICATION FOR KOMAC BEAM EMITTANCE*

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Abstract

Korea Multi-purpose Accelerator Complex (KOMAC) has been operating a 100 MeV proton linear accelerator that accelerates a beam using ion source, a radio frequency quadrupole (RFQ), 11 drift tube linac (DTL). And the accelerated protons are transported to target rooms that meets the conditions required by the users. It is important to figure out the beam profile of the proton linac to provide the proper beam condition to users. We installed 8 wire scanners to measure beam emittance of KOMAC at beam lines. And beam profile application to measure beam emittance has been implemented using EPICS and python. This paper will describe the implementation of the beam profile application for KOMAC beam emittance.

INTRODUCTION

KOMAC has been operating five beamlines and five target rooms for clients. A proton beam that clients require is transported to a target room through a beamline. So it is important to identify the characteristics for the proton linac and a proton beam to provide and appropriate beam. Therefor KOMAC installed Beam profile measurement devices that are Beam Position Monitor, Beam Loss Monitor, Beam Phase Monitor to measure beam characteristics and eight wire scanners at beamlines that are TR23, TR103, TR104, TR105 and straight beamline to figure out the beam profile of the proton beam. Following Fig. 1 shows layout of KOMAC linac and beamlines.

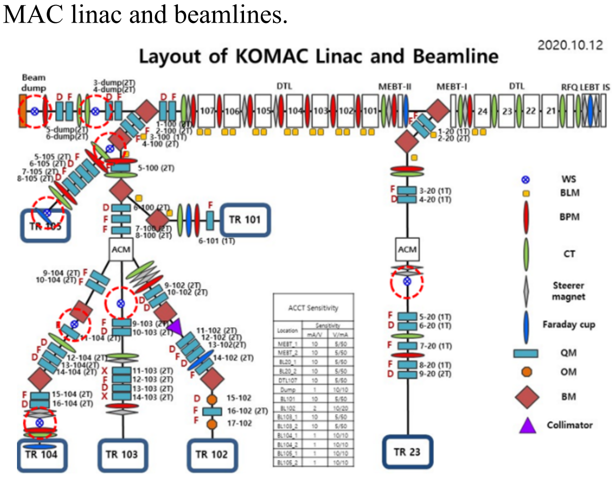

Figure 1: the layout of KOMAC linac and beamlines.

KOMAC control system based on Experimental Physics and Industrial Control System (EPICS) framework has been implemented to control the 100 MeV linac and peripheral devices at the control room [1]. Figure 2 shows the block diagram of KOMAC control system.

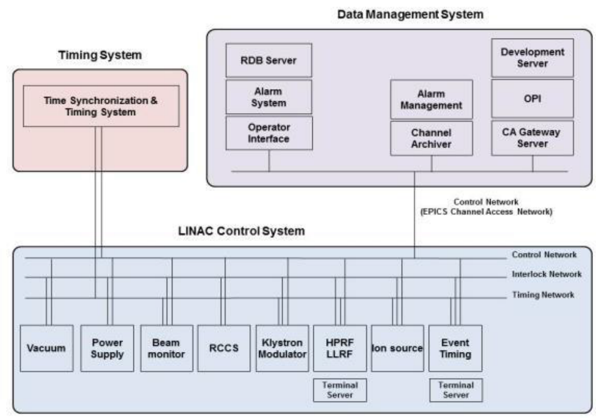

Figure 2: Block diagram of KOMAC control system.

We adopted Control System Studio (CSS) for user interface and Archiver Appliance for data saving system [2], [3]. And we have been developed high level applications that can communicate with the control system to study the beam profile of the linac. To integrate the wire scanner into KOMAC control system, the wire scanner control system was implemented using EPICS to control wire scanner and pyEPICS for data process [4].

WIRE SCANNER

The wire scanner has been developed to measure beam emittance of the KOMAC linac. The specification of the wire scanner is shown in Table 1.

Table 1: The Specification of The Wire Scanner

Specification	
Wire material	W tungsten
Wire diameter	0.1 mm
Moving speed &	100 mm/s, 50 mm
Range	(± 25 mm)
Spatial accuracy	0.05 mm
Spatial resolution	0.1 mm
Mounting Flange	6” CF

The wire scanner control system is divided into two part: driving wire scanner; data analysis. The layout of the existing wire scanner control system is shown in Fig. 3.

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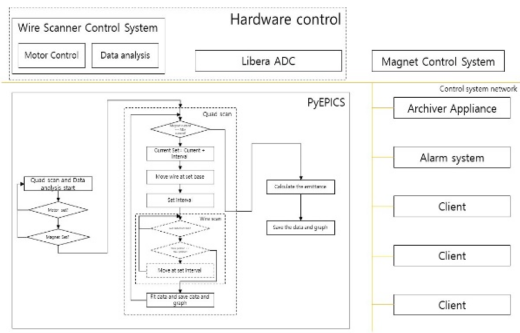

Figure 3: The existing wire scanner control system.

The part of driving wire scanner controls a position of the wires using the motor and gets the current data from the wires using libera ADC. The data process part analyses the obtained data from wire scanner.

Wire Scanner Control System

EPICS IOC controls a motor to move a position of a wire in wire scanner by communicating with a motor controller. A Libera digit electronic captures data whenever a beam passes the wires and delivers the data to EPICS IOC. For the convenience of managing the wire scanners, a wire scanner control unit that is made up of two motor controllers and a libera digit electronic, is created and installed as shown Fig. 4 and Fig. 5.

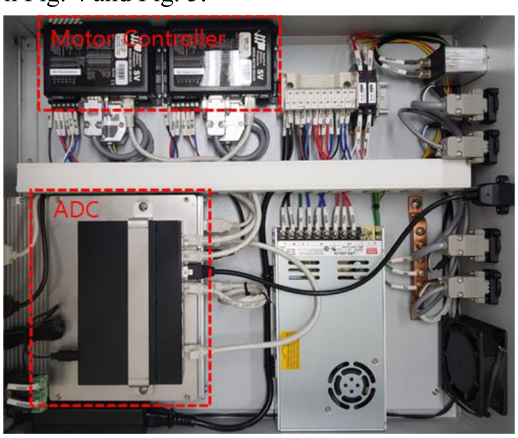

Figure 4: The wire scanner control units.

Figure 5: The wire scanner control units installed at KOMAC linac.

Quad Scan Interface with pyEPICS

pyEPICS that can access the EPICS IOC using Channel Access protocol was adopted for the quad scan interface. the quad scan interface using pyEPICS based on Python programming language takes data from EPICS IOC in synchronization with the beam repetition rate. The algorithm diagram of quad scan and data analysis is shown in Fig. 6.

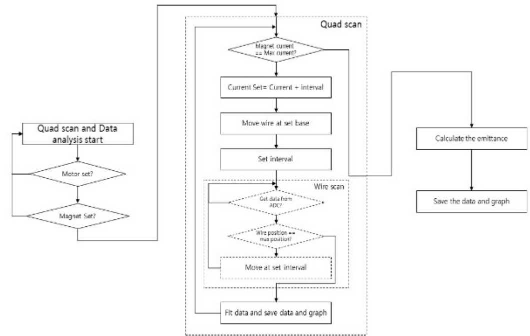

Figure 6: The algorithm diagram of the quad scan interface.

After quad scanning, the quad scan interface delivers the processed data to the EPICS IOC, and all the data are archived by the Archiver appliance that is chosen for the KOMAC data archiving system. In addition, the processed data are saved in file and picture format. However, quad scan interface must be running in the background as a daemon. And when a modification occurs, we need to modify both EPICS IOC and python code

Quad Scan Interface with sscan and asub Record

To simplify the process of the quad scan and wire scan, All the process has been integrated into the EPICS IOC. So for implementation of the quad scan interface, sscan EPICS modules and asub record were adopted [5], [6]. The sscan module performs the quad scan algorithm previously implemented by pyEPICS. The EPICS database for quad scan is shown in Fig. 7.

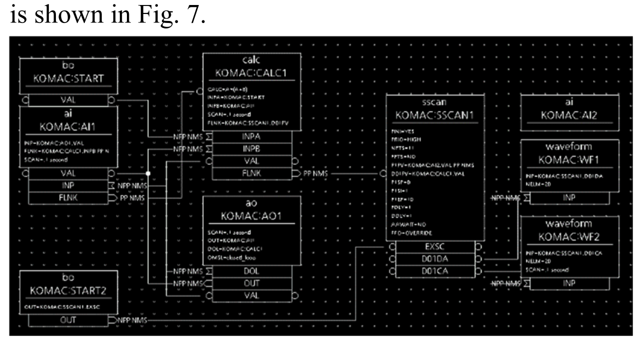

Figure 7: The block diagram of the EPICS database for the quad scan.

Quad scanning is started with the start button and the sscan module moves the wire and acquire data of a proton beam according to a beam repetition until the wire is moved at the set position. The obtained data are passed to the waveform record and are shown on CSS in real-time.

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After scanning, all the data are delivered to asub record and are analyzed. Figure 8 shows the raw data and the fitted data after quad scanning.

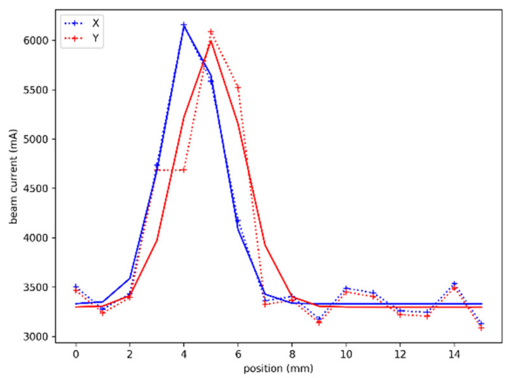

Figure 8: The raw data da fitted data from quad scan.

The obtained data are saved in text and graph file format. And asub record reads all the text file resulted from quad scan and calculated the rms beam size versus Field gradient that is shown in Fig. 9.

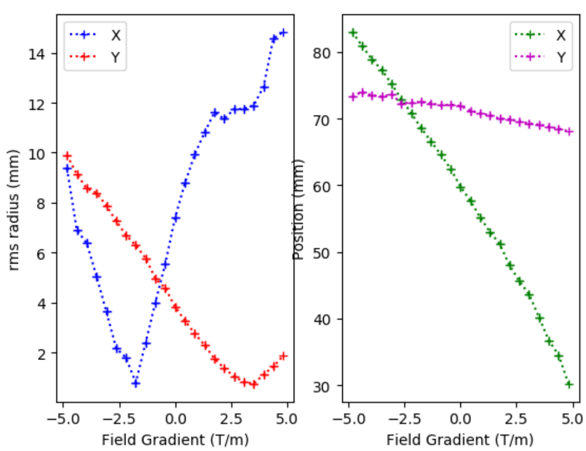

Figure 9: The rms beam size versus Field gradient.

The beam emittance of the 100 MeV proton linac is then obtained from the rm beam size versus field gradient. Following Fig. 10 shows the beam emittance in test environment.

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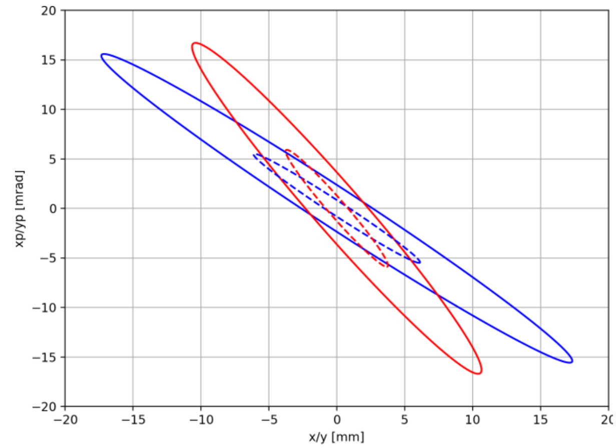

Figure 10: The beam emittance of the linac in test environment.

CONCLUSION

The beam profile application for the KOMAC beam emittance has been integrated into KOMAC control system. The wire scanner control system performs the quad scan and data processing automatically. By using sscan and asub record, the process of the quad scan has been reduced. The program shows the wire scan data in real time and then calculated the fitted data and beam emittance after quad scanning. In the future, the beam profile application is applied to KOMAC 100 MeV proton linac to conduct the test.

ACKNOWLEDGEMENTS

This work has been supported through KOMAC (Korea Multi-purpose Accelerator Complex) operation fund of KAERI by MSIT (Ministry of Sci-ence and ICT).

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[5] sscan – EPICS, https://epics.anl.gov/bcda/synApps/sscan/sscan.html
[6] Array Subroutine Record (aSub) – EPICS, https://epics.anl.gov/base/R7-0/4-docs/aSubRecord.html