Design of Slit-Collector System for the PEFP 20MeV linac

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1. Introduction

The emittance measurements are important in determining the behavior of beam. Knowing the emittance of a beam along its normal direction trajectory could be used to apply correction to the beam. There are several methods for measuring emittance. One of conventional ways is slit and collector method.[1] This method provides a relatively simple way to measure the emittance of a particle beam. In this study, the slit and collector system was designed for measuring the beam emittance at the end of the 20MeV beam line.

2. Methods and Results

2.1 Experiment Set-up

The slit and collector system will be installed at 20 MeV proton beam line, which consists of 4 quadrupole magnets and beam extraction window as shown in Fig. 1. The measurement of emittance is performed at the middle of the 4th quadrupole magnet and beam window. Table 1 shows the operation beam condition of the measuring beam emittance is shown.

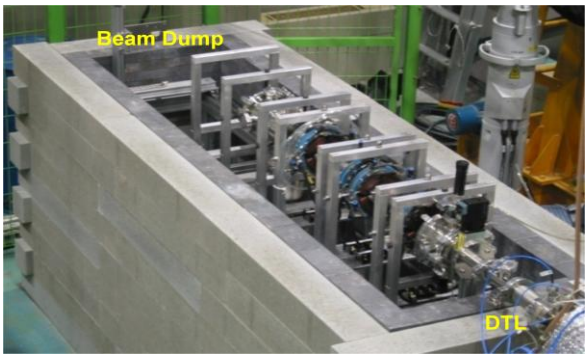


Fig. 1. 20 MeV proton accelerator beam line

Table 1. Beam parameters for emittance measurement

Parameter	Value
Beam Enegry	20 MeV
Beam Current	20 mA
Pulse Width	50 us
Repetition Rate	1Hz

In the process of measurement, a slit and a wire are stepped in small increments through the beam trajectory in normal direction. After the accelerated beam passed the slit, the beam is detected with a scanning wire (collector). The measurement system consists of a moving slit, a wire scanner, and supporting equipment which includes a linear motion, linear motion controller, an oscilloscope and a DAQ(Data Acquisition) module. The measurement system block diagram is shown in Fig. 2.

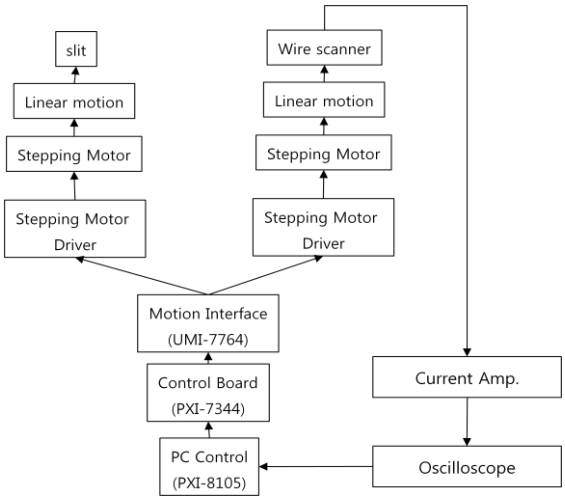
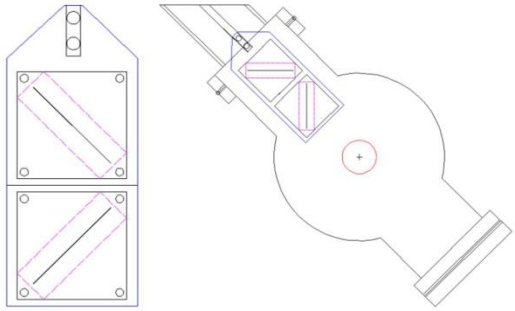


Fig. 2. Block diagram of the slit-collector system

2.2 Hardware.

The slit is mounted on the actuator which is inserted into the beam pipe by feed-through. The inserting angle is 45 degree. The slit system includes only one actuator to which two slits are attached. The actuator is designed to have the maximum moving range of 150mm toward 45 degree for covering the whole measurement point.



(a) (b)

Fig. 3. Drawings of slit (a) and inserting status in beam pipe (b)

Figure 3 presents the slit feature and drawing of inserting slit in the beam pipe. The wire scanner is installed at the downstream from slit by using same method as the slit is inserted. Table 2 shows a plausible parameter set for the slit and wire system.

Table 2. Slit and wire design parameters set

Parameter	Value
slit width	0.1 mm
slit length	50 mm
slit thickness	>5 mm
slit dimension	40 mm (square)
wire material	Tungsten
wire diameter	~ 0.1 mm
slit-wire spacing	>200 mm

In order to determine the slit material, the calculation of a thermal load on the slit was performed with assuming constant heat capacity and considering only the radiation heat transfer [2]. In the result, the temperature was increased up to 1200K with tungsten slit case under the operation beam condition. However, the temperature of the copper case was increased over its melting temperature.

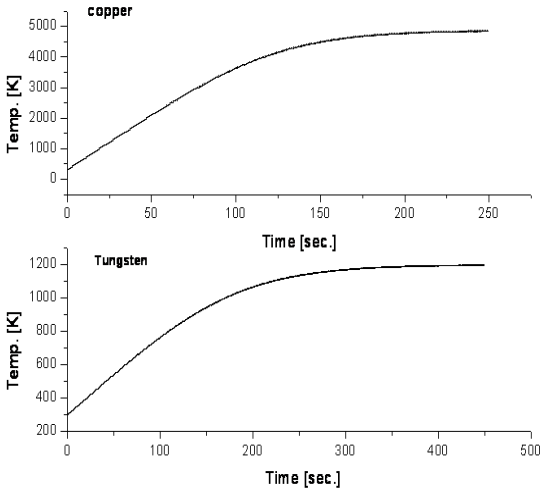


Fig. 4. Thermal load of materials for the slit under beam condition

Tungsten is a more suitable material than a copper from results of the calculation.

2.3 Control and Data Acquisition.

There are two main parts for measuring emittance with slit and wire. One is the slit and wire movement control system and the other is data acquisition system.

To cover the whole of the phase space, the slit and wire should move in a specific manner where the slit moves to position and the wire scans over the range from it. This is repeated for a number of planed slit positions until the whole beam has been scanned.

Signals are collected while the wire is scanning the beam behind the slit. For each position of the movable slit, all the beam divergence information is detected simultaneously by segmental controlled wire. The current from wire is converted into a voltage using a current amplifier. This signal is read out by the oscilloscope, and acquisition of the measured data is carried out by using LABVIEW program. Figure 5 shows the control interface for moving actuators and measuring signals.

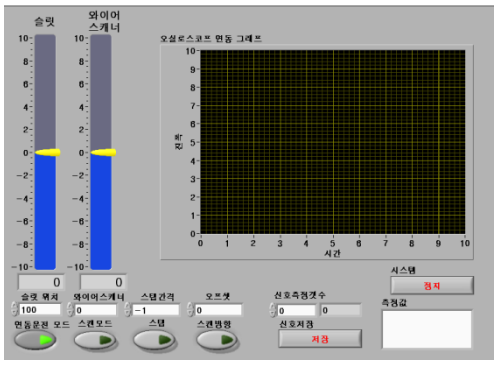


Fig. 5. Control interface of measurement system

3. Conclusions

The design of slit-collector system for emittance measurement is performed. To simplify the measuring process, slit is controlled by using only one actuator and the operation of actuators and signals measurement is controlled by using LABVIEW on united interface. The designed system will be fabricated and tested in near future.

4. Acknowledgement.

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REFERENCES

[1] K. Wittenburg, Conventional wire scanner for TESLA, DESY, 2000.
[2] B. Cheymol, Proceeding of IPAC'10 Kyoto, Japan. MOPE052, 2010.