Slit-Collector System for the Transverse Emittance Measurement for the PEFP 20MeV linac

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1. Introduction

There are several methods for measuring emittance. One of conventional method 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.

The slit and collector located on, perpendicularly to beam propagation direction, upstream and downstream respectively. The movable slit selects a small fraction of the beam that spreads out before it is scanned by the collector to determine the associated transverse angle distribution. [2]

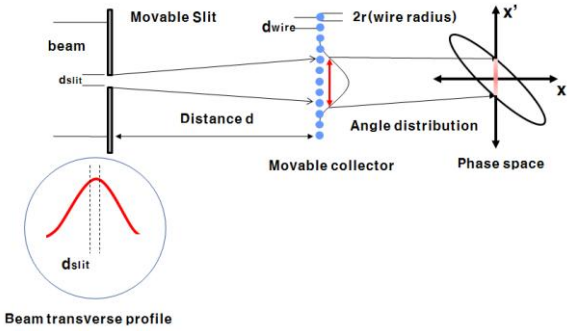

Fig. 1. Schematic of the slit and collector method for measurement of transverse beam emittance.

The results from this measurement use to evaluate the root-mean-square (rms) emittance. Base on the quantity of signal intensity c (x,x') passing through the position coordinate x with a angle distribution component x'.

2. Methods and Results

2.1 Experiment set-up

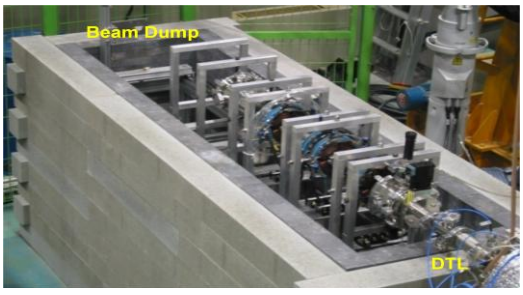

Fig. 2. 20 MeV proton accelerator beam line

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.

2.2 Slit thermal load

The slit material was determined by considering the thermal load for incident beam to slit. the beam condition which evaluated for increasing slit temperature were a beam power (20 MeV), a beam current (3 mA), a repetition rate(1Hz) and a beam pulse width(50 μs). In this calculation, the only radiation cooling was considered with cooling mechanism.

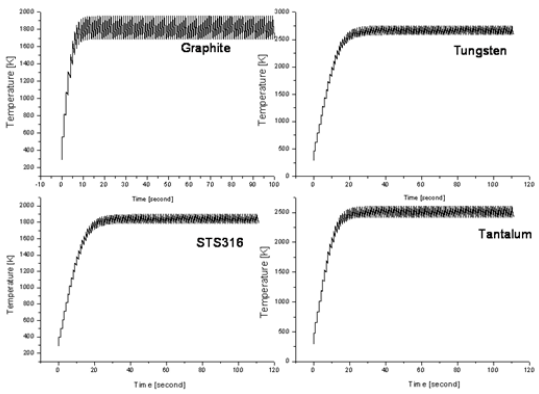

Fig. 3. Thermal load of materials for the slit under beam conditions

Graphite is a more suitable material than the other (Tungsten, STS316, and Tantalum) from results of the calculation. And the slit width for incident beam was determined by concerning a range of beam and limits of beam transition through the slit.

2.3 Slit and collector system

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

installed at the downstream from slit by using same method as the inserted slit. Figure 4 presents the slit feature and drawing of inserting collector in the beam pipe.

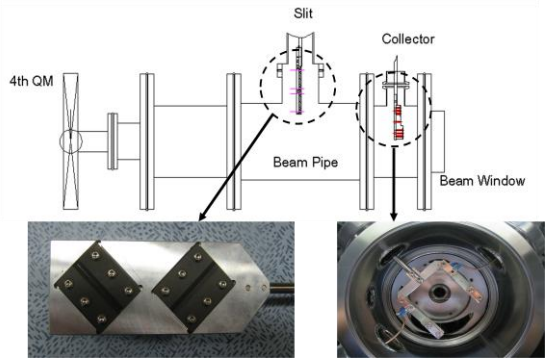

Fig. 4. Schematics of slit and collector system

The whole 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 Figure 5.

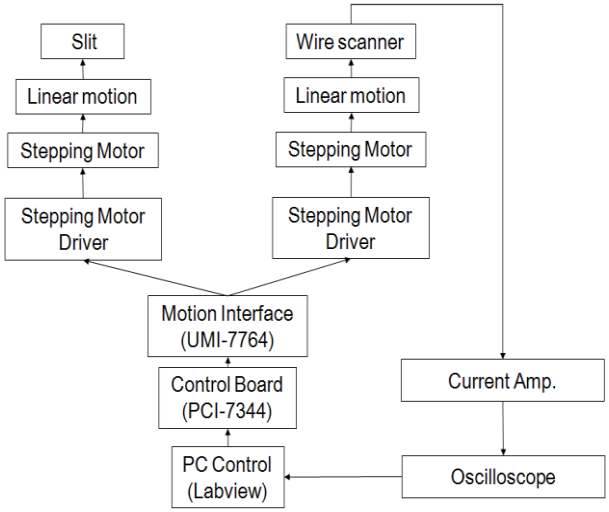

Fig. 5. Block diagram of the slit-collector system

2.4 Control and data acquisition.

There are two main parts for measuring emittance with slit and wire. One part is the slit and wire movement control system and the other part is data acquisition system. To cover the whole of the space to measure, the slit and collector 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 signals are detected simultaneously by segmental controlled collector. 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 6 shows the control interface for moving actuators and measuring signals.

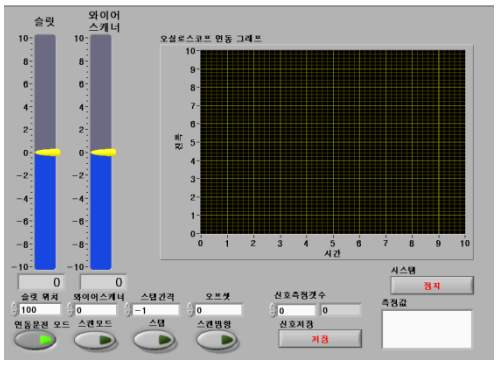

Fig. 6. LABVIEW control interface of measurement system

3. Conclusions

The transverse emittance measurement with slit-collector system 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.

4. Acknowledgement.

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