CONCEPTUAL DESIGN OF THE BEAM LINE FOR THE PEFP USER FACILITY*

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Abstract

The Proton Engineering Frontier Project (PEFP) will supply 20-MeV and 100-MeV proton beams from a 100 MeV proton linear accelerator for beam applications. The extracted 20 MeV or 100 MeV proton beams will be simultaneously distributed into the five targets through a dipole magnet equipped with a controllable AC power supply. The most important design criterion is the flexibility of the irradiation conditions in order to meet various user requirements in many application fields. For this purpose, we have designed the beamlines to the targets for wide or focused beams, external or in-vacuum beams, and horizontal or vertical beams. This work includes details of the conceptual design of the beamlines.

INTRODUCTION

The main concept of the PEFP proton beam facility is that a high power proton accelerator supplies proton beam to many users simultaneously. This concept can be compared with a facility with many low power proton accelerators for many users. Based on the user demand survey for proton beam applications, we had chosen a facility with a high power accelerator. There are many types of proton accelerator for proton beam applications, such as cyclotron, synchrotron, and linac. Because the capability of high beam power is the most important feature, we had decided to choose a linac for the main accelerator of the facility. Figure 1 shows the schematic diagram of the PEFP user beam line.

BEAM LINE REQURIEMENTS

The surveys for proton beam demand from many application fields, such as nano-technology (NT), bio-technology (BT), space technology (ST), and radio-isotope production, had been done through the homepage (http://www.komac.re.kr) and the user program from 2003 to 2006. From these activities, we had selected the common requirements for many applications and have summarized the beam line requirements for 10 beam lines of 100MeV and 20MeV. In the selection process, we had put more weighting to high beam power applications, which will be main applications in this facility.

Proton beams of 100MeV and 20MeV will be extracted and distributed to maximum five users simultaneously by AC magnets with a programmable current power supply. We will control the beam energy stepwise with RF ON/OFF of each DTL tank. To control the beam energy continuously, we will put energy degraders and energy filters in the beam lines for special applications.

BEAM LINES

Table 3 shows the beam parameters form the proton linac, which consists of a 50 keV proton injector, a 3 MeV RFQ, and a 20 MeV DTL [2], and a 100MeV DTL as shown in Figure 1.

Table 3: Beam Parameters.

Energy (MeV)	20	100
Energy spread (%)	< 1%	< 1%
Peak current (mA)	1~20	1~20
Max. beam duty (%)	24	8
Average beam current (mA)	0.1~4.8	0.1~1.6
Pulse width (ms)	0.1~2	0.1~1.33
Max. repetition rate (Hz)	120	60
Max. beam power (kW)	96	160

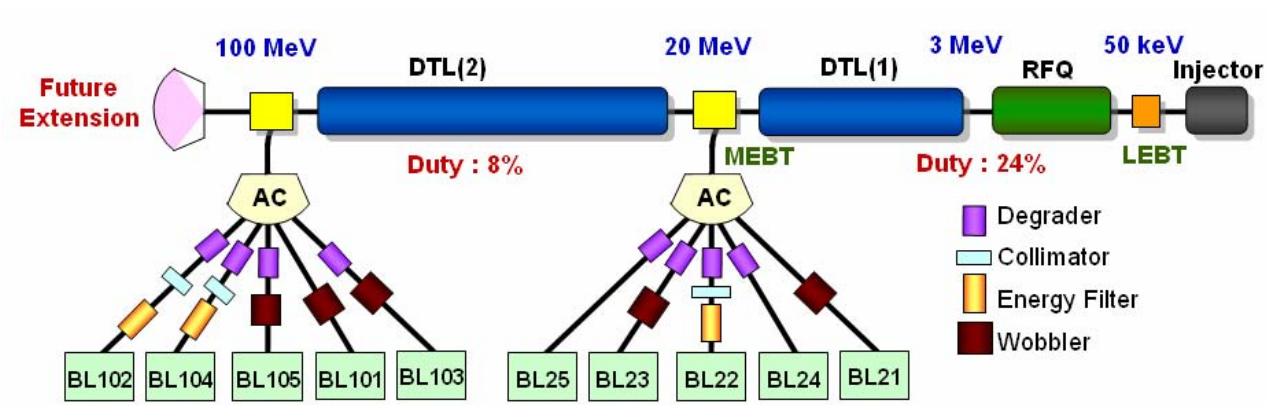

Figure 1: Schematic diagram of PEFP user beam line.

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With the beam line requirements, we had arranged target rooms for beam applications on the experimental hall, which will be 50m wide and 150m long. Figure 2 shows the layout of 20MeV beam lines.

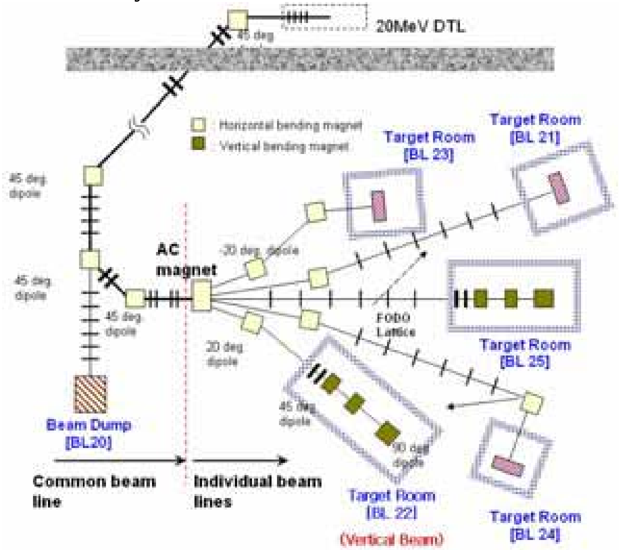

Figure 2: Layout of 20MeV Beam Lines.

A 20MeV proton beam from the Drift Tube Linac (DTL) is transported with bending magnets and quadrupole magnets from linac tunnel to experimental hall. The first bending magnet for the user beam line is located between two buncher cavities of medium energy beam transport (MEBT) [3] at the end of the 20MeV Linac. The basic lattice of the beam transport line is FODO, and the all bends are achromatic.

Figure 3 is an example of the beam optics calculation from the 20MeV Linac to target room #25 with TRACE-3D [4].

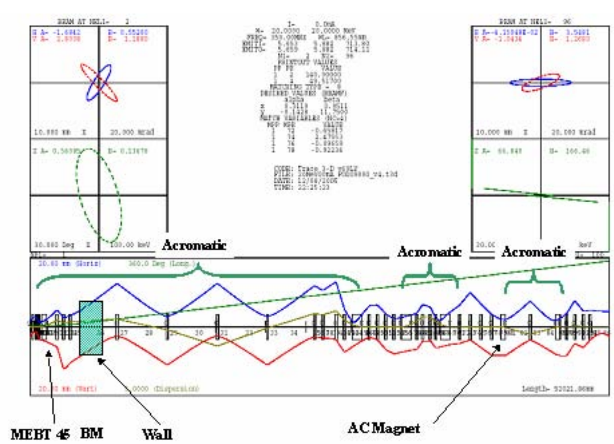

Figure 3: Beam Optics of BL25.

For 100MeV beam lines, the schematic layout is almost same with the 20MeV beam lines. A 100MeV beam is transported through long transport line with doublet lattice from the 100MeV DTL. Figure 4 shows the beam optics from the liac to the target room #102.

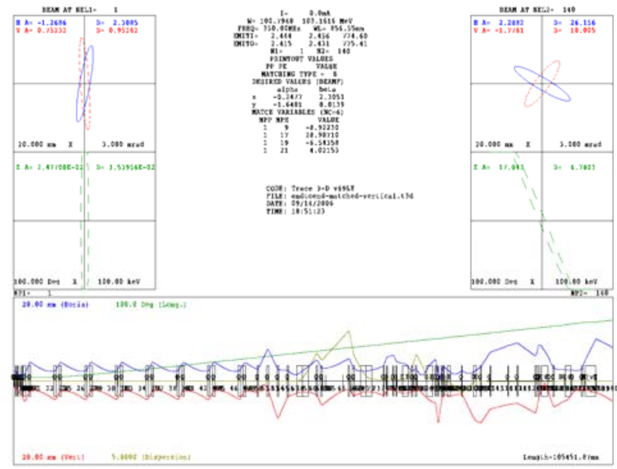

Figure 4: Beam Optics of BL102.

BEAM LINE COMPONENT R&D

In the concept of the user facility, AC magnets are important components. We are designing the AC magnet, as shown in Figure 5. The AC magnet will be excited with a programmable current power supply, which is synchronized with linac beam pulses.

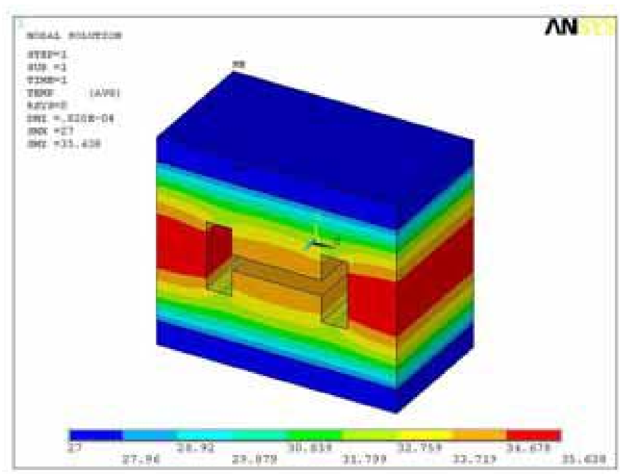

Figure 5: Thermal Analysis of AC Magnet.

An important requirement in the beam lines is external beam, which requires beam windows. It is not easy to develop high power beam window with large area because of thermal load for 20MeV proton beam and radiation damage for 100MeV proton beam.

Magnets for beam irradiation, such as wobbler magnet, scanning magnet, and large aperture quadrupole magnet, are also important to utilize high proton beam current efficiently for applications, which require uniform irradiation on the target, as shown in Figure 6. Figure 7 shows a prototype quadrupole magnet for beam transport. Quadrupole magnets for 20MeV and for 100MeV beam lines have same specifications for easy mass production.

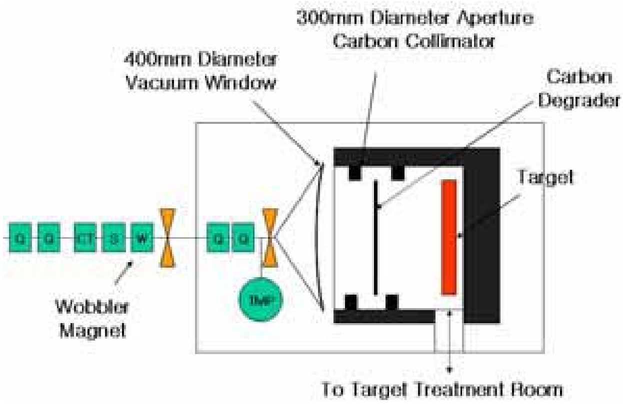

Figure 6: Target Room for external beam with large area

Figure 7: Prototype quadrupole magnet for beam lines

SUMMARY

20MeV and 100MeV proton beams from a 100MeV proton linear accelerator will be supplied to users for beam applications. From the results of user demand survey, beam line requirements had been prepared. With the requirements, the 10 beamlines are designed and the layout of the experimental hall is developed as shown in Figure 8. The R&D for beam line components, such as AC magnets, is on-going.

The project host site was selected, in January 2006, to be Gyeongju city. After geological surveys of the site and site plan have been done, and the architectural works of conventional facilities are under way. The operation of this facility will start in 2011.

REFERENCES

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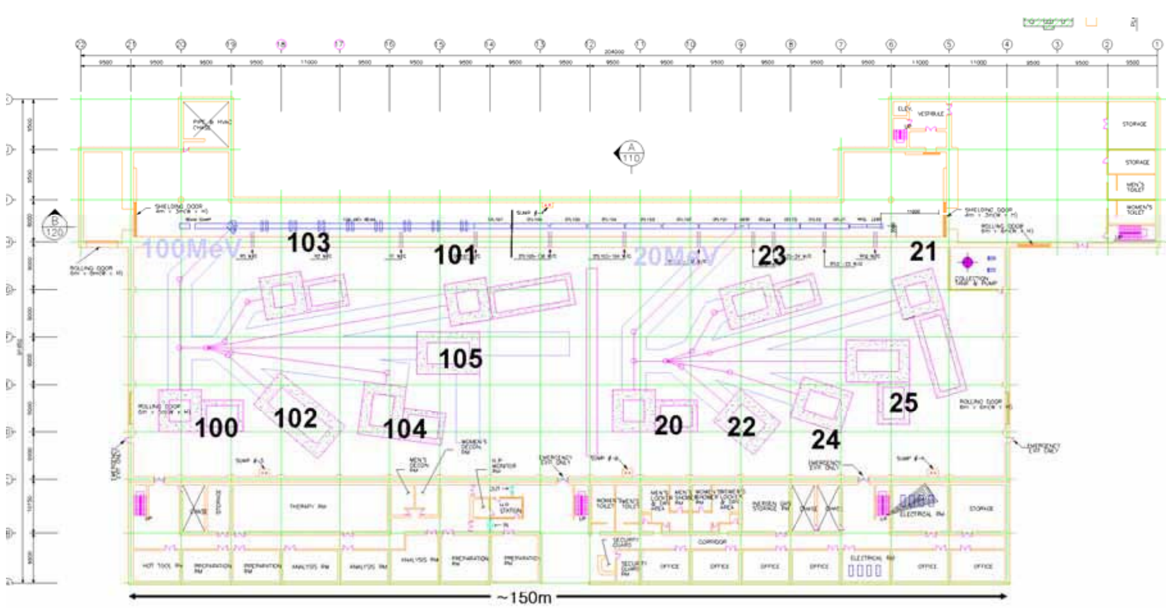

Figure 8: PEFP Experimental Hall with user beam lines.