Beam Current Measurement System in CSNS LINAC

Peng Li (lipeng@ihep.ac.cn), T.G. Xu, M. Meng, F. Li

Institute of High Energy and Physics, Beijng, China

Abstract

Beam Current Transformers (BCTs) have been designed to measure the H-minus beam current in CSNS Linac. The macro-pulse width is about 500μs which repeat period is 40ms and the current will be 5~50mA in CSNS Linac. Besides, a FCT is planned to measure the macro-pulse current also because there is no enough space to install a BCT after DTL1.

Introduction

The CSNS accelerator consists of an 80MeV H- linac, an 1.6 GeV Rapid Cycling Synchrotron (RCS) and related beam transport line. The layout of the CSNS linac is shown in Fig. 1.

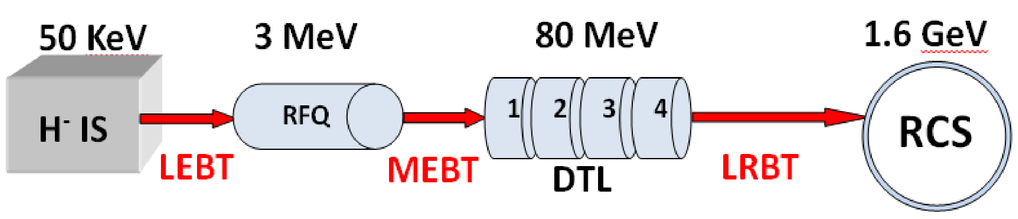

Fig.1 Layout of CSNS Linac

We plan to install BCTs in front and rear of each transport line and space between DTL tanks. So we can got the beam's pass through ratio and evaluate the beam loss of each part.

BCTs

The BCT measurement system contains a toroid monitor and related electronic module. To measure 500μs macro-pulse, and the waveform we got more close to real beam pulse. we do our best to increase the toroid's inductance L and decrease the input resistance R of electronic module. So that we can got the longer droop time constant τ=L/R, The input resistance of electronic module is about 10Ω. And the toroid's inductance is more than 0.5H. The amplitude decay at 500μs is lower than 1%.

The main parameters on which toroid's inductance dependent are the coil turns N, the relative permeability μr, and the size of toroid h, ro, r_i.

We choose a kind of Co-based alloy material which called CAL shown in figure 2. It's relative permeability μr is larger than 20000 in the condition of 25Hz, magnetic flux density not more than 0.5A/m.

Fig. 2 CAL core

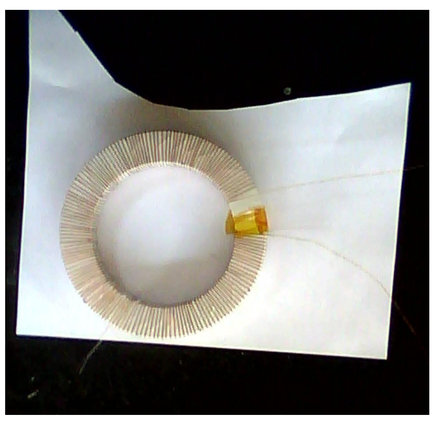

Fig. 3 turn coils on CAL core

Due to the equivalent signal amplitude which input the electronic module is I/N. The more turns, the smaller amplitude, and the lower SNR. So it's not always a good thing to increase toroid turns as more as we can. We choose 150 turns (shown in Fig. 3) to ensure the good SNR at last.

Table 1: Toroid sizes

	Quantity	Length	Inner	Outer
LEBT	2	17mm	110mm	157mm
MEBT	2	17mm	60mm	85mm
DTL	3	17mm	60mm	85mm
LRBT	4	17mm	105mm	150mm

We plan to use the same electronic module, and designed the same toroid inductance although these transport lines have different vacuum pipe outer size. We designed different sizes of BCTs for each beam transport line. The detail sizes are listed in Table 1. The inductance is about 0.5H.

After winding 150 turns on the magnetic core of toroid, we poured epoxy on it to be a regular whole. And each side size will increase about 2mm.

Conclusion

We did experiments on 3.5MeV RFQ beam line using the BCT designed by ourselves and got accordant results shown in the figer below. The green line is beam current.