Study on the Field Tuning of the PEFP DTL Tank1

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1. Introduction

A 100MeV proton accelerator has been developed at PEFP as a 21C Frontier Project [1]. The goal of the first stage of the project is to develop a 20MeV accelerator. The 20MeV accelerator consists of ion source, LEBT, 3MeV RFQ and 20MeV DTL. The 3MeV RFQ were already installed and being tested [2]. The 20MeV DTL consists of 4 tanks [3]. The first tank was fabricated and waits for installation and alignment of the drift tubes. The second and third tanks are during machining. After the completion of the alignment of the drift tubes, the field tuning should be done. The field tuning of the DTL tank means not only frequency tuning but also field profile tuning against perturbation. The 8ea. slug tuners are used for frequency and field profile tuning and 17ea. post couplers for stability against perturbation in DTL tank 1. The tuning of the DTL tank 1 will start at November, 2004.

2. Tuning Procedures

2.1 Tuning Parameters and Procedures

The tuning of the DTL tank1 means three items, which are frequency tuning, field profile tuning and stability tuning against perturbations. The target frequency is 349.915 MHz which includes the air effect and high power RF effect. The target of the field profile tuning is within 1% of the design average accelerating gradient of each cell. The target of the stability tuning is to minimize the stability parameter well below 1%. The tuning procedures which should meet the above target parameters were proposed. At first, the field tuning using only slug tuners will be carried out. In this stage, the best tuner length can be determined without post couplers. After determination of the best tuner length, the post coupler length will be determined with the criterion of the stability parameter [4]. In this stage, perturbation of about ±10kHz will be introduced at the both end side of the DTL tank1 using slug tuners or any other perturbators. Moreover, the frequency effect of the post couplers can be measured in this stage and some modifications of the tuners and post couplers should be made if necessary to meet the target frequency. Two or three iterations may be necessary to determine the best tuner length and post coupler length. After iterations, the tap rotation of the post coupler will be done to meet the target field profile.

2.2 Field Measurement

A bead perturbation method is used to measure the field distribution of the DTL tank. To determine the measurement schemes, the number of data per distance and measurement time should be determined. For DTL tank1, it is desirable to measure the field profile within 180s and in this case if the sampling rate of the field data is 100Hz, the spatial resolution is about 0.25mm that is enough value even at the first cell. The phase shift measurement by bead perturbation using network analyzer is used to meet the above conditions. If 6mm diameter metal bead is used, the frequency and phase shift is about 1.5kHz, 8 degree and if the phase shift formula is linearized within this frequency shift range the linearized value is 99.7 % of the real calculated value that is enough for measurement accuracy. The measurement system was already setup and being test. The network analyzer is operated using tuned receiver mode and Labview program is used to control the network analyzer.

2.3 Determination of Best Tuner Length

An algorithm for determining the best tuner length has been setup. It uses the least square method using the data of field profiles at present tuner position and at perturbed position per each tuner. The simulation using SUPERFISH code showed that the set of 8ea. tuner length of the DTL tank1 could be determined using two iterations within 1% field profile from the 25% tilt field profile.

2.4 Measurement Condition

During tuning, the DTL tank should be maintained at its operating temperature that is 40C or at least constant temperature. Because the DTL tank parameters are very sensitive to the temperature. Three methods were proposed. The first one is to set the DTL tank inside the air conditioned hot house. The second one is to install a band heater around the DTL tank. The last one is to flow the coolant. The most feasible should be determined considering some check points which including capability of temperature regulation, working temperature, reproducibility of the measurement data and so on.

3. Conclusion

The field tuning of the PEFP 20MeV DTL tank 1 will be started at November, 2004. The tuning parameters and procedures have been setup. The field measurement method to meet the required condition and algorithm for choosing the best sets of tuner length were also

determined. The methods were validated from real field measurement and simulations. Now check for the methods to maintain the constant tank temperature has been carried out.

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