Preliminary Test Plan for PEFP 20MeV DTL

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1. Introduction

A 20MeV DTL has been developed at PEFP (Proteon Engineering Frontier Project), KAERI (Korea Atomic Energy Research Institute). The PEFP 20MeV DTL consists of four tanks and will be driven by one 1.1MW klystron. For preliminary test of the 20MeV DTL, it is important to setup the test plan to determine RF set points, those are to determine the RF amplitude and RF phase of the DTL tanks [1], [2], [3]. In this paper, several methods are compared and the most suitable method is presented. Also the preparations for the selected test scheme are presented.

2. Test Methods

There are several methods to determine the RF set point of the DTL. They can be summarized as bellows.

- Scheme 1 : Phase scan with single phase measurement.
- Scheme 2 : Phase scan with phase difference measurement.
- Scheme 3 : Acceptance scan with energy degrader and Faraday cup.
- Scheme 4 : Phase scan with signature matching with phase difference measurement.
- Scheme 5 : Beam loading scan with RF pick up.

But all of the above methods are related to a cavity driven by one klystron. In PEFP DTL, four cavities are driven by one klystron. Therefore two operation options may be possible which are depending on the scan method.

- Option 1 : Simultaneous phase and amplitude scan of four DTL tanks.
- Option 2 : Independent phase and simultaneous amplitude scan of four DTL tanks.

The 20MeV DTL layout including RF system is presented in Figure 1.

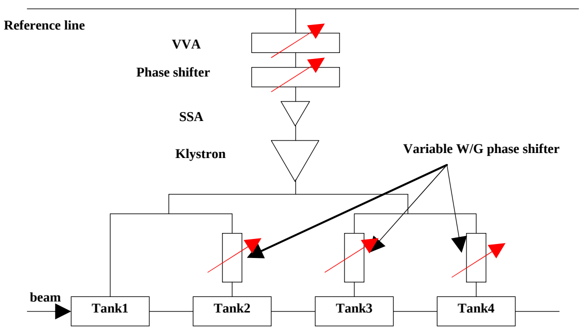

Figure1. Layout of 20MeV DTL with RF system

2.1 Scheme 1

This method is to compare the results of single beam phase measurement after the tank under tuning during the RF phase scan with that of the PARMILA calculation. This method uses one BPM as a beam phase measurement device. This method is considered simple because it uses only one BPM but may show more ambiguous data for large scan range.

2.2 Scheme 2

This method is to compare the results of beam phase difference measurement after the tank under tuning during RF phase scan with that of the PARMILA calculation. This method uses two BPMs to measure the beam phase difference. This method is considered less ambiguous compared with Scheme 1, but two BPMs should be installed at the both side of the de-tuned tank just after the tank under tuning because the allowable space is limited in case of testing each tank. Therefore, in this method, beam de-bunch along long de-tuned tanks may reduce the measurement accuracy.

2.3 Scheme 3

This method is to measure the Faraday cup signal after the energy degrader and compare it with the PARMILA calculation results. This method is considered less ambiguous for large phase scan range and largely accepted as a RF tuning method of DTL. But in PEFP DTL, there is not enough space to accommodate energy degrader and Faraday cup between tanks in case of testing each tank.

2.4 Scheme 4

This method is to compare the results of beam phase difference measurement with that of calculation using single particle. This method has unique feature that it can tune the tank using iteration method, that is to tune the upstream tanks. But this method uses also two BPMs just like scheme 2, therefore the disadvantage of this method to tune the individual tank is just the same to scheme 2.

2.5 Scheme 5

This method is the most simple one. It just measures the RF pick up signal and compares it with PARMILA results – not beam results but RF results. It needs no additional devices for tuning. But it is difficult to determine accurate RF set point using this method. This method can be used for initial coarse tuning.

2.6 Operation option : Option 1, Option2

The PEFP 20MeV DTL is driven by single klystron. The RF system has phase shifter with three stub tuners in each waveguide leg which can be adjusted only manually. It is planned to install all four tanks and then start to test. Therefore it is considered to be difficult to tune each tank separately, that is option 2, because of following reasons. To tune the tanks separately, the measurement devices should be installed between tanks, because there are no empty drift tubes in DTL. Therefore the measurement devices should be installed between de-tuned tank due to limited space. This may affect the measurement accuracy because the beam drift long (about 4.5m) DTL tank without longitudinal focusing. Another problem is that the phase shift range of the phase shifter is ±22.5 degree. The usual phase scan ranges are ±10~±15 degree, therefore it is not possible to de-tune the successive tank entirely without remove RF power using methods such as installation a shorting plane or entirely detune the RF coupler and so on, which need disassembly of the waveguide system. Therefore it is planned to consider all four tanks as a single tank and tune it simultaneously using option 1.

2.7 RF Tuning Scheme

As stated earlier, all four tanks are installed and then RF tuned using option 1 as if all four tanks were one cavity. Scheme 5 is used as a initial coarse tuning, and then scheme 2 ~ scheme 5 are used for fine tuning. In this case there is no problem associated with installation space for measurement device. To operate the four tanks just as if they were one tank, phase stabilization mechanism using coolant temperature is used. The RF set point is determined with respect to tank 1, and the RF phases of the other tanks are set with respect to tank 1. The RF phases can be controlled by the drift tube temperature using flow rate adjustment.

3. Conclusion

For preliminary test of PEFP 20MeV DTL, several schemes for RF set point determination are compared. Beam loading scan will be used as a coarse tuning, and beam phase difference measurement and acceptance scan method as a fine tuning. In PEFP case, it is convenient and more realistic to operate four tanks as if they were one tank, it is determined to use a simultaneous phase and amplitude scan method. To accomplish the above scheme, the RF phase is determined from the tank 1 and phases of the other tanks are adjusted with respect to tank 1 by controlling the temperature of the drift tube.

4. Acknowledgement

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