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High Power RF Test of the PEFP 20 MeV DTL

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1. Introduction

A conventional 20 MeV drift tube linac(DTL) for the Proton Engineering Frontier Project(PEFP) has been developed as a low energy section of 100 MeV accelerator. The DTL consists of four tanks with 152 cells supplied with 900 kW RF power from 350 MHz klystron through the ridge-loaded waveguide coupler.

The fabrication and assembling of the DTL have been completed and the DTL tuning for the proper resonant frequency of the tank, desired field profile and tilt sensitivity also has been completed, which means the DTL is ready for high power RF test[1][2].

For the high power RF test, many subsystems such as LLRF, measurement system and interlock safety system are required. LLRF systems in this study are composed of the signal generator and the solid state amplifier. For the measurement of RF power, the directional coupler and the RF detector with the proper attenuator were used. The interlock signals are fed from various points in the RF system such as the arc detector in the klystron output window, the RF windows and the circulator.

One of the objectives of the initial high power test is the conditioning of the DTL cavities and RF windows and RF couplers. Therefore, the RF pulse width and repetition rate was gradually increased from very low duty. The vacuum pressure level of the RF window and DTL cavity was carefully observed to locate the point where the spark occurred during the full reflection case and to decide when to increase the duty of RF pulse.

The detailed description of the high power RF test and the results obtain from the test are presented in the following sections.

2. High Power RF Test Setup

Four tanks in the 20 MeV PEFP DTL are driven by single RF source. That configuration is very unique for the proton linac. The RF power generated in the 1.1 MW CW klystron is divided in four-way using three the magic Tees. Each magic T has RF dummy load to dissipate the reflected or mismatched RF power. The accuracy of power dividing of the magic T was about 1%. Each leg has the mechanical phase shifter for the independent phase control of the tanks. The adjustable phase range of the phase shifter is ±22.5°.

The RF power coupler is iris type with ridge-loaded waveguide. The coupling coefficient of the RF coupler can be adjusted with coupling hole in the front of the coupler. The optimum coupling coefficient under the beam loading condition is given by Equation 1 and was about 1.6 for each tank.

$$\beta_o = 1 + \frac{P_b}{P_c} \qquad \text{[Eq. 1]}$$

P_b is beam power and P_c is cavity loss.

In Figure 1, the schematics of RF system can be found. The 20 MeV DTL with RF coupler is shown in Figure 2.

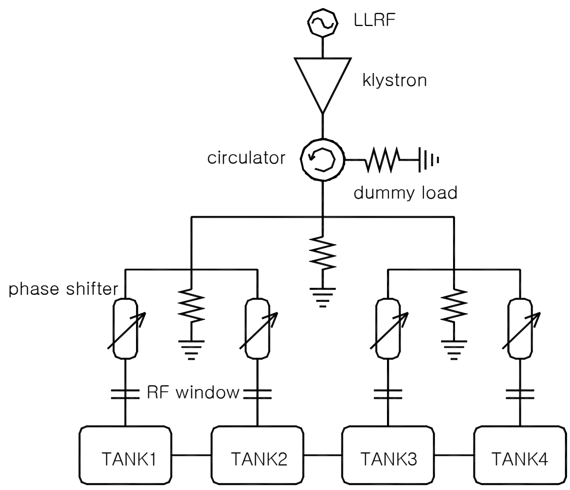

Figure 1. RF schematics for the 20 MeV DTL

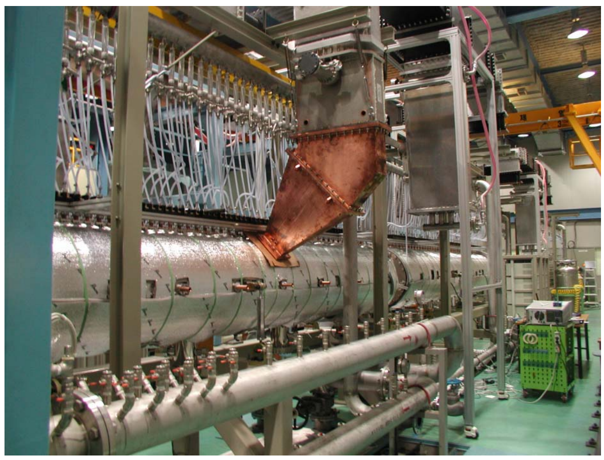

Figure 2. 20 MeV DTL with RF coupler

3. High Power RF Test Results

The initial RF pulse width was 50 us with the repetition rate of 2 Hz. These values were determined from the vacuum level criterion. The initial vacuum level was measured and shown in table 1. When the reflected power was abruptly increased, usually one of the vacuum levels of the tank or RF window was also increased, from which we could locate where the arc occurred.

Table 1. Initial vacuum level

	cavity [torr]	RF window [torr]
Tank 1	8e-7	6e-8
Tank 2	8e-7	6e-8
Tank 3	2e-7	3e-8
Tank 4	3e-7	3e-8

During the test the forward RF power was gradually increased to the desired value of 150 kW for each tank with 100 us pulse width. In Figure 3, 4 and 5 the forward power, reflected power and the cavity field were shown respectively.

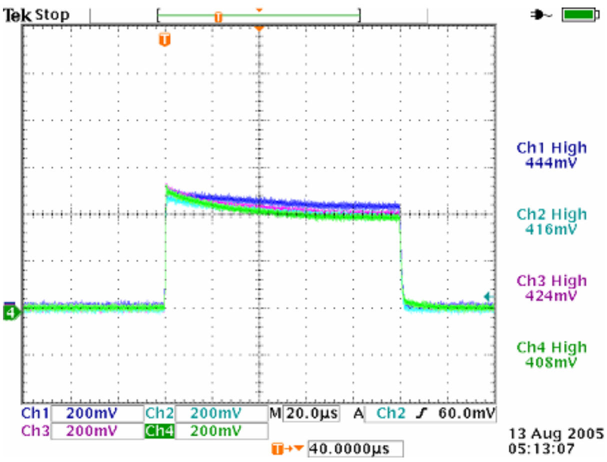

Figure 3. forward power waveform
(CH1:tank 1, CH2:tank 2, CH3:tank 3, CH4:tank 4)

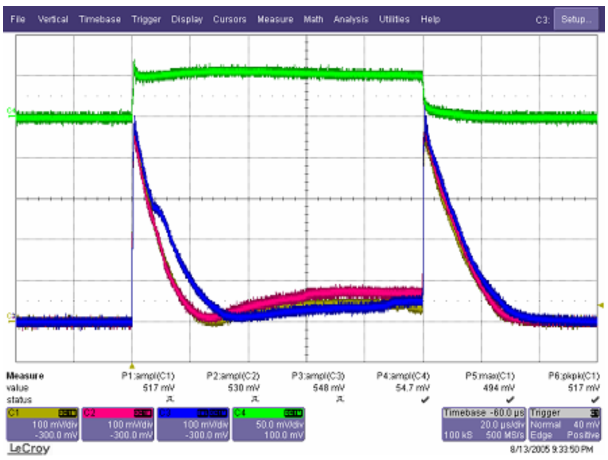
Figure 4. reflected power waveform
(CH1:tank 1, CH2:tank 2, CH3:tank 3, CH4:kly rev)

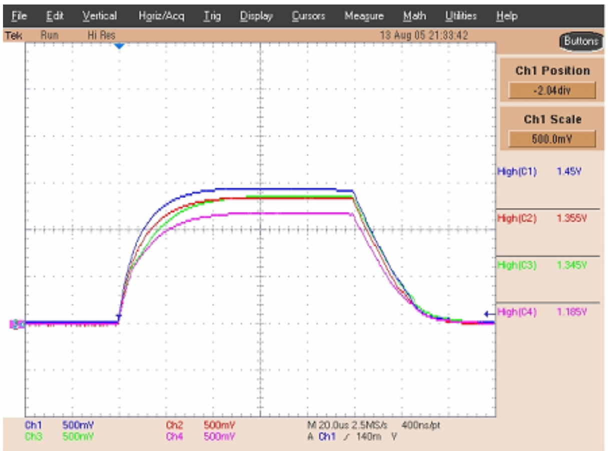
Figure 5. forward power waveform
(CH1:tank 1, CH2:tank 2, CH3:tank 3, CH4:tank 4)

4. Conclusions and Future Works

The high power RF test was successfully performed. The beam accelerating test is next step and about to start.

REFERENCES

[1] Han-Sung Kim, et al, Test Scheme Setup for the PEFP 20 Mev DTL, PAC05, 2005
[2] Han-Sung Kim, et al, Initial Test of the PEFP 20 MeV DTL, PAC05, 2005

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