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Commissioning Plan of the Klystron and Modulator System for 100MeV Proton Accelerator

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1. Introduction

Proton Engineering Frontier Project (PEFP) is developing a 100MeV proton linear accelerator for basic science research and industrial applications. [1][2]

The installation of the klystron and modulator system for 100MeV proton accelerator starts in September 2012 when the modulator room and the klystron gallery are prepared in the accelerator building at Gyeongju. There are total 9 sets of klystron for the 100MeV proton accelerator and 4 sets of modulator to power the klystrons. Each 3 sets of modulator drive the 2sets of klystron simultaneously and the last one drives 3sets of klystron in parallel. After the proper installation, the commissioning of the system starts step by step from the low power test of the modulator to high power test of the klystron. In this paper, a brief introduction of the installation and commissioning plan of the klystron and modulator system are presented.

2. Installation

The 9 sets of klystron will be installed at 2nd floor where most of the other RF devices such as circulators, waveguides, resonance frequency control cooling system (RCCS) and control racks are positioned. The 4 sets of the modulator will be installed at 3rd floor where only modulator and its ancillary components are installed.

2.1 Modulator

The specification of the PEFP modulator is -105kV, 50A, 1.5ms with 60Hz repetition rate. Now, total 4 sets of modulator are stored in the accelerator assembly room as shown in Fig. 1 waiting for installation. The modulator consists of three main parts, modulator oil tank, SCR unit and controller. It contains an isolation transformer in its modulator oil tank. After the modulator room prepares, the modulator parts will be delivered from the accelerator assembly room to 3rd floor through the crane lift. Before installation, the inside of the modulator oil tank will be checked by opening the oil tank to check the soundness of the inside components. All the parts will be positioned by using the laser tracker. And then the modulator will be connected to its utilities such as 3,300V input power lines, 220V power lines and DI cooling water lines. The 3,300V electrical power lines for driving a modulator were already installed and the DI water cooling lines for modulator oil tank and SCR unit cooling were also installed. The output cable will be connected from the modulator oil tank in 3rd floor to the voltage dividing resistor oil tank located in 2nd floor through the penetration hole.

The control system for the modulator is the PLC based system which is connected to the EPICS through the Ethernet. In addition, an oscilloscope is installed in each modulator controller to monitor the waveform at local position.

Fig. 1: 4th Modulator stored in the accelerator assembly room

2.2 Klystron

The specification of the PEFP klystron is 350MHz, 1.6MW peak power with 1.5ms pulse width and 60Hz repetition rate. Now, total 9 sets of the klystron are stored in the accelerator assembly room as shown in Fig. 2. After the 2nd floor is ready for installation, the klystrons will be moved. It will be installed in right position by using the laser tracker. The positioning of the klystron is especially important because the klystron is connected to the accelerating cavity through the rigid waveguide. The waveguides parts which are already installed through the penetration hole between 1st and 2nd floor are the reference part for the positioning of the all parts in 2nd floor. As soon as the klystron is delivered, the ion pump will be installed to check the soundness of the klystron vacuum and maintain the klystron in commissioning ready stage. After the positioning finished, the power supplies such as electromagnet power supply and heater power supply will be connected. In addition, DI water cooling lines for collector, body and cavity will be connected.

Fig. 2: 9 sets of klystron stored in the accelerator assembly room

3. Commissioning

The commissioning of the klystron will be carried out after the low power test of the modulator finishes. During the commissioning stage, all the interlock systems for the klystron and modulator are checked.

3.1 Modulator

The non-inductive high voltage resistors are prepared as a dummy load for the low power test of the modulator. The specification of the dummy load is 2kohm with 2kW power rating. The modulator can be tested with the operation parameters of 100kV, 50A, 50us pulse width with 8Hz repetition rate, which is enough to check the installation soundness and low power performance of the modulator. The remote control system based on the EPICS is also checked in this stage. In addition to the parameter monitoring, the set valve command and start / stop functions of the device are incorporated in the EPICS.

3.2 Klystron

The klystron commissioning stages are divided into two. The first stage is the pulse beam test and the second stage is the RF amplification test.

After the low power test of the modulator finishes, the dummy load for the modulator is removed and the modulator output is connected to the klystron via voltage dividing resistor oil tank. The key of the pulse beam test stage is to check and adjust the beam perveance. The voltage dividing ratio can be adjusted within 1% steps of the expected value by adding or subtracting resistors with the resistance of 1% of the total resistance. The initial operation parameters are 100kV, 25A, 50us, 1Hz.

It is planned to do the RF test after the beam test completes. In this stage, it is necessary to the RF test without the connection to the accelerating cavity, because the purpose of this test is to check the performance of the RF system itself. To do such a test, we will disconnect the waveguide pieces directed to the accelerating cavity and install a shorting plate to reflect all the RF power from the klystron to the RF dummy load through circulator. The average power of the RF dummy load is 45kW with peak power of 1.6MW. Therefore we can test the RF system itself up to the 30% of the full duty factor, which is enough to check the RF system performance.

3.3 Schedule

The installation of the modulator and klystron starts at September 2012 when the 3rd floor and 2nd floor are ready for installation. The connections of the DI water system and electrical power system to the modulator and klystron start after the utility test completes in October 2012. After that, the modulator test starts step by step. With the success completion of the modulator test, the connection between modulator and klystron starts. The RF test of the RF system will finish in December 2012 preparing the accelerating cavity conditioning planned at January, and proton beam acceleration test at February 2013.

4. Conclusions

The commissioning plan of the modulator and klystron system are prepared to follow the proton beam acceleration test planned at February 2013. The plan is to test the modulator itself with dummy non-inductive resistor and then to test the klystron in pulse beam mode and RF amplification mode. The commissioning schedule is strongly dependent on the building preparation and utility test schedule.

Acknowledgement

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