PRESENT STATUS OF 700MHZ KLYSTRON

Bohyun Chung*[1], Kiehyung Chung[1], Kangok Lee[1], Seungkook Ko[1], Seungjeong Noh[2], Yongdeuk Lee[3]
[1] Korea Accelerator and Plasma Research Association, Cheorwon 817-345, KOREA
[2] Dankook Univ., Seoul 140-714, KOREA
[3] Kwangwoon Univ., Seoul 139-701, KOREA

Abstract

The big power Klystron (1 MW, CW at 700 MHz) for proton accelerator has been under developing by PTL, KAPRA (Physico-Technology Laboratory, Korea Accelerator and Plasma Research Association). The proton accelerator (100MeV, 20mA, CW) has been developing as one of the 21st Century Frontier Research Programs of the Ministry of Science & Technology for 10 years starting from 2002 by the Proton Engineering Frontier Project in KAERI (Korea Atomic Energy Research Institute).

Those situations make it to imperative to develop the big power RF system in domestic design, fabrication, and machining of relating to its components and accessories.

In this paper, we will show a present status of Klystron Amplifier, those are the first results of cathode baking and heating processing, fabrication of the 700MHz Solid State Amplifier.

INTRODUCTION

A triode type electron gun including a modulating anode, six cavities including one second harmonic cavity and the electromagnets for electron beam focusing were designed and fabricated to meet the requirements of the that proton accelerator RF source using various computer codes. Based on design parameters [1-3], the main components of the klystron tube, such as electron gun, RF cavity, collector and supporting structure were fabricated. The fabricated Klystron 2003 was moved to KAERI site for confirmation of its performance last year. The purpose of test Klystron 2003 was a confirmation of principle. Modified Klystron 2004 for infrastructure stability is under developing.

KLYSTRON 2003

The design parameters for the 700 MHz 1 MW CW klystron and overview of fabricated Klystron 2003 with 470(L)×80(W)×120(H)[cm] dimension including supporting frame are shown in Table 1 [2,3] and Fig. 1, respectively. As shown Table 1, the efficiency of the Klystron is about 60%. This means 1.6MW power supplies are needed. About 10 Klystrons are required in a total 100MeV Proton accelerator and about 6MW CW power is dumped for useless. To utilize the wasted energies, the study of energy recovery system is required.

* Swipe486@hanmail.net

Table 1: Design Parameters for the Klystron 2003

Parameter	Value
Operating frequency (MHz)	700
Output RF power (kW)	1,000
Maximum beam Voltage (kV)	100
Maximum beam current (A)	20
Efficiency (%)	> 60 %
Power gain (dB)	~ 40
Number of cavities (Incl. 2nd Harm.)	6
Drift tube radius (mm)	30
Beam radius (mm)	~ 20
Focusing magnetic field (G)	250 ~ 300
Collector dissipation (kW)	1,000

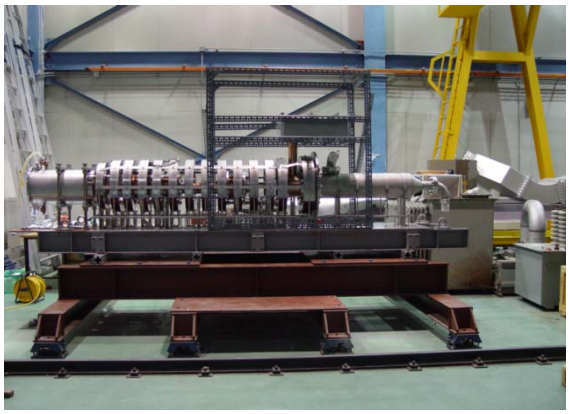

Figure 1: Overview of Klystron 2003

Cathode Baking Experiment

The electron gun was designed using electron trajectory program E-gun code [3]. The electron gun was a triode type with a modulating anode. With the modulating anode, it is possible to switch the beam, and vary the perveance or the beam current without varying the beam voltage.

Before cathode heating, baking process has been done for 72 hours to remove gas, molecules, and dust adsorbed or dissolved into the surface of the cathode. The experimented dispenser cathode with 80mm radius and spherical surface of 120mm curvature radius was made by Specta-Mat, USA according to our designed value. Conditions for beam emission from cathode are 980°C ~ 1050°C operating temperature and below 10^{-7} torr vacuum pressure. The Nickel sheet with 0.2(T)×9(W)×50(L) [mm] is used as a heater choke. The starting vacuum

pressure with 10^{-6} mbar was increased in every increasing baking temperature so that the stabilized time after increasing of the vacuum pressure was needed. Fig. 2 shows the experimental setup. We failed to extract the beam through experiments. We found many dusty thin films were deposited onto around the anode electrode. We are planning to retest with new cathode in improved conditions.

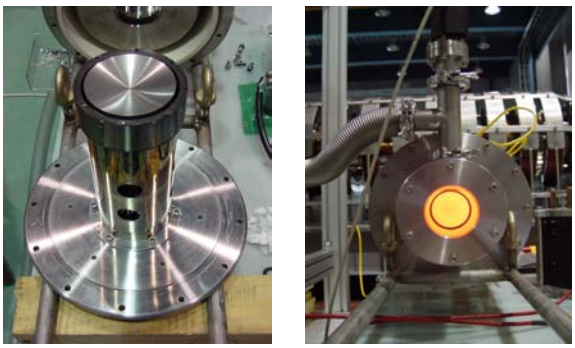

Figure 2: Experimental setup

Solid State Amplifier

The 4-stage 700MHz 180W Solid State big power amplifier is fabricated and tested for its performance. It is represented in Fig. 3. Experimental drive curve shows in Fig. 4.

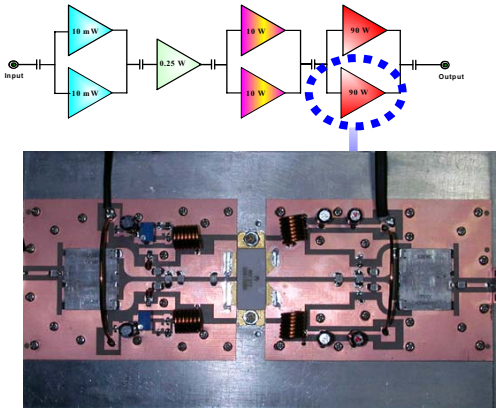

Figure 3: 4-stage 700MHz, 180W Solid State Big Power Amplifier

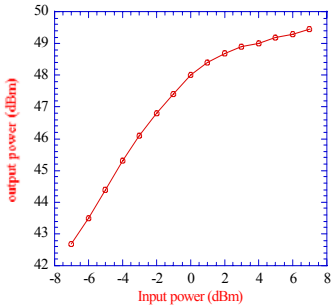

Figure 4: Experimental Drive Curve

From the above 4-stage 700MHz, 180W Solid State Amplifier, we could obtain 49.5dBm power, 56.5 dB gain, and 32% efficiency respectively. They are consistent with design value.

KLYSTRON 2004

The main purpose of Klystron 2004 is for infrastructure stability compared with the Klystron 2003 for confirmation of principle. We modified some parts of the Klystron 2003, changed O-ring type connection to welding type and anodized supporting frame, so on. The overview of Klystron 2004 is shown in Fig. 5. Basic tests are going on.

(a) Front View (b) Side View

Figure 5: Overview of Klystron 2004

SUMMARY

The 700 MHz 1MW CW klystron was fabricated to meet the requirements of the proton accelerator RF source. Each part of the klystron was tested to check for designed parameters.

FUTURE WORKS

It is well known that the Quality factor is dependent on the surface roughness value, so that reducing roughness value below sub-micro order is essential. We are planning to construct a precise and clean manufacturing laboratory with aids of Cheorwon County and participating companies. Due to change the welding type connection of each components Klystron 2004 comparing with O-ring type Klystron 2003, researches for welding method including welding lip materials and Hydrogen Furnace for it are required.

And also the study for configuration of the input-output coupler on the coupling coefficient, waveguide coupler, and the RF window are needed.

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