UPGRADES OF THE LINAC SYSTEM AT CAMD*

Y. Wang#, M. Fedurin, P. Jines, T. Miller, T. Zhao, CAMD/LSU, Baton Rouge, LA 70806, USA

Abstract

The 180 - 200 MeV linac is an injector of Center of Advanced Microstructures and Devices (CAMD) 1.3 or 1.5 GeV accelerator, and was configured, installed and commissioned more than 10 years ago[1]. CAMD has pursued the upgrades of linac due to the bad reliability and performance of linac. In the paper, the latest operation parameters of linac are introduced, the results of recent upgrades of linac, such as the linac control system upgrade, the linac timing system upgrade, the master oscillator upgrade, and the klystron focusing power supply upgrades are presented, and the linac energy increase is discussed.

1 INTRODUCTION

The linac at CAMD as shown in Figure 1 consists of a 50kV triode electron gun, a 500MHz chopper-prebuncher, a 4MeV, 3GHz standing wave buncher, and two 6-meter long traveling wave accelerating sections. The RF system which drives the linac consists of two 35MW, 3GHz Klystrons and modulators, RF drivers, master oscillator, and so on. The linac can be operated in either a 2.5 nS pulse of electrons or a 50-500 nS pulse. The current operation parameters are below:

Energy	180 MeV
Energy Spread	± 0.25%
RF frequency	2998.2MHz
Repetition rate	1 Hz
Pulse Length	150 nS
Current	50 mA
Current stability	±15%

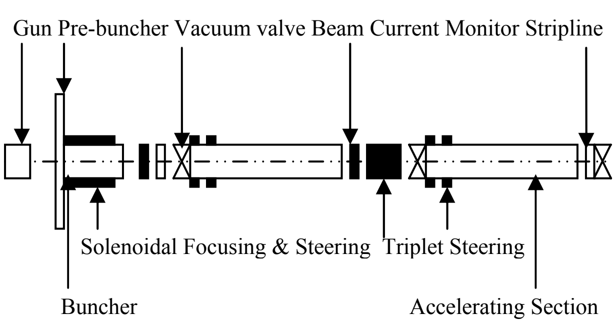

Figure 1: Linac at CAMD

2 THE CONTROL SYSTEM UPGRADE

The old linac control system consists of a 68020 microprocessor board and a VME interface board which makes the link between the VME bus and the I/O bus. Due to the poor reliability and the poor performance of the old control system, we replace it with the PLC as shown in Figure 2[2].

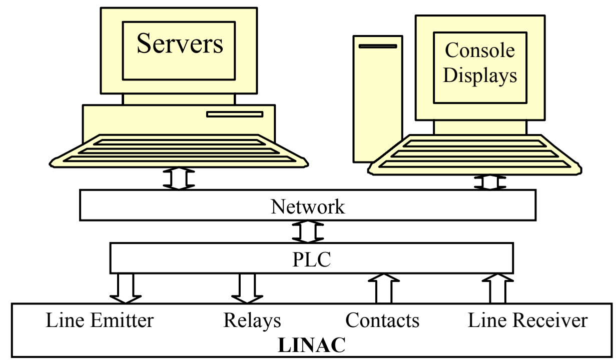

Figure 2: The linac control system

In the new control system, the servers and console display communicate PLC through network. The PLC controls linac by analog inputs/outputs which are connected to line emitter/line receiver and logic inputs/outputs which are connected to relays and contacts.

3 THE TIMING SYSTEM UPGRADE

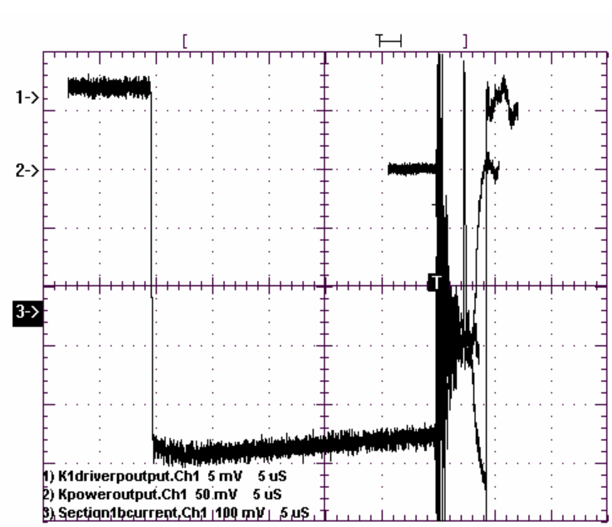

Figure 3: The time relation between prebuncher input(1), klystron output(2) and beam(3)

Three Stanford Research Systems' DG535 Digital Delay / Pulse Generators in the timing system in linac are used to realize the time relation between prebuncher input, klystron output and beam as shown in Figure 3 and to function the protection for the system under abnormal

* Work supported by the State of Louisiana
# wangysh@lsu.edu

operation conditions. The old timing system is made of a timing board in the VME crate. In order to protect the system from noise, TTL to fiber transducers are used; therefore, fiber to TTL transducers are used at the equipments.

4 THE MASTER OSCILLATOR UPGRADE

The master oscillator consists of three main parts: an EMF phase locked oscillator, two CTT APN/032-3840 amplifiers, and a LORCH phase shifter as shown in Figure 4. A 499.7 MHz is multiplied by six in the EMF phase locked oscillator to 2998.2 MHz as shown in Figure 5. There is a CW output port which parameters are listed in Table 1 as the reference signal to measure the phase ripple for the master oscillator output [3, 4]; moreover, the phase ripple of klystron output power can be measured.

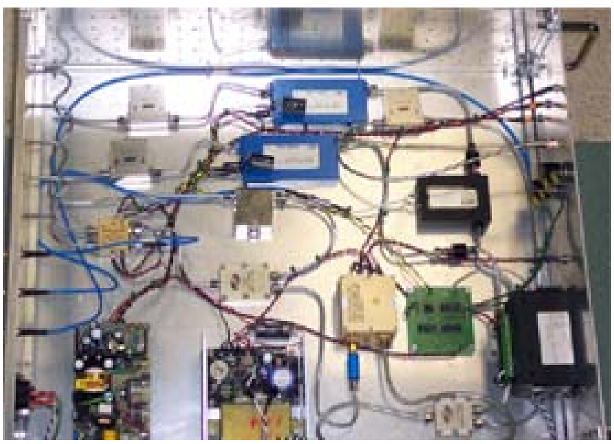

Figure 4: Layout of the master oscillator of linac

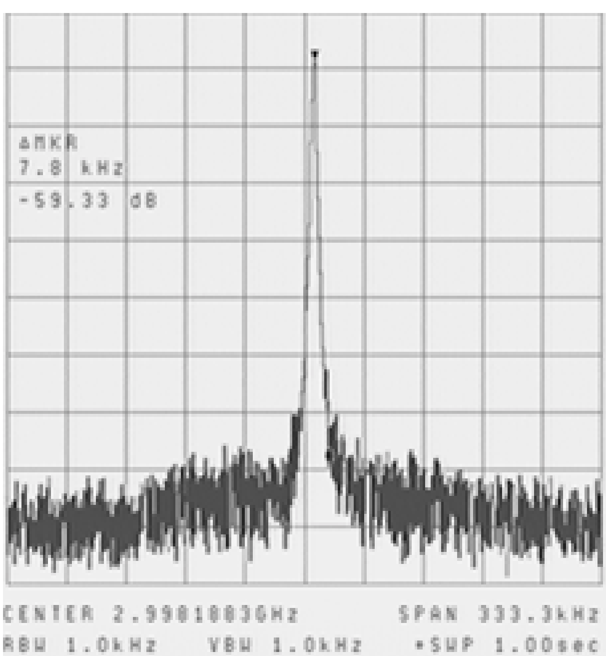

Figure 5: 3 GHz, CW output measured by spectrum analyzer from master oscillator

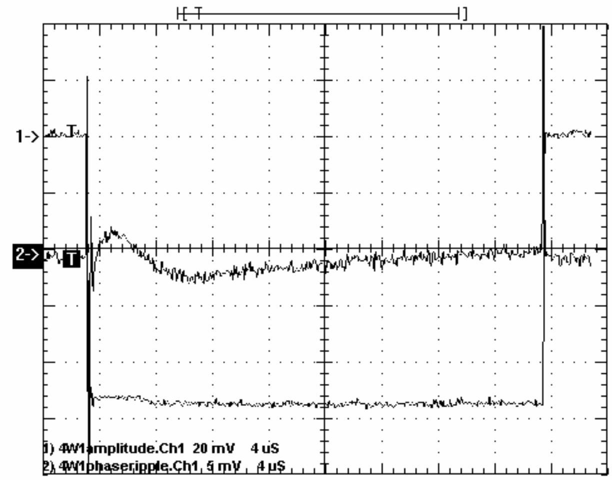

Figure 6: Amplitude and phase-ripple at 4W1 output of master oscillator at linac

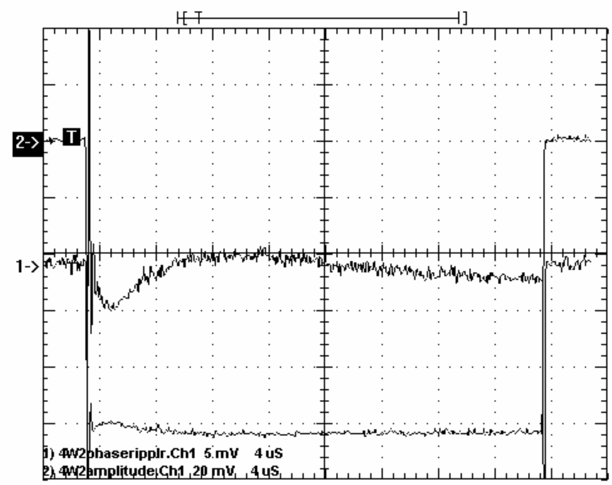

Figure 7: Amplitude and phase-ripple at 4W2 output of master oscillator at linac

Table 1: The test parameters of the CW output port

Output Power	10 dBm,
Frequency	2998.1883 MHz
Phase Noise	100 dBc

Table 2: The output parameters of the master oscillator

Output	Power	Phase Ripple
4W1	36 dBm	± 0.3 Degrees
4W2	36.6 dBm	± 0.3 Degrees

As mentioned in the introduction, there are two klystrons are used at CAMD linac, so the master oscillator has two ports to drive the preamplifiers of the klystrons. The tested results are shown in Figure 6 and Figure 7, and the parameters are listed in Table 2.

5 THE UPGRADE OF KLYSTRON FOCUSING POWER SUPPLIES

There are six power supplies for klystron focusing in the linac. Due to the sense of impeding failure of major components which is not easy to get them in spare because of the age of power supplies, the six new POWER TEN power supplies are used to replace the old power supplies. All new power supplies are installed in a cabinet and tested. They will be used in case of the failure of old power supplies. The parameters of power supply's current are listed in Table 3.

Table 3: The current in coils of klystrons

Klystron 1	Coil 1	178.4 A
	Coil 2	120.8 A
	Coil 3	157.1 A
Klystron 2	Coil 1	172.7 A
	Coil 2	102.8 A
	Coil 3	180.6 A

6 INCREASE ENERGY

The purpose to increase energy is to increase the beam current in the storage ring at CAMD. Through careful study, the 200MeV can be achieved from 180MeV based on the measured data.

The variable voltage-controlled attenuator has been installed to the RF loop to the buncher to adjust the input power. The characteristics of the attenuator are shown in Figure 8 & Figure 9.

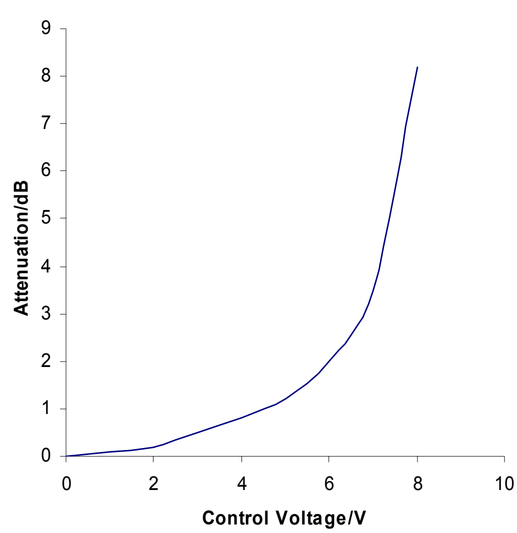

Figure 8: The attenuation of the attenuator at buncher

The RF system at linac is optimized during the last shutdown. We should calibrate the output voltage of the high voltage power supply for the modulators of klystron in the RF system because the power supply is saturated when the voltage is increased.

There is another way to increase energy to 250MeV by adding another accelerating section in the linac tunnel. This proposal was discussed by the Machine Advisory Committee for CAMD/LSU. The transport line is also needed to upgrade because its limitation is a little over 200MeV.

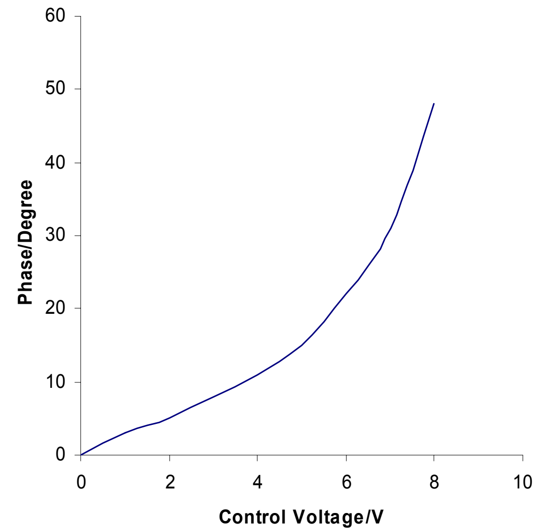

Figure 9: The phase of the attenuator at buncher

7 FUTURE PLAN

The linac at CAMD can be used as a user facility to generate a coherent light in DUV or VUV range when the injection is completed [5]. We also hope the linac can be re-circulated one time to achieve electron beam energy more than 300 MeV by used current RF system and accelerating sections.

ACKNOWLEDGEMENTS

The authors are grateful to the late Deputy Director Dr. B. Craft for the suggestions of the linac upgrades; to Mr. A Crappell, Mr. D. Dixon, Mr. D. Launey, Mr. S. LeGrand, and Mr. M. Smiths for their hard work in the linac upgrades; to the Machine Advisory Committee for CAMD/LSU for reviewing the projects; to Dr. G. Vignola (LNF) & Mr. K. Morris for discussions; to all other CAMD staffs for the support and encouragement.

REFERENCES

[1] CGR MeV, 200MeV Electron Linac for Louisiana State University, Baton Rouge, LA, USA, April 1989.

[2] P. Jines et al., Proc. of the Particle Accelerator Conference, 2003.

[3] J. Xie, et al., Nuclear Physics and Method A407, 1998, p. 146-150.

[4] J. Fox & H. Schwarz, IEEE Transactions on Nuclear Science, 30(4), 1983, p2264-2266.

[5] L. Yu et al., Proc. of the Particle Accelerator Conference, 2001, p2719-2721.