PROGRESS IN RAISING THE ENERGY OF THE CAMD LINAC TO 300 MEV*

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Abstract

Technical design details are presented of the proposed upgrade to 300 MeV of the linac at the Center for Advanced Microstructures & Devices (CAMD). The key parameters of the linac are listed and the benefits of 300 MeV injection to the CAMD synchrotron radiation light source are explained.

The optimum placement of the 300MeV linac in the existing tunnel has been established and the upgrades and locations of ancillary sub-systems are being prepared. Simulations of the electron beam trajectory by a MATLAB based linear accelerator program are ongoing.

INTRODUCTION

Figure 1: A HELIOS accelerating section under test at CAMD.

Increasing the injection energy of the CAMD linac will reduce the synchrotron radiation damping time by about a factor 4.[1] This will allow injection of higher beam currents (over 300 mA) which are presently limited by low energy instabilities. Additionally, a reduced vertical injection aperture requirement will assist installation of new insertion devices with restricted apertures. [2]

The options for higher energy injection at CAMD have been discussed previously [1]. All necessary components of the former HELIOS linac [3] have now been transferred from Jefferson Laboratory to CAMD, where they are being refurbished. It is planned to reconfigure the CAMD injector linac by installing one of the HELIOS accelerating sections (seen in Figure 1) in series with the two existing CAMD sections [4], thereby increasing the energy to 300 MeV.

Preliminary RF and vacuum tests for the accelerating sections have been conducted and the results are encouraging.

RECOMMISSIONING

The currently available microwave system will be used to commission the additional accelerating section (see Figure 2). A 500 MHz RF signal from frequency synthesizer PT620 is multiplied by a factor six with an EMF phase locked oscillator to drive three stages of amplifiers. These are listed in Table 1.

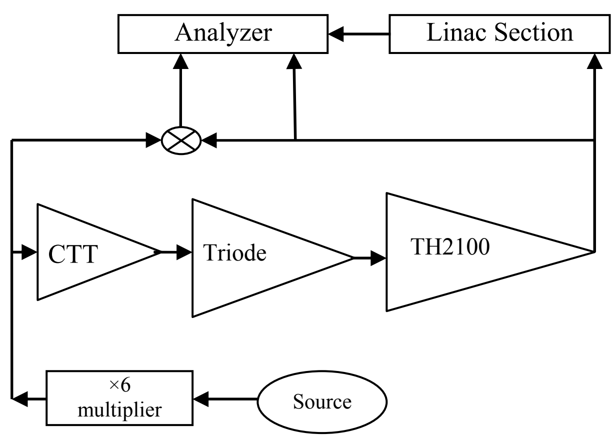

Figure 2: The RF system for commissioning.

Table 1: Major Specifications of Amplifiers

Parameter	CTT	Triode	TH2100
Frequency	3 GHz	2998.2 MHz	2998.2 MHz
RF Power	4 W	400 W	35 MW
Amplification Factor	38 dB	21 dB	60 dB
Pulse Width	30 μS	10 μS	3.5 μS
Rep. Rate	10 Hz	10 Hz	10 Hz

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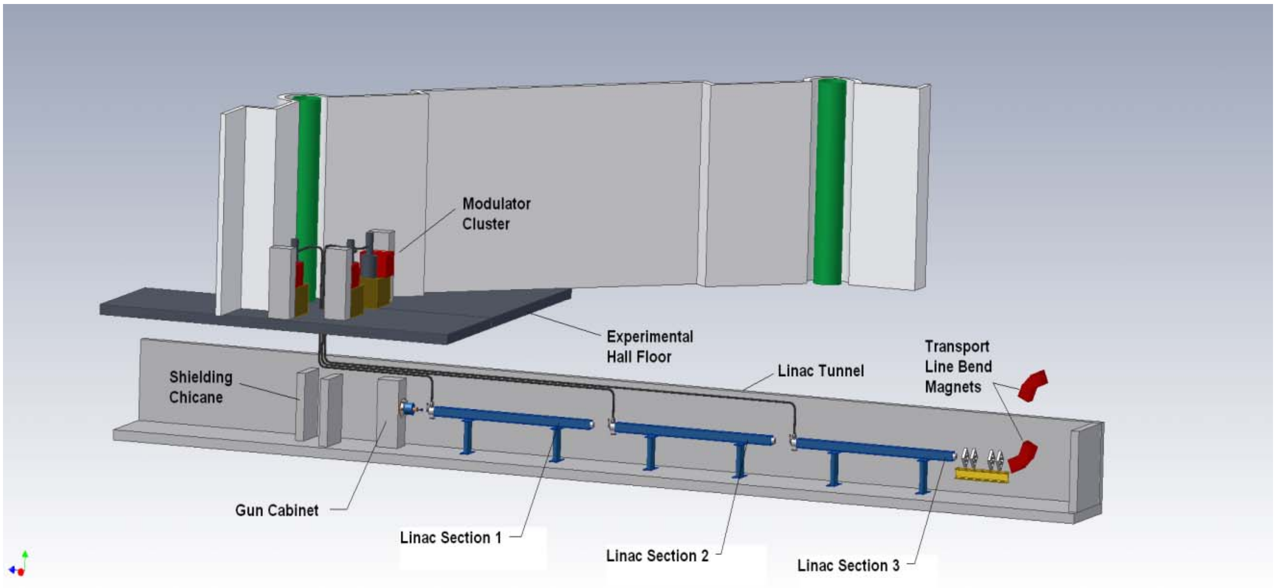


Figure 3: Cutaway view of the tunnel and experimental hall showing layout of the 300 MeV linac at CAMD.

MECHANICAL DESIGN

After careful consideration it has been decided to install the three linac sections in line. This configuration was judged to make maximum use of the space available in the tunnel and needs only minor alterations to the tunnel architecture.

The scope of work includes relocating the two existing modulators and klystrons from the linac tunnel, which is at a lower level, to the experimental hall and using the freed space to install the additional accelerating section. One HELIOS modulator and klystron will be added to those in the experimental hall to drive the new section (see figure 3). The klystron outputs will feed to the accelerating sections through WR284 waveguides passing through a hole bored in the hall floor.

For the first phase of the energy upgrade the 2 HELIOS klystrons and modulators will be installed in the new location in the experimental hall and used to drive the existing linac

The water cooling system will be redesigned and upgraded to meet the increased requirements of the three microwave systems at 300 MeV. One additional ion pump and valve will be added to the vacuum system for the linac.

ELECTRICAL & CONTROL DESIGN

The two cabinets for klystron focusing and modulator high voltage power supply will be located in the linac tunnel adjacent to similar equipment for the existing sections. All ancillary apparatus will be installed into existing cabinets in order to make efficient use of the space available.

The controls signals for the 300MeV linac will be integrated to the current control system through the existing interface.

The power, RF drives, control signals, etc for all three modulators and klystrons in the hall will be located in the linac tunnel.

TRANSPORT LINE STUDY

The transport line to transfer the electron beam from the linac to the storage ring consists of four main sections [5]. The functions of these sections are; linac matching; achromatic vertical translation; ring matching; and achromatic injector array.

The linac and transport line have been run at energies between 180 and 200 MeV in order to measure and calibrate the magnets. The principal energy related magnets are given in Table 1, where TB12 is the bending magnet in the achromatic vertical translation section, TB3, TK and TN are located in the achromatic injector array, and Main are the dipole magnets in the storage ring. The results show that TK and TN will operate at 300 MeV, but TB12 and TB3 will saturate and will need to be replaced.

Table 2: Transport Line Magnet Parameters

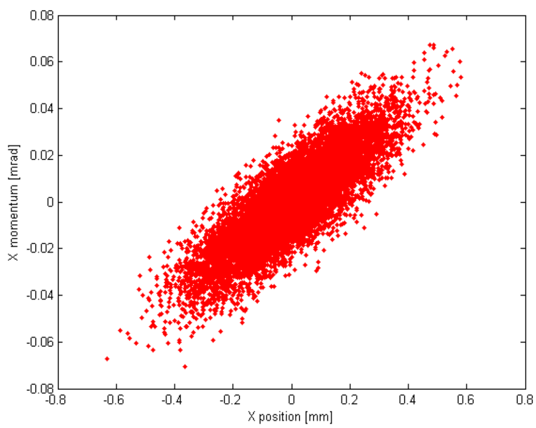
Magnet	180MeV	200MeV
TB12	273 A/1.025 T	313 A/1.138 T
TB3	344 A/1.08 T	408 A/1.208 T
TK	341 A/0.202 T	371 A/0.208 T
TN	5.2 kV	5.9 kV
Main	121.6 A/0.2 T	135.1 A/0.222 T

SIMULATION & KEY PARAMETERS

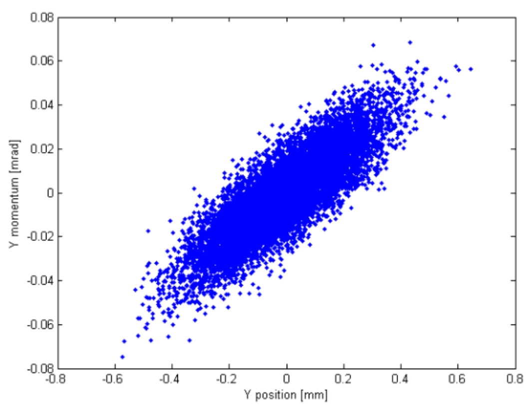
Taking the output parameters of the beam after acceleration to 200 MeV in the existing linac, the beam has been tracked through the additional section using the software Lucretia based on MATLAB[6]. The following table 3 summarizes the key parameters without weak field, and Figure 4 shows the phase space distribution.

It is apparent that there is no significant growth in emittance and an expected reduction in energy spread after acceleration in the third section.

Further simulation of the transport line at 300 MeV will be conducted soon, and a new transport line will be designed at a later stage.



(a)



(b)

Figure 4: Phase space distribution at output of the third accelerating section. ((a) horizontal, (b) vertical).

Table 3: Key Simulation Parameters

Parameter	**Input**	**Output**
Energy	200.0 MeV	299.8 MeV
Current	10 mA	10 mA
X emittance	0.310 π mm mrad	0.3125 π mm mrad
Y emittance	0.310 π mm mrad	0.3097π mm mrad
Energy spread	1%	0.67%

DISCUSSION

New insertion devices recently proposed for CAMD will result in more stringent requirements for the vertical injection aperture. Therefore injection at higher energy will be advantageous because of the reduced beam size. It is also probable that higher beam current will result by a reduction in the low energy beam instabilities which are frequently experienced. The present injection rate of 1 Hz can also be improved due to the shorter radiation damping time, although the injection rate of 5Hz proposed previously [1] may not be achieved.

The maximum injection energy which will be available with the increased configuration, 300 MeV, represents the performance with all systems working at maximum rating. From past operational experience [3, 4, 7] optimum reliability will be achieved with the linac running at about 275 MeV.

ACKNOWLEGEMENTS

The work described in the paper could not have been accomplished and will not been finished without the assistance, advice, and support of the State of Louisiana and Jefferson Lab scientific and administrative staff.

Authors are also grateful to the Lucretia Project team at SLAC for their software and support.

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