CHAPTER 7

CONCLUSIONS AND FUTURE PLANS

7.1 CONCLUSIONS

A 1.6 cell BNL/SLAC/UCLA type S-band photocathode RF gun has been designed using SUPERFISH and CSTMWS and the RF parameters optimized to minimize the emittance of the electron beam. Two structures of the photocathode RF gun have been developed. During development a novel two-step tuning procedure has been established to tune the photocathode RF gun to desired RF parameters. The two-step procedure is further extended to predict the geometrical dimensions of the gun cells during fabrication to achieve the desired RF parameters under operational conditions, which simplifies the tuning of a photocathode RF gun by eliminating the need of tuning of the gun by the iterative cut-and-measure technique used earlier. A procedure of brazing of the photocathode RF gun components in H$_2$ furnace has also been established and qualified by successful brazing of multiple structures with a leak rate of $2 \times 10^{-10}$ mbar l/s. The gun structures have been characterization experimentally by measuring the RF parameters using a VNA and by confirming that the desired RF parameters were achieved. A high power RF conditioning test setup with the required diagnostics has been developed and pumped down to vacuum of $3 \times 10^{-8}$ mbar and ready for high power test of the gun. The sub-systems required for operation of the photocathode RF gun like emittance compensation solenoid, quadrupole magnets, bending magnet, and vacuum beam line components have been developed in-house and other sub-systems like laser, RF and diagnostics have been procured. A beam transport line has also been designed, different components have developed and beam line
readied for beam acceleration experiments. Although the end goal of acceleration of electron beam could not be met, however our research is beneficial to the accelerator physics community in the future, to develop and tune of the photocathode RF guns.

7.2 FUTURE PLANS

The results of our beam dynamics simulations, low power RF measurements, development of high power RF condition test setup and emittance compensation beam transport beam line points the way for future work described below.

As mentioned in previous chapter the high power RF conditioning setup is ready and development of high power RF system is in advance stage. Since RF conditioning has to be performed in a radiation shielded area, which is presently not available. A multipurpose Accelerator Test Area (ATA) for testing of accelerating structures developed in-house has been designed and is proposed to be constructed in near future. The high power RF system presently in advance stage of development will be installed in this area and the photocathode RF gun test setup will also be housed in this area where RF conditioning will be performed.

The RF parameter of the gun such as resonant frequency, quality factor, and waveguide to cavity coupling coefficient at high RF power level will be measured by analyzing the transient response of the reflected RF power. If there is any variation in the RF parameters due to RF power dissipation in the gun, then a algorithm will be developed to tune the gun to the desired RF parameters by controlling the cooling water temperature.

The design of a cathode plate capable to incorporate the cathode of different materials such as Mg, Al etc is underway, hence by replacing adjusting copper cathode plate study of quantum
efficiency of different material will be carried out in order to find out the material with high quantum efficiency.

Since the laser system and other sub-systems are ready the beam acceleration experiments will be performed in the shielded area after high power RF conditioning.

The LCR circuit analysis will be further extended for multi-cell accelerating structures in order to establish a tuning method for desired RF parameters which reduce/eliminate the need of tuning by conventional iterative cut-and-measure technique.