Chapter 8
Further Developments

Due to time constraint, the experiments have been done in this thesis cannot cover all sophisticated diagnostics possible. Determination of electron bunch lengths to verify the predictions in Chapter 3 is also required a few more steps than I have been able to fulfil at this point. In this chapter, I therefore indicate what should be done in order to improve the system performance and to maximize the transition radiation signal.

8.1 Electron Beam Stability

To improve the performance of the system, the beam stability is the most concern. The instability of the beam from the RF-gun arises when the electron back-bombardment effect becomes violent. In order to stabilize this effect, the cathode heating feedback control is necessary to sustain a stable output beam. A problem in implementing a cathode feedback control program directly in SURIYA system is that strong ripple noises occur over the current monitor output signals while operating the linac. This noises must be minimized as much as possible, otherwise, the cathode feedback control would not be effective.

8.2 Beam Transportation though the Linac

To maximize transition radiation signals at the experimental station, the electron beam current and electron density should be maximized. We can expect factor four of the transition radiation signal if the beam current transported through the linac is doubled. There are several parameters concerning optimization of such beam transportation. First, the relative RF-phase between the RF-gun and the linac should be optimized by adjusting the phase shifter to obtain higher beam energy and minimize the beam energy spread. Second, the linac temperature must be adjusted to be matched with the klystron frequency in order to reduce the reflected RF-power and to maximize the energy gain in the linac. Third, the steering and focusing elements must be adjusted such that the electron beam can be accelerated through the linac without the significant losses. From our experience, the electron beam current while passing through the linac was very sensitive to the steering fields. The steering magnets on the linac section must be more efficient than what we have now in order to steer the most part of the beam through the linac.

8.3 Bunch Length Measurement

Since the coherent transition radiation signal is a good relative measure of the bunch length the signal maximization must be done by optimizing the α-magnet gradient, the linac entrance phase, the quadrupole focusing and the steering magnet currents. To maximize the transition radiation, adjusting for the best α-magnet gradient to compress electron bunhes from the RF-gun is required. However, changing of the α-magnet gredient varies the path length of electrons and results in the change of the time-of-flight between the RF-gun and the linac. Hence, to optimize the α-magnet gradient would involve rephasing of the linac entrance phase as well as re-adjusting the quadrupole and the steering magnet currents. This can be a time consuming optimization but it is neccessary to be done.

Once the transition radiation is maximized, a Michelson interferometer should be installed at a proper location in the beam transport system so one can perform the bunch length measurement. When the electron bunch length can be measured, an α-magnet energy slit scans should be performed to remove the useless part of low energy electrons in order to minimize the electron bunch length. During these scans, the RF-gun power and the beam current are required to keep at a constant condition. Based on simulation results, it is possible to generate and compress electron bunches into femtosecond range at the experimental station for SURIYA and it is expected to be verified experimentally in the near future after these optimizations have been done.