Chapter 10

Conclusions

10.1 Part I: Linear Optics and Coupling

The knowledge of accurate linear optics and coupling and appropriate lattice corrections are fundamental to the RHIC collider performance and sustain stable operation. An approach using SVD technique on BPM data with coherent betatron oscillations driven by ac dipoles has been discussed in detail. Optics measurement during a tune scan experiment during Run 2004 is presented and no significant effect on machine tunes were found on global β-beat which was approximately 15%. Two approaches using a global correction and local three β-bump have been outlined. Simulations on LHC lattice to keep the β-beat level under a strict aperture limitation of 20% are underway.

The SVD approach has been extended to fully coupled system and relevant parameters characterizing coupling parameters in the lattice have been derived. A comparison of different formalisms were made and numerical techniques to determine the coupling terms have been discussed. Detailed measurements from ac dipole driven data have been analyzed for RHIC at injection and top energies. A possible corrector scan strategy was implemented due to several constraints imposed by the BPM system. The nominal IR corrector settings are clearly not the most optimum and suggested settings for improvements are presented. An anomalous slope phenomena observed is under investigation and fitting techniques are being implemented to identify the sources for this behavior.

10.2 Part II: SRF Cavities

A SC-ERL has been identified as the most viable technology for generating and accelerating ampere class CW electron beams to $\sim$54 MeV. These high

energy electrons low emittance electrons are introduced into RHIC to cool the ion beams and combat intra-beam scattering resulting in an increase of both the peak and average luminosity. The two fundamental components of the SC-ERL, the $\frac{1}{2}$-cell SRF gun and a five-cell SRF cavity, are the central focus of part II of this thesis. A detailed design and development of the two components with comparisons to some existing and future SRF facilities are discussed. The optimization of the elliptical cell shape and the cavity structure along with strong HOM damping makes the five-cell cavity the first of its kind in the high current regime. Extensive simulations and measurements on copper prototypes have been carried and beam breakup thresholds beyond 2 Amps was calculated for the electron cooling scheme. The fabrication of the cavity is complete and chemical treatment of the cavity surface is underway. Extensive testing at 2 K and cryostat assembly will follow the chemical surface treatment.

The $\frac{1}{2}$-cell gun will be the first step to develop an all niobium SRF gun with a diamond amplified photo-cathode. A detailed study of both RF and beam dynamics issues lead to a final optimized gun shape. Several major challenges including an intricate power coupler, cathode stalk, laser stability issues have been overcome. A conceptual $1\frac{1}{2}$-cell design has been developed for the electron cooling scheme, and further optimization is required to arrive at the final design.