RF Beam Control System for the Brookhaven Relativistic Heavy Ion Collider, RHIC*,

J.M. BRENNAN, A. CAMPBELL, J. DELONG, T. HAYES, E. ONILLON, J. ROSE, K. VETTER, Brookhaven National Laboratory - The Relativistic Heavy Ion Collider, RHIC, is two counter-rotating rings with six interaction points that will collide 100 GeV/nucleon heavy ions and 250 GeV polarized protons. The RF Beam Control system for each ring will control two 28 MHz cavities for acceleration, and five 197 MHz cavities for preserving the 5 ns bunch length during 10 hour beam stores. Digital technology is used extensively: in 1) Direct Digital Synthesis of rf signals to, drive the cavities, control synchronization between rings and injector, and supply the beam-synchronous clock to the timing system of the complex: and in 2) Digital Signal Processing for, the realization of state-variable feedback loops, real-time calculation of rf frequency, and bunch-by-bunch phase measurement of the 120 bunches. DSP technology enables programming the parameters of the feedback loops (phase, radial, and synchronization) in order to obtain closed-loop dynamics that are independent of synchrotron frequency. The LQR method is used in conjunction with pole placement (Ackermann's formula) to give system gains as functions of changing machine parameters.