v. Lattice Correction Systems

The lattice configuration described above would be completely adequate to assure stable motion of single particles assuming ideal properties of all magnet elements. Real magnets depart unavoidably from the ideal situation and will exhibit 1) systematic errors due to design or intrinsic material properties such as iron saturation or superconductor magnetization and 2) random errors due to fabrication and installation tolerances. Furthermore, the goal of high luminosity implies intense beams imposing additional operational requirements. Proper operation of the collider as built therefore requires additional systematic trim and random error correction magnets.

The primary objectives for the correction of beam optics distortions are to assure 1) that the orbit is centered in the good field aperture of the magnets and 2) that the operating tune remains in a range which is free from 10th order and lower resonances. The tune diagram for RHIC is shown in Fig. 11-15 with the selected working point at $v_x = 28.19$ and $v_y = 29.18$ as well as the neighboring sum resonances $n\, v_x + m\, v_y = p$ where n, m, and p are positive integers and n + m denotes the order of the resonance. The nominal tune is located between the 5th order systematic resonance at 28.20 and the 6th order resonance at 28.166 yielding a useable tune range of 33×10^{-3}. The trim/correction magnet systems for RHIC with a brief description of the beam optical purpose are listed in Table 11-4, and their ring location is shown in Fig. 11-16.

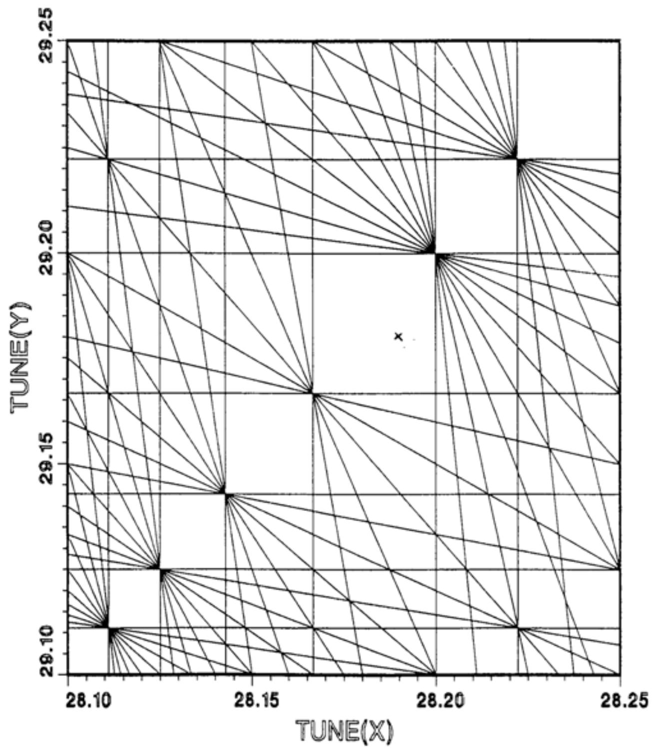

Fig. 11-15. Tune diagram showing the selected working point of RHIC at $\nu_x = 28.19$, $\nu_y = 29.18$ with neighboring sum and difference resonances.

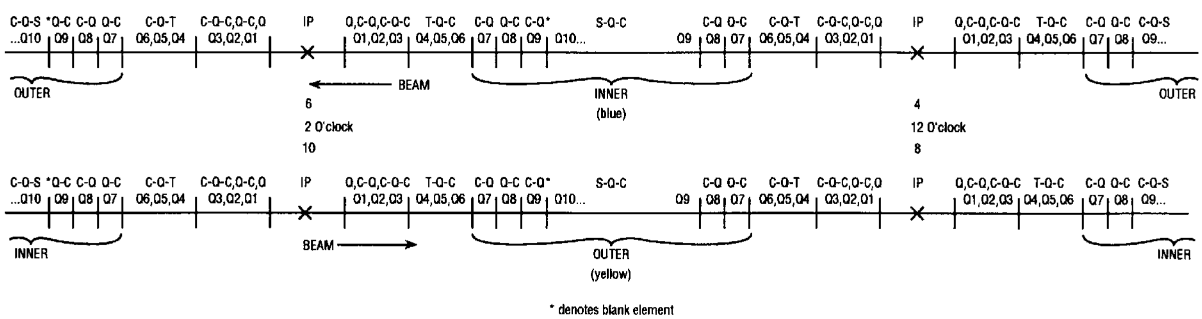

Fig. 11-16. Ring location of trim-quadrupole T, sextupole S and corrector C magnets. Note that Q9O at 6 o'clock is a CQ (not CQ*) assembly.

Table 11-4. Trim/Correction Magnet Systems Per Ring with Power Supplies on Day-One

Magnet System	Beam Optical Purpose	Units/Ring, Location, Strength
Dipole	Correct closed orbit, beam separation @ crossing point during acceleration and storage	222 b_o/a_o units, 0.3 T·m each @ each QF/QD, Q4-Q9, and focussing Q2, Q3 individually powered
		12 a_o units/insertion, 0.3 T·m each @ defocussing Q2, Q3 individually powered
Quadrupole	γ_T-jump	8 b_1 units/sextant, 1.5 T each @ QF in insertion and arc 2 families*/sextant
	Correct β_x, β_y, X_p @ crossing points and arcs	Trim power supplies @ Q1 - Q3, Q7, QFA, QDA Trim magnets, 21 T each @ Q4, Q5, Q6
Skew Quadrupole	Correct linear coupling and tune splitting	8 a_1 units/insertion, 1.5 T each 2 families/insertion
		2 a_1 units/insertion, 0.8 T each @ Q2, individually powered
	Correct vertical dispersion @ crossing points	Future option
Sextupole	Correct skew chromaticity	2 b_2 and 2 a_2 units/insertion individually powered
Octupole	Correct quadratic chromaticity	15 b_3 units/sextant, 3.6 kT/m^2 each 2 F + 2 D families/sextant
	Triplet correction	4 b_3 units/insertion, 240 T/m^2 @ Q2, Q3 in low beta insertions individually powered
Decapole	Correct tune spread due to $\langle b_4 \rangle \neq 0$ in dipoles iron saturation	Future option
	Triplet correction	2 b_4 units/insertion, 565 kT/m^3 each @ Q2, Q3 in low beta insertions individually powered
Dodecapole	Correct tune spread due to $\langle b_5 \rangle \neq 0$ in high-beta quads iron saturation	4 b_5 units/insertion, 4.9 MT/m^4 each @ Q2, Q3 in low beta insertions individually powered

*A family of corrector magnets is powered by one supply.