Recycler Ring Lattice Design with Combined Function Magnets

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A combined function magnet lattice for the "Recycler" ring has been constructed which follows the footprint of the MI and includes a high beta section in the MI-30 straight section for the electron cooling. There are many options for optimizing the number, length, strength, and gradient of the combined function magnets and the lengths and gradients of the straight section quads. This lattice serves as a proof of principal. Little or no optimization of magnet parameters has been performed.

The current lattice replicates the lattice arc cell length (17.288639 m) and dispersion cell lengths (12.966479 m)of the Main Injector. At each quad location in the arc, two combined function magnets are centered (with a foot spacing between them for bellows) about the MI cell boundry. The space between the magnet pairs is beampipe which gives over 8 meters for position detectors, ion pumps and other diagnostic equipment. The arcs use two 4 meter magnets, the dispersion suppressor uses two 2.67 meter magnets and the boundry between the arc and dispersion suppressors use one of each. A sextupole component has been included in each of the combined function magnets for chromaticity correction. The magnets in the straight sections are 1 meter quads. At the interface of the straight section 1/2 meter quads are used (with the same gradient as the SS quads). An alternate selection of quads could use multiple gradients and a fixed quad length. The magnet requirements and parameters are summarized in Table 1.

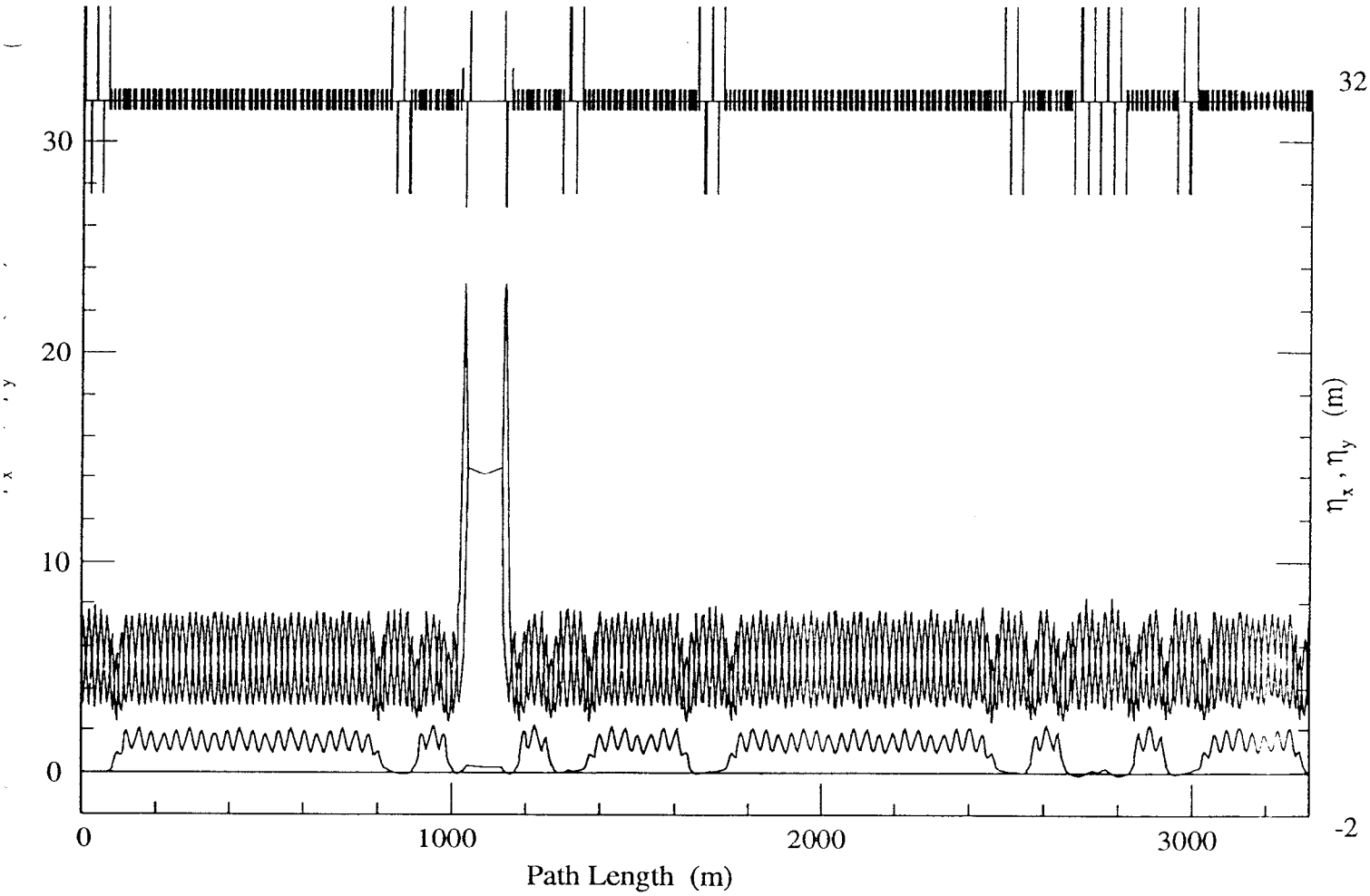
Figure 1 shows the lattice for the entire ring. A typical straight section, and dispersion suppression section are shown in Figure 2. Figure 3 shows the high beta insert (and the dispersion suppressors on either side of the straight section) in the MI-30 long straight section. The lattice parameters are summarized in Table 2.

Table 1: Magnet Requirements

Magnet type	Length [m]	Number Req'd.	B_0 [kG]	B_1 $[kG - m^{-1}]$	B_2 $[kG - m^{-2}]$
F Grad. Dipole (arc)	4	108	1.547	3.69	3.35
D Grad. Dipole (arc)	4	108	1.547	-3.73	-6.35
F Grad. Dipole (dis)	2.67	64	1.547	7.15	3.35
D Grad. Dipole (dis)	2.67	64	1.547	-7.27	-6.35
Straight Section quad	1	20	-	24.76	-
Straight Section quad	.5	14	-	24.76	-
High Beta Quad 1	.5	2	-	8.207	-
High Beta Quad 2	1	2	-	-27.96	-
High Beta Quad 3	1	2	-	23.66	-

Table 2: Lattice Parameters

Circumference	3319.414 m
Arc cell β_{max}	56.1 m
Arc cell β_{min}	9.75 m
Max Dispersion, D_x	2.23 m
Max β_x (insert)	210 m
Max β_y (insert)	542 m
Insert $\beta_x = \beta_y$	200 m
H Tune, ν_x	25.45
V Tune, ν_y	25.45
Natural chromaticity, ξ_x	-34.7
Natural chromaticity, ξ_y	-36.3



FILEs: HEA.lat : match_hb.prc

Figure 1

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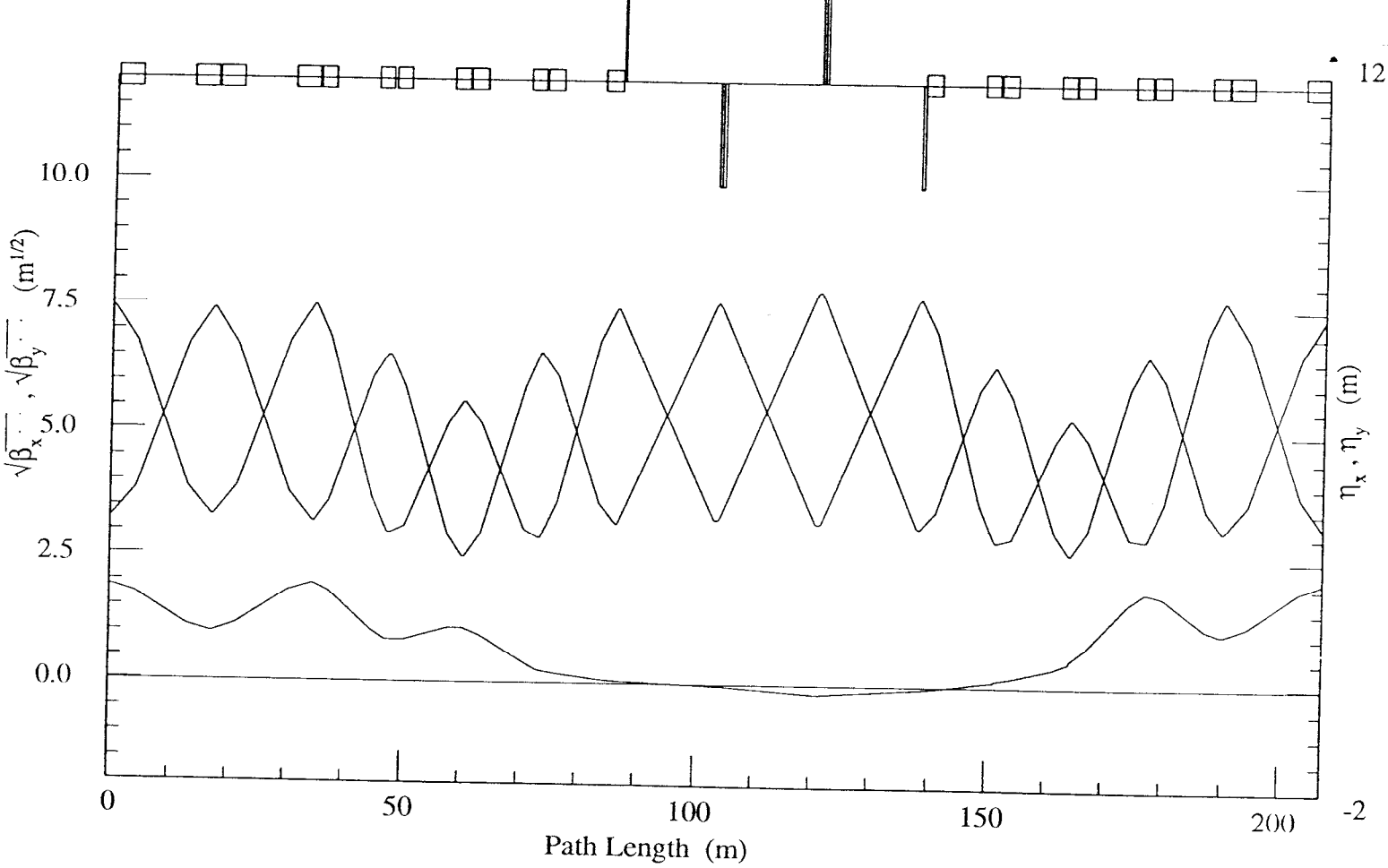

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Figure 2

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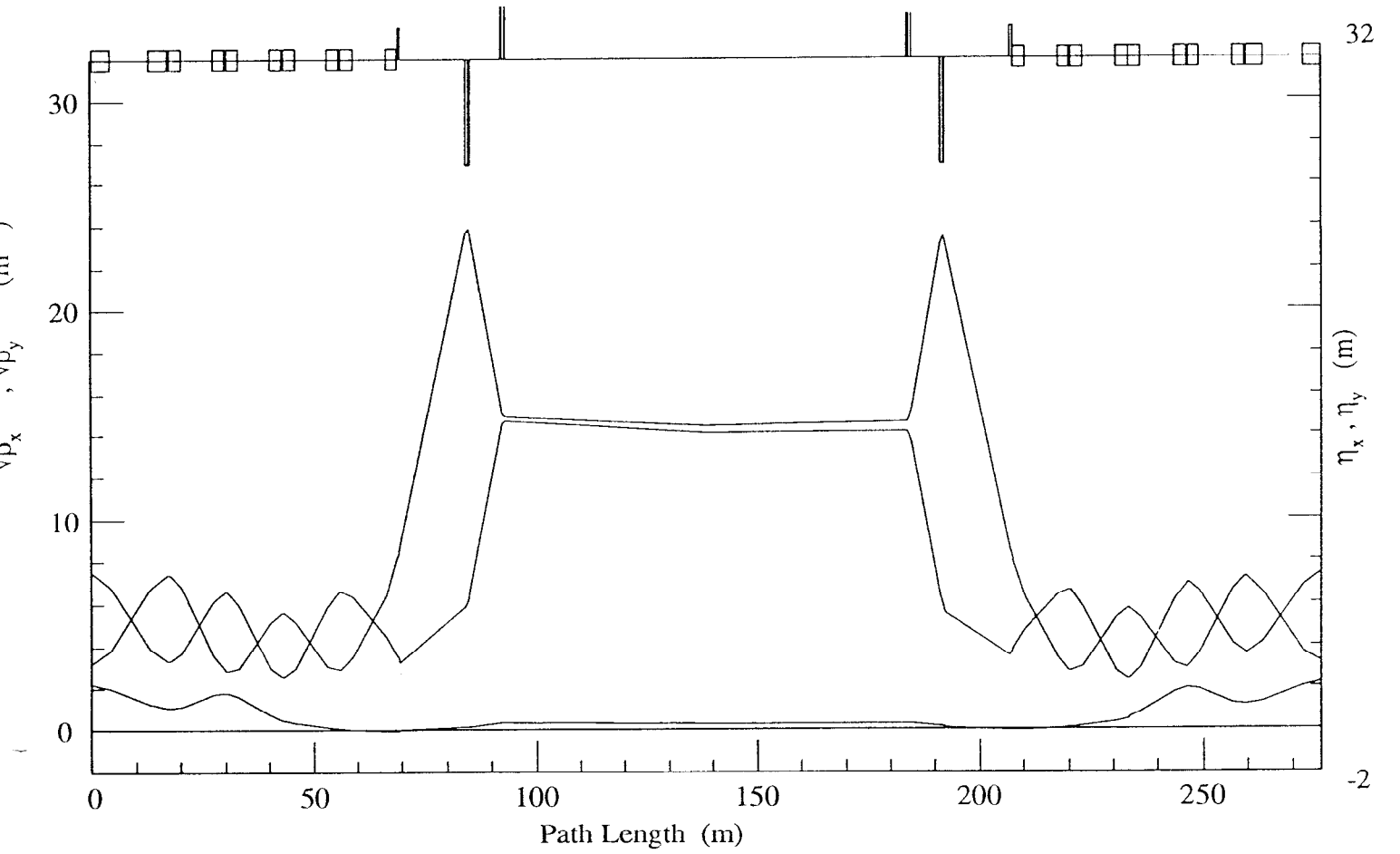

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Figure 3

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