Recycler Dump Magnet Requirements

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The Recycler dump beamline is used to transport protons to the Main Injector abort dump. The beam to be dumped is kicked to the outside by a Recycler style kicker located downstream of Q400. The extraction Lambertson bends the beam down at the nominal 23 mr design angle. A series of one horizontal and two vertical permanent magnet gradient magnets, a mirror dipole, and five permanent magnet quads are used to transport the beam to the dump. The magnet parameters are summarized in Table 1.

Since the release of MI Note 0224, a horizontal and vertical MR correction dipole have been inserted in the lattice between Q1 and H001. The quad Q1 was shifted upstream to keep the vertical beam size through H001 comparable to that in the Recycler. The geometry (roll angles) shifted slightly. The new tilt and quad strengths are listed below.

Table 1. Magnet Parameters

Name	Type	#	L [in]	Theta* [mr]	B0L [kG-m]	k1 [1/m^2]	K2 [1/m^3]	Tilt [deg.]
RK400		1	~45	.99		-	-	-
LAM402	RLA	1	177	23	6.8195	-	-	83.65
H001	RGDR	1	177	20.9	6.1824	-0.0109208	-0.021643	-1.30
V001	RGDR	1	177	20.9	6.1824	-0.0109208	-0.021643	82.27
V003	RGD	1	177	-20.9	-6.1824	-0.0109208	-0.021643	83.39
V004	MDA	1	177	-20.9	-6.1824	0	0	81.54
Q001	RQMD	1	20	-		-0.08539	-	-
Q002	RQAA	1	20	-		+0.03379	-	-
Q003	RQAB	1	20	-		+0.06059	-	-
Q004	RQAC	2	20	-		-0.07155	-	-

The *type* parameter is used to indicate the pole face design. The length, L is the pole tip length. The polarity* of the dipole field or strength of the quad or sextupole field is indicated by the sign of theta, k1 and k2. The values for k1 and k2 in H001, V001, and V003 are determined by the pole face shape

and match those of the RGD type. For quads Q002-004 the pole face used the same design as the RQM magnets but the strength and polarity are different.

The coordinate system used for the design of the abort line is a *rht* system with $+x$ pointing to the inside of the ring, $+y$ pointing up, and $+z$ in the direction of the protons. For horizontal bends, a *positive* theta corresponds to a *positive* **B***y* which bends to the right toward the outside of the ring (- *x looking in the proton direction*). **Note: the standard Recycler gradient magnets (RGF/D and SGF/D) have a *negative* By (or the field pointing *down*).** The vertical bends are defined as horizontal bends rolled or rotated about their axis. A positive tilt, looking in the downstream direction, indicates a rotation in the clockwise direction. This implies that a standard Recycler magnet with its field pointing down rotated a positive 90 degrees will have a positive **B***x* and bend protons up. Likewise, a magnet with a positive **B***y* (i.e. RGDR type) rotated a positive 90 degrees will bend protons downward. Using this convention, LAM402 bends down and to the right, H001 bends to the right and up, V001 bends down and to the right, V003 bends up and to the left, and V004 bends up and to the left.