BNL-101800-2014-TECH
AD/RHIC/RD/18;BNL-101800-2013-IR

The Effect of the Stripping Foil SA on the Injection Beam of RHIC

J. Xu

April 1990

Collider Accelerator Department
Brookhaven National Laboratory

U.S. Department of Energy
USDOE Office of Science (SC)

DISCLAIMER

AD/RHIC/RD–18

RHIC PROJECT

Brookhaven National Laboratory

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Introduction

The characteristics of the stripping foil have been calculated by Dr. M.J. Rhoades–Brown.[1] There is some difference between the results and those data published in the blue book.[2] The beam transport line with low β waist for foil SA has been described.[3] But considering that, between UQ3 and UQ4 most space is filled by soil and a lot of constructional work will be needed in order to install quadrupoles between UQ3 and UQ4, two new lattices with the required low β waist are found.

In this paper, these new low β waist lattices of the beam transport line between AGS and RHIC are described and the effects of the stripping foil SA on the injection beam of RHIC are calculated using the new dates in reference 1.

Transverse Motion

After transversing the foil, the rms emittance growth of the beam in the transverse planes equals $\beta\langle\theta\rangle^2$ ($\alpha << 1$). Where $\langle\theta\rangle$ is the rms scattering angle after passing the foil and β is the amplitude function of the transport line where the foil is situated. In order to decrease this emittance growth a low β waist should be formed in the beam transport line for the foil SA.

In the first lattice, this low β waist is formed at a point 8.934 meters downstream of UQ5, where $\beta_x = \beta_y = 5.5$ meters and $\alpha_x = \alpha_y = 0$. For 40 mg/cm^2 gold foil and 10.4 GeV/u gold beam $\langle\theta\rangle^2$ is 1.75×10^{-9} rad. The corresponding rms emittance growth is 0.0096 πmm·mrad and the relative emittance growth is about 7.4%. (The AGS ejected beam rms emittance is 0.13 πmm·mrad.)

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[1] M.J. Rhoades–Brown, "The Heavy Ion Stripping Foil Requirements between AGS and RHIC", AD/RHIC–88 (1990).

[2] Conceptual Design of the Relativistic Heavy Ion Collider, p. 60, BNL 52195, 1989.

[3] Jianming Xu, "The Low β Waist in the Beam Transport Line for the Stripping Foil", AD/RHIC/RD–16, 1990.

In this lattice two additional quadrupoles are added which are UQ6′ and UQ9′. And the positions of UQ5, UQ6, UQ7, UQ8 and UQ11 are adjusted also. The coordinates of these magnets in this variant and in the original lattice[4] are shown in Table 1.

Table 1.

Name of Element	UQ5	UQ6	UQ7	UQ8	UQ11	UQ6′	UQ9′	SA
Position in first variant M.	37.641	49.30	61.62	73.946	131.622	54.893	105.276	46.574
Position in original lattice M.	39.641	47.30	62.62	75.946	127.623			

In the second variant the low β waist is formed at a point 1 meter downstream of UQ4, where $\beta_x = \beta_y = 7.0$ meters and $\alpha_x = \alpha_y = 0$. And the rms emittance growth is about 0.0123 πmm·mrad or the relative emittance growth is 9.4%. Two additional quadrupoles are added which are UQ3′ and UQ6′ and the position of UQ5 and UQ6 are adjusted. The coordinates of these magnets in this variant and in the original lattice are shown in Table 2.

Table 2.

Name of Element	UQ5	UQ6	UQ3′	UQ6′	SA
Position in the second variant M.	36.641	41.300	17.081	50.893	33.947
Position in original lattice M.	39.641	47.300			

The parameters of the elements of the first variant are shown in Table 3. The Twiss parameters of this variant can be found from Table 4. The parameters of the elements of the second variant are shown in Table 5. The Twiss parameters of the second variant can be found from Table 6.

The first variant is preferred not only because it has a lower β value but also this variant doesn't need very strong quadrupoles as the second variant does. The beam emittance growth after passing the foil SA should be considered in evaluating the beam envelops.

[4] J. Claus and H. Foelsche, "Beam Transfer from AGS to RHIC", AD/RHIC–47, 1988.

Longitudinal Motion

The additional root–mean–square value of the energy spread $\langle \delta E \rangle$ of a 10.4 GeV/u gold beam in a 40 mg/cm^2 gold foil is 0.065 MeV/u and the energy loss ΔE after passing the foil is 0.65 MeV/u. The relative energy spread of the AGS ejected beam is 0.102% which corresponds to a half width of 10.6 MeV/u.[5] The bunch area growth is proportional to $\langle \delta E \rangle^2$. So the relative increase of the bunch area after passing foil SA is about 0.02%. It is negligibly small. The relative energy loss after passing foil SA is 6.3×10^{-5}. This decrease of the injection energy should be considered in commissioning the beam transport line and RHIC.

Acknowledgment

I am thankful to Drs. H. Foelsche, M.J. Rhoades–Brown and A.G. Ruggiero for helpful discussions.

[5] Conceptual Design of the Relativistic Heavy Ion Collider, p. 64, BNL 52195, 1989.

Table 3.

```
LUKS:DRIFT,L=5.00000
LU01:DRIFT,L=0.374005
LU12:DRIFT,L=0.495300
LU231:DRIFT,L=0.477256
LU232:DRIFT,L=0.459994
LU233:DRIFT,L=0.459994
LU234:DRIFT,L=0.255379
LU34:DRIFT,L=15.139416
LU45:DRIFT,L=4.92404
LU56:DRIFT,L=5.933184
LU66':DRIFT,L=4.866622
LU6'7:DRIFT,L=6
LU78:DRIFT,L=11.599619
LU891:DRIFT,L=5.534764
LU892:DRIFT,L=0.609600
LU193:DRIFT,L=0.609600
LU293:DRIFT,L=0.609600
LU894:DRIFT,L=0.609600
LU895:DRIFT,L=8.364036
LU910:DRIFT,L=10.695975
LU011:DRIFT,L=5.106874
LU112:DRIFT,L=10.227535
LU100:DRIFT,L=1.000
LU800:DRIFT,L=8.000
LU450:DRIFT,L=4.500

UQ1:QUADRUPOLE,TYPE=MQ,L=0.9525,K1=0.3325605
UQ2:QUADRUPOLE,TYPE=MQ,L=0.9525,K1=-0.3973553
UQ3:QUADRUPOLE,TYPE=MQ,L=0.4572,K1=0.1901247
UQ4:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=-0.2057149
UQ5:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=0.1759136
UQ6:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=-0.09937573
UQ7:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=-0.1916022
UQ8:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=0.06067053
UQ9:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=-0.153695
UQ10:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=0.3463872
UQ11:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=-0.1944525
UQ12:QUAD,TYPE=MQ,L=0.72644,K1=0.1878129
UQ6':QUAD,TYPE=MQ,L=0.72644,K1=0.1828273
UQ9':QUAD,L=0.72644,K1=0.1036447

UD1:RBEND,L=2.080006,ANGLE=24.725E-3
UD2:RBEND,L=2.080006,ANGLE=24.725E-3
UD3:RBEND,L=2.080006,ANGLE=24.725E-3
U4F:RBEND,L=3.657600,ANGLE=34.906E-3,K1=0.018823143
U5D:RBEND,L=3.657600,ANGLE=34.906E-3,K1=-0.018823143
U6D:RBEND,L=3.657600,ANGLE=34.906E-3,K1=-0.018823143
U7F:RBEND,L=3.657600,ANGLE=34.906E-3,K1=0.018823143

U1:LINE=(LUKS,LU01,UQ1,LU12,UQ2,LU231,UD1,LU232,UD2,LU233,UD3,&
    LU234,UQ3,LU34,UQ4,LU45,UQ5,LU56,3*LU100,SA,2*LU100,&
    UQ6,LU66',UQ8',LU8'7,UQ7,LU78,UQ8,LU891)
U2:LINE=(U4F,LU892,U5D,LU193,LU293,U6D,LU894,U7F,LU800,UQ9',LU895,&
    UQ9,&LU910,UQ10,LU011,UQ11,LU112,UQ12)
U:LINE=(U1,U2)
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Table 4.

DELTA(P)/P = Ø.ØØØØØØ SYMM = F

POS. NO.	ELEMENT NAME	SEQUENCE OCC. NO.	I I	DIST [M]	BETAX [M]	ALFAX [1]	HORIZONTAL MUX [2PI]	X(CO) [MM]	PX(CO) [.ØØ1]	DX [M]	DPX [1]	I I	BETAY [M]	ALFAY [1]	VERTICAL MUY [2PI]	Y(CO) [MM]	PY(CO) [.ØØ1]	DY [M]	DPY [1]
BEGIN	U	1		Ø.ØØØ	37.59Ø	-4.778	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	-2.96Ø	-Ø.295		8.Ø5Ø	1.Ø53	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
1	LUKS	1		5.ØØØ	1Ø1.218	-7.948	Ø.Ø13	Ø.ØØØ	Ø.ØØØ	-4.435	-Ø.295		4.Ø69	-Ø.257	Ø.169	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
2	LUØ1	1		5.374	1Ø7.252	-8.185	Ø.Ø13	Ø.ØØØ	Ø.ØØØ	-4.545	-Ø.295		4.298	-Ø.355	Ø.183	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
3	UQ1	1		6.327	91.177	23.328	Ø.Ø15	Ø.ØØØ	Ø.ØØØ	-4.144	1.117		6.813	-2.546	Ø.213	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
4	LU12	1		6.822	69.536	2Ø.366	Ø.Ø16	Ø.ØØØ	Ø.ØØØ	-3.591	1.117		9.6Ø5	-3.Ø9Ø	Ø.223	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
5	UQ2	1		7.774	55.Ø55	-3.379	Ø.Ø19	Ø.ØØØ	Ø.ØØØ	-3.129	-Ø.118		11.992	Ø.893	Ø.236	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
6	LU231	1		8.252	58.332	-3.487	Ø.Ø2Ø	Ø.ØØØ	Ø.ØØØ	-3.185	-Ø.118		11.174	Ø.821	Ø.243	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
7	UD1	1		1Ø.332	73.811	-3.956	Ø.Ø25	Ø.ØØØ	Ø.ØØØ	-3.4Ø4	-Ø.Ø93		8.4Ø1	Ø.512	Ø.277	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
8	LU232	1		1Ø.792	77.498	-4.Ø6Ø	Ø.Ø26	Ø.ØØØ	Ø.ØØØ	-3.447	-Ø.Ø93		7.981	Ø.443	Ø.286	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
9	UD2	1		12.872	95.36Ø	-4.529	Ø.Ø3Ø	Ø.ØØØ	Ø.ØØØ	-3.615	-Ø.Ø68		6.765	Ø.132	Ø.332	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
1Ø	LU233	1		13.332	99.574	-4.633	Ø.Ø3Ø	Ø.ØØØ	Ø.ØØØ	-3.646	-Ø.Ø68		6.675	Ø.Ø63	Ø.343	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
11	UD3	1		15.412	119.819	-5.1Ø2	Ø.Ø34	Ø.ØØØ	Ø.ØØØ	-3.763	-Ø.Ø44		7.Ø6Ø	-Ø.248	Ø.392	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
12	LU234	1		15.667	122.439	-5.159	Ø.Ø34	Ø.ØØØ	Ø.ØØØ	-3.774	-Ø.Ø44		7.196	-Ø.286	Ø.397	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
13	UQ3	1		16.124	122.278	5.5Ø8	Ø.Ø34	Ø.ØØØ	Ø.ØØØ	-3.719	Ø.283		7.786	-1.Ø22	Ø.4Ø7	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
14	LU34	1		31.264	14.24Ø	1.628	Ø.Ø94	Ø.ØØØ	Ø.ØØØ	Ø.567	Ø.283		98.919	-4.998	Ø.499	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
15	UQ4	1		31.99Ø	13.443	-Ø.491	Ø.1Ø2	Ø.ØØØ	Ø.ØØØ	Ø.8Ø8	Ø.385		95.444	9.6Ø7	Ø.5ØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
16	LU45	1		36.914	2Ø.518	-Ø.946	Ø.15Ø	Ø.ØØØ	Ø.ØØØ	2.7Ø3	Ø.385		24.533	4.794	Ø.516	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
17	UQ5	1		37.64Ø	2Ø.ØØ9	1.624	Ø.156	Ø.ØØØ	Ø.ØØØ	2.854	Ø.Ø27		2Ø.ØØ9	1.624	Ø.522	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
18	LU56	1		43.574	7.136	Ø.545	Ø.238	Ø.ØØØ	Ø.ØØØ	3.Ø15	Ø.Ø27		7.136	Ø.545	Ø.6Ø4	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
19	LU1ØØ	1		44.574	6.227	Ø.364	Ø.262	Ø.ØØØ	Ø.ØØØ	3.Ø42	Ø.Ø27		6.227	Ø.364	Ø.628	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
2Ø	LU1ØØ	2		45.574	5.682	Ø.182	Ø.289	Ø.ØØØ	Ø.ØØØ	3.Ø69	Ø.Ø27		5.682	Ø.182	Ø.655	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
21	LU1ØØ	3		46.574	5.5ØØ	Ø.ØØØ	Ø.318	Ø.ØØØ	Ø.ØØØ	3.Ø96	Ø.Ø27		5.5ØØ	Ø.ØØØ	Ø.684	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
22	SA	1		46.574	5.5ØØ	Ø.ØØØ	Ø.318	Ø.ØØØ	Ø.ØØØ	3.Ø96	Ø.Ø27		5.5ØØ	Ø.ØØØ	Ø.684	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
23	LU1ØØ	4		47.574	5.682	-Ø.182	Ø.346	Ø.ØØØ	Ø.ØØØ	3.123	Ø.Ø27		5.682	-Ø.182	Ø.712	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
24	LU1ØØ	5		48.574	6.227	-Ø.364	Ø.373	Ø.ØØØ	Ø.ØØØ	3.15Ø	Ø.Ø27		6.227	-Ø.364	Ø.739	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
25	UQ6	1		49.3ØØ	7.2Ø4	-1.ØØ5	Ø.391	Ø.ØØØ	Ø.ØØØ	3.253	Ø.257		6.511	-Ø.Ø2Ø	Ø.757	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
26	LU66'	1		54.167	23.588	-2.362	Ø.452	Ø.ØØØ	Ø.ØØØ	4.5Ø5	Ø.257		1Ø.341	-Ø.767	Ø.858	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
27	UQ6'	1		54.893	24.742	Ø.825	Ø.456	Ø.ØØØ	Ø.ØØØ	4.473	-Ø.344		12.643	-2.5Ø3	Ø.869	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
28	LU6'7	1		6Ø.893	17.291	Ø.417	Ø.5Ø3	Ø.ØØØ	Ø.ØØØ	2.41Ø	-Ø.344		63.361	-5.95Ø	Ø.9Ø3	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
29	UQ7	1		61.62Ø	18.488	-2.12Ø	Ø.51Ø	Ø.ØØØ	Ø.ØØØ	2.279	-Ø.Ø2Ø		65.534	3.Ø6Ø	Ø.9Ø4	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
3Ø	LU78	1		73.219	1Ø7.678	-5.569	Ø.552	Ø.ØØØ	Ø.ØØØ	2.Ø44	-Ø.Ø2Ø		15.824	1.226	Ø.963	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
31	UQ8	1		73.946	112.341	-Ø.782	Ø.553	Ø.ØØØ	Ø.ØØØ	1.997	-Ø.11Ø		14.6Ø2	Ø.475	Ø.971	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
32	LU891	1		79.48Ø	121.439	-Ø.862	Ø.56Ø	Ø.ØØØ	Ø.ØØØ	1.391	-Ø.11Ø		11.913	Ø.Ø11	1.Ø4Ø	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
33	U4F	1		83.138	98.813	6.521	Ø.565	Ø.ØØØ	Ø.ØØØ	Ø.898	-Ø.154		16.286	-1.3Ø4	1.Ø84	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
34	LU892	1		83.748	91.Ø26	6.252	Ø.566	Ø.ØØØ	Ø.ØØØ	Ø.8Ø4	-Ø.154		17.937	-1.4Ø5	1.Ø89	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
35	U5D	1		87.4Ø5	68.54Ø	Ø.4Ø5	Ø.574	Ø.ØØØ	Ø.ØØØ	Ø.384	-Ø.Ø8Ø		24.44Ø	-Ø.22Ø	1.116	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
36	LU193	1		88.Ø15	68.Ø52	Ø.394	Ø.575	Ø.ØØØ	Ø.ØØØ	Ø.335	-Ø.Ø8Ø		24.724	-Ø.246	1.12Ø	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
37	LU293	1		88.624	67.578	Ø.384	Ø.577	Ø.ØØØ	Ø.ØØØ	Ø.286	-Ø.Ø8Ø		25.Ø4Ø	-Ø.272	1.124	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
38	U6D	1		92.282	83.Ø15	-4.954	Ø.585	Ø.ØØØ	Ø.ØØØ	Ø.Ø83	-Ø.Ø33		21.419	1.177	1.148	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
39	LU894	1		92.892	89.169	-5.141	Ø.586	Ø.ØØØ	Ø.ØØØ	Ø.Ø62	-Ø.Ø33		2Ø.Ø25	1.1Ø9	1.153	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
4Ø	U7F	1		96.549	1Ø3.919	1.452	Ø.592	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ		17.557	-Ø.379	1.186	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
41	LU8ØØ	1		1Ø4.549	82.594	1.213	Ø.6Ø6	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ		27.787	-Ø.9ØØ	1.245	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
42	UQ9'	1		1Ø5.276	76.475	7.Ø56	Ø.6Ø7	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ		3Ø.725	-3.218	1.249	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
43	LU895	1		113.64Ø	4.9ØØ	1.5Ø1	Ø.678	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ		11Ø.423	-6.31Ø	1.271	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
44	UQ9	1		114.366	3.367	Ø.665	Ø.7Ø7	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ		11Ø.577	6.1Ø5	1.273	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
45	LU91Ø	1		125.Ø62	38.159	-3.918	1.Ø11	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ		19.578	2.4Ø3	1.3Ø9	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
46	UQ1Ø	1		125.789	36.835	5.628	1.Ø14	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ		19.642	-2.496	1.316	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
47	LU011	1		13Ø.895	2.486	1.Ø98	1.1Ø3	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ		54.731	-4.375	1.34Ø	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
48	UQ11	1		131.622	1.528	Ø.266	1.165	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ		55.423	3.456	1.342	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
49	LU112	1		141.849	69.388	-6.9Ø1	1.434	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ		9.16Ø	1.Ø67	1.417	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
5Ø	UQ12	1		142.576	72.47Ø	2.8ØØ	1.435	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ		8.57Ø	-Ø.229	1.431	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ
END	U	1		142.576	72.47Ø	2.8ØØ	1.435	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ		8.57Ø	-Ø.229	1.431	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ	Ø.ØØØ

Table 5.

```
LUKS:DRIFT,L=5.00000
LU01:DRIFT,L=0.374005
LU12:DRIFT,L=0.495300
LU231:DRIFT,L=0.477256
LU232:DRIFT,L=0.459994
LU233:DRIFT,L=0.459994
LU234:DRIFT,L=0.255379
LU34:DRIFT,L=15.139416
LUs5:DRIFT,L=8.412536
LU45:DRIFT,L=1.96704
LU56:DRIFT,L=3.933184
LU66':DRIFT,L=8.866622
LU6'7:DRIFT,L=11.000
LU78:DRIFT,L=12.599619
LU891:DRIFT,L=3.534764
LU892:DRIFT,L=0.609600
LU193:DRIFT,L=0.609600
LU293:DRIFT,L=0.609600
LU894:DRIFT,L=0.609600
LU895:DRIFT,L=17.090476
LU910:DRIFT,L=10.695975
LU011:DRIFT,L=1.106874
LU112:DRIFT,L=14.227735
LU100:DRIFT,L=1.000

UQ1:QUADRUPOLE,TYPE=MQ,L=0.9525,K1=0.2463658
UQ2:QUADRUPOLE,TYPE=MQ,L=0.9525,K1=-0.2055742
UQ3:QUADRUPOLE,TYPE=MQ,L=0.4572,K1=0.6449417
UQ4:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=0.03068713
UQ5:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=0.1649762
UQ6:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=-0.3019272
UQ7:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=-0.15931
UQ8:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=0.02263587
UQ9:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=-0.02775456
UQ10:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=0.3639885
UQ11:QUADRUPOLE,TYPE=MQ,L=0.72644,K1=-0.3338852
UQ12:QUAD,TYPE=MQ,L=0.72644,K1=0.2098442
UQ6':QUAD,TYPE=MQ,L=0.72644,K1=0.1630758
UQ3':QUAD,L=0.4572,K1=-0.7071184

UD1:RBEND,L=2.080006,ANGLE=24.725E-3
UD2:RBEND,L=2.080006,ANGLE=24.725E-3
UD3:RBEND,L=2.080006,ANGLE=24.725E-3
U4F:RBEND,L=3.657600,ANGLE=34.906E-3,K1=0.018823143
U5D:RBEND,L=3.657600,ANGLE=34.906E-3,K1=-0.018823143
U6D:RBEND,L=3.657600,ANGLE=34.906E-3,K1=0.018823143
U7F:RBEND,L=3.657600,ANGLE=34.906E-3,K1=-0.018823143

U1:LINE=(LUKS,LU01,UQ1,LU12,UQ2,LU231,UD1,LU232,UD2,LU233,UD3,LU234,UQ3,LU,UQ3',LU34,UQ4,LU100,LU45,UQ5,LU56,&
   UQ6,LU66',UQ6',LU6'7,UQ7,LU78,UQ8,LU891)
U2:LINE=(U4F,LU892,U5D,LU193,LU293,U6D,LU894,U7F,LU895,UQ9,LU910,UQ10,LU011,UQ11,LU112,UQ12)
U:LINE=(U1,U2)
```

Table 6.

DELTA(P)/P = 0.000000 SYMM = F

POS. NO.	ELEMENT NAME	OCC. NO.	DIST [M]	BETAX [M]	ALFAX [1]	MUX [2PI]	X(CO) [MM]	PX(CO) [.001]	DX [M]	DPX [1]	BETAY [M]	ALFAY [1]	MUY [2PI]	Y(CO) [MM]	PY(CO) [.001]	DY [M]	DPY [1]
	ELEMENT SEQUENCE		I	HORIZONTAL						I	VERTICAL						
BEGIN	U	1	0.000	37.590	-4.778	0.000	0.000	0.000	-2.960	-0.295	8.050	1.053	0.000	0.000	0.000	0.000	0.000
1	LUKS	1	5.000	101.218	-7.948	0.013	0.000	0.000	-4.435	-0.295	4.069	-0.257	0.169	0.000	0.000	0.000	0.000
2	LU01	1	5.374	107.252	-8.185	0.013	0.000	0.000	-4.545	-0.295	4.298	-0.355	0.183	0.000	0.000	0.000	0.000
3	UQ1	1	6.327	98.917	16.274	0.015	0.000	0.000	-4.317	0.765	6.369	-1.980	0.214	0.000	0.000	0.000	0.000
4	LU12	1	6.822	83.455	14.943	0.016	0.000	0.000	-3.939	0.765	8.520	-2.362	0.224	0.000	0.000	0.000	0.000
5	UQ2	1	7.774	70.467	-0.469	0.018	0.000	0.000	-3.560	0.042	11.646	-0.714	0.239	0.000	0.000	0.000	0.000
6	LU231	1	8.252	70.918	-0.477	0.019	0.000	0.000	-3.541	0.042	12.357	-0.775	0.245	0.000	0.000	0.000	0.000
7	UD1	1	10.332	72.978	-0.513	0.023	0.000	0.000	-3.428	0.066	16.135	-1.040	0.269	0.000	0.000	0.000	0.000
8	LU232	1	10.792	73.454	-0.521	0.024	0.000	0.000	-3.398	0.066	17.119	-1.100	0.273	0.000	0.000	0.000	0.000
9	UD2	1	12.872	75.696	-0.557	0.029	0.000	0.000	-3.234	0.091	22.240	-1.362	0.290	0.000	0.000	0.000	0.000
10	LU233	1	13.332	76.212	-0.565	0.030	0.000	0.000	-3.192	0.091	23.520	-1.421	0.294	0.000	0.000	0.000	0.000
11	UD3	1	15.412	78.638	-0.601	0.034	0.000	0.000	-2.976	0.116	29.969	-1.679	0.306	0.000	0.000	0.000	0.000
12	LU234	1	15.667	78.946	-0.605	0.035	0.000	0.000	-2.947	0.116	30.835	-1.711	0.307	0.000	0.000	0.000	0.000
13	UQ3	1	16.124	69.281	20.785	0.036	0.000	0.000	-2.699	0.958	36.919	-12.189	0.310	0.000	0.000	0.000	0.000
14	LU	1	16.624	50.058	17.660	0.037	0.000	0.000	-2.220	0.958	50.121	-14.215	0.311	0.000	0.000	0.000	0.000
15	UQ3'	1	17.081	41.414	2.169	0.039	0.000	0.000	-1.937	0.294	55.631	2.763	0.313	0.000	0.000	0.000	0.000
16	LU34	1	32.221	7.308	0.083	0.207	0.000	0.000	2.512	0.294	7.545	0.413	0.445	0.000	0.000	0.000	0.000
17	UQ4	1	32.947	7.143	0.143	0.223	0.000	0.000	2.705	0.236	7.143	0.143	0.461	0.000	0.000	0.000	0.000
18	LU100	1	33.947	7.000	0.000	0.245	0.000	0.000	2.940	0.236	7.000	0.000	0.484	0.000	0.000	0.000	0.000
	SA	1	33.947	7.000	0.000	0.245	0.000	0.000	2.940	0.236	7.000	0.000	0.484	0.000	0.000	0.000	0.000
19	LU45	1	35.914	7.553	-0.281	0.289	0.000	0.000	3.404	0.236	7.553	-0.281	0.527	0.000	0.000	0.000	0.000
20	UQ5	1	36.641	7.372	0.522	0.304	0.000	0.000	3.426	-0.177	8.740	-1.400	0.542	0.000	0.000	0.000	0.000
21	LU56	1	40.574	5.935	-0.157	0.405	0.000	0.000	2.731	-0.177	24.991	-2.732	0.584	0.000	0.000	0.000	0.000
22	UQ6	1	41.300	7.281	-1.793	0.424	0.000	0.000	2.820	0.424	24.946	2.790	0.589	0.000	0.000	0.000	0.000
23	LU66'	1	50.167	84.595	-6.927	0.482	0.000	0.000	6.581	0.424	3.153	-0.332	0.835	0.000	0.000	0.000	0.000
24	UQ6'	1	50.893	87.314	3.291	0.483	0.000	0.000	6.604	-0.362	4.134	-1.057	0.868	0.000	0.000	0.000	0.000
25	LU6'7	1	61.893	31.303	1.801	0.517	0.000	0.000	2.617	-0.362	89.357	-6.690	0.965	0.000	0.000	0.000	0.000
26	UQ7	1	62.620	31.317	-1.821	0.521	0.000	0.000	2.461	-0.071	91.500	3.823	0.966	0.000	0.000	0.000	0.000
27	LU78	1	75.219	99.094	-3.558	0.557	0.000	0.000	1.572	-0.071	22.255	1.673	1.011	0.000	0.000	0.000	0.000
28	UQ8	1	75.946	103.116	-1.956	0.558	0.000	0.000	1.511	-0.096	20.163	1.219	1.017	0.000	0.000	0.000	0.000
29	LU891	1	79.481	117.530	-2.122	0.563	0.000	0.000	1.172	-0.096	13.085	0.783	1.052	0.000	0.000	0.000	0.000
30	U4F	1	83.138	103.952	5.518	0.568	0.000	0.000	0.753	-0.128	11.703	-0.374	1.101	0.000	0.000	0.000	0.000
31	LU892	1	83.748	97.337	5.333	0.569	0.000	0.000	0.675	-0.128	12.196	-0.434	1.110	0.000	0.000	0.000	0.000
32	U5D	1	87.405	82.479	-0.935	0.576	0.000	0.000	0.339	-0.060	13.224	0.177	1.154	0.000	0.000	0.000	0.000
33	LU193	1	88.015	83.628	-0.949	0.577	0.000	0.000	0.303	-0.060	13.038	0.129	1.161	0.000	0.000	0.000	0.000
34	LU293	1	88.625	84.793	-0.963	0.578	0.000	0.000	0.267	-0.060	12.909	0.082	1.169	0.000	0.000	0.000	0.000
35	U6D	1	92.282	71.370	4.320	0.585	0.000	0.000	0.087	-0.036	16.854	-1.249	1.211	0.000	0.000	0.000	0.000
36	LU894	1	92.892	66.205	4.152	0.587	0.000	0.000	0.065	-0.036	18.433	-1.341	1.216	0.000	0.000	0.000	0.000
37	U7F	1	96.549	52.600	-0.125	0.597	0.000	0.000	0.000	0.000	24.256	-0.114	1.243	0.000	0.000	0.000	0.000
38	LU895	1	113.640	62.495	-0.454	0.645	0.000	0.000	0.000	0.000	40.343	-0.828	1.335	0.000	0.000	0.000	0.000
39	UQ9	1	114.366	64.092	-1.754	0.647	0.000	0.000	0.000	0.000	40.967	-0.028	1.337	0.000	0.000	0.000	0.000
40	LU910	1	125.062	108.900	-2.435	0.667	0.000	0.000	0.000	0.000	44.360	-0.289	1.378	0.000	0.000	0.000	0.000
41	UQ10	1	125.789	92.421	23.648	0.669	0.000	0.000	0.000	0.000	53.931	-13.718	1.380	0.000	0.000	0.000	0.000
42	LU011	1	126.896	47.496	16.939	0.671	0.000	0.000	0.000	0.000	88.597	-17.601	1.383	0.000	0.000	0.000	0.000
43	UQ11	1	127.622	32.155	5.405	0.674	0.000	0.000	0.000	0.000	98.300	5.039	1.384	0.000	0.000	0.000	0.000
44	LU112	1	141.850	68.573	-7.965	1.125	0.000	0.000	0.000	0.000	9.264	1.219	1.462	0.000	0.000	0.000	0.000
45	UQ12	1	142.576	72.470	2.800	1.127	0.000	0.000	0.000	0.000	8.570	-0.229	1.475	0.000	0.000	0.000	0.000
END	U	1	142.576	72.470	2.800	1.127	0.000	0.000	0.000	0.000	8.570	-0.229	1.475	0.000	0.000	0.000	0.000