

AD/RHIC/RD-18

RHIC PROJECT  
Brookhaven National Laboratory

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

Jianming Xu

April 1990

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

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## Introduction

The characteristics of the stripping foil have been calculated by Dr. M.J. Rhoades-Brown.<sup>1</sup> There is some difference between the results and those data published in the blue book.<sup>2</sup> The beam transport line with low  $\beta$  waist for foil SA has been described.<sup>3</sup> 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  $\beta$  waist are found.

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

In the first lattice, this low  $\beta$  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<sup>2</sup> gold foil and 10.4 GeV/u gold beam  $\langle\theta\rangle^2$  is  $1.75 \times 10^{-9}$  rad. The corresponding rms emittance growth is 0.0096  $\pi$ mm·mrad and the relative emittance growth is about 7.4%. (The AGS ejected beam rms emittance is 0.13  $\pi$ mm·mrad.)

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<sup>1</sup> M.J. Rhoades-Brown, "The Heavy Ion Stripping Foil Requirements between AGS and RHIC", AD/RHIC-88 (1990).

<sup>2</sup> Conceptual Design of the Relativistic Heavy Ion Collider, p. 60, BNL 52195, 1989.

<sup>3</sup> Jianming Xu, "The Low  $\beta$  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<sup>4</sup> 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  $\beta$  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  $0.0123 \pi\text{mm}\cdot\text{mrad}$  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  $\beta$  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 envelopes.

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<sup>4</sup> 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<sup>2</sup> gold foil is 0.065 MeV/u and the energy loss  $\Delta E$  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.<sup>5</sup> 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  $6.3 \times 10^{-5}$ . 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.

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<sup>5</sup> Conceptual Design of the Relativistic Heavy Ion Collider, p. 64, BNL 52195, 1989.

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=4.868622  
 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=8.384036  
 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  
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 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',UQ6',LU6'7,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)

Table 4.

DELTA(P)/P = 0.000000 SYMM = F

PAGE

1

POS. NO.	ELEMENT NAME	SEQUENCE OCC. NO.	H O R I Z O N T A L						V E R T I C A L							
			DIST I [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]
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	91.177	23.328	0.015	0.000	0.000	-4.144 1.117	6.813	-2.546	0.213	0.000	0.000	0.000	0.000
4	LU12	1	6.822	89.536	20.366	0.016	0.000	0.000	-3.591 1.117	9.605	-3.090	0.223	0.000	0.000	0.000	0.000
5	UQ2	1	7.774	55.055	-3.379	0.019	0.000	0.000	-3.129-0.118	11.992	0.893	0.236	0.000	0.000	0.000	0.000
6	LU231	1	8.252	58.332	-3.487	0.020	0.000	0.000	-3.185-0.118	11.174	0.821	0.243	0.000	0.000	0.000	0.000
7	UD1	1	10.332	73.811	-3.956	0.025	0.000	0.000	-3.404-0.093	8.401	0.512	0.277	0.000	0.000	0.000	0.000
8	LU232	1	10.792	77.498	-4.060	0.028	0.000	0.000	-3.447-0.093	7.981	0.443	0.286	0.000	0.000	0.000	0.000
9	UD2	1	12.872	95.360	-4.529	0.030	0.000	0.000	-3.615-0.068	6.765	0.132	0.332	0.000	0.000	0.000	0.000
10	LU233	1	13.332	99.574	-4.633	0.030	0.000	0.000	-3.648-0.068	6.675	0.063	0.343	0.000	0.000	0.000	0.000
11	UD3	1	15.412	119.819	-5.102	0.034	0.000	0.000	-3.763-0.044	7.060	-0.248	0.392	0.000	0.000	0.000	0.000
12	LU234	1	15.667	122.439	-5.159	0.034	0.000	0.000	-3.774-0.044	7.198	-0.286	0.397	0.000	0.000	0.000	0.000
13	UQ3	1	16.124	122.278	5.508	0.034	0.000	0.000	-3.719 0.283	7.786	-1.022	0.407	0.000	0.000	0.000	0.000
14	LU34	1	31.264	14.240	1.628	0.094	0.000	0.000	0.567 0.283	98.919	-4.998	0.499	0.000	0.000	0.000	0.000
15	UQ4	1	31.990	13.443	-0.491	0.102	0.000	0.000	0.808 0.385	95.444	9.607	0.500	0.000	0.000	0.000	0.000
16	LU45	1	38.914	20.518	-0.946	0.150	0.000	0.000	2.703 0.385	24.533	4.794	0.516	0.000	0.000	0.000	0.000
17	UQ5	1	37.640	20.009	1.624	0.156	0.000	0.000	2.854 0.027	20.009	1.624	0.522	0.000	0.000	0.000	0.000
18	LU56	1	43.574	7.136	0.545	0.238	0.000	0.000	3.015 0.027	7.136	0.545	0.604	0.000	0.000	0.000	0.000
19	LU100	1	44.574	6.227	0.364	0.262	0.000	0.000	3.042 0.027	6.227	0.364	0.628	0.000	0.000	0.000	0.000
20	LU100	2	45.574	5.682	0.182	0.289	0.000	0.000	3.069 0.027	5.682	0.182	0.655	0.000	0.000	0.000	0.000
21	LU100	3	46.574	5.500	0.000	0.318	0.000	0.000	3.098 0.027	5.500	0.000	0.684	0.000	0.000	0.000	0.000
22	SA	1	46.574	5.500	0.000	0.318	0.000	0.000	3.098 0.027	5.500	0.000	0.684	0.000	0.000	0.000	0.000
23	LU100	4	47.574	5.682	-0.182	0.346	0.000	0.000	3.123 0.027	5.682	-0.182	0.712	0.000	0.000	0.000	0.000
24	LU100	5	48.574	6.227	-0.364	0.373	0.000	0.000	3.150 0.027	6.227	-0.364	0.739	0.000	0.000	0.000	0.000
25	UQ6	1	49.300	7.204	-1.005	0.391	0.000	0.000	3.253 0.257	6.511	-0.020	0.757	0.000	0.000	0.000	0.000
26	LU66'	1	54.167	23.588	-2.362	0.452	0.000	0.000	4.505 0.257	10.341	-0.767	0.858	0.000	0.000	0.000	0.000
27	UQ6'	1	54.893	24.742	0.825	0.456	0.000	0.000	4.473-0.344	12.643	-2.503	0.869	0.000	0.000	0.000	0.000
28	LU6'7	1	60.893	17.291	0.417	0.503	0.000	0.000	2.410-0.344	63.361	-5.950	0.903	0.000	0.000	0.000	0.000
29	UQ7	1	61.620	18.488	-2.120	0.510	0.000	0.000	2.279-0.020	65.534	3.080	0.904	0.000	0.000	0.000	0.000
30	LU78	1	73.219	107.678	-5.569	0.552	0.000	0.000	2.044-0.020	15.824	1.226	0.963	0.000	0.000	0.000	0.000
31	UQ8	1	73.946	112.341	-0.782	0.553	0.000	0.000	1.997-0.110	14.602	0.475	0.971	0.000	0.000	0.000	0.000
32	LU891	1	79.480	121.439	-0.862	0.560	0.000	0.000	1.391-0.110	11.913	0.011	1.040	0.000	0.000	0.000	0.000
33	U4F	1	83.138	98.813	6.521	0.565	0.000	0.000	0.898-0.154	16.286	-1.304	1.084	0.000	0.000	0.000	0.000
34	LU892	1	83.748	91.026	6.252	0.566	0.000	0.000	0.804-0.154	17.937	-1.405	1.089	0.000	0.000	0.000	0.000
35	U6D	1	87.405	68.540	0.405	0.574	0.000	0.000	0.384-0.080	24.440	-0.220	1.116	0.000	0.000	0.000	0.000
36	LU193	1	88.015	68.052	0.394	0.575	0.000	0.000	0.335-0.080	24.724	-0.246	1.120	0.000	0.000	0.000	0.000
37	LU293	1	88.624	67.578	0.384	0.577	0.000	0.000	0.286-0.080	25.040	-0.272	1.124	0.000	0.000	0.000	0.000
38	U6D	1	92.282	83.015	-4.954	0.585	0.000	0.000	0.083-0.033	21.419	1.177	1.148	0.000	0.000	0.000	0.000
39	LU894	1	92.892	89.169	-5.141	0.586	0.000	0.000	0.062-0.033	20.025	1.109	1.153	0.000	0.000	0.000	0.000
40	U7F	1	96.549	103.919	1.452	0.592	0.000	0.000	0.000 0.000	17.557	-0.379	1.186	0.000	0.000	0.000	0.000
41	LU800	1	104.549	82.594	1.213	0.606	0.000	0.000	0.000 0.000	27.787	-0.900	1.245	0.000	0.000	0.000	0.000
42	UQ9'	1	105.276	76.475	7.056	0.607	0.000	0.000	0.000 0.000	30.725	-3.218	1.249	0.000	0.000	0.000	0.000
43	LU895	1	113.640	4.900	1.501	0.678	0.000	0.000	0.000 0.000	110.423	-6.310	1.271	0.000	0.000	0.000	0.000
44	UQ9	1	114.366	3.367	0.665	0.707	0.000	0.000	0.000 0.000	110.577	6.105	1.273	0.000	0.000	0.000	0.000
45	LU910	1	125.082	38.159	-3.918	1.011	0.000	0.000	0.000 0.000	19.578	2.403	1.309	0.000	0.000	0.000	0.000
46	UQ10	1	125.789	36.835	5.628	1.014	0.000	0.000	0.000 0.000	19.642	-2.496	1.316	0.000	0.000	0.000	0.000
47	LU011	1	130.895	2.486	1.098	1.103	0.000	0.000	0.000 0.000	54.731	-4.375	1.340	0.000	0.000	0.000	0.000
48	UQ11	1	131.622	1.528	0.266	1.165	0.000	0.000	0.000 0.000	55.423	3.456	1.342	0.000	0.000	0.000	0.000
49	LU112	1	141.849	69.388	-6.901	1.434	0.000	0.000	0.000 0.000	9.160	1.067	1.417	0.000	0.000	0.000	0.000
50	UQ12	1	142.578	72.470	2.800	1.435	0.000	0.000	0.000 0.000	8.570	-0.229	1.431	0.000	0.000	0.000	0.000
END	U	1	142.578	72.470	2.800	1.435	0.000	0.000	0.000 0.000	8.570	-0.229	1.431	0.000	0.000	0.000	0.000

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  
 LU55: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  
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 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

PAGE 1

ELEMENT SEQUENCE			H O R I Z O N T A L								V E R T I C A L						
POS. NO.	ELEMENT NAME	OCC. NO.	DIST I [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]
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 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	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
20	UQ5	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
21	LU56	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
22	UQ6	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
23	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
24	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
25	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
26	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
27	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
28	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
29	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
30	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
31	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
32	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
33	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
34	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
35	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
36	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
37	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
38	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
39	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
40	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
41	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
42	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
43	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
44	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
45	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
46	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