Superconducting Super Collider Laboratory

Beam Loss and Radiation Effects in the SSC Lattice Elements

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CONTENTS

FIGURES.....	v
TABLES.....	vii
1. INTRODUCTION.....	1
2. TOLERABLE BEAM LOSS IN SC MAGNETS.....	1
3. CALCULATIONAL APPROACH.....	2
4. BEAM-GAS SCATTERING.....	4
5. ACCIDENTAL BEAM LOSS.....	5
5.1 Energy Deposition Distribution.....	5
5.2 Catastrophic Loss.....	6
5.3 Quench Level.....	7
6. INTERCEPTING COLLIMATORS.....	10
7. PP COLLISIONS.....	11
7.1 Radiation in the Low- β Interaction Region.....	11
7.2 Beam Loss Downstream of the IR.....	14
8. BEAM ABORT SYSTEM.....	16
8.1 Lambertson as a Source of Radiation.....	16
8.2 Beam Loss Downstream of the Utility Straight Section.....	19
8.3 Accidental Beam Loss on the Lambertson.....	19
9. INTRODUCING A DISPERSION INTO THE UTILITY STRAIGHT SECTION.....	25
11. BENT CRYSTAL.....	26
11. CONCLUSIONS AND SC MAGNETS MATERIALS CHOICE.....	26
12. SUGGESTIONS FOR THE FUTURE.....	26
ACKNOWLEDGEMENTS.....	28
REFERENCES.....	28
APPENDIX.....	29

FIGURES

Figure 1.	Schematic of Protons Incidence on the "Target" in the Lattice.	3
Figure 2.	Exit Probabilities in the Case of "Incidence A."	3
Figure 3.	Exit Probabilities in the Case of "Incidence B."	4
Figure 4.	Instantaneous Temperature Rise in the SSC Lattice Beam Pipe for the Accidental 2 TeV Beam Loss. The various curves correspond to the different azimuthal distances from the beam axis	8
Figure 5.	Adiabatic Isotherms in the Beam Pipe for the Accidental 2 TeV Beam Loss of 1.63×10^{13} Protons. Initial temperature $T_0 = 4.35\text{K}$; Isotherms are shown in Centigrades; 1 is the distance from the beam axis on the beam pipe in the azimuthal direction.....	8
Figure 6.	Longitudinal Distribution of the Maximal Energy Deposition in the SC Coil of the Dipole 1 m Downstream of the Collimator for 20 TeV Beam Loss at the Collimator.....	12
Figure 7.	Longitudinal Distribution of the Maximal Energy Deposition in the SC Coil of the Dipole 1 m Downstream of the Collimator for 2 TeV Beam Loss at the Collimator	12
Figure 8.	Longitudinal Distribution of the Maximal Energy Deposition in the SC Coils in the Low- β Region Downstream of the SSC IP. Results are normalized per one 20×20 TeV pp-interaction	14
Figure 9.	Longitudinal Distribution of the Maximal Energy Deposition in the Beam Pipe in the Low- β Region Downstream of the SSC IP	15
Figure 10.	Contribution into the Maximal Energy Deposition of Photons from the 20×20 TeV pp Interaction Point	15
Figure 11.	Energy Deposited per 1 m of the Low- β Magnetic Elements Downstream of the 20×20 TeV Interaction Point.....	17
Figure 12.	Momentum Distributions of the Neutrals at the Zero - angle Calorimeter Position Downstream of the 20×20 TeV Interaction Point.....	18

Figure 13.	Schematic of the Model Describing Protons Incidence on the Lambertson Septum. Z and R are the vertical and horizontal coordinates, respectively. Z' is the space angle projection to the vertical plane.....	20
Figure 14.	Probabilities of the Incident Proton Leakage out of the Lambertson Septum as a Function of the Parameter δ	21
Figure 15.	Phase Space Distribution of the 20 TeV Scattered Protons in the Vertical Plane at the Downstream End of the Lambertson Magnet.....	21
Figure 16.	Phase Space Distribution of the 20 TeV Scattered Protons in the Horizontal Plane at the Downstream End of the Lambertson Magnet	22
Figure 17.	Phase Space Distribution of 2-TeV Scattered Protons in the Vertical Plane at the Downstream End of the Lambertson Magnet	22
Figure 18.	Phase Space Distribution of 2-TeV Scattered Protons in the Horizontal Plane at the Downstream End of the Lambertson Magnet	23

TABLES

Table 1.	Tolerable Energy Deposition and Accidental Beam Loss in the SSC Dipoles.....	2
Table 2.	Initial Gas Pressure Model.....	4
Table 3.	Energy Depositions and Annual Dose to Beam-Gas Scattering.....	5
Table 4.	Energy Depositions Distribution in the Dipole at $\phi_{\max}$	6
Table 5.	Lateral Integrated Energy Deposition in the Dipole for Catastrophic Beam Loss.....	7
Table 6.	Instantaneous Temperature Rise ΔT (K) at $\phi_{\max}$	9
Table 7.	Annual Dose (Mrad per Year) at $\phi_{\max}$ and $Q = 0.2$ mW/g.....	10
Table 8.	Tolerable Scraping Rate.....	11
Table 9	Maximal Energy Deposition ϵ , Absorbed Dose Rate D' and Annual D in the Superconducting Coils of the SSC Low- β IR Beam Elements. The last column is the power P deposited in the element. Interaction rate is 10^9 per second at $L = 10^{34}$ cm ⁻² S ⁻¹ . The operational year is 10^7 sec.....	16
Table 10.	Circulating Beam Axis Positions Δ Related to Inner Edge of Lambertson Magnet Pole.....	19
Table 11.	Contribution to the Beam Loss of 2 TeV Protons Re-scattered on Collimator C6.....	23
Table 12.	Beam Loss Downstream of the Lambertson Magnet per One Proton Scattered Out from the Septum at 20 TeV. δ Is the parameter of incident model.....	24
Table 13.	Radiation Doses to the Abort Lambertson Coils Due to Accidental Beam Loss (mrad/accident).....	24
Table 14.	Maximal Energy Deposition, Absorbed Dose d and Annual Dose D in the Coil of the First Beam Elements Downstream of Collimators C1 and C6 for Various Scenarios of Beam Loss at the Lambertson Septum.....	25
Table 15.	Radiation Resistance of Selected Materials.....	27
Table A1.	Beam Loss Downstream of the Low- β IR.....	30

Table A2.	Beam Loss Downstream of the Abort Lambertson at 20 TeV.....	40
Table A3.	Beam Loss Downstream of the Abort Lambertson at 2 TeV (Injection).....	54

1. INTRODUCTION

The Superconducting Super Collider (SSC) [1] is designed to be an advanced machine with relatively low beam loss-induced radiation levels. However, a fraction of the beam lost in the lattice due to pp-collisions at the interaction points, beam-gas scattering, beam-halo scraping, various instabilities and errors will result in the irradiation of conventional and superconducting components of the accelerator and experimental apparatus. The level of the beam loss and its distribution along the machine structure has impact on all of the three crucial radiation effects at the SSC: quenching of the superconducting magnets, survivability of the accelerator and detectors components in the near-beam regions, and influence to the environment. This paper, based on the full-scale Monte Carlo simulation, will explore all major sources of beam loss in the Collider and measures to reduce the irradiation of the accelerator components.

Basic parameters of the Super Collider accepted throughout this report are as follows: Proton energy $E_0 = 20$ TeV, injection energy is 2 TeV, number of protons circulating in each of the collider rings is $N = 1.3 \times 10^{14}$, circumference is 87.12 km, the transverse normalized emittance $\epsilon_N(\sigma) = 1 \pi$ mm-mrad, for the regular lattice ($\beta = 305$ m) the beam R.M.S. sizes are $\sigma = 0.12$ mm at 20 TEV and $\sigma = 0.38$ mm at the injection energy. The dipole length is 15.815 m with the effective field length of 15.165 m. The magnetic field map for $B_0 = 6.5999$ T has been calculated with the POISSON program by Greg Snitchler. The turn angle of each dipole is $\alpha = 1.50027$ mrad. The dipole aperture is 50 mm. The two beam pipe diameters are studied 33 and 40 mm. The operating temperature is $T_0 = 4.35$ K.

2. TOLERABLE BEAM LOSS IN SC MAGNETS

The problem of radiation fields prediction at the high energy proton accelerator consists of two unavoidable major parts:

- the beam loss distribution in a phase-space should be simulated, or estimated, or guesstimated;
- the complicated process of lost-proton energy dissipation in material media should be carefully simulated, taking into account all the possible kinds of particle interactions with matter, the accelerator lattice and constructions.

Only the interaction of these two parts allows a solution of all the radiation problems before the new accelerator launch. Going from the first part to the second, one can obtain the estimation of doses, temperature rises, etc. Going from the second to the first, one can determine the tolerable levels for the beam loss, find a correspondence of an elementary loss to radiation effects, and design adequate protective measures.

It is obvious that the vital problem for superconducting accelerators is quench stability of the SC magnets [1-5]. It is related to the extremely small tolerable energy deposition in the superconducting coils [3-7] and, on the other hand, to the fact that hundreds of megajoules of energy are stored in the beams. Therefore a negligible fraction of the beam lost in the lattice can cause radiation-induced quenches of the SC coils.

The quench level in the SSC magnets depends on the space-time distribution of the deposited energy and the proximity of the operational point to the critical one. Taking into account the Tevatron experience [3, 6], data [4, 5, 7] and our calculational results (see Sections 4-8), one can suggest as a first approach the tolerable limits on the maximal energy deposition presented in Table 1. The numbers are given for the SSC dipoles and beams with parameters taken from [1]. The spread in the limits should be eliminated as a result of the further studies. At the 50 mm dipole aperture, the 33 mm beam pipe diameter limits are softer by about 30% compared to 40 mm pipe, but in general one can expect the lower beam loss rate for the larger beam pipe.

3. CALCULATIONAL APPROACH

To calculate beam loss distribution in the SSC lattice and the corresponding radiation effects, then to design the intercepting collimators, the technique [8-12] used is the same as that at Tevatron [13] and UNK [14-16]. It is a three step approach: initial beam-"target" interaction; transport of the scattered proton or produced secondaries through the lattice, creating a file of protons lost in the accelerator elements; and the full-scale hadronic-electromagnetic cascade simulation in the regions of interest to determine the resulting radiation effects.

On the first step, the initial source of radiation is created, consisting of two groups:

1. positively charged particles with an energy of $E < 0.7 \times E_0$, negatives, neutrons and photons;
2. positives with $E > .0.7 \times E_0$, where E_0 is an energy of the circulating protons.

Particles of the first group are handled promptly with the MARS10 program [12] to calculate the consequent showers and radiation effects in the relatively nearby (hundred meters) downstream regions. The second group is destined for long-term tracking. In the case of pp-collision in the Interaction Points (IP) the full ISAJET [17] events are simulated. Interactions with a bent crystal and other similar targets are calculated using MARS10.

Interaction of a circulating proton out of the beam-edge or beam-halo with an initial "target" as the inner edge of scraper, collimator or septa (see Figure 1) is calculated with sophisticated algorithm [8,10]. A similar algorithm is described in [18,19]. A proton trajectory in material is very close to the material surface. One or a few scatterings can change proton direction and position and, therefore, the probability to exit can be significant. The exit probabilities as functions of x or θ extracted from [10] for the SSC energies are shown in Figures 2 and 3. It can be seen that for both proton energies E_0 there is a region of x or θ where the exit probability is significantly high. Therefore no scraper can absorb all the entering protons, and some of them will be lost downstream.

On the second step, high energy positives (mainly protons) of the second group are tracked through the SSC lattice with the STRUCT program [13,14]. The SSC lattice description is taken from [20]. When the particle loss occurs, i.e., its coordinates exceed some element aperture, the particle energy, statistical weight and phase space coordinates at the upstream end of that element are recorded for further analysis. At this stage, one can get an overall beam loss distribution, and find the preliminary positions for the collimators intercepting the particles with the energy close to that of the circulating beam (see Table 1).

Table 1
Tolerable Energy Deposition and Accidental Beam Loss in the SSC Dipoles

Energy (TeV)	Fast		Slow	
	mJ/g	ppp	mW/g	p/sec
2	5-10	3.1×10^8	20	6.3×10^8
20	0.3-1	2.3×10^6	4-8	1.9×10^7

* Beam loss limits are given for the larger energy depositions.

On the third step the shower simulation in the regions with the increased particle losses is performed with the MARS10 code using information pre-recorded on the previous step. The hadron histories in the equipment material are followed down to about 2 MeV, and electromagnetic components of showers down

to 0.1 MeV. All the physical processes, details of the magnetic fields, geometry and material distribution are taken into account. The three-dimensional distributions of energy deposition density and particle fluxes are calculated for any region of interest. If necessary, muon and low energy neutron distributions in the equipment, tunnel and surroundings can be calculated additionally. The possibility of installation of each scraper and intercepting collimator and optimization of their parameters are explored at this stage.

A collection of the results obtained using the described techniques is presented in the rest of the paper for the variety of the SSC beam loss cases. If it is not mentioned specially, the results correspond to the SSC standard cell with parameters taken from [1] (see Section 2).

Figure 1. Schematic of Protons Incidence on the "Target" in the Lattice.

Figure 2. Exit Probabilities in the Case of "Incidence A". PO is a momentum of the incident proton.

Figure 3. Exit Probabilities in the Case of "Incidence B".

4. BEAM-GAS SCATTERING

The permanent source of beam loss and associated radiation is interaction of the circulating protons with the gas in the beam pipe. The effect due to this source is an unavoidable, almost uniform, pedestal in the overall distribution. In the warm sections of the lattice there is a residual gas. In the cold beam tube a gas is a result of the photodesorption process induced by synchrotron radiation of the circulation protons [1].

The initial gas pressure model parameters in the SSC are listed in Table 2.

Table 2
Initial Gas Pressure Model

Section	Length (km)	Gas	Pressure (Torr)
Cold	76.14	H ₂	10 ⁻⁸
		CO	10 ⁻¹⁰
		CO ₂	2 × 10 ⁻¹¹
Warm	10.98	N	10 ⁻⁹

Then, the calculated intensities of the 20 TeV proton-nuclei interactions for 1.3×10^{14} circulating protons are

$$I = 10^3 \text{ int./ (meter} \times \text{sec) in the cold section,}$$

$$I = 840 \text{ int./ (meter} \times \text{sec) in the section.}$$

The calculated two-dimensional energy deposition distribution in the SC coil is given in Table 3 as well as the absorbed dose for the 6000 hours year operation. The data correspond to 20 TeV circulating beam. As in the rest of the paper, the azimuthal angle convention is

$\phi = 0$ - up, $\phi = 90$ - out of the ring center and $\phi = 270$ - toward the ring center.

Table 3
Energy Deposition and Annual Dose Due to Beam-Gas Scattering

ϕ (deg)	270-275	275-280	280-290	290-80	80-100
Energy deposition (GeV/g per int./meter)					
Radius (mm)					
24-25	3.90	2.20	1.10	0.62	2.60
25-31	2.90	1.40	0.64	0.30	2.20
31-38	1.40	0.81	0.36	0.13	1.30
38-44	0.86	0.71	0.27	0.09	0.73
44-50	0.54	0.38	0.17	0.06	0.52
Annual dose (Mrad per year = 6000 hours)					
Radius (mm)					
24-25	1.37	0.77	0.39	0.22	0.91
25-31	1.02	0.49	0.22	0.11	0.77
31-38	0.49	0.28	0.13	0.05	0.46
38-44	0.30	0.25	0.10	0.03	0.26
44-50	0.19	0.13	0.06	0.02	0.18

As one can see the numbers are rather small, in the hottest point of the coil the annual dose is about 1 Mrad. Averaged over ϕ angle the annual doses for the larger radii are much smaller:

D = 1.8 krad/yr, superinsulation at radius = 20 cm,
D = 18 krad/yr, interconnections at radius = 10 cm,
D = 77 krad/yr, interconnections at radius = 5 cm.

5. ACCIDENTAL BEAM LOSS

5.1 Energy Deposition Distribution

If accidental loss of protons from the circulating beam occurs in the regular lattice, the maximal angle for striking the beam pipe can be estimated as $\theta = 0.15$ mrad. The most probable region for such an incidence is one near $\phi = 270$ deg on the beam tube in the median plane closer to the ring center. Two-dimensional distributions of maximal energy deposition density calculated with MARS10 are presented in Table 4 for protons of two energies having the corresponding phase-space distributions (see Introduction) and entering the upstream end of the dipole at $\phi = 270$ and at distance 3σ between the beam axis and the beam pipe. At the injection energy the overall magnetic field map has been scaled as $B(2) = B(20)/10$. The energy deposition reaches the maximum at some distance from the entrance, which is shorter for 20 TeV beam because it has a smaller σ and therefore is closer to the beam pipe at the upstream end. For both cases there is a strong radial dependence of the deposited energy.

Table 4
Energy Depositions Distribution in the Dipole at $\phi_{\max}$ (GeV/g per 1 Proton)

Depth (m)	Radius (mm)						
	20-21	25-30	30-35	35-40	40-45	45-50	170-220
	Beam pipe	Superconducting coil					Superins.
2 TeV							
0.0 - 2.0	.19E-1	.72E-3	.33E-3	.12.E-3	.97E-4	.55E-5	.18E-6
2.0 - 3.0	.38E+0	.17E-1	.52E-2	.21E-2	.72E-3	.53E-3	.23E-5
3.0 - 3.5	.11E+1	.61E-1	.18E-1	.67E-2	.58E-2	.21E-2	.56E-5
3.5 - 4.0	.17E+1	.78E-1	.29E-1	.11E-1	.68E-2	.32E-2	.88E-5
4.0 - 4.5	.20E+1	.13E+0	.42E-1	.14E-1	.84E-2	.44E-2	.20E-4
4.5 - 5.0	.13E+1	.11E+0	.36E-1	.17E-1	.81E-2	.55E-2	.22E-4
5.0 - 5.5	.53E+0	.68E-1	.23E-1	.11E-1	.56E-2	.36E-2	.32E-4
5.5 - 6.0	.16E+0	.36E-1	.11E-1	.60E-2	.38E-2	.19E-2	.33E-4
6.0 - 7.0	.33E-1	.18E-1	.68E-2	.42E-2	.16E-2	.11E-2	.11E-4
7.0 - 8.0	.12E-1	.85E-2	.48E-2	.15E-2	.71E-3	.44E-3	.67E-5
8.0 - 10.0	.80E+2	.41E-2	.21E-2	.11E-2	.59E-3	.25E-3	.31E-5
10.0 - 15.0	.45E+2	.18E-2	.94E-3	.56E-3	.30E-3	.16E-3	.21E-6
20 TeV							
0.0 - 1.0	.79E-1	.34E-2	.20E-2	.91E-3	.27E-3	.20E-3	.35E-6
1.0 - 1.5	.29E+1	.13E+0	.65E-1	.30E-1	.28E-1	.98E-2	.30E-5
1.5 - 2.0	.15E+2	.79E+0	.39E+0	.29E+0	.20E+0	.16E+0	.10E-2
2.0 - 2.5	.25E+1	.19E+1	.11E+1	.76E+0	.51E+0	.35E+0	.26E-2
2.5 - 3.0	.15E+2	.17E+1	.86E+0	.60E+0	.42E+0	.31E+0	.16E-2
3.0 - 3.5	.28E+1	.69E+0	.37E+0	.26E+0	.18E+0	.13E+0	.50E-3
3.5 - 4.0	.70E+0	.28E+0	.15E+0	.11E+0	.63E-1	.33E-1	.62E-3
4.0 - 5.0	.22E+0	.11E+0	.76E-1	.59E-1	.46E-1	.41E-1	.26E-3
5.0 - 6.0	.94E-1	.58E-1	.50E-1	.36E-1	.31E-1	.22E-1	.13E-3
6.0 - 8.0	.63E-1	.58E-1	.50E-1	.31E-1	.20E-1	.16E-1	.64E-4
8.0 - 10.0	.58E-1	.27E-1	.15E-1	.12E-1	.12E-1	.57E-2	.10E-3
10.0 - 15.0	.28E-1	.60E-2	.44E-3	.28E-2	.28E-2	.26E-2	.14E-4

* ϕ -averaged at the cascade maximum and $25 < r < 30$ mm:

0.022 GeV/g at 2 TeV and 0.20 GeV/g at 20 TeV.

5.2 Catastrophic Loss

The only way to guarantee a normal operation of the superconducting machine for the HEP is to provide it with an absolutely reliable beam abort system, as has been done at the Tevatron [3]. Such a system has to exclude completely accidental losses in the lattice of the meaningful part of the beam. In order to know what a catastrophic loss of the full-intensity beam means for the accelerator, this situation should be considered. The catastrophic loss of the whole beam in an arbitrary place around the lattice with a frequency of once-per-year is at the heart of a scenario for radiation considerations in the SSC Design [1].

Supposing a catastrophic loss of full intensity for a 20 TeV beam, and of $\frac{1}{8}$ of that ($=1.63 \times 10^{13}$ ppp) for a 2 TeV beam (see [1]), and taking the results of energy deposition distribution as an input, one can get the numbers for these extreme cases. A longitudinal distribution of the deposited energy as well as the total energy are presented in Table 5. It is almost the whole energy stored in the beam. Apart from a quench, some regions in the beam pipe and in the inner coil will be melted with correspondent problems to the cryogenic and vacuum systems. Even for the "soft" case of the 2 TeV accident, a slot of about 3.5 meter long will be created in the steel beam pipe (see Figures 4 and 5).

Table 5
Lateral Integrated Energy Deposition in the Dipole for Catastrophic Beam Loss

Depth (m)	E (GeV/proton)	W (MJ/pulse)
2 TeV		
0.0 - 1.5	2.5	0.01
1.5 - 3.0	63.5	0.16
3.0 - 4.5	560.0	1.46
4.5 - 6.0	625.0	1.63
6.0 - 7.5	236.0	0.62
7.5 - 9.0	121.0	0.32
9.0 - 10.5	75.2	0.20
10.5 - 12.0	45.2	0.12
12.0 - 13.5	20.1	0.05
13.5 - 15.0	15.9	0.04
20 TeV		
0 - 1	14	0.02
1 - 2	1710	35.6
2 - 3	8720	181.4
3 - 4	3810	79.3
4 - 5	1410	29.3
5 - 6	805	16.7
6 - 7	508	10.6
7 - 9	682	14.2
9 - 11	330	6.9
11 - 15	313	6.5
Total	18302	380.5

* Pulse is $N = 1.63 \times 10^{13}$ ppp for 2 TeV beam
and $N = 1.30 \times 10^{14}$ ppp for 20 TeV beam

5.3 Quench Level

Taking data of Tables 1 and 4 as an input, instantaneous temperature rise distributions in the beam pipe and superconducting coil can be calculated. The results are presented in Table 6 for two cases of the accidental adiabatic irradiations. Initial temperature $T_0 = 4.35\text{K}$. The temperature-dependent properties of the dipole materials are of the MARS10 system [12]. The maximal temperatures in the coil, $T = T_0 + \Delta T$, are close to the critical one for the corresponding magnet current [7] that is, in fact, a basis for the quench-level beam loss numbers given in Table 1 for the adiabatic case and is in agreement with the Fermilab experience. Azimuthally averaged temperature rise is significantly lower than that at the hottest point.

TIP-01304

Figure 4. Instantaneous Temperature Rise in the SSC Lattice Beam Pipe for the Accidental 2 TeV Beam Loss. The various curves correspond to the different azimuthal distances from the beam axis.

TIP-01305

Figure 5. Adiabatic Isotherms in the Beam Pipe for the Accidental 2 TeV Beam Loss of 1.63×10^{13} Protons. Initial temperature $T_0 = 4.35\text{K}$; Isotherms are shown in Centigrades; l is a distance from the beam axis on the beam pipe in the azimuthal direction.

Table 6
Instantaneous Temperature Rise ΔT (K) at $\phi_{\max}$

Depth (m)	Radius (mm)					
	20-21	25-30	30-35	35-40	40-45	45-50
	Beam pipe			Superconducting coil		
2 TeV at $N = 3 \times 10^8$ ppp						
0.0 - 2.0	1.40	0.08	0.04	0.01	0.01	0.00
2.0 - 3.0	7.30	1.30	0.56	0.21	0.08	0.06
3.0 - 3.5	11.00	3.00	1.40	0.62	0.55	0.22
3.5 - 4.0	13.00	3.50	1.90	0.91	0.63	0.33
4.0 - 4.5	14.00	4.40	2.40	1.20	0.76	0.43
4.5 - 5.0	11.00	4.20	2.20	1.30	0.73	0.52
5.0 - 5.5	8.30	3.20	1.60	0.94	0.53	0.36
5.5 - 6.0	4.90	2.20	0.97	0.56	0.38	0.19
6.0 - 7.0	2.10	1.30	0.63	0.41	0.16	0.12
7.0 - 8.0	0.98	0.76	0.48	0.16	0.08	0.05
8.0 - 10.0	0.72	0.41	0.22	0.12	0.06	0.03
10.0 - 15.0	0.44	0.19	0.10	0.06	0.03	0.02
20 TeV at $N = 2 \times 10^6$ ppp						
0.0 - 1.0	0.057	0.003	0.002	0.001	0.000	0.000
1.0 - 1.5	1.500	0.090	0.047	0.022	0.020	0.007
1.5 - 2.0	3.900	0.500	0.270	0.200	0.140	0.110
2.0 - 2.5	5.100	1.100	0.680	0.490	0.340	0.240
2.5 - 3.0	3.900	0.970	0.540	0.390	0.280	0.220
3.0 - 3.5	1.400	0.450	0.250	0.180	0.130	0.090
3.5 - 4.0	0.450	0.200	0.110	0.078	0.046	0.024
4.0 - 5.0	0.150	0.077	0.055	0.043	0.033	0.030
5.0 - 6.0	0.068	0.043	0.037	0.026	0.023	0.016
6.0 - 8.0	0.046	0.043	0.037	0.022	0.014	0.012

* ϕ -averaged at the cascade maximum and $25 < r < 30$ mm:

$\Delta T = 1.52\text{K}$ at 2 TeV and $\Delta T = 0.13\text{K}$ at 20 TeV.

As an example, assuming a steady-state operational beam loss level to be equal to $\frac{1}{40}$ of the quench one at 20 TeV, which is $Q = 0.2$ mW/g, the annual dose distribution can be calculated in the SC dipole. The results are shown in Table 7 for 6000 hours of operation for the maximum in the ϕ - distribution, which is usually at $\phi = 270$ deg. Just to indicate the energy dependence, data at injection energy are presented for the same $Q = 0.2$ mW/g. The maximal dose in the coil reaches 300 Mrad, and azimuthally averaged value in the minimal radial bin is 30 Mrad per year. The numbers are rather high; these levels might occur in the limited regions of the lattice, and any possible measures should be undertaken to move the operational beam loss level in most of the ring far away from the quench level. Note that the contribution of the injection stage should be considered individually for corresponding beam loss regions (see Section 8), not as a steady-state irradiation during a year.

Table 7
Annual Dose (Mrad per Year) at $\phi_{\max}$ and $Q = 0.2 \text{ mW/g}$

Depth (m)	Radius (mm)						
	20-21	25-30	30-35	35-40	40-45	45-50	170-220
	Beam pipe	Superconducting coil					Superins.
2 TeV at I = 3.0 × 10 ⁶ p/sec							
0.0 - 2.0	38.00	1.44	0.66	0.24	0.19	0.01	0.00
2.0 - 3.0	760.00	34.00	10.40	4.20	1.44	1.06	0.00
3.0 - 3.5	2200.00	122.00	36.00	13.40	11.60	4.20	0.01
3.5 - 4.0	3400.00	156.00	58.00	22.00	13.60	6.40	0.02
4.0 - 4.5	4000.00	260.00	84.00	28.00	16.80	8.80	0.04
4.5 - 5.0	2600.00	220.00	72.00	34.00	16.20	11.00	0.05
5.0 - 5.5	1060.00	136.00	46.00	22.00	11.20	7.20	0.06
5.5 - 6.0	320.00	72.00	22.00	12.00	7.60	3.80	0.07
6.0 - 7.0	66.00	36.00	13.60	8.40	3.20	2.20	0.02
7.0 - 8.0	24.00	17.00	9.60	3.00	1.42	0.88	0.01
8.0 - 10.0	16.00	8.20	4.20	2.00	1.18	0.50	0.00
10.0 - 15.0	9.00	3.60	1.88	1.12	0.06	0.32	0.00
20 TeV at I = 4.4 × 10 ⁵ p/sec							
0.0 - 1.0	11.85	0.51	0.30	0.14	0.04	0.03	0.00
1.0 - 1.5	435.00	19.50	9.75	4.50	4.20	1.47	0.00
1.5 - 2.0	2250.00	118.50	58.50	43.50	30.00	24.00	0.15
2.0 - 2.5	3750.00	285.00	165.00	114.00	76.50	52.50	0.39
2.5 - 3.0	2250.00	255.00	129.00	90.00	63.00	46.50	0.24
3.0 - 3.5	420.00	103.50	55.50	39.00	27.00	19.50	0.08
3.5 - 4.0	105.00	42.00	22.50	16.50	9.45	4.95	0.09
4.0 - 5.0	33.00	16.50	11.40	8.85	6.90	6.15	0.04
5.0 - 6.0	14.10	8.70	7.50	5.40	4.65	3.30	0.02
6.0 - 8.0	9.45	8.70	7.50	4.65	3.00	2.40	0.01
8.0 - 10.0	8.70	4.05	2.25	1.80	1.65	0.86	0.01
10.0 - 15.0	4.20	0.90	0.66	0.42	0.41	0.39	0.00

* ϕ -averaged at the cascade maximum and $25 < r < 30 \text{ mm}$:

$D = 44 \text{ Mrad}$ at 2 TeV and $D = 30 \text{ Mrad}$ at 20 TeV.

6. INTERCEPTING COLLIMATORS

All the major measures to protect the superconducting magnets against exceeding irradiation have been incorporated in the SSC design since the very beginning. These include: the overall scheme of the collider with a separate set of the boosters, a long utility straight section with the dog-leg and collimators there, a reliable beam abort system, etc. Non-uniform beam loss distribution is possible in the lattice due to various reasons. The Tevatron experience [13, 18] and calculations for the UNK [8, 9, 14-16] confirm that.

It turns out [13] the efficient way to decrease further the beam loss in the machine is by installation of collimators at some available pre-determined places. The disposition of these in the structure is chosen in accordance with the following rules:

1. the circulating and scattered beams should be separated in the space as far as possible;
2. the distance L between a collimator and a downstream SC unit should be as long as possible;
3. the shorter L is the smaller amount of the scattered beam can be intercepted by the collimator;
4. the last is controlled by positioning the collimator jaws at the corresponding distance δ from the circulating beam edge;
5. the positioning is varied during the cycle either by a beam displacement with the correctors, or by moving the jaws;
6. typically the collimator length is equal to 4-5 meters of steel;
7. if necessary, low-energy radiation out of the collimator can be intercepted by an additional wider-aperture-short collimator just upstream of the SC element.

To understand these collimators as a source of radiation, calculations have been performed for various beam distributions at the collimator, various collimator lengths (L_c) and distances between collimator and SC element (L), and for two proton energies. Results of these calculations are used in preliminary arrangement of collimators in the lattice (see Sections 7 and 8 below). Longitudinal distributions of the maximal energy deposition in the SC coils of the first magnet 1 m downstream of the 3 m long steel collimator are shown in Figures 6 and 7 for 2 and 20 TeV protons incident on collimator. With data of Table 1 as an input, the corresponding tolerable scraping rates on this collimator are given in Table 8. For the longer collimators and larger distances L , the allowable scraping rates can be higher up to one or even two orders of magnitude.

Table 8
Tolerable Scraping Rate

Energy (TeV)	Fast (ppp)	Slow (p/sec)
2	6.3×10^9	1.3×10^{10}
20	7.8×10^7	6.3×10^8

7. PP COLLISIONS

7.1 Radiation in the Low- β Interaction Region

As mentioned earlier, the ISAJET code [17] is used to generate 5000 minimum bias events for the one hemisphere at 40 TeV pp-collision energy. TWOJET and other high-Pt options have not been included in the present consideration because it deals with the forward region (angles from the IP less than a few mrad). The produced stable hadrons and photons are used as a source for MARS10 hadronic and electromagnetic cascades full-scale simulation in the SSC low- β IR at the first 326 m downstream of the IP.

The beam pipe diameter is supposed to be 33 mm for the first 73 m followed by 66 mm pipe up to the entrance to the quad QVD at the end of the considered region. In accordance with the SDC and EMPACT experimental set-ups, a forward calorimeter followed by a short collimator (40 mm inner diameter) are supposed to be installed just upstream of the first low- β quad QL1. A "Zero-angle

TIP-01306

Figure 6. Longitudinal Distribution of the Maximal Energy Deposition in the SC Coil of the Dipole 1 m Downstream of the Collimator for 20 TeV Beam Loss at the Collimator.

TIP-01307

Figure 7. Longitudinal Distribution of the Maximal Energy Deposition in the SC Coil of the Dipole 1 m Downstream of the Collimator for 2 TeV Beam Loss at the Collimator.

calorimeter" is assumed at the straight forward direction, at the distance of 130 m from IP, either to do some physics or just to absorb the forward leakage energy.

Collimators C10 and C11 with the vertical aperture ± 7 mm are introduced in the structure to reduce significantly irradiation of the vertical bends BV1+ and downstream superconducting elements in the lattice (see Table A1).

The results are presented in Figures 8 through 12 and in Table 9. The first two plots show energy deposition ϵ in the SC coils and in the beam pipe at the hottest region of the low- β straight section. The value of ϵ varies greatly, reaching its maximum at the downstream end of the QL1 quad. Distributions are rather symmetrical over azimuthal angle having maxima in the horizontal or vertical planes. Increasing the beam pipe diameter up to 40 mm has a moderate influence on the maximum energy deposition in the low- β quads SC coils.

A contribution to ϵ of photons produced at the interaction point is shown in Figure 10. Due to its zero charge, this component itself behaves longitudinally very smoothly compared to the total energy deposition. For the fixed beam pipe diameter this IP photon component can be described as

$$\begin{aligned}\epsilon \text{ (MeV/g)} &\cong 1.35 - 0.013 \times L, \text{ for the inner coils,} \\ \epsilon \text{ (MeV/g)} &\cong 11.8 \times e^{-0.0175 \times L}, \text{ for the beam pipe,}\end{aligned}$$

where L is a path length in meters.

The maximal dose rate and annual dose in the superconducting coils of the low- β elements are given in Table 9 for the maximal luminosity $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$. Except for three first quads, the dose rate is well below the tolerable level. For QL1 and QL2 a reserve is not enough; therefore, some measures (such as an upstream collimator positioned close to the circulating beam, with a controllable aperture as small as ± 7 mm) should be taken to reduce maximal energy deposition there. Although the situation is ten times better at $L=10^{33} \text{ cm}^{-2} \text{ s}^{-1}$, consider such measures as necessary, noting that the maximal annual dose D is close to or even exceeds the radiation limits (see Section 11) for most materials in the coils (except metals). In any case, special attention should be paid to the material selection of the low- β quads.

The linear density of the total energy deposited in the low- β IR beam elements is shown in Figure 11. Distribution reproduces all the major features of the ones for the inner parts (Figures 8, 9). If the forward calorimeter and short collimator upstream of QL1 is removed it gives no influence to the energy deposition ϵ in the beam pipe and in the superconducting coils (for 40 mm aperture of calorimeter and collimator), but increases the total power deposited in QL1 by 32%, by a factor of 2.6 for the first two meters of it and much bigger for the very upstream end of QL1. Therefore, for any of the SSC experiments a collimator + forward calorimeter of total length about 4 meters for steel or shorter for the heavier materials (U, Pb etc.) with controllable jaws must be installed just upstream of the first low- β quad. This measure is the only way to reduce both maximal dose in the coils and extremely high load to the cryogenic system because, as it can be seen from Table 9, about 2.2 kW power is deposited in the elements of the low- β region and half of this (1130 W) is deposited in the cold mass.

"Zero-angle calorimeter" or a beam-stop should be installed in the forward direction downstream of the last of the three vertical bends BV1-, to absorb particles carrying about 5 TeV of energy. A possible position for such a device is at 130 meters from the IP. High energy protons and charged mesons as well as wide range energy neutrals and muons are presented in the particle spectra. Momentum distributions of these forward neutrons and photons are presented in Figure 12 and can be fitted as

$$\begin{aligned}dN/dP &= 1.2 \times e^{-2.57P/PO} && \text{for neutrons,} \\ dN/dP &= 16.4 \times e^{-15.7P/PO} && \text{for photons.}\end{aligned}$$

7.2 Beam Loss Downstream of the IR

Among the particles being created in pp collisions at IRs protons with low momentum transfer play a separate role. They can penetrate through the lattice and be lost far from IRs due to the small difference between their momentum and the momentum of beam protons. Therefore, the loss distribution downstream of the IRs will be strongly dependent on these proton's momentum distribution along with the lattice features.

The authors do not consider the ISAJET predictions in the region of low momentum transfers as adequate for reality. This problem needs a separate investigation and will be considered later. The ISAJET fills the phase space near the circulating beam and calculates the loss distribution of these particles downstream of the IRs. Approach is enough to solve the task of the superconducting magnets protection by properly distribution of intercepting collimators in the lattice.

The results are presented in Table A1 of Appendix A for the SSC structure section length of 5085 meters downstream of the IP for the two possible aperture options. These are not significantly different, and therefore, beam loss in this case isn't the reason for the main beam pipe diameter choice. The vertical bends placed near the IP efficiently separate the circulating beam from the secondaries, which can be intercepted by the downstream collimators, with the jaws placed close to the admittance boundary.

It can be easily seen from Table A1, the introduced collimators C10-C17 with indicated distances between the circulating beam axis and horizontal or vertical jaws can efficiently reduce the undesirable beam loss at the superconducting elements. The full-scale cascade simulation in collimator C10 and in the downstream region confirm the necessity and high efficiency of this collimator and show no side effect to the SC elements. Collimators C11, C12, C16 and C17 are positioned at 6-8 meters distance before the SC elements so the maximum scraping rate at these is about a few times 10^9 protons-per-second.

Figure 8. Longitudinal Distribution of the Maximal Energy Deposition in the SC Coils in the Low- β Region Downstream of the SSC IP. Results are normalized per one 20×20 TeV pp-interaction.

Figure 9. Longitudinal Distribution of the Maximal Energy Deposition in the Beam Pipe in the Low- β Region Downstream of the SSC IP.

Figure 10. Contribution into the Maximal Energy Deposition of Photons from the 20×20 TeV pp Interaction Point.

Table 9

Maximal Energy Deposition ϵ , Absorbed Dose Rate D' , and Annual Dose D in the Superconducting Coils of the SSC Low- β IR Beam Elements. The last column is the power P deposited in the element. Interaction rate at the IP is 10^9 per second at $L = 10^{34} \text{cm}^{-2}\text{s}^{-1}$. The operational year is 10^7 sec.

Name	Length (m)	Path Length (m)	ϵ (MeV/g per 1 int.)	D' (mW/g)	D (mrad per year)	P (W)
		0				
DL0	15.00	15.00				38.4
DL1	5.00	20.00				16.8
FWD CAL	3.00	18.00				140.8
COLLIM	2.00	20.00				24.8
QL1	15.14	35.14	20	3.20	3200	513.1
OR	0.80	35.94				3.7
QL2	11.22	47.16	12	1.92	1920	155.3
D	1.00	48.16				2.0
QL2	11.22	59.38	14	2.22	2220	260.3
OR	0.80	60.18				3.6
QL3	12.96	73.14	6	0.96	960	161.9
D3	7.00	80.14				1.0
BV1-	5.00	85.14	0.4	0.06	64	5.4
D	1.00	86.14				0.7
BV1-	5.00	91.14	0.7	0.11	1112	7.6
D	1.00	92.14				0.3
BV1-	5.00	97.14	1.3	0.21	208	12.7
D	33.00	130.14				1.6
Z-CAL	1.00	131.14				809.8
D	76.00	207.14				3.6
C10	4.00	211.14				78.7
D	78.00	281.94				
BV1+	5.00	286.94				0.1
Total						2242.2

*Maximal numbers ϵ , D' and D in the superconducting elements correspond to the maxima in the azimuthal distributions at the inner radii of the inner coils.

**Outer radius for all the elements assumed to be equal to 15 cm.

Because loss rates at the collimators vary within two orders of magnitude, one might be tempted to remove "insignificant" collimators C13, C15 and C17. But remembering uncertainty in the pp interaction model and possible lattice changes, it would be strongly recommended to avoid "improvements" of that kind.

8. BEAM ABORT SYSTEM

8.1 Lambertson as a Source of Radiation

In the beam abort system, the extraction Lambertson septum magnet followed by horizontal and vertical scrapers (SHV) [1] should be the narrowest places in the both collider rings during the injection, acceleration and collision stages in the SSC. This way the beam halo growths, for various reasons, would

be prevented, and the corresponding secondary particles can be rather easily intercepted in the utility straight section.

To achieve this, one needs to provide the circulating beam position related to the Lambertson magnet pole as indicated in Table 10 for two beam pipe diameters, both for injection and collisions. The shown distances Δ are equal to the corresponding accelerator admittances.

Since the beam is close to the Lambertson septum, there are some reasons to suppose that the beam periphery or halo will sometimes touch the edge of the pole. These reasons are possible instabilities of the beam position and its periphery size. No quantitative estimations of the beam fraction hitting the septum can be made at the present, and the following model of the incidence on the septum is just an educated guess.

The schematic of that model is shown in Figure 13. Starting from the beam angular sizes, the value of δ_0 is determined as 0.32 mm at 2 TeV and 0.11 mm at 20 TeV. The incident beam density is assumed to be linearly decreasing to zero at $Z = \Delta + \delta$, and δ is supposed to be the model parameter. The calculated exit probabilities for particles of the group (ii) are presented in Figure 14 as functions of the parameter δ . As can be easily seen, these are not negligibly small for any reasonable value of δ . The phase space cross-sections of these scattered particles at the end of the Lambertson magnet are presented in Figures 15-18.

There are no serious reasons to consider the Lambertson septum as a source of group (i) radiation because these particles carry out only 2.5% and 4.5% of all the leakage energy at 2 TeV and 20 TeV, respectively. In addition, the nearest magnet downstream of the Lambertson is completely screened by the scraper SHV.

Figure 11. Energy Deposited per 1 m of the Low- β Magnetic Elements Downstream of the 20×20 TeV Interaction Point.

TIP-01312

Figure 12. Momentum Distributions of the Neutrals at the Zero - angle Calorimeter Position Downstream of the 20×20 TeV Interaction Point.

Table 10
Circulating Beam Axis Positions Δ Related to the Inner Edge of the Lambertson Magnet Pole

Collider mode	Beam pipe diameter of standard cell quads (mm)	Beam pipe diameter of QL5,QL6,QU1 and QU2 (mm)	Beam-pole distance Δ (mm)
Injection at E = 2 TeV $\beta^* = 8$ m	33	40	9.2
	40	50	11.2
Collisions at E = 20 TeV $\beta^* = 0.5$ m	33	40	3.0
	40	50	3.6

8.2 Beam Loss Downstream of the Utility Straight Section

The loss distributions of protons described in the previous section throughout the collider structure downstream of the Lambertson with the total length of 7377.95 m are presented in Tables A2 and A3 (see Appendix A) both for injection and collision mode. It can be seen in regions with significant levels of beam loss. To reduce these, additional collimators should be installed with parameters indicated in the same tables.

The resulting beam loss distribution, when all the collimators are in, is shown in Tables A2 and A3 at the right. It can also be seen how significantly the beam loss level could be decreased.

The "zero level" of the beam loss density in Tables A2-A3 is estimated to be less than 10^{-5} protons-per-element per-one-proton hitting the Lambertson septum when the collimators are in. If the number of protons intercepted by any collimator is comparable to the number of protons hitting the Lambertson septum, the effect of re-scattering can be significant. For example, the collimator C6 at the injection energy intercepts about one-third of the protons scattered out from the Lambertson septum. The contribution to the beam loss at 2 TeV due to protons re-scattered at C6 for the "full aperture" case is presented in Table 11. The maximal energy deposition in the superconducting coil of the first quad QF downstream of the collimator C6 is equal to 0.05 mJ/g under the maximal allowable beam loss at the Lambertson (2.2×10^{10} ppp; see the following section), which is well below the quench level. A corresponding maximal dose in the coil is equal to 2.4×10^{-10} rad per one 2 TeV proton hitting the septum.

All the data of Tables A2 and A3 were calculated for the incidence model parameter $\delta = 0.1$ mm. Table 12 shows that the loss distribution normalized to one proton leaving the Lambertson septum is not very sensitive to δ . Therefore, the dependence of the beam loss distribution on δ is mostly the dependence of the normalization factor, which can be taken from Figure 14.

8.3 Accidental Beam Loss on the Lambertson

Improper functioning of the abort kicker can cause accidental beam loss on the Lambertson septum. If the vertical deflection produced by the kicker is less than that required to put the beam into the field-free region of the Lambertson, then the beam will hit the face of the septum or its inner surface.

The calculated maximal energy deposition ϵ_m in GeV/g per-one-hitting proton is presented below for the beam incident on the face of the septum and for two values of the angle α between the septum inner surface and the incident beam axis:

E_0, TeV	Face inc.	$\alpha = 1 \text{ mrad}$	$\alpha = 0.5 \text{ mrad}$
2	21.	4.6	3.0
20	1100.	250.	170.

Supposing accidental beam intensity at 20 TeV as 1.3×10^{14} and as $\frac{1}{8}$ of this value at the injection, one can estimate that instantaneous overheating of the septum will be high enough to melt it. In the case of the beam face incidence, first 1.2 m and 2.6 m of the septum will be melted at 2 TeV and 20 TeV, respectively. To protect the septum one can place a "false septum" upstream of it. But it will not work if the missing vertical deflection of the beam causes the incidence on the inner surface of the septum. The melted spot in this case will be similar to those shown on Figures 4 and 5.

It can be seen from Table 13 that the maximal dose absorbed in the Lambertson coils caused just by a single accident is rather high. Therefore, these two effects—melting and high doses in the Lambertson—are two additional serious reasons for the creation of the extremely reliable kicker for the beam abort system.

Figure 13. Schematic of the Model Describing Protons Incidence on the Lambertson Septum. Z and R are the vertical and the horizontal coordinates, respectively. Z' is the space angle projection to the vertical plane.

Figure 14. Probabilities of the Incident Proton Leakage out of the Lambertson Septum as Function of the Parameter δ .

Figure 15. Phase Space Distribution of the 20 TeV Scattered Protons in the Vertical Plane at the Downstream End of the Lambertson Magnet.

Figure 17. Phase Space Distribution of 2-TeV Scattered Protons in the Vertical Plane at the Downstream End of the Lamberton Magnet.

Figure 16. Phase Space Distribution of the 20 TeV Scattered Protons in the Horizontal Plane at the Downstream End of the Lamberton Magnet.

TIP-01318

Figure 18. Phase Space Distribution of 2-TeV Scattered Protons in the Horizontal Plane at the Downstream End of the Lambertson Magnet.

Table 11
Contribution to the Beam Loss of 2 TeV Protons Re-scattered on Collimator C6

Element No.	Element Name	Beam Loss (protons/1hp)	
		From the Lambertson	From C6
263			3.9×10^{-4}
264	QF		5.7×10^{-5}
267			1.3×10^{-5}
270	C7	3.8×10^{-5}	1.2×10^{-4}
275			6.6×10^{-4}
276	QL5		4.8×10^{-5}
277			2.5×10^{-5}
278	QL4		4.0×10^{-4}
314	C8		2.3×10^{-4}
381	QL4		1.0×10^{-4}
525	C9		1.2×10^{-4}

Table 12

Beam Loss Downstream of the Lambertson Magnet per One Proton Scattered Out from the Septum at 20 TeV. δ is the parameter of incidence model.

Element	No	4	10	11	12	22	26	51	262	489
	Name	C1	QU2	TUB	C2	C3	C4	C5	C6	QL4
δ , mm	0.1	2.6-2	7.8-4	7.5-4	3.0-2	1.2-2	2.4-2	2.6-4	3.3-1	2.6-4
	1.0	2.7-2	5.2-5	1.6-4	2.7-2	1.3-2	1.6-2	1.7-6	3.1-1	6.0-4

* $2.6 - 2 = 2.6 \times 10^{-2}$

Table 13

Radiation Doses to the Abort Lambertson Coils Due to Accidental Beam Loss (Mrad/accident).

Section number	2 TeV	20 TeV
	1.63×10^{13} ppp	1.3×10^{14} ppp
1	1.90	150.0
2	0.74	43.0
3	0.38	29.0
4	0.16	14.0
5	0.10	11.0
6	0.09	6.5
7	0.07	7.4
8	0.05	2.9
9	0.05	2.3
10	0.02	1.8
11	0.02	1.4
12	0.02	1.4
13	0.02	0.5
14	0.02	0.5
15	0.02	0.6

* Section length is equal to 5.9 m.

Assuming $\Delta T = 500^\circ\text{C}$ as the tolerable limit for an instantaneous temperature rise in the septum, it can be determined that the maximum number of protons per one fast accidental beam loss at the Lambertson is:

$$N = 1.7 \times 10^9 \text{ protons per spill at 20 TeV,}$$

$$N = 2.2 \times 10^{10} \text{ protons per spill at 2 TeV.}$$

Table 14 summarizes the results of the full-scale cascade simulations in the nearby regions of the "hottest" collimators, C1 and C6, for various scenarios of beam loss at the Lambertson septum.

Table 14

Maximal Energy Deposition, Absorbed Dose d and Annual Dose D in the Coil of the First Beam Elements Downstream of Collimators C1 and C6 for Various Scenarios of Beam Loss at the Lambertson Septum.

Scenario	Value	B behind C1		QF behind C6	
		2 TeV	20 TeV	2 TeV	20 TeV
1	ϵ (mJ/g)	0.0215	0.0025	0.0528	0.0015
	d (rad)	2.15	0.25	5.28	0.15
2	D (Mrad/yr)	0.21	0.32	0.52	0.19
3	D (Mrad/yr)	7.61	11.5	18.7	6.86
ϵ (GeV/g per 1 p @ Lamb)		6.1×10^{-6}	9.2×10^{-6}	1.5×10^{-5}	5.5×10^{-6}

* Parameters of collimators are given in Tables A2 and A3 (See Appendix A).

Scenario 1 : Maximal tolerable single accidental beam loss

(2.2×10^{10} ppp at 2 TeV and 1.7×10^9 ppp at 20 TeV)

Scenario 2: Routine operation - 10^8 p/sec halo rate

Scenario 3: Routine operation - 10% full intensity per hour of beam scraping at the Lambertson and downstream scraper

9. INTRODUCING A DISPERSION INTO THE UTILITY STRAIGHT SECTION

In the current zero-dispersion structure of the SSC straight section [1], there is no way to intercept the protons with a difference in the momentum Δp , because these have a zero radial displacement $\Delta R = D \times \Delta p/p = 0$, where $D = 0$ is a dispersion. In the SSCDR [1] a section between the utility and low- β regions looks like this:

1. two cells of a dispersion suppressor;
2. six normal cells;
3. two cells of a dispersion suppressor;
4. two-and-a half normal cells without dipoles;
5. low- β region starting from QL6.

It is strongly recommended that a segment (4) be inserted between (1) and (2), and that in that segment are placed two collimators just downstream of the QF quad. In this case the dispersion in that segment would be equal to 1.8 m, as in the regular lattice. The circulating beam and scattered protons, having different momenta, would be separated in the space and could be intercepted with the collimators. The scraping rate could be controlled taking into account the results of Section 6.

10. BENT CRYSTAL

Use of the bent crystal for low-intensity beam extraction from the SSC with no influence on the collider experiments is a very attractive possibility for a fixed-target B physics experiment and for the test beams. There are two possible schemes of the extraction: 1.) prompt with the crystal in the East straight section, and 2.) increase of the betatron oscillation amplitude with the crystal in the lattice and consequent extraction with the septum magnet in the straight section. The intensity calculated from the beam halo rate of such a "parasitic" extraction is about 10^7 p/sec [21]. For both schemes the beam-crystal interactions at this level are a rather moderate source of irradiation of the downstream SC magnets, giving a value well below tolerable.

11. CONCLUSIONS AND SC MAGNETS MATERIALS CHOICE

Distribution of the radiation effects along the SSC structure is rather non-uniform, following the beam loss behavior. Analyzing the results of the previous sections, the following conclusions can be derived on the annual dose in the SC coils for 6000 hours of operation per year at the maximal parameters (10^{34}) in the SSC:

1. the lower limit for the maximal dose $D_{\max}$ is about 1 Mrad per year;
2. the upper limit for the maximal dose $D_{\max}$ in the coils can occur in a few low- β quads and is equal to about 3000 Mrad per year;
3. the most probable value for the majority of the SC beam elements, with all the collimators and other measures suggested in Sections 7 through 9 and with the corresponding low level of the beam abort system signal, can be estimated as $D_{\max} \approx 10$ Mrad per year, scattered in the range between a few Mrad and 100 Mrad per year;
4. the maximal dose $D_{\max}$ is reached at the inner radius of the inner coils, usually in the median plane; averaged over azimuth ϕ dose is smaller $D = (0.1-0.25)D_{\max}$, depending on the irradiation conditions;
5. the ratio of the $D_{\max}$ and the corresponding doses averaged over radii of the inner coil D_i and the outer coil D_o is 1:0.65:0.26.

Radiation resistance of the materials to be used in the SSC superconducting magnets is given in Table 15 [22]. Assuming a 20 year lifetime for the SSC, taking into account all the enumerated sources of the beam loss in the Collider, and choosing the appropriate materials, the reliability of the machine can be estimated. Special attention should be paid to the quads in the low- β regions, where doses are reasonably small at a luminosity $10^{33}\text{cm}^{-2}\text{s}^{-1}$ but become very high at ten times greater luminosity.

12. SUGGESTIONS FOR THE FUTURE

1. Studies of the tolerable energy deposition in SSC dipoles and quads as a function of proton energy, irradiation conditions, time and cooling system parameters at 4.35K and 1.8K.
2. Continuous upgrade of the SSC-IHEP Monte-Carlo Package, marriage of the SYNCH/TEAPOT and MARS10 programs, standardization of file exchange formats.
3. Multi-turn beam loss calculations simulating all the possible errors in systems and the beam instabilities.

4. Calculations of the accelerator and HEP detectors' interference with a continuous update of the details of the detectors' description; collimators upstream of the low- β quads; zero-angle calorimeter/beam stop; irradiation of the detector components, etc.
5. Introduction of a dispersion into the Utility Straight Section to design an effective beam loss localization system.
6. Beam loss calculations for the beam injection and abort lines.
7. Beam halo rate full-scale recalculations in the application to the bent crystal extraction.
8. PP-collision model update, especially for elastic and diffractive particles.
9. Muons in and around the experimental halls and the arcs; muons in bypass configuration: operational aspects.
10. Further detailed studies of the beam loss distribution and intercepting collimators in the "hot" regions of the SSC lattice with formation of low-energy neutron sources.
11. Low energy neutron full-scale calculations: electronics in the tunnel.
12. Low energy neutron full-scale calculations: labyrinths and shafts.

Table 15
Radiation Resistance of Selected Materials

Material	Tolerable dose (Mrad)*
Kapton, polyimide	5000
Kapton film	
Carbon-fiber reinforced tube	
Carbon-fiber-filled epoxy rods	
G11 CR tube	2000
PK102 (epoxy)	1000
Crest 7450 epoxy	
Fiberglass (epoxy impregnated)	
Fiberglass rein. polyester resin	500
Alum. mylars	200
Superinsulation	200
Electrical insulation	10-1000
Tefzel adhesive	
Cerex spunbonded nylon	50
Reemay spunbonded polyester	6
Teflon	1

* 1 Mrad = 10^4 Gy

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APPENDIX
Tables A1 through A3

Table A1. Beam Loss Downstream of the Low- β IR.

Elements names correspond to the SSCD[1] besides and C10-C17 for the suggested collimators. Distance is measured between the interaction point and the end of the element. "Full" aperture corresponds to the 40 mm inner diameter of the beam pipe in the lattice and the "small" one corresponds to the 33 mm beam pipe diameter. Loss rates are presented for 10^{11} interactions per second at IR.

No	Name	Lattice elements				Loss rate			
		Length meters	Distance meters	Apertures, mm				prot/(m/s)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
1		20.00	20.00	20.0	20.0	16.5	16.5		
2	QL1	15.14	35.14	20.0	20.0	16.5	16.5		
3		.80	35.94	20.0	20.0	16.5	16.5		
4	QL2	11.22	47.16	20.0	20.0	16.5	16.5		
5		1.00	48.16	20.0	20.0	16.5	16.5		
6	QL2	11.22	59.38	20.0	20.0	16.5	16.5		
7		.80	60.18	20.0	20.0	16.5	16.5		
8	QL3	12.96	73.14	20.0	20.0	16.5	16.5		
9		7.00	80.14	33.0	33.0	33.0	33.0		
10	SVM	5.00	85.14	33.0	33.0	33.0	33.0		
11		1.00	86.14	33.0	33.0	33.0	33.0		
12	SVM	5.00	91.14	33.0	33.0	33.0	33.0		
13		1.00	92.14	33.0	33.0	33.0	33.0		
14	SVM	5.00	97.14	33.0	33.0	33.0	33.0		
15		110.00	207.14	33.0	33.0	33.0	33.0	8.3+3	8.3+3
16	C10	4.00	211.14	20.0	7.0	16.5	6.5	8.3+3	9.1+5
17		70.00	281.14	33.0	33.0	33.0	33.0	4.9+6	5.0+6
18		.80	281.93	33.0	33.0	33.0	33.0	3.4+4	3.4+4
19	SVM	5.00	286.93	33.0	33.0	33.0	33.0	1.8+4	1.8+4
20		1.00	287.93	33.0	33.0	33.0	33.0	1.6+4	1.6+4
21	SVM	5.00	292.93	33.0	33.0	33.0	33.0	5.3+4	5.3+4
22		1.00	293.93	33.0	33.0	33.0	33.0	8.0+3	8.0+3
23	SVM	5.00	298.93	33.0	33.0	33.0	33.0		
24		2.07	301.01	33.0	33.0	33.0	33.0		
25	C11	5.00	306.01	20.0	5.0	16.5	4.0	8.7+5	9.6+5
26		6.00	312.01	33.0	33.0	33.0	33.0	2.2+3	2.2+3
27	QVD	14.25	326.26	25.0	25.0	20.0	20.0	6.1+4	1.1+5
28		.80	327.06	25.0	25.0	20.0	20.0		
29	QVF	14.25	341.31	25.0	25.0	20.0	20.0		
30		4.20	345.51	25.0	25.0	20.0	20.0		
31	QVF	14.25	359.76	25.0	25.0	20.0	20.0	9.3+2	
32		.80	360.56	25.0	25.0	20.0	20.0		
33	QVD	14.25	374.81	25.0	25.0	20.0	20.0	4.7+3	2.8+3
34		4.20	379.01	25.0	25.0	20.0	20.0		
35	QVD	14.25	393.26	25.0	25.0	20.0	20.0		
36		.80	394.06	25.0	25.0	20.0	20.0		
37	QVF	14.25	408.31	25.0	25.0	20.0	20.0		
38		4.20	412.51	25.0	25.0	20.0	20.0		
39	QVF	14.25	426.76	25.0	25.0	20.0	20.0		
40		.80	427.56	25.0	25.0	20.0	20.0		
41	QVD	14.25	441.81	25.0	25.0	20.0	20.0		
42		4.96	446.77	25.0	25.0	20.0	20.0		
43	VM	12.64	459.41	25.0	25.0	20.0	20.0		
44		1.00	460.41	25.0	25.0	20.0	20.0		
45	VM	12.64	473.05	25.0	25.0	20.0	20.0		
46		1.00	474.05	25.0	25.0	20.0	20.0	1.3+4	

Table A1. (cont.)

No	Name	Lattice elements						Loss rate			
		Length Distance		Apertures, mm				prot/(mts)		prot/s	
		meters		full		small		coll. off		coll. on	
				hor.	ver.	hor.	ver.	full	small	full	small
47	VM	12.64	486.68	25.0	25.0	20.0	20.0	1.1+3	1.1+3		
48		1.41	488.09	25.0	25.0	20.0	20.0	9.4+3	9.4+3		
49	C12	5.00	493.09	2.0	20.0	2.0	16.5	*	**	*	1.3+4
50		7.00	500.09	25.0	25.0	20.0	20.0	5.7+3	3.8+3		
51	VM	12.64	512.73	25.0	25.0	20.0	20.0	4.2+3	2.1+3		
52		1.00	513.73	25.0	25.0	20.0	20.0				
53	VM	12.64	526.37	25.0	25.0	20.0	20.0	5.3+3	1.1+3		
54		1.00	527.37	25.0	25.0	20.0	20.0				
55	VM	12.64	540.01	25.0	25.0	20.0	20.0	3.2+3	1.1+3		
56		.80	540.81	25.0	25.0	20.0	20.0				
57	QL4	10.63	551.43	20.0	20.0	16.5	16.5	3.1+4	1.4+4		
58		.80	552.23	25.0	25.0	20.0	20.0				
59	QL5	14.08	566.32	25.0	25.0	20.0	20.0	5.7+3	3.8+3		
60		4.00	570.32	25.0	25.0	20.0	20.0	1.3+4	6.6+3		
61	C13	5.00	575.32	20.0	3.0	16.5	3.0	*	**	*	1.3+4 1.3+4
62		95.00	670.32	25.0	25.0	20.0	20.0	4.2+3	2.5+3		
63	QL6	4.68	675.00	25.0	25.0	20.0	20.0				
64		4.00	679.00	25.0	25.0	20.0	20.0				
65	C14	5.00	684.00	20.0	3.5	16.5	3.0	*	**	*	8.0+4 5.3+4
66		78.40	762.40	25.0	25.0	20.0	20.0				
67	QF	5.20	767.60	20.0	20.0	16.5	16.5				
68		4.00	771.60	20.0	20.0	16.5	16.5				
69	C15	5.00	776.60	4.0	20.0	3.0	16.5	*	**	*	1.3+4
70		75.80	852.40	20.0	20.0	16.5	16.5				
71	QD	5.20	857.60	20.0	20.0	16.5	16.5				
72		84.80	942.40	20.0	20.0	16.5	16.5				
73	QF	2.60	945.00	20.0	20.0	16.5	16.5				
74	QSF	3.52	948.52	20.0	20.0	16.5	16.5				
75		6.80	955.32	20.0	20.0	16.5	16.5				
76	SM	12.64	967.96	20.0	20.0	16.5	16.5				
77		.65	968.61	20.0	20.0	16.5	16.5				
78	SM	12.64	981.25	20.0	20.0	16.5	16.5				
79		.65	981.90	20.0	20.0	16.5	16.5				
80	SM	12.64	994.54	20.0	20.0	16.5	16.5				
81		.65	995.19	20.0	20.0	16.5	16.5				
82	SM	12.64	1007.82	20.0	20.0	16.5	16.5	1.1+3	1.9+3		
83		1.15	1008.98	20.0	20.0	16.5	16.5			2.3+4	
84	QSD	7.05	1016.52	20.0	20.0	16.5	16.5	9.4+3	3.8+3		
85		12.33	1028.36	20.0	20.0	16.5	16.5	1.6+4	2.1+4		
86	SM	12.64	1041.00	20.0	20.0	16.5	16.5	2.1+4	2.2+4		
87		.65	1041.65	20.0	20.0	16.5	16.5				
88	SM	12.64	1054.28	20.0	20.0	16.5	16.5	2.3+4	2.1+4		
89		.65	1054.93	20.0	20.0	16.5	16.5	4.1+4	2.0+4		
90	SM	12.64	1067.57	20.0	20.0	16.5	16.5	1.2+4	1.2+4		
91		8.90	1076.48	20.0	20.0	16.5	16.5	1.4+4	1.1+4	1.3+4	
92	QSF	7.05	1083.52	20.0	20.0	16.5	16.5		1.9+3		
93		13.35	1096.87	20.0	20.0	16.5	16.5				
94	SM	12.64	1109.51	20.0	20.0	16.5	16.5				
95		.65	1110.16	20.0	20.0	16.5	16.5				
96	SM	12.64	1122.80	20.0	20.0	16.5	16.5				
97		.65	1123.45	20.0	20.0	16.5	16.5				
98	SM	12.64	1136.08	20.0	20.0	16.5	16.5				

Table A1. (cont.)

No	Name	Lattice elements				Loss rate			
		Length meters	Distance	Apertures, mm		prot/(mts)		prot/s	
				full		coll. off		coll. on	
				hor.	ver.	full	small	full	small
99		7.89	1143.98	20.0	20.0	16.5	16.5		
100	QSD	7.05	1151.02	20.0	20.0	16.5	16.5		
101		2.00	1153.02	20.0	20.0	16.5	16.5		
102	C16	3.00	1156.02	2.0	20.0	2.0	16.5	9.7+5	8.4+5
103		8.42	1164.45	20.0	20.0	16.5	16.5		
104	SM	12.64	1177.09	20.0	20.0	16.5	16.5	2.1+3	2.1+3
105		.65	1177.74	20.0	20.0	16.5	16.5	2.0+4	
106	SM	12.64	1190.37	20.0	20.0	16.5	16.5	9.5+3	7.7+3
107		.65	1191.02	20.0	20.0	16.5	16.5	2.0+4	
108	SM	12.64	1203.66	20.0	20.0	16.5	16.5	5.3+3	5.3+3
109		7.82	1211.48	20.0	20.0	16.5	16.5	6.8+3	5.1+3
110	QSF	3.52	1215.00	20.0	20.0	16.5	16.5		
111	QF	2.60	1217.60	20.0	20.0	16.5	16.5		
112		3.19	1220.79	20.0	20.0	16.5	16.5		
113	M	15.16	1235.95	20.0	20.0	16.5	16.5		
114		.65	1236.60	20.0	20.0	16.5	16.5		
115	M	15.16	1251.77	20.0	20.0	16.5	16.5		
116		.65	1252.42	20.0	20.0	16.5	16.5		
117	M	15.16	1267.58	20.0	20.0	16.5	16.5		
118		.65	1268.23	20.0	20.0	16.5	16.5		
119	M	15.16	1283.40	20.0	20.0	16.5	16.5		
120		.65	1284.05	20.0	20.0	16.5	16.5		
121	M	15.16	1299.21	20.0	20.0	16.5	16.5		
122		3.19	1302.40	20.0	20.0	16.5	16.5		
123	QD	2.60	1305.00	20.0	20.0	16.5	16.5		
124	QSD	3.52	1308.52	20.0	20.0	16.5	16.5		
125		7.82	1316.34	20.0	20.0	16.5	16.5		
126	SM	12.64	1328.98	20.0	20.0	16.5	16.5		
127		.65	1329.63	20.0	20.0	16.5	16.5		
128	SM	12.64	1342.26	20.0	20.0	16.5	16.5		
129		.65	1342.91	20.0	20.0	16.5	16.5		
130	SM	12.64	1355.55	20.0	20.0	16.5	16.5		
131		13.42	1368.98	20.0	20.0	16.5	16.5	2.0+3	
132	QSF	7.05	1376.02	20.0	20.0	16.5	16.5		
133		7.89	1383.92	20.0	20.0	16.5	16.5		
134	SM	12.64	1396.55	20.0	20.0	16.5	16.5		
135		.65	1397.20	20.0	20.0	16.5	16.5		
136	SM	12.64	1409.84	20.0	20.0	16.5	16.5		
137		.65	1410.49	20.0	20.0	16.5	16.5		
138	SM	12.64	1423.13	20.0	20.0	16.5	16.5		
139		2.00	1425.13	20.0	20.0	16.5	16.5		
140	C17	3.00	1428.13	2.0	20.0	2.0	16.5	1.3+4	1.3+4
141		8.35	1436.48	20.0	20.0	16.5	16.5		
142	QSD	7.05	1443.52	20.0	20.0	16.5	16.5		
143		8.90	1452.43	20.0	20.0	16.5	16.5		
144	SM	12.64	1465.07	20.0	20.0	16.5	16.5		
145		.65	1465.72	20.0	20.0	16.5	16.5		
146	SM	12.64	1478.35	20.0	20.0	16.5	16.5		
147		.65	1479.00	20.0	20.0	16.5	16.5		
148	SM	12.64	1491.64	20.0	20.0	16.5	16.5		
149		12.33	1503.98	20.0	20.0	16.5	16.5		

Table A1. (cont.)

No	Name	Lattice elements						Loss rate			
		Length meters	Distance	Apertures, mm				prot/(ats)		prot/s	
				full		small		coll. off		coll. on	
				hor.	ver.	hor.	ver.	full	small	full	small
150	QSF	7.05	1511.02	20.0	20.0	16.5	16.5				
151		1.15	1512.18	20.0	20.0	16.5	16.5				
152	SM	12.64	1524.81	20.0	20.0	16.5	16.5				
153		.65	1525.46	20.0	20.0	16.5	16.5				
154	SM	12.64	1538.10	20.0	20.0	16.5	16.5				
155		.65	1538.75	20.0	20.0	16.5	16.5				
156	SM	12.64	1551.39	20.0	20.0	16.5	16.5				
157		.65	1552.04	20.0	20.0	16.5	16.5				
158	SM	12.64	1564.68	20.0	20.0	16.5	16.5				
159		6.80	1571.48	20.0	20.0	16.5	16.5				
160	QSD	3.52	1575.00	20.0	20.0	16.5	16.5				
161	QD	2.60	1577.60	20.0	20.0	16.5	16.5				
162		84.80	1662.40	20.0	20.0	16.5	16.5				
163	QF	5.20	1667.60	20.0	20.0	16.5	16.5				
164		84.80	1752.40	20.0	20.0	16.5	16.5				
165	QD	5.20	1757.60	20.0	20.0	16.5	16.5				
166		87.40	1845.00	25.0	25.0	20.0	20.0				
167	QL6	4.68	1849.68	25.0	25.0	20.0	20.0				
168		104.00	1953.68	25.0	25.0	20.0	20.0				
169	QL5	14.08	1967.77	25.0	25.0	20.0	20.0				
170		.80	1968.57	25.0	25.0	20.0	20.0				
171	QL4	10.63	1979.19	20.0	20.0	16.5	16.5				
172		.80	1979.99	25.0	25.0	20.0	20.0				
173	VM	12.64	1992.63	25.0	25.0	20.0	20.0				
174		1.00	1993.63	25.0	25.0	20.0	20.0				
175	VM	12.64	2006.27	25.0	25.0	20.0	20.0				
176		1.00	2007.27	25.0	25.0	20.0	20.0				
177	VM	12.64	2019.91	25.0	25.0	20.0	20.0				
178		13.41	2033.32	25.0	25.0	20.0	20.0				
179	VM	12.64	2045.95	25.0	25.0	20.0	20.0				
180		1.00	2046.95	25.0	25.0	20.0	20.0				
181	VM	12.64	2059.59	25.0	25.0	20.0	20.0				
182		1.00	2060.59	25.0	25.0	20.0	20.0				
183	VM	12.64	2073.23	25.0	25.0	20.0	20.0				
184		4.96	2078.19	25.0	25.0	20.0	20.0				
185	QVF	14.25	2092.44	25.0	25.0	20.0	20.0				
186		.80	2093.24	25.0	25.0	20.0	20.0				
187	QVD	14.25	2107.49	25.0	25.0	20.0	20.0				
188		4.20	2111.69	25.0	25.0	20.0	20.0				
189	QVD	14.25	2125.94	25.0	25.0	20.0	20.0				
190		.80	2126.74	25.0	25.0	20.0	20.0				
191	QVF	14.25	2140.99	25.0	25.0	20.0	20.0				
192		4.20	2145.19	25.0	25.0	20.0	20.0				
193	QVF	14.25	2159.44	25.0	25.0	20.0	20.0				
194		.80	2160.24	25.0	25.0	20.0	20.0				
195	QVD	14.25	2174.49	25.0	25.0	20.0	20.0				
196		4.20	2178.69	25.0	25.0	20.0	20.0				
197	QVD	14.25	2192.94	25.0	25.0	20.0	20.0				
198		.80	2193.74	25.0	25.0	20.0	20.0				
199	QVF	14.25	2207.99	25.0	25.0	20.0	20.0				
200		13.07	2221.07	33.0	33.0	33.0	33.0				
201	SVH	5.00	2226.07	33.0	33.0	33.0	33.0				
202		1.00	2227.07	33.0	33.0	33.0	33.0				

Table A1. (cont.)

No	Name	Lattice elements				Loss rate			
		Length meters	Distance	Apertures, mm				prot/(mts)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
203	SVM	5.00	2232.07	33.0	33.0	33.0	33.0		
204		1.00	2233.07	33.0	33.0	33.0	33.0		
205	SVM	5.00	2238.07	33.0	33.0	33.0	33.0		
206		90.00	2328.07	33.0	33.0	33.0	33.0		
207	C9	4.00	2332.07	20.0	10.0	16.5	8.0		
208		90.00	2422.07	33.0	33.0	33.0	33.0		
209		.80	2422.86	33.0	33.0	33.0	33.0		
210	SVM	5.00	2427.86	33.0	33.0	33.0	33.0		
211		1.00	2428.86	33.0	33.0	33.0	33.0		
212	SVM	5.00	2433.86	33.0	33.0	33.0	33.0		
213		1.00	2434.86	33.0	33.0	33.0	33.0		
214	SVM	5.00	2439.86	33.0	33.0	33.0	33.0		
215		7.00	2446.86	33.0	33.0	33.0	33.0		
216	QL3	12.96	2459.82	20.0	20.0	16.5	16.5	1.0+3	1.0+3
217		.80	2460.62	20.0	20.0	16.5	16.5		
218	QL2	11.22	2471.84	20.0	20.0	16.5	16.5		
219		1.00	2472.84	20.0	20.0	16.5	16.5		
220	QL2	11.22	2484.06	20.0	20.0	16.5	16.5		
221		.80	2484.86	20.0	20.0	16.5	16.5		
222	QL1	15.14	2500.00	20.0	20.0	16.5	16.5		
223		20.00	2520.00	20.0	20.0	16.5	16.5		
224		20.00	2540.00	20.0	20.0	16.5	16.5		
225	QL1	15.14	2555.14	20.0	20.0	16.5	16.5		
226		.80	2555.94	20.0	20.0	16.5	16.5		
227	QL2	11.22	2567.16	20.0	20.0	16.5	16.5		
228		1.00	2568.16	20.0	20.0	16.5	16.5		
229	QL2	11.22	2579.38	20.0	20.0	16.5	16.5		
230		.80	2580.18	20.0	20.0	16.5	16.5		
231	QL3	12.96	2593.14	20.0	20.0	16.5	16.5		
232		7.00	2600.14	33.0	33.0	33.0	33.0		
233	SVM	5.00	2605.14	33.0	33.0	33.0	33.0		
234		1.00	2606.14	33.0	33.0	33.0	33.0		
235	SVM	5.00	2611.14	33.0	33.0	33.0	33.0		
236		1.00	2612.14	33.0	33.0	33.0	33.0		
237	SVM	5.00	2617.14	33.0	33.0	33.0	33.0		
238		184.00	2801.14	33.0	33.0	33.0	33.0		
239		.80	2801.93	33.0	33.0	33.0	33.0		
240	SVM	5.00	2806.93	33.0	33.0	33.0	33.0		
241		1.00	2807.93	33.0	33.0	33.0	33.0		
242	SVM	5.00	2812.93	33.0	33.0	33.0	33.0		
243		1.00	2813.93	33.0	33.0	33.0	33.0		
244	SVM	5.00	2818.93	33.0	33.0	33.0	33.0		
245		13.07	2832.01	33.0	33.0	33.0	33.0		
246	QVD	14.25	2846.26	25.0	25.0	20.0	20.0		
247		.80	2847.06	25.0	25.0	20.0	20.0		
248	QVF	14.25	2861.31	25.0	25.0	20.0	20.0		
249		4.20	2865.51	25.0	25.0	20.0	20.0		
250	QVF	14.25	2879.76	25.0	25.0	20.0	20.0		
251		.80	2880.56	25.0	25.0	20.0	20.0		
252	QVD	14.25	2894.81	25.0	25.0	20.0	20.0		
253		4.20	2899.01	25.0	25.0	20.0	20.0		
254	QVD	14.25	2913.26	25.0	25.0	20.0	20.0		

Table A1. (cont.)

No	Name	Lattice elements				Loss rate			
		Length meters	Distance	Apertures, mm				prot/(mts)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
								full	small
255		.80	2914.06	25.0	25.0	20.0	20.0		
256	QVF	14.25	2928.31	25.0	25.0	20.0	20.0		
257		4.20	2932.51	25.0	25.0	20.0	20.0		
258	QVF	14.25	2946.76	25.0	25.0	20.0	20.0		
259		.80	2947.56	25.0	25.0	20.0	20.0		
260	QVD	14.25	2961.81	25.0	25.0	20.0	20.0		
261		4.96	2966.77	25.0	25.0	20.0	20.0		
262	VM	12.64	2979.41	25.0	25.0	20.0	20.0		
263		1.00	2980.41	25.0	25.0	20.0	20.0		
264	VM	12.64	2993.05	25.0	25.0	20.0	20.0		
265		1.00	2994.05	25.0	25.0	20.0	20.0		
266	VM	12.64	3006.68	25.0	25.0	20.0	20.0		
267		13.41	3020.09	25.0	25.0	20.0	20.0		
268	VM	12.64	3032.73	25.0	25.0	20.0	20.0		
269		1.00	3033.73	25.0	25.0	20.0	20.0		
270	VM	12.64	3046.37	25.0	25.0	20.0	20.0		
271		1.00	3047.37	25.0	25.0	20.0	20.0		
272	VM	12.64	3060.01	25.0	25.0	20.0	20.0		
273		.80	3060.81	25.0	25.0	20.0	20.0		
274	QL4	10.63	3071.43	20.0	20.0	16.5	16.5		
275		.80	3072.23	25.0	25.0	20.0	20.0		
276	QL5	14.08	3086.32	25.0	25.0	20.0	20.0		
277		104.00	3190.32	25.0	25.0	20.0	20.0		
278	QL6	4.68	3195.00	25.0	25.0	20.0	20.0		
279		87.40	3282.40	25.0	25.0	20.0	20.0		
280	QF	5.20	3287.60	20.0	20.0	16.5	16.5		
281		84.80	3372.40	20.0	20.0	16.5	16.5		
282	QD	5.20	3377.60	20.0	20.0	16.5	16.5		
283		84.80	3462.40	20.0	20.0	16.5	16.5		
284	QF	5.20	3467.60	20.0	20.0	16.5	16.5		
285		84.80	3552.40	20.0	20.0	16.5	16.5		
286	QD	5.20	3557.60	20.0	20.0	16.5	16.5		
287		84.80	3642.40	20.0	20.0	16.5	16.5		
288	QF	2.60	3645.00	20.0	20.0	16.5	16.5	5.1+3	5.1+3
289	QSF	3.52	3648.52	20.0	20.0	16.5	16.5		
290		2.31	3650.84	20.0	20.0	16.5	16.5		
291	SM	12.64	3663.47	20.0	20.0	16.5	16.5		
292		.65	3664.12	20.0	20.0	16.5	16.5		
293	SM	12.64	3676.76	20.0	20.0	16.5	16.5		
294		.65	3677.41	20.0	20.0	16.5	16.5		
295	SM	12.64	3690.05	20.0	20.0	16.5	16.5		
296		.65	3690.70	20.0	20.0	16.5	16.5		
297	SM	12.64	3703.34	20.0	20.0	16.5	16.5		
298		5.64	3708.98	20.0	20.0	16.5	16.5		
299	QSD	7.05	3716.52	20.0	20.0	16.5	16.5		
300		2.91	3718.94	20.0	20.0	16.5	16.5		
301	SM	12.64	3731.58	20.0	20.0	16.5	16.5		
302		.65	3732.23	20.0	20.0	16.5	16.5		
303	SM	12.64	3744.86	20.0	20.0	16.5	16.5		
304		.65	3745.51	20.0	20.0	16.5	16.5		
305	SM	12.64	3758.15	20.0	20.0	16.5	16.5		
306		.65	3758.80	20.0	20.0	16.5	16.5		
307	SM	12.64	3771.44	20.0	20.0	16.5	16.5		

Table A1. (cont.)

No	Name	Lattice elements				Loss rate			
		Length meters	Distance	Apertures, mm		prot/(mts)		prot/s	
				full	small	coll. off	full	small	coll. on
				hor.	ver.	full	small	full	small
308		5.04	3776.48	20.0	20.0	16.5	16.5		
309	QSF	7.05	3783.52	20.0	20.0	16.5	16.5		
310		2.41	3785.93	20.0	20.0	16.5	16.5		
311	SM	12.64	3798.57	20.0	20.0	16.5	16.5		
312		.65	3799.22	20.0	20.0	16.5	16.5		
313	SM	12.64	3811.86	20.0	20.0	16.5	16.5		
314		.65	3812.51	20.0	20.0	16.5	16.5		
315	SM	12.64	3825.15	20.0	20.0	16.5	16.5		
316		.65	3825.80	20.0	20.0	16.5	16.5		
317	SM	12.64	3838.43	20.0	20.0	16.5	16.5		
318		5.54	3843.98	20.0	20.0	16.5	16.5		
319	QSD	7.05	3851.02	20.0	20.0	16.5	16.5		
320		3.04	3854.07	20.0	20.0	16.5	16.5	4.4+3	
321	SM	12.64	3866.70	20.0	20.0	16.5	16.5	4.2+3	2.1+3
322		.65	3867.35	20.0	20.0	16.5	16.5		
323	SM	12.64	3879.99	20.0	20.0	16.5	16.5	3.2+3	3.2+3
324		.65	3880.64	20.0	20.0	16.5	16.5		
325	SM	12.64	3893.28	20.0	20.0	16.5	16.5	4.2+3	3.2+3
326		.65	3893.93	20.0	20.0	16.5	16.5		
327	SM	12.64	3906.57	20.0	20.0	16.5	16.5	4.2+3	7.4+3
328		4.91	3911.48	20.0	20.0	16.5	16.5	2.7+3	2.7+3
329	QSF	3.52	3915.00	20.0	20.0	16.5	16.5	7.6+3	
330	QF	2.60	3917.60	20.0	20.0	16.5	16.5		
331		.65	3918.25	20.0	20.0	16.5	16.5		
332	M	15.16	3933.42	20.0	20.0	16.5	16.5		
333		.65	3934.06	20.0	20.0	16.5	16.5		
334	M	15.16	3949.23	20.0	20.0	16.5	16.5		
335		.65	3949.88	20.0	20.0	16.5	16.5		
336	M	15.16	3965.04	20.0	20.0	16.5	16.5		
337		1.15	3966.20	20.0	20.0	16.5	16.5		
338	M	15.16	3981.36	20.0	20.0	16.5	16.5		
339		.65	3982.01	20.0	20.0	16.5	16.5		
340	M	15.16	3997.18	20.0	20.0	16.5	16.5		
341		5.22	4002.40	20.0	20.0	16.5	16.5		
342	QD	2.60	4005.00	20.0	20.0	16.5	16.5		
343	QD	2.60	4007.60	20.0	20.0	16.5	16.5		
344		.65	4008.25	20.0	20.0	16.5	16.5		
345	M	15.16	4023.42	20.0	20.0	16.5	16.5		
346		.65	4024.06	20.0	20.0	16.5	16.5		
347	M	15.16	4039.23	20.0	20.0	16.5	16.5		
348		.65	4039.88	20.0	20.0	16.5	16.5		
349	M	15.16	4055.04	20.0	20.0	16.5	16.5		
350		1.15	4056.20	20.0	20.0	16.5	16.5		
351	M	15.16	4071.36	20.0	20.0	16.5	16.5		
352		.65	4072.01	20.0	20.0	16.5	16.5		
353	M	15.16	4087.18	20.0	20.0	16.5	16.5	8.8+2	
354		5.22	4092.40	20.0	20.0	16.5	16.5		
355	QF	5.20	4097.60	20.0	20.0	16.5	16.5		
356		.65	4098.25	20.0	20.0	16.5	16.5		
357	M	15.16	4113.42	20.0	20.0	16.5	16.5		
358		.65	4114.06	20.0	20.0	16.5	16.5		
359	M	15.16	4129.23	20.0	20.0	16.5	16.5		

Table A1. (cont.)

No	Name	Lattice elements				Loss rate			
		Length meters	Distance	Apertures, mm		prot/(m/s)		prot/s	
				full		coll. off		coll. on	
				hor.	ver.	full	small	full	small
360		.65	4129.88	20.0	20.0	16.5	16.5		
361	M	15.16	4145.04	20.0	20.0	16.5	16.5		
362		1.15	4146.19	20.0	20.0	16.5	16.5		
363	M	15.16	4161.36	20.0	20.0	16.5	16.5		
364		.65	4162.01	20.0	20.0	16.5	16.5		
365	M	15.16	4177.17	20.0	20.0	16.5	16.5		
366		5.22	4182.40	20.0	20.0	16.5	16.5		
367	QD	5.20	4187.60	20.0	20.0	16.5	16.5		
368		.65	4188.25	20.0	20.0	16.5	16.5		
369	M	15.16	4203.42	20.0	20.0	16.5	16.5		
370		.65	4204.06	20.0	20.0	16.5	16.5		
371	M	15.16	4219.23	20.0	20.0	16.5	16.5		
372		.65	4219.88	20.0	20.0	16.5	16.5		
373	M	15.16	4235.04	20.0	20.0	16.5	16.5		
374		1.15	4236.19	20.0	20.0	16.5	16.5		
375	M	15.16	4251.36	20.0	20.0	16.5	16.5		
376		.65	4252.01	20.0	20.0	16.5	16.5		
377	M	15.16	4267.17	20.0	20.0	16.5	16.5		
378		5.22	4272.40	20.0	20.0	16.5	16.5	2.6+3	
379	QF	5.20	4277.60	20.0	20.0	16.5	16.5		
380		.65	4278.25	20.0	20.0	16.5	16.5		
381	M	15.16	4293.42	20.0	20.0	16.5	16.5		
382		.65	4294.06	20.0	20.0	16.5	16.5		
383	M	15.16	4309.23	20.0	20.0	16.5	16.5		
384		.65	4309.88	20.0	20.0	16.5	16.5		
385	M	15.16	4325.04	20.0	20.0	16.5	16.5		
386		1.15	4326.19	20.0	20.0	16.5	16.5		
387	M	15.16	4341.36	20.0	20.0	16.5	16.5		
388		.65	4342.01	20.0	20.0	16.5	16.5		
389	M	15.16	4357.17	20.0	20.0	16.5	16.5		
390		5.22	4362.40	20.0	20.0	16.5	16.5		
391	QD	5.20	4367.60	20.0	20.0	16.5	16.5		
392		.65	4368.25	20.0	20.0	16.5	16.5		
393	M	15.16	4383.42	20.0	20.0	16.5	16.5		
394		.65	4384.06	20.0	20.0	16.5	16.5		
395	M	15.16	4399.23	20.0	20.0	16.5	16.5		
396		.65	4399.88	20.0	20.0	16.5	16.5		
397	M	15.16	4415.04	20.0	20.0	16.5	16.5		
398		1.15	4416.19	20.0	20.0	16.5	16.5		
399	M	15.16	4431.36	20.0	20.0	16.5	16.5		
400		.65	4432.01	20.0	20.0	16.5	16.5		
401	M	15.16	4447.17	20.0	20.0	16.5	16.5		
402		5.22	4452.40	20.0	20.0	16.5	16.5	5.1+3	
403	QF	5.20	4457.60	20.0	20.0	16.5	16.5		
404		.65	4458.25	20.0	20.0	16.5	16.5		
405	M	15.16	4473.42	20.0	20.0	16.5	16.5		
406		.65	4474.06	20.0	20.0	16.5	16.5		
407	M	15.16	4489.23	20.0	20.0	16.5	16.5		
408		.65	4489.88	20.0	20.0	16.5	16.5		
409	M	15.16	4505.04	20.0	20.0	16.5	16.5		
410		1.15	4506.19	20.0	20.0	16.5	16.5		
411	M	15.16	4521.36	20.0	20.0	16.5	16.5		

Table A1. (cont.)

No	Name	Lattice elements				Loss rate			
		Length meters	Distance	Apertures, mm				prot/(mts)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
412		.65	4522.01	20.0	20.0	16.5	16.5		
413	M	15.16	4537.17	20.0	20.0	16.5	16.5		
414		5.22	4542.40	20.0	20.0	16.5	16.5		
415	OD	5.20	4547.60	20.0	20.0	16.5	16.5		
416		.65	4548.25	20.0	20.0	16.5	16.5		
417	M	15.16	4563.42	20.0	20.0	16.5	16.5		
418		.65	4564.06	20.0	20.0	16.5	16.5		
419	M	15.16	4579.23	20.0	20.0	16.5	16.5		
420		.65	4579.88	20.0	20.0	16.5	16.5		
421	M	15.16	4595.04	20.0	20.0	16.5	16.5		
422		1.15	4596.19	20.0	20.0	16.5	16.5		
423	M	15.16	4611.36	20.0	20.0	16.5	16.5		
424		.65	4612.01	20.0	20.0	16.5	16.5		
425	M	15.16	4627.17	20.0	20.0	16.5	16.5		
426		5.22	4632.40	20.0	20.0	16.5	16.5		
427	OF	5.20	4637.60	20.0	20.0	16.5	16.5		
428		.65	4638.25	20.0	20.0	16.5	16.5		
429	M	15.16	4653.42	20.0	20.0	16.5	16.5		
430		.65	4654.06	20.0	20.0	16.5	16.5		
431	M	15.16	4669.23	20.0	20.0	16.5	16.5		
432		.65	4669.88	20.0	20.0	16.5	16.5		
433	M	15.16	4685.04	20.0	20.0	16.5	16.5		
434		1.15	4686.19	20.0	20.0	16.5	16.5		
435	M	15.16	4701.36	20.0	20.0	16.5	16.5		
436		.65	4702.01	20.0	20.0	16.5	16.5		
437	M	15.16	4717.17	20.0	20.0	16.5	16.5		
438		5.22	4722.40	20.0	20.0	16.5	16.5		
439	OD	5.20	4727.60	20.0	20.0	16.5	16.5		
440		.65	4728.25	20.0	20.0	16.5	16.5		
441	M	15.16	4743.42	20.0	20.0	16.5	16.5		
442		.65	4744.06	20.0	20.0	16.5	16.5		
443	M	15.16	4759.23	20.0	20.0	16.5	16.5		
444		.65	4759.88	20.0	20.0	16.5	16.5		
445	M	15.16	4775.04	20.0	20.0	16.5	16.5		
446		1.15	4776.19	20.0	20.0	16.5	16.5		
447	M	15.16	4791.36	20.0	20.0	16.5	16.5		
448		.65	4792.01	20.0	20.0	16.5	16.5		
449	M	15.16	4807.17	20.0	20.0	16.5	16.5		
450		5.22	4812.40	20.0	20.0	16.5	16.5		
451	OF	5.20	4817.60	20.0	20.0	16.5	16.5		
452		.65	4818.25	20.0	20.0	16.5	16.5		
453	M	15.16	4833.42	20.0	20.0	16.5	16.5		
454		.65	4834.06	20.0	20.0	16.5	16.5		
455	M	15.16	4849.23	20.0	20.0	16.5	16.5		
456		.65	4849.88	20.0	20.0	16.5	16.5		
457	M	15.16	4865.04	20.0	20.0	16.5	16.5		
458		1.15	4866.19	20.0	20.0	16.5	16.5		
459	M	15.16	4881.36	20.0	20.0	16.5	16.5		
460		.65	4882.01	20.0	20.0	16.5	16.5		
461	M	15.16	4897.17	20.0	20.0	16.5	16.5		
462		5.22	4902.40	20.0	20.0	16.5	16.5		
463	OD	5.20	4907.60	20.0	20.0	16.5	16.5		

Table A1. (cont.)

No	Name	Lattice elements				Loss rate			
		Length meters	Distance	Apertures, mm		prot/(mts)		prot/s	
				full	small	coll. off	small	coll. on	small
				hor.	ver.	full	small	full	small
464		.65	4908.25	20.0	20.0	16.5	16.5		
465	M	15.16	4923.42	20.0	20.0	16.5	16.5		
466		.65	4924.06	20.0	20.0	16.5	16.5		
467	M	15.16	4939.23	20.0	20.0	16.5	16.5		
468		.65	4939.88	20.0	20.0	16.5	16.5		
469	M	15.16	4955.04	20.0	20.0	16.5	16.5		
470		1.15	4956.19	20.0	20.0	16.5	16.5		
471	M	15.16	4971.36	20.0	20.0	16.5	16.5		
472		.65	4972.01	20.0	20.0	16.5	16.5		
473	M	15.16	4987.17	20.0	20.0	16.5	16.5		
474		5.22	4992.40	20.0	20.0	16.5	16.5		
475	QF	5.20	4997.60	20.0	20.0	16.5	16.5		
476		.65	4998.25	20.0	20.0	16.5	16.5		
477	M	15.16	5013.42	20.0	20.0	16.5	16.5		
478		.65	5014.06	20.0	20.0	16.5	16.5		
479	M	15.16	5029.23	20.0	20.0	16.5	16.5		
480		.65	5029.88	20.0	20.0	16.5	16.5		
481	M	15.16	5045.04	20.0	20.0	16.5	16.5		
482		1.15	5046.19	20.0	20.0	16.5	16.5		
483	M	15.16	5061.36	20.0	20.0	16.5	16.5		
484		.65	5062.01	20.0	20.0	16.5	16.5		
485	M	15.16	5077.17	20.0	20.0	16.5	16.5		
486		5.22	5082.40	20.0	20.0	16.5	16.5		
487	QD	2.60	5085.00	20.0	20.0	16.5	16.5		

Table A2. Beam Loss Downstream of the Abort Lambertson at 20 TeV.

Elements names correspond to the SSCD[1] besides C1-C9 for the suggested collimators. Distance is measured between the end of the Lambertson and the end of the element. "Full" aperture corresponds to the 40 mm inner diameter of the beam pipe in the lattice and the "small" one corresponds to the 33 mm beam pipe diameter. Beam loss density is normalized to 1 proton hitting the Lambertson septum (lhp).

No	Name	Lattice elements				Loss density					
		Length meters	Distance meters	Apertures, mm				prot/(m*lhp)			
				full		small		coll. off		coll. on	
				hor.	ver.	hor.	ver.	full	small	full	small
1		3.00	3.00	20.0	20.0	16.5	16.5	.12-3	.17-3	.37-3	.50-3
2	SHV	10.00	13.00	4.2	4.2	3.5	3.5			.12-2	.12-2
3		150.63	163.63	20.0	20.0	16.5	16.5	.85-5	.85-5	.15-3	.11-3
4	C1	10.00	173.63	4.8	20.0	4.0	16.5	†	††	†	.15-2
5		.32	173.95	20.0	20.0	16.5	16.5	.86-4	.99-4		
6	B	27.50	201.45	63.0	23.0	63.0	23.0				
7		1.50	202.95	25.0	25.0	20.0	20.0	.44-5	.19-4		
8	QU1	11.29	214.24	25.0	25.0	20.0	20.0	.47-7	.22-7		
9		1.25	215.49	25.0	25.0	20.0	20.0				
10	QU2	11.00	226.49	25.0	25.0	20.0	20.0	.22-7	.36-6	.20-7	
11		119.84	346.33	25.0	25.0	20.0	20.0	.21-5	.27-5	.67-4	.91-4
12	C2	5.00	351.33	2.4	4.2	2.0	3.5	†	††	†	.13-2
13		1.00	352.33	20.0	20.0	16.5	16.5	.16-3	.64-4		.16-2
14	LI	37.00	389.33	20.0	20.0	16.5	16.5	.12-5	.14-5		
15		1.00	390.33	20.0	20.0	16.5	16.5				
16	QU3	9.17	399.50	20.0	20.0	16.5	16.5				
17		17.82	417.32	20.0	20.0	16.5	16.5	.21-6	.78-6		
18	QU4	7.05	424.37	20.0	20.0	16.5	16.5	.47-7	.20-6		
19		1.00	425.37	20.0	20.0	16.5	16.5				
20	TUD	10.00	435.37	20.0	20.0	16.5	16.5				
21		5.00	440.37	20.0	20.0	16.5	16.5				
22	C3	5.00	445.37	20.0	4.2	16.5	3.5	†	††	†	.10-2
23		89.98	535.35	20.0	20.0	16.5	16.5	.37-5	.27-5	.12-2	
24	QF	5.20	540.55	20.0	20.0	16.5	16.5		.71-6		
25		65.80	606.35	20.0	20.0	16.5	16.5				
26	C4	5.00	611.35	2.4	20.0	2.0	16.5	†	††	†	.78-3
27		1.00	612.35	20.0	20.0	16.5	16.5			.13-2	
28	KI	12.00	624.35	20.0	20.0	16.5	16.5				
29		1.00	625.35	20.0	20.0	16.5	16.5				
30	QD	2.60	627.95	20.0	20.0	16.5	16.5				
31	QSD	3.52	631.47	20.0	20.0	16.5	16.5				
32		2.31	633.79	20.0	20.0	16.5	16.5				
33	SM	12.64	646.42	20.0	20.0	16.5	16.5				
34		.65	647.07	20.0	20.0	16.5	16.5				
35	SM	12.64	659.71	20.0	20.0	16.5	16.5				
36		.65	660.36	20.0	20.0	16.5	16.5				
37	SM	12.64	673.00	20.0	20.0	16.5	16.5		.94-7		
38		.65	673.65	20.0	20.0	16.5	16.5				
39	SM	12.64	686.29	20.0	20.0	16.5	16.5	.29-6	.15-5		
40		5.64	691.93	20.0	20.0	16.5	16.5	.18-5	.52-5		
41	QSF	7.05	698.97	20.0	20.0	16.5	16.5	.12-5	.10-5		
42		2.91	701.89	20.0	20.0	16.5	16.5				
43	SM	12.64	714.53	20.0	20.0	16.5	16.5				
44		.65	715.18	20.0	20.0	16.5	16.5				
45	SM	12.64	727.81	20.0	20.0	16.5	16.5				
46		.65	728.46	20.0	20.0	16.5	16.5				

Table A2. (cont.)

No	Name	Lattice elements				Loss density			
		Length Distance		Apertures, mm		prot/(m ² lhp)		prot/lhp	
		meters		full small		coll. off		coll. on	
				hor.	ver.	hor.	ver.	full	small
47	SM	12.64	741.10	20.0	20.0	16.5	16.5	.45-7	
48		.65	741.75	20.0	20.0	16.5	16.5		
49	SM	12.64	754.39	20.0	20.0	16.5	16.5	.49-6	.17-6
50		.04	754.43	20.0	20.0	16.5	16.5		
51	C5	4.00	758.43	2.4	20.0	2.0	16.5	†	††
52		1.00	759.43	20.0	20.0	16.5	16.5		.11-5
53	QSD	7.05	766.47	20.0	20.0	16.5	16.5	.44-5	.20-5
54		2.41	768.88	20.0	20.0	16.5	16.5	.72-5	.11-4
55	SM	12.64	781.52	20.0	20.0	16.5	16.5	.65-5	.50-5
56		.65	782.17	20.0	20.0	16.5	16.5	.19-4	.26-5
57	SM	12.64	794.81	20.0	20.0	16.5	16.5	.27-5	.44-5
58		.65	795.46	20.0	20.0	16.5	16.5	.25-6	.78-5
59	SM	12.64	808.10	20.0	20.0	16.5	16.5	.48-5	.21-5
60		.65	808.75	20.0	20.0	16.5	16.5	.81-5	
61	SM	12.64	821.38	20.0	20.0	16.5	16.5	.18-5	.49-5
62		5.54	826.93	20.0	20.0	16.5	16.5	.30-5	.48-5
63	QSF	7.05	833.97	20.0	20.0	16.5	16.5	.15-5	
64		3.04	837.02	20.0	20.0	16.5	16.5		
65	SM	12.64	849.65	20.0	20.0	16.5	16.5		
66		.65	850.30	20.0	20.0	16.5	16.5		
67	SM	12.64	862.94	20.0	20.0	16.5	16.5		
68		.65	863.59	20.0	20.0	16.5	16.5		
69	SM	12.64	876.23	20.0	20.0	16.5	16.5		
70		.65	876.88	20.0	20.0	16.5	16.5		
71	SM	12.64	889.52	20.0	20.0	16.5	16.5		
72		4.91	894.43	20.0	20.0	16.5	16.5		
73	QSD	3.52	897.95	20.0	20.0	16.5	16.5		
74	QD	2.60	900.55	20.0	20.0	16.5	16.5		
75		.65	901.20	20.0	20.0	16.5	16.5		
76	M	15.16	916.36	20.0	20.0	16.5	16.5		
77		.65	917.02	20.0	20.0	16.5	16.5		
78	M	15.16	932.18	20.0	20.0	16.5	16.5		
79		.65	932.83	20.0	20.0	16.5	16.5		
80	M	15.16	947.99	20.0	20.0	16.5	16.5		
81		1.15	949.15	20.0	20.0	16.5	16.5	.72-7	.44-5
82	M	15.16	964.31	20.0	20.0	16.5	16.5	.69-6	.84-6
83		.65	964.96	20.0	20.0	16.5	16.5		
84	M	15.16	980.13	20.0	20.0	16.5	16.5	.31-5	.16-5
85		5.22	985.35	20.0	20.0	16.5	16.5	.20-5	.21-5
86	QF	5.20	990.55	20.0	20.0	16.5	16.5		.93-6
87		.65	991.20	20.0	20.0	16.5	16.5		
88	M	15.16	1006.36	20.0	20.0	16.5	16.5		
89		.65	1007.02	20.0	20.0	16.5	16.5		
90	M	15.16	1022.18	20.0	20.0	16.5	16.5		
91		.65	1022.83	20.0	20.0	16.5	16.5		
92	M	15.16	1037.99	20.0	20.0	16.5	16.5		
93		1.15	1039.15	20.0	20.0	16.5	16.5		
94	M	15.16	1054.31	20.0	20.0	16.5	16.5		
95		.65	1054.96	20.0	20.0	16.5	16.5		
96	M	15.16	1070.13	20.0	20.0	16.5	16.5		
97		5.22	1075.35	20.0	20.0	16.5	16.5		
98	QD	5.20	1080.55	20.0	20.0	16.5	16.5		.17-5
99		.65	1081.20	20.0	20.0	16.5	16.5		

Table A2. (cont.)

No	Name	Lattice elements				Loss density			
		Length meters	Distance	Apertures, mm				prot/(m#lhp)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
100	M	15.16	1096.36	20.0	20.0	16.5	16.5	.32-6	
101		.65	1097.02	20.0	20.0	16.5	16.5	.72-5	
102	M	15.16	1112.18	20.0	20.0	16.5	16.5	.16-5	.16-5
103		.65	1112.83	20.0	20.0	16.5	16.5	.38-7	
104	M	15.16	1127.99	20.0	20.0	16.5	16.5	.23-5	.16-5
105		1.15	1129.15	20.0	20.0	16.5	16.5	.41-5	
106	M	15.16	1144.31	20.0	20.0	16.5	16.5	.22-5	.36-5
107		.65	1144.96	20.0	20.0	16.5	16.5	.73-5	.12-4
108	M	15.16	1160.13	20.0	20.0	16.5	16.5	.19-5	.69-5
109		5.22	1165.35	20.0	20.0	16.5	16.5	.53-5	.25-5
110	QF	5.20	1170.55	20.0	20.0	16.5	16.5		
111		.65	1171.20	20.0	20.0	16.5	16.5		
112	M	15.16	1186.36	20.0	20.0	16.5	16.5		
113		.65	1187.02	20.0	20.0	16.5	16.5		
114	M	15.16	1202.18	20.0	20.0	16.5	16.5		
115		.65	1202.83	20.0	20.0	16.5	16.5		
116	M	15.16	1217.99	20.0	20.0	16.5	16.5		
117		1.15	1219.15	20.0	20.0	16.5	16.5		
118	M	15.16	1234.31	20.0	20.0	16.5	16.5		
119		.65	1234.96	20.0	20.0	16.5	16.5		
120	M	15.16	1250.13	20.0	20.0	16.5	16.5		
121		5.22	1255.35	20.0	20.0	16.5	16.5		
122	QD	5.20	1260.55	20.0	20.0	16.5	16.5		
123		.65	1261.20	20.0	20.0	16.5	16.5		
124	M	15.16	1276.36	20.0	20.0	16.5	16.5		
125		.65	1277.02	20.0	20.0	16.5	16.5		
126	M	15.16	1292.18	20.0	20.0	16.5	16.5		
127		.65	1292.83	20.0	20.0	16.5	16.5		
128	M	15.16	1307.99	20.0	20.0	16.5	16.5		
129		1.15	1309.15	20.0	20.0	16.5	16.5		
130	M	15.16	1324.31	20.0	20.0	16.5	16.5		
131		.65	1324.96	20.0	20.0	16.5	16.5		
132	M	15.16	1340.13	20.0	20.0	16.5	16.5	.33-6	.62-6
133		5.22	1345.35	20.0	20.0	16.5	16.5		.89-6
134	QF	5.20	1350.55	20.0	20.0	16.5	16.5		
135		.65	1351.20	20.0	20.0	16.5	16.5		
136	M	15.16	1366.36	20.0	20.0	16.5	16.5		
137		.65	1367.02	20.0	20.0	16.5	16.5		
138	M	15.16	1382.18	20.0	20.0	16.5	16.5		
139		.65	1382.83	20.0	20.0	16.5	16.5		
140	M	15.16	1397.99	20.0	20.0	16.5	16.5		
141		1.15	1399.15	20.0	20.0	16.5	16.5		
142	M	15.16	1414.31	20.0	20.0	16.5	16.5		
143		.65	1414.96	20.0	20.0	16.5	16.5		
144	M	15.16	1430.13	20.0	20.0	16.5	16.5		
145		5.22	1435.35	20.0	20.0	16.5	16.5		
146	QD	5.20	1440.55	20.0	20.0	16.5	16.5		
147		.65	1441.20	20.0	20.0	16.5	16.5		
148	M	15.16	1456.36	20.0	20.0	16.5	16.5		
149		.65	1457.02	20.0	20.0	16.5	16.5		

Table A2. (cont.)

No	Name	Lattice elements				Loss density			
		Length	Distance	Apertures, mm				prot/(m ² lhp)	
				full		small		coll. off	
		meters		hor.	ver.	hor.	ver.	full	small
150	M	15.16	1472.18	20.0	20.0	16.5	16.5		
151		.65	1472.83	20.0	20.0	16.5	16.5		
152	M	15.16	1487.99	20.0	20.0	16.5	16.5		
153		1.15	1489.15	20.0	20.0	16.5	16.5		
154	M	15.16	1504.31	20.0	20.0	16.5	16.5		
155		.65	1504.96	20.0	20.0	16.5	16.5		
156	M	15.16	1520.13	20.0	20.0	16.5	16.5	.50-6	.20-7
157		5.22	1525.35	20.0	20.0	16.5	16.5	.45-7	
158	QF	5.20	1530.55	20.0	20.0	16.5	16.5		
159		.65	1531.20	20.0	20.0	16.5	16.5		
160	M	15.16	1546.36	20.0	20.0	16.5	16.5		
161		.65	1547.02	20.0	20.0	16.5	16.5		
162	M	15.16	1562.18	20.0	20.0	16.5	16.5		
163		.65	1562.83	20.0	20.0	16.5	16.5		
164	M	15.16	1577.99	20.0	20.0	16.5	16.5		
165		1.15	1579.15	20.0	20.0	16.5	16.5		
166	M	15.16	1594.31	20.0	20.0	16.5	16.5		
167		.65	1594.96	20.0	20.0	16.5	16.5		
168	M	15.16	1610.13	20.0	20.0	16.5	16.5		
169		5.22	1615.35	20.0	20.0	16.5	16.5		
170	QD	5.20	1620.55	20.0	20.0	16.5	16.5		
171		.65	1621.20	20.0	20.0	16.5	16.5		
172	M	15.16	1636.36	20.0	20.0	16.5	16.5		
173		.65	1637.02	20.0	20.0	16.5	16.5		
174	M	15.16	1652.18	20.0	20.0	16.5	16.5		
175		.65	1652.83	20.0	20.0	16.5	16.5		
176	M	15.16	1667.99	20.0	20.0	16.5	16.5		
177		1.15	1669.15	20.0	20.0	16.5	16.5		
178	M	15.16	1684.31	20.0	20.0	16.5	16.5		
179		.65	1684.96	20.0	20.0	16.5	16.5		
180	M	15.16	1700.13	20.0	20.0	16.5	16.5		
181		5.22	1705.35	20.0	20.0	16.5	16.5		
182	QF	5.20	1710.55	20.0	20.0	16.5	16.5		
183		.65	1711.20	20.0	20.0	16.5	16.5		
184	M	15.16	1726.36	20.0	20.0	16.5	16.5		
185		.65	1727.02	20.0	20.0	16.5	16.5		
186	M	15.16	1742.18	20.0	20.0	16.5	16.5		
187		.65	1742.83	20.0	20.0	16.5	16.5		
188	M	15.16	1757.99	20.0	20.0	16.5	16.5		
189		1.15	1759.15	20.0	20.0	16.5	16.5		
190	M	15.16	1774.31	20.0	20.0	16.5	16.5		
191		.65	1774.96	20.0	20.0	16.5	16.5		
192	M	15.16	1790.13	20.0	20.0	16.5	16.5		
193		5.22	1795.35	20.0	20.0	16.5	16.5		
194	QD	5.20	1800.55	20.0	20.0	16.5	16.5		
195		.65	1801.20	20.0	20.0	16.5	16.5		
196	M	15.16	1816.36	20.0	20.0	16.5	16.5		
197		.65	1817.02	20.0	20.0	16.5	16.5		
198	M	15.16	1832.18	20.0	20.0	16.5	16.5		
199		.65	1832.83	20.0	20.0	16.5	16.5		

Table A2. (cont.)

No	Name	Lattice elements				Loss density			
		Length meters	Distance	Apertures, mm				prot/(m+lh)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
200	M	15.16	1847.99	20.0	20.0	16.5	16.5		
201		1.15	1849.15	20.0	20.0	16.5	16.5		
202	M	15.16	1864.31	20.0	20.0	16.5	16.5		
203		.65	1864.96	20.0	20.0	16.5	16.5		
204	M	15.16	1880.13	20.0	20.0	16.5	16.5		
205		5.22	1885.35	20.0	20.0	16.5	16.5	.89-6	.94-5
206	QF	5.20	1890.55	20.0	20.0	16.5	16.5	.86-6	
207		.65	1891.20	20.0	20.0	16.5	16.5		
208	M	15.16	1906.36	20.0	20.0	16.5	16.5		
209		.65	1907.02	20.0	20.0	16.5	16.5		
210	M	15.16	1922.18	20.0	20.0	16.5	16.5		
211		.65	1922.83	20.0	20.0	16.5	16.5		
212	M	15.16	1937.99	20.0	20.0	16.5	16.5		
213		1.15	1939.15	20.0	20.0	16.5	16.5		
214	M	15.16	1954.31	20.0	20.0	16.5	16.5		
215		.65	1954.96	20.0	20.0	16.5	16.5		
216	M	15.16	1970.13	20.0	20.0	16.5	16.5		
217		5.22	1975.35	20.0	20.0	16.5	16.5		
218	QD	2.60	1977.95	20.0	20.0	16.5	16.5		
219	QSD	3.52	1981.47	20.0	20.0	16.5	16.5		
220		2.31	1983.79	20.0	20.0	16.5	16.5		
221	SM	12.64	1996.42	20.0	20.0	16.5	16.5		
222		.65	1997.07	20.0	20.0	16.5	16.5		
223	SM	12.64	2009.71	20.0	20.0	16.5	16.5		
224		.65	2010.36	20.0	20.0	16.5	16.5		
225	SM	12.64	2023.00	20.0	20.0	16.5	16.5		
226		.65	2023.65	20.0	20.0	16.5	16.5		
227	SM	12.64	2036.29	20.0	20.0	16.5	16.5		
228		5.64	2041.93	20.0	20.0	16.5	16.5		
229	QSF	7.05	2048.97	20.0	20.0	16.5	16.5		
230		2.91	2051.89	20.0	20.0	16.5	16.5		
231	SM	12.64	2064.53	20.0	20.0	16.5	16.5		
232		.65	2065.18	20.0	20.0	16.5	16.5		
233	SM	12.64	2077.81	20.0	20.0	16.5	16.5		
234		.65	2078.46	20.0	20.0	16.5	16.5		
235	SM	12.64	2091.10	20.0	20.0	16.5	16.5		
236		.65	2091.75	20.0	20.0	16.5	16.5		
237	SM	12.64	2104.39	20.0	20.0	16.5	16.5		
238		5.04	2109.43	20.0	20.0	16.5	16.5		
239	QSD	7.05	2116.47	20.0	20.0	16.5	16.5		
240		2.41	2118.88	20.0	20.0	16.5	16.5		
241	SM	12.64	2131.52	20.0	20.0	16.5	16.5		
242		.65	2132.17	20.0	20.0	16.5	16.5		
243	SM	12.64	2144.81	20.0	20.0	16.5	16.5		
244		.65	2145.46	20.0	20.0	16.5	16.5		
245	SM	12.64	2158.10	20.0	20.0	16.5	16.5		
246		.65	2158.75	20.0	20.0	16.5	16.5		
247	SM	12.64	2171.38	20.0	20.0	16.5	16.5		
248		5.54	2176.93	20.0	20.0	16.5	16.5		
249	QSF	7.05	2183.97	20.0	20.0	16.5	16.5		

Table A2. (cont.)

No	Name	Lattice elements				Loss density			
		Length	Distance	Apertures, mm				prot/(m ² lhp)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
250		3.04	2187.02	20.0	20.0	16.5	16.5		
251	SM	12.64	2199.65	20.0	20.0	16.5	16.5		
252		.65	2200.30	20.0	20.0	16.5	16.5		
253	SM	12.64	2212.94	20.0	20.0	16.5	16.5		
254		.65	2213.59	20.0	20.0	16.5	16.5		
255	SM	12.64	2226.23	20.0	20.0	16.5	16.5		
256		.65	2226.88	20.0	20.0	16.5	16.5		
257	SM	12.64	2239.52	20.0	20.0	16.5	16.5		
258		4.91	2244.43	20.0	20.0	16.5	16.5		
259	QSD	3.52	2247.95	20.0	20.0	16.5	16.5		
260	QD	2.60	2250.55	20.0	20.0	16.5	16.5		
261		4.00	2254.55	20.0	20.0	16.5	16.5		
262	C6	5.00	2259.55	20.0	4.0	16.5	3.5	††	† .19-2 .16-2
263		75.80	2335.35	20.0	20.0	16.5	16.5		
264	QF	5.20	2340.55	20.0	20.0	16.5	16.5		
265		84.80	2425.35	20.0	20.0	16.5	16.5		
266	QD	5.20	2430.55	20.0	20.0	16.5	16.5		
267		84.80	2515.35	20.0	20.0	16.5	16.5		
268	QF	5.20	2520.55	20.0	20.0	16.5	16.5		
269		4.00	2524.55	20.0	20.0	16.5	16.5		
270	C7	5.00	2529.55	3.4	20.0	3.0	16.5	††	† .12-2 .94-3
271		75.80	2605.35	20.0	20.0	16.5	16.5		
272	QD	5.20	2610.55	20.0	20.0	16.5	16.5		
273		87.40	2697.95	25.0	25.0	20.0	20.0		
274	QL6	4.68	2702.63	25.0	25.0	20.0	20.0		
275		104.00	2806.63	25.0	25.0	20.0	20.0		
276	QL5	14.08	2820.72	25.0	25.0	20.0	20.0		
277		.80	2821.52	25.0	25.0	20.0	20.0		.45-5
278	QL4	10.63	2832.14	20.0	20.0	16.5	16.5	.58-5	.16-4
279		.80	2832.94	25.0	25.0	20.0	20.0		
280	VM	12.64	2845.58	25.0	25.0	20.0	20.0		
281		1.00	2846.58	25.0	25.0	20.0	20.0		
282	VM	12.64	2859.22	25.0	25.0	20.0	20.0		
283		1.00	2860.22	25.0	25.0	20.0	20.0		
284	VM	12.64	2872.86	25.0	25.0	20.0	20.0		
285		13.41	2886.27	25.0	25.0	20.0	20.0		
286	VM	12.64	2898.90	25.0	25.0	20.0	20.0		
287		1.00	2899.90	25.0	25.0	20.0	20.0		
288	VM	12.64	2912.54	25.0	25.0	20.0	20.0		
289		1.00	2913.54	25.0	25.0	20.0	20.0		
290	VM	12.64	2926.18	25.0	25.0	20.0	20.0		
291		4.96	2931.14	25.0	25.0	20.0	20.0		
292	QVF	14.25	2945.39	25.0	25.0	20.0	20.0		
293		.80	2946.19	25.0	25.0	20.0	20.0		
294	QVD	14.25	2960.44	25.0	25.0	20.0	20.0		
295		4.20	2964.64	25.0	25.0	20.0	20.0		
296	QVD	14.25	2978.89	25.0	25.0	20.0	20.0		
297		.80	2979.69	25.0	25.0	20.0	20.0		
298	QVF	14.25	2993.94	25.0	25.0	20.0	20.0		
299		4.20	2998.14	25.0	25.0	20.0	20.0		

Table A2. (cont.)

No	Name	Lattice elements				Loss density			
		Length	Distance	Apertures, mm				prot/(att)hp	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
		meters						full	small
300	QVF	14.25	3012.39	25.0	25.0	20.0	20.0		
301		.80	3013.19	25.0	25.0	20.0	20.0		
302	QVD	14.25	3027.44	25.0	25.0	20.0	20.0		
303		4.20	3031.64	25.0	25.0	20.0	20.0		
304	QVD	14.25	3045.89	25.0	25.0	20.0	20.0		
305		.80	3046.69	25.0	25.0	20.0	20.0		
306	QVF	14.25	3060.94	25.0	25.0	20.0	20.0		
307		13.07	3074.02	33.0	33.0	33.0	33.0		
308	SVM	5.00	3079.02	33.0	33.0	33.0	33.0		
309		1.00	3080.02	33.0	33.0	33.0	33.0		
310	SVM	5.00	3085.02	33.0	33.0	33.0	33.0		
311		1.00	3086.52	33.0	33.0	33.0	33.0		
312	SVM	5.00	3091.02	33.0	33.0	33.0	33.0		
313		90.00	3181.02	33.0	33.0	33.0	33.0	.84-6	.81-7
314	CB	4.00	3185.02	20.0	10.0	16.5	8.5	* * *	* .41-3 .36-3
315		90.00	3275.02	33.0	33.0	33.0	33.0	.86-5	.67-5
316		.80	3275.81	33.0	33.0	33.0	33.0		
317	SVM	5.00	3280.81	33.0	33.0	33.0	33.0	.32-5	.12-4
318		1.00	3281.81	33.0	33.0	33.0	33.0	.53-4	
319	SVM	5.00	3286.81	33.0	33.0	33.0	33.0	.20-4	.20-4
320		1.00	3287.81	33.0	33.0	33.0	33.0	.49-4	
321	SVM	5.00	3292.81	33.0	33.0	33.0	33.0	.11-4	.82-6
322		7.00	3299.81	33.0	33.0	33.0	33.0	.75-5	.88-5
323	QL3	12.96	3312.77	20.0	20.0	16.5	16.5	.21-3	.32-3
324		.80	3313.57	20.0	20.0	16.5	16.5		.25-3
325	QL2	11.22	3324.79	20.0	20.0	16.5	16.5	.50-4	.63-4
326		1.00	3325.79	20.0	20.0	16.5	16.5		
327	QL2	11.22	3337.01	20.0	20.0	16.5	16.5		
328		.80	3337.81	20.0	20.0	16.5	16.5		
329	QL1	15.14	3352.95	20.0	20.0	16.5	16.5		
330		20.00	3372.95	20.0	20.0	16.5	16.5		
331		20.00	3392.95	20.0	20.0	16.5	16.5		
332	QL1	15.14	3408.09	20.0	20.0	16.5	16.5		
333		.80	3408.89	20.0	20.0	16.5	16.5		
334	QL2	11.22	3420.11	20.0	20.0	16.5	16.5		
335		1.00	3421.11	20.0	20.0	16.5	16.5		
336	QL2	11.22	3432.33	20.0	20.0	16.5	16.5		
337		.80	3433.13	20.0	20.0	16.5	16.5		
338	QL3	12.96	3446.59	20.0	20.0	16.5	16.5	.38-5	.38-5
339		7.00	3453.09	33.0	33.0	33.0	33.0		.49-4
340	SVM	5.00	3458.09	33.0	33.0	33.0	33.0		
341		1.00	3459.09	33.0	33.0	33.0	33.0		
342	SVM	5.00	3464.09	33.0	33.0	33.0	33.0		
343		1.00	3465.09	33.0	33.0	33.0	33.0		
344	SVM	5.00	3470.09	33.0	33.0	33.0	33.0		
345		184.00	3654.09	33.0	33.0	33.0	33.0		
346		.80	3654.88	33.0	33.0	33.0	33.0		
347	SVM	5.00	3659.88	33.0	33.0	33.0	33.0		
348		1.00	3660.88	33.0	33.0	33.0	33.0		
349	SVM	5.00	3665.88	33.0	33.0	33.0	33.0		

Table A2. (cont.)

No	Name	Lattice elements				Loss density			
		Length meters	Distance	Apertures, mm		prot/(m ² lhp)		prot/lhp	
				full	small	coll. off	full	small	coll. on
				hor.	ver.	hor.	ver.	full	small
350		1.00	3666.88	33.0	33.0	33.0	33.0		
351	SYM	5.00	3671.88	33.0	33.0	33.0	33.0		
352		13.07	3684.96	33.0	33.0	33.0	33.0		
353	QVD	14.25	3699.21	25.0	25.0	20.0	20.0		
354		.80	3700.01	25.0	25.0	20.0	20.0		
355	QVF	14.25	3714.26	25.0	25.0	20.0	20.0		
356		4.20	3718.46	25.0	25.0	20.0	20.0		
357	QVF	14.25	3732.71	25.0	25.0	20.0	20.0		
358		.80	3733.51	25.0	25.0	20.0	20.0		
359	QVD	14.25	3747.76	25.0	25.0	20.0	20.0		
360		4.20	3751.96	25.0	25.0	20.0	20.0		
361	QVD	14.25	3766.21	25.0	25.0	20.0	20.0		
362		.80	3767.01	25.0	25.0	20.0	20.0		
363	QVF	14.25	3781.26	25.0	25.0	20.0	20.0		
364		4.20	3785.46	25.0	25.0	20.0	20.0		
365	QVF	14.25	3799.71	25.0	25.0	20.0	20.0		
366		.80	3800.51	25.0	25.0	20.0	20.0		
367	QVD	14.25	3814.76	25.0	25.0	20.0	20.0		
368		4.96	3819.72	25.0	25.0	20.0	20.0		
369	VM	12.64	3832.36	25.0	25.0	20.0	20.0		
370		1.00	3833.36	25.0	25.0	20.0	20.0		
371	VM	12.64	3846.50	25.0	25.0	20.0	20.0		
372		1.00	3847.00	25.0	25.0	20.0	20.0		
373	VM	12.64	3859.63	25.0	25.0	20.0	20.0		
374		13.41	3873.04	25.0	25.0	20.0	20.0		
375	VM	12.64	3885.68	25.0	25.0	20.0	20.0		
376		1.00	3886.68	25.0	25.0	20.0	20.0		
377	VM	12.64	3899.32	25.0	25.0	20.0	20.0		
378		1.00	3900.32	25.0	25.0	20.0	20.0		
379	VM	12.64	3912.96	25.0	25.0	20.0	20.0		
380		.80	3913.76	25.0	25.0	20.0	20.0		
381	QL4	10.63	3924.38	20.0	20.0	16.5	16.5		
382		.80	3925.18	25.0	25.0	20.0	20.0		
383	QL5	14.08	3939.27	25.0	25.0	20.0	20.0		
384		104.00	4043.27	25.0	25.0	20.0	20.0		
385	QL6	4.68	4047.95	25.0	25.0	20.0	20.0		
386		87.40	4135.35	25.0	25.0	20.0	20.0		
387	QF	5.20	4140.55	20.0	20.0	16.5	16.5		
388		84.80	4225.35	20.0	20.0	16.5	16.5		
389	QD	5.20	4230.55	20.0	20.0	16.5	16.5		
390		84.80	4315.35	20.0	20.0	16.5	16.5		
391	QF	2.60	4317.95	20.0	20.0	16.5	16.5		
392	QSF	3.52	4321.47	20.0	20.0	16.5	16.5		
393		6.80	4328.27	20.0	20.0	16.5	16.5		
394	SM	12.64	4340.91	20.0	20.0	16.5	16.5		
395		.65	4341.56	20.0	20.0	16.5	16.5		
396	SM	12.64	4354.20	20.0	20.0	16.5	16.5		
397		.65	4354.85	20.0	20.0	16.5	16.5		
398	SM	12.64	4367.49	20.0	20.0	16.5	16.5		
399		.65	4368.14	20.0	20.0	16.5	16.5		

Table A2. (cont.)

No	Name	Lattice elements						Loss density			
		Length	Distance	Apertures, mm				prot/(m#lhp)		prot/lhp	
				full		small		coll. off		coll. on	
				hor.	ver.	hor.	ver.	full	small	full	small
400	SM	12.64	4380.77	20.0	20.0	16.5	16.5				
401		1.15	4381.93	20.0	20.0	16.5	16.5				
402	QSD	7.05	4388.97	20.0	20.0	16.5	16.5				
403		12.33	4401.31	20.0	20.0	16.5	16.5				
404	SM	12.64	4413.95	20.0	20.0	16.5	16.5				
405		.65	4414.60	20.0	20.0	16.5	16.5				
406	SM	12.64	4427.23	20.0	20.0	16.5	16.5				
407		.65	4427.88	20.0	20.0	16.5	16.5				
408	SM	12.64	4440.52	20.0	20.0	16.5	16.5				
409		8.90	4449.43	20.0	20.0	16.5	16.5				
410	QSF	7.05	4456.47	20.0	20.0	16.5	16.5				
411		13.35	4469.82	20.0	20.0	16.5	16.5				
412	SM	12.64	4482.46	20.0	20.0	16.5	16.5				
413		.65	4483.11	20.0	20.0	16.5	16.5				
414	SM	12.64	4495.75	20.0	20.0	16.5	16.5				
415		.65	4496.40	20.0	20.0	16.5	16.5				
416	SM	12.64	4509.04	20.0	20.0	16.5	16.5				
417		7.89	4516.93	20.0	20.0	16.5	16.5				
418	QSD	7.05	4523.97	20.0	20.0	16.5	16.5				
419		2.00	4525.97	20.0	20.0	16.5	16.5				
420	SH4	3.00	4528.97	20.0	20.0	16.5	16.5				
421		8.42	4537.40	20.0	20.0	16.5	16.5				
422	SM	12.64	4550.04	20.0	20.0	16.5	16.5				
423		.65	4550.69	20.0	20.0	16.5	16.5				
424	SM	12.64	4563.32	20.0	20.0	16.5	16.5				
425		.65	4563.97	20.0	20.0	16.5	16.5				
426	SM	12.64	4576.61	20.0	20.0	16.5	16.5				
427		7.82	4584.43	20.0	20.0	16.5	16.5				
428	QSF	3.52	4587.95	20.0	20.0	16.5	16.5				
429	QF	2.60	4590.55	20.0	20.0	16.5	16.5				
430		3.19	4593.74	20.0	20.0	16.5	16.5				
431	M	15.16	4608.90	20.0	20.0	16.5	16.5				
432		.65	4609.55	20.0	20.0	16.5	16.5				
433	M	15.16	4624.72	20.0	20.0	16.5	16.5				
434		.65	4625.37	20.0	20.0	16.5	16.5				
435	M	15.16	4640.53	20.0	20.0	16.5	16.5				
436		.65	4641.18	20.0	20.0	16.5	16.5				
437	M	15.16	4656.35	20.0	20.0	16.5	16.5				
438		.65	4657.00	20.0	20.0	16.5	16.5				
439	M	15.16	4672.16	20.0	20.0	16.5	16.5				
440		3.19	4675.35	20.0	20.0	16.5	16.5				
441	QD	2.60	4677.95	20.0	20.0	16.5	16.5				
442	QSD	3.52	4681.47	20.0	20.0	16.5	16.5				
443		7.82	4689.29	20.0	20.0	16.5	16.5				
444	SM	12.64	4701.93	20.0	20.0	16.5	16.5				
445		.65	4702.58	20.0	20.0	16.5	16.5				
446	SM	12.64	4715.21	20.0	20.0	16.5	16.5				
447		.65	4715.86	20.0	20.0	16.5	16.5				
448	SM	12.64	4728.50	20.0	20.0	16.5	16.5				
449		13.42	4741.93	20.0	20.0	16.5	16.5				

.37-6

Table A2. (cont.)

No	Name	Lattice elements				Loss density			
		Length	Distance meters	Apertures, mm				prot/(m ² lhp)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
450	QSF	7.05	4748.97	20.0	20.0	16.5	16.5		
451		7.89	4756.87	20.0	20.0	16.5	16.5		
452	SM	12.64	4769.50	20.0	20.0	16.5	16.5		
453		.65	4770.15	20.0	20.0	16.5	16.5		
454	SM	12.64	4782.79	20.0	20.0	16.5	16.5		
455		.65	4783.44	20.0	20.0	16.5	16.5		
456	SM	12.64	4796.58	20.0	20.0	16.5	16.5		
457		2.00	4798.08	20.0	20.0	16.5	16.5		
458	SH5	3.00	4801.08	20.0	20.0	16.5	16.5		
459		8.35	4809.43	20.0	20.0	16.5	16.5		
460	QSD	7.05	4816.47	20.0	20.0	16.5	16.5		
461		8.90	4825.38	20.0	20.0	16.5	16.5		
462	SM	12.64	4838.02	20.0	20.0	16.5	16.5		
463		.65	4838.67	20.0	20.0	16.5	16.5		
464	SM	12.64	4851.30	20.0	20.0	16.5	16.5		
465		.65	4851.95	20.0	20.0	16.5	16.5		
466	SM	12.64	4864.59	20.0	20.0	16.5	16.5		
467		12.33	4876.93	20.0	20.0	16.5	16.5		
468	QSF	7.05	4883.97	20.0	20.0	16.5	16.5		
469		1.15	4885.13	20.0	20.0	16.5	16.5		
470	SM	12.64	4897.76	20.0	20.0	16.5	16.5		
471		.65	4898.41	20.0	20.0	16.5	16.5		
472	SM	12.64	4911.05	20.0	20.0	16.5	16.5		
473		.65	4911.70	20.0	20.0	16.5	16.5		
474	SM	12.64	4924.34	20.0	20.0	16.5	16.5		
475		.65	4924.99	20.0	20.0	16.5	16.5		
476	SM	12.64	4937.63	20.0	20.0	16.5	16.5		
477		6.80	4944.43	20.0	20.0	16.5	16.5		
478	QSD	3.52	4947.95	20.0	20.0	16.5	16.5		
479	QD	2.60	4950.55	20.0	20.0	16.5	16.5		
480		84.80	5035.35	20.0	20.0	16.5	16.5		
481	QF	5.20	5040.55	20.0	20.0	16.5	16.5		
482		84.80	5125.35	20.0	20.0	16.5	16.5		
483	QD	5.20	5130.55	20.0	20.0	16.5	16.5		
484		87.40	5217.95	25.0	25.0	20.0	20.0		
485	QL6	4.68	5222.63	25.0	25.0	20.0	20.0		
486		104.00	5326.63	25.0	25.0	20.0	20.0		
487	QL5	14.08	5340.72	25.0	25.0	20.0	20.0		
488		.80	5341.52	25.0	25.0	20.0	20.0		
489	QL4	10.63	5352.14	20.0	20.0	16.5	16.5		
490		.80	5352.94	25.0	25.0	20.0	20.0		
491	VM	12.64	5365.58	25.0	25.0	20.0	20.0		
492		1.00	5366.58	25.0	25.0	20.0	20.0		
493	VM	12.64	5379.22	25.0	25.0	20.0	20.0		
494		1.00	5380.22	25.0	25.0	20.0	20.0		
495	VM	12.64	5392.86	25.0	25.0	20.0	20.0		
496		13.41	5406.27	25.0	25.0	20.0	20.0		
497	VM	12.64	5418.90	25.0	25.0	20.0	20.0		
498		1.00	5419.90	25.0	25.0	20.0	20.0		
499	VM	12.64	5432.54	25.0	25.0	20.0	20.0		

Table A2. (cont.)

No	Name	Lattice elements				Loss density			
		Length Distance		Apertures, mm		prot/(m ² lhp)		prot/lhp	
		meters		full small		coll. off		coll. on	
				hor.	ver.	hor.	ver.	full	small
500		1.00	5433.54	25.0	25.0	20.0	20.0		
501	VM	12.64	5446.18	25.0	25.0	20.0	20.0		
502		4.96	5451.14	25.0	25.0	20.0	20.0		
503	QVF	14.25	5465.39	25.0	25.0	20.0	20.0		
504		.80	5466.19	25.0	25.0	20.0	20.0		
505	QVD	14.25	5480.44	25.0	25.0	20.0	20.0		
506		4.20	5484.64	25.0	25.0	20.0	20.0		
507	QVD	14.25	5498.89	25.0	25.0	20.0	20.0		
508		.80	5499.69	25.0	25.0	20.0	20.0		
509	QVF	14.25	5513.94	25.0	25.0	20.0	20.0		
510		4.20	5518.14	25.0	25.0	20.0	20.0		
511	QVF	14.25	5532.39	25.0	25.0	20.0	20.0		
512		.80	5533.19	25.0	25.0	20.0	20.0		
513	QVD	14.25	5547.44	25.0	25.0	20.0	20.0		
514		4.20	5551.64	25.0	25.0	20.0	20.0		
515	QVD	14.25	5565.89	25.0	25.0	20.0	20.0		
516		.80	5566.69	25.0	25.0	20.0	20.0		
517	QVF	14.25	5580.94	25.0	25.0	20.0	20.0		
518		13.07	5594.02	33.0	33.0	33.0	33.0		
519	SVM	5.00	5599.02	33.0	33.0	33.0	33.0		
520		1.00	5600.02	33.0	33.0	33.0	33.0		
521	SVM	5.00	5605.02	33.0	33.0	33.0	33.0		
522		1.00	5606.52	33.0	33.0	33.0	33.0		
523	SVM	5.00	5611.02	33.0	33.0	33.0	33.0		
524		90.00	5701.02	33.0	33.0	33.0	33.0		
525	C9	4.00	5705.02	20.0	10.0	16.5	8.5	†	†
526		90.00	5795.02	33.0	33.0	33.0	33.0	.22-6	.51-7
527		.80	5795.81	33.0	33.0	33.0	33.0		
528	SVM	5.00	5800.81	33.0	33.0	33.0	33.0		
529		1.00	5801.81	33.0	33.0	33.0	33.0		
530	SVM	5.00	5806.81	33.0	33.0	33.0	33.0		
531		1.00	5807.81	33.0	33.0	33.0	33.0		
532	SVM	5.00	5812.81	33.0	33.0	33.0	33.0		
533		7.00	5819.81	33.0	33.0	33.0	33.0	.63-6	
534	QL3	12.96	5832.77	20.0	20.0	16.5	16.5	.15-3	.33-3
535		.80	5833.57	20.0	20.0	16.5	16.5		.44-5
536	QL2	11.22	5844.79	20.0	20.0	16.5	16.5	.44-5	.39-6
537		1.00	5845.79	20.0	20.0	16.5	16.5		.49-4
538	QL2	11.22	5857.01	20.0	20.0	16.5	16.5		
539		.80	5857.81	20.0	20.0	16.5	16.5		
540	QL1	15.14	5872.95	20.0	20.0	16.5	16.5		
541		20.00	5892.95	20.0	20.0	16.5	16.5		
542		20.00	5912.95	20.0	20.0	16.5	16.5		
543	QL1	15.14	5928.09	20.0	20.0	16.5	16.5		
544		.80	5928.89	20.0	20.0	16.5	16.5		
545	QL2	11.22	5940.11	20.0	20.0	16.5	16.5		.44-5
546		1.00	5941.11	20.0	20.0	16.5	16.5	.20-3	.15-3
547	QL2	11.22	5952.33	20.0	20.0	16.5	16.5		
548		.80	5953.13	20.0	20.0	16.5	16.5		
549	QL3	12.96	5966.59	20.0	20.0	16.5	16.5		

Table A2. (cont.)

No	Name	Lattice elements				Loss density			
		Length	Distance	Apertures, mm				prot/(m ² lhp)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
		meters						full	small
550		7.00	5973.09	33.0	33.0	33.0	33.0		
551	SVM	5.00	5978.09	33.0	33.0	33.0	33.0		
552		1.00	5979.09	33.0	33.0	33.0	33.0		
553	SVM	5.00	5984.09	33.0	33.0	33.0	33.0		
554		1.00	5985.09	33.0	33.0	33.0	33.0		
555	SVM	5.00	5990.09	33.0	33.0	33.0	33.0		
556		184.00	6174.09	33.0	33.0	33.0	33.0		
557		.80	6174.88	33.0	33.0	33.0	33.0		
558	SVM	5.00	6179.88	33.0	33.0	33.0	33.0		
559		1.00	6180.88	33.0	33.0	33.0	33.0		
560	SVM	5.00	6185.88	33.0	33.0	33.0	33.0		
561		1.00	6186.88	33.0	33.0	33.0	33.0		
562	SVM	5.00	6191.88	33.0	33.0	33.0	33.0		
563		13.07	6204.96	33.0	33.0	33.0	33.0		
564	QVD	14.25	6219.21	25.0	25.0	20.0	20.0		
565		.80	6220.01	25.0	25.0	20.0	20.0		
566	QVF	14.25	6234.26	25.0	25.0	20.0	20.0		
567		4.20	6238.46	25.0	25.0	20.0	20.0		
568	QVF	14.25	6252.71	25.0	25.0	20.0	20.0		
569		.80	6253.51	25.0	25.0	20.0	20.0		
570	QVD	14.25	6267.76	25.0	25.0	20.0	20.0		
571		4.20	6271.96	25.0	25.0	20.0	20.0		
572	QVD	14.25	6286.21	25.0	25.0	20.0	20.0		
573		.80	6287.01	25.0	25.0	20.0	20.0		
574	QVF	14.25	6301.26	25.0	25.0	20.0	20.0		
575		4.20	6305.46	25.0	25.0	20.0	20.0		
576	QVF	14.25	6319.71	25.0	25.0	20.0	20.0		
577		.80	6320.51	25.0	25.0	20.0	20.0		
578	QVD	14.25	6334.76	25.0	25.0	20.0	20.0		
579		4.96	6339.72	25.0	25.0	20.0	20.0		
580	VM	12.64	6352.36	25.0	25.0	20.0	20.0		
581		1.00	6353.36	25.0	25.0	20.0	20.0		
582	VM	12.64	6366.50	25.0	25.0	20.0	20.0		
583		1.00	6367.00	25.0	25.0	20.0	20.0		
584	VM	12.64	6379.63	25.0	25.0	20.0	20.0		
585		13.41	6393.04	25.0	25.0	20.0	20.0		
586	VM	12.64	6405.68	25.0	25.0	20.0	20.0		
587		1.00	6406.68	25.0	25.0	20.0	20.0		
588	VM	12.64	6419.32	25.0	25.0	20.0	20.0		
589		1.00	6420.32	25.0	25.0	20.0	20.0		
590	VM	12.64	6432.96	25.0	25.0	20.0	20.0		
591		.80	6433.76	25.0	25.0	20.0	20.0		
592	QL4	10.63	6444.38	20.0	20.0	16.5	16.5		
593		.80	6445.18	25.0	25.0	20.0	20.0		
594	QL5	14.08	6459.27	25.0	25.0	20.0	20.0		
595		104.00	6563.27	25.0	25.0	20.0	20.0		
596	QL6	4.68	6567.95	25.0	25.0	20.0	20.0		
597		87.40	6655.35	25.0	25.0	20.0	20.0		
598	QF	5.20	6660.55	20.0	20.0	16.5	16.5		
599		84.80	6745.35	20.0	20.0	16.5	16.5		

Table A2. (cont.)

No	Name	Lattice elements				Loss density			
		Length Distance		Apertures, mm				prot/(m ² lhp)	
		meters						coll. off	
				full	small	full	small	full	small
				hor.	ver.	hor.	ver.	full	small
600	QD	5.20	6750.55	20.0	20.0	16.5	16.5		
601		84.80	6835.35	20.0	20.0	16.5	16.5		
602	QF	5.20	6840.55	20.0	20.0	16.5	16.5		
603		84.80	6925.35	20.0	20.0	16.5	16.5		
604	QD	5.20	6930.55	20.0	20.0	16.5	16.5		
605		84.80	7015.35	20.0	20.0	16.5	16.5		
606	QF	2.60	7017.95	20.0	20.0	16.5	16.5		
607	QSF	3.52	7021.47	20.0	20.0	16.5	16.5		
608		2.31	7023.79	20.0	20.0	16.5	16.5		
609	SM	12.64	7036.42	20.0	20.0	16.5	16.5		
610		.65	7037.07	20.0	20.0	16.5	16.5		
611	SM	12.64	7049.71	20.0	20.0	16.5	16.5		
612		.65	7050.36	20.0	20.0	16.5	16.5		
613	SM	12.64	7063.00	20.0	20.0	16.5	16.5		
614		.65	7063.65	20.0	20.0	16.5	16.5		
615	SM	12.64	7076.29	20.0	20.0	16.5	16.5		
616		5.64	7081.93	20.0	20.0	16.5	16.5		
617	QSD	7.05	7088.97	20.0	20.0	16.5	16.5		
618		2.91	7091.89	20.0	20.0	16.5	16.5		
619	SM	12.64	7104.53	20.0	20.0	16.5	16.5		
620		.65	7105.18	20.0	20.0	16.5	16.5		
621	SM	12.64	7117.81	20.0	20.0	16.5	16.5		
622		.65	7118.46	20.0	20.0	16.5	16.5		
623	SM	12.64	7131.10	20.0	20.0	16.5	16.5		
624		.65	7131.75	20.0	20.0	16.5	16.5		
625	SM	12.64	7144.39	20.0	20.0	16.5	16.5		
626		5.04	7149.43	20.0	20.0	16.5	16.5		
627	QSF	7.05	7156.47	20.0	20.0	16.5	16.5		
628		2.41	7158.88	20.0	20.0	16.5	16.5		
629	SM	12.64	7171.52	20.0	20.0	16.5	16.5		
630		.65	7172.17	20.0	20.0	16.5	16.5		
631	SM	12.64	7184.81	20.0	20.0	16.5	16.5		
632		.65	7185.46	20.0	20.0	16.5	16.5		
633	SM	12.64	7198.10	20.0	20.0	16.5	16.5		
634		.65	7198.75	20.0	20.0	16.5	16.5		
635	SM	12.64	7211.38	20.0	20.0	16.5	16.5		
636		5.54	7216.93	20.0	20.0	16.5	16.5		
637	QSD	7.05	7223.97	20.0	20.0	16.5	16.5		
638		3.04	7227.02	20.0	20.0	16.5	16.5		
639	SM	12.64	7239.65	20.0	20.0	16.5	16.5		
640		.65	7240.30	20.0	20.0	16.5	16.5		
641	SM	12.64	7252.94	20.0	20.0	16.5	16.5		
642		.65	7253.59	20.0	20.0	16.5	16.5		
643	SM	12.64	7266.23	20.0	20.0	16.5	16.5		
644		.65	7266.88	20.0	20.0	16.5	16.5		
645	SM	12.64	7279.52	20.0	20.0	16.5	16.5		
646		4.91	7284.43	20.0	20.0	16.5	16.5		
647	QSF	3.52	7287.95	20.0	20.0	16.5	16.5		
648	QF	2.60	7290.55	20.0	20.0	16.5	16.5		
649		.65	7291.20	20.0	20.0	16.5	16.5		

Table A2. (cont.)

No	Name	Lattice elements				Loss density			
		Length	Distance	Apertures, mm				prot/(#1hp)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
650	M	15.16	7306.37	20.0	20.0	16.5	16.5		
651		.65	7307.02	20.0	20.0	16.5	16.5		
652	M	15.16	7322.18	20.0	20.0	16.5	16.5		
653		.65	7322.83	20.0	20.0	16.5	16.5		
654	M	15.16	7338.00	20.0	20.0	16.5	16.5		
655		1.15	7339.15	20.0	20.0	16.5	16.5		
656	M	15.16	7354.31	20.0	20.0	16.5	16.5		
657		.65	7354.96	20.0	20.0	16.5	16.5		
658	M	15.16	7370.13	20.0	20.0	16.5	16.5		
659		5.22	7375.35	20.0	20.0	16.5	16.5		
660	QD	2.60	7377.95	20.0	20.0	16.5	16.5		

Table A3. Beam Loss Downstream of the Abort Lambertson at 2 TeV (Injection).

Elements names correspond to the SSC0[1] besides C1-C9 for the suggested collimators. Distance is measured between the end of the Lambertson and the end of the element. "Full" aperture corresponds to the 40 mm inner diameter of the beam pipe in the lattice and the "small" one corresponds to the 33 mm beam pipe diameter. Beam loss density is normalized to 1 proton hitting the Lambertson septum (1hp).

No	Name	Lattice elements						Loss density			
		Length meters	Distance meters	Apertures, mm				prot/(m*1hp)		prot/1hp	
				full		small		coll. off		coll. on	
				hor.	ver.	hor.	ver.	full	small	full	small
1		3.00	3.00	20.0	20.0	16.5	16.5	.12-2	.20-2	.36-2	.61-2
2	SHV	10.00	13.00	11.2	11.2	9.2	9.2			.81-2	.90-2
3		150.63	163.63	20.0	20.0	16.5	16.5	.15-3	.18-3	.15-1	.18-1
4	C1	10.00	173.63	13.2	13.2	10.9	10.9	*	**	*	.12-1
5		.32	173.95	20.0	20.0	16.5	16.5	.36-2	.82-2		
6	B	27.50	201.45	63.0	23.0	63.0	23.0				
7		1.50	202.95	25.0	25.0	20.0	20.0	.33-4	.92-5		
8	QU1	11.29	214.24	25.0	25.0	20.0	20.0	.34-4	.97-4		.14-4
9		1.25	215.49	25.0	25.0	20.0	20.0	.21-3	.40-3		.13-3
10	QU2	11.00	226.49	25.0	25.0	20.0	20.0	.11-3	.87-4	.38-3	.18-3
11		119.84	346.33	25.0	25.0	20.0	20.0	.35-5	.23-5	.36-3	.23-3
12	C2	5.00	351.33	5.5	11.0	4.5	9.1	*	**	*	.14-1
13		1.00	352.33	20.0	20.0	16.5	16.5	.55-3	.86-3		
14	LI	37.00	389.33	20.0	20.0	16.5	16.5	.27-5	.26-5		
15		1.00	390.33	20.0	20.0	16.5	16.5				
16	QU3	9.17	399.50	20.0	20.0	16.5	16.5	.82-4	.29-4		
17		17.82	417.32	20.0	20.0	16.5	16.5	.29-3	.24-3		
18	QU4	7.05	424.37	20.0	20.0	16.5	16.5	.13-3	.12-3	.96-5	.13-3
19		1.00	425.37	20.0	20.0	16.5	16.5				
20	TUD	10.00	435.37	20.0	20.0	16.5	16.5				
21		5.00	440.37	20.0	20.0	16.5	16.5				
22	C3	5.00	445.37	20.0	11.5	16.5	9.5	*	**	*	.57-2
23		89.98	535.35	20.0	20.0	16.5	16.5	.80-4	.89-4		.71-2
24	QF	5.20	540.55	20.0	20.0	16.5	16.5				
25		65.80	606.35	20.0	20.0	16.5	16.5				
26	C4	5.00	611.35	5.5	20.0	4.5	16.5	*	**	*	.12-1
27		1.00	612.35	20.0	20.0	16.5	16.5				.13-1
28	KI	12.00	624.35	20.0	20.0	16.5	16.5				
29		1.00	625.35	20.0	20.0	16.5	16.5	.25-3			
30	QD	2.60	627.95	20.0	20.0	16.5	16.5				
31	QSD	3.52	631.47	20.0	20.0	16.5	16.5				
32		2.31	633.79	20.0	20.0	16.5	16.5				
33	SM	12.64	646.42	20.0	20.0	16.5	16.5				
34		.65	647.07	20.0	20.0	16.5	16.5				
35	SM	12.64	659.71	20.0	20.0	16.5	16.5				
36		.65	660.36	20.0	20.0	16.5	16.5				
37	SM	12.64	673.00	20.0	20.0	16.5	16.5				
38		.65	673.65	20.0	20.0	16.5	16.5				
39	SM	12.64	686.29	20.0	20.0	16.5	16.5	.16-5			
40		5.64	691.93	20.0	20.0	16.5	16.5				
41	QSF	7.05	698.97	20.0	20.0	16.5	16.5				
42		2.91	701.89	20.0	20.0	16.5	16.5				
43	SM	12.64	714.53	20.0	20.0	16.5	16.5				
44		.65	715.18	20.0	20.0	16.5	16.5				
45	SM	12.64	727.81	20.0	20.0	16.5	16.5				
46		.65	728.46	20.0	20.0	16.5	16.5				

Table A3. (cont.)

No	Name	Lattice elements						Loss density			
		Length	Distance meters	Apertures, mm				prot/(π lhp)		prot/lhp	
				full		small		coll. off		coll. on	
				hor.	ver.	hor.	ver.	full	small	full	small
47	SM	12.64	741.10	20.0	20.0	16.5	16.5				
48		.65	741.75	20.0	20.0	16.5	16.5				
49	SM	12.64	754.39	20.0	20.0	16.5	16.5	.79-6	.52-6		
50		.04	754.43	20.0	20.0	16.5	16.5				
51	CS	4.00	758.43	4.0	20.0	3.3	16.5	#	#	#	.13-3 .13-3
52		1.00	759.43	20.0	20.0	16.5	16.5			.10-4	
53	QSD	7.05	766.47	20.0	20.0	16.5	16.5				
54		2.41	768.88	20.0	20.0	16.5	16.5	.27-5	.38-5		
55	SM	12.64	781.52	20.0	20.0	16.5	16.5	.22-5	.40-6		
56		.65	782.17	20.0	20.0	16.5	16.5				
57	SM	12.64	794.81	20.0	20.0	16.5	16.5	.40-7			
58		.65	795.46	20.0	20.0	16.5	16.5				
59	SM	12.64	808.10	20.0	20.0	16.5	16.5	.11-5	.11-4		
60		.65	808.75	20.0	20.0	16.5	16.5				
61	SM	12.64	821.38	20.0	20.0	16.5	16.5	.99-5			
62		5.54	826.93	20.0	20.0	16.5	16.5	.15-5			
63	QSF	7.05	833.97	20.0	20.0	16.5	16.5				
64		3.04	837.02	20.0	20.0	16.5	16.5				
65	SM	12.64	849.65	20.0	20.0	16.5	16.5				
66		.65	850.30	20.0	20.0	16.5	16.5				
67	SM	12.64	862.94	20.0	20.0	16.5	16.5				
68		.65	863.59	20.0	20.0	16.5	16.5				
69	SM	12.64	876.23	20.0	20.0	16.5	16.5				
70		.65	876.88	20.0	20.0	16.5	16.5				
71	SM	12.64	889.52	20.0	20.0	16.5	16.5				
72		4.91	894.43	20.0	20.0	16.5	16.5				
73	QSD	3.52	897.95	20.0	20.0	16.5	16.5				
74	QD	2.60	900.55	20.0	20.0	16.5	16.5				
75		.65	901.20	20.0	20.0	16.5	16.5				
76	M	15.16	916.36	20.0	20.0	16.5	16.5				
77		.65	917.02	20.0	20.0	16.5	16.5				
78	M	15.16	932.18	20.0	20.0	16.5	16.5				
79		.65	932.83	20.0	20.0	16.5	16.5				
80	M	15.16	947.99	20.0	20.0	16.5	16.5				
81		1.15	949.15	20.0	20.0	16.5	16.5				
82	M	15.16	964.31	20.0	20.0	16.5	16.5				
83		.65	964.96	20.0	20.0	16.5	16.5				
84	M	15.16	980.13	20.0	20.0	16.5	16.5				
85		5.22	985.35	20.0	20.0	16.5	16.5				
86	QF	5.20	990.55	20.0	20.0	16.5	16.5				
87		.65	991.20	20.0	20.0	16.5	16.5				
88	M	15.16	1006.36	20.0	20.0	16.5	16.5				
89		.65	1007.02	20.0	20.0	16.5	16.5				
90	M	15.16	1022.18	20.0	20.0	16.5	16.5				
91		.65	1022.83	20.0	20.0	16.5	16.5				
92	M	15.16	1037.99	20.0	20.0	16.5	16.5				
93		1.15	1039.15	20.0	20.0	16.5	16.5				
94	M	15.16	1054.31	20.0	20.0	16.5	16.5				
95		.65	1054.96	20.0	20.0	16.5	16.5				
96	M	15.16	1070.13	20.0	20.0	16.5	16.5				
97		5.22	1075.35	20.0	20.0	16.5	16.5				
98	QD	5.20	1080.55	20.0	20.0	16.5	16.5				

Table A3. (cont.)

No	Name	Lattice elements				Loss density			
		Length	Distance	Apertures, mm				prot/(a#lhp)	
				full		small		coll. off	
		meters		hor.	ver.	hor.	ver.	full	small
99		.65	1081.20	20.0	20.0	16.5	16.5		
100	M	15.16	1096.36	20.0	20.0	16.5	16.5		
101		.65	1097.02	20.0	20.0	16.5	16.5		
102	M	15.16	1112.18	20.0	20.0	16.5	16.5	.19-6	
103		.65	1112.83	20.0	20.0	16.5	16.5		
104	M	15.16	1127.99	20.0	20.0	16.5	16.5		
105		1.15	1129.15	20.0	20.0	16.5	16.5		
106	M	15.16	1144.31	20.0	20.0	16.5	16.5		
107		.65	1144.96	20.0	20.0	16.5	16.5		
108	M	15.16	1160.13	20.0	20.0	16.5	16.5	.27-4	
109		5.22	1165.35	20.0	20.0	16.5	16.5	.24-4	.96-4
110	OF	5.20	1170.55	20.0	20.0	16.5	16.5	.48-4	
111		.65	1171.20	20.0	20.0	16.5	16.5		
112	M	15.16	1186.36	20.0	20.0	16.5	16.5		
113		.65	1187.02	20.0	20.0	16.5	16.5		
114	M	15.16	1202.18	20.0	20.0	16.5	16.5		
115		.65	1202.83	20.0	20.0	16.5	16.5		
116	M	15.16	1217.99	20.0	20.0	16.5	16.5		
117		1.15	1219.15	20.0	20.0	16.5	16.5		
118	M	15.16	1234.31	20.0	20.0	16.5	16.5		
119		.65	1234.96	20.0	20.0	16.5	16.5		
120	M	15.16	1250.13	20.0	20.0	16.5	16.5		
121		5.22	1255.35	20.0	20.0	16.5	16.5		
122	OD	5.20	1260.55	20.0	20.0	16.5	16.5		
123		.65	1261.20	20.0	20.0	16.5	16.5		
124	M	15.16	1276.36	20.0	20.0	16.5	16.5		
125		.65	1277.02	20.0	20.0	16.5	16.5		
126	M	15.16	1292.18	20.0	20.0	16.5	16.5		
127		.65	1292.83	20.0	20.0	16.5	16.5		
128	M	15.16	1307.99	20.0	20.0	16.5	16.5		
129		1.15	1309.15	20.0	20.0	16.5	16.5		
130	M	15.16	1324.31	20.0	20.0	16.5	16.5		
131		.65	1324.96	20.0	20.0	16.5	16.5		
132	M	15.16	1340.13	20.0	20.0	16.5	16.5		
133		5.22	1345.35	20.0	20.0	16.5	16.5		
134	OF	5.20	1350.55	20.0	20.0	16.5	16.5		
135		.65	1351.20	20.0	20.0	16.5	16.5		
136	M	15.16	1366.36	20.0	20.0	16.5	16.5		
137		.65	1367.02	20.0	20.0	16.5	16.5		
138	M	15.16	1382.18	20.0	20.0	16.5	16.5		
139		.65	1382.83	20.0	20.0	16.5	16.5		
140	M	15.16	1397.99	20.0	20.0	16.5	16.5		
141		1.15	1399.15	20.0	20.0	16.5	16.5		
142	M	15.16	1414.31	20.0	20.0	16.5	16.5		
143		.65	1414.96	20.0	20.0	16.5	16.5		
144	M	15.16	1430.13	20.0	20.0	16.5	16.5		
145		5.22	1435.35	20.0	20.0	16.5	16.5		
146	OD	5.20	1440.55	20.0	20.0	16.5	16.5		
147		.65	1441.20	20.0	20.0	16.5	16.5		
148	M	15.16	1456.36	20.0	20.0	16.5	16.5		
149		.65	1457.02	20.0	20.0	16.5	16.5		

Table A3. (cont.)

No	Name	Lattice elements						Loss density			
		Length Distance		Apertures, mm				prot/(π lhp)		prot/lhp	
		meters		full		small		coll. off		coll. on	
				hor.	ver.	hor.	ver.	full	small	full	small
150	M	15.16	1472.18	20.0	20.0	16.5	16.5				
151		.65	1472.83	20.0	20.0	16.5	16.5				
152	M	15.16	1487.99	20.0	20.0	16.5	16.5				
153		1.15	1489.15	20.0	20.0	16.5	16.5				
154	M	15.16	1504.31	20.0	20.0	16.5	16.5				
155		.65	1504.96	20.0	20.0	16.5	16.5				
156	M	15.16	1520.13	20.0	20.0	16.5	16.5	.49-6	.82-5		
157		5.22	1525.35	20.0	20.0	16.5	16.5		.96-4		
158	QF	5.20	1530.55	20.0	20.0	16.5	16.5	.24-4			
159		.65	1531.20	20.0	20.0	16.5	16.5				
160	M	15.16	1546.36	20.0	20.0	16.5	16.5				
161		.65	1547.02	20.0	20.0	16.5	16.5				
162	M	15.16	1562.18	20.0	20.0	16.5	16.5				
163		.65	1562.83	20.0	20.0	16.5	16.5				
164	M	15.16	1577.99	20.0	20.0	16.5	16.5				
165		1.15	1579.15	20.0	20.0	16.5	16.5				
166	M	15.16	1594.31	20.0	20.0	16.5	16.5				
167		.65	1594.96	20.0	20.0	16.5	16.5				
168	M	15.16	1610.13	20.0	20.0	16.5	16.5				
169		5.22	1615.35	20.0	20.0	16.5	16.5				
170	QD	5.20	1620.55	20.0	20.0	16.5	16.5				
171		.65	1621.20	20.0	20.0	16.5	16.5				
172	M	15.16	1636.36	20.0	20.0	16.5	16.5				
173		.65	1637.02	20.0	20.0	16.5	16.5				
174	M	15.16	1652.18	20.0	20.0	16.5	16.5				
175		.65	1652.83	20.0	20.0	16.5	16.5				
176	M	15.16	1667.99	20.0	20.0	16.5	16.5				
177		1.15	1669.15	20.0	20.0	16.5	16.5				
178	M	15.16	1684.31	20.0	20.0	16.5	16.5				
179		.65	1684.96	20.0	20.0	16.5	16.5				
180	M	15.16	1700.13	20.0	20.0	16.5	16.5				
181		5.22	1705.35	20.0	20.0	16.5	16.5				
182	QF	5.20	1710.55	20.0	20.0	16.5	16.5				
183		.65	1711.20	20.0	20.0	16.5	16.5				
184	M	15.16	1726.36	20.0	20.0	16.5	16.5				
185		.65	1727.02	20.0	20.0	16.5	16.5				
186	M	15.16	1742.18	20.0	20.0	16.5	16.5				
187		.65	1742.83	20.0	20.0	16.5	16.5				
188	M	15.16	1757.99	20.0	20.0	16.5	16.5				
189		1.15	1759.15	20.0	20.0	16.5	16.5				
190	M	15.16	1774.31	20.0	20.0	16.5	16.5				
191		.65	1774.96	20.0	20.0	16.5	16.5				
192	M	15.16	1790.13	20.0	20.0	16.5	16.5				
193		5.22	1795.35	20.0	20.0	16.5	16.5				
194	QD	5.20	1800.55	20.0	20.0	16.5	16.5				
195		.65	1801.20	20.0	20.0	16.5	16.5				
196	M	15.16	1816.36	20.0	20.0	16.5	16.5				
197		.65	1817.02	20.0	20.0	16.5	16.5				
198	M	15.16	1832.18	20.0	20.0	16.5	16.5				
199		.65	1832.83	20.0	20.0	16.5	16.5				

Table A3. (cont.)

No	Name	Lattice elements				Loss density			
		Length Distance		Apertures, mm				prot/(π lhp)	
		meters		full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
200	M	15.16	1847.99	20.0	20.0	16.5	16.5		
201		1.15	1849.15	20.0	20.0	16.5	16.5		
202	M	15.16	1864.31	20.0	20.0	16.5	16.5		
203		.65	1864.96	20.0	20.0	16.5	16.5		
204	M	15.16	1880.13	20.0	20.0	16.5	16.5		
205		5.22	1885.35	20.0	20.0	16.5	16.5		
206	QF	5.20	1890.55	20.0	20.0	16.5	16.5	.24-4	
207		.65	1891.20	20.0	20.0	16.5	16.5		
208	M	15.16	1906.36	20.0	20.0	16.5	16.5		
209		.65	1907.02	20.0	20.0	16.5	16.5		
210	M	15.16	1922.18	20.0	20.0	16.5	16.5		
211		.65	1922.83	20.0	20.0	16.5	16.5		
212	M	15.16	1937.99	20.0	20.0	16.5	16.5		
213		1.15	1939.15	20.0	20.0	16.5	16.5		
214	M	15.16	1954.31	20.0	20.0	16.5	16.5		
215		.65	1954.96	20.0	20.0	16.5	16.5		
216	M	15.16	1970.13	20.0	20.0	16.5	16.5		
217		5.22	1975.35	20.0	20.0	16.5	16.5		
218	QD	2.60	1977.95	20.0	20.0	16.5	16.5		
219	QSD	3.52	1981.47	20.0	20.0	16.5	16.5		
220		2.31	1983.79	20.0	20.0	16.5	16.5		
221	SM	12.64	1996.42	20.0	20.0	16.5	16.5		
222		.65	1997.07	20.0	20.0	16.5	16.5		
223	SM	12.64	2009.71	20.0	20.0	16.5	16.5		
224		.65	2010.36	20.0	20.0	16.5	16.5		
225	SM	12.64	2023.00	20.0	20.0	16.5	16.5		
226		.65	2023.65	20.0	20.0	16.5	16.5		
227	SM	12.64	2036.29	20.0	20.0	16.5	16.5		
228		5.64	2041.93	20.0	20.0	16.5	16.5		
229	QSF	7.05	2048.97	20.0	20.0	16.5	16.5		
230		2.91	2051.89	20.0	20.0	16.5	16.5		
231	SM	12.64	2064.53	20.0	20.0	16.5	16.5		
232		.65	2065.18	20.0	20.0	16.5	16.5		
233	SM	12.64	2077.81	20.0	20.0	16.5	16.5		
234		.65	2078.46	20.0	20.0	16.5	16.5		
235	SM	12.64	2091.10	20.0	20.0	16.5	16.5		
236		.65	2091.75	20.0	20.0	16.5	16.5		
237	SM	12.64	2104.39	20.0	20.0	16.5	16.5		
238		5.04	2109.43	20.0	20.0	16.5	16.5		
239	QSD	7.05	2116.47	20.0	20.0	16.5	16.5		
240		2.41	2118.88	20.0	20.0	16.5	16.5		
241	SM	12.64	2131.52	20.0	20.0	16.5	16.5		
242		.65	2132.17	20.0	20.0	16.5	16.5		
243	SM	12.64	2144.81	20.0	20.0	16.5	16.5		
244		.65	2145.46	20.0	20.0	16.5	16.5		
245	SM	12.64	2158.10	20.0	20.0	16.5	16.5		
246		.65	2158.75	20.0	20.0	16.5	16.5		
247	SM	12.64	2171.38	20.0	20.0	16.5	16.5		
248		5.54	2176.93	20.0	20.0	16.5	16.5		
249	QSF	7.05	2183.97	20.0	20.0	16.5	16.5		

Table A3. (cont.)

No	Name	Lattice elements						Loss density			
		Length	Distance	Apertures, mm				prot/(m ² lhp)		prot/lhp	
				full		small		coll. off		coll. on	
				hor.	ver.	hor.	ver.	full	small	full	small
250		3.04	2187.02	20.0	20.0	16.5	16.5				
251	SM	12.64	2199.65	20.0	20.0	16.5	16.5				
252		.65	2200.30	20.0	20.0	16.5	16.5				
253	SM	12.64	2212.94	20.0	20.0	16.5	16.5				
254		.65	2213.59	20.0	20.0	16.5	16.5				
255	SM	12.64	2226.23	20.0	20.0	16.5	16.5				
256		.65	2226.88	20.0	20.0	16.5	16.5				
257	SM	12.64	2239.52	20.0	20.0	16.5	16.5				
258		4.91	2244.43	20.0	20.0	16.5	16.5				
259	QSD	3.52	2247.95	20.0	20.0	16.5	16.5				
260	QD	2.60	2250.55	20.0	20.0	16.5	16.5				
261		4.00	2254.55	20.0	20.0	16.5	16.5				
262	C6	5.00	2259.55	20.0	10.0	16.5	8.3	†	††	†	.16
263		75.80	2335.35	20.0	20.0	16.5	16.5				.15
264	QF	5.20	2340.55	20.0	20.0	16.5	16.5				
265		84.80	2425.35	20.0	20.0	16.5	16.5				
266	QD	5.20	2430.55	20.0	20.0	16.5	16.5				
267		84.80	2515.35	20.0	20.0	16.5	16.5				
268	QF	5.20	2520.55	20.0	20.0	16.5	16.5				
269		4.00	2524.55	20.0	20.0	16.5	16.5				
270	C7	5.00	2529.55	10.0	20.0	8.0	16.5	†	††	†	
271		75.80	2605.35	20.0	20.0	16.5	16.5				
272	QD	5.20	2610.55	20.0	20.0	16.5	16.5				
273		87.40	2697.95	25.0	25.0	20.0	20.0				
274	QL6	4.68	2702.63	25.0	25.0	20.0	20.0				
275		104.00	2806.63	25.0	25.0	20.0	20.0				
276	QL5	14.08	2820.72	25.0	25.0	20.0	20.0	.17-3		.45-3	
277		.80	2821.52	25.0	25.0	20.0	20.0	.16-2		.14-2	
278	QL4	10.63	2832.14	20.0	20.0	16.5	16.5	.16-2		.15-2	
279		.80	2832.94	25.0	25.0	20.0	20.0				
280	VM	12.64	2845.58	25.0	25.0	20.0	20.0				
281		1.00	2846.58	25.0	25.0	20.0	20.0				
282	VM	12.64	2859.22	25.0	25.0	20.0	20.0				
283		1.00	2860.22	25.0	25.0	20.0	20.0				
284	VM	12.64	2872.86	25.0	25.0	20.0	20.0				
285		13.41	2886.27	25.0	25.0	20.0	20.0				
286	VM	12.64	2898.90	25.0	25.0	20.0	20.0				
287		1.00	2899.90	25.0	25.0	20.0	20.0				
288	VM	12.64	2912.54	25.0	25.0	20.0	20.0				
289		1.00	2913.54	25.0	25.0	20.0	20.0				
290	VM	12.64	2926.18	25.0	25.0	20.0	20.0				
291		4.96	2931.14	25.0	25.0	20.0	20.0				
292	QVF	14.25	2945.39	25.0	25.0	20.0	20.0				
293		.80	2946.19	25.0	25.0	20.0	20.0				
294	QVD	14.25	2960.44	25.0	25.0	20.0	20.0				
295		4.20	2964.64	25.0	25.0	20.0	20.0				
296	QVD	14.25	2978.89	25.0	25.0	20.0	20.0				
297		.80	2979.69	25.0	25.0	20.0	20.0				
298	QVF	14.25	2993.94	25.0	25.0	20.0	20.0				
299		4.20	2998.14	25.0	25.0	20.0	20.0				

Table A3. (cont.)

No	Name	Lattice elements						Loss density			
		Length	Distance meters	Apertures, mm				prot/(π ihp)		prot/lhp	
				full		small		coll. off		coll. on	
				hor.	ver.	hor.	ver.	full	small	full	small
300	QVF	14.25	3012.39	25.0	25.0	20.0	20.0				
301		.80	3013.19	25.0	25.0	20.0	20.0				
302	QVD	14.25	3027.44	25.0	25.0	20.0	20.0				
303		4.20	3031.64	25.0	25.0	20.0	20.0				
304	QVD	14.25	3045.89	25.0	25.0	20.0	20.0				
305		.80	3046.69	25.0	25.0	20.0	20.0				
306	QVF	14.25	3060.94	25.0	25.0	20.0	20.0				
307		13.07	3074.02	33.0	33.0	33.0	33.0				
308	SVM	5.00	3079.02	33.0	33.0	33.0	33.0				
309		1.00	3080.02	33.0	33.0	33.0	33.0				
310	SVM	5.00	3085.02	33.0	33.0	33.0	33.0				
311		1.00	3086.52	33.0	33.0	33.0	33.0				
312	SVM	5.00	3091.02	33.0	33.0	33.0	33.0				
313		90.00	3181.02	33.0	33.0	33.0	33.0				
314	CB	4.00	3185.02	20.0	6.5	16.5	5.0	*	**	*	
315		90.00	3275.02	33.0	33.0	33.0	33.0				
316		.80	3275.81	33.0	33.0	33.0	33.0				
317	SVM	5.00	3280.81	33.0	33.0	33.0	33.0				
318		1.00	3281.81	33.0	33.0	33.0	33.0				
319	SVM	5.00	3286.81	33.0	33.0	33.0	33.0				
320		1.00	3287.81	33.0	33.0	33.0	33.0				
321	SVM	5.00	3292.81	33.0	33.0	33.0	33.0				
322		7.00	3299.81	33.0	33.0	33.0	33.0				
323	QL3	12.96	3312.77	20.0	20.0	16.5	16.5	.58-4		.68-4	
324		.80	3313.57	20.0	20.0	16.5	16.5	.94-3		.47-3	
325	QL2	11.22	3324.79	20.0	20.0	16.5	16.5	.25-3		.23-3	
326		1.00	3325.79	20.0	20.0	16.5	16.5				
327	QL2	11.22	3337.01	20.0	20.0	16.5	16.5				
328		.80	3337.81	20.0	20.0	16.5	16.5				
329	QL1	15.14	3352.95	20.0	20.0	16.5	16.5				
330		20.00	3372.95	20.0	20.0	16.5	16.5				
331		20.00	3392.95	20.0	20.0	16.5	16.5				
332	QL1	15.14	3408.09	20.0	20.0	16.5	16.5				
333		.80	3408.89	20.0	20.0	16.5	16.5				
334	QL2	11.22	3420.11	20.0	20.0	16.5	16.5				
335		1.00	3421.11	20.0	20.0	16.5	16.5				
336	QL2	11.22	3432.33	20.0	20.0	16.5	16.5				
337		.80	3433.13	20.0	20.0	16.5	16.5				
338	QL3	12.96	3446.59	20.0	20.0	16.5	16.5				
339		7.00	3453.09	33.0	33.0	33.0	33.0				
340	SVM	5.00	3458.09	33.0	33.0	33.0	33.0				
341		1.00	3459.09	33.0	33.0	33.0	33.0				
342	SVM	5.00	3464.09	33.0	33.0	33.0	33.0				
343		1.00	3465.09	33.0	33.0	33.0	33.0				
344	SVM	5.00	3470.09	33.0	33.0	33.0	33.0				
345		184.00	3654.09	33.0	33.0	33.0	33.0				
346		.80	3654.88	33.0	33.0	33.0	33.0				
347	SVM	5.00	3659.88	33.0	33.0	33.0	33.0				
348		1.00	3660.88	33.0	33.0	33.0	33.0				
349	SVM	5.00	3665.88	33.0	33.0	33.0	33.0				

Table A3. (cont.)

No	Name	Lattice elements				Loss			
		Length	Distance	Apertures, mm				prot/(m ² lhp)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
		meters						full	small
350		1.00	3666.88	33.0	33.0	33.0	33.0		
351	SVM	5.00	3671.88	33.0	33.0	33.0	33.0		
352		13.07	3684.96	33.0	33.0	33.0	33.0		
353	QVD	14.25	3699.21	25.0	25.0	20.0	20.0		
354		.80	3700.01	25.0	25.0	20.0	20.0		
355	QVF	14.25	3714.26	25.0	25.0	20.0	20.0		
356		4.20	3718.46	25.0	25.0	20.0	20.0		
357	QVF	14.25	3732.71	25.0	25.0	20.0	20.0		
358		.80	3733.51	25.0	25.0	20.0	20.0		
359	QVD	14.25	3747.76	25.0	25.0	20.0	20.0		
360		4.20	3751.96	25.0	25.0	20.0	20.0		
361	QVD	14.25	3766.21	25.0	25.0	20.0	20.0		
362		.80	3767.01	25.0	25.0	20.0	20.0		
363	QVF	14.25	3781.26	25.0	25.0	20.0	20.0		
364		4.20	3785.46	25.0	25.0	20.0	20.0		
365	QVF	14.25	3799.71	25.0	25.0	20.0	20.0		
366		.80	3800.51	25.0	25.0	20.0	20.0		
367	QVD	14.25	3814.76	25.0	25.0	20.0	20.0		
368		4.96	3819.72	25.0	25.0	20.0	20.0		
369	VM	12.64	3832.36	25.0	25.0	20.0	20.0		
370		1.00	3833.36	25.0	25.0	20.0	20.0		
371	VM	12.64	3846.50	25.0	25.0	20.0	20.0		
372		1.00	3847.00	25.0	25.0	20.0	20.0		
373	VM	12.64	3859.63	25.0	25.0	20.0	20.0		
374		13.41	3873.04	25.0	25.0	20.0	20.0		
375	VM	12.64	3885.68	25.0	25.0	20.0	20.0		
376		1.00	3886.68	25.0	25.0	20.0	20.0		
377	VM	12.64	3899.32	25.0	25.0	20.0	20.0		
378		1.00	3900.32	25.0	25.0	20.0	20.0		
379	VM	12.64	3912.96	25.0	25.0	20.0	20.0		
380		.80	3913.76	25.0	25.0	20.0	20.0		
381	QL4	10.63	3924.38	20.0	20.0	16.5	16.5	.34-2	.36-2
382		.80	3925.18	25.0	25.0	20.0	20.0		
383	QL5	14.08	3939.27	25.0	25.0	20.0	20.0		.19-3
384		104.00	4043.27	25.0	25.0	20.0	20.0		
385	QL6	4.68	4047.95	25.0	25.0	20.0	20.0		
386		87.40	4135.35	25.0	25.0	20.0	20.0		
387	QF	5.20	4140.55	20.0	20.0	16.5	16.5		
388		84.80	4225.35	20.0	20.0	16.5	16.5		
389	QD	5.20	4230.55	20.0	20.0	16.5	16.5		
390		84.80	4315.35	20.0	20.0	16.5	16.5		
391	QF	2.60	4317.95	20.0	20.0	16.5	16.5		
392	QSF	3.52	4321.47	20.0	20.0	16.5	16.5		
393		6.80	4328.27	20.0	20.0	16.5	16.5		
394	SM	12.64	4340.91	20.0	20.0	16.5	16.5		
395		.65	4341.56	20.0	20.0	16.5	16.5		
396	SM	12.64	4354.20	20.0	20.0	16.5	16.5		
397		.65	4354.85	20.0	20.0	16.5	16.5		
398	SM	12.64	4367.49	20.0	20.0	16.5	16.5		
399		.65	4368.14	20.0	20.0	16.5	16.5		

Table A3. (cont.)

No	Name	Length	Distance	Lattice elements				Loss density			
				Apertures, mm				prot/(#1hp)		prot/1hp	
				full		small		coll. off		coll. on	
				hor.	ver.	hor.	ver.	full	small	full	small
400	SM	12.64	4380.77	20.0	20.0	16.5	16.5				
401		1.15	4381.93	20.0	20.0	16.5	16.5				
402	QSD	7.05	4388.97	20.0	20.0	16.5	16.5				
403		12.33	4401.31	20.0	20.0	16.5	16.5				
404	SM	12.64	4413.95	20.0	20.0	16.5	16.5				
405		.65	4414.60	20.0	20.0	16.5	16.5				
406	SM	12.64	4427.23	20.0	20.0	16.5	16.5				
407		.65	4427.88	20.0	20.0	16.5	16.5				
408	SM	12.64	4440.52	20.0	20.0	16.5	16.5				
409		8.90	4449.43	20.0	20.0	16.5	16.5				
410	QSF	7.05	4456.47	20.0	20.0	16.5	16.5				
411		13.35	4469.82	20.0	20.0	16.5	16.5				
412	SM	12.64	4482.46	20.0	20.0	16.5	16.5				
413		.65	4483.11	20.0	20.0	16.5	16.5				
414	SM	12.64	4495.75	20.0	20.0	16.5	16.5				
415		.65	4496.40	20.0	20.0	16.5	16.5				
416	SM	12.64	4509.04	20.0	20.0	16.5	16.5				
417		7.89	4516.93	20.0	20.0	16.5	16.5				
418	QSD	7.05	4523.97	20.0	20.0	16.5	16.5				
419		2.00	4525.97	20.0	20.0	16.5	16.5				
420	SH4	3.00	4528.97	20.0	20.0	16.5	16.5				
421		8.42	4537.40	20.0	20.0	16.5	16.5				
422	SM	12.64	4550.04	20.0	20.0	16.5	16.5				
423		.65	4550.69	20.0	20.0	16.5	16.5				
424	SM	12.64	4563.32	20.0	20.0	16.5	16.5				
425		.65	4563.97	20.0	20.0	16.5	16.5				
426	SM	12.64	4576.61	20.0	20.0	16.5	16.5				
427		7.82	4584.43	20.0	20.0	16.5	16.5				
428	QSF	3.52	4587.95	20.0	20.0	16.5	16.5				
429	QF	2.60	4590.55	20.0	20.0	16.5	16.5				
430		3.19	4593.74	20.0	20.0	16.5	16.5				
431	M	15.16	4608.90	20.0	20.0	16.5	16.5				
432		.65	4609.55	20.0	20.0	16.5	16.5				
433	M	15.16	4624.72	20.0	20.0	16.5	16.5				
434		.65	4625.37	20.0	20.0	16.5	16.5				
435	M	15.16	4640.53	20.0	20.0	16.5	16.5				
436		.65	4641.18	20.0	20.0	16.5	16.5				
437	M	15.16	4656.35	20.0	20.0	16.5	16.5				
438		.65	4657.00	20.0	20.0	16.5	16.5				
439	M	15.16	4672.16	20.0	20.0	16.5	16.5				
440		3.19	4675.35	20.0	20.0	16.5	16.5				
441	QD	2.60	4677.95	20.0	20.0	16.5	16.5				
442	QSD	3.52	4681.47	20.0	20.0	16.5	16.5				
443		7.82	4689.29	20.0	20.0	16.5	16.5				
444	SM	12.64	4701.93	20.0	20.0	16.5	16.5				
445		.65	4702.58	20.0	20.0	16.5	16.5				
446	SM	12.64	4715.21	20.0	20.0	16.5	16.5				
447		.65	4715.86	20.0	20.0	16.5	16.5				
448	SM	12.64	4728.50	20.0	20.0	16.5	16.5				
449		13.42	4741.93	20.0	20.0	16.5	16.5				

Table A3. (cont.)

No	Name	Lattice elements				Loss density			
		Length	Distance meters	Apertures, mm				prot/(π ihp)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
450	QSF	7.05	4748.97	20.0	20.0	16.5	16.5		
451		7.89	4756.87	20.0	20.0	16.5	16.5		
452	SM	12.64	4769.50	20.0	20.0	16.5	16.5		
453		.65	4770.15	20.0	20.0	16.5	16.5		
454	SM	12.64	4782.79	20.0	20.0	16.5	16.5		
455		.65	4783.44	20.0	20.0	16.5	16.5		
456	SM	12.64	4796.58	20.0	20.0	16.5	16.5		
457		2.00	4798.08	20.0	20.0	16.5	16.5		
458	SH5	3.00	4801.08	20.0	20.0	16.5	16.5		
459		8.35	4809.43	20.0	20.0	16.5	16.5		
460	QSD	7.05	4816.47	20.0	20.0	16.5	16.5		
461		8.90	4825.38	20.0	20.0	16.5	16.5		
462	SM	12.64	4838.02	20.0	20.0	16.5	16.5		
463		.65	4838.67	20.0	20.0	16.5	16.5		
464	SM	12.64	4851.30	20.0	20.0	16.5	16.5		
465		.65	4851.95	20.0	20.0	16.5	16.5		
466	SM	12.64	4864.59	20.0	20.0	16.5	16.5		
467		12.33	4876.93	20.0	20.0	16.5	16.5		
468	QSF	7.05	4883.97	20.0	20.0	16.5	16.5		
469		1.15	4885.13	20.0	20.0	16.5	16.5		
470	SM	12.64	4897.76	20.0	20.0	16.5	16.5		
471		.65	4898.41	20.0	20.0	16.5	16.5		
472	SM	12.64	4911.05	20.0	20.0	16.5	16.5		
473		.65	4911.70	20.0	20.0	16.5	16.5		
474	SM	12.64	4924.34	20.0	20.0	16.5	16.5		
475		.65	4924.99	20.0	20.0	16.5	16.5		
476	SM	12.64	4937.63	20.0	20.0	16.5	16.5		
477		6.80	4944.43	20.0	20.0	16.5	16.5		
478	QSD	3.52	4947.95	20.0	20.0	16.5	16.5		
479	QD	2.60	4950.55	20.0	20.0	16.5	16.5		
480		84.80	5035.35	20.0	20.0	16.5	16.5		
481	QF	5.20	5040.55	20.0	20.0	16.5	16.5		
482		84.80	5125.35	20.0	20.0	16.5	16.5		
483	QD	5.20	5130.55	20.0	20.0	16.5	16.5		
484		87.40	5217.95	25.0	25.0	20.0	20.0		
485	QL6	4.68	5222.63	25.0	25.0	20.0	20.0		
486		104.00	5326.63	25.0	25.0	20.0	20.0	.23-4	.38-4
487	QL5	14.08	5340.72	25.0	25.0	20.0	20.0		
488		.80	5341.52	25.0	25.0	20.0	20.0		
489	QL4	10.63	5352.14	20.0	20.0	16.5	16.5	.14-3	.14-3 .13-3
490		.80	5352.94	25.0	25.0	20.0	20.0		
491	VM	12.64	5365.58	25.0	25.0	20.0	20.0		
492		1.00	5366.58	25.0	25.0	20.0	20.0		
493	VM	12.64	5379.22	25.0	25.0	20.0	20.0		
494		1.00	5380.22	25.0	25.0	20.0	20.0		
495	VM	12.64	5392.86	25.0	25.0	20.0	20.0		
496		13.41	5406.27	25.0	25.0	20.0	20.0		
497	VM	12.64	5418.90	25.0	25.0	20.0	20.0		
498		1.00	5419.90	25.0	25.0	20.0	20.0		
499	VM	12.64	5432.54	25.0	25.0	20.0	20.0		

Table A3. (cont.)

No	Name	Length	Distance	Lattice elements				Loss			
				Apertures, mm		prot/(m ² lhp)		prot/lhp			
				meters		full		coll. off		coll. on	
						hor.	ver.	hor.	ver.	full	small
500		1.00	5433.54	25.0	25.0	20.0	20.0				
501	VM	12.64	5446.18	25.0	25.0	20.0	20.0				
502		4.96	5451.14	25.0	25.0	20.0	20.0				
503	QVF	14.25	5465.39	25.0	25.0	20.0	20.0				
504		.80	5466.19	25.0	25.0	20.0	20.0				
505	QVD	14.25	5480.44	25.0	25.0	20.0	20.0				
506		4.20	5484.64	25.0	25.0	20.0	20.0				
507	QVD	14.25	5498.89	25.0	25.0	20.0	20.0				
508		.80	5499.69	25.0	25.0	20.0	20.0				
509	QVF	14.25	5513.94	25.0	25.0	20.0	20.0				
510		4.20	5518.14	25.0	25.0	20.0	20.0				
511	QVF	14.25	5532.39	25.0	25.0	20.0	20.0				
512		.80	5533.19	25.0	25.0	20.0	20.0				
513	QVD	14.25	5547.44	25.0	25.0	20.0	20.0				
514		4.20	5551.64	25.0	25.0	20.0	20.0				
515	QVD	14.25	5565.89	25.0	25.0	20.0	20.0				
516		.80	5566.69	25.0	25.0	20.0	20.0				
517	QVF	14.25	5580.94	25.0	25.0	20.0	20.0				
518		13.07	5594.02	33.0	33.0	33.0	33.0				
519	SVM	5.00	5599.02	33.0	33.0	33.0	33.0				
520		1.00	5600.02	33.0	33.0	33.0	33.0				
521	SVM	5.00	5605.02	33.0	33.0	33.0	33.0				
522		1.00	5606.52	33.0	33.0	33.0	33.0				
523	SVM	5.00	5611.02	33.0	33.0	33.0	33.0				
524		90.00	5701.02	33.0	33.0	33.0	33.0				
525	C9	4.00	5705.02	20.0	6.5	16.5	5.0	*	**	*	
526		90.00	5795.02	33.0	33.0	33.0	33.0				
527		.80	5795.81	33.0	33.0	33.0	33.0				
528	SVM	5.00	5800.81	33.0	33.0	33.0	33.0				
529		1.00	5801.81	33.0	33.0	33.0	33.0				
530	SVM	5.00	5806.81	33.0	33.0	33.0	33.0				
531		1.00	5807.81	33.0	33.0	33.0	33.0				
532	SVM	5.00	5812.81	33.0	33.0	33.0	33.0				
533		7.00	5819.81	33.0	33.0	33.0	33.0				
534	QL3	12.96	5832.77	20.0	20.0	16.5	16.5				
535		.80	5833.57	20.0	20.0	16.5	16.5				
536	QL2	11.22	5844.79	20.0	20.0	16.5	16.5				
537		1.00	5845.79	20.0	20.0	16.5	16.5				
538	QL2	11.22	5857.01	20.0	20.0	16.5	16.5				
539		.80	5857.81	20.0	20.0	16.5	16.5				
540	QL1	15.14	5872.95	20.0	20.0	16.5	16.5				
541		20.00	5892.95	20.0	20.0	16.5	16.5				
542		20.00	5912.95	20.0	20.0	16.5	16.5				
543	QL1	15.14	5928.09	20.0	20.0	16.5	16.5				
544		.80	5928.89	20.0	20.0	16.5	16.5				
545	QL2	11.22	5940.11	20.0	20.0	16.5	16.5				
546		1.00	5941.11	20.0	20.0	16.5	16.5				
547	QL2	11.22	5952.33	20.0	20.0	16.5	16.5				
548		.80	5953.13	20.0	20.0	16.5	16.5				
549	QL3	12.96	5966.59	20.0	20.0	16.5	16.5				

Table A3. (cont.)

No	Name	Lattice elements				Loss density			
		Length	Distance	Apertures, mm				prot/(m ² lhp)	
				full		small		coll. off	
				hor.	ver.	hor.	ver.	full	small
		meters						full	small
550		7.00	5973.09	33.0	33.0	33.0	33.0		
551	SVM	5.00	5978.09	33.0	33.0	33.0	33.0		
552		1.00	5979.09	33.0	33.0	33.0	33.0		
553	SVM	5.00	5984.09	33.0	33.0	33.0	33.0		
554		1.00	5985.09	33.0	33.0	33.0	33.0		
555	SVM	5.00	5990.09	33.0	33.0	33.0	33.0		
556		184.00	6174.09	33.0	33.0	33.0	33.0		
557		.80	6174.88	33.0	33.0	33.0	33.0		
558	SVM	5.00	6179.88	33.0	33.0	33.0	33.0		
559		1.00	6180.88	33.0	33.0	33.0	33.0		
560	SVM	5.00	6185.88	33.0	33.0	33.0	33.0		
561		1.00	6186.88	33.0	33.0	33.0	33.0		
562	SVM	5.00	6191.88	33.0	33.0	33.0	33.0		
563		13.07	6204.96	33.0	33.0	33.0	33.0		
564	QVD	14.25	6219.21	25.0	25.0	20.0	20.0		
565		.80	6220.01	25.0	25.0	20.0	20.0		
566	QVF	14.25	6234.26	25.0	25.0	20.0	20.0		
567		4.20	6238.46	25.0	25.0	20.0	20.0		
568	QVF	14.25	6252.71	25.0	25.0	20.0	20.0		
569		.80	6253.51	25.0	25.0	20.0	20.0		
570	QVD	14.25	6267.76	25.0	25.0	20.0	20.0		
571		4.20	6271.96	25.0	25.0	20.0	20.0		
572	QVD	14.25	6286.21	25.0	25.0	20.0	20.0		
573		.80	6287.01	25.0	25.0	20.0	20.0		
574	QVF	14.25	6301.26	25.0	25.0	20.0	20.0		
575		4.20	6305.46	25.0	25.0	20.0	20.0		
576	QVF	14.25	6319.71	25.0	25.0	20.0	20.0		
577		.80	6320.51	25.0	25.0	20.0	20.0		
578	QVD	14.25	6334.76	25.0	25.0	20.0	20.0		
579		4.96	6339.72	25.0	25.0	20.0	20.0		
580	VM	12.64	6352.36	25.0	25.0	20.0	20.0		
581		1.00	6353.36	25.0	25.0	20.0	20.0		
582	VM	12.64	6366.50	25.0	25.0	20.0	20.0		
583		1.00	6367.00	25.0	25.0	20.0	20.0		
584	VM	12.64	6379.63	25.0	25.0	20.0	20.0		
585		13.41	6393.04	25.0	25.0	20.0	20.0		
586	VM	12.64	6405.68	25.0	25.0	20.0	20.0		
587		1.00	6406.68	25.0	25.0	20.0	20.0		
588	VM	12.64	6419.32	25.0	25.0	20.0	20.0		
589		1.00	6420.32	25.0	25.0	20.0	20.0		
590	VM	12.64	6432.96	25.0	25.0	20.0	20.0		
591		.80	6433.76	25.0	25.0	20.0	20.0		
592	QL4	10.63	6444.38	20.0	20.0	16.5	16.5		
593		.80	6445.18	25.0	25.0	20.0	20.0		
594	QL5	14.08	6459.27	25.0	25.0	20.0	20.0		
595		104.00	6563.27	25.0	25.0	20.0	20.0		
596	QL6	4.68	6567.95	25.0	25.0	20.0	20.0		
597		87.40	6655.35	25.0	25.0	20.0	20.0		
598	QF	5.20	6660.55	20.0	20.0	16.5	16.5		
599		84.80	6745.35	20.0	20.0	16.5	16.5		