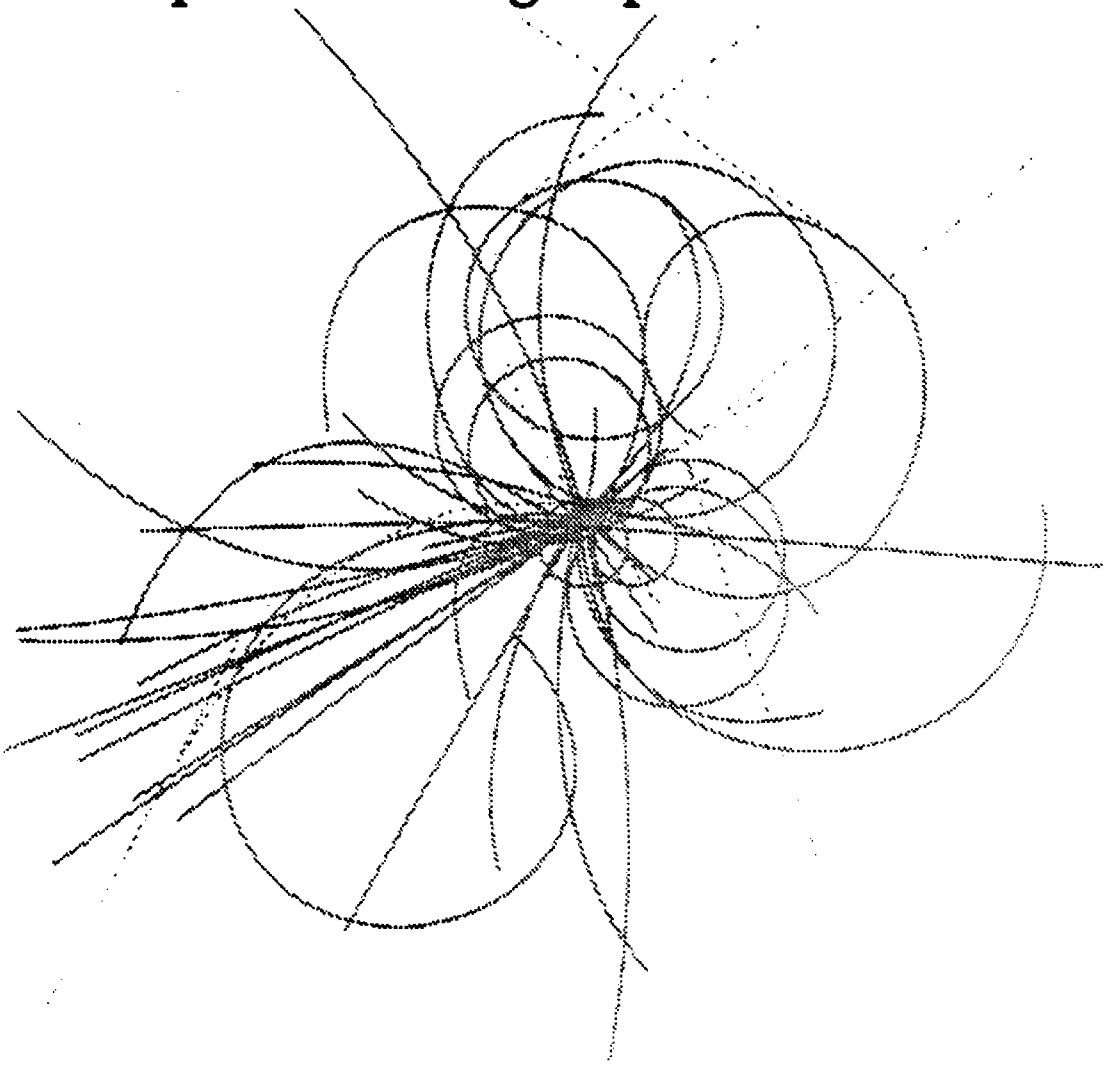
SSCL-264

Superconducting Super Collider Laboratory



Accelerator Parameters Relevant to Detector Design

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Superconducting Super Collider Laboratory*
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*Operated by the Universities Research Association, Inc., for the U.S. Department of Energy under Contract No. DE-AC02-89ER40486.

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In order to ensure that all the first Expressions of Interest address the same accelerator parameters, we give below a set of tables of relevant quantities. It should be borne in mind that the accelerator is still under design at this time. Therefore, some of these parameters could be different in the final design.

The bunch length and radius, the length of the luminous region, and the crossing time are calculated assuming the bunch shape is a three-dimensional Gaussian. The values quoted represent the full central portion of the distribution. For all but the radius, therefore, this is twice one standard deviation.

Unfilled buckets are left in the beam to accommodate the operation of kicker magnets and other devices. This leads to a "filling factor" of about 92%, which has been incorporated in the other data. Some change in this factor is possible in the final design.

In the low-β^* IRs a radiation shield must be placed before the first quadrupole. This shield must contain at least enough material to reduce the energy deposited in the first quadrupole well below the quench threshold, which is expected to be about 8 mWg^{-1}. The shield may be incorporated into the active detector if desired. The beam aperture at this point must be 1.0 cm diameter during normal operation. During injection and ramping the aperture must be enlarged; the enlarged size is not determined at this time. In the high-β^* IRs this quadrupole shield is outside the experimental hall.

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Accelerator Parameters for Detector Designers

TABLE 1

No. particles/bunch	N	=	0.80×10^{10}
No. bunches/ring			1.60×10^{4}
Filling factor	F	=	92%
Bunch collision frequency	f	=	60 MHz
Bunch separation			5.0 m
Avg. beam current per beam			71 mA
Bunch length (68% of bunch)	$2\sigma_z$	=	12.0 cm
Amplitude function at IP	β^*	=	$\begin{cases} 0.5 \text{ m at 2 IRs}^\dagger \\ 10.0 \text{ m at IRs}^\dagger \end{cases}$
Beam radius (68% of bunch)	$\sigma = \sqrt{4.69 \times 10^{-11}\beta^*}$	=	$\begin{cases} 4.8\ \mu\text{m} \quad (\beta^* = 0.5 \text{ m}) \\ 21.7\ \mu\text{m} \quad (\beta^* = 10 \text{ m}) \end{cases}$
Crossing angle	α	=	0–150 μrad (adjustable)
Length of luminous region (68% of interactions)			$\begin{cases} \dfrac{12.0}{\sqrt{2+7.8 \times 10^{7}\alpha^2}} \text{ cm } (\beta^* = 0.5 \text{ m}) \\ \dfrac{12.0}{\sqrt{2+3.8 \times 10^{6}\alpha^2}} \text{ cm } (\beta^* = 10 \text{ m}) \end{cases}$
Crossing time (68% of interactions)			0.28 ns
Standard luminosity	$\mathscr{L} = \dfrac{fN^2}{4\pi\sigma^2} \dfrac{F^2}{\sqrt{1+\alpha^2\sigma_z^2/(4\sigma^2)}}\ 10^{-4}(\text{m}^2/\text{cm}^2)$	=	$\begin{cases} 10^{33}\ \text{cm}^{-2}\text{s}^{-1} \quad (\beta^* = 0.5 \text{ m at } \alpha = 75\ \mu\text{rad}) \\ 5.5 \times 10^{31}\ \text{cm}^{-2}\text{s}^{-1} \quad (\beta^* = 10 \text{ m at } \alpha = 75\ \mu\text{rad}) \end{cases}$
Avg. no. interactions/collision			$\begin{cases} 1.8 \quad (\beta^* = 0.5 \text{ m}) \\ 0.09 \quad (\beta^* = 10 \text{ m}) \end{cases}$
Power radiated from collisions			$\begin{cases} 580 \text{ J/s} \quad (\beta^* = 0.5 \text{ m}) \\ 30 \text{ J/s} \quad (\beta^* = 10 \text{ m}) \end{cases}$
Luminosity lifetime			~24 hr
Free space at IP			$\begin{cases} \pm 20\text{m} \quad (\beta^* = 0.5 \text{ m}) \\ \pm 120\text{m} \quad (\beta^* = 10 \text{ m}) \end{cases}$

†Low-β^* regions are paired together in series in the same diamond; similarly for high-β^* regions.

Table II
Low-β^*
IR Beam Elements

Designation	Type	Length (m)	Approx. Diameter (cm)	Approx. Weight (kg)	Distance of nearest end from IP (m)
DL0	Drift	20.0000			0.0000
QL1b	Quad	14.2594	69†	4500*	20.0000
OR	Drift	0.8000			34.2594
QL2b	Quad	11.2966	69†	3500*	35.0594
D	Drift	1.0000			46.3560
QL2b	Quad	11.2966	69†	3500*	47.3560
OR	Drift	0.8000			58.6526
QL3	Quad	13.2976	69†	4100*	59.4526
D3	Drift	7.0000			72.7502
BV1-	V-Bend	5.0000			79.7502
D	Drift	1.0000			84.7502
BV1-	V-Bend	5.0000			85.7502
D	Drift	1.0000			90.7502
BV1-	V-Bend	5.0000			91.7502
DLV1	Drift	184.7972			96.7502

†Diameter of standard ring quadrupole cryostat. IR magnets may differ somewhat; design not completed at this date.

*Based on scaling of standard ring quadrupole by length; actual design not completed at this date.

Table III
Approximate Depth of IP
Beneath Surface (m)

IR1	55
IR2	50
IR3	40
IR4	45
IR5	45
IR6	45
IR7	40
IR8	40