LCC-0009
RAD-D-98/22 (KEK)

Muon BG estimation for 1997-type JLC (2)

20 JAN 1999
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Muon back ground is estimated for 1997-type JLC design. 8-particle collimators are assumed in collimation section. The particle collimators locate from 1509.9 m to 2855.7 m from the IP. The list of the locations and functions of collimators and bending magnets are shown in Table 1. The location of COLLI1.3 to COLLI1.8 is also shown in Fig.7.

The effect of long iron cylinder shield was investigated. The outer and inner radius of the long iron cylinder shield are 31 and 1 cm respectively. The beam pipe locates inside this 1 cm–radius space.

1 Best case: muon attenuator at 1510-2856 m

The part of beam line from 1510 m to 2856 m from the IP is assumed to be covered with the long cylinder shield.

Fig.1 shows number of lost electron to produce one muon at the IP for 250 GeV electron beam. In case the case that no muon is scored, 0.5 muon is assumed to be scored for an order-estimate (This is shown as 1.6×10^{10} e/mu in fig. 1). The x-axis is the source location from IP in m. The open circle represents e/mu for no shield case. The filled symbols represent e/mu for long iron cylinder shield; filled circle: 0 kG, upper triangle: 10 kG magnetic field inside the shield to focus mu+ in the inside layer, lower triangle: 10 kG magnetic field inside the shield to focus mu- in the inside layer.

The simulation shows,

- The long iron cylinder shield reduces muon back ground to 2 –4 order of magnitude.
- The magnetic field inside the shield is effective.
- If mu+ is focused in the inside layer of the shield, e/mu becomes largest.

2 Muon attenuator at 1510-2856 m, into the tunnel

The length of muon attenuator is the same as the previous section (1510-2856 m). But muon attenuator is assumed to bend to the opposite direction as beam line from the bend 2 by 30 mrad, so that muon inside attenuator goes into the tunnel. μ/e values for COLLI1.8 was 2.7e9±1.6e9, which was 8.0e8±2.5e8 in the previous section. μ/e values for other 7 collimators were the same as the previous sections.

Table 1: Location of bending magnets and collimators

Element	s (m)	Function
Bend1	90	-3.28 mrad
Bend2	1600	7 mrad
COLLI1.8	1840.3	x', y' second colli.
COLLI1.7	1966.7	x', y' first colli.
COLLI1.6	2093.1	x , y second colli.
COLLI1.5	2219.5	x , y first colli.
COLLI1.4	2357.4	Momentum second colli.
COLLI1.3	2483.9	Momentum first colli.
COLLI1.2	2725.4	(In the linac)
COLLI1	2855.6	(In thc linac)

3 Muon attenuator at 1721-2856 m

The part of beam line from 1721 m to 2856 m from the IP is assumed to be covered with the long cylinder shield. In this case muon attenuator ends just up-stream of bend-2. Only 0 kG case is calculated. The result is shown in 2. Comparing to the longer attenuator case, this case is worse by factor 10. μ/e for 500 GeV electron beam is also calculated. μ/e for 500 GeV electron beam is about a half of that for 250 GeV electron beam.

4 Muon attenuator at 1721-2856 m + Concrete filling

After setting attenuator from 1721 m to 2856 m from the IP, following two parts of tunnel was filled with concrete to reduce the muon.

1. 1629-1719 m
2. 800-890 m

As shown in fig.3, the μ/e becomes worse for 1629-1719 m filling and the μ/e is about the same for 800-890 m filling.

5 Case study: muon attenuator at 1510-2856 m, various radius

While keeping the length and location of the muon attenuator, the radius of muon attenuator is varied. Following point is known from the result e/μ values shown in Fig. 4;

- e/μ is the largest for the r=31 cm case.
- e/μ becomes smaller as r becomes smaller. (In some points, this tendency looks reverse due to statistical fluctuation.)
- The r=5 cm attenuator increases e/μ value by 10-100 comparing to the no attenuator case.
- Partial use of muon attenuator (ex only for collimators with large number of electron loss) may be an option. Or use of different radius attenuator for different location may be an option. These things are belong to the detailed design.

6 Case study: muon attenuator of 60 m long

While keeping the radius of the muon attenuator to be 31 cm, the length of muon attenuator is shortened to be 60 m. 8 muon attenuators are placed from collimators to the down-stream direction. Following point is known from the result e/μ values shown in Fig. 5;

- In this case, e/μ is better than that in the no attenuator case by one or two order of magnitude. But, e/μ is worse comparing to the long muon attenuator (1510-2856 m) by one or two order of magnitude.

Appendix Layout of final transfer and collimator section

For the convenience, layout of final transfer (Fig. 6) and collimator section (Fig. 7) are attached here. These figures were taken from JLC Design Study (April 1997).

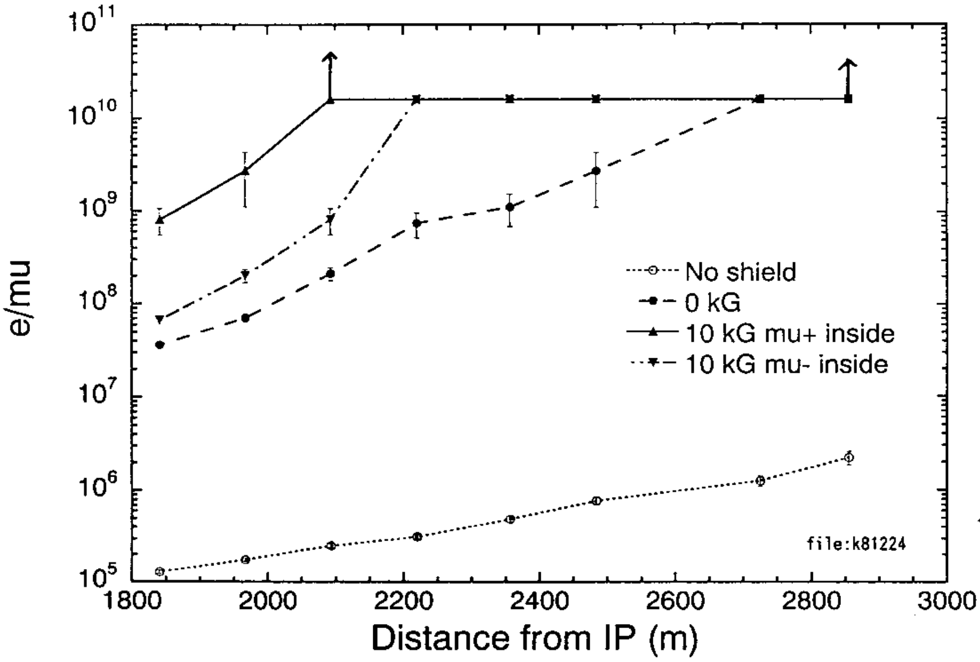

Figure 1: Number of electron to produce one muon which reaches the IP.Att:1510-2856 m

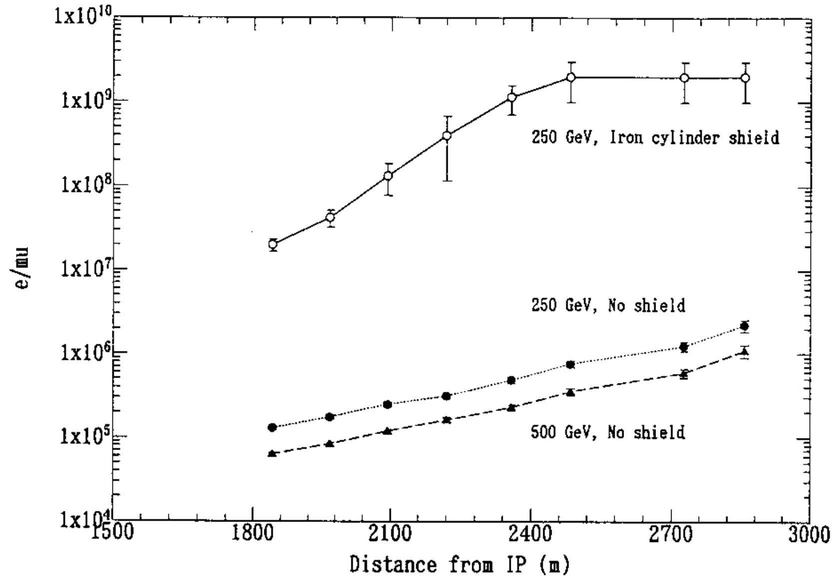

Figure 2: Number of electron to produce one muon which reaches the IP. Att:1721-2856 m

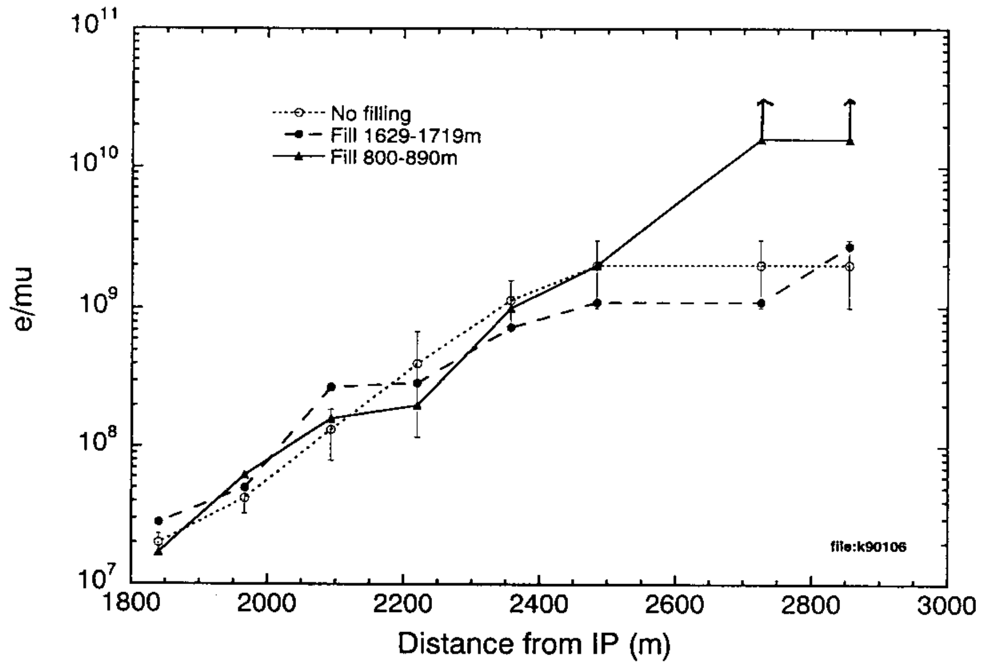

Figure 3: Number of electron to produce one muon which reaches the IP. Att:1721-2856 m, Concrete filling

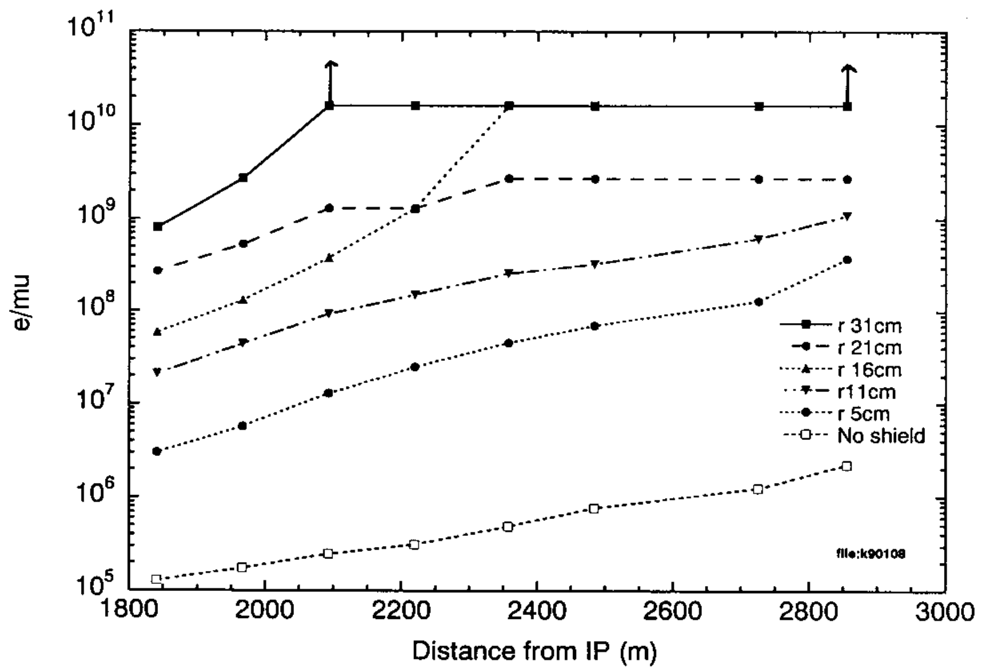

Figure 4: Number of electron to produce one muon which reaches the IP. Att:1510-2856 m Various radius.

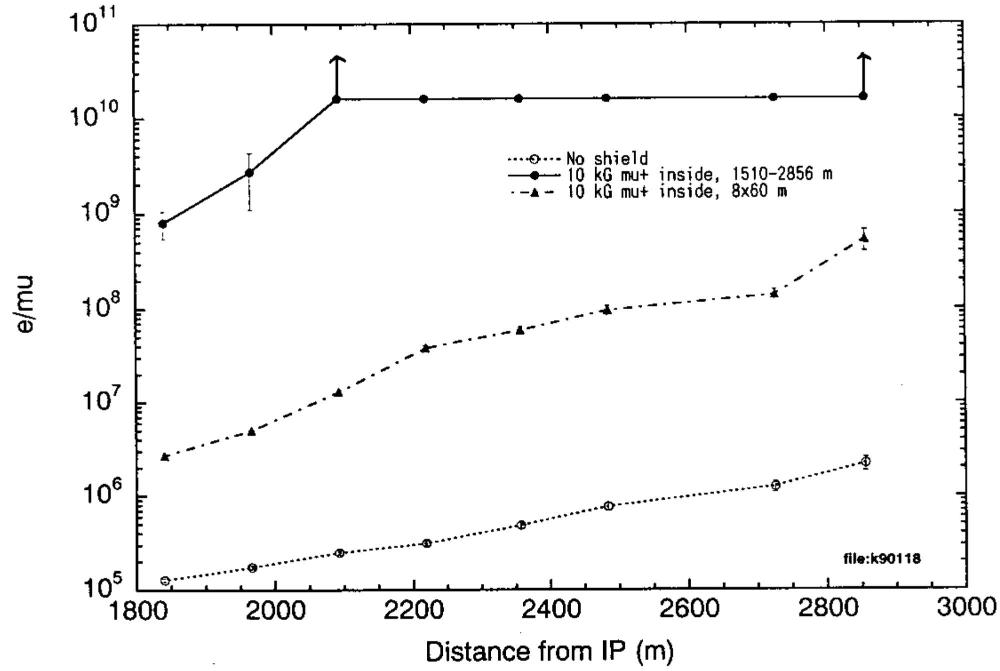

Figure 5: Number of electron to produce one muon which reaches the IP. Att:8x60 m.

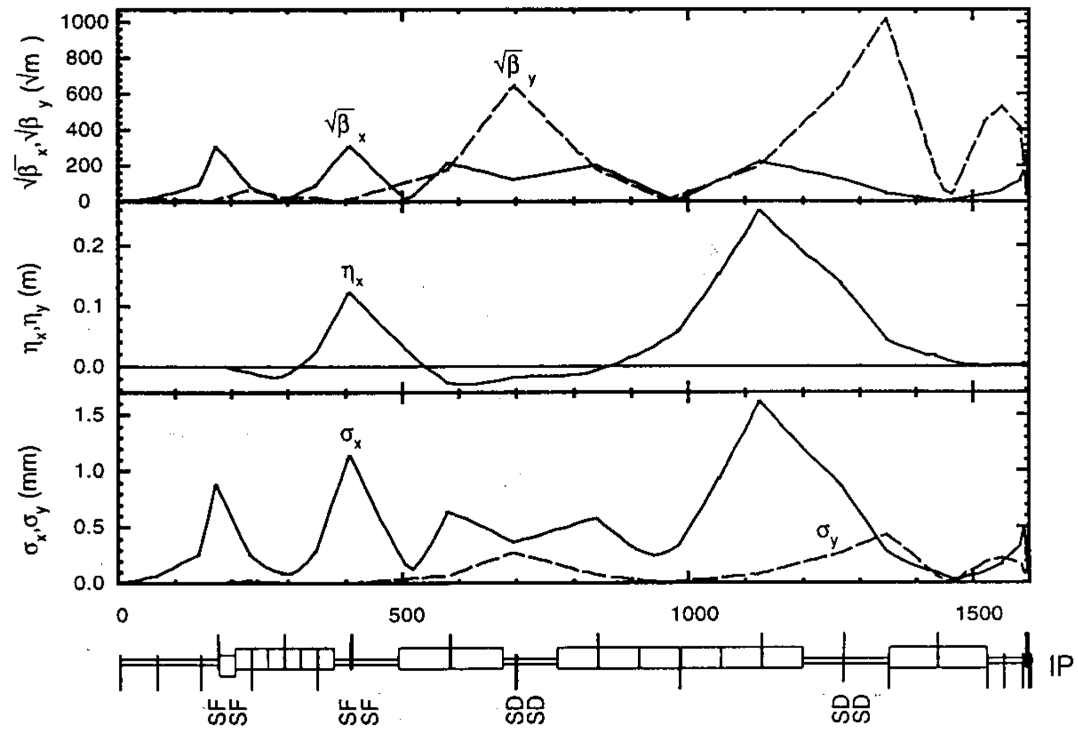

Figure 6: Optical functions and linear beam sizes of the final transformer

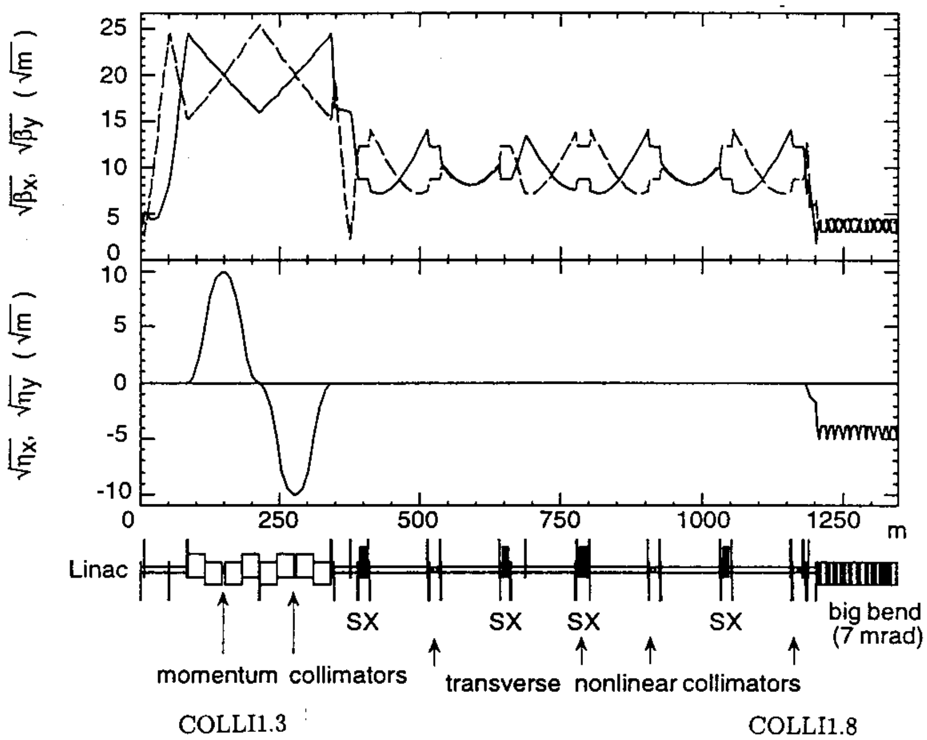

Figure 7: Lattice of the collimator and the big bend. SX denotes the four identical sextupole magnets for the nonlinear transverse collimator