EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN SL/Note 95-44(AP)

Matching LEP2 Optics for Bunch Trains with More SC Cavities

Chuang Zhang*

Abstract

More superconducting (SC) cavities might be installed in LEP in order to push it to higher energy. In the present LEP, the space between either QS7 and QS8 or QS8 and QS9 in Pit2 and Pit6 is too large for one SC module but too small to install two. To make the effective use of the space for SC cavities, these quadrupoles need to be rearranged. Three versions of moving the quadrupoles are considered. The computation is based on LP configuration, which is foreseen to be used for bunch trains operation in 1995. With four additional variables, i.e. independent power supplies, for QS7 - QS9, perfect match has been obtained. As the arcs and the low-β insertions remain the same as in the LP configuration, the results of the studies on separator bumps and side effects of bunch trains can be applied directly to the new optics. The matching procedure is described and the results are presented. It is concluded that the quadrupoles QS7, QS8 and QS9 near Pit2 and Pit6 can be moved as needed for installing more SC cavities in LEP2.

Geneva, Switzerland

April 11, 1995

*on leave of absence from IHEP, Beijing, China

1 Moving quadrupoles

More superconducting cavities might be installed in LEP in order to push it to higher energy. In the present LEP, the available space between either QS7 and QS8 or QS8 and QS9 (22.26 m) in Pit2 and Pit6 is too large for one SC module but too small to install two SC modules [1]. To make the effective use of the space for SC cavities, these quadrupoles need to be rearranged. An auxiliary input file was produced for editing the beam line sequence of LEP in MAD [2], as shown below:

```
seqedit sequence=lep
move QS7.L2 by = DQ7
move QS8.L2 by = DQ8
move QS9.L2 by = DQ9

move QS7.L6 by = DQ7
move QS8.L6 by = DQ8
move QS9.L6 by = DQ9
endedit
return;
```

The distances DQ7, DQ8 and DQ9 for the different versions are listed in Table 1, in which the plus and minus mean to move towards and backwards IP2 (or IP6) from its left side. The symbol V0 means the original optics, i.e. the LP configuration.

Table 1 The distances of moving quadrupoles towards IP2 or IP6 from its left side

Version #	File name	Distance to be moved (m)		
		DQ7	DQ8	DQ9
V0	-	0.0	0.0	0.0
V1	moveq.v1	+3.0974	+1.5113	-2.5530
V2	moveq.v2	+3.5974	+1.5113	-2.5530
V3	moveq.v3	+3.8959	+0.6744	-2.5527

Three versions, i.e. V1, V2 and V3, are considered. In V1, unfortunately, there is not enough space for two modules. Then QS7 is moved further towards the IP by 0.5 m in the version 2. In order to provide a space for CV.QS7, which was replaced by QT3, a new scheme (version 3) is then proposed. The additional advantage of this version is the equal-distance between QS7 and QS8 and between QS8 and QS9 is reserved. Table 2 shows the drift spaces between quadrupoles of the RF region in the three versions.

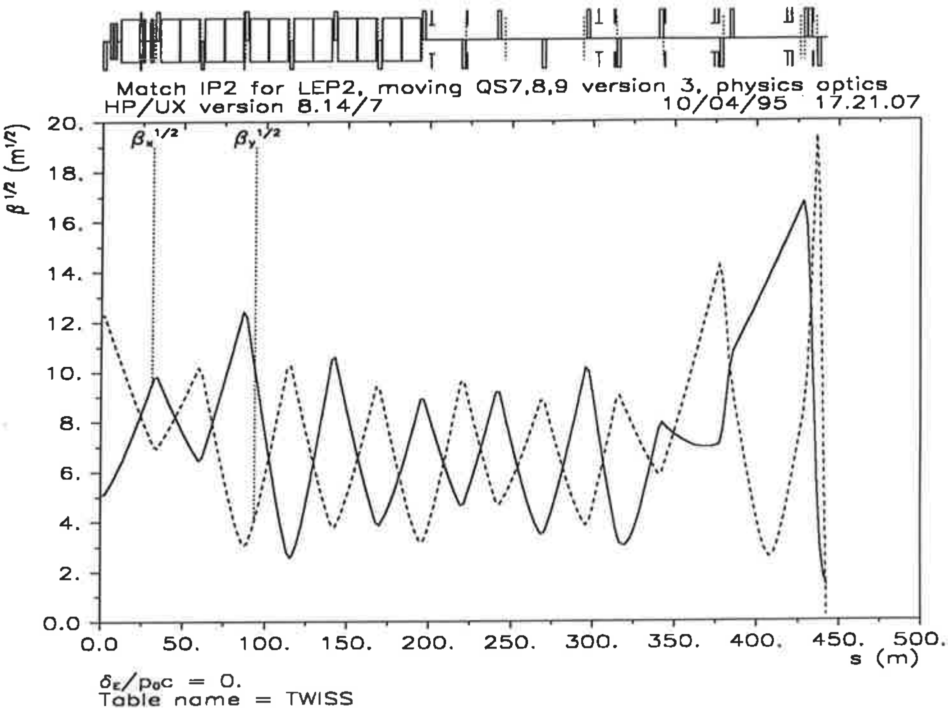
3 The matching results

The calculation has been carried out in the subdirectory **/users/zhangc/lep/lep2/** of the computer hpslap02. An executive file **/users/zhangc/bin/lep2** can be activated to carry out all the matching tasks mentioned in this note. The matching results are summarized in Table 3.

Three configurations were computed for each pit. The file names for physics and injection configurations begin with "90" and "20" respectively. The physics configurations matched with the constraint of $k_{max} = 0.0353$ m^{-2} and $k_{max} = 0.0318$ m^{-2} correspond to the quadrupole capacity for 93 GeV and slightly above 100 GeV [4] and are labeled with "a" and "b" in their file names respectively. The input and output files are saved in the **/users/zhangc/lep/lep2/** subdirectory with the file type "inp", "out", "ps" and "kq" corresponding to input dataset, MAD output file, plot of β-functions and sets of quadrupole strengths respectively.

Table 3 Matching results for LEP2 with moved quadrupoles

Version	Pit #	Optics	File name	Constraints		Convergence		
				β_{max} (m)	k_{max} (m^{-2})	Penalty	$\beta_{y,max}$ @rfc (m)	k_{max} (m^{-2})
V0	2	physics	90v0a2.⋆	-	-	-	87.09	0.0285
		injection	20v0a2.⋆	-	-	-	87.07	0.0285
	6	physics	90v0a6.⋆	-	-	-	84.80	0.0285
		injection	20v0a6.⋆	-	-	-	96.56	0.0285
V1	2	physics	90v1a2.⋆	150	0.0353	1.7E-26	112.5	0.0338
		physics	90v1b2.⋆	150	0.0318	1.3E-26	124.4	0.0318
		injection	20v1a2.⋆	150	0.1589	1.3E-26	132.7	0.0346
	6	physics	90v1a6.⋆	150	0.0353	2.3E-25	90.73	0.0344
		physics	90v1b6.⋆	150	0.0318	1.6E-25	119.6	0.0317
		injection	20v1a6.⋆	150	0.1589	4.4E-25	82.51	0.0344
V2	2	physics	90v2a2.⋆	150	0.0353	1.4E-27	119.4	0.0341
		physics	90v2b2.⋆	150	0.0318	3.2E-17	113.6	0.0318
		injection	20v2a2.⋆	150	0.1589	2.0E-26	99.92	0.0347
	6	physics	90v2a6.⋆	150	0.0353	1.1E-26	87.26	0.0346
		physics	90v2b6.⋆	150	0.0318	2.6E-26	146.2	0.0318
		injection	20v2a6.⋆	150	0.1589	1.4E-25	82.31	0.0339
V3	2	physics	90v3a2.⋆	150	0.0353	3.0E-26	92.74	0.0350
		physics	90v3b2.⋆	150	0.0318	1.6E-26	102.0	0.0317
		injection	20v3a2.⋆	150	0.1589	1.1E-26	99.06	0.0324
	6	physics	90v3a6.⋆	150	0.0353	6.9E-26	100.0	0.0334
		physics	90v3b6.⋆	150	0.0318	2.8E-17	114.4	0.0318
		injection	20v3a6.⋆	150	0.1589	1.3E-25	87.25	0.0374



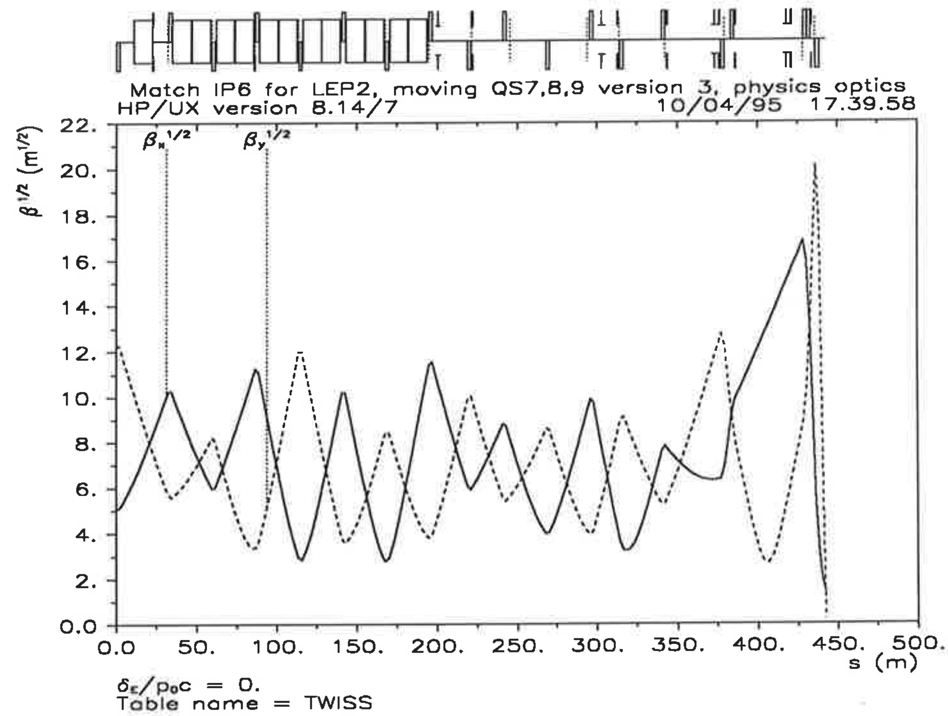
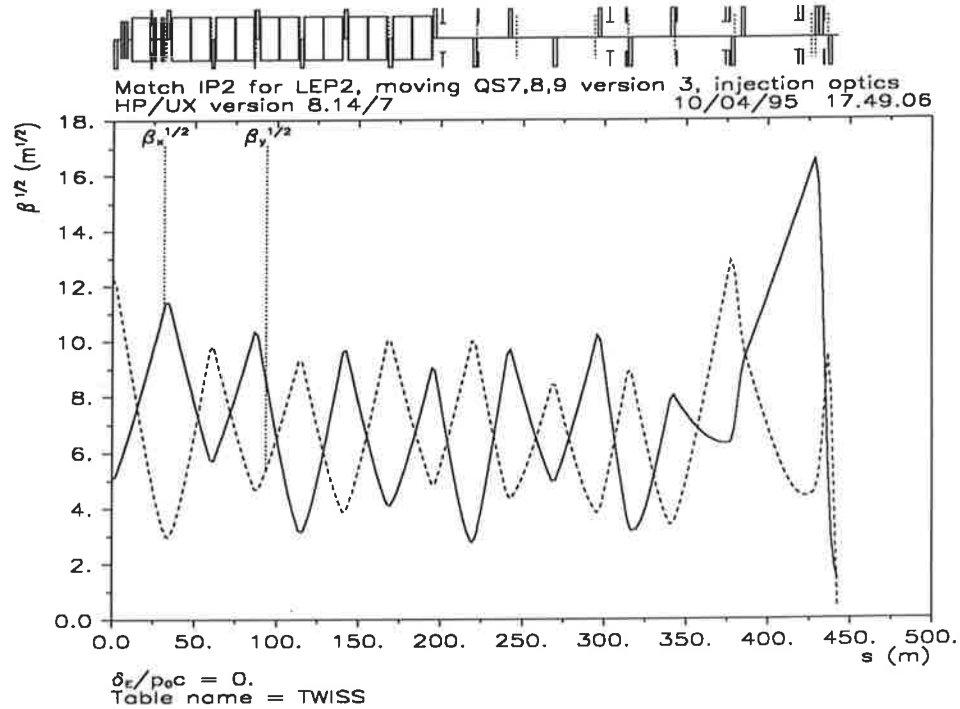


Figure 1: β-functions in the case of 90v3a (physics configuration near IP2 (above) and IP6 (below), k_{max} = 0.0353 m^{-2}, Version 3)



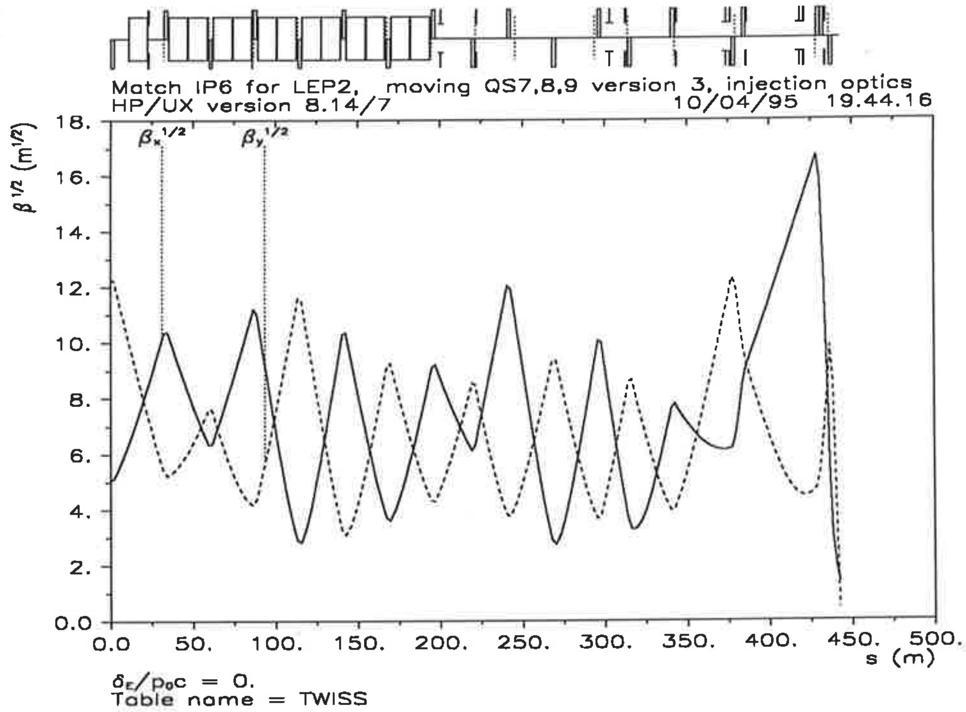


Figure 3: β-functions in the case of 20v3a (injection configuration near IP2 (above) and IP6 (below), Version 3)