PS-PA Note 91-10

8 April 1991

# MODIFICATION OF THE LAYOUT OF THE PS GAMMA TRANSITION JUMP SCHEME

Thys Risselada

## 1 Introduction

The space in PS straight section 57, occupied since 1979 by a *triplet* quadrupole (QST57) of the *gamma transition jump* system, had to be abandoned to make room for a septum of the new Slow Ejection scheme. The 41-49-57 triplet family is closely surrounded on either side by a doublet family, and can therefore not be displaced as a whole without equally moving at least one doublet family. A new type of solution had to be found, involving a minimum number of quadrupole displacements.

## 2 The 1979 layout

Since the implementation of the gamma transition jump [1] in 1973 its layout has changed several times. Between 1979 and 1991 the scheme used the following straight sections:

```
87--95   99--07--15   19--27          29--37   41--49--57   61--69
-    +   -   ++   -   +    -          -    +   -   ++   -   +    -
```

All triplet quadrupoles have the same strength, and polarity as shown by the signs. All doublet quadrupoles have the same strength, their polarities *before* the jump correspond to the signs. The doublet polarities change during the jump. At transition the value of $\gamma_t$ increases first from 6.1 to 8.1, then jumps down rapidly to 5.6 and finally returns to 6.1. The maximum horizontal dispersion value is 9.1 $m$.

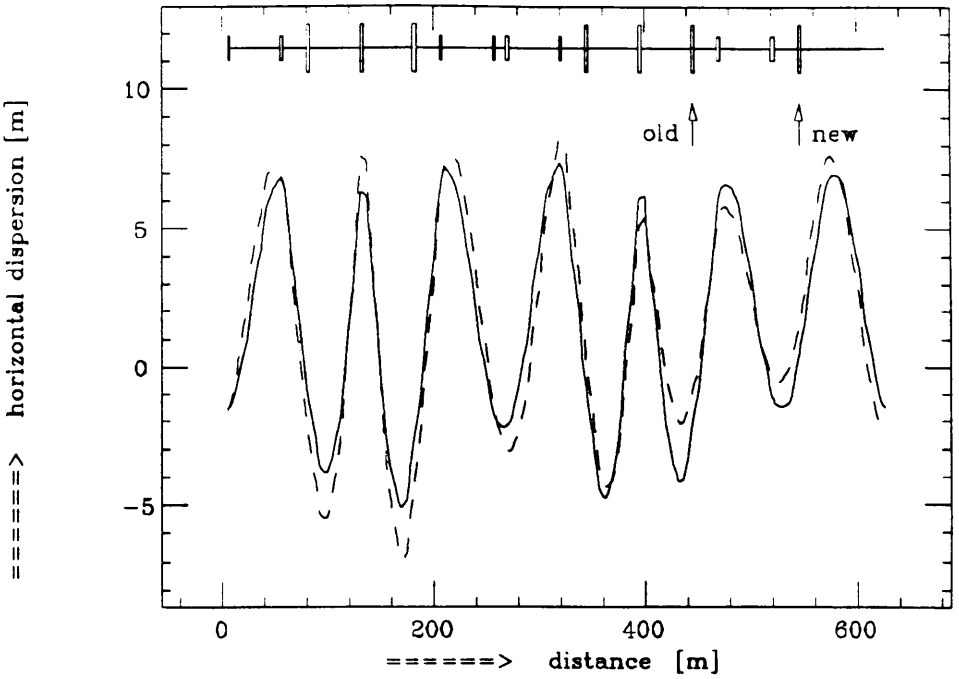


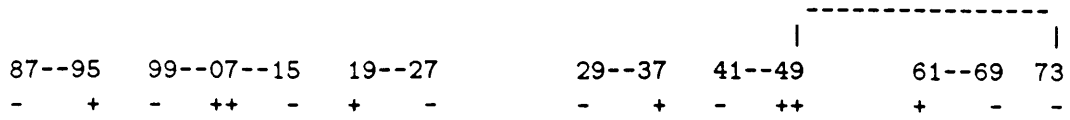

Figure 1: The horizontal dispersion at average $\beta$ in the presence of the old (solid line) and the new (dashed line) gamma transition jump scheme. The doublet quadrupoles are shown as low boxes, the triplets as high boxes. The old and new locations of the displaced triplet quadrupole are indicated by the arrows.

# 3 The 1991 layout

The zero tune shift requirement implies the use of $\pi$-doublets, where two quadrupoles at $\pi$ betatron phase advance are connected in series with opposite polarity. The 45° cell phase advance in the PS lattice implies a distance of 8 straight sections between two quadrupoles belonging to the same doublet. Two doublets may be grouped together to form a triplet. Quadrupoles may be displaced by a $\pi$ phase advance without effect on the tune, provided the different doublets do not overlap. On the other hand, for the effect on $\gamma_t$ to be constant the quadrupoles may be displaced by multiples of $2\pi$ only. A $2\pi$ displacement modifies thus neither the tune nor the $\Delta\gamma_t$ [2].

However, $\Delta\gamma_t$ depends not exactly on the phase advances between the quadrupoles, but rather on the quantities $C_{ij} = cos(\pi\ Q\ -\ |\ \mu_i\ -\ \mu_j\ |)$. If quadrupole $i$ is moved by $2\pi$ to *the other side* of quadrupole $j$ the quantity $C_{ij}$ is generally modified. This is the case of QST57, located too close to the adjacent jump quadrupoles 49 and 61.

The compromise solution applied in 1991, whereby QST57 is replaced by a quadrupole located in ss 73, at the other side of the 61-69 doublet, respects the $2\pi$ phase advance rule and does not change the tune, but the resulting $\Delta\gamma_t$ is slightly smaller for identical quadrupole currents:




The jump amplitude is smaller by 3 or 4 % (depending on the exact tune value) in the new layout. The maximum dispersion value has increased to 9.7 $m$ in the 1991 scheme (figure 1).

# 4 Conclusion

To liberate the space occupied in ss 57 the triplet quadrupole QST57 has been replaced by a quadrupole of identical strength and polarity located at the other side of the adjacent doublet family (in ss 73, i.e. one full betatron wavelength away from ss 57), while all other transition quadrupoles keep their old locations and polarities. This solution preserves the zero tune shift, but yields a slightly smaller $\Delta\gamma_t$ than the old scheme for identical currents. The new scheme is in operation since March 1991.

# References

[1] W. Hardt, Gamma Transition Jump Scheme of the CPS, Proc. 9th Int. Conf. on High Energy Acc., Stanford, April 1974

[2] T. Risselada, Design of Quadrupole Schemes to modify Gamma Transition, CERN PS/90-51 (PA)

Distribution:

J. Boillot
M. Bole-Feysot
R. Cappi
L. Danloy
H. Dijkhuizen
J. Gruber
S. Hancock
W. Hardt
M. Martini
A. Pace
J.P. Riunaud
C. Steinbach