The COSY–11 Beam Optics

COSY–11 Collaboration

The special feature of COSY is high flexibility in adjusting the tune and choosing optimized beam conditions for each experiment [1].
The specific requirement of COSY-11 with its target point in one of the arcs is amongst a high luminosity a small diameter of the interaction zone, because in particular an uncertainty of the point of interaction in the horizontal plane leads to an increase of the width of the reconstructed mass spectrum [2].
The beam dimensions horizontaly and verticaly are given by the standard deviations:
$\sigma_x(s) = \sqrt{\epsilon \cdot \beta_x(s) + D_x^2 \cdot (\frac{\Delta p}{p_0})^2}$ and $\sigma_y(s) = \sqrt{\epsilon \cdot \beta_y(s)}$.
Notice that at present (without any cooling) at 3.3 GeV/c beam momentum $\epsilon \approx 1.7$ mm mrad and the momentum spread $\delta = (\frac{\Delta p}{p_0}) = 0.7 \cdot 10^{-3}$. Thus with standard values at the target point in the arc of $\beta_x \approx 10$ m and $D_x \geq 10$ m the enlargement of the beam diameter in the horizontal plane is mainly caused by the dispersion.
In the calculated "COSY-11 optics" it was attained to constrain the horizontal beam dimension to the width of the cluster target (actual 9 mm) by minimizing the dispersion at the target point (fig. 1, tab. 1).

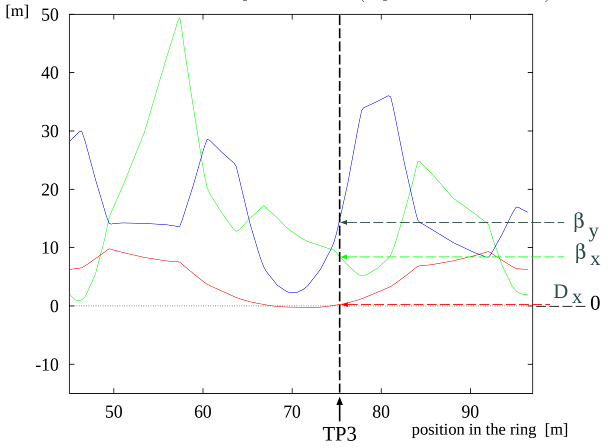

Figure 1: The optical functions of the COSY-11 optics at the target point TP3.

Table 1: The values for the COSY-11 optics representing the required optics. The finally installed optics has got a horizontal tune of $Q_x = 3.65$ staying underneath the $\frac{2}{3}$-resonance.

For the calculations the program MAD (Methodical Accelerator Design) was used [3].
Due to the symmetry of COSY the three families of focusing quadrupoles in the arcs are varied to different values, the three defocusing families are varied in the same manner (tab. 2).
The tune of the calculated COSY-11 optics is only slightly shifted with respect to the "standard optics".

optics	quadrupole currents [A]			
	Qu1/Qu5	Qu2/Qu6	Qu3	Qu4
standard	-183.8	216.4	-214.8	344.2
COSY-11	-199.9	308.5	-199.9	179.1

Table 2: Quadrupole currents at flat top [A] (at 3.205 GeV) representing the focusing strength.

As the measurements of COSY-11 are performed only during the flat top, it is possible to get to the new optic by varying the quadrupole strength in the flat top. Hence injection and acceleration take place with the well known standard optics always moving $\gamma_{trans.}$ forward. Since the COSY-11 optics has a $\gamma_{trans.}$, which is too low for the required beam momentum of 3.3 GeV/c, the beam has to be debunched before changing the optics (fig. 2).

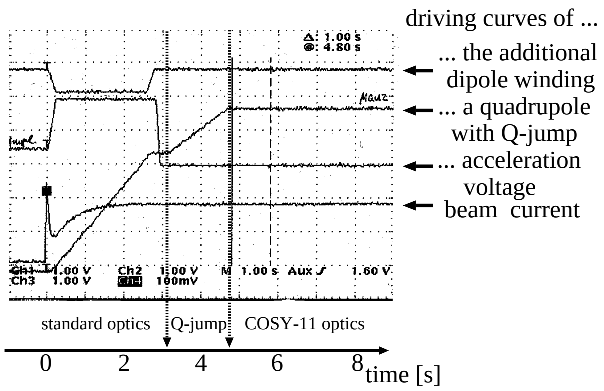

Figure 2: COSY cyclus. The change of the optics takes place after switching off the acceleration voltage.

In the threshold production of the η' (3208 GeV/c) and the K^+K^- (3302 GeV/c) as well the COSY-11 optics has been successfully used already.

References:

[1] R. Maier et al., EPAC 94, Proc. of the Conf. (1994) 165.

[2] M. Sokolowski and J. Zejma Inst. of Physics Jagellonian University, Report 3 , 22 Jan 1991, Crakow

[3] H.Grote and F. Chr. Iselin, The MAD Program Version 8.10, User's References Manual,Geneva, Switzerland 19. Jan. 1993