ISR-MA/GG/KT/rh

5 June 1975

ISR PERFORMANCE REPORT

Run 600 - 20 May 1975

Ring 1 - 26 GeV/c

A simple and precise method for coupling measurement

Introduction

The simple and precise method for measuring the magnitude of the coupling coefficient of the difference resonance as proposed in Ref. 1 works well in practice. The method consists in observing simultaneously the following two quantities of the coherent coupled oscillations of beam excited by a horizontal kick:

i) the period T of the amplitude modulation in the vertical plane;

ii) the ratio R of the minimum to the maximum of the amplitude modulation envelope in the horizontal plane.

The T and R are related to the coupling coefficient κ[2] of the difference resonance by the following expressions:

$$T = \frac{1}{f\sqrt{\Delta^2 + 4|\kappa|^2}} \qquad (1)$$

$$R = \frac{|\Delta|}{\sqrt{\Delta^2 + 4|\kappa|^2}} \qquad (2)$$

where Δ denotes an unperturbed Q-separation $\Delta = Q_h - Q_v$, and f a revolution frequency of the beam. A simultaneous measurement of T and R enables us to get the $|\kappa|$ and $|\Delta|$ at once. The method differs from the previous ones[3] in the point that the unperturbed Q-separation $|\Delta|$ is measured at the same time with $|\kappa|$. Thus, neither calibrations of the Δ-varying magnet nor any tedious data fitting procedures are necessary, which were previously required because of lack of the knowledge of Δ. Since it is possible to quickly know $|\kappa|$ from a single measurement of T and R, the method may be operational in the ISR, and even an electronic measurement will be possible[1].

Results

The T and R were measured by taking photographs of the filter output signals of the automatic Q-meter. Figure 1 shows an example of the photographs taken. In order to confirm that the proposed method works well in practice, the coupling coefficient is measured at different values of Δ with the other conditions fixed. Figure 2 shows the obtained data in this series of the experiment. Here the abscissa denotes the percentage current of the TD1 which is used to vary Δ. The obtained values of $|\kappa|$ for different values of Δ agree quite well with each other. From this we can conclude that we can accurately know $|\kappa|$ by a single measurement provided that the Δ- varying magnet is set at an arbitrary value within the region of $|\Delta|/|\kappa| \lesssim 1.7$, or $R \lesssim 0.6$. In the second series of the experiment, we have tried to seek an optimum setting of the correction skew quadrupole magnet. Figure 3 shows the obtained data of $|\kappa|$ for different excitations of the skew quadrupole Q2 with the other conditions fixed (Ring 1, central orbit, Q1 = −2.06 %, TD1 = +3.00 %). From this figure it is found that the optimum setting of Q2 is −2.4 % for the conditions investigated, and the coupling coefficient $|\kappa|$ is reduced to as small as 0.3×10^{-3}. The third series of the experiment, intended to survey $|\kappa|$ at different radial positions of the Ring, could not be made due to PS failure.

G. Guignard
K. Takikawa

References

1) K. Takikawa, A simple and precise method for measuring the coupling coefficient of difference resonance, to be published.

2) G. Guignard, Divisional Report CERN ISR-MA/75-23.

3) P.J. Bryant and G. Guignard, ISR Performance Report ISR-MA/PJB/GG/mm of 15 May 1975, Runs 575, 580 and 587.

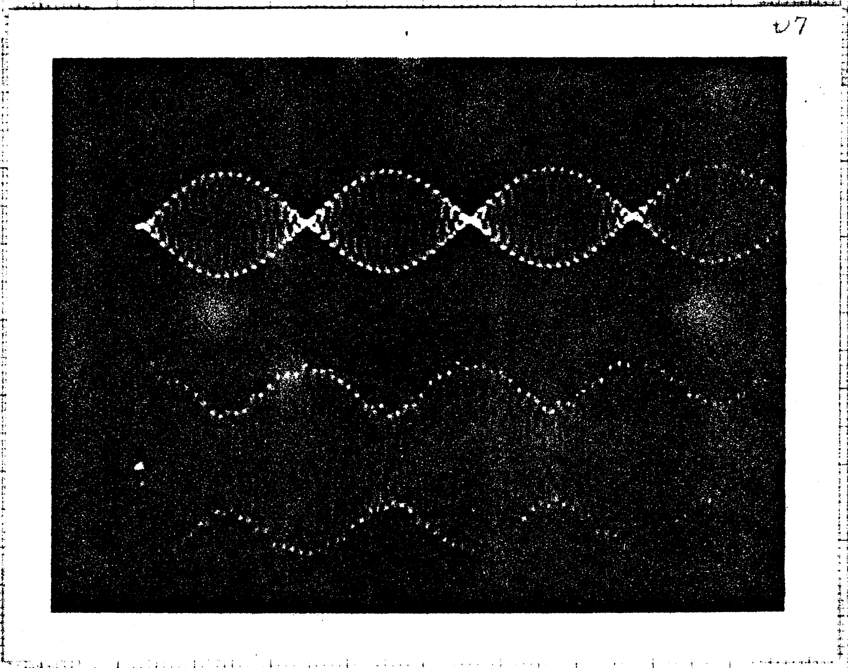

Fig. 1 An example of the photographs of the filter output signals of the automatic Q-meter. The upper trace shows the vertical coherent oscillation, and the lower trace the horizontal coherent oscillation, when the beam is kicked horizontally. The time base is 0.2 ms/div. From the upper trace we obain the period T, and from the lower trace the ratio R.

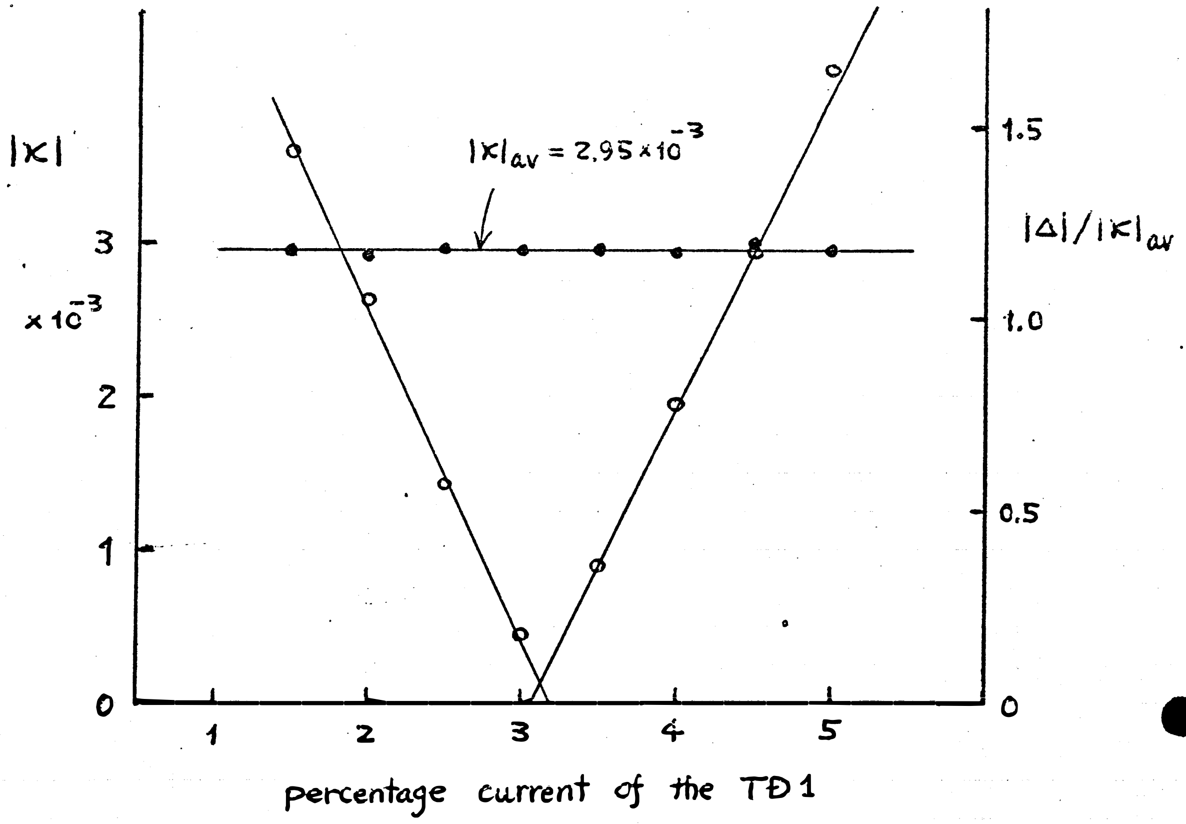

Fig. 2 The coupling coefficient $|\kappa|$ and the unperturbed Q-sepation $|\Delta|/|\kappa|_{av}$ for different excitations of the TD1.

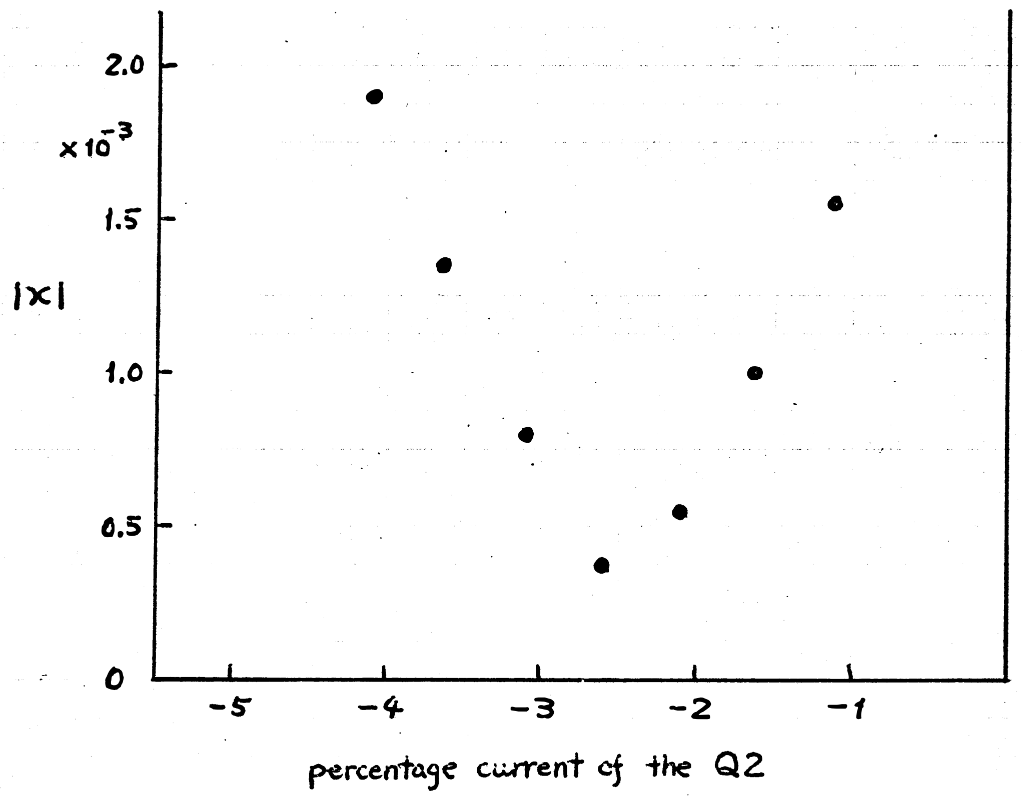

Fig. 3 An optimization of the correction skew-quadrupoles Q2