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MD NOTE

Continuous Transfer Test on 22.6.1972

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1. Coherent oscillation compensation studies

After the failures in finding the right compensation conditions during the last test session, the problem was studied with the help of the SYNCH programme. The calculations showed that it is very easy to have a coherent oscillation amplitude of even more than 20% of the applied betatron oscillation amplitude when not working under the right conditions. The results are given in fig. 1.

The compensation process itself consists simply of adjusting the phase between the kickers 71 and 95 with the help of the quadrupoles 73 and 89 such that the beam displacement in ss 95, created by the kick of FK 71, becomes zero and then of compensating for the angle by adjusting the kick strength of FK 95.

In practice we adopted the following procedure :

a) Set up a 23 μs long flat top kick of kickers 71 and 95.

b) Switch on quadrupoles 73 and 89 with the approximate strength to obtain the wanted β-function increase in ss 83.

c) Observe the radial position pick-up station in ss 83 and change the quadrupole 89 strength until the beam displacement during the first and the second turn is equal.

d) Change the FK 95 kick strength until the beam displacement during the first and the third turn is equal.

e) Repeat c) and d) until the coherent oscillations disappear.

In our case, we have to attenuate the FK 95 kick strength and to increase the strength of quadrupole 89, but in fact we decrease the quadrupole 73 strength for practical reasons.

To test this, we started with a fairly high horizontal Q-value, $Q_H = 6.265$, which corresponds to a mean radial beam position of - 9.7 mm at 10 GeV/c. At first we had difficulties with beam losses when switching on the quadrupole current, but after a change of the current of the octupoles we got a stable beam. The FK 95 kick strength was attenuated by 11% from the beginning and quadrupole 73 was roughly 12% weaker which corresponds to the calculated values for best coherent oscillation compensation. Then the above mentioned compensation procedure was applied. The results are shown in figs. 2 to 5.

Machine conditions : $I_p \approx 170 \cdot 10^{10}$ ppp, Q-jump on, octupoles - 19 A, beam control pick-ups 22 + 72.
$Q_{HO} = 6.265$ and $\bar{r} = -9.7$ mm for the clean machine, but octupoles powered.

With quadrupole 73 and 89 current of 170 A, the mean radial beam position shifted to $\bar{r} = -11.7$ mm and $Q_H = 6.284$ (see fig. 2).
When changing the shunt resistor of quadrupole 73 from 2 Ohms to 3,4 Ohms (quadrupole 89 now 7% stronger), we got $Q_H = 6.273$ with $\bar{r} = -11.2$ mm (fig. 5). Changing the FK 95 attenuator to 7.5% the coherent oscillation is more or less cancelled.

For a perfect compensation the adjustment should be made in presence of all needed slow bumps because they distort the closed orbit and act via the beam control system on the Q-value.

2. Efficiency of the peeling ejection

The peeling operation was set up under the compensation conditions of Fig. 5 (a refinement in the presence of the slow bumps was not possible due to a rather strong 500 KHz modulation of the beam).

The extracted beam showed vertical instabilities which were cured by an inversion of the octupole current polarity.

The current pulses of the kickers 71 and 95, shown in fig. 6, resulted in a flat top external beam current pulse.

It is interesting to see that the negative steps in the staircase pulse are much smaller compared with earlier measurements. This is certainly a result of the better compensation of the coherent oscillations. So it seems that the observed negative steps have no fundamental importance.

This time it was no problem to eject all particles. For the efficiency measurement a SEC (Secondary Emission Chamber, DC 103) installed in the beam transfer line was used. The indicated value was compared with the efficiency indication for a 20 bunches losses fast ejection on the same instrument. Care was taken to have all screens removed and the beam well centered (otherwise errors of a few percent are certain).

Results	F.E. 16	Continuous Transfer
Losses	negligible	ss 83 : 180 mV ss 85 : 60 mV ss 16 : 0 mV
Efficiency on transformer	99.5%	not valid
Efficiency indication on DC 103	= 89.4%	= 84.56%
True Efficiency	assumed to be 100%	94.7%

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Coherent oscillation compensation requirements as function of the initial clean machine Q_H-value

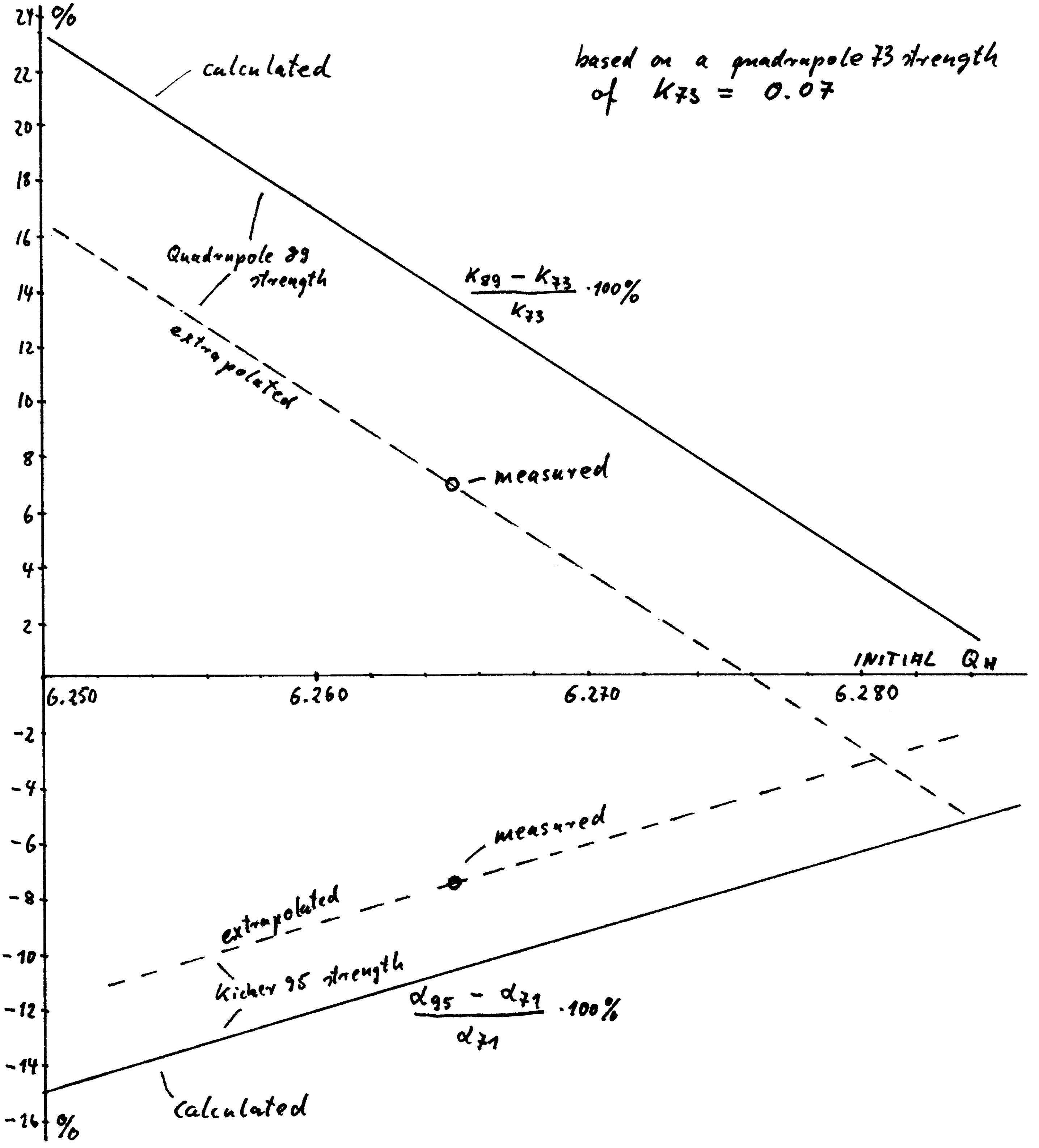

Fig. 1

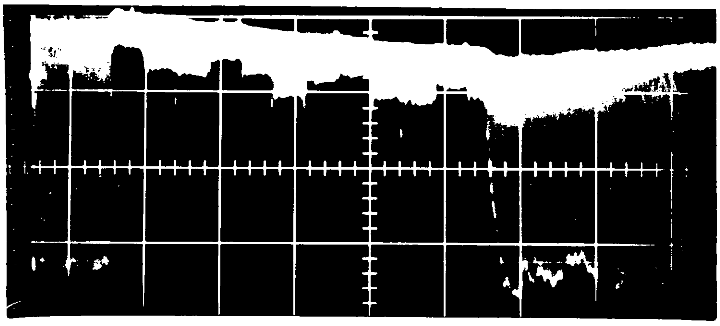

Fig. 2: Radial beam displacement in ss 83.
Quad. 73 shunted with 2 Ω
Fk 95 attenuated 11 %
(5 μs/div)

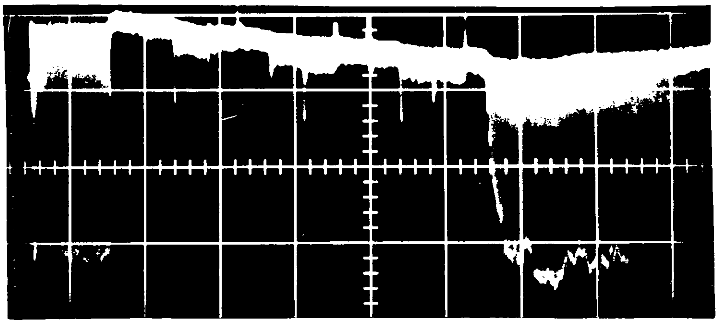

Fig. 3
Same as fig. 2, but quad. 73 shunt 3 Ω
(5 μs/div)

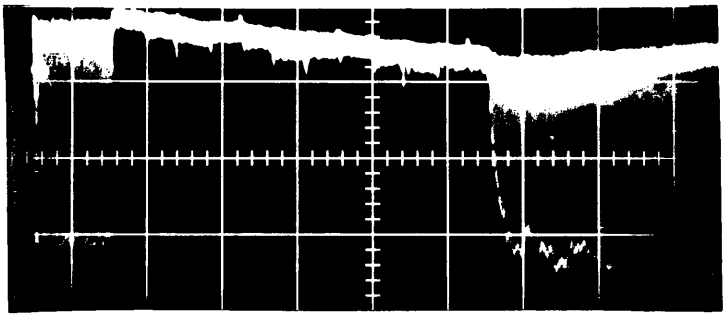

Fig. 4
qudrupole 73 shunt 3 Ω
Fk 95 attenuator 7.5 %
(5 μs/div)

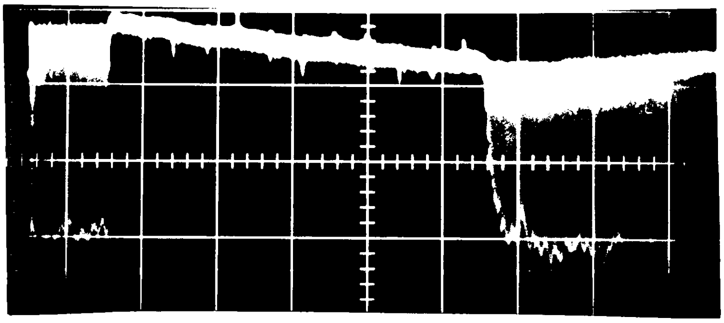

Fig. 5
Best compensation, obtained with:
quad 73 shunt 3.4 Ω
Fk 95 attenuator 7.5 %
(5 μs/div)

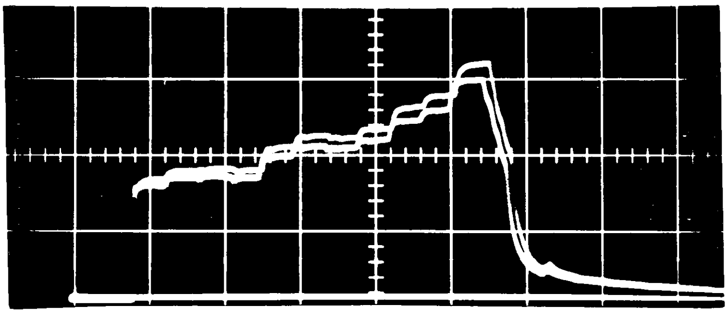

Fig. 6
Fk 71 (upper) and Fk 95 (lower) currents adjusted to give flat CT extraction