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SPS/DI-MST/ME-84-12

5th November, 1984

SPS-ME-84-12 (DI-MST)

Measurement of the coupling impedance of the SPS

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The head-tail Q-shift arising from the interaction of a dense proton bunch with the reactive part of the transverse impedance of the SPS, was evaluated in the ppbar workshop of 1980[1], using the standard broad-band model.

For the mode m = 0, the result of ref. 1 page 5, can be scaled by the following formula

$$\Delta Q_{HT} = 0.012 * \frac{2.1}{\tau_L} * \frac{270}{p} \quad \frac{I_b}{10^{11}} * \frac{Z_\perp}{125}$$

where

τ_L is the total bunch duration in nS
p is the momentum in GeV/c
I_b is the n of protons in the bunch
$Z_\perp$ is the transverse impedance in $M\Omega\ m^{-1}$.

It is also usual to relate the longitudinal and the transverse impedance by the following formula

$$Z_\perp = \frac{2C}{b^2 \omega_{rev}} \quad \frac{Z_{//}}{n}$$

where

$c = 3 \times 10^8$ mS^{-1} is the speed of light

$\omega_{rev} = 2\pi f_{rev}$ is the angular revolution frequency

b is the vacuum pipe dimension

(for the vertical plane b = 23 mm).

We succeeded in measuring the relative shift of the vertical tune between two bunches, one of which had previously been strongly reduced in intensity, during a storage at 315 GeV/c. The relevant parameters of the three bunches were the following

$P = 315$ GeV/c

$i_A = 8.22\ 10^{10}$

$i_B = 5.0\ 10^{9}$

$i_C = 7.53\ 10^{10}$

$\tau_A = \tau_B = \tau_C = 2.4$ n S

The vertical tune of each bunch was measured using the Schottky noise detector. The Schottky signal of the less intense bunch B was relatively enhanced by a white noise vertical excitation, gated in time.

The result of the measurement is shown in photo 1. The bunch shapes are shown in photos 2 to 4.

The tune shift between the bunch B and bunch A is

$$\Delta Q_v = 2.65\ 10^{-3}$$

As a consequence one can deduce the following values for the transverse and the longitudinal impedance of the SPS

$$Z_\perp = 47.7\ M\Omega\ m^{-1}$$

$$Z_{/\!/}/n = 11.5\ \Omega$$

1) Workshop on ppbar in the SPS, May 1980, SPS/ppbar/1.

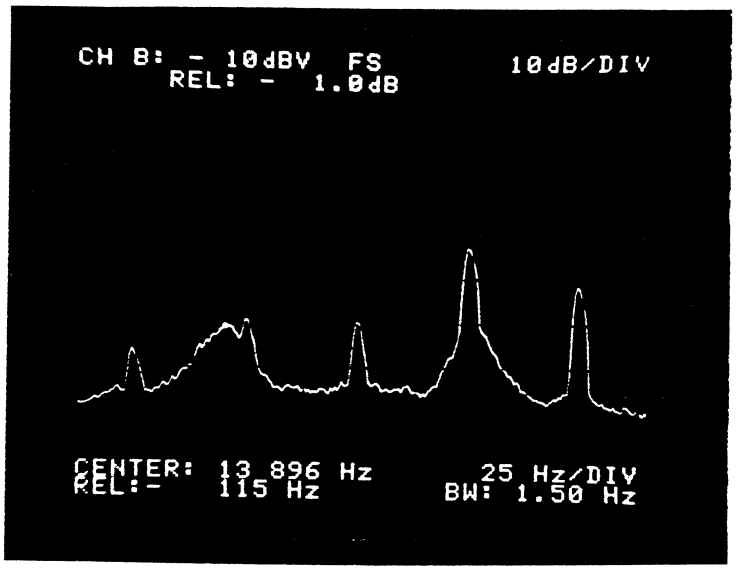

Photo 1

Schottky scan of the vertical tune
Beam having bunch A of 8.22 10^{10} proton bunch B of 5 10^{9} protons

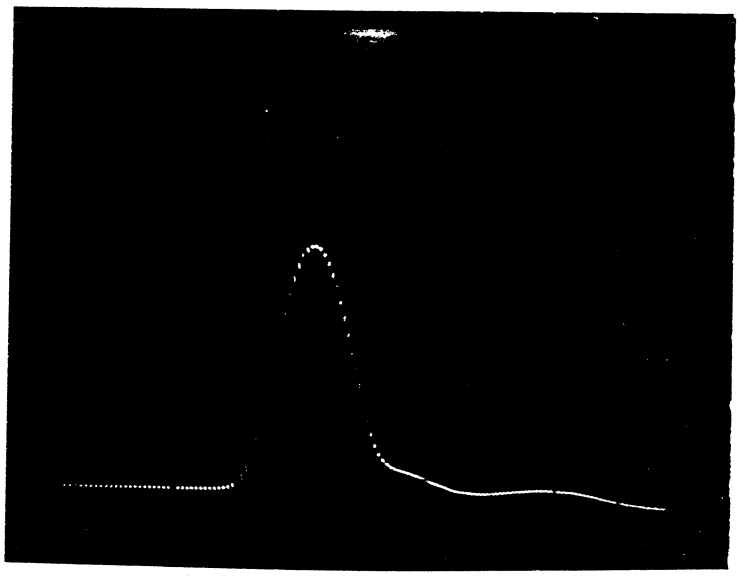

Photo 2

Shape of bunch A (1 nS/div)

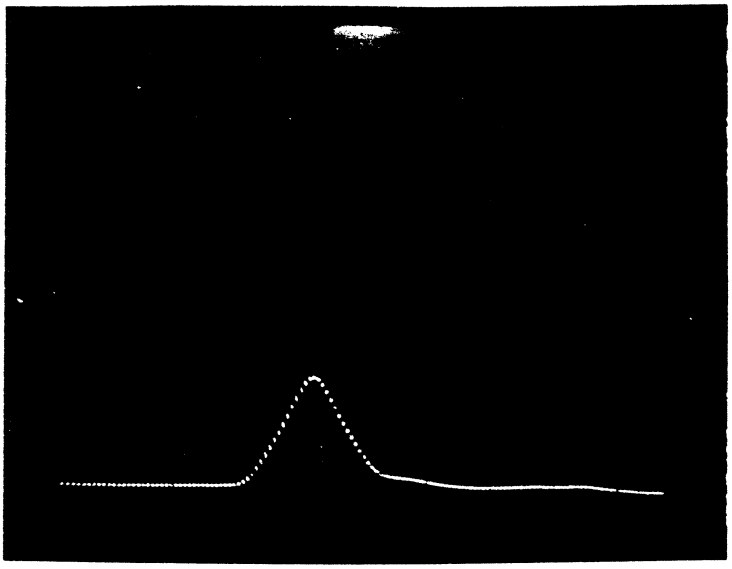

Photo 3

Shape of bunch B (1 nS/div)

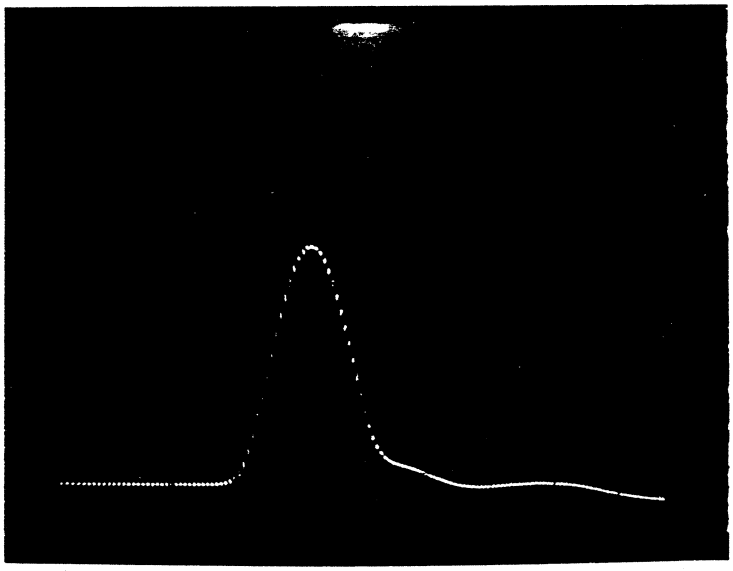

Photo 4

Shape of bunch C (1 nS/diV)