Minutes of the SPS Studies Working Group
(SSWG)

9^{th} meeting -18^{th} July 2000

Present: A. Arauzo, G. Arduini (chairman), T. Bohl, R. Cappi, Yu-Chiu Chao, L. Jensen, N. Hilleret, J. Klem, D. Manglunki, M. Martini, F. Ruggiero, G. Rumolo, E. Shaposhnikova, F. Schmidt, R. Tomas, L. Vos, F. Zimmermann, M.P. Zorzano (secretary)

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1 Dispersion measurements at the transfer line TT2/TT10 (G. Arduini)

The SPS injection line dispersion, with the new optics, has been measured during an MD (07/08/00). This new optics has been matched assuming the starting point to be the measured value of last year. The analysis of the data could be performed on-line by means of an interface (based on the PS/SL Passarelle) developed by D. Jacquet.

The comparison between the results from MAD and the measurements are in very good agreement in both planes. A residual mismatch is present, nevertheless, the agreement has improved with respect to last years.

The measured initial condiions differ significantly from those measured last year.

This could be the result of the absence of orbit correction at high energy in the PS (present last year). Profile measurements performed in TT10 with OTR monitors evidenced the presence

Table 1: Dispersion measurements

TT10 2000	dispersion at initial point	disp. derivative at initial point
H	3.622	0.432
V	0.049	-0.029
TT10 1999	dispersion at initial point	disp. derivative at initial point
H	3.128	0.346
V	0.118	-0.027

of coupling. This could be affected by th orbit correction at high energy in the PS but not by the magnetic cycle of the skew-quedrupoles in TT10. Coupling in the PS ring at extraction or the stray fields at extractions are very likely the sources of such a coupling.

The following items should be therefore addressed as soon as possible"

- presence of betatron coupling before extraction from the PS?,
- dispersion measurements with closed orbit correction and compare with last years measurements
- effect of extraction trajectory on couplinc

(R. Cappi): it would be interesting to repeat these measurements for several $\Delta p/p$ to check the linearity of the transverse plane.

2 Resonance driving terms (R. Tomas)

These MDs are part of the studies aimed to measure the higher order resonances driving terms. The analysis of the 26GeV MD data with a MESPS short single proton bunch and typical bunch intensity of 2×10^{10} p has been presented. The set-up includes chromaticity correction and octupolar errors compensation. The dampers act on the beam just until the moment of the kick (unlike last years measurements). The Q-kickers have been applied in both transverse planes to monitor the average (over 40 measurements) ratio of the spectrum density at the frequency of the plane and the spectrum density at the frequency of the other plane (coupling signal). The plot of this ratio as function of the strength in the skew quadrupoles shows a minimum where the coupling is compensated. The data are very scattered from fill to fill. Using this approach there might be an artificial coupling because of miss-alignments in the pick ups. This method has been cross-checked with the closest tune approach and the results agree. In the future, similar measurements will be done using the 1000 turn method and the signal of all the pick ups in the ring.

The detuning increases linearly with the amplitude of the applied kick (up to 20 mm this year), unlike last year, showing that the remanent sextupolar field has changed with respect to last year. This is due to the fact that last year's supercycle was different and because of the magnetic history of the supercycle, the dipole had some remanent sextupole component that could be detected in the proton MD cycle.

2.1 RF MDs (E. Shaposhnikova)

There has been an MD on the P2 part of the cycle (10/07/00) using a long (25 ns) proton bunch at 26 GeV with $\epsilon = 0.3$ eVs and bunch population of $5 - 6 \times 10^{10}$ p. The experiment measures the spectrum of the longitudinal profile oscillations induced once the RF system is turned off. The debunching time is about 50 ms, where the fast instabilities are developed (not being affected by the synchrotron motion nor by the rf itself). In the spectrum one can distinguish peaks at all the frequencies that correspond to a machine impedance. This is studied as a function of the bunch population.

From last years experience it is known that an impedance is detected at about 200 MHz corresponding to the travelling wave cavities which is the most important one in the machine (check: SL-Note-2000-016 MD T. Bohl, T. Linnecar, E. Shaposhnikova). A secondary peak can be seen at about 400MHz, whose strength increases with the bunch population, being as important as the first impedance when $N_p = 5 - 6 \times 10^{10}$ p. This years measurements show a similar behaviour and therefore no improvement has been seen after the shielding of the MSE and MST tanks. Numerical simulations show that the 400 MHz peak cannot be a second harmonic of the 200 MHz response, generated by the nonlinearity of the process, since its expected strength would not be higher that half the strength of the 1st harmonic. The 400 MHz oscillation rises earlier than the 200 MHz one and in a stronger way. At highest intensities from 1/4 to 1/3 of particles were lost in a continuous way at the end of the flat bottom (600 ns).

A second MD has been done with an LHC-like beam (12/07/00) on coast, using the MESPS short (3.2 ns) single bunch with parameters $\epsilon = 0.15$ eVs, $N_p = 3\times10^{10}$ and RF on with $V = 790$ kV. There are continuous losses on flat bottom after injection. Monitoring the peak detected signal shows its decay in a continuous way. The BCT shows losses after 1 s, the lifetime being of the order of a few minutes. There is a bunch lengthening process. The bunch longitudinal profile was very unstable, from the beginning a clean quadrupole oscillation is developed (later on also sextupole and higher order modes as the increasing bunch length excites new modes). The synchrotron frequency was 140 Hz. At the end of the coast the bunch is stable although, as a result of the instability, the bunch profile is clearly deformed. The initial amplitude of quadrupole oscillations can be reduced by reducing the RF voltage, but they never disappear. A Beam Transfer Function study was done applying a 800 MHz in bunch lengthening/shortening mode to stabilise the bunch. With lengthening/shortening due to 800 MHz, no high multipole oscillations were observed but the lifetime was the same. Lifetime was slightly improved with reducing the noise in one of the RF loops. There is a clear evidence of particle loss but so far it is not understood how these losses are produced.

Comments: (FZ, MPZ) Toushek or intrabeam scattering could explain the bunch lengthening, it would be interesting to monitor the bunch length as a function of time, (FR) space-charge induces a modulation of the betatron tune with the synchrotron tune, this could explain a coupling with the transverse plain where the particles could be lost, (LV) for this beam space charge would induce a tune shift of the order of 0.01, (RC) bad vacuum could also induce bunch lengthening and losses.

3 Comments (G. Arduini)

- Call for the MDs request of next month.
- A. Variola could not assist today to the SSWG meeting to present the proposal of a new application of the BGIP monitor to measure the energy spectrum of the multipacting electrons in the SPS. This will be postpone to a future meeting.

4 Next meeting

The next meeting is scheduled for Tuesday 1st August, at 09:15, Room 865-1D17. A reminder will be sent by email in due time and the agenda will be announced on the web page of the working group

http://cern.ch/sl-mgt-sps-swg

M.P. Zorzano 5th July 2000