Minutes of the SPS Studies Working Group (SSWG)

13$^{\text{th}}$ meeting -12$^{\text{th}}$ September 2000

Present: G. Arduini, T. Bohl, H. Burkhardt, K. Cornelis (chairman), W. Hofle, L. Jensen, J. Klem, M. Martini, E. Shaposhnikova, R. Steerenberg, J. Tuckmantel, L. Vos, F. Zimmermann, M.P. Zorzano (secretary)

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1 Scheduling of parallel MD during lead run (G. Arduini)

The first two weeks will be dedicated to the MDs with a single bunch at 26 GeV (impedance and resonance driving terms measurements). The following weeks will operate with the LHC-like beam at 26 GeV (rf long bunch MDs studies and LHC beam with double batch injection).

If LEP operation is extended, it would be compatible with SPS MDs on proton beams at low energy (26 GeV), and only after implementing a safety chain preventing extraction to the west.

2 CPS emittance measurements (R. Steerenberg)

The emittance has been measured as a function of the intensity, which is varied by changing the rate of the multi-turn injection from the booster.

Using the MDPRO beam for fast extraction an intensity record was achieved during these studies with $I = 3.5 \times 10^{13}$ p. This year injection from the booster is done at 1.4 GeV (instead of 1 GeV as last year), this has helped reaching the record in I. The emittances increase linearly in the intensity range $10^{13} \rightarrow 3.5 \times 10^{13}$ p, in the horizontal plane by a factor of 2.5 and in the vertical plane by a factor of 1.4 (measured at TT2). The emittance is determined mainly by the booster, where the same correlation is found. Ideally the vertical emittance should not increase that much but for these high intensities we need to operate with coupling between the two planes.

The same measurements have been performed for the continuous extraction beam (5 turns CT extraction of MDPRO). In this case the intensity can not reach values higher than 3×10^{13}. Beyond this value careful adjusting is needed. This could be further studied with the SFTPRO beam during the lead run. Over the range of intensity $10^{13} \to 3 \times 10^{13}$, the horizontal emittance increases by 2.4 and the vertical emittance by 2.8. The emittance now increases faster, maybe due to the fact that we have more losses in the septum.

(M. Martini) The momentum spread is not well known for this beam.

For further information see *Transverse emittance as a function of the proton beam intensity* by R. Steerenberg, PS/OP/Note 2000-13 (MD).

3 Results from recent MDs.

3.1 Electron cloud measurements (G. Arduini).

There is an instability in the train of LHC-like bunches when the current is beyond the electron cloud threshold. The bunches oscillate with an amplitude that increases towards the end of the train and those in the last part of the train show a significant emittance blow up. As it was reported by K. Cornelis, this instability can be suppressed by inducing a beam blow-up using the octupoles (this creates an amplitude dependent tune spread in the bunch particles and helps Landau damping to act).

In this MD similar studies were done by increasing the chromaticity to induce a momentum dependent tune spread. The octupolar components were corrected, and measurements close to zero chromaticity show the expected unstable behaviour: H plane slow wave modulating of the centroid oscillation along the batch, V plane bunch to bunch variation of the centroid oscillation, increasing drasticly towards the end and being strongly correlated to local densities. By the end of the batch the emittances are blown up. Setting the vertical chromaticity to $Q'_V = +0.25$ the vertical oscillations are suppressed, showing the same behaviour as the horizontal plane.

The BCT indicates tail losses for $Q'_V \approx 0$ and strongly correlated with local I. For $Q'_v = +0.25$ these losses occur later and are less correlated with local I. When also the horizontal chromaticity is incremented to $Q'_H = +0.25$ the losses disappear completely as well as the oscillation. Also less blow up of the emittance is found.

(K. Cornelis) This should be repeated above and below the electron cloud threshold to confirm that the instability is related to the electron cloud phenomenon.

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(F. Zimmermann, E. Shaposhnikova) The electron cloud is sensitive to the bunch length $\sqrt{\sigma_l}$, using bunches twice shorter should make a difference. These might be achieved by injecting shorter bunches from the PS (2.5 ns), being captured on the SPS side with $400 - 500$ kV matching voltage and rising the voltage to the maximum available 2 MV. The bunch length would decrease by $(4)^{1/4} = \sqrt{2}$.

(H. Burkhardt) Successful energy loss measurements have been performed at HERA, where the vacuum conditions are better than those of the SPS by some orders of magnitude. Schotky monitor measurements performed on the same beam with a certain time delay shows the spectrum shift due to synchrotron radiation energy loss. Other effects that create energy losses:

rest-gas scattering, impedances, persistent currents after the ramp.

5 Next meeting

The next meeting is scheduled for Tuesday 26th September, 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 13th September 2000