Minutes of the SPS Studies Working Group (SSWG)

17^{th} meeting -12^{th} December 2000

Present: G. Arduini (acting chairman), Yu-Chiu Chao, J. Gareyte, W. Hofle, L. Jensen, R. Jones, J. Klem, G. Rumolo, E. Shaposhnikova, J. Tuckmantel, L. Vos, F. Zimmermann (secretary)

Excused: T. Bohl, H. Burkhardt, R. Cappi, K. Cornelis (chairman), D. Manglunki

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1 Multi-turn beam-position readings (J. Klem)

The orbit data acquisition system was expanded, so that the number of turns sampled is almost arbitrary. Jukka showed an example position reading over 175000 SPS turns, from which he obtained an image of the tune variation during the cycle. Also different windowing options for the FFT calculation are now available online.

2 Electron-cloud studies in 2000 (M. Jimenez)

Two primary observables recorded by the vacuum group are the (1) relative pressure increase and (2) signals from dedicated pick ups. The vacuum pressure responds with a slow time constant, whereas the pick ups detect the cloud evolution during the batch passage. Primary study items in 2001 were the differences between regions with and without magnetic field, the effect of missing bunches, and evidence for beam scrubbing.

The threshold for the pressure increase was higher without magnetic field (6e10 ppb) than in a dipole (3-4e10 ppb). The threshold also depended on the length of the train. The minimum train length for which a pressure rise was observed decreases with the intensity per bunch. There was some clear evidence for scrubbing. The current threshold increased by about 30-50% after 50-hour processing with LHC beam, and the pressure increase at constant current almost disappeared. Regions with magnetic field require additional processing, whenever the beam intensity is raised. Nitrogen glow discharge treatment reduces the pressure increase after venting.

Data were also taken with 50 ns spacing. No pressure rise was observed, but unfortunately the bunch intensity was below the threshold of multipacting even for the 25 ns spacing.

The pressure increase did not show any saturation, presumably due to the long time scales involved. However, a saturation at the end of the batch can be seen clearly in the pick up data, which also demonstrate that for higher bunch intensity the electron avalanche starts earlier along the batch.

Sometimes the apparent gap location and the length of the subsequent batch segment, as detected on the pick up, do not seem to be entirely consistent. Hence, for future studies it will be useful to have an exact timing reference. Also the energy spectrum of the incident electrons could be measured by applying a proper bias voltage, possibly by averaging over long times, *e.g.*, seconds. If stability of electron cloud or beam turns out to be a problem, the bias voltage could be 'wobbled' (J. Tuckmantel).

Comparing pick up data before and after processing may help us to distinguish a decrease in the molecular desorption yield from the presumed decrease in the electron cloud (G. Arduini). Both of these could be responsible for the observed reduction in pressure increase.

One project for next year is the direct measurement of the secondary emission yield. A special set up will be installed in BA5 that will allow for a quasi-continuous monitoring of the secondary emission yield during the run. The first sample will be analogous to the SPS beam pipe. Later it could be replaced by an LHC chamber.

3 TT10 line profile measurements (C.-Y. Chao)

The 4x4 covariance matrix is obtained by fitting the beam-size and x-y correlation data from 3 or 4 OTR screens to a common reference point upstream. Dispersion at the screens is measured independently by varying the PS beam energy. In total 11 remaining quantities are determined by the fit. Repeating the same measurement for three different optics considerably improves the fit quality, and this proved a key ingredient for getting physical and reproducible results. Initially 2-D Gaussian fits were applied to the OTR data. These were later discarded in view of poor results. Instead direct evaluation of the correlation coefficients is now employed.

Data were taken on October 9 (26 Gev), November 1 (20 GeV), and November 2 (26 GeV). The momentum spread obtained from the fit is about 1/2 the number quoted by the PS. On October 9, a significant coupling was observed in all data sets. The fitted coupling coefficients were not affected by changes to the assumed energy spread. In November, the measured coupling was much smaller. On November 2, the OTR screen in the SPS ring was included. Analysing only 4 out of the 5 OTR screen measurements results in slightly inconsistent results. Vertical and horizontal bending magnets appear to introduce some bias. In November, already the bare OTR screen images looked markedly different from those on October 9.

In parallel, the transfer matrix along the beam line was measured by sampling difference orbits for various corrector excitations. In principle the transfer matrices should be symplectic, but such condition has not yet been imposed. Backtracing the coupling, as represented in the fitted σ matrix, to a point source in TT2/TT10 did not reveal any outstanding coupling source, because the σ_{13} correlation matrix is nowhere sufficiently close to zero. The σ matrix

was backtraced using either the model optics or the measured transfer matrices.

A conclusion from these measurements is that the optics model for TT2 and TT10 looks rather good. Although there is a small but unmistakable cross plane coupling generated in the transfer line itself (of the order of 1/20), the huge coupling which is sometimes observed appears to be a feature of the beam delivered by the PS. Emittance numbers obtained from the fitted σ matrix are mostly consistent with each other on the 10% level, except for the vertical emittance measured on November 2.

Y-C. Chao also discussed improved procedures of fitting to the OTR image. If the beam is tilted on the screen the rms data may be biased. Determining the principal axes of the image and cutting at a certain number of transverse σ gives better results.

Other possible improvements for the future include the use of an OTR screen in TT2, a more rigorous transfer-matrix determination, and a 15 parameter fit containing the dispersion.

4 Beams next year (G. Arduini)

We should inform the PS about the types of beams needed next year. In this regard, G. Arduini will send out an email asking for MD requests shortly.

One specific question is whether an LHC beam with 75 ns spacing should be made available in 2001. Note that it is not possible to quickly switch between this beam and the nominal one, so that at least two separate MD sessions would be required for comparative studies.

The SPS cycle next year will be 16.8 s long, and it will contain a parasitic segment of 4 s, compared with 700 ms this year. This means, in particular, that a short energy ramp, *e.g.*, up to 50 GeV, could be part of the parasitic MDs.

5 Next meeting

No meeting has yet been scheduled for 2001. An announcement will be sent by email in due time and the agenda will be posted on the web page of the working group http://cern.ch/sl-mgt-sps-swg

F. Zimmermann, 12th December 2000