Minutes of the SPS Studies Working Group (SSWG)

2nd meeting 14th May 2002

Present: G. Arduini, R. Bailey, T. Bohl, H. Burkhardt, R. Cappi, P. Collier, K. Cornelis (chairman), B. Dehning, W. Höfle, M. Jimenez, T. Linnecar, F. Roncarolo, G. Rumolo, F. Schmidt, R. Tomas, J. Tückmantel, P. Urschuetz, J. Uythoven, L. Vos, J. Wenninger, F. Zimmermann (secretary)

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1 Status of the Scrubbing Run (K. Cornelis)

The scrubbing run progresses well. The SPS operates with about 1.2×10^{11} protons per bunch, 2 batches of 72 bunches, at 26 GeV, with presently 15.9 s store time (high duty cycle). Over the last days the vacuum pressure has improved, and it is now everywhere below the 2001 trip levels. Until Monday, 20–50% transverse emittance blow up was measured. This has decreased to about 20% after an adjustment of the transverse damper on Monday afternoon. The observed beam losses become smaller from day to day, which indicates that they are caused either by the electron cloud or by the bad vacuum. K. Cornelis stressed that in order to determine where in the batch losses occur the possibility of taking fast-BCT measurements at two times in the same cycle would be highly desirable. It is unclear if the beam losses are related to transverse or longitudinal blow up. A possible explanation could be a 'dynamic scraping' due to the high chromaticity and the nonlinear field of the cloud.

On Monday morning the maximum secondary emission yield had decreased to 1.7 from an initial value of 2.3, measured two or three days earlier. At the same time the multipacting threshold has also improved. On Saturday evening the threshold (with a single batch) was around 6×10^{10} for a field-free region, and $4 - 4.5 \times 10^{10}$ in a dipole field. On Monday the threshold in the field-free region had increased to about 8×10^{10} and $6 - 6.5 \times 10^{10}$, respectively.

Due to the surface conditioning, the electron signal has attenuated, and the strip detector no longer detects a signal from a single batch. M. Jimenez mentioned that the electron cloud still poses a problem for COLDEX, however. According to one diagnostics up to 5 W/m heat load are deposited, while two other COLDEX signals and the upstream WAMPAC calorimeter indicate a 10 times lower heat load of about 0.5 W/m.

T. Linnecar asked why the scrubbing situation is so much better than last year. K. Cornelis replied that we do not know yet what will happen if we change the beam orbit. M. Jimenez pointed out that near the threshold we are losing the two strip structure, which suggests that the entire chamber is being cleaned. He also emphasizes that the bunch intensity this year is considerably higher than last

year. This increases the electron energies and should result in a much better cleaning efficiency of the electrons. A second question by T. Linnecar concerned the difference between operation at constant energy and acceleration in the 450 GeV cycle. It is believed that the electron cloud is not sensitive to the chamber temperature.

The present bunch length is 4ns (4σ). J. Uythoven reported that since the start of 2-batch operation the temperature of the kicker ferrite is constantly rising. So far it has increased to about 50°C, with no sign of saturation. The kickers are believed to stop functioning around 100–130°C. The performance of the Q kickers should suffer earlier than the extraction/injection kickers. The heating is expected to become worse with 3-batch operation.

K. Cornelis mentioned that there is a regular meeting every morning at 8:45 near the control room, where the progress of the scrubbing run is being discussed.

2 Resonance Driving Terms at 26 GeV (R. Tomas)

R. Tomas reported on the analysis of the 2001 MDs. Measurements were performed at 26 GeV with a single bunch of 2×10^{10} protons. The chromaticity was set close to zero, tunes were varied, and data were taken for different settings of the extraction sextupoles.

A serious problem is the high ratio of bad BPMs for the 100-turn data taking. R. Tomas showed typical examples, where it appears that the BPM errors are caused by noise, occurring on every so many turns. This problem might not show up in the closed orbit reading which is averaged.

In addition to singular bad BPMs, often all BPMs in one or two entire sextants fail together (different sectors for different data sets). R. Tomas developed a scheme to reject bad BPMs from the resonance analysis. This is based on comparing the rms spread in the FFT spectrum outside the tune line with a threshold value chosen after inspecting the data. F. Schmidt asked who from BI should be contacted to help in resolving this problem. It was remarked that J.-J. Gras is responsible for the BPM software and R. Jones for all other aspects.

A complete understanding of the linear coupling measurement was achievd. The strength of the linear coupling is inferred by comparing the height of the two lines in the FFT spectrum corresponding to the horizontal and vertical tune as a function of the skew quadrupole setting. Computing this ratio of tuen lines for both planes and multiplying the results removes the dependence on the ratio of oscillation amplitudes (the latter depends on the orientation of the coupled planes of motion at the kicker). The new analysis procedure renders the measurement fully symmetric. A finite amount of residual coupling remains even at the optimum setting of the skew quadrupole. F. Schmidt mentioned that this residual corresponds to a closest tune approach of the order of 10^{-3}. For the real machine the best skew-quadrupole setting was found to be -0.11 A.

The analysis of resonance-driving terms calculates the height of a sextupole-resonance line for all BPMs around the ring. In this plot locations of strong sextupoles show up as step changes. Data were taken with and without activation of the extraction sextupoles. In the latter case, the orbit offsets at the extraction sextupoles are a concern, since they introduce signficant beta beating. The beta beating was inferred from turn-by-turn orbit data, following the scheme developed by J. Morpugo and J Klem. The phase beating was found to be 3° for the baseline optics, and 8.5° with extraction sextupoles turned on. The latter corresponds to 15% beta beating.

In several but not all cases including the sextupole displacement in the simulation yielded a better agreement between simulation and measurement. The orbit offset in the extraction sextupoles was estimated from the orbit reading at nearby BPMs. K. Cornelis pointed out that this does not necessarily correspond to the actual offset of the sextupole, whose girder could be offset. For the lattice sextupoles BPMs are further away and, therefore, for them no displacement was added to the model so far.

R. Tomas then summarized his presentation. The results of the 2001 analysis are very promising. For the first time sextupole driving terms were measured around a real machine. The suspected correction factor of 2 due to decoherence was confirmed for the sextupole resonance lines. The coupling measurement was understood and is now operational. Overall agreement between simulations and measurements was improved by taking into account the beta beating due to the sextupole displacements.

H. Burkhardt asked for the role of the octupoles during these MDs. R. Tomas responded that the octupoles were adjusted so as to zero the detuning with amplitude. H. Burkhardt also mentioned the possible effect of space charge, which was not yet taken into account. He pointed out that the longer cycle in 2001 helped to improve the reproducibility of the experiment at 26 GeV.

G. Arduini asked whether the updated model can be used to identify the optimum working point for the LHC beam (*e.g.*, in the presence of high vertical chromaticity). Two possibilities are scanning the strength of resonances in the tune diagram, suggested by K. Cornelis, or a more direct tracking of the dynamic aperture. F. Schmidt and R. Tomas will look into this.

3 MD Planning (G. Arduini)

G. Arduini proposed to start the MDs with single-bunch studies for three weeks starting 27th of May. On 12th June a long MD at 80 GeV is foreseen with a single bunch. This MD will be allocated to impedance measurements (with negligible space charge) and studies of resonant driving terms, and they should provide informations on the behavior of a single LHC-type bunch during acceleration in the SPS.

4 Next Meeting

The next meeting of the SPS SWG is tentatively scheduled for Tuesday, 28th May, at 09:15, in Room 865-1D17. The agenda will be posted on the web page of the working group http://cern.ch/sl-mgt-sps-swg, and an invitation will be sent by email.

F. Zimmermann, 14th May 2002