# Minutes of the SPS Studies Working Group (SSWG)

$7^{\text{th}}$ meeting $4^{\text{th}}$ September 2001

**Present:** T. Bohl, H. Burkhardt, R. Cappi, P. Collier, K. Cornelis (chairman), J. Gareyte, L. Jensen, J. Klem, T. Linnecar, G. Rumolo, F. Schmidt, E. Shaposhnikova, L. Vos, F. Zimmermann (secretary)

**Excused:** G. Arduini, W. Höfle, D. Manglunki, J. Tückmantel

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## 1 Recent MD Results

### 1.1 RF Studies (T. Bohl, T. Linnecar)

Analysis of the rf MD data is still underway. T. Bohl reported that phase damping has been set up for individual batches. There was an observation of 4 small pre-cursor bunches with about 5% of the average charge in front of the LHC batch, and also occasional evidence for beam in the gap. R. Cappi and P. Collier mentioned that the nominal rf set up of the CPS had been done for $10^{11}$ protons per bunch, and that this set up is not optimum for the presently typical SPS operation with $5 \times 10^{10}$. A longitudinal tail of the main bunches can be influenced by a phase-loop feedforward in the CPS. This feedforward compensates for the energy change due to orbit lengthening when the fast bumpers are excited at extraction. A CPS pick used for the adjustment had been modified The pick up signal shows the tail, but it has not been immediately clear which part of this tail was instrumental.

Energy matching between CPS and SPS is a concern. In the last MD it took several hours instead of the usual half an hour. An additional complication arises, because the SPS field is still changing at the start of the injection plateau.

K. Cornelis reported that J. Wenninger has implemented a continous tune measurement, by means of which it is possible to obtain the chromaticity during the full cycle within 1 hour instead of 2 shifts previously required.

P. Collier mentioned that the intensity of the bunches was equalized to within $\pm 20\%$. The splitting in the CPS is sensitive to the longitudinal emittance, which is not easily controlled and adjusted, as R. Cappi pointed out.

T. Bohl and T. Linnecar discussed a study of noise sources and cross-coupling of different rf loops. Changing the reference to the synchro-loop from the beam signal to the rf has eliminated an instability of the quadrupole mode. The investigation of noise on the dipole field is continuing. Different from $p\bar{p}$ operation, for an LHC batch only the $m = 1$ mode is damped, whereas relative oscillations of bunches against each other are not damped.

## 1.2 Vertical Instability of Fixed-Target Beam (L. Jensen)

L. Jensen presented observations with the head-tail monitor made with R. Jones on the fixed target beam. About 40 ms into the cycle a vertical instability affects a few bunches towards the end of the long bunch train. The zone of instability grows in time, moving towards the front of the train. 1800 ms after injection, far above transition, the beam is stable again. K. Cornelis suspected that this instability was caused by a non-perfect set up of the transverse damper.

## 1.3 Impedance (E. Shaposhnikova, H. Burkhardt)

E. Shaposhnikova compared recent longitudinal impedance measurements with those from previous years. There is no longer a threshold in the measured bunch length as a function of intensity. and thus no sign of longitudinal instability. Bunch lengths were measured up to intensities of about $8 \times 10^{10}$. The large 400-MHz peak in the frequency spectrum during debunching has disappeared. The lowest-frequency (small) peak is now around 2.8 GHz. This frequency agrees with the cut-off frequency of the wall-current monitor and the peak could thus be an artifact. The comparison was made with spectral data taken in 1996. The absolute values cannot easily be compared, due to various hardware changes in the meantime. A quantitative comparison would be possible below transition, where reference data were taken more recently, in 2000. With the rf turned off, a strong self-bunching of the beam is seen, modulated at the 200-MHz fundamental frequency. This is different from all previous years. The dominance of the 200-MHz impedance may complicate the identification of the other remaining impedance sources in the machine.

H. Burkhardt proposed to establish an updated impedance model for the SPS. He noted that the transverse growth-rate measurements are sensitive to the resonator frequencies. Good results may be obtained by scanning the chromaticity at a low single-bunch intensity of $10^9$. T. Linnecar recalled that the transverse impedance of the cavities exhibits a resonance at 460 MHz with a low Q ($< 100$).

## 1.4 Electron Cloud (R. Cappi, K. Cornelis, P. Collier)

Electron cloud effects on the fixed-target beam depend on the rf voltage. Presumably, the reason for this is that multipacting more easily occurs for the shorter bunches. The point in the cycle where electron cloud is seen appears to be related to the three-dimensional beam density (G. Arduini).

R. Cappi reported that last week the CPS has reached the ultimate LHC beam intensity, with all other beam parameters close to the nominal value. The test was performed, since the

growth rate of the electron-cloud instability for a stored beam had been observed to increase strongly with intensity. The experiment demonstrates that even at ultimate intensity the instability rise time is longer than the time needed for bunch rotation and extraction, and that, thus, the electron cloud does not affect the quality of the ultimate beam delivered from the CPS.

Both in the SPS and in the PS the electron-cloud instability first starts in the horizontal plane. The SPS data show that the vertical instability growth rate increases with beam current, whereas the fast horizontal instability appears to be less sensitive to the beam intensity (K. Cornelis). The electron-cloud instability threshold with stored beam in the CPS is $3 \times 10^{10}$ protons per bunch. Some evidence suggests that the growth rate saturates at $5 - 6 \times 10^{10}$ (R. Cappi). The effective present bandwidth of the SPS transverse damper was measured with the beam. It was about 14–16 MHz. At the SPS, the threshold of the electron cloud appears to be much higher in the field-free regions than in a dipole field. Without field the threshold detected at the stripe monitor is about $7 \times 10^{10}$ protons per bunch.

# 2 Next Meeting

The next meeting of the SPS SWG will be announced in due time. 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, 4th September 2001