Minutes of the SPS Studies Working Group (SSWG)

2^{nd} meeting 15^{th} May 2001

Present: H. Burkhardt, R. Cappi, K. Cornelis (chairman), B. Goddard, M. Hayes, W. Höfle, J. Klem, T. Linnecar, D. Manglunki, E. Metral, G. Rumolo, E. Shaposhnikova, R. Tomas, J. Tückmantel, F. Zimmermann (secretary)

Excused: T. Bohl

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1 PS Status (R. Cappi)

The PS is running well. Set up for users, AD etc., has been finished. Preliminary CT test at the beginning of the run looked ok, but a detailed set up still needs to be done. During the downtime most of the rf hardware required for the LHC beam was changed. Presently, the PS MD efforts concentrate on the hardware re-commissioning. Work on the LHC beam might start next week, first on the nominal beam, later on the variants.

2 An Alternative Way of Measuring the Longitudinal Impedance (H. Burkhardt)

About fifteen years ago, A. Hofmann determined the longitudinal impedance of the SLC damping rings from the synchronous phase shift and the synchrotron tune shift as a function of rf voltage and current. A similar procedure was successfully applied at LEP by H. Burkhardt, A.-S. Müller, and J. Wenninger, who could deduce the beam energy with an unanticipatedly high precision from a measurement of Q_s vs. rf voltage $\hat{V}$. The LEP analysis was based on the relation $Q_s^2 = \eta h/(2\pi\beta^2 E_0)\sqrt{e^2\hat{V}^2 - U_0^2}$, where U_0 denotes the energy loss per turn. In LEP the latter was dominated by synchrotron radiation. Results were presented at PAC'99.

H. Burkhardt launched the idea of attempting a similar measurement at the SPS, where U_0 is entirely due to the impedance and is expected to scale roughly with the inverse third power of the bunch length. The estimated energy loss is 40 keV/turn for $\sigma_z/c = 0.5$ ns.

It was pointed out that there already exist various different ways of measuring the longitudinal impedance and that the proton beam conditions are inherently more unstable than those

for electron beams. In addition, the change of the bunch length with beam current and voltage might complicate the data analysis. T. Linnecar offered to try an exploratory measurement this year.

3 SPS Optics Model (F. Zimmermann)

A collaboration of A. Faus-Golfe (U. Valencia), G. Arduini, and F. Zimmermann attempts to revise the SPS optics model and to develop a procedure by which the nonlinear model can quickly be updated from a standard set of measurements. This study was motivated, first, by optics inconsistencies discovered by A. Faus-Golfe, R. Tomas, and F. Schmidt in the course of resonance-driving term studies and, second, by two observations made during electron-cloud MDs in October 2000: the optimum setting of the octupoles was found to be quite different from previous years, and an unexpected large third order chromaticity was observed in the vertical plane.

Measurements of nonlinear chromaticity and of detuning with amplitude for various octupole settings taken in October 18–20, 2000, form the basis of the present exercise. The data are fitted to an extended MAD model, by gradually adding multipole components and increasing the optical order of the fit.

The measured and modelled tunes agree with a remarkable precision. While the vertical chromaticity is also consistent, the measured horizontal chromaticity is far off from the prediction. It could be explained by a 30% strength error in one of the two focusing sextupole families or by a common error of 15% in both families. It is difficult to attribute this effect to a b_3 component in the bending magnets, as this component would need to be of opposite sign in MBB and MBA. The quadratic part of the chromaticity is fitted by introducing a small b_4 component in the quadrupole magnets. Finally, from the large third order vertical chromaticity one determines a sizable b_5 field component in the dipole magnets. Even with this modified model, the measured effect of the octupoles on the detuning with amplitude still differs significantly from the model prediction. This indicates that the assumed calibrations of either octupoles or oscillation amplitudes are wrong.

For this year, it was proposed to re-measure the nonlinear chromaticity and the detuning with amplitude, as well as the calibration. Additional chromaticity measurements for reduced sextupole strengths and measuring the tune change as a function of bending field, with radial re-steering would allow for an unambiguous identification of the sextupole-strength errors and the actual size of the b_3 components in the dipoles. K. Cornelis suggested to take 1000-turn data for various radial steerings, which should reveal the location of the sextupoles as sudden step changes in the phase-advance difference.

Two additional study proposals concern the transverse impedance measurements. A preliminary experiment in 2000 indicated that the head-tail monitor is sensitive to impedance effects. Measuring the frequency change for the $l = 1$ head-tail mode as a function of current would thus reveal the real 'wake' impedance without contamination from incoherent wakes, which impair the $l = 0$ coherent tune shift measurement. According to an old paper by B. Zotter we should observe the TMCI threshold for the SPS proton beam, if the coherent tune shift equals

about 5 times the synchrotron tune. We are close to this regime. E. Shaposhnikova mentioned that the threshold prediction may change if radial modes are taken into account.

4 AOB: New CNGS Transfer Scheme from the PS (K. Cornelis, R. Cappi)

A recent proposal by R. Garoby foresees to create long bunches in the PS by rotation using the 7.6 MHz rf system, and to send these bunches, through a new 200-MHz rf system in TT10, to the SPS. After a quarter bunch rotation in the SPS, the beam would then be captured by the SPS 200-MHz system. Advantage of this scheme is that it avoids debunching in the PS, which should render the beam more stable and allow for higher intensities. SPS beam intensity and emittance would show a modulation at 8 MHz.

5 Next Meeting

The next meeting of the SPS SWG is tentatively scheduled for Tuesday 29th May, at 09:15, Room 865-1D17.

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, 15th May 2001