Minutes of the SPS Studies Working Group (SSWG)

1$^{\text{st}}$ meeting 2$^{\text{nd}}$ May 2001

Present: G. Arduini, H. Burkhardt, P. Collier, K. Cornelis (chairman), B. Dehning, J. Gareyte, M. Giovannozzi, B. Goddard, M. Hayes, W. Hofle, L. Jensen, T. Linnecar, D. Manglunki, G. Rumolo, E. Shaposhnikova, R. Tomas, J. Wenninger, F. Zimmermann (secretary)
Excused: T. Bohl, R. Cappi, J. Klem, J.M. Laurent, G. Roy

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1 News from the High Proton Intensity Front (K. Cornelis, R. Cappi)

In the PS various scenarios are studied which could provide a higher intensity CNGS beam. The 3 main tricks are (1) double batch injection, (2) improved version of 5-turn continuous transfer — see below —, (3) extraction at 26 GeV. An intensity increase from the presently foreseen 5×10^{13} protons per SPS cycle to 10^{14} is conceivable. The intensity can be raised further if a 2.2-GeV superconducting proton linac, or a 120-MeV first stage H^- linac become available.

Operating a 10^{14} proton cycle in the SPS calls for an aperture survey, a modified RF feed-forward for beam loading compensation, assessment of kicker heating, and addressing problems associated with transition crossing and longitudinal emittance blow up (rf power).

2 Novel 5-Turn Continuous Transfer from the PS (M. Giovannozzi)

Presently the beam is extracted in 5 slices with a tune close to 6.25 and using an electrostatic septum. Problems are losses on the septum, unequal emittances of the various slices, and a mismatch of the slices in phase space, which results in emittance growth.

The new approach being studied is similar to the longitudinal gymnastics for the LHC beam. The linear machine is augmented by sextupoles and octupoles, and by a linear tune variation with time. Exciting the octupoles, and moving the tune across the 4th order resonance, 4 resonance islands are created, in which part of the beam is trapped. Moving the tune further away from the resonance, after mixing, the filled islands are moved to larger amplitudes prior to extraction. A critical parameter is the adiabaticity of the tune variation. Different speeds will be tested. Further numerical simulations are planned, which include an evaluation of the trapping efficiency and emittance reduction, and using a more realistic 4D model. Monitoring of the beam phase space requires pencil beams and a dedicated monitor, under development by the PS instrumentation group. The role of nonlinear elements in the bumper region needs to be investigated.

3 Objectives and Priorities in 2001 (K. Cornelis)

The first objective in 2001 is to recover from the ‘big bang’ in this shut down. This recovery comprises (1) aperture survey and alignment, (2) re-commissioning of rf controls, (3) effect of impedance reduction.

The next objective is setting up the LHC beam with 4×10^{10} protons per bunch and accelerating this beam to 450 GeV with the correct emittances (3.5 μm). The storage and acceleration of 3 or 4 batches with nominal spacing between batches is of particular interest.

The third objective concerns the high-intensity proton beam. The PS made a vague promise to provide a high-intensity CT beam in pulsed mode by October. Questions here are beam loading, emittance control and rf power.

The 4th objective relates to the electron-cloud studies. It is to define and measure observables to test the simulation hypotheses, and to extract informations from dedicated electron-cloud monitors.

4 Status of the Electron-Cloud Test Bench in LSS5 (G. Arduini)

The test-bench crash program involves a number of CERN groups and lots of good will. Main motivation of this study is to obtain a more reliable estimate of the heat load in the LHC. The latter depends on the parameters of the seconary emission yield ($\delta_{\rm max}$ and $\epsilon_{\rm max}$) and on the contribution from elastically scattered electrons. In the dipoles, the cloud will form two vertical stripes, whose positions and widths are sensitive to the critical simulation parameters and will determine the optimum location of the LHC pumping slots. The time evolution of the electron cloud will give information on scrubbing (long time scale) and elastic scattering (short time scale).

A test bench is being installed in LSS5. It consists of 4 IMHH magnets in a wiggler configuration. The maximum field is 0.266 T, whic hcorresponds to a maximum bump ampitude of 2.2 mm at 26 GeV. The dispersion is about 40 cm, and radial steering can vary the beam orbit in this region by $\pm$35 mm.

The system contains 4 separate vacuum chambers, which can easily be exchanged. The relevant SPS vacuum sector is small, but it could be decreased further. The section will contain electron stripe monitors, which are under development, and two electron-cloud pick ups.

The stripe monitors will measure the position and width of the electron-cloud stripe as a function of bunch intensity. They integrate over ms time scale, but with proper electronics the resolution might be as good as a single revolution or less. Expected stripe width is 2 mm and separation from the chamber center between 8 and 20 mm. A challenge is the condition that the monitor should not disturb the electron-cloud build up. Transparency is between 10% and 30% depending on the monitor design, which means that about this fraction of electrons passes through holes in the chamber and reaches the detector located underneath. The chamber holes are not aligned in the beam direction to avoid bias. The hole size is 1 mm in radius. The arrangement envisioned reaches a signal flatness better than 10%. The expected signal is of the order of 10^{10} e^- per batch and per ms, assuming 9% transparecy. Adding a bias voltage will also allow for an energy analysis. There are two alternative concepts for the detector. One uses $\sim$ 13 Cu 2-mm wide stripes on a ceramic, the other triangular plates. The latter has a larger trasparency of 30%, but it requires calibration by horizontal steering. The proposed electronics is of the fast spill type, so that it provides the signal for one turn every two turns. Most optimistically, we might get a 40-MHz sampling in a second stage. Various error sources for the stripe detectors have been identified and their effects estimated. These include detector granularity, source granularity, deviation of the field from the vertical direction, alignment of beam and detector (maximum sagitta 0.5 mm; orbit excursion of 0.4 mm for 10^{-3} energy oscillation).

The electron pick ups are of the same type as those employed last year. One pick up is unshielded and will be used as a trigger. Steering the beam across the pick ups is a fall-back option for the stripe measurements.

5 MD Program for 2001 (G. Arduini)

The 2001 program comprises hardware tests, impedance measurements, beam commissioning, studying the transverse behavior of 3 or 4 consecutive LHC batches, electron-cloud measurements, TT2-TT10 optics studies (coupling, stray fields), and CNGS type beams.

Long MDs are allocated to the LHC beam. Wednesday MDs address the Gran Sasso beam, OTR matching, hardware tests which are not compatible with physics. The last Wednesday MD is for the LHC beam. Parallel MDs initially use beams on the 26 GeV plateau, and later also contain acceleration to 50–80 GeV. These MDs are assigned to BI studies, impedance measurements, scrubbing tests, e-cloud monitors, TT2-TT10 optics. Lower priority items are dynamic effects, measurement of resonant terms, and any new ideas.

K. Cornelis pointed out that the high intensity beam does not appear too useful if available for 8 hours only, but that it would best be studied over a one week period, or longer.

C. Fischer's IPM will be operated first in the multiturn mode, later in the synchrotron mode.

6 Any Other Business

It was decided to keep the SPS SWG meetings on Tuesday morning, 9:15.

7 Next Meeting

The next meeting of the SPS SWG is tentatively scheduled for Tuesday 15th 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, 3rd May 2001