Minutes of the SPS Studies Working Group (SSWG)

11^{th} meeting 6^{th} November 2001

Present: G. Arduini (chairman), T. Bohl, H. Burkhardt, R. Cappi, J. Gareyte, L. Jensen, T. Linnecar, D. Manglunki, F. Roncarolo, G. Rumolo, E. Shaposhnikova, R. Tomas, J. Tückmantel, L. Vos, F. Zimmermann (secretary)

Excused: K. Cornelis, W. Hofle

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1 Recent MD Results and Status of the LHC Beam (G. Arduini)

In the last days before the shutdown, an LHC type beam consisting of 48 bunches with 25 ns spacing was accelerated to 450 GeV and slowly extracted to the CMS and ATLAS test areas.

G. Arduini presented a data set from the experiments which revealed satellite bunches. The satellites were found every 5 ns, and, thus, they did not only occupy the buckets adjacent to a main bunch. The satellite population was of the order of a few percent. G. Arduini emphasized that these satellites were not visible with the available beam diagnostics in the SPS, *e.g.*, using the wide-band head-tail monitor or the longitudinal profile measurement. The satellites could be suppressed by raising the rf voltage at injection.

Questions were raised about the longitudinal matching at injection into the SPS. As mentioned by E. Shaposhnikova, the normal way of adjusting the rf voltage is to minimize the quadrupole oscillation after injection. R. Cappi pointed out that the PS can easily change the longitudinal emittance, but that the final bunch length may be affected by cavity performance. Also, he stressed that the synchronization between the PS and the SPS cannot be better than 0.5 ns or approximately 40° in rf phase.

Also further electron-cloud studies have been performed during the last week. The multipacting threshold with 48 bunches was reached at a bunch population of about 3×10^{10} protons, the same number as seen previously with a larger number of bunches.

The effect of the beam size on the electron cloud was explored by inserting screens in the injection line, in order to increase the emittance. This experiments was done with 5–6$\times10^{10}$

particles per bunch and 72 bunches. Doubling the beam size from about 3.9 (x) and 1.2 mm (y) to 8 and 2 mm, respectively, completely suppressed the electron signal.

Emittance preservation during the full cycle was another study item. Beam sizes were measured using two wire scanners, one of which in a non-dispersive location, and also the residual-gas monitor. With a single batch and 5×10^{10} protons per bunch (about half the LHC design intensity), the emittances observed by the non-dispersive monitor were typically 2.05 (x) and 2.08 (y) injection increasing to 2.86 and 3.36 at 450 GeV (all emittances are normalized rms values in units of microns). The vertical emittance measured by the other wire scanner was 2.0 initially and increased to 3.0 at 450 GeV. The gas monitor only measured the horizontal emittance, which was 1.3 at 26 GeV, increasing to 2.95 at 450 GeV. The residual blow up, about 50%, occurs during the injection plateau and at the start of the ramp. In summary, all the monitor are roughly consistent, and yield an emittance value of about 3 μm at 450 GeV.

In particular, these emittances are in the desired range for the LHC. This satisfactory performance was achieved by operating with LEP-like tunes (26.19 and 26.24) and with a chromaticity of about 0.5 in both planes. R. Cappi suggested to repeat the measurement with only 12 bunches, where the beam is not affected by an electron cloud.

Studies were also conducted with more than 1 batch, but these were limited to time intervals of 5–10 minutes each, due to the large pressure rise from multipacting. For several batches, the emittance blow up increased, and the final emittances were about 4 μm. The question was raised how to operate the SPS next year with more than 2 batches, given the intolerable pressure rise. Some of the most sensitive regions are those near the kickers, where it will be difficult to relax the tolerance for valve closure, and near the electro-static septa.

Concerning the scrubbing, the threshold has increased from about 2×10^{10} protons per bunch to 3×10^{10} during the course of this year. The only effective cure of the electron-cloud instability found so far is operation at high chromaticity.

To study whether prolonged scrubbing will further improve the multipacting threshold beyond the present value of 3×10^{10} protons per bunch, an extended period of beam time would be required, of the order of at least two weeks. J. Gareyte was astonished that it appears to be difficult to get sufficient beam time for this key issue of the LHC project. He and R. Cappi pointed out that the LHC should be the top priority of CERN, and that there should be no question of getting sufficient beam time. G. Arduini was encouraged to strongly ask for more time. This will be discussed in the SLOC and LCC.

Some doubts were expressed as to whether the in-situ measurements of the secondary emission yield are reliable at the moment. R. Cappi remarked correctly that independent of the monitor the cleaning effect should be directly visible in the behavior of the beam.

2 AC Dipole (R. Tomas)

A study of the rf dipole was undertaken with the help of O. Berrig. In this experiment, the SPS damper is used to excite the beam coherently. In the vertical plane, this was successful. In the horizontal plane the gain of the damper was too low to excite any coherent motion, even on the resonance. Attempts to measure the emittances failed due to a problem with the wire

scans, whose use on the p2 cycle proved impossible at the time of this MD. The BOSC system, maintained by H. Jacob, was extremely useful, since MOPOS did not work properly. Data analysis is in progress.

3 Next Meeting

In view of the BI review on 20th November, the next meeting of the SPS SWG is tentatively scheduled for Tuesday, 27th November, 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, 6th November 2001