Minutes of the SPS Studies Working Group (SSWG)

5^{th} meeting -9^{th} May 2000

Present: G. Arduini, T. Bohl, H. Burkhardt, R. Cappi, K. Cornelis (chairman), Y.C. Chao, W. Hofle, L. Jensen, R. Jung, J. Klem, P. Knaus, G. Rumolo, E. Shaposhnikova, R. Tomas, J. Tuckmantel, L. Vos, M.P. Zorzano (secretary)
Excused: T. Linnecar, F. Schmidt, G. Roy

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1 MD results related to electron cloud(G. Arduini)

- **Emittance size measurements** From last year and this year experience it is known that, for a given bunch spacing and filling pattern (LHC type beam, about 80 bunches with 25 ns bunch spacing), there is a current threshold above which vacuum and electrostatic pick-ups show the presence of electron cloud. This year the threshold is $I \geq 6 \times 10^{12}$ protons per batch which is higher than last year one (4×10^{12}). The beam size along the batch has been monitored for an intensity above the threshold, with no octupolar component in the machine and vertical dampers off.

  Use of the fast wire scanner allows us to measure every 200 ns and monitor the beam size along the 2μs long batch. Measurements are performed twice, one right after injection (20 ms) and the other one 600 ms after injection. Qualitatively both measurements are similar: from the head to the tail of the batch there is an emittance blow up of a factor 7 in the horizontal plane, and a factor 3 in the vertical plane affecting mainly the last bunches of the batch. Last year the beam size blow up affected also bunches in the middle of the batch, and there was also a continuous blow up of the vertical beam sizes along the injection plateau (this was thought to be due to the vertical damper which was continuously exciting the beam).

- **Oscillations** The first bunches in the batch are lost (due to the extraction kicker of the PS). At this intensity (we are on the threshold), the behaviour seems to depend on the shot. For some cases it has been observed that the bunches start to oscillate on the horizontal plane and almost in phase from head to tail (low frequency oscillation). The rise time of this oscillation is about 10/20 turns ($\approx$ 1 ms). The bunches in the tail have

bigger oscillation amplitude. After the initial current losses, the beam losses are small and mainly in the tails (this has not yet been studied systematically).

(W. Hofle) To kill this oscillations it is probably necessary to implement a damper with an adjustable gain factor from the head to the tail of the batch.

(R. Cappi) *Could this be due to some other instability?* The electron cloud model is supported by the following facts: this depends on the filling pattern (and not on the local density), there is a common threshold for vacuum and pick-ups to detect it, the damper pick-ups get charged, and the threshold has improved after scrubbing.

2 Discussion on MD distribution

In view of the available beams and cycles, the MD distribution is the following:

Next Thursday MD (0-8:00) will be dedicated to measurements of the $Q \to 0.5$ problem with normal fixed target beam, and the luminescence monitor (to measure light production cross-section) with normal fixed target beam or MDPRO beam.

Next Wednesday MD (8:00-16:00) will study the LHC cycle and acceleration with single batch (80 bunches). The long MD will study 3 batches. The 120 MHz gain variation will be studied during these days.

Single short bunch measurements will start after the 24th of May, and single long bunch measurements in June.

3 AOB

- **120 MHz detection scheme for damper pick-up signals with LHC-type beam (W. Hofle)** Due to the 40 MHz bunch repetition rate all envelope information repeats every 40 MHz. Assuming that the contributions from the electron cloud effect (electrons collected by pick-up plates) are small at 120 MHz compared with the pick-up signal itself, we can use the pick-up measurements at multiples of this frequency to get measurements practically free from the electron cloud component. This is already available for the horizontal plane and connected to the feedback. Next week it shall be implemented on the vertical plane.

- **Instability when $Q \to 0.5$ due to too high damper gain (W. Hofle)**

  Already on previous runs, it was observed that when the machine tune is set very close to $Q = 0.5$ the beam becomes unstable. When the feedback works in a resistive mode (of operation) it introduces a tune shift modulation that averaged over time is zero, but instantaneously can bring the tune to 0.5. The amplitude of the oscillation of this tune shift increases with the damper gain. The gain margin for stability goes to zero as the tune approaches 0.5.

The problem disappears in simulations when the two kickers are located 90 degrees apart in betatron phase space. A phase advance smaller than 90 defrees also helps. The minimum phase advance required in practice is about 60 degrees.

Up to now the procedure for this problem is to

- reduce the damper gain (e.g. by switching off one vertical damper) or/and
- raise the vertical tune.

However this may require frequent intervention by the operators, when the beam intensity is varying too much (damper gain and instability vary with beam intensity), and good damping and beam stability cannot be guaranteed at all times.

The theory will be checked in an MD.

- **Vacuum measurements at the gage close to the supra-cavities (T. Bohl)**

  Intensity and vacuum pressure measurements performed at the gage used for the interlock system of the supra-cavities along a day show a significant improvement at the beginning and end of the scrubbing period. In the first day current in the ring and pressure were very strongly correlated, on the last day the vacuum stayed constant even when the current was above the threshold. Therefore this will not be a problem for the super-conducting cavities.

4 Next meeting

The next meeting is scheduled for Tuesday 23th May, at 09:15, Room 865-1D17. A reminder will be sent by email in due time and the agenda will be announced on the web page of the working group

http://cern.ch/sl-mgt-sps-swg

M.P. Zorzano 9th April 2000