SPS Studies Working Group

Tenth Meeting – 26 October 1999

Present: G. Arduini, T. Bohl, H. Burkhardt, R. Cappi, K. Cornelis (chairman), J. Gareyte, W. Höfle, J. Klemm, P. Knaus, T. Linnecar, F. Schmidt, J. Tückmantel, L. Vos, G. Roy (secretary)

Excused: P. Collier

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1 Proton MDs until end of year

G. Arduini presented the MD requests for the proton beam until the end of the year. A total of eight sessions are available until 15 November. The following studies have been requested:

- Electron cloud: emittance blow-up (head and tail of the batch) as a function of intensity. Dependence of the intensity threshold on the number of bunches. 1-2 sessions. Requires damper in good shape.
- 26 GeV single short bunch for impedance reference measurements (detuning and phase advance measurement with intensity) - 1 session
- 20 GeV single bunch for microwave instability studies below transition (2 sessions week 44)
- Measurement of the resonant terms from multi-turn measurements (1 session)
- Aperture measurement (1 session at 20 or 26 GeV)
- Test of a new (another!) beam profile monitor (3 sessions)
- IBS studies with lead ions (last long MD)
- Measurement on the lead ion optics without stripper

After discussion a planning was proposed which was later changed again. The final version is available on the Web on the SPS MD pages:
`http://nicewww.cern.ch/~arduini/spsmd/1999/mdpage.html`

After November 15 only measurements with unstripped lead ions will be possible on the P2 segment.

2 High Tune Optics

G. Arduini presents the tests of a higher tune optics in the SPS. The horizontal tune was raised from $Q_h = 26.62$ to $Q_h = 32.62$; the vertical tune was left unchanged. The predicted benefits being a reduction of the horizontal dispersion of the order of 35%, a small reduction of η/η_0 and therefore an increase of the transition energy and a reduction in the debunching time at the intermediate plateau (conversely a smaller momentum spread required for a given debunching time). Disadvantages are a very modest increase of the maxima of the beta functions, a longer debunching time at extraction and less sampling of the orbit in the horizontal plane. Note that in this configuration the maximum energy of the SPS is still above 392 GeV.

The performance obtained – intensity and transmission – is similar to the standard optics case. However a bad horizontal orbit ($\sigma_h = 7.7$ mm) with a vertical orbit mostly unchanged was observed. The horizontal scraping at low energy is still present which seem to point to a phenomenon in the transverse plane (horizontal emittance?). Losses are observed on the flat bottom at positions 2.20, 2.21 and 2.23. Slow extraction settings were calculated by P. Knaus but are incompatible with leptons operations since electrons would hit the MST.

G. Arduini concluded that no pathological problem was found with this higher horizontal tune optics. However in many respects the standard SPS tunes (26/26) seem to be hard coded, *eg.* injection dogleg and extraction, which could be important for other optics studies in view of LHC. The alignment data should be revised in view of the orbit observations.

T. Bohl then reported on longitudinal observations on this optics. The dispersion at the radial pickup is reduced from 1.94 m to 1.37 m. The nominal and observed (in bold) parameters on the two supercycles are summarized in the table below and show very good agreement.

	cycle-361 (nominal)	cycle-362 (high tune)
γ_t	23.3 (55.5 GeV/c)	27.8 (66.2 GeV/c)
time in cycle [ms]	**5232 (54.9 GeV/c)**	**5318 (66.0 GeV/c)**

The debunching time on the intermediate plateau went from 721 ms to 662 ms, a reduction of 8.2% in agreement with the predictions.

On the flat top the debunching did not evolve as initially expected for the optics of CY-362: Before the beam debunches, as observed at $4 \times f_{\rm rev}$, a slight bunching occurs, probably induced by the way the beam debunches earlier at the intermediate flat top. There, particles with a high momentum spread move into the holes between the four batches and are then re-captured at this place for the second ramp towards the flat top. The particles with a low momentum spread will be displaced less and stay proportionally closer to the original batch positions. This means that at the end of the intermediate flat top there will be an unequal momentum distribution around the SPS circumference. If this distribution is kept until the flat top, the particles with a large momentum deviation will move fast towards the original batch positions

before the particles with the low momentum deviation start to move away from this position. As a consequence the $4 \times f_{\rm rev}$ component of the beam might first rise before it decays.

A similar behaviour is expected for the optics of CY-361. However, the data acquired with CY-361 was obtained with the slow extraction on and could not be used for comparison. Further observations are necessary.

A discussion followed on some of the observations presented. However the proof of principle was given: the transmission is at least as good on the high tune optics and the debunching time on the intermediate plateau is indeed reduced. Another lesson learned is that the momentum spread is not the important parameter for the losses at injection and the horizontal emittance seems more important. The orbit also needs attention and with an increased transition energy one also has less control of the orbit around transition as the correctors become less effective.

3 Injection Damping

W. Höfle reported on injection damping of the Lead beam. Last year the damper clearly helped in reducing the injection oscillation in the horizontal plane with no effect in the vertical plane. This year horizontal injection oscillations are naturally smaller, and not reduced when the damper is switched on, and some damping is seen in the vertical plane. If the damper is detuned the oscillations increase as expected. W. Höfle suspects some "natural" damping sources such as chromaticity or octupoles. The octupole settings are the same as last year, the chromaticity should be checked.

4 High Intensity in CPS

K. Cornelis expressed strong interest in emittance measurements on the proton beam at high intensity to be made in the PS before the end of the year.

R. Cappi explained that the CPS priority is now on getting the nominal LHC beam. If all goes well, they can then turn to high intensity studies which require significant tuning beyond the 2×10^{13} ppp already obtained two weeks ago.

R. Cappi will report on these measurements at the next meeting, if they are available.

5 Next Meeting

The next meeting is scheduled for Tuesday 9th November 1999, at 09:15, Room 865 1-D17. 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://wwwinfo.cern.ch/~ghislain/sswg/sswg.html`

G. Roy
29 October 1999