SPS/RF/TL/BS

1st June, 1976

SPS COMMISSIONING REPORT No. 7

RF Team Report on the Run of 25 - 26 May 1976

RF-Group

The RF run began at 00.30, 26 May after a series of experiments on the transverse phase plane. The circulating beam was very stable. Initially the beam was captured using RF locked to a frequency synthesiser and the optimum frequency was found to be 1 KHz lower than that used for modulation in the PS. This indicated that synchronised bunch into bucket transfer was not possible without adjusting the two machines. Consequently, in order to optimise the capture without changing the operating conditions the phase loop was switched on at a time soon after injection. Different timings were tried but the value was not critical and a final setting of 10 revolutions after injection was kept. The resultant situation was very stable; without the radial loop the phase loop offset could be adjusted to hold the radial position ∿ constant for > 100 mSecs. Almost complete beam loss was observed at ∿ 630 mSecs, this loss being similar to, but more stable in form and timing from cycle to cycle, than that seen in previous runs.

Because the situation was stable it was possible to add the phase programme to complete the system for the 50 GeV cycle. The correction to the radial error signal was of the correct sign and neutralised the phase offsets to a large extent. The dump was then moved to 1000 mSecs and the behaviour of the various loops during the beam loss was examined in more detail. Nothing unusual was found and indeed it was clear that from time to time a very small quantity of beam was surviving after the 630 mSec allowing the loops to retain control (see photo 1). This suggests that the dynamic range of the system is good and approximately centred. An attempt was made to "steer" the beam, using radial control, through the 630 mSec barrier but was unsuccessful.

At 2.00 a.m. a Q measurement was asked for and as a result the injection Q_h and Q_v were both lowered by 0.05. This change did not affect the beam loss pattern.

In order to remove one unknown, that of the behaviour of the unpowered cavity (No 1), this cavity was brought into operation. A series of measurements and adjustments to ensure that with zero degrees counterphasing the phase of the RF as seen by the beam in both cavities was zero, was carried out with the dump at 300 Secs. Using the detected wideband signal the bunch shape oscillations due to mismatch between bucket and bunch were observed just after injection. By counterphasing, the effective R.F. voltage was progressively lowered from 2 MV (injection), the synchrotron oscillations decreasing in frequency and amplitude until at 80 kV the buckets were well matched to the bunches. The counterphasing was programmed to give a linearly rising effective voltage from 180 kV at injection to ∿ 2 MV after 20 mSecs. The dump was moved to 700 mSecs and the capture efficiency in this mode of capture was found to be of the order of 75 %. However, the beam loss at ∿ 630 mSecs was unaffected.

At this point, 5.15 a.m. the Q was again measured but this time at 570 mSecs, the result indicating that the Q's were good (Q_v ∿ 0,6 Q_h ∿ 0,55).

The beam was unavailable from this time until approximatively 11 a.m. when measurements on Q and closed orbit were taken. At 2.15 the RF again had control and a series of experiments at different harmonic numbers allowed measurements of the various systems at constant field but with varying frequency. The phase difference between cavity and phase pick up was measured for h = 4620 to 4635 and the resultant change was consistent with the decrease in bunch wavelength. The synchrotron frequency varied from ∿ 825 Hz at h = 4620 to > 1 KHz at h = 4635; this change agrees with the change in effective voltage due to phase slip. Acceleration with all loops on (no freg. prog.) and at a harmonic number of 4627 showed loss at exactly the same field and tune as before. As the frequency was now different at the point of loss it was obvious that a longitudinal effect was not responsible. A return to h = 4620 showed again the loss at the same field.

It was now clear that the RF low and high level systems were behaving nromally and a series of Q measurements at different times during the cycle were undertaken.

Q measurements showed that a large change in Q occurred at the time of loss, the Q in fact falling rapidly towards and through the half integer resonance. Raising the Q's to give more "room" in the Q diagram allowed the beam to survive to 900 mSecs. The next step was a correction to the quadrupole tracking to correct for this large fall in Q.

The settings for transition had previously been implemented and the transition timings switched on. Following the final modifications to Q tracking, the beam immediately passed transition and accelerated straight to 50 GeV. Losses at transition were very small (Photo 2) and the wideband pick up indicated that the bunches were stable to 50 GeV.

Conclusions

1) The phase program behaves as expected.

2) The counterphasing loop has been tested and used successfully with the beam. This is the last major item to be tested with the beam.

3) Measurements with differing harmonic numbers allowed successful testing of all systems at different frequencies with constant magnetic field.

4) The losses at 630 mSecs seen during the early part of this run and during previous runs was due to a transverse resonance crossing.

5) With the present rate of rise of field (0.1 T/sec) the crossing of transition has not presented any problem.

T. Linnecar

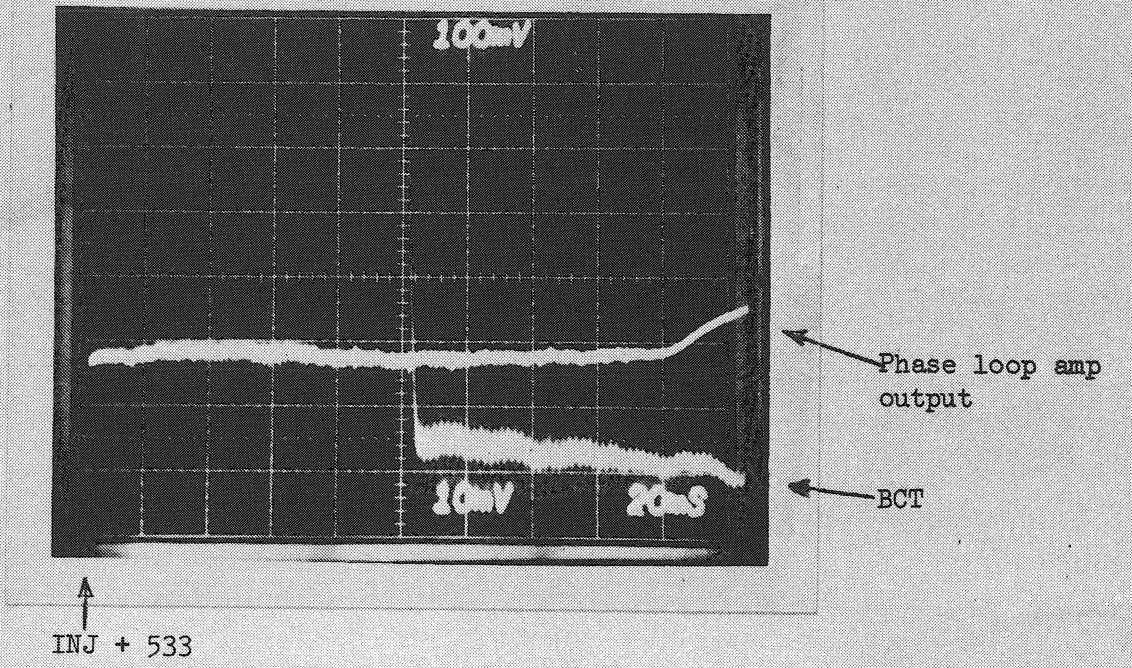

PHOTO 1 The phase and radial loops retain control even after severe loss of beam. Equivalent height of BCT pulse just before loss is 40 divisions.

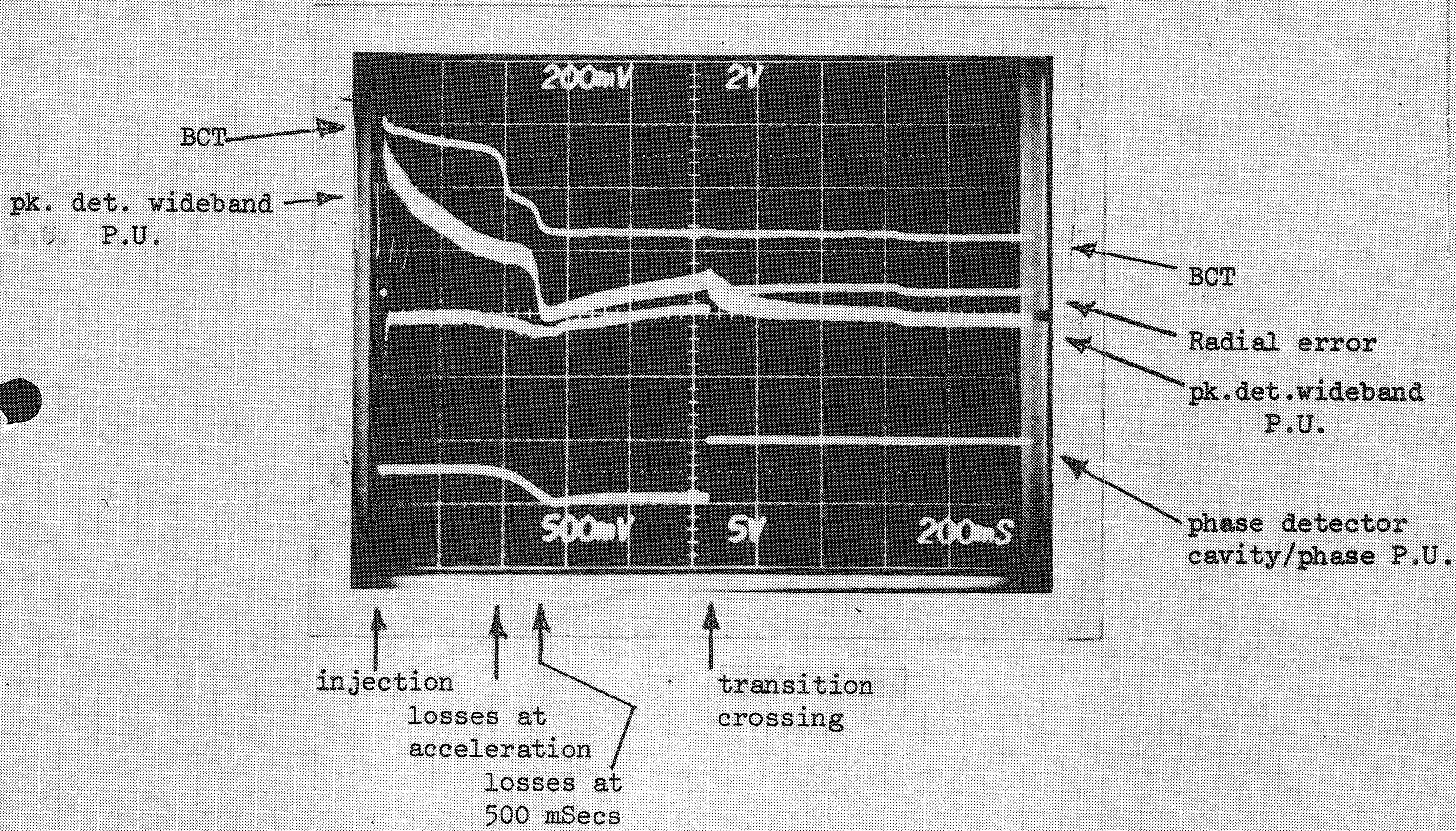

PHOTO 2 This shows the situation just after transition had been crossed for the first time. The loss of the uncaptured part of the beam at acceleration can clearly be seen by comparing the beam current transformer and the pk. detected wideband P.U. signal. The losses at 500 mSecs appear on both and would appear to be due to the proximity of the integer resonance at this time. At transition the wideband signal shows the increasing height of the bunches while on the BCT a very small loss is observed.