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THE CPS CONTRIBUTION TO MULTIBATCH FILLING OF THE SPS

D. Fiander*

1. Summary

This note outlines the modifications which have to be made to the CPS to allow it to be an efficient injector for the transfer of up to 5 CPS batches per SPS filling.

The first proposed modification is to reduce to about 0.65s the present CPS cycle of 1.2s for 10 GeV/c beams. This will be achieved by changes to the Booster main and auxiliary power supplies and by alteration of the PS main magnet inter-cycle field.

The second proposed modification is to complement the existing Continuous Transfer (CT) system with a faster fast bump. This will allow high efficiency shaving extraction over one or two revolutions, and used in conjuction with the CPS full aperture kicker will furnish beams for 3 and 5 batch filling.

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* Chairman of PS Multipulsing Working Group

2. Reduction of CPS Cycle Time

The CPS comprises three inter-linked machines, the 50 MeV Linac, the 800 MeV Booster and the 26 GeV PS. The cycle times of the Linac and Booster do not depend on the peak energy to which the beam is accelerated in the PS whereas the PS cycle time is directly influenced. The design figure for beam energy at transfer is 10 - 14 GeV/c but to date all transfers have been at 10 GeV/c; it is assumed that the transfer of beams for multibatch filling will take place only at this energy. With this limitation it seems possible to reduce the cycle time to about 0.65s* if the following modifications are made.

50 MeV Linac

No modifications are needed. The new 50 MeV Linac, which will enter service in 1979, has a design cycle time of 0.5s.

Booster

The present cycle time is 1.2s. To reduce this to 0.65s requires a higher main magnet voltage. This can be provided if the main magnet power supply is modified by adding an extra real power rectifier-inverter group and a new reactive power compensator. With these modifications the present high reliability and low disturbance level on the CERN 18 kV network will not be impaired. Certain auxiliary power supplies require reinforcement or replacement but the magnets which they feed are adequately rated.

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* On the basis of computation a minimum cycle time of 0.6 and 0.65s can be expected. The final value remains to be determined experimentally.

Tests have been made in conjunction with the Services Industriels de Genève (SIG) to determine the power transients on rotating plant connected to the SIG network due to the intermittent pulsed loading of the Booster main magnet. These tests, up to a Booster frequency of 1.8Hz, have shown the transient loading of the Verbois alternators to be less than 1.5% of the nominal machine rating. The conclusion drawn at CERN is that there would be no power supply network problem for a Booster cycle time of about 0.65s - formal confirmation from SIG is outstanding.

PS

The PS main magnet cycle can be shortened to about 0.65s by raising the inter-cycle field to about 400 gauss and minimizing the dead time. Only the controls of the main PS magnet power supply need to be modified to obtain this shorter cycle time. Some capacitor discharge auxiliary power supplies must be rebuilt.

3. Changes to Ejection System

The present CT ejection system, whilst designed for single batch transfer, is able to handle 2 batch transfers. It is not able to handle 3 and 5 batch transfers because of the high absolute and inter-step voltages which would occur in the fast bumper pulse generator. To make efficient 3 and 5 batch transfers it is necessary to provide a faster fast bump, excited from higher voltage 2-step pulse generators. This new equipment, when used in conjunction with the existing PS fast kicker, would extract the beam over 2 or 3 PS revolutions as a "mixed" extraction i.e. partly by "shaving" and partly by fast extraction. This principle has been proven in PS Machine Development time.

4. Conclusions

The CPS can be turned into a reliable and efficient multibatch injector for the SPS. The cycle time can be reduced to about 0.65s thus aligning the SPS filling time with the waiting time inherrent in many of its operating cycles.

The present CT ejection system can provide reliable 1 and 2 batch filling. With some hardware additions good quality 3 and 5 batch filling can be provided.

The modifications needed to the CPS would be based on well proven engineering techniques and could be applied without perturbing the operation of the CPS.

For further more detailed information relating to this proposal reference should be made to PS/AE/Note 77-2 Rev. 1.