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POSSIBLE TASKS FOR A COMPUTER CONTROL

(POWER HOUSE AND BEAM TRANSPORT)

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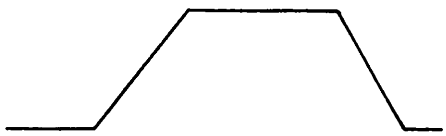
1. MAIN MAGNET POWER SUPPLY

1.1 Future cycles

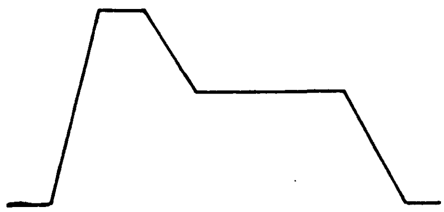
In the future the ISR and the 24 - 28 GeV/c physics will no longer use the same magnetic cycle of the PS. ISR users will want 26 or 28 GeV/c with little or no flat-top, the other physicists will probably want a period with 4 bunches ejected before each filling. The following cycles could therefore be necessary:

a)



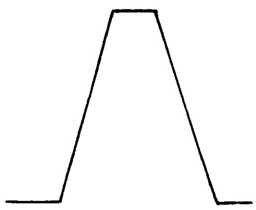
24 GeV/c physics

b)



preparation of filling of
ISR + 24 GeV/c physics

c)



ISR filling

Later, an additional 10 GeV/c front cycle will be needed for the 300 GeV/c:

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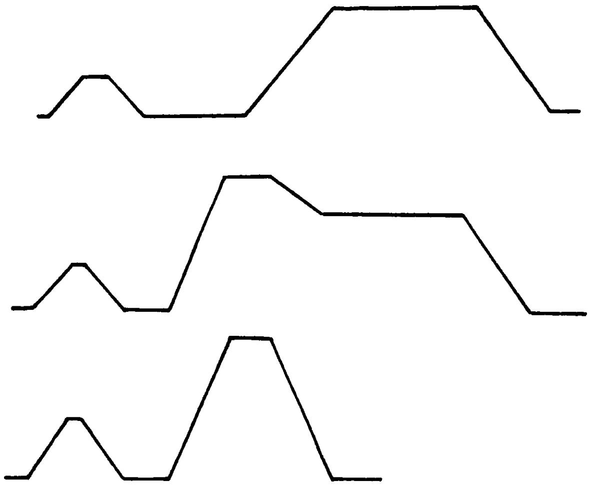


a')

b')

c')

1.2 Possible tasks for a computer

The computer should be a satellite of the central IBM 1800 for the reason outlined in ref. 1.

1.2.1 Synthetise the required cycle

For OPERATION one finds that, via the IBM 1800 one should be able to request a satellite computer to set up all the settings (including the PFW) and to make the final adjustments to obtain a given cycle. It could be done with similar methods as at Berkeley[2]. This will become necessary because with the number of changes of cycle per day (at least 3 if there is only one ISR filling per day), one should facilitate and speed up the change-over. These change-overs need to make settings (5 or 6 timings and between 4 and 10 potentiometers) according to a table in the memory of the local computer: this is an easy task for a computer. The second part of the change-over consists of final adjustments (tune excitation potentiometers to adjust B_9 - B_{19}, tune the energy of the flat-top, change the number of M pulses of the rise and the average speed, adjust the ripple on the flat-top, etc.): this is more difficult because one must computerize the loop actually closed by an operator looking at signals on scopes and correcting the timings accordingly, but it could be made when more experience is gained on the implications of a change of cycle. In this spirit it would be desirable to have the possibility to change between 2 sets of tunings. With this possibility one would be able to study, for instance, the influence on the time to stabilize the flat-top energy of the duration of the stop and of the variation of the power consumed for the 2 cycles.

With control by computer, the change-over is not limited to a small number of cycles and it is possible to make changes to a part of the total cycle (for instance the injection to the 300 GeV/c or the first flat-top of a double flat-top cycle) without affecting the rest of the cycle too strongly (for instance maintain the energy of the second flat-top). Moreover, when one wants a change of cycle the computer can check that the new cycle asked takes into account the operational parameters of the power supply and magnet; for instance it can check that the power demand is the same, that the repetition rate is not too high. When the computer has answered that the cycle requested is within the possibilities of the power supply, one can select the new cycle for pulsing. The computer can also take into account in the choice of the new cycle the limitations introduced by the duty cycles of other elements (septa for slow ejection for example).

With computer control one is also able to indicate the faults, to log them, eventually to reset them, and finally to restart the power supply.

In the POWER group data logging is being prepared of 100 measurements related to the status of the main generator (voltages, currents, temperatures, water flows). This will be made with the East Zone Siemens 301 computer and will be ready after the next shutdown. Timing settings could also be acquired, but this is not foreseen for the moment. Scanning of all the values recorded and indication of certain values drifting would be made.

Concerning setting-up of cycles by computer, they are not yet convinced that this is necessary but they could make the change-over of settings (but not final adjustments such as ripple minimization) and some drift compensation with the Siemens 301 computer. They emphasize that a lot of experience can be gained about the adjustments necessary when one changes cycle, if the settings could be duplicated and if one could pass from one series of settings to the other by the means of a simple switch. Concerning the stabilization of the second flat-top energy when the first one is changed in the case of a double flat-top cycle (for instance if one has two fast ejections in 58 at high energy and slow ejection or targets at a lower energy) an ad hoc loop could be installed.

Conclusion for this point: During the time period concerned (1971 - 1976) the change-over of cycles must be facilitated and a small computer would make it possible to do this and to add all the additional tunings found necessary from the experience gained. Therefore the CO group is not in favour of making many specialized loops to cure the possible instabilities: a computer should do it, working in real-time.

Nevertheless, it is agreed that further experience is needed before computer control is introduced into operation and therefore duplication of the settings possible would be very useful.

1.2.2 Servo action

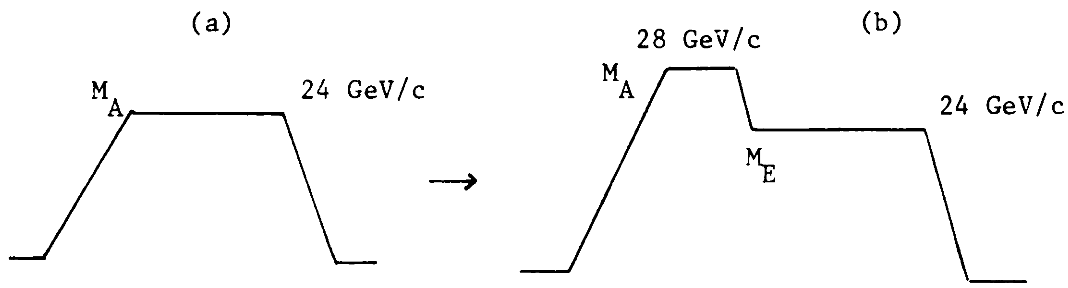
This concerns action on the main magnet power supply as part of the process of servo control of the slow ejection SQUARE[3]. The "learning" controller could be the satellite computer and it could be instructed to keep the values of the preceding pulse as reference if the beam is lost before the flat-top (and not to come back to zero action because otherwise too many pulses would have a bad servo-control after the lost pulse). This action on the main magnet power supply would be authorized by the Power group only if the changes are slow. This could be guaranteed by the computer control of the operation.

Closed loop control of the field stability could also be achieved by the satellite computer.

1.2.3 Timings to trigger high energy operations

The Siemens power supply already delivers pulses which could be used to start special timing trains for each operation (ISR, 300 GeV/c, 24 - 28 GeV/c physics): this would be equivalent to the old T train. For these trains, the IBM 1800 could derive pulses to trigger the various power supplies, debunching, RF perturbations, etc.

The generation of these trains must take into account the type of cycle. For instance, if one makes the following change:



the pulse starting the flat-top at 24 GeV/c is not the same in the two cases. So, of one wants to avoid changing all the timings and retuning the operation at 24 GeV/c after the change of cycle, the train of pulses used for this operation must be linked to the master pulse M_A(a) or M_E(b). The logic to warrant that this is the case could very well be made by the satellite computer.

2. BEAM TRANSPORT

2.1 Future beams

In the future the proton beams will be derived from SE 62, FE 58, SE and FE 16, FE 74. All these beams will go to the South Zone (South or North Hall), East Zone (East and South-East Halls), West Hall and 300 GeV/c. Secondary beams will be derived from external or internal targets as now.

2.2 Applications for computers

Here again there should be satellite computers linked to the central IBM 1800. But small computers are already there or have been ordered; ad hoc solutions to link them with the IBM 1800 are being investigated (data link) but as this problem had not been foreseen earlier, it is not excluded that the time during which the central computer is occupied to deal with these small computers will be relatively long.

2.2.1 Setting-up and logging for proton beams

For all proton beams foreseen, one wants for the OPERATION to be able to ask for an energy in a beam from the MCR and to have the settings made by the satellite computer via the IBM 1800- Moreover, one should be able to correct only one or a few elements and to have a log of all elements.

The POWER group has mainly studied the problem for the West Hall. The beam transport between the PS and the West Hall will be tuned by the Argus 500 computer of the ISR and it will be possible to control settings from the MCR. A data link with the IBM 1800 is being studied. The beam transport elements in the West Hall will be tuned by a Siemens 301 [4] and it may be sufficient to send to this computer, via the IBM 1800, the energy and the beam which one wants to set up. To achieve this, the link between computers could probably be made with data channels. The total tuning will then take a few minutes for 70 elements. For the East Zone operation with a Siemens 301, there is only a data logging system and a drift signal can be given. The reference values are in the core of the computer and are compared with the actual values; moreover, all values are printed once an hour. There is also a possibility of setting up currents with one digital voltmeter: while moving a potentiometer it compares the value wanted to a reading of the current in the power supply and stops the potentiometer when the value required is obtained. This must be done for each power supply successively and to set up the 100 elements of the East Zone would take about an hour. A first trial will be made with the elements of the bubble chambers' beams. For the South Zone only data logging is foreseen for the time being. At first this will also be made with the Siemens 301 computer of the East Zone.

If it is wanted to make the setting-up of beams in the East Zone, logging of currents (East and South Zones) and also to log the settings of the Power House, the memory of the Siemens 301 computer of the East Zone will have to be extended (from 8 K to 12 or 16 K).

Conclusion for this point: The situation needs to be improved, mainly in the East Zone. If it is decided to make the tuning of the beam transport elements in the East Zone with the Siemens 301 as for the West Hall, digital sources similar to those for the West Hall would be necessary. The price to modify the 90 power supplies would be about 100 to 150 kF but it is not excluded that cheaper elements arriving on the market could lower this price. This modification would simplify the setting-up of proton beams and of the secondary beams by users.

2.2.2 Information on currents in some other elements

In the case of beam transport elements, placed near the PS vacuum chamber, for secondary beams in the South Zone, one should have indications of their currents. These indications sent to the IBM 1800 could give rise to either a veto on a too big change (making too big a modification of the injection orbit) to to the start of a correcting action to compensate the effect of the current, or a combination of both actions.

REFERENCES

1) O. Barbalat, The PS development programme, MPS/DL 71-10

2) D.M. Evans, R. Frias, B. Hordos, Bevatron guide field control, UCRL 20189

3) G. Shering, Servo control and short interruption of the "SQUARE" resonant extraction. MPS/CO Note 71-19

4) B. Danner, H. Ullrich, The control system for the West Area beam beam transport power supplies, MPS/PO/Note 71-2