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PS PHYSICS OF THE FUTURE - AVAILABILITY OF PROTONS

I. INTRODUCTION

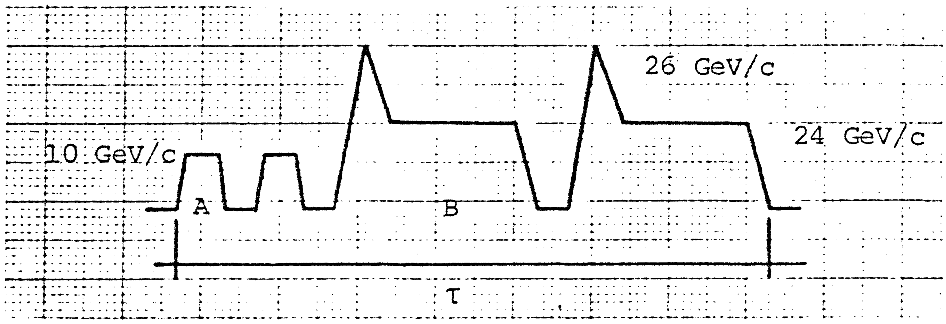
This problem was last examined about a year ago, (Future possibilities of physics at the PS : DIR/PS-Memo 78-15). We can now, even though there are still many factors unknown, make some new guesses about proton availability for PS 25 GeV physics, including the not yet accepted project LEAR.

In what follows no attempts at optimization are made but after some simplifying assumptions the main points relating to proton availability for PS Physics are given.

II. PS CYCLES

1. 1979 - The Supercycle

The SPS cycle time τ dictates the length of the PS cycle, this is composed of two components A & B, for example



The cycle time τ must be a multiple (integer) of the A cycle time. Today, A is ≥ 1.2 s and may be repeated up to five times whilst B is typically repeated three times with a cycle time of 2.4 s.

2. 1980-81 - The Supercycle

a) With the completion of the PS part of the SPS Increase of Intensity Project the A cycle time will be ≥ 0.65 s but with a forbidden region between 0.65 and 0.83 s as required by the Services Industriels de Genève. Typical supercycle times will be about 11-12 seconds varying with the number of A pulses (say 3 or 5) needed for the SPS and its final Energy. Commissioning of the full equipment cannot start before the end of the PS 1980 shutdown and it is not now clear how soon one will be able to operate at the fastest cycle times.

b) When a B cycle is used for $\bar{p}$ production for filling the AA, 2.6 s is estimated to be the minimum time for cooling reasons.

III. PROTONS FOR PS PHYSICS

Given the assumptions and comments outlined below we can attempt to assemble in the attached table indications of the changing availability of protons for PS Physics during the coming years. The column heavily outlined shows percentage availability compared to the beginning of 1979.

a) For convenience we have taken a PS operating year made up as follows :

44 weeks decomposed into : 2 x 5 week periods (for SPS $\bar{p}$ runs = 23% of total PS time), 4 x 7 week period and one six week period. This is probably too optimistic.

b) The first half of 1980 will see no major changes in the operational requirements of the PS, but the second half of the year in which an eight week shutdown takes place is complicated by a number of factors:

- Booster controls conversion.
- Final installation for "SPS Increase of Intensity Project" to be followed by commissioning (for this and the above, an additional 8 weeks shutdown, thus 50 MeV operation during this time for PS).
- Acceleration of high intensity 5 bunch beams ($\bar{p}$ production) in pulse-to-pulse parameter programming mode.
- Need to give priority to AA tests and running-in vs ISR/PS Physics,
- Preparations for $\bar{p}$ acceleration in PS, etc.

This matter is best treated in a separate note after further evaluation.

c) 1981 is perhaps a more difficult year to treat, as one supposes that a considerable time will have to be devoted to $\bar{p}$ testing in all its aspects combined with the pressure to run both proton and $p\bar{p}$ physics in the SPS together with $p\bar{p}$ in ISR and protons for PS physics. This is under study and it is felt better not to make any comment until there is better understanding of the matter than there is now. (We assume no pp physics for ISR - this may not be true).

d) For $p\bar{p}$ physics in ISR we assume a complete filling takes 5 days (ref.: ISR-BOM/78-18) and is followed by five or more days running for physics. In 1982 we assume in an arbitrary way three such fillings plus runs per 7 week period. This leaves $\simeq$ 600 hours for PS physics per 7 week period or 66% of that available in 1979 (1) but for 77% of the yearly time; thus the average yearly number of pulses per year is down to about 50% of that of the beginning of 1979.

e) For 1982, we assume that LEAR (if accepted) will not need $\bar{p}$s outside M.D. time or possibly only late in the year.

f) For 1983, it is assumed that the ISR has stopped running (LEP).

IV. CONCLUSIONS

a) For the remainder of 1979 it is likely that proton availability (always for PS Physics) will fall to 80% of that of the beginning of the year. Investigations are under way to improve the possibilities for PS Physics and these will be reported on later if they progress.

b) For the first half of 1980, no change is expected from that of the latter part of 1979. The planning of the shut-down is being carried out in close collaboration with the SPS within the framework of the $\bar{p}$ Steering Committee. A separate report on this will be made.

c) 1981 will be a difficult and complicated year and the first discussions have only just started in an attempt to understand the first few months.

d) 1982 we would hope that this will represent steady state operation with $\bar{p}$s, from the table we see that proton availability can be down to half or somewhat less than that of the beginning of 1979.

e) In 1983, if we anticipate the closure of ISR and operation of LEAR with SPS running still for about 25% of the time with $\bar{p}$s, then proton availability increases somewhere between 70 and 84% of that at the beginning of 1979; otherwise this situation will be that of 1982.

f) If ISR has stopped East Hall operation and LEAR are in competition. If we take the time ava ilable when SPS is doing fixed target proton physics (77% according to our model), and we arbitrarily divide the protons between East Hall and LEAR operation we get :

$\sim$ 500 pulse/hour (in round figures) for both activities. This means :

1. the East Hall will get about half the number of pulses/hour compared with the beginning of 1979 (But a yearly average of about 40%);

2. LEAR will produce about 1.7×10^6 $\bar{p}$/s assuming an overall transfer efficiency of 60% for the running time available. This corresponds with the figure given in the "Conceptual Study of a facility for Low Energy Antiproton Experiments" PS/DL/Note 79-1, prepared for the Karlsruhe Workshop. We have assumed negligible breakdown in the AA and its subsequent transfer to the PS, LEAR, etc., which is far too optimistic. The time to prepare and make the transfer has also been neglected. Equally well we have assumed that the AA (& LEAR) can essentially operate all the time that the PS operates ; this too is too optimistic.

g) However, if we imagine that LEAR physics starts in a more modest way then there is still a reasonable East Hall activity. A point to be investigated, how much competition will there be for power supplies and other equipment between the East Hall and the LEAR installations; can the SC, assumed stopped by 1983, contribute ?

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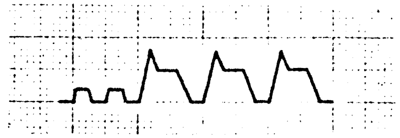
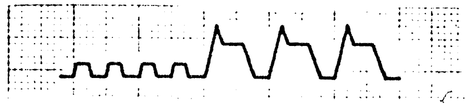
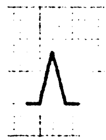
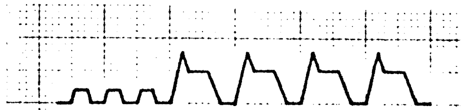
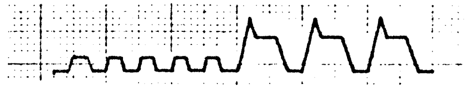
SPS	Year	Pulse/h PS Physics	% Time	Ave yearly Pulse/h PS Physics	% PS Pulses for PS Physics 1979 1 = 100%	Supercycle	Remarks
400 GeV p	(1) 1979	1125	95	1069	100	A = 1.2 s B = 2.4 s τ = 9.6 s 	ISR typically takes nominally 100 h per 7 week period. In reality ∿ 50 h/7 w period. PS Physics ∿ 910 h/7 w period for 95% of availabilitë time.
450 GeV p	(2)	900	93.5	900	78.7	τ = 12 s 	as above, but ISR will take slightly more time because now τ = 12 s.
450/400 GeV p	(3) 1980	900	?	?	?		As (1) or (2) Year complicated by shutdowns and need to give priority to AA running-in. The Topic of a separate note.
450/400 GeV p 270 GeV pp̄	(4) 1981	?	?	?	?		See paragraph III in text for remarks
270 GeV pp̄	(5) 1982	0	23	-	See below	 No A cycle 26 GeV/c τ = 2.6 s	Assume : No ISR, no PS Physics, no target 1.23% yearly time PS p̄ production time ∿ SPS p̄ running time
450 GeV p	(6)	1165	∿50	∿583	∿54	A = 0.65 s B = 2.6 s τ = 12.35 	ISR pp̄ plus PS Physics: 77%yearly time We assume in paragraph III of text ∿ 600 hours/period for PS Physics = 66% of 1979 time but for 77% of yearly time ∿ 50%.
400 GeV p	(7)	977	∿50	∿489	∿46	A = 0.65 s B = 2.6 s τ = 11.05 s 	Same as (6)
450/400 GeV p	(8) 1983	1165/977	77	897/752	84/70	As (6) / (7)	Assume ISR OFF but PS Physics, which could be either East Hall and/or LEAR and this for 77% of the yearly running time (23% pp̄ Physics SPS)