Revised
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P.S. BEAMS FOR AFTER THE 1968 SHUT-DOWN

I. INTRODUCTION

The proposals are based on those made by G. Petrucci and C. Daum and J.C. Sens, which were discussed in the May E.E.C. and presented to the May N.P.R.C. G. Cocconi has subsequently gone over the main lines with G. Petrucci and the writer.

Discussions have taken place on the technological implications of these proposals on the following topics: Beam Layout (G. Petrucci (d) responsible for the drawing attached, J. Geibel, L. Hoffmann, L. Danloy); power supply requirements (L. Danloy, R. Jacquin); water supplies and 18 kV, Rectifier Building, a.c./d.c. distribution (M. Georgijevic, K. Braun, H. Reitz and L. Danloy); shielding and building modifications (J. Geibel, L. Hoffmann and L. Turner (SB)); separaters and H.T. sets (L. Danloy, C. Germain and R. Tinguely); targets and ejection (D. Dekkers, L. Henny and L. Hoffmann); control and security aspsects (J.H.B. Madsen). Some general points have been discussed with P.H. Standley.

An attempt has been made to assemble an integral programme along with its financial and technical implications. It will be seen that many decisions must be made with the greatest urgency if the time scale under discussion is to be realized. In some cases (e.g. new separators) this is clearly impossible.

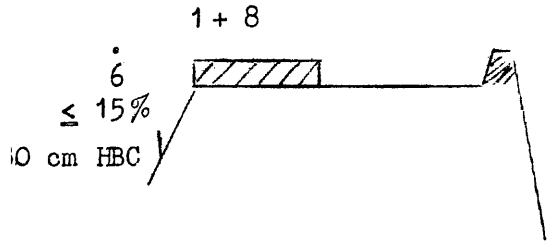
The East Hall is to remain substantially unchanged but it is proposed to add two beams from target 8 into the South Hall which requires, amongst other things, important additions of water and power supplies.

The types of machine operations which could be used are listed below in paragraph II, subsequent paragraphs deal with the facilities (beam, transport, separators, water and power supplies, etc.) required to carry out these operations.

II. MACHINE OPERATIONS ENVISAGED AND TIME DISTRIBUTION

A. MACHINE OPERATIONS

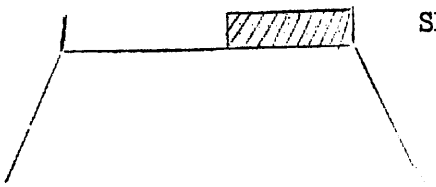
(a)



FSE 58 2 m HBC k_8 or m_6

FE 58 2 m HBC u_4 or m_6 or k_8

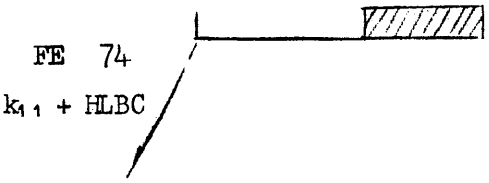
(b)



SE 62 - e_3

FE 58 2 m HBC u_4 or m_6 or k_8

(c)



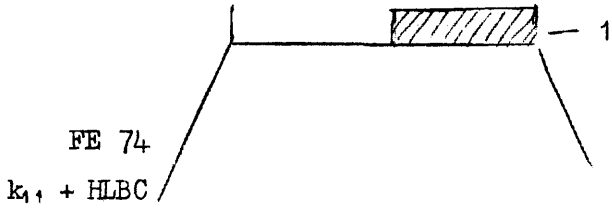
— SE 62 - e_3 (see below V(A))

FE 58 + FE 74 ≤ 10 bunches

Energies of 58 and 74 interchangeable

FE 58 - 2 m u_4 or m_6 or k_8

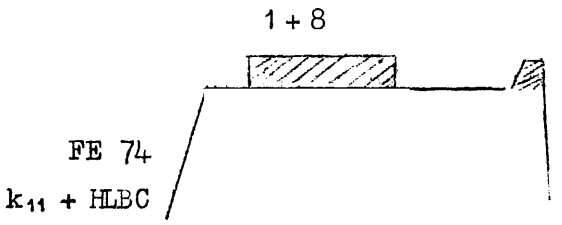
(d)



— 1 + 8

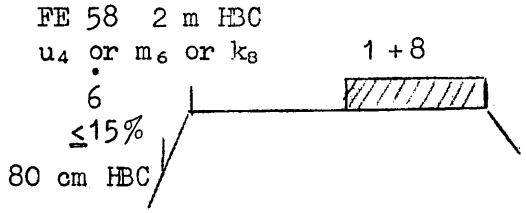
Same remarks as (c)

(e)



FSE 58 2 m HBC m_6 or k_8

(f)



REMARKS

(1) Some of these operations (c and d) suppose preferably two kickers (NPA kicker 97 with additional facilities, see report which is soon to appear : B. Kuiper, and MPS kicker 66) or at least one kicker 97 with double pulsing per machine pulse.

(2) Sharing between e_3 and target 1 in the proper sense of the word has been excluded even though tests will be pursued. Probably the most useful policy (also under way) would be to get some form of "parasitic" operation which perhaps would give a few percent of the beam for e_3 whilst target 1 (and possible 8) is in operation.

(3) The "parasitic" operation such as is being given to target 1 in the present programme, i.e. a per cent or so on the rising field with R.F. structure is not excluded.

(4) Generally speaking, fast ejection is the most economical use of protons for bubble chamber use; there is roughly a factor of two more protons used for fast-slow than for fast ejection. However, Ch. Peyrou claims a gain of 20% more information per picture with the fast-slow technique. With present techniques fast-slow ejection allows a longer spill time for counter targets than would the use of fast ejection.

(5) Fast repetition rate for the 2 m HBC has so far been excluded.

(6) It is assumed that an operation with double flat top will be used whenever useful.

(7) It is assumed that with the increased repetition rate from the P.S. power supply, there will be a move towards higher incident proton energies and higher secondary beam momenta.

(8) In the above schemes time intervals and burst lengths have been left open until some technical points are cleared.

B. TIME AND PROTON INTENSITY DISTRIBUTION

The following gives a possible rough time distribution for beams for a period which might be from the end of the 68 shut-down to the 1969 shut-down. Calender weeks 36, which are equivalent to P.S. weeks 24 (max. 158 hours/week according to present time-table).

No. of P.S. Weeks	Type of operation possible	Beams operating
2	Special: e.g. 2 m HBC doing 14 GeV/c Ks	u_4 : 2 m HBC plus maybe k_{10}: 80 cm HBC
11	b	u_4 or m_6 or k_8: 2 m HBC e_3 combination
4	d	u_4 or m_6 or k_8: 2 m HBC k_{11} : HLC All target 1 + 8 beams physically compatible
	or e	As above but without u_4
7	a	k_{10} : 80 cm HBC m_6 or k_8 : 2 m HBC All target 1 + 8 beams physically compatible
	or f	As above but with u_4

The above distribution which gives to TCC : EEC an approximately equal figure for protons × time may be summarized as follows

Weeks 36 calender 24 P.S.	Operation + % protons(*)	
2 P.S.	Special : 2 m (+ 80 cm ? HBC)	100 %
11 "	2 m HBC	$\leq$ 40 %
7 "	2 m HBC + 80 cm HBC	$\leq$ 40 %
4 "	2 m HBC + HLBC	$\leq$ 50 %
11 "	Target 1 + 8	$\geq$ 60 %
11 "	Slow ejection e_3	60 %

(*) Protons consumed on target or in ejection; no account is taken of inefficiencies.

III. BEAMS PROPOSED

A. EAST AREA This is to remain essentially unchanged.

a) Ejection 58 (e_2) feeds :

1) u_4 (u_{4a} JET Area not in use)

or 2) m_6

or 3) k_8

b) Ejection 62 (e_3) feeds:

1) b_{13} neutral

and 2) p_2 } variable energy $\leq$ 18 GeV/c $\pi^{\pm}$

and 3) p_1 }

and 4) b_{14} } common target

and 5) small angle p - p or large angle or some restricted form of d beam.

N.B. k_9 (500 MeV/c K's and stopped has not been asked for formally as there seems the possibility to carry out many physics III experiments elsewhere).

B. SOUTH AREA

a) North Hall : Target 6

1) k_{10} for 80 cm HBC
a modified k_7 beam going to ~ 1.2 GeV/c Ks using the same beam transport except - preferably - for separators (q.V.)

b) South Hall : Target 1

2) s_4 : test beam ~ 1 GeV/c $\leq 10^{-4}$ π/pulse
3) q_3 if possible improved : one branch only
4) d possibly with improved acceptance probably two groups as at present
5) m_{4bb} improved version with better separation : one branch only
6) neutral at 5 mrad.
7) Provision for a Quark beam to replace the d beam temporarily, (using additional elements?)
8) Provision for a "c" beam.

NOTE : Probable satisfactory beams combination from space view point :

d + c
d + neutral
but Quark $\neq$ c and d + b_{16} .
Experimental space may be very limited in certain cases.

c) South Hall : Target 8

k_{12} separated K's ~ 1 - 1.5 GeV/c
q_x unseparated π's $\leq$ 4/5 GeV/c.

Note experimental space may be very much restricted in these beams.

NOTE : A) In this proposal the following beams are killed and their beam transport elements (plus others to be ordered) are utilized in the combinations given above.

1) q_{3b}
2) m_{4e}
3) h_3

B) The most complicated combination of beams in the South Area which can be operated are q_3 m_4 d c_x k_{12} q_x k_{10} . These define the number of power supplies required and the amount of water (including large magnets).

IV. AVAILABLE SPACE FOR BEAMS AND EXPERIMENTS AND THEIR PREPARATION

(1) East Hall; with the addition of the small angle and the k_8 the total Hall space is taken.

(2) The South Hall will be to a good approximation completely filled if the present proposal is carried out.

(3) The North Hall has a little less than half its area available which is not easy to use except for a large angle ($\sim 50^\circ$) beam from target 8. This has not been considered here but might serve as an additional test beam for electronic equipment.

(4) It is imperative that adequate space be provided for apparatus construction, and testing be planned (this involves TC, NP, MPS and NPA Divisions) together with the facilities that go with them, i.e. power supplies for testing and measuring magnets; loads for testing power supplies, etc. Nowhere in this note is any one of these facilities supplied.

(5) Similarly adequate storage space for useful equipment must be planned.

V. POWER AND WATER SUPPLIES : GENERAL

A) East plus Neutrino Areas

From after the 1968 shut-down there will be 14.5 MW ($\Delta T \simeq 30^\circ$) at 400 m^3/h water cooling capacity plus the 6 MW independent cooling plant for the 2 m HBC.

With this we make the following points:

(1) The 14.5 MW cooling capacity is sufficient for the beams planned for the 2 m HBC and for the e_3 and for the e_3 combination (including a spectrometer $\leq$ 1.5 MW) and k_{11} + HLC. However, one would need 15 additional rectifiers of which only 7 can be housed in the ERB 3. (5 R1 = 0.2 MFr., 8 R2 = 0.36 MFr. and 2 R3 = 0.24 MFr. i.e. Total 0.8 MFr. plus cables, etc.).

(2) Later on, at the time when Gargamelle comes into operation, the water supply will be insufficient to run all the beams in (1) with Gargamelle substituted for the CERN HLC. Moreover, if Gargamelle needs as it might a more complicated beam, even more rectifiers would be required, plus possibly an additional 2 MVA transformer, etc.

PROPOSAL

We do not attempt the complete operation outlined above, i.e. machine operation II(c) with all e_3 beams is excluded (partial operation may be imagined). Operations of II(d) or (e) type may be carried out both with the CERN HLC and later with Gargamelle.

Testing the chamber (π's or p's) can surely be programmed either with targets 1 + 8 or reduced e_3. For neutrino work where most of the PS protons are required there is no difficulty. If there is a m_x or k_x beam in the Gargamelle area and this works for 4 - 6 weeks per year, this too can be programmed with targets 1 + 8.

Hence, no new 6 MW water supply should be bought whilst it is in the neutrino area. However, it should be provided with the 4 MW auxiliary water cooling supply for compressors, etc. (P.S. Improvement Programme Budget). A much higher ΔT is permissible than is the case with the magnet.

To liberate the two type R4 (750 kW) rectifiers either for their proper use in the East or maybe in the South Hall (q.V.) we propose to replace them by 6 R2 rectifiers. As there is space for one more rectifier R2 in the ERB 3, this can act as a spare.

(1) Rectifiers East Area

Thus 7 R2 rectifiers	0.445 M.Fr.
a.c. distribution	
Cables, etc.	

(2) Water East Area

The proposal very roughly worked out imagines an integral change in the South and East water supplies. However, for convenience the costs have been divided although with reservations.

Increase of East Area cooling to 14.5 MW ≡ 0.290 M.Fr.

B) South and North Hall

Present water supply is 10 MW.

With the addition of the extra beams plus a 1.5 MW spectrometer magnet the water supply should be increased to 12.5 MW at 400 m^3/h.

To run the most power consuming programme, i.e. q_3 m_4 d ($\leq$ 16 GeV/c) c_x k_{12} q_x, we need 11 R2 rectifiers.

This will require a new building to house the rectifiers with an installed power of 4 MWA. This supposes that 2 R4 now being used in the East Area programme can be made available for the South Area for a 1.5 MW spectrometer [in addition to the other two large magnets]. The rectifiers at present housed in the South Hall will be installed in the new rectifier building.

(1) Rectifiers, etc. South Area

Rectifiers	0.550
Building A.C. distribution + 4 MVA transformers D.C. distribution	0.880
Cables + hoses	0.060
Rheostats - 6	0.050
	1.540 M.Fr.

(2) Water South Area

Increase to 12.5 MW	
New pipes plus pump	0.206 M.Fr.
Additional heat exchangers	0.160
	0.366 M.Fr.

Again as mentioned for the East Area the cost and technical solution is given with reservations.

Summary Costs for Water (S + E) and Power Supplies

	East Rectifiers		0.445
	South Rectifiers + Building		1.540
(*)	Spare R3		0.120 } These may be difficult to order in ones
	Spare R1		0.040 }
	Water S + E Areas	≃	0.656
			2.801 M.Sw.Fr.

Gargamelle 4 MW auxillary water cooling is not accounted for.

(*) To these may be added those that should be used in testing and measuring halls.

VI. SHIELDING AND BUILDING MODIFICATIONS

1)	Large angle p-p in e_3	650 t
2)	Steel for shielding k_{12} in South Area	150 t
3)	Concrete - sufficient without h_3	
		800 t
	Cost	0.480 M.Fr.

Building modification East Hall for L.A. in e_3

1)	Cheap solution providing minimum space	0.3	M.Sw.Fr.
2)	Max. space solution but with adequate shielding for future - no answer yet	?	"

VII. CONTROLS AND SECURITY, ETC.

A most approximate figure for the modifications likely to be made in S and E halls 0.200 M.Fr.

VIII. BEAM TRANSPORT, SEPARATORS AND H.T. SETS

To accomplish the programme as set out we need

5 M2 , 4 Q30, 10 Q50, 2 Special lens(Length 1 metre, Ø 10 cm for k_{12}) and one six metre separator. If a new 2 m separator is put into k_{10} we save a pair of H.T. sets over the present beam (k_7) and we would then have just enough.

The total price is estimated at 1.760 M.Fr.

If the c_x beam is not built 2 M2 can be saved thus reducing the total cost to 1.500 M.Fr.

The six metre separater cannot be fabricated and tested before the end of 1968; however, for use in the k_{12} beam it must be installed in a shut-down. If this is accepted, a technical solution must be found. The 9 m separators now in stock would make the beam rather too long for the K momentum at present envisaged. Moreover, the increased beam length would further reduce the already restricted experimental space at the end of the beam.

IX. k_{11} items not included in above 0.740 M.Fr.

X.. Total cost for the complete programme 5.981 + unknown building modification. First approximation is ~ 6.281 M.Fr.

G.L. Munday

Distribution: (Open)

Members of the N.P.R.C.