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SETTING UP OF THE ENHANCED NEUTRINO BEAM

by
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1. Introduction

The enhanced neutrino beam 1) consists of the fast ejection system 2), the pulsed beam transport magnets and the neutrino horn 3). In the fast kicker the magnetic field has a constant value during 2 μsec with a rise and decay time smaller than 0.1 μsec. In all other magnets the current is a half sine wave or damped oscillation of a sufficiently low frequency that the magnetic field can be considered as constant during the 2 μsec that the proton beam is ejected.

The following table gives the succession of magnets through which the protons (or pions) pass and the approximate frequency of the current discharge in each magnet. The location of magnets is shown in drawing P 29-179-0.

Magnet	Approximate frequency (Hz)
Fast kicker K	2 μsec flat top
PS units 97, 98, 99, 100	1/3
Ejection magnet EM	5000
Stray field PS unit 1	1/3
Quadrupole Q 1	400
Stray field PS unit 2	1/3
Bending magnets B 1 - B 5	60
Quadrupole Q 2	400
Quadrupoles Q 3, Q 4	120
Bending magnet B 6	60
Neutrino horn H	5000

1) S. van der Meer and B. de Raad - CERN/NPA/Int. 61-3.

2) B. Kuiper and G. Plass - CERN 59-30.

3) S. van der Meer - CERN 61-7.

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The quadrupole Q 1 is horizontally focusing and counteracts the influence of the stray fields of units 1 and 2 which are horizontally defocusing. The resultant ejected beam is slightly divergent in the vertical plane and has a horizontal waist somewhere near straight section 3. The quadrupoles Q 2, Q 3 and Q 4 are horizontally F, D and F. The beam has its maximum vertical extent inside Q 3 and its maximum horizontal extent inside Q 4.

2. Method of observation

The short beam duration and high intensities make the use of counters difficult. The injected beam of the PS is always observed and adjusted by means of zinc-sulfide screens and television cameras. The specific ionisation of 25 GeV protons with $\beta = 1$ is about 15 o/o of that of 50 MeV protons with $\beta = 0.3$. The luminosity of the injected beam is more than adequate and since the ejected beam will have a smaller cross section we expect a sufficient light intensity.

The screens must be placed at such positions in the beam, that the effects of individual magnets can be studied separately. Since the ejected proton beam will run through vacuum in order to reduce multiple scattering, they cannot easily be displaced. It is proposed to place six screens, marked S 1 to S 6 in drawing P 29-179-0.

Screen S 1 is used to observe the beam displacement due to the fast kicker. It is proposed to place this screen in the pumping part of unit 100, where usually the targets are located. It must be flipped into position after the diameter of the internal beam has become sufficiently small. It is expected that a standard target drive or a modified version of it can be used for this purpose.

Screen S 2, immediately behind Q 1 shows the deflection due to the ejecting magnet. However, this is not very precise and it is mainly used to measure the beam position in straight section 3 to ensure that Q 1 is properly centered on the beam.

Screen S 3 between B 1 and B 2 gives the best measurement of the deflection due to the ejection magnet and also shows the effect of Q 1.

Screen S 4 in front of Q 3 can be used to adjust B 1 to B 5 and Q 1 and Q 2. It also shows approximately the maximum vertical dimension of the beam.

Screen S 5 in front of Q 4 shows approximately the maximal horizontal dimension of the beam.

Finally screen S 6 placed against the neutrino horn, is used to optimize the currents in Q 2 to Q 4 in order to obtain the smallest possible image.

At each of the positions S 3 to S 5 there will be a simple remotely controlled driving mechanism that can place either of two screens in the beam. The first screen is a normal full screen on which the beam size can be observed during the setting up period. During experimental use of the beam it is replaced by a screen which has a hole somewhat larger than the beam at that position. When everything is properly adjusted the beam passes through the hole and produces no light. As soon as the beam is displaced or wrongly focused the edges of the screen will light up. This light could of course be detected with photocells and used to warn the beam operator or even used to steer the magnets in the beam. However, such refinements would only be considered after some operational experience with the beam has been obtained.

3. Variables and adjustment procedure

In general the PS magnet will be operated without flat top and ejection will take place near the end of the rising slope in order to obtain the maximum possible repetition rate. It is important that the protons are always ejected at the same PS magnetic field so that their momentum is always accurately matched to the magnetic fields in the subsequent pulsed beam transport system. The only way to obtain this is to consider the PS magnetic field as the independent variable and to derive all timing from the B - pulses.

By means of a standard coincidence unit a master trigger pulse is obtained at a preset number of B - pulses. This pulse is distributed through delay boxes to the switching circuits of the different magnets. The delays are set so that the magnetic fields in all magnets reach their maximum values at the same time. The relative timing of the ejection magnet and the fast kicker must be accurate within 1 μsec. The timing of the magnetic horn must be accurate within 5 μsec, and the admissible timing error of the pulsed beam transport magnets is about 25 μsec.

Each magnet must have a pickup loop around its yoke or a transformer in its current lead. When the magnetic field (or current) passes through its maximum the induced voltage passes through zero. The zero crossing for all magnets should coincide with the centre of the pulse in the fast kicker magnet. This can be adjusted by visual observation on a CRO. For the ejection magnet the time delay in the signal cables must be taken into account.

The maximum value of the currents in the ejection magnet and the bending magnets must be stabilised with a precision of 0.2 o/o. For the quadrupoles an accuracy of 0.4 o/o is sufficient. The currents will be measured with low inductance shunts, using a zero method. The current signal is balanced against an accurately known adjustable reference voltage and the difference observed on a CRO.

All these magnets are pulsed from capacitor banks that are charged to preset voltages by accurately stabilised charging supplies. The largest source of fluctuations will be the influence of temperature variations on the C of the capacitor banks, the resistance in the circuit and the voltage drop in the ignitrons. There can be variations in the ambient temperature or the temperatureof the cooling water (of magnets and ignitrons) and, last but not least, there will be a certain heating up time, when the pulsing is started again after an interruption. Therefore continuous pulsing is very desirable.

The temperature fluctuations will mainly affect the maximum currents but have little influence on the timing. Therefore they can be compensated with a peak current stabiliser. Such a device measures the peak value of each current pulse and readjusts the reference voltage of the charging supply to correct the peak current of the next pulse. Tests on a prototype pulsing circuit indicate that the desired precision can probably be reached without a peak current stabiliser. However, more extensive experiments are required before a final decision can be made on this point.

For the fast kicker and magnetic horn a lesser precision of the current is sufficient and this problem does not arise.

The controls for the fast kicker and ejecting magnet will be located in the PS main control room. The controls for the pulsed beam transport magnets and the neutrino horn will be grouped together in the counting room. Both control centres will have a television receiver and a switch panel with which any of the screens S 1 to S 6 can be placed in the beam and the appropriate television pickup camera connected to the receiver. Excellent communication between both control centres will be essential.

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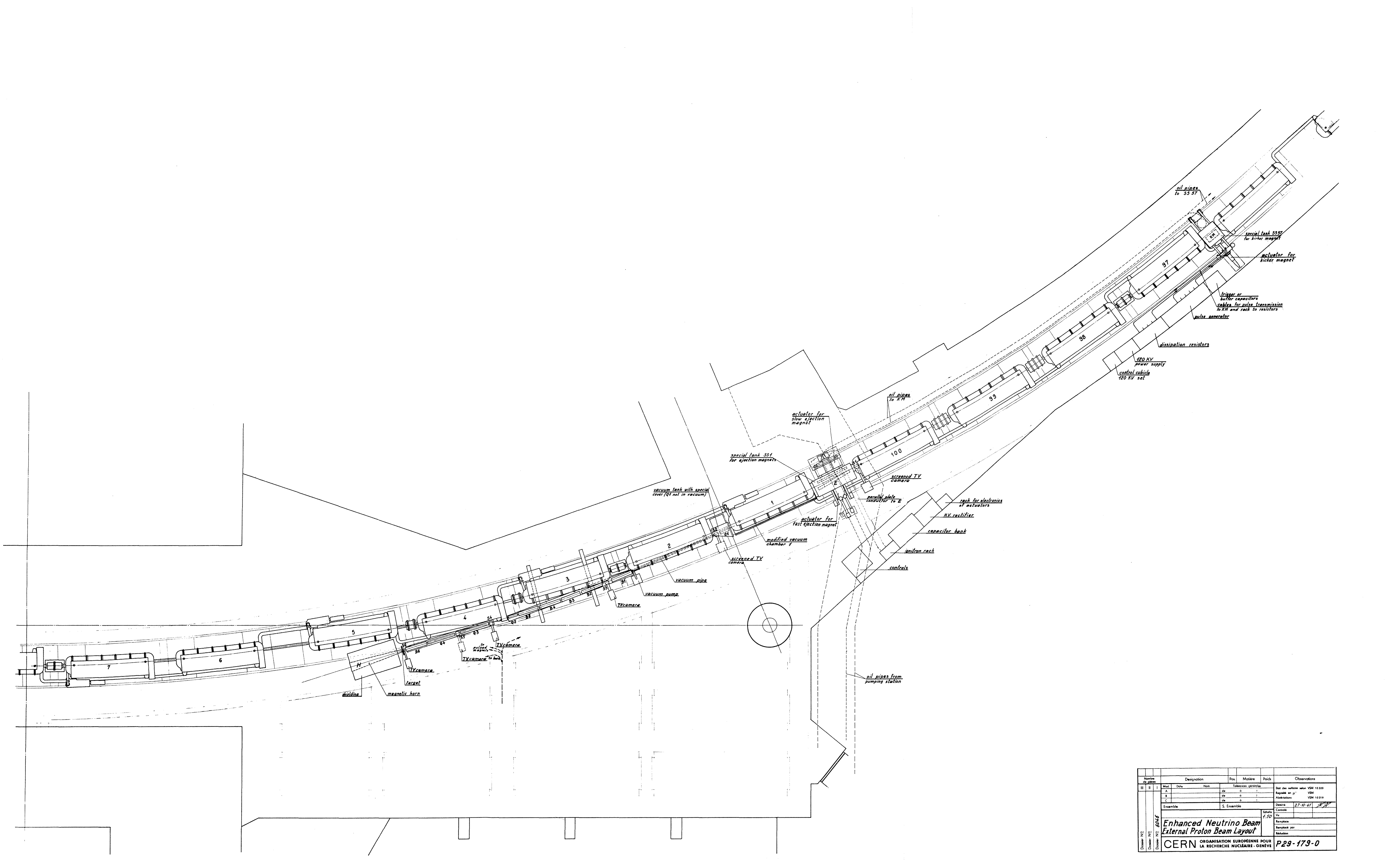

Nombre de pièces			Designation	Pos.	Matière	Poids	Observations
III	II	I					

Mod.	Date	Nom	Tolérances générales
A			de à ±
B			de à ±
C			de à ±

Etat des surfaces selon VSM 10 320
Rugosité en μ' VSM
Abréviations VSM 10 319

Ensemble
S. Ensemble

Dessiné 27·10·61 K.H.
Contrôlé
Vu

Echelle 1:50

Dossier No
Dossier No
Dossier No 6046

Enhanced Neutrino Beam
External Proton Beam Layout

Remplace
Remplacé par
Réduction

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