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M E M O R A N D U M

To: Members of the SPSC for Cogne III meeting

From: K. Winter

Re: The Wide Band Neutrino Beam

1. INTRODUCTION

Experiment WA79, aiming for high statistics measurements of neutrino and antineutrino scattering, requires a target and a wide band neutrino beam which provide the maximum event rate per incident proton. We assume SPS operation at 450 GeV.

The rate of events per incident proton depends on the target geometry and on the focussing properties of the horn and the reflectors.

The longitudinal segmentation of the target aims at nearly full target efficiency and is therefore identical for both the neutrino and the antineutrino beam.

The present geometry of 11 Be rods of 10 cm length each, separated by gaps of 10 cm is satisfactory.

The event rate per interacting proton depends strongly on the target radius; secondaries escape much better from targets of small radius and can therefore be more effectively focussed towards the detector. Table 1 shows a comparison of the performance of a 3 mm diameter Be target (scheme 1) and a 30 mm diameter carbon target (scheme 2), first in conjunction with the present focussing system (old WBB). The performance is described by the average efficiency for neutrino and antineutrino runs with integrated proton fluxes in the ratio 1 to 2,

$$\varepsilon = (\varepsilon_\nu + 2\varepsilon_{\bar{\nu}}) \ / \ 3 \ ,$$

with $\varepsilon_\nu = \varepsilon_{\bar{\nu}} = 1$ for 3 mm diameter Be targets. In comparison with a 30 mm diameter carbon target, the 3 mm diameter Be-target increases considerably (times 1.87) the number of events per interacting proton.

The event rate can be further increased by improved focussing of secondaries of lower energy which are produced, on average, at larger angles. To achieve this the West Area Neutrino Facility[1)] was originally equipped with two different longitudinal positions of the horn with respect to the target. Unfortunately this possibility of moving the horn towards the target cannot be used anymore because of heavy radioactive contamination. The horn and the target can, however, stay at their present position provided a new inner conductor is built for the horn to improve the focussing (new WBB). The event rate can be enhanced by a factor 1.43 in conjunction with a 3 mm diameter Be target (scheme 3), but only by a factor 1.19 in conjunction with a 30 mm diameter carbon target (scheme 4).

The SPS has now reached a new record of proton intensity which in future will allow $2 \cdot 10^{13}$ ppp to be ejected on target T9 for the wide band beam. We would like to make use of this performance to achieve and even to improve the statistics of our experiment. Table 1 shows 3 different ejection schemes:

(a) single ejection of $2 \cdot 10^{13}$ ppp onto a 30 mm diameter carbon target;
(b) single ejection of 1.3 to $1.5 \cdot 10^{13}$ ppp onto the 3 mm diameter Be target;
(c) double ejection at the beginning and at the end of the flat top operation of 1.6 to $1.85 \cdot 10^{13}$ ppp onto the 3 mm diameter Be target.

Scheme 5 gives the best figure of merit M, defined as

$$M = \varepsilon \cdot N_p/10^{13} \ ,$$

it will improve the event rate with respect to scheme 4 by a factor of ~ 2. The last column shows the effective number of protons for 136 days of running in 1986 assuming an average CPS/SPS efficiency of 62%. Experiment WA79 has

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1) J.V. Allaby, H.W. Atherton, G. Brianti, P. Coet, P. Lazeyras and G. Petrucci, CERN/SPSC/T 73-7.

been approved for a minimum of $1.5 \cdot 10^{19}$ protons.

We conclude that a 3 mm diameter Be target, double pulsing and a new inner horn conductor with modified profile are required to accumulate the bulk of the data for this precision experiment in 1986, leaving additional runs in 1987 for calibration and checks.

Table 1

WA79 Target and Beam Operation Schemes

scheme	target	WBB	ε	max ($N_p/10^{13}$)	M	$\Sigma N_p.M$ (1986)
1	3 mm Be	old	1	1.5*	1.5	$1.02 \cdot 10^{19}$
2	30 mm C	old	0.535	2	1.07	$0.73 \cdot 10^{19}$
3	3 mm Be	new	1.43	1.5*	2.15	$1.46 \cdot 10^{19}$
4	30 mm C	new	0.637	2	1.27	$0.87 \cdot 10^{19}$
5	3 mm Be	new	1.43	1.85*	2.65	$1.79 \cdot 10^{19}$

*) These figures are 15% higher than the limits presently quoted by the SPS Division for thin Be targets.

2. REQUESTS FOR THE WA79 WIDE BAND BEAM

To achieve the performance outlined as scheme 5 in Table 1 we require:

(1) A general overhaul of the technical infrastructure of the neutrino cave, of the horn-reflector system, and of the solid state detectors in the shield.

(2) A single 3 mm diameter Be target equipped with a mechanism which allows initial remote adjustment of one end of the target, both vertically and horizontally to match the line towards the detector.

(3) Independent adjustment of the position and the direction of the ejected proton beam (EPB) on the target.

(4) Beam monitoring equipment allowing measurements of the position and the angle of the EPB.

(5) Double ejection of protons at the beginning and at the end of the flat top.

(6) A new inner horn conductor and remote adjustment of the horn position and angle, and 6 ms flat top operation of the horn and of one reflector. The second reflector has to be removed.

(7) Double pulsing of the horn-reflector system.

(8) Change of the window at the entrance of the decay tunnel.

(9) A calibration beam of 2 to 47 GeV/c derived from X7, as designed by M. Reinharz (see figure 1). It coincides closely, both in angle and in position, with the neutrino beam line and allows calibration of the WA79 calorimeter in situ. The beam has to travel in a vacuum pipe up to the detector.

(10) Measurements of veto rates in various shielding conditions performed by us in December 1983 showed the need of an additional iron shield of 12 m length in good geometry (4 x 4 m^2 cross-section) and removal of the present wide shielding wall which increases the veto rate by a factor of 10 due to "μ-shine". A 6 ms flat top operation of the horn-reflector system is nevertheless required to cope with the increased rates of scheme 5.

Modifications (1)-(4), (6), and (8)-(10) are required for the test and calibration run in 1985; (5) and (7) can wait for the 1986 run.

We also propose to perform high intensity tests on Be targets in 1985 to determine the maximum allowed proton intensity.

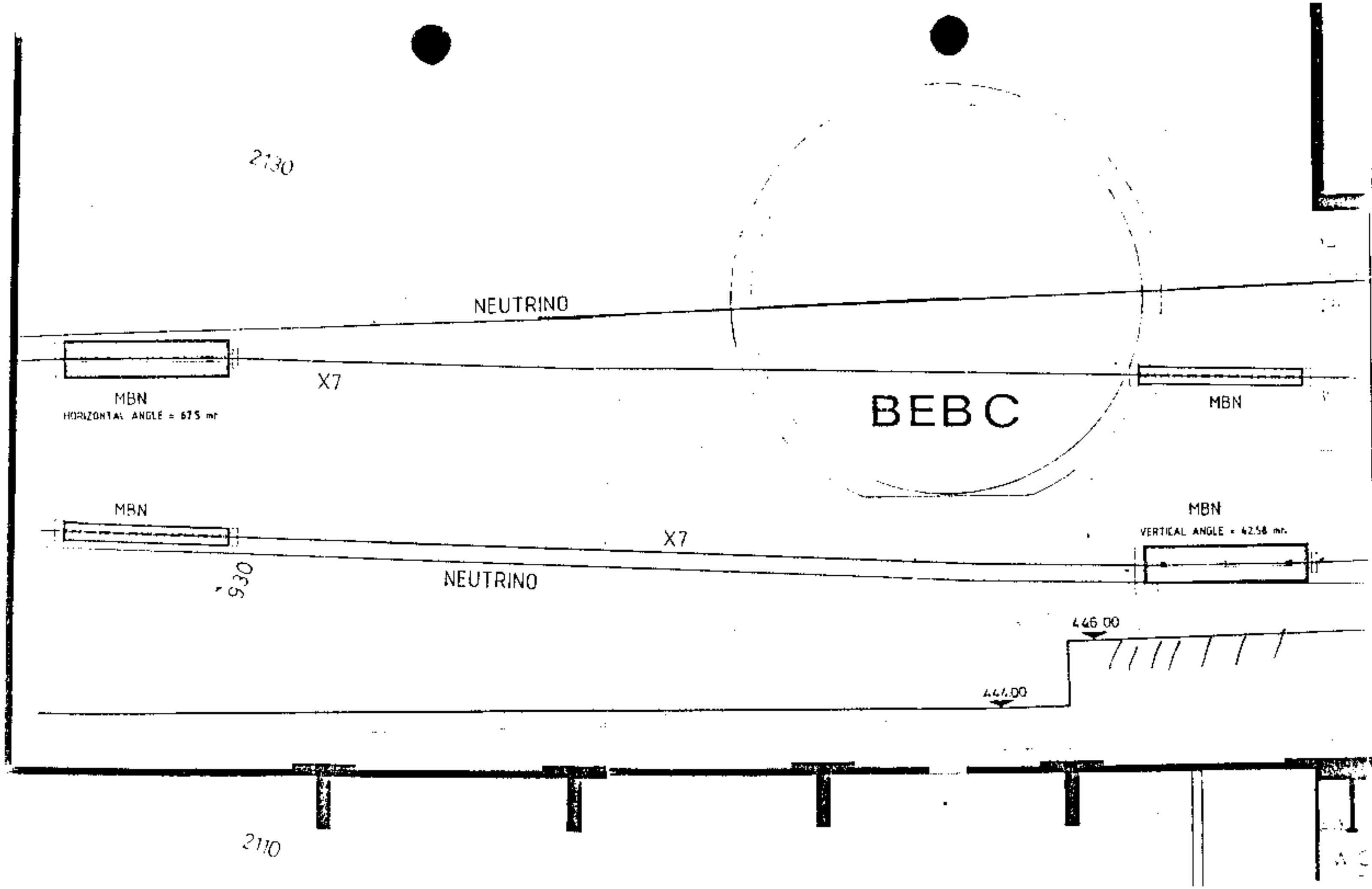

FIG. 1 X7 CALIBRATION BEAM FOR WA79