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M E M O R A N D U M

To: SPSC

From: Aachen-Bonn-CERN-Oxford Collaboration, WA21.

Subject: Neutrino and Anti-neutrino running times in wide-band H_2 experiment.

The initial runs in this experiment are tentatively scheduled for three weeks in the fourth running period (April 1977). We expect to obtain $\sim$ 90 Kpix containing $\sim$ 5000 events, depending on the division of time between ν and $\bar{\nu}$ beams and SPS intensity.

Also envisaged in this period is a run of the emulsion experiment WA17. The physicists of WA17 prefer running with neutrinos only, in order to maximize charm particle production. We want to emphasize that WA21 needs both neutrino and anti-neutrino events at an early stage of the experiment (i.e. before the May shut-down).

We recapitulate here some of the physics reasons why WA21 requests both signs of beam:

(a) The wide-band (horn + plug + reflector) system at WANF is superior to the FNAL wide-band system, not only from viewpoint of intensity and absolute flux monitoring but, just as important, because of beam purity. The neutrino event contamination in anti-neutrino running will be at the 2% level, instead of 50% as at FNAL. This makes a qualitative difference to the entire programme of analysis; for example, it is crucial in the study of neutral currents and the comparison of the neutrino/anti-neutrino neutral current cross sections.

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(b) A main object of the hydrogen experiment is to obtain information on secondary hadrons, uncontaminated by nuclear re-interaction. In the region above 50 GeV, there will be several hundred events, and in this region y-anomalies have been reported in E1A anti-neutrino runs at FNAL. If these effects are genuine, they indicate probable excitation of new quantum numbers whose nature is quite unknown. Perhaps the only way to obtain further information is to look at the high energy hadrons ($Z > 0.3$) in the current fragmentation region, which directly reflect the properties of the quarks concerned. In particular, comparison of π^+/π^- ratios, strange particles etc. in <u>both</u> neutrino and anti-neutrino events can give clues on the nature of charge-symmetry violations and other effects.

(c) Comparison of νp and $\bar{\nu}p$ cross sections is a much cleaner way of investigating "u" and "d" quark distributions than a $\nu n/\nu p$ comparison in deuterium, because of the well-known Fermi motion problems, as well as the difficulty of n/p event separation. The ratio

$$F_2^{\bar{\nu}p}(x)/F_2^{\nu p}(x) \text{ as } x \to 1,$$

for example, provides crucial tests of quantum chromodynamics; this ratio is 5 for vector gluons and 2 for scalar gluons (electron-deuteron experiments fail in the limit $x \to 1$). On a more general basis, both νp and $\bar{\nu}p$ cross sections are essential to evaluate the interference term $xF_3(x)$ and to establish whether right-handed as well as left-handed constituents are involved at high energy, and in which region of x they contribute.

In summary, the physics of our proposal depends on combining data from neutrino and anti-neutrino interactions, both analyzed with common experimental criteria by the same group of physicists. We emphasize that in period 4 we should obtain many more hydrogen events than have been obtained, or will be obtained, at FNAL by May 1977. A comparison of neutrino and anti-neutrino reactions will enable several major physics results to be obtained at an early stage of the SPS programme.