MEMORANDUM

TO: SPS Committee
FROM: G. Myatt, Spokesman of Expt. WA21

Requests for Future Running of WA21 - Wideband Neutrino and Antineutrino Interactions in Hydrogen in BEBC

In the memo CERN/SPSC/78-143 SPSC/M143 (27.11.78) we outlined the wishes of the WA21 collaboration concerning running until the SPS shutdown in mid-1980. A total of 3 periods of running was requested, two of antineutrino and one of neutrino. Given the pressure on the SPS schedule, it may be useful to the SPSC to know our priorities in case all of this running cannot be scheduled.

The period of antineutrino running is our first priority. At present we have no antineutrino data. The measurement of structure functions and many other studies are impossible without this data.

If only one further period were available then we would request that it be devoted to neutrino running. The reasons for this choice are outlined in the remainder of this memo.

The WA21 collaboration is currently analysing a data summary tape containing the data on 80% of the existing event sample of 8,000 charged current events and a corresponding number of neutral current events. One period of running in the neutrino beam would yield, if 450 GeV protons were used and depending upon the repetition rate, approximately 18,000 charged current events. This greater than threefold increase in event statistics would permit significant progress in the physics topics currently under investigation.

1. PRODUCTION OF CHARMED PARTICLES

In the data so far analysed we have two unambiguous examples of $D^+$ (2010) production. The increase of the data sample might bring this up to a total of \sim8 events. Of particular interest in these events is the sensitivity to the natural width of the $D^*$. Experimentally, this can be measured with an accuracy of 0.5 MeV, much more precisely than in $e^+e^-$ colliding beam experiments which so far give only a limit of 2 MeV. The inclusive $D^+$ production rate has been measured to be approximately ($6 \pm 3$)\% in WA21. The additional data would permit this uncertainty to be halved.

To date only two examples have been reported of neutrino production of the charmed baryons $\Xi_c^+$ and $\Delta_c^+$ in completely identified final states. Calculations based on the quark model would predict quasi-elastic production cross-sections for $\Xi_c^+$ and $\Xi_c^{++}$ of approximately 10\% of the $D^+$ cross-sections. In a sample of 18,000 CC events therefore there should be \sim160 $\Xi_c^{++}$ and \sim210 $\Xi_c^{++}$, produced quasi-ellastically. Even at 1\% decay branching ratio into observable modes these charmed baryons should be detected.
2. QUARK FRAGMENTATION FUNCTIONS

The study of the final state hadrons is leading to important
comparisons with QCD. Due to the discovery of non factorisation
(i.e. dependence of fragmentation on the "x" of the struck quark) a
double moment analysis is required. As stressed in the Neutrino
Workshop in October 1978 this leads to the need for high statistics
experiments on a proton target where nuclear fragments and rescattering
effects are absent.

3. NEUTRAL CURRENTS

The studies undertaken by the WA21 collaboration to determine
the ratio NC/CC on a proton target have shown that a clean extraction
of the signal is possible with only small backgrounds from neutral
hadrons and misidentified CC events. However, in order to achieve
this, selections have to be made which reduce the data sample to \( \approx 800 \)
NC events. Clearly more statistics are required in order to exploit
fully this measurement and to test the dependence upon the selection
criteria. It should be pointed out that measurements on a proton
target supply information on the neutral current couplings (i.e.
a determination of \( u_L \) and \( d_L \) separately) which cannot be obtained from
isoscalar targets.

4. RESONANCE PRODUCTION

Data from WA21 on resonance production has been presented at
various conferences and papers are in preparation for publication.
The \( \Delta(1236) \), \( \rho^+ \), \( \rho^0 \), \( E(1385) \) and possibly \( A_1 \) have been observed both in
inclusive and exclusive states. There is clear evidence for production
of a \( \Delta(1950) \) although several states seem to be excited. There is a
wealth of information to be obtained from studies of the production of
these resonances and important comparisons with PCAC and CVC can be
made. However to obtain significant event numbers in these many states
a large data sample is required. Only the bubble chamber can supply
these data and the hydrogen target gives the most precise measurements.

5. OTHER STUDIES

In addition to the above topics which are under active study
by the WA21 collaboration a variety of other subjects could be tackled
given a larger data sample. It has been pointed out in the Neutrino
Workshop that neutrino interactions can give information on the structure
function of the pion and on the nature of the Pomeron. Leptonic
interactions can be studied in the reaction \( \nu_e \mu^- \nu_e \) of which one
positively identified example has so far been found in the WA21 experiment.
An event sample of 26,000 events would yield approximately 60 events and
constitute the cleanest possible test of this fundamental process. The
search for resonant states (\( \rho \), \( A_1 \)) produced diffractively in neutral
current reactions can provide new tests of the V-A structure of the
current.

CONCLUSION

The WA21 collaboration feel that the study of neutrino interactions
in hydrogen is providing new and exciting information on a whole spectrum
of topics in neutrino physics. We are convinced that much higher
statistics are required to exploit fully this technique and a period of
running in 1980 would be a significant step in this direction.