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P R O P O S A L

TO MEASURE THE YIELD OF $\pi^{\pm}$, $K^{\pm}$ IN 400 GeV PROTON BERRYLLIUM COLLISIONS

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A precise knowledge of the pion and kaon production in the neutrino target material (Be) is one of the basic requirements for the determination of neutrino spectra in wideband neutrino beams. Although extensive muon flux measurements - the other basic requirement - are done continuously during the neutrino runs, these cannot give information about either the muon neutrino spectrum at energies above $\sim$ 20% of the proton beam energy or the electron neutrino spectrum. These components come from kaon decay, and their determination depends entirely on the knowledge of the K/π production ratios as a function of momentum and angle. The measured muon fluxes come predominantly ($\sim$ 90%) from pion decay and hence determine only that part of the neutrino spectrum coming from pion decay. Even for that part of the spectrum, knowledge of the momentum and angular distribution of the produced pions and kaons provides important constraints for the correct understanding and interpretation of the measured muon fluxes.

During the setting up and tuning of the H2 beam a collaboration of the Experimental Areas and Neutrino Beam Users groups measured $\pi^{\pm}$ and $K^{\pm}$ yields from 400 GeV p-Be collisions at p_t = 0 and 500 MeV/c for 4 secondary momenta (60, 120, 200 and 300 GeV/c) and for four different target lengths (40, 100, 300 and 500 mm).

This pilot study [1] showed that K/π production ratios could be measured in this way to $\pm$ 2%, relative production rates at different momenta and angles to $\pm$ 3% and absolute production rates to $\pm$ 5%. Furthermore the results strongly suggest that the thick target effects which must be allowed for in applying the results to production from a wideband neutrino target: (a) can be adequately described simply in terms of absorption plus additional production at low energy by leading secondary baryons and (b) to first order cancel in K/π production ratios.

The results have been used to correct the standard production spectrum tables derived from thermodynamical model predictions [2] previously used for neutrino flux computations. However the correction factors required have turned out to be large (up to a factor 2) and rapidly varying from one point to the next so that there is excessive freedom and uncertainty

concerning how to interpolate between and extrapolate beyond the measured points. A more complete mapping of $\pi^{\pm}$ and $K^{\pm}$ production from Berryllium targets is necessary to reduce this major remaining source of uncertainty in both wideband and narrowband neutrino and anitneutrino spectra. We therefore request further running in the H2 beam for this purpose. No apparatus is required other than the beam line and its standard control and monitoring equipment as presently installed.

The intention is to measure production at some 35 points in the $p - p_T$ plane (e.g. secondary momenta of 60, 90, 120, 160, 200, 250 and 300 GeV/c if using 400 GeV protons, and p_T values of 0, 167, 333, 500 and 667 MeV/c). All measurements would be made with the same (50 cm long) Berryllium target, with the possible exception of some additional short-target measurements at low secondary momentum. To minimise systematic errors in relative production rates at different momenta and angles, one would scan (at least twice) as rapidly as possible through all 35 points measuring the total particle production rates with fixed collimator settings during a 3 or 4 day period of stable SPS operation. The absolute (radioactivity foil) calibration of the proton beam intensity should also be performed at this time. Both the prior tuning of the beam for the various conditions required and the subsequent measurements of the (e)/π/K/p composition of the beam at each point, using collimator and final-quadrupole settings adjusted to give appropriate counting rates and beam-parallelity in the CEDAR's, could be scheduled separately according to H2 beam availability.

It seems most practical and useful to carry out these measurements using 450 GeV protons. For application to the wideband beam we would then wish to measure at secondary momenta slightly higher than those listed above, scaled by the factor 450/400 (i.e. at the same x values). Comparison with the measurements already made would then permit the most direct possible check of the procedure presently used for scaling the production spectra to the lower proton energies used for past wide-band runs (400, 350 and 330 GeV). Since the most critical application

of the measurements at the highest secondary momenta is to the narrowband beam, the precise secondary momenta and angles to be measured in this range would be chosen to best cover the acceptance of the narrow band beam.

REFERENCE

[1] H.W. Atherton et al.,CERN yellow report, in preparation.

[2] J. Ranft, private communication.