1/5/83

FNAL Proposal No. 730
Scientific Spokesman:
R.J. Wilkes
Dept. of Physics, FM-15
Univ. of Washington
Seattle, WA 98195
(206) 543-4963

EMULSION EXPOSURE TO 250 GEV SIGMA-MINUS

Submitted by:
S. Krzywdzinski, H. Wilczynski, W. Wolter
Laboratory of High Energy Physics
Institute of Nuclear Physics
ul. Kawiory 26A
30-055 Krakow, Poland

J.J. Lord, R.J. Wilkes
Dept. of Physics, FM-15
University of Washington
Seattle, WA 98195

December 14, 1982

SUMMARY

We request an exposure of approximately seven emulsion stacks to the 250 GeV sigma-minus beam during the first running period of Saver (presummably second half of 1983). The emulsion stacks would consist of pure emulsion pellicles and emulsion plates with embedded microgranules of heavy metals. The exposure would be parasitic to experiment E715 (P.S. Cooper, spokesperson) and would utilize procedures and facilities identical to those used in our previous exposure E666. The emulsion exposure could be completed during one shift of typical running efficiency.

MOTIVATION

The proposed exposure is part of a comprehensive study of the hadron-nucleus multiparticle production process as a function of energy, projectile type and target mass, carried out by the Krakow and Seattle laboratories either in collaboration (E382, E564) or separately (Krakow: E90, E249, E339, E508, E574; Seattle: E171, E237, E387, E471, E524). Data from the proposed exposure would be compared with our previous results from proton and pion exposures [1,2].

Emulsion provides a track-sensitive target with uniform four-pi acceptance for the observation of charged multiplicities (including heavily ionizing tracks not seen by other techniques) and pseudorapidity distributions. The proposed experiment would provide the only emulsion data in the >100 GeV energy range using a strange-particle beam. Measurements of particle production characteristics in the central rapidity region would be very useful for testing quark models of hadron-nucleus interactions [3,4,5].

The proposed exposure would be similar in motivation and method to our previous sigma-minus exposure, E666 (R.J. Wilkes, spokesman). That experiment will probably not produce useful results due to extremely poor emulsion quality, as described below.

TECHNICAL DETAILS

We would like to expose 6 stacks of emulsion plates (layers of emulsion on glass backing). The stacks would have external dimensions 10 x 10 x 2.5 cm^3, and each would contain 10 plates, with emulsion area 7.5 x 7.5 cm^2 and thickness 400 microns. Some of the plates would contain a central embedded layer of metal microgranules to serve as pure-element targets. The granules have mean diameter 15-20 microns. Metals used would be W, Cr and Ag, as in our previous experiments (e.g., E524). In addition we would like to expose one stack of stripped emulsion pellicles (i.e., solid slabs of emulsion with no backing material).

In our previous exposure (E666), we used a single batch of Ilford emulsion at a time when the company was still resolving quality-control problems due to staff and plant location changes several years ago. At the time, Ilford was the sole commercial source for nuclear emulsion. The exposed plates displayed an extremely high level of background fog and a very low density of developed grains along tracks (about 15 grains per 100 microns of minimum ionizing track), making it extremely difficult to locate events with reasonable efficiency. Our problem was not unique, and groups at LBL and CERN have had similar experiences.

To avoid such problems with the new exposure, we propose to use at least two batches of emulsion from two manufacturers. Fuji Film Corp. of Japan has agreed to sell us small quantities of their ET7B emulsion, which in our opinion is the best available (track density typically 35-40 grains/100 microns). Previously ET7B emulsion was sold only within Japan. We will also order a batch of Ilford G5 emulsion gel, and will ask Ilford to prepare the pellicle stack at their factory in Britain. As with E666, the glass-backed plates (includng microgranule loaded plates) will be prepared in Seattle.

To permit appropriate pre-exposure testing, we must receive the emulsions at least one month before the exposure date. The ordering lead time for Ilford is at least three months. We therefore would hope to have a decision regarding this proposal at least 4 months before the planned exposure date.

The exposure procedure used in E666 was entirely adequate. A positioner constructed by the Proton Department was used to move our stacks across the E497 beam line. Because the beam spot is smaller than the emulsion stack cross-section, several spots must be exposed for each stack. Our optimum track density for scanning purposes is about 10**5 tracks/cm^2. According to E715, for a 400 GeV primary beam, 3E10 protons/pulse, one expects the hyperon beam to contain 2.5E4 particles/pulse, so that about four pulses/exposed spot would be required. The background of 3E5 muons per pulse does not constitute a problem; we have successfully scanned plates with muon backgrounds as high as 5E5/cm^2. However, E715 indicates a sigma-minus/pion ratio of only 1/4 in a secondary beam of 250 GeV/c, which is not acceptable for our purposes. Our experiment requires at least a 50% hyperon fraction for success. We presume it will be possible to operate at a higher secondary energy, where the sigma-minus fraction is higher.*

*In a recent paper (6) by E497 collaboration, a measured hyperon fraction of more than 50% at 360 GeV/c was reported.

The entire exposure procedure, which involves an access after each stack, can be completed during one shift. Following exposure, the emulsions will be processed in Seattle. Scanning and measurement will be shared between Seattle and Krakow.

REFERENCES

1. J. Babecki, Z. Czachowska, B. Furmanska, J. Gierula, R. Holynski, A. Jurak, S. Krzywdzinski, G. Nowak, B. Slezak, W. Wolter,
   Phys. Lett. 47B (1973) 268
   Acta Phys. Polonica B5 (1974) 315
   Phys. Lett. 52B (1974) 247
   Institute of Nuclear Physics, Report No. 872/PH(1974)
   R. Holynski, S. Krzywdzinski, K. Zalewski, Acta Phys. Polonica B5 (1974) 321
   J. Babecki, Acta Phys. Polonica B6 (1975) 443
   J. Babecki, Inst. of Nuclear Physics, Report No. 911/PH(1976)
   B. Wosiek, Acta Phys. Polonica B8 (1977) 493
   A. Jurak, A. Linscheid, Acta Phys. Polonica B8 (1977) 875
   B. Furmanska, R. Holynski, S. Krzywdzinski, W. Wolter, Acta Phys. Polonica B8 (1977) 973
   A. Jurak, Inst. of Nuclear Physics, Report No. 988/PH (1977)
   J. Babecki, B. Furmanska, R. Holynski, A. Jurak, G. Nowak, H. Wilczynski, W. Wolter, B. Wosiek, Acta Phys. Polonica B9 (1978) 495
   G. Nowak, PhD thesis, unpublished (1978)
   J. Babecki, G. Nowak, Acta Phys. Polonica B10 (1979) 705
   J. Babecki, G. Nowak, Inst. of Nuclear Physics, Report No. 1050/PH (1979)
   B. Wilczynska, PhD thesis, unpublished (1980)
   A. Jurak, H. Wilczynski, Institute of Nuclear Physics, Report No. 1088/PH (1980).

2. J.R. Florian, et al., "Experiments on High Energy Particle Collisions - 1973", R. Panvini, ed., AIP New York, 1973, p. 126.
   J.R. Florian, et al, "Particles and Fields - 1973", H. Bingham, M. Davier and G. Lynch, eds., AIP, New York, p. 490.
   R.E. Gibbs, et al., Phys. Rev. D10, 783 (1974).
   J.W. Martin, et al, Nuovo Cimento 25A, 447 (1975).
   J.R. Florian, et al, Phys. Rev. D13, 558 (1976).
   M.Y. Lee et al, Phys. Rev. D19, 55 (1979).
   R.E. Gibbs, et al, Phys. Rev. D24, 1112 (1981).

3. A. Bialas, Fermilab-CONF-79/35-THY, 1979.

4. L. Caneschi and A. Schwimmer, Nucl. Phys. B102, 381 (1976).

5. S. Brodsky, J. Gunion and J. Kuhn, Phys. Rev. Lett. 39, 1129 (1977).

6. L.J. Teig et al, Fermilab-Conf-82/97-EXP.