Fermilab Proposal No. 367

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A PROPOSAL TO STUDY J AND CHARMED MESON PRODUCTION IN THE M4 NEUTRAL BEAM LINE

Chicago-Wisconsin-La Jolla

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Proponents of E-82

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We would like to utilize our currently operating E-82 spectrometer in M4 in a search for the poduction of J's, J''s and, possibly, neutral charmed particles, by neutrons.

Properties of the spectrometer: Ability to identify electrons, muons and hadrons. Typical mass resolution: 12 MeV FWHM for K^{o}'s of 80 GeV. With its current "picket-fence" logic, this spectrometer can be triggered preferentially on two-body decays with specified transverse momentum, e.g. 209 Mev/c for $K \rightarrow 2\pi$.

Properties of the M4 neutral beam: Neutrons and kaons are produced at 7.5 mrad in a 5:1 overall ratio, with a flux of 10^{6} particles/10^{12} protons on target and a spectrum as indicated in Fig. 1. This neutron spectrum is Hagedorn-Ranft in shape, but adjusted in intensity to actual measurements.

In view of the low incident flux, one needs maximum acceptance for the "rare" bosons. The spectrometer as it stands can accept only small decay vertex opening angles, i.e. only very asymmetric configurations for decays with large transverse momenta (e.g. $p_T = 1.6$ GeV for $J \rightarrow 2e$ vs. 0.21 GeV for $K \rightarrow 2\pi$). We propose to "parallelize" the products of 2-body decays of heavy bosons (2 - 4 GeV), as we now do for $K \rightarrow 2\pi$, by producing these particles inside a long magnet of appropriate $\int B.dl = 44$ kGauss-meters, as indicated in Fig. 2. An extra bonus of the proposed arrangement is its ability to sweep out a large fraction of the unwanted charged particles.

Availability of Magnet: Fermilab has a BM 109 which is currently not in use. Fully energized (and with its gap adjusted to give the required $\int B.dl$) it needs 240 kW at 80 V. Preliminary discussions with the Meson Lab staff indicate that no problems are anticipated in providing power and cooling in the M4 beam line.

Study of the J (ψ, 3.105 GeV) particle production: This particle can be detected through its electromagnetic decay modes with a mass resolution of 16 MeV x (p_J/100 GeV). Triggering on muon or electron pairs, we expect little background. A production cross-section $\sigma = 10^{-32}$ cm^2/nucleon leads, with 5.10^5 interacting neutrons/pulse, to $\simeq$ 15 events/day. We note that a simple-minded diffraction estimate yields the above cross-section.

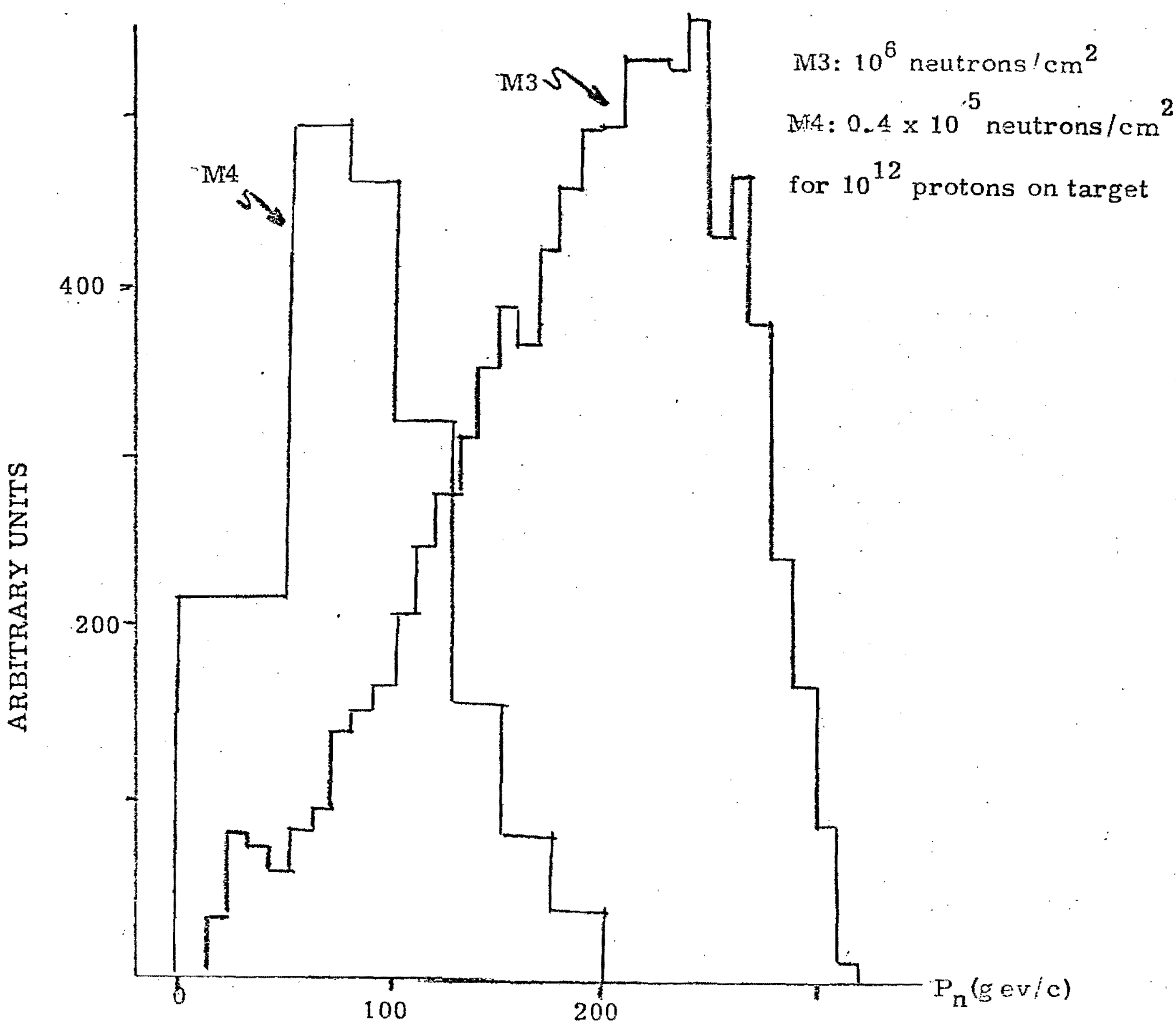
The purpose of this study would be to determine the energy dependence of J-production, in particular in an exclusive (diffractive) process. In a second stage, it would be interesting to get a diffracted neutron beam into M4, since the coherent production cross-section on Pb (at $>$ 200 GeV) is expected to be considerably larger.

In addition, since J-particle is well established, we would gain valuable experience with our modified E-82 spectrometer.

Search for the neutral "charmed" boson (D^0, $\bar{D}^0$): This particle, of anticipated mass $\simeq$ 2 GeV, could perhaps be detected through its weak decay into $K^+ + \pi^-$ (or c.c.). It is difficult to estimate properly the backgrounds arising from two particles (primarily pions) produced in ordinary collisions accidentally faking the same momentum configuration and hence invariant mass. From the p_T distributions of E-100 one estimates 0.7 "fake" events/pulse in a 10-MeV mass bin around 2 GeV, again for 5.10^5 interacting neutrons/pulse. A production cross-section of $\simeq$ 1 ub for the charmed bosons corresponds to this background in intensity. It should be noted that this background estimate represents an absolute upper limit, since it is based on <u>inclusive</u> pion production rates. For instance, by anti-ing large angle, low p_T particles, one can hope to reduce the background without killing the effect, in particular if the D^o's are produced diffractively together with a charmed baryon.

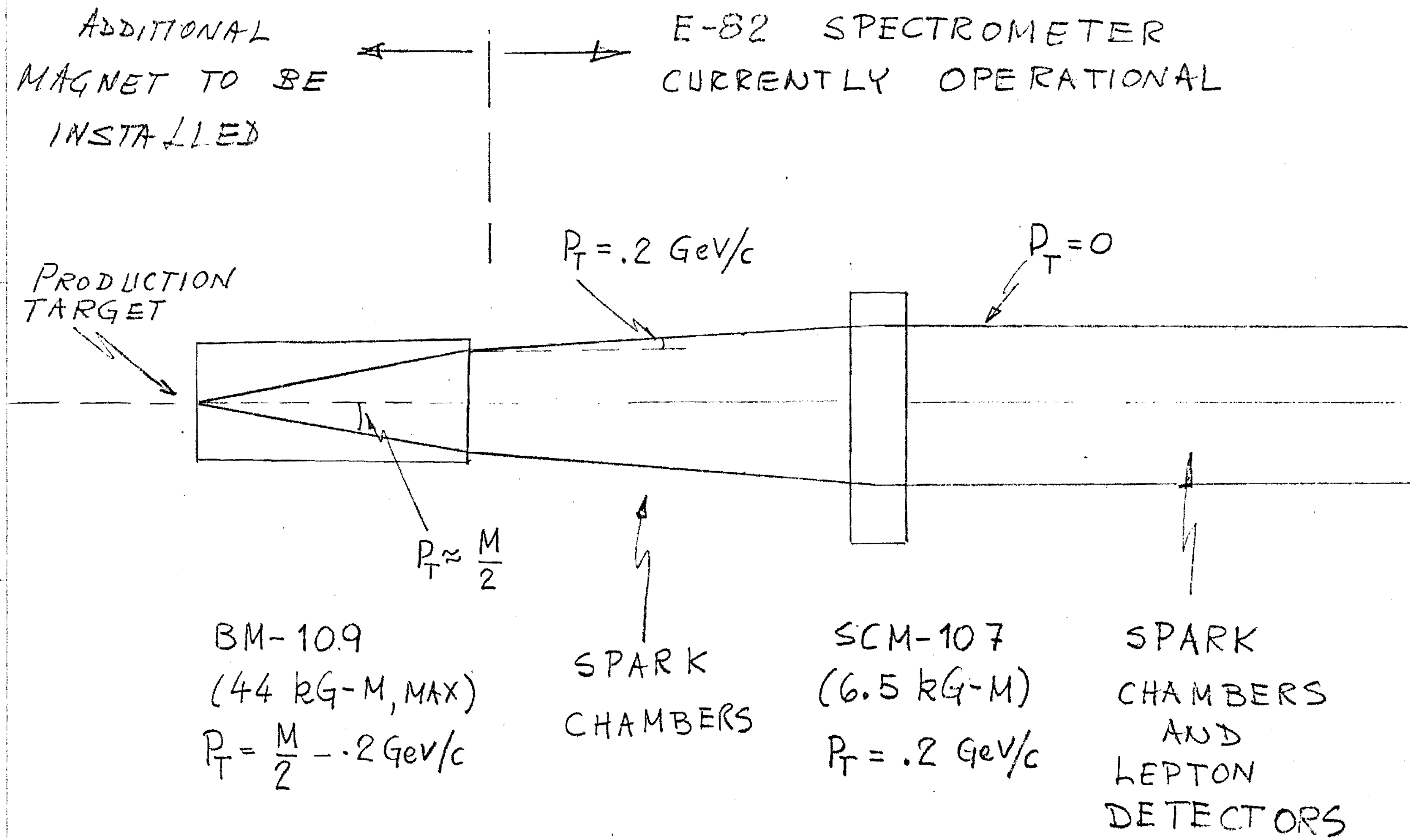
We consider this part of our present proposal primarily exploratory in character. It is only an empirical study of the backgrounds that will enable us to develop improved selection criteria.

VLT/sob



NEUTRON SPECTRA FOR THE M3 AND M4 BEAM LINES

Figure 1



ADDITIONAL MAGNET TO BE INSTALLED
E-82 SPECTROMETER CURRENTLY OPERATIONAL
PRODUCTION TARGET
$P_T = .2$ GeV/c
$P_T = 0$
$P_T \approx \frac{M}{2}$
BM-109
(44 kG-M, MAX)
$P_T = \frac{M}{2} - .2$ GeV/c
SPARK CHAMBERS
SCM-107
(6.5 kG-M)
$P_T = .2$ GeV/c
SPARK CHAMBERS AND LEPTON DETECTORS

FIG. 2