LETTER OF INTENT

On the Energy Upgrade of the MP Beam Line and Proposed Experiments

E-581/704 Collaboration

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We would like to express our intentions concerning the future use and development of the Fermilab polarized beam and associated experiments. A complete proposal on the energy upgrade of the MP beam line and on measurements with energies up to 500 GeV will be submitted by March 1, 1990.

After completion of the 1990 fixed-target run, we intend to propose an upgrade of the MP beam line from 200 GeV/c to 500 GeV/c. To increase the polarized beam energy, an additional eight quadrupoles will be required (currently there are two 4-Q-120's and six 3-Q-120's). This implies the need for a total of 16 4-Q-120's. In a recent study, we found that such a configuration using conventional quadrupoles up to 500 GeV is nearly as effective as equivalent superconducting quadrupoles.

Experiments to be proposed using polarized beams up to 500 GeV/c would include:

1) Studies of the energy dependence of various reactions studied in E-704 such as i) $\Delta\sigma_L(pp)$ and ii) asymmetries in π°, η°, Λ/Σ, $\pi^\pm$ production at large $p_\perp$ or large x_F are planned. We may set priority on these reactions based on our forthcoming observations at 200 GeV/c.

2) We intent to study direct-gamma production experiments with good statistical accuracy:

A_N $(p^\uparrow p \to \gamma + x)$ $p_\perp$ up to 5 GeV/c

A_{LL} $(p^\uparrow p^\uparrow \to \gamma + x)$ $p_\perp$ up to 4 GeV/c

The QCD Compton effect, gluon + quark → gamma + quark, is expected to be the dominant mechanism for direct-γ production at large $p_\perp$. These measurements are aimed at understanding the basic question of the origin of proton spin by determining the gluon spin distribution in the proton.

The advantages at higher energies are: i) the direct-gamma production cross section at high $p_\perp$ increases rapidly with energy; from 200 to 500 GeV there is more than a factor of three increase and ii) the polarized beam intensity also increases by a factor of three.

Rate and error estimates are as follows:

Primary and Polarized Beams:	$4 \cdot 10^{12}$ incident protons and $3 \cdot 10^7$ polarized protons/spill	
Beam Momentum:	500 GeV/c	
Liquid H_2 Target:	100-cm long for the A_N measurement	
Polarized Target:	20-cm long for the A_{LL} measurement	
Total Number of Cells in the CEMC:	2016 (including 1,000 more cells being made at Serpukhov)	
Statistical Errors: (1000 hours of beam time)	ΔA_N < 1%	$3 < p_\perp < 4$ GeV/c
	< 3%	$4 < p_\perp < 5$ GeV/c
	ΔA_{LL} < 2%	$3 < p_\perp < 4$ GeV/c
	≈ 5%	$4 < p_\perp < 5$ GeV/c

3) We intend to study the possible increase of the quark-diquark content of the proton versus $p_\perp$ in

$A_N\ (p^\uparrow p \to (\pi^\circ, \pi^+, \pi^-) + x)$ at $p_\perp$ up to 6 GeV/c with $\Delta A_N < 5\%$.

We intend to test PQCD predictions based on subprocesses such as uu → uu, ud → ud, qg → qg and also on the gluon spin distribution in

$A_{LL}(p^\uparrow p^\uparrow \to \pi^\circ$ (also $\pi^\pm) + x)$ at $p_\perp$ up to 5 GeV/c with $\Delta A_{LL} < 5\%$.

4) A sensitive way of analyzing the gluon polarization inside a polarized proton will be to measure the following hyperon production at large $p_\perp$ in pp collisions, by using initial and final state polarizations. The dominant mechanism for associated strange-particle production at large $p_\perp$ is strange-quark production from gluon-gluon annihilation. Theoretical predictions suggest absolute values of about 20%. This measurement, using the E-704 facility, only becomes feasible at 500 GeV/c and is not feasible at 200 GeV/c because of the geometrical acceptance.

$A_{LL}\ (p^{\uparrow}p^{\uparrow} \rightarrow \Lambda^{\circ} + x)$

$D_{LL}\ (p^{\uparrow}p \rightarrow \Lambda^{\circ\uparrow} + x)$

at $p_{\perp}$ up to 3 GeV/c with error $\approx$ 5%.

5) Finally we are considering the possibility of studying asymmetry in jet production (at present, we do not have a jet detector in the E-581/704 setup). This process at high $p_{\perp}$ is dominated by gluon-gluon or quark-gluon scattering. Although this process is not as clean as the prompt photon production in the determination of the gluon-spin distributions, the cross section is about an order of three higher than that of the prompt photon which is therefore suited for higher $p_{\perp}$ coverage.

$A_N(p^{\uparrow}p \rightarrow \text{jet} + x)$

$A_{LL}(p^{\uparrow}p^{\uparrow} \rightarrow \text{jet} + x)$

high $p_{\perp}$ coverage, $p_{\perp} > 6$ GeV/c