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PROPOSAL
to Fermilab

Spin Effects in High-$P_\perp^2$ Proton-Proton Elastic Scattering

SPIN Collaboration:

Michigan, Indiana, Fermilab, N. Carolina

Protvino, Dubna, Moscow

KEK

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Introduction

This is a proposal to study the spin-spin asymmetry A_{nn} and the spin-orbit analyzing power A in $p + p \rightarrow p + p$ at large-$P_\perp^2$. We propose to run at Fermilab with an 800 GeV unpolarized beam in 1994 and with a 120 GeV spin-polarized beam around 1996. We would scatter both beams from a polarized proton target and measure the quantities,

$$A_{nn} = \frac{d\sigma/dt(\uparrow\uparrow) + d\sigma/dt(\downarrow\downarrow) - 2d\sigma/dt(\uparrow\downarrow)}{\Sigma d\sigma/dt(i,j)}$$

$$A = \frac{d\sigma/dt(\uparrow\uparrow) - d\sigma/dt(\downarrow\downarrow)}{\Sigma d\sigma/dt(i,j)}$$

where $\uparrow$ and $\downarrow$ denote the beam and target spin-polarization directions. A_{nn} is the spin-spin correlation parameter which measures the spin-spin force, while A is the analyzing power which measures the spin-orbit force.

Our main goal is to determine if the unexpected large values of A and A_{nn} in proton-proton elastic scattering found at the ZGS and AGS persist to Fermilab energies. As shown in Fig. 1, at 24 GeV the one-spin analyzing power A was found[1] to be 20.4 ± 3.9% near $P_\perp^2$ of 7 $(GeV/c)^2$. An earlier ZGS experiment[2] near 12 GeV found an A_{nn} value of 60 ± 8% at $P_\perp^2$ near 5 $(GeV/c)^2$, as shown in Fig. 2. These large and unexpected spin effects have been difficult to reconcile with conventional models of strong interactions such as perturbative Quantum Chromodynamics (QCD). The validity of perturbative QCD is believed to improve with increasing energy and $P_\perp^2$; this proposed Fermilab experiment at 800 GeV and 120 GeV would increase the maximum energy for high-$P_\perp^2$ A and A_{nn} data respectively by factors of about 30 and 10.

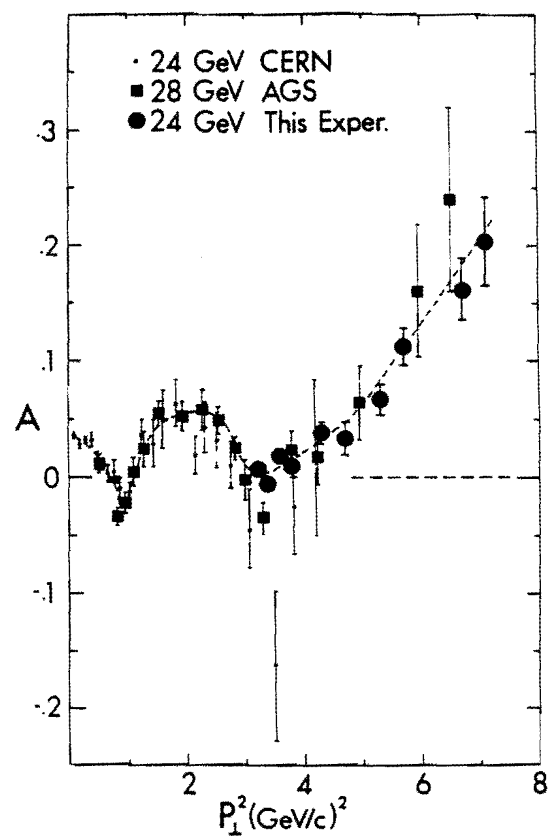

Fig. 1 The spin analyzing power or left-right asymmetry is plotted against $P_\perp^2$ for spin polarized proton-proton elastic scattering at 24 to 28 GeV.

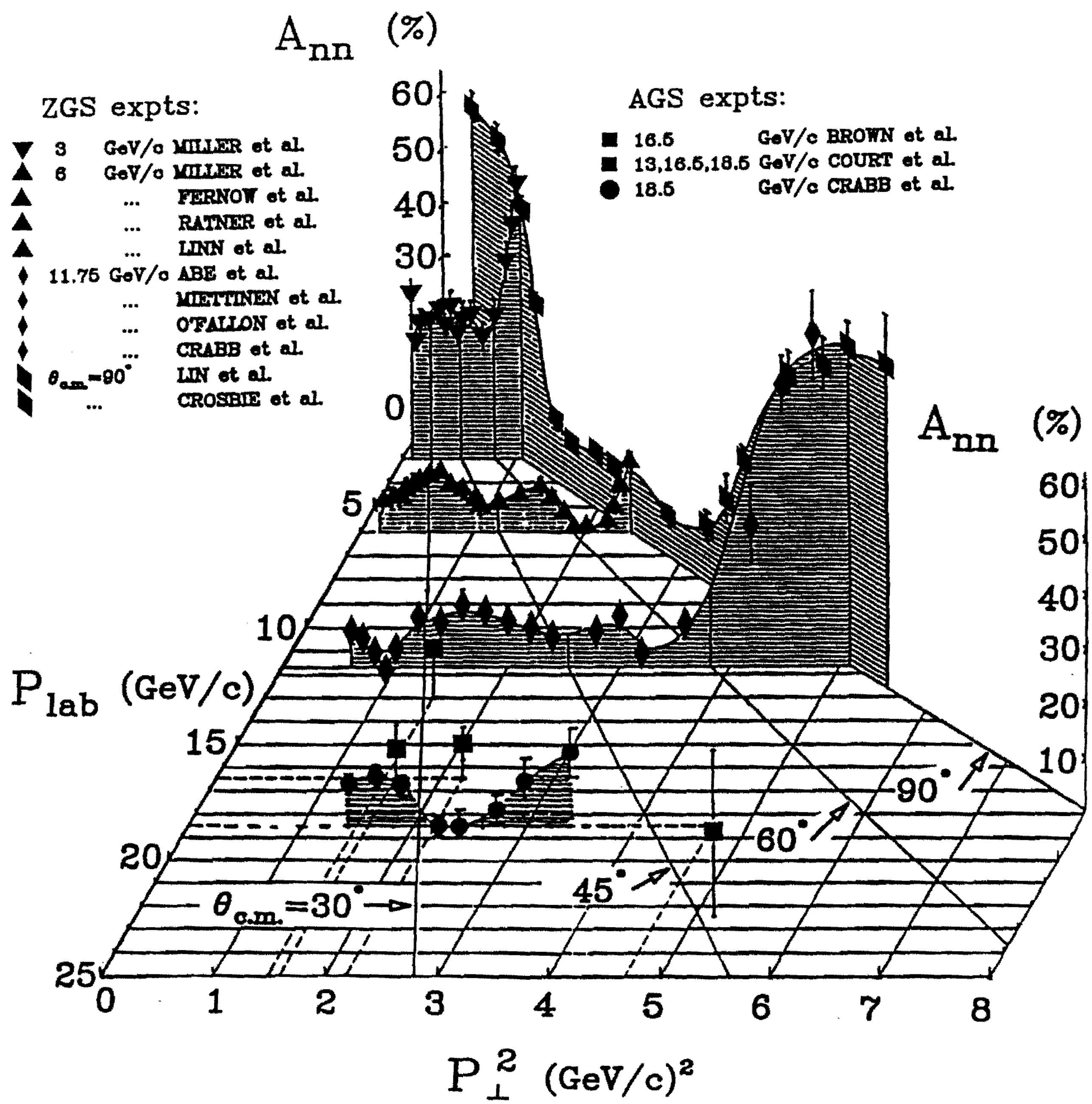

Fig. 2 All high energy A_{nn} data for proton-proton elastic scattering is plotted in 3 dimensions against P_{lab} and $P_{\perp}^2$.

The proposed experiment would use the new Michigan 1 Watt cooling power polarized proton target (PPT) containing radiation-doped frozen ammonia (NH_3) beads. This unexpectedly successful target operated with a beam intensity of 10^{11} protons per sec at the AGS, which allowed the precise large-$P_\perp^2$ measurements of A shown in Fig. 1. The high beam intensity would allow good precision measurements of spin effects in large-$P_\perp^2$ proton-proton elastic scattering at Fermilab energies out to a $P_\perp^2$ of 10 or 12 $(GeV/c)^2$.

We propose to run in an underground target station such as P-west first in 1994 with 800 GeV unpolarized protons and then around 1996 with 120 GeV polarized protons from the Main Injector; the P-west area is well suited for this high-$P_\perp^2$ elastic scattering experiment. We would use a recoil-arm spectrometer consisting of magnets with considerable bending power, medium-resolution scintillation hodoscopes, high-resolution proportional wire chambers and Cerenkov counters. The resulting high precision measurement of the recoil momentum would allow a clear identification of elastic events with only two simple hodoscopes and no magnets in the forward arm. Two pairs of focusing quadrupoles in the recoil spectrometer would reduce the divergence of the recoil protons and thus significantly increase the solid angle acceptance and reduce the background.

During the past six months, the SPIN Collaboration has been carefully studying the depolarizing resonances which must be overcome to accelerate polarized protons in the Booster and Main Injector; the preliminary results are encouraging. A detailed report "Acceleration of Polarized Protons to 120 and 150 GeV in the Fermilab Main Injector" will be submitted to Fermilab by 29 February 1992.

This proposal begins with a brief discussion of the theoretical background of spin effects in large-$P_\perp^2$ elastic scattering; we then describe the Michigan polarized proton target and the proposed SPIN spectrometer. We next calculate the event rates for the proposed experiment and discuss the preliminary budget and scope of the Main Injector Polarized Beam Project. Finally, we discuss the personnel and status of the SPIN Collaboration along with its related activities.

Theoretical Background

The spin physics of large-$P_\perp^2$ hadron elastic scattering is important because it provides clear and unambiguous information about the short distance behavior of the hadronic constituents' interactions. According to the Quantum Chromodynamic theory of strong interactions,[3] only the lowest Fock states with valence quarks and zero orbital angular momentum can contribute to the helicity amplitudes.

The Quantum Chromodynamics (QCD) analysis of elastic scattering assumes that large momentum transfer reactions are controlled by short distance quark-gluon subprocesses. Due to asymptotic freedom this theory leads to the familiar power-law dimensional scaling quark-counting rule.[4] The power-law scaling predictions for form factors and for two-body hadron scattering cross-sections are generally consistent with unpolarized experiments at transverse momenta beyond a few GeV/c.

However, earlier measurements[2] with polarized proton beams and targets indicated that this agreement with unpolarized experiments cannot in itself be considered as a confirmation of the validity of QCD. Large spin effects were discovered which cannot be explained by perturbative QCD[5] because QCD conserves helicity at large momentum transfer due to the vector-like nature of the quark-gluon interaction.

For a binary reaction a+b → c+d, perturbative QCD gives a simple and general helicity conservation law:[3]

$$\lambda_a + \lambda_b = \lambda_c + \lambda_d \tag{1}$$

where λ_i is the helicity of the i particle. This law implies that the analyzing power A and the spin-spin correlation parameters A_{ij} in elastic proton-proton scattering must satisfy the relations:

$$\begin{aligned} A &= A_{ls} = 0 \\ A_{nn} &= -A_{ss} \end{aligned} \tag{2}$$

where n, l, and s denote that the spin is respectively normal, longitudinal, and sideways. Violations of these relations would be quite exciting, since they would demonstrate the non-perturbative nature of hadronic dynamics at short distances. The analyzing power and spin-spin correlation parameter were measured in the 5 to 30 GeV energy region at large-$P_\perp^2$; the experiments clearly show that A is non-zero and that A_{nn} is about 60%.

The large spin effects observed in high-$P_\perp^2$ experiments may be caused by non-perturbative dynamics having its origin in chiral symmetry breakdown or in confinement effects. Many models have been proposed for the treatment of these large spin effects at high-$P_\perp^2$.[6-18] Some of these models involve non-perturbative mechanisms such as: strange and charmed particle production thresholds,[11] geometric mechanisms of quark scattering in an effective field,[9] and quark interactions due to an infinite sequence of meson exchanges.[10] These and some other models were able to reproduce the large observed values for the spin-spin parameter A_{nn} near 12 GeV/c and $\theta_{cm} = 90°$, as well as the sparser 18.5 GeV/c data on A_{nn}. Some models give an explanation for the large value of the analyzing power A discovered in high-$P_\perp^2$ elastic scattering.[1] But there is not yet any satisfactory explanation of all spin effects in proton-proton elastic scattering at large-$P_\perp^2$.

Some of the above models predict large values for A and the A_{nn} at higher energies. For example the quark U-matrix model[9] predicts a rising $P_\perp^2$-dependence for A in elastic proton-proton scattering at 120 GeV in the $P_\perp^2$ region of 5 to 15 $(\mathrm{GeV/c})^2$. The predicted value of A reaches 12.0% at $P_\perp^2 = 10$ $(\mathrm{GeV/c})^2$. The parameter A_{nn} also has a large predicted value at this energy: $A_{nn} = 0.53$ at $P_\perp^2 = 10$ $(\mathrm{GeV/c})^2$. This parameter is even larger at smaller $P_\perp^2$: $A_{nn} = 0.76$ at $P_\perp^2 = 5$ $(\mathrm{GeV/c})^2$. This model as well as several other models[8,11,12] predict an oscillatory energy dependence for A_{nn}.

Note that the power-law behavior predicted by QCD for spin-averaged cross-sections just starts to work at $P_\perp^2 = 5$ $(\mathrm{GeV/c})^2$. In this $P_\perp^2$ region the parameter A_{nn} is dominated by the one-flip helicity amplitude $f_5 = \langle -+|++\rangle$.

Thus it seems important to measure both the analyzing power A and the spin-spin correlation parameter A_{nn} at large-$P_\perp^2$ in the region of hundreds of GeV. The studies of spin effects in large-$P_\perp^2$ elastic scattering in this totally unexplored region should provide a strong test of perturbative QCD; it will also yield information on the hadronic wave function, which cannot be obtained from deep-inelastic scattering.

Only a high intensity accelerated polarized proton beam can provide adequate intensity to study spin effects in high-$P_\perp^2$ hadron interactions with good accuracy. The resulting high precision experiments could allow a decisive conclusion about the nature of strong interactions at short distances.

Polarized Proton Target

We propose to use the new University of Michigan high-cooling-power polarized proton target[19] which is shown in Fig. 3. This target was used at the AGS in 1990; it operates at 5 T and 1 K and has an unexpectedly high polarization maximum of 96%. Moreover, its 5 minute polarization rise time allows fast and frequent target polarization direction reversals. The target material is radiation-doped NH_3 beads, with a hydrogen density of about 0.098 g cm^{-3}. The target length is 3.6 cm, and the target diameter is 2 cm. The proton polarization in the 5 T field is driven by a 140 GHz microwave system using the Dynamic Nuclear Polarization method. The polarization is monitored by a 213 MHz NMR Q-meter system. This target had an average polarization of 85% during a 3 month long AGS run[1] with an average beam intensity of about 10^{11} protons per sec.

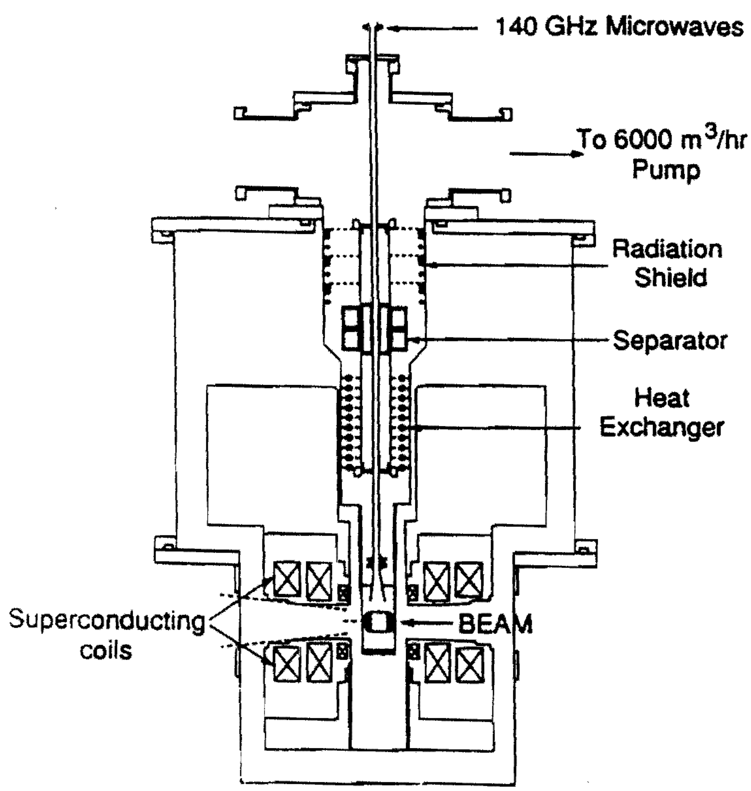

Fig. 3 Diagram of the polarized-proton-target. The superconducting magnet produces a highly uniform 5 T field. At 1 K, the ^{4}He cryostat provides about 1 W of cooling power to the target material in the small cavity at the bottom. The 140 GHz microwaves from the 20 W Varian EIO are fed into the target cavity via the horn.

The unexpectedly high polarization and rapid polarization growth time can be clearly seen in Fig. 4. Note that the average beam intensity of about 10^{11} per sec used at the AGS corresponds to a per pulse intensity of 5.5 10^{12} protons per pulse with the 800 GeV Tevatron's 55 sec cycle time; it corresponds to 2.8 10^{11} protons per pulse with the 120 GeV Main Injector's 2.8 sec cycle time.

Because of the small transverse size of the Fermilab extracted beam, the beam should probably be rastered across the 20 mm diameter target cylinder using beam line magnets and possibly some motion of the target.

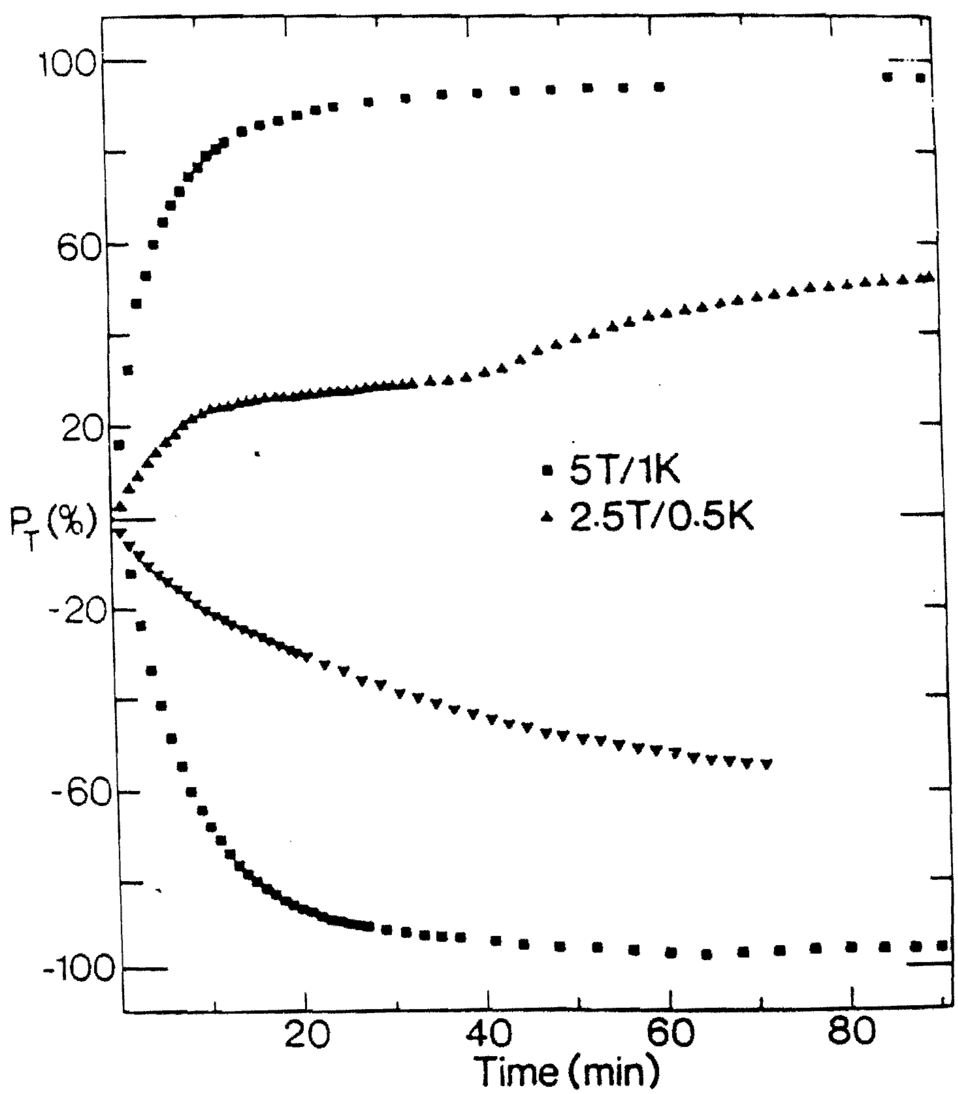

Fig. 4 The spin polarization of the free protons in NH_3 is plotted against the time of microwave irradiation. The new target data at 5 T and 1 K are shown as squares; the earlier data at 2.5 T and 0.5 K are triangles.

Spectrometer

Large-$P_\perp^2$ elastic and inclusive events would be detected using a 55 m long focusing recoil spectrometer similar to the 50 m long spectrometer of our NEPTUN-A experiment, which will study 400 GeV proton-proton elastic scattering at UNK in Protvino, Russia.[20]

The proposed spectrometer is shown in Fig. 5. The quadrupole pairs Q_1, Q_2 and Q_3, Q_4 focus our acceptance of about $\Delta\theta_{lab} = 20$ mrad and $\Delta\phi = 400$ mrad so that our detectors and magnet apertures can be reasonably small. The scintillator counters S_1, S_2, and S_3 are combined with signals from the threshold Cerenkov counters C_1 and C_2 to give a fast first level trigger. The 10° vertical bend in the M_3 magnet is combined with the 1 mm vertical resolution wire chambers $W_1 \rightarrow W_4$ to give a momentum resolution of about 0.1%. The scintillator hodoscopes H_1, H_2 and H_3, H_4 are pairs with horizontal and vertical resolution which would give a rough momentum and scattering angle measurement as well as time-of-flight information for particle identification. This time-of-flight information is most useful for the low momentum recoil particles, for which the Cerenkov Counters are not efficient.

The very precise recoil momentum measurement will strongly discriminate against inelastic and quasi-elastic events. Therefore, we would need only a minimal angular measurement by the forward arm which would probably contain 2 small vertical resolution hodoscopes and no magnet except possibly to realign the beam for downstream users. (The PPT magnet has $\int B \cdot dl = 1.17$ T $\cdot$ m.) This is in sharp contrast to our earlier P-768 proposal which required a very costly 100 to 300 meter long forward spectrometer containing many 6 meter long magnets.

We would employ a 3-level trigger system to select elastic events. The first level is a fast coincidence between the scintillators S_1, S_2 and S_3 and the Cerenkov counters C_1 and C_2:

$$S_1 \cdot S_2 \cdot S_3 \cdot \bar{C}_1 \cdot C_2$$

C_1 is set at the threshold for kaons, while C_2 is set at the threshold for protons. The decision time for this trigger is a few nanoseconds.

The second level trigger, which is gated by the first level trigger, checks that there is exactly one hit in each plane $H_1 \rightarrow H_4$. In this trigger, the hit pattern of the vertical resolution hodoscopes H_1 and H_3 are compared in a memory lookup unit (MLU) to form a rough momentum cut. The decision time for this trigger is around 50 nsec.

At low $P_\perp^2$ where the recoil particle momentum is low, it is difficult and dangerous to run a threshold Cerenkov counter at a high enough pressure to detect protons. Therefore a TDC with a start signal from the second level trigger and a stop signal from the S_3 scintillator will be installed for low $P_\perp^2$ particle identification. The conversion time for a TDC is about 10 μsec; thus the TDC value from each event will be examined by an MLU and the output will form a third level trigger. We will form a similar trigger for inclusive events by simply reprogramming the MLU to accept a different set of TDC values. The information from the Cerenkov counters and the TDC is complementary, since at high $P_\perp^2$ the Cerenkov counters work better and at low $P_\perp^2$ the TDC is more practical.

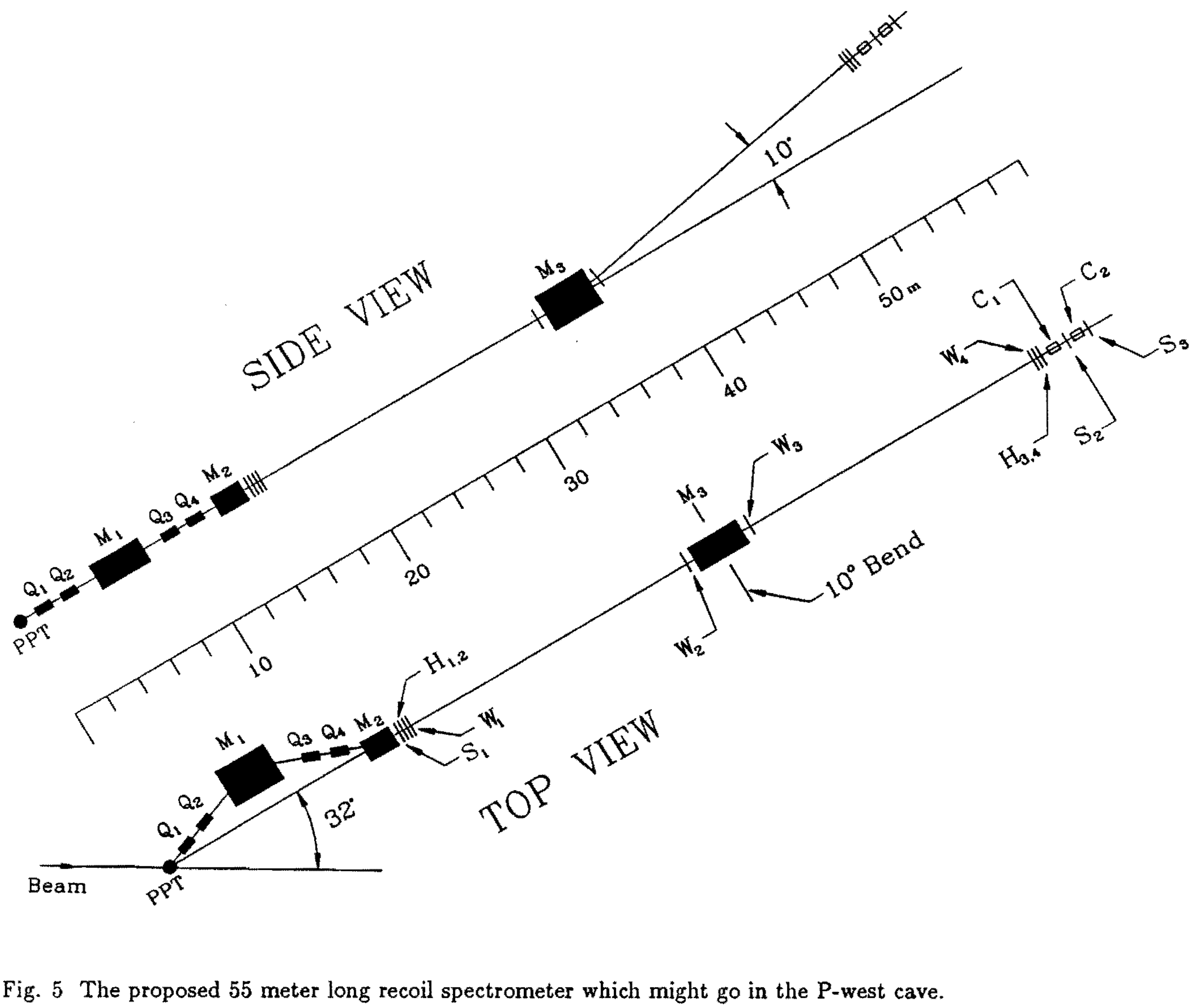

Fig. 5 The proposed 55 meter long recoil spectrometer which might go in the P-west cave.

The SPIN collaboration would provide all detectors, logic, and data analysis computers. A complete list of the required magnets is given below. We expect that IHEP-Protvino could provide the two 3 m dipoles. We hope that Fermilab could provide most of the other below tabulated dipoles, quadrupoles and power supplies from the standard experimental area supply. We might provide some of these magnets from the ones that we used at the ZGS and then at the AGS if they are needed. We would probably provide the superconducting quadrupole Q_1 which would be used in the later large-$P_\perp^2$ running.

Magnet	Length (inches)	Width (horizontal) (inches)	height (vertical) (inches)	B_{max} (T)	B'_{max} (T/m)
Q_1	36	8	8	–	15
Q_1^{super}	39 (1m)	4	8	–	34.9
Q_2	36	8	8	–	15.5
Q_3	36	8	8	–	6.7
Q_4	36	8	8	–	5.3
M_1	118 (3m)	16	8	1.5	–
M_2	72	12	8	1.5	–
M_3	118 (3m)	8	16	1.5	–

We propose that the spectrometer and the polarized proton target (PPT) be installed in the large upstream cave of the P-west extracted beam line as shown in Fig. 6. This cave might also house the SPIN-Tensor spectrometer proposed by Professor L. I. Sarycheva of Moscow State University. As shown in Fig. 6 the following modifications of the cave would be required for the recoil spectrometer:

1. An extension of the downstream left corner of the cave of about 8 ft. by 25 ft.
2. A new pit for the 3 m vertical bending magnet M_3 of about 10 ft. by 20 ft.
3. An 18 inch diameter beam pipe at 32° connecting the extension to the pit.
4. A 24 inch diameter beam pipe angled up from the pit at an angle of about 10° going to ground level.
5. A 10 ft. by 20 ft. hut at ground level for the detectors.

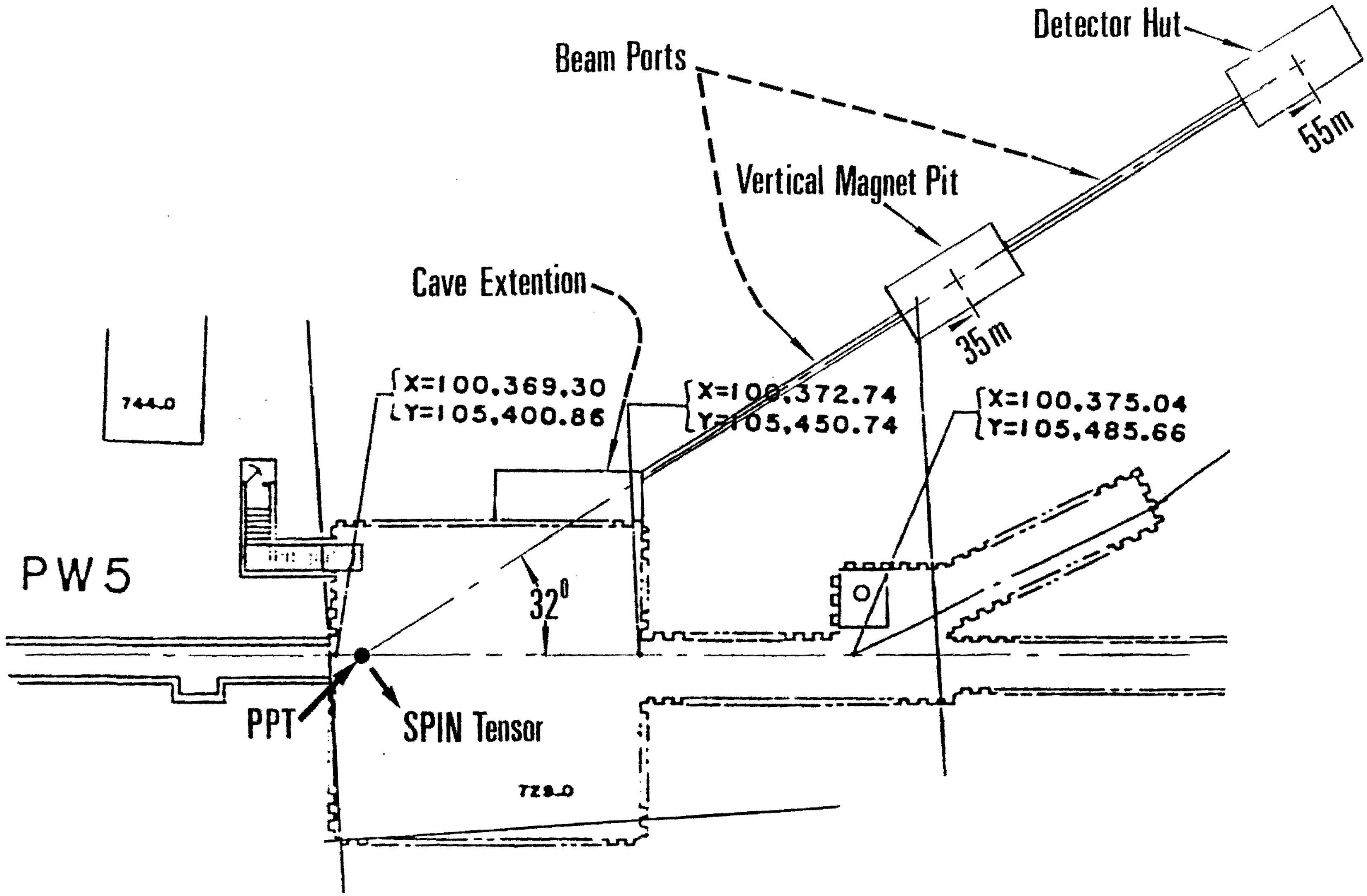

Fig. 6 The experiment placed in the upstream P-west cave.

Event Rates

We can calculate the event rate for large-$P_\perp^2$ proton-proton elastic scattering at Fermilab using the Michigan polarized target and the proposed SPIN recoil spectrometer. Our polarized target has a thickness of:

$$N_0(\rho)t = 6.02\ 10^{23}(.098\ \text{gm/cm}^3)\ 3.6\ \text{cm} = 2.1\ 10^{23}\ \text{polarized protons cm}^{-2}.$$

The 800 GeV Tevatron has an intensity of about 1.5 10^{13} unpolarized protons with a 55 sec repetition rate. If 15% of these protons were extracted to our experiment, then the average intensity passing through our target would be 4.1 10^{10} protons per sec. Our 800 GeV time-averaged luminosity would then be

$$L = 8.6\ 10^{33}\ \text{sec}^{-1}\ \text{cm}^{-2}$$

The proposed SPIN spectrometer has a vertical acceptance of about $\Delta\phi = 0.4$ rad, while the Δt acceptance increases with $P_\perp^2$. At $P_\perp^2 = 8$ (GeV/c)^2 the Δt is about 0.7 (GeV/c)^2. Using the measured or interpolated $d\sigma/dt$, we can calculate the event rate and the statistical error in A for an 800 GeV unpolarized beam run using the equation:

$$\text{Events/hr} = L\ d\sigma/dt\ (\Delta t \cdot \Delta\phi/2\pi)\ 3600\ \text{sec/hr} = 1970\ d\sigma/dt \cdot \Delta t\ [\text{nb}]$$

800 GeV Unpolarized Beam

$P_\perp^2$ [GeV/c]^2	Δt [GeV/c]^2	$d\sigma/dt$ nb/(GeV/c)^2	Events / hr	Hours	Events	Δ A $[.85\sqrt{Events}]^{-1}$
2	0.17	45	1.5 10^4	100	1.5 10^6	0.1%
3	0.23	8	3600	100	3.6 10^5	0.2%
4	0.31	1.7	1000	100	1 10^5	0.4%
5	0.40	0.4	300	100	3 10^4	0.7%
6	0.50	0.07	70	100	7000	1.4%
8	0.69	0.008	11	200	2200	2.5%
10	0.91	0.0012	2.2	500	1100	3.5%
TOTAL				1200 hrs		

Note that because of the excellent statistics the data up to $P_\perp^2$ of 6 (GeV/c)^2 could easily be subdivided into finer bins as was done at the AGS. Thus data at $P_\perp^2$ of 5 (GeV/c)^2 could be split into $P_\perp^2$ bins of 4.9 and 5.1 (GeV/c)^2 each with an error of about 1.0%.

Now let us assume that the 120 GeV Main Injector has a 2.8 sec repetition rate and a polarized beam intensity of 4 10^{11} protons per pulse. If 50% of these protons go to our experiment, then 7 10^{10} polarized protons per sec pass through our target. With our target thickness of 2.1 10^{23} polarized protons cm^{-2}, the 120 GeV luminosity would then be

$$L = 1.4\ 10^{34}\ sec^{-1}\ cm^{-2}$$

If we again take the SPIN spectrometer acceptance to be $\Delta t \cdot \Delta\phi/2\pi$ and use the measured or interpolated $d\sigma/dt$, then we can calculate the event rate for a 120 GeV polarized beam run with the Main Injector using the same equation:

$$\text{Events/hr} = L\ d\sigma/dt\ (\Delta t \cdot \Delta\phi/2\pi)\ 3600\ \text{sec/hr} = 3200\ d\sigma/dt \cdot \Delta t\ [\text{nb}]$$

These event rates are given in the table along with the statistical uncertainty in the analyzing power A and the spin-spin correlation parameter A_{nn}.

120 GeV Polarized Beam

$P_\perp^2$ $[GeV/c]^2$	Δt $[GeV/c]^2$	$d\sigma/dt$ $nb/(GeV/c)^2$	Events/hr	Hours	Events	ΔA $[.85\sqrt{N}]^{-1}$	ΔA_{nn} $[.85(.75)\sqrt{N}]^{-1}$
2	0.16	60	3.1 10^4	100	3.1 10^6	0.1%	0.1%
3	0.23	13	9600	100	9.6 10^5	0.1%	0.2%
4	0.32	2.5	2600	100	2.6 10^5	0.2%	0.3%
5	0.41	0.6	790	100	7.9 10^4	0.4%	0.6%
6	0.49	0.15	230	100	2.3 10^4	0.8%	1.0%
8	0.72	0.012	28	300	8400	1.3%	1.7%
10	0.93	0.0014	4.2	500	2600	2.3%	3.1%
12	1.19	0.0003	1.1	800	880	4.0%	4.7%
TOTAL				2300 hrs			

Thus we request a total of **1200 hours** for the **800 GeV** measurements of A in $p + p \rightarrow p + p$ during an unpolarized beam run around 1994. We also request **2300 hours** to study A and A_{nn} at **120 GeV** when the Main Injector polarized beam first operates around 1996. We believe that these fundamental measurements should give important information about the inner structure of the proton and about the spin forces in strong interactions.

Main Injector Polarized Beam Project

Based on our preliminary studies of the various Fermilab accelerators and our experience with similar projects at the ZGS, the AGS, and the IUCF Cooler Ring, we believe that it is technically feasible to accelerate a polarized proton beam to about 150 GeV in the new Main Injector by making certain hardware modifications. These modifications are symbolically indicated in Fig. 7 and are listed below with our preliminary cost estimates in FY 1992 Dollars. A detailed report on this project will be submitted to Fermilab on 29 February 1992.

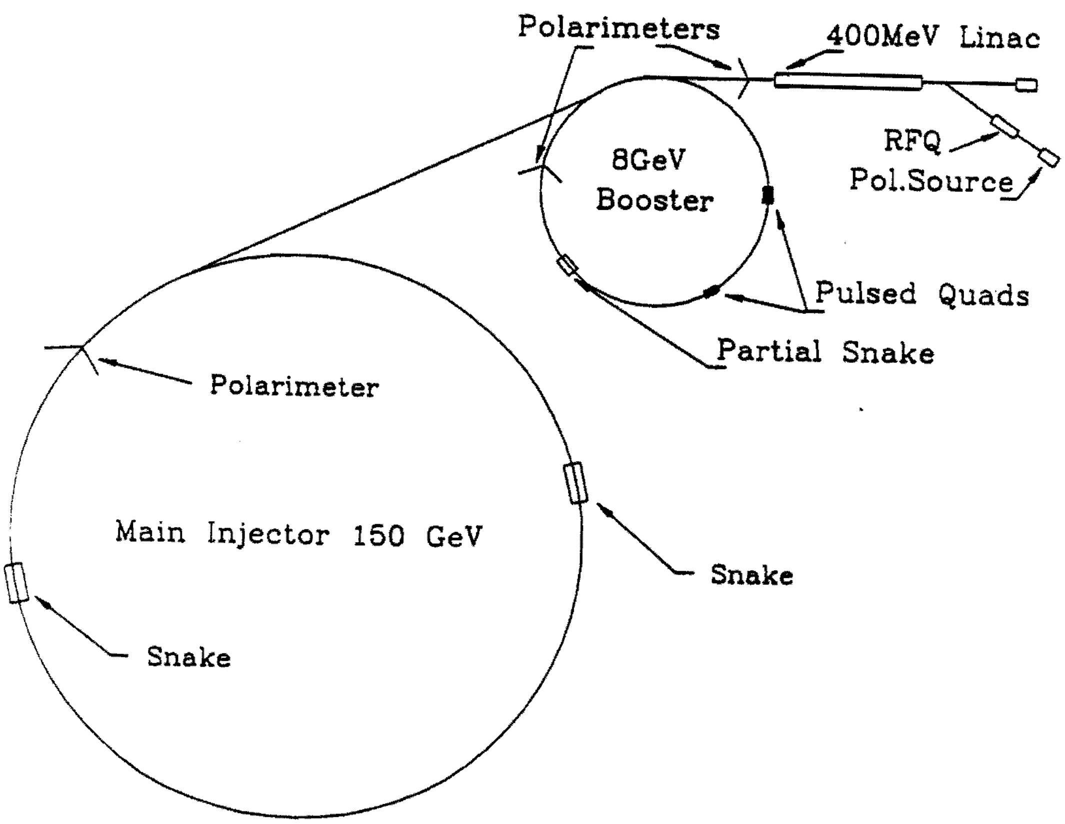

Fig. 7 Modifications to the various Fermilab accelerators necessary for polarized proton acceleration to 150 GeV.

Preliminary Budget Estimate
Main Injector Polarized Beam Project

Main Injector	
Two Siberian snakes (fourteen 1 to 2 T·m dipoles; normal or superconducting)	\$0.8 M
150 GeV polarimeters (Coulomb-nuclear interference and p-Nylon)	\$0.6 M
8 GeV Booster	
Two pulsed quadrupoles with 4 to 5 μsec rise time with power supplies	\$0.5 M
Solenoid-partial Siberian snake (ramped normal)	\$0.3 M
8 GeV polarimeter (p-Nylon)	\$0.2 M
400 MeV LINAC	
400 MeV polarimeter (p-Carbon)	\$0.2 M
Preaccelerator	
RFQ (20 KeV to 750 KeV)	\$1.0 M
Polarized ion source (Conventional or Ultra-Cold)	\$1.5 M
Low energy beam transport and switching magnets with vacuum pipes	\$0.4 M
Miscellaneous	
Computers, control modules, cables, and interfaces	\$0.8 M
Three power supplies and/or helium connections for snakes @\$70 K	\$0.2 M
Large-$P_\perp^2$ Experiment	
Cost to modify the P-west cave and install our polarized target and large-$P_\perp^2$ recoil spectrometer	\$1.1 M
Subtotal	**\$7.6 M**
Inflation & Contingency (25%)	\$1.9 M
Total	**\$9.5 M**

About six additional Siberian snakes and one more Coulomb-nuclear interference polarimeter would allow the later acceleration of polarized protons to about 800 GeV in the Tevatron-Collider. The additional cost would probably be about \$2 Million. However, we plan to delay any detailed work on the Tevatron-Collider until one has successfully finished the report for accelerating polarized protons to 120 and 150 GeV in the Main Injector.

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Related Activities of SPIN Collaboration

We were initially concerned that, without proper planning, some parts of the SPIN Collaboration could become overcommitted by taking on the non-trivial task of accelerating a polarized beam to 120 and 150 GeV at the new Fermilab Main Injector. However, we now believe that the SPIN collaboration could successfully assume the major scientific responsibility for this exciting and challenging project.

About 70 members of the SPIN collaboration are also involved in SPIN at SSC. We were recently informed by R. Schwitters that SSC now plans to leave appropriate spaces for the possible later installation of 26 Siberian snakes in each main ring which would allow the acceleration of polarized protons to 20 TeV. However many scientists in the SPIN collaboration are concerned about the time scale for SSC polarized beam hardware activity; there is special concern about the training of young polarized beam experts during the next five years. The involvement of the SPIN collaboration with the SSC seems unlikely to interfere seriously with the acceleration of polarized protons in the Fermilab Main Injector.

About 30 members of the SPIN collaboration are also involved with the NEPTUN-A experiment[20] which plans to use an ultra-cold spin-polarized atomic hydrogen gas jet as an internal target at UNK in Protvino, Russia. NEPTUN-A should start running in 1994 as the first experiment at the 400 GeV/3 TeV UNK. About 50 members of SPIN are not involved in NEPTUN-A; thus we feel that it would be quite possible and indeed mutually beneficial to run both of these experiments during the mid-1990's.

About 15 members of the SPIN collaboration are participating in CE-20 at the IUCF Cooler Ring, which studies Siberian snakes and depolarizing resonances. This experiment should have a very positive interaction with SPIN at Fermilab. It has about 4 one-week runs each year studying questions directly related to polarized beam acceleration.

Status of SPIN

Below we list the present status of the five conditions discussed in our 13 May 1991 Letter of Intent.

1. A significant group of Fermilab accelerator physicists should join in the polarized beam acceleration project.
   [*This condition has been met.*]
2. Several Fermilab experimenters should join in the large-$P_\perp^2$ elastic experiments.
   [*This is somewhat important, but we accept John Peoples' 23 July 1991 statement that this should await approval of the polarized beam project.*]
3. The Fermilab management should simultaneously make a serious commitment to both the experiment and the polarized beam.
   [*On 14 August 1991 John Peoples indicated that he plans to make this decision just after the June 1992 PAC meeting.*]
4. Appropriate funding for the project should be obtained in a timely way. The preliminary budget estimate is about $9.6 Million of US funding for the total project; perhaps about half of this could come from Fermilab's budget and about half directly to Michigan. Part of Michigan's budget could be used to help our foreign and US collaborators to provide some of the hardware.
   [*We are now reviewing this budget estimate in detail; so far it seems reasonable.* *(See page 16.)* *Providing this funding is of course the responsibility of DoE and possibly Fermilab.*]
5. The funding should begin in FY 1992 for the hardware modifications necessary to accelerate an 8 GeV polarized proton beam in the Booster with a target date of 1994 for 8 GeV beam.
   [*Fermilab provided $100,000 in September 1991; this allowed us to begin the polarized beam study last year.*]

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