FERMILAB-Proposal-0526

Spokesman: R. Lander
Physics Dept. UC Davis
tel: (916) 752-1780
FTS 453-1780
Home: (916) 756-5182

PROPOSAL FOR ANTI-PROTON PROTON STUDIES IN THE FERMILAB 15-FOOT HYDROGEN BUBBLE CHAMBER AT 100 GeV

R.D. Kass, J.H. Klems, Winston Ko, R.L. Lander, J. Pearson,

D.E. Pellett and P.M. Yager

Department of Physics

University of California

Davis, California

95616

6 pgs.

Data Collection

This is a proposal to study $\bar{p}p$ interactions in the Fermilab 15-foot HBC. We request 150 K photos with a 30% $\bar{p}$ content. The large volume of that BC makes it the best detector we know of for simultaneously detecting neutral and charged tracks over 4π solid angle. Furthermore the data can be collected at very little cost to Fermilab beyond what is already committed to run the negative beam exposure for Prof. Kitagaki sometime this year. The agreement on that experiment calls for π^- at 100 GeV. However, since the enrichment achieved for 30-inch BC beams was produced in enclosure 100, the same procedure can be used for an enriched beam to the 15-foot BC. Thus the 30% $\bar{p}$ enrichment already achieved for 30-inch runs can be obtained for the 15-foot BC with <u>no further testing</u>. The $\pi^-/\bar{p}$ cherenkov is in place, as is the tagger. However, some work would have to be done to make sure the tagging data is "flowing" properly and to activate the separation facility. UC Davis personnel are eager to do this work. We have had extensive experience with the 30-inch tagging system and beam line. We think the manpower cost to Fermilab would be minimal.

It seems that failure to obtain $\bar{p}$ data this year would be a shame, particularly when the additional cost is relatively little, since the π^- run is already scheduled. We would be pleased to put in the work necessary to get $\bar{p}$ data simultaneously.

The logistics of film exchanges could be worked out with Prof. Kitagaki at his convenience.

We have considered the question of obtaining K^- tagging. It is much more difficult, because the K^- cherenkov system is not installed.

The uniqueness of the physics lies with the neutral particle detection capability of the 15-foot BC. This chamber has better 4π detection for neutrals than does the 30-inch. In particular the large path length for secondaries gives a non-negligible probability of 20% for secondary neutrons or antineutrons to interact. K_s^o interactions drop rapidly ($\beta\gamma c\tau \simeq 20$ cm) and photon interactions would almost never resemble n or $\bar{n}$ interactions. We can even obtain in this way a sample (albeit small) of events with both n and $\bar{n}$ detected.

The large chamber allows easy separation of the particles in the forward cone, as we found from our 400 GeV pp tests of the utility of the 15-foot chamber for hadron physics. Thus all tracks can be detected and measured, so single particle distributions can be obtained without much bias.

We can also study two-particle correlations: charged-charged, charged-neutral, and in fact neutral-neutral correlations. The 15-foot chamber is particularly good for studies of strange-particle correlations.

This exposure would provide an interesting sample of $\bar{p}p$ interactions in a unique instrument and at a cost far less than that for a separate run.

Physics Objectives

In Exp. E311, Oh, et al find $(\sigma_{\bar{p}p} - \sigma_{pp}) \sim 3.5$ mb and attribute the difference to baryon annihilation. However, there are several increasingly respectable quark models which would attribute this difference to $q\bar{q}$ annihilation. In these models, the $\bar{p}$ beam is ideally suited for the study of $q\bar{q}$ annihilation since it possesses three valence antiquarks. The excess of particles produced in antinucleon-nucleon interactions over nucleon-nucleon interactions is the valence interaction. By simple quark counting, some definite results can be predicted for this excess. For example, the ratio of excess pions produced at x = 0 is expected to be 2:5:2 in $p\bar{p}$ interaction.

At 100 GeV, charged pions near x = 0 have laboratory momentum around 2.5 GeV for $p_T = 0.3$ GeV and around 7 GeV for $p_T = 1$ GeV. These momenta can be very accurately measured in the 15'. Furthermore, since the pions produced in valence interactions may have different p_T dependence, it is particularly important to measure wide angle pions above 7 GeV. This is much better done in the 15' bubble chamber rather than in, for example, the 30" hybrid system.

The detection efficienty of γ's in the 15' is around 15%. The 2% efficiency of detectin π^o is not to be entirely discounted. A π^o signal is clearly seen in the $m(\gamma\gamma)$ plot (Fig. 1) in the preliminary data in our 400 pp experiment. In the moderately high statistics experiment we are proposing, enough π^o data can be obtained to compare with the yield of charged pions near x = 0. If the large cross section difference $\sigma_{\bar{p}p} - \sigma_{pp}$ is due to $p\bar{p}$ annihilation, the probability for producing new particles will be enhance in $\bar{p}p$ interactions. The detection efficiency for such particles should be good since the 15' chamber is an excellent detector for neutral strange particles and detects γ's relatively well, allowing measurement of all hadronic decay products.

Scan-Measure-Analysis

A year ago (Dec. 1975), we took 34 K pictures of pp at 400 GeV/c in the 15-foot chamber. That experiment was a feasibility test for hadron physics in the 15-foot. We developed a microprocessor controlled Scan-Image-Plane-Digitizing-system at UCD and a semi-automatic measuring system, CICERO, at LBL. The measurement and analysis is still in progress, but we have achieved an important bench mark for the feasibility test - we can see an excellent π^0 signal in the $m(\gamma\gamma)$ as we have shown.

In production, our IPD scan rate is 15-20 frames/hour/table. To scan 50 K pictures $\bar{p}$ equivalent to a 150,000 picture exposure, will take $1\frac{1}{2}$ FTE year. Three FTE-scanners are what we are planning to devote to this experiment. In other words, the IPD scan will take six months. Our measurement rate of these events is $\sim$ 4/hour/machine. Assuming 30,000 events, the measurement will take 4 FTE year. Since it is not likely that we will measure every event in all topologies, the 3 FTE measurers will take about one year to complete the analysis.

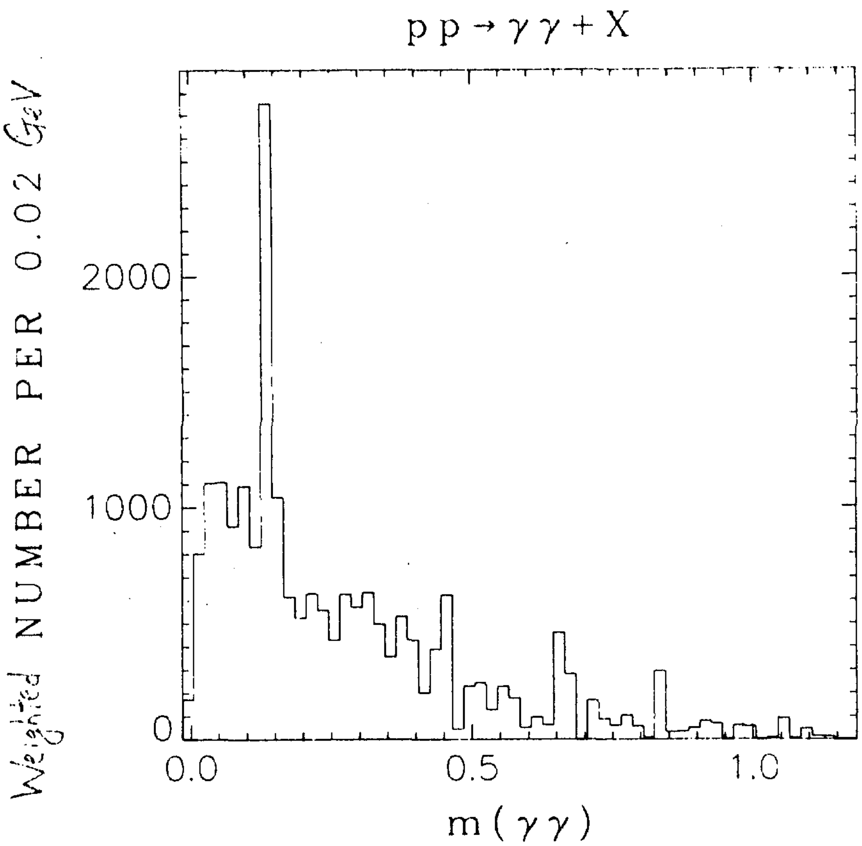

Fig. 1