Yale University

PHYSICS DEPARTMENT
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Dr. Leon M. Lederman, Director
Fermi National Accelerator Laboratory
P.O. Box 500
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Dear Leon:

We are writing to express our intent to submit a proposal this fall to study beauty and charm at the TEVATRON using a high resolution streamer chamber and a downstream spectrometer. As will be discussed further below, this proposal describes an experiment using a charged hadron beam. However, we view it as the beginning of a major program of such studies which may use neutron or photon beams as well as charged beams with good particle identification.

This collaboration (Brussels, Fermilab, NYU, Yale) has had a continuing interest in a systematic program of charm and, especially beauty physics. Our experiences in SPS NA25, BNL 726 and Fermilab E-490 and E630 have convinced us that the TEVATRON II is an excellent and in many ways a unique laboratory for these heavy quark studies, provided the proper "experimental technology" can be brought to bear on the problem. We believe this entails:

1. A high resolution holographic streamer chamber with track width of the order of (or less than) 30 μm,
2. a fully instrumented downstream spectrometer,
3. a trigger system based on the detection of a high $P_\perp$ ($\gtrsim$ 1 GeV/c) electron with the aid of a tracking TRD and a fast processor.

There is now wide agreement on the need for a suitable vertex detector for charm and beauty physics. An ideal vertex detector should provide a large number of high resolution points on each track. It should be triggerable, have good time resolution and a controllable memory time, and have low dead time. No currently existing or proposed detector meets the ideal in all respects. Solid state detectors can have good resolution, good timing properties and low dead time. However, because of particle interactions in the detectors and high costs, it does not seem possible to have a sufficient number of detectors to provide more than a few (~ 3) points per track. This is a serious limitation for the very complex events

characteristic of beauty production at the TEVATRON. The data cuts required to provide adequate pattern recognition with the small number of points per track lead to large inefficiencies in reconstructing events.

Nuclear emulsions have superb spatial resolution but are continuously sensitive. Even with the best ancillary detectors including solid state hodoscopes, the nuclear emulsion experiments will have severe rate limitations relative to the streamer chamber approach. High resolution bubble chambers have resolutions comparable to that for the streamer chamber we propose but are not triggerable devices and thus have a much lower rate capability.

A more complete analysis, which will be presented in our forthcoming proposal, has convinced us that our streamer chamber approach has major advantages over the solid state approach for beauty, and is very competitive and somewhat complementary in the charm physics questions which can be addressed. The holographic streamer chamber with diffusion suppression is a triggerable device with high resolution (track width ~ 30 μm, setting error ~ 5 μm, over a large volume of space (15 x 5 x 1.5 cm^3). Furthermore, it operates at sufficiently high pressure (~ 60 atmospheres) so that high interaction rates are obtained with available beams. If, as we believe, a sufficiently selective trigger can be made, the relatively long recovery time of the streamer chamber (~ 100 ms) will not lead to a significant loss of efficiency.

The Yale group (with FNAL and DOE support) has been concentrating on the development of the high resolution streamer chamber. Holographic recording of streamers with diameters $\lesssim$ 30 μm was achieved several months ago. Recently, the technique of capturing ionization electrons on oxygen molecules and releasing them by photoionization after a suitable trigger delay was successfully demonstrated. The use of this technique will allow us to "park" the ionization electrons in massive (and non-diffusing) negative oxygen ions until we are ready to use them to initiate streamers. We have now demonstrated the basic techniques needed for the desired chamber and are ready to design and construct the actual chamber to be used in an experiment.

Our collaboration has begun to focus on the trigger and the downstream apparatus as we prepare our proposal. We intend to submit the proposal in September, aiming for a run in 1986 (the third running period). However, we are aware of the importance of the June PAC meeting in reviewing the physics program and wish to make our intentions known now.

As originally advised by the committee with respect to P694, we had assumed that we would use an existing spectrometer such as those planned for E687, E690 or E706. However, our work on a detailed proposal has suggested an alternative plan, motivated by two considerations. First, neither the E687 or E706 spectrometers could be available to us for testing or running until sometime in late 1987 or early 1988 in an as yet unscheduled fourth running period. The E690 spectrometer could be shared during the right time scale, but presents problems. Second, we are working on a very

powerful trigger using a TRD that would require substantial modifications to any one of the three spectrometers.

We believe that a phased approach to our program makes more sense. Phase I would use the streamer chamber and a trigger system based on a tracking TRD and a fast trigger processor, but would use a modest spectrometer. The spectrometer would have charged particle tracking and lead glass calorimetry for use in the trigger (in conjunction with the TRD) but would not provide particle identification, hadron calorimetry, or fine grained photon calorimetry. Much of the equipment (including the lead glass) required for this exists and is available. This first phase could be set up in any one of several locations (such as ME).

In Phase I, we would concentrate on beauty hadroproduction, with a sensitivity of ~ 5 detected events per nb allowing a measurement of the hadronic production cross section, a direct measurement of the lifetimes of charged and neutral B flavored hadrons, and a "first look" at the types of beauty particles made available for study via hadroproduction at the TEVATRON. In Phase II, with a proven streamer chamber, trigger processor, and tracking TRD, we would either augment the spectrometer with particle identification, a second magnet, etc., or more to another, by then commissioned spectrometer.

We would, of course, be pleased to provide any further information desired.

Sincerely,

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Spokesman

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