COLLIDING-DETECTOR FACILITY WORKSHOP

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About 20 theorists (10 from collaborating institutions) and 40 Colliding Detector Facility (CDF) collaborators participated in the November 5-8 workshop on CDF physics at Fermilab. Preliminary conclusions and plans for further studies were presented on the morning of November 8 in a series of progress reports. Results from these further studies will be collected in mid-December and distributed.

The following is a brief summary of the progress reports, including a list of the processes studied, some preliminary conclusions, and a list of studies being carried out. Complete copies of the progress reports can be obtained by writing or calling me at Fermilab Ext. 4602 or Mail Station #223. Further discussion on data from cosmic rays and the implication for physics at the CDF will take place in early December with the visit of Thomas Gasser.

Group A -- W, Z Physics (M. Mishina, Organizer)

Processes studied included pp into W, Z, WW, ZZ, WZ, $W\gamma$, + gluons.

For W or Z production, the non-scaling cross section is considerably larger than the scaling cross section, although there is probably some (perhaps a factor 2) uncertainty depending on the low-x part of the quark distribution function. Signatures and background will be investigated using the present Monte Carlo program.

Precise measurement of masses and widths of single W and Z was stressed. WW production, although the rate is low (of order 8 pb), could be used to establish the renormalizability of gauge theory. $W\gamma$ production is important, but almost impossible.

Group B -- Heavy Quark (t) (W. Carithers, Organizer)

The QCD process gg into $t\bar{t}$ was studied in detail; the expected cross section was 60 nb × $(M/25\ \mathrm{GeV})^{-4.35}$ giving (for 10^{36} luminosity) 60,000 events if M_t is 25 GeV, but only 300 events for M_t = 75 GeV.

The cleanest signature for this process is for those t produced at high P_t, so that almost all the decayed particles (whether three jets with 40% probability, one jet with an isolated lepton with 30% probability, or three jets with a lepton inside one of the jets with 30% probability) are within 1 to 2 steradians; only about 3% of the produced tt will have P_t greater than

50 GeV/c and decay into an angle θ between 45° and 135° (for M_t = 25 GeV); thus we end up with about 200 top decays for three jets + three jets and about 200 decays with three jets + one jet and one lepton. For the three jet mode, the signal is expected to be above the background from jets with gluon bremsstrahlung (signal/background will be of order 1:1). The three jets + one jet and one lepton mode should be much cleaner and will be studied in detail; leptons inside the jet will also be investigated.

Another possible process for t production was suggested by ISR diffractive dissociation production of charm at large x. Brodsky suggested that this could be due to "intrinsic" heavy quarks inside the proton; he expects that the mass dependence should be $1/M^2$. If this is correct, then we expect 3 μb for M_t = 25 GeV and 0.3 μb for M_t = 75 GeV, completely swamping the QCD $t\bar{t}$ cross section at low P_t and at large x.

Dileptons from toponia should occur at the 10 pb level for $M_{t\bar{t}}$ = 50 GeV and could be seen above the Drell-Yan background. Further studies on t signatures and background at low P_t and for the diffractive dissociation scenario will be done.

Group C/D -- Hard Jets and QCD Tests (G. Bellettini, Organizer)

The rate for QCD jets (as calculated by Horgan) was studied; for 10^{36} cm^{-2} integrated luminosity, one expects 1000 events/GeV at P_t = 80 GeV/c; single-hadron production will be down by about 500 (1000/GeV at P_t = 30 GeV) at 10^{30} cm^{-2} sec^{-1} luminosity, the rate for 10-GeV P_t jets would be 100/sec; various triggering schemes were considered.

Jet flavor study was investigated; in particular, silicon detectors inside the beam pipe were suggested to study secondary vertices (charm decay). Another suggestion was to replace some of the calorimeter modules by Cherenkov modules backed by calorimeters further away from the beam. The silicon detectors could also be used for quark searches.

Other processes studied include Drell-Yan and single photons. Rates for Drell-Yan are low and will only reach masses of 20-30 GeV. Single photons appeared to be very interesting, may have γ/π^0 exceeding 0.1. It could be separated from $\pi^0 \rightarrow 2\gamma$ up to P_t = 20 GeV at the expense of refining the chamber position determination in the shower counters. This separation could be extended if some calorimeter module is moved further back from the beam.

Further studies will be done on understanding whether one can separate bremsstrahlung gluons, more detailed photon studies, and tagging of heavy flavors.

Group E -- New Particles (R. Diebold, Organizer)

This group discussed various possibilities for heavy new particles that might appear at $(s)^{1/2} = 2000$ GeV. In general, heavy particles will be produced at low rapidity and will appear at relatively large angles. "Standard" new particles such as quarks and monopoles were considered briefly, as were Higgs and supersymmetric particles, which according to present ideas will likely be hard to see (of course, Nature may be more imaginative and give us a good signature if we are alert).

Considerable thought was given to the possibility of observing technicolor particles, such as the η_T with mass approximately 250 GeV. If these particles exist, the minimal production cross section is expected to be of order 80 pb, and they would prefer to decay into heavy objects such at $t\bar{t}$ (Kane et al.). This theory would also suggest that the dominant t decay would be $t \to bh^+$ where h^+ would be a charged Higgs of mass 8 GeV. The h^+ decay would often include neutrinos in the final state, and Monte Carlo studies will be made to see if the η_T mass can be reconstructed when the constraints of $t(\bar{t})$ mass and P_t balance are included.

"Stable" ($T \gtrsim 10^{-11}$ sec) particles were also considered; such objects are suggested by delayed particles seen in cosmic ray showers. Further, they are not unexpected in various theoretical scenarios. The identification of such particles would benefit from dE/dx and time-of-flight capabilities not included in the present "standard" detector. Further study will be given to the cost and benefits of adding these capabilities.

Another possibility is that of observing the effects of quark and lepton substructure in hard collisions (for example, DeRujula's glints). These might show up as events with large multiplicities (including several leptons), large $p_\perp$, and acoplanarity. As for many types of heavy particles, a large-$p_\perp$ trigger and the jet capability already built into the detector should work well in this case.

Group F -- 0° Physics (D. Cline, P. McIntyre, and G. Brandenburg, Organizers)

There appear to be good arguments for having at least nonmagnetic tracking, electromagnetic, and hadron calorimeters in the forward region ($\theta < 15°$). The measurement of energy flow would be useful for determining missing P_t; effects such as Centauros could be studied, etc.

Forward magnetic toroids could also be useful for muon identification and triggering; however, trigger and background rates should be investigated much more thoroughly. Some room should be left for the toroids even if they do not exist at first.

At present, there does not appear to be any strong justification for particle identification or momentum analysis (aside from muons) in the forward direction. P. McIntyre and collaborators will investigate further the usefulness and feasibility of these and other options. Compatibility of these options with the forward calorimeter and toroids should be considered.

Items for further studies include diffractive top production, beam jets as background for high-P_t physics, ln s physics, and further work on all the detector elements and options at forward angles.

PROPOSALS RECEIVED FROM MAY 17, 1980
THROUGH DECEMBER 12, 1980

No.	Title	Spokesperson
659	Electron Target Facility at Fermilab and a Lepton-Quark Structure Experiment	R. R. Wilson W. Lee
660	Proposal to Study the Effect of Bent Crystals on Channeling Near the Critical Radius of Bending	W. Gibson
661	Energy and Momentum Dissipation in Nuclei in High Energy Hadron Nucleus Interactions	H. H. Gutbrod
662	Correlations Among Nuclear Fragments in Relativistic Proton-Induced Breakup of Heavy Nuclei	E. P. Steinberg
663	Comparison of Polarizations of Inclusively Produced Lambdas and Antilambdas by Protons, Antiprotons, Kaons, and Pions on Hydrogen	H. Kobrak
664	An Experiment to Search for Neutrino Oscillations Using a ν_e Enriched Beam	R. Loveless
665	Muon Scattering with Hadron Detection at the Tevatron	T. B. W. Kirk
666	Emulsion Exposure to Σ^- Beam at Fermilab	R. J. Wilkes
667	Study of Pion-Nucleus Interactions in Pure Emulsion Stacks and Emulsion Chambers at Energy Above 500 GeV	W. Wolter
668	Study of Proton-Nucleus Interactions in Pure Emulsion Stacks and Emulsion Chambers at Energy Above 800 GeV	W. Wolter

An impromptu discussion held last month between sessions of the Colliding Detector Facility workshop. Participating in this discussion are (left to right) Roy Schwitters from Fermilab and Harvard University, Chris Quigg, head of Fermilab's Theoretical Physics Department, Art Garfinkel, Purdue University, and Willy Chinowski, University of California at Berkeley.
(Photograph by Fermilab Photo Unit)