PRELIMINARY RESULTS FROM A SEARCH FOR DISORIENTED CHIRAL CONDENSATES AT MINIMAX

J.STREETS
Fermi National Accelerator Laboratory
Batavia, IL 60510, U.S.A

Representing the MiniMax Collaboration

We report on the progress of a search for disoriented chiral condensates (DCCs) in the far forward region at $\sqrt{s} = 1.8\ TeV$. MiniMax is a small collider experiment situated at the C0 interaction region of the Tevatron and has been designed to measure the ratio of charged to neutral pions produced at $\eta \approx 4.1$. The distribution of this ratio is expected to be very different for the generic binomial and DCC particle production models. We present a method used for the search using the factorial moments of particle generating functions, which can be extracted directly from the data. A preliminary comparison of robust ratios of measured values and those expected from the different models is also presented.

1 Disoriented Chiral Condensates

There is a class of events seen in cosmic ray experiments which occur at much higher rates than expected from studies of standard Monte Carlo simulations.[1] These events have high multiplicity in the forward direction ($3.5 \leq \eta \leq 4.5$), abnormal ratios of electromagnetic to hadronic energy and $\sqrt{s} \tilde{>} 1\ TeV$. It has been proposed that these events can arise from the strong-interaction with unconventional orientation of the chiral order parameter. This disoriented chiral condensate is then supposed to decay into a coherent semiclassical pion field having the same chiral orientation.[2]

In the DCC model, the fraction of neutral pions in the event ($f = \frac{n}{N}$) can be shown to occur with a probability distribution $\frac{1}{2\sqrt{f}}$ in the limit of large numbers. The striking differences in the distributions at $f = 0$ and $f = 1$ for the DCC and generic binomial models can be seen in figure 1.

2 The MiniMax Detector

Figure 2 shows the layout of the detector.[3] Charged tracks are measured by 24 MWPCs which cover a circle of radius approximately 0.65 units in (η, ϕ) space centered on $\eta = 4.1$. Neutral tracks are reconstructed from conversions in a moveable lead plate, typically $1X_0$ in thickness. The trigger is comprised of scintillating counters placed both in the telescope and at $\eta = -3.5$ in the

anti-proton direction. This trigger was measured to be sensitive to $35-40$ mb of the total $p\bar{p}$ cross-section.

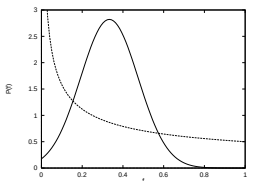

Figure 1: P(f) for the generic (binomial curve) and DCC models ($\propto 1/\sqrt{f}$)

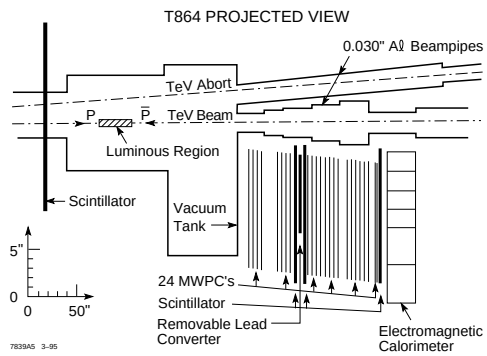

Figure 2: The MiniMax Detector

3 Using Moments of the Generating Functions

The factorial moments of the generating functions for bivariate distributions of m charged pions and n observed gamma rays are expressed as f_{mn}. The first few moments reduce to robust observables if we assume that the detection efficiencies of tracks are independent of track multiplicity.

$$\begin{array}{ll} f_{10} =< N_{ch} > & f_{20} =< N_{ch}(N_{ch}-1) > \\ f_{01} =< N_{\gamma} > & f_{21} =< N_{ch}(N_{ch}-1)N_{\gamma} > \\ f_{11} =< N_{ch}N_{\gamma} > & f_{30} =< N_{ch}(N_{ch}-1)(N_{ch}-2) > \end{array} \quad (1)$$

The ratios $r_{m1} = \frac{f_{m1}f_{10}}{f_{(m+1)0}f_{01}}$ all yield 1 for generic distribtions and $\frac{1}{m}$ for pure DCC. They have many nice properties. In particular, they are independent of the form of the parent pion multiplicity distribution, of the (uncorrelated) detection efficiency for charged tracks, of the (uncorrelated) detection efficiency for gammas, of the different trigger efficiency MiniMax has for events in which no particles are detected, and possess definite and very different values for pure generic and pure DCC production.[4] (Note that generalizations involving gamma-gamma correlations are possible, but depend on a single detector dependent parameter in these cases).

Table 1: Values of r_{ij} from the data and Monte Carlo

r_{ij}	PYTHIA and GEANT	pure DCC	DCC and GEANT	Data
r_{11}	$1.01 \pm .02$	0.500	$0.56 \pm .01$	$0.98 \pm .01$
r_{21}	$1.02 \pm .05$	0.333	$0.40 \pm .03$	$0.99 \pm .02$
r_{31}	$1.09 \pm .14$	0.250	$0.34 \pm .05$	$1.03 \pm .04$

4 Preliminary Comparison with Monte Carlo Predictions

Table 1 shows the measured values of lower order ratios of the factorial moments. The results were found to be independent of the run conditions, independent of the converter thickness or composition, and consistent with a high $x_F = 0.9$ trigger. The data are consistent with the generic production mechanisms. Comparison between the different trigger samples, and between the calculated and Monte Carlo [5] corrected values suggest the errors due to systematic effects are in the 5% range. We believe we are sensitive to admixtures of DCC mechanisms to the $10 - 20\%$ level, however more work is needed to place a limit on the quantity of DCC we may observe. These values are dependent on the model used to mix DCC into the generic fragmentation.

Acknowledgments

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References

1. C.M.G.Lattes, Y.Fujimoto and S.Hasegawa, *Phys. Rep.* **65** 151 (1980).
2. For a review, K.Rajagopal, in Quark-Gluon Plasma 2, ed. R.Hwa, World Scientific, 1995, HUTP-95-A013.
3. T.Brooks *et al*, The MiniMax Detector. NIM article in preparation.
4. T.Brooks *et al*, Analysis of Charged-Particle/Photon Correlations in Hadronic Multiparticle Production. In preparation.
5. GEANT Detector and Simulation Tool, CERN, PM0062 (1993).
   T. Sjostrand *CERN-TH.6488/92 (PYTHIA 5.6 Manual)*