A study of the $\eta\eta\pi^-$ and $\omega\eta\pi^-$ systems produced in the reaction $\pi^- p \to p\pi^+\pi^-\pi^- 4\gamma$ at 18 GeV/c

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Preliminary results are reported on the production of $\eta\eta\pi^-$ and $\omega\eta\pi^-$ in the reaction $\pi^- p \to p\pi^+\pi^-\pi^-\pi^0\eta$ at 18 GeV/c where both π^0 and η decay to 2γ. The data were obtained using the MultiParticle Spectrometer at Brookhaven National Laboratory. In the $\eta\eta\pi^-$ channel, a strong $a_0(980)$ signal decaying to $\eta\pi^-$ is present. The accepted $\eta\eta\pi^-$ mass spectrum exhibits a structure consistent with the mass and width to the $\pi(1800)$. In the $\omega\eta\pi^-$ channel, the $\omega\pi^-$ mass spectrum peaks at the mass of the $b_1(1235)$.

1. INTRODUCTION

An analysis effort of the Brookhaven E852 data(A description of Brookhaven E852 is given in these proceedings[1].) is currently underway which focuses on the $\eta\eta\pi^-$ and $\omega\eta\pi^-$ systems produced in the reaction $\pi^- p \to p\pi^+\pi^-\pi^- 4\gamma$. The flux-tube model predicts characteristic decays of hybrid mesons to $L = 0$, $L = 1$ meson pairs[2]. Several states are predicted to decay into $\eta\eta\pi$ and $\omega\eta\pi$[3]. The $\pi(1800)$ recently reported by the VES Collaboration[4] to have a large decay to $\eta\eta\pi$ has been argued to be a hybrid meson based on its decay to flux-tube favored modes[5]. The $\omega\eta\pi$ final state is also of considerable interest since this channel has not been previously studied.

The data were collected during the 1995 Brookhaven E852 run where 265 million triggers of the type designed to enrich this exclusive final state sample were acquired. Out of these data, 45.6 thousand events were fully reconstructed and kinematically fitted to the hypothesis of $\pi^- p \to p\pi^+\pi^-\pi^-\pi^0\eta$ with a confidence level greater than 10%. To eliminate incorrectly hypothesized events arising from ambiguous fits of the 4 gammas into $\gamma\gamma$ pairs, events that also fitted a $\pi^- p \to p\pi^+\pi^-\pi^-\pi^0\pi^0$ hypothesis were removed.

2. FEATURES OF THE $\pi^+\pi^-\pi^-\pi^0\eta$ SYSTEM

The accepted invariant mass distribution of the $\eta\pi^+\pi^-\pi^-\pi^0$ system produced in the reaction $\pi^- p \to p\pi^+\pi^-\pi^-\pi^0\eta$ is shown in Figure 1a. There are no obvious resonant-like structures in the distribution. The accepted invariant mass distribution of the $\pi^+\pi^-\pi^-\pi^0$ subsystem is shown in Figure 1b. This distribution exhibits a prominent enhancement at 1.3 GeV/c^2 with a width of 0.200 GeV/c^2. Assuming only isoscalar and isovector

*The E852 Collaboration authors are listed in the contribution to this conference by P. Eugenio, titled *Meson Spectroscopy in $\pi^- p$ Interactions at 18 GeV/c –Recent Results from Brookhaven E852.*

contributions, an overall charged 4π system must have an $I^G = 1^+$. Therefore the only known candidate for this structure is the $b_1(1235)$.

Figure 2a displays the accepted $\pi^+\pi^-\pi^0$ invariant mass distribution. Two prominent narrow resonances are observed: at 0.550 GeV/c^2, an η signal; and at 0.785 GeV/c^2, an ω signal.

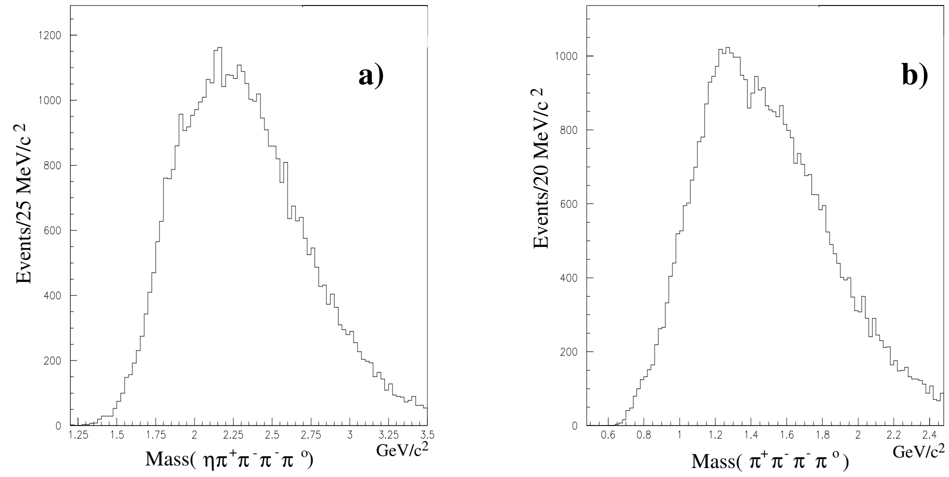

Figure 1. [a] The $\eta\pi^+\pi^-\pi^-\pi^0$ effective mass distribution. [b] The $\pi^+\pi^-\pi^-\pi^0$ effective mass distribution.

3. $\eta\eta\pi^-$ SYSTEM

For an η selection of 0.500 GeV/c^2 $\leq Mass[\pi^+\pi^-\pi^0] \leq$ 0.580 GeV/c^2, 5000 events were used to study the $\eta\eta\pi^-$ system. The accepted invariant mass distribution of the $\eta\pi$ subsystem is shown in Figure 2b. The main feature is a clear $a_0(980)$ signal. In addition, the distribution exhibits a shoulder-like structure in the region of 1.3 GeV/c^2 suggesting the presence of some $a_2(1320)$ signal. The accepted $\eta\eta$ invariant mass distribution, shown in Figure 3a, exhibits a broad structure in the 1.4-1.5 GeV/c^2 region which appears correspond to events in the $\eta\eta\pi$ Dalitz plot(not shown) where the $a_0(980)$ bands cross, suggesting that the $\eta\eta$ structure might be due to constructive interference of the a_0 bands. Figure 3b shows the accepted $\eta\eta\pi^-$ invariant mass distribution. The mass spectrum exhibits a resonant-like structure with a mass of 1.8 GeV/c^2 and a width of about 0.200 GeV/c^2. This mass and width is consistent with the $\pi(1800)$[6]. As shown by the dashed histogram there appears to be a strong $a_0(980)\eta$ component to this structure. A partial wave analysis will be carried out to see if this is indeed correct.

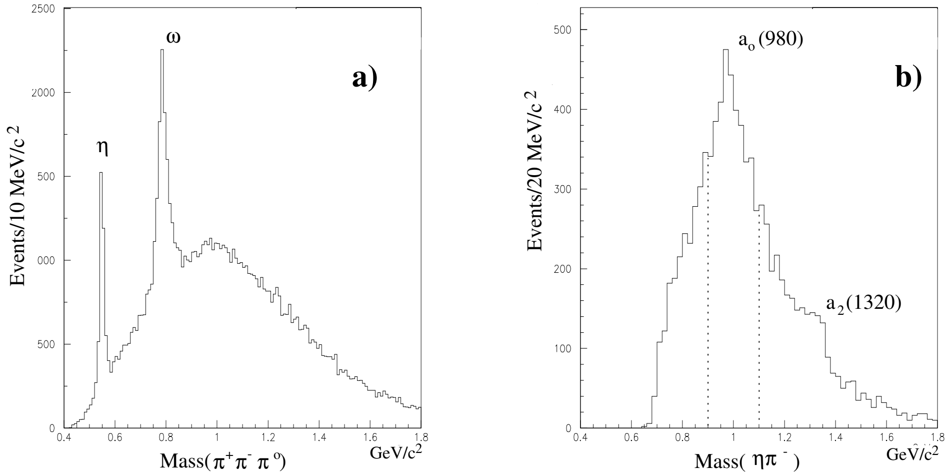

Figure 2. [a] The $\pi^+\pi^-\pi^0$ effective mass distribution(2 entries/event). [b] The $\eta\pi^-$ effective mass distribution of the $\eta\eta\pi^-$ system(2 entries/event).

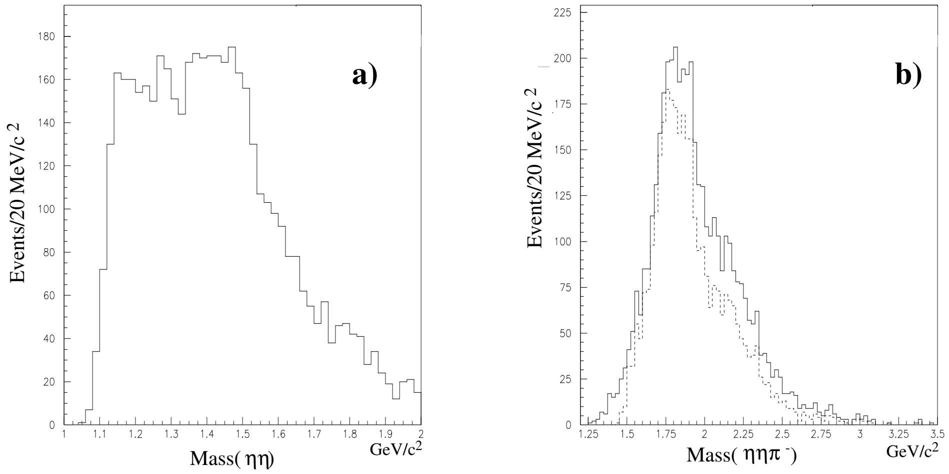

Figure 3. [a] The $\eta\eta$ effective mass distribution of the $\eta\eta\pi^-$ system. [b] The $\eta\eta\pi^-$ effective mass distribution; the dashed histogram corresponds to an $a_0(980)\eta$ selection.

4. $\omega\eta\pi^-$ SYSTEM

To study the $\omega\eta\pi^-$ system, 16,400 events were selected for an omega signal of 0.720 GeV/$c^2 \leq Mass[\pi^+\pi^-\pi^0] \leq 0.870$ GeV/c^2. The accepted invariant mass distributions(not shown) of the $\omega\eta$ and $\eta\pi^-$ subsystems are featureless. The accepted $\omega\pi^-$ mass spectrum, shown in Figure 4a, exhibits a peak with a mass and width consistent with the $b_1(1235)$ which suggests a $b_1(1235)\eta$ component in the data. Figure 4b shows the accepted $\omega\eta\pi^-$ invariant mass distribution. The dashed histogram in the figure represents events consistent with a $b_1(1235)\eta$ selection. A partial wave analysis is in progress to determine if there are resonance structures in the $\omega\eta\pi^-$ system.

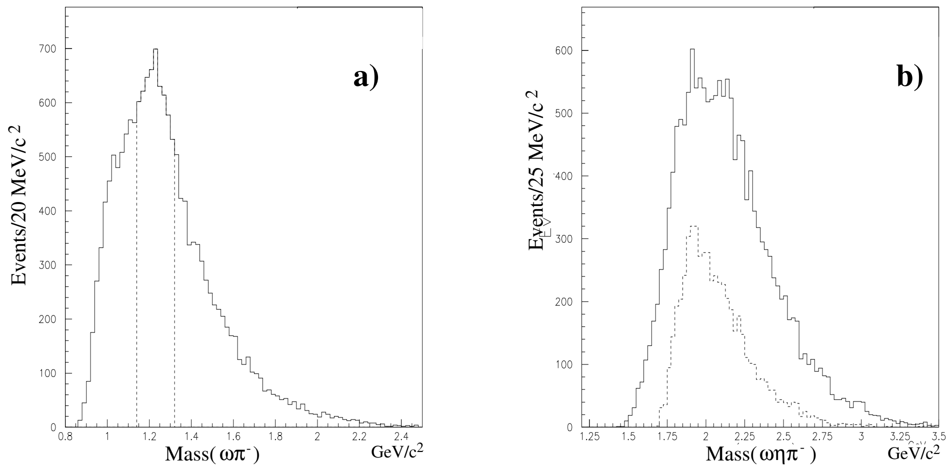

Figure 4. [a] The $\omega\pi^-$ effective mass distribution of the $\omega\eta\pi^-$ system. [b] The $\omega\eta\pi^-$ effective mass distribution.

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