Dalitz Analysis of $D^+ \to \pi^+\pi^-\pi^{+*}$

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Abstract

Using 281/pb of data recorded by the CLEO-c detector observing e^+e^- collisions at the $\psi(3770)$, corresponding to 1.8 million $D\bar{D}$ pairs, the substructure of the decay $D^+ \to \pi^+\pi^-\pi^+$ is investigated using the Dalitz plot technique. The results presented in this document are preliminary.

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A Dalitz plot analysis [1] of $D^+ \to \pi^+\pi^-\pi^+$ has previously been done by E791 [2] and FOCUS [3]. The preliminary analysis described here is from CLEO-c [4], and represents the first time we have done the same Dalitz plot analysis as the fixed target experiments. Previously CLEO has focused on analyses with π^0's in the final state. The decay is selected with cuts on the beam constrained mass of three charged tracks consistent with pions and the difference of their energy from the beam energy. A sample of 4100 events is selected with a signal to noise of about two to one. The E791 and FOCUS samples are of similar size and cleanliness.

The Dalitz plot is symmetric under the interchange of like-sign pions thus we do the analysis in the two dimensions of high unlike-sign pion mass squared versus low unlike-sign pion mass. There is a large contribution from $K_S\pi$ which because of the long K_S lifetime should not interfere with the other contributions to the plot. We do not consider this stripe on the Dalitz plot when fitting for two body resonance contributions. The efficiency across the Dalitz plot is modeled with simulated events that are fit to a two-dimensional second order polynomial. While there is a notable fall of the efficiency in the corners of the Dalitz plot the changes are smooth, and well modeled by the polynomial. Backgrounds are taken from sidebands and extra resonance contributions to the background are allowed from mismeasured K_S, ρ, and $f_2(1270)$ decays. Many possible resonances can contribute to the decay, and a total of 13 different resonances are considered. Parameters describing these resonances are taken from previous experiments. Only contributions with an amplitude significant at more than three standard deviations are said to be observed, and others are limited. Contributions that are not significant are not included in the decay model used for the result.

Figure 1 shows the Dalitz plot and projections on to the squared masses. Contributions from $\rho^0\pi$ and $f_2(1270)\pi$ are clearly visible. Table I shows the preliminary fit fractions measured by CLEO comparing with the results of the E791 analysis mentioned above. There

TABLE I: Comparison of the fit fractions, in percent, found in the Dalitz plot analysis of $D^+ \to \pi^+\pi^-\pi^+$ between the preliminary CLEO analysis and E791. CLEO limits are at 90% confidence level.

Contribution	**CLEO**	**E791**
$\rho^0\pi^+$	20.0 ± 2.5	33.6 ± 3.9
$\sigma^0\pi^+$	41.8 ± 2.9	46.3 ± 9.2
$f_2(1270)\pi^+$	18.2 ± 2.7	19.4 ± 2.5
$f_0(980)\pi^+$	4.1 ± 0.9	6.2 ± 1.4
$f_0(1370)\pi^+$	2.6 ± 1.9	2.3 ± 1.7
$f_0(1500)\pi^+$	3.4 ± 1.3	
Non-resonant	< 3.5	7.8 ± 6.6
$\rho(1450)\pi^+$	< 2.4	0.7 ± 0.8

is broad agreement between the two results, including the observation of a $\sigma\pi$ contribution. In an alternative analysis using the same decay model as E791 the agreement is only slightly better, but the fit is much less likely to model our data than the model shown in the table which does not include non-resonant and $\rho(1450)\pi^+$ contributions, but does include a $f_0(1500)\pi^+$ contribution. Models without a $\sigma\pi$ contribution do not agree well with the data.

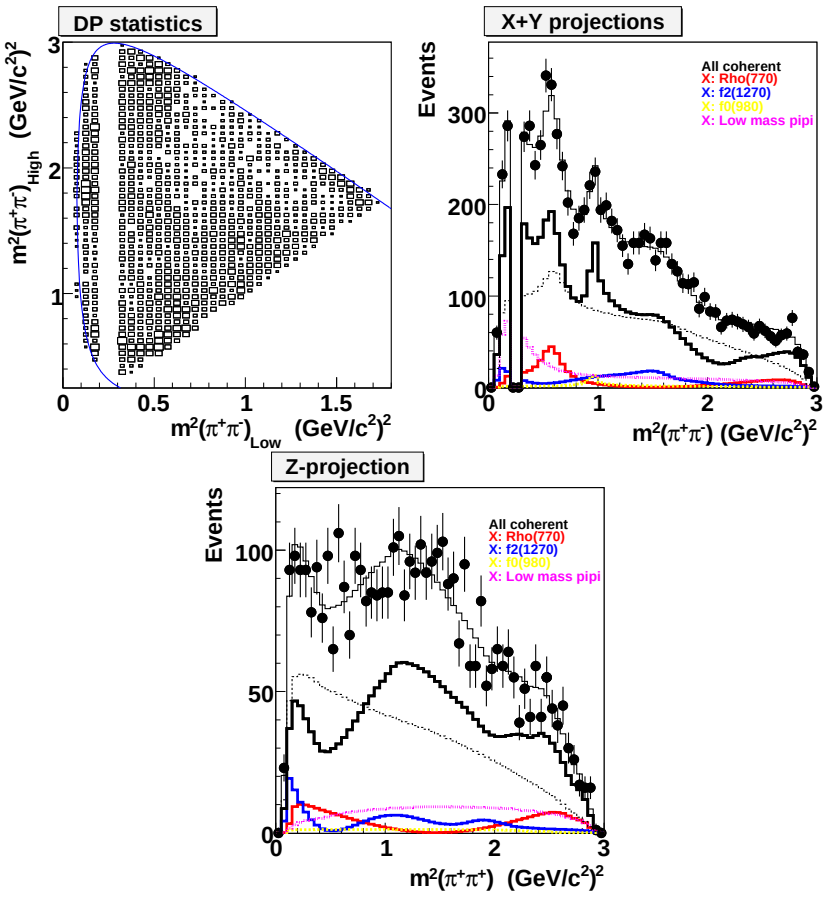

FIG. 1: Dalitz plot and projections for $D^+ \to \pi^+\pi^-\pi^+$

This CLEO analysis is preliminary, and we plan to consider a generalized model of $\pi\pi$ S-wave interactions to model σ and f_0 contributions such as the K-matrix which is used in the FOCUS analysis mentioned above.

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