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Abstract

A preliminary analysis of an experiment designed as a sensitive dibaryon resonance search in the reaction $pp \to p\pi^+ n$ is presented. At 2 GeV/c incident momentum, we have obtained 440,000 unambiguously reconstructed events. In this preliminary analysis, we report the results of a search of the pn mass spectrum for evidence of chain decays of possible dibaryon resonances, i.e. $pp \to d^{**}$, $d^{**} \to d^{*}\pi^+$, $d^{*} \to pn$. No evidence of narrow peaks (≤ 7 MeV) is seen in the data for cross-section-times-branching-ratio greater than 50 μb.

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Introduction

The ZGS polarized proton beam and the Effective Mass Spectrometer[1] (EMS), augmented with a vertex detector[2] surrounding a liquid hydrogen target, were used to collect data on the inelastic reaction $p_{\uparrow}p \to p\pi^{+}n$ at 1.2, 1.5, 1.74, and 2.0 GeV/c lab momenta. For part of the data, superconducting solenoids were used to rotate the usually transverse incident beam spin to the longitudinal direction. The analysis of these data is expected to yield density matrix elements and polarization correlations, both transverse and longitudinal, for $p_{\uparrow}p \to \Delta^{++}n$ over the full range of Δ^{++} production angles.

Along with similar data at 3-11.75 GeV/c already acquired, these data allow a complete description of this channel from threshold to beyond the resonance region. In addition, we will perform a sensitive search for effects due to recently proposed dibaryon resonances.[3] These objects, which some authors have invoked to account for structures observed in elastic polarization observables,[4] are expected to have large inelastic decay widths. The energies chosen for this experiment cover the region of these proposed resonances in steps comparable to their assumed widths and extend both above and below threshold. At each energy, we recorded about 6×10^{6} triggers with two charged particles in the final state. Of these, about 440,000 were unambiguously reconstructed as $p\pi^{+}n$ events at 2 GeV/c, with similar statistics at the other energies.

In this paper, we report a preliminary study of the pn effective mass spectrum from the 2 GeV/c data only, and give experimental limits on the existence of narrow peaks in this spectrum. In contrast to this study, our

final analysis will be able to detect the presence of broad resonant states through the behavior of the various quantities determined from amplitude and partial wave analyses.

Event Reconstruction

The trigger required two charged particles in the final state, at least one of which was forward enough to pass through the spectrometer. This forward particle was momentum analyzed in the EMS to precisions of $\sigma(p) \simeq 0.005p$ GeV/c and $\sigma(\theta) \simeq 2.0$ mrad, for momentum and angle respectively. More than 50% of the triggers were thus elastic scatters, events that proved useful in the analysis for beam polarization measurement, flux monitoring, chamber alignment, and kinematic calibration. The second trigger particle most often did not go through the spectrometer, and only its direction[5] was measured in the vertex detector with accuracies of σ(azimuth)$\sim$ 10 mrad and $\sigma(\cot\theta) \simeq 0.02$. For the channel of interest, $\sim$90% of the events thus had angle and momentum measurements for one track, usually a proton, and direction measurements only for the other track. The remainder had second tracks passing sufficiently through the spectrometer to yield more complete measurements. Final state neutrals were undetected.

At higher energies, where many channels are open, this set of measured quantities doesn't provide enough constraints to fit uniquely the $p\pi^+n$ hypothesis to the triggering events. However, at 2 GeV/c and below, multipion production channels are neglible and the only reactions with appreciable cross sections are $pp \to pp$ ($\sim$24 mb), $pp \to p\pi^+n$ ($\sim$17 mb), $pp \to pp\pi^0$ ($\sim$4 mb), and $pp \to d\pi^+$ ($<$ 3 mb). The first and last of these have very restrictive kinematics and

can be cleanly separated in our data. The forward proton (deuteron) is well measured in the spectrometer, so the second track must satisfy not only two body coplanarity but also missing mass constraints for these channels. The major analysis problem is then separating the three body channels (with undetected neutral) into the dominant $p\pi^+n$ channel and the background $pp\pi^0$ channel. In our kinematic regime, this separation is cleanly made by removing all events where $pp\pi^0$ is a possible interpretation. Monte Carlo studies show that this cut eliminates ~99% of the smaller cross section $pp\pi^0$ events while retaining ~90% of the desired $p\pi^+n$ events. The acceptance for $p\pi^+n$ events lost by this procedure is confined to small momentum transfers to the $p\pi^+$ system.

Narrow Resonances

Figure 1 shows the pn mass spectrum of the nearly 440,000 events which unambiguously fit the $p\pi^+n$ hypothesis for the 2 GeV/c data. This spectrum, in 5 MeV bins (comparable to our resolution), contains 5,000-11,000 events/bin in the mass range 1.93 - 2.17 GeV and reveals no obvious narrow peaks of width 5-10 MeV. Such peaks might be expected from the chain decay of the postulated[3] dibaryon resonances into the $p\pi^+n$ final state, $pp \to d^{**}$, $d^{**} \to d^*\pi^+$, $d^* \to pn$. As shown in Fig. 1, there is no bin more than 3.2, nor any pair of neighboring bins more than 2.0 standard deviations above a locally smooth fit to the data. A resonance with cross-section-times-branching-ratio of 50 μb and width $\sigma = 7$ MeV would have produced 1250 events in our experiment. The smallest signal from these events would have been two neighboring bins each at least 3.2 standard

deviations above background. Such an isolated structure is clearly ruled out by our data. However, narrow enhancements of lower cross section, or enhancements with broader widths, may be uncovered by a more complete analysis.

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5. $\cot\theta = X/L$, where X = coordinate along the beam direction (parallel to the axis of the cylindrical chambers) and L is the perpendicular distance from the interaction vertex to the chamber hit.

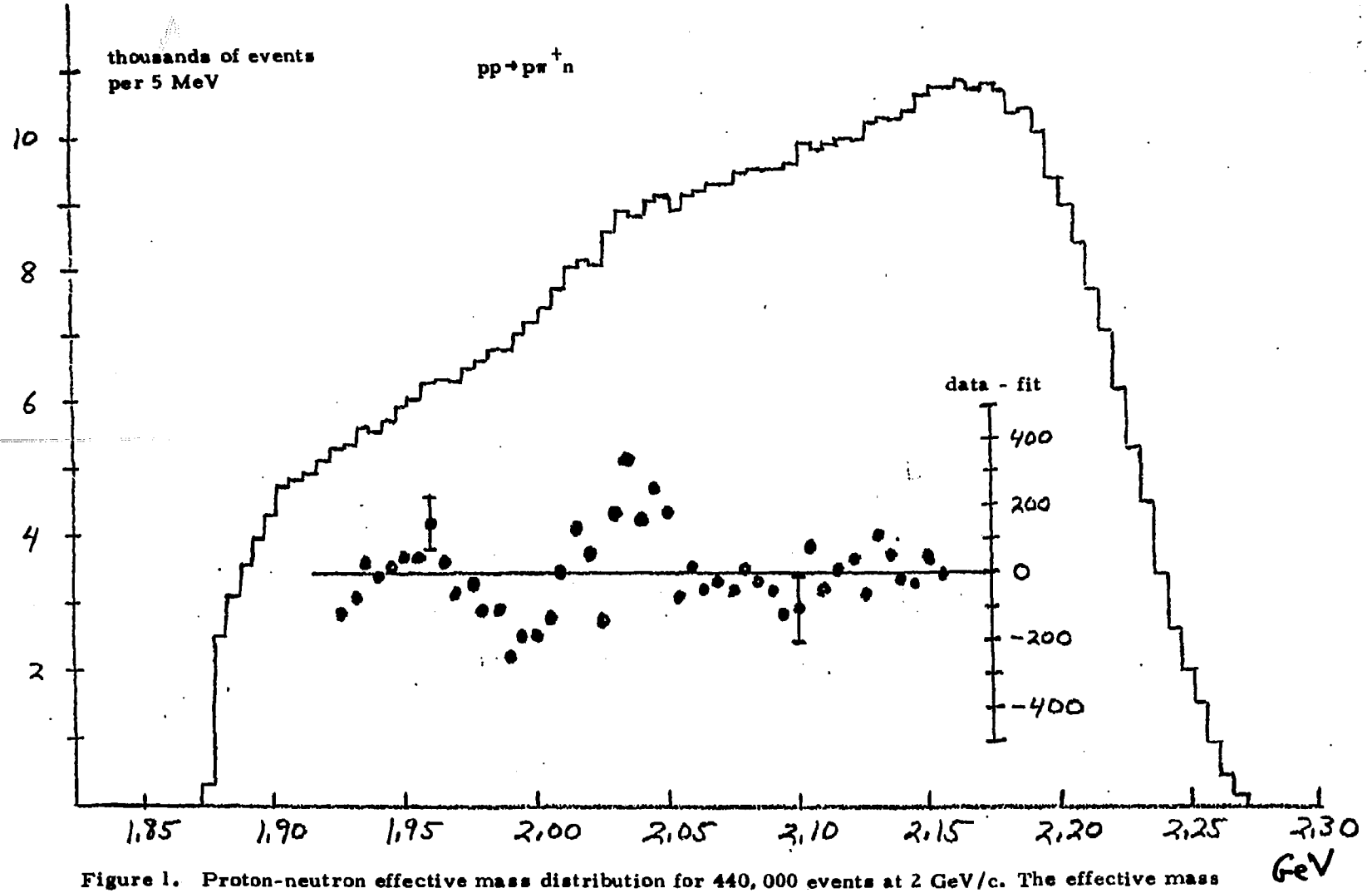

Figure 1. Proton-neutron effective mass distribution for 440,000 events at 2 GeV/c. The effective mass resolution is about ±1.5 bins. The insert shows the difference between the data and a smooth polynomial fit, with a few representative error bars.