CERN/ISRC/74-39
25 August 1974

M E M O R A N D U M

To : ISR Committee

From : R603 (Phase II) Collaboration

Subject : R603 status and vector meson studies (ρ^0 and ϕ^0) with the R603 spectrometer.

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R603 Phase II is now under way. In the present report, we summarize the status of the experiment with specific attention to the following items:

1) People
2) Apparatus
3) Vector meson search (ρ^0 and ϕ^0).

In the latter section, evidence is presented from R603 Phase I for production of $\rho^0 \to \pi^+\pi^-$ and $\phi^0 \to K^+K^-$ using Čerenkov counter pulse-height information for particle identification.

1. PEOPLE

The R603 Phase II group consists of the following full-time people:

Univ. of California, Los Angeles

W. Lockman
T. Meyer
R. Poster
J. Rander
P. Schlein
R. Webb

Centre d'Etudes Nucleaires-Saclay

G. Burgun
P. Le Du
J.P. Michau
J. Zsembery

After the experiment is completed, at least six of us will be heavily involved in analysis of the data, with bulk processing of the tapes being carried out at the UCLA IBM 360/91 and the Saclay CDC 7600.

2. APPARATUS

Although being mindful of the ISRC request not to attempt too-major modifications to the R603 spectrometer, the additional strength of the Saclay group, the generous help of the ISR-Division Experimental-Support-Group and the use of existing γ-sensitive counters (see below) has made it possible for us to achieve most of

our original (modest) hardware objectives on schedule. We summarize below the status of the various elements of the spectrometer.

a) ISR -- During the shutdown between the July-August periods, the R603 vacuum chamber was reinstalled and a bake-out successfully completed. The R603 double septum magnet was reinstalled.

b) Counting room -- Although the ISRC suggested that we not build up a new counting room (in the former R601 counting room), we were nontheless obliged to do so because the Rubbia group wished to retain their counting room for other purposes. The IBM 1800 computer has therefore been moved into our new quarters. This installation work has been completed and the new counting room has been set up with 13 racks of electronics.

c) Proportional chamber system -- Although the chambers have been in the tunnel since R603 was dismantled in December 1973, wires were found to be broken in several planes both before and after moving them to their spectrometer positions. Two months work went into testing and reorganizing the amplifier card system. The chambers are now being plateaued and it is anticipated that they will be ready for operation by the beginning of the September period.

d) Magnet proportional chambers -- Although it was planned to have these chambers ready for installation at the beginning of the September period, it now seems unlikely that this can be accomplished. Due to unexpectedly long delivery times of a large number of capacitors and printed circuits for the read-out electronics system, it has proven to be impossible to complete the system on schedule. It is now expected that the chambers will not be completed until about mid-September.

e) Some minor improvements have been made to the UCLA Čerenkov counters to improve their pulse-height resolution for π, K and ρ identification. The counters have been reinstalled in the magnets.

f) Two small hodoscopes, with 1 cm vertical resolution have been constructed at Saclay and installed on remote control scanning tables in the arm opposite the spectrometer. These will permit the identification of single recoiling protons in arm 2 and the clean separation between single and double excitation events permitting detailed tests of factorization as a function of momentum transfer.

g) A full set (nearly 4π geometry) of lead scintillator counters for γ-detection have been installed. In all cases these were existing counters borrowed from Orsay and CERN groups (Yvert, Vivargent, Winter). The ISR division provided supports for these counters. These counters permit the clean separation of single from double diffraction excitation events for those cases when the arm-2 system momentum remains in the beam pipe as explained in our last status report.

h) A neutron detector (not a calorimeter) has been installed in arm-2, which (together with the γ-sensitive veto system) should allow the identification of the reaction $pp \to \Delta^{++}n$, as stated in the original R603 proposal. The ISR division provided the support.

i) Aside from the above-mentioned Saclay hodoscope, the only other new counters installed in R603 Phase II were two new front trigger counters for the spectrometer, which offer a much-improved match to the spectrometer acceptance. New light guides for the hodoscopes at the magnet centres were constructed so that the magnet chambers could be accommodated.

3. VECTOR-MESON SEARCH

The particle identification capabilities of the Cerenkov counters permit us to identify $\pi^+\pi^-$ or K^+K^- pairs and hence to search for: $\rho^0 \to \pi^+\pi^-$ and $\phi^0 \to K^+K^-$. Although no special triggers were used in the R603 Phase I run to select or enhance vector meson detection, it has been possible to find evidence for production of both ρ^0 and ϕ^0 in the data from that run. These results discussed in the following section show that we can selectively enhance their detection in our forthcoming run. The final two 22 GeV periods this year should be adequate for this purpose.

ρ^0-MESON PRODUCTION

The ρ^0-meson is seen in almost any $\pi^+\pi^-$ invariant mass spectrum in our experiment, as a small shoulder on a large di-pion background, presumably arising from a large variety of sources.

We have attempted to isolate a relatively clean ρ^0-sample by looking in the $x \sim 1$ region where baryon exchange might dominate. For this purpose we have used a sample of 320,000 2-track events with 11.8 GeV in the spectrometer arm with one positive and one negative track (one in each spectrometer). $\sim$ 1600 of these events are $\pi^+\pi^-$ pairs with each pion momentum $p_{\pi\pm} > 4$ GeV and identified by the Cerenkov counters. Figures 1(a,b,c) show the uncorrected invariant mass distribution for three different selections on total momentum of the pair: $x \equiv p_{\pi^+\pi^-}/p_{beam} > 0.68$, $x > 0.8$ and $x > 0.9$.

The distinct shoulder seen in Fig. 1a becomes more and more isolated as x is increased. The shape of the ρ^0-meson in Fig. 1c is distorted by the acceptance which falls off on the high side as illustrated.

In addition, the production mechanism may influence the ρ^0-shape since for any value of x, u_{min} is closer to the nucleon pole with decreasing $m_{\pi\pi}$ ($u_{min} \approx 0$ for a ρ^0 with $x \approx 0.7$).

At 22 GeV, with the magnet chambers installed and with the Cerenkov counters used in the trigger, it should be possible to obtain a sufficiently large ρ^0 sample to perform acceptance corrections and look for evidence of the nucleon pole.

ϕ^0-MESON PRODUCTION

Whereas the ρ-meson has a sufficiently large opening angle in its decay that one pion may enter each spectrometer, thus permitting the $p_t = 0$ region to be studied, the ϕ^0 can only be seen with both decay products in one magnet.

We show in Fig. 2(a,b) the K^+K^- invariant mass spectra for events at 22/22 and 26/26 GeV in which the momentum of the three-track (++-) charge combination is in the diffractive region (X>0.9). The (+-) charge combination appears in one spectrometer with at least one track above pion threshold with no light in the Cerenkov counter. The other positive track is alone in the second spectrometer above pion threshold with no light. This selection defines events of the type

$$pp \rightarrow (pK^+K^-) + x \ .$$

A significant $\phi^0(1020)$ signal is seen above the background.

These events can be selectively enhanced by requiring 3 tracks in the spectrometer with no Cerenkov light in either counter and with no particles in the central region. Inclusive ϕ^0 spectra can be obtained by using our UP or DOWN trigger.

11/11 Gev
11/26 Gev.

$p\,p \rightarrow (\pi^+\pi^-) + \text{"anything"}$

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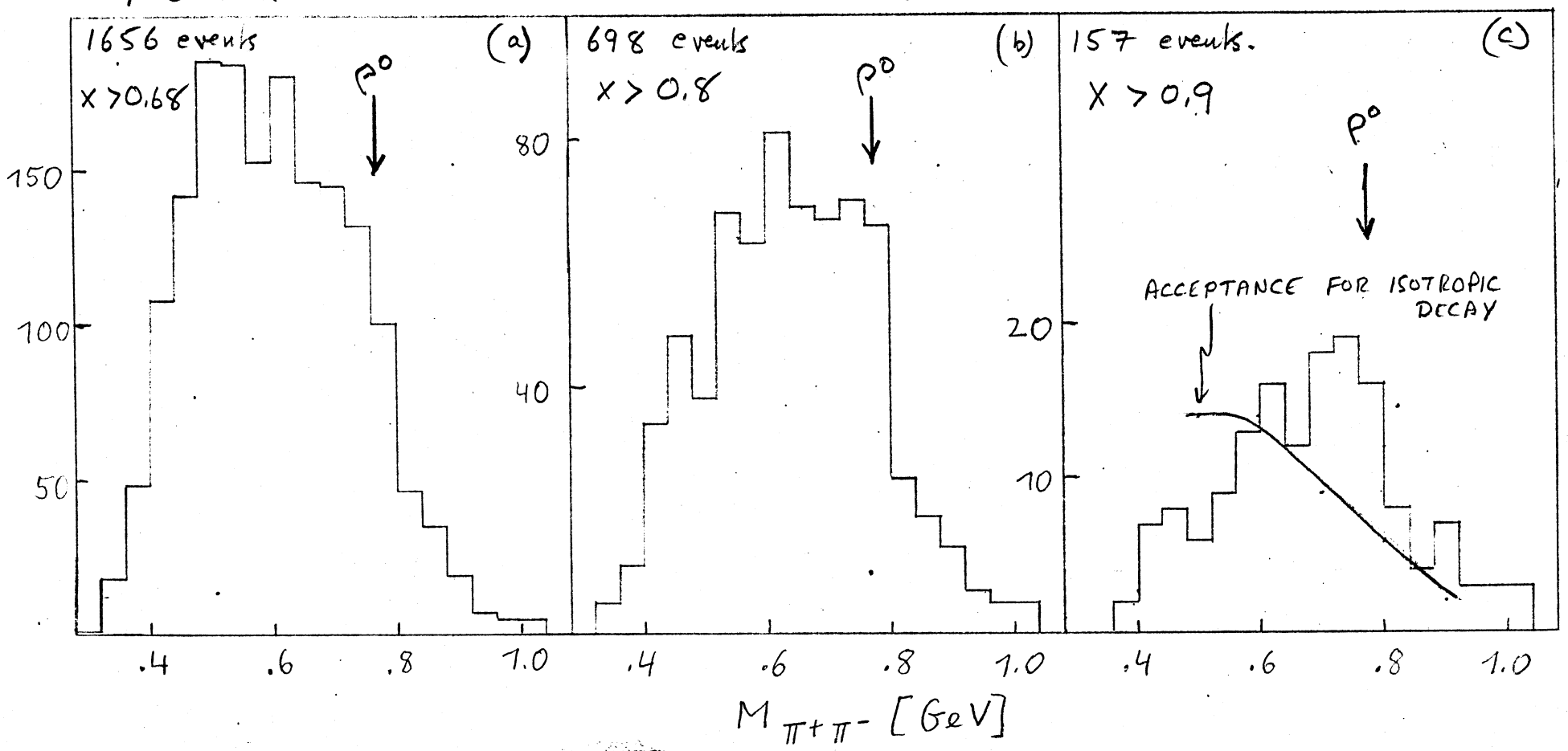

Fig. 1

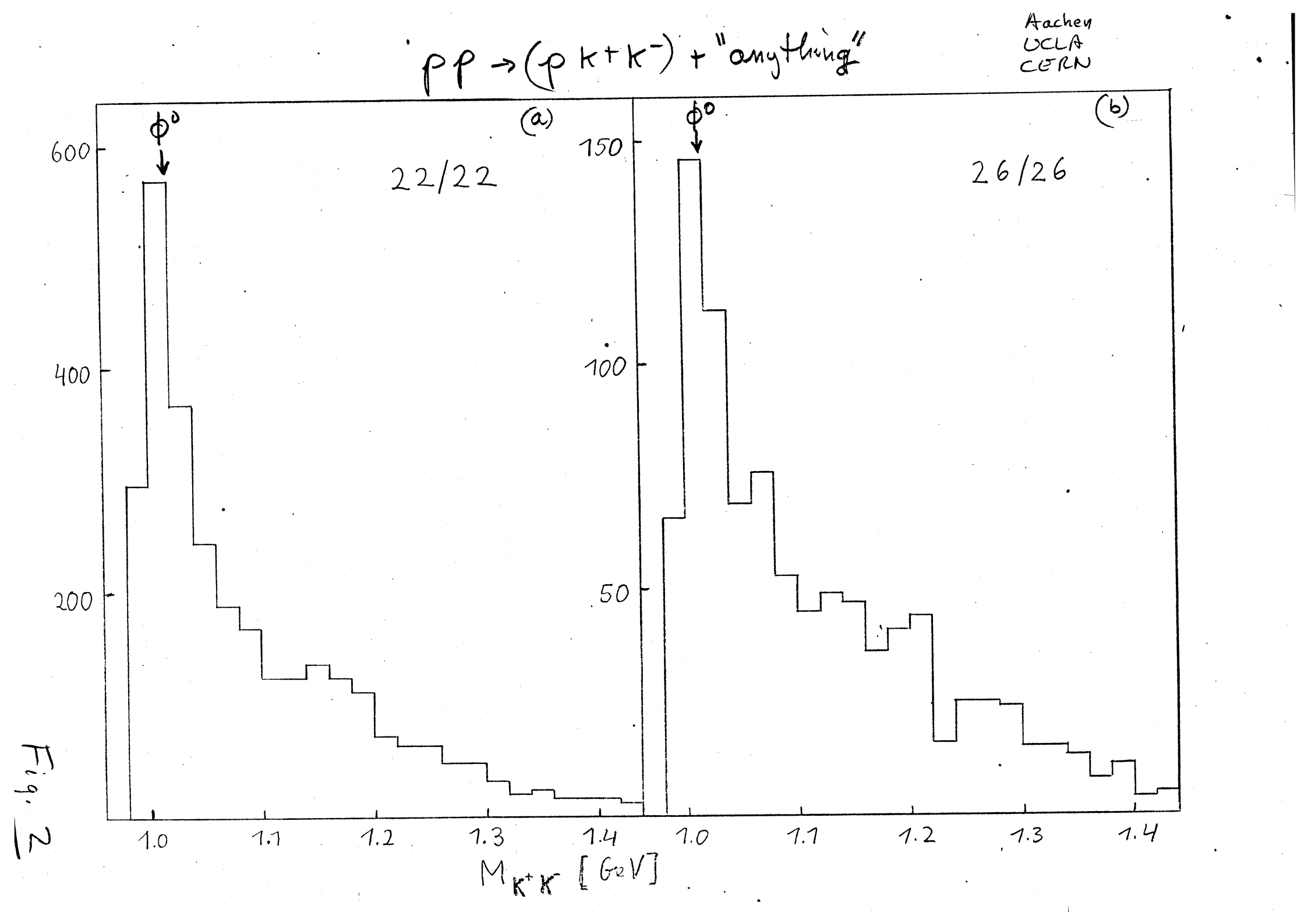
pp → (φ K+K−) + "anything"
Aachen
UCLA
CERN
(a)
(b)
φ0
φ0
22/22
26/26
600
400
200
150
100
50
1.0
1.1
1.2
1.3
1.4
1.0
1.1
1.2
1.3
1.4
M K+K− [GeV]

Fig. 12