New results from WA102 experiment

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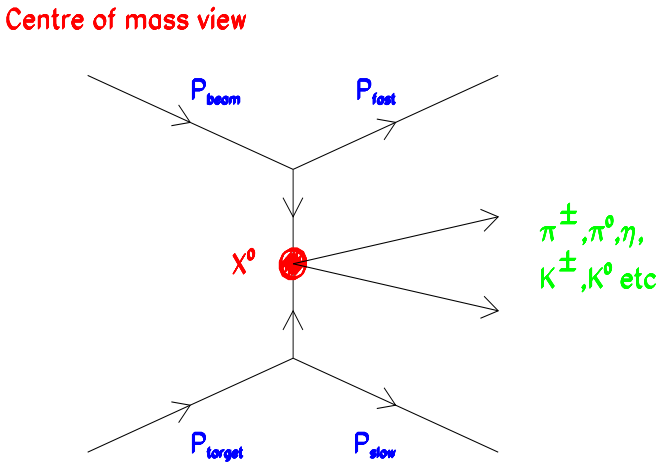
1. An introduction to the WA102 experiments
2. An update on the central production mechanism
3. The results on meson spectroscopy:
   - spin of $f_J(1710)$
   - $f_0(1500)$ and $f_0(1710)$
   - $f_1(1285)$ and $f_1(1420)$
4. An update on the glueball-$q\bar{q}$ filter

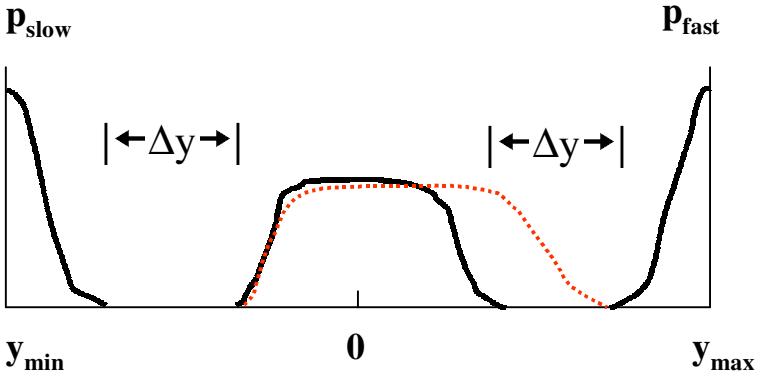
New results from WA102 experiment



Experiment WA102

has studied exclusive final states in the reaction: $pp \rightarrow p_f p_s (x^0)$
at 450 GeV/c which is predicted to be a source of gluonic final states via double Pomeron exchange.

The production process is selected by requiring at the trigger level a certain rapidity gap between fast and slow protons and the central particles



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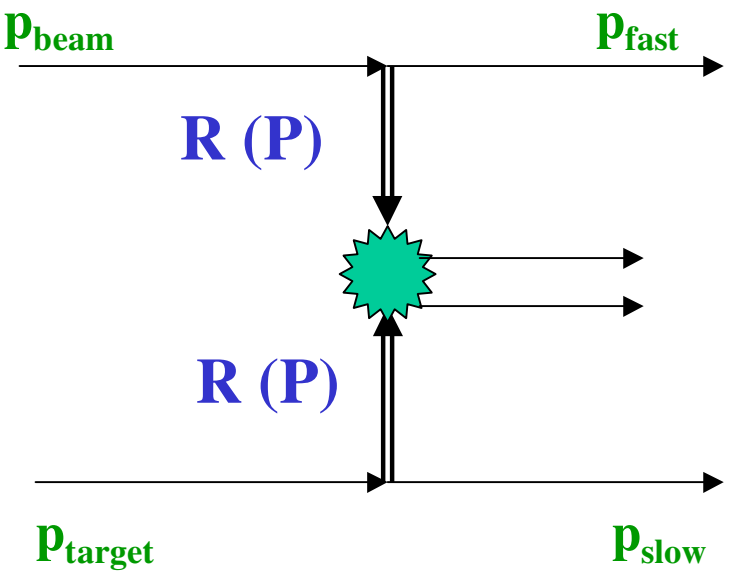


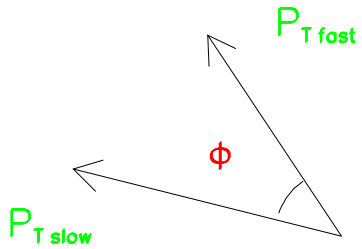
Rapidity gap selection is equally valid for any double Reggeon process.

The double Pomeron process has to dominate at high energy.

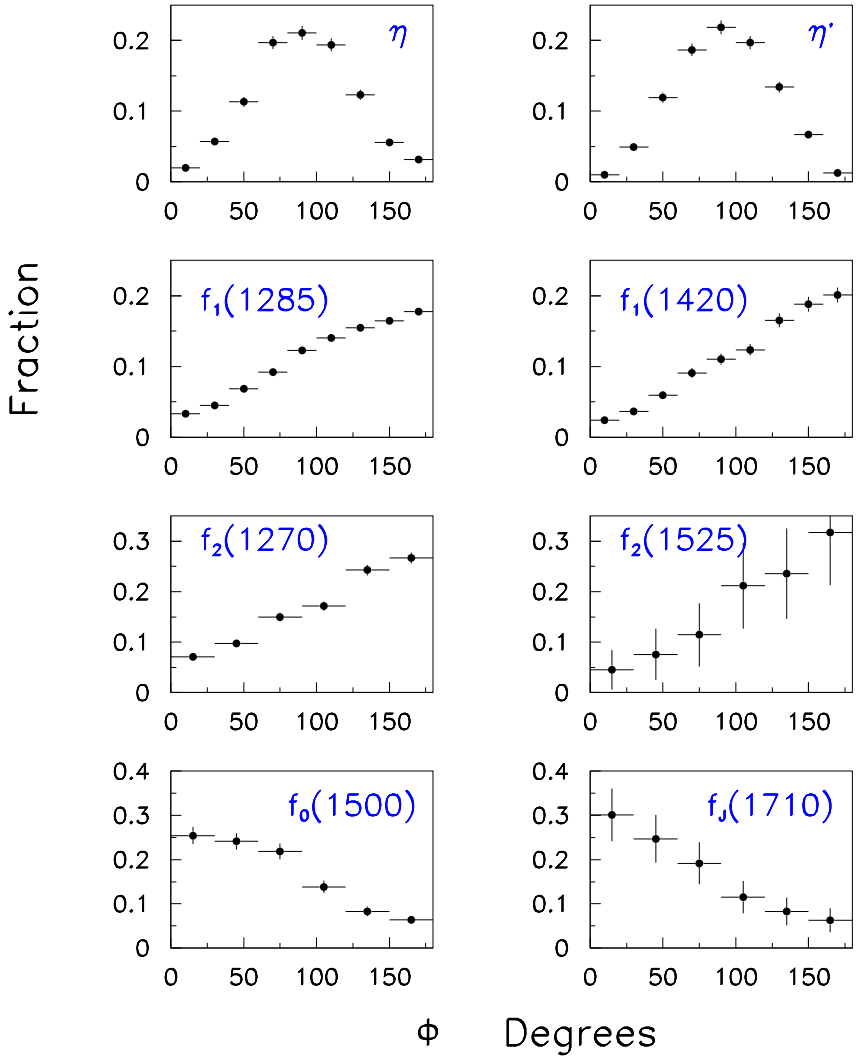
At the currently available energies ($s^{1/2}$=29.1GeV for the p_{beam}=450GeV) the central production should be a mixture of all allowed double Reggeon exchanges (with about 50% of the total double exchange cross section supposed to be due to DPE).

New results from WA102 experiment

The azimuthal angle ϕ between outgoing protons



Resonance production as a function of ϕ



One would expect a flat ϕ distribution for the double exchange process with factorized vertices.

The observed ϕ distributions are not flat and are resonance dependent.

New results from WA102 experiment

Several theoretical papers have been published on ϕ dependence.

All agree that the exchange particle must have $J>0$ and that $J=1$ is a simplest solution.

Using $\gamma^*\gamma^*$ collisions as an analogy Close and Schuller[1)] have calculated the ϕ dependencies for the production of resonances with different J^{PS}s.

[1] "Evidence that the Pomeron transforms as a non-conservated vector current" F.E.Close and G.Schuller hep-ph/9905305.

New results from WA102 experiment

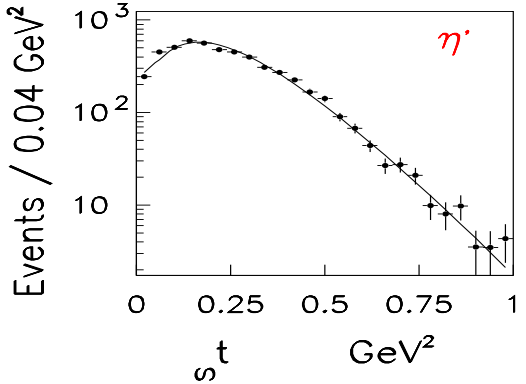
Close and Shuller model predictions

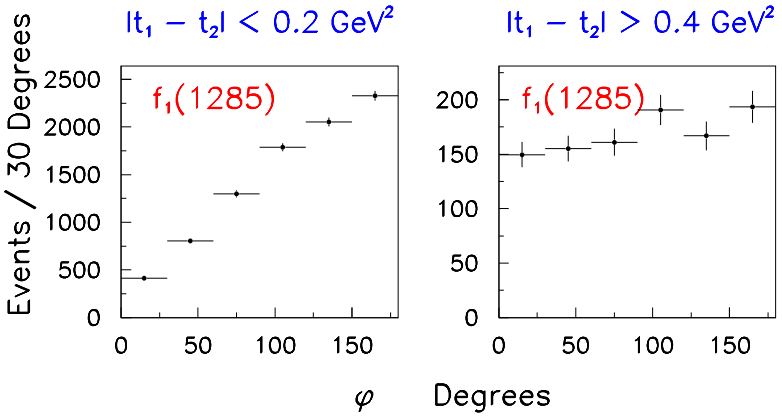
0^{-+}

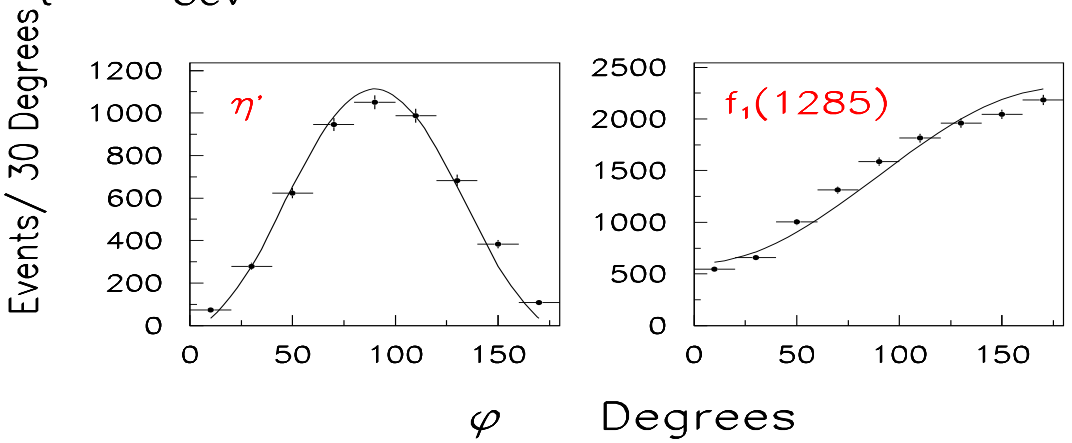
$$\frac{d^3\sigma}{d\phi dt_1 dt_2} \propto t_1 t_2 \sin^2\phi$$

1^{++}

$$\frac{d^3\sigma}{d\phi dt_1 dt_2} \propto (\sqrt{t_2} - \sqrt{t_1})^2 + \sqrt{t_1 t_2}\sin^2(\phi/2)$$







New results from WA102 experiment

Summary of the production mechanism

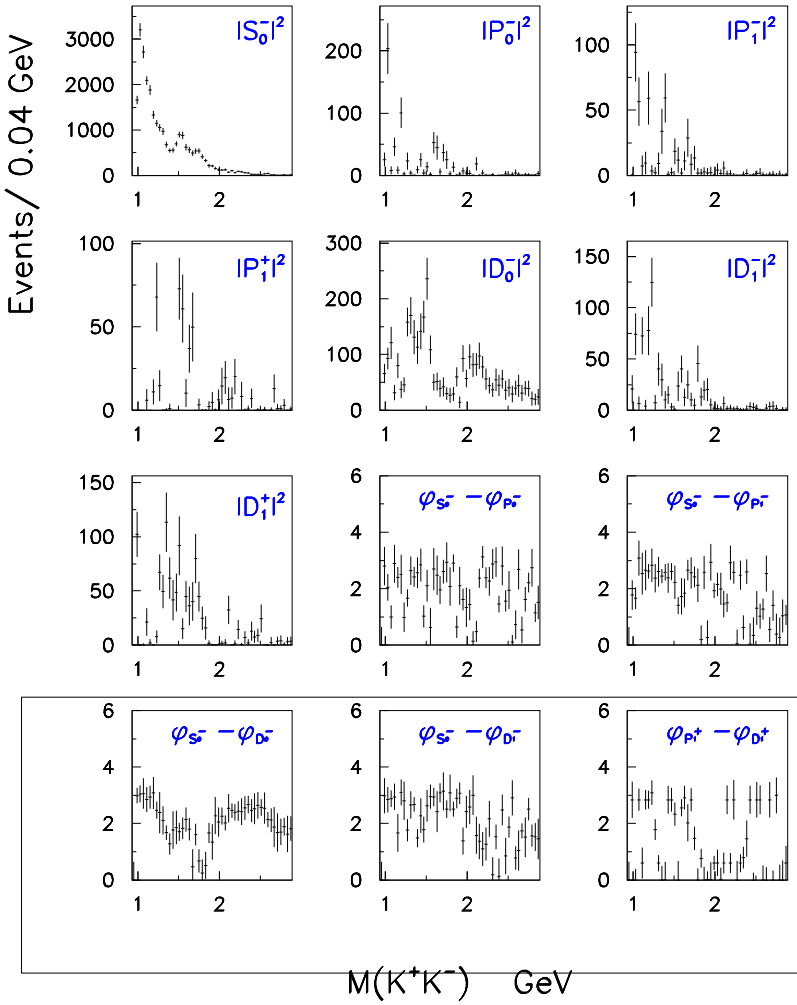
The ϕ dependencies are consistent with the dominant production by two vector particles.

The production cross section of $f_0(980)$, $f_2(1270)$, $f_0(1500)$, $f_1(1285)$ and $f_1(1420)$, measured at $s^{1/2}$=12.7 GeV by WA76 and $s^{1/2}$=29.1 GeV by WA102 are compatible with being independent of energy which is consistent with them being produced via double Pomeron exchange.

The central production at $s^{1/2}$=29.1 GeV is consistent with being mediated by two **vector Pomerons**.

New results from WA102 experiment

PWA of $pp \rightarrow p_f p_s (K^+K^-)$



For S,P and D waves there are eight solutions.

5 solutions P-wave dominant at threshold.

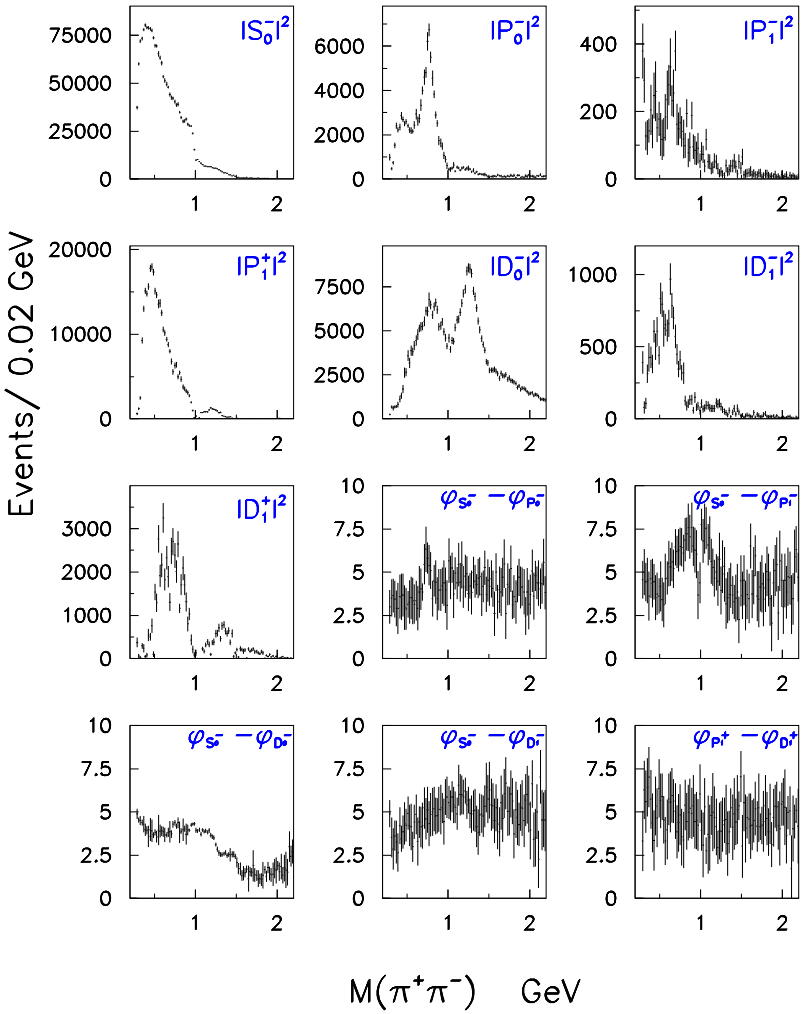
1 solution D-wave dominant at threshold.

1 solution equal S and P-wave at threshold.

One unambiguous physical solution.

New results from WA102 experiment

PWA of $pp \rightarrow p_f p_s (\pi^+\pi^-)$



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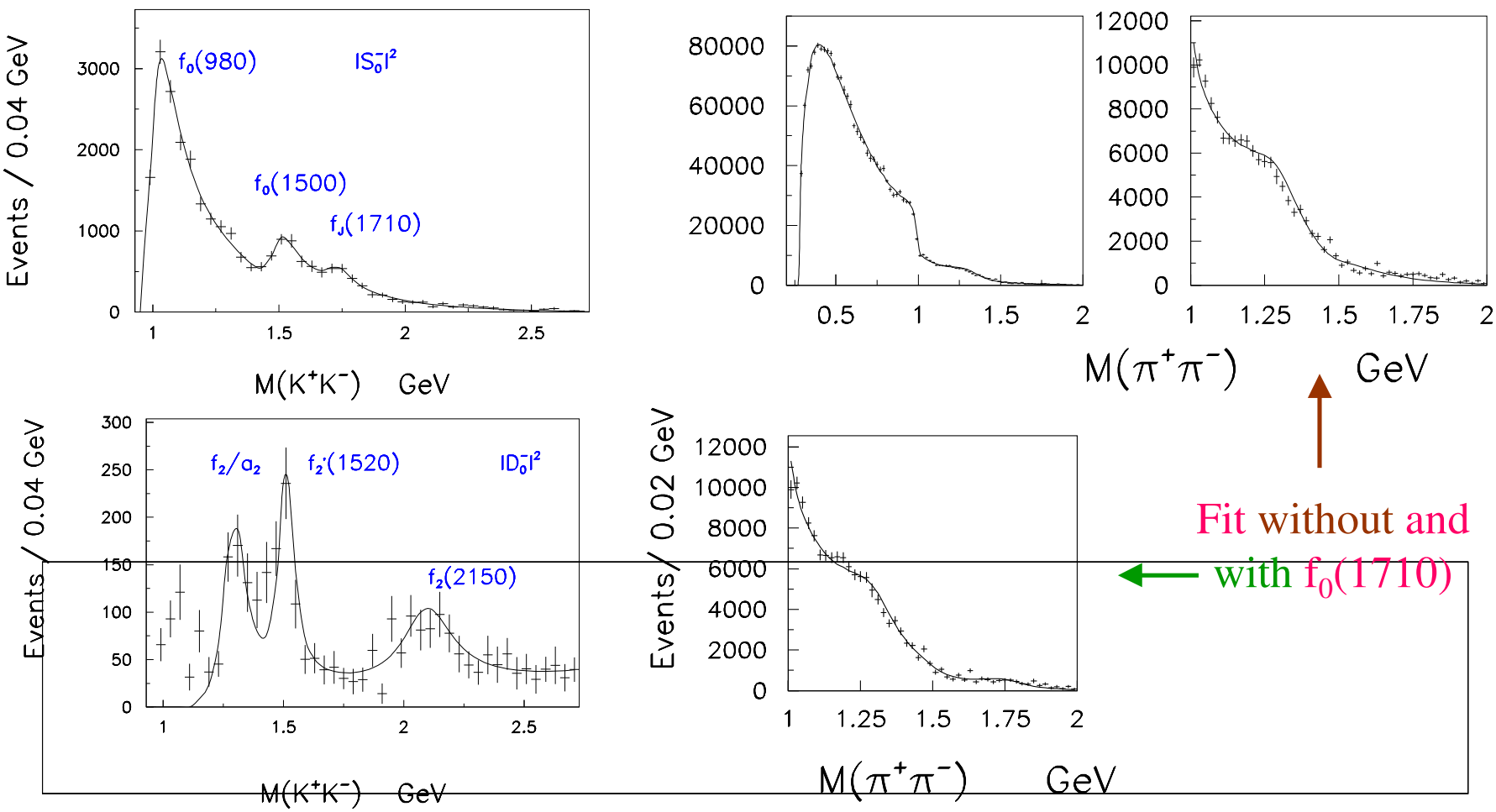
New results from WA102 experiment

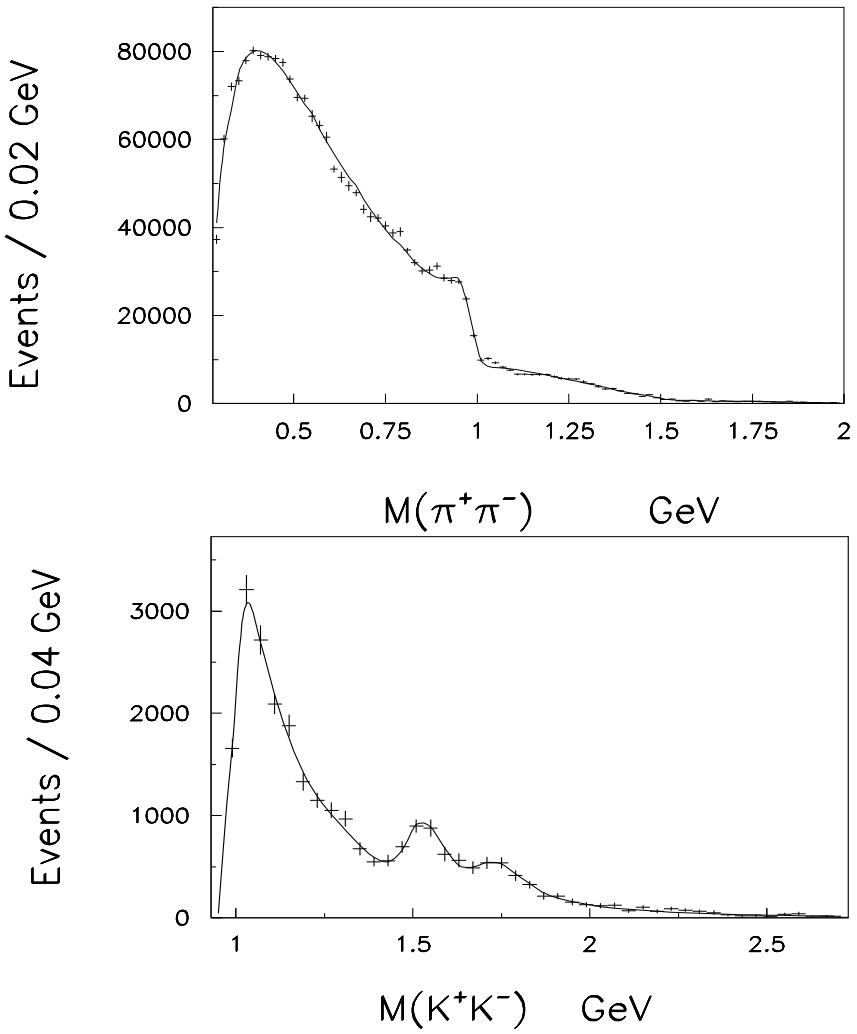
$f_0(1710)$

K^+K^- $\pi^+\pi^-$



New results from WA102 experiment

A coupled channel analysis of the K^+K^- and $\pi^+\pi^-$ channels



Three methods of fitting the data where used:

1. **Interfering Breit-Wigners**
2. **T-Matrix analysis**
3. **K-Matrix analysis**

The pole positions are:

$f_0(980)$ M=(987 ± 6 ± 6) -i(48 ±12 ±8)MeV

$f_0(1370)$ M=(1312 ±25±10) -i(109±22±15)MeV

$f_0(1500)$ M=(1502 ±12±10) -i(49± 9± 8)MeV

$f_0(1710)$ M=(1727 ±12±11) -i(63± 8± 9)MeV

Branching ratios:

$$\frac{f_0(1370)\to K\bar{K}}{f_0(1370)\to\pi\pi} = 0.46\pm0.15\pm0.11$$

$$\frac{f_0(1500)\to K\bar{K}}{f_0(1500)\to\pi\pi} = 0.33\pm0.03\pm0.07$$

$$\frac{f_0(1710)\to K\bar{K}}{f_0(1710)\to\pi\pi} = 5.0\pm0.6\pm0.9$$

New results from WA102 experiment

The branching fractions of $f_1(1285)$ and $f_1(1420)$

Central production is a clean process to study the properties of the $f_1(1285)$ and $f_1(1420)$ due to their strong production relative to suppressed $J^{PC}=0^{-+}$ states in the same mass region.

$f_1(1285)$

Decay mode	Fraction (%)
$\pi\pi\pi\pi$	$33.0 \pm 1.5 \pm 1.5$
$K\bar{K}\pi$	$8.7 \pm 0.4 \pm 0.4$
$\eta\pi\pi$	$52.8 \pm 3.8 \pm 2.5$
$\rho^0\gamma$	$5.4 \pm 0.4 \pm 0.3$
$\phi\gamma$	< 0.043 (95% c.l.)

$f_1(1420)$

Decay mode	Fraction (%)
$K^*(892)\bar{K}$	$96.0 \pm 1.0 \pm 1.0$
$a_0(980)\pi$	$4.0 \pm 1.0 \pm 1.0$
$\phi\gamma$	$0.3 \pm 0.12 \pm 0.2$

New results from WA102 experiment

Summary of the most essential meson spectroscopy results

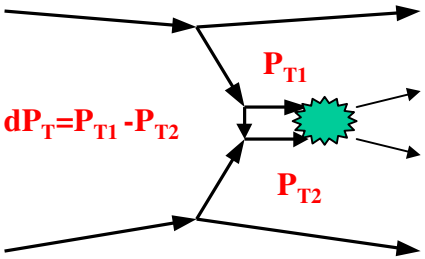
- Spin of the $f_J(1710)$ state is unambiguously defined to be J=0.

- The pole positions for $f_0(980)$, $f_0(1370)$, $f_0(1500)$ and $f_0(1710)$ states are defined from the couple channels analysis of the K^+K^- and $\pi^+\pi^-$ S-wave spectra. The KK to $\pi\pi$ branching ratios are also defined.

- The branching fractions of $f_1(1285)$ and $f_1(1420)$ are measured with high precision.

New results from WA102 experiment

An update on the glueball-$\bar{q}q$ filter

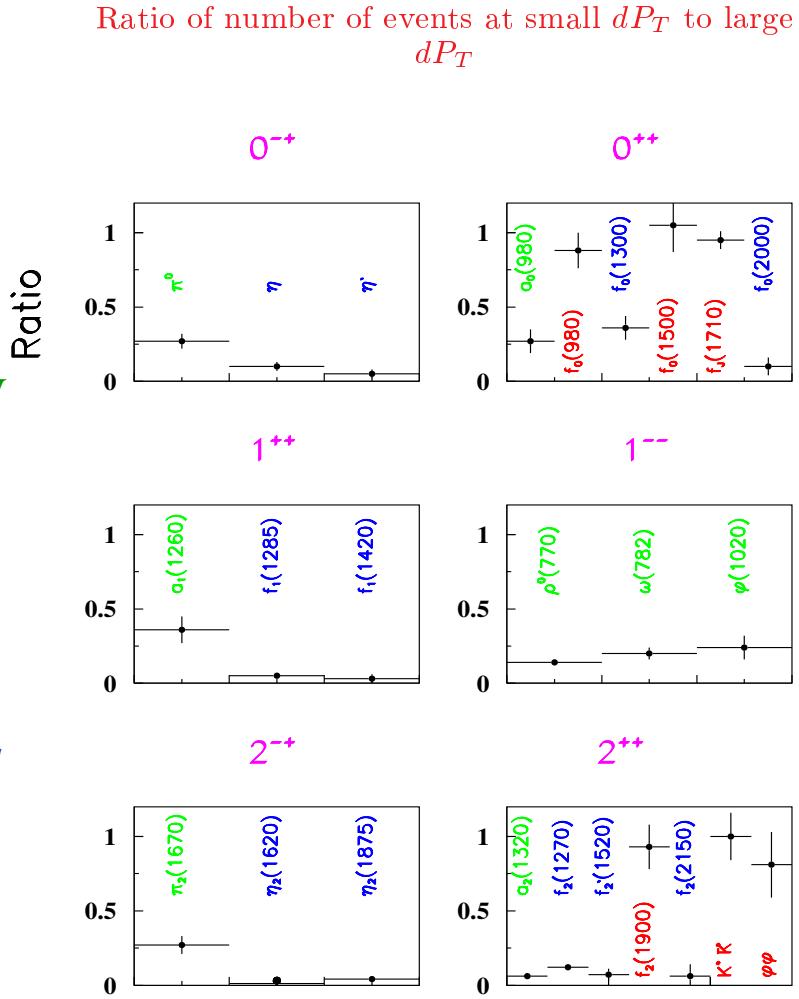


The ratio of the number of events for dP_T<0.2GeV to the number of events for dP_T>0.5GeV is found to be sensitive to the resonance nature:

- for undisputed $\bar{q}q$ states which can be produced by DPE (G=+ and I=0), ratio is very small, <0.1;

- for the states which cannot be produced by DPE (I=1 or G=-), ratio is ≈0.25;

- for all glueball candidates this ratio is large, close to 1.



New results from WA102 experiment

The dP_T filtering effect is not yet fully understood.

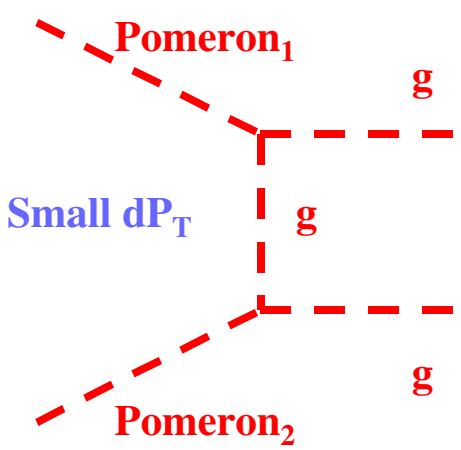
There is a correlation between ϕ and dP_T : $\cos(\phi)=(dP_T^2-P_T^2)/4t_st_f$

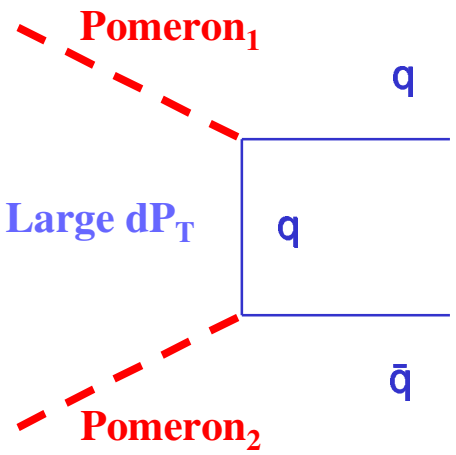
Whether the ϕ dependence can explain all the observed dP_T effect or some other mechanist is needed is still under study.

According to the model proposed by Close and Kirk, the effect deals with the exchanged Pomerons hardonization:

- for small difference in transverse momentum, the two exchange particles are coupled via gluon and the gluonic state is produced,

- for large dP_T the coupling is by a quark and quark state is produced





Summary

The observed effect in the azimuthal angle of the two scattering protons may give information on the nature of Pomeron.

New high quality data on the production and decay properties of scalar and axial vector mesons has been presented.

There is an evidence for a kinematical filter which selects out gluon exotics candidates from known quark states.