Investigation of Resonance Structure in the System of Two K_S Mesons in the Mass Region around 1450 MeV

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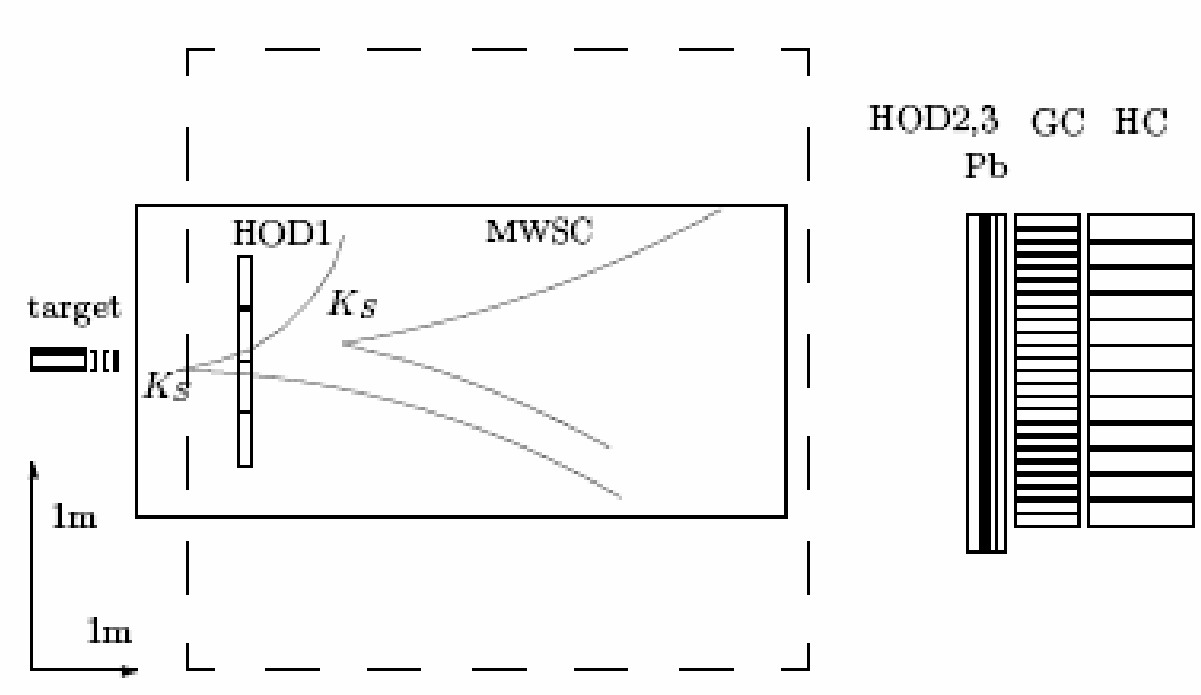
6-m MIS ITEP Spectrometer Overview



MWSC—tracking detectors;
HOD 1,2,3– Hodoscopes;
GS– Gamma-calorimeter;
HC– Hadron calorimeter.

Experimental data

The experimental data on the production of K_S pairs were obtained in $\pi^- p$ interaction at 40 GeV by using a neutral trigger.

The system of two K_S-mesons that was recorded under the experimental conditions of 6-m spectrometer is produced in the following two reactions:

$$\pi^- \mathbf{p} \rightarrow \mathbf{K_S K_S n}, \tag{1}$$

$$\pi^- \mathbf{p} \rightarrow \mathbf{K_S K_S} + (\mathbf{n} + \mathbf{m}\pi^{\mathbf{0}}, \mathbf{p} + \pi^-, ...). \tag{2}$$

We have registered $\sim$ 40 000 events of these reactions.

The efficiency of registered $K_S K_S$ system is about 45% in the mass region near 1450 MeV.

The precision of measurement of the effective mass of the $K_S K_S$-system is better than 3 MeV in the mass region around 1450 MeV.

Kinematical variables:

1. The effective mass M_{KK} of the pair of K_S-mesons;

2. The missing mass squared MM^2 defined as the squared mass of particles that are produced together with the K_SK_S-system and which are not recorded in the spectrometer;

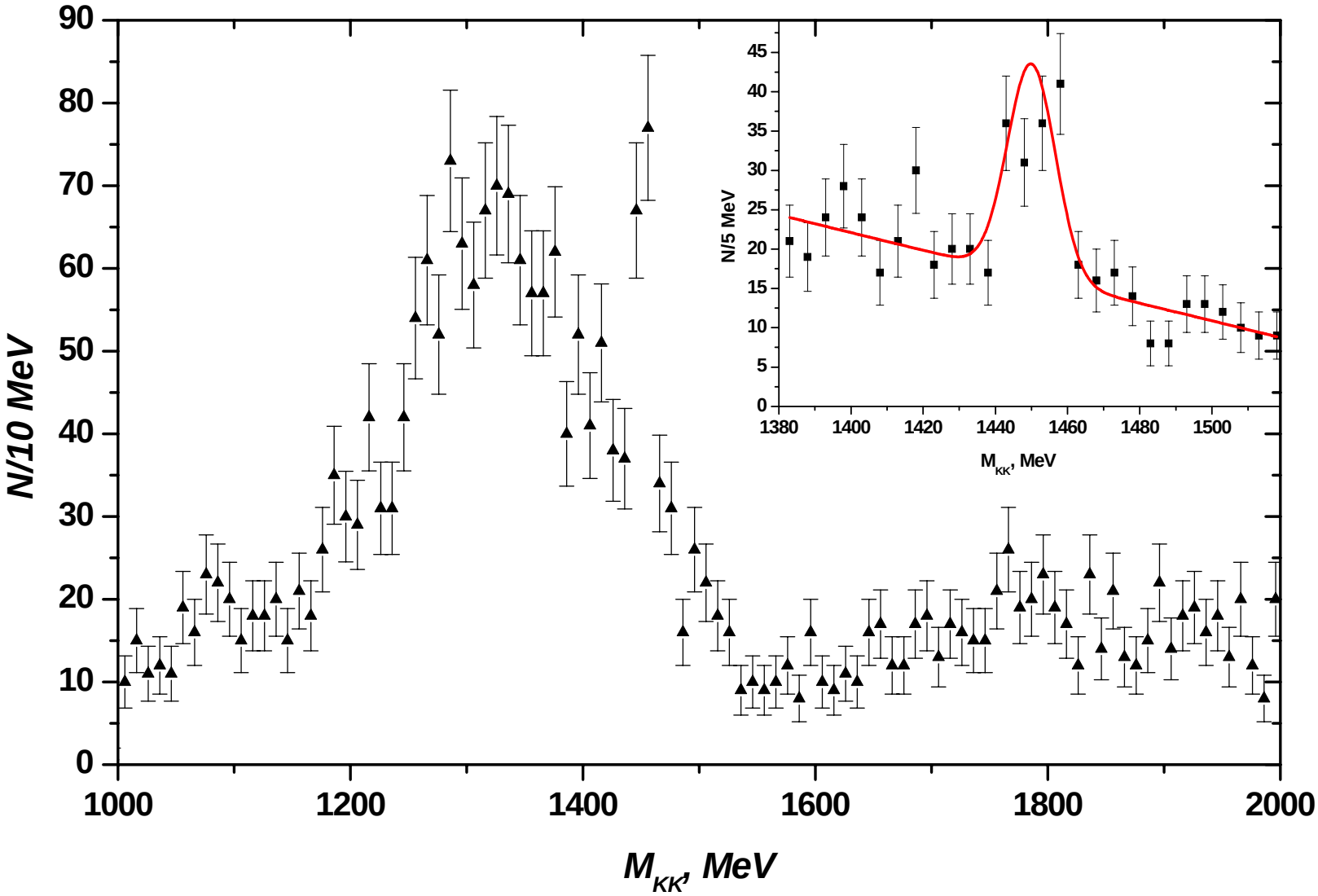
3. The 4-momentum transferred from the beam to the system being studied, t;

4. The cosine of the Gottfried-Jackson angle, $cos\theta_{GJ}$;

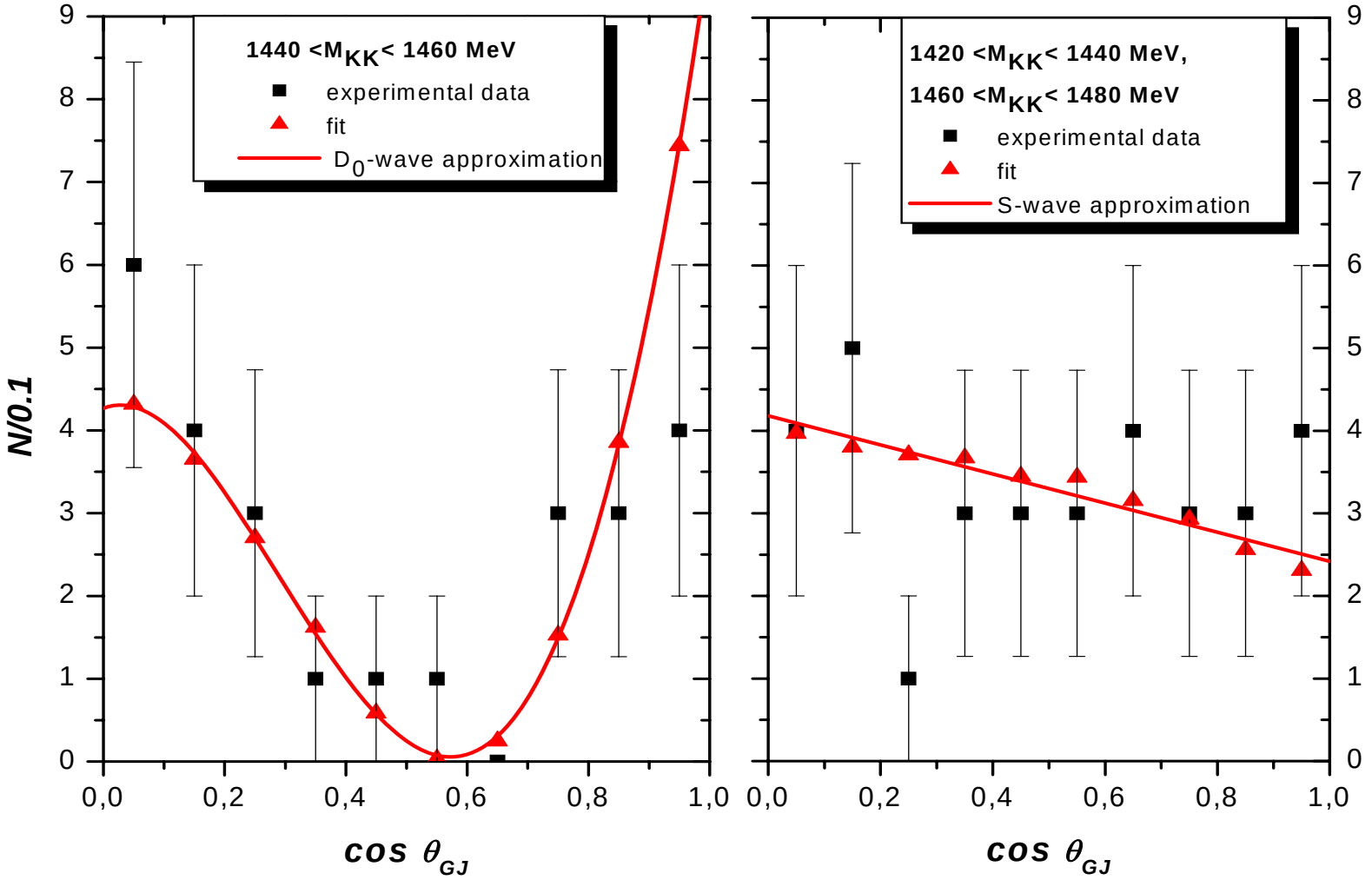
5. The Treiman-Yang angle, ϕ_{TY}.

The angles are calculated in the rest frame of the pair of K_S-mesons, the beam axis direction in this system being taken for the polar axis. The plane from which the Treiman-Yang angle is reckoned is spanned by the momenta of the beam and of the target proton in this reference frame.

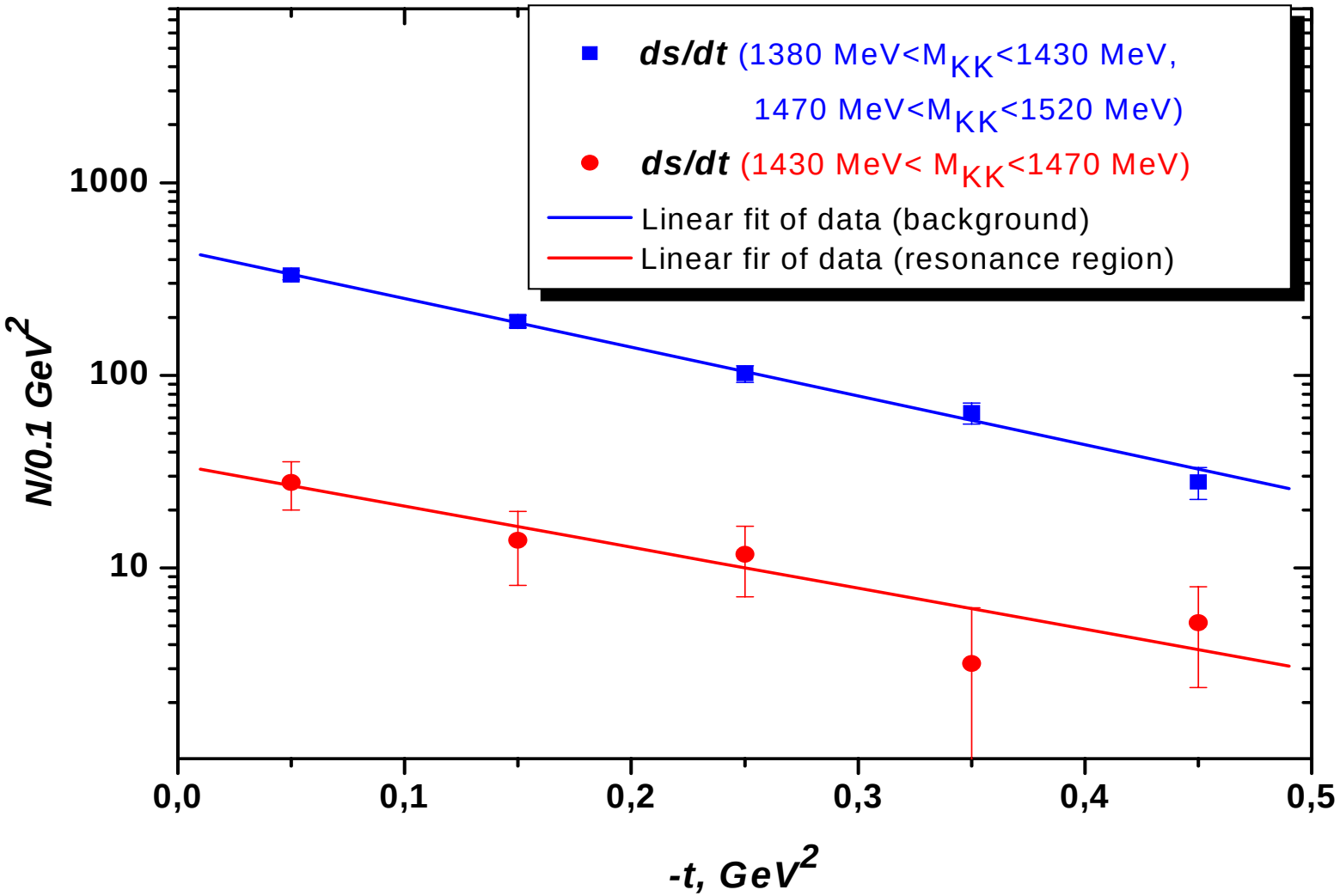
Effective-mass spectrum of two K_S-mesons



Cosine of Gottfried-Jackson angle



Momentum-transfer distribution



The Method of Maximum Likelihood

$F(P;\Omega)$ –the probability-density function, where P is the set of the following parameters –

1. The amplitude of the resonance,
2. The mass M of the resonance,
3. The width σ appearing in the Gauss function,
4. The coefficients of the squared amplitudes of the angular distributions.

Elements of the phase space Ω are

1. Effective mass of two K_S-mesons,
2. The cosine of the Gottfried-Jackson angle θ_{GJ},
3. The Treiman-Yang angle ϕ_{TY}.

In order to obtain the most probable values of the parameters, we minimized the functional:

$$L = \int_{\Omega} \epsilon(\Omega) F(P;\Omega) d\Omega - \sum_{i=1}^{N} \ln F(P;\Omega_i). \quad (1)$$

where $\epsilon(\Omega)$ is the event-detection recording, N being the number of events. To compare the probabilities of experimental-data description with different parameter set, we calculated χ^2 by the formula:

$$\chi^2 = -2 \ln L + const. \quad (2)$$

Conclusion

At the confidence better than 6 standard deviations, we have obtained an indication of the existence of the resonance having
the mass 1449.5 $\pm 2.0 \pm 3.0$ MeV
and the width $\sigma = 7.5 \pm 1.5$ MeV.
Number of events in the resonance region is 67 ± 10.
The spin-parity of this resonance is preferably $J^{PC} = 2^{++}$.
The product of the cross section for $X(1450)$ formation and the relevant branching ratio $\sigma Br(K_S K_S)$ is estimated at about $25\ ^{+25}_{-5}$ nbn.

Comparison with other results

TECN	Reaction	Mass, MeV	Width, MeV
87 DM2	$J/\psi \to \gamma\pi^+\pi^-$	1421 $\pm$5	30 $\pm$9
86 SPEC	$pp \to pp\pi^+\pi^-$	1480 $\pm$50	150 $\pm$50
84 CNTR	17-18 $\pi^- p \to K^+K^-n$	1436 $^{+26}_{-16}$	81 $^{+56}_{-29}$
84 CNTR	63 $\pi^- p \to K^0_S K^0_S n, K^+K^-n$	1412 $\pm$3	14 $\pm$6
67 OSPK	5, 7, 12 $\pi^- p \to K^0_S K^0_S n$	1439 $^{+5}_{-6}$	43 $^{+17}_{-18}$
07 SPEC	40 $\pi^- p \to K_S K_S n$	1449.5 $\pm$2 $\pm$3	7.5 $\pm$ 1.5