Experimental study of the $e^+e^- \to K^+K^-$ process cross section with the SND detector at the VEPP-2000 e^+e^- collider

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Abstract: In experiment at the VEPP-2000 e^+e^- collider with the SND detector the $e^+e^- \to K^+K^-$ process cross section has been measured in the energy range $1.05 \div 2.0$ GeV. Its value was found to be consistent with previous measurements.

Key words: collider, experiment, calorimeter, mesons

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1 Introduction

The experimental study of the $e^+e^- \to K^+K^-$ process is of interest because of its considerable contribution to the total $e^+e^- \to$ hadrons cross section, what is important for (g-2)$_\mu$ factor and α_{em} constant at Z-mass. The isovector part of this cross section is related to the $\tau \to K^+K^0\nu_\tau$ decay mass spectrum. In addition, the $e^+e^- \to K^+K^-$ cross section can be used to specify the excited vector meson parameters.

This process was studied in many experiments, the latest are experiments at VEPP-2M [1, 2] and BABAR [3].

In this talk the $e^+e^- \to K^+K^-$ cross section was measured at VEPP-2000 collider [4] with the SND detector [5]. The important feature of the SND detector is the aerogel Cherenkov detector with n=1.13 index of refraction [6], used in our study to separate pions and kaons.

The data were collected during 2011 and 2012 runs, the integrated luminosity in the energy range $1.05 \div 2.0$ GeV is about 35 pb^{-1}.

2 Data analysis

In our analysis the events were selected with two collinear tracks coming from the interaction region. Besides the K^+K^- events, the similar collinear processes $e^+e^- \to e^+e^-, \mu^+\mu^-, \pi^+\pi^-, p\bar{p}$ and cosmic muons events contribute in this class. To suppress the $\mu^+\mu^-$ and $\pi^+\pi^-$ background we require that one of the tracks hits the Cherenkov counter, which produce the veto signal from these events. The K^+K^- events don't produce the Cherenkov signal in our momentum range. To suppress the background from $p\bar{p}$ events, the dE/dx cut was imposed for one of two tracks: $dE/dx_K < 1.5 dE/dx_e$, where indices K and e correspond to kaons and electrons. The $e^+e^- \to e^+e^-$ background was subtracted using the total energy deposition in calorimeter (shown as a peak 1 in Fig.1). The background from the multihadron processes like $e^+e^- \to \pi^+\pi^-\pi^o, \pi^+\pi^-\pi^o\pi^o, K^+K^-\pi^o$, etc. was subtracted by the sideband method in the $\Delta\phi - \Delta\theta$ plane, where $\Delta\phi$ and $\Delta\theta$ are noncolinearity angles in ϕ and θ planes for the pair of tracks.

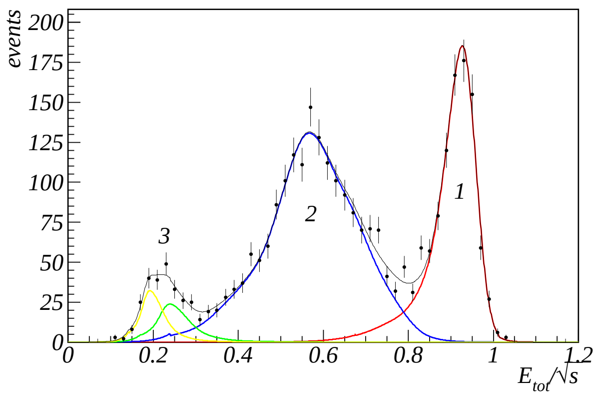

Fig. 1. The distribution of the normalized energy deposition in calorimeter at E=1.425 GeV. The lines are the approximation curves for the signal and background processes.

The detection efficiency of the $e^+e^- \to K^+K^-$ process versus beam energy is shown in Fig.2. The dependence of the detection efficiency on the radiative photon energy in Fig.3 is taken into account. The correction coefficient from the kinematic cut is estimated to be $c_{kin} = 1.0076 \pm 0.0022$, the correction from Cherenkov counter is $c_{ch} = 1.0035 \pm 0.0012$, the geometry correction is $c_{geom} = 1.0025 \pm 0.0013$.

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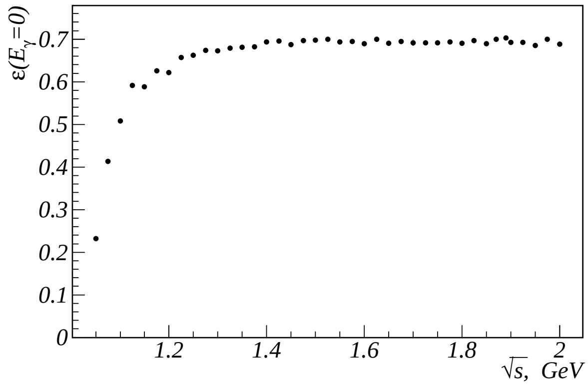

Fig. 2. The detection efficiency of the process $e^+e^- \to K^+K^-$ versus energy.

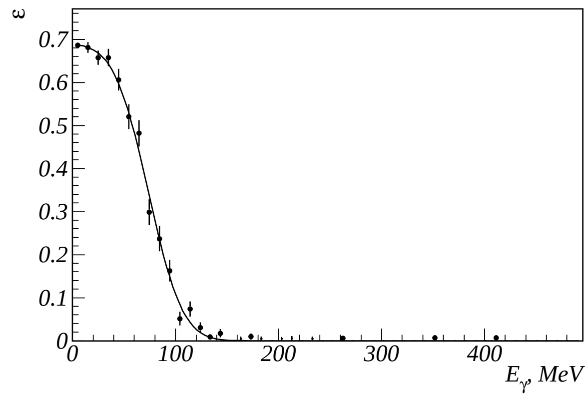

Fig. 3. The detection efficiency of the process $e^+e^- \to K^+K^-$ versus radiative photon energy at E=1.6 GeV.

3 The total cross section

The visible cross section σ_{vis} of the process under study is related to the total cross section σ_0 as:

$$\sigma_{vis}(\sqrt{s}) = \int_0^1 dz \cdot \sigma_0(\sqrt{s}(1-z)) \cdot F(z,s) \cdot \varepsilon(\sqrt{s}, z) \quad (1)$$

where $s = E^2$, $F(z,s)$ is the probability for the initial particles to emit the photon carrying the fraction of energy $z\sqrt{s}$, $\varepsilon(\sqrt{s}, z)$ is a detection efficiency as a function of $\sqrt{s}$ and z.

The total cross section σ_0 is determined using the following procedure. The measured visible cross section at each energy point as a function of energy $\sigma_{vis} = N/IL$ (here N is a number of selected events, IL is an integrated luminosity) is approximated by a function calculated using Eq. (1) with some model for the total cross section. As a result of the approximation the parameters of this model are calculated together with the function $R(s) = \sigma_{vis}(s)/\sigma_0(s)$. Experimental values for the total cross section are determined then according to the following equation:

$$\sigma_0 = \frac{\sigma_{vis}}{R(s)}. \quad (2)$$

Model dependence of the result is estimated by variation of the total cross section models.

In Fig.4 the obtained values of the cross section versus energy are presented together with previously measured BABAR result. The good agreement between both measurements is seen. The rise of the cross section at ~ 1 GeV is due to the $\phi(1020)$ state, the structure at ~ 1.7 GeV comes from the contribution of the $\phi(1680)$ resonance.

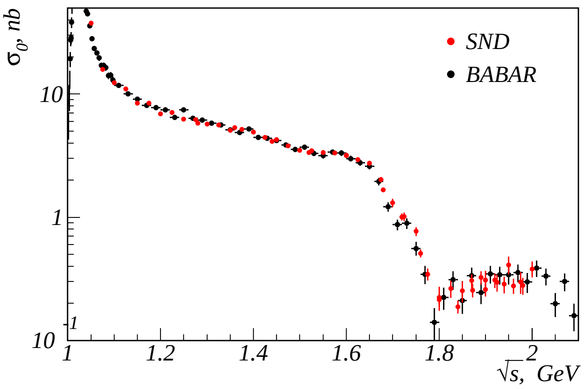

Fig. 4. The total cross section of the $e^+e^- \to K^+K^-$ process from this work and BABAR [3].

The systematic uncertainty in the measured cross section is defined by the luminosity accuracy 1%, the detection efficiency error 1.3%, radiative correction error 0.1%. Total uncertainty is about 1.7%.

4 Conclusions

The cross section of the $e^+e^- \to K^+K^-$ process in the energy range 1.05 - 2.0 GeV was measured at the VEPP-2000 e+e- collider with the SND detector. The measured cross section well agrees with existing data.

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