Study the $e^+e^- \to K_S K_L \pi^0$ process with the CMD-3 detector

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Outline

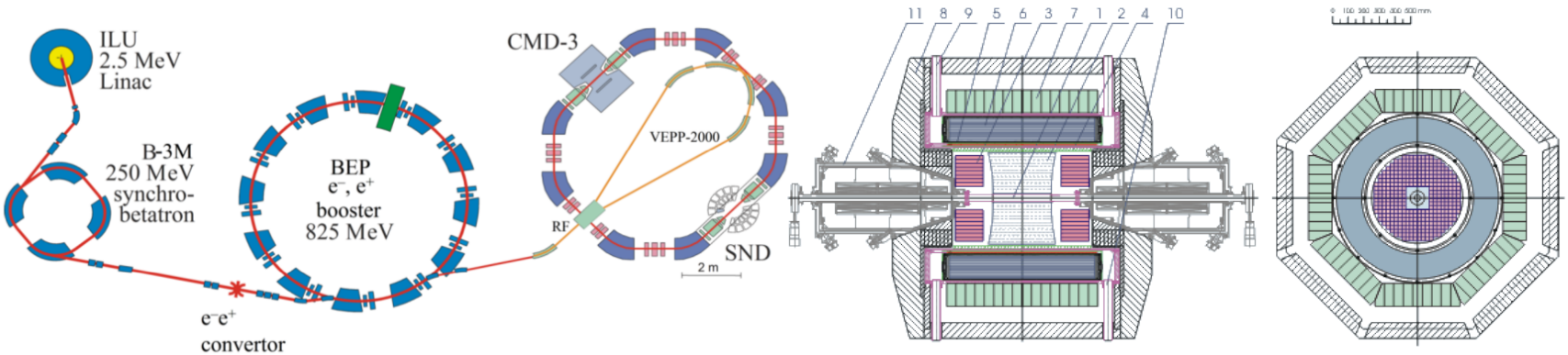
- Objective and motivation
- VEPP-2000 project
- List of the selection constraints
- Results
- Conclusion and future plans

Objective and motivation

The main goal of the current work is to measure the $e^+e^- \to K_S K_L \pi^0$ process cross-section up to 2 GeV in the mass center system.

- Study the light quarks interaction
- Non-perturbative QCD
- Contribution of this process into the processes with two K and one π equals 12%.
- Anomalous magnetic moment $(g-2)_\mu$.

VEPP-2000 project



Data of 2011-2012 seasons
Integrated luminosity is 33.18 pb^{-1}

Preliminary event selection

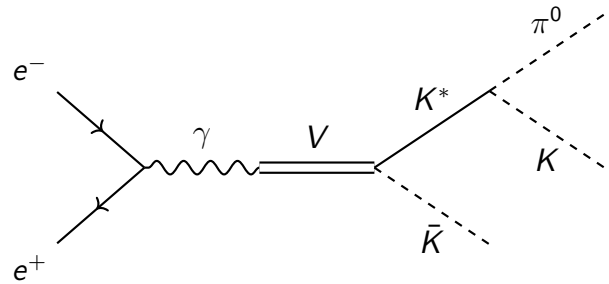
The next decay modes are used:

- $K_S \to \pi^+\pi^-$ (69%)
- $\pi_0 \to \gamma\gamma$ (99%)

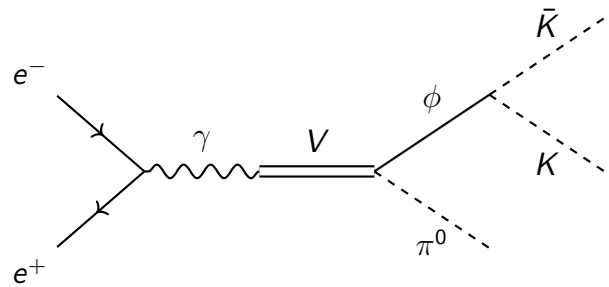
Preliminary selection cuts:

- Number of tracks, $N_{tr} = 2$
- Number of photons, $N_{ph} \geq 2$
- One vertex of a K_S meson, $N_{K_S} = 1$

$e^+ e^- \to K^* \bar{K}$



$e^+ e^- \to \phi \pi^0$



Event selection

- Ionization losses $(\frac{dE}{dx})_\pi$
- The cosine of the angle between the momentum and the position vector of the K_S vertex in the XY plane is more than 0.8
- The solid angle between tracks is more than theoretical mean $\psi > \psi_{min}$
- The energy release of the photon signal in the LXe or in BGO-calorimeters is more than threshold energy
- The solid angle between signal photons is more than theoretical mean
- The polar angles of tracks are in the range $(0.9, \pi - 0.9)$

Ionization losses

The beams energy is 840 MeV

Present/images/tdedx.png

$(\frac{dE}{dx})_\pi(p) = a + \frac{b}{p^2}$
$a = 2047.2$
$b = 2.3 * 10^7$

- $N_{tr} = 2$
- $N_{ph} \geq 2$
- $N_{K_S} = 1$

Ionization losses

$$\xi_{tr} = \frac{(dE/dx)_{exp}}{(dE/dx)_{aprx}}$$

The selection criterion is $\xi_{tr} < 1.6$

Simulation
(840 MeV, ISR on)

Present/images/xiSim.png

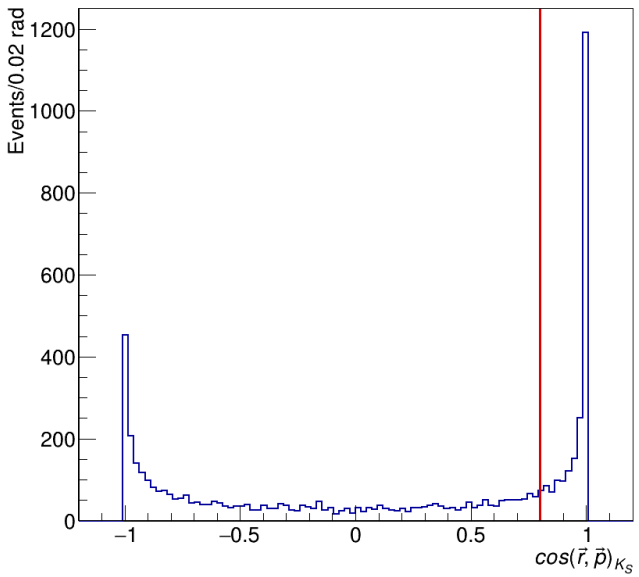
Experiment
(840 MeV, ISR on)

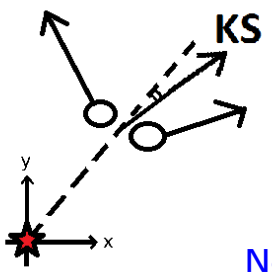
Present/images/xiExp.png

$$N_{tr} = 2,\ N_{ph} \geq 2,\ N_{K_S} = 1$$

The cosine between the momentum and the radius-vector of the K_S

The selection criterion is $cos_{K_S} > 0.8$

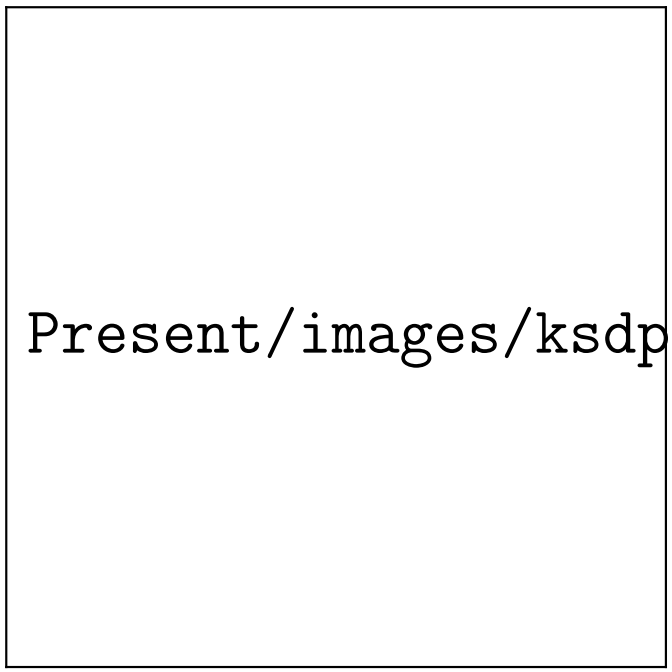


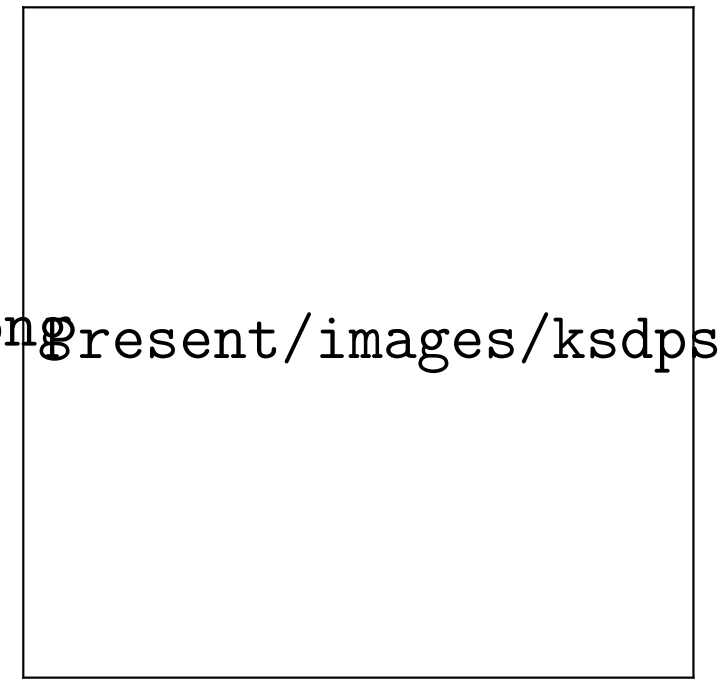


- $N_{tr} = 2$
- $N_{ph} \geq 2$
- $N_{K_S} = 1$
- $\xi_{tr} < 1.6$
- $E_{phlxe} > 15$
  or
  $E_{phbgo} > 15$

The minimal angle between the tracks

$$\psi_{min} = 2\,\mathrm{arctg}\,(\sqrt{M^2 - 4m^2}/P)$$



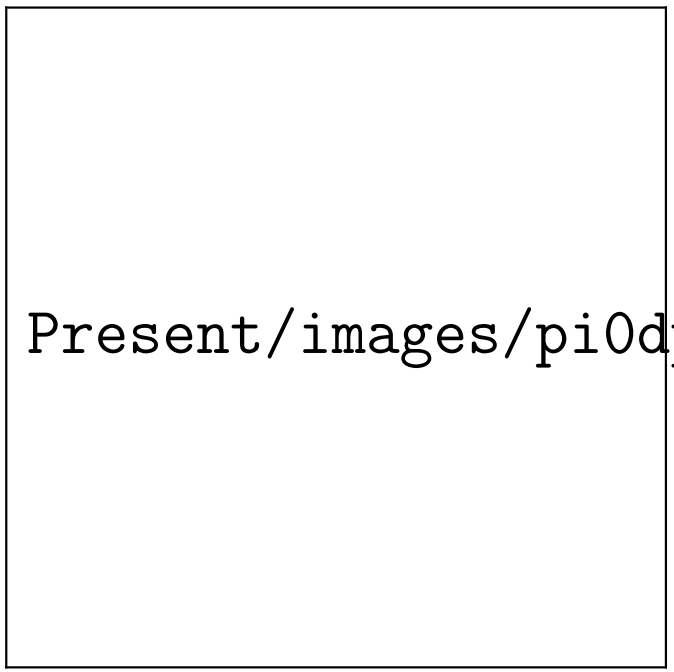


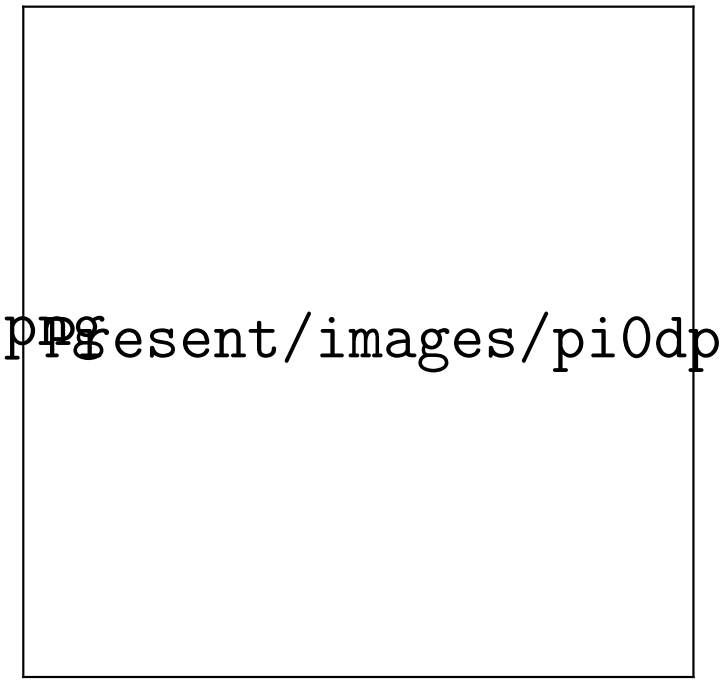
$$N_{tr} = 2,\ \ N_{ph} \geq 2,\ \ N_{K_S} = 1,\ \ \xi < 1.6,\ \ cos(\vec{r}_{Ks}, \vec{P}) > 0.8,$$
$$E_{phlxe} > 15 \text{ or } E_{phbgo} > 15$$

The condition of the pion's turn π, $P_{K_S} > 768$ MeV
$(E = 915$ MeV$)$

The minimal angle between the signal photons

$$\alpha_{min} = 2\,\mathrm{arctg}\,(m/P)$$

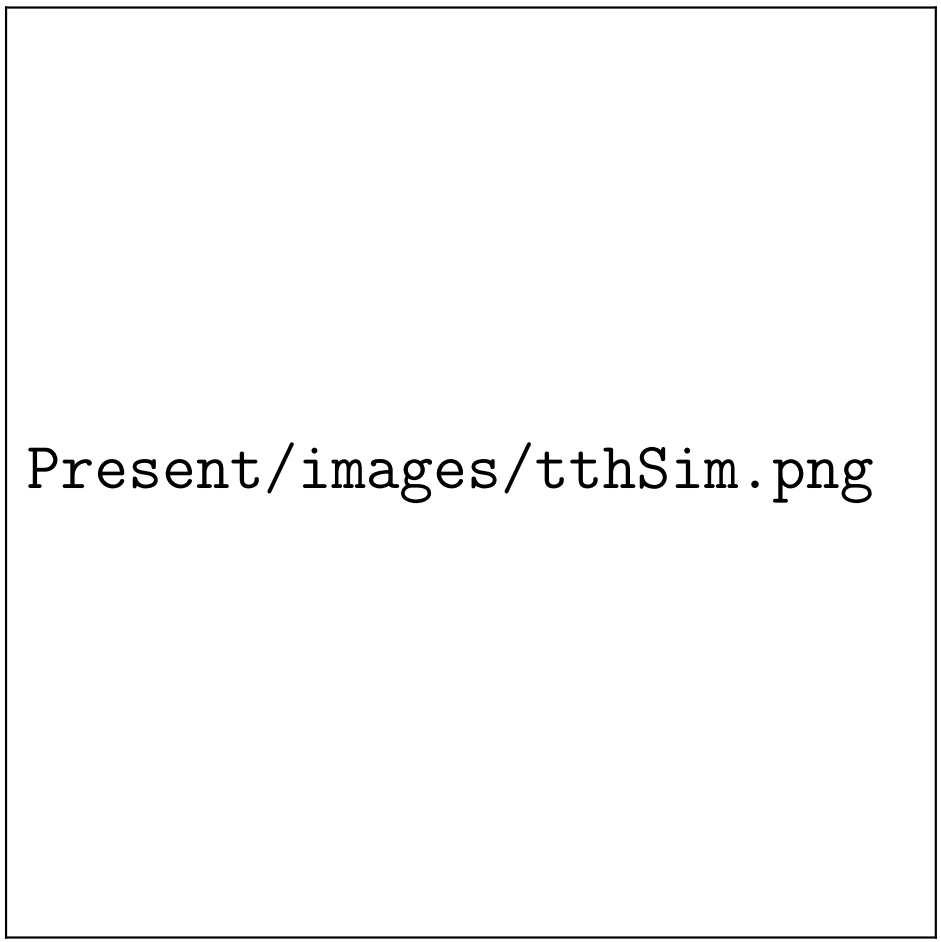




$$N_{tr} = 2,\ \ N_{ph} \geq 2,\ \ N_{K_S} = 1,\ \ \xi < 1.6,\ \ cos(\vec{r}_{Ks}, \vec{P}) > 0.8,$$
$$E_{phlxe} > 15 \text{ or } E_{phbgo} > 15$$

Polar angles of the tracks

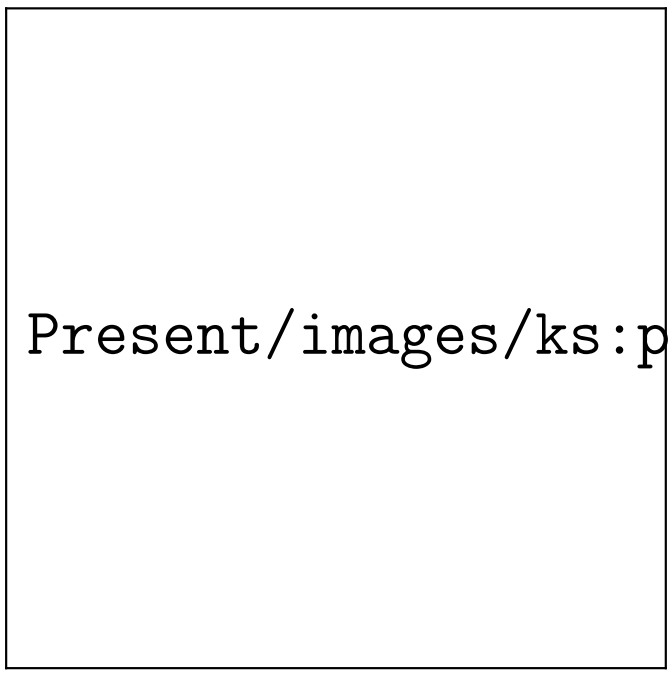
The selection criterion is $\theta_{tr} \in (0.9; \pi - 0.9)$



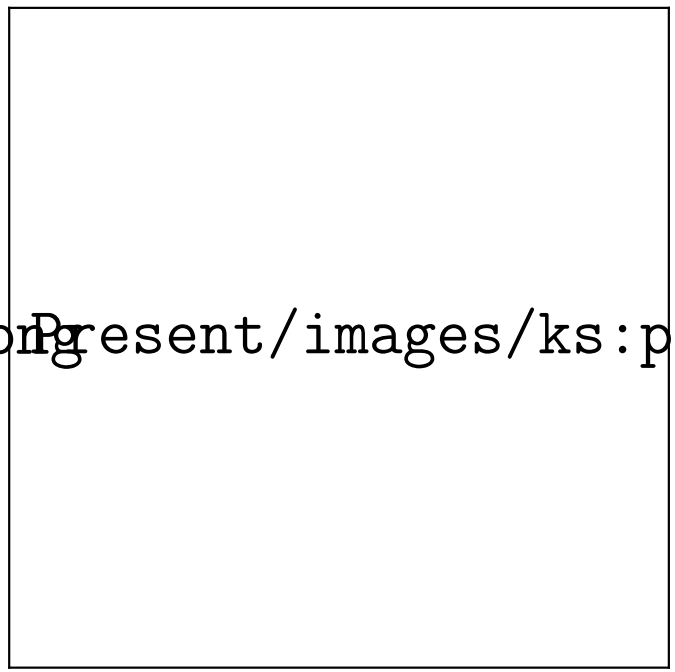
- $N_{tr} = 2$
- $N_{ph} \geq 2$
- $N_{K_S} = 1$
- $\xi_{tr} < 1.6$
- $E_{phlxe} > 15$
  or
  $E_{phbgo} > 15$

Results (840 MeV)

Simulation (840 MeV, ISR on)



Experiment (840 MeV)

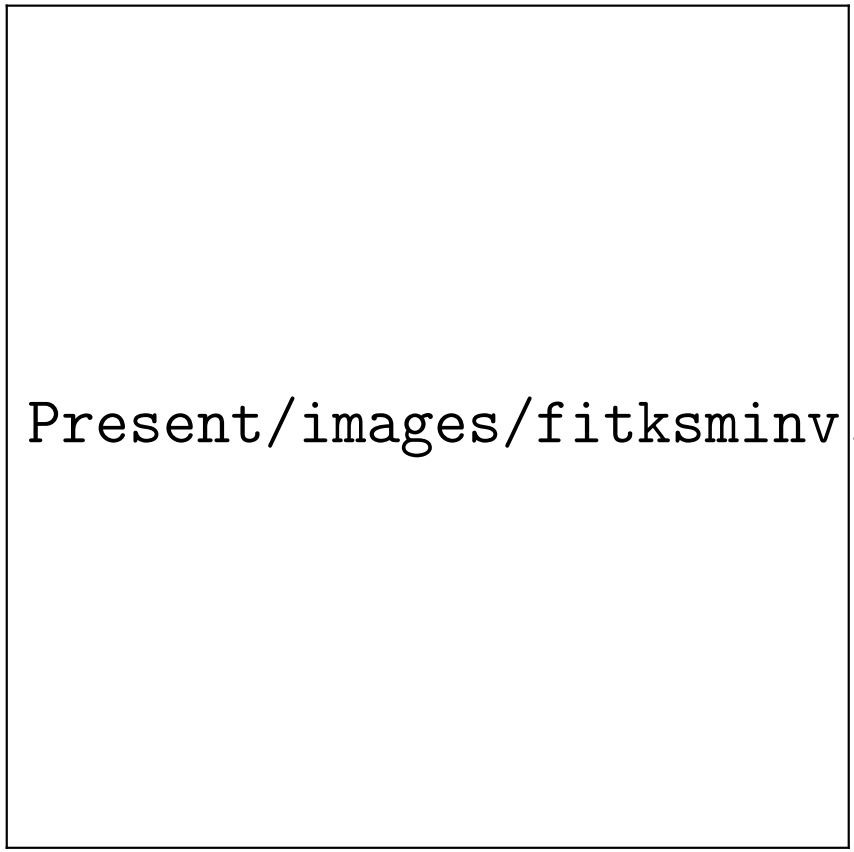


Dependence of the K_S meson mass on the π^0 meson mass

Effiency

$\epsilon = \frac{N_{det}}{N}$, where $N = 10^5$.
2011 — 1.0 T, 2012 — 1.3 T

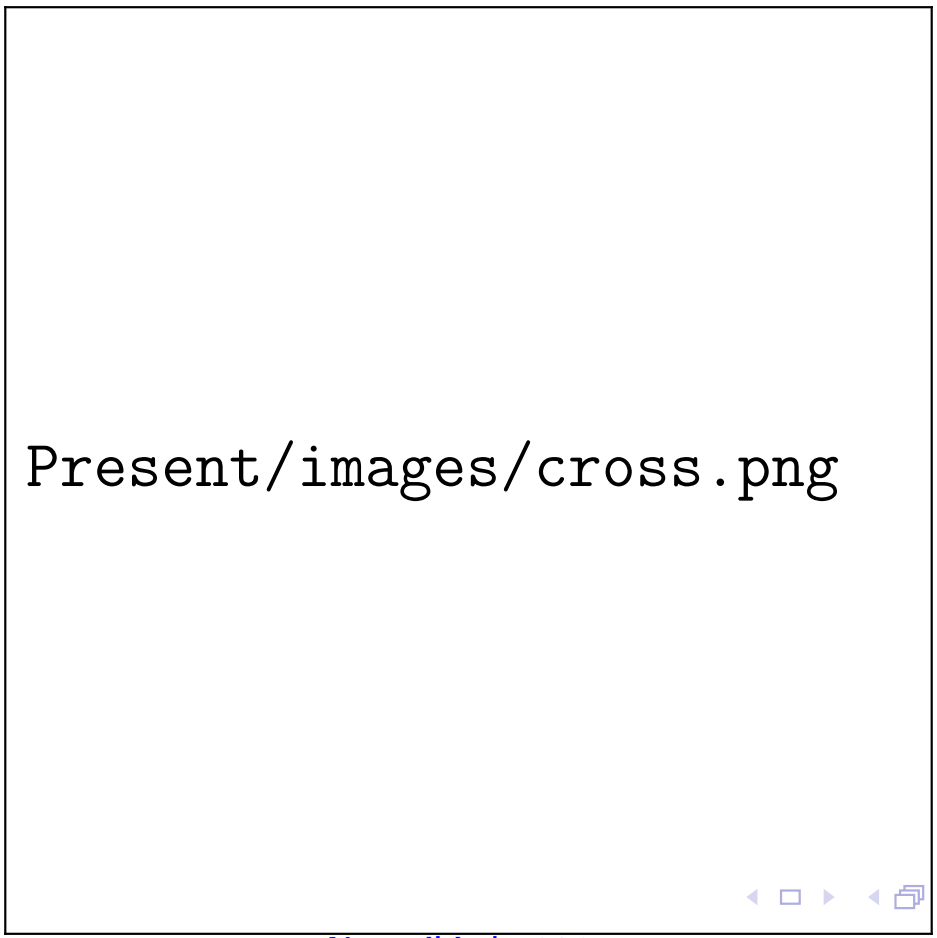
Calculation of the cross section



- $S(x) = N * (\alpha * gausn(x, \bar{x}_{\mathbf{1}}, \sigma_{\mathbf{1}}) + \beta * gausn(x, \bar{x}_{\mathbf{2}}, \sigma_{\mathbf{2}}) + (1 - \alpha - \beta) * gausn(x, \bar{x}_{\mathbf{3}}, \sigma_{\mathbf{3}}))$ — **signal**
- $\Phi(x) = k * (x - b)$ — **background**
- $S(x) + \Phi(x)$ — **total.**

Preliminary cross-section

$\sigma = \frac{N}{\epsilon L}$, where N — number of the good events, ϵ — efficiency and L — integrated luminosity.



Conclusion and future plans

Conclusion:

- The optimal criteria for selecting the events of the process have been developed.
- The efficiency of registration by means of Monte-Carlo simulation have been determined.
- The total cross-section of the process $e^+ e^- \to K_s K_L \pi^0$ in the energy range from 1.1 GeV to 2 GeV have been measured.

Future plans:

- Detailed background study
- Publication

Thank you for your attention!