Study of the process $e^+e^- \to K_S K_L$ in the center-of-mass energy range 1.05 – 2.0 GeV

with the CMD-3 Detector at VEPP-2000 collider

Nikita Petrov
Budker Institute of Nuclear Physics

Outline

$e^+e^- \rightarrow K_S K_L$
$1.05 < \sqrt{s} < 2$ GeV

- Motivation
- Experimental setup & Data
- Analysis
  - Cross section
- Conclusion

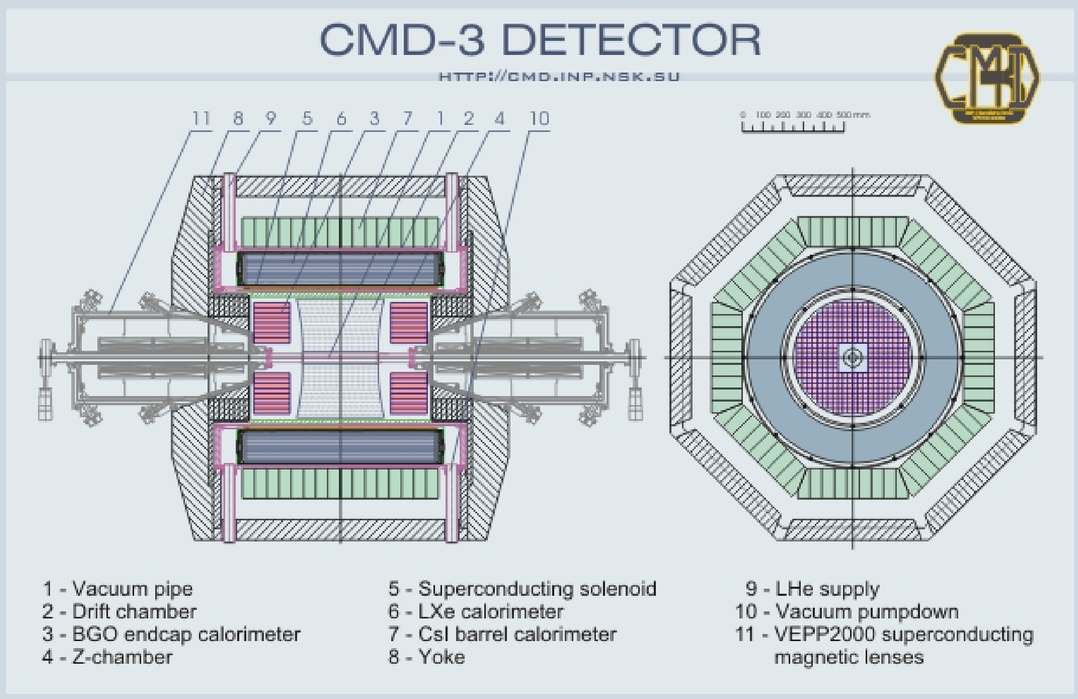
Motivation

Get the cross section of the $e^+e^- \to K_S K_L$ process

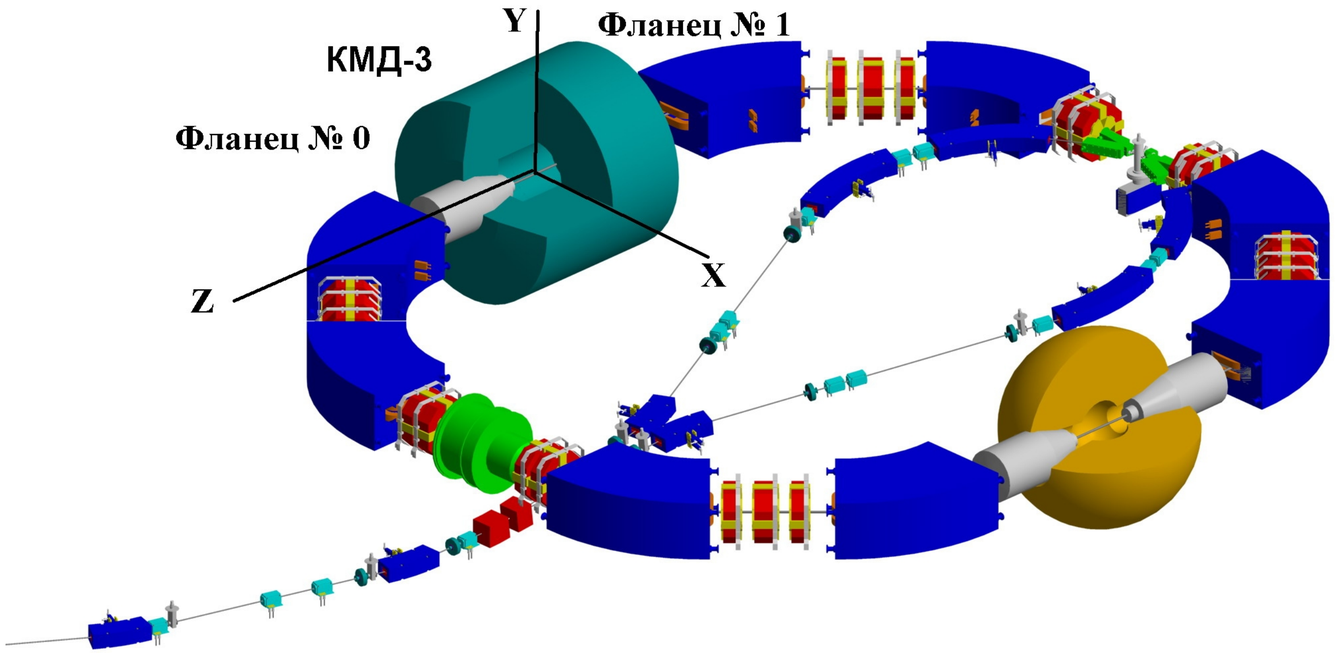
Study of the excited states of the vector mesons

Take into account contribution in $e^+e^- \to$ hadrons for anomalous muon magnetic moment

CMD-3 detector and VEPP-2000 collider



Scheme of the CMD-3 detector[1]



VEPP-2000 collider[2]

Round beam concept
Beam energy range: 200–1000 MeV
Luminosity: 10^{32} cm^{-2} s^{-1}

[1] Fedotovich, G. (2006). CMD-3 detector for VEPP-2000. Nucl. Phys. B Proc. Suppl., 162, 332–338.
[2] Shatunov, P., et al. (2016). Status and perspectives of the VEPP-2000. Phys. Part. Nucl. Lett., 13(7), 995–1001.

Data

Experimental data

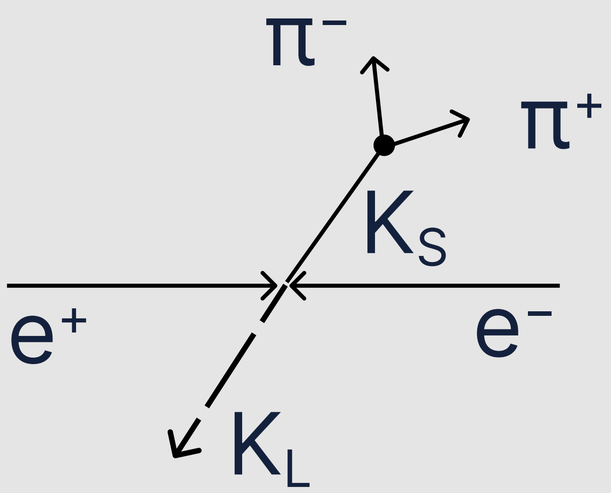
	L, pb^{-1}	√s range, GeV	N_{points}
2011	20	1.05–2.0	40
2012	13	1.28–2.0	16
2017	44	1.28–1.96	32
2019	63	1.07–1.98	43
2020	47	1.87–1.94	5
2021	48	1.94–2.01	4
Total	**233**	**1.05–2.01**	**140**

Monte-Carlo data

20 000 events of the signal process per energy point

500k events per energy point to estimate physical background

Analysis principles



$e^+e^- \to K_SK_L$ events are detected with

$K_S \to \pi^+\pi^-$ decay (Br ~ 70%)
$c\tau\ (K_S) \approx 2.68$ cm

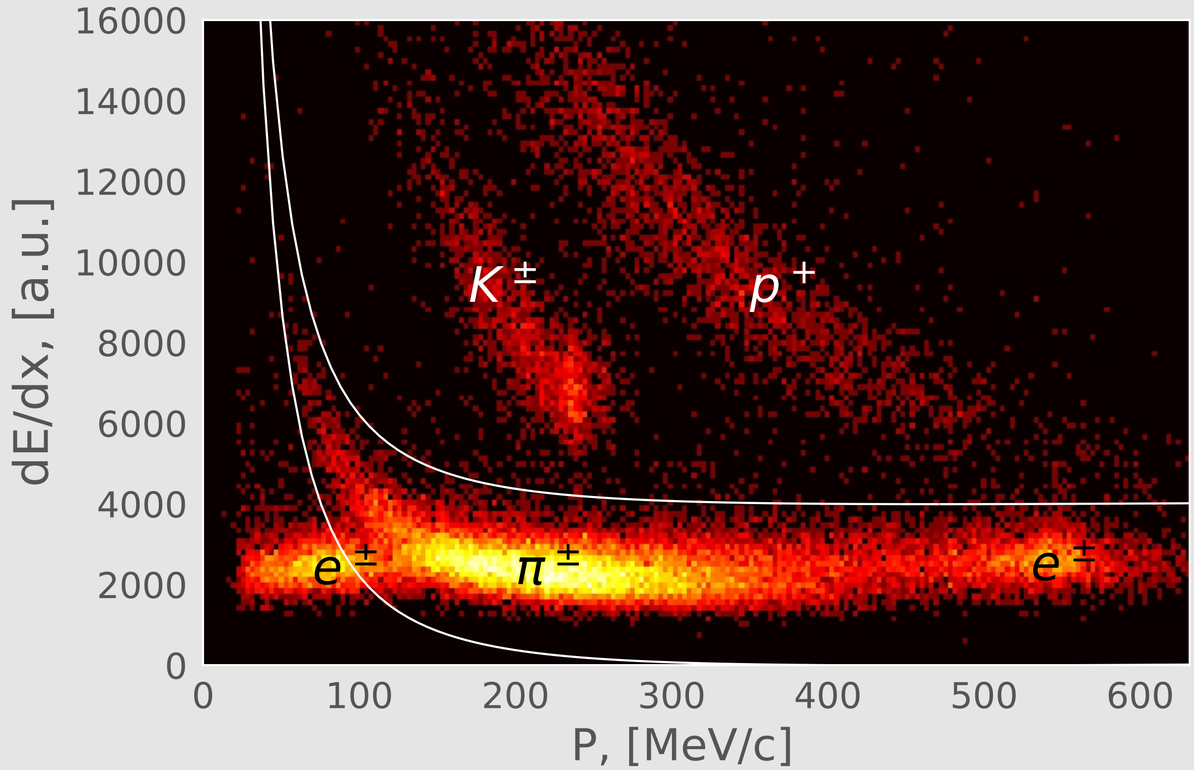
K_L is not detected
$c\tau\ (K_L) \approx 15.34$ m

Method

1. Find out 2 tracks corresponding to $\pi^\pm$
2. Check that these tracks are from K_S decay

Event selection

- 2 tracks:
  - $n_{hits} > 6$, $\chi^2_{r/z} < 25$
  - ionization losses like $\pi^{\pm}$
- L (K_S) > 0.15 cm (r-φ plane)
- 0.5 < θ (K_S) < π−0.5 rad
- cos α* > 0.8
- appropriate K_S decay space angle



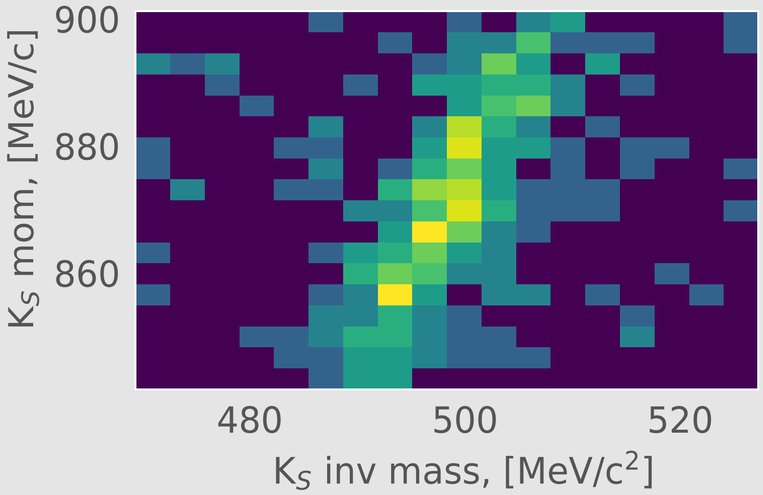
ionization losses vs track momenta
white lines are selection criteria

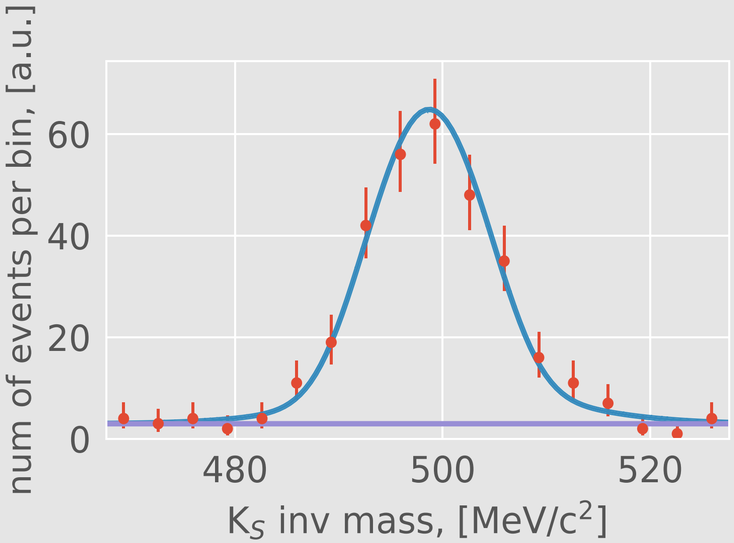
* α is the angle between K_S momentum and the direction from K_S decay vertex to the beam point in r-φ plane

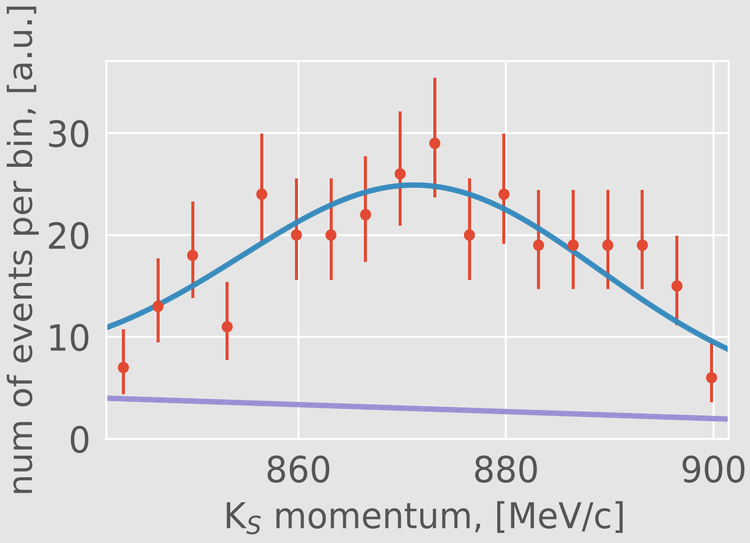
Events number

2D fit of the K_S momentum vs K_S invariant mass distribution

signal and background shapes were fixed from Monte-Carlo

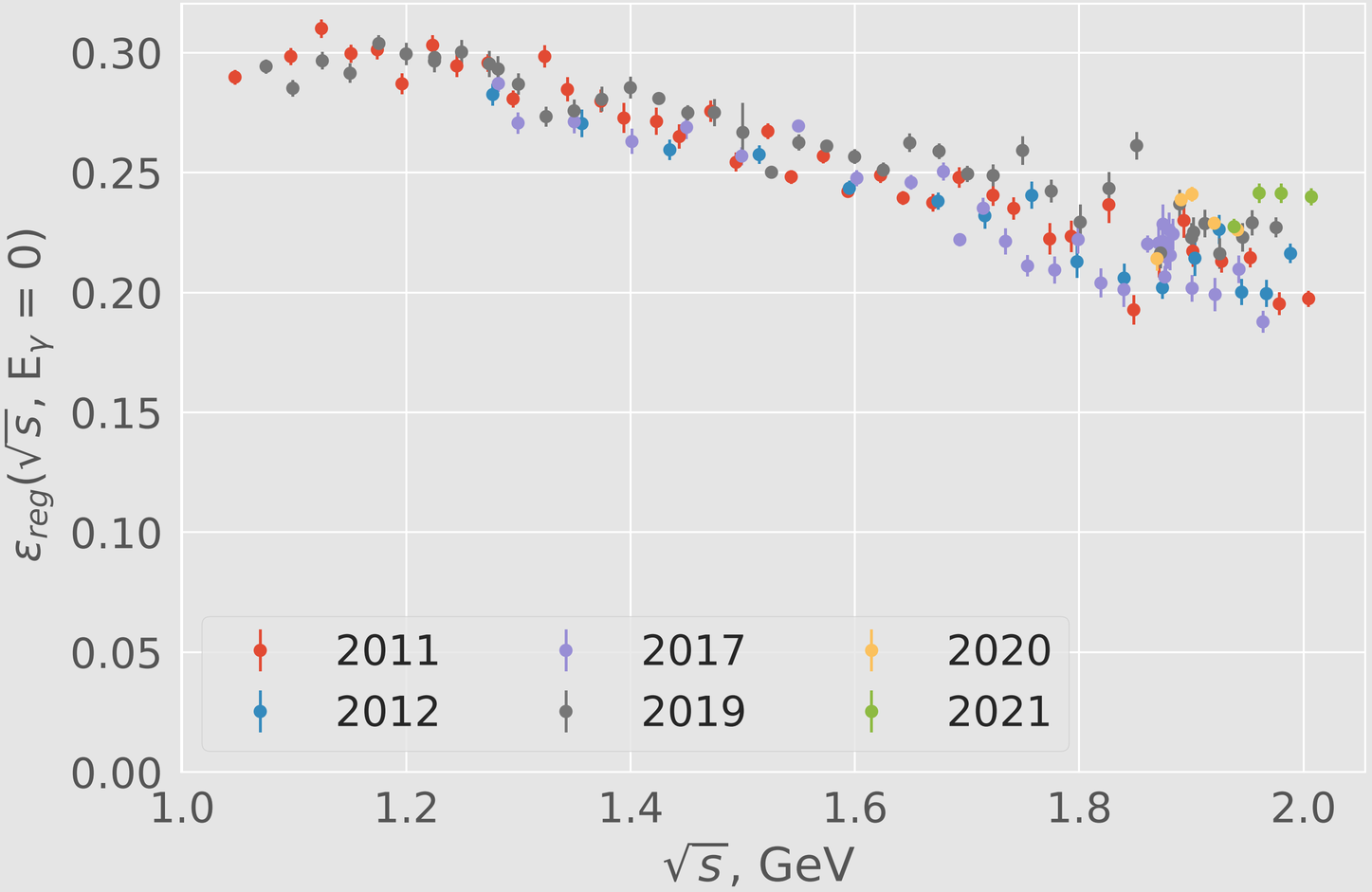




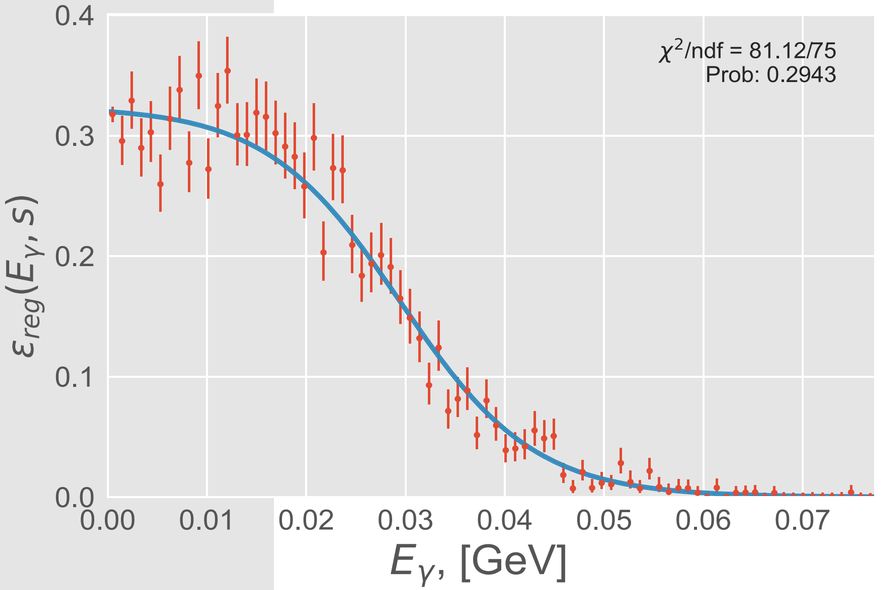


an example of the fit of the experimental data
2021, √s = 2.0 GeV

Detection efficiency

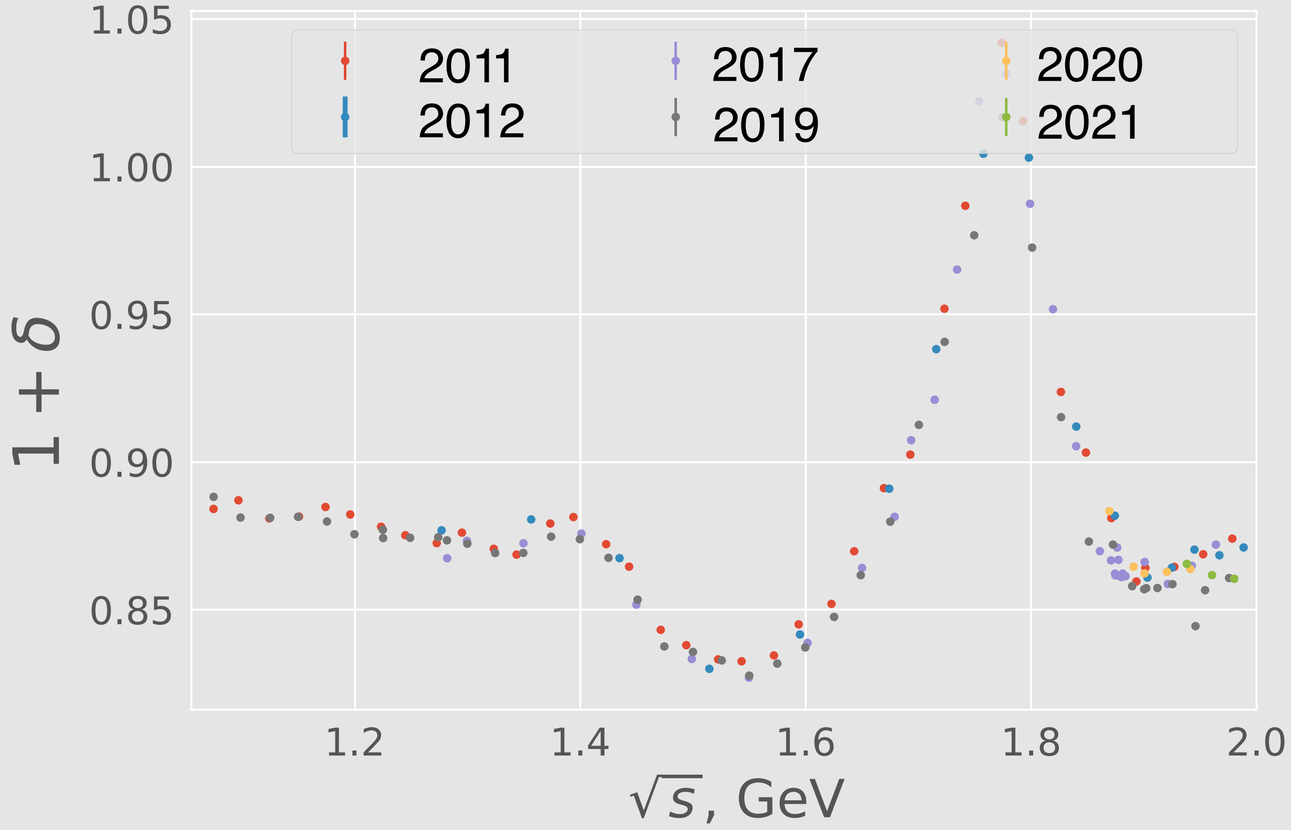


Detection efficiency vs center-of-mass energy



Detection efficiency vs radiative photon energy

Radiative corrections



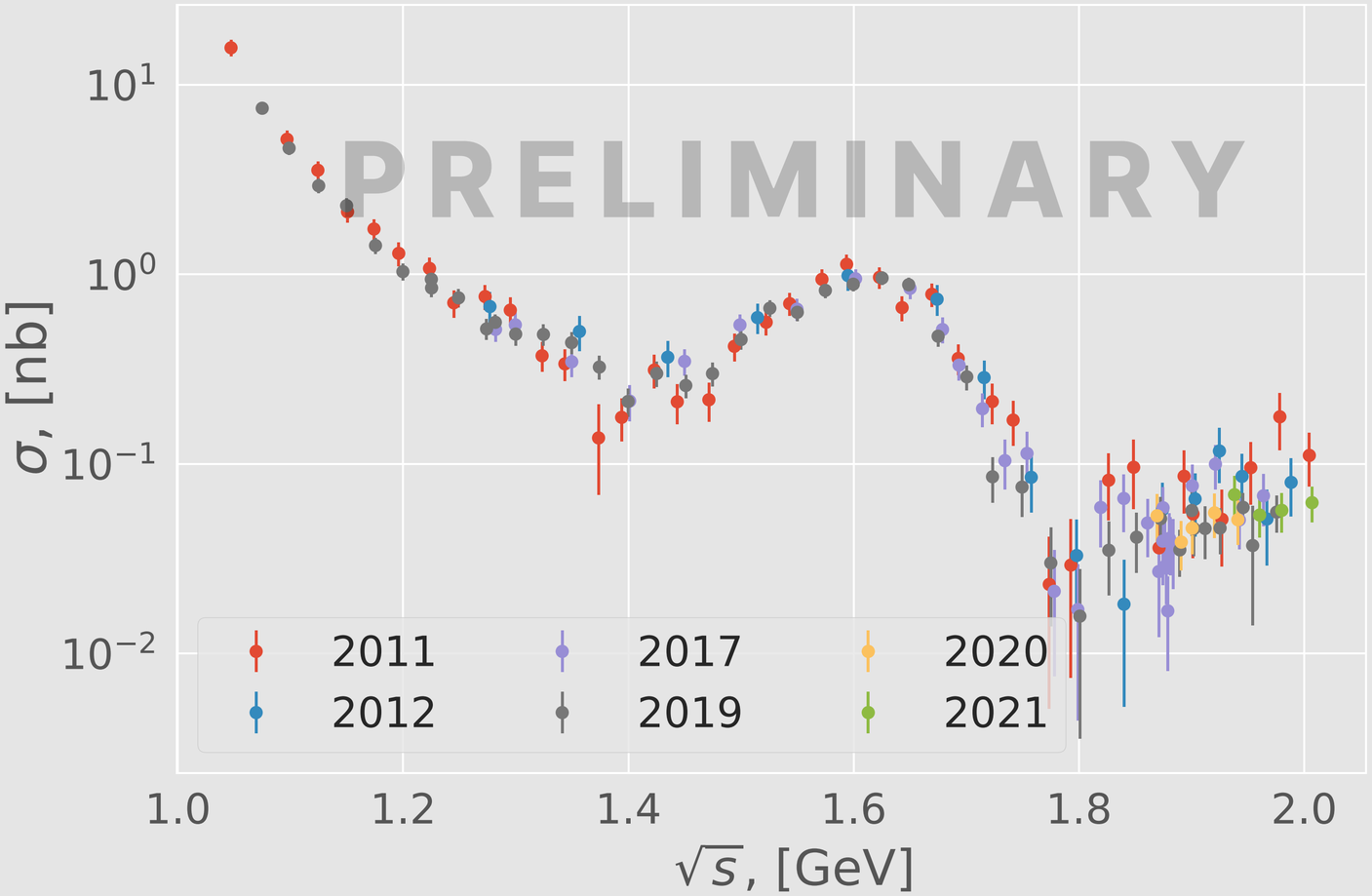
Radiative correction vs center-of-mass energy

Radiative corrections were calculated with structure functions by Kuraev and Fadin[*]

$$\frac{N_{sig}}{L} = \int_0^1 dx\, \sigma_b(s[1-x])\varepsilon(x,s)F(x,s)$$

[*] Kuraev, E., & Fadin, V. (1985). Calculation of radiative corrections to the cross-section of one photon annihilation by means of structure functions. Sov. J. Nucl. Phys. 41

Cross sections



$$\sigma = \frac{N_{sig}}{L\varepsilon(1+\delta)}$$

Cross sections of the $e^+e^- \to K_S K_L$ process vs center-of-mass energy

Conclusion

- cross section of the $e^+e^- \to K_S K_L$ process has been measured in the center-of-mass energy range 1.05 – 2.0 GeV with integrated luminosity of 233 pb^{-1}

- systematic uncertainties need to be accurately accounted for

Thanks for attention!