The 15th International Workshop on Tau Lepton Physics
24–28 September 2018 Amsterdam The Netherlands

Scientific Programme

Properties of the tau
Prospects for tau physics
Tau lepton production
CP violation in the tau sector
Tau in EW and Higgs physics
Tau in searches for BSM

Lepton flavour violation
Lepton universality
Lepton g-2
Neutrino physics
Hadronic decays and QCD

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Measurement of the spectral function for the $\tau^- \to K^- K_S \nu_\tau$ decay in BaBaR experiment

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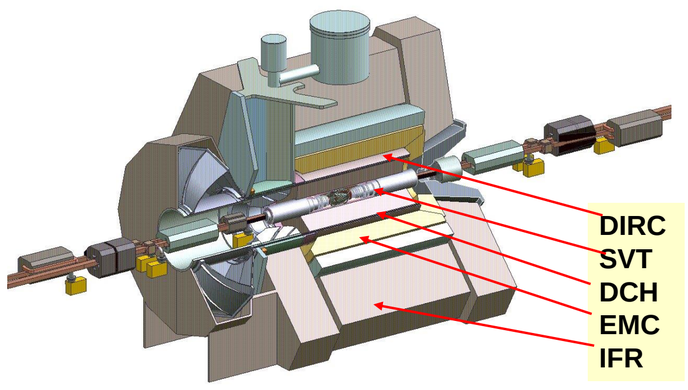
Abstract

The decay $\tau^- \to K^- K_S \nu_\tau$ has been studied using 430 10^6 $e^+ e^- \to \tau^+ \tau^-$ events produced at a center-of-mass energy around 10.6 GeV at the PEP-II collider and studied with the BaBar detector.
The mass spectrum of the $K^- K_S$ system has been measured and the spectral function has been obtained. The measured branching fraction
$BF(\tau^- \to K^- K_S \nu_\tau) = (0.739 \pm 0.011(stat.) \pm 0.020(syst.)) \, 10^{-3}$
is found to be in agreement with earlier measurements.

BaBaR detector

$E_+ = 3.1$ GeV, $E_- = 9$ GeV



$E_{CM} = M(\Upsilon(4S)) = 10.6$ GeV
2000 – 2008 yrs
$L_{ins} \sim 10$ nb^{-1}/sec
$L_{int} \approx 500$ fb^{-1}
$N(\tau) \sim 10^9$

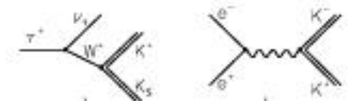
BaBar Data : Run1-run6 - 468.3 fb^{-1}
kL=L_{MC} /Lrun
2. MC $e^+e^- \to \tau^+\tau^-$, 816.3 fb^{-1} , kL = 1.74
3. MC $e^+e^- \to \tau^+\tau^- \to l^+ K_S K^- \nu_\tau$, 1088 fb^{-1} , kL = 2.32
4. MC $e^+e^- \to$ uds , 856 fb^{-1} , kL= 1.83
5. MC $e^+e^- \to$ c-cbar , 868.5 fb^{-1} , kL= 1.85
6. MC $e^+e^- \to$ B-Bbar, 1352.4 fb^{-1} , kL= 2.89

Spectral function (SF) definition

$$V(m) = 2\frac{1}{N}\frac{dN}{dm}\frac{1}{m(M_\tau^2 - m^2)^2(M_\tau^2 + 2m^2)}\frac{B(\tau \to K_S K \nu)}{B(\tau \to e\nu\nu)}\frac{M_\tau^6}{12\pi V_{ud}^2}$$

dN/dm - K^+K_S mass spectrum

Relation between SF and e^+e^- cross section (CVC)

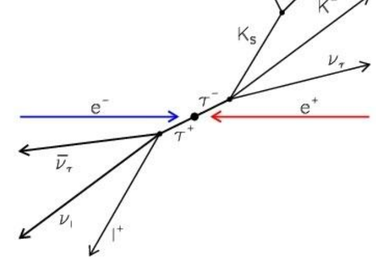


$$V(m) = \frac{m^2}{4\pi^2\alpha^2}\sigma_{e^+e^- \to K\bar{K}(I=1)}(m)$$

Conclusions for e+e- cross sections

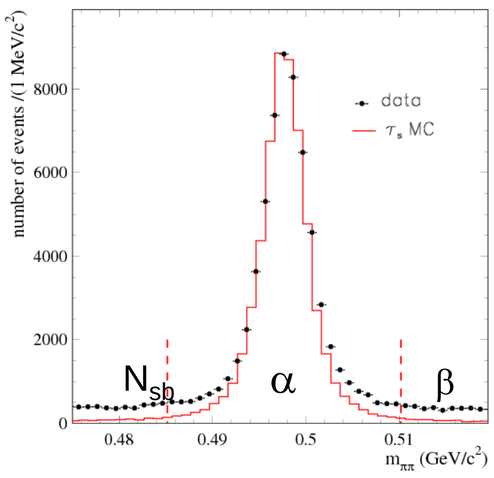
$\sigma(K^+K^-) + \sigma(K_S K_L) \sim \sigma_{I=1}(KK) + \sigma_{I=0}(KK)$

Selection requirements



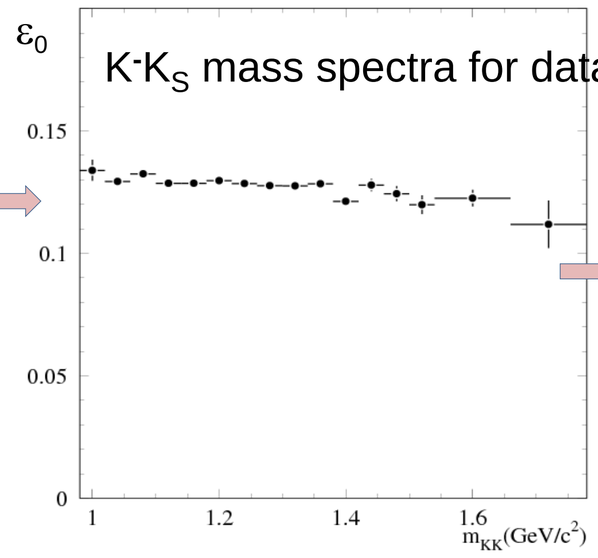
1. N(tracks)=4,
2. $N(K_S)=1, K_S \to \pi^+\pi^-$
3. $N(K^\pm)=1$, $N(\mu)$.or.$N(e)=1$
4. $r_{KS} = 1 - 70$ cm
5. thrust > 0.875
6. $K^\pm$: $p_{lab} = 0.4–5$,
7. e,μ : $\cos\theta_{lab} < 0.9$, $p_{lab} > 1.2$, $p_{cm} < 4.5$
8. $\theta_{CM} > 110^o$, - angle lept. <--> KK_S
9. $\Sigma E\gamma < 2$ GeV

K_S background subtraction

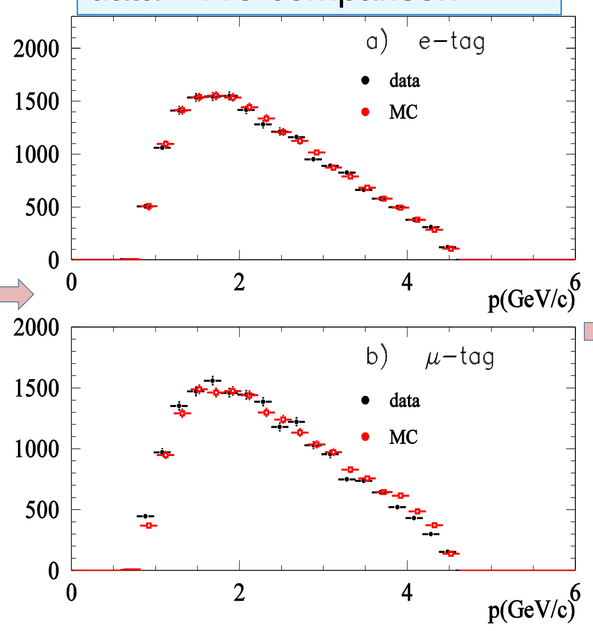


Sideband method is used to subtract KS background
$N_{KS} = (\alpha N - N_{sb})/(\alpha - \beta)$,
$\alpha = 0.5$, $\beta = 0.0315$

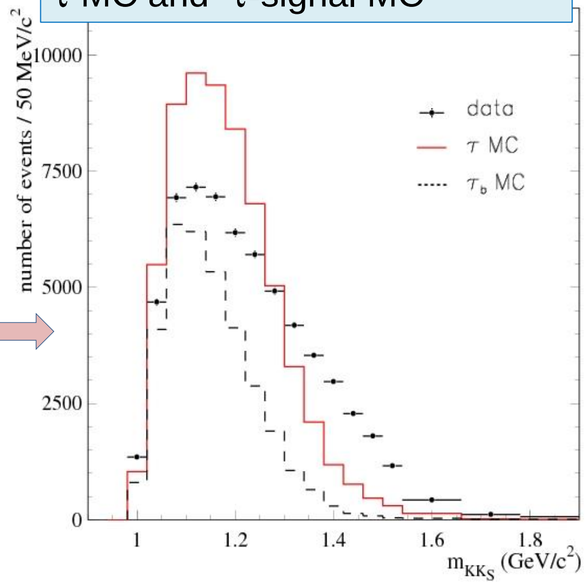
Detection efficiency ε_0 vs K^-K_S mass

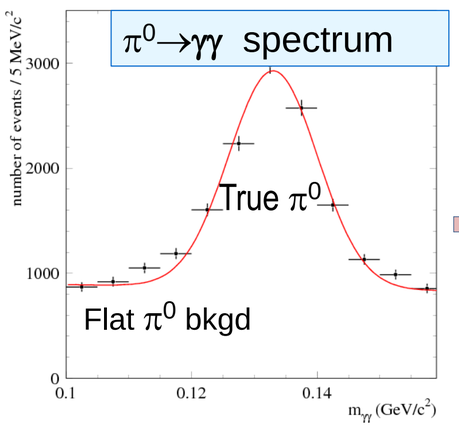


Lepton momentum spectra: data – MC comparison



K^-K_S mass spectra for data , τ MC and τ-signal MC





π^0 background subtracted from the fit to $\gamma\gamma$ mass spectrum

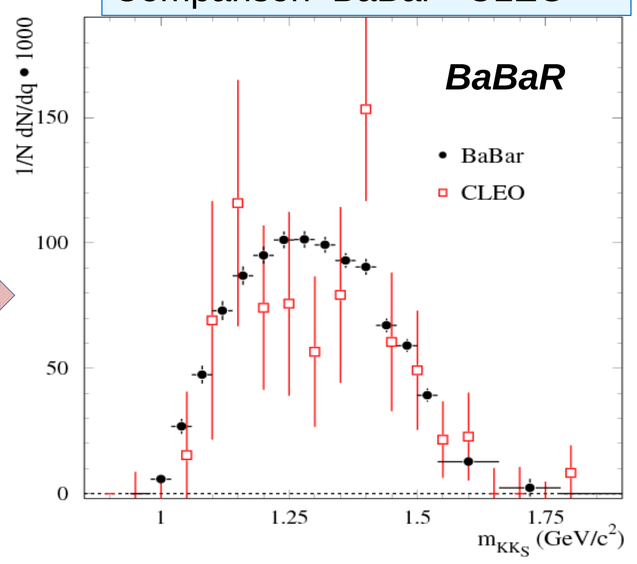
Equation for obtaining the number of signal events in each $m(K^-K_S)$ bin
(N^τ_{sig} – signal mass spectrum) :

Data events with found π^0 → $N_{ex0} = (1-\varepsilon_S)N^\tau_{sig} + (1-\varepsilon_b)N^\tau_{bg}$

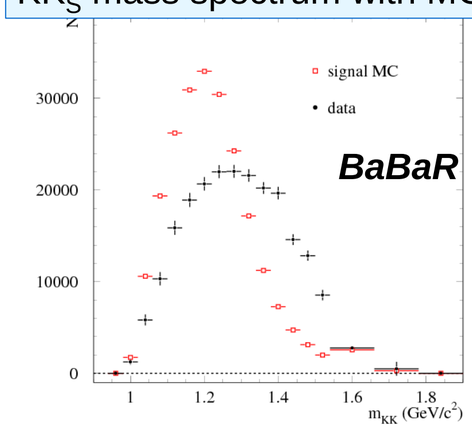
Data events wthout found π^0 → $N_{ex1} = \varepsilon_S N^\tau_{sig} + \varepsilon_b N^\tau_{bg}$

ε_s, ε_b – probabilities to find a π^0 ,
corrected to true π^0 efficiency ($\varepsilon_s \approx 0.13$, $\varepsilon_b \approx 0.72$)

Comparison BaBar - CLEO



Comparison of measured KK_S mass spectrum with MC



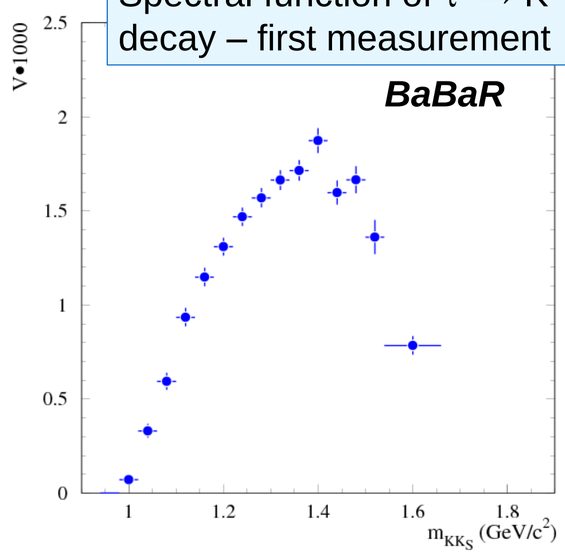
Measured BF($\tau^- \to K K_S \nu_\tau$) by *BaBaR*

BF = N^τ_{sig} / (2 L B_{lept} ε_0 $\sigma_{\tau\tau}$), L=468.3 fb^{-1},
$\sigma_{\tau\tau}$=0.919 nb, $\varepsilon_0 \approx$ 0.13, B_{lep}=0.3521,
$N^\tau_{sig} \approx 29000$.

BF = (0.739 ±0.011(stat) ±0.020(syst)) 10^{-3}

BF (PDG_2016) = 0.740+-0.025 10^{-3}

Spectral function of $\tau^- \to K^- K_S \nu_\tau$ decay – first measurement



This poster is presented at the 18-th Workshop on Tau Lepton Physics, Amsterdam, 24-28 September, 2018