Status of $\tau \longrightarrow \eta\pi\pi\nu$

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Outline:

- Summary of experimental data
- CVC basics
- Fits based on CVC and RChL
- Conclusions

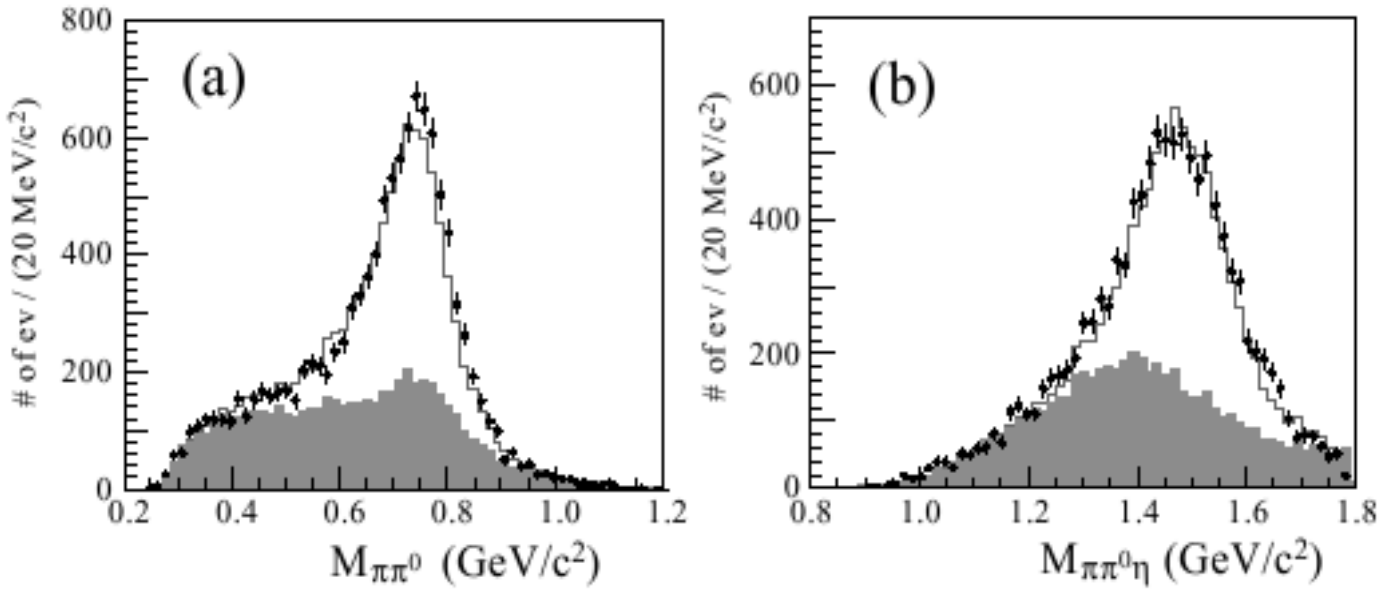
Motivation

- A new high-statistics measurement appeared at Belle in 2009
- Good knowledge of the $\eta\pi^-\pi^0$ may help in a search for 2nd class current $\tau \longrightarrow \eta\pi\nu$
- Belle is repeating the analysis of BaBar to study production of $e^+e^- \longrightarrow \eta\pi^+\pi^-$

Summary of $\tau \to \eta\pi\pi\nu$ measurement

Group	$\mathcal{B}$,%
CLEO, 1992	$0.170 \pm 0.020 \pm 0.020$
ALEPH, 1997	$0.180 \pm 0.040 \pm 0.020$
Belle, 2009	$0.135 \pm 0.003 \pm 0.007$

Most recent and high statistics result came from Belle. See the mass spectra below

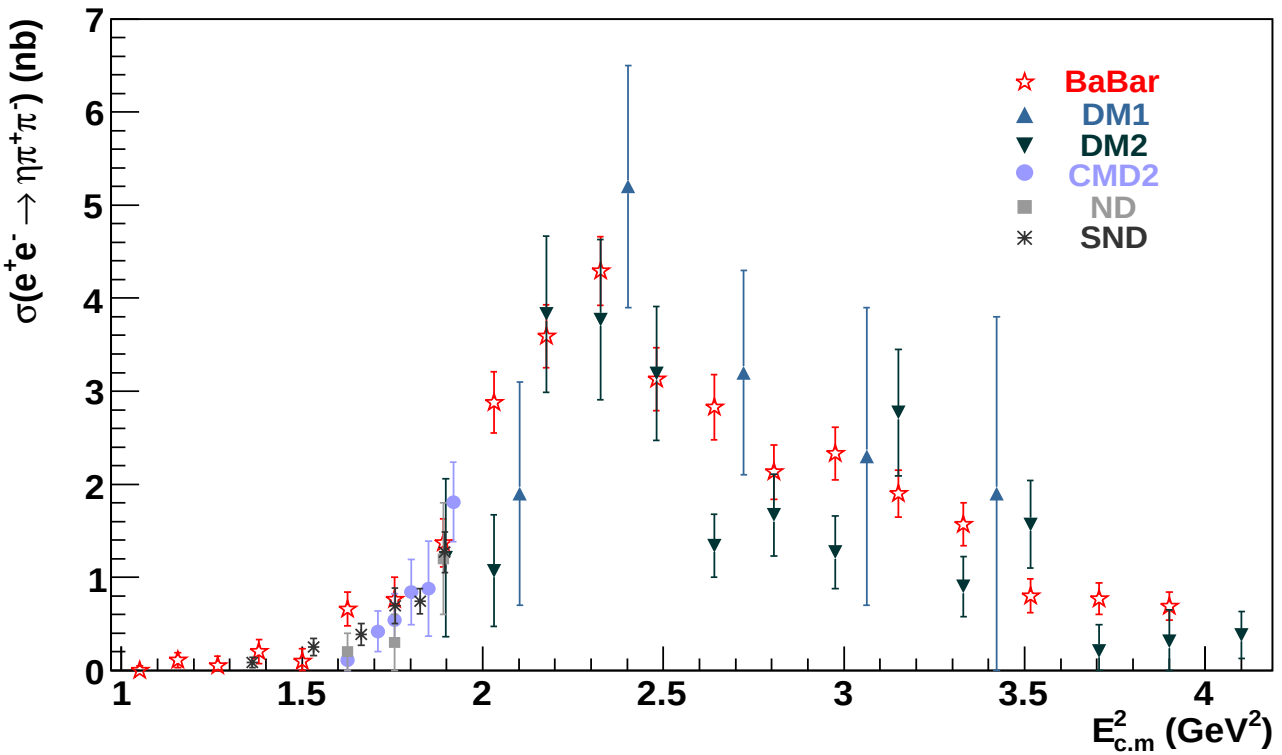


Summary of $e^+e^- \to \eta\pi^+\pi^-$ measurements I

Group	$\sqrt{s}$, GeV	N_{points}	Δ_{stat}, %	Δ_{syst}, %
ND, 1986	1.25 - 1.40	3	50 - 100	10
CMD-2, 2000	1.25 - 1.40	6	30 - 60	15
SND, 2010	1.17 - 1.38	6	15 - 60	10.5
DM1, 1982	1.40 - 1.80	4	30 - 60	10
DM2, 1988	1.35 - 1.80	10	25 - 60	10
BaBar, 2007	1.00 - 1.80	16	10 - 60	8

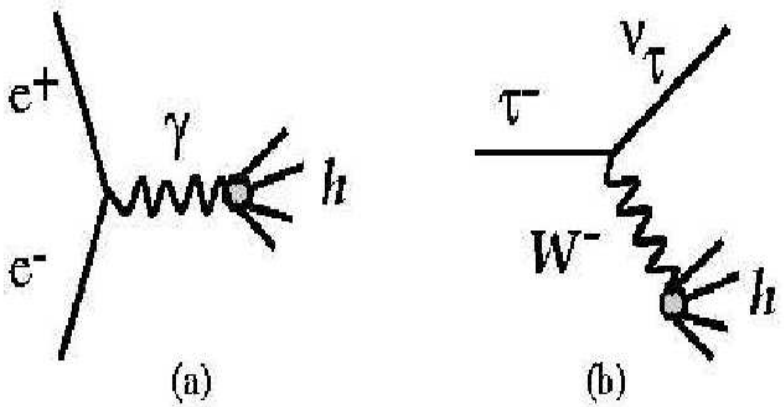
BaBar studied the whole range from threshold to m_τ
SND: M.N. Achasov et. al., JETP Lett. 92, 84 (2010)

Cross section of $e^+e^- \to \eta\pi^+\pi^-$



BaBar data are much precise than those at DM1,DM2 above 1.4 GeV.

CVC basics



The allowed
$J^{PG} = 1^{-+}, \tau \to 2n\pi\nu_\tau, \omega\pi\nu_\tau, \eta\pi\pi\nu_\tau, \ldots$
$\mathcal{B}(\tau^- \to V^-\nu_\tau) \approx 32\ \%$

For the vector part of the weak hadronic current the mass distributions of the produced hadrons is

$$\frac{d\Gamma}{dq^2} = \frac{G_F|V_{ud}|^2 S_{EW}}{32\pi^2 m_\tau^3}(m_\tau^2 - q^2)^2(m_\tau^2 + 2q^2)v(q^2),$$

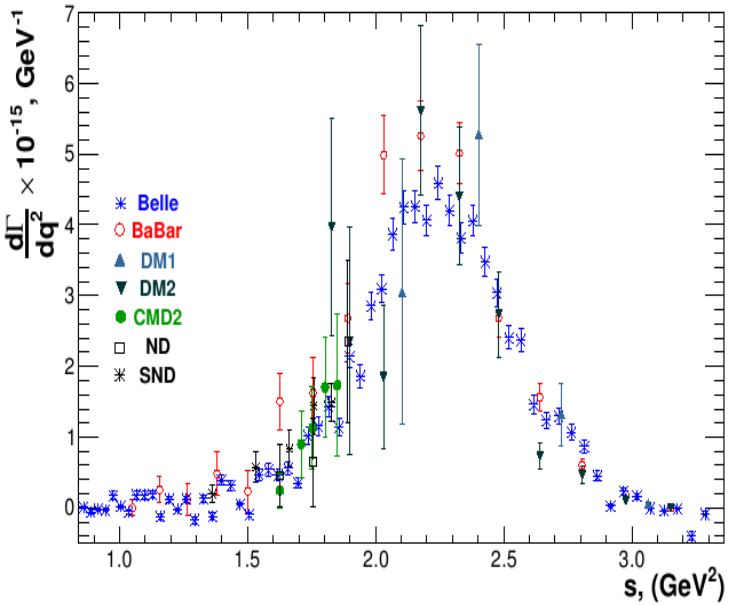
where the spectral function is

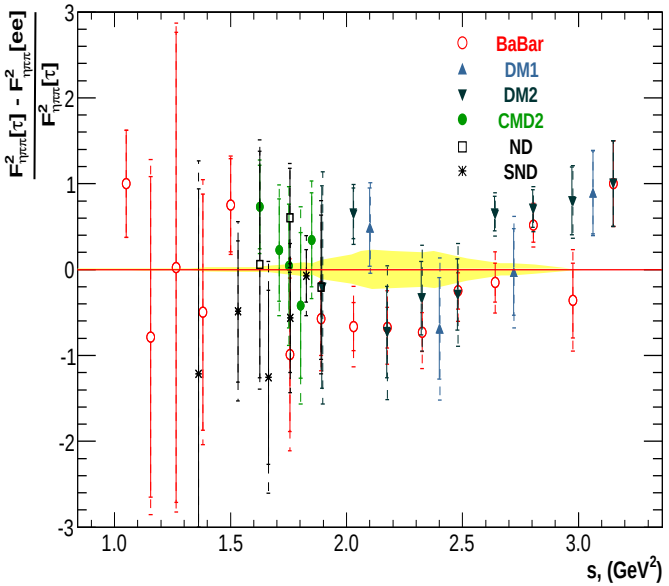
$$v(q^2) = \frac{q^2\sigma^{I=1}_{e^+e^-}(q^2)}{4\pi^2\alpha^2},$$

Integration gives the branching fraction:

$$\frac{\mathcal{B}(\tau^- \to X^-\nu_\tau)}{\mathcal{B}(\tau^- \to e^-\nu_e\nu_\tau)} = \frac{3|V_{ud}|^2 S_{EW}}{2\pi\alpha^2}\int_{4m_\pi^2}^{m_\tau^2} dq^2 \frac{q^2}{m_\tau^2}\left(1 - \frac{q^2}{m_\tau^2}\right)\left(1 + 2\frac{q^2}{m_\tau^2}\right)\sigma^{I=1}_{e^+e^-}(q^2)$$

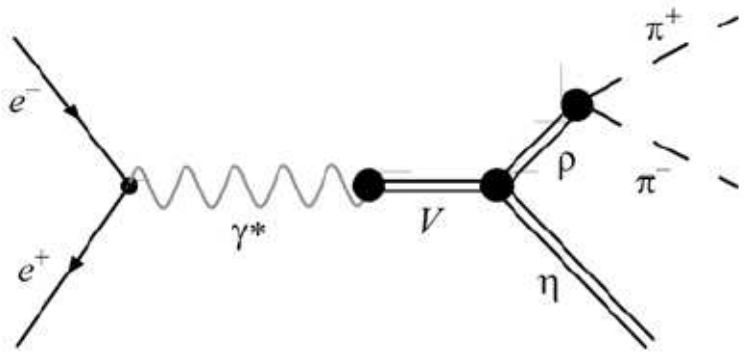
Comparison of e^+e^- and τ spectra





In general, τ spectra are consistent with e^+e^-.
Yellow band on the "difference" plot denotes a 5.3 % syst. error of Belle.

A fit of e^+e- data



Spectra are described by the interfering $\rho(1450)$ and $\rho(1700)$:
$A \sim A_{\rho'} + A_{\rho''} e^{i\phi}$

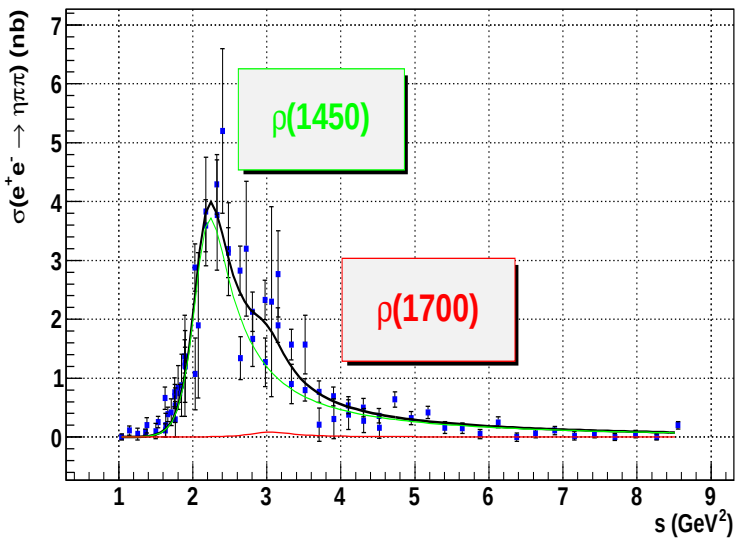
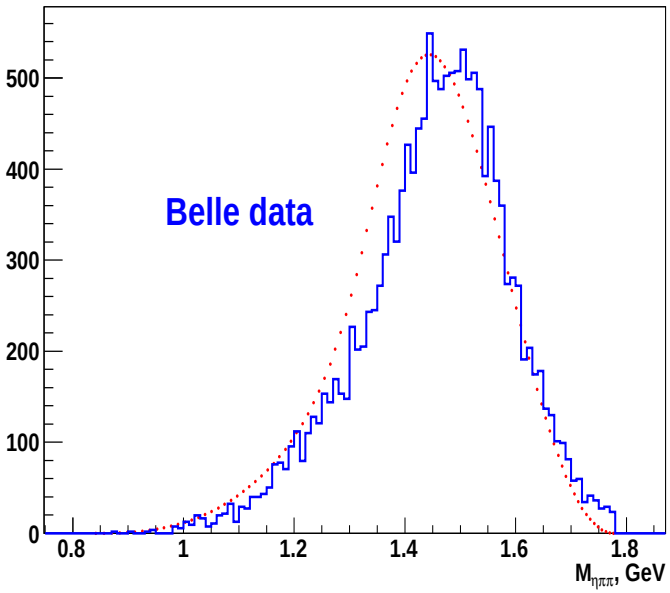
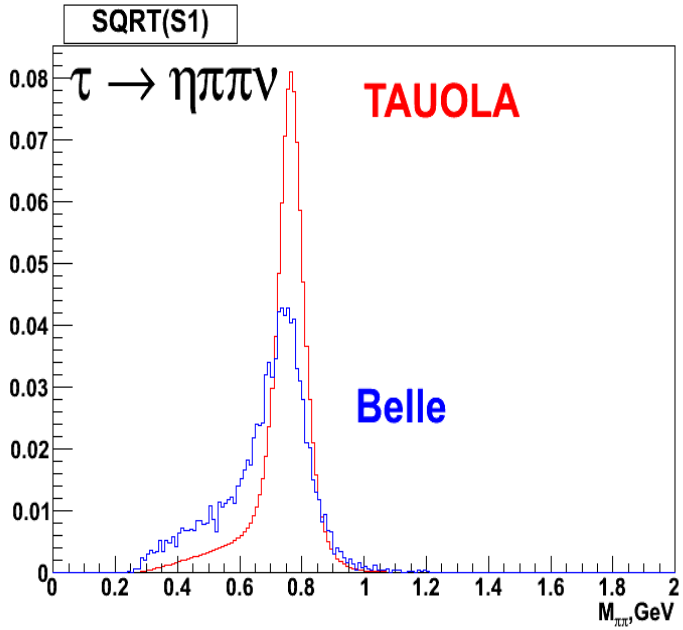


Table 6: Parameters

NAME	VALUE	ERROR
$M_{\rho'}$	1.48090e+00	4.84222e-03
$\Gamma_{\rho'}$	2.19227e-01	1.57122e-02
$\sigma_{\rho'}$	3.72342e+00	2.77443e-01
$M_{\rho'}$	1.75000e+00	3.08308e-02
$\Gamma_{\rho''}$	2.00000e-01	2.29732e-02
ϕ, rad	1.15087e+00	2.40200e-01
$\sigma_{\rho''}$	6.01821e-01	3.43210e-01
Babar_syst	-1.17334e-04	1.15003e-03
cmd2_syst	-7.45284e-04	1.53529e-02
dm1_syst	-6.08189e-02	1.18563e-01
dm2_syst	1.63477e-03	9.03404e-03
nd_syst	-1.36641e-04	8.05996e-03
snd_syst	-2.61551e-07	1.04999e-04
FCN=52.0045	NDF=73-7	

A fit of τ spectra based on RChL current





- An agreement of $\pi\pi$ mass might be improved by doing 2-dim fit
- As a cross check τ spectral function can be compared to one obtained from e^+e^-

P.Roig, D. Dumm, Phys.Rev. D86 (2012) 076009

Conclusions

- Spectral functions of τ and e^+e^- are compatile
- The whole dataset on $e^+e^- \longrightarrow \eta\pi^+\pi^-$ can be used to exctract $\eta\pi\pi$ fromfactors
- 2dim or two 1-dim fits can be done using RCHL currents
- The same fitting code as for $\tau^- \longrightarrow \pi^+\pi^-\pi^-\nu$ can be used
- Any comments or suggestions are appreciated