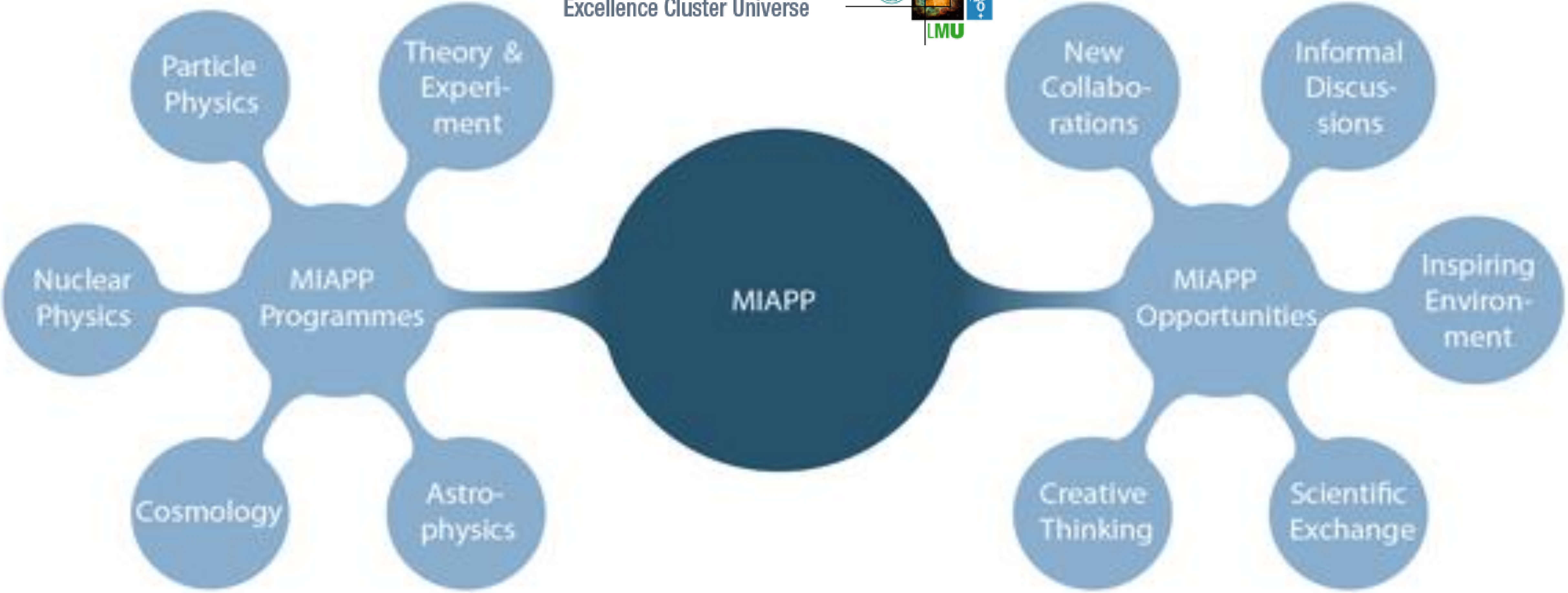
Flavour Physics with High-Luminosity Experiments

24 October–18 November 2016

Excellence Cluster Universe



Some issues in hadronic tau decays

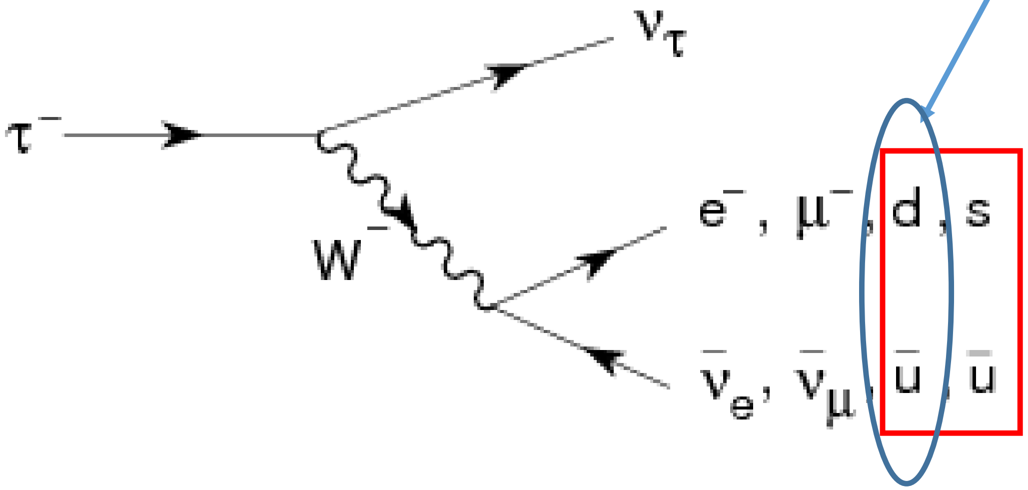
Pablo Roig

Cinvestav (Mexico City)

Outline

- Towards the discovery of **S**econd **C**lass **C**urrents in $\tau^- \rightarrow \pi^- \eta \nu_\tau$ decays @ Belle-II

- Other issues in **hadronic τ decays**



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(introduced by **Simon**)

Towards the discovery of Second Class Currents in $\tau^- \to \pi^- \eta \nu_\tau$ decays @Belle-II

Non-strange V-A currents can be split into: 1st class currents $J^{PG} = 0^{++}, 0^{--}, 1^{+-}, 1^{-+}$ (Weinberg'58)

2nd class currents $J^{PG} = 0^{+-}, 0^{-+}, 1^{++}, 1^{--}$

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$$\mathrm{G-Parity}: G|X\rangle = e^{i\pi I_y} C|X\rangle = (-1)^I C|X\rangle$$

$$G|\bar{d}\gamma^\mu u\rangle = +|\bar{d}\gamma^\mu u\rangle \neq G|\pi^-\eta\rangle = -|\pi^-\eta\rangle$$

(Leroy-Pestieau'78)

G-parity(Isospin)-violating process ($m_u \neq m_d$, $e \neq 0$)

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Note: For efforts to discover SCCs in Nuclear Physics see Rev. Mod. Phys. 78. 991 (but they need to rely on CVC).

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*Note: With **SCC**s I mean either **genuine** SCCs (BSM) or SCCs **induced** by G-parity violation (SM)*

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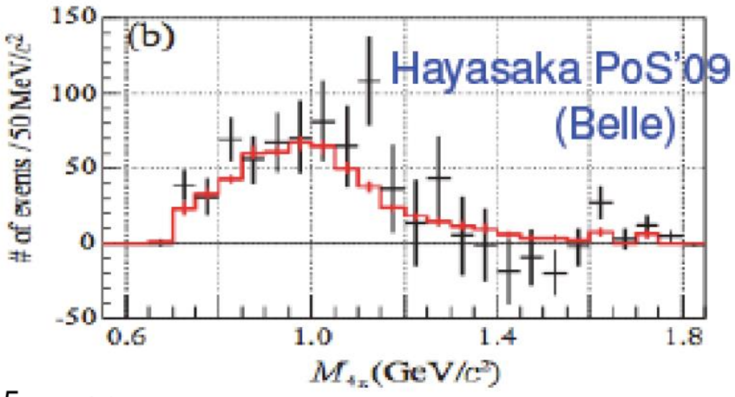

SCCs would have been discovered @ BaBar/Belle if it was not for the tough background !!

$BR_{exp}^{BaBar} < 9.9 \cdot 10^{-5}$ 95% CL

(PRD 83 (2011) 032002)

$BR_{exp}^{Belle} < 7.3 \cdot 10^{-5}$ 90% CL

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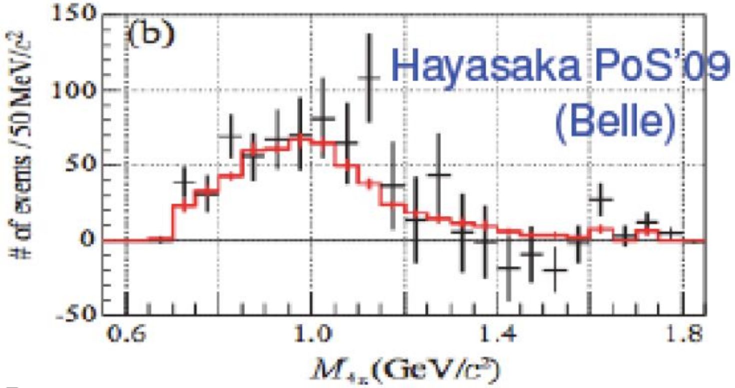

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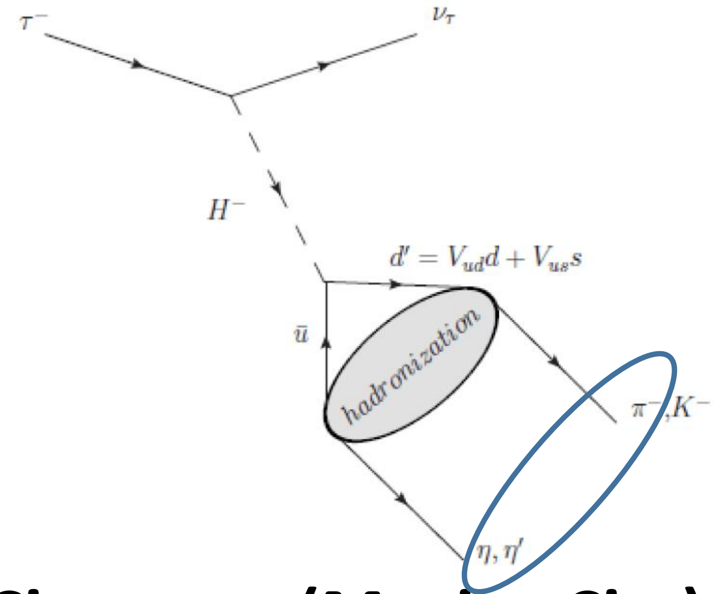

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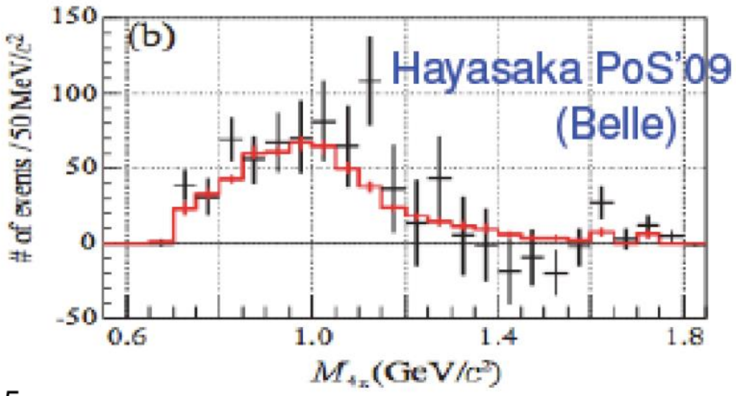

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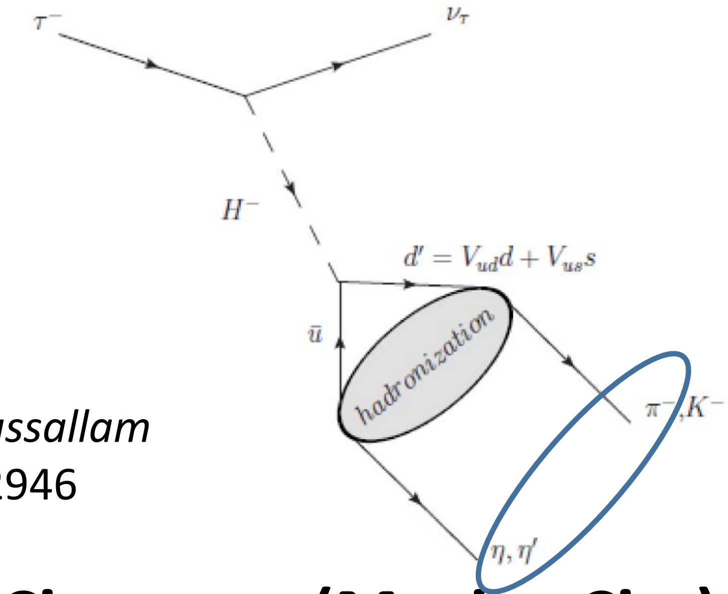
Bounds competitive with $B \to \tau\nu_\tau$ if the SFF is known (th. & exp.) with 20% accuracy!!

Descotes-Genon & Moussallam
Eur.Phys.J. C74 (2014) 2946



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Escribano, González-Solís & Roig Phys.Rev. D94 (2016) no.3, 034008

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- Analyticity+Unitarity+Chiral Expansion
- VFF: $\eta \pi \to \pi \pi$ is related to $\eta \to \pi \pi \pi$
- SFF: Dispersion relation + realistic model for phaseshift + SR constraint for inelastic region

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Input from Guo, Oller & Ruiz de Elvira Phys. Rev. D 86, 054006 (2012)

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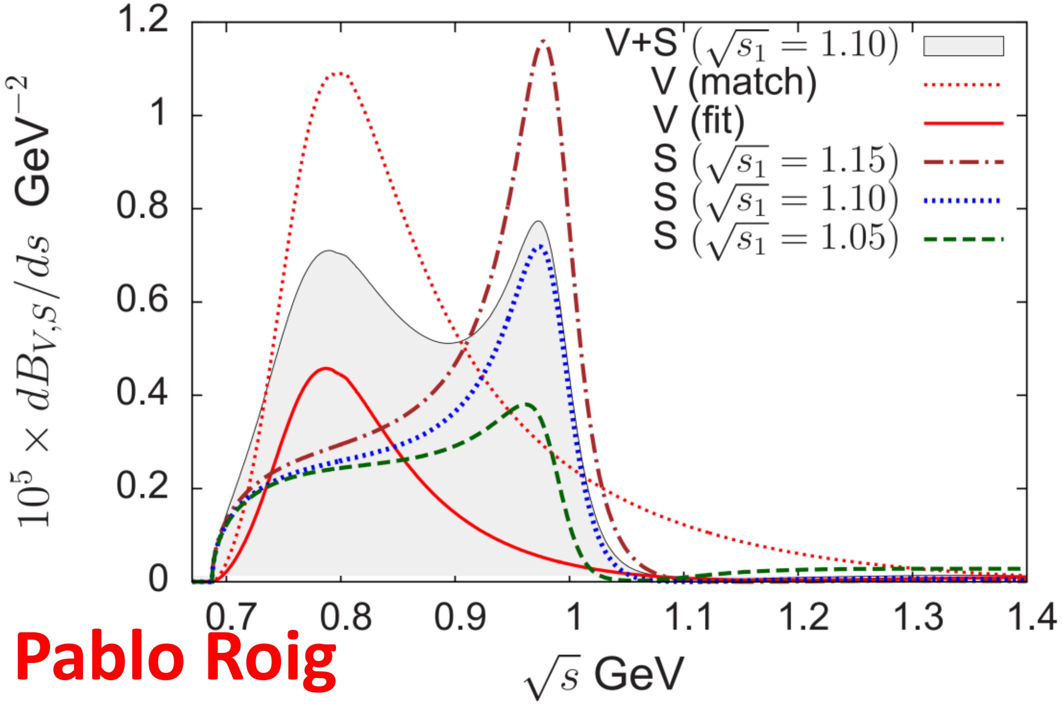

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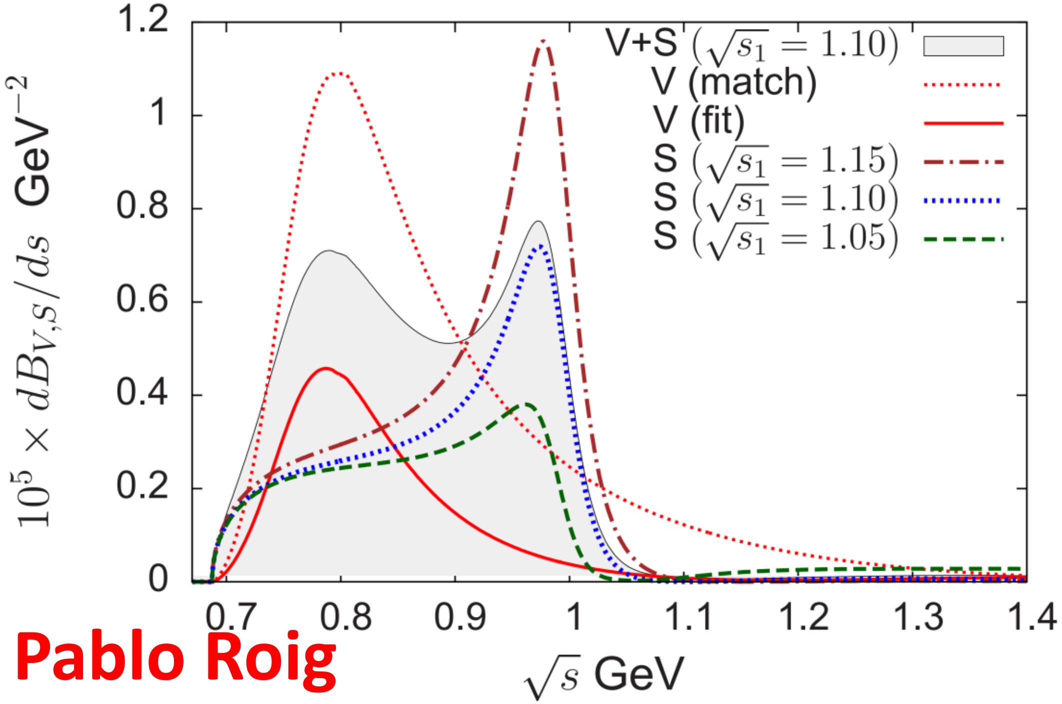

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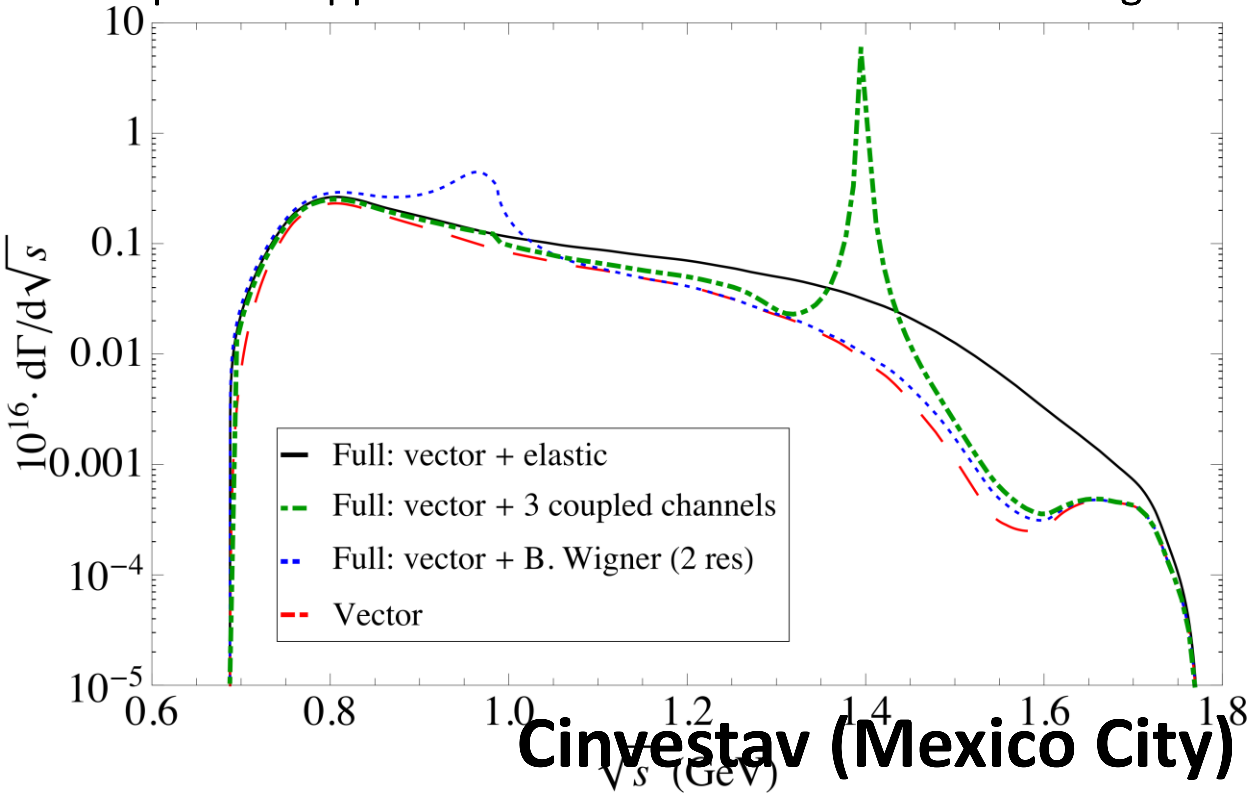

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$BR_V \times 10^5$	$BR_S \times 10^5$	$BR \times 10^5$	Reference
0.25	1.60	1.85	Tisserant, Truong [84]
0.12	1.38	1.50	Bramon, Narison, Pich [85]
0.15	1.06	1.21	Neufeld, Rupertsberger [86]
0.36	1.00	1.36	Nussinov, Soffer [87]
$[0.2, 0.6]$	$[0.2, 2.3]$	$[0.4, 2.9]$	Paver, Riazuddin [88]
0.44	0.04	0.48	Volkov, Kostunin [89]
0.13	0.20	0.33	Descotes-Genon, Moussallam [83]
$BR_V \times 10^5$	$BR_S \times 10^5$	$BR \times 10^5$	Our analysis
0.26 ± 0.02	1.41 ± 0.09	1.67 ± 0.09	3 coupled channels

Errors from SFF parameters not included !!

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SCCs could be discovered @ Belle-II, but take care with the tough background !!

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BR_V	BR_S	BR	Reference
$< 10^{-7}$	$[0.2, 1.3] \times 10^{-6}$	$[0.2, 1.4] \times 10^{-6}$	Nussinov, Soffer [90]
$[0.14, 3.4] \times 10^{-8}$	$[0.6, 1.8] \times 10^{-7}$	$[0.61, 2.1] \times 10^{-7}$	Paver, Riazuddin [91]
1.11×10^{-8}	2.63×10^{-8}	3.74×10^{-8}	Volkov, Kostunin [89]
BR_V	BR_S	BR	Our analysis
$[0.3, 5.7] \times 10^{-10}$	$[1 \times 10^{-7}, 1 \times 10^{-6}]$	$[1 \times 10^{-7}, 1 \times 10^{-6}]$	3 coupled channels

Errors dominated by $\varepsilon_{\pi\eta'}$

At least one order of magnitude suppressed with respect to $\tau \rightarrow \pi \eta \nu_\tau$!!

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Much more challenging to discover SCC with η' than with η!!

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*An **'unexpected' background** (A. Guevara, G. López Castro & P. Roig, to appear soon)*

The Mexican members of Belle-II are studying the 'expected' backgrounds in the search for SCCs @ Belle-II (with Hayasaka-san)

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We have evaluated these using Resonance Chiral Lagrangians (and MDM for comparison)

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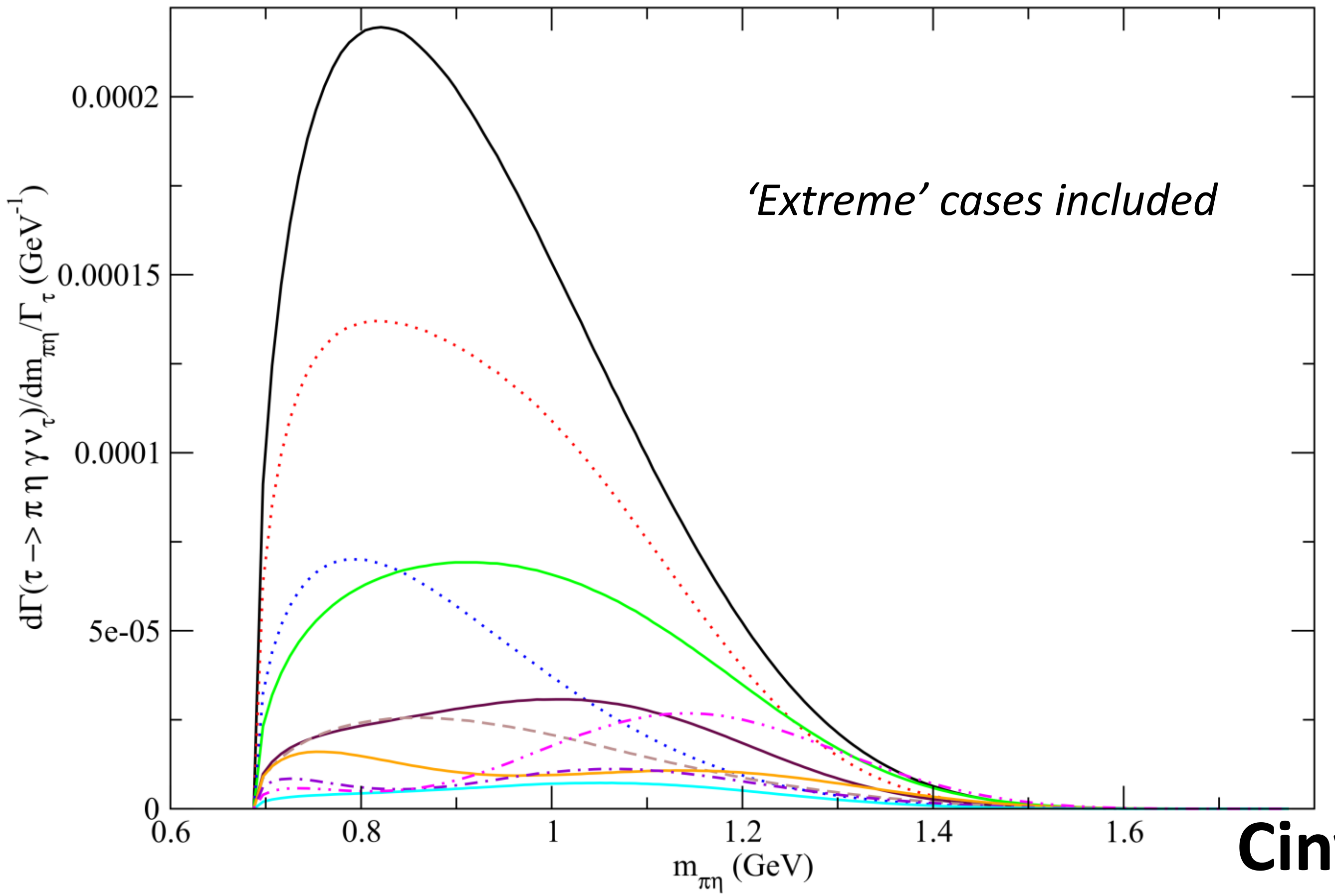
As expected, comparable to $\tau \to \pi \eta \nu_\tau$!!



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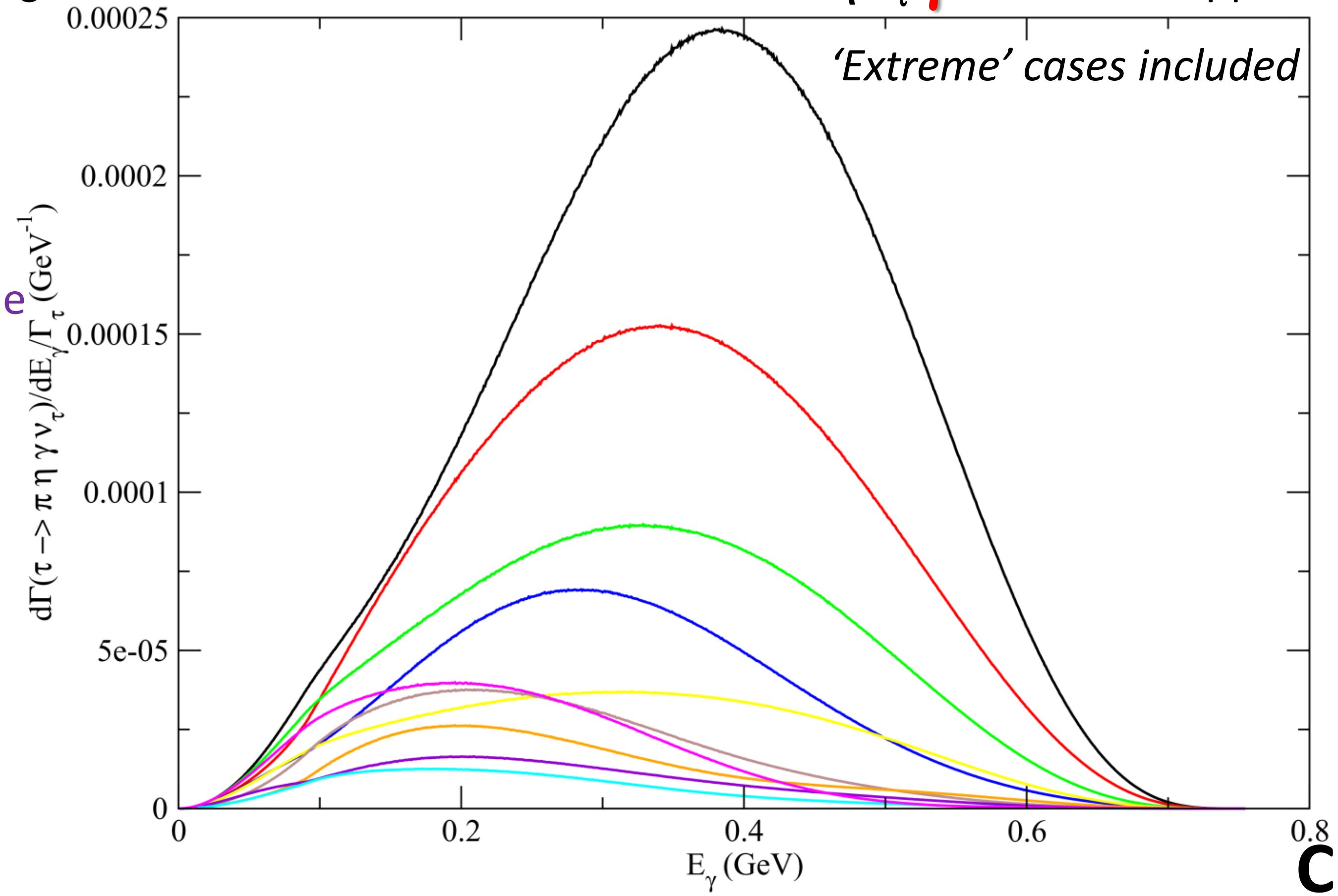

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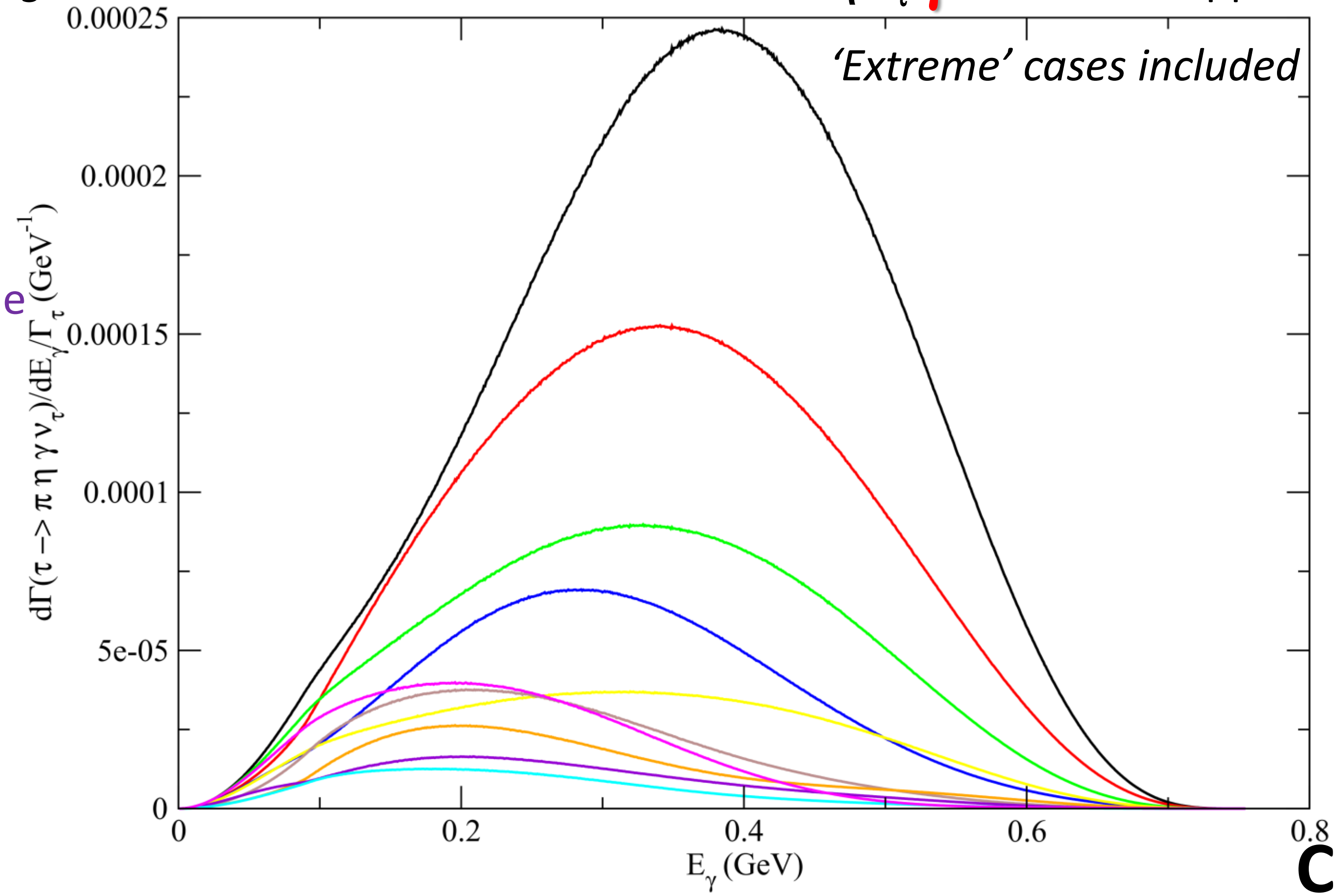

One can just cut γs above certain E (leaving windows for detecting π^0's & η's) !!

Pablo Roig

Cinvestav (Mexico City)

(introduced by **Simon**)

Towards the discovery of Second Class Currents in $\tau^- \to \pi^- \eta \nu_\tau$ decays @Belle-II

*An **'unexpected' background** (A. Guevara, G. López Castro & P. Roig, to appear soon)*

The Mexican members of Belle-II are studying the 'expected' backgrounds in the search for SCCs @ Belle-II (with Hayasaka-san)

'Unexpected' background: There are **contributions** to $\tau \to \pi \eta \nu_\tau \gamma$ which are suppressed by α but not by **G**-parity

$BR^{R\chi L} = (2.7 \pm 0.8) 10^{-5}$

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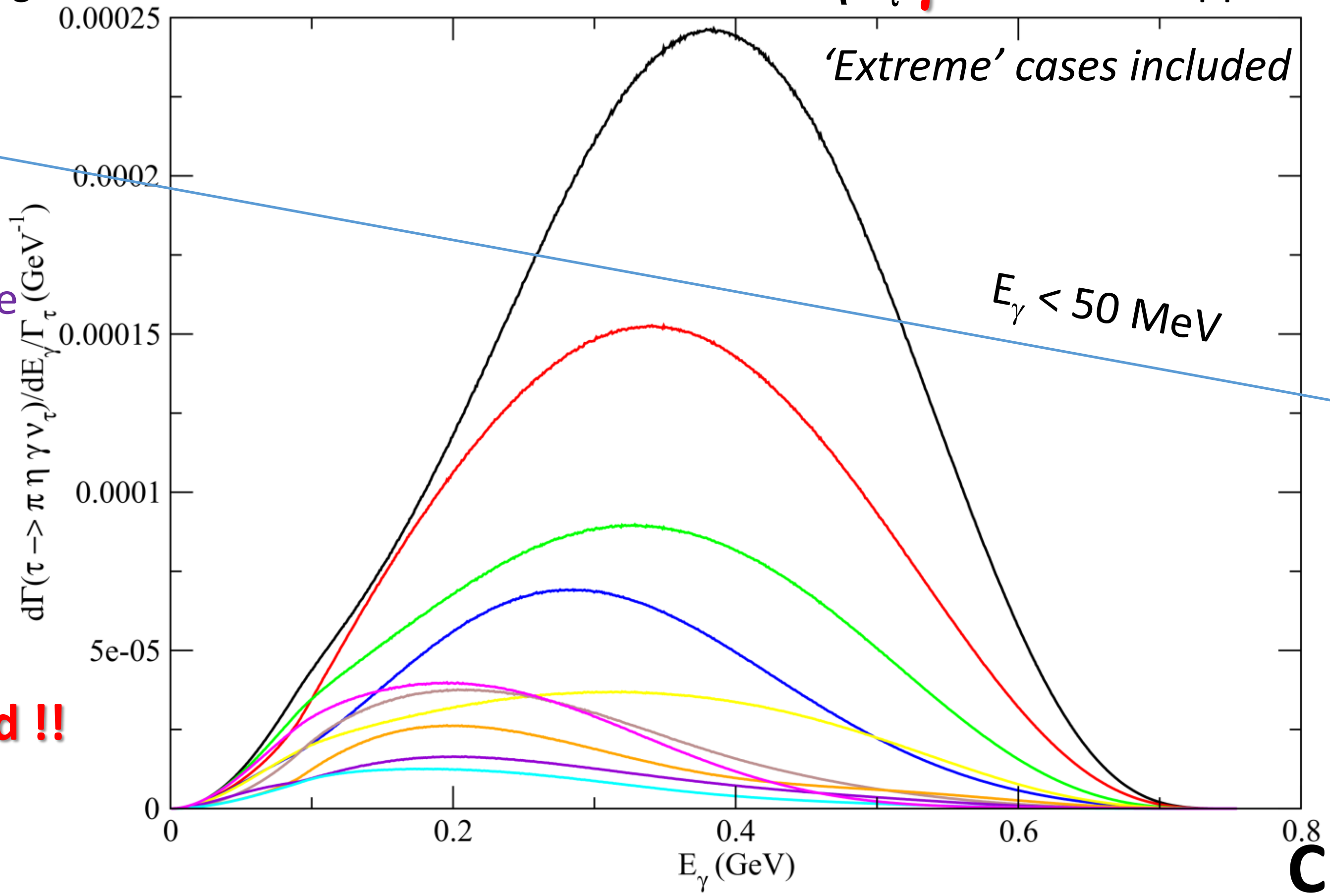
$BR^{R\chi L}_{\text{cuts on } E_\gamma} \sim 1 \cdot 10^{-7}$

'Unexpected' bkg killed !!



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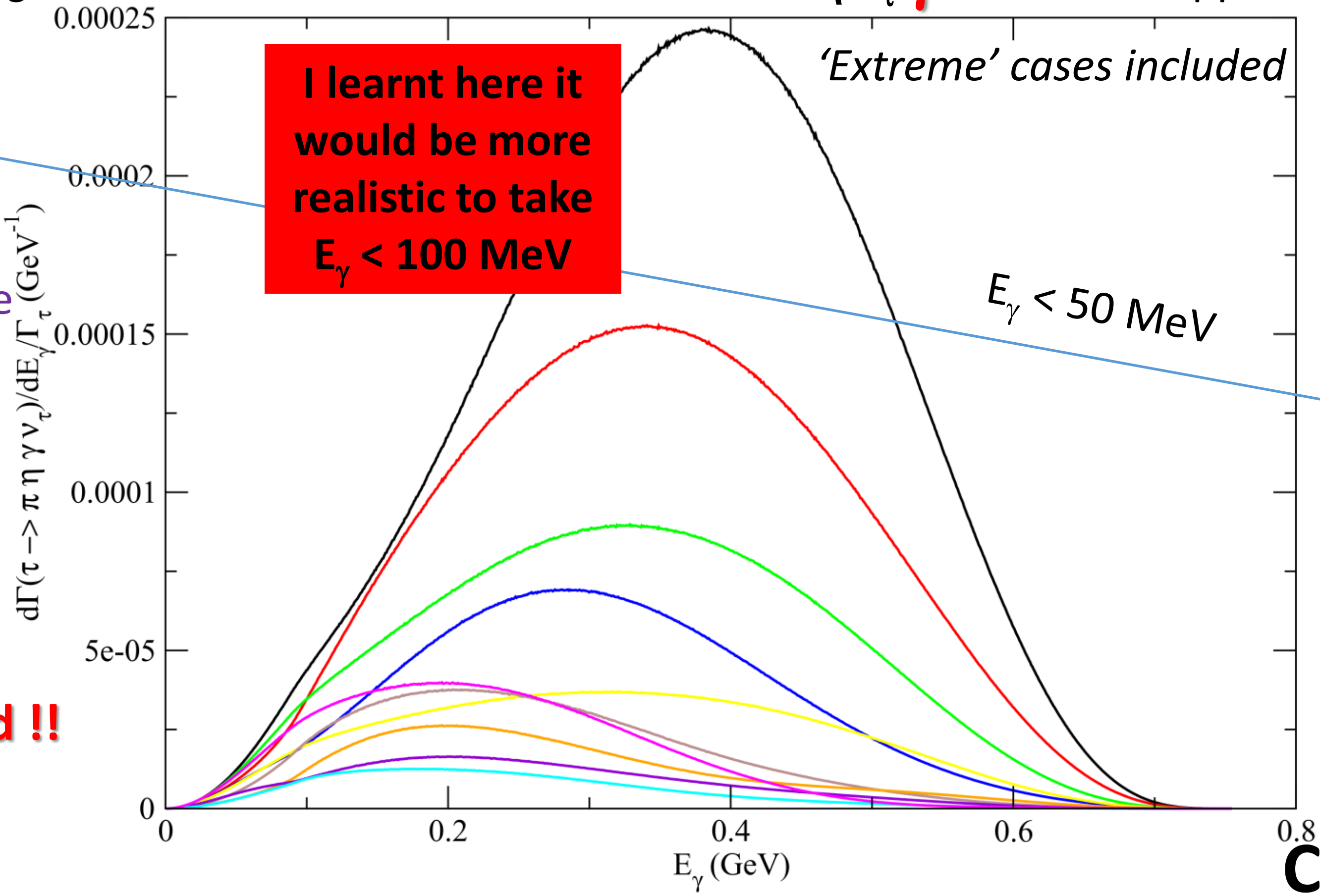

I learnt here it would be more realistic to take E_γ < 100 MeV

One can just cut γs above certain E (leaving windows for detecting π^0's & η's) !!

Pablo Roig

Cinvestav (Mexico City)

Towards the discovery of Second Class Currents in $\tau^- \to \pi^- \eta \nu_\tau$ decays @ Belle-II

*Note: With **SCC**s I mean either **genuine** SCCs (BSM) or SCCs **induced** by G-parity violation (SM)*

Pablo Roig

Cinvestav (Mexico City)

(introduced by **Simon**)

Other issues in hadronic τ decays

$\tau^- \rightarrow (\pi/K)^- \nu_\tau$ are trivial hadronically $\rightarrow$ **Lepton Universality tests**

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Pich, A. Prog.Part.Nucl.Phys. 75 (2014) 41-85

	$\Gamma_{\tau\to\mu}/\Gamma_{\tau\to e}$	$\Gamma_{\pi\to\mu}/\Gamma_{\pi\to e}$	$\Gamma_{K\to\mu}/\Gamma_{K\to e}$	$\Gamma_{K\to\pi\mu}/\Gamma_{K\to\pi e}$	$\Gamma_{W\to\mu}/\Gamma_{W\to e}$
$\lvert g_\mu/g_e\rvert$	1.0018 (14)	1.0021 (16)	0.9978 (20)	1.0010 (25)	0.996 (10)

	$\Gamma_{\tau\to e}/\Gamma_{\mu\to e}$	$\Gamma_{\tau\to\pi}/\Gamma_{\pi\to\mu}$	$\Gamma_{\tau\to K}/\Gamma_{K\to\mu}$	$\Gamma_{W\to\tau}/\Gamma_{W\to\mu}$
$\lvert g_\tau/g_\mu\rvert$	1.0011 (15)	0.9962 (27)	0.9858 (70)	1.034 (13)

	$\Gamma_{\tau\to\mu}/\Gamma_{\mu\to e}$	$\Gamma_{W\to\tau}/\Gamma_{W\to e}$
$\lvert g_\tau/g_e\rvert$	1.0030 (15)	1.031 (13)

(introduced by **Simon**)

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We should not forget the importance of testing the Lorentz structure of the charged current (Michel parameters)

See e. g. arXiv:1609.08280 [hep-ex] (Belle Coll.)

$\bar{\eta}=-2.0\pm1.5\pm0.8$ and $\xi\kappa=0.6\pm0.4\pm0.2$

(introduced by Simon)

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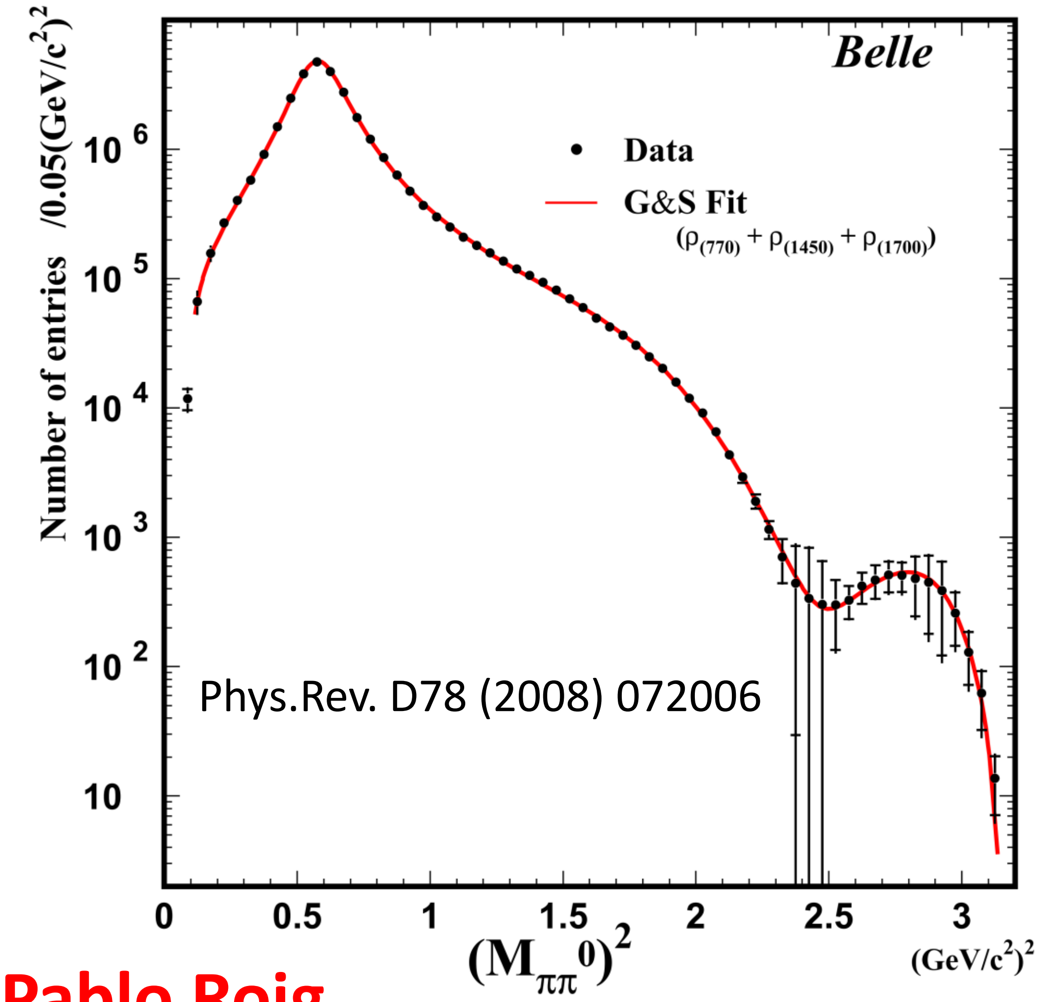
$\tau^- \rightarrow (\pi/K)^- \nu_\tau$ are trivial hadronically → **Lepton Universality tests**

$\tau^- \rightarrow \pi^- \pi^0 \nu_\tau (\gamma)$: ρ, ρ', ρ'' **pole** parameters



Theory tools (common to 2-meson decay channels):

Dispersion relations + Chiral Constraints

Gómez-Dumm & Roig, EPJC 73, no.8, 2528 (2013)

Celis, Cirigliano & Passemar PRD 89, no 1., 013008 (2014)

Pablo Roig

Cinvestav (Mexico City)

(introduced by **Simon**)

Other issues in hadronic τ decays

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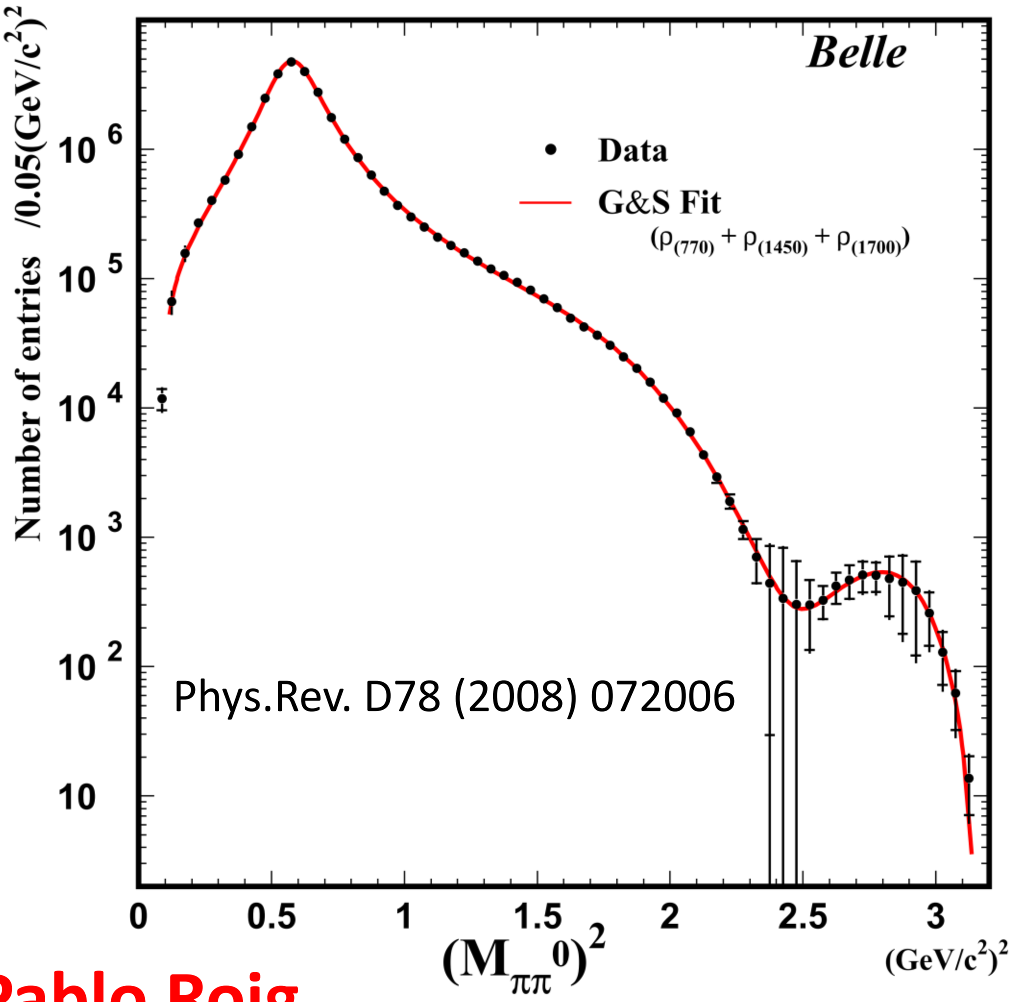
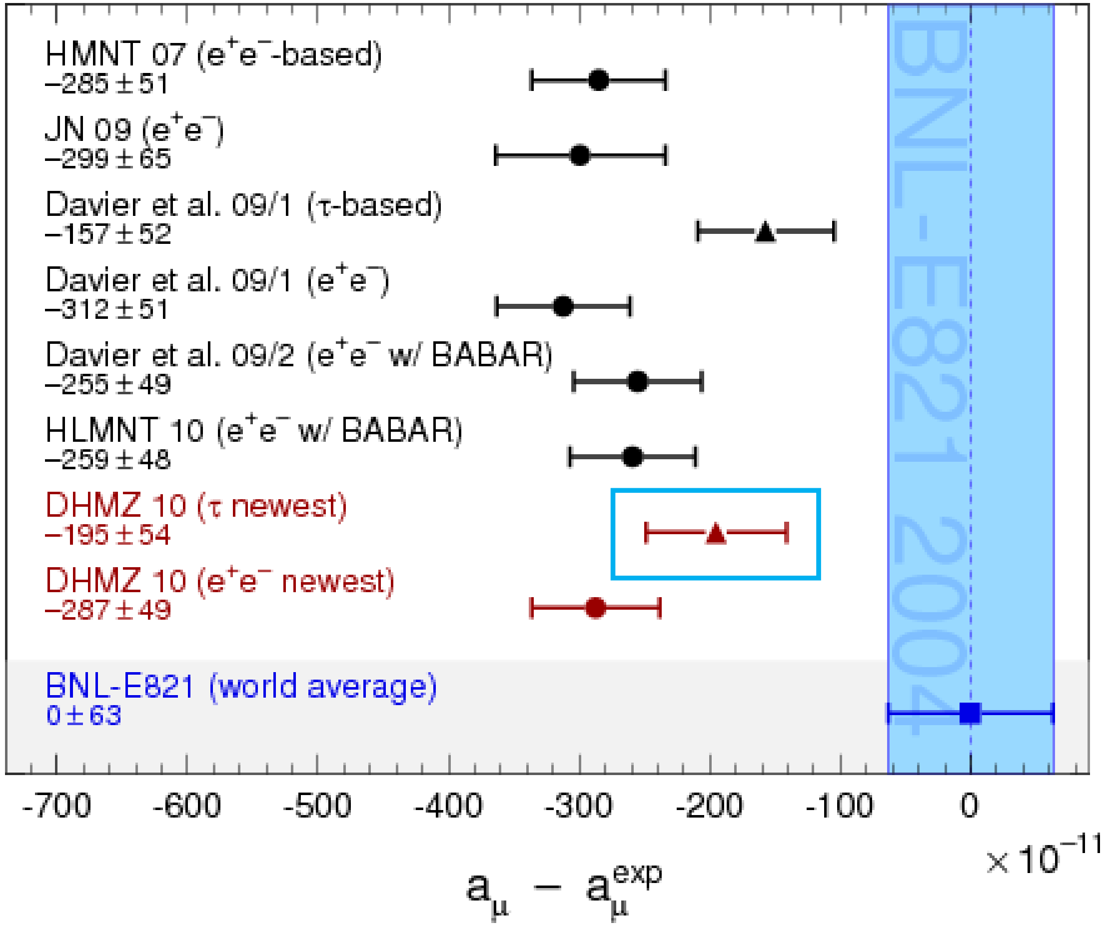
That's **'Golden'** mode!

$\tau^- \to \pi^- \pi^0 \nu_\tau (\gamma)$: ρ, ρ', ρ'' **pole** parameters & Check of $e^+ e^- \to \pi^+ \pi^- (\gamma)$ for $\mathbf{a_\mu^{HVP}}$



Phys.Rev. D78 (2008) 072006

Davier, Michel et al. Eur.Phys.J. C71 (2011) 1515, Erratum: Eur.Phys.J. C72



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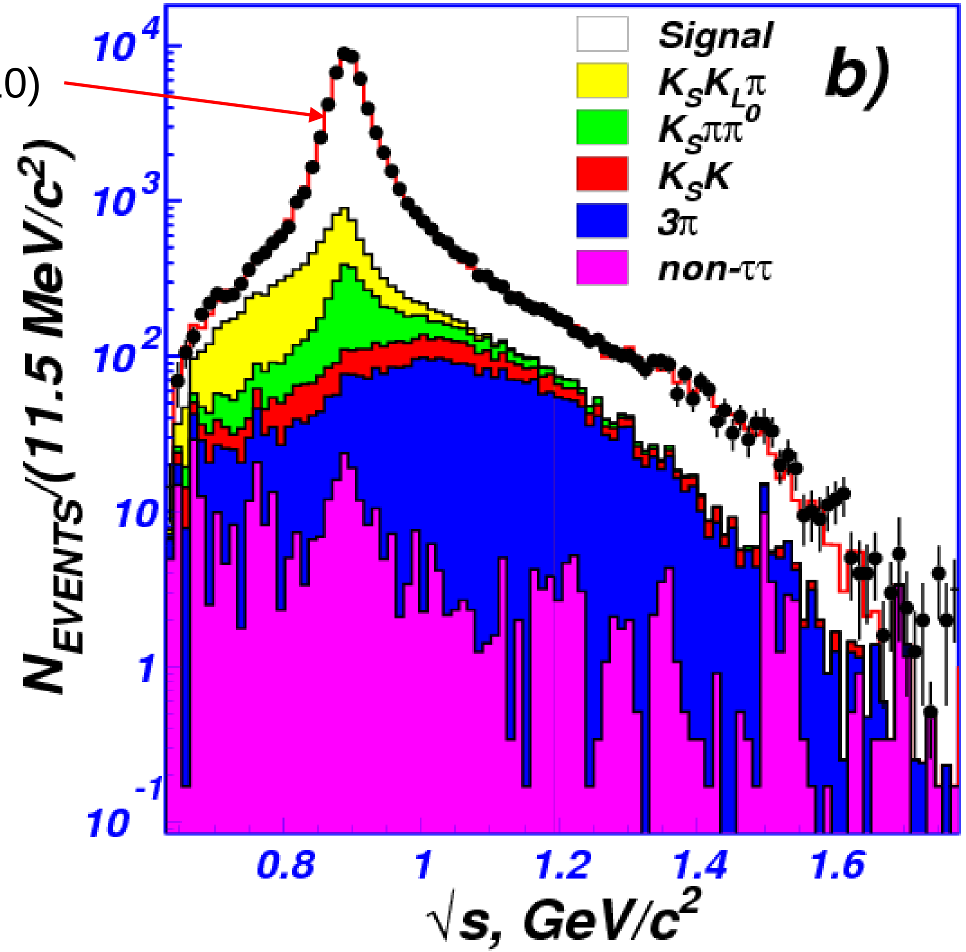
Belle Collaboration (Epifanov, D. et al.) Phys.Lett. B654 (2007) 65-73

$K^*(892)+K^*_0(800)+K^*(1410)$



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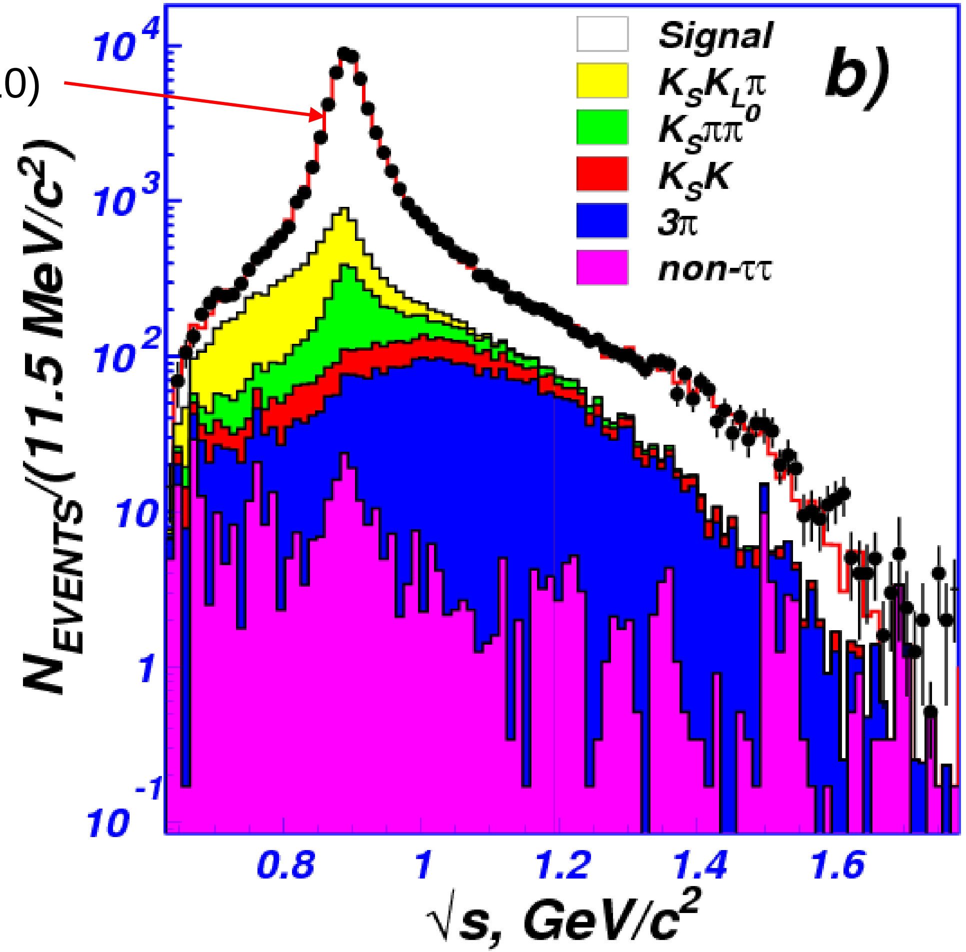

Theory tools (2-meson decay channels):
Dispersion relations + Chiral Constraints

Boito, Escribano & Jamin EPJC 59, 821 (2009); JHEP 1009, 031 (2010)

Pablo Roig **Cinvestav (Mexico City)**

(introduced by **Simon**)

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$\tau^- \to (K\pi)^- \nu_\tau$ dis

$K^*(892$

Data / Error	Current	Belle-I	Belle-I $K\pi$	Belle-I $K\eta$	Belle-II	Belle-II $K\pi$	Belle-II $K\eta$
$\bar{B}_{K\pi}(\%)$	0.404 ± 0.012	± 0.005	± 0.005	± 0.012	$^\dagger(0.001)$	$^\dagger(0.001)$	± 0.012
M_{K^*}	892.03 ± 0.19	± 0.09	± 0.09	± 0.19	$^\dagger(0.02)$	$^\dagger(0.02)$	± 0.19
Γ_{K^*}	46.18 ± 0.44	± 0.20	± 0.20	± 0.44	$^\dagger(0.02)$	$^\dagger(0.03)$	± 0.42
$M_{K^{*\prime}}$	1304 ± 17	$^\dagger(7)$	$^\dagger(9)$	$^\dagger(8)$	$^\dagger(1)$	$^\dagger(1)$	$^\dagger(1)$
$\Gamma_{K^{*\prime}}$	168 ± 62	$^\dagger(19)$	$^\dagger(24)$	$^\dagger(25)$	$^\dagger(3)$	$^\dagger(4)$	$^\dagger(11)$
$\lambda'_{K\pi} \times 10^3$	23.9 ± 0.9	$^\dagger(0.3)$	$^\dagger(0.3)$	± 0.8	$^\dagger(0.04)$	$^\dagger(0.04)$	± 0.8
$\lambda''_{K\pi} \times 10^4$	11.8 ± 0.2	± 0.07	± 0.07	± 0.2	$^\dagger(0.01)$	$^\dagger(0.01)$	± 0.2
$\bar{B}_{K\eta} \times 10^4$	1.58 ± 0.10	± 0.05	± 0.10	± 0.05	$^\dagger(0.01)$	± 0.10	$^\dagger(0.01)$
$\gamma_{K\eta}(=\gamma_{K\pi}) \times 10^2$	-3.3 ± 1.3	$^\dagger(0.3)$	$^\dagger(0.3)$	$^\dagger(0.4)$	$^\dagger(0.04)$	$^\dagger(0.04)$	$^\circ(0.3)$
$\lambda'_{K\eta} \times 10^3$	20.9 ± 2.7	$^\dagger(0.7)$	± 2.7	$^\dagger(0.8)$	$^\dagger(0.10)$	± 2.7	$^\circ(0.4)$
$\lambda''_{K\eta} \times 10^4$	11.1 ± 0.5	$^\dagger(0.2)$	± 0.5	$^\dagger(0.2)$	$^\dagger(0.02)$	± 0.5	$^\dagger(0.06)$

Table 4. The errors of our final results (3.3) are compared, in turn, to those achievable by analysing the complete Belle-I data sample, and updating only the $K_S\pi^-$ or $K^-\eta$ analyses. The last three columns show the potential of fitting all data collected by Belle-II and the same only for $K_S\pi^-$ or for $K^-\eta$ (assuming the other mode has not been updated to include the complete Belle-I data sample). Current Belle $K_S\pi^-$ ($K^-\eta$) data correspond to 351 (490) fb^{-1} for a complete data set of $\sim 1000\,\mathrm{fb}^{-1} = 1\ \mathrm{ab}^{-1}$. Expectations for Belle-II correspond to 50 ab^{-1}. All errors include both statistical and systematic uncertainties. † means that statistical errors (in brackets) will become negligible, while $^\circ$ signals a tension with the current reference best fit values. We thank Denis Epifanov for conversations on these figures and on expected performance of Belle-II at the detector and analysis levels. All errors have been symmetrised for simplicity.

Escribano, González-Solís, Jamin & Roig JHEP 09 (2014) 042

t. B654 (2007) 65-73

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$K^*(89$

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Theory assumptions need to be revised for Belle-II full data sample!!

(introduced by Simon)

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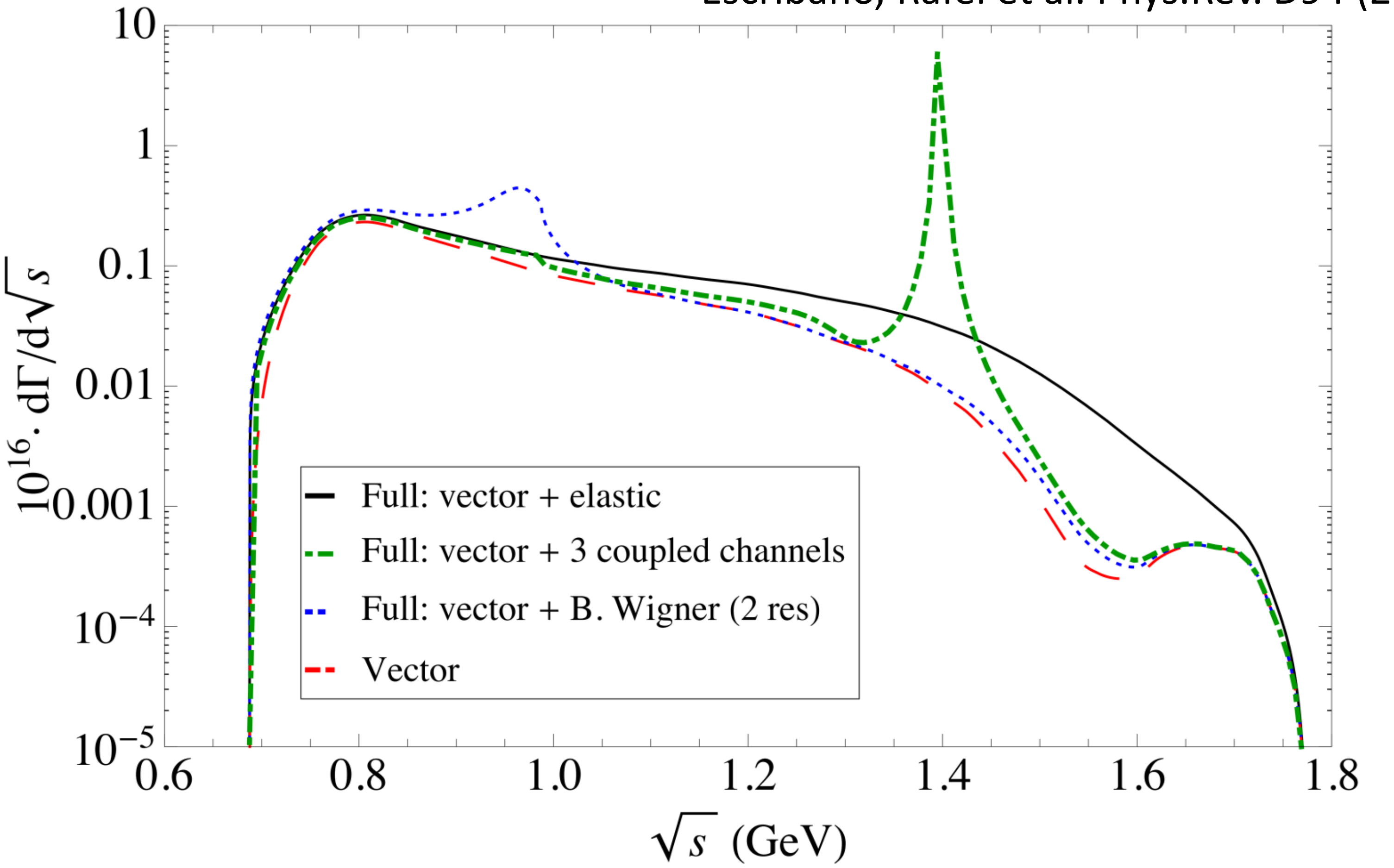
Escribano, Rafel et al. Phys.Rev. D94 (2016) no.3



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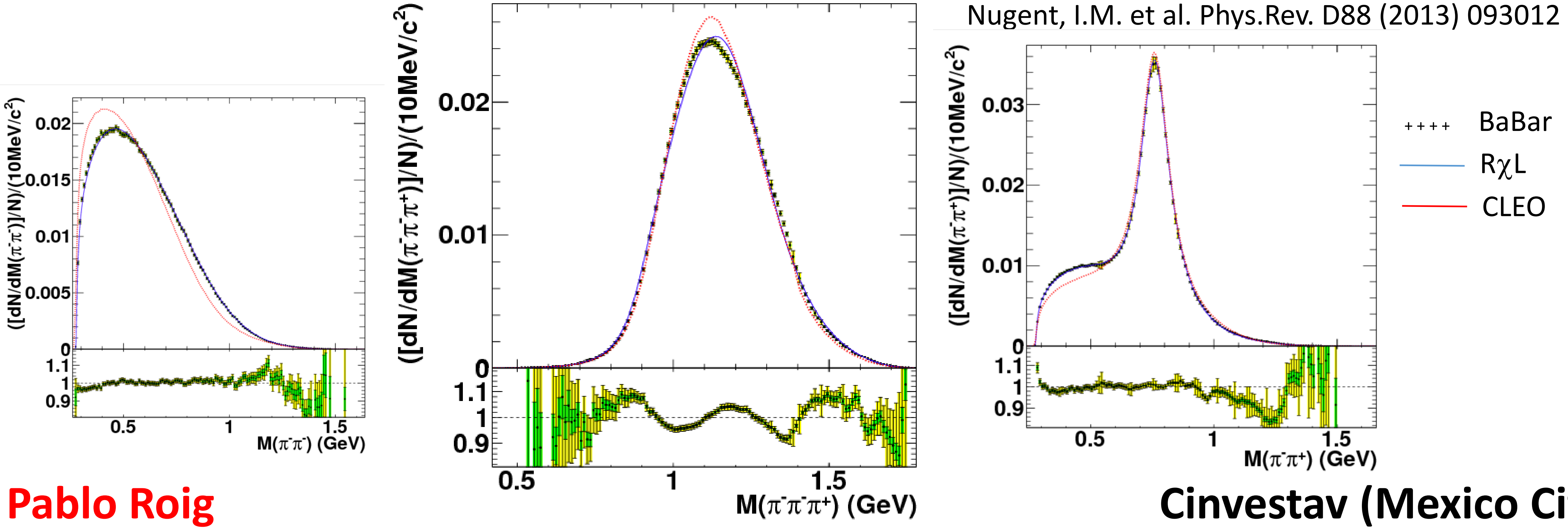
Nugent, I.M. et al. Phys.Rev. D88 (2013) 093012



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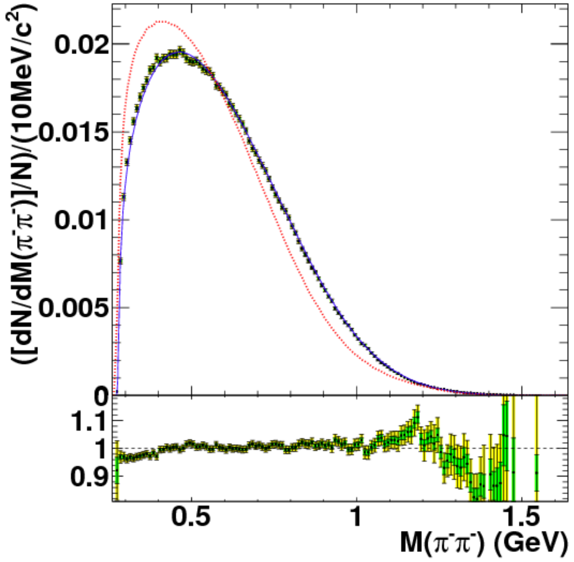

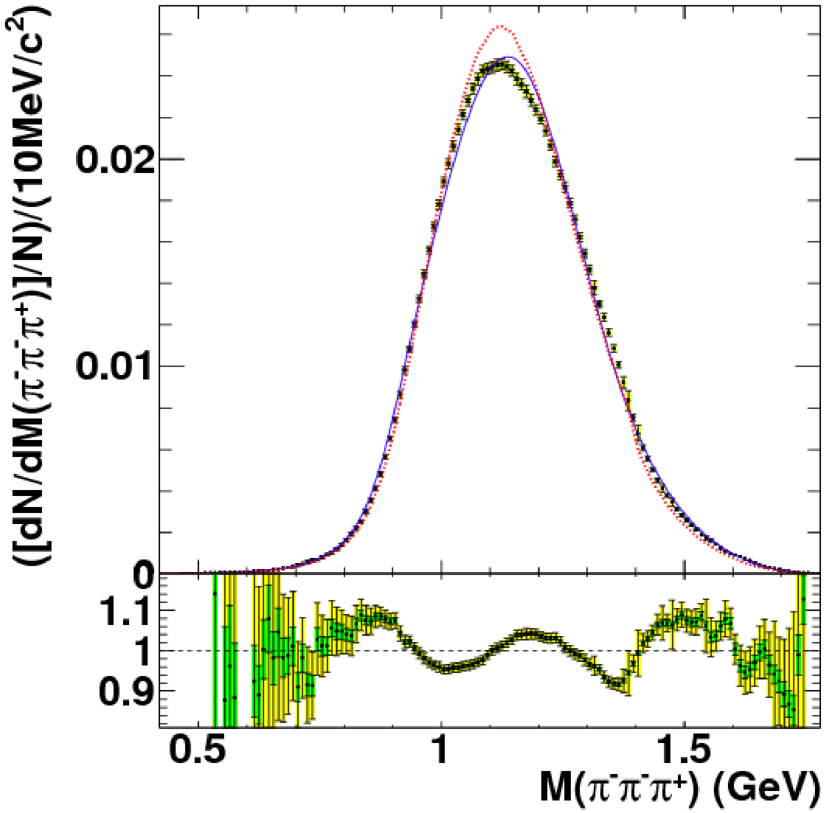

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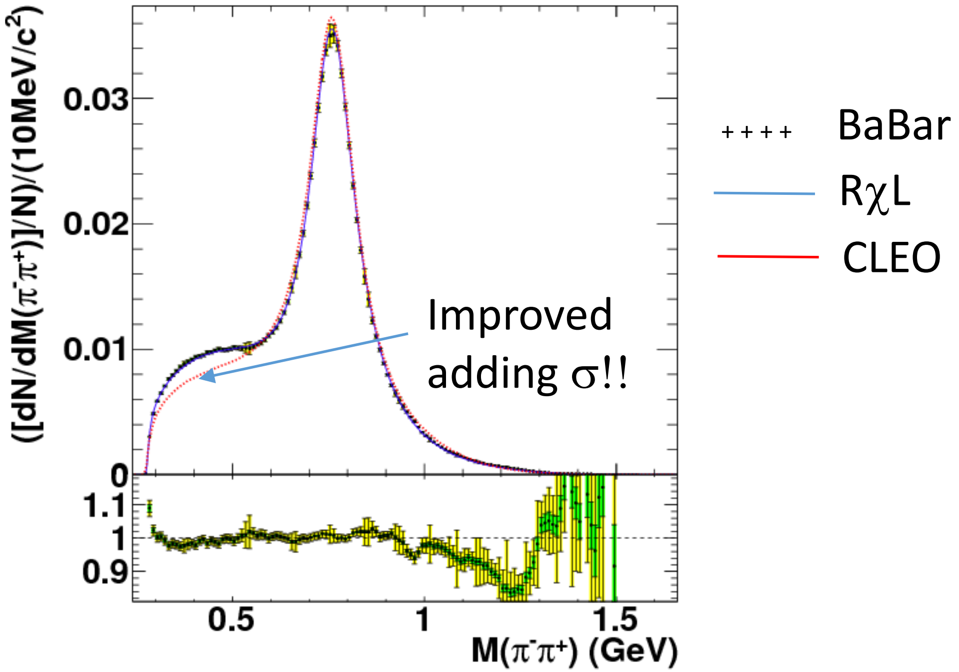

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τ spin correlations for H CP study (Z.Phys. C64 (1994) 21-30, …)

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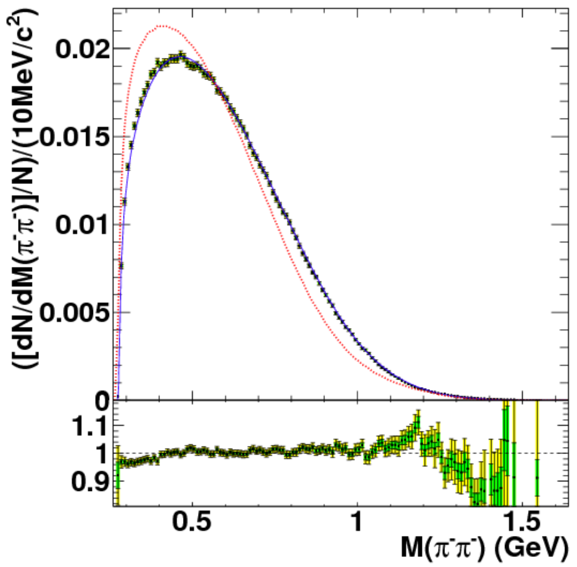

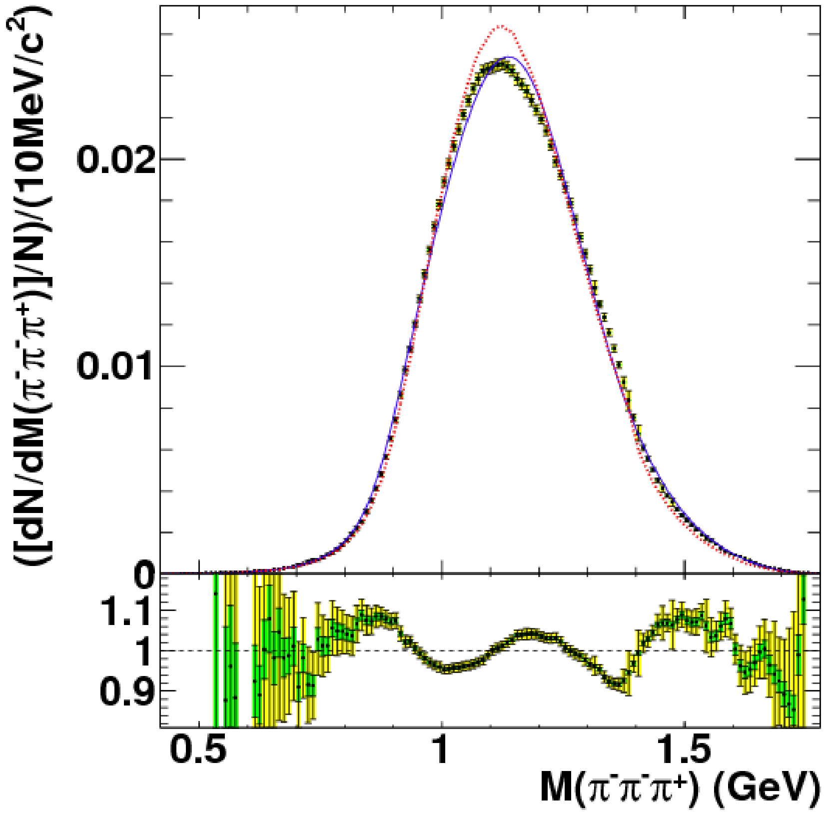

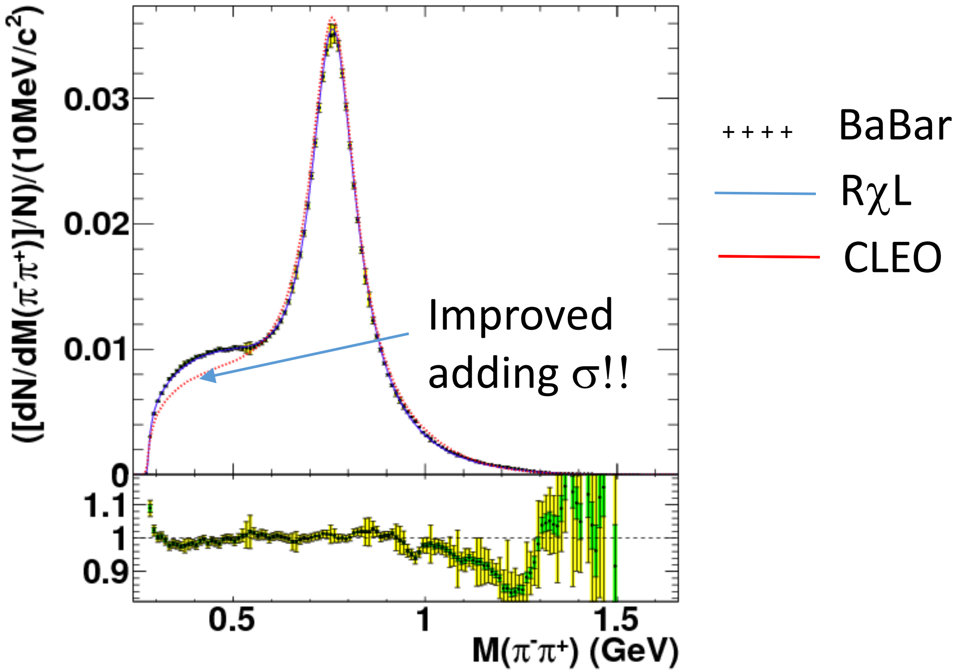

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(introduced by **Simon**)

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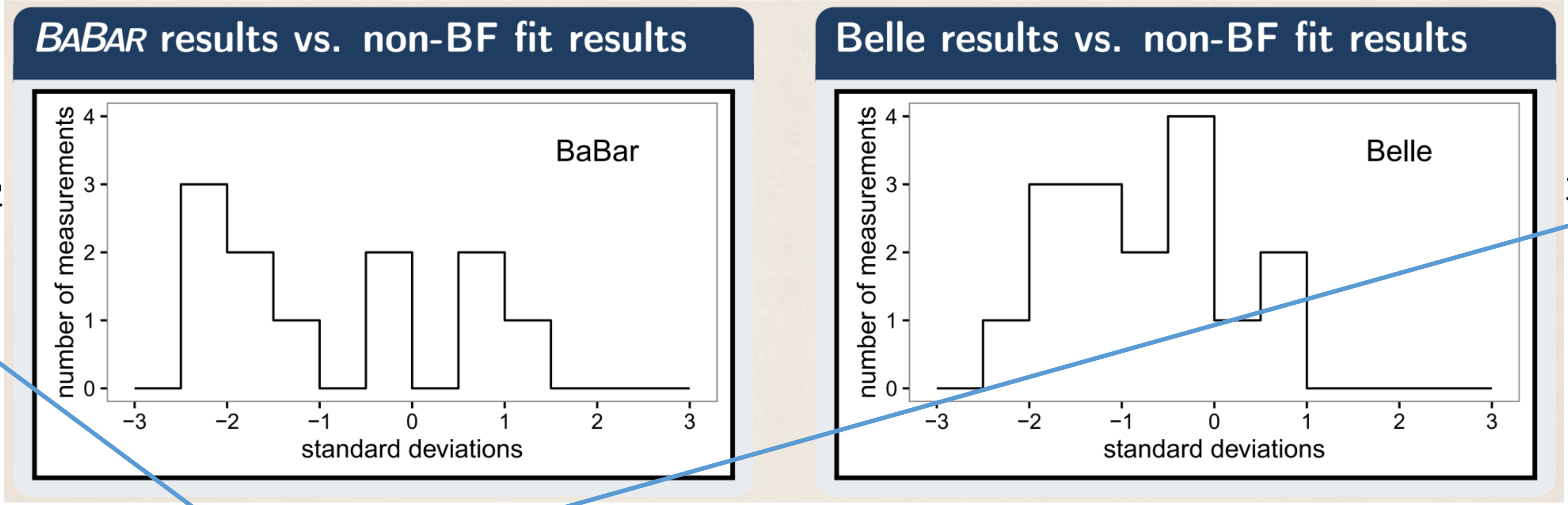
Improved **BR** measurements to test **Unitarity**

A. Lusiani, HFAG Status, TAU'16

1.58 ±0.13 ±0.12

Phys.Rev.Lett. 100 (2008) 011801



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Phys.Rev. D81 (2010) 113007

BABAR and Belle $\mathcal{B}(\tau \to K^- K^- K^+ \nu_\tau)$ results (times 10^{-5})

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$\tau^- \to (K\pi)^- \nu_\tau$ discussed by **Matthias**

$\tau^- \to (\eta\pi)^- \nu_\tau$ discussed previously (**SCC**)

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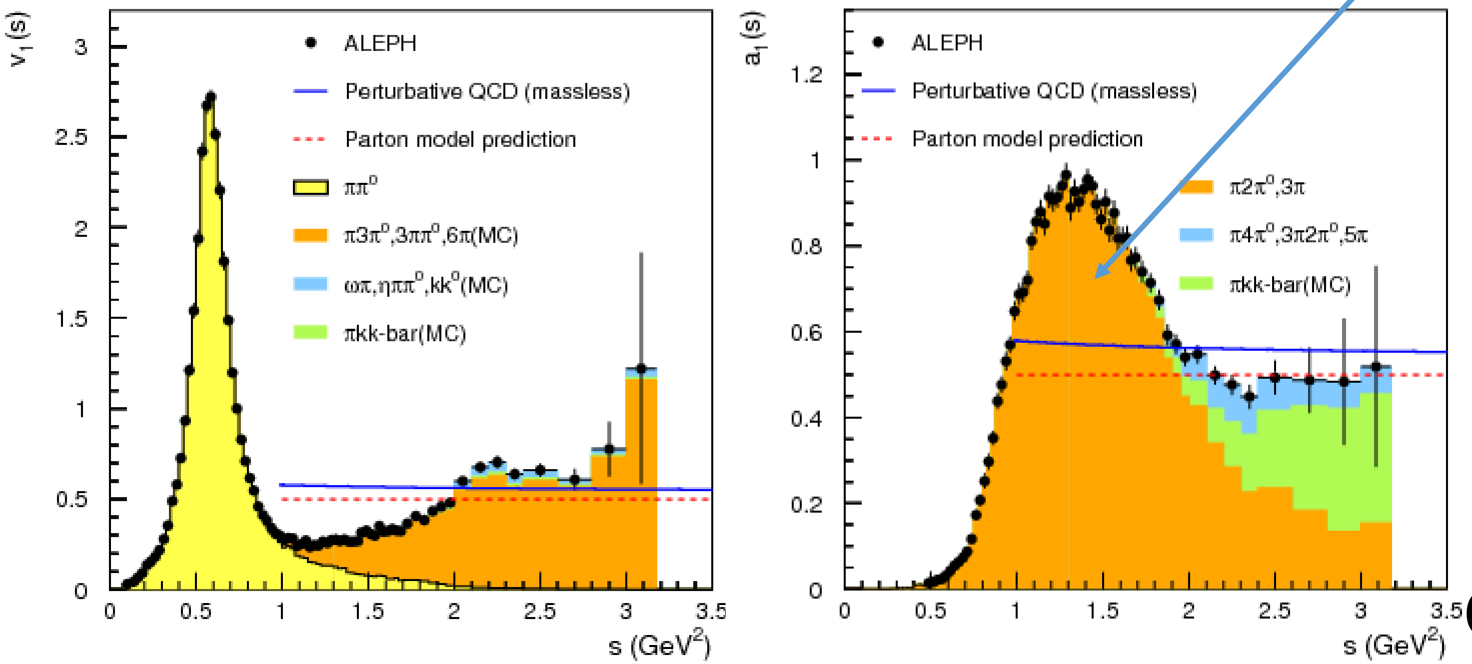
Improved **BR** measurements to test **Unitarity**

Better **non-strange spectral functions** (discussed by **Matthias**)

Davier, Michel et al. Eur.Phys.J. C74 (2014) no.3



DV's

$\alpha_S(M_Z^2)$

Pablo Roig **Cinvestav (Mexico City)**

(introduced by **Simon**)

Other issues in hadronic τ decays

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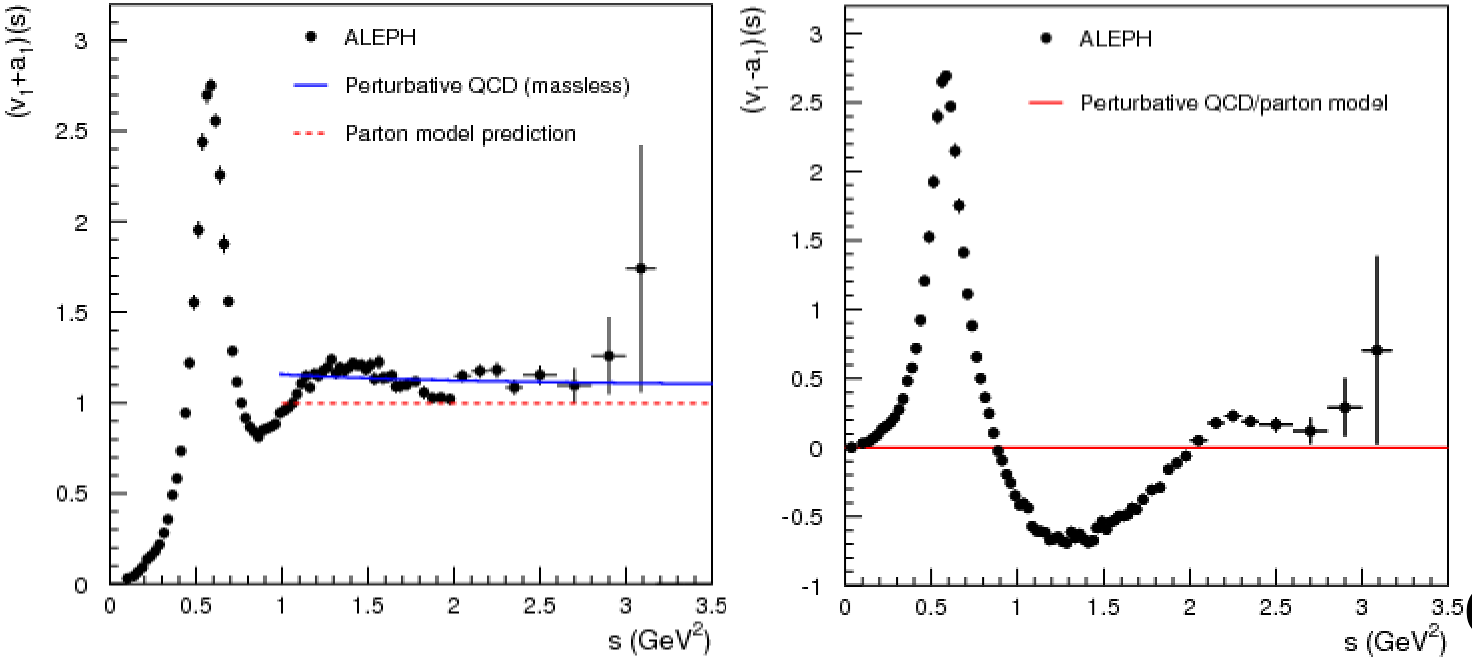

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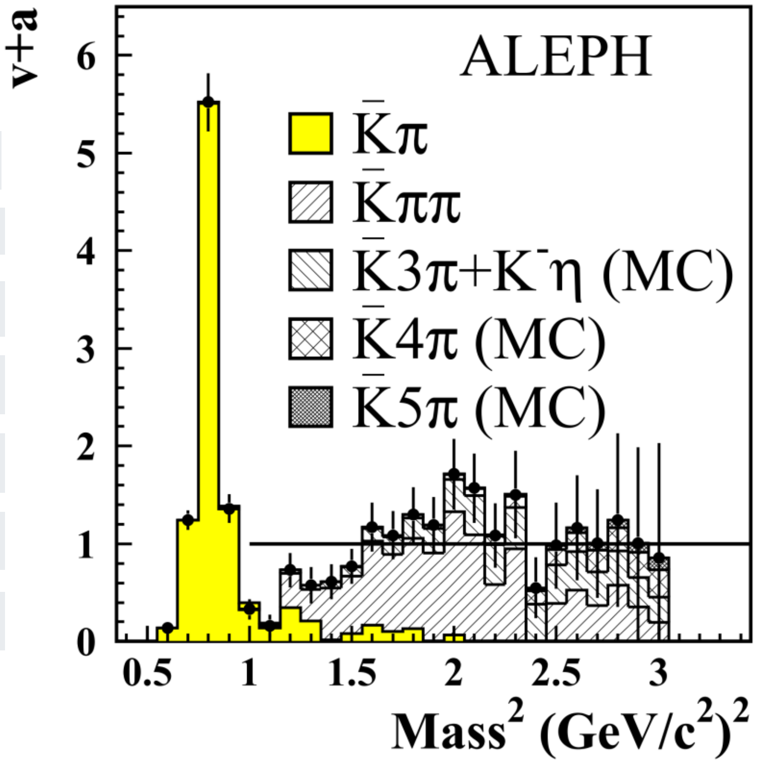
HFAG '16 errors on main strange BRs (%)

$\pi^- \bar{K}^0 \pi^0 \pi^0 \nu_\tau$ (ex. K^0)	0.0234 ± 0.0231
$K^- 2\pi^0 \nu_\tau$ (ex. K^0)	0.0640 ± 0.0220
$K^- 3\pi^0 \nu_\tau$ (ex. K^0, η)	0.0428 ± 0.0216
$K^- \pi^0 \nu_\tau$	0.4327 ± 0.0149
$K^- \pi^- \pi^+ \pi^0 \nu_\tau$ (ex. K^0, ω, η)	0.0410 ± 0.0143
$\pi^- \bar{K}^0 \nu_\tau$	0.8386 ± 0.0141
$\pi^- \bar{K}^0 \pi^0 \nu_\tau$	0.3812 ± 0.0129

Eur.Phys.J. C11 (1999) 599-618



Miss-ID between π's & K's

$m_s(m_s)$ & V_{us}

Pablo Roig **Cinvestav (Mexico City)**

(introduced by Simon)

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CPV studies in $\tau^- \to K^-\pi^-\pi^+ \nu_\tau$ & $\tau^- \to K^-K^+\pi^- \nu_\tau$ ($\tau^- \to (\pi\pi\pi\pi)^- \nu_\tau$) (Phys.Rev. D78 (2008) 113008, …)

→ ($\tau^- \to K_S \pi^- \nu_\tau$ is **'Golden'** mode, although the situation is clear *theoretically*: Bigi-Sanda '05,Grossman-Nir'12)

Pablo Roig **Cinvestav (Mexico City)**

(introduced by Simon)

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Hadronic LFV τ decays are also of prime interest (JHEP 0806 (2008) 079, Phys.Rev. D89 (2014) 013008, …)

Pablo Roig **Cinvestav (Mexico City)**

(introduced by Simon)

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TAUOLA for Belle-II

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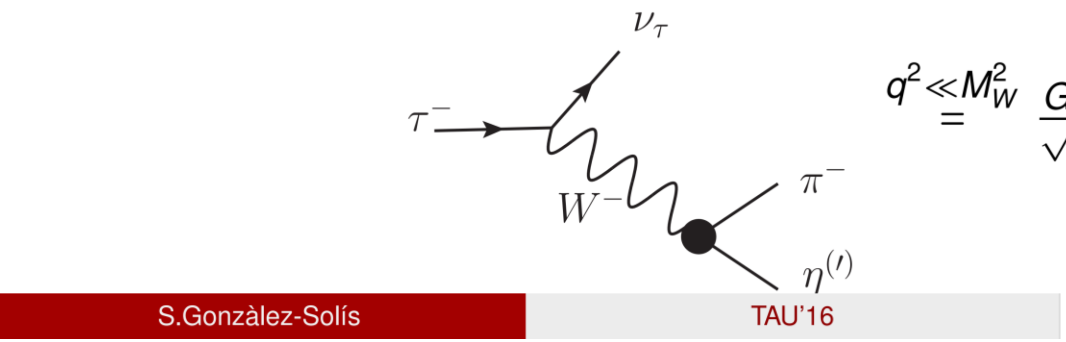
ADDITIONAL MATERIAL

Towards the discovery of Second Class Currents in $\tau^- \to \pi^- \eta \nu_\tau$ decays @ Belle-II



$$\stackrel{q^2 \ll M_W^2}{=} \frac{G_F}{\sqrt{2}} V_{ud} \bar{u}(p_{\nu_\tau}) \gamma^\mu (1-\gamma^5) u(p_\tau) \langle \pi^- \eta^{(\prime)} | \bar{d} \gamma^\mu (1 - \cancel{\gamma^5}) u | 0 \rangle$$

$0^-, 1^+ \nrightarrow 0^+, 1^-$

$\leftrightarrow \quad \Delta_{PQ} = M_P^2 - M_Q^2$

$$\langle \pi^- \eta^{(\prime)} | \bar{d} \gamma^\mu u | 0 \rangle = \left[(p_{\eta^{(\prime)}} - p_\pi)^\mu + \frac{\Delta_{\pi^-\eta^{(\prime)}}}{s} q^\mu \right] C^V_{\pi\eta^{(\prime)}} F_+^{\pi\eta^{(\prime)}}(s) + \frac{\Delta^{QCD}_{K^0K^+}}{s} q^\mu C^S_{\pi^-\eta^{(\prime)}} F_0^{\pi^-\eta^{(\prime)}}(s)$$

Matrix element & decay width

$$\frac{d\Gamma(\tau^- \to \pi^- \eta^{(\prime)} \nu_\tau)}{d\sqrt{s}} = \frac{G_F^2 M_\tau^3}{24\pi^3 s} S_{EW} |V_{ud}|^2 |F_+^{\pi^-\eta^{(\prime)}}(0)|^2 \left(1 - \frac{s}{M_\tau^2}\right)^2$$

$$\left\{ \left(1 + \frac{2s}{M_\tau^2}\right) q^3_{\pi^-\eta^{(\prime)}}(s) |\widetilde{F}_+^{\pi^-\eta^{(\prime)}}(s)|^2 + \frac{3\Delta^2_{\pi^-\eta^{(\prime)}}}{4s} q_{\pi^-\eta^{(\prime)}}(s) |\widetilde{F}_0^{\pi^-\eta^{(\prime)}}(s)|^2 \right\}$$

$$\widetilde{F}_{+,0}^{\pi^-\eta^{(\prime)}}(s) = \frac{F_{+,0}^{\pi^-\eta^{(\prime)}}(s)}{F_{+,0}^{\pi^-\eta^{(\prime)}}(0)}, \qquad F_+^{\pi^-\eta^{(\prime)}}(0) = -\frac{C^S_{\pi^-\eta^{(\prime)}}}{C^V_{\pi^-\eta^{(\prime)}}} \frac{\Delta^{QCD}_{K^0K^+}}{\Delta_{\pi^-\eta^{(\prime)}}} F_0^{\pi^-\eta^{(\prime)}}(0)$$

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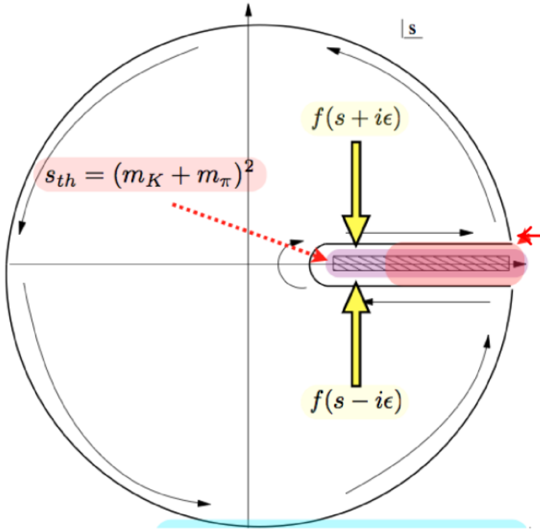
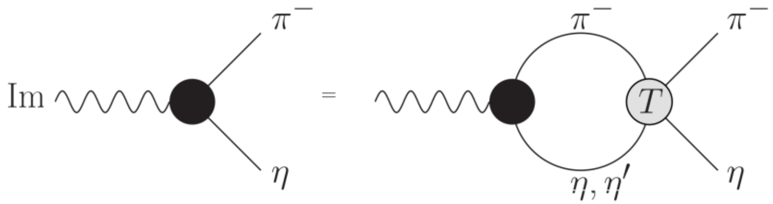
Towards the discovery of Second Class Currents in $\tau^- \to \pi^- \eta \nu_\tau$ decays @ Belle-II



$$F_0^i(s) = \frac{1}{\pi}\sum_{j=1}^{2}\int_{s_i}^{\infty} ds' \frac{\Sigma_j(s')F_0^j(s')T_0^{i\to j}(s')^\star}{(s'-s-i\varepsilon)}$$

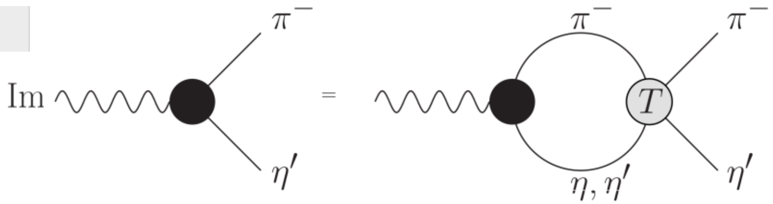
Other cuts $(K\bar{K}, \pi\eta'...)$

Coupled channels for the SFF



$$F_0^{\pi\eta}(s) = \frac{1}{\pi}\int_{s_{th1}}^{\infty} ds' \frac{\sigma_{\pi\eta}(s')F_0^{\pi\eta}(s')T^*_{\pi\eta\to\pi\eta}(s')}{s'-s-i\varepsilon} + \frac{1}{\pi}\int_{s_{th2}}^{\infty} ds' \frac{\sigma_{\pi\eta'}(s')F_0^{\pi\eta'}(s')T^*_{\pi\eta'\to\pi\eta}(s')}{s'-s-i\varepsilon}$$

S.Gonzàlez-Solís TAU'16



Input from Guo, Oller & Ruiz de Elvira Phys. Rev. D 86, 054006 (2012)

$$F_0^{\pi\eta'}(s) = \frac{1}{\pi}\int_{s_{th1}}^{\infty} ds' \frac{\sigma_{\pi\eta}(s')F_0^{\pi\eta}(s')T^*_{\pi\eta\to\pi\eta'}(s')}{s'-s-i\varepsilon} + \frac{1}{\pi}\int_{s_{th2}}^{\infty} ds' \frac{\sigma_{\pi\eta'}(s')F_0^{\pi\eta'}(s')T^*_{\pi\eta'\to\pi\eta'}(s')}{s'-s-i\varepsilon}$$

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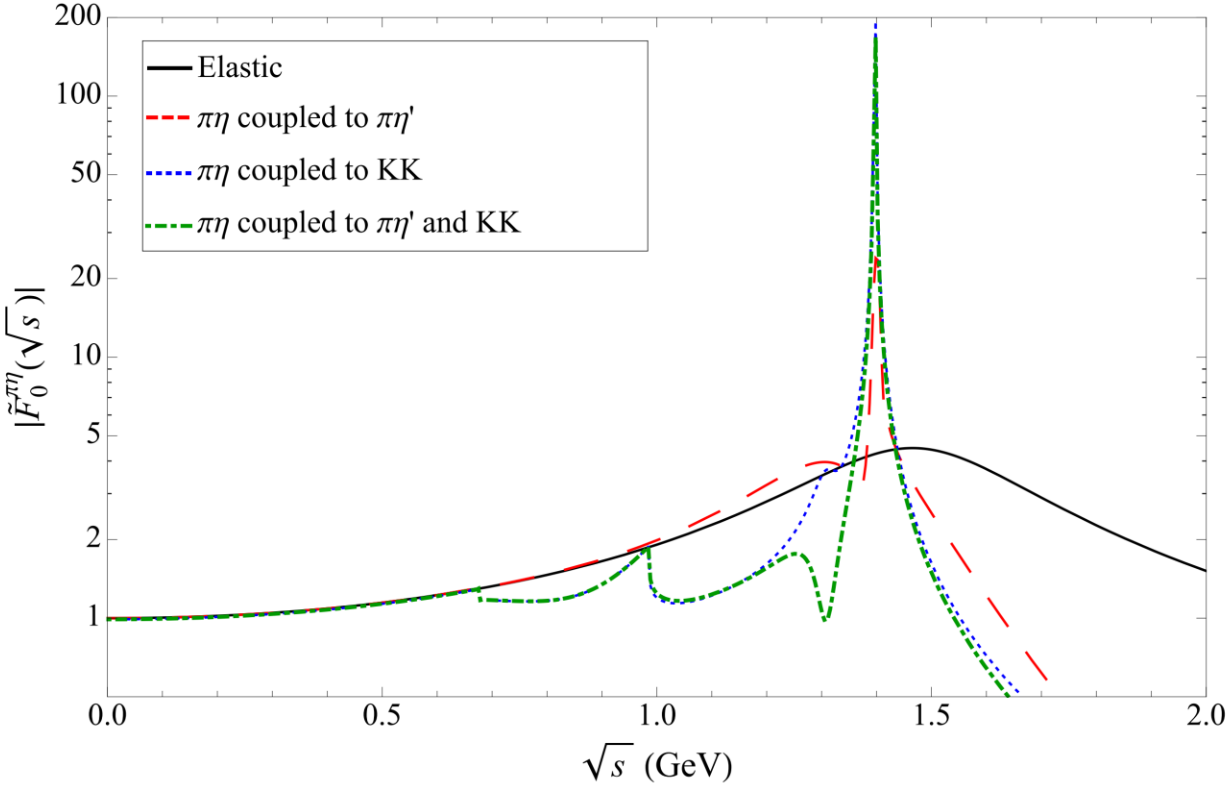
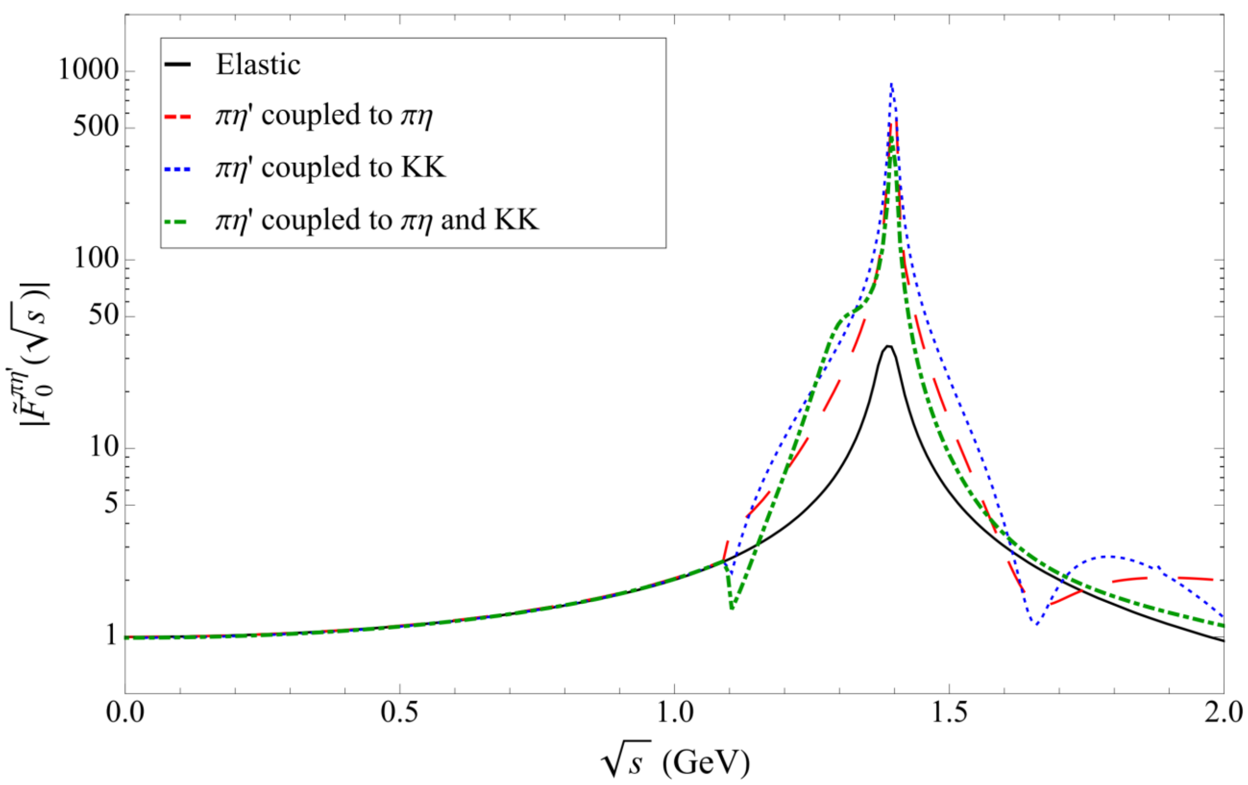
Towards the discovery of Second Class Currents in $\tau^- \to \pi^- \eta \nu_\tau$ decays @ Belle-II

Main physical effect: Coupling of $\pi\eta$ & KK channels on $\pi\eta$ SFF !!





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- π^0-η-η' mixing (P. Kroll, Mod. Phys. Lett. A20, 2667 (2005))

$$\begin{pmatrix} \pi^0 \\ \eta \\ \eta' \end{pmatrix} = \begin{pmatrix} 1 & \varepsilon_{\pi\eta} c\theta_{\eta\eta'} + \varepsilon_{\pi\eta'} s\theta_{\eta\eta'} & \varepsilon_{\pi\eta'} c\theta_{\eta\eta'} - \varepsilon_{\pi\eta} s\theta_{\eta\eta'} \\ -\varepsilon_{\pi\eta} & c\theta_{\eta\eta'} & -s\theta_{\eta\eta'} \\ -\varepsilon_{\pi\eta'} & s\theta_{\eta\eta'} & c\theta_{\eta\eta'} \end{pmatrix} \cdot \begin{pmatrix} \pi_3 \\ \eta_8 \\ \eta_0 \end{pmatrix}$$

where $\varepsilon_{\pi\eta^{(\prime)}}$ and $\theta_{\eta\eta'}$ are the π^0-$\eta^{(\prime)}$ and η-η' mixing angles

- $\pi - \eta - \eta'$ mixing: Next-to-leading order prediction in Res. ChPT

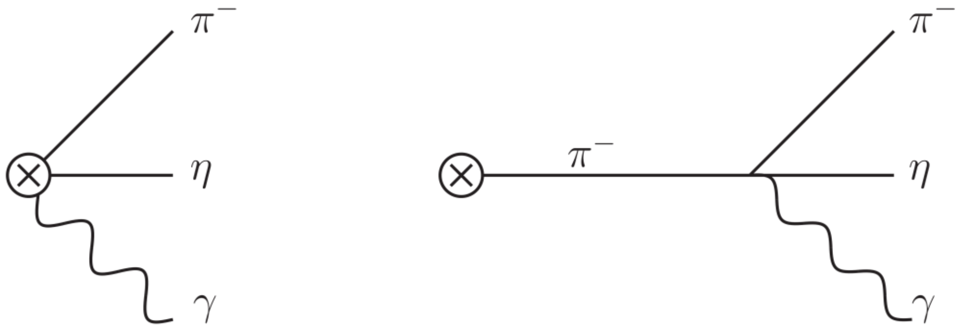
$$F_+^{\pi^-\eta^{(\prime)}}(0) = -\frac{C^S_{\pi^-\eta^{(\prime)}}}{C^V_{\pi^-\eta^{(\prime)}}} \frac{\Delta^{QCD}_{K^0K^+}}{\Delta_{\pi^-\eta^{(\prime)}}} F_0^{\pi^-\eta^{(\prime)}}(0)$$

$$\left. \begin{aligned} F_+^{\pi^-\eta^{(\prime)}}(0) &= \varepsilon_{\pi\eta^{(\prime)}} \\ F_0^{\pi^-\eta^{(\prime)}}(0) &= c_0^{\pi^-\eta^{(\prime)}} \frac{M_S^2+\Delta_{\pi^-\eta^{(\prime)}}}{M_S^2} \end{aligned} \right\} \quad \begin{aligned} \varepsilon_{\pi\eta} &= 9.8(3)\cdot 10^{-3} \\ \varepsilon_{\pi\eta'} &= 2.5(1.5)\cdot 10^{-4} \end{aligned}$$

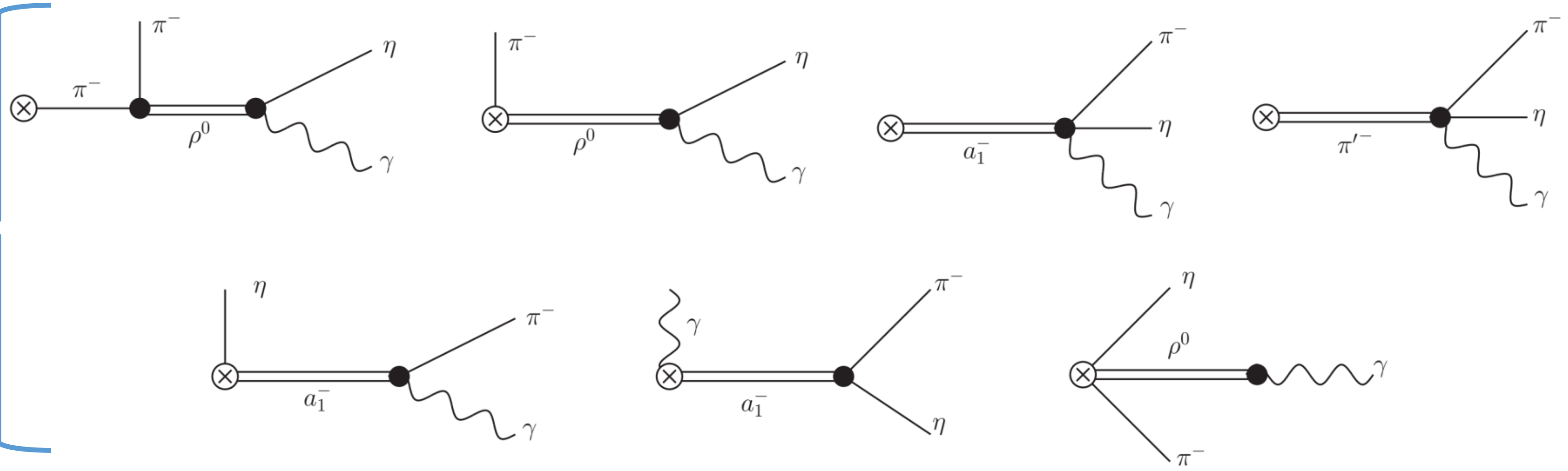
Towards the discovery of Second Class Currents in $\tau^- \to \pi^- \eta \nu_\tau$ decays @ Belle-II

Main diagrams suppressed by α but not by **G**-parity violation (*Axial-vector FFs*):

Wess-Zumino-Witten



1R contibutions



2R contibutions

...

Pablo Roig

BR($\tau^- \to \pi^- \eta \nu_\tau$)~$10^{-5}$

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Towards the discovery of Second Class Currents in $\tau^- \rightarrow \pi^- \eta \nu_\tau$ decays @ Belle-II

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Wess-Zumino-Witten { …

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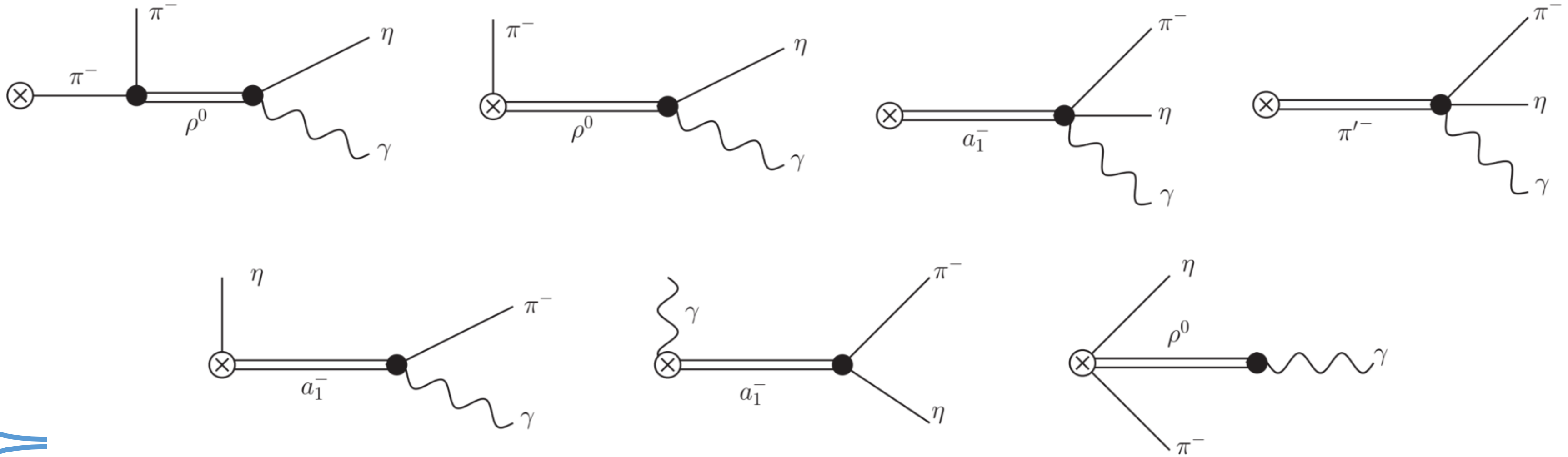
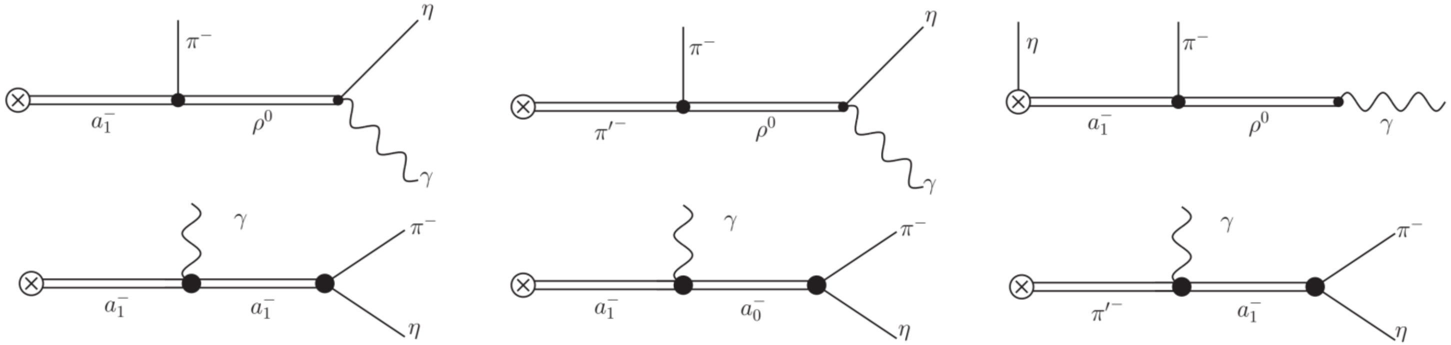


2R contibutions



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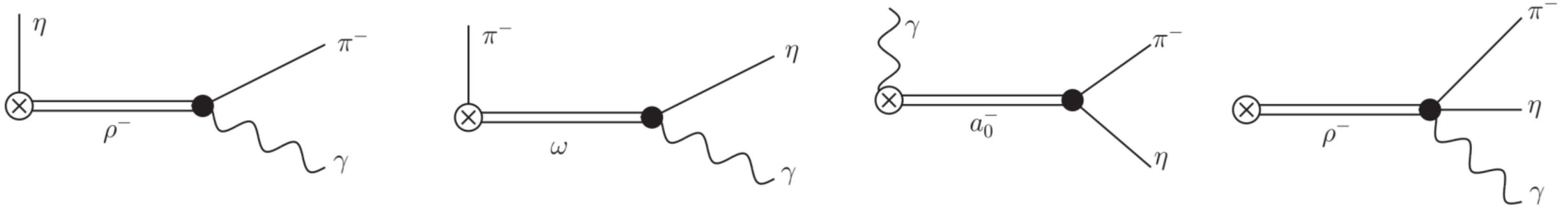
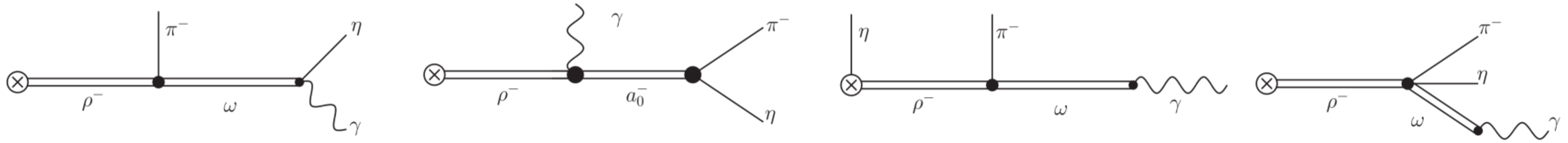
Towards the discovery of Second Class Currents in $\tau^- \to \pi^- \eta \nu_\tau$ decays @ Belle-II

Main diagrams suppressed by α but not by **G**-parity violation (*Vector FFs*):

1R contibutions



2R contibutions



Pablo Roig

$BR(\tau^- \to \pi^- \eta \nu_\tau) \sim 10^{-5}$

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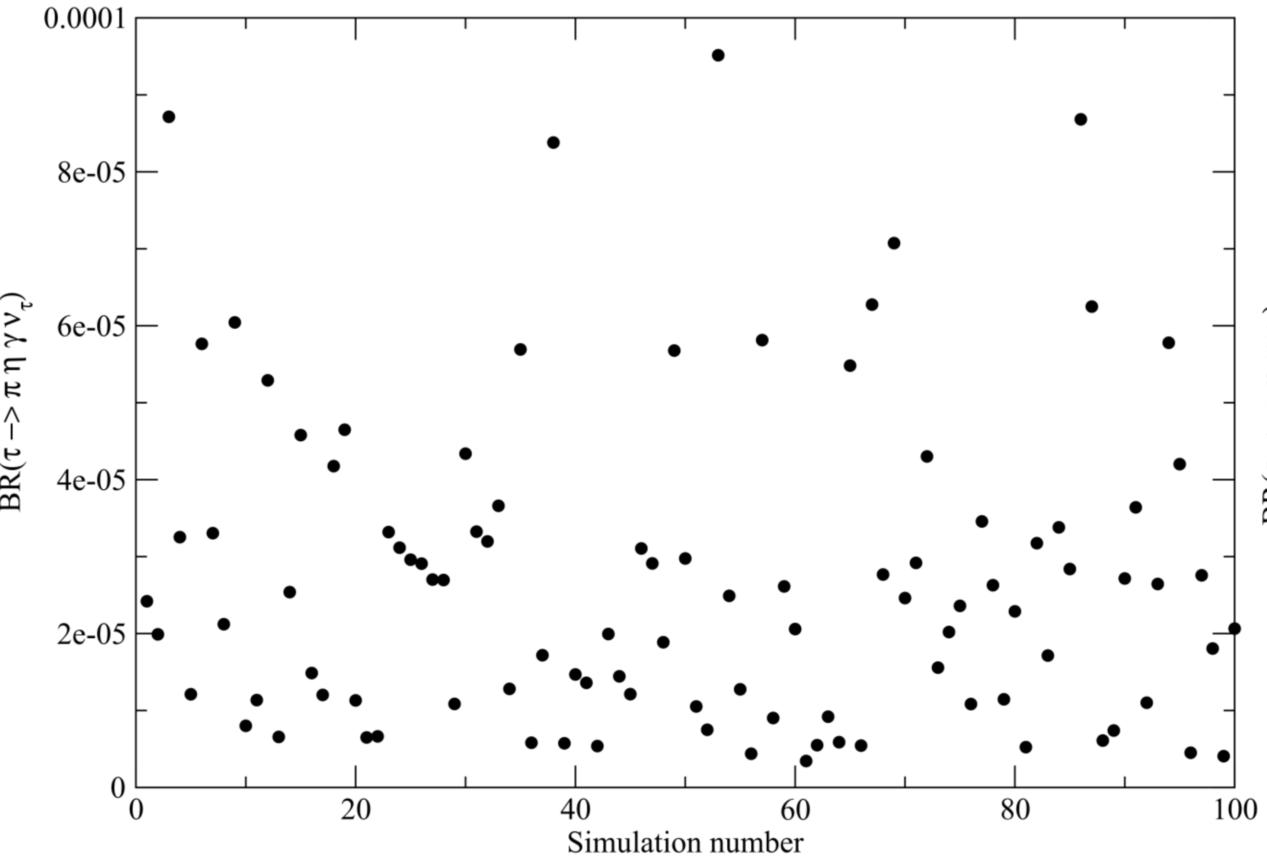
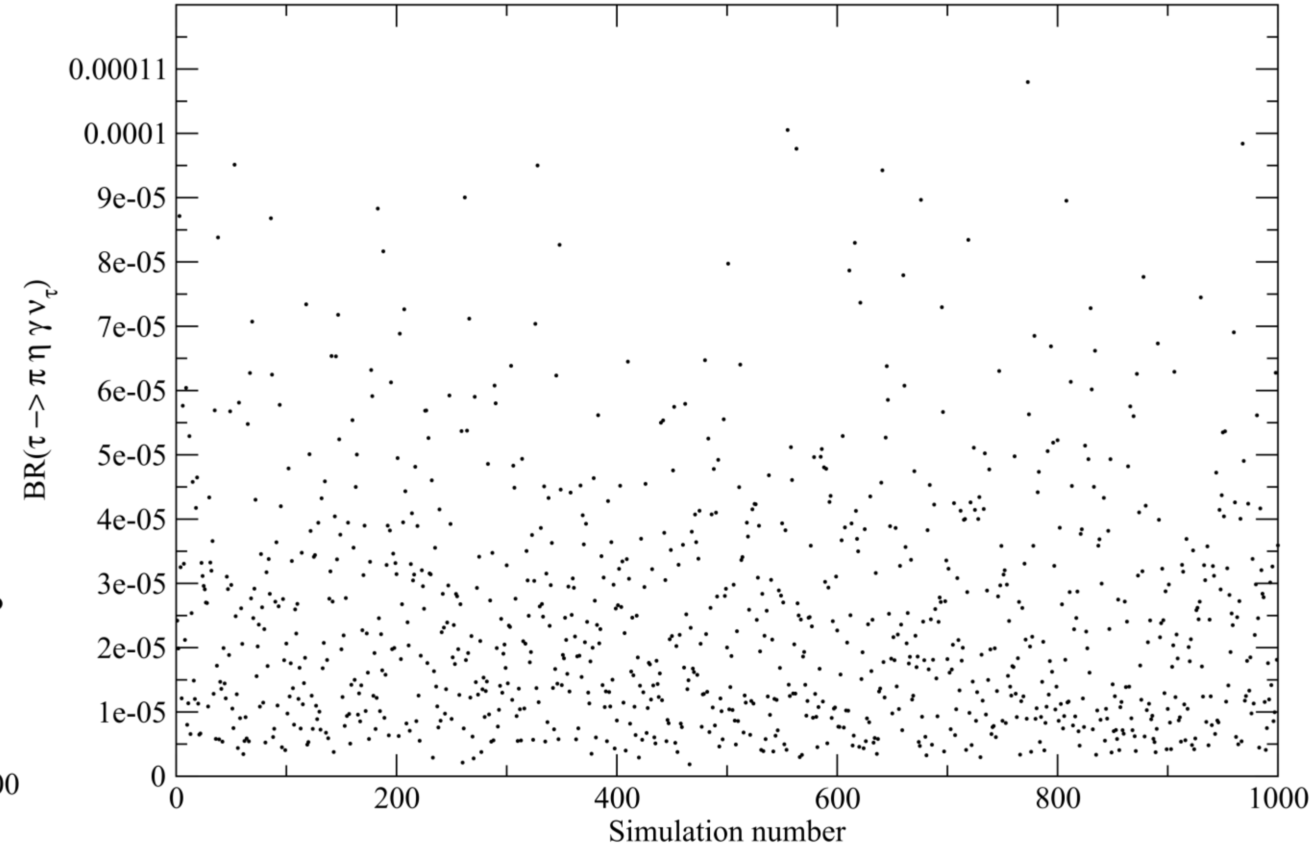
Towards the discovery of Second Class Currents in $\tau^- \to \pi^- \eta \nu_\tau$ decays @ Belle-II

No cuts on E_γ





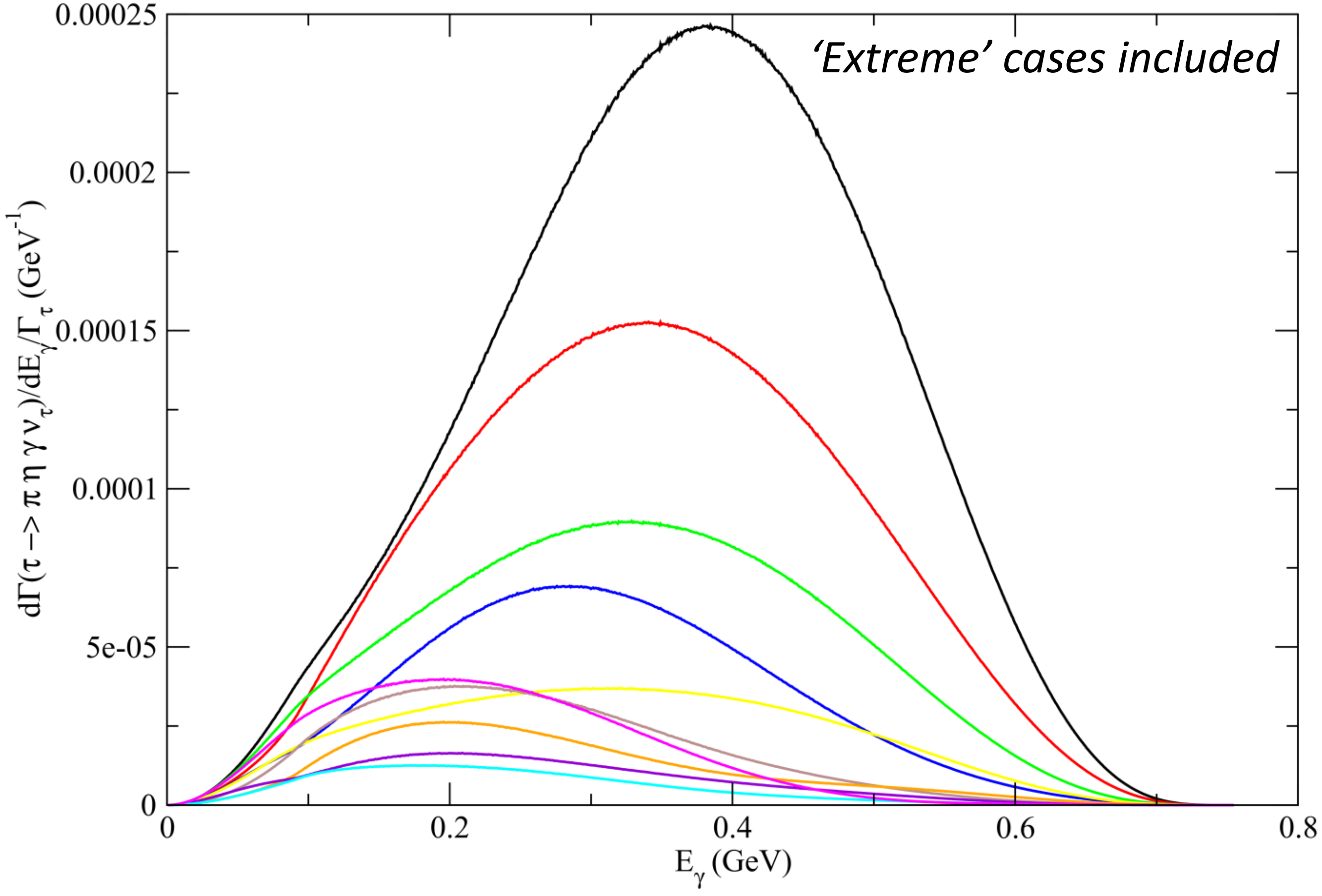
$BR(\tau^- \to \pi^- \eta \nu_\tau) \sim 10^{-5}$

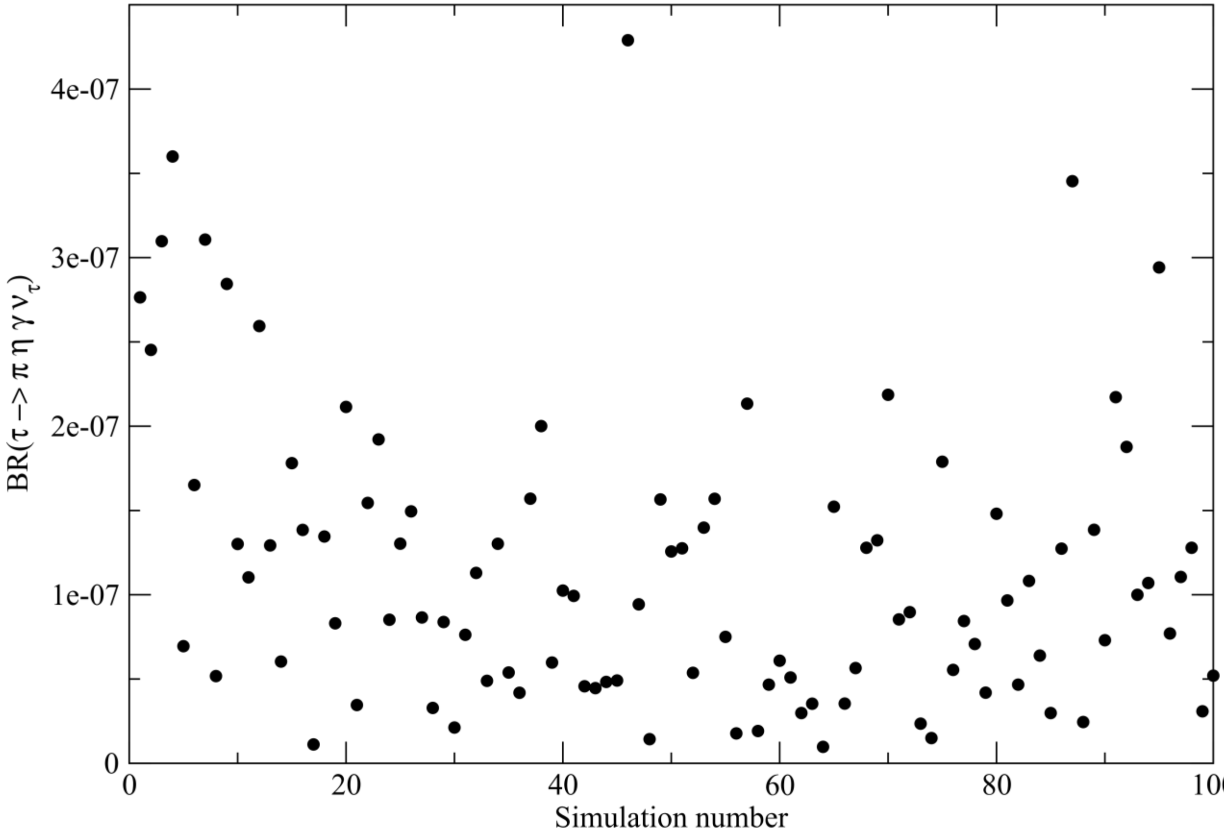
Towards the discovery of Second Class Currents in $\tau^- \to \pi^- \eta \nu_\tau$ decays @ Belle-II

Cutting out E_γ>50 MeV

I learnt here it would be more realistic to take E_γ < 100 MeV

(But it will still work)





$BR(\tau^- \to \pi^- \eta \nu_\tau)$~$10^{-5}$

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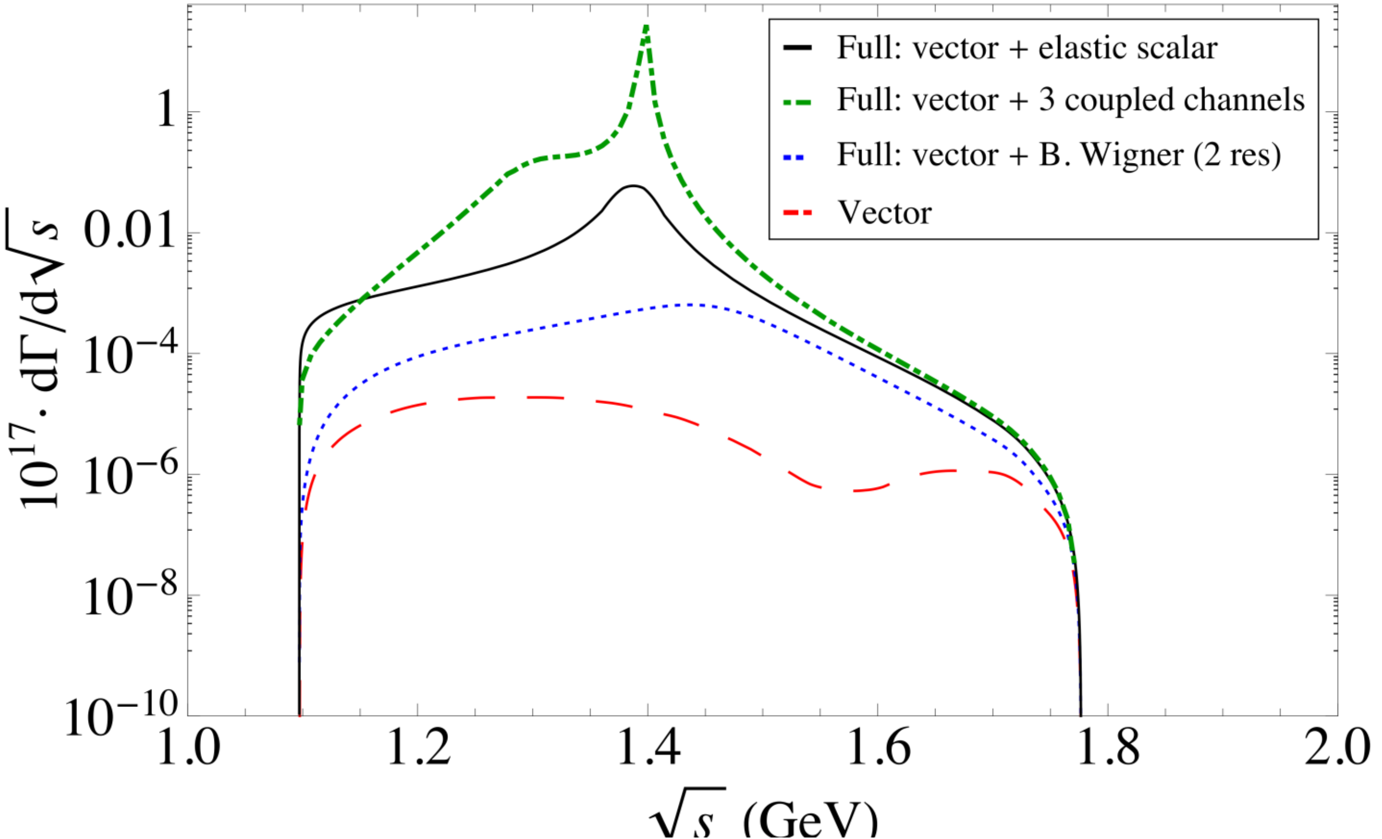
Towards the discovery of Second Class Currents in $\tau^- \to \pi^- \eta' \nu_\tau$ decays @ Belle-II

Escribano, González-Solís & Roig Phys.Rev. D94 (2016) no.3, 034008

BR_V	BR_S	BR	Our analysis
$[0.3, 5.7] \times 10^{-10}$	$[1 \times 10^{-7}, 1 \times 10^{-6}]$	$[1 \times 10^{-7}, 1 \times 10^{-6}]$	3 coupled channels

Errors dominated by $\varepsilon_{\pi\eta'}$

At least one order of magnitude suppressed with respect to $\tau \to \pi \eta \nu_\tau$!!



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Cinvestav (Mexico City)

WG8: Tau and low multiplicity

Presented by E. Kou
24/10/16 @ MIAPP
Flavor Programme

Section author(s): H. Czyz, T. Teubner, D. Nomura, J. Hisano, E. Passemar, T. Ferber, K. Hayasaka, C. Hearty, B. Shvartz

+ E. Kou

(New content is currently under discussion…)