

Charged pion lifetime

Particle Data Group

0.02%

<u>VALUE (10^{-8} s)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
2.6033 \pm 0.0005 OUR AVERAGE	Error includes scale factor of 1.2.			
2.60361 \pm 0.00052	¹ KOPTEV 95	SPEC	+	Surface μ^+ 's
2.60231 \pm 0.00050 \pm 0.00084	NUMAO 95	SPEC	+	Surface μ^+ 's
2.609 \pm 0.008	DUNAITSEV 73	CNTR	+	
2.602 \pm 0.004	AYRES 71	CNTR	\pm	
2.604 \pm 0.005	NORDBERG 67	CNTR	+	
2.602 \pm 0.004	ECKHAUSE 65	CNTR	+	

- Why measure it again and better?
 - Lightest hadrons, cleanest probe of the quark weak charged current
 - *In conjunction with new BR measurements, can shed light on the 1st row CKM unitarity tension*

$$\Gamma(\pi^\pm \rightarrow X) = \text{BR}(X)/\tau_\pi \sim |V_{ud}|^2 \times |\text{m.e.}|^2 \times (1 + \text{R.C.}) \times \text{Phase space}$$

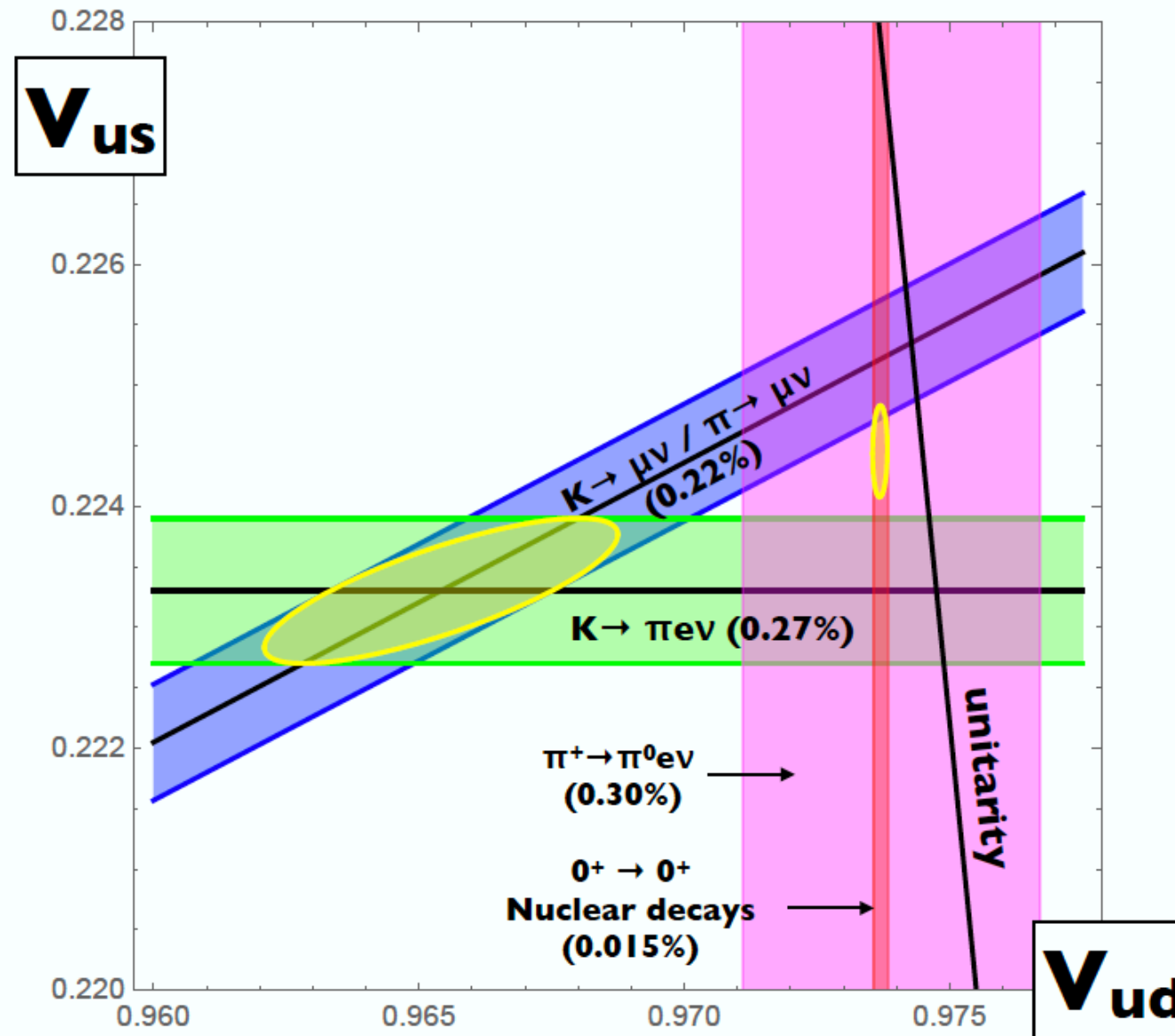
$$X = \mu\nu(\gamma)$$

$$\delta\text{BR}/\text{BR} \sim 10^{-6}$$

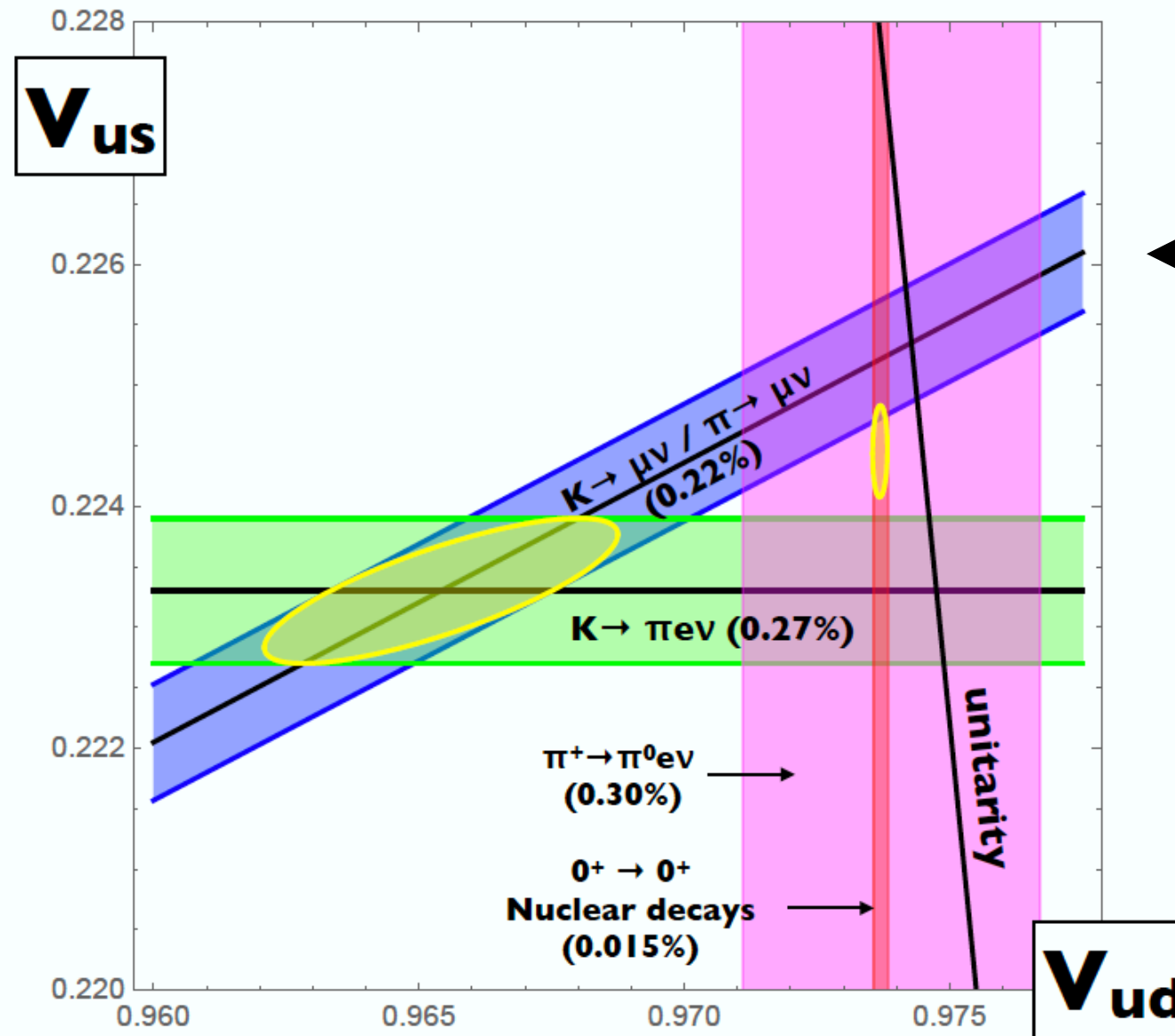
$$X = \pi^0 e^\pm \nu(\gamma)$$

$$\delta\text{BR}/\text{BR} \sim 0.58\%$$

Pion decays and CKM analysis



Pion decays and CKM analysis



Marciano,
hep-ph/0402299, PRL

$$R_A = \frac{\Gamma(K \rightarrow \mu\nu(\gamma))}{\Gamma(\pi \rightarrow \mu\nu(\gamma))}$$

Here pion lifetime improvement would not help: uncertainty dominated by theory and K expt. input

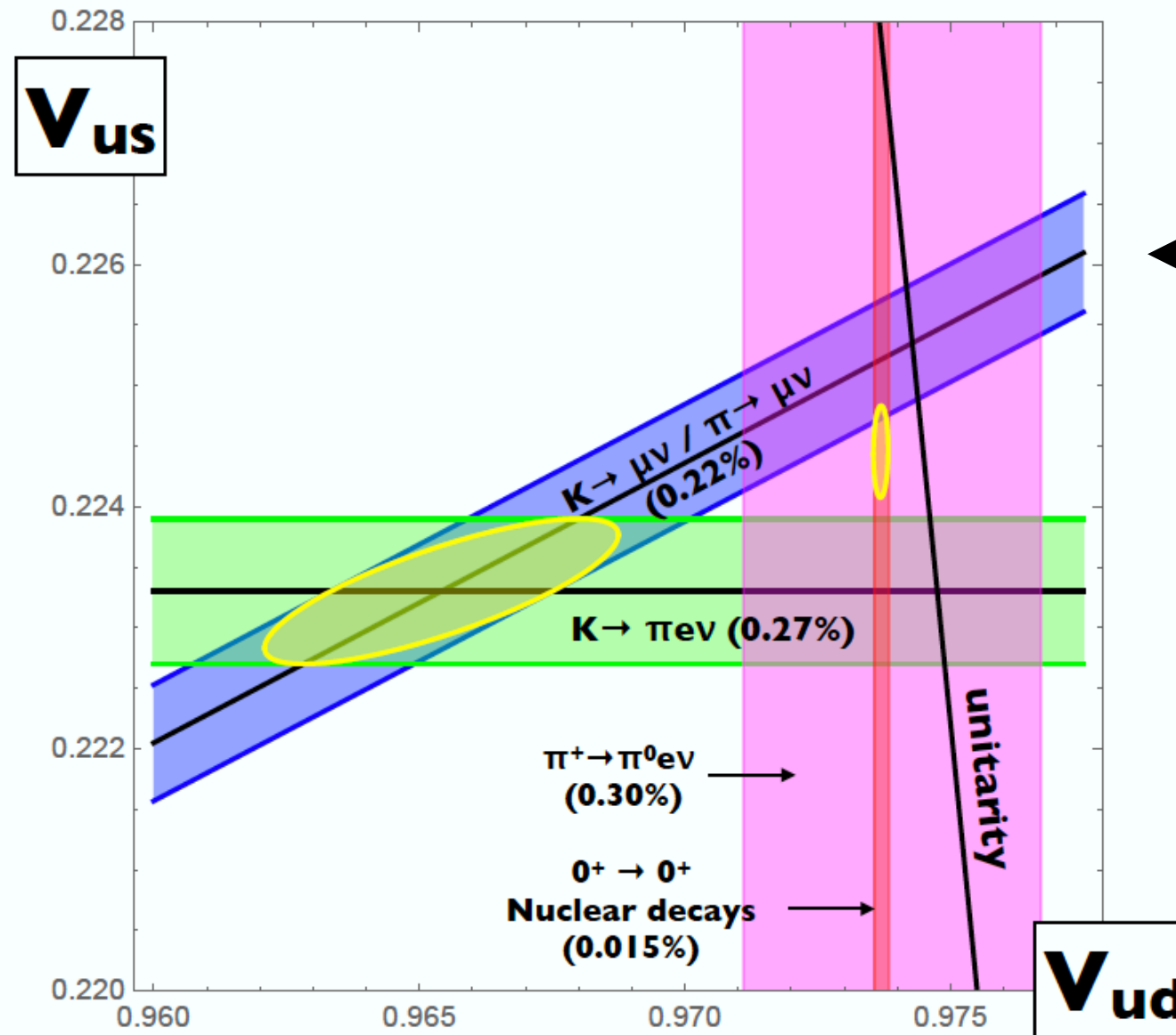
Pion decays and CKM analysis

Currently from pion
beta decay:

$$V_{ud} = 0.9739 (28)_{BR} (1)_{\tau} (1)_{th}$$

Need 20x
improvement in BR
for a competitive
extraction of V_{ud}
(PIENUXe phase 2?)

At that level,
current uncertainty
in the lifetime
becomes relevant



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input