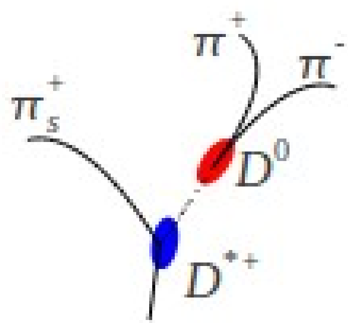
1st NexT PhD Workshop

18-20 July 2011
The Cosener's House
Abingdon - UK



CHARM, CP VIOLATION AND NEW PHYSICS: THE TOOL

19/07/2011
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- In the standard model, CP violation originates from the complex phase naturally occurring in the CKM matrix: is this the end of the story?

- Is there a unique environment where to perform precision tests of the CKM mechanism and where to look for CP violation and new physics?

...We explore Time-dependent CP asymmetries formalism in the charm sector for the first time...

Time-dependent CP asymmetries in D and B decays

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(Dated: June 21, 2011)

The measurement of time-dependent CP asymmetries in charm decays can provide a unique insight into the flavor changing structure of the Standard Model. We examine a number of different

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ArXiv: 1106.5075

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CKM Matrix

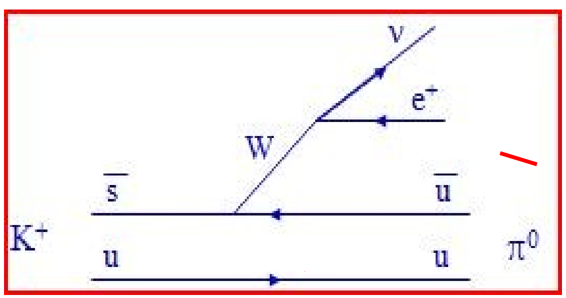
$$V_{CKM}=\begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}=\begin{pmatrix} c_{12}c_{13} & s_{12}c_{13} & s_{13}e^{-i\delta} \\ -s_{12}c_{23}-c_{12}s_{23}s_{13}e^{i\delta} & c_{12}c_{23}-s_{12}s_{23}s_{13}e^{i\delta} & s_{23}c_{13} \\ s_{12}s_{23}-c_{12}c_{23}s_{13}e^{i\delta} & -c_{12}s_{23}-s_{12}c_{23}s_{13}e^{i\delta} & c_{23}c_{13} \end{pmatrix}$$

$c_{ij}=\cos\theta_{ij}; s_{ij}=\sin\theta_{ij}$ $\quad$ $\delta = cp\ violating\ phase$ $\quad$ $s_{13} \ll s_{23} \ll s_{12} \ll 1\,(EXPERIMENTS)$

Wolfenstein parametrization

$$expansion\ \ in\ \ terms\ \ of\ \ \sin\theta_c : V_{us}=0.225=\lambda \rightarrow V_{ud}=1-\frac{\lambda^2}{2}+O(\lambda^3)$$

$$V_{CKM}=\begin{pmatrix} 1-\lambda^2/2 & \lambda & A\lambda^3(\rho-i\eta) \\ -\lambda & 1-\lambda^2/2 & A\lambda^2 \\ A\lambda^3(1-\rho-i\eta) & -A\lambda^2 & 1 \end{pmatrix}+O(\lambda^4)$$



$$s_{12}=\lambda=\frac{|V_{us}|}{\sqrt{|V_{ud}|^2+|V_{us}|^2}};\ s_{23}=A\lambda^2=\lambda\left|\frac{V_{cb}}{V_{us}}\right|;$$

$$s_{13}e^{i\delta}=V_{ub}^*=A\lambda^3(\rho+i\eta)=A\lambda^3(\bar{\rho}+i\bar{\eta})\frac{\sqrt{1-A^2\lambda^4}}{(\sqrt{1-\lambda^2}\,1-A^2\lambda^4(\bar{\rho}+i\bar{\eta}))}$$

CKM-M may be forced to be unitary to all order in λ !!

CKM Matrix

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$c_{ij}=\cos\theta_{ij};s_{ij}=\sin\theta_{ij}$ $\quad\delta = cp\ violating\ phase$ $\quad s_{13}\ll s_{23}\ll s_{12}\ll 1\,(EXPERIMENTS)$

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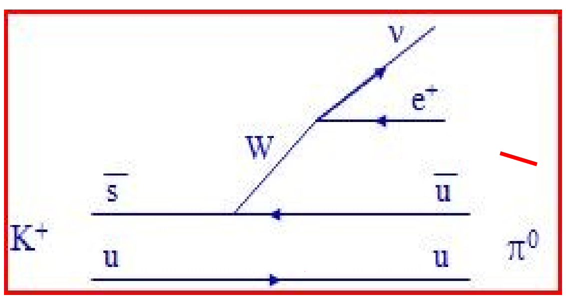
PAST, NOT ENOUGH!



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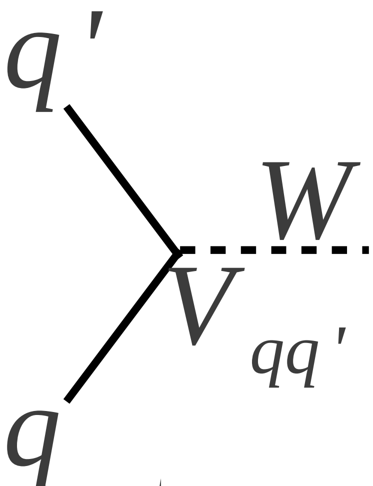
CKM-M may be forced to be unitary to all order in λ !!

1a

Buras parametrization of the CKM matrix up to λ^5



$$V_{CKM}=\begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$

$$PDG \quad standard \quad parametriazation \quad with$$

$$s_{12}=\lambda,\quad s_{13}\sin\delta_{13}=A\lambda^3\eta,\quad \overline{\eta}=\eta[1-\frac{\lambda^2}{2}+O(\lambda^4)]$$

$$s_{23}=A\lambda^{2,}\quad s_{13}\cos\delta_{13}=A\lambda^3\rho,\quad \overline{\rho}=\rho[1-\frac{\lambda^2}{2}+O(\lambda^4)]$$

$$V_{CKM}=\begin{pmatrix} 1-\lambda^2/2-\lambda^4/8 & \lambda & A\lambda^3(\overline{\rho}-i\overline{\eta})+A\lambda^5(\overline{\rho}-i\overline{\eta})/2 \\ -\lambda+A^2\lambda^5[1-2(\overline{\rho}+i\overline{\eta})] & 1-\lambda^2/2-\lambda^4(1+4A^2)/8 & A\lambda^2 \\ A\lambda^3[1-(\overline{\rho}+i\overline{\eta})] & -A\lambda^2+A\lambda^4[1-2(\overline{\rho}+i\overline{\eta})]/2 & 1-A^2\lambda^4/2 \end{pmatrix}+O(\lambda^6)$$

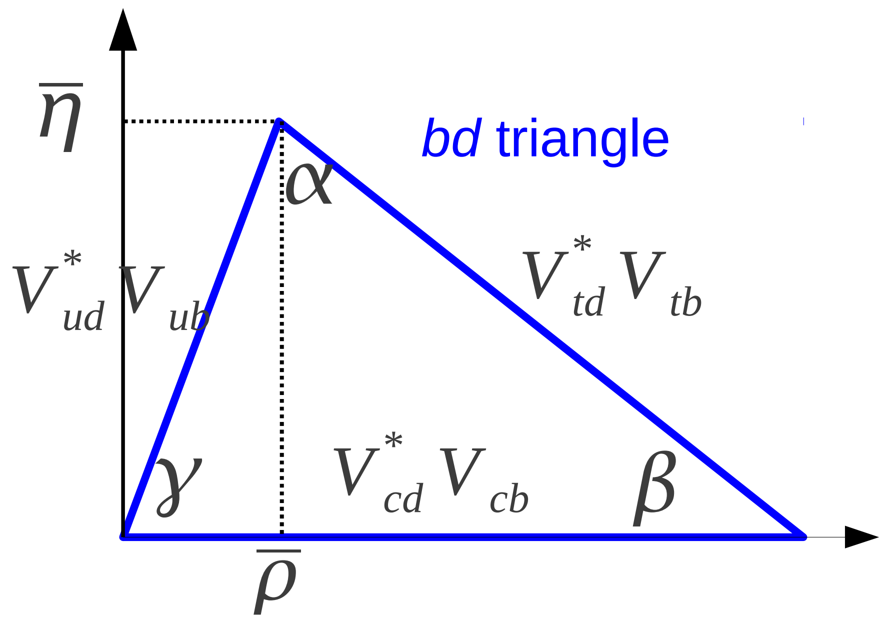
TAB 1

	UTFit	**CKM Fitter**
λ	0.22545 ± 0.00065	0.22543 ± 0.00077
A	0.8095 ± 0.0095	$0.812^{+0.013}_{-0.027}$
ρ	0.135 ± 0.021	-------------
η	0.367 ± 0.013	-------------
$\overline{\rho}$	0.132 ± 0.020	0.144 ± 0.025
$\overline{\eta}$	0.358 ± 0.012	$0.342+0.016$

Why do we express the matrix in terms of $\overline{\rho}\,\overline{\eta}$?

Unitarity triangles

Unitarity conditions of the CKM matrix are translated into 6 possible unitary triangles in the complex plane. We illustrate two here.



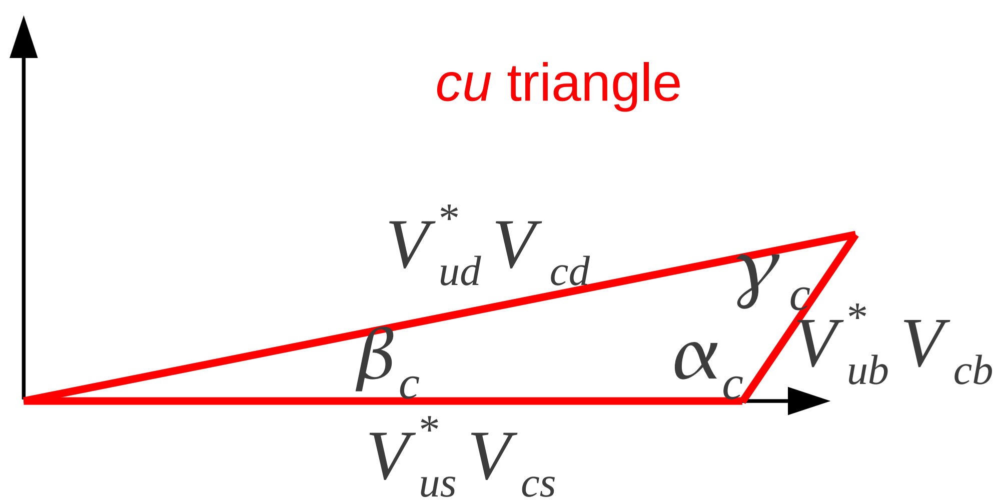
$$V^*_{ud} V_{ub} + V^*_{cd} V_{cb} + V^*_{td} V_{tb} = 0$$

$$\alpha = arg\left[\frac{-V_{td} V^*_{tb}}{V_{ud} V^*_{ub}}\right] = (91.4 \pm 6.1)^o$$

$$\beta = arg\left[\frac{-V_{cd} V^*_{cb}}{V_{td} V^*_{tb}}\right] = (21.1 \pm 0.9)^o$$

$$\gamma = arg\left[\frac{-V_{ud} V^*_{ub}}{V_{cd} V^*_{cb}}\right] = (74 \pm 11)^o$$

FROM EXPERIMENTS



$$V^*_{ud} V_{cd} + V^*_{us} V_{cs} + V^*_{ub} V_{cb} = 0$$

$$\alpha_c = arg\left[\frac{-V^*_{ub} V_{cb}}{V^*_{us} V_{cs}}\right] = (111.5 \pm 4.2)^o$$

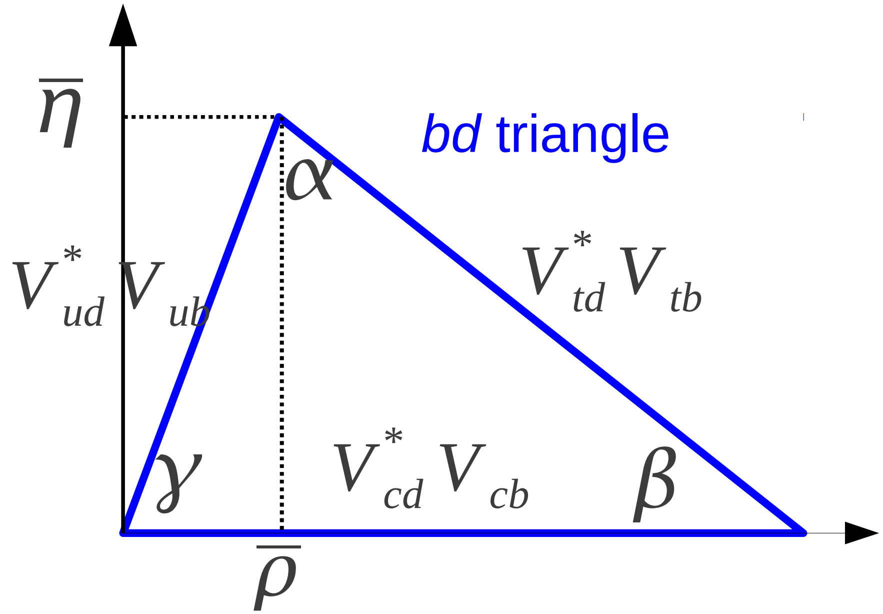
$$\beta_c = arg\left[\frac{-V^*_{ud} V_{cd}}{V^*_{us} V_{cs}}\right] = (0.035 \pm 0.0001)^o$$

$$\gamma_c = arg\left[\frac{-V^*_{ub} V_{cb}}{V^*_{ud} V_{cd}}\right] = (68.4 \pm 0.1)^o$$

AVERAGE OF VALUES IN TAB 1

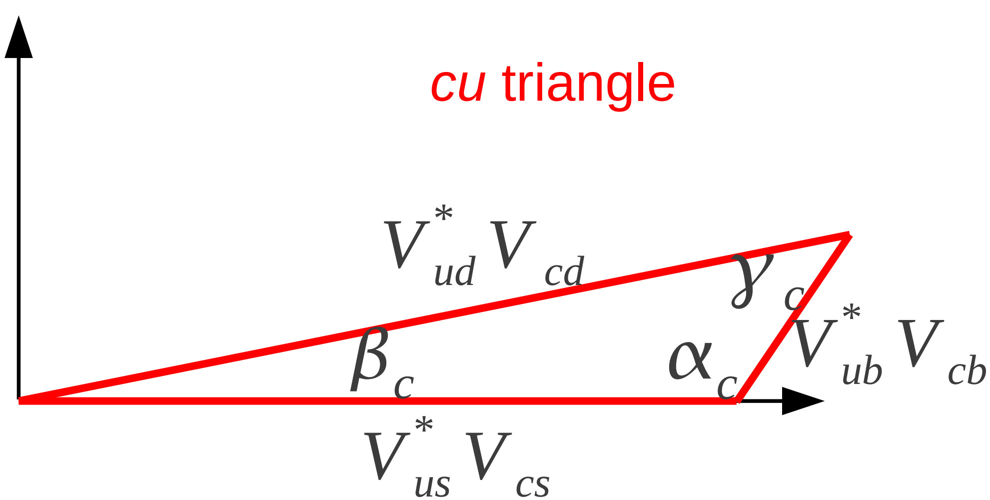
Unitarity triangles

Unitarity conditions of the CKM matrix are translated into 6 possible unitary triangles in the complex plane. We illustrate two here.



$$V^*_{ud}V_{ub}+V^*_{cd}V_{cb}+V^*_{td}V_{tb}=0$$

The value of sin(2β) differs from the predicted value (see paper) by 3.2 standard deviation: need to be checked!
CKM mechanism “maybe” is breaking down.. **arXiv: 1104.2117v2**



$$V^*_{ud}V_{cd}+V^*_{us}V_{cs}+V^*_{ub}V_{cb}=0$$

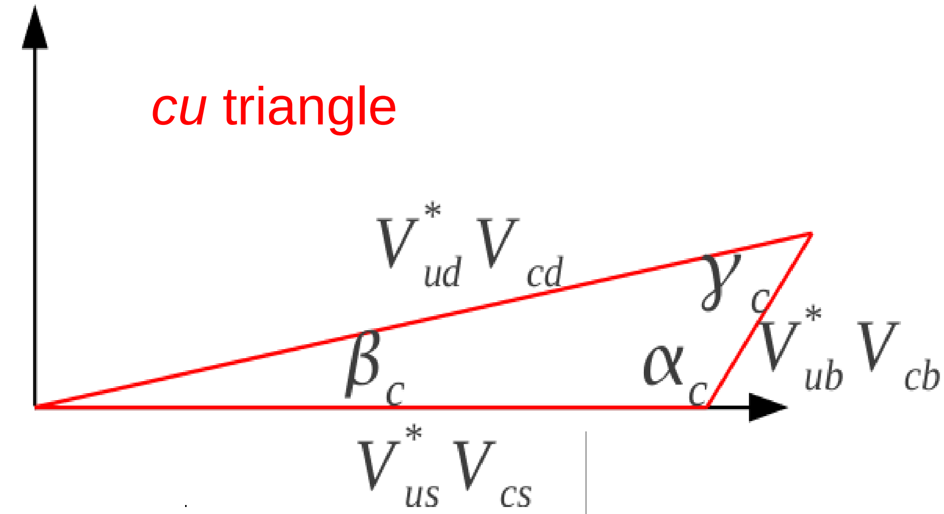
$$\alpha_c=arg[\frac{-V^*_{ub}V_{cb}}{V^*_{us}V_{cs}}]=(111.5\pm4.2)^o$$

$$\beta_c=arg[\frac{-V^*_{ud}V_{cd}}{V^*_{us}V_{cs}}]=(0.035\pm0.0001)^o$$

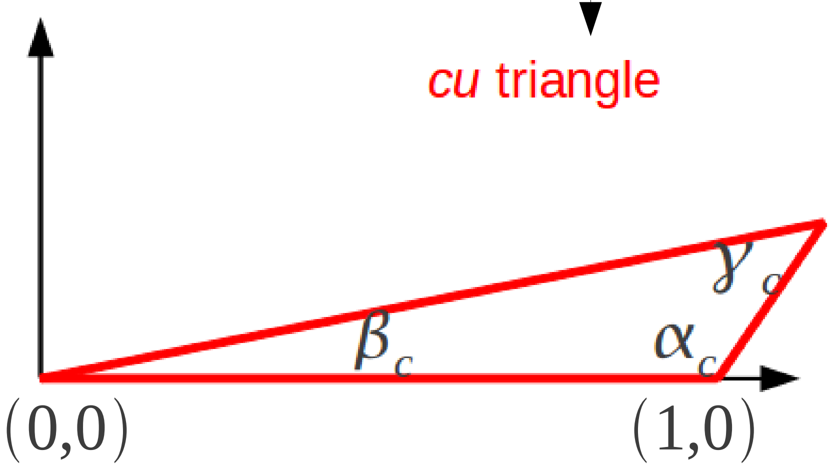
$$\gamma_c=arg[\frac{-V^*_{ub}V_{cb}}{V^*_{ud}V_{cd}}]=(68.4\pm0.1)^o$$

AVERAGE OF VALUES IN TAB 1

Constraint on the *cu* triangle



Normalizing the baseline to 1, so dividing by $V_{us}^{*}V_{cs}$



It is possible to constrain the apex of the *cu* triangle in two ways:

1) by constraining two internal angles
2) by measuring the sides

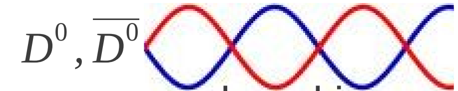
$$\gamma_c = (68.4 \pm 0.1)^o \quad \text{from } CKM\ prediction$$
$$+ any\ measurement\ of\ \beta_c \rightarrow constraint\ \ on\ \ the\ \ apex\ of\ the\ triangle$$

$$X + iY = 1 + \frac{A^2\lambda^5(\bar{\rho} + i\,\bar{\eta})}{\lambda - \lambda^3/2 - \lambda^5(1/8 + A^2/2)}$$

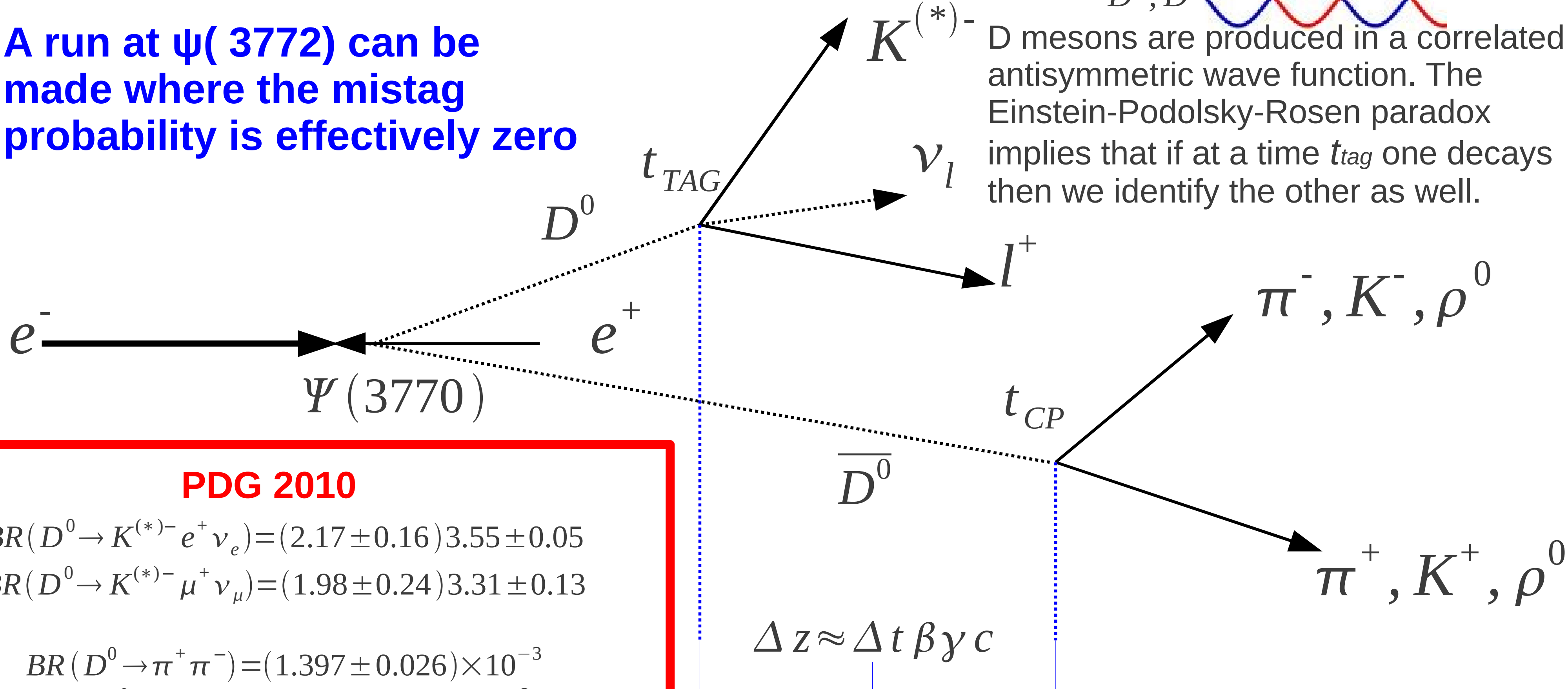
$$X = 1.00025$$
$$Y = 0.00062$$

Correlated mesons: semi-leptonic tagging

A run at ψ(3772) can be made where the mistag probability is effectively zero



D mesons are produced in a correlated antisymmetric wave function. The Einstein-Podolsky-Rosen paradox implies that if at a time t_{tag} one decays then we identify the other as well.



PDG 2010

$$BR(D^0 \to K^{(*)-} e^+ \nu_e) = (2.17 \pm 0.16)3.55 \pm 0.05$$
$$BR(D^0 \to K^{(*)-} \mu^+ \nu_\mu) = (1.98 \pm 0.24)3.31 \pm 0.13$$

$$BR(D^0 \to \pi^+ \pi^-) = (1.397 \pm 0.026) \times 10^{-3}$$
$$BR(D^0 \to K^+ K^-) = (3.94 \pm 0.07) \times 10^{-3}$$

At time t_{TAG} the decays $D \to K^{-(+)} l^{+(-)} \nu_l$ account for 11% of all D decays and unambiguously assigns the flavour: D^0 is associated to a l^+, $\overline{D^0}$ is associated to a l^-

Assuming PDG values for BR and CLEO_c efficiency for double tagging we expect with semi-leptonic tag ~158000 for $D^0 \to \pi^+ \pi^-$

Time-dependent formalism (i)

Neutral meson systems exhibit mixing of mass eigenstates $|P_{1,2}>$ where:

$$i\frac{d}{dt}\begin{pmatrix}|P_1>\\|P_2>\end{pmatrix}=\begin{pmatrix}M_{11}-\frac{i}{2}\Gamma_{11} & M_{12}-\frac{i}{2}\Gamma_{12}\\ M_{12}^{*}-\frac{i}{2}\Gamma_{12}^{*} & M_{22}^{*}-\frac{i}{2}\Gamma_{22}^{*}\end{pmatrix}\begin{pmatrix}|P^0>\\|\overline{P^0}>\end{pmatrix}=H_{eff}\begin{pmatrix}|P^0>\\|\overline{P^0}>\end{pmatrix}$$

$$|P_{1,2}>=p|P^0>\pm q|\overline{P^0}>$$

$$q^2+p^2=1 \quad \textit{normalize the wavefunction}$$

$$\frac{q}{p}=\sqrt{\frac{m_{12}^{*}-i\Gamma_{12}^{*}/2}{M_{12}-i\Gamma_{12}/2}}$$

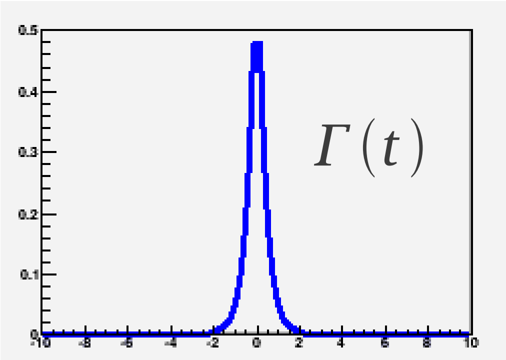
$$H_{eff}=M-\frac{i}{2}\Gamma$$

$$M_{11}=M_{22},\Gamma_{11}=\Gamma_{22} \quad \leftarrow \quad CPT \;\; INVARIANCE$$

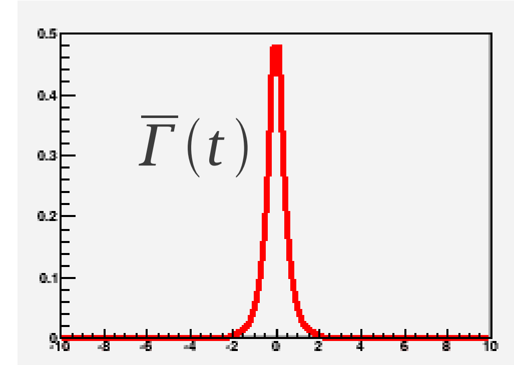
$$M_{11}=M_{22},\Gamma_{11}=\Gamma_{22},\Im[\frac{\Gamma_{12}}{M_{12}}]=0 \quad \leftarrow \quad CP \;\; INVARIANCE$$

$$\Im[\frac{\Gamma_{12}}{M_{12}}]=0 \quad \leftarrow \quad T \;\; INVARIANCE$$

$$\boxed{\frac{d}{dt}\langle\Psi(t)|\Psi(t)\rangle=-\langle\Psi(t)|\Gamma|\Psi(t)\rangle}$$



Time-dependent formalism (ii)



The time-dependence of decays of P^0 (P^0) to final state |f > are:

$$\Gamma(P^0 \to f) \propto e^{-\Gamma_1|\Delta t|}\left[\frac{h_+}{2} + \frac{\Re(\lambda_f)}{1+|\lambda_f|^2} h_- + e^{[\Delta\Gamma|\Delta t|/2]}\left(\frac{1-|\lambda_f|^2}{1+|\lambda_f|^2}\cos\Delta M\Delta t - \frac{2\Im(\lambda_f)}{1+|\lambda_f|^2}\sin\Delta M\Delta t\right)\right]$$

$$\overline{\Gamma}(\overline{P^0} \to f) \propto e^{-\Gamma_1|\Delta t|}\left[\frac{h_+}{2} + \frac{\Re(\lambda_f)}{1+|\lambda_f|^2} h_- - e^{[\Delta\Gamma|\Delta t|/2]}\left(\frac{1-|\lambda_f|^2}{1+|\lambda_f|^2}\cos\Delta M\Delta t - \frac{2\Im(\lambda_f)}{1+|\lambda_f|^2}\sin\Delta M\Delta t\right)\right]$$

$$where: \quad h_{+-} = 1 \pm e^{\Delta\Gamma|\Delta t|}, \quad \lambda_f = \frac{q}{p}\frac{\overline{A}}{A}$$

λ_f very important!

We now obtain the time-dependent CP asymmetry

$$A^{Phys}(\Delta t) = \frac{\overline{\Gamma}^{Phys}(\Delta t) - \Gamma^{Phys}(\Delta t)}{\overline{\Gamma}^{Phys}(\Delta t) + \Gamma^{Phys}(\Delta t)} = -\Delta\omega + \frac{(D+\Delta\omega)e^{\Delta\Gamma|\Delta t|/2}(|\lambda_f|^2-1)\cos\Delta M\Delta t + 2\Im(\lambda_f)\sin\Delta M\Delta t}{(1+|\lambda_f|^2)h_+/2 + h_-\Re(\lambda_f)}$$

Where we included mistag probability effects

Uncorrelated D^0 mesons

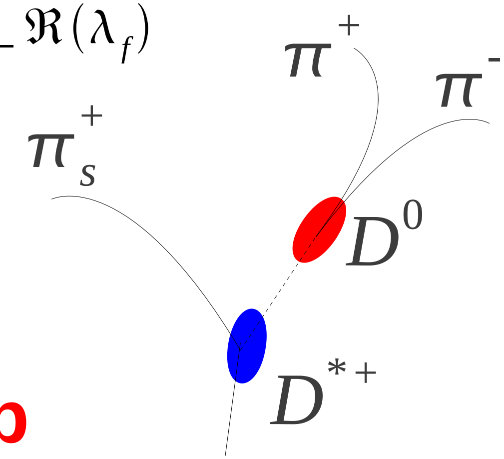
$$A(t)=\frac{\overline{\Gamma}(t)-\Gamma(t)}{\overline{\Gamma}(t)+\Gamma(t)}=2e^{\Delta\Gamma t/2}\frac{(|\lambda_f|^2-1)\cos\Delta M\, t+2\Im(\lambda_f)\sin\Delta M\, t}{(1+|\lambda_f|^2)(1+e^{\Delta\Gamma t})+2\Re(\lambda_f)(1-e^{\Delta\Gamma t})}$$

Mistag probability and dilution become important

$$A^{Phys}(t)=\frac{\overline{\Gamma^{Phys}}(t)-\Gamma^{Phys}(t)}{\overline{\Gamma^{Phys}}(t)+\Gamma^{Phys}(t)}=+\Delta\omega+\frac{(D-\Delta\omega)e^{\Delta\Gamma t/2}(|\lambda_f|^2-1)\cos\Delta M\, t+2\Im(\lambda_f)\sin\Delta M\, t}{(1+|\lambda_f|^2)h_+/2+h_-\Re(\lambda_f)}$$

The flavour tagging is accomplished by identifying a "slow" pion in the processes (CP and CP conjugated):

$$D^{*+}\rightarrow D^0\pi_s^+$$
$$D^{*-}\rightarrow \overline{D^0}\pi_s^-$$



SuperB at Υ(4S) and LHCb

D* from $e^+e^-\rightarrow c\bar{c}$ can be separated from those coming from B's by applying a momentum cut.
Clean environment.
More easier to separate prompt D* from B cascade than LHCb

D* mesons are secondary particles produced in the primary decay of a B meson.
High background level to keep under control.
Trigger efficiency.

Analysis of CP eigenstates (i)

When exploring CP violation, ignoring long distance effects, the parameter λ may be written as:

$$\lambda_f = \left|\frac{q}{p}\right| e^{i\phi_{MIX}} \left|\frac{\bar{A}}{A}\right| e^{i\phi_{CP}}$$

$$\phi_{MIX} : phase\ of\ D^0\overline{D^0}\ mixing$$

$$\phi_{CP} : overall\ phase\ of\ D^0 \rightarrow f_{CP}\,(eigenstate)$$

$$A = |T|\ e^{i(\phi_T+\delta_T)} + |CS|\ e^{i(\phi_{CS}+\delta_{CS})} + |W|\ e^{i(\phi_W+\delta_W)} + \sum_{q=d,s,b} |P_q|\ e^{(i\phi_q+\delta_q)}$$

The following processes, as we will see, are tree dominated

$$D^0 \rightarrow K^+K^-, \pi^+\pi^-, K^+K^-K^0, K^0\pi^+\pi^-$$

Assuming negligible the contribution due to P/CS/W amplitudes, then:

$$\boxed{\lambda_f = \left|\frac{q}{p}\right| e^{i\phi_{MIX}}\, e^{-2i\,\phi_T{}^W}}$$

Analysis of CP eigenstates (ii)

mode	η_{CP}	T	CS	P_q	W_{EX}
$D^0 \to K^+K^-$	$+1$	$V_{cs}V_{us}^*$		$V_{cq}V_{uq}^*$	
$D^0 \to K_S^0 K_S^0$	$+1$				$V_{cs}V_{us}^* + V_{cd}V_{cd}^*$
$D^0 \to \pi^+\pi^-$	$+1$	$V_{cd}V_{ud}^*$		$V_{cq}V_{uq}^*$	$V_{cd}V_{ud}^*$
$D^0 \to \pi^0\pi^0$	$+1$		$V_{cd}V_{ud}^*$	$V_{cq}V_{uq}^*$	$V_{cd}V_{ud}^*$
$D^0 \to \rho^+\rho^-$	$+1$	$V_{cd}V_{ud}^*$		$V_{cq}V_{uq}^*$	$V_{cd}V_{ud}^*$
$D^0 \to \rho^0\rho^0$	$+1$		$V_{cd}V_{ud}^*$	$V_{cq}V_{uq}^*$	$V_{cd}V_{ud}^*$
$D^0 \to \phi\pi^0$	$+1$		$V_{cs}V_{us}^*$	$V_{cq}V_{uq}^*$	
$D^0 \to \phi\rho^0$	$+1$		$V_{cs}V_{us}^*$	$V_{cq}V_{uq}^*$	
$D^0 \to f^0(980)\pi^0$	-1		$V_{cs}V_{us}^* + V_{cd}V_{ud}^*$	$V_{cq}V_{uq}^*$	
$D^0 \to \rho^0\pi^0$	$+1$		$V_{cd}V_{ud}^*$	$V_{cq}V_{uq}^*$	$V_{cd}V_{ud}^*$
$D^0 \to a^0\pi^0$	-1		$V_{cd}V_{ud}^*$	$V_{cq}V_{uq}^*$	$V_{cd}V_{ud}^*$
$D^0 \to K_S^0 K_S^0 K_S^0$	$+1$				$V_{cs}V_{ud}^* + V_{cd}V_{us}^*$
$D^0 \to K_L^0 K_S^0 K_S^0$	-1				$V_{cs}V_{ud}^* + V_{cd}V_{us}^*$
$D^0 \to K_L^0 K_L^0 K_S^0$	$+1$				$V_{cs}V_{ud}^* + V_{cd}V_{us}^*$
$D^0 \to K_L^0 K_L^0 K_L^0$	-1				$V_{cs}V_{ud}^* + V_{cd}V_{us}^*$

Analysis of CP eigenstates (iii)

Amplitude to order λ^6:

REAL

COMPLEX

$$V_{cs}V_{us}^* = \lambda - \frac{\lambda^3}{2} - \left(\frac{1}{8} + \frac{A^2}{2}\right)\lambda^5,$$

$$V_{cd}V_{ud}^* = -\lambda + \frac{\lambda^3}{2} + \frac{\lambda^5}{8} + \frac{A^2\lambda^5}{2}[1 - 2(\bar{\rho} + i\bar{\eta})]$$

$$V_{cb}V_{ub}^* = A^2\lambda^5(\bar{\rho} + i\bar{\eta}),$$

$$V_{cd}V_{cd}^* = \lambda^2 - \lambda^6 A^2[1 - 2\bar{\rho}],$$

$$V_{cs}V_{ud}^* = 1 - \lambda^2 - \frac{A^2\lambda^4}{2} + A^2\lambda^6\left[\frac{1}{2} - \bar{\rho} - i\bar{\eta}\right]$$

$$V_{cd}V_{us}^* = -\lambda^2 + \frac{A^2\lambda^6}{2}[1 - 2(\bar{\rho} + i\bar{\eta})].$$

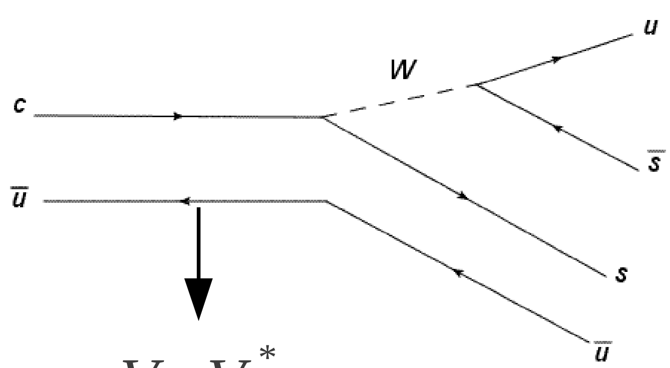
$V_{cb}V_{ub}^*$ *large phase* : $V_{ub} \rightarrow \gamma_c = \gamma$

$V_{cd}V_{ud}^*$ and $V_{cd}V_{us}^*$ *small phase* : $V_{cd} \rightarrow \beta_c$

$V_{cs}V_{ud}^*$ *small phase entering at* $O(\lambda^6)$

$D^0 \rightarrow K^+ K^-$

Tree topology

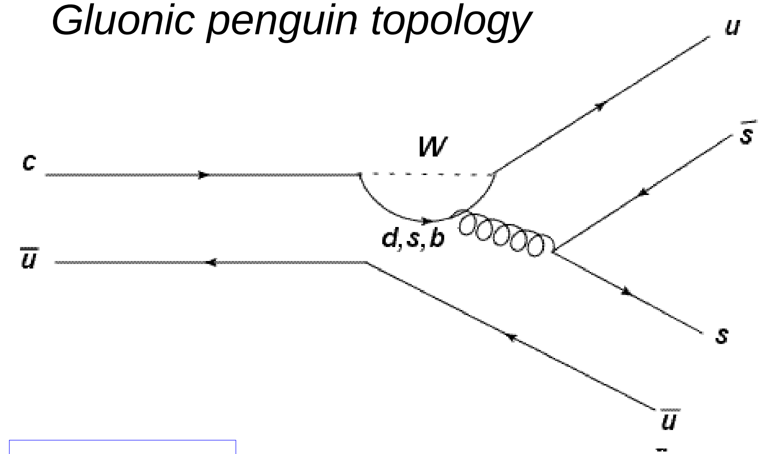


$$V_{cs} V_{us}^*$$

$$V_{cs}V_{us}^* = \lambda - \frac{\lambda^3}{2} - \left(\frac{1}{8} + \frac{A^2}{2}\right)\lambda^5$$

Real

Gluonic penguin topology



$$\boxed{V_{cd} V_{ud}^*} + V_{cs} V_{us}^* + V_{cb} V_{ub}^*$$

Real **Negligible**

$$\boxed{V_{cd}V_{ud}^* = -\lambda + \frac{\lambda^3}{2} + \frac{\lambda^5}{8} + \frac{A^2\lambda^5}{2}[1 - 2(\bar{\rho} + i\bar{\eta})]}$$

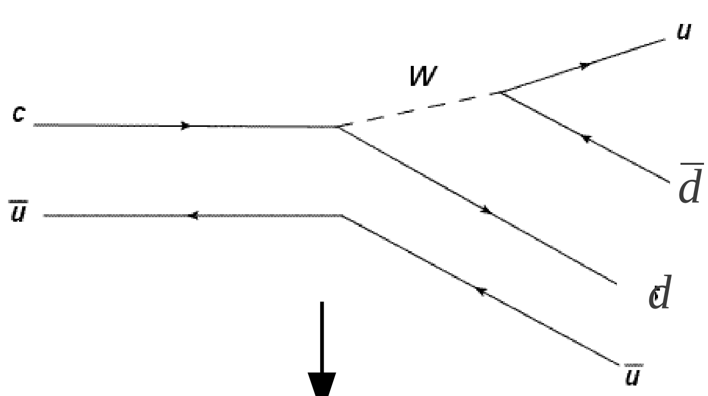
To first order one would expect to measure an asymmetry consistent with zero:

→ **cross check of detector reconstruction and calibration**

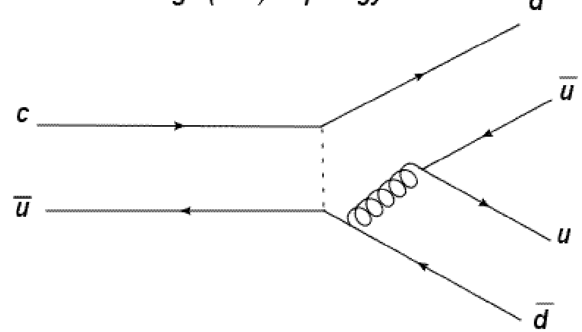
→ **ideal mode to use when searching for new physics (NP)**

$D^0 \to \pi^+ \pi^-$ (i)

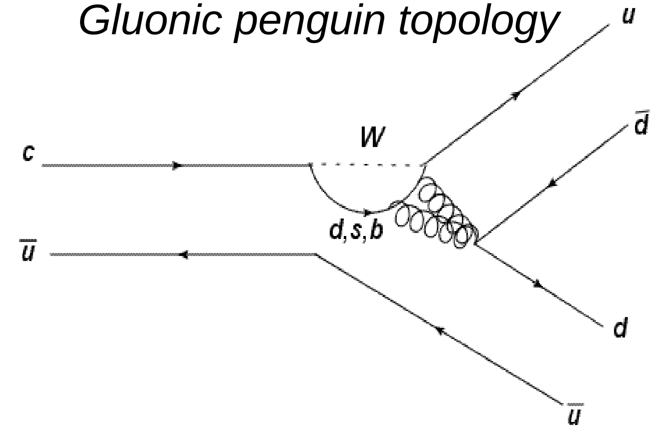
Tree topology



Weak Exchange (WE) topology



Gluonic penguin topology



$\boxed{V_{cd} V_{ud}^{*}}$

$\boxed{V_{cd} V_{ud}^{*}}$

$\boxed{V_{cd} V_{ud}^{*}} + V_{cs} V_{us}^{*} + V_{cb} V_{ub}^{*}$

Real **Negligible**

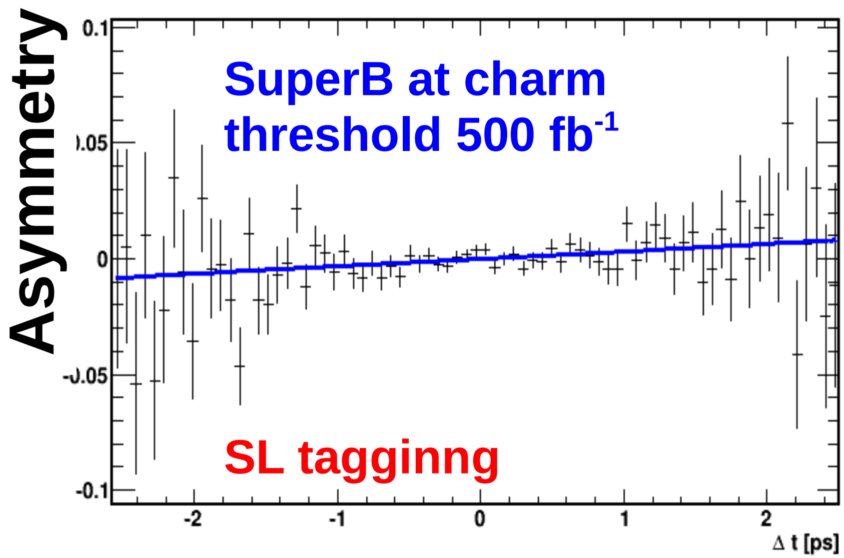
$$\boxed{V_{cd}V_{ud}^{*} = -\lambda + \frac{\lambda^3}{2} + \frac{\lambda^5}{8} + \frac{A^2\lambda^5}{2}[1 - 2(\bar{\rho} + i\bar{\eta})]} \longrightarrow V_{cd} V_{ud}^{*} \to \beta_c$$

Penguin topologies are DCS loops while the Tree amplitude is CS

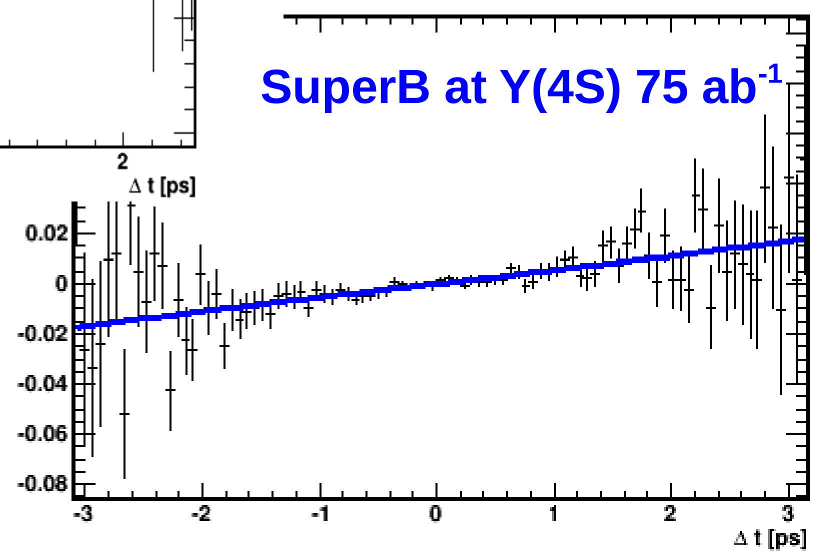
→ **Penguin contributions could in principle be ignored, but..**

→ **A complete theoretical analysis is necessary if one wants to extract the weak phase and disentangle the c → s → u penguin**

TDCPV in charm: numerical analysis

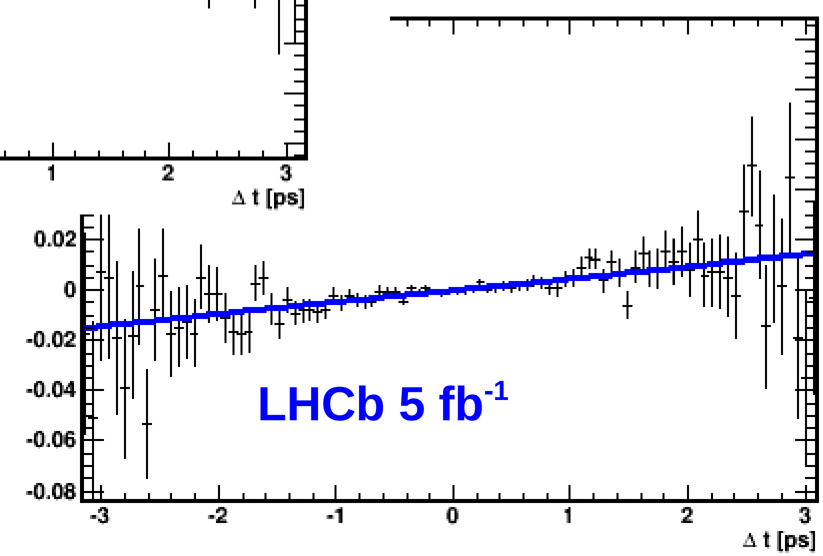


$$A^{Phys}(\Delta t)=\frac{\overline{\Gamma^{Phys}}(\Delta t)-\Gamma^{Phys}(\Delta t)}{\overline{\Gamma^{Phys}}(\Delta t)+\Gamma^{Phys}(\Delta t)}$$



$$D^0 \rightarrow f_{cp}$$

$$f_{cp}=\pi^+\pi^-$$



TDCPV will be more clear to be observed at SuperB (or Belle2) running at $\Upsilon(4S)$ and at LHCb than at SuperB running at charm threshold, but...

Results: precision on β_c

Parameter	SuperB SL	SuperB SL + K	SuperB $\Upsilon(4S)$	LHCb
$\phi = \arg(\lambda_f)$	8.0°	3.4°	2.2°	2.3°
$\phi_{CP} = \phi_{KK} - \phi_{\pi\pi}$	9.4°	3.9°	2.6°	2.7°
$\beta_{c,eff}$	4.7°	2.0°	1.3°	1.4°

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9 months running at charm threshold at SuperB will provide $\sigma_{\beta_{c,eff}} < 1.3^o$

Conclusions

We are exploring time-dependent CP asymmetries in charm and we defined a measurement for the β_c angle in the charm UT.

After defining the tagging for charm, we have studied a number of possible final states.

Using the developed formalism we simulated pseudo-experiments assuming SuperB luminosity and we have shown that a possible measurement for TDCP asymmetries will be reasonable.

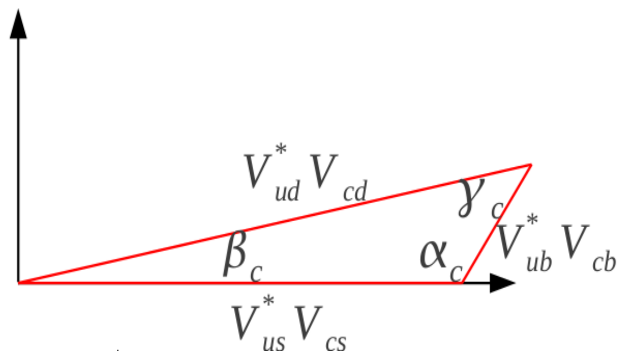
We simulated pseudo-experiments and applied the formalism for uncorrelated mesons for both SuperB and LHCb and we compared the obtained results. We highlight that a precision measurement of any time-dependent effect will require a detailed understanding of the background.

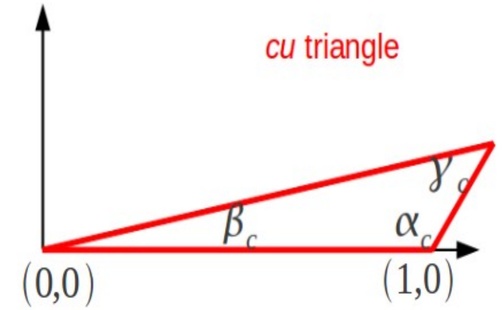
We define a test of the standard model by constraining the apex of the cu triangle

A larger run at charm threshold would provide a more precise measurement of β_c

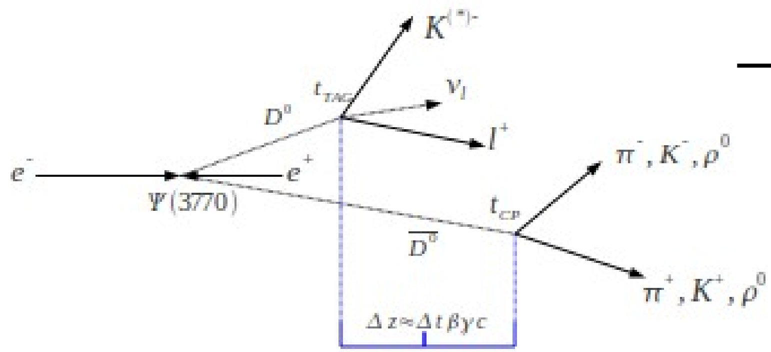
Conclusions: pictures

$$V_{CKM}=\begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$

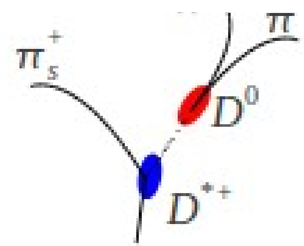




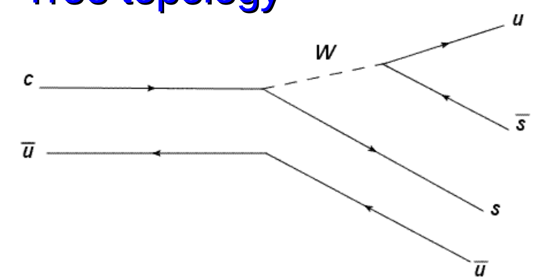
Semi-leptonic tagging



Uncorrelated mesons



Tree topology



$$A^{Phys}(\Delta t)=\frac{\overline{\Gamma}^{Phys}(\Delta t)-\Gamma^{Phys}(\Delta t)}{\overline{\Gamma}^{Phys}(\Delta t)+\Gamma^{Phys}(\Delta t)}=-\Delta\omega+\frac{(D+\Delta\omega)\,e^{\Delta\Gamma|\Delta t|/2}(|\lambda_f|^2-1)\cos\Delta M\Delta t+2\Im(\lambda_f)\sin\Delta M\Delta t}{(1+|\lambda_f|^2)h_+/2+h_-\Re(\lambda_f)}$$

Parameter	Super*B* SL	Super*B* SL + K	Super*B* $\Upsilon(4S)$	LHCb
$\phi=\arg(\lambda_f)$	8.0°	3.4°	2.2°	2.3°
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Thank you for your attention!