Study of $B^0 \to D^* \pi$ decay for CP violation measurement

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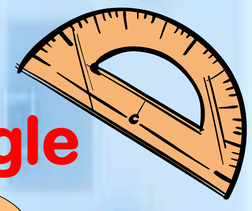
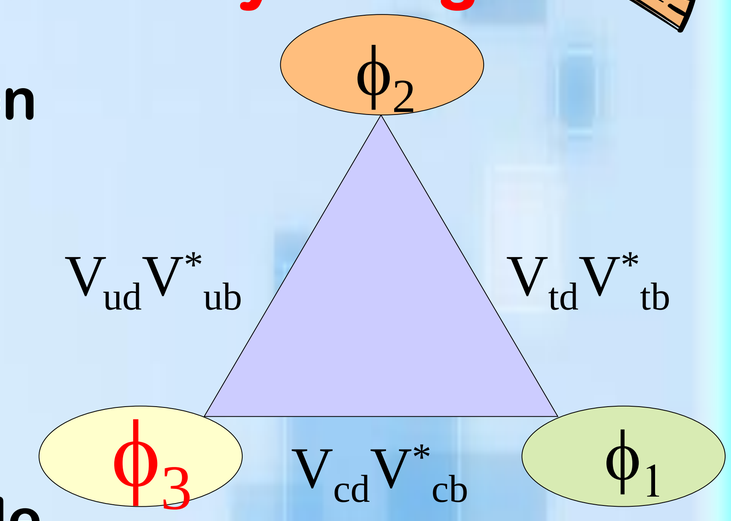
Motivation

Precise measurement of ϕ_3 : the angle of CKM unitary triangle



- The quark mixing matrix meets unitary condition by request from Standard Model.
- The unitary triangle is showing of the following unitary condition on complex plane.

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



CKM unitary triangle

- If Standard Model is correct, the unitary triangle must be closed.

→ $\phi_1 + \phi_2 + \phi_3 = 180^\circ$

→ The length of tree sides build closed triangle.

⇨ **Measurements of the three interior angles and three sides is verification of Standard Model and search for new physics beyond the Standard Model.**

- New physics appears the misalignment of the triangle.
- ϕ_3 is the worst determined.

$$\phi_1 = 21.25^\circ {}^{+0.90^\circ}_{-0.88^\circ}$$

$$\phi_2 = 89.0^\circ {}^{+4.4^\circ}_{-4.2^\circ}$$

$$\phi_3 = 71^\circ {}^{+21^\circ}_{-25^\circ}$$

$$\begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \approx \begin{pmatrix} 1-\frac{\lambda^2}{2} & \lambda & A\lambda^3(\rho - i\eta) \\ -\lambda & 1-\frac{\lambda}{2} & A\lambda^2 \\ A\lambda^3(1-\rho-i\eta) & -A\lambda^2 & 1 \end{pmatrix}$$

quark mixing matrix

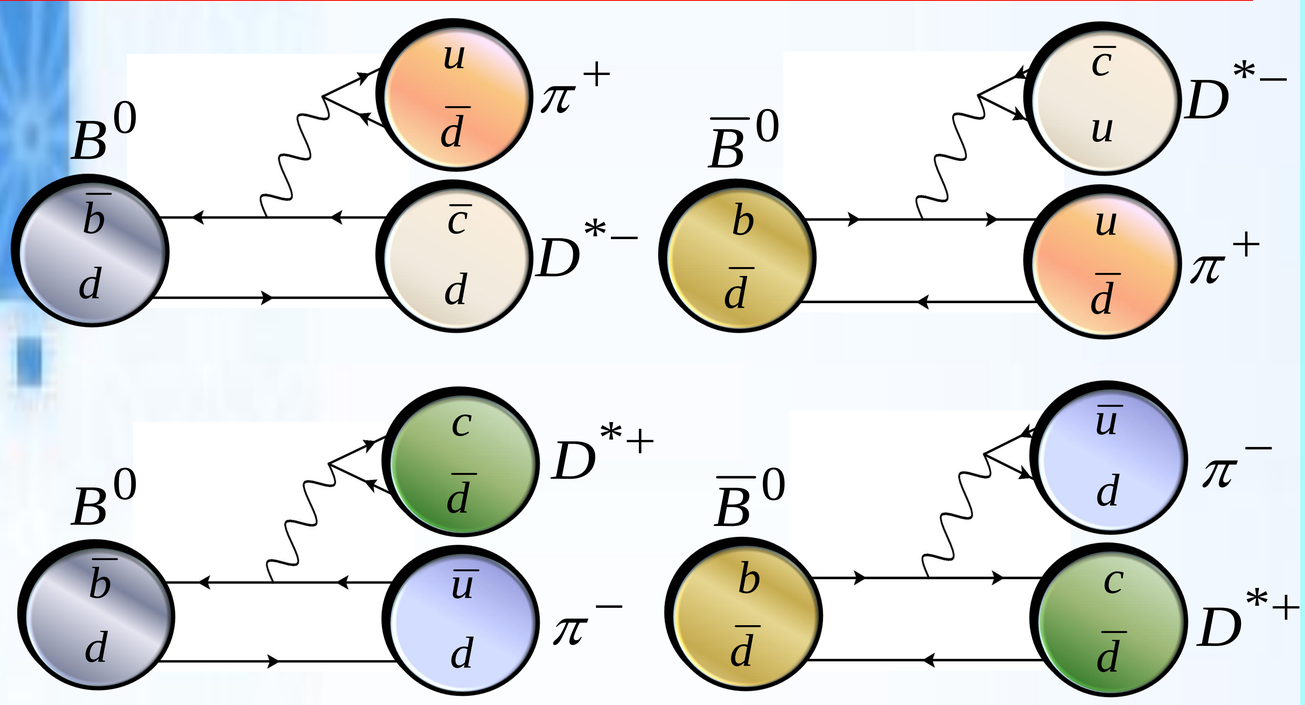
Belle

- In this study, Final Belle data sample is used.
- There are **770,000,000** B anti-B pair.

$B^0 \to D^* \pi$ decay

- It is following 4 decays.

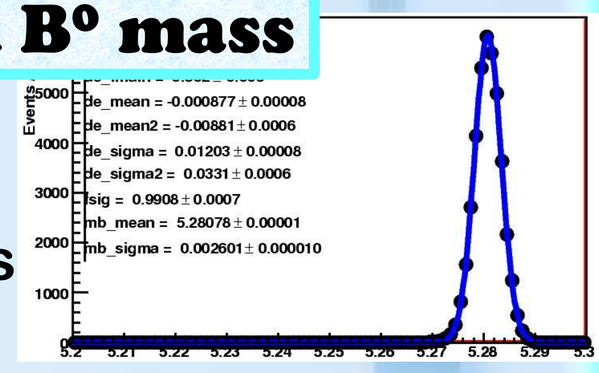
$$B^0 \to D^{*-}\pi^+, B^0 \to D^{*+}\pi^-, \bar{B}^0 \to D^{*+}\pi^-, \bar{B}^0 \to D^{*-}\pi^+$$



- Detected particle is same, although original particle is different.

Reconstructed B^0 mass

- $D^*\pi$ was reconstructed.
- This plot contains B^0 and anti-B^0.



Measurement of ϕ_3

- In this decay, B^0 and anti-B^0 seems almost the same. However, "When it decays" is different, because of quark mixing.
- Time information is understood from the distance where the particle runs.
- It is possible to take $\sin(2\phi_1+\phi_3)$ by observing the time variation of this decay.