

Analysis Part - $|V_{cb}|$

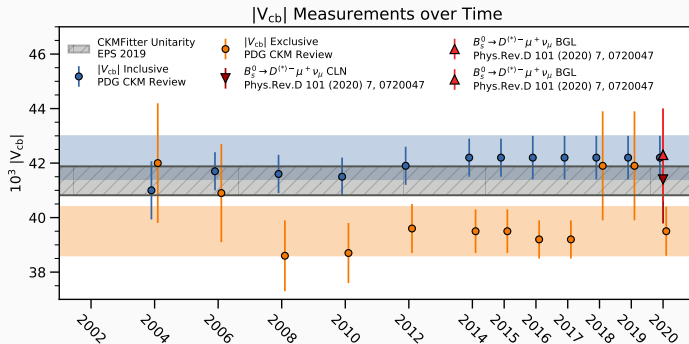
2. Belle II Academy - Bonn

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- $|V_{cb}|$ is a fundamental parameter of the SM.
- Experimentally and theoretically, two approaches to $|V_{cb}|$: Inclusive and exclusive.
- Long standing tension between the two.



Our Focus: Exclusive Determination

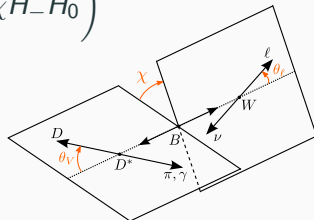
Differential Decay Rate of $B \rightarrow D^* \ell \nu_\ell$

$$\begin{aligned} \frac{d\Gamma B \rightarrow D^*(\rightarrow \dots) \ell \nu_\ell}{dw d\cos\theta_\ell d\cos\theta_V d\chi} &= \frac{6m_B m_{D^*}^2}{8(4\pi)^4} \sqrt{w^2 - 1} (1 - 2wr + r^2) G_F^2 |V_{cb}|^2 \times \mathcal{B}(D^* \rightarrow \dots) \\ &\times \left((1 - \cos\theta_\ell)^2 \sin^2\theta_V H_+^2 + (1 + \cos\theta_\ell)^2 \sin^2\theta_V H_-^2 \right. \\ &\quad + 4 \sin^2\theta_\ell \cos^2\theta_V H_0^2 - 2 \sin^2\theta_\ell \sin^2\theta_V \cos 2\chi H_+ H_- \\ &\quad - 4 \sin\theta_\ell (1 - \cos\theta_\ell) \sin\theta_V \cos\theta_V \cos\chi H_+ H_0 \\ &\quad \left. + 4 \sin\theta_\ell (1 + \cos\theta_\ell) \sin\theta_V \cos\theta_V \cos\chi H_- H_0 \right) \end{aligned}$$

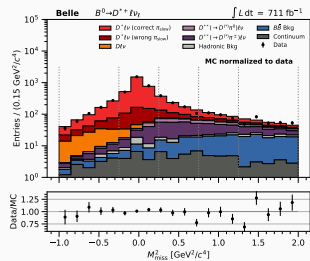
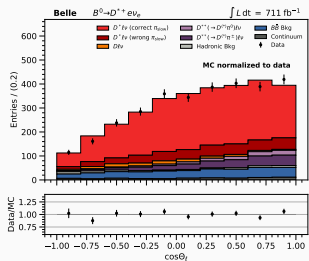
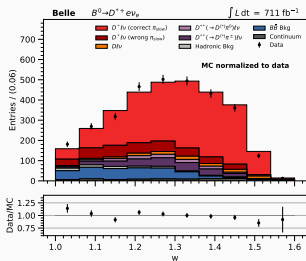
$$r = m_{D^*}/m_B$$

$$w = (m_B^2 + m_{D^*}^2 - q^2)/(2m_B m_{D^*})$$

$$|V_{cb}| = \sqrt{\frac{\mathcal{B}(B \rightarrow D^* \ell \nu_\ell)}{\tau_B \Gamma(B \rightarrow D^* \ell \nu_\ell)}}$$

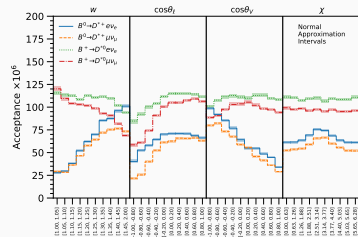
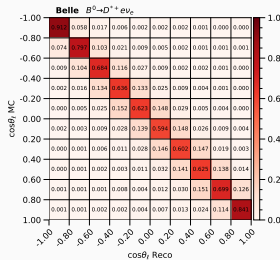
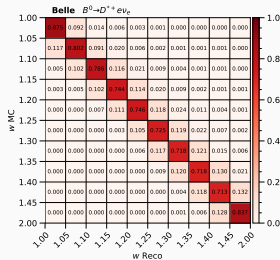


Block I: Background Subtraction



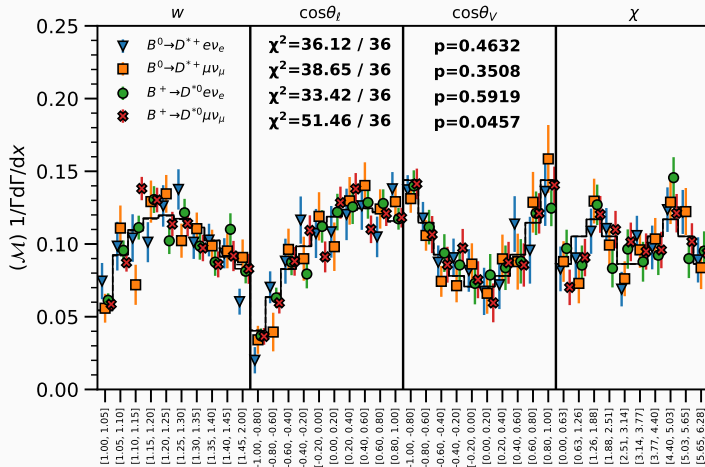
First Goal: Model independent determination of the signal yield.

Block II: Unfolding & Acceptance Correction



Second Goal: Determine migration matrices and acceptance function to unfold the background subtracted distribution.

Block III: Extraction of Form Factors and $|V_{cb}|$



Third Goal: Extract $|V_{cb}|$ and form factors from the measured distribution.