

Hadronic B decay reconstruction in early Belle II data

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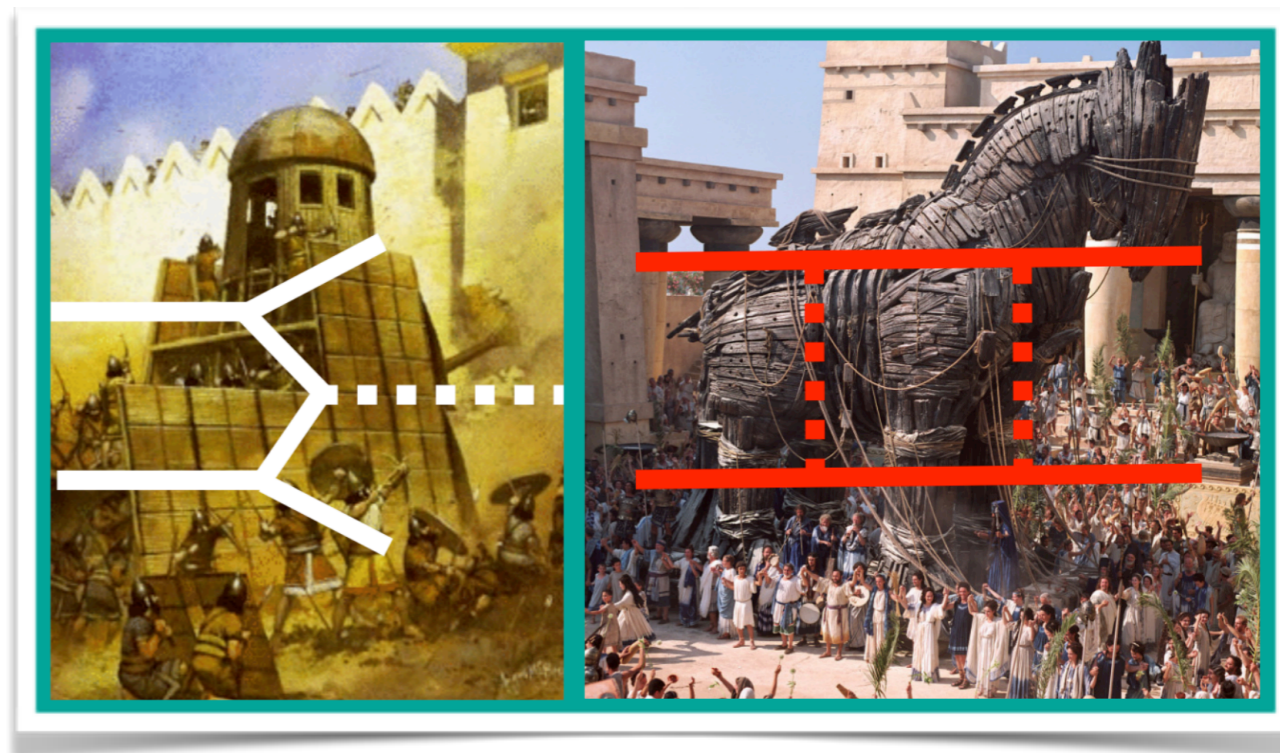
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Motivation

The standard model is successful but incomplete.

Identifying the theory that completes the SM is the main goal of today's HEP.

Flavor — a powerful instrument in indirect searches for non-SM physics.



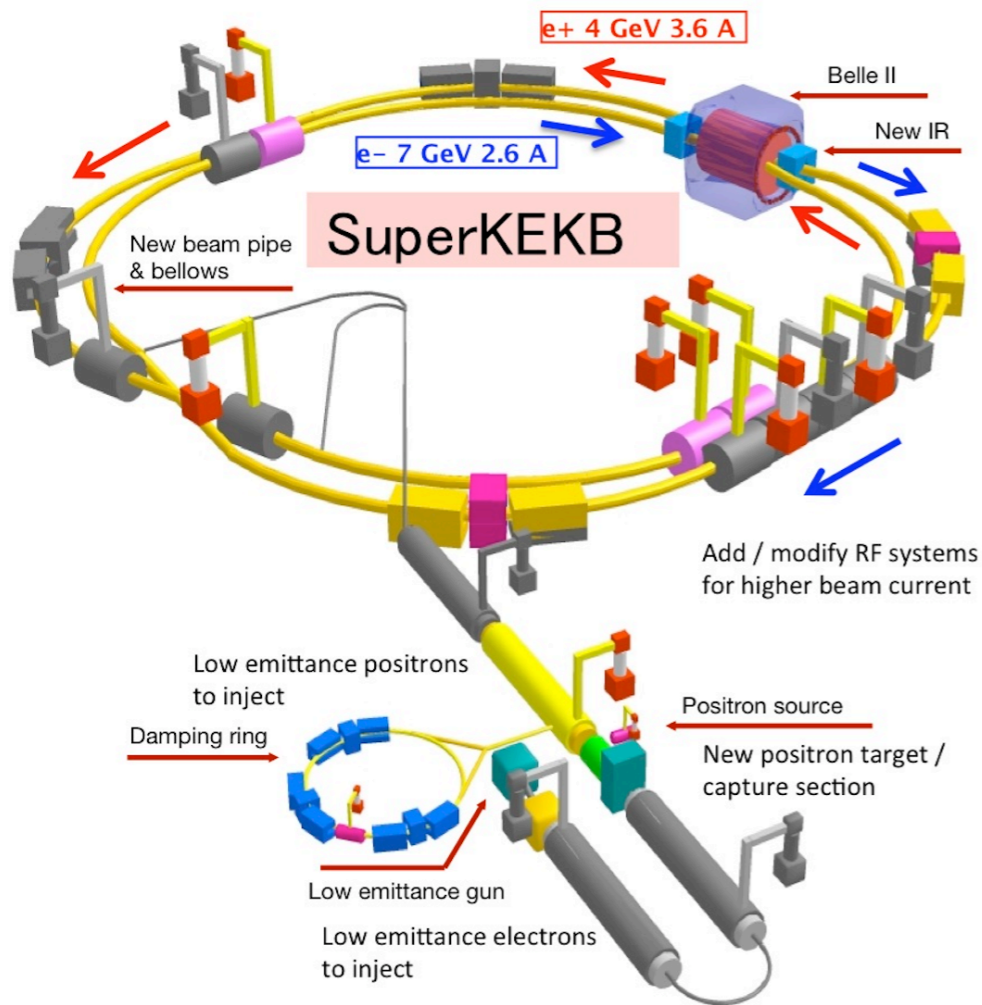
Belle II hadronic B decay program has key role:

- Reach 1° precision or better on α/φ_2 , γ/φ_3 to tighten CKM constraints;
- Probe non-SM CPV in penguin $b \rightarrow d$ and $b \rightarrow s$ transitions in $B^0 \rightarrow \eta' K^0$ and $B^0 \rightarrow \varphi K^0$.

Belle II in 2019: first 6.5 fb^{-1} collected with all the subdetectors installed and fully operational.

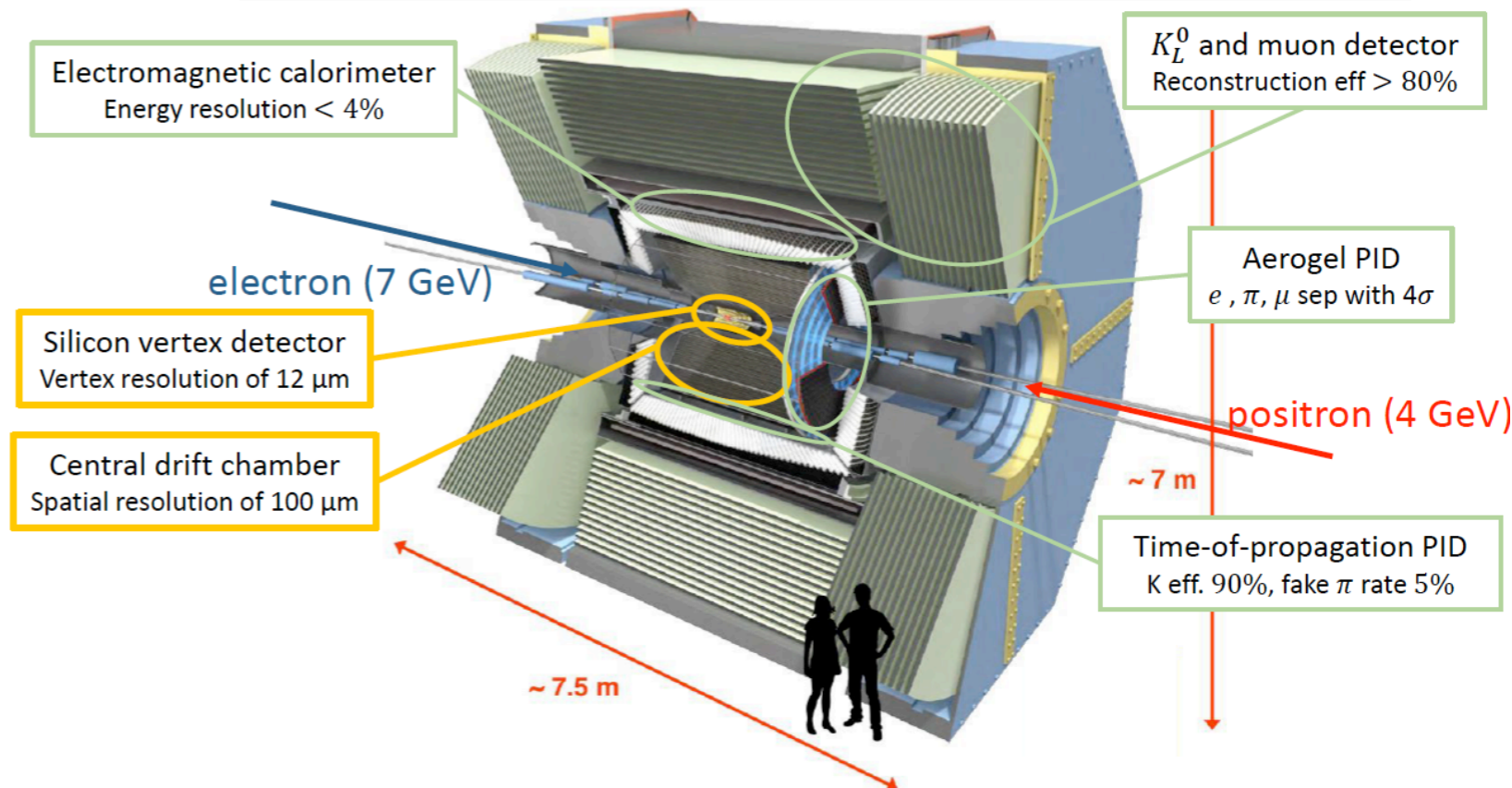
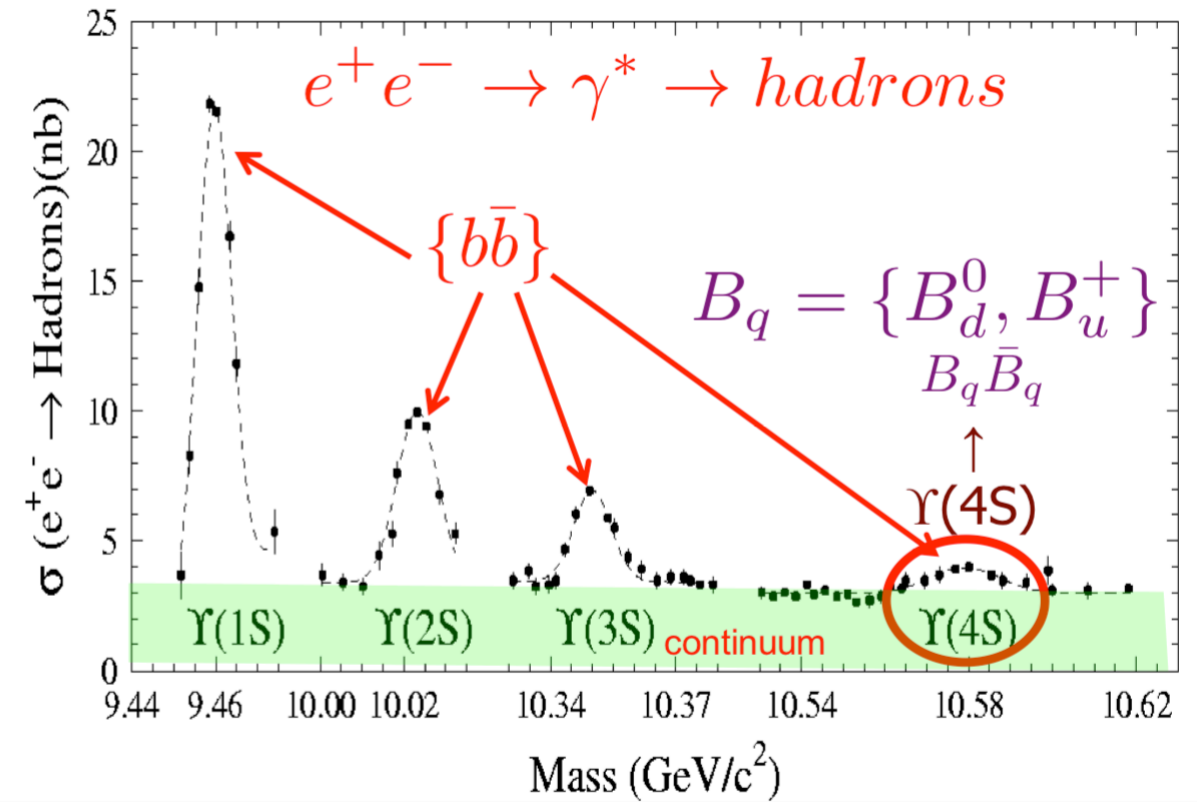
Goal: use hadronic B decays to validate various aspects of detector performance.

Belle II at SuperKEKB

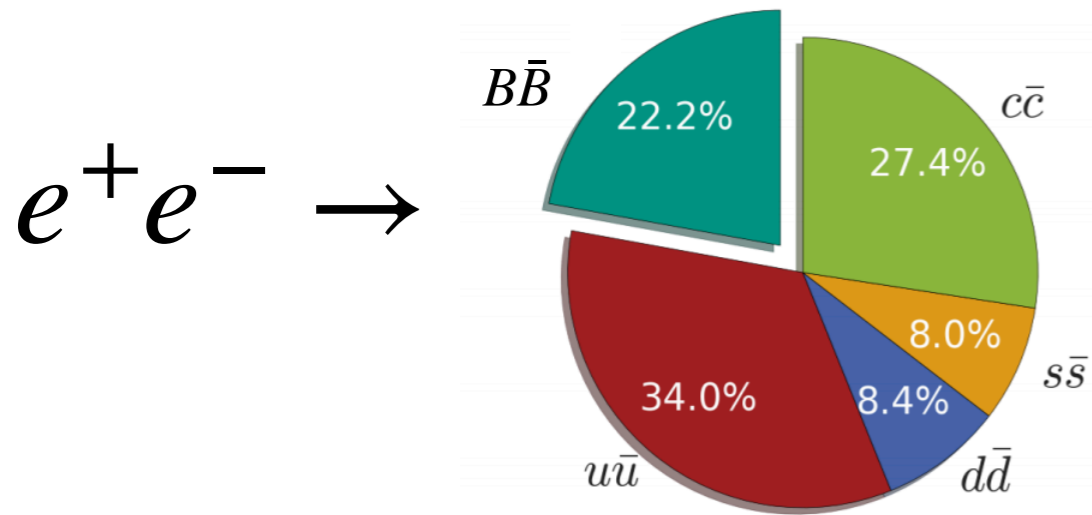


Goal: collect > 50 billion $B\bar{B}$ pairs
(50x full Belle data set)

- low background
- known collision energy
- coherent $B^0\bar{B}^0$ evolution

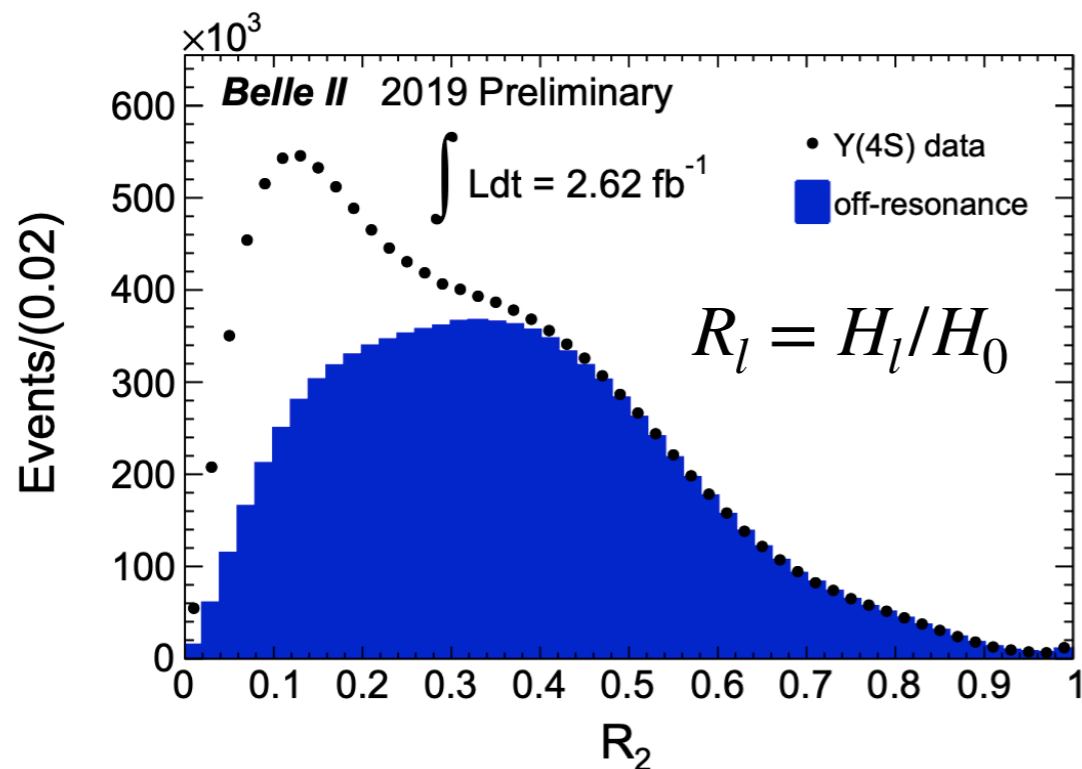
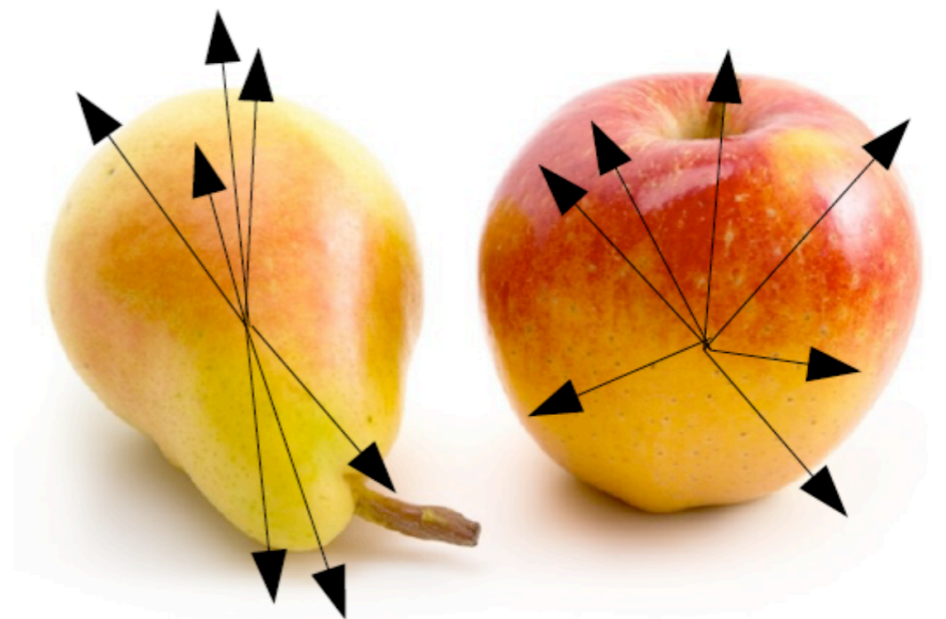


Continuum suppression



S/B ratio at production is $10^{-3} - 10^{-6}$ due to light-quark production (continuum) and BF.

Fox-Wolfram $H_l = \sum_{ij} \frac{|p_i||p_j|}{E_{vis}^2} P_l(\cos\theta_{ij})$

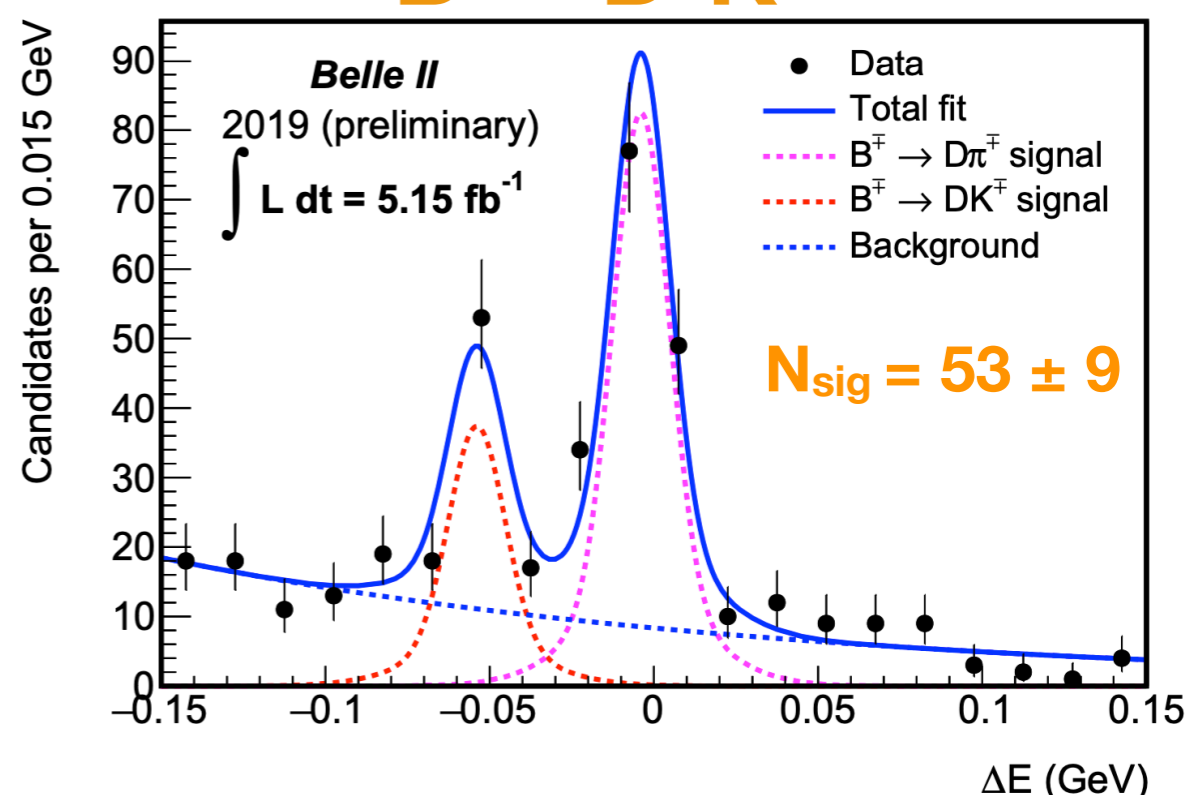
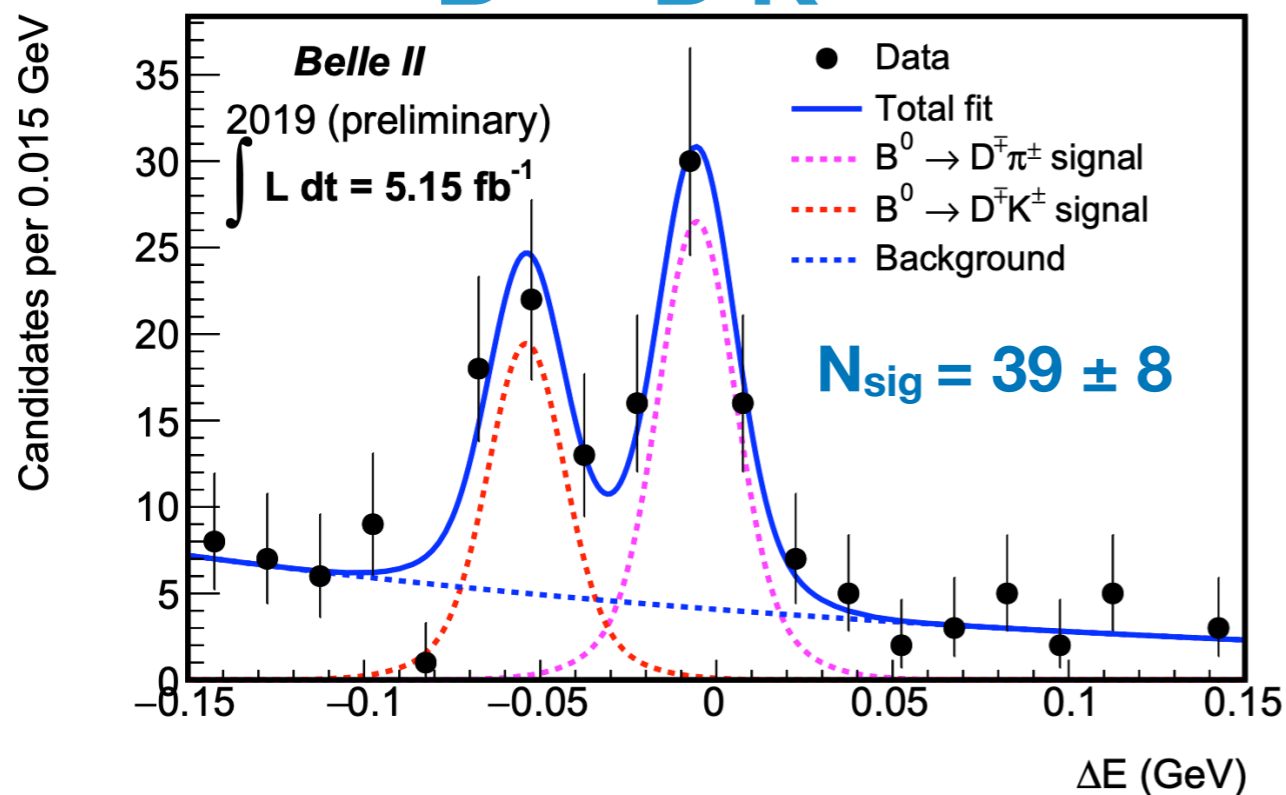
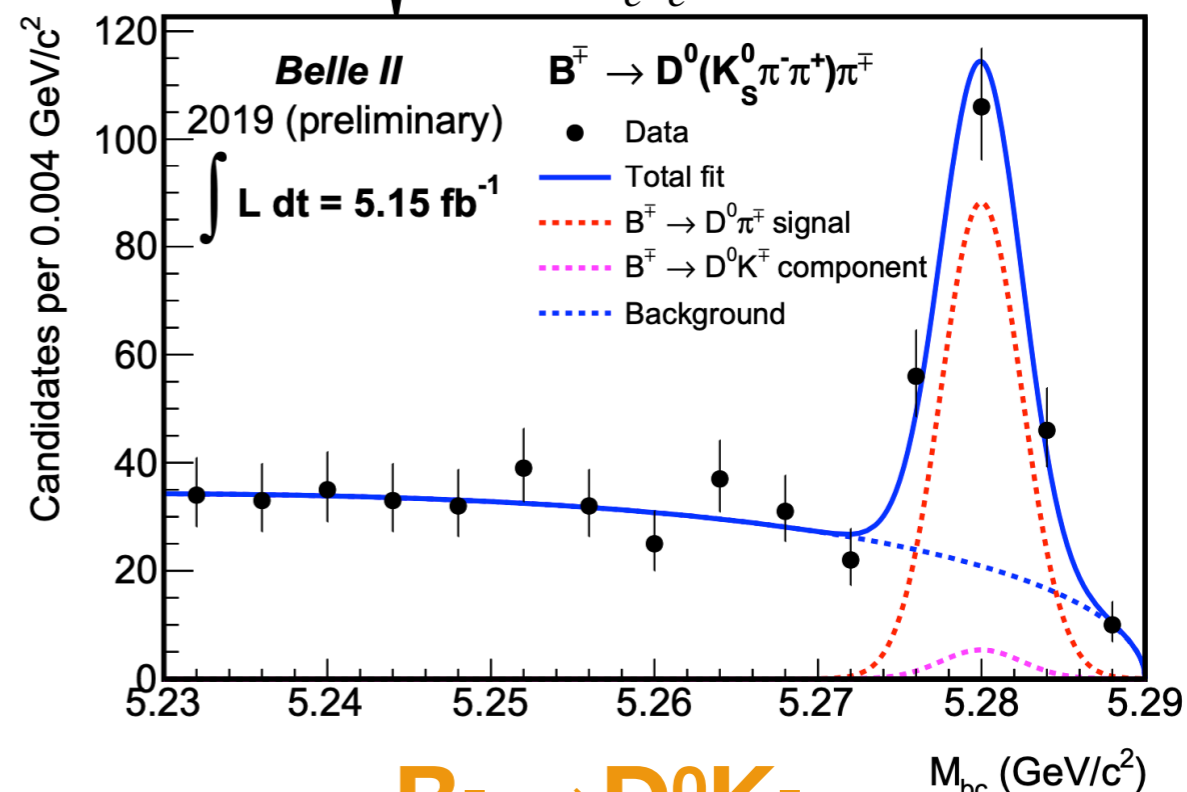
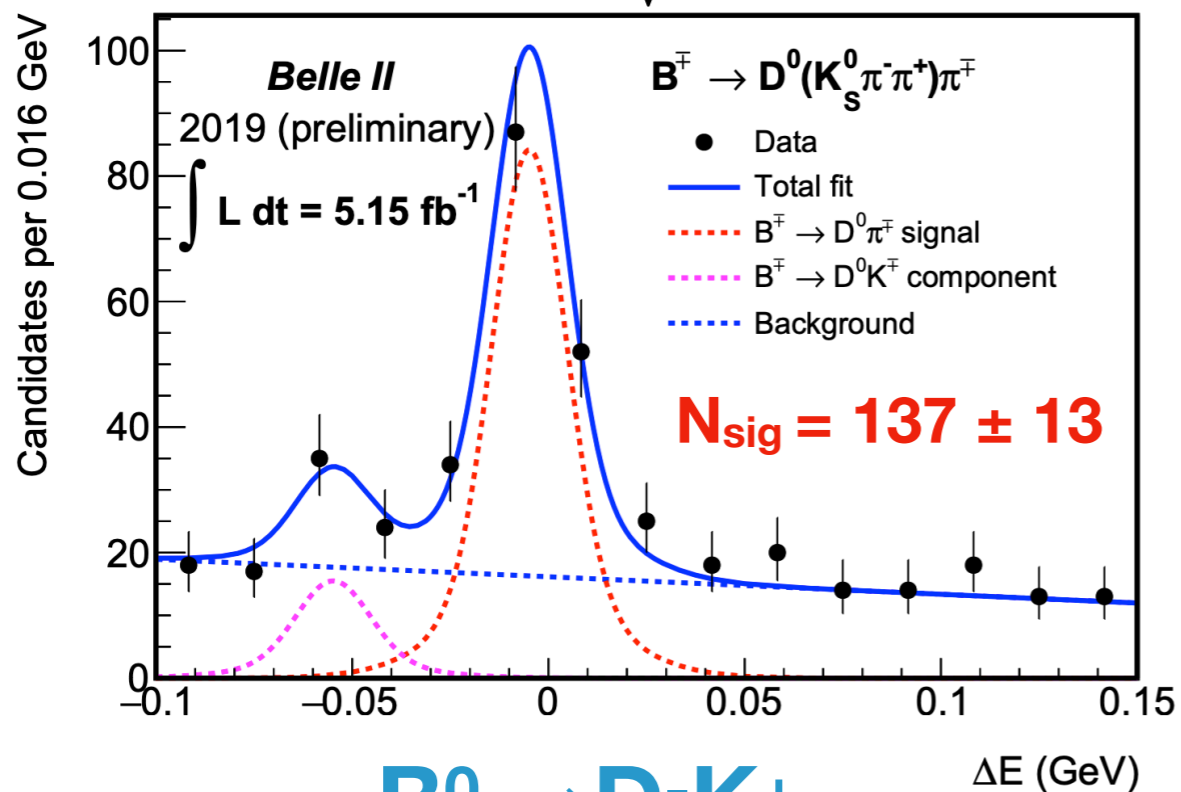


Squeeze out more information: combine nonlinearly 20+ kinematic, decay-time, PID, and topology variables to maximize S/B.

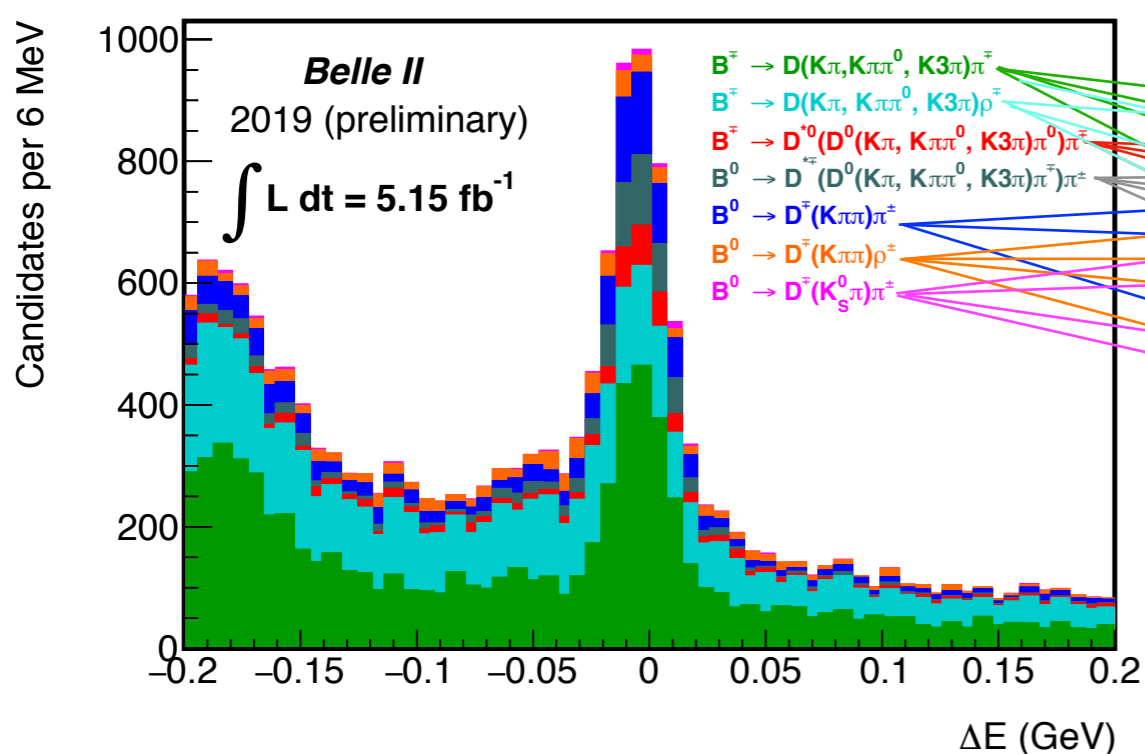
B → Dh results

$$\Delta E = \frac{p_B p_{e^+e^-} - s/2}{\sqrt{s}}$$

$$M_{bc} = \sqrt{\frac{(s/2 + \mathbf{p}_B \mathbf{p}_{e^+e^-})^2}{E_{e^+e^-}^2} - p_B^2}$$

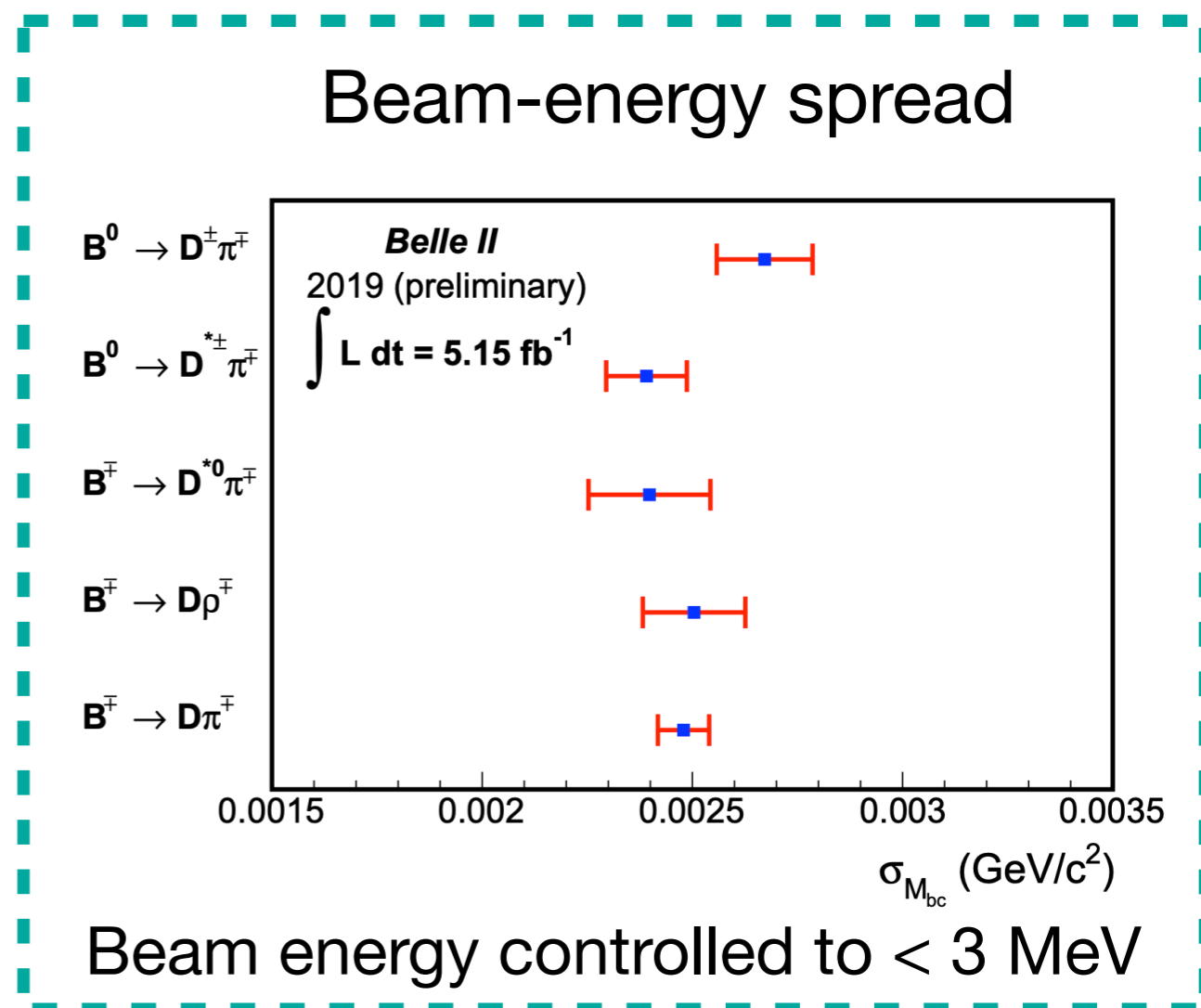
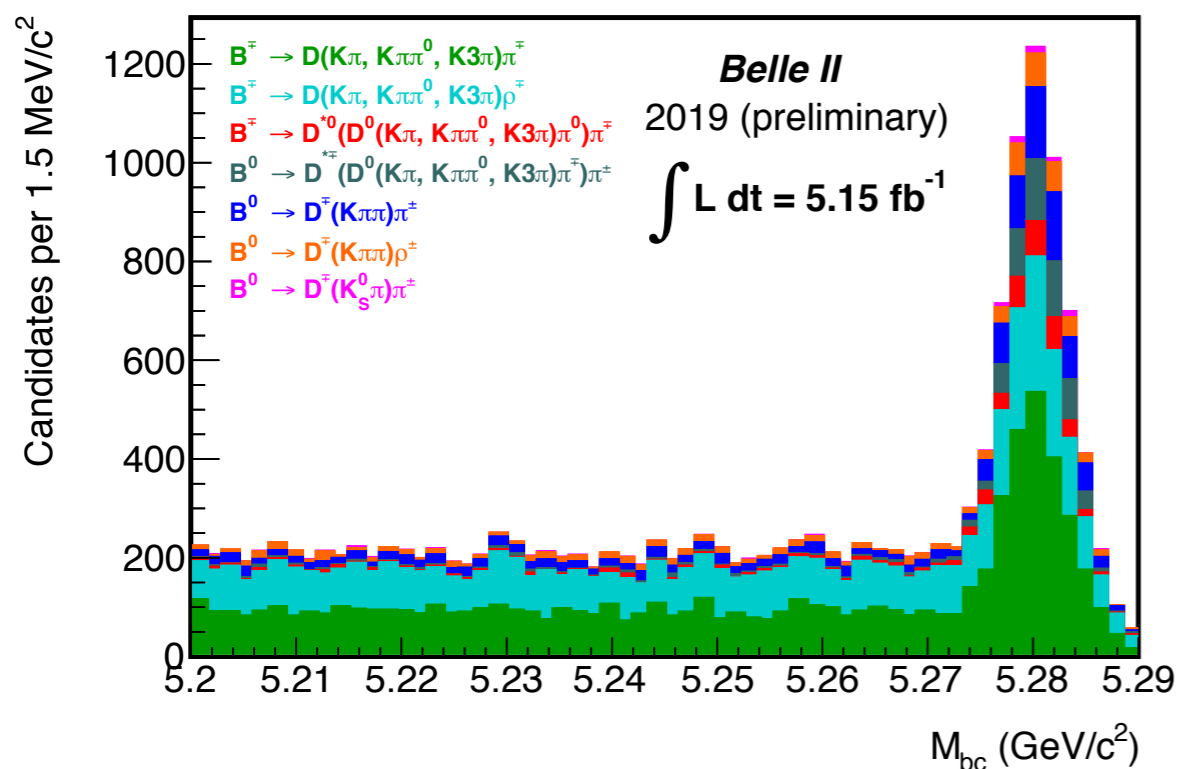


B → Dh results



Validation

- Tracking & vertexing
- Binary kaon/pion PID
- π^0 reconstruction
- K_S^0 reconstruction
- Continuum suppression

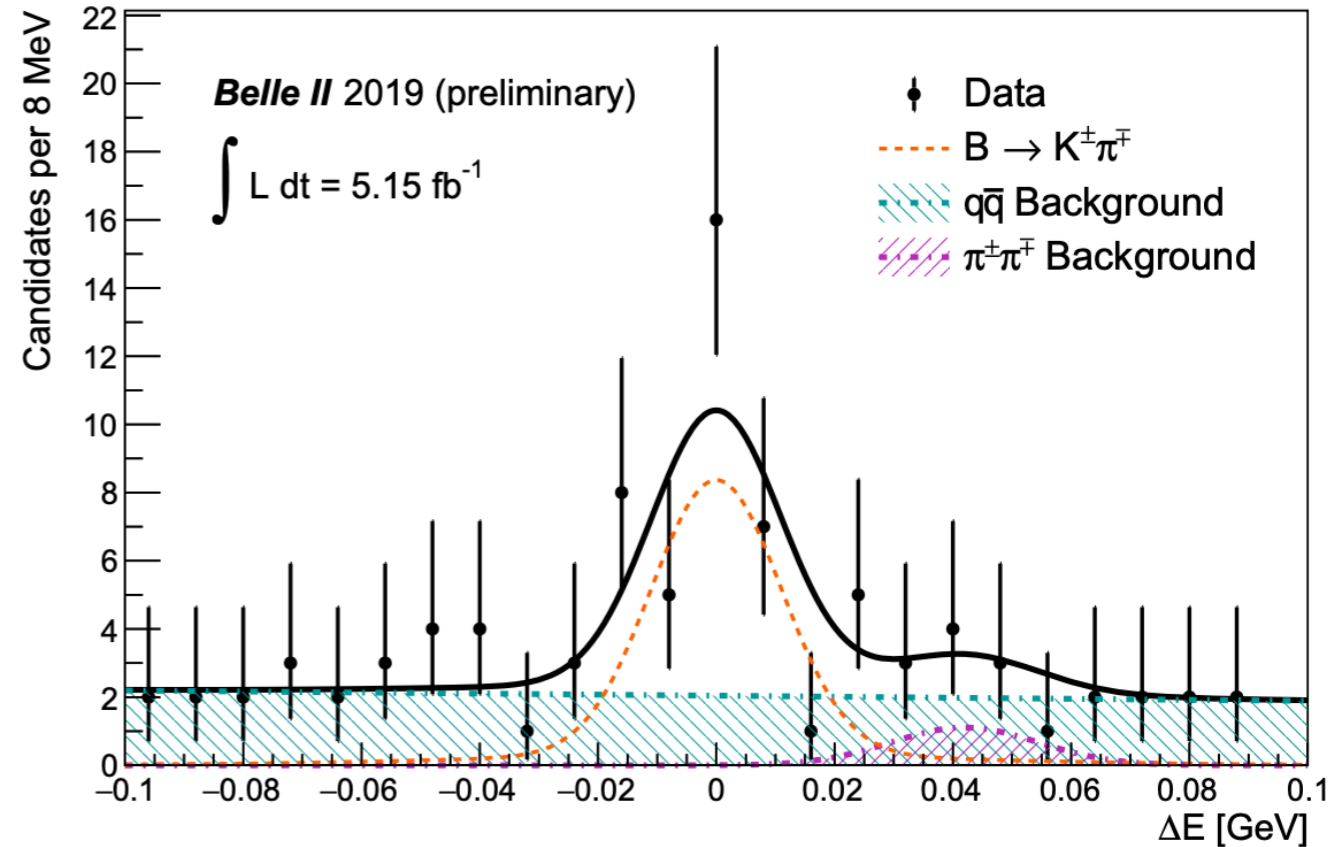
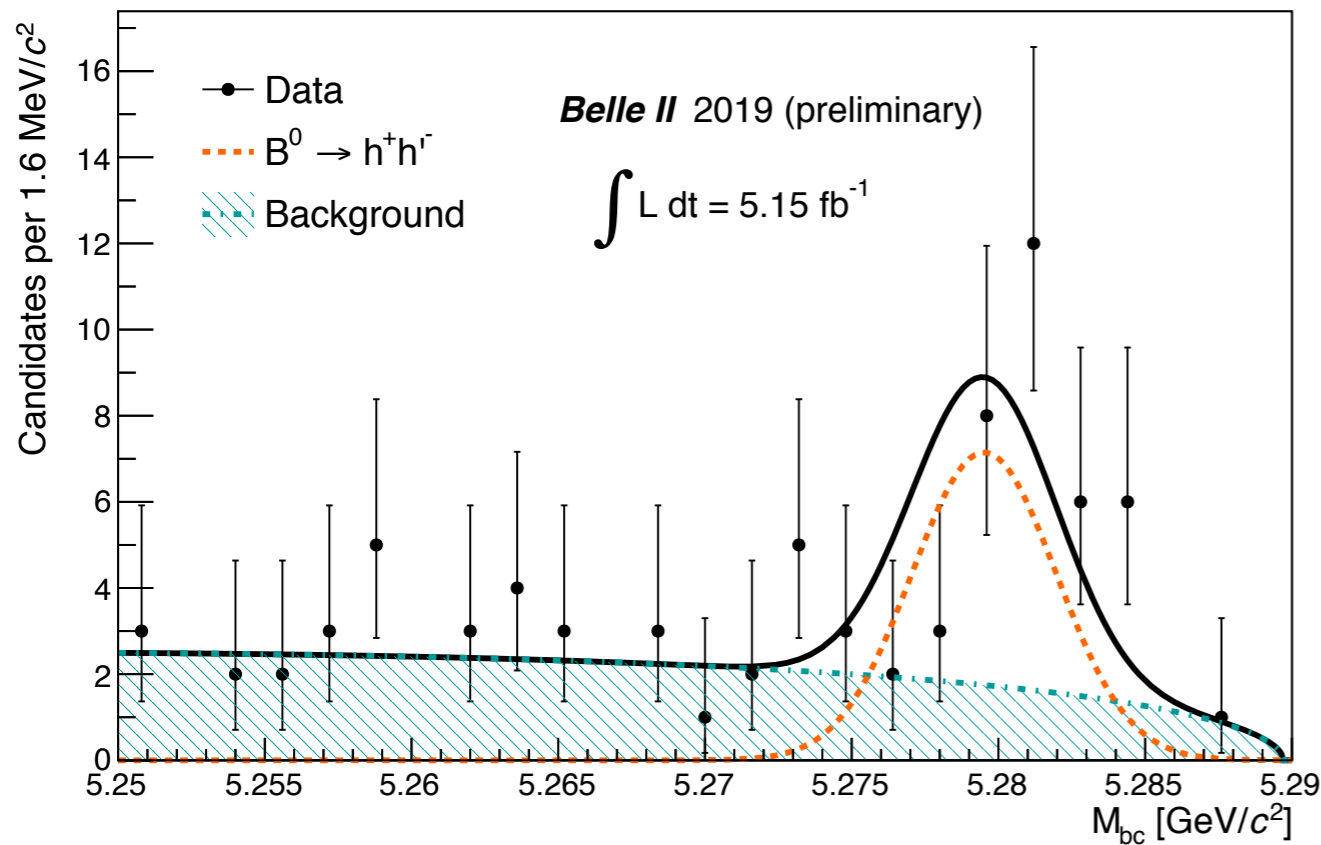


Beam energy controlled to < 3 MeV

4500 B → D^(*)h reconstructed in 5.15 fb⁻¹

First charmless from Belle II

Branching fraction $\sim 10^{-5}$.



Signal dominated by $\sim 25 B^0 \rightarrow K^+ \pi^-$ events.

Summary

- Belle II: at the forefront of indirect exploration of non-SM physics
- Hadronic B decays have a key role
- Mid-2019: first 6.5 fb^{-1} of data with complete detector offer detailed validation of performance
- Beam energy controlled to $< 3 \text{ MeV}$
- $4500 B \rightarrow D^{(*)}h$ reconstructed in 5.15 fb^{-1}
- First observation of suppressed $B \rightarrow DK$ decay in Belle II
- First observation of charmless B decays in Belle II
- Remarkable performance — Belle II is ready for physics