MAX-PLANCK-INSTITUT FÜR PHYSIK

Belle II

First Belle II results on charmless B-decays and prospects

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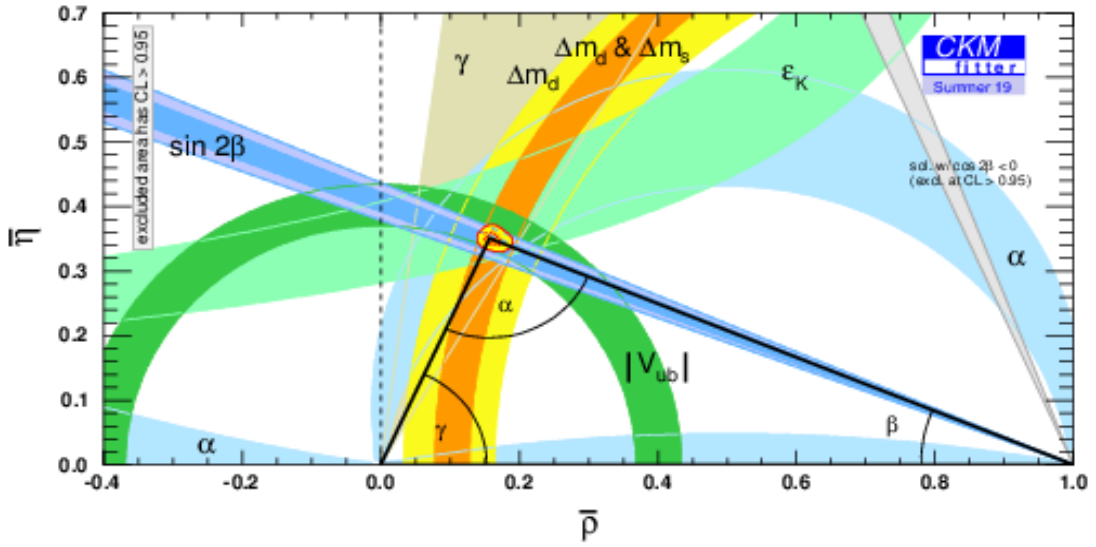
The Belle II experiment

Upgrade of the Belle experiment, located in Tsukuba, Japan

Experiment on the intensity frontier of the search for new physics (NP)

Goal:

- Perform most precise measurements of Standard Model (SM) parameters
- → Focus on CPV and extraction of CKM angles



SuperKEKB

e^+- e^- collisions at $\sqrt{s} = m\left(\Upsilon(4S)\right) = 10.58$ GeV

$\Upsilon(4S)$ decays into B-meson pair → B factory

Beam energies are asymmetric: 4 & 7 GeV → boost

Luminosity goals:

30 x Belle peak luminosity ($\mathcal{L} = 6 \times 10^{35} cm^{-2} s^{-1}$)

50 x Belle integrated luminosity ($\mathcal{L}_{int} = 50 ab^{-1}$)

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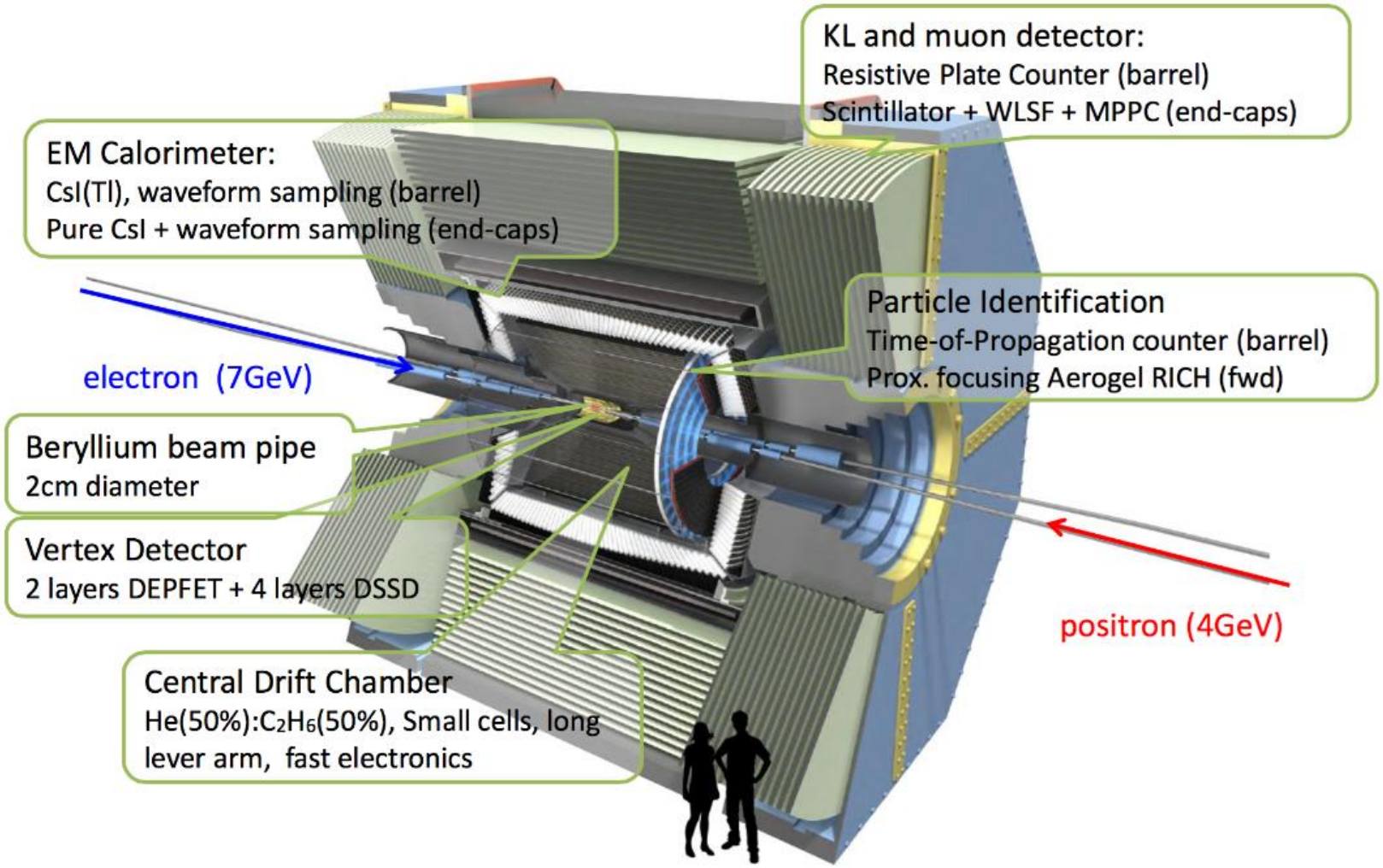
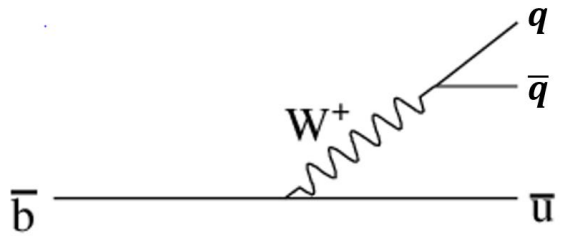
The Belle II Detector



Hadronic Charmless B-Decays



Mediated by Cabibbo-suppressed $b \to u$ trees and $b \to d, s$ penguins

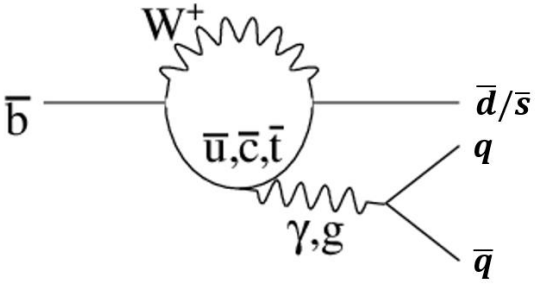
Belle II goals:

Potentially find NP in loop contributions

Extraction of α/φ_2 from $B \to \pi\pi$ system

Test SM using isospin sum rules

Investigate puzzling A_{CP} measurements in $B \to K\pi$ system



Short term:

Achieve first BR and direct CPV measurements using $34.6\ fb^{-1}$

→validate detector and analysis tools

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Analysis Strategy

1. **Reconstruction**

   combine candidates in kinematic fits to fill list of B-meson candidates

2. **Selection**

   loose baseline selection followed by optimized continuum suppression and particle identification cuts

3. **Modelling**

   use simulated data (MC) to model relevant features in

   determine selection efficiencies for BR calculations

4. **Fit to data & calculate physics quantities**

5. **Assess systematic uncertainties**

Continuum Suppression

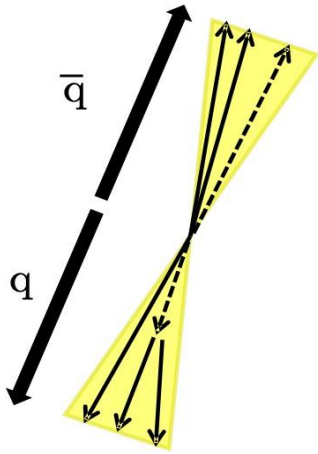
$\Gamma(q\bar{q})$: $\Gamma(\Upsilon(4S)) = 3:1$ at $\sqrt{s} = 10.58$ GeV

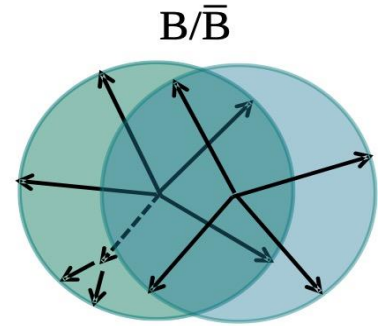
Exploit differences in the decay shapes of continuum $(q\bar{q})$ and $B\bar{B}$ events

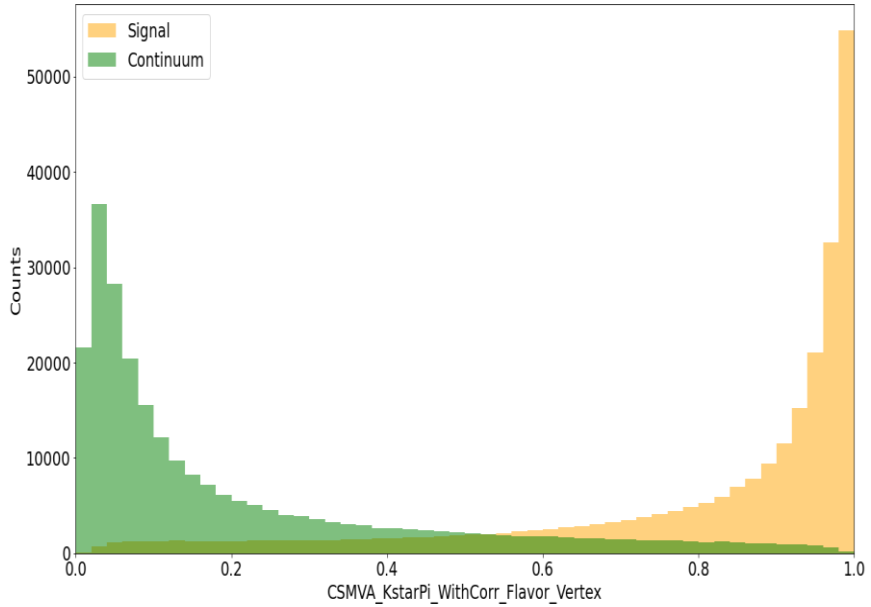
Train boosted decision tree with 39 event variables to create combined continuum suppression variable (CSV)

Simultaneously optimize CSV and PID using

$$FOM = \frac{S}{\sqrt{S+B}}$$







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Results

	BR $[10^{-6}]$	A_{CP}
$B^0 \to K^+\pi^-$	$18.9 \pm 1.4(stat.) \pm 1(syst.)$	$0.030 \pm 0.064(stat.) \pm 0.008(syst.)$
$B^+ \to K^+\pi^0$	$12.7^{+2.2}_{-2.1}(stat.) \pm 1.1(syst.)$	$0.052^{+0.121}_{-0.119}(stat.) \pm 0.022(syst.)$
$B^+ \to K^0\pi^+$	$21.8^{+3.3}_{-3.0}(stat.) \pm 2.9(syst.)$	$-0.072^{+0.109}_{-0.114}(stat.) \pm 0.024(syst.)$
$B^0 \to K^0\pi^0$	$10.9^{+2.9}_{-2.6}(stat.) \pm 1.6(syst.)$	
$B^0 \to \pi^+\pi^-$	$5.6^{+1.0}_{-0.9}(stat.) \pm 0.3(syst.)$	
$B^+ \to \pi^+\pi^0$	$5.7 \pm 2.3(stat.) \pm 0.5(syst.)$	$-0.268^{+0.249}_{-0.322}(stat.) \pm 0.123(syst.)$
$B^+ \to K^+K^-K^+$	$32.0 \pm 2.2(stat.) \pm 1.4(syst.)$	$-0.049 \pm 0.063(stat.) \pm 0.022(syst.)$
$B^+ \to K^+\pi^-\pi^+$	$48.0 \pm 3.8(stat.) \pm 3.3(syst.)$	$-0.063 \pm 0.081(stat.) \pm 0.023(syst.)$

Charmless Note: https://docs.belle2.org/record/2117/files/BELLE2-CONF-PH-2020-012.pdf

Conclusion and Outlook

First measurement of BRs and direct CPVs of charmless B-decays at Belle II

Results are in agreement with current world averages, but errors are still large

Results with more sophisticated analysis and a data set of $62.8\ fb^{-1}$ presented at Moriond and more to come!