Study of the decay $D^0 \to K_S^0 K_S^0$ at Belle and its Belle II projection & SVD beam background at Belle II

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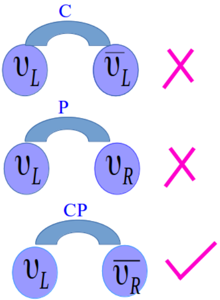
April 17, 2018

Outline

Introduction



- CP Violation: Physics is not symmetric under *CP* conjugate systems
- In Standard Model, *CP* symmetry is slightly violated by weak interaction
- CP Violation is first observed in neutral Kaon meson System
- CP violation is measured the asymmetry of matter-antimatter

Kinds of CP Violation (CPV) :

1. Direct CP violation (neutral and charged D, mode dependent)

   - CPV in decay: $A_d \equiv \frac{|A_f|^2 - |\bar{A}_{\bar{f}}|^2}{|A_f|^2 + |\bar{A}_{\bar{f}}|^2} \Big\}$ occurs if $A_d \neq 0$, through time- integrated asymmetries = $\frac{\Gamma(D \to f) - \Gamma(\bar{D} \to \bar{f})}{\Gamma(D \to f) + \Gamma(\bar{D} \to \bar{f})}$

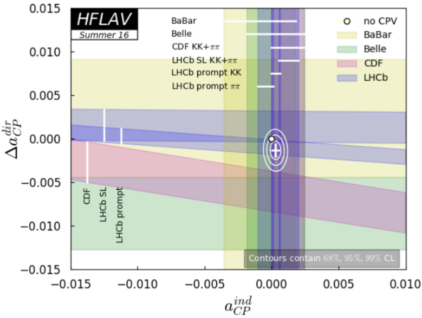
2. Indirect CP violation (neutral D only, common for all decay modes)

   - CPV in mixing : $A_m \equiv \frac{|q/p|^2 - |p/q|^2}{|q/p|^2 + |p/q|^2}$
   - CPV in interference through : ϕ = arg $\left(\frac{q\bar{A}_{\bar{f}}}{pA_f}\right)$

   $\Big\}$ occurs if |q/p| $\neq$ 1 or CPV phase $\phi \neq 0$

Introduction ...

- Mixing in the up-quark sector only occurs for D^0 meson
- mass eigenstates : $|D^0_{1,2}\rangle = p\,|D^0\rangle \pm q\,|\bar{D}^0\rangle$, $x = \Delta M/\Gamma$, $y = \Delta\Gamma/2\Gamma$
- Asymmetry in time- integrated decay rates :
  $A^f_{\rm CP}(t) = \frac{\Gamma(D\to f)-\Gamma(\bar{D}\to \bar{f})}{\Gamma(D\to f)+\Gamma(\bar{D}\to \bar{f})} \approx A^{\rm dir}_{\rm CP} + A^{\rm ind}_{\rm CP}\frac{t}{D}$ with
  $A^{\rm ind}_{\rm CP} = -A_\Gamma(\text{universal})$
- *CP* violation in charm sector is expected to be $\mathcal{O}(0.1)\%$ in SM since most of the charm decays are well described by the first two quark generation.
- In 2012, LHCb and CDF measured an unexpectedly high value of $\Delta A_{CP} = A_{CP}(D^0 \to KK) - A_{CP}(D^0 \to \pi\pi)$



$A^{\rm ind}_{CP} = (0.030 \pm 0.026)\%$

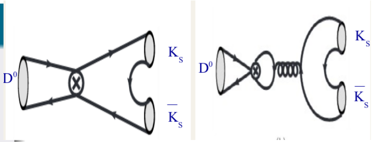
$\Delta A^{\rm dir}_{CP} = (-0.134 \pm 0.070)\%$

- Compatible with 0 with P = 0.093.
- BaBar and Belle provide contribution competitive with hadronic experiments.

Motivation

Theory status

- Predict *CP* asymmetry of the order of 1% or even larger...
- Required penguin enhancement to accommodate all data on CPV can be even more larger
  [G. Hiller et al., PRD 87, 014024(2013)]
- SCS decays (such as $D^0 \to K^0_S K^0_S$) are special interest
- SM limit of 1.1% (Upper Limit 95% confidence level)
  [U. Nierste and A. Schacht, PRD 92 (2015) 054036]



Tree   Penguin annihilation

Expt. status

- CLEO 13.7 fb^{-1} A_{CP} = ($-23\pm$ 19)% [PRD 63, 071101 (2001)]
- LHCb 3 fb^{-1} A_{CP} = ($-2.9 \pm 5.2 \pm 2.2$)%[JHEP 10 (2015) 055]
  No result from Belle and BaBar till now
- Neutral modes not easy for LHCb, limited results from CLEO
- Belle is very capable to measure neutral final states
  - $A_{CP}(D^0 \to \pi^0\pi^0) = [-0.03 \pm 0.64 \pm 0.10]\%$
  - $A_{CP}(D^0 \to K^0_S\pi^0) = [-0.21 \pm 0.16 \pm 0.07]\%$

- Expected error on asymmetry to be 2% based on CLEO error estimation
- World-Average of $\mathcal{B}$ ($D^0 \to K^0_S K^0_S$)
  $(1.8 \pm 0.4)10^{-4}$
- Recently BESIII $(1.67 \pm 0.11 \pm 0.11)10^{-4}$

[N. K. Nisar et al., PRL 112 (2014) 211601]

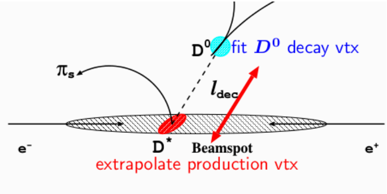
Introduction ...

objectives

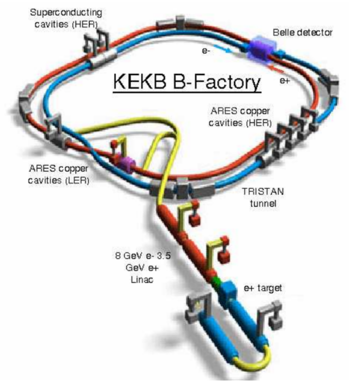
- Measure BF ratio and BF of $D^0 \to K_S^0 K_S^0$
- Time-integrated CP violation asymmetry in the decay $D^0 \to K_S^0 K_S^0$

} Using a normalization mode ($D^0 \to K_S^0 \pi^0$)

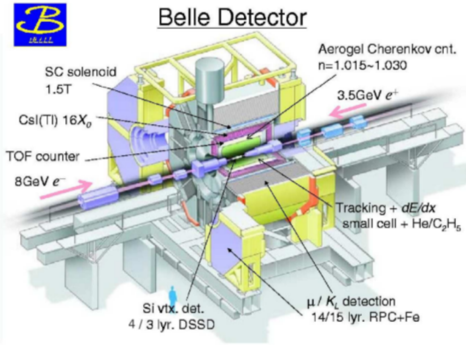
- Usually using $D^{*\pm} \to D^0 \pi_s^\pm$
  - flavor tagging by slow π charge
  - provides also considerable background suppression
- Observable:ΔM : reconstructed mass difference of D^* and D^0
- The slow pion is constrained to originate from the IP in order to improve the ΔM resolution.



Belle Detector



NIM A 479 (2002) 117-232



$$e^+e^- \to \Upsilon(4S) \to B\bar{B} \quad 1.1\text{nb}$$
$$e^+e^- \to c\bar{c} \quad 1.3\text{nb}$$

Data used $\Upsilon(4S)\&\Upsilon(5S)$ **(921 fb^{-1})**

Overviews & methods

- Raw asymmetry :

$$A_{\rm rec}(A_{\rm raw}) = \frac{N_{\rm rec}^{D^{*+}\to D^0\pi_s^+} - N_{\rm rec}^{D^{*-}\to \bar{D}^0\pi_s^-}}{N_{\rm rec}^{D^{*+}\to D^0\pi_s^+} + N_{\rm rec}^{D^{*-}\to \bar{D}^0\pi_s^-}} = \frac{N(D^0)-N(\bar{D}^0)}{N(D^0)+N(\bar{D}^0)} = A_{\rm CP} + A_{\rm FB} + A_\epsilon^{\pm} + A_\epsilon^K$$

- $A_{\rm CP}$: *CP* asymmetry
- $A_{\rm FB}$: forward-backward production asymmetry
- $A_\epsilon^{\pm}$: Asymmetry in π_s detection
- A_ϵ^K : Asymmetry in interaction of $K^0/\bar{K}^0$

($A_{\rm FB}$ and $A_\epsilon^{\pm}$:) Independent on final states

$$A_{\rm CP}^{D^0\to K_S^0K_S^0} = (A_{\rm rec}^{D^0\to K_S^0K_S^0} - A_{\rm rec}^{D^0\to K_S^0\pi^0}) + A_{\rm CP}^{D^0\to K_S^0\pi^0} + A_\epsilon^K$$

$A_{\rm CP}$ measurement

Normalization mode cancels common systematics and common independent terms

$A_{\rm CP}^{D^0\to K_S^0\pi^0} = (-0.20 \pm 0.17)\%$

[C. Patrignani et al. Chin. Phys. C 40, 100001 (2016)]

$A_\epsilon^K = (-0.11 \pm 0.01)\%$

[B.R. Ko et al., Phys. Rev. D 84 (2011) 111501]

- Yield (N) = $\mathcal{L} \times \sigma(e^+e^- \to c\bar{c}) \times \mathcal{B}(c\bar{c} \to D^{*\pm}X) \times \mathcal{B}(\rm Decay) \times$ efficiency
- $$\frac{\mathcal{B}(D^0\to K_S^0K_S^0)}{\mathcal{B}(D^0\to K_S^0\pi^0)} = \frac{N(D^0\to K_S^0K_S^0)}{N(D^0\to K_S^0\pi^0)} \times \frac{\epsilon(D^0\to K_S^0\pi^0)}{\epsilon(D^0\to K_S^0K_S^0)}$$

Branching ratio measurement

Results & interpretation

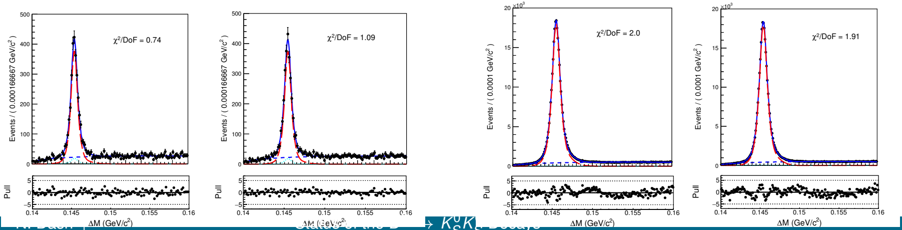
- Optimized in the SR of M_D and ΔM (2.5σ)
- $6 \times \mathcal{L}$ Generic MC samples used
- Signal scaled by $\mathcal{B}_{\rm PDG}/\mathcal{B}_{\rm MC}$ and $\mathcal{L}$
- Background scaled by correction factor data/MC in ΔM SB and $\mathcal{L}$

$$\text{FOM} = \frac{N_{\rm signal}}{\sqrt{N_{\rm signal}+N_{\rm background}}}$$

- PDF : Signal (Gauss + Gauss + Bif-Gauss)+ Peak. Bkg(as signal)+ combinatorial Bkg. (Th. function)

Variables	cuts
dr	< 1 cm
|dz|	< 3 cm
KID	< 0.6
$\|M_{\pi\pi} - m_{K_S^0}\|$	< 15 MeV
M_{D^0}	[1.847, 1.882] GeV
$P^*_{D^*}$	> 2.2 GeV

- 85% Bkg. rejection with 26% sig. loss
- Multiplicity found 8.6%
  Best candidate selection performed with vertex of K_S^0 with 98% efficient.
- Peaking background : estimated in K_S^0 mass SB



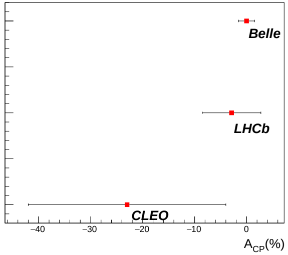
Results...

- selection efficiency : (11.04 $\pm$ 0.02)% (weighted according to E & $\mathcal{L}$ [(12.60 $\pm$ 0.02)% normalization mode]
- N= 5399 $\pm$ 87 , Araw = (+ 0.45$\pm$ 1.53)%
- N= 537360$\pm$ 833 , Araw = (+ 0.16 $\pm$ 0.14)%
- A_{CP} = ($-$0.02$\pm$ 1.53 (stat. only))%
- $\mathcal{B}$ done @ P_{D*} >2.5GeV $\Big($ eff. (9.74 $\pm$ 0.02)% and (11.11 $\pm$ 0.02)% , and corresponding yields are 4755 $\pm$ 79 and 475439 $\pm$ 767$\Big)$
- corrected efficiency for K_S^0 and π^0
- Systematics are dominated by external input

Source	A_{CP} (%)	$\mathcal{B}$ (%)
$D^0 \rightarrow K_S^0 K_S^0$ PDF parametrization	$\pm$0.01	$\pm$0.3
$D^0 \rightarrow K_S^0 \pi^0$ PDF parametrization	$\pm$0.00	$\pm$0.2
$D^0 \rightarrow K_S^0 K_S^0$ peaking background	$\pm$0.01	$\pm$0.6
$D^0 \rightarrow K_S^0 \pi^0$ peaking background	$\pm$0.00	$\pm$0.03
$K^0 / \bar{K}^0$ material effects	$\pm$0.01	-
K_S^0 reconstruction efficiency	-	$\pm$1.57
π^0 reconstruction efficiency	-	$\pm$2.16
Quadratic sum of above	$\pm$0.02	$\pm$2.76
External input ($D^0 \rightarrow K_S^0 \pi^0$ mode)	$\pm$0.17	$\pm$3.30

Discussion

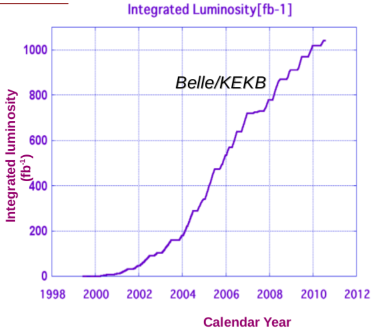
- Most sensitive measurement
- getting closer to theory limit ($\leq$ 1.1%)
- Probing region of interest

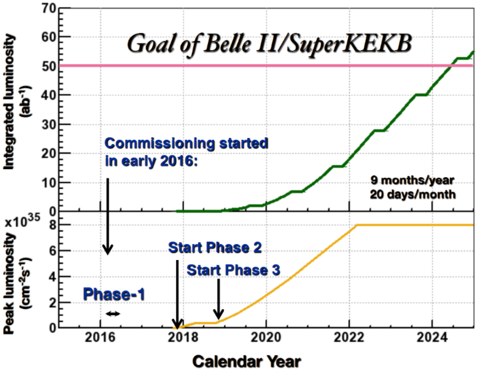


Results

- A_{CP} = (-0.02 $\pm$ 1.53 $\pm$ 0.02 $\pm$ 0.17)%
- $\frac{\mathcal{B}(D^0 \to K_S^0 K_S^0)}{\mathcal{B}(D^0 \to K_S^0 \pi^0)}$ = (1.101 $\pm$ 0.023 $\pm$ 0.030)%,
- $\mathcal{B}(D^0 \to K_S^0 K_S^0) = (1.321 \pm 0.023 \pm 0.036 \pm 0.044) \times 10^{-4}$. **[N. Dash *et al.* Phys. Rev. Lett. 119 (2017) 171801]**

KEKB→ *SuperKEKB*



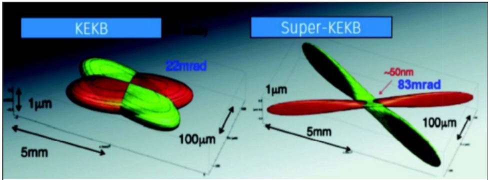


New physics opportunities :

- Precise measurement of UT parameters
- Search for charged Higgs
- New sources of *CP* violation
- Lepton Flavour Violation in *B* and τ decays
- New physics search in missing energy modes of *B* decays Search for Dark matter, etc..
- New QCD phenomena (XYZ, new states including heavy flavors) + more

L_{int} = 50 ab^{-1} (50 $\times$ KEKB)
L_{peak} = 8 X $10^{35} cm^{-2} s^{-1}$ (40$\times$ KEKB)

Ingredients for Success



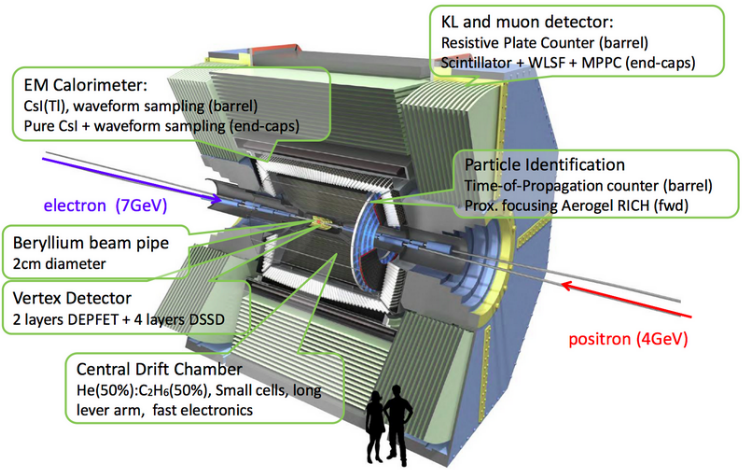
$$L = \frac{\gamma_{\pm}}{2 e r_e}\left(1+\frac{\sigma_y^*}{\sigma_x^*}\right)\left(\frac{I_{\pm}\xi_{y\pm}}{\beta_{y\pm}^*}\right)\left(\frac{R_L}{R_{\xi y}}\right) \propto \frac{I_{\pm}\xi_{y\pm}}{\beta_{y\pm}^*}$$

	KEKB design	KEKB Achieved: with crab	SuperKEKB	Unit
Energy	3.5/8.0	3.5/8.0	4.0/7.0	GeV
β_y^*	10/10	5.9/5.9	0.27/0.30	mm
β_x^*	330/330	1200/1200	32/25	mm
ε_x	18/18	18/24	3.2/5.3	nm
x-y coupling ($\varepsilon_y/\varepsilon_x$)	1	0.85/0.64	0.27/0.24	%
σ_y^*	1.9	0.94	0.048/0.062	μm
ξ_y	0.052	0.129/0.090	0.09/0.081	
σ_z	4	6-7	6/5	mm
I	2.6/1.1	1.64/1.19	3.6/2.6	A
N_{bunch}	5000	1584	2500	
Luminosity	1	2.11	80	10^{34} cm^{-2}s^{-1}

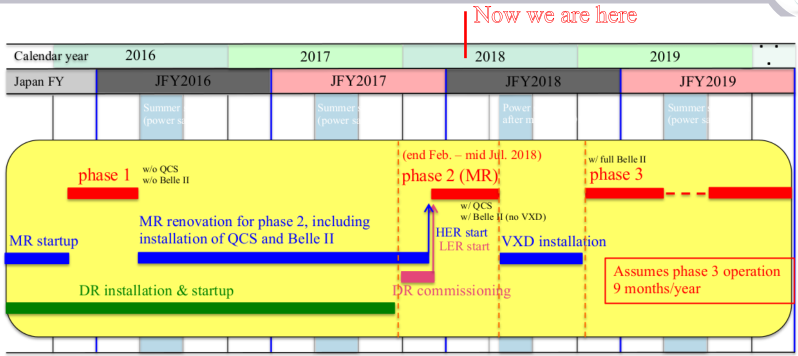
Beam current: $\times 2$

Beam size: 1/20

BelleII Detector



Schedule



Phase 1
without QCS or Belle II

Vacuum scrubbing
Basic machine tuning
… Finished in success

Phase 2
with QCS and Belle II
without VXD
Background study
Luminosity tuning
(target: 1 x 10^{34} /cm^2/s)

Phase 3
Physics run

Luminosity tuning
(target: 8 x 10^{35} /cm^2/s)

Belle II prospects of $D^0 \to K_S^0 K_S^0$

Improvement @ Belle II

- K_S^0 , π^0 and slow pions reconstruction efficiency
- Clean experimental environment
- The outer radius of the SVD detector has been significantly increased from 8.8 to 14.0 cm
- Large various of SVD will allow % more K_S^0 candidates whose daughters have associated SVD hits

- Expect similar systematic error in Belle II
- irreducible sys. err. due to the neutral K interactions in the material (0.01×10^{-2})
- Large fraction of systematics will be reduced With higher statistics
- Dominant error arises from A_{CP} measurements of $D^0 \to K_S^0 \pi^0$ errors on $D^0 \to K_S^0 \pi^0$ will reduce with increased statistics at Belle II

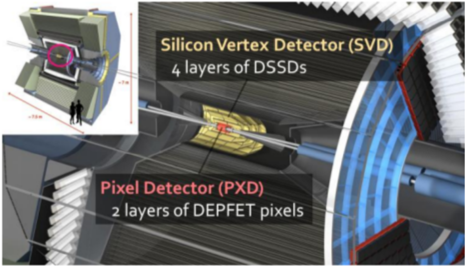
$$\sigma_{BelleII}^{Total} = \sqrt{(\sigma^2_{Stat.} + \sigma^2_{Syst.}(red.)) \times (\mathcal{L}^{Belle}_{int} / \mathcal{L}^{BelleII}_{int}) + \sigma^2_{ired.}}$$

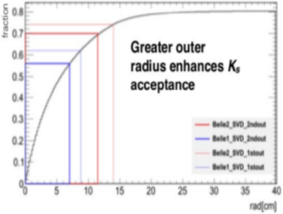
$\mathcal{L}$	Statistically (%)	Systematically (%)		Total (%)
		Red.	irred.	
921 fb^{-1}	1.53	0.17	0.01	1.54
5 ab^{-1}	0.66	0.003	0.01	0.66
50 ab^{-1}	0.21	0.03	0.01	0.21

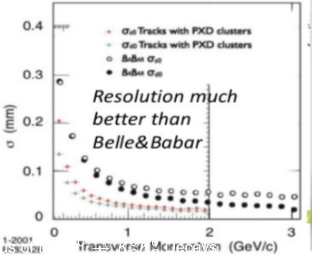
- Expected precision on A_{CP} will be 0.2% @ Belle II (with same K_S^0 efficiency)
- Probe for NP

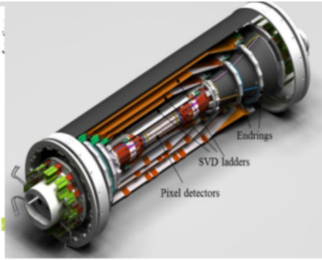
Belle II Vertex Detector

- A vertexing and inner tracking system:
- Determine the vertex position of the weakly decaying particles
- Precisely measure the track position and momentum for low p_T tracks
- Critical component for CPV measurement
- New vertex detectors: * PXD: 2-layer pixel detector based on DEPFET (Depleted P-channel Field Effect Transistor) technology. * SVD: 4-layer DSSD (Double Sided Silicon Detector)
- Smaller beam pipe radius =1cm (2cm $\rightarrow$ 1.5cm @ Belle)
- Larger outer radius : Improved K_S^0 acceptance
- Excellent performance (position resolution, efficiency)



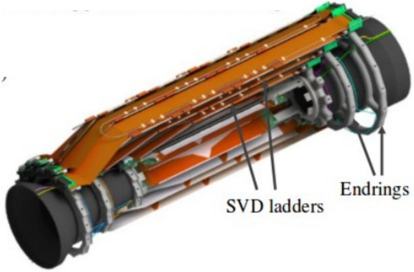


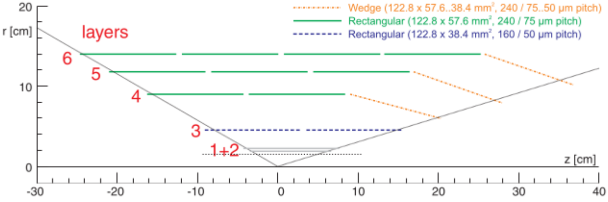


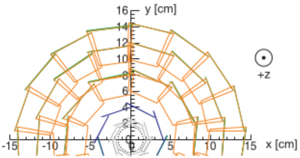


Belle II Silicon Vertex Detector

- SVD is important for efficient reconstruction of low p_T tracks from D^* and K^0_S
- 4 layers of DSSD sensors (DSSD: low material budget).
- Slant FW region (material budget reduction)
- Angular acceptance : $17^0 < \theta < 150^0$
- Radii : 38 mm, 80 mm, 115 mm & 140 mm
- SVD length : $\sim$ 650 mm
- Excellent time resolution ($\sigma \sim$2-3 ns), impact parameter ($\sim$20 μm)







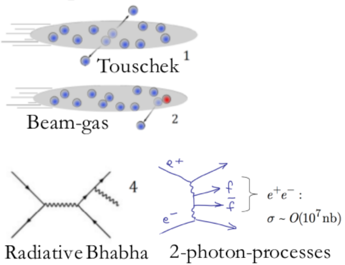
Beam Background simulation

- Smaller beam pipe radius =1cm (2cm 1.5cm @ Belle)
- Larger outer radius : Improved K_S^0 acceptance
- Excellent performance (position resolution, efficiency) confirmed in beam test at DESY.
- Among the technical challenges at Belle2, there are beam backgrounds
- In Belle/KEKB, unexpected backgrounds burnt a hole in the beam pipe and damaged inner detectors
- Dangerous at SuperKEKB (Especially SVD)

- Temporary damage or faults in electronics
- Obscure physics processes
- Fake interesting physics signals

Factor ∼40-50 in the luminosity

Higher backgrounds



Phase 1 (no collisions)

Touschek scattering:	Beam-gas scattering:	Synchrotron radiation:
• intra-bunch scattering process • dominant with highly compressed beams • 20 times higher	• Bremsstrahlung (negligible) & Coulomb interactions (up to 100 times higher) with residual gas atoms & molecules	• emission of photons by charged particles (e^+e^-) when deflected in *B*-field

Phase 2 (collisions)

Radiative Bhabha **process:**	***Two photon*** **process:**
• photon emission prior or after *Bhabha* scattering • interaction with iron in the magnets leads to neutron background	• very low momentum e^+e^- pairs via $e^+e^- \to e^+e^-e^+e^-$ • increased hit occupancy in inner detectors

Beam Background simulation

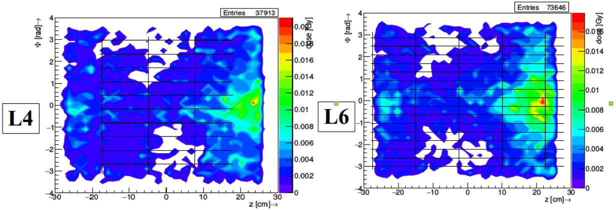
QED Background : MC Campaign used

- Coulomb LER
- Touschek LER
- Touschek HER
- Radiative Bhabha (RBB) LER
- Radiative Bhabha HER
- Two Photon

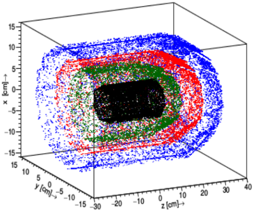
Layer	No. of Ladders	Sensors/Ladder
L3	7	2
L4	10	3
L5	12	4
L6	16	5

- Radiation dose study in each background type

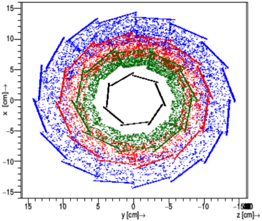
Skin plots & Two photon background map



Radiation dose (Rd) in φ vs. Z plane



Side view



End view

Conclusion

- Belle II will further explore these opportunity with a target integrated luminosity of $50ab^{-1}$
- Detector to start operation in early 2018 (phase 2) and start taking physics data beginning 2019 (phase 3)
- Result of $D^0 \rightarrow K_S^0 K_S^0$ at Belle is consistent with no CPV and improved the precision
- A_{CP} result is a significant improvement over the previous measurements of CLEO and LHCb (about a factor 4)
- The most precise branching fraction over world average and BESIII
- Prospects for these measurements at Belle II were also discussed, in this decay mode cases the sensitivity would reach a 0.2 % level
- Upgraded Belle II detector will face the higher level of backgrounds
- In SVD 2-γ QED background contributed more as expected earlier

Thank You!!

CPV in charm :

Experimental results on ΔA_{CP}

Experiment	$\Delta A_{CP}(\%)$
BaBar	$+0.24 \pm 0.61 \pm 0.18$
Belle preliminary	$-0.87 \pm 0.41 \pm 0.06$
CDF	$-0.62 \pm 0.21 \pm 0.10$
LHCb (2014)	$+0.14 \pm 0.16 \pm 0.08$
LHCb (2016)	$-0.10 \pm 0.08 \pm 0.03$
HFAG	-0.134 ± 0.070

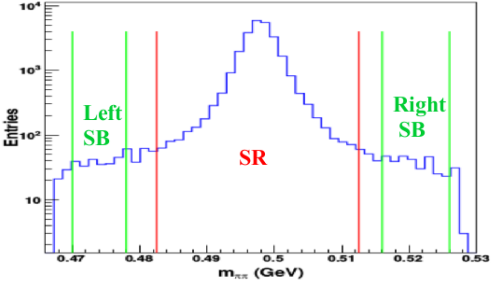
CP violation observables in mixing/induced: A_Γ , y_{CP}

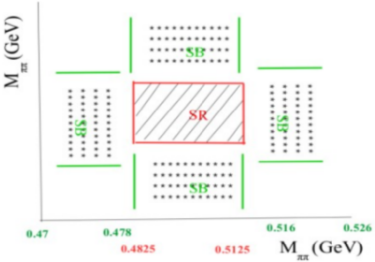
$$A_\Gamma = \frac{\hat{\Gamma}(D\to f)-\hat{\Gamma}(\bar{D}\to\bar{f})}{\hat{\Gamma}(D\to f)+\hat{\Gamma}(\bar{D}\to\bar{f})} = \frac{1}{2}\left[\overbrace{\left(\left|\frac{q}{p}\right| - \left|\frac{p}{q}\right|\right) y \cos\phi}^{\text{CP violation in mixing}} - \underbrace{\left(\left|\frac{q}{p}\right| + \left|\frac{p}{q}\right|\right) x \sin\phi}_{\text{CP violation in interference}} \right]$$

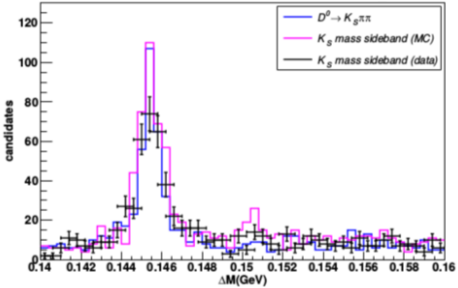
In the absence of direct CP violation, y_{CP} is given by

$$y_{CP} = \frac{\hat{\Gamma}(K^-\pi^+)}{\hat{\Gamma}(K^+K^-)} - 1 = \left(\left|\frac{q}{p}\right| + \left|\frac{p}{q}\right|\right) y \cos\phi - \left(\left|\frac{q}{p}\right| - \left|\frac{p}{q}\right|\right) x \sin\phi$$

Peaking Background estimation







- Peaking background ($K_S^0\pi^+\pi^-$)

  SR and SB (Generic MC sample)

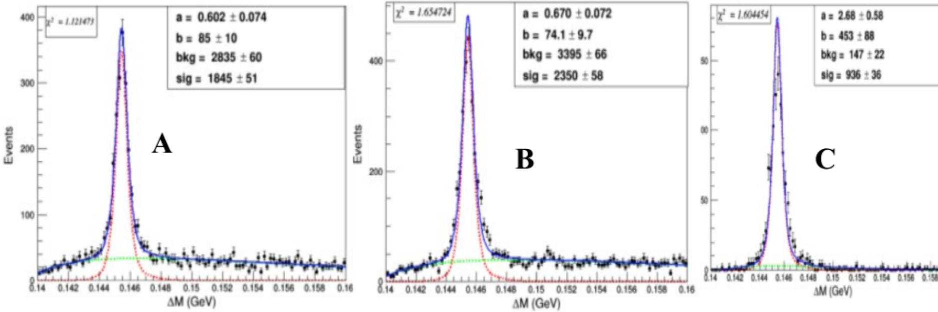
  SB for **real data sample**

Can have control on peaking Backgroun

In real data : used K_S^0 mass SB

Peaking Background...

Generic MC (6 x *L* of data)



PDF shape same as signal and fixed

Signal contamination (S') the SB considered

Sample	A	B	C	D(B-C)	Scale factor Sf (D/A)
6 * MC	1845± 51	2350± 58	936± 36	1414± 68	0.76 ± 0.04

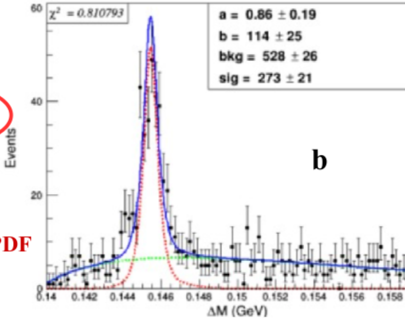
A : P in K_S^0 mass SR (tagged) B: P+S' in K_S^0 mass SB

C: S' in the SB of K_S^0 mass D: P in K_S^0 mass SB

Peaking Background...

Sample	b	c	d (b-c)	A (d/Sf)
data	273± 21	70 ± 3	203 ± 21	267 ± 31

Fixed in data final PDF



PDF shape same as signal and fixed

b : P+S' in K_S^0 mass SB

c: S' in the SB of K_S^0 mass

d: P K_S^0 mass SB

a : P in K_S^0 mass SR

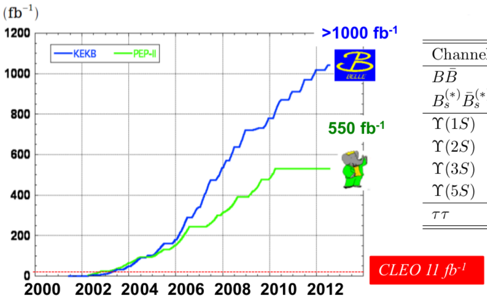
Signal contamination (S') in the SB considered after scaling with L and BF ratio in PDG and MC of S

BF of S in PDG 1.8 * 10^{-4} and in MC 4.0 * 10^{-4}

Belle Detector

Why an e^+e^- Machine?

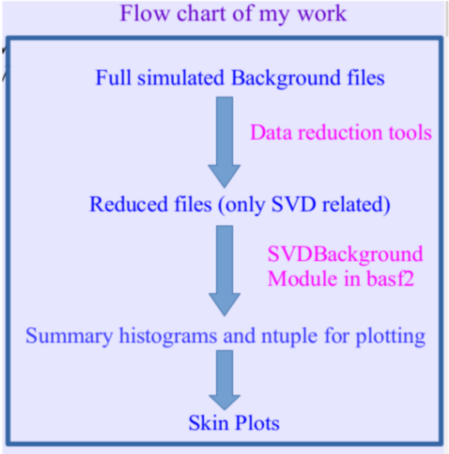
- Low backgrounds, high trigger efficiency, excellent γ and π^0 reconstruction (and thus η , η' , ρ^+, etc. reconstruction), high flavor-tagging efficiency with low dilution, many control samples to study systematics
- Due to low backgrounds, negligible trigger bias, and good kinematic resolutions, Dalitz plots analyses are straightforward. Absolute branching fractions can be measured. Missing energy and missing mass analyses are straightforward.
- systematics quite different from those at LHCb. If true NP is seen by one of the experiments, confirmation by the other would be important.



Channel	Belle	BaBar
$B\bar{B}$	7.7×10^8	4.8×10^8
$B_s^{(*)}\bar{B}_s^{(*)}$	7.0×10^6	–
$\Upsilon(1S)$	1.0×10^8	
$\Upsilon(2S)$	1.7×10^8	0.9×10^7
$\Upsilon(3S)$	1.0×10^7	1.0×10^8
$\Upsilon(5S)$	3.6×10^7	–
$\tau\tau$	1.0×10^9	0.6×10^9

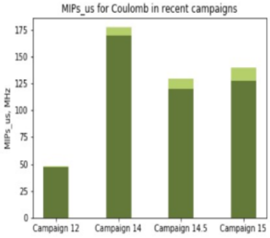
SVD beam background

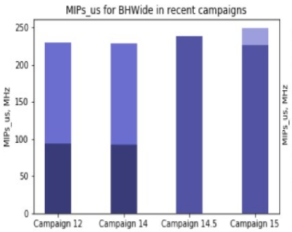
SVD Background simulation :

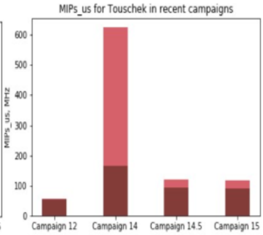


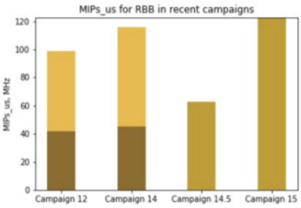
- Huge chunk of backgrounds
- Studied only backgrounds related to SVD
- Observed Energy deposition, N.F and occupancy
- Validate statistics
- Compare the results with different MC

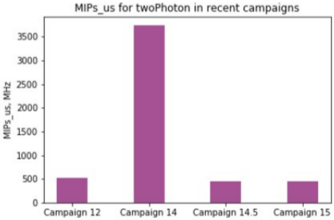
Backgrounds in recent campaigns





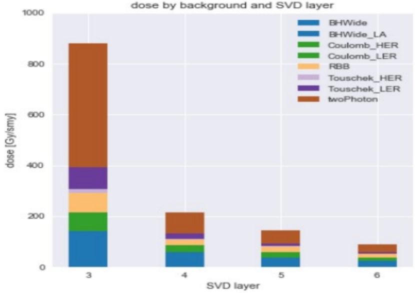






- consistent official simulation results though the big two-photon background with 15th campaign 13
- show that the two-photon background is important and more abundant than initially expected

Backgrounds in SVD layer



dose [Gy/smy] by background and SVD layer

SVD layer	3	4	5	6
BHWide	124	52	33	22
BHWide_LA	19	5	4	2
Coulomb_HER	6	2	2	1
Coulomb_LER	64	25	21	13
RBB	77	22	19	14
Touschek_HER	18	5	3	2
Touschek_LER	85	20	11	6
twoPhoton	488	82	52	31

- 2-photon background is the most important background in SVD
- Official simulation consistent with previous results
- Big 2-photon background from 14-th campaign was not confirmed

Research Plan

- Least well-known of the unitarity triangle angles
- $\phi_3 = \gamma \equiv \arg\left(-V_{ud}V_{ub}^{*}/V_{cd}V_{cb}^{*}\right)$
- precise measurement of γ is a crucial test of the SM
- current precision is slightly better than 5 (much larger than the SM prediction)
- Belle II projection pushing this down to 1 (based on simulation)
- γ is measured through a combination of simple charge-specific decays rates of rare channels
- Not crucially depend on the vertexing performance
- measure γ in one of the most abundant channels
- chose once the accelerator and detector performances are assessed more precisely (later 2018/start 2019 data)