Thesis for the Degree of Master

Feasibility study of $D^0 \rightarrow K_s\ K_s\ \pi^0$ and $D^0 \rightarrow K_s\ K_s\ \eta$ branching fraction measurement based on Belle II Monte Carlo simulation samples

Belle II 몬테 카를로 데이터를 이용한 $D^0 \rightarrow K_s\ K_s\ \pi^0$ 그리고 $D^0 \rightarrow K_s\ K_s\ \eta$의 붕괴 갈래비 측정 방식에 대한 탐색

June 2025

Department of Physics

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A thesis supervisor : Doris Y Kim

Thesis submitted in partial fulfillment of the requirements for the Degree of Master

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Department of Physics

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To approve the submitted thesis for the

Degree of Master by Jihun An

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먼저, 저의 석사 과정을 지도해 주신 김양수 교수님께 감사드립니다. 학부 연구생부터 석사과정까지 Belle II 연구 그룹에서 소프트웨어, 하드웨어, 데이터 분석 그리고 여러 콘퍼런스까지 제가 관심을 가지고 하고 싶어 하는 것에 항상 기회와 도움을 주셔서 이제 막 석사를 졸업하는 학생으로서는 얻기 힘든 귀중한 경험과 공부를 할 수 있었습니다. 많이 부족하게 석사과정을 시작했음에도, 클러스터 매니지먼트, Belle II DAQ 업무 등 여러 일들을 맡겨주셔서 계속 배우고 나아갈 수 있었습니다. 교수님께 배웠던 모든 것들 덕분에 제가 물리학자로서, 또는 사회 구성원으로서 저만의 역할을 해내는 사람이 되기 위해 더 발전하고 있다고 진심으로 생각하고 있습니다. 저에게 부족한 점과 배울 것이 많다는 것을 잘 이해하고 있습니다. 학부 연구생과 석사 과정으로부터 얻는 경험을 토대로 제가 받은 것들을 누군가에게 나누어 줄 수 있는, 그런 연구자가 되기 위해 더욱 정진하겠습니다.

저의 논문 심사를 맡아주신 교수님들께도 감사 인사를 드립니다. 먼저 김진민 교수님, 학부 과정부터 교수님이 설명해 주셨던 아름다운 자연 원리들은, 해주셨던 비유들까지 아직도 잘 기억하고 있습니다. 물리학 강의부터 저의 논문 심사까지 교수님에게 받을 수 있게 되어서 정말

감사드립니다. 그리고 천명기 교수님, 학부 현대 물리 수업부터 물리학의 꽃이라고 생각하는 핵물리학 수업까지 교수님의 강의를 들을 수 있어서 행운이었다고 생각합니다. 이 분야를 이해하는 데에 여전히 교수님의 설명들로부터 도움을 받고 있습니다. 제가 존경하는 교수님들께 심사를 받을 수 있어서 저에게는 과분한 기쁨이 되었습니다.

또한 방대한 우주에 대해 알려주신 이태훈 교수님, 항상 따뜻하고 열정적으로 지도해 주신 이항모 교수님, 학부 때부터 지도와 조언을 주신 정진석 교수님, 그리고 실험 조교 동안 항상 배려와 격려를 보내주신 최현희 교수님께도 많은 감사 인사를 드립니다. 숭실대학교에서 학부와 석사 과정을 보내는 동안 교수님들을 만나 배울 수 있어 너무 기뻤습니다.

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마지막으로 무한한 지지와 응원을 보내주신, 저에게 너무 소중한 사랑하는 가족들과 붉은 딱따구리 친구들 그리고 코타츠 친구들에게도 감사드립니다.

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ABSTRACT

Feasibility study of D0 → Ks Ks π0 and D0 → Ks Ks η branching fraction measurement based on Belle II Monte Carlo simulation samples

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On December 2024, SuperKEKB has achieved the world record luminosity 5.1×10^{34} cm^{-2} s^{-1}, and accumulated 575.47/fb until January 2025. To analyze this dataset, this thesis generated Monte Carlo simulation samples using the Belle II analysis software framework and studied the method to measure the branching fraction of $D^0 \rightarrow$ Ks Ks π^0 and $D^0 \rightarrow$ Ks Ks η. During the project, the event selection criteria were optimized and the fitting procedure was studied, which in turn enhances the applicability of this study for future analyses. These decay modes have not been well measured yet. It is important to visit many research steps to improve precision. One example is to study background events created by other D meson decays and B meson decays.

국문초록

Belle II 몬테 카를로 데이터를 이용한 D0 → Ks Ks π0 그리고 D0 → Ks Ks η의 붕괴 갈래비 측정 방식에 대한 탐색

안지훈
물리학과
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2024년 12월, SuperKEKB는 세계 기록인 5.1×10^{34} $cm^{-2}s^{-1}$의 광도를 달성하였고, 2025년 1월까지 총 575.47/fb의 데이터를 축적하였다. 이 데이터를 분석하기 위해 Belle II 분석 소프트웨어 프레임워크를 사용하여 몬테카를로 시뮬레이션 샘플을 생성하고, 생성된 시그널 샘플을 이용해 $D^0 \rightarrow Ks^0\ Ks^0\ \pi^0$ 및 $D^0 \rightarrow Ks^0\ Ks^0\ \eta$의 붕괴율을 측정, 이벤트 선택 기준을 최적화하는 것을 목적으로 한다. 이는 향후 연구에 본 분석을 효과적으로 응용할 수 있도록 한다. 이 두 가지 붕괴 모드는 아직 정밀하게 측정되지 않았기 때문에, 다른 D 중간자 붕괴나 B 중간자 붕괴로 생성된 배경 데이터를 정확히 이해하는 것이 매우 중요하다.

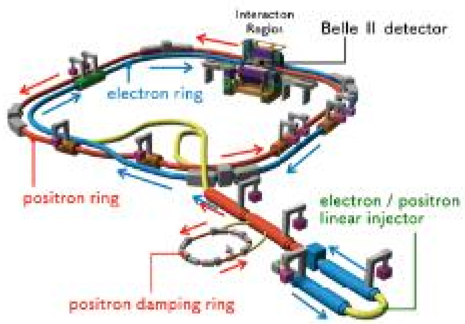
CHAPTER 1 Introduction

Many decay modes of the D^0 meson have been precisely measured. However, three-body decays involving neutral particles remain relatively unexplored. In particular, the branching fractions of $D^0 \rightarrow K_S^0 K_S^0 \pi^0$ and $D^0 \rightarrow K_S^0 K_S^0 \eta$, so-called 3-body neutral singly Cabibbo-suppressed mode, were measured as 1.45×10^{-4} and $(1.3 \pm 0.6) \times 10^{-4}$, respectively [1]. Due to this limitation, such D meson decay modes cannot be used as reference modes or background components in various studies of B physics and other D meson decay modes conducted by experiments such as Belle II, BaBar, BESIII, and LHCb. Therefore, precise measurements of their branching fractions are important. Moreover, for the study of CP asymmetries in singly Cabibbo-suppressed (SCS) decay modes, accurate determination of the branching fraction is a necessary first step.

1.1 Belle II experiment environment

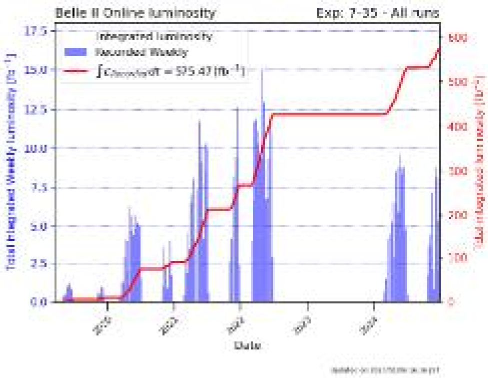
1.1.1 SuperKEKB accelerator

[Figure 1-1] Configuration of SuperKEKB



SuperKEKB is an asymmetric-energy electron-positron collider located at KEK in Tsukuba, Japan with 7.0 GeV electron and 4.0 GeV positron beams. SuperKEKB is the upgrade from KEKB, using the nanobeam scheme with the aim of vertical beam sizes down to 50 nm [2]. SuperKEKB targets a peak luminosity of 8×10^{35} $cm^{-2}s^{-1}$ and total integrated luminosity of 50 ab^{-1}. The aim of the upgrade project is to explore new physics in the flavour sector at the luminosity frontier [3].

[Figure 1-2] Belle II online luminosity delivered by SuperKEKB



Following the 2022–2023 long shutdown, Run 2 began in January 2024. On 27 December 2024 SuperKEKB set a new world record instantaneous luminosity of 5.1×10^{34} and accumlated 575.47 ab^{-1} until January 2025 [3].

The luminosity is expressed as,

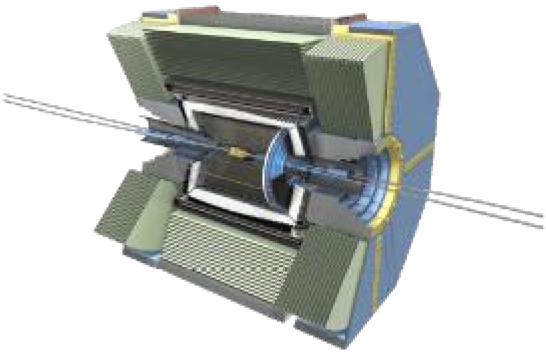
$$L = \frac{1}{4\pi} \cdot \frac{N_p N_e}{\sigma_x^{\text{effective}} \sigma_y^*} \cdot f_{\text{col}} R_L$$

and is also expressed by well-known formula:

$$L = \frac{\gamma_\pm}{2er_e} \left(\frac{I_\pm \xi_{y\pm}}{\beta_{y\pm}^*} \right) \left(\frac{R_L}{R_{\xi_r}} \right)$$

1.1.2 Belle II detector

[Figure 1-3] The Belle II detector



Starting from the beam interaction point, Belle II detector in [Figure 1-3] consists of PXD (Pixel Detector), SVD (Silicon Vertex Detector), CDC (Central Drift Chamber), TOP (Time-Of-Propagation Counter), ARICH (Aerogel Ring Imaging Cherenkov Detector), ECL (Electromagnetic Calorimeter) and KLM (K_L and Muon Detector). The detector can identify and precisely measure a wide range of particles, including charged particles, photons, neutral hadrons, muons, and kaon mesons, over nearly the full solid angle. More details of components are in [Table 1-1].

[Table 1-1] Sub-detectors in Belle II detector

Radius(cm)	Type	Role in π/K ID
1.4 - 1.6	PXD	precise decay-point reconstruction
1.6 - 11	SVD	dE/dx for low-p π/K separation
16 -113	CDC	dE/dx for various charged particles
120 (barrel)	TOP	π/K separation
120 (forward)	ARICH	π/K separation
125	ECL	photon / π^0 / η reconstruction
170	KLM	μ/K_L tagging

1.2 Singly Cabibbo-suppressed (SCS) processes in D meson decay

The Cabibbo–Kobayashi–Maskawa matrix categorizes decays of charm hadrons into Cabibbo-favored (CF), doubly suppressed (DCS) and singly Cabibbo-suppressed (SCS) amplitudes. Because SCS amplitudes receive comparable tree and loop (penguin) contributions, they are uniquely sensitive to CP-violating phases beyond the Standard Model. More specifically, examples of SCS processes in D meson decays to three bodys including CF and DCS are in the [Table 1-2].

[Table 1-2] Example of three body decay in D decay

Decay	examples
CF	$D^0 \rightarrow K^0\pi^0\pi^0$,$D^+ \rightarrow K^-\pi^+\pi^+$
SCS	$D^0 \rightarrow K^0K^0\pi^0$,$D^+ \rightarrow K^+K^-\pi^+$
DCS	$D^0 \rightarrow K^0K^0K^0$,$D^+ \rightarrow K^+\pi^-\pi^+$

For SCS modes the tree and penguin topologies have comparable magnitudes. Interference between them permits direct CP violation if the strong and weak phase differences are non-zero. The main subjects of this thesis, $D^0 \rightarrow Ks^0\, Ks^0\, \pi^0$ and $D^0 \rightarrow Ks^0\, Ks^0\, \eta$, are also SCS modes. Time-integrated CP asymmetry is defined as

$$A_{CP} = \frac{\Gamma(D^0 \rightarrow f) - \Gamma(\overline{D}^0 \rightarrow f)}{\Gamma(D^0 \rightarrow f) + \Gamma(\overline{D}^0 \rightarrow f)}$$

And this is a useful measure to search for penguin-induced new physics.

CHAPTER 2 Motivation

2.1 Importance of measuring multi body neutral decays

SCS charm decays are suppressed, therefore occur at the $O(10^{-4})$ level or below. In these modes, the interference explained in the previous chapter can generate direct CP violation so measurement of their exact branching fractions is important as the first step of the overall analysis strategy. Neutral multi-body final states have amplified sensitivity to CP asymmetry.

Also, rich phase-space allows local CP tests in Dalitz sub-regions, boosting discovery potential [4]. The 2019 LHCb discovery of $\Delta A_{CP} \neq 0$ in the two-body SCS decays $D^0 \rightarrow K^+ K^-, \pi^+ \pi^-$ with significance 5.3 σ proves that CPV in SCS can be found by current detector technology[5].

2.2 Previous research

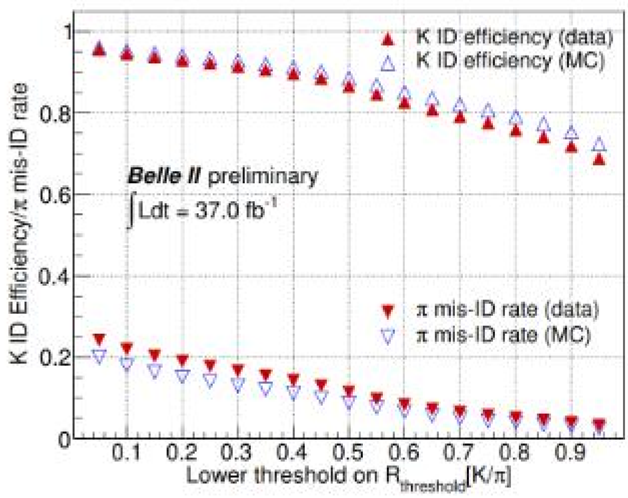
For the $D^0 \rightarrow Ks^0\, Ks^0\, \pi^0$ and $D^0 \rightarrow Ks^0\, Ks^0\, \eta$ decay modes, currently only CLEO and BES III presented meaningful sensitivity to branching fractions as shown on [Table 2-1] [6][7][8].

[Table 2-1] Previously obtained branching fractions of $D^0 \rightarrow Ks^0\ Ks^0\ \pi^0/\eta$

decay mode	experiment	branching fraction
$D^0 \rightarrow Ks^0\ Ks^0\ \pi^0$	CLEO	$< 5.9 \times 10^{-4}$ (with 2.7 fb^{-1})
$D^0 \rightarrow Ks^0\ Ks^0\ \pi^0$	BES III	$< 1.57 \times 10^{-4}$
$D^0 \rightarrow Ks^0\ Ks^0\ \eta$	BES III	$< (1.33 \pm 0.62) \times 10^{-4}$

Belle II is designed for 50 ab-1 luminosity and has high efficiency of π/K PID. TOP and ARICH deectors give ≥ 90% K efficiency with ≤ 5% π-fake for 0.5–2 GeV/c tracks [9]. And with good ECL resolution, Belle II data can increase efficiency of reconstruction of π^0/η.

[Figure 2-1]K-efficiencies and π-mis-ID rates are calculated for different PID criteria (Belle II note BELLE2-NOTE-PL-2020-024)



CHAPTER 3 Analysis framework

3.1 Monte-Carlo (MC) data sets

A 1 million event Monte Carlo run-dependent signal sample adjusted by detector and running condition is used as signal data. Since the decay structures of $D^0 \rightarrow Ks^0\ Ks^0\ \pi^0$ and $D^0 \rightarrow Ks^0\ Ks^0\ \eta$ are not measured yet, simple phase-space decay was assumed to generate the simulated events. The topoAna software tool generates [Table 3-1] that shows the detailed decay paths of events included in the simulated sample of $D^0 \rightarrow Ks^0\ Ks^0\ \pi^0$.

[Table 3-1] Cascade decay branches of D^0 in the simulated event sample

rowNo	cascade decay branch of D^0	iCascDcyBrP	nCase	nCCase
1	$D^0 \to \pi^0 K_S^0 K_S^0, K_S^0 \to \pi^+\pi^-, K_S^0 \to \pi^+\pi^-$	0	811547	811547
2	$D^0 \to \pi^0 K_S^0 K_S^0, K_S^0 \to \pi^+\pi^-, K_S^0 \to \pi^+\pi^-\gamma^F$	1	152543	964090
3	$D^0 \to \pi^0 K_S^0 K_S^0, K_S^0 \to \pi^+\pi^-$	5	18495	982585
4	$D^0 \to \pi^0 K_S^0 K_S^0, K_S^0 \to \pi^+\pi^-\gamma^F, K_S^0 \to \pi^+\pi^-\gamma^F$	3	7240	989825
5	$D^0 \to \pi^0 K_S^0 K_S^0, K_S^0 \to \pi^+\pi^-, K_S^0 \to \pi^+\pi^-\gamma^F\gamma^F$	2	7100	996925
6	$D^0 \to \pi^0 K_S^0 K_S^0, K_S^0 \to \pi^+\pi^-\gamma^F$	4	1752	998677
7	$D^0 \to \pi^0 K_S^0 K_S^0, K_S^0 \to \pi^+\pi^-\gamma^F, K_S^0 \to \pi^+\pi^-\gamma^F\gamma^F$	6	690	999367
8	$D^0 \to \pi^0 K_S^0 K_S^0, K_S^0 \to \pi^+\pi^-, K_S^0 \to \pi^+\pi^-\gamma^F\gamma^F\gamma^F$	7	204	999571
9	$D^0 \to \pi^0 K_S^0 K_S^0$	10	121	999692
10	$D^0 \to \pi^0 K_S^0 K_S^0, K_S^0 \to \pi^+\pi^-\gamma^F\gamma^F$	9	68	999760
11	$D^0 \to \pi^0 K_S^0 K_S^0, K_S^0 \to \pi^+\pi^-\gamma^F\gamma^F, K_S^0 \to \pi^+\pi^-\gamma^F\gamma^F$	14	15	999775
12	$D^0 \to \pi^0 K_S^0 K_S^0, K_S^0 \to \pi^+\pi^-\gamma^F, K_S^0 \to \pi^+\pi^-\gamma^F\gamma^F\gamma^F$	8	14	999789
13	$D^0 \to \pi^0\pi^+K^-$	13	9	999798
14	$D^0 \to \pi^0\pi^+K^-\gamma^F$	21	3	999801
15	$D^0 \to K^-a_1^+, a_1^+ \to \rho^0\pi^+$	22	3	999804
16	$D^0 \to K_L^0\pi^+\pi^-$	32	3	999807
17	$D^0 \to e^+\nu_e K^-$	34	3	999810

3.2 Software setup

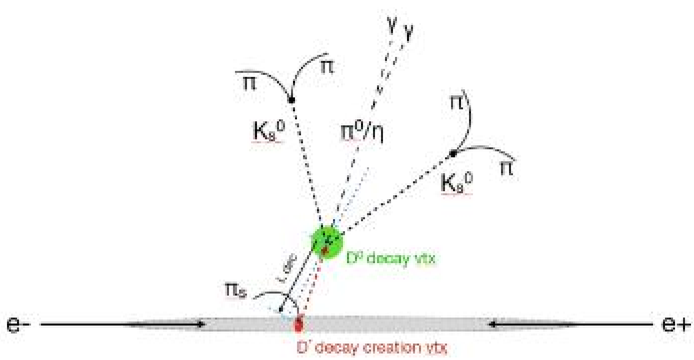
The basf2 (Belle II Analysis Software Framework) is the modular C++/Python framework that steers all Belle II workflows—generation, simulation, reconstruction (clustering, tracking, vertex-fitting, PID), and user analysis (vertex-fitting, applying selection cuts and deep learning). The core concepts are structured as modules and workflow paths are configured in a Python steering file [10].

CHAPTER 4 Event selection

4.1 Reconstruction

4.1.1 Reconstruction method

[Figure 4-1] Diagram of reconstruction structure



The steering script reconstruct $\pi0/\eta$ with two gamma with E >50 MeV (barrel), E > 100 MeV (forward endcap) and E > 150 MeV (backward endcap). These photons are represented as stdPhothon in the steering script. Ks^0 are reconstructed with two charged pions, by KS0finder which is essentially a vertex fit to improve mass resolution. All these particles are used to reconstruct D^0. At the final reconstruction step, a slow pion is chosen with selection cuts: |dr| < 1.0 cm, |dz| < 3.0 cm, thetaInCDCAcceptance (17~150 degrees) and chiProb > 0.001 (pvalue). Then the slow pion is merged into D* with the reconstructed D^0 in the previous step.

4.1.2 Reconstructed signal data sample

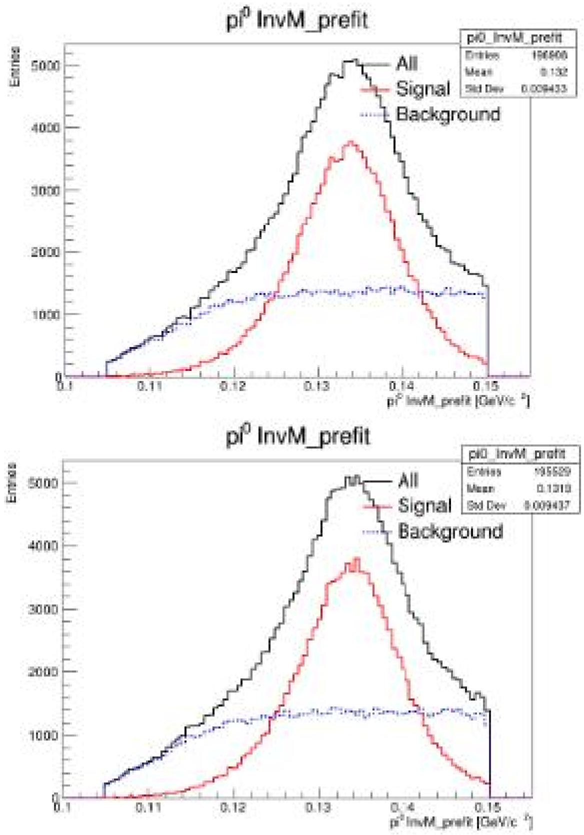
[Figure 4-2] and [Figure 4-3] show that invariant mass of π^0/η before the final D0 mass reconstruction. π^0 has 0.105 GeV/c^2 < InvM < 0.15 GeV/c^2 selection cut and 0.5 GeV/c^2 < InvM < 0.58 GeV/c^2 on η. Right side cut on π^0 mass distribution is due to a preselection limitation. Each mean value and PDG value are summarized in [Table 4-1]. For D^0 mass reconstruction fixed mass of π^0/η are used. (for example, 0.135 GeV/c^2 for neutral pion)

[Table 4-1] Obtained mean value of invariant mass of π^0/η and PDG value

type	obtained value	PDG value
π^0	0.1320 GeV/c^2	0.1349 GeV/c^2
η	0.5402 GeV/c^2	0.5478 GeV/c^2

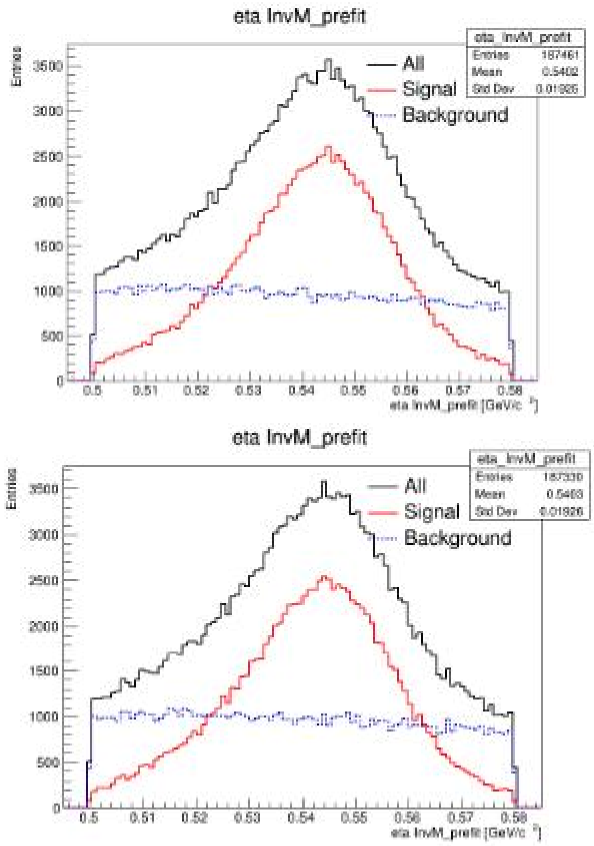
[Figure 4-2] Reconstructed π^0 invariant mass before D^0 mass fit in $D^0 \rightarrow Ks^0\ Ks^0\ \pi^0$

and charge conjugate mode (below)



[Figure 4-3] Reconstructed η invariant mass before D mass fit in $D^0 \rightarrow Ks^0\ Ks^0\ \eta$

and charge conjugate mode (below)

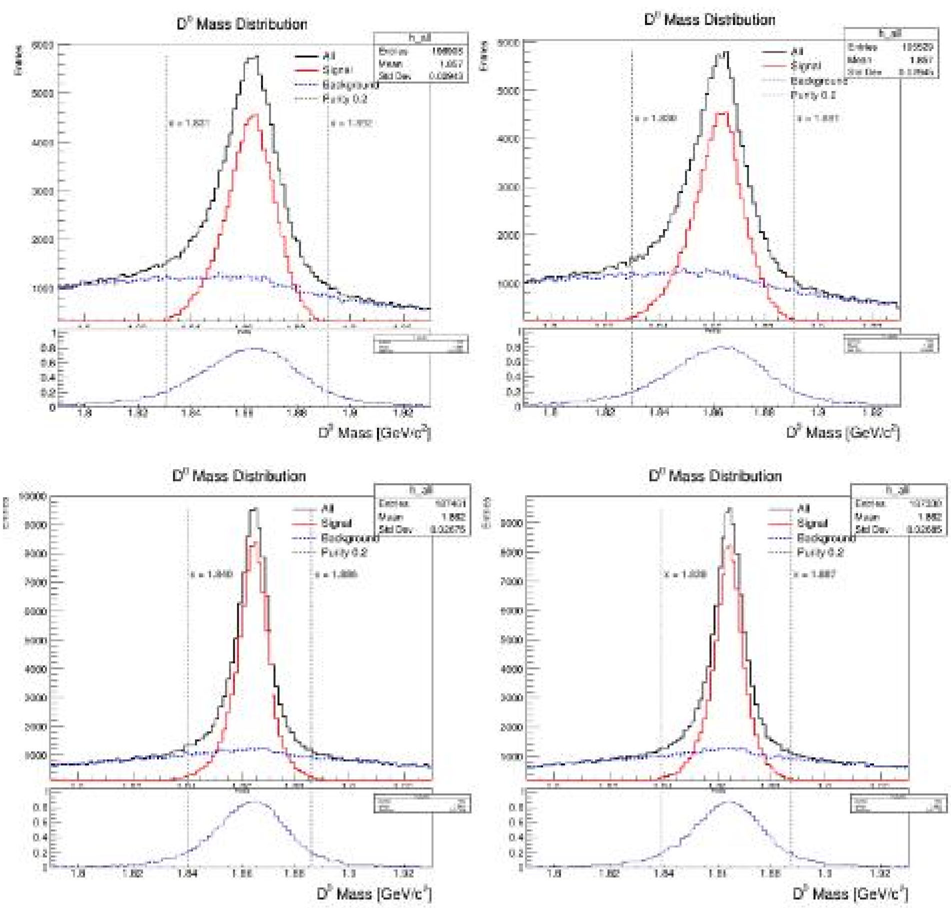


Mass distribution of reconstructed D^0 is in [Figure 4-4] with vertical line at purity value 0.2 given by Purity = $N_{sig}/(N_{sig} + N_{bkg})$. Since the exact nature of the background events is not studied yet, the vertical lines are arbitrary. A small peak in background was observed which is expected to be $D^+ \rightarrow Ks^0\ \pi^+\ \pi^-\ \pi^0$ and $D^+ \rightarrow Ks^0\ \pi^+\ \pi^-\ \eta$. The decay length significance of Ks will be useful and efficient to suppress this peaking background. Each mean value and PDG value of the reconstructed D^0 mass summarized in [Table 4-2]. With topology analysis in [Table 3-1], one can find more candidate decay modes on the background peak.
The distributions of delta M which can be obtained as difference between mass of D* and D^0 show on [Figure 4-5] and [Figure 4-6]. The delta M information will be used for selection cut and branching fraction fit. Their charge conjugate modes are also shown on those figures.

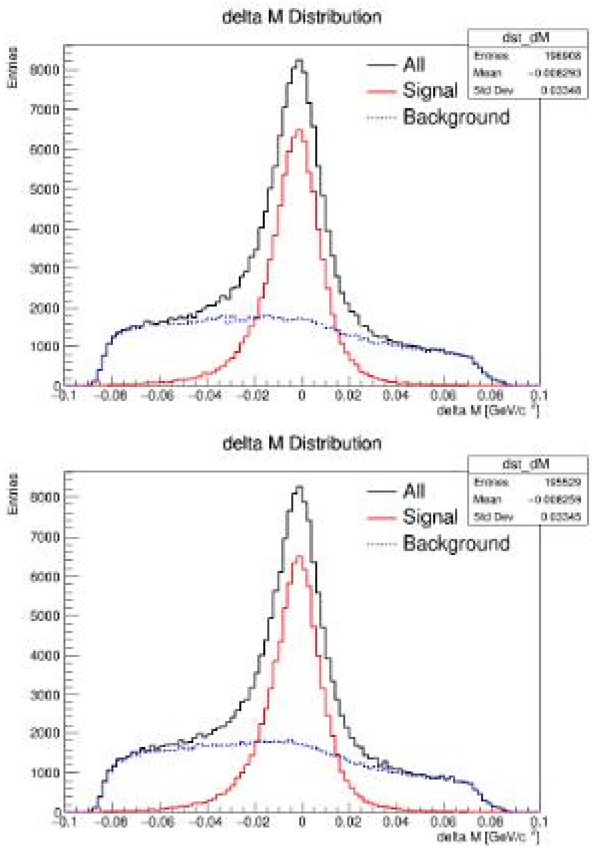
[Table 4-2] Mean value of reconstructed mass of D^0 and PDG value

decay mode	obtained value	PDG value
$D^0 \rightarrow Ks^0\ Ks^0\ \pi^0$	1.857 GeV/c^2	1.864 GeV/c^2
$D^0 \rightarrow Ks^0\ Ks^0\ \eta$	1.862 GeV/c^2	1.864 GeV/c^2

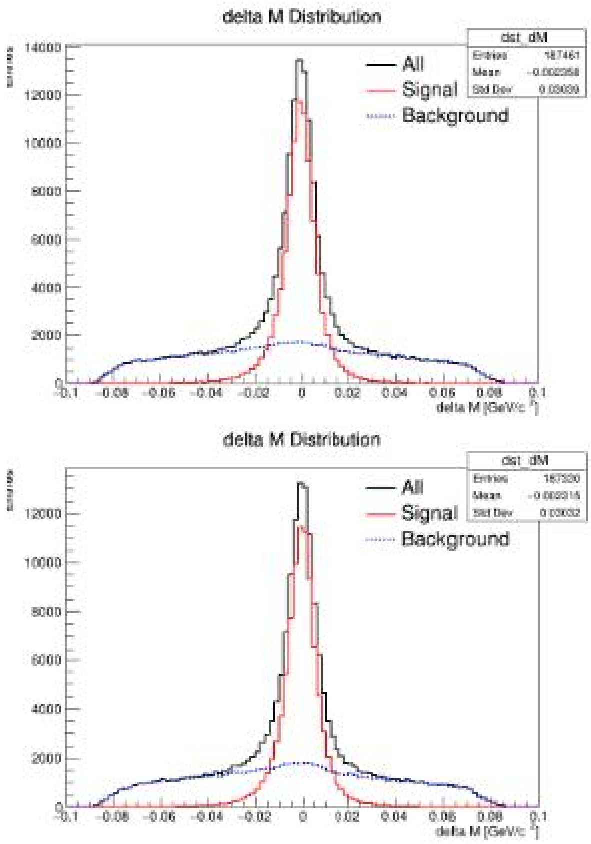
[Figure 4-4] Reconstructed signal MC (D^0 mass distribution) $D^0 \rightarrow Ks^0\ Ks^0\ \pi^0$ and $D^0 \rightarrow Ks^0\ Ks^0\ \eta$ with their charge conjugate mode (right each)



[Figure 4-5] Reconstructed signal MC (delta M (mass of [D* - D^0]) of $D^0 \rightarrow Ks^0$ Ks^0 π^0 and charge conjugate mode (below))



[Figure 4-6] Reconstructed signal MC (delta M (Mass of [D* - D^0]) of $D^0 \rightarrow Ks^0$ Ks^0 η and charge conjugate mode (below))



4.2 Selection criteria

4.2.1 Pre-selection

[Table 4-3] Pre-selection criteria

candidate	selection criteria
η	0.5 GeV/c^2 < InvM < 0.58 GeV/c^2, p > 0.5 GeV/c, cosbetweenD <1.0
π^0	0.105 GeV/c^2 < InvM < 0.15 GeV/c^2, p > 0.5 GeV/^{2}
π_s	|dr| < 1.0 cm, |dz| < 3.0 cm, thetaInCDCAcceptance (17~150 degrees)
D^0	1.78 GeV/c^2 < M < 1.94 GeV/c^2
D*	0.14 GeV/c^2 < massDifference < 0.16 GeV/c^2

Selection criteria for reconstruction of signal monte calro sample are in [Table 4-3]. These loose pre-selection criteria are chosen for background study.

4.2.2 Loose selection criteria and optimization strategy

Pre-selection criteria were chosen with loose selection criteria, since a tighter selection may cause too much background suppression which can hinder background study for suitable optimization. The planned selection criteria are summarized in [Table 4-3]. Figure of merit (FoM = $S/\sqrt{(S + B)}$) is used for optimization and to suppress background events. For multiple candidate events, the best candidate selection is performed by choosing smallest $\sum\chi^2_{mv}(K_S^0) + \chi^2_m(\pi^0/\eta)$ +

$\sum\chi^2_{vtx}(D)$. About expected peaking background $D^0 \rightarrow K_S{}^0\ \pi^+\ \pi^-\ \pi^0/\eta$ f for signal modes, although their contamination probability is strongly suppressed by narrow mass window ($m_{K_S{}^o}$ ± 10 MeV: ~3σ), the branching fraction is large [B = (5.2 ± 0.6)%] and [B = (2.80 ± 0.19) × 10^{-3}] and [B = (1.49 ± 0.06)%], which results to this significant background. It is expected that the decay length significance of KS will be useful to suppress these kinds of background events.

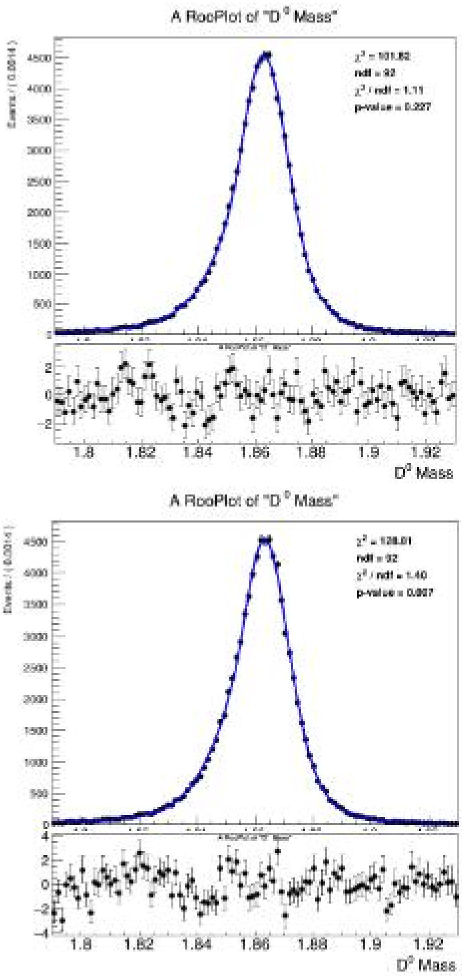
[Table 4-4] Selection criteria

candidate	selection
γ	$E(\gamma) > 50$ (100) MeV at barrel (end-cap)
η	$500 < M(\gamma\gamma) < 580$ MeV/c^2, $p(\eta) > 0.5$ GeV/c, $\chi^2_m < 50$, E_γ balance < 0.8, pi0-veto
π^0	$115 < M(\gamma\gamma) < 150$ MeV/c^2, $p(\pi^0) > 0.5$ GeV/c, $\chi^2_m < 50$
π_s	dr| < 1.0 cm, |dz| < 3.0 cm, prob(π:K) > 0.4
K_s	$\pi^+\pi^-$: using nisKsFinder, within 10 MeV/c^2 around nominal mass; mass-vertex fit with $\chi^2_m < 100$; decay length significance $L/\sigma > 10$
D^0	vertex fit with Ks track to obtain D^0 decay vertex (also as Ks product vertex). Add π^0/η momentum to obtain right D^0 momentum for π^0/η-involved channels
D*	apply IP constraint for D^0 candidates to obtain the product vertex, slow pion refit with such vertex to improve Q resolution

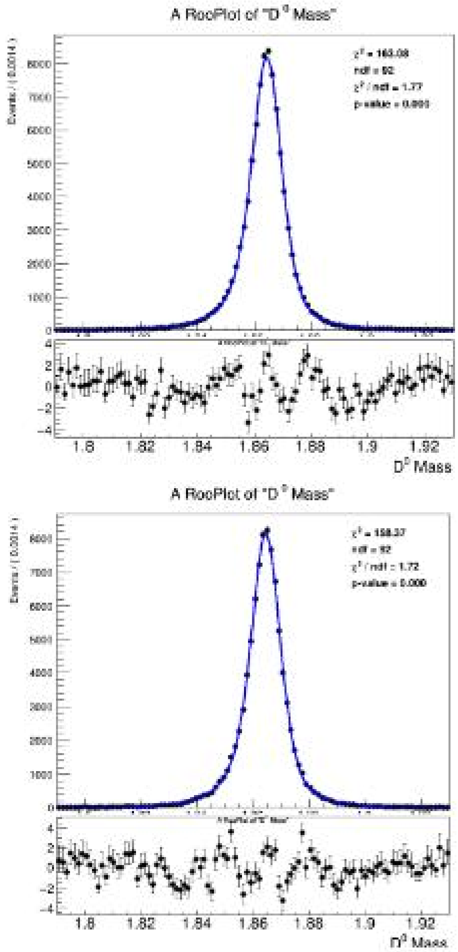
4.3 Fitting result

The signal data was fitted using the double Crystal Ball function. The quality of the fit was evaluated using the chi-squared per degree of freedom, the p-value, and the pull distribution, all of which indicated satisfactory agreement between the model and the data show in [Figure 4-7] and [Figure 4-8].

[Figure 4-7] Double Crystal Ball fit on $D^0 \rightarrow Ks^0\ Ks^0\ \pi^0$ and its charged conjugate mode (below)



[Figure 4-8] Double Crystal Ball fit on $D^0 \rightarrow Ks^0\ Ks^0\ \eta$ and its charged conjugate mode (below)



CHAPTER 5 Conclusion

In this study, $D^0 \rightarrow Ks^0\ Ks^0\ \pi^0$ and $D^0 \rightarrow Ks^0\ Ks^0\ \eta$ channels are studied, since they are singly Cabibbo suppressed and rare D decay modes for which precise measurement is necessary. 1 million signal MC events have been generated and reconstructed. Fitting D^0 mass distribution with double Crysal Ball functions show reconstruction of the signal events is done well. In future studies, fitting of the background events and the combined fitting of background and signal events are planned. With these results and with the expected size of the Belle II collision data, the feasibility of measuring the branching fractions of the two decay channels will be calculated. We showed the first result on selection of the signal events and fitting of D^0 mass distribution. By optimizing the fitting procedure and background suppression, and by carefully evaluating both systematic and statistical uncertainties, the sensitivity of measuring branching fractions will be determined. If the precision is determined as very precise, this project may pave the way for a subsequent measurement of CP asymmetry.

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