Study of $\Omega_{c0} \to \pi^+ \Omega(2012)^-$ at Belle II

Chengbo Zhu[1], Yitong Jiang[2], Zhiwei Lv[3], Jixi Li[4]

Fudan University[1]

Nankai University[2]

Southeast University[3]

Jiling University[4]

Group 4

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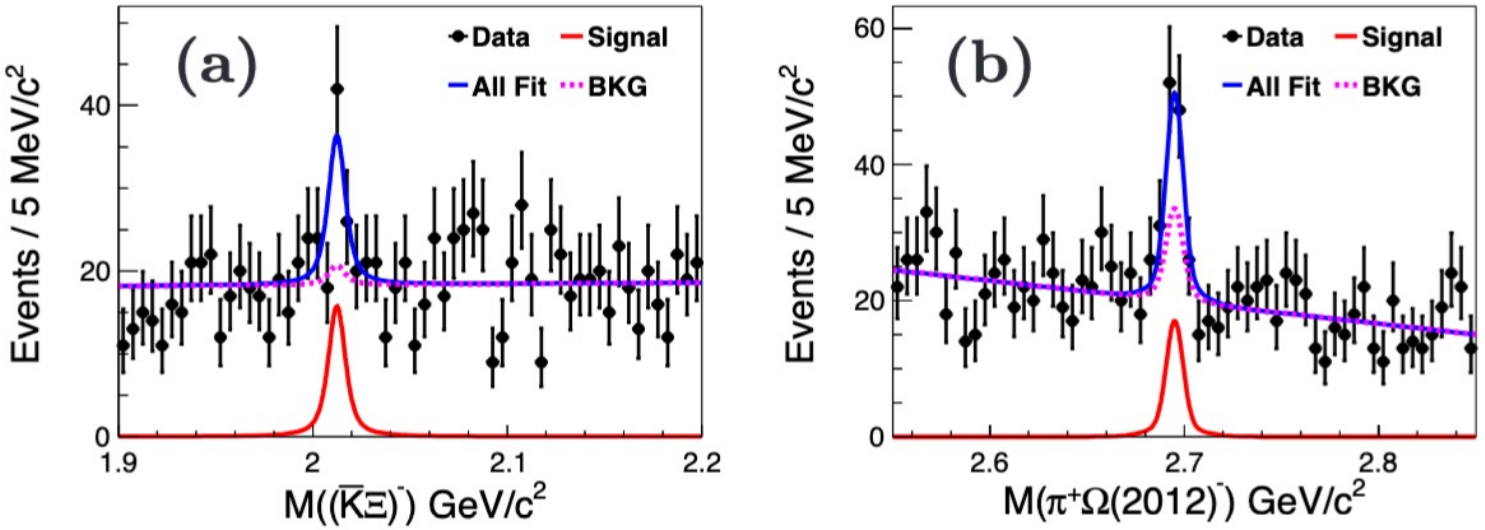
Winter School 2026 for Belle II China Group

Outline

- **Motivation**
- **Datasets and MC samples**
- **Event selection**
- **Belle II MC and Data Study**
- **Summary**

Motivation

- The $\Omega(2012)^-$ provides a valuable probe of multistrange baryon spectroscopy and hadron structure.
- Belle reported evidence for $\Omega_c^0 \to \pi^+\Omega(2012)^-$, with $\Omega(2012)^- \to \Xi\bar{K}$, but the measurements remain statistically limited.



- Using Belle II data, we study the $\Xi^0 K^-$ and $\Xi^- K_S^0$ modes to independently test this production process, providing further experimental input on Ω_c^0 hadronic decay dynamics and the properties of the $\Omega(2012)^-$.

[1].Y. Li et al. (Belle Collaboration), Phys. Rev. D 104, 052005 (2021).

DataSet

Software Version: basf2 light-2609-luna

Data (hardon Skim), $\mathscr{L}[fb^{-1}]$

	$\Upsilon(4S)$	off-res.	$5S$ scan
Run 1, proc16 `proc16_{4S,offres,5Sscan}_had_v1`	353.39	40.95	19.24
Run 2, Rel8 `exp30_to_exp35_had_{4S,4Soffres}_v1`	129.35	17.68	–
Run 2, Rel9 `prompt_rel9_25c_26ab_4S_{hadron,offres_hadron}`	309.62	27.29	–
Sum	**792.36**	**85.92**	**19.24**

Generic MC, $\mathscr{L}[fb^{-1}]$

$u\bar{u}, d\bar{d}, s\bar{s}, c\bar{c}, B^+B^-, B^0\bar{B}^0$	$\Upsilon(4S)$
Run 1, proc16 `MC16rd_proc16_*_Run1_4S_v2`	1429.23
Run 2, Rel8 `MC16rd_prompt_*_Run2_4S_v1`	517.11
Run 2, Rel9 `MCrdPromptRel9_*_Run2_4S_v1`	1238.52
Sum	**3184.86**

Signal MC: $\Omega_c^0 \to \pi^+\Omega(2012)^-$, PHOTOS PHSP, run-dependent

Channel	exp 12–26	exp 30–35	exp 37–42	N_{gen} total
$\Omega(2012)^- \to K^-\Xi^0$, $\Omega(2012)^- \to K_S^0\Xi^-$ (each)	927 355	325 985	746 615	**1 999 955**

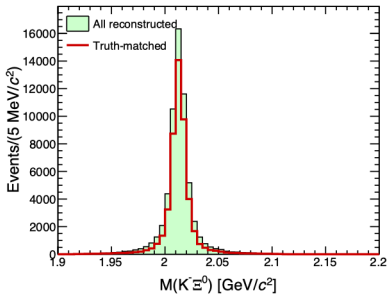
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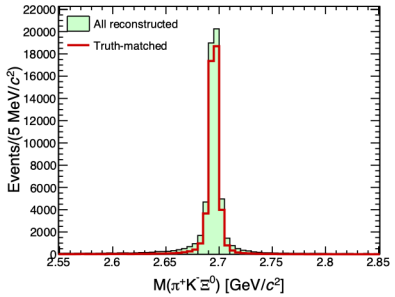
Event Selection

	Event Selection
Λ reconstruction:	stdLambdas:$\lvert dM_{\Lambda}\rvert < 0.0035$ GeV/c^2(Ξ^0), $\lvert dM_{\Lambda}\rvert < 0.006$ GeV/c^2(Ξ^-), for proton, $R_{\mathrm{p}} > 0.02$, $\chi^2(\Lambda) > 0$.
π^0 reconstruction:	gamma:pi0eff40_May2020, $\lvert dM_{\pi^0}\rvert < 0.0174$ GeV/c^2, $P(\pi^0) > 0.15$ GeV/c, For γ: [clusterReg==1 and E>0.050] or [clusterReg==2 and E>0.030] or [clusterReg==3 and E>0.050].
Ξ^- reconstruction:	$\lvert dM_{\Xi^-}\rvert < 0.010$ GeV/c^2, $pt(\pi^-) > 0.05$, $\sqrt{\mathrm{dr}^2 + \mathrm{dz}^2}(\Xi^-) > 0.15$cm, $\frac{\cos\theta_{\Lambda}^{xy}}{\cos\theta_{\Xi}^{xy}} < 1.006$.
Ξ^0 reconstruction:	$\lvert dM_{\Xi^0}\rvert < 0.008$ GeV/c^2, $\sqrt{\mathrm{dr}^2 + \mathrm{dz}^2}(\Xi^0) > 0.25$cm.
K_S^0 reconstruction:	stdKshorts, KsSelector (K_S0:loose),V0_mva > 0.5, Lam_mva > 0.1, $\lvert dM_{K_S^0}\rvert < 0.015$ GeV/c^2.
$\Omega(2012)$ reconstruction:	1.9 GeV/c^2 < $M(\Xi^0\mathrm{K}^-)$ < 2.2GeV/c^2, 1.9 GeV/c^2 < $M(\Xi^- K_S^0)$ < 2.2 GeV/c^2
Charged Tracks from Ω_c^0	nCDCHits > 0 and thetaInCDCAcceptance and dr < 2.0 and abs(dz) < 1.0, From Ξ^0, $R(K\lvert\pi) > 0.8$, $R(\pi\lvert K) > 0.6$
Ω_c^0 reconstruction:	$x_p(\Omega_c^0) > 0.6$,$\chi^2/ndf < 0.01$, 2.549 GeV/c^2 < $M(\Omega_c^0)$ < 2.851 GeV/c^2 .

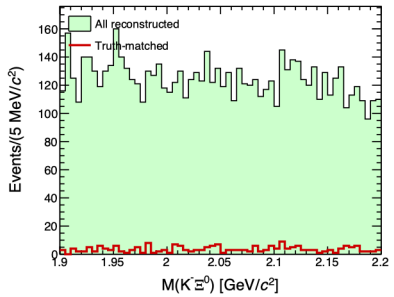
Belle II MC and Data Study

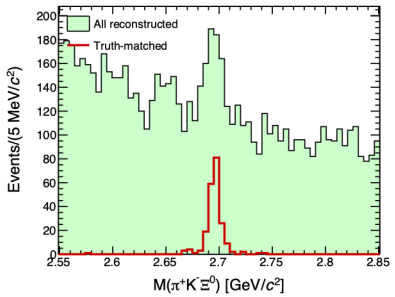
Signal MC



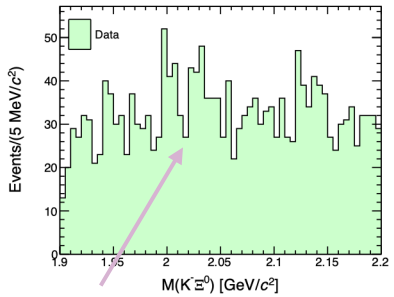


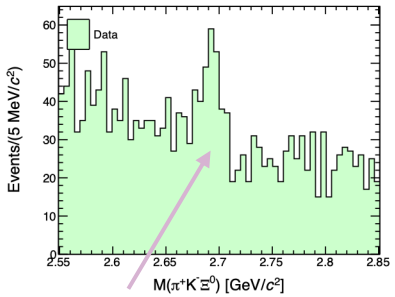
Inclusive MC (all periods)

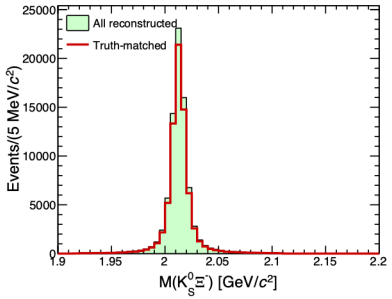


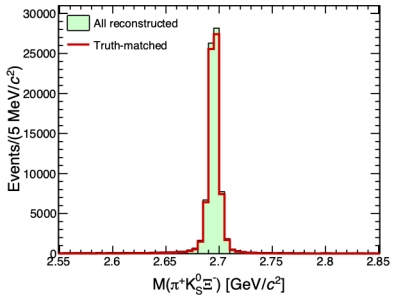


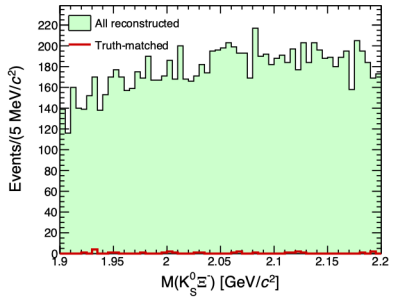
Data (all periods, 4S)

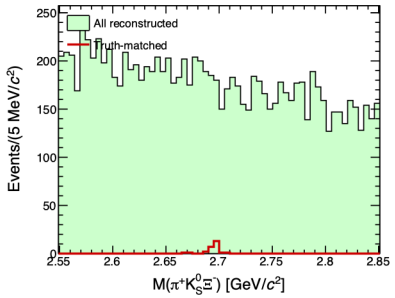


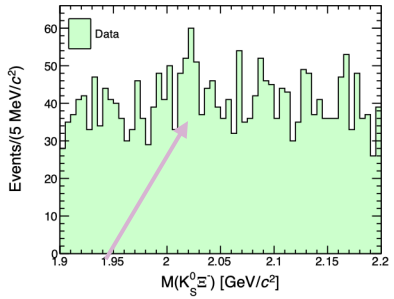


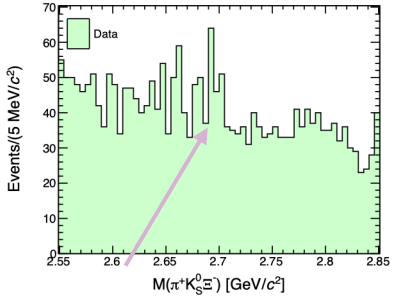








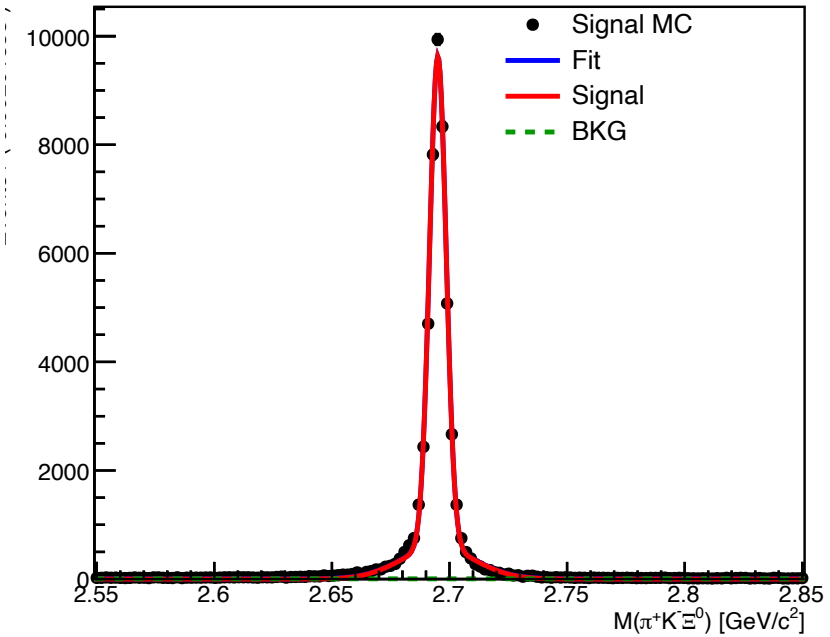


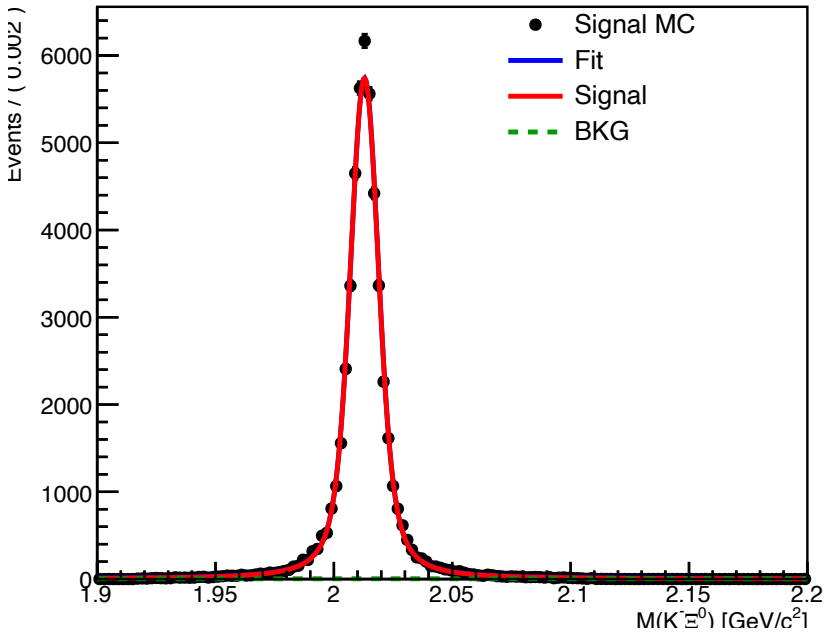


- The first line shows the distributions for $\Omega_c^0 \to \pi^+\Omega(2012) \to \pi^+K^+\Xi^0$ in signal MC, inclusive MC, and data.
- The second line shows the distributions for $\Omega_c^0 \to \pi^+\Omega(2012) \to \pi^+K_S^0\Xi^-$ in signal MC, inclusive MC, and data.

Belle II MC and Data Study

$\Omega_c^0 \to \pi^+\Omega(2012) \to \pi^+K^+\Xi^0$





The extended two-dimensional unbinned likelihood is

$$\mathcal{L} = \frac{(N_S + N_B)^N}{N!} e^{-(N_S+N_B)} \prod_{i=1}^{N} \left[\frac{N_S}{N_S + N_B} S(x_i, y_i) + \frac{N_B}{N_S + N_B} B(x_i, y_i) \right].$$

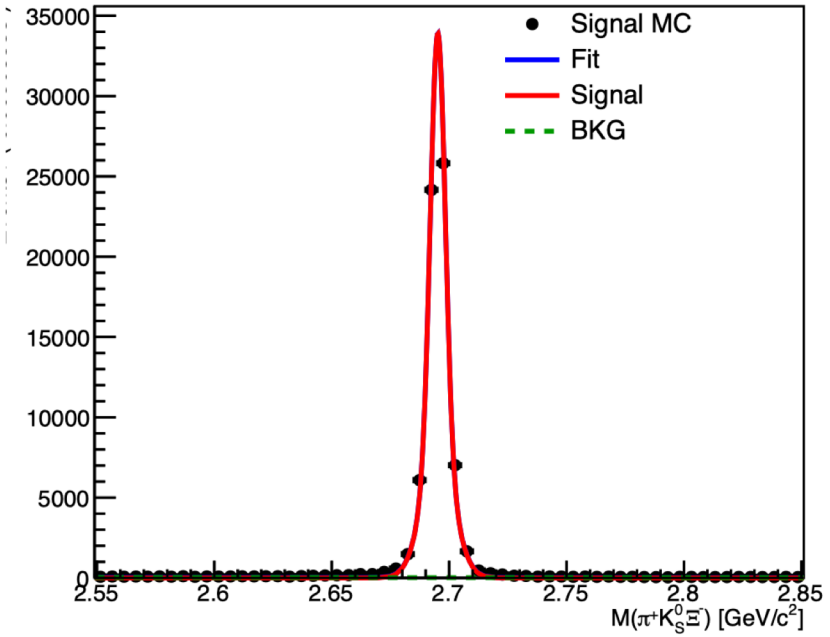
$$\mathbf{N_{sig} = 50685 \pm 233}$$

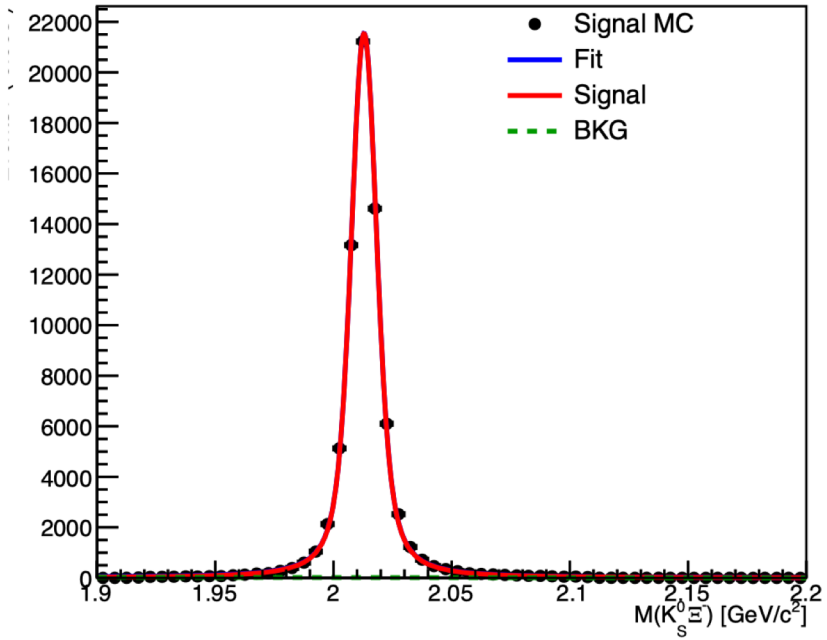
$$\boldsymbol{\varepsilon = 2.534\%}$$

Component	Peak / variable	PDF	Parameter	Value
Signal	Ω_c^0 (x)	Double Gaussian	μ_x	2.69508 GeV/c^2
			σ_1	3.22 MeV/c^2
			σ_2	9.14 MeV/c^2
			f	0.732
	$\Omega(2012)^-$ (y)	Voigtian (BW $\otimes$ Gaussian)	μ_y	2.01294 GeV/c^2
			Γ	6.4 MeV/c^2 (fixed)
			σ_y	4.20 MeV/c^2
Background	x	First-order Chebyshev	a_1	-0.249 ± 0.028
	y	First-order Chebyshev	b_1	-0.288 ± 0.040

Belle II MC and Data Study

$\Omega_c^0 \to \pi^+\Omega(2012) \to \pi^+ K_S^0 \Xi^-$





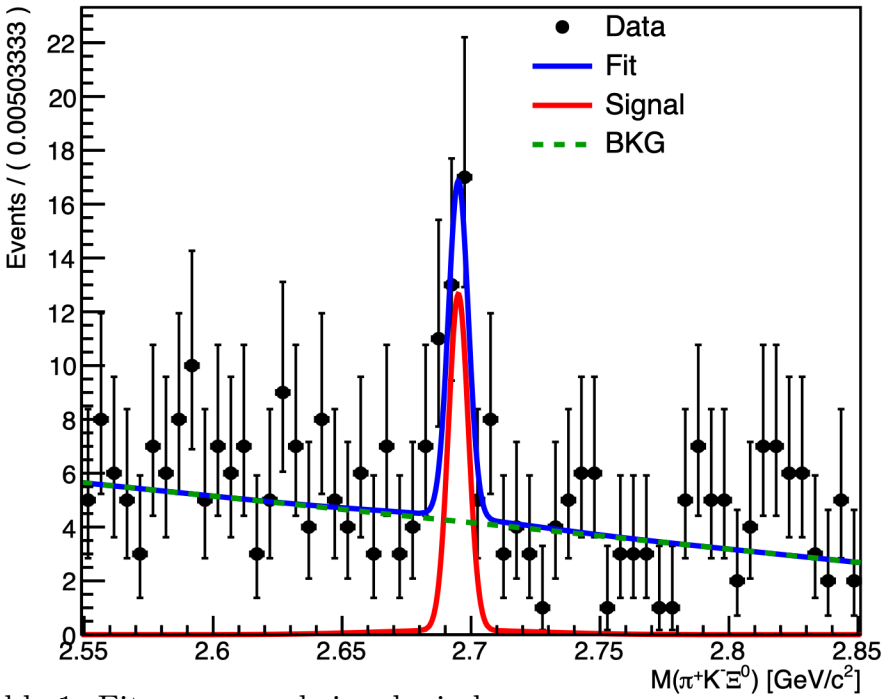
$\mathbf{N_{sig} = 70589 \pm 270}$

$\boldsymbol{\varepsilon = 3.529\%}$

Component	Peak / variable	PDF	Parameter	Value
Signal	Ω_c^0 (x)	Double Gaussian	μ_x	2.69519 GeV/c^2
			σ_1	3.16 MeV/c^2
			σ_2	6.81 MeV/c^2
			f	0.627
	$\Omega(2012)^-$ (y)	Voigtian (BW $\otimes$ Gaussian)	μ_y	2.01293 GeV/c^2
			Γ	6.4 MeV/c^2 (fixed)
			σ_y	3.97 MeV/c^2
Background	x	First-order Chebyshev	a_1	-0.207 ± 0.034
	y	First-order Chebyshev	b_1	-0.179 ± 0.064

Belle II MC and Data Study

$\Omega_c^0 \to \pi^+\Omega(2012) \to \pi^+K^+\Xi^0$



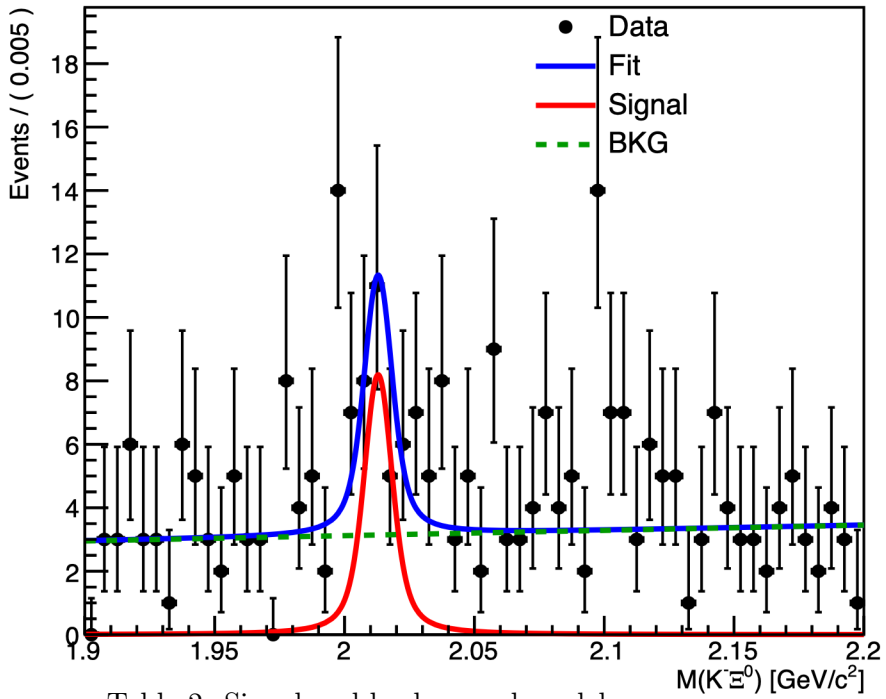


Table 1: Fit ranges and signal windows.

Quantity	Range
Fit range in $x = M(\pi^+K^-\Xi^0)$	2.549–2.851 GeV/c^2
Fit range in $y = M(K^-\Xi^0)$	1.9–2.2 GeV/c^2
Signal window in x	2.67968–2.70968 GeV/c^2
Signal window in y	1.9924–2.0324 GeV/c^2

$N_{\text{net}} = 30.4 \pm 7.7$

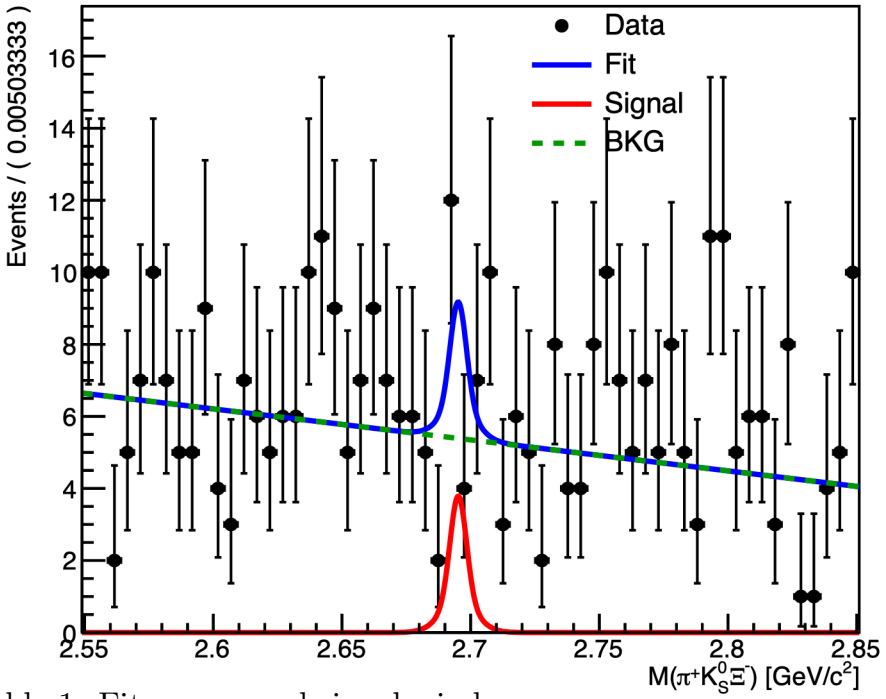
$N_{\text{net}} = 28.3 \pm 8.9$ (Belle)

Table 2: Signal and background models.

Component	Peak / variable	PDF	Parameter	Value
Signal	Ω_c^0 (x)	Double Gaussian	μ_x	2.69508 GeV/c^2
			σ_1	3.22 MeV/c^2
			σ_2	9.14 MeV/c^2
			f	0.732
	$\Omega(2012)^-$ (y)	Voigtian (BW $\otimes$ Gaussian)	μ_y	2.01294 GeV/c^2
			Γ	6.4 MeV/c^2 (fixed)
			σ_y	4.20 MeV/c^2
Background	x	First-order Chebyshev	a_1	-0.357 ± 0.038
	y	First-order Chebyshev	b_1	0.079 ± 0.041

Belle II MC and Data Study

$\Omega_c^0 \to \pi^+\Omega(2012) \to \pi^+ K_S^0\,\Xi^-$



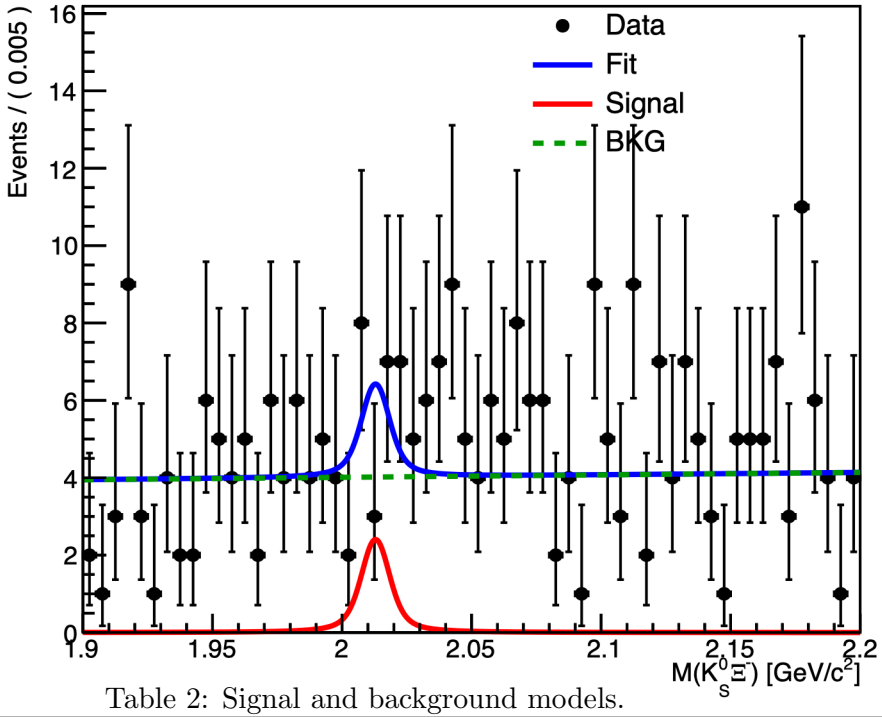


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Fit range in $y = M(K_S^0 \Xi^-)$	1.9–2.2 GeV/c^2
Signal window in x	2.67968–2.70968 GeV/c^2
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			Γ	6.4 MeV/c^2 (fixed)
			σ_y	3.97 MeV/c^2
Background	x	First-order Chebyshev	a_1	-0.243 ± 0.035
	y	First-order Chebyshev	b_1	0.023 ± 0.036

$N_{\text{net}} = 8.2 \pm 5.0$

$N_{\text{net}} = 17.9 \pm 8.9$ (Belle)

Summary

- **A preliminary study for $\Omega_c^0 \to \pi^+\Omega(2012) \to \pi^+K^+\Xi^0$, $\Omega_c^0 \to \pi^+\Omega(2012) \to \pi^+K_S^0\Xi^-$ is performed.**
  - Use Belle II signal and Generic MC Run1(proc16) and Run2(PromptRel8/9);
  - Determine the efficiencies using signal MC samples;
  - Signals of $\Omega(2012)^-$ and Ω_c^0 are seen in the fits to the data.
- **Next to do:**
  - Simultaneous fit;
  - Systematic uncertainties;
  - Generate the signal MC events of $\Omega_c^0 \to \pi^+K^+\Xi^0$, $\Omega_c^0 \to \pi^+K_S^0\Xi^-$.

Thanks for your attention!