Belle NPC の活動報告
Exotic nuclei search in Belle data

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多彩な フレーバーで探る新しいハドロン存在形態の包括的研究

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Outline

- PID (KID,eID,muID) study for Belle new data
- Physics by using the Belle data.
- Summary

Belle PID study (exp61-65)

- We started in the beginning of July.
- KID Table (Niiyama) $D^* \to D\pi_{slow} \to (K\pi)\pi_{slow}$
- Lepton ID : compare with $\gamma\gamma \to ll$, $J/\psi \to ll$
  - (Muramatsu, Sumihama, Uchida)
- Electron ID: $\gamma\gamma \to ee$ (Sumihama)
- Muon ID: $\gamma\gamma \to \mu\mu$ (Muramatsu)
- High mutiplicity: $J/\psi \to ll$ (Uchida)
- This study was finished and distributed in Aug. for Exp. 61,63 and 65.

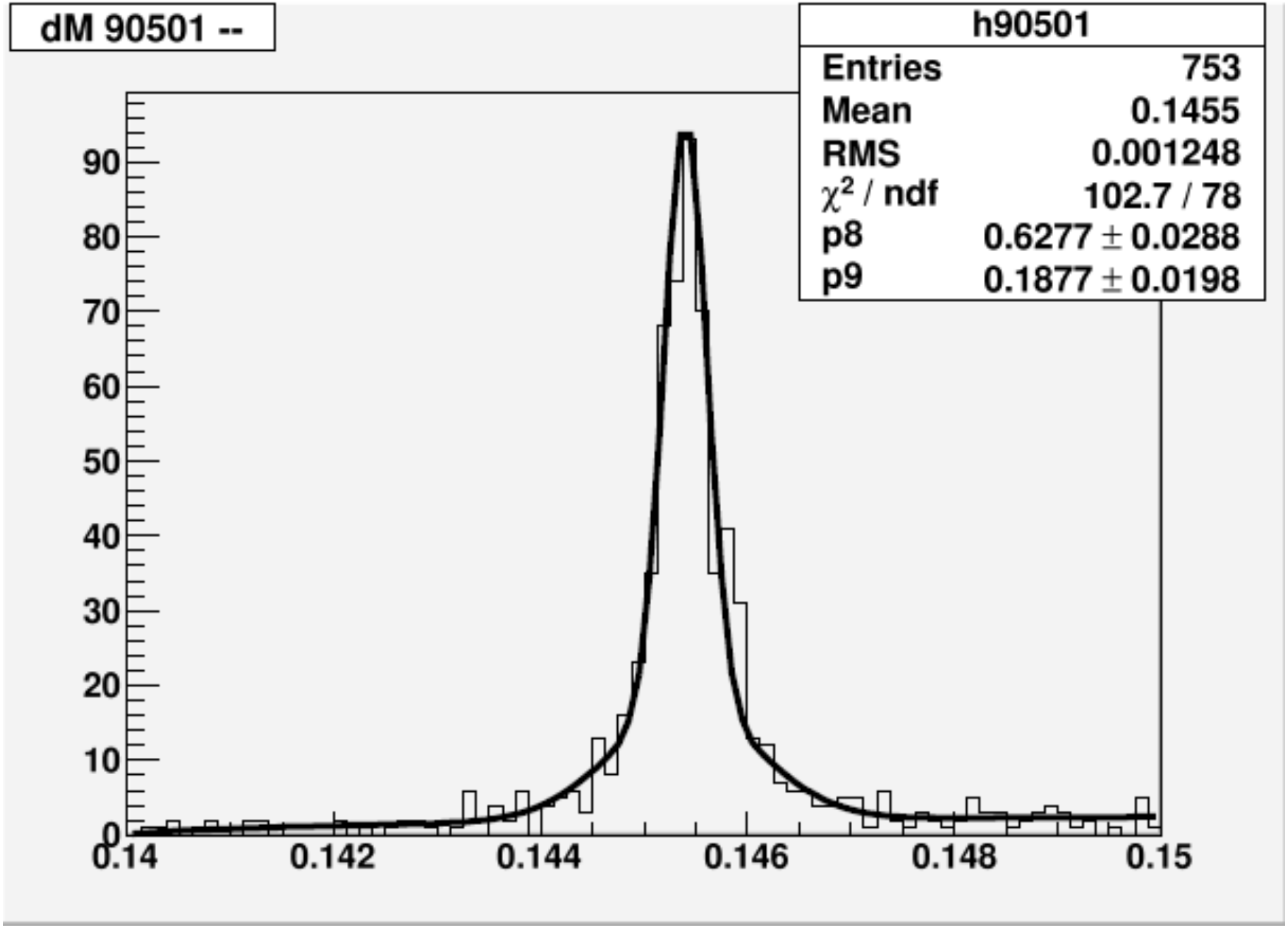
Kaon ID table

$$D^{*-} \to \overline{D}^0 \pi_s^- \qquad D^{*+} \to D^0 \pi_s^+$$

$$\overline{D}^0 \to K^+\pi^-, \qquad D^0 \to K^-\pi^+$$

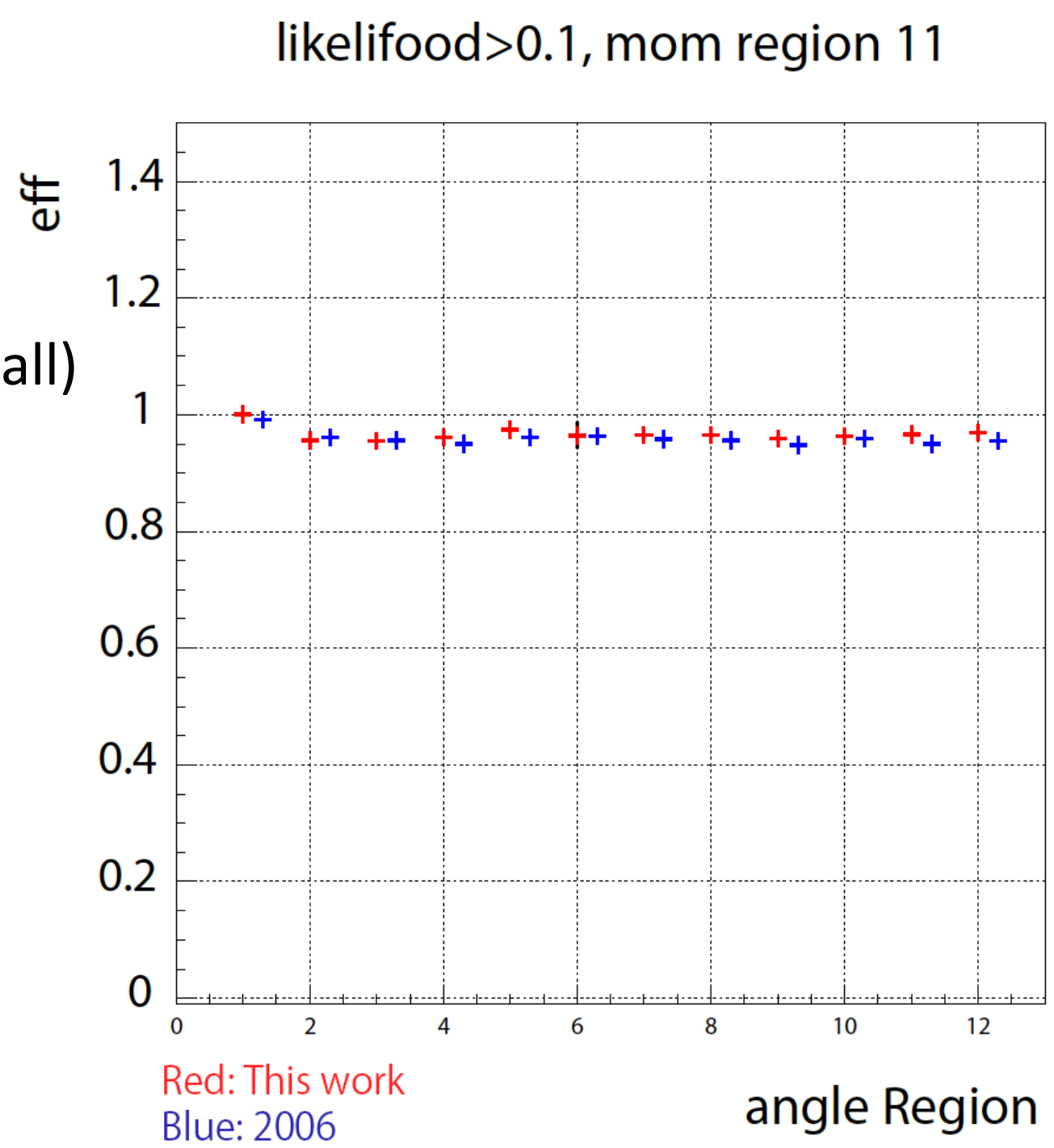
Selection Criteria

- $p^*_{D^*} > 2$ GeV/c, i.e. $x \equiv p^*_{D^*}/E^*_{\rm beam} > 0.378$.
- $1.835\ {\rm GeV}/c^2 < m_{D^0} < 1.895\ {\rm GeV}/c^2$.
- $m^{\rm rev}_{D^0} < 1.835\ {\rm GeV}/c^2$ or $m^{\rm rev}_{D^0} > 1.895\ {\rm GeV}/c^2$, where $m^{\rm rev}_{D^0}$ is the $K\pi$ invariant mass with reversed mass assignment.
- $|\cos\theta_D| < 0.8$.
- $\Delta m < 0.155\ {\rm GeV}/c^2$, where Δm is the mass difference between D^* and D.
- with slow pion vertex refitted,



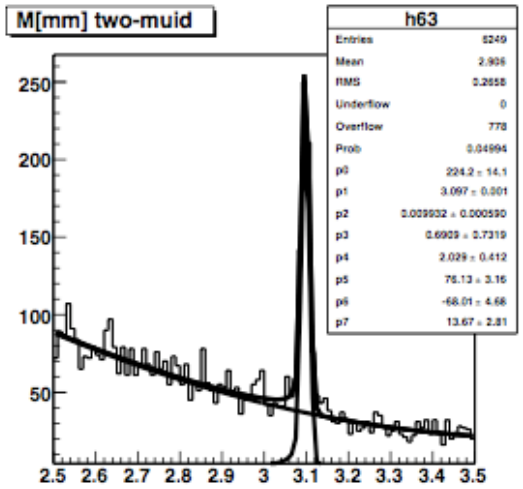
$\Delta M = M_{D^*} - M_D$ (GeV)

eff =N(L>0.1)/N(all)

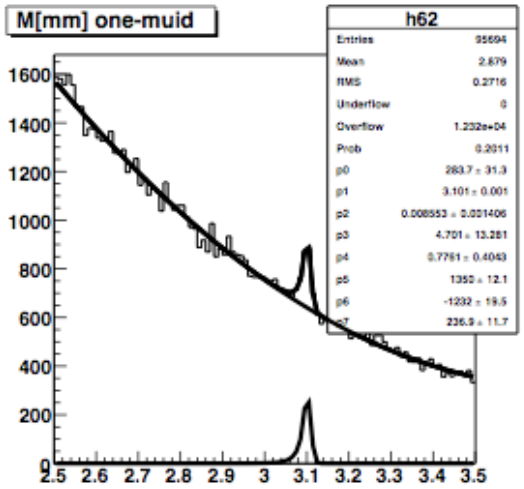


J/ψ -> *ll* fitting

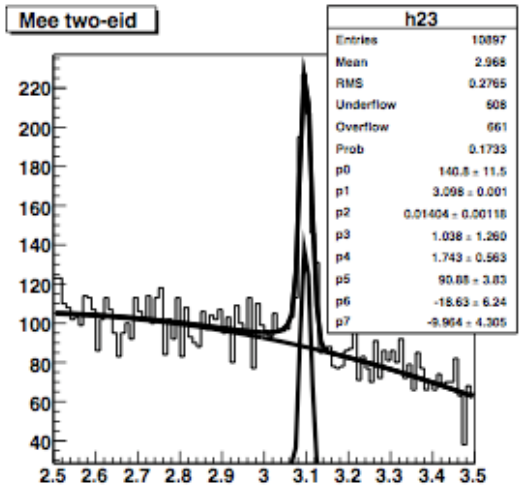
2μ ID



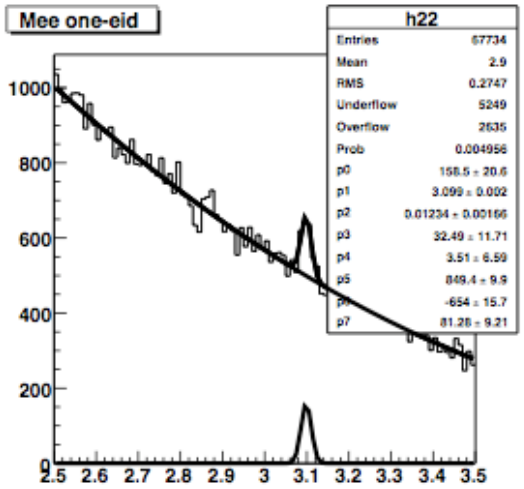
1μ ID



2e ID

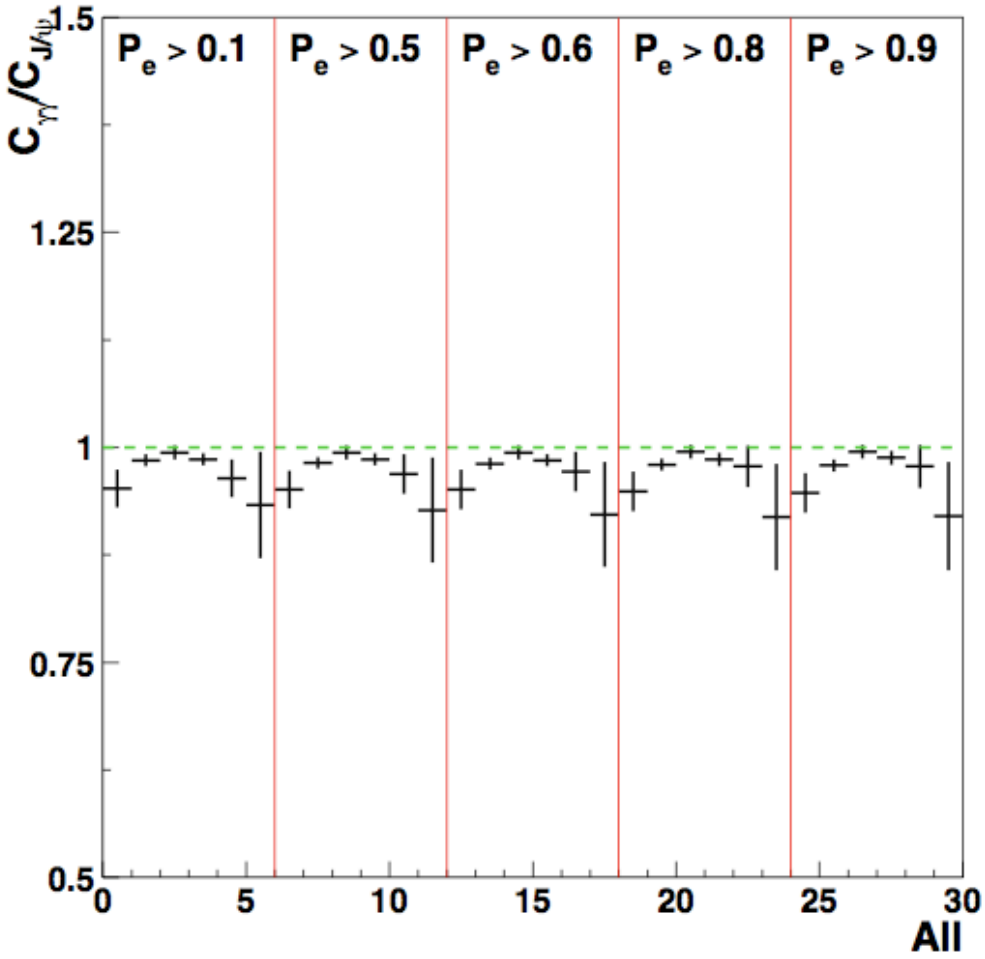


1e ID

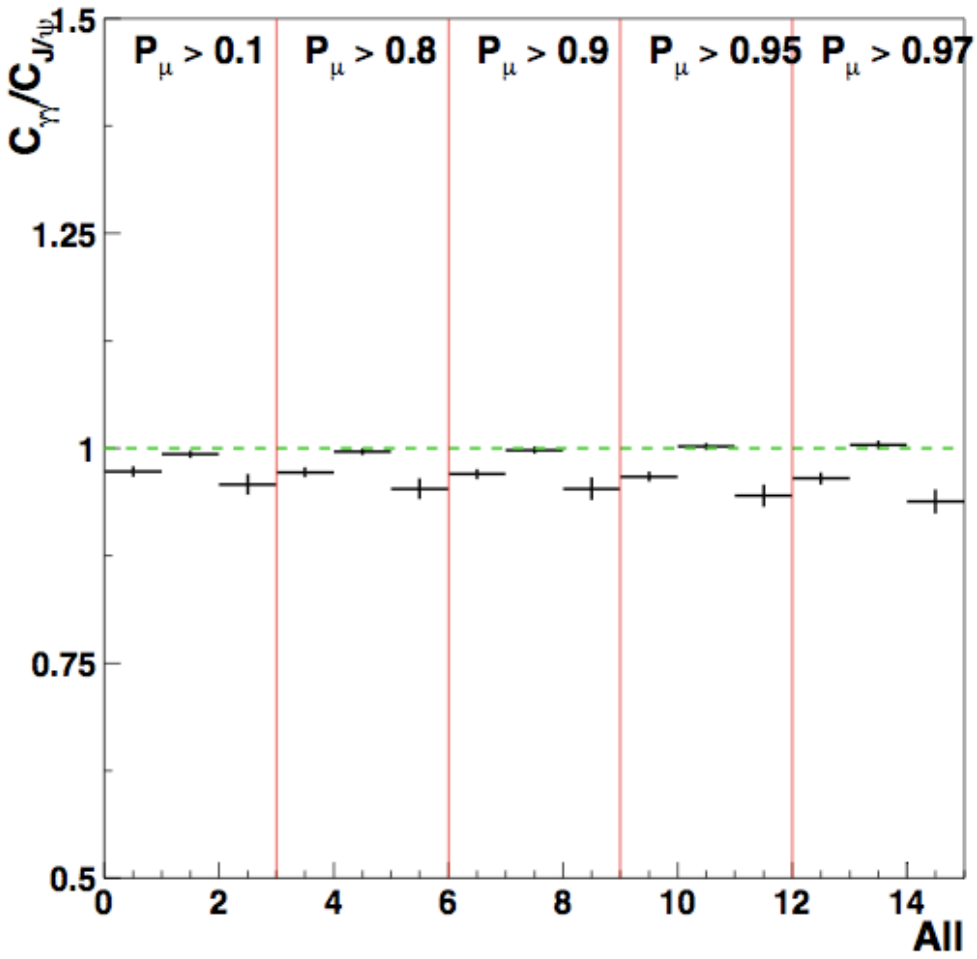


Electron ID table

$C = eff_{Data}/eff_{MC}$



Muon ID table

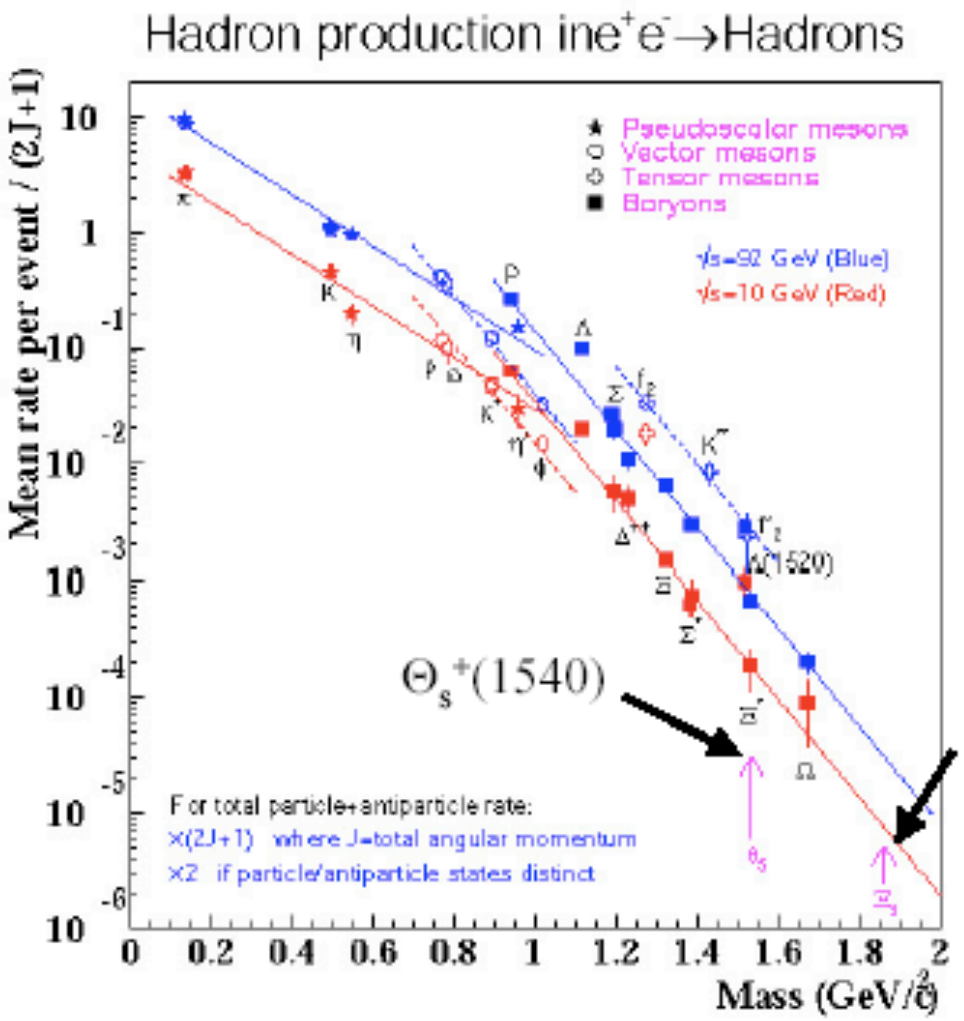


Consistent with previous tables

Physics by using the Belle data

- Production rate of meson, baryon, exotic hadron.
- Kaonic nuclei (KK^barN) search
- Other topics, Niyama-san's talk.

Hadron Rate in e^+e^- → Hadron



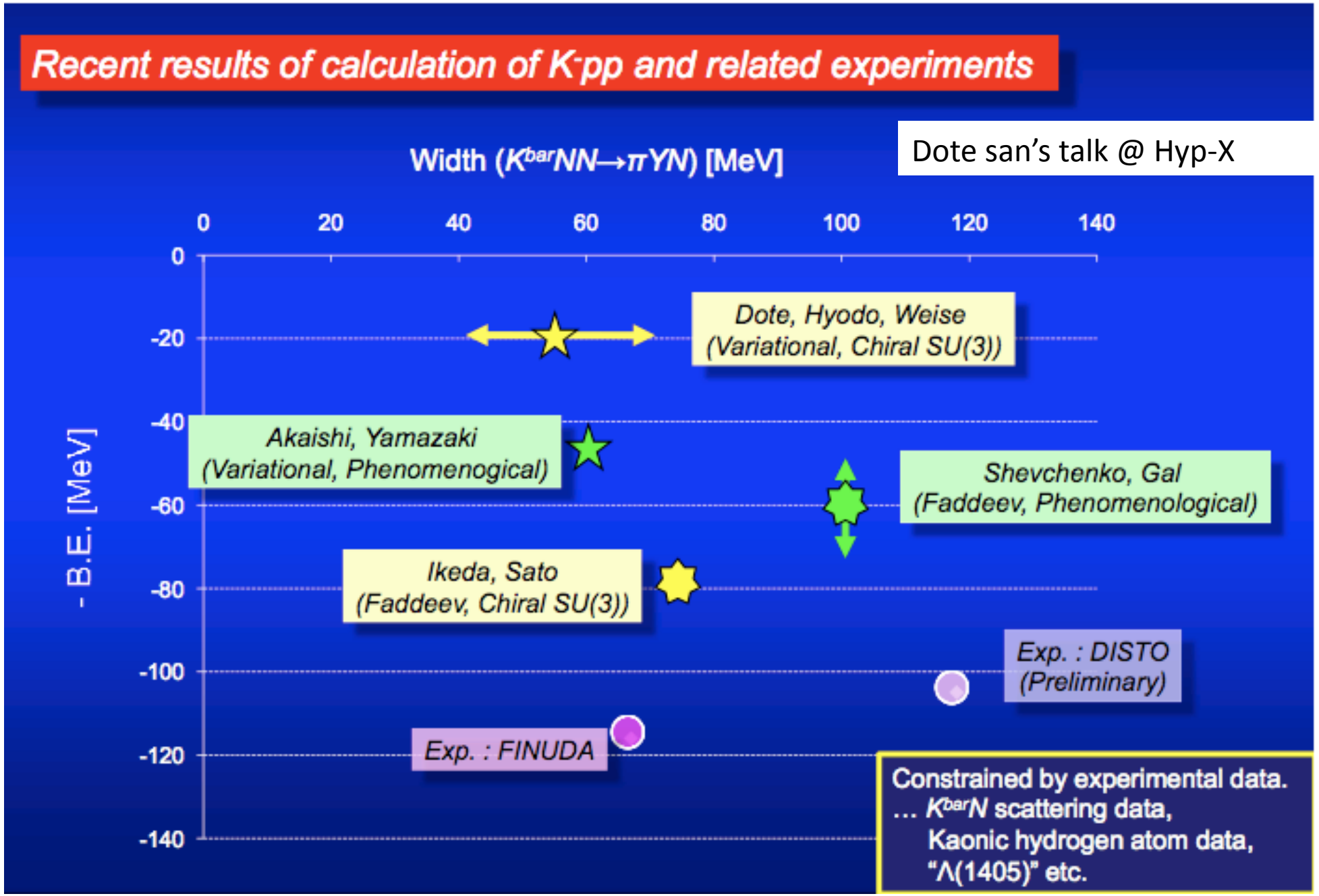
Talk by Nakano-san @B-WS 2009

Where a0/f0 and Λ(1405)
-> Information about Meson of Baryon like or genuine exotic?

Assuming the Pentaquark production is the same as baryon production we expect the total production of Θ_s^+, Ξ_5^{--} per event continuum to be $\Theta_s^+ = 7 \times 10^{-4}$, $\Xi_5^{--} = 3. \times 10^{-5}$

Exotic nuclei – Kaonic nuclei

- Strong K^bar N interaction
- $\Lambda(1405)$ seems to be M-B molecular state.
- K^- pp candidate was reported in FINUDA, DISTO.
- Theoretical approach: Chiral unitary (Hyodo *et al.*) vs. Phenomenological (Yamazaki and Akaishi). Some difference of binding energy and width.
- Detailed explanation: Hyodo-san's talk (probably).


Recent results of calculation of K⁻pp and related experiments
Dote san's talk @ Hyp-X
Width (K^barNN→πYN) [MeV]
0
20
40
60
80
100
120
140
0
-20
-40
-60
-80
-100
-120
-140
- B.E. [MeV]
Dote, Hyodo, Weise
(Variational, Chiral SU(3))
Akaishi, Yamazaki
(Variational, Phenomenogical)
Shevchenko, Gal
(Faddeev, Phenomenological)
Ikeda, Sato
(Faddeev, Chiral SU(3))
Exp. : DISTO
(Preliminary)
Exp. : FINUDA
Constrained by experimental data.
… K^barN scattering data,
Kaonic hydrogen atom data,
"Λ(1405)" etc.

$K^+ K^- p$ bound state ($I = \frac{1}{2}, J^\pi = \frac{1}{2}^+$)

assumption

non-relativistic potential model

$\Lambda(1405)$ is a quasi-bound state of $K^{bar}N$

$f_0(980)$ and $a_0(980)$ are quasi-bound states of KK^{bar}

s-wave

Λ(1405) 

$f_0(980)$, $a_0(980)$ 

Interactions in $KK^{bar}N$ system

		I=0	I=1	threshold
attraction	$\bar{K}N$	$\Lambda(1405)$	weak attraction	1434.6 MeV
	$K\bar{K}$	$f_0(980)$	$a_0(980)$	991.4 MeV
repulsion	KN	very weak	strong repulsion	1434.6 MeV

Talk by Jido-san @ Hyp-X 2009

$K^+ K^- p$ bound state

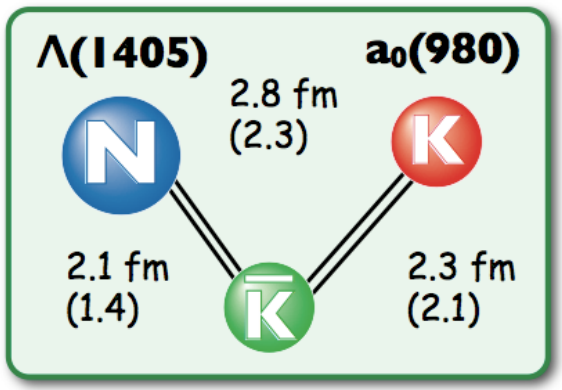
loosely bound system

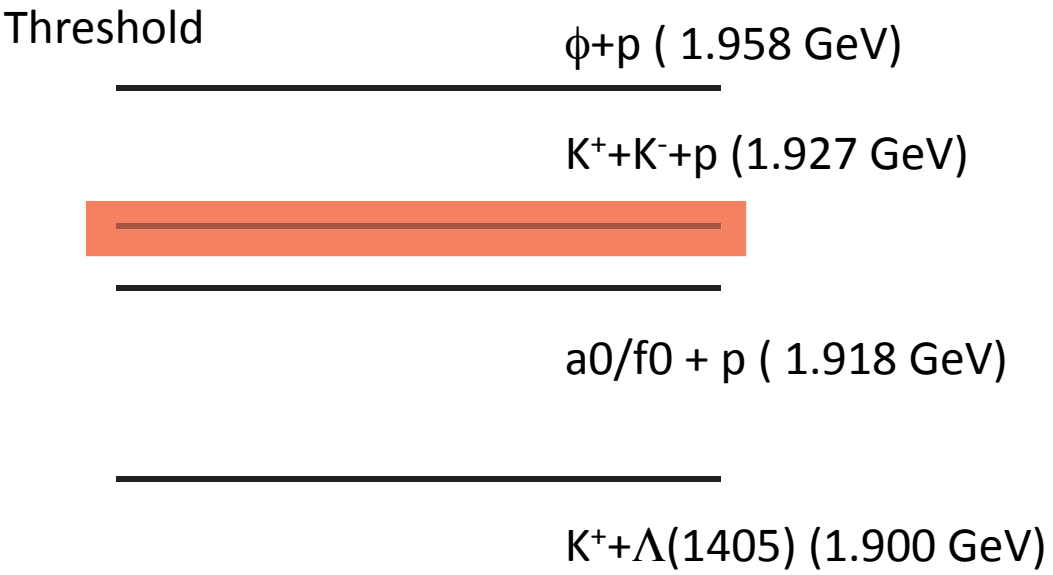
	B.E. from KKbarN	width
HW:	**19 MeV**	**88 MeV**
AY:	**39 MeV**	**98 MeV**

HW- Hyodo and Weise

AY – Akaishi and Yamasaki

spatial structure





Target reactions for KKbarN search

- $\gamma\gamma$ -> X p^bar : X = K^+K^-p
- e^+e^- -> γ_{ISR} X p^bar
- Y(1,2,3S) -> γ X p^bar
- J/Ψ -> γ X p^bar from B decay
- Etc …
- Decay
  - a_0/f_0+p -> $\pi\eta/\pi\pi$ + p -> 4γ / $\pi\pi$ + p
  - K^++Λ(1405) -> K^++π+Σ

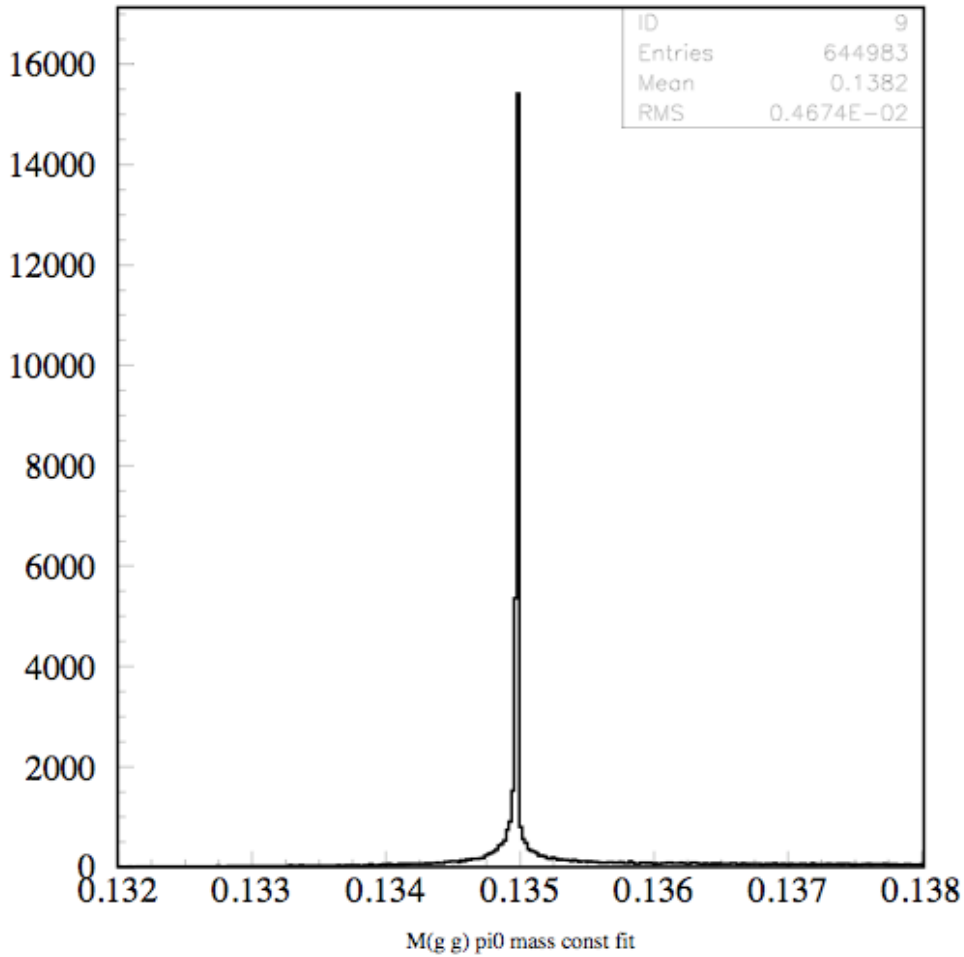
Belle data analysis

- Very easy to access and manage for beginner! (Thanks to all of Belle people)
- Minimum bias triggered data.
- Accessible to charged particles, neutral particles (except for neutron), gamma's and leptons.

Quick analysis for KK^bar p search

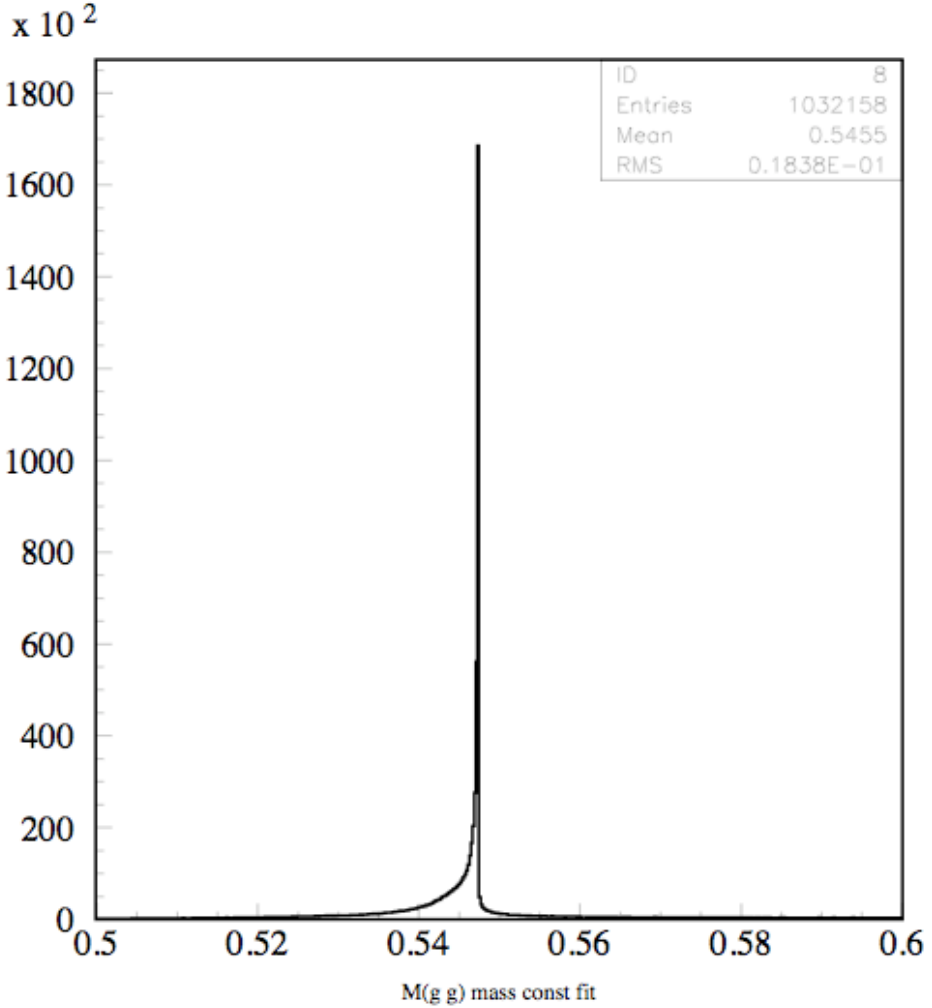
- Belle NPC people can access all of the belle data.
- Data sample: Low Multiplicity skim
- I tried to make a reconstruction for some of known mesons and baryons (next slides).
- K^+, proton and anti-proton are produced so many.
- Invariant mass of a0p or $K\pi\Sigma$ can be reconstructed.

π_0 invariant mass ($m_{\gamma\gamma}$)



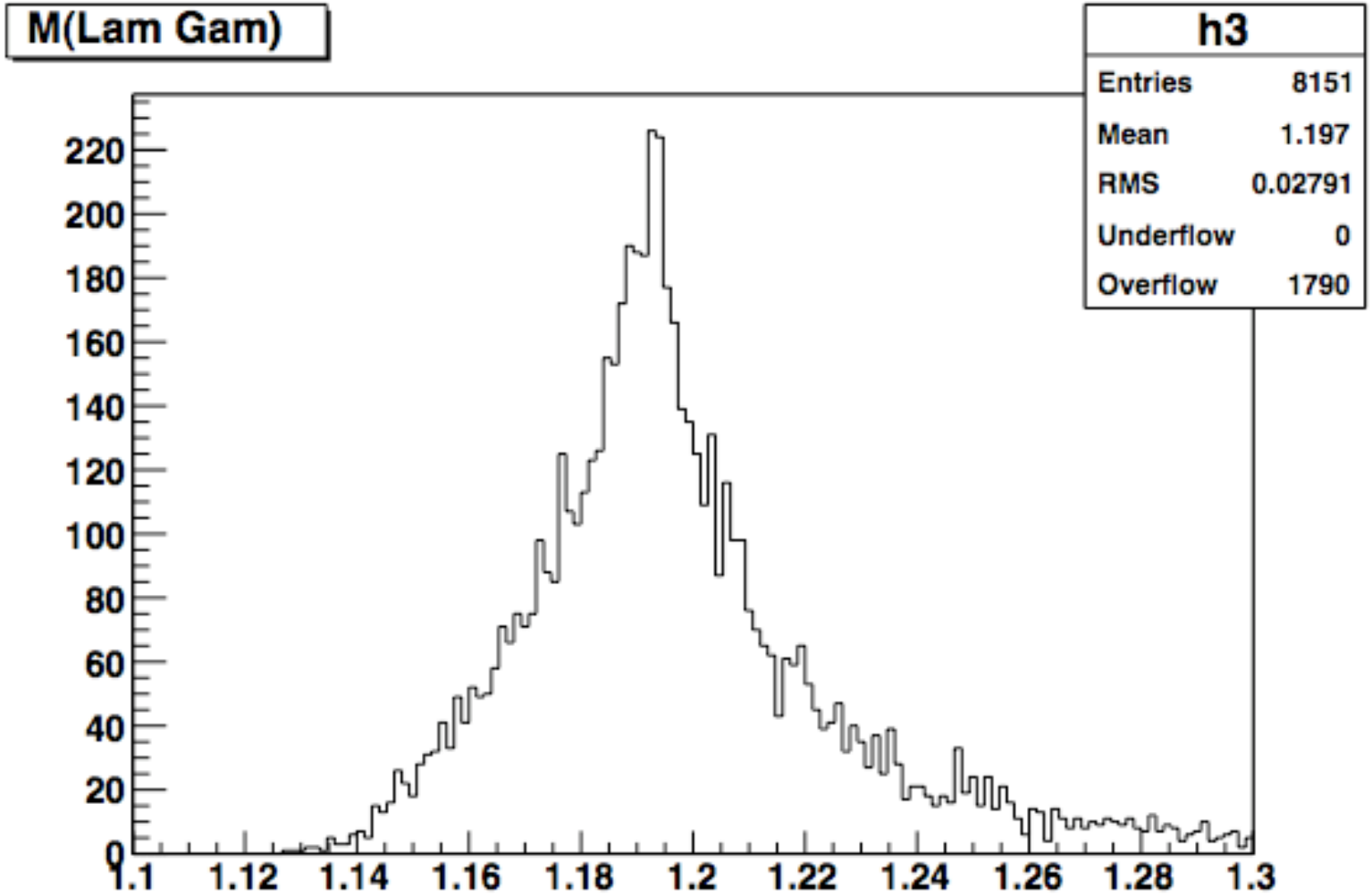
m = 0.1382 GeV

η invariant mass ($m_{\gamma\gamma}$)



m = 0.5455 GeV

$\gamma\Lambda$ invariant mass



Ref. Belle Note 782 by Y. Sakai-san

Summary

- Service task for PID table of Belle new data was performed.
- After ground reprocess, we will replace all of PID table.
- Possibility of searches for KK^barN bound state (open discussion).
- DD^bar N possible?
- Belle analysis framework is very nice!
- We (NPC) can learn Belle analysis with minimal efforts thanks to Belle people.
- NPC will make outputs as soon as possible!