Limit on H-dibaryon production in the Y(1,2S) decay

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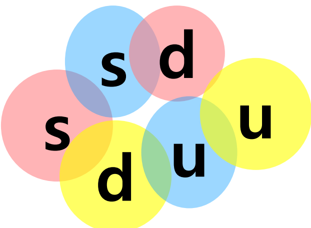
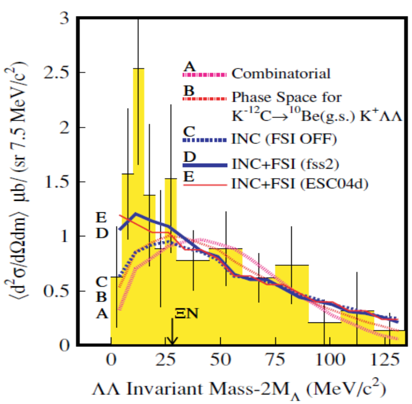
For the Belle collaboration

Motivation

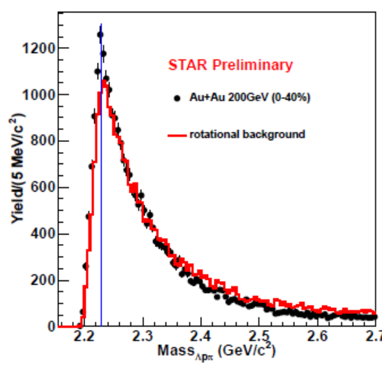
Channels with Λ



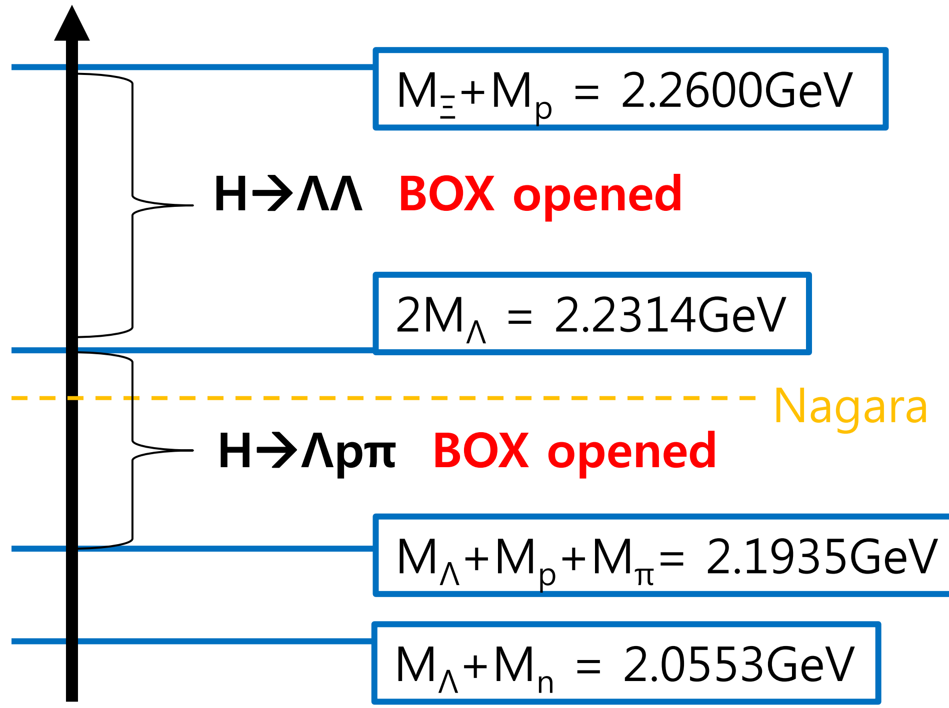
These days, there are some experiments that claim sign of the H-dibaryon.



KEK-PS E522(2007)



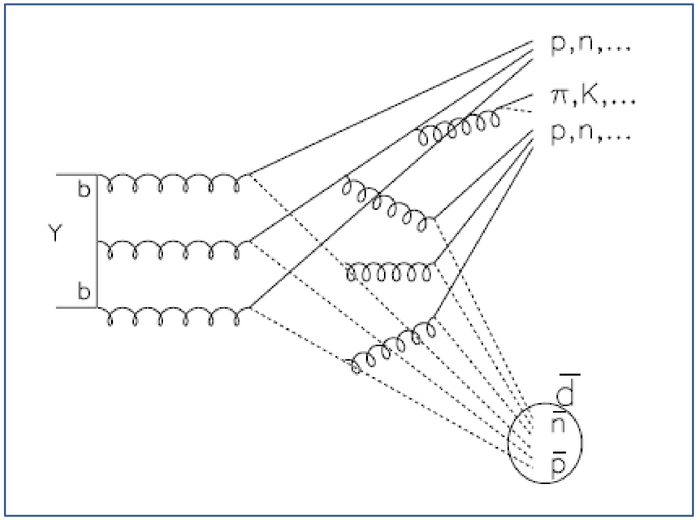
RHIC-STAR detector (2011)

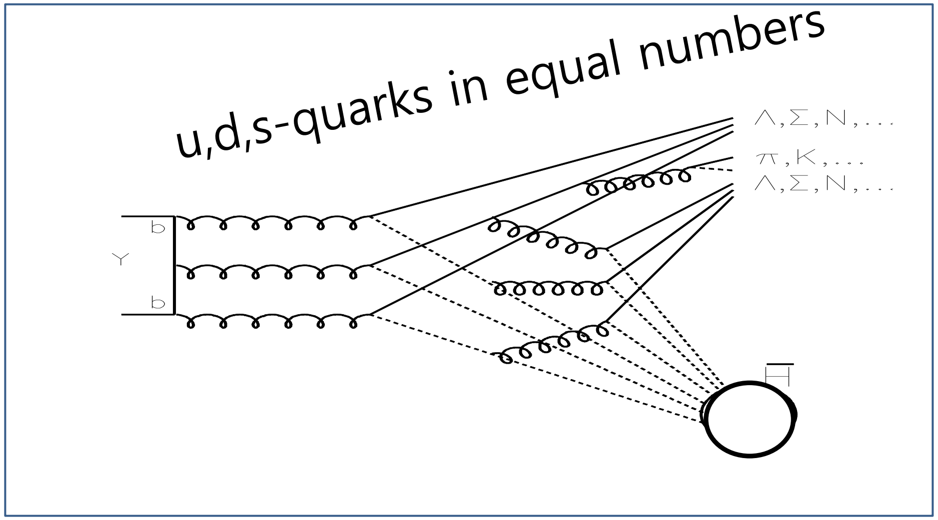


Our expectation for Y(ns)decay

- **clean signature for Belle : We have enough data for Y(1,2S)=(102+158)*10^6#**

Υ(1S)→ anti-deuteron + anything

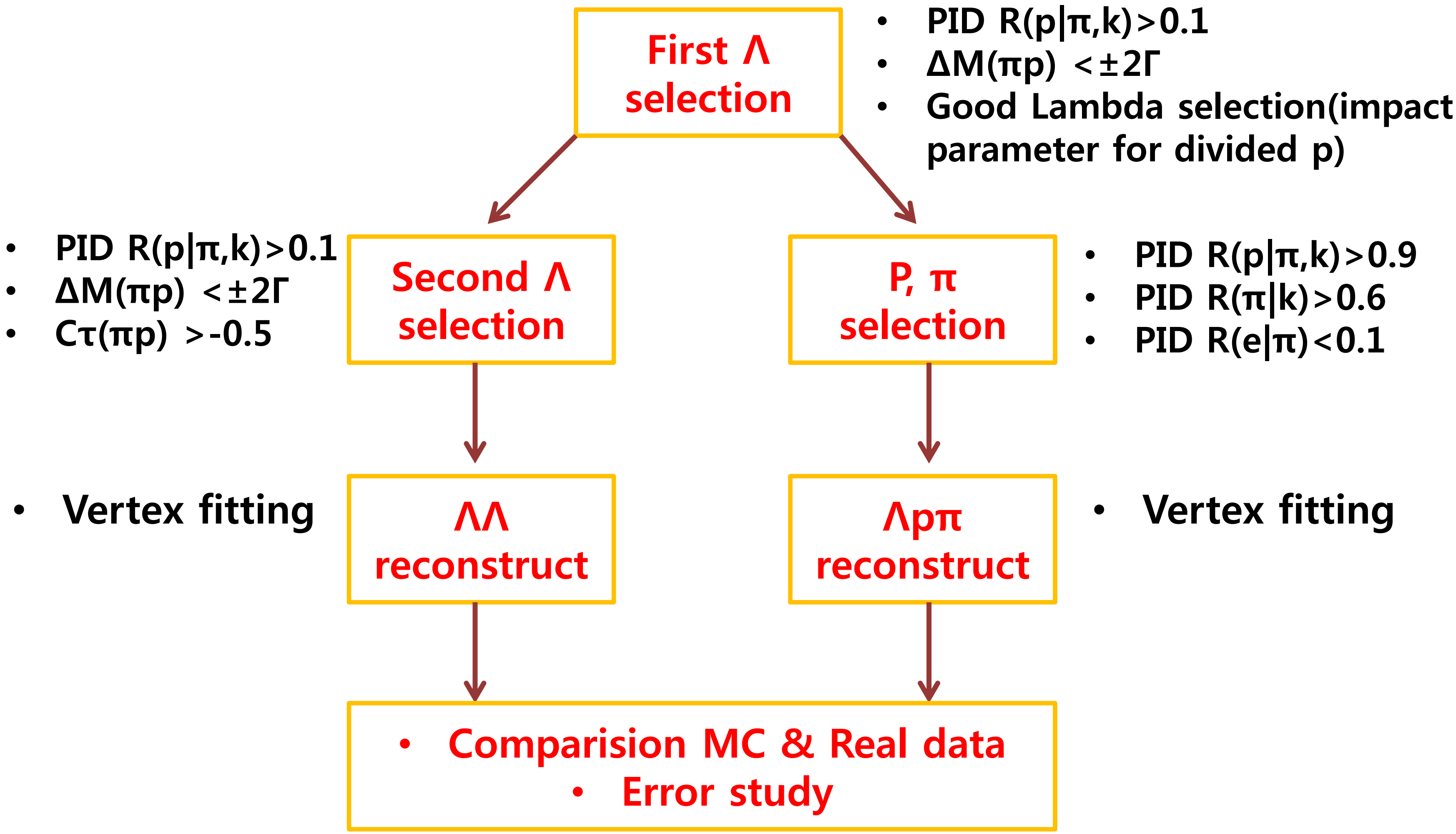




CLEO: Bf[Υ(1S)→ anti-deuteron + X]=3 x 10^{-5} ← Large!!

If H-dibaryon exists, one can naively expect a Bf of order ~ 3x10^{-5}

Analysis method

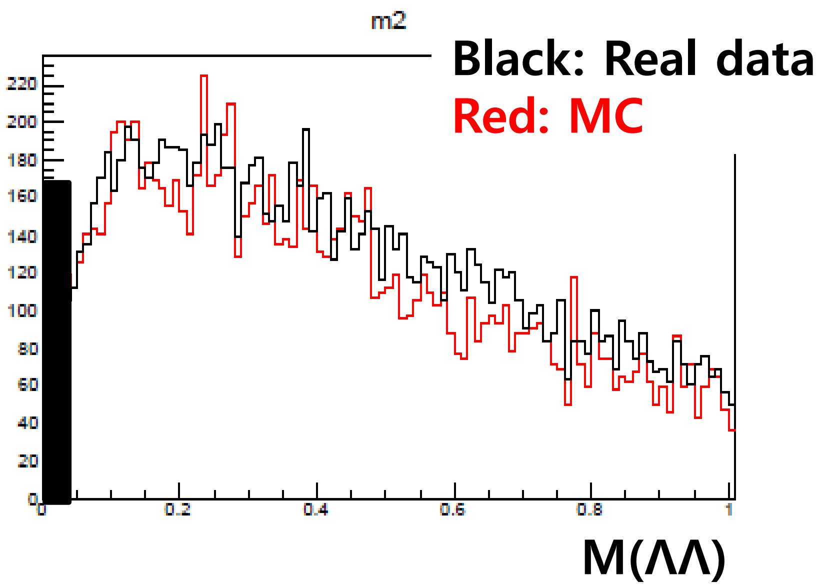


ΛΛ cut value

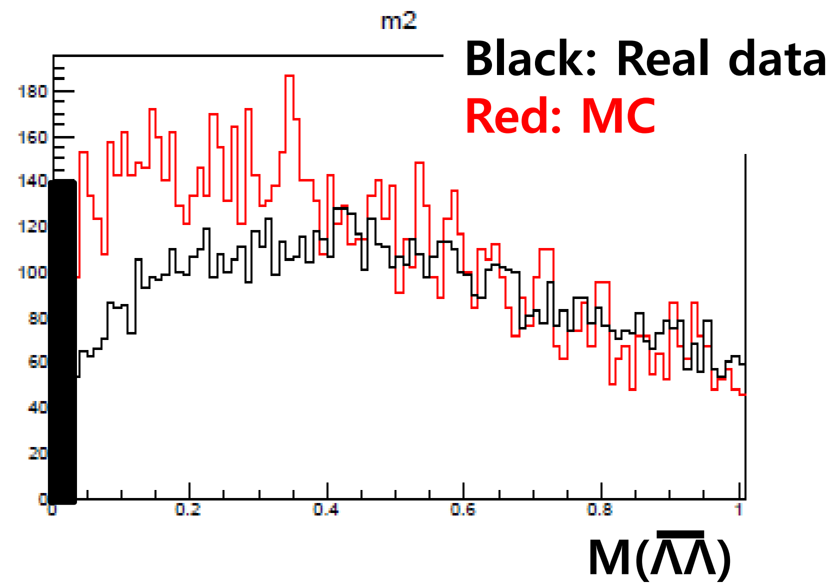
Particle	Quantity	Requirement
Λ_1		
	PID(P_1|π or K)	>0.1
	Goodvee	1 or 2
	ΔM(πp)	<±2Γ
Λ_2		
	PID(P_2|π or K)	>0.1
	ΔM(πp)	<±2Γ
	$ct_{\Lambda 2}$	>-0.5
$\Lambda_1\Lambda_2$	χ^2	<200
$\Lambda_1\Lambda_2$(multiple entry)	χ^2	smallest
$\pi_1\pi_2$	$M(\pi_1\pi_2)$	>0.288
p_1p_2		
	$M(p_1p_2)$	>1.878
	Nhit(p_1+p_2)	>60

$M(\overline{\Lambda}\overline{\Lambda})$ Distribution problem

$M(\Lambda\Lambda)-M(\Lambda_1)-M(\Lambda_2)$



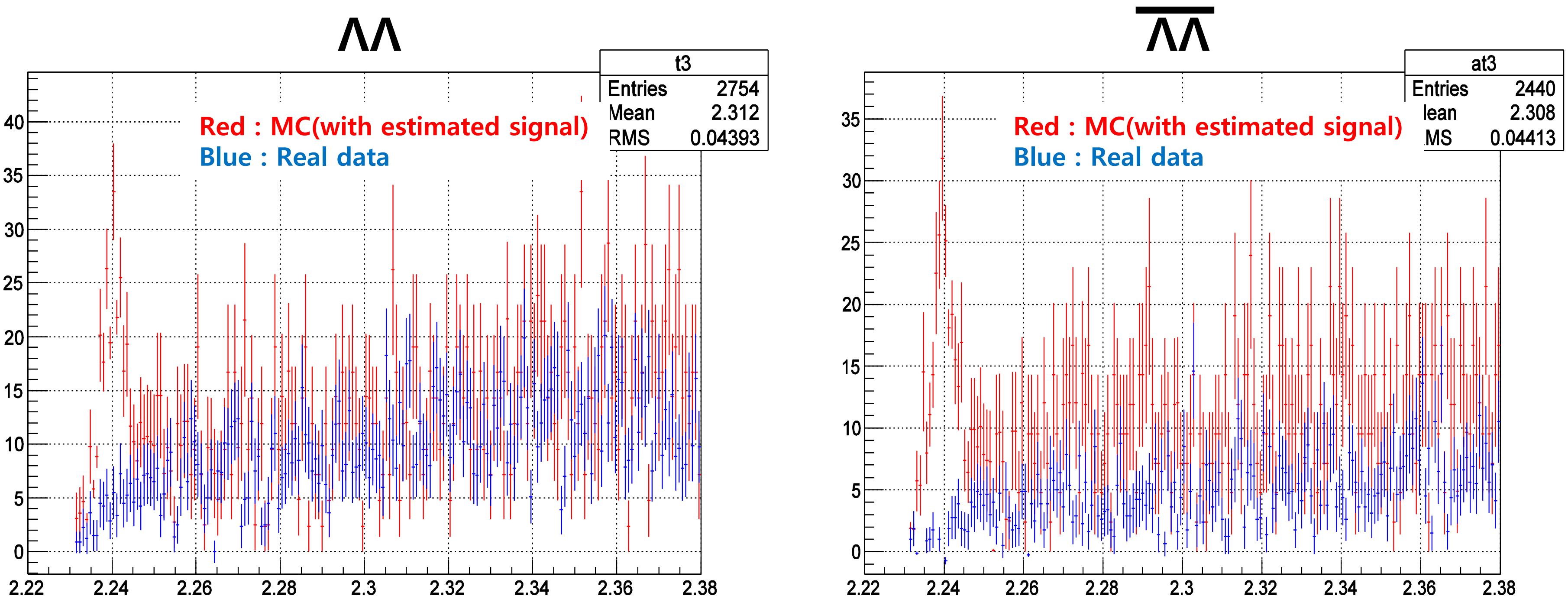
$M(\overline{\Lambda}\overline{\Lambda})-M(\overline{\Lambda}_1)-M(\overline{\Lambda}_2)$



- → **low momentum $\overline{N}$ annihilation. cross sections large & poorly measured,**
- → **Discrepancy likely due to underestimates of these effects in the MC.**
- → **we correct efficiency using data to make $\Lambda\Lambda$ & $\overline{\Lambda}\overline{\Lambda}$ yields equal.**
- → **Correction factor: $R = 0.768 \pm 0.061$ (0.061 = systematic error)**

Open $\Lambda\Lambda/\overline{\Lambda\Lambda}$ Box

M($\Lambda\Lambda$ or $\overline{\Lambda\Lambda}$) Distribution using Υ(1S)



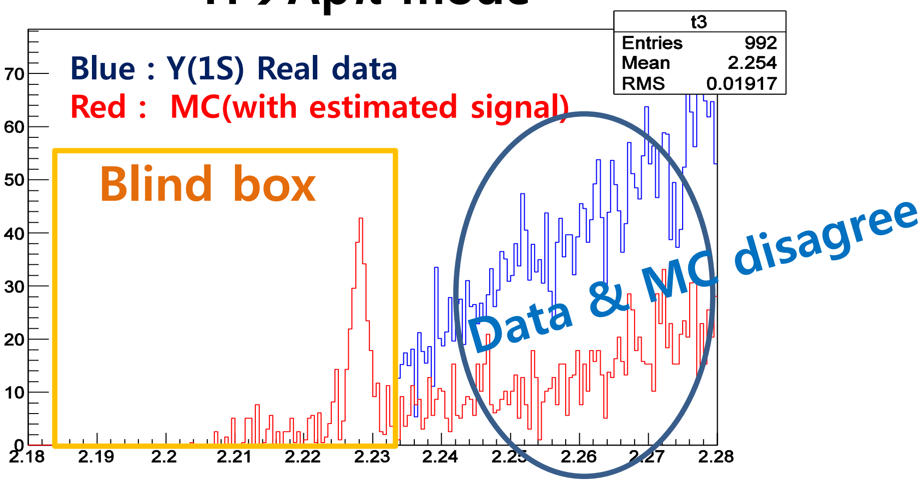
Red : MC(with signal at BF[Υ(1S)→HX] = $4*10^{-5}$level)
Blue : Real Υ(1S) data

Λpπ cut value

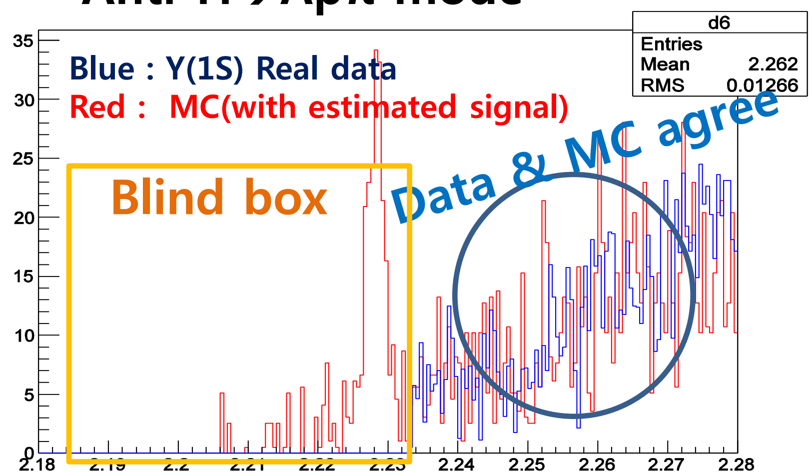
Particle	Quantity	Requirement
Λ		
	PID(P_1|π or K)	>0.1
	Goodvee	1 or 2
	ΔM(πp)	<±2Γ
p_2	PID(P_2|π or K)	>0.9
π_2	PID(π_2|k)	>0.6
	PID(e|π_2)	<0.1
$\Lambda p_2 \pi_2$		
	χ^2	<50
	$c\tau_H$	>0
$\Pi_1 \pi_2$	M($\pi_1 \pi_2$)	>0.28
$p_1 p_2$		
	M($p_1 p_2$)	>1.878
	Nhit(p_1+p_2)	>50
$\Lambda p_2 \pi_2$	χ^2	Smallest one
Λ(not anti)	momentum	0.5
p_2(not anti)	Momentum	0.5

M(Λpπ) Distribution problem

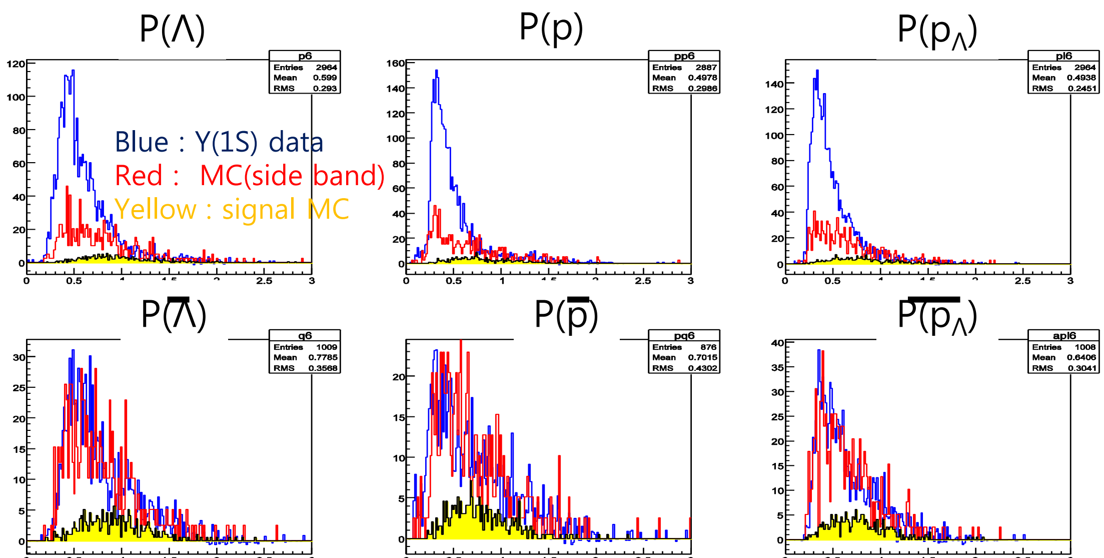
H→Λpπ mode



Anti-H→$\overline{\Lambda}$pπ mode



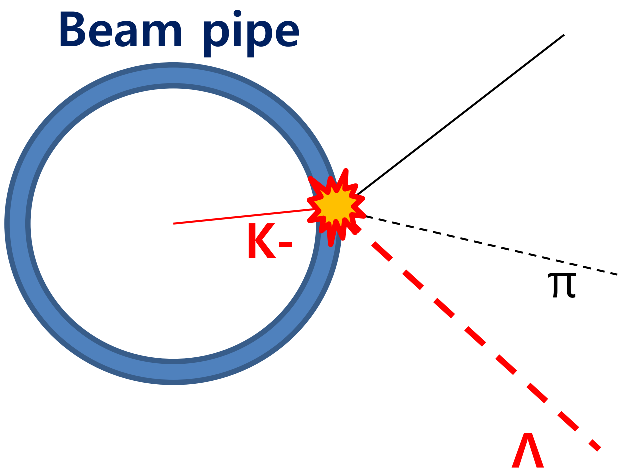
LAB Frame



Difference:
Λpπ data>MC
$\overline{\Lambda p}$π data≃MC
Excess Low-momentum Λpπ
(not $\overline{\Lambda p}$π)

M(Λpπ) Distribution problem

- difference between MC& data due to p's & Λ's produced in detector by low energy K's
- Not an issue for $\bar{p}$'s & $\bar{\Lambda}$'s



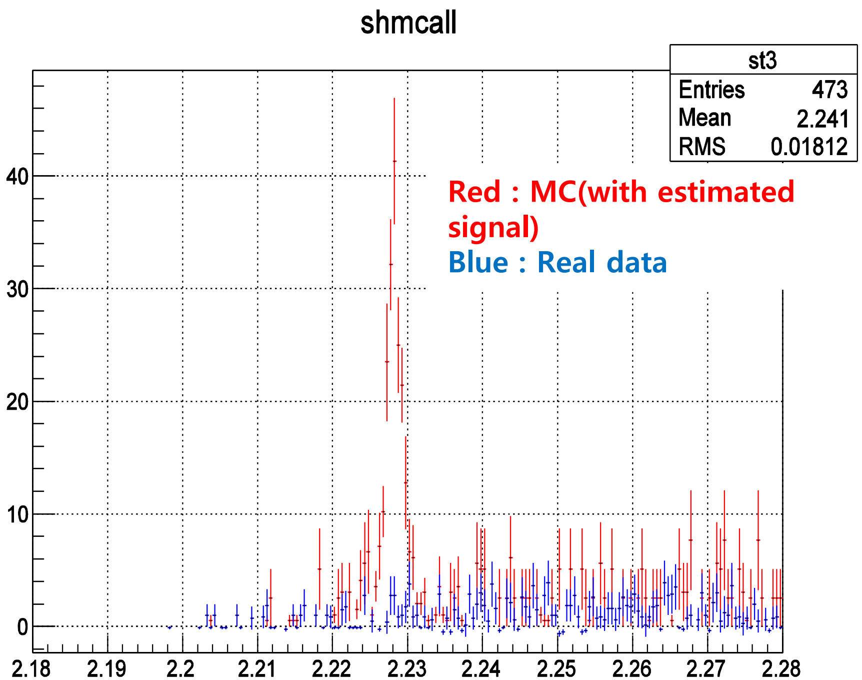
- Reject p's and Λ's with p<0.5GeV/c

(not applied $\bar{p}$ & $\bar{\Lambda}$)

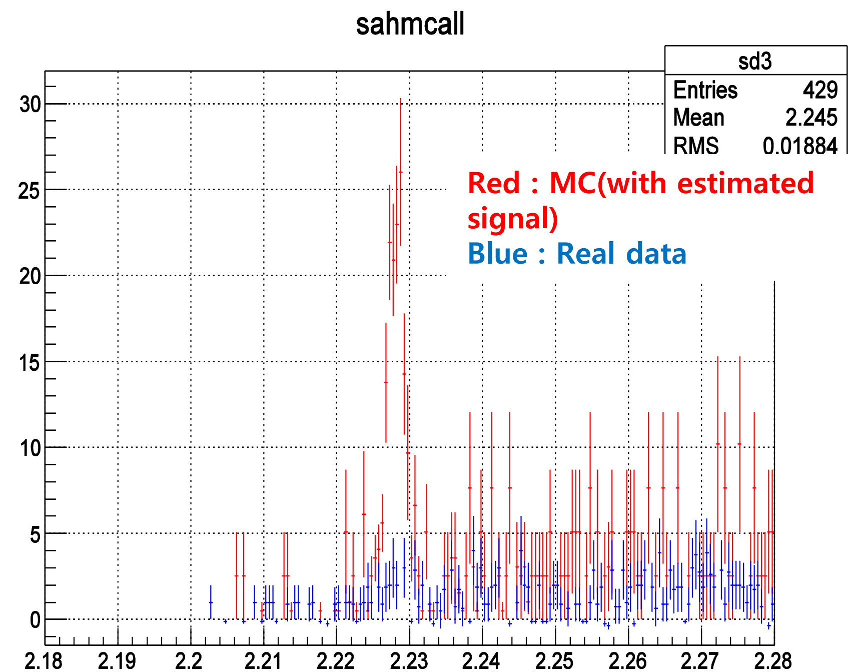
Open $\Lambda p\pi/\Lambda\overline{p\pi}$ Box

M(Λpπ) distribution using Υ(1S)

H→Λpπ mode



Anti-H→$\overline{\Lambda}$pπ mode



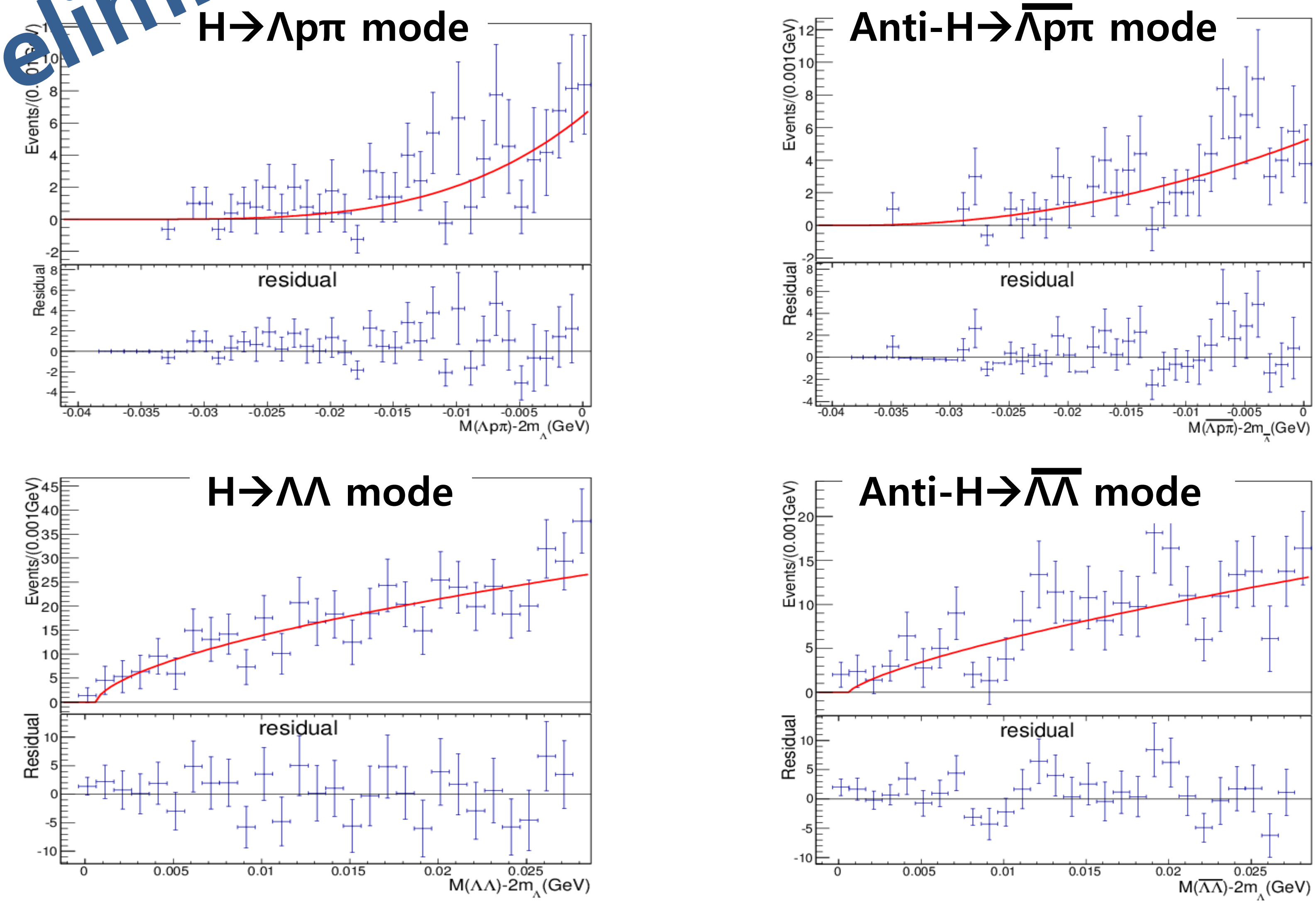
Red : MC(with signal at BF[Υ(1S)→HX] = 2.5*10^{-5}level)

Blue : Real Υ(1S) data

Fitting distribution using Υ(1,2S) (no signal PDF)

preliminary

BG function = Argus



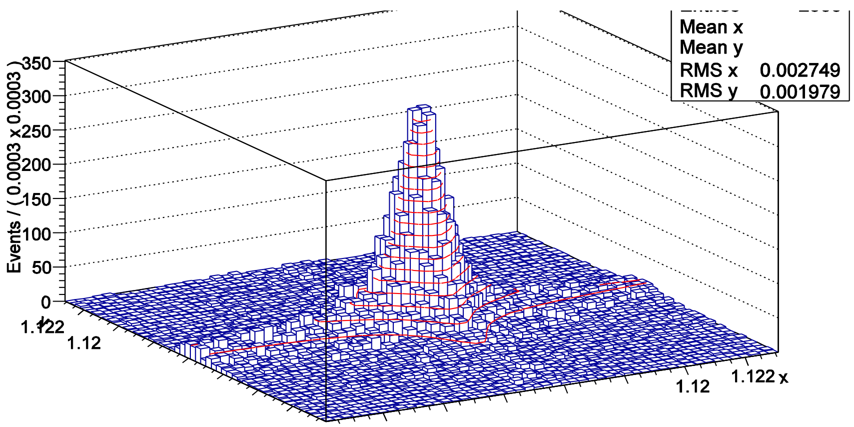
Systematic Error(%err only)

	lambdalambda	anti-lambdalambda	lambdappi	anti-lambdappi	
N(Y(1S))	2.3	2.3	2.3	2.3	bn1138
N(Y(2S))	3.6	3.6	3.6	3.6	bn1185
tracking	1.4	1.4	1.4	1.4	bn1165(high p)
Proton ID	4.3	4.3	6.58	6.58	ProtonID
pion ID:K	0	0	2.78	2.78	kid_eff6
momentumcut			1.7		MC study(Ξ^-)
lambda recon	12	9	3	5	bn684
goodvee	3.4	2.6	0.5	1.6	bn684
M(lambda)	2	2	1	1	bn684
BF[lambda->ppi]	1	1	0.5	0.5	PDG
continuum	0.7	0.7	0.7	0.7	Belle page
chisq	2.5	2.5	2.8	2.8	MC study(Λλbar)
ct	2.5	2.5	2.7	2.7	MC study(Λλbar)
binning	1.8	1.8	1.8	1.8	MC study(Ξc)
resolution	2.6	2.6	2.6	2.6	MC study(Ξc)
fitrange	0.8	0.8	0.8	0.8	MC study(Ξc)
Acceptance(mc stat+efficency R)	2.4	8.2861329943	2.7	2.6	MC study(signal MC)
Total	15.1	15.0	10.9	11.4	

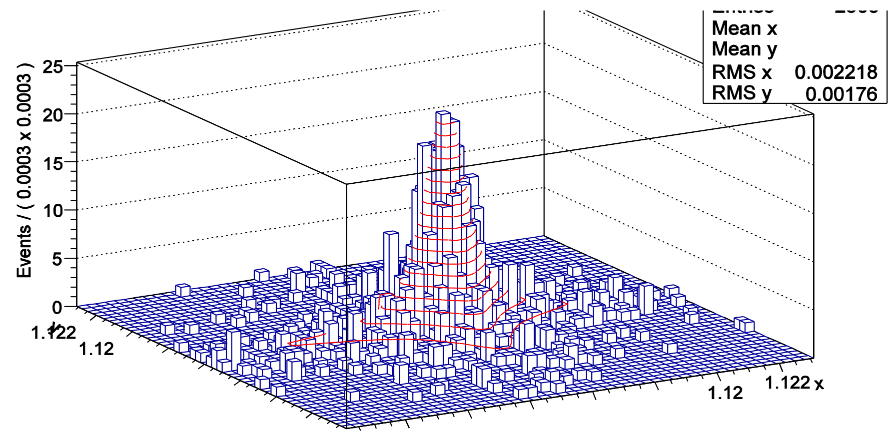
χ^2 & ct Systematic error study

- For getting χ2 cut efficiency we see loose cut χ^2<250 and χ^2<200 cut(what we used)
- For ct cut, we see without ct cut and ct>-0.5(what we used)

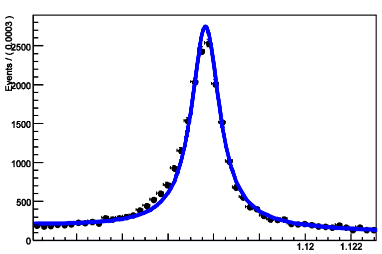
ΛΛ mass 2dfit (Real data)_normal cut



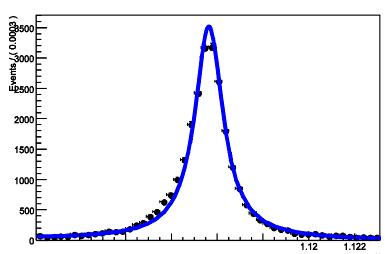
ΛΛ mass 2dfit (MC data)_normal cut



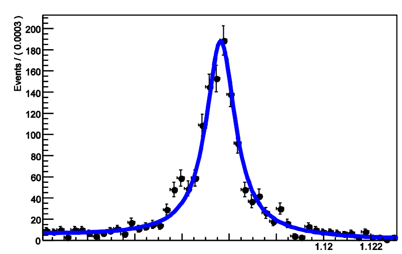
X axis projection



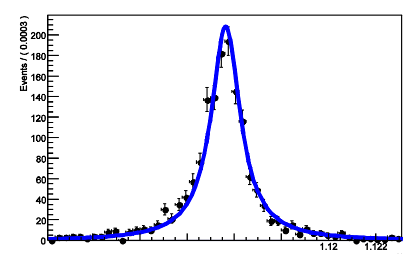
Y axis projection



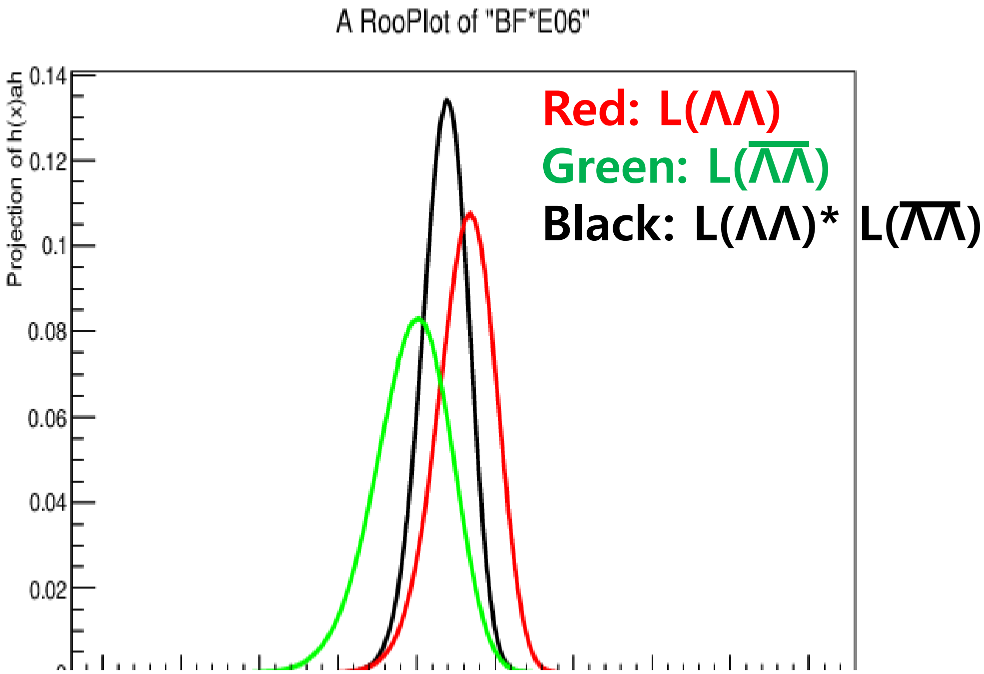
X axis projection



Y axis projection



Combine ΛΛ & $\overline{\Lambda\Lambda}$



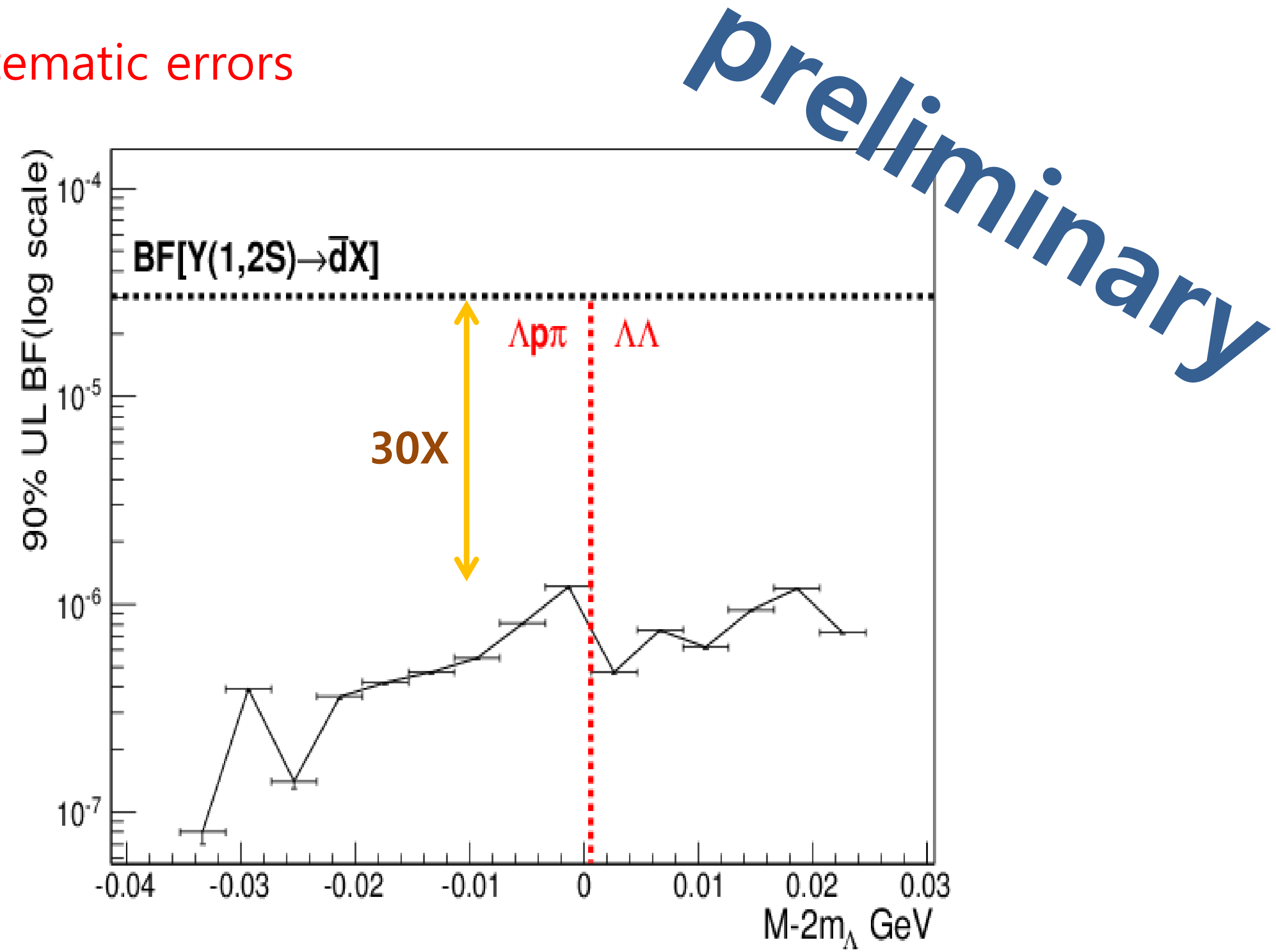
Fit with signal included: ΛΛ and $\overline{\Lambda\Lambda}$ channels are combined by multiplying likelihoods (including systematics

(90% from BF[Y(nS)→HX] =0)

$$\int_0^{UL} L_{sys} \cdot \overline{L_{sys}} dbf = 0.9 \rightarrow B(Y(1,2S) \rightarrow HX) \cdot B(H \rightarrow f) \leq UL$$

90%UL BF for H-dibaryon

UL with systematic errors



Result

- Y(nS) decay well suited for production of state with multiple s-quark.
- No evidence for

  $H \rightarrow \Lambda p \pi^-$ $(m < 2m_\Lambda)$

  $H \rightarrow \Lambda\Lambda$ $(m < 2m_\Lambda)$

- $BF[(Y(nS) \rightarrow HX)*(H \rightarrow \Lambda p \pi)] \leq BF[Y(nS) \rightarrow DX]$

$\therefore$factor $\leq$ 1/30

- PRL in process

Thank you!